EPSON

EPSON RC+ 7.0 Ver.7.0

User's Guide

Project Management and Development

Rev.4 EM136S2535F

EPSON RC+ 7.0 (Ver.7.0)

User's Guide

Rev.4

FOREWORD

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

WARRANTY

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

Product malfunctions resulting from normal handling or operation will be repaired free of charge during the normal warranty period. (Please ask your Regional Sales Office for warranty period information.)

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

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

Warnings, Cautions, Usage:

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

TRADEMARKS

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TRADEMARK NOTATION IN THIS MANUAL

Microsoft® Windows® XP Operating system
Microsoft® Windows® Vista Operating system
Microsoft® Windows® 7 Operating system
Throughout this manual, Windows XP, Windows Vista, and Windows 7 refer to above respective operating systems. In some cases, Windows refers generically to Windows XP, Windows Vista, and Windows 7.

NOTICE

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

INQUIRIES

Contact the following service center for robot repairs, inspections or adjustments.
If service center information is not indicated below, please contact the supplier office for your region.

Please prepare the following items before you contact us.

-Your controller model and its serial number
-Your manipulator model and its serial number
-Software and its version in your robot system
-A description of the problem

SERVICE CENTER

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1. Introduction

1.1 Welcome to EPSON RC+ 7.0

Welcome to the EPSON RC+ 7.0 Project Management and Development Environment. EPSON RC+ 7.0 is used to develop application software for the Robot Controller.

EPSON RC+ 7.0 features

- Operable on Microsoft Windows XP, Windows Vista and Windows 7
- Integrated application development environment
- Communicates with the Controller by USB or Ethernet
- Allows you to connect one computer with multiple Controllers
- Multi simultaneous session
- SPEL+ programming language
  A powerful, easy to use BASIC-like programming language that supports multi-tasking, robot motion control, I/O control, and networking.
- I/O systems including Digital I/O boards and Fieldbus I/O
- TCP/IP and RS-232 communications
- Background task
  Controls entire system
- Database access
- Vision Guide option
  Integrated vision robot guidance
- RC+ API option
  Enables you to control the system using standard Microsoft .NET programming environments including Microsoft Visual Basic and Microsoft Visual C++.
- Security option
  Allows you to administrate all EPSON RC+ users on your system. It also includes usage auditing, so you can track how many hours are spent using the system, and if changes were made.
- Conveyor Tracking option
  Enables one or more robots to pick parts from moving conveyors using vision or sensors.
- PG Motion System option
  Allows you to use third party motors and drivers to control auxiliary equipment such as XY tables, slides, etc.
- ECP option
  Supports CP motion relative to a fixed point.
- GUI Builder option
  Integrated GUI development tool
- Force Sensing option
  Allows a robot to use torque/force sensing and measurement

1.2 System Overview

EPSON RC+ 7.0 software, which is installed to the computer connected to the robot controller, contains several components that enable you to control an entire robotic work cell. EPSON RC+ 7.0 communicates with the controller using USB or Ethernet.

EPSON RC+ 7.0 and the Controller can be used in following environments:

Slave system	The Controller is PLC or PC cell slave. Application is developed with EPSON RC+ 7.0. After saving the object code to the Controller, it does not need to be connected to the computer. The Controller is controlled by I/O or fieldbus.
Standalone system	Controls the robot and peripheral equipment as the robot controller. EPSON RC+ 7.0 displays the simple operator window in AUTO mode. By using RC+ API option, .NET application can be controlled.
Offline development system	Program edition and project build can be checked on the offline PC.
Simulation system	EPSON RC+ 7.0 on the PC which is connected to the Controller can execute the program without the actual I/O or robot by using the virtual I/O and dry run.

1.2.1 Controller

RC700

The RC700 Controller is a powerful robotic work cell controller that controls our SCARA robots and 6-axis robots.

Controller features

- Sophisticated yet achieving reliability and stability
- Built in Motion System
  The motion drive system can control up to 6 axes simultaneously and 1 robot, and can add drive units (to be added)
- Includes standard I/O
- Wide variety of options

For detailed information on the Controller, refer to the controller manual.

RC90

The RC90 Controller with the following label attached can be used in combination with EPSON RC+ 7.0.

EPSON RC+ 7.0	RC90 Controller firmware
	Ver.7.0.2.0
Before Ver.7.0.1	!!!
Ver.7.0.2 or later	OK

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

!!!: Compatible Connection is OK. We recommend using EPSON RC+7.0 Ver. 7.0.2 or later.

NOTE

This option is not available for Robot Controller RC90 (EPSON RC+ 5.0) without the label.

NOTE

Manual PDF for this robot system is available from EPSON RC+ 7.0 Ver. 7.0.2

The RC90 Controller is a robot controller that can drive LS series manipulators.

Features:

- Built in motion drive system. The motion drive system can control one robot.
- Standard I/O
- Optional digital I/O expansion boards
- Optional Fieldbus slave support for DeviceNet, PROFIBUS-DP, CC-Link Ethernet/IP, and PROFINET.
- RS232 ports (standard + optional)

For details on the Controller, refer to the RC90 controller manual.

1.2.2 Software

EPSON RC+ 7.0 needs to be installed to your development PC. To communicate with the Controller, the computer should support USB 1.1 / 2.0 or Ethernet communication.

You can purchase options with the product or add them later.

Using EPSON RC+ 7.0, you can develop application software for the SPEL+ language that runs in the RC700 controller.

1.2.3 Simulator

Simulator functions enable easy robot motion check on your PC, which gives you flexibility to consider the system layout, measure the operation time, and create the robot programs.

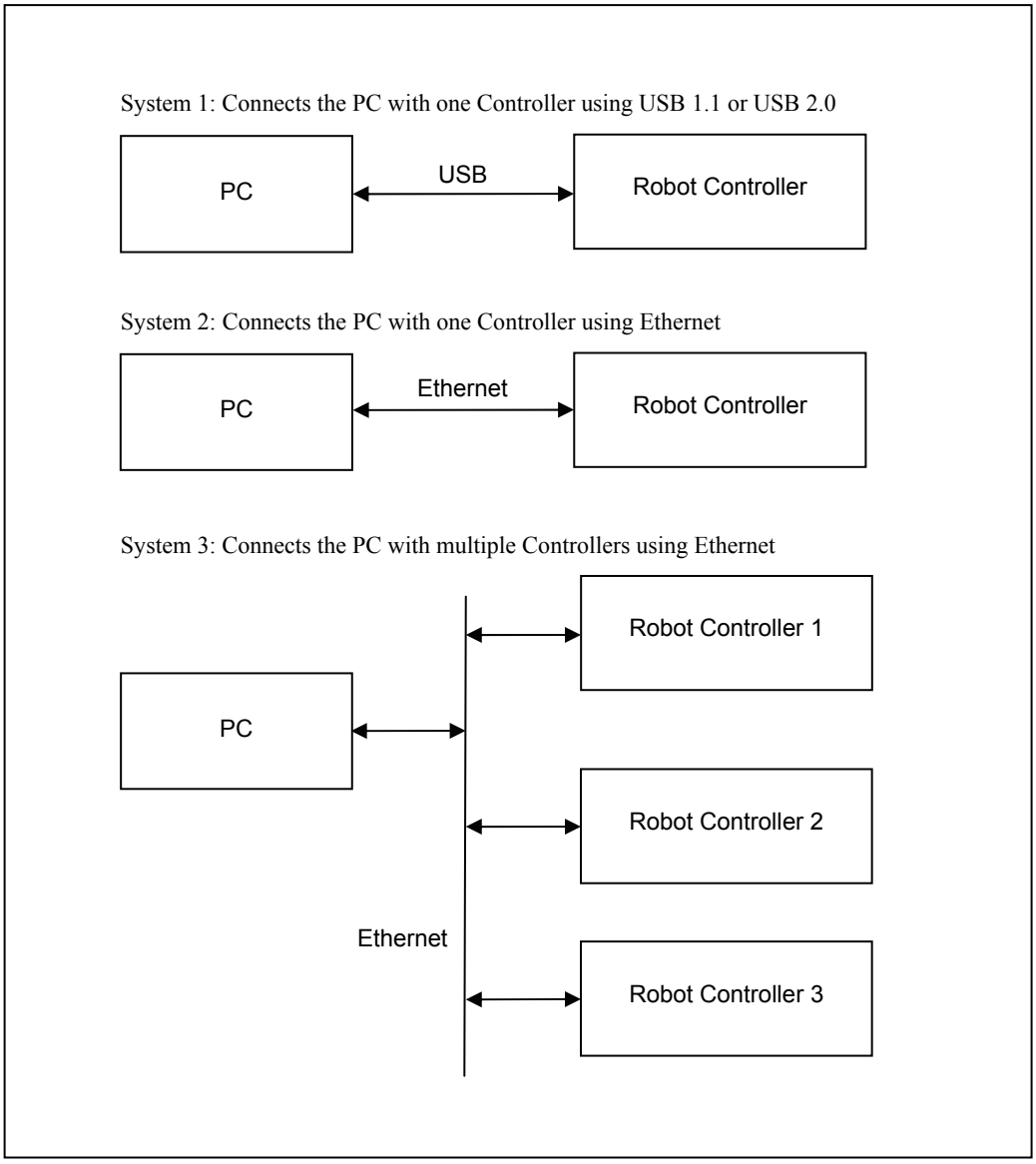
They are useful in all the way from introduction stage of robot automation to launch of robot system.

Simulator is supported by EPSON RC+ 7.0 Ver.7.0.0 or later as standard.

For details, refer to *8. Simulator*.

1.2.4 System Block Diagram

The following system block diagram shows methods for connecting a PC running EPSON RC+ 7.0 to one or more controllers.



1.3 Options

EPSON RC+ 7.0 enables the purchased Controller options.

Refer to *21. Installing Controller Options* for details.

1.4 Precautions When Using Windows 7

Connecting development PC to Robot Controller using Ethernet

The robot controller does not support internet protocol version 6 (TCP/IPv6). When connecting the development PC to the robot controller using the Ethernet, be sure to use the internet protocol version 4 (TCP/IPv4).

1.5 EPSON RC+ 5.x and 6.x Users

EPSON RC+ 7.0 is compatible with EPSON RC+ 5.x and 6.x for the operation and language.

For EPSON RC+ 7.0, you can use all commands of EPSON RC+ 5.x and 6.x.

You can use the current numbers for the I/O and communication port.

To enable the EPSON RC+ 5.x and 6.x project in EPSON RC+ 7.0 environment, convert the project using [Project] menu-[Import].

With above conversion, the entire project will be copied by EPSON RC+ 7.0.

\EPSONRC50\Project directory → \EpsonRC70\Project directory

\EPSONRC60\Project directory → \EpsonRC70\Project directory

1.6 EPSON RC+ 3.x and 4.x Users

EPSON RC+ 7.0 is compatible with EPSON RC+ 3.x and 4.x for the operation.

For EPSON RC+ 7.0, there are new commands added to SPEL$^+$ language. Though there are also some commands deleted or amended, most commands are available.

To enable the project of EPSON RC+ 3.x or 4.x in EPSON RC+ 7.0 environment, convert the project using [Project] menu-[Import].

With above conversion, the entire project will be copied by EPSON RC+ 7.0.

\EPSONRC\Project directory → \EpsonRC70\Project directory

Refer to *Appendix A: Automatic Processing of Project Import* for the details.

1.7 SPEL for Windows Users

EPSON RC+ 7.0 is compatible with SPEL for Windows 1.x and 2.x for the operation.

For EPSON RC+ 7.0, there are many new commands added to SPEL$^+$ language, which replaces SPEL. Also there are some commands deleted or amended.

To enable the project of SPEL for Windows 2.x in EPSON RC+ 7.0 environment, convert the project using [Project] menu-[Import].

With above conversion, the file will be copied to a new directory or the program will optionally be converted by EPSON RC+ 7.0.

Refer to *Appendix A: Automatic Processing of Project Import* for the details.

1.8 Documentation

All documentation is installed on the PC in PDF format.

To view manuals on the PC:

- Select [Manuals] from the [Help] menu in EPSON RC+ 7.0
- From Windows desktop, click <Start>-[Programs]-[EPSON RC+ 7.0]

Available manuals are shown in the table below.

Title	Contents
EPSON RC+ 7.0 Users Guide	Information for the entire system
SPEL+ Language Reference	Information for the SPEL+ Language
Vision Guide 7.0	Information for options
Vision Guide 7.0 reference	
RC+ API 7.0	
GUI Builder 7.0	
Fieldbus IO	
PG Motion System	
TP1	
TP2	
Remote Control Reference	Information for Remote I/O control extended function
Manipulator manual	Information for the purchased robot Each series has its own manual
Controller manual	Information for the purchased robot
Safety & Installation	Information for installing the robot system safely Paper manual will come with the product

NOTE ☞	The “NOTE” sections describe important information to be followed for operating the Robot system.
TIP ☞	The "TIP" sections describe hints for easier or alternative operations.

2. Safety

2.1 Overview

This chapter describes the important safety requirements for robotic systems using EPSON RC+ 7.0 and the Controller.

Installation of robots and robotic equipment should only be performed by qualified personnel in accordance with national and local codes. Please read and understand this entire chapter before using your EPSON RC+ 7.0 system.

Safety is the most important consideration when designing and operating any robotic system.

In this manual, important matters are shown with the symbols below.

Each symbol has following meanings.

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

2.2 Definitions

2.2.1 Robot Power

The status of robot power is explained below in terms of restriction to operation:

Operation-prohibited status: Robot cannot be operated.

Restricted (low power) status: Robot can operate at low speed and low torque.

Unrestricted (high power) status: Robot can operate without restriction.

The robot will not operate regardless of the control actions taken by the operator when in the operation-prohibited state. During operation, when the safeguard circuit opens, the system will switch to operation-prohibited state.

The robot will operate at low speed and torque in the restricted state (low power). In the unrestricted state (high power), the robot will operate at the programmed speed and torque.

In the event that the robot should make an unexpected movement, the restricted state (low power) decreases operating speed allowing the operator to avoid danger. The torque is also decreased to minimize serious injury to the operator should one be struck by the robot. The maximum values of the decreased speed and torque are set according to the robot used and cannot be changed by the user.

As a safety precaution the initial power state of the robot will be set to either the restricted (low power) state or the operation-prohibited state. The system will not change to the unrestricted (high power) state if the appropriate procedures are not followed.

When the system is in restricted (low power) state or operation-prohibited state, a single failure will not cause a runaway action that surpasses the assigned speed or torque decrease. This is due to the multi-protect circuit and mutual monitoring circuit in the control system.

2.2.2 Safeguard

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

WARNING	■ The EMERGENCY connector on the controller has a safeguard input circuit to connect the safety device interlock switch. To protect operators working near the robot, be sure to connect the interlock switch and make sure that it works properly.

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

Safeguard closed: The safeguard input is turned ON. The robot can automatically operate in unrestricted (high power) state.

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

For further details on the safeguard and interlock, refer to *2.4 Installation and Design Precautions* later in this chapter. For detailed wiring instructions, refer to the *Robot Controller manual, Setup & Operation: 8. EMERGENCY.*

2.2.3 Operation Modes

The operation mode is defined as the single control point for the controller, therefore you cannot use more than one operation mode at the same time.

There are four operation modes for the controller: AUTO, PROGRAM, TEACH, and TEST.

- AUTO operation modes allow you to execute programs in the controller when the safeguard is closed.
- PROGRAM operation mode allows you to execute and debug programs when the safeguard is closed.
- TEACH operation mode allows you to jog and teach the robot at slow speed while inside the safeguarded area.
- TEST operation mode allows you to execute a program at slow speed while the safeguard is opened.

2.2.4 Start Mode

The Start mode specifies the operation mode for EPSON RC+ 7.0 when it starts.

You can set the EPSON RC+ 7.0 to start in AUTO or PROGRAM mode.

For information on how to change the start mode, refer to *4. Operation*.

2.2.5 Changing Operation Mode

You can change from AUTO operation mode or PROGRAM operation mode to TEACH mode by setting the mode selector key switch on the Teach Pendant to the TEACH position.

When the mode selector key switch is changed back to AUTO, the operation mode is returned to previous operation mode (AUTO or PROGRAM).

The AUTO operation mode can be changed to PROGRAM mode during the EPSON RC+ 7.0 startup sequence. A password can be used to allow only certain personnel to change the startup operation mode.

When EPSON RC+ 7.0 starts in AUTO operation mode, the AUTO operation mode cannot be changed to PROGRAM operation mode after the system has started. To change the operation mode, restart the system and log into PROGRAM mode, then set the start mode again and restart EPSON RC+ 7.0.

For more information, refer to *4. Operation*.

To change to TEST operation mode, switch the mode selector on the Teach Pendant to TEACH, and then select Function key F1: Test Mode.

For more information, refer to *Robot Controller option Teach Pendant TP1 maunal, 4. Operation Mode (TEACH/AUTO/TEST)*.

2.2.6 Emergency Stop

The controller is equipped with an emergency stop input terminal. If the normally closed emergency stop circuit is broken, the power supplied to all motors will be shut off (and enter servo-free status) and the robot will be stopped by dynamic braking.

CAUTION	■ The path that the robot will follow from the time the emergency stop switch is pressed until the device stops, as well as the stop position itself, cannot be positively determined. In many cases, the stop position will not exceed the target position for the operation prior the emergency stop. Depending on the robot's loading condition and operation speed, overruns are inevitable. Taking this into consideration, be sure the layout for the peripheral equipment includes extra space.

For detailed wiring instructions, refer to the *Robot Controller manual, Setup & Operation: 8. EMERGENCY*.

2.2.7 Teach Control Device

Operators can use the TP1 teach pendant to operate the robot in the TEACH or TEST operation mode.

Refer to the *Robot Controller option Teach Pendant TP1 manual* for operation instructions.

2.3 Safety-related Requirements

Specific tolerances and operating conditions for safety are contained in the manuals for the robot, controller and other devices. Be sure to read those manuals as well.

For the installation and operation of the robot system, be sure to comply with the applicable local and national regulations.

Robot systems safety standards and other examples are given in this chapter. Therefore, to ensure that safety measures are complete, please refer to the other standards listed as well.

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

ENISO10218-1	Robots for industrial environments -Safety requirements-Part 1: Robot
ENISO 12100-1	Safety of machinery - Basic concepts, general principles for design - Part 1: Basic terminology, methodology
ENISO 12100-2	Safety of machinery - Basic concepts, general principles for design - Part 2: Technical principles
ENISO 13849-1	Safety of machinery – Safety – related parts of control systems – Part 1: General principles for design
EN 60204-1	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
EN55011	Industrial, scientific and medical (ISM) radio-frequency equipment - Electromagnetic disturbance characteristics - Limits and methods of measurement
EN61000-6-2	Electromagnetic compatibility (EMC) -- Part 6-2: Generic standards - Immunity for industrial environments
ANSI/RIA R15.06	American National Standard for Industrial Robots and Robot Systems – Safety Requirements

UL specification

Compatibility assessment of the UL-compliant model is performed according to the following standards.

UL1740 (Third Edition, Dated December 7, 2007)

ANSI/RIA R15.06-1999

NFPA 79 (2007 Edition)

CSA/CAN Z434-03 (February 2003)

CE Marking – Machinery Directive, Low Voltage Directive, EMC Directive

2.4 Installation and Design Precautions

2.4.1 Designing a Safe Robot System

It is important to operate robots safely. It is also important for robot users to give careful consideration to the safety of the overall robot system design.

This section summarizes the minimum conditions that should be observed when using EPSON robots in your robot systems.

Please design and manufacture robot systems in accordance with the principles described in this and the following sections.

Environmental Conditions
Carefully observe the conditions for installing robots and robot systems that are listed in the "Environmental Conditions" tables included in the manuals for all equipment used in the system.

System Layout
When designing the layout for a robot system, carefully consider the possibility of error between robots and peripheral equipment. Emergency stops require particular attention, since a robot will stop after following a path that is different from its normal movement path. The layout design should provide enough margins for safety. Refer to the manuals for each robot, and ensure that the layout secures ample space for maintenance and inspection work.

When designing a robot system to restrict the area of motion of the robots, do so in accordance with the methods described in each manipulator manual. Utilize both software and mechanical stops as measures to restrict motion.

Install the emergency stop switch at a location near the operation unit for the robot system where the operator can easily press and hold it in an emergency.

Do not install the controller at a location where water or other liquids can leak inside the controller. In addition, never use liquids to clean the controller.

Disabling Power to the System using lock out / tag out
The power connection for the robot controller should be such that it can be locked and tagged in the off position to prevent anyone from turning on power while someone else is in the safeguarded area. For further details, refer to the section *Procedure of Lockout/Tagout* in the chapter *Safety Precautions* in the controller manual.

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

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

Design the size of the end effector with care, since the robot body and robot end effector can interfere with each other.

Peripheral Equipment Design

When designing equipment that removes and supplies parts and materials to the robot system, ensure that the design provides the operator with sufficient safety. If there is a need to remove and supply materials without stopping the robot, install a shuttle device or take other measures to ensure that the operator does not need to enter a potentially dangerous zone.

Ensure that an interruption to the power supply (power shutoff) of peripheral equipment does not lead to a dangerous situation. Take measures that not only prevent a work piece held from being released as mentioned in "End effector Design" but that also ensure peripheral equipment other than the robots can stop safely. Verify equipment safety to ensure that, when the power shuts off, the area is safe.

Remote Control

To prevent operation by remote control from being dangerous, start signals from the remote controller are allowed only when the control device is set to REMOTE, TEACH mode is OFF, and the system is configured to accept remote signals. Also when remote is valid, motion command execution and I/O output are available only from remote. For the safety of the overall system, however, safety measures are needed to eliminate the risks associated with the start-up and shutdown of peripheral equipment by remote control.

Emergency Stop

Each robot system needs equipment that will allow the operator to immediately stop the system's operation. Install an emergency stop device that utilizes emergency stop input from the controller and all other equipment.

During an emergency stop, the power that is supplied to the motor driving the robot is shut off, and the robot is stopped by dynamic braking.

The emergency stop circuit should also remove power from all external components that must be turned off during an emergency. Do not assume that the robot controller will turn off all outputs if configured to. For example, if an I/O card is faulty, the controller cannot turn off a component connected to an output. The emergency stop on the controller is hardwired to remove motor power from the robot, but not external power supplies.

Do not press the Emergency Stop switch unnecessarily while the Robot is operating. Pressing the switch during the operation makes the brakes work. This will shorten the life of the brakes due to the worn friction plates.

Normal brake life cycle: About 2 years (when the brakes are used 100 times/day or 1000 times of emergency stops for H8)

Do not turn OFF the Controller while the Manipulator is operating.
If you attempt to stop the Manipulator in emergency situations such as "Safeguard Open", make sure to stop the Manipulator using the Emergency Stop switch of the Controller.

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

Reduction of the life and damage of the reduction gear unit
Position gap at the joints

In addition, if the Controller was forced to be turned OFF by blackouts and the like while the Manipulator is operating, make sure to check the following points after power restoration.

Whether or not the reduction gear is damaged
Whether or not the joints are in their proper positions

If there is a position gap, perform calibration by referring to the Maintenance: Calibration in the Manipulator manual.

Following manuals contain information on the Emergency Stop.
Robot System Safety and Installation (RC700 / EPSON RC+7.0) Manipulator manual
Please also read the descriptions in the manuals and use the robot system properly.

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

- The Emergency Stop (E-STOP) switch should be used to stop the Robot only in case of emergencies.
- To stop the Robot operating the program except in emergency, use Pause (halt) or STOP (program stop) commands, or release the Safeguard system. Pause and STOP commands do not turn OFF the motors. Therefore, the brake does not function. Releasing the Safeguard system stops the Robot with a quick pause, and makes the brakes work. Pushing the Emergency Stop switch (E-STOP) turns OFF the motors and makes the brakes work. The brakes lock while the Robot is operating.
- For the Safeguard system, do not use the circuit for E-STOP.

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

Safety and Installation *2.6 Connection to EMERGENCY Connector*

To check brake problems, refer to the following manuals.

Manipulator Manual Maintenance *2.2.2 Inspection While the Power is ON (Robot is operating)*

Safety and Installation *5.2 Inspection Point - Inspection While the Power is ON (Robot is operating)*

Safeguard System

To ensure safety, a safeguard system should be installed for the robot system.

When installing the safeguard system, strictly observe the following points:

Refer to each manipulator manual, and install the safeguard system outside the maximum space. Carefully consider the size of the end effector and the work pieces to be held so that there will be no error between the moving parts and the safeguard system.

Manufacture the safeguard system to withstand calculated external forces (forces that will be added during operation and forces from the surrounding environment).

When designing the safeguard system, make sure that it is free of sharp corners and projections, and that the safeguard system itself is not a hazard.

Make sure that the safeguard system can only be removed by using a tool.

There are several types of safeguard devices, including safety doors, safety barriers, light curtains, safety gates, and safety floor mats. Install the interlocking function in the safeguard device. The safeguard interlock must be installed so that the safeguard interlock is forced to work in case of a device failure or other unexpected accident. For example, when using a door with a switch as the interlock, do not rely on the switch's own spring force to open the contact. The contact mechanism must open immediately in case of an accident.

Connect the interlock switch to the safeguard input of the drive unit's EMERGENCY connector. The safeguard input informs the robot controller that an operator may be inside the safeguard area. When the safeguard input is activated, the robot stops immediately and enters pause status, as well as either operation-prohibited status or restricted status (low power status).

Make sure not to enter the safeguarded area except through the point where the safeguard interlock is installed.

The safeguard interlock must be installed so that it can maintain a safe condition until the interlock is released on purpose once it initiates. The latch-release input is provided for the EMERGENCY connector on the Controller to release the latch condition of the safeguard interlock. The latch release switch of the safeguard interlock must be installed outside of the safeguarded area and wired to the latch-release input.

It is dangerous to allow someone else to release the safeguard interlock by mistake while the operator is working inside the safeguarded area. To protect the operator working inside the safeguarded area, take measures to lock out and tag out the latch-release switch.

Presence Sensing Device

The above mentioned safeguard interlock is a type of presence sensing device, since it indicates the possibility of somebody being inside the safeguard system. When separately installing a presence sensing device, however, perform a satisfactory risk assessment and pay thorough attention to its dependability.

Here are precautions that should be noted:

- Design the system so that when the presence sensing device is not activated or a dangerous situation still exists that no personnel can go inside the safeguard area or place their hands inside it.
- Design the presence sensing device so that regardless of the situation the system operates safely.
- If the robot stops operating when the presence sensing device is activated, it is necessary to ensure that it does not start again until the detected object has been removed. Make sure that the robot cannot automatically restart.

Resetting the Safeguard

Ensure that the robot system can only be restarted through careful operation from outside the safeguarded system. The robot will never restart simply by resetting the safeguard interlock switch. Apply this concept to the interlock gates and presence sensing devices for the entire system.

Robot Operation Panel

The robot operation panel must not be located inside of the robot work envelope / workcell. Ensure that the robot system can be operated from outside of the safeguard.

2.4.2 Robot System Installation, Start-up, and Testing

Installation

When installing the robot and robot system, follow the instructions contained in each of the robot and robot controller manuals.

Start-up and Functional Testing

If the safeguard system is not ready at the time of start-up and functional testing, specify an area to install the safeguard system (as a temporary measure) and then begin.

During start-up and functional testing, do not allow workers inside the safeguarded area until the safeguard function is activated.

Before start-up and functional testing, carefully read the related manuals and obtain a good understanding of safety-related precautions.

Before supplying the robot and robot system with power for the first time, verify the items listed below.

Items to check before supplying with power

- Prescribed bolts are securely tightened to the robot.
- Electrical connections are set up correctly, and power supply conditions (including voltage, frequency, and error level) are within the specified range.
- Compressed air source (if applicable) is properly connected.
- Peripheral devices are properly connected.
- Safety device is equipped with an interlock switch, and it functions properly.
- Operating environment conditions conform to the conditions specified in the robot and controller manuals.

Items to check after supplying with power

- Start/stop, mode selection, and other functions work properly.
- Moving axes operate normally, and that the area of motion is limited as stipulated in the specifications.
- Emergency stop circuit functions correctly.
- Power supply can be shut off.
- Teach operation mode is functioning properly.
- Safety device and interlock switch function correctly.
- Other safeguards (if applicable) are installed correctly in their prescribed locations.
- Robot operates accurately in restricted status (low power status).
- Robot operates properly under rated loads and at maximum speed.

Restarting after a Change

When restarting the robot system after its hardware or software has been corrected or serviced, strictly observe the following:

- Before supplying the system with power, check the locations where the hardware was modified.
- Test the functions of the robot system to make sure that it operates correctly.

2.5 Precautions regarding Robot Operation

2.5.1 General Precautions

Before operation, become familiar with the location of all emergency stop switches.

During an emergency, always press the nearest emergency stop switch. There should never be any emergency stop switches in the system that do not operate.

After an emergency, do not restore the emergency stop circuit until it has been determined that the entire system is safe to restart.

If your robot is a 6-axis type, record the pulse values of the reference points used for the calibration. For details, refer to the *6-axis Manipulator manual, Setup & Operation: 3.6 Setting the Reference Points for Calibration*.

2.5.2 Automatic Operation

Ensure that system automatic operation is enabled only while the following requirements are being met:

- Emergency stop switches are installed in the prescribed location and operate correctly.
- No personnel are inside the safeguarded area of the system.
- Safety procedures that are established separately for the robot system (if applicable) are being followed.

2.5.3 Teaching Robot Points

If possible, teaching should be performed with no personnel inside the safeguarded area.

Teach mode can be used to allow the robot to be jogged or moved at slow speed when the safeguard is open. Before going inside the safeguarded area, robot operators that need to move the robot under servo control must switch Teach mode to ON by using the mode selector key switch of the teach pendant. Operators then carry the teach pendant while inside the safeguarded area. As a result, the operation mode cannot be changed from outside the safeguarded system while somebody is inside the safeguarded area.

Auto Mode and Program Mode

With the safeguard circuit open, the robot motors will be turned off and the robot cannot be jogged under power. However, the robot can be moved by hand to a position with the safeguard circuit open and the position can then be taught.

Teach Mode

The robot can be jogged or moved at slow speed as long as the three position enable (dead man) switch is engaged.

Please observe the following guidelines for teaching points:

- Robot operators must receive training that utilizes the same type of robot. Before teaching, the operator should be thoroughly familiar with teaching procedures.
- Before teaching, remove all errors and malfunctions.
- Before the robot operator goes inside the safeguard system, confirm that the robot motors go off when the safeguard is open and that emergency stop switches are functioning correctly.
- The robot operator should visually check the robot system and safeguard system interior to ensure that there are no potential hazards.
- Design the system in such a way that prevents the overall robot system from being started up from any location while the operator is inside the safeguarded area.

- If there is a possibility of a dangerous situation arising from the operation of a device other than the robot, such as an actuator, take steps to prevent such operation or ensure that these devices can only be controlled by the teaching operator.

2.5.4 Return to Automatic Operation

If there are safety devices that have been temporarily disabled for system inspection or other reasons, always return them to their original status before restarting automatic operation.

2.5.5 Program Verification

If it is necessary to verify a program on the EPSON RC+ 7.0 while the system is in unrestricted (high power) status, first make sure that no personnel are inside the safeguarded area.

If it is necessary to verify a program on Teach Pendant TP1 (TEST operation mode), follow the rules below.

- An operator must receive training about the robot of the same type. Program verification should be done after the operator has a thorough knowledge about the operation procedure of TEST operation mode.
- Remove all obstacles and failures before the program verification.
- An operator should check that the Motor is turned OFF when the safeguard is opened, and check if the Emergency Stop switch functions properly before entering inside the safeguard.
- An operator should check the possibility of risk by checking the robot system and inside of the safeguard visually.
- If someone is inside the safeguard, do not allow the whole robot system to be controlled to start operation from outside.
- If there is a possibility that operation of equipment other than the robot, such as an actuator, may cause danger, do not allow the operation of equipment, or allow only the program verifier to control the equipment.

2.5.6 Troubleshooting

Troubleshoot from outside the safeguard system. If that is not possible, strictly observe the requirements below.

- Operators responsible for troubleshooting should be trained and qualified to perform such work.
- Establish work safety procedures to minimize the danger that operators inside the safeguard system will be exposed to.

2.5.7 Maintenance

In order to keep the robot and robot system operating safely, maintenance (and inspection) is important. Adequately trained personnel should perform the procedures required to do the maintenance work safely. Make sure that maintenance is performed according to the instructions in the robot and controller manuals (maintenance editions).

If maintenance is required inside the safeguarded area, take the following precautions:

- Shut off the power supply using lockout / tagout to prevent anyone from turning ON the robot power supply by mistake. For further details, refer to the section *Procedure of Lockout/Tagout* in the chapter *Safety Precautions* in the controller manual.
- If the robot system power supply cannot be shut off, strictly observe the following:
  (1) Visually inspect the robot system to ensure that there are no conditions that could lead to a malfunction.
  (2) If it is discovered that the robot system is damaged or malfunctioning, perform the required repairs and retest it before allowing the operator to go inside the safeguard system.
- Grant full control of the robot and robot system to those performing maintenance and/or repairs inside the safeguard system.
- Ensure that the robot system does not respond to any remote control devices.
- Ensure that all emergency stop devices are functioning correctly.
- Before starting the robot system in automatic operation, return all temporarily disabled safety devices to their original enabled status.
- Do not use tweezers or other metal tools to aid in battery replacement. This could cause a battery short. Replace a battery using only the specified type and be careful to observe the polarity of the battery.

2.5.8 Backup of Projects and Controller

After a project has been created or edited, or after system data including robot parameters has been edited, the project and controller files should be copied and stored in media other than the hard disk on the PC (e.g. USB memory key). Keep the backup media in a safe place in case of damaged data on the hard disk

To backup, select [Controller] from the EPSON RC+ 7.0 [Tools] menu and execute Backup Controller. Refer to the section *5.11.8 EPSON RC+ 7.0 GUI - Controller Command (Tools Menu)*.
Backup Controller is a function to backup both the project and the controller.

To backup only the project data, select [Copy] from the [Project] menu. Refer to the section *5.9.10 EPSON RC+ 7.0 GUI - Copy Command (Project Menu)*.

CAUTION	■ If your system cannot be restored by Restore Controller, you must restore robot calibration parameters (Hofs, CalPls) before operating the robot. If you fail to do so, the robot will move to incorrect positions.

2.6 End User Instruction Manual

Be sure that the robot system instruction manual supplies a list of all the equipment included in the system (such as the robots, associated equipment, and safety devices) as well as a description of how to use each.

Be sure to provide the following in the manual:

- An easy to follow explanation of the robot system and how to install it, as well as a step by step summary of the system installation and external power supply connections.
- A description of all hazards and how to avoid them.
- A description (including interconnection diagrams) of the safety devices, interacting functions, and safeguard's interlocking function against hazardous conditions, in particular, the safeguard's interlocking function for devices installed to perform interactively.
- Precise instructions regarding usage of the system.

2.7 End User Training

Be sure those in charge of safety management confirm that the operators who program, operate, and maintain the robot and robot system obtain proper training and have the expertise to conduct the work safely.

Training should include at least the following:

- Study of regulation safety procedures, and safety-related recommendations by robot manufacturers and system designers.
- Clear explanation of the work involved.
- Description of all control equipment required for the work and their functions.
- Explanation of potential hazards involved in the work.
- Work safety procedures and specific methods of avoiding potential hazards.
- Safety device and interlock function testing and confirmation methods are working properly.

3. Getting Started

This chapter contains instructions for setting up and using EPSON RC+ 7.0. It is recommended that first time users first read the preceding Safety chapter, then read through this chapter to get more familiar with the system.

Contents

- Hardware Installation
- Software Installation
- Windows Security Administration

3.1 Hardware Installation

EPSON RC+ 7.0 is used with the Controller. You need to install the controller and robot before you can use EPSON RC+ 7.0 to develop and run SPEL+ applications.

You need to prepare the PC which has Windows which can run the EPSON RC+7.0, and which can connect with the Controller using USB or Ethernet.

The Controller comes pre-configured at the factory. For instructions on installation, refer to the Robot Controller manual.

3.2 Software Installation

EPSON RC+ 7.0 should be installed to the PC with Windows. For details of adding the options, version upgrade, and re-installation, refer to *Appendix B: EPSON RC+ 7.0 Software*.

3.3 Windows Security Administration

Users need Administrator rights to use the EPSON RC+. Other users such as Power User, Limited User, Guest User cannot use EPSON RC+.

To provide security within the EPSON RC+ environment, a Security software option is available. This option allows you to manage EPSON RC+ users and audit development activity. Refer to *15. Security* for details.

4. Operation

This chapter contains instructions for operation of the EPSON RC+ 7.0 system. The main topics are:

- System Power Up Procedure
- Starting EPSON RC+ 7.0
- System Shutdown Procedure
- Writing your first program

4.1 System Power Up Procedure

Follow this procedure to power up the system:

1. Ensure that all safeguards are in place and that all personnel are clear of the equipment.
2. Apply power to the Controller, monitor, and I/O devices.
3. Start the EPSON RC+ 7.0 software on the PC, if the PC is used in the system.

4.2 Starting EPSON RC+ 7.0

There are three ways to start EPSON RC+ 7.0. You can also configure the mode that EPSON RC+ 7.0 starts in.

Start Method 1

1. Double click on the EPSON RC+ 7.0 robot icon located on the Windows desktop.

Start Method 2

1. Click the Windows <Start> button.
2. Select the EPSON RC+ 7.0 [Program] group.
3. Select [EPSON RC+ 7.0]-[EPSON RC+ 7.0].

Start Method 3

Configure EPSON RC+ 7.0 to start automatically after Windows starts.
For details, refer to *4.2.7 Auto Start*.

NOTE ☞ When using the RC+ API option, you do not need to start EPSON RC+ 7.0. The library provided with RC+ API will load EPSON RC+ 7.0 into your .NET application process automatically.

4.2.1 Startup Sequence

When EPSON RC+ 7.0 starts, it reads initial settings for the current user and local system from the Windows registry.

The startup sequence depends on the following two factors:

a. Control device

b. Independent mode

When start mode is other than Independent mode
(Any control device)

If there is no project file specified in the startup command line, the last-opened project will be opened.

If the start mode is Auto, the [Start Mode] dialog will be displayed (see *4.2.4 Start Mode Dialog*).

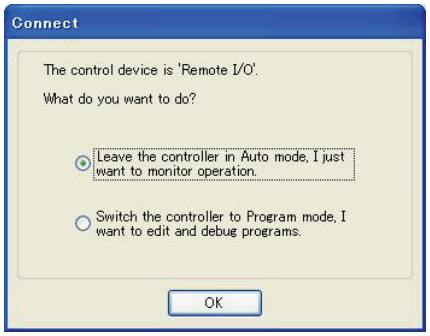
If the start mode is Program, the EPSON RC+ 7.0 GUI will be displayed.

When start mode is Independent mode
(Control device : Remote)

If there is no project file specified in the startup command line, the last-opened project will be opened as read only.

If tasks are currently running, EPSON RC+ 7.0 will prompt to enter Monitor Mode.

If no tasks are currently running, a dialog below will be displayed.



Cooperative mode and Independent mode

The Robot Controller consists of the following two parts.

Real Part : Controls the SPEL$^+$ program (Specialized for the real time control)

Windows Part : Controls the Windows applications (GUI)

The main function of the robot can be run by Real Part and some functions of the Controller uses the connected Windows Part (See below).

Function	RC+ Enabled	PC Enabled
Detail of available function	Vision Guide (Frame Grabber) RC+ API option Fieldbus master	PC file PC RS-232C Database access DLL calling

Real Part and connected Windows Part are started up separately at the each timing.
To operate the robot system without problem, you should synchronize these two parts. At the shipment of the Robot Controller, the **Independent mode** which these parts operate individually is applied.

NOTE

According to the design of robot system, it may not need to synchronize Real Part and connected Windows Part. In this case, change to **Cooperative mode**.
For the instructions of this settings, see the section below *How to set the Cooperative mode*.

When the controller is in Cooperative mode, it has to wait until both of Real Part and connected Windows Part can start up without failure.

Meanwhile, on the front surface of the controller displays as below:

RC700 Seven-segment LED	RC90 LED
Repeats and alternately.	Repeats E-STOP AUTO ERROR TEACH PROGRAM , E-STOP AUTO ERROR TEACH PROGRAM alternately.

Then, it also has to wait until connected Windows part is ready and RC+ 7.0 can start up without failure.

The table below shows the startup sequence when the controller is in Cooperative mode:

	RC700 Seven-segment LED	RC90 LED	Console instruction	Background task
(1) Power ON	No display	E-STOP AUTO ERROR TEACH PROGRAM Blinking	Not available	Not started yet
(2) Real Part starts up	Repeats and alternately.	Repeats E-STOP AUTO ERROR TEACH PROGRAM and E-STOP AUTO ERROR TEACH PROGRAM alternately.	Not available	Not started yet
(3) Windows part starts up	Repeats and alternately.	E-STOP AUTO ERROR TEACH PROGRAM and E-STOP AUTO ERROR TEACH PROGRAM alternately.	Not available	Not started yet
(4) RC+ starts up	Blinking	E-STOP AUTO ERROR TEACH PROGRAM Blinking	Available	Already started

(Includes the startup of the Operator Window and RC+ API application)

The table below shows the startup sequence when the controller is in Independent mode:

	RC700 Seven-segment LED	RC90 LED	Console instruction	Background task
(1) Power ON	No display	E-STOP AUTO ERROR TEACH PROGRAM Blinking	Not available	Not started yet
(2) Real Part starts up	Blinking	E-STOP AUTO ERROR TEACH PROGRAM Blinking	Available *1	Already started
(3) Windows part starts up	Blinking	E-STOP AUTO ERROR TEACH PROGRAM Blinking	Available *1	Running
(4) RC+ starts up	Blinking	E-STOP AUTO ERROR TEACH PROGRAM Blinking	Available	Running

*1 When the control device is “PC”:
It waits the command execution from the Operator Window or RC+ API application.
When the control device is other than “PC”:
(2) At Real Part starts up, Remote function becomes enable and starts operating.

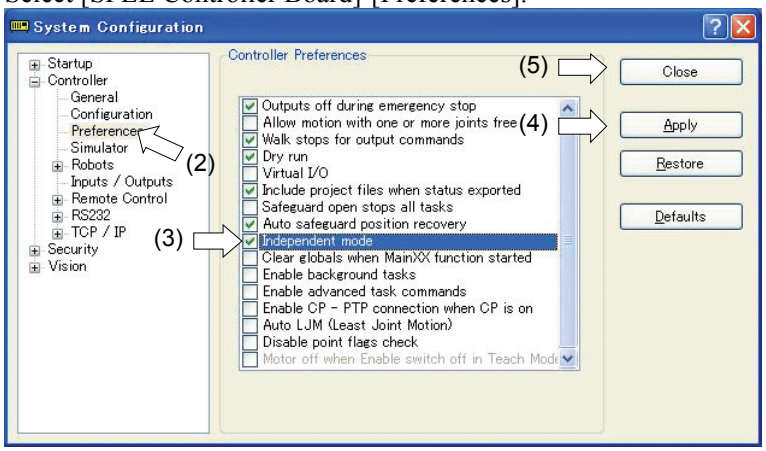
NOTE

When the controller is in Cooperative mode, the state does not back to wait for the RC+ connection even after RC+ shutdown. Also when the control device is other than “PC”, you need to be careful during the RC+ shutdown because the remote command is still executable.

How to set the Cooperative mode

(1) Select [Setup]-[System Configuration] from the main menu and displays the [System Configuration] dialog box as shown below.

(2) Select [SPEL Controller Board]-[Preferences].



(3) Uncheck the [Independent mode] checkbox.

(4) Click <Apply> button.

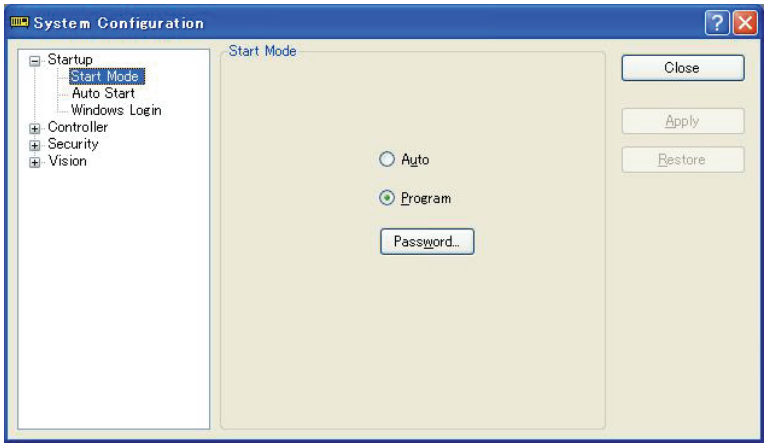
(5) Click the <Close> button.

4.2.2 Startup Configuration

To configure startup, select [System Configuration] from the [Setup] menu. The [Startup] section has pages for Start Mode, Auto Start, and Windows Login.

4.2.3 Start Mode

This page has settings for the EPSON RC+ 7.0 start mode.



There are two start modes:

Auto This mode starts the system and displays the Operator Window.

Program This mode allows you to develop your projects. This is the default startup mode.

Use the <Password> button to change the start mode password.

4.2.4 Start Mode Dialog

When the start mode is set for Auto, then a dialog is displayed at start up that allows you to change the startup mode using a password. After a few seconds, if the <Change To Program Mode> button has not been clicked, the system will initialize and the Operator Window will be displayed.

You can disable this startup dialog using command line options described later in this section, *4.2.10 Command Line Options*.

If you click the <Change To Program Mode> button, another dialog will be displayed, as shown below:

To change to Program mode, you must supply the password and click <OK>, or you can abort startup all together by clicking <Cancel>.

This allows authorized personnel to enter Program mode temporarily to make changes or adjustments.

NOTE

When you change to PROGRAM mode from this dialog, it is only temporary. The next time EPSON RC+ 7.0 runs, the original start mode setting will be used.

4.2.5 Start Mode: Program

Program mode is the default start mode. This is the EPSON RC+ 7.0 development environment, from which you can:

- Create / edit projects.

- Configure the controller and set preferences.

- Run and debug programs.

4.2.6 Start Mode: Auto

Auto mode displays the Operator Window. The Operator Window is configured according to the settings in [Project]-[Properties].

The Auto mode is set by the control device as follows:

Control Device	Description
PC	The Operator Window can be used as a simple operator interface for production.
Remote I/O Remote Ethernet Remote RS232	The Operator window is displayed with no operator buttons to allow any diagnostic messages to be viewed.

4.2.7 Auto Start

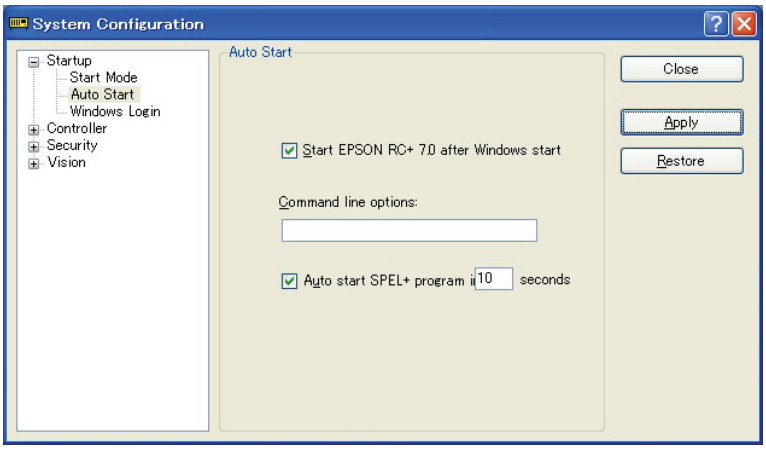
You can configure EPSON RC+ 7.0 to automatically start when Windows starts.

From [Setup]-[System Configuration]-[Auto Start] page, set the [Start EPSON RC+ 7.0 after Windows start] check box.

In addition, if you set the checkbox above, you can specify EPSON RC+ 7.0 command line options (/auto, /nosplash, etc.) in the [Command line options] text box. Refer to the section *4.2.10 Command Line Options*.

When the startup mode is Auto, a main function of the SPEL+ program can be started automatically. Check the [Auto start SPEL+ program in ## seconds] check box. Time from the RC+7.0 startup until a main function starts can be specified in the textbox on the right. In the example below, a main function starts 10 seconds after the RC+ 7.0 run. Startup of the main function can be aborted if it is within the specified time.

NOTE ☞ When using auto start, ensure that your application can automatically start safely and inform operators how to abort the startup.



4.2.8 Using Monitor Mode

Monitor Mode allows you to monitor operation of the controller. In Monitor Mode, you can do the following:

- View print output on the Run window
- Monitor I/O status using the I/O Monitor.
- Monitor task status using the Task Manager.
- Monitor variable values using Display Variables.

To enter the monitor mode, follow the steps below.

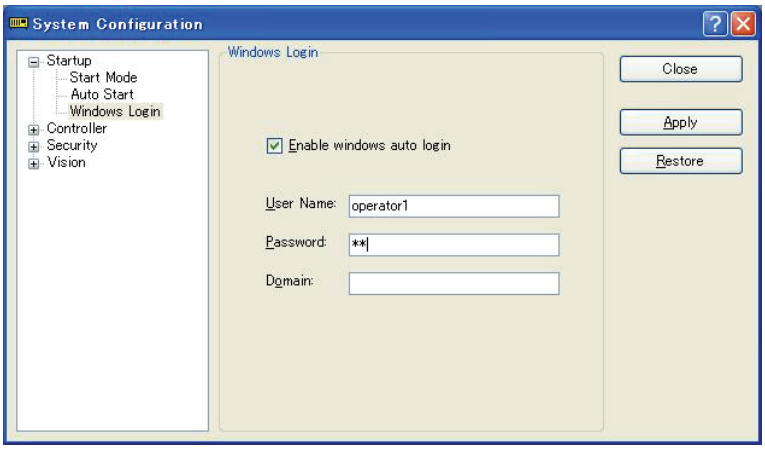
When control device is remote and independent mode is on

1. Start the EPSON RC+ 7.0.
2. If tasks are running, you will be prompted to connect and monitor operation. If tasks are not running, you will be prompted to connect in monitor mode, or switch to the Program mode.

4.2.9 Windows Login

You can configure automatic Windows login from EPSON RC+ 7.0. In [Setup]-[System Configuration]-[Startup]-[Windows Login] page, check the [Enable windows auto login] check box. Then, enter the name and password of the user logging in. Optionally, you can supply a domain, if required.

However, you must have the authority of Windows Administrator to set login parameters. To configure automatic Windows login from EPSON RC+ 7.0, you must reboot the system the first time. After the reboot, Windows login will be automatic.



4.2.10 Command Line Options

Refer to *4.2.11 Using Command Line Options* to see how to use the command line options.

There are command line options for EPSON RC+ 7.0 that provide the following functions:

Starting EPSON RC+ 7.0 for a specific project

When you start EPSON RC+ 7.0, you can optionally specify a project name in the command line.

```
ERC70.EXE  [drive:project_name]
```

drive:project_name The drive letter and name of a project. The name can include a subfolder of the \EpsonRC70\Projects directory.

Example

Open project *myapp* on drive C: at startup:

```
ERC70.EXE c:myapp
```

Change the EPSON RC+ 7.0 startup mode

You can select the startup mode and override the startup dialog using command line options.

To start in Program mode (no password required)

```
ERC70.EXE  /PROG
```

To start in Auto mode

```
ERC70.EXE  /AUTO
```

Use these command line options to override and hide the startup dialog and open the Operator Window directly.

If only the AUTO flag is supplied and the control device is PC, EPSON RC+ 7.0 will open the project from the last session and display the operator window. EPSON RC+ 7.0 will only be visible in the Windows Task Manager. When the operator window is closed, EPSON RC+ 7.0 will be terminated.

NOTE ☞ When the control device is PC, you cannot close the operator window while tasks are running.

Example

Open project *myapp* on drive C and display the operator window:

```
ERC70.EXE c:myapp /AUTO
```

NOTE ☞ The Controller should be ON before starting EPSON RC+ 7.0 with the /AUTO command line option. If EPSON RC+ 7.0 cannot communicate with the controller, then an error message will be displayed with a retry button.

For more details, see *7.6 Operator Window*.

Login

You can automatically login from the command line if you are not using the Auto Login feature for the security Option:

```
ERC70.EXE /LOGIN "userID", "password"
```

This is especially useful when you are starting in operator mode.

If the user I/D or password is invalid, it will display an error dialog and exit the EPSON RC+ 7.0.

Starting EPSON RC+ 7.0 specifying the language

You can specify the language to use in EPSON RC+ 7.0 GUI.

Japanese	: `ERC70.EXE`	`/LANG_JAPANESE` [*1]
English	: `ERC70.EXE`	`/LANG_ENGLISH`
German	: `ERC70.EXE`	`/LANG_GERMAN` [*2]
French	: `ERC70.EXE`	`/LANG_FRENCH` [*2]
Chinese (Simplified)	: `ERC70.EXE`	`/LANG_CHINESE_SIMP` [*3]
Chinese (Traditional)	: `ERC70.EXE`	`/LANG_CHINESE_TRAD` [*3]

[*1] Available for Japanese OS
[*2] Available for English, German, and French OS
[*3] Available for Chinese OS

Disabling the EPSON RC+ 7.0 splash window

You can suppress the splash window displayed at startup using the following syntax:

```
ERC70.EXE /NOSPLASH
```

4.2.11 Using Command Line Options

Examples of command line options are:

Running from the Windows Run Box

You can specify a command from the Windows [Start] menu-[Run]-[Open] text box.

e.g. C:\EpsonRC70\exe\erc70.exe C:myapp

Making startup icons for your projects

You can create icons that automatically start EPSON RC+ 7.0 for different projects and start Auto or Program modes.

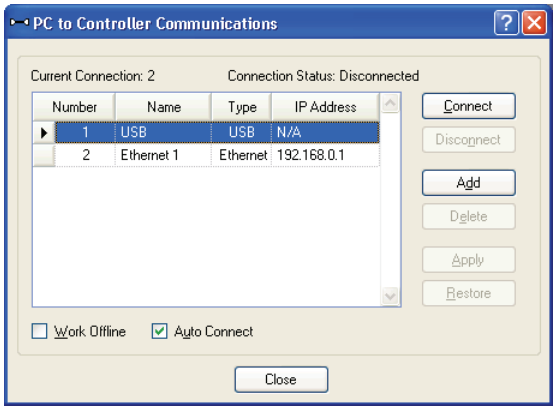
1. Right click on your desktop and select [New]-[Shortcut].
2. Click <Browse…> in the [Create Shortcut] dialog box.
   Select “C:\EpsonRC70\exe\erc70.exe” and click the <OK> button. After the dialog changes, click the <Next> button.
3. Type a name for the shortcut and click <Finish>.
4. Right click the created icon and select [Properties]. Add an option such as “/AUTO” or “/PROG” to [Target:].

4.3 Communications with Controller

Your PC running can communicate with a Controller using USB or Ethernet.

4.3.1 Configuring Communications with the Controller

To configure communications with the Controller, select [PC to Controller Communications] from the [Setup] menu. This will open the dialog shown below:



The dialog has a list of connections. The first connection is for USB and is fixed. You cannot delete it or rename it.

You can add one or more Ethernet connections and give each one a meaningful name.

The name for each connection is also shown in the Connections dropdown list on the main toolbar. If no name is supplied, the Ethernet IP address is shown in the dropdown list.

For more information on PC to Controller Communications, see the *[PC to Controller Communications]* section in chapter 5.

4.3.2 USB Communications

USB 2.0 or USB 1.1 can be used to communicate with one controller. This is the default communication method for EPSON RC+ 7.0 and requires no configuration.

To connect to a controller via USB:

1. Connect a USB cable between the PC and the controller.
2. Turn on the Controller.
3. Start EPSON RC+ 7.0.
4. Click the [PC to Controller Communications] button on the tool bar.
5. Ensure that connection #1 (USB) is selected.
6. Click <Connect> button.
7. Click <Close> button.

NOTE ☞ If the EPSON RC+ 5.0 is installed in the same computer and is performing the USB communication, the EPSON RC+ 7.0 cannot perform the USB communication. Make sure that the EPSON RC+ 5.0 is disconnected before connecting the EPSON RC+7.0.

NOTE ☞ When used with the Robot Controller RC620, the EPSON RC+ 7.0 cannot perform the USB communication.

4.3.3 Ethernet Communications

NOTE

The robot controller does not support internet protocol version 6 (TCP/IPv6). When you connect the development PC to the robot controller using the Ethernet, make sure to use internet protocol version 4 (TCP/IPv4).

You can communicate with one or more Controllers from one PC using Ethernet. For Ethernet communications, each Controller must have a unique IP address. You can set the IP address, mask, and gateway for the controller from [Setup]-[System Configuration]-[Controller]-[Configuration]. The gateway setting is only required if you will be accessing the controller from outside of the local network.

You can connect a PC to a controller directly using an Ethernet cross-over cable, or you can connect the PC and controller to an Ethernet switch or hub.

Before you can communicate with a controller using Ethernet, you must configure the controller's IP address, IP mask, and IP gateway. This is accomplished by first connecting to the controller with USB, and then from the EPSON RC+ 7.0 [Setup]-[System Configuration]-[Controller]-[Configuration] page, set the IP address, IP mask, and IP gateway of the controller as shown below.

The following is the configuration of the controller at the time of shipment.

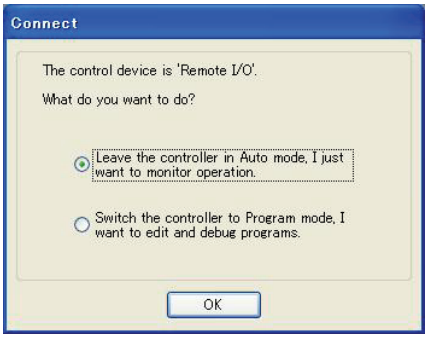
IP Address : 192.168.0.1
IP Mask : 255.255.255.0
IP Gateway : 0.0.0.0

Use the USB connection to configure Ethernet communications.

4.3.4 Connecting When Control Device is not PC

Connecting while control device is not PC and tasks are not running

If your PC is not a control device and tasks are not running, you will see the following message box:

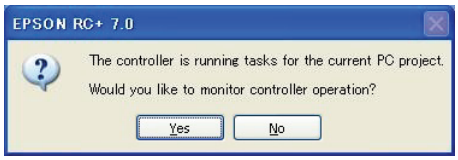


This allows you to [Leave the controller in Auto mode] to monitor operation, or [Switch the controller to Program mode] so you can edit and debug programs. If you choose to [Switch to Program mode], then the remote device cannot start programs until remote control has been enabled from the Run window.

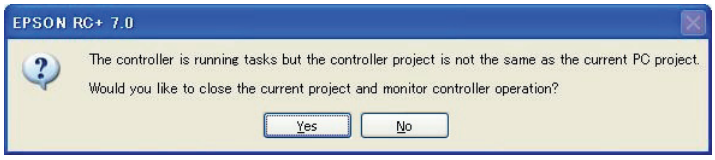
Connecting from Remote Control while tasks are running

If the controller is running tasks with the control device set to Remote, you can connect the PC to the controller to monitor operation. For example, you can connect to a controller that is running tasks to temporarily monitor display output, tasks, and I/O, and then disconnect while tasks continue to run.

If the project on the PC is the same as on the controller, you will see the following message box when connection is established:



If the project on the PC is not the same as the project in the controller, you will see the following message box when connection is established:



If you choose to monitor controller operation, the Run window will open if EPSON RC+ 7.0 is started in Program mode. If EPSON RC+ 7.0 is started in Auto mode, the Operator window will appear. From the Run window or Operator window, you can view display output from Print statements executing in the application. You can also use the Task Manager and I/O monitor.

When monitoring controller operation, the controller remains in Auto mode. You cannot stop tasks from EPSON RC+ 7.0, because the control device is not PC. If you want to switch the controller to Program mode, you must first stop all tasks from the current control device, then connect to the controller from EPSON RC+ 7.0 and choose to switch to Program mode (see the previous section *Connecting while control device is not PC and tasks are not running*).

Disconnecting while tasks are running

You can only disconnect from the controller with tasks running when the control device is set to Remote.

1. Stop communications with the controller by selecting [Offline] from the [Connection] dropdown list on the toolbar.
2. You may now disconnect the communications cable between the PC and the controller. Tasks will continue to run in the controller.

4.4 Writing your first Program

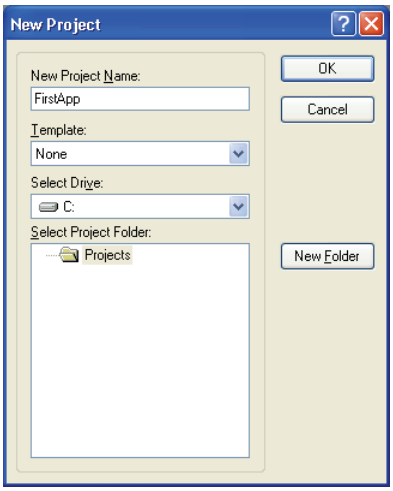
After installing the controller, robot, and EPSON RC+ 7.0 software on the RC700 Robot Controller, follow these instructions to create a simple application program so that you will become more familiar with the EPSON RC+ 7.0 development environment.

1. Start EPSON RC+ 7.0

Double-click the EPSON RC+ 7.0 icon on the desktop.

2. Create a new project

(1) Select New from the Project Menu.



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

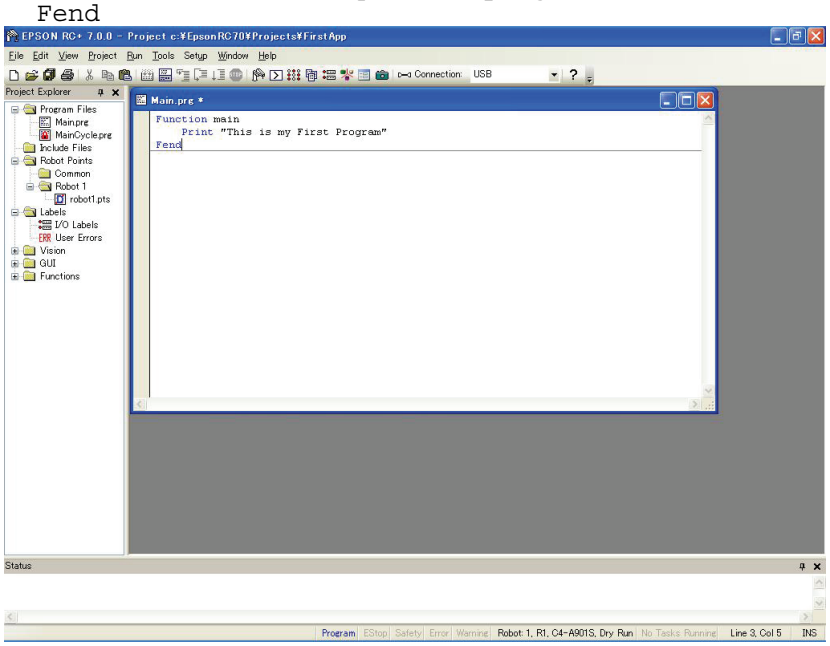
(3) Click **OK** to create the new project.

When the new project is created, a program called "Main.prg" is created. You will see the "Main.prg" window open with a cursor flashing in the upper left corner. Now you are ready to start entering your first program.

3. Edit the program

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

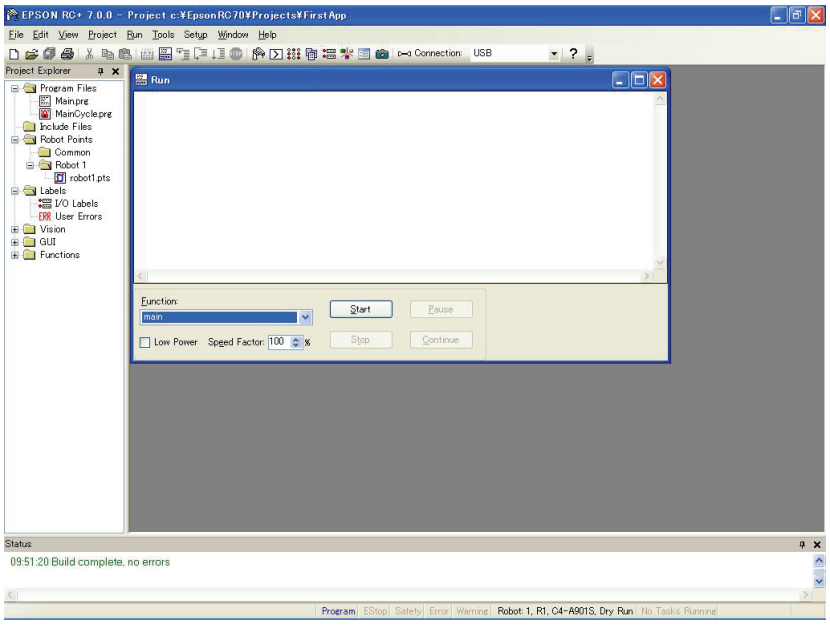
```
Function main
    Print "This is my first program."
Fend
```



4. Run the program

(1) Press **F5** to run the program. (F5 is the hot key for the [Run Window] of the [Run] Menu). You will see the Status window located at the bottom of the main window showing the build operation status.

(2) During project build, your program is compiled and linked. Then communications is established with the controller and project files are sent to the controller. If there are no errors during build, the Run window will appear.



(3) Click the <Start> button on the [Run] window to run the program.

(4) You should see text similar to the following displayed in the [Status] window:

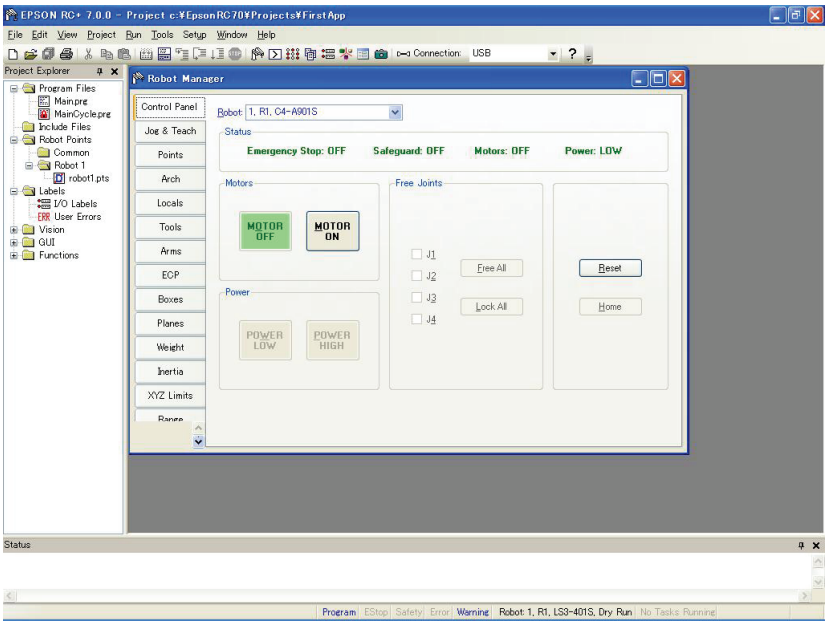
```
19:32:45 Task main started
19:32:45 All tasks stopped
```

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

Now let's teach some robot points and modify the program to move the robot.

5. Teach robot points

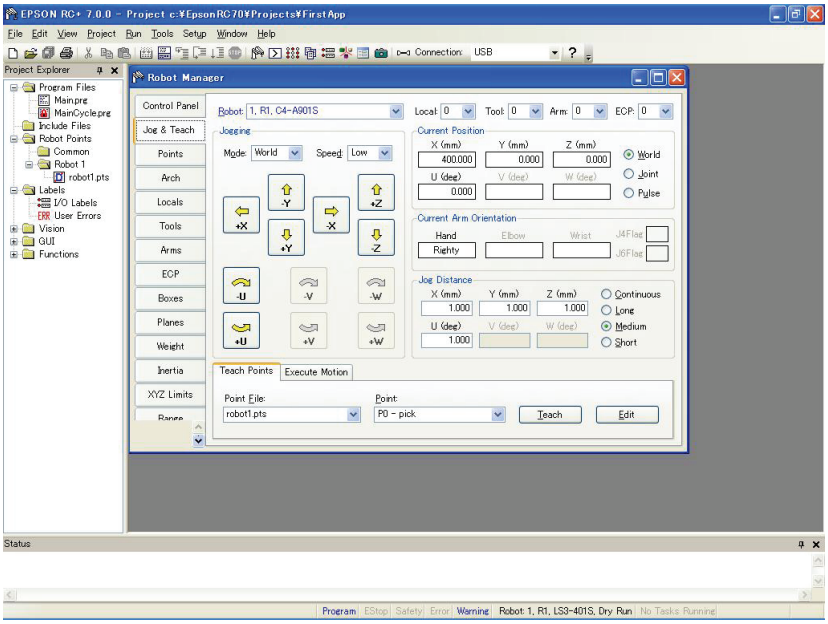
(1) Ensure that it is safe to operate the robot. Click the <Robot Manager> button on the toolbar. You will see the [Robot Manager] window with the [Control Panel] page displayed.



(2) Click on the <Motor On> button to turn on the robot motors. You will be prompted to confirm the operation.

(3) Answer <Yes> to continue.

(4) Click the [Jog & Teach] tab.



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

(6) Jog the robot by clicking the <+Y> jog button. Hold the button down to continue jogging. Let go when the robot is about half way out in the work envelope.

(7) Jog the robot down by clicking the <-Z> button.

(8) Now change the current point to P1 by selecting P1 in the Point dropdown list next to the <Teach> button.

(9) Click the <Teach> button. You will see a confirmation message to teach the point.

(10) Answer <Yes>.

(11) Click the <+X> button to jog the robot in the +X direction.

(12) Change the current point to P2 by selecting P2 in the Point dropdown list.

(13) Click the <Teach> button. You will see a confirmation message to teach the point.

(14) Answer <Yes>.

(15) Click the <Save Project> toolbar button to save the changes.

6. Modify the program to include robot motion commands

(1) Insert three new Go statements into the Main.prg program as shown below:

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

(2) Run the program by pressing F5 and then click on the <Start> button on the Run window.

(3) The robot should move to each of the points you taught.

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

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

```
Function main
    Print "This is my first program."
    Power High
    Speed 50
    Accel 50, 50
    Go P1
    Go P2
    Go P0
Fend
```

(2) Run the program by pressing F5

(3) Click on the <Start> button on the Run window.
The robot should go to each of the points you taught at 50% speed, acceleration, and deceleration. The Power High statement enables your program to run the robot at high (normal) power, which in turn allows the robot speed and acceleration to be increased.

8. Backup the project and system configuration

Even though this is only a sample project, we will backup the project and controller configuration. This is easy to do with EPSON RC+ 7.0. It is important that you keep regular backups of your applications on an external media such as a USB memory key.

Follow these steps to backup the project and system configuration:

(1) From the [Project] menu, select [Copy].
(2) Change the [Destination Drive] to an arbitrary drive.
(3) Click <OK>. The project will be copied to the external media.
(4) From the [Tools] menu, select [Controller].
(5) Click on the <Backup Controller> button.
(6) Select the arbitrary drive.
(7) Click <OK>. The system configuration will be backed up on the external media.

Now that you have written your first program, you should read *7.1.1 Creating the simplest application*.

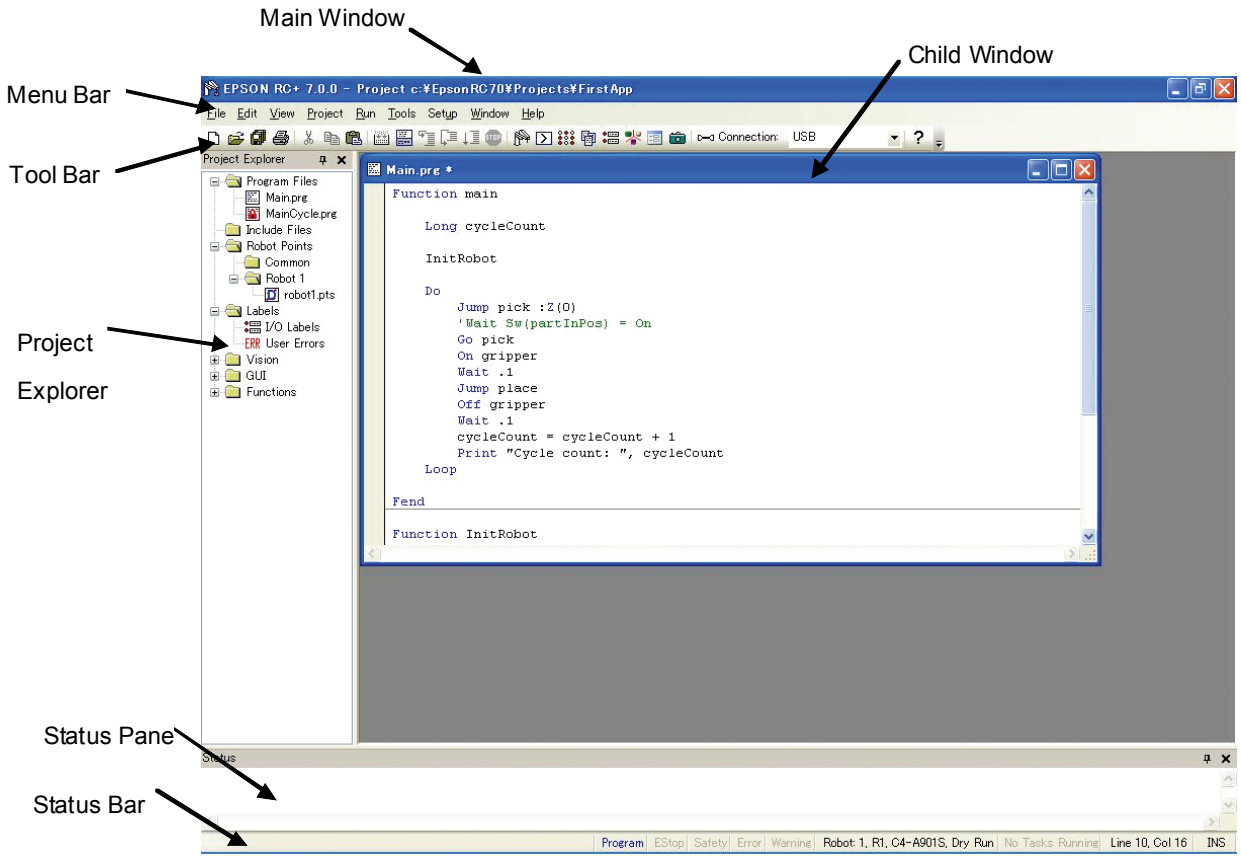
5. The EPSON RC+ 7.0 GUI

The chapter contains information on the EPSON RC+ 7.0 GUI. After an overview and discussing online help and toolbars, the remainder of the chapter is divided into sections that follow the menu system.

Contents

5.1 GUI Overview

EPSON RC+ 7.0 is a multiple document interface (MDI) application. There is one main parent window and several child windows which can be opened simultaneously. The main window has a menu bar, tool bar, and status bar, as shown below. In addition, there is a Project Explorer pane and Status Window pane.



5.2 Project Explorer Pane

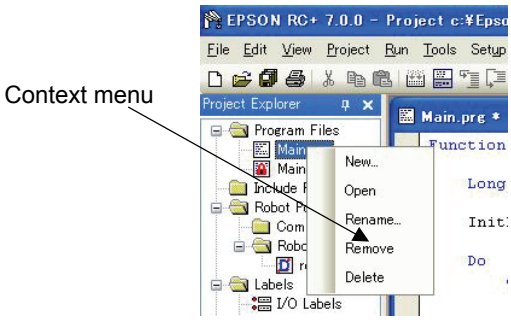
The Project Explorer pane enables you to quickly open any file in the current project or jump to any function. The project files and functions are organized in a sorted tree structure.

Open a file or jump to a function	: Double-click on the item.
Hide the Project Explorer	: Click the X button on the bar above the pane.
Show the Project Explorer	: Select Project Explorer from the View Menu.
Resize the Project Explorer	: Move the mouse cursor over the right side of the pane, then drag the pane right or left to the desired width.

You can move the Project Explorer pane to either the left or right side of the main window. To move the pane, click down on the bar above the pane, then drag to either the left or right side of the main window and release the mouse button.

5.2.1 Context Menu

The Project Explorer Pane has a context menu for various operations for elements in the project tree. To access the context menu, right click on an item in the project tree.



5.3 Status Window Pane

The status pane displays status messages, such as project build status, system errors and warnings, etc.

Hide the Status pane	: Click the X button on the bar above the pane.
Show the Status pane	: Select Status Window from the View Menu.
Resize the Status pane	: Move the mouse cursor over the top edge of the pane, and then drag the top edge up or down.

The Status pane is always located at the bottom of the main window and cannot be moved.

NOTE

If the Status pane is closed and an error message is displayed on the status pane, such as during project build, the Status pane will automatically be opened so that the error message can be seen.

5.4 Status Bar

The status bar located at the bottom of the main window displays the following:

Message area	Displays the syntax error for the current line and system messages.
Operation Mode status	Indicates the controller operation mode.
Emergency Stop status	Indicates if emergency stop is active.
Safeguard status	Indicates if one or more safeguard circuits is open.
Error status	Indicates if the controller is in the error state. Put the mouse cursor over the Error status area to see the warning message.
Warning status	Indicates if there is a warning. Put the mouse cursor over the Warning status area to see the warning message.
Current robot	Displays the currently selected robot number, name, type number, and the dry run status.
Tasks running status	Indicates that one or more tasks are running.
Current Line and Column	When a program editor window is active, the current line and column are displayed.
INS / OVR status	Indicates insert or overtype mode.

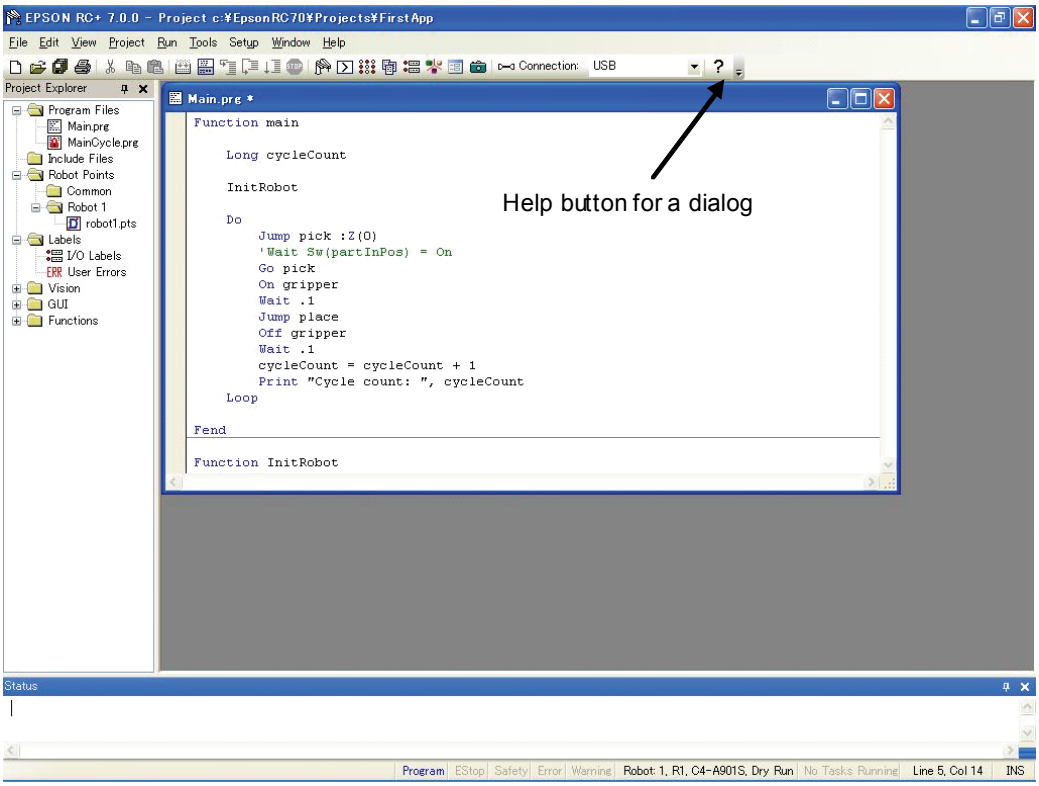
5.5 Online Help

EPSON RC+ 7.0 has an extensive context sensitive help system.

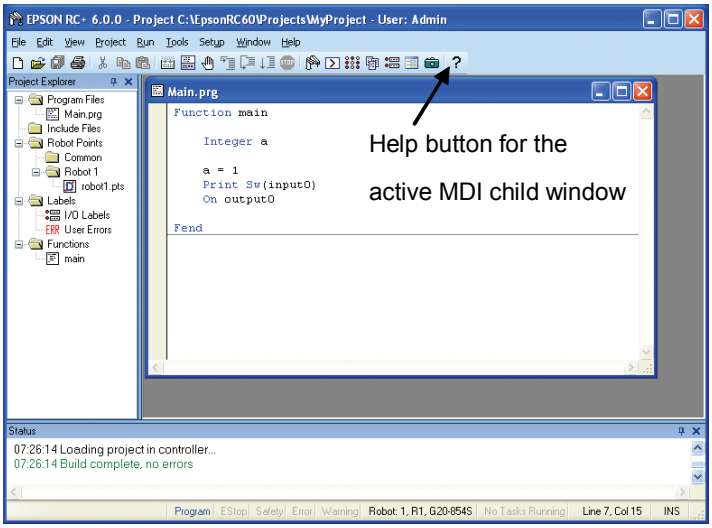
There are several methods to get help.

- Select [Contents] from the [Help] menu to browse help topics.
- Select [Index] from the [Help] menu to enter the name of a specific topic.
- Select [Search] from the Help Menu to search for a specific topic.
- When editing programs, press F1 with the caret in the keyword of interest.

When a dialog is open, press F1 or click the Help button. For dialogs, the Help button is located in the window title bar on the right side and is shown as a question mark icon as shown below.



For MDI child windows, the Help button is located on the main toolbar and is also shown as a question mark icon as shown below.



5.6 [File] Menu

The EPSON RC+ 7.0 File Menu includes commands for managing and printing files in the current project.

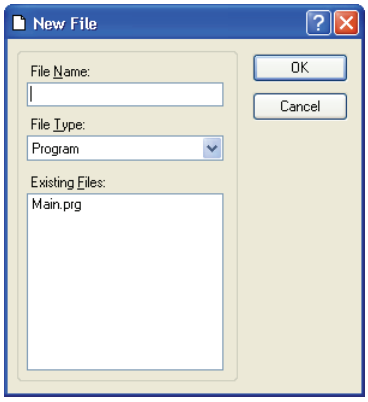
5.6.1 New Command (File Menu)

Shortcuts

Toolbar: 🗋

Keys: Ctrl + N

The New command is used to add new files to the current project. When the New command is selected, the New File dialog is opened.



Item	Description
File Name	Enter a name for the new file in this box. If you supply a valid file extension, the File Type selection will change to match the extension. For a file name, two byte characters such as Japanese, Chinese characters are not allowed.
File Type	Use this dropdown list to select Program, Include or Point file.
Existing Files	Shows the files for the selected type currently in the Project folder.
OK	Click OK when you are ready to create the new file.
Cancel	Cancels the operation.

5.6.2 Open Command (File Menu)

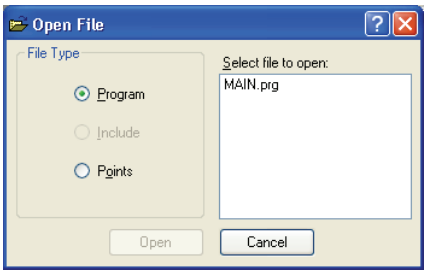
Shortcuts

Toolbar: 

Keys: Ctrl + O

Open one or more files in the current project for editing. You can open program files, include files, or point files.

If there is a file in the current project folder (as shown in the Edit Project dialog box) and the file is not in the current project, you will not be able to open the file. You must add the file to the project before you can open it. This also applies to include files and point files.



Item	Description
Program	Select this radio button to show a list of program files in the current project.
Include	Select this radio button to show a list of include files in the current project.
Points	Select this radio button to show a list of point files in the current project.
Select file to open	Click on the file name you want to open. You can select more than one file by using the Ctrl key or Shift key. The Ctrl key allows you to select or deselect any file. The Shift key allows you to select a group of files.
Open	Opens the selected file(s).
Cancel	Cancels the open operation.

TIP

You can also double click on a file name in the [Select file to open] list box to open the file without having to choose the <OK> button.

5.6.3 Close Command (File Menu)

Shortcuts

Keys: Ctrl + D

Close the currently active window.

Any of the windows can be closed with this command: Programs, Include files, Point files, Command Window, Run window, I/O Label Editor, user errors.

TIP

You can also close a window or dialog box by double clicking on the control box button located in the upper left corner of the window or dialog box.

5.6.4 Save Command (File Menu)

Shortcuts

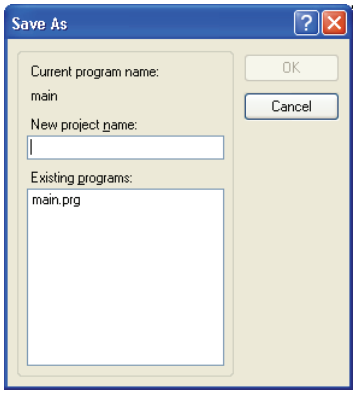
Keys: Ctrl + S

The [Save] command writes the current file to disk. The current file can be a program file, include file, points file, I/O label editor, etc. This command is disabled if the current file does not need to be saved.

5.6.5 Save As Command (File Menu)

Save the program, include file, or point file in the currently active window with a new file name. The original file will be removed from the project but will remain on the disk. The new name will be used throughout the current project in place of the old name.

If you use [Save As] on an include file, you must rename the file in each of your #include statements that refer to it. For a file name, two byte characters such as Japanese, Chinese characters are not allowed.



5.6.6 Restore Command (File Menu)

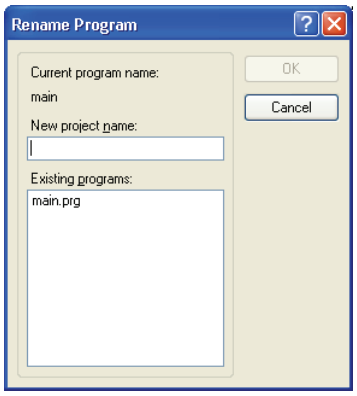
Restores the currently active program, include file, I/O labels, user errors, or point files from disk.

Use this function to change a document to the state it was in since last saved.

You will be prompted to confirm this operation.

5.6.7 Rename Command (File Menu)

Use [Rename] to change the name of the program, include file, or point file you are currently editing.



To rename a file

- Click anywhere on the program window
- Select the Open command from the File Menu
- Select the Window from the Window Menu
- Select from the Window Menu list

Select Rename from the File Menu. Type in a new name for the file and click <OK>.

The new file name cannot be the same as the existing files. You will get an error message if you enter a new name that is already being used.

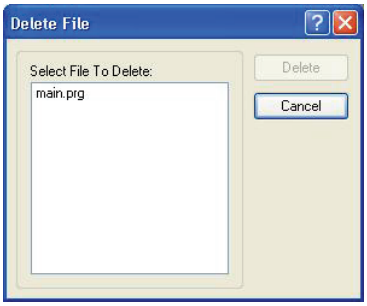
If you use [Rename] on an include file, you must rename the file in each of your #include statements that refer to it.

For a file name, two byte characters such as Japanese, Chinese characters are not allowed.

5.6.8 Delete Command (File Menu)

This command allows you to delete a file in the current project folder. You can delete program files, include files, and point files.

The file does not have to be registered in the project to delete.

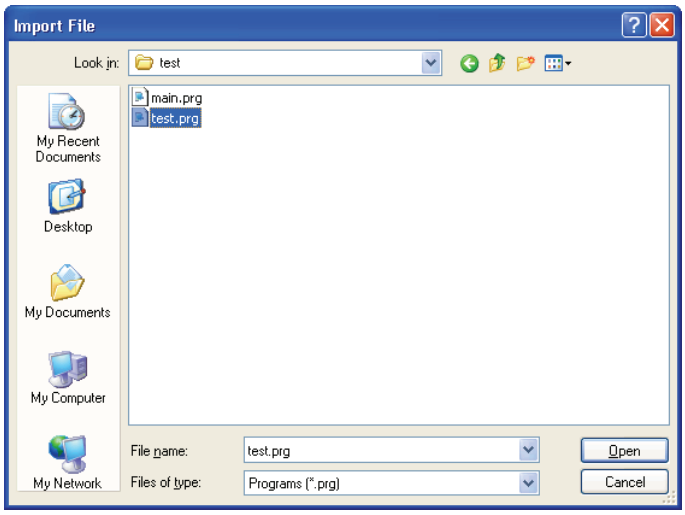


Item	Description
Select file to delete	Click on the file name you want to delete. This file list displays all .PRG, .INC, and .PTS files in the current project folder.
Delete	Deletes the selected file. You will be prompted with a confirmation message before the file is deleted. If the file is currently open, it will be closed and removed from the current project before it is deleted from disk.
Cancel	Cancels the delete operation.

5.6.9 Import Command (File Menu)

Import a file from other EPSON RC+ 7.0 projects. Use this command to import program files, include files, point files, I/O labels, user errors, and macros.

- Program file names for importing must have a .PRG extension.
- Include file names for importing must have a .INC extension.
- Point file names for importing must have a .PTS extension.
- I/O labels must have the file name IOLABEL.DAT
- User errors must have the file name USERERRORS.DAT.
- Macros must have the .MAC extension.



To import a file

1. Select the file type from the [File Type] list box.
2. Navigate to the file you want to import.
3. Click <Open> to continue. If a file name is already used in the project folder, you will be prompted to confirm overwrite. The file will then be copied to the current project's folder.

NOTE

If you need to import files from previous versions of EPSON RC+ or from SPEL for Windows 2.0, you must first import the project using [Project]-[Import], which converts the point files and label files into EPSON RC+ 7.0 formats. Then you can use File Import to import the desired files.

5.6.10 Print Command (File Menu)

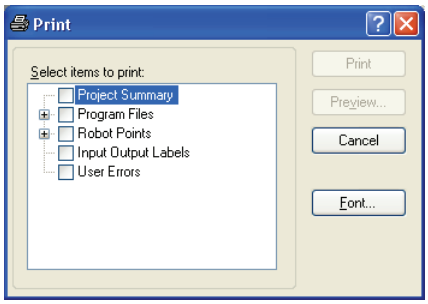
Shortcuts

Toolbar:

Keys: Ctrl + P

This command opens the Print dialog box. You can print programs, include files, point files, I/O labels, and user errors. Also you can print out a project summary.

Each document is printed with a header that includes the project name, product name, file name, date and time, and page number.



Item	Description
Select items to print	Check the items in the tree that you would like to print out.
Project Summary	Select this check box to print a summary of the programs and points used in the current project.

Item	Description
Program Files	Select this check box to print all program files, or click on the + button to view all program files and check the ones you want printed.
Include Files	Select this check box to print all include files, or click on the + button to view all include files and check the ones you want printed. This check box is not shown if there are no include files in the current project.
Robot Points	Select this check box to print all point files, or click on the + button to view all point files and check the ones you want printed.
Input Output Labels	Select this check box to print a listing of the all of the I/O labels used in the project.
User Errors	Prints a listing of all user errors for the current project. If either the label or message is non-blank, then the error definition will be printed.
Print	Prints the selected files. This button will be dimmed if nothing is selected to be printed.
Preview	Preview the selected files before printing. This button will be dimmed if nothing is selected to be printed.
Font...	Opens a dialog for selecting the printer font. The selected font is saved for subsequent printing.
Cancel	Closes the dialog box without printing anything.

5.6.11 Exit Command (File Menu)

Shortcuts

Keys: Alt + F4

Exits from EPSON RC+ 7.0.

If you are running a program from the Run Window and the control device is PC, you will see a message that a program is running and you will not be allowed to exit. You must stop all tasks first before you can exit.

If there are any open program files, include files, point files, I/O labels, or user point files that have not been saved, for each file you will be prompted to save it with Yes, No, or Cancel.

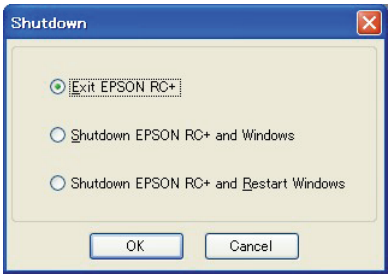
If you select <Yes>, then the file will be saved.

If you select <No>, then the program will exit without saving the files.

If you select <Cancel>, it will return to the EPSON RC+ 7.0 main window.

If the display of the dialog at EPSON RC+ 7.0 shutdown is enabled, the following dialog will be displayed at the shutdown and you can select a termination process.

For details on the shutdown dialog, refer to *5.12.3 [Preferences] Command (Setup Menu).*



Item	Description
Exit EPSON RC+	Exits the EPSON RC+ 7.0.
Shutdown EPSON RC+ and Windows	Exits the EPSON RC+ 7.0 and shutdown the Windows.
Shutdown EPSON RC+ and Restart Windows	Exits the EPSON RC+ 7.0 and reboot the Windows.
OK	Executes the selected operation.
Cancel	Cancels the operation and close the dialog.

5.7 [Edit] Menu

The EPSON RC+ 7.0 <Edit> menu includes commands for editing files.

TIP

You can also access the <Edit> menu by right-clicking anywhere in a program editor window.

5.7.1 [Undo] Command (Edit Menu)

Shortcuts

Keys: Ctrl + Z

Undo the changes to the currently active program since it was open.

5.7.2 [Redo] Command (Edit Menu)

Shortcuts

Keys: Ctrl+Y

Redo the previous undo.

5.7.3 [Cut] Command (Edit Menu)

Shortcuts

Toolbar:

Keys: Ctrl + X

Copies the current selection into the Clipboard and then deletes the selection.

5.7.4 [Copy] Command (Edit Menu)

Shortcuts

Toolbar:

Keys: Ctrl + C

Copies the current selection into the Clipboard.

5.7.5 [Paste] Command (Edit Menu)

Shortcuts

Toolbar:

Keys: Ctrl + V

Puts the contents of the Clipboard into the currently active document starting at the insertion point.

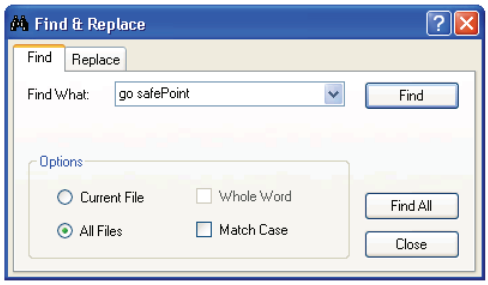
5.7.6 [Find] Command (Edit Menu)

Shortcuts

Keys: Ctrl + F

Find a text string in the current program or all programs in the project.

The first time you execute this function, the dialog box will be centered over the main window. If you reposition it, then the next time Find is executed, the dialog will appear where you last positioned it.



Item	Description
Find What	Type the text you want to search for. If any text was selected when you execute the Find command, it will be displayed here. When executing the Find with a text string selected, selected text will displayed. If no text was selected, then the text from the last Find will be displayed. You are limited to one line of text. If selecting more than one line before executing Find, the search will not start.
Current File	Searches only in the current program file and include file.
All Files	Searches all files in the project.
Whole Word	Searches for the full word by itself and not as part of another word.
Match Case	Text must also match lower and upper case in order to be found.
Find	Starts the search. If the text is found in a file that is not open, then the file will be opened to display. This button will be dimmed if nothing is entered to be searched.
Find All	Search for all occurrences and list the results in the Status pane. Each result shows the file name, line number, and line where the text was found. You can then double click on a result to open the file where the text was found. The Find & Replace dialog will close after the results are displayed. This button will be dimmed if nothing is entered to be searched.
Close	Closes the dialog box.

5.7.7 [Find Next] Command (Edit Menu)

Shortcuts

Key: F3

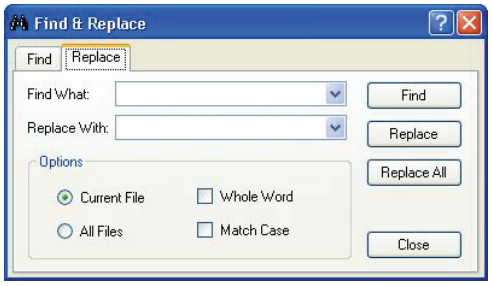
Find the next occurrence of the search text specified in the last Find command.

5.7.8 [Replace] Command (Edit Menu)

Shortcuts

Keys: Ctrl + R

Search for a text string and replace it with new text. The first time you execute this function, the dialog box will be centered over the main window. If you reposition it, then the next time Replace is executed, the dialog will appear where you last positioned it.



Item	Description
Find What	Type the text you want to search for. If any text was selected when you execute the Replace command, it will be displayed here. If no text was selected, then the text from the last Find will be displayed.
Replace With	Enter the replacement text here. The replacement text can be empty.
Current File	Searches only in the current program file and include file.
All Files	Searches all files in the project.
Whole Word	Searches for the full word by itself and not as part of another word.
Match Case	Text must also match lower and upper case in order to be found.
Find	Finds the next occurrence.
Replace	If already found, replaces the current find, otherwise searches for the next occurrence.
Replace All	Replaces all occurrences.
Close	Closes the dialog box.

5.7.9 [Select All] Command (Edit Menu)

Shortcuts

Keys: Ctrl + A

Selects the entire program file, include file, point file, I/O labels, or user errors. You can then execute Cut or Copy.

5.7.10 [Indent] Command (Edit Menu)

Shortcuts

Key: Tab

Move the selected line one tab to the right.

5.7.11 [Outdent] Command (Edit Menu)

Shortcuts

Keys: Shift + Tab

Move the selected line one tab to the left.

5.7.12 [Comment Block] Command (Edit Menu)

Comments out the selected block of lines by adding the comment character to the beginning of each line.

To use, select one or more lines to be commented. Then :

- Select Comment Block from the Edit Menu.

- Right click and select Comment Block from the Context Menu.

A comment character will be added to the beginning of each of the selected lines.

5.7.13 [Uncomment Block] Command (Edit Menu)

Removes leading comment character from the selected block of lines.

To use, select one or more lines to be uncommented. Then:

- Select Uncomment Block from the Edit Menu.

- Right click and select Uncomment Block from the Context Menu.

The first comment character from each of the selected lines will be removed.

5.7.14 [Go To Definition] Command (Edit Menu)

Opens the window and sets the line where a function, variable, macro, point label, I/O label, or user error label is defined.

To use,

- Click on an identifier in a program window,
  and select Go To Definition from the Edit Menu.

- Right click on the identifier,
  and select Go To Definition from the Context Menu.

Identifier type	Display
Function name or variable	Program window where a function name or variable is declared.
Pont label	Point file which a label is defined.
I/O label	I/O label editor which a label is defined.
User error label	User error which a label is defined.

5.8 [View] Menu

The EPSON RC+ 7.0 View Menu includes commands for opening the Project Explorer and Status window. In addition, there is a command for viewing the system history.

5.8.1 [Project Explorer] Command (View Menu)

If you have closed the [Project Explorer] pane, you can open it by using this command.

For details, refer to *5.2 Project Explorer Pane*.

5.8.2 Status Window Command (View Menu)

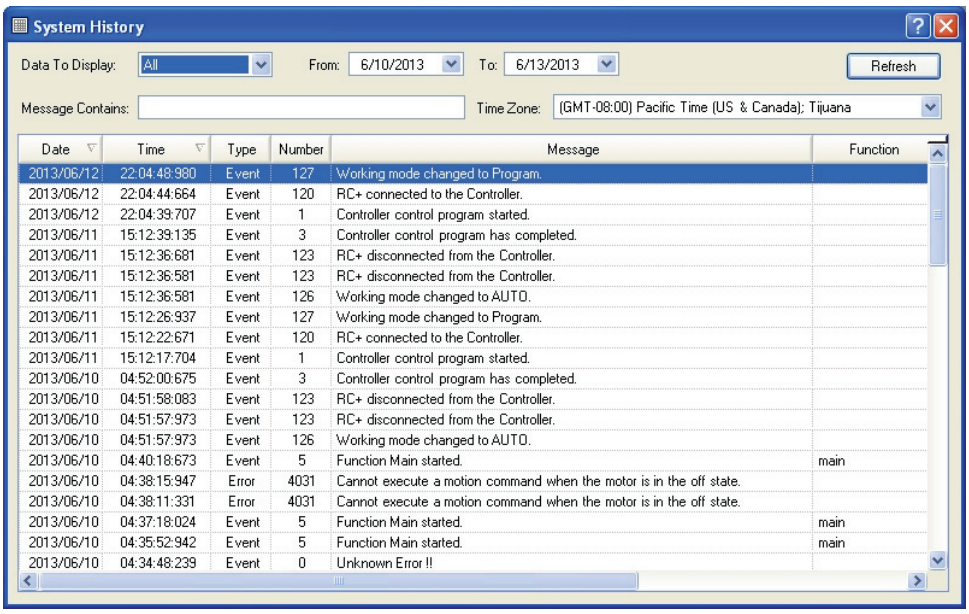
If you have closed the [Status Window] pane, you can open it by using this command.

For details, refer to *5.3 Status Window Pane*.

5.8.3 System History Command (View Menu)

This command opens the System History window. This window shows events, errors, and warnings that have been logged in the current controller's system history.

The data can be sorted by clicking on any column header. To sort multiple columns, hold down the shift key and click on multiple columns headers.



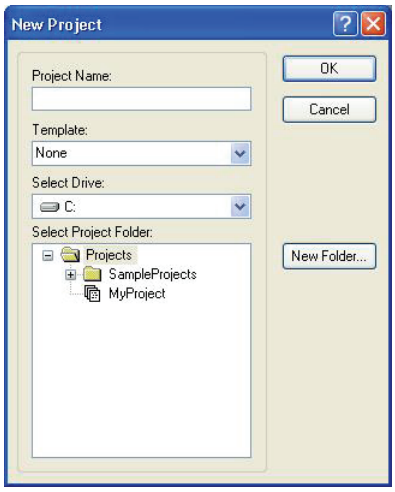
Item	Description
Data To Display	Select which data you would like to view. Choices are All, Events, Errors, and Warnings.
From / To	Select the dates you want to view data from. When the window is first opened, these are automatically set to the first and last dates in the history data.
Message Contains	Type in text to be found in the error message. After typing in the text, click the Refresh button.
Time Zone	Select a time zone. Time of event, warning, and error occurrences are displayed according to the selected time zone.
Refresh	Click this button to reload the data from the controller.
Type Event	Information for operation and mode change.
Warning	Program can be executed continuously, however, needs countermeasure.
Error	Error occurred in the program or the Robot.
Number	For details of the number, refer to *SPEL+ Error Message* in the *SPEL+ Language Reference*.
Message	
Function and Line number	Function name and the line number are displayed when error occurred while executing a program.
Robot and axis number	Robot and the axis number are displayed when Robot error occurred.
Task number	Task number of the task with error is displayed when error occurred while executing the program. “0” is displayed for others.
Additional information 1 and 2	More details are displayed for some errors. For details, refer to *SPEL+ Error Message* in the *SPEL+ Language Reference*.

5.9 [Project] Menu

The EPSON RC+ 7.0 Project Menu includes commands for managing and building projects.

5.9.1 [New] Command (Project Menu)

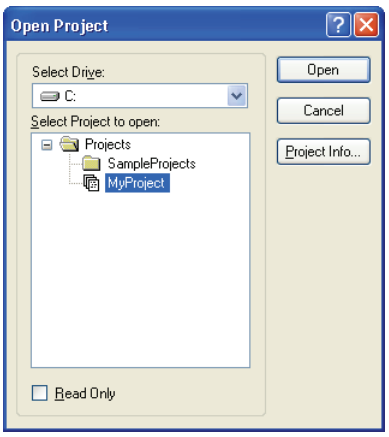
The New command is used to create a new EPSON RC+ 7.0 project. Projects can be on any disk drive on the system. They are stored in the \EpsonRC70\Projects folder on the selected drive. Subfolder can also be created.



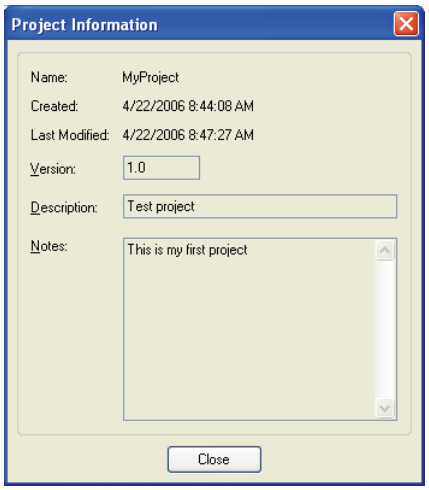
Item	Description
Project Name	Type in a new name for the project. The name can include alphanumeric characters along with underscores. For a project name, two byte characters such as Japanese, Chinese characters are not allowed.
Template	Select a project template. The new project will be a copy of the template project.
Select Drive	Select the desired disk drive for the new project.
Select Project Folder	This is a list of folders and projects on the selected drive. If you click on a name in this list, it will be displayed in the New Project Name text box. You can then edit the name, or you can create a new project with the same name as one that has already been created. In the later case, you will be prompted to overwrite the old project if it is in the same folder.
New Folder	Creates a new folder in the currently selected folder.
OK	Creates the new project.
Cancel	Aborts creating a new project.

5.9.2 [Open] Command (Project Menu)

Use this command to open an EPSON RC+ 7.0 project. When the project is opened, the previous project is closed. You will be prompted to save changes.



Item	Description
Select Drive	Select the desired disk drive for the project you want to open.
Select Project to Open	Select a project name from the list box. To open a folder, double click on the folder or click the + box located to the left of the folder.
Read Only	If you set this check box and open a project, you can not edit the program file, include file, point file, I/O label, and user error.
Open	Opens the selected project.
Cancel	Cancels the operation.
Project Info	Displays general project properties for the selected project. To view project information, first select a project in the list, then click the **Project Info** button.



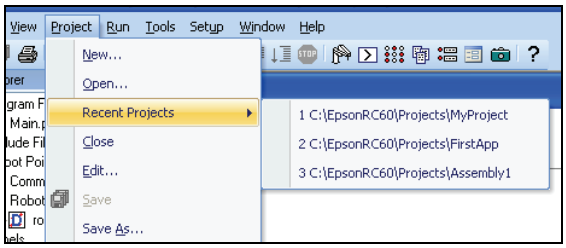
NOTE

Project information for a project can be changed by selecting [Properties] from the [Project] menu after opening the project.

5.9.3 Recent Projects Submenu (Project Menu)

The Recent Projects submenu contains up to eight of the most recently used projects.

When you select a project in the menu, the current project is closed and the selected project is opened the same as if you used the [Open] command from the [Project] menu.



5.9.4 [Close] Command (Project Menu)

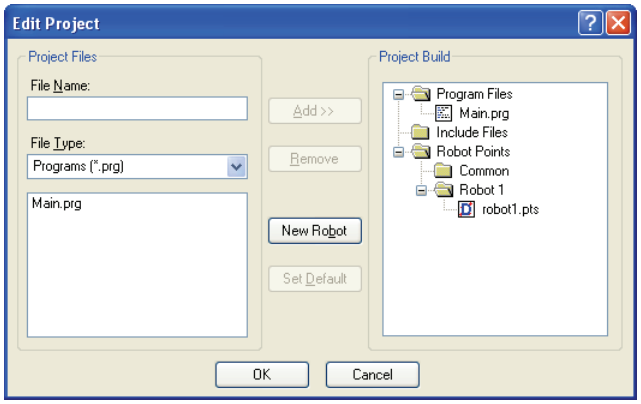
Use the [Close] command to close the current project. Several menu and toolbar commands will be disabled after the project is closed.

5.9.5 [Edit] Command (Project Menu)

The [Edit] command is used to define which program files, include files, and point files are to be used in the current project.

The [Project Files] contains a list of files in the current project folder. You can select which files to view from the [File Type] list box.

The [Project Make] contains a project make tree that includes program files, include files, and point files.



The files shown in the file list are in the current project disk directory. Before you can use a file in the project, you must put it into the project make tree using the <Add> button.

To create a new program

1. Type the name of program file in the [File Name] text box in the Program Files section. Add the PRG extension to the file name. For a file name, two byte characters such as Japanese, Chinese characters are not allowed.
2. Click the <Add> button. You will be prompted to create a new file. Answer <Yes> to create the file and put it in Program Files folder in the project make tree.

To add an existing program file

1. Select the Program in the [File Type] list box.
2. Select the program file name you want to add to the project from the list box.
3. Click the <Add> button, or
   double click on the program file name in the file list box.

The file will be added to the Program Files folder in the project make tree.

To create a new include file

1. Type the name of the include file in the [File Name] text box.
   Add the INC extension to the file name. The name of the include file can also be the same name as a program. For a file name, two byte characters such as Japanese, Chinese characters are not allowed.
2. Click the <Add> button. You will get a message asking if it is okay to create the new file. Click <Yes> to create the file and put it in the Include Files folder in the project make tree.

To add an existing include file to the project

1. Select Include in the <File Type> list box.
2. Select the include file name you want to add to the project from the list box.
3. Click the <Add> button, or
   double click on the include file name in the file list box. The file will be added to the list of include files of [Project Build] tree.

To add a new point file

1. Type the name of the point file you want to create into the [File Name] text box.
   Add the PTS extension. For a project name, two byte characters such as Japanese, Chinese characters are not allowed.
2. Select the robot folder you want to register from the Robot Points folder in the [Project Build] tree.
3. Click the <Add> button. You will be prompted to create a new file. Click <Yes> to create the file and put it in the selected robot of the Robot Points folder.

To add an existing point file to the project

1. Select Points from the [File Type] list box.
2. Select the robot folder you want to register from the Robot Points folder in the [Project Build] tree.
3. Select the point file name you want to add to the project from the list.
4. Click the <Add> button. The file will be put in the selected robot of the Robot Points folder.

To remove a program file, include file, or point file

1. Select the file you want to remove in the [Project Build] tree.
2. Click the <Remove> button to remove the file from the [Project Build]. The file is not deleted from the project folder, so you will still see the file in the file list.

To add a new robot

Click the <New Robot> button. A robot will be added to the Robot Points folder in the [Project Build] tree.

To set a default point file

1. Select a point file to set as the default from each robot of Robot Points folder in the [Project Build] tree.
2. Click the <Set as default> button. The file will be set as the default of the registered robot.

NOTE

The common point file is a point file that is available for all robots on the controller. To use this point file, you need to load it from the SPEL$^+$ program to the robot using LoadPoints command.

The default point file is a point file that is automatically loaded to a robot with the project load. Each robot can have one point file as the default.

5.9.6 [Save] Command (Project Menu)

Shortcuts

Toolbar:

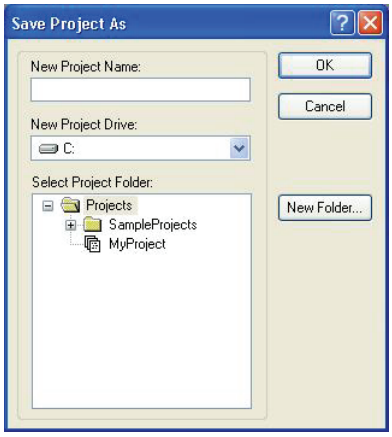
This command saves the active program file, include file, point file, I/O labels, or user errors. This menu selection will be dimmed if nothing needs to be saved.

TIP

It's a good idea to save files frequently while you are editing project files. Just click the disk button on the toolbar to save all of your files.

5.9.7 [Save As] Command (Project Menu)

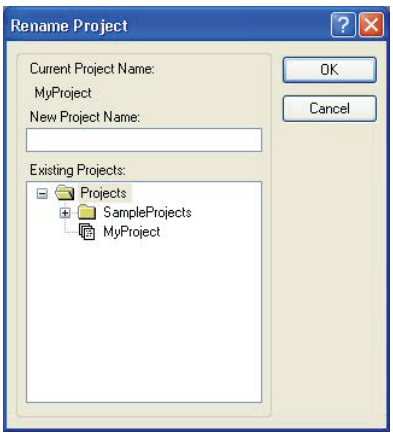
Saves all files in the current project to a new drive and/or project name. The current project will be preserved.



Item	Description
New Project Name	Type in a new name for the project. The name can include alphanumeric characters along with underscores but cannot include two byte characters such as Japanese, Chinese characters. The maximum number of characters is 24. You can use the same name as the current project if you select a drive and folder that is not the same as the current project folder and the folder drive.
New Project Drive	Drives for the new project location.
Select Project Folder	Click on the desired folder for the project.
New Folder	Click this button to create a new folder under the Projects folder.
OK	Saves the project using the new name and location.
Cancel	Cancels the operation.

5.9.8 [Rename] Command (Project Menu)

This command renames the current project. The project folder and all associated project files are also renamed.



Item	Description
New Project Name	Type in a new name for the project. The name can include alphanumeric characters along with underscores but cannot include two byte characters such as Japanese, Chinese characters.
Existing Project	This list box shows other projects on the selected drive. The new name you choose cannot be one of the names in this list.
OK	Renames the project.
Cancel	Cancels the operation.

5.9.9 [Import] Command (Project Menu)

The Project Menu Import Command uses a wizard to import projects from a PC, the current controller, or a controller status folder.

When a project is imported, the files are copied to a new project folder, so the original project is not changed.

NOTE

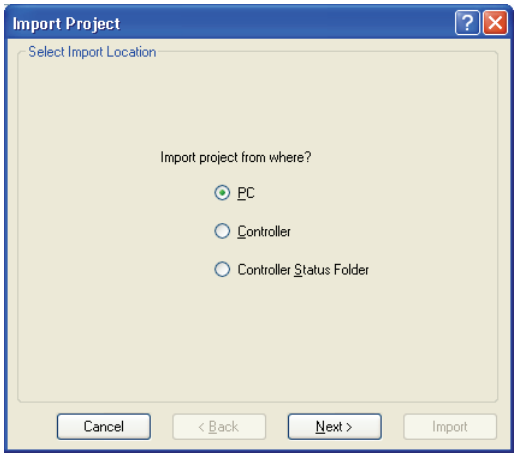
If the project to be imported is an EPSON RC+ 3.x / 4.x / 5.x /6.x project or a SPEL for Windows 2.0 project, the files are converted to EPSON RC+ 7.0 format.

The sections below have instructions for importing a project from each type of source location.

Importing a PC project

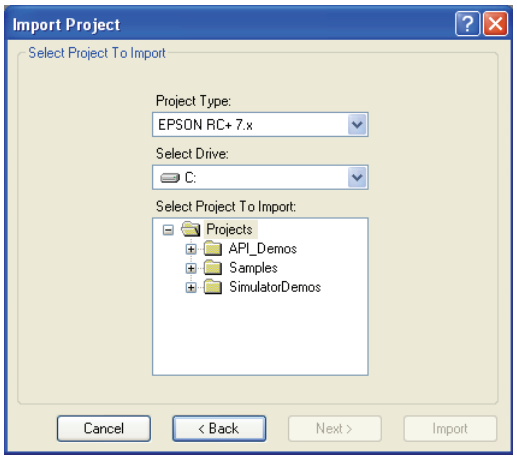
Follow these steps to import a project from a PC:

1. Select Import from the [Project] menu to open the [Import Project] dialog box.
2. Select <PC> and click <Next>.



3. Select the project type. You can select from the following:

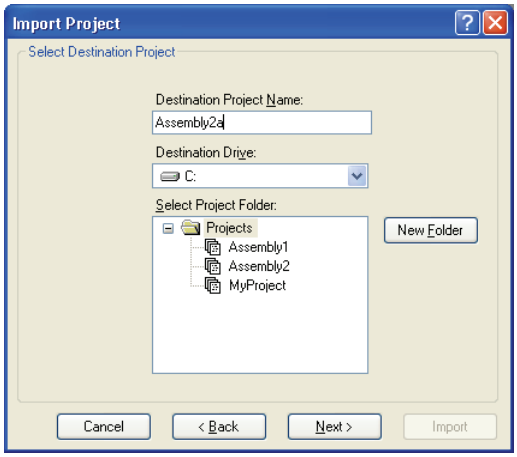
- EPSON RC+ 7.0
- EPSON RC+ 3.x / 4.x / 5.x / 6.x
- SPEL for Windows 2.0



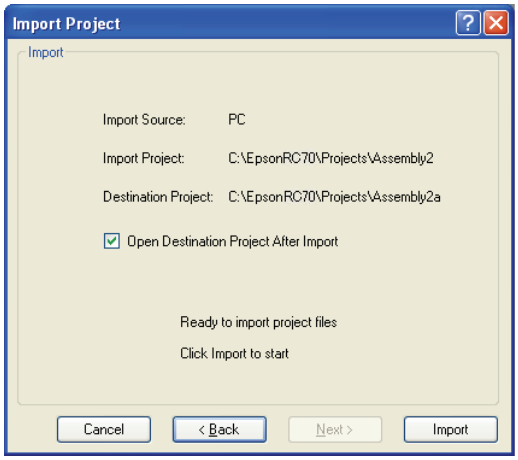
NOTE

When project for EPSON RC+ 3.x / 4.x / 5.x /6.x or SPEL for Windows 2.0 is imported, the project is converted to project for EPSON RC+ 7.0 by automatic processing.
For details, refer to *Appendix A: Automatic Processing of Project Import*.

4. Select the drive. After you select the project type and drive, the project list will be updated to show the projects available for import. Select the project to import in the list and click <Next>.
5. The new project name is set to the name of the imported project. You can modify the destination project name if desired. Select the destination drive and project folder, then click <Next>.



6. Verify the import source, import project, and destination project. Check [Open Destination Project After Import] if you want the project to open after import.

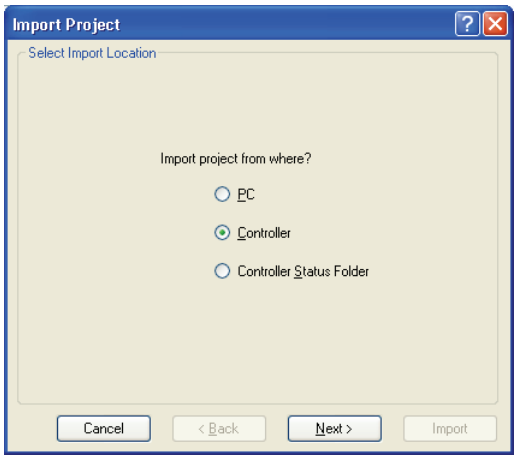


7. Click the <Import> button. If the destination project already exists, you will be asked if you want to overwrite it.

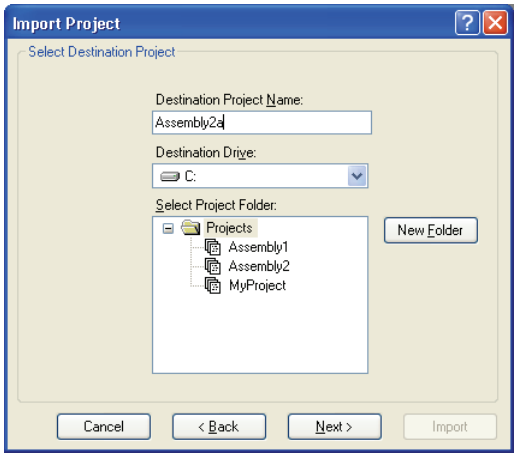
Importing a Controller project

Follow these steps to import a project from a controller:

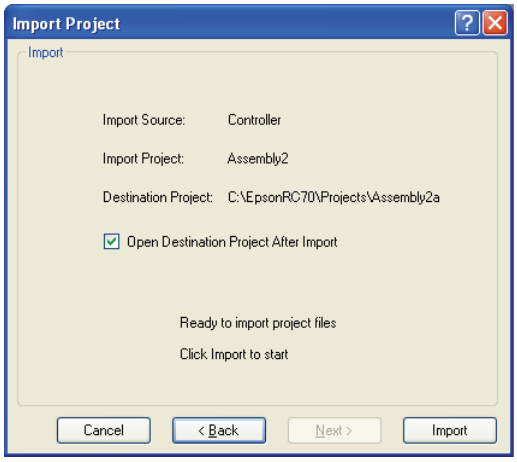
1. Select Import from the [Project] menu to open the [Import Project] dialog box.
2. Select <Controller> and click <Next>.



3. The new project name is set to the name of the current project in the controller. You can modify the new project name if desired. Select the destination drive and project folder, then click <Next>.



4. Verify the import source, import project, and destination project. Check [Open Destination Project After Import] if you want the project to open after import.



5. Click the <Import> button. If the destination project already exists, you will be asked if you want to overwrite it.
6. The project in the destination project will be built.

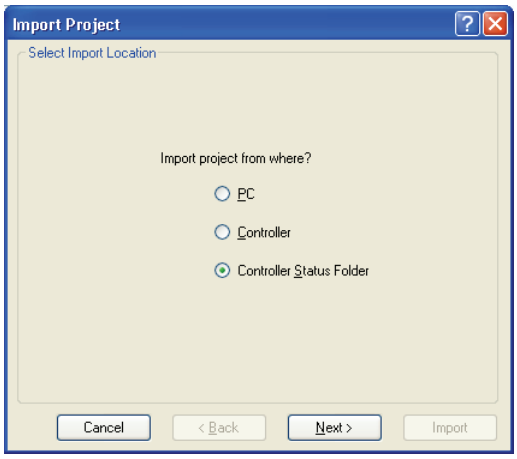
Importing a Controller Status project

The projects using Vision Guide cannot be imported from the Controller Status Folder.

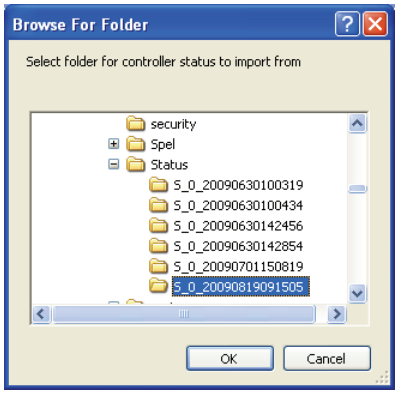
NOTE

Follow these steps to import a project from a Controller Status Folder:

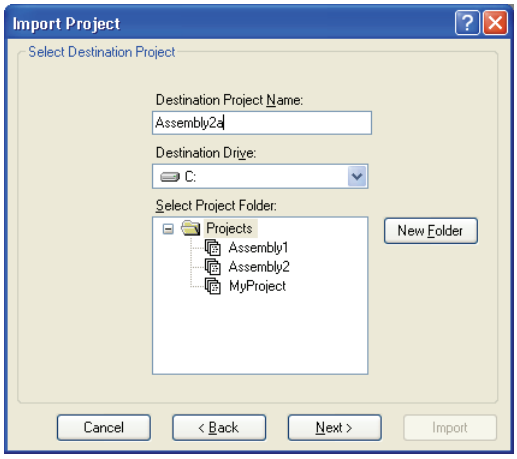
1. Select [Import] from the [Project] menu to open the [Import Project] dialog box.
2. Select <Controller Status Folder> and click [Next].



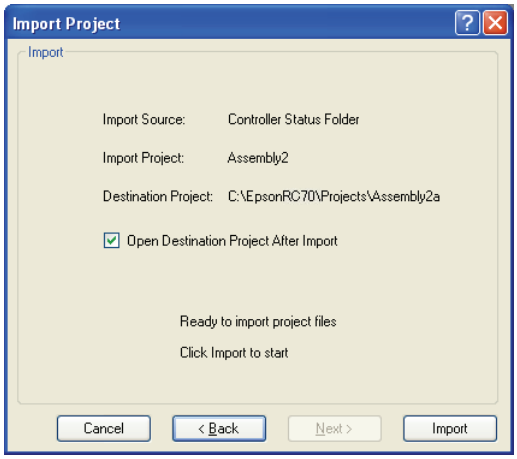
3. Select a controller status folder and click <OK>.



4. The new project name is set to the project found in the controller status folder. You can modify the new project name if desired. Select the destination drive and folder, then click <Next>.



5. Verify the import source, import project, and destination project. Check [Open Destination Project After Import] if you want the project to open after import.



6. Click the <Import> button. If the destination project already exists, you will be asked if you want to overwrite it.

5.9.10 [Export] Command (Project Menu)

The Project Menu Export Command uses a wizard to export projects to EPSON RC+ 6.0 projects.

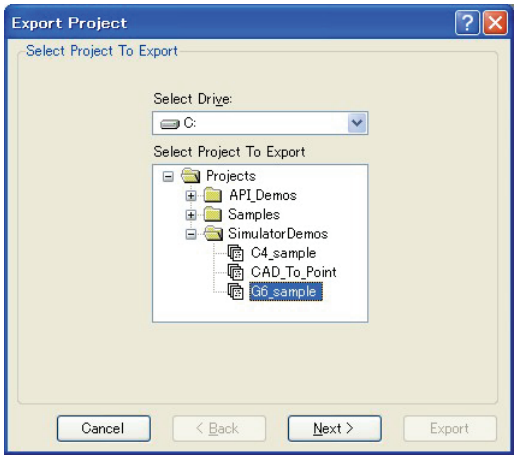
When a project is exported, the files are copied to a new project folder, so the original project is not changed.

NOTE

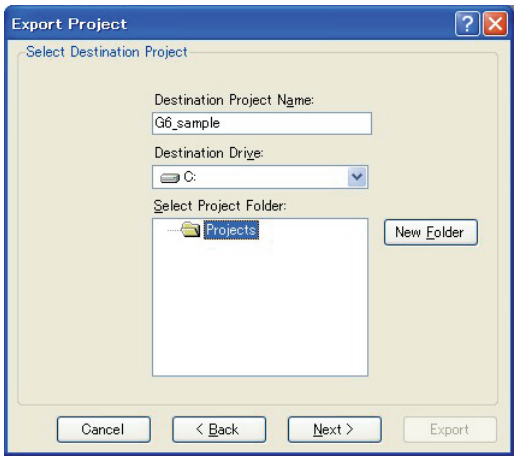
SPEL+ commands and syntax added to the EPSON RC+ 7.0 are not supported by EPSON RC+ 6.0. It is recommended to change the compiler version according to the version of your controller and check the compatibility before exporting projects. For details, refer to *[Project]-[Properties]-[Compiler] Page* in *5.9.15 [Properties] Command (Project Menu).*

Follow these steps to export a project:

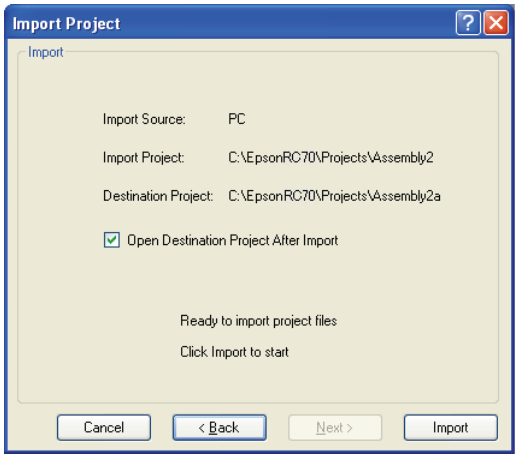
1. Select EPSON RC+ 7.0 menu-[Project]-[Export] to display the [Export Project] dialog.
2. Select a drive. A project list will be refreshed and exportable projects will be displayed. Select a project you want to export from the list and click <Next> button.



3. Name of a new project is set to the name of the exported project. The name of the new project can be changed. Select the destination drive and project folder. Then, click <Next>.



4. Confirm the export source and destination.

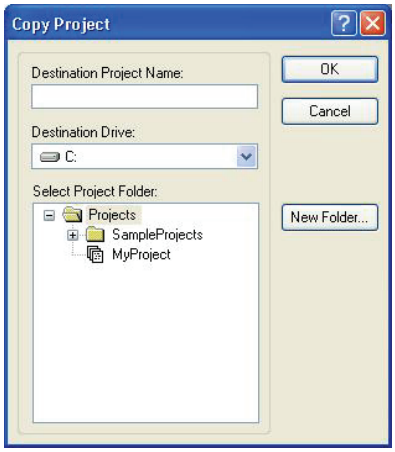


5. Click <Export>. If the destination already exists, you will be asked whether or not to overwrite the project.

5.9.11 [Copy] Command (Project Menu)

The [Copy] command copies all files in the current project to a specified drive, folder, and project name. You can use the current project name for the destination name if you select a new drive or folder. You can also specify a new name for the destination project.

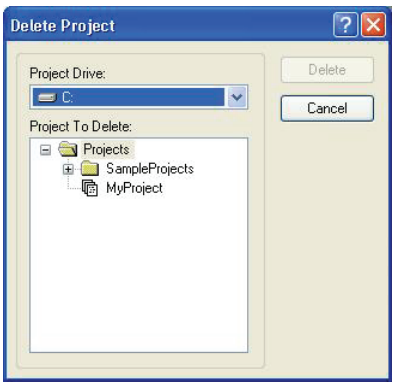
You should use the [Copy] command to make backup copies of your project on a regular basis.



Item	Description
Destination Project Name	Type in a name for the new copy of the project. The name can include alphanumeric characters along with underscores but cannot include two byte characters such as Japanese, Chinese characters. The maximum number of characters is 24. You can use the same name as the current project if you select a drive and folder that is not the same as the current project's drive and folder.
Destination Drive	Drives for the project copy.
OK	Performs the copy process.
Cancel	Cancels the operation.

5.9.12 [Delete] Command (Project Menu)

This command deletes an entire project from a PC disk. All files in the project folder will be destroyed.



Item	Description
Project Drive	Select drive for the project to delete.
Project To Delete	Select a project to delete from the list.
Delete	Delete the project. You will be prompted to confirm the operation.
Cancel	Cancel the operation.

5.9.13 [Build] Command (Project Menu)

Shortcuts

Toolbar:  Keys: Ctrl + B

This command builds the current project so that it can be executed. The Build command does the minimum amount of work required to bring the project up to date in the robot controller. For example, if a change was made to one program file in the project, then Build will compile the changed file, link it with the remaining object files (if they exist), and send the new files to the controller.

During the build process, the status window displays each step of the build. If there are any errors, they will be displayed on the status window.

5.9.14 [Rebuild] Command (Project Menu)

Shortcuts

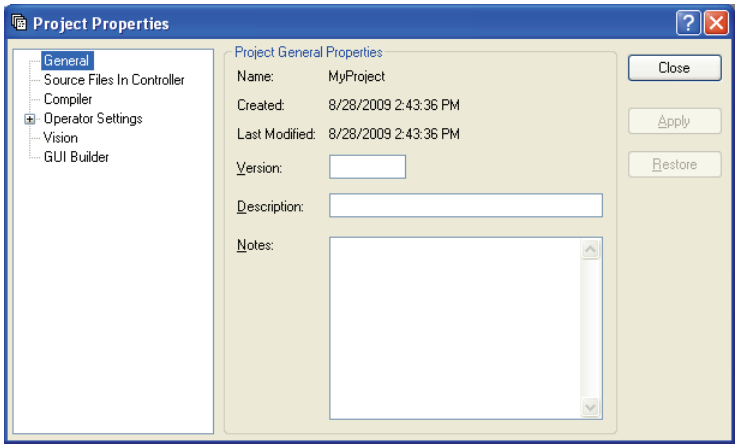
Keys: Ctrl + Shift + B

Rebuilds the entire current project. All program files are re-compiled, linked, and sent to the controller. All point files in the project are sent to the controller.

5.9.15 [Properties] Command (Project Menu)

[Project]-[Properties]-[General] Page

Use this page to view and edit general properties for the current project. All project property settings are stored in the project file, which is also stored in the controller during project build.



Item	Description
Name	The name of the current project.
Created	Date and time when the project was created.
Last Modified	Date and time when the project was last modified.
Version	User version number of the project. You can type any text here.
Description	A description of the project. You can type any text here.
Notes	Any project notes can be entered into this section.
Apply	Set current values after changes have been made.
Restore	Revert back to previous values.
Close	Close the Project Properties dialog.

TIP

When the [Open Project] dialog is used, clicking the <Project Info> button will open a dialog that contains the general project properties entered on this page.

[Project]-[Properties]-[Source Files In Controller] Page

This page allows you to select which source files will be stored in the controller during project build.

After changes are applied, the next project build will clear the project in the controller and perform a rebuild.

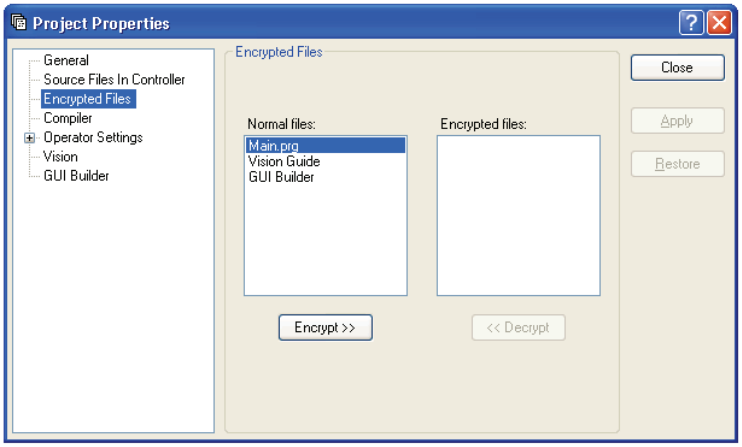
Item	Description
Select Source Files To Store in Controller	This is a list of the source files in the project. Select which source files you want to have stored in the controller.
Apply	Set current values after changes have been made.
Restore	Reverts back to the previous values.
Close	Closes the [Project Properties] dialog.

[Project]-[Properties]-[Encrypted Files] Page

This page allows you to encrypt files in the current project.

For details on using encrypted files, refer to section *7.8 Using Encrypt Files*.

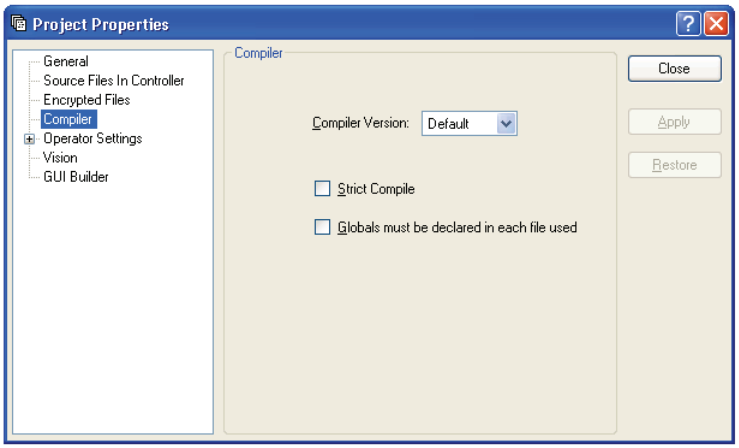
CAUTION	■ USE EXTREME CAUTION! Keep a record of the password(s) used for encryption in a safe place. Once a file is encrypted, it can only be opened with the password you enter. If you forget the password, the file contents CANNOT BE RECOVERED



Item	Description
Normal Files	This is a list of the source files in the project that are not encrypted. Select which source files you want to encrypt.
Encrypted Files	This is a list of the source files in the project that are encrypted. Select which source files you want to decrypt.
Encrypt >>	Encrypts the files selected in the [Normal files] list. When this button is clicked, you will be prompted for a password that will be used to access these encrypted files.
<<Decrypt	Decrypts the files selected in the [Encrypted files] list. When this button is clicked, you will be prompted for the password that was used to encrypt the files.
Apply	Set current values after changes have been made.
Restore	Reverts back to the previous values.
Close	Closes the [Project Properties] dialog box.

[Project]-[Properties]-[Compiler] Page

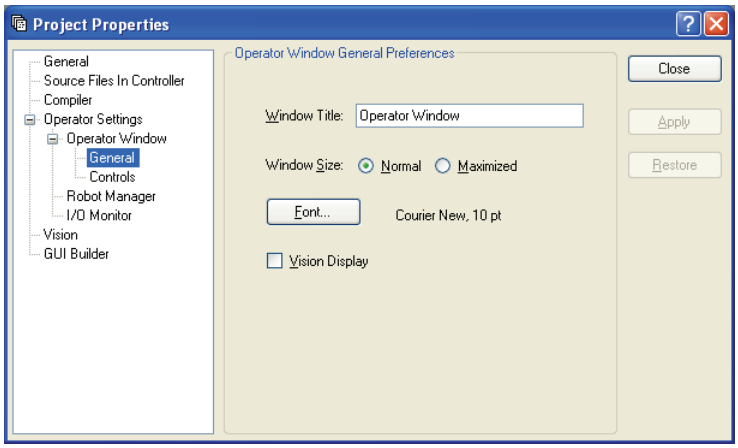
This page allows you to configure the compiler settings.



Item	Description
Compiler Version	[Default] is the normal setting. When the projects cannot be built because new SPEL+ language keywords have been added that conflict with your variable names, you can select a previous version to build the projects. Specify the controller version that compiles the project.
Strict Compile	Checks the Boolean type strictly. If the program contains following descriptions, an error will occur. Boolean variables are assigned to other numerical types Specifies a wait time to Wait Compares Boolean types
Globals must be declared in each file used	Checks the Global variables (including Global Preserve variables) for each file. When this item is checked, you must declare Global variables in each file in which they are used, otherwise an error will occur at build time. Enabling this item reduces a build time of a project which uses many Global variables.
Apply	Sets current values after changes have been made.
Restore	Reverts back to the previous values.
Close	Closes the [Project Properties] dialog box.

[Project]-[Properties]-[Operator Settings] -[Operator Window]-[General] Page

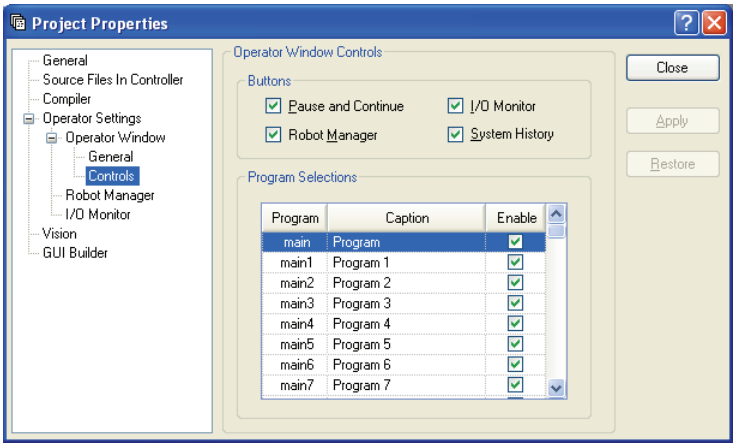
This page allows you to configure the general settings for the Operator Window.



Item	Description
Window Title	Type in the title that you want to appear at the top of the operator window.
Window Size	Choose Normal or Maximized.
Font	Click on the <Font> button to open the fonts dialog. Choose the font you desire for the operator window. The current font name and size is displayed next to the <Font> button.
Vision Display	If this check box is set, the Vision Guide image will be displayed in the operator window.
Restore	Reverts back to the previous values.
Close	Closes the [Project Properties] dialog box.

[Project]-[Properties]-[Operator Settings]-[Operator Window]-[Controls] Page

This page allows you to configure the controls for the Operator Window.



Item	Description
Pause and Continue	Check this box if you want the <Pause> and <Continue> buttons to be displayed. This will allow the operator to pause and continue from the operator window.
I/O Monitor	Check this box if you want the <I/O Monitor> button to be displayed. This will allow the operator to view input and output status.
Robot Manager	Check this box if you want the <Robot Manager> button to be displayed. This will allow the operator to open the Robot Manager from the operator window.
System History	If this check box is set, the <System History> button will appear. You can check the system history.
Apply	Set current values after changes have been made.
Restore	Reverts back to the previous values.
Close	Closes the [Project Properties] dialog.

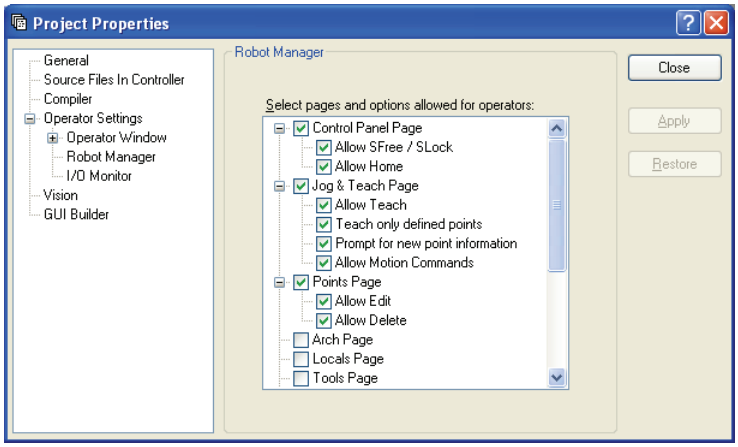
Program Selections Details

Each project can have up to 64 programs that can be started from the Operator Window. The programs are named main, main1 main2, … main63. Each program has an associated startup function using the same name as the program (main, main1, main2…main63).

In the program selections grid, you can define a friendly name for each of the 64 programs. You can also define which selections will be displayed in the Operator Window program list by checking the Enable checkbox.

[Project]-[Properties]-[Operator Settings]-[Robot Manager] Page

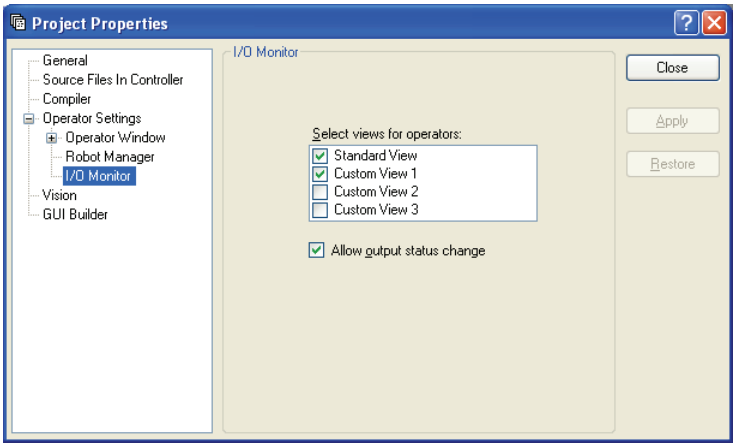
Use this page to configure the Robot Manager for operators.



Item	Description
Page and options enabled for operators	Check the pages that you want the operator to have access to when the Robot Manager is displayed from the operator window. In some pages, there are additional options.
Allow SFree / SLock	Allows the operator to free or lock joints from the [Control Panel] page.
Allow Home	Allows the operator to home the robot from the [Control Panel] page.
Allow Teach	Allows the operator to teach points from the [Jog & Teach] page.
Teach only defined points	Only defined points are shown in the point list on the [Jog & Teach] page.
Prompt for new point information	When the operator teaches a new point, a dialog will be displayed for entering the point label and description.
Allow Motion Commands	Allows the operator to execute motion commands from the [Jog & Teach] page.
Allow Edit	Allows the operator to edit point data on the [Points] page.
Allow Delete	Allows the operator to delete points on the [Points] page.
Apply	Set current values after changes have been made.
Restore	Reverts back to the previous values.
Close	Closes the [Project Properties] dialog box.

[Project]-[Properties]-[Operator Settings]-[I/O Monitor] Page

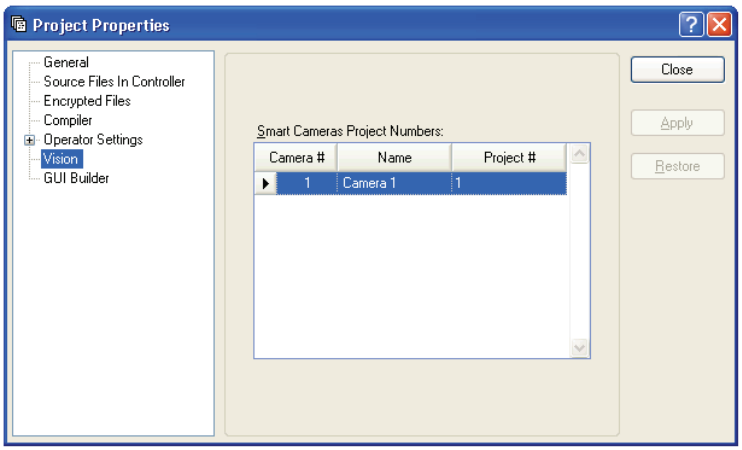
Use this page to configure the I/O Monitor for operators.



Item	Description
Views Enabled for Operators	Configures the I/O views that operators use when opening the [I/O Monitor] from the [Operator Window]. You can configure the custom views.
Allow output status change	Check this box if you want to allow operators to turn outputs on or off.
Apply	Set current values after changes have been made.
Restore	Reverts back to the previous values.
Close	Closes the [Project Properties] dialog box.

[Project]-[Properties]-[Vision]

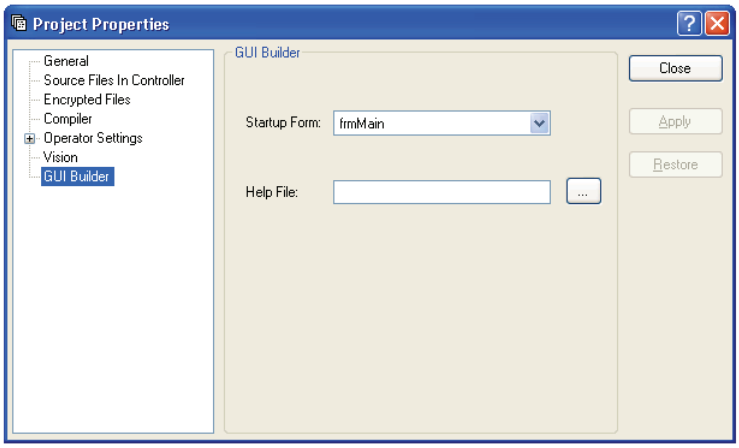
The EPSON Smart Camera supports two vision projects simultaneously. Each vision project can be used by one controller, so two controllers can use the same camera. Project 1 is used by default. In this page, you can configure the project number used by each Smart Camera for this project.



Item	Description
Smart Camera Project Numbers	Select the project number used by each Smart Camera for this project in the "Project #" column.
Apply	Set current values after changes have been made.
Restore	Reverts back to the previous values.
Close	Closes the [Project Properties] dialog box.

[Project]-[Properties]-[GUI Builder]

On this page, you can specify the startup form for GUI Builder and also set the value of the help file used in your project.



Item	Description
Startup Form	Select the startup form for the current project. If no forms have been created in GUI Builder, then there will be no forms in the list.
Help File	Set help file that will be used by forms in GUI Builder.
Apply	Set current values after changes have been made.
Restore	Reverts back to the previous values.
Close	Closes the [Project Properties] dialog box.

5.10 [Run] Menu

The EPSON RC+ 7.0 [Run] menu includes commands for running and debugging programs.

5.10.1 [Run Window] Command (Run Menu)

Shortcuts

Toolbar:  Key: F5

Opens the [Run] window to run a program.

Before opening the [Run] window, all files will be saved automatically if there are any unsaved files and then the project will be built. If there are any errors during build, the Run window will not be opened.

(If the *Auto File Save* preference is off in [Setup]-[Preferences]-[Workspace], you will be prompted to save all files if there are any unsaved files.)

After the [Run] window opens, you must click the <Start> button to initialize program execution.

For more information, see *7.5.1 The Run Window*.

5.10.2 [Operator Window] Command (Run Menu)

Shortcuts

Keys: Shift + F5

Opens the [Operator] window.

Before opening the [Operator] window, all files will be saved automatically if there are any unsaved files and then the project will be built. If there are any errors during build, the [Operator] window will not be opened.

(If the *Auto File Save* preference is off in [Setup]-[Preferences]-[Workspace], you will be prompted to save all files if there are any unsaved files.)

If the project is ready to run (last build was successful), then the [Operator] window will be opened.

For more information, see *7.6 The Operator Window*.

5.10.3 [Step Into] Command (Run Menu)

Shortcuts

Toolbar:  Key: F11

Execute the current source line. If the current line is a function, the next step will be the first line in the function.

5.10.4 [Step Over] Command (Run Menu)

Shortcuts

Toolbar:  Key: F10

Execute the current source line. If the current line is a function, the entire function will be executed.

5.10.5 [Walk] Command (Run Menu)

Shortcuts

Key: F12

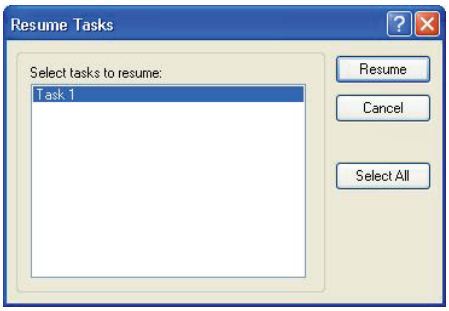
Execute lines until after the next motion command or output command, depending on the *Walk stops for output commands* preference on the [Setup]-[System Configuration]-[Controller]-[General] page.

5.10.6 [Resume] Command (Run Menu)

Shortcuts

Toolbar: Key: F7

Opens the [Resume Tasks] dialog box. Use this command to resume one or more halted tasks. This command is available only when one or more tasks are in halt mode.



Item	Description
Select tasks to resume	A list of all currently halted tasks. Click on one or more tasks to resume.
Resume	Click to resume.
Select All	Click to select all of the tasks in the list.
Cancel	Cancel the operation and close the dialog.

5.10.7 [Stop] Command (Run Menu)

Shortcuts

Toolbar:

Stops all tasks. This command is disabled when no tasks are running.

5.10.8 [Toggle Breakpoint] Command (Run Menu)

Shortcuts

Toolbar: Key: F9

Sets the selected line as a breakpoint or returns it to normal. When a line is a breakpoint, a breakpoint icon is displayed in the program window left margin.

You can set breakpoints while tasks are running.

If a line cannot be a breakpoint (such as a blank line), then the breakpoint icon will not appear for that line.

5.10.9 [Clear All Breakpoints] Command (Run Menu)

Shortcuts

Keys: Ctrl + Shift + F9

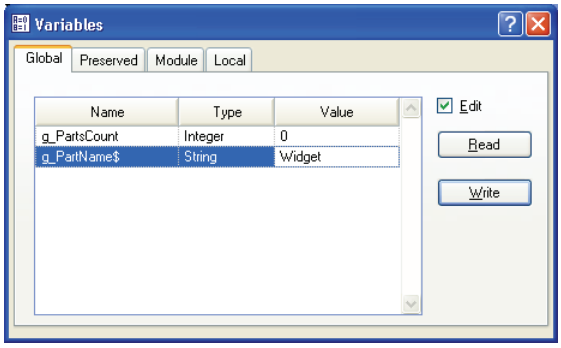
Clears all breakpoints.

5.10.10 [Display Variables] Command (Run Menu)

Shortcuts

Key: F4

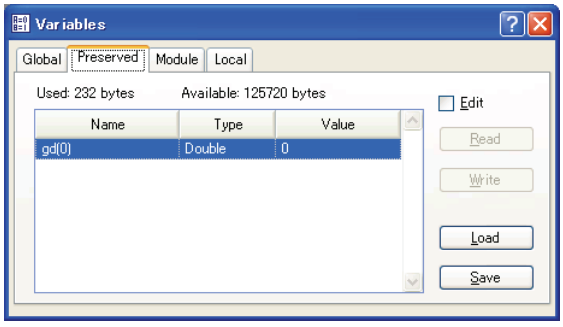
Displays a dialog box that shows the values for all variables in robot controller memory.



To change a variable value

1. Check the [Edit] checkbox.
2. Type the new value in the [Value] column. As you type in new values, the text color changes to red, indicating that the value is new and as not been written.
3. Click the <Write> button to save the changes. Click <Read> or uncheck [Edit] to cancel changes and restore the previous values.

When an array is displayed, the first element is shown. You can change which element to view by typing in the desired array subscript and then clicking the <Read> button.



The Preserved page displays the Global Preserve variables. The numbers of used and available bytes for preserved variables are also displayed.
You can save the values of Global Preserve variables in the controller to a file on the PC by clicking the <Save> button. The default file name is “GlobalPreserves.dat”.

A “GlobalPreserves.dat” file is also saved by using Backup Controller from the Tools Menu.

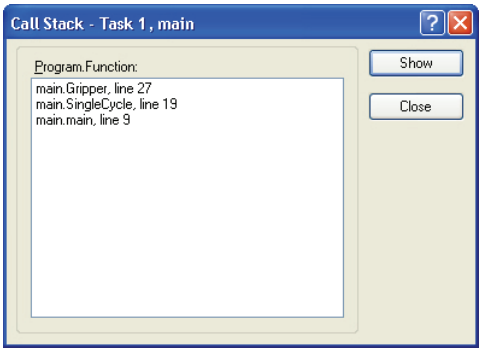
You can load the global preserve variables that are stored in the file on the PC by clicking <Load> button.

For module variables, you must select the desired program.

Local variables are not displayed unless one or more tasks have reached a breakpoint or have been halted from the Task Manager. You can view local variables for each function in the call stack for each halted task.

5.10.11 [Call Stack] Command (Run Menu)

The Call Stack dialog displays the function call stack for one task.



The Call Stack command is available when a program window is clicked which contains a function that is currently halted.

The most recent function is at the top of the list, and parent functions are listed afterwards in descending order. The last function is the task function.

Each row in the list shows a program, function, and line number.

You can view the code for any of the function calls in the list by selecting a function, then clicking <Show>. The program window for the function you selected is then displayed and the line of the function call is marked by a yellow arrow in the editor left margin.

5.11 [Tools] Menu

EPSON RC+ 7.0 has several GUI tools to support the system development. All tools can be accessed from the [Tools] menu. Many also have tool bar buttons and hot keys.

The Tools Menu includes the following selections:

- Robot Manager
  Motor control, Jog & Teach, change robot parameters.
- Command Window
  Execute SPEL+ commands directly.
- I/O Monitor
  Monitor and change I/O status.
- Task Manager
  Monitor and control task status.
- Macros
  Opens the Macro Window.
- I/O Label Editor
  Edit I/O labels.
- User Error Editor
  Edit user errors.
- Controller
  Do maintenance on the controller, such as backup, restore, and export status.

5.11.1 [Robot Manager] Command (Tools Menu)

Shortcuts

Toolbar: Key: F6

This command opens the Robot Manager window. This window contains several tabs that are used to control the robot motors and power, jog the robot and teach points, and view/edit several parameters for the robot.

You can configure how the Robot Manager window can be viewed in the development environment from the [Setup]-[Preferences]-[Robot Manager]-[General] page.

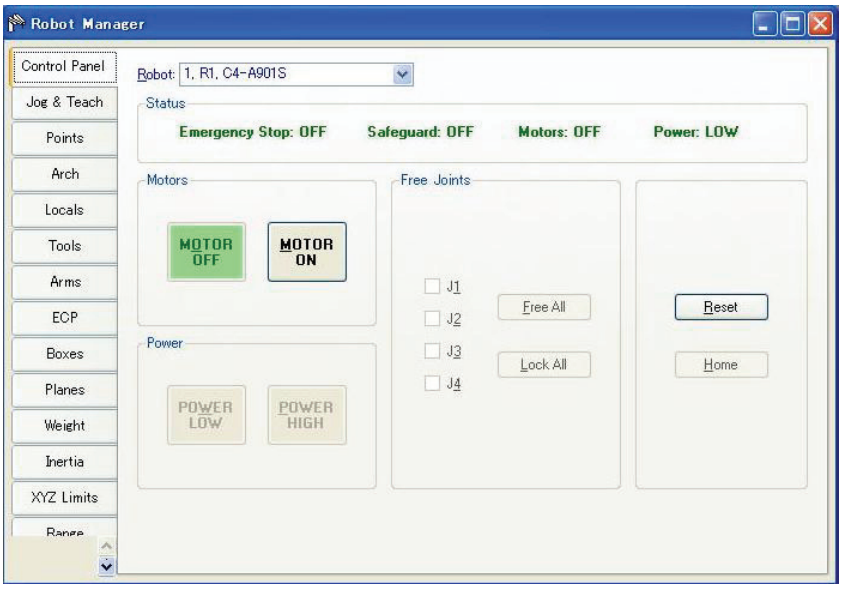
MDI window	The Robot Manager is displayed as a child window along with the other child windows inside the EPSON RC+ 7.0 development environment main window.
Dialog	The Robot Manager is displayed as a modal dialog which is displayed in the foreground over the development environment main window.

NOTE

If the screen resolution is less than 1024 x 768, the Robot Manager will always be displayed in dialog mode so it can fit on the screen.

[Tools]-[Robot Manager]-[Control Panel] Page

The Control Panel page contains buttons for basic robot operations, such as turning motors on/off and homing the robot. It also shows status for Emergency Stop, Safeguard, Motors, and Power.



Status Indicators

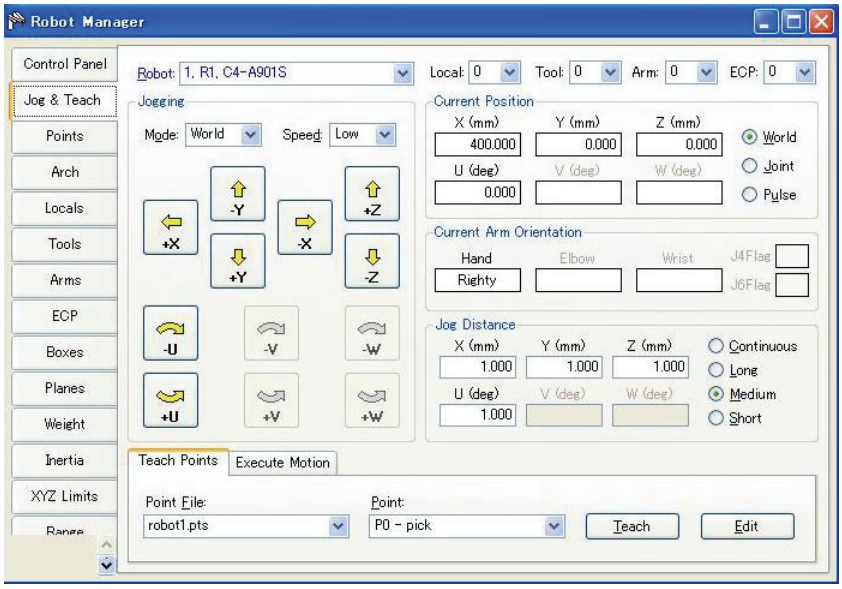
Indicator	Description
Emergency Stop	Indicates if Emergency Stop has occurred. To clear the Emergency Stop status, click <Reset>.
Safeguard	Indicates whether the Safeguard input is on or off.
Motors	Indicates whether the robot motors are on or off.
Power	Indicates whether the robot motor power is high or low.

Controls	Description
Robot	Select a robot.
MOTOR OFF	Turns off all robot motors of the selected robot.
MOTOR ON	Turns on all robot motors of the selected robot.
POWER LOW	Puts the robot servo system in low power mode.
POWER HIGH	Puts the robot servo system in high power mode.
J1 to J4 checkboxes	You can free one or more joints using the checkboxes. Not available for 6-axis robots.
Free All	Click this button to free all joints from the servo control.
Lock All	Click this button to lock all joints under the servo control.
Reset	Resets the robot servo system and Emergency Stop condition.
Home	Moves the robot to the position specified by the HomeSet command.

[Tools]-[Robot Manager]-[Jog and Teach] Page

The [Jog & Teach] page is primarily used for jogging the robot to a desired position and teaching a point using the current coordinates and orientation.

You can jog the robot in World, Tool, Local, Joint, or ECP modes. You can also execute motion commands.



Jog Controls

The [Robot Manager]-[Jog & Teach] page contains several controls, described below.

[Robot]

Select a robot.

[Jogging] Group

This group contains controls for setting jog mode, speed, and jog buttons.

Mode

This dropdown list contains the following choices jog mode.

World Jogs the robot along the X, Y, Z axes in the current local, tool, arm, and ECP. For robots with 4 DOF, you can also jog U (roll). For robots with 6 DOF, you can jog U (roll), V (pitch), and W (yaw). This is the default setting.

Tool Jogs the robot in the coordinate system defined by the current tool.

Local Jogs the robot in the coordinate system defined by the current local.

Joint Jogs each joint of the robot. A separate set of jog buttons will appear when using joint mode when using non-Cartesian robots.

ECP Jogs the robot along the axes of the coordinate system defined by the current external control point. Coordinates are World coordinates.

Speed

The speed for jogging and motion commands can be changed by selecting Low or High. When the Robot Manager is first open, the speed is set to Low. Jogging is always in low power mode. The speeds and accelerations associated with the jog speed settings are shown in the next page.

Jog Speed	Jog Method	Speed	Accel	Decel
Low	Continuous World/Tool/ECP XYZ	10 mm/sec	100 mm/sec^2	200 mm/sec^2
	Continuous World/Tool/ECP UVW	2 deg/sec	20 mm/sec^2	40 mm/sec^2
	Continuous Joint	*	10 mm/sec^2	20 mm/sec^2
	Step	1/5 of default PTP speed	Default PTP acceleration	Default PTP deceleration
High	Continuous World/Tool/ECP XYZ	50 mm/sec	100 mm/sec^2	200 mm/sec^2
	Continuous World/Tool/ECP UVW	10 deg/sec	20 mm/sec^2	40 mm/sec^2
	Continuous Joint	*	10 mm/sec^2	20 mm/sec^2
	Step	Default PTP speed	Default PTP acceleration	Default PTP deceleration

*Continuous joint speed and acceleration depends on robot model

Jog Buttons

Use the jog buttons to jog the robot throughout the work envelope. They can be controlled only by the mouse.

The robot jogs one step at a time as you click the button in either “Long”, “Medium”, or “Short” mode of the Jog Distance. The robot jogs continuously by holding the button down.

To jog continuously without stepping, set the Jog Distance to Continuous. See *How to jog robot* for details

You can change the orientation of the jog buttons to align your PC monitor with the robot from [Setup]-[Preferences]-[Robot Manager]-[Jogging].

The jog buttons are displayed differently depending on the Jog mode. For World, Local, Tool, and ECP jogging, the X, Y, Z, U, V, W buttons appear (V and W are only for 6-axis robots). For Joint jogging, the joint buttons labeled J1 - J6 appear.

The X, Y, and Z buttons jog the robot in the Cartesian axis.

The U buttons rotate the Tool coordinate system of the Z axis. (*roll)*

For 6-axis robots, the V buttons rotate the Tool coordinate system of the Y axis. *(pitch)*.

The W buttons rotate the Tool coordinate system of the X axis. *(yaw)*.

Local

This drop down list is used to select the current Local for jogging and teaching. Only Locals that have been defined are shown in the list. When you teach a point, the Local point attribute defaults to the current local number.

Tool

This drop down list is used to select the current Tool for jogging and teaching. Only Tools that have been defined are shown in the list.

Arm

This drop down list is used to select the current Arm for jogging and teaching. Only Arms that have been defined are shown in the list. Arms are not used with 6-axis robots.

ECP

This drop down list is used to select the current ECP for jogging. Only ECPs that have been defined are shown in the list. ECPs are only allowed if the External Control Point option has been activated.

Current Position Group

This group displays the current position of the robot. There are three ways to display position. **World** displays the current position and tool orientation in the selected local coordinate system, **Joint** displays the current joint values, and **Pulse** displays the current encoder pulse count for each joint.

Current Arm Orientation Group

This group displays the current arm orientation.

6-axis robot : Hand orientation, Elbow orientation, wrist orientation, J4Flag value, J6Flag value

RS series : Hand orientation, J1Flag value, J2Flag value

Others : Hand orientation

Jog Distance Group

This group contains text boxes that are used to specify the distance that each axis moves when its corresponding jog button is pressed. There are radio buttons for selecting Continuous, Long, Medium, and Short jog distances. When “Continuous” is selected, the robot is jogged in continuous mode and the jog distance text boxes are grayed out. When “Long”, “Medium”, or “Short” are selected, the robot is jogged in step mode for the distance specified in the jog distance text box for the axis being jogged.

To change a jog distance, first select the distance to be changed, then type in the new value.

Distance	Set Value *	Default Value
Short	0 to 10	0.1
Medium	0 to 30	1
Long	More than 0 to 180	10

* If you enter a too large value, an error message appears when you attempt to jog.

When the jog mode is changed, the jog distance units change appropriately between millimeters (mm) and degrees (deg).

NOTE ☞ When the jog distance is longer than the default, jog distance is reset to default status by rebooting the controller.

[Teach Points] Tab

This tab shows the current point file name and point number.

Use the <Teach> button to register the current robot position.

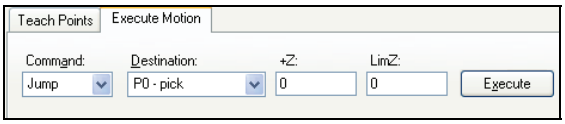
Use the <Edit> button to select and view the current point in the Points tab.

See *How to teach points* for more information.

Execute Motion Tab

This tab executes motion commands.

Click <Execute> from this group to execute the motion.



The Execute Motion tab can be disabled from [Setup]-[Preferences]-[Robot Manager]-[Jog & Teach].

How to jog

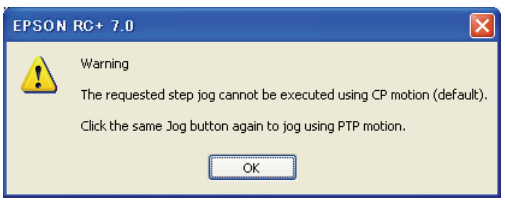
In the upper left hand corner of the [Jog & Teach] page, you will see a control group called Jogging that contains jog buttons. In the World, Local, Tool, and ECP jog modes, the robot is jogged in the Cartesian coordinate system (X, Y, Z). In the Joint jog mode, each robot joint can be jogged separately.

The jog speed is determined by the Speed setting. In step mode, each time you click a jog button, the robot moves along the appropriate axis by the amount specified in the [Jog Distance] control group. In continuous mode, when a jog button held down, the robot moves continuously using linear interpolated motion.

NOTE

For robots other than the 6-axis robots, the jog motion in step mode is PTP (point to point) motion. It is difficult to predict exact jog motion trajectory. Therefore, be careful that the robot doesn't collide with peripheral equipment and that the robot arms don't collide with the robot itself during jogging.

For the 6-axis robots, the jog motion in step mode is CP (Continuous Path) motion. Note that when jogging near the singularity, if you try to pass through the singularity, a warning dialog below will appear.



Click the <OK> button and click the same Jog button again to jog using PTP motion and pass the singularity.

It is difficult to predict exact jog motion trajectory in the PTP motion. Therefore, be careful that the robot doesn't collide with peripheral equipment and that the robot arms don't collide with the robot itself during jogging. Also, if you attempt the other jogs or operations, it cancels the switching to PTP motion. So when jogging near the singularity again, the same warning dialog will appear.

When jogging in continuous mode, if an out of range condition occurs, the robot motors will turn off and an error will be displayed. In this case you must execute a Reset and Motor On from the Control Panel page to continue the jog.

To jog

Select the jog mode: World, Tool, Local, Joint, or ECP.

Select the jog speed: Low or High.

Select Continuous, Long, Medium, or Short jog distance. You can type in the desired jog distance when Continuous is not selected.

Click on one of the jog buttons with the left mouse button. If you hold the mouse button down, the robot will continue to jog.

When jogging is started, the jog button picture color will change from yellow to cyan. After jogging is completed, the jog button picture color will change back to yellow.

If you click any jog button during a step jog, the robot will stop.

TIP

You can change the orientation of the jog buttons for the robot by selecting [Preferences]-[Robot Manager]-[Jogging] from the [Setup] menu. This will allow you to align your PC monitor with the orientation of the robot.

Jogging in Teach Mode

You can jog and move the robot at slow speed with the safeguard open by using the Teach Pendant.

See the *Robot Controller option: Teach Pendant TP1* manual.

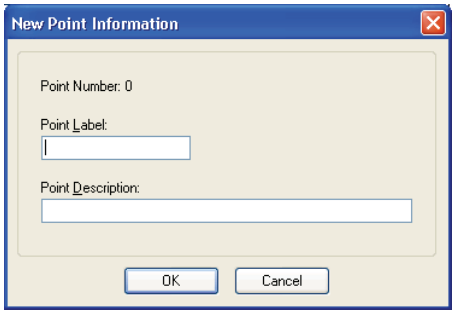
How to teach points

Teaching a robot point means that you are defining a location for the robot to move to using the current robot position.

Follow these steps to teach points from the [Robot Manager]:

1. Select the point file you are teaching points for by using the [Point File] dropdown list box on the [Teach] page.
2. Select the point number you want to teach in the [Points] box.
3. Jog the robot to the desired position or free some or all axes and manually move the robot into position.
4. Click on the <Teach> button. This will retrieve the robot's current position and store it in the coordinates for the point. If the Prompt for New Point Data preference is active, you will be prompted for a point label and description.

   Point labels can include up to 16 alphanumeric characters and the underscore character. Characters can be upper case or lower case. Only alphabets can be used for the first letter.



   (As an alternative to clicking the <Teach> button, on the [Points] tab you can type in the coordinates of the point.)

Saving your work

Robot Manager MDI Child

To save your work, use the [File] menu to select [Save]. You can also execute [Project]-[Save] or click the <Save all files> toolbar button.

When you want to restore the data without saving the point files, select [Restore] from the [File] menu.

Robot Manager Dialog

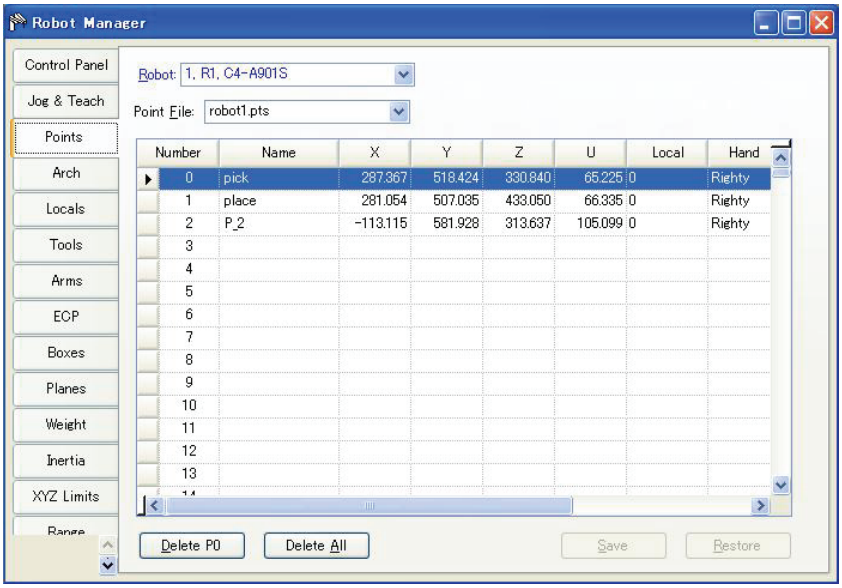
When you close the [Robot Manager], you will be prompted if you want to save your changes. Answer <Yes> to make your changes permanent or <No> to cancel saving of the changes.

[Tools]-[Robot Manager]-[Points] Page

You can input/delete the point data. When a point file is selected, the robot controller loads the file into memory.

As points are taught on the [Robot Manager]-[Jog & Teach] page, the spreadsheet on the Points page is updated.

When the Robot Manager is used as an MDI child window, you can save the point data by typing Ctrl + S to the point file.

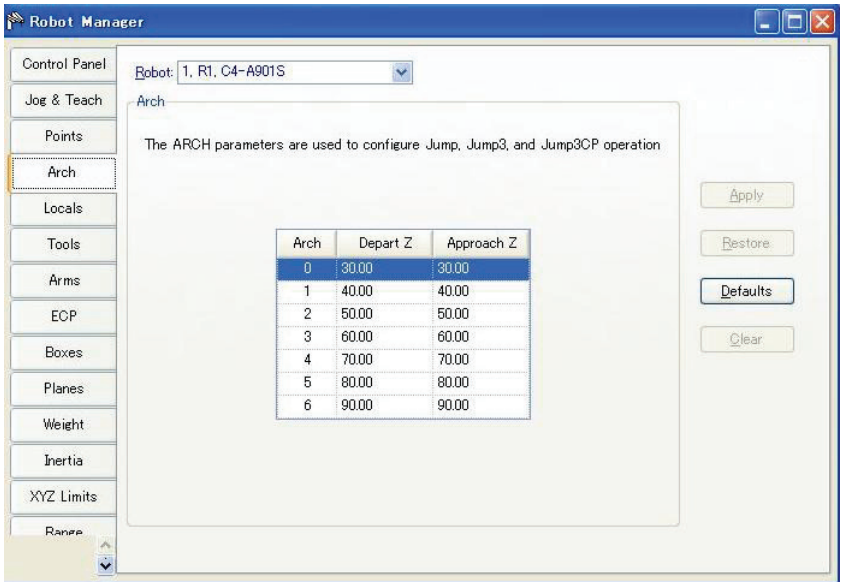


Item	Description
Robot	Select a robot.
Point File	Select a point file.
Delete Pxxx	Deletes the selected point. You will be prompted to confirm the operation.
Delete All	Deletes all points in the file. You will be prompted to confirm the operation.
Save	Saves the current values.
Restore	Reverts back to the previous values. You will be prompted to confirm the operation.

[Tools]-[Robot Manager]-[Arch] Page

This page allows you to configure the depart Z and approach Z settings in the robot's Arch table. Arch is used for the Jump, Jump3, and Jump3CP motion commands. There are seven different setting pairs in the Arch table.

For details on using Arch, see the *SPEL+ Language Reference: Arch Statement*.



To change Arch settings

1. Put the cursor in the Depart Z or Approach Z cell of the row you want to change.
2. Type in the new value.

Press the TAB key to move to the next cell.

Item	Description
Robot	Select a robot.
Apply	Set the current values.
Restore	Reverts back to the previous values.
Defaults	Click the defaults button to display factory default settings.

[Tools]-[Robot Manager]-[Locals] Page

This page allows you to define local coordinate systems for a robot. When the page is selected, the current values are displayed.

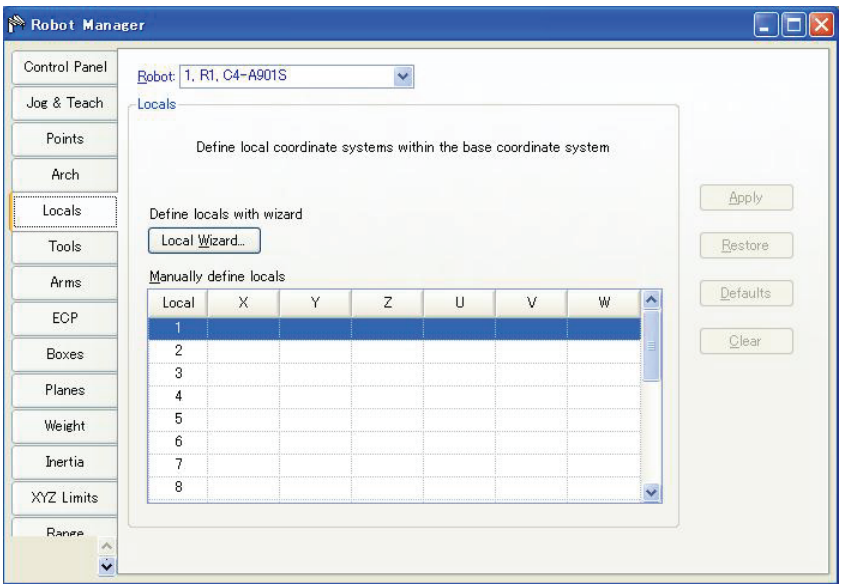
A grid is used to display all of the values for the locals you can define. Local "0" is the base coordinate system and cannot be changed from this page.

NOTE

To change the base coordinate system, use the Base command from the command window. See the SPEL+ Language Reference for more information.

When a local is undefined, then all fields for that local will be blank. When you enter a value in any of the fields for an undefined local, then the remaining fields will be set to zero and the local will be defined when you click the <Apply> button.

For details on using Local, see the *SPEL+ Language Reference: Local Statement*.



Navigating the grid

Use the TAB key to move to the next field. Use the arrow keys or the mouse to move to any field.

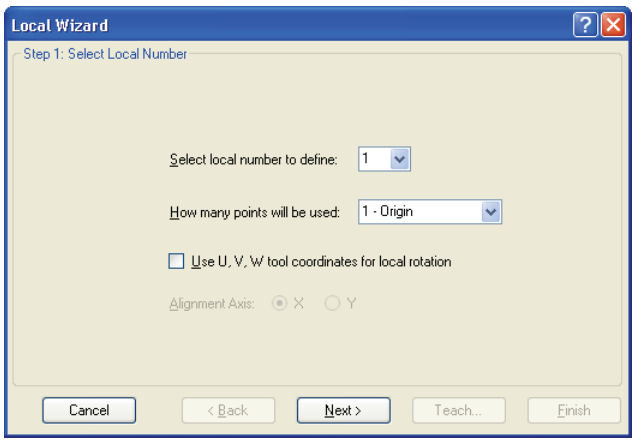
Item	Description
Local Wizard	Click this button to start the Local Wizard. Follow the instructions for each step to define a local. See details in the next section.
X	The X coordinate of the local origin in the base coordinate system.
Y	The Y coordinate of the local origin in the base coordinate system.
Z	The Z coordinate of the local origin in the base coordinate system.
U	Rotation angle of the local about the base Z axis (roll).
V	Rotation angle of the local about the base Y axis (pitch).
W	Rotation angle of the local about the base X axis (yaw).
Apply	Saves the current changes.
Restore	Reverts back to the previous values.
Clear	Clears all values for the selected local.

Using the Local Wizard

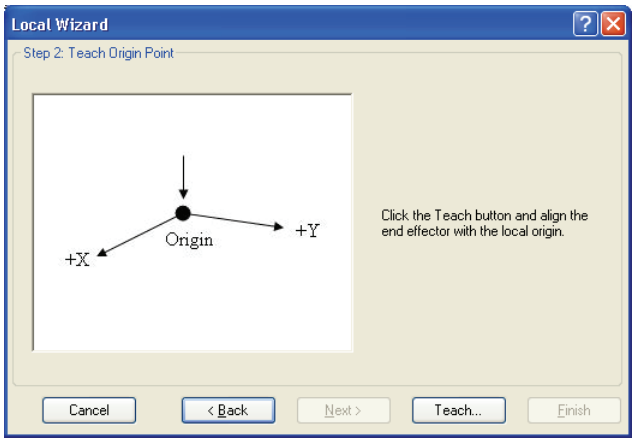
A wizard is provided for defining a local coordinate system. You can define a local using a single point or three points, as described in the following sections.

Using the Local Wizard to teach a single point local

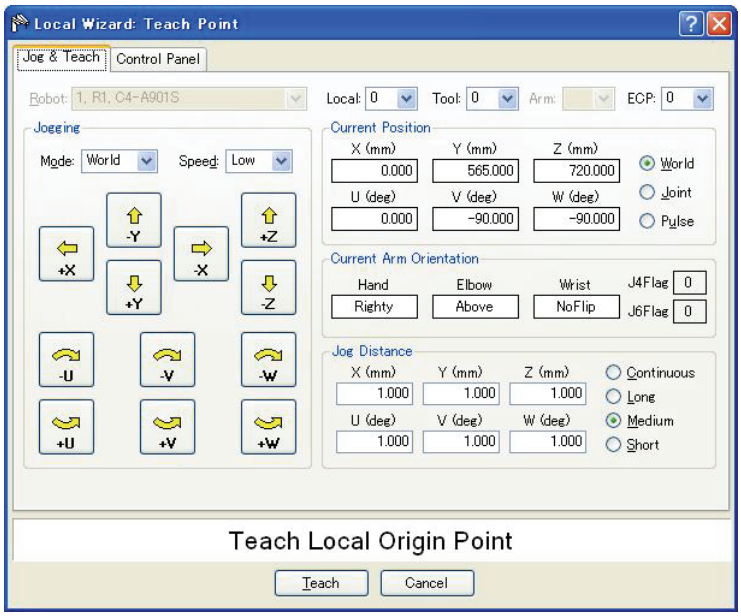
1. Open the [Robot Manager] and click on [Locals] to show the [Locals] page.
2. Click the <Local Wizard> button. You will see the dialog shown below.



3. Select the local number you want to define. For [How many points will be used], select [1 – Origin]. Since this is a single point local, you will just teach the origin of the new coordinate system. If you want to use the U, V, or W axes for the orientation of the coordinate system, check the [Use U, V, W tool coordinates for local rotation] checkbox. If this checkbox is unchecked, the new coordinate system is offset from local 0 in X and Y, but is not rotated about any axis. Click the <Next> button.

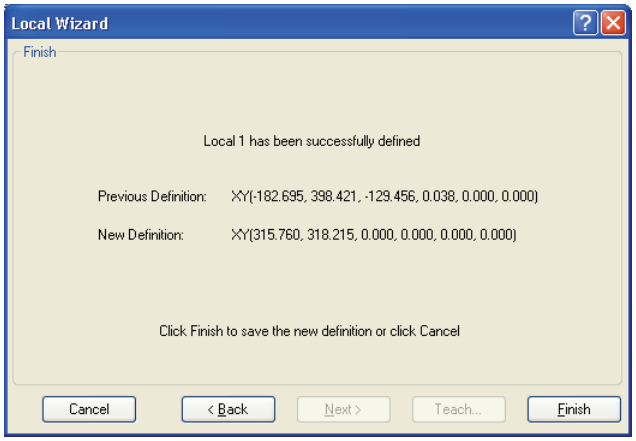


4. We will now teach the local origin point. Click the <Teach> button to open the [Local Wizard Teach Point] dialog box.



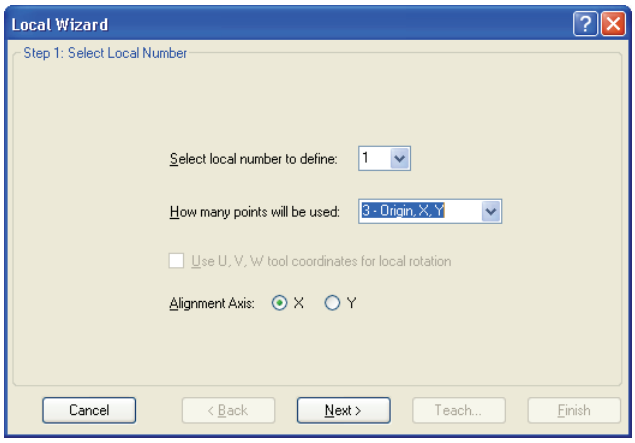
5. Jog the robot until the end effector is aligned with the local origin point. Then click the <Teach> button.

6. The new local definition is displayed as shown below. Click <Finish> to accept the new definition.

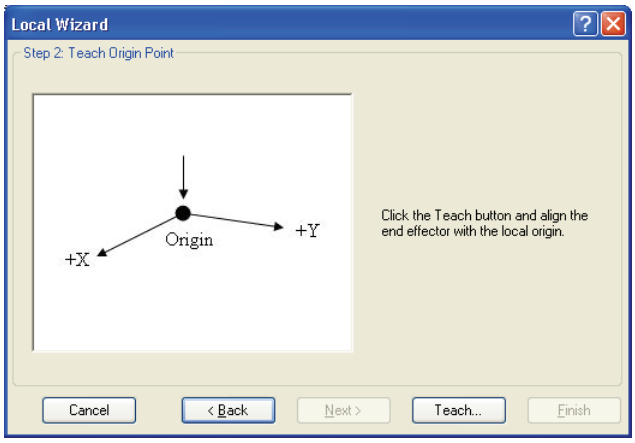


Using the Local Wizard to teach a three point local

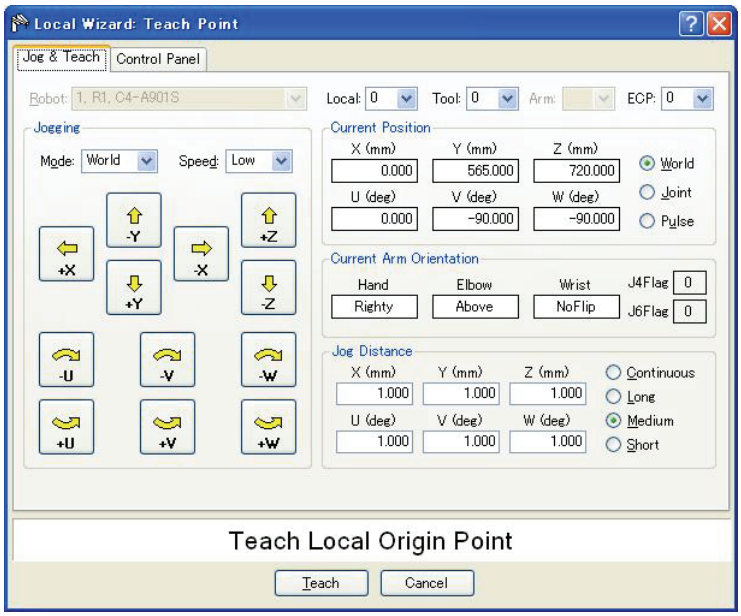
1. Open the [Robot Manager] and click on [Locals] to show the [Locals] page.
2. Click the <Local Wizard> button. You will see the dialog shown below.



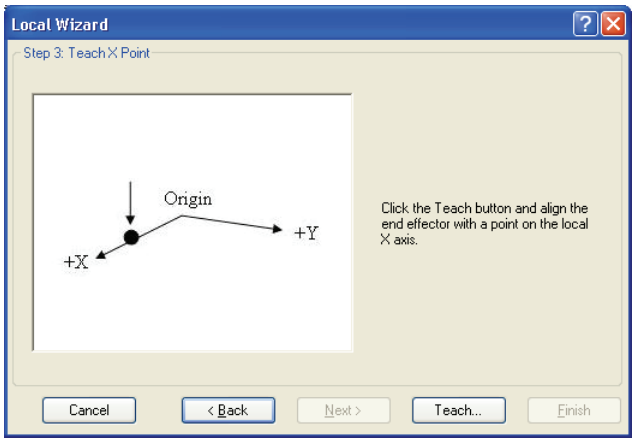
3. Select the local number you want to define. For [How many points will be used], select [3 - Origin, X, Y]. Since this is a three point local, you will teach the origin of the new coordinate system, and then teach one point anywhere along the X axis and one point anywhere along the Y axis. Select which axis will be used to align the coordinate system. For example, if you select X, then the new coordinate system X axis will be aligned to the X axis point that you will teach in a later step. The Y axis point will be used to determine tilt. Click the <Next> button.



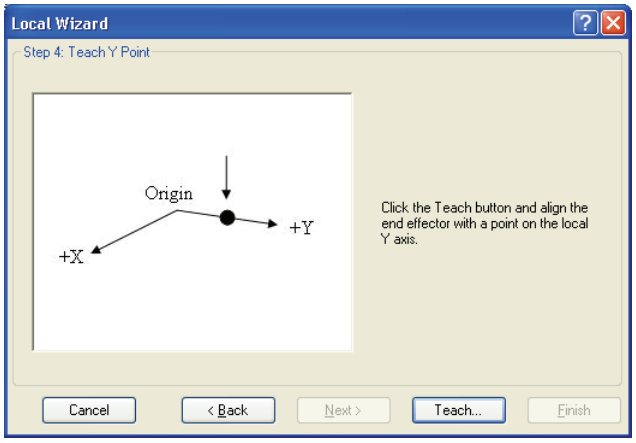
4. We will now teach the local origin point. Click the <Teach> button to open the [Local Wizard: Teach Point] dialog.



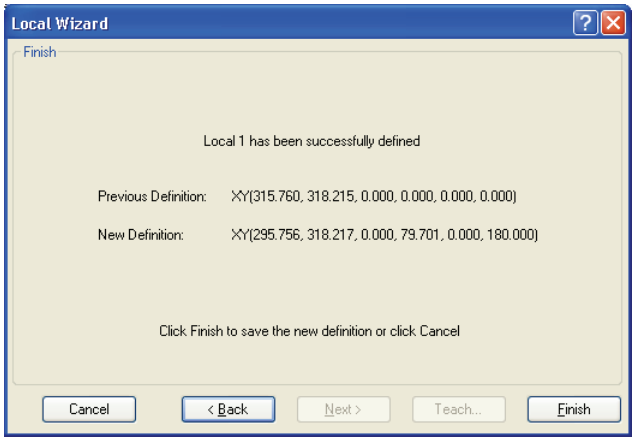
5. Jog the robot until the end effector is aligned with the origin point. Then click the <Teach> button. The next step will be displayed.



6. We will now teach a point on the local X axis. Click the <Teach> button and jog the robot until the end effector is aligned with a point anywhere along the X axis of the new coordinate system. Click the <Teach> button on the [Teach Point] dialog box to continue.



7. We will now teach a point on the local Y axis. Click the <Teach> button and jog the robot until the end effector is aligned with a point anywhere along the Y axis of the new coordinate system. Click the <Teach> button on the [Teach Point] dialog box to continue.
8. The new local definition is displayed as shown below. Click <Finish> to accept the new definition.



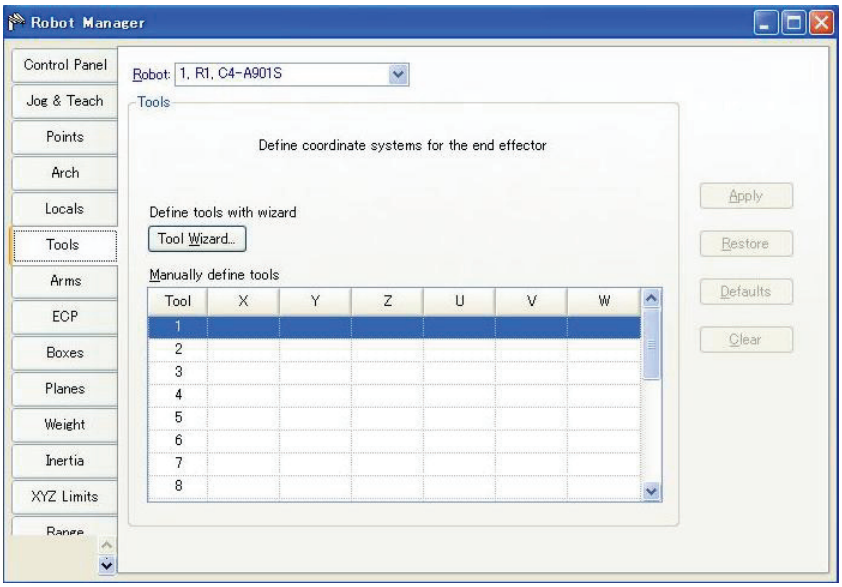
[Tools]-[Robot Manager]-[Tools] Page

This page allows you to define tool settings for a robot. When the tab is selected, the current values are displayed.

A grid is used to display all the values for all 15 tools you can define.

When a tool is undefined, then all fields for that tool will be blank. When you enter a value in any of the fields for an undefined tool, then the remaining fields will be set to zero and the tool will be defined when you click the <Apply> button.

For more information on tools, see the *SPEL+ Language Reference: TLSet Statement*.



Navigating the grid

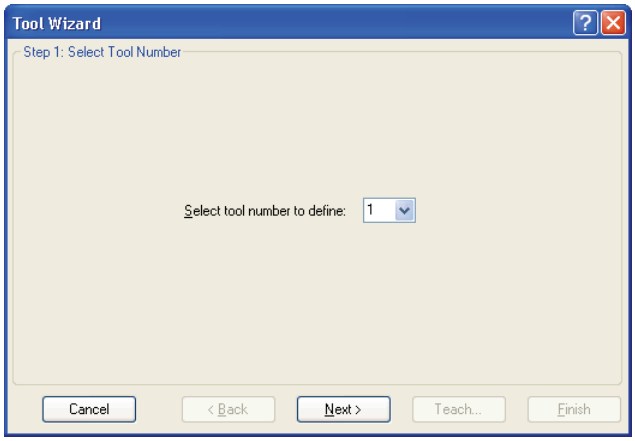
Use the <TAB> key to move to the next field. Use the arrow keys or the mouse to move to any field.

Item	Description
Robot	Select a robot.
Tool Wizard	This button starts the Tool Wizard. Follow the instructions for each step of the wizard to define a tool. See details in the next section.
X	The X coordinate of the tool.
Y	The Y coordinate of the tool.
Z	Z offset of tool.
U	Rotation angle of the tool about the Z axis (roll).
V	Rotation angle of the tool about the Y axis (pitch).
W	Rotation angle of the tool about the X axis (yaw).
Apply	Sets the current values.
Restore	Reverts back to the previous values
Clear	Clears all values for the selected tool.

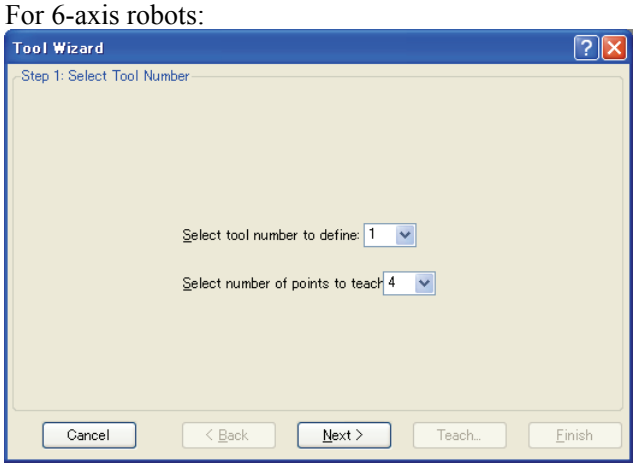
Using the Tool Wizard

1. Open the [Robot Manager] and click on [Tools] to show the [Tools] page.
2. Click the <Tool Wizard> button. You will see the dialog shown below.

   For SCARA robots:



   For 6-axis robots:

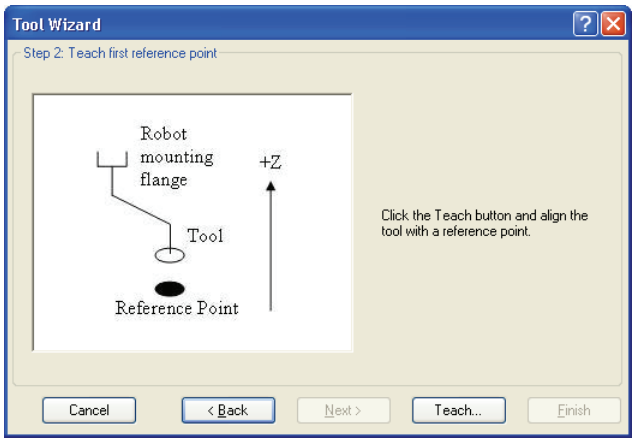


3. Select the tool you want to define (and the number of points to teach if you use 6-axis robots) and click <Next>.

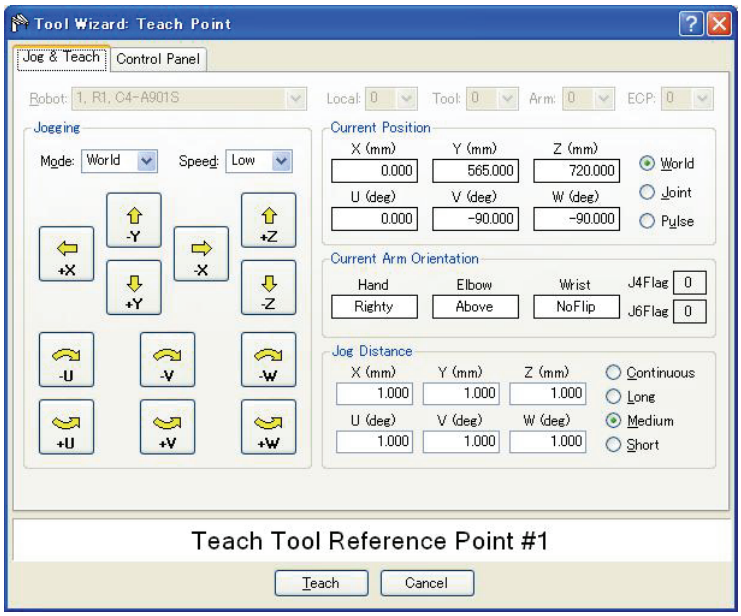
   The "number of points to teach" is the amount of times to teach the same point (reference point) in the robot motion range while changing only the tool direction. The number to teach should be at least three. Although it depends on the teaching accuracy of each point, more accurate tool setting can be set by increasing the number.

NOTE

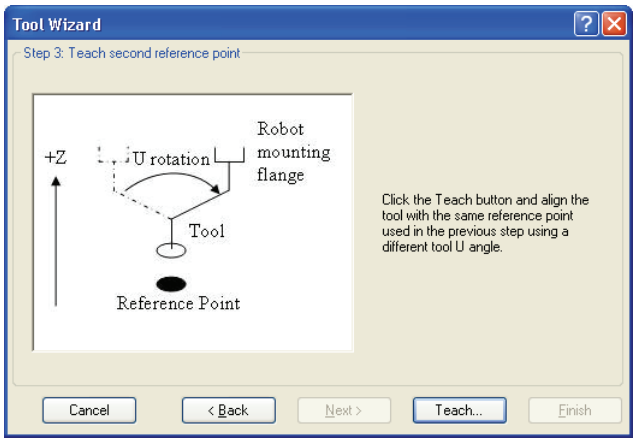
To increase the tool setting accuracy, set the angle of approximately 10 degrees or more for J5 pulse in order to avoid singularity near 0 degree when teaching the reference point.



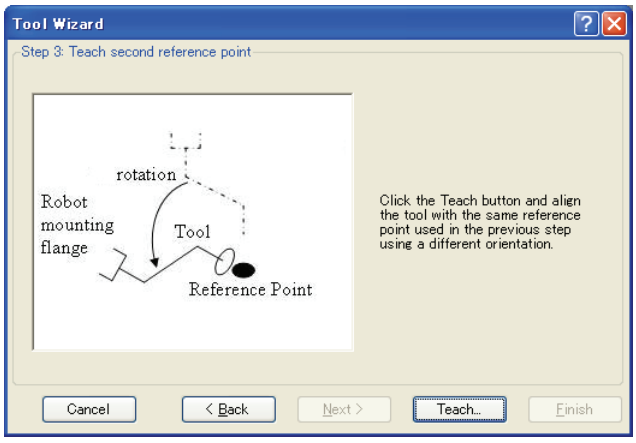
4. Click the <Teach> button to open the [Tool Wizard Teach Point] dialog box.



5. Jog the robot until the tool is aligned with the reference point. Then click the <Teach> button. The next step will be displayed in the wizard.
For SCARA robots:

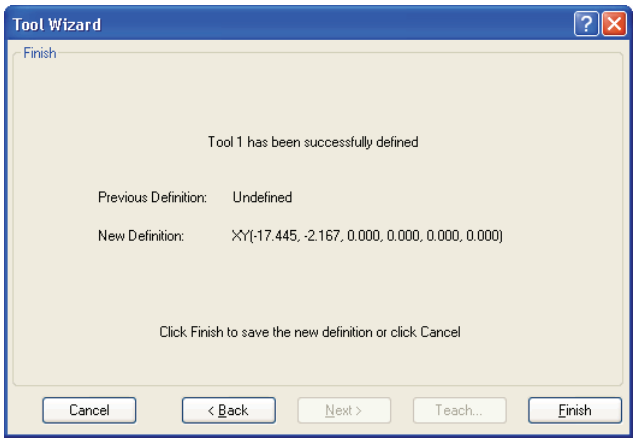


For 6-axis robots:



6. Click the <Teach> button. Jog the robot so that the tool is aligned with the reference point, but from another U angle. To do this, jog the U axis several degrees, then jog X & Y until the tool is aligned with the reference point. After you have finished jogging to the reference point, click <Teach>.

7. For 6-axis robots only: Jog the robot back to the reference point from other U, V, and W positions. That is, jog the robot to the reference point by rotating the U, V, and W changing the tool orientation 45 degrees. Then click <Teach>. Repeat teaching until the robot can reach the reference point from other tool orientation as often as you specified in (3).
8. The new tool definition is displayed as shown below. Click <Finish> to accept the new definition.



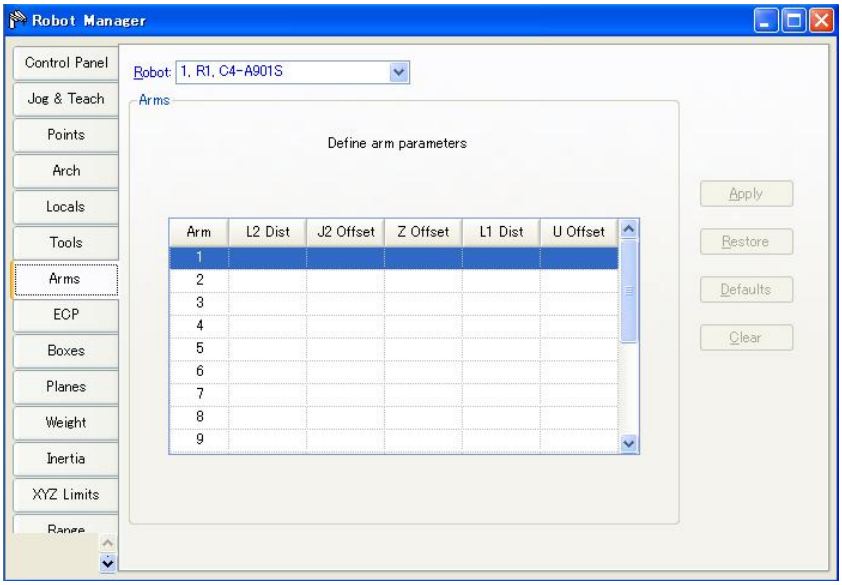
[Tools]-[Robot Manager]-[Arms] Page

This page allows you to define Arm settings for a robot. When the tab is selected, the current Arm values are displayed. The tab is disabled if the current robot does not support the Arm command.

A grid is used to display all the values for all 15 arm configurations you can define.

When an arm is undefined, then all fields for that arm will be blank. When you enter a value in any of the fields for an undefined arm, then the remaining fields will be set to zero and the tool will be defined when you click the <Apply> button.

For more information on arm parameters, see the *SPEL+ Language Reference: ArmSet Statement*.



Navigating the grid

Use the <TAB> key to move to the next field. Use the arrow keys or the mouse to move to any field.

Item	Description
Robot	Select a robot.
L2 Dist	Distance between the center of joint 2 and the center of the orientation joint in millimeters.
J2 Offset	Angle of the line from the center of joint 2 to the center of the orientation joint in degrees.
Z Offset	The Z offset between the new orientation axis and the standard orientation axis.
L1 Dist	Distance between the center of the shoulder joint and the center of the elbow joint in millimeters.
U Offset	The angle offset between the standard orientation zero position and the new orientation axis zero position in degrees.
Apply	Set current values.
Restore	Revert to the previous values.
Clear	Clear all values for the selected arm

[Tools]-[Robot Manager]-[ECP] Page

This page allows you to define ECP (external control point) settings for a robot. When the page is selected, the current values are displayed.

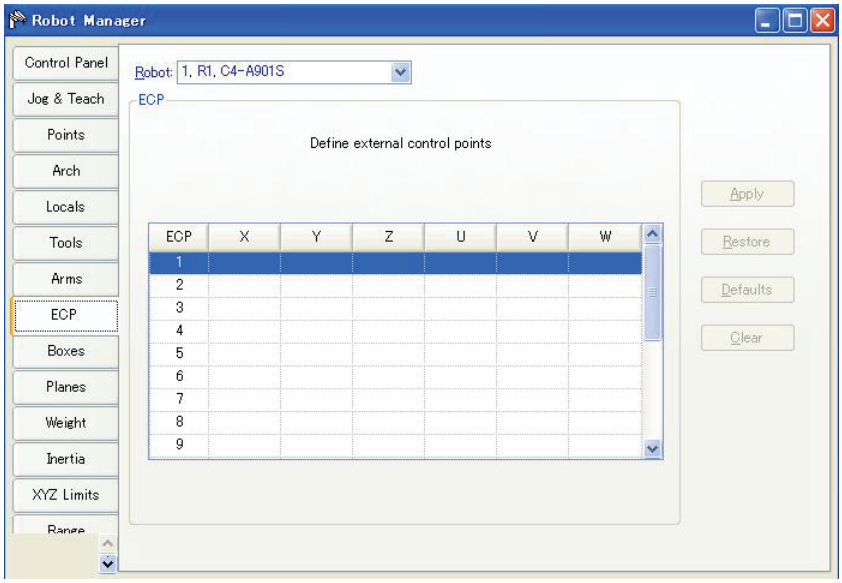
NOTE

If the ECP option is not enabled in the controller, this page will not be visible.

For detailed information on using external control points in your application, refer to *6.16.5 ECP Coordinate Systems (Option)*.

A grid is used to display all of the values for all ECPs you can define.

When an ECP is undefined, then all fields for that ECP will be blank. When you enter a value in any of the fields for an undefined ECP, then the remaining fields will be set to zero and the ECP will be defined when you press the <Apply> button.



Navigating the grid

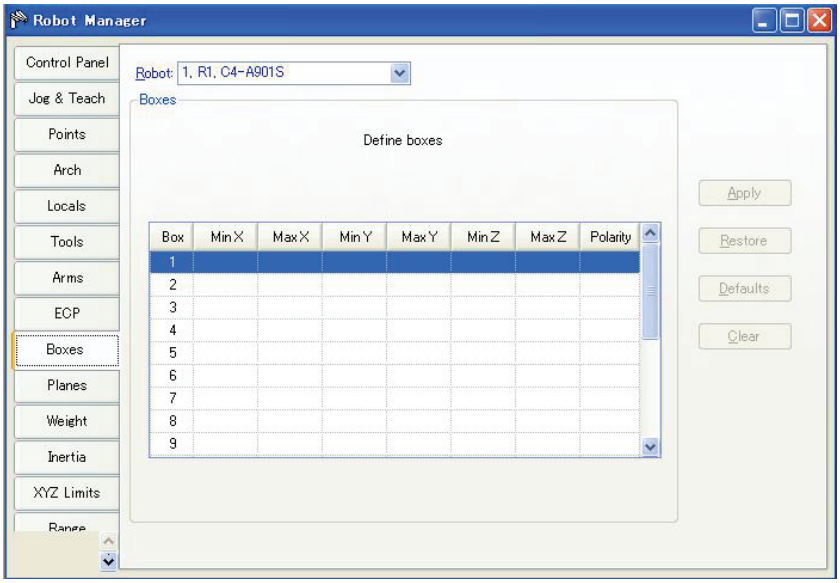
Use the <TAB> key to move to the next field. Use the arrow keys or the mouse to move to any field.

Item	Description
Robot	Select a robot.
X	The X coordinate of the ECP.
Y	The Y coordinate of the ECP.
Z	The Z coordinate of the ECP.
U	Rotation angle of the ECP about the Z axis (roll).
V	Rotation angle of the ECP about the Y axis (pitch).
W	Rotation angle of the ECP about the X axis (yaw).
Apply	Set current values.
Restore	Revert back to the previous values.
Clear	Clear all values for the selected ECP.

[Tools]-[Robot Manager]-[Box] Page

This page allows you to define Box (approach check area) settings for a robot. When the page is selected, the current values are displayed. When a Box is undefined, then all fields for that Box will be blank. When you enter a value in any of the fields for an undefined Box, then the remaining fields will be set to zero and the Box will be defined when you press the <Apply> button.

For more information on Box, see the *SPEL+ Language Reference: Box Statement*.



Navigating the grid

Use the <TAB> key to move to the next field. Use the arrow keys or the mouse to move to any field.

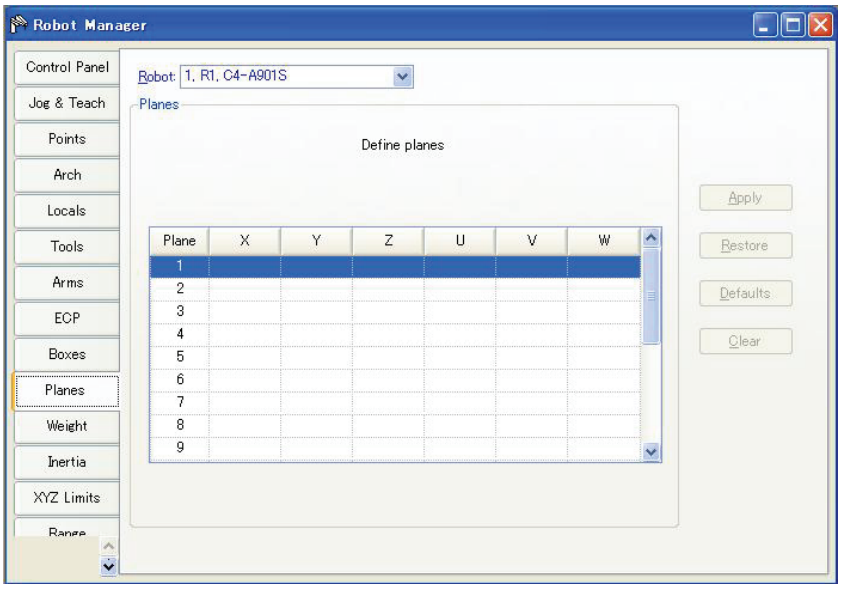
Item	Description
Robot	Select a robot.
Min X	Type in the minimum X limit value in millimeters.
Max X	Type in the maximum X limit value in millimeters.
Min Y	Type in the minimum Y limit value in millimeters.
Max Y	Type in the maximum Y limit value in millimeters.
Min Z	Type in the minimum Z limit value in millimeters.
Max Z	Type in the maximum Z limit value in millimeters.
Polarity	Sets the polarity to output I/O at approach check.
Apply	Sets current values.
Restore	Reverts back to the previous values.
Clear	Clears all values.

Setting both values to zero disables the limits.

[Tools]-[Robot Manager]-[Plane] Page

This page allows you to define Plane (approach check plane) settings for a robot. When the page is selected, the current values are displayed. When a Plane is undefined, then all fields for that Plane will be blank. When you enter a value in any of the fields for an undefined Plane, then the remaining fields will be set to zero and the Plane will be defined when you press the <Apply> button.

For more information on Plane, see the *SPEL+ Language Reference: Plane Statement*.



Navigating the grid

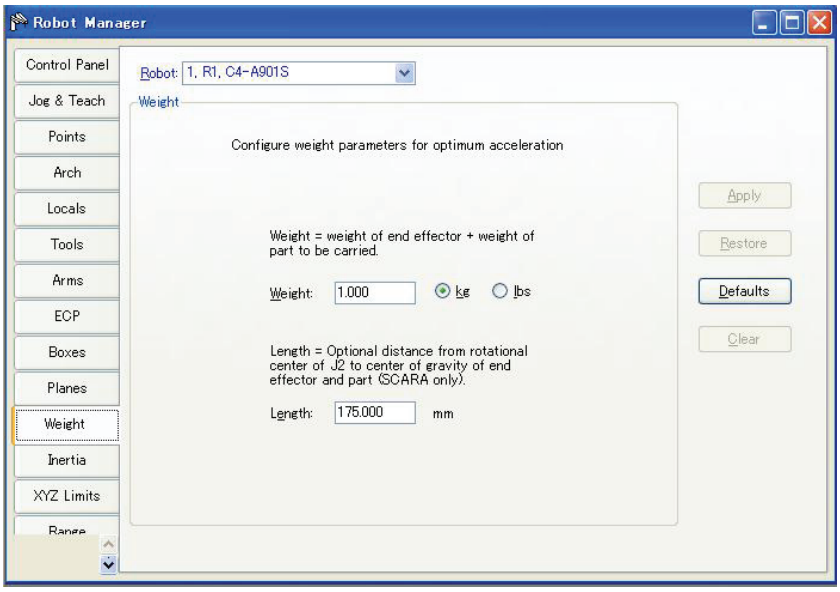
Use the <TAB> key to move to the next field. Use the arrow keys or the mouse to move to any field.

Item	Description
Robot	Select a robot.
X	Sets the X origin of the coordinate for approach check plane.
Y	Sets the Y origin of the coordinate for approach check plane.
Z	Sets the Z origin of the coordinate for approach check plane.
U	Sets the U origin of the coordinate for approach check plane.
V	Sets the V origin of the coordinate for approach check plane.
W	Sets the W origin of the coordinate for approach check plane.
Apply	Set current values.
Restore	Revert back to the previous values.
Clear	Clear all values.

[Tools]-[Robot Manager]-[Weight] Page

This page is for changing the Weight parameters for the robot.

For details on the Weight parameters, see the *SPEL+ Language Reference: Wight Statement*.

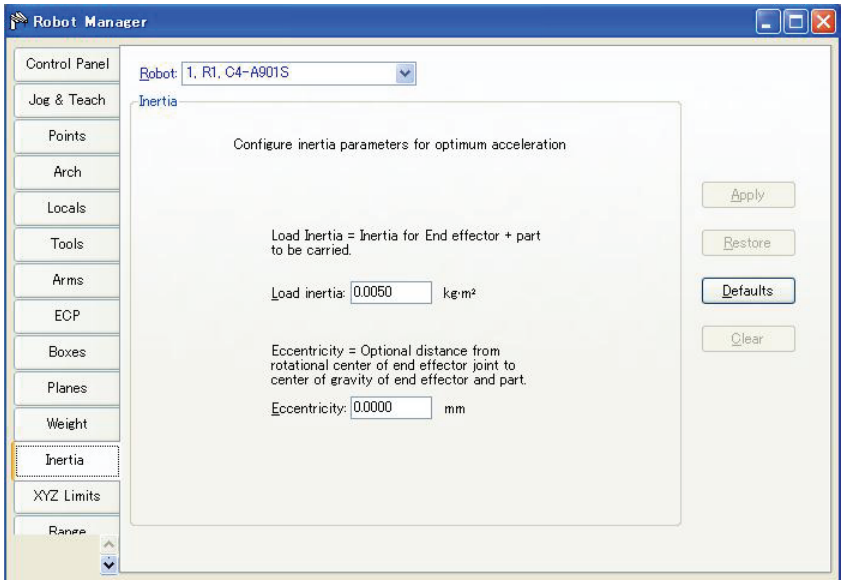


Item	Description
Robot	Select a robot.
Weight	Type in the new total weight of the payload on the robot.
Kg/Lb	Choose which unit the weight is represented in: kilograms or pounds.
Length	Type in the new length.
Apply	Sets the current values.
Restore	Reverts back to the previous values.
Defaults	Displays factory default settings.

[Tools]-[Robot Manager]-[Inertia] Page

This page is for changing the Inertia parameters.

For details on the Inertia parameters, see the *SPEL+ Language Reference: Inertia Statement*.

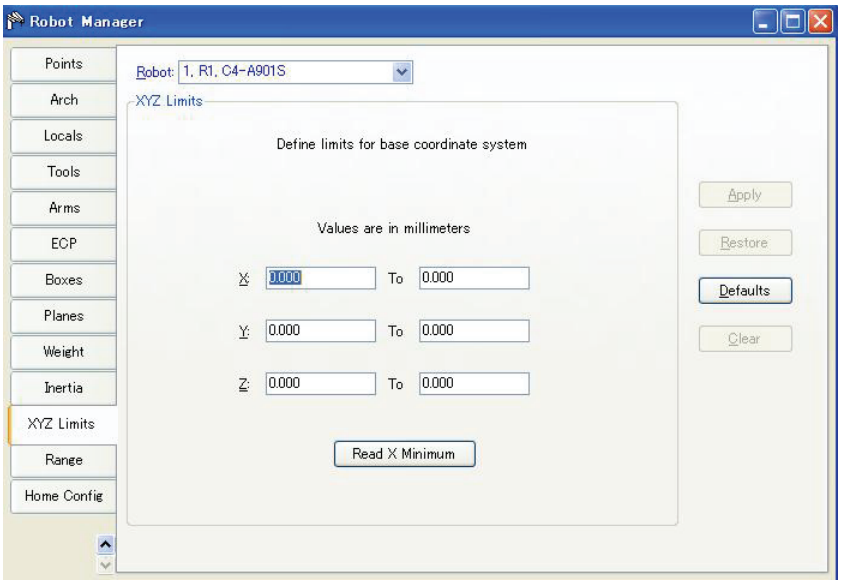


Item	Description
Robot	Select a robot.
Load inertia	Type in the new load inertia of the payload on the robot in kg·m^2. This includes the inertia of end effector plus the part to be carried.
Eccentricity	Type in the new eccentricity value in millimeters. This is the distance from rotational center of joint 4 to the center of gravity of end effector and part.
Apply	Set the current values.
Restore	Revert back to the previous values.
Defaults	Press the defaults button to display factory default settings.

[Tools]-[Robot Manager]-[XYZ Limits] Page

This page allows you to configure limits for X, Y and Z motion in the robot envelope.

For details on the XYZ limits, see the *SPEL+ Language Reference: XYLim Statement*.



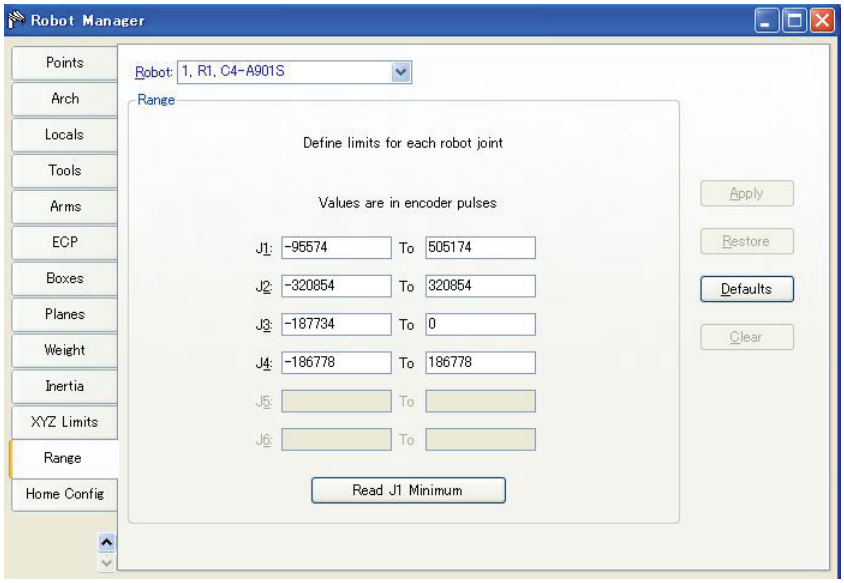
Item	Description
Robot	Select a robot.
X, Y, Z	Type in the minimum and maximum X, Y, and Z limit values. Setting both values to zero disables the limits.
Read Current	Click this button to read the value from the current robot position. The button text shows the axis and minimum or maximum depending on which text field has the current focus.
Apply	Set the current values.
Restore	Revert back to previous values.
Defaults	Set default values.

[Tools]-[Robot Manager]-[Range] Page

This page allows you to configure the robot joint software limits.

For more information on Range, see the SPEL+ Language Reference and the manual for the robot you are using.

For details on configuring the motion range, see the *SPEL+ Language Reference: Range Statement*.

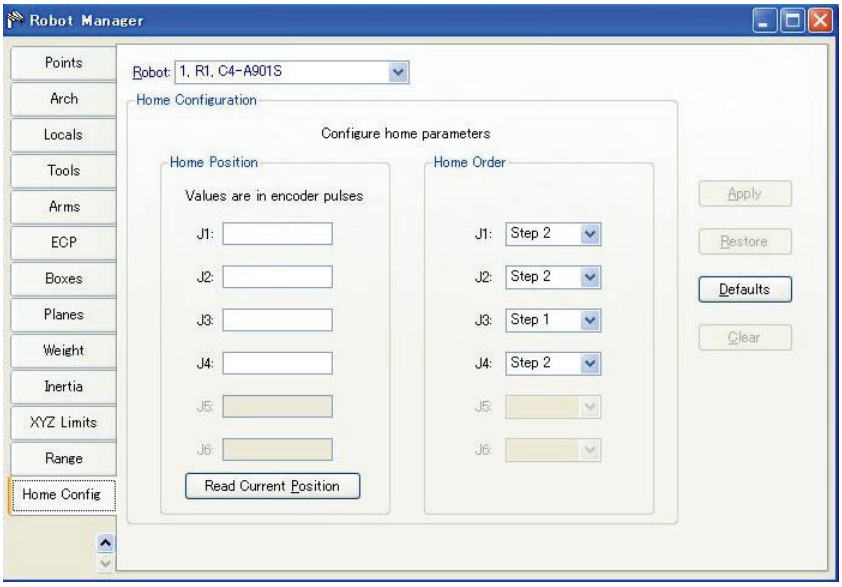


Item	Description
Robot	Select a robot.
J1 - J6	Type in the minimum and maximum encoder pulse values for each joint.
Read Current	Click this button to read the current joint value of the robot into the currently field. The button text will change depending on which text field has focus.
Apply	Save the current changes.
Restore	Revert back to the previous values.
Defaults	Set the default values.

[Tools]-[Robot Manager]-[Home Config] Page

Home Config allows you to configure the optional user home position.

For details on configuring the home position, see the *SPEL+ Language Reference: HomeSet Statement*.



Changing home position

When you select the [Home Config] tab, the current home position is read from the robot controller and displayed in the text boxes. If the home position has never been defined, then the text boxes will be blank.

To define the home position, you can enter an encoder position value for each of the four robot joints in the text boxes, or you can select the [Jog & Teach] page to jog the robot to the desired home position, then select the [Home Config] page and click the <Read Current Position> button to read the current encoder position values.

Changing home order

The home command executes in steps. The number of steps equals the number of joints on the robot. Select the home step number for each joint using the dropdown list for each joint. More than one joint can be homed in the same step.

Testing home

After making changes to the home position and home order, you can click the [Robot Manager]–[Control Panel] tab and click the <Home> button.

Item	Description
Robot	Select a robot.
Read Current	Click this button to read the current position encoder pulse value into the currently selected text field. The button text will change according which text field is selected.
Defaults	Set the value of the [Home order] group box to the default value.
Apply	Save the current changes.
Restore	Revert back to the previous values.

5.11.2 [Command Window] Command (Tools Menu)

You can execute SPEL+ commands from the robot controller and view the results.

To open the Command window

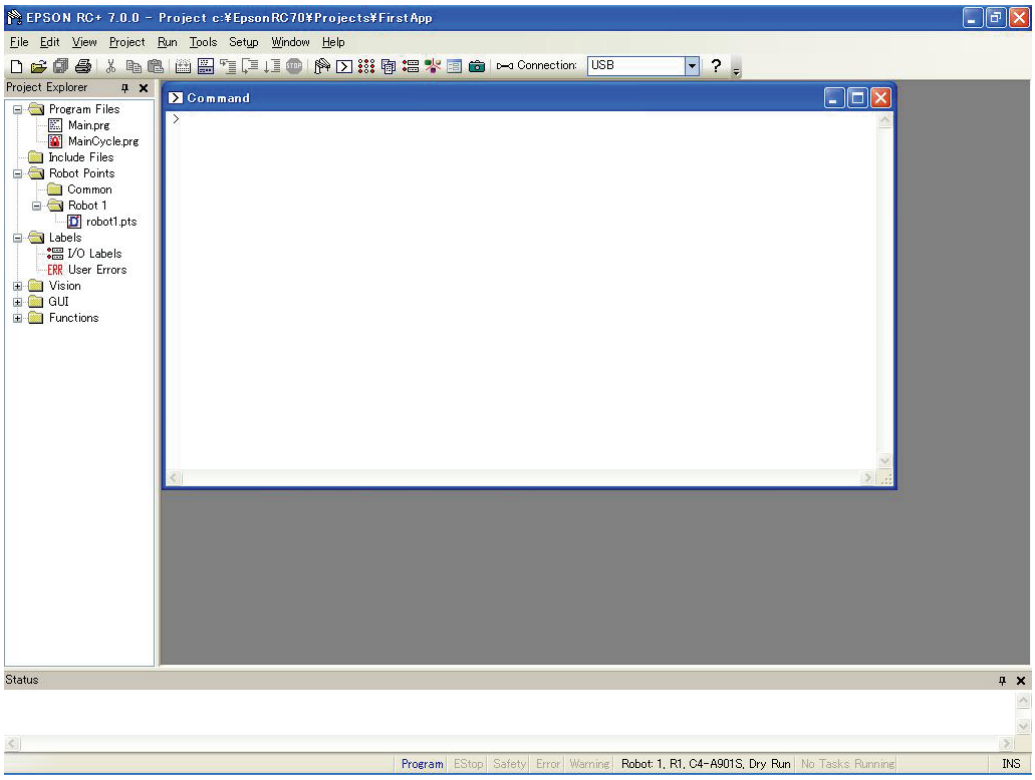
Select Command Window from the Tools Menu

Or

Click on the button on the toolbar.

Or

Type Ctrl+M



To execute SPEL+ commands from the Command window

1. Type in the desired command after the prompt (>). Commands can be entered in upper or lower case.
2. Press <Enter> to execute the command. The cursor can be anywhere on the line when you press <Enter>.
3. Wait for the prompt to return before typing in a new command.

When an error occurs, an error number will be displayed along with an error message.

You can use the arrow keys or the mouse to move the cursor to any line in the window that starts with a prompt (>) character and execute it by pressing <Enter>.

Command Window Keys

Key	Action
Ctrl+A	Select entire window.
Ctrl+C	Stop the program and initialize robot controller. If a robot motion command is in progress, the prompt will return when the command has been completed.

Key	Action
Ctrl+V	Execute Paste command. Paste from Clipboard to current selection.
Ctrl+W	Re-display last command line after the prompt.
Ctrl+X	Execute Cut command. Cut current selection and put in Clipboard.
Ctrl+Z	Undo last change.
Ctrl+Home	Go to the top of the window.
Ctrl+End	Go to last prompt at end of the window.
?	Translates to "PRINT " when used as the first character of a command. This can be used to display variables or any statement that requires a PRINT command.

5.11.3 [I/O Monitor] Command (Tools Menu)

The I/O Monitor window lets you monitor all controller hardware inputs and outputs and also memory I/O. There are up to four views available: one standard view and three custom views.

On the standard view, there are two grids. For each grid you can specify which type and size of I/O to monitor.

For each custom view, you can specify a list of any combination of input, output, or memory. By default, there is one custom view available. To use the other two custom views, right click on a tab and check the views you want to be visible. See the section *Custom I/O Views* later in this chapter.

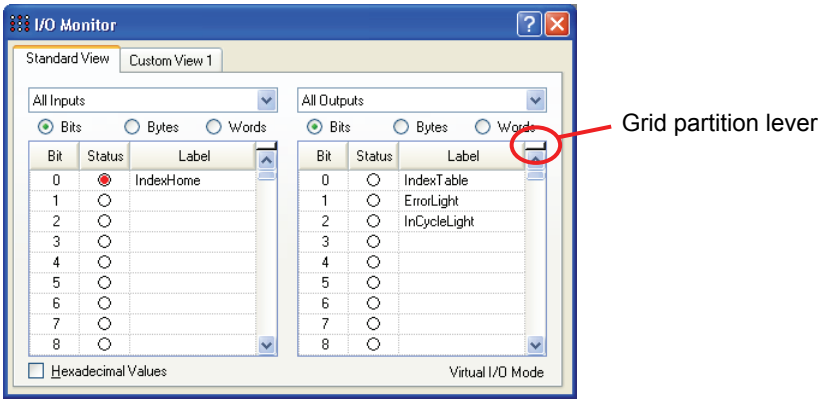
Labels that have been defined using the [I/O Label Editor] are displayed next to each bit, byte, or word.

After the [I/O Monitor] window has been opened, the input and output status for the current view is constantly updated.

The I/O monitor will always be displayed on top of other child windows, such as program windows and point windows.

If a description has been entered for an I/O port (bit, byte, or word) in the I/O Label Editor, then a tool tip will be displayed when the mouse pointer is over the row containing the port.

You can turn outputs on and off by double clicking on the output LED images in the Status column.



To open the I/O Monitor

Select I/O Monitor from the Tools Menu.

Or

Click on the tool bar button.

Or

Type Ctrl + I.

Using the I/O Monitor

Select the [Standard View] tab.

Scroll through the grids to locate the desired inputs or outputs to monitor.

You can split each grid into two scroll regions by selecting the split bar in the upper right corner of the grid and dragging it down. Each scroll region can be individually scrolled.

To turn an output off or on, double click on the LED image for the desired output.

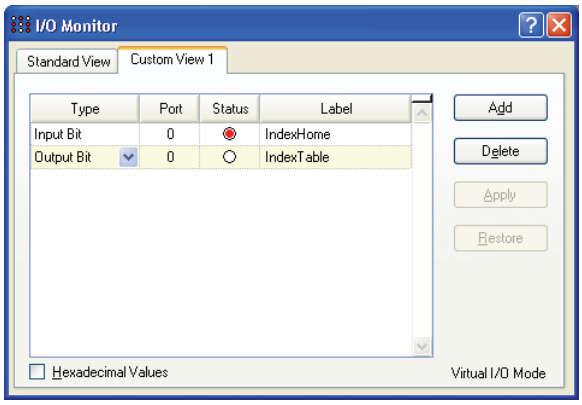
When Virtual I/O is active, you can turn input bits on and off by double clicking on the input LED images in the Status column.

To view bytes and words in hexadecimal format, check the [Hexadecimal Values] checkbox.

You can resize the I/O monitor in the vertical direction to show more data. Move your mouse pointer to the lower right corner of the window to activate a size handle, then click down and drag the window down or up to the desired size.

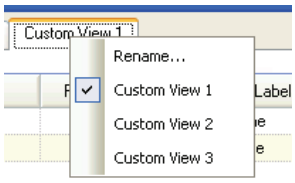
Custom I/O Views

You can configure up to three custom I/O views. In each view, you can add any combination of I/O. You can also change the name of each view and hide each view.



To change a view

1. Click on a custom view tab. If none are currently shown, right click on the [Standard View] tab and select one of the three custom views to show it.



2. Click the <Add> button to add a new row to the list.
3. Select the <Type> by clicking in the [Type] column, then click the arrow to view a list of I/O types and select one.

4. In the [Port] column, select the port (bit, byte, or word, depending on I/O type).
5. Add more rows as needed by repeating steps 2 - 4.

<Apply>:	Save the changes
<Delete>:	Delete a row
<Restore>:	Cancel changes.

To rename a view

1. Click on a custom view tab. If none are currently shown, right click on the [Standard View] tab and select one of the three custom views to show it.
2. Right click on the view tab and select [Rename].
3. Enter the new name for the view.

5.11.4 Task Manager Command (Tools Menu)

The Task Manager window allows you to Halt (suspend), Resume (continue), and Quit (abort) tasks.

To open the Task Manager

Select Task Manager from the Tools Menu.

Or

Type Ctrl + T.

Or

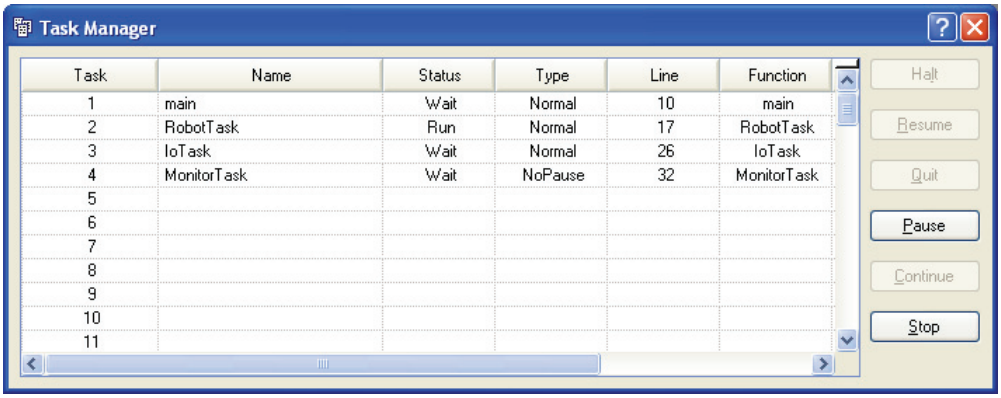
Click on the button on the toolbar.

Operation

The Task Manager is used for suspending, resuming, stepping, and stopping tasks.

When Task Manager is started, you will see a grid containing status information for 32 tasks standard tasks and 11 trap tasks. Also, you will see the status information of 16 background tasks if the background task is enabled. There are 8 items shown for each task. To view all of the columns, use the scroll bar or resize the window.

Task	Number of task from 1 to 32 and 11 trap tasks.
Name	Name of the function that was started as a task.
Status	Current task status: Run, Wait, Halt, Pause, Aborted, Finished.
Type	Task types Normal — This task is a normal task NoPause — This task does not pause with Pause statement or when Pause input or Safety Door open occur. NoEmgAbort — This task continuously processes during the Emergency Stop or error occurrence.
Line	Current task line number.
Function	Current task function name.
Program	Current task program name.
Start	The date and time that the task was started.



Item	Description
Halt	Suspends the selected task. The halted task can be resumed by the <**Resume**> button. **Halt** can only be executed when a task is running (status is Run). When **Halt** is executed, the <**Resume**> button will be enabled. If a motion command associated with **Halt** is executed, the motion will be completed before the task reaches the **Halt** state. The task also temporarily stops when the task is NoPause type or NoEmgAbort type.
Resume	After one or more tasks are suspended with the <Halt> button, clicking <Resume> make the halted tasks continue where they left off. First, a confirmation dialog is displayed.
Quit	This button stops the selected task permanently. You cannot resume a task once you have executed Quit. To restart the task, you must start it from within a program or from the Run window. The task also stops when the task is NoPause type or NoEmgAbort type.
Pause	This button pauses tasks that can be paused. After pause, you must use either <Continue> or <Stop>. The task does not pause when the task is NoPause type or NoEmgAbort type.
Continue	This button continues all tasks that were paused with the <Pause> button.
Stop	This button stops all tasks.

To Halt, Step, Walk, and Resume a task

The <Halt> button will become active after you select a running task.

Click the <Halt> button to stop the task you selected for a moment.

After a task has been halted, the source code will be displayed and the next step will be indicated. You can click on the <Resume> button to resume execution. (You can also execute [Step Into], [Step Over], or [Walk] from the [Run] Menu.)

To Pause and Continue tasks

Pause allows you to "suspend" all tasks that can be suspended.

Click on the <Pause> button to pause available tasks. The robot will decelerate to a stop immediately.

After executing Pause, click on <Continue> to resume all suspended tasks.

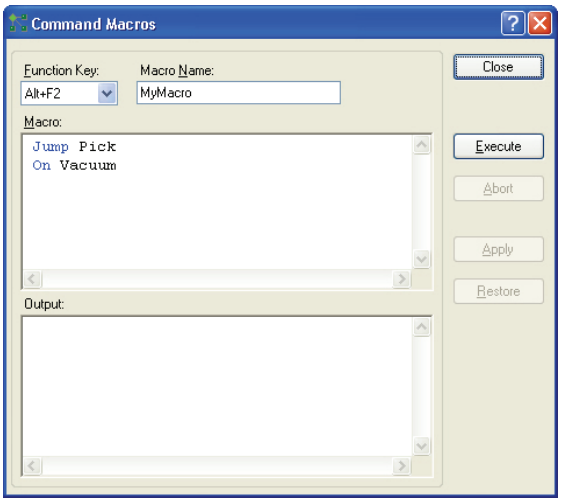
To view source code at the current execution line

Select a task row. Then right click and select [Go To Line]. The program editor will be opened at the current execution line

5.11.5 Macros Command (Tools Menu)

You can create SPEL+ command macros using the Macro Editor. Macros consist of one or more SPEL+ statements that can be executed from the command window. A macro statement may use global variables, I/O labels, and point labels. You can assign a macro to each of the Alt function keys except for Alt+F4, which is a Windows shortcut to close the application.

1. Select [Tools]-[Macros] to open the [Command Macros] dialog box.



2. Type the macro statements in the [Macro] text box.
3. Click the <Apply> button to save changes.
4. Click <Execute> to run the macro.
5. Click <Close> to close the dialog. You will be prompted to save the macros you have created or changed.

To open a macro and execute it, type <Alt> + function key. Then click <Execute> to run it. Macros never execute by pressing the function key. The separate execute step is provided for safety, since macros can move the robot and control I/O.

Macros can be executed while tasks are running. If invalid commands are executed while tasks are running, an error will occur.

5.11.6 [I/O Label Editor] Command (Tools Menu)

The I/O label editor lets you define meaningful names for inputs, outputs, and memory I/O for each project. The labels can be used in your programs, from the Command window, or in macros. They are also displayed in the I/O Monitor window.

To open the I/O Label Editor

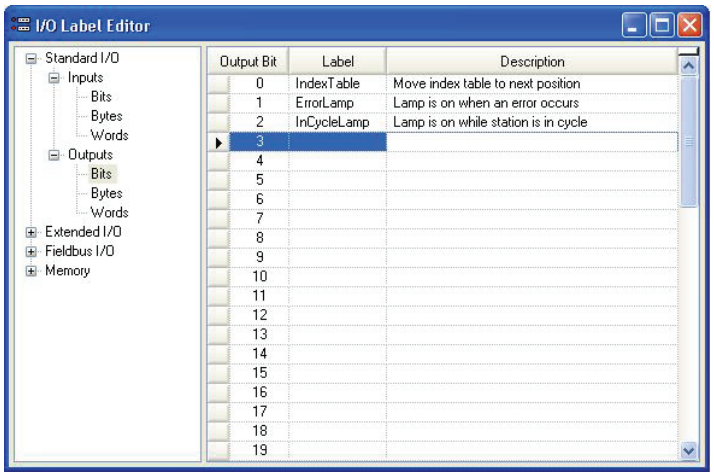
Select I/O Label Editor from the Tools Menu.

Or

Type Ctrl + L.

Or

Click on the button on the toolbar.



The I/O Label Spreadsheet

When you select [I/O Label Editor] from the [Tools] menu, a window opens that contains a tree and a spreadsheet editor.

The tree on the left side of the window shows the various types of I/O for the controller. For each type of I/O you can view and edit labels for bits, bytes (8 bits), and words (16 bits).

The first column of the spreadsheet shows the bit, byte, or word number, depending on which type of I/O you are viewing.

The second column contains the label for each bit, byte, or word in column 1. You can type in up to 16 characters for a label. Label characters can be alphanumeric or underscore.

The third column contains the description associated with the label.

If you add a description to an I/O point, then the description will be displayed as a tool tip on the I/O Monitor.

NOTE

- The I/O Label Editor shows all available I/O types on your controller.
- For the Editor version, the I/O Label Editor shows the all I/O types.
  For example, you can edit Fieldbus I/O labels, but you may not have a Fieldbus board installed in the controller.

To add or edit a label

Select the type of I/O you want to label in the tree. After you select the I/O type, the spreadsheet will be refreshed to display the labels for that type. The number of rows in the spreadsheet equals the number of bits, bytes, or words available for the type you have selected.

Use the mouse to scroll through the spreadsheet and put the cursor in the [Label] field next to the bit, bytes, or words number that you want to add a label to. Type in the label, which can be up to 16 alphanumeric characters without any spaces. Optionally, you can type a description for the label in the [Description] field.

After adding or editing labels, save the changes by executing [Save] from the [File] menu or by clicking on the <Save Project> toolbar button. If any duplicate labels are detected, an error message will be displayed and the save operation will be aborted. You must correct the duplication before you can save the labels successfully.

To cut and paste labels and descriptions

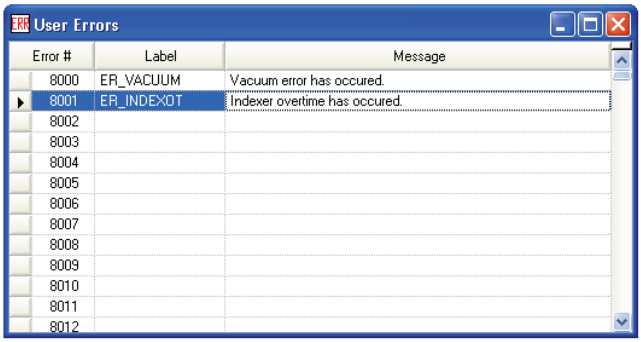
You can cut and paste labels and descriptions by selecting with the mouse, then executing [Copy], [Cut], and [Paste] from the [Edit] menu.

You can also cut and paste entire rows using the following steps:

1. Select one or more rows by using the row selectors on the left and execute either the [Cut] or [Copy] command from the [Edit] menu. When selecting multiple rows, hold down the shift or control key while selecting rows with the mouse.
2. Select the row where you want to start the paste by clicking the row selector on the left of the row.
3. Execute the [Paste] command from the [Edit] menu.

5.11.7 User Error Editor Command (Tools Menu)

The User Error Editor allows you to define user errors.



User error numbers can be from 8000 to 8999.

Labels can be up to 16 characters in length.

It is recommended that you use the `ER_` prefix for each error label and use all caps for the label. This makes it easy to see error labels in your code.

Some user error examples:

Error #	Label	Message
8000	ER_VACUUM	Vacuum error has occurred.
8001	ER_INDEXOT	Indexer overtime has occurred.

In your program code, use the Error statement to generate a user error. For example:

```
On Vacuum
Wait Sw(VacOn), 1
If Tw = 1 Then
  Error ER_VACUUM
EndIf
```

The user error information is stored in the current project directory in a file called UserErrors.dat.

You can use the [Import] command from the [File] menu to import user errors from other projects.

After adding new error definitions, save the changes by executing Save from the [File] menu or by clicking on the <Save Project> toolbar button. If any duplicate labels are detected, an error message will be displayed and the save operation will be aborted. You must correct the duplication before you can save the labels successfully.

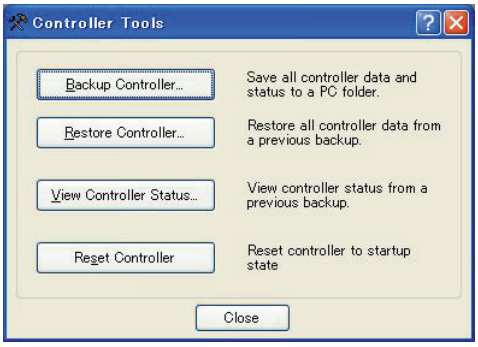
5.11.8 [Controller] Command (Tools Menu)

Select Controller from the [Tools] menu to open the [Controller Tools] dialog box.

From the [Controller Tools] dialog box, you can save and restore the complete controller configuration and the project using the [Backup Controller] and [Restore Controller] commands. You can also save and view controller status, and reset the controller.

Before servicing the system, you should execute [Backup Controller] and store the system configuration on an external media such as a USB memory key.

If required, you can use [Restore Controller] to restore previously stored data.



Backup Controller

Use Backup Controller to save controller configuration data on your PC.
The current status is saved in a folder containing several files. The controller configuration settings, task status, I/O status, robot status, etc. are saved in these files. This is useful for users to send a snapshot of the controller status to a system vendor or to Epson technical support, should the need arise.

NOTE

Backup Controller is equivalent to connecting a USB memory key to the controller and pressing the TRIG button on the controller to save controller status.
Controller status is stored in a folder named “B” followed by the controller type, the controller serial number, and the date / time.

You can configure the controller whether to save the project files in the status folder or not. See [Setup]-[System Configuration]-[Controller]-[Preferences].

1. Select [Tools]-[Controller].
2. Click on the <Backup Controller> button to open the [Browse For Folder] dialog box.

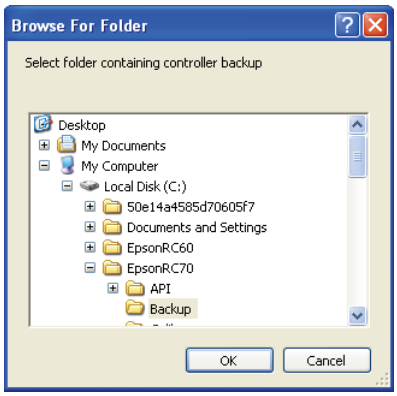
3. Select the disk drive and parent folder where you want to save the information. You can create a new parent folder by clicking the <Make New Folder> button.
4. Click <OK>. A new folder containing the backup files will be created in the selected folder named "B" followed by the controller type, the controller serial number, and the date / time.

Restore Controller

Use Restore Controller to load controller settings from previously saved backup data. You cannot restore the controller data while tasks are running. If you attempt to do so, an error message will be displayed.

To restore controller configuration:

1. Select [Tools]-[Controller].
2. Click on the <Restore Controller> button to open the [Browse For Folder] dialog box.

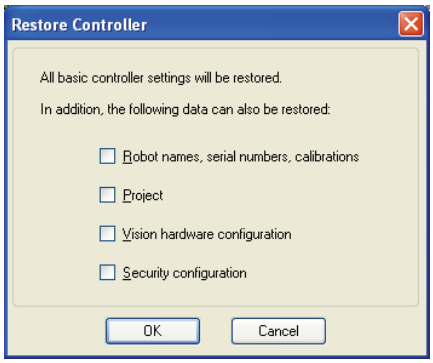


3. Select the drive and folder where the information is stored. Controller backup information is stored in a folder that is named "B" followed by the controller type, the controller serial number, and the date / time.

NOTE

You can also select a folder containing export controller status information.

4. Click <OK> to display the dialog to select the restore data.



Robot names, serial numbers, calibrations checkbox

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

Project checkbox

This checkbox allows you to restore the files related to projects.
The default setting is unchecked.
When the project is restored, all the values of Global Preserve variables are restored.
For details about Global Preserve variable backup, refer to *5.10.10 [Display Variables] Command (Run Menu)*.

Vision hardware configuration checkbox

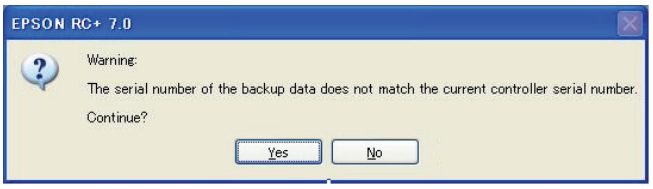
This checkbox allows you to restore the vision hardware configuration.
For details, refer to the *EPSON RC+ 7.0 option: Vision Guide 7.0*.
This is not checked by the default setting.

Security configuration checkbox

This checkbox allows you to restore the security configuration.
For details, refer to *14. Security*.
This is not checked by the default setting.

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

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



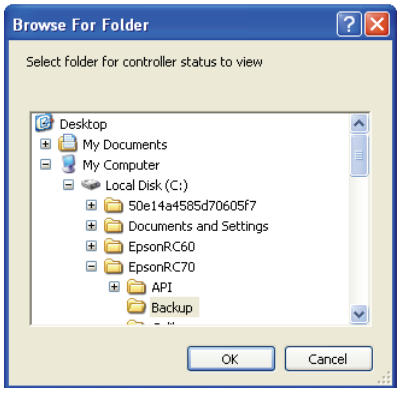
Click the <No> button to cancel restoration of data except for special situations such as controller replacement.

View Controller Status

Click the <View Controller Status> button to view the status data stored from a previous status export (see the Export Controller Status section above).

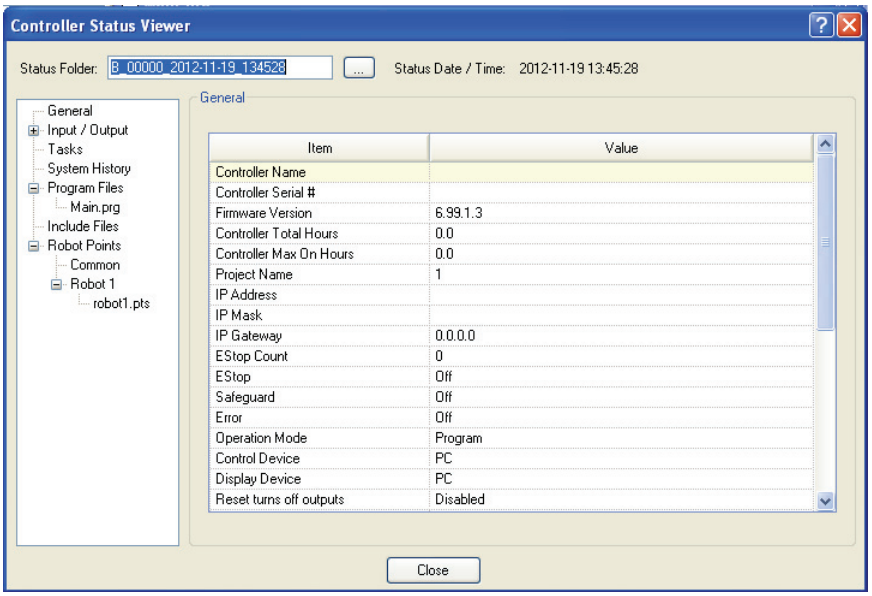
To view controller status:

1. Select [Tools]-[Controller].
2. Click on the <View Controller Status> button to open the [Browse For Folder] dialog.



3. Select the drive and folder where the information is stored. Controller status information is stored in a folder that is named “B” followed by the controller type, the controller serial number, and the date / time.
4. Click <OK> to view the selected controller status.

5. The [Controller Status Viewer] dialog will be displayed.



6. Select items to view from the tree on the left side of the dialog.
7. To view another controller status, click the ellipses button next to the Status Folder name and select a new status folder.

Reset Controller

Use the <Reset Controller> button to reset the SPEL controller.

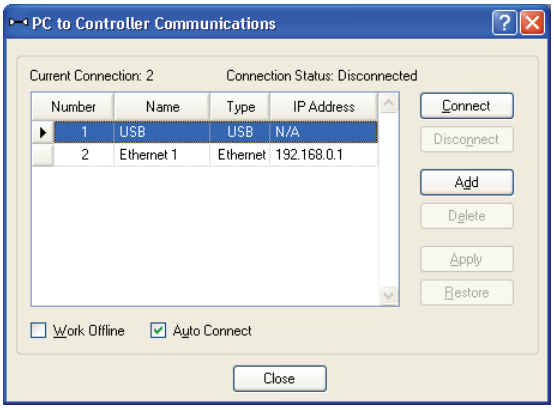
5.12 [Setup] Menu

The [Setup] menu contains the following commands:

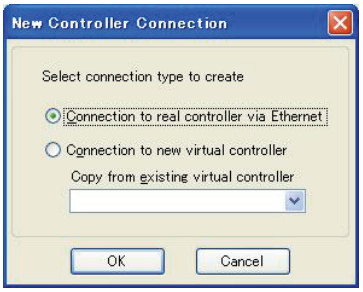
- PC to Controller Communications
- System Configuration
- Preferences
- Options

5.12.1 [PC to Controller Communications] Command (Setup Menu)

To configure communications with the Controller, select [PC to Controller Communications] from the [Setup] menu. The [PC to Controller Communications] dialog will be displayed as shown below:



Item	Description
Connect	Connect the selected communication.
Disconnect	Disconnect the communication.
Add	Add communication information of Ethernet or a virtual controller. Clicking this button opens the dialog to specify the communication type.
Delete	Deletes selected communication information. Connection #1 "USB" cannot be deleted.
Apply	Saves changes.
Restore	Restores to previous settings.
Work Offline	You can build a project without connecting to the controller in Offline mode. Some functions such as Robot Manager are not available in this mode.
Auto Connect	If the connection is enabled, connects to the controller automatically.
Close	Closes the dialog.



Program execution time

In the virtual controller, programs will execute continuously for up to one hour.
If continuous execution is over one hour, a warning message appears.
You can execute the program again after the warning is displayed, and the continuous execution timer will be reset.

5.12.2 [System Configuration] Command (Setup Menu)

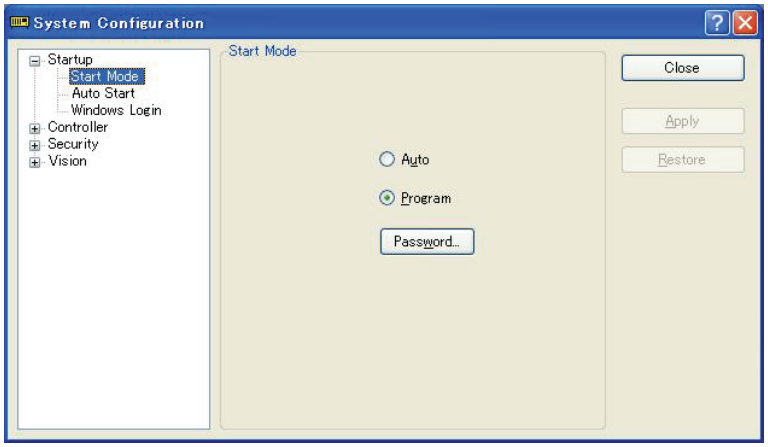
The [System Configuration] command opens a dialog that contains several pages that are used to configure the system for the EPSON RC+ 7.0 environment.

To open the [System Configuration] dialog, select [Setup]-[System Configuration]  .

[Setup]-[System Configuration]-[Startup]

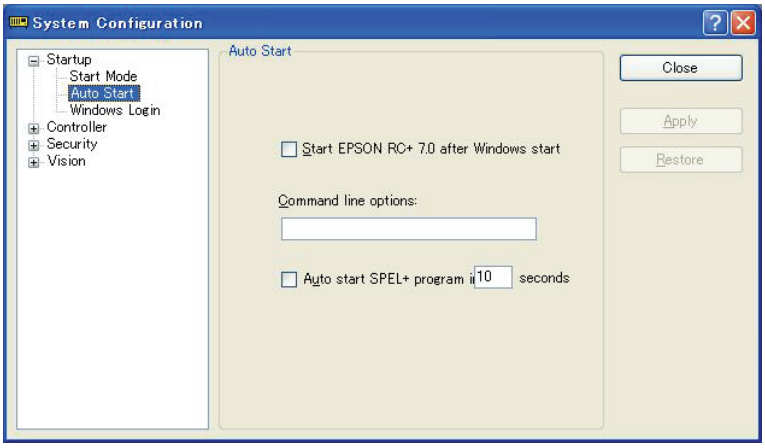
[Setup]-[System Configuration]-[Startup]-[Start Mode] Page

From the Start Mode page, you can choose whether EPSON RC+ 7.0 starts in Auto mode or Program mode.



Item	Description
Auto	Select Auto to start EPSON RC+ 7.0 in Auto mode. Refer to *4. Operation* for details.
Program	Select Program to start EPSON RC+ 7.0 in Program mode. Refer to *4. Operation* for details.
Password	Click this button to change the password required to enter Program mode from Operator mode when EPSON RC+ 7.0 starts.
Apply	Saves the current changes.
Restore	Reverts back to previous settings.
Defaults	Click this button to set the default startup mode.
Close	Closes the System Configuration dialog.

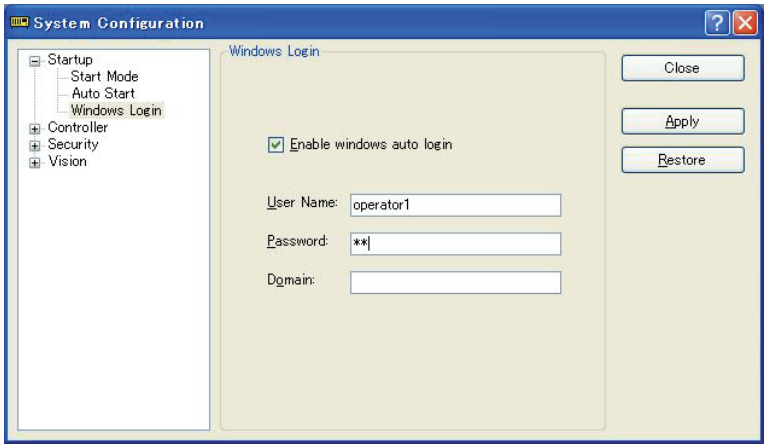
[Setup]-[System Configuration]-[Startup]-[Auto Start] Page



Item	Description
Start EPSON RC+ after Windows start	Check this box if you want EPSON RC+ 7.0 to automatically start after Windows starts.
Command line options	Enter the command line options used when EPSON RC+ 7.0 is automatically started. This is active only when the Start EPSON RC+ 7.0 with Windows start checkbox is not checked.
Auto start SPEL+ program	Check this box if you want to execute the main program after a delay. This is active only when starting in Operator mode and the control device is “Self”.
Apply	Saves the current changes.
Restore	Reverts back to previous settings.
Close	Closes the System Configuration dialog.

[Setup]-[System Configuration]-[Startup]-[Windows Login] Page

The Windows Login page allows you to configure the automatic login when Windows starts.



Item	Description
Enable windows auto login	Check this box if you want to automatically login to Windows when it starts. You must supply a valid user name, password, and domain.
User Name	Enter the name of a valid Windows user on the system.
Password	Enter the login password for the user.
Domain	Optional. If the PC is the member of a domain, enter the name here.
Apply	Saves the current changes.
Restore	Reverts back to previous settings.
Close	Closes the System Configuration dialog.

[Setup]-[System Configuration]-[Controller]

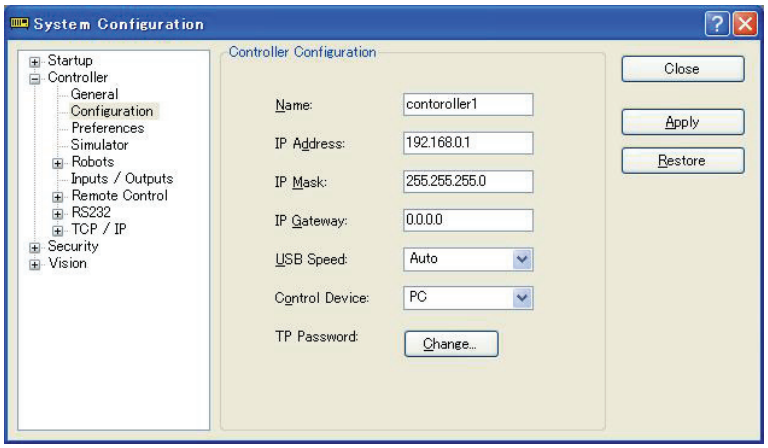
[Setup]-[System Configuration]-[Controller]-[General] Page

This page allows the user to view general information about the controller.

Item	Description
Serial #	Displays the serial number of the current controller.
MAC Address	Displays the MAC Address of the controller.
Firmware Version	Displays the firmware version used in the current controller.
Date / Time	Displays the current date and time in the controller.
Project Name	Displays the name of the project in the controller.
Close	Closes the Setup Controller dialog.

[Setup]-[System Configuration]-[Controller]-[Configuration] Page

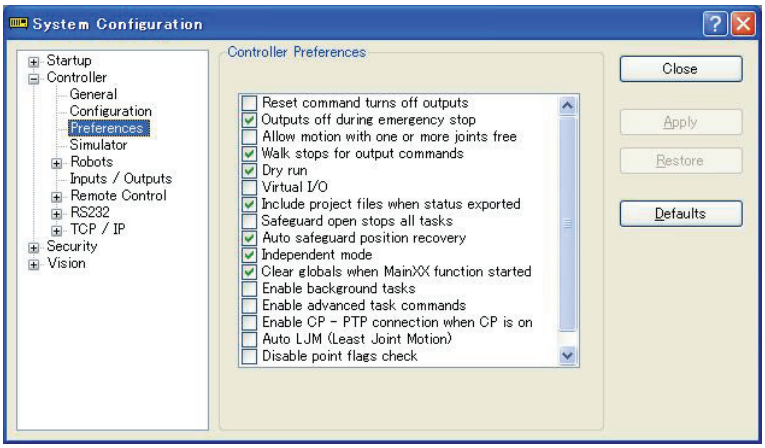
This page allows the user to view and change the controller configuration settings.



Item	Description
Name	Use this text box to change the controller name. You may use any name up to 16 characters long using alphanumeric characters and underscore.
IP Address	Use this text box to set current IP address of the LAN-1 port. The IP Address must be on the same subnet as the PC.
IP Mask	Use this text box to set the IP mask of the LAN-1 port. Note that the IP Mask must match the IP mask used for your network.
IP Gateway	Use this text box to set the IP gateway of the LAN-1 port. This is only required if you will be accessing the controller from outside of the local network.
Control Device	Allows you to select the Control Device.
TP Password	Allows you to change the TP password.
Apply	Saves the current changes. If necessary, the controller will be reset to use the new settings.
Restore	Reverts back to previous settings.
Close	Closes the Setup Controller dialog.

[Setup]-[System Configuration]-[Controller]-[Preferences] Page

This page contains controller preference settings.



RESET command turns off outputs

When this preference is turned on, all outputs other than remote control outputs will be turned off when a Reset instruction is executed. The default setting is off.

NOTE ☞ The outputs of the standard I/O, expansion I/O, and Fieldbus I/O are included in the "outputs" mentioned in the above preferences [RESET command turns off outputs] and [Outputs off during Emergency Stop]. Memory I/O is not affected by these preferences. Therefore, memory I/O bits are not turned off by the RESET command execution or during Emergency Stop.

Outputs off during Emergency Stop

When this preference is turned on, all outputs other than remote control outputs will be turned off when emergency stop occurs. Also, no outputs can be turned on until the emergency stop condition is cleared. The default setting is on.

Uncheck this preference to execute I/O On/Off using the NoEmgAbort task or background task after Emergency Stop. If it remains checked, the execution order of turn Off by this preference and turn On using the task are not guaranteed.

NOTE ☞ You should design your system to always remove all power to output devices when emergency stop occurs. Even if the controller turns off outputs, the I/O hardware could malfunction.

Allow motion with one or more joints free

When this preference is turned on, motion commands can be executed after SFree has been used to free one or more joints. The default setting is off.

Walk stops for output commands

When checked, the Walk command from the Run Menu will execute lines until after the next motion or output statement (whichever comes first). When unchecked, the Walk command will execute lines until after the next motion statement and will not stop for output statements. The default setting is on.

Dry run

This preference allows you to run programs without a robot connected to the controller. All program statements will work. Motion statements will execute approximately the same amount of time as when connected to a robot.

Virtual I/O

This preference allows you to run programs using virtual I/O. When Virtual I/O is enabled, I/O commands do not affect the hardware I/O. There are also several commands available for turning on inputs from within a program. The default setting is off.

NOTE

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

Include project files when status exported

This preference allows you to configure whether project files are included or not when the controller status is exported. Refer to *5.11.8 [Controller] Command- Export Controller Status*. The default setting is on.

Safeguard open stops all tasks

Check this option to cause all normal tasks and NoPause task to stop when the safeguard is open. Only NoEmgAbort task and background tasks will continue.

This option can be used in applications where pause / continue are not required.

The default setting is off.

Auto safeguard position recovery

This preference allows you to move a robot back to the position where it was at the safeguard opened when continuing the program execution.

Auto recover ON	Automatically turns ON a motor and moves a robot in low power status to the position where it was when the safeguard opened. Continues the usual cycle. (Default)
Auto recover OFF	In the Run Window and Operator Window, when an operator clicks the Continue button, a dialog with a Recover button will be shown. The operator needs to hold down the Recover button until the motor is ON and the robot's return is finished. Otherwise the robot will stop before reaching final position. After verifying that the robot's return is finished, the operator clicks the Continue button to continue the usual cycle.

For more information, refer to *15. Security – Recover motion to safeguard open position*.

Independent Mode

This preference allows you to use the controller without interfacing with the Windows (Independent mode).

Use this option when you want to use the controller through the external device using Remote I/O. This option is checked by default.

Initialize global variables when Main XX function started

This preference allows you to initialize the global variables as the main function becomes active.

Turn off this preference when you sue the global variables from the background task. Otherwise, the variables will be initialized by the controller and the variable-access conflict from tasks will occur. This is turned on by default.

Enable background tasks

This preference allows you to execute background tasks.
This is turned off by default.

Enable advanced task commands

This preference allows you to execute StartMain, Cont, Recover, Reset, Error commands.
This is turned off by default.

CAUTION	■ Before you execute StartMain, Cont, Recover, Reset, Error commands, you should understand each command's specification and verify that the system has the appropriate condition to execute these commands. Improper use, such as executing commands continuously in a loop, can reduce the security of system.

Enable CP – PTP connection when CP is ON

This preference allows you to overlap the trajectories of CP motion and PTP motion during CP ON.

NOTE

Over-speed error or Over-acceleration-speed error may occur according to the motion acceleration / deceleration speed setting. If the error occurs, adjust the acceleration / deceleration speed setting or uncheck this checkbox.

Auto LJM (Least Joint Motion)

This preference allows you to enable Auto LJM at the controller start up. To disable Auto LJM temporarily, use AutoLJM Off command.

NOTE

If Auto LJM is enabled at all times, this function automatically adjusts the posture of the robot to reduce the motion distance, even when you intended to move the joint widely. Therefore, it is recommended to disable Auto LJM at the controller start up and operate the robot as you desired using AutoLJM On command or LJM function.

Disable Point flag check

This preference allows you to continue operation even when point flags, one was specified as a target point and the other one after the motion completion, do not match in a CP motion.

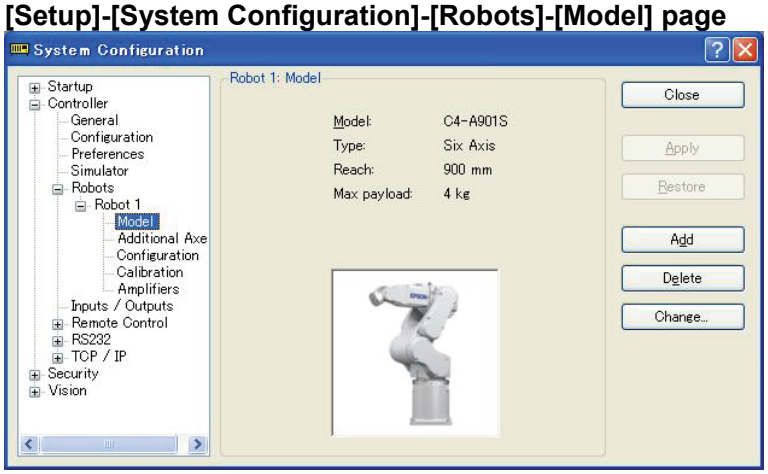
However, if the flags do not match at the transferring point while CP On is used, the robot will stop at the point and the motion will not become a path motion.

Motor off when Enable switch off in Teach Mode

This preference is read-only. It shows whether motors will be turned off when the Enable switch is off during Teach Mode.

[Setup]-[System Configuration]-[Robots]

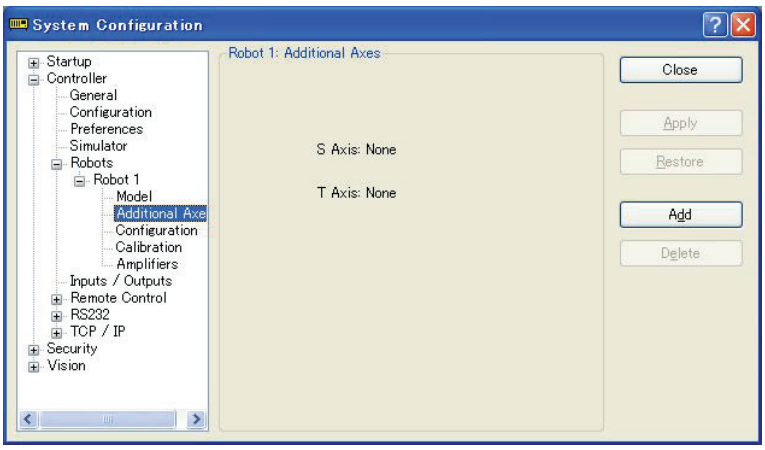
[Setup]-[System Configuration]-[Robots]-[Model] page



Item	Description
Model	Displays the robot model.
Type	Displays the robot type.
Reach	Displays the robot length (J1 + J2 for SCARA robots) or reach for 6-axis robots.
Max payload	Displays maximum payload of the robot.
Add	Adds a robot.
Remove	Deletes a robot.
Close	Closes the System Configuration dialog.

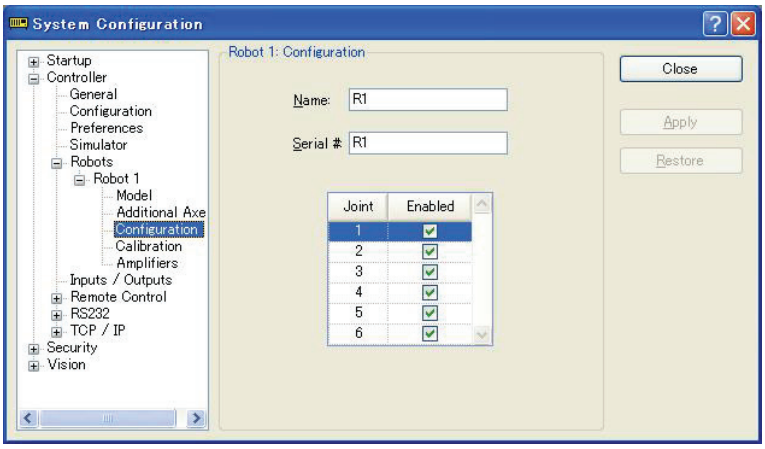
[Setup]-[System Configuration]-[Robots]-[Robot**]-[Additional Axes]

For details of the additional ST axis, refer to *9.2 Configuration of Additional Axes*.



Item	Description
S Axis	Displays the configuration of additional S axis.
T Axis	Displays the configuration of additional T axis.
Apply	Saves the current changes.
Restore	Reverts back to previous settings.
Add	Adds an additional axis.
Remove	Deletes an additional axis.
Close	Closes the dialog.

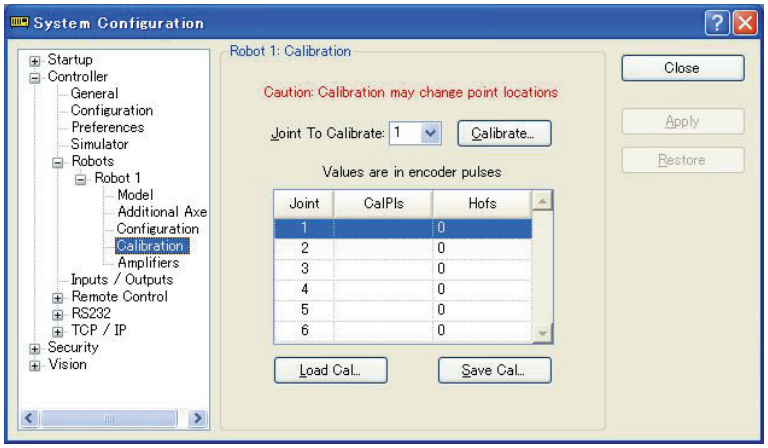
[Setup]-[System Configuration]-[Robots]-[Robot**]-[Configuration] page



Item	Description
Name	Enter a Name for the robot.
Serial #	Enter the Serial number of the robot.
Joint	These checkboxes determine if the respective joint is enabled or disabled.
Apply	Saves the current changes.
Restore	Reverts back to previous settings.
Close	Closes the Setup Controller dialog.

[Setup]-[System Configuration]-[Robots]-[Robot**]-[Calibration] Page

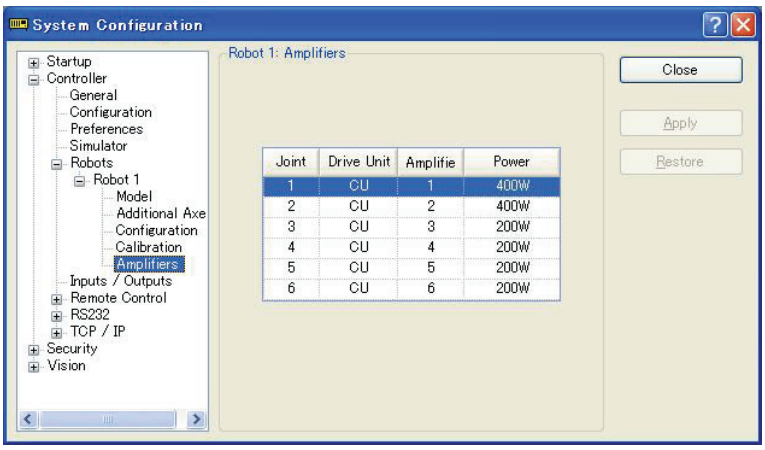
You can calibrate each joint of the robot from this page.



Item	Description
Joint to Calibrate	Select the joint that you want to Calibrate.
Calibrate	Starts the Calibration Wizard dialog that walks you through the calibration process.
Calpls	These are the Calpls settings for each joint. Normally, the calibration wizard will calculate these values.
Hofs	These are the Hofs settings for each joint. Normally, the calibration wizard will calculate these values.
Load Cal	Use this button to load data from a previously save calibration file. After the data is loaded, the grid will be refreshed to show the values.
Save Cal	Use this button to save the calibration data to a calibration file.
Apply	Saves the current changes.
Restore	Reverts back to previous settings.
Close	Closes the Setup Controller dialog.

[Setup]-[System Configuration]-[Robots]-[Robot**]-[Amplifiers] Page

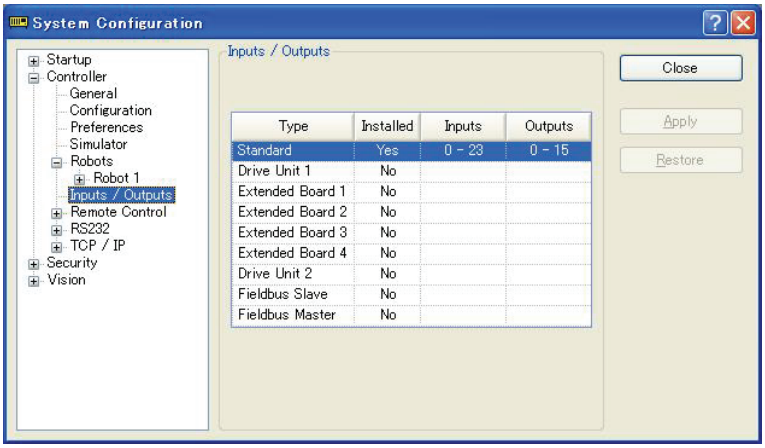
This page shows the power values for the motor amplifiers installed in the controller.



Item	Description
Robot Amplifiers	This shows the power for each robot amplifier currently in the controller along with the associated drive unit and amplifier number.
Close	Closes the System Configuration dialog.

[Setup]-[System Configuration]-[Inputs / Outputs] Page

This page shows the I/O hardware installed in the controller. There are no settings to configure.



[Setup]-[System Configuration]-[Inputs / Outputs]-[Fieldbus Master]

For details of Fieldbus master, refer to the *Robot Controller RC700 option: Fieldbus I/O manual*.

[Setup]-[System Configuration]-[Inputs / Outputs]-[Fieldbus Slave]

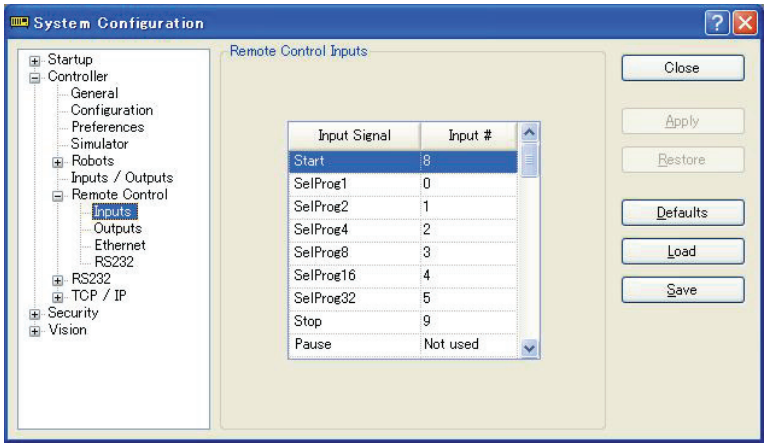
For details of Fieldbus slave, refer to the *Robot Controller RC700 option: Fieldbus I/O manual*.

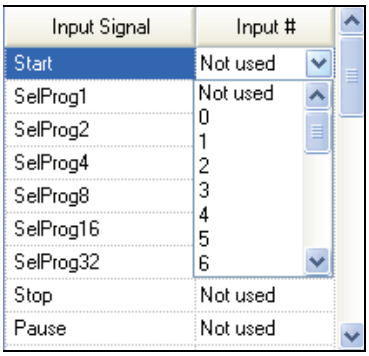
[Setup]-[System Configuration]-[Remote]

For details of Remote function, refer to *12. Remote Control*.

[Setup]-[System Configuration]-[Remote Control Inputs] Page

Use this page to configure the controller remote control inputs.



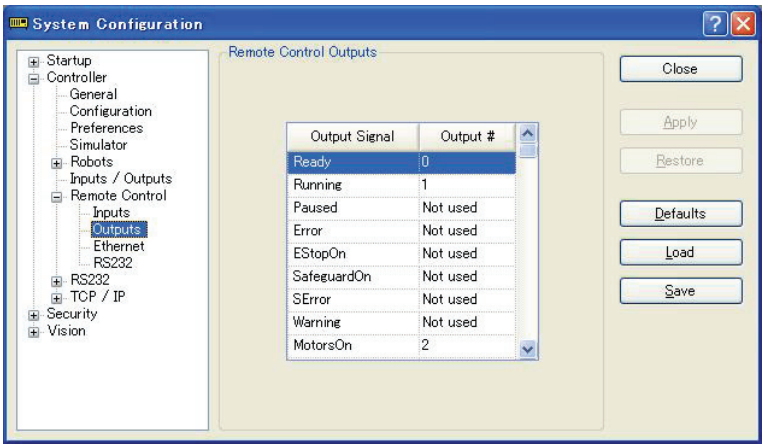
Item	Description
Input #	Select an input bit to use for the corresponding input signal. Select "Not used" to disable the remote input. For example, if “Start” is assigned to I/O input bit 0, select “Not used” to use this as a normal I/O input. 
Apply	Saves the current changes.
Restore	Reverts back to previous settings.
Defaults	Click this button to set the default remote inputs. First, a dialog box will be displayed asking you which type of inputs to use for defaults: Standard, Fieldbus master, or Fieldbus slave I/O. You can also select Clear All to set all remote inputs to Not used.
Load	Reads the assigned remote inputs and outputs from a file on the PC and save it in the controller.
Save	Saves the assigned remote inputs and outputs shown in the dialog to a file on the PC.
Close	Closes the Setup Controller dialog.

NOTE

Both the remote inputs and outputs are loaded or saved together when using <Load> or <Save>.

[Setup]-[System Configuration]-[Remote Control]-[Outputs] Page

Use this page to configure the controller remote control outputs.



Item	Description
Output #	Select an output bit to use for the corresponding output signal. Select "Not used" to disable the remote output. For example, if “Ready” is assigned to I/O output bit 0, select “Not used” to use this as a normal I/O output.
Apply	Saves the current changes.
Restore	Reverts back to previous settings.
Defaults	Click this button to set the default remote outputs. First, a dialog box will be displayed asking you which type of outputs to use for defaults: Standard, Fieldbus master, or Fieldbus slave I/O. You can also select <Clear All> to set all remote outputs to “Not used”.
Load	Reads the assigned remote inputs and outputs from a file on the PC and save it in the controller.
Save	Saves the assigned remote inputs and outputs shown in the dialog to a file on the PC.
Close	Closes the Setup Controller dialog.

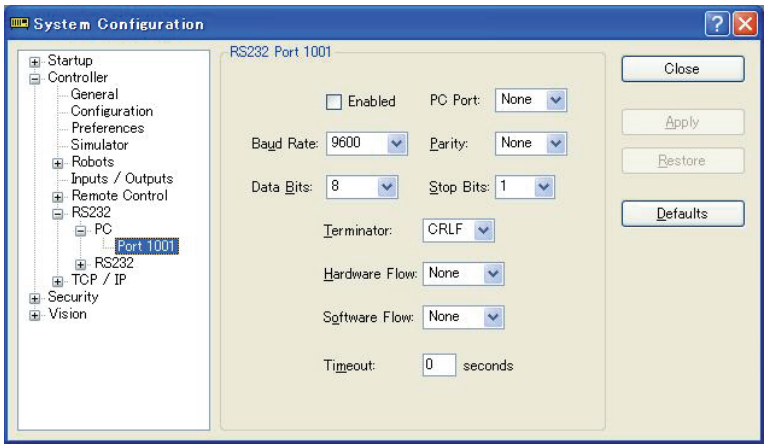
NOTE

Both the remote inputs and outputs are loaded or saved together when using <Load> or <Save>.

[Setup]-[System Configuration]-[RS232]

[Setup]-[System Configuration]-[RS232]-[PC] Page

Use this page to configure the RS232 ports on PC.

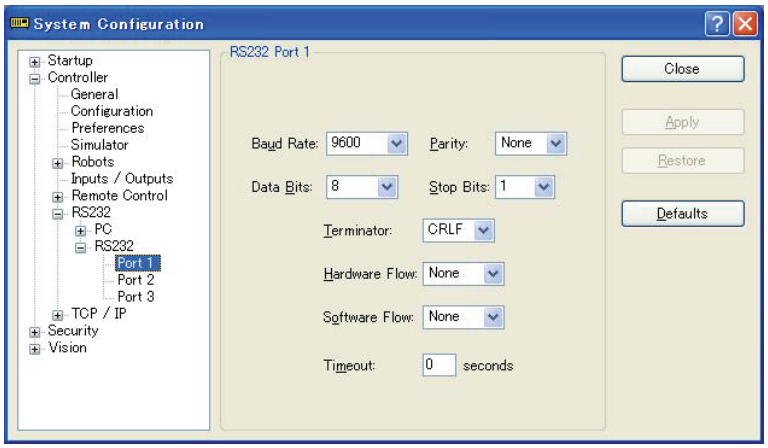


To configure an RS-232 port

1. Select [System Configuration] from the [Setup] menu and select the page for the RS232C port you want to configure.
2. Select the [PC port] and change the settings as desired.
3. Set the [Enable] check box.
4. Click <Apply> to save the new settings and click <Close>.

[Setup]-[System Configuration]-[RS232]-[RS232] Page

There is one page for each PS232C port. If there are no RS232C ports installed in the special slot, then no selections are visible in the tree.

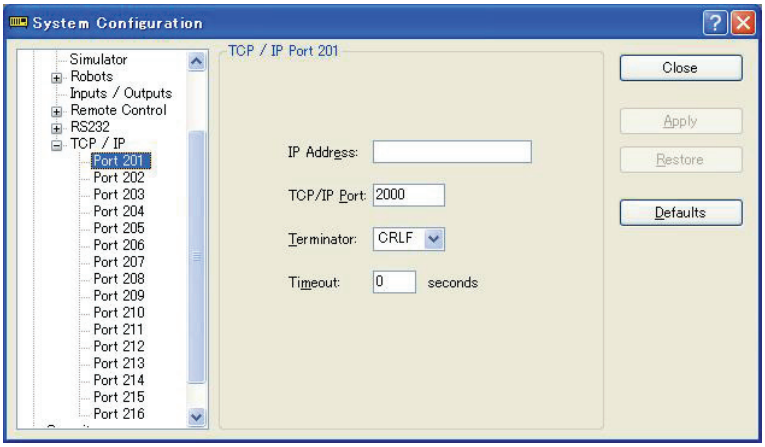


To configure an RS-232 port

1. Select [System Configuration] from the [Setup] menu and select the page for the RS232C port you want to configure.
2. Change the settings as desired.
3. Click <Apply> to save the new settings and click <Close>.

[Setup]-[System Configuration]-[TCP/IP] Pages

There is one page for each TCP / IP port in the controller.



To configure a TCP/IP port

1. Select [System Configuration] from the [Setup] menu and select the page for the TCP/IP port you want to configure.
2. Enter the host name or IP address for the controller or PC that you want this controller to communicate with.
3. Enter the TCP/IP port number. This must be the same port number that is used on the host device. It must be different from any of the other TCP/IP port numbers used for the other TCP/IP ports.
4. Change the other settings as desired.
5. Click <Apply> to save the new settings and click <Close>.

[Setup]-[System Configuration]-[Conveyor Encoder]

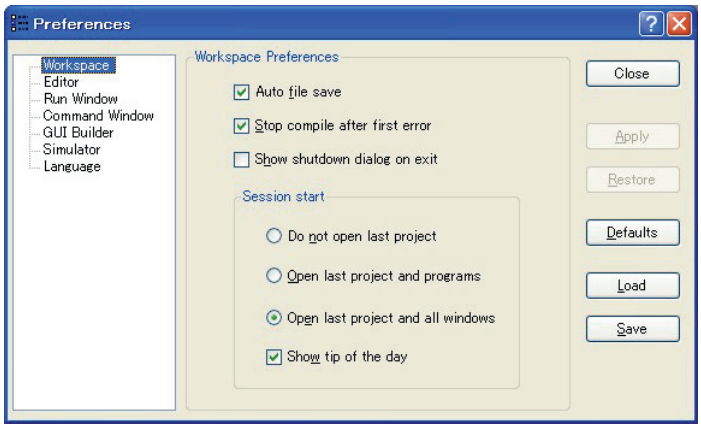
For details, refer to *15. Conveyor Tracking*.

5.12.3 [Preferences] Command (Setup Menu)

The Preferences command opens a dialog that contains several pages that are used to configure user preferences for the EPSON RC+ 7.0 environment. To open the [Preferences] dialog box, select [Setup]-[Preferences].

[Setup]-[Preferences]-[Workspace] Page

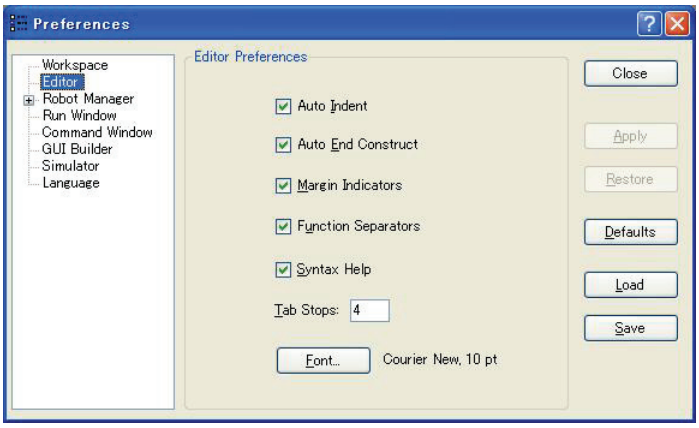
From this page, you can configure your workspace preferences.



Item	Description
Auto file save	Checking this box will cause EPSON RC+ 7.0 to automatically save any open files before executing a command that requires the file to be saved. For example, if a file needs to be saved before executing a project build, the file will automatically be saved before running the build. Default is On.
Stop compile after first error	Stops compile after first error occurs. This makes it easier to see the first error in the status pane and allows you to fix one error at a time. Default is On.
Display the shutdown dialog on exit	Displays the shutdown dialog when closing the EPSON RC+ 7.0. For details, refer to 5.6.11 Exit Command (File Menu). Default is Off.
Do not open last project	If this radio button is selected, the last project will not be opened when EPSON RC+ 7.0 is started.
Open last project and program file	If this radio button is selected, the last project will be opened and any program windows that were previously opened will be opened.
Open last project and all windows	If this radio button is selected, the last project will be opened and all windows will be restored to their previous locations. This is the default setting.
Show Tip of the Day	If this check box is on, the Tip of the Day dialog will be displayed when EPSON RC+ 7.0 is started.
Apply	Saves the current changes.
Restore	Reverts back to previous settings.
Default	Sets the default values.
Load	Reads the preferences previously saved on the PC.
Save	Saves the preferences to a file on the PC.
Close	Closes the Preferences dialog.

[Setup]-[Preferences]-[Editor] Page

This page is used to configure your preferences for the program editor windows.

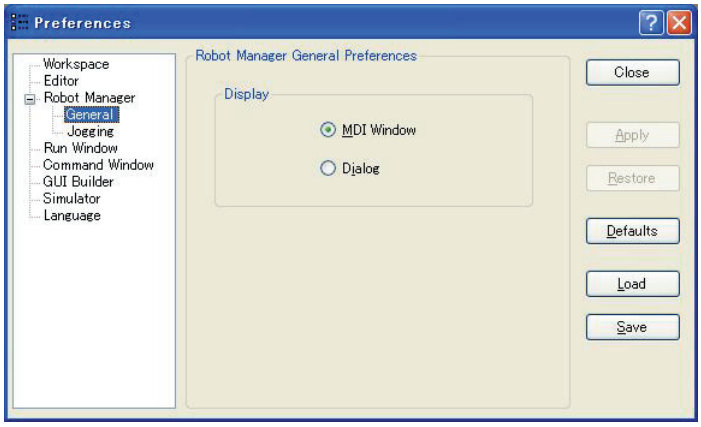


Item	Description
Auto Indent	Check this box if you want new lines to follow the indentation for the previous line. Also, lines will automatically be indented after Do, If, Else, For, Select, and Case statements. Default is on.
Auto End Construct	Check this box if you want EPSON RC+ 7.0 to add the end construct statement for a loop construct. For example, if you enter a For statement, then a Next statement will be added automatically. Default is on.
Margin Indicators	Check this box to display a margin on the left side. This margin is used to indicate lines with breakpoints, current step line, current execution line. Default is on.
Function Separators	Check this box to display a line after each Fend statement. Default is on.
Syntax Help	Check this box to enable the Syntax Help window. The Syntax Help window displays syntax for a keyword after it has been typed. Default is on.
Tab Stops	Type in the number of columns to move for the TAB key. Default is 4.
Font	Click on the Font button to open the fonts dialog. Choose the font you desire for the editor. The monitor window also uses the editor font. The current font name and size is displayed next to the <Font> button.
Apply	Applies the current settings.
Restore	Reverts back to the previous settings.
Defaults	Sets default value.
Load	Reads the preferences previously saved on the PC.
Save	Saves the preferences to a file on the PC.
Close	Closes the Preferences dialog.

[Setup]-[Preferences]-[Robot Manager]

[Setup]-[Preferences]-[Robot Manager]-[General] Page

This page lets you configure your preferences for the Robot Manager.

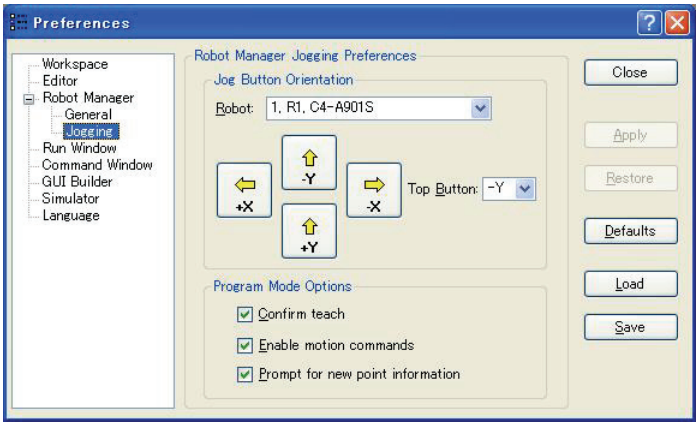


Item	Description
Display	Choose if you want the Robot Manager to be displayed as an MDI Window or as a Dialog.
Apply	Applies the current settings.
Restore	Reverts back to the previous settings.
Defaults	Sets default values.
Load	Reads the preferences previously saved on the PC.
Save	Saves the preferences to a file on the PC.
Close	Closes the Preferences dialog

The Robot Manager can be displayed as an MDI child window (default) or as a dialog. When displayed as an MDI child, the Robot Manager is displayed in the MDI document area and can remain open while you work with other windows and dialogs. When displayed as a dialog, you can only work with the Robot Manager controls until you close the dialog. When using screen resolutions less than 1024 × 768, only the Dialog mode is allowed.

[Setup]-[Preferences]-[Robot Manager]-[Jogging] Page

This page lets you configure the Robot Manager Jog and Teach page.



Setting Jog Button Orientation

Item	Description
Robot	Select a robot.

The jog button orientations are useful for "aligning" your PC monitor with the robot's Cartesian coordinate system. Align the buttons so that the robot moves in the direction of the arrows.

You can change the orientation of the jogging buttons and arrow keys for the X and Y axes by selecting the desired top button from the **Top Button** dropdown list.

You can also click on one of the buttons to change it to the top button position.

Program Mode Options

NOTE

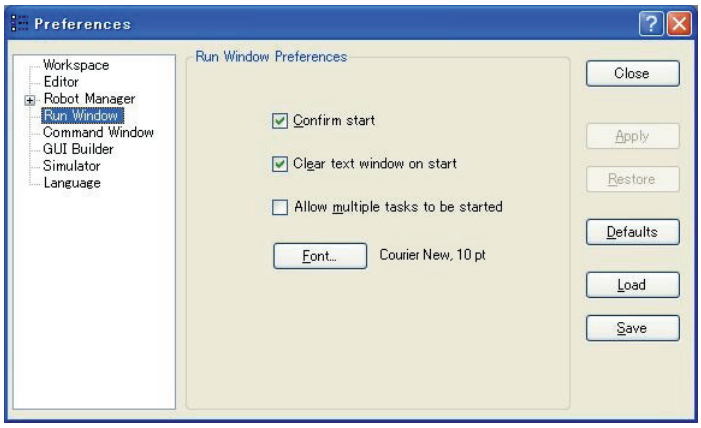
These options affect the Robot Manager Jog & Teach page when used from program mode.

These settings do not affect the Robot Manager when used for operators in auto mode, such as for the Operator Window or from RC+ API. To configure the Robot Manager for operators, see [*Project]-[Properties]-[Operator Settings]-[Robot Manager]*.

Item	Description
Confirm teach	Check this box if you want a confirmation prompt each time you press the <Teach> button on the Robot Manager Jog & Teach page.
Enable motion commands	Check this box if you want to execute motion commands (Go, Jump, etc.) from the Robot Manager Jog & Teach page.
Prompt for new point information	Check this box if you want to be prompted for point label and description when a new point is taught using the Teach button.
Apply	Applies the current settings.
Restore	Reverts back to the previous settings.
Defaults	Sets default values.
Load	Reads the preferences previously saved on the PC.
Save	Saves the preferences to a file on the PC.
Close	Closes the Preferences dialog.

[Setup]-[Preferences]-[Run Window] Page

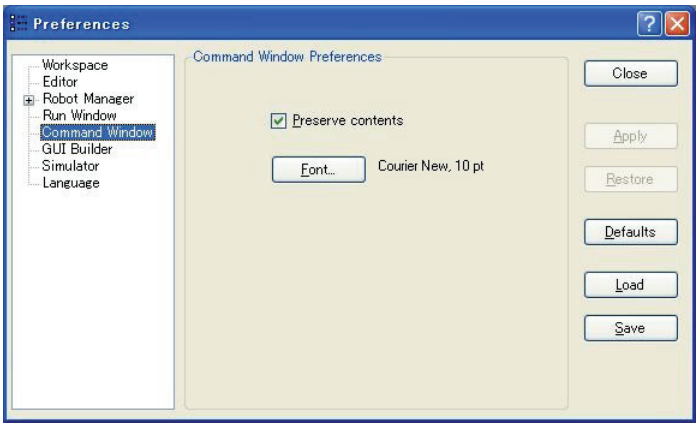
This page allows you to change preferences for the Run Window.



Item	Description
Confirm Start	This checkbox allows you to select if you want to see a confirmation message box before a program is started.
Clear text window on start	Checking this will cause the Run Window text pane to be cleared each time the <Start> button is clicked.
Allow multiple tasks to be started	Checking this allows you to start a task from the Run window while other tasks are running. The <Start> button will not be disabled after starting a task.
Font	Click on the <Font> button to open the fonts dialog. Choose the font you desire for the Run window. The current font name and size is displayed next to the <Font> button.
Apply	Applies the current settings.
Restore	Reverts back to the previous settings.
Defaults	Sets default values.
Restore	Reverts back to the previous settings.
Defaults	Sets default values.
Load	Reads the preferences previously saved on the PC.
Save	Saves the preferences to a file on the PC.
Close	Closes the Preferences dialog.

[Setup]-[Preferences]-[Command Window] Page

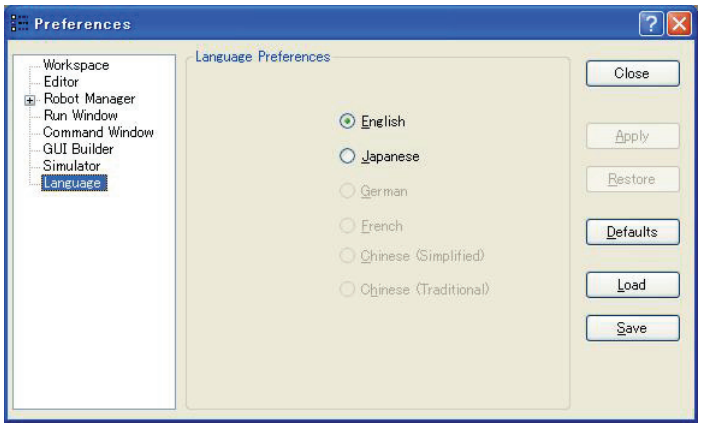
This page allows you to change preferences for the Command Window.



Item	Description
Preserve contents	Checking this option will cause the command window to preserve its contents between sessions.
Font	Click on the Font button to change the font for the Command window.
Apply	Saves the current changes.
Restore	Reverts back to the previous values.
Defaults	Set default values.
Load	Reads the preferences previously saved on the PC.
Save	Saves the preferences to a file on the PC.
Close	Closes the Preferences dialog.

[Setup]-[Preferences]-[Language] Page

This page allows you to change the EPSON RC+ 7.0 GUI language.



When EPSON RC+ 7.0 is installed on a Windows system using a Western language, then the English, German, and French selections are available.
When it is installed on a Windows system using Japanese, then English and Japanese are available.
When it is installed on a Windows system using Chinese, then English, Chinese (Simplified), and Chinese (Traditional) are available.

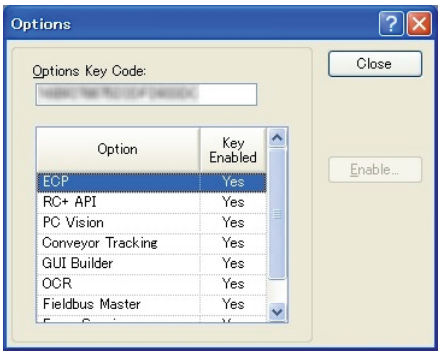
After selecting the desired language, you must reboot EPSON RC+ 7.0.

Item	Description
Language	This set of option buttons allows you to choose which language to use for the EPSON RC+ 7.0 GUI.
Apply	Saves the current changes.
Restore	Reverts back to the previous values.
Defaults	Set the default language.
Load	Reads the preferences previously saved on the PC.
Save	Saves the preferences to a file on the PC.
Close	Closes the Preferences dialog.

5.12.4 [Options] Command (Setup Menu)

This dialog allows you to view and enable options in the controller.

EPSON RC+ 7.0 uses a key that is stored in the Spel controller board to enable options on the system.



If an option is not enabled, you can purchase it from your distributor. When you call to purchase, you must give the **Options Key Code** to the operator. You will then be given a code to enable the option for the current software options key.

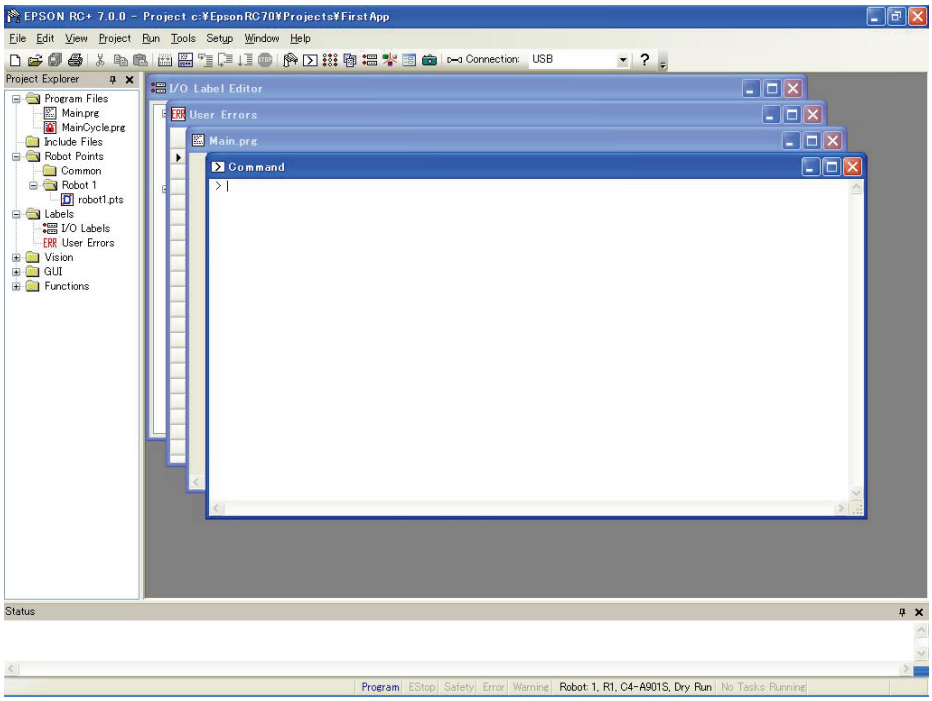
After receiving the code, click the <OK> button and enter the code. The option you purchased should now be enabled.

5.13 [Window] Menu

The [Window] menu contains selections for managing the currently open EPSON RC+ 7.0 child windows.

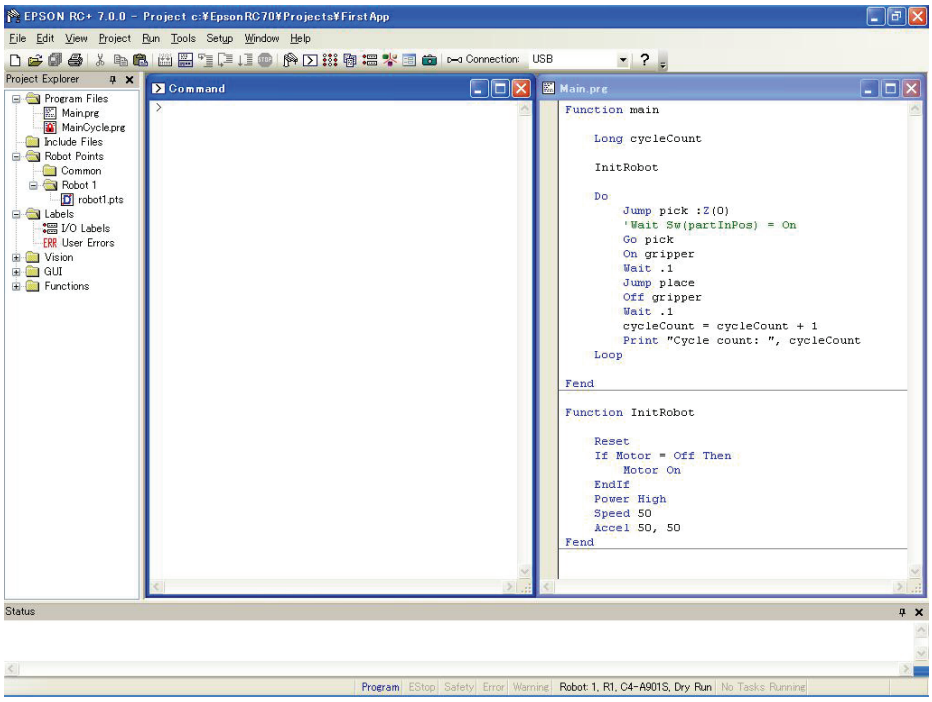
5.13.1 [Cascade] Command (Window Menu)

Use Cascade to show all of the currently open files in windows of the same size, stacked one on top of another.



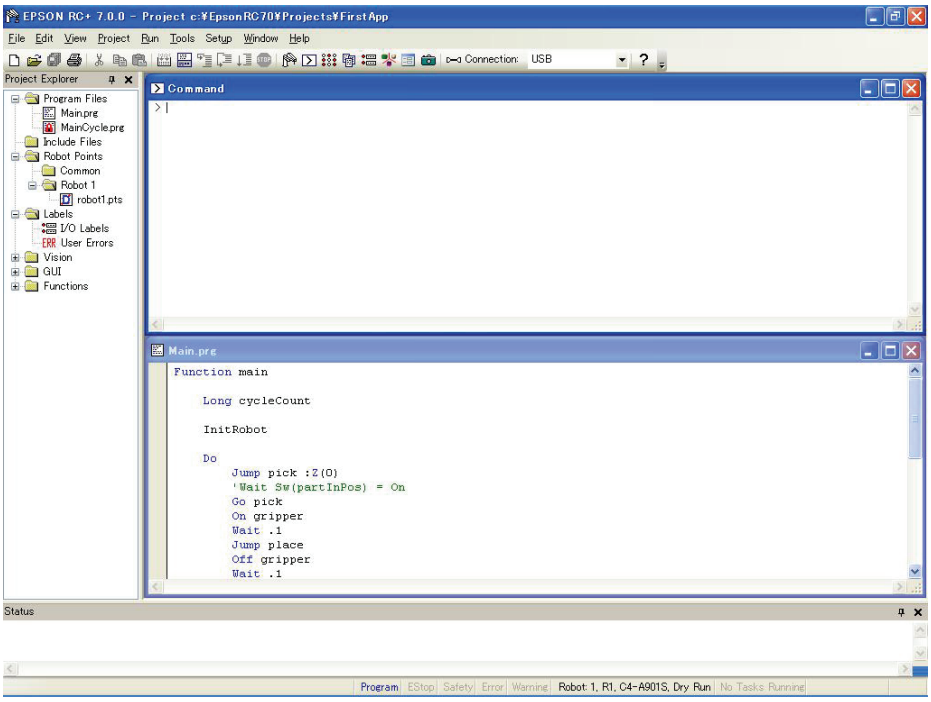
5.13.2 [Tile Vertical] Command (Window Menu)

Use Tile Vertical to evenly display all open windows vertically.



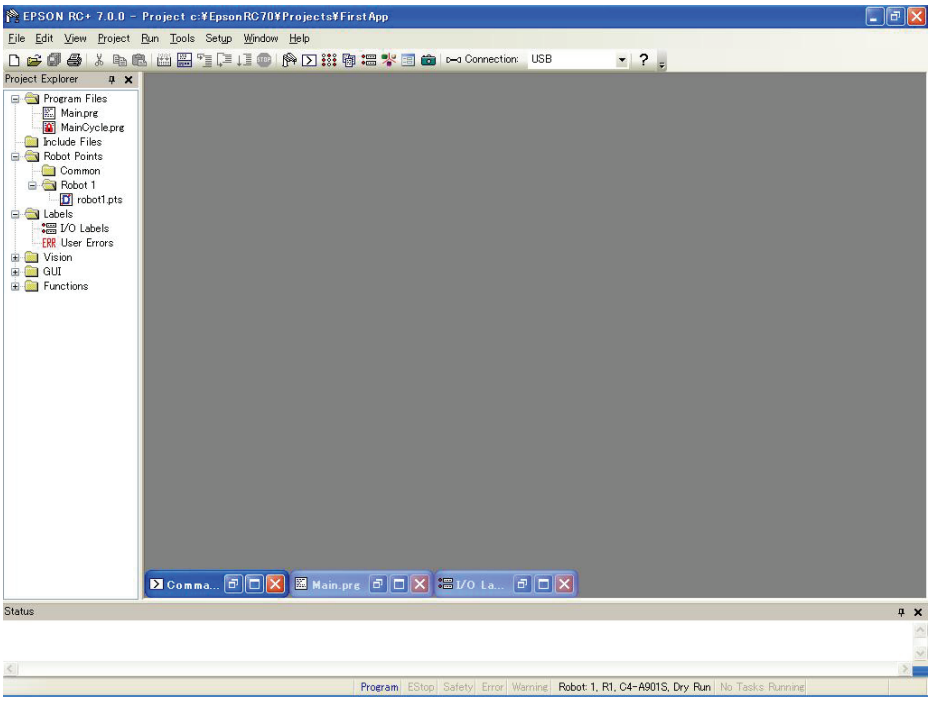
5.13.3 [Tile Horizontal] Command (Window Menu)

Use Tile Horizontal to evenly display all open windows horizontally.



5.13.4 [Arrange Icons] Command (Window Menu)

Arrange the icons for all child windows that have been minimized.



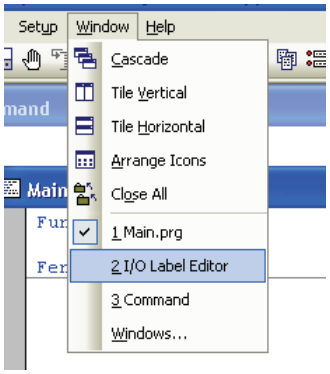
5.13.5 [Close All] Command (Window Menu)

This command closes all EPSON RC+ 7.0 child windows.

5.13.6 1, 2, 3 Command (Window Menu)

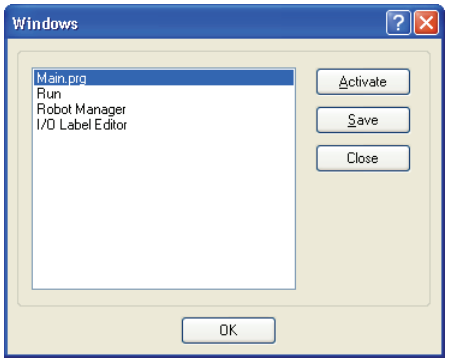
A listing of currently open document windows is displayed at the bottom of the [Window] menu.

When you choose an open window from the listing, you make that document active. A check mark appears in front of the document name of the currently active window.



5.13.7 [Windows] Command (Window Menu)

This command displays a dialog that contains a list of all currently open EPSON RC+ 7.0 windows.



Item	Description
Activate	Brings the selected window into focus.
Save	Saves the contents of the selected windows.
Close	Closes the selected windows.
OK	Closes the dialog.

5.14 [Help] Menu

The [Help] menu contains selections for accessing the help system and manuals along with version information.

5.14.1 [How Do I] Command (Help Menu)

Select [How Do I] to view topics that contain information for performing common tasks in EPSON RC+ 7.0.

Shortcuts

Keys: Ctrl + F1

5.14.2 [Contents] Command (Help Menu)

This command opens the Contents view for the EPSON RC+ 7.0 online help system.

From the Contents view, you can navigate through all of the topics in the help system. Double-click on a book icon to open or close the subtopic list contained within the book folder.

5.14.3 [Index] Command (Help Menu)

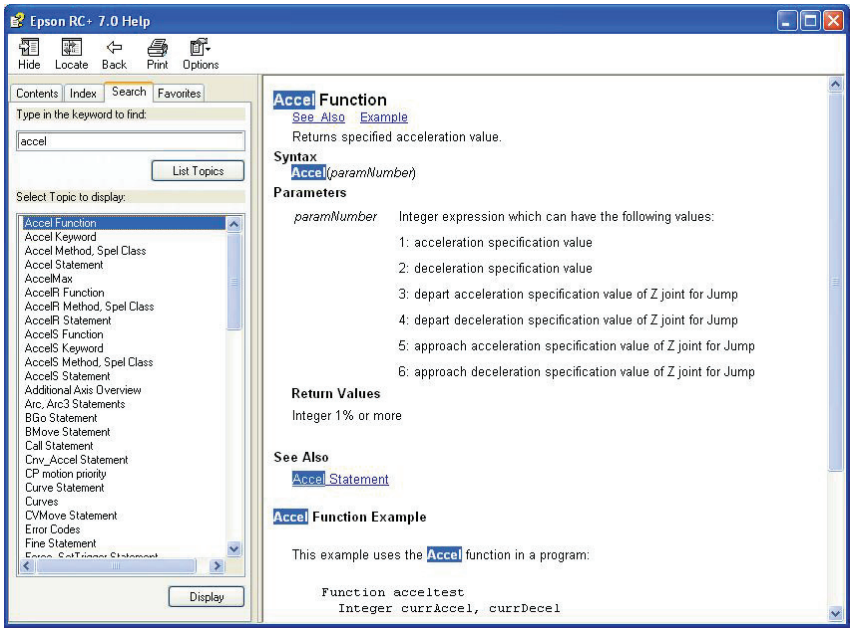
This command opens the Index view for the EPSON RC+ 7.0 online help system.

From the Index view, as you begin typing in a keyword, the alphabetical topic list will show the keywords starting with the letters you have typed.

5.14.4 [Search] Command (Help Menu)

This command opens the Search view for the EPSON RC+ 7.0 online help system.

From the Search view, you can type in one or more keywords and click List Topics to show a list of all topics containing one or more of the keywords. The keywords are highlighted in the topics as shown below.



5.14.5 [Manuals] Submenu (Help Menu)

The Help Menu Manuals submenu contains selections for each of the manuals in Adobe PDF format. These include manuals for EPSON RC+ 7.0, SPEL+ Language Reference, Controller, Robot, and the Options.

5.14.6 [About EPSON RC+ 7.0] Command (Help Menu)

The About command displays a dialog box showing the current version of the EPSON RC+ 7.0 software, along with copyright and license information. When calling technical support about EPSON RC+ 7.0, you should report the version you are using from this dialog.

6. The SPEL+ Language

This chapter contains information about the SPEL+ Language.

Contents

6.1 Overview

SPEL+ is a BASIC-like programming language that runs in the controller. It supports multitasking, motion control, I/O control.

Programs are written in ASCII text and then compiled into executable object files.
Several language instructions can also be executed in immediate mode from the Command window.

6.2 Program Structure

6.2.1 What is a SPEL+ program?

A SPEL+ program is a collection of functions, variables, and macros. You can put one or more statement in each line of a program (Multi-Statement). Every program file has a ".prg" extension and is stored in the project directory.

Each project must include at least one program and define the function called "main". "Function main" is the default definition. If "Function main" is not found, an error occurs.

In addition, you can define other 63 main functions in the same project. Each program has own start function: main1, main2…main63. Each of the main functions can be started from the [Operator window], the remote console, or RC+ API.

A function definition begins with the Function statement and ends with the Fend statement.

The following program file contains two function definitions. Function Main calls function Func1.

```
MAIN.PRG
Function Main
  Call Func1
  ...
Fend
Function Func1
  Jump pickpnt
  ...
Fend
```

6.2.2 Calling functions

You can execute a user function by using the Call statement. The function can reside in any program file in the current project. You can also omit the Call statement if you don't need the return value. When Call is omitted, then parentheses for the arguments must not be supplied. To get a return value, use the function in the right hand side of an expression.

Here are some examples:

```
Call MyFunc(1, 2)
MyFunc 1, 2
Print MyFunc(1, 2)
```

6.3 Commands and Statements

Commands and statements consist of a SPEL+ instruction followed by the parameters for that instruction.

A command is executed immediately. You can execute commands from the Command window or from the Macros dialog box.

Statements can be used only in programs.

Statements can include more than one SPEL+ instruction. When you put several statements in a line of a program (Multi-Statement), use a semi-colon (;) to separate instructions.

The maximum length for a line is 512 characters.

6.4 Function and Variable Names (Naming restriction)

The function name can include up to 64 characters. The variable name can include up to 32 alphanumeric, Japanese, or underscore characters. Characters can be upper case or lower case.

The following names are valid:

```
Function main
Real real_var
Integer IntVar
```

Function and variable names **cannot** begin with an underscore.

SPEL+ keywords cannot be used as function or variable names.

String variables must have an additional dollar sign ('$') suffix, as shown in the example below:

```
Function Test
  String modname$
  Print "Enter model name:"
  Line Input modname$
  Print "model is ", modname$
Fend
```

Restrictions for naming in SPEL+ language

- Characters can be alphanumeric, Japanese, or underscore character.
- Use alphabets for the first letter.
- Characters can be upper case or lower case.
- No keywords can be used.
- Maximum limits of names are as follows. (For one –byte character)

Name	Max. limit
Point label	32
I/O label	16
User error label	16
Function name	64
Variable name	32
Line label	32

6.5 Data Types

You can declare different types of data in your program. All variables must be declared.

The following table shows the different data types for the SPEL+ language.

Data Type	Size	Range
Boolean	2 byte	True or False
Byte	2 byte	–128 to +127
Double	8 bytes	–1.79E+308 to 1.79E+308 Number of significant figure is 14
Int32	4 bytes	–2147483648 to +2147483647
Integer	2 bytes	–32768 to +32767
Long	4 bytes	–2147483648 to +2147483647
Real	4 bytes	–3.40E+38 to 3.40E+38 Number of significant figure is 6
Short	2 bytes	-32768 to +32767
String	256 bytes	All ASCII characters Up to 255 characters
UByte	2 bytes	0 to +255
UInt32	4 bytes	0 to 4294967295
UShort	2 bytes	0 to 65535

6.6 Operators

The following table shows the operators for the SPEL+ language.

Keyword or Symbol	Description
+	Addition
–	Subtraction
*	Multiplication
/	Division
**	Exponentiation
=	Equal
>	Greater than
<	Less than
>=	Greater than or equal
<=	Less or than equal
<>	Not equal
And	Performs logical and bitwise AND operation.
Mod	Returns the remainder obtained by dividing a numeric expression by another numeric expression.
Not	Performs logical or bitwise negation of the operand.
Or	Performs the bitwise Or operation on the values of the operands.
Xor	Performs the bitwise Xor operation on the values of the operand.

6.7 Working with Variables

6.7.1 Variable scopes

There are three different scopes for variables in SPEL+:

- Local
- Module
- Global

6.7.2 Local variables

Local variables are available to all statements in the same function. Functions using local variable names can not refer to the same local variables in other functions. This is why they are called locals, because they are local to the function they are being used in.

To declare local variables in a function, use one of the variable declaration instructions at the beginning of the function after the Function statement:

Boolean, Byte, UByte, Integer, Short, UShort, Long, Int32, UInt32, Real, Double, String

For example, the following function declares several local variables:

```
Function test
  Integer intVar1, intVar2
  Real realVar
  String dataStr$
  Integer array(10)
  .....
Fend
```

6.7.3 Module variables

Module variables are available to all functions in the same program file.

To declare module variables in a program, use one of the variable declaration instructions at the beginning of the program before any Function statements:

Boolean, Byte, UByte, Integer, Short, UShort, Long, Int32, UInt32, Real, Double, String

TIP

In order to indicate that a variable is module level, precede the name with "m_", as shown in the example below. With this, you can improve the program readability.

For example, the following function declares several module level variables:

```
' Module level vars, used by all functions in this file
Integer m_IntVar1, m_IntVar2
Real m_RealVar
String m_DataStr$
Integer m_Array(10)

Function main
  m_IntVar1 = 25
  Call test
Fend

Function test
  Print m_IntVar1
Fend
```

6.7.4 Global variables

Global variables can be shared between all functions in a project. The Global instruction is used to declare a global variable.

To declare global variables in a program, use the Global instruction with the desired variable type (Boolean, Byte, UByte, Integer, Short, UShort, Long, Int32, UInt32, Real, Double, String) at the beginning of the program before any Function statements:

TIP

In order to indicate that variables are global, precede the name with "g_", as shown in the example below. With this, you can improve the program readability.

Program: MAIN.PRG

```
Global Integer g_TotalCycles
Function main
  Call LoadPart
  :::
Fend
```

Program: LOADPART.PRG

```
Function LoadPart
  Jump pick
  On gripper
  Wait .1
  Jump place
  Off gripper
  Wait .1
  g_TotalCycles = g_TotalCycles + 1
Fend
```

For more information, see Data Types.

6.7.5 Global Preserve variables

You can preserve global variable values by using the optional Preserve parameter when you declare global variables.

Preserved variables are stored in the controller's SRAM.

If the data type of a preserved variable is changed, or the number of dimensions is changed, then the variable values will be cleared.

NOTE

Be careful about the backup battery power, because you will lose the data of global preserve variables stored in SRAM if the battery is weak.

6.7.6 Arrays

You can declare local, module, and global variables with up to three dimensions as arrays for all data types.

To declare an array, use this syntax:

dataType *name* **(** *ubound1* [, *ubound2* [, *ubound3*]] **)**

SPEL+ arrays are zero based. The first element is referenced with a value of zero.

The total available number of array elements for local variables is 200 for strings and 2000 for all other types.

The total available number of array elements for global preserve variables is 400 for strings and 4000 for all other types.

The total available number of array elements for global and module variables is 10,000 for strings and 100,000 for all other types.

To calculate the total elements used in an array, use the following formula. (If a dimension is not used, substitute 0 for the ubound values.)
total elements = (ubound1 + 1) * (ubound2 + 1) * (ubound3 + 1)

Array declaration examples:

```
' Global string array
Global String gData$(10)
Function main
   ' Arrays local to this function
   Integer intArray(10)
   Real coords(20, 10)
```

Use Redim to change the bounds of an array at run time.

```
Integer a(10)
Redim a(20)
```

To preserve values when using Redim, add the Preserve optional argument.

```
Integer a(10)
Redim Preserve a(20)
```

Use UBound to get the maximum element number.

```
Integer i, a(10)
For i = 1 to UBound(a)
  a(i) = i
Next i
```

6.7.7 Initial values

All variables are initialized when first used except for Global Preserve variables. Strings are set to empty, and all other variables are set to zero.

6.7.8 Clearing arrays

Execute Redim (without Preserve) to clear all of the elements of array variables.

6.8 Working with Strings

A string in SPEL$^+$ is a set of ASCII characters (Code &h01 ~ &hff) with a maximum length of 255.

You must declare strings in your programs with the String instruction.

All string variable names must end with a dollar sign ($) suffix.

The following table shows the string commands available in SPEL$^+$.

Keyword	Description
Asc	Returns the decimal ASCII value of the first character in a string.
Chr$	Converts an ASCII value into a one character string.
FmtStr$	Formats a numerical or date/time expression.
Hex$	Returns a string containing the hexadecimal value of a number.
InStr	Returns the position of a substring within a string.
LCase$	Returns the specified string in lower case characters.
Left$	Returns a substring beginning with the first character of a string.
Len	Returns the length (number of characters) of a string.
LTrim$	Returns the specified string with left spaces removed.
Mid$	Returns a substring of a string.
ParseStr	Parses a string into an array of tokens.
Right$	Returns a substring from the end of a string.
RTrim$	Returns the specified string with right spaces removed.
Space$	Returns a string containing a specified number of space (ASCII 32) characters.
Str$	Converts a number to a string.
String	Declare a string variable in a program.
Tab$	Returns a tab string.
UCase$	Returns the specified string in upper case characters.
Val	Converts a string to a number.

6.9 Working with Files

SPEL+ has several commands for handling files.

Keyword	Description
AOpen	Opens a file for append.
BOpen	Opens a file for binary access.
Close	Closes a file.
FileExists	Checks if a file exists.
FolderExists	Check if a folder exists.
FreeFile	Returns an unused file handle.
Input	Inputs one or more variables from a file
Kill	Deletes a file.
Line Input	Inputs line from a file.
Read	Reads a specified number of bytes into a string variable.
ReadBin	Reads binary data.
ROpen	Opens a file for reading.
Seek	Sets the current file pointer.
Flush	Writes data buffer to disk.
WOpen	Opens a file for writing.
Write	Writes out a variable at the current file pointer without appending a line terminator.
WriteBin	Writes binary data.

Before using a file you must open it with one of the following commands: AOpen, Bopen, ROpen, and WOpen. And specify a file number in the Open statement. File number can be 30 ~ 63.

Here is an example to save a text file and read it.

```
Function SaveData(ByRef data$() As String)
  Integer fNum, i

  fNum = FreeFile
  WOpen "c:\mydata\data.txt" As #fNum
  ' Store the count
  Print #fNum, UBound(data$)
  For i = 0 To UBound(data$)
    Print #fNum, data$(i)
  Next i
  Close #fNum
Fend
```

```
Function LoadData(ByRef data$() As String)
  Integer fNum, i

  fNum = FreeFile
  ROpen "c:\mydata\data.txt" As #fNum
  Input #fNum, i
  Redim data$(i)
  For i = 0 To UBound(data$)
    Input #fNum, data$(i)
  Next i
  Close #fNum
Fend
```

NOTE

The files on the networks are not available to access.

6.10 Multi-statements

A program statement can contain several statements separated by semi-colons. The total length of a multi-statement program line cannot exceed 255 characters.

For example:

```
Function Test
  Pass P1; Pass P2; Go P3     ' Multi-statement
Fend
```

It is not recommended to use multi-statements. Multi-statements can make your code more difficult to read and debug.

6.11 Labels

A program line is an alphanumeric name followed by a colon (":") that marks a location in a program for a GoTo or GoSub statement. The name may be up to 32 characters long and can include alphanumeric characters and the underscore ("_") character if it is not the first character. You cannot use any SPEL$^+$ keywords as labels.

For example:

```
Function Main
  Do
    Jump P1
    Jump P2
    If Sw(1) Then GoTo MainAbort
  Loop
MainAbort:    ' Program label
  Print "Program aborted"
Fend
```

6.12 Comments

Use comments to add notes to your programs. An apostrophe character (') starts a comment.

Example:

```
Function Main
   ' ****** Main Demo Program ******
   Xqt conveyor       ' Start up the task for conveyor
   Do
       Print "Press ENTER to run demo cycle"
       Print "Press CTRL+C to quit"
       Input dumy
       Call demo    ' Execute the demo function
   Loop             ' Return to start of main loop
```

6.13 Error Handling

When an error occurs in a SPEL$^+$ function, you can cause execution to be transferred to an error handling routine for processing the error. The routine must be inside a function definition.

The table on the next page shows the program instructions that are used for error handling.

Item	Purpose
OnErr	Use the OnErr statement to define the location of the error handling routine.
Err	Use Err to retrieve the number for the current error status. Use this in the error handling routine to determine which error has occurred.
Error	Generate a user defined error which can be caught by an error handler.
Era	Use Era to retrieve the axis number for which the error occurred. This is normally used in the error handling routine.
Erl	Use Erl to retrieve the line number in which the error occurred. This is normally used in the error handling routine.
Ert	Use Ert to retrieve the task number in which the error occurred. This is normally used in the error handling routine.
ErrMsg$	Use ErrMsg$ to retrieve the error message associated with a specified error number.
Errb	Use Errb to retrieve the robot number in which the error occurred. This is normally used in the error handling routine.

User Errors

You can define your own error messages by using the User Error Editor which is available from the Tools Menu. For details refer to *5.11.7 User Error Editor (EPSON RC+ 7.0 GUI)*.

Example

The following example shows a simple error handling routine. When an error occurs, program execution goes to the ErrHandler label, where the error handler starts. The error number is displayed and the operator is asked to continue or not. If the operator enters "N" then the program executes the Quit All statement to end the program.

```
Function Main
  String cont$
  Integer i
  OnErr Goto Errhandler
  For i = 1 To 10
    Jump P(i)
  Next i
  Exit Function
' *** Error handler ***
Errhandler:
  enum = Err
  Print "Error #", enum, " occurred"
  Print "Continue (Y or N)?"
  Line Input cont$
  Select cont$
    Case "y", "Y"
      EResume Next
    Default
      Quit All
    Send
  Fend
```

6.14 Multi-tasking

For some applications, you may want to control other equipment besides the robot, such as conveyors, pick and place units, etc. By using multi-tasking, you can control this other equipment with their own tasks.

SPEL$^+$ supports up to 32 normal tasks and 16 background tasks (48 tasks in total) running simultaneously. A task is a function that has been started by the system or by the Xqt statement.

Use the Xqt statement to start another task from within a function. You can optionally specify a task number from 1 to 32 in the Xqt statement.

A task started from a background task is started as a background task. You can execute up to 16 background tasks simultaneously.

The table below shows the program instructions that are used for multitasking.

Statement	Purpose
Xqt	Starts a function as a task.
Halt	Temporarily suspends execution of a task.
Resume	Resumes a task that has been halted.
Quit	Stops a task.
Signal	Sends a signal to one or more tasks that are waiting for the signal using WaitSig.
SyncLock	Locks a resource for use by the current task and blocks other tasks from using the resource until **SyncUnlock** is executed.
WaitSig	Waits for a signal from another task.
Pause	Pause all tasks.

One example for starting another task is to run a conveyor system for the robot work cell.

Program: MAINTASK.PRG

```
Function Main
  Xqt Conveyor                ' Start the conveyor task
  Do
     ...
     ...
  Loop
Fend
```

Program: CONVTASK.PRG

```
Function Conveyor
  Do
     Select True
        Case Sw(10) = On
           Off convCtrl
        Case Sw(11) = On
           On convCtrl
     Send
  Loop
Fend
```

6.15 Using Multiple Robots

You can control more than one robot in the same project. Use the Robot statement to switch the current robot for the current task. For most applications, you should use a separate task for each robot.

Each robot has its own set of point files. You can configure which point files to se in the Project Editor. The default point file you configure for each robot is automatically loaded into memory when the main task is started.

The following program is an example where two robots run simultaneously, each with its own task.

```
Function main
  Xqt Robot1
  Xqt Robot2
Fend

Function Robot1
  Robot 1
  Speed 50
  Do
    Jump pick
    On gripper1
    Wait .1
    Jump place
    Off gripper1
    Wait .1
  Loop
Fend

Function Robot2
  Robot 2
  Speed 50
  Do
    Jump pick
    On gripper2
    Wait .1
    Jump place
    Off gripper2
    Wait .1
  Loop
Fend
```

6.16 Robot Coordinate Systems

6.16.1 Overview

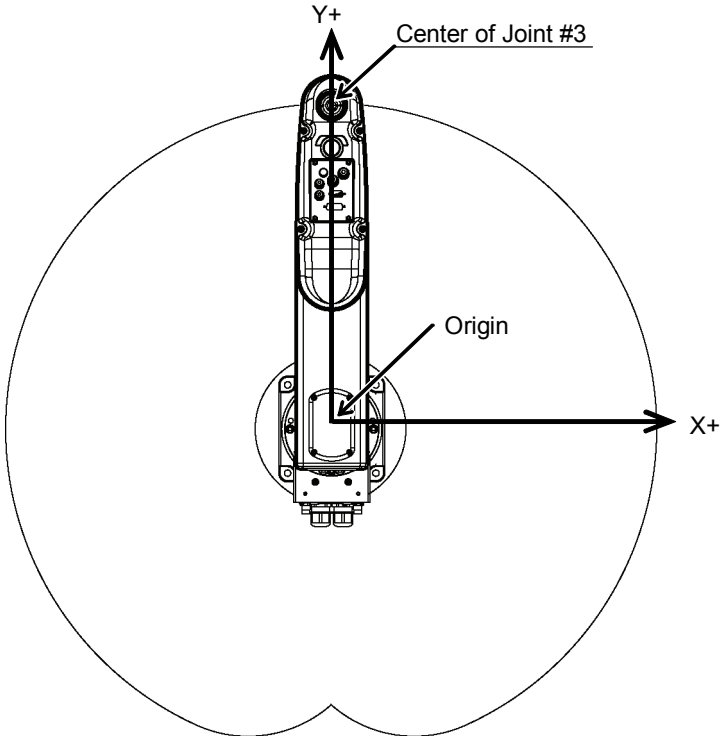
In this section we discuss the coordinate systems for different types of robots supported in SPEL+.

The following coordinate systems are used in SPEL+:

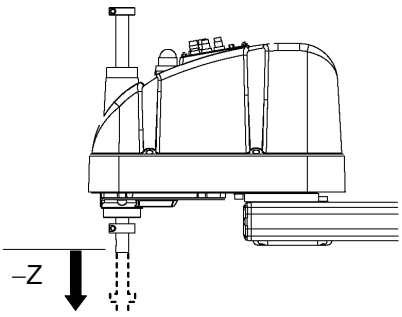
Robot Coordinate System	This is the native coordinate system of the robot. This is also known as the default base coordinate system.
Local Coordinate System	This is a user defined coordinate system located somewhere within the working envelop.
Tool Coordinate System	This is the coordinate system of the tool mounted on the robot end-effector.

6.16.2 Robot Coordinate Systems

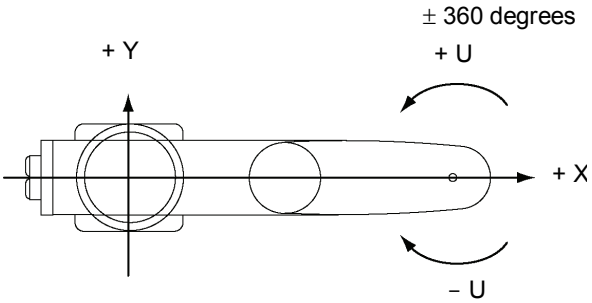
Robot Coordinate System of SCARA Robot



Robot coordinate system Z axis

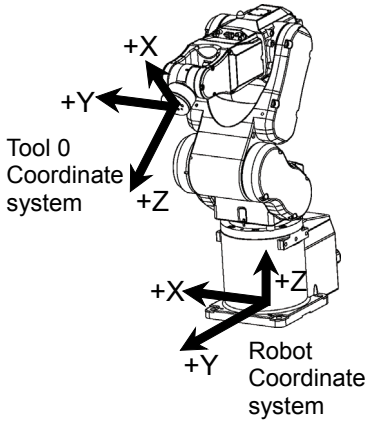


Robot coordinate system U axis

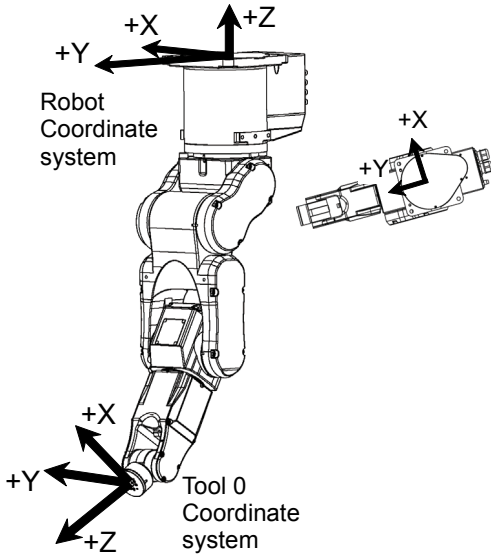


Robot Coordinate Systems for 6-Axis Robot

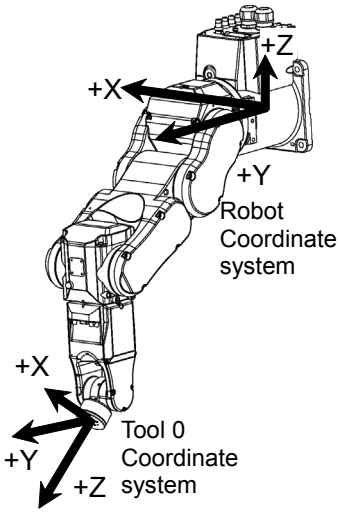
Table Top Mounting



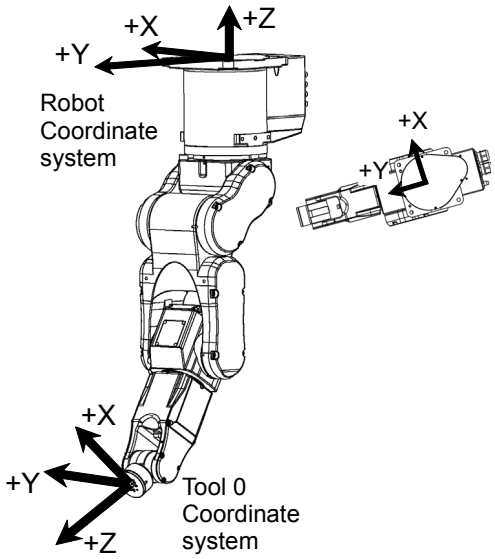
Ceiling Mounting



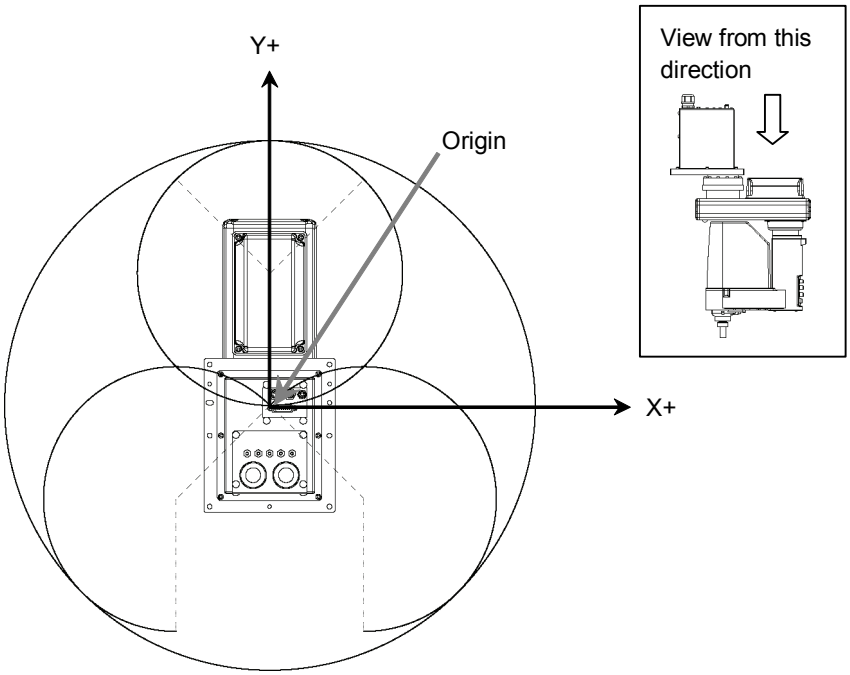
Side (Wall) Mounting



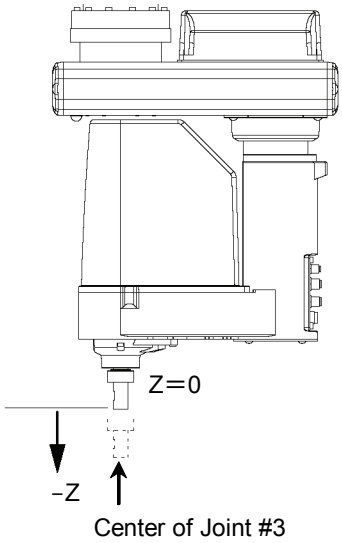
Skewed Mounting



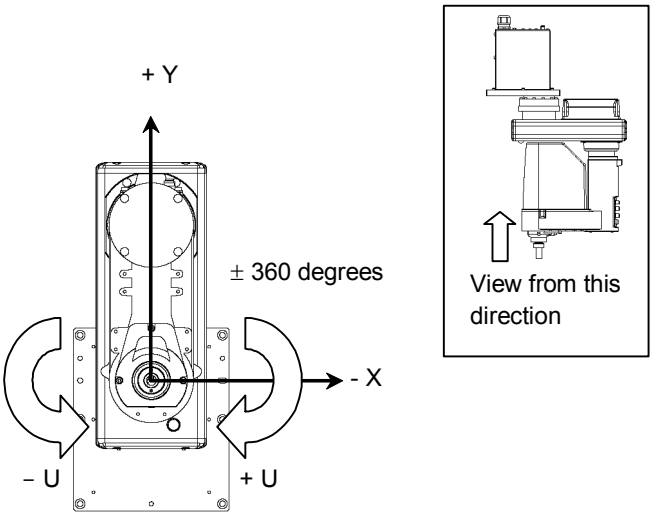
Robot Coordinate Systems for RS series



Robot coordinate system Z axis



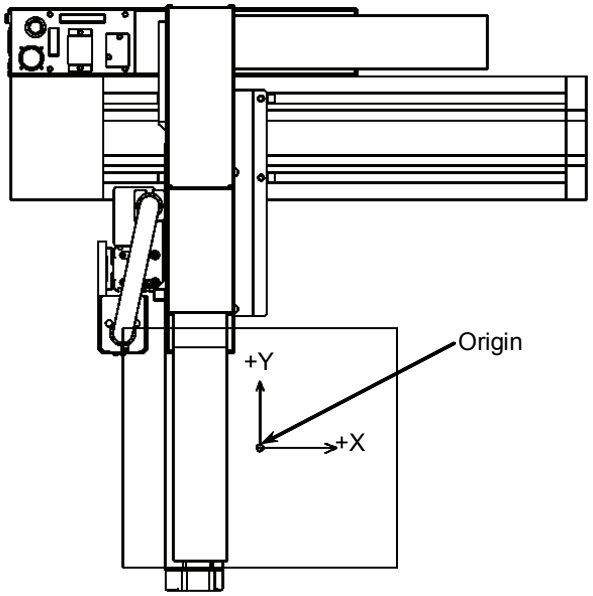
Robot coordinate system U axis



Robot Coordinate Systems for Cartesian Robot

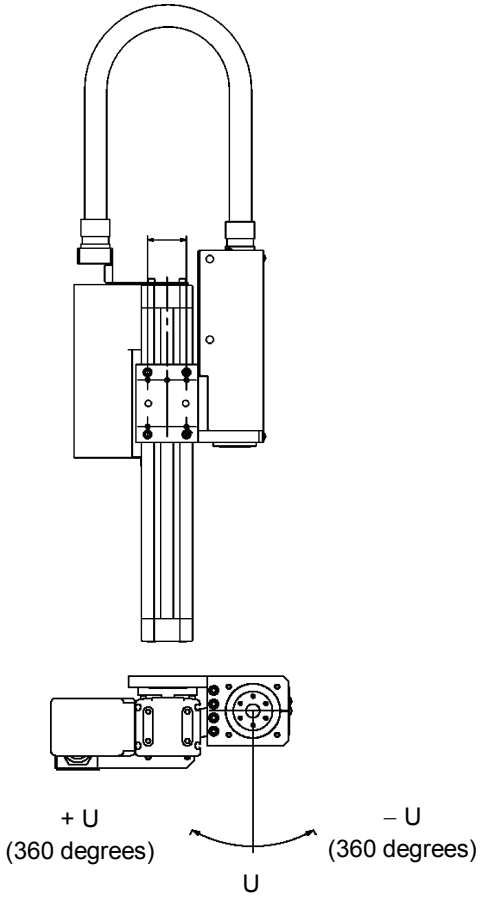
For the EZ Modules X5 series, the robot coordinate system differs depending on the robot model and mounting direction. Refer to the EZ Modules X5 series manipulator manual for details of each robot coordinate system.

E.g. X5 series RU-HMSz A type



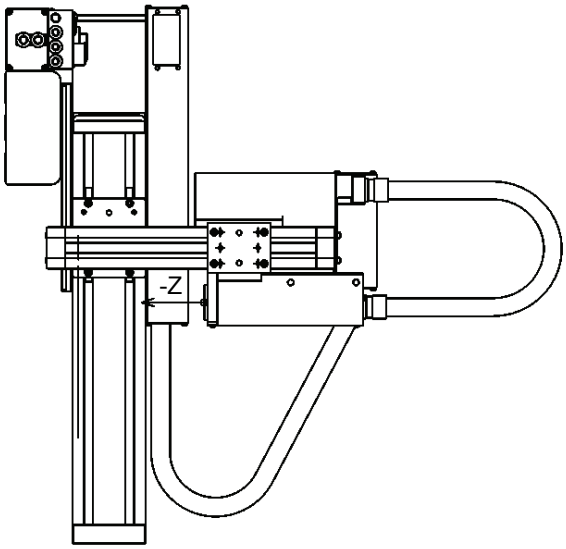
U axis in Robot Coordinate System of Cartesian Robot

E.g. X5 series RU-HMSz A type



Z axis in Robot Coordinate System of Cartesian Robot

E.g. X5 series RU-HMSz A type



6.16.3 Local Coordinate Systems

With SPEL+, a maximum of 15 local coordinate systems can be defined. SPEL+ correlates robot coordinate systems and local coordinate systems by defining in advance the relative positional relationship of the local coordinate system from the robot coordinate system, assigning local numbers (1 to 15), and then assigning the local numbers to coordinate system attributes (local).

To define a local coordinate system, use the Local statement.

6.16.4 Tool Coordinate Systems

Point data is defined by the position and orientation of the tool coordinate system with respect to some reference rectangular coordinate system. The position is specified by the position data (X, Y, Z) and the orientation is specified by the orientation data (U, V, W) that correspond with roll, pitch, and yaw.

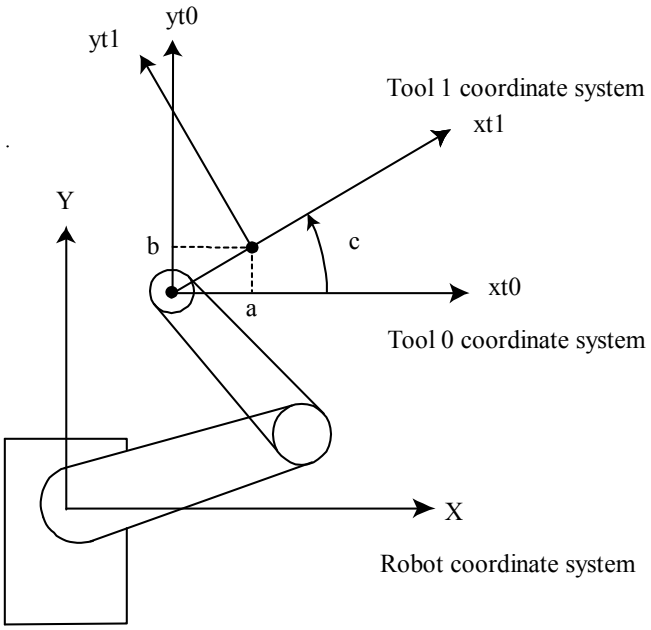
You can also define and use your own tool coordinate systems. To define the tool coordinate systems, use Tlset.

The default TOOL 0 coordinate systems are defined as follows according to the robot type.

SCARA Tool 0 coordinate system

The origin of tool 0 for SCARA robots is the center of the forth joint (rotation joint). When the fourth joint is adjusted to the position of 0 degrees, the tool 0 coordinate system axes are parallel to the robot coordinate system axes (see the figure below.)

The tool 0 coordinate system rotates as the fourth joint rotates.



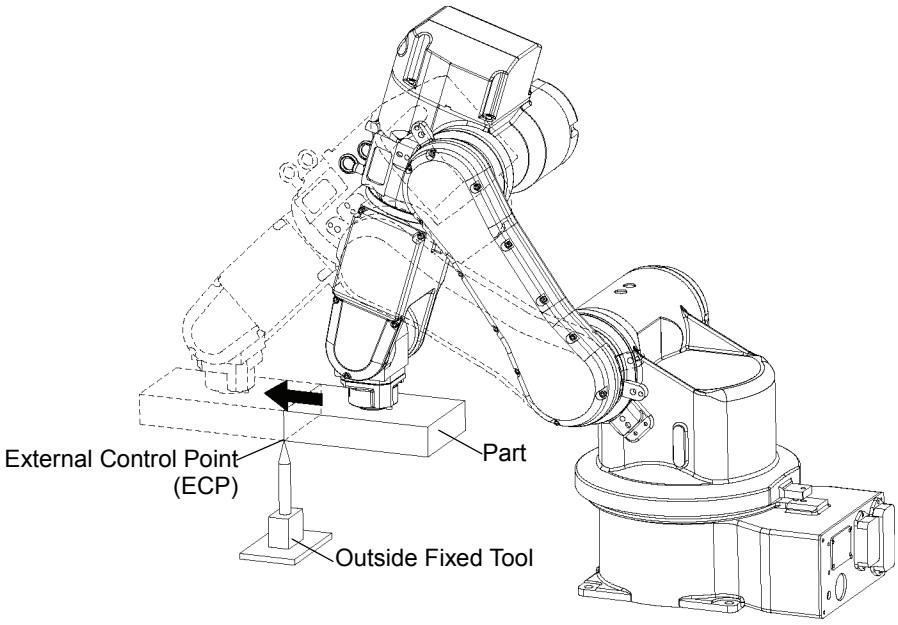
6-axis Tool 0 coordinate system

For table mounting, the origin of TOOL 0 is the flange side center of the sixth joint. In TOOL 0, the tool Z axis is perpendicular to the sixth joint flange. (See the figure in the previous section *Robot Coordinate Systems*). The TOOL 0 coordinate system moves as the 6-axis robot changes its orientation.

For ceiling mounting and wall mounting robots, the TOOL 0 coordinate systems are defined as shown in the figures in the section *Robot Coordinate Systems*.

6.16.5 ECP Coordinate Systems (Option)

Specify a coordinate system whose origin point is on the tip of the outside fixed tool (hereafter referred to as the external control point or ECP) to move the robot arm holding a part in the trajectory made on the external control point along with the part's edges.



Use the ECPSet statement for defining an ECP coordinate system. A maximum of 15 ECP coordinate systems can be defined.

The following commands are available for optional ECP:

- Move command
- Arc3 command
- Curve and CVMove commands
- ECP jog motion

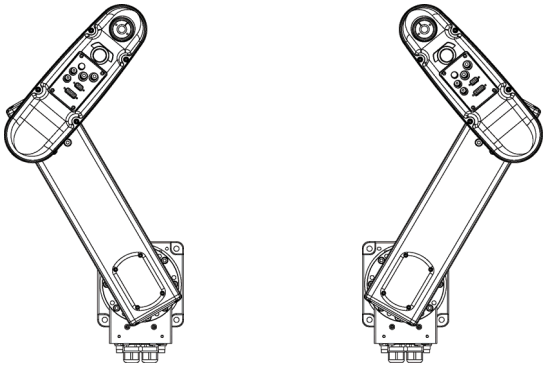
For details, refer to *17. ECP Motion*.

6.17 Robot Arm Orientations

When developing a robot program, it is necessary to specify the point data taught for a particular arm orientation. If you fail to do so, the position can deviate slightly depending on the arm orientation, which in turn can cause the arm to follow an unexpected path, resulting in interference with peripheral equipment. This can be dangerous! To prevent this from happening, the orientation that the arm will be in when moved to the given point should be specified ahead of time in the point data. Such information can also be changed from the program.

6.17.1 SCARA robot arm orientations

With two types of arm orientation, a SCARA robot can move to nearly any position and orientation within a given work envelope. Examples are shown in the figures on the next page.



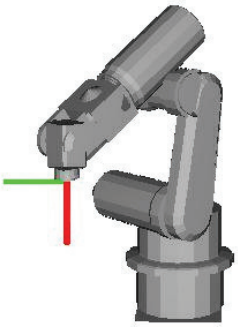
Lefty arm orientation Righty arm orientation

Examples of moving to the same point using Lefty and Righty arm orientations

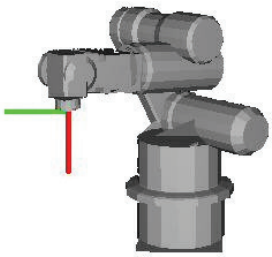
6.17.2 6-axis robot arm orientations

The 6-axis robot can be operated in various arm orientations within a given work envelope as shown below:

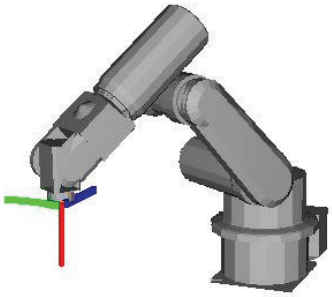
Righty hand orientation



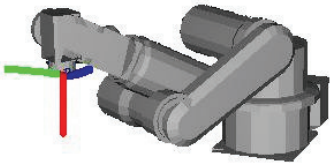
Lefty hand orientation



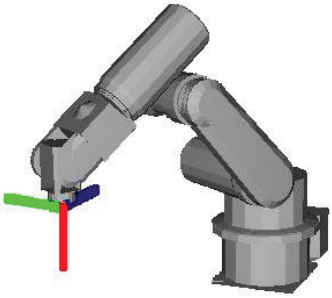
Above elbow orientation



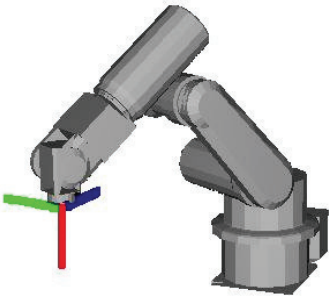
Below elbow orientation



NoFlip wrist orientation



Flip wrist orientation



To specify orientation for the 6-axis robot, add a forward slash (/) followed by L (for Lefty hand orientation) or R (Righty hand orientation), A (Above elbow orientation) or B (Below elbow orientation), and NF (NoFlip wrist orientation) or F (Flip wrist orientation).

There are eight available orientations as shown below, however, the 6-axis robot cannot be operated in all of the orientations depending on point.

Available Orientation

1	/R /A /NF	5	/R /A /F
2	/L /A /NF	6	/L /A /F
3	/R /B /NF	7	/R /B /F
4	/L /B /NF	8	/L /B /F

At some points in the work envelope, the 6-axis robot can have the same position and orientation even if the fourth joint or the sixth joint is rotated 360 degrees. To distinguish these points, the J4Flag and J6Flag point attributes are provided.

To specify the J4Flag, add a forward slash (/) followed by J4F0 (-180 < the forth joint angle <= 180) or J4F1 (the forth joint angle <= -180 or 180 < the forth joint angle).

To specify the J6Flag, add a forward slash (/) followed by J6F0 (-180 < the sixth joint angle <= 180), J6F1 (-360 < the sixth joint angle <= -180 or 180 <the sixth joint angle <= 360), or J6Fn (-180*(n+1) < the sixth joint angle <= 180*n or 180*n <the sixth joint angle <= 180*(n+1)).

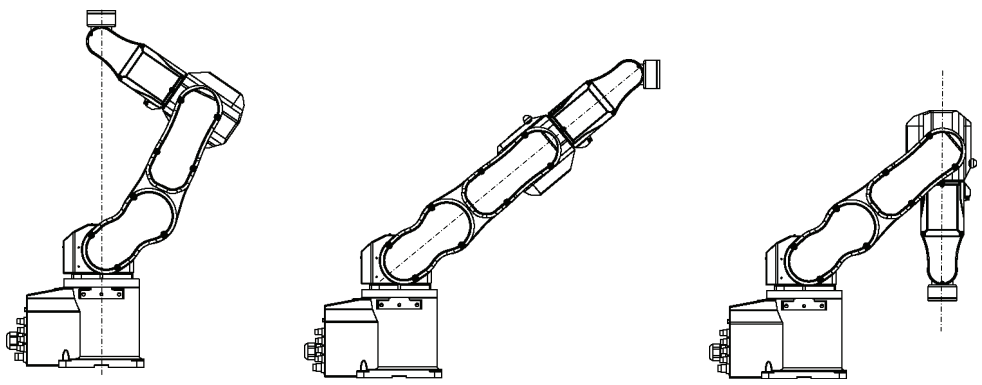
Singularity

The orientation in the boundary where the arm orientation switches to the other

Hand singularity : The boundary where Righty hand orientation and Lefty hand orientation switch

Elbow singularity : The boundary where Above elbow orientation and Below elbow orientation switch

Wrist singularity : The boundary where NoFlip wrist orientation and Flip wrist orientation switch



Hand singularity Elbow singularity Wrist singularity

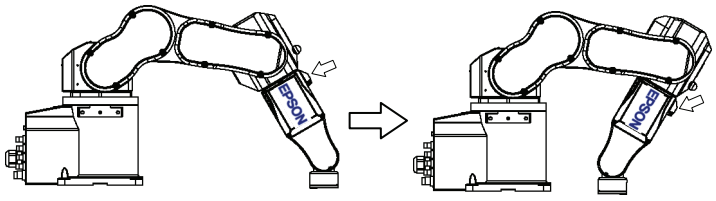
For the 6-axis robot, Hand / Wrist singularities exist also inside the motion range. When jogging near the singularity, follow the directions below.

PTP motion near the singularity

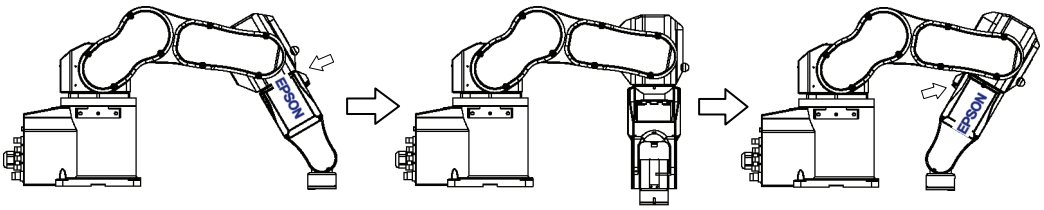
When jogging a robot from point P1 near the singularity to a point calculated by point operations such as P1+X(10), the robot may move to unintended direction because the arm orientation is not properly specified.

For example, when jogging from a point where the wrist is NoFlip to another point calculated by point operations, if the wrist keeps the NoFlip orientation while jogging, Joints #4 and #6 may rotate widely (by approx. 180 degrees).

In this case, switch to the Flip wrist orientation to jog smoothly through the wrist singularity. This phenomenon occurs not only with the point operations but also when creating points automatically with Pallet command or the result values that run from vision sequence.



Proper motion



Unintended motion (Joints #4, #6 rotate 180 degrees)

However in the cases, it is difficult for users to specify the proper arm orientations by a program. For this LJM function is a useful command. LJM function switches the arm orientations to enable the least motion of the joints. For the details of LJM function, refer to *SPEL+ Language Reference manual*.

Also, AutoLJM command can automatically apply LJM function to the motion commands which are included in a particular section of the program without using LJM function. For details of AutoLJM command, refer to the *SPEL+ Language Reference*.

In addition, you can set AutoLJM function to be enabled at the controller start up by setting preferences of the controller. However, if Auto LJM is enabled in preferences, this function automatically adjusts the posture of the manipulator to reduce the motion distance, even when you intend to move the joint widely. Therefore, it is recommended to build a program using AutoLJM command or LJM function to operate the manipulator as you desired.

If you specify all points by teaching, the arm orientations are also recorded. Therefore, the manipulator moves to the taught position without using LJM function or AutoLJM. Instead, the manipulator may move differently from the taught position by the use of LJM and AutoLJM.

LJM function for CP motion command

LJM function and AutoLJM command described above are also available for CP motion commands. However, since CP motion commands give priority to operate based on specified trajectories, the manipulator sometimes reach to the point with a different posture from the specified one. At this time, if CP motion command is used with CP On, an error from 4274 to 4278 will occur according to the mismatched point flag. To avoid the error, operate the manipulator with CP Off, or match the point flag of a target point and the one after motion completion. If operated with CP Off, the error does not occur and the manipulator can continue operation from the point where the mismatch happened.

Also, you can set the controller's preference so that the mismatches of flags are not considered as an error at the controller startup. However, path motions which use CP On will be disabled.

CP motion near the singularity (singularity avoiding function in CP motion)

When executing Move or CP motion near the singularity, the joint speed may increase rapidly. The over speed error will occur and the joints will move widely and interfere with peripherals. In particular, the position of Joint #1 near the hand singularity and Joints #2 - #6 near the wrist singularity change greatly.

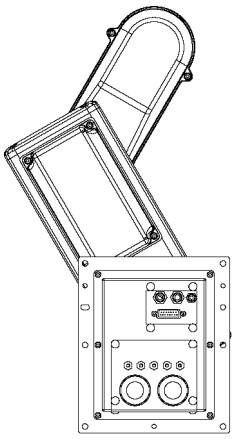
RC+7.0 has a singularity avoiding function to prevent acceleration errors during the execution of CP motion commands that pass the wrist singularity described above. With this function, the manipulator takes a detour to avoid an acceleration error by passing a different trajectory and returns to the original trajectory after passing the singularity. For details of the singularity avoiding function, refer to *AvoidSingularity* in the *SPEL+ Language Reference*.

Singularity avoiding function is enabled as default. If you want to avoid the error by reducing the motion speed in order to maintain the trajectory accuracy, you can disable the function temporarily by setting "0" to AvoidSingularity.

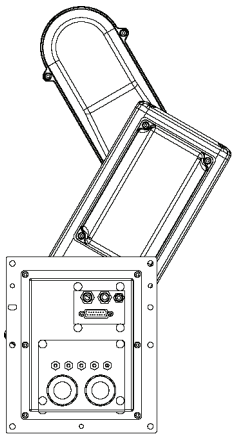
If you cannot avoid errors even if you use the singularity avoiding function, use PTP motion to enable the least motion of the joints or arrange the manipulator installation position and hand offset volume to prevent the CP motion near the singularity.

6.17.3 RS series arm orientations

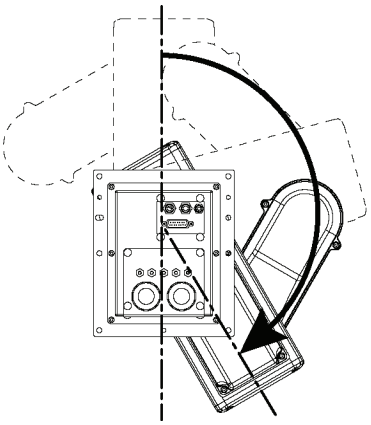
The RS series can be operated in various arm orientations within a given work envelope as shown below:



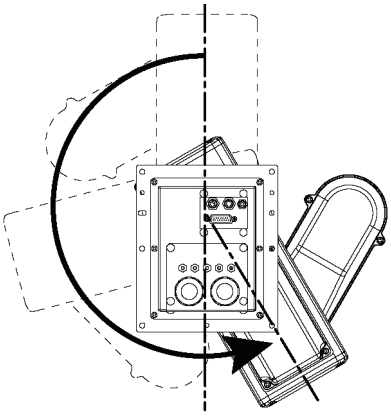
Lefty arm orientation



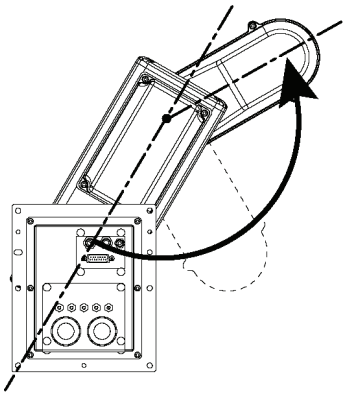
Righty arm orientation



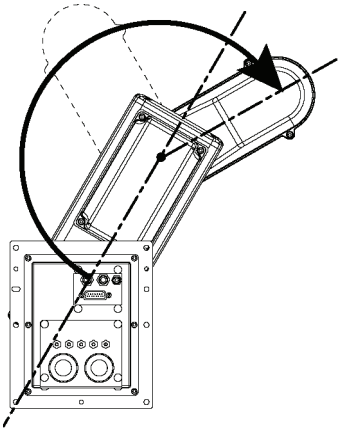
J1 F0 arm orientation



J1 F1 arm orientation



J2 F0 arm orientation



J2 F1 arm orientation

To specify the arm orientation of the RS series, add a forward slash (/) followed by:
- L (for Lefty hand orientation) or R (Righty hand orientation)
- J1F0 or J1F1
- J2F0 or J2F1.

For the RS series robots, some points in the work envelope can have the same position and orientation even if J1 or J2 is rotated 360 degrees.
To distinguish these points, the J1Flag and J2Flag point attributes are provided.

To specify the J1Flag, add a forward slash (/) followed by:

- J1F0 (–90 < the first joint angle <= 270), or
- J1F1 (–270 < the first joint angle <= –90 or 270 < the first joint angle <= 450)

To specify the J2Flag, add a forward slash (/) followed by:

- J2F0 (–180 < the second joint angle <= 180), or
- J2F1 (–360 < the second joint angle <= –180 or 180 < the second joint angle <= 360)

There are eight available orientations as shown below.
Note that some combinations are not avairable depending on the point.

	Available Orientation
1	/R /J1F0 /J2F0
2	/L /J1F0 /J2F0
3	/R /J1F1 /J2F0
4	/L /J1F1 /J2F0
5	/R /J1F0 / J2F1
6	/L /J1F0 / J2F1
7	/R /J1F1 / J2F1
8	/L /J1F1 / J2F1

6.18 Robot Motion Commands

SPEL+ includes several commands for controlling the robot from your programs.

6.18.1 Homing the robot

The Home command moves the robot to a user defined "park" or "idle" position. This command works for all robots. It is mainly used for absolute encoder robots that normally do not need to be mechanically homed. Use the HomeSet command to set the home position and the Hordr command to set the home order.

6.18.2 Point to point motion

Point to point (PTP) commands move the robot from its current position to a specified point. Motion may not be in a straight line.

To set the speed for point to point commands, use the Speed command. To set acceleration and deceleration, use the Accel command.

Command	Description
Go	Move directly to a point using point to point motion.
Jump	Jump to a point. First move up to the current LimZ setting, the move over the destination point, then move to the point. The Arch table settings determine the Jump profile.
Jump3	Jump to a point in 3 dimensions.
Pass	Move near one or more points.
TGo	Move directly to a point in a tool coordinate system.

6.18.3 Linear motion

Linear motion commands move the robot from its current position to a specified point in a *straight line*. Liner motion is a CP (Continuous Path) motion.

To set velocity (speed) for straight motion, use the SpeedS command. To set acceleration and deceleration, use the AccelS command.

Command	Description
Move	Move in a straight line to the specified point.
TMove	Move in a straight line to the specified point in a tool coordinate system.
Jump3CP	Jump to a point in 3 dimensions using CP motion.

6.18.4 Curves

Curves commands move the robot in a circular arc. Curves is a CP (Continuous Path) motion.

To set velocity (speed) for Curves, use the SpeedS command. To set acceleration and deceleration, use the AccelS command.

Command	Description
Arc	Move the robot through one point to another point using circular interpolation.
Arc3	Move the robot in 3D using circular interpolation.
Curve	Creates a file containing a path specification.
CVMove	Executes a path specified by Curve.

6.18.5 Joint motion

Command	Description
JTran	The JTran command can be used to move one joint of the robot to a position specified in degrees or millimeters, depending on the joint type. The speed and acceleration are the same as for point to point motion commands -- i.e., specified with Speed or Accel commands.
PTran	The PTran command can be used to move one joint of the robot to an encoder pulse position. The speed and acceleration are the same as for point to point motion commands -- i.e., specified with Speed or Accel commands.
Pulse	The Pulse command can be used to move all joints of the robot to encoder pulse positions. The speed and acceleration are the same as for point to point motion commands -- i.e., specified with Speed or Accel commands.
PG_Scan	The PG_Scan command can be used to rotate a pulse generator axis of a Joint-type single axis PG robot continuously in CW/CCW directions. (To rotate it continuously, you need to enable the continuous rotation parameter.) The speed and acceleration are the same as for point to point motion commands -- i.e., specified with Speed or Accel commands.

6.18.6 Controlling position accuracy

Use the Fine command to adjust position accuracy for the end of a motion command. Fine specifies, for each joint, the allowable positioning error for detecting completion of any given move. The lower the Fine settings, the more accurate the final position of the joint, which can cause slower performance. Conversely, large Fine settings can speed up motion commands, but position accuracy will decrease. For many applications, the default settings can be used.

6.18.7 CP Motion Speed / Acceleration and Tool Orientation

When you attempt to change only the tool orientation while keeping the tool tip of the robot arm at the specified coordinate point or when the tool orientation variation is larger than the travel distance of the tool tip, moving the arm by normal CP motion commands will cause an increase in the variation of speed, acceleration and deceleration of tool orientation. In some cases, an error will occur.

To prevent these situations, add the ROT parameter to the CP motion commands. The arm will be moved based on the specified angular velocity and acceleration/deceleration of the main axis regarding the orientation variation.

The angular velocity and acceleration/deceleration of the main axis regarding the orientation variation should be specified with the SpeedR and AccelR commands in advance.

For example:

```
SpeedR 50              ' degree/sec
AccelR 200, 200        ' degree/sec2
Move P1 ROT
```

NOTE

The tool orientation variation is normally comprised of orientation variations of more than one rotation axis.

The SpeedR and AccelR parameters specify the angular velocity and acceleration/ deceleration of the main axis regarding the orientation variation. Therefore, actual angular velocity and acceleration/deceleration of the orientation variation are different from the parameters except for the case where the rotation axis of the orientation is only one.

While the motion command with the ROT parameter is executed, the specified SpeedS and AccelS parameters are invalid.

The ROT parameter can be used with the following motion commands:

Move	BMove
Arc	TMove
Arc3	Jump3CP

6.18.8 PTP Speed / Acceleration for Small Distances

You can change the speed and acceleration for small distances using PTPBoost and PTPBoostOK. Normally, PTPBoost is not required. In certain cases, you may want to shorten the cycle time even if vibration becomes larger, or conversely you may want to reduce vibration even if cycle time becomes longer. PTPBoost is a robot parameter with values from 0 – 100 that affects the speed and acceleration for small distances. Normally, for small distance motion, the desired speed cannot be attained using the current acceleration. By increasing PTPBoost, acceralation, deceleration, and speed are increased for small distance motion. To check if a motion command will be affected by PTPBoost, use the PTPBoostOK function. See PTPBoost and PTPBoostOK in the *SPEL+ Language Reference* manual for more details.

6.19 Working with Robot Points

A robot point is a set of coordinates that define a position in the robot work envelope. For SCARA and Cartesian robots, a point is defined by the position data (X, Y, Z) within the reference rectangular coordinate space and the orientation data (U) which is the rotation about the Z axis of the rectangular coordinate.

For 6-axis robots, a point is defined by the position and orientation of the tool coordinate system with respect to a reference rectangular coordinate system. The point is specified by the position data (X, Y, Z) and the orientation is specified by the orientation data (U, V, W) which correspond with *roll* (rotation about the Z axis), *pitch* (rotation about the Y axis), and *yaw* (rotation about the X axis).

When the additional ST axis is installed, the point is specified by the position data of each additional axis (S, T).

The X, Y, and Z coordinates of a point are specified in millimeters. The U, V, and W coordinates are specified in degrees.

The S and T coordinates of a point are specified in millimeters or degrees, according to the type of axis.

Points are referenced using the letter P followed by an integer number or integer expression or by a label defined in the point file editor or Robot Manager Jog & Teach page.

6.19.1 Defining points

You can define points in a program statement, points editor window, Robot Manager Jog and Teach page, or at the Command window.

In a program statement or at the Command window, you can assign coordinates to a point, or define a point that is the current robot arm position.

```
P1 = XY(200, 100, -25, 0)     'Assign coordinates to point P1
Pick = XY(300, 200, -45, 0)   'Assign coordinates to point pick
P10 = Here                    'Assign a point to current position
```

6.19.2 Referencing points by point label

You can assign names to point numbers so you can refer to points by name in a program. Assign names from the point editor (see Editing Points) or the Robot Manager Jog and Teach page. Names must be unique for each point number when used in the same point file.
Point labels can include up to 32 one-byte alphanumeric, Japanese, and the underscore characters, or 16 two-byte characters. Characters can be upper case or lower case. Only alphabets and Japanese can be used for the first letter.

```
For i = 0 To 10
  Go pick
  Jump place
Next i
```

6.19.3 Referencing points with variables

Use the letter P followed by a variable name within parentheses that represents the point number you are referencing.

```
For i = 0 To 10
  Go P(i)
Next i
```

NOTE

Although you can define points at the Command window for test purposes, it is recommended that all points be defined in a program, point editor, or with the Robot Manager Jog and Teach page. Points defined at the Command window will be cleared from memory when you build a project or run a program unless you execute SavePoints.

6.19.4 Using points in a program

When starting programs, the default point file for the robot is loaded. You can also load other points in the program using the LoadPoints statement.

```
Function main
  Integer i

  LoadPoints "model1.pts"
  For i = 0 To 10
    Jump pick
    Jump place
  Next i
Fend
```

6.19.5 Importing points into program

You can import points into the current project while the program is running using the ImportPoints statement.

```
Function main
    Integer i

    ImportPoints "c:\models\model1.pnt", "robot1.pnt"
    LoadPoints "robot1.pnt"
    For i = 0 To 10
      Jump pick
      Jump place
    Next i
Fend
```

6.19.6 Saving and loading points

Use LoadPoints to load a point file in the current project. You can optionally specify the **Merge** parameter to combine points in a file with points that have already been loaded.

Use SavePoints to save the points in a point file. If the point file is in the current project, it will be updated on the PC when it is connected and the same project is open.

If the point file is not the current project, it will not be automatically updated on the PC. Use Project Synchronize to copy the file to the PC if desired.

6.19.7 Point attributes

Each point definition can optionally specify a local number and various arm orientations, depending on the robot type. You can specify point attributes in point assignment statements or use individual statements and functions to change the attributes of a previously defined point.

Local point attribute

To specify a local coordinate system number for a point in an assignment statement, add a forward slash (/) followed by the local number after the coordinates of the point.

```
P1 = XY(300, -125.54, -42.3, 0) /1   ' P1 is in local 1
```

The local number can also be an expression enclosed in parentheses.

```
P2 = P3 /(mylocal)
```

Use the PLocal function and statement to read and set the local attribute of a point.

Hand point attribute

To specify orientation for the SCARA or 6-axis robot, add a forward slash (/) followed by L (for Lefty hand orientation) or R (for Righty hand orientation).

```
P2 = XY(200, 100, -20, -45) /L  ' Hand orientation is Lefty
P3 = XY(50, 0, 0, 0) /2 /R      ' Righty in Local 2
```

You can read and set point hand orientation using the Hand statement and function.

```
Hand P1, Righty
```

Elbow point attribute

To specify elbow orientation for the 6-axis robot in a point assignment statement, add a forward slash (/) followed by A (Above elbow orientation) or B (Below elbow orientation),

Elbow orientation is Below.

```
P1 = XY(0, 600, 400, 90, 0, 180) /B
```

You can read and set point elbow orientation using the Elbow statement and function.

Wrist point attribute

To specify wrist orientation for the 6-axis robot in a point assignment statement, add a forward slash (/) followed by NF (NoFlip wrist orientation) or F (Flip wrist orientation).

Wrist orientation is Flip.

```
P2 = XY(0, 600, 400, 90, 0, 180) /F
```

You can read and set point wrist orientation using the Wrist statement and function.

J4Flag and J6Flag point attributes

At some points in the work envelope, the 6-axis robot can have the same position and orientation even if the fourth joint or the sixth joint is rotated 360 degrees. To distinguish these points, the J4Flag and J6Flag point attributes are provided. These flags allow you to specify a position range for joint 4 and joint 6 for a given point.

To specify the J4Flag in a point assignment statement, add a forward slash (/) followed by J4F0 (–180 < the forth joint angle <= 180) or J4F1 (the forth joint angle <= –180 or 180 < the forth joint angle).

```
P2 = XY(0, 600, 400, 90, 0, 180) /J4F1
```

To specify the J6Flag in a point assignment statement, add a forward slash (/) followed by J6F0 (–180 < the sixth joint angle <= 180), J6F1 (–360 < the sixth joint angle <= –180 or 180 < the sixth joint angle <= 360), or J6Fn (–180*(n+1) < the sixth joint angle <= 180*n or 180*n < the sixth joint angle <= 180*(n+1)).

```
P2 = XY(50, 400, 400, 90, 0, 180) /J6F2
```

J1Flag and J2Flag point attributes

At some points in the work envelope, the RS series can have the same position and orientation even if the first joint or the second joint is rotated 360 degrees. To distinguish these points, the J1Flag and J2Flag point attributes are provided. These flags allow you to specify a position range for joint 1 and joint 2 for a given point.

To specify the J1Flag in a point assignment statement, add a forward slash (/) followed by J1F0 (–90 < the first joint angle <= 270) or J1F1 (–270 <= the first joint angle <= –90 or 270 < the first joint angle <= 450).

```
P2 = XY(-175, -175, 0, 90) /J1F1
```

To specify the J2Flag in a point assignment statement, add a forward slash (/) followed by J2F0 (–180 < the second joint angle <= 180), J2F1 (–360 < the second joint angle <= –180 or 180 < the second joint angle <= 360).

```
P2 = XY(300, 175, 40, 90) /J2F1
```

J1Ang and J2Flag point attributes

At the origin of the robot coordinate system, the RS series can have the same position and orientation even if the first joint is rotated. To distinguish these points, the J1Ang point attributes are provided.

6.19.8 Extracting and setting point coordinates

Use the CX, CY, CZ, CU, CV, CW, CS, and CT commands to get a coordinate of a point or set it.

```
xcoord = CX(P1)
P2 = XY(xcoord, 200, -20, 0)
ycoord = CY(P*)          ' Gets current Y position coordinate

CX(pick) = 25.5
CY(pick) = CY(pick) + 2.3
```

6.19.9 Alteration of points

There are several ways of modifying a point without re-teaching it. You can change one or more coordinate values with relative offsets or absolute values.

To set an absolute value for a coordinate, use a colon followed by the axis letter and the value.

To add a relative offset to a coordinate, use an axis letter followed by the offset value or expression in parentheses. If the offset is negative, then precede the axis letter with the minus sign. If parentheses are omitted, they will be automatically added.

`Go P1 -Z(20)`	Move to P1 with a z offset of –20mm
`Go P1 :Z(-25)`	Move to P1 with a z absolute position of –25mm
`Go P1 -X(20) +Y(50) :Z(-25)`	Move to P1 with offsets for X and Y relative offsets and an absolute position for Z

6.20 Input and output control

6.20.1 Hardware I/O

There are 24 DC inputs and 16 DC outputs on a standard controller. By purchasing I/O boards, you can add additional 128 inputs and 128 outputs. You can also expand the I/O by using the Fieldbus I/O master option and Fieldbus I/O slave option. Refer to *11. Inputs and Outputs* for details.

6.20.2 Memory I/O

There are 128 bytes (1024 bits) of memory I/O. Memory I/O is especially useful for synchronizing multi-tasking. Each memory bit can be treated as both an input and an output.

Use the commands with the "Mem" prefix for memory I/O.

6.20.3 I/O Commands

Command	Description
In	Reads one byte (eight bits) of input data.
InW	Reads one word (sixteen bits) of input data.
MemIn	Reads one byte (eight bits) of Memory I/O.
MemInW	Reads one word (sixteen bits) of Memory I/O.
MemOff	Turns off one Memory I/O bit.
MemOn	Turns on one Memory I/O bit.
MemSw	Read status of one bit of memory I/O.
Off	Turns off one output bit.
On	Turns on one output bit.
Out	Sets/reads one byte (eight bits) of output data.
OutW	Sets/reads one word (sixteen bits) of output data.
Oport	Reads the status of one output bit.
InBCD	Reads one byte of input data in BCD (binary coded decimal) format.
OpBCD	Outputs one byte of output data in BCD format.
Sw	Read status of one bit of hardware inputs or memory inputs.

6.21 Using Traps

Traps enable a program to jump to a label or enable a function to be called when a certain event occurs.

Traps are divided into the following two types:

- 4 Traps are fired by user defined input
- 7 Traps are fired by system

You should keep trap functions short and avoid continuous loops. According to the type, some Traps must be re-armed. Also, some motion commands are limited to execute in trap functions.

For details on Trap statement, see the *SPEL+ Language Reference manual*.

Here is a simple example for a trap. In this example, when input 1 turns on, it executes the Sw1Trap function.

```
Function main
  ' Sets the trap
  Trap 1 Sw(1) = On Xqt Sw1Trap
  Do
    RunCycle
  Loop
Fend
Function Sw1Trap
  ' Turn on output 1 for 2 seconds
  On 1, 2
  ' Wait for trap condition to clear
  Wait Sw(1) = Off
  ' Re-arm the trap
  Trap 1 Sw(1) = On Xqt Sw1Trap
Fend
```

Trap	Description
Trap 1 – 4 Goto Trap 1 – 4 Call Trap 1 – 4 Xqt	Triggered by an input condition specified by the user. User traps can use GoTo, Call, or Xqt.
Trap Emergency Xqt	When Emergency Stop occurs, a specified function is executed.
Trap Error Xqt	When an error occurs, a specified function is executed.
Trap SgOpen Xqt	When the Safeguard circuit is open, a specified function is executed.
Trap SgClose Xqt	When the Safeguard circuit is closed, a specified function is executed.
Trap Pause Xqt	When the system enters the Pause state, a specified function is executed.
Trap Abort Xqt	When all tasks (except background tasks) have been stopped by user or system, such as when a command corresponding to Abort All is executed, a specified function is executed.
Trap Finish Xqt	When all tasks (except background tasks) have been finished, a specified function is executed. However, the function will not be executed under the condition that executes Trap Abort.

6.21.1 Cautions of Trap when it triggers the system condition

CAUTION	**Forced Flag** Specify Forced flag in the I/O output commands such as On/Off command to enable On/Off of the I/O outputs during Emergency Stop, Safety Door open, Teach mode, and error condition. Do not connect external equipment that operates mechanically such as actuator to the I/O output that specifies Forced flag. Otherwise, the external equipment may move during Emergency Stop, Safety Door Open, Teach mode, or error condition and this will cause serious safety problems. Forced flag is designed to be specified for I/O outputs connected to external equipment without mechanical motion such as status display LEDs.

Outputs off during Emergency Stop

Uncheck **Outputs off during Emergency Stop** in the Preferences page of System Configuration SPEL Controller Board to execute I/O On/Off using the Trap Emergency Xqt task after Emergency Stop. If this checkbox is checked, the execution order of turning Off by the controller and turning On using the task are not guaranteed.

6.22 Special Tasks

Each task of SPEL$^+$ pauses by Pause input or Safety Door open and stops by Emergency Stop or Error. Therefore you cannot create a system that monitors the whole system.

To enable the Robot Controller to monitor the whole system, the following special tasks are provided:

NoPause/NoEmgAbort task

You can create a task that continues a processing even when the Pause is input or safeguard is open by specifying NoPause or NoEmgAbort as a task type when creating Xqt data task.

Background task

You can create a task that starts as the controller power is turned ON and continues a processing even when the Pause is input or safeguard is open.

These special tasks are useful tasks but may reduce the safety of the system by using them improperly.

Be sure to understand the following items when using these tasks.

6.22.1 Precautions to Use the Special Tasks

CAUTION	**Forced Flag** Specify Forced flag in the I/O output commands such as On/Off command to enable On/Off of the I/O outputs during Emergency Stop, Safety Door open, and error. Do not connect external equipment that operates mechanically such as actuator to the I/O output that specifies Forced flag. Connecting external equipment may cause serious safety problems and operate the external equipment during Emergency Stop, Safety Door Open, or error occurrence. Forced flag is designed to be specified for I/O outputs connected to external equipment without mechanical motion such as status display LEDs.

NoEmgAbort Task

When Emergency Stop or errors occur, finish the task promptly after completing the error handling.

If you do not complete the NoEmgAbort task, the controller does not change to Ready status and you cannot cancel the Emergency Stop or the error. You cannot execute Reset command from the NoEmgAbort task to cancel the Emergency Stop or the error automatically.

NoEmgAbort task is designed for I/O process without motion and communication with external device using the Ethernet. Therefore there are commands such as robot motion commands that cannot be executed in the NoEmgAbort task. An error occurs if you use these commands. The list of these commands is in the next section.

For details, refer to EPSON RC+ 7.0 *Online Help* or *Xqt* in *SPEL$^+$ Language Reference*.

NoPause Task

NoPause task continues the operation during the Pause or Safety Door open condition. However, when a robot is operating NoPause task, the task pauses as the robot pauses.

Background task

Background task always exists while the controller is working, and it is designed for monitor of the entire system and communication with external device. Therefore there are commands such as robot motion commands that cannot be executed in the background task. An error occurs if you use these commands. The list of these commands is in the next section.

In addition, the background task continues processing even when Pause is input or safeguard is open, so it doesn't affect the controller state transition.

For details, refer to *6.23 Background Task*.

Outputs off during Emergency Stop

Uncheck this preference to execute I/O On/Off using the NoEmgAbort task or background task after Emergency Stop. If this check box is checked, the execution order of turn Off by the controller and turn On using the task are not guaranteed.

Setting of Safeguard open stops all tasks

When this preference is checked, NoPause task stops by Safety Door open. NoEmgAbort task or background task continues the task.

Setting of [Enable the Background task]

Set this preference when you use the background task.

Setting of [Initialize global variables as the MainXX starts]

Uncheck this preference when you use the global variables from the background task. When this check box is checked, the controller will initialize the variables and the variable-access conflict from tasks will occur.

CAUTION	**Setting of [Enable advanced task commands]** Check this preference when you execute the commands below from a background task. StartMain, Cont, Recover, Reset Error, Reset When you execute these commands from a task, you should understand each command specification and verify that the system has the appropriate conditions. Improper use, such as executing commands continuously in a loop, can reduce the security of system.

6.22.2 NoPause/NoEmgAbort task specification

Status by Event and Task

Event	Task Type		
	Normal	NoPause	NoEmgAbort
Pause Statement Pause Input Pause Button	Pause	Continue *1	Continue
Safety Door Open	Pause *2	Continue *1 *2	Continue
Error during Auto Mode	Stop	Stop	Continue
Error during Program Mode	Pause	Pause	Continue
Emergency Stop	Stop	Stop	Continue
Stop Button Stop Input	Stop	Stop	Stop
Halt Statement Halt Button	Pause	Pause	Pause
Brake Point	Pause	Pause	Pause
Switching to Teach Mode	Stop	Stop	Stop

*1 When the robot is operating, the task pauses as the robot pauses.

*2 When [Outputs off during Emergency Stop] is checked in the [Preferences] page of [Setup Controller], normal tasks and NoPause tasks stop by Safety Door open.

Task Execution

Normal	Omit the task type in Xqt statement, or specify Normal for the task type. Xqt NormalTask Xqt NormalTask, Normal
NoPause	Specify NoPause in Xqt statement. Xqt NoPauseTask, NoPause
NoEmgAbort	Specify NoEmgAbort in Xqt statement. Xqt NoEmgAbortTask, NoEmgAbort

You cannot change the task type after executing a task.

main to main63 that are executed at the beginning of the program are executed as normal tasks.

Type of a task executed in Trap Xqt is determined by the event type.

For details, refer to EPSON RC+ 7.0 *Online Help* or *Trap* in *SPEL+ Language Reference*.

Restricted Commands by Task Types

Normal	No restriction
NoPause	No restriction
NoEmgAbort	Cannot execute the following commands. Command for robot motion Commands for vision Reset, Xqt, Trap, etc. For details, refer to EPSON RC+ 7.0 *Online Help* or *Xqt* in *SPEL+ Language Reference*.

6.22.3 NoPause/NoEmgAbort task example

The following example shows a program that monitors the error of the controller and switches the I/O On/Off when error occurs according to the error number.

The program example of ErrOn, EStopOn, SafetyOn are indicated in the *EPSON RC+ 7.0 SPEL+ Language Reference*.

```
Function main
    Xqt ErrorMonitor, NoEmgAbort
    :
    :
Fend

Function ErrorMonitor
    Wait ErrorOn
    If 4000 < SysErr And Syserr < 5999 Then
         Print "Mortion Error = ", SysErr
         Off 10, Forced
         On 12, Forced
    Else
         Print "Other Error = ", SysErr
         Off 11, Forced
         On 13, Forced
    EndIf
Fend
```

6.23 Background Task

6.23.1 Primary features of background task

The purpose of the background task is to monitor the status of the cell as a whole and to communicate with external devices.

Function BgMain, a function specified as the “Background task” will be automatically activated as task 65 when the controller starts and loads the project.

If another task is created within the background task using the XQT command, that created task will be assigned to task No.65 (and onward in the ascending order) and will also function as a background task. In addition, specifying a task type for an XQT command in a background task has no meaning.

An operator is not necessarily aware of the operating Background task which does not stop at the input of emergency stop or safeguard signal. The Background task will not stop when an operator inputs “PAUSE” or “ABORT”.

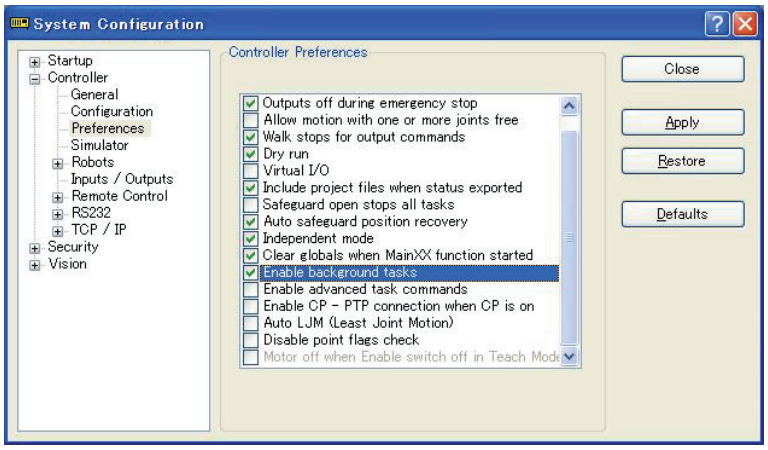
In this sense, the background task functions for the application program to work as a part of the system.

On the other hand, the execution commands to operate the Manipulator, set-up commands for the Manipulator or the commands for image processing cannot be executed within the background task.

CAUTION	■ Specify Forced flag in the I/O output commands operated from the background tasks to enable On/ Off of the I/O outputs during Emergency Stop, Safety Door open, and error. Do not connect external equipment that operates mechanically such as actuators to the I/O output that specifies the Forced flag. Connecting external equipment may cause serious safety problems and operate the external equipment during Emergency Stop, Safety Door Open, or error occurrence. Forced flag is designed to be specified for I/O outputs connected to external equipment without mechanical motion such as status display LEDs.

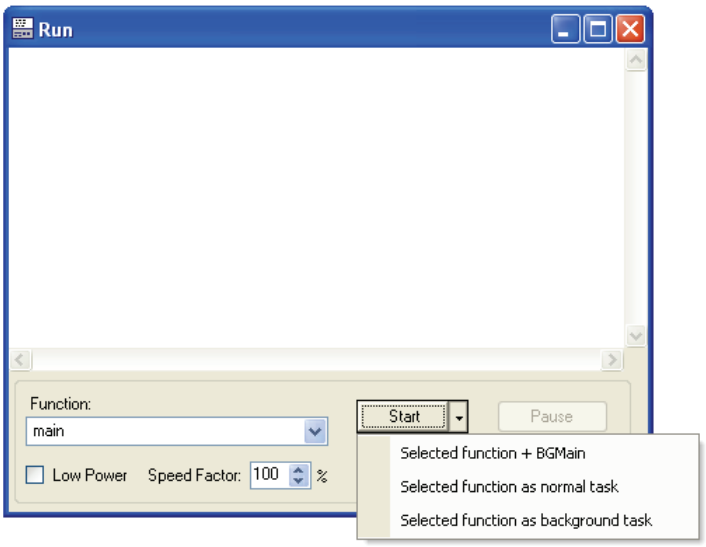
6.23.2 Setup and start the background task

When you use the background task, first of all you need to check the [Enable background tasks] in the [Preferences] page of [Setup]-[System Configuration]-[SPEL Controller Board].



When you have already checked the box above and the Function BgMain exists in your program, it will automatically start as Task 65 as the controller starts and loads the project, it executes as a “Background task”.

However in PROGRAM mode, the Function BgMain will not start automatically. You need to start it using the <Start> button in the [Run] window.
This is because the PROGRAM mode is for creating programs and debugging and it may be more efficient when it doesn't start the Function BgMain.

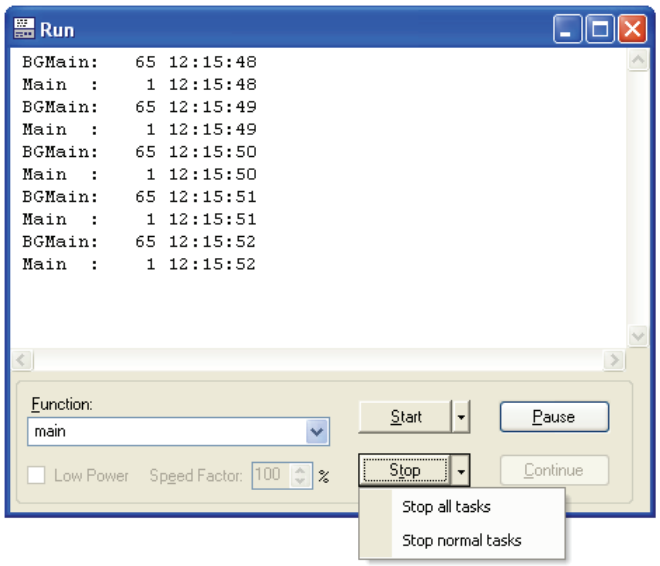


When the controller operating mode shifts from PROGRAM to AUTO mode, the Function BgMain will start automatically.

6.23.3 Holding background task (from being activated)

The purpose of the background task is to monitor the status of the cell as a whole and to communicate with external devices. It is activated before a non-background task is activated and continues to function when the non-background task either generates an error or is aborted by an operator. In this sense, the background task can be a program that never stops functioning.

The background task can be debugged in PROGAM mode. Click the <Stop> button dropdown menu in the [Run] window and you can select the background task is to be aborted as well or not.



In the [Task Manager] window, the background tasks can be managed in the same way as the non-background tasks except for the <Pause/Cont> button. You can set a break point in a background task and step through the code.

As a rule, the background task cannot be controlled in AUTO mode. It is by design that any error that occurs in the background task cannot be recovered in AUTO mode. Therefore, thorough debugging in PROGRAM mode is recommended. Be particularly careful that the communication errors are handled properly without fail before using the background task in AUTO mode.

The following tables show how the background will (or will not) be affected by operation from the console.

Operator Window

Button	Background task
START	It will not be affected.
Abort	It will not be affected.
Pause	It will not be affected.
Continue	It will not be affected.

Remote Input

Button	Background task
Start / Stop	It will not be affected.
Pause / Continue	It will not be affected.
Reset	It will not be affected.
Shutdown	It will be stopped.

Run Window (PROGRAM mode)

Button	Background task
Start	You can select how to start the task.
Abort	You can select how to abort the task: abort only non-background task or abort all tasks including the background task.
Pause	It will not be affected.
Continue	It will not be affected.

Task Manager (PROPGRAM mode)

Button	Background task
Halt / Resume	When the background task is selected, you cannot execute Halt/Resume.
Quit	When the background task is selected, you can execute Quit.
Pause/Cont	It will not be affected.
Stop	All tasks including the background task will stop.

Break point (PROGRAM mode)

Switch name	Background task
Set a break point	You can set a breakpoint to the background task. It will pause at the break point.
Step Into	Available
Step Over	Available
Continue	Available
Walk	Available, but the motion commands are not available to execute from the background task.

6.23.4 Commands that will cause error in background task

The following commands are prohibited in background tasks and execution will result in error:

- commands that relate to the Manipulator operation or operation settings
- commands that relate to the Vision relation instruction
- TRAP commands

If a program that is to be executed as the background task includes any of the following commands, it will result in error when executed.

However, using the command related to the Manipulator operation settings or the Manipulator settings to gain the current setting values or refer to them will not result in error:

Commands that will cause error are almost the same as with NoEmgAbort, but there are some commands such as Xqt that can be executed in a background task.

For details, refer to EPSON RC+ 7.0 *Online Help* or *Xqt* in *SPEL$^+$ Language Reference*.

6.23.5 Background task and Remote control

No matter whether the background task is being executed or not, it doesn't affect the remote I/O outputs Ready, Running, and Pause. For example, even if the background task is being executed, when no non-background tasks (Task No. 1 ~ 32) are being executed, the READY output will be ON.

6.24 Predefined Constants

There are several predefined constants for use in SPEL+ program. A project build time, the values for these constants are substituted for the constant name.

Constant name	Value	Use
TRUE	-1	Boolean expression
FALSE	0	Boolean expression
High	1	
Low	0	
Off	0	
On	1	
Above	1	
Below	2	
NoFlip	1	
Flip	2	
Righty	1	
Lefty	2	
J1	1	
J2	2	
J3	4	
J4	8	
J5	16	
J6	32	
J7	64	
MB_OK	0	MsgBox flags
MB_OKCANCEL	1	MsgBox flags
MB_ABORTRETRYIGNORE	2	MsgBox flags
MB_YESNOCANCEL	3	MsgBox flags
MB_YESNO	4	MsgBox flags
MB_RETRYCANCEL	5	MsgBox flags
MB_ICONSTOP	16	MsgBox flags
MB_ICONQUESTION	32	MsgBox flags
MB_ICONEXCLAMATION	48	MsgBox flags
MB_ICONINFORMATION	64	MsgBox flags
MB_DEFBUTTON1	0	MsgBox flags
MB_DEFBUTTON2	256	MsgBox flags
IDOK	1	MsgBox return
IDCANCEL	2	MsgBox return
IDABORT	3	MsgBox return
IDRETRY	4	MsgBox return
IDIGNORE	5	MsgBox return
IDYES	6	MsgBox return
IDNO	7	MsgBox return
BACKCOLORMODE_VISUALSTYLE	0	For GUI Builder
BACKCOLORMODE_USER	1	For GUI Builder
BORDERSTYLE_NONE	0	For GUI Builder
BORDERSTYLE_FIXEDSINGLE	1	For GUI Builder
BORDERSTYLE_FIXED3D	2	For GUI Builder
CNV_QUELEN_ALL	0	Cnv_QueLen
CNV_QUELEN_UPSTREAM	1	Cnv_QueLen
CNV_QUELEN_PICKUPAREA	2	Cnv_QueLen
CNV_QUELEN_DOWNSTREAM	3	Cnv_QueLen
DEVID_SELF	21	CLS
DEVID_TP	24	CLS
DIALOGRESULT_NOE	0	For GUI Builder
DIALOGRESULT_OK	1	For GUI Builder
DIALOGRESULT_CANCEL	2	For GUI Builder
DLG_IOMON	102	RunDialog
DLG_ROBOTMNG	100	RunDialog
DLG_ROBOTPANEL	100	ShowDialog

Constant name	Value	Use
DLG_VGUIDE	110	ShowDialog
DROPDOWNSTYLE_SIMPLE	0	For GUI Builder
DROPDOWNSTYLE_DROPDOWN	1	For GUI Builder
DROPDOWNSTYLE_DROPDOWNLIST	2	For GUI Builder
ERROR_DOINGMOTION	2999	For GUI Builder
ERROR_NOMOTION	2998	For GUI Builder
EVENTTASKTYPE_NORMAL	0	For GUI Builder
EVENTTASKTYPE_NOPAUSE	1	For GUI Builder
EVENTTASKTYPE_NOEMGABORT	2	For GUI Builder
FORCE_LESS	0	Force_SetTrigger
FORCE_GREATER	1	Force_SetTrigger
FORCE_XFORCE	2	Force_SetTrigger
FORCE_YFORCE	3	Force_SetTrigger
FORCE_ZFORCE	4	Force_SetTrigger
FORCE_XTORQUE	5	Force_SetTrigger
FORCE_YTORQUE	6	Force_SetTrigger
FORCE_ZTORQUE	7	Force_SetTrigger
FORMBORDERSTYLE_NONE	0	For GUI Builder
FORMBORDERSTYLE_FIXEDSINGLE	1	For GUI Builder
FORMBORDERSTYLE_FIXED3D	2	For GUI Builder
FORMBORDERSTYLE_FIXEDDIALOG	3	For GUI Builder
FORMBORDERSTYLE_SIZABLE	4	For GUI Builder
IMAGEALIGN_TOPLEFT	1	For GUI Builder
IMAGEALIGN_TOPCENTER	2	For GUI Builder
IMAGEALIGN_TOPRIGHT	3	For GUI Builder
IMAGEALIGN_MIDDLELEFT	4	For GUI Builder
IMAGEALIGN_MIDDLECENTER	5	For GUI Builder
IMAGEALIGN_MIDDLERIGHT	6	For GUI Builder
IMAGEALIGN_BOTTOMLEFT	7	For GUI Builder
IMAGEALIGN_BOTTOMCENTER	8	For GUI Builder
IMAGEALIGN_BOTTOMRIGHT	9	For GUI Builder
IOTYPE_INPUT	0	IOLabel function
IOTYPE_OUTPUT	1	IOLabel function
IOTYPE_MEMORY	2	IOLabel function
IOSIZE_BIT	1	IOLabel function
IOSIZE_BYTE	8	IOLabel function
IOSIZE_WORD	16	IOLabel function
LANGID_ENGLISH	0	ErrMsg$
LANGID_JAPANESE	1	ErrMsg$
LANGID_GERMAN	2	ErrMsg$
LANGID_FRENCH	3	ErrMsg$
LANGID_SIMPLIFIED_CHINESE	4	ErrMsg$
LANGID_TRADITIONAL_CHINESE	5	ErrMsg$
MODE_STANDARD	1	PerformMode
MODE_HIGH_SPEED	2	PerformMode
MODE_LOW_OSCILLATION	3	PerformMode
SCROLLBARS_NONE	0	For GUI Builder
SCROLLBARS_HORIZ	1	For GUI Builder
SCROLLBARS_VERT	2	For GUI Builder
SCROLLBARS_BOTH	3	For GUI Builder
SETLATCH_PORT_CU_0	24	SetLatch
SETLATCH_PORT_CU_1	25	SetLatch
SETLATCH_PORT_DU1_0	56	SetLatch
SETLATCH_PORT_DU1_1	57	SetLatch
SETLATCH_PORT_DU2_0	280	SetLatch
SETLATCH_PORT_DU2_1	281	SetLatch
SETLATCH_TRIGGERMODE_LEADINGEDGE	1	SetLatch
SETLATCH_TRIGGERMODE_TRAILINGEDGE	0	SetLatch
SHUTDOWN_ALL	0	Shutdown

Constant name	Value	Use
SHUTDOWN_RESTART	1	Shutdown
SHUTDOWN_EPSONRC	2	Shutdown
SIZEMODE_NORMAL	0	For GUI Builder
SIZEMODE_STRETCHIMAGE	1	For GUI Builder
SIZEMODE_AUTOSIZE	2	For GUI Builder
SIZEMODE_CENTERIMAGE	3	For GUI Builder
SIZEMODE_ZOOM	4	For GUI Builder
STARTPOSITION_MANUAL	0	For GUI Builder
STARTPOSITION_CENTERSCREEN	1	For GUI Builder
STARTPOSITION_CENTERPARENT	2	For GUI Builder
TEXTALIGN_LEFT	1	For GUI Builder
TEXTALIGN_CENTER	2	For GUI Builder
TEXTALIGN_RIGHT	3	For GUI Builder
TEXTALIGN_TOPLEFT	1	For GUI Builder
TEXTALIGN_TOPCENTER	2	For GUI Builder
TEXTALIGN_TOPRIGHT	3	For GUI Builder
TEXTALIGN_MIDDLELEFT	4	For GUI Builder
TEXTALIGN_MIDDLECENTER	5	For GUI Builder
TEXTALIGN_MIDDLERIGHT	6	For GUI Builder
TEXTALIGN_BOTTOMLEFT	7	For GUI Builder
TEXTALIGN_BOTTOMCENTER	8	For GUI Builder
TEXTALIGN_BOTTOMRIGHT	9	For GUI Builder
VISION_SORT_NONE	0	For Vision Guide
VISION_SORT_PIXELX	1	For Vision Guide
VISION_SORT_PIXELY	2	For Vision Guide
VISION_SORT_PIXELXY	3	For Vision Guide
VISION_SORT_CAMERAX	4	For Vision Guide
VISION_SORT_CAMERAY	5	For Vision Guide
VISION_SORT_CAMERAXY	6	For Vision Guide
VISION_SORT_ROBOTX	7	For Vision Guide
VISION_SORT_ROBOTY	8	For Vision Guide
VISION_SORT_ROBOTXY	9	For Vision Guide
VISION_SIZETOFIND_ANY	0	For Vision Guide
VISION_SIZETOFIND_LARGEST	1	For Vision Guide
VISION_SIZETOFIND_SMALLEST	2	For Vision Guide
VISION_BACKCOLOR_NONE	0	For Vision Guide
VISION_BACKCOLOR_BLACK	1	For Vision Guide
VISION_BACKCOLOR_WHITE	2	For Vision Guide
VISION_CAMORIENT_STANDALONE	1	For Vision Guide
VISION_CAMORIENT_FIXEDDOWN	2	For Vision Guide
VISION_CAMORIENT_FIXEDUP	3	For Vision Guide
VISION_CAMORIENT_MOBILEJ2	4	For Vision Guide
VISION_CAMORIENT_MOBILEJ4	5	For Vision Guide
VISION_CAMORIENT_MOBILEJ5	6	For Vision Guide
VISION_CAMORIENT_MOBILEJ6	7	For Vision Guide
VISION_FOUNDCOLOR_LIGHTGREEN	1	For Vision Guide
VISION_FOUNDCOLOR_DARKGREEN	2	For Vision Guide
VISION_GRAPHICS_ALL	1	For Vision Guide
VISION_GRAPHICS_POSONLY	2	For Vision Guide
VISION_GRAPHICS_NONE	3	For Vision Guide
VISION_OPERATION_OPEN	1	For Vision Guide
VISION_OPERATION_CLOSE	2	For Vision Guide
VISION_OPERATION_ERODE	3	For Vision Guide
VISION_OPERATION_DILATE	4	For Vision Guide
VISION_OPERATION_SMOOTH	5	For Vision Guide
VISION_OPERATION_SHARPEN1	6	For Vision Guide
VISION_OPERATION_SHARPEN2	7	For Vision Guide
VISION_OPERATION_HORIZEDGE	8	For Vision Guide
VISION_OPERATION_VERTEDGE	9	For Vision Guide

Constant name	Value	Use
VISION_OPERATION_EDGEDETECT1	10	For Vision Guide
VISION_OPERATION_EDGEDETECT2	11	For Vision Guide
VISION_OPERATION_LAPLACE1	12	For Vision Guide
VISION_OPERATION_LAPLACE2	13	For Vision Guide
VISION_OPERATION_THIN	14	For Vision Guide
VISION_OPERATION_THICKEN	15	For Vision Guide
VISION_OPERATION_BINARIZE	16	For Vision Guide
VISION_OPERATION_ROTATE	17	For Vision Guide
VISION_OPERATION_FLIPHORIZ	18	For Vision Guide
VISION_OPERATION_FLIPVERT	19	For Vision Guide
VISION_OPERATION_FLIPBOTH	20	For Vision Guide
VISION_OPERATION_COLORFILTER	21	For Vision Guide
VISION_OPERATION_SUBTRACTABS	22	For Vision Guide
VISION_OPERATION_ZOOM	23	For Vision Guide
VISION_ACQUIRE_NONE	0	For Vision Guide
VISION_ACQUIRE_STATIONARY	1	For Vision Guide
VISION_ACQUIRE_STROBED	2	For Vision Guide
VISION_TRIGGERMODE_LEADINGEDGE	1	For Vision Guide
VISION_TRIGGERMODE_TRAILINGEDGE	2	For Vision Guide
VISION_THRESHCOLOR_BLACK	1	For Vision Guide
VISION_THRESHCOLOR_WHITE	2	For Vision Guide
VISION_OBJTYPE_CORRELATIO	1	For Vision Guide
VISION_OBJTYPE_BLOB	2	For Vision Guide
VISION_OBJTYPE_EDGE	3	For Vision Guide
VISION_OBJTYPE_POLAR	4	For Vision Guide
VISION_OBJTYPE_LINE	5	For Vision Guide
VISION_OBJTYPE_POINT	6	For Vision Guide
VISION_OBJTYPE_FRAME	7	For Vision Guide
VISION_OBJTYPE_IMAGEOP	8	For Vision Guide
VISION_OBJTYPE_OCR	9	For Vision Guide
VISION_OBJTYPE_CODEREADER	10	For Vision Guide
VISION_OBJTYPE_GEOMETRIC	11	For Vision Guide
VISION_DETAILLEVEL_MEDIUM	1	For Vision Guide
VISION_DETAILLEVEL_HIGH	2	For Vision Guide
VISION_DETAILLEVEL_VERYHIGH	3	For Vision Guide
VISION_IMAGESOURCE_CAMERA	1	For Vision Guide
VISION_IMAGESOURCE_FILE	2	For Vision Guide
VISION_CODETYPE_AUTO	0	For Vision Guide
VISION_CODETYPE_EAN13	2	For Vision Guide
VISION_CODETYPE_CODE39	3	For Vision Guide
VISION_CODETYPE_INTERLEAVED25	4	For Vision Guide
VISION_CODETYPE_CODE128	5	For Vision Guide
VISION_CODETYPE_CODABAR	6	For Vision Guide
VISION_CODETYPE_PDF417	8	For Vision Guide
VISION_CODETYPE_QR	10	For Vision Guide
VISION_CODETYPE_EAN8	13	For Vision Guide
VISION_CODETYPE_UPCA	18	For Vision Guide
VISION_CODETYPE_UPCE	19	For Vision Guide
VISION_CODETYPE_UPC	20	For Vision Guide
VISION_EDGETYPE_SINGLE	1	For Vision Guide
VISION_EDGETYPE_PAIR	2	For Vision Guide
VISION_IMAGECOLOR_ALL	1	For Vision Guide
VISION_IMAGECOLOR_RED	2	For Vision Guide
VISION_IMAGECOLOR_GREEN	3	For Vision Guide
VISION_IMAGECOLOR_BLUE	4	For Vision Guide
VISION_IMAGECOLOR_GRAYSCALE	5	For Vision Guide
VISION_POINTTYPE_POINT	0	For Vision Guide
VISION_POINTTYPE_ENDPOINT	1	For Vision Guide
VISION_POINTTYPE_MIDPOINT	2	For Vision Guide

Constant name	Value	Use
VISION_POINTTYPE_PERPTOLINE	3	For Vision Guide
VISION_POINTTYPE_STARTPOINT	4	For Vision Guide
VISION_POINTTYPE_PERPTOSTARTPOINT	5	For Vision Guide
VISION_POINTTYPE_PERPTOMIDPOINT	6	For Vision Guide
VISION_POINTTYPE_PERPTOENDPOINT	7	For Vision Guide
VISION_REFTYPE_TAUGHTPOINTS	1	For Vision Guide
VISION_REFTYPE_UPWARDCAMERA	2	For Vision Guide
VISION_IMAGESIZE_320X240	1	For Vision Guide
VISION_IMAGESIZE_640X480	2	For Vision Guide
VISION_IMAGESIZE_800X600	3	For Vision Guide
VISION_IMAGESIZE_1024X768	4	For Vision Guide
VISION_IMAGESIZE_1280X1024	5	For Vision Guide
VISION_IMAGESIZE_1600X1200	6	For Vision Guide
VISION_IMAGESIZE_2048X1536	7	For Vision Guide
VISION_IMAGESIZE_2560X1920	8	For Vision Guide
VISION_WINTYPE_RECTANGLE	1	For Vision Guide
VISION_WINTYPE_ROTATEDRECT	2	For Vision Guide
VISION_WINTYPE_CIRCLE	3	For Vision Guide
VISION_ORIENT_BOTH	1	For Vision Guide
VISION_ORIENT_HORIZ	2	For Vision Guide
VISION_ORIENT_VERT	3	For Vision Guide
VISION_DIRECTION_INSIDEOUT	1	For Vision Guide
VISION_DIRECTION_OUTSIDEIN	2	For Vision Guide
VISION_POLARITY_DARK	1	For Vision Guide
VISION_POLARITY_LIGHT	2	For Vision Guide
VISION_PASSTYPE_SOMEFOUND	1	For Vision Guide
VISION_PASSTYPE_ALLFOUND	2	For Vision Guide
VISION_PASSTYPE_SOMENOTFOUND	3	For Vision Guide
VISION_PASSTYPE_ALLNOTFOUND	4	For Vision Guide
WIN_IOMON	-1	For GUI Builder
WIN_TASKMGR	-2	For GUI Builder
WIN_FORCEMON	-3	For GUI Builder
WIN_SIMULATOR	-4	For GUI Builder
WINDOWSTATE_NORMAL	0	WindowsStatus
WINDOWSTATE_MINIMIZED	1	WindowsStatus
WINDOWSTATE_MAXIMIZED	2	WindowsStatus
WithMove	0	Recover
WithoutMove	1	Recover

6.25 Calling Native Functions in Dynamic Link Libraries

EPSON RC+ 7.0 allows you to call native functions in Dynamic Link Libraries (DLLs).

This is used for complicated arithmetic processing and call for a native function of an external device.

To call the native DLL function, use a Declare statement which is a function definition command from the SPEL$^+$ program and write a function call as normal.

For details, refer to the *Declare* in the *EPSON RC+ 7.0 SPEL$^+$ Language Reference*.

Sample of calling a native DLL

By using a development tool such as Microsoft Visual Studio 2008, you can create a native DLL that can be called from SPEL$^+$. Here, it uses Visual Studio 2008 as a sample to create a function that executes the arithmetic operator.

Step 1: Decide on variable type for a native DLL

You need to plan the data type to use for transferring with the native DLL in the EPSON RC+ 7.0.
Correspondence table for the EPSON RC+ 7.0 data type and the C/C++ variable type is shown below.
You cannot use the C/C++ byte type and structure because the EPSON RC+ 7.0 has no correspond data for them.

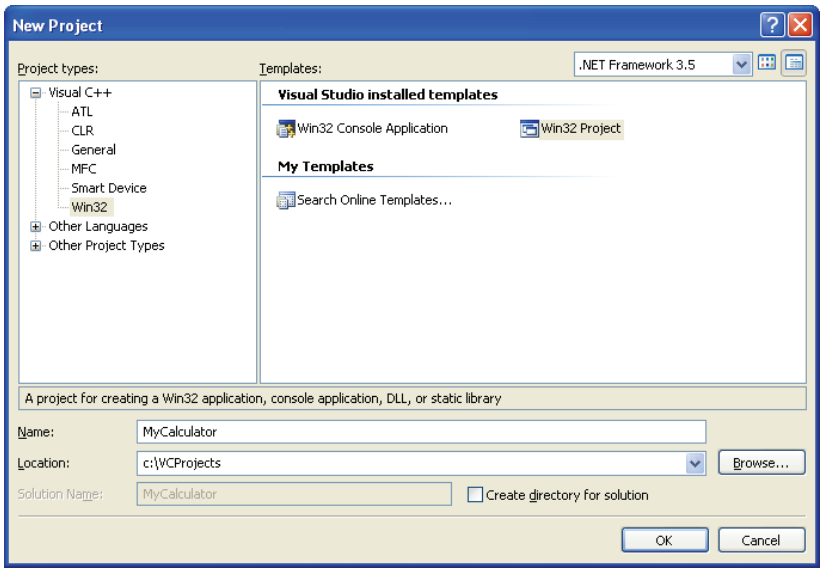
Data correspondence

EPSON RC+ 7.0	C/C++
Boolean	short
Byte	short
Short	short
Integer	short
Long	int
Real	float
Double	double
String	char [256] * Null included

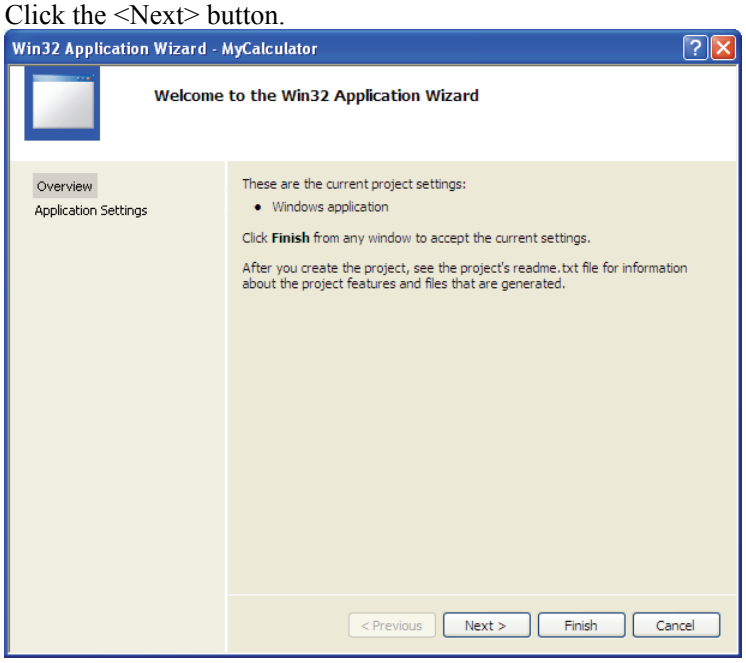
Step 2: Create a native DLL

(1) Start Visual Studio 2008.

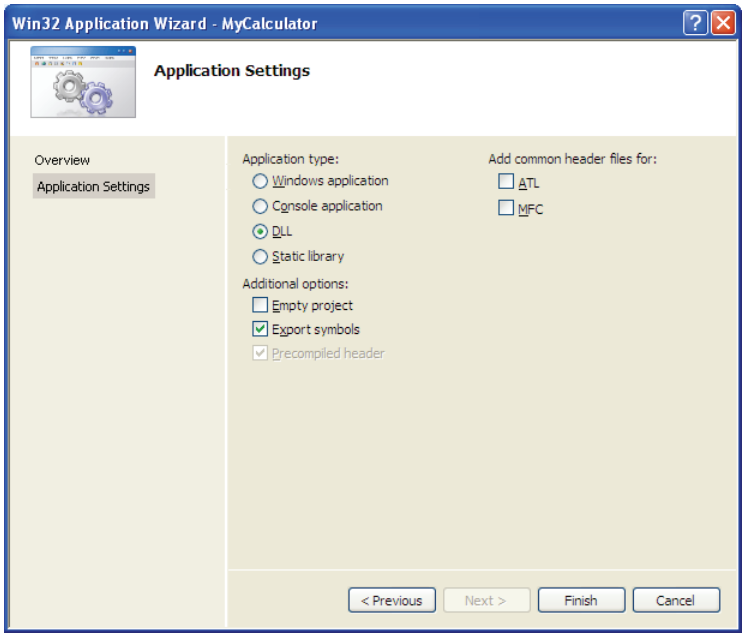
(2) Select the [File]-[New]-[Project] from the Visual Studio 2008 menu.
Select the Win32 in the [Project type (P):].
Select the Win32 project in the [Template (T):].
Type in a project name in the [Project (N):]. (Here types in “MyCalculator”.)
Click the <OK> button.



(3) Start the Win32 application wizard.
Click the <Next> button.



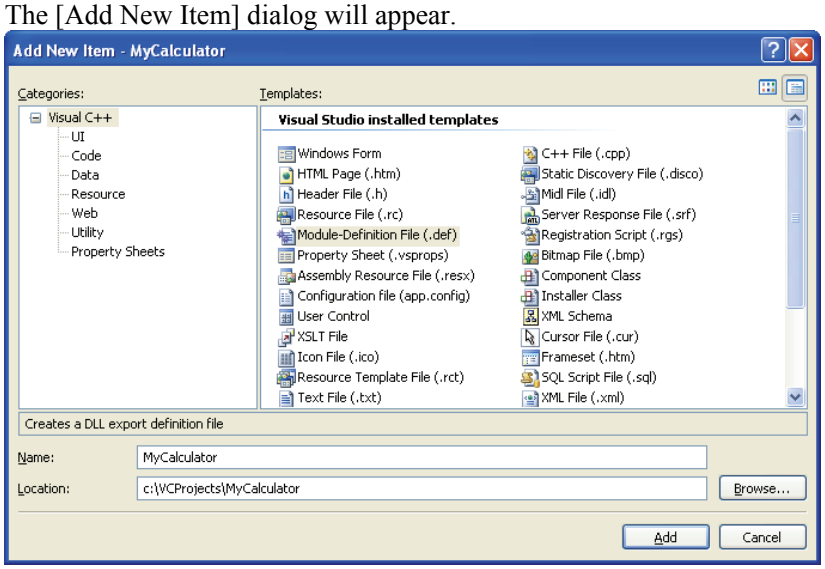
(4) Select the <DLL> option button in the [Application type:].
Check the [Export symbols] box in the [Additional options:].
Click the <Finish> button.



(5) A simple example of function fnMyCalculator will be created in MyCalculato.cpp.
Add a function MyArithmetic which executes the arithmetic operator to this file.

```
MYCALCULATOR_API float MyArithmetic(short value1, short
value2, char * kind )
 {
      if ( !strcmp(kind, "add") )
      {
            return (float)(value1 + value2);
      }
      else if ( !strcmp(kind, "sub") )
      {
            return (float)(value1 - value2);
      }
      else if ( !strcmp(kind, "mul") )
      {
            return (float)(value1 * value2);
      }
      else if ( !strcmp(kind, "div") )
      {
            return (float)(value1) / (float)(value2);
      }
      else
      {
            strcat_s(kind, 10, " NG");
            return 0;
      }
}
```

(6) Export a function to enable it to be called from SPEL+.
Select the [Add New Item] from the Project menu.
The [Add New Item] dialog will appear.



Select the module definition file (def) in the [Templates:].
Type in a file name in the [Name:].
(Here sets MyCalculator as a file name.)
Click the <Add> button.

Register “fnMyCalculator function” and “MyArithmetic function” to the created “MyCalculator.def” file.

```
LIBRARY     "MyCalculator"
      EXPORTS
            fnMyCalculator
            MyArithmetic
```

(7) Build the project and create the DLL.
Select the [Build]-[MyCalculator] build from the Visual Studio 2008 menu.
DLL will be successfully created if any error is displayed.

Step 3: Call the DLL function from SPEL+

You can now try your DLL function from SPEL+.

NOTE

Before you call your function from the EPSON RC+ 7.0, you must debug it and check thoroughly if it can work without errors.
In case that error occurs (such as system error) in the native function, the EPSON RC+ 7.0 will not work normally.

(1) Copy the created MyCalculator.dll to the EPSON RC+ 7.0 project folder (e.g. C:\EpsonRC70\projects\dllcall).

(2) Define a DLL function which executes the arithmetic operator in the SPEL+ program and write a function call for MyArithmetic in Function main.

```
Declare MyArithmetic, "MyCalculator.dll"(value1 As Integer,
value2 As Integer, ByRef calc$ As String) As Real
Function main
      Real result;
      String calc$

      calc$ = "add"
      result = MyArithmetic(1, 2, ByRef calc$);
      Print "1+2=", Str$(result)
      calc$ = "sub"
      result = MyArithmetic(1, 2, ByRef calc$);
      Print "1-2=", Str$(result)
      calc$ = "mul"
      result = MyArithmetic(1, 2, ByRef calc$);
      Print "1*2=", Str$(result)
      calc$ = "div"
      result = MyArithmetic(1, 2, ByRef calc$);
      Print "1/2=", Str$(result)
Fend
```

(3) Build and execute the project.
The following result will be displayed.

```
1+2=3
1-2=-1
1*2=2
1/2=0.5
```

NOTE

Before you build the project, be sure to copy the native DLL to the project folder without fail. If you fail, a warning or error will occur.

7. Building SPEL+ Applications

7.1 Designing Applications

7.1.1 Creating the simplest application

The simplest SPEL+ application has one program and one point file. This is what is automatically defined for you when you create a new project. A blank program named "Main.prg" and a blank point file named "Points.pts" are created.

To write and run a simple application

1. Select [New Project] from the [Project] menu to create a new project.
2. Write your program source code in the file that was created for you called "Main.prg".
3. Teach the robot points using the [Robot Manager]-[Jog & Teach] page.
4. Run the program by selecting [Run] Window from the [Run] menu or by pressing F5 (the shortcut key for the [Start] command).

7.1.2 Application layout

Before writing your application, you need to decide what your application will accomplish and how the project will be structured. Here are some general guide lines.

Programs

Each project can contain up to 64 programs that can be started from the Operator Window, Remote Control, RC+ API, or GUI Builder. Each program has a start function, as shown in the table below.

Program #	Program Name	Start Function
0	main	main
1	main1	main1
2	main2	main2
3	main3	main3
4	main4	main4
5	main5	main5
6	main6	main6
7	main7	main7
…	…	…
63	main63	main63

Your project must always define function main so that the main program can be started. The other programs are optional. If you use the Operator Window for your operator interface, you can define meaningful names for each of the programs used in your project in [Project]-[Properties]-[Operator setting]-[Operator Window].

Operator interface

Operator Window

Use the operator window provided with EPSON RC+ 7.0. You can configure EPSON RC+ 7.0 so that after Windows starts, EPSON RC+ 7.0 will start in Auto mode, which will automatically open the Operator Window.

Operators can select up to 64 programs. They can also optionally use the Pause/Continue buttons, I/O Monitor, Robot Manager, and System History viewer.

To use the Operator Window to allow programs to be started and stopped, the Control Device must be set to Self from [Setup]-[System Configuration]-[Controller]-[Configuration].

For details on configuring EPSON RC+ 7.0 for auto start, see section *Start Mode* in the *Operation* chapter.

Remote Control

Use remote control to turn motors on/off, home the robot, start programs, etc. A simple push button box can be used, or a PLC can be connected.

When using Remote Control, the Control Device must be set to Remote from [Setup]-[System Configuration]-[SPEL Controller Board]-[Configuration].

Windows Applications using RC+ API

Use the RC+ API Option along with a Windows development tool such as Visual Basic, Visual C#, or Visual C++. See the RC+ API Manual for more information.

GUI Builder

To use the GUI Builder option, refer to the *GUI Builder manual*.

Safety interface

Use guard doors, safety mats, light curtains, etc. to protect the operator from injury.

Robot Points, Pallets, Tools, Locals

Decide on which points you need for the work cell. In many cases you will only need one point file per robot.

Take advantage of Pallets, Tools, and Locals. Time spent on using these can save hours later on the production line. For example, if your cell has many points that take a lot of time to train, consider using Locals so that if the end effecter is damaged or replaced, you only need to redefine the Locals, not retrain all of the points.

Try to design in automatic or semi-automatic procedures for calibrating tools and locals. Even if you define them manually, write instructions on how to define them so the process can be repeated easily.

Inputs and outputs

Layout your I/O early in the design stages. Use I/O labels in your programs. You must purchase additional I/O boards if you need more than 24 inputs or 16 outputs. You can also use the Fieldbus option so the controller can be a Fieldbus slave.

Peripherals

The Robot Controller has one RS-232C port as standard (two ports depending on the type of controller). You can also add up to 9 ports by installing an optional RS232C expansion board. Refer to *12. RS-232 Communications* for details.

You can use TCP/IP to connect peripheral equipment.
Refer to *13. TCP/IP Communications* for details.

7.1.3 Auto start at power up

Your application can automatically log in a Windows user and start you SPEL$^+$ project after Windows boots.

Refer to *4.2.7 Auto Start*.

7.2 Managing Projects

7.2.1 Overview

What is an EPSON RC+ 7.0 Project?

An EPSON RC+ 7.0 project is a collection of SPEL$^+$ program files, include files, robot point files, I/O labels, user errors, Vision settings, and conveyor settings used to run a SPEL$^+$ application.

Why do you need projects?

Projects are a safe and convenient way to manage your SPEL$^+$ applications. All the information for each application is kept in one project. By keeping all of your application code and point definitions in one project, it is easy to open a project and begin running or editing. Also, it is easy to create new versions of an application and run older versions.

Projects make it easier to maintain your application code with less chance of a program being lost.

There are also functions for copying and renaming projects, making it easy to create new projects from previous versions and for backing up projects to an external media such as a USB memory key.

What does an EPSON RC+ 7.0 project consist of?

Each project is stored in the \EpsonRC70\Projects directory.

The following paragraphs describe the components of a project.

Project file

This file contains all of the information that describes the project. This file is automatically created by EPSON RC+ 7.0. You should never edit this file. Doing so may cause errors when you open the project. The file extension is “.sprj”.

Program files

A program file is an ASCII text file that contains one or more SPEL$^+$ functions. Each function in SPEL$^+$ can be run as a separate task (thread) in the controller or called from other functions.

Include files can also be used. These contain macro definitions and must be included in a program file using the #include statement. The file extension is “.prg”.

Point files

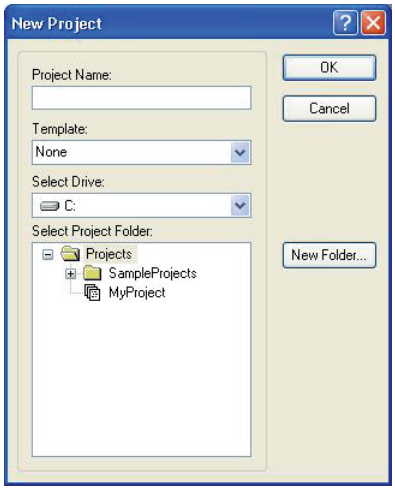
A point file contains a list of robot points. The file extension is “.pts”.

Include files

In the include file, you can declare variables and macros. The file extension is “.inc”.

7.2.2 Creating a new project

Projects always reside in specific drive, \EpsonRC70\Projects folder. Also you can create a sub-folder to systematize the projects of different types.



To create a new project

1. Select [New Project] from the [Project] menu.
   The [New Project] dialog box will appear.
2. Select the disk drive where you want the project to be stored on.
3. Select the project folder or create a new folder by clicking the <New Folder> button after selecting the parent folder.
4. Type in the name for the new project.
5. Optionally, select a template to base the project on.
6. Choose <OK> to create the project.

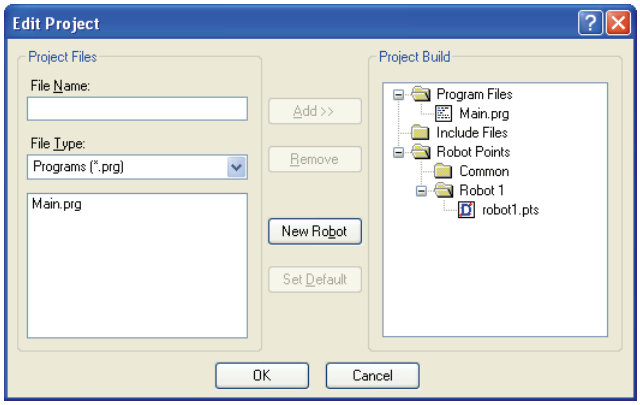
7.2.3 Configuring a project

Each application project you create must be configured properly before you can run the program.

There are two commands in the [Project] menu that allow you to configure a project: [Edit and Properties].

Editing a project

Select [Edit] from the [Project] Menu to open the [Edit Project] dialog. From this dialog, you configure program files, include files, and point files used in the current project.



For details on [Project]-[Edit], refer to *5.9.5 [Edit] Command*.

7.2.4 Building a project

Before you run any program in your application, you must build the project.

To build your application project

Select [Build] from the [Project] menu or click on the <Build> button on the toolbar.

Or

Select [Rebuild] from the [Project] menu. This will rebuild the entire project.

Or

Select [Run Window] from the [Run] menu or click the <Run> button on the toolbar. The project will be built before the [Run] Window appears.

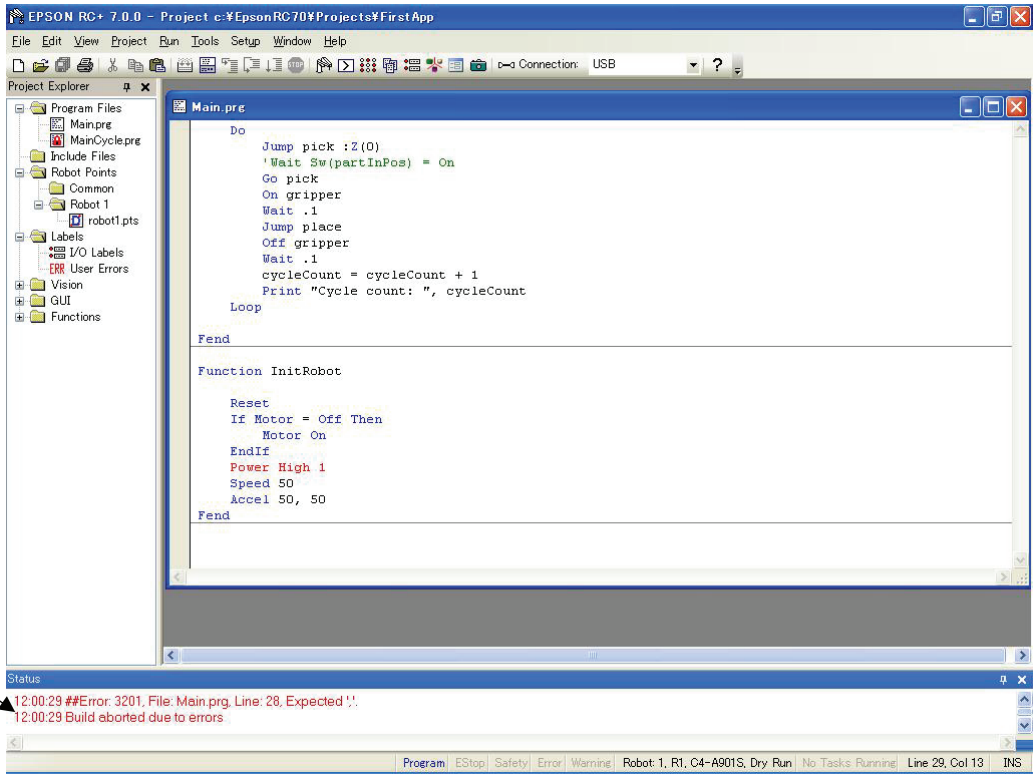
Or

Select [Operator Window] from the [Run] Menu. The project will be built before the [Operator Window appears.

After the files have been compiled and linked, the project files are sent to the controller.

Status Pane

This window shows progress messages and error messages during project build.



Double click this line to go to the source code.

When errors occur during the build process, a message is displayed that includes the error number, program file name, and line number. Double click on the line with the error to go directly to the source code that caused the error.

7.2.5 Backing up a project

To make a backup copy of the current project, use the [Copy Project] command in the [Project] menu to copy the project to another disk drive or folder. You can also save the project under a different name.

This command is useful for transferring a project to an external media such as a USB memory.

7.3 Editing Programs

Before you can edit a program, it must be in the current project and opened in a program window.

To open a program for editing

1. Select [Open] from the [File] menu.
2. Select the file(s) you want to open.
3. Choose <OK> to open the file.

7.3.1 Program rules

A program contains one or more SPEL$^+$ function definitions.

Lines can be blank. You can insert any number of blank lines to separate subroutines and functions, if desired.

The maximum length for each line is 512 characters, including the line number, if used.

7.3.2 Typing in program code

You can enter program statements in upper or lower case. Whenever you leave a line that has been changed, the line will be formatted. SPEL$^+$ keywords are case formatted and spaces are inserted around operators and after semi-colons and commas.

Consider using mixed case or lower case for variables and function names instead of all CAPs. This will make your code easier to read.

Use indentation for statements within loops. The **Auto Indent** feature automatically moves the cursor under the start of the previous line. It also indents lines after If, Else, For, Select, Case, and Do statements.

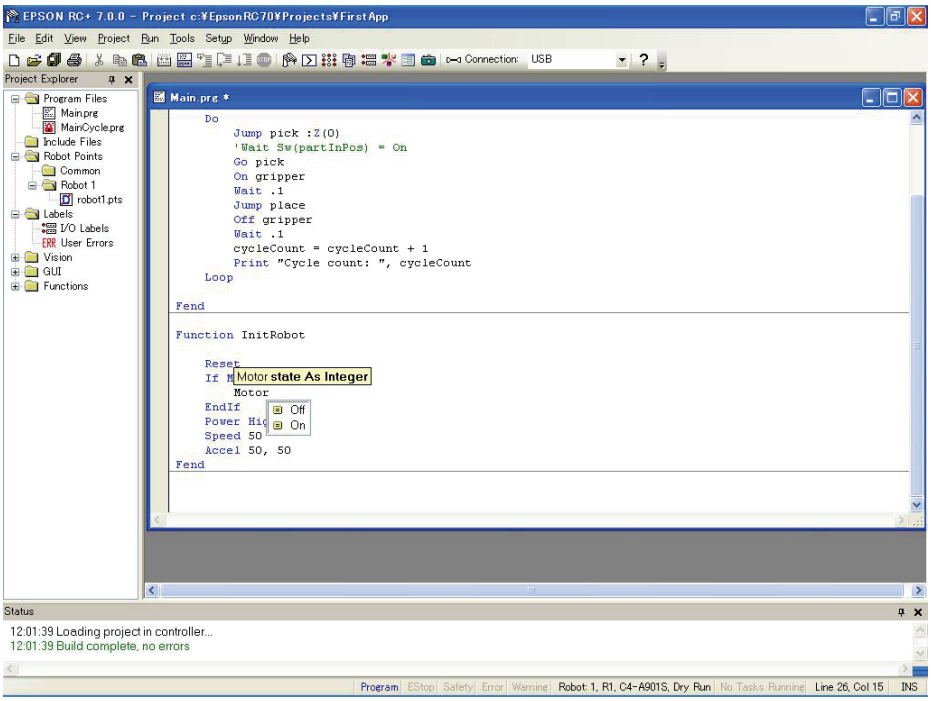
```
For i = 1 To 10
    Jump P(i)
    Jump P0
Next i
```

Use the **Auto End Construct** feature to automatically add the end construct statement. For example, when you enter a For statement and press <Enter>, a Next statement is automatically created with an indented blank line above it.

7.3.3 Syntax Help

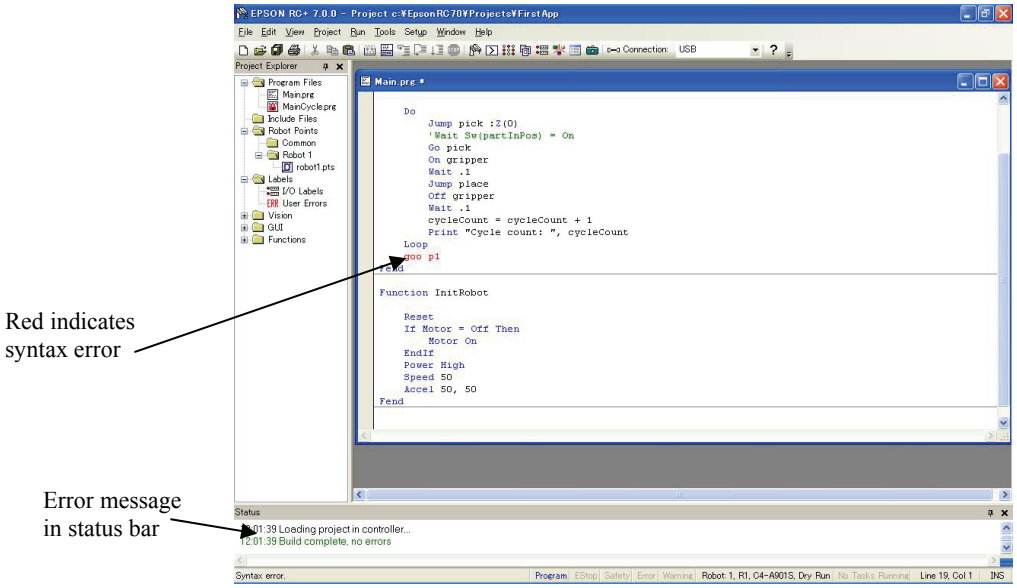
When you type in a SPEL+ keyword, the syntax help window will appear to show the syntax of the statement or function. After the statement is entered, the syntax helper will automatically close, or you can press the Esc key to close it. You can enable / disable Syntax Help from the [Setup]-[Preferences]-[Editor] tab.

A list box will be displayed for some parameters as you type. To select a value in the list, use the up and down arrow keys, or type the first few characters, to highlight the desired item, then press <Tab> to select the item. You can also type in a value not shown in the list, such as a variable or literal constant. Press <Esc> to hide the list box. In addition to <Tab>, you can use a comma or period to select an item. In the example shown below, the first parameter of the On statement can be an output label, so a list of output labels in the current project is displayed.



7.3.4 Syntax Errors

When a syntax error is detected, the line with the error will be displayed in red. If the caret is placed on the line with the error, then a brief message will be displayed on the status bar. For example, in the program shown below, the message "Expression expected" is displayed on the status bar.



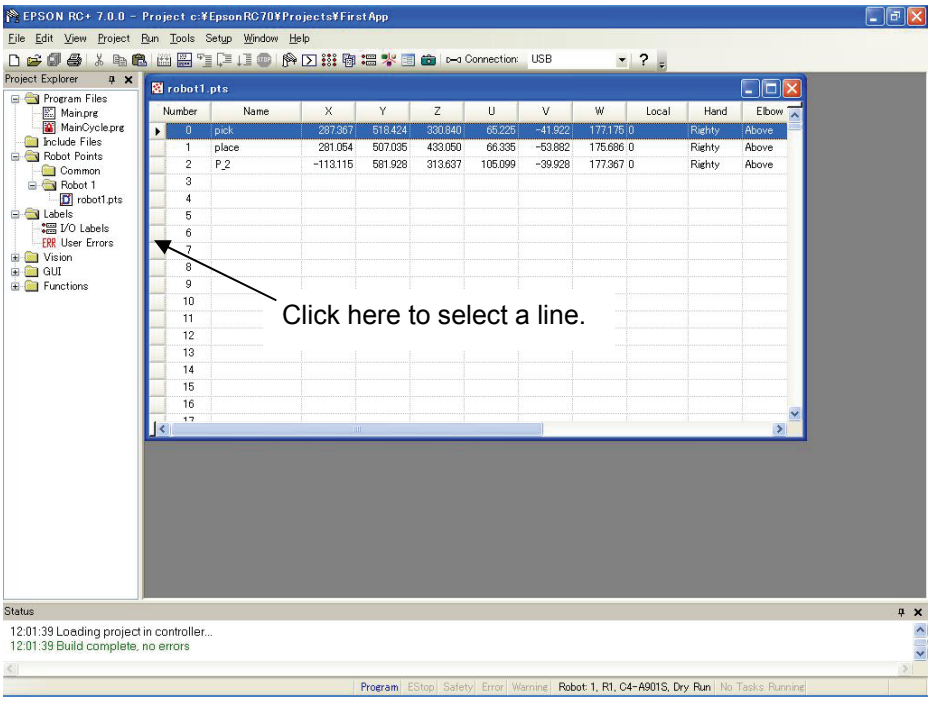
7.4 Editing Points

You can edit the robot points from the robot point file. You can define new points or cut, copy, and paste points from one point file to another, including between projects.

To open a point file for editing

1. Select [Open] from the [File] menu to show the Open dialog box.
2. Choose the Points option button. You will see a list of point file names in the files list box.
3. Select the point file you want to edit by clicking on the name.
4. Click <Open> to open the file. You will see a spread sheet window for the point file you selected.

The robot points spread sheet window



The spreadsheet window contains one row for each point in the file. The spreadsheet always contains rows for all points, even if they are not defined. The cells for an undefined point are blank.

Row select column	This is the leftmost column. Click on this column to select a row.
Number column	Point number. Range is from 0 to a maximum point number.
Name column	Name of the point.
Coordinate columns	Coordinates of X, Y, Z in millimeters and U, V, and W in degrees.
Local number column	Drop down list of local numbers. Range is from “0” to “15”.
Hand column	Drop down list of robot hand orientations: Lefty and Righty.
Elbow column	Drop down list of robot elbow orientations: Above and Below. This column is shown only for 6-axis robots.
Wrist column	Drop down list of robot wrist orientations: Flip and NoFlip. This column is shown only for 6-axis robots.
J4Flag column	Drop down list of robot J4Flag: “0” and “1”. This column is shown only for 6-axis robots.
J6Flag column	Drop down list of robot J6Flag: “0” – “127”. This column is shown only for 6-axis robots.
J1Flag column	Drop down list of robot J1Flag: “0” and “1”. This column is shown only for RS series.
J2Flag column	Drop down list of robot J2Flag: “0” and “1”. This column is shown only for RS series.
J1Angle	Coordinate in units of degrees. This column is shown only for RS series.

To select one or more rows

Click on the row select column (first column on the left) to select a row. To select more than one row, point to the row select column of the first row you want to select. Hold down the left mouse button and drag the mouse down or up to select more rows.

To select all rows

Execute Select All from the Edit Menu, or type <Ctrl> + A.

To define a new point

Move the cursor anywhere in the row of the point you want to define using the mouse, and then click a cell you want to type in. Enter information for the point. This automatically defines the point, which means it will be sent to the robot controller at the next project build or Jog and Teach command.

For example, click on the Name column and type in a name of the point. Press the <TAB> key to move to the X coordinate column. Type a coordinate value and then press <Enter>. You will see zeros automatically entered in all of the other coordinates. This means that the point is defined.

To delete a point

Select the row containing the point and cut it by selecting [Cut] from the [Edit] menu or by typing <Ctrl> + X.

To cut and paste points

1. Select one or more rows and execute either [Cut] or [Copy] from the [Edit] menu.
2. Select the row where you want to start the paste.
3. Select [Paste] from the [Edit] menu.

7.5 Running and Debugging Programs

You can run programs from the Run Window or from the Operator Window. The Run Window is used primarily for testing and debugging. The Operator Window is used as an operator interface for simple applications or demos. You can also run programs using the RC+ API option or GUI Builder option.

To run a program

Select [Run] Window from the [Run] menu. This command will build the project (if required) and open the [Run] Window. The [Run] Window allows you to choose which function to execute. Select a function, and then click <Start>.

7.5.1 The Run window

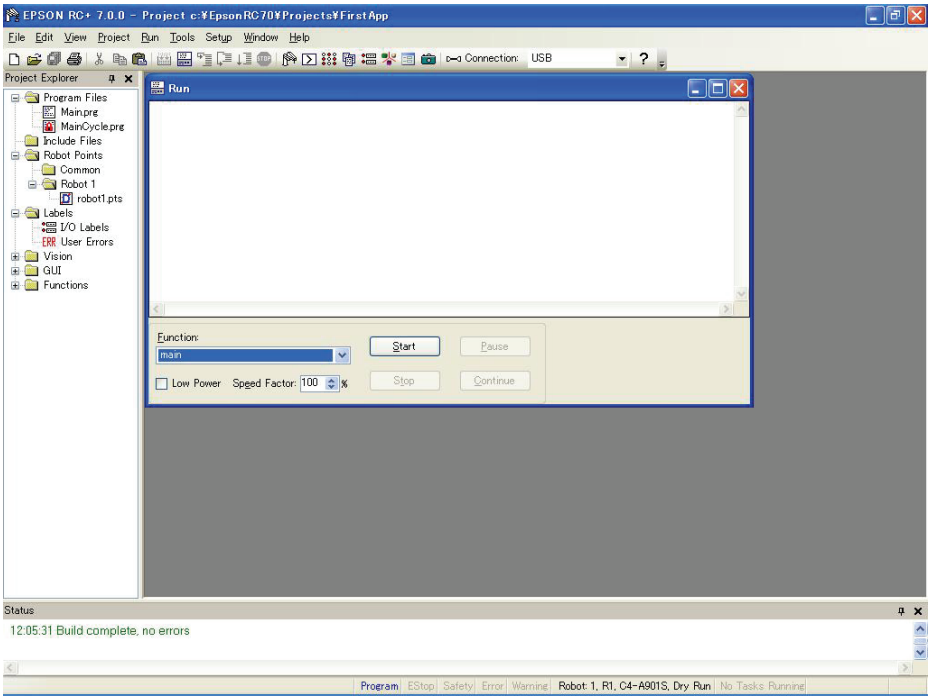
The Run window includes controls for running the programs in the current project.

To open the Run window

Select [Run] Window from the [Run] Menu, or click on the <Run> button on the toolbar. If necessary, all changed open files will be saved and the project will be built. If the build is successful, the Run window will appear.

To close the Run window

Choose [Close] from the [File] menu or click on the ✕ button in the upper right hand corner of the window.



Item	Description
Text area	This is the area that takes up most of the run window. Output from your programs is displayed here. When your program uses an Input statement, you can type in the requested input from this text box. You can use the scroll bars to view the entire text buffer. If an error occurs while running a program, the error number, program file name, line number and function name will be displayed in this text area. You can double click on the line where the error is displayed to directly go to the source line that caused the problem.
Function	Select a function to start. Functions are sorted alphabetically. Function main is selected by default.
Low Power	When this box is checked, SPEL$^+$ ignores the Power High command. This allows you to run your program in low power mode to verify operation without having to change the program.
Speed Factor	Specifies the robot motion speed factor. The speed factor is a percentage of maximum point to point speed and linear interpolated speed. For example, if you program executes Speed 80 and the speed factor is 50%, the robot will move at speed 40.
Start	Starts the function shown in the function drop down list.
Stop	Stops all tasks. If the robot is executing a motion command when this button is pressed, the robot will decelerate to a stop.
Pause	Pauses all tasks with pause enabled. Activates the <Continue> button. If the robot is executing a motion command when this button is pressed, the robot will decelerate to a stop.
Continue	Continues paused tasks.
CTRL+C	Same as <Stop> button.

7.5.2 Debugging

EPSON RC+ 7.0 supports source level debugging. You can set breakpoints and step through your source code. You can also pause / continue a program or halt a task using the Task Manager.

Setting and clearing breakpoints

Open the program where you want to set a breakpoint, then click on the line where you want to stop. Use one of the following methods to set a breakpoint:

- If Margin Indicators are enabled, then click in the margin next to the line on the left. You will see a breakpoint symbol next to the line.

Or

- Type F9.

Or

- Select Toggle Breakpoint from the [Run] Menu.

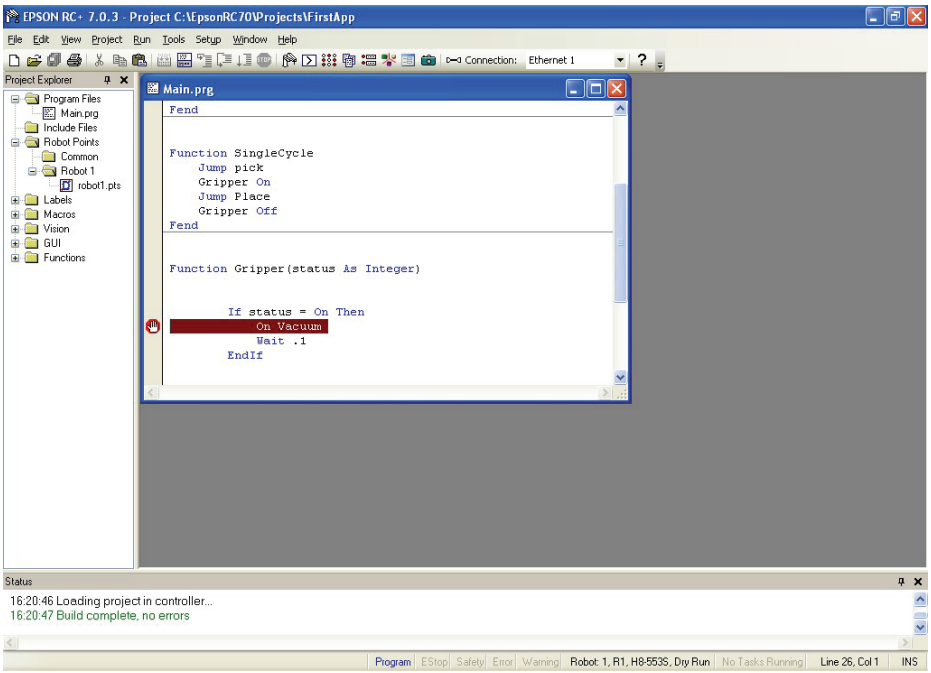
Execute one of the methods above to clear a breakpoint, or select [Clear All Breakpoints] from the [Run] Menu.

You cannot set a breakpoint on non-executing statements, such as #define, #include, or blank lines.

After setting a breakpoint, the task will halt when the execution line is reached the breakpoint. You can set or clear a breakpoint while a task is running.

When reached a breakpoint, the program window containing the program source line at the breakpoint is opened and the line is highlighted in yellow. The task number is shown in the title of the program window.

If more than one task reaches a breakpoint, then a program window will be opened for each task. This allows you to step through each task that reached the breakpoint.



Stepping through a program

There are three commands on the [Run] Menu that are used for stepping through code.

[Step Into] steps through each line and also steps into functions when a step is executed on a Call statement.

[Step Over] steps through each line but when a Call statement is encountered, the function in the statement is executed completely.

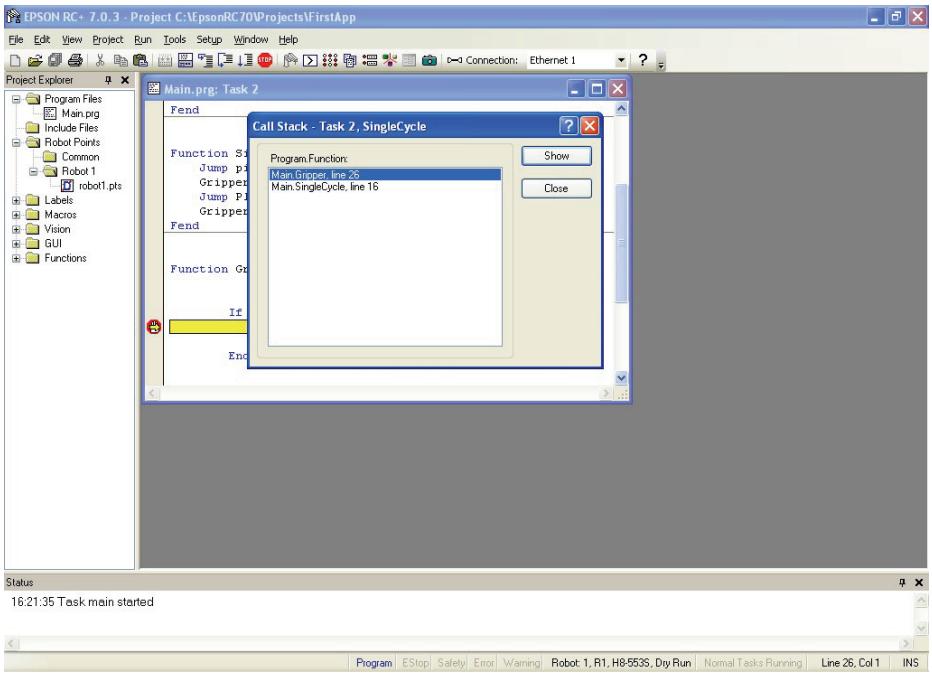
Walk executes lines until after the next motion command and then halts the task. It will halt after the next output command if the [Setup]-[System Configuration]-[Controller]-[Preferences]-[Walk stops for outputs] checkbox is checked.

To step through code, you must set a breakpoint and run until the breakpoint is reached, or suspend a task from the Task Manager using the <Halt> button.

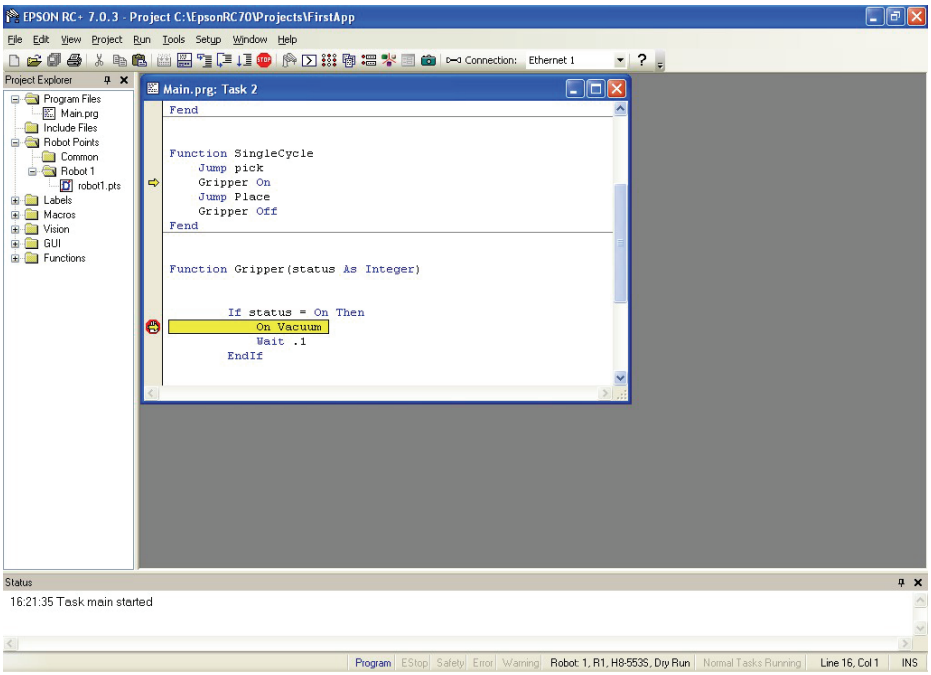
Viewing the Call Stack

Sometimes you may want to examine the call stack for the current task after you halt the task from the task manager, or reach a break point.

To view the call stack, select [Call Stack] from the [Run] Menu. The [Call Stack] list will be displayed, as shown below.



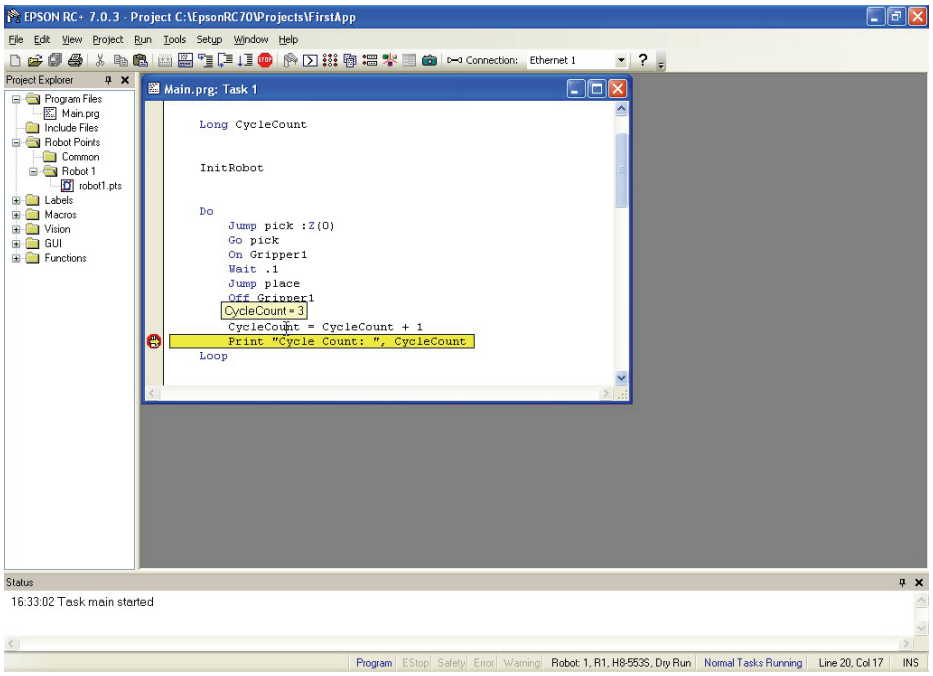
After you double click a function in the Call Stack list, the function will be displayed in a program window and an arrow in the left margin will point to the line where the next function in the call stack is being called. In the example below, the arrow in the SingleCycle function is pointing to the Gripper On statement to indicate that Gripper was called from SingleCycle.



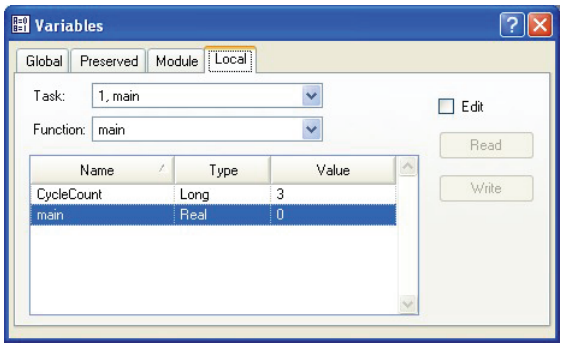
Displaying variables

To view variable values, you can do one of the following:

1. When a task is halted by halt or breakpoint, you can view the value for a variable by moving the mouse cursor over the variable name. The value will be displayed in a tool tip type window above the variable name.



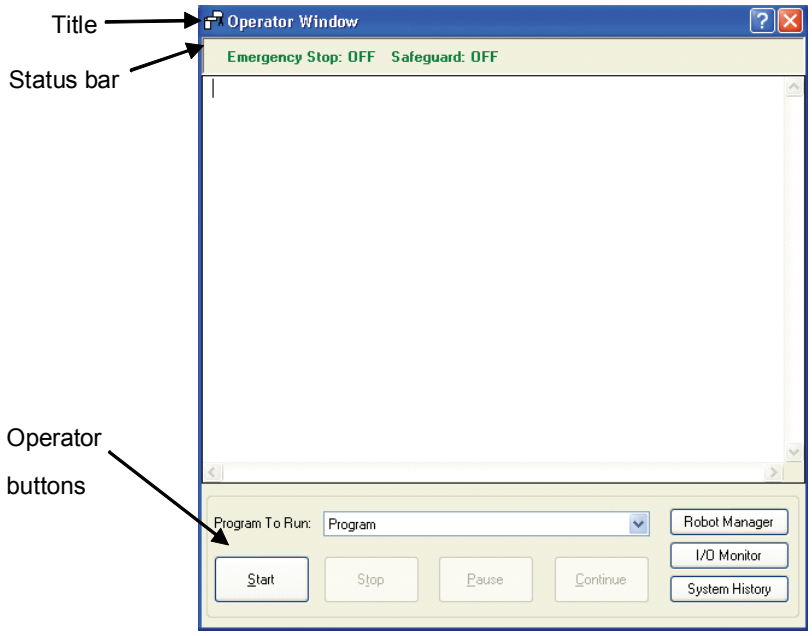
2. Select [Display Variables] from the [Run] menu to display the variable display dialog. This dialog has three tabs for viewing Global, Module, and Local variables.



You can change the value of a variable by checking the [Edit] check box, then type in the new value in the value column. Next, click the <Write> button to change the variable. When the [Edit] box is checked, the variable values are not automatically updated. You can click the <Read> button to update all values.

7.6 The Operator Window

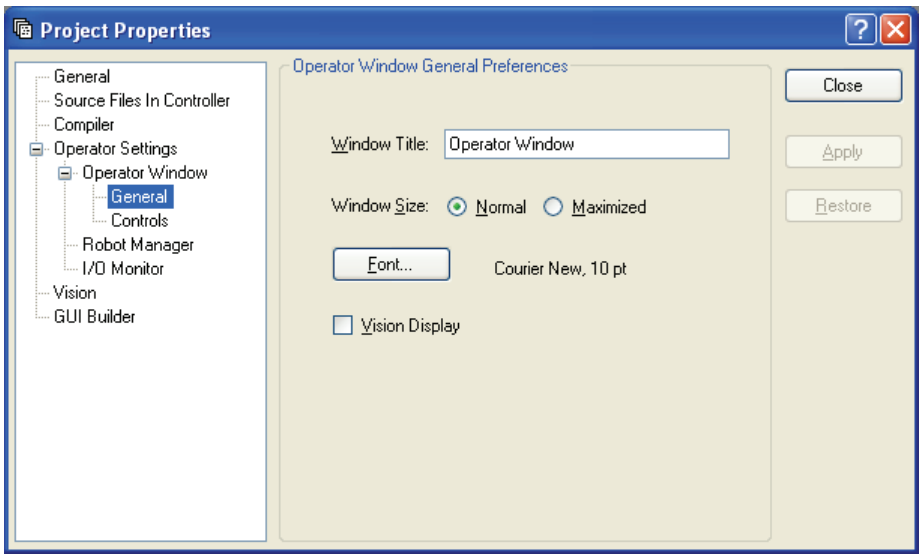
The Operator Window can be used as a simple interface for operators. You can configure EPSON RC+ 7.0 to open only the Operator Window when started. In addition, when Remote Control is being used, the Operator Window can be displayed for monitoring purposes.



Item	Description
Program to Run	Select a program to run.
Start	Starts the selected program.
Stop	Stops all tasks.
Pause	Pauses all tasks that are enabled for pause.
Continue	Continues paused tasks.
Robot Manager	Opens the Robot Manager dialog in operator mode. It cannot be shown while the program is running.
I/O Monitor	Opens the I/O Monitor in operator mode. This window can remain open while programs are running.
System History	Opens the System History window. This window can remain open while programs are running.
Status Bar	The status bar is located at the top of the window and shows emergency stop and safeguard status. In addition, if a warning is detected from the controller (such as low encoder battery), a warning label will be displayed on the right side of the status bar. If the mouse is over this label, you can see the warning error message. When there is no warning, the warning label is hidden.

7.6.1 Operator window configuration

You can configure the Operator Window from the Operator Window pages in [Project]-[Properties].



There are several settings for operator Robot Manager and I/O Monitor.

Fore details, refer to *5.9.14 Properties Command*.

7.6.2 Auto start configuration

You can configure the system to let it log into Windows automatically. Also you can configure a program to start automatically from the [Operator] window. For details, refer to *4.2.7 Auto Start*.

7.7 Using Remote Control

You can design your application to be run from external equipment using hardware I/O control. This includes push button boxes, PLCs, and other PC systems.

Refer to *12. Remote Control* for details.

7.8 Using Encrypt Files

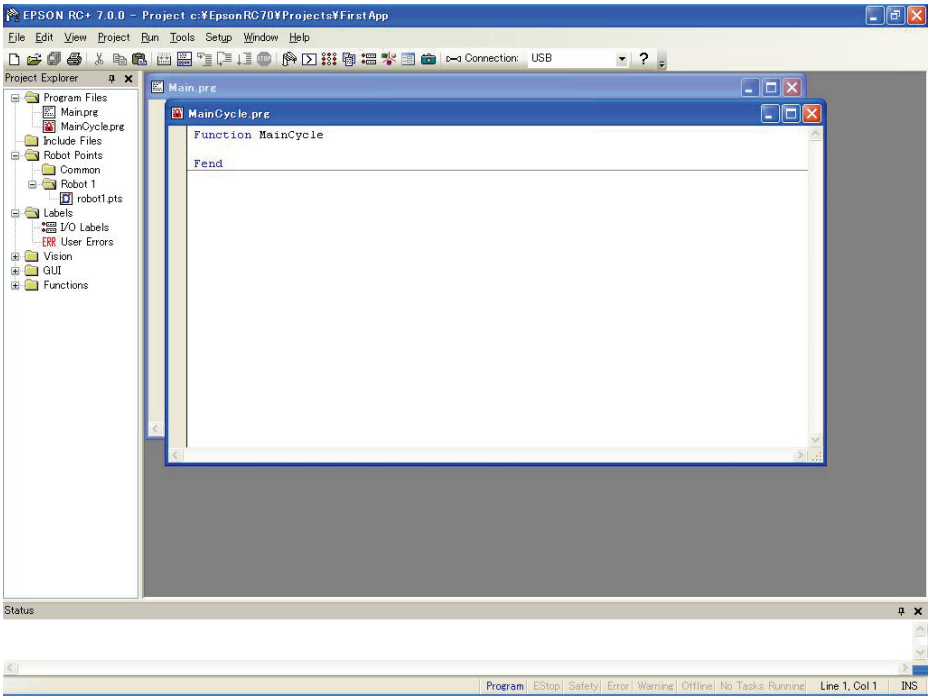
Encrypted files allow you to prevent end users from viewing your source code. When a file is encrypted, you must supply a password to open the file. Other users cannot view the file contents, even with an external editor, such as Notepad.

Each encrypted file can have its own password, or you can choose to encrypt multiple files with one password. You can encrypt program files, include files, Vision Guide, and GUI Builder.

If an encrypted file is imported from another project, it will remain encrypted in the current project.

As an example, assume you have some special SPEL+ programming code that you do not want your end users to view. But you want to allow end users to change some of the code in the project. To do this, put all of the functions you want to be hidden in one or more encrypted program and include files. When you go to the customer site, you can view your encrypted code by supplying the password(s) to open the encrypted files.

When files are encrypted, their icons are shown with a lock in the Project Explorer and also in the title bar of the program window. In the screenshot below, the file MainCycle.prg is encrypted, so its icons include a lock image.



When you open an encrypted file, you will be prompted for the password.

CAUTION	USE EXTREME CAUTION! Keep a record of the password(s) used for encryption in a safe place. Once a file is encrypted, it can only be opened with the password you enter. If you forget the password, the file contents CANNOT BE RECOVERED.

To configure encrypted files in your project, select Properties from the Project menu, then select Encrypted Files in the tree on the left. Refer to section *5.9.14 [Properties] Command (Project Menu)* for details.

8. Simulator

8.1 Simulator Functions

Simulator functions enable easy robot motion checking on your PC, which gives you flexibility to consider the system layout, measure the operation time, and create robot programs.

They are useful from the introduction stage to the launch of robot system.

8.1.1 Overview

The following are the major simulator functions:

Robot motion 3D display

Shows robot orientation and motion in a 3D display from various viewpoints.

Offers accurate display data based on design data.

Interference check

Checks whether the robot (including the hand) interferes with itself or its peripherals.

Robot operation time prediction

Predicts the robot operation time for a program.

Considers the speed setting (Speed, etc.) and acceleration / deceleration setting (Accel, etc.) when predicting the robot motion time.

SPEL+ program execution

Allows you to create, execute, and debug SPEL^{+} programs.

The restrictions on the simulator functions are described in *8.4 Specification and Restriction of Simulator*.

8.1.2 System Requirements

Recommended specification

When using CAD data, we recommend using a PC running Windows 7 Professional 32 bit version.

OS	Windows 7 Professional 32 bit version
CPU	Core i5 or more
Memory	2 GB or more
Hard disk spare capacity	4 GB or more
Graphic	DirectX10.1 or later must be available. OpenGL2.1 or later must be supported.

Minimum specification

To use one robot with several peripherals and operate them in a simple manner, the following environment is required.

OS	Windows 7 Professional 32 bit version Windows XP Professional 32 bit version, SP3 or later Windows Vista Business 32 bit version, SP2 or later
CPU	1.6 GHz or more, 32 bit (x86) Multi Core Processor
Memory	512 MB or more
Hard disk spare capacity	4 GB or more

8.2 Using the Simulator

You can try the simulation functions using the provided sample virtual controllers and projects. See section *8.2.1 Working with the samples*.

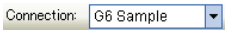
You can also select the robot model and build your own system. See section *8.2.2 Working with a user created system*.

8.2.1 Working with the samples

You can operate a robot easily using the samples provided. Follow the steps below:

1. Connect with a sample virtual controller (robot)
2. Open the corresponding sample project
3. Display the simulator window
4. Operate the robot by executing a program
5. Next step

1. Connect with a sample virtual controller

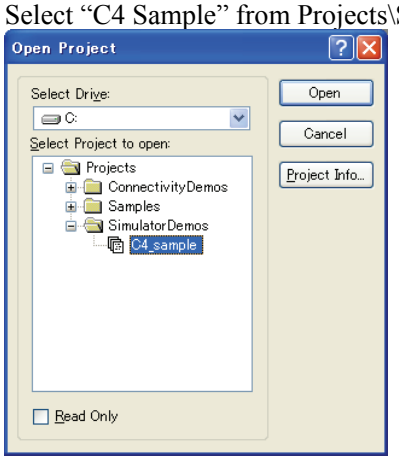


Select “C4 Sample” from the EPSON RC+ 7.0 Tool bar-<Connection> list box.
When the connection is complete, the <Connection> list box shows “C4 Sample”.

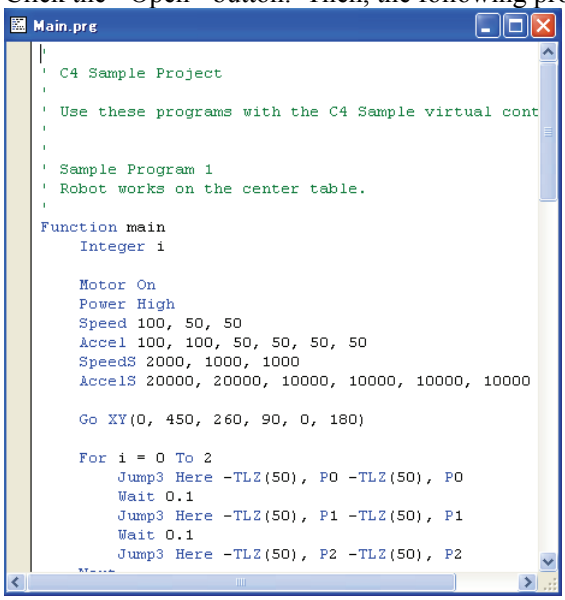
2. Open a corresponding sample project

(1) Click the EPSON RC+ 7.0 menu-[Project]-[Open…].

(2) Select “C4 Sample” from Projects\SimulatorDemos.

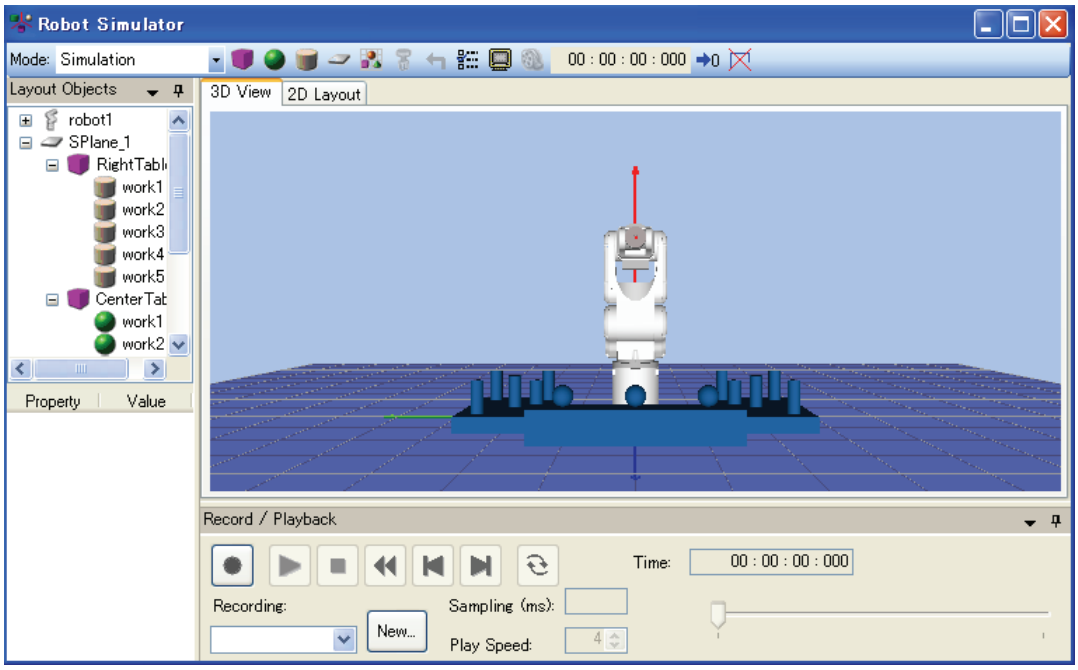


(3) Click the <Open> button. Then, the following program window appears.



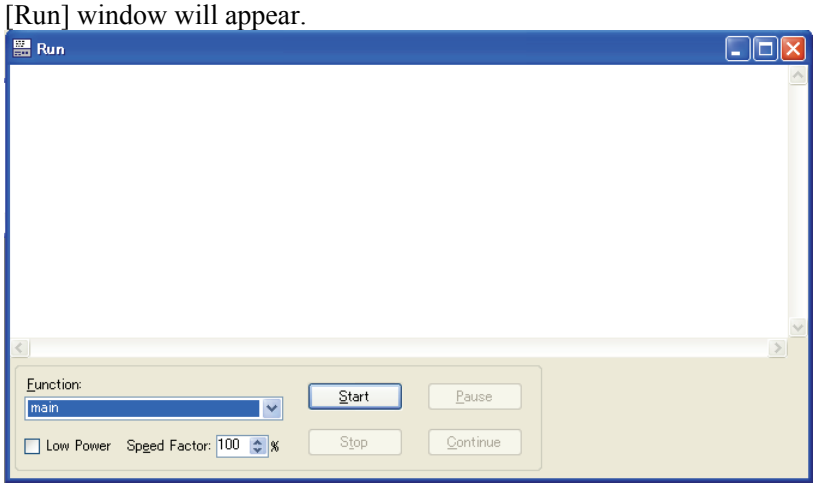
3. Display the simulator window

Click the Tool bar-<Simulator > button. The [Robot Simulator] window appears.



4. Operate the robot by executing program

(1) Click the Tool bar-<Run Window > button. The project will be built and the [Run] window will appear.



(2) Click the <Start> button.
The message "Are you ready to start?" appears. Click the <Yes> button.
The program starts and the robot moves in the 3D display.

5. Next step

If you want to change the sample, follow the steps in *8.2.2 Using with a user created system - Steps 5 to 7*. If you want to create your own system, start from *Step 1*.

If you want to change the sample virtual controller, follow the steps in *8.3.4 Virtual controller - Copy the sample or configured virtual controller* and change the copied sample.

8.2.2 Working with a user created system

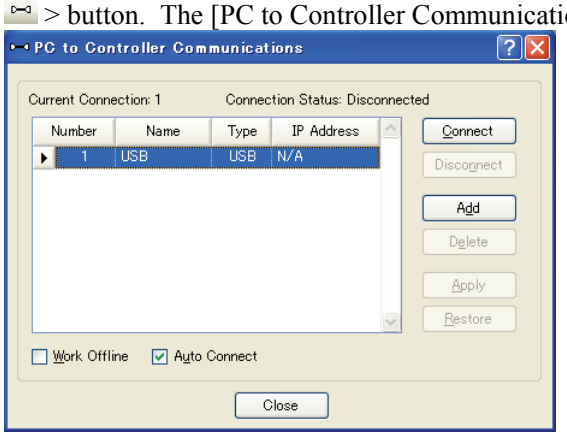
You can create your own system and simulate the robot operation on your PC.

Follow the steps below:

1. Create a new virtual controller (Connection setting)
2. Connect with the virtual controller
3. Configure a robot
4. Display the simulator window
5. Create and place objects
6. Create a project and program
7. Operate the robot by executing the program
8. Measure the robot operation time
9. Test for collisions

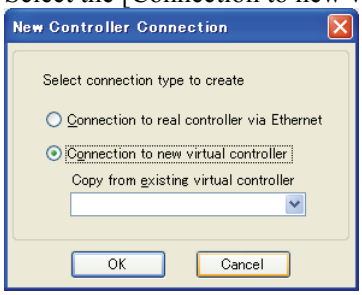
1. Create a new virtual controller (Connection setting)

(1) Click the EPSON RC+7.0 Tool bar-<Setup PC to robot controller communications. > button. The [PC to Controller Communications] dialog appears.

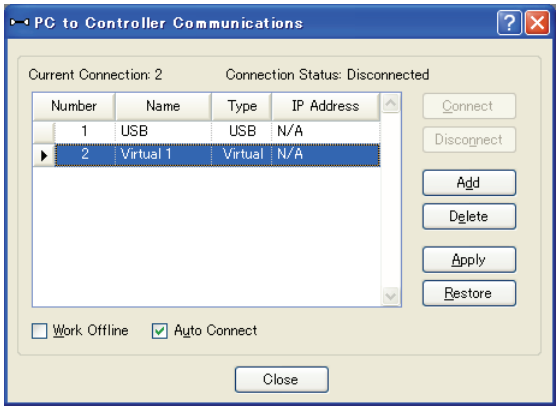


(2) Click the <Add> button. The [New Controller Connection] dialog appears.

(3) Select the [Connection to new virtual controller] and click the <OK> button.



(4) A new virtual controller named "Virtual 1" is created. Click the <Apply> button.



Note: In the virtual controller, programs will execute continuously for up to one hour.

If continuous execution is over one hour, a warning message appears.
You can execute the program again after the warning is displayed, and the continuous execution timer will be reset.

(5) Close the dialog to return to the EPSON RC+ 5.0 main window.

2. Connect with the virtual controller

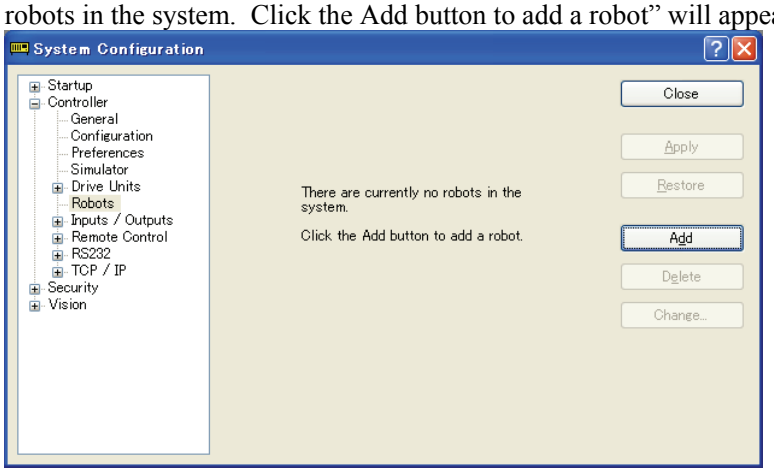
(1) Select the created "Virtual 1" connection from the EPSON RC+ 7.0 Tool bar-<Connection> list box. When the connection is complete, the <Connection> list box shows "Virtual 1".

3. Configure a robot

In this tutorial, a C4-A601S robot model is used.

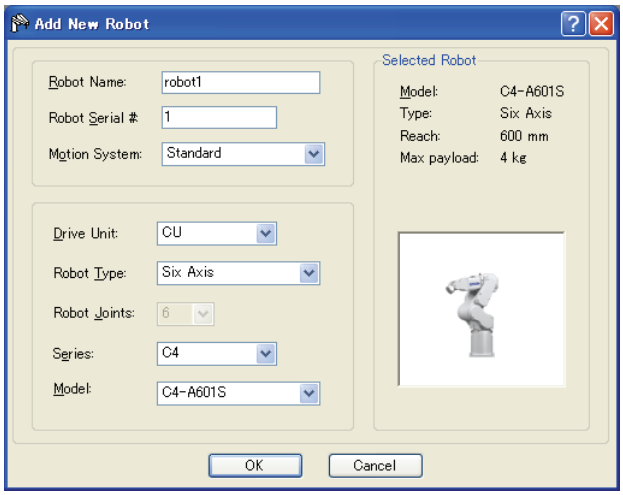
(1) Select the EPSON RC+ 7.0 menu-[Setup]-[Controller].

(2) Select the [Controller]-[Robots] from the tree, the message "There are currently no robots in the system. Click the Add button to add a robot" will appear.



(3) Click the <Add> button to open the [Add New Robot] dialog box. Input the robot information as follows:

[Robot Name]:	robot1
[Robot Serial #]:	1
[Drive Unit]:	CU
[Robot Type]:	Six Axis
[Series]:	C4
[Robot]:	C4-A601S

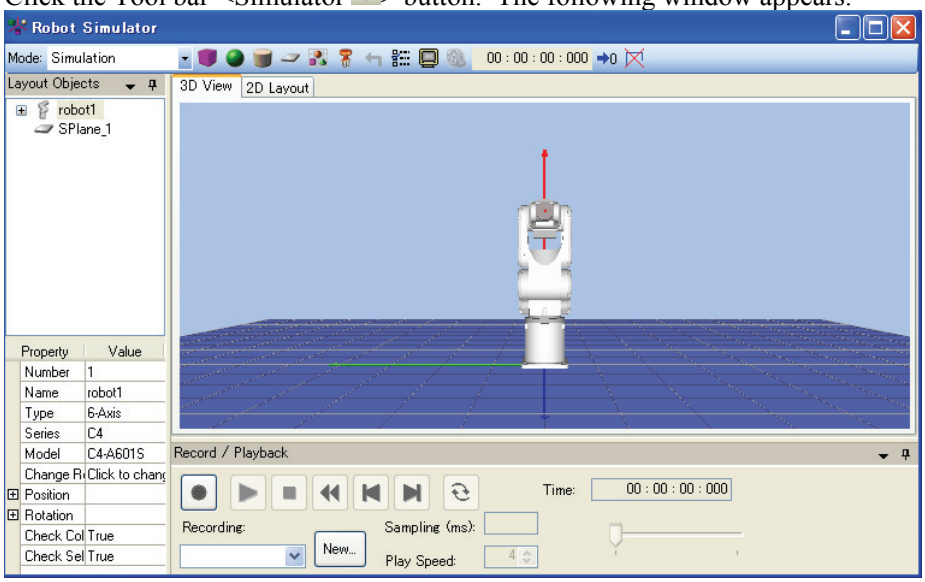


(4) Click the <Apply> button. The message "Restarting Controller" appears.

(5) When the message disappears, close the window and go back to the EPSON RC+ 7.0 main window.

4. Display the [Robot Simulator] window

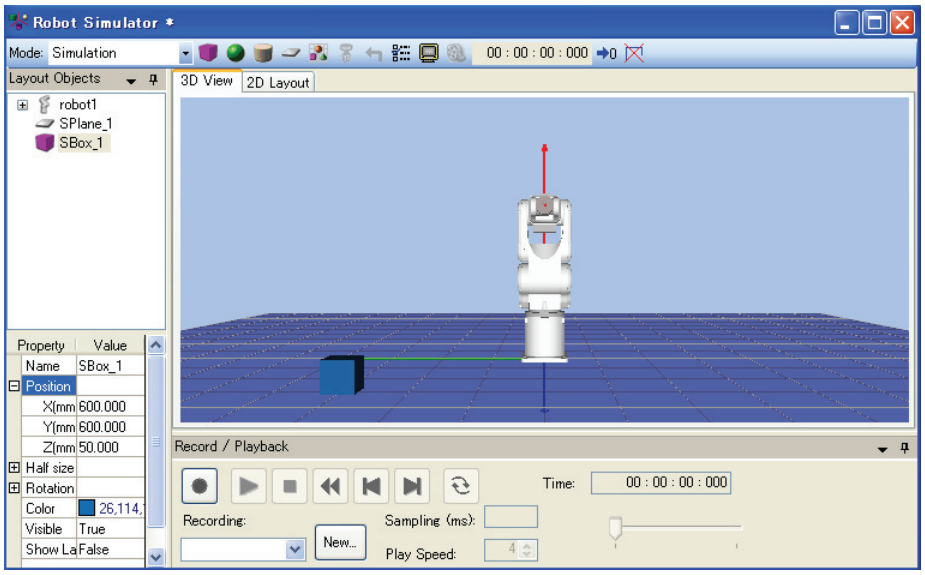
(1) Click the Tool bar-<Simulator > button. The following window appears.



5. Place the objects

For this tutorial, we will add a box to the layout.

(1) Click the <Box > button on the Tool bar.



(2) Select “SBox_1” from the [Layout Objects] and change the [Property]-[Position]. For this tutorial, enter X = 600, Y = 300.

TIP

To change the position, you can also drag the objects in the [2D Layout] tab.

To save the layout change, execute the EPSON RC+ 7.0 menu-[File]-[Save].

6. Create a project and program

(1) Create a new project

(1)-1 Click the EPSON RC+ 7.0 menu-[Project]-[New Project].

(1)-2 Enter a new project name. For this tutorial, enter “Test”.

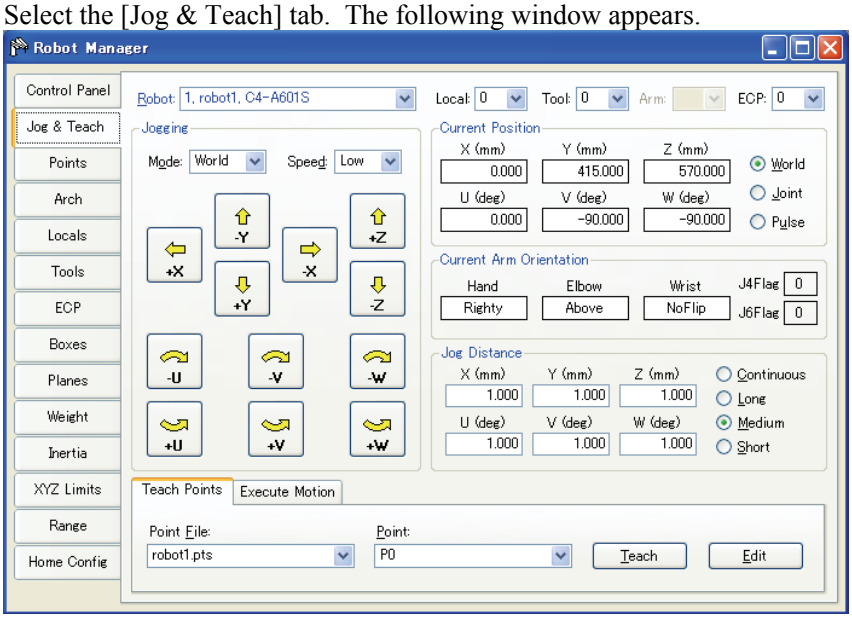
(1)-3 Click the <OK> button. Then, the project “Test” is created.

(2) Operate the robot and teach points.

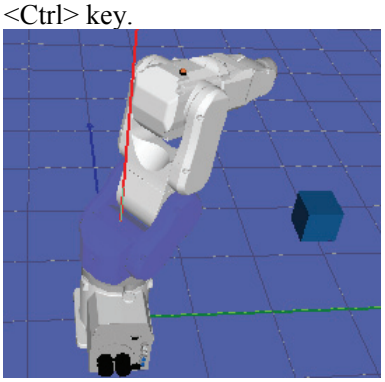
(2)-1 Click the Tool bar-<Robot Manager > button. The [Robot Manager] window appears.

(2)-2 Select the [Control Panel] tab and click the <MOTOR ON> button.
The message appears to confirm the operation. Click the <Yes> button.

(2)-3 Select the [Jog & Teach] tab. The following window appears.



(2)-4 In the [Robot Simulator] window, move the robot joint to a point where it does not interfere with the box.
To move the robot joint, drag the robot joint while simultaneously pressing the <Ctrl> key.



(2)-5 Go back to the [Robot Manager] window and click the <Teach> button in the [Teach] tab. The message appears to confirm the operation. Click the <Yes> button.

(2)-6 The [New Point Information] dialog appears. Click the <OK> button.

(2)-7 Select “P1 - (undefined)” from the [Point] list box on the lower right.

(2)-8 In the [Robot Simulator] window, drag the robot joint while simultaneously pressing the <Ctrl> key to another point without interfering with the box.

(2)-9 Go back to the [Robot Manager] window and click the <Teach> button. The message appears to confirm the operation. Click the <Yes> button.

(2)-10 The [New Point Information] window appears. Click the <OK> button.

(2)-11 Click the Tool bar-<Save all files> button to save the P0 and P1 data.

TIP

You can also use the [Jog & Teach] window to move the robot.

(3) Create and execute a program with robot motion.

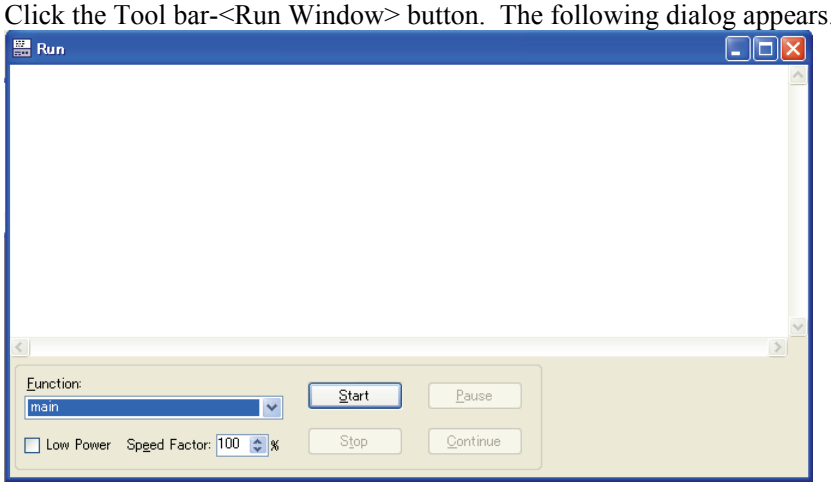
(3)-1 Create the following program in the program "Main.prg".

```
Function main
      Go P0
      Go P1
Fend
```

(3)-2 Click the Tool bar-<Build> button to build the program.
When the program building is completed, the message "Build complete, no errors" appears in the [Status] window.

7. Operate the robot by executing program

(1) Click the Tool bar-<Run Window> button. The following dialog appears.

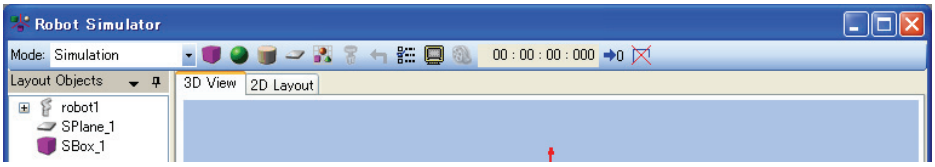


(2) Click the <Start> button.
The message "Are you ready to start?" appears. Click <Yes> button.
The program starts and the robot moves in the 3D display.

8. Measure the robot operation time

The elapsed program run time (cycle time) is displayed in the Tool bar of the [Robot Simulator] window.

It is the execution time of the program from start to finish.



The following describes how to measure the operation time between two points (P0 → P1).

(1) Change the program in the "Main.prg" file to the following program.

```
Function main
   Motor On
   Power High
   Speed 100
   Accel 100,100
   Go P0
Fend

Function main2
   Go P1
Fend
```

(2) Click the Tool bar-<Build> button to build the project.
When the project build is complete, the message "Build complete, no errors" appears in the [Status] window.

(3) Click the Tool bar-<Run Window> button.

(4) Confirm that "main" is selected in the [Function] dropdown list and click the <Start> button.
The message "Are you ready to start?" appears. Click <Yes> button.
The program starts and the robot goes to P0, the point to start the time measurement, in the 3D display.

(5) Select "main2" in the [Function] dropdown list.

(6) Click the <Start> button.
The message "Are you ready to start?" appears. Click the <Yes> button.
The program starts and the robot moves in the 3D display.
Now, the cycle time displayed in the Tool bar is the execution time to move the robot from P0 to P1.

NOTE

When you operate the real robot, the actual cycle time will be longer than the simulated cycle time according to the model, Fine, load settings. For details, refer to *8.4 Specification and Restriction of Simulator*.

Also, when Speed, Accel values in the program are changed, the cycle time will reflect it.

TIP

Motion command includes Move and Jump as well as Go.

For the information on how to use these commands, refer to *Online Help* or *SPEL+ Language Reference manual*.

9. Test the collision detection

(1) Go back to the [Robot Simulator] window.

(2) Drag the robot joint while simultaneously pressing the <Ctrl> key to a point where it interferes with the box. When the robot joint hits the box, the display turns to red.

(3) In the [Robot Manager] window, select “P2 - (undefined)” from the [Point] list box in the [Teach] tab.

(4) Click the <Teach> button.
The message to confirm the operation appears. Click the <Yes> button.

(5) The [New Point Information] dialog appears. Click the <OK> button.

(6) Click the Tool bar-<Save all files> button and save the P2 information.

(7) Go back to the [Robot Simulator] window and drag the robot joint while simultaneously pressing the <Ctrl> key to the point where it does not interfere with the box.

(8) Click the Tool bar-<Reset Collision > button. Then, the red display returns to normal.

(9) Add the following function to the “Main.prg” program file.

```
Function main3
   Go P2
Fend
```

(10) Click the Tool bar-<Build> button to build the project.
When the project build is complete, the message “Build complete, no errors” appears in the [Status] window.

(11) Click the Tool bar-<Run Window> button.

(12) Select “main2” in the [Function].

(13) Click the <Start> button. The message “Are you ready to start?” appears. Click the <Yes> button. The program starts and the robot moves in the 3D display. When the robot joint hits the box, the display turns to red.

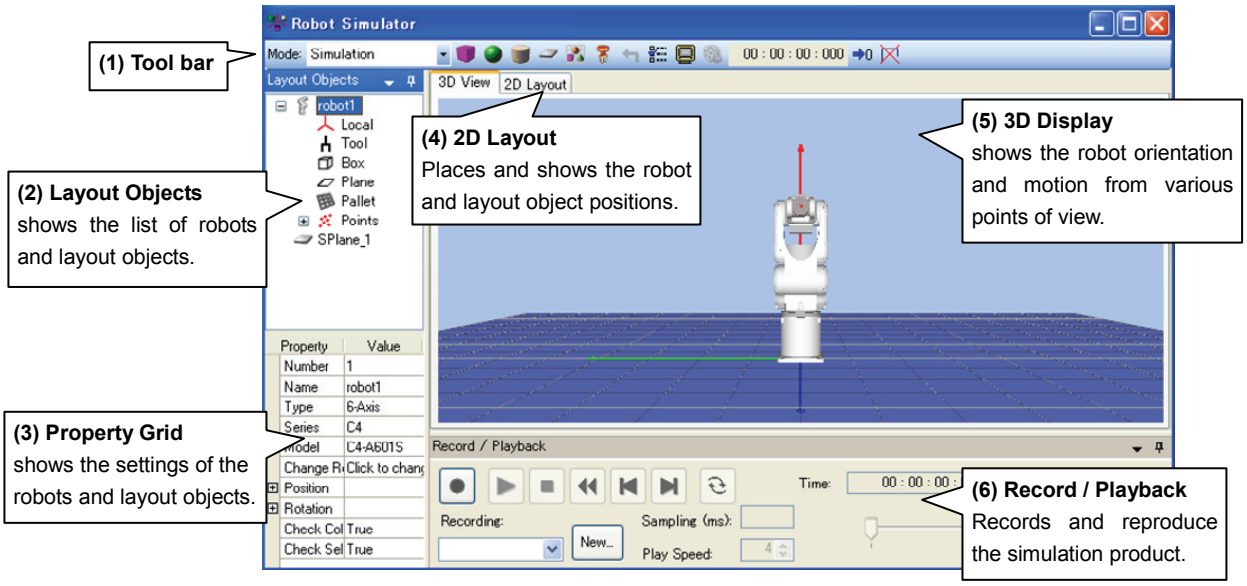
TIP

When a collision happens, the users can stop the controller program execution with an error. For details, refer to *8.3.3 Collision detection*.

8.3 Description of Functions

This section describes how to use the simulator window and its functions.

8.3.1 Simulator window layout



(1) Tool bar

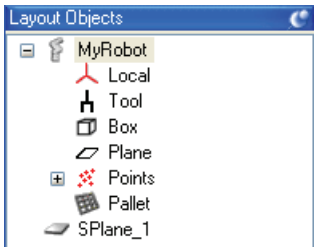
Icon	Description
Mode: Simulation	Simulator operating mode. It switches between <Simulation Mode> and <Playback Mode>.
Layout Box	Adds a box object.
Layout Sphere	Adds a sphere object.
Layout Cylinder	Adds a cylinder object.
Layout Plane	Adds a floor / wall object.
CAD	Adds a CAD object. When you click this button, a dialog appears to load the CAD data from a file.
Hand	Adds a hand object. When you click this button, the dialog appears to load CAD data from a file. Sample data is provided in EPSON RC+7.0 directory (EpsonRC70\Simulator\HandSamples)
Reset Collision	Resets the collision detection status. When you click this button while the robot is not interfering with any layout objects, the red display turns to normal.
Simulator Settings	Shows the [Simulator Settings] dialog. In this dialog, the 3D [Render Options] can be configured.
Screenshot	Saves the current 3D display as an image file. A dialog appears to specify a file name and format before saving.

Button	Description
Create Movie	Plays a simulation result (log file) in the Playback mode and saves into a movie file. A dialog appears to specify the file and format to save.
00 : 00 : 00 : 000 Elapsed Time	Shows the program execution time as if you ran the same program with a real controller. When a program starts, the elapsed time counter counts from 0 and stops when the program finished. It pauses counting when the program is paused and resumes when the program continues execution.
Clear Elapsed Time	Resets the elapsed time.
Clear end effector path	Clear the end effector path which the robot displays.

(2) Layout Objects Pane

The Layout Objects pane shows the robot objects and layout objects in a tree format.

When you right-click on a layout object, the deletion menu appears.



What is an Object?

The objects in the simulator are either a “Robot Object” or a “Layout Object”:

A “Robot Object” includes the robot itself, its hand, local coordinates, point information, etc.

A “Layout Object” includes objects to be placed around the robot to simulate the robot peripheral environment in the 3D display.

◆ Robot Object

Robot : The robot itself. The display data is handled by the simulator.

Hand : The hand is created by loading CAD data (VRML2.0, STEP, or IGES) from a file.

Object to reflect a robot parameter : Local, Tool, Box, Plane, Pallet

Object to reflect robot point data : Point

◆ Layout Objects

Simple object : Box, Sphere, Cylinder, Floor / Wall
The display data for these objects is handled by the simulator.
The object size can be changed as desired by editing properties.

CAD object : These objects are created by loading CAD data (VRML2.0, STEP, IGES, DXF) from a file.

(3) Property Grid Pane

In the Property Grid pane, you can view and change the settings of the robot objects and layout objects in the Layout Object pane.

◆ Robot Object Properties

Robot

Property	Value
Name	MyRobot
Type	Scara
Series	G6
Model	G6-551S
Change Robot	Click to change
Position	
X(mm)	0.000
Y(mm)	0.000
Z(mm)	0.000
Rotation	
X(degree)	0.00
Y(degree)	0.00
Z(degree)	0.00
Check Collision	True
Check Self Collision	True

Property	Value
Number	Robot number
Name	Robot name You can specify any name for a robot.
Type	Robot type The robot type (Scara, 6-Axis, and RS) is shown. This property is read-only.
Series	Robot series The robot series is shown. This property is read-only.
Model	Robot model name The robot model is shown. This property is read-only.
Change Robot	If you want to change the robot model, click on button. When you click on this button, a dialog appears to change the robot. For details, see *Changing the robot model* described later in this chapter.
Position	Robot position Specifies the robot's base center in the simulator World coordinates.
Rotation	Robot angle
Check Collision	Enables / disables the collision detection for layout objects. Enable : True (default) Disable : False Even if this is enabled, it does not detect collision between the robot base and layout objects.
Check Self Collision	Enables / disables the collision detection for a robot itself. Enable : True (default) Disable : False

Changing the robot model

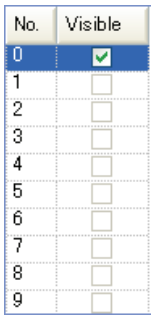
When you want to change the displayed robot model, click the <Change Robot> button. The [System Configuration]-[(Name of the displayed robot)]–[Model] dialog will be displayed. If you cannot see the button, increase the property grid width and click the [Value] column of the grid once.

NOTE

When you change the displayed robot model, all the settings for the robot (Local coordinates, Tool coordinates, etc.) will be initialized to the default values.

Local / Tool / Box / Plane / Pallet

If the local coordinate system of the corresponding number is not defined yet, the check box is grayed.



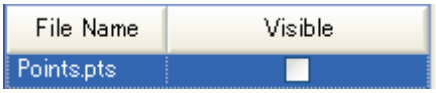
Property	Description
Visible	Displays a base / local coordinate system Visible : Check Not visible : Uncheck (default)

TIP

For Local 0 (Base), Visible is the default.

Points

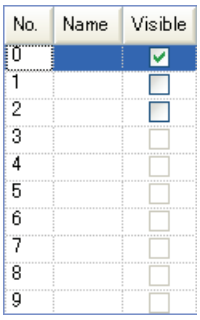
Display the point display setting status in the point file. Switch to show/non-show all points.



Property	Description
File Name	Show a point file name.
Visible	Shows / Not show all points Visible : Check Not visible : Uncheck If it is set to show some points, the check box shows indeterminate state.

Point

If the point of the corresponding number is not defined yet, the check box is grayed.



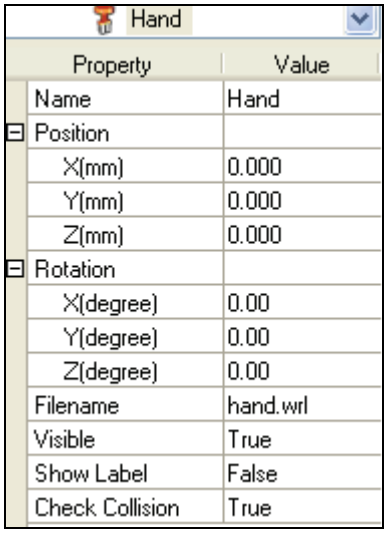
Property	Description
Name	Shows a point label In the Property Grid, point labels cannot be configured or edited.
Visible	Shows / Not show a point Visible : Check Not visible : Uncheck (default)

TIP

If you cannot see the [Visible] column, increase the property grid display width.

Hand

When a hand is registered with a robot, “Hand” is added in the Layout Objects tree.



Property	Value
Name	Hand
⊟ Position	
X(mm)	0.000
Y(mm)	0.000
Z(mm)	0.000
⊟ Rotation	
X(degree)	0.00
Y(degree)	0.00
Z(degree)	0.00
Filename	hand.wrl
Visible	True
Show Label	False
Check Collision	True

Property	Value
Name	Hand name You can specify any name for a hand. (Default: Hand)
Position	Mounting offset from the robot end effector position.
Rotation	Hand mounting direction
File name	CAD data file name of the hand It cannot be changed.
Visible	Visible : True (default) Not visible : False
Show Label	Displays the label: True Not display the label : False (default) This property sets whether to display the label when [Label Display] in the [Simulator setting] is specified.
Check Collision	Detect collision : True (default) Not detect collision : False

◆ Layout Object

Layout Box / Layout Sphere / Layout Cylinder / Layout Plane / CAD

There are common attributes for all objects and others are for particular objects.

SBox_1

Property	Value
Name	SBox_1
⊟ Position	
X(mm)	600.000
Y(mm)	600.000
Z(mm)	50.000
⊟ Half size	
X(mm)	50.000
Y(mm)	50.000
Z(mm)	50.000
⊟ Rotation	
X(degree)	0.00
Y(degree)	0.00
Z(degree)	0.00
Color	26,114,189
Visible	True
Show Label	False
Check Collision	True

Sphere_1

Property	Value
Name	Sphere_1
⊟ Position	
X(mm)	1250.000
Y(mm)	1250.000
Z(mm)	50.000
Radius(mm)	50.000
⊟ Rotation	
X(degree)	0.00
Y(degree)	0.00
Z(degree)	0.00
Color	26,114,189
Visible	True
Show Label	False
Check Collision	True

Cylinder_1

Property	Value
Name	Cylinder_1
⊟ Position	
X(mm)	1250.000
Y(mm)	1250.000
Z(mm)	50.000
Radius(mm)	50.000
Height(mm)	100.000
⊟ Rotation	
X(degree)	0.00
Y(degree)	0.00
Z(degree)	0.00
Color	26,114,189
Visible	True
Show Label	False
Check Collision	True

SPlane_1

Property	Value
Name	SPlane_1
Type	Horizontal
⊟ Position	
X(mm)	0.000
Y(mm)	0.000
Z(mm)	0.000
⊟ Half size	
Height(mm)	2000.000
Width(mm)	2000.000
⊟ Rotation	
X(degree)	0.00
Y(degree)	0.00
Z(degree)	0.00
Visible	True
Show Label	False
Check Collision	True

CAD_1

Property	Value
Name	CAD_1
⊟ Position	
X(mm)	700.000
Y(mm)	700.000
Z(mm)	0.000
⊟ Rotation	
X(degree)	0.00
Y(degree)	0.00
Z(degree)	0.00
Filename	cad.wrl
Visible	True
Show Label	False
Check Collision	True
⊟ VertexToPoint	
Display vertex	False
Vertices	200
Mesh ratio	100
Export points...	Click to export

Property	Object	Description
Name	All	You can specify any name.
Type	Plane	Floor : Horizontal (default) Wall : Vertical
Position	All	Specifies a center point in simulator World coordinates. Layout Cylinder: Bottom surface center
Half size	Box	Specifies a length from the center. The box length is double this length.

Radius	Sphere	Sphere radius
	Cylinder	Cylinder radius
Height	Cylinder	Cylinder height
	Plane	Floor length / Wall height
Width	Plane	Floor width / Wall width
Rotation	All	Object angle (Z-axis centering)
File name	CAD	CAD data file name. It cannot be changed.
Color	Box Sphere Cylinder	Display color Click the drop-down to change display color. The display color setting dialog will be displayed. Refer to *Change layout object color* for the details.
Visible	All	Visible : True (default) Not visible : False
Show Label	All	Displays the label : True Not display the label : False (default) This property sets whether to display the label when [Label Display] in the [Simulator setting] is specified.
Check Collision	All	Detect collision : True (default) Not detect collision : False
Display vertex	CAD	Displays vertex True Not display vertex False(default)
Vertices	CAD	Number of vertices
Mesh ratio	CAD	Ratio of vertices to be displayed
Export points…	CAD	Click the button to export the vertex coordinate as a point data. Point output dialog box will be displayed. For details, refer to *8.3.4 CAD To Point* described later in this section.

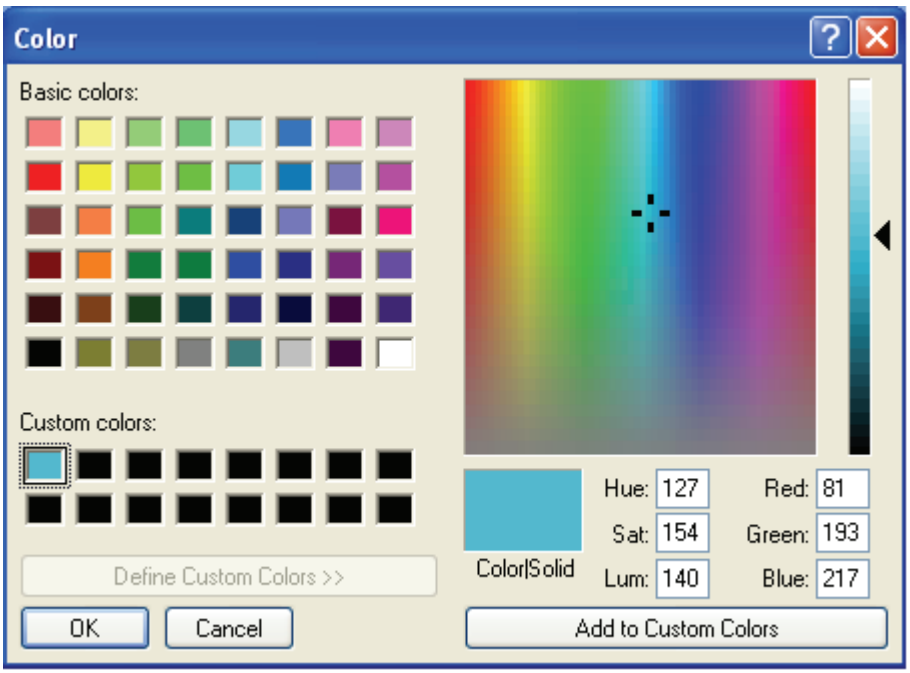
Change layout object color

When you want to change layout object color, click on the drop-down in the Color property and the dialog shown below will be displayed. If you cannot see the drop-down , increase the property grid width.

Click color you want to display. Layout object color will be changed.

If you do not want to change color, click anywhere other than the display color setting window. The window will be closed.

If you create a custom color, right-click any color in the bottom two rows (16 colors) in the [Custom] tab, and the color setting dialog will be displayed.

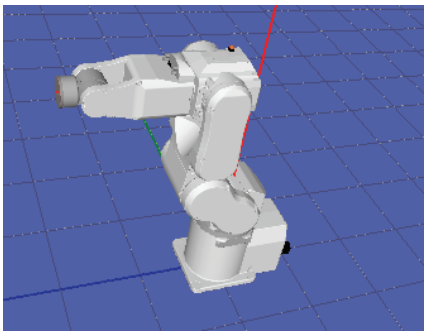


Create a custom color and click the <OK> button.

Created color will be displayed in the display color setting window.

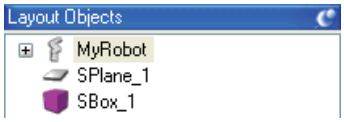
(4) 3D Display

In the 3D display, you can check the robot orientation and motion from various points of view.

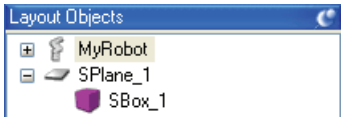


Adding a layout object

When a layout object is added while the robot object is selected in [Layout Objects], it will be added as independent object.



When a layout object is added while the layout object is selected in [Layout Objects], it will be added as a grouped object of the selected object.



Grouped objects move together when the parent object moves.

RightTable/CenterTable/LeftTable of the sample virtual controller “C4 Sample” is an example of grouping.

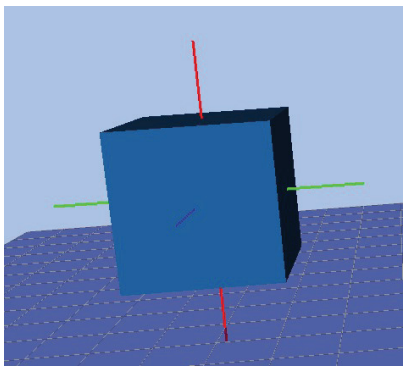
Changing a hierarchy of layout objects

To change a hierarchy of layout objects, drug and drop a layout object in the object tree.

Change the robot / layout object position

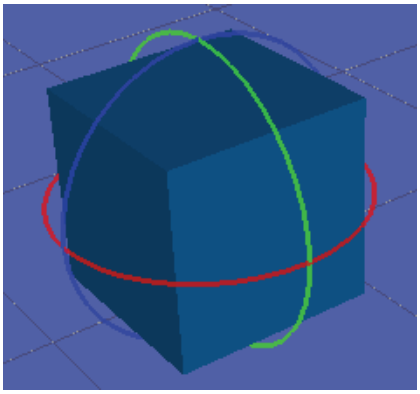
To display a guide which indicates the directions to move, press the <Shift> key and click on the object (box, etc.).

To move the object, drag the grid corresponding to the axis.



Rotate the robot / layout object

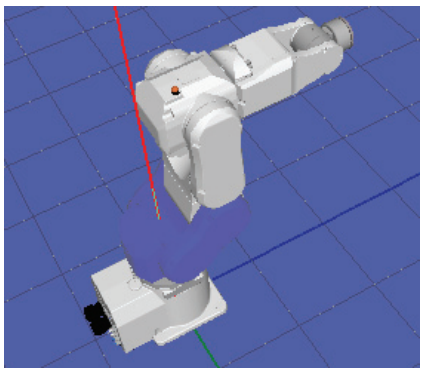
Clicking the robot base or box while pressing the <Ctrl> key displays guides indicating the rotation directions.
To rotate the object, drug the guide corresponding to the direction you want to rotate the object.



Move the robot joint

To move a robot joint, press the <Ctrl> key and drag the robot joint. The selected joint is displayed in blue.

If a robot moves to a point out of the motion range, the joint comes back to the previous point.



Change the view point

To rotate the view point, press the mouse left button and drag the 3D display.

To move the view point up and down, press the mouse right and left button and drag the 3D display.

Also, you can use the <L>, <R>, <D>, and <U> key to move the view point.

You can reset the view point from the menu opened by right click.

Zoom the layout

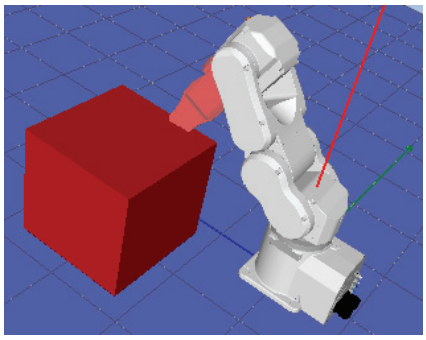
To zoom the 3D display, use the mouse wheel to scroll.

You can change the zoom level from the menu opened by right clicking with the mouse.

Check for collisions

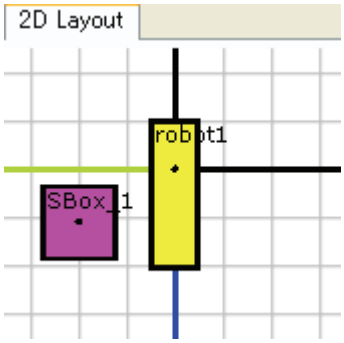
When a collision between a robot and layout object is detected, the collided robot joint and layout object are displayed in red.

For details, refer to *8.3.3 Collision detection*.



(5) 2D Layout

In the [2D Layout] panel, you can specify and check the robot objects and layout objects positions.



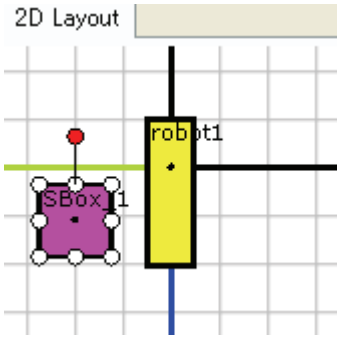
Change robot and layout object position

Drag an object (robot, box, etc.) to change its position.

To move an object in Z direction, use the <D> and <U> keys.

Drag ○ to change the size of an object, and drag ● to rotate an object.

If you are moving a box, it is shown as in the figure on the right:



Zoom the layout

To zoom the 2D layout, use the mouse wheel to scroll.

Move the display area

To move the 2D layout display area, drag the 2D layout while simultaneously pressing the <Shift> key.

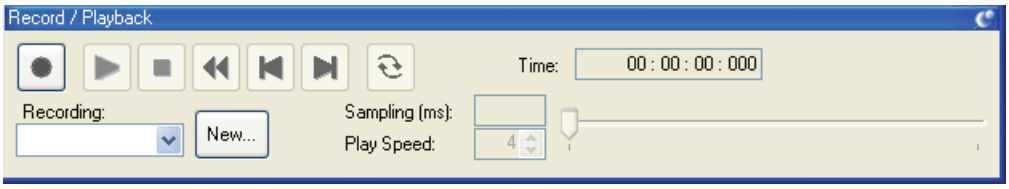
Rotate the display

To rotate the 2D layout display area, right-click on the 2D layout and use the options - [Rotate Clockwise] [Rotate CounterClockwise].

(6) Record / Playback

In Playback mode, you can record and produce simulation results.

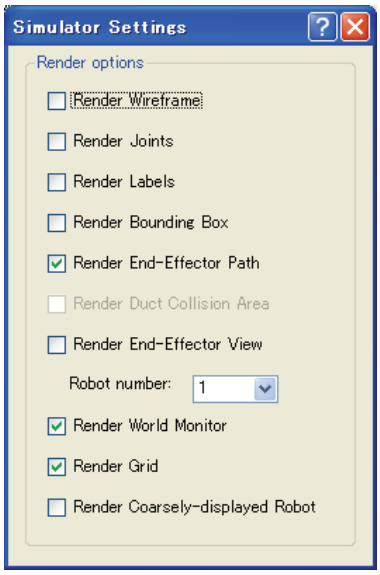
Also, you can store the simulation results in movie files.



Function	Description
RECORD	When the button is red, it saves the simulation result into the specified log file. Every time you execute the program, the log file is overwritten with the new information. When the button is gray, it doesn't save the simulation result. As the default, it doesn't save the simulation result.
PLAY	Plays a simulation result of a specified log file.
STOP	Stops the simulation playback.
REWIND	Puts the playback step to the starting point.
BACK	Goes back one step. The number of steps back is specified in [Play Speed].
NEXT	Goes to next step. The number of steps to go is specified in [Play Speed].
REPEAT	When this button is pressed, repeats the simulation playback.
Log: Log list	Specifies a recording file to record and play.
New... New button	Create a new log file.
Sampling (ms): 4 Sampling	Displays the log file sampling interval.
Play Speed: 1 Play Speed	Specifies the playback interval with a number of steps.
Play position	Display the current playing position.

8.3.2 Simulator Settings

When you click the Tool bar-<Simulator Settings > button, the [Simulator Settings] dialog appears.



Render options

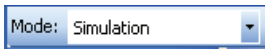
In the [Render options] dialog above, you can specify the 3D display method.

The specified display method is valid while EPSON RC+ 7.0 is running. However, when EPSON RC+ 7.0 is restarted, it returns to the default display settings.

Function	Description
Render Wireframe	Changes to the wire frame display (a three dimensional graphic using lines and points).
Render Joints	Displays fulcrum points of robot joints.
Render Labels	Displays names of robots and layout objects.
Render Bounding Box	Displays robots and layout objects in bounding box.
Render End-Effector Path	Displays robot end effectors path of a certain period of time.
Render Duct Collision Area	Available with G1 series and LS series manipulators. Shows the collision detection range of the robot ducts with the bounding view.
Render End-Effector View	Displays the view from the end effectors.
Robot number	Select the manipulator to display the view from the end effector.
Render World Monitor	Displays the simulator World coordinates.
Render Grid	Displays the simulator grid.
Render Coarsely-displayed Robot	Display the manipulator in a simplified data. The setting will be reflected at the next connection. This option is effective when the spec of your PC is insufficient or when you use the large data.

Produce the robot motion by outputting to a recording file

(1) Confirm that the mode is “Simulation” mode on the Simulator Tool bar.



(2) Click on the <New> button in the [Record / Playback] window. The [New Recording] dialog appears.

(3) Here, enter “TestPlayBack” and click the <OK> button.
Now, you can see “TestPlayBack” in the Recording list.

(4) Click on the <RECORD> button in the [Record / Playback] window, which enables recording. Now, the <RECORD> button is in red .

(5) Start a program from the [Run] window to move the robot. The simulation result is saved in the recording file while executing the program.

(6) Change the simulator operating mode to “Playback Mode” again.

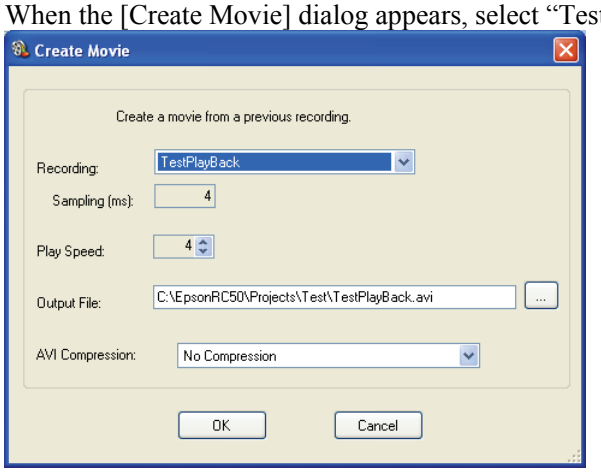
(7) Click on the <PLAY> button and the simulation result starts to play.

Produce the robot motion with saving in a movie file at once

(1) Confirm that the mode is set to “Playback” on the Simulator Tool bar.

(2) Click the <Create Movie> button in the Simulator Tool bar.

(3) When the [Create Movie] dialog appears, select “TestPlayBack” from the Log list.



(4) Specify the [Output File] and [AVI Compression] if necessary.

(5) Click on the <OK> button.
The [Create Movie] status window appears and the specified movie file is created with playing the log file.

(6) The created movie file is “TestPlayBack.avi” in EPSON RC+ 7.0 project folder (\EpsonRC70\projects\“a project name”).

8.3.3 Collision detection

In the simulation, collisions can be detected between the robots including its hand and the layout objects. Here we describe the settings and details of collision detection.

Basic settings for collision detection

In the [Property Grid] of the robot, the following can be configured.

Property	Value
Check Collision	Enables / disables the collision detection for layout objects. Enable: True (default) Disable: False Even if this is enabled, it does not detect collision between the robot base and layout objects.
Check Self Collision	Enables / disables the collision detection for a robot itself. Enable: True (default) Disable: False

Target of collision detection

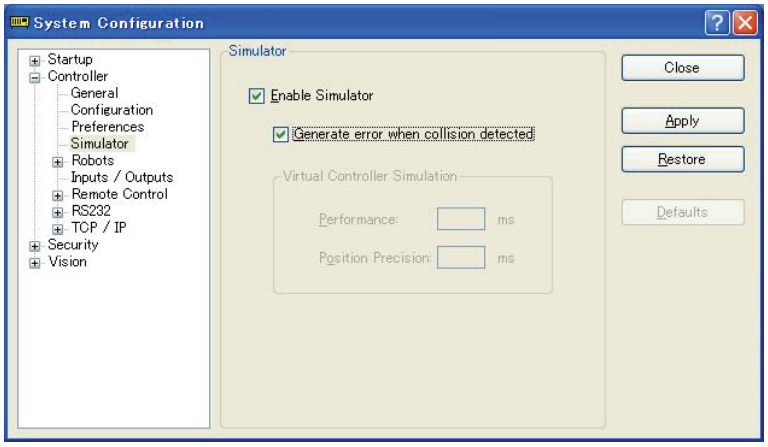
In the Property Grid of the layout objects, the following can be configured.

Property	Value
Check Collision	Enables / disables the collision detection for a robot.) Enable: True (default) Disable: False Even if this is enabled, it does not detect collision when the robot collision detection is disabled.

Generate error when collision is detected

When you open the [Setup]-[System Configuration]-[Controller]-[Simulator] and check the [Generate error when collision detected] checkbox, if a collision is detected during SPEL^{+} program execution, an error occurs in the controller and the program stops.

After checking the check box, click <Apply> and then click <Close>.



NOTE

The purpose of this function is to find where the program has a problem and not to prevent the collision of robots.

It cannot guarantee that it has enough time for robots to stop when the simulator detects the collision.

Caution about the collision detection of Floor / Wall

A collision is detected when a floor or wall is in contact with the robot. If the robot or plane positions are changed so that the robot passes completely through the plane, then no collision is detected.

Accuracy of collision detection

The collision detection in the simulator cannot guarantee accuracy. Make sure to have a margin when you apply the simulation result for a real robot system.

The restrictions of the simulator are described in *8.4 Specification and Restriction of Simulator*.

8.3.4 CAD To Point

CAD To Point outputs each vertex coordinate as a point data. Since this function automatically register points of manipulator motion based on the CAD data of the work piece, it can save time to develop a program.

Follow the simple CAD data sample below to use CAD To Point.

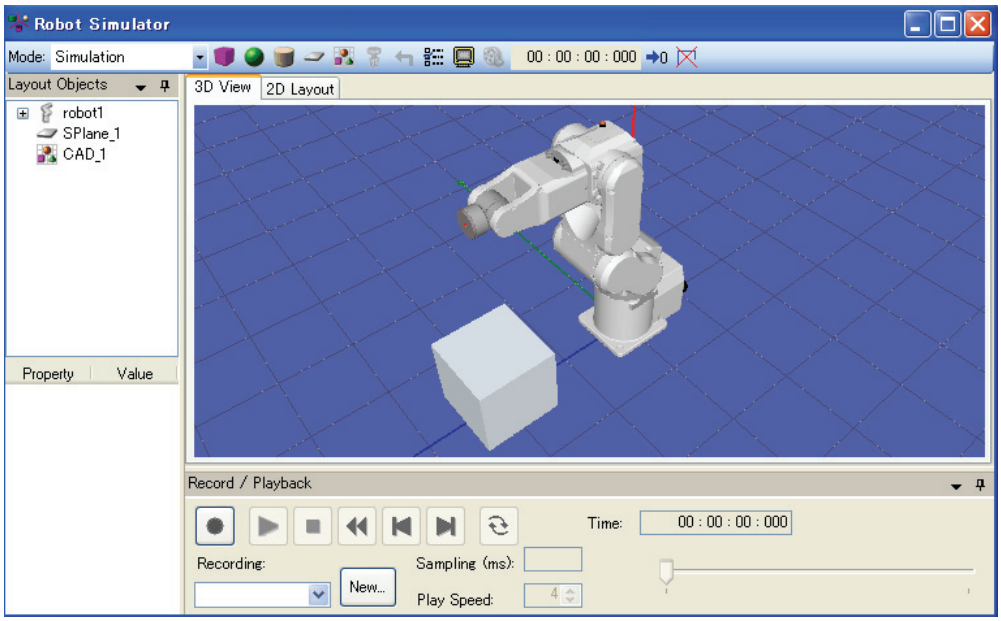
1. Connect to the virtual controller (CAD To Point)
2. Display the vertices of the CAD data
3. Export the vertices as point data
4. Create a program
5. Execute the program and operate the manipulator

1. Connection to the virtual controller (CAD To Point)

Select “CAD To Point” from the EPSON RC+ 7.0 tool bar-<Current controller connection> list box. When the connection is completed, “CAD To Point” will be displayed in <Current controller connection> list box.

Click the EPSON RC+ 7.0menu-[Project]-[Open…]. Select [Projects]-[SimulatorDemos]-[CAD To Point].

Click the tool bar-<Simulator > to display the simulator window. Cad object “CAD_1” is arranged in “CAD To Point”.



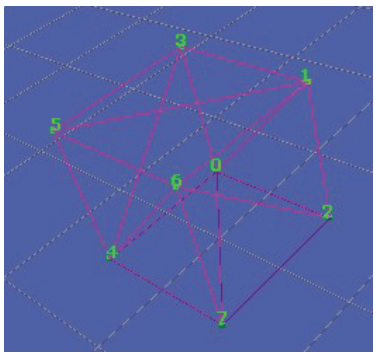
2. Display the vertices of the CAD data

By changing the property grid “Display vertex” of the CAD object to “true”, CAD object will be displayed by vertices and polygon. Numbers will be displayed for each vertex.

Property	Value
Name	CAD_1
⊞ Position	
⊞ Rotation	
Filename	CAD_To_Point_E
Visible	True
Show Label	False
Check Collision	True
⊟ VertexToPoint	
Display vertex	False
Vertices	8
Mesh ratio	100
Export points...	Click to export

In this example, change “Display vertex” of “CAD_1” to “true”.

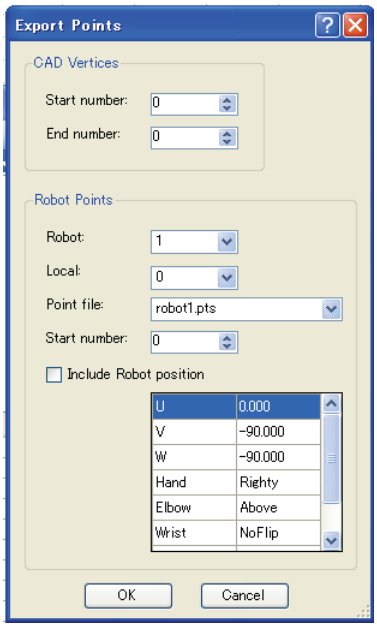
Vertices will be displayed with numbers.



TIP
If the object has too many vertices, change “Mesh ratio”. You can adjust the number of vertices of the CAD object by entering a value from 1 to 100 in this option

3 Output the vertices as point data

To output the vertex coordinates as point data, click button in the [Export points…] of the property grid. The [Export Points] dialog box will be displayed.

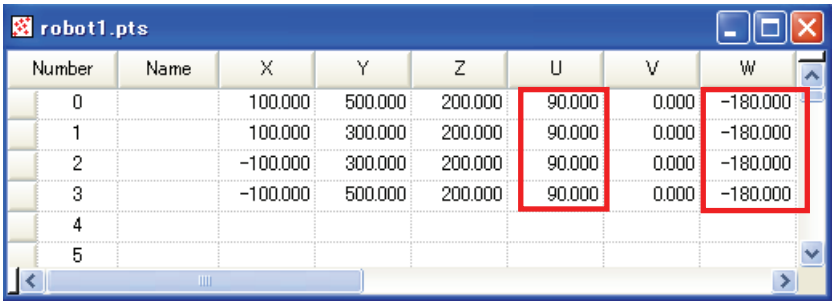


In this example, click button in the [Export points…] of the property grid and enter “4” for <Start number> and “7” for <End number> in the [CAD Vertices]. Click <OK> to export vertices 4 to 7 of the “CAD_1” to “No.0-3” of “robot1.pts”.

4. Create a Program

(1) Set the appropriate robot posture for the point data

Open the point file “robot1.pts from the object tree and edit the exported No.0-3 “U” and “W” as shown below.



robot1.pts

Number	Name	X	Y	Z	U	V	W
0		100.000	500.000	200.000	90.000	0.000	-180.000
1		100.000	300.000	200.000	90.000	0.000	-180.000
2		-100.000	300.000	200.000	90.000	0.000	-180.000
3		-100.000	500.000	200.000	90.000	0.000	-180.000
4							
5							

NOTE
When the point data is exported with the [Export Points] dialog box-[Include Robot position] check box is check, points with current robot position will be registered.

(2) Create a following program in “Main.prg” program

```
Function main
 Motor On
 Go P0, P1, P2, P3, P0
Fend
```

(3) Click the tool bar-<Build project>. The program will be built.

When the program build is completed normally, the message “Build complete, no errors” will be displayed in the Status window.

5. Execute the program and operate the manipulator

(1) Click the tool bar<Open run window> to open the <Run> window

(2) Click <Start>. Then, the message “Are you ready to start?” will be displayed. Click <Yes>.

(3) The program will be executed and the manipulator will move among the registered vertices. Check if the manipulator moves in the order of vertices 4→5→6→7→4.

8.3.5 Virtual controller

To execute programs in the simulator, you need to create a virtual controller with defined robot and layout.

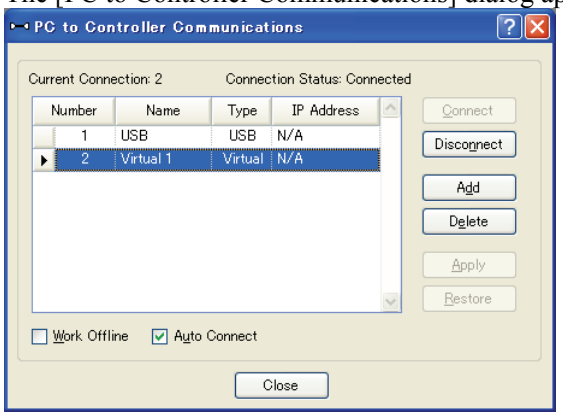
Robot settings and layout settings for the 3D display are saved for each virtual controller. If you want to transfer the robot or layout data, you can copy and transfer the data.

Create a new virtual controller

Refer to *8.2.2 Working with a user created system*.

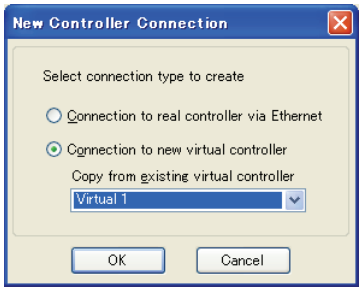
Copy the sample or configured virtual controller

(1) Click the EPSON RC+ 7.0 Tool bar-<Connection > button.
The [PC to Controller Communications] dialog appears.

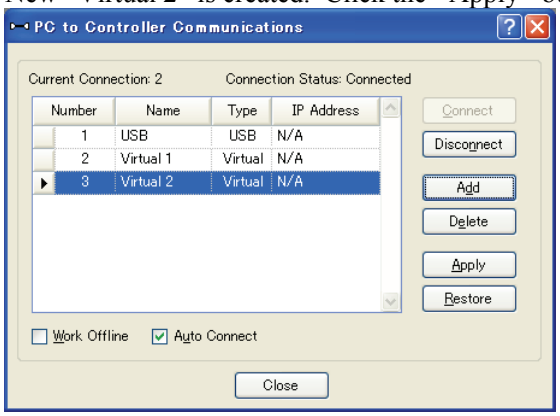


(2) Click the <Add> button. The [New Controller Connection] dialog appears.

(3) Select the <Connection to new virtual controller> option button and specify a virtual controller from the list box. Click the <OK> button.



(4) New “Virtual 2” is created. Click the <Apply> button.



(5) Close the dialog and go back to the EPSON RC+ 7.0 main window.

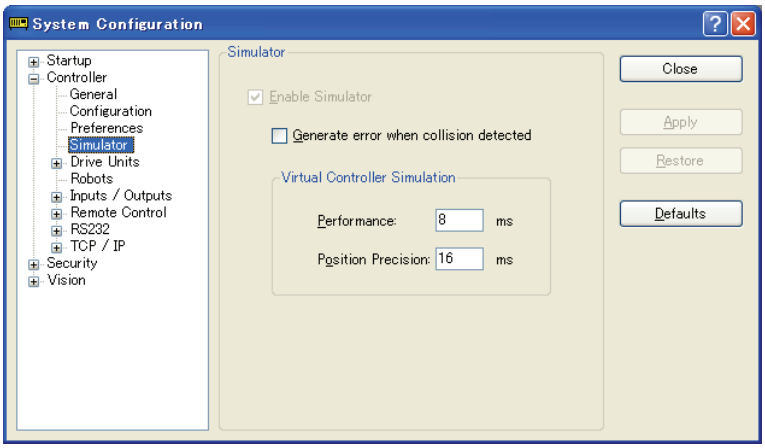
(6) Connect to “Virtual 2” and display the simulator window.
The robot setting and layout setting of 3D display has been taken over from “Virtual 1”.

(7) When you want to change the robot type, use the [Change Robot] in the robot object property.
For details, refer to *8.3.1 Simulator window structure – (3) Property Grid*.

Virtual controller configuration

Normally you don’t need to configure a virtual controller.

The configuration is available from the [Setup]-[System Configuration]-[Controller]-[Simulator] page.



[Performance] : You normally don’t need to change the setting from 8 ms (default).

[Position Precision] : You normally don’t need to change the setting from 16 ms (default).

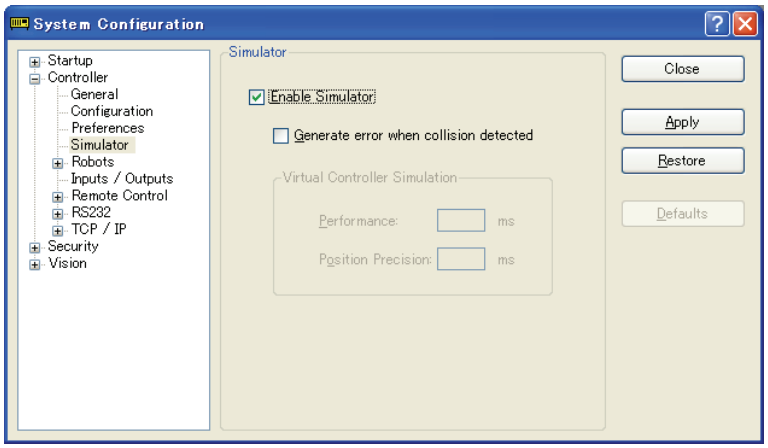
The situations when you need to change these settings are described in *8.4 Specification and Restriction of Simulator*.

8.3.6 Connection with controller

Enable the Simulator in controller

From the [Setup]-[System Configuration]-[Controller]-[Simulator], check the [Enable Simulator] check box to enable the simulator function.

After checking the check box, click the <Apply> button and then click the <Close> button.



If collision with the simulator object is detected during a Jog motion or a robot motion command execution when the Simulator is enabled, the Manipulator stops operation and a Warning occurs.

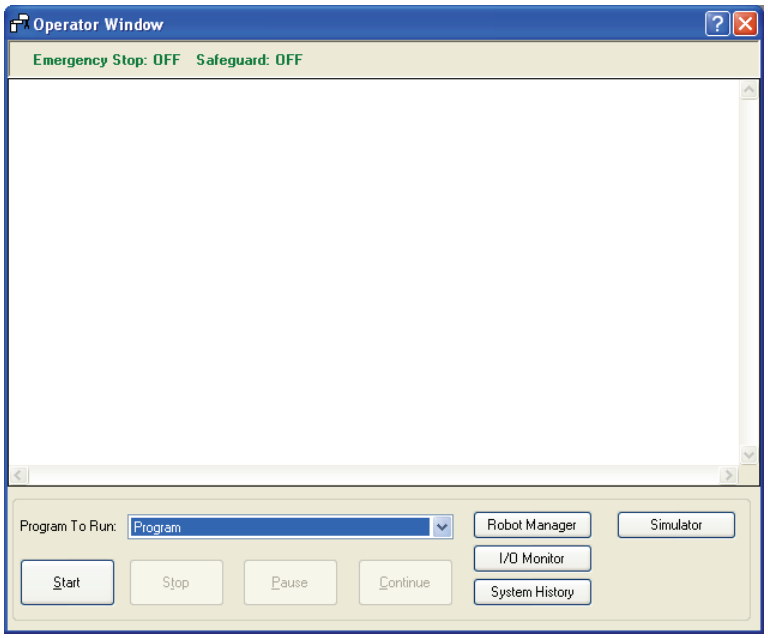
To avoid collision with peripherals by using the Simulator, set 15 mm or greater margins to the simulator object.

Function restrictions when connected with controller

- You cannot change the manipulator from the Simulator window.
- You cannot select and move the manipulator arms in the Simulator window, except during the controller Dry run.
- When the manipulator connected to the controller is not supported in the Simulator, the object list and the manipulator in 2D layout and 3D window are not displayed.
- The [Record/Playback] functions are not available.

Operator Window

When you enable the Simulator, the <Simulator> button is added to the Operator Window. When you click on the <Simulator> button, the 3D display window appears.



8.4 Simulator Specifications and Restrictions

This section describes the simulator specification, its restrictions, and precautionary statements.

8.4.1 EPSON RC+ 7.0 package

EPSON RC+ 7.0 has two packages:

- EPSON RC+ 7.0 : Standard package for developing the robot system
- EPSON RC+ 7.0 Trial : Trial package for limited use (program execution on PC)
  * It cannot connect with a robot controller.

	Program execution on PC	Connection with controller	Connection with controller + 3D display
EPSON RC+ 7.0	OK *2	OK	OK *1
EPSON RC+ 7.0 Trial	OK *2	×	×

*1 Requires the configuration to enable the simulator functions in EPSON RC+ 7.0. Refer to *8.3.6 Connection with controller* for the detail information.

*2 Continuous execution time of program is limited.

8.4.2 Specifications and precautions for the 3D display

Available robots for 3D display

In the future, we will add more robots for 3D display. Call your EPSON Regional Sales Manager for the latest information.

NOTE

The flexible duct is displayed roughly.

- Check the dimensions in the manipulator manual.
- The duct actually vibrates while the manipulator is moving, the simulator doesn't display the vibration. Check how the duct vibrates with your real manipulator.

The bellow for Cleanroom or Protection model is displayed roughly

- Check the dimensions in the manipulator manual.

Available CAD data for 3D display

The following format is available for 3D display to show the robot hand and CAD object.

- VRML 2.0
  Limits of reading: VRML2.0 prototype is not supported.
- STEP (AP203/AP214)
  Limits of reading:
  If Color is configured in Face, the specified Color is displayed.
- IGES
- DXF
  DXF Format (DXF R13, DXF R14, DXF 2000/2000i, DXF 2002) of AutoCAD ® software

NOTE

The data file must be saved in the specified folder on the PC and not saved in EPSON RC+.

CAD data setup orientation

Some CAD data coordinates may be different from those of the simulator.

Adjust the coordinates to the correct position by changing [Property]-[Rotation] after loading the CAD data.

When loading CAD data as a hand, set the origin of the CAD data in the Tool0 position of the manipulator. Set the coordinates to the correct position by changing [Property]-[Position] after loading the CAD data.

Number of available layout objects

You can create as many layout objects as you want.

However, when there are many objects to display, the display update interval becomes longer and the judgment of collision detection becomes rough. Especially for CAD data, displaying data that is too complicated is not recommended.

8.4.3 Specifications and precautions for Simulation (program execution on PC)

Overview

The Simulator produces the robot motions virtually on your PC.

It is designed to make the performance gap between the real system and the virtual system as small as possible. However, a few differences in the virtual system are inevitable. The operation time prediction and collision detection do not guarantee the precision.

Fully understand the contents in this chapter and check if the real system operates without any problems before you go to full-scale operation.

Operation time prediction

Operation time displayed in the Simulator window is approximate time required for executing the program.

Time for the motion commands such as Go, Jump reflects the Speed and Accel values in the program. The operation time may vary when you operate the real robots from the displayed operation time according to conditions such as the Fine setting and servo delay.

In particular, when small ranges are used with the Fine instruction, the real robots need a longer operation time for accurate positioning.

The simulation cannot guarantee the precision but the margin of error in the operation time is within 10% when you execute motions with the standard cycle time (with the default Fine settings).

Considered in the operation time prediction	Not considered in the operation time prediction
Robot model Speed settings (Speed, Speeds, etc.) Acceleration settings (Accel, Accels, etc.) Load (Weight, Inertia) Others (ARCH, CP)	Fine setting Error within 10% from the default (Motions of standard cycle time) With larger setting than the default, the operation time will be shorter. With smaller setting than the default, the operation time will be shorter. Servo delay With the real robots, the operation will be longer.

Time for the other commands than the motion commands is a virtually executed time on PC; therefore the actual time varies widely depending on the PC performance.

When measuring the motion time between two points, as simple program as possible is recommended. Refer to *8.2.2 Working with a user created system - 8. Measure the robot operation time*.

Collision Detection Precision

The Simulator Collision Detection provides an indication whether robots collide with the peripheral equipment or not when the program is executed. It does not consider the error in trajectory due to servo delay. Be aware that a margin is necessary for the real robot system.

The Simulator judges collisions more accurately when the robot motion speed is slow.

The judgment of collision detection during program execution is accomplished with the 3D display update. When your PC has high graphics performance, the collision judgment becomes more accurate.

In Playback mode, the Simulator judges collisions in all steps and is useful when you need accurate detection.

The Simulator cannot guarantee the precision but the margin of error in the collision detection is within 10 mm when you execute motions with Speed 100% on a PC of the recommended specifications.

Motion duty and Overload error

In the Simulator, you cannot detect the overload error. Even when the motion duty is too high and the robot should have the overload error and stop, it keeps moving.

Duty 50 % - As a measure of possible duty, the robot can really keep moving at duty 50% with the maximum acceleration/deceleration speed and without the overload error. However, it depends on the robot model type, load, points to go to, and acceleration/deceleration speed setting, etc.

Time progress difference by PC condition

On a PC that meets the system condition, progress of the time in the Simulator and the real time (as you see on the watch) are almost the same (few percentages difference).

If you are running other applications such as Windows Media Player simultaneously, the time progress in the Simulator can widely vary from the real time. In this case, use the Simulator function while other applications are not running.

Also, on some PC models, the time progress in the Simulator may widely vary from the real time. In this case, set the [Performance] at 16 ms and the [Position Precision] at 20 ms, which may close the gap of the time progress.

Time confirmation program

(If the two printed times are within 27 to 33 seconds, there is no problem.)

```
Function main
    Print Time$
    Wait 30
    Print Time$
Fend
```

Execution on PC below the minimum of specification

You can install the EPSON RC+ and use the Simulator functions on a PC that doesn't meet the minimum of the specification.

However, it doesn't guarantee the correct motions because the following may happen:

- Operation time prediction is not accurate
- Collision Detection has a large margin of error
- 3D display skips updates

8.4.4 Specifications and precautions of EPSON RC+

Restriction on the controller settings

When you connect with a virtual controller, the following items are grayed and become unavailable to change.

- Setup: System Configuration: Controller: Configuration Page: IP Address, etc.
- Setup: System Configuration: Controller: Preference Page: Dry run, etc.

Backup and restore of the controller setting

The setting data that you backup in the virtual controller cannot be restored in a controller. Also, the setting data that you backup in a controller cannot be restored in a virtual controller.

8.4.5 Restriction on SPEL+ command execution

(1) I/O operation and commands (On, Off, SW, Ctr, etc.)

All I/O including the option boards are available in a virtual controller. Operating I/O data is stored in the PC memory (virtual I/O mode). The I/O input status can be changed from the EPSON RC+ I/O Monitor window. Also, the I/O input status can be changed using the SetSw or SetIn statements in a SPEL+ program.

NOTE

Even if you specify an asynchronous On/Off command, the I/O status cannot be changed after the specified time and the Ctr function always returns 0.

(2) Ethernet / RS-232C communication command (Print #, Input #, OpenCom, OpenNet, etc.)

All ports including the option RS-232C board are available in a virtual controller. However, an Ethernet port requires configuration of the IP address and TCP/IP port. Ethernet / RS-232C communication commands do not perform actual communication.

Output data from Print #, etc. is saved in the communication output file. In the input by Input#, etc, the return value is 0 (numeric data) or blank (string). However, if you create a communication response file, the return value depends on the file content.

Communication output file

When calling OpenCom or OpenNet command, a communication output file is created in the \EpsonRC70\Virtual\Mounted Volume\Project folder on the PC.

DummySend***.dat : Communication output file (*** is the port number)

When a communication output file already exists, the previous output data is deleted. The file is deleted when you switch the project; save the file in a proper folder if you need.

When executing the following program,

```
OpenCom #1
Print #1, 123
Print #1, "TEST DATA"
CloseCom #1
```

the DummySend001.dat file will contain...

```
123
TEST DATA
```

Communication response file

Copy the communication response file to the \EpsonRC70\Virtual\Mounted Volume\Project folder in before running a program. The file is deleted when you change the project; save the file in another folder if you need to keep it.

When calling OpenCom or OpenNet command, the communication response file is loaded.

DummyRead***.dat : Communication response file (*** is a port number)

When the following DummyRead001.dat file is used,

```
321
Test Data
```

and the following program is executed,

```
Integer i
String s$
OpenCom #1
Input #1, i
Input #1, s$
CloseCom #1
Print i
Print s$
```

the return values are i = 321 (numeric data), and s$ = "Test Data" (string).

(3) Vision command (VRun, VGet, etc.)

For the vision-related commands, communication with the Compact Vision (CV1) is not performed. However, the commands can be executed with virtual camera function. Vision sequence can be executed with an image file set in ImageFile property as an input image. Also the result can be acquired by VGet. When the PC vision is set and the GigE camera is connected, vision commands such as VRun and VGetthe can be executed using actual camera image. In this case, commands can be executed from the virtual camera function like the Compact Vision, when the GigE camera is not connected.

Foe the Vision Guide, refer to *EPSON RC+ option Vision Guide 7.0*.

(4) Other restrictions

For the Wait command, the following syntax is not supported:

Wait InsideBox()
Wait InsidePlane()

For the Time and Date commands, the time can be displayed, but the time setting is not available.

(5) Program execution time

In the virtual controller, programs will execute continuously for up to one hour.

If continuous execution is over one hour, a warning message appears.

You can execute the program again after the warning is displayed, and the continuous execution timer will be reset.

8.4.6 Specifications and precautions of EPSON RC+ 7.0 Trial

Version upgrade from EPSON RC+ 7.0 Trial to EPSON RC+ 7.0

Follow the procedures in *Appendix A: Software Installation* to upgrade to EPSON RC+ 7.0. The EPSON RC+ 7.0 Trial version doesn't need to be uninstalled.

NOTE

You can continue to use the projects and virtual controllers (layout) that you used in the EPSON RC+ 7.0 Trial in the EPSON RC+ 7.0 Standard version.

9. Motion System

EPSON RC+ supports the motion systems listed below.

- Standard Motion System
- PG Motion System

9.1 Standard Motion System

The standard motion system consists of Control Units.

You can connect one robot to the Control Unit directly. For details on the Robot Controller and maintenance, refer to the *Robot Controller* manual.

9.2 Drive Module Software Configuration

The drive module is configured at the factory before shipment. It is automatically recognized by the controller and you do not have to configure the settings.

Also, you do not have to configure the settings for the drive module in the Drive Unit which is automatically recognized.

9.3 PG Motion System

The PG (Pulse Generator) Motion System is an option.

When a PG board is installed in the controller, it is automatically recognized. You can select it in the robot configuration dialog.

For instructions on using the PG Motion System, refer to the *Robot Controller Option PG Motion System* manual.

10. Robot Configuration

This chapter contains information for adding robots and configuring additional axes.

- Robot Configuration

  Adding a standard robot

- Additional axes Configuration

  Adding a robot with additional axes

Robots are configured from the Robots folder on the [Setup]-[Controller] dialog tree.

10.1 Setting the Robot Model

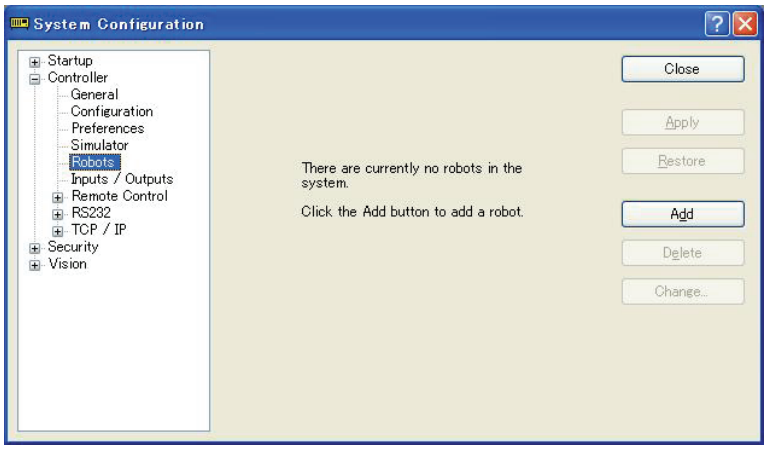
CAUTION

■ Each robot is configured before shipment. Therefore, it is normally unnecessary to change the settings. If you change the settings, it may cause the robot to malfunction or perform unusual motion. This is extremely hazardous and you should be careful.

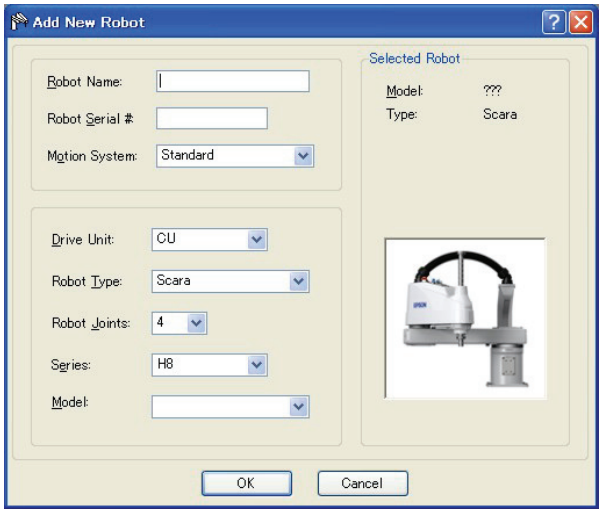
10.1.1 Adding a standard robot

If you have purchased the PG motion system Option, you can add user defined robots. Refer to the *Robot Controller Option PG Motion System* manual.

1. From the Setup Menu, select System Configuration.
2. Click [Robots] in the tree on the left.



3. Click <Add> and the following dialog box will appear.



4. Type in a name for the new manipulator and enter the serial number on the manipulator's nameplate. Any serial number can be used, but it is recommended tat you use the number that is stamped on the manipulator.
5. Select a motion system to use from the [Motion System] dropdown list. If there are no other motion systems installed, then "Standard" will already be selected.
6. Select a Drive Unit for your manipulator from the [Drive Unit] dropdown list.
7. Select a manipulator type from the [Robot type] box.
8. Select a manipulator series from the [Series] dropdown list.
9. Select a manipulator model from the [Model] dropdown list.
   After you select a manipulator model, all manipulators available for the type of motor driver currently installed in the controller will be displayed. If you use [Dry run], all robots selected in step 9 will be shown.
10. Click <OK> and the controller will be rebooted.

10.1.2 Calibrating a standard robot

The calibration method differs according to the manipulator model.

For details, refer to the *Manipulator manual: Maintenance section: Calibration*.

10.1.3 Changing robot system parameters

The following system parameters for the robot can be changed from EPSON RC+ 7.0:

- **Enable/Disable Joints**
  You can disable one or more joints from [Setup]-[System Configuration]-[Robots]-[Robot**]-[Configuration]. On robots with a ball screw Z axis, you must disable both joints 3 and 4 together.
- **Hofs**
  Hofs are the joint home offsets. You can view and edit the values from [System Configuration]-[Robots]-[Robot**]-[Calibration]. However, it is recommended that you use the Robot Calibration wizard to set these values. These values are unique for each robot and are supplied from the factory. Hofs are especially important for SCARA robots because the values determine that both lefty and righty hand orientation will position the robot at the same point.
- **CalPls**
  CalPls values are joint calibration offsets. You can view and edit the values from [System Configuration]-[Robots]-[Robot**]-[Calibration]. However, it is recommended that you use the Robot Calibration wizard to set these values. These values are unique for each robot and are supplied from the factory. CalPls values are used to calibrate joint position after replacing a motor or encoder.

These are one-time settings for each robot. Additional robot parameters can be set from the Robot Manager.

To change robot parameters, follow these steps:

1. Select [System Configuration] from the [Setup Menu].
2. Under the [Robot] folder in the tree on the left, select [Robot**]-[Calibration].
3. Execute the calibration wizard or change values for Hofs or CalPls.
4. Click <Apply> to make the changes permanent.

Saving robot calibration data

You can save and load individual robot calibration files. This is useful for moving a robot from one controller to another. When you save calibration data, a file is created with an MPD file extension. This file contains Hofs and CalPls values.

To save robot calibration data

1. Select [System Configuration] from the [Setup] menu.
2. Under the [Robot] folder in the tree on the left, select [Robot**]-[Calibration].
3. Ensure that the robot serial number is correct. The serial number will be used to create the default file name. It is recommended that the serial number be used.
4. Click the <Save Cal> button. Browse to a destination directory and click Save.

Loading robot calibration data

To load robot calibration data

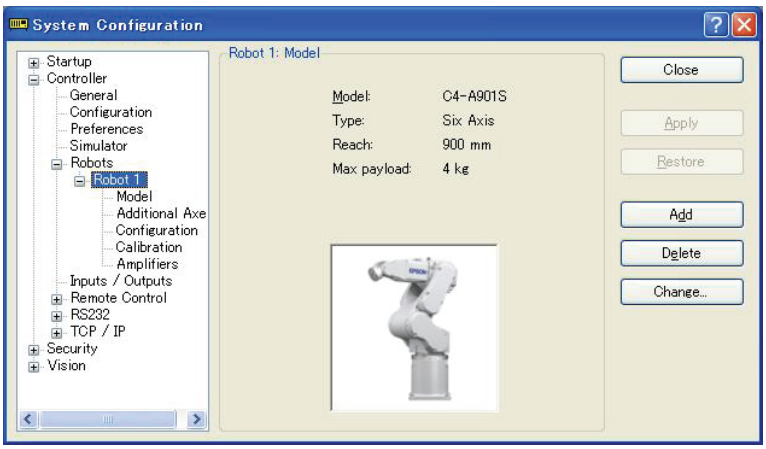
1. Select [System Configuration] from the [Setup] menu.
2. Under the Robot folder in the tree on the left, select [Robot**]-[Calibration].
3. Click the <Load Cal> button.
4. Browse to the desired MPD file and click <Open>.

10.1.4 Deleting a standard robot

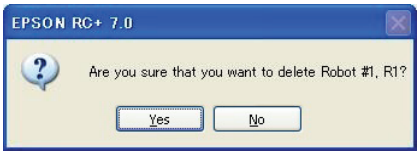
1. Select <System Configuration> from the <Setup> menu.
2. Under the [Robot] folder in the tree on the left, select [Robot**].

NOTE

You can only delete the last robot.



3. Click <Delete> and the next dialog will appear.



4. Click <Yes> and the controller will be rebooted.

If you delete only an additional axis from its installed robot, refer to *10.2.6 Deleting the additional axes*.

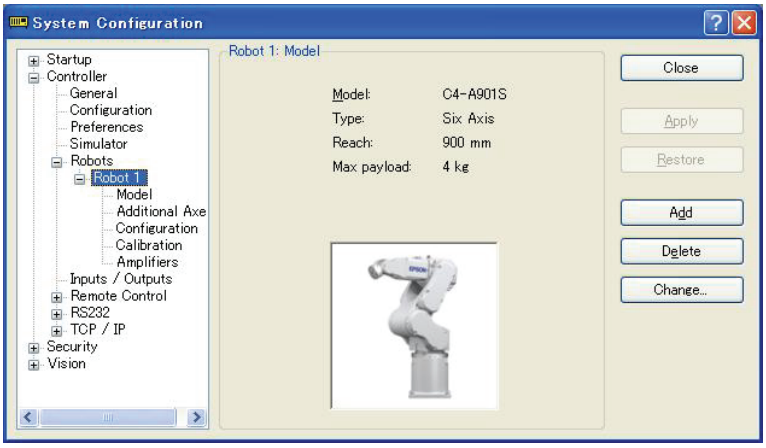
10.1.5 Changing the Robot

CAUTION

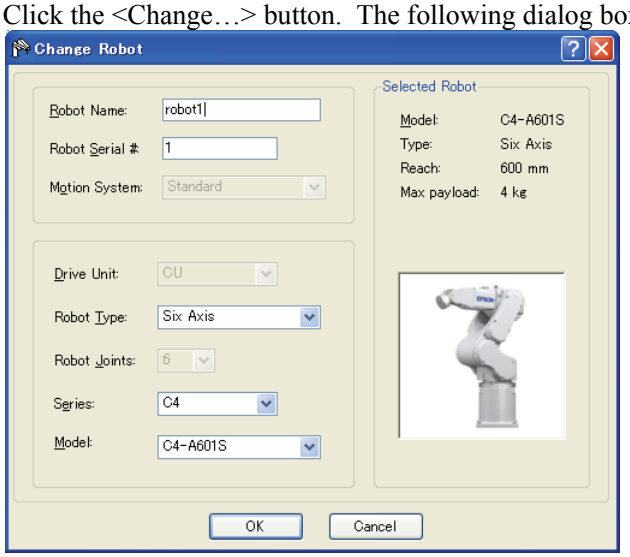
■ Changing the manipulator should be done with great caution. It initializes the robot calibration parameters (Hofs, CalPls), additional axis information, and PG parameter data. Before changing the robot, make sure to save the calibration data by following the procedure below.

1. Select the EPSON RC+ 7.0 menu-[Setup]-[System Configuration].
2. Select [Robot]-[Robot**]-[Calibration] from the tree list. Then, click <Save>.

1. Select the EPSON RC+ 7.0 menu-[Setup]-[System Configuration].
2. Select [Robot]-[Robot**] from the tree list.



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



4. Input the robot name and serial number printed on the name plate of the manipulator. Any serial number can be entered. However, enter the number printed on the manipulator.
5. Select the robot type in the [Robot type] box.
6. Select the series name of the manipulator in the [Series] box.
7. Select the robot model in the [Model] box. Available robots will be displaed according to the format of the currently installed motor driver. When [Dry run] is used, all the manipulators of the series selected in Step 6 will be displayed.
8. Click the <OK> button. The controller will be restarted.

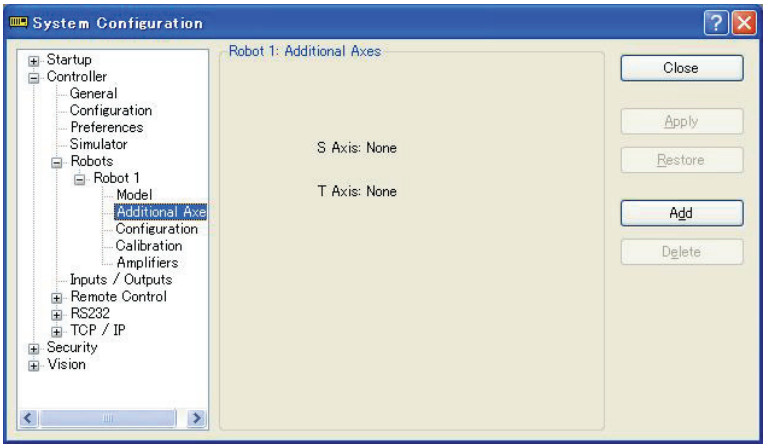
10.2 Configuration of Additional Axes

Using the additional axes feature, you can configure the axes that move with the manipulator.

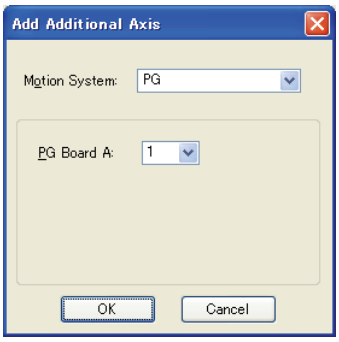
You can configure up to two additional axes (S and T).

10.2.1 Adding the additional S axis

1. Select [System Configuration] form the [Setup] menu.
2. Under the [Robot] folder in the tree on the left, select [Robot**]-[Additional Axes].



3. Click <Add> and the next dialog will appear.



4. Select “PG” for a motion syste.
5. Select a PG board A.
6. Click **OK** and the controller will be rebooted.

10.2.2 Adding the additional T axis

NOTE

After the additional S axis has been added to the robot, you can add the additional T axis. The procedure is the same as for the S axis. Refer to *10.2.1 Adding the additional S axis*.

10.2.3 Changing the parameters of robot with additional axes installed

For details, refer to *the Robot Controller Option PG Motion System* manual.

10.2.4 Differences of the standard robot and robot with additional axes

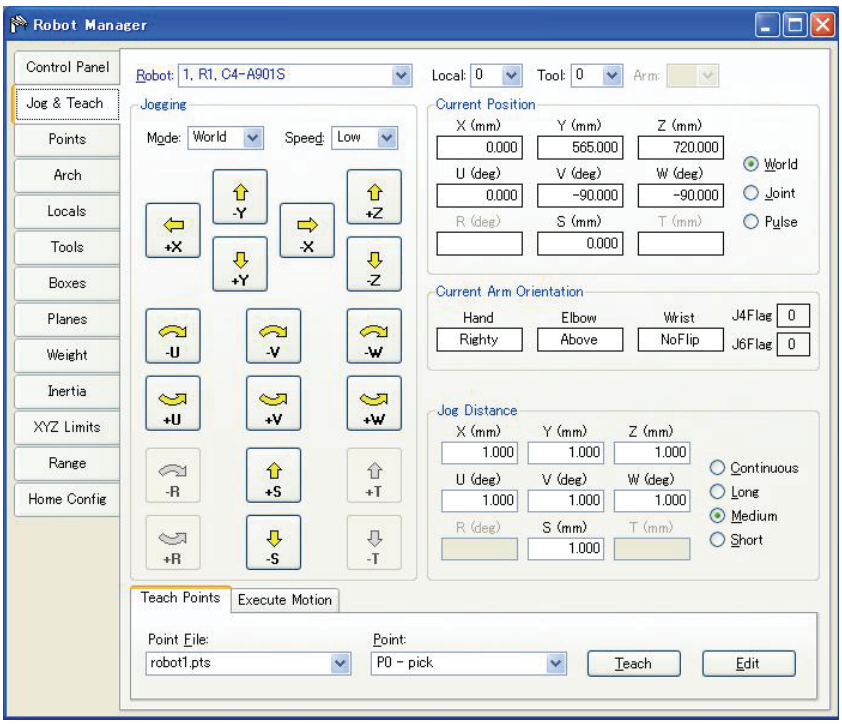
The robot with additional axes installed has some parts which are different from the standard robot when using GUI and SPEL+ commands.

For the SPEL+ commands, refer to the *SPEL+ Language Reference manual*.

The main differences in the EPSON RC+ 7.0 GUI are as below.

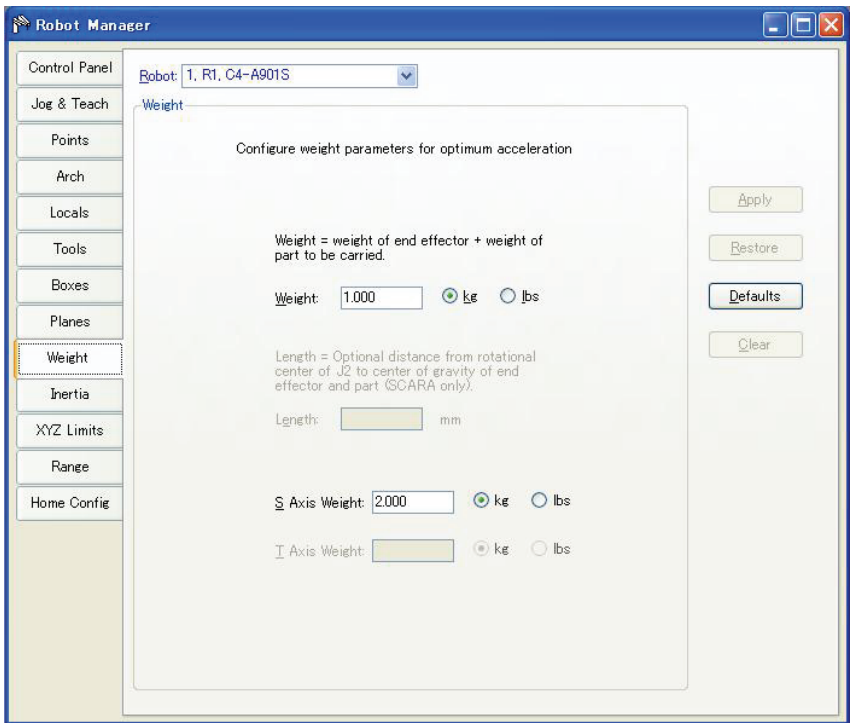
Tools: Robot Manager: Jog & Teach Page

You can jog the additional S and T axes. When the additional T axis is not installed, the jog buttons will be dimmed.



Tools: Robot manager: Weight Page

This page is for changing the Weight parameters for the robot. When the additional T axis is not installed, the corresponding weight setting will be dimmed.



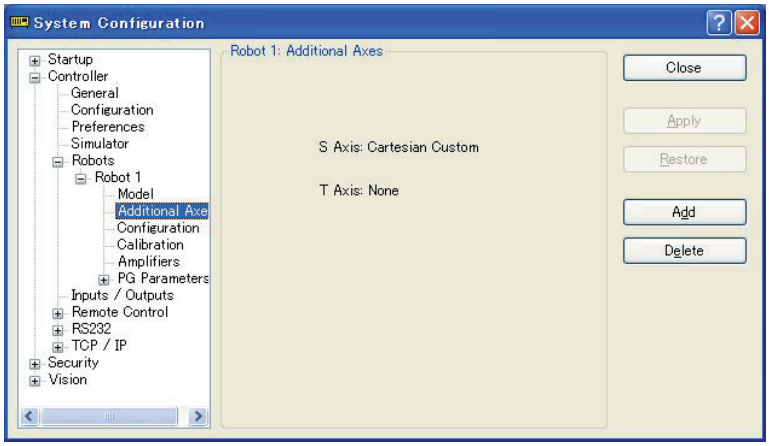
10.2.5 Deleting the additional axes

NOTE

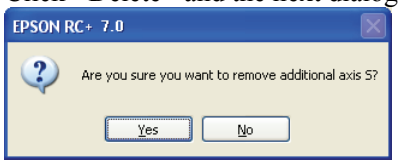
When the additional T axis is installed, delete it first.

When only the additional S axis is installed, delete it.

1. Select System Configuration from the Setup Menu.
2. Under the [Robot] folder in the tree on the left, select [Robot**]-[Additional Axes].



3. Click <Delete> and the next dialog will appear.



4. Click <Yes> and the controller will be rebooted.

11. Inputs and Outputs

11.1 Overview

The controller I/O has the following types of I/O:

Standard I/O	This digital I/O comes standard with the controller.
Expansion I/O	This is optional digital I/O that can be added to the controller to expand standard I/O. Up to four boards can be added, each with 24 inputs and 16 outputs.
Fieldbus master I/O	An optional board for the controller to expand the standard I/O. You can add one of the following boards which support the fieldbus master board: DeviceNet, EtherNet/IP, PROFIBUS-DP
Fieldbus slave I/O	An optional board for the controller to expand the standard I/O. You can add one of the following boards which support the Fieldbus slave mode: DeviceNet, EtherNet/IP, PROFIBUS-DP, CC-Link, PROFINET
Memory I/O	This is built-in memory bits that can be used for inter-task communications.

For Standard, Expansion, Fieldbus master, and Fieldbus slave I/O, there are input bits numbered starting with 0, and output bits numbered starting with 0.

For memory I/O, each memory bit is both an input and an output.

For specifications and instructions on wiring I/O, refer to the *Robot Controller manual*.

11.2 I/O Commands

The SPEL+ language has several commands for inputs and outputs listed below. For details on each command, see the SPEL+ Language Reference.

Input Commands

In	Reads one byte of input bits.
InBCD	Reads one byte of input bits in Binary Coded Decimal format.
InW	Reads one word of input bits.
Oport	Reads one output bit.
Sw	Reads one input bit.

Output Commands

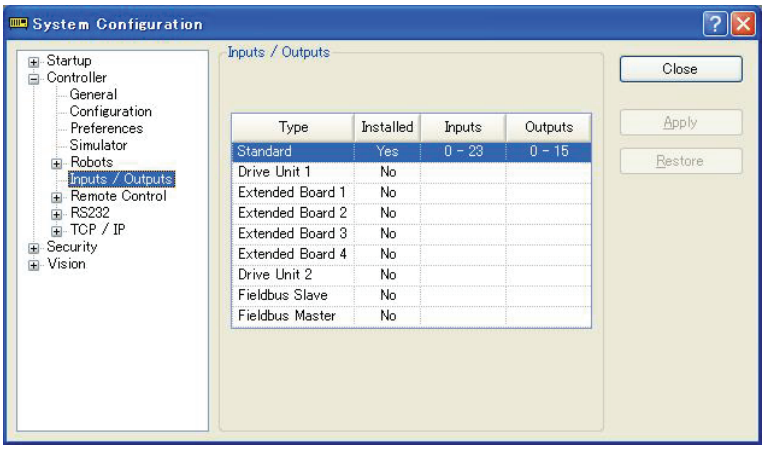
Off	Turns off one output bit with optional time.
On	Turns on one output bit with optional time.
OpBCD	Sets one byte of output bits in Binary Coded Decimal format.
Out	Sets / reads one byte of output bits.
OutW	Sets / reads one word of output bits.

Memory I/O Commands

MemOff	Turns off one memory bit.
MemOn	Turns on one memory bit.
MemOut	Sets / reads one byte of memory bits.
MemSw	Reads one bit of memory.

11.3 I/O Configuration

To view the current I/O configuration, select [Setup]-[System Configuration]-[Inputs and Outputs]. This will show you what I/O is installed on the controller.



Standard and expansion I/O

The board is automatically configured by the controller. To add expansion I/O boards, refer to *Robot Controller manual*.

The standard I/O in the Drive Unit automatically increases depending on the number of Drive Unit.

Fieldbus master I/O / Fieldbus slave I/O

For details on how to configure, add, check the boards, refer to the *Robot Controller Option Fieldbus I/O* manual.

11.4 Monitoring I/O

To monitor I/O, use the I/O Monitor tool by selecting [Tools]-[I/O Monitor]. From the I/O monitor, you can view inputs and outputs or memory I/O in bit, byte, and word formats.

For details on how to use the I/O Monitor tool, see *5.11.3 [I/O Monitor] Command*.

11.5 Virtual I/O

The Controller supports virtual I/O. When enabled, virtual I/O allows you to simulate your hardwired I/O. You can turn on / off any input bit or output bit. Normally this is used when the controller is in Dry Run mode with no robot or I/O connected.

Virtual I/O Commands

SetIn	Set the value of an 8 bit input port.
SetInW	Set the value of a 16 bit input port.
SetSw	Set the value of one input bit.

11.6 Fieldbus Master I/O

The Fieldbus master I/O is an option.
For details on how to use, refer to the *Robot Controller Option Fieldbus I/O* manual.

11.7 Fieldbus Slave I/O

The Fieldbus slave I/O is an option.
For details on how to use, refer to the *Robot Controller Option Fieldbus I/O* manual.

12. Remote Control

By using Input/Output, Ethernet (TCP/IP), and RS-232C, the controller can control manipulators from an external device. The external device can execute several commands, including Motor On/Off, Start, Pause, Continue, and Stop.

For details on extended function of the remote I/O, refer to *EPSON RC+ 7.0 Remote Control Reference manual*.

12.1 Remote I/O

There are three basic steps required for remote control configuration:

1. Configure Remote Control inputs and outputs using the [Remote Control] tab on the [Setup]-[System Configuration]-[Remote Control] page.
   Nothing is initially assigned to remote functions.
2. Set the control device to remote on the [Setup]-[System Configuration]-[Configuration] page.
   To enable external remote inputs, assign the remote functions and also set the control device to remote. When control device setting is remote, the controller is only controllable from the remote device.

Remote control function can be used in the following systems.

Example: Control the robot from a PLC
Use remote control to control the robot (controller) from a PLC.
When using a PLC, you will need to be familiar with the handshake required to use remote inputs. See details below.

Example: Control the robot using a push button box with buttons and lights
The lights are connected to remote control outputs on the controller to indicate status, such as AutoMode, MotorOn, Error, etc. The buttons are connected to remote inputs to control motor power and start programs.

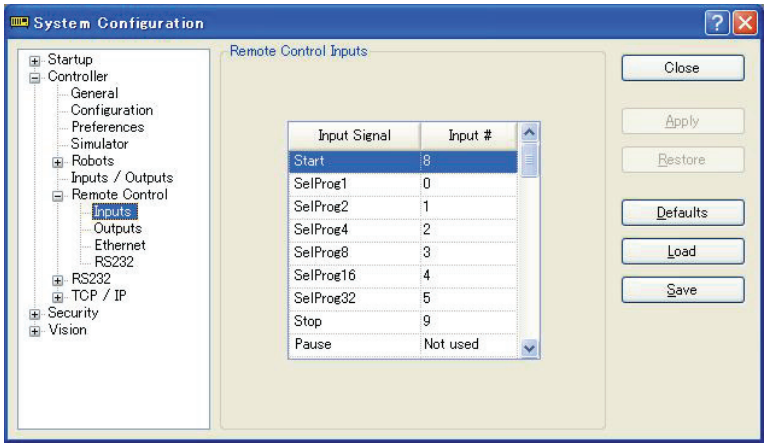
For details of each I/O connection, refer to the following manuals:

Robot Controller Setup & Operation	*I/O Connector*
	I/O Remote Settings
	Expansion I/O Board
Robot Controller Option Fieldbus I/O	

12.1.1 Remote Control Input Output Configuration

The following is the procedure to assign the remote control functions to the I/O system.

1. Select [System Configuration] from the [Setup] menu and select the [Remote Control Inputs] or [Remote Control Outputs] page.
2. For each input or output you want to use for remote control, click on the Input # or Output # cell for the desired signal, then click the dropdown arrow and select a bit number in the list.
3. Click <OK> to save the new settings.



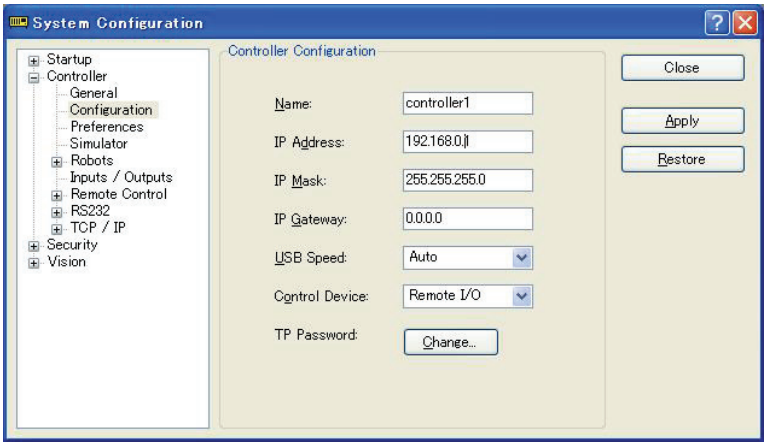
For details using this dialog, refer to *5.12.1 [System Configuration] Command (Setup Menu)*.

12.1.2 Control Device Configuration

The following is the procedure to set the control device to “Remote I/O”.

1. Select [System Configuration] from the [Setup] menu, and click on [SPEL Controller Board]-[Configuration] in the tree on the left.

   Select “Remote” in the [Control Device] box.
2. Click <Apply> to save the new setting and the click <Close>.



For details on using this dialog, refer to *5.12.1 [System Configuration] Command (Setup Menu) – [Setup]-[System Configuration]-[Controller]-[Configuration]*.

12.1.3 Auto Mode with Remote Control

To run in auto cycle with remote control

1. The host device (e.g. PLC) should wait for the AutoMode or Ready remote output to turn on before issuing remote commands.
2. Now the remote input commands will be accepted.

To monitor remote operation from the EPSON RC+ 7.0 Operator Window

1. Set the EPSON RC+ 7.0 Start Up Mode to **Auto**. For details, refer to *4.2.3 Start Mode*.
2. The PC should also be configured to auto log into Windows and start EPSON RC+ 7.0 during Windows start. Refer to *4.2.7 Auto Start*.

12.1.4 Teach Mode with Remote Control

When using a remote control with Teach Mode ON, no remote input commands can be used. Remote status outputs will still operate.

WARNING	■ Remote status outputs (such as MotorOn, Home, etc.) will operate when Teach Mode is ON, even when the enable switch (dead man's switch) is disengaged. Therefore, DO NOT use remote status outputs to drive any devices that cause motion or any other safety hazard.

You can monitor teach mode status using the TeachMode remote output.

12.1.5 Debugging Remote Control

You can debug programs using Remote Control from the EPSON RC+ 7.0 development environment.

To run programs by remote control for debugging:

1. Create a program (in the same manner as usual).
2. Open the Run Window and click Enable Remote I/O.
3. Now the remote commands will be accepted.

You can set breakpoints and print messages to the run window.

NOTE

If you cannot wire the I/O, use virtual I/O mode for debugging. Remote function is also available when virtual I/O is enabled.

12.1.6 Remote Inputs

Remote inputs are used to control the Manipulators and start programs. Certain conditions must be met before inputs are enabled, as shown in the table below.

To accept external remote inputs, assign the remote function and set remote to the control device. When external remote input is available, “AutoMode output” turns ON.

Except “SelProg”, the signals execute each function when the signal starts in input acceptance condition. The function executes automatically. Therefore, no special programming is needed.

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

Name	Default	Description	Input Acceptance Condition (*1)
Start	0	Executes function selected at SelProg. (*2)	Ready output ON Error output OFF EStopOn output OFF SafeguardOn output OFF Pause input OFF Stop input OFF
SelProg1	1	Specifies the executing Main function number. (*2)	
SelProg2	2		
SelProg4	3		
SelProg8	Not Set		
SelProg16	Not Set		
SelProg32	Not Set		
Stop	4	All tasks and commands are stopped.	
Pause	5	All tasks are paused. (*3)	Running output ON
Continue	6	Continues the paused task.	Paused output ON Pause input OFF Stop input OFF
Reset	7	Resets emergency stop and error. (*4)	Ready output ON
Shutdown	Not Set	Terminates the system	
ForcePowerLow (*6)	Not Set	Stops all tasks and commands. Sets the motor power at Low. The status is Low power mode while the input is ON even executing Power High command.	Any time This input is acceptable even AutoMode output is OFF.
SelRobot	Not Set	Changes the output condition of MotorsOn, AtHome, PowerHigh, and MCalReqd. (*9)	
SelRobot1 SelRobot2 SelRobot4 SelRobot8 SelRobot16	Not Set	Specify the number of robot which executes a command. (*5)	

Name	Default	Description	Input Acceptance Condition (*1)
SetMotorOn	Not Set	Turn ON robot motors. (*5) (*6)	Ready output ON EStopOn output OFF SafeguardOn output OFF SetMotorsOff input OFF
SetMotorOff	Not Set	Turn OFF robot motors. (*5)	Ready output ON
SetPowerHigh	Not Set	Set the robot power mode to High (*5)	Ready output ON EStopOn output OFF SafeguardOn output OFF SetPowerLow input OFF
SetPowerLow	Not Set	Set the robot power mode to Low. (*5)	Ready output ON
Home	Not Set	Move the Robot Arm to the home position defined by the user.	Ready output ON Error output OFF EStopOn output OFF SafeguardOn output OFF MotorsOn output ON Pause input OFF Stop input OFF
MCal	Not Set	Execute MCal (*5) (*7)	Ready output ON Error output OFF EStopOn output OFF SafeguardOn output OFF MotorsOn output ON Pause input OFF Stop input OFF
Recover	Not Set	After the safeguard is closed, recover to the position where the safeguard is open.	Paused output ON Error output OFF EStopOn output OFF SafeguardOn output OFF RecoverReqd output ON Pause input OFF Stop input OFF

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

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

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

0=OFF, 1=ON

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

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

(*5) When specifying a robot, executes a function specified by the following bits: SelRobot 1, 2, 4, 8, and 16.

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

0=OFF, 1=ON

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

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

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

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

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

12.1.7 Remote Outputs

Remote outputs provide status for the Manipulator(s) and Controller.

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

Name	Default	Description
Ready	0	Turns ON when the controller startup completes and no task is running.
Running	1	Turns ON when task is running. However, turns OFF when “Paused output” is OFF.
Paused	2	Turns ON when pause task exists.
Error	3	Turns ON when an error occurs. Use “Reset input” to recover from the error.
EStopOn	4	Turns ON at Emergency Stop.
SafeguardOn	5	Turns ON when the safeguard is open.
SError	6	Turns ON when critical error occurs. When a critical error occurs, “Reset input” does not function. Reboot the controller to recover.
Warnig	7	Turns ON when warning occurs. The task runs as normal with the warning. However, be sure to eliminate the cause of the warning as soon as possible.
MotorsOn	Not set	Turns ON when the robot motor is ON. (*5)
AtHome	Not set	Turns ON when the robot is in the home position. (*5)
PowerHigh	Not set	Turns ON when the robot’s power mode is High. (*5)
MCalReqd	Not set	Turns ON when the robot hasn’t executed MCal. (*5)
RecoverReqd	Not set	Turns ON when at least one robot is waiting for Recover after the safeguard is closed.
RecoverInCycle	Not set	Turns ON when at least one robot is executing Recover.
CmdRunning	Not set	Turns ON when an input command is executing.
CmdError	Not set	Turns ON when an input command cannot be accepted.
CurrProg1 CurrProg2 CurrProg4 CurrProg8 CurrProg16 CurrProg32	Not set	Indicates the running or the last main function number (*1)
AutoMode	Not set	Turns ON in remote input acceptable status. (*2)
TeachMode	Not set	Turns ON in TEACH mode.
ErrorCode1 ⋮ ErrorCode8192	Not set	Indicates the error number.
InsideBox1 ⋮ InsideBox15	Not set	Turns ON when the robot is in the approach check area. (*3)
InsidePlane1 ⋮ InsidePlane15	Not set	Turns ON when a robot is on the approach plane area. (*4)

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

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

0=OFF, 1=ON

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

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

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

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

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

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

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

12.1.8 Remote Input Handshake Timing

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

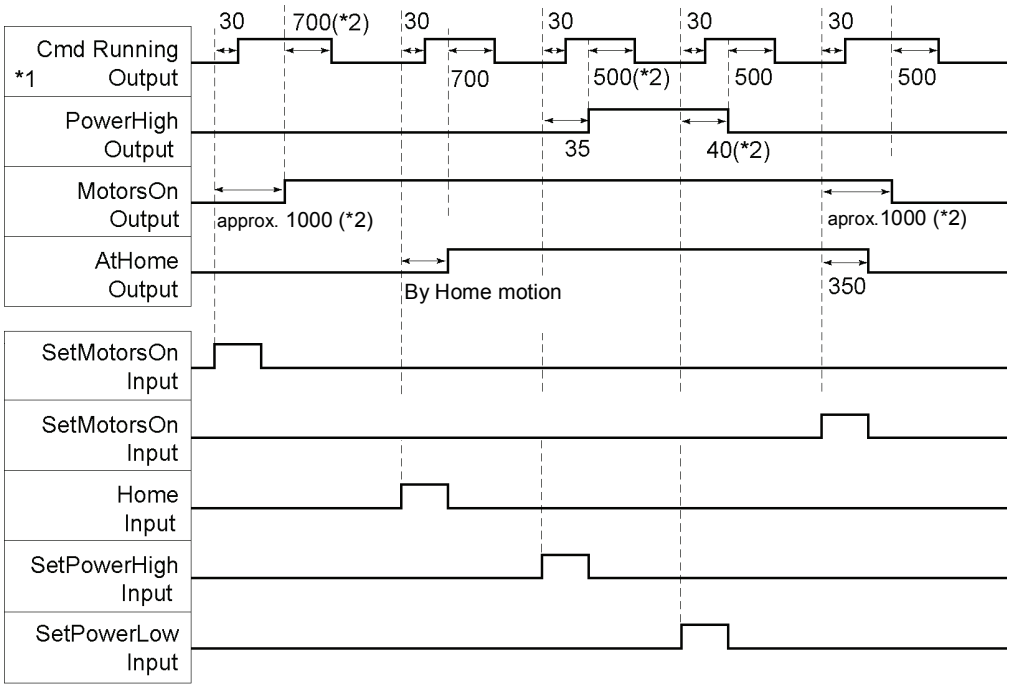
The indicated time lapses (time durations) should be referred to only as reference values since the actual timing values vary depending on some factors such as the numbers of manipulators and running tasks. Check carefully and refer to the following charts for the timing interrelation when you enter an input signal.

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

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

[Unit: msec]

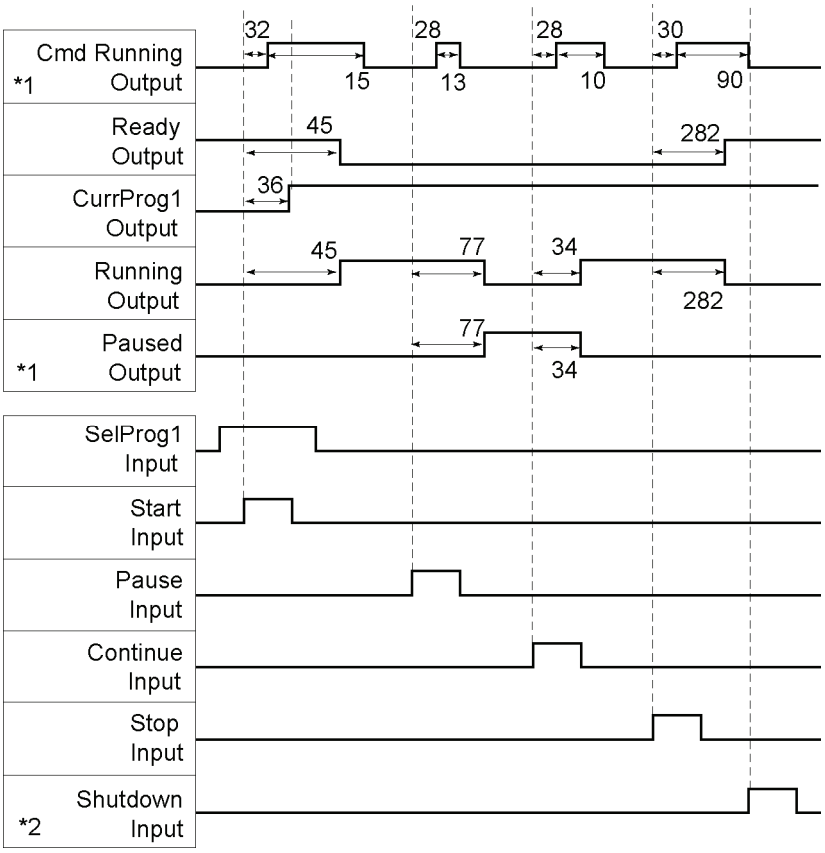
Timing Diagram for Operation Execution Sequence



*1 The motion of the CmdRunnig can be different from this figure according to the condition.

*2 Refer to only as reference value for a robot. It can be different according to the number of robots.

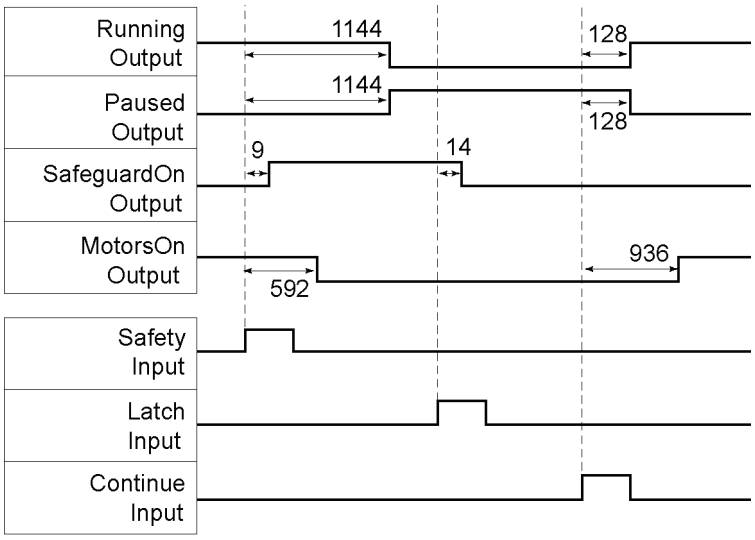
Timing Diagram for Program Execution Sequence



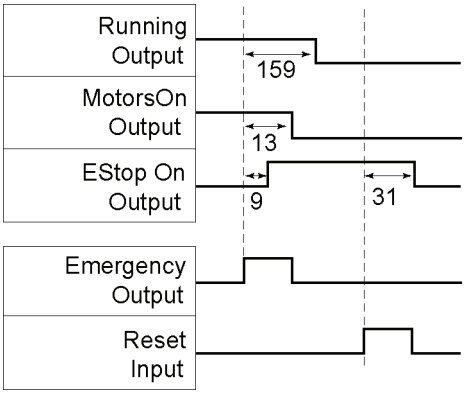
*1 Differs according to the setting condition of Quick Pause and the program running condition when the PAUSE is input.

*2 Shutdown input can be accepted when the Ready output is ON.

Timing Diagram for Safety Door Input Sequence

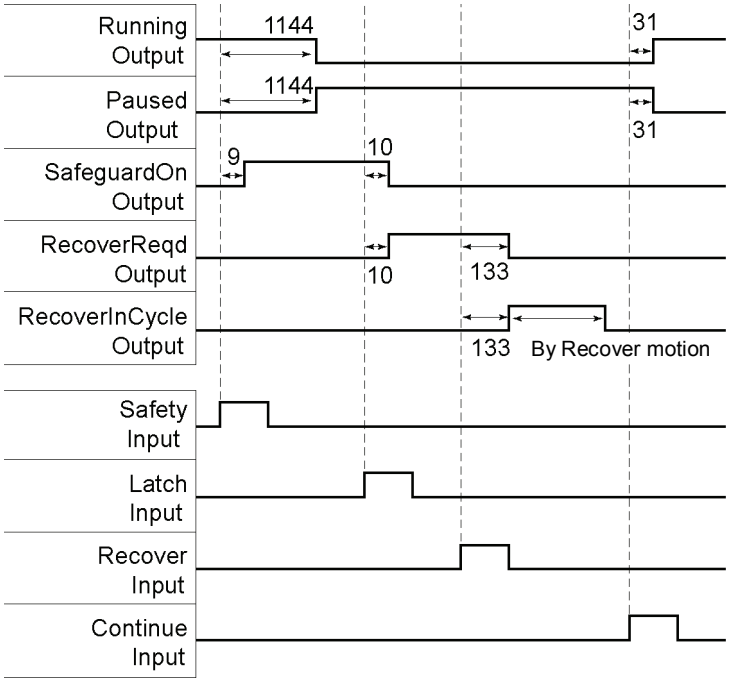


Timing Diagram for Emergency Stop Sequence



If an error occurs, the Error output will turn on. To clear the error, you must turn on the Reset input. No other inputs will be accepted when there is an error condition.

Timing Diagram for Recover Sequence



12.2 Remote Ethernet

Remote Ethernet makes it possible to control the robot and controller from external equipment by sending the remote commands through Ethernet (TCP/IP).

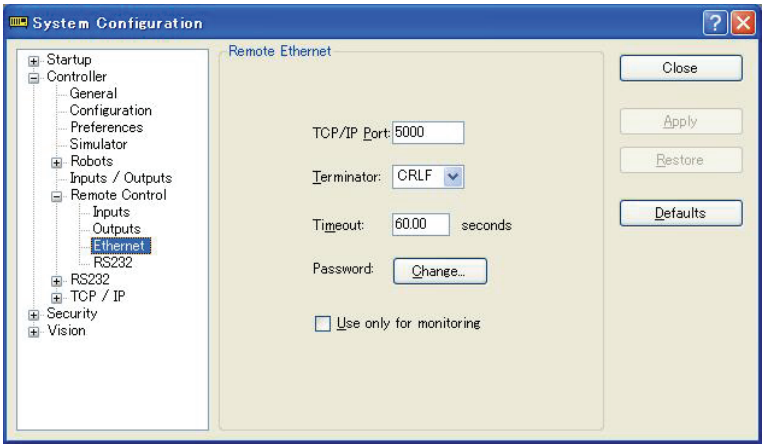
12.2.1 Remote Ethernet Configuration

To set the remote Ethernet functions valid, follow the procedures below to configure the parameter.

(1) Select [System Configuration] from the [Setup] menu and select the [Remote Control]-[Ethernet] page.

(2) Configure the necessary items for the remote Ethernet control.

(3) Click <Apply> to save the new setting and click <Close>.



For the details of the dialog setting, refer to the section *5.12.1 [System Configuration] Command (Setup menu)–[Setup]-[System Configuration]-[Remote]*.

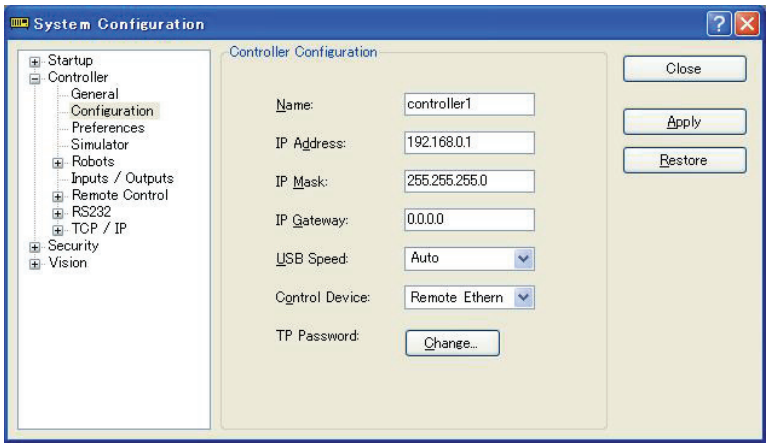
Following setting for the control device is not necessary when you select “Use only for monitoring”, and only acquire the value using the Remote Ethernet control.

12.2.2 Control Device Configuration

Set the control device to “Remote Ethernet” by the following procedure.

(1) Select [System Configuration] from the [Setup] menu and select [Controller Configuration] page.
Select “Remote Ethernet” in the [Controller device] box.

(2) Click <Apply> button to save the new settings, click <Close>.



For the details of the dialog setting, refer to the section *5.12.1 [System Configuration] Command (Setup menu) – [Setup]-[System Configuration]-[Setup]*.

12.2.3 Remote Ethernet Control Execution

Set the remote control available by the following procedure.

(1) Connect from client equipment to the specified port in the Remote Ethernet of the Controller.

(2) Specify the password set in the Remote Ethernet to the parameter and send the Login command.

(3) Client equipment has to wait until Auto (GetStatus command response) is ON, before execution of remote command.

(4) Now remote command will be accepted.
Each command executes the function the input acceptance condition.

12.2.4 Debugging Remote Ethernet Control

Program debug from EPSON RC+ 7.0 development environment is capable as follows.

(1) Build a program as usual.

(2) Open the Run window and click the <Ethernet Enable>button.

When you only acquire the value using the Remote Ethernet control, the <Ethernet Enable> button is not displayed. Click the <Start> button of the device specified as the control device.

(3) Now remote command will be accepted.

Breakpoint setting and output to the Run window is available.

NOTE

If not Login within 5 minutes from external equipment, the connection will be cut down automatically. After Login, if no command is send within the timeout duration of the remote Ethernet, connection will be cut down. In this case, establish the connection again.

If error occurs execute the Reset command to clear the error condition before executing the operation command. To clear the error condition from external equipment by monitoring, use the “GetStatus” and “Reset” command.

CAUTION

■ If you set “0” in the [Timeout] box, time out duration is infinite. In this case, the task continues to execute even without the communication from client. This means the robot may keep moving and cause unexpected damage. Ensure the ways other than the communication to stop the task.

12.2.5 Remote Ethernet Command

Format: $ remote command {, parameter....} terminator

Remote command	Parameter	Contents	Input acceptance condition (*1)
Login	Password	Start the Controller Remote Ethernet function Authentication by password Execute Login correctly, commands execution is enabled until Logout	Available any time (*10)
Logout		Exit Controller Remote Ethernet function After Logout, execute the Login command to start remote Ethernet function. Logout during task execution causes an error.	Available any time (*10)
Start	Function No.	Execute the function of specified number (*3)(*11)	Auto ON Ready ON Error OFF EStop OFF Safeguard ON
Stop		Stop all tasks and commands	Auto ON
Pause		Pause all tasks (*4)	Auto ON Running ON
Continue		Continue paused tasks	Auto ON Paused ON
Reset		Clear emergency stop and error (*5)	Auto ON Ready ON
SetMotorsOn	Robot number	Turn ON the robot motor (*6)(*7)	Auto ON Ready ON EStop OFF Safeguard OFF
SetMotorsOff	Robot number	Turn OFF the robot motor (*7)	Auto ON Ready ON
SetCurRobot	Robot number	Select the manipulator	Auto ON Ready ON
GetCurRobot		Acquires the current manipulator number	Available any time (*2)
Home	Robot number	Move the arm to home position defined by user	Auto ON Ready ON Error OFF EStop OFF Safeguard OFF
GetIO	I/O bit No.	Acquire the specified I/O bit	Available any time (*10)
SetIO	I/O bit No. & value	Set the I/O specified bit 1: Turn ON the bit 0: Turn OFF the bit	Ready ON
GetIOByte	I/O port No.	Acquire the specified I/O port (8 bit) (*8)	Available any time (*10)
SetIOByte	I/O port No. & value	Set the I/O specified port (8 bit)	Ready ON
GetIOWord	I/O word port No.	Acquire the specified I/O word port (16 bit)	Available any time (*10)

Remote command	Parameter	Contents	Input acceptance condition (*1)
SetIOWord	I/O word port No. & value	Set the I/O specified word port (8 bit)	Auto ON Ready ON
GetMemIO	Memory I/O bit No.	Acquire the specified memory I/O bit	Available any time (*10)
SetMemIO	Memory I/O bit No. & value	Set the specified memory I/O bit 1: Turn ON the bit 0: Turn OFF the bit	Auto ON Ready ON
GetMemIOByte	Memory I/O port No.	Acquire the specified memory I/O port	Available any time (*10)
SetMemIOByte	Memory I/O port No. & value	Set the specified memory I/O port (8 bit)	Auto ON Ready ON
GetMemIOWord	Memory I/O word port No.	Acquire the specified memory I/O word port (16 bit)	Available any time (*10)
SetMemIOWord	Memory I/O word port No. & value	Set the specified memory I/O word port (16 bit)	Auto ON Ready ON
GetVariable	Parameter name {, type}	Acquire the value of backup (Global Preserve) parameter (*8)	Available any time (*10)
	[Parameter name] (Array element), [Parameter name type], [Number to acquire]	Acquire the value of backup (Global Preserve) array parameter (*9)	
SetVariable	Parameter name & value {, type}	Set the value in the backup (Global Preserve) parameter (*8)	Auto ON Ready ON
GetStatus		Acquire the Controller state	Available any time (*10)
Execute	Command string	Execute the command (*10) (*11)	Auto ON Ready ON Error OFF EStop OFF Safeguard OFF
Abort		Abort the command execution	Auto ON

(*1) The Controller state bit from GetStatus.

(*2) “Available any time” is applicable if the following conditions are met.

When “Remote Ethernet” is set as the control device, or,

“Remote Ethernet” is not set as the control device, but set to be used for monitoring.

(*3) Execute the function specified in the Main[Function No.].

Function Name	Function No.
Main	0
Main1	1
Main2	2
Main3	3
Main4	4
Main5	5
Main6	6
Main7	7

(*4) Pause command is not available for "NoPause task" and "NoEmgAbort task".
For the details, refer to the help or the section "*Pause"* in the EPSON RC+7.0 Language reference manual.

(*5) I/O output will be turned OFF and the robot parameter will be initialized.
For the details, refer to the help or the section "*Reset*" in the EPSON RC+7.0 Language reference manual.

(*6) The robot parameter will be initialized.
For the details, refer to the help or the section "*Motor*" in the EPSON RC+7.0 Language reference manual.

(*7) When "0" is specified for the manipulator number, all the manipulator will be operated
If you wish to operate particular manipulator, specify the manipulator number (1 to 16) of the target manipulators.

(*8) Parameter type means {Boolean | Byte | Double | Integer | Long | Real | String | Short | UByte | UShort | Int32 | UInt32}.
Type specified: for the backup parameters when the parameter name and type are same.
Type not specified: for the backup parameters when the parameter names are same.

(*9) For the array element, specify an element you acquire as the following:
You need to specify an element if when acquiring from the head of the array.

1D array	Parameter name (0)	Acquire from the head.
	Parameter name (Element number)	Acquire from the specified element number.
2D array	Parameter name (0,0)	Acquire from the head.
	Parameter name (Element number 1, 2)	Acquire from the specified element number.
3D array	Parameter name (0,0,0)	Acquire from the head.
	Parameter name (Element number 1, 2, 3)	Acquire from the specified element number.

You cannot omit the parameter type and number to acquire.
You cannot specify a string for the parameter type.
Available number to acquire is up to 100. If you specify a number over the number of array elements, you have an error.
e.g.) "$GetVariable,gby2(3,0),Byte,3"
It acquires values of gby2(3,0), gby2(3,1), gby2(3,2) of Byte type 2D array parameter gby2.

(*10) Specify the command and parameters in the double quotation marks.

Command string to be executed and execution result string are restricted to 4060 bytes.
Robot motion command will be executed to the selected manipulator. Check which robot is selected by using GetCurRobot before command execution.

Following commands are available while Execute is running.

Commands available while Execute is running

Remote Command
Abort
GetStatus
SetIO
SetIOByte
SetIOWord
SetMemIO
SetMemIOByte
SetMemIOWord

Execute execution command and output command

When the commands specified in (SetIO, SetIOByte, SetIOWord, SetMemIO, SetMemIOByte, SetMemIOWrod) are the same and executed at the same time, the command executed later will result in error. Make sure to check the execution result by using GetStatus after the execution of Execute command and output command which the Execute command is being executed.

(*11) To execute commands of PCDaemon function, be sure to execute while the RC+ 7.0 is connected. If the RC+ 7.0 is not connected, command execution will result in error.

12.2.6 Monitoring command

When the Remote Ethernet control is not set as the control device but set to be used for monitoring, following commands are only available to be executed.

Remote Command
Login
Logout
GetIO
GetIOByte
GetIOWord
GetMemIO
GetMemIOByte
GetMemIOWord
GetVariable
GetStatus
GetCurRobot

12.2.7 Response

When the Controller receives the command correctly, the response in the following format is shown in the executing command.

Command	Format
Remote command that acquire the value Except GetIO, GetVariable, and GetStatus	#[Remote command],[0] terminator
GetIO	#GetIO,[0 | 1] terminator *1
GetMemIO	#GetMemIO,[0 | 1] terminator *1
GetIOByte	#GetIOByte,[Hex string (00 to FF) of Byte (8Bit)] terminator
GetMemIOByte	#GetMemIOByte,[Hex string (00 to FF) of Byte (8Bit)] terminator
GetIOWord	#GetIOWord,[Hex string (0000 to FFFF) of Word (16Bit)] terminator
GetIOMemWord	#GetMemIOWord,[Hex string (0000 to FFFF) of Word (16Bit)] terminator
GetVariable	# GetVariable,[Parameter value] terminator
GetVariable (in case of array)	# GetVariable,[Parameter value 1],[Parameter value 2],...,terminator *4
GetStatus	#GetStatus,[Status],[Error, Warning code] tenimator Example) #GetStatus,aaaaaaaaaa,bbbb *2 *3
Execute	If the value is returned as a result of command execution #Execute,"[Execution result]" terminator

*1 [0 | 1] I/O bit ON: 1/ OFF: 0

*2 Status
In the example above, 10 digits "aaaaaaaaaa" is for the following 10 flags.
Teach/Auto/Warning/SError/Safeguard/EStop/Error/Paused/Running/Ready
1 is ON /0 is OFF
If Teach and Auto are ON, it is 1100000000.

*3 Error / Warning code
It is indicated in 4 digits. If there is no error and warning, it is 0000.

e.g.)1 : #GetStatus,0100000001,0000
The bits for Auto and Ready us ON (1).
This means that AutoMode is ON and be in Ready state. Command execution is enabled.

e.g.)2 : #GetStatus,0110000010,0517
This means the warning occurs during the operation. Take appropriate action for the warning code. (In this case, warning code is 0517)

Flag	Contents
Test	Turn ON in the TEST mode
Teach	Turn ON in the TEACH mode
Auto	Turn ON in the remote input acceptance condition

Flag	Contents
Warnig	Turn ON in the warning condition Task can be executed as usual even a warning condition. However, take action for the warning as soon as possible.
SError	Turn ON in the serious error condition When a serious error occurs, Reboot the Controller to recover from the error condition. “Reset input” is not available.
Safeguard	Turn ON with safety door open
EStop	Turn ON in the emergency condition
Error	Turn ON in the error condition Use “Reset input” to recover from the error condition.
Paused	Turn ON with paused task
Running	Turn ON with task executing Turn OFF when “Paused output” is ON
Ready	Turn ON with the Controller completed the startup and no task executing

*4 It returns values of specified number in the Number to acquire.

Error response

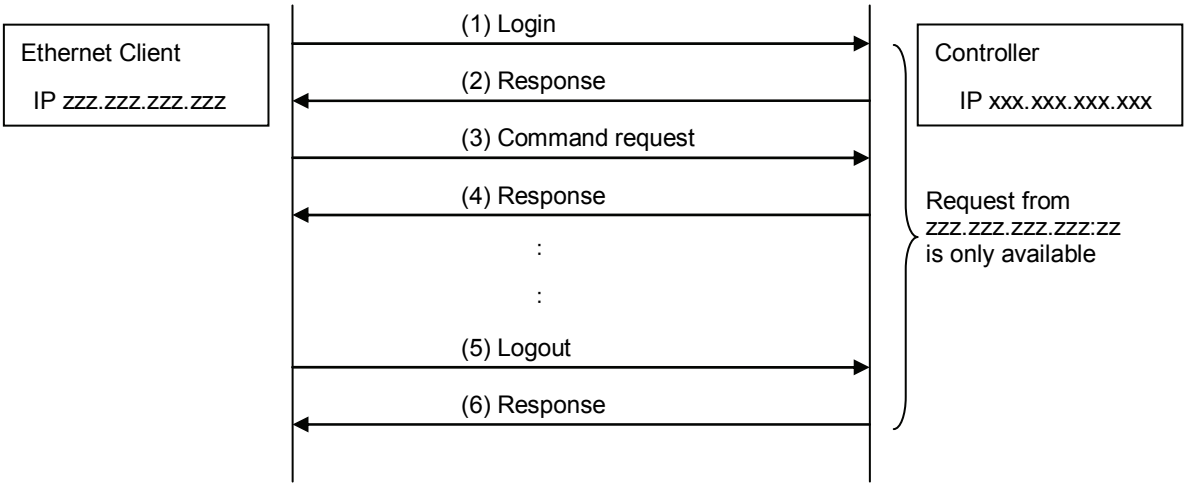
When the Controller cannot receive the remote command correctly, the error response is shown in the following format.

Format: ![Remote command],[Error code] terminator

Error code	Contents
10	Remote command does not begin with $
11	Remote command is wrong Login is not executed
12	Remote command format is wrong
13	Login command password is wrong
14	Specified number to acquire is out of range (Less than 1 or more than 100) Number to acquire is omitted Specified a string parameter
15	Parameter is not existed Dimension of parameter is wrong Element out of range is called
19	Request time out
20	Controller is not ready
21	Cannot execute since the Execute is running
99	System error Communication error

12.2.8 Response timing of Remote Ethernet control

Communication sequence



12.3 Remote RS232

Remote RS232 makes it possible to control the robot and controller from external equipment by sending the remote commands through RS-232C.

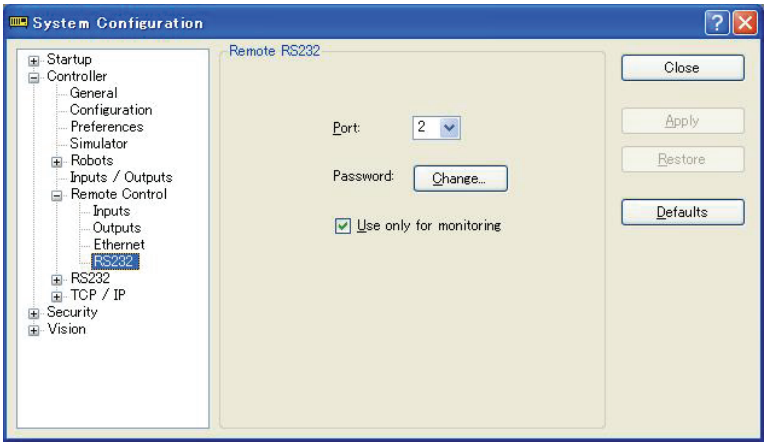
12.3.1 Remote RS232 setting

To set the remote RS232 functions valid, follow the procedures below to configure the remote RS232.

(1) Select [Controller] from the [Setup] menu-[System Configuration] and display the [System Configuration] dialog box. Select [RS232] from the tree structure-[Controller]-[Remote].

(2) Configure the necessary items for the remote RS232 control.

(3) Click <Apply> to save the new setting and click <Close>.



For the details of the dialog setting, refer to the section *5.12.1 [Controller] (Setup menu) – [Setup]-[Controller]-[Remote]*.

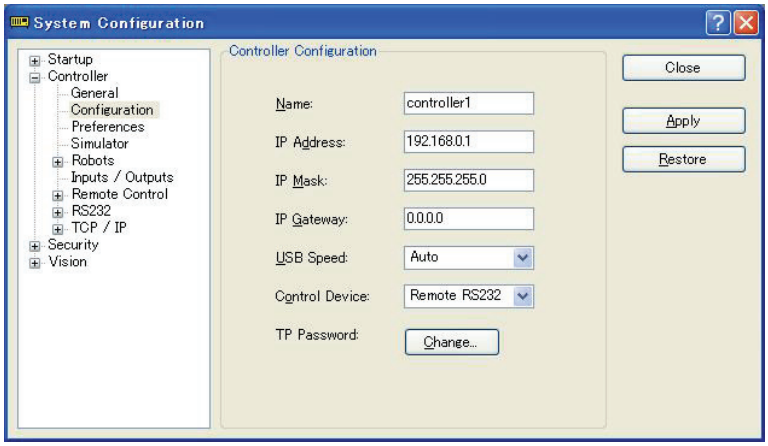
When you only acquire the value using the Remote RS232 control, the RS232 Enable button is not displayed. Click the Start button of the device specified as the control device. Following setting for the control device is not necessary when you select "Use only for monitoring", and only acquire the value using the remote RS232 control.

12.3.2 Control device setting

Set the control device to “Remote RS232” by the following procedure.

(1) Select Controller from the [Setup] menu and select [System Configuration] to display the [System Configuration] dialog box.
Select “Remote RS232” in the [Controller device] box.

(2) Click <Apply> to save the new settings, and then click <Close>.



For the details of the dialog setting, refer to the section *5.12.2 [Controller] (Setup menu)–[Setup]-[Controller]-[Setup]*.

12.3.3 Execution of remote RS232 control

Set the remote RS232 control available by the following procedure.

(1) Open RS-232C port that is connected from client equipment to the specified port in the Remote RS232 of the Controller, using the communication parameter specified in the RS-232C port setting.

(2) Send the remote start command (EOT).

(3) Specify the password set in the Remote RS232 to the parameter and send the Login command.

(4) Client equipment has to wait until Auto (GetStatus command response) is ON, before execution of remote command.

(5) Now remote command will be accepted.
Each command executes the function when the input acceptance condition is satisfied.

12.3.4 Debugging remote RS232 control

Program debug from EPSON RC+ 7.0 development environment is capable as follows.

(1) Build a program as usual.

(2) Open the Run window and click the <RS232 Enable> button.

When you only acquire the value using the Remote RS232 control, the <RS232 Enable> button is not displayed. Click the Start button of the device specified as the control device.

(3) Now remote command will be accepted.

Breakpoint setting and output to the Run window is available.

NOTE

After Login, if no command is send within the timeout duration of the RS-232C, the timeout error will be returned. In this case, re-execute from sending remote start command.

If error occurs, execute the Reset command to clear the error condition before executing the operation command. To clear the error condition from external equipment by monitoring, use the “GetStatus” and “Reset” command.

CAUTION

■ If you set “0” in the [Timeout] box, time out duration is infinite. In this case, the task continues to execute even without the communication from client. This means the robot may keep moving and cause unexpected damage. Ensure the ways other than the communication to stop the task.

12.3.5 Remote RS232 Command

Remote start

Start the Remote RS232function of the Controller.

EOT
1byte

EOT : &H04(&H is hexadecimal)

Request format

STX	Command	Data	ETX	BCC
1byte	1Byte	Variable	1Byte	1Byte

STX : &H02

ETX : &H03

BCC : Checksum of sent and received data

XOR value from the command to ETX per 1Byte

Remote Command	Send command	Data	Description	Input Acceptance Condition (*1)
Login	'L' &H4C	Password	Authentication by password Execute Login correctly, commands execution is enabled until Logout	Available any time (*2)
Logout	'l' &H6C		After Logout, execute the Login command to start remote RS232 function. Logout during task execution causes an error.	Available any time (*2)
Start	'G' &H47	Function No. (1Byte)	Execute the function of specified number(*3)(*11) Example) Execute 'main' &H02&H47&H00&H03&H44	Auto ON Ready ON Error OFF EStop OFF Safeguard ON
Stop	'Q' &H51		Stop all tasks and commands	Auto ON
Pause	'P' &H50		Pause all tasks (*4)	Auto ON Running ON
Continue	'C' &H43		Continue paused tasks	Auto ON Paused ON
Reset	'R' &H52		Clear emergency stop and error (*5)	Auto ON Ready ON
SetMotorsOn	'M' &H4D	Robot number (1Byte)	Turn ON the robot motor (*6)(*7)	Auto ON Ready ON EStop OFF Safeguard OFF
SetMotorsOff	'N' &H4E	Robot number (1Byte)	Turn OFF the robot motor (*7)	Auto ON Ready ON
SetCurRobot	'Y' &H59	Robot number (1Byte)	Select the robot	Auto ON Ready ON
GetCurRobot	'y' &H79		Acquire the current robot number	Available any time (*2)
Home	'H' &H48	Robot number (1Byte)	Move the arm to home position defined by user	Auto ON Ready ON Error OFF EStop OFF Safeguard OFF
GetIO	'i' &H69	I/O bit No (2Byte)	Acquire the specified I/O bit Example) Acquire the I/O bit 1 &H02&H69&H0001&H03&H6B	Available any time (*2)
SetIO	'I' &H49	[I/O bit No.] (2Byte) [value] (1Byte)	Set the I/O specified bit &H01: Turn ON the bit &H00: Turn OFF the bit Example) Turn ON the I/O bit 1 &H02&H49&H0001&H01&H03&H4A	Auto ON Ready ON
GetIOByte	'b' &H62	I/O port No. (1Byte)	Acquire the specified I/O port (8 bit) (*8) Example) Acquire the I/O port 1 &H02&H62&H01&H03&H60	Available any time (*2)

Remote Command	Send command	Data	Description	Input Acceptance Condition (*1)
SetIOByte	'B' &H42	[I/O port No.](1Byte)[value] (1Byte)	Set the I/O specified port (8 bit) (*8) Example) Set &H0F to the I/O port 1 &H02&H42&H01&H0F&H03&H4F	Auto ON Ready ON
GetIOWord	'w' &H77	I/O word port No. (1Byte)	Acquire the specified I/O word port (16 bit) (*8) Example) Acquire the I/O word port 1 &H02&H77&H01&H03&H75	Available any time (*2)
SetIOWord	'W' &H57	[I/O word port No.] (1Byte) [value] (2Byte)	Set the I/O specified word port (16 bit) (*8) Example) Set &H010F to the I/O word port 1 &H02&H57&H01&H010F&H03&H5B	Auto ON Ready ON
GetMemIO	'o' &H6F	Memory I/O bit No. (2Byte)	Acquire the specified memory I/O bit (*8) Example) Acquire memory I/O bit 1 &H02&H6F&H0001&H03&H6D	Available any time (*2)
SetMemIO	'O' &H4F	[Memory I/O bit No.] (2Byte) [value] (1Byte)	Set the I/O specified bit (*8) &H01: Turn ON the bit &H00: Turn OFF the bit Example) Turn ON the memory I/O bit 1 &H02&H4F&H0001&H01&H03&H4C	Auto ON Ready ON
GetMemIOByte	't' &H74	Memory I/O port No. (1Byte)	Acquire the specified memory I/O port (8 bit) (*8) Example) Acquire the memory I/O port 1 &H02&H74&H01&H03&H76	Available any time (*2)
SetMemIOByte	'T' &H54	[Memory I/O port No.] (1Byte) [value] (1Byte)	Set the I/O specified port (8 bit) (*8) Example) Set &H0F to the memory I/O port 1 &H02&H54&H01&H0F&H03&H59	Auto ON Ready ON
GetMemIOWord	'u' &H75	Memory I/O word port No. (1Byte)	Acquire the specified memory I/O word port (16 bit) (*8) Example) Acquire the memory I/O word port 1 &H02&H75&H01&H03&H77	Available any time (*2)
SetMemIOWord	'U' &H55	[Memory I/O word port No.] (1Byte) [value] (1Byte)	Set the I/O specified word port (16 bit) (*8) Example) Set &H010F to the memory I/O word port 1 &H02&H55&H01&H010F&H03&H59	Auto ON Ready ON
GetVariable	'v' &H76	[Parameter name],(&H2C) [type] (1Byte)	Acquire the value of backup (Global Preserve) parameter (*8) Example) Acquire the Global Integer g_Status &H02&H76&H67&H5F&H53&H74&H61&H74&H75&H73&H2C&H03&H03&H56	Available any time (*2)
		[Parameter name] (&H2C)	Acquire the value of backup (Global Preserve) array parameter (*9) Example) Acquire all of Global Integer	

Remote Command	Send command	Data	Description	Input Acceptance Condition (*1)
		(Array element) (&H2C), [Parameter type] (1Byte), (&H2C) [Number to acquire] (2Byte)	g_intArray(10) &H02&H76&H67&H5F&H69&H6E&H74&H41&H72&H72&H61&H79&H2C&H0000&H2C&H03&H2C&H000A&H03&H42E Example) Acquire 10 elements from elements (3,5,0) of Global Integer g_int3Array(10,10,10) &H02&H76&H67&H5F&H69&H6E&H74&H33&H41&H72&H72&H61&H79&H2C&H0003&H2C&H0005&H2C&H0000&H2C&H03&H2C&H000A&H03&H77	
SetVariable	'V' &H56	[Parameter name], (&H2C) [value] (type size) (&H2C), [type] (1Byte)	Set the value in the backup (Global Preserve) parameter (*8) Example) Set &H0 to Global Integer g_Status &H02&H56&H67&H5F&H53&H74&H61&H74&H75&H73&H2C&H0000&H2C&H03&H03&H5A	Auto ON Ready ON
GetStatus	'S' &H53		Acquire the Controller state	Available any time (*10)
Execute	'X' &H58	Command string	Execute the command (*10) (*11) Example) Execute 'print here' &H02&H58&H22&H70&H72&H69&H6E&H74&H20&H68&H65&H72&H65&H22&H03&H10	Auto ON Ready ON Error OFF EStop OFF Safeguard OFF
Abort	'A' &H41		Abort the command execution (*10)	Auto ON

(*1) The Controller state bit from GetStatus.

(*2) "Available any time" is applicable if the following conditions are met.

When "Remote Ethernet" is set as the control device, or,

"Remote Ethernet" is not set as the control device, but set to be used for monitoring.

(*3) Execute the function specified in the Main[Function No.].

Function Name	Function No.
Main	0
Main1	1
Main2	2
Main3	3
Main4	4
Main5	5
Main6	6
Main7	7

(*4) Pause command is not available for "NoPause task" and "NoEmgAbort task".
For the details, refer to the help or the section "*Pause*" in the EPSON RC+7.0 Language reference manual.

(*5) I/O output will be turned OFF and the robot parameter will be initialized.

For the details, refer to the help or the section "*Reset*" in the EPSON RC+7.0 Language reference manual.

(*6) The robot parameter will be initialized.
For the details, refer to the help or the section "*Motor*" in the EPSON RC+7.0 Language reference manual.

(*7) When "0" is specified for the manipulator number, all the manipulator will be operated
If you wish to operate particular manipulator, specify the manipulator number (1 to 16) of the target manipulators.

(*8) Parameter type

Parameter type	Type value(1Byte)
Boolean	&H00
Byte	&H01
Double	&H02
Integer	&H03
Long	&H04
Real	&H05
String	&H06
UByte	&H07
Short	&H08
UShort	&H09
Int32	&H0A
UInt32	&H0B

For the backup parameters when the parameter name and type are same.

(*9) For the array element, specify an element you acquire as the following:
You need to specify an element when acquiring from the head of the array.

Specify the array element in 2Byte value.

1D array	Parameter name&H2C&H0000	Acquire from the head.
	Parameter name, element number.	Acquire from the specified element number.
2D array	Parameter name &H2C&H0000&H2C&H0000	Acquire from the head.
	Parameter name, element number 1, element number 2	Acquire from the specified element number.
3D array	Parameter name &H2C&H0000&H2C&H0000&H2C&H0000	Acquire from the head.
	Parameter name, element number 1, element number 2, element number 3	Acquire from the specified element number.

You cannot specify a string for the parameter type.

Available number to acquire is up to 100. If you specify a number over the number of array elements, you have an error.

(*10) Specify the command and parameters in the double quotation marks.

Command string to be executed and execution result string are restricted to 4060 bytes.
Robot motion command will be executed to the selected manipulator. Check which robot is selected by using GetCurRobot before command execution.

Following commands are available while Execute is running.

Commands available while Execute is running

Remote Command
Abort
GetStatus
SetIO
SetIOByte
SetIOWord
SetMemIO
SetMemIOByte
SetMemIOWord

When the commands specified in (SetIO, SetIOByte, SetIOWord, SetMemIO, SetMemIOByte, SetMemIOWrod) are the same and executed at the same time, the command executed later will result in error. Make sure to check the execution result by using GetStatus after the execution of Execute command and output command which the Execute command is being executed.

(*11) To execute commands of PCDaemon function, be sure to execute while the RC+ 7.0 is connected. If the RC+ 7.0 is not connected, command execution will result in error.

12.3.6 Monitoring command

When the remote RS232 control is not set as the control device but set to be used for monitoring, following commands are only available to be executed.

Remote Command
Login
Logout
GetIO
GetIOByte
GetIOWord
GetMemIO
GetMemIOByte
GetMemIOWord
GetVariable
GetStatus
GetCurRobot

12.3.7 Response

When the Controller receives the command correctly, the response in the following format is shown in the executing command.

Response Format

ACK	Command	Data	ETX	BCC
1Byte	1Byte	Variable	1Byte	1Byte

ACK : &H06

ETX : &H03

BCC : Checksum of sent and received data

XOR value from the command to ETX per 1Byte

Command	Format
Remote command that acquire the value Except the following commands	[ACK][Command](1Byte)[ETX][BCC]
GetCurRobot	[ACK]'y'[Robot number] [ETX][BCC]
GetIO	[ACK] 'i'[&H00 | &H01] [ETX][BCC] *1
GetMemIO	[ACK] 'o'[&H00 | &H01] [ETX][BCC] *1
GetIOByte	[ACK] 'b'[Byte value (8Bit) (&H00 to &HFF)] [ETX][BCC]
GetMemIOByte	[ACK] 't'[Byte value (8Bit) (&H00 to &HFF)] [ETX][BCC]

Command	Format
GetIOWord	[ACK] ‘w’[Word value (16Bit) (&H0000 to &HFFFF)] [ETX][BCC]
GetIOMemWord	[ACK] ‘u’[Word value (16Bit) (&H0000 to &HFFFF)] [ETX][BCC]
GetVariable	[ACK] ‘u’[Parameter value] [ETX][BCC]
GetVariable (in case of array)	[ACK] ‘u’[Parameter value 1][Parameter value 2]... [ETX][BCC] *4
GetStatus	[ACK] ‘S’[Status][Error, Warning code] [ETX][BCC] Example: [ACK] ‘S’[aaaaaaaaaaa][bbbb][ETX][BCC] *2 *3
Execute	If the value is returned as a result of command execution [ACK] ‘X’”[Execution result]” [ETX][BCC]

*1 [&H00 | &H01] I/O bit ON: &H01/ OFF: &H00

*2 Status
In the example above, 11 digits [aaaaaaaaaaa] is for the following 11 flags.
Test/Teach/Auto/Warning/SError/Safeguard/EStop/Error/Paused/Running/Ready
&H01 is ON /&H00 is OFF
If Ready and Auto are ON, it is
[&H00&H00&H01&H00&H00&H00&H00&H00&H00&H00&H01].

*3 Error / Warning code
It is indicated in 4 digits. If there is no error and warning, it is “0000”(&H30&H30&H30&h30).

e.g.)1 : [ACK]
‘S[&H00&H00&H01&H00&H00&H00&H00&H00&H00&H00&H01][&H30&H30&H30&h30]
The bits for Auto and Ready are &H01.
This means that AutoMode is ON and in Ready state. Command execution is enabled.

e.g.)2 : [ACK]
‘S[&H00&H00&H01&H01&H00&H00&H00&H00&H00&H01&H00][&H30&H35&H31&h37]
This means the warning occurs during the operation. Take appropriate action according to the warning code. (In this case, warning code is 0517)

Flag	Contents
Test	Turn ON in the TEST mode
Teach	Turn ON in the TEACH mode
Auto	Turn ON in the remote input acceptance condition
Warnig	Turn ON in the warning condition Task can be executed as usual even a warning condition. However, take action for the warning as soon as possible.
SError	Turn ON in the serious error condition When a serious error occurs, Reboot the Controller to recover from the error condition. “Reset input” is not available.
Safeguard	Turn ON with safety door open
EStop	Turn ON in the emergency condition

Flag	Contents
Error	Turn ON in the error condition Use “Reset input” to recover from the error condition.
Paused	Turn ON with paused task
Running	Turn ON with task executing Turn OFF when “Paused output” is ON
Ready	Turn ON with the Controller completed the startup and no task executing

*4 It returns values of specified number in the Number to acquire.

Error response

When the Controller cannot receive the remote command correctly, the error response is shown in the following format.

NAK 1Byte	Command 1Byte	Error code 2Byte	ETX 1Byte	BCC 1Byte

NAK : &H15

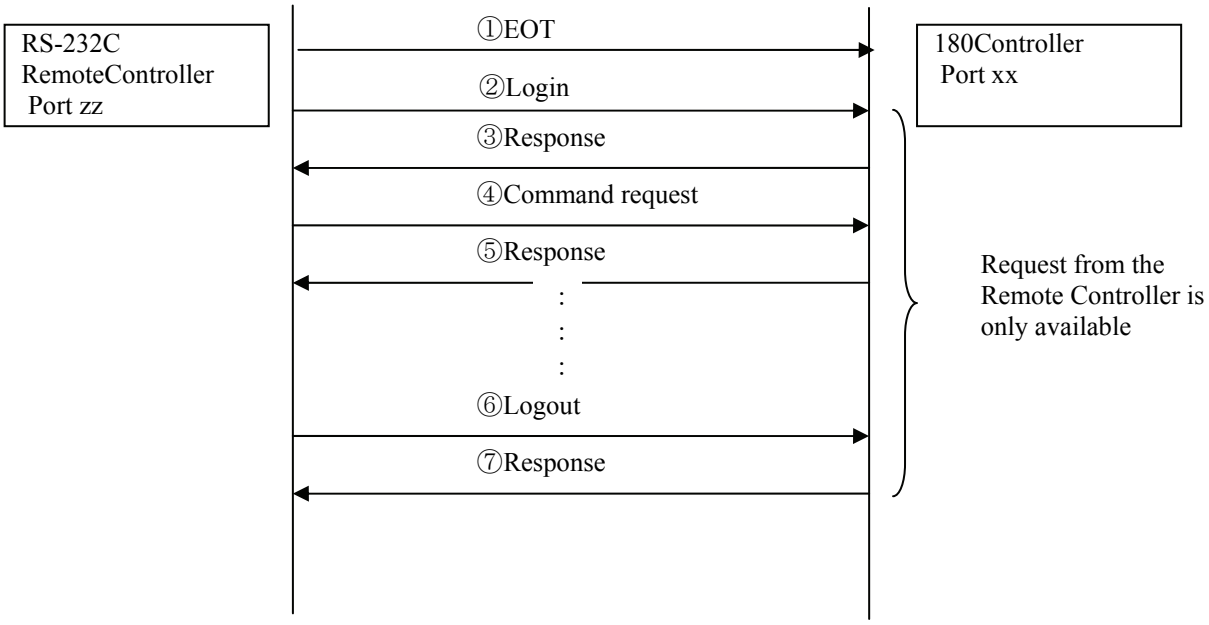
ETX : &H03

BCC : Checksum of sent and received data

XOR value from the command to ETX per 1Byte

Error code	Contents
10	Remote command does not begin with $
11	Remote command is wrong Login is not executed
12	Remote command format is wrong
13	Login command password is wrong
14	Specified number to acquire is out of range (Less than 1 or more than 100) Number to acquire is omitted Specified a string parameter
15	Parameter is not existed Dimension of parameter is wrong Element out of range is called
19	Request time out
20	Controller is not ready
21	Cannot execute since the Execute is running
99	System error Communication error

12.3.8 Response timing of Remote Ethernet control



13. RS-232C Communications

The Robot Controller supports:

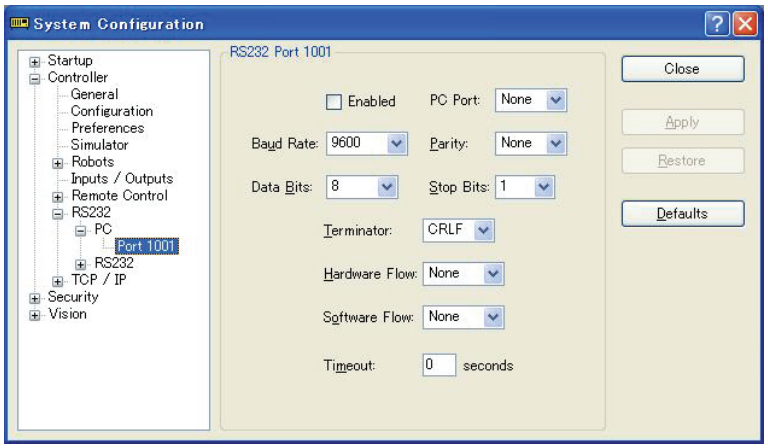
Windows part	: Standard RS-232C port × 2 (Standard: Port 1001 only, High-speed: Port 1001, 1002)
Windows part	: RS-232C port installed on the PC × 8 maximum
Expanded RS-232C	: Option RS-232C port × 8 maximum (4 ports per board)

For instructions on how to install RS-232C boards, refer to the *Robot Controller* manual.

13.1 RS-232C Software Configuration

To configure a standard RS-232C port

1. Select [System Configuration] from the [Setup] menu and open the dialog box.



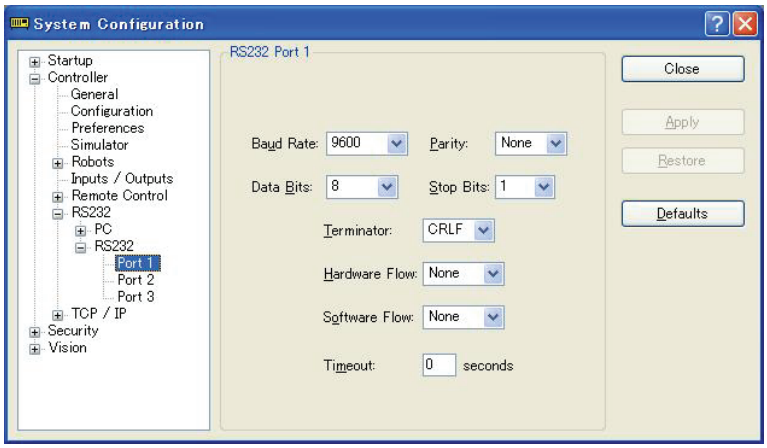
2. Select [Controller]-[RS-232C]-[PC] from the tree on the left.
3. Set the [Enabled] check box.
4. Change the settings as desired.
5. Click <Apply> to save the new settings.
6. Click <Close>.

NOTE

If several ports are used for communication at one time with more than a 19200 baud rate, error 2929 or 2922 may occur. In this case, select a lower baud rate or avoid using several ports at one time.

To configure an option RS-232C port

1. Select [System Configuration] from the [Setup] menu and open the dialog box.



2. Select the [Controller]-[RS-232C]-[RS-232C] from the tree on the left.
3. Select a port to configure.
4. Change the settings as desired.
5. Click <Apply> to save the new settings.
6. Click <Close>.

13.2 RS-232C Commands

The following is a list of all of the commands associated with RS-232C communications. For details, please see the online help or *SPEL+ Language Reference Manual*.

OpenCom	Opens a communications port.
ChkCom	Returns port status: the number of bytes waiting to be read or error condition.
CloseCom	Closes a communications port.
SetCom	Sets communications port parameters at runtime or from the Command window.
Print #	Sends characters out of the port.
Input #	Receives characters from the port into one or more variables.
Line Input #	Receives one line characters from the port into one string variable.
Read #	Receives one or more characters from the port into one string variable.
ReadBin #	Receives one or more bytes from the port.
Write #	Sends characters out of the port.
WriteBin #	Sends one or more bytes out of the port.

14. TCP/IP Communications

EPSON RC+ 7.0 supports 16 TCP/IP ports that allow peer to peer communications.

This chapter contains instructions on using TCP/IP, including IP addresses of LAN-1 port and Windows TCP/IP configuration.

CAUTION

■ LAN-2 is not available for pear to pear communications of EPSON RC+ 7.0. For details, refer to *Robot Controller* manual: *6. LAN (Ethernet Communication) Port*.

14.1 TCP/IP Setup

Before you can use TCP/IP communications between PCs and controllers, you must configure your network. The following sections describe basic network configuration.

14.1.1 Ethernet Hardware

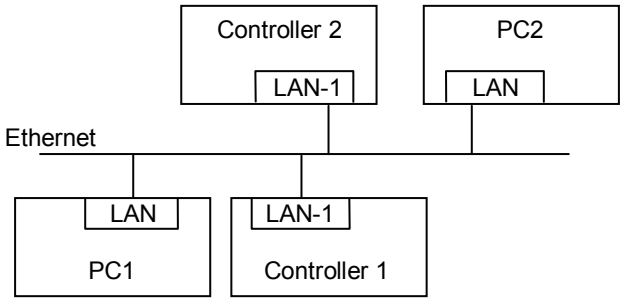
The Controller includes a built in Ethernet interface with an RJ45 connector accessible from the controller rear panel. It supports 10BaseT (10 Mbps) and 10BaseTX (100 Mbps).

Your PC will need a 10BaseT 10/100 adapter to communicate with the Controller via Ethernet.

14.1.2 IP Addresses

The controller has a fixed IP address that you can configure from EPSON RC+ 7.0. To configure the IP address, mask, and gateway for the controller, refer to *5.12.1 [System Configuration] Command (Setup Menu)*.

The following table shows a typical IP address configuration.



Host Name	IP Address	Subnet	Subnet Mask
PC1	192.168.0.1	192.168.0	255.255.255.0
PC2	192.168.0.2	192.168.0	255.255.255.0
Controller1	192.168.0.3	192.168.0	255.255.255.0
Controller2	192.168.0.4	192.168.0	255.255.255.0

In this example, the network address (subnet) is 192.168.0. With a subnet mask of 255.255.255.0, there can be 254 hosts on this subnet (0 and 255 cannot be used).

Refer to the Microsoft Windows operating system manual for instructions on setting the PC IP address.

14.1.3 IP Gateway

If you are connecting PCs and controllers on different networks, you will need to route traffic between the networks using one or more routers. Each device communicating via Ethernet will need to have their default gateway address set to the address of the router for its subnet.

To configure the gateway address for the controller, refer to *5.12.1 [System Configuration] Command (Setup Menu).*

14.1.4 Testing Windows TCP/IP setup

Use the ping command from a Command Window to test communications.

First, do a loopback test to check if you can ping your own address by using the local IP address:

```
C:\>ping 127.0.0.1
Pinging 127.0.0.1 with 32 bytes of data:
Reply from 127.0.0.1: bytes=32 time<10ms TTL=128
Reply from 127.0.0.1: bytes=32 time<10ms TTL=128
Reply from 127.0.0.1: bytes=32 time<10ms TTL=128
Reply from 127.0.0.1: bytes=32 time<10ms TTL=128
C:\>
```

Ping your PC's IP address:

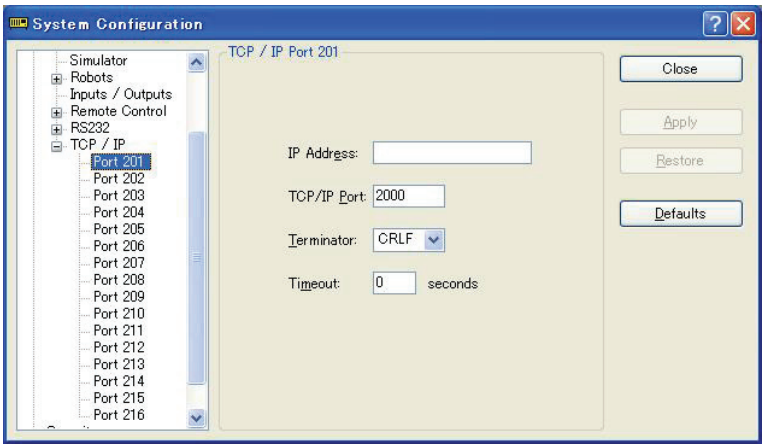
```
C:\>ping 192.168.0.1
Pinging 192.168.0.1 with 32 bytes of data:
Reply from 192.168.0.1: bytes=32 time<10ms TTL=128
Reply from 192.168.0.1: bytes=32 time<10ms TTL=128
Reply from 192.168.0.1: bytes=32 time<10ms TTL=128
Reply from 192.168.0.1: bytes=32 time<10ms TTL=128
C:\>
```

Now ping controller on the network. :

```
C:\>ping 192.168.0.3
Pinging pc2 [192.168.0.3] with 32 bytes of data:
Reply from 192.168.0.3: bytes=32 time<10ms TTL=128
Reply from 192.168.0.3: bytes=32 time<10ms TTL=128
Reply from 192.168.0.3: bytes=32 time<10ms TTL=128
Reply from 192.168.0.3: bytes=32 time<10ms TTL=128
C:\>
```

14.2 TCP/IP Software Configuration

You can configure TCP/IP settings for the controller in a SPEL+ program using the SetNet command. You can also configure settings from the [TCP/IP] tab on the [Setup]-[System Configuration] dialog.



To configure a TCP/IP port

1. Select the TCP/IP port you want to configure from [Setup]-[System Configuration]-[Controller]-[TCP/IP].
2. Enter the IP address for the controller or PC that you want this controller to communicate with.

   The controller does not support DNS, so you must specify an IP address for the host you are communicating with. You cannot specify a name for the host.
3. Enter the TCP/IP port number. This must be the same port number that is used on the host device. It must be different from any of the other TCP/IP port numbers used for the other TCP/IP ports.
4. Change the other settings as desired.
5. Click <Apply> to save the new settings and click <Close>.

14.3 TCP/IP Commands

Here is a list of all of the commands associated with TCP/IP communications. For details, please see the online help or SPEL+ Language Reference Manual.

OpenNet	Opens a TCP/IP port.
ChkNet	Returns port status: the number of bytes waiting to be read or error condition.
CloseNet	Closes a TCP/IP port.
SetNet	Sets communications port parameters at runtime or from the Command window.
Print #	Sends characters out of the port.
Input #	Receives characters from the port into one or more variables.
Line Input #	Receives one line characters from the port into one string variable.
Read #	Receives one or more characters from the port into one string variable.
ReadBin #	Receives one or more bytes from the port.
Write #	Sends characters out of the port.
WriteBin #	Sends one or more bytes out of the port.

15. Security

15.1 Overview

The Security function allows you to manage EPSON RC+ 7.0 users and also monitor usage.

When the Security function is activated, administrators can add groups and users. Each group can have one or more rights associated with it. For example, you can create a group called Maintenance that has rights to edit robot points, use Jog & Teach, and enable you to use the Command Window. When a user attempts to do something that he/she does not have a right for, a message “Permission denied” will be displayed.

Each login session is recorded in a Microsoft Access compatible data base. Security Log Viewer is included that allows you to view each session’s activity.

User can login to EPSON RC+ with a name and password. Optionally, EPSON RC+ can use the Windows user name to log in automatically.

15.2 Security Configuration

EPSON RC+ 7.0 requires a path for security files. If you have more than one system on a network, it is recommended that you setup the security files path for all systems to store the security logs in a server on the network.

To administer EPSON RC+ 7.0 security:

1. Start EPSON RC+ 7.0.
2. Select [Setup]-[System Configuration].
3. Click on the [Security] tree.
4. On the [General] tree, type in the path for your security files or click the <Browse> button.
5. Click on the [Users] tree.
6. For each user on your system, click <New> button.
   Each new user belongs to the Guest group by default. Click in the group field, then click the dropdown button to select the desired group.

General Tab

This tab allows you to configure the general security settings.

Automatic log in using current Windows user name

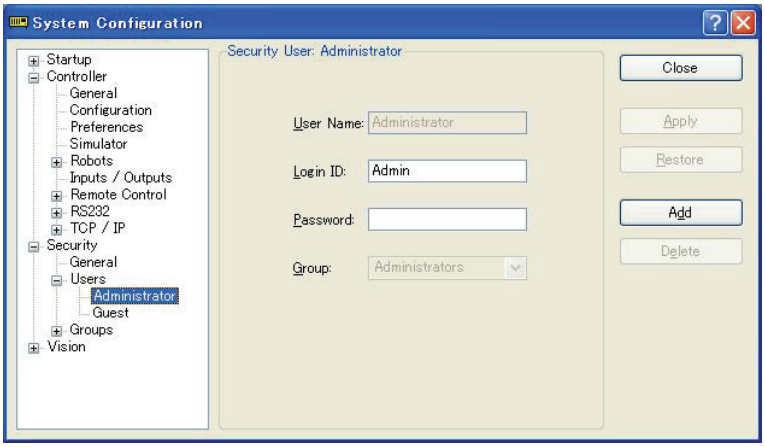
Check this box if you want EPSON RC+ 7.0 to use the current Windows login ID. When the Security function is active, you will not see a login dialog when EPSON RC+ starts, unless EPSON RC+ cannot find the user in the Security system.

Security data path

This is the path where security files will be stored.
This path should be protected with Windows security rights so that only Administrators can delete the files in this path. All other EPSON RC+ users should have only read rights to the files in this path.

User Page

This page allows you to add and remove EPSON RC+ 7.0 users.
Two users are permanent: Administrator and Guest. Only the passwords can be changed for these users. You should always use a password for the Administrator, though no password is set at shipment time.



To add a user

1. Click the <Add> button.
2. A new user will be added to the tree.
3. Click the [Group] tree for the new user.
4. Click the dropdown button and select the group for the user.

To delete a user

1. Click the [User] you want to delete in the tree.
2. Click the <Delete> button.
3. A confirmation message to delete the user will appear.

To change a user's group

1. Click the [Group] dropdown for the user you want to change.
2. Click a dropdown button in the field and select a new group.

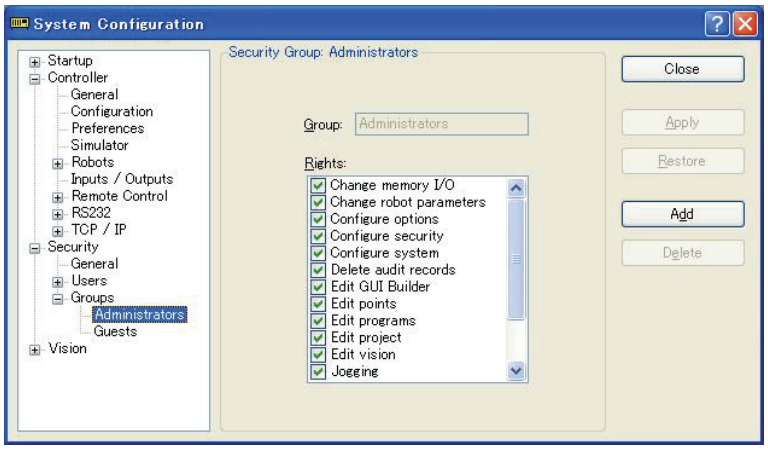
Editing Name, Login ID, and Password

1. Click a [User] you want to change.
2. Edit the field. All fields are not case sensitive.

Group Page

This page allows you to configure user groups. Every EPSON RC+ 7.0 user must belong to a group.

Two groups cannot be deleted or modified: Administrators and Guests. Administrators have full rights, and Guests have no rights.



To add a group

1. Click the <Add> button.
2. Type in a name for the group.
3. Click the <Apply> button.

To delete a group

1. Select the group you want to delete.
2. Click the <Delete> button.
3. A confirmation message to delete the group will appear.

To change rights for groups

1. Select the group you want to change rights for.
   Note that you cannot change rights for Administrators and Guests.
2. To add a right, set the checkbox(es) for the desired rights in the [Rights] checkbox list.
3. To remove rights, clear the checkbox(es) for the rights you want to remove in the [Right] checkbox list.

Group Rights

The list below shows the rights that are available for user groups. Administrators have full rights, and Guests have no rights.

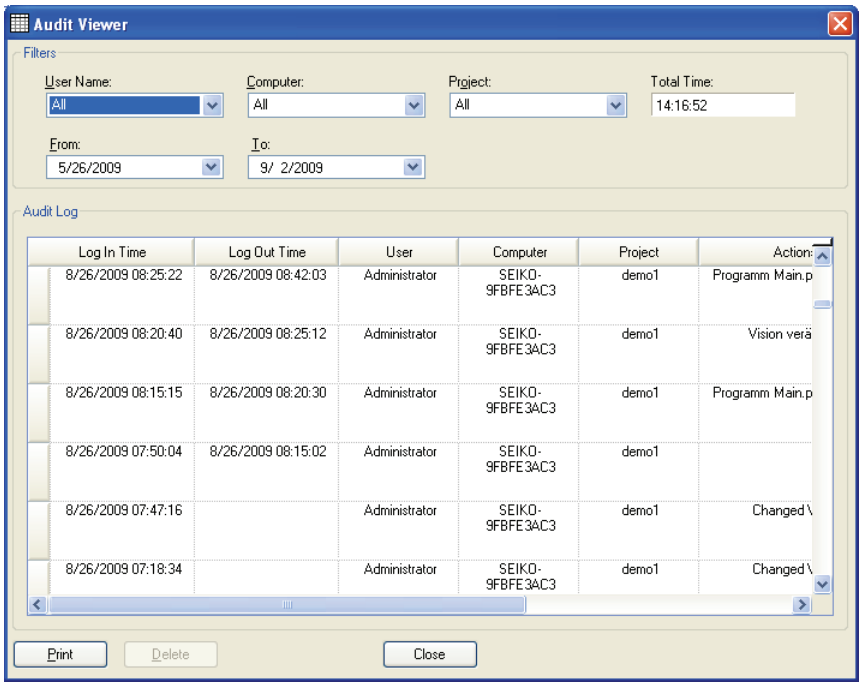
Right	Description
Configure options	Users can change option settings in [Setup]-[Options].
Use Command Window	Users can open the command window and execute commands.
Configure system	Users can configure the entire EPSON RC+ system.
Jog	Users can open the [Jog & Teach] dialog and jog a robot.
Check security log	Users can see security logs.
Delete security log	Users can delete security logs in [Tools]-[Audit Viewer].
Teach points	Users can teach points and delete points from the Jog & Teach dialog.
Edit vision	Users can edit vision parameters.
Edit programs	Users can edit program.
Edit projects	Users can edit projects.
Edit points	Users can change points.
Change memory I/O	Users can turn ON/OFF memory I/O bits.
Change robot parameter	Users can open the [Robot Manager] dialog and change the settings.
Output port ON	Users can turn ON/OFF outputs.

15.3 Security Audit Viewer

When the Security function is enabled, EPSON RC+ 7.0 will keep track of who logs into the system and actions performed.

Activity is stored to the security data path in the Microsoft Access compatible data base format.

To view the security logs, select [Audit Viewer] from the [Tools] menu.



15.4 SPEL+ Security Command

Here are the SPEL+ commands that are enabled with the Security function. For details, please see the *EPSON RC+ 7.0 Online Help* or *SPEL+ Language Reference manual*.

Command	Description
LogIn Function	Logs in the application as another user at runtime.
GetCurrentUser$ Function	Returns the login ID of the current user.

16. Conveyor Tracking

16.1 Overview

Conveyor Tracking is a process in which a robot picks up parts from a stationary or moving conveyor that are found by a vision system or sensor.

The EPSON RC+ 7.0 Conveyor Tracking option supports both tracking and indexed conveyor systems.

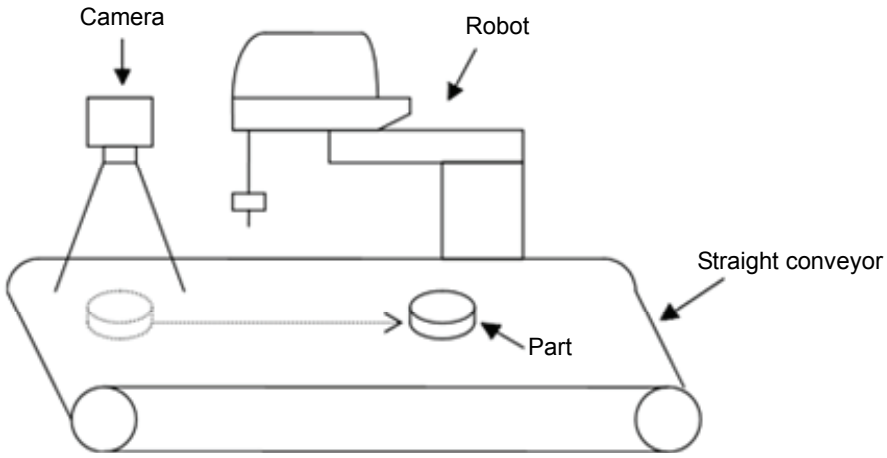
- Tracking conveyor system
  Conveyor moves constantly. Vision system or sensor system finds the parts on it and robot picks them up as they move. During tracking, the robot can move along with the part as it picks up parts.
- Indexed conveyor system
  Conveyor moves a specified distance and then stops. The vision system finds the parts and robot picks up each part. After finding and picking up all parts, the conveyor moves again.

A total of 16 physical conveyors can be defined on each system. A physical conveyor has one encoder whose signals are received by an encoder board.

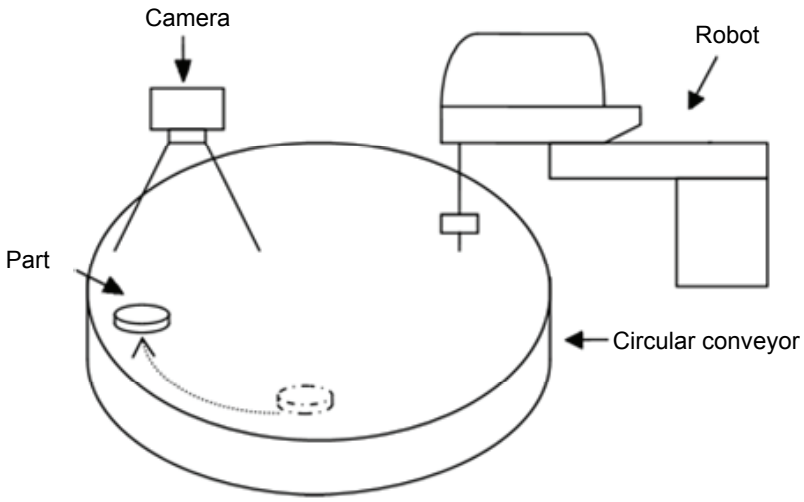
Up to 16 logical conveyors can be defined in each project. To define a logical conveyor, set a conveyor number, a robot number, encoder number and select vision or sensor.

Multiple conveyors are supported.

The Conveyor Tracking option is available for straight conveyors and circular conveyors, as shown in the figures below. These conveyors have different calibration and programming methods. For details, refer to *16.11 Vision Conveyors* and *16.12 Sensor Conveyors*.



Straight conveyor tracking system

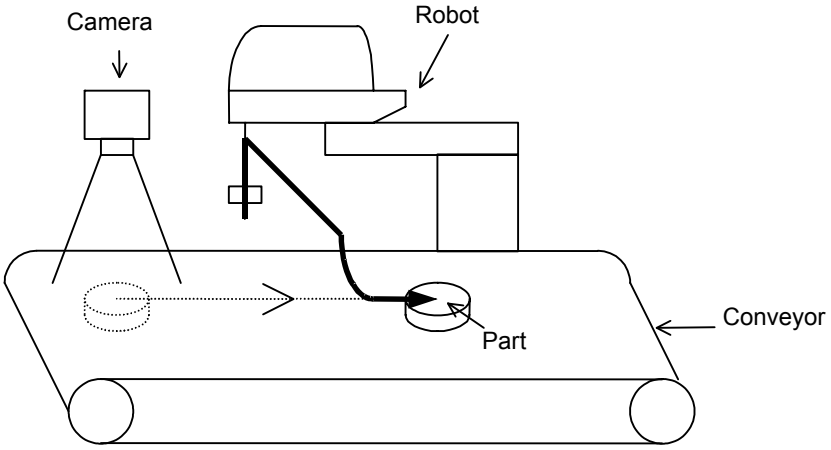


Circular conveyor tracking system

16.2 Conveyor Tracking Processes

Tracking conveyor system

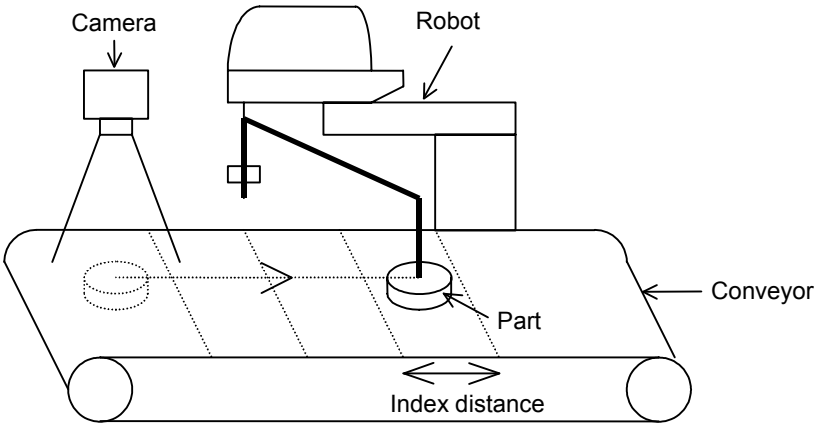
1. Vision system or sensor system finds the parts on a continuously moving conveyor.
2. Robot picks up the parts on the conveyor as they move.



Tracking Conveyor System

Indexed conveyor system

1. Conveyor moves a specified distance.
2. Vision system or sensor system finds the parts on the conveyor when it stops.
3. Robot picks up the parts found by vision system.
4. After finding and picking up all parts, conveyor moves by the specified distance again.



Indexed Conveyor System

16.3 Hardware Installation

To use conveyor tracking, you must install encoders for each physical conveyor on the system. Each encoder is wired to a single channel on a PG (Pulse Generator) board. Each board can accommodate up to 4 encoders. A trigger input is also provided for each encoder to latch position, such as when used with a strobed vision camera.

PG board specifications

The table below shows the specification for the PG board.

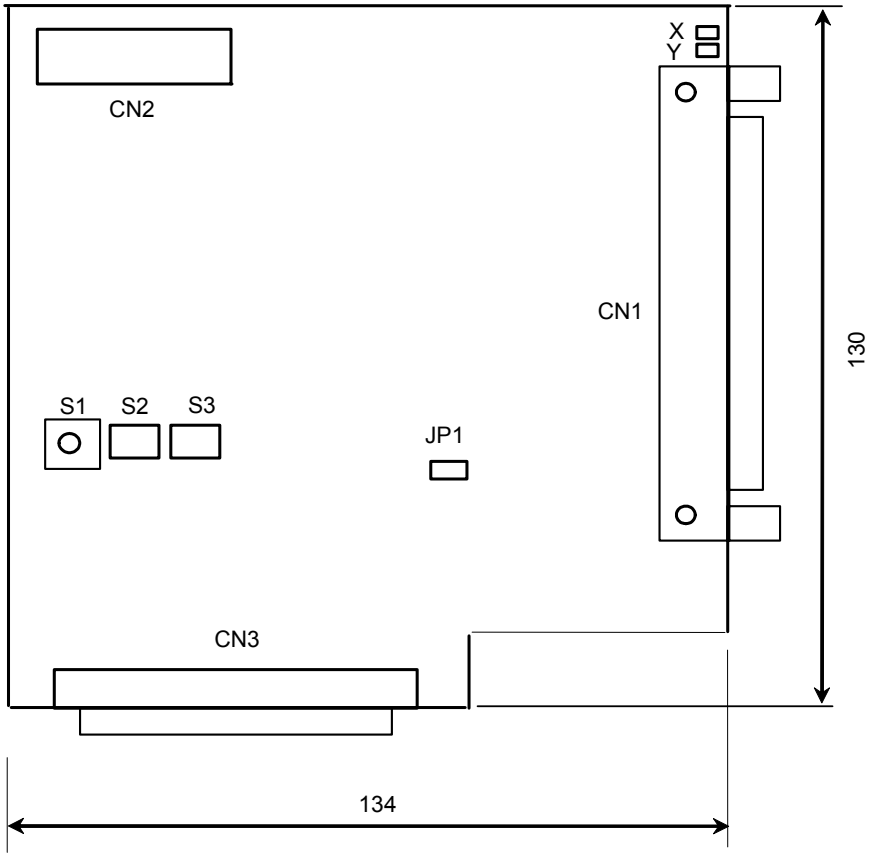
Board Name	H756
Compatible Controller	RC700/ RC90 (EPSON RC+ 7.0)
Board Extension Capability	4 boards maximum
Encoder channels	4 channels / board
Encoder Type	ABZ phase differential input (RS-422 line receiver)
Input Pulse Rate	Max. 5 MPPS
Input Signal	Conveyor pulse latch input
Board Address	Set the DIP switch according the board number. (See DIP Switch Settings later in this chapter).
connector	DX10A - 100S (Hirose Electric Co.,Ltd.)
Power Supply	24V ±2V 200mA or under

The following encoder models have been tested:

OMRON E6B2-CWZ1X

TAMAGAWA TS5312N512-2000C/T

The figure below shows the layout of the PG board.



DIP switch settings

The board address is set by DIP switch (S2, S3) on the PG Board according to the board number, as shown in the following table.

Board #	Address	S2				S3			
		1 (A15)	2 (A14)	3 (A13)	4 (A12)	1 (A11)	2 (A10)	3 (A9)	4 (A8)
1	1100h	OFF	OFF	OFF	ON	OFF	OFF	OFF	ON
2	1200h	OFF	OFF	OFF	ON	OFF	OFF	ON	OFF
3	1300h	OFF	OFF	OFF	ON	OFF	OFF	ON	ON
4	1400h	OFF	OFF	OFF	ON	OFF	ON	OFF	OFF

If you purchased the PG board separately, place the attached Board No. Label sticker on the board panel prior to installation of the board in the Control Unit and keep a written record of the address setting and the board number.

If you have purchased the PG Board with the Control Unit, the board address has been set properly before shipment and further settings should not be necessary.

Jumper settings

The jumpers are reserved and should not be changed.

Rotary switch settings

The rotary switch S1 is reserved and should not be changed.

S1 : Position of 1

Signal Connections

The table below lists the connectors on the PG board and the compatible connectors for wiring:

Receptacle on the Board		DXA10A-100S (manufacturer: Hirose Electric Co.,Ltd.)
Wiring Plug Connectors	Individually pressed-in type	DX30-100P (for AWG#30) DX30A-100P (for AWG#28)
	Pressed-in-as-a-whole type	DX31-100P (for AWG#30) DX31A-100P (for AWG#28)
	Soldered type	DX40-100P
Connector for Wiring to the Cover		DX-100-CV1

Signal Assignments: PG board connector (DX10A-100S)

The signals on the PG board connector are assigned as shown in the table below.

Pin	Dir	Signal	Description	Pin	Dir	Signal	Description
1	-	-	Not used	51	-	-	Not used
2	-	-	Not used	52	-	-	Not used
3	-	-	Not used	53	-	-	Not used
4	-	-	Not used	54	-	-	Not used
5	-	-	Not used	55	-	-	Not used
6	-	-	Not used	56	-	-	Not used
7	-	-	Not used	57	-	-	Not used
8	-	-	Not used	58	-	-	Not used
9	-	-	Not used	59	-	-	Not used
10	In	TRG1	Trigger input for Counter1	60	-	-	Not used
11	In	TRG2	Trigger input for Counter2	61	-	-	Not used
12	In	TRG3	Trigger input for Counter3	62	-	-	Not used
13	In	TRG4	Trigger input for Counter4	63	-	-	Not used
14	In	EXTV	External power supply for Input circuit	64	In	EXTV GND	External power supply GND for Input circuit
15	In	EXTV	External power supply for Input circuit	65	In	EXTV GND	External power supply GND for Input circuit
16	-	-	Not used	66	-	-	Not used
17	-	-	Not used	67	-	-	Not used
18	-	-	Not used	68	-	-	Not used
19	-	-	Not used	69	-	-	Not used
20	-	-	Not used	70	-	-	Not used
21	-	-	Not used	71	-	-	Not used
22	-	-	Not used	72	-	-	Not used
23	-	-	Not used	73	-	-	Not used
24	-	-	Not used	74	-	-	Not used
25	In	+A1	Phase +A signal for Counter 1	75	In	+A3	Phase +A signal for Counter 3
26	In	–A1	Phase –A signal for Counter 1	76	In	–A3	Phase –A signal for Counter 3
27	In	+B1	Phase +B signal for Counter 1	77	In	+B3	Phase +B signal for Counter 3
28	In	–B1	Phase –B signal for Counter 1	78	In	–B3	Phase –B signal for Counter 3
29	In	+Z1	Phase +Z signal for Counter1	79	In	+Z3	Phase +Z signal for Counter 3
30	In	–Z1	Phase –Z signal for Counter 1	80	In	–Z3	Phase –Z signal for Counter 3
31	-	-	Not used	81	-	-	Not used
32	-	-	Not used	82	-	-	Not used
33	-	-	Not used	83	-	-	Not used
34	-	-	Not used	84	-	-	Not used
35	-	-	Not used	85	-	-	Not used
36	-	-	Not used	86	-	-	Not used
37	-	-	Not used	87	-	-	Not used
38	-	-	Not used	88	-	-	Not used
39	-	-	Not used	89	-	-	Not used
40	-	-	Not used	90	-	-	Not used
41	In	+A2	Phase +A signal for Counter 2	91	In	+A4	Phase +A signal for Counter 4
42	In	–A2	Phase –A signal for Counter 2	92	In	–A4	Phase –A signal for Counter 4

Pin	Dir	Signal	Description	Pin	Dir	Signal	Description
43	In	+B2	Phase +B signal for Counter 2	93	In	+B4	Phase +B signal for Counter 4
44	In	–B2	Phase –B signal for Counter 2	94	In	–B4	Phase –B signal for Counter4
45	In	+Z2	Phase +Z signal for Counter 2	95	In	+Z4	Phase +Z signal for Counter 4
46	In	–Z2	Phase –Z signal for Counter 2	96	In	–Z4	Phase –Z signal for Counter 4
47	-	-	Not used	97	-	-	Not used
48	-	-	Not used	98	-	-	Not used
49	-	-	Not used	99	-	-	Not used
50	-	GND	GND	100	-	GND	GND

Pin # 25 ~ 30, 41 ~ 46, 75 ~ 80, 91 ~ 96

Connect the pin numbers shown above with encoder output (+A, –A, +B, –B, +Z, –Z).

Pins # 10 ~ 13

When the conveyor pulse is latched by external signal, connect the pin numbers shown above with latch signal. Exactly when the signal is turned OFF to ON, the encoder pulse is latched.

Pins # 14, 15, 64 and 65

When using the pin # 10 ~ 13, connect external power with the pin numbers shown above.

When not using the pin # 10 ~ 13, it is not necessary to connect external power with the pin numbers shown above.

Signal Assignments: PG board connector terminal block 1

The signals on the PG board connector terminal block #1 are assigned as shown in the table below. The pin numbers in parentheses are the pins on the PG board connector.

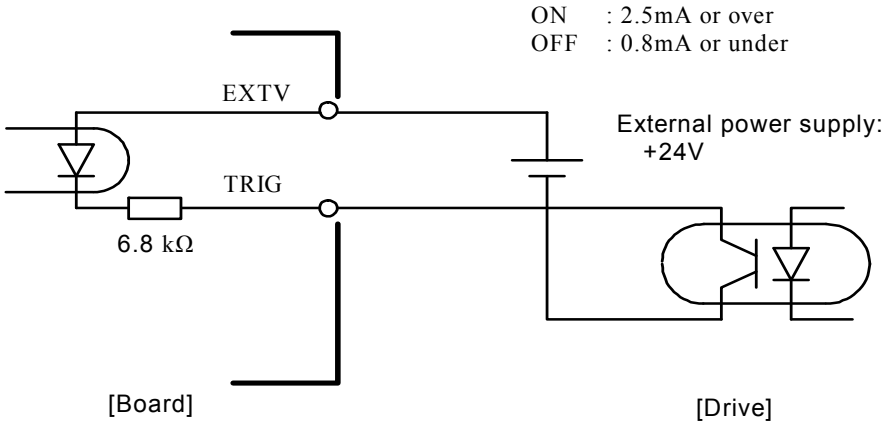
Pin	Signal	Description	Pin	Signal	Description
1 (16)	-	Not used	26 (32)	-	Not used
2 (17)	-	Not used	27 (33)	-	Not used
3 (18)	-	Not used	28 (34)	-	Not used
4 (19)	-	Not used	29 (35)	-	Not used
5 (20)	-	Not used	30 (36)	-	Not used
6 (21)	-	Not used	31 (37)	-	Not used
7 (22)	-	Not used	32 (38)	-	Not used
8 (23)	-	Not used	33 (39)	-	Not used
9 (24)	-	Not used	34 (40)	-	Not used
10 (25)	+A1	Phase +A signal for Counter 1	35 (41)	+A2	Phase +A signal for Counter 2
11 (26)	–A1	Phase –A signal for Counter 1	36 (42)	–A2	Phase –A signal for Counter 2
12 (27)	+B1	Phase +B signal for Counter 1	37 (43)	+B2	Phase +B signal for Counter 2
13 (28)	–B1	Phase –B signal for Counter 1	38 (44)	–B2	Phase –B signal for Counter 2
14 (29)	+Z1	Phase +Z signal for Counter 1	39 (45)	+Z2	Phase +Z signal for Counter 2
15 (30)	–Z1	Phase –Z signal for Counter 1	40 (46)	–Z2	Phase –Z signal for Counter 2
16 (31)	-	Not used	41 (47)	-	Not used
17 (48)	-	Not used	42 (49)	-	Not used
18 (9)	-	Not used	43 (50)	GND	Ground
19 (60)	-	Not used	44 (61)	-	Not used
20 (10)	TRG1	Trigger input for Counter 1	45 (11)	TRG2	Trigger input for Counter 2
21 (1)	-	Not used	46 (5)	-	Not used
22 (2)	-	Not used	47 (6)	-	Not used
23 (3)	-	Not used	48 (7)	-	Not used
24 (4)	-	Not used	49 (8)	-	Not used
25 (14)	EXTV	External power supply	50 (64)	EXTV GND	External power supply ground

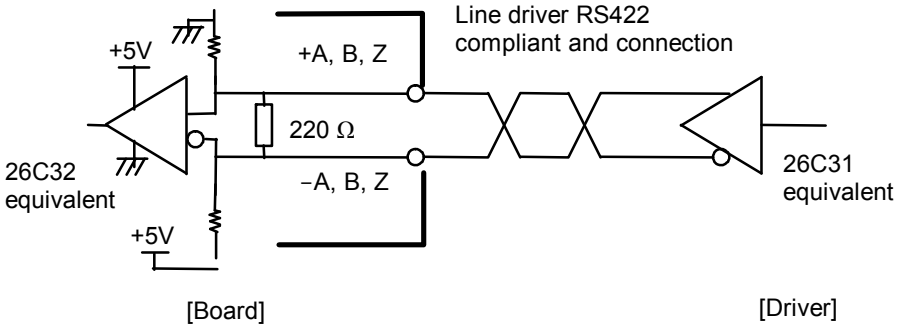
Signal Assignments: PG board connector terminal block 2

The signals on the PG board connector terminal block #2 are assigned as shown in the table below. The pin numbers in parentheses are the pins on the PG board connector.

Pin	Signal	Description	Pin	Signal	Description
1 (66)	-	Not used	26 (82)	-	Not used
2 (67)	-	Not used	27 (83)	-	Not used
3 (68)	-	Not used	28 (84)	-	Not used
4 (69)	-	Not used	29 (85)	-	Not used
5 (70)	-	Not used	30 (86)	-	Not used
6 (71)	-	Not used	31 (87)	-	Not used
7 (72)	-	Not used	32 (88)	-	Not used
8 (73)	-	Not used	33 (89)	-	Not used
9 (74)	-	Not used	34 (90)	-	Not used
10 (75)	+A3	Phase +A signal for Counter 3	35 (91)	+A4	Phase +A signal for Counter 4
11 (76)	–A3	Phase –A signal for Counter 3	36 (92)	–A4	Phase –A signal for Counter 4
12 (77)	+B3	Phase +B signal for Counter 3	37 (93)	+B4	Phase +B signal for Counter 4
13 (78)	–B3	Phase –B signal for Counter 3	38 (94)	–B4	Phase –B signal for Counter 4
14 (79)	+Z3	Phase +Z signal for Counter 3	39 (95)	+Z4	Phase +Z signal for Counter 4
15 (80)	–Z3	Phase –Z signal for Counter 3	40 (96)	–Z4	Phase –Z signal for Counter 4
16 (81)	-	Not used	41 (97)	-	Not used
17 (98)	-	Not used	42 (99)	-	Not used
18 (59)	-	Not used	43 (100)	GND	Ground
19 (62)	-	Not used	44 (63)	-	Not used
20 (12)	TRG3	Trigger input for Counter 3	45 (13)	TRG4	Trigger input for Counter 4
21 (51)	-	Not used	46 (55)	-	Not used
22 (52)	-	Not used	47 (56)	-	Not used
23 (53)	-	Not used	48 (57)	-	Not used
24 (54)	-	Not used	49 (58)	-	Not used
25 (15)	EXTV	External power supply	50 (65)	EXTV GND	External power supply ground

Encoder Input Circuit





16.4 System Structure

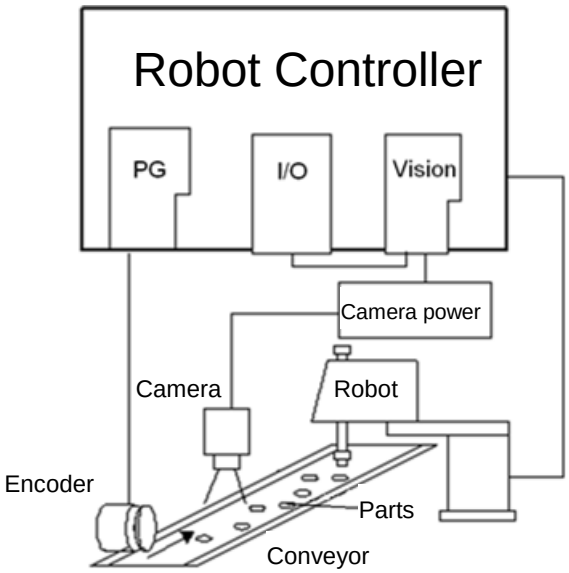
Structure of Vision Conveyor Tracking System

The structure of a vision conveyor tracking system is shown in the figures below.

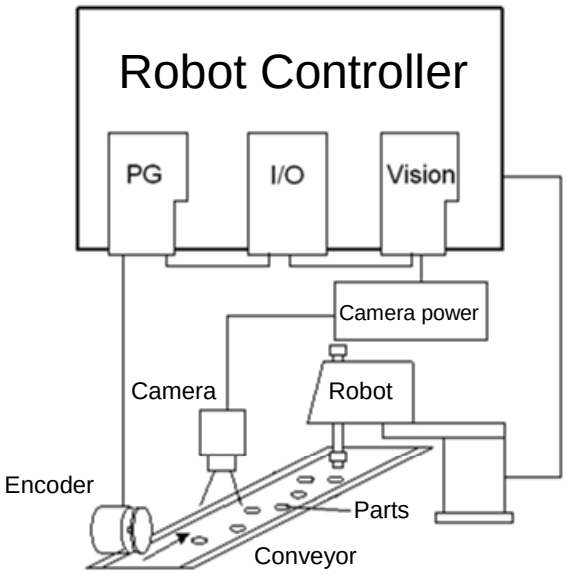
For this system, you need to set the same timing for the vision system to search for parts on the conveyor and for the encoder on the conveyor to latch position. To set the same timing, use the asynchronous reset mode in the vision system (if you don't use asynchronous reset mode, the timing of image acquisition is different from the encoder latch timing and the pickup precision will decrease).

Asynchronous reset mode allows the camera to acquire an image at the moment of trigger input and transfers the image to the vision sequence.

This section inputs the trigger using I/O and shows the wiring example using a frame grabber camera in the vision system.



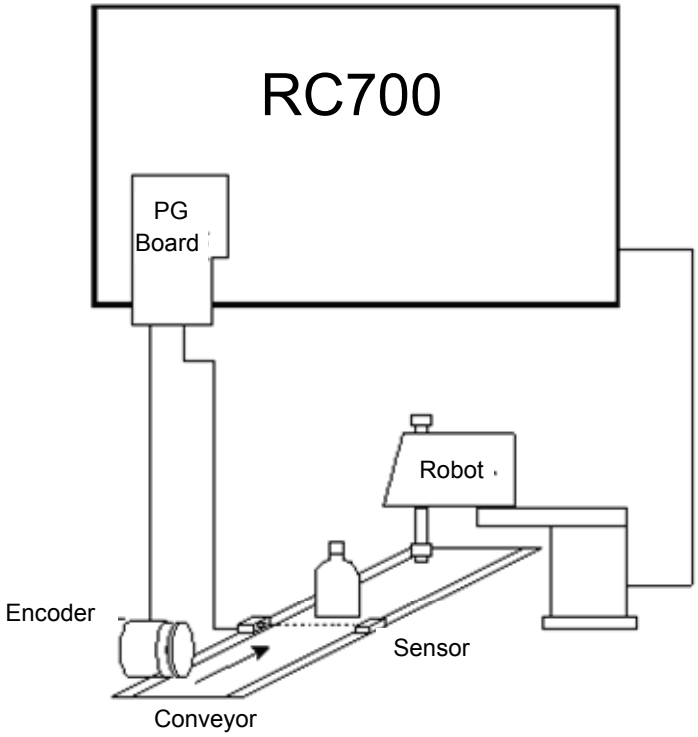
Vision Conveyor Tracking Overview (using a software trigger)



Vision Conveyor Tracking Overview (using a hardware trigger)

Structure of Sensor Conveyor Tracking System

The structure of Sensor Conveyor Tracking System is shown in the figure below. This system uses a hardware trigger. The hardware trigger signals the counter trigger input on the PG board and latches the encoder on the conveyor using the signals from the sensor or I/O.



Sensor Conveyor Tracking Overview

Wiring of PG Board

The following describes the procedures to connect the encoder to the Axis #1 and to use the hardware trigger.

(1) Encoder wiring
Connect the encoder output +A, –A, +B, –B, +Z, –Z to pins 25 to 30.

(2) Hardware trigger wiring
Connect pin 14 and I/O (Out). For sensor conveyor tracking, connect pin 14 to the sensor trigger.
Connect the 24V external power supply to the pin 14 and 64 .

NOTE

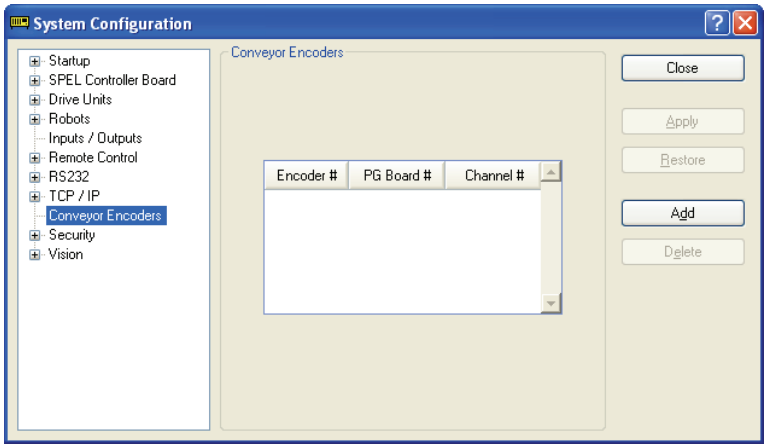
- The pin number indicates the number on the PG board connector.
- The hardware trigger latches the encoder pulse when the signal turns from OFF to ON.
- When you use vision conveyor tracking, the software trigger is available instead of the hardware trigger.
  When you use a software trigger, you need only the encoder wiring with the PG board and use the Cnv_Trigger command in the SPEL+ program. For the command usage, refer to the sample program.
- The software trigger uses the Cnv_Trigger command and latches the encoder on the conveyor.

16.5 Conveyor Encoder Configuration

Before you can create any conveyors in a project, you must first add conveyor encoders to the system. Each physical conveyor must have an encoder.

First, you must install one PG board for every four encoders in the PC Control Unit and wire the encoders to the board(s). Please refer to the Hardware Installation section of this chapter for details.

To define system encoders in EPSON RC+, select [Setup]-[System Configuration] and select the [Conveyor Encoders].



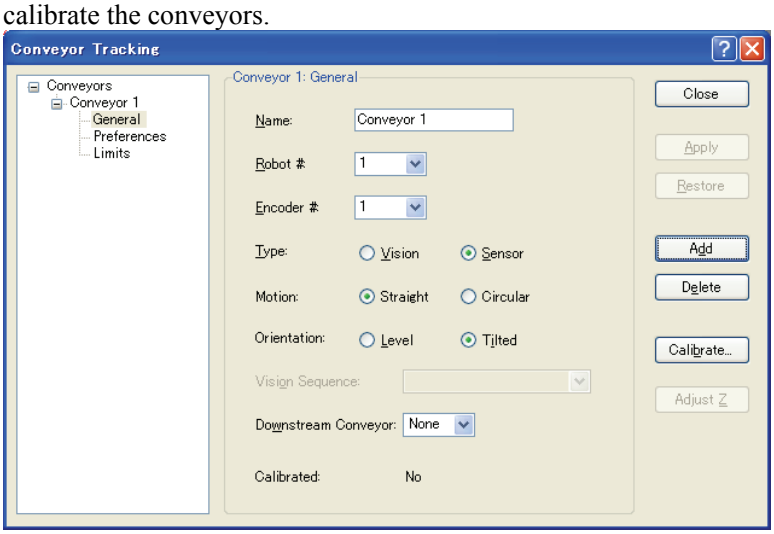
Click the <Add> button to add an encoder. Encoders are added in the order of Axis number.

You can delete the last encoder in the list. Select it, then click the <Delete> button.

16.6 Verifying New Encoder Operation

After wiring one or more new encoders and adding them to RC+ (as described in the previous section), follow these steps to verify operation.

1. Start RC+.
2. Create a new project called “TestCnv”.
3. Create a conveyor by reference to the previous section.
   Conveyor 1: Encoder
   Type : Sensor
   Make sure to perform the calibration, otherwise the conveyor tracking system cannot work properly. When you only check the encoder operation, it is not necessary to calibrate the conveyors.



4. Now you can use the Cnv_Pulse function to read pulses from Encoder 1 from a program or from the monitor window.

For example, execute this print statement from the monitor window to read the pulses from encoder 1. Then move the conveyor and execute the command again.

```
>print cnv_pulse(1)
```

You can also use a simple program as shown below. Start the program and move the conveyor. When the conveyor starts moving, the value of Cnv_Pulse will be changed.

```
Function main
  Do
    Print Cnv_Pulse(1)
    Wait .5
  Loop
Fend
```

16.7 Conveyor Tracking Commands

All Conveyor Tracking commands begin with the same prefix: "Cnv_". Here is a list of all of the commands. For details, please see the *EPSON RC+ Online Help* or *SPEL+ Language Reference manual*.

Command	Description / Usage
Cnv_AbortTrack	Aborts a motion command to a conveyor queue point.
Cnv_Accel Function	Sets/ returns acceleration and deceleration of the conveyor.
Cnv_Accel	Sets acceleration and deceleration of the conveyor.
Cnv_DownStream Function	Returns the downstream limit for the specified conveyor.
Cnv_Downstream	Sets the downstream limit of the conveyor.
Cnv_Fine Function	Returns the setting of the range to judge if the tracking motion is completed or not for the specified conveyor.
Cnv_Fine	Sets / returns the value of Cnv_Fine for one conveyor.
Cnv_Mode Function	Returns the conveyor mode setting value.
Cnv_Mode	Sets the conveyor mode setting value.
Cnv_LPulse Function	Returns the pulse latched by a conveyor trigger.
Cnv_Name$ Function	Returns the name of the specified conveyor.
Cnv_Number Function	Returns the number of a conveyor specified by name.
Cnv_OffsetAngle	Sets the angle offset. Usage: This command is available only for the circular conveyor.
Cnv_OffsetAngle Function	Returns the offset angle.
Cnv_Point Function	Returns a robot point in the specified conveyor's coordinate system derived from sensor coordinates. Usage: Use this function when registering a point in the queue.
Cnv_PosErr Function	Returns deviation in current tracking position compared to tracking target.
Cnv_Pulse Function	Returns the current position of a conveyor in pulses.
Cnv_QueAdd	Adds a robot point to a conveyor queue. Usage: Use this command to register a point in the queue.
Cnv_QueGet Function	Returns a point from the specified conveyor's queue. Usage: Use this command for robot tracking motion.
Cnv_QueLen Function	Returns the number of items in the specified conveyor's queue. Usage: Use this command to keep the robot waiting until the part (queue) enters the tracking area.
Cnv_QueList	Displays a list of items in the specified conveyor's queue.
Cnv_QueMove	Moves data from upstream conveyor queue to downstream conveyor queue. Usage: Use this command for the multi conveyor system.
Cnv_QueReject	Sets / displays the minimum distance to prevent the double conveyors register.
Cnv_QueReject Function	Sets / returns and displays the queue reject distance for a conveyor.
Cnv_QueRemove	Removes items from a conveyor queue.
Cnv_QueUserData Function	Sets / returns and displays user data associated with a queue entry.

Cnv_RobotConveyor Function	Returns the conveyor being tracked by a robot.
Cnv_Speed Function	Returns the current speed of a conveyor.
Cnv_Trigger	Latches current conveyor position for the next Cnv_QueAdd statement. Usage: Use this command when using the software trigger.
Cnv_Upstream Function	Returns the upstream limit for the specified conveyor.
Cnv_Upstream	Sets the upstream limit of the conveyor.

NOTE

To track a part as the conveyor moves, you must use Cnv_QueGet in a motion command statement. For example:

```
Jump Cnv_QueGet(1) '  this tracks the part
```

You cannot assign the result from Cnv_QueGet to a point and then track it by moving to the point.

```
P1 = Cnv_QueGet(1)
Jump P1  '  this does not track the part!
```

When you assign the result from Cnv_QueGet to a point, the coordinate values correspond to the position of the part when the point assignment was executed.

16.8 Key Terms

Here explains key terms used in this section.

Queue	Waiting queue of the FIFO (First-In, First-Out) type for each conveyor. With the queue, you can register the pose data of work pieces running on the conveyor and user data. When you add data, it will be registered to the end of the queue. When you delete data from the queue, the remaining data in the queue will be moved up automatically.
Queue depth	The number of data entries registered in a queue. Maximum number of queue data is 1000.
Queue user data	Optional real value that can be registered in a queue. You can store additional information such as sorted data or part type determined by the image processing.
Downstream Conveyor	Use this when using multiple conveyors and you run them continuously. By making an association (upstream/downstream) between conveyors, you can move a queue using the Cnv_QueMove command. "Multiple conveyors" is not necessarily more than one conveyor. You can use one long physical conveyor and set upstream side and downstream side as different logical conveyors. This enables the robots cooperative work, for instance, robot at the downstream side can pick up the work pieces that the robot at upstream fails to pick in time.
Upstream Limit	Dividing line in the upstream side of the Pickup Area.
Downstream Limit	Dividing line in the downstream side of the Pickup Area.
Pickup Area	The area between the upstream limit and downstream limit. The robot picks parts which flow in the Pickup Area. The robot starting pickup near the downstream limit continues its operation over the downstream limit. Make sure that the Pickup Area covers the whole robot motion range. For details, refer to *16.15 Pickup Area*.

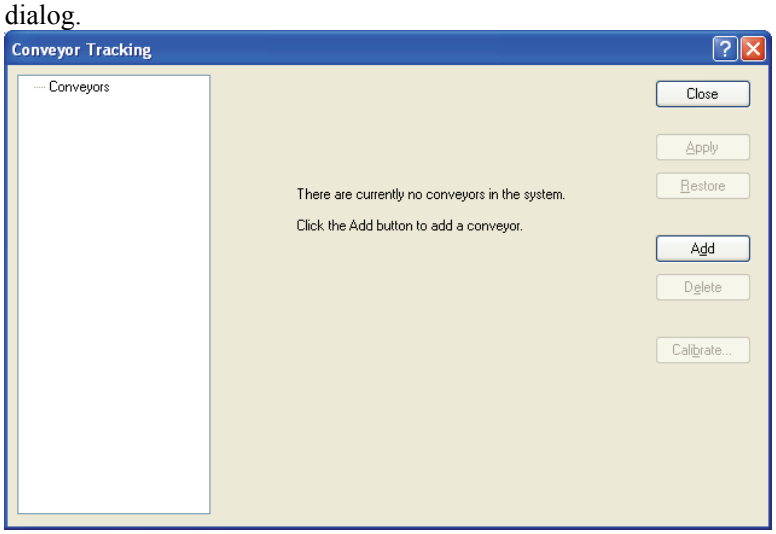
16.9 Creating Conveyors in a Project

Conveyors are configured for each EPSON RC+ project. Up to 16 conveyors can be created per project. A conveyor is a logical entity that combines a robot with one or more conveyors.

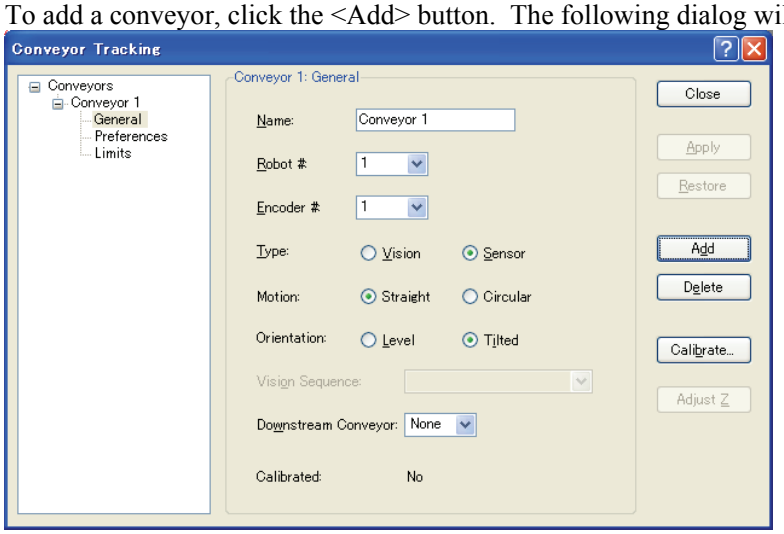
There are two types of conveyors: vision and sensor. If you will be using a vision camera to find the parts on the conveyor, you must first create a vision sequence to find the parts. This vision sequence is required when you define the conveyor.

To add a conveyor to a project

1. Select [Tools]-[Conveyor Tracking] to open the [Conveyor Tracking] configuration dialog.



2. To add a conveyor, click the <Add> button. The following dialog will appear.



3. Enter a name for the conveyor, then specify the Robot #, Encoder #, Type, Motion, and Orientation.

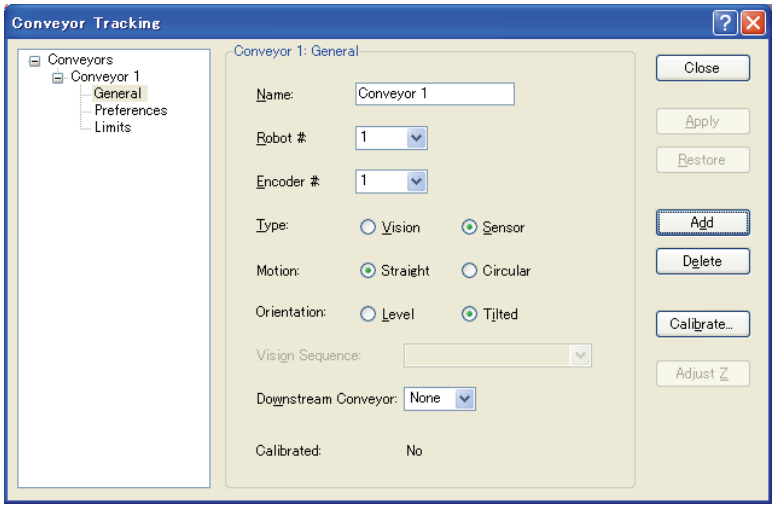
NOTE

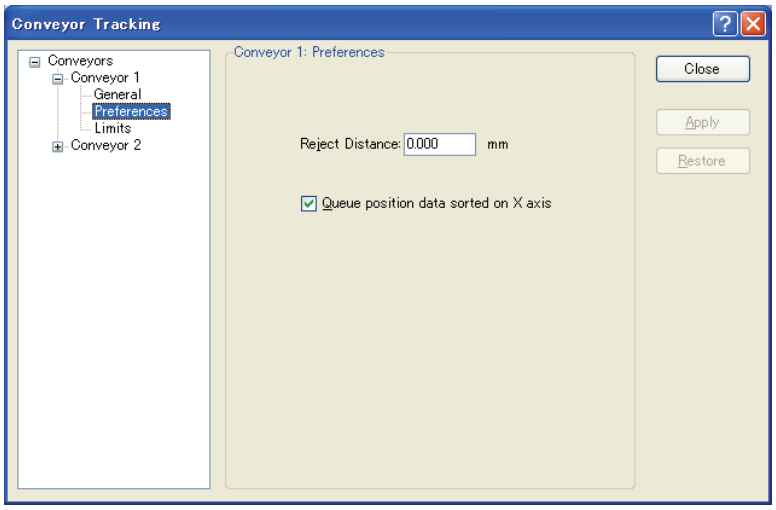
- A default conveyor name is created automatically when a new conveyor is added. You can change the name as desired.
- When you use a straight conveyor, select “Straight” for [Motion].
- When you use a circular conveyor, select “Circular” for [Motion].

16.10 Configuring Conveyors

After a conveyor has been created, you can change its parameters.

1. Select [Tools]-[Conveyor Tracking].
2. Click on the conveyor you want to change.
3. There are three setup pages shown in the tree under each conveyor: [General], [Preferences], and [Limits].
   To change the parameters for the upstream and downstream limits, click on [Limits].
   For details on the Limits settings, refer to *16.15 Pickup Area - Changing the Upstream / Downstream limits positions*.
   To change the settings of Reject Distance and queue position data sort, click on [Preferences].
   To change other parameters, click on [General].
4. Click on [General] or [Preferences].
   The following dialog appears. Edit any of the configuration options.





5. Click <Apply> to save changes.

NOTE ☞ If you changed Robot #, Encoder #, Orientation, Type, or Vision Sequence, then you need to calibrate the conveyor again.

The following table explains the parameters you can edit in the [General] and [Preferences] pages.

Name	You can name conveyors.
Robot #	You can select a robot number from the robots currently configured in the controller.
Encoder #	You can select an encoder number from the encoders currently configured in the controller.
Type	Vision: Detects work pieces using vision search. Sensor: Detects work pieces using a sensor.
Motion	You can select the conveyor motion; Straight conveyor or Circular conveyor.
Orientation	When you selected Straight conveyor, you can specify if the conveyor is level or tilted. <Tilted> is selected by default and normally you don't have to change it. Tilted: Conveyor slope is detected during the calibration. Level: Conveyor slope is not detected during the calibration. You need to observe the following: The conveyor must be level with the robot X and Y planes.
Vision Sequence	Select a vision sequence for the calibration. This is only necessary when using the vision type.
Downstream Conveyor	When two or more conveyors have been set, you can select a conveyor number for the downstream conveyor.
Calibrate…	Click this button to execute the calibration. The calibration procedure is different for each type and conveyor orientation.
Adjust Z	After the calibration is completed, you can calibrate the Z coordinate value of the conveyor again.
Reject Distance	You can set a minimum distance to prevent the registration of duplicate conveyors. ・The distance also can be set from the SPEL program using the Cnv_QueReject command. ・If the distance is different from the one set by Cnv_QueReject command, the Cnv_QueReject command setting has precedence.
Queue position data sorted on X axis	You can select whether to sort the queue or not.

16.11 Vision Conveyors

A vision conveyor uses a camera to locate parts that will be retrieved by one or more robots. In this section, instructions are provided for vision conveyor calibration and programming.

The straight conveyor and circular conveyor have different calibration and programming methods.

Vision conveyor camera and lighting

It is important to choose the correct camera and lighting for the vision conveyors used in your application.

For applications with a slow moving conveyor and non-critical pick up constraints, you may be able to use a Vision Guide camera and simple lighting with no strobe.

For applications with fast moving parts, you will need to use a camera that is capable of asynchronous reset along with a strobe lamp. This method is more expensive.

If you are using multiple asynchronous reset cameras in multiple tasks, you must use SyncLock to lock the vision system during VRun and waiting until the picture is acquired.

For example:

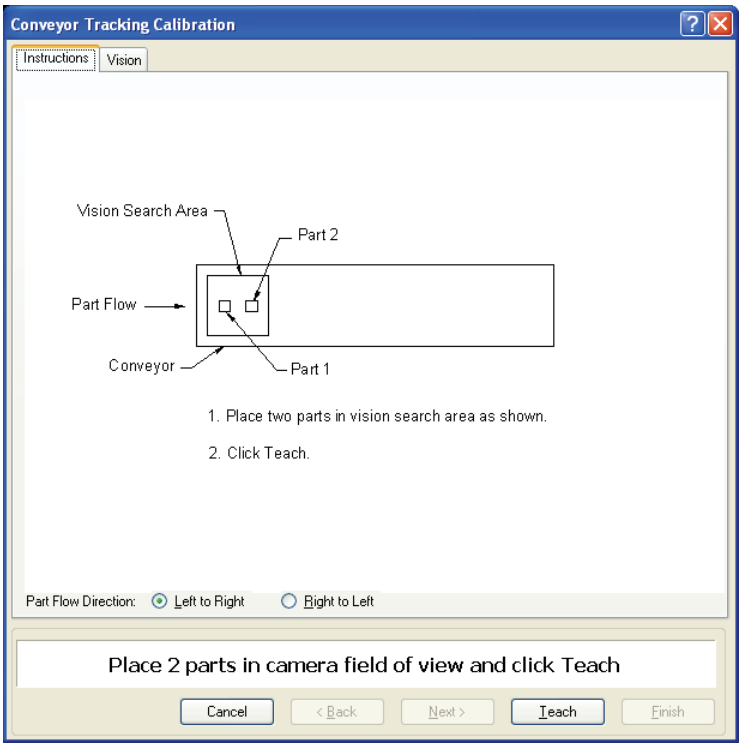
```
SyncLock 1     ' Lock vision for this task
VRun FindPart
On strobe, .2
Do
  VGet FindPart.AcquireState, state
Loop Until state = 3
SyncUnlock 1 ' Unlock vision
```

Vision calibration sequence

Before you can calibrate a vision conveyor, you must first create a calibration sequence. This sequence is used by the system during the calibration process and must be linked to a camera calibration. The conveyor system commands use camera coordinates in millimeters. Although you can use any type of Vision Guide camera calibration, you only need to use a Standalone calibration.

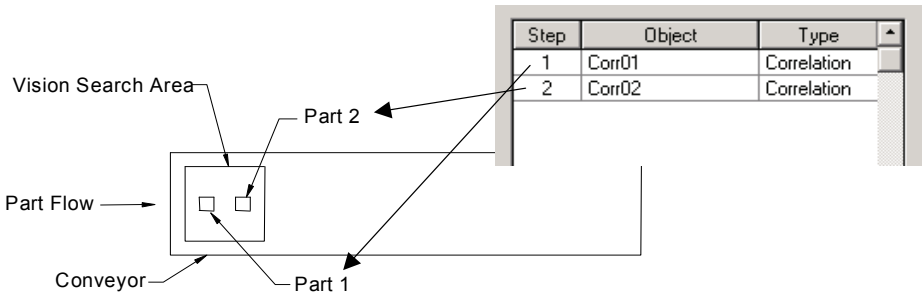
The calibration sequence needs a sequence that uses one object for each work piece.

Place two work pieces on the conveyor as shown below.



The two parts can be anywhere in the field of view. However, the first object of a sequence must be taught with the robot as Part 1. The second object of a sequence must be taught with the robot as Part 2.

Also, the two parts can be anywhere in the field of view. However, to make it as easy as possible for operators to calibrate the conveyor, the parts that will be found in the vision sequence should be located such that part 2 is after part 1 in the direction of part flow. In the figure below, object 1 in the vision sequence is Corr01, which locates Part 1. Object 2 is Corr02, which locates Part 2.



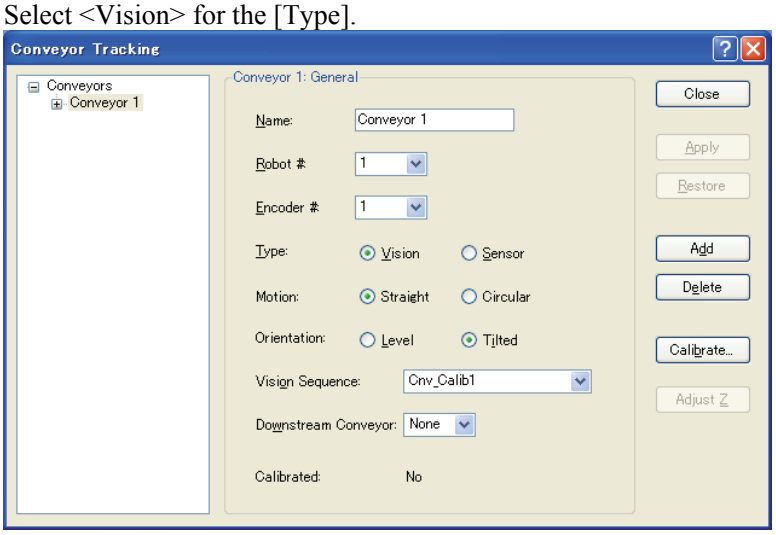
Vision conveyor calibration (Straight conveyor)

Follow these steps to calibrate a straight vision conveyor:

NOTE

- When teaching part positions with the robot during calibration, it is important to position X, Y, and Z of each point accurately. The conveyor is calibrated in X, Y, Z, U, V, and W.
- To perform the fine calibration, in the step 15 and 17, set as wide distance as possible between the upstream limit and downstream limit. After the calibration, adjust the Pickup Area by resetting the upstream / downstream limits.
- For the level orientation, it determines the conveyor height with the position of robot end effector taught in the step 12. It cannot be used for the tilted conveyor for it does not detect the conveyor slope. The steps 19 to 20 are not displayed.
- For the tilted orientation, it calibrates the conveyor slope with the position of robot end effector taught in the steps 12, 14, 16, 18, and 20.

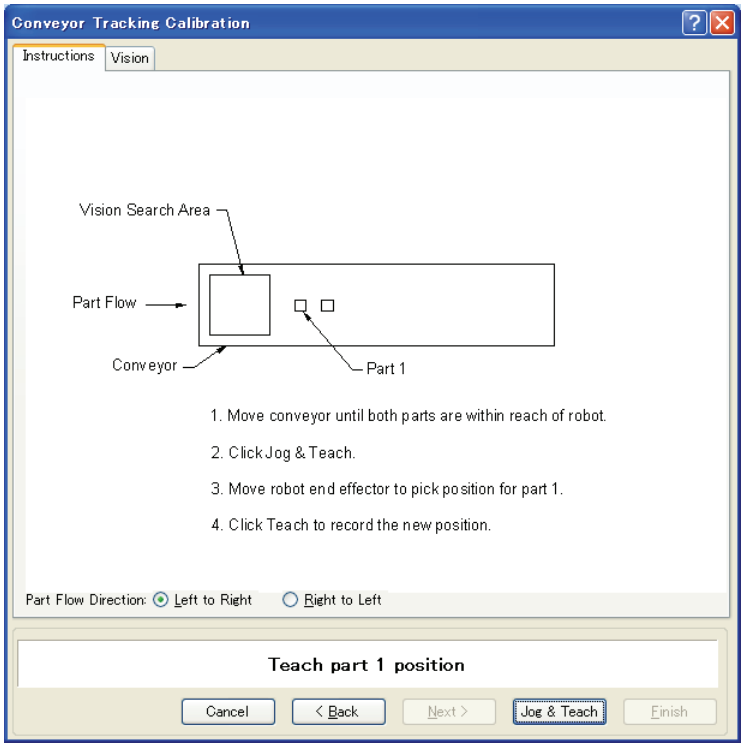
1. Select [Tools]-[Conveyor Tracking].
2. Select the conveyor you want to calibrate.
3. Select <Vision> for the [Type].



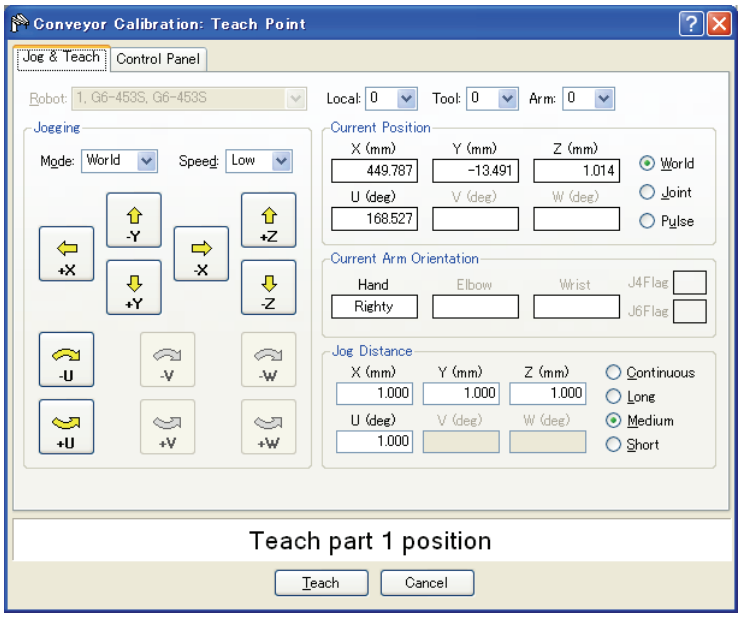
4. Set the [Vision Sequence].
5. Click the <Apply> button.
6. Click the <Calibrate> button. The [Conveyor Tracking Calibration] wizard will appear. Follow the instructions for each step. Before you can proceed to the next step, you must click the <Teach> button. You can go back to previous steps using the <Back> button.
7. Select the [Part Flow Direction] to best match the conveyor you are calibrating. The instruction pictures will change according to the setting. [Part Flow Direction] is only used to aid in the instructions. It has no affect on the calibration.
8. Place two parts on the conveyor as shown in the figure in the wizard.
9. Select the [Vision] tab to see live video. The camera orientation may not be the same as the picture.

10. Arrange the parts to be inside the range correctly and click <Teach> button. Use the camera video to ensure that the parts are within the correct search area for each. Click the <Teach> button. If the [Vision] tab is selected when you click <Teach>, you will see the vision sequence graphical results displayed. In this case, the wizard will not advance to the next step and you must click the <Next> button to view the next step. This allows you to click <Teach> more than one time in case you want to adjust the parts.

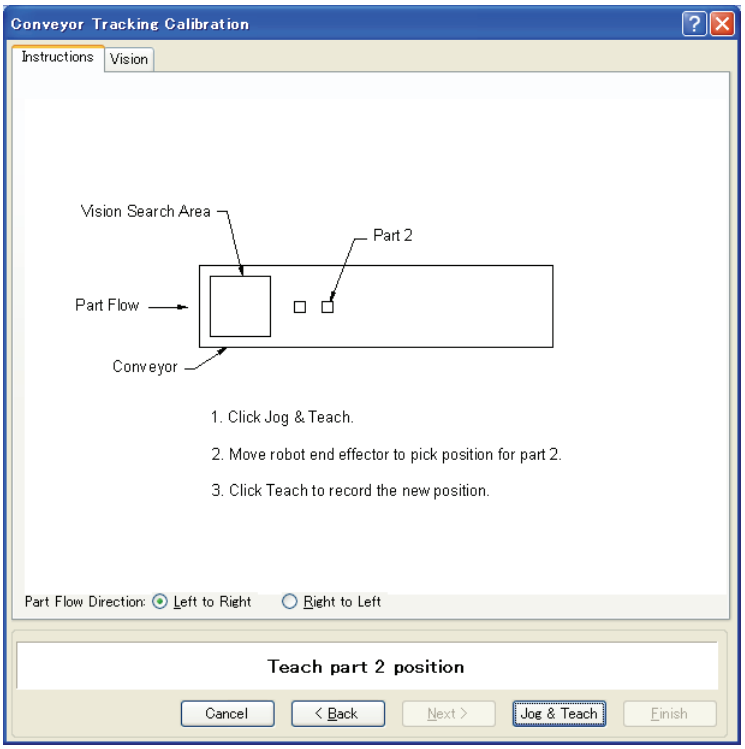
11. Move the conveyor by hand until both parts are within reach of the robot. Do not move the parts, only the conveyor. Click the <Jog & Teach> button.



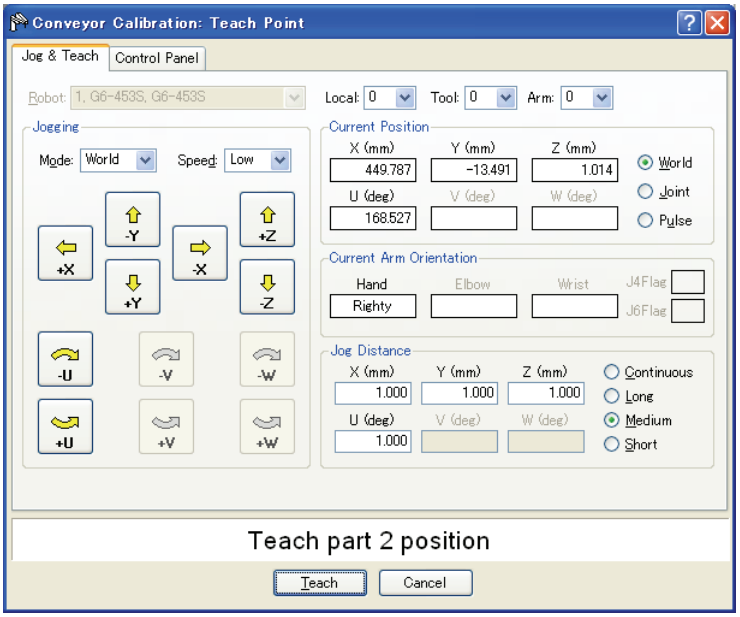
12. The [Jog & Teach] dialog will appear. Click the jog buttons to move the robot end effector to the pick position for Part 1. Click the <Teach> button.



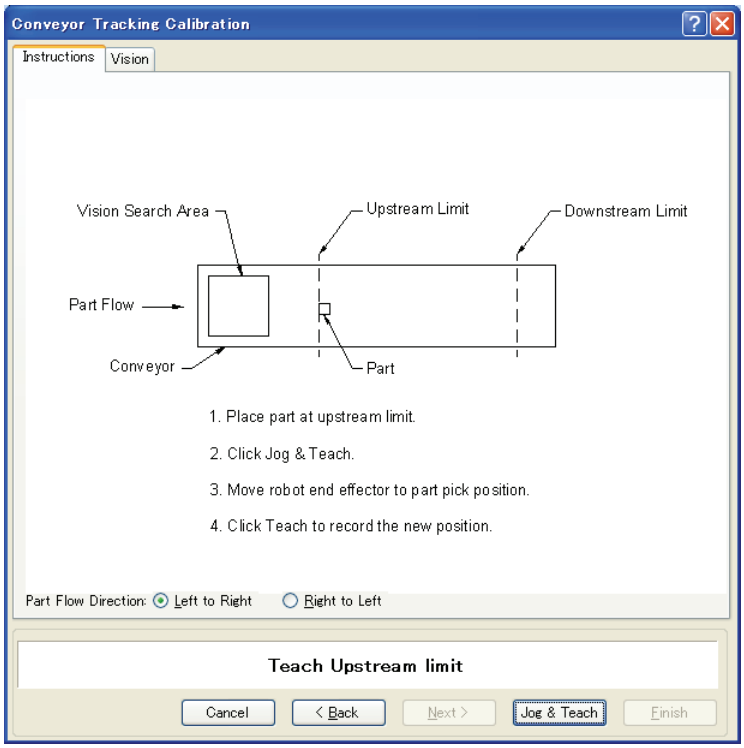
13. Click the <Jog & Teach> button.



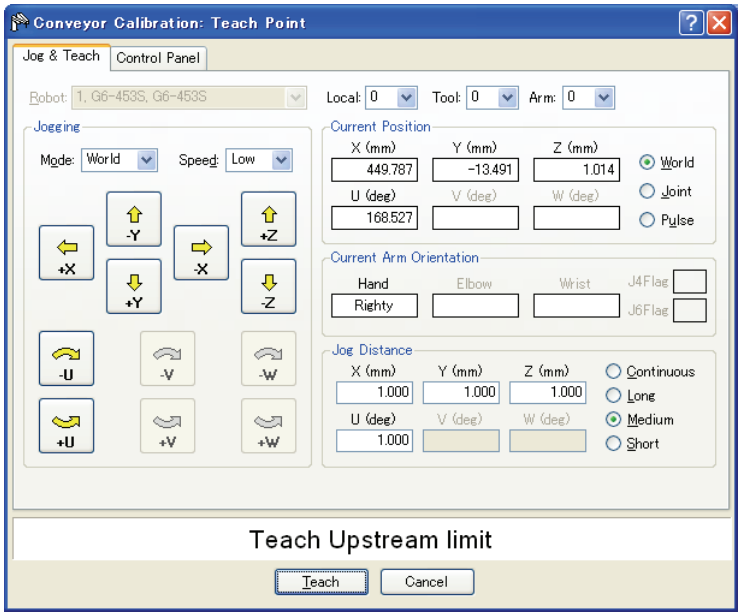
14. The [Jog & Teach] dialog will appear. Click the jog buttons to move the robot end effector to the pick position for Part 2. Click the <Teach> button.



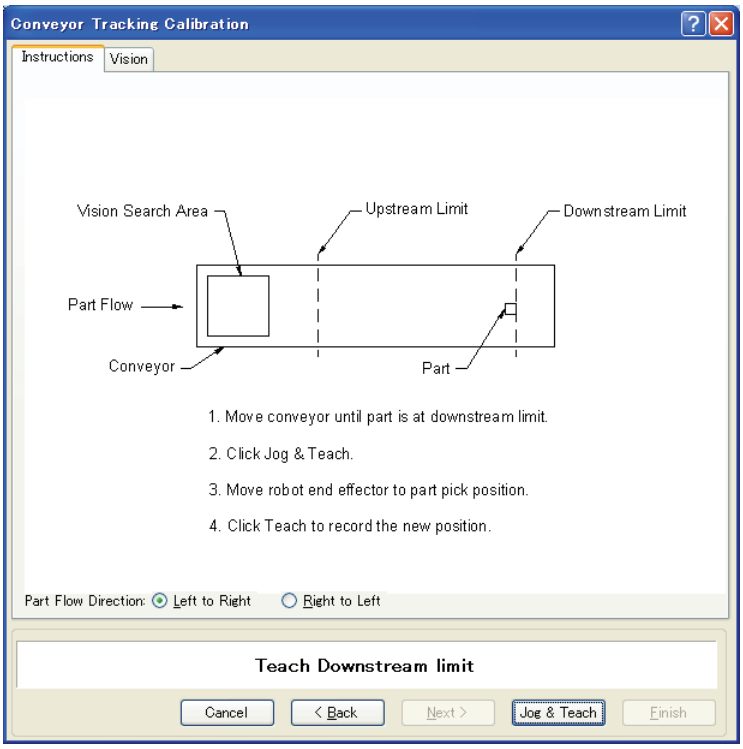
15. Now move or place the part at the upstream limit.
    Click the <Jog & Teach> button.



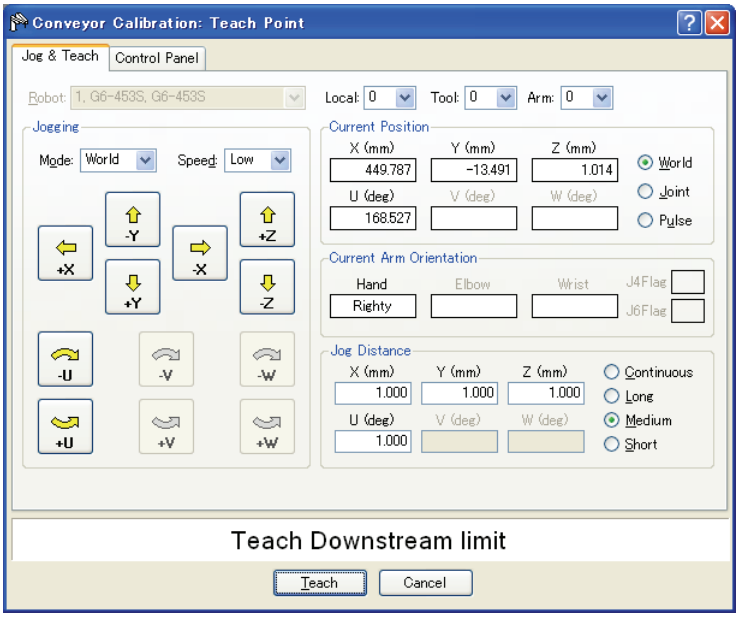
16. The [Jog & Teach] dialog will appear. Click the jog buttons to move the robot end effector to the pick position. Click the <Teach> button.



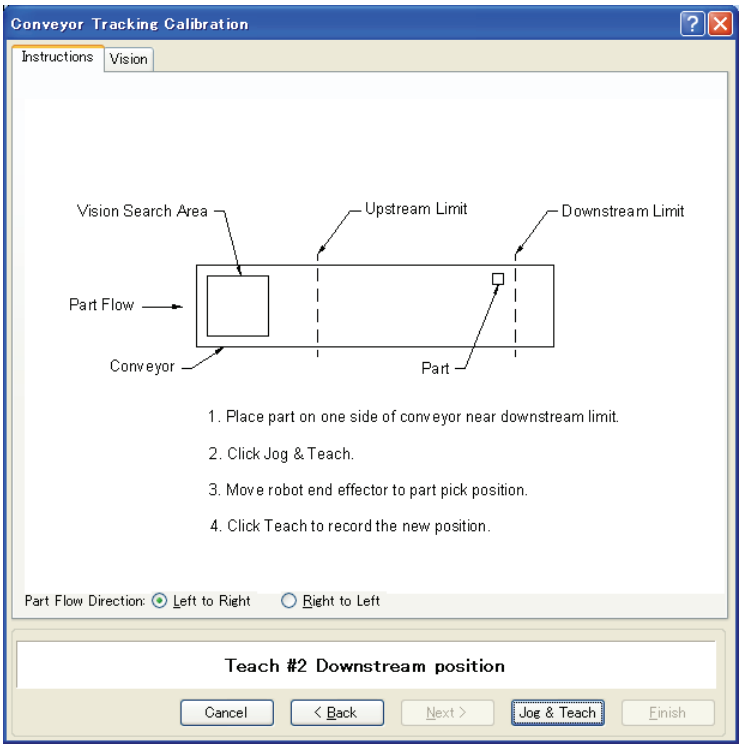
17. Move the conveyor so the part is at the downstream limit. Do not move the part, only the conveyor. Click the <Jog & Teach> button.



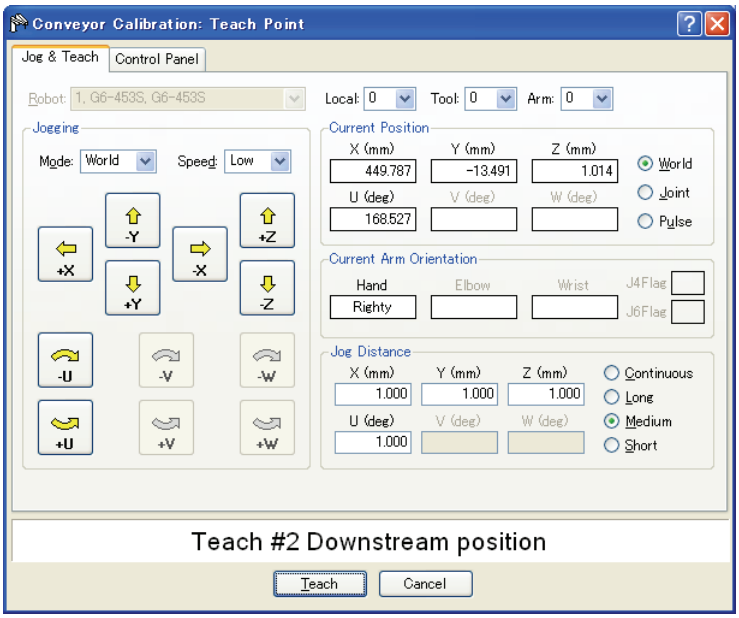
18. The [Jog & Teach] dialog will appear. Click the jog buttons to move the robot end effector towards the part. Click the <Teach> button.



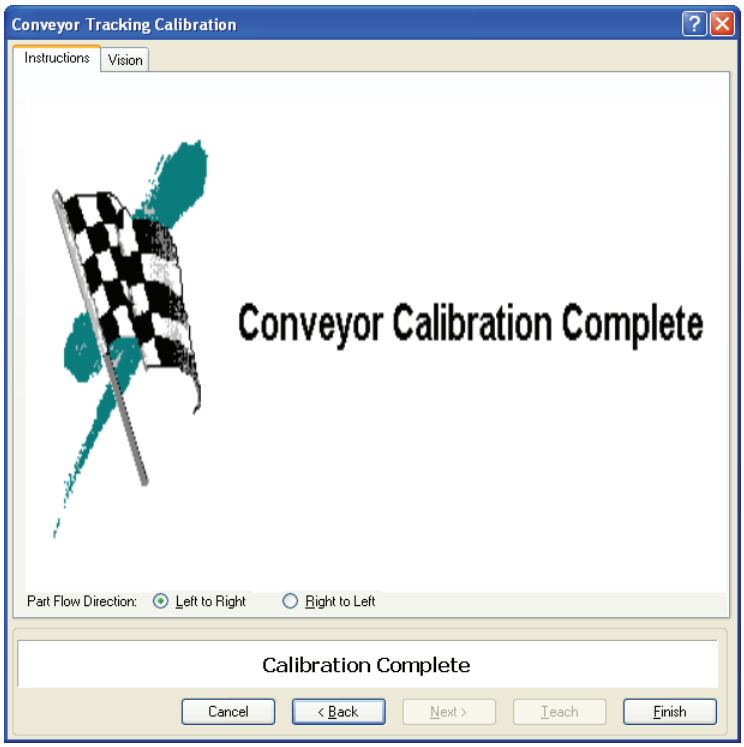
19. Place a part on one side of the conveyor near the downstream limit. This point is used to determine the tilt of the conveyor from side to side. Click the <Jog & Teach> button.



20. The [Jog & Teach] dialog will appear. Click the jog buttons to move the robot end effector to the part position. Click the <Teach> button.



21. The calibration complete picture will be displayed. Click the <Finish> button.



Vision conveyor calibration (Circular conveyor)

Follow these steps to calibrate a circular vision conveyor:

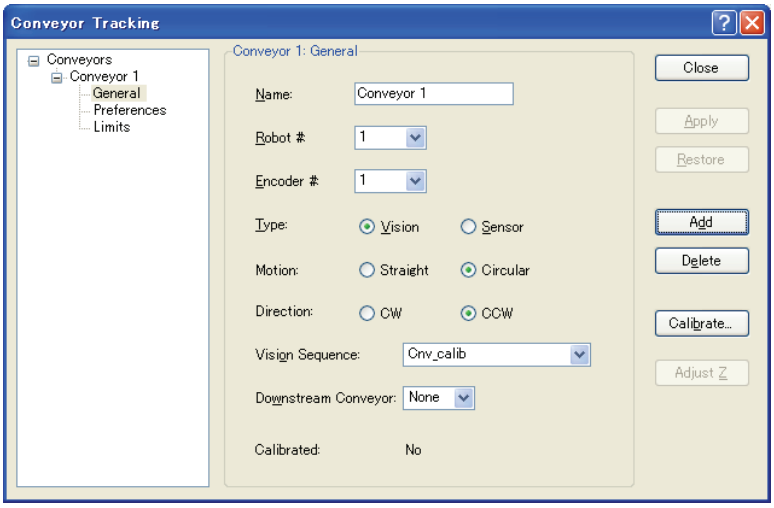
NOTE

- When teaching part positions with the robot during calibration, it is important to position X, Y, and Z of each point accurately. The conveyor is calibrated in X, Y, Z, U, V, and W.
- To perform the fine calibration, in steps 13, 17, and 19, teach the position when the robot is directly above the parts 1 and set as wide a distance as possible between the points to be taught.

1. Select [Tools]-[Conveyor Tracking].
2. Select the conveyor you want to calibrate.
3. Select <Vision> for the [Type].
4. Select <Circular> for the [Motion].
5. Select the conveyor rotating direction for the [Direction].

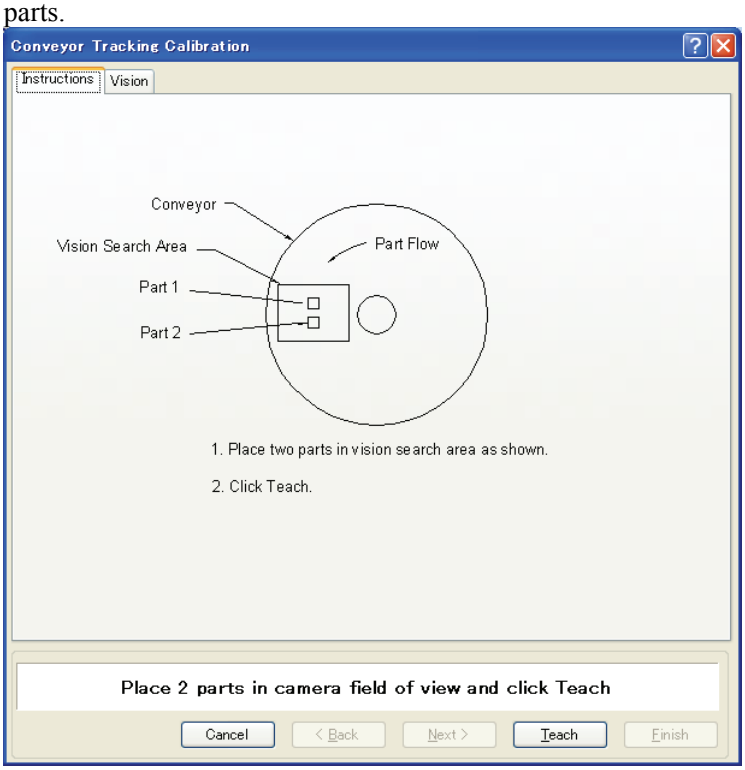
NOTE

Be careful not to calibrate with a wrong direction, otherwise, the robot will not track the parts.

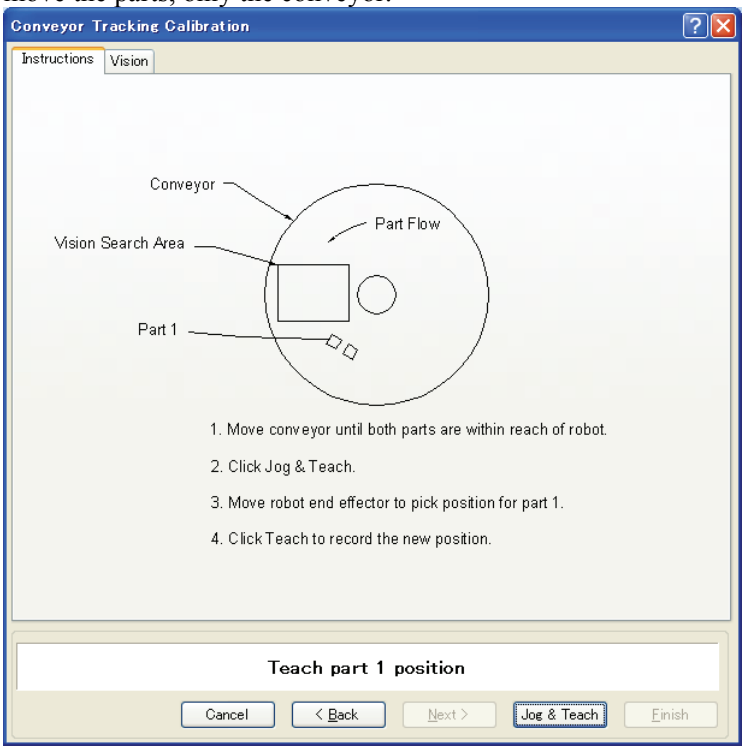


6. Select the [Vision Sequence].
7. Click the <Apply> button.
8. Click the <Calibrate> button. The [Conveyor Tracking Calibration] wizard will appear. Follow the instructions for each step. Before you can proceed to the next step, you must click the <Teach> button. You can go back to previous steps using the <Back> button.
9. Check if the conveyor direction shown in the wizard is the same as the conveyor you want to use.
10. Place two parts on the conveyor as shown in the figure in the wizard.
11. Select the [Vision] tab to see live video. The camera orientation may not be the same as the picture.

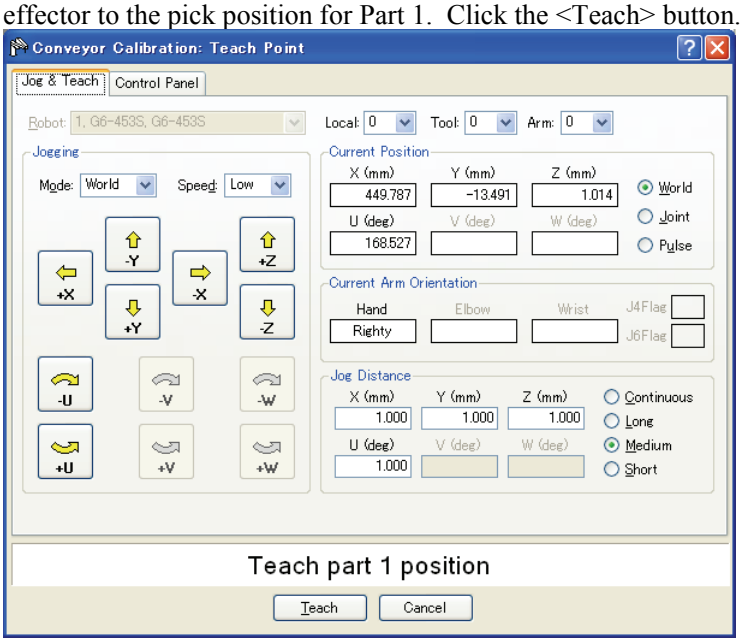
12. Arrange the parts to be inside the range correctly and click the <Teach> button.
    If the Vision tab is selected when you click <Teach>, you will see the vision sequence graphical results displayed. In this case, the wizard will not advance to the next step and you must click the <Next> button to view the next step.
    This allows you to click <Teach> more than one time in case you want to adjust the parts.



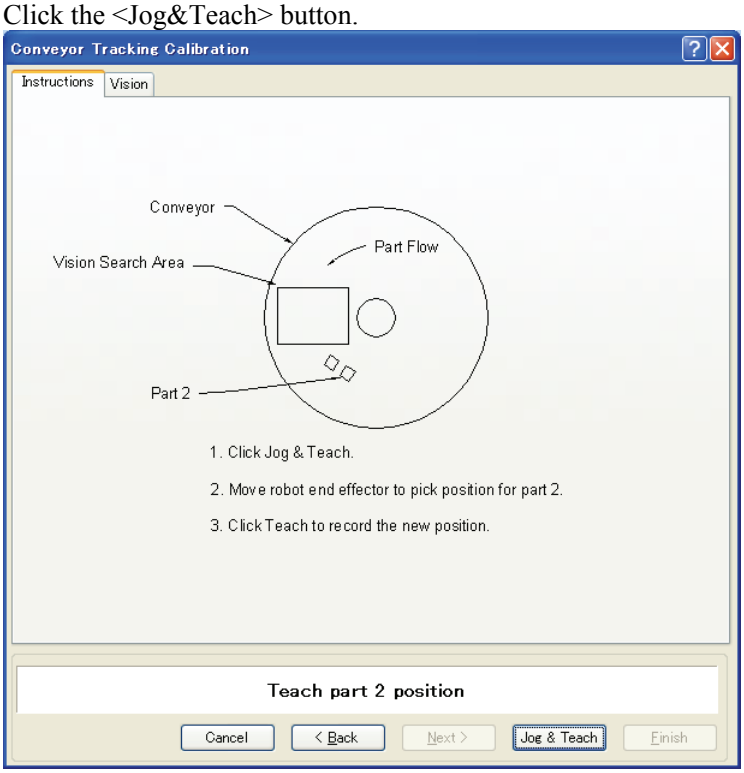
13. Move the conveyor by hand until both parts are within reach of the robot. Do not move the parts, only the conveyor.



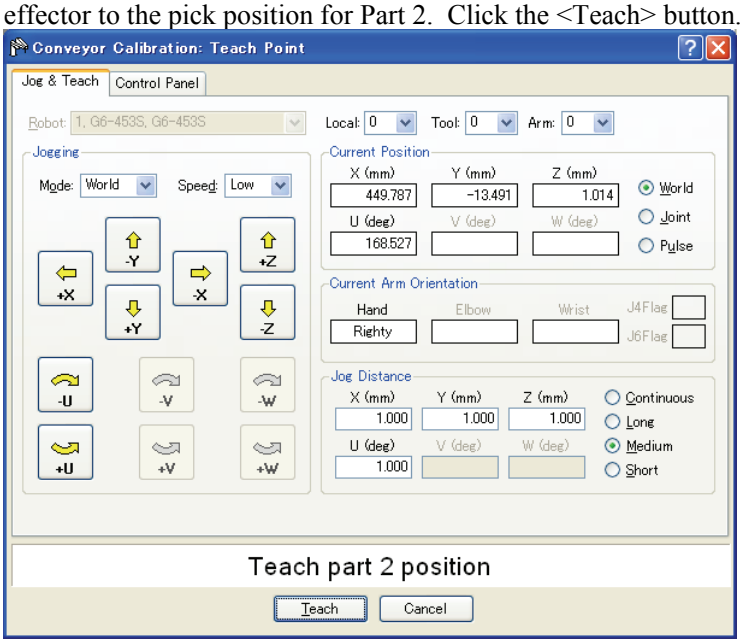
14. The [Jog & Teach] dialog will appear. Click the jog buttons to move the robot end effector to the pick position for Part 1. Click the <Teach> button.



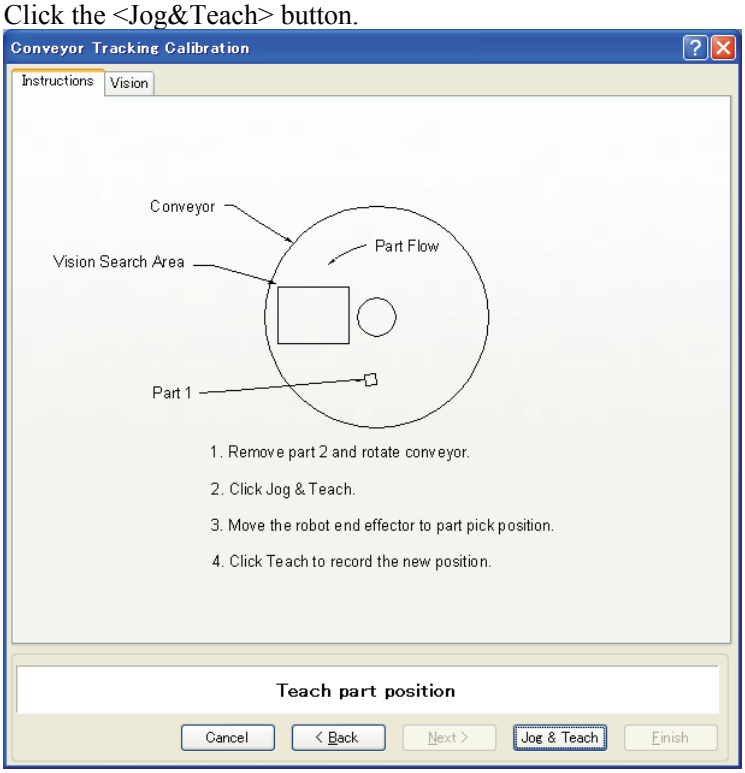
15. Click the <Jog&Teach> button.



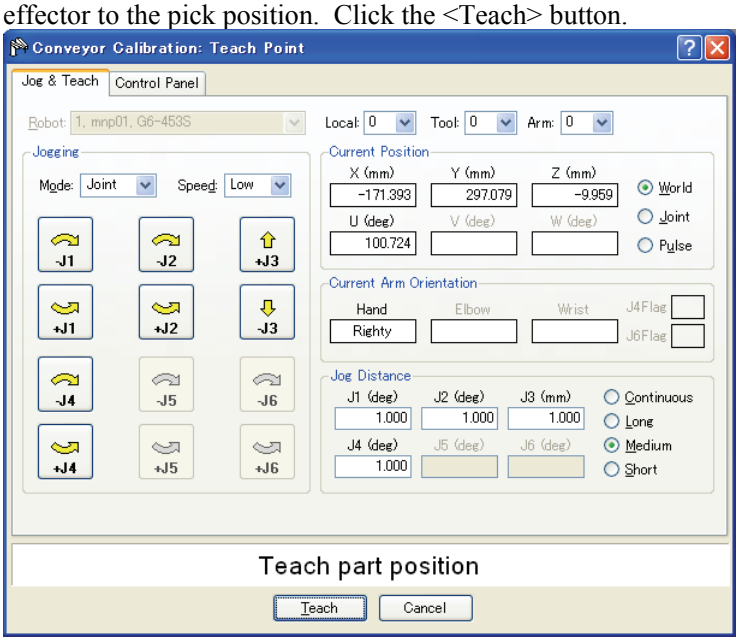
16. The [Jog & Teach] dialog will appear. Click the jog buttons to move the robot end effector to the pick position for Part 2. Click the <Teach> button.



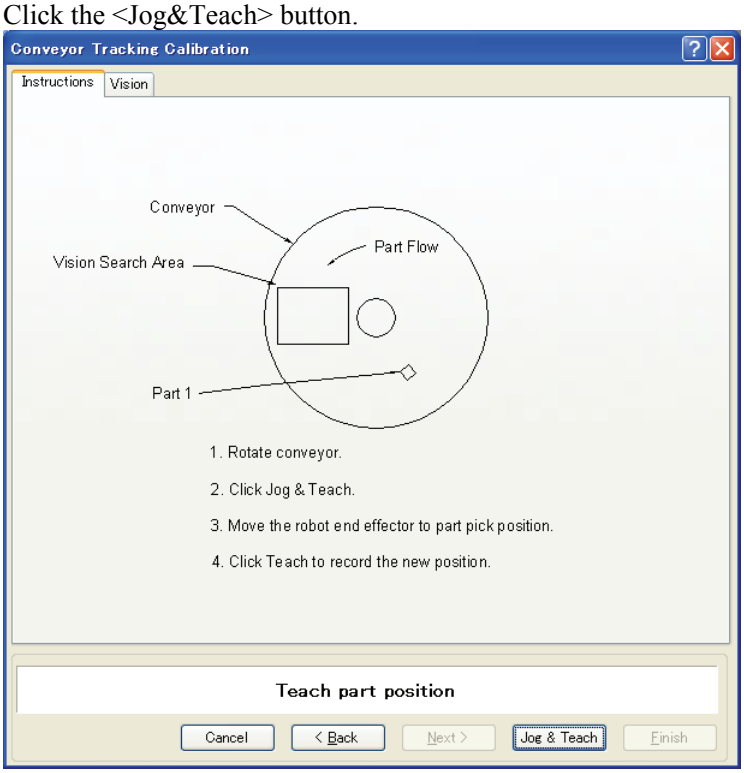
17. Remove Part 2. Move the conveyor by hand to move Part 1. Click the <Jog&Teach> button.



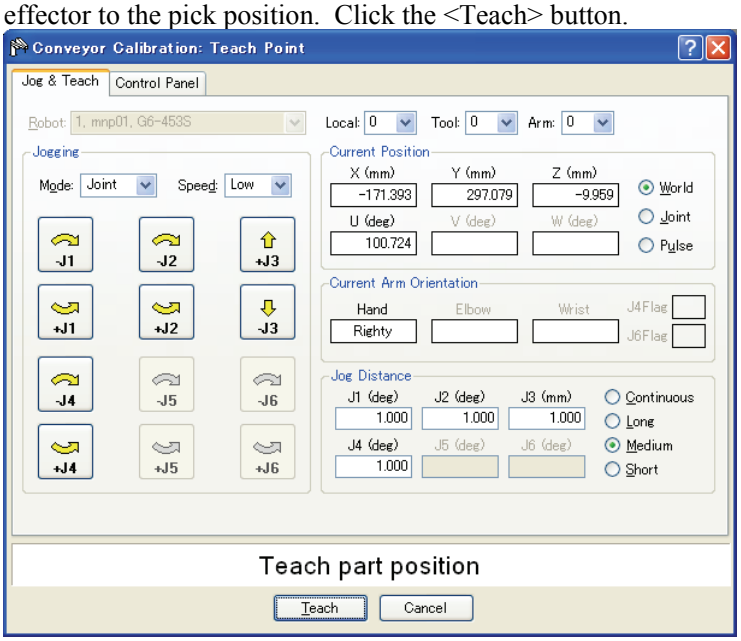
18. The [Jog & Teach] dialog will appear. Click the jog buttons to move the robot end effector to the pick position. Click the <Teach> button.



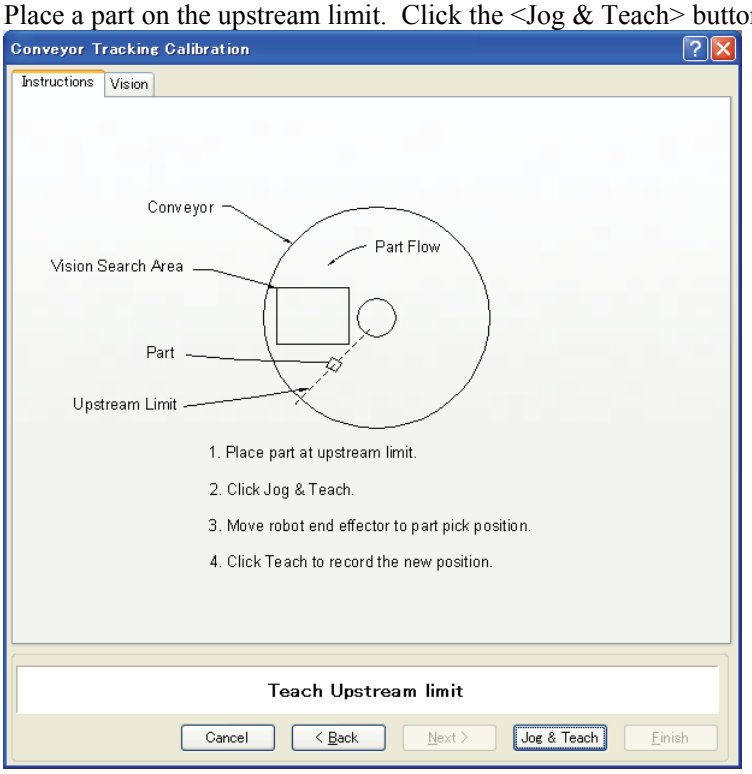
19. Move the conveyor by hand to move Part 1.
Click the <Jog&Teach> button.



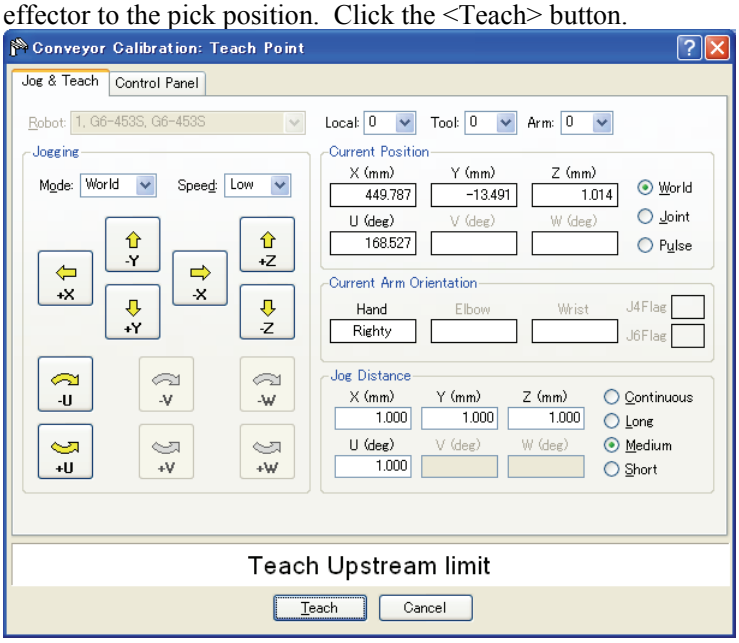
20. The [Jog & Teach] dialog will appear. Click the jog buttons to move the robot end effector to the pick position. Click the <Teach> button.



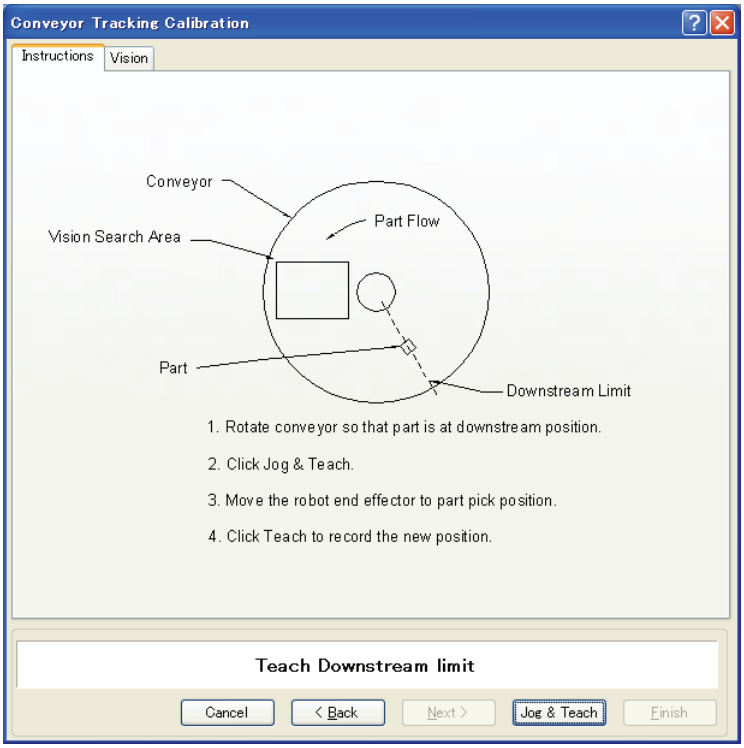
21. Place a part on the upstream limit. Click the <Jog & Teach> button.



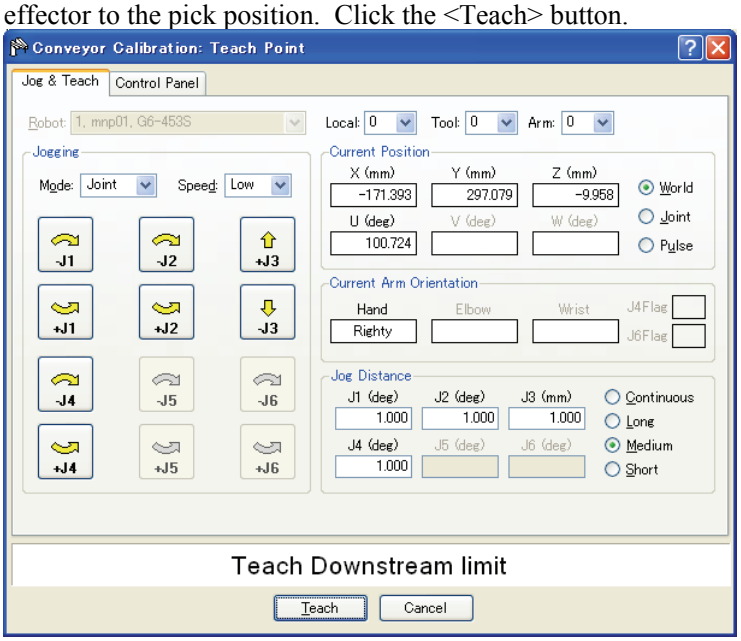
22. The [Jog & Teach] dialog will appear. Click the jog buttons to move the robot end effector to the pick position. Click the <Teach> button.



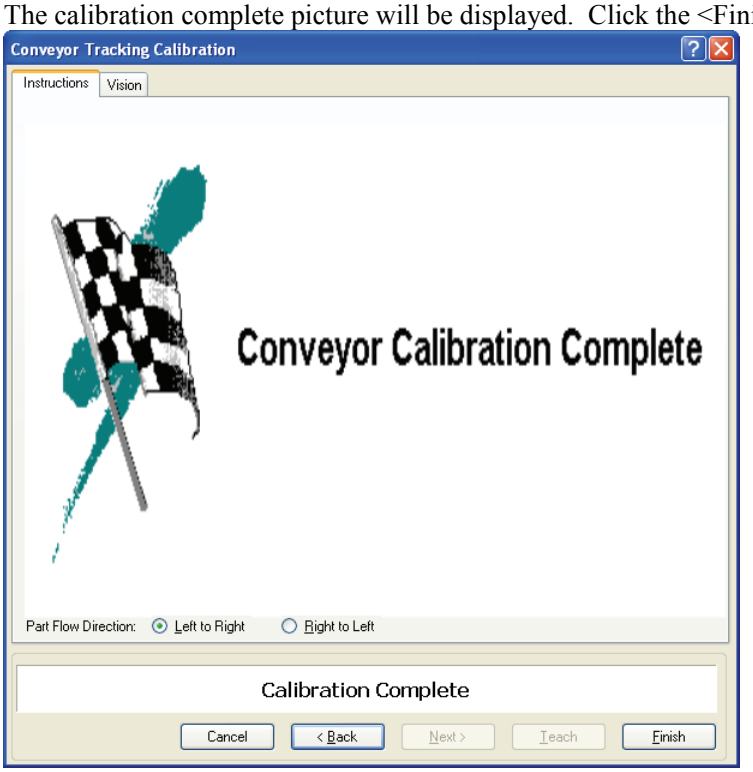
23. Move the conveyor so the part is on the downstream limit. Click the <Jog & Teach> button.



24. The [Jog & Teach] dialog will appear. Click the jog buttons to move the robot end effector to the pick position. Click the <Teach> button.



25. The calibration complete picture will be displayed. Click the <Finish> button.



Vision conveyor operation check

After the calibration, we recommend that you check if the vision conveyor works properly. Use the sample program “ScanConveyorStrobed” and the Command Window and follow the procedure below.

In this section, the operation of Conveyor #1 will be checked.

1. Clear the all queue data registered to the conveyor.

   ```
   >Cnv_QueRemove 1,all
   ```

2. Place parts in the vision search area.
3. Execute the program “ScanConveyorStrobed” to register a queue.
4. Halt the program “ScanConveyorStrobed” and move the conveyor until parts reach the Pickup Area.
5. Pick up parts.

   ```
   >Go Cnv_Queget(1,0):U(90):V(0):W(180)
   ```

6. Check if the robot end effector is over the center of the part to pick.
7. Move the conveyor and check if the robot follows the part. At this point, the end effector will be off the center of part but this is no problem.
8. Stop the tracking motion.

   ```
   >Cnv_AbortTrack
   ```

In case the following symptoms occur, the Vision Guide or conveyor calibration was not executed correctly. Perform the calibration again.

- Robot cannot pick a part in the center.
- Robot cannot follow parts when the conveyor is moving.

Vision conveyor programming

Typically, two tasks are used to operate a vision conveyor. One task finds parts with the vision system and adds them to the conveyor queue.

The other task checks for parts in the Pickup Area of the conveyor queue. When a part is in the Pickup Area, the robot is commanded to pick up the part and place it to the specified position.

The following example shows two tasks. The scanning task uses the vision system to find parts and add them to the conveyor queue. There are two examples for the scanning task. "ScanConveyorNonStrobed" does not use a strobe lamp and hardware trigger. In this case, "Cnv_Trigger" must be called before running the vision sequence.
"ScanConveyorStrobed" uses a strobe lamp and hardware conveyor trigger. "PickParts" waits for parts to be present in the Pickup Area and commands the robot to pick and place each part.

If you are using an asynchronous reset camera and strobe, then the strobe trigger should also be wired to the trigger on the PG board. In this case, the vision sequence "RuntimeAcquire property" must be set to "Strobed".

The following program is a sample with Conveyor #1.

```
Function main
  Xqt ScanConveyorStrobed      'Task that registers queues
  Xqt PickParts                'Task that tracks parts (queue)
Fend

Function ScanConveyorNonStrobed
  Integer i, numFound
  Real x, y, u
  Boolean found
  Cnv_OffsetAngle 1,xx       'Command used for only circular conveyors
                             'Adjust the tracking error with an offset value in xx
  Do
    Cnv_Trigger 1            'Latch the encoder with software trigger
    'Search for parts on the conveyor
    VRun FindParts
    VGet FindParts.Parts.NumberFound, numFound
    'Register the part as a queue
    For i = 1 to numFound
      VGet FindParts.Parts.CameraXYU(i), found, x, y, u
      Cnv_QueAdd 1, Cnv_Point(1, x, y)
    Next i
    Wait .1
  Loop
Fend

Function ScanConveyorStrobed
  Integer i, numFound, state
  Real x, y, u
  Boolean found
```

```
  Cnv_OffsetAngle 1,xx        ' Command used for only circular conveyors
                              'Adjust the tracking error with an offset value in xx

  'Turn OFF the camera shutter and I/O (conveyor trigger)
  Off trigger; off Cv_trigger
  Do
    'Search for parts on the conveyor
    VRun FindParts
    'Turn ON the camera shutter and I/O (conveyor trigger)
    On Trigger; On Cv_Trigger
    Do
      VGet FindParts.AcquireState, state
  Loop Until state = 3
  VGet FindParts.Parts.NumberFound, numFound
  'Register the part that has been shot as a queue
  For i = 1 to numFound
      VGet FindParts.Parts.CameraXYU(i), found, x, y, u
      Cnv_QueAdd 1, Cnv_Point(1, x, y)
  Next I
  'Turn OFF the camera shutter and I/O (conveyor trigger)
  Off Trigger; Off Cv_Trigger
  Wait .1
  Loop
Fend

Function PickParts
  OnErr GoTo ErrHandler
  Integer ErrNum
  'Select the tracking mode
  Cnv_Mode 1,1
  WaitParts:
  Do
    'Wait until a part (queue) enters the Pickup Area
    Wait Cnv_QueLen(1, CNV_QUELEN_PICKUPAREA) > 0
    'Start tracking the parts
    Jmp3 place_1,Cnv_QueGet(1):Z(**):U(90):V(0):W(180),
         Cnv_QueGet(1):U(90):V(0):W(180)
    On gripper
    Wait .1
    'Move the picked part to a specified place
    Go place_2
    Off gripper
    Wait .1
    'Clear the picked part (queue)
```

```
    Cnv_QueRemove 1, 0
  Loop
  'Clear the parts (queue) in the downstream side from the Pickup Area
  'When error 4406 occurs, restore automatically
  ErrHandler:
    ErrNum = Err
    If ErrNum = 4406 Then
      Cnv_QueRemove 1, 0
      EResume WaitParts
    'When an error except error 4406 occurs, display the error
    Else
      Print "Error!"
      Print "No.", Err, ":", ErrMsg$(Err)
      Print "Line :", Erl(0)
    EndIf
Fend
```

NOTE

When you use the strobe light and software trigger, use the “ScanConveyorStrobed” function shown below.

```
Function ScanConveyorStrobed
  Integer i, numFound, state
  Real x, y, u
  Boolean found
  Cnv_OffsetAngle 1,xx       ' Command used only for circular conveyors
                             'Adjust the tracking error with an offset value in xx
  'Turn OFF the camera shutter
  Off trigger
  Cnv_Trigger 1              'Latch the encoder with software trigger
  Do
    'Search for parts on the conveyor
    VRun FindParts
    'Turn ON the camera shutter
    On Trigger; On Cv_Trigger
    Do
      VGet FindParts.AcquireState, state
  Loop Until state = 3
  VGet FindParts.Parts.NumberFound, numFound
  'Register the part that has been shot as a queue
  For i = 1 to numFound
    VGet FindParts.Parts.CameraXYU(i), found, x, y, u
    Cnv_QueAdd 1, Cnv_Point(1, x, y)
  Next I
  'Turn OFF the camera shutter
  Off Trigger
  Wait .1
  Loop
Fend
```

16.12 Sensor Conveyors

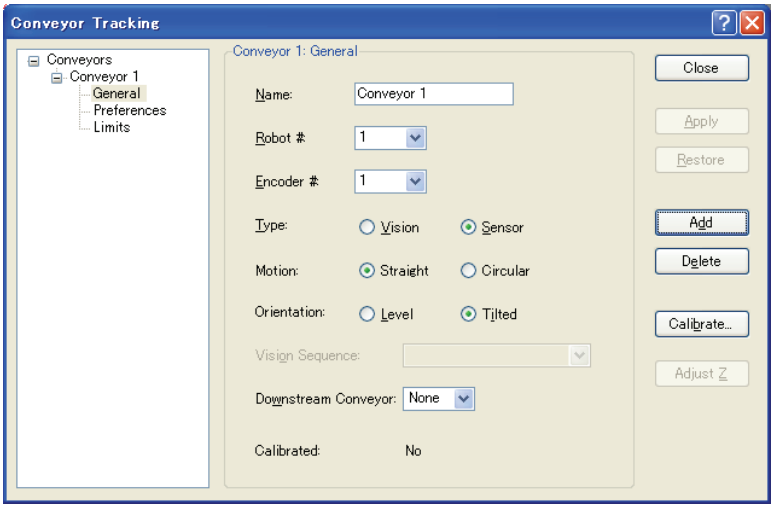
Sensor conveyor calibration (Straight conveyor)

Follow these steps to calibrate a straight sensor conveyor:

NOTE

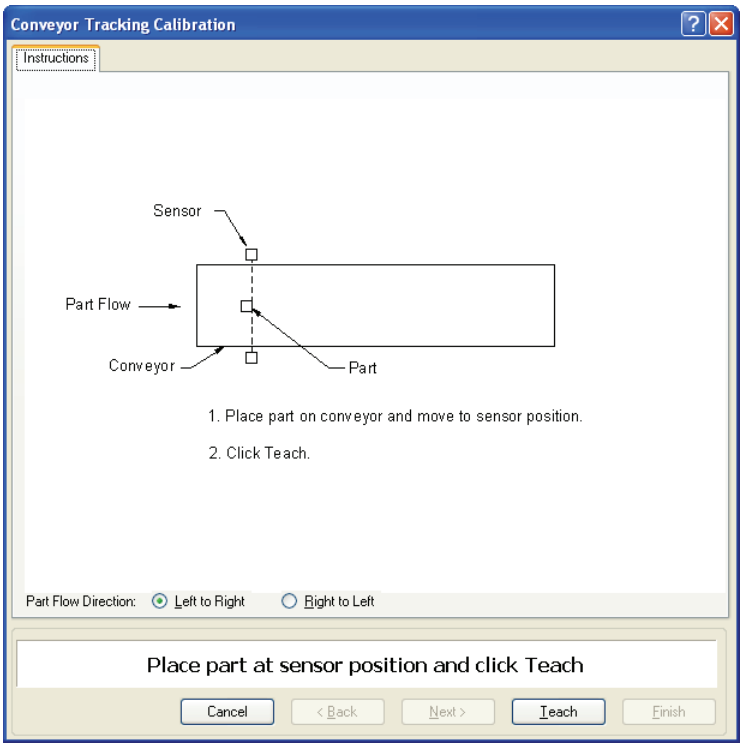
- When teaching part positions with the robot during calibration, it is important to position X, Y, and Z of each point accurately. The conveyor is calibrated in X, Y, Z, U, V, and W.
- To perform the fine calibration, in steps 9 and 11, set as wide a distance as possible between the upstream limit and the downstream limit. After calibration, adjust the Pickup Area by resetting the upstream / downstream limits.
- For the level orientation, the conveyor height is determined by the position of the robot end effector taught in step 8. It cannot be used for the tilted conveyor for it does not detect the conveyor slope. Steps 19 to 20 are not displayed.
- For the tilted orientation, it calibrates the conveyor slope with the position of robot end effector taught in the steps 8, 10, 12, and 14.

1. Select [Tools]-[Conveyor Tracking].
2. Select the conveyor you want to calibrate.

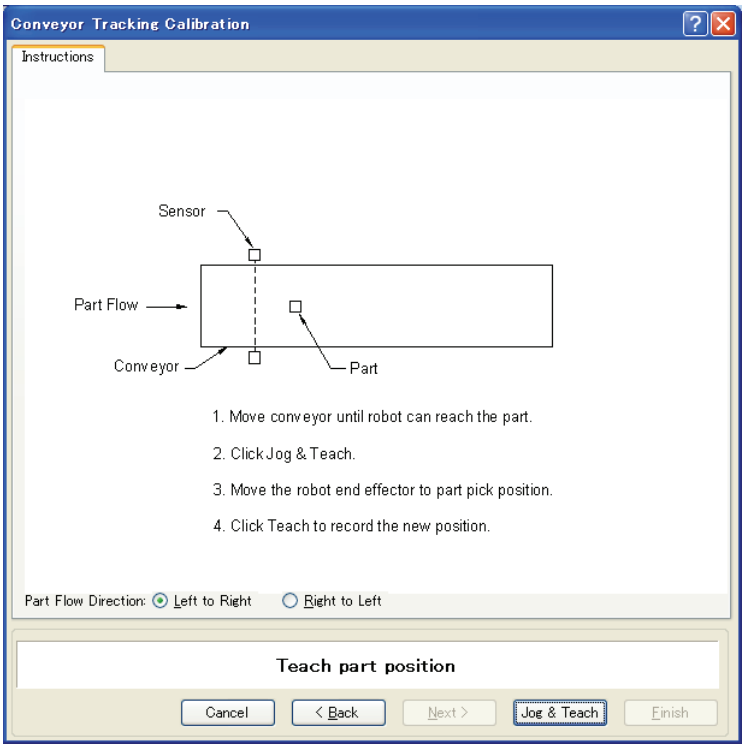


3. Click the <Calibrate> button. The Conveyor Tracking Calibration wizard will appear.
4. Follow the instructions for each step. Before you can proceed to the next step, you must click the <Teach> button. You can go back to previous steps using the <Back> button.
5. Select the [Part Flow Direction] to best match the conveyor you are calibrating. The instruction pictures will change according to the setting. [Part Flow Direction] is only used to aid in the instructions. It has no affect on the calibration.

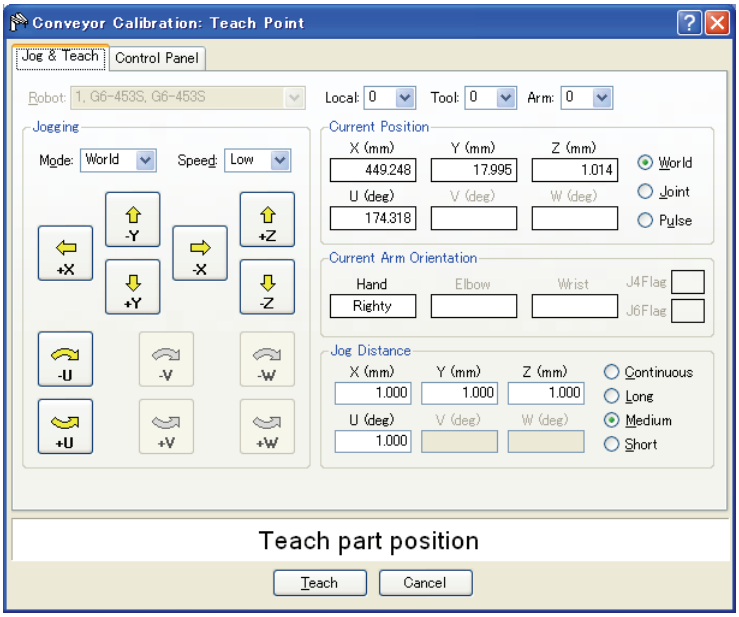
6. For the first wizard step, place a part on the conveyor and move the conveyor toward the sensor until the sensor just turns on. Click the <Teach> button.



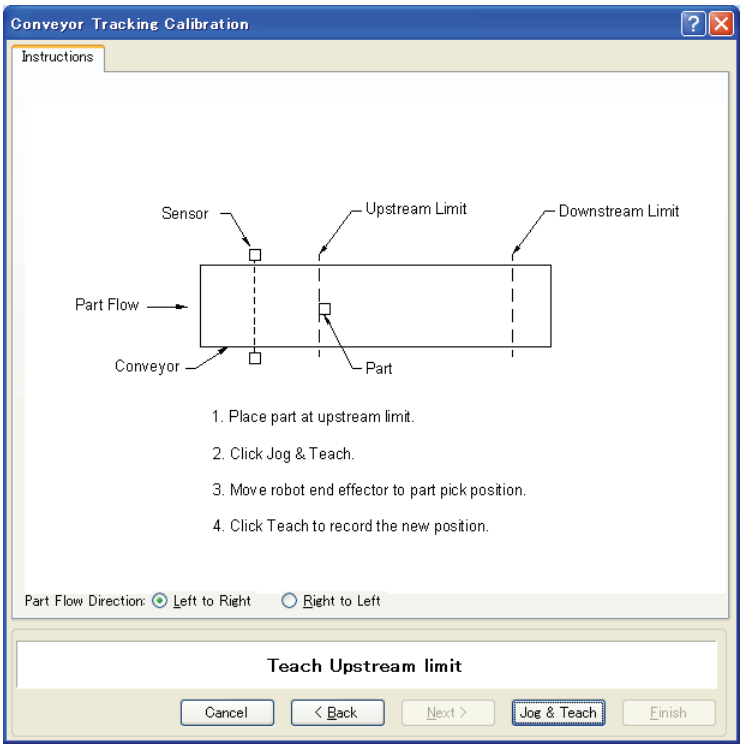
7. Move the conveyor by hand until the part is within reach of the robot. Do not move the part itself, only the conveyor. Click the <Jog & Teach> button.



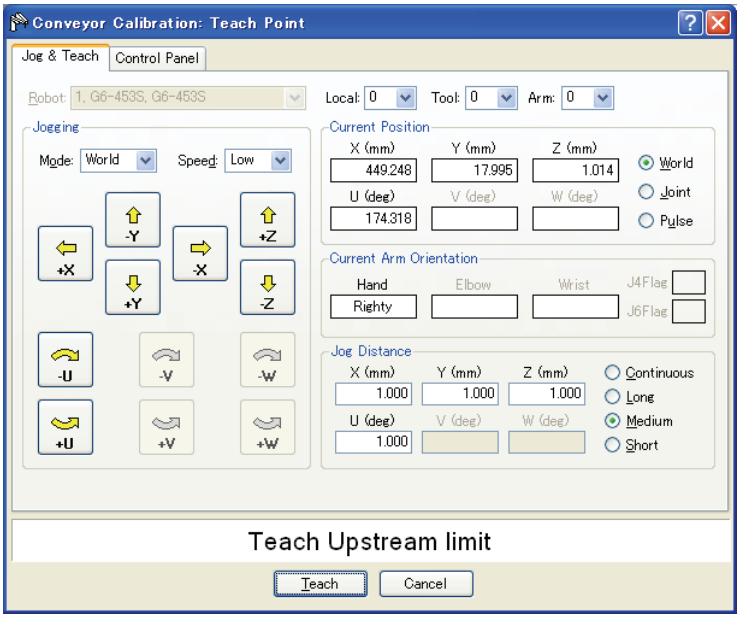
8. The Jog & Teach dialog will appear. Click the jog buttons to move the robot end effector to the pick position. Click the <Teach> button.



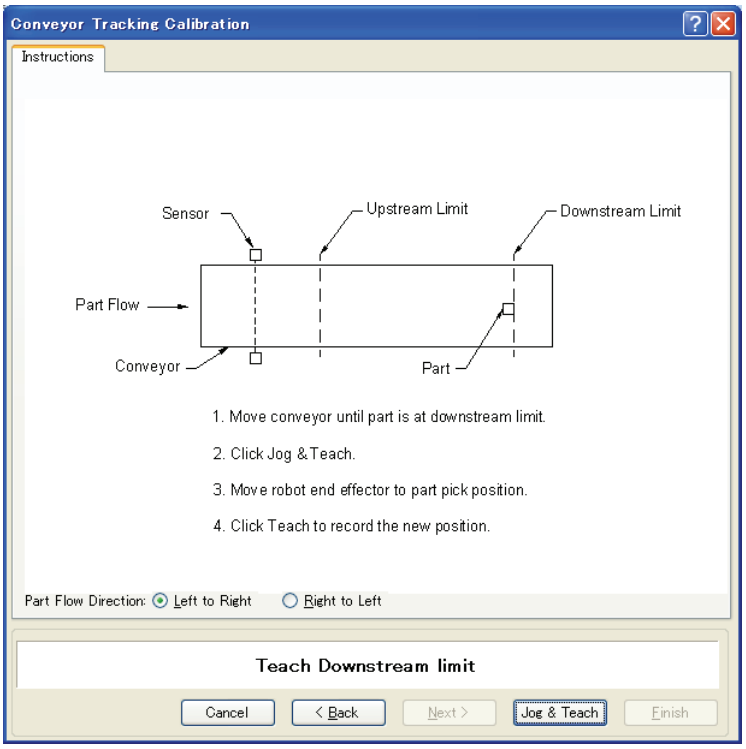
9. Now move or place the part at the upstream limit. Click the <Jog & Teach> button.



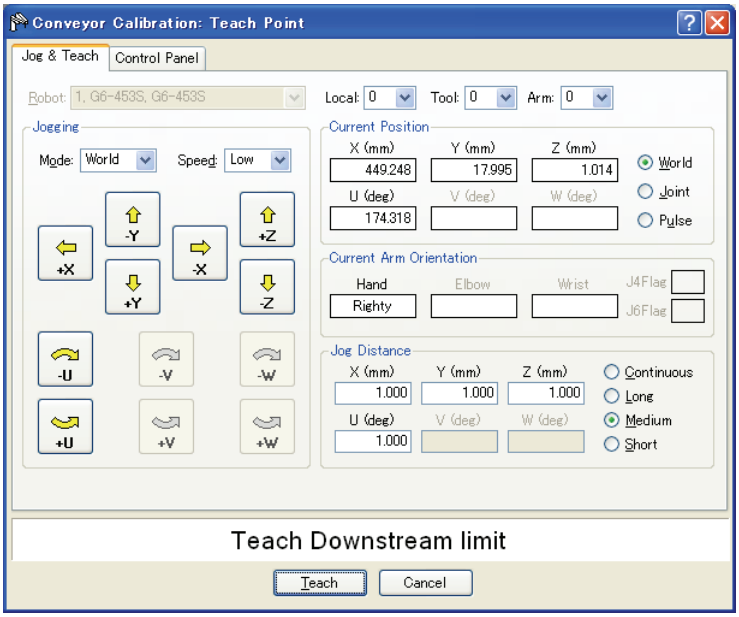
10. The Jog & Teach dialog will appear. Click the jog buttons to move the robot end effector to the pick position. Click the <Teach> button.



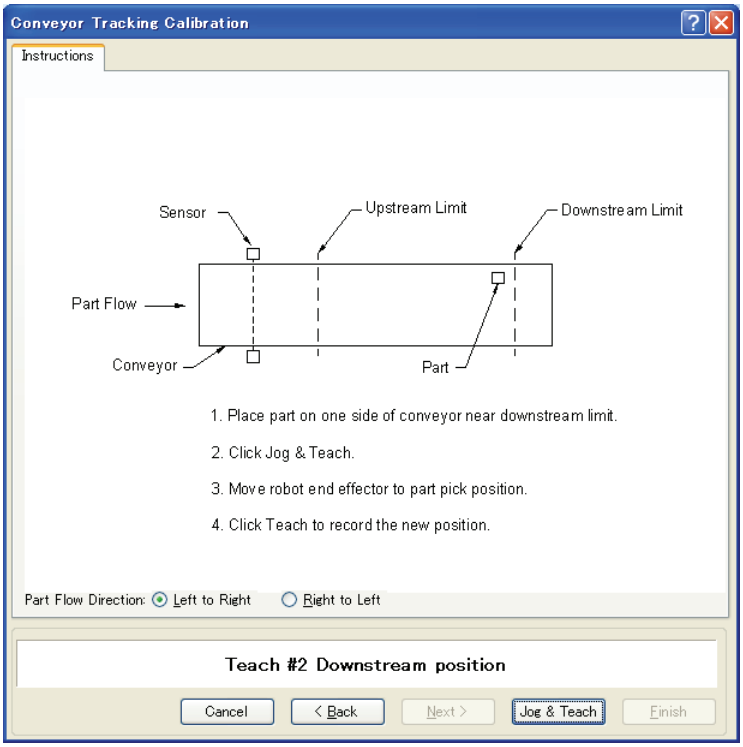
11. Move the conveyor so the part is at the downstream limit. Do not move the part, only the conveyor. Click the <Jog & Teach> button.



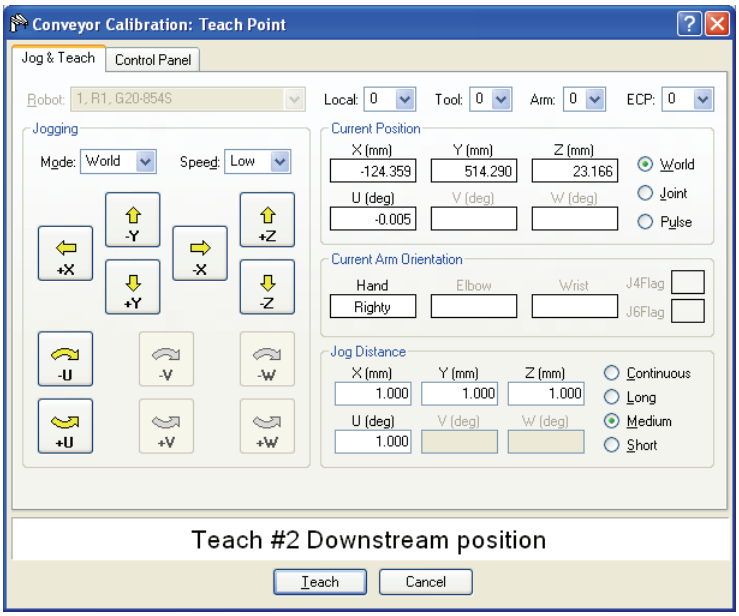
12. The [Jog & Teach] dialog will appear. Click the jog buttons to move the robot end effector to the pick position. Click the <Teach> button.



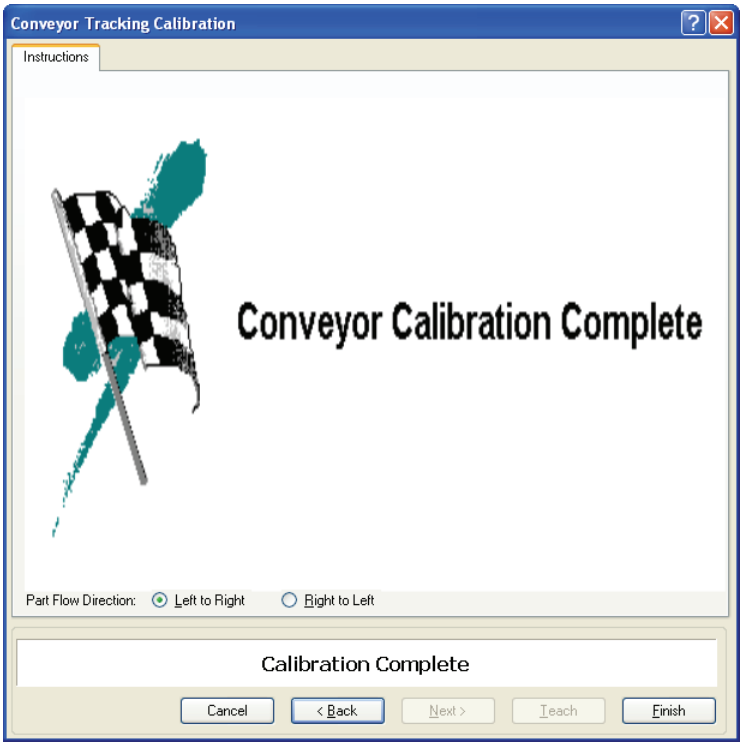
13. Place a part on one side of the conveyor near the downstream limit. This point is used to determine the tilt of the conveyor from side to side. Click the <Jog & Teach> button.



14. The [Jog & Teach] window will appear. Click the jog buttons to move the robot end effector to the pick position. Click the <Teach> button.



15. The calibration complete picture will be displayed. Click the <Finish> button.



Sensor Conveyor Calibration (Circular conveyor)

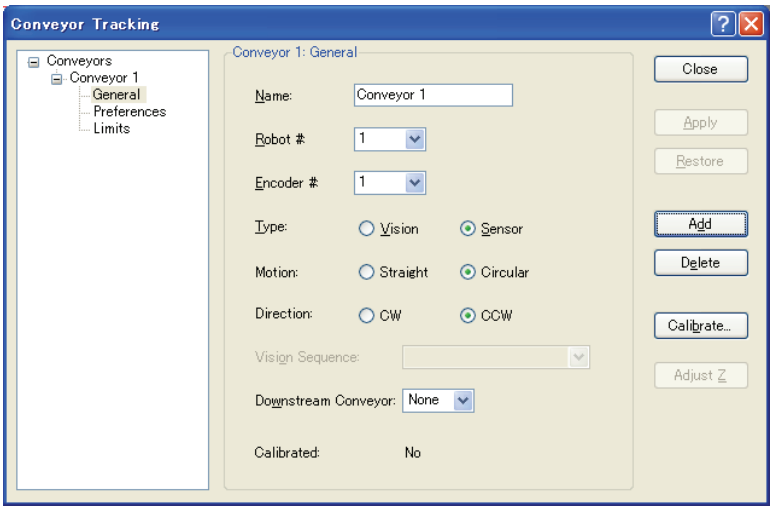
Follow these steps to calibrate a circular sensor conveyor:

NOTE

- When teaching part positions with the robot during calibration, it is important to position X, Y, and Z of each point accurately. The conveyor is calibrated in X, Y, Z, U, V, and W.
- To perform the fine calibration, in steps 10, 12, and 14, teach the position when the robot is directly above the parts and set as wide a distance as possible between the points being taught.

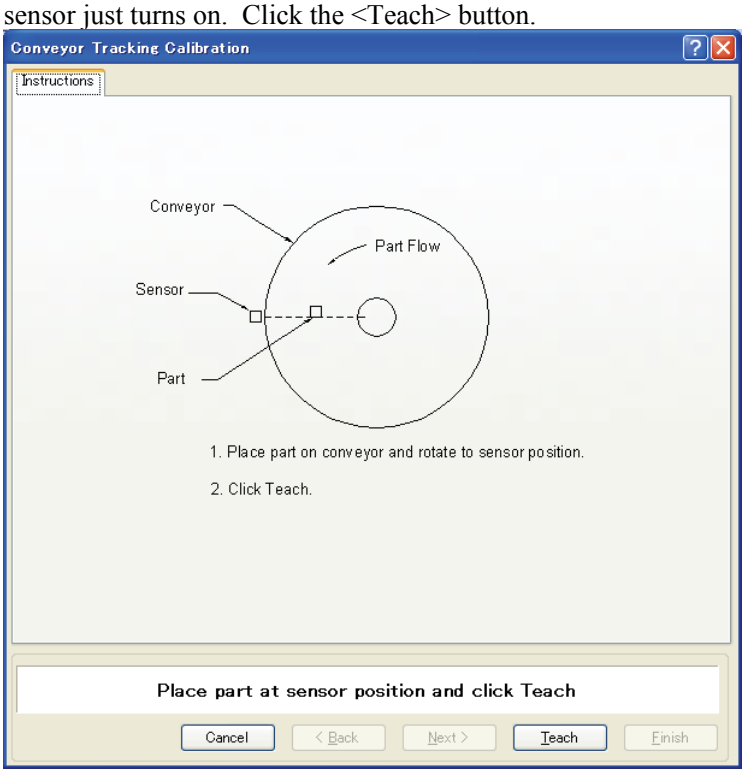
1. Select [Tools]-[Conveyor Tracking].
2. Select the conveyor you want to calibrate.
3. Select <Sensor> for the [Type].
4. Select <Circular> for the [Motion].
5. Select the conveyor rotating direction for the [Direction].

   Be careful not to calibrate with a wrong direction, otherwise, the robot will not track the parts.

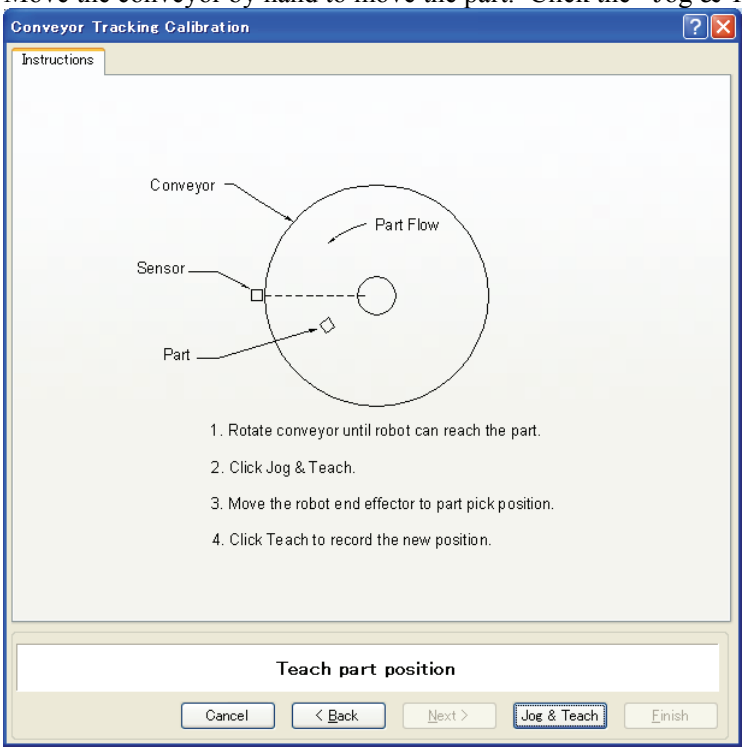


6. Click the <Apply> button.
7. Click the <Calibrate> button. The [Conveyor Tracking Calibration] wizard will appear. Follow the instructions for each step. Before you can proceed to the next step, you must click the <Teach> button. You can go back to previous steps using the <Back> button.
8. Check if the conveyor direction shown in the wizard is the same as the conveyor you want to use.

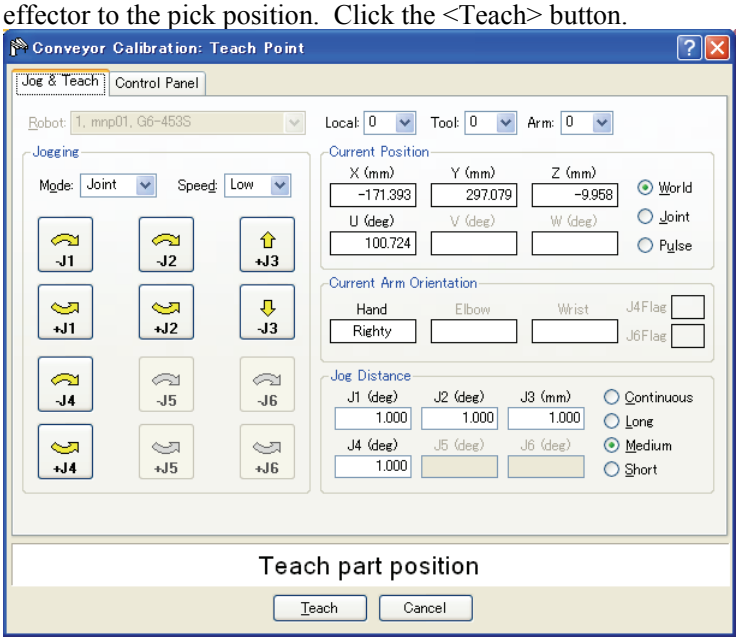
9. Place a part on the conveyor and move the conveyor toward the sensor until the sensor just turns on. Click the <Teach> button.



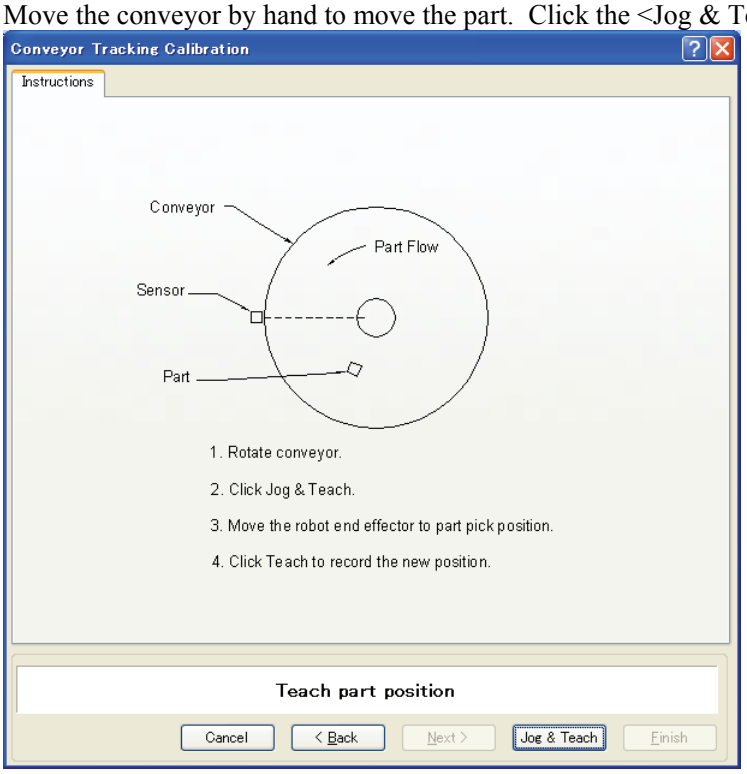
10. Move the conveyor by hand to move the part. Click the <Jog & Teach> button.



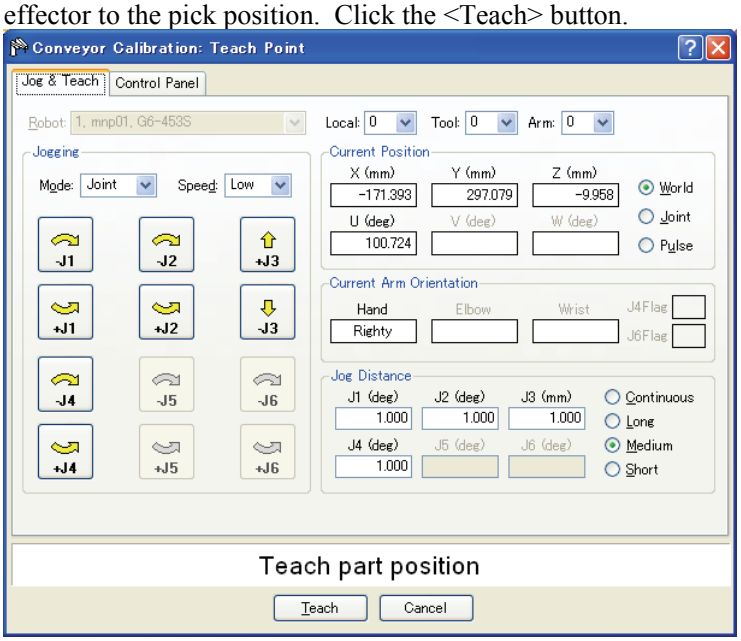
11. The [Jog & Teach] dialog will appear. Click the jog buttons to move the robot end effector to the pick position. Click the <Teach> button.



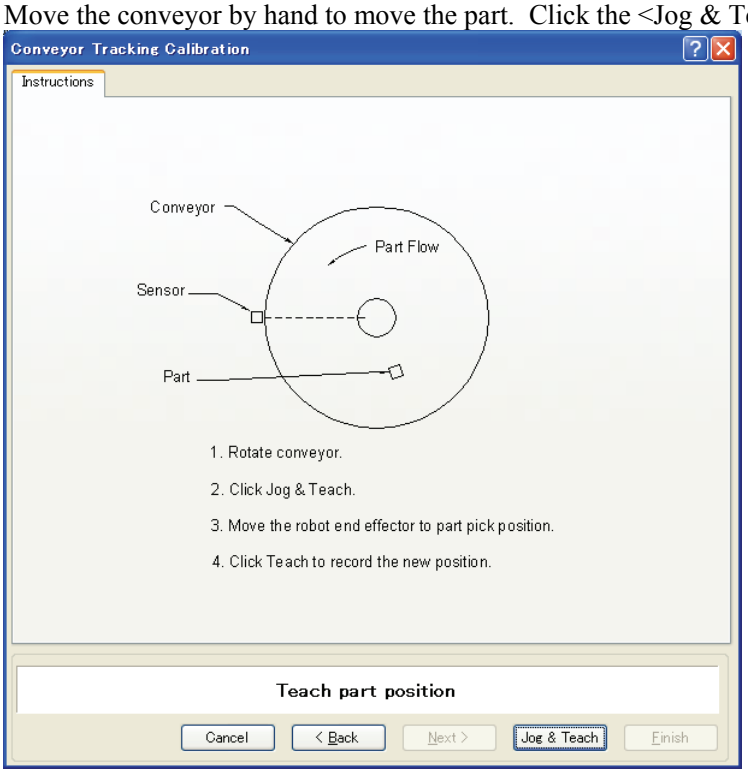
12. Move the conveyor by hand to move the part. Click the <Jog & Teach> button.



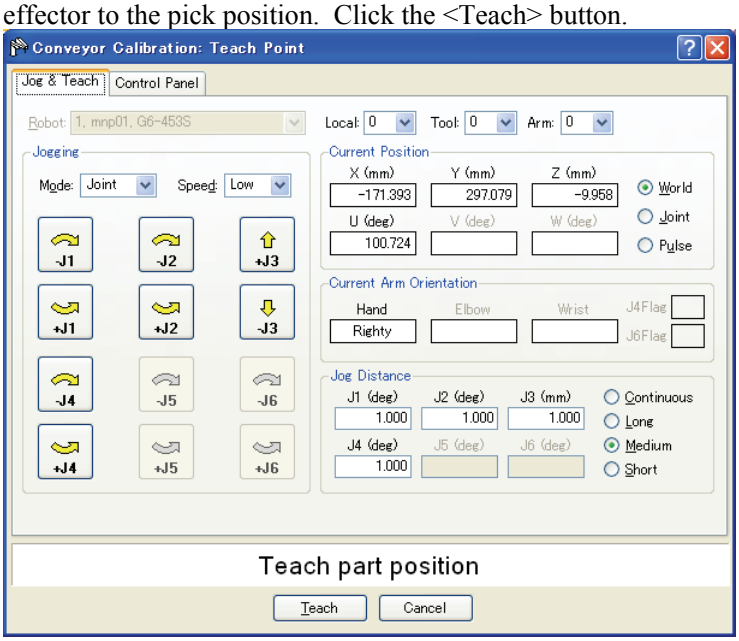
13. The [Jog & Teach] dialog will appear. Click the jog buttons to move the robot end effector to the pick position. Click the <Teach> button.



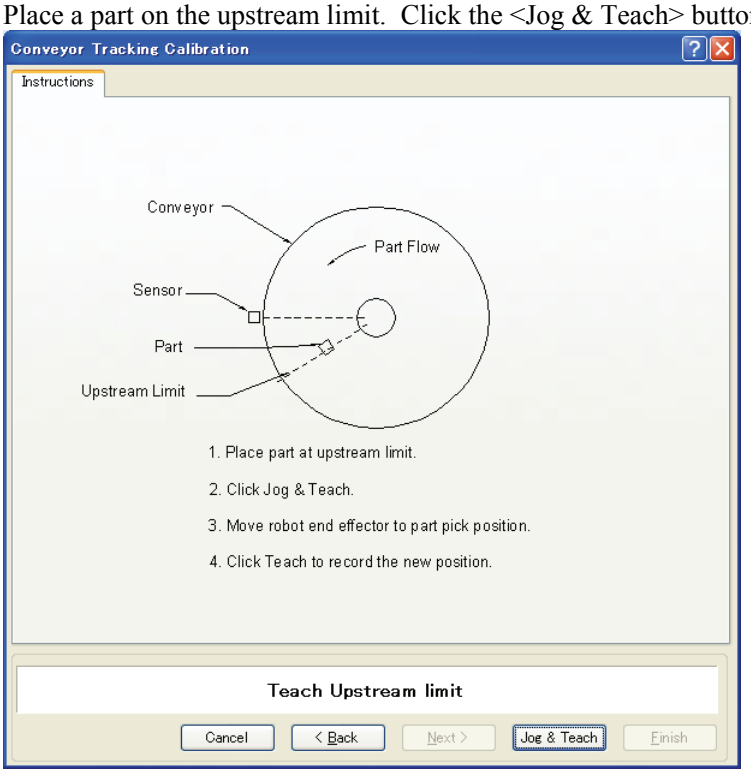
14. Move the conveyor by hand to move the part. Click the <Jog & Teach> button.



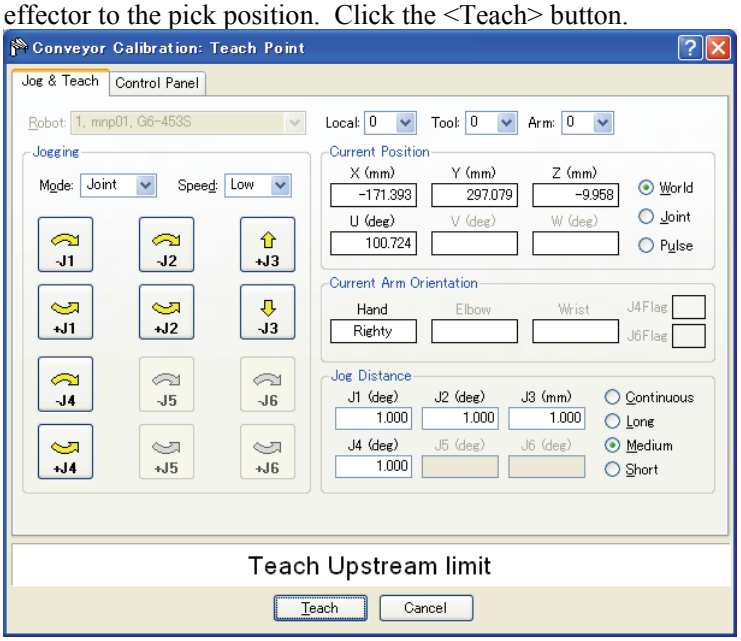
15. The [Jog & Teach] dialog will appear. Click the jog buttons to move the robot end effector to the pick position. Click the <Teach> button.



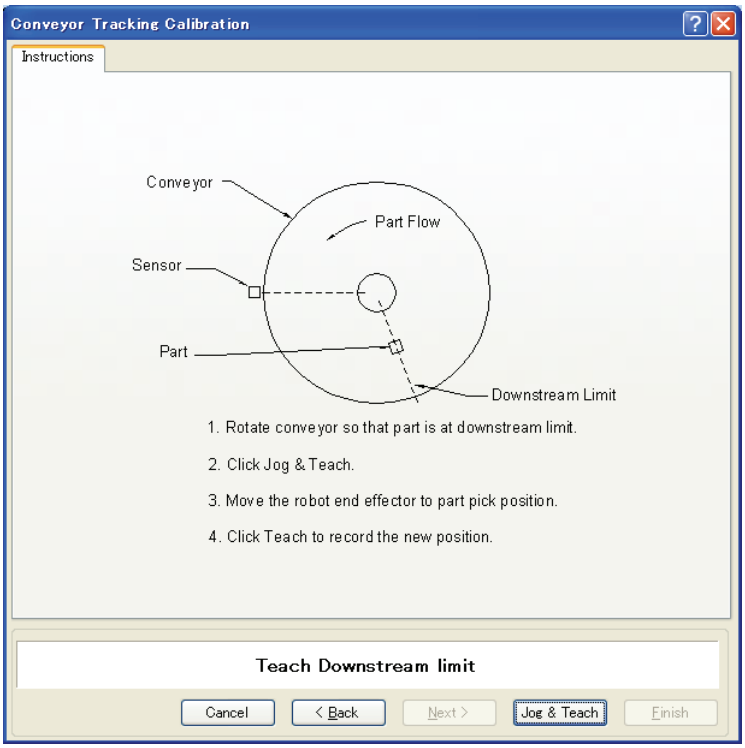
16. Place a part on the upstream limit. Click the <Jog & Teach> button.



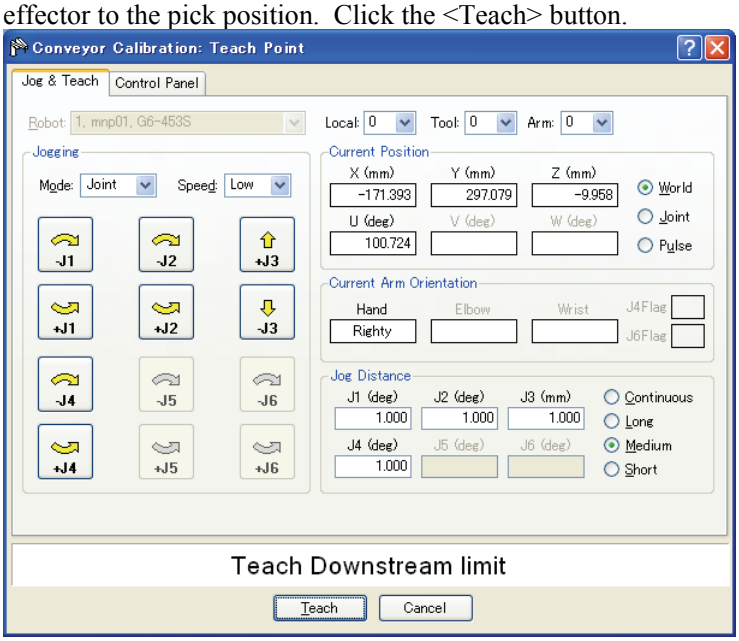
17. The [Jog & Teach] dialog will appear. Click the jog buttons to move the robot end effector to the pick position. Click the <Teach> button.



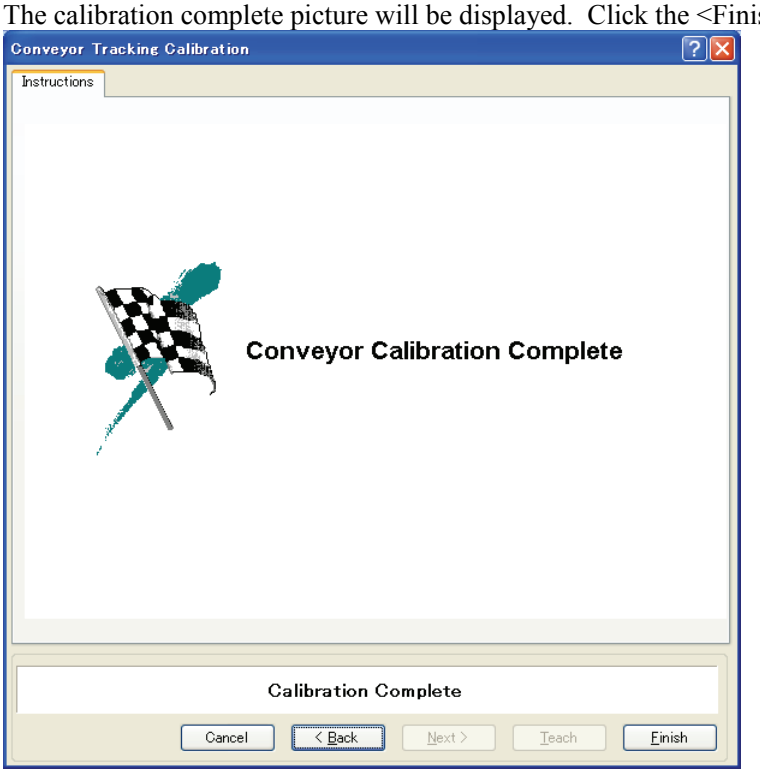
18. Move the conveyor so the part is at the downstream limit. Click the <Jog & Teach> button.



19. The Jog & Teach dialog will appear. Click the jog buttons to move the robot end effector to the pick position. Click the <Teach> button.



20. The calibration complete picture will be displayed. Click the <Finish> button.



Sensor conveyor operation check

After the calibration, we recommend that you check if the sensor conveyor works properly. Use the Command Window and follow the procedure below.

In this section, the operation of Conveyor #1 is checked.

1. Clear the all queue data registered to the conveyor.
   ```
   >Cnv_QueRemove 1,all
   ```
2. Place parts before the sensor area. Move the conveyor until the sensor turns ON.
3. Register a queue data.
   ```
   >Cnv_QueAdd 1,Cnv_Point(1,0,0)
   ```
4. Move the conveyor until the parts reach the Pickup Area.
5. Pick up parts.
   ```
   >Go Cnv_Queget(1,0):U(90):V(0):W(180)
   ```
6. Check if the robot end effector is over the center of the part to pick.
7. Move the conveyor and check if the robot follows the part. At this point, the end effector will be off the center of the part but this is no problem.
8. Stop the tracking motion.
   ```
   >Cnv_AbortTrack
   ```

In case the following symptoms occur, perform the calibration again.

- Robot cannot pick parts in the center.
- Robot cannot follow parts while the conveyor is moving.

Sensor conveyor programming

Typically, two tasks are used to operate a sensor conveyor. One task waits for a part to trip the sensor and add it to the conveyor queue. The other task checks for parts in the Pickup Area of the conveyor queue. When a part is in the Pickup Area, the robot is commanded to pick up the part and place it to the specified position.

```
Function main
  Xqt ScanConveyor      'Task that registers queues
  Xqt PickParts         'Task that tracks parts (queue)
Fend

Function ScanConveyor
  Double lpulse1                'Previous latch pulse
    lpulse1 = Cnv_LPulse(1)     'Register the latch pulse as lpulse1
    Do
      'Register a part as a queue only when it passes the sensor
      If lpulse1 <> Cnv_LPulse(1) Then
        Cnv_QueAdd 1, Cnv_Point(1, 0, 0)
```

```
        lpulse1 = Cnv_LPulse(1)   'Update lpulse1
      EndIf
    Loop
Fend

Function PickParts
  OnErr GoTo ErrHandler
  Integer ErrNum
  'Select the tracking mode
  Cnv_Mode 1,1
  WaitParts:
  Do
    'Wait until a part (queue) enters the Pickup Area
    Wait Cnv_QueLen(1, CNV_QUELEN_PICKUPAREA) > 0
    'Start tracking the parts
    Jmp3 place_1,Cnv_QueGet(1):Z(**):U(90):V(0):W(180),
         Cnv_QueGet(1):U(90):V(0):W(180)
    On gripper
    Wait .1
    'Move the picked part to a specified place
    Go place_2
    Off gripper
    Wait .1
    'Clear the picked part (queue)
    Cnv_QueRemove 1, 0
  Loop
  'Clear the parts (queu) in the downstream side from the Pickup Area
  'When error 4406 occurs, restore automatically
  ErrHandler:
    ErrNum = Err
    If ErrNum = 4406 Then
      Cnv_QueRemove 1, 0
      EResume WaitParts
    'When an error other than error 4406 occurs, display the error
    Else
    Print "Error!"
    Print "No.", Err, ":", ErrMsg$(Err)
    Print "Line :", Erl(0)
    EndIf
Fend
```

16.13 Multiple Conveyors

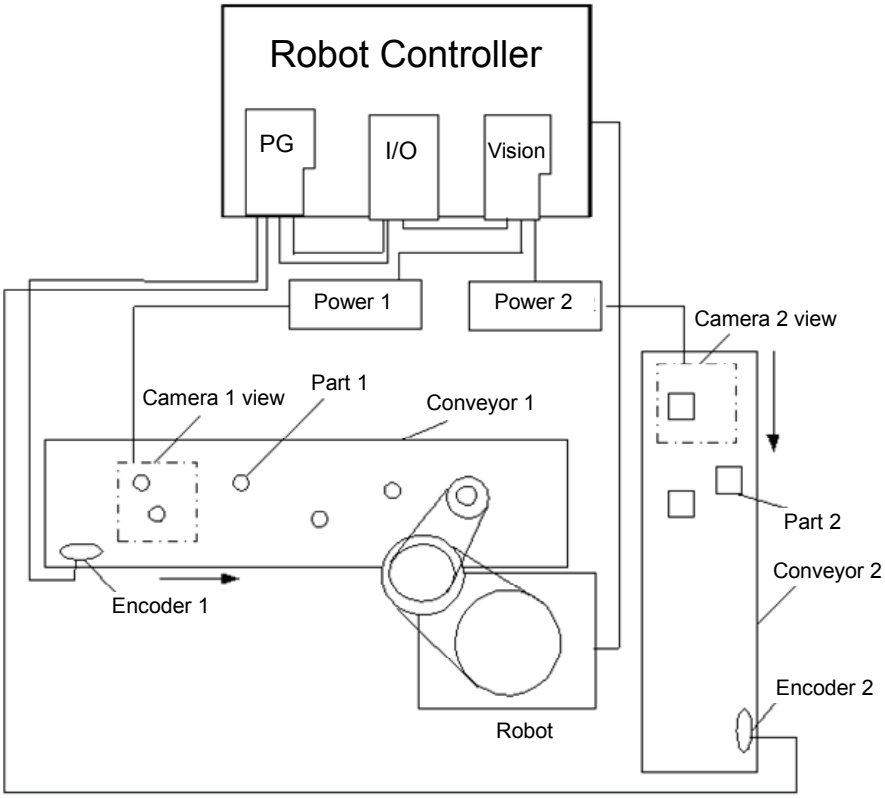
EPSON RC+ 7.0 supports multiple logical conveyors and robots. You can use multiple robots with one conveyor.

This section describes a conveyor system that uses one robot with two or more conveyors.

Conveyor Tracking for Several Conveyors

This section describes a conveyor system where one robot picks up “Part 1” from Conveyor 1 and puts the picked parts above “Parts 2” on Conveyor 2 as shown in the figure below.

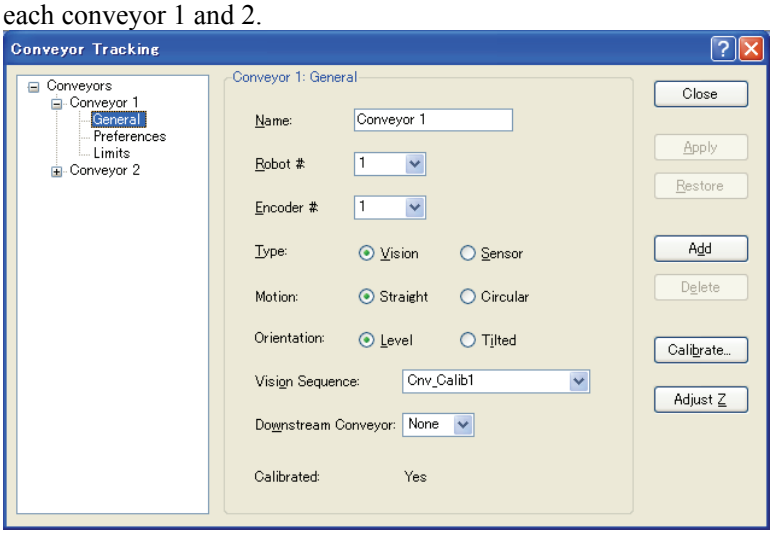
In this conveyor system, each conveyor needs one encoder and camera (sensor).



How to Use Several Conveyors

The usage of several conveyors is described below.

1. Refer to *15.9 Creating Conveyors in a Project* and create Conveyor 1 and Conveyor 2. (Set the robot in the upstream side to the Conveyor 1.)
2. For the [Encoder] and [Vision Sequence], set the different number and sequence for each conveyor 1 and 2.



3. Calibrate Conveyor 1.
4. Refer to *16.11 Vision Conveyors* or *16.12 Sensor Conveyors* and check the conveyor operation.
5. Calibrate Conveyor 2.
6. Check the operation of Conveyor 2.

   The following program is a sample.

```
Function main
  'Task that registers parts in the queues
  Xqt ScanConveyorStrobed
  'Task that tracks parts (queue)
  Xqt PickParts
Fend

Function ScanConveyorStrobed
  Integer i, j, numFound, state
  Real x, y, u
  Boolean found
  'Turn OFF the camera shutter and I/O (conveyor trigger)
  'Cv_trigger1: Conveyor 1, Cv_trigger2: Conveyor 2
  Off trigger; off Cv_trigger1; off Cv_trigger2
  Do
  'Register the parts (queue) of the Conveyor 1
    'Search for a part on the conveyor
    VRun FindParts1
    'Turn ON the camera shutter and I/O (conveyor trigger)
```

```
    On Trigger; On Cv_Trigger1
    Do
      VGet FindParts1.AcquireState, state
  Loop Until state = 3
  VGet FindParts1.Parts.NumberFound, numFound
  'Register the part that has been shot as a queue
  For i = 1 to numFound
    VGet FindParts.Parts.CameraXYU(i), found, x, y, u
    Cnv_QueAdd 1, Cnv_Point(1, x, y)
  Next I
  'Turn OFF the camera shutter and I/O (conveyor trigger)
  Off Trigger; Off Cv_Trigger
  Wait .1

  'Register the parts (queue) of the Conveyor 2
    'Search for part on the conveyor
    VRun FindParts2
    'Turn ON the camera shutter and I/O (conveyor trigger)
    On Trigger; On Cv_Trigger1
    Do
      VGet FindParts2.AcquireState, state
  Loop Until state = 3
  VGet FindParts2.Parts.NumberFound, numFound
  `Register the part that has been shot as a queue
  For j = 1 to numFound
    VGet FindParts2.Parts.CameraXYU(j), found, x, y, u
    Cnv_QueAdd 2, Cnv_Point(2, x, y)
  Next J
  'Turn OFF the camera shutter and I/O (conveyor trigger)
  Off Trigger; Off Cv_Trigger2
  Wait .1

  Loop
Fend

Function PickParts
  OnErr GoTo ErrHandler
  Integer ErrNum
  MemOff 1
  MemOff 2
  Do
  WaitPickup1:
```

```
  'Tracking of Conveyor 1
'Turn ON the memory I/O when the Conveyor 1 tracking phase starts
  MemOn 1
  'Clear the parts (queue) in the downstream side from the downstream limit
  Do While Cnv_QueLen(1 CNV_QUELEN_DOWNSTREAM) > 0
    Cnv_QueRemove 1, 0
  Loop
  'Move to the standby position when  there is no part (queue) in the Pickup Area
  If Cnv_QueLen(1, CNV_QUELEN_PICKUPAREA) = 0 Then
    Jump place
  EndIf
  'Wait until a part (queue) enters the Pickup Area
  Wait Cnv_QueLen(1, CNV_QUELEN_PICKUPAREA) > 0
  'Start tracking the parts
  Jump Cnv_QueGet(1)
  On gripper
  Wait .1
  'Clear the picked part (queue)
  Cnv_Queremove 1,0
  'Finish the Conveyor 1 tracking phase
  MemOff 1

  'Tracking of the Conveyor 2
  WaitPickup2:
'Start the Conveyor 2 tracking phase
  MemOn 2
  'Clear the parts (queue) in the downstream side from the downstream limit
  Do While Cnv_QueLen(2, CNV_QUELEN_DOWNSTREAM) > 0
    Cnv_QueRemove 2, 0
  Loop
  'Move to the standby position when  there is no part (queue) in the Pickup Area
  If Cnv_QueLen(2, CNV_QUELEN_PICKUPAREA) = 0 Then
    Jump place
  EndIf
  'Wait until a part (queue) enters the Pickup Area
  Wait Cnv_QueLen(2 CNV_QUELEN_PICKUPAREA) > 0
  'Start tracking the parts
  Jump Cnv_QueGet(2)
  Off gripper
  Wait .1
  'Clear the picked part (queue)
  Cnv_QueRemove 2, 0
'Finish the Conveyor 2 tracking phase
```

```
        MemOff 2
      Loop
      'Parts (queue) in the downstream side from the Pickup Area
      'When error 4406 occurs, restore automatically
      ErrHandler:
        ErrNum = Err
        If ErrNum = 4406 Then
          If MemSw(1) = On Then
            Cnv_QueRemove 1
            EResume WaitPickup1
          EndIf
          If MemSw(2) = On Then
            Cnv_QueRemove 2
            EResume WaitPickup2
          EndIf
        'When error 4406 occurs, restore automatically
        Else
        Print "Error!"
        Print "No.", Err, ":", ErrMsg$(Err)
        Print "Line :", Erl(0)
        EndIf
Fend
```

16.14 Adjusting the Z value

You can adjust the conveyor Z value after the calibration is completed.

Adjusting the Z value is a function to change the work pickup height that has been determined during calibration.

In the following cases, adjust the Z value:

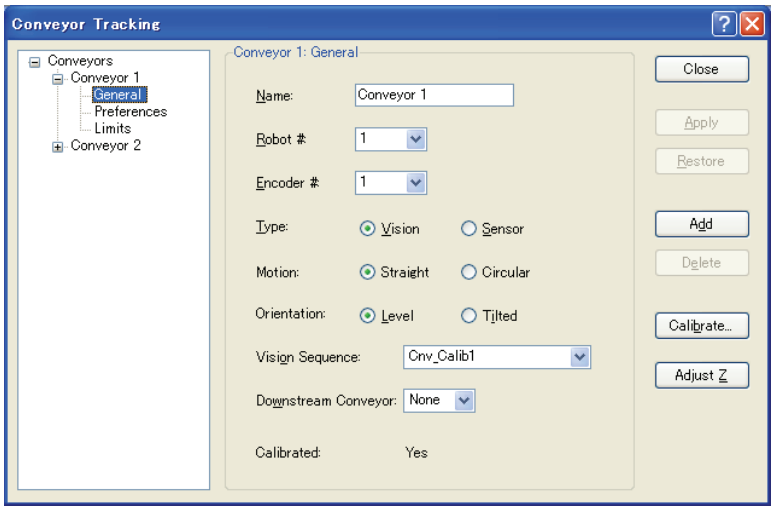
- To use a pickup area that is different from the one defined during calibration.

- The tool has been changed on the robot after calibration.

To adjust the Z value:

1. Select [Tools]-[Conveyor Tracking].
2. Select the conveyor you want to edit.
3. Click on [General].
4. The dialog shown below appears.

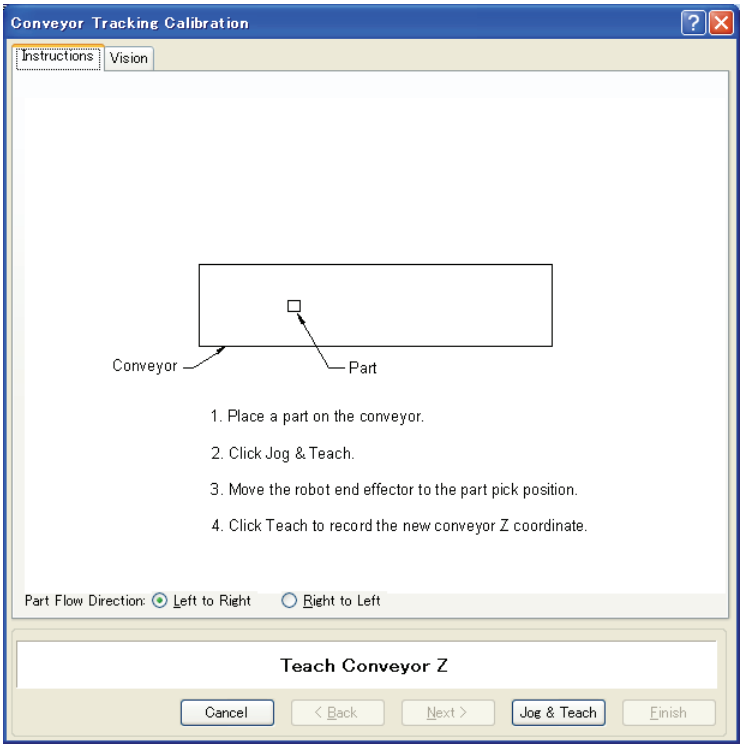
   Click on the <Adjust Z> button.



5. The dialog shown below appears.

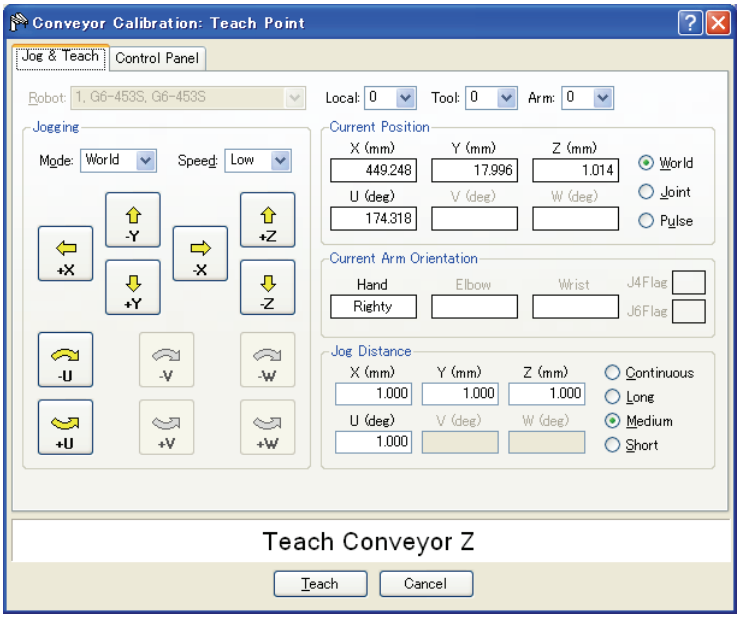
   Place a part on the conveyor in the robot motion range.

   Click on the <Jog & Teach> button.



6. The [Jog & Teach] dialog will appear. Click the jog buttons to move the robot end effector to the pick position.

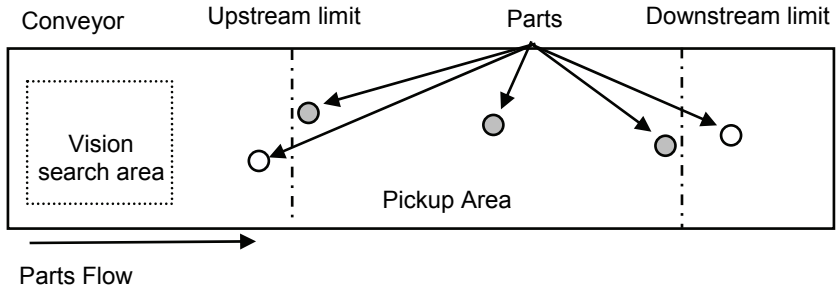
   Click the <Teach> button.



16.15 Pickup Area

The Pickup Area is the range where the robot can pickup parts.

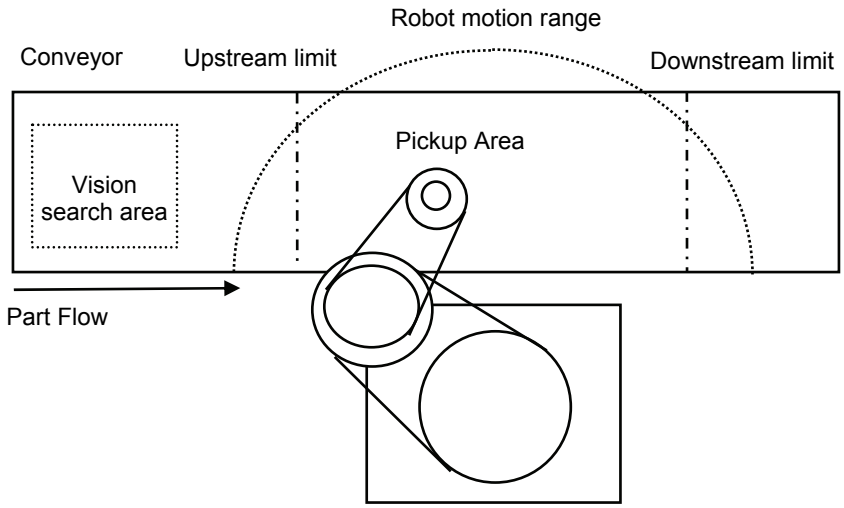
In the figure below, the robot can pick up the parts in gray.



If the Pickup Area is not appropriate, the robot cannot pick up parts. Follow the steps and cautions below to carefully set the Pickup Area.

To define the Pickup Area:

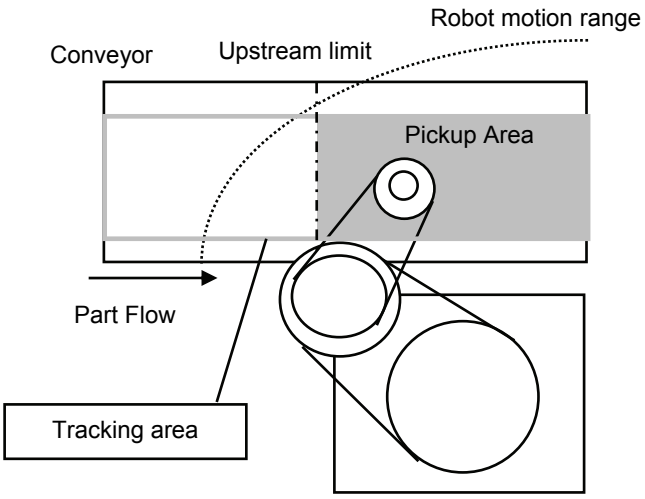
1. After calibration, the Pickup Area will be defined as shown in the following figure. Note that the positions of upstream limit and downstream limit depend on the positions you teach during the calibration.



2. Decide the upstream limit position.

   The robot starts pickup from the line defined by the upstream limit. The Pickup Area from the upstream limit must be within the robot motion range. (See the figure below.)

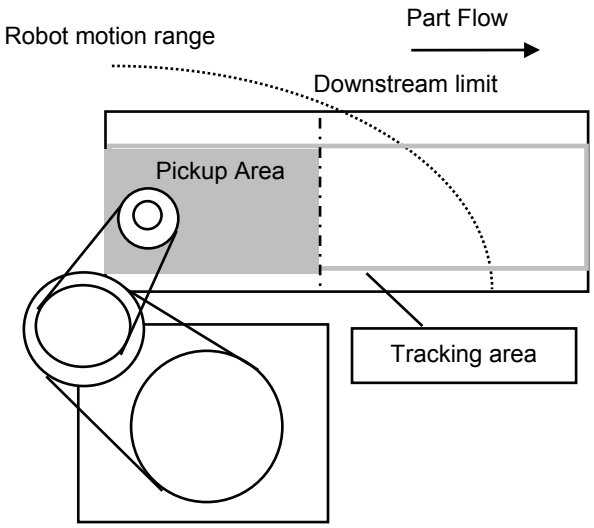
NOTE The robot does not start pickup until parts cross the upstream limit. If you set the upstream limit in uppermost position, you can reduce the robot standby time.



3. Decide the downstream limit position.

   Once the robot starts pickup, it continues its operation even over the downstream limit to complete the whole operation. Therefore, set the downstream limit in uppermost possible position so that the robot can operate within its motion range until it completes the operation. (See the figure below.)

NOTE The downstream limit position depends on the conveyor speed and robot position when it starts pickup. If the robot goes over the motion range during the operation, move the downstream limit to upper side.



Changing the Upstream / Downstream limits positions

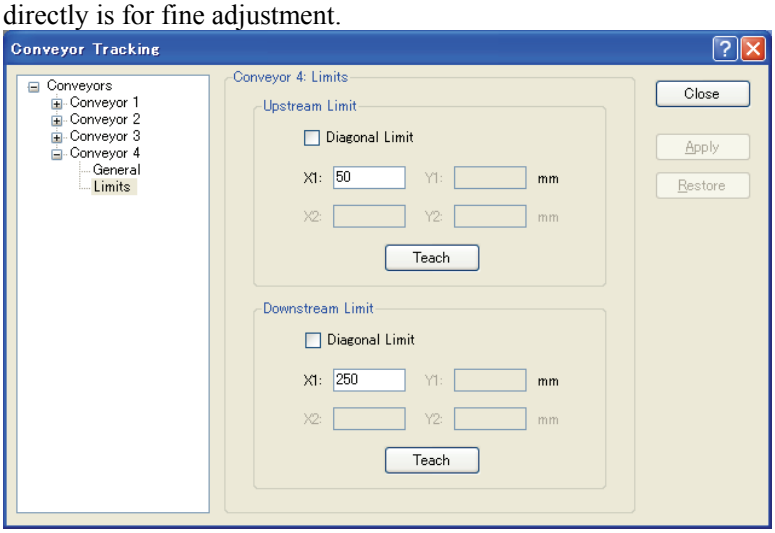
To change the upstream limit and downstream limit positions, follow the steps below.

To change the Upstream Limit:

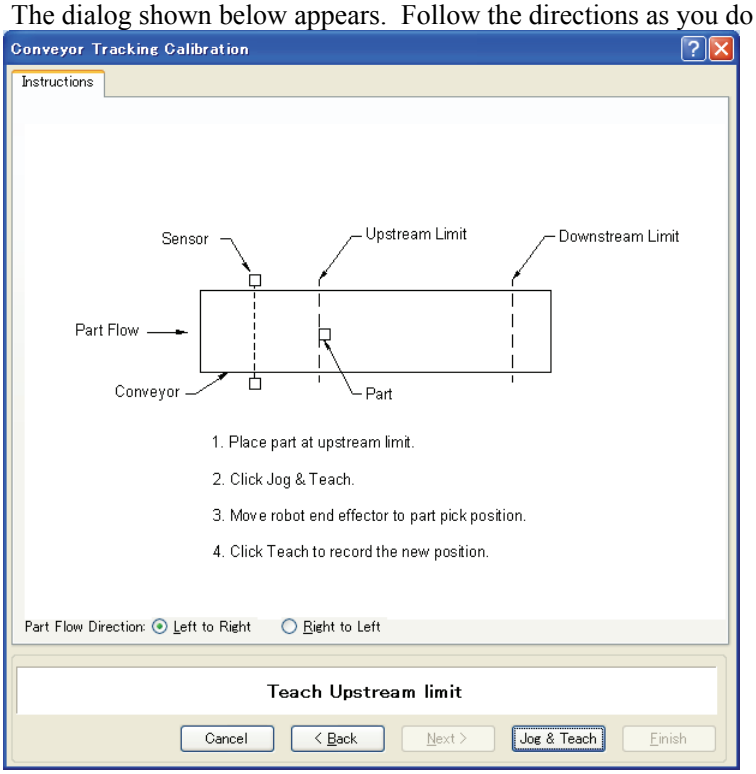
1. Select [Tools]-[Conveyor Tracking].
2. Select the conveyor you want to edit.
3. Click [Limits].
4. The dialog shown below appears.

   Edit the [Upstream Limit] value.

   To define the X1 value, enter a value directly or use Jog & Teach. Entering values directly is for fine adjustment.



5. When you directly specify the value, enter the value in the box and click <Apply>.
6. When you use Jog & Teach, click the <Teach> button.
7. The dialog shown below appears. Follow the directions as you do during calibration.



To change the downstream limit, edit the [Downstream Limit] value the same as described for the upstream limit.

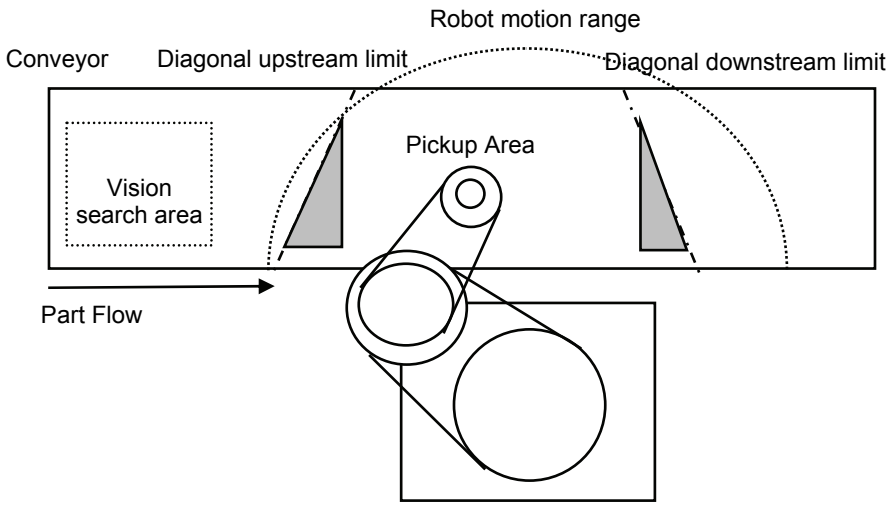
NOTE

Upstream and downstream positions can be changed from the Spel program by using Cnv_Upstream and Cnv_Downstream commands.
(Diagonal upstream and downstream cannot be changed from the Spel program)

Diagonal Upstream / Downstream Limits

After the calibration, you can set the dividing lines for the Pickup Area (upstream limit / downstream limit) directed diagonally to the part flow.

When you change the dividing lines to diagonal positions, the Pickup Area also changes as shown below. The area indicated in gray is widened by changing the dividing lines to diagonal positions. In addition, diagonal dividing lines are called the diagonal upstream / downstream limits.



The following are the advantages you can get by widening the Pickup Area.

- Reduce robot standby time by widening the upper side Pickup Area.

- Less possibility of missing parts which flow longer after the downstream limit.

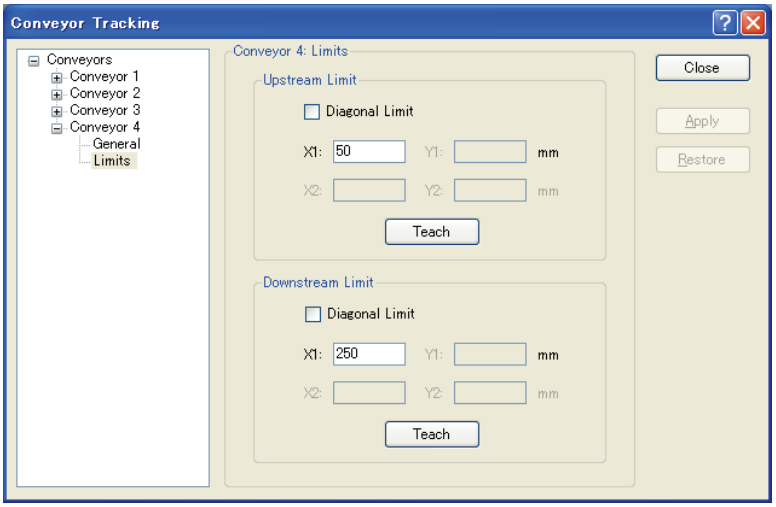
NOTE

If there are too many parts on the conveyor for the robot to pick up, it only makes the robot move for longer distance and longer time and the number of parts the robot can pick up may decrease, even in a widened Pickup Area.

The robot capacity (how fast or how many parts robot can pick up) depends on the Pickup Area width, robot standby position, and conveyor speed.

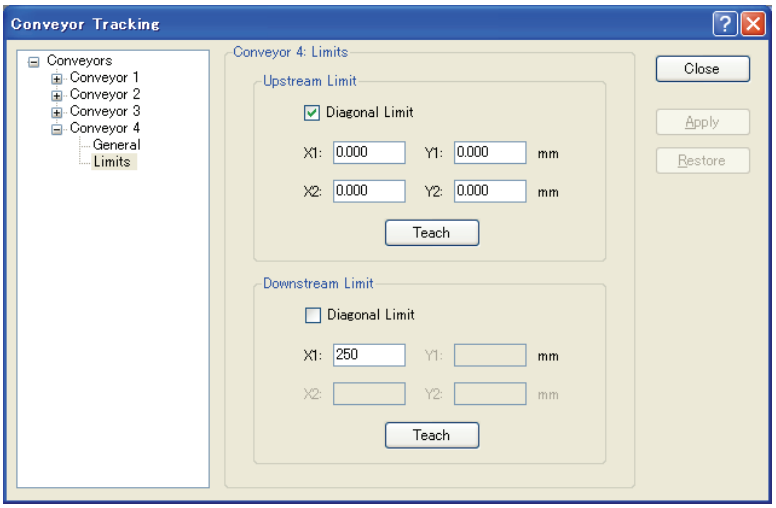
To set the diagonal upstream limit:

1. Select [Tools]-[Conveyor Tracking].
2. Select the conveyor you want to edit.
3. Click on [Limits].
4. The dialog shown below appears.



Check the <Diagonal Limit> check box in [Upstream Limit] and click <Apply>.

The following dialog appears.

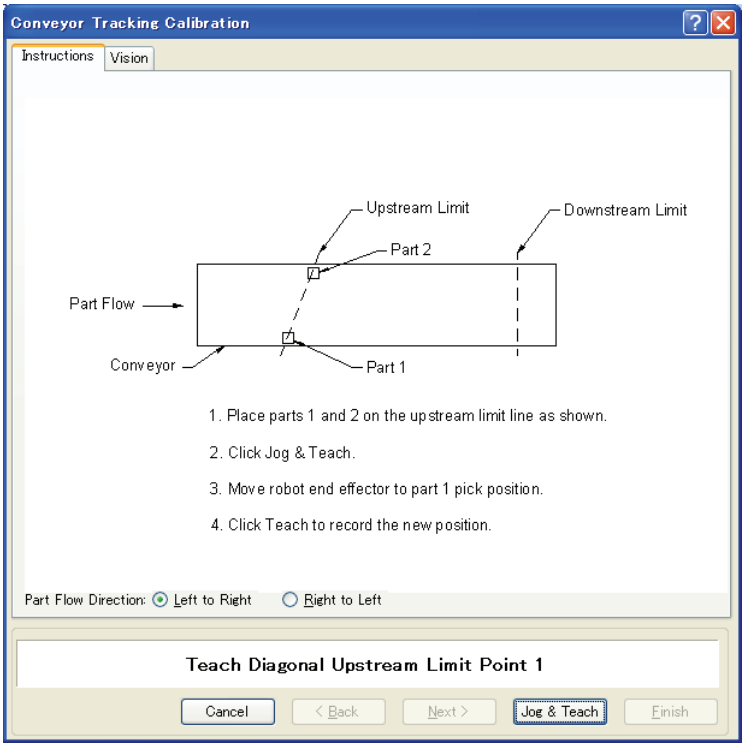


To define the values for X1, Y1, X2, Y2, enter the values directly or use Jog & Teach. Entering values directly is for fine adjustment.

5. When you directly specify the values, enter the values in the boxes and click <Apply>.

6. When you use Jog & Teach, click <Teach>.

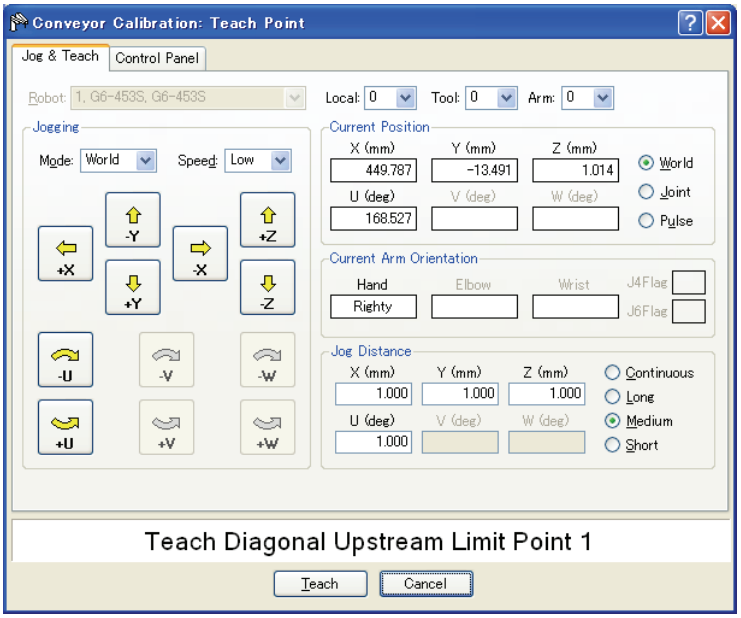
   The dialog shown below appears.



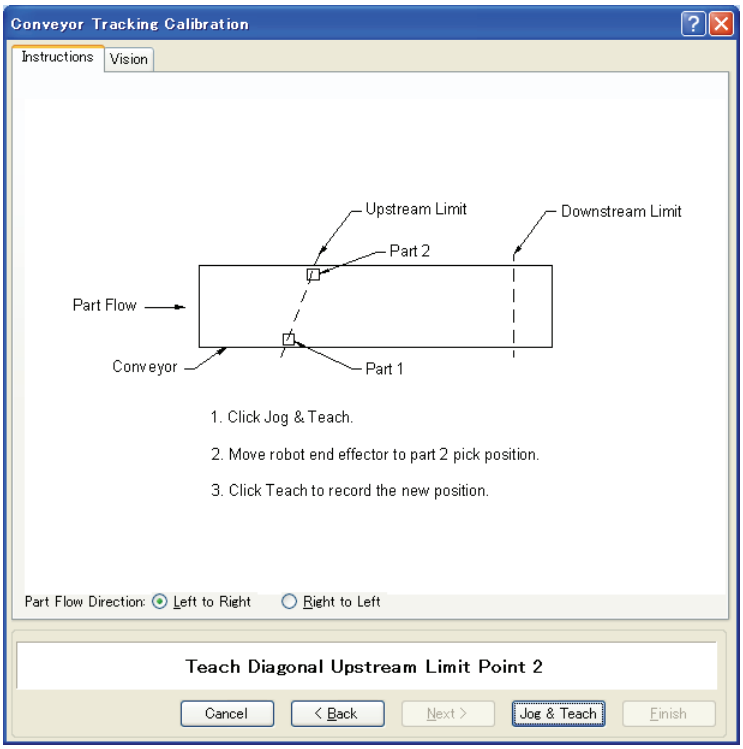
7. Place two parts on the conveyor.

   Click the <Jog & Teach> button.

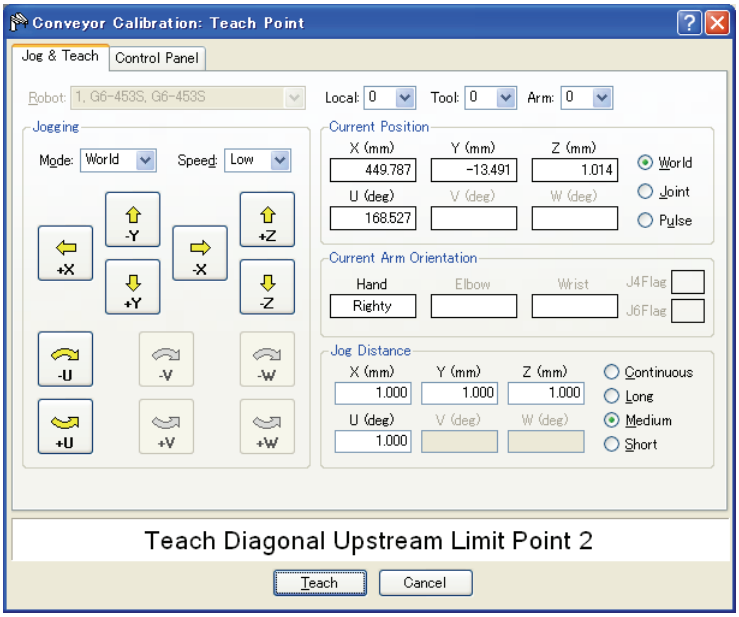
8. The [Jog & Teach] dialog appears. Click the jog buttons to move the robot end effector to the pick position. Click the <Teach> button.



9. The dialog shown below appears. Click the <Jog & Teach> button.

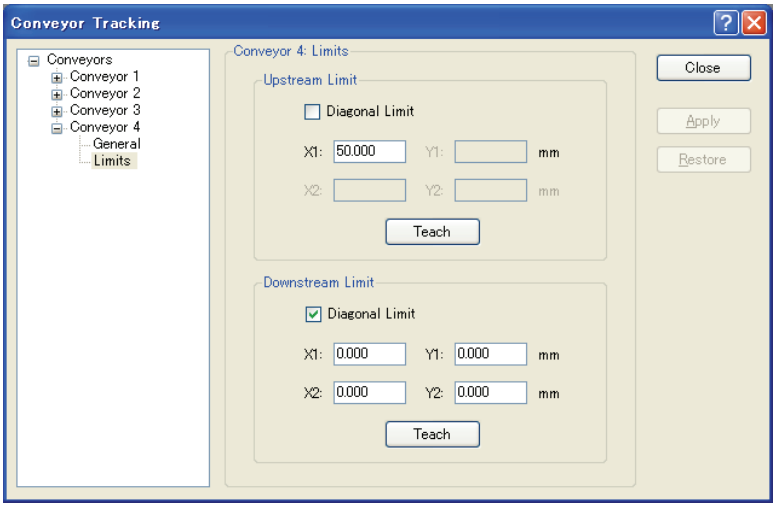


10. The [Jog & Teach] dialog appears. Click the jog buttons to move the robot end effector to the pick position. Click the <Teach> button.



To set the diagonal downstream limit, check the <Diagonal Limit> check box in the [Downstream Limit] area and click <Apply>.

The following dialog appears. Click the <Teach> button and follow the directions in the wizard.



Note that error 4415 occurs when the diagonal upstream / downstream limits are defined as in the following cases.

- They are perpendicular to the part flow direction.
- They are parallel to the part flow direction.
- The diagonal upstream limit and downstream limit cross on the conveyor.

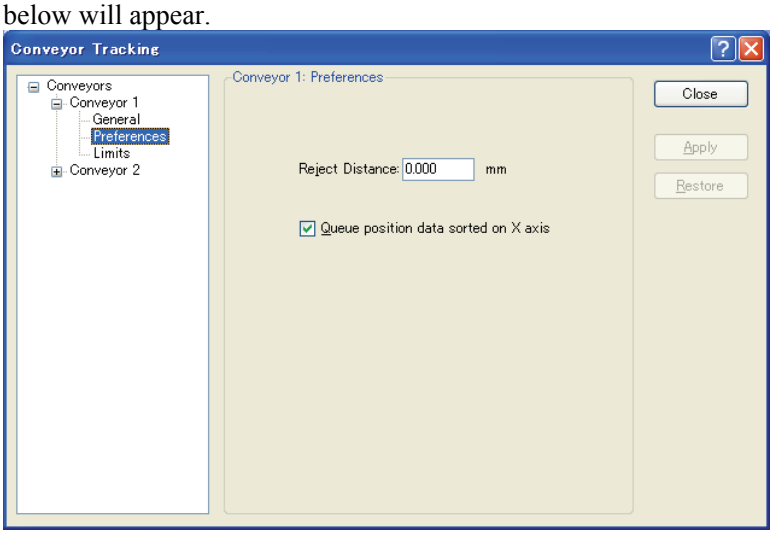
16.16 Queue Sorting

When you set the queue sorting, it registers the queue data in the order of position along the X axis in the conveyor local coordinate system.

Set 0 for the index number of Cnv_QueGet command. If you set nothing, the robot picks up parts from the downstream side.

To set the queue sorting

1. Select [Tools]-[Conveyor Tracking].
2. Click the conveyor you want to configure and select the [Preferences]. The dialog below will appear.



3. Set the [Queue position data sorted on X axis] box.
4. Click the <Apply> button.

NOTE

When you set a diagonal upstream limit, register the queue data in the order of entering the Pickup Area.

Also, when you set a diagonal upstream limit, note that the queue sorting cannot be canceled.

NOTE

The queue sorting function is applied to both upstream and downstream conveyors.

16.17 Abort Tracking

There are some situations when you want to abort tracking a part that moves out of the Pickup Area while the robot is tracking the part. In this case, use the Cnv_AbortTrack command in a separate task that monitors the conveyor queue.

```
Function MonitorDownstream
  Robot 1
  Do
    If Cnv_QueLen(1, CNV_QUELEN_DOWNSTREAM) > 0 Then
      Cnv_AbortTrack 0
    EndIf
    Wait .1
  Loop
Fend
```

16.18 Conveyor Tracking with 6-Axis Robot

When you use a 6-axis robot in a conveyor tracking system, you need to set the values of U, V, and W. For this, use the Cnv_QueGet command.

The following shows the case where the robot end effector moves toward a part during the pickup.

```
Go Cnv_Queget(Conveyor number,[Index]):U(90):V(0):W(180)
```

To use the Jump3 command, write a program as follows:

```
Jmp3 P1,Cnv_QueGet(1):Z(**):U(90):V(0):W(180),
     Cnv_QueGet(1):U(90):V(0):W(180)
```

NOTE

P1 and Z(**) height should be the same.

The followings are points to be known before setting the Z(**) height.

- Home position of Z in the tracking coordinate is the calibration position.
- To raise the Z height in the tracking coordinate, offset in a positive (+) direction.
- To lower the Z height in the tracking coordinate, offset in a minus (-) direction.
- Robot coordinate P1 can be converted to the conveyor coordinate and displayed.

  > print P1@cnv1

16.19 Tracking Mode

There are two tracking modes: picking quantity-priority mode and picking accuracy-priority mode. The mode can be selected by the Cnv_Mode command.

Tracking mode selection is only available for linear conveyors. For circular conveyors, the picking quantity-priority mode is only available.

Picking quantity-priority mode

Picking quantity-priority mode prioritizes reducing time to catch up with the work piece (queue) over the picking accuracy. This mode is suitable for the conveyor tracking system in which space between the work pieces is narrow.

NOTE

When the picking quantity-priority mode is selected, tracking delay (situation in which the Manipulator does picking motion at the posterior part of the work piece to the direction of the conveyor motion) may occur. If the tracking delay occurs, write the program as follows.

```
Go Cnv_Queget(Conveyor number,[Index])+X(**)
```

Picking accuracy-priority mode

Picking accuracy-priority mode improves the picking accuracy while it takes more time to catch up with the work piece. This mode is suitable for the conveyor tracking system for small work pieces.

Picking accuracy-priority mode should be used for the conveyors of 350 mm/sec or less.

NOTE

When the conveyor of 350 mm/sec or more is used, the tracking mode will be picking quantity-priority mode regardless of the setting of Cnv_Mode.

NOTE

Although the tracking delay does not occur in the picking accuracy-priority mode, the Manipulator may slide to the direction of the conveyor motion in Go, Move, or Jump3 motions after the downward motion of the Z-axis. If this occurs, take following countermeasures (these may not be effective for Go and Move motions)

- For Go motion: Change to Jump motion. Or, reduce the values of Accel and Speed.
- For Move and Jump3 motions: Reduce the values of AccelS and SpeedS.

16.20 How to shorten the picking cycle time

There are following two methods to shorten the picking cycle time.

- Use the Arch command
- Use the Cnv_Accel command

NOTE

The followings are the points to consider when using the Cnv_Accel command.

- Maximum Cnv_Accel value is 5000 mm/sec$^{2.}$
- If the Cnv_Accel setting value is 0 or exceeds 5001, the default value (2000 mm/sec^2) will be set.
- If the acceleration error occurs, greater Cnv_Accel value cannot be specified. Decrease the Cnv_Accel value or decrease Accel or AccelS.
- When Cnv_Accel is used in the picking accuracy-priority mode, the manipulator may slide to the direction of the conveyor motion after the downward motion of the Z-axis.

16.21 Manipulator Posture

Manipulator posture during the tracking motion is always the default posture regardless of the posture at the conveyor tracking calibration. To specify the posture for the tracking, write a program as follows.

Example: tracks the work piece with Lefty arm position

```
jump Cnv_Queget(Conveyor number,[Index])/L
```

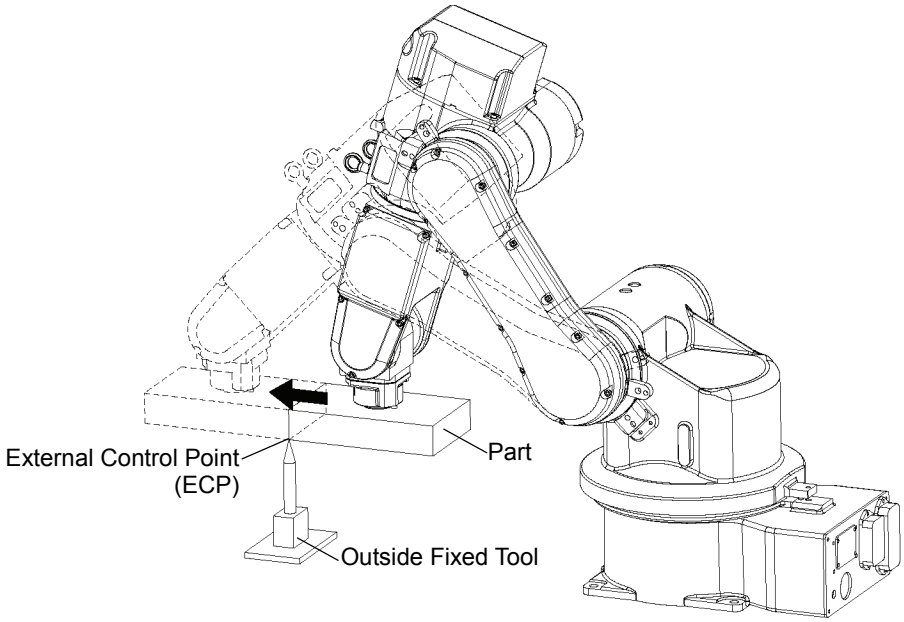
NOTE

During tracking motion, singularity avoiding function cannot be used. Therefore, set the positions of the Manipulator and the conveyor so that the Manipulator does not pass through the singularity.

17. ECP Motion

17.1 Overview

An ECP (external control point) motion is when the robot arm holding a part follows a specified trajectory (part's edges, etc.) using an outside fixed tool.



The ECP option supports the following:

- ECP definition by ECPSet statement and selection by ECP statement
- ECP motion commands (additional functions of Move, Arc3, Curve, and CVMove commands)
- Teaching with ECP jogging

This option is available for SCARA (including RS series), Cartesian and 6-axis robots. Also, it can be used with multi-robot systems.

Up to 15 ECP coordinate systems can be defined.

How to move the arm with ECP motion

In the following paragraphs, the process for moving the 6-axis robot arm with ECP motion is explained as an example.

1. Setting an ECP

The ECP (external control point) is a coordinate system data used for defining the robot position and orientation at a processing point on the tip of the outside fixed tool.

The ECP should be defined based on the robot coordinate system or desired local coordinate system.

For example, when a drawing shows that the ECP is located at X=300, Y=300, Z=300 based on the robot coordinate system, specify it as shown below.

```
ECPSet 1,XY(300,300,300,0,0,0)    ' Defines ECP No.1
```

When you have no ECP location data, you can specify it by teaching.

As an example, attach the tool of which you know the data precisely and bring the tip of the tool close to the ECP and then teach its position anywhere as P0. Then, specify the ECP using P0 coordinate data as shown below.

```
ECPSet 1,P0 :U(0) :V(0) :W(0)      ' Defines ECP No.1
```

The orientation data (U, V, W) were set to 0 in the above examples. In these cases, the orientation in the ECP coordinate system is equal to that in the reference robot coordinate system.

You can specify U, V, and W coordinates in the ECP coordinate system. However, this data is valid only during the tangential correction mode ON in the Curve statement and ECP jog motion.

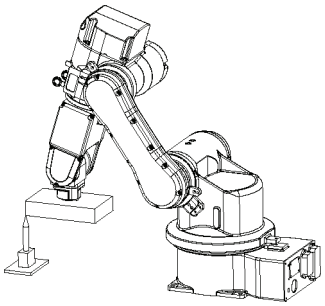
2. Teaching

Teach the point data while moving the robot arm holding the actual part. In this section, the part is assumed to be a rectangular solid and the arm is moved straight so that it touches one side of the part of the ECP specified in the previous section *1. Setting the ECP*.

For details on teaching, refer to *5.12.2 Robot Manager (Tools Menu)*.

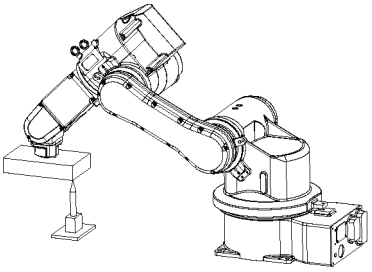
2-1 Teaching the motion start point

Move the arm to the motion start point and teach it as P1.



2-2 Teaching the motion end point

Move the arm to the motion end point and teach it as P2.



ECP Jog Mode:

The ECP jog mode is an additional jog mode used for teaching besides the Joint, World, and Tool jog modes.

NOTE

The ECP jog mode is based on the selected ECP coordinate system.

3. Executing Motion

To move the arm with ECP motion, add the “ECP” parameter to a motion command.

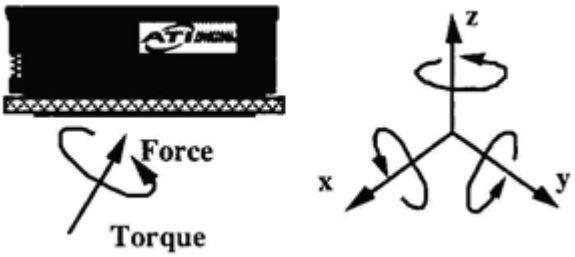
```
ECP 1          ' Select ECP
Go P1          ' Moves the arm to the motion start point
Move P2 ECP    ' Executes ECP motion
```

Use the Arc3 command to move the arm in an arc trajectory with the fixed tool. Use the Curve and CVMove commands to move the arm in cubic spline curves.

18. Force Sensing

18.1 Overview

The EPSON RC+ Force Sensing Option allows you to integrate force sensing in your applications. The force sensor is typically mounted on the robot's U axis. The sensor has 6 axes: ForceX, ForceY, ForceZ, TorqueX, TorqueY, TorqueZ.



With this option you can do the following:

- Read one or all 6 force/torque sensing axes values.
- Set triggers for motion commands.
- Use multiple force sensors in the same application. (up to 2 sensors)

SCARA robot with Gamma force sensor

18.2 Specifications

EPSON RC+ supports ATI force sensors using PCI interface boards.

For the PCI interface board, we support the following products of National Instruments.

PCI-6220	Connect one force sensor
PCI-6224	Connect one or two force sensors
PCI-6034E	Connect one force sensor (Conventional)

Note that we offer only the software license of this option. If you need ATI Force Sensor, a set of the PCI interface board and the sensor, please purchase it separately.

For specifications on force sensors, please see the ATI website:

http://www.ati-ia.com/products/ft/sensors.aspx

In addition, it is required for the users to prepare for installation to the manipulator. For details, refer to the installation drawing below.

18.3 Installation

The Force Sensing Option must be enabled in the RC700 controller. If you purchased the option with your system, the option will already be installed and configured.

You can also purchase the Force Sensing Option and install it in the field. See the chapter *Installing EPSON RC+ Options* for details.

Installing the force transducer circuit board

If you are adding Force Sensing in the field, you must install the force transducer board(s) in your system, and then run the NI-DAQmx driver installer.

Board Installation

Before installing the force sensing circuit board(s), you must first install the National Instruments DAQmx drivers that came with the board. To install the National Instruments DAQ drivers:

1. Run the NI-DAQmx driver installer.
2. Accept defaults for each step of the installation wizard.
3. Shutdown the system.
4. Install the board(s).
5. Start the system.
6. Run the National Instruments Measurement & Automation Explorer program once to verify that the board(s) that were installed are recognized.

You do not need to install the ATI software that came with the force transducer.

NOTE

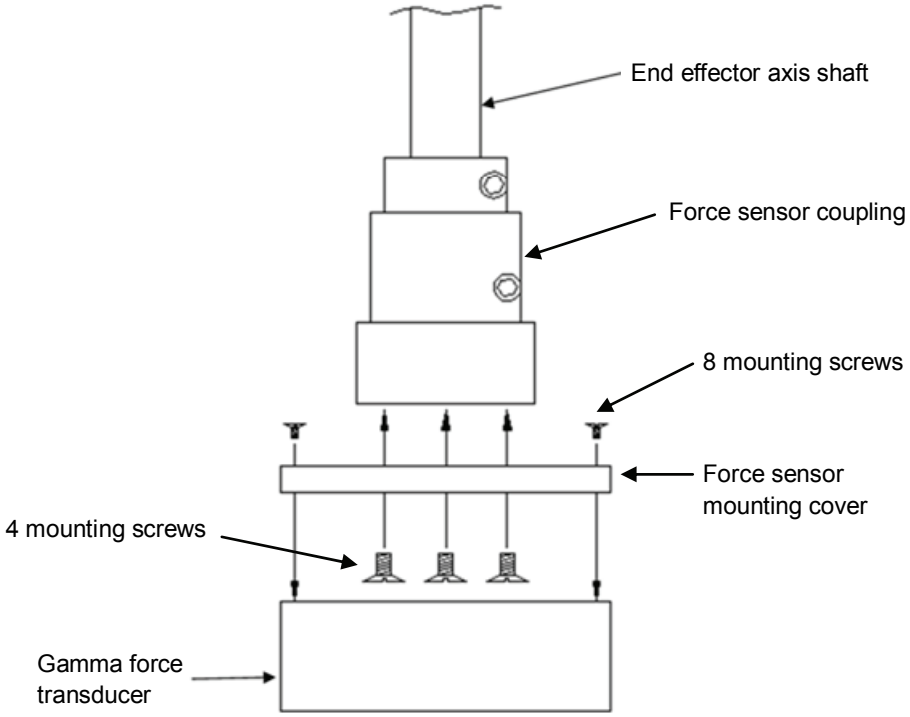
The calibration for the transducer must be loaded into memory. EPSON RC+ 7.0 handles this when you import the calibration data file as described in the section *Software Configuration* later in this chapter. The calibration data file can be located on the CD that came with the force transducer.

Mounting the force transducer

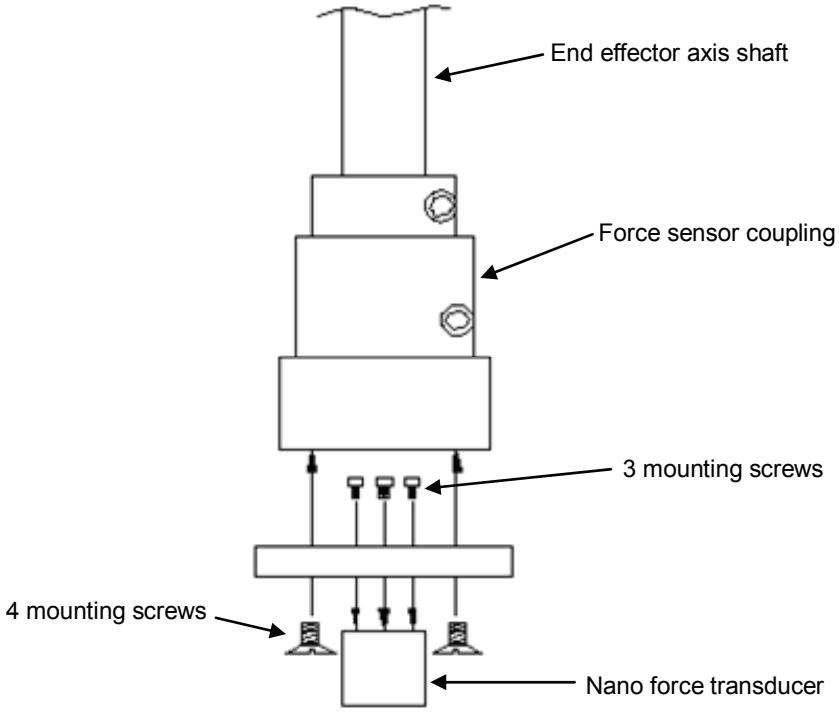
To mount the force transducer to the robot:

1. Remove the top cover of the transducer.
2. Remove the robot's end effector axis coupling and mount it to the transducer cover.
3. Install the transducer cover / coupling assembly onto the transducer.
4. Install the entire assembly on the end effector axis.

The following figures show mounting for gamma and nano transducers.



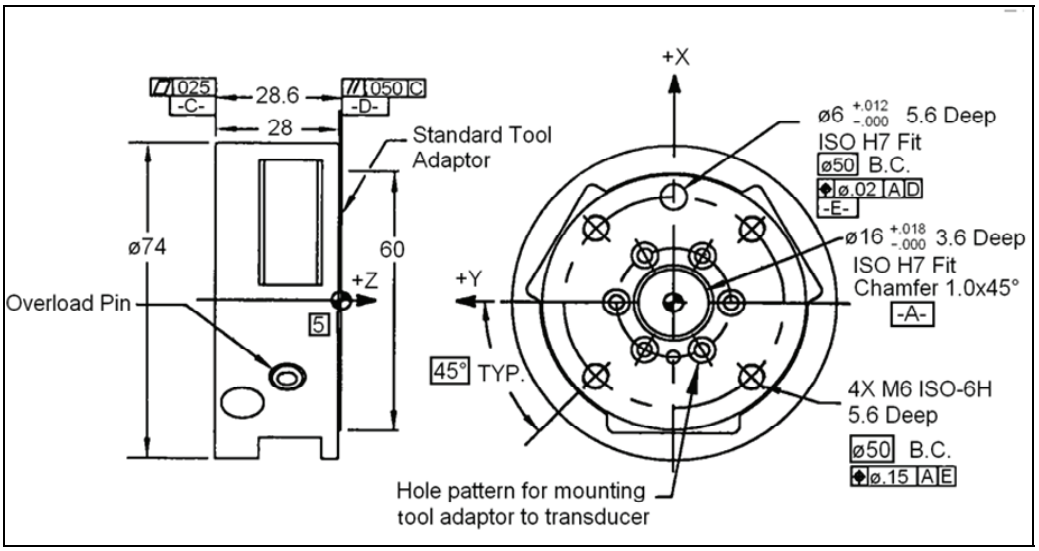
Mounting the Gamma Force Sensor



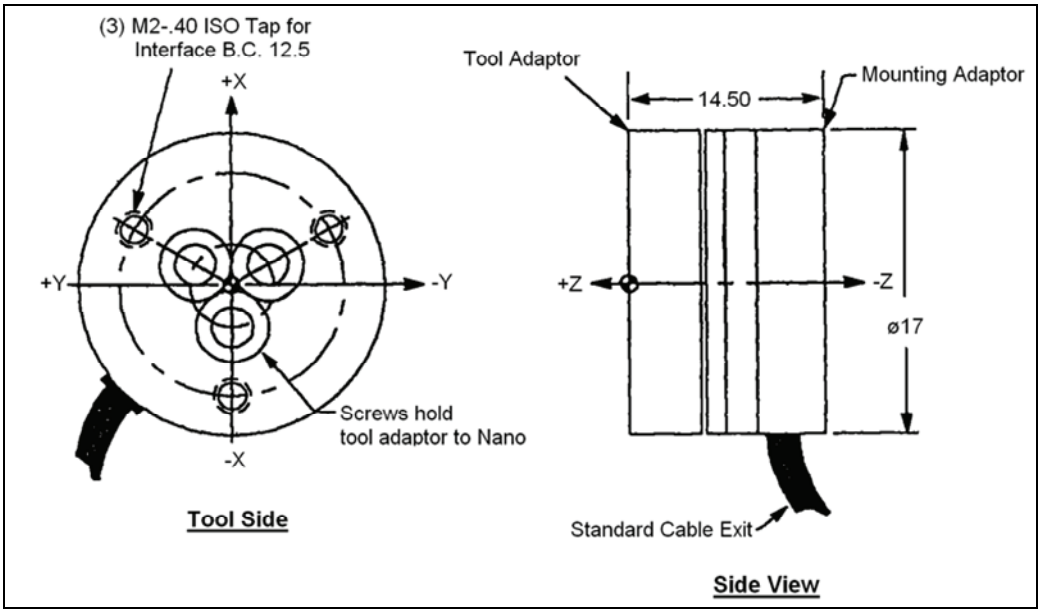
Mounting the Nano Force Sensor

Mounting tooling to force sensor

The following diagrams show the tooling mounting dimensions for Gamma and Nano force transducers.



Tool mounting for Gamma transducer



Tool mounting for Nano transducer

Connecting the force transducer

Use the cable supplied with the transducer to connect it to the PC board. The Nano transducer connects to an external interface box which in turn connects to the PC board.

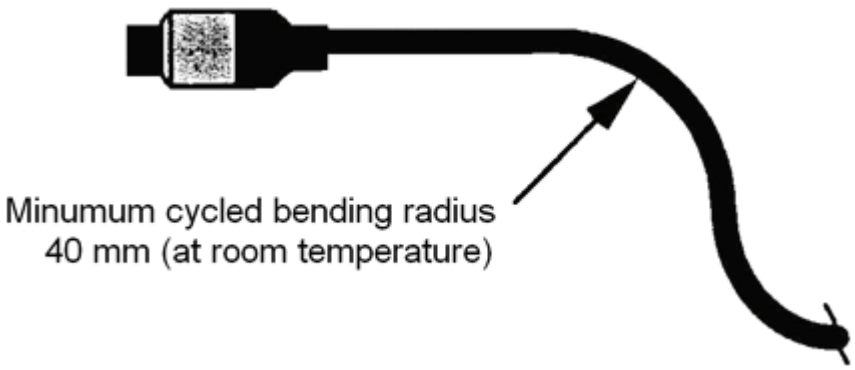
CAUTION

- Make sure power is off before connecting or disconnecting the force transducer. Protect transducer from electro-static discharge. Do not touch the internal electronics or connector pins.

Routing the transducer cable

The transducer cable must be routed so that it is not stressed, pulled, kinked, cut, or otherwise damaged throughout the full range of motion. If the cable will rub other cables during cycling, use a plastic spiral wrap to protect it.

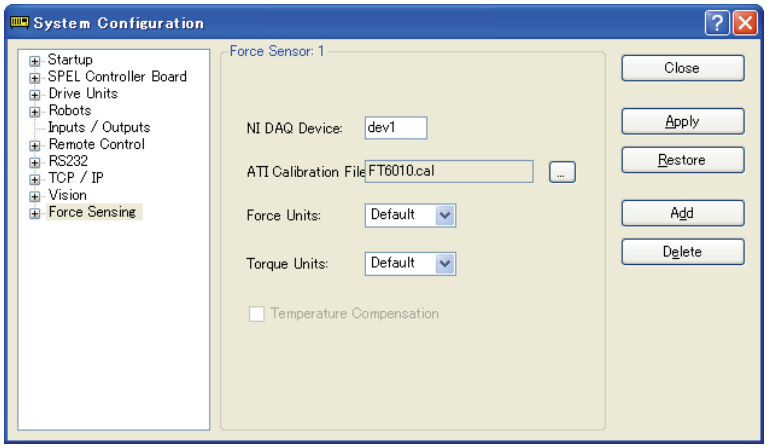
When the cable is cycling below the minimum bending radius the cable may fail due to fatigue. A small radius can be used if the cable is not being moved.



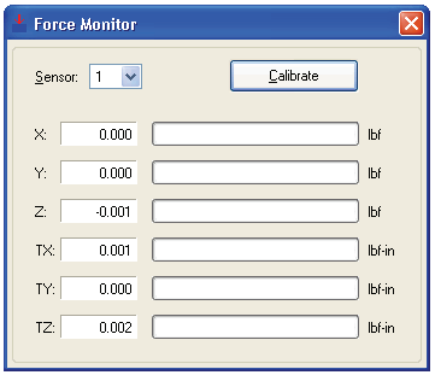
Software Configuration

To configure EPSON RC+ 7.0 Force Sensing:

1. Start EPSON RC+ 7.0, then select [Setup]-[System Configuration].
2. Click on the [Force Sensing] item in the tree on the left. If [Force Sensing]is not displayed, then the software options key for Force Sensing has not been enabled.
3. To add a board, click the <Add> button. A new force sensor will be shown in the tree on the left, and the controls used to configure the sensor will become enabled.



4. Enter the [NI DAQ device] name. This is assigned by the National Instruments software. To view NI DAQ device numbers, run the Nation Instruments Measurement & Automation Explorer.
5. Click the button shown on the right of [ATI Calibration File] to import a calibration file for the sensor. This can be found on the CD that came with the sensor. Navigate to the calibration file whose name includes the serial number of the sensor. Click <Open>, and the file will be copied to the EpsonRC70\force directory.
6. Leave the force and torque units at the default setting to use the native units. The actual units will be displayed in the sensor list after you click <Apply>. Or, you can select the desired units.
7. Click <Apply> to accept the new sensor.
8. From the [Tools] menu, select [Force Monitor]. This will open the [Force Monitor] window.



9. Apply pressure to the sensor. You should see the values change on the [Force Monitor] window. If you are using multiple sensors, change the sensor number on the monitor and verify that each sensor is working.

18.4 Force Sensing Commands

All Force Sensing commands begin with the same prefix: "Force_". Here is a list of all of the commands. For details, please see the online help or SPEL+ Language Reference Manual.

Force_Calibrate	Zeros out all axes for the current sensor.
Force_ClearTrigger	Clears all trigger conditions for the current sensor.
Force_GetForce	Returns the current value for one axis for the current sensor.
Force_GetForces	Returns the current values for all axes for the current sensor in an array.
Force_Sensor	Sets / returns the current sensor for the current task.
Force_SetTrigger	Sets /displays the force limit triggers for the current sensor.

18.5 Using the Force Sensing Trigger

You can configure the system to stop the robot after the force sensing trigger has been activated. You can set the trigger to activate when one or more force sensing axes reaches a preset limit. You use the Till command to check the trigger condition during motion.

Stopping Motion along Z axis

Use a trigger on the ZForce axis to stop the robot during Z axis motion.

For example:

```
' Set the force trigger to fire when force on Z axis is less than –10

Force_ClearTrigger
Force_SetTrigger FORCE_ZFORCE, -10, FORCE_LESS
Till Force
Jump P1
Speeds 1
Move P2 Till
```

You can combine other conditions with Force in the Till command:

```
Till Sw(1) = On Or Force
```

You can combine other force/torque conditions by calling Force_SetTrigger more than once. In this case, clear all triggers first before setting them.

```
Force_ClearTrigger
Force_SetTrigger FORCE_ZFORCE, -10, FORCE_LESS
Force_SetTrigger FORCE_XFORCE, 5, FORCE_GREATER
```

Stopping Motion along X or Y axes

Use a trigger on the XForce, XTorque, YForce, YTorque axes to stop the robot during Z axis motion. You need to align the force sensor by rotating the robot's U axis. The X and Y axes of the force sensor are marked on the transducer.

For example:

```
' Set the force trigger to fire when torque or force on X axis is less than –10

Force_ClearTrigger
Force_SetTrigger FORCE_XFORCE, -10, FORCE_LESS
Force_SetTrigger FORCE_XTORQUE, -10, FORCE_LESS
Till Force
Jump P1
Speeds 1
Move P2 Till
```

19. Real-Time I/O

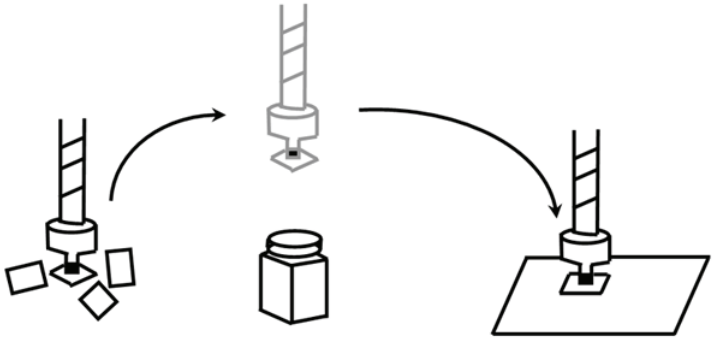
You can use this function only with the controller RC700 and EPSON RC+7.0 compatible RC90.

19.1 Overview

Real-time I/O is a feature that allows you to input trigger signals into the R-I/O connector of the robot controller so that you can latch and acquire the robot position at high speed while it is operating.

An example of an application using real-time I/O is "Picture on the fly": This synchronizes the robot position detection and the vision position detection, and performs part pickup, alignment, and assembly without stopping the robot.

With the real-time I/O feature, you can reduce the robot stop time for vision image acquisition that is necessary for traditional vision applications.



19.2 Specifications

R-I/O Connector

The RC700 and the RC90 (EPSON RC+7.0) robot controller has an R-I/O connector that is used to connect the real-time I/O trigger input signals. An R-I/O input is a special input interface that monitors the signals at higher speed than the standard I/O inputs. There are two trigger input signals on each of the RC700 Control Unit and external Drive Unit. For example, set the transmission type sensor so that it reacts when the robot passes the camera acquisition point and use the R-I/O connector so that the R-I/O input is detected at the moment shutter clicked.

For the details of the hardware (connection connector, connection circuit), refer to the *Robot Controller* manual, *Setup & Operation: I/O Remote Settings.*

Real-time I/O commands

There are special commands provided for use the real-time I/O. The following are basic descriptions of these commands.

For more details, refer to the manual *SPEL+ Language Reference*.

LatchEnable

This command is used to enable or disable the latch function of the robot position information with the real-time I/O. When LatchEnable On executes, it enables the robot position latch function using the trigger input signals connected to the R-I/O connector. After the latch is enabled, the robot current position information is latched when the first trigger input is detected. To repeatedly latch the robot position, execute LatchEnable Off and then execute LatchEnable On again. To use the

command repeatedly, it requires 60 ms minimum interval for each command processing time but it is not necessary to consider the command executing time.

SetLatch

Specifies the real-time input port that you connected the trigger input signal to, and the input logic. The table below shows the port numbers you can specify. Specify the port number that the robot using R-I/O is connected. If the other ports are specified, an error will occur. One robot cannot wait for the trigger signals from multiple ports.

		Point	Port number
Control Unit	INPUT	2 points	24,25

Execution of SetLatch requires approximately 40 msec for processing.

LatchState Function

This function returns the position latch status.

After it confirms that the latch has been done, it acquires the position information using the LatchPos Function.

LatchPos Function

This function returns the robot position information latched by the trigger input.

Executing the LatchPos Function needs approximately 15 msec for processing.

RobotPos Vision Sequence Property

Set the RobotPos sequence property to set the robot coordinates of the image acquisition position to calculate the part position when you use a mobile camera system. The system can calculate the correct part position by using the position acquired by LatchPos Function in this property.

For the details, refer to the manual *Vision Guide 7.0 Properties & Results Reference*.

Latch accuracy

The following is the theoretical sampling time used to latch the position information.

		Sampling time [μsec]
Control Unit	4-axis robot	32
	6-axis robot	32

You can get a rough idea of latch accuracy from the robot speed (parts moving speed) at the latch trigger input and the sampling time. For real accuracy, you must have a margin on the required accuracy because time delay and variation in the hardware may affect. The latch accuracy will improve as the robot moves slower at the trigger input.

Latched position accuracy [mm] = Robot speed [mm/sec] × Sampling time [sec]

19.3 Usage

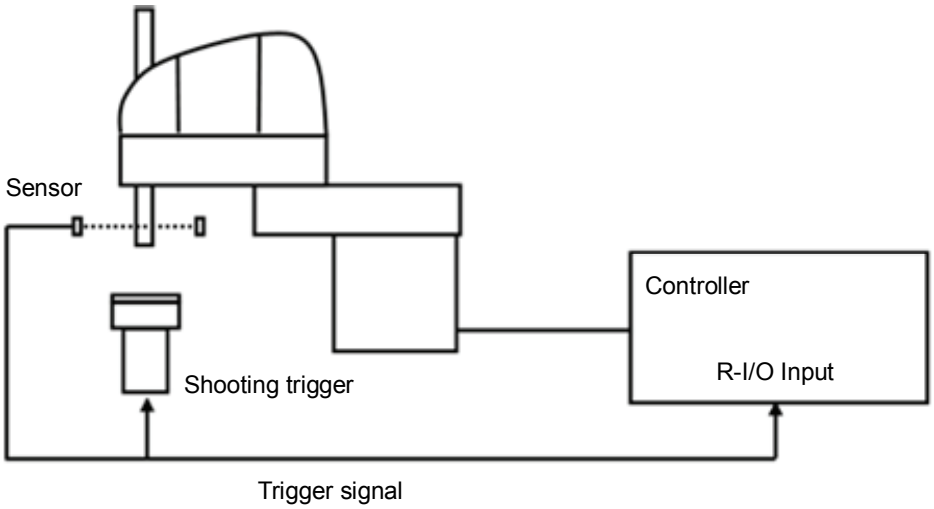
1. Basic example

The following program is a sample to connect any trigger signal to the R-I/O connector of the controller, latch the robot position information while it is operating at the trigger input, and show the latched position information.

```
Function Main
   Motor On
   Power High

   Speed 50; Accel 50, 50
   SpeedS 500; AccelS 5000

   Go P0                        'Start point
   SetLatch SETLATCH_PORT_CU_0, SETLATCH_TRIGGERMODE_LEADINGEDGE
   LatchEnable On               'Enable the latch
   Move P1                      'Start the operation, trigger input while operating

   Wait LatchState = True       'Confirmed the latch is complete
   P3 = LatchPos                'Acquire the latched position
   LatchEnable Off              'Disable the latch

   Print P3                     'Show the latched position
Fend
```

2. Example with Vision system

This is an example that uses the robot end effector to handle parts, passes above the external fixed upward camera acquisition point without stopping, and assembles the parts with an appropriate position correction.

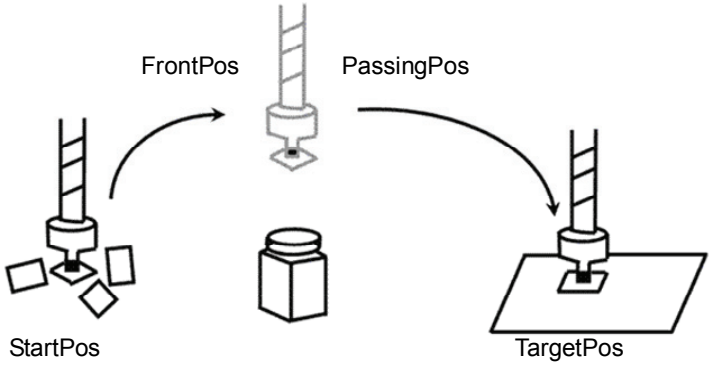


This system has a transmission type sensor that outputs the trigger signal when the robot end effector handles a part and passes the camera acquisition point. Then, it connects the sensor output with both the R-I/O and the camera trigger input for external tuning and synchronizes the latched robot position information and the camera image. It calculates the part position error and offsets the position comparing the robot position information from the camera image to the robot position information from the real-time I/O.

In this case, the robot vision system must be calibrated.

For details on the camera trigger signal connection and the vision calibration, refer to the manual *Vision Guide 7.0*.

The following program is a sample.




```
'  Variable that stores the position correction amount
Global Double g_RevPosX_i, g_RevPosY_i, g_RevPosU_i

Function Main
  Robot 1
  Motor On
  Power High

  Speed 100
  Accel 100, 100

  Jump InitPos                          'Move to the initial position
  Wait 1.0

  SetLatch 24, SETLATCH_TRIGGERMODE_LEADINGEDGE
                                        'Set the latch condition

  MemOff 0
  Xqt PictureOnFly_Camera               'Start the shooting task

  Jump StartPos C0                      'Move to the part feed point
  Wait 0.5

  LatchEnable On                        'Start waiting the latch

  MemOn 0                               'Enable the shooting

  Jump FrontPos C0 CP                   'Move close to the camera
  Go PassingPos CP                      'Pass over the camera

  Go TargetPos :Z(-70) CP               'Move over the assembly point

  Wait MemSw(1) = On              'Wait until the image processing is complete
  Wait LatchState = True                'Wait for position latch completion
  LatchEnable Off                       'Disable the position latch
  Jump TargetPos +X(g_RevPosX_i) +Y(g_RevPosY_i) +U(g_RevPosU_i) C0 LimZ(-70)
                                        'Move to the assembly point
  Wait 0.5

  Jump InitPos                          'Move to the initial point
  Wait 0.5

  Motor Off

Fend
```

```
'  Function to execute from work imaging to offset calculation
Function PictureOnFly_Camera

   'Vision Result variable
   Double RbX, RbY, RbU      'Work position on the robot coordinate system
   Double PxX, PxY, PxU      'Work position of the image coordinate system
   Double Angle              'Work angle
   Integer AcqStat           'Strobe imaging completion flag
   Boolean FoundRb,FoundPx   'Work detection status

   Double Xtmp, Ytmp, Xofs, Yofs 'Position offset calculation variable

   Wait MemSw(0) = On        'Waits the imaging start flag
   MemOff 1                  'Clear the imaging completion flag
   MemOff 0                  'Clear the imaging start flag
   AcqStat = 0               'Clear the strobe imaging flag

   VRun PictureOnFly_i

   Do Until AcqStat = 3      'Wait for strobe
         VGet PictureOnFly_i.AcquireState, AcqStat
   Loop

   'Check the work detection
   VGet PictureOnFly_i.Geom01.Found, Found

   If Found = False Then
         Print "Work NotFound"
         Pause
   Else
         MemOn  1            'Change the camera imaging flag
   EndIf

   'Acquire the imaging result
   VGet PictureOnFly_i.Geom01.RobotXYU, Found, RbX, RbY, RbU
   VGet PictureOnFly_i.PixelXYU, FoundPx, PxX, PxY, PxU

   Wait LatchState = True    'Wait for the trigger
   ShutterPos = LatchPos     'Saves the trigger position

   'Work offset calculation
   Xtmp = CX(ShutterPos) - RbX
   Ytmp = CY(ShutterPos) - RbY
   Angle = PxU

   'Position offset calculation
   g_RevPosX_i = Xtmp * Cos(DegToRad(Angle)) - Ytmp * Sin(DegToRad(Angle))
   g_RevPosY_i = Xtmp * Sin(DegToRad(Angle)) + Ytmp * Cos(DegToRad(Angle))
   g_RevPosU_i = Angle

   If(g_RevPosU_i > 180) Then
         g_RevPosU_i = g_RevPosU_i - 180
   ElseIf(g_RevPosU_i < -180) Then
         g_RevPosU_i = g_RevPosU_i + 180
   EndIf

Fend
```

20. Additional Axis

20.1 Overview

You can attach up to two additional drive axes (per manipulator) which can operate in association with the manipulator. The position data of the additional axis is saved with the robot point data. The additional axis can move simultaneously with the manipulator by motion commands and you can design an application using a traveling axis (manipulator on the straight axis) with simple programming.

NOTE

If you want to operate the manipulator and drive axis separately, you need to define the additional axis as another manipulator using the multi-manipulators feature.

CAUTION

- When you use the additional axis as traveling axis and mount a manipulator(s) on the axis, the reaction force of manipulator(s) is put on the traveling axis. Therefore, you should limit the acceleration/deceleration speed with the Accel setting so that it is within the allowable inertia of traveling axis. In addition, the manipulator may swing widely at the positioning and possibly break the additional axis.

20.2 Specification

Types of additional axis

The supported additional axes are the servo axis (X5 series Single-axis robot) controlled by the servo driver of the controller and the PG axis, controlled by the pulse generator board.
However, note that the PG axis has some limitations.

Limitations of a PG additional axis

a. Synchronizes with the manipulator to start motion but not to finish.
b. Does not support Path motion with CP On and Pass. Stops for every motion.
c. Does not go through the CvMove series of points
d. Calibration is necessary using the MCAL command. Cannot operate robots until the calibration is complete.

Number of additional axis

Up to two additional axes are available for each of the SCARA robot series (including RS series), Cartesian coordinate robot, 6-axis robot, and JOINT type robot. However, the number of axes you can add is determined by how many axes are available with your controller.

Position data management

The additional axes are allocated to Joint #8 and #9 for all robot types. Tthe position data are shown in the S and T coordinate values of point data of the manipulator to which you add the additional axes.
The additional axis as Joint #8 is called the additional S axis and Joint #9 is the additional T axis.
The coordinate values of additional axes are saved with the robot point data but don’t have any effect on the robot coordinate system.

How to operate

The additional axis can move simultaneously with the manipulator (synchronous start / stop). However, if you use the PG axis, it doesn't synchronize with manipulator to finish and operate by the different acceleration/deceleration speed from the manipulator. See below for the details of motion commands.
Also, you can operate the additional axis and manipulator separately by proper management of the point data. However, you cannot operate separately both of them in arbitrary timing. In this case, use the multi-manipulators function and set the drive axis as another manipulator.

Command specification

Pulse, Go, BGo, TGo, Pass

The additional axis can operate in association with the manipulator motion. However, if you use the PG axis, it synchronizes only to start the motion and a motion command completes when both the manipulator and axis finish each motion. In addition, if the PG additional axis has a travel distance, the Path motion with CP On and Pass are prohibited and the axis moves with CP Off automatically.

Move, BMove, Tmove

The additional axis can operate in association with the manipulator motion. However, if you use the PG axis, it synchronizes only to start the motion and a motion command completes when both the manipulator and axis finish each motion. In addition, if the PG additional axis has a travel distance, the Path motion with CP On is prohibited and the axis moves with CP Off automatically.

Arc, Arc3

The additional axis can operate in association with the manipulator motion. It doesn't go through the specified midPoint and directly goes to the end point. If you use the PG axis, it synchronizes only to start the motion and a motion command completes when both the manipulator and axis finish each motion. In addition, if the PG additional axis has a travel distance, the Path motion with CP On is prohibited and the axis moves with CP Off automatically.

CVMove

The additional axis can operate in association with the manipulator motion. If you use a servo axis for the additional axis, for each of the S and T axis it creates a curve going through the S and T coordinates specified by a series of point data. However, if you use the PG axis for the additional axis, it doesn't go through the series of points and directly goes to the end point. Also, it synchronizes only to start the motion and a motion command completes when both the manipulator and axis finish each motion. In addition, if the PG additional axis has a travel distance, the Path motion with CP On is prohibited and the axis moves with CP Off automatically.

Jump

The additional axis executes PTP motion in association with the manipulator horizontal motion. However, if you use the PG axis, it synchronizes only to start the motion and a motion command completes when both the manipulator and axis finish each motion. In addition, if the PG additional axis has a travel distance, the Path motion with CP On is prohibited and the axis moves with CP Off automatically.

Jump3, Jump3CP

The additional axis can operate in association with the manipulator depart / span / approach motion. However, if you use the PG axis, it synchronizes only to start the motion and a motion command completes when both the manipulator and axis finish each motion. In addition, if the PG additional axis has a travel distance, the Path motion with CP On and Pass are prohibited and the axis moves with CP Off automatically.

JTran, PTran

The additional axis can operate separately by specifying as Joint #8, #9.

Example:

```
> JTran 8, 90        'Move the additional S axis by 90 mm
> PTran 9, 10000     'Move the additional T axis by 10000 pulse
```

20.3 Usage

Additional axis configuration

For the instruction of configuring the additional axis, refer to *9.2 Configuration of Additional Axes*.
If you use the PG axis for the additional axis, you need to set the PG parameters. For the details of PG parameters, refer to the *Robot Controller option: PG Motion System* manual.

Point data usage

This example specifies the position data of manipulator and additional ST axes and substitutes them to the point data.

```
P1 = XY(10, 20, 30, 40) :ST(10, 20)            ' SCARA robot
P1 = XY(10, 20, 30, 40, 50, 60) :ST(10, 20)    ' 6-axis robot
```

This example specifies the position data of manipulator and additional ST axes and executes a PTP motion.

```
Go XY(10, 20, 30, 40) :ST(10, 20)
Go XY(10, 20, 30, 40, 50, 60) :ST(10, 20)
```

This example specifies the position data of additional ST axes individually

```
P1 = XY(10, 20, 30, 40) :S(10) :T(20)
P1 = XY(10, 20, 30, 40) :S(10)
P1 = XY(10, 20, 30, 40) :T(20)
```

This example omits the robot position assignment XY( ) and specifies only the additional axis position. Then, the point data is defined so that the manipulator doesn't move (undefined).

```
P1 = ST(10, 20)
Go P1    ' Only additional axis moves and the manipulator remains at the current position.
```

This example operates only the additional axis.

```
Go ST(10, 20)      ' Only the additional axis moves.
```

This example omits the additional axis position assignment ST( ) and specifies only the manipulator position. Then, the point data is defined so that the additional axis doesn't move (undefined).

```
P1 = XY(10, 20, 30, 40)
Go P1    ' Only the manipulator moves and the additional axis remains at the current
           position.
```

This example operates the manipulator only.

```
Go XY(10, 20, 30, 40)      ' Only the manipulator moves.
```

This example calculates the additional axis coordinate value using a point operator expression.

```
P1 = XY(10, 20, 30, 40, 50, 60) :ST(10, 20)
P2 = P1 + S(10) + T(20)  ' Add the offset amount to the additional ST axes for P1.
```

Note that you cannot use the point operator for undefined points.

```
P1 = XY(10, 20, 30, 40, 50, 60)
P2 = P1 + S(10) + T(20)
               ' Error (ST are undefined for P1 and
                 you cannot use the point operator)
P1 = XY(10, 20, 30, 40, 50, 60) +ST(10, 20)    ' Error
P1 = XY(10, 20, 30, 40, 50, 60) +S(10) +T(20)  ' Error
Go ST(10, 20) + X(10)
               ' Error (XY are undefined and
                 you cannot use the point operator)
```

This example shows the additional ST axes coordinate values retrieved from the point data.

```
Print CS(P1),  CT(P1)
```

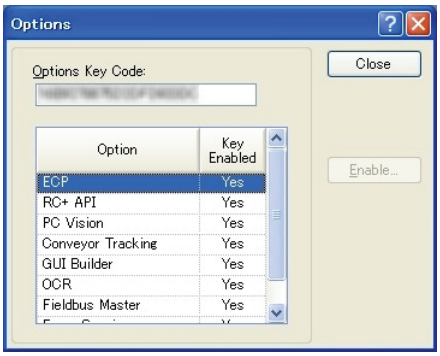
Pallet motion

When you specify a pallet with the point data including the position data of additional axis, the position data of additional axis is also calculated by the pallet operator. If you use the additional axis as traveling axis, you can define a wide range pallet than for a single manipulator.
Also, if you want to use the additional axis not as traveling axis and exclude the additional axis position from the pallet operator, define the pallet with the point data that clears the additional axis position data.

21. Installing Controller Options

When you purchase options with your system, the options have already been installed on your system before shipment. Of course, you can purchase options separately.

To see what options are enabled on your system, select [Setup]-[Options]. The following dialog will be displayed.



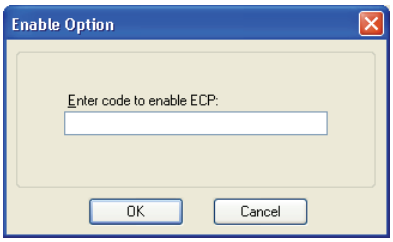
Item	Description
Option	Name of the option.
Key Enabled	Indicates that the option is enabled in the controller.

To enable an option on site

1. Copy and paste or write down the Options Key Code. You can view this from the [Setup]-[Controller]-[Options] dialog.
2. Call your distributor to purchase the enable key code for the desired option.
3. You will receive a code to enable the option from your distributor.
4. Select the option to enable on the grid, and then click the <Enable> button.
5. Enter in the code you received from your distributor.

NOTE

The key code is case sensitive.



Enabling an option

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Appendix A: Automatic Processing of Project Import

Project Import for EPSON RC+ 6.*

When projects created in EPSON RC+ 6.* are imported, all project files are copied to the new EPSON RC+ 7.0 project directory.

Project Import for EPSON RC+ 5.*

When projects created in EPSON RC+ 5.* are imported, all project files are copied to the new EPSON RC+ 7.0 project directory. In addition, the following processes are executed automatically:

- Point file update
- User Program Conversion

Point File Update

For EPSON RC+ 5.*, the .PTS files are updated automatically to the EPSON RC+ 6.0 .PTS file version.

User Program Conversion

Project Import for EPSON RC+ 3.* / 4.*

When projects created in EPSON RC+ 3.* / 4.* are imported, the following processes are executed automatically:

- User program conversion
- Point file conversion
- I/O label file conversion
- User error label file conversion
- Vision Guide conversion

User Program Conversion

The tables below show the syntax conversions from EPSON RC+ 3.* / 4.* to EPSON RC+ 7.0.

Project Type	EPSON RC+ 4.*	EPSON RC+ 7.0
Syntax	While	Do While
	Wend	Loop
	Trap...Call	Trap...Xqt

Project Type	EPSON RC+ 3.*	EPSON RC+ 7.0
Syntax	While	Do While
	Wend	Loop
	Trap...Call	Trap...Xqt
	On $, Off $	MemOn, MemOff
	Sw($	MemSw(
	Sw $(	MemSw(
	In($	MemIn(
	In $(	MemIn(
	Out $	MemOut
	Xqt !	Xqt
	Quit !	Quit
	Resume !	Resume
	Halt !	Halt

Point File Conversion

For EPSON RC+ 3.*, the EPSON RC+ 7.0 *PTS files are generated automatically from the .PNT files and corresponding .DEF files.

Project Type	EPSON RC+ 3.*	EPSON RC+ 7.0
Point File	*.PNT file (Point file) *.DEF file (Point label file)	*.PTS

For EPSON RC+ 4.*, the EPSON RC+ 7.0 *.PTS files are generated automatically from the .PNT files.

Project Type	EPSON RC+ 4.*	EPSON RC+ 7.0
Point File	*.PNT file (Point file)	*.PTS

I/O Label File Conversion

IOLabels.dat is generated automatically from the following three files.

Project Type	EPSON RC+ 3.* / 4.*	EPSON RC+ 7.0
I/O Label File	inplabel.txt outlabel.txt memlabel.txt	IOLabels.dat

User Error Label File Conversion

Files are changed automatically as the user error numbers are changed.

Project Type	EPSON RC+ 3.* / 4.*	EPSON RC+ 7.0
User Error Label	30000 to 30999	8000 to 8999
User Error Label File	UserErrors.txt	UserErrors.dat

Vision GuideConversion

EPSON RC+ 3.* / 4.* project vision files are updated to EPSON RC+ 7.0 format automatically. Files related to sequence, objects, and calibration are all imported.

Project Import for SPEL for Windows 2.*

When projects created in SPEL for Windows 2.* are imported, the following processes are executed automatically.

- User program conversion
- Point file conversion
- I/O label file conversion
- Global Preserve variable table conversion
- Global variable conversion
- Local variable conversion

User Program Conversion

The table below shows the syntax conversions to EPSON RC+ 7.0.

Project Type	SPEL for Windows 2.*	EPSON RC+ 7.0
Syntax	While	Do While
	Wend	Loop
	Trap n...Call	Trap n...Xqt
	On $, Off $	MemOn, MemOff
	Sw($	MemSw(
	Sw $(	MemSw(
	In($	MemIn(
	In $(	MemIn(
	Out $	MemOut
	Xqt !	Xqt
	Quit !	Quit
	Resume !	Resume
	Halt !	Halt
	Palet	Pallet
	Print"	Print "
	Date$(0)	Date$
	Time$(0)	Time$
	JS(0)	JS
	TW(0)	TW
	ZeroFlg(0)	ZeroFlg
	Entry	Global
	Config statement	SetCom statement
	Cooked	Line deleted
	SetRaw	Line deleted
	SelRB	Line deleted
	SelRB1	Line deleted
	Extern	Line deleted
	End	Quit All
	GetDate d$	d$ = Date$
	GetTime t$	t$ = Time$

Point File Conversion

EPSON RC+ 7.0 *.PTS files are generated automatically from the .PNT files and corresponding .DEF files.

Project Type	SPEL for Windows 2.*	EPSON RC+ 7.0
Point File	*.PNT file (Point file) *.DEF file (Point label)	*.PTS

I/O Label File Conversion

Converts the I/O labels automatically.

Project Type	SPEL for Windows 2.*	EPSON RC+ 6.0
I/O Label File	*ProjectName*.IOL	IOLabels.dat

Global Preserve Variable Table Conversion

Backup variable definitions created in the SPEL for Windows 2.* Project Menu are converted into Global Preserve declaration statements in the first program file.

(Example)

If the SPEL for Windows 2.* project defines an integer backup variable called "s_iValue", the following statement is generated in the first program of the project.

```
Global Preserve Integer s_iValue
```

Global Variable Conversion

Global variables (Entry / Extern) in SPEL for Windows 2.* projects are converted to Global variables in EPSON RC+ 7.0.

Project Type	SPEL for Windows 2.*	EPSON RC+ 7.0
Global Variable (Command)	Entry / Extern command	Global command

Local Variable Conversion

Local variables in SPEL for Windows 2.* functions can be used throughout the entire file in which they are declared. These variables are converted to module variables or local variables in EPSON RC+ 7.0, depending on their scope.

If the variable is used in only one function, it is converted to a local variable in that function.

If the variable is used in more than one function, it is converted to a module variable.

Appendix B: EPSON RC+ 7.0 Software

EPSON RC+ 7.0 can be used in the following operating systems.

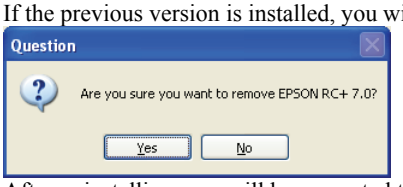
Windows XP Professional Service Pack 3
Windows Vista Business Service Pack 2
Windows 7 Professional

EPSON RC+ 7.0 Software Installation

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

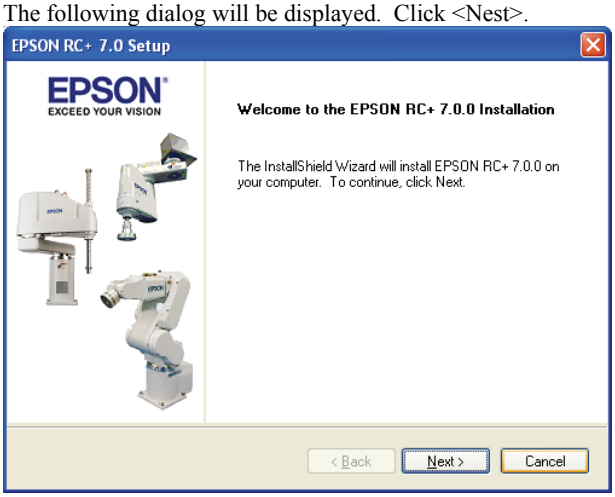
(1) Insert the EPSON RC+ 7.0 Setup DVD in the DVD drive.

(2) If the previous version is installed, you will be asked to uninstall the previous version.

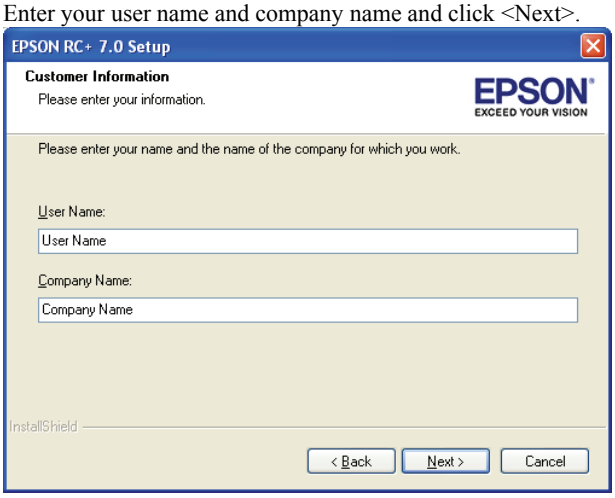


After uninstalling, you will be prompted to restart the computer. Start the setup program again by selecting [My Computer]-[Install DVD], or by re-inserting the DVD.

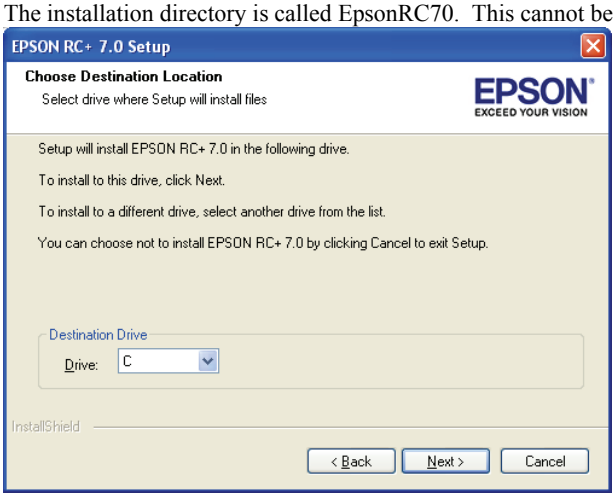
(3) The following dialog will be displayed. Click <Nest>.



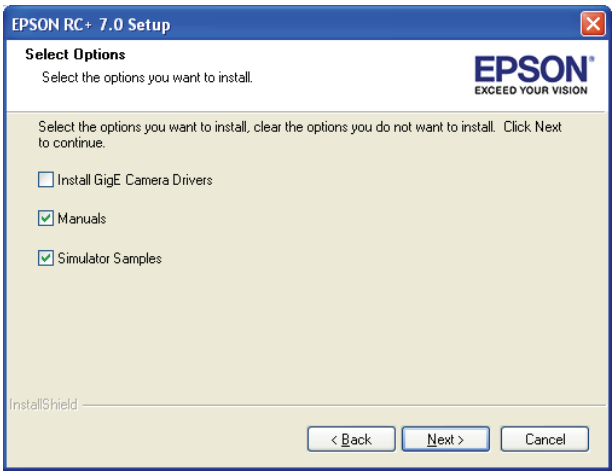
(4) Enter your user name and company name and click <Next>.



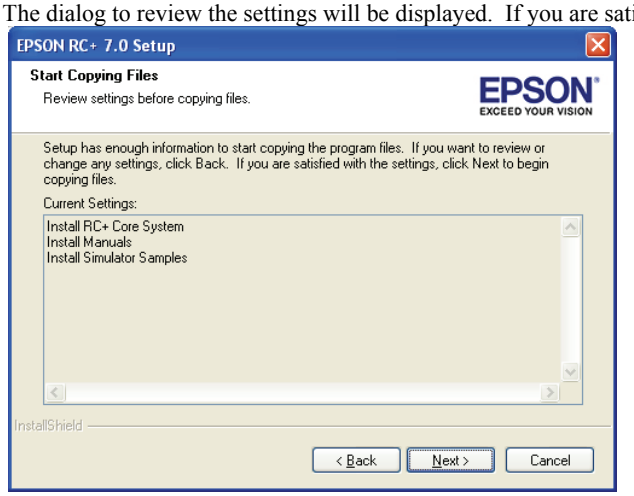
(5) Select the drive where you want to install EPSON RC+ 7.0 and click <Next>.
The installation directory is called EpsonRC70. This cannot be changed.



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



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



(8) If required, install “Windows Installer” and “Microsoft .NET Framework 3.5” on your system. This may take several minutes.

NOTE

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

(9) After the installation has completed, restart your computer.

The EPSON RC+ 7.0 software installation is now completed.

To install the service pack

If the following folder exists in the EPSON RC+7.0 setup DVD, the service pack is available.

\EpsonRC\Service_Packs

Install the latest service pack by double-clicking “erc***sp*.exe” in the folder. (***: RC+ version / *: service pack version)

For details of the service pack, refer to “readme*.txt”. (*: language)

EPSON RC+ 7.0 Software Update

Make sure that the EPSON RC + 7.0 is updated by a user with Administrator right.

Insert the EPSON RC+ 7.0 setup DVD into the DVD drive and follow the menu to update the software.