OMRON

Machine Automation Controller

NJ-series

Robot Integrated System

Startup Guide

NJ501-R□□□
AC1-152000
RL4-□□□□□□□

O049-E1-01

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Introduction

Thank you for purchasing an NJ-series Robot Integrated CPU Unit.

This guide describes the startup procedure of the "Robot Integrated System" that contains NJ-series Robot Integrated CPU Unit and Omron robots and the basic operating procedure of the Sysmac Studio using a simple machine model. You can learn the basics of the Robot Integrated System in a short time while you operate the system according to this guide.

For information on wiring and operation settings of NJ-series Robot Integrated CPU Unit, IPC Application Controller, robots and their peripheral devices, refer to *Related Manuals* on page 22.

This guide does not contain safety information and other details required for actual use of the products. Thoroughly read and understand the manuals for all of the devices that are used in this guide to ensure that the system is used safely. Review the entire contents of these materials, including all safety precautions, precautions for safe use, and precautions for correct use.
For safety instruction of the robot and details on robot use, refer to the *Robot Safety Guide (Cat. No. I590)*.

Intended Audience

This manual is intended for the following personnel, who must also have knowledge of electrical systems (an electrical engineer or the equivalent).

- Personnel in charge of introducing FA systems.
- Personnel in charge of designing FA systems.
- Personnel in charge of installing and maintaining FA systems.
- Personnel in charge of managing FA systems and facilities.

Also, this manual is intended for the personnel, who understand the following contents.

- Personnel who understand the programming language specifications in international standard IEC 61131-3 or Japanese standard JIS B 3503, for programming[*1].
- Personnel who understand the specifications of NJ-series CPU Unit and know how to use it[*1].
- Personnel who understand basic operation procedure of the Sysmac Studio[*1].
- Personnel who have attended the industrial robot seminar held by Omron or have equivalent knowledge.
- Personnel in charge of working with a robot and well knowing how to handle the robot.

[*1] For information of the international standard IEC 61131-3 and basic operation procedure of NJ-series CPU Unit and Sysmac Studio, refer to the *Relevant Technical Guides* on page 25.

Applicable Products

This manual covers the following products.

- NJ-series Robot Integrated CPU Unit
NJ501-R□□□

- SCARA robot eCobra 600/800
RL4-□□□□□□□

- IPC Application Controller

AC1-152000

Relevant Manuals

The following table provides the relevant manuals for the NJ-series CPU Units. Read all of the manuals that are relevant to your system configuration and application before you use the NJ-series CPU Unit.

Most operations are performed from the Sysmac Studio Automation Software. Refer to the *Sysmac Studio Version 1 Operation Manual (Cat. No. W504)* and the *Sysmac Studio Robot Integrated System Building Function with Robot Integrated CPU Unit Operation Manual (Cat. No. W595)* for information on the Sysmac Studio.

Purpose of use	**Manual**											
	Basic information											
	NJ-series CPU Unit Hardware User's Manual	**NJ/NX-series CPU Unit Software User's Manual**	**NJ/NX-series Instructions Reference Manual**	**NJ/NX-series CPU Unit Motion Control User's Manual**	**NJ/NX-series Motion Control Instructions Reference Manual**	**NJ/NX-series CPU Unit Built-in EtherCAT Port User's Manual**	**NJ/NX-series CPU Unit Built-in EtherNet/IP Port User's Manual**	**NJ-series Robot Integrated CPU Unit User's Manual**	**eV+3 User's Manual**	**eV+3 Keyword Reference Manual**	**NJ-series NJ Robotics CPU Unit User's Manual**	**NJ/NX-series Troubleshooting Manual**
Introduction to NJ-series Controllers	○											
Setting devices and hardware	○											
Using motion control				○								
Using EtherCAT						○						
Using EtherNet/IP							○					
Using robot control for OMRON robots								○				
Software settings		○										
Using motion control				○								
Using EtherCAT						○						
Using EtherNet/IP							○					
Using robot control for OMRON robots								○	○	○		
Using robot control with NJ Robotics function											○	
Writing the user program		○	○									
Using motion control				○	○							
Using EtherCAT						○						
Using EtherNet/IP							○					
Using robot control for OMRON robots								○	○	○		
Using robot control with NJ Robotics function											○	
Programming error processing								○	○	○		○
Testing operation and debugging		○										
Using motion control				○								
Using EtherCAT						○						
Using EtherNet/IP							○					
Using robot control for OMRON robots								○	○	○		
Using robot control with NJ Robotics function											○	

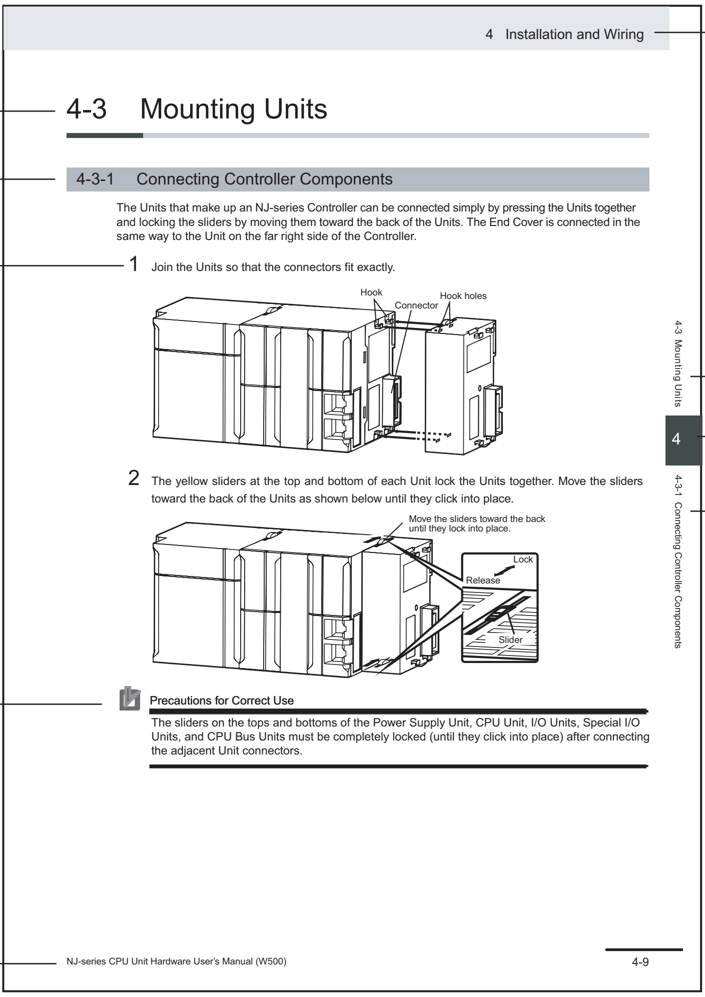
Purpose of use	Manual											
	Basic information											
	NJ-series CPU Unit Hardware User's Manual	**NJ/NX-series CPU Unit Software User's Manual**	**NJ/NX-series Instructions Reference Manual**	**NJ/NX-series CPU Unit Motion Control User's Manual**	**NJ/NX-series Motion Control Instructions Reference Manual**	**NJ/NX-series CPU Unit Built-in EtherCAT Port User's Manual**	**NJ/NX-series CPU Unit Built-in EtherNet/IP Port User's Manual**	**NJ-series Robot Integrated CPU Unit User's Manual**	**eV+3 User's Manual**	**eV+3 Keyword Reference Manual**	**NJ-series NJ Robotics CPU Unit User's Manual**	**NJ/NX-series Troubleshooting Manual**
Learning about error management functions and corrections[1]								△	△	△	△	○
Maintenance	○											
Using motion control				○								
Using EtherCAT						○						
Using EtherNet/IP							○					

[1] Refer to the *NJ/NX-series Troubleshooting Manual (Cat. No. W503)* for the error management concepts and the error items. However, refer to the manuals that are indicated with triangles for details on errors corresponding to the products with the manuals that are indicated with triangles.

Manual Structure

Page Structure

The following page structure is used in this manual.



4 Installation and Wiring

4-3 Mounting Units

4-3-1 Connecting Controller Components

The Units that make up an NJ-series Controller can be connected simply by pressing the Units together and locking the sliders by moving them toward the back of the Units. The End Cover is connected in the same way to the Unit on the far right side of the Controller.

1 Join the Units so that the connectors fit exactly.

Hook
Connector
Hook holes

2 The yellow sliders at the top and bottom of each Unit lock the Units together. Move the sliders toward the back of the Units as shown below until they click into place.

Move the sliders toward the back until they lock into place.
Lock
Release
Slider

Precautions for Correct Use

The sliders on the tops and bottoms of the Power Supply Unit, CPU Unit, I/O Units, Special I/O Units, and CPU Bus Units must be completely locked (until they click into place) after connecting the adjacent Unit connectors.

4-3 Mounting Units
4
4-3-1 Connecting Controller Components
NJ-series CPU Unit Hardware User's Manual (W500)
4-9

Level 1 heading

Level 2 heading

Level 3 heading

Gives the current headings.

Level 2 heading

Level 3 heading

A step in a procedure

Indicates a procedure.

Page tab

Gives the number of the main section.

Special information

Icons indicate precautions, additional information, or reference information.

Manual name

This illustration is provided only as a sample. It may not literally appear in this manual.

Special Information

Special information in this manual is classified as follows:

Precautions for Safe Use

Precautions on what to do and what not to do to ensure safe usage of the product.

Precautions for Correct Use

Precautions on what to do and what not to do to ensure proper operation and performance.

Additional Information

Additional information to read as required.
This information is provided to increase understanding or make operation easier.

Version Information

Information on differences in specifications and functionality for Controller with different unit versions and for different versions of the Sysmac Studio is given.

Precaution on Terminology

In this manual, "download" refers to transferring data from the Sysmac Studio to the physical Controller and "upload" refers to transferring data from the physical Controller to the Sysmac Studio.
For the Sysmac Studio, "synchronization" is used to both "upload" and "download" data. Here, "synchronize" means to automatically compare the data for the Sysmac Studio on the computer with the data in the physical Controller and transfer the data in the direction that is specified by the user.

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1 Overview

2 Before You Begin

3 Implementation Example of Static Pick-and-place Equipment

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Terms and Conditions Agreement

Warranty, Limitations of Liability

Warranties

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NEVER USE THE PRODUCT FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY OR IN LARGE QUANTITIES WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT(S) IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

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Disclaimers

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Errors and Omissions

Information presented by Omron Companies has been checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical or proofreading errors or omissions.

Safety Precautions

Definition of Precautionary Information

The following notation is used in this manual to provide precautions required to ensure safe usage of the NJ-series Robot Integrated CPU Unit.

The safety precautions that are provided are extremely important for safety. Always read and heed the information provided in all safety precautions.

The following notation is used.

⚠ WARNING	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury. Additionally, there may be severe property damage.
⚠ Caution	Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury, or property damage.

Symbols

🛇	The circle and slash symbol indicates operations that you must not do. The specific operation is shown in the circle and explained in text. This example indicates that disassembly is prohibited.
⚠	The triangle symbol indicates precautions (including warnings). The specific operation is shown in the triangle and explained in text. This example indicates a precaution for electric shock.
⚠	The triangle symbol indicates precautions (including warnings). The specific operation is shown in the triangle and explained in text. This example indicates a general precaution.
❗	The filled circle symbol indicates operations that you must do. The specific operation is shown in the circle and explained in text. This example shows a general precaution for something that you must do.

WARNING

⚠ WARNING

Refer to the following manuals for warnings.

- *NJ-series CPU Unit Hardware User's Manual (Cat. No. W500)*
- *NJ-series Robot Integrated CPU Unit User's Manual (Cat. No. O037)*

Cautions

⚠ Caution

Refer to the following manuals for cautions.

- *NJ-series CPU Unit Hardware User's Manual (Cat. No. W500)*
- *NJ-series Robot Integrated CPU Unit User's Manual (Cat. No. O037)*

Precautions for Safe Use

Refer to the following manuals for precautions for safe use.

- *NJ-series CPU Unit Hardware User's Manual (Cat. No. W500)*
- *NJ-series Robot Integrated CPU Unit User's Manual (Cat. No. O037)*

Precautions for Correct Use

Refer to the following manuals for precautions for correct use.

- *NJ-series CPU Unit Hardware User’s Manual (Cat. No. W500)*
- *NJ-series Robot Integrated CPU Unit User’s Manual (Cat. No. O037)*

Regulations and Standards

Refer to the following manuals for regulations and standards.

- *NJ-series CPU Unit Hardware User's Manual (Cat. No. W500)*

Additional Information

The Robot Integrated CPU Unit is not a robot control device that is defined in ISO 10208-1. Therefore, the Robot Integrated CPU Unit does not comply with the robot regulations and standards.
Refer to the OMRON robot manuals for information on the OMRON robot itself.

Versions

Hardware revisions and unit versions are used to manage the hardware and software in NJ-series Units and EtherCAT slaves. The hardware revision or unit version is updated each time there is a change in hardware or software specifications. Even when two Units or EtherCAT slaves have the same model number, they will have functional or performance differences if they have different hardware revisions or unit versions.

Checking Versions

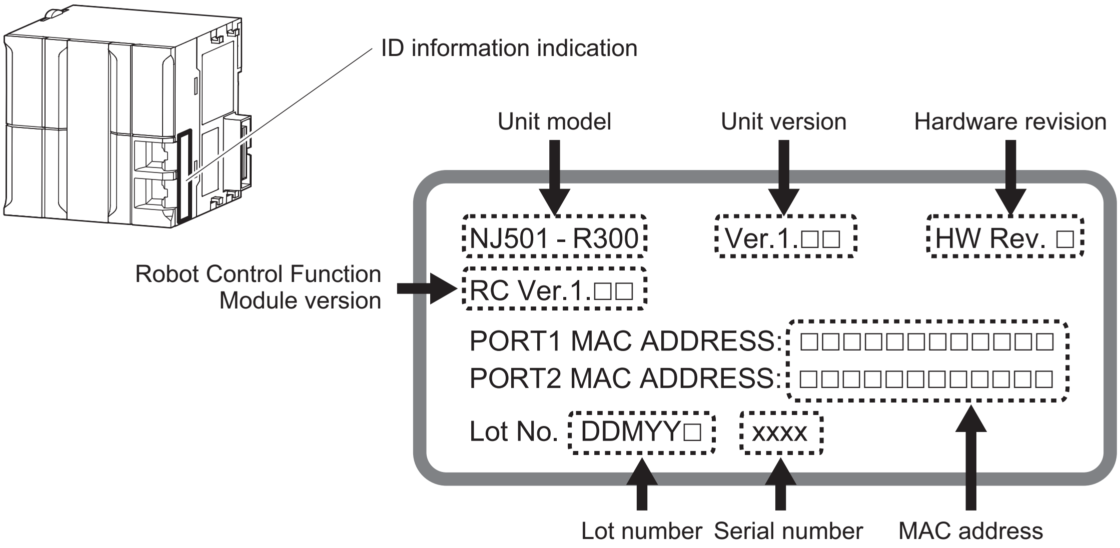
You can check versions on the ID information indications or with the Sysmac Studio.

Checking Unit Versions on ID Information Indications

The unit version is given on the ID information indication on the side of the product.

- **NJ501-R□00**

The ID information on the NJ-series NJ501-R300 CPU Unit is shown below.


ID information indication
Unit model
Unit version
Hardware revision
NJ501 - R300
Ver.1.□□
HW Rev. □
Robot Control Function Module version
RC Ver.1.□□
PORT1 MAC ADDRESS: □□□□□□□□□□□□
PORT2 MAC ADDRESS: □□□□□□□□□□□□
Lot No. DDMYY□
xxxx
Lot number
Serial number
MAC address

Note The hardware revision is not displayed for the Unit that the hardware revision is in blank.

Checking Unit Versions with the Sysmac Studio

You can use the Sysmac Studio to check unit versions.

● Checking the Unit Version of an NJ-series CPU Unit

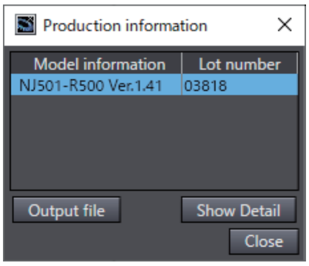
You can use the Production Information while the Sysmac Studio is online to check the unit version of a Unit. You can do this for the CPU Unit, CJ-series Special I/O Units, and CJ-series CPU Bus Units. You cannot check the unit versions of CJ-series Basic I/O Units with the Sysmac Studio.

1. Double-click **CPU Rack** under **Configurations and Setup - CPU/Expansion Racks** in the Multiview Explorer. Or, right-click **CPU Rack** under **Configurations and Setup** - **CPU/Expansion Racks** in the Multiview Explorer and select **Edit** from the menu.
   The Unit Editor is displayed.

2. Right-click any open space in the Unit Editor and select **Production Information**.
   The Production Information Dialog Box is displayed.

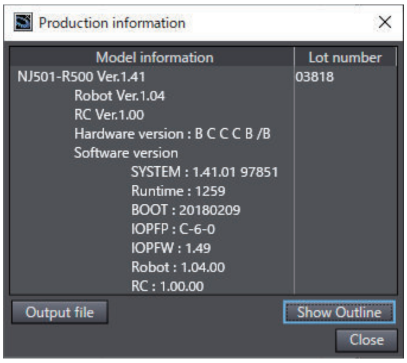
● Changing Information Displayed in Production Information Dialog Box

1. Click the **Show Detail** or **Show Outline** Button at the lower right of the **Production Information** Dialog Box.
   The view will change between the **production information** details and outline.



Model information	Lot number
NJ501-R500 Ver.1.41	03818

Outline View



Model information	Lot number
NJ501-R500 Ver.1.41	03818
Robot Ver.1.04	
RC Ver.1.00	
Hardware version : B C C C B /B	
Software version	
SYSTEM : 1.41.01 97851	
Runtime : 1259	
BOOT : 20180209	
IOPFP : C-6-0	
IOPFW : 1.49	
Robot : 1.04.00	
RC : 1.00.00	

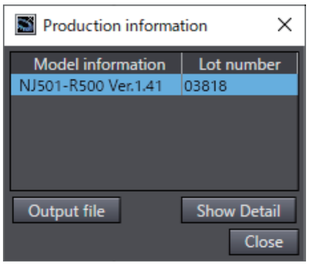
Detailed View

The information that is displayed is different for the Outline View and Detail View. The Detail View displays the unit version, hardware revision, and various versions. The Outline View displays only the unit version.

Note The hardware revision is separated by "/" and displayed on the right of the hardware version. The hardware revision is not displayed for the Unit that the hardware revision is in blank.

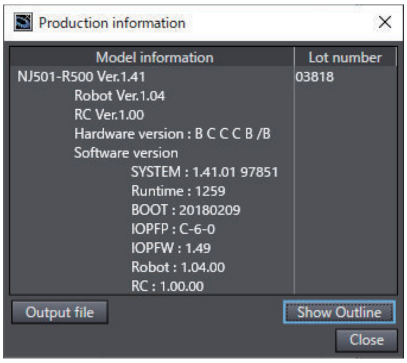
● Changing Information Displayed in Production Information Dialog Box

1. Click the **Show Detail** or **Show Outline** Button at the lower right of the **Production Information** Dialog Box.
   The view will change between the **production information** details and outline.


Production information
Output file
Show Detail
Close

Model information	Lot number
NJ501-R500 Ver.1.41	03818

Outline View


Production information
Output file
Show Outline
Close

Model information	Lot number
NJ501-R500 Ver.1.41	03818

Robot Ver.1.04
RC Ver.1.00
Hardware version : B C C C B /B
Software version
SYSTEM : 1.41.01 97851
Runtime : 1259
BOOT : 20180209
IOPFP : C-6-0
IOPFW : 1.49
Robot : 1.04.00
RC : 1.00.00

Detailed View

Related Manuals

The following are the manuals related to this manual. Use these manuals for reference.

Manual name	Cat. No.	Model numbers	Application	Description
NJ-series CPU Unit Hardware User's Manual	W500	NJ501-□□□□ NJ301-□□□□ NJ101-□□□□	Learning the basic specifications of the NJ-series CPU Units, including introductory information, designing, installation, and maintenance. Mainly hardware information is provided.	An introduction to the entire NJ-series system is provided along with the following information on the CPU Unit. • Features and system configuration • Introduction • Part names and functions • General specifications • Installation and wiring • Maintenance and inspection
NJ/NX-series CPU Unit Software User's Manual	W501	NX701-□□□□ NX102-□□□□ NX1P2-□□□□ NJ501-□□□□ NJ301-□□□□ NJ101-□□□□	Learning how to program and set up an NJ/NX-series CPU Unit. Mainly software information is provided.	The following information is provided on a Controller built with an NJ/NX-series CPU Unit. • CPU Unit operation • CPU Unit features • Initial settings • Programming based on IEC 61131-3 language specifications
NJ/NX-series Instructions Reference Manual	W502	NX701-□□□□ NX102-□□□□ NX1P2-□□□□ NJ501-□□□□ NJ301-□□□□ NJ101-□□□□	Learning detailed specifications on the basic instructions of an NJ/NX-series CPU Unit.	The instructions in the instruction set (IEC 61131-3 specifications) are described.
NJ/NX-series CPU Unit Motion Control User's Manual	W507	NX701-□□□□ NX102-□□□□ NX1P2-□□□□ NJ501-□□□□ NJ301-□□□□ NJ101-□□□□	Learning about motion control settings and programming concepts.	The settings and operation of the CPU Unit and programming concepts for motion control are described.
NJ/NX-series Motion Control Instructions Reference Manual	W508	NX701-□□□□ NX102-□□□□ NX1P2-□□□□ NJ501-□□□□ NJ301-□□□□ NJ101-□□□□	Learning about the specifications of the motion control instructions.	The motion control instructions are described.
NJ/NX-series CPU Unit Built-in EtherCAT® Port User's Manual	W505	NX701-□□□□ NX102-□□□□ NX1P2-□□□□ NJ501-□□□□ NJ301-□□□□ NJ101-□□□□	Using the built-in EtherCAT port on an NJ/NX-series CPU Unit.	Information on the built-in EtherCAT port is provided. This manual provides an introduction and provides information on the configuration, features, and setup.
NJ/NX-series CPU Unit Built-in EtherNet/IP™ Port User's Manual	W506	NX701-□□□□ NX102-□□□□ NX1P2-□□□□ NJ501-□□□□ NJ301-□□□□ NJ101-□□□□	Using the built-in EtherNet/IP port on an NJ/NX-series CPU Unit.	Information on the built-in EtherNet/IP port is provided. Information is provided on the basic setup, tag data links, and other features.
NJ-series Robot Integrated CPU Unit User's Manual	O037	NJ501-R□□□	Using the NJ-series Robot Integrated CPU Unit.	Describes the settings and operation of the CPU Unit and programming concepts for OMRON robot control.

Manual name	Cat. No.	Model numbers	Application	Description
Sysmac Studio Robot Integrated System Building Function with Robot Integrated CPU Unit Operation Manual	W595	SYSMAC-SE2□□□ SYSMAC-SE200D-64	Learning about the operating procedures and functions of the Sysmac Studio to configure Robot Integrated System using Robot Integrated CPU Unit.	Describes the operating procedures of the Sysmac Studio for Robot Integrated CPU Unit.
Sysmac Studio Robot Integrated System Building Function with IPC Application Controller Operation Manual	W621	SYSMAC-SE2□□□ SYSMAC-SE200D-64	Learning about the operating procedures and functions of the Sysmac Studio to configure Robot Integrated System using IPC Application Controller.	Describes the operating procedures of the Sysmac Studio for IPC Application Controller.
Sysmac Studio 3D Simulation Function Operation Manual	W618	SYSMAC-SE2□□□ SYSMAC-SA4□□□-64	Learning about an outline of the 3D simulation function of the Sysmac Studio and how to use the function.	Describes an outline, execution procedures, and operating procedures for the 3D simulation function of the Sysmac Studio.
eV+3 User's Manual	I651	NJ501-R□□□	Operating the OMRON robot with the V+ program.	Describes the V+ language to control the OMRON robots.
eV+3 Keyword Reference Manual	I652	NJ501-R□□□	Operating the OMRON robot with the V+ program.	Describes V+ keywords that are used in the V+ language.
eCobra 600 and 800 Robot with EtherCAT User's Guide	I653	RL4-□□□□□□□	Using the eCobra.	Describes the eCobra.
Viper 650 and 850 Robot with EtherCAT User's Guide	I654	RL6-□□□□□□□	Using the Viper.	Describes the Viper.
Robot Safety Guide	I590	RL4-□□□□□□□ RL6-□□□□□□□	Learning how to use the OMRON robot safely.	Describes how to use the OMRON robot safely.
Teaching Pendant T20 User's Manual	I601	10046-010	Operating the OMRON robot with a teaching pendant.	Describes the setup, operation, and user maintenance for the Teaching Pendant T20.
IPC Application Controller User's Manual	I632	AC1-152000	Using the IPC Application Controller.	Describes the IPC Application Controller.
NJ-series NJ Robotics CPU Unit User's Manual	W539	NJ501-4□□□ NJ501-R□□□	Controlling robots with NJ-series CPU Units.	Describes the functionality to control robots.
NJ/NX-series Troubleshooting Manual	W503	NX701-□□□□ NX102-□□□□ NX1P2-□□□□ NJ501-□□□□ NJ301-□□□□ NJ101-□□□□	Learning about the errors that may be detected in an NJ/NX-series Controller.	Concepts on managing errors that may be detected in an NJ/NX-series Controller and information on individual errors are described.
Sysmac Studio Version 1 Operation Manual	W504	SYSMAC-SE2□□□	Learning about the operating procedures and functions of the Sysmac Studio.	Describes the operating procedures of the Sysmac Studio.
NX-series Position Interface Units User's Manual	W524	NX-EC0□□□ NX-ECS□□□ NX-PG0□□□	Learning how to use NX-series Position Interface Units.	The hardware, setup, and functions for the NX-series Incremental Encoder Input Units, SSI Input Units, and Pulse Output Unit are described.

Manual name	Cat. No.	Model numbers	Application	Description
AC Servomotors/Servo Drives 1S-series with Built-in EtherCAT® Communications User's Manual	I586	R88M-1□ R88D-1SN□-ECT	Learning how to use the Servomotors/ Servo Drives with built-in EtherCAT Communications.	Describes the hardware, setup methods and functions of the Servomotors/Servo Drives with built-in EtherCAT Communications.
	I621	R88M-1AL□/ -1AM□ R88D-1SAN□-ECT		
AC Servomotors/Servo Drives G5 Series with Built-in EtherCAT® Communications User's Manual	I576	R88M-K□ R88D-KN□-ECT	Learning how to use the AC Servomotors/ Servo Drives with built-in EtherCAT Communications.	Describes the hardware, setup methods and functions of the AC Servomotors/ Servo Drives with built-in EtherCAT Communications. The Linear Motor Type models and dedicated models for position control are available in G5-series.
	I577	R88L-EC-□ R88D-KN□-ECT-L		

Relevant Technical Guides

The following table lists the relevant technical guides for the NJ-series CPU Units. Use these manuals for reference.

Manual name	Cat. No.	Application	Description
Machine Automation Controller Startup Guide for CPU Unit	W513	Learning about outline and operation procedure of the NJ-series CPU Unit and Sysmac Studio.	Describes the startup procedure of the NJ-series CPU Unit and the basic operating procedure of the Sysmac Studio on an example of simple sequence control.
Machine Automation Controller Startup Guide for Motion Control	W514	Learning about the basics of the motion control functions of the NJ-series CPU Unit.	Describes the startup procedures and Sysmac Studio operating procedures for someone that will use NJ-series motion control functions for the first time. The procedures are explained in simple examples of one-axis positioning and two-axis linear interpolation.

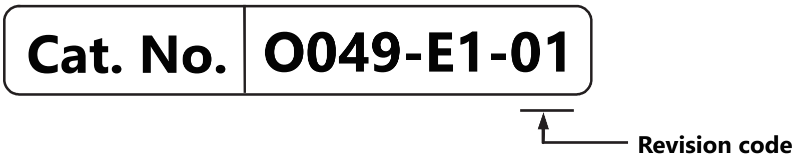
Terminology

This section describes the terms that are used in this manual.

Term	Description
continuous-path motion	A motion to move continuous operations smoothly without stopping motion of the OMRON robot.
IEC 61131-3 language	A programming language to write a sequence control program.
robots controllable by NJ Robotics function	Specify the controllable robots by the data processing for robot in the Motion Control Function Module of the NJ-series CPU Unit. The controllable robot consists of the 1S-series or G5-series Servomotor/Servo Drive with built-in EtherCAT communications and the robot arm that is prepared by the customer.
TCP	A tip (Tool Center Point) defined in each OMRON robot. The target position or path can be specified based on the TCP.
V+ keyword	A generic term for instructions that are used during a V+ program and monitoring command.
V+ language	A programming language for OMRON robot control.
V+ task	A task that can execute a V+ program.
V+ program	A control program written in the V+ language.
OMRON robot	Specifies the OMRON robot controllable from the Robot Integrated CPU Unit. The robot consists of the robot amplifier and the robot arm connected to the robot amplifier.
shared variable	A variable that can be shared between the sequence control program and V+ program.
sequence control program	A control program written in IEC 61131-3 language including the motion control.
hardware servo	A servo system built into the robot amplifier.
user program	A generic term for the collection of programs written in the ladder diagram, ST, and V+ languages.
recipe	A set of product type data in the customer’s system.
recipe change	Specifies that the product data and information (recipe) related to the production process are changed. The target recipe for the Robot Integrated CPU Unit is a property from the present values of variables and a vision sensor.
Robot Control Function Module	A software to perform robot control that is installed in the Robot Integrated CPU Unit.
robot control instructions	FB instructions written in the sequence control program to control the OMRON robots. They include an instruction to directly control the OMRON robots and an instruction to execute or abort V+ programs assigned to the V+ tasks.
Robot Integrated CPU Unit	A CPU Unit that supports control function for the OMRON robot with the NJ-series CPU Unit.

Revision History

A manual revision code appears as a suffix to the catalog number on the front and back covers of the manual.


Cat. No.
O049-E1-01
Revision code

Revision code	Date	Revised content
01	August 2020	Original production

1

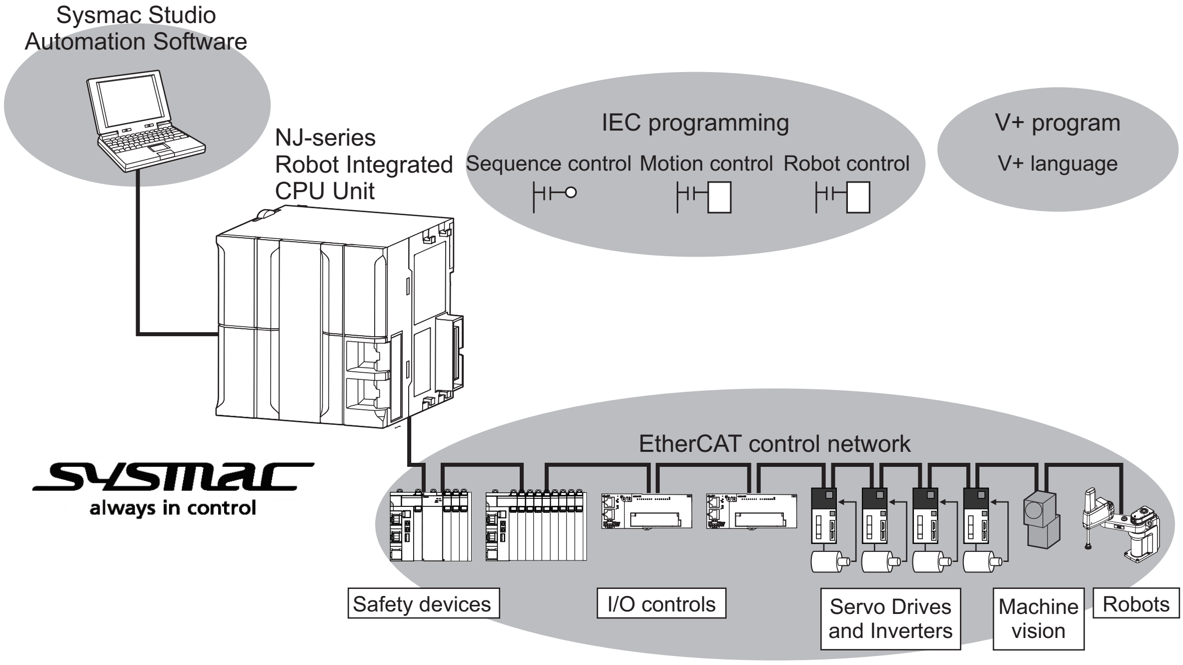
Overview

This section describes the overview of robot integrated system.

1-1 Features of Robot Integrated System 1-2
  1-1-1 Features of the NJ-series Robot Integrated CPU Unit 1-2
  1-1-2 Features of the EtherCAT-compatible OMRON robots 1-2
  1-1-3 Features of the Sysmac Studio Automation Software 1-2
1-2 System Configuration for Static Pick-and-place Equipment 1-3
1-3 Operations of Static Pick-and-place Equipment 1-5
  1-3-1 Operating Specifications 1-5
  1-3-2 Operating Modes for Equipment 1-6
1-4 Hardware 1-7
1-5 Software 1-8
  1-5-1 Sysmac Studio 1-8
1-6 User Program 1-9
  1-6-1 Types of Method to Create User Program 1-9
  1-6-2 Proper Use of Sequence Control Program and V+ Program 1-9
  1-6-3 Command and Data Flow 1-10

1-1 Features of Robot Integrated System

The robot integrated system is a system to integrate the sequence control and robot control into a Controller, network, and software.


Sysmac Studio
Automation Software
NJ-series
Robot Integrated
CPU Unit
IEC programming
Sequence control
Motion control
Robot control
V+ program
V+ language
EtherCAT control network
always in control
Safety devices
I/O controls
Servo Drives and Inverters
Machine vision
Robots

The system consists of the NJ-series Robot Integrated CPU Unit, the OMRON robots that support EtherCAT communications, and the Sysmac Studio Automation Software.

1-1-1 Features of the NJ-series Robot Integrated CPU Unit

The sequence control and the robot control can be executed with a CPU Unit. This allows you to design interface easily between the sequence control and robot control and reduce the design time and the adjustment time at startup.

1-1-2 Features of the EtherCAT-compatible OMRON robots

The robots and peripheral devices can connect to the same EtherCAT network. The operations for the robots and the peripheral devices can be handled in the same time axis with the synchronization function of the EtherCAT, so wait time for asynchronous operation or variations of timing are reduced. This enables you to reduce the tact time, identify an error cause during operation, and make predictive control for the operations of peripheral devices.

1-1-3 Features of the Sysmac Studio Automation Software

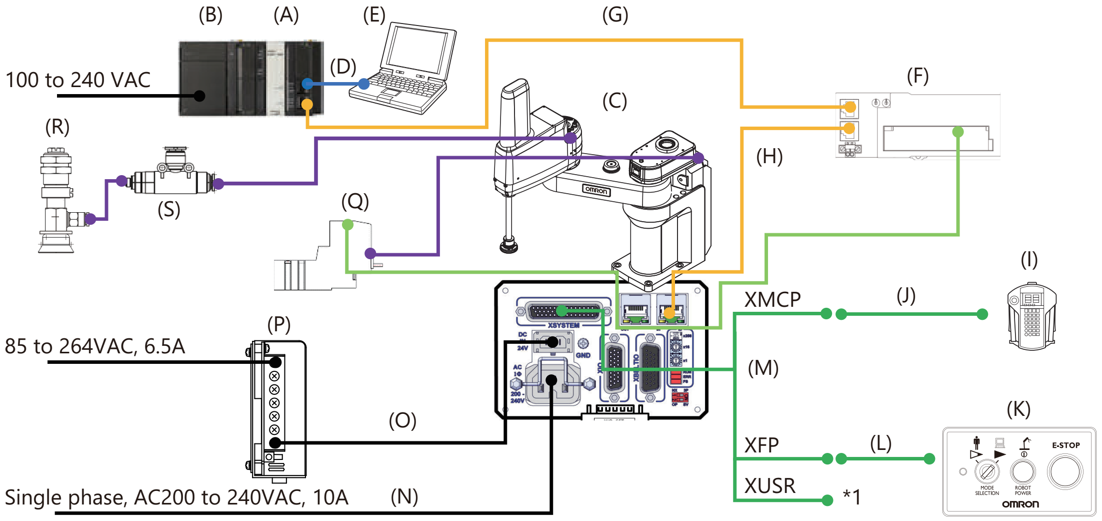
The sequence control and the robot control can be developed with a software. It is easy to perform the advance verification on paper because the system operations to use with the sequence control and robot control can be simulated with the 3D model.

1-2 System Configuration for Static Pick-and-place Equipment

This section describes the system configuration for the static pick-and-place equipment that is explained in this guide.

An equipment to move a workpiece that is not moved at the specified position to the target position is called a static pick-and-place equipment in this guide.

"XUSR" in the following figure is a wiring to the safety circuits. Refer to *A-1 Designing Example of the Safety Functions for the Pick-and-place Equipment* on page A-2, and design the safety circuits required for the actual equipments.


(B)
(A)
(E)
(G)
100 to 240 VAC
(D)
(F)
(C)
(R)
(H)
(S)
(Q)
(I)
XMCP
(J)
85 to 264VAC, 6.5A
(P)
(M)
(K)
(O)
XFP
(L)
E-STOP
XUSR
*1
Single phase, AC200 to 240VAC, 10A
(N)

The parts that are used in the system configuration are given below.

Letter	Name	Model	Version
A	Robot Integrated CPU Unit	NJ501-R300	Ver.1.41
B	Power Supply Unit	NJ-PA3001	---
C	SCARA Robot eCobra 600 Pro	RL4-2166000	3.0 0-0 Edit A1
D	Ethernet cable[*1]	---	---
E	Computer (Sysmac Studio)	---	---
F	EtherCAT Digital I/O Terminal	GX-MD3218	---
G	Ethernet cable[*1]	---	---
H	Ethernet cable[*1]	---	---
I	T20 Pendant	10046-010	3.0.0.1
J	T20 Adapter Cable		---
K	Front Panel	90356-10358	---
L	Front Panel Cable		---
M	XSYSTEM Cable Assembly	Incudes in the RL4-2166000.	---
N	AC Power Cable	04118-000	---
O	DC Power Cable	04120-000	---
P	24 VDC Power Supply 150 W	S8FS-G15024CD	---
Q	Solenoid valve	Selects depending on the workpiece.	---
R	Vacuum pad		---
S	Vacuum ejector		---

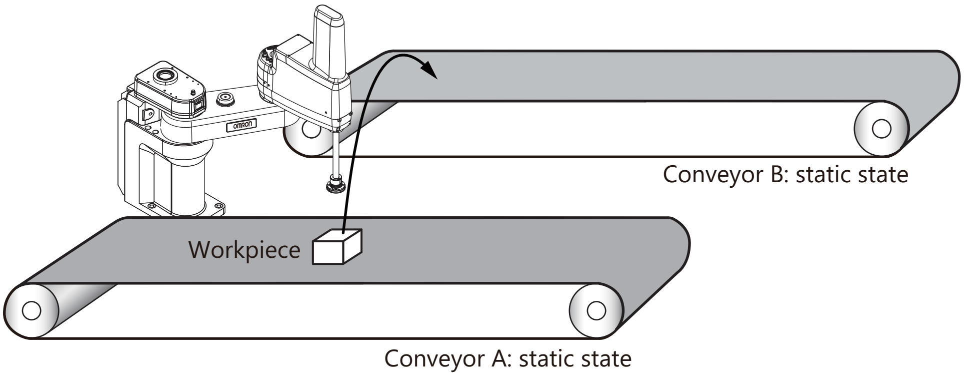
*1. Use a twisted-pair cable (double shielding with aluminum tape and braiding) of category 5 (100BASE-TX) or higher.

1-3 Operations of Static Pick-and-place Equipment

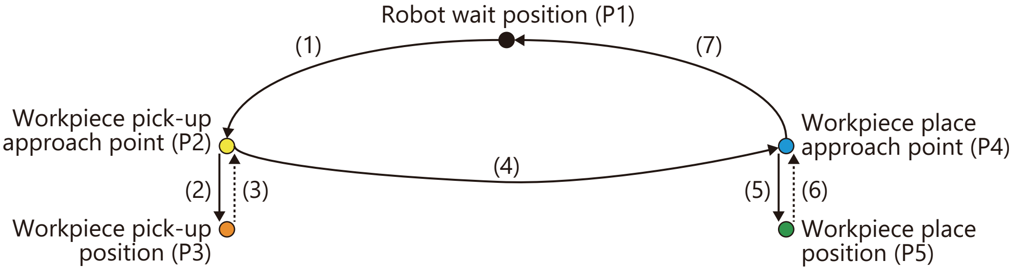
This section describes the operating specifications and procedures for the static pick-and-place equipment.

1-3-1 Operating Specifications

This equipment picks up a workpiece that is not moving on the conveyor A and transfers it to the specified position on the conveyor B.


Conveyor B: static state
Workpiece
Conveyor A: static state

The following figure shows a specific operation for a robot.


Robot wait position (P1)
(1)
(7)
Workpiece pick-up approach point (P2)
Workpiece place approach point (P4)
(4)
(2)
(3)
(5)
(6)
Workpiece pick-up position (P3)
Workpiece place position (P5)

Number	Description of operation
(1)	Move from the robot wait position (P1) to the workpiece pick-up approach point (P2) in joint interpolation operation.
(2)	Move from the workpiece pick-up approach point (P2) to the workpiece pick-up position (P3) in linear interpolation operation.
(3)	Move from the workpiece pick-up position (P3) to workpiece pick-up approach point (P2) in linear interpolation operation.
(4)	Move from the workpiece pick-up approach point (P2) to the workpiece place approach point (P4) in joint interpolation operation.
(5)	Move from the workpiece place approach point (P4) to the workpiece place position (P5) in linear interpolation operation.
(6)	Move from the workpiece place position (P5) to the workpiece place approach point (P4) in linear interpolation operation.
(7)	Move from the workpiece place approach point (P4) to the robot wait position (P1) in joint interpolation operation.

Additional Information

The operations for conveyor A and B are not described in this guide. Program it by the customer according to the operating specifications of actual equipments.

1-3-2 Operating Modes for Equipment

Assume that this equipment have two operating modes, manual operation and automatic operation. Perform teaching in manual operation, and execute the actual pick-and-place operations in automatic operation.

1-4 Hardware

The following table shows an overview of each hardware in the system configuration.
Refer to the manual for the specific product for details.

Hardware	Model	Description
Robot Integrated CPU Unit	NJ501-R□□□	A CPU Unit that integrates the sequence control and robot control. To use the robot control function, you must insert the included SD Memory Card.
EtherCAT-compatible OMRON robot	RL□-□□□□□□□	The OMRON robot that supports EtherCAT.
Computer	---	A computer that the Sysmac Studio Automation Software to make the settings for the robot integrated system and perform debugging is installed. [*1]
Front Panel	90356-10358	A control panel for a robot. The panel has switches to change modes, enable the high power, and make a emergency stop.
T20 Pendant	10046-010	A teaching pendant for a robot. Use the pendant for teaching coordinates. It has the built-in E-Stop button and built-in enable switch as safety functions.
Safety circuits	---	The safety circuits that consist of safety I/O devices, a Safety Controller, etc. Refer to *A-1 Designing Example of the Safety Functions for the Pick-and-place Equipment* on page A-2 for details.
Connected external devices	---	I/O devices connected to the digital I/O terminals of the robot.
EtherCAT slaves	---	EtherCAT slaves such as digital I/O, servos, and inverters.

*1. Refer to the *Sysmac Studio Robot Integrated System Building Function with Robot Integrated CPU Unit Operation Manual (Cat. No. W595)* for information on the recommended operating environment for the computer.

1-5 Software

This section describes an overview of each software in the system configuration.
Use the Sysmac Studio as a development environment for the robot integrated system.

1-5-1 Sysmac Studio

The Sysmac Studio provides development environment for a robot integrated system on a computer.

Precautions for Correct Use

For a robot integrated system, use the 64-bit edition DVD (SYSMAC-SE200D-64) with the Sysmac Studio version 1.☐☐. You cannot use the 32-bit edition DVD (SYSMAC-SE200D).

The Sysmac Studio has the following functions.

Function	Description
Robot control function	A function to make settings and create a program to control a robot with the Robot Integrated CPU Unit and IPC Application Controller. To use this function, you need a license for the Standard Edition (SYSMAC-SE2☐☐L).
3D simulation function	A function to perform a 3D simulation including robots and peripheral devices. To use this function, you need a license with the 3D Simulation Option (SYSMAC-SA4☐☐L-64).

Refer to the *Sysmac Studio Robot Integrated System Building Function with Robot Integrated CPU Unit Operation Manual (Cat. No. W595)* for information on the robot control function in the Sysmac Studio and the *Sysmac Studio 3D Simulation Function Operation Manual (Cat. No. W618)* for information on the 3D simulation function.

Additional Information

Refer to *A-2 Setting Items on the Sysmac Studio and the Setting Targets* on page A-21 for information on which hardware setting corresponds to the items on the Multiview Explorer of the Sysmac Studio.

1-6 User Program

The user program for robot control is created in the Sysmac Studio.
There is more than one method to create a user program. Realize applications to use with programs created by multiple methods.

1-6-1 Types of Method to Create User Program

The following table shows the types of method to create a user program.

Method	Description
Sequence control program	The user program that is operated in the Robot Integrated CPU Unit can be programmed with the language that is defined in IEC61131-3. The robots are controlled with robot control instructions and system-defined variables for robot control. This program is suitable for operating simple robot motions or controlling with robots and peripheral devices. Ladder diagram is used in this guide.
V+ program	The user program that is operated in the Robot Integrated CPU Unit can be programmed with V+ language. The language is a programming language for robot control for the OMRON robots. The robots can be controlled using V+ keywords. In addition, you can use ACE Sight V+ keywords and V+ module API to call and use the functions of the Application Manager. This program is suitable for using various robot control.

1-6-2 Proper Use of Sequence Control Program and V+ Program

The following shows proper use of the sequence control program and V+ program.

- The sequence control program manages the status, errors, and interlocks of the entire system including sequence control and robot control.
- The robot control is performed with a combination of the sequence control program and the V+ program.
- The sequence control program performs the control other than robot control.

A typical example of differences for robot control that can be used in the sequence control program and the V+ program is given below.
The sequence control program can use a part of the control that is available in the V+ program.

Classification	Item	Applicability (if applicable, the specified method is described.)	
		Sequence control program	V+ program
Robot operations	Joint interpolation operation	RC_MoveDirect [*1]	MOVE
	Linear interpolation operation	RC_MoveLinear [*1]	MOVES
	Circular interpolation operation	Not possible.	MOVEC
	Jog operation	Not possible.	JOG
	Joint coordinate system operation	Not possible.	JMOVE
	Tool coordinate system operation	Not possible.	APPRO/DEPART/ALIGN

Classification	Item	Applicability (if applicable, the specified method is described.)	
		Sequence control program	V+ program
Robot's coordinate	Flange surface	_RC_RBT[*].TCPActPos [2]	HERE
	Coordinates of the tool center point	_RC_RBT[*].TCPActPos [2] (RC_SetToolTransform [1])	HERE (TOOL)
	Joint coordinates for each axis	_RC_RBT[*].JointActPos [2]	#PHERE
Other functions	Robot built-in I/O	_RC_RBT_IO[*].XIO [2]	SIGNAL/SIG
	Expanded robot I/O	_RC_RBT_IO[*].IOBlox1 [2] _RC_RBT_IO[*].IOBlox2 [2]	SIGNAL/SIG
	Teaching	Not possible.	Position variables
	End effector operation	_RC_RBT_IO[*].RO [2]	SIGNAL/SIG
	Robot position latching	Not possible.	LATCH
	Robot built-in encoder latching	Not possible.	DEVICE
	Cooperation with Application Manager	Not possible.	ACE Sight V+ keyword V+ Module API

*1. This is a robot control instruction.

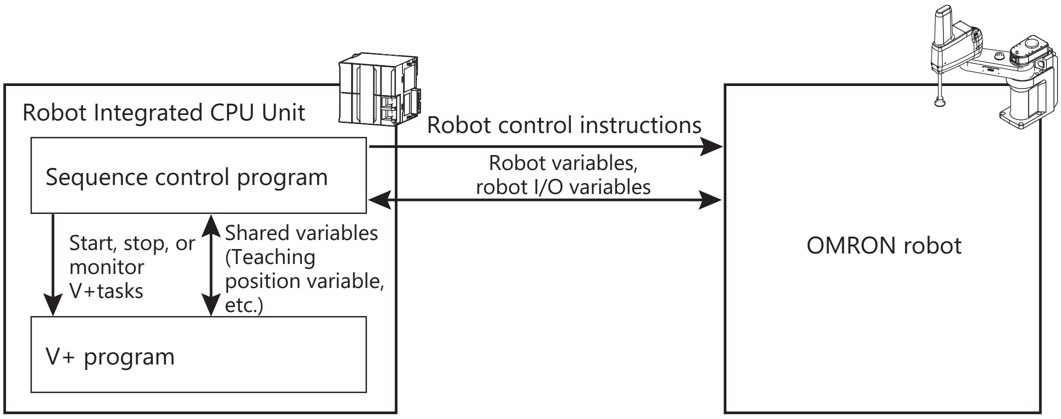
*2. This is a system-defined variable for robot control.

Refer to the *NJ-series Robot Integrated CPU Unit User's Manual (Cat. No. O037)* for detailed information when a robot is controlled with a sequence control program.
Refer to the *eV+3 User's Manual (Cat. No. I651)* and *eV+3 Keyword Reference Manual (Cat. No. I652)* for detailed information when a robot is controlled with a V+ program.

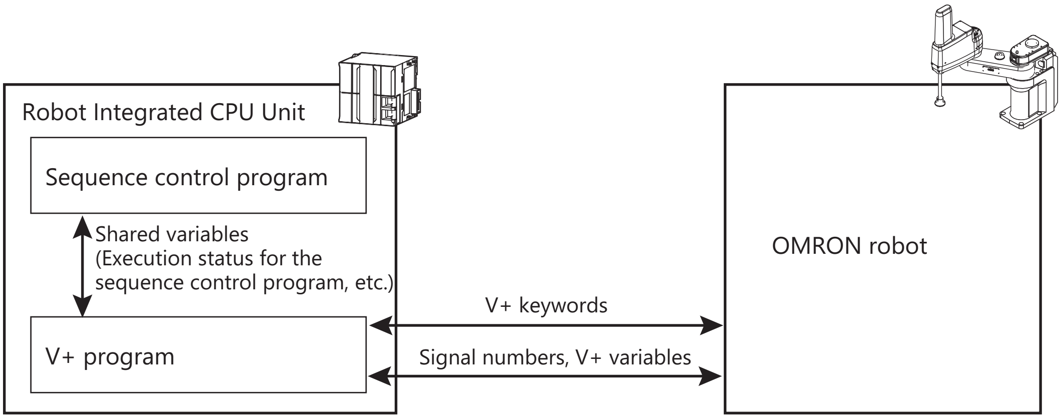
1-6-3 Command and Data Flow

This section describes the flow of commands and data for the the sequence control program, V+ program, Application Manager, and robot.

The sequence control program can control robots with robot control instructions, robot variables, and robot I/O variables.
The program must call a V+ program with RC_ExecVpPrgTask and copy the location information to the shared variables because the teaching location information is a position variable in the V+ program.


Robot Integrated CPU Unit
Sequence control program
Start, stop, or monitor V+tasks
Shared variables (Teaching position variable, etc.)
V+ program
Robot control instructions
Robot variables, robot I/O variables
OMRON robot

The V+ program can control robots with V+ keywords, signal numbers, and V+ variables.
The V+ program starts or stops with RC_ExecVpPrgTask from the sequence control program.


Robot Integrated CPU Unit
Sequence control program
Shared variables
(Execution status for the sequence control program, etc.)
V+ program
V+ keywords
Signal numbers, V+ variables
OMRON robot

Refer to the *NJ-series Robot Integrated CPU Unit User’s Manual (Cat. No. O037)* for details on the robot control function and shared variables in the sequence control program.
Refer to the *eV+3 User's Manual (Cat. No. I651)* and *eV+3 Keyword Reference Manual (Cat. No. I652)* for details on the robot control function in the V+ program.

2

Before You Begin

This section describes the installation procedure of the Sysmac Studio and how to assemble and wire the hardware.

2-1 Installing the Sysmac Studio 2-2
2-2 Installing and Wiring the System 2-3
- 2-2-1 Wiring the Robot Integrated CPU Unit and the EtherCAT Digital I/O Terminal 2-3
- 2-2-2 Setting the Node Address of the EtherCAT Digital I/O Terminal 2-4
- 2-2-3 Wiring the EtherCAT Digital I/O Terminal and the Robot................................ 2-4
- 2-2-4 Setting the EtherCAT Node Address of the Robot 2-5
- 2-2-5 Wiring the Robot Integrated CPU Unit and the Computer............................... 2-5
- 2-2-6 Wiring the Robot, T20 Pendant and the Front Panel 2-5
- 2-2-7 Wiring the EtherCAT Digital I/O Terminal and the Solenoid Valve................... 2-7

2-1 Installing the Sysmac Studio

The Sysmac Studio Ver.1.□□ 64-bit edition DVD (SYSMAC-SE200D-64) is the Support Software that you use for the Robot Integrated System. On it, you can set up the configurations and parameters, you can create programs, and you can debug and simulate operation.

1. Set the Sysmac Studio installation disk into the DVD-ROM drive.
   The setup program is started automatically and the **Select Setup Language** Dialog Box is displayed.
2. Select the language to use, and then click the **OK** button.
   The Sysmac Studio Setup Wizard is started.
3. Follow the instructions given by the Setup Wizard to complete the installation.
4. Restart the computer when the installation is completed.

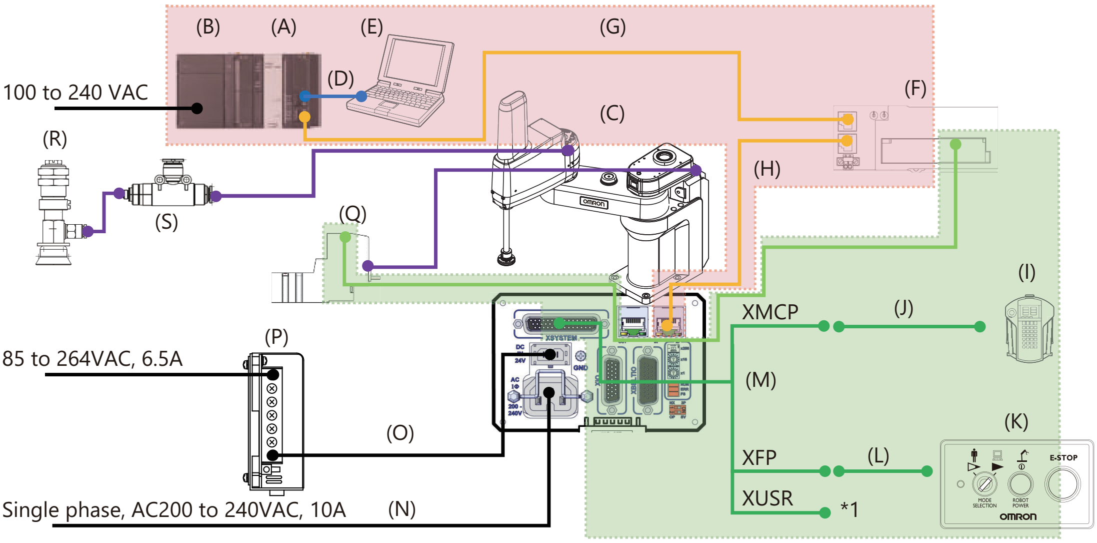
Additional Information

- Refer to the *Sysmac Studio Robot Integrated System Building Function with Robot Integrated CPU Unit Operation Manual (Cat. No. W595)* for information on the system requirements for the computer to which you install the Sysmac Studio.
- Refer to the *Sysmac Studio Version 1 Operation Manual (Cat. No. W504)* if you are unable to install the Sysmac Studio with the above instructions.

2-2 Installing and Wiring the System

In the system configuration, you must wire the signal lines covered in the colored areas in the figure below and set the node address of the robot.

- Wiring between the Robot Integrated CPU Unit (A) and the EtherCAT Digital I/O Terminal (F)
- Wiring between the EtherCAT Digital I/O Terminal (F) and the robot (C)
- Wiring between the Robot Integrated CPU Unit (A) and the computer (E)
- Wiring between the robot (C) and the T20 pendant (I)
- Wiring between the robot (C) and the front panel (K)
- Wiring between the EtherCAT Digital I/O Terminal (F) and the solenoid valve (Q)



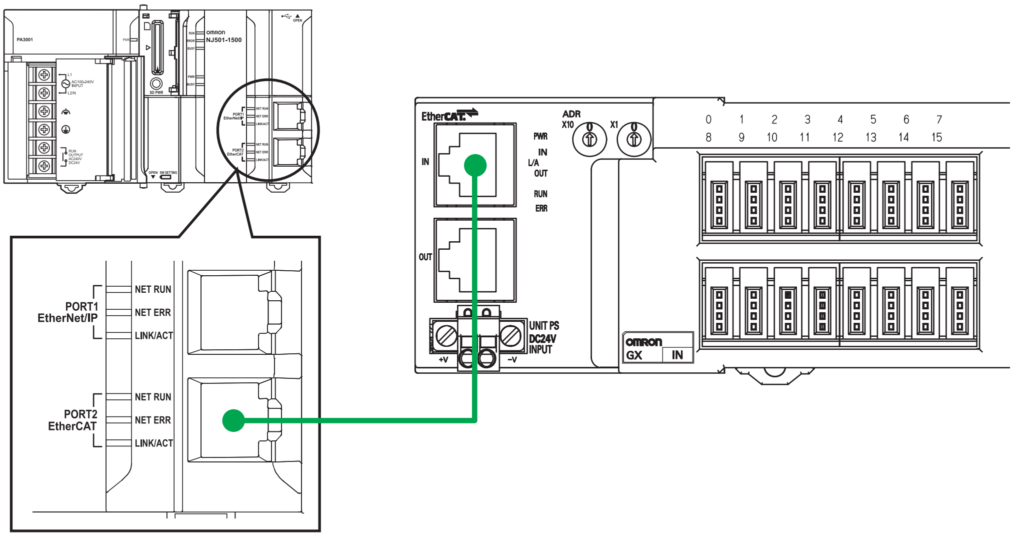
Refer to *1-2 System Configuration for Static Pick-and-place Equipment* on page 1-3 for information on the parts used in the system configuration.

Refer to the manual for the specific product for details on power lines not covered in the colored area as well as for ducting from the robot.

2-2-1 Wiring the Robot Integrated CPU Unit and the EtherCAT Digital I/O Terminal

You must wire the Robot Integrated CPU Unit and the EtherCAT Digital I/O Terminal.

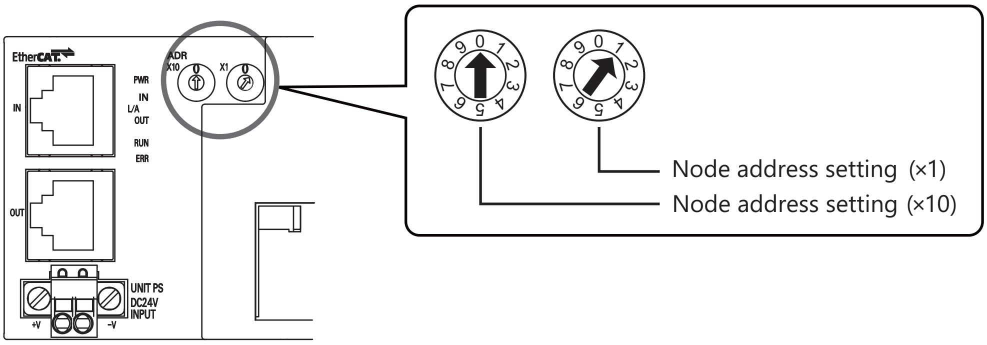
1. Connect the EtherCAT port of the Robot Integrated CPU Unit and the EtherCAT IN port of the EtherCAT Digital I/O Terminal with an Ethernet cable.


omron
NJ501-1500
PA3001
PORT1
EtherNet/IP
NET RUN
NET ERR
LINK/ACT
PORT2
EtherCAT
NET RUN
NET ERR
LINK/ACT
EtherCAT
ADR
X10
X1
PWR
IN
L/A
OUT
RUN
ERR
IN
OUT
UNIT PS
DC24V
INPUT
+V
-V
0 1 2 3 4 5 6 7
8 9 10 11 12 13 14 15
omron
GX
IN

2-2-2 Setting the Node Address of the EtherCAT Digital I/O Terminal

You must set the EtherCAT node address of the EtherCAT Digital I/O Terminal.

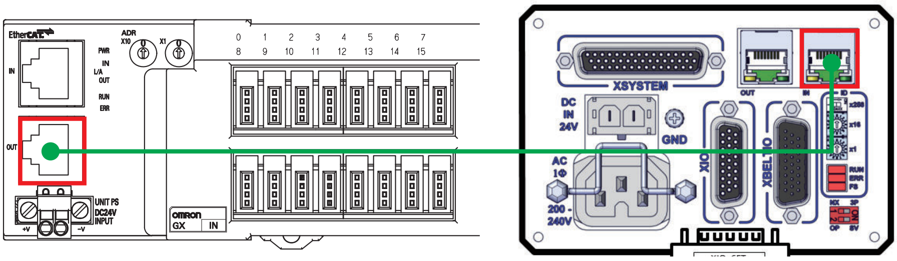
1. Use the switches on the EtherCAT Digital I/O Terminal to set the EtherCAT node address.
   To set the node address to 1, set the x10 switch to 0 and the x1 switch to 1.


EtherCAT
ADR
X10
X1
PWR
IN
L/A
OUT
RUN
ERR
IN
OUT
UNIT PS
DC24V
INPUT
+V
-V
0 1 2 3 4 5 6 7 8 9
Node address setting (×1)
Node address setting (×10)

2-2-3 Wiring the EtherCAT Digital I/O Terminal and the Robot

You must wire the EtherCAT Digital I/O Terminal and the robot.

1. Connect the EtherCAT OUT port of the EtherCAT Digital I/O Terminal and the EtherCAT IN port on the interface panel of the robot with an Ethernet cable.


EtherCAT
ADR
X10
X1
PWR
IN
L/A
OUT
RUN
ERR
IN
OUT
UNIT PS
DC24V
INPUT
+V
-V
0 1 2 3 4 5 6 7
8 9 10 11 12 13 14 15
omron
GX
IN
XSYSTEM
OUT
IN
DC
IN
24V
GND
AC
1Φ
200 -
240V
XIO
XBELT IO
x16
x1
RUN
ERR
FS

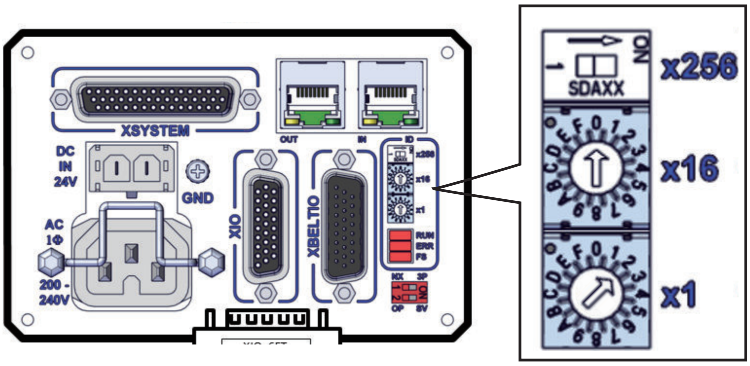
Precautions for Correct Use

Refer to the *NJ/NX-series CPU Unit Built-in EtherCAT Port User's Manual (Cat. No. W505)* for details on the Ethernet cable to be used.

2-2-4 Setting the EtherCAT Node Address of the Robot

You must set the EtherCAT node address of the robot.

1. Use the switches on the interface panel of the robot to set the EtherCAT node address.
   To set the node address to 2, set the x256 switch to OFF, the x16 switch to 0, and the x1 switch to 2.

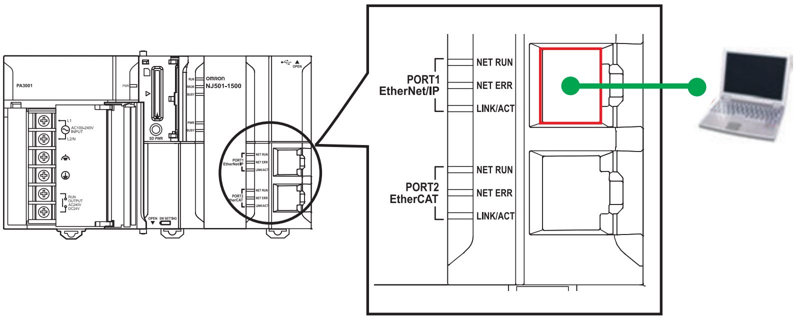

XSYSTEM
DC IN 24V
GND
AC 1Φ 200 - 240V
XIO
XBELTIO
OUT
IN
ID
RUN
ERR
FS
ON
SDAXX
x256
x16
x1

Refer to the manual for your robot on how to set the node address.

2-2-5 Wiring the Robot Integrated CPU Unit and the Computer

You must wire the Robot Integrated CPU Unit and the computer.

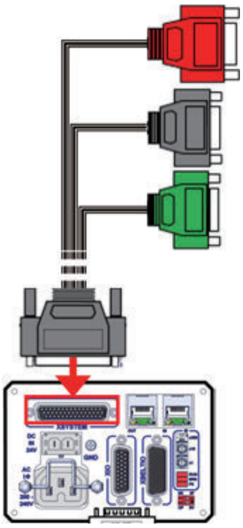
1. Connect the built-in EtherNet/IP port of the Robot Integrated CPU Unit and the computer with an Ethernet cable.


PA3001
omron
NJ501-1500
PORT1
EtherNet/IP
NET RUN
NET ERR
LINK/ACT
PORT2
EtherCAT
NET RUN
NET ERR
LINK/ACT

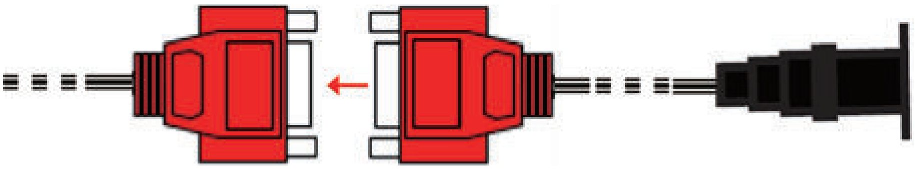
2-2-6 Wiring the Robot, T20 Pendant and the Front Panel

You must wire the robot and the T20 pendant, as well as the robot and the front panel. Use an XSYSTEM cable assembly, a T20 adapter cable, and a front panel cable for wiring.

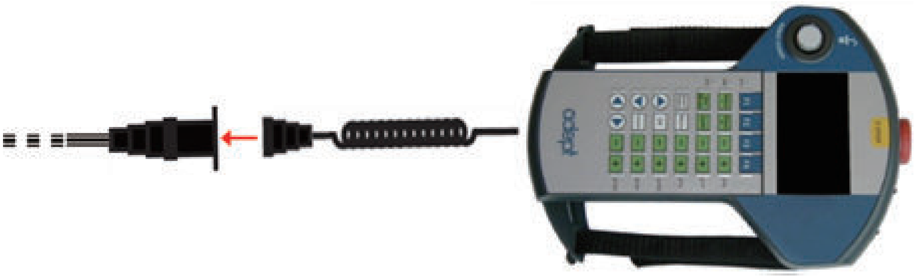
1. Connect the robot and the XSYSTEM cable assembly.



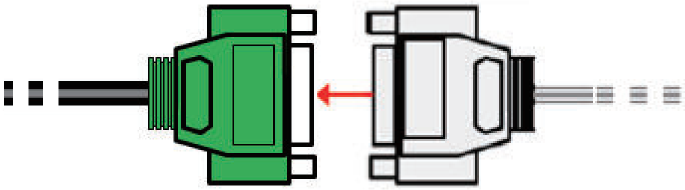
2 Connect the XMCP connector (Red) of the XSYSTEM cable assembly and the T20 adapter cable.



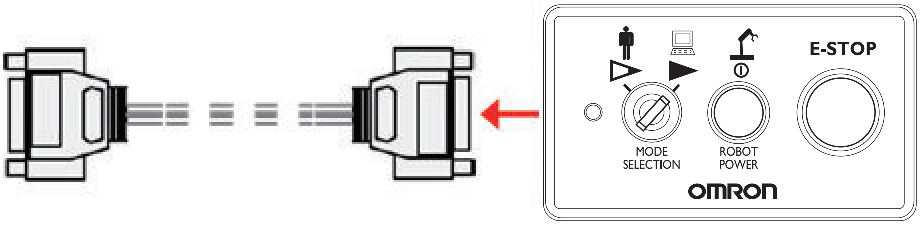
3 Connect the T20 adapter cable to the T20 pendant.



4 Connect the XFP connector (Green) of the XSYSTEM cable assembly and the front panel cable.



5 Connect the front panel cable and the front panel.


E-STOP
MODE SELECTION
ROBOT POWER
OMRON

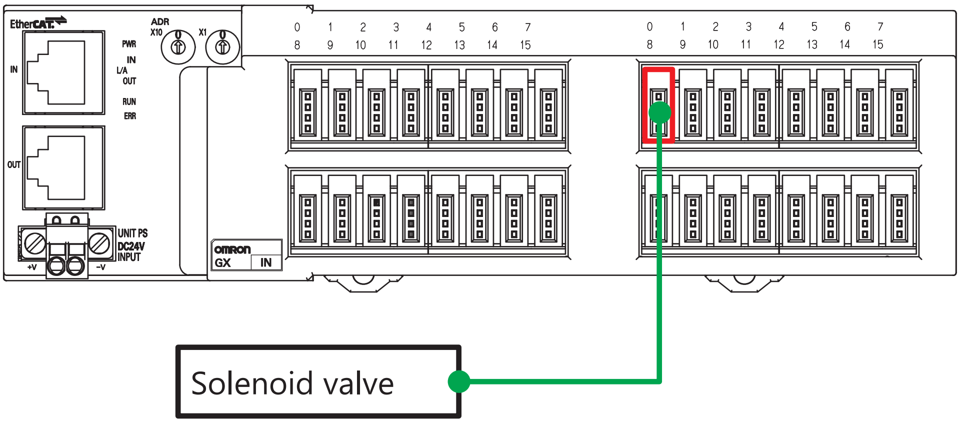
2-2-7 Wiring the EtherCAT Digital I/O Terminal and the Solenoid Valve

You must wire the EtherCAT Digital I/O Terminal and the solenoid valve.
Refer to the manuals for the EtherCAT Digital I/O Terminal and the solenoid valve for details on the cable wiring, and make the cable appropriately in accordance with the wiring diagrams and specifications.

1 Make the cable so that the solenoid valve will behave as shown in the table below.

Output value of Digital I/O Terminal	Solenoid valve behavior
FALSE	Duct is closed
TRUE	Duct is open

2 Wire the EtherCAT Digital I/O Terminal and the solenoid valve.


EtherCAT
ADR
X10
X1
PWR
IN
L/A
OUT
RUN
ERR
IN
OUT
UNIT PS
DC24V
INPUT
+V
−V
OMRON
GX
IN
0 1 2 3 4 5 6 7
8 9 10 11 12 13 14 15
0 1 2 3 4 5 6 7
8 9 10 11 12 13 14 15
Solenoid valve

3

Implementation Example of Static Pick-and-place Equipment

This section describes the implementation example of the static pick-and-place equipment.
An equipment to move a workpiece that is not moved at the specified position to the target position is called a static pick-and-place equipment in this guide.
This example can realize with the sequence control program and V+ program.

3-1 Program Specifications for Static Pick-and-place Equipment 3-2

3-1-1 When Operations are Controlled with Sequence Control Program 3-3
3-1-2 When Operations are Controlled with V+ Program 3-11

3-2 Basic Startup Procedures 3-17

3-3 Programming and Simulation Procedures 3-18

3-3-1 Creating a Project File 3-18
3-3-2 Creating the EtherCAT Network Configuration 3-19
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3-3-4 Creating V+ Programs 3-28
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3-3-7 Teaching Positions 3-57
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3-4 Setup Procedure for Actual System 3-75

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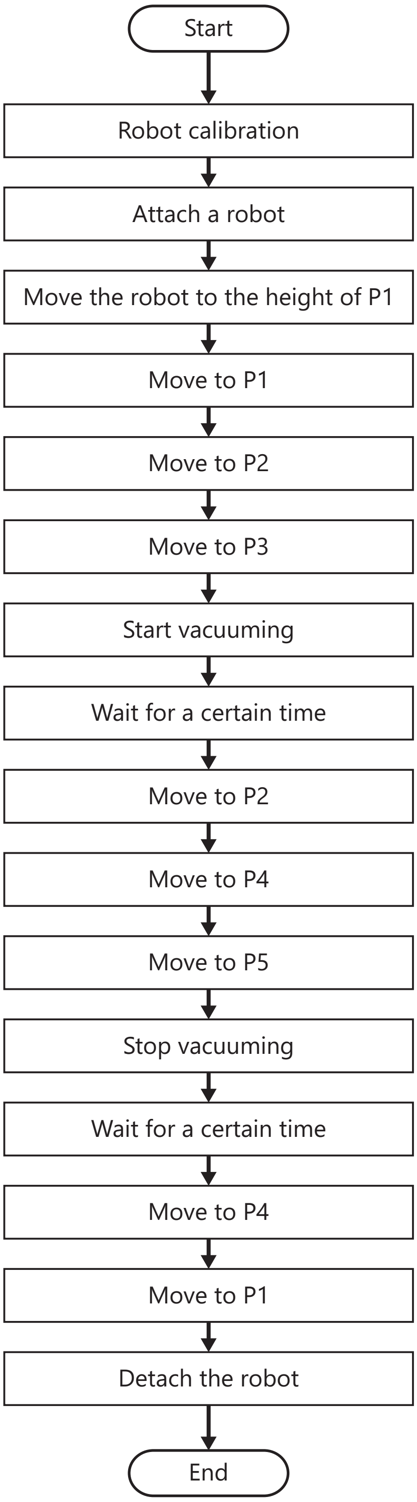
3-4-2 Transferring Settings and Programs 3-77
3-4-3 Teaching 3-80
3-4-4 Executing Program to Check Operation 3-91

3-1 Program Specifications for Static Pick-and-place Equipment

The program specifications are described if operations of static pick-and-place equipment are controlled with the sequence control program and if the operations are controlled with the V+ program.
A flow chart of a program is given below. Refer to *1-3-1 Operating Specifications* on page 1-5 for information on the positions of P1 to P5 in the flow chart.


Start
Robot calibration
Attach a robot
Move the robot to the height of P1
Move to P1
Move to P2
Move to P3
Start vacuuming
Wait for a certain time
Move to P2
Move to P4
Move to P5
Stop vacuuming
Wait for a certain time
Move to P4
Move to P1
Detach the robot
End

3-1-1 When Operations are Controlled with Sequence Control Program

The program specifications when operations of static pick-and-place equipment are controlled with the sequence control program are described below.

The program consists of the following programs.

Program name	Language	Description
Main	Sequence control program (Ladder diagram)	Main program
Run	Sequence control program (Ladder diagram)	Operating program
loccopy	V+ program	Variable copy program

Shared Variables

The following table shows a list of shared variables that are used in this program.

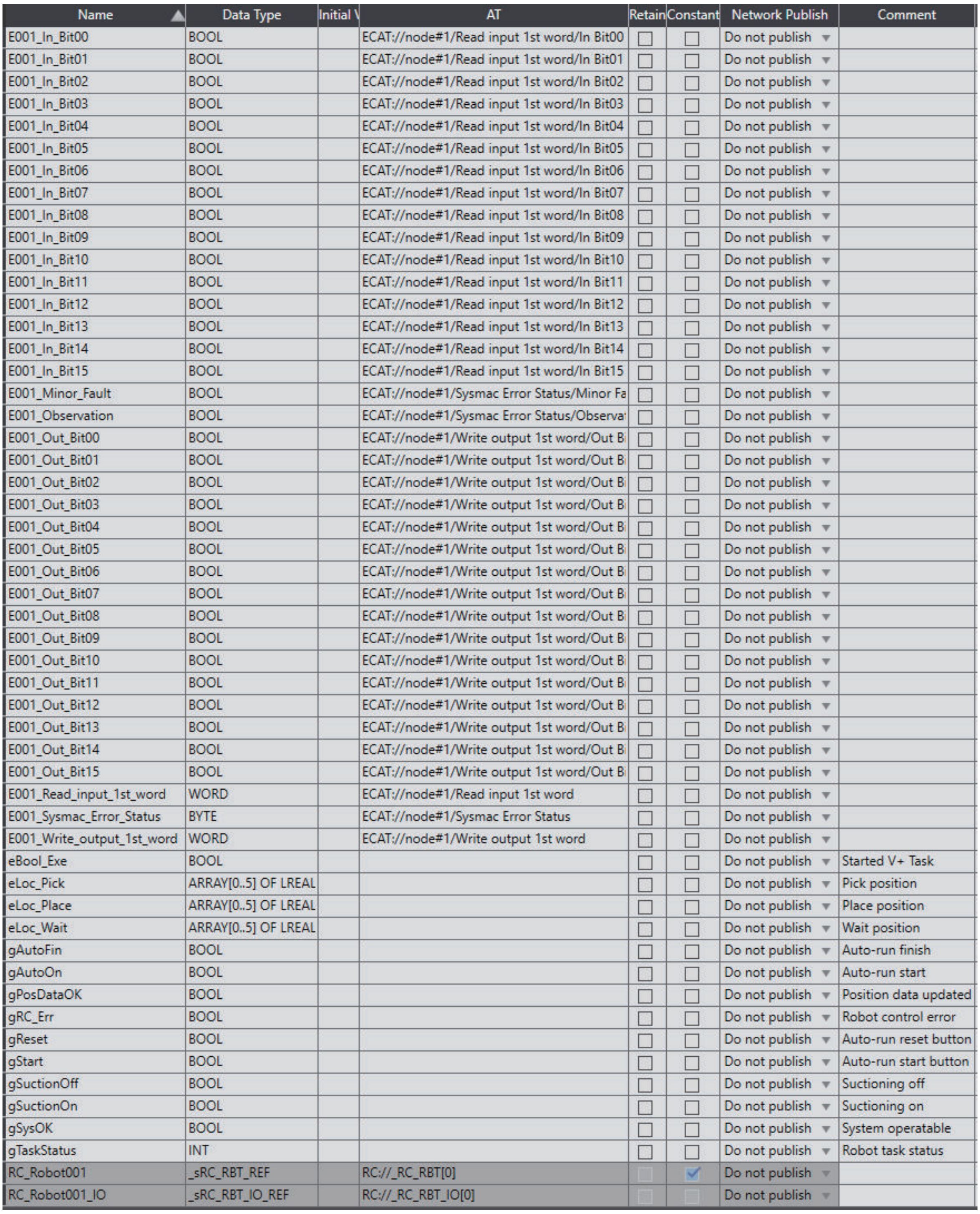
No.	Variable name	Data type	Description
1	eLoc_Wait	ARRAY[0..5] OF LREAL	Use the variable to send the robot wait position from the V+ program to the sequence control program.
2	eLoc_Place	ARRAY[0..5] OF LREAL	Use the variable to send the robot place position from the V+ program to the sequence control program.
3	eLoc_Pick	ARRAY[0..5] OF LREAL	Use the variable to send the robot pick-up position from the V+ program to the sequence control program.
4	eBool_Exe	BOOL	Use the variable to check that the execution of a V+ task is started in the sequence control program.

Sequence Control Program

This section describes the sequence control program to control the static pick-and-place equipment. The sequence control program is used to register global variables and create two programs, "Main" (main program) and "Run" (operating program).

● Global Variables

Register the global variables that are used in the sequence control program.



Name	Data Type	Initial	AT	Retain	Constant	Network Publish	Comment
E001_In_Bit00	BOOL		ECAT://node#1/Read input 1st word/In Bit00	☐	☐	Do not publish	
E001_In_Bit01	BOOL		ECAT://node#1/Read input 1st word/In Bit01	☐	☐	Do not publish	
E001_In_Bit02	BOOL		ECAT://node#1/Read input 1st word/In Bit02	☐	☐	Do not publish	
E001_In_Bit03	BOOL		ECAT://node#1/Read input 1st word/In Bit03	☐	☐	Do not publish	
E001_In_Bit04	BOOL		ECAT://node#1/Read input 1st word/In Bit04	☐	☐	Do not publish	
E001_In_Bit05	BOOL		ECAT://node#1/Read input 1st word/In Bit05	☐	☐	Do not publish	
E001_In_Bit06	BOOL		ECAT://node#1/Read input 1st word/In Bit06	☐	☐	Do not publish	
E001_In_Bit07	BOOL		ECAT://node#1/Read input 1st word/In Bit07	☐	☐	Do not publish	
E001_In_Bit08	BOOL		ECAT://node#1/Read input 1st word/In Bit08	☐	☐	Do not publish	
E001_In_Bit09	BOOL		ECAT://node#1/Read input 1st word/In Bit09	☐	☐	Do not publish	
E001_In_Bit10	BOOL		ECAT://node#1/Read input 1st word/In Bit10	☐	☐	Do not publish	
E001_In_Bit11	BOOL		ECAT://node#1/Read input 1st word/In Bit11	☐	☐	Do not publish	
E001_In_Bit12	BOOL		ECAT://node#1/Read input 1st word/In Bit12	☐	☐	Do not publish	
E001_In_Bit13	BOOL		ECAT://node#1/Read input 1st word/In Bit13	☐	☐	Do not publish	
E001_In_Bit14	BOOL		ECAT://node#1/Read input 1st word/In Bit14	☐	☐	Do not publish	
E001_In_Bit15	BOOL		ECAT://node#1/Read input 1st word/In Bit15	☐	☐	Do not publish	
E001_Minor_Fault	BOOL		ECAT://node#1/Sysmac Error Status/Minor Fa	☐	☐	Do not publish	
E001_Observation	BOOL		ECAT://node#1/Sysmac Error Status/Observa	☐	☐	Do not publish	
E001_Out_Bit00	BOOL		ECAT://node#1/Write output 1st word/Out B	☐	☐	Do not publish	
E001_Out_Bit01	BOOL		ECAT://node#1/Write output 1st word/Out B	☐	☐	Do not publish	
E001_Out_Bit02	BOOL		ECAT://node#1/Write output 1st word/Out B	☐	☐	Do not publish	
E001_Out_Bit03	BOOL		ECAT://node#1/Write output 1st word/Out B	☐	☐	Do not publish	
E001_Out_Bit04	BOOL		ECAT://node#1/Write output 1st word/Out B	☐	☐	Do not publish	
E001_Out_Bit05	BOOL		ECAT://node#1/Write output 1st word/Out B	☐	☐	Do not publish	
E001_Out_Bit06	BOOL		ECAT://node#1/Write output 1st word/Out B	☐	☐	Do not publish	
E001_Out_Bit07	BOOL		ECAT://node#1/Write output 1st word/Out B	☐	☐	Do not publish	
E001_Out_Bit08	BOOL		ECAT://node#1/Write output 1st word/Out B	☐	☐	Do not publish	
E001_Out_Bit09	BOOL		ECAT://node#1/Write output 1st word/Out B	☐	☐	Do not publish	
E001_Out_Bit10	BOOL		ECAT://node#1/Write output 1st word/Out B	☐	☐	Do not publish	
E001_Out_Bit11	BOOL		ECAT://node#1/Write output 1st word/Out B	☐	☐	Do not publish	
E001_Out_Bit12	BOOL		ECAT://node#1/Write output 1st word/Out B	☐	☐	Do not publish	
E001_Out_Bit13	BOOL		ECAT://node#1/Write output 1st word/Out B	☐	☐	Do not publish	
E001_Out_Bit14	BOOL		ECAT://node#1/Write output 1st word/Out B	☐	☐	Do not publish	
E001_Out_Bit15	BOOL		ECAT://node#1/Write output 1st word/Out B	☐	☐	Do not publish	
E001_Read_input_1st_word	WORD		ECAT://node#1/Read input 1st word	☐	☐	Do not publish	
E001_Sysmac_Error_Status	BYTE		ECAT://node#1/Sysmac Error Status	☐	☐	Do not publish	
E001_Write_output_1st_word	WORD		ECAT://node#1/Write output 1st word	☐	☐	Do not publish	
eBool_Exe	BOOL			☐	☐	Do not publish	Started V+ Task
eLoc_Pick	ARRAY[0..5] OF LREAL			☐	☐	Do not publish	Pick position
eLoc_Place	ARRAY[0..5] OF LREAL			☐	☐	Do not publish	Place position
eLoc_Wait	ARRAY[0..5] OF LREAL			☐	☐	Do not publish	Wait position
gAutoFin	BOOL			☐	☐	Do not publish	Auto-run finish
gAutoOn	BOOL			☐	☐	Do not publish	Auto-run start
gPosDataOK	BOOL			☐	☐	Do not publish	Position data updated
gRC_Err	BOOL			☐	☐	Do not publish	Robot control error
gReset	BOOL			☐	☐	Do not publish	Auto-run reset button
gStart	BOOL			☐	☐	Do not publish	Auto-run start button
gSuctionOff	BOOL			☐	☐	Do not publish	Suctioning off
gSuctionOn	BOOL			☐	☐	Do not publish	Suctioning on
gSysOK	BOOL			☐	☐	Do not publish	System operatable
gTaskStatus	INT			☐	☐	Do not publish	Robot task status
RC_Robot001	_sRC_RBT_REF		RC://_RC_RBT[0]	☐	☑	Do not publish	
RC_Robot001_IO	_sRC_RBT_IO_REF		RC://_RC_RBT_IO[0]	☐	☐	Do not publish	

- **Main Program**

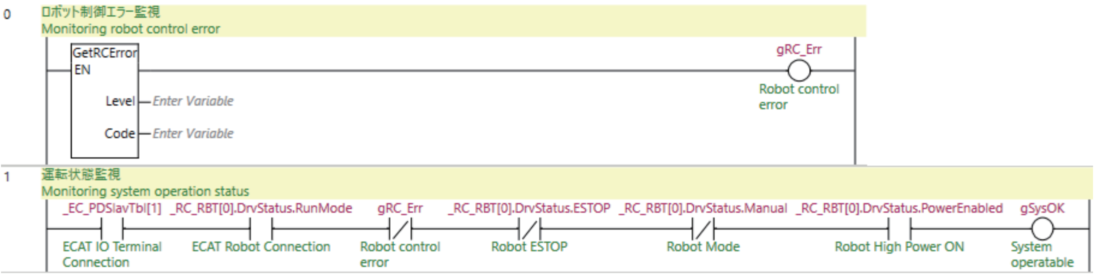
"Main" (main program) is used to monitor the status of the following robots and EtherCAT Digital I/O Terminals and determine whether the automatic operation can start.

Refer to the manual for each device for details on variables.

No.	Variable name	Description
1	_EC_PDSlavTbl[1]	Check that the communications of the EtherCAT Digital I/O Terminal are established.
2	_RC_RBT[0].DrvStatus.RunMode	Check that the communications between the Robot Integrated CPU Unit and the robot are established.

No.	Variable name	Description
3	GetRCError	Check whether an error caused by the Robot Control Function Module exists.
4	_RC_RBT[0].DrvStatus.ESTOP	Check whether the robot is in ESTOP state.
5	_RC_RBT[0].DrvStatus.Manual	Check that the operating mode of the robot is Manual mode.
6	_RC_RBT[0].DrvStatus.Power-Enabled	Check that the robot high power is enabled.

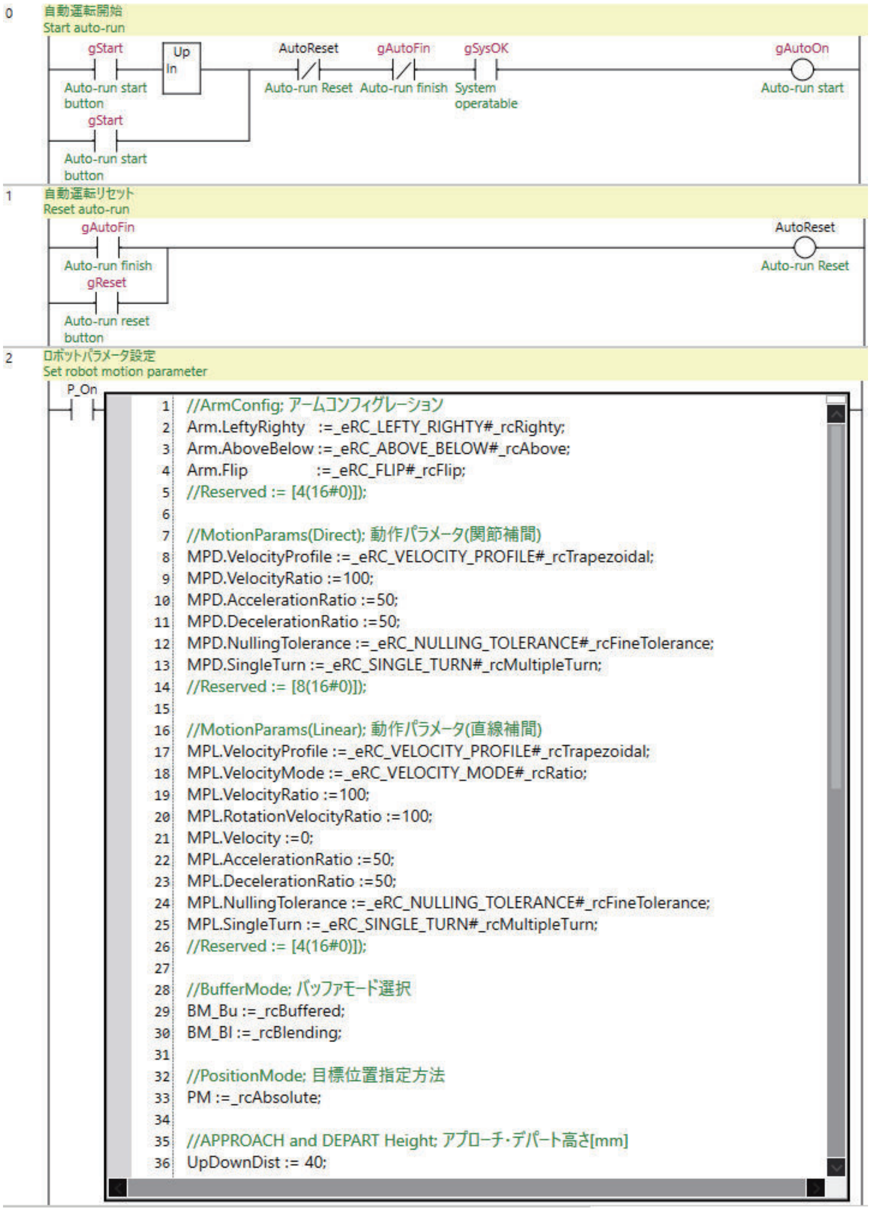
A program is described below.


0
ロボット制御エラー監視
Monitoring robot control error
GetRCError
EN
Level
Enter Variable
Code
Enter Variable
gRC_Err
Robot control error
1
運転状態監視
Monitoring system operation status
_EC_PDSlavTbl[1]
ECAT IO Terminal Connection
_RC_RBT[0].DrvStatus.RunMode
ECAT Robot Connection
gRC_Err
Robot control error
_RC_RBT[0].DrvStatus.ESTOP
Robot ESTOP
_RC_RBT[0].DrvStatus.Manual
Robot Mode
_RC_RBT[0].DrvStatus.PowerEnabled
Robot High Power ON
gSysOK
System operatable

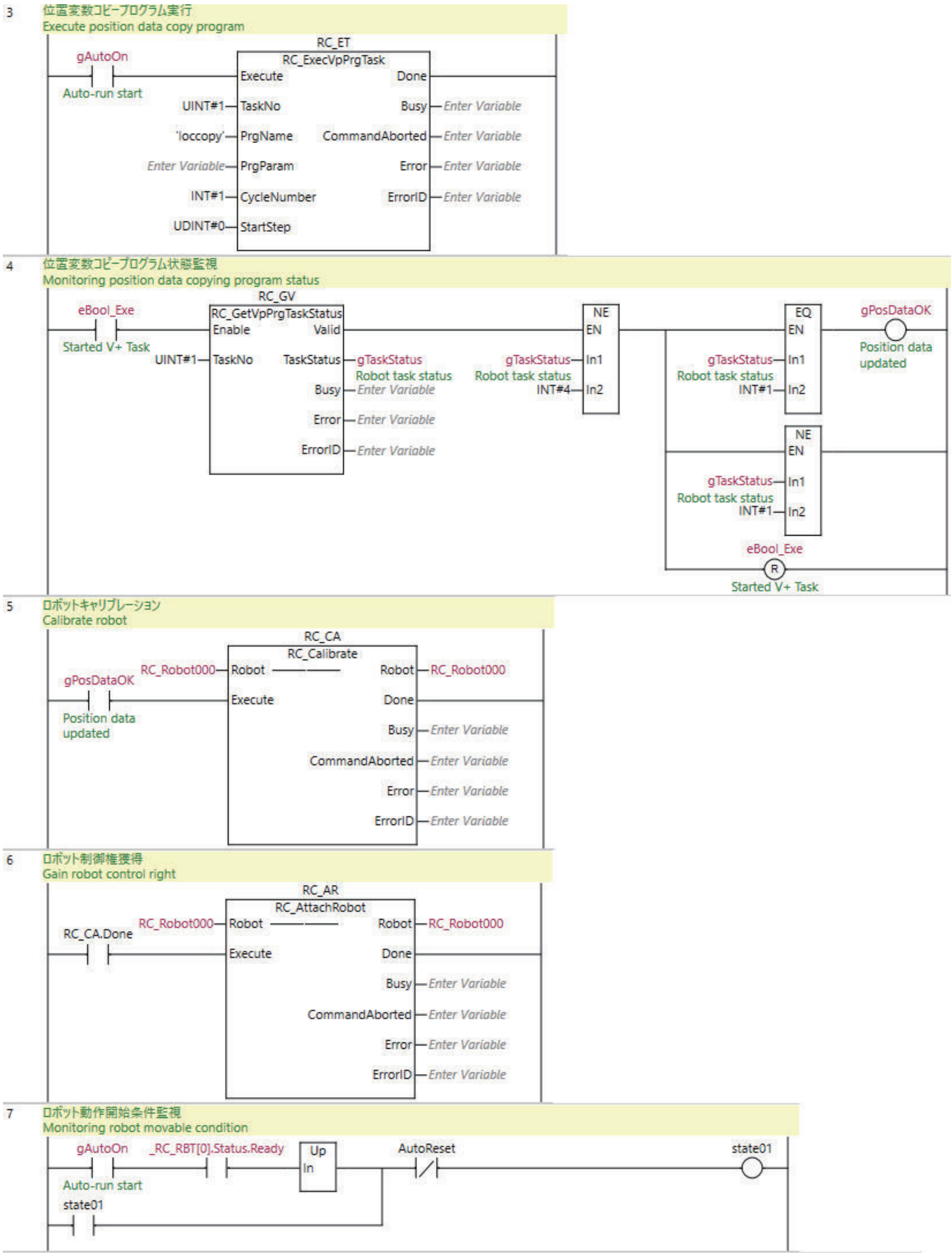
● Operating Program

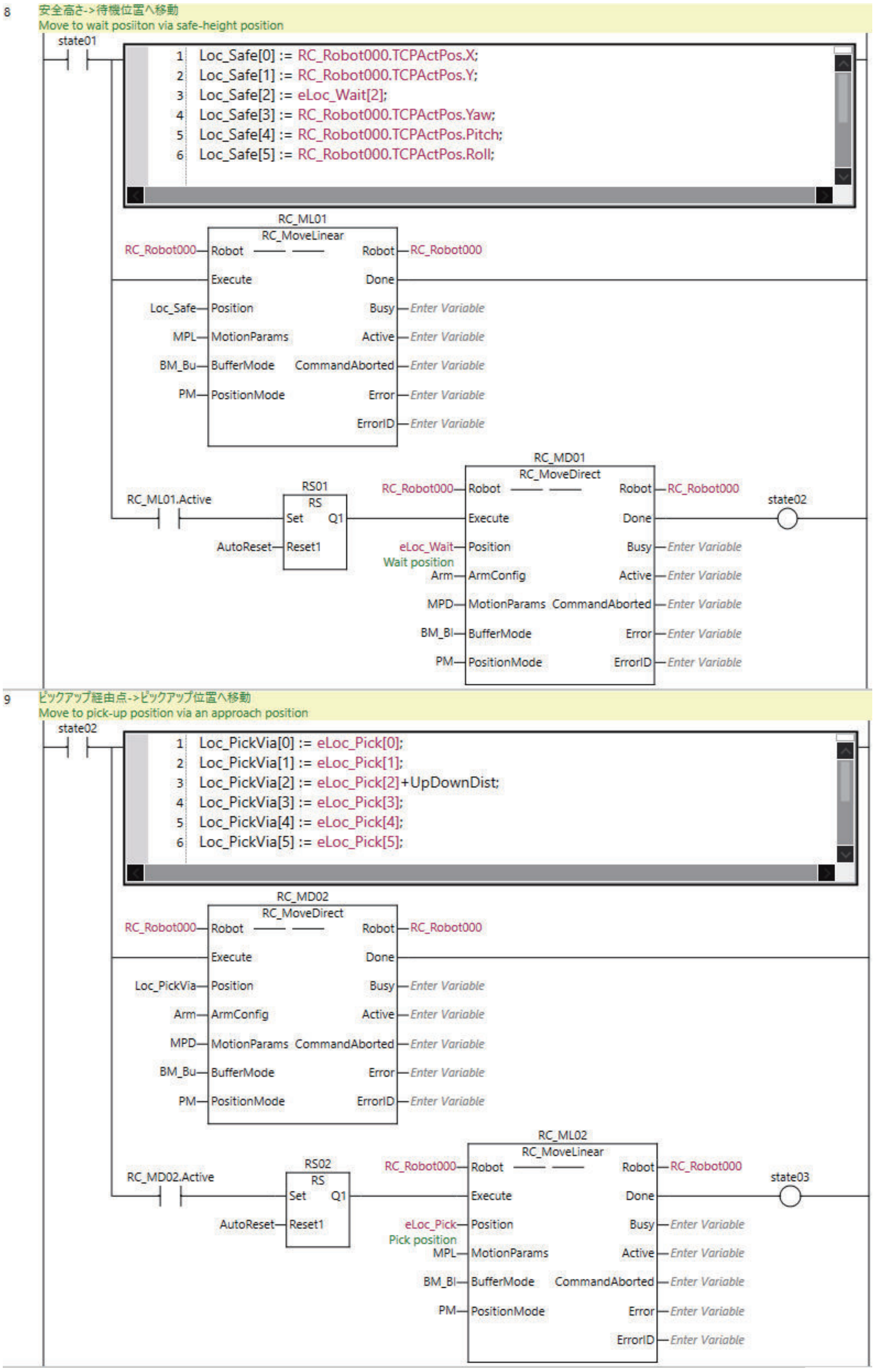
"Run" (operating program) is used to operate a robot.

A program is described below.


0
自動運転開始
Start auto-run
gStart
Auto-run start button
Up
In
gStart
Auto-run start button
AutoReset
Auto-run Reset
gAutoFin
Auto-run finish
gSysOK
System operatable
gAutoOn
Auto-run start
1
自動運転リセット
Reset auto-run
gAutoFin
Auto-run finish
gReset
Auto-run reset button
AutoReset
Auto-run Reset
2
ロボットパラメータ設定
Set robot motion parameter
P_On

```
//ArmConfig; アームコンフィグレーション
Arm.LeftyRighty   :=_eRC_LEFTY_RIGHTY#_rcRighty;
Arm.AboveBelow :=_eRC_ABOVE_BELOW#_rcAbove;
Arm.Flip             :=_eRC_FLIP#_rcFlip;
//Reserved := [4(16#0)]);

//MotionParams(Direct); 動作パラメータ(関節補間)
MPD.VelocityProfile :=_eRC_VELOCITY_PROFILE#_rcTrapezoidal;
MPD.VelocityRatio :=100;
MPD.AccelerationRatio :=50;
MPD.DecelerationRatio :=50;
MPD.NullingTolerance :=_eRC_NULLING_TOLERANCE#_rcFineTolerance;
MPD.SingleTurn :=_eRC_SINGLE_TURN#_rcMultipleTurn;
//Reserved := [8(16#0)]);

//MotionParams(Linear); 動作パラメータ(直線補間)
MPL.VelocityProfile :=_eRC_VELOCITY_PROFILE#_rcTrapezoidal;
MPL.VelocityMode :=_eRC_VELOCITY_MODE#_rcRatio;
MPL.VelocityRatio :=100;
MPL.RotationVelocityRatio :=100;
MPL.Velocity :=0;
MPL.AccelerationRatio :=50;
MPL.DecelerationRatio :=50;
MPL.NullingTolerance :=_eRC_NULLING_TOLERANCE#_rcFineTolerance;
MPL.SingleTurn :=_eRC_SINGLE_TURN#_rcMultipleTurn;
//Reserved := [4(16#0)]);

//BufferMode; バッファモード選択
BM_Bu :=_rcBuffered;
BM_Bl :=_rcBlending;

//PositionMode; 目標位置指定方法
PM :=_rcAbsolute;

//APPROACH and DEPART Height; アプローチ・デパート高さ[mm]
UpDownDist := 40;
```


3
位置変数コピープログラム実行
Execute position data copy program
RC_ET
RC_ExecVpPrgTask
gAutoOn
Auto-run start
Execute
Done
UINT#1
TaskNo
Busy
Enter Variable
'loccopy'
PrgName
CommandAborted
Enter Variable
Enter Variable
PrgParam
Error
Enter Variable
INT#1
CycleNumber
ErrorID
Enter Variable
UDINT#0
StartStep
4
位置変数コピープログラム状態監視
Monitoring position data copying program status
RC_GV
RC_GetVpPrgTaskStatus
eBool_Exe
Started V+ Task
Enable
Valid
NE
EN
EQ
EN
gPosDataOK
Position data updated
UINT#1
TaskNo
TaskStatus
gTaskStatus
Robot task status
gTaskStatus
Robot task status
In1
INT#4
In2
gTaskStatus
Robot task status
In1
INT#1
In2
Busy
Enter Variable
Error
Enter Variable
ErrorID
Enter Variable
NE
EN
gTaskStatus
Robot task status
In1
INT#1
In2
eBool_Exe
R
Started V+ Task
5
ロボットキャリブレーション
Calibrate robot
RC_CA
RC_Calibrate
RC_Robot000
Robot
Robot
RC_Robot000
gPosDataOK
Position data updated
Execute
Done
Busy
Enter Variable
CommandAborted
Enter Variable
Error
Enter Variable
ErrorID
Enter Variable
6
ロボット制御権獲得
Gain robot control right
RC_AR
RC_AttachRobot
RC_Robot000
Robot
Robot
RC_Robot000
RC_CA.Done
Execute
Done
Busy
Enter Variable
CommandAborted
Enter Variable
Error
Enter Variable
ErrorID
Enter Variable
7
ロボット動作開始条件監視
Monitoring robot movable condition
gAutoOn
Auto-run start
_RC_RBT[0].Status.Ready
Up
In
AutoReset
state01
state01



8 安全高さ->待機位置へ移動
Move to wait posiiton via safe-height position

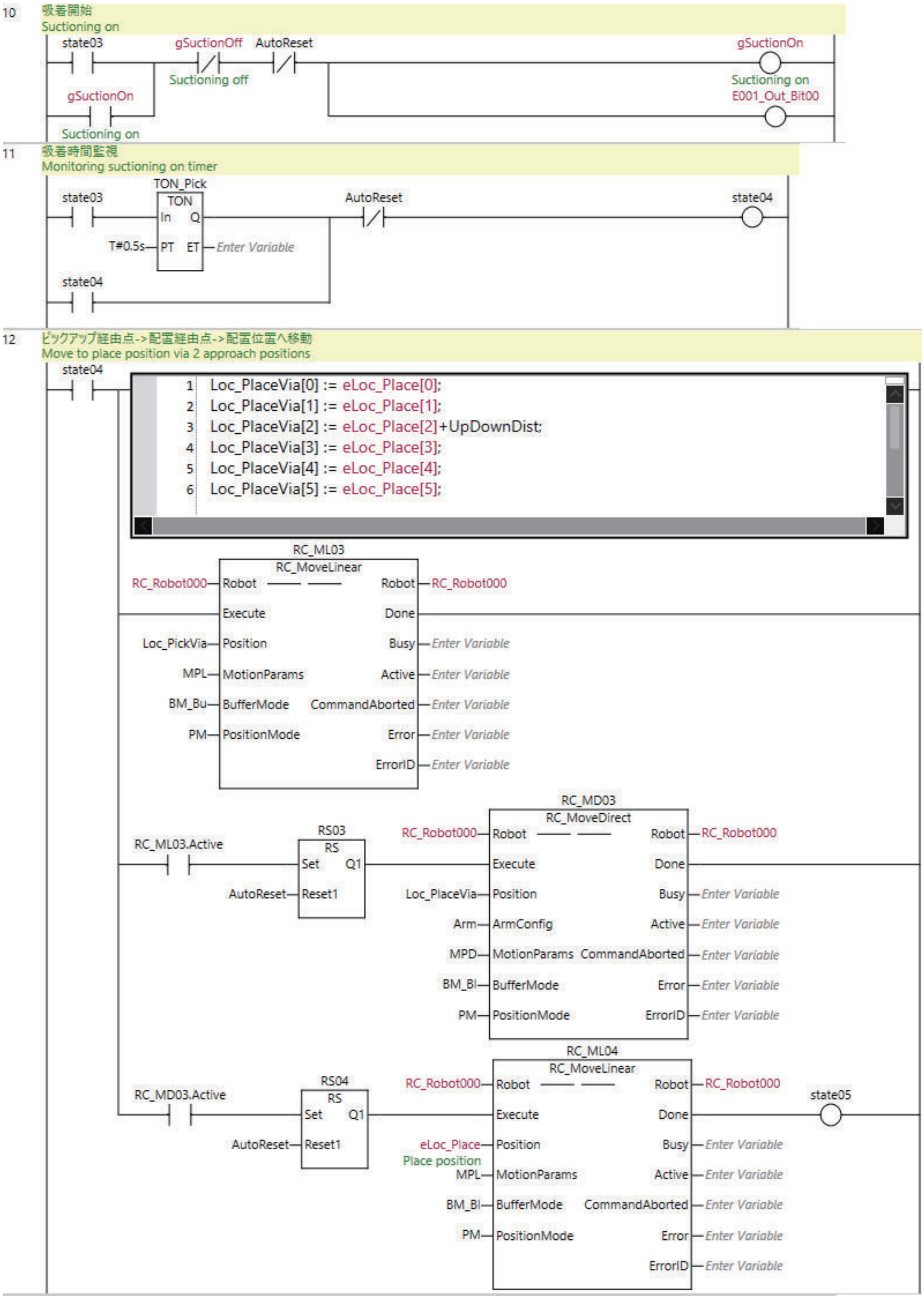
```
Loc_Safe[0] := RC_Robot000.TCPActPos.X;
Loc_Safe[1] := RC_Robot000.TCPActPos.Y;
Loc_Safe[2] := eLoc_Wait[2];
Loc_Safe[3] := RC_Robot000.TCPActPos.Yaw;
Loc_Safe[4] := RC_Robot000.TCPActPos.Pitch;
Loc_Safe[5] := RC_Robot000.TCPActPos.Roll;
```

state01
RC_ML01
RC_MoveLinear
RC_Robot000—Robot
Robot—RC_Robot000
Execute
Done
Loc_Safe—Position
Busy—Enter Variable
MPL—MotionParams
Active—Enter Variable
BM_Bu—BufferMode
CommandAborted—Enter Variable
PM—PositionMode
Error—Enter Variable
ErrorID—Enter Variable
RC_ML01.Active
RS01
RS
Set
Q1
AutoReset—Reset1
RC_MD01
RC_MoveDirect
RC_Robot000—Robot
Robot—RC_Robot000
Execute
Done
eLoc_Wait—Position
Wait position
Arm—ArmConfig
MPD—MotionParams
BM_Bl—BufferMode
PM—PositionMode
Busy—Enter Variable
Active—Enter Variable
CommandAborted—Enter Variable
Error—Enter Variable
ErrorID—Enter Variable
state02

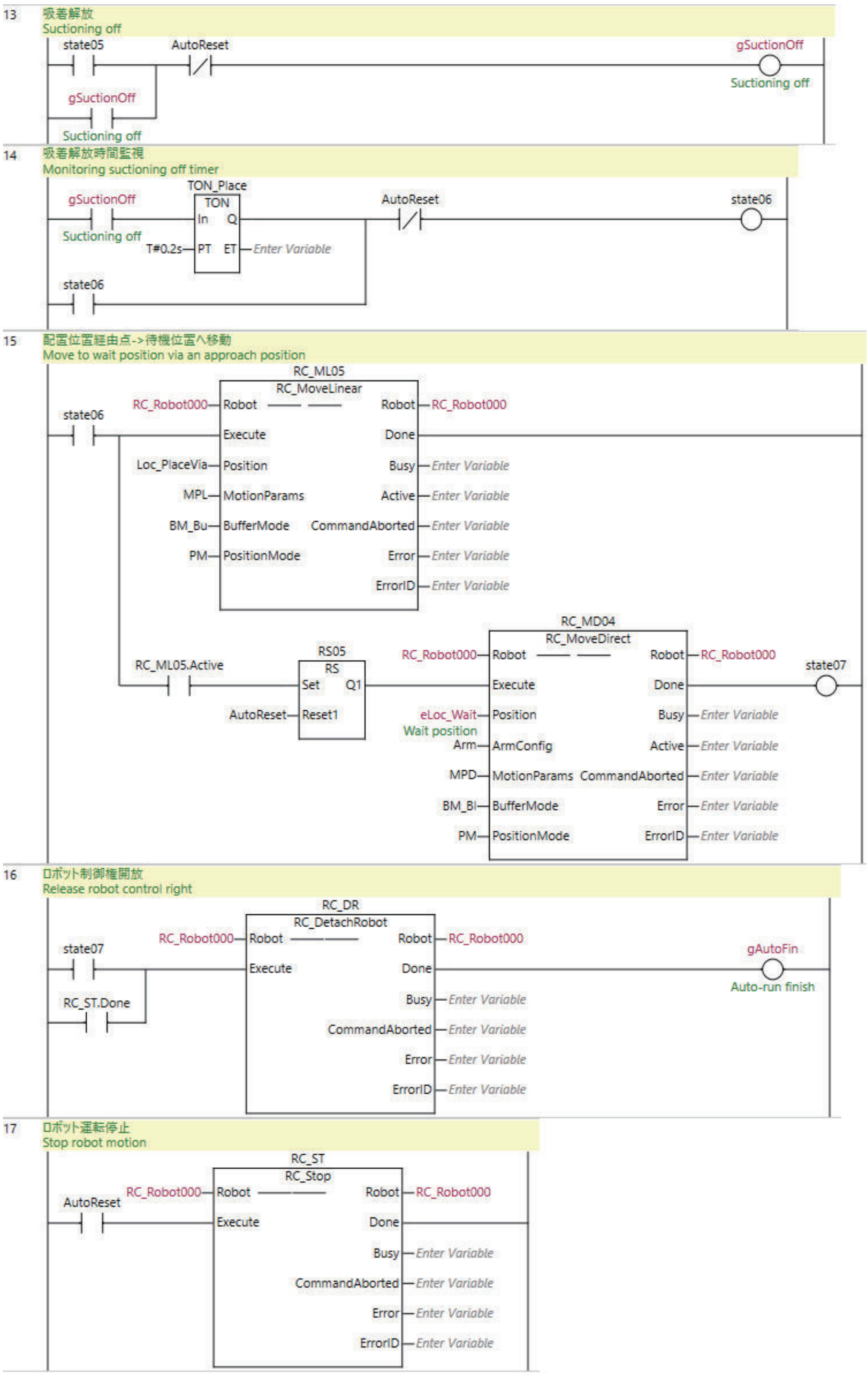
9 ピックアップ経由点->ピックアップ位置へ移動
Move to pick-up position via an approach position

```
Loc_PickVia[0] := eLoc_Pick[0];
Loc_PickVia[1] := eLoc_Pick[1];
Loc_PickVia[2] := eLoc_Pick[2]+UpDownDist;
Loc_PickVia[3] := eLoc_Pick[3];
Loc_PickVia[4] := eLoc_Pick[4];
Loc_PickVia[5] := eLoc_Pick[5];
```

state02
RC_MD02
RC_MoveDirect
RC_Robot000—Robot
Robot—RC_Robot000
Execute
Done
Loc_PickVia—Position
Busy—Enter Variable
Arm—ArmConfig
Active—Enter Variable
MPD—MotionParams
CommandAborted—Enter Variable
BM_Bu—BufferMode
Error—Enter Variable
PM—PositionMode
ErrorID—Enter Variable
RC_MD02.Active
RS02
RS
Set
Q1
AutoReset—Reset1
RC_ML02
RC_MoveLinear
RC_Robot000—Robot
Robot—RC_Robot000
Execute
Done
eLoc_Pick—Position
Pick position
MPL—MotionParams
BM_Bl—BufferMode
PM—PositionMode
Busy—Enter Variable
Active—Enter Variable
CommandAborted—Enter Variable
Error—Enter Variable
ErrorID—Enter Variable
state03


10
吸着開始
Suctioning on
state03
gSuctionOff
Suctioning off
AutoReset
gSuctionOn
Suctioning on
E001_Out_Bit00
gSuctionOn
Suctioning on
11
吸着時間監視
Monitoring suctioning on timer
TON_Pick
TON
state03
In
Q
T#0.5s
PT
ET
Enter Variable
AutoReset
state04
state04
12
ピックアップ経由点->配置経由点->配置位置へ移動
Move to place position via 2 approach positions
state04
RC_ML03
RC_MoveLinear
RC_Robot000
Robot
Robot
RC_Robot000
Execute
Done
Loc_PickVia
Position
Busy
Enter Variable
MPL
MotionParams
Active
Enter Variable
BM_Bu
BufferMode
CommandAborted
Enter Variable
PM
PositionMode
Error
Enter Variable
ErrorID
Enter Variable
RC_ML03.Active
RS03
RS
Set
Q1
AutoReset
Reset1
RC_MD03
RC_MoveDirect
RC_Robot000
Robot
Robot
RC_Robot000
Execute
Done
Loc_PlaceVia
Position
Busy
Enter Variable
Arm
ArmConfig
Active
Enter Variable
MPD
MotionParams
CommandAborted
Enter Variable
BM_Bl
BufferMode
Error
Enter Variable
PM
PositionMode
ErrorID
Enter Variable
RC_MD03.Active
RS04
RS
Set
Q1
AutoReset
Reset1
RC_ML04
RC_MoveLinear
RC_Robot000
Robot
Robot
RC_Robot000
state05
Execute
Done
eLoc_Place
Place position
Position
Busy
Enter Variable
MPL
MotionParams
Active
Enter Variable
BM_Bl
BufferMode
CommandAborted
Enter Variable
PM
PositionMode
Error
Enter Variable
ErrorID
Enter Variable

```
Loc_PlaceVia[0] := eLoc_Place[0];
Loc_PlaceVia[1] := eLoc_Place[1];
Loc_PlaceVia[2] := eLoc_Place[2]+UpDownDist;
Loc_PlaceVia[3] := eLoc_Place[3];
Loc_PlaceVia[4] := eLoc_Place[4];
Loc_PlaceVia[5] := eLoc_Place[5];
```

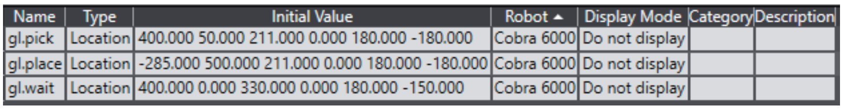

13
吸着解放
Suctioning off
state05
AutoReset
gSuctionOff
Suctioning off
gSuctionOff
Suctioning off
14
吸着解放時間監視
Monitoring suctioning off timer
TON_Place
TON
In
Q
gSuctionOff
Suctioning off
T#0.2s
PT
ET
Enter Variable
AutoReset
state06
state06
15
配置位置経由点->待機位置へ移動
Move to wait position via an approach position
RC_ML05
RC_MoveLinear
RC_Robot000
Robot
Robot
RC_Robot000
state06
Execute
Done
Loc_PlaceVia
Position
Busy
Enter Variable
MPL
MotionParams
Active
Enter Variable
BM_Bu
BufferMode
CommandAborted
Enter Variable
PM
PositionMode
Error
Enter Variable
ErrorID
Enter Variable
RC_MD04
RC_MoveDirect
RS05
RS
RC_ML05.Active
Set
Q1
AutoReset
Reset1
RC_Robot000
Robot
Robot
RC_Robot000
Execute
Done
state07
eLoc_Wait
Wait position
Position
Busy
Enter Variable
Arm
ArmConfig
Active
Enter Variable
MPD
MotionParams
CommandAborted
Enter Variable
BM_BI
BufferMode
Error
Enter Variable
PM
PositionMode
ErrorID
Enter Variable
16
ロボット制御権開放
Release robot control right
RC_DR
RC_DetachRobot
state07
RC_Robot000
Robot
Robot
RC_Robot000
Execute
Done
gAutoFin
Auto-run finish
RC_ST.Done
Busy
Enter Variable
CommandAborted
Enter Variable
Error
Enter Variable
ErrorID
Enter Variable
17
ロボット運転停止
Stop robot motion
RC_ST
RC_Stop
AutoReset
RC_Robot000
Robot
Robot
RC_Robot000
Execute
Done
Busy
Enter Variable
CommandAborted
Enter Variable
Error
Enter Variable
ErrorID
Enter Variable

V+ Program

The V+ program that is required for controlling operations of the static pick-and-place equipment in the sequence control program is described below.
The V+ program is used to register global variables and create two programs, "loccopy" (variable copy program) and "auto" (read program).

● Global Variables

Register the global variables that are used in the V+ program.



Name	Type	Initial Value	Robot ▲	Display Mode	Category	Description
gl.pick	Location	400.000 50.000 211.000 0.000 180.000 -180.000	Cobra 6000	Do not display		
gl.place	Location	-285.000 500.000 211.000 0.000 180.000 -180.000	Cobra 6000	Do not display		
gl.wait	Location	400.000 0.000 330.000 0.000 180.000 -150.000	Cobra 6000	Do not display		

● Variable Copy Program

"loccopy" (variable copy program) is used to copy the global variables in the V+ program to the shared variables with the sequence control program.
A program is described below.

```
.PROGRAM loccopy()
              ; ABSTRACT:  Copy location data to IEC 61131-3 global variables.
              ; MISC:  Program created in ACE version 1.0.1.0
              ;* Copyright (c) 2020 by {OMRON}
        GLOBAL gl.pick, gl.place, gl.wait
        EXTERNAL eloc_pick[], eloc_place[], eloc_wait[]
        EXTERNAL ebool_exe
        ebool_exe = TRUE
              ; Copy location data to external variables
        DECOMPOSE eloc_pick[] = gl.pick
        DECOMPOSE eloc_place[] = gl.place
        DECOMPOSE eloc_wait[] = gl.wait
.END
```

● Read Program

"auto" (read program) is used to read the V+ program and global variables from the SD Memory Card to main memory.
Refer to *3-3-8 Setting up Automatic Loading of V+ Programs and Variables at Power ON* on page 3-67 for information on "auto" (read program).

3-1-2 When Operations are Controlled with V+ Program

The program specifications when operations of static pick-and-place equipment are controlled with the V+ program are described below.

The program consists of the following programs.

Program name	Language	Description
Main	Sequence control program (Ladder diagram)	Main program
run	V+ program	Robot commands send program
run.checkmode	V+ program	V+ program stop program

Precautions for Correct Use

The V+ programs continue even if the Robot Integrated CPU Unit changes to PROGRAM mode. The run.checkmode is a program to detect PROGRAM mode and stop the robot motion and V+ programs.

Shared Variables

The following table shows a list of shared variables that are used in the sequence control program.

No.	Variable name	Data type	Description
1	eBool_ExeT1	BOOL	Use the variable to check that the execution of V+ task 1 is started in the sequence control program.
2	eBool_ExeT2	BOOL	Use the variable to check that the execution of V+ task 2 is started in the sequence control program.
3	eBool_Mode	BOOL	Use the variable to check the operating mode in the Robot Integrated CPU Unit in the V+ program.
4	eBool_Reset	BOOL	Use the variable to check that the reset button is pressed during automatic operation in the V+ program.

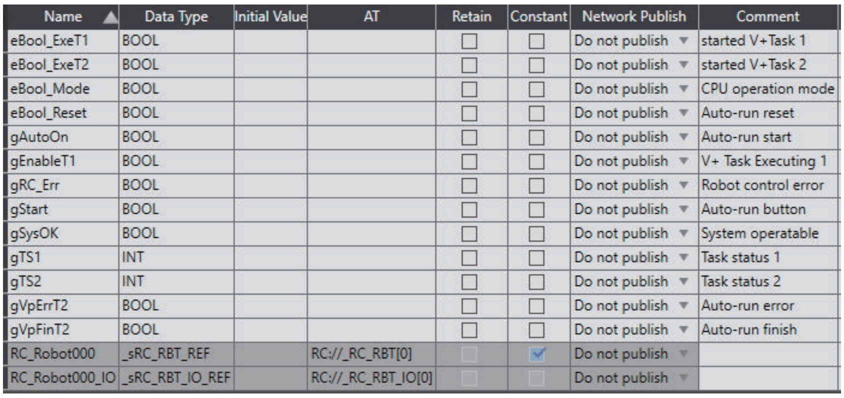
Sequence Control Program

This section describes the sequence control program required for controlling the operation of the static pick-and-place equipment with the V+ program.

The sequence control program is used to register global variables and create "Main", a main program that monitors the status of peripheral devices and determines whether the automatic operation can start.

● Global Variables

Register the global variables that are used in the sequence control program.



Name	Data Type	Initial Value	AT	Retain	Constant	Network Publish	Comment
eBool_ExeT1	BOOL			☐	☐	Do not publish	started V+Task 1
eBool_ExeT2	BOOL			☐	☐	Do not publish	started V+Task 2
eBool_Mode	BOOL			☐	☐	Do not publish	CPU operation mode
eBool_Reset	BOOL			☐	☐	Do not publish	Auto-run reset
gAutoOn	BOOL			☐	☐	Do not publish	Auto-run start
gEnableT1	BOOL			☐	☐	Do not publish	V+ Task Executing 1
gRC_Err	BOOL			☐	☐	Do not publish	Robot control error
gStart	BOOL			☐	☐	Do not publish	Auto-run button
gSysOK	BOOL			☐	☐	Do not publish	System operatable
gTS1	INT			☐	☐	Do not publish	Task status 1
gTS2	INT			☐	☐	Do not publish	Task status 2
gVpErrT2	BOOL			☐	☐	Do not publish	Auto-run error
gVpFinT2	BOOL			☐	☐	Do not publish	Auto-run finish
RC_Robot000	_sRC_RBT_REF		RC://_RC_RBT[0]	☐	☑	Do not publish	
RC_Robot000_IO	_sRC_RBT_IO_REF		RC://_RC_RBT_IO[0]	☐	☐	Do not publish	

● Main Program

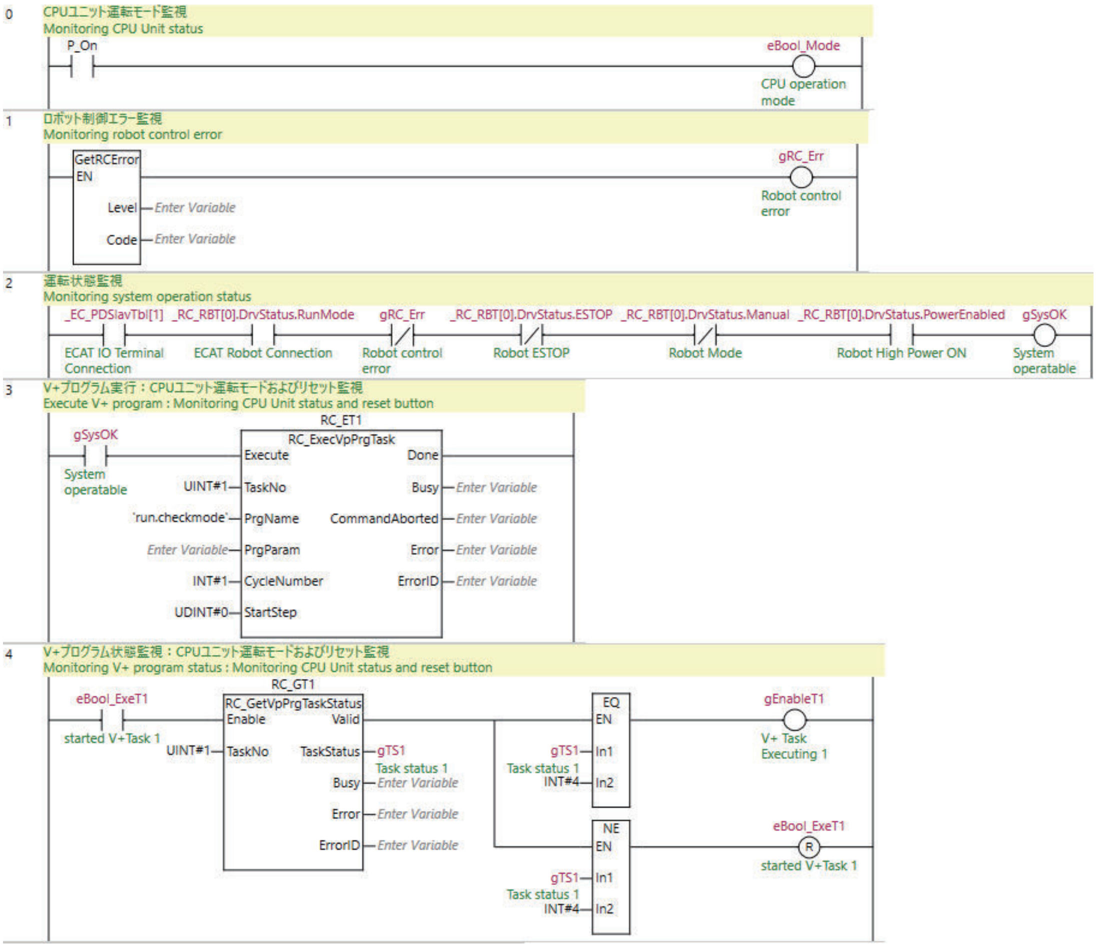
"Main" (main program) is used to monitor the following status of the robot and EtherCAT Digital I/O Terminal and determine whether the automatic operation can start.

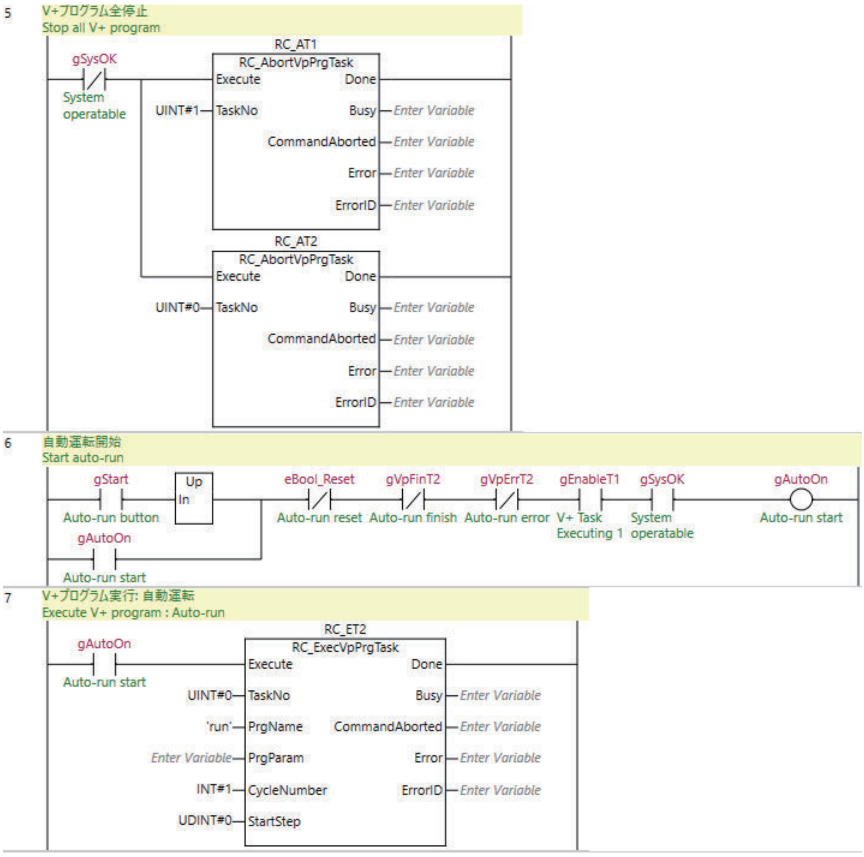
Refer to the manuals of each device for details on the variables.

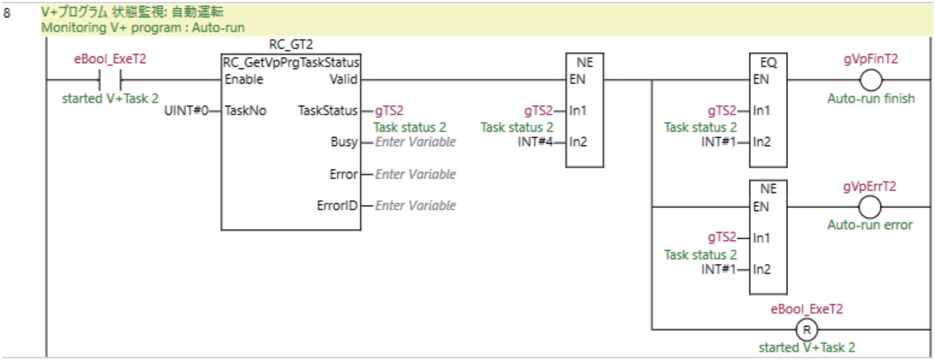
No.	Variable name	Description
1	_EC_PDSlavTbl[1]	Check that the communications of the EtherCAT Digital I/O Terminal are established.
2	_RC_RBT[0].DrvStatus.RunMode	Check that the communications between the Robot Integrated CPU Unit and the robot are established.
3	GetRCError	Check whether an error caused by the Robot Control Function Module exists.
4	_RC_RBT[0].DrvStatus.ESTOP	Check whether the robot is in ESTOP state.

No.	Variable name	Description
5	_RC_RBT[0].DrvStatus.Manual	Check that the operating mode of the robot is Manual mode.
6	_RC_RBT[0].DrvStatus.PowerEnabled	Check that the robot high power is enabled.

A program is described below.


0
CPUユニット運転モード監視
Monitoring CPU Unit status
P_On
eBool_Mode
CPU operation mode
1
ロボット制御エラー監視
Monitoring robot control error
GetRCError
EN
Level
Enter Variable
Code
Enter Variable
gRC_Err
Robot control error
2
運転状態監視
Monitoring system operation status
_EC_PDSlavTbl[1]
ECAT IO Terminal Connection
_RC_RBT[0].DrvStatus.RunMode
ECAT Robot Connection
gRC_Err
Robot control error
_RC_RBT[0].DrvStatus.ESTOP
Robot ESTOP
_RC_RBT[0].DrvStatus.Manual
Robot Mode
_RC_RBT[0].DrvStatus.PowerEnabled
Robot High Power ON
gSysOK
System operatable
3
V+プログラム実行：CPUユニット運転モードおよびリセット監視
Execute V+ program : Monitoring CPU Unit status and reset button
gSysOK
System operatable
RC_ET1
RC_ExecVpPrgTask
Execute
Done
UINT#1
TaskNo
Busy
Enter Variable
'run.checkmode'
PrgName
CommandAborted
Enter Variable
Enter Variable
PrgParam
Error
Enter Variable
INT#1
CycleNumber
ErrorID
Enter Variable
UDINT#0
StartStep
4
V+プログラム状態監視：CPUユニット運転モードおよびリセット監視
Monitoring V+ program status : Monitoring CPU Unit status and reset button
eBool_ExeT1
started V+Task 1
RC_GT1
RC_GetVpPrgTaskStatus
Enable
Valid
UINT#1
TaskNo
TaskStatus
gTS1
Task status 1
Busy
Enter Variable
Error
Enter Variable
ErrorID
Enter Variable
EQ
EN
gTS1
Task status 1
In1
INT#4
In2
gEnableT1
V+ Task Executing 1
NE
EN
gTS1
Task status 1
In1
INT#4
In2
eBool_ExeT1
R
started V+Task 1


5
V+プログラム全停止
Stop all V+ program
gSysOK
System operatable
RC_AT1
RC_AbortVpPrgTask
Execute
Done
UINT#1
TaskNo
Busy
Enter Variable
CommandAborted
Enter Variable
Error
Enter Variable
ErrorID
Enter Variable
RC_AT2
RC_AbortVpPrgTask
Execute
Done
UINT#0
TaskNo
Busy
Enter Variable
CommandAborted
Enter Variable
Error
Enter Variable
ErrorID
Enter Variable
6
自動運転開始
Start auto-run
gStart
Auto-run button
Up
In
gAutoOn
Auto-run start
eBool_Reset
Auto-run reset
gVpFinT2
Auto-run finish
gVpErrT2
Auto-run error
gEnableT1
V+ Task Executing 1
gSysOK
System operatable
gAutoOn
Auto-run start
7
V+プログラム実行: 自動運転
Execute V+ program : Auto-run
gAutoOn
Auto-run start
RC_ET2
RC_ExecVpPrgTask
Execute
Done
UINT#0
TaskNo
Busy
Enter Variable
'run'
PrgName
CommandAborted
Enter Variable
Enter Variable
PrgParam
Error
Enter Variable
INT#1
CycleNumber
ErrorID
Enter Variable
UDINT#0
StartStep

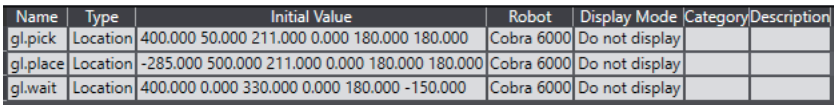

8
V+プログラム 状態監視: 自動運転
Monitoring V+ program : Auto-run
eBool_ExeT2
started V+Task 2
RC_GT2
RC_GetVpPrgTaskStatus
Enable
Valid
UINT#0
TaskNo
TaskStatus
gTS2
Task status 2
Busy
Enter Variable
Error
Enter Variable
ErrorID
Enter Variable
NE
EN
gTS2
Task status 2
In1
INT#4
In2
EQ
EN
gTS2
Task status 2
In1
INT#1
In2
gVpFinT2
Auto-run finish
NE
EN
gTS2
Task status 2
In1
INT#1
In2
gVpErrT2
Auto-run error
eBool_ExeT2
R
started V+Task 2

V+ Program

This section describes the V+ program to control the static pick-and-place equipment.
The V+ program is used to register global variables and create three programs, "run" (robot commands send program), "run.checkmode" (V+ program stop program), and "auto" (read program).

● Global Variables

Register the global variables that are used in the V+ program.



Name	Type	Initial Value	Robot	Display Mode	Category	Description
gl.pick	Location	400.000 50.000 211.000 0.000 180.000 180.000	Cobra 6000	Do not display		
gl.place	Location	-285.000 500.000 211.000 0.000 180.000 180.000	Cobra 6000	Do not display		
gl.wait	Location	400.000 0.000 330.000 0.000 180.000 -150.000	Cobra 6000	Do not display		

● Robot Commands Send Program

"run" (robot commands send program) is used to send robot commands to execute the static pick-and-place operations.
A program is described below.

```
.PROGRAM run()
; ABSTRACT: Pick and place program
; MISC:  Program created in ACE version 4.1.0.22
;* Copyright (c) 2019 by {OMRON}
        AUTO ar.speed, ar.accel, ar.wait_on, ar.wait_off, ar.dist, ar.loc[5], al.
safe
        EXTERNAL ebool_exet2
        ebool_exet2 = TRUE
; Set parameter
        ar.speed = 100 ; Speed ratio per full speed [%]
        ar.accel = 50 ; Accel ratio per full speed [%]
        ar.wait_on = 0.5 ; Wait time for air-on [sec]
        ar.wait_off = 0.2 ; Wait time for air-off [sec]
        ar.dist = 40 ; Approach and depart distance [mm]
; Calculate and set temporary destination
        DECOMPOSE ar.loc[] = HERE
        SET al.safe = TRANS(ar.loc[0], ar.loc[1], DZ(gl.wait), ar.loc[3], ar.loc[
4], ar.loc[5])
; Prepare robot motion ready
        CALIBRATE
        ATTACH ()
        SPEED ar.speed, ar.speed ALWAYS
        ACCEL ar.accel, ar.accel
; Approrch/Move to wait position
        MOVES al.safe
        MOVE gl.wait
        BREAK
; Approrch/Move to pick position
        APPRO gl.pick, ar.dist
        MOVES gl.pick
        BREAK
; Suctioning on and waiting
        SIGNAL 4001
        WAIT.EVENT , ar.wait_on
; Depart/Approach/Move to place position
        DEPARTS ar.dist
        APPRO gl.place, ar.dist
        MOVES gl.place
        BREAK
; Suctioning off and waiting
        SIGNAL -4001
        WAIT.EVENT , ar.wait_off
```

```
; Depart/Move to wait position
        DEPARTS ar.dist
        MOVE gl.wait
        BREAK
; Release robot control
        DETACH ()
.END
```

V+ Program Stop Program

"run.checkmode" (V+ program stop program) is used to detect that the Robot Integrated CPU Unit changes to PROGRAM mode and stop the robot motion and V+ program with shared variables for sequence control program and V+ program.
A program is described below.

```
.PROGRAM run.checkmode()
; ABSTRACT: Stop pick and place program
; MISC:  Program created in ACE version 4.1.0.22
;* Copyright (c) 2019 by {OMRON}
        EXTERNAL ebool_mode
        EXTERNAL ebool_exet1, ebool_reset
        ebool_exet1 = TRUE
        WHILE TRUE DO
; Check NJ mode and reset-button
            IF (ebool_mode == FALSE) OR (ebool_reset == TRUE) THEN
; Abort current robot motion
                BRAKE
; Terminate "run" program task
                ABORT 0
; Wait until "run" program task has stoppped
                CYCLE.END 0
; Clear a program execution stack
                KILL 0
            END
;Wait next robot control period
            WAIT
        END
.END
```

Read Program

"auto" (read program) is used to read the V+ program and global variables from the SD Memory Card to main memory.
Refer to *3-3-8 Setting up Automatic Loading of V+ Programs and Variables at Power ON* on page 3-67 for information on "auto" (read program).

3-2 Basic Startup Procedures

This section gives an overview of the basic startup procedures to build a static pick-and-place system. First, program a machine operation, configure and check the settings using the simulator, and then run the system for fine-tuning the operation.

No.	Procedure		Description	Reference
1	Programming and Simulation Procedures	Creating a project	Create a project file in the Sysmac Studio.	page 3-18
2		Creating the network configuration	Create the EtherCAT Network Configuration and add a robot on the network.	page 3-19
3		Writing the programs	Create a sequence control program and V + programs.	page 3-22 page 3-28
4		Placing 3D shape data	Place 3D shape data and make the operating range of the robot visible on the 3D Visualizer.	page 3-34
5		Starting simulation	Activate the simulation function and start to simulate the robot motion.	page 3-56
6		Teaching (Simulation)	Use the simulation function of the Sysmac Studio for teaching the positions.	page 3-57
7		Running the program (Simulation)	Run the sequence control program on the simulator of the Sysmac Studio.	page 3-70
8	Setup Procedure for Actual System	Going online	Place the Sysmac Studio online with the Robot Integrated CPU Unit.	page 3-75
9		Transferring settings and programs	Download the programs and settings in the Sysmac Studio project file to the Robot Integrated CPU Unit.	page 3-77
10		Teaching (On the actual equipment)	Operate the robot to check and correct the teaching data.	page 3-80
11		Running the programs (On actual equipment)	Let the robot operate automatically according to the programs.	page 3-91

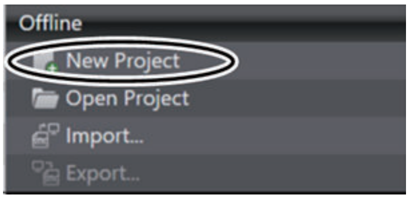
3-3 Programming and Simulation Procedures

This section describes the procedure for creating project files, programing, and setting and checking operation in simulation.
The simulation function allows you to check the equipment operation in advance without purchasing actual equipment.

3-3-1 Creating a Project File

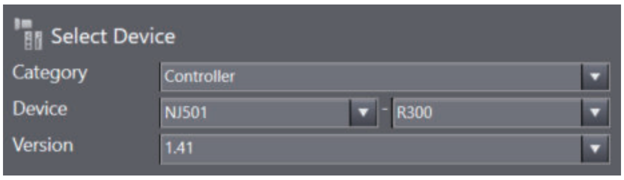
Create a project in the Sysmac Studio.

1. Start the Sysmac Studio and click **New Project** in the Start page.



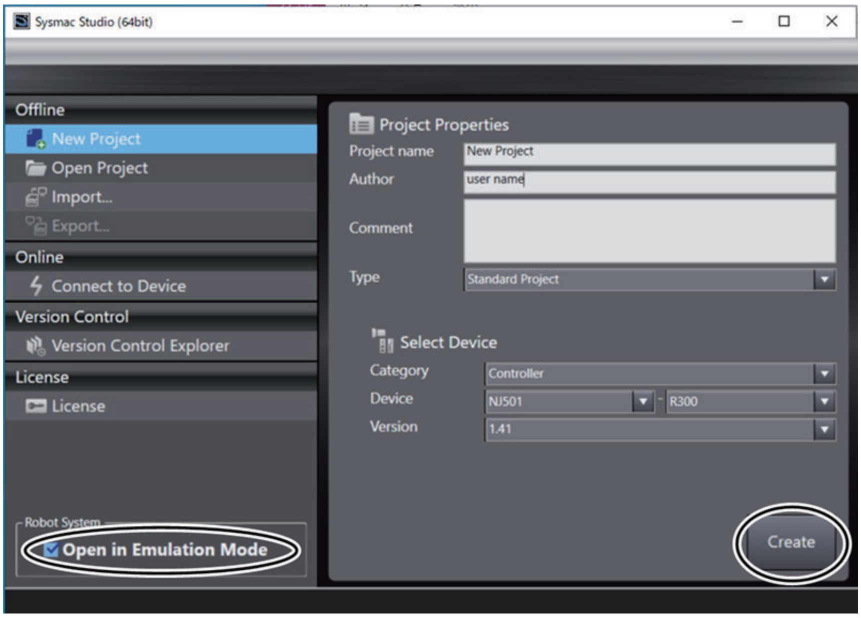
The **Project Properties** dialog box is displayed.

2. In the **Project Properties** dialog box, enter the **Project name**, **Author**, and **Comment**, and select the **Category**, **Device**, and **Version** as shown in the figure below.


Select Device

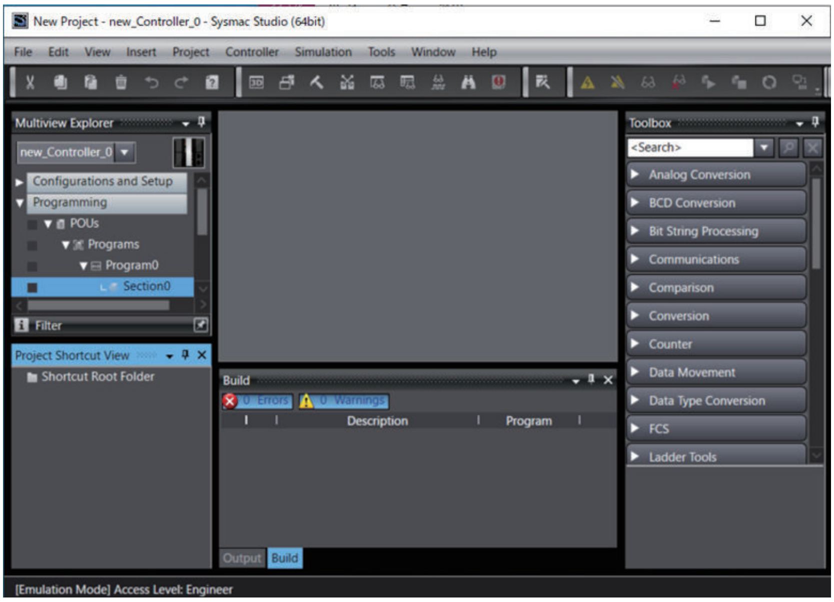
Category: Controller
Device: NJ501 - R300
Version: 1.41

3. Select the **Open in Emulation Mode** check box, and click the **Create** button.


Sysmac Studio (64bit)
Offline
New Project
Open Project
Import...
Export...
Online
Connect to Device
Version Control
Version Control Explorer
License
License
Robot System
Project Properties
Select Device
Create

Project name: New Project
Author: user name
Comment:
Type: Standard Project
Category: Controller
Device: NJ501 - R300
Version: 1.41
☑ Open in Emulation Mode

A project file is created and the following window is displayed.

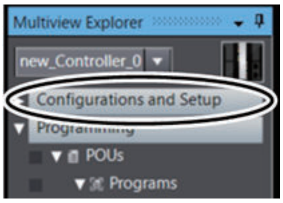

New Project - new_Controller_0 - Sysmac Studio (64bit)
File Edit View Insert Project Controller Simulation Tools Window Help
Multiview Explorer
new_Controller_0
Configurations and Setup
Programming
POUs
Programs
Program0
Section0
Filter
Project Shortcut View
Shortcut Root Folder
Build
0 Errors
0 Warnings
Description
Program
Output
Build
Toolbox
<Search>
Analog Conversion
BCD Conversion
Bit String Processing
Communications
Comparison
Conversion
Counter
Data Movement
Data Type Conversion
FCS
Ladder Tools

[Emulation Mode] Access Level: Engineer

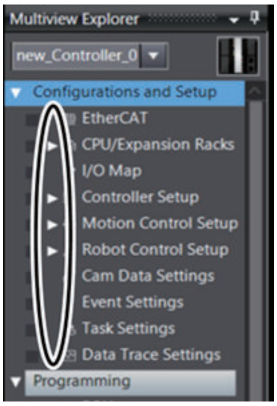
3-3-2 Creating the EtherCAT Network Configuration

Create the EtherCAT network configuration and add a robot on the network.

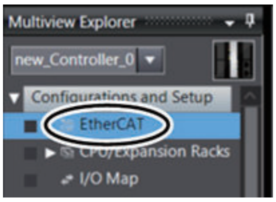
1 Click **Configurations and Setup** in the Multiview Explorer.


Multiview Explorer
new_Controller_0
Configurations and Setup
Programming
POUs
Programs

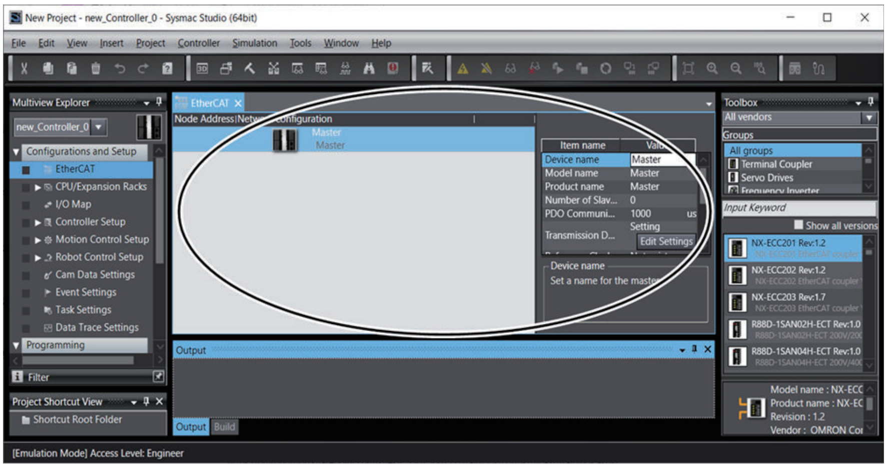
Setting items are displayed under **Configurations and Setup** in the tree.


Multiview Explorer
new_Controller_0
Configurations and Setup
EtherCAT
CPU/Expansion Racks
I/O Map
Controller Setup
Motion Control Setup
Robot Control Setup
Cam Data Settings
Event Settings
Task Settings
Data Trace Settings
Programming

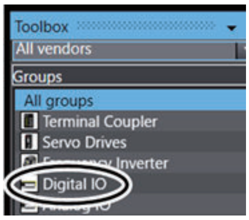
2 Double-click **EtherCAT** under **Configurations and Setup** in the Multiview Explorer. Or right-click **EtherCAT** under **Configurations and Setup** and select **Edit** from the menu.


Multiview Explorer
new_Controller_0
Configurations and Setup
EtherCAT
CPU/Expansion Racks
I/O Map

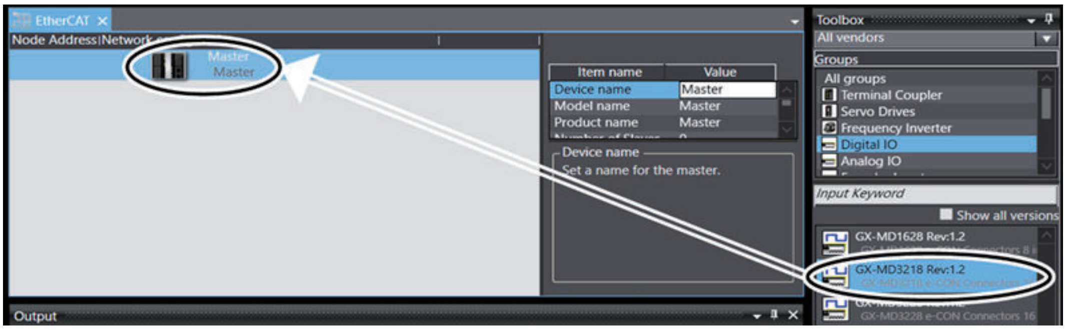
The EtherCAT Master is displayed in the EtherCAT tab page.


New Project - new_Controller_0 - Sysmac Studio (64bit)
File
Edit
View
Insert
Project
Controller
Simulation
Tools
Window
Help
Multiview Explorer
new_Controller_0
Configurations and Setup
EtherCAT
CPU/Expansion Racks
I/O Map
Controller Setup
Motion Control Setup
Robot Control Setup
Cam Data Settings
Event Settings
Task Settings
Data Trace Settings
Programming
Filter
Project Shortcut View
Shortcut Root Folder
EtherCAT
Node Address|Network configuration
Master
Master
Item name
Value
Device name
Master
Model name
Master
Product name
Master
Number of Slav...
0
PDO Communi...
1000
us
Transmission D...
Setting
Edit Settings
Device name
Set a name for the master
Output
Output
Build
Toolbox
All vendors
Groups
All groups
Terminal Coupler
Servo Drives
Frequency Inverter
Input Keyword
Show all versions
NX-ECC201 Rev:1.2
NX-ECC202 Rev:1.2
NX-ECC202 EtherCAT coupler
NX-ECC203 Rev:1.7
NX-ECC203 EtherCAT coupler
R88D-1SAN02H-ECT Rev:1.0
R88D-1SAN02H-ECT 200V/200
R88D-1SAN04H-ECT Rev:1.0
R88D-1SAN04H-ECT 200V/400
Model name : NX-ECC
Product name : NX-EC
Revision : 1.2
Vendor : OMRON Cor
[Emulation Mode] Access Level: Engineer

3 From the **Toolbox**, select the group of **Digital I/O**.


Toolbox
All vendors
Groups
All groups
Terminal Coupler
Servo Drives
Frequency Inverter
Digital IO
Analog IO

4 Click and drag the digital I/O to use and drop it on the EtherCAT Master in the EtherCAT tab page. In this example, select **GX-MD3218**.

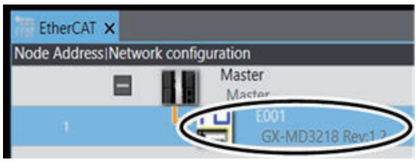

EtherCAT
Node Address|Network configuration
Master
Master
Toolbox
All vendors
Groups
All groups
Terminal Coupler
Servo Drives
Frequency Inverter
Digital IO
Analog IO
Input Keyword
Show all versions
GX-MD1628 Rev:1.2
GX-MD3218 Rev:1.2
GX-MD3218 e-CON Connectors
GX-MD3228 e-CON Connectors 16
Output

Item name	Value
Device name	Master
Model name	Master
Product name	Master

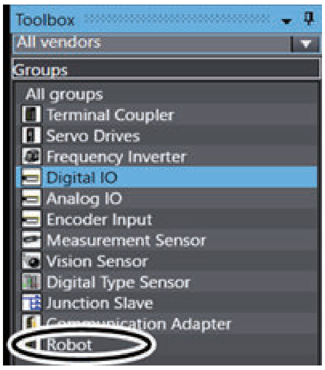
Device name

Set a name for the master.

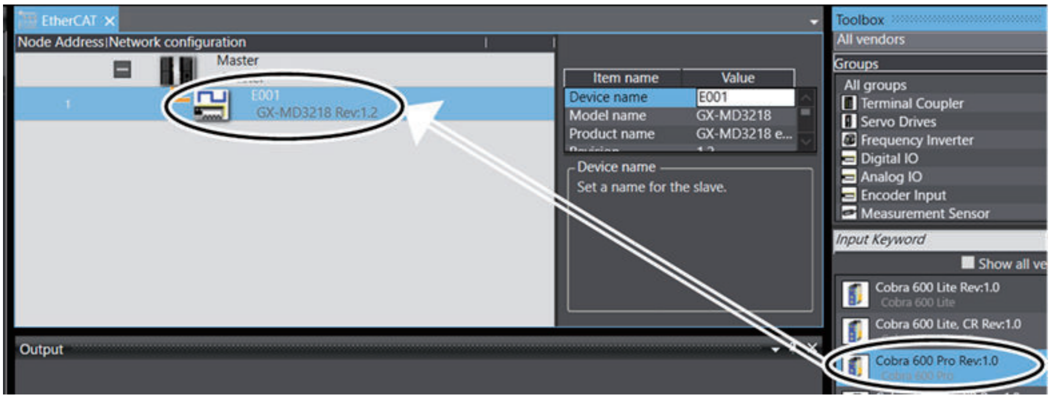
A **GX-MD3218** is registered under the EtherCAT Master.


EtherCAT
Node Address|Network configuration
Master
Master
1
E001
GX-MD3218 Rev:1.2

5 From the **Toolbox**, select the group of **Robot**.


Toolbox
All vendors
Groups
All groups
Terminal Coupler
Servo Drives
Frequency Inverter
Digital IO
Analog IO
Encoder Input
Measurement Sensor
Vision Sensor
Digital Type Sensor
Junction Slave
Communication Adapter
Robot

6 Select and drag the robot to use and drop it on the **GX-MD3218** in the EthercAT tab page. Here, select **Cobra 600 Pro**.

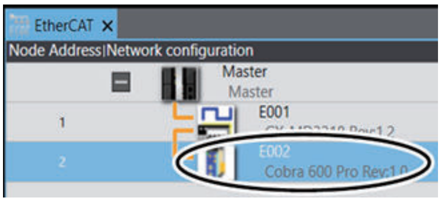

EtherCAT
Node Address|Network configuration
Master
1
E001
GX-MD3218 Rev:1.2
Toolbox
All vendors
Groups
All groups
Terminal Coupler
Servo Drives
Frequency Inverter
Digital IO
Analog IO
Encoder Input
Measurement Sensor
Input Keyword
Show all ve
Cobra 600 Lite Rev:1.0
Cobra 600 Lite
Cobra 600 Lite, CR Rev:1.0
Cobra 600 Pro Rev:1.0
Cobra 600 Pro
Output

Item name	Value
Device name	E001
Model name	GX-MD3218
Product name	GX-MD3218 e...

Device name

Set a name for the slave.

A **Cobra 600 Pro** is added under the **GX-MD3218**.


EtherCAT
Node Address|Network configuration
Master
Master
1
E001
2
E002
Cobra 600 Pro Rev:1.0

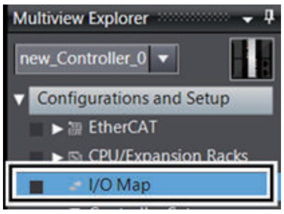
3-3-3 Creating a Sequence Control Program

This section provides the procedure for creating a sequence control program.
For details on the program to create, refer to *3-1 Program Specifications for Static Pick-and-place Equipment* on page 3-2.

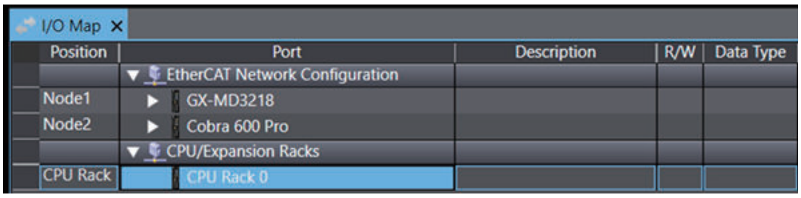
Creating Device Variables

Create device variables to control solenoid valves.
You need to create device variables to use sequence control programs for controlling static pick-and-place operation.
This setting is not required if you use V+ programs for controlling the operation.

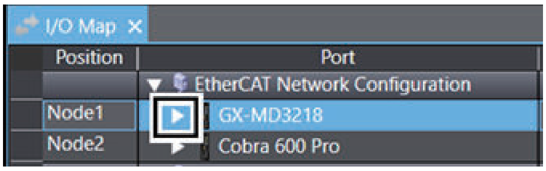
1 Double-click **I/O Map** under **Configurations and Setup** in the Multiview Explorer.


Multiview Explorer
new_Controller_0
Configurations and Setup
EtherCAT
CPU/Expansion Racks
I/O Map

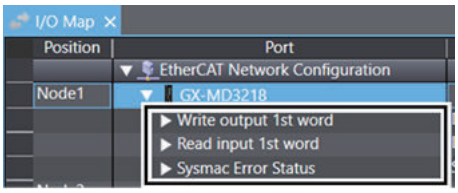
The **I/O Map** tab page is displayed.


I/O Map
Position
Port
Description
R/W
Data Type
EtherCAT Network Configuration
Node1
GX-MD3218
Node2
Cobra 600 Pro
CPU/Expansion Racks
CPU Rack
CPU Rack 0

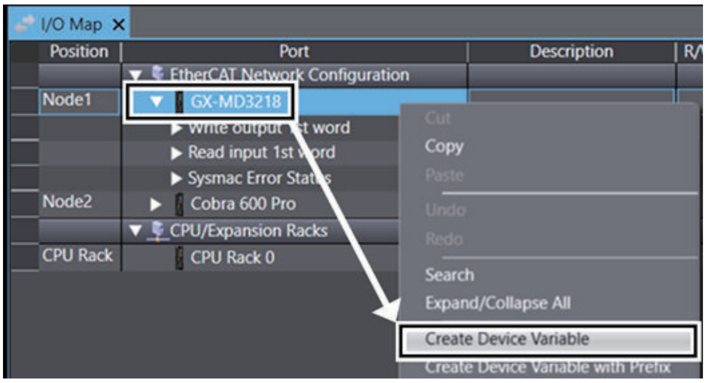
2 Tap the ▶ icon to the left of **GX-MD3218**.


I/O Map
Position
Port
EtherCAT Network Configuration
Node1
GX-MD3218
Node2
Cobra 600 Pro

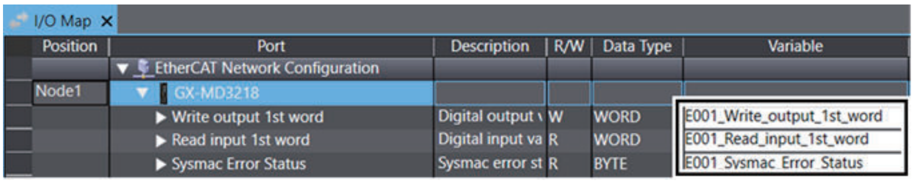
The I/O ports of the **GX-MD3218** are displayed.


I/O Map
Position
Port
EtherCAT Network Configuration
Node1
GX-MD3218
Write output 1st word
Read input 1st word
Sysmac Error Status

3 Right-click on the **GX-MD3218** and select **Create Device Variable** from the menu.


I/O Map
Position
Port
Description
R/
EtherCAT Network Configuration
Node1
GX-MD3218
Write output 1st word
Read input 1st word
Sysmac Error Status
Node2
Cobra 600 Pro
CPU/Expansion Racks
CPU Rack
CPU Rack 0
Cut
Copy
Paste
Undo
Redo
Search
Expand/Collapse All
Create Device Variable
Create Device Variable with Prefix

Device variables are automatically registered for the I/O ports of the **GX-MD3218**.

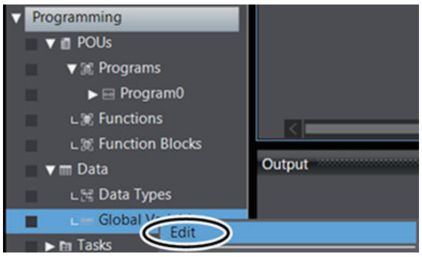


Position	Port	Description	R/W	Data Type	Variable
	▼ EtherCAT Network Configuration				
Node1	▼ GX-MD3218				
	▶ Write output 1st word	Digital output v	W	WORD	E001_Write_output_1st_word
	▶ Read input 1st word	Digital input va	R	WORD	E001_Read_input_1st_word
	▶ Sysmac Error Status	Sysmac error st	R	BYTE	E001_Sysmac_Error_Status

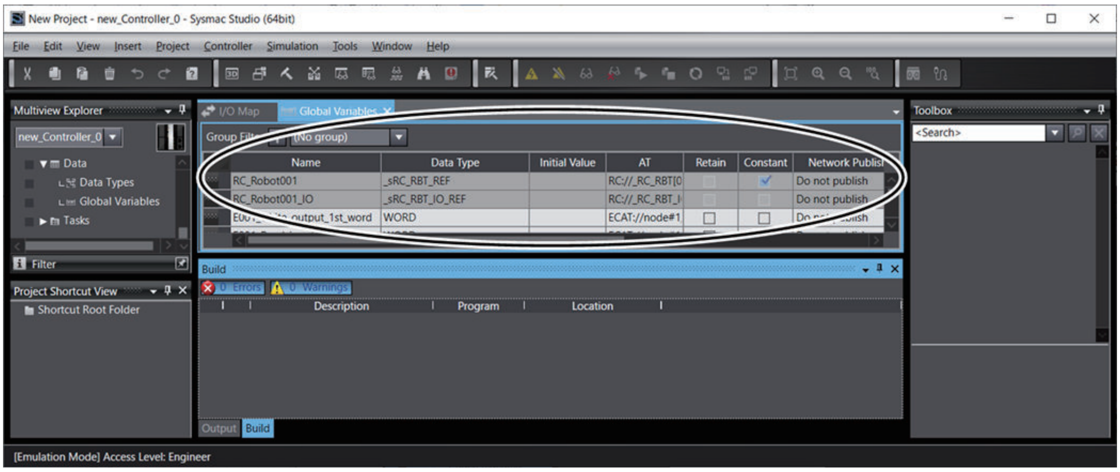
Defining Global Variables

Define global variables used as the position data in the sequence control program.

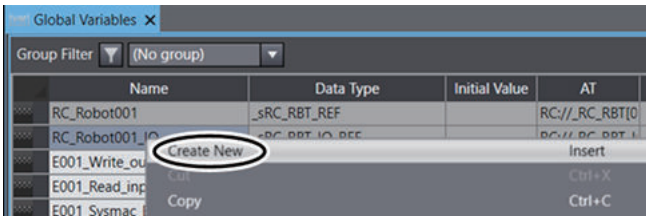
1 Double-click **Global Variables** under **Programming** - **Data** in the Multiview Explorer. Or, right-click **Global Variables** under **Programming** - **Data** and select **Edit** from the menu.


Programming
POUs
Programs
Program0
Functions
Function Blocks
Data
Data Types
Global V
Edit
Tasks
Output

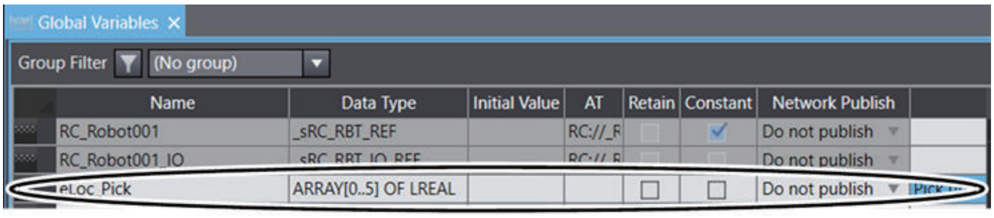
The global variable table is displayed.


New Project - new_Controller_0 - Sysmac Studio (64bit)
File Edit View Insert Project Controller Simulation Tools Window Help
Multiview Explorer
new_Controller_0
Data
Data Types
Global Variables
Tasks
Filter
Project Shortcut View
Shortcut Root Folder
I/O Map
Global Variables
Group Filter
(No group)
Name
Data Type
Initial Value
AT
Retain
Constant
Network Publish
RC_Robot001
_sRC_RBT_REF
RC://_RC_RBT[0
Do not publish
RC_Robot001_IO
_sRC_RBT_IO_REF
RC://_RC_RBT_I
Do not publish
E001_..._output_1st_word
WORD
ECAT://node#1
Build
0 Errors
0 Warnings
Description
Program
Location
Output
Build
Toolbox
<Search>
[Emulation Mode] Access Level: Engineer

2 Press the **Insert** key in the global variable table, or right-click in the global variable table and select **Create New** from the menu.


Global Variables
Group Filter
(No group)
Name
Data Type
Initial Value
AT
RC_Robot001
_sRC_RBT_REF
RC://_RC_RBT[0
RC_Robot001_IO
E001_Write_ou
E001_Read_inp
E001_Sysmac
Create New
Insert
Cut
Ctrl+X
Copy
Ctrl+C

3 Enter or select setting for each item, and then press the **Enter** key.


Global Variables
Group Filter
(No group)

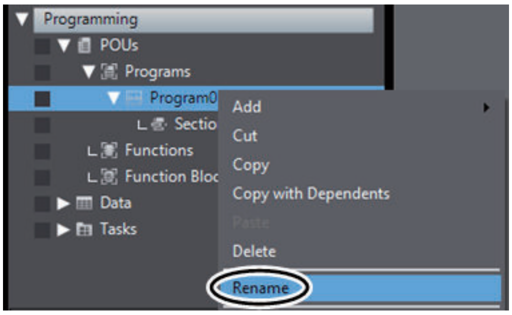
Name	Data Type	Initial Value	AT	Retain	Constant	Network Publish
RC_Robot001	_sRC_RBT_REF		RC://_R	☐	☑	Do not publish
RC_Robot001_IO	_sRC_RBT_IO_REF		RC://_R	☐	☐	Do not publish
eLoc_Pick	ARRAY[0..5] OF LREAL			☐	☐	Do not publish

The global variable is registered.

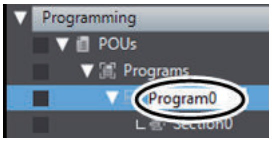
Creating Ladder Diagram Programs

This section describes how to create the ladder diagram programs.

1 Right-click **Program0** under **Programming** - **POUs** - **Programs** in the Multiview Explorer and select **Rename** from the menu.

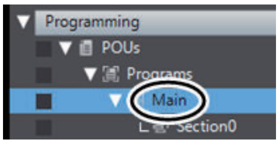

Programming
POUs
Programs
Program0
Sectio
Functions
Function Bloc
Data
Tasks
Add
Cut
Copy
Copy with Dependents
Paste
Delete
Rename

This allows you to edit the name of the sequence control program.

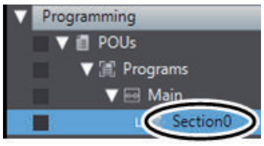

Programming
POUs
Programs
Program0
Section0

2 Enter the name of the sequence control program.

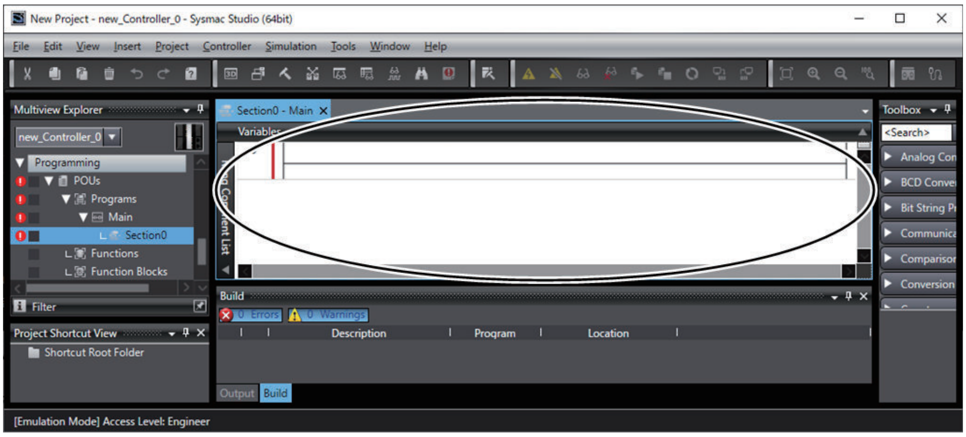
The name of the sequence control program is changed.


Programming
POUs
Programs
Main
Section0

3 Double-click the section to edit.


Programming
POUs
Programs
Main
Section0

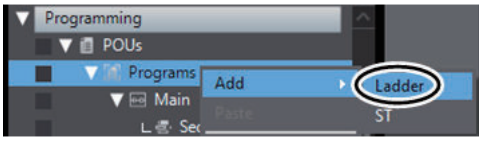
The variable table and Ladder Editor are displayed in the Edit Pane.


New Project - new_Controller_0 - Sysmac Studio (64bit)
File Edit View Insert Project Controller Simulation Tools Window Help
Multiview Explorer
new_Controller_0
Programming
POUs
Programs
Main
Section0
Functions
Function Blocks
Filter
Project Shortcut View
Shortcut Root Folder
Section0 - Main
Variables
Build
0 Errors
0 Warnings
Description
Program
Location
Output
Build
Toolbox
<Search>
Analog Con
BCD Conve
Bit String P
Communica
Comparison
Conversion
[Emulation Mode] Access Level: Engineer

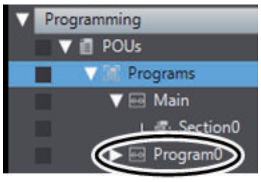
4 Enter the program in the Ladder Editor. Internal and external variables are automatically registered when they are entered in the program.

To create more than one sequence control program, perform the following steps.

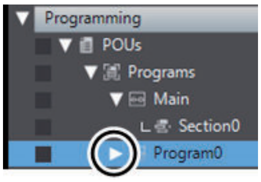
5 Right-click **Programs** under **Programming** - **POUs** in the Multiview Explorer, and then select **Add** - **Ladder** from the menu.


Programming
POUs
Programs
Main
Sec
Add
Paste
Ladder
ST

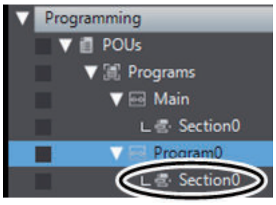
Program0 is added under **Programs**.


Programming
POUs
Programs
Main
Section0
Program0

6 Click the icon displayed to the left of **Program0** under **Programming** - **POUs** - **Programs** in the Multiview Explorer.


Programming
POUs
Programs
Main
Section0
Program0

Section0 is added under **Program0**.

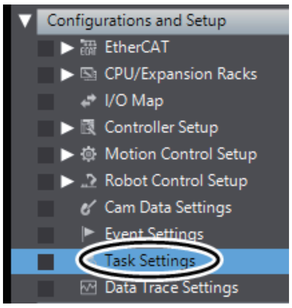

Programming
POUs
Programs
Main
Section0
Program0
Section0

7 Returns to step 1 and repeat the above steps.

Assigning Programs to Tasks

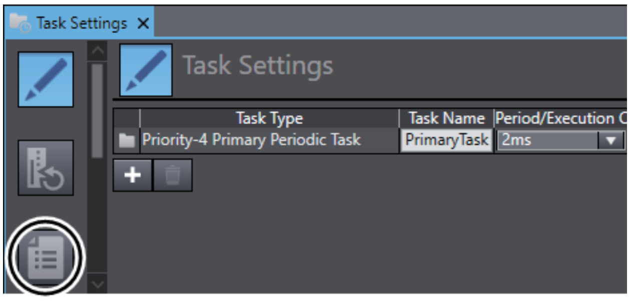
In this section, assign the ladder diagram programs to tasks of the Robot Integrated CPU Unit.
In this guide, multiple ladder diagram programs are used to control the static pick-and-place equipment, so it is necessary to assign the programs to tasks.
When the equipment is controlled by the V+ Program, only one ladder diagram program is used and you do not need to perform the steps in this section.

1 Double-click **Task Settings** under **Configurations and Setup** in the Multiview Explorer.

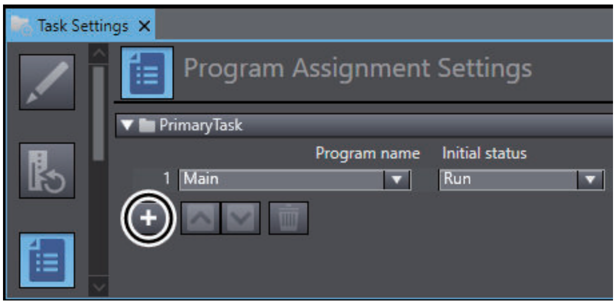

Configurations and Setup
EtherCAT
CPU/Expansion Racks
I/O Map
Controller Setup
Motion Control Setup
Robot Control Setup
Cam Data Settings
Event Settings
Task Settings
Data Trace Settings

The **Task Settings** tab page is displayed.

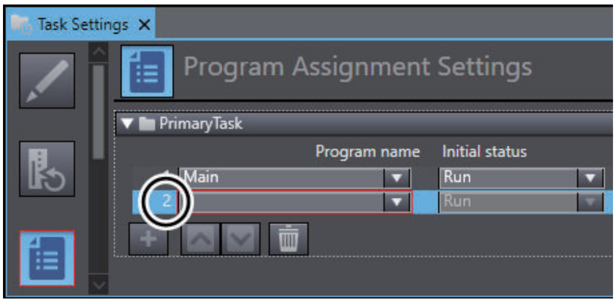
2 Click the **Program Assignment Settings** button ( ) in the Edit Pane.


Task Settings
Task Settings
Task Type
Task Name
Period/Execution C
Priority-4 Primary Periodic Task
PrimaryTask
2ms

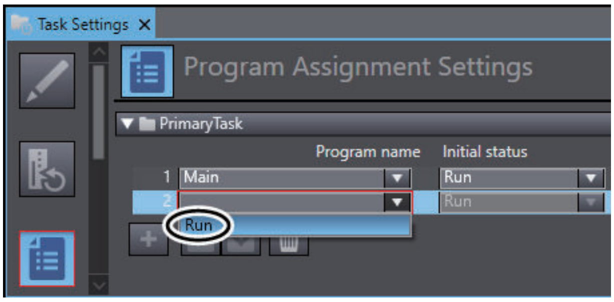
3 Click the **+** button.


Task Settings
Program Assignment Settings
PrimaryTask
Program name
Initial status
1
Main
Run

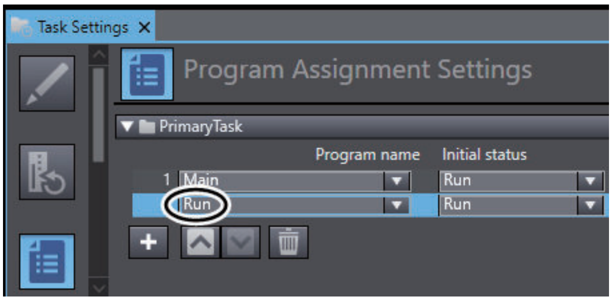
A new row is added for the program to assign.


Task Settings
Program Assignment Settings
PrimaryTask
Program name
Initial status
1
Main
Run
2
Run

4 Select a name of the program to use from the list of the **Program name**.


Task Settings
Program Assignment Settings
PrimaryTask
Program name
Initial status
1
Main
Run
2
Run
Run

The name of the selected program is displayed.


Task Settings
Program Assignment Settings
PrimaryTask
Program name
Initial status
1
Main
Run
Run
Run

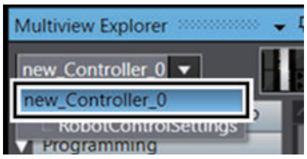
3-3-4 Creating V+ Programs

This section provides the procedure for creating the V+ programs.
For details on the program to create, refer to *3-1 Program Specifications for Static Pick-and-place Equipment* on page 3-2.

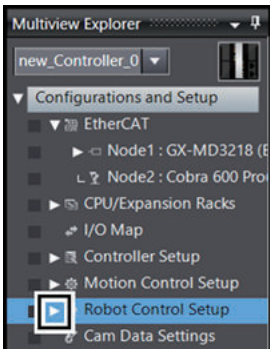
Setting V+Digital I/O

To control EtherCAT Slaves by V+ programs, you must assign V+ digital I/Os.
This setting is required to control the operation of the static pick-and- place equipment with the V+ program. If you use sequence control programs for controlling the operation, this setting is unnecessary.

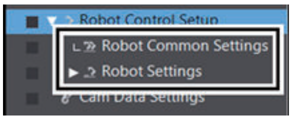
1 In the Multiview Explorer, select **new_Controller_0** from the device list.


Multiview Explorer
new_Controller_0
new_Controller_0
RobotControlSettings
Programming

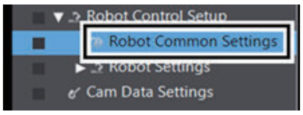
2 Click the ▶ icon to the left of **Robot Control Setup** in the Multiview Explorer.


Multiview Explorer
new_Controller_0
Configurations and Setup
EtherCAT
Node1 : GX-MD3218 (E
Node2 : Cobra 600 Pro
CPU/Expansion Racks
I/O Map
Controller Setup
Motion Control Setup
Robot Control Setup
Cam Data Settings

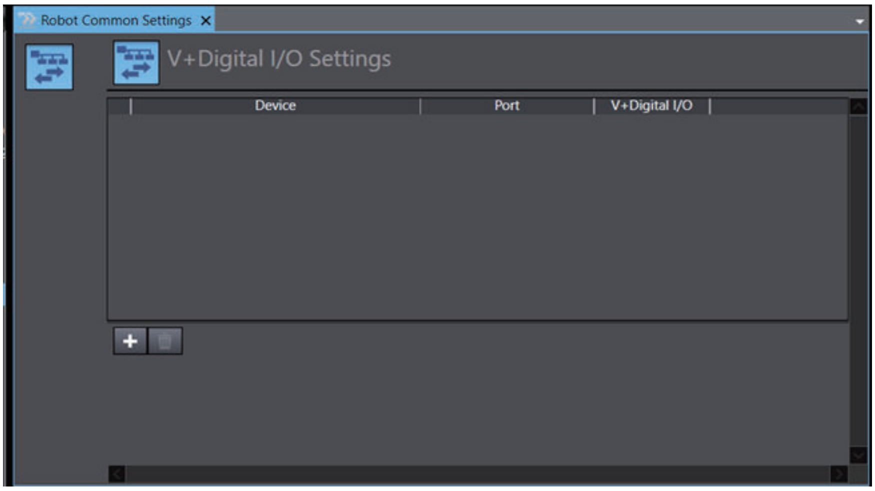
The setting items are displayed in the tree view as shown below.


Robot Control Setup
Robot Common Settings
Robot Settings
Cam Data Settings

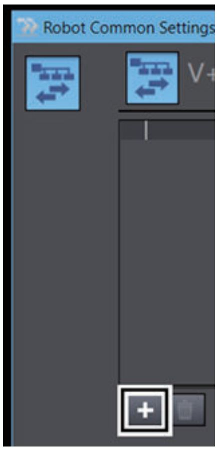
3 Double-click **Robot Common Settings**.


Robot Control Setup
Robot Common Settings
Robot Settings
Cam Data Settings

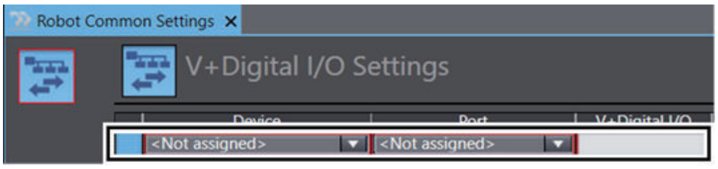
The **Robot Common Settings** tab page is displayed.


Robot Common Settings
V+Digital I/O Settings
Device
Port
V+Digital I/O
+

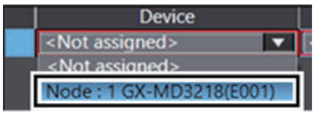
4 Click the **+** button in the **Robot Common Settings** tab page.


Robot Common Settings
V+
+

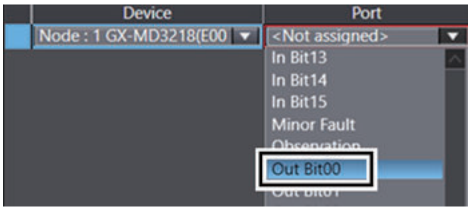
A row for registering a new V+ digital I/O is added.


Robot Common Settings
V+Digital I/O Settings
Device
Port
V+Digital I/O
<Not assigned>
<Not assigned>

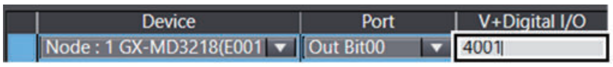
5 Click the drop-down list for **Device** in the newly added row, and then select **Node:1 GX-MD3218(E001)**.


Device
<Not assigned>
<Not assigned>
Node : 1 GX-MD3218(E001)

6 Click the drop-down list for **Port** in the same row, and select **Out Bit00**.


Device
Port
Node : 1 GX-MD3218(E00
<Not assigned>
In Bit13
In Bit14
In Bit15
Minor Fault
Observation
Out Bit00
Out Bit01

7 Enter *4001* for **V+Digital I/O**.

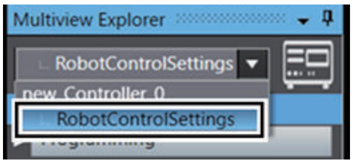


Device	Port	V+Digital I/O
Node : 1 GX-MD3218(E001	Out Bit00	4001

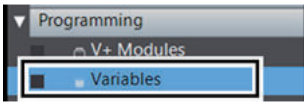
Defining Global Variables

Define the global variables for use in the V+ program.
Here, the procedure to create a variable *gl.wait* is given below as an example, which is a global variable used in the V+ program in *3-1-1 When Operations are Controlled with Sequence Control Program* on page 3-3.

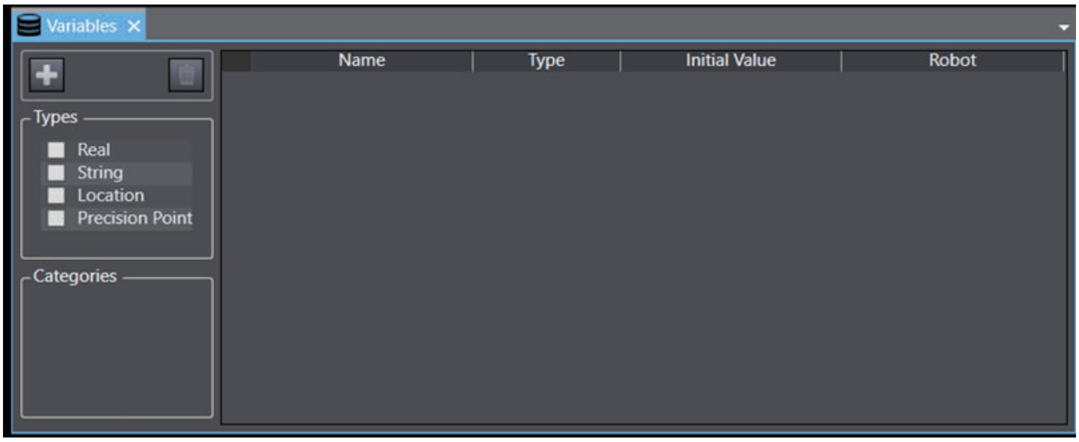
1 In the Multiview Explorer, select **RobotControlSettings** from the device list.


Multiview Explorer
RobotControlSettings
new_Controller_0
RobotControlSettings
Programming

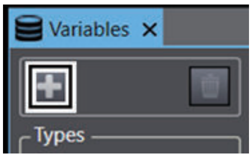
2 Double-click **Variables** under **Programming** in the Multiview Explorer.


Programming
V+ Modules
Variables

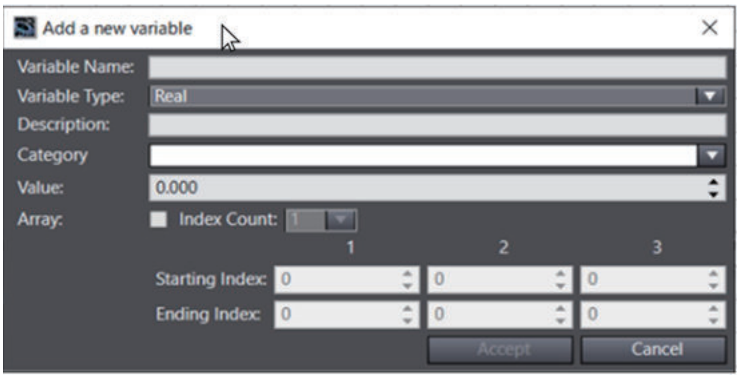
A tab page to edit variables is displayed in the Edit Pane so that you can register variables.


Variables
Name
Type
Initial Value
Robot
Types
Real
String
Location
Precision Point
Categories

3 Click the **+** button.


Variables
Types

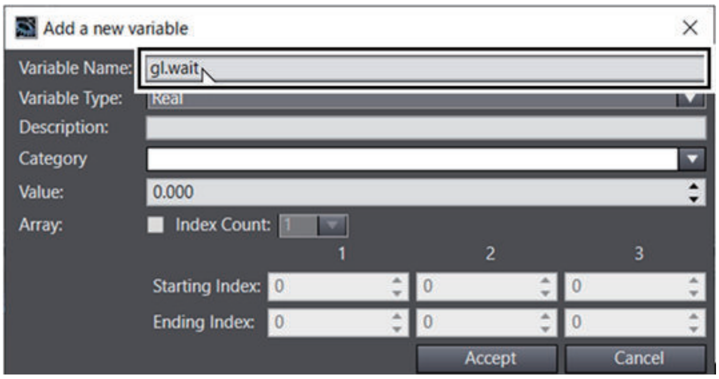
The **Add New Variable** table is displayed.


Add a new variable
Variable Name:
Description:
Category
Array:
Index Count:
1
2
3
Starting Index:
Ending Index:
Accept
Cancel

Variable Type: Real

Value: 0.000

4 Input a variable name.

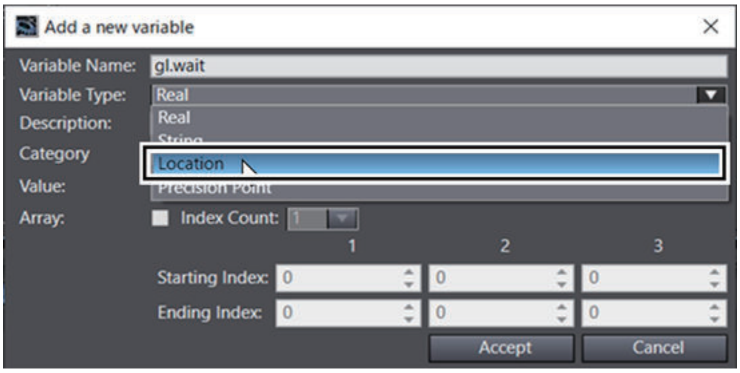

Add a new variable
Description:
Category
Array:
Index Count:
1
2
3
Starting Index:
Ending Index:
Accept
Cancel

Variable Name: gl.wait

Variable Type: Real

Value: 0.000

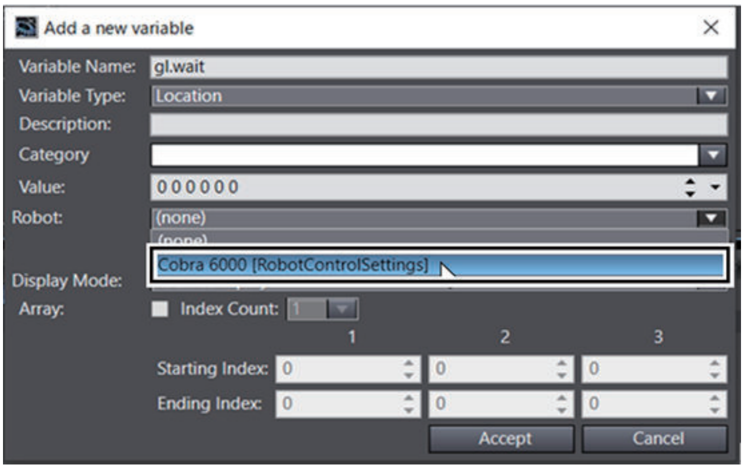
5 Select **Locations** from the list of variable types.


Add a new variable
Real
String
Location
Precision Point
Description:
Category
Value:
Array:
Index Count:
1
2
3
Starting Index:
Ending Index:
Accept
Cancel

Variable Name: gl.wait

Variable Type: Real

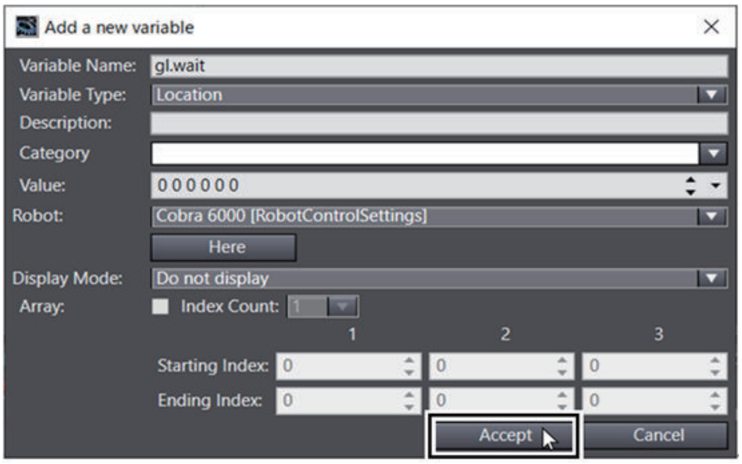
6 For Robot, select **Cobra 6000** from the list.


Add a new variable
Accept
Cancel

Variable Name: gl.wait
Variable Type: Location
Description:
Category
Value: 000000
Robot: (none)
(none)
Cobra 6000 [RobotControlSettings]
Display Mode:
Array: ☐ Index Count: 1

	1	2	3
Starting Index:	0	0	0
Ending Index:	0	0	0

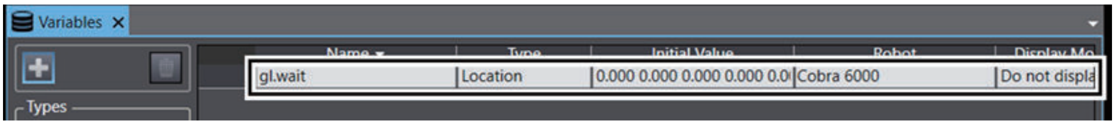
7 Click the **Accept** button.


Add a new variable
Here
Accept
Cancel

Variable Name: gl.wait
Variable Type: Location
Description:
Category
Value: 000000
Robot: Cobra 6000 [RobotControlSettings]
Display Mode: Do not display
Array: ☐ Index Count: 1

	1	2	3
Starting Index:	0	0	0
Ending Index:	0	0	0

The variable **gl.wait** is added to the table.

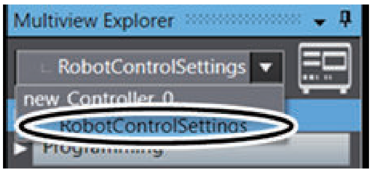

Variables
Types

Name	Type	Initial Value	Robot	Display Mo
gl.wait	Location	0.000 0.000 0.000 0.000 0.0	Cobra 6000	Do not displa

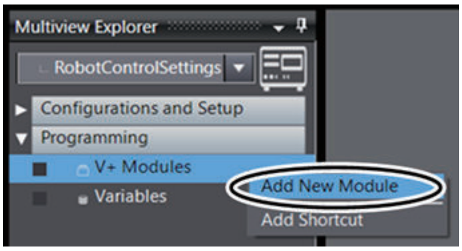
Creating V+ Programs

This section describes the procedure to create V+ programs.

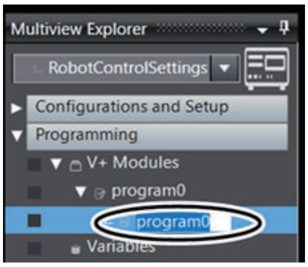
1 In the Multiview Explorer, select **RobotControlSettings** from the device list.


Multiview Explorer
RobotControlSettings
new_Controller_0
RobotControlSettings
Programming

2 Right-click **V+ Modules** under **Programming** in the Multiview Explorer, and select **Add New Module** from the menu.

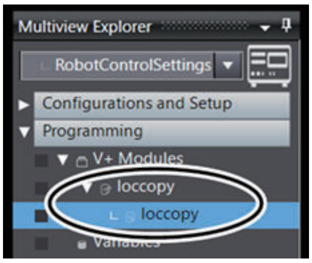

Multiview Explorer
RobotControlSettings
Configurations and Setup
Programming
V+ Modules
Variables
Add New Module
Add Shortcut

In the tree of the Multiview Explorer, **program0 - program0** are added under **V+ Modules**, which allows you to edit the name of the V+ program.

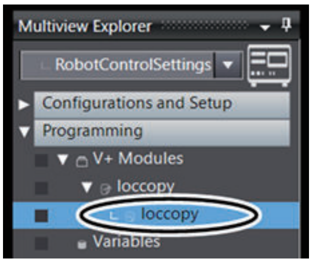

Multiview Explorer
RobotControlSettings
Configurations and Setup
Programming
V+ Modules
program0
program0
Variables

3 Enter the name of the V+ program.

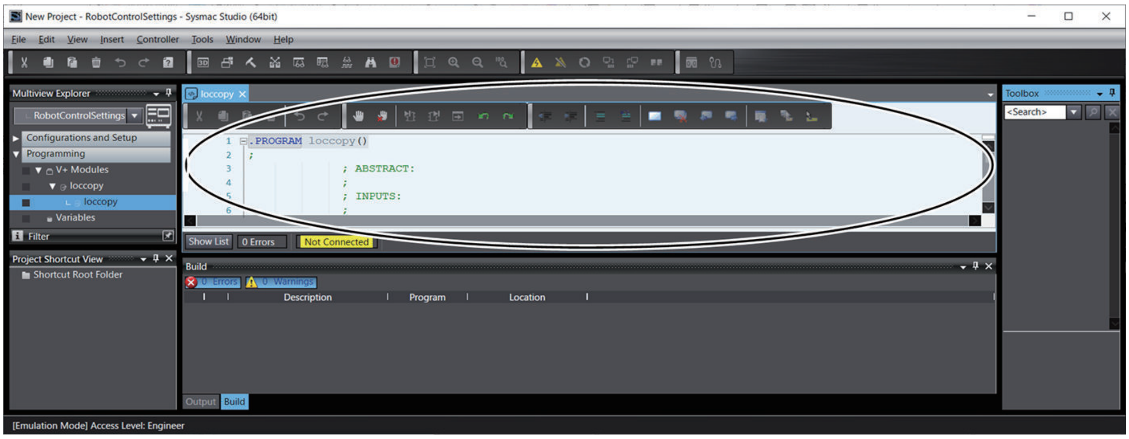
The name of the V+ program is changed.


Multiview Explorer
RobotControlSettings
Configurations and Setup
Programming
V+ Modules
loccopy
loccopy
Variables

4 Double-click the program to edit.


Multiview Explorer
RobotControlSettings
Configurations and Setup
Programming
V+ Modules
loccopy
loccopy
Variables

A tab page to edit the V+ program is displayed in the Edit Pane.



New Project - RobotControlSettings - Sysmac Studio (64bit)
File Edit View Insert Controller Tools Window Help
Multiview Explorer
RobotControlSettings
Configurations and Setup
Programming
V+ Modules
loccopy
loccopy
Variables
Filter
Project Shortcut View
Shortcut Root Folder
loccopy
Show List
0 Errors
Not Connected
Build
0 Errors
0 Warnings
Description
Program
Location
Output
Build
Toolbox
<Search>
[Emulation Mode] Access Level: Engineer

```
.PROGRAM loccopy()
;
            ; ABSTRACT:
            ;
            ; INPUTS:
            ;
```

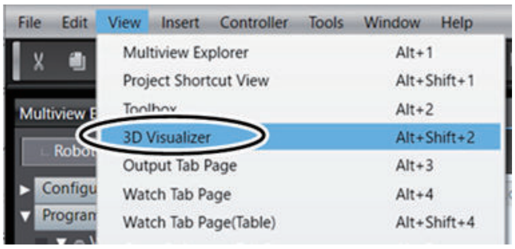
5 Create the program in the Edit Pane.

3-3-5 Placing 3D Shape Data

Making the Robot Motion Range Visible

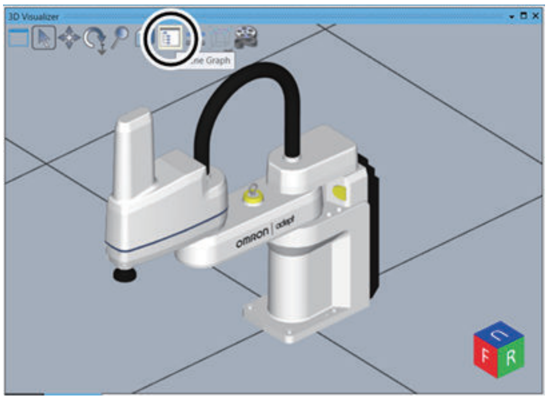
You can make the operating range of the robot visible on the 3D Visualizer. Making the operating range visible makes it easier to set the position of the robot.

1 Select **3D Visualizer** from the **View** menu on the main window of the Sysmac Studio.



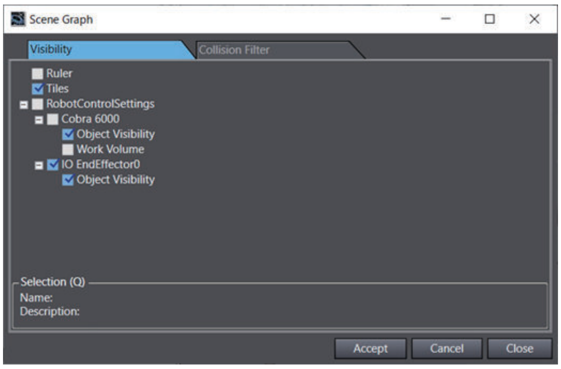
File Edit View Insert Controller Tools Window Help
Multiview Explorer Alt+1
Project Shortcut View Alt+Shift+1
Toolbox Alt+2
3D Visualizer Alt+Shift+2
Output Tab Page Alt+3
Watch Tab Page Alt+4
Watch Tab Page(Table) Alt+Shift+4
Multiview E
Robo
Configu
Program

2 In the 3D Visualizer, click the Scene Graph icon.

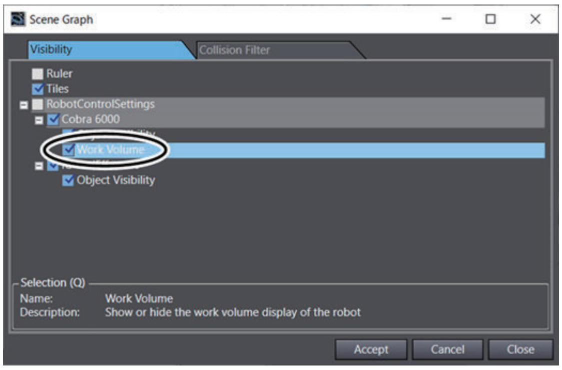


3D Visualizer
Scene Graph
omron | adept
F
R

The **Scene Graph** dialog box is displayed.

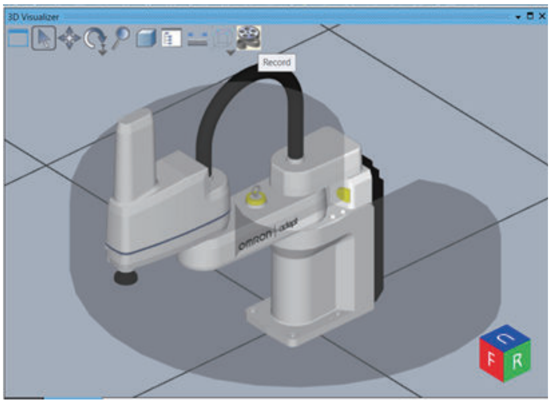

Scene Graph
Visibility
Collision Filter
☐ Ruler
☑ Tiles
☐ RobotControlSettings
☐ Cobra 6000
☑ Object Visibility
☐ Work Volume
☑ IO EndEffector0
☑ Object Visibility
Selection (Q)
Name:
Description:
Accept
Cancel
Close

3 In the **Visibility** tab page, select the **Work Volume** check box located under **RobotControlSettings** - **Cobra 6000**.

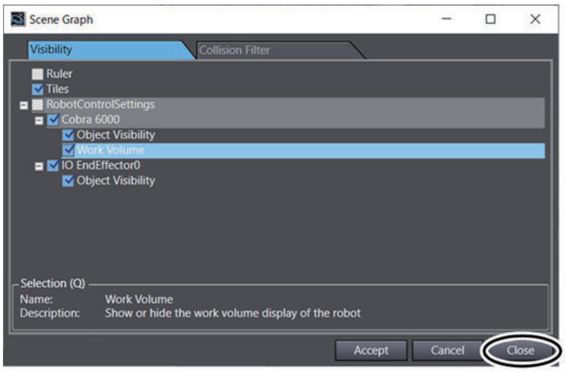

Scene Graph
Visibility
Collision Filter
☐ Ruler
☑ Tiles
☐ RobotControlSettings
☑ Cobra 6000
☑ Work Volume
☑ Object Visibility
Selection (Q)
Accept
Cancel
Close

Name: Work Volume
Description: Show or hide the work volume display of the robot

The 3D Visualizer illustrates the robot’s operating range in gray.


3D Visualizer
Record
F
R

4 Click the **Close** button on the **Scene Graph** dialog box.

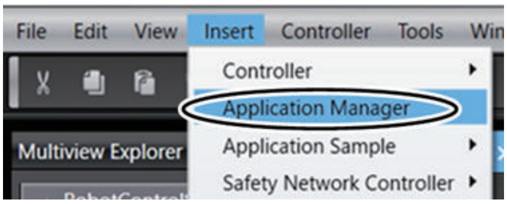

Scene Graph
Visibility
Collision Filter
☐ Ruler
☑ Tiles
☐ RobotControlSettings
☑ Cobra 6000
☑ Object Visibility
☑ Work Volume
☑ IO EndEffector0
☑ Object Visibility
Accept
Cancel
Close

Selection (Q)
Name: Work Volume
Description: Show or hide the work volume display of the robot

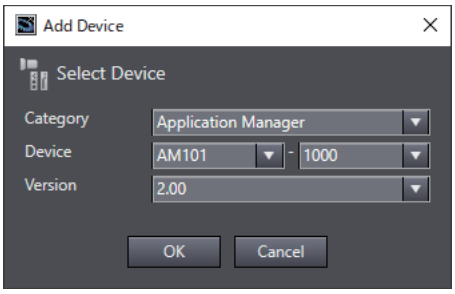
Importing 3D CAD Data

Import the 3D CAD data of the conveyors as 3D shape data to the Sysmac Studio.
This section describes the procedure to import the 3D CAD Data of Conveyor A and Conveyor B used in the equipment model in *1-3 Operations of Static Pick-and-place Equipment* on page 1-5.

1 Select **Application Manager** from the **Insert** menu on the main window of the Sysmac Studio.

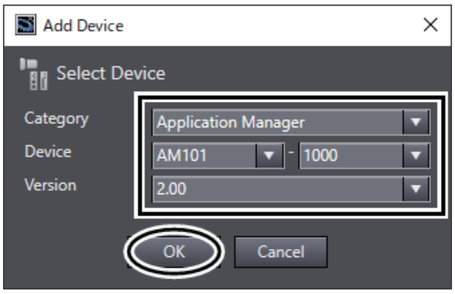

File
Edit
View
Insert
Controller
Tools
Win
Multiview Explorer
Controller
Application Manager
Application Sample
Safety Network Controller

The **Add Device** dialog box is displayed.


Add Device
Select Device
OK
Cancel

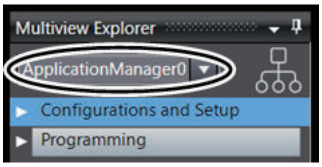
Category: Application Manager
Device: AM101 - 1000
Version: 2.00

2 Select **Category**, **Device**, and **Version** as shown in the figure below, and then click the **OK** button.


Add Device
Select Device
OK
Cancel

Category: Application Manager
Device: AM101 - 1000
Version: 2.00

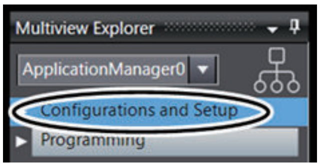
ApplicationManager0 is added to the drop-down list at the top of the Multiview Explorer


Multiview Explorer
ApplicationManager0
Configurations and Setup
Programming

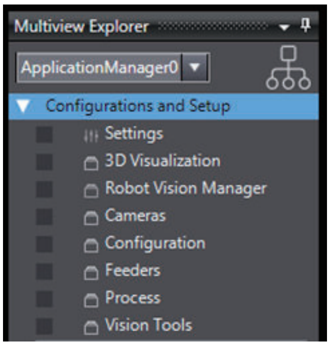
Additional Information

Application Manager added by this operation can only be used for simulation. Do not use it for actual device

3 Click **Configurations and Setup** in the Multiview Explorer.


Multiview Explorer
ApplicationManager0
Configurations and Setup
Programming

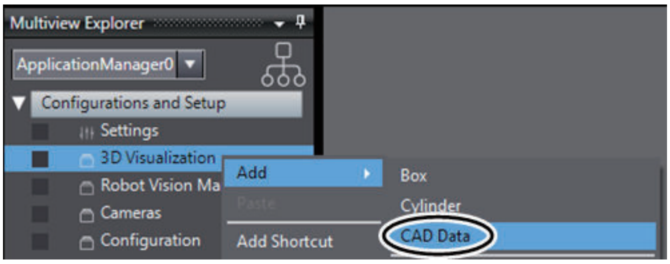
Setting items are displayed under **Configurations and Setup** in the tree.


Multiview Explorer
ApplicationManager0
Configurations and Setup
Settings
3D Visualization
Robot Vision Manager
Cameras
Configuration
Feeders
Process
Vision Tools

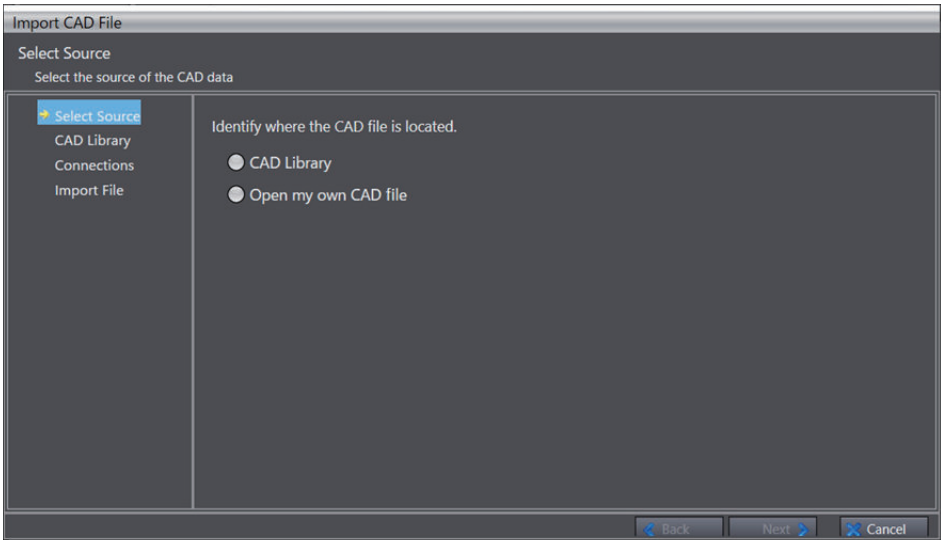
4 Right-click **3D Visualization**.

The menu commands are displayed.

5 From the menu, select **Add - CAD Data**.


Multiview Explorer
ApplicationManager0
Configurations and Setup
Settings
3D Visualization
Robot Vision Ma
Cameras
Configuration
Add
Paste
Add Shortcut
Box
Cylinder
CAD Data

The **Import CAD File** wizard starts.


Import CAD File
Select Source
Select the source of the CAD data
Select Source
CAD Library
Connections
Import File
Back
Next
Cancel

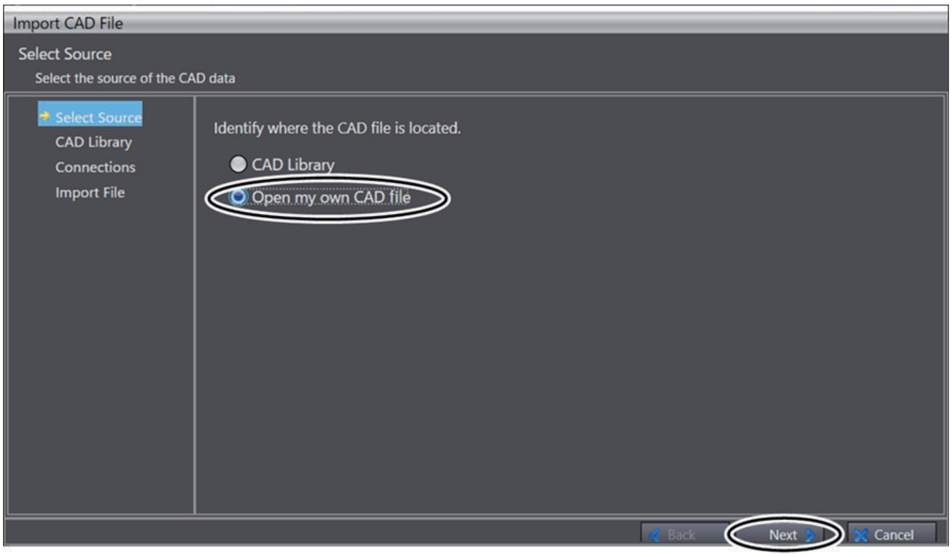
Identify where the CAD file is located.

○ CAD Library

○ Open my own CAD file

6 Select **Open my own CAD file**.

7 Click the **Next** button.

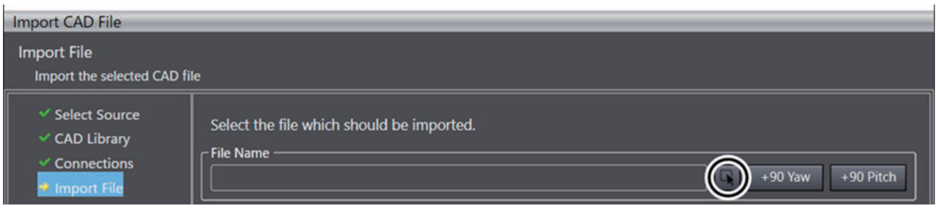

Import CAD File
Select Source
Select the source of the CAD data
Select Source
CAD Library
Connections
Import File
Back
Next
Cancel

Identify where the CAD file is located.

○ CAD Library

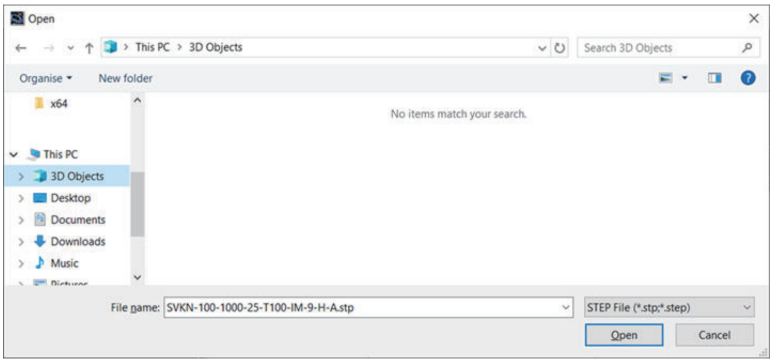
● Open my own CAD file

8 Click the **Open File** button.


Import CAD File
Import File
Import the selected CAD file
✓ Select Source
✓ CAD Library
✓ Connections
Import File
File Name
+90 Yaw
+90 Pitch

Select the file which should be imported.

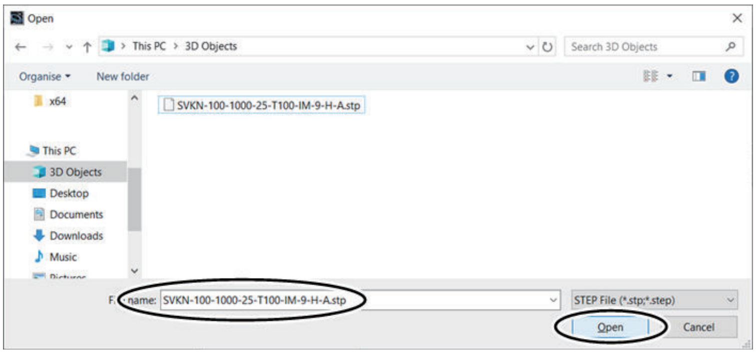
The **Open** dialog box is displayed.


Open
This PC > 3D Objects
Search 3D Objects
Organise
New folder
x64
This PC
3D Objects
Desktop
Documents
Downloads
Music
Pictures
No items match your search.
File name:
STEP File (*.stp;*.step)
Open
Cancel

File name: SVKN-100-1000-25-T100-IM-9-H-A.stp

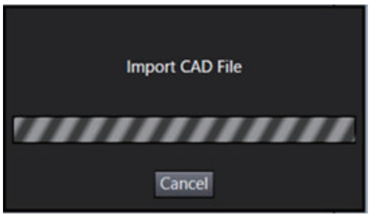
9 Select 3D CAD data to import, and then click the **Open** button.

In this example, you select the conveyor of MISUMI Corporation whose model number is SVKN-100-1000-25-T100-IM-9-H-A for the Conveyor A. You can import the 3D CAD data with the file name extension “stp”.

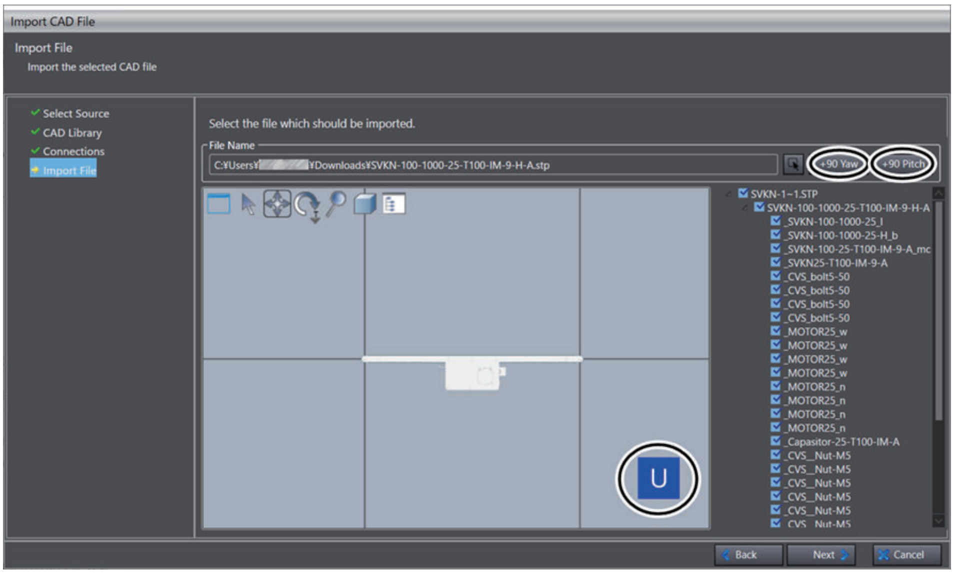

Open
This PC > 3D Objects
Search 3D Objects
Organise
New folder
x64
This PC
3D Objects
Desktop
Documents
Downloads
Music
Pictures
SVKN-100-1000-25-T100-IM-9-H-A.stp
File name:
STEP File (*.stp;*.step)
Open
Cancel

File name: SVKN-100-1000-25-T100-IM-9-H-A.stp

The **Open** dialog box is closed and import of 3D CAD data starts automatically.


Import CAD File
Cancel

When the import completes, the assemblies of the import 3D CAD data is displayed in the **Import CAD File** wizard.


Import CAD File
Import File
Import the selected CAD file
Select Source
CAD Library
Connections
Import File
File Name
+90 Yaw
+90 Pitch
U
SVKN-1~1.STP
SVKN-100-1000-25-T100-IM-9-H-A
_SVKN-100-1000-25_l
_SVKN-100-1000-25-H_b
_SVKN-100-25-T100-IM-9-A_mc
_SVKN25-T100-IM-9-A
_CVS_bolt5-50
_CVS_bolt5-50
_CVS_bolt5-50
_CVS_bolt5-50
_MOTOR25_w
_MOTOR25_w
_MOTOR25_w
_MOTOR25_w
_MOTOR25_n
_MOTOR25_n
_MOTOR25_n
_MOTOR25_n
_Capasitor-25-T100-IM-A
_CVS_Nut-M5
_CVS_Nut-M5
_CVS_Nut-M5
_CVS_Nut-M5
_CVS_Nut-M5
_CVS_Nut-M5
Back
Next
Cancel

Select the file which should be imported.

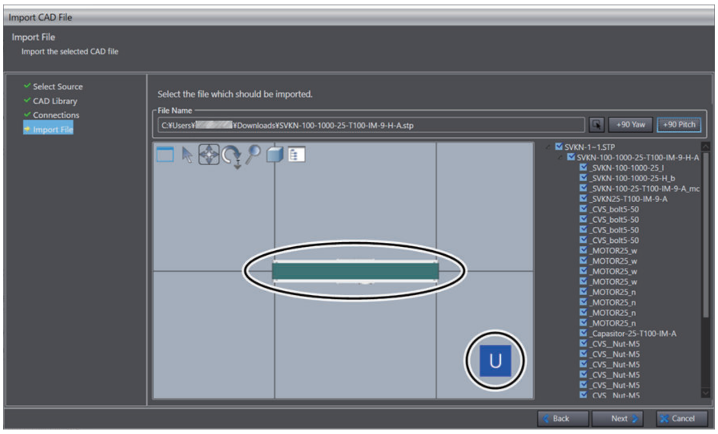
File Name: C:¥Users¥[redacted]¥Downloads¥SVKN-100-1000-25-T100-IM-9-H-A.stp

Additional Information

Align the conveyor top to the U face. Click the **+90 Yaw** button or **+90 Pitch** button to change the orientation of the conveyor.

10 Click the buttons in the following order; **+90 Yaw**, **+90 Pitch**, **+90 Yaw**, **+90 Pitch** and **+90 Pitch**

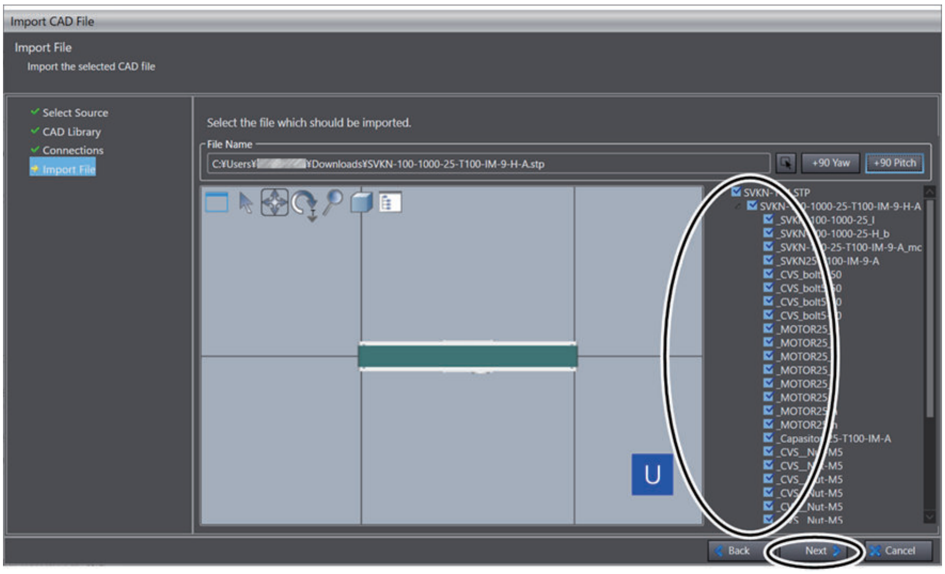
The conveyor top comes to the U face.


Import CAD File
Import File
Import the selected CAD file
Select Source
CAD Library
Connections
Import File
File Name
+90 Yaw
+90 Pitch
U
SVKN-1~1.STP
SVKN-100-1000-25-T100-IM-9-H-A
_SVKN-100-1000-25_l
_SVKN-100-1000-25-H_b
_SVKN-100-25-T100-IM-9-A_mc
_SVKN25-T100-IM-9-A
_CVS_bolt5-50
_CVS_bolt5-50
_CVS_bolt5-50
_CVS_bolt5-50
_MOTOR25_w
_MOTOR25_w
_MOTOR25_w
_MOTOR25_w
_MOTOR25_n
_MOTOR25_n
_MOTOR25_n
_MOTOR25_n
_Capasitor-25-T100-IM-A
_CVS_Nut-M5
_CVS_Nut-M5
_CVS_Nut-M5
_CVS_Nut-M5
_CVS_Nut-M5
_CVS_Nut-M5
Back
Next
Cancel

Select the file which should be imported.

File Name: C:¥Users¥[redacted]¥Downloads¥SVKN-100-1000-25-T100-IM-9-H-A.stp

11 Select the parts to add for simulation, and click the **Next** button.



Import CAD File

Import File

Import the selected CAD file

✓ Select Source
✓ CAD Library
✓ Connections
Import File

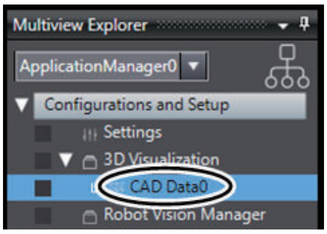
Select the file which should be imported.

File Name: C:¥Users¥[redacted]¥Downloads¥SVKN-100-1000-25-T100-IM-9-H-A.stp

+90 Yaw
+90 Pitch
U
Back
Next
Cancel

The **Import CAD File** wizard is closed and the main window is displayed again.

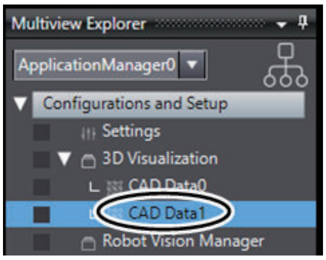
12 Check that **CAD Data0** is added under **Configurations and Setup** - **3D Visualization** in the Multiview Explorer.



Multiview Explorer
ApplicationManager0
Configurations and Setup
Settings
3D Visualization
CAD Data0
Robot Vision Manager

13 Perform step 4 and later to import the 3D CAD data of the Conveyor B.

In the Multiview Explorer, **CAD Data1** is added under **Configurations and Setup** - **3D Visualization**.



Multiview Explorer
ApplicationManager0
Configurations and Setup
Settings
3D Visualization
CAD Data0
CAD Data1
Robot Vision Manager

The 3D CAD Data for Conveyor A and Conveyor B are now imported.

Placing 3D Shape Data on the 3D Visualizer

Place the imported 3D shape data in the appropriate position on the 3D Visualizer.

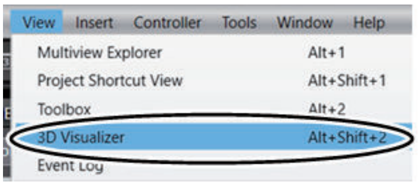
When 3D shape data is imported, the 3D shape data is positioned so that it has the same coordinate origin as the robot coordinate system. Therefore, it is necessary to move the 3D shape data to the appropriate position.

This section describes the procedure to place Conveyor A used in the equipment model in *1-3 Operations of Static Pick-and-place Equipment* on page 1-5 as an example.

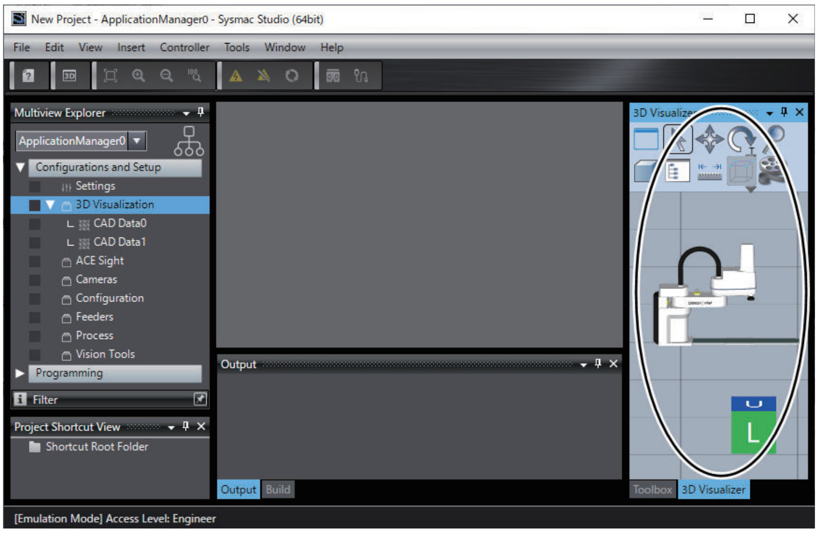
Additional Information

For information on setting up in the 3D Visualizer and translating the point of view, refer to the *Sysmac Studio 3D Simulation Function Operation Manual (Cat. No. W618)*.

1 Select **3D Visualizer** from the **View** menu on the main window of the Sysmac Studio.


View
Insert
Controller
Tools
Window
Help
Multiview Explorer Alt+1
Project Shortcut View Alt+Shift+1
Toolbox Alt+2
3D Visualizer Alt+Shift+2
Event Log

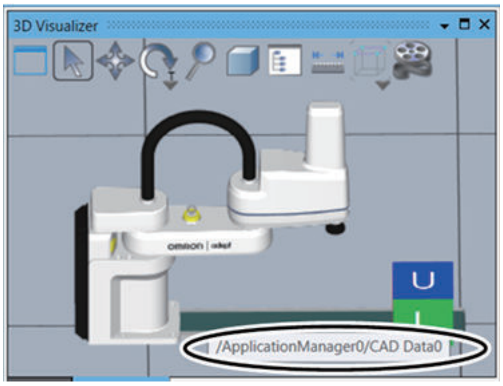
The 3D Visualizer is displayed on the right side of the main window.


New Project - ApplicationManager0 - Sysmac Studio (64bit)
File
Edit
View
Insert
Controller
Tools
Window
Help
Multiview Explorer
ApplicationManager0
Configurations and Setup
Settings
3D Visualization
CAD Data0
CAD Data1
ACE Sight
Cameras
Configuration
Feeders
Process
Vision Tools
Programming
Filter
Project Shortcut View
Shortcut Root Folder
Output
Output
Build
3D Visualizer
Toolbox
3D Visualizer
[Emulation Mode] Access Level: Engineer

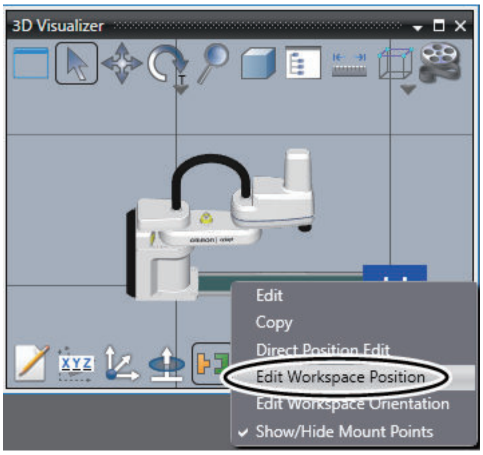
2 In the 3D Visualizer, select the imported 3D shape data with the mouse cursor and right-click it.
The menu commands are displayed.

Additional Information

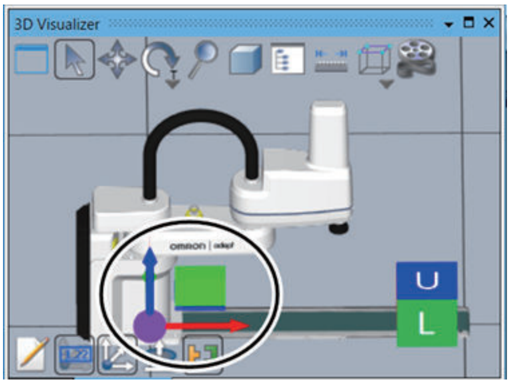
When you move the mouse cursor on the 3D shape data in the 3D Visualizer, the name of the 3D shape data **/ApplicationManager0/CAD Data0** is displayed.


3D Visualizer
/ApplicationManager0/CAD Data0

3 Select **Edit Workspace Position** from the menu.

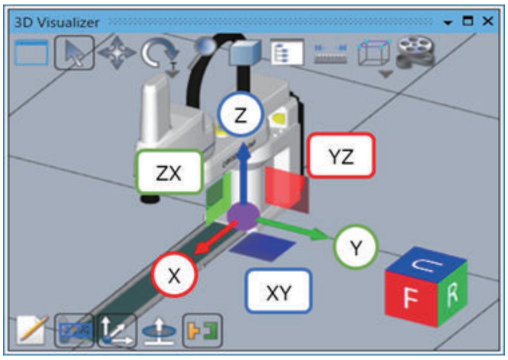

3D Visualizer
Edit
Copy
Direct Position Edit
Edit Workspace Position
Edit Workspace Orientation
✓ Show/Hide Mount Points

The Move icon consisting of colored arrows, a purple circle, and faces is displayed on the origin of the 3D shape data.

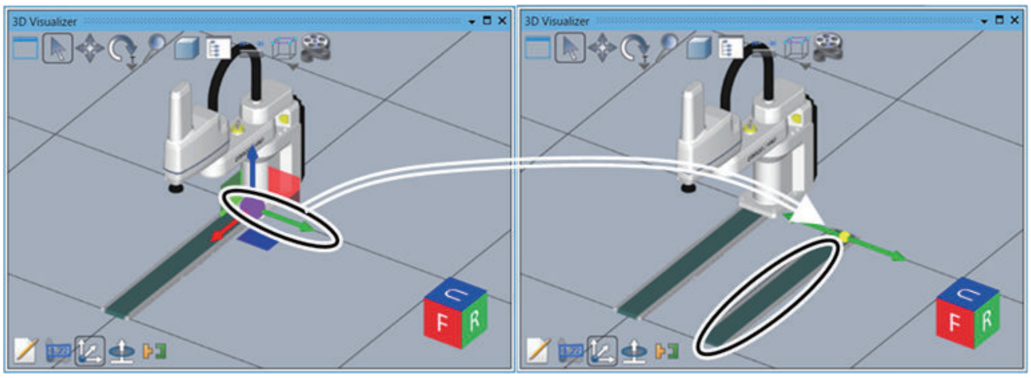

3D Visualizer
U
L

4 Drag one of the arrows, faces, or the purple circle and drop it on the place to move the 3D shape data.

The Move icon has red, green, and blue arrows, which represent the X-axis, Y-axis, and Z-axis, respectively. The red face shows the YZ plane, the green face shows the ZX plane, and the blue face shows the XY plane.

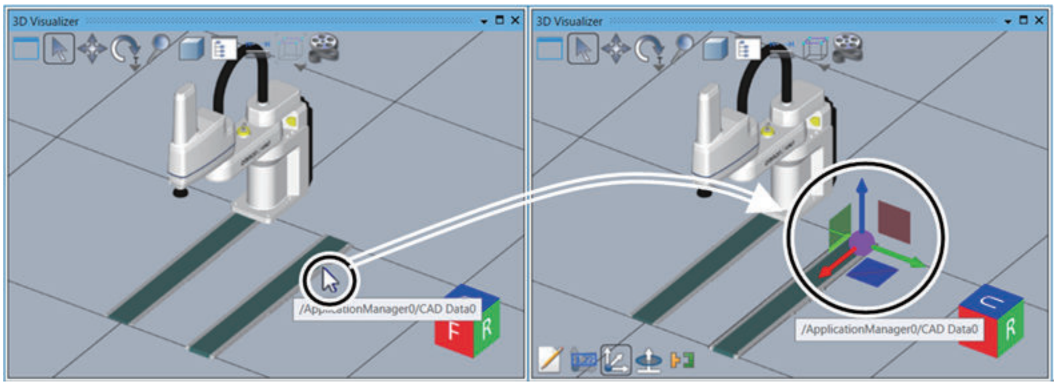

3D Visualizer
Z
ZX
YZ
Y
X
XY
F
R

You can drag an arrow to move the 3D shape data along the axis. Or, use the face icon to move the 3D shape data on the corresponding plane. You can also move the 3D shape data independently from the axis direction by dragging the purple circle.


3D Visualizer
3D Visualizer

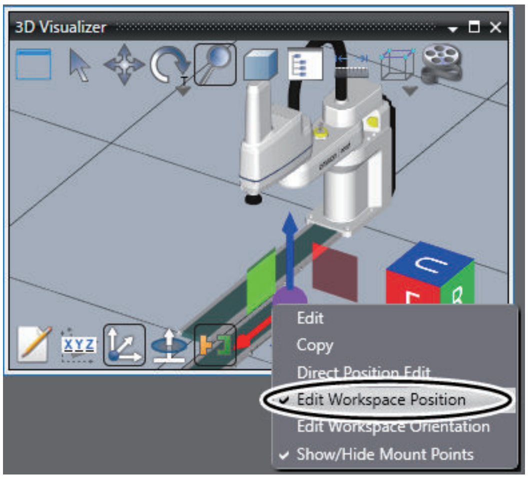
Additional Information

When the Move icon is hidden, click the 3D shape data to display it.


3D Visualizer
3D Visualizer
/ApplicationManager0/CAD Data0
/ApplicationManager0/CAD Data0

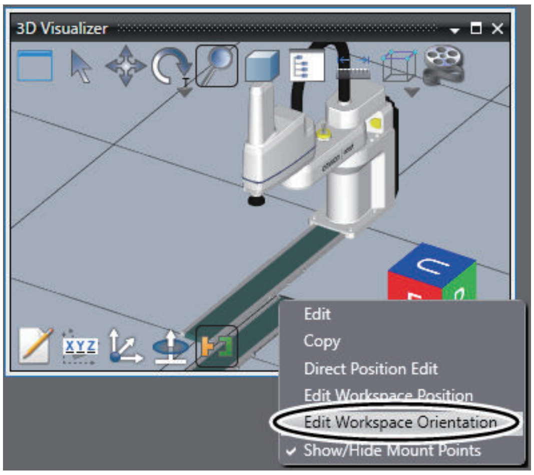
5 Right-click the 3D shape data you are moving in the 3D Visualizer.
The menu commands are displayed.

6 Select **Edit Workspace Position** from the menu to clear the selection.

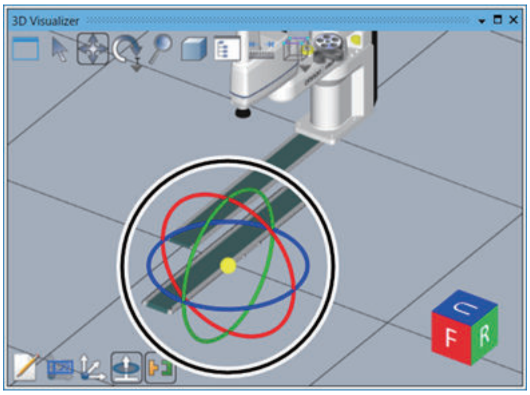

3D Visualizer
Edit
Copy
Direct Position Edit
✓ Edit Workspace Position
Edit Workspace Orientation
✓ Show/Hide Mount Points

7 Right-click the 3D shape data in the 3D Visualizer.
The menu commands are displayed.

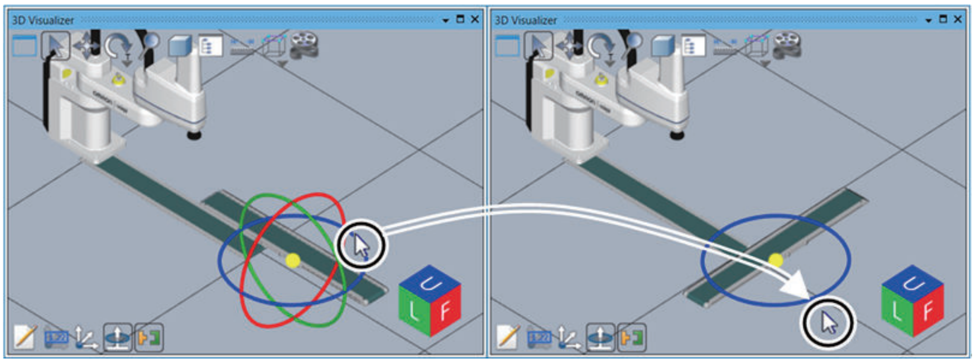
8 Select **Edit Workspace Orientation** from the menu.


3D Visualizer
Edit
Copy
Direct Position Edit
Edit Workspace Position
Edit Workspace Orientation
✓ Show/Hide Mount Points

The Rotate icon is displayed on the 3D shape data.

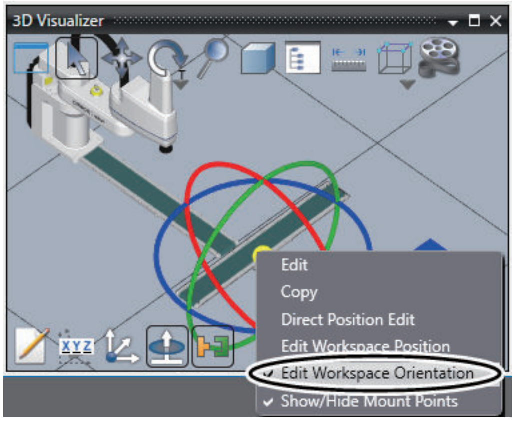

3D Visualizer

9 Drag and drop the handle of the Rotate icon to rotate the 3D shape data around the axis to an appropriate orientation.
The icon has red, green, and blue handles, which represent rotation around the X-axis, Y-axis, and Z-axis, respectively.


3D Visualizer
3D Visualizer

10 Right-click the 3D shape data to adjust the orientation in the 3D Visualizer.
The menu commands are displayed.

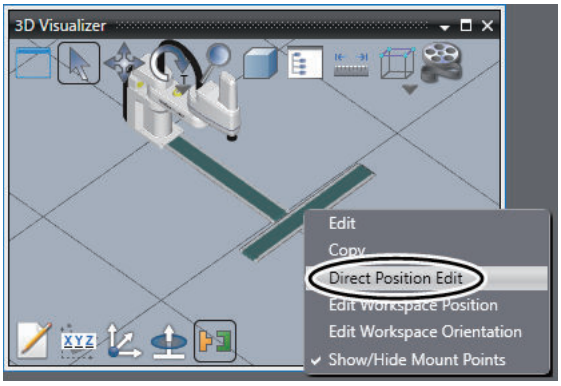
11 Select **Edit Workspace Orientation** from the menu to clear the selection.


3D Visualizer
Edit
Copy
Direct Position Edit
Edit Workspace Position
✓ Edit Workspace Orientation
✓ Show/Hide Mount Points

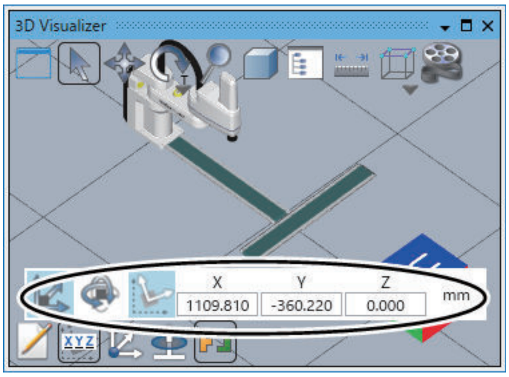
12 Right-click the 3D shape data that you were adjusting the orientation in the 3D Visualizer.

The menu commands are displayed.

13 Select **Direct Position Edit** from the menu.


3D Visualizer
Edit
Copy
Direct Position Edit
Edit Workspace Position
Edit Workspace Orientation
✓ Show/Hide Mount Points

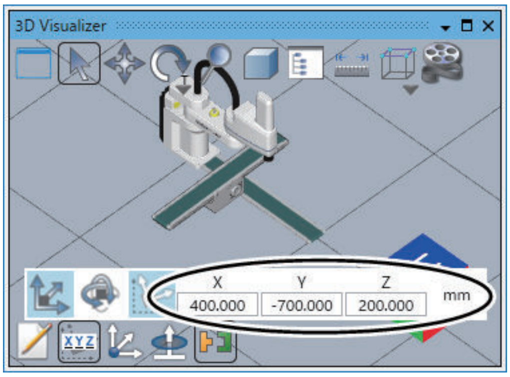
The input fields for editing the position of the 3D shape data is displayed.


3D Visualizer

X	Y	Z	
1109.810	-360.220	0.000	mm

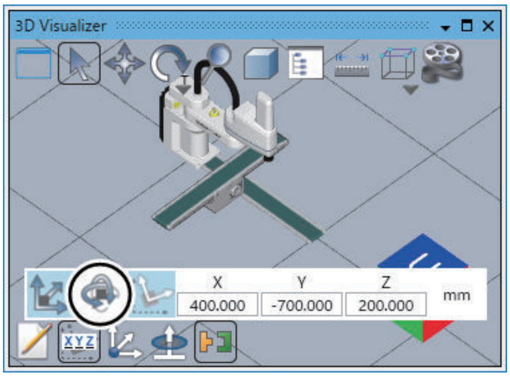
14 Enter values in mm in the X, Y, and Z fields to move the 3D shape data to an appropriate position.

The position of the 3D shape data changes according to the input values.



X 400.000, Y -700.000, Z 200.000 mm

15 Click the **Edit Workspace Orientation** icon.

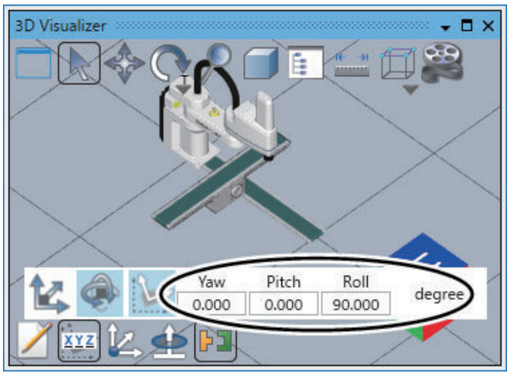


X 400.000, Y -700.000, Z 200.000 mm

The input fields for editing the orientation of the 3D shape data is displayed.

16 Enter values in degree in the input fields for Yaw, Pitch, and Roll to adjust the orientation of the 3D shape data.

The orientation of the 3D shape data changes according to the input values.

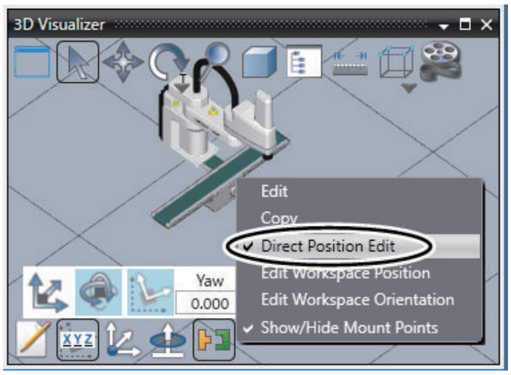


Yaw 0.000, Pitch 0.000, Roll 90.000 degree

17 In the 3D Visualizer, right-click the 3D shape data that you adjusted the position and orientation.

The menu commands are displayed.

18 Select **Direct Position Edit** from the menu to clear the selection.

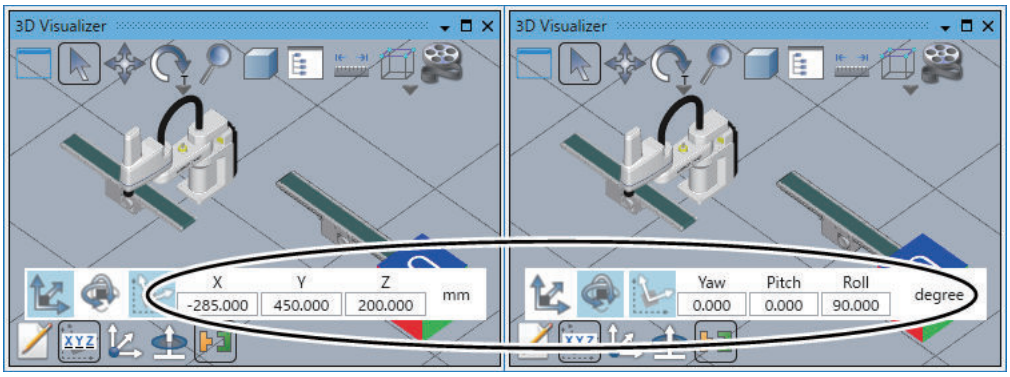


Yaw: 0.000

Precautions for Correct Use

Refer to the *Sysmac Studio 3D Simulation Function Operation Manual (Cat. No. W618)* for details on coordinate system in the 3D Visualizer.

19 Perform step 2 and later to adjust the position and orientation of the CAD Data1 of Conveyor B.



X: -285.000, Y: 450.000, Z: 200.000 mm

Yaw: 0.000, Pitch: 0.000, Roll: 90.000 degree

The 3D shape data of Conveyor A and Conveyor B are now placed in the appropriate positions in the 3D Visualizer.

Activating Collision Detection Function

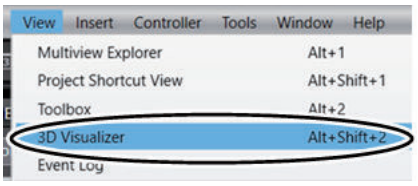
The collision detection function detects the contacts in simulation that may occur between the robot and other 3D shape data, such as objects imported as 3D CAD data. If the robot may contact with other 3D shape data, you need to change the layout of the robot or the 3D shape data, or modify the movement of the robot.

In this section, the setting procedure to detect a contact between the robot, Conveyor A and Conveyor B is given. Because the collision detection function checks whether 3D shape data may conflict between groups, you create two groups; Group 0, which includes the robot, and Group 1, which includes Conveyor A and Conveyor B.

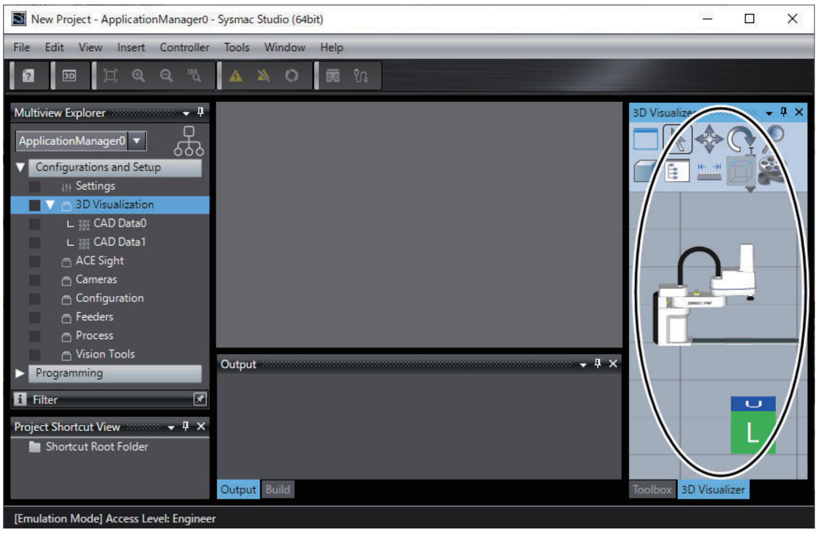
Precautions for Correct Use

In this guide, the target of collision detection is the robot. When the 3D shape data is placed at the tool center point, collision detection of that 3D shape data is also required. For the operation procedure for the 3D shape data placed at the tool center point, refer to the *Sysmac Studio 3D Simulation Function Operation Manual (Cat. No. W618)*.

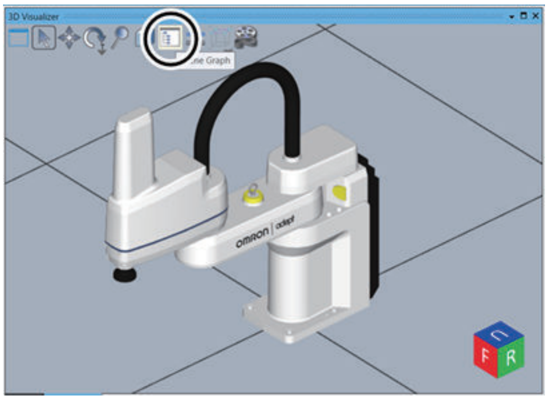
1 Select **3D Visualizer** from the **View** menu on the main window of the Sysmac Studio.


View
Insert
Controller
Tools
Window
Help
Multiview Explorer Alt+1
Project Shortcut View Alt+Shift+1
Toolbox Alt+2
3D Visualizer Alt+Shift+2
Event Log

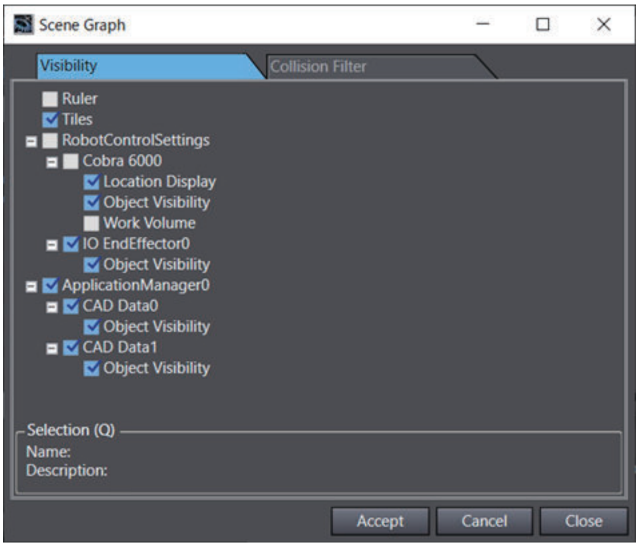
The 3D Visualizer is displayed on the right side of the main window.


New Project - ApplicationManager0 - Sysmac Studio (64bit)
File
Edit
View
Insert
Controller
Tools
Window
Help
Multiview Explorer
ApplicationManager0
Configurations and Setup
Settings
3D Visualization
CAD Data0
CAD Data1
ACE Sight
Cameras
Configuration
Feeders
Process
Vision Tools
Programming
Filter
Project Shortcut View
Shortcut Root Folder
Output
Output
Build
3D Visualizer
Toolbox
3D Visualizer
[Emulation Mode] Access Level: Engineer

2 In the 3D Visualizer, click the **Scene Graph** icon.


3D Visualizer
Scene Graph
omron | adept

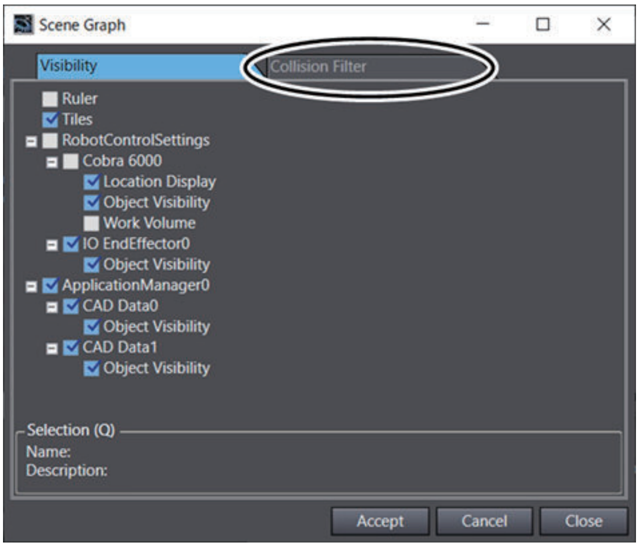
The **Scene Graph** dialog box is displayed.


Scene Graph
Visibility
Collision Filter
Accept
Cancel
Close

- ☐ Ruler
- ☑ Tiles
- ☐ RobotControlSettings
  - ☐ Cobra 6000
    - ☑ Location Display
    - ☑ Object Visibility
    - ☐ Work Volume
  - ☑ IO EndEffector0
    - ☑ Object Visibility
- ☑ ApplicationManager0
  - ☑ CAD Data0
    - ☑ Object Visibility
  - ☑ CAD Data1
    - ☑ Object Visibility

Selection (Q)
Name:
Description:

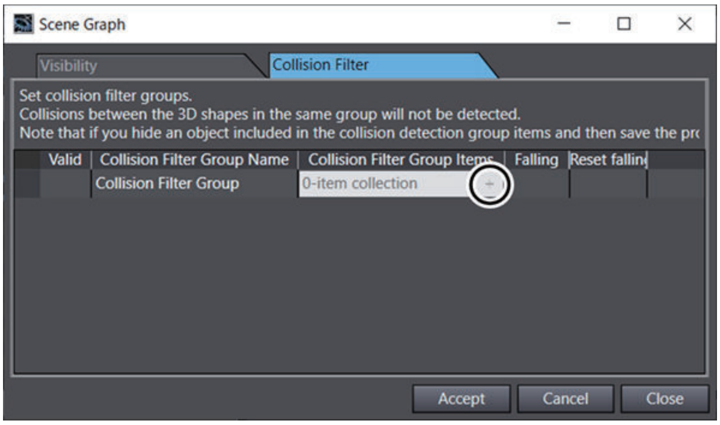
3 Click the **Collision Filter** tab.


Scene Graph
Visibility
Collision Filter
Accept
Cancel
Close

- ☐ Ruler
- ☑ Tiles
- ☐ RobotControlSettings
  - ☐ Cobra 6000
    - ☑ Location Display
    - ☑ Object Visibility
    - ☐ Work Volume
  - ☑ IO EndEffector0
    - ☑ Object Visibility
- ☑ ApplicationManager0
  - ☑ CAD Data0
    - ☑ Object Visibility
  - ☑ CAD Data1
    - ☑ Object Visibility

Selection (Q)
Name:
Description:

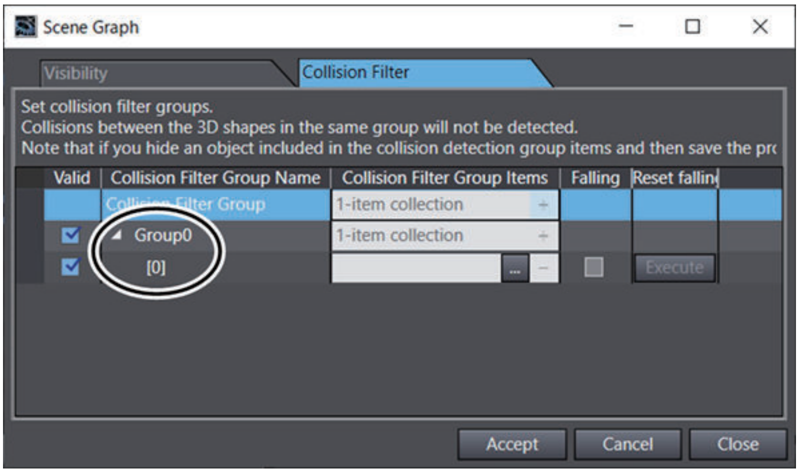
4 Click the **+** button in the **Collision Filter Group Items** column for the **Collision Filter Group**.


Scene Graph
Visibility
Collision Filter
Accept
Cancel
Close

Set collision filter groups.
Collisions between the 3D shapes in the same group will not be detected.
Note that if you hide an object included in the collision detection group items and then save the prc

Valid	Collision Filter Group Name	Collision Filter Group Items	Falling	Reset fallin
	Collision Filter Group	0-item collection +		

A new row with the **Collision Filter Group Name** set as **Group0** is added on the **Scene Graph** dialog box.

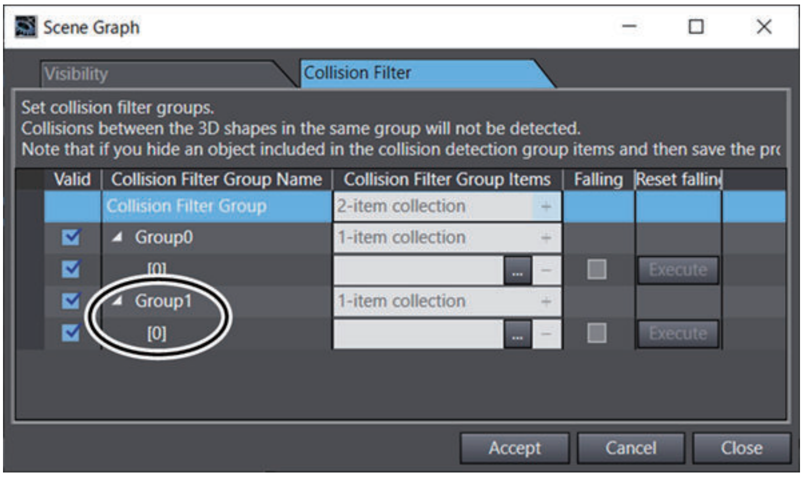

Scene Graph
Visibility
Collision Filter
Accept
Cancel
Close

Set collision filter groups.
Collisions between the 3D shapes in the same group will not be detected.
Note that if you hide an object included in the collision detection group items and then save the pr

Valid	Collision Filter Group Name	Collision Filter Group Items	Falling	Reset fallin
	Collision Filter Group	1-item collection +		
☑	Group0	1-item collection +		
☑	[0]	... −	☐	Execute

5 Repeat step 4 above.

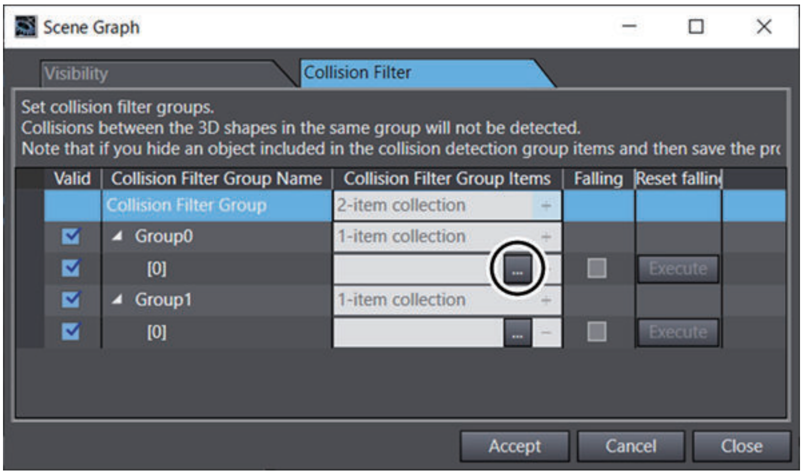
A new row with the **Collision Filter Group Name** set as **Group1** is added on the **Scene Graph** dialog box.


Scene Graph
Visibility
Collision Filter
Accept
Cancel
Close

Set collision filter groups.
Collisions between the 3D shapes in the same group will not be detected.
Note that if you hide an object included in the collision detection group items and then save the pr

Valid	Collision Filter Group Name	Collision Filter Group Items	Falling	Reset fallin
	Collision Filter Group	2-item collection +		
☑	Group0	1-item collection +		
☑	[0]	... −	☐	Execute
☑	Group1	1-item collection +		
☑	[0]	... −	☐	Execute

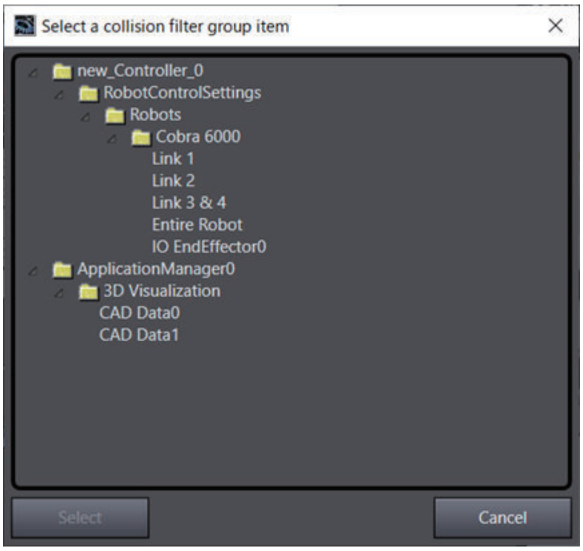
6 Click the **...** button in the **Collision Filter Group Items** column for **Group0 - [0]**.


Scene Graph
Visibility
Collision Filter
Accept
Cancel
Close

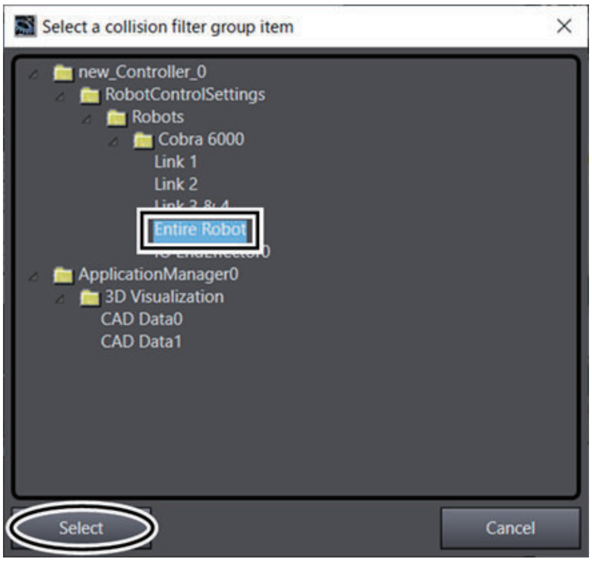
Set collision filter groups.
Collisions between the 3D shapes in the same group will not be detected.
Note that if you hide an object included in the collision detection group items and then save the pr

Valid	Collision Filter Group Name	Collision Filter Group Items	Falling	Reset fallin
	Collision Filter Group	2-item collection +		
☑	Group0	1-item collection +		
☑	[0]	... −	☐	Execute
☑	Group1	1-item collection +		
☑	[0]	... −	☐	Execute

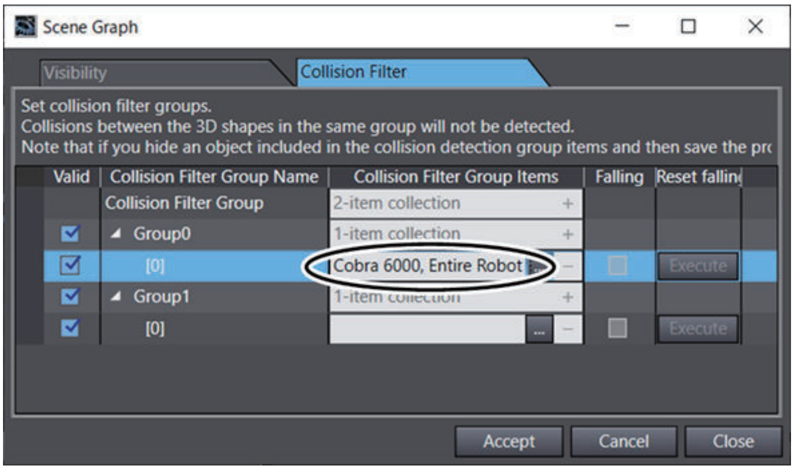
The **Select a collision filter group item** dialog box is displayed.


Select a collision filter group item
new_Controller_0
RobotControlSettings
Robots
Cobra 6000
Link 1
Link 2
Link 3 & 4
Entire Robot
IO EndEffector0
ApplicationManager0
3D Visualization
CAD Data0
CAD Data1
Select
Cancel

7 Select **new_Controller_0** - **RobotControlSettings** - **Robots** - **Cobra 6000** - **Entire Robot** in the tree, and then click the **Select** button.


Select a collision filter group item
new_Controller_0
RobotControlSettings
Robots
Cobra 6000
Link 1
Link 2
Entire Robot
ApplicationManager0
3D Visualization
CAD Data0
CAD Data1
Select
Cancel

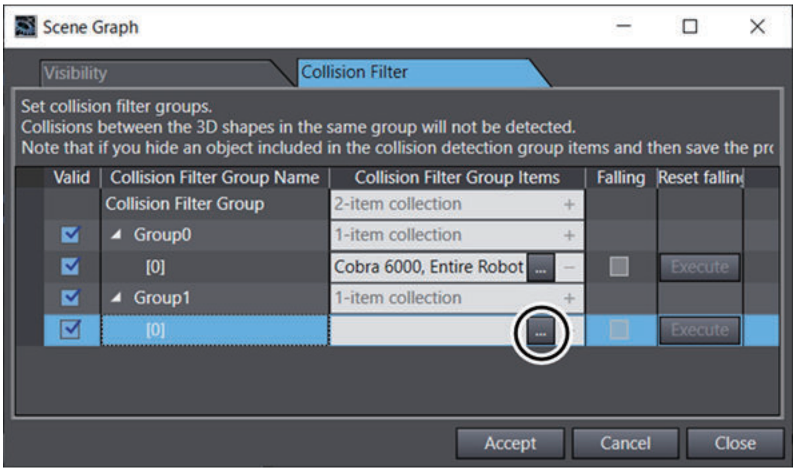
The **Select a collision filter group item** dialog box closes and the **Scene Graph** dialog box is displayed again. * **Entire Robot** is registered as the **Collision Filter Group Items** for **Group0** - **[0]**.


Scene Graph
Visibility
Collision Filter
Accept
Cancel
Close

Set collision filter groups.
Collisions between the 3D shapes in the same group will not be detected.
Note that if you hide an object included in the collision detection group items and then save the prc

Valid	Collision Filter Group Name	Collision Filter Group Items	Falling	Reset fallin
	Collision Filter Group	2-item collection +		
☑	◢ Group0	1-item collection +		
☑	[0]	Cobra 6000, Entire Robot ... −	☐	Execute
☑	◢ Group1	1-item collection +		
☑	[0]	... −	☐	Execute

8 Click the **...** button in the **Collision Filter Group Items** column whose **Collision Filter Group Name** is **Group1 - [0]**.

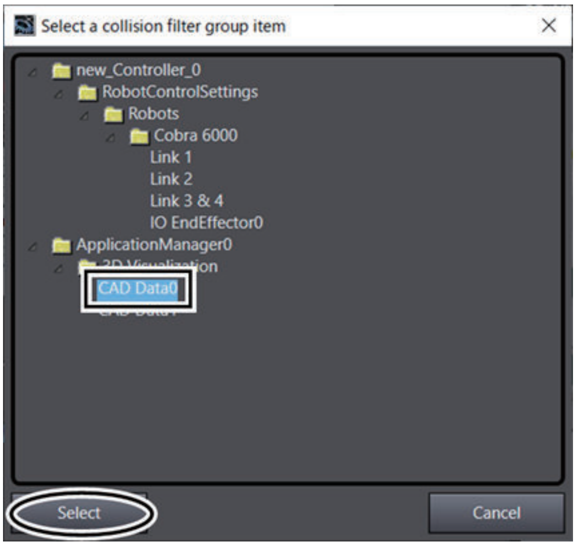

Scene Graph
Visibility
Collision Filter
Accept
Cancel
Close

Set collision filter groups.
Collisions between the 3D shapes in the same group will not be detected.
Note that if you hide an object included in the collision detection group items and then save the prc

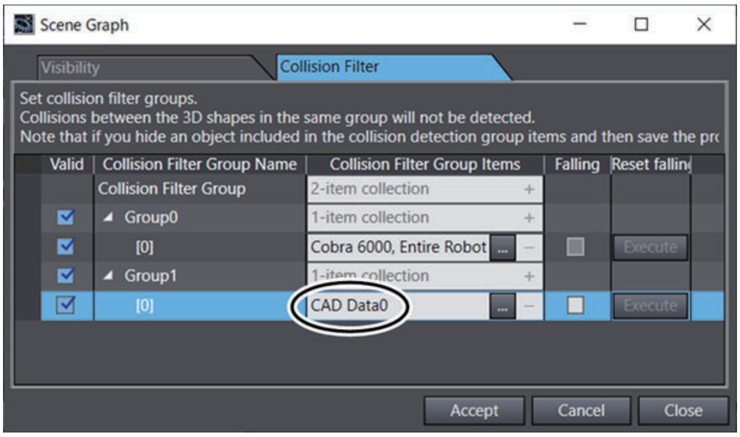
Valid	Collision Filter Group Name	Collision Filter Group Items	Falling	Reset fallin
	Collision Filter Group	2-item collection +		
☑	◢ Group0	1-item collection +		
☑	[0]	Cobra 6000, Entire Robot ... −	☐	Execute
☑	◢ Group1	1-item collection +		
☑	[0]	... −	☐	Execute

The **Select a collision filter group item** dialog box is displayed.

9 Select **ApplicationManager0 - 3D Visualization - CAD Data0** from the tree, and then click the **Select** button.


Select a collision filter group item
new_Controller_0
RobotControlSettings
Robots
Cobra 6000
Link 1
Link 2
Link 3 & 4
IO EndEffector0
ApplicationManager0
3D Visualization
CAD Data0
CAD Data1
Select
Cancel

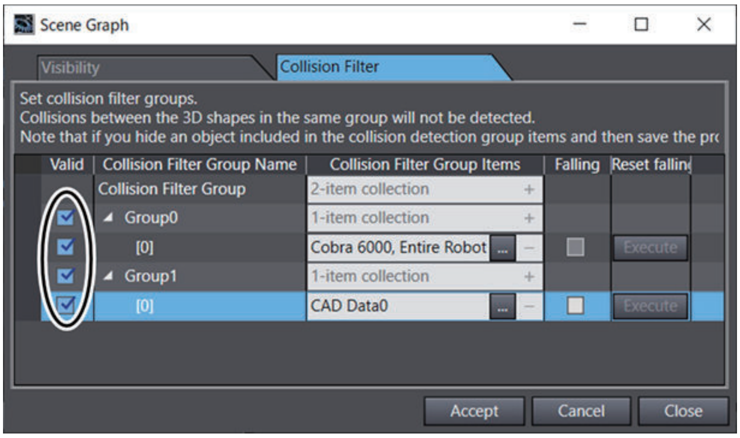
The **Select a collision filter group item** dialog box closes and the **Scene Graph** dialog box is displayed again. **CAD Data0** is registered to the **Collision Filter Group Items** column for **Group1** - **[0]**.



Set collision filter groups.
Collisions between the 3D shapes in the same group will not be detected.
Note that if you hide an object included in the collision detection group items and then save the pr

Valid	Collision Filter Group Name	Collision Filter Group Items	Falling	Reset fallin
	Collision Filter Group	2-item collection +		
☑	Group0	1-item collection +		
☑	[0]	Cobra 6000, Entire Robot	☐	Execute
☑	Group1	1-item collection +		
☑	[0]	CAD Data0	☐	Execute

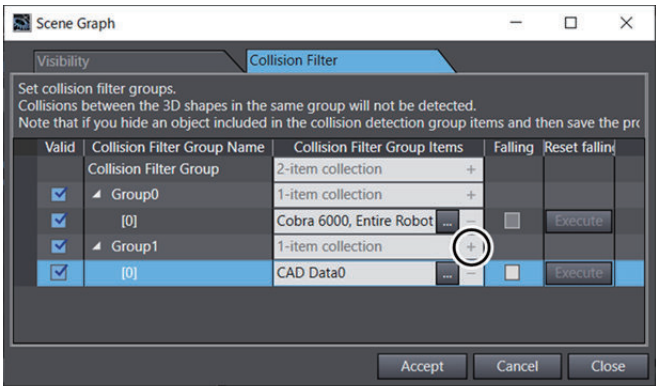
10 Check that the **Valid** check boxes are all selected. If there is a check box not selected, click it to select.



Set collision filter groups.
Collisions between the 3D shapes in the same group will not be detected.
Note that if you hide an object included in the collision detection group items and then save the pr

Valid	Collision Filter Group Name	Collision Filter Group Items	Falling	Reset fallin
	Collision Filter Group	2-item collection +		
☑	Group0	1-item collection +		
☑	[0]	Cobra 6000, Entire Robot	☐	Execute
☑	Group1	1-item collection +		
☑	[0]	CAD Data0	☐	Execute

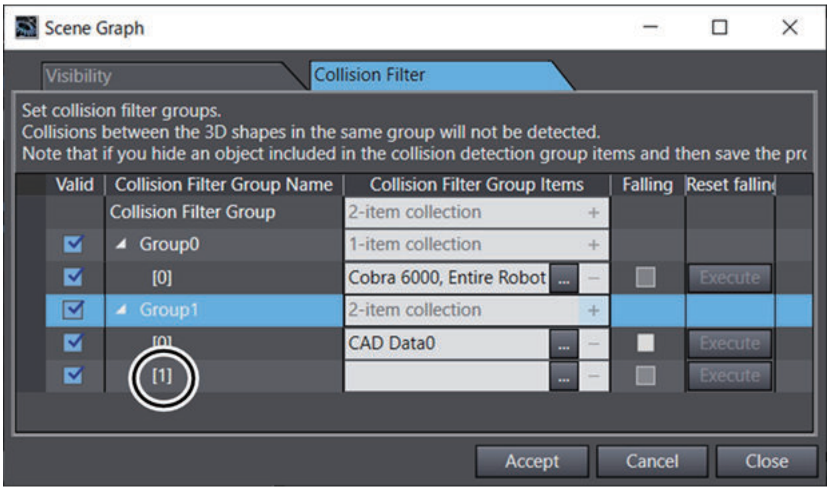
11 Click the **+** button in the **Collision Filter Group Items** column for **Group1**.



Set collision filter groups.
Collisions between the 3D shapes in the same group will not be detected.
Note that if you hide an object included in the collision detection group items and then save the pr

Valid	Collision Filter Group Name	Collision Filter Group Items	Falling	Reset fallin
	Collision Filter Group	2-item collection +		
☑	Group0	1-item collection +		
☑	[0]	Cobra 6000, Entire Robot	☐	Execute
☑	Group1	1-item collection +		
☑	[0]	CAD Data0	☐	Execute

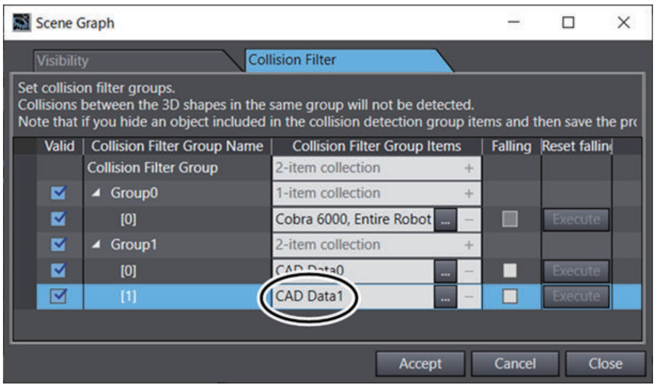
A new row for **[1]** is added under **Group1**.



Set collision filter groups.
Collisions between the 3D shapes in the same group will not be detected.
Note that if you hide an object included in the collision detection group items and then save the pr

Valid	Collision Filter Group Name	Collision Filter Group Items	Falling	Reset fallin
	Collision Filter Group	2-item collection		
☑	Group0	1-item collection		
☑	[0]	Cobra 6000, Entire Robot	☐	Execute
☑	Group1	2-item collection		
☑	[0]	CAD Data0	☐	Execute
☑	[1]		☐	Execute

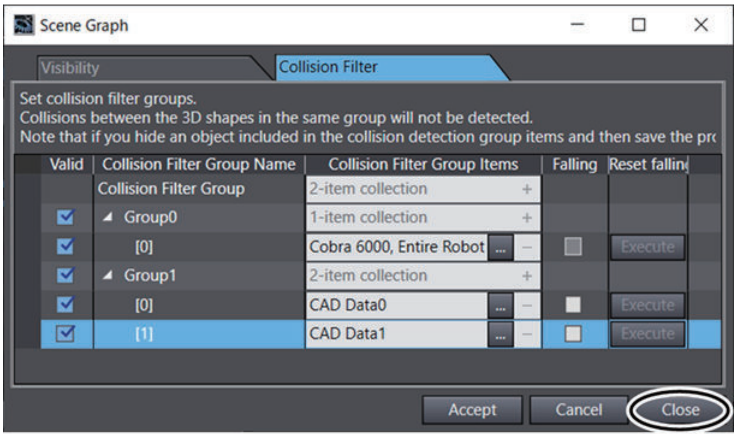
12 Follow the step 8 to 10 to register **CAD Data1** for **Group1** - **[1]**.
CAD Data1 is registered to the **Collision Filter Group Items** column for **Group1** - **[1]**.



Set collision filter groups.
Collisions between the 3D shapes in the same group will not be detected.
Note that if you hide an object included in the collision detection group items and then save the pr

Valid	Collision Filter Group Name	Collision Filter Group Items	Falling	Reset fallin
	Collision Filter Group	2-item collection		
☑	Group0	1-item collection		
☑	[0]	Cobra 6000, Entire Robot	☐	Execute
☑	Group1	2-item collection		
☑	[0]	CAD Data0	☐	Execute
☑	[1]	CAD Data1	☐	Execute

13 Click the **Close** button in the **Scene Graph** dialog box.



Set collision filter groups.
Collisions between the 3D shapes in the same group will not be detected.
Note that if you hide an object included in the collision detection group items and then save the pr

Valid	Collision Filter Group Name	Collision Filter Group Items	Falling	Reset fallin
	Collision Filter Group	2-item collection		
☑	Group0	1-item collection		
☑	[0]	Cobra 6000, Entire Robot	☐	Execute
☑	Group1	2-item collection		
☑	[0]	CAD Data0	☐	Execute
☑	[1]	CAD Data1	☐	Execute

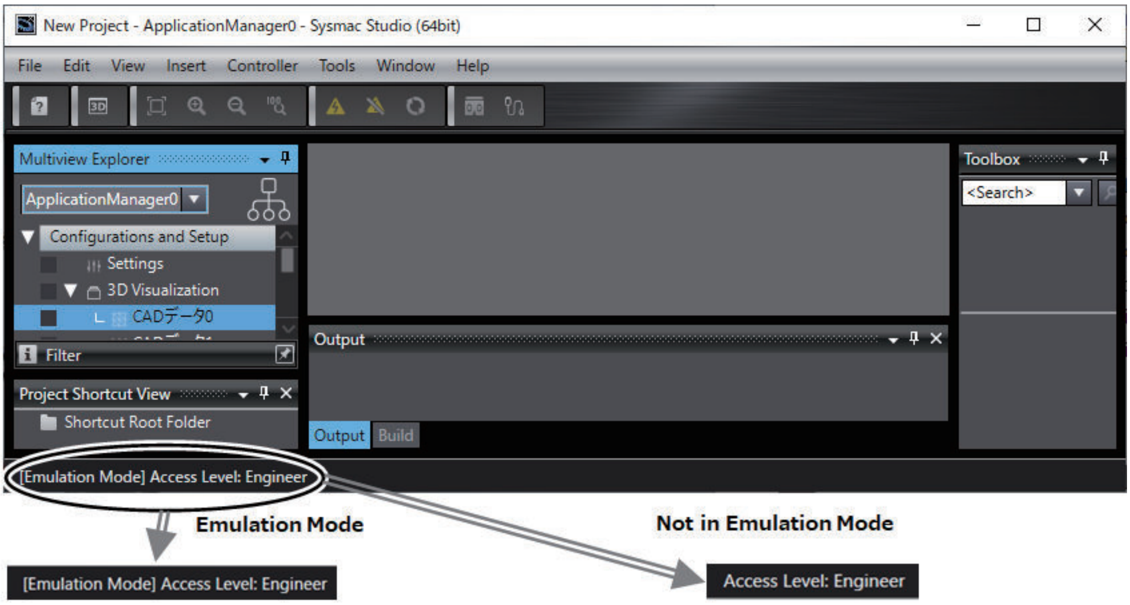
Now, the settings for checking the conflict between the robot, Conveyor A, and Conveyor B have been completed.

3-3-6 Starting Simulation

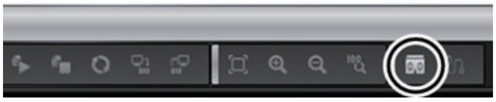
Enabling Robot Simulation Function

Enable the simulation function of the Sysmac Studio.
To simulate the operation of the robot, open the project file in EMULATION mode.

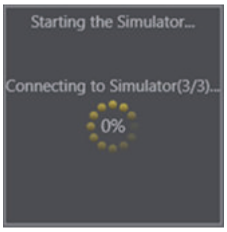
If you want to know whether the project file opened on the Sysmac Studio is in EMULATION mode or not, check the status bar on the main window. When you see **[Emulation Mode] Access Level: Engineer** on the status bar, the project is opened in EMULATION mode.


New Project - ApplicationManager0 - Sysmac Studio (64bit)
File Edit View Insert Controller Tools Window Help
Multiview Explorer
ApplicationManager0
Configurations and Setup
Settings
3D Visualization
CADデータ0
Filter
Project Shortcut View
Shortcut Root Folder
Output
Output Build
Toolbox
<Search>
[Emulation Mode] Access Level: Engineer
Emulation Mode
[Emulation Mode] Access Level: Engineer
Not in Emulation Mode
Access Level: Engineer

If the project is opened in a different mode, click the **Enable emulation mode** icon on the toolbar to change to EMULATION mode.



1 Select **Run** from the **Simulation** menu.
The screen below is displayed while the simulator is starting.

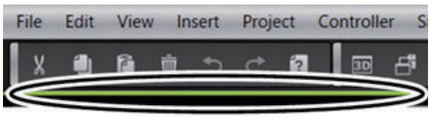


Starting the Simulator...

Connecting to Simulator(3/3)...

0%

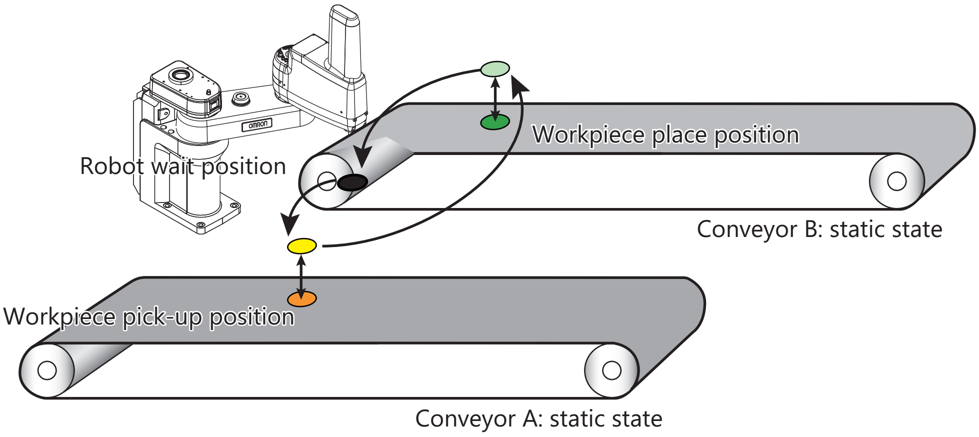
After this screen is closed, the lower part of the toolbar in the main window turns yellow-green.


File
Edit
View
Insert
Project
Controller
S

3-3-7 Teaching Positions

This section describes the procedure to use the simulation function of the Sysmac Studio for teaching the positions.

The target of teaching in this equipment model is the wait position of the robot and the pick-up and place positions of the workpiece.

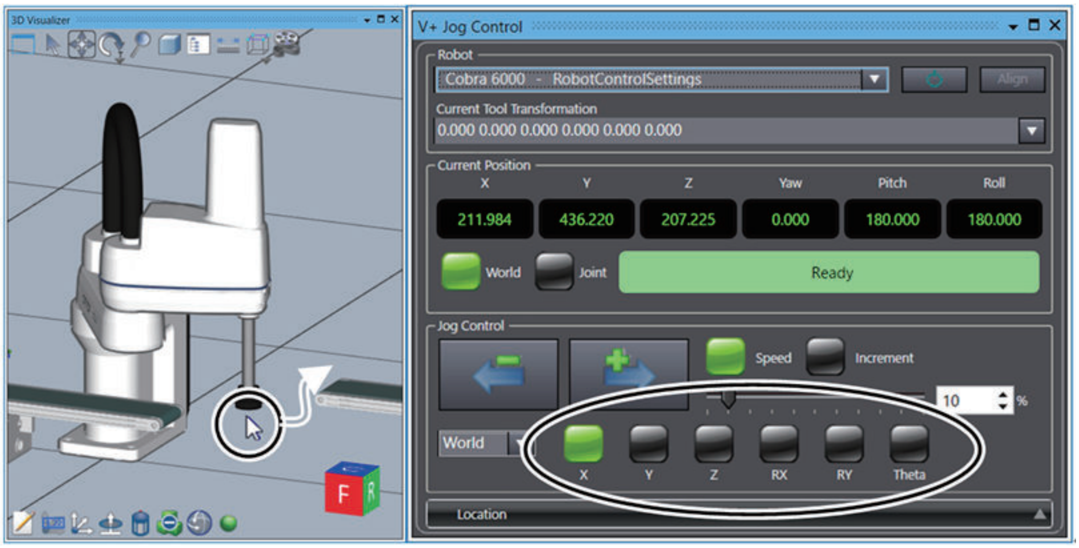

Workpiece place position
Robot wait position
Conveyor B: static state
Workpiece pick-up position
Conveyor A: static state

You can operate the robot during the simulation in either of the following two ways. Select one of the following depending on the positioning accuracy required for operation and movement.

- Manipulate the tool center point of the robot with the mouse in the 3D Visualizer
- Manipulate each axis of the robot in **V+ Jog Control** pane

Additional Information

- To move the robot to its approximate position, it is convenient to use the mouse and move the tool center point of the robot on the 3D Visualizer.
- To move the robot precisely to its correct position, manipulate each axis of the robot in the **V+ Jog Control** pane


3D Visualizer
F
R
V+ Jog Control
Robot
Align
Jog Control
World
Joint
Speed
Increment
%
X
Y
Z
RX
RY
Theta
Location

Robot: Cobra 6000 - RobotControlSettings

Current Tool Transformation: 0.000 0.000 0.000 0.000 0.000 0.000

Current Position

X	Y	Z	Yaw	Pitch	Roll
211.984	436.220	207.225	0.000	180.000	180.000

Ready

World

10

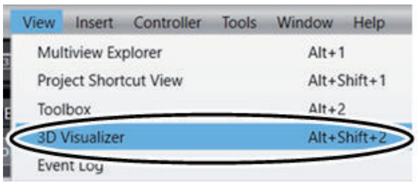
When teaching positions to the robot, you must store the position data of the robot in the V+ position variables. Here, create the following position variables.

Variable name	Data type	Application	Corresponding IEC variable
gl.pick	Location	Has the data of workpiece pick-up position.	eLoc_pick
gl.place	Location	Has the data of workpiece place position.	eLoc_place
gl.wait	Location	Has the data of robot wait position.	eLoc_wait

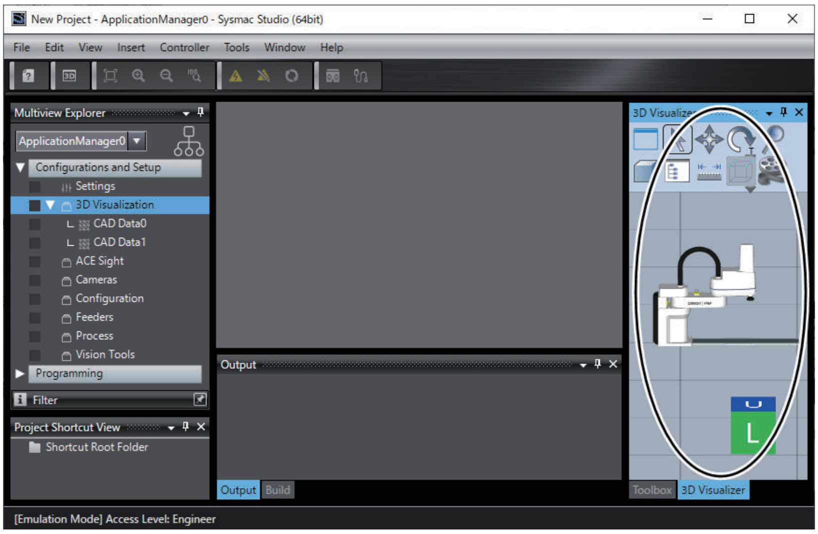
Manipulating the Robot with the Mouse in the 3D Visualizer

This section describes the procedure to manipulate the tool center point of the robot with the mouse in the 3D Visualizer. This operation is suitable for determining rough position and posture, because the tool center point of the robot moves to follow the mouse cursor, enabling intuitive robotic operation.

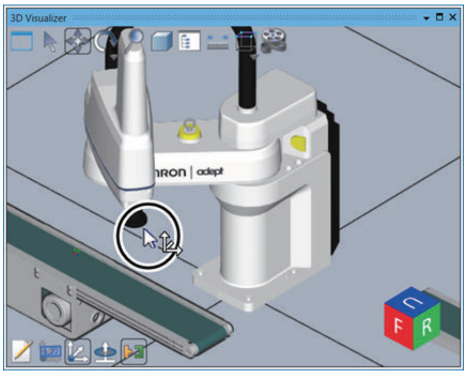
1 Select **3D Visualizer** from the **View** menu on the main window of the Sysmac Studio.


View
Insert
Controller
Tools
Window
Help
Multiview Explorer
Alt+1
Project Shortcut View
Alt+Shift+1
Toolbox
Alt+2
3D Visualizer
Alt+Shift+2
Event Log

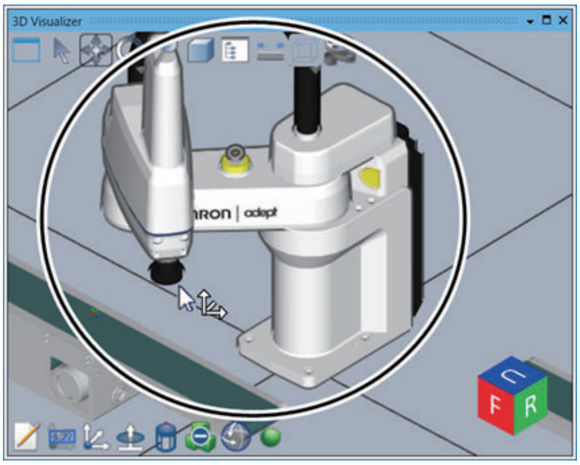
The 3D Visualizer is displayed on the right side of the main window.


New Project - ApplicationManager0 - Sysmac Studio (64bit)
File
Edit
View
Insert
Controller
Tools
Window
Help
Multiview Explorer
ApplicationManager0
Configurations and Setup
Settings
3D Visualization
CAD Data0
CAD Data1
ACE Sight
Cameras
Configuration
Feeders
Process
Vision Tools
Programming
Filter
Project Shortcut View
Shortcut Root Folder
Output
3D Visualizer
L
Output
Build
Toolbox
3D Visualizer
[Emulation Mode] Access Level: Engineer

2 Move the mouse cursor to the tool center point of the robot and click on it.

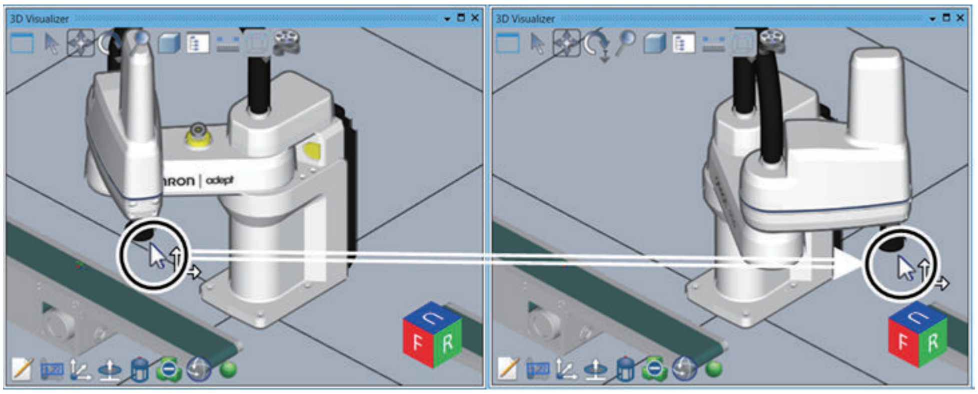

3D Visualizer
RON | adept
U
F
R

When you click the Move icon, the outline of the robot is highlighted with black lines.

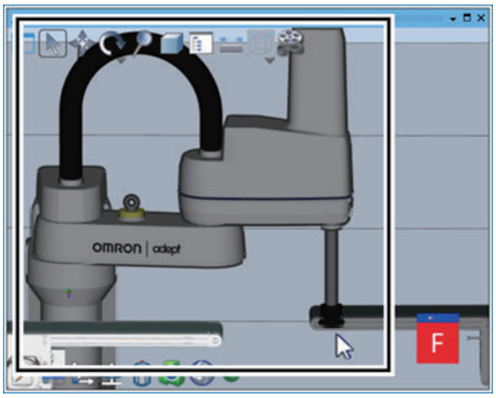

3D Visualizer
RON | adept
U
F
R

3 Drag the mouse cursor.

The tool center point moves to follow the mouse cursor.



4 Move the tool center point to the position where it overlaps the conveyor, which is the position you specify.
The collision detection function set in *Activating Collision Detection Function* on page 3-48 detects a conflict between the robot and the conveyor and the color of them changes to gray.



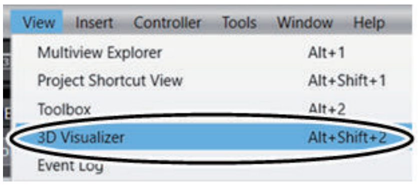
5 Drop with the mouse immediately after the color of the robot and the conveyor changes to gray.
The robot will stop at the drop position.

The robot position is now determined. If you set the current position as the picking or placing position of the robot, proceed to *Saving Current Positions to Variables* on page 3-64. If you need to specify a more precise position or want to specify a position along the axis of the robot coordinate system or each joint axis, proceed to *Manipulating the Robot in the* ***V+ Jog Control*** *Pane* on page 3-60 for the next step.

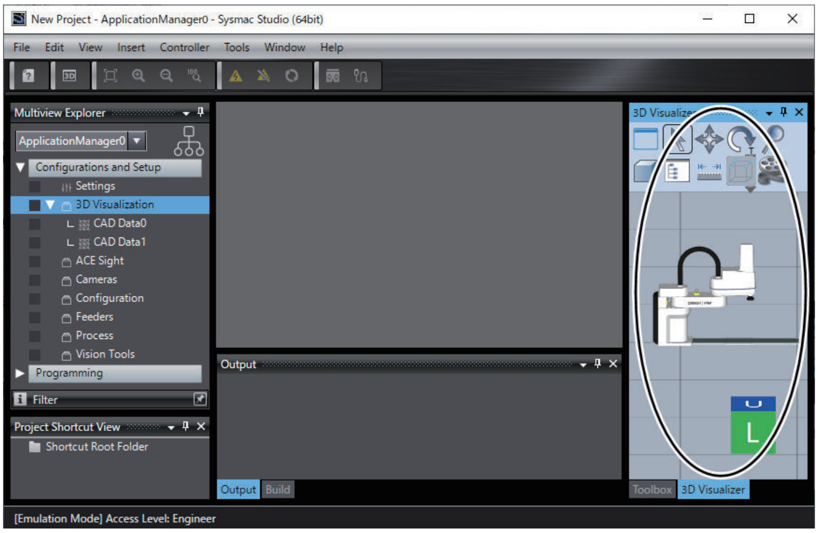
Manipulating the Robot in the V+ Jog Control Pane

This section describes the procedure to manipulate the robot in **V+ Jog Control** pane. Use this procedure to move the robot along the coordinate system or each joint axis of the robot.

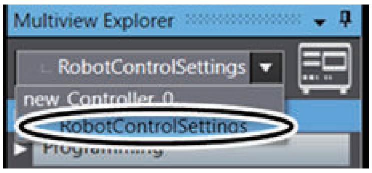
1 Select **3D Visualizer** from the **View** menu on the main window of the Sysmac Studio.


View
Insert
Controller
Tools
Window
Help
Multiview Explorer Alt+1
Project Shortcut View Alt+Shift+1
Toolbox Alt+2
3D Visualizer Alt+Shift+2
Event Log

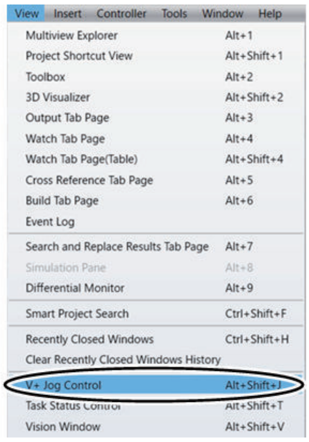
The 3D Visualizer is displayed on the right side of the main window.


New Project - ApplicationManager0 - Sysmac Studio (64bit)
File Edit View Insert Controller Tools Window Help
Multiview Explorer
ApplicationManager0
Configurations and Setup
Settings
3D Visualization
CAD Data0
CAD Data1
ACE Sight
Cameras
Configuration
Feeders
Process
Vision Tools
Programming
Filter
Project Shortcut View
Shortcut Root Folder
Output
Output Build
3D Visualizer
Toolbox 3D Visualizer
[Emulation Mode] Access Level: Engineer

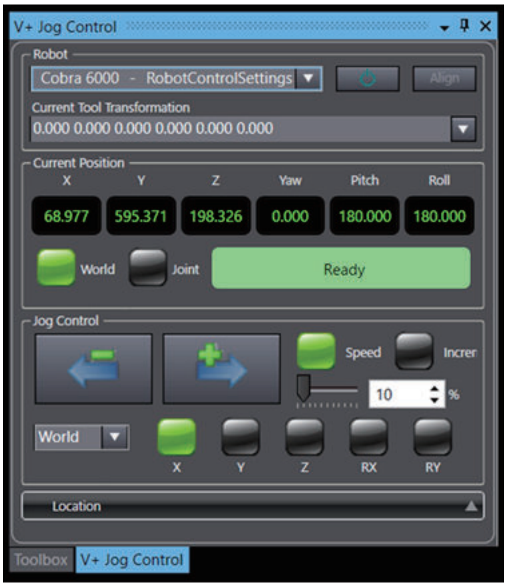
2 Select **RobotControlSettings** from the device list in the Multiview Explorer.


Multiview Explorer
RobotControlSettings
new_Controller_0
RobotControlSettings
Programming

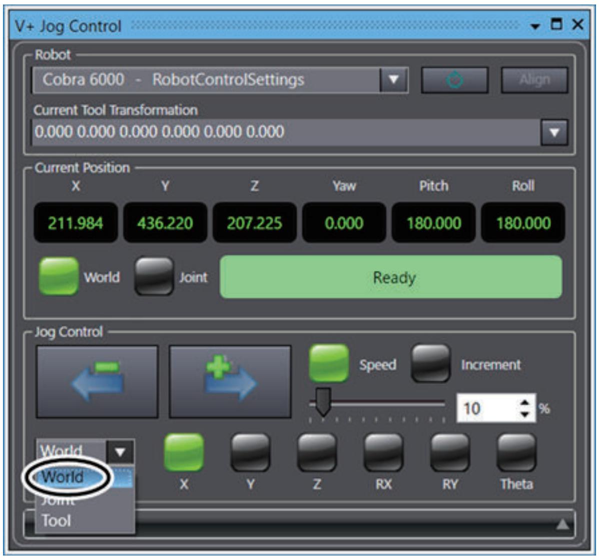
3 Select **V+ Jog Control** from the **View** menu on the main window.


View Insert Controller Tools Window Help
Multiview Explorer Alt+1
Project Shortcut View Alt+Shift+1
Toolbox Alt+2
3D Visualizer Alt+Shift+2
Output Tab Page Alt+3
Watch Tab Page Alt+4
Watch Tab Page(Table) Alt+Shift+4
Cross Reference Tab Page Alt+5
Build Tab Page Alt+6
Event Log
Search and Replace Results Tab Page Alt+7
Simulation Pane Alt+8
Differential Monitor Alt+9
Smart Project Search Ctrl+Shift+F
Recently Closed Windows Ctrl+Shift+H
Clear Recently Closed Windows History
V+ Jog Control Alt+Shift+J
Task Status Control Alt+Shift+T
Vision Window Alt+Shift+V

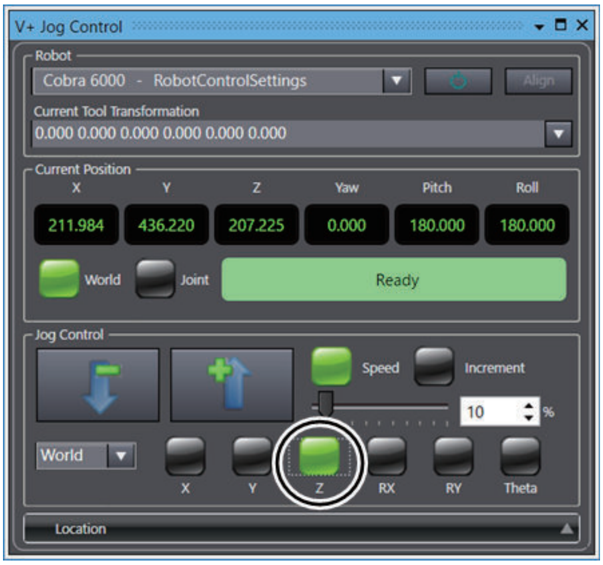
The **V+ Jog Control** pane appears on the right side of the main window.


V+ Jog Control
Robot
Cobra 6000 - RobotControlSettings
Align
Current Tool Transformation
0.000 0.000 0.000 0.000 0.000 0.000
Current Position
X
Y
Z
Yaw
Pitch
Roll
68.977
595.371
198.326
0.000
180.000
180.000
World
Joint
Ready
Jog Control
Speed
Incre
10
%
World
X
Y
Z
RX
RY
Location
Toolbox
V+ Jog Control

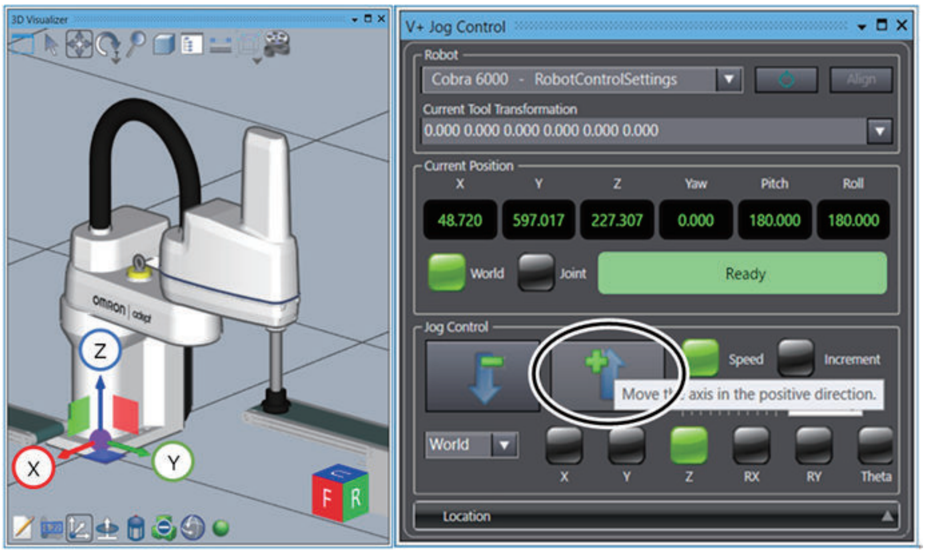
4 From the drop-down list of **Jog Control** on **V+ Jog Control** pane, select the coordinate system of **World**, **Joint**, or **Tool**.
When **World** is selected, positions of the robot can be specified in the robot coordinate system, and when **Joint** is selected, the position can be set in the coordinate system of the joint. Select **Tool** for specifying the position in the coordinate system of the tool center point.
In this example, select **World**.


V+ Jog Control
Robot
Cobra 6000 - RobotControlSettings
Align
Current Tool Transformation
0.000 0.000 0.000 0.000 0.000 0.000
Current Position
X
Y
Z
Yaw
Pitch
Roll
211.984
436.220
207.225
0.000
180.000
180.000
World
Joint
Ready
Jog Control
Speed
Increment
10
%
World
World
Joint
Tool
X
Y
Z
RX
RY
Theta

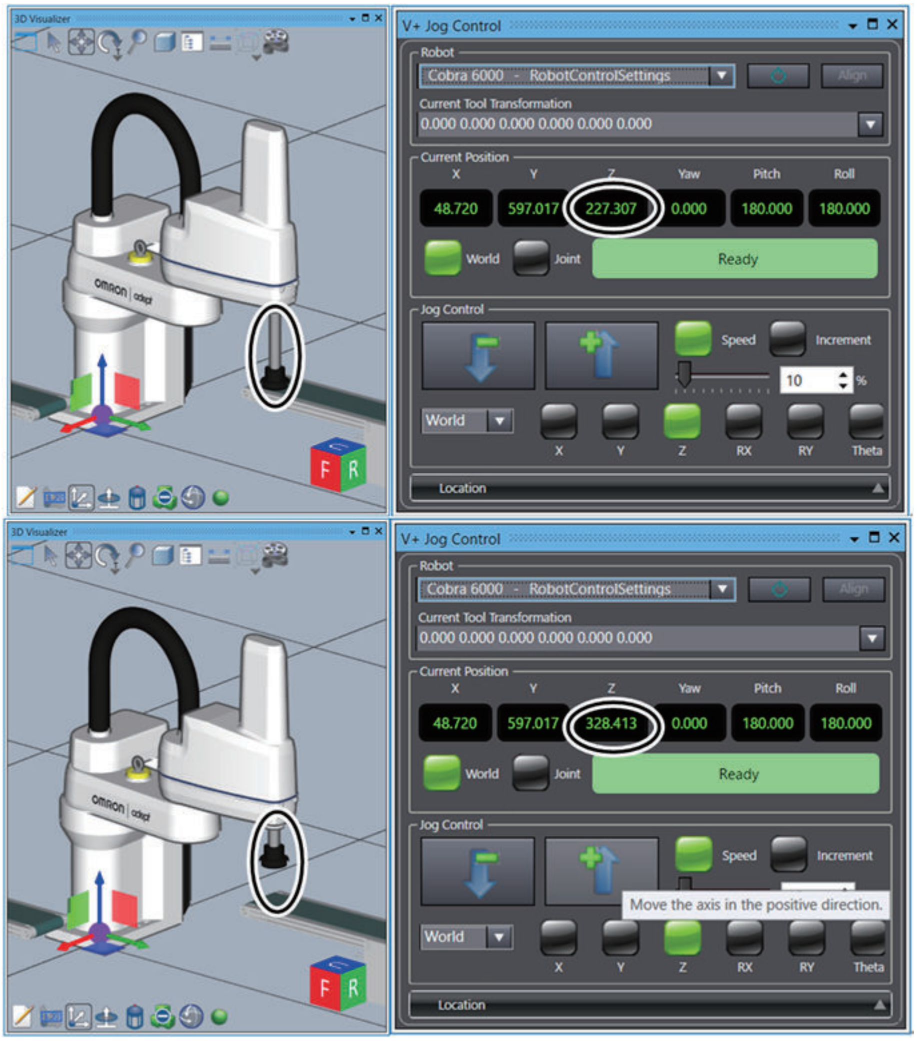
5 Click one of the lamps of **Jog Control** in the **V+ Jog Control** pane.
The lamp clicked turns green. The robot can be moved along the coordinate axis of the illuminated lamp.
Select the **Z** lamp in this example.


V+ Jog Control
Robot
Cobra 6000 - RobotControlSettings
Align
Current Tool Transformation
0.000 0.000 0.000 0.000 0.000 0.000
Current Position
X Y Z Yaw Pitch Roll
211.984 436.220 207.225 0.000 180.000 180.000
World
Joint
Ready
Jog Control
Speed
Increment
10 %
World
X
Y
Z
RX
RY
Theta
Location

6 Press and hold the arrow button labeled **+** or **-** of **Jog Control** in the **V+ Jog Control** pane. The labels **+** and **-** on the arrow buttons represent positive or negative directions on the specified coordinate system. For example, the arrow in the figure below indicates positive direction in the robot coordinate system.


3D Visualizer
Z
X
Y
F
R
V+ Jog Control
Robot
Cobra 6000 - RobotControlSettings
Align
Current Tool Transformation
0.000 0.000 0.000 0.000 0.000 0.000
Current Position
X Y Z Yaw Pitch Roll
48.720 597.017 227.307 0.000 180.000 180.000
World
Joint
Ready
Jog Control
Speed
Increment
Move t axis in the positive direction.
World
X
Y
Z
RX
RY
Theta
Location

While the arrow button is kept pressed, the robot moves along the specified axis of the coordinate system.


3D Visualizer
V+ Jog Control
Robot
Cobra 6000 - RobotControlSettings
Align
Current Tool Transformation
0.000 0.000 0.000 0.000 0.000 0.000
Current Position
X
Y
Z
Yaw
Pitch
Roll
48.720
597.017
227.307
0.000
180.000
180.000
World
Joint
Ready
Jog Control
Speed
Increment
10
%
World
X
Y
Z
RX
RY
Theta
Location
328.413

Move the axis in the positive direction.

7 Take step 4 to 6 again to move the robot to the position and posture you want to specify.

Now the robot position has been configured.

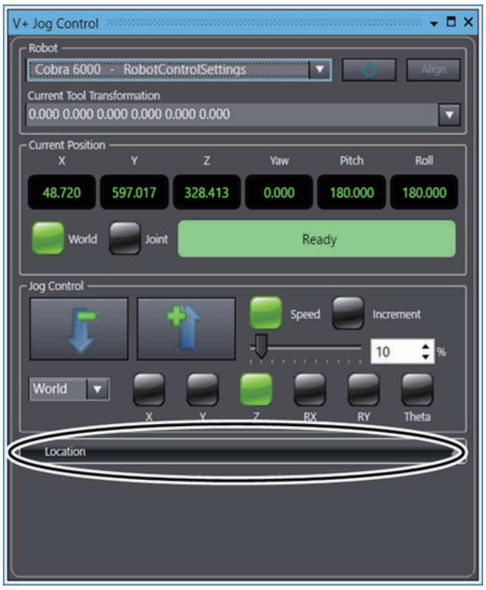
Saving Current Positions to Variables

The current positions of the robot set by teaching must be saved in the V+ variables.
The procedure to save the current position of the robot to the already created V+ variable is described below.
V+ position variables that need to be saved are listed in the table below.

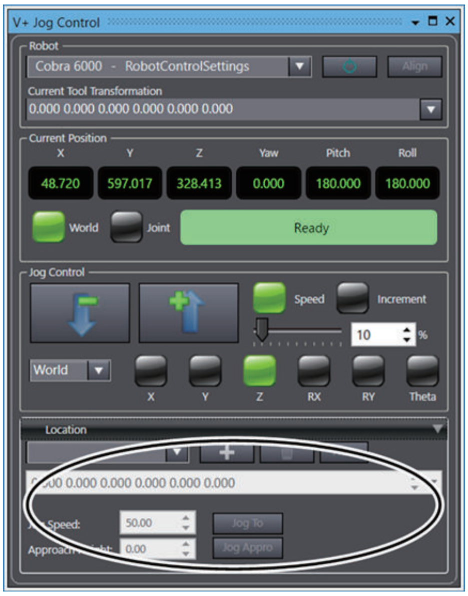
Name of position (Name of variable)	Description
gl.wait	Robot wait position
gl.pick	Workpiece pick-up position
gl.place	Workpiece place position

Save a current position to the variable *gl.wait* as an example. Save current positions to two other variables in the same manner.

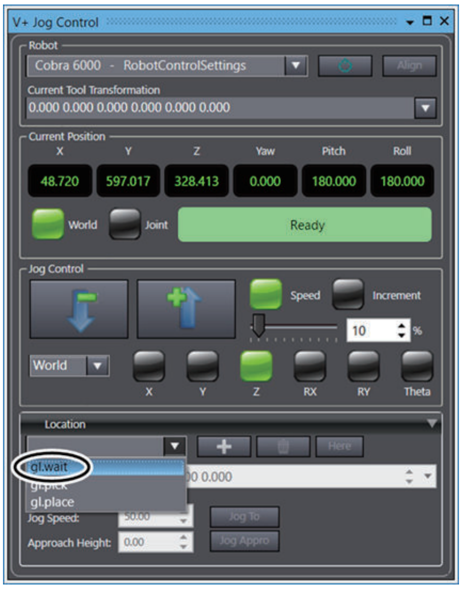
1 Click **Location** in the **V+ Jog Control** pane.


V+ Jog Control
Robot
Cobra 6000 - RobotControlSettings
Align
Current Tool Transformation
0.000 0.000 0.000 0.000 0.000 0.000
Current Position
X
Y
Z
Yaw
Pitch
Roll
48.720
597.017
328.413
0.000
180.000
180.000
World
Joint
Ready
Jog Control
Speed
Increment
10
%
World
X
Y
Z
RX
RY
Theta
Location

The field to set the position variable is displayed.


V+ Jog Control
Robot
Cobra 6000 - RobotControlSettings
Align
Current Tool Transformation
0.000 0.000 0.000 0.000 0.000 0.000
Current Position
X
Y
Z
Yaw
Pitch
Roll
48.720
597.017
328.413
0.000
180.000
180.000
World
Joint
Ready
Jog Control
Speed
Increment
10
%
World
X
Y
Z
RX
RY
Theta
Location
.000 0.000 0.000 0.000 0.000 0.000
Speed:
50.00
Jog To
Approach Height:
0.00
Jog Appro

2 Selects a variable that you want to set the current position or an element of the array variable from the drop-down list.


V+ Jog Control
Robot
Align
Current Position
X
Y
Z
Yaw
Pitch
Roll
World
Joint
Ready
Jog Control
Speed
Increment
%
X
Y
Z
RX
RY
Theta
Location
Here
Jog Speed:
Approach Height:
Jog To
Jog Appro

Cobra 6000 - RobotControlSettings

Current Tool Transformation: 0.000 0.000 0.000 0.000 0.000 0.000

48.720 597.017 328.413 0.000 180.000 180.000

World

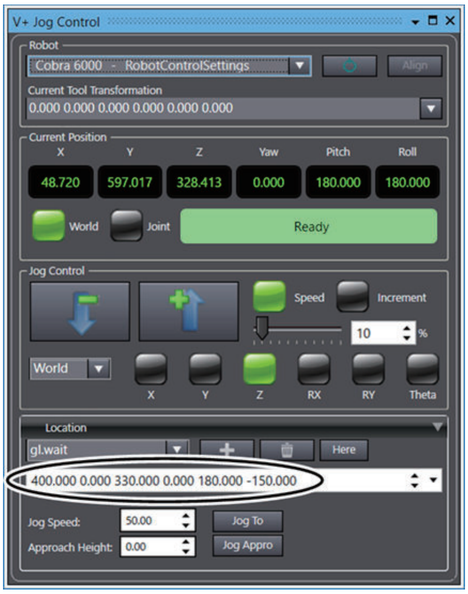
10

gl.wait
gl.pick
gl.place

Jog Speed: 50.00

Approach Height: 0.00

The variable name and values set in the selected variable are displayed.


V+ Jog Control
Robot
Align
Current Position
X
Y
Z
Yaw
Pitch
Roll
World
Joint
Ready
Jog Control
Speed
Increment
%
X
Y
Z
RX
RY
Theta
Location
Here
Jog Speed:
Approach Height:
Jog To
Jog Appro

Cobra 6000 - RobotControlSettings

Current Tool Transformation: 0.000 0.000 0.000 0.000 0.000 0.000

48.720 597.017 328.413 0.000 180.000 180.000

World

10

gl.wait

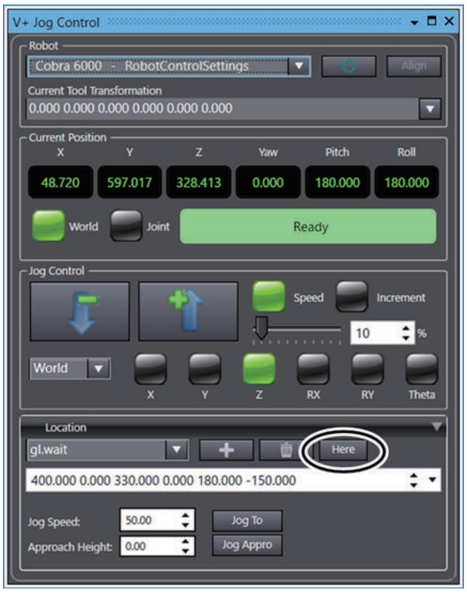
400.000 0.000 330.000 0.000 180.000 -150.000

Jog Speed: 50.00

Approach Height: 0.00

Select the variable *gl.wait*.

3 Click the **Here** button of **Location** in the **V+ Jog Control** pane.


V+ Jog Control
Robot
Align
Current Position
World
Joint
Jog Control
Speed
Increment
World
X
Y
Z
RX
RY
Theta
Location
Here
Jog To
Jog Appro

Cobra 6000 - RobotControlSettings

Current Tool Transformation: 0.000 0.000 0.000 0.000 0.000 0.000

X	Y	Z	Yaw	Pitch	Roll
48.720	597.017	328.413	0.000	180.000	180.000

Ready

10 %

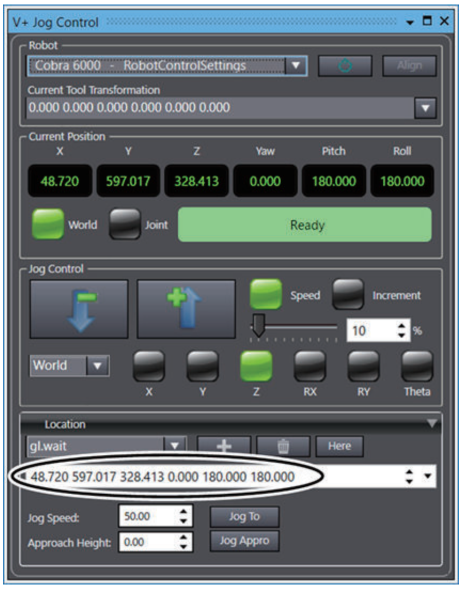
gl.wait

400.000 0.000 330.000 0.000 180.000 -150.000

Jog Speed: 50.00

Approach Height: 0.00

The current position is registered to the value of the selected variable.


V+ Jog Control
Robot
Align
Current Position
World
Joint
Jog Control
Speed
Increment
World
X
Y
Z
RX
RY
Theta
Location
Here
Jog To
Jog Appro

Cobra 6000 - RobotControlSettings

Current Tool Transformation: 0.000 0.000 0.000 0.000 0.000 0.000

X	Y	Z	Yaw	Pitch	Roll
48.720	597.017	328.413	0.000	180.000	180.000

Ready

10 %

gl.wait

48.720 597.017 328.413 0.000 180.000 180.000

Jog Speed: 50.00

Approach Height: 0.00

Now you have registered the current position of the robot to the V+ variable.

Additional Information

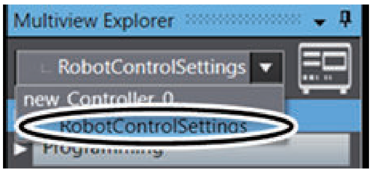
When the sequence control program controls the robot operation, the variable copy program "loccopy" copies the position variables of the V+ program to the shared variables of the sequence control program.

3-3-8 Setting up Automatic Loading of V+ Programs and Variables at Power ON

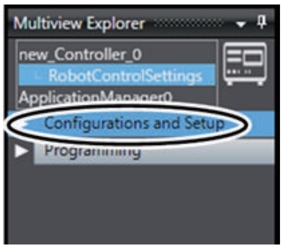
The V+ programs that you created and V+ global variables are not automatically loaded to the Robot Integrated CPU Unit by default settings of the project when power to the Robot Integrated CPU Unit is turned ON.

This section describes the setting procedure for automatically loading the V+ programs and V+ global variables to the Robot Integrated CPU Unit when its power is turned ON.

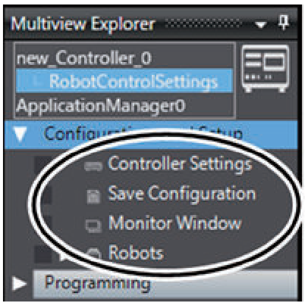
1. Select **RobotControlSettings** from the device list in the Multiview Explorer.


Multiview Explorer
RobotControlSettings
new_Controller_0
RobotControlSettings
Programming

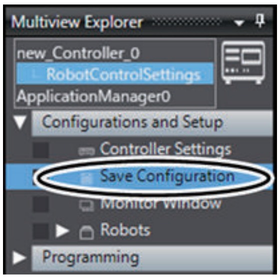
2. Click **Configurations and Setup** in the Multiview Explorer.


Multiview Explorer
new_Controller_0
RobotControlSettings
ApplicationManager0
Configurations and Setup
Programming

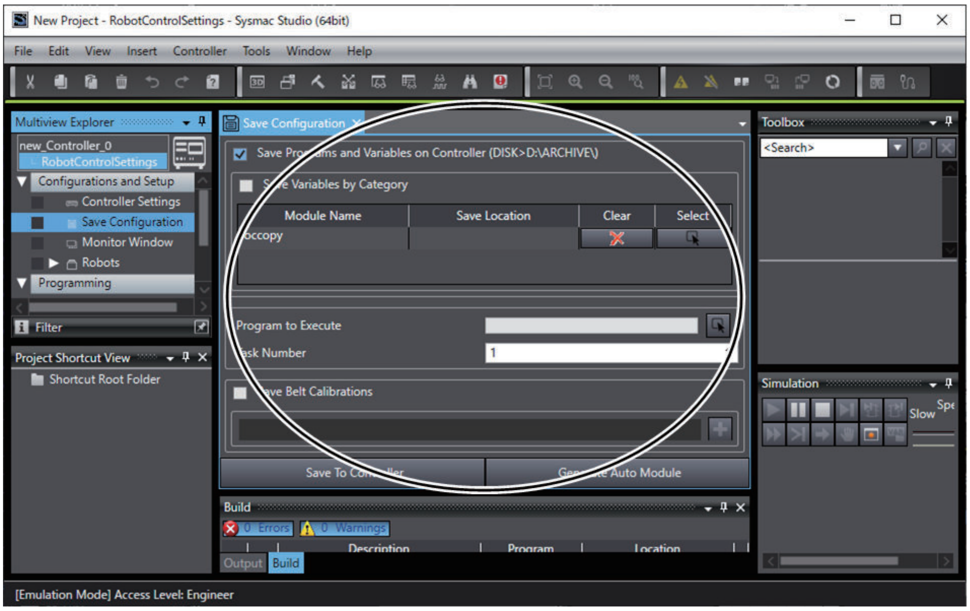
Setting items are displayed under **Configurations and Setup** in the tree.


Multiview Explorer
new_Controller_0
RobotControlSettings
ApplicationManager0
Configurations and Setup
Controller Settings
Save Configuration
Monitor Window
Robots
Programming

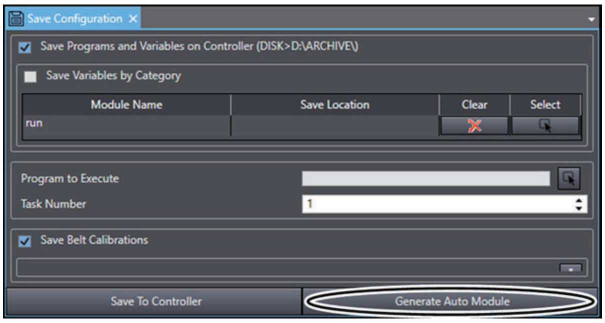
3. Double-click **Save Configuration**.


Multiview Explorer
new_Controller_0
RobotControlSettings
ApplicationManager0
Configurations and Setup
Controller Settings
Save Configuration
Monitor Window
Robots
Programming

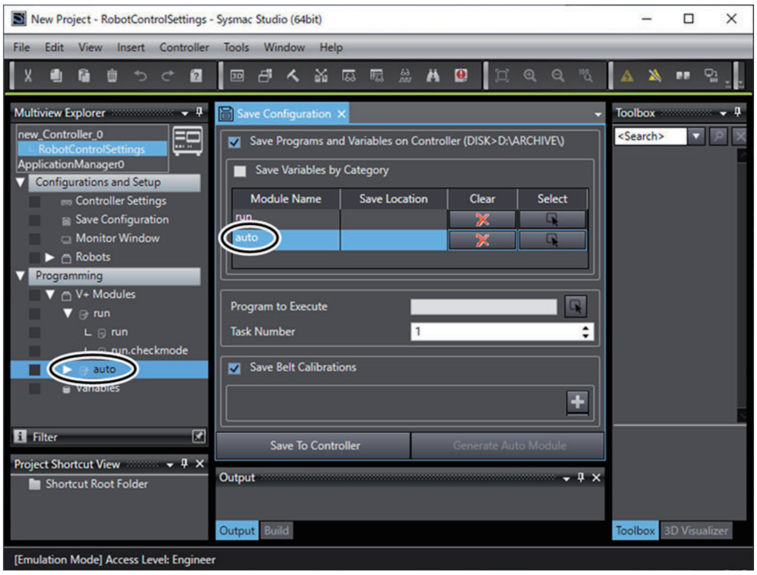
The **Save Configuration** tab page is displayed in the Edit Pane.


New Project - RobotControlSettings - Sysmac Studio (64bit)
File Edit View Insert Controller Tools Window Help
Multiview Explorer
new_Controller_0
RobotControlSettings
Configurations and Setup
Controller Settings
Save Configuration
Monitor Window
Robots
Programming
Filter
Project Shortcut View
Shortcut Root Folder
Save Configuration
Save Programs and Variables on Controller (DISK>D:\ARCHIVE\)
Save Variables by Category
Module Name
Save Location
Clear
Select
occopy
Program to Execute
Task Number
1
Save Belt Calibrations
Save To Controller
Generate Auto Module
Build
0 Errors
0 Warnings
Description
Program
Location
Output
Build
Toolbox
<Search>
Simulation
Slow
[Emulation Mode] Access Level: Engineer

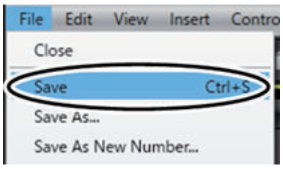
4 Click the **Generate Auto Module** button in the **Save Configuration** tab page.


Save Configuration
Save Programs and Variables on Controller (DISK>D:\ARCHIVE\)
Save Variables by Category
Module Name
Save Location
Clear
Select
run
Program to Execute
Task Number
1
Save Belt Calibrations
Save To Controller
Generate Auto Module

The module name **auto** is added to the module list in the **Save Configuration** tab page. In the tree of the Multiview Explorer, **V+ Modules** - **auto** are added under **Programming**.


New Project - RobotControlSettings - Sysmac Studio (64bit)
File Edit View Insert Controller Tools Window Help
Multiview Explorer
new_Controller_0
RobotControlSettings
ApplicationManager0
Configurations and Setup
Controller Settings
Save Configuration
Monitor Window
Robots
Programming
V+ Modules
run
run
run.checkmode
auto
Variables
Filter
Project Shortcut View
Shortcut Root Folder
Save Configuration
Save Programs and Variables on Controller (DISK>D:\ARCHIVE\)
Save Variables by Category
Module Name
Save Location
Clear
Select
run
auto
Program to Execute
Task Number
1
Save Belt Calibrations
Save To Controller
Generate Auto Module
Output
Output
Build
Toolbox
<Search>
Toolbox
3D Visualizer
[Emulation Mode] Access Level: Engineer

5 Select **Save** from the **File** menu.


File
Edit
View
Insert
Contro
Close
Save
Ctrl+S
Save As...
Save As New Number...

The Robot Integrated CPU Unit is now configured to automatically load the V+ programs and V+ global variables when it is powered ON. The program **auto** starts automatically when the Robot Integrated CPU Unit is powered ON and reads the saved V+ programs and V+ global variables.

The program **auto** is created in a form called command program, which is different from the V+ program. For details about the command program, refer to the *eV+3 User's Manual (Cat. No. I651)*.

3-3-9 Running the Program and Checking Operation

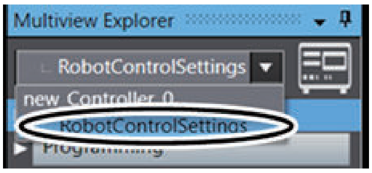
This section describes the procedure to run and simulate the sequence control program created in *3-3-3 Creating a Sequence Control Program* on page 3-22.
You can run the program by changing the global variable *gStart* in the sequence control program from FALSE to TRUE in the Watch Tab Page.
The V+ program is called from the sequence control program executed in this procedure.

Precautions for Correct Use

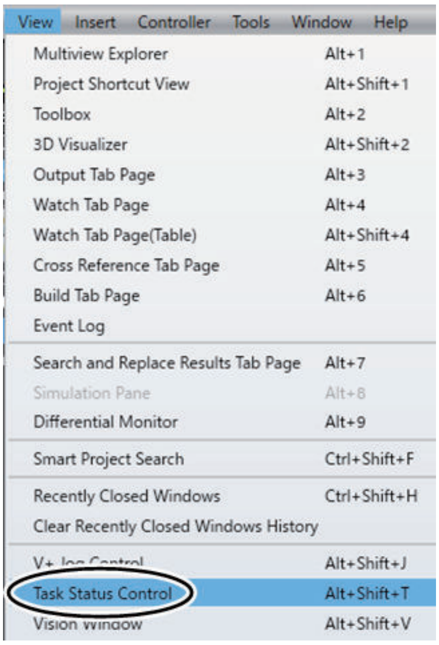
When you perform this procedure, check that the project file has been opened in EMULATION mode. Refer to *Enabling Robot Simulation Function* on page 3-56 for the checking procedure.

When you control the operation with the V+ programs, start from step1.
To control the operation with the sequence control programs, start with step 6.

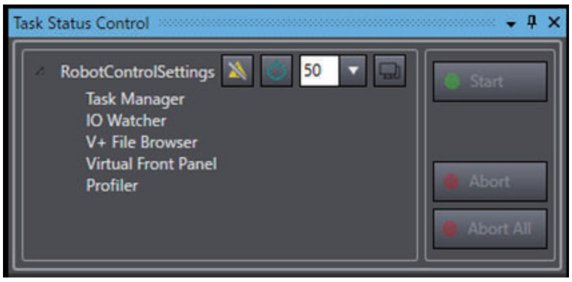
1 Select **RobotControlSettings** from the device list in the Multiview Explorer.


Multiview Explorer
RobotControlSettings
new_Controller_0
RobotControlSettings
Programming

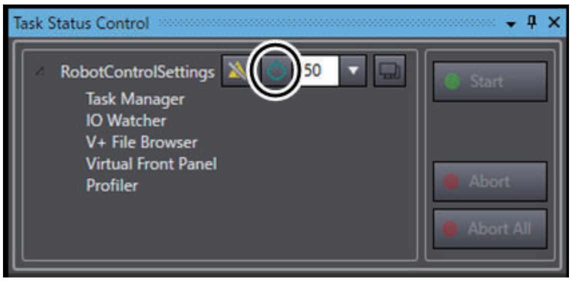
2 Select **Task Status Control** from the **View** menu on the main window.


View
Insert
Controller
Tools
Window
Help
Multiview Explorer Alt+1
Project Shortcut View Alt+Shift+1
Toolbox Alt+2
3D Visualizer Alt+Shift+2
Output Tab Page Alt+3
Watch Tab Page Alt+4
Watch Tab Page(Table) Alt+Shift+4
Cross Reference Tab Page Alt+5
Build Tab Page Alt+6
Event Log
Search and Replace Results Tab Page Alt+7
Simulation Pane Alt+8
Differential Monitor Alt+9
Smart Project Search Ctrl+Shift+F
Recently Closed Windows Ctrl+Shift+H
Clear Recently Closed Windows History
V+ Log Control Alt+Shift+J
Task Status Control Alt+Shift+T
Vision Window Alt+Shift+V

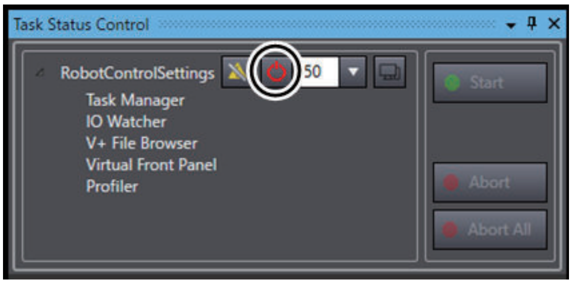
The **Task Status Control** pane appears on the right side of the main window.


Task Status Control
RobotControlSettings
50
Task Manager
IO Watcher
V+ File Browser
Virtual Front Panel
Profiler
Start
Abort
Abort All

3 Click the power button in the **Task Status Control** pane.

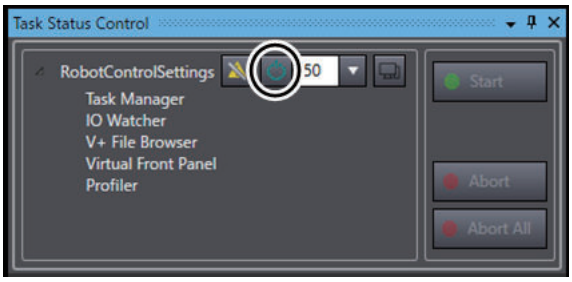

Task Status Control
RobotControlSettings
50
Task Manager
IO Watcher
V+ File Browser
Virtual Front Panel
Profiler
Start
Abort
Abort All

The color of the power button changes from green to red.

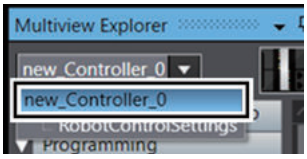

Task Status Control
RobotControlSettings
50
Task Manager
IO Watcher
V+ File Browser
Virtual Front Panel
Profiler
Start
Abort
Abort All

4 Click the power button again in the **Task Status Control** pane.

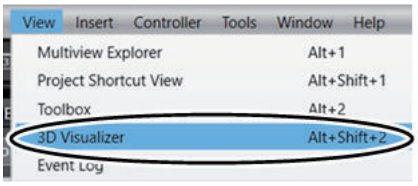
The power button turns from red to green.


Task Status Control
RobotControlSettings
50
Task Manager
IO Watcher
V+ File Browser
Virtual Front Panel
Profiler
Start
Abort
Abort All

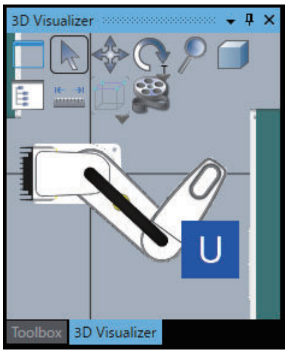
5 In the Multiview Explorer, select **new_Controller_0** from the device list.


Multiview Explorer
new_Controller_0
new_Controller_0
RobotControlSettings
Programming

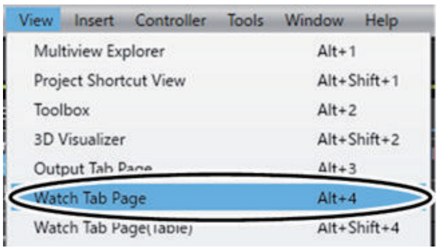
6 Select **3D Visualizer** from the **View** menu on the main window of the Sysmac Studio.


View
Insert
Controller
Tools
Window
Help
Multiview Explorer Alt+1
Project Shortcut View Alt+Shift+1
Toolbox Alt+2
3D Visualizer Alt+Shift+2
Event Log

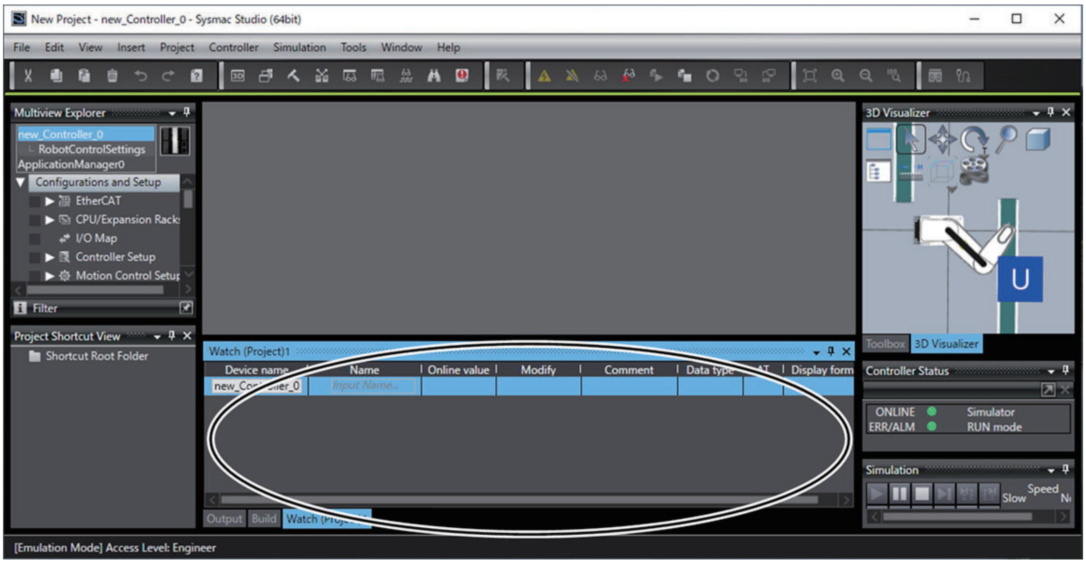
The 3D Visualizer is displayed on the right side of the main window.


3D Visualizer
U
Toolbox
3D Visualizer

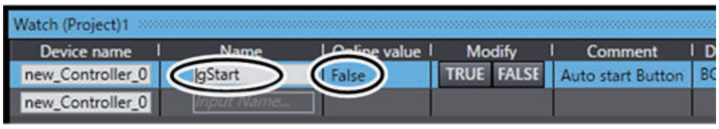
7 Select **Watch Tab Page** from the **View** menu on the main window.


View
Insert
Controller
Tools
Window
Help
Multiview Explorer Alt+1
Project Shortcut View Alt+Shift+1
Toolbox Alt+2
3D Visualizer Alt+Shift+2
Output Tab Page Alt+3
Watch Tab Page Alt+4
Watch Tab Page(Table) Alt+Shift+4

The **Watch (Project)1** tab page appears at the bottom of the main window.


New Project - new_Controller_0 - Sysmac Studio (64bit)
File Edit View Insert Project Controller Simulation Tools Window Help
Multiview Explorer
new_Controller_0
RobotControlSettings
ApplicationManager0
Configurations and Setup
EtherCAT
CPU/Expansion Racks
I/O Map
Controller Setup
Motion Control Setup
Filter
Project Shortcut View
Shortcut Root Folder
Watch (Project)1
Device name
Name
Online value
Modify
Comment
Data type
AT
Display form
new_Controller_0
Input Name...
Output Build Watch (Project)1
3D Visualizer
Toolbox 3D Visualizer
Controller Status
ONLINE
ERR/ALM
Simulator
RUN mode
Simulation
Slow Speed
[Emulation Mode] Access Level: Engineer

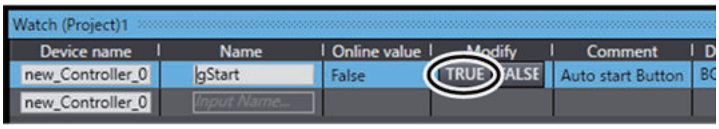
8 Type *gStart* in the **Name** column on the **Watch (Project)1** tab page.
The **Online value** column displays the current value of **False** for the internal variable **gStart** in **Program0**.



Watch (Project)1

Device name	Name	Online value	Modify	Comment	D
new_Controller_0	gStart	False	TRUE FALSE	Auto start Button	BC
new_Controller_0	Input Name...				

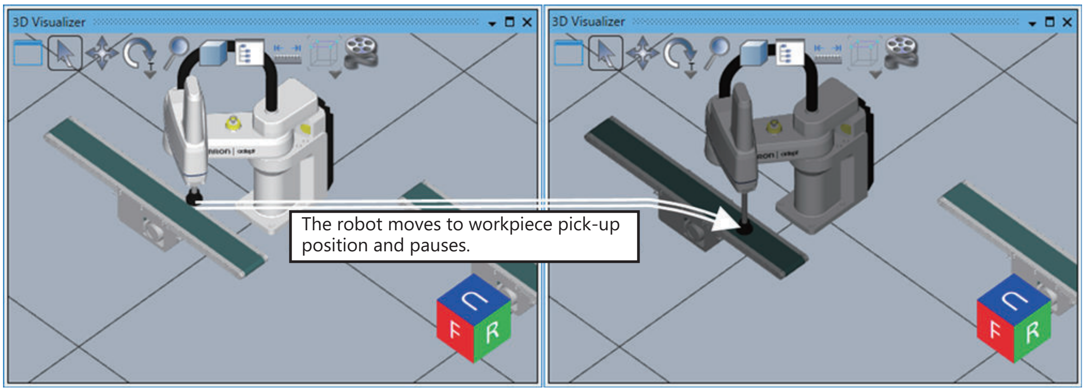
9 Click the **TRUE** button in the **Modify** column for the variable **gStart** in the **Watch (Project)1** tab page.



Watch (Project)1

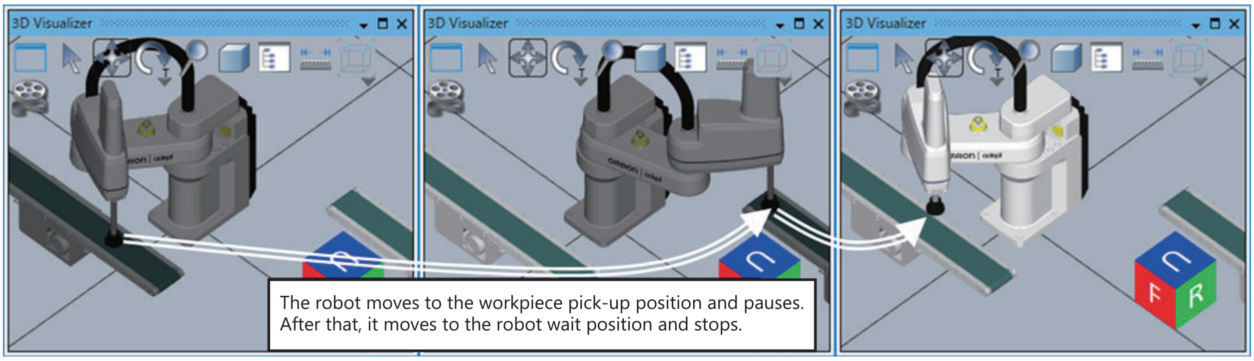
Device name	Name	Online value	Modify	Comment	D
new_Controller_0	gStart	False	TRUE FALSE	Auto start Button	BC
new_Controller_0	Input Name...				

The robot starts to move and pauses at the workpiece pick-up position in the 3D Visualizer.


3D Visualizer
3D Visualizer
U
F
R

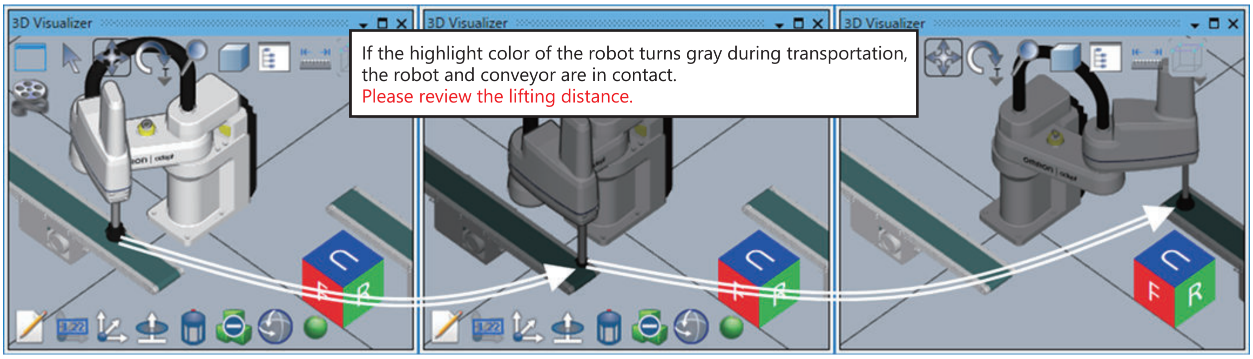
The robot moves to workpiece pick-up position and pauses.

After that, the robot restarts operation from the workpiece pick-up position, moves to the robot wait position via the workpiece place position, and stops.



The robot moves to the workpiece pick-up position and pauses.
After that, it moves to the robot wait position and stops.

During operation, check that the robot does not turn gray in locations other than the workpiece pick-up position and workpiece place position. If the color changes to gray, the robot and the conveyor are interfering with each other. In that case, refer to *Manipulating the Robot in the* ***V+ Jog Control*** *Pane* on page 3-60 and move the workpiece pick-up approach point or the workpiece place approach point to a higher position by teaching.



If the highlight color of the robot turns gray during transportation, the robot and conveyor are in contact.
Please review the lifting distance.

Now you can run the sequence control program on the actual equipment.

3-4 Setup Procedure for Actual System

This section describes the procedures for wiring devices, checking operation on the actual system, and adjusting the system.
Check operation with the simulation function before you check operation on the actual system.

Precautions for Correct Use

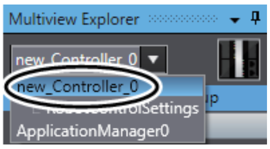
When you operate the robot in MANUAL mode with the T20 pendant, you must plug the iCS Commissioning Jumper into the XBELTIO connector and change the setting for the Teach Restrict. Refer to the *eCobra 600 and 800 Robot with EtherCAT User's Guide (Cat. No. I653)* for details.

3-4-1 Connecting Online

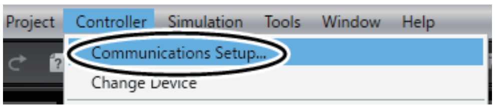
The computer and the Robot Integrated CPU Unit are connected online.

1 Turn ON the power supplies to the Robot Integrated CPU Unit and the robot.

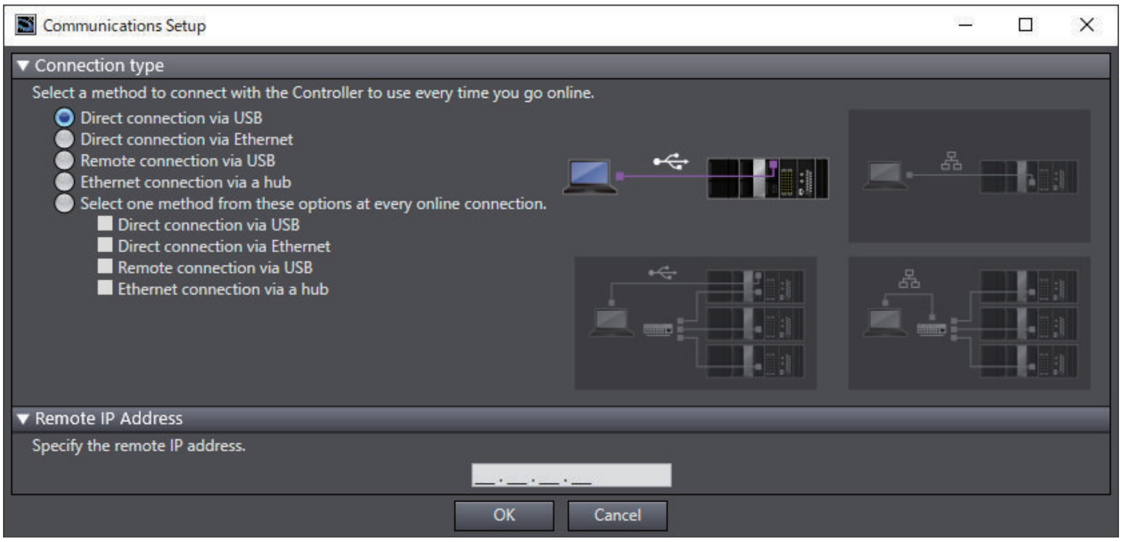
2 Click **new_Controller_0** from the device list in the Multiview Explorer of the Sysmac Studio.


Multiview Explorer
new_Controller_0
new_Controller_0
ControlSettings
ApplicationManager0

3 Select **Controller** - **Communications Setup** from the menu bar in the main window.


Project
Controller
Simulation
Tools
Window
Help
Communications Setup...
Change Device

The **Communications Setup** dialog box is displayed.



Communications Setup

▼ Connection type

Select a method to connect with the Controller to use every time you go online.

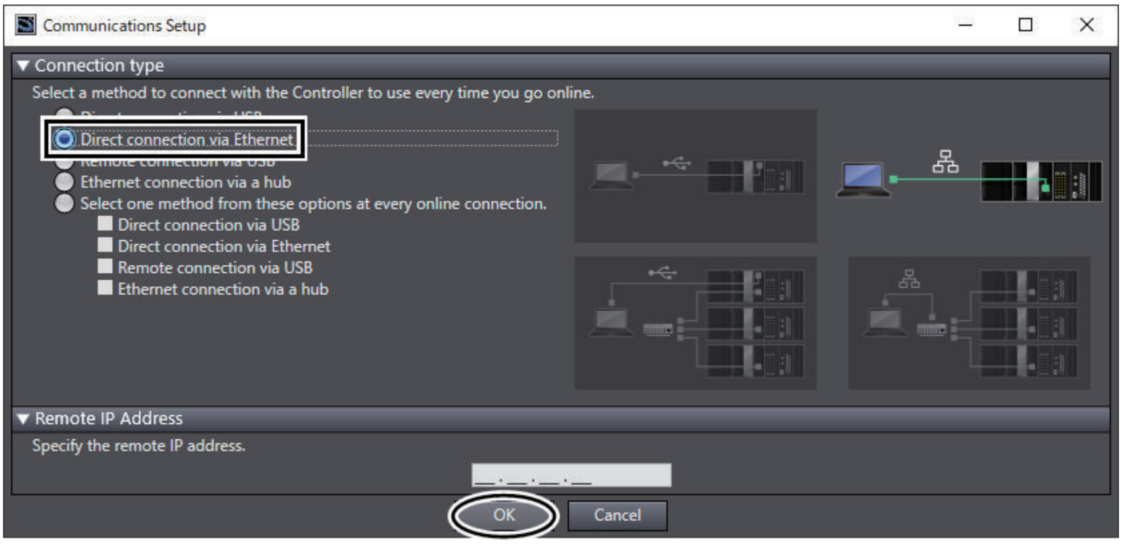
● Direct connection via USB
○ Direct connection via Ethernet
○ Remote connection via USB
○ Ethernet connection via a hub
○ Select one method from these options at every online connection.
  ☐ Direct connection via USB
  ☐ Direct connection via Ethernet
  ☐ Remote connection via USB
  ☐ Ethernet connection via a hub

▼ Remote IP Address

Specify the remote IP address.

___.___.___.___

4 Click the **Direct connection via Ethernet** from the Communication type, and then click the **OK** button.


Communications Setup
▼ Connection type

Select a method to connect with the Controller to use every time you go online.

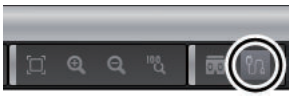
○ Direct connection via USB
● Direct connection via Ethernet
○ Remote connection via USB
○ Ethernet connection via a hub
○ Select one method from these options at every online connection.
☐ Direct connection via USB
☐ Direct connection via Ethernet
☐ Remote connection via USB
☐ Ethernet connection via a hub
▼ Remote IP Address

Specify the remote IP address.

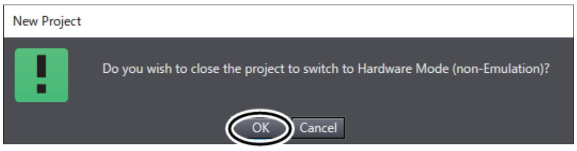
OK
Cancel

The **Communications Setup** dialog box is closed.

5 Click the **Disable emulation mode** icon in the toolbar.



The confirmation dialog box for Disable emulation mode is displayed.


New Project

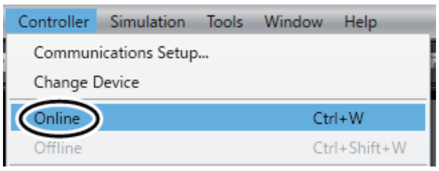
Do you wish to close the project to switch to Hardware Mode (non-Emulation)?

OK
Cancel

6 Click the **OK** button.

The main window is displayed again after the Sysmac Studio returns to the menu screen.

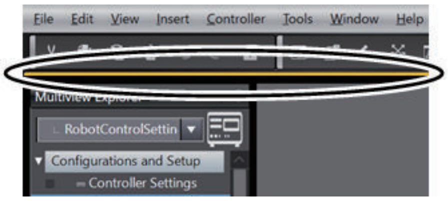
7 Select **Controller** - **Online** from the menu bar.


Controller
Simulation
Tools
Window
Help
Communications Setup...
Change Device
Online Ctrl+W
Offline Ctrl+Shift+W

Precautions for Correct Use

Depending on the status of the connected Robot Integrated CPU Unit, the dialog box for writing the CPU Unit name or checking the serial ID is displayed. Refer to the *Sysmac Studio Version 1 Operation Manual (Cat. No. W504)* for details.

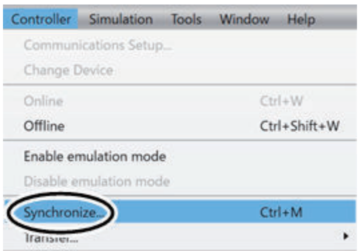
When it is online, the yellow line is displayed on the top of the edit pane.


File Edit View Insert Controller Tools Window Help
Multiview Explorer
RobotControlSettin
Configurations and Setup
Controller Settings

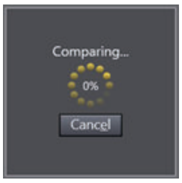
3-4-2 Transferring Settings and Programs

The settings and programs in the project file are transferred from the Sysmac Studio to the Robot Integrated CPU Unit.

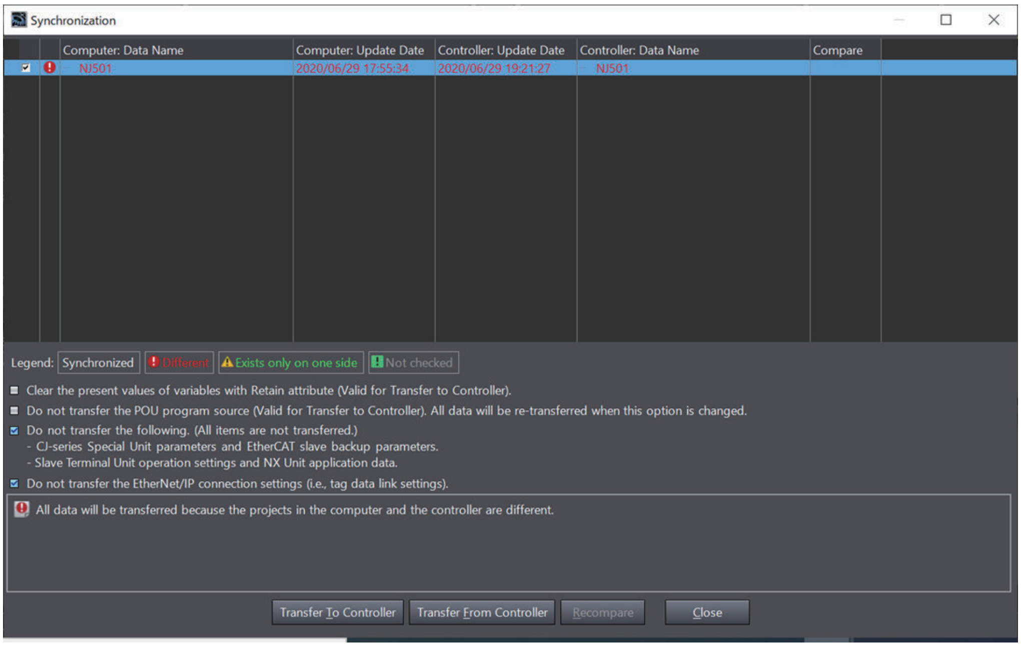
1 Select **Controler** - **Synchoronizatioin** from the menu bar on the Sysmac Studio.


Controller Simulation Tools Window Help
Communications Setup...
Change Device
Online Ctrl+W
Offline Ctrl+Shift+W
Enable emulation mode
Disable emulation mode
Synchronize... Ctrl+M
Transfer...

The comparison of the user program and parameter settings between the Sysmac Studio and the Controller is started.


Comparing...
0%
Cancel

When the comparison is completed, the Synchronization dialog box is displayed.


Synchronization

		Computer: Data Name	Computer: Update Date	Controller: Update Date	Controller: Data Name	Compare
☑	!	NJ501	2020/06/29 17:55:34	2020/06/29 19:21:27	NJ501	

Legend: Synchronized | ! Different | ⚠ Exists only on one side | ! Not checked

☐ Clear the present values of variables with Retain attribute (Valid for Transfer to Controller).

☐ Do not transfer the POU program source (Valid for Transfer to Controller). All data will be re-transferred when this option is changed.

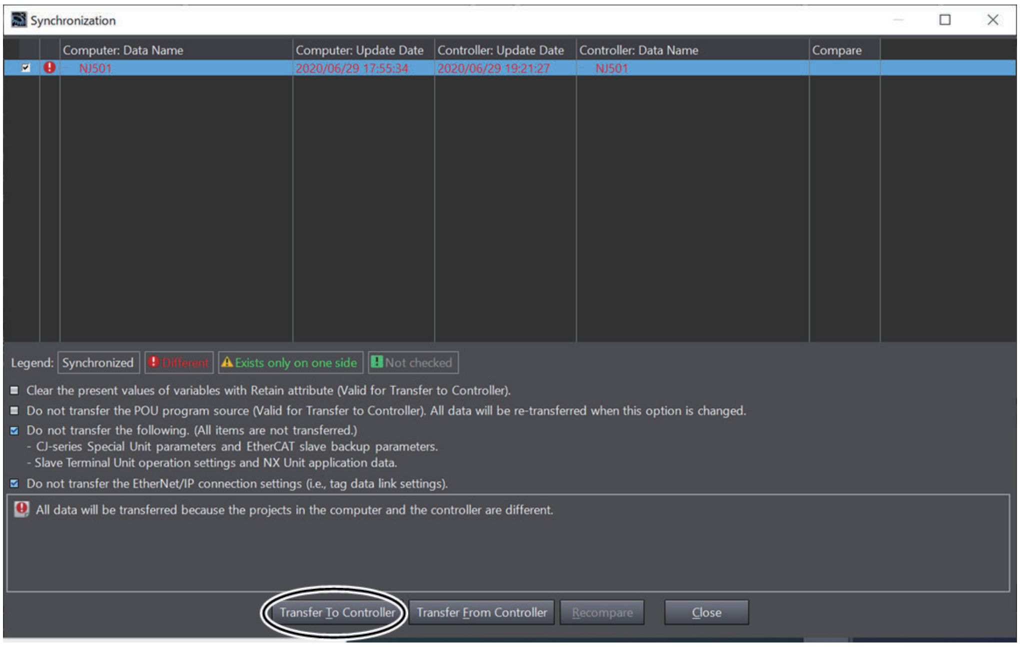
☑ Do not transfer the following. (All items are not transferred.)
- CJ-series Special Unit parameters and EtherCAT slave backup parameters.
- Slave Terminal Unit operation settings and NX Unit application data.

☑ Do not transfer the EtherNet/IP connection settings (i.e., tag data link settings).

! All data will be transferred because the projects in the computer and the controller are different.

Transfer To Controller
Transfer From Controller
Recompare
Close

2 Click the **Transfer to Controller** button.



		Computer: Data Name	Computer: Update Date	Controller: Update Date	Controller: Data Name	Compare
☑	!	NJ501	2020/06/29 17:55:34	2020/06/29 19:21:27	NJ501	

Legend: Synchronized | Different | Exists only on one side | Not checked

☐ Clear the present values of variables with Retain attribute (Valid for Transfer to Controller).

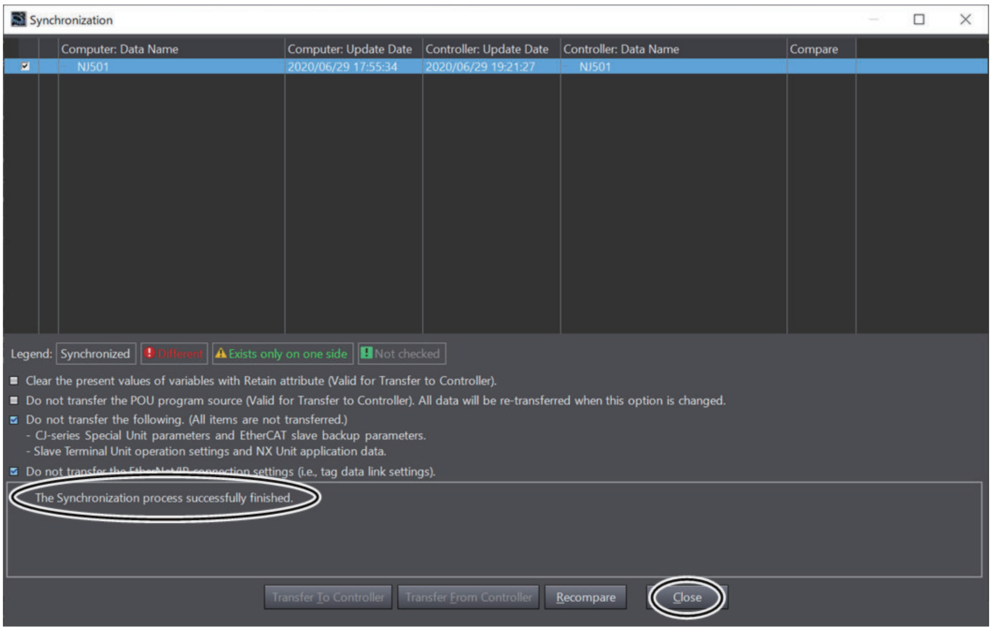
☐ Do not transfer the POU program source (Valid for Transfer to Controller). All data will be re-transferred when this option is changed.

☑ Do not transfer the following. (All items are not transferred.)
- CJ-series Special Unit parameters and EtherCAT slave backup parameters.
- Slave Terminal Unit operation settings and NX Unit application data.

☑ Do not transfer the EtherNet/IP connection settings (i.e., tag data link settings).

All data will be transferred because the projects in the computer and the controller are different.

3 Confirm that "The Synchronization process successfully finished." is diaplayed, and then click the **Close** button.



		Computer: Data Name	Computer: Update Date	Controller: Update Date	Controller: Data Name	Compare
☑		NJ501	2020/06/29 17:55:34	2020/06/29 19:21:27	NJ501	

Legend: Synchronized | Different | Exists only on one side | Not checked

☐ Clear the present values of variables with Retain attribute (Valid for Transfer to Controller).

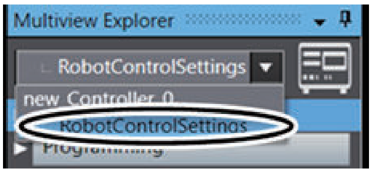
☐ Do not transfer the POU program source (Valid for Transfer to Controller). All data will be re-transferred when this option is changed.

☑ Do not transfer the following. (All items are not transferred.)
- CJ-series Special Unit parameters and EtherCAT slave backup parameters.
- Slave Terminal Unit operation settings and NX Unit application data.

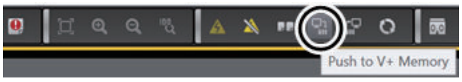
☑ Do not transfer the EtherNet/IP connection settings (i.e., tag data link settings).

The Synchronization process successfully finished.

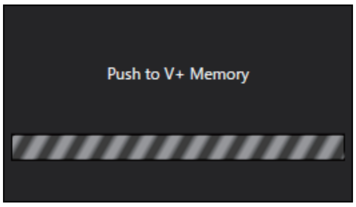
4 Select **RobotControlSettings** from the device list in the Multiview Explorer.


Multiview Explorer
RobotControlSettings
new_Controller_0
RobotControlSettings
Programming

5 Click the **Push to V+ Memory** icon in the toolbar.


Push to V+ Memory

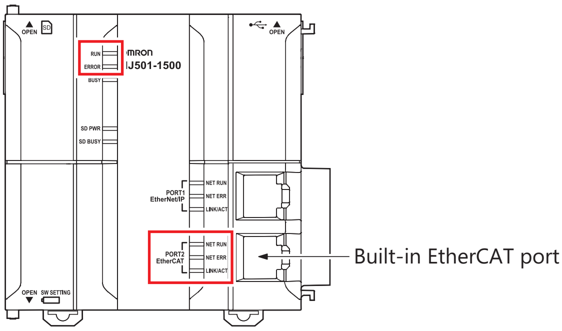
Push to V+ Memory is displayed during the processing.


Push to V+ Memory

6 Confirm that the Robot Integrated CPU Unit is turned ON normally.

The status of indicators for normal operation is given below.

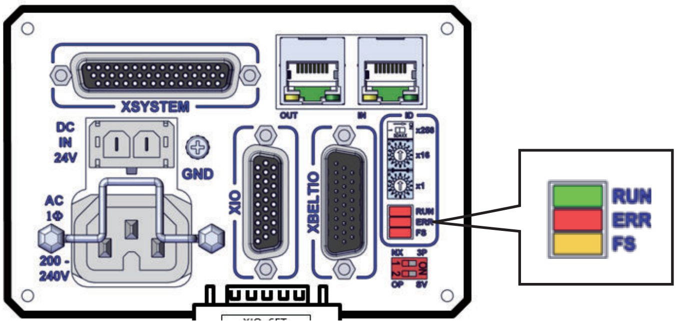
Indicators	Status
RUN indicator	Lit green
ERROR indicator	Not lit
NET RUN	Lit green
NET ERR	Not lit
LINK/ACT	Flashing


OPEN
SD
RUN
ERROR
BUSY
SD PWR
SD BUSY
OMRON
NJ501-1500
OPEN
PORT1 EtherNet/IP
NET RUN
NET ERR
LINK/ACT
PORT2 EtherCAT
NET RUN
NET ERR
LINK/ACT
OPEN
SW SETTING
Built-in EtherCAT port

7 Confirm that the robot is turned ON normally.

The status of indicators for normal operation is given below.

Indicators	Status
RUN indicator	Lit green
ERR indicator	Not lit


XSYSTEM
DC IN 24V
GND
AC 1Φ 200 - 240V
XIO
XBELTIO
OUT
IN
RUN
ERR
FS

3-4-3 Teaching

A robot is operated actually to check and correct teaching data.
Move the robot to the teaching position set in the simulation operation actually, and adjust the position if necessary. The teaching position data is saved in the SD Memory Card so that the data is retained after the power supply to the Robot Integrated CPU Unit is turned OFF.
The T20 pendant is used for teaching. Refer to the *T20 Pendant User's Guide (Cat. No. I601)* for information on the specifications of the T20 pendant.
Place a workpiece where you plan to pick it up before performing the teaching operation.

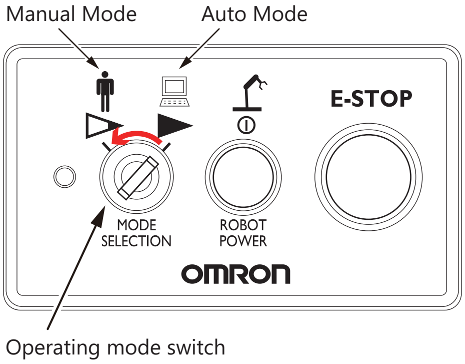
Precautions for Correct Use

When you operate the robot in MANUAL mode with the T20 pendant, you must plug the iCS Commissioning Jumper into the XBELTIO connector and change the setting for the Teach Restrict. Refer to the *eCobra 600 and 800 Robot with EtherCAT User's Guide (Cat. No. I653)* for details.

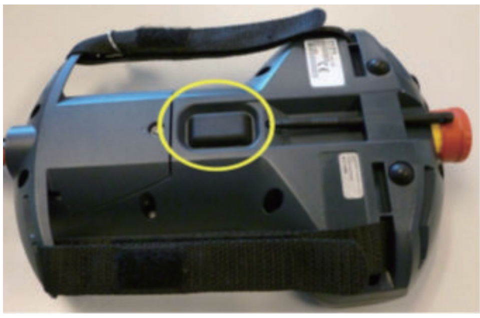
Turning Robot High Power ON

The robot high power is turned ON.

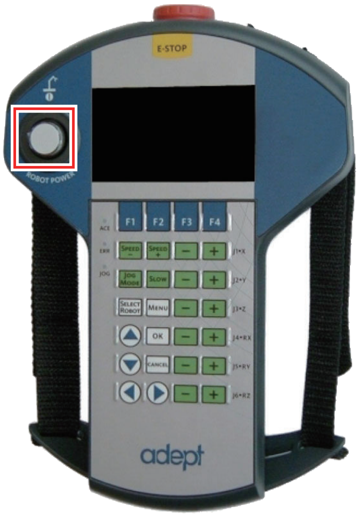
1 Change the operating mode switch on the front panel to Manual Mode.


Manual Mode
Auto Mode
E-STOP
MODE SELECTION
ROBOT POWER
OMRON
Operating mode switch

2 Press the enable switch on the T20 pendant to Position 2 (half-way).



3 Press and release the ROBOT POWER button while the enable switch keeps to Position 2 (half-way).



After a few seconds, the robot high power is turned ON and the ROBOT POWER button lights.

If you release the enable switch (Position 1) or press the enable switch again from Position 2 (half-way) (Position 3), the robot high power is turned OFF. Perform the later operations while the enable switch keeps to Position 2 (half-way) except when it is specified.

Adjusting Teaching Position in Simulation Operation

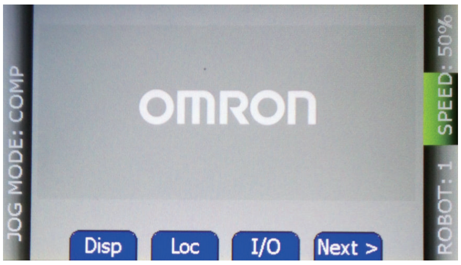
The teaching position that is set in setup procedure with the simulation operation is adjusted to match the actual place position. The robot actually moves to the teaching position set in the simulation operation, and correct the position if there are differences between teaching position and expected position. Use the following procedure to adjust position according to the travel route of the robot. You must adjust the wait position and approach position more than once.

Position name (Variable name)	Description	Order of adjustment
gl.wait	Robot wait position	1, 4
gl.pick	Workpiece pick-up position	2
gl.place	Workpiece place position	3

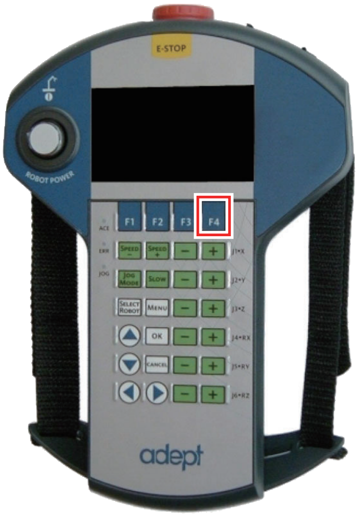
Precautions for Correct Use

Perform the adjustment in the above order in the table. If the adjustment is performed in different order, the robot may move to the unintended travel route and contact to the equipments such as a conveyor, and then the devices may be damaged.

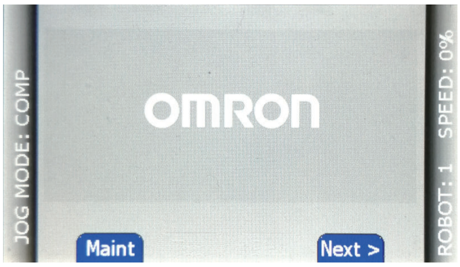
1. Confirm that the T20 pendant displays the **HOME1** screen.


JOG MODE: COMP
OMRON
SPEED: 50%
ROBOT: 1
Disp
Loc
I/O
Next >

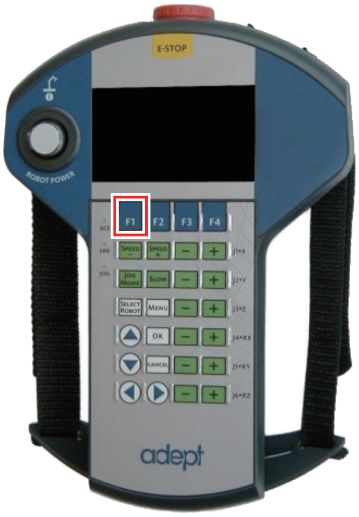
2. Press the F4 button (Next>) twice.


E-STOP
F1
F2
F3
F4
adept

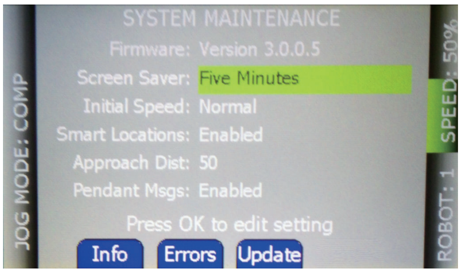
The **HOME3** screen is displayed.


JOG MODE: COMP
OMRON
SPEED: 0%
ROBOT: 1
Maint
Next >

3. Press the F1 button (Maint).

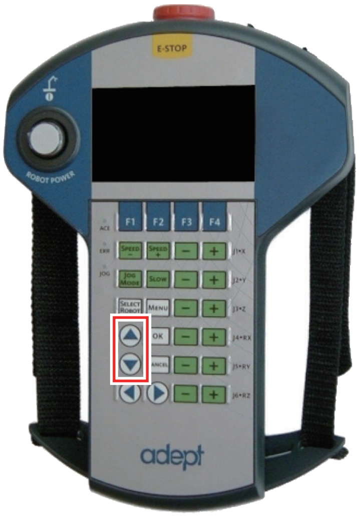

E-STOP
ROBOT POWER
F1
F2
F3
F4
adept

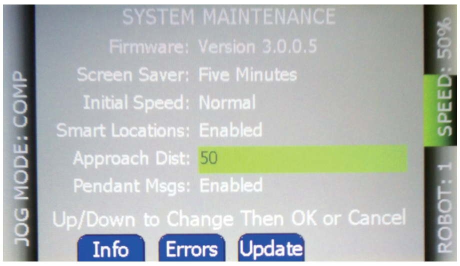
The **SYSTEM MAINTENANCE** screen is displayed.


JOG MODE: COMP
SPEED: 50%
ROBOT: 1
Info
Errors
Update

SYSTEM MAINTENANCE
Firmware: Version 3.0.0.5
Screen Saver: Five Minutes
Initial Speed: Normal
Smart Locations: Enabled
Approach Dist: 50
Pendant Msgs: Enabled
Press OK to edit setting

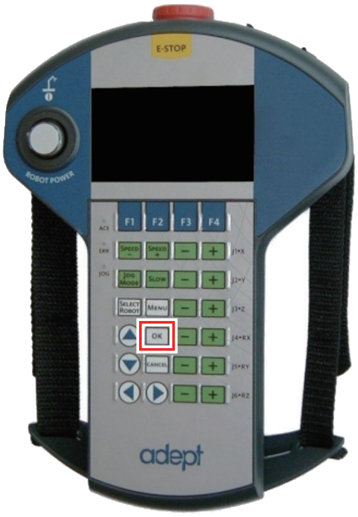
4 Press the up or down arrow button to select **Approach Dist** field.


E-STOP
ROBOT POWER
F1
F2
F3
F4
adept

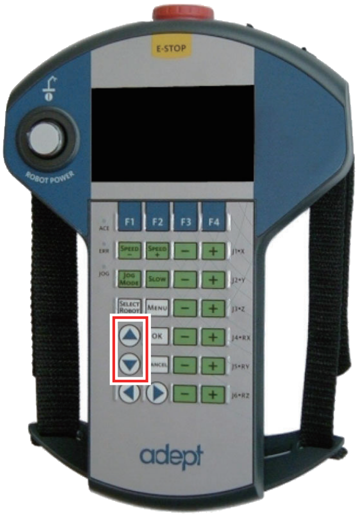

JOG MODE: COMP
SPEED: 50%
ROBOT: 1
Info
Errors
Update

SYSTEM MAINTENANCE
Firmware: Version 3.0.0.5
Screen Saver: Five Minutes
Initial Speed: Normal
Smart Locations: Enabled
Approach Dist: 50
Pendant Msgs: Enabled
Up/Down to Change Then OK or Cancel

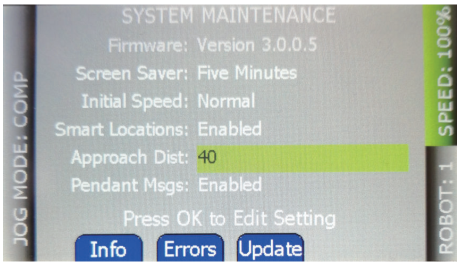
5 Press the OK button.


E-STOP
ROBOT POWER
F1
F2
F3
F4
SPEED
SPEED
JOG MODE
SLOW
SELECT ROBOT
MENU
OK
CANCEL
adept

6 Press the up or down arrow button to change the value of **Approach Dist** field. You can select the height to rise and fall in the range of 1 to 200 mm.


E-STOP
ROBOT POWER
F1
F2
F3
F4
SPEED
SPEED
JOG MODE
SLOW
SELECT ROBOT
MENU
OK
CANCEL
adept

Assume that the value of height to rise and fall is 40 in this step.



SYSTEM MAINTENANCE

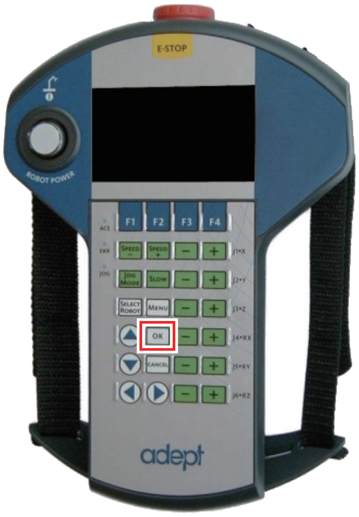
Firmware: Version 3.0.0.5
Screen Saver: Five Minutes
Initial Speed: Normal
Smart Locations: Enabled
Approach Dist: 40
Pendant Msgs: Enabled

Press OK to Edit Setting

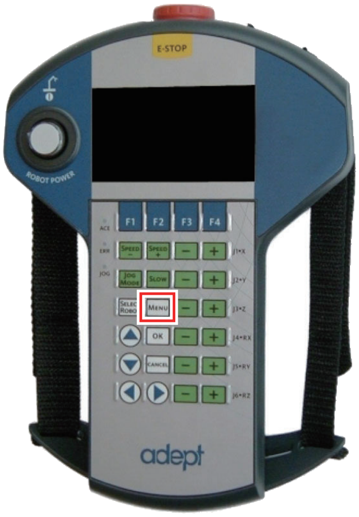
JOG MODE: COMP
SPEED: 100%
ROBOT: 1

Info
Errors
Update

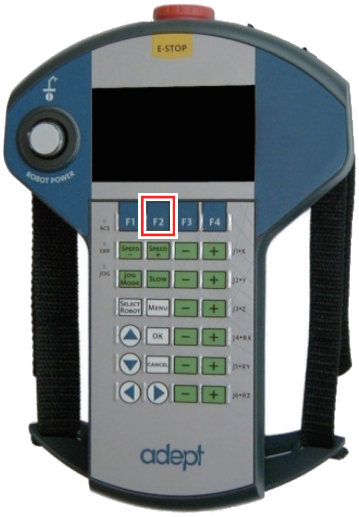
7 Press the OK button.



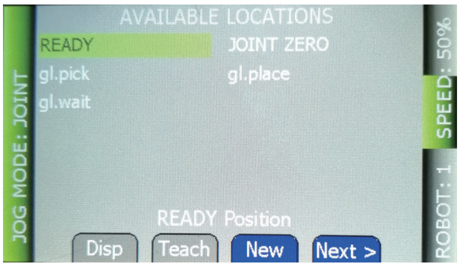
8 Press the MENU button to back to **HOME1** screen.



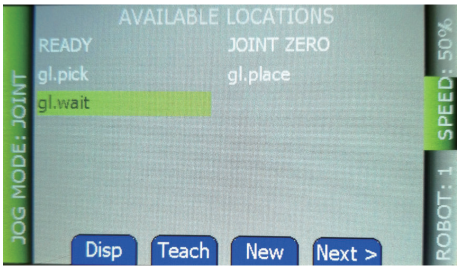
9 Press the F2 button (Loc).



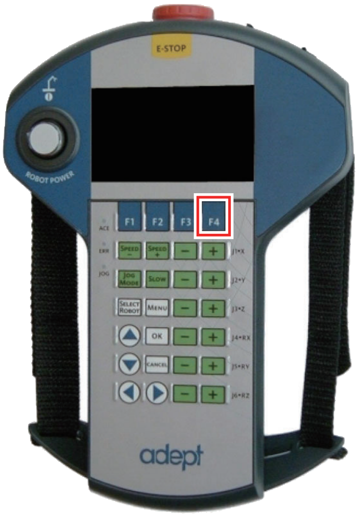
The **AVAILABLE LOCATIONS** screen is displayed.


AVAILABLE LOCATIONS
READY
JOINT ZERO
gl.pick
gl.place
gl.wait
READY Position
Disp
Teach
New
Next >
JOG MODE: JOINT
SPEED: 50%
ROBOT: 1

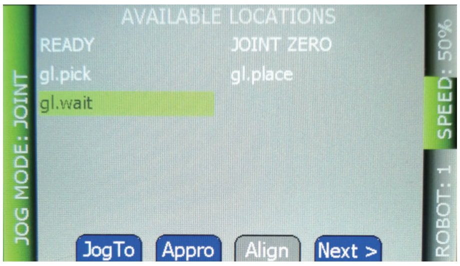
10 On the **AVAILABLE LOCATIONS** screen, use the arrow buttons to select the teaching position from the list of locations.


AVAILABLE LOCATIONS
READY
JOINT ZERO
gl.pick
gl.place
gl.wait
Disp
Teach
New
Next >
JOG MODE: JOINT
SPEED: 50%
ROBOT: 1

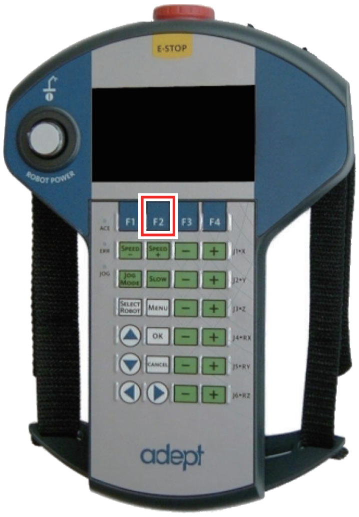
11 Press the F4 button (Next>).


E-STOP
ROBOT POWER
F1
F2
F3
F4
adept

The display for the soft keys changes on the bottom of the screen.

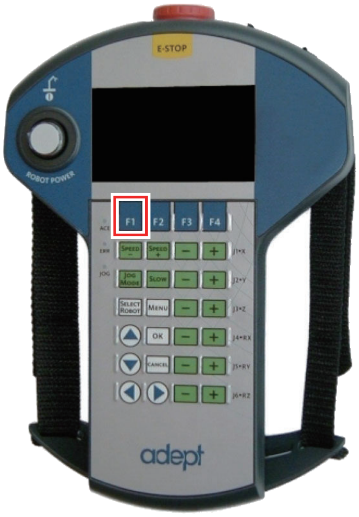

AVAILABLE LOCATIONS
READY
JOINT ZERO
gl.pick
gl.place
gl.wait
JogTo
Appro
Align
Next >
JOG MODE: JOINT
SPEED: 50%
ROBOT: 1

12 If the variable selected in step 10 is *gl.pick* or *gl.place*, press and hold the F2 button (Appro).


E-STOP
ROBOT POWER
F1
F2
F3
F4
SPEED –
SPEED +
JOG MODE
SLOW
SELECT ROBOT
MENU
OK
CANCEL
adept

The robot moves linearly to the top of the selected position.

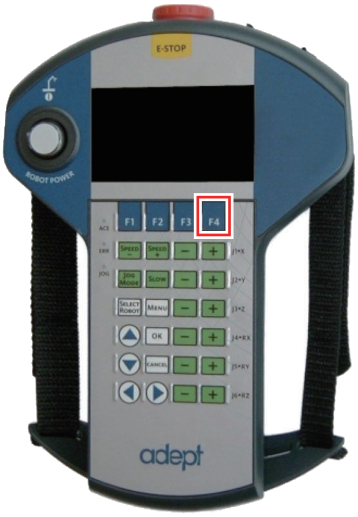
13 Press and hold the F1 button (JogTo).


E-STOP
ROBOT POWER
F1
F2
F3
F4
SPEED –
SPEED +
JOG MODE
SLOW
SELECT ROBOT
MENU
OK
CANCEL
adept

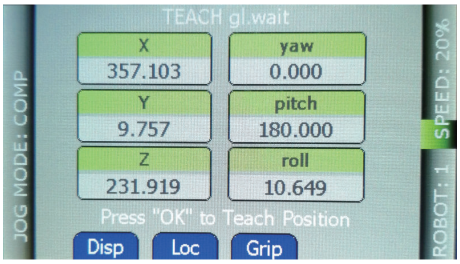
The robot moves linearly to the selected position.

14 When the robot moves to the selected position, release the F1 button (JogTo).
If there is no problem with the position and posture after the move, proceed to step 20. If you adjust the position and posture, perform step 15 and later.

15 Press the F4 button (Next>) and then F2 button (Teach).



The **TEACH** screen for the selected location is displayed.



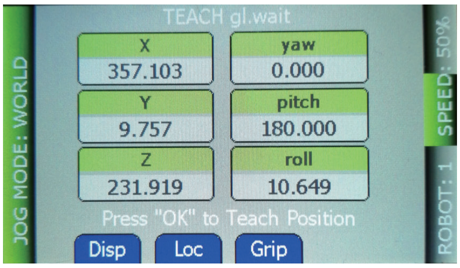
TEACH gl.wait

X 357.103
yaw 0.000
Y 9.757
pitch 180.000
Z 231.919
roll 10.649

Press "OK" to Teach Position

JOG MODE: COMP
SPEED: 20%
ROBOT: 1

16 Press the Jog Mode button until the desired mode is displayed in the Jog Mode Indicator area. Assumes that the adjustment of the position in World Mode is performed in this step, and press the button until **WORLD** is displayed.



TEACH gl.wait

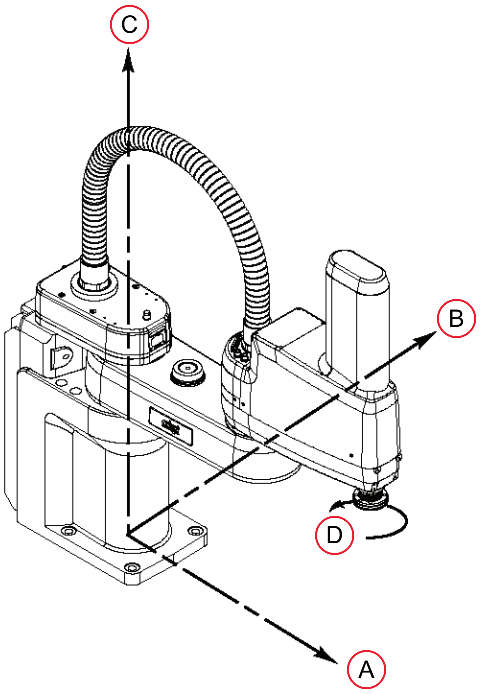
X 357.103
yaw 0.000
Y 9.757
pitch 180.000
Z 231.919
roll 10.649

Press "OK" to Teach Position

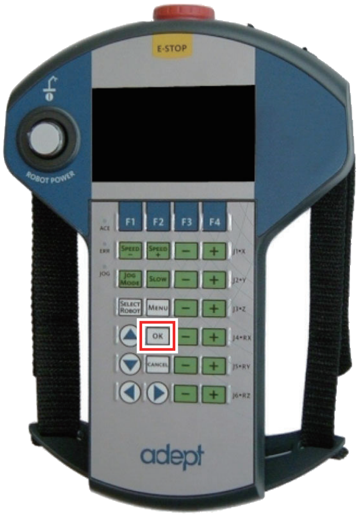
JOG MODE: WORLD
SPEED: 50%
ROBOT: 1

17 Press the JOINT/AXIS CONTROL button to move the robot to the desired position and posture.
The following table shows the relationship between coordinate axes in World Mode and JOINT/AXIS CONTROL button.

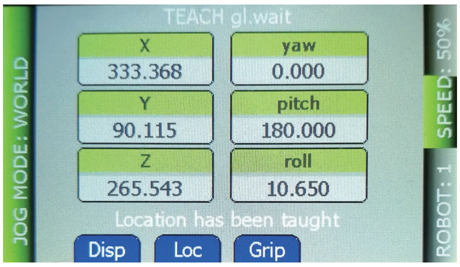
Letter	Description	JOINT/AXIS CONTROL button
A	+X (X direction)	X
B	+Y (Y direction)	Y
C	+Z (Z direction)	Z
D	+RZ, CCW (RZ rotation)	RZ



18 Press the OK button.


E-STOP
ROBOT POWER
F1
F2
F3
F4
OK
CANCEL
adept

The value of position is updated to the current robot position.



TEACH gl.wait

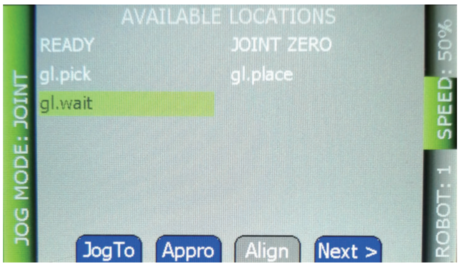
X	yaw
333.368	0.000
Y	pitch
90.115	180.000
Z	roll
265.543	10.650

Location has been taught

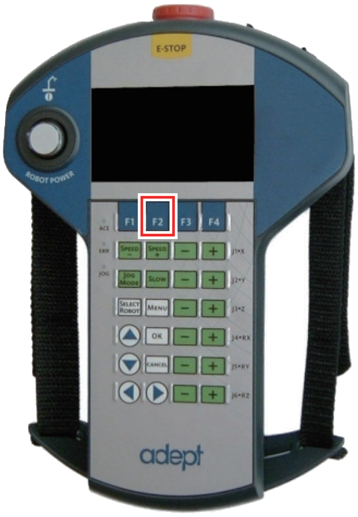
JOG MODE: WORLD
SPEED: 50%
ROBOT: 1
Disp
Loc
Grip

19 Press the F2 (Loc) button and then F4 button (Next>).

The **AVAILABLE LOCATIONS** screen is displayed again.


AVAILABLE LOCATIONS
READY
JOINT ZERO
gl.pick
gl.place
gl.wait
JOG MODE: JOINT
SPEED: 50%
ROBOT: 1
JogTo
Appro
Align
Next >

20 If the variable selected in step 10 is *gl.pick* or *gl.place*, press and hold the F2 button (Appro).


E-STOP
ROBOT POWER
F1
F2
F3
F4
adept

The robot moves linearly to the top of the selected position.

21 If there are still positions left to adjust, return to step 10.

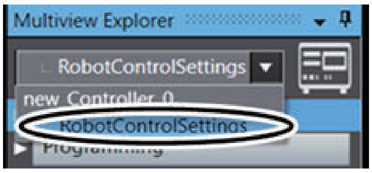
Saving Teaching Position in SD Memory Card

The teaching position data is saved in the SD Memory Card so that the data is retained after the power supply to the Robot Integrated CPU Unit is turned OFF.

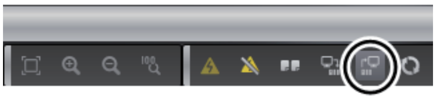
Precautions for Correct Use

If the power supply to the Robot Integrated CPU Unit turned OFF without saving position data in the SD Memory Card, the adjusted position data is lost, and then the robot may perform unintended operations the next time that the CPU Unit is started. Perform this procedure if you perform teaching on the actual system.

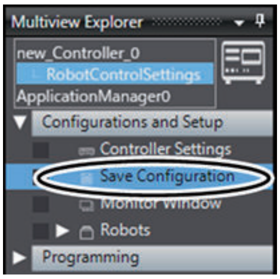
1 Click **RobotControlSettings** from the device list in the Multiview Explorer of the Sysmac Studio.


Multiview Explorer
RobotControlSettings
new_Controller_0
RobotControlSettings
Programming

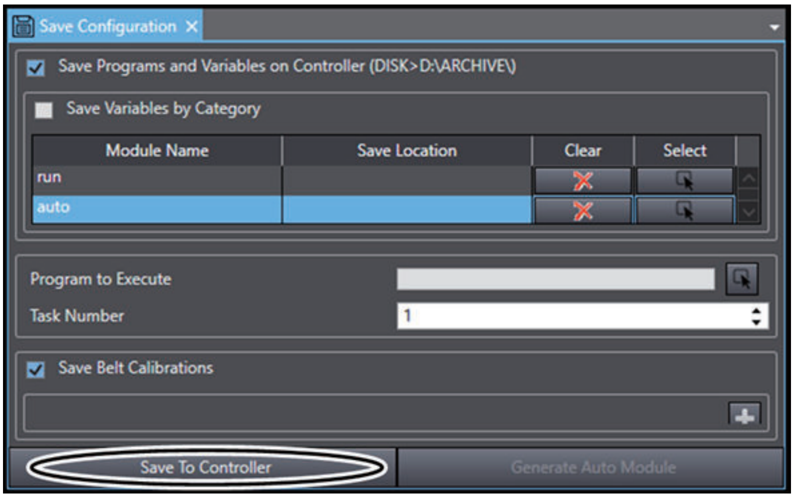
2 Click the **Pull from V+ Memory** icon in the toolbar of the Multiview Explorer.



3 Select **Configurations and Setup** - **Save Configuration** in the Multiview Explorer.


Multiview Explorer
new_Controller_0
RobotControlSettings
ApplicationManager0
Configurations and Setup
Controller Settings
Save Configuration
Monitor Window
Robots
Programming

4 Click the **Save To Controller** button in the **Save Configuration** tab page.


Save Configuration
Save To Controller
Generate Auto Module

☑ Save Programs and Variables on Controller (DISK>D:\ARCHIVE\)

☐ Save Variables by Category

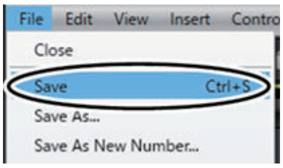
Module Name	Save Location	Clear	Select
run		✗	
auto		✗	

Program to Execute

Task Number 1

☑ Save Belt Calibrations

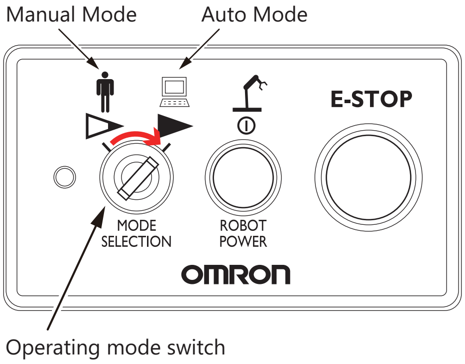
5 Click **File** - **Save** from the menu bar.


File
Edit
View
Insert
Contro
Close
Save Ctrl+S
Save As...
Save As New Number...

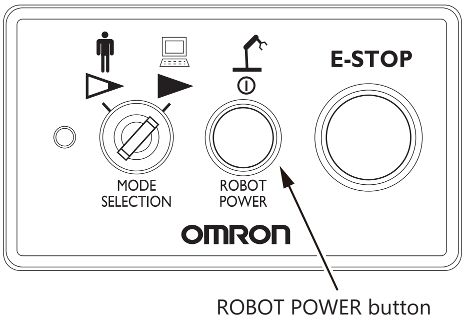
3-4-4 Executing Program to Check Operation

The robot operation before the automatic operation is checked according to the program.

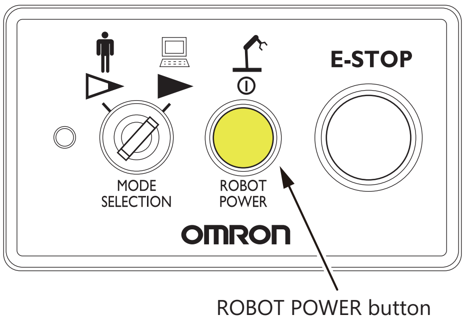
1 Change the operating mode switch on the front panel to Auto Mode.


Manual Mode
Auto Mode
E-STOP
MODE SELECTION
ROBOT POWER
OMRON
Operating mode switch

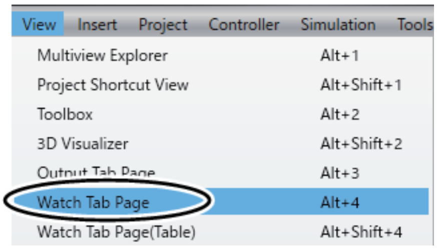
2 Press the Robot Power button on the front panel.


E-STOP
MODE SELECTION
ROBOT POWER
OMRON
ROBOT POWER button

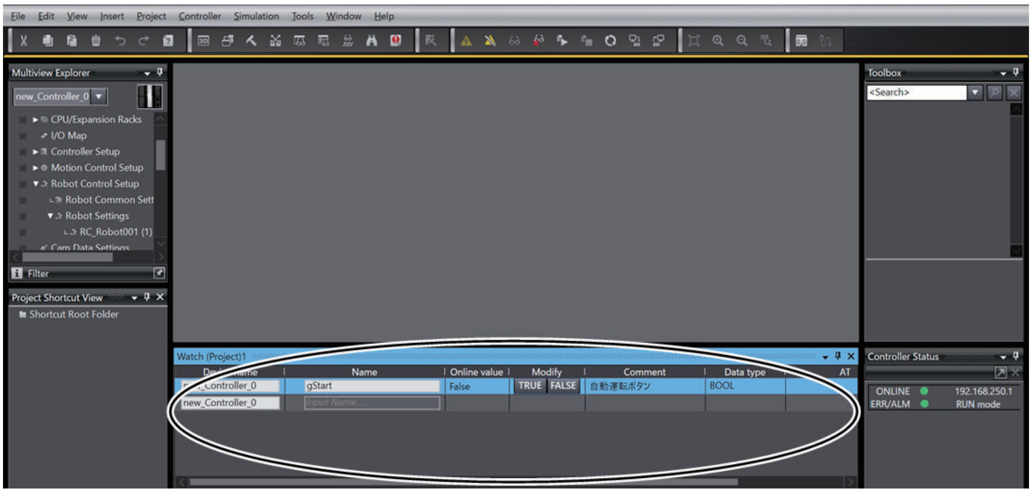
After a few seconds, the ROBOT POWER button lights.


E-STOP
MODE SELECTION
ROBOT POWER
OMRON
ROBOT POWER button

3 Select **View** - **Watch Tab Page** from the menu bar in the main window of the Sysmac Studio on the computer.


View
Insert
Project
Controller
Simulation
Tools
Multiview Explorer Alt+1
Project Shortcut View Alt+Shift+1
Toolbox Alt+2
3D Visualizer Alt+Shift+2
Output Tab Page Alt+3
Watch Tab Page Alt+4
Watch Tab Page(Table) Alt+Shift+4

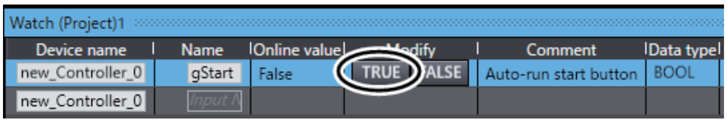
The **Watch** tab page is displayed under the main window.


File Edit View Insert Project Controller Simulation Tools Window Help
Multiview Explorer
new_Controller_0
CPU/Expansion Racks
I/O Map
Controller Setup
Motion Control Setup
Robot Control Setup
Robot Common Sett
Robot Settings
RC_Robot001 (1)
Cam Data Settings
Filter
Project Shortcut View
Shortcut Root Folder
Toolbox
<Search>
Controller Status
ONLINE
ERR/ALM
192.168.250.1
RUN mode

Watch (Project)1

Device name	Name	Online value	Modify	Comment	Data type	AT
new_Controller_0	gStart	False	TRUE FALSE	自動運転ボタン	BOOL	
new_Controller_0	Input Name...					

4 Click the **TRUE** button in the **Modify** column for **gStart**.


Watch (Project)1

Device name	Name	Online value	Modify	Comment	Data type
new_Controller_0	gStart	False	TRUE FALSE	Auto-run start button	BOOL
new_Controller_0	Input N				

The robot performs pick-and-place operation according to the program.

If you use this program actually, write a program so that you can operate *gStart* variable from the HMI.

Precautions for Correct Use

If the operation is controlled with the V+ program and the operating mode of the Robot Integrated CPU Unit is switched from RUN mode to PROGRAM mode, and then to RUN mode again, press the ROBOT POWER button on the front panel to make sure that the light of the button is OFF, and then press the button again to confirm that it is lit before executing the above procedure.

A

Appendices

A-1 Designing Example of the Safety Functions for the Pick-and-place Equipment.......... A-2
A-1-1 Pick-and-place Equipment Configuration.......... A-2
A-1-2 Hazards.......... A-4
A-1-3 Protective Measure.......... A-4
A-1-4 Safety Functions.......... A-4
A-1-5 Safety System Configuration and Devices.......... A-5
A-1-6 Installation and Wiring.......... A-7
A-1-7 Settings and Programming.......... A-13
A-2 Setting Items on the Sysmac Studio and the Setting Targets.......... A-21
A-3 Using Troubleshooting Functions.......... A-22

A-1 Designing Example of the Safety Functions for the Pick-and-place Equipment

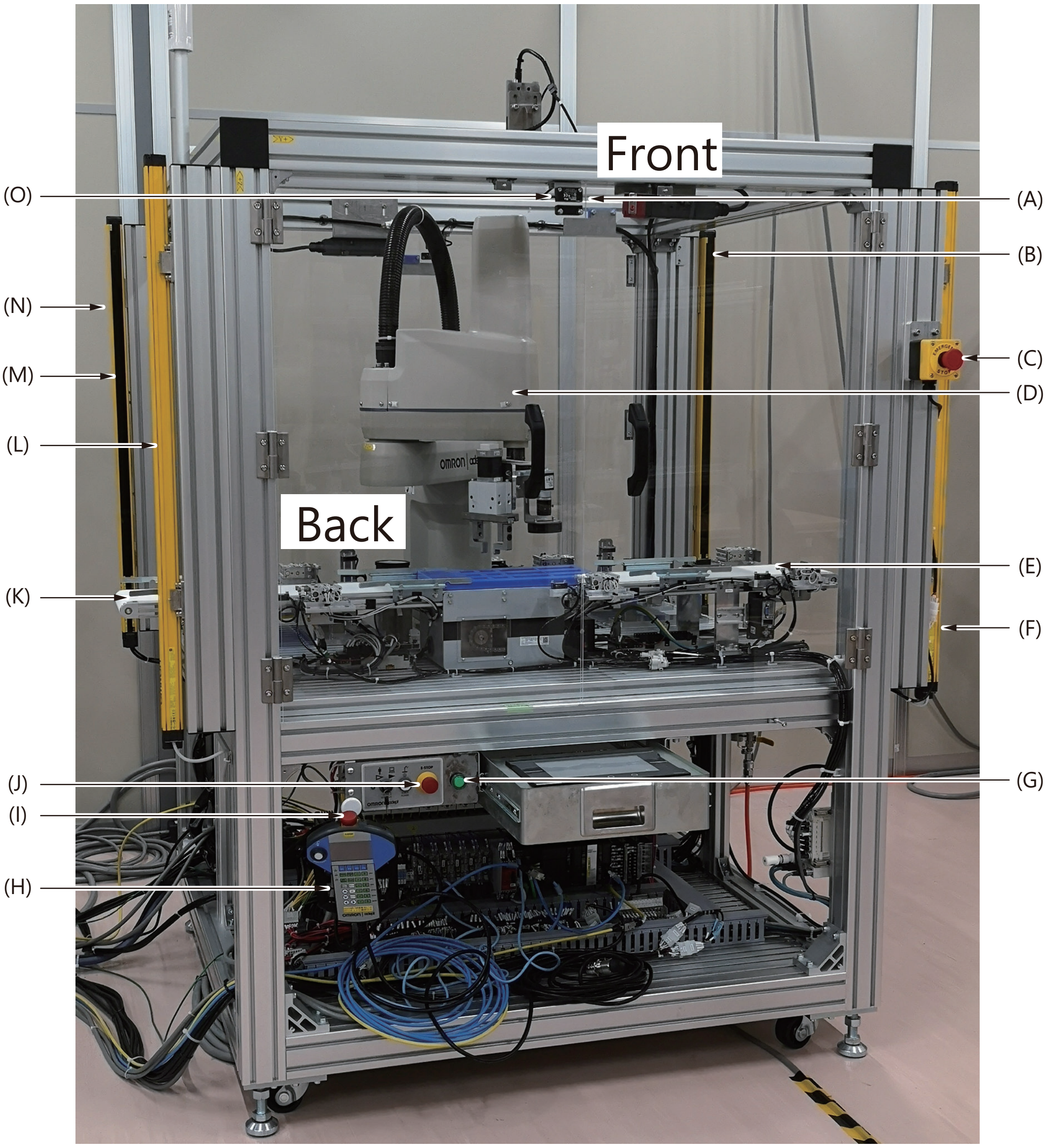
This section describes the designing example of the safety functions for the pick-and-place equipment.

Precautions for Correct Use

You must implement the actual safety measures based on the *Robot Safety Guide (Cat. No. I590)* and risk assessment. In addition, it is necessary to consider the performance level and safety distances of the equipment while it conforms to the safety standards.

A-1-1 Pick-and-place Equipment Configuration

The configuration of the pick-and-place equipment inclusive of the safety devices is shown in the table below.


Front
Back
(A)
(B)
(C)
(D)
(E)
(F)
(G)
(H)
(I)
(J)
(K)
(L)
(M)
(N)
(O)

Letter	Name
A	Safety door switch 2
B	Safety light curtain 2 (Emitter)
C	Emergency stop pushbutton switch 1
D	Robot
E	Belt conveyor (Unload side)
F	Safety light curtain 2 (Receiver)
G	Reset switch
H	Enable switch on T20 pendant
I	E-STOP button on T20 pendant
J	E-STOP button on front panel
K	Belt conveyor (Load side)
L	Safety light curtain 1 (Receiver)
M	Safety light curtain 1 (Emitter)
N	Emergency stop pushbutton switch 2
O	Safety door switch 1

A-1-2 Hazards

The movable parts of the robot are the mechanical hazards in the system configuration described in this section.

A-1-3 Protective Measure

You must assume the cases in which the hazards are approached from each side of the pick-and-place equipment.
The safeguarding to each case is implemented as shown in the table below.

Equipment side	Approached case	Safeguarding	Safety device
Back	---	Fixed guard	---
Front	Adjustment/ maintenance	Movable guard	Safety door switch
Loading side	Loading	Opto-electronic protective device	Safety light curtain
Unload side	Unloading	Opto-electronic protective device	Safety light curtain

In addition to the safeguarding, the emergency stop switches as the complementary protective measures are placed at positions accessible from each side of the equipment.

Equipment side	Complementary protective measure	Safety device
Back	Emergency stop switch	Emergency stop pushbutton switch
Front		Emergency stop pushbutton switch
		E-STOP button on T20 pendant
		E-STOP button on front panel

A-1-4 Safety Functions

You must decide the safety function of each safety device for the case it operated.
The functions need to be decided for each operating mode of the OMRON robot.

Auto Mode

Set the safety functions when the operating mode of the OMRON robot is in Auto mode as shown in the table below.

Safety device	Safety function	Recovery
Emergency stop pushbutton switch 1	Stop the robot when pressed	High power ON after resetting
Emergency stop pushbutton switch 2	Stop the robot when pressed	High power ON after resetting
Safety light curtain 1	Stop the robot when the beam is interrupted	High power ON
Safety light curtain 2	Stop the robot when beam is interrupted	High power ON
Safety door switch 1	Stop the robot when the door is open	High power ON after resetting
Safety door switch 2	Stop the robot when the door is open	High power ON after resetting
E-STOP button on front panel	Stop the robot when pressed	High power ON after resetting
E-STOP button on T20 pendant	Stop the robot when pressed	High power ON after resetting
Enable switch on T20 pendant	---	---

Manual Mode

Set the safety functions when the operating mode of the OMRON robot is in Manual mode as shown in the table below.

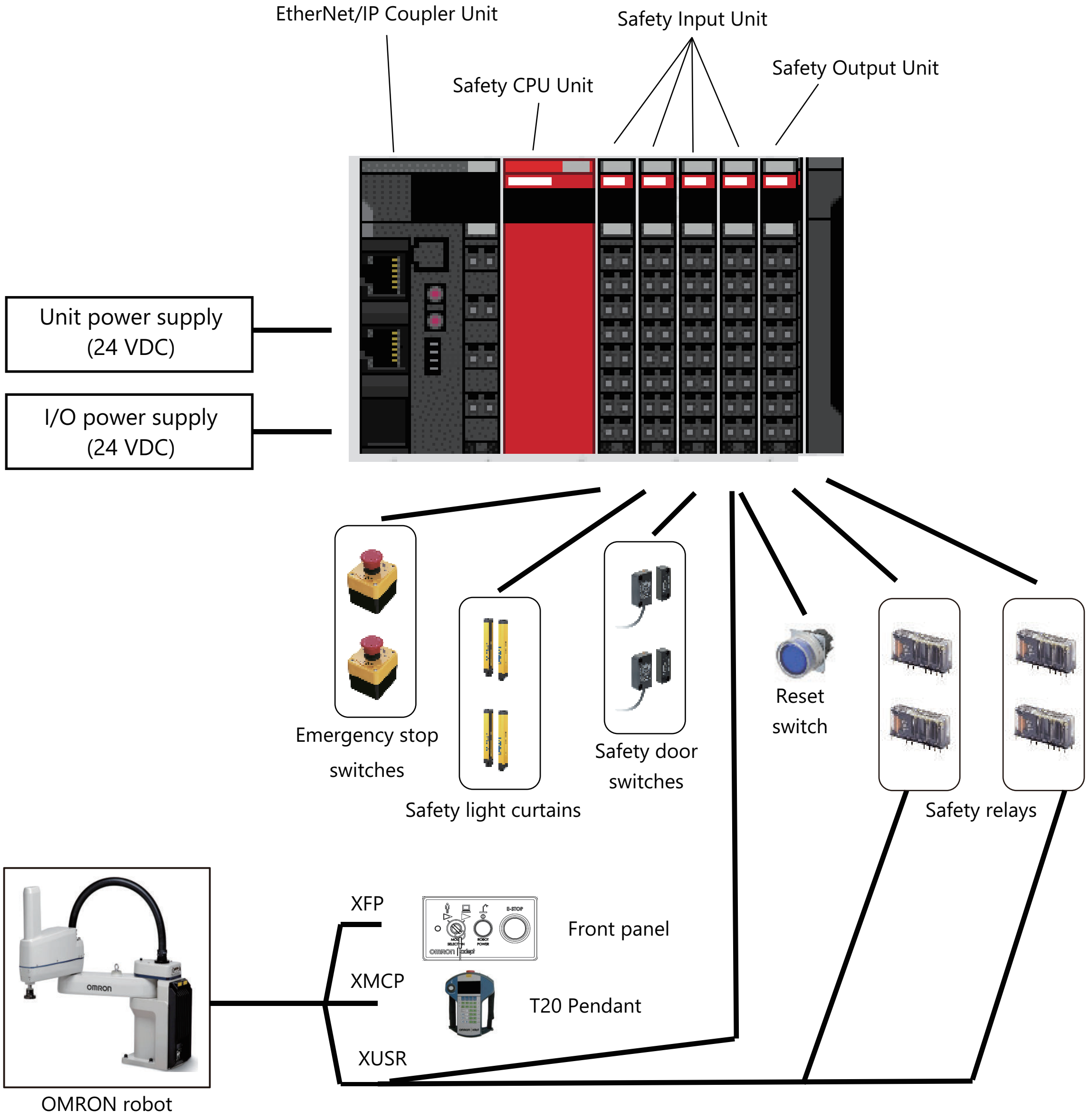
Safety device	Safety function	Recovery
Emergency stop pushbutton switch 1	Stop the robot when pressed	Reset
Emergency stop pushbutton switch 2	Stop the robot when pressed	Reset
Safety light curtain 1	---	---
Safety light curtain 2	---	---
Safety door switch 1	---	---
Safety door switch 2	---	---
E-STOP button on front panel	Stop the robot when pressed	Reset
E-STOP button on T20 pendant	Stop the robot when pressed	Reset
Enable switch on T20 pendant	Stop the robot when not pressed or fully pressed passing the middle position	High power ON

A-1-5 Safety System Configuration and Devices

You must select the safety system configuration and devices for it to achieve the safety functions.

Safety System Configuration

The safety system configuration in this guide uses an NX-series EtherNet/IP Coupler Unit and NX-series Safety Control Units.


EtherNet/IP Coupler Unit
Safety Input Unit
Safety CPU Unit
Safety Output Unit
Unit power supply (24 VDC)
I/O power supply (24 VDC)
Emergency stop switches
Safety light curtains
Safety door switches
Reset switch
Safety relays
XFP
Front panel
XMCP
T20 Pendant
XUSR
OMRON robot

Configuration Devices

The safety system configuration in this guide uses the devices shown in the table below.

Name	Model	Manufac-turer	Description
EtherNet/IP Coupler Unit	NX-EIC202	OMRON	A Coupler Unit that supports EtherNet/IP. This Unit can compose a Slave Terminal by connecting with an NX Unit.
Safety CPU Unit	NX-SL3300	OMRON	A Unit that runs safety programs.
Safety Input Unit	NX-SIH400	OMRON	A Unit to be connected with safety input devices.
Safety Output Unit	NX-SOD400	OMRON	A Unit to be connected with safety output devices.
Safety Light Curtain	F3SG	OMRON	A photoelectric safety sensor. This sensor detects human entry to hazardous area.
Safety Door Switch	D40A	OMRON	A non-contact safety door switch. This switch detects open and close of the entrance door to hazardous area.
Reset Switch	A22-H☐-10M	OMRON	A reset switch. This switch is used to manually recover the equipment from the stop state after the safety function operated.
Emergency Stop Pushbutton Switch	A22E	OMRON	An emergency stop switch.
Safety Relay	G7SA	OMRON	A safety relay.
Unit Power Supply	S8VK	OMRON	A 24 VDC power supply. This control power supply is for the EtherNet/IP Coupler Units and the NX Units.
I/O Power Supply	S8VK	OMRON	A 24 VDC power supply. This power supply is for the I/O circuits of the NX Units and the connected external devices.

A-1-6 Installation and Wiring

This section describes the installation and wiring related to the safety functions for the pick-and-place equipment.

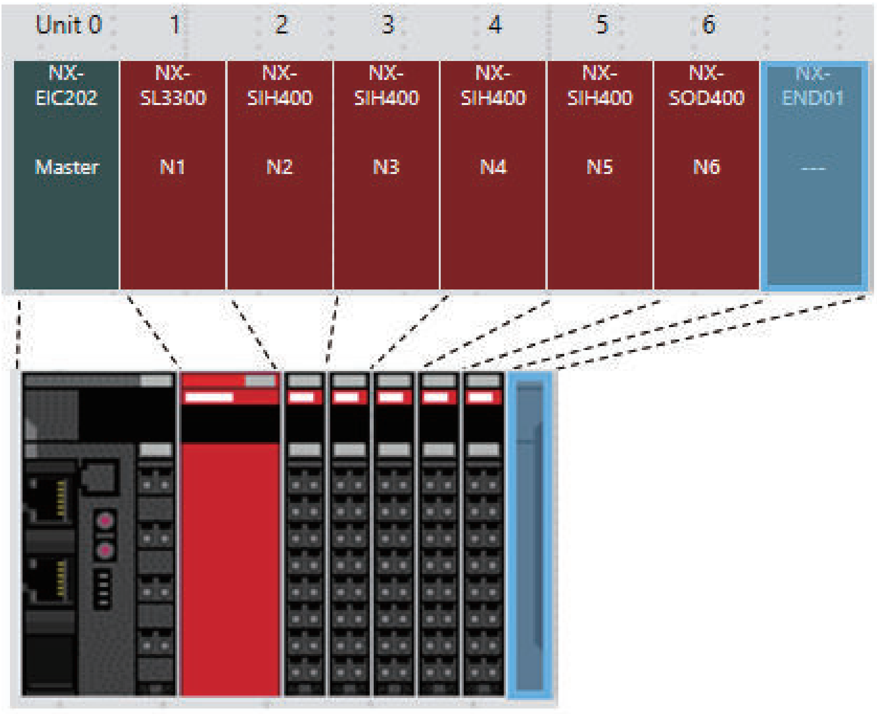
The NX Unit configuration of the EtherNet/IP Slave Terminal and the wiring diagram of the safety devices are described in this guide.

Refer to the following manual for details on installing and wiring the actual devices.

- NX-series Safety Control Unit User’s Manual (Cat. No. Z930)
- NX-series EtherNet/IP Coupler Unit User’s Manual (Cat. No. W536)
- eCobra 600 and 800 Robot with EtherCAT User’s Guide (Cat. No. I653)
- T20 Pendant User's Guide (Cat. No. I601)

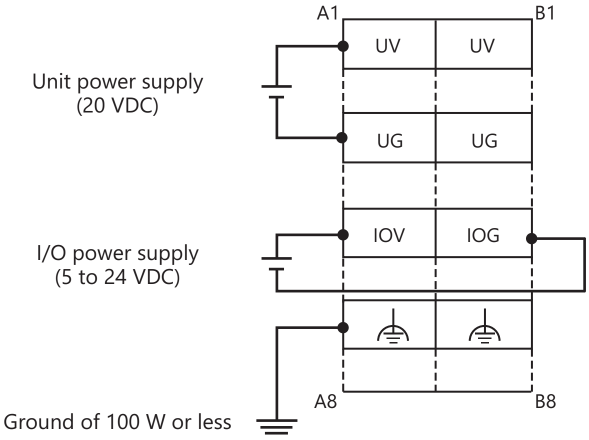
NX Unit Configuration

Compose the EtherNet/IP Slave Terminal by the connection order shown in the figure below.


Unit 0
1
2
3
4
5
6
NX-EIC202
Master
NX-SL3300
N1
NX-SIH400
N2
NX-SIH400
N3
NX-SIH400
N4
NX-SIH400
N5
NX-SOD400
N6
NX-END01

Wiring the Power Supplies

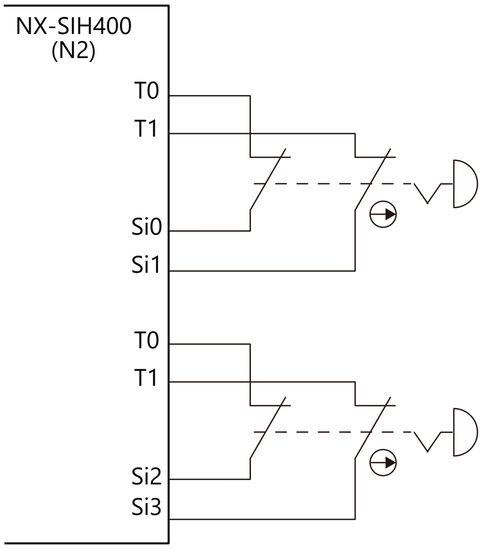
The power supply wirings and grounding for the EtherNet/IP Coupler Unit are shown in the figure below.


A1
B1
UV
UV
Unit power supply (20 VDC)
UG
UG
IOV
IOG
I/O power supply (5 to 24 VDC)
Ground of 100 W or less
A8
B8

- Connect the + terminal (24 VDC) of the Unit power supply to A1 or B1.
- Connect the - terminal (0 VDC) of the Unit power supply to A3 or B3.
- Connect the + terminal (5 to 24 VDC) of the I/O power supply to A5.
- Connect the - terminal (0 VDC) of the I/O power supply to B5.
- Connect the ground line to A7 or B7.

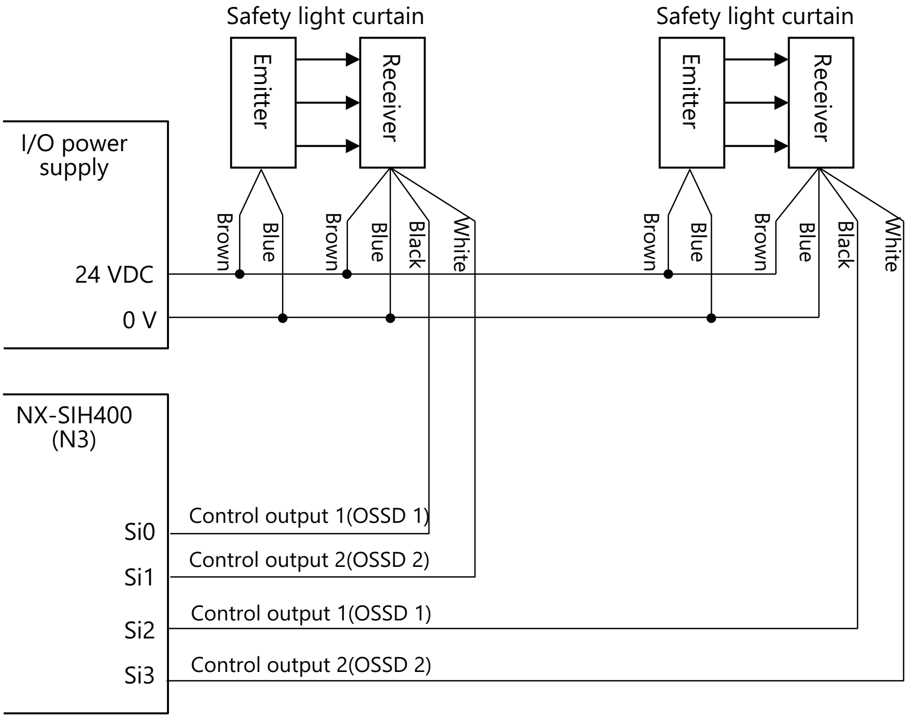
Wiring the Emergency Stop Pushbutton Switch

Connect the emergency stop pushbutton switch to the Safety Input Unit (N2).


NX-SIH400
(N2)
T0
T1
Si0
Si1
T0
T1
Si2
Si3

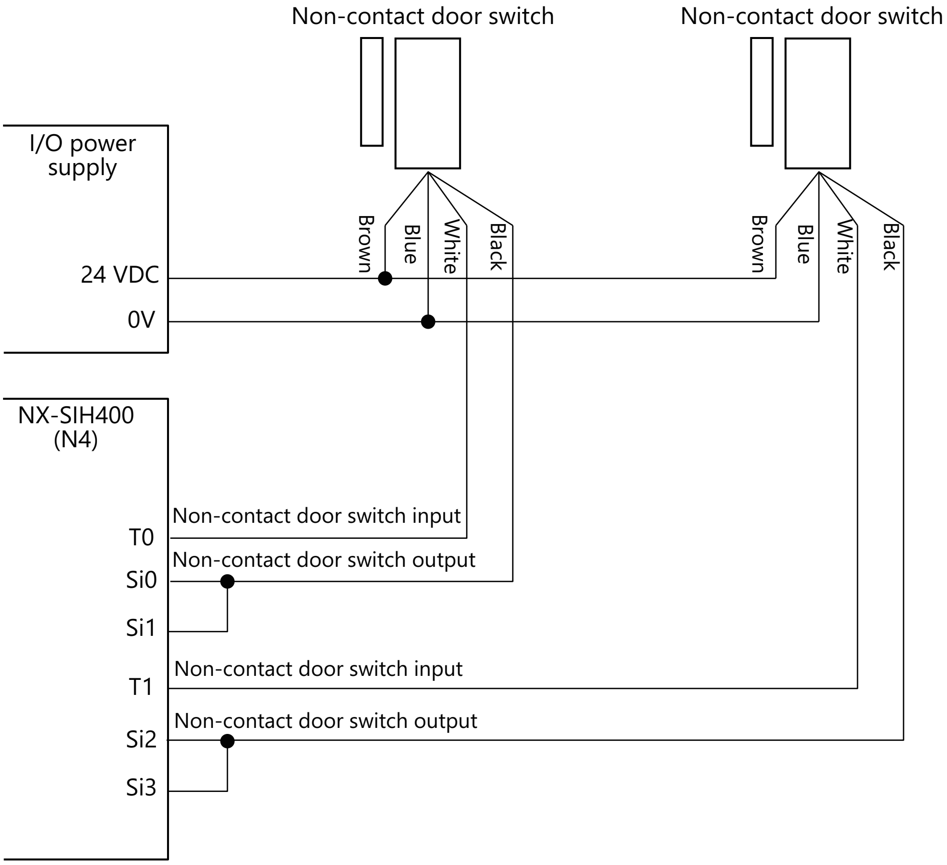
Wiring the Safety Light Curtain

Connect the safety light curtain to the I/O power supply and Safety Input Unit (N3).


Safety light curtain
Emitter
Receiver
Safety light curtain
Emitter
Receiver
I/O power supply
24 VDC
0 V
Brown
Blue
Brown
Blue
Black
White
Brown
Blue
Brown
Blue
Black
White
NX-SIH400
(N3)
Si0
Si1
Si2
Si3
Control output 1(OSSD 1)
Control output 2(OSSD 2)
Control output 1(OSSD 1)
Control output 2(OSSD 2)

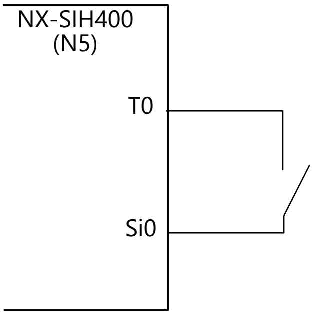
Wiring the Safety Door Switch

Connect the non-contact door switch to the I/O power supply and Safety Input Unit (N4).


Non-contact door switch
Non-contact door switch
I/O power supply
24 VDC
0V
Brown
Blue
White
Black
Brown
Blue
White
Black
NX-SIH400 (N4)
T0
Non-contact door switch input
Si0
Non-contact door switch output
Si1
T1
Non-contact door switch input
Si2
Non-contact door switch output
Si3

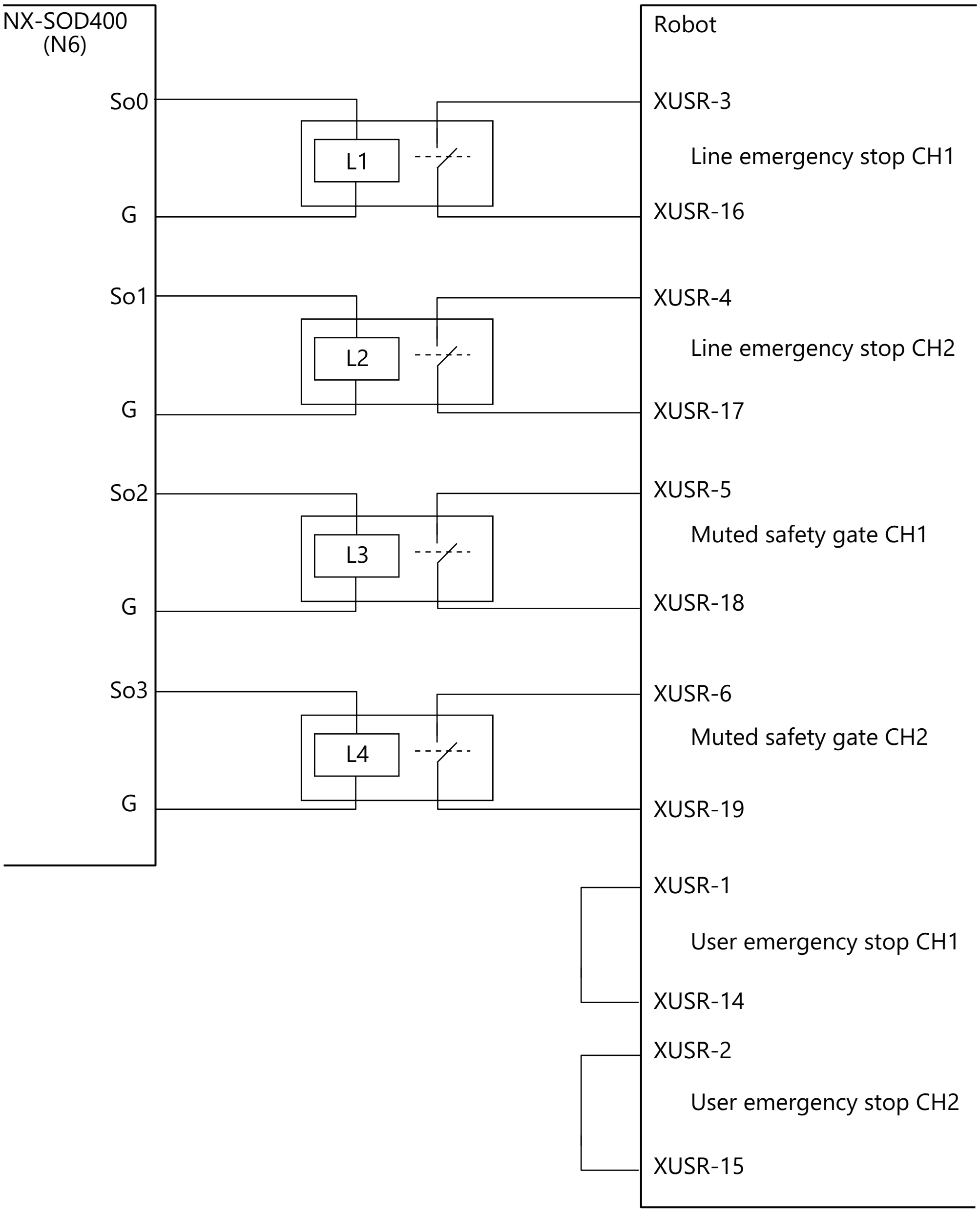
Wiring the Reset Switch

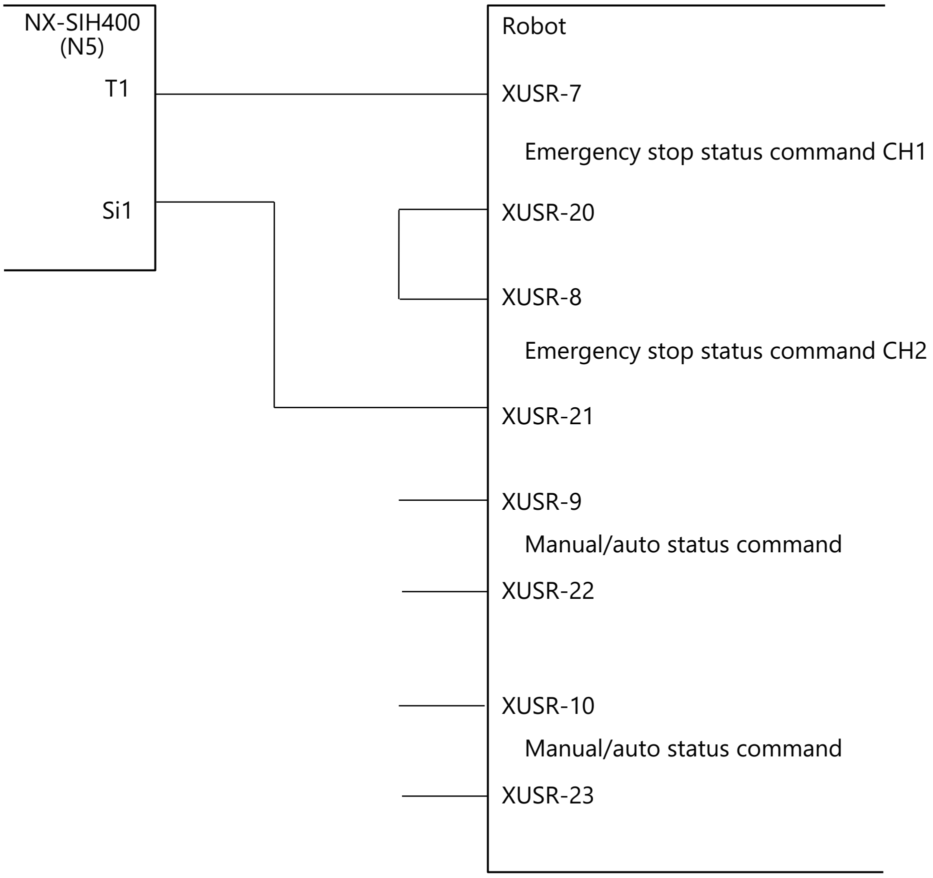
Connect the reset switch to the Safety Input Unit (N5).


NX-SIH400 (N5)
T0
Si0

Wiring the Robot

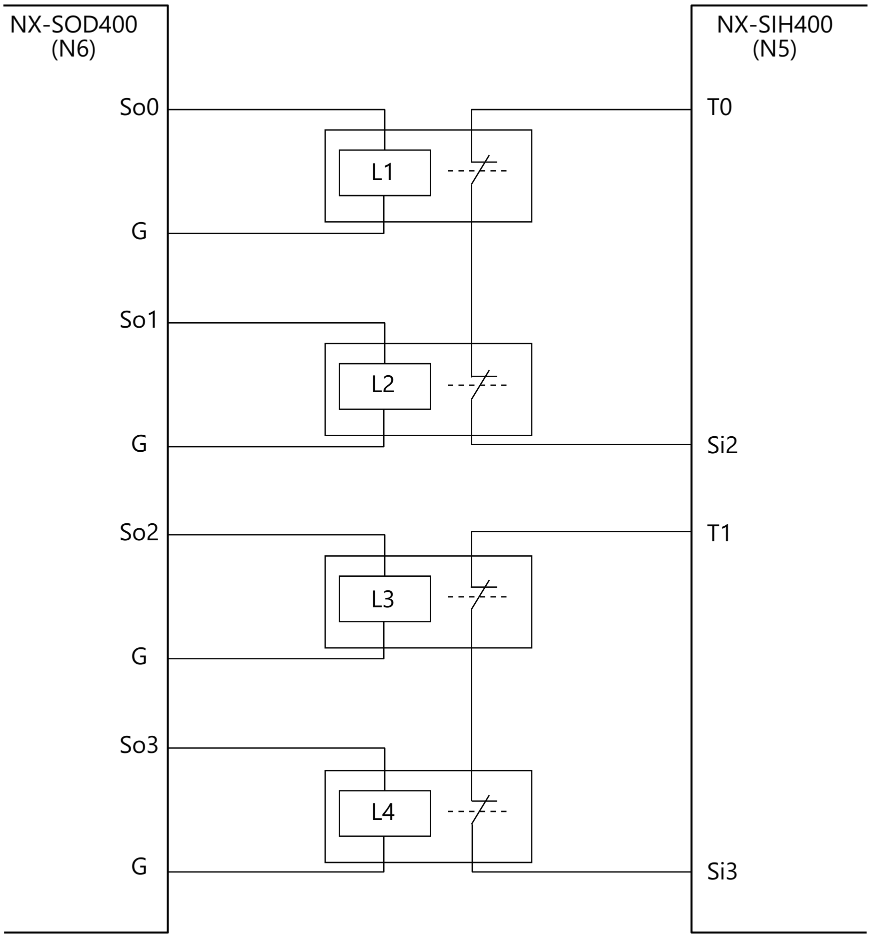
Connect the robot to the Safety Output Unit (N6), Safety Input Unit (N5) and safety relays.
The outputs of the Safety Output Unit (N6) and the inputs of the robot cannot be directly connected, therefore they are connected through the safety relays.
Use the contact a of each safety relay L1 to L4.


NX-SOD400
(N6)
So0
G
So1
G
So2
G
So3
G
L1
L2
L3
L4
Robot
XUSR-3
Line emergency stop CH1
XUSR-16
XUSR-4
Line emergency stop CH2
XUSR-17
XUSR-5
Muted safety gate CH1
XUSR-18
XUSR-6
Muted safety gate CH2
XUSR-19
XUSR-1
User emergency stop CH1
XUSR-14
XUSR-2
User emergency stop CH2
XUSR-15


NX-SIH400
(N5)
T1
Si1
Robot
XUSR-7
Emergency stop status command CH1
XUSR-20
XUSR-8
Emergency stop status command CH2
XUSR-21
XUSR-9
Manual/auto status command
XUSR-22
XUSR-10
Manual/auto status command
XUSR-23

Wiring the Safety Relays for Operation Check

Connect the contact b of each safety relay L1 to L4 to the Safety Input Unit (N5) for checking the operation of each contact a.



A-1-7 Settings and Programming

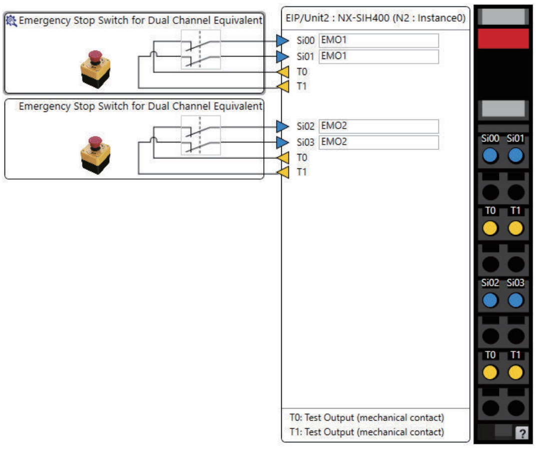
This section describes the settings and programming related to the safety functions.

Refer to the *NX-series Safety Control Unit Instructions Reference Manual (Cat. No. Z931)* for information on the instructions for the Safety CPU Unit.
Refer to the *NX-series Safety Control Unit User’s Manual (Cat. No. Z930)* for information on the specifications and how to configure the Safety Control Units.

Setting Safety I/O Unit

Use the Sysmac Studio and set the safety functions of each safety I/O terminal.

Set the Safety Input Unit (N2) as shown below.



Emergency Stop Switch for Dual Channel Equivalent

Emergency Stop Switch for Dual Channel Equivalent

EIP/Unit2 : NX-SIH400 (N2 : Instance0)

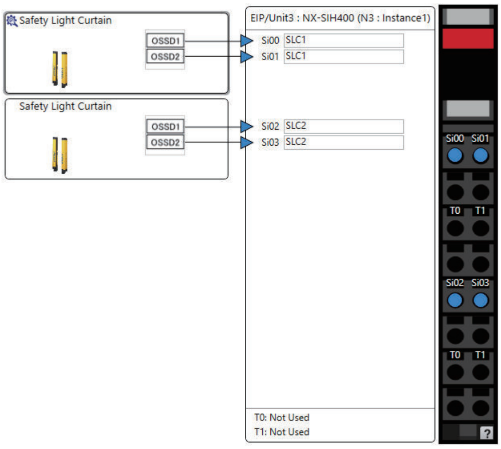
Si00 EMO1
Si01 EMO1
T0
T1

Si02 EMO2
Si03 EMO2
T0
T1

T0: Test Output (mechanical contact)
T1: Test Output (mechanical contact)

Si00
Si01
T0
T1
Si02
Si03
T0
T1
?

Set the Safety Input Unit (N3) as shown below.



Safety Light Curtain

Safety Light Curtain

EIP/Unit3 : NX-SIH400 (N3 : Instance1)

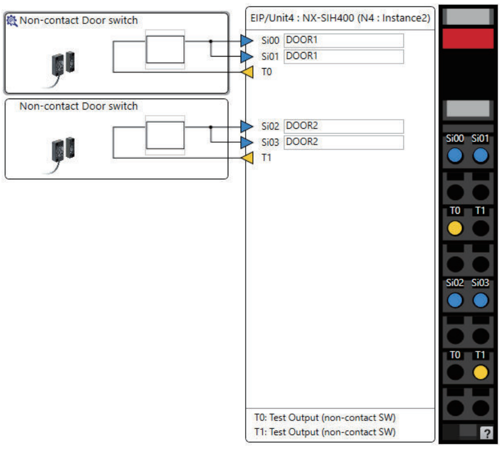
Si00 SLC1
Si01 SLC1

Si02 SLC2
Si03 SLC2

T0: Not Used
T1: Not Used

OSSD1
OSSD2
OSSD1
OSSD2
Si00
Si01
T0
T1
Si02
Si03
T0
T1
?

Set the Safety Input Unit (N4) as shown below.



Non-contact Door switch

Non-contact Door switch

EIP/Unit4 : NX-SIH400 (N4 : Instance2)

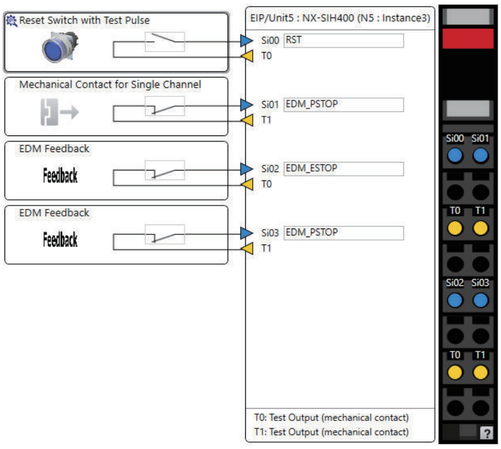
Si00 DOOR1
Si01 DOOR1
T0

Si02 DOOR2
Si03 DOOR2
T1

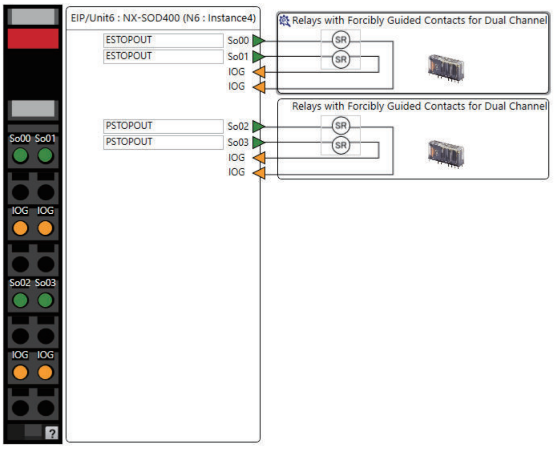
T0: Test Output (non-contact SW)
T1: Test Output (non-contact SW)

Si00
Si01
T0
T1
Si02
Si03
T0
T1
?

Set the Safety Input Unit (N5) as shown below.

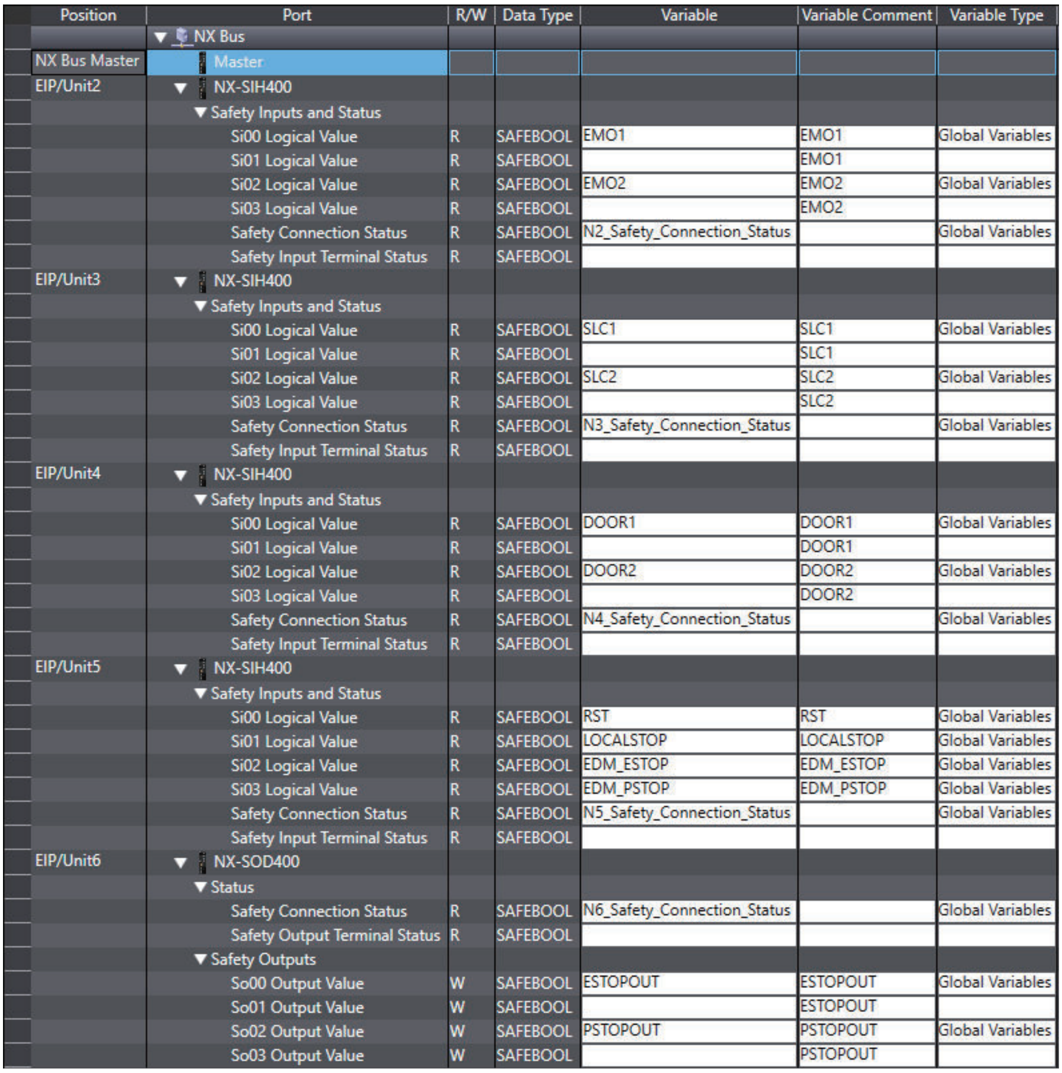

Reset Switch with Test Pulse
Mechanical Contact for Single Channel
EDM Feedback
Feedback
EDM Feedback
Feedback
EIP/Unit5 : NX-SIH400 (N5 : Instance3)
Si00 RST
T0
Si01 EDM_PSTOP
T1
Si02 EDM_ESTOP
T0
Si03 EDM_PSTOP
T1
T0: Test Output (mechanical contact)
T1: Test Output (mechanical contact)
Si00 Si01
T0 T1
Si02 Si03
T0 T1

Set the Safety Output Unit (N6) as shown below.


EIP/Unit6 : NX-SOD400 (N6 : Instance4)
ESTOPOUT So00
ESTOPOUT So01
IOG
IOG
PSTOPOUT So02
PSTOPOUT So03
IOG
IOG
Relays with Forcibly Guided Contacts for Dual Channel
SR
SR
Relays with Forcibly Guided Contacts for Dual Channel
SR
SR
So00 So01
IOG IOG
So02 So03
IOG IOG

Registering Device Variables

Use the Sysmac Studio and set the device variables of each Safety I/O Unit.

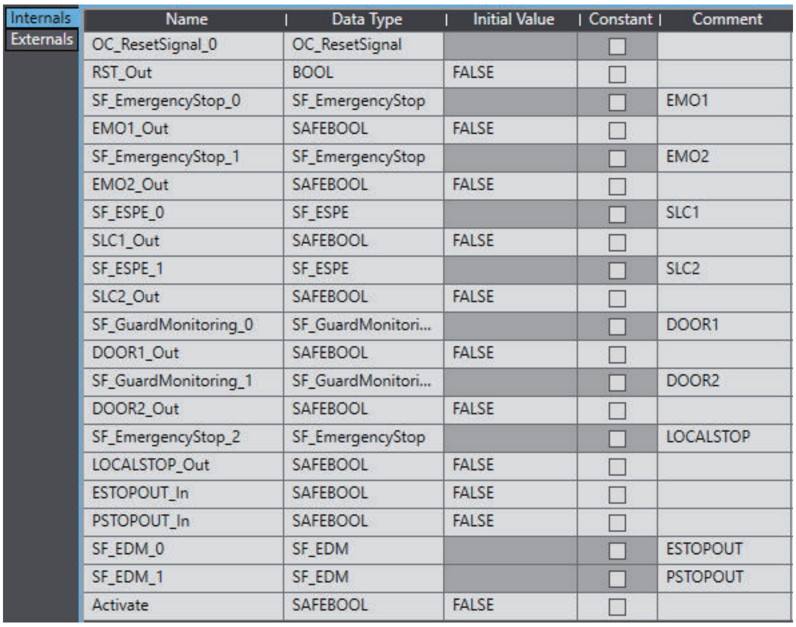


Position	Port	R/W	Data Type	Variable	Variable Comment	Variable Type
	▼ NX Bus					
NX Bus Master	Master					
EIP/Unit2	▼ NX-SIH400					
	▼ Safety Inputs and Status					
	Si00 Logical Value	R	SAFEBOOL	EMO1	EMO1	Global Variables
	Si01 Logical Value	R	SAFEBOOL		EMO1	
	Si02 Logical Value	R	SAFEBOOL	EMO2	EMO2	Global Variables
	Si03 Logical Value	R	SAFEBOOL		EMO2	
	Safety Connection Status	R	SAFEBOOL	N2_Safety_Connection_Status		Global Variables
	Safety Input Terminal Status	R	SAFEBOOL			
EIP/Unit3	▼ NX-SIH400					
	▼ Safety Inputs and Status					
	Si00 Logical Value	R	SAFEBOOL	SLC1	SLC1	Global Variables
	Si01 Logical Value	R	SAFEBOOL		SLC1	
	Si02 Logical Value	R	SAFEBOOL	SLC2	SLC2	Global Variables
	Si03 Logical Value	R	SAFEBOOL		SLC2	
	Safety Connection Status	R	SAFEBOOL	N3_Safety_Connection_Status		Global Variables
	Safety Input Terminal Status	R	SAFEBOOL			
EIP/Unit4	▼ NX-SIH400					
	▼ Safety Inputs and Status					
	Si00 Logical Value	R	SAFEBOOL	DOOR1	DOOR1	Global Variables
	Si01 Logical Value	R	SAFEBOOL		DOOR1	
	Si02 Logical Value	R	SAFEBOOL	DOOR2	DOOR2	Global Variables
	Si03 Logical Value	R	SAFEBOOL		DOOR2	
	Safety Connection Status	R	SAFEBOOL	N4_Safety_Connection_Status		Global Variables
	Safety Input Terminal Status	R	SAFEBOOL			
EIP/Unit5	▼ NX-SIH400					
	▼ Safety Inputs and Status					
	Si00 Logical Value	R	SAFEBOOL	RST	RST	Global Variables
	Si01 Logical Value	R	SAFEBOOL	LOCALSTOP	LOCALSTOP	Global Variables
	Si02 Logical Value	R	SAFEBOOL	EDM_ESTOP	EDM_ESTOP	Global Variables
	Si03 Logical Value	R	SAFEBOOL	EDM_PSTOP	EDM_PSTOP	Global Variables
	Safety Connection Status	R	SAFEBOOL	N5_Safety_Connection_Status		Global Variables
	Safety Input Terminal Status	R	SAFEBOOL			
EIP/Unit6	▼ NX-SOD400					
	▼ Status					
	Safety Connection Status	R	SAFEBOOL	N6_Safety_Connection_Status		Global Variables
	Safety Output Terminal Status	R	SAFEBOOL			
	▼ Safety Outputs					
	So00 Output Value	W	SAFEBOOL	ESTOPOUT	ESTOPOUT	Global Variables
	So01 Output Value	W	SAFEBOOL		ESTOPOUT	
	So02 Output Value	W	SAFEBOOL	PSTOPOUT	PSTOPOUT	Global Variables
	So03 Output Value	W	SAFEBOOL		PSTOPOUT	

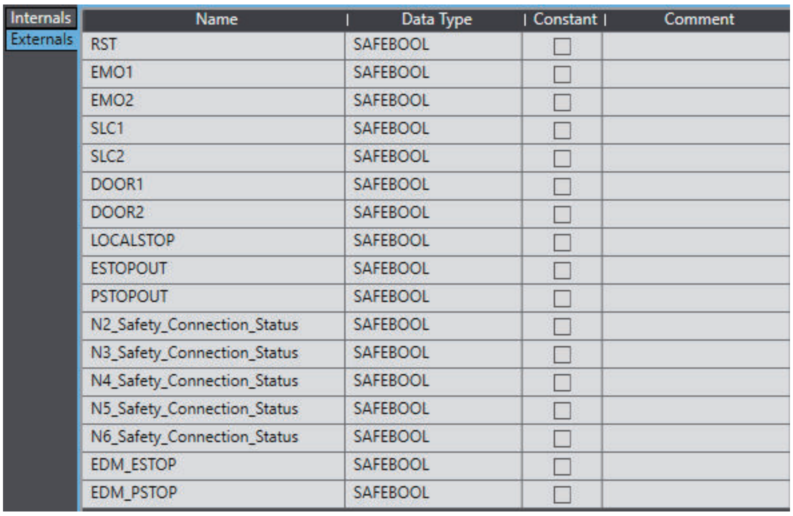
Safety Programs

Use the Sysmac Studio to create variables and programs as shown below.

Create variables as shown below.

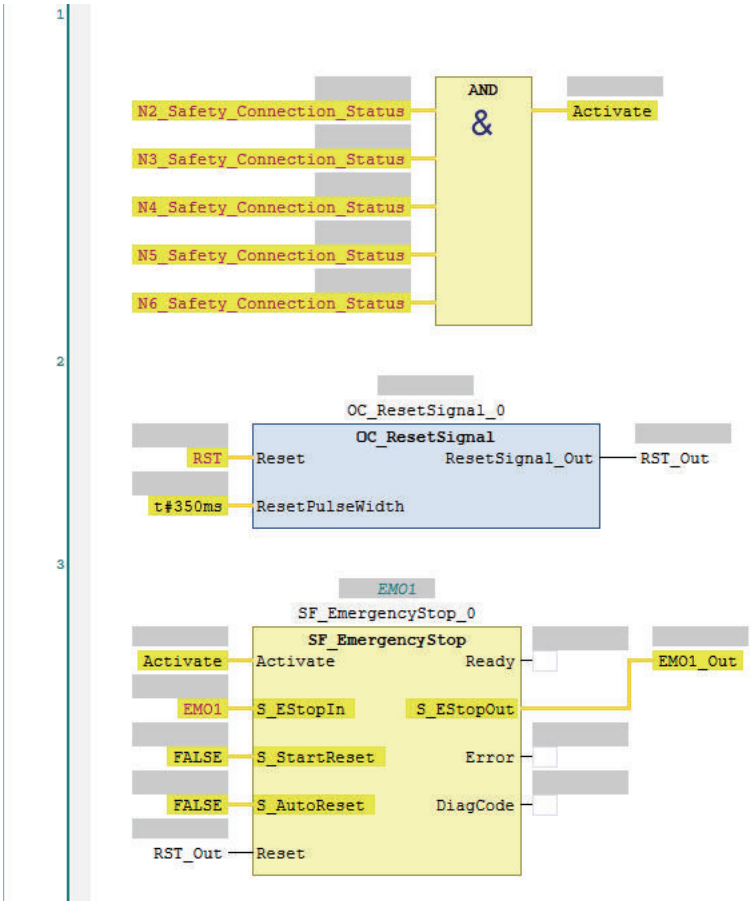


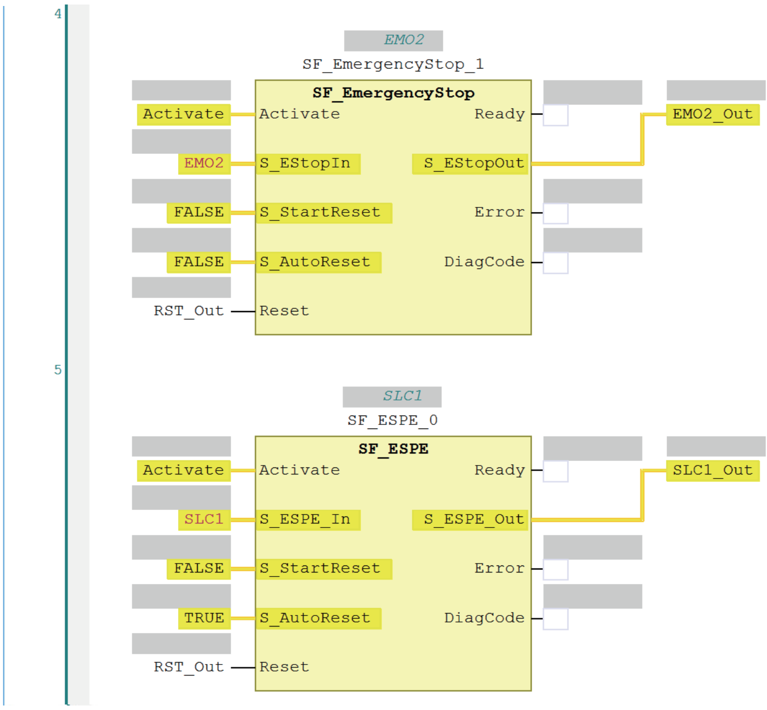
Name	Data Type	Initial Value	Constant	Comment
OC_ResetSignal_0	OC_ResetSignal		☐	
RST_Out	BOOL	FALSE	☐	
SF_EmergencyStop_0	SF_EmergencyStop		☐	EMO1
EMO1_Out	SAFEBOOL	FALSE	☐	
SF_EmergencyStop_1	SF_EmergencyStop		☐	EMO2
EMO2_Out	SAFEBOOL	FALSE	☐	
SF_ESPE_0	SF_ESPE		☐	SLC1
SLC1_Out	SAFEBOOL	FALSE	☐	
SF_ESPE_1	SF_ESPE		☐	SLC2
SLC2_Out	SAFEBOOL	FALSE	☐	
SF_GuardMonitoring_0	SF_GuardMonitori...		☐	DOOR1
DOOR1_Out	SAFEBOOL	FALSE	☐	
SF_GuardMonitoring_1	SF_GuardMonitori...		☐	DOOR2
DOOR2_Out	SAFEBOOL	FALSE	☐	
SF_EmergencyStop_2	SF_EmergencyStop		☐	LOCALSTOP
LOCALSTOP_Out	SAFEBOOL	FALSE	☐	
ESTOPOUT_In	SAFEBOOL	FALSE	☐	
PSTOPOUT_In	SAFEBOOL	FALSE	☐	
SF_EDM_0	SF_EDM		☐	ESTOPOUT
SF_EDM_1	SF_EDM		☐	PSTOPOUT
Activate	SAFEBOOL	FALSE	☐	

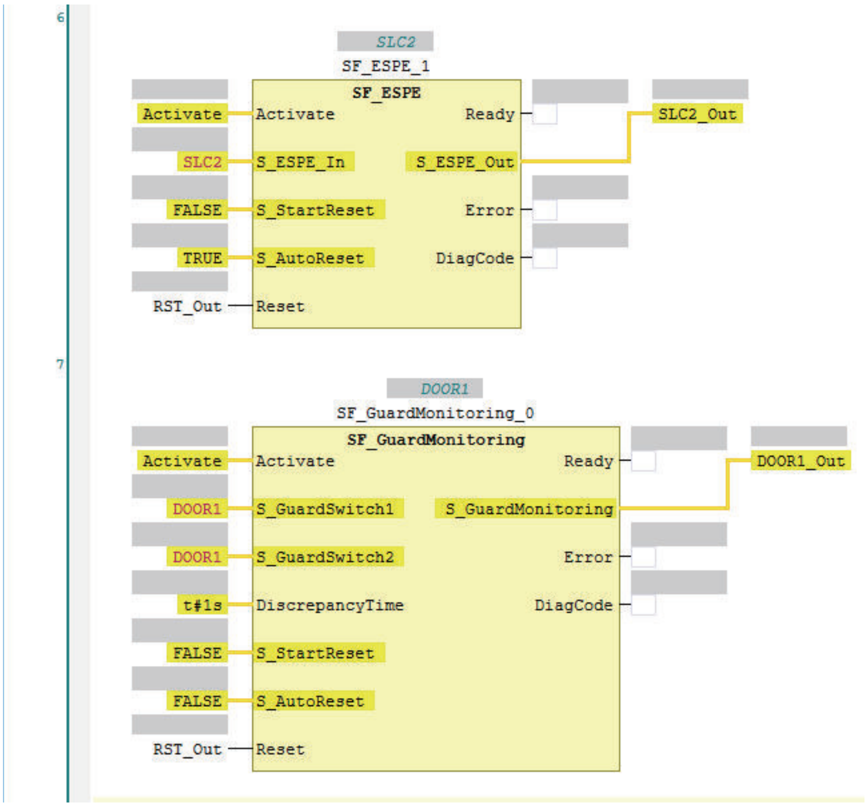


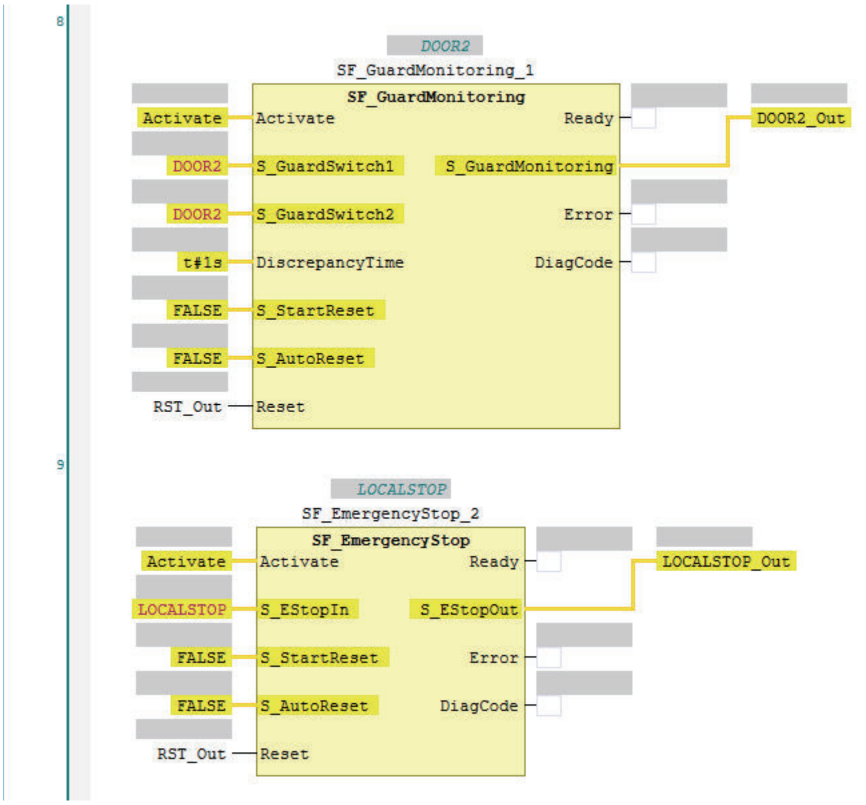
Name	Data Type	Constant	Comment
RST	SAFEBOOL	☐	
EMO1	SAFEBOOL	☐	
EMO2	SAFEBOOL	☐	
SLC1	SAFEBOOL	☐	
SLC2	SAFEBOOL	☐	
DOOR1	SAFEBOOL	☐	
DOOR2	SAFEBOOL	☐	
LOCALSTOP	SAFEBOOL	☐	
ESTOPOUT	SAFEBOOL	☐	
PSTOPOUT	SAFEBOOL	☐	
N2_Safety_Connection_Status	SAFEBOOL	☐	
N3_Safety_Connection_Status	SAFEBOOL	☐	
N4_Safety_Connection_Status	SAFEBOOL	☐	
N5_Safety_Connection_Status	SAFEBOOL	☐	
N6_Safety_Connection_Status	SAFEBOOL	☐	
EDM_ESTOP	SAFEBOOL	☐	
EDM_PSTOP	SAFEBOOL	☐	

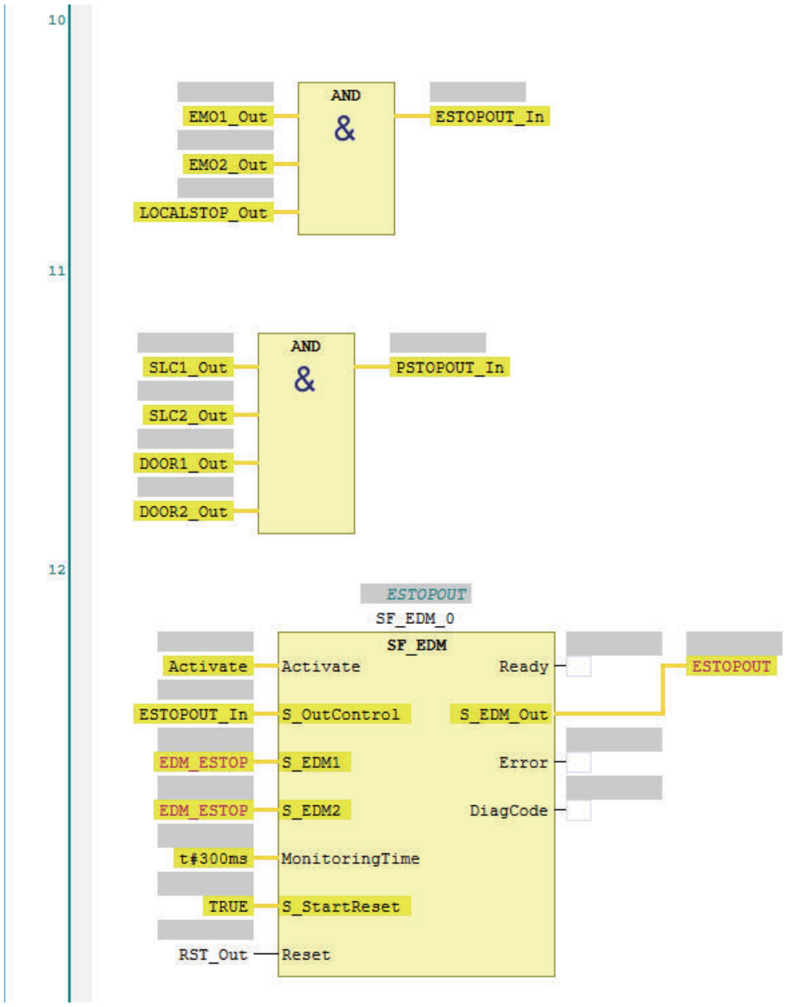
Create programs as shown below.

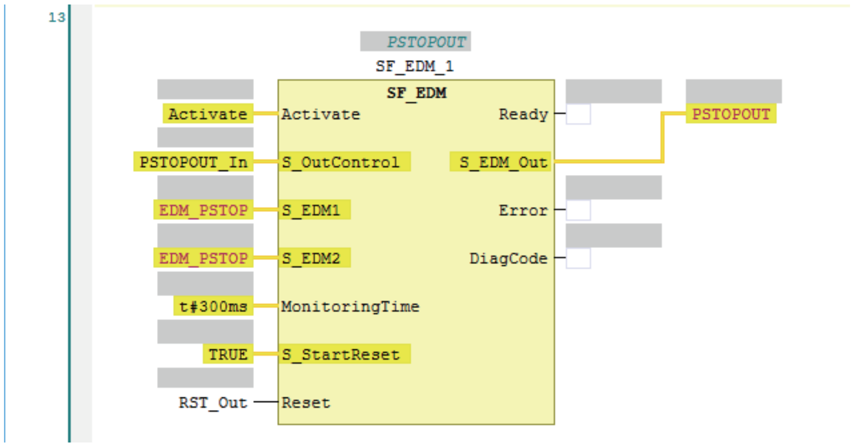

1
N2_Safety_Connection_Status
N3_Safety_Connection_Status
N4_Safety_Connection_Status
N5_Safety_Connection_Status
N6_Safety_Connection_Status
AND
&
Activate
2
OC_ResetSignal_0
OC_ResetSignal
RST
Reset
ResetSignal_Out
RST_Out
t#350ms
ResetPulseWidth
3
EMO1
SF_EmergencyStop_0
SF_EmergencyStop
Activate
Activate
Ready
EMO1_Out
EMO1
S_EStopIn
S_EStopOut
FALSE
S_StartReset
Error
FALSE
S_AutoReset
DiagCode
RST_Out
Reset


4
EMO2
SF_EmergencyStop_1
SF_EmergencyStop
Activate
Activate
Ready
EMO2_Out
EMO2
S_EStopIn
S_EStopOut
FALSE
S_StartReset
Error
FALSE
S_AutoReset
DiagCode
RST_Out
Reset
5
SLC1
SF_ESPE_0
SF_ESPE
Activate
Activate
Ready
SLC1_Out
SLC1
S_ESPE_In
S_ESPE_Out
FALSE
S_StartReset
Error
TRUE
S_AutoReset
DiagCode
RST_Out
Reset


6
SLC2
SF_ESPE_1
SF_ESPE
Activate
Activate
Ready
SLC2_Out
SLC2
S_ESPE_In
S_ESPE_Out
FALSE
S_StartReset
Error
TRUE
S_AutoReset
DiagCode
RST_Out
Reset
7
DOOR1
SF_GuardMonitoring_0
SF_GuardMonitoring
Activate
Activate
Ready
DOOR1_Out
DOOR1
S_GuardSwitch1
S_GuardMonitoring
DOOR1
S_GuardSwitch2
Error
t#1s
DiscrepancyTime
DiagCode
FALSE
S_StartReset
FALSE
S_AutoReset
RST_Out
Reset


8
DOOR2
SF_GuardMonitoring_1
SF_GuardMonitoring
Activate
Activate
Ready
DOOR2_Out
DOOR2
S_GuardSwitch1
S_GuardMonitoring
DOOR2
S_GuardSwitch2
Error
t#1s
DiscrepancyTime
DiagCode
FALSE
S_StartReset
FALSE
S_AutoReset
RST_Out
Reset
9
LOCALSTOP
SF_EmergencyStop_2
SF_EmergencyStop
Activate
Activate
Ready
LOCALSTOP_Out
LOCALSTOP
S_EStopIn
S_EStopOut
FALSE
S_StartReset
Error
FALSE
S_AutoReset
DiagCode
RST_Out
Reset


10
EMO1_Out
EMO2_Out
LOCALSTOP_Out
AND
&
ESTOPOUT_In
11
SLC1_Out
SLC2_Out
DOOR1_Out
DOOR2_Out
AND
&
PSTOPOUT_In
12
ESTOPOUT
SF_EDM_0
SF_EDM
Activate
Activate
Ready
ESTOPOUT
ESTOPOUT_In
S_OutControl
S_EDM_Out
EDM_ESTOP
S_EDM1
Error
EDM_ESTOP
S_EDM2
DiagCode
t#300ms
MonitoringTime
TRUE
S_StartReset
RST_Out
Reset


13
PSTOPOUT
SF_EDM_1
SF_EDM
Activate
Activate
Ready
PSTOPOUT
PSTOPOUT_In
S_OutControl
S_EDM_Out
EDM_PSTOP
S_EDM1
Error
EDM_PSTOP
S_EDM2
DiagCode
t#300ms
MonitoringTime
TRUE
S_StartReset
RST_Out
Reset

A-2 Setting Items on the Sysmac Studio and the Setting Targets

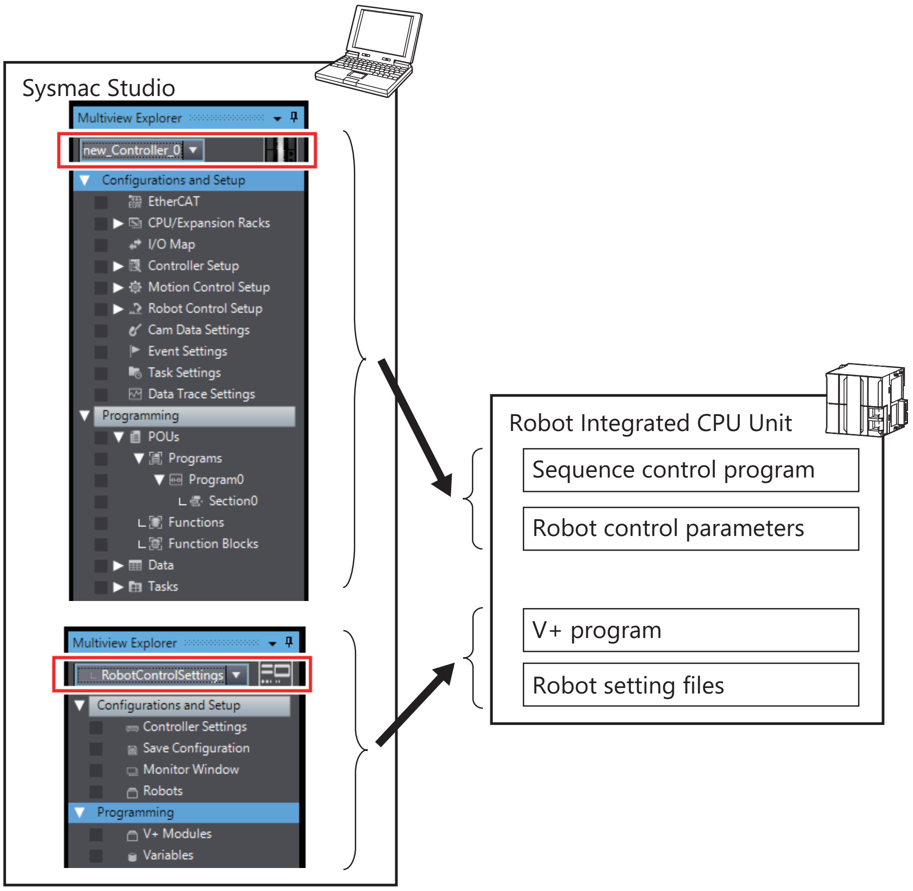
The correspondances between the items in the Multiview Explorer of the Sysmac Studio and each hardware are provided below.

If you select **new_Controller_0** for the device in the Multiview Explorer, the settings for a sequence control program of a Robot Integrated CPU Unit, and if you select **RobotControlSettings**, the settings for a V+ program of a Robot Integrated CPU Unit are made.

Refer to the manual for the specific product for details.

Setting items in the MultiView Explorer

Setting target


Sysmac Studio
Multiview Explorer
new_Controller_0
Configurations and Setup
EtherCAT
CPU/Expansion Racks
I/O Map
Controller Setup
Motion Control Setup
Robot Control Setup
Cam Data Settings
Event Settings
Task Settings
Data Trace Settings
Programming
POUs
Programs
Program0
Section0
Functions
Function Blocks
Data
Tasks
Multiview Explorer
RobotControlSettings
Configurations and Setup
Controller Settings
Save Configuration
Monitor Window
Robots
Programming
V+ Modules
Variables
Robot Integrated CPU Unit
Sequence control program
Robot control parameters
V+ program
Robot setting files

A-3 Using Troubleshooting Functions

Refer to the *Sysmac Studio Robot Integrated System Building Function with Robot Integrated CPU Unit Operation Manual (Cat. No. W595)* for the operation procedure of the troubleshooting functions on the Sysmac Studio.

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