Machine Automation Controller

NJ-series

CPU Unit Built-in EtherCAT Port

User's Manual

NJ501-1300
NJ501-1400
NJ501-1500

CPU Unit

always in control

W505-E1-01

Introduction

Thank you for purchasing an NJ-series CPU Unit.
This manual contains information that is necessary to use the NJ-series CPU Unit. Please read this manual and make sure you understand the functionality and performance of the NJ-series CPU Unit before you attempt to use it in a control system.
Keep this manual in a safe place where it will be available for reference during operation.

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.

For programming, this manual is intended for personnel who understand the programming language specifications in international standard IEC 61131-3 or Japanese standard JIS B3503.

Applicable Products

This manual covers the following products.

- NJ-series CPU Units
  - NJ501-1300
  - NJ501-1400
  - NJ501-1500

Relevant Manuals

There are three manuals that provide basic information on the NJ-series CPU Units: the *NJ-series CPU Unit Hardware User's Manual*, the *NJ-series CPU Unit Software User's Manual* (this manual), and the *NJ-series Instructions Reference Manual*.

Most operations are performed from the Sysmac Studio Automation Software. Refer to the *Sysmac Studio Version 1 Operation Manual* (Cat. No. W504) for information on the Sysmac Studio.

Other manuals are necessary for specific system configurations and applications.

Read all of the manuals that are relevant to your system configuration and application to make the most of the NJ-series CPU Unit.

	NJ-series User's Manuals								
	Basic information								
	NJ-series CPU Unit Hardware User's Manual	NJ-series CPU Unit Software User's Manual	NJ-series Instructions Reference Manual	NJ-series CPU Unit Motion Control User's Manual	NJ-series CPU Unit Built-in EtherCAT Port User's Manual	NJ-series Motion Control Instructions Reference Manual	NJ-series CPU Unit Built-in EtherNet/IP Port User's Manual	NJ-series Troubleshooting Manual	CJ-series Special Unit Operation Manuals for NJ-series CPU Unit
Introduction to NJ-series Controllers	●								
Setting devices and hardware									
Using motion control				●					
Using EtherCAT	●				●				
Using EtherNet/IP							●		
Using CJ-series Units									●
Software settings		●							
Using motion control				●					
Using EtherCAT					●				
Using EtherNet/IP							●		
Programming		●	●						
Using motion control				●		●			
Using EtherCAT					●				
Using CJ-series Units									●
Programming error processing								●	
Testing operation and debugging		●							
Using motion control				●					
Using EtherCAT					●				
Using EtherNet/IP							●		
Troubleshooting and managing errors in an NJ-series Controller	△ Use the relevant manuals for references according to any error that occurs.	△		△	△		△	●	
Maintenance									
Using EtherCAT	●				●				
Using EtherNet/IP							●		
Using CJ-series Units									●

Manual Configuration

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

Section	Description
Section 1 **Introduction**	This section provides an introduction to the NJ-series Controllers and their features, and gives the NJ-series Controller specifications.
Section 2 **System Configuration**	This section describes the system configuration used for NJ-series Controllers.
Section 3 **Configuration Units**	This section describes the parts and functions of the configuration devices in the NJ-series Controller configuration, including the CPU Unit and Configuration Units.
Section 4 **Installation and Wiring**	This section describes where and how to install the CPU Unit and Configuration Units and how to wire them.
Section 5 **Troubleshooting**	This section describes the event codes, error confirmation methods, and corrections for errors that can occur.
Section 6 **Inspection and Maintenance**	This section describes the contents of periodic inspections, the service life of the Battery and Power Supply Units, and replacement methods for the Battery and Power Supply Units.
Appendices	The appendices provide the specifications of the Basic I/O Units, Unit dimensions, load short-circuit protection detection, line disconnection detection, and measures for EMC Directives.

NJ-series CPU Unit Software User's Manual (Cat. No. W501)

Section	Description
Section 1 **Introduction**	This section provides an introduction to the NJ-series Controllers and their features, and gives the NJ-series Controller specifications.
Section 2 **CPU Unit Operation**	This section describes the variables and control systems of the CPU Unit and CPU Unit status.
Section 3 **I/O Ports, Slave Configuration, and Unit Configuration**	This section describes how to use I/O ports, how to create the slave configuration and unit configuration and how to assign functions.
Section 4 **Controller Setup**	This section describes the initial settings of the function modules.
Section 5 **Designing Tasks**	This section describes the task system and types of tasks.
Section 6 **Programming**	This section describes programming, including the programming languages and the variables and instructions that are used in programming.
Section 7 **Simulation, Transferring Projects to the Physical CPU Unit, and Operation**	This section describes simulation of Controller operation and how to use the results of simulation.
Section 8 **CPU Unit Status**	This section describes CPU Unit status.
Section 9 **CPU Unit Functions**	This section describes the functionality provided by the CPU Unit.
Section 10 **Communications Setup**	This section describes how to go online with the CPU Unit and how to connect to other devices.
Section 11 **Example of Actual Application Procedures**	This section describes the procedures that are used to actually operate an NJ-series Controller.
Section 12 **Troubleshooting**	This section describes the event codes, error confirmation methods, and corrections for errors that can occur.
Appendices	The appendices provide the CPU Unit specifications, task execution times, system-defined variable lists, data attribute lists, CJ-series Unit memory information, CJ-series Unit memory allocation methods, and data type conversion information.

NJ-series CPU Unit Built-in EtherCAT Port User's Manual (Cat. No. W505) (This Manual)

Section	Description
Section 1 **Introduction**	This section provides an overview of EtherCAT communications, describes the system configuration and specifications, and provides operating procedures.
Section 2 **Part Names and Slave Settings**	This section provides the part names and describes the slave settings and Sysmac device functions.
Section 3 **EtherCAT Communications**	This section describes the different types of EtherCAT communications, EtherCAT settings, and state transitions.
Section 4 **EtherCAT Network Wiring**	This section describes how to connect and wire an EtherCAT network.
Section 5 **Setting Up EtherCAT Communications with the Sysmac Studio**	This section describes how to set the network configuration information and how to check EtherCAT communications from the Sysmac Studio.
Section 6 **Process Data Communications and SDO Communications**	This section describes the timing of communications, response times, and special instructions for process data communications and SDO communications. It also provides sample programming.
Section 7 **System-defined Variables That Are Related to the Built-in EtherCAT Port**	This section describes the system-defined variables that are related to the built-in EtherCAT port.
Section 8 **Example of Operations for EtherCAT Communications**	This section provides a series of example operations for when an NJ-series CPU Unit is connected to slaves.
Section 9 **Troubleshooting**	This section describes the event codes, error confirmation methods, and corrections for errors that can occur for EtherCAT communications. It also describes how to replace slaves.
Appendices	The appendices describe the relation of EtherCAT communications to overall CPU Unit status, packet monitoring functions, and multi-vendor application.

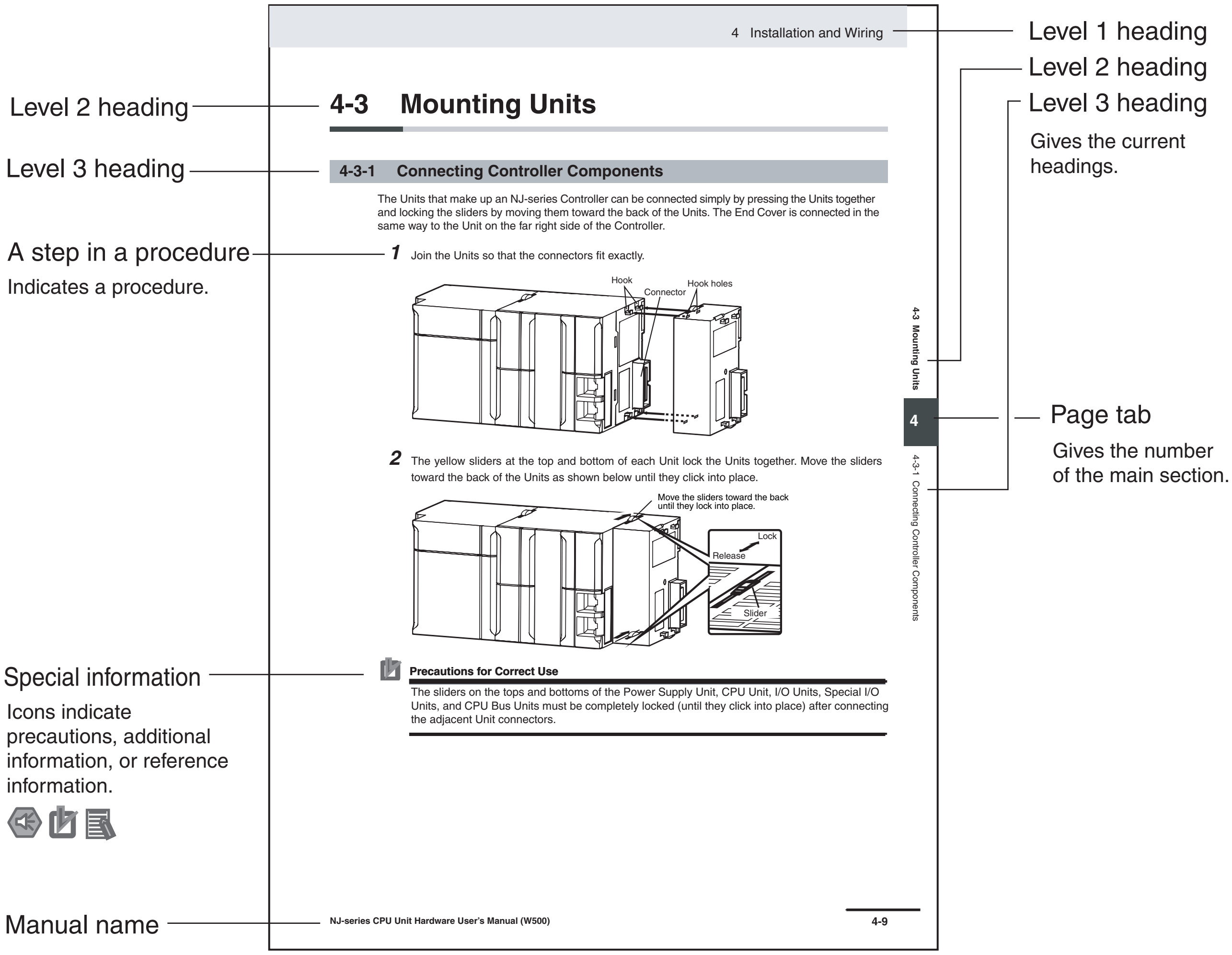
Sysmac Studio Version 1 Operation Manual (Cat. No. W504)

Section	Description
Section 1 **Introduction**	This section provides an overview and lists the specifications of the Sysmac Studio and describes its features and components.
Section 2 **Installation and Uninstallation**	This section describes how to install and uninstall the Sysmac Studio.
Section 3 **System Design**	This section describes the basic concepts for designing an NJ-series System with the Sysmac Studio and the basic operating procedures.
Section 4 **Programming**	This section describes how to create programs with the Sysmac Studio.
Section 5 **Online Connections to a Controller**	This section describes how to go online with a Controller.
Section 6 **Debugging**	This section describes how to debug the programs online on the Controller or debug it offline with the Simulator.
Section 7 **Other Functions**	This section describes Sysmac Studio functions other than system design functions.
Section 8 **Reusing Programming**	This section describes how to reuse the programs that you create with the Sysmac Studio.
Section 9 **Support Software Provided with the Sysmac Studio**	This section describes the Support Software that is provided with the Sysmac Studio.
Section 10 **Troubleshooting**	This section describes the error messages that are displayed when you check a program on the Sysmac Studio and how to correct those errors.
Appendices	The appendices describe the following: Driver Installation for Direct USB Cable Connection Specifying One of Multiple Ethernet Interface Cards Online Help Simulation Instructions

Manual Structure

Page Structure

The following page structure is used in this manual.


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
Hook
Connector
Hook holes
Move the sliders toward the back until they lock into place.
Lock
Release
Slider
4-3 Mounting Units
4
4-3-1 Connecting Controller Components

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.

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.

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.

NJ-series CPU Unit Hardware User's Manual (W500) 4-9

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.

Note References are provided to more detailed or related information.

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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2 Part Names and Slave Settings

I Index

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4 EtherCAT Network Wiring

5 Setting Up EtherCAT Communications with the Sysmac Studio

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7 System-defined Variables That Are Related to the Built-in EtherCAT Port

8 Example of Operations for EtherCAT Communications

9 Troubleshooting

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Read and Understand this Manual

Please read and understand this manual before using the product. Please consult your OMRON representative if you have any questions or comments.

Warranty and Limitations of Liability

WARRANTY

OMRON's exclusive warranty is that the products are free from defects in materials and workmanship for a period of one year (or other period if specified) from date of sale by OMRON.

OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, REGARDING NON-INFRINGEMENT, MERCHANTABILITY, OR FITNESS FOR PARTICULAR PURPOSE OF THE PRODUCTS. ANY BUYER OR USER ACKNOWLEDGES THAT THE BUYER OR USER ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. OMRON DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED.

LIMITATIONS OF LIABILITY

OMRON SHALL NOT BE RESPONSIBLE FOR SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED ON CONTRACT, WARRANTY, NEGLIGENCE, OR STRICT LIABILITY.

In no event shall the responsibility of OMRON for any act exceed the individual price of the product on which liability is asserted.

IN NO EVENT SHALL OMRON BE RESPONSIBLE FOR WARRANTY, REPAIR, OR OTHER CLAIMS REGARDING THE PRODUCTS UNLESS OMRON'S ANALYSIS CONFIRMS THAT THE PRODUCTS WERE PROPERLY HANDLED, STORED, INSTALLED, AND MAINTAINED AND NOT SUBJECT TO CONTAMINATION, ABUSE, MISUSE, OR INAPPROPRIATE MODIFICATION OR REPAIR.

Application Considerations

SUITABILITY FOR USE

OMRON shall not be responsible for conformity with any standards, codes, or regulations that apply to the combination of products in the customer's application or use of the products.

At the customer's request, OMRON will provide applicable third party certification documents identifying ratings and limitations of use that apply to the products. This information by itself is not sufficient for a complete determination of the suitability of the products in combination with the end product, machine, system, or other application or use.

The following are some examples of applications for which particular attention must be given. This is not intended to be an exhaustive list of all possible uses of the products, nor is it intended to imply that the uses listed may be suitable for the products:

- Outdoor use, uses involving potential chemical contamination or electrical interference, or conditions or uses not described in this manual.
- Nuclear energy control systems, combustion systems, railroad systems, aviation systems, medical equipment, amusement machines, vehicles, safety equipment, and installations subject to separate industry or government regulations.
- Systems, machines, and equipment that could present a risk to life or property.

Please know and observe all prohibitions of use applicable to the products.

NEVER USE THE PRODUCTS FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCTS ARE PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

PROGRAMMABLE PRODUCTS

OMRON shall not be responsible for the user's programming of a programmable product, or any consequence thereof.

Disclaimers

CHANGE IN SPECIFICATIONS

Product specifications and accessories may be changed at any time based on improvements and other reasons.

It is our practice to change model numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the products may be changed without any notice. When in doubt, special model numbers may be assigned to fix or establish key specifications for your application on your request. Please consult with your OMRON representative at any time to confirm actual specifications of purchased products.

DIMENSIONS AND WEIGHTS

Dimensions and weights are nominal and are not to be used for manufacturing purposes, even when tolerances are shown.

PERFORMANCE DATA

Performance data given in this manual is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of OMRON's test conditions, and the users must correlate it to actual application requirements. Actual performance is subject to the OMRON Warranty and Limitations of Liability.

ERRORS AND OMISSIONS

The information in this manual has been carefully 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 built-in EtherCAT port on an NJ-series CPU Unit. The safety precautions that are provided are extremely important to safety. Always read and heed the information provided in all safety precautions.
The following notation is used. Refer to the following manuals for safety precautions for the built-in EtherCAT port. Installation precautions are also provided for the NJ-series CPU Unit and NJ-series Controller system.

- NJ-series CPU Unit Hardware User's Manual (Cat. No. W500)
- NJ-series CPU Unit Software User's Manual (Cat. No. W501)

⚠ **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.

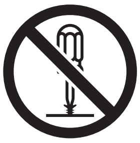
Precautions for Safe Use

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

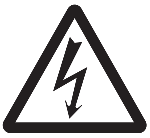
Precautions for Correct Use

Indicates precautions on what to do and what not to do to ensure proper operation and performance.

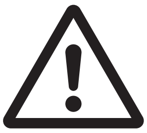
Symbols



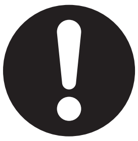
The circle and slash symbol indicates operations that you must not do.
The specific operation is shown in the circle and explained in text.
This example indicates prohibiting disassembly.



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.

Precautions for Safe Use

Refer to the following manuals for precautions for the safe use of the built-in EtherCAT port. Installation precautions are also provided for the NJ-series CPU Unit and NJ-series Controller system.

- NJ-series CPU Unit Hardware User's Manual (Cat. No. W500)
- NJ-series CPU Unit Software User's Manual (Cat. No. W501)

Precautions for Correct Use

Refer to the following manuals for precautions for the correct use of the built-in EtherCAT port. Installation precautions are also provided for the NJ-series CPU Unit and NJ-series Controller system.

- NJ-series CPU Unit Hardware User’s Manual (Cat. No. W500)
- NJ-series CPU Unit Software User’s Manual (Cat. No. W501)

Regulations and Standards

Conformance to EC Directives

Applicable Directives

- EMC Directives
- Low Voltage Directive

Concepts

● EMC Directive

OMRON devices that comply with EC Directives also conform to the related EMC standards so that they can be more easily built into other devices or the overall machine. The actual products have been checked for conformity to EMC standards.*

Whether the products conform to the standards in the system used by the customer, however, must be checked by the customer. EMC-related performance of the OMRON devices that comply with EC Directives will vary depending on the configuration, wiring, and other conditions of the equipment or control panel on which the OMRON devices are installed. The customer must, therefore, perform the final check to confirm that devices and the overall machine conform to EMC standards.

* Applicable EMC (Electromagnetic Compatibility) standards are as follows:
EMS (Electromagnetic Susceptibility): EN 61131-2 and EN 61000-6-2
EMI (Electromagnetic Interference): EN 61131-2 and EN 61000-6-4 (Radiated emission: 10-m regulations)

● Low Voltage Directive

Always ensure that devices operating at voltages of 50 to 1,000 VAC and 75 to 1,500 VDC meet the required safety standards. The applicable directive is EN 61131-2.

● Conformance to EC Directives

The NJ-series Controllers comply with EC Directives. To ensure that the machine or device in which the NJ-series Controller is used complies with EC Directives, the Controller must be installed as follows:

- The NJ-series Controller must be installed within a control panel.
- You must use reinforced insulation or double insulation for the DC power supplies connected to DC Power Supply Units and I/O Units.
- NJ-series Controllers that comply with EC Directives also conform to the Common Emission Standard (EN 61000-6-4). Radiated emission characteristics (10-m regulations) may vary depending on the configuration of the control panel used, other devices connected to the control panel, wiring, and other conditions.
  You must therefore confirm that the overall machine or equipment complies with EC Directives.

Conformance to Shipbuilding Standards

The NJ-series Controllers comply with the following shipbuilding standards. Applicability to the shipbuilding standards is based on certain usage conditions. It may not be possible to use the product in some locations. Contact your OMRON representative before attempting to use a Controller on a ship.

Usage Conditions for NK and LR Shipbuilding Standards

- The NJ-series Controller must be installed within a control panel.
- Gaps in the door to the control panel must be completely filled or covered with gaskets or other material.
- The following noise filter must be connected to the power supply line.

Noise Filter

Manufacturer	Model
Cosel Co., Ltd.	TAH-06-683

Trademarks

- Sysmac and SYSMAC are trademarks or registered trademarks of OMRON Corporation in Japan and other countries for OMRON factory automation products.
- Windows, Windows 98, Windows XP, Windows Vista, and Windows 7 are registered trademarks of Microsoft Corporation in the USA and other countries.
- EtherCAT® is a registered trademark of Beckhoff Automation GmbH for their patented technology.
- The SD logo is a trademark of SD-3C, LLC.

Other company names and product names in this document are the trademarks or registered trademarks of their respective companies.

Software Licenses and Copyrights

This product incorporates certain third party software. The license and copyright information associated with this software is available at http://www.fa.omron.co.jp/nj_info_e/.

Unit Versions

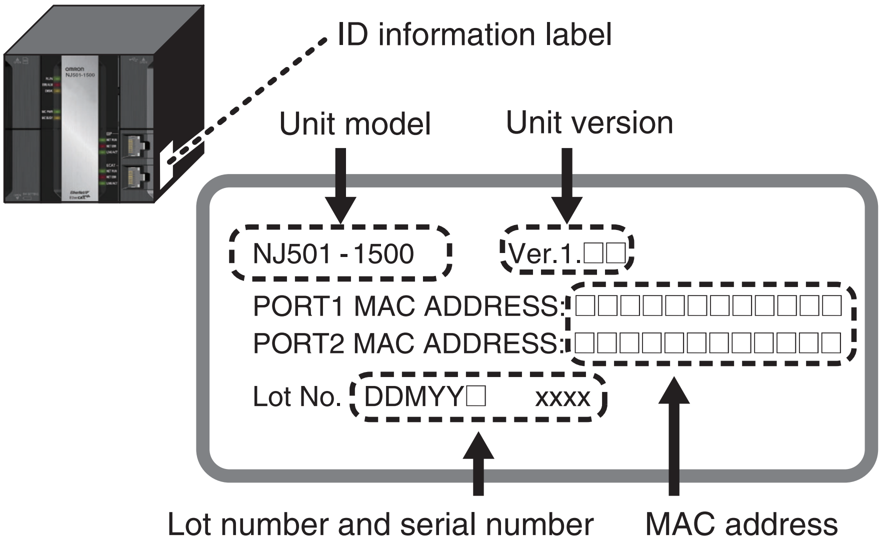
Unit Versions

A “unit version” has been introduced to manage CPU Units in the NJ Series according to differences in functionality accompanying Unit upgrades.

Notation of Unit Versions on Products

The unit version is given on the ID information label of the products for which unit versions are managed, as shown below.

Example for NJ-series NJ501-□□□□ CPU Unit:



The following information is provided on the ID information label.

Item	Description
Unit model	Gives the model of the Unit.
Unit version	Gives the unit version of the Unit.
Lot number and serial number	Gives the lot number and serial number of the Unit. DDMYY: Lot number, □: For use by OMRON, xxxx: Serial number “M” gives the month (1 to 9: January to September, X: October, Y: November, Z: December)
MAC address	Gives the MAC address of the built-in port on the Unit.

Confirming Unit Versions with Sysmac Studio

You can use the Unit Production Information on the Sysmac Studio to check the unit version of the CPU Unit, CJ-series Special I/O Units, CJ-series CPU Bus Units, and EtherCAT slaves. The unit versions of CJ-series Basic I/O Units cannot be checked from the Sysmac Studio.

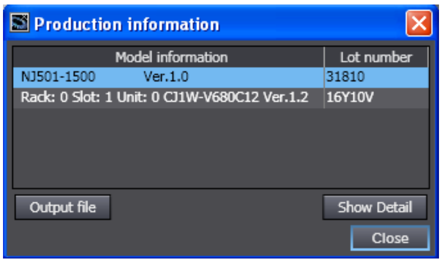
- **CPU Unit and CJ-series Units**

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

The Unit Editor is displayed for the Controller Configurations and Setup layer.

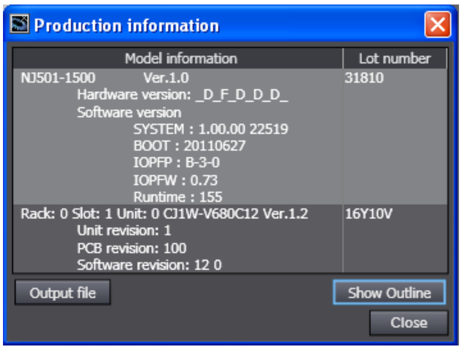
2 Right-click any open space in the Unit Editor and select ***Production Information***.

The Production Information Dialog Box is displayed.



Model information	Lot number
NJ501-1500 Ver.1.0	31810
Rack: 0 Slot: 1 Unit: 0 CJ1W-V680C12 Ver.1.2	16Y10V

Simple Display



Model information	Lot number
NJ501-1500 Ver.1.0 Hardware version: _D_F_D_D_D_ Software version SYSTEM : 1.00.00 22519 BOOT : 20110627 IOPFP : B-3-0 IOPFW : 0.73 Runtime : 155	31810
Rack: 0 Slot: 1 Unit: 0 CJ1W-V680C12 Ver.1.2 Unit revision: 1 PCB revision: 100 Software revision: 12 0	16Y10V

Detailed Display

In this example, “Ver.1.0” is displayed next to the unit model.

The following items are displayed.

CPU Unit	CJ-series Units
Unit model	Unit model
Unit version	Unit version
Lot number	Lot number
	Rack number, slot number, and unit number

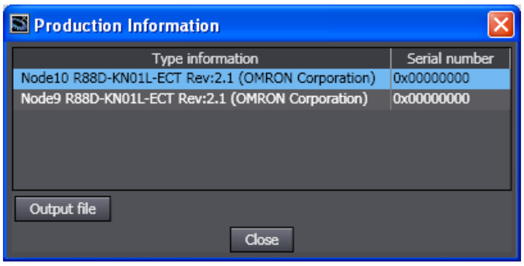
● EtherCAT Slaves

1 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.

The EtherCAT Configuration Tab Page is displayed for the Controller Configurations and Setup layer.

2 Right-click the master in the EtherCAT Configurations Editing Pane and select **Display Production Information**.

The Production Information Dialog Box is displayed.



Type information	Serial number
Node10 R88D-KN01L-ECT Rev:2.1 (OMRON Corporation)	0x00000000
Node9 R88D-KN01L-ECT Rev:2.1 (OMRON Corporation)	0x00000000

The following items are displayed.
Node address
Type information*
Serial number

* If the model number cannot be determined (such as when there is no ESI file), the vendor ID, product code, and revision number are displayed.

Unit Version Notation

In this manual, unit versions are specified as shown in the following table.

Product nameplate	Notation in this manual	Remarks
"Ver.1.0" or later to the right of the lot number	Unit version 1.0 or later	Unless unit versions are specified, the information in this manual applies to all unit versions.

Related Manuals

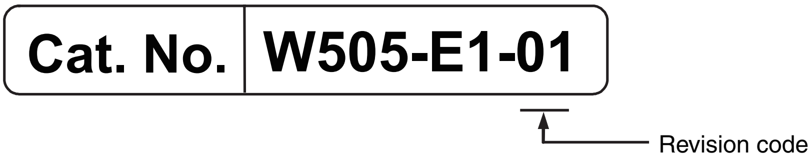
The following manuals are related to the NJ-series Controllers. Use these manuals for reference.

Manual name	Cat. No.	Model numbers	Application	Description
NJ-series CPU Unit Hardware User's Manual	W500	NJ501-□□□□	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 a Controller built with an NJ501 CPU Unit. • Features and system configuration • Introduction • Part names and functions • General specifications • Installation and wiring • Maintenance and inspection Use this manual together with the *NJ-series CPU Unit Software User's Manual* (Cat. No. W501).
NJ-series CPU Unit Software User's Manual	W501	NJ501-□□□□	Learning how to program and set up an NJ-series CPU Unit. Mainly software information is provided.	The following information is provided on a Controller built with an NJ501 CPU Unit. • CPU Unit operation • CPU Unit features • Initial settings • Programming based on IEC 61131-3 language specifications Use this manual together with the *NJ-series CPU Unit Hardware User's Manual* (Cat. No. W500).
NJ-series CPU Unit Motion Control User's Manual	W507	NJ501-□□□□	Learning about motion control settings and programming concepts.	The settings and operation of the CPU Unit and programming concepts for motion control are described. Use this manual together with the *NJ-series CPU Unit Hardware User's Manual* (Cat. No. W500) and *NJ-series CPU Unit Software User's Manual* (Cat. No. W501).
NJ-series Instructions Reference Manual	W502	NJ501-□□□□	Learning about the specifications of the instruction set that is provided by OMRON.	The instructions in the instruction set (IEC 61131-3 specifications) are described. When programming, use this manual together with the *NJ-series CPU Unit Hardware User's Manual* (Cat. No. W500) and *NJ-series CPU Unit Software User's Manual* (Cat. No. W501).
NJ-series Motion Control Instructions Reference Manual	W508	NJ501-□□□□	Learning about the specifications of the motion control instructions that are provided by OMRON.	The motion control instructions are described. When programming, use this manual together with the *NJ-series CPU Unit Hardware User's Manual* (Cat. No. W500), NJ-series CPU Unit Software User's Manual (Cat. No. W501) and *NJ-series CPU Unit Motion Control User's Manual* (Cat. No. W507).
CJ-series Special Unit Manuals for NJ-series CPU Unit	W490 W498 W499 W491 Z310 W492 W494 W497	CJ1W-□□□□	Learning how to use CJ-series Units with an NJ-series CPU Unit.	The methods and precautions for using CJ-series Units with an NJ501 CPU Unit are described, including access methods and programming interfaces. Manuals are available for the following Units. Analog I/O Units, Insulated-type Analog I/O Units, Temperature Control Units, ID Sensor Units, High-speed Counter Units, Serial Communications Units, and DeviceNet Units. Use these manuals together with the *NJ-series CPU Unit Hardware User's Manual* (Cat. No. W500) and *NJ-series CPU Unit Software User's Manual* (Cat. No. W501).

Manual name	Cat. No.	Model numbers	Application	Description
NJ-series CPU Unit Built-in EtherCAT Port User's Manual	W505	NJ501-□□□□	Using the built-in EtherCAT port on an NJ-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. Use this manual together with the *NJ-series CPU Unit Hardware User's Manual* (Cat. No. W500) and *NJ-series CPU Unit Software User's Manual* (Cat. No. W501).
NJ-series CPU Unit Built-in EtherNet/IP Port User's Manual	W506	NJ501-□□□□	Using the built-in EtherNet/IP port on an NJ-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. Use this manual together with the *NJ-series CPU Unit Hardware User's Manual* (Cat. No. W500) and *NJ-series CPU Unit Software User's Manual* (Cat. No. W501).
NJ-series Troubleshooting Manual	W503	NJ501-□□□□	Learning about the errors that may be detected in an NJ-series Controller.	Concepts on managing errors that may be detected in an NJ-series Controller and information on individual errors are described. Use this manual together with the *NJ-series CPU Unit Hardware User's Manual* (Cat. No. W500) and *NJ-series CPU Unit Software User's Manual* (Cat. No. W501).
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.
CX-Integrator CS/CJ/CP/NSJ-series Network Configuration Tool Operation Manual	W464		Learning how to configure networks (data links, routing tables, Communications Unit settings, etc.).	Describes operating procedures for the CX-Integrator.
CX-Designer User's Manual	V099		Learning to create screen data for NS-series Programmable Terminals.	Describes operating procedures for the CX-Designer.
CX-Protocol Operation Manual	W344		Creating data transfer protocols for general-purpose devices connected to CJ-series Serial Communications Units.	Describes operating procedures for the CX-Protocol.

Revision History

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



Revision code	Date	Revised content
01	July 2011	Original production

1

Introduction

This section provides an overview of EtherCAT communications, describes the system configuration and specifications, and provides operating procedures.

1-1 Introduction to EtherCAT 1-2

1-1-1 EtherCAT Features 1-2

1-1-2 EtherCAT Communications 1-2

1-1-3 EtherCAT Features for NJ-series CPU Units 1-3

1-2 System Configuration and Configuration Devices 1-4

1-2-1 System Configuration 1-4

1-2-2 Determining the Network Configuration 1-7

1-3 Specifications of Built-in EtherCAT Port 1-8

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1-4 EtherCAT Communications Procedure 1-10

1-4-1 Overview 1-10

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1-1 Introduction to EtherCAT

EtherCAT (Ethernet Control Automation Technology) is a high-performance industrial network system that enables faster and more efficient communications based on Ethernet. Each node achieves a short communications cycle time by transmitting Ethernet frames at high speed. Furthermore, even though EtherCAT is a unique protocol, it offers excellent general-purpose applicability. For example, you can use Ethernet cables because EtherCAT utilizes standard Ethernet technology for the physical layer. And the effectiveness of EtherCAT can be fully utilized not only in large control systems that require high processing speeds and system integrity, but also in small and medium control systems.

1-1-1 EtherCAT Features

EtherCAT provides the following features.

High-speed Communications at 100 Mbps

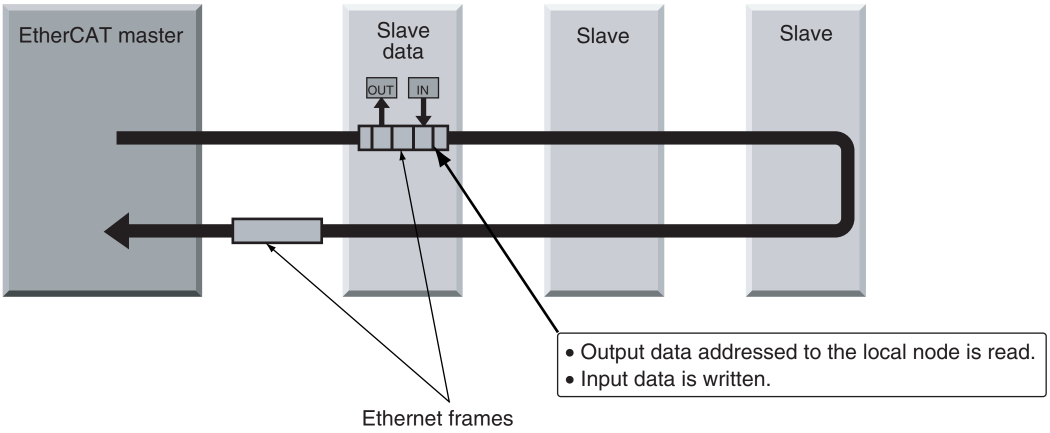
The I/O response time from signal input to signal output has been significantly reduced. By fully utilizing the optimized Ethernet frame bandwidth to transmit data using a high-speed repeat method, it is possible to efficiently transmit a wide variety of data.

Extremely High Compatibility with Ethernet

EtherCAT is an open network with extremely high compatibility with conventional Ethernet systems.

1-1-2 EtherCAT Communications

EtherCAT does not send data to individual slave nodes on the network, instead, it passes Ethernet frames through all of the slave nodes.
When frame passes through a slave node, the slave node reads and writes data in the areas allocated to it in the frames in a few nanoseconds.
The Ethernet frames transmitted by the EtherCAT master pass through all EtherCAT slaves without stopping. The last slave returns all of the frames, which again pass through all of the slaves before returning to the EtherCAT master.
This mechanism ensures high speed and realtime data transmission.



1-1-3 EtherCAT Features for NJ-series CPU Units

EtherCAT in the NJ-series CPU Units has the following features.

Synchronization of the CPU Unit Processing Period and the EtherCAT Communications Cycle

The period of sequence processing and motion processing in the CPU Unit matches the process data communications cycle of EtherCAT.
This enables high-precision sequence control and motion control with a stable fixed period.

Accessing Data with Device Variables without Considering Addresses

EtherCAT slaves are accessed using device variables in the same way as the Units on the NJ-series CPU Racks and Expansion Racks. Various types of data in Servo Drive and the encoder input slaves are accessed using structure-type Axis Variables prepared in advance.
This enables access to slaves on EtherCAT without regard to addresses.

Optimum Functionality and Ease of Operation Based on Unified Specifications

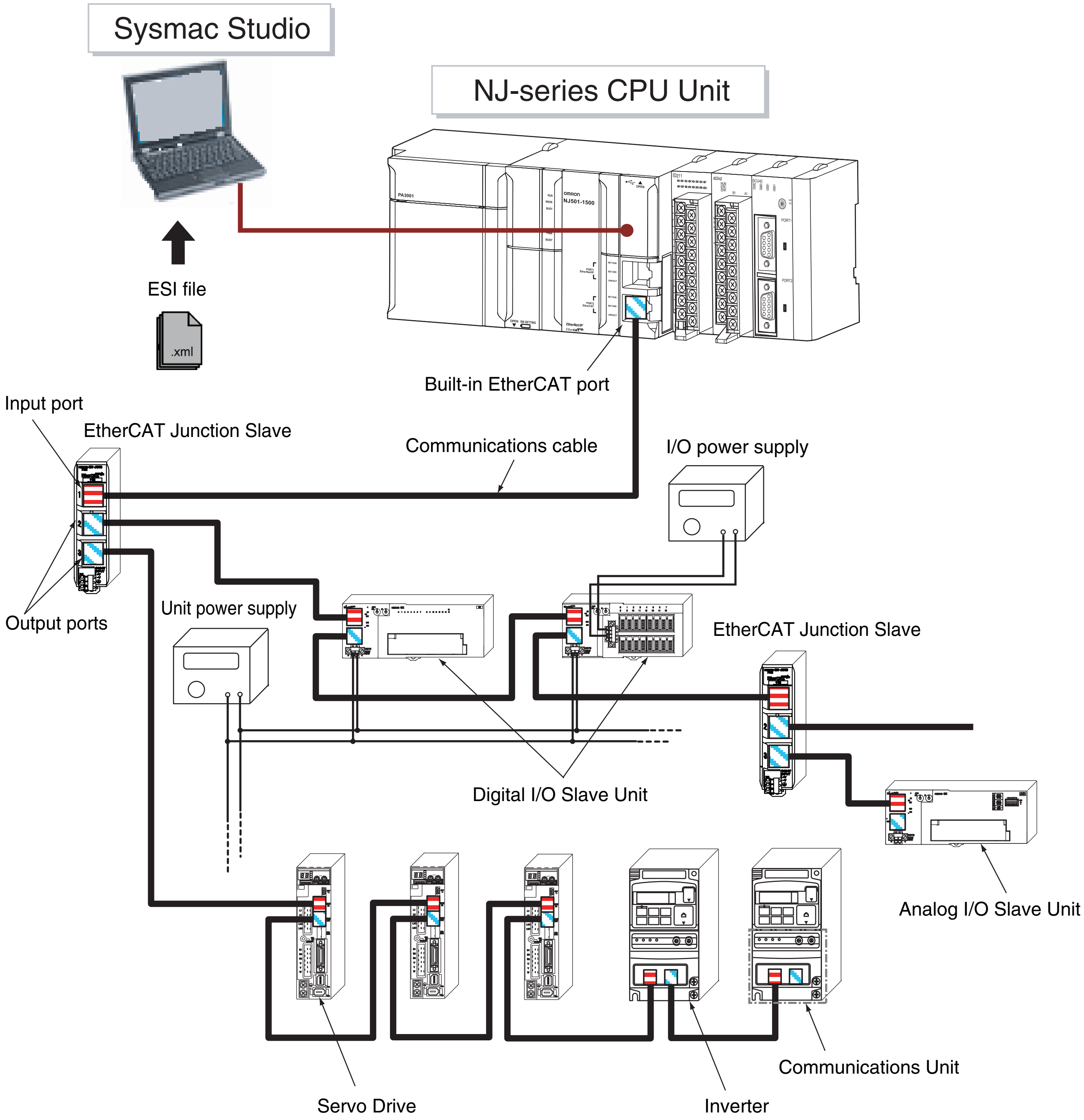
You can use the NJ-series Machine Automation Controllers together with Sysmac devices* and the Sysmac Studio Automation Software to achieve optimum functionality and ease of operation.

* Sysmac devices is a generic name for EtherCAT slaves and other OMRON control components that were designed with the same communications and user interface specifications.

1-2 System Configuration and Configuration Devices

1-2-1 System Configuration

The EtherCAT network configuration and configuration devices are shown below.



Outlines of the configuration devices are given below.

● EtherCAT Master

The EtherCAT master manages the network, monitors the status of slaves, and exchanges I/O data with slaves. There is one output port.

● Output Port

The output port transmits EtherCAT communications data to other devices. When you connect the output port to another device, always connect it to the input port on the other device. Normal communications will not be possible if you connect to the output port on another device.

● Input Port

This port is used to input EtherCAT communications data. Always connect it to the output port on another device. Normal communications will not be possible if you connect to the input port on another device.

● EtherCAT Slaves

Each EtherCAT slave outputs the output data that it received from the EtherCAT master through the EtherCAT network. It also sends input data to the EtherCAT master through the EtherCAT network. In the EtherCAT network, you can use a total of 192 slaves nodes. These can include the slaves that are listed below. The slaves are synchronized even when multiple non-synced slaves and Junction Slaves are connected. Slaves have one input port and at least one output port. Assign node addresses 1 to 192 to the slaves. You can assign any address within the node address setting range (1 to 192) regardless of the type of slave. However, each node address can be used for only one slave. There are also Junction Slaves for which more than one node address is set.

Non-synced Slaves

These slaves perform sequence control. Synchronization is not required between them. They include digital slaves, analog slaves, etc. Each non-synced slave has one input port and one output port.

Synced Slaves

The operation of these slaves is synchronized with a distributed clock (DC). They include Servo Drive and encoder input slaves. Each synced slave has one input port and one output port.

The following tables lists some of the OMRON EtherCAT slaves that are available.

Name	Type	Model	Synced/Non-synced Slaves	Assigning an axis
Digital I/O Slaves	Slaves with screw terminals and 2-tier terminal block	GX-□D16□1/OC1601	Non-synced Slaves	Not possible
	Slaves with screw terminals and 3-tier terminal block	GX-ID16□2/OD16□2/MD16□2	Non-synced Slaves	Not possible
	Slaves with e-CON connectors	GX-□D16□8/□D32□8	Non-synced Slaves	Not possible
Analog I/O Slaves	Slaves with screw terminals and 2-tier terminal block	GX-AD0471/DA0271	Non-synced Slaves	Not possible
Multifunctional, Compact Inverters	MX2 Series	3G3MX2 with EtherCAT Communications Unit 3G3AX-MX2-ECT	Non-synced Slaves	Not possible
AC Servo Drive	G5-series Servo Drive with EtherCAT communications	R88M-K/R88D-KN□-ECT	Synced Slaves	Possible
Encoder Input Slaves	Slave with 3-tier terminal block	GX-EC0211/EC0241	Synced Slaves	Possible

EtherCAT Junction Slave

This is a special unit for branching EtherCAT network wiring. Set the node address in the EtherCAT Junction Slave.

Each Junction Slave has one input port and more than one output port. The output ports on each Junction Slave can be connected to another Junction Slave or other EtherCAT slaves.

The following models are examples of some of the OMRON EtherCAT slaves.[*1]

Slave type/name	Number of ports	Model
EtherCAT Junction Slave	3 ports	GX-JC03
	6 ports	GX-JC06[*2]

*1 OMRON EtherCAT Junction Slaves are scheduled for release in the near future.

*2 Two node addresses are set for the GX-JC06.

● Sysmac Studio

The Sysmac Studio runs on a personal computer and it is used to configure EtherCAT networks and slaves, and to program, monitor, and debug the Controller.

● Communications Cables

Use a shielded twisted-pair cable (double shielding with aluminum tape and braiding) of Ethernet category 5 (100Base-TX) or higher, and use straight wiring.

● ESI (EtherCAT Slave Information) File

The ESI files contain information unique to the EtherCAT slaves in XML format. You can load an ESI file into the Sysmac Studio, to easily allocate slave process data and make other settings.

● Unit Power Supplies

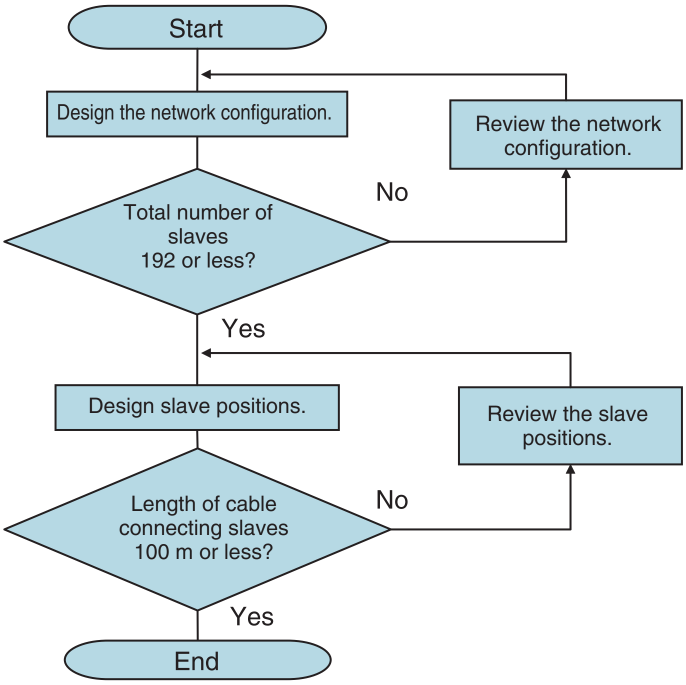
This power supply is for slave communications and internal operation.

● I/O Power Supply

This power supply is for slave communications and internal operation.

1-2-2 Determining the Network Configuration

Determine the type, total number, and positions of slaves in the network. Check the total number of slaves and the cable length between slaves based on the following workflow.


Start
Design the network configuration.
Review the network configuration.
No
Total number of slaves 192 or less?
Yes
Design slave positions.
Review the slave positions.
No
Length of cable connecting slaves 100 m or less?
Yes
End

Precautions for Safe Use

Make sure that the communications distance, number of devices connected, and method of connection for EtherCAT are within specifications.

1-3 Specifications of Built-in EtherCAT Port

1-3-1 Performance Specifications

Item	Specification
Communications protocol	EtherCAT protocol
Supported services	CoE (Process data communications and SDO communications)*1
Synchronization	DC (Distributed Clock)
Physical layer	100BASE-TX
Modulation	Baseband
Baud rate	100 Mbit/s (100Base-TX)
Duplex mode*2	Auto
Topology*3	Daisy chain, branch wiring
Transmission media	Category 5 twisted-pair cable or higher (Cable with double, aluminum tape and braided shielding, and straight wiring, are recommended.)
Transmission distance	Distance between nodes: 100 m or less (IEEE 802.3)
Maximum number of slaves	192
Maximum process data size	Input: 5,736 bytes Output: 5,736 bytes However, the data must not exceed 4 frames (the maximum number of process data frames).
Maximum data sizes per slave	Input: 1,434 bytes Output: 1,434 bytes
Maximum message size	2,048 bytes
Communications cycle	500 µs, 1,000 µs, 2,000 µs, or 4,000 µs
Minimum communications cycle	500 µs
Maximum communications cycle	4,000 µs
Sync jitter between slaves	1 µs max.

*1 Refer to *3-1-1 CoE (CAN Application Protocol over EtherCAT)* for details on CoE.

*2 Connection is possible only in full duplex mode. Half-duplex connections will result in link OFF status.

*3 Wiring in a ring configuration is not possible.

List of Supported Functions

Function name	Description
Process data communications	PDO mapping using CoE
	Fail-soft operation for slave communications errors
	Stop operation for slave communications errors
DC (distributed clock)	Clock synchronization
SDO communications	CoE • Emergency message server (receptions from slaves) • SDO requests and responses • Communications between slaves
Configuration	Automatic setting of device variable names, etc.
	Setting node address using hardware switches on the slaves
	Setting node address using the Sysmac Studio
	Network scan (collection of information on devices connected to the network)
	Display of network configuration information (display of supported topology)
RAS functions	Slave configuration check when starting network
	Reading of error information (emergency error history, subscription information, etc.)
	Packet monitoring
	Troubleshooting information
Operations during errors	When error occurs (stop communications or change to fail-soft operation)
	Restoring communications when errors are cleared (Moves to operational state.)
Slave information	Number of slaves: 192
	Enabling/disabling slaves
	Disconnecting/reconnecting slaves

1-4 EtherCAT Communications Procedure

1-4-1 Overview

Step	Section
1. Mounting and Setting Devices and Hardware	*2-2 Setting the Node Addresses of the EtherCAT Slaves*
↓	
2. Laying EtherCAT Communications Cables	*Section 4 EtherCAT Network Wiring*
↓	
3. Creating the EtherCAT Network Configuration	*5-2 Creating the EtherCAT Network Configuration*
↓	
4. Setting EtherCAT Slave Variables and Axes	*5-3 Setting EtherCAT Slave Variables and Axes*
↓	
5. Setting EtherCAT Parameters	*5-4 EtherCAT Master and Slave Parameter Settings*
↓	
6. Programming	*Section 6 Process Data Communications and SDO Communications*
↓	
7. Turning ON Power and Going Online from the Sysmac Studio	*2-1-3 Connecting the Sysmac Studio* *3-3 State Transitions for EtherCAT Communications*
↓	
8. Online Debugging	*5-5 Comparing and Merging EtherCAT Network Configurations*
↓	
9. Downloading the Network Configuration Information and the User Program	*5-6 Downloading the Network Configuration Information*
↓	
10. Checking Indicators	*5-7 Confirming Communications after Completing EtherCAT Configuration and Settings*

1-4-2 Details

Step		Description	Sysmac Studio operation	Section
1. Mounting and Setting Devices and Hardware		1. Use the hardware switches on all of the EtherCAT slaves in the network to set the node addresses. (The starting node address and sequence are not specified.) See the manuals for each slave for information on the procedure for setting node addresses. **Note** Use the Sysmac Studio to set the node address if there are no hardware switches or the node address is beyond the range that can be set with the hardware switches. 2. Connect the EtherCAT slaves and external I/O devices.		*2-2 Setting the Node Addresses of the EtherCAT Slaves*
↓				
2. Laying EtherCAT Communications Cables		Connect the EtherCAT slaves to the EtherCAT port of the NJ-series CPU Unit. If there is more than one EtherCAT slave, connect them using a daisy chain or branch wiring.		*Section 4 EtherCAT Network Wiring*
↓				
3. Creating the EtherCAT Network Configuration		1. Use the Sysmac Studio to create a new project. 2. (a) Create EtherCAT network configuration offline. or (b) Go online and create the EtherCAT network configuration from the actual network devices. Do so after making the online connection that is described in step 7.	Create EtherCAT network configurationn with **EtherCAT** under **Configurations and Setup**.	*5-2 Creating the EtherCAT Network Configuration*
↓				
4	Setting EtherCAT Slave Variables and Axes			
	All EtherCAT Slaves	Allocate variables to the I/O ports. • If necessary, change the names of automatically generated device variables for each I/O port to user-defined variable names.	Make the settings with **I/O Map** under **Configurations and Setup**.	*5-3-1 Registering Device Variables for All EtherCAT Slaves*
	Only EtherCAT Servo Drive and encoder input slaves	Set up the axes. • Create axes (axes variables). • Set the axis types for the Axis Variables (to a servo axis, virtual axis, etc.), and set the IDs of the Servo Drives. Axis Variables are automatically registered in the global variable table	Create and set up the axes with the ***Add* – *Axis Settings*** command for **Configurations and Setup** – **Motion Control Setup** – **Axis Settings**.	*5-3-2 Axis Settings for Servo Drives and Encoder Input Slaves*
↓				

Step		Description	Sysmac Studio operation	Section
5	Setting EtherCAT Parameters			
	Setting EtherCAT Master Parameters	Set the EtherCAT master parameters. (Examples: process data communications cycle and wait all slaves startup time) The values that are set are reflected in the network configuration information.	Create an EtherCAT master with **EtherCAT** under **Configurations and Setup**.	*5-4-1 Setting EtherCAT Master*
	Setting EtherCAT Slave Parameters	Set the EtherCAT slave parameters. Example: Enable/disable slaves.	Create EtherCAT slaves with **EtherCAT** under **Configurations and Setup**.	*5-4-2 Setting EtherCAT Slaves*

↓

6	Programming			
	Process Data Communications	Specify the device variables in the user program. Input conditions include system-defined variables for network error flags and normal or error flags for each slave.	Create the programs with **POUs** under **Programming**.	*6-1 Process Data Communications (PDO Communications)*
	SDO Communications	Read and write the following specified data for slaves: Use EC_CoESDORead and EC_CoESDOWrite instructions. • SDO data in slaves (parameters, error information, etc.)	Create the programs with **POUs** under **Programming**.	*6-2 SDO Communications*

↓

7. Turning ON Power and Going Online from the Sysmac Studio		1. Turn ON the power supply to EtherCAT slaves. 2. Turn ON the I/O power supplies to the slaves. 3. Turn ON the power supply to NJ-series Controller. 4. Use the Sysmac Studio to set communications with the NJ-series Controller and connect online. Go online with the Controller before you create the slave configuration from the installed network in step 3.	Select ***Communications Setup*** from the Controller Menu and make the settings to go online.	*2-1-3 Connecting the Sysmac Studio* *3-3 State Transitions for EtherCAT Communications*

↓

8. Online Debugging		Compare and merge the network configuration that was set on the Sysmac Studio and the actual network configuration.	Right-click the EtherCAT master under ***Configurations and Setup*** – ***EtherCAT*** and select Actual network configuration.	*5-5 Comparing and Merging EtherCAT Network Configurations*

↓

Step	Description	Sysmac Studio operation	Section
9. Downloading the Network Configuration Information and the User Program	Download the network configuration information (EtherCAT configuration, process data information, and parameters). **Note** Use the synchronization operation of the Sysmac Studio to download the project.	Select ***Synchronization*** from the Controller Menu to download and verify the network configuration information.	*5-6 Downloading the Network Configuration Information*

↓

10. Checking Indicators	Check the indicators on the NJ-series CPU Unit. • A flashing yellow EtherCAT LINK/ACT indicator shows that data is being transmitted and received after the link is established. • A solid green EtherCAT NET RUN indicator shows the device is in the operational state (normal communications state). • If the EtherCAT NET ERR indicator is not lit, there is no error.		*5-7 Confirming Communications after Completing EtherCAT Configuration and Settings*

2

Part Names and Slave Settings

This section provides the part names and describes the slave settings and Sysmac device functions.

2-1 Part Names and Functions 2-2

2-1-1 EtherCAT Master Indicators 2-2

2-1-2 Windows Used in Sysmac Studio 2-3

2-1-3 Connecting the Sysmac Studio 2-6

2-2 Setting the Node Addresses of the EtherCAT Slaves 2-8

2-3 Features of Sysmac Devices 2-10

2-3-1 Sysmac Devices 2-10

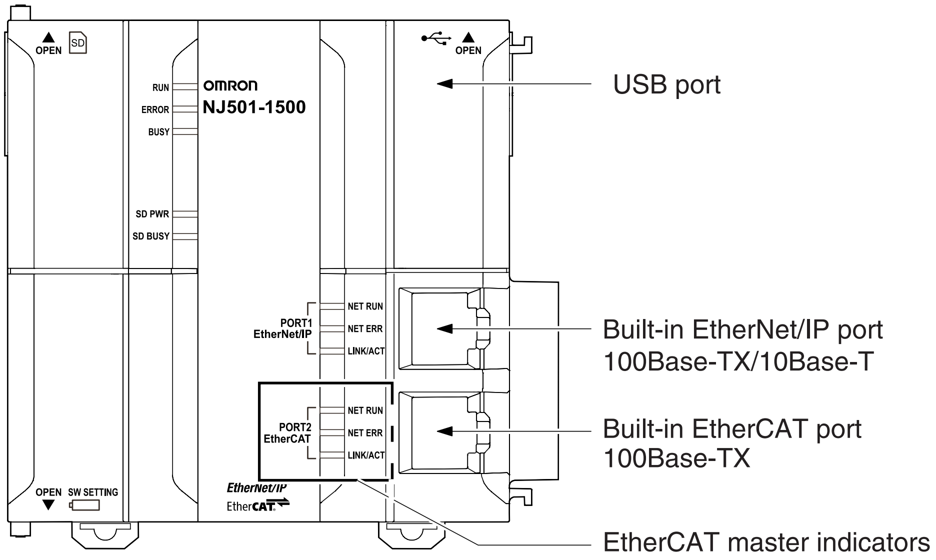
2-3-2 Sysmac Device Features 2-10

2-3-3 List of Sysmac Devices 2-14

2-3-4 Sysmac Device Features and EtherCAT Masters 2-15

2-1 Part Names and Functions

2-1-1 EtherCAT Master Indicators



Label	Name	Color	Status	Meaning
EtherCAT NET RUN	RUN	🟩 Green	Lit	EtherCAT communications are in progress. • I/O data is being input and output.
			Flashing	EtherCAT communications are established. Communications is in one of the following states. • Only message communications is functioning. • Only message communications and I/O data input operations are functioning.
			Not lit	EtherCAT communications are stopped. • Power is OFF or the Unit is being reset. • There is a MAC address error, communications controller error, or other error.
EtherCAT NET ERR	ERROR	🟥 Red	Lit	There is an unrecoverable error, such as a hardware error or an exception.
			Flashing	There is a recoverable error.
			Not lit	There is no error.
EtherCAT LINK/ACT	Link/Activity	🟨 Yellow	Lit	The link is established.
			Flashing	A link is established and data is being sent and received. The indicator flashes whenever data is sent or received.
			Not lit	The link is not established.

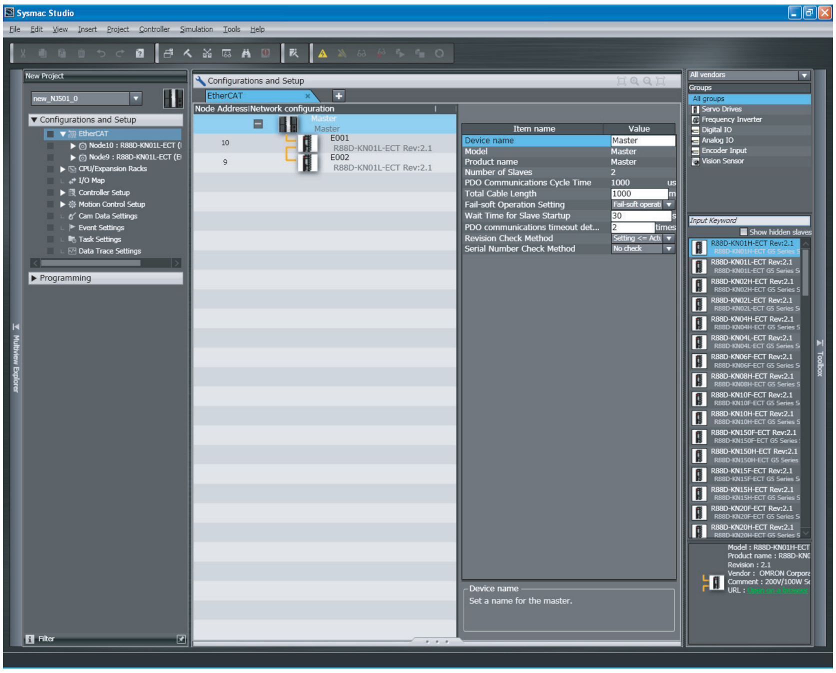
Refer to *3-3-2 Control States for EtherCAT Communications* for details on the states.

2-1-2 Windows Used in Sysmac Studio

Use the Sysmac Studio to create the EtherCAT network configuration and to make other settings. The following windows are used.

● Creating the EtherCAT Network Configuration

Use the EtherCAT Configuration Editor offline to register slaves in the EtherCAT slave configuration. Or, upload the network configuration online.



Item name	Value
Device name	Master
Model	Master
Product name	Master
Number of Slaves	2
PDO Communications Cycle Time	1000 us
Total Cable Length	1000 m
Fail-soft Operation Setting	Fail-soft operati
Wait Time for Slave Startup	30 s
PDO communications timeout det...	2 times
Revision Check Method	Setting <= Actu
Serial Number Check Method	No check

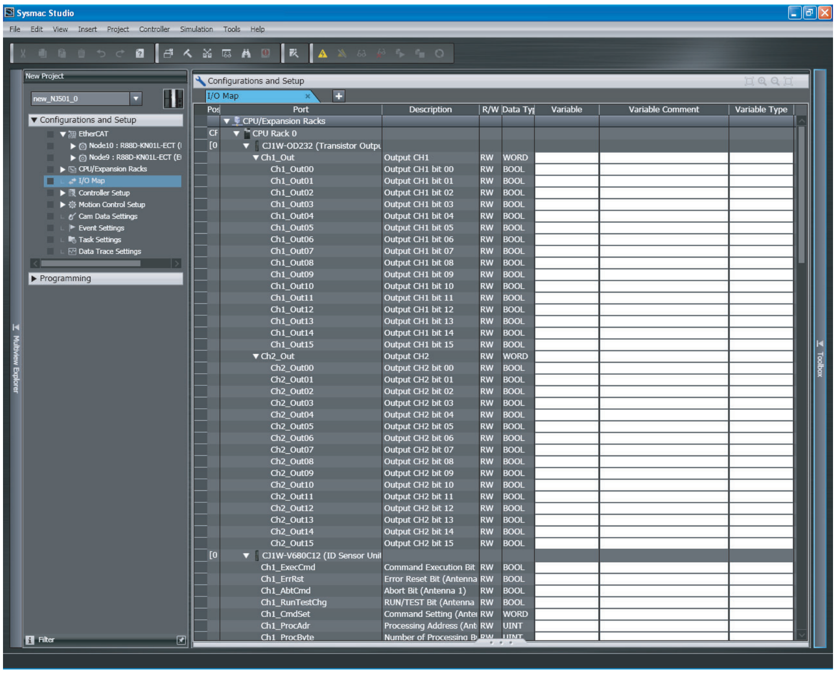
Device name

Set a name for the master.

● Setting EtherCAT Slave Variables and Axes

I/O Map: Used to allocate device variables.

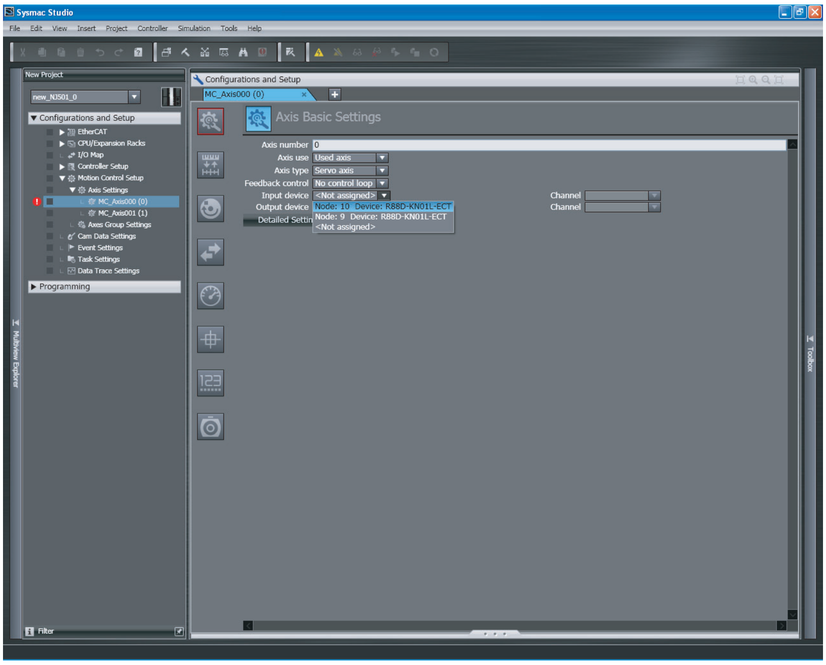
Use the I/O Map to assign device variables to the I/O ports of the EtherCAT slaves.



Pos	Port	Description	R/W	Data Typ	Variable	Variable Comment	Variable Type
	▼ CPU/Expansion Racks						
CF	▼ CPU Rack 0						
[0	▼ CJ1W-OD232 (Transistor Outpu						
	▼Ch1_Out	Output CH1	RW	WORD			
	Ch1_Out00	Output CH1 bit 00	RW	BOOL			
	Ch1_Out01	Output CH1 bit 01	RW	BOOL			
	Ch1_Out02	Output CH1 bit 02	RW	BOOL			
	Ch1_Out03	Output CH1 bit 03	RW	BOOL			
	Ch1_Out04	Output CH1 bit 04	RW	BOOL			
	Ch1_Out05	Output CH1 bit 05	RW	BOOL			
	Ch1_Out06	Output CH1 bit 06	RW	BOOL			
	Ch1_Out07	Output CH1 bit 07	RW	BOOL			
	Ch1_Out08	Output CH1 bit 08	RW	BOOL			
	Ch1_Out09	Output CH1 bit 09	RW	BOOL			
	Ch1_Out10	Output CH1 bit 10	RW	BOOL			
	Ch1_Out11	Output CH1 bit 11	RW	BOOL			
	Ch1_Out12	Output CH1 bit 12	RW	BOOL			
	Ch1_Out13	Output CH1 bit 13	RW	BOOL			
	Ch1_Out14	Output CH1 bit 14	RW	BOOL			
	Ch1_Out15	Output CH1 bit 15	RW	BOOL			
	▼Ch2_Out	Output CH2	RW	WORD			
	Ch2_Out00	Output CH2 bit 00	RW	BOOL			
	Ch2_Out01	Output CH2 bit 01	RW	BOOL			
	Ch2_Out02	Output CH2 bit 02	RW	BOOL			
	Ch2_Out03	Output CH2 bit 03	RW	BOOL			
	Ch2_Out04	Output CH2 bit 04	RW	BOOL			
	Ch2_Out05	Output CH2 bit 05	RW	BOOL			
	Ch2_Out06	Output CH2 bit 06	RW	BOOL			
	Ch2_Out07	Output CH2 bit 07	RW	BOOL			
	Ch2_Out08	Output CH2 bit 08	RW	BOOL			
	Ch2_Out09	Output CH2 bit 09	RW	BOOL			
	Ch2_Out10	Output CH2 bit 10	RW	BOOL			
	Ch2_Out11	Output CH2 bit 11	RW	BOOL			
	Ch2_Out12	Output CH2 bit 12	RW	BOOL			
	Ch2_Out13	Output CH2 bit 13	RW	BOOL			
	Ch2_Out14	Output CH2 bit 14	RW	BOOL			
	Ch2_Out15	Output CH2 bit 15	RW	BOOL			
[0	▼ CJ1W-V680C12 (ID Sensor Unit						
	Ch1_ExecCmd	Command Execution Bit	RW	BOOL			
	Ch1_ErrRst	Error Reset Bit (Antenna	RW	BOOL			
	Ch1_AbtCmd	Abort Bit (Antenna 1)	RW	BOOL			
	Ch1_RunTestChg	RUN/TEST Bit (Antenna	RW	BOOL			
	Ch1_CmdSet	Command Setting (Ante	RW	WORD			
	Ch1_ProcAdr	Processing Address (Ant	RW	UINT			
	Ch1_ProcByte	Number of Processing B	RW	UINT			

Axis Settings: Used to create Axis Variables and set parameters for Servo Drive and encoder input slaves.

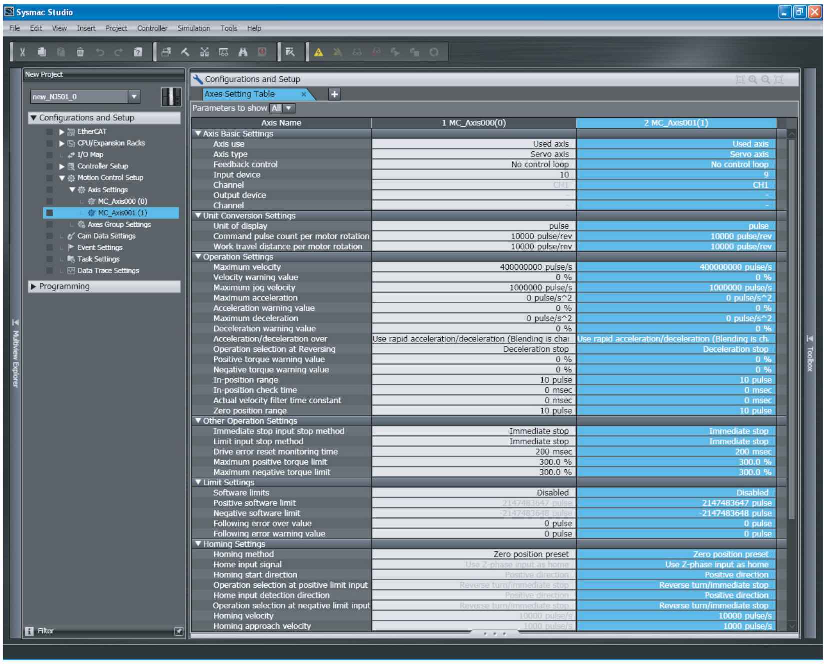
Use the Axis Settings to assign Axis Variables to the Servo Drive/encoder input slaves.



Axis number: 0
Axis use: Used axis
Axis type: Servo axis
Feedback control: No control loop
Input device: <Not assigned>
Output device:
- Node: 10 Device: R88D-KN01L-ECT
- Node: 9 Device: R88D-KN01L-ECT
- <Not assigned>

Channel
Channel

Setting Axis Parameters:

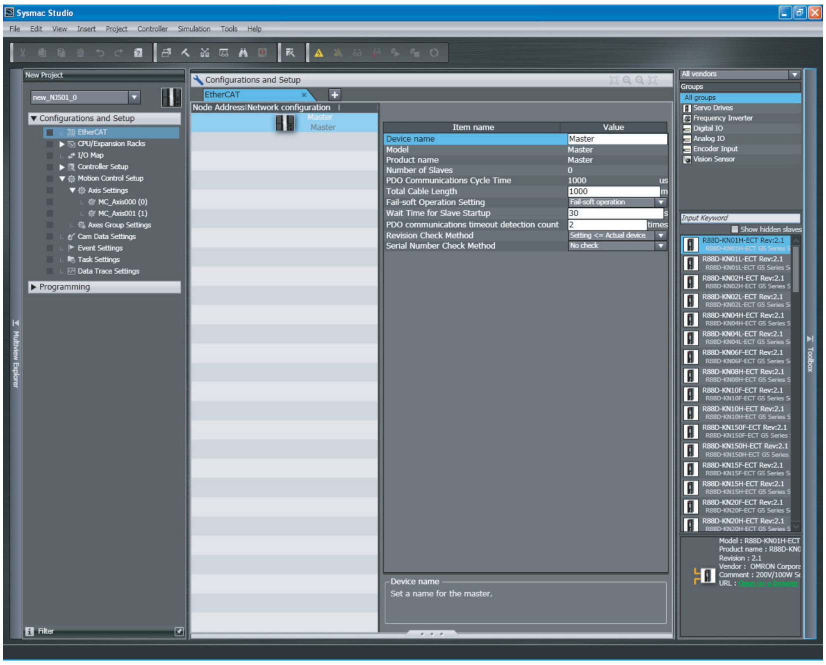


Parameters to show: All

Axis Name	1 MC_Axis000(0)	2 MC_Axis001(1)
▼ Axis Basic Settings		
Axis use	Used axis	Used axis
Axis type	Servo axis	Servo axis
Feedback control	No control loop	No control loop
Input device	10	9
Channel	CH1	CH1
Output device	-	-
Channel	-	-
▼ Unit Conversion Settings		
Unit of display	pulse	pulse
Command pulse count per motor rotation	10000 pulse/rev	10000 pulse/rev
Work travel distance per motor rotation	10000 pulse/rev	10000 pulse/rev
▼ Operation Settings		
Maximum velocity	400000000 pulse/s	400000000 pulse/s
Velocity warning value	0 %	0 %
Maximum jog velocity	1000000 pulse/s	1000000 pulse/s
Maximum acceleration	0 pulse/s^2	0 pulse/s^2
Acceleration warning value	0 %	0 %
Maximum deceleration	0 pulse/s^2	0 pulse/s^2
Deceleration warning value	0 %	0 %
Acceleration/deceleration over	Use rapid acceleration/deceleration (Blending is char	Use rapid acceleration/deceleration (Blending is ch
Operation selection at Reversing	Deceleration stop	Deceleration stop
Positive torque warning value	0 %	0 %
Negative torque warning value	0 %	0 %
In-position range	10 pulse	10 pulse
In-position check time	0 msec	0 msec
Actual velocity filter time constant	0 msec	0 msec
Zero position range	10 pulse	10 pulse
▼ Other Operation Settings		
Immediate stop input stop method	Immediate stop	Immediate stop
Limit input stop method	Immediate stop	Immediate stop
Drive error reset monitoring time	200 msec	200 msec
Maximum positive torque limit	300.0 %	300.0 %
Maximum negative torque limit	300.0 %	300.0 %
▼ Limit Settings		
Software limits	Disabled	Disabled
Positive software limit	2147483647 pulse	2147483647 pulse
Negative software limit	-2147483648 pulse	-2147483648 pulse
Following error over value	0 pulse	0 pulse
Following error warning value	0 pulse	0 pulse
▼ Homing Settings		
Homing method	Zero position preset	Zero position preset
Home input signal	Use Z-phase input as home	Use Z-phase input as home
Homing start direction	Positive direction	Positive direction
Operation selection at positive limit input	Reverse turn/immediate stop	Reverse turn/immediate stop
Home input detection direction	Positive direction	Positive direction
Operation selection at negative limit input	Reverse turn/immediate stop	Reverse turn/immediate stop
Homing velocity	10000 pulse/s	10000 pulse/s
Homing approach velocity	1000 pulse/s	1000 pulse/s

● EtherCAT Master Settings: Used to set the EtherCAT master.

Set the EtherCAT master and slaves from the EtherCAT master settings, and the slave settings in the EtherCAT configuration.



Item name	Value
Device name	Master
Model	Master
Product name	Master
Number of Slaves	0
PDO Communications Cycle Time	1000 us
Total Cable Length	1000 m
Fail-soft Operation Setting	Fail-soft operation
Wait Time for Slave Startup	30 s
PDO communications timeout detection count	2 times
Revision Check Method	Setting <= Actual device
Serial Number Check Method	No check

Device name
Set a name for the master.

Refer to *Section 5 Setting Up EtherCAT Communications with the Sysmac Studio* for the Sysmac Studio procedures.

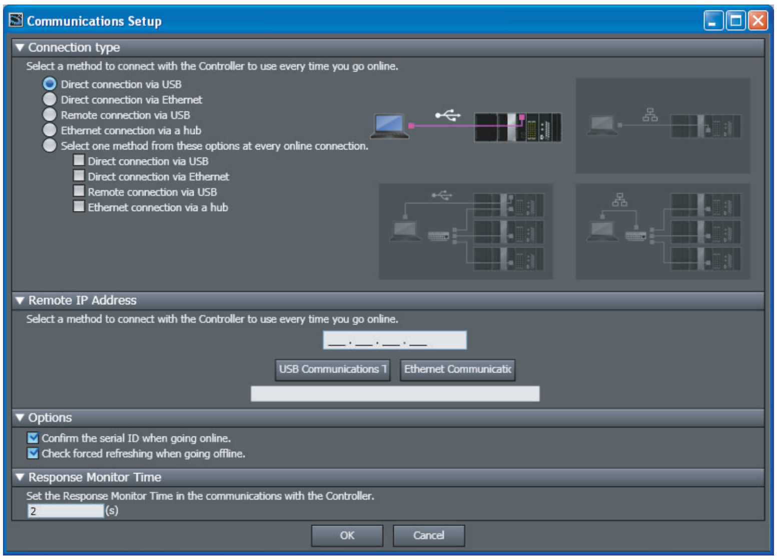
2-1-3 Connecting the Sysmac Studio

You can connect the Sysmac Studio to the NJ-series CPU Unit through the USB or EtherNet/IP port.

You must set the connection method, IP address to connect to, and other parameters for communications between the computer and Controller.

1 Select ***Communications Setup*** from the Controller Menu.

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

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

__ . __ . __ . __

▼ Options

- ☑ Confirm the serial ID when going online.
- ☑ Check forced refreshing when going offline.

▼ Response Monitor Time

Set the Response Monitor Time in the communications with the Controller.

2 (s)

2 Select the connection method for the connection configuration from the Connection type Area.

If you specify a Remote connection via USB or an Ethernet connection via a hub, enter the IP address of the Controller in the Remote IP Address Area. Also set the Options and Response Monitor Time parameter to the required time. Refer to *Communications Setup Dialog Box Settings* on the next page for information on the settings.

3 Click the **OK** Button.

This completes the setup.

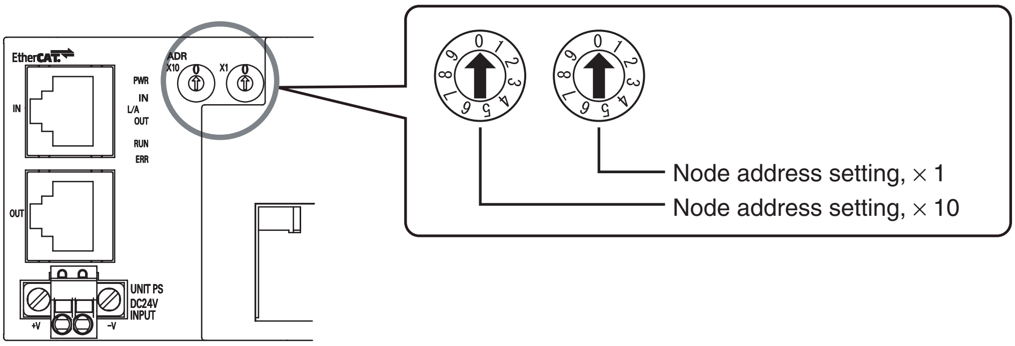
● Communications Setup Dialog Box Settings

Item	Description	
Connection type	Specify the connection method to use for online communications. The specified connection method is used when you go online.	
Remote IP Address	If you specify a USB remote or Ethernet hub connection, set the IP address of the Controller that you normally will connect to.	
	USB Communications Test Button Ethernet Communications Test Button	These buttons perform a communication test with the Controller at the specified IP address. The result is displayed as follows: • Normal: “Test OK” • Error: “The Controller was not found." or "There is more than one Controller with the specified IP address.”
Options	Confirm the serial ID when going online.	If you select this option, the names and serial IDs are compared between the project and the Controller when you go online to make sure that a connection is made to the intended Controller.
	Check forced refreshing when going offline.	If you select this option, a check is made to see if any forced refreshing values are still in effect before going offline.
Response Monitor Time	You can set the response monitor time for communications with the Controller. An error is displayed if a response is not received before this time expires. **Note** The time can be set to between 1 and 3,600 s.	

2-2 Setting the Node Addresses of the EtherCAT Slaves

● Setting Node Address Using Hardware Switches

Setting the node address is described here. An OMRON GX-series Remote I/O Terminal is used as the slave. With a GX-series Remote I/O Terminal, the node address is set on hardware switches. With a GX-series Remote I/O Terminal, these switches are used to set the node address as a slave on the EtherCAT network.
The 10s digit is set using the left rotary switch and the 1s digit is set using the right rotary switch. The setting range is from 00 to 99.



The node address setting values are described in the following table.

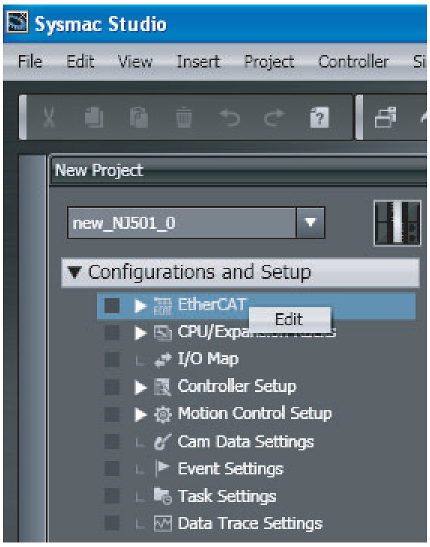
Switch setting	Node address setting
00	Set with the Sysmac Studio (1 to 192).
01 to 99	Set with the hardware switches.

● Setting the Node Address from the Sysmac Studio

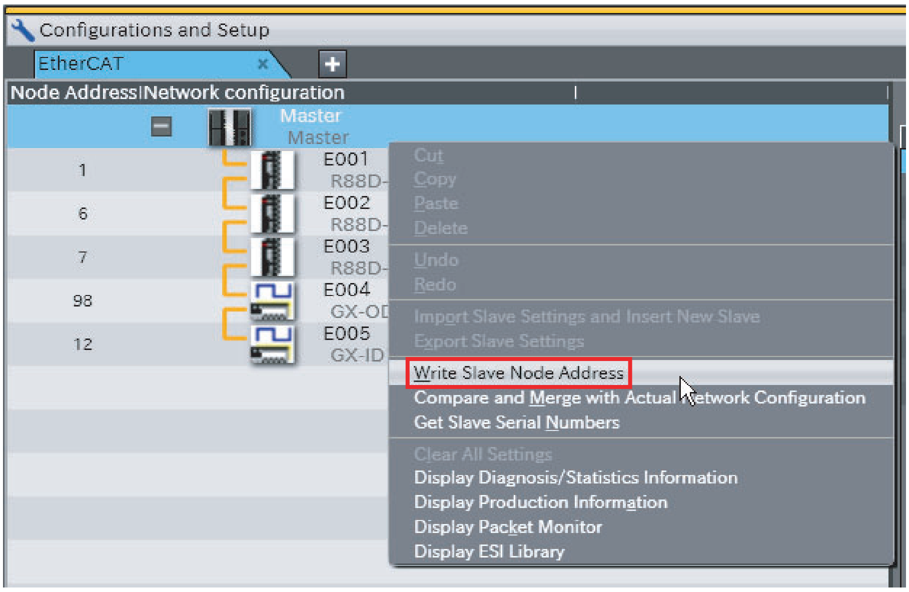
Use the Sysmac Studio to set the node address if there are no hardware switches or the node address is beyond the range that can be set with the hardware switches.

1 Start the Sysmac Studio and go online with the Controller.

2 Double-click **EtherCAT** under **Configurations and Setups** on the Multiview Explorer. Or, right-click **EtherCAT** under **Configurations and Setups** and select ***Edit***.



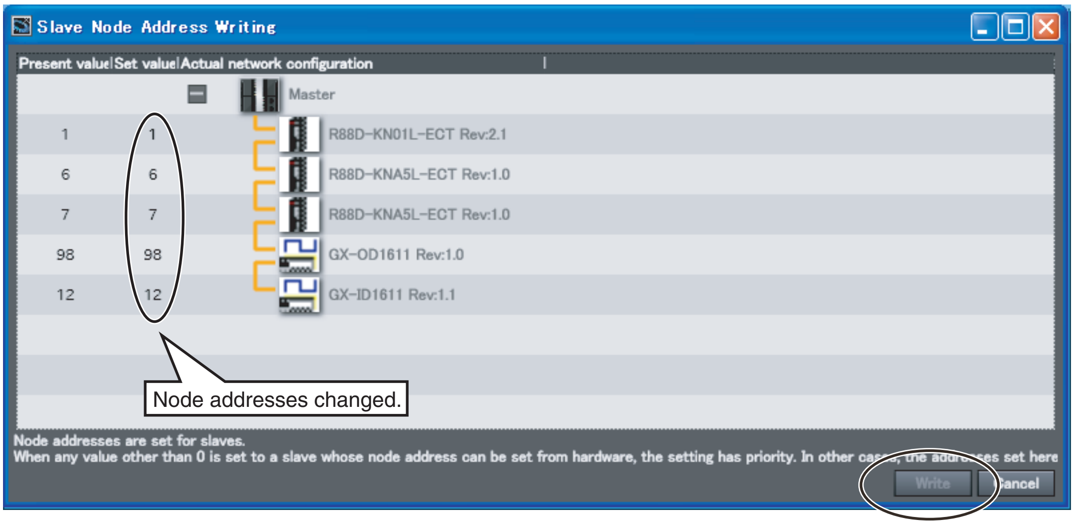
3 Right-click the EtherCAT master that is displayed in the Edit Pane and select ***Write Slave Node Address***.



The Slave Node Address Writing Dialog Box is displayed.

4 If there are slaves for which the node address is not set (i.e., for which the present value is 0) or if there is more than one slave with the same node address (indicated by "!"), change the set values of the slave addresses, and then click the **Write** Button.

(If the correct node addresses are set for all of the slaves, click the **Cancel** Button.)


Slave Node Address Writing

Present value	Set value	Actual network configuration
		Master
1	1	R88D-KN01L-ECT Rev:2.1
6	6	R88D-KNA5L-ECT Rev:1.0
7	7	R88D-KNA5L-ECT Rev:1.0
98	98	GX-OD1611 Rev:1.0
12	12	GX-ID1611 Rev:1.1

Node addresses changed.

Node addresses are set for slaves.
When any value other than 0 is set to a slave whose node address can be set from hardware, the setting has priority. In other cases, the addresses set here

The node addresses are written to the actual slaves.

Additional Information

- The switch setting is read only once when the power is turned ON. Even if the setting is changed after the power supply is turned ON, the new setting will not be used until the next time that power is turned ON.
- If same node address is set for more than one node, a Slave Node Address Duplicated Error occurs and the operation of the slave stops. If a duplicated node address is set, the system-defined variable *_EC_SlavAdrDupErr* (Slave Node Address Duplicated Error) changes to TRUE.
- Use the Sysmac Studio to set the node address if there are no hardware switches or the node address is beyond the range that can be set with the hardware switches.

2-3 Features of Sysmac Devices

2-3-1 Sysmac Devices

“Sysmac devices” is a generic name for EtherCAT slaves and other OMRON control components that were designed with the same communications and user interface specifications. You can use the NJ-series Machine Automation Controllers together with Sysmac devices and the Sysmac Studio Automation Software to achieve optimum functionality and ease of operation.

2-3-2 Sysmac Device Features

You can connect Sysmac device slaves to an NJ-series Machine Automation Controller to use the following features.

Sysmac device feature	Description
Troubleshooting	OMRON defines component error status as Sysmac errors for the entire Sysmac Series. You can use Sysmac errors to display errors that occur in slaves on the Sysmac Studio together with corrections for the errors.
Backing up and restoring parameters	An optional feature in the version-1.0.1 ESI specifications is used to enable backing up and restoring slave parameters (called backup parameters).
Saving node address settings	The node address setting for each slave is stored in non-volatile memory within the slave.
Verifying the EtherCAT network configuration using serial numbers	You can verify the EtherCAT network configuration based on serial numbers.

Troubleshooting

OMRON defines component error status as Sysmac errors for the entire Sysmac Series.

You can use Sysmac errors to display errors that occur in slaves on the Sysmac Studio together with corrections for the errors.

This allows you to detect slave errors and isolate the causes of the errors.

If a Sysmac error occurs in a slave, the values of the *_EC_SlavErr* system-defined variable and the element of the *_EC_SlavErrTbl* system-defined variable that corresponds to the slave node address change.

Refer to *9-1-1 How to Check for Errors* for details on the values.

Additional Information

- This feature is not supported for OMRON slaves that are not Sysmac devices and slaves that are manufactured by other companies. Check the error detection methods for each slave.
- Before you reset an error from the NJ-series EtherCAT master, make sure you confirm the cause of the error in the slave.
- Sysmac errors are not displayed on the Troubleshooting Dialog Box when the slaves are in Init state. When a slave in Init state where a Sysmac error was detected is connected, you cannot confirm the Sysmac error that was detected by the slave until communications are restarted with that slave. Therefore, if an error that results in a slave going to Init state and a slave Sysmac error are detected at the same time, first reset the slave Init state, restart communications with the slave, and then check the Sysmac error. Then, eliminate the cause of the error and reset the error. Refer to *9-2-2 Error Descriptions* for the errors that result in the Slave entering Init state.
- If you delete the assignment of the Sysmac error status from the processing data communications data, e.g., to reduce the load on the EtherCAT communications line, you will not be able to use the Sysmac error status in troubleshooting. (To delete the assignment, edit the PDO map settings in the EtherCAT master settings on the Sysmac Studio so that the map object that is mapped to object 2002 hex is not selected.) If you do so, you can detect errors that occur in the slave applications other than communications errors only through the transmission of emergency messages or status information that is mapped for other process data communications. Use emergency messages and other status information for which PDOs are mapped to detect slave errors in this case. Transmission of emergency messages is disabled by default for OMRON slaves.
- When the EtherCAT master detects an emergency message from a slave, the _EC_SlavEmergErr system-defined variable changes to TRUE. Check the contents of the emergency message from the slave on the Troubleshooting Dialog Box.
- Refer to *Section 9 Troubleshooting* for details on checking for errors and corrections.

Backing Up and Restoring Parameters

The Sysmac devices use an option in the version-1.0.1 ESI specifications to enable backing up and restoring the backup parameters that are specified in the ESI files in non-volatile memory in the slaves.

You can back up and restore the backup parameters that are stored from the Sysmac Studio.

This makes it easy to set slaves when they are replaced.

Additional Information

- If you use slaves from other manufacturers, obtain the slave information files that are compliant with the version-1.0.1 ESI specifications from the slave manufacturers.
- Refer to *9-3-3 Backing Up Settings* for the procedure to back up slave data from the Sysmac Studio.
- Refer to *9-3-4 Restoring Settings* for the procedure to restore slave data from the Sysmac Studio.
- Refer to *A-3 Multi-vendor Environments* for information on ESI.

Saving Node Address Settings

Each Sysmac device stores its own node address setting in non-volatile memory within the slave.

This allows the master to identify slaves on the network.

The node addresses are set as given below depending on the type of slave.

- Slaves with Hardware Switches
  0: The node address is set from the Sysmac Studio.
  Not 0: The setting on the hardware switches is used.
- Slaves without Hardware Switches
  The node address is set from the Sysmac Studio.

Precautions for Correct Use

- Set a node address for every slave so that the slaves can be identified on the EtherCAT network. Do not assign the same node address more than once.
- If you connect slaves from other manufacturers to the NJ-series EtherCAT master, set the node addresses for them from the Sysmac Studio. (The NJ-series EtherCAT master recognizes the value that is stored at address 0x0012 in the EtherCAT slave controller of the slave as the node address.)
- For OMRON slaves that are not Sysmac devices, set the node addresses on the hardware switches. If the node address switches are set to 0, a Network Configuration Verification Error occurs.

Additional Information

- Refer *2-2 Setting the Node Addresses of the EtherCAT Slaves* or the manuals for each slave for the procedure to set the node addresses.
- Refer to *5-4-2 Setting EtherCAT Slaves* for information on setting node addresses with the Sysmac Studio.

Verifying the EtherCAT Network Configuration Using Serial Numbers

Each Sysmac device slave stores its serial number in non-volatile memory within the slave.

If serial number verification is enabled in the EtherCAT master settings, the EtherCAT network configuration is verified based on the serial numbers when the EtherCAT master is started. The following are enabled by verification of the serial numbers.

- If the EtherCAT network configuration changes, the serial numbers will not match and a Network Configuration Verification Error occurs. This helps prevent forgetting to set the parameters when a slave is replaced.
- The serial numbers of any of the slaves can be checked from the EtherCAT master.

Additional Information

Refer to *5-4-1 Setting EtherCAT Master* for information on checking serial numbers.

2-3-3 List of Sysmac Devices

The following table lists the OMRON Sysmac slaves. Refer to the manual for the slave for information on OMRON slaves that are not listed in the following table.

Name	Model	Revision	Unit version
AC Servo Drives	R88D-KN□□□-ECT	Revision 2.1 or higher	Unit version 2.1 or later
Multifunctional, Compact Inverters	3G3AX-MX2-ECT	Revision 1.1 or higher	Unit version 1.1 or later
Digital I/O Slaves	GX-ID□□□□ GX-OD□□□□ GX-MD□□□□ GX-OC□□□□	Revision 1.1 or higher	Unit version 1.1 or later
Analog I/O Slaves	GX-AD0□71 GX-DA0□71	Revision 1.1 or higher	Unit version 1.1 or later
Encoder Input Slaves	GX-EC02□1	Revision 1.1 or higher	Unit version 1.1 or later

2-3-4 Sysmac Device Features and EtherCAT Masters

The following table shows the relationship between Sysmac device features and EtherCAT masters.

OMRON Sysmac Device Slaves

Sysmac device feature	OMRON EtherCAT master		EtherCAT master from another manufacturer
	NJ501-1□□□ NJ-series CPU Unit	CJ1-NC□8□ CJ-series Position Control Unit	
Troubleshooting	Supported.	Not supported.*1	Not supported.*1
Backing up and restoring parameters	Supported.	Partially supported.*2	Partially supported.*3
Saving node address settings	Supported.	Supported.	Partially supported.*4
Verifying the EtherCAT network configuration	Supported.	Not supported.	Partially supported.*5

*1 Error notification is provided with emergency messages.

*2 You cannot specify the parameters that are backed up and restored.

*3 The ability to back up and restore parameters depends on the ability of the EtherCAT master from another manufacturer.

*4 The ability to store node addresses depends on the ability of the EtherCAT master from another manufacturer.

*5 The ability to verify serial numbers depends on the ability of the EtherCAT master from another manufacturer.

OMRON Slaves That Do Not Support Sysmac Devices

Sysmac device feature	OMRON EtherCAT master		EtherCAT master from another manufacturer
	NJ501-1□□□ NJ-series CPU Unit	CJ1-NC□8□ CJ-series Position Control Unit	
Troubleshooting	Not supported.*1	Not supported.*1	Not supported.*1
Backing up and restoring parameters	Supported.	Partially supported.*2	Partially supported.*3
Saving node address settings	Partially supported.*4	Partially supported.*4	Partially supported.*5
Verifying the EtherCAT network configuration	Not supported.	Not supported.	Partially supported.*6

*1 Error notification is provided with emergency messages.

*2 You cannot specify the parameters that are backed up and restored.

*3 The ability to back up and restore parameters depends on the ability of the EtherCAT master from another manufacturer.

*4 Setting is possible on the node address switches. Node addresses set with the software cannot be stored in the slave.

*5 The ability to store node addresses depends on the ability of the EtherCAT master from another manufacturer.

*6 The ability to verify serial numbers depends on the ability of the EtherCAT master from another manufacturer.

Slaves from Other Manufacturers

If you connect slaves from other manufacturers to an OMRON EtherCAT master, functionality is restricted as given below depending on the functionality of the slaves.

- Slaves cannot be connected if the ESI files do not comply with the most recent ESI standards.
- The Sysmac Studio operation to set node addresses may not be supported by some slaves depending on the slave specifications.
- Verification with serial numbers is not possible for slaves that do not have the serial number in SII.

3

EtherCAT Communications

This section describes the different types of EtherCAT communications, EtherCAT settings, and state transitions.

3-1 EtherCAT Communications Types and Settings 3-2
3-1-1 CoE (CAN Application Protocol over EtherCAT) 3-2
3-1-2 Types of Communications 3-4
3-1-3 Types of EtherCAT Variables 3-6
3-1-4 Settings Required for EtherCAT Communications 3-7
3-2 Programming EtherCAT Communications 3-8
3-3 State Transitions for EtherCAT Communications 3-9
3-3-1 Self Diagnosis at Startup 3-9
3-3-2 Control States for EtherCAT Communications 3-9
3-3-3 CPU Unit Status in Relation to EtherCAT 3-11

3-1 EtherCAT Communications Types and Settings

3-1-1 CoE (CAN Application Protocol over EtherCAT)

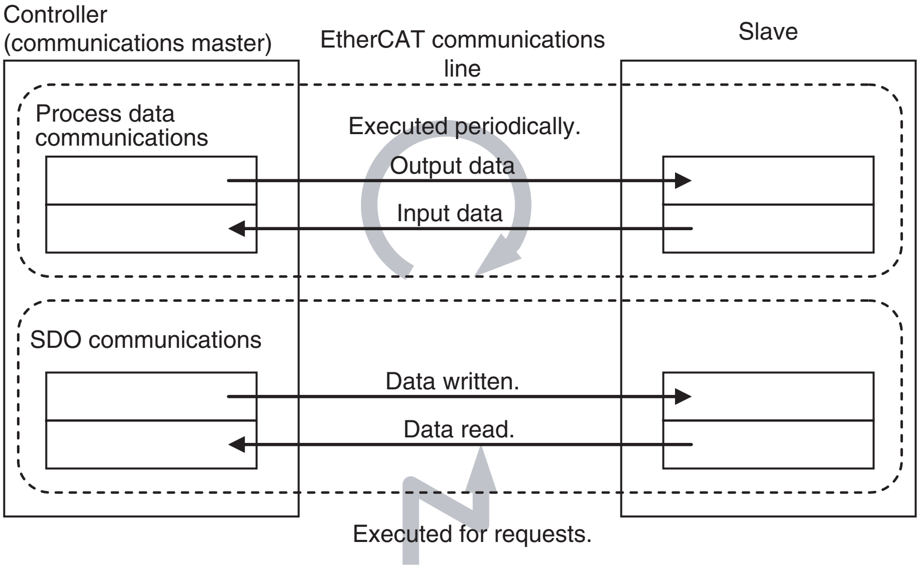
The EtherCAT port built into the NJ-series CPU Unit uses CoE (CAN application protocol over EtherCAT) to exchange information with slaves over EtherCAT. CoE implements CANOpen (an industrial communications protocol developed by CiA) communications over an EtherCAT network. With CoE, the parameters and control information held by the slaves are specified according to data specifications for the object dictionary.

Process data Communications and SDO Communications

There are two communications that are used to communicate data between the master and slaves. These are described below.

1) Process Data Communications:
Communications using process data objects (PDOs) to exchange information in realtime with a fixed period.

2) SDO Communications:
Communications using service data objects (SDOs) for communicating information when required.



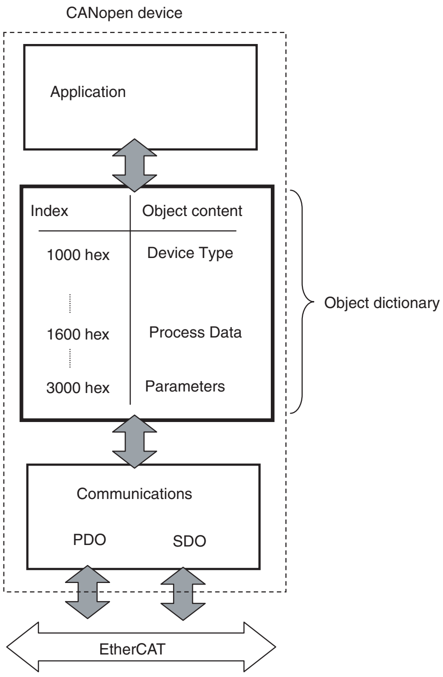
The EtherCAT port built into the NJ-series CPU Unit uses process data communications for commands to refresh I/O data in a fixed control period, including I/O data for EtherCAT slaves, and position control data for Servomotors. It uses SDO communications for commands to read and write data, such as for parameter transfers, at specified times.

Process data communications are executed each control cycle to refresh data continuously, and SDO communications are executed between PDO communications.

Additional Information

Object Dictionary

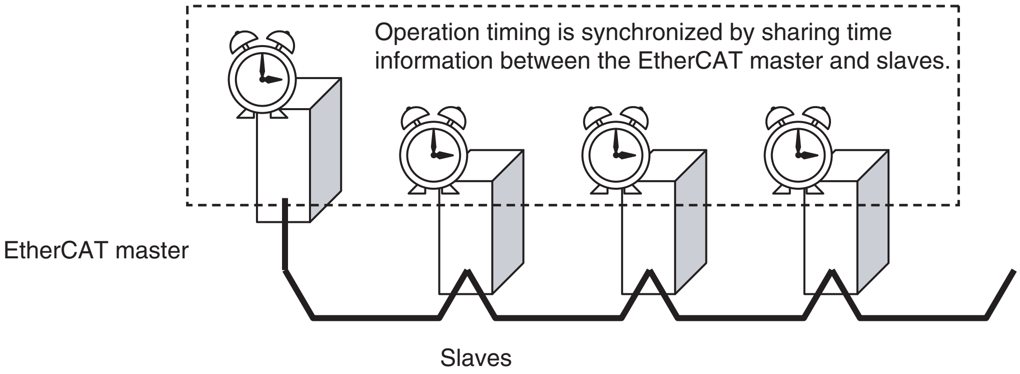
The object dictionary is a data table within the device that interfaces the application and communications. It describes the information handled by the device. Each piece of information is called an object. Each object is assigned a 4-digit hexadecimal index.
Each object is divided into a data type area, a CoE communications area, and a manufacturer-specific area.



Process data communications is used to read and write the process data in the CoE communications area in these objects.
SDO communications is used to read and write the parameters within the manufacturer-specific area in these objects.

Distributed Clock (DC)

This is a unique EtherCAT feature that enables precisely synchronizing time. The DC-based clock synchronization enables sharing the same time (i.e., the EtherCAT System Time) between the EtherCAT master and the slaves. This enables the timing of the operation of the EtherCAT master and slaves to be synchronized with the shared time.

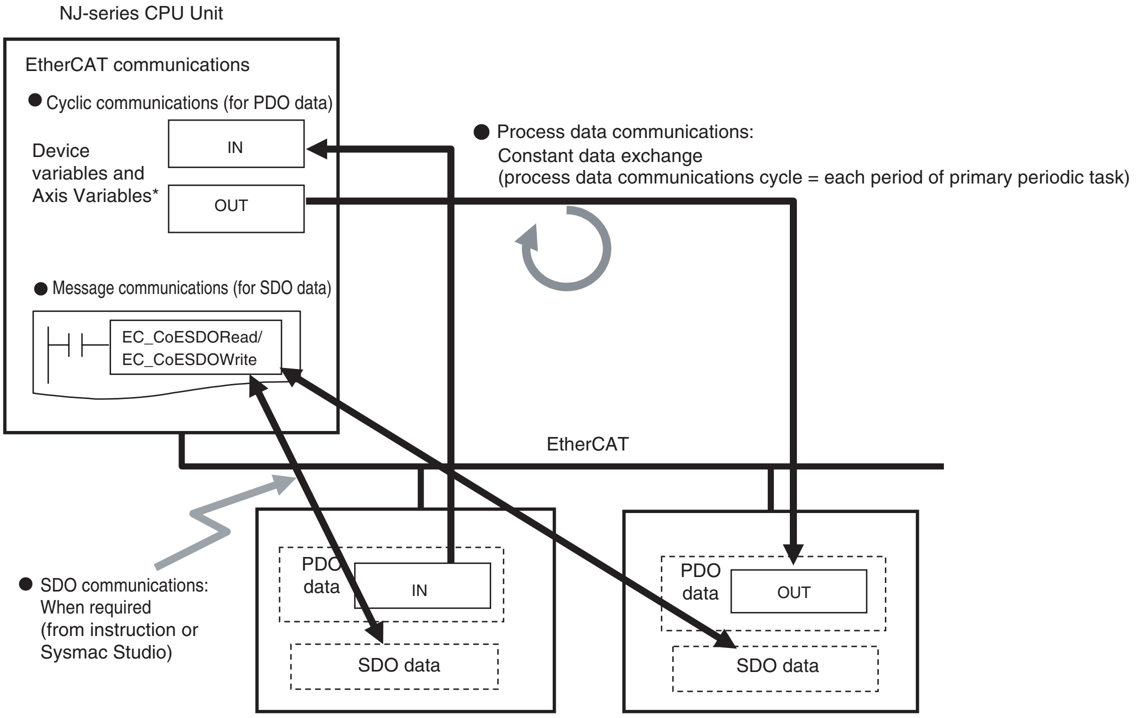

Operation timing is synchronized by sharing time information between the EtherCAT master and slaves.
EtherCAT master
Slaves

All slaves that support a distributed clock (synchronized slaves) are synchronized with the reference clock. In this EtherCAT system, the closest slave on the network to the EtherCAT master of all the slaves with a reference clock provides the reference clock. The EtherCAT master and slaves automatically access this reference clock.

3-1-2 Types of Communications

The following two methods are used to exchange data between master and slaves in EtherCAT communications.

Communication type	Name of communication type	Timing of processing	Type of data
Cyclic communications	Process data communications (PDO communications)	Constant (process data communications cycle)	PDO data
Message communications	SDO communications	When required.	SDO data


NJ-series CPU Unit
EtherCAT communications
● Cyclic communications (for PDO data)
Device variables and Axis Variables*
IN
OUT
● Message communications (for SDO data)
EC_CoESDORead/
EC_CoESDOWrite
● Process data communications:
Constant data exchange
(process data communications cycle = each period of primary periodic task)
EtherCAT
● SDO communications:
When required
(from instruction or Sysmac Studio)
PDO data
IN
SDO data
PDO data
OUT
SDO data

* Device variables for EtherCAT slaves
Axis Variables only for Servo Drive and encoder input slaves to which axes are allocated

Process Data Communications (PDO Communications)

PDO communications is used for constant data exchange between the master and slaves. It is called process data communications. PDO data (i.e., I/O data that is mapped to PDOs) that is allocated in advance is input and output periodically each EtherCAT process data communications cycle (i.e., the period of primary periodic task).
It is accessed from the NJ-series CPU Unit in the following ways.

- With device variables for EtherCAT slave I/O
- With Axis Variables for Servo Drive and encoder input slaves to which an axis is allocated

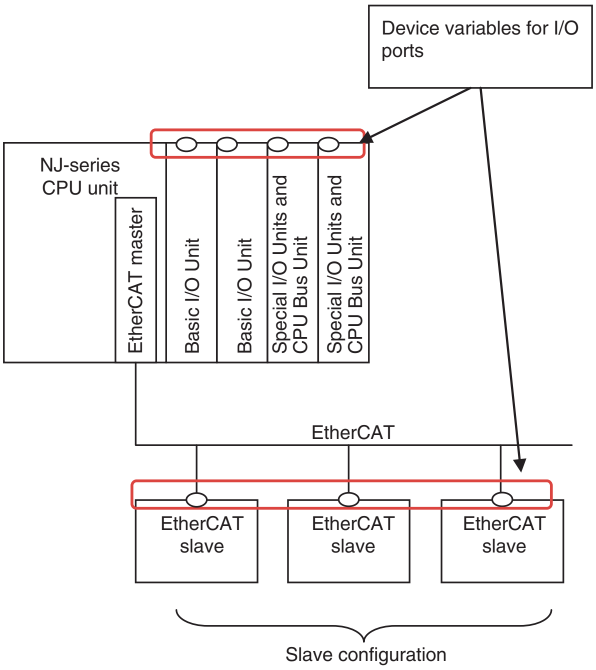
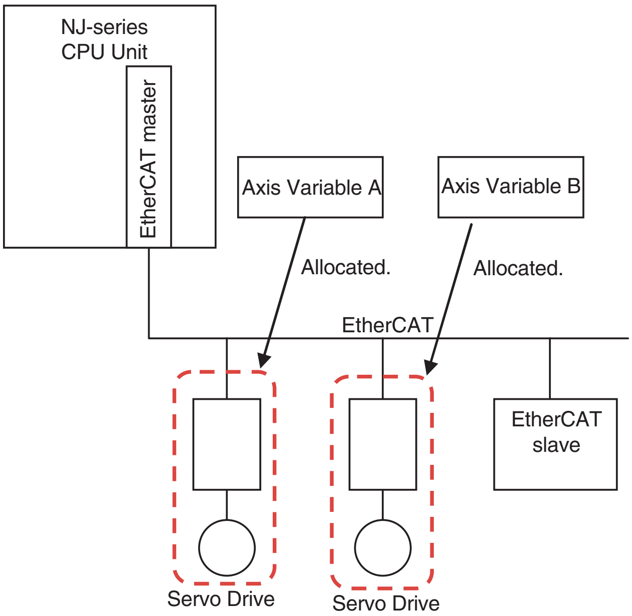
SDO Communications

SDO communications are used to read and write specified slave data from the master when required. This is called SDO communications.
You can read/write the following specified slave data with the EC_CoESDORead (Read CoE SDO) instruction or the EC_CoESDOWrite (Write CoE SDO) instruction.

- SDO data in slaves (parameters, error information, etc.)

3-1-3 Types of EtherCAT Variables

There are three types of EtherCAT variables as listed below.

Variable type		Description
Allocated variables	Device variables	These are common in-out variables for EtherCAT slaves. You can change the names of these variables.  Device variables for I/O ports NJ-series CPU unit EtherCAT master Basic I/O Unit Basic I/O Unit Special I/O Units and CPU Bus Unit Special I/O Units and CPU Bus Unit EtherCAT EtherCAT slave EtherCAT slave EtherCAT slave Slave configuration
	Axis Variables	These are structure variables for I/O and parameters for Servo Drive and encoder input slaves. You can change the names of these variables.  NJ-series CPU Unit EtherCAT master Axis Variable A Axis Variable B Allocated. Allocated. EtherCAT EtherCAT slave Servo Drive Servo Drive
System-defined variables	System-defined variables for EtherCAT master	These variables are defined by the system for communications parameters, communication status, and other functions. You cannot change the names of these variables.

3-1-4 Settings Required for EtherCAT Communications

For EtherCAT communications, you must set the following network configuration information from the Sysmac Studio and download it to the CPU Unit.

- Network configuration: Master and slave configuration
- EtherCAT master settings: Parameters settings, such as the process data communications cycle
- Process data information: Allocation information for slave PDO data

Additional Information

EtherCAT communications cannot be performed unless the correct network configuration information is downloaded to the CPU Unit.
Refer to *Section 5 Setting Up EtherCAT Communications with the Sysmac Studio* for details.

3-2 Programming EtherCAT Communications

The user program in the NJ-series CPU Unit reads/writes EtherCAT slave data and performs motion control for Servo Drive and encoder input slaves.

Instructions and variables are used according to slave types and target data as shown below.

Slave type	Type of data	Timing	Instructions	Variables
Slaves to which you cannot assign axes	Process data	Constantly read/written	Read/write instructions such as LD, OUT and MOV	Device variables
	SDO data	Read/written as required	EtherCAT instructions (EC_CoESDORead or EC_CoESDOWrite)	User-defined variables
Slaves to which you can assign axes	Process data	Constantly read/written	Motion control instructions or read/write instructions such as LD, OUT and MOV	Axis Variables or device variables
	SDO data	Read/written as required	EtherCAT instructions (EC_CoESDORead or EC_CoESDOWrite)	User-defined variables

3-3 State Transitions for EtherCAT Communications

3-3-1 Self Diagnosis at Startup

The EtherCAT master executes the following self-diagnosis when the power is turned ON.
The results of self-diagnosis are provided in the following system-defined variables as EtherCAT master errors if errors are detected.

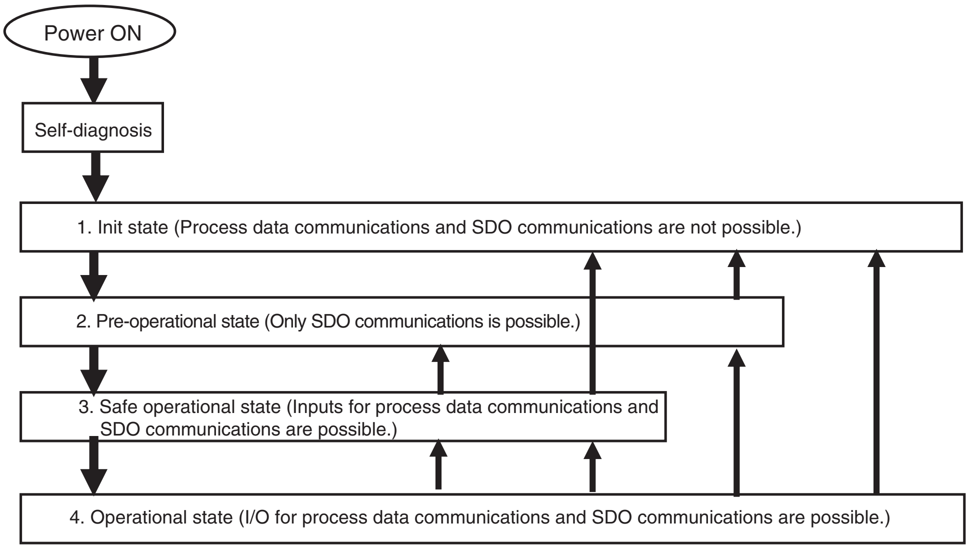
Diagnosis	Detected error type	System-defined variables
Diagnosis of network configuration information	Network configuration information error	_EC_NetCfgErr
Diagnosis of communications port	MAC address error	_EC_MacAdrErr
	Communications controller error	_EC_LanHwErr

Refer to *9-1 Overview of Errors* for details on error types.

3-3-2 Control States for EtherCAT Communications

Control State Machine

EtherCAT communications provides four control states. Communications is controlled by moving between these states.


Power ON
Self-diagnosis
1. Init state (Process data communications and SDO communications are not possible.)
2. Pre-operational state (Only SDO communications is possible.)
3. Safe operational state (Inputs for process data communications and SDO communications are possible.)
4. Operational state (I/O for process data communications and SDO communications are possible.)

After the power is turned ON, the communications master and slaves go from the Init state to the Pre-operational state, Safe-operational state, and then Operational state before starting EtherCAT communications. Afterwards, EtherCAT communications are performed while the state changes automatically between these states according to error occurrence and other conditions.

The current control state can be determined using the RUN indicator on the front panel.

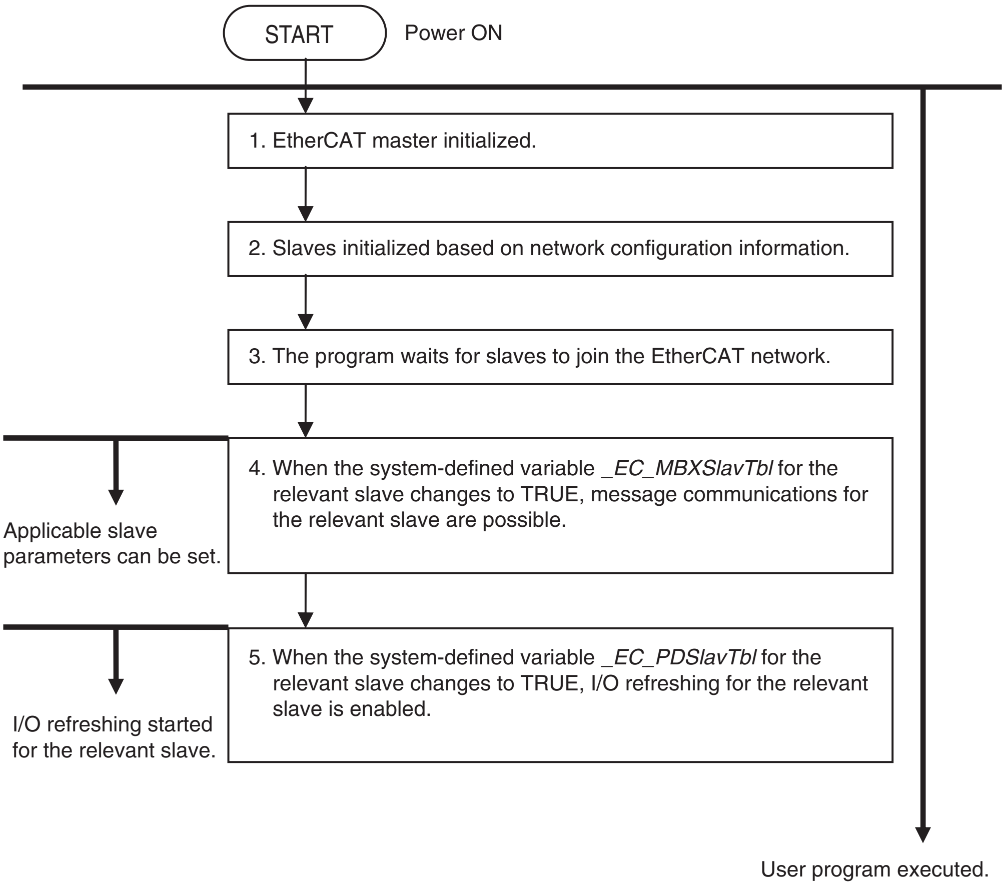
State	Description	Process data communications	SDO communications	RUN indicator
1. Init	Communications are being initialized. Communications are not possible.	Not allowed	Not allowed	Not lit
	This state continues if the network is not configured.			
2. Pre-operational	Only SDO communications are possible in this state. Communications always enters this state after initialization, and changes to the safe-operational state after initial setting of the network is performed.	Not allowed	Possible	Flashing
3. Safe operational	In this state, SDO communications and only inputs for process data communications are possible. Communications always enters this state before going into the Operational state.	Only inputs are possible	Possible	Flashing
4. Operational	This is the normal state for communications.	Possible	Possible	Lit

Additional Information

I/O Refreshing

The procedure from startup of the EtherCAT network until process data I/O can be refreshed is shown below. There is no correlation between the startup of the EtherCAT network and the execution of the user program. Design the user program by adding the system-defined variables* for the relevant slaves to the interlock conditions of the device variables for the slaves.

*. _EC_ActSlavTbl[1..192], _EC_MBXSlavTbl[1..192], _EC_PDSlavTbl[1..192], _EC_DisconnSlavTbl[1..192]


START
Power ON
1. EtherCAT master initialized.
2. Slaves initialized based on network configuration information.
3. The program waits for slaves to join the EtherCAT network.
4. When the system-defined variable _EC_MBXSlavTbl for the relevant slave changes to TRUE, message communications for the relevant slave are possible.
Applicable slave parameters can be set.
5. When the system-defined variable _EC_PDSlavTbl for the relevant slave changes to TRUE, I/O refreshing for the relevant slave is enabled.
I/O refreshing started for the relevant slave.
User program executed.

3-3-3 CPU Unit Status in Relation to EtherCAT

Refer to *A-1 EtherCAT Status in Relation to CPU Unit Status* for details on the following: memory related to the EtherCAT master, the ability to download master settings and slave settings, and the status of slaves according to the CPU Unit operating mode and the status of Controller errors.

4

EtherCAT Network Wiring

This section describes how to connect and wire an EtherCAT network.

4-1 Laying the EtherCAT Network 4-2

4-1-1 Supported Network Topologies 4-2
4-1-2 Installation Precautions 4-4
4-1-3 Installing EtherCAT Communications Cables 4-4
4-1-4 Connecting Communications Cables 4-7
4-1-5 Cable Connection Procedure 4-8

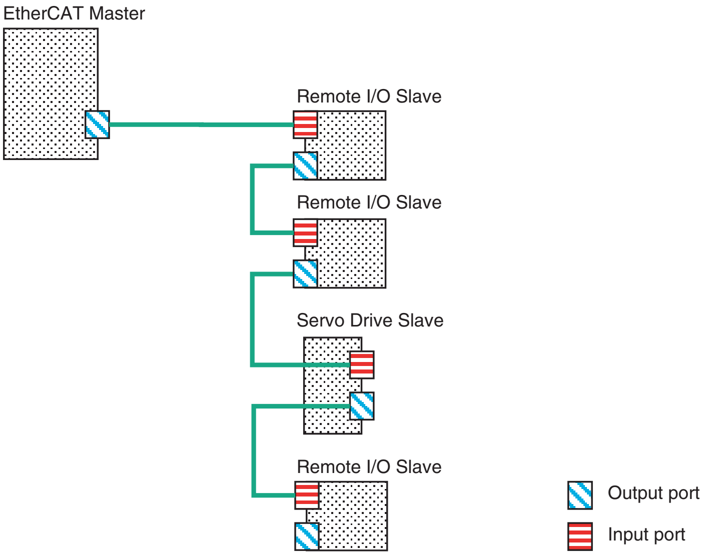
4-1 Laying the EtherCAT Network

This section describes how to install EtherCAT networks.

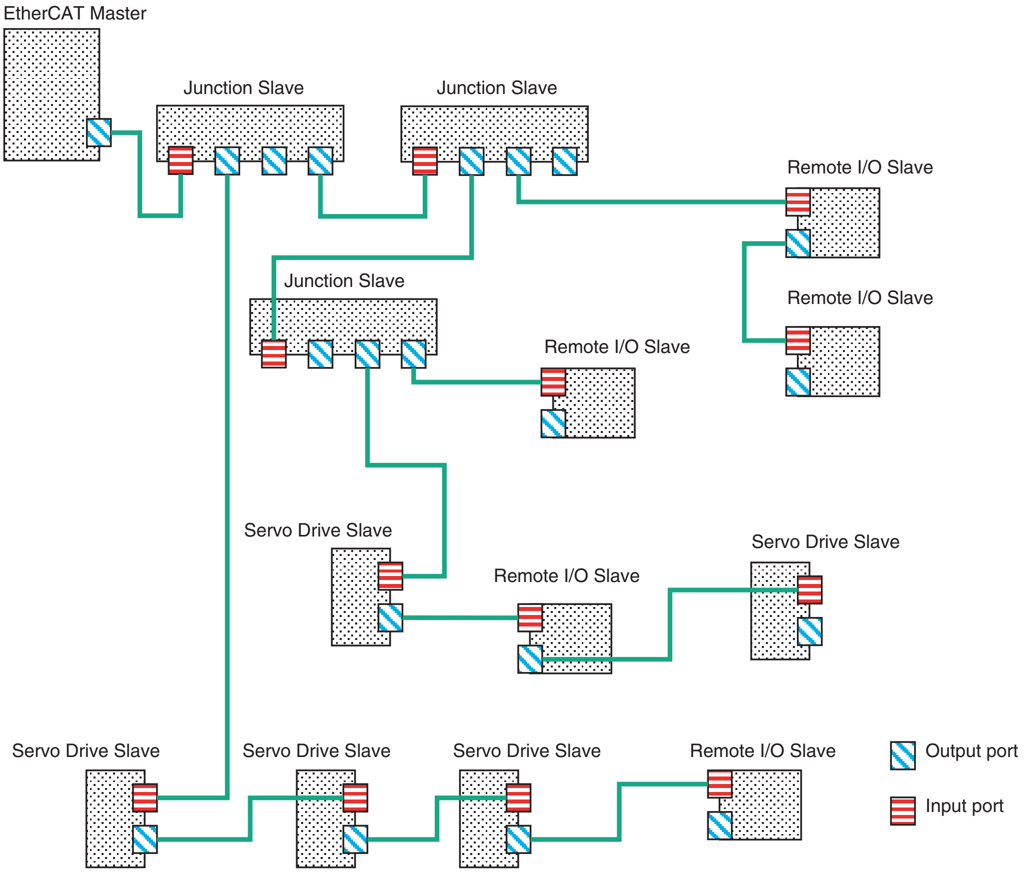
4-1-1 Supported Network Topologies

The NJ-series CPU Unit can be connected using daisy chain connections with no branching, or with branching connections using Junction Slaves. This supports redundancy, and all topologies other than rings. Examples of topology without branching and with branching (Junction Slaves) are shown below.

● No Branching



● Branching



Additional Information

When you use a system configuration in which an EtherCAT Junction Slave is connected to synchronized slaves that provide a distributed clock, at least one of the following two conditions below must be met.

- A slave that provides a reference clock must be connected between the EtherCAT master and the first Junction Slave.
- The Junction Slave must provide a reference clock.

However, the above conditions do not apply when synchronization is not performed between slaves providing a distributed clock throughout the entire EtherCAT network.
You can determine whether the Junction Slave supports a reference clock from the Reference Clock setting in the Sysmac Studio slave settings. OMRON Junction Slaves support a reference clock.

4-1-2 Installation Precautions

Basic precautions for the installation of EtherCAT networks are provided below.

Precautions when Installing a Network

- When you install an EtherCAT network, take sufficient safety precautions and perform the installation according to standards and specifications. (Refer to JIS X5252 or to electrical facility technical references.)
  An expert well versed in safety measures and the standards and specifications should be asked to perform the installation.
- Do not install EtherCAT network equipment near sources of noise. If the network must be installed in an area with noise, take steps to address the noise, such as placing equipment in metal cases.

Precautions when Installing Communications Cables

- Check the following items on the communications cables that are used in the network.
  - Are there any breaks?
  - Are there any shorts?
  - Are there any connector problems?
- When you connect the cable to the communications connectors on devices, firmly insert the communications cable connector until it locks in place.
- Do not lay the communications cables together with high-voltage lines.
- Do not lay the communications cable near devices that generate noise.
- Do not lay the communications cables in locations subject to high temperatures or high humidity.
- Do not lay the communications cables in locations subject to excessive dirt and dust or to oil mist or other contaminants.
- There are limitations on the bending radius of communications cables. Check the specifications of the communications cable for the bending radius.

4-1-3 Installing EtherCAT Communications Cables

Ethernet communications cables and connectors are used to connect the built-in EtherCAT port with EtherCAT slaves.

Use a shielded twisted-pair cable (double shielding with aluminum tape and braiding) of Ethernet category 5 (100Base-TX) or higher, and use straight wiring.

Cable with Connectors

● Sizes and Conductor Pairs: AWG 22 × 2 Pairs

Product name	Manufacturer	Length length (m)*	Model	Contact information
Cable with Connectors on both Ends (RJ45/RJ45)	OMRON Corporation	0.3	XS5W-T421-AMD-K	OMRON Customer Service Center
		0.5	XS5W-T421-BMD-K	
		1	XS5W-T421-CMD-K	
Cable with Connectors on both Ends (M12/RJ45)	OMRON Corporation	2	XS5W-T421-DMC-K	OMRON Customer Service Center
		5	XS5W-T421-GMC-K	
		10	XS5W-T421-JMC-K	

* Cables are available in the following lengths: 0.3, 0.5, 1, 2, 3, 5, 10, and 15 m. Refer to the *Industrial Ethernet Connectors Catalog* (Cat. No. G019)

Cables and Connectors

● Sizes and Conductor Pairs: AWG 24 × 4 Pairs

Part name	Manufacturer	Model	Contact information
Cables	Tonichi Kyosan Cable, Ltd.	NETSTAR-C5E SAB 0.5 × 4P*	Planning Department, Kanetsu Co., Ltd.
	Kuramo Electric Co.	KETH-SB*	Kuramo Electric Co.
	SWCC Showa Cable Systems Co.	FAE-5004*	SWCC Showa Cable Systems Co.
RJ45 Connectors	Panduit Corporation	MPS588*	Panduit Corporation US Headquarters

* We recommend that you use combinations of the above Cables and Connectors.

● Sizes and Conductor Pairs: AWG 22 × 2 Pairs

Part name	Manufacturer	Model	Contact information
Cables	Kuramo Electric Co.	KETH-PSB-OMR*	Kuramo Electric Co.
RJ45 Assembly Connectors	OMRON Corporation	XS6G-T421-1*	OMRON Customer Service Center

* We recommend that you use combinations of the above Cables and Connectors.

Precautions for Correct Use

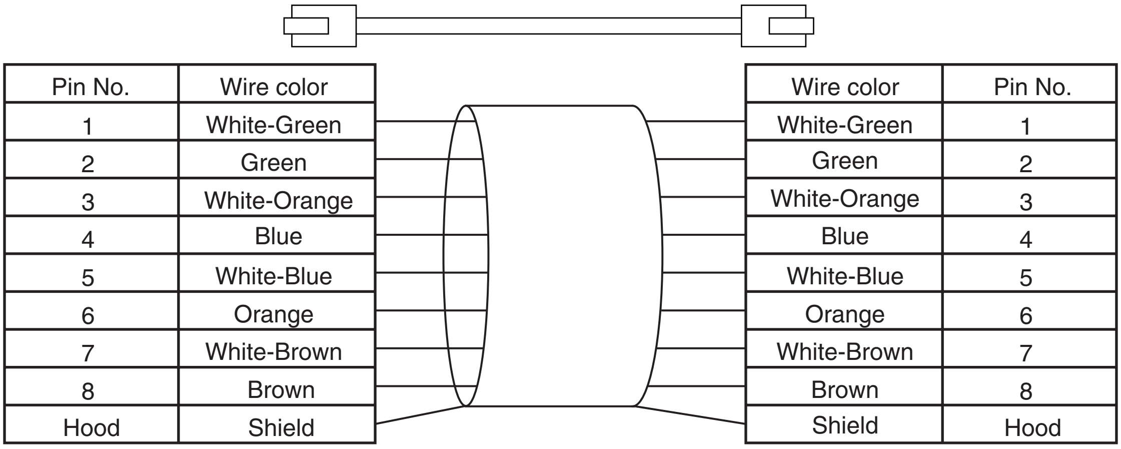
- The maximum length between nodes is 100 m. However, some cables are specified for less than 100 m. Generally speaking, if the conductors are twisted wire rather than solid wire, transmission performance will be lower, and reliable communications may not be possible at 100 m. Confirm details with the cable manufacturer.
- When selecting a connector, confirm that it is applicable to the cable that will be used. Confirm the following items: Conductor size, conductor type (solid wire or twisted wire), number of twisted pairs (2 or 4), outer diameter, etc.

Additional Information

If an Ethernet cable of category 5 or higher is used, communications will be possible even if the cable is not shielded. However, we recommend a cable with double, aluminum tape and braided shielding to ensure sufficient noise immunity.

Attaching the Connectors to the Cable and Pin Assignments

Use straight wiring to attach the connectors to the communications cable.



Pin No.	Wire color
1	White-Green
2	Green
3	White-Orange
4	Blue
5	White-Blue
6	Orange
7	White-Brown
8	Brown
Hood	Shield

Wire color	Pin No.
White-Green	1
Green	2
White-Orange	3
Blue	4
White-Blue	5
Orange	6
White-Brown	7
Brown	8
Shield	Hood

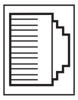
*1 Connect the cable shield to the connector hood at both ends of the cable.

*2 There are two connection methods for Ethernet: T568A and T568B. The T568A connection method is shown above, but the T568B connection method can also be used.

Connector Specifications

Specification	Description
Electrical characteristics	Conforms to IEEE 802.3 standards.
Connector structure	RJ45 8-pin modular connector (Conforms to ISO 8877.)

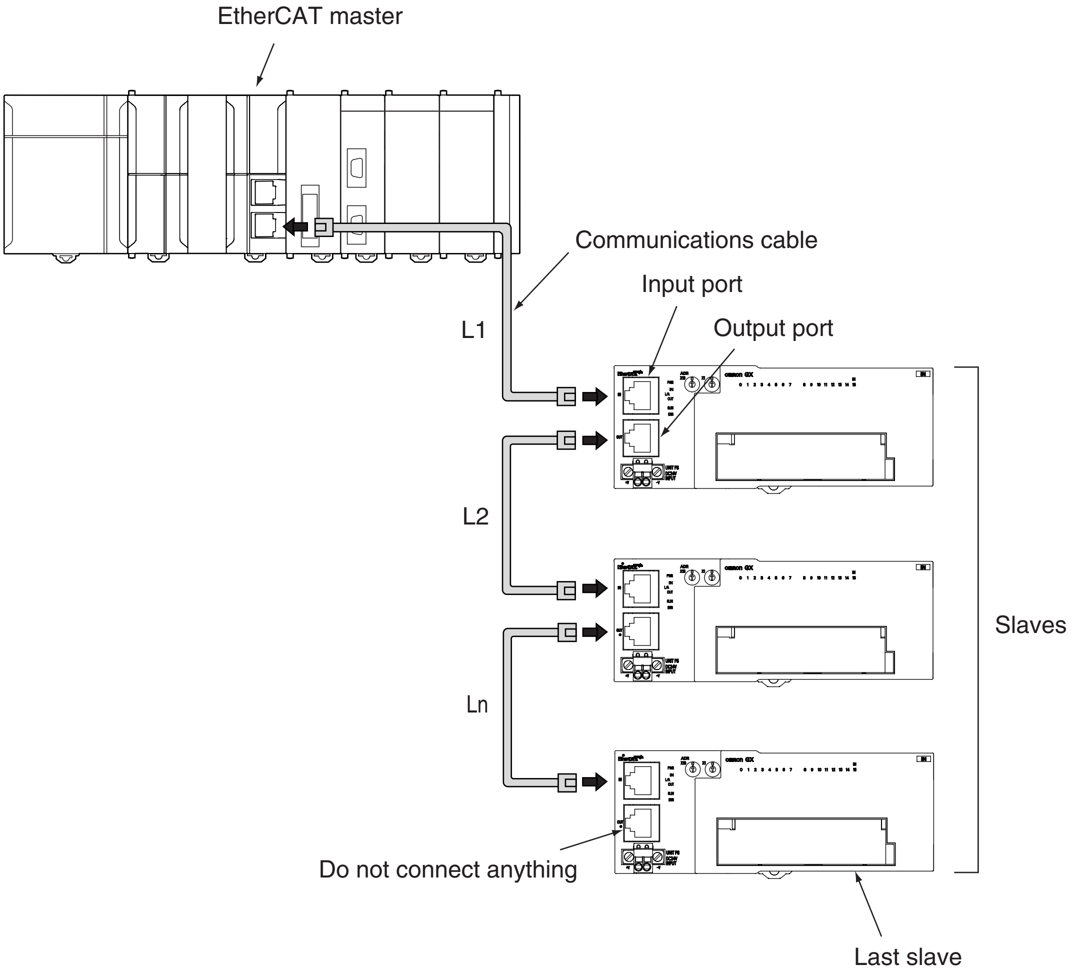
Pin Assignments

	Pin No.	Signal name	Abbreviation	Signal direction
	1	Transmission data +	TD+	Output
	2	Transmission data –	TD–	Output
	3	Reception data +	RD+	Input
	4	Not used.	---	---
	5	Not used.	---	---
	6	Reception data –	RD–	Input
	7	Not used.	---	---
	8	Not used.	---	---
	Hood	Frame ground	FG	---

4-1-4 Connecting Communications Cables

Cable connections can be made freely in EtherCAT networks. Connect the communications cable from the EtherCAT master to the input port on the first slave, and then connect the communications cable to the next slave to the output port on the first slave.

Do not connect anything to the output port of the slave at the end of the network.



The cable between any two nodes (L1, L2 ... Ln) must be 100 m or less. Use the Sysmac Studio to confirm if communications are possible for the total cable length. Firmly connect the communications cable connector until it clicks into place.

Precautions for Correct Use

Do not disconnect the EtherCAT slave cables during operation. The output may become unstable. Refer to *9-3 Replacing Slaves during Communications* for information on replacing slaves during operation.

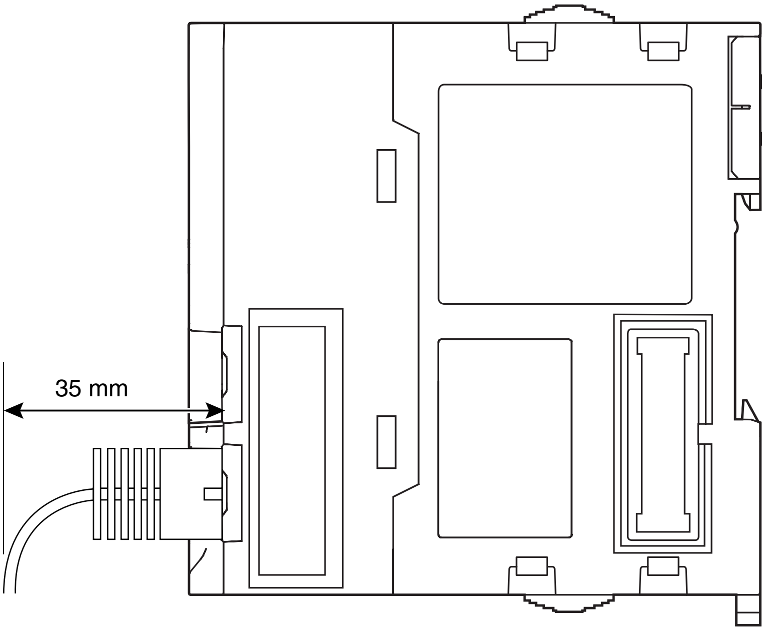
Additional Information

Make sure the cable between each pair of devices connects an output port to an input port. Normal communications are not possible if an output port is connected to another output port or an input port is connected to another input port.

4-1-5 Cable Connection Procedure

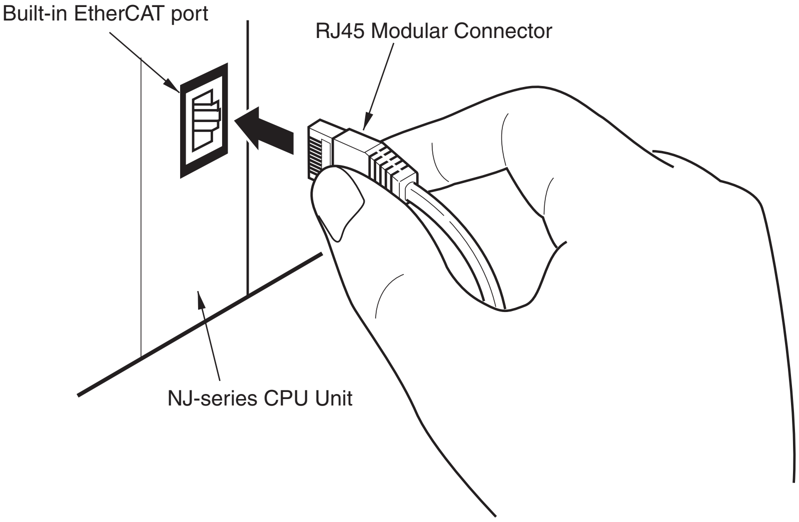
Precautions for Correct Use

- Turn OFF the Controller's power supply before connecting or disconnecting Ethernet communications cable.
- Allow enough space for the bending radius of the Ethernet communications cable as shown below.



1 Lay the Ethernet communications cable.

2 Connect the Ethernet communications cable to the built-in EtherCAT port on the NJ-series CPU Unit. Firmly insert the connector until it locks into place.



5

Setting Up EtherCAT Communications with the Sysmac Studio

This section describes how to set the network configuration information and how to check EtherCAT communications from the Sysmac Studio.

5-1 Overview of Network Configuration Information 5-2

5-2 Creating the EtherCAT Network Configuration 5-3

5-3 Setting EtherCAT Slave Variables and Axes 5-5

5-3-1 Registering Device Variables for All EtherCAT Slaves 5-5

5-3-2 Axis Settings for Servo Drives and Encoder Input Slaves 5-10

5-4 EtherCAT Master and Slave Parameter Settings 5-15

5-4-1 Setting EtherCAT Master 5-15

5-4-2 Setting EtherCAT Slaves 5-18

5-5 Comparing and Merging EtherCAT Network Configurations 5-21

5-5-1 Comparing and Merging with the Actual Network Configuration from the Sysmac Studio 5-21

5-5-2 Automatically Creating the Network Configuration 5-24

5-5-3 Using the Sysmac Studio to Obtain Serial Numbers from the Actual Network Configuration 5-27

5-6 Downloading the Network Configuration Information 5-29

5-6-1 Downloading the Network Configuration Information from the Sysmac Studio 5-29

5-7 Confirming Communications after Completing EtherCAT Configuration and Settings 5-31

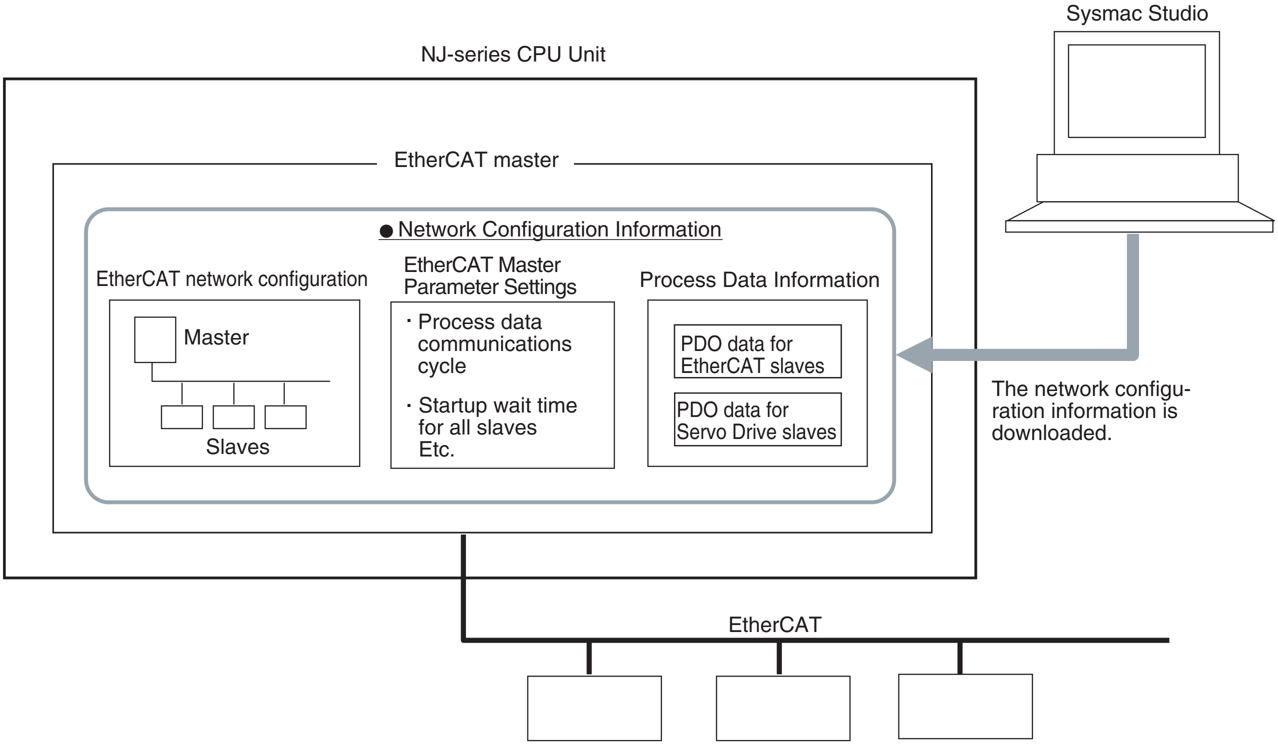
5-1 Overview of Network Configuration Information

To execute EtherCAT communications, you must create the following three types of data with the Sysmac Studio and download the data to the CPU Unit. When this data is set, the network configuration information is automatically created.

When you download the network configuration information to the CPU Unit, the EtherCAT master initializes slaves and performs process data communications based on the network configuration information. This section describes the procedures to set the network configuration information and how to check EtherCAT communications.

Network Configuration Information

Network configuration information	1. EtherCAT network configuration
	2. Process data information This is allocation information for PDO data in the slaves. It is also called PDO mapping data.
	3. EtherCAT master and slave parameter settings (Examples: process data communications cycle and wait all slaves startup time)


Sysmac Studio
NJ-series CPU Unit
EtherCAT master
● Network Configuration Information
EtherCAT network configuration
Master
Slaves
EtherCAT Master Parameter Settings
· Process data communications cycle
· Startup wait time for all slaves
Etc.
Process Data Information
PDO data for EtherCAT slaves
PDO data for Servo Drive slaves
The network configuration information is downloaded.
EtherCAT

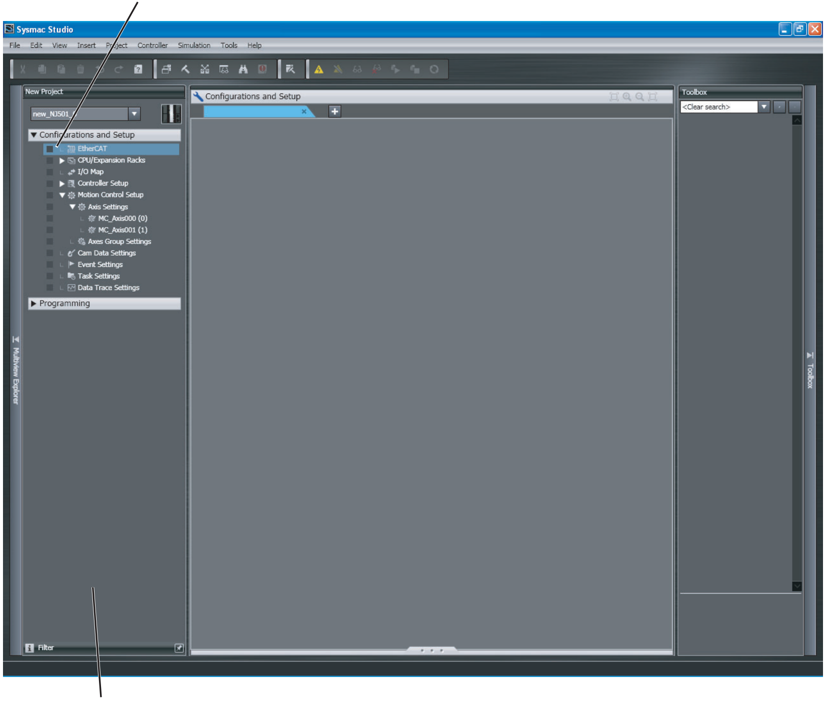
5-2 Creating the EtherCAT Network Configuration

This section describes how to create the EtherCAT network configuration.

1 Start the Sysmac Studio offline.

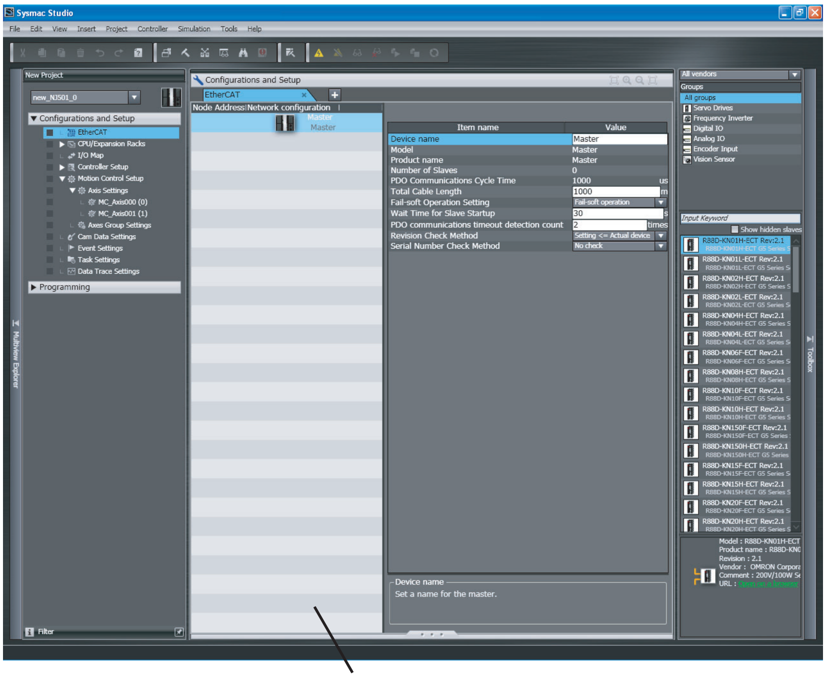
2 Double-click **EtherCAT** under **Configurations and Setup** on the Multiview Explorer. Or, right-click EtherCAT under **Configurations and Setup** and select ***Edit***.

Double-click *EtherCAT* or rightclick *EtherCAT* and select ***Edit***.



Multi-view Explorer

EtherCAT master will be displayed in the Edit Pane.

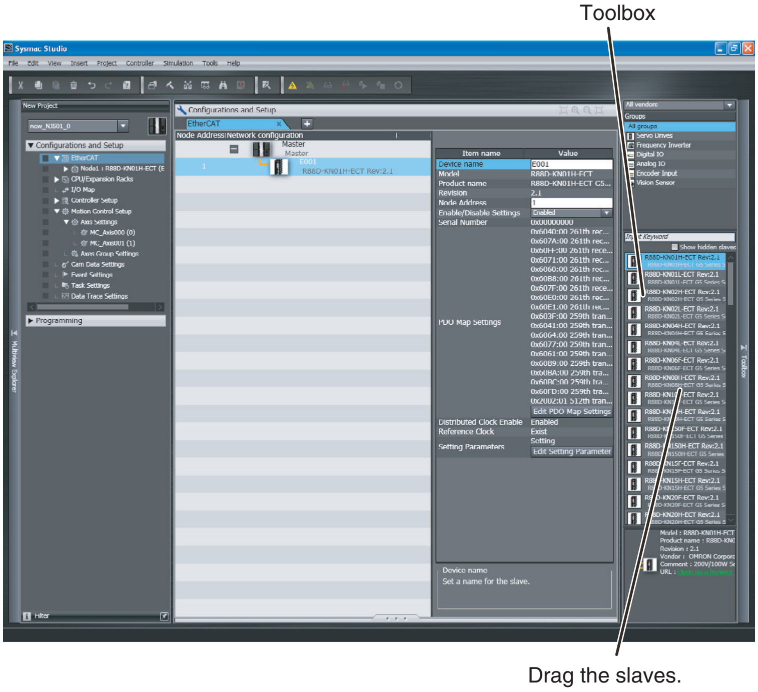


Item name	Value
Device name	Master
Model	Master
Product name	Master
Number of Slaves	0
PDO Communications Cycle Time	1000 us
Total Cable Length	1000 m
Fail-soft Operation Setting	Fail-soft operation
Wait Time for Slave Startup	30 s
PDO communications timeout detection count	2 times
Revision Check Method	Setting <= Actual device
Serial Number Check Method	No check

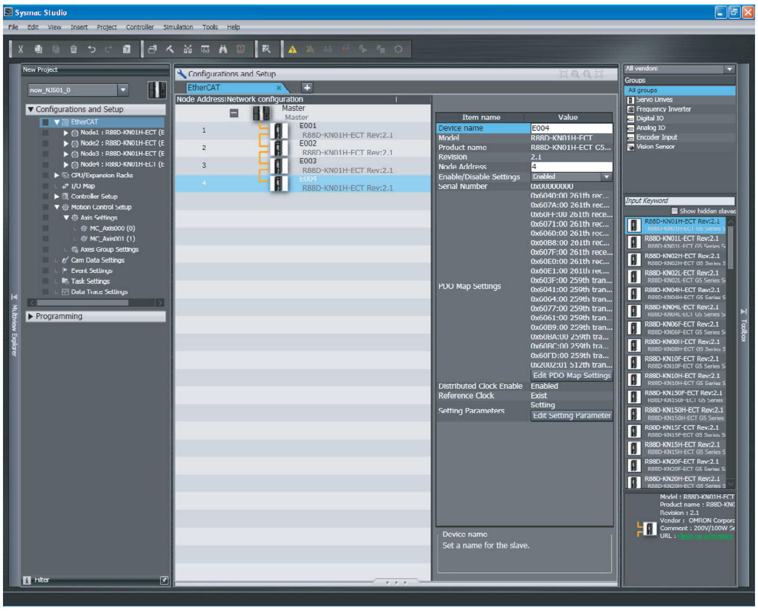
Device name
Set a name for the master.

Edit Pane

3 Select a slave in the Toolbox, drag it to the Edit Pane, and drop it under the master. The slave will be added under the master.



4 Select another slave in the Toolbox, drag it to the Edit Pane, and drop it under the slave to which you want to connect it to. The slave will be added under the slave.



For detailed procedures, such as those for deleting slaves, or copying and pasting slaves, refer to the *Sysmac Studio Version 1 Operation Manual* (Cat. No. W504).

Additional Information

You can go online and read the actual network configuration from the Sysmac Studio to display it and to use it as the network configuration in the project.
For details, refer to *5-5-2 Automatically Creating the Network Configuration*.

5-3 Setting EtherCAT Slave Variables and Axes

Device variables are used to read and write process data for EtherCAT slaves. Axis variables are used to manipulate slaves to which axes are assigned from the Motion Control Function Module. This section describes how to register device variables and set the axes.

5-3-1 Registering Device Variables for All EtherCAT Slaves

You use the I/O Map Tab Page in the Sysmac Studio to assign device variables to the I/O ports. The device variables that you create are registered in the global variable table.
Use one of the following three methods.

- Selecting variables that were previously registered in a variable table
- Inputting new device variable names
- Automatically creating device variable names

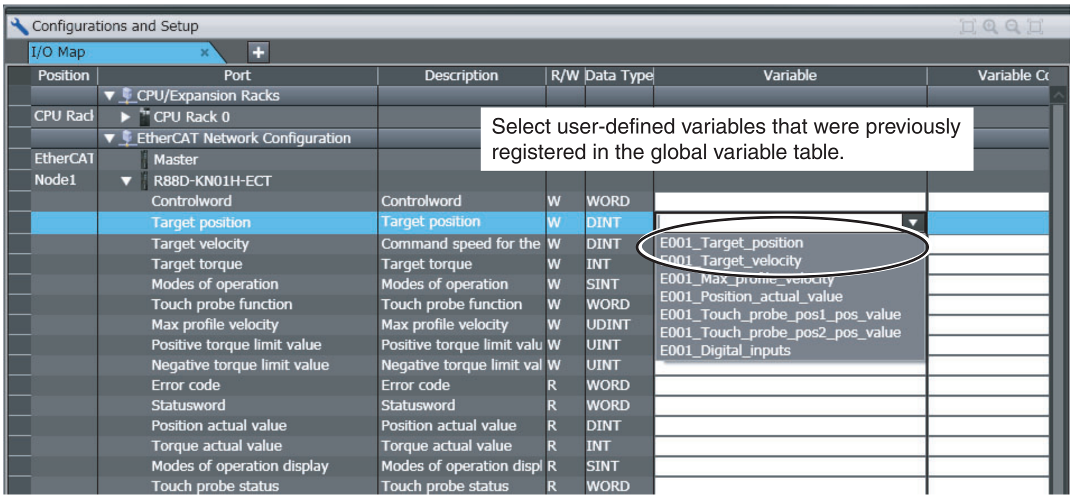
Selecting Variables That Were Previously Registered in a Variable Table

You can select variables that are already registered on the menu on the I/O Map Tab Page. For example, this method can be used to register device variables in the following cases.

- To write the program before the slave configuration information is created.
- To reuse programming from another project.

Use the following procedure.

1. Register the variables in advance in the global variable table or the local variable table of one of the POUs.
2. Program using those variables.
3. Create the slave configuration information.
4. Select the variables from the pull-down list in the I/O Map Tab Page to assign them to I/O ports.



Position	Port	Description	R/W	Data Type	Variable	Variable Cc
	▼ CPU/Expansion Racks					
CPU Racl	▶ CPU Rack 0					
	▼ EtherCAT Network Configuration					
EtherCAT	Master					
Node1	▼ R88D-KN01H-ECT					
	Controlword	Controlword	W	WORD		
	Target position	Target position	W	DINT	▼	
	Target velocity	Command speed for the	W	DINT		
	Target torque	Target torque	W	INT		
	Modes of operation	Modes of operation	W	SINT		
	Touch probe function	Touch probe function	W	WORD		
	Max profile velocity	Max profile velocity	W	UDINT		
	Positive torque limit value	Positive torque limit valu	W	UINT		
	Negative torque limit value	Negative torque limit val	W	UINT		
	Error code	Error code	R	WORD		
	Statusword	Statusword	R	WORD		
	Position actual value	Position actual value	R	DINT		
	Torque actual value	Torque actual value	R	INT		
	Modes of operation display	Modes of operation displ	R	SINT		
	Touch probe status	Touch probe status	R	WORD		

E001_Target_position
E001_Target_velocity
E001_Max_profile_velocity
E001_Position_actual_value
E001_Touch_probe_pos1_pos_value
E001_Touch_probe_pos2_pos_value
E001_Digital_inputs

Select user-defined variables that were previously registered in the global variable table.

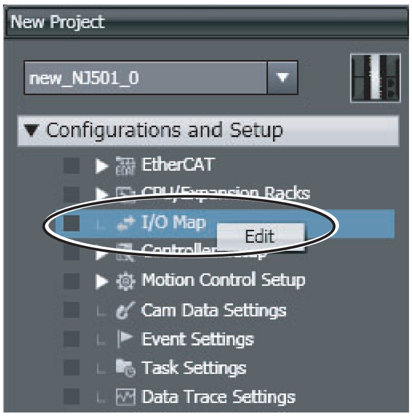
Inputting New Device Variable Names

You can input the required device variable names. For example, this method can be used to register device variables in the following case.

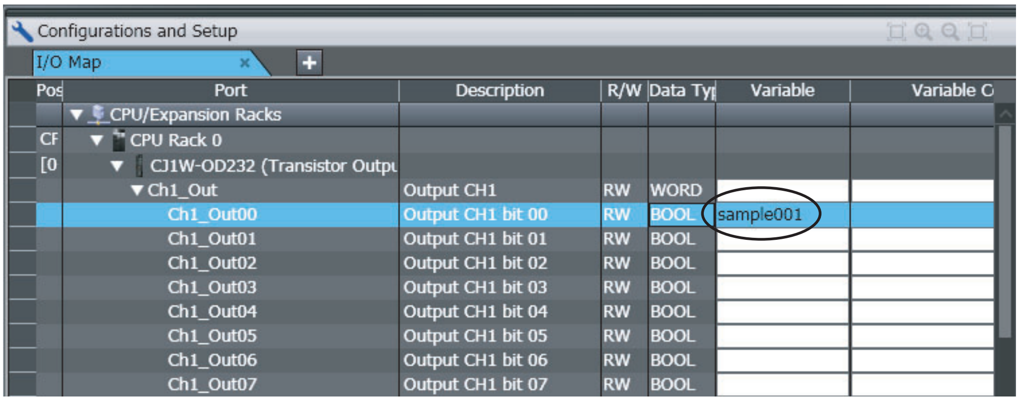
- To give suitable names to device variables that are assigned to I/O for I/O slaves.

Use the following procedure.

1 Double-click **I/O Map** under **Configurations and Setup** on the Multiview Explorer. Or, right-click **I/O Map** under **Configurations and Setup** and select ***Edit***.



2 Select the I/O port on the I/O Map Tab Page and enter the variable name in the Variable column.



Pos	Port	Description	R/W	Data Typ	Variable	Variable C
	CPU/Expansion Racks					
CF	CPU Rack 0					
[0	CJ1W-OD232 (Transistor Outpu					
	Ch1_Out	Output CH1	RW	WORD		
	Ch1_Out00	Output CH1 bit 00	RW	BOOL	sample001	
	Ch1_Out01	Output CH1 bit 01	RW	BOOL		
	Ch1_Out02	Output CH1 bit 02	RW	BOOL		
	Ch1_Out03	Output CH1 bit 03	RW	BOOL		
	Ch1_Out04	Output CH1 bit 04	RW	BOOL		
	Ch1_Out05	Output CH1 bit 05	RW	BOOL		
	Ch1_Out06	Output CH1 bit 06	RW	BOOL		
	Ch1_Out07	Output CH1 bit 07	RW	BOOL		

Device variables are automatically assigned to the I/O ports of the slaves and registered in the variable table that is specified by the Variable Type.

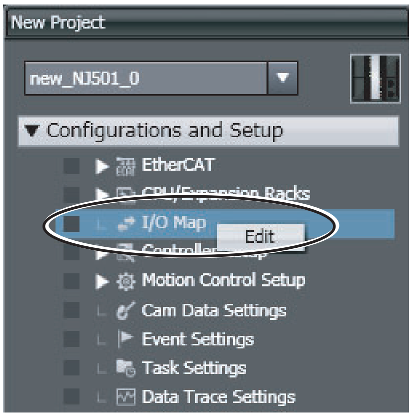
Automatically Creating Device Variable Names

The device variable names will be created by combining the device name and the I/O port name. The device names are set in the slave parameters. The default device names are “E” followed by a serial number that starts from 001. For example, this method can be used to register device variables in the following case.

- To eliminate the work that is involved in obtaining the device variable names.

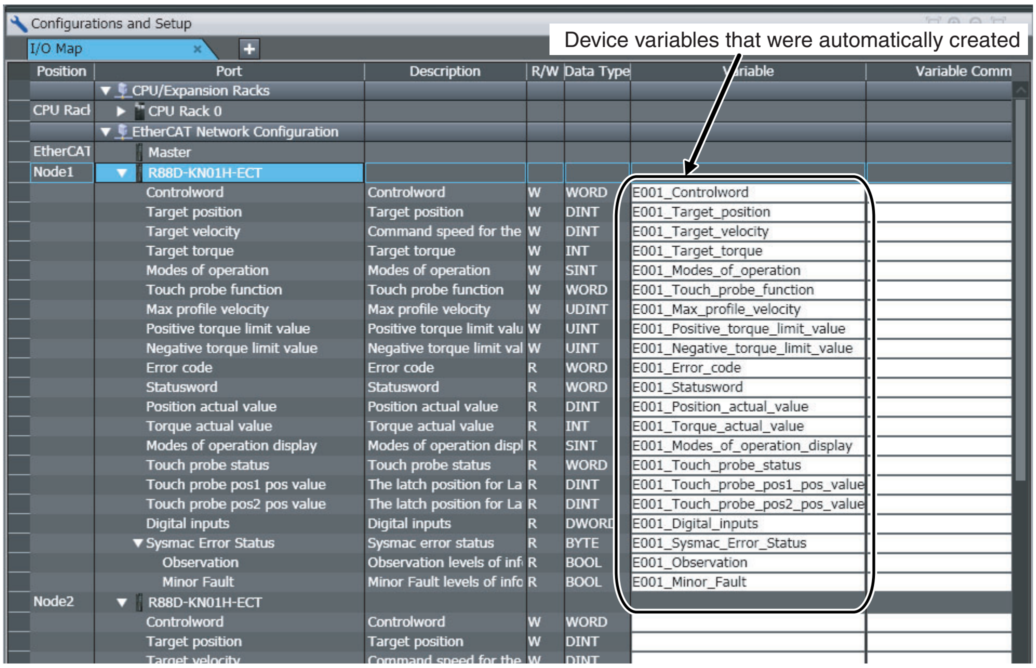
Use the following procedure.

1 Double-click **I/O Map** under **Configurations and Setup** on the Multiview Explorer. Or, right-click **I/O Map** under **Configurations and Setup** select ***Edit***.



The I/O Map Tab Page will be displayed.

2 Select a slave or I/O ports on the I/O Map Tab Page, right-click, and select ***Create Device Variable***.



Device variables that were automatically created

Position	Port	Description	R/W	Data Type	Variable	Variable Comm
	▼ CPU/Expansion Racks					
CPU Rack	▶ CPU Rack 0					
	▼ EtherCAT Network Configuration					
EtherCAT	Master					
Node1	▼ R88D-KN01H-ECT					
	Controlword	Controlword	W	WORD	E001_Controlword	
	Target position	Target position	W	DINT	E001_Target_position	
	Target velocity	Command speed for the	W	DINT	E001_Target_velocity	
	Target torque	Target torque	W	INT	E001_Target_torque	
	Modes of operation	Modes of operation	W	SINT	E001_Modes_of_operation	
	Touch probe function	Touch probe function	W	WORD	E001_Touch_probe_function	
	Max profile velocity	Max profile velocity	W	UDINT	E001_Max_profile_velocity	
	Positive torque limit value	Positive torque limit valu	W	UINT	E001_Positive_torque_limit_value	
	Negative torque limit value	Negative torque limit val	W	UINT	E001_Negative_torque_limit_value	
	Error code	Error code	R	WORD	E001_Error_code	
	Statusword	Statusword	R	WORD	E001_Statusword	
	Position actual value	Position actual value	R	DINT	E001_Position_actual_value	
	Torque actual value	Torque actual value	R	INT	E001_Torque_actual_value	
	Modes of operation display	Modes of operation displ	R	SINT	E001_Modes_of_operation_display	
	Touch probe status	Touch probe status	R	WORD	E001_Touch_probe_status	
	Touch probe pos1 pos value	The latch position for La	R	DINT	E001_Touch_probe_pos1_pos_value	
	Touch probe pos2 pos value	The latch position for La	R	DINT	E001_Touch_probe_pos2_pos_value	
	Digital inputs	Digital inputs	R	DWORD	E001_Digital_inputs	
	▼ Sysmac Error Status	Sysmac error status	R	BYTE	E001_Sysmac_Error_Status	
	Observation	Observation levels of inf	R	BOOL	E001_Observation	
	Minor Fault	Minor Fault levels of info	R	BOOL	E001_Minor_Fault	
Node2	▼ R88D-KN01H-ECT					
	Controlword	Controlword	W	WORD		
	Target position	Target position	W	DINT		
	Target velocity	Command speed for the	W	DINT		

Device variables are automatically assigned to the I/O ports of the slaves and registered in the variable table that is specified by the Variable Type.

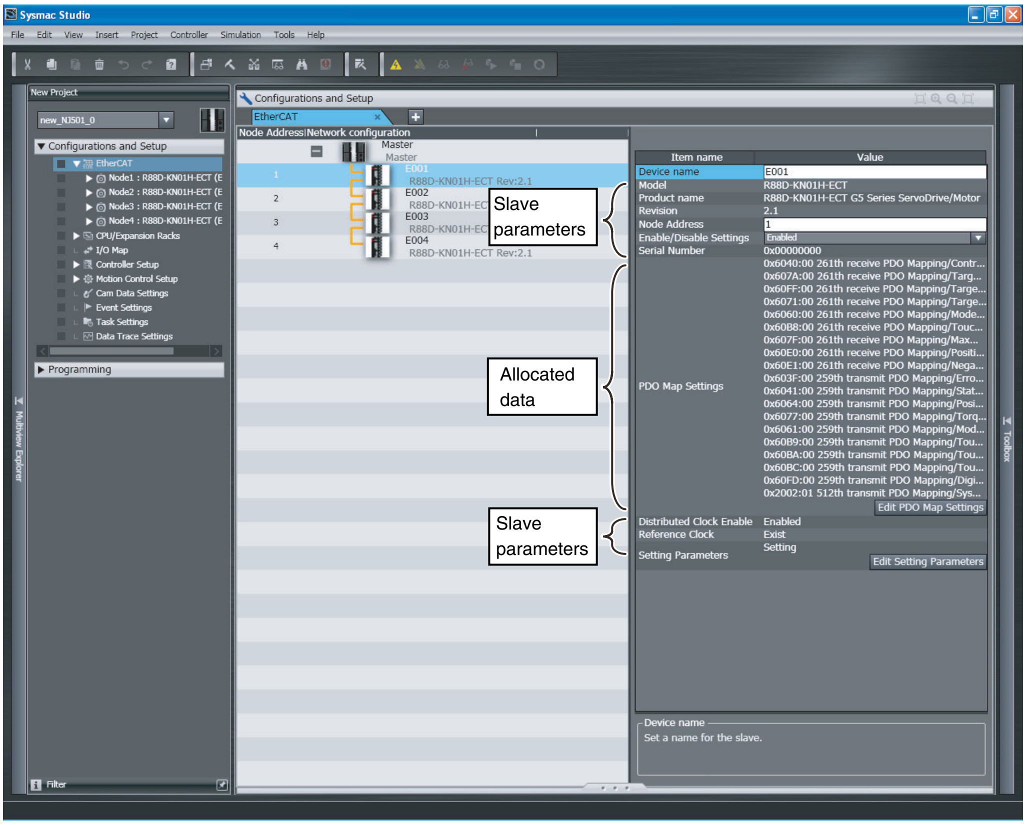
Additional Information

- We recommend that you set device names.
- To delete the mapping for the variable that is assigned to a port, delete the contents of the cell in the *Variable* column or right-click the cell and select ***Reset Assignment***.
  The mapping of the device variable is deleted. The variable is not deleted from the variable table.
  Refer to *NJ-series CPU Unit Software User's Manual* (Cat. No. W501) for details on device variables.

Additional Information

Default allocations of process data for slaves are defined in the ESI files. Depending on the slave, you may have to change the process data assignment as required by the application.
Use the following procedure.

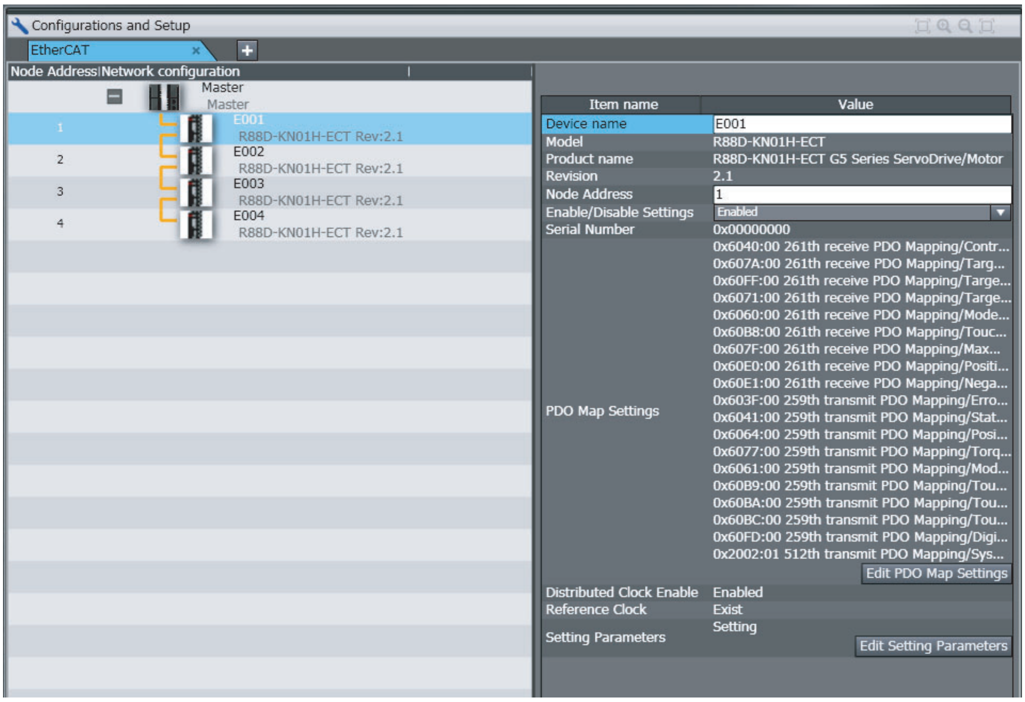
1 Select the slave for which to change the allocated data. The parameters and allocated data for the slave will appear.



Item name	Value
Device name	E001
Model	R88D-KN01H-ECT
Product name	R88D-KN01H-ECT G5 Series ServoDrive/Motor
Revision	2.1
Node Address	1
Enable/Disable Settings	Enabled
Serial Number	0x00000000
PDO Map Settings	0x6040:00 261th receive PDO Mapping/Contr... 0x607A:00 261th receive PDO Mapping/Targ... 0x60FF:00 261th receive PDO Mapping/Targe... 0x6071:00 261th receive PDO Mapping/Targe... 0x6060:00 261th receive PDO Mapping/Mode... 0x60B8:00 261th receive PDO Mapping/Touc... 0x607F:00 261th receive PDO Mapping/Max... 0x60E0:00 261th receive PDO Mapping/Positi... 0x60E1:00 261th receive PDO Mapping/Nega... 0x603F:00 259th transmit PDO Mapping/Erro... 0x6041:00 259th transmit PDO Mapping/Stat... 0x6064:00 259th transmit PDO Mapping/Posi... 0x6077:00 259th transmit PDO Mapping/Torq... 0x6061:00 259th transmit PDO Mapping/Mod... 0x60B9:00 259th transmit PDO Mapping/Tou... 0x60BA:00 259th transmit PDO Mapping/Tou... 0x60BC:00 259th transmit PDO Mapping/Tou... 0x60FD:00 259th transmit PDO Mapping/Digi... 0x2002:01 512th transmit PDO Mapping/Sys...
Distributed Clock Enable	Enabled
Reference Clock	Exist
Setting Parameters	Setting

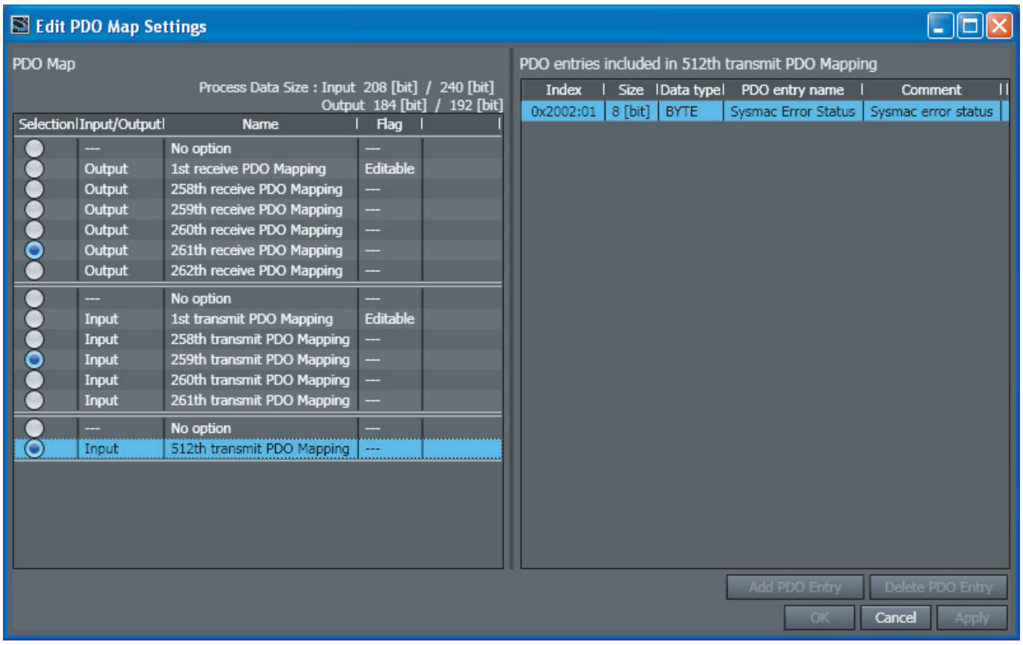
Device name
Set a name for the slave.

2 Click the **Edit PDO Map Settings** Button at the lower right of the allocated data in the pane.



Item name	Value
Device name	E001
Model	R88D-KN01H-ECT
Product name	R88D-KN01H-ECT G5 Series ServoDrive/Motor
Revision	2.1
Node Address	1
Enable/Disable Settings	Enabled
Serial Number	0x00000000
PDO Map Settings	0x6040:00 261th receive PDO Mapping/Contr... 0x607A:00 261th receive PDO Mapping/Targ... 0x60FF:00 261th receive PDO Mapping/Targe... 0x6071:00 261th receive PDO Mapping/Targe... 0x6060:00 261th receive PDO Mapping/Mode... 0x60B8:00 261th receive PDO Mapping/Touc... 0x607F:00 261th receive PDO Mapping/Max... 0x60E0:00 261th receive PDO Mapping/Positi... 0x60E1:00 261th receive PDO Mapping/Nega... 0x603F:00 259th transmit PDO Mapping/Erro... 0x6041:00 259th transmit PDO Mapping/Stat... 0x6064:00 259th transmit PDO Mapping/Posi... 0x6077:00 259th transmit PDO Mapping/Torq... 0x6061:00 259th transmit PDO Mapping/Mod... 0x60B9:00 259th transmit PDO Mapping/Tou... 0x60BA:00 259th transmit PDO Mapping/Tou... 0x60BC:00 259th transmit PDO Mapping/Tou... 0x60FD:00 259th transmit PDO Mapping/Digi... 0x2002:01 512th transmit PDO Mapping/Sys...
Distributed Clock Enable	Enabled
Reference Clock	Exist
Setting Parameters	Setting

The Edit PDO Map Settings Dialog Box will appear. Edit the allocated data as required.



Edit PDO Map Settings

PDO Map

Process Data Size : Input 208 [bit] / 240 [bit]
Output 184 [bit] / 192 [bit]

Selection	Input/Output	Name	Flag
○	---	No option	---
○	Output	1st receive PDO Mapping	Editable
○	Output	258th receive PDO Mapping	---
○	Output	259th receive PDO Mapping	---
○	Output	260th receive PDO Mapping	---
●	Output	261th receive PDO Mapping	---
○	Output	262th receive PDO Mapping	---
○	---	No option	---
○	Input	1st transmit PDO Mapping	Editable
○	Input	258th transmit PDO Mapping	---
●	Input	259th transmit PDO Mapping	---
○	Input	260th transmit PDO Mapping	---
○	Input	261th transmit PDO Mapping	---
○	---	No option	---
●	Input	512th transmit PDO Mapping	---

PDO entries included in 512th transmit PDO Mapping

Index	Size	Data type	PDO entry name	Comment
0x2002:01	8 [bit]	BYTE	Sysmac Error Status	Sysmac error status

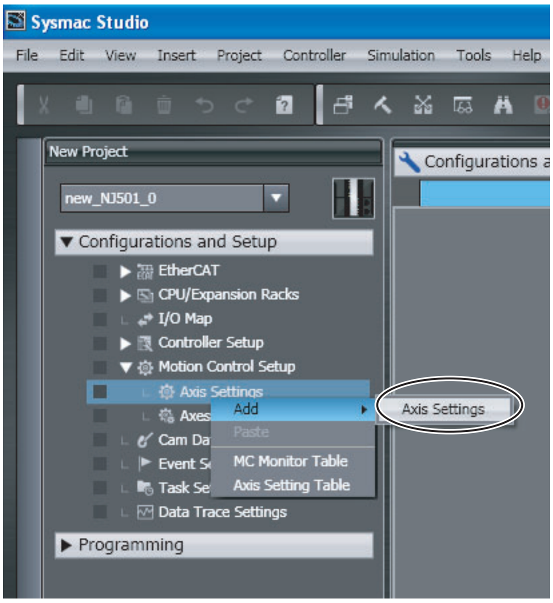
3 Select the output data (RxPDO) and input data (TxPDO) in the PDO Map List. You can add or delete the PDOs with Editable Flags as entries for the objects to use for the slaves.

4 Click the **OK** Button.

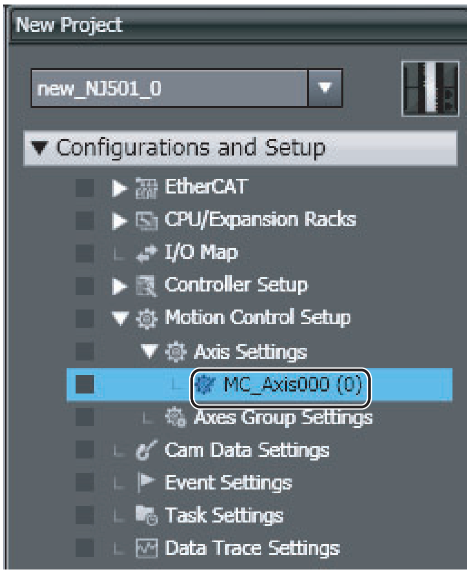
5-3-2 Axis Settings for Servo Drives and Encoder Input Slaves

Adding Axes

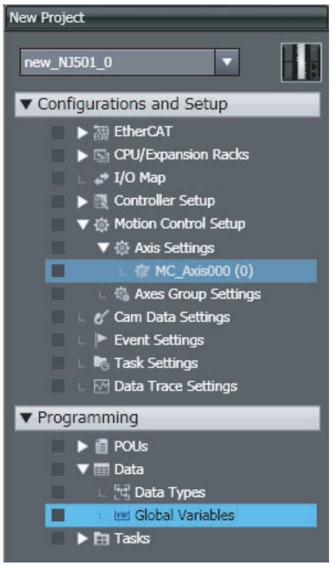
1 Right-click **Axis Settings** under **Configurations and Setup** – **Motion Control Setup** on the Multiview Explorer. Select ***Add*** – ***Axis Settings*** from the menu.



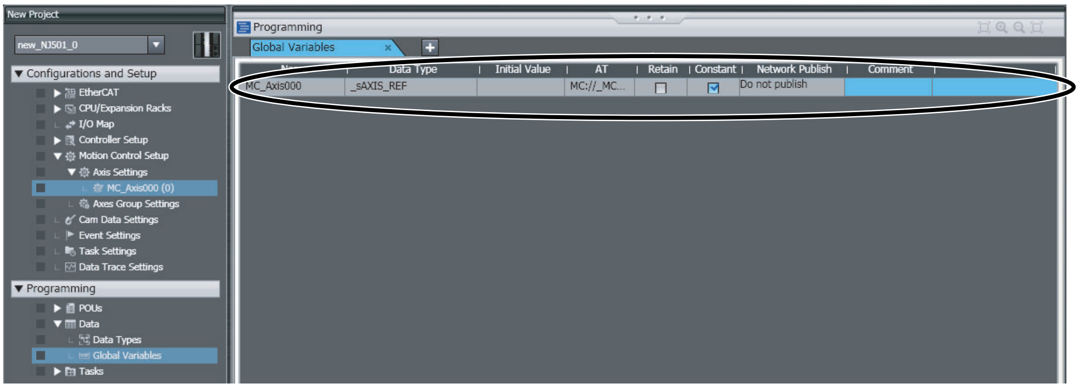
The *MC_Axis000* Axis Variable is added under the **Axis Settings**.



2 Double-click **Global Variables** under **Programming** – **Data** on the Multiview Explorer.



You can confirm that the *MC_Axis000* Axis Variable has been added automatically.



Name	Data Type	Initial Value	AT	Retain	Constant	Network Publish	Comment
MC_Axis000	_sAXIS_REF		MC://_MC...	□	☑	Do not publish	

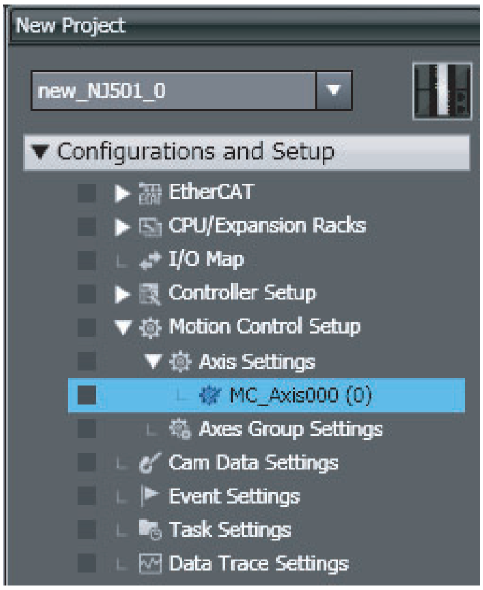
Refer to the *Sysmac Studio Version 1 Operation Manual* (Cat. No. W504) for the procedures to change, delete, or copy Axis Variables or the procedure to register axes groups.

Additional Information

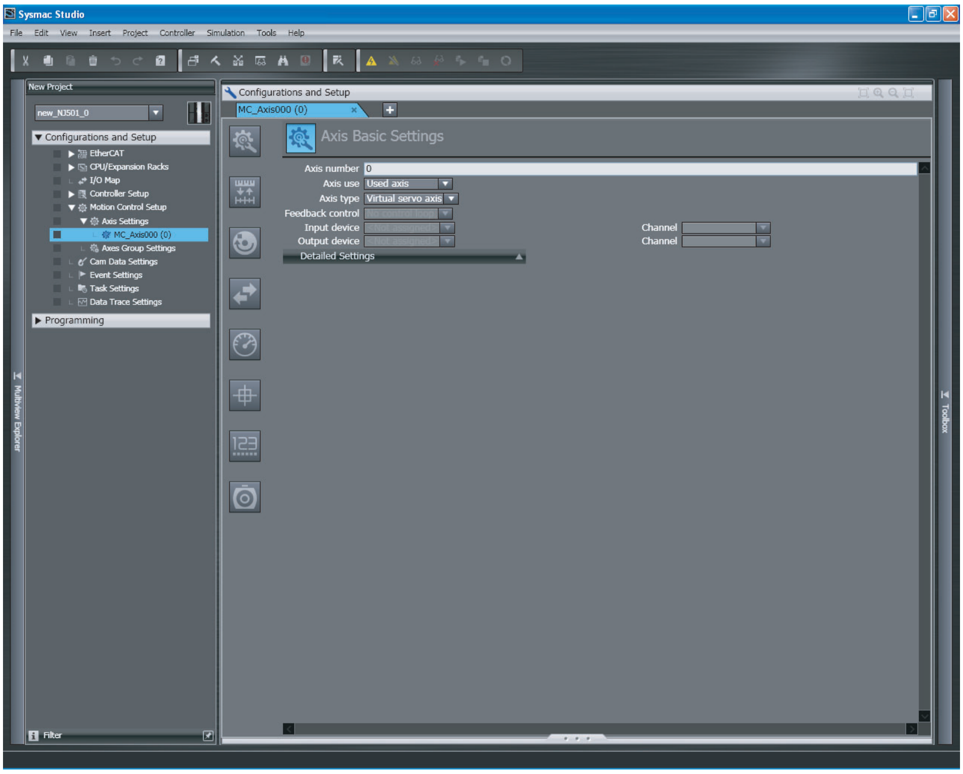
Even if you change an axis name in the Global Variable Table, the axis name in the Motion Control Setup will not change. Always change the axis name in the Motion Control Setup.

Registering Slaves to Axes

1 Double-click the *MC_Axis000* Axis Variable that was registered.

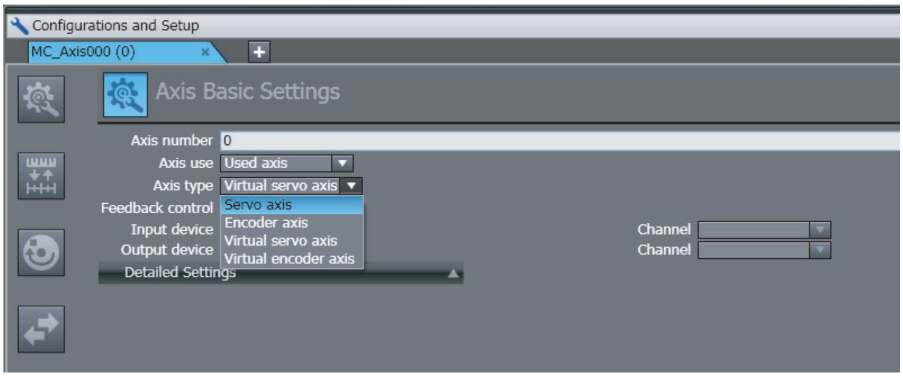


The Axis Parameter Setting View will be displayed in the Edit Pane. The Axis Basic Settings Tab Page will be displayed first.



Axis number 0
Axis use Used axis
Axis type Virtual servo axis
Feedback control No control loop
Input device <Not assigned> Channel
Output device <Not assigned> Channel

2 To enable the use of a servo axis, set the *Axis use* Box to *Used axis* and set the *Axis type* to *Servo axis*.


Configurations and Setup

MC_Axis000 (0)

Axis Basic Settings

Axis number 0

Axis use Used axis

Axis type Virtual servo axis

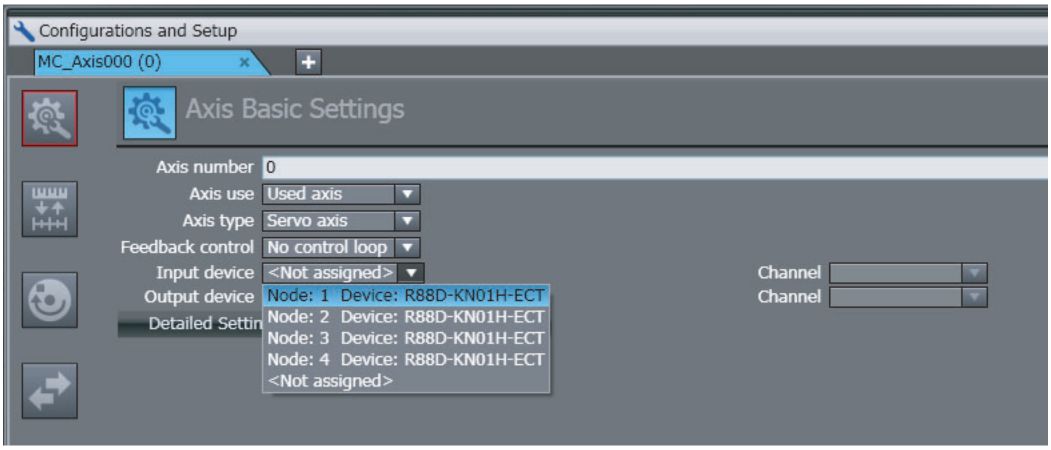
Feedback control

Input device

Output device

Detailed Settings

3 Select the slave that is assigned to the registered servo axis for the input device.


Configurations and Setup

MC_Axis000 (0)

Axis Basic Settings

Axis number 0

Axis use Used axis

Axis type Servo axis

Feedback control No control loop

Input device <Not assigned>

Output device

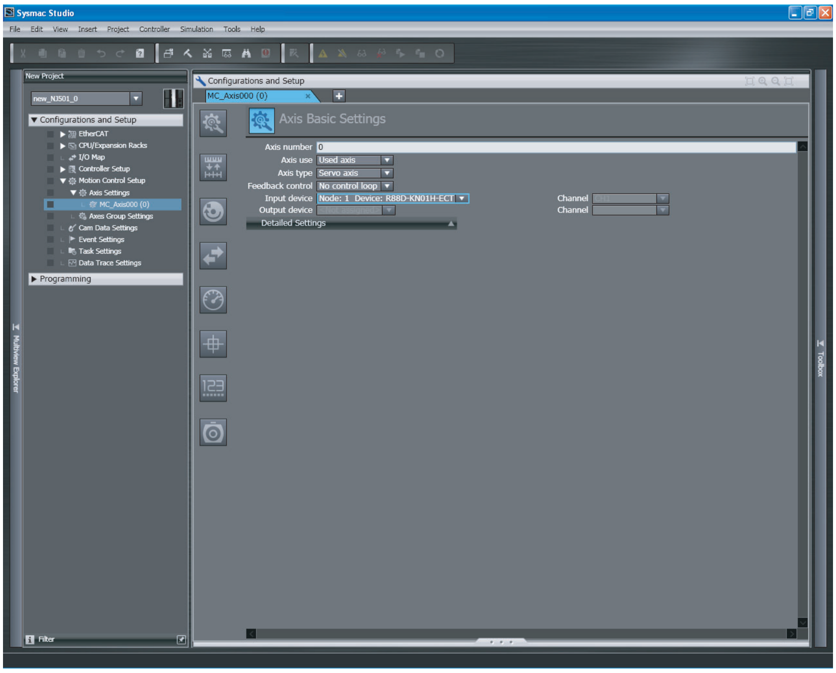
Detailed Settin

Node: 1 Device: R88D-KN01H-ECT
Node: 2 Device: R88D-KN01H-ECT
Node: 3 Device: R88D-KN01H-ECT
Node: 4 Device: R88D-KN01H-ECT
<Not assigned>
Channel
Channel

Setting Axis Parameters

1 Click each of the icons in the Axis Parameter Settings Tab Page.

The settings for each icon are displayed on the Axis Parameter Settings Tab Page.


Axis number 0

Axis use Used axis

Axis type Servo axis

Feedback control No control loop

Input device Node: 1 Device: R88D-KN01H-ECT

Output device

Detailed Settings

The parameters that are displayed for these icons are described in the following table.

Overview of Axis Parameter Settings Tab Page

Icon	Name	Description
	Axis Basic Settings	Displays the page to enable/disable axis and to set axis types, node addresses, and channels.
	Unit Conversion Settings	Displays the page to set the gear ratio of the electronic gear using the pulses per motor rotation and travel distance.
	Operation Settings	Displays the page to set the velocity, acceleration rate, deceleration rate, torque warning values, and other monitor parameters.
⇄	Other Operation Settings	Displays the page to set the Servo Drive I/O.
	Limit Settings	Displays the page to set software limits and following error limits.
	Homing Settings	Displays the page to set the homing operation.
123	Position Count Settings	Displays the page to set Count Mode of the Controller.
	Servo Drive Settings	Displays the page to set the Servo Drive parameters.

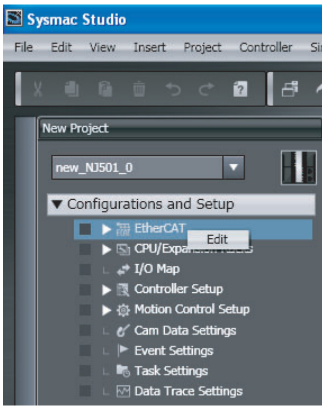
Additional Information

You can display all of the axis parameters in an Axis Setting Table. You can edit the axis parameters in this table in the same way as for the Axis Parameter Setting View.
Any parameters that are edited in the Axis Parameter Setting View are automatically updated in the Axis Setting Table.
Refer to the *Sysmac Studio Version 1 Operation Manual* (Cat. No. W504) for details on the Axis Setting Table.
Refer to *NJ-series CPU Unit Motion Control User's Manual* (Cat. No. W507) for details on axis parameters.

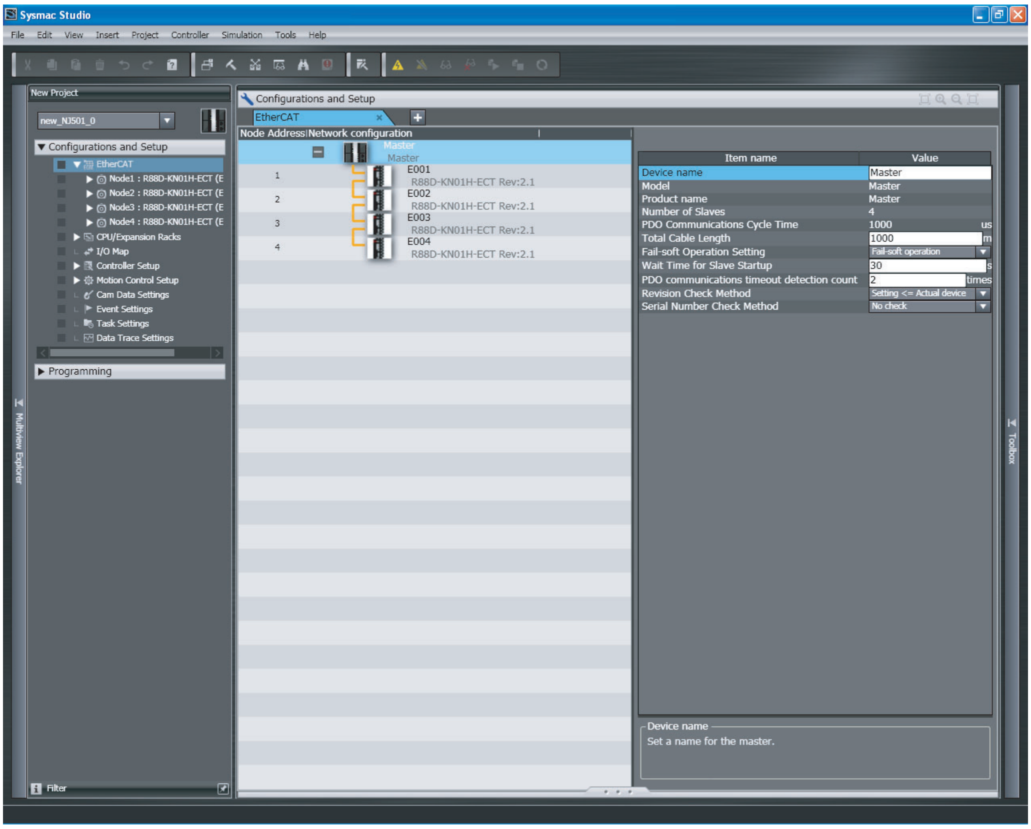
5-4 EtherCAT Master and Slave Parameter Settings

5-4-1 Setting EtherCAT Master

1 Double-click **EtherCAT** under **Configurations and Setup** on the Multiview Explorer. Or, right-click **EtherCAT** under **Configurations and Setup** and select ***Edit***.



2 Select the EtherCAT master that is displayed in the Edit Pane.



Item name	Value
Device name	Master
Model	Master
Product name	Master
Number of Slaves	4
PDO Communications Cycle Time	1000 us
Total Cable Length	1000 m
Fail-soft Operation Setting	Fail-soft operation
Wait Time for Slave Startup	30 s
PDO communications timeout detection count	2 times
Revision Check Method	Setting <= Actual device
Serial Number Check Method	No check

Device name
Set a name for the master.

The EtherCAT master settings are listed below.

Name	Editing	Remarks
Device name	OK	Displays the name of the EtherCAT master. Default setting: Master
Model	Not allowed.	Always ”Master.”
Product name	Not allowed.	Always ”Master.”
Number of Slaves	Not allowed.	The number of slaves is automatically calculated based on the topology. There can be up to 192 slaves. Display range: 0 to 192.
PDO Communications Cycle Time	Not allowed.	This is automatically input based on the task period of the primary periodic task. Setting range: 500 to 4,000 µs
Total Cable Length	OK	This is the total cable length between the slaves. Setting range: 1 to 4,294,967,295 Default setting: 1,000 m
Fail-soft Operation Setting	OK	Select *Stop* or *Fail-soft* operation for communications with all slaves on the network when the master detects a communications error (cable disconnection, slave malfunction, etc.). Default setting: Fail-soft operation Refer to *9-1 Overview of Errors* for details on errors.
Wait Time for Slave Startup	OK	Set the time to wait from the detection of the link on the EtherCAT port until all slaves join the network. Setting range: 3 to 200 s Default setting: 30 s Process data communications start if all slaves are present within the wait time. If all of the slaves are not present after the wait time elapses, a network configuration verification error occurs. When you use a slave that takes time to start, use a longer wait time setting to prevent errors.
PDO communications timeout detection count	OK	A Process Data Reception Timeout error occurs if process data (PDO) communications timeouts occur continuously the specified number of times. Increase the setting if process data reception timeout errors occur frequently, such as in high-noise environments. Set the value to 2 or higher for a slave that needs to be replaced. Setting range: 1 to 8 errors Default setting: 2 errors
Revision Check Method	OK	Specify the method to use to verify the revision numbers that are stored in the network configuration information (setting) against the actual revision numbers of the slaves (actual device) at the start of communications. Verification is required to enable operation. Communications will not start if there are unverified slaves, and a network configuration verification error will occur. Setting values: Setting <= Actual device, Setting = Actual device, or No check[*1] Default setting: Setting <= Actual device
Serial Number Check Method[*2]	OK	Specify whether to verify the slave serial numbers that are stored in the network configuration information against the serial numbers that are set in the actual slaves when initiating communications. Communications will not start if there are unverified slaves, and a network configuration verification error will occur. Setting values: Setting = Actual device or No check Default setting: No check

[1] Operations for the setting values of the revision check method are described in the following table.

Setting value	Result of revision number check	Communications with slaves
Setting <= Actual device	Setting > Actual device	Communications are not possible.
	Setting = Actual device	Communications are possible.
	Setting < Actual device	Communications are possible.
Setting = Actual device	Setting > Actual device	Communications are not possible.
	Setting = Actual device	Communications are possible.
	Setting < Actual device	Communications are not possible.
No check	Setting > Actual device	Communications are possible.
	Setting = Actual device	Communications are possible.
	Setting < Actual device	Communications are possible.

[2] If the set value is "Setting = Actual device", communications with slaves in the network is not started if a slave is replaced. If it is necessary to replace a slave while the set value is "Setting = Actual device", you must correct the network configuration information and transfer it to the EtherCAT master again. Set this parameter to "Setting = Actual device" if strict management of the equipment configuration is required.

Precautions for Safe Use

- If the Fail-soft Operation Setting parameter is set to “Stop”, process data communications will stop for all slaves when an EtherCAT communications error is detected in a slave. For this reason, if Servo Drives are connected, the Servo Drives for all axes will be turned OFF. Make sure that the Fail-soft Operation parameter setting results in safe operation when a device error occurs.
- If verifying revisions is disabled, parameters are also transferred to slaves with different EtherCAT revisions. If an incompatible revision of a slave is connected, incorrect parameters may be set and operation may not be correct. If you disable the revision check, make sure that only compatible slaves are connected before transferring the parameters.

Additional Information

Network Configuration Verification

The network configuration information is verified against the actual network when the EtherCAT master is started. If an inconsistency is found during verification, the system-defined variable for a Network Configuration Verification Error provides notification. This setting applies to the entire system and not to individual slaves.

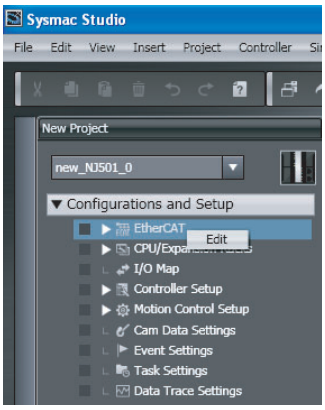
Verified information	Required/optional	Description
Number of slaves connected	Required	Number of slaves in the network
Vender ID	Required	Vendor ID of each slave
Product code	Required	Product code of each slave
Revision	Optional[1]	Revision number of each slave
Serial number	Optional[1][2]	Serial numbers of all slaves

[1] Options are selectable.

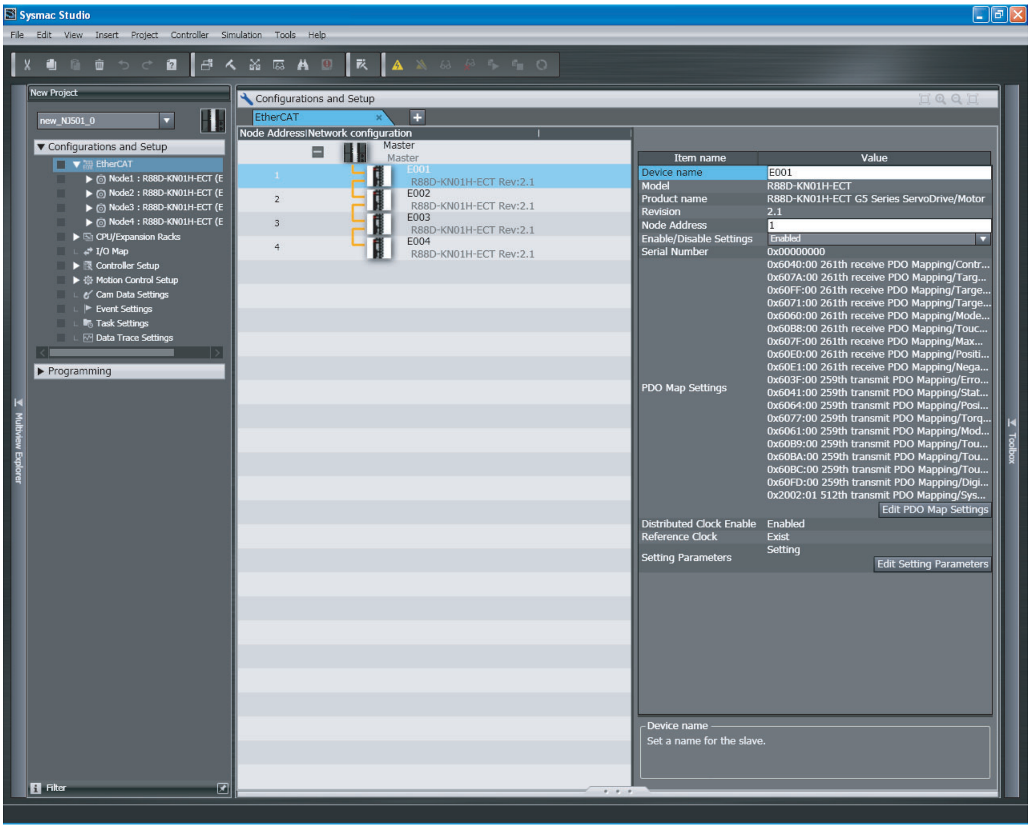
[2] Serial number verification is performed for all slaves in the EtherCAT topology. You cannot specify verification for individual slaves. The default setting is *No check* .

5-4-2 Setting EtherCAT Slaves

1 Double-click **EtherCAT** under **Configurations and Setup** on the Multiview Explorer. Or, right-click **EtherCAT** under **Configurations and Setup** and select ***Edit***.



2 Select an EtherCAT slave that is displayed in the Edit Pane.



Item name	Value
Device name	E001
Model	R88D-KN01H-ECT
Product name	R88D-KN01H-ECT G5 Series ServoDrive/Motor
Revision	2.1
Node Address	1
Enable/Disable Settings	Enabled
Serial Number	0x00000000
PDO Map Settings	0x6040:00 261th receive PDO Mapping/Contr... 0x607A:00 261th receive PDO Mapping/Targ... 0x60FF:00 261th receive PDO Mapping/Targe... 0x6071:00 261th receive PDO Mapping/Targe... 0x6060:00 261th receive PDO Mapping/Mode... 0x60B8:00 261th receive PDO Mapping/Touc... 0x607F:00 261th receive PDO Mapping/Max... 0x60E0:00 261th receive PDO Mapping/Positi... 0x60E1:00 261th receive PDO Mapping/Nega... 0x603F:00 259th transmit PDO Mapping/Erro... 0x6041:00 259th transmit PDO Mapping/Stat... 0x6064:00 259th transmit PDO Mapping/Posi... 0x6077:00 259th transmit PDO Mapping/Torq... 0x6061:00 259th transmit PDO Mapping/Mod... 0x60B9:00 259th transmit PDO Mapping/Tou... 0x60BA:00 259th transmit PDO Mapping/Tou... 0x60BC:00 259th transmit PDO Mapping/Tou... 0x60FD:00 259th transmit PDO Mapping/Digi... 0x2002:01 512th transmit PDO Mapping/Sys...
Distributed Clock Enable	Enabled
Reference Clock	Exist
Setting Parameters	Setting

Device name
Set a name for the slave.

The EtherCAT slave settings are listed below.

Name	Editing	Remarks
Device name	OK	Displays the name of the slave. Default setting: E*** (where * is a serial number starting from 001) The default value is automatically generated based on the node address. Setting range: 1 to 192
Model	Not allowed.	Automatically displays the name of the slave model.
Product name	Not allowed.	Displays the product name of the slave.

Name	Editing	Remarks
Revision	Not allowed.	Displays the revision of the slave.
Node Address	OK	Sets the node address. The default value is set automatically when a slave is added. Setting range: 1 to 192
Enable/Disable Settings	OK	Enables or disables the slave as a communications target. • Enabled: The slave will operate. • Disabled: The slave will not operate.* Register slaves that are not installed on the EtherCAT network but are scheduled for addition at a later date as disabled slaves. Even for disabled slaves, process data allocations can be set and used as system-defined variables and device variables in the user program. Default setting: Enabled
Serial Number	Not allowed.	Displays the serial number of the slave. Default: 0x00000000 (when offline) The value is updated to the serial number of the physical slave when you select ***Get Slave Serial Numbers*** from the menu for the master. A Network Configuration Verification Error occurs if the serial number on the Sysmac Studio and the serial number of the physical slave do not agree when the Serial Number Check Method in the master settings is set to *Setting = Actual device*. Refer to *5-5-3 Using the Sysmac Studio to Obtain Serial Numbers from the Actual Network Configuration* for how to access the serial number of the physical slave.
PDO Map Settings	OK	Default allocations of process data for slaves are provided by the Sysmac Studio. When the network configuration is created, device variables are automatically created in the initial process data allocations. You can read and write these process data allocations as device variables from the user program. When valid PDOs are present, a list of them is displayed. When valid PDOs are not present, “---” is displayed. If editing the process data allocations is required, click the **Edit PDO Map settings** Button at the bottom of the list. Refer to *5-3-1 Registering Device Variables for All EtherCAT Slaves* for details.
Distributed Clock Enable	OK	If a slave provides a distributed clock, *Enabled* is displayed. You can also disable the distributed clock. If a slave provides a distributed clock and you can disable it, either *Enabled* or *Disabled* is displayed. If a slave does not provide a distributed clock, --- is displayed.

Name	Editing	Remarks
Reference Clock	Not allowed.	Displays whether the slave provides a reference clock. If there is more than one slave in the system with an enabled distributed clock, there must be a slave that provides a reference clock before the first Junction Slave. “Exist” is displayed if the slave provides a reference clock. “Not exist” is displayed if the slave does not provide a reference clock.
Setting Parameters	OK	If a slave has an initial parameter setting function, *Setting* is displayed. If a slave does not have an initial parameter setting function, “---” is displayed. To edit the settings, click the **Edit Setting Parameters** Button.
Backup Parameter Settings	OK	If a slave has a backup parameter setting function, *Setting* is displayed. If a slave does not have a backup parameter setting function, “---” is displayed. To edit the settings, click the **Edit Backup Parameter Settings** Button.

* Network errors do not occur even if disabled slaves are not present on the EtherCAT network. You can use them to prepare for future system expansions.
When you actually add the slave to the network, communications between the master and the new slave will not be initiated until the disabled slave is enabled in the Sysmac Studio and the network configuration information is downloaded to the built-in EtherCAT master in the NJ-series CPU Unit again. A disabled slave is treated as not existing even if it is actually present on the network. Make sure you download the network configuration information when actually adding a slave.
When a slave is present in the position of a disabled slave in the actual network configuration, operations occur as shown in the following table. Refer to *9-1-1 How to Check for Errors* for the behavior of enabled slaves.

	Slave in actual network configuration		**Operation for disabled slave**	
	Node address	**Vendor ID/ Product Code**	**Process data communications**	**Error**
1	Matches	Matches	None	Normal operation (no error)
2	Matches	Different	None	Network configuration verification error
3	Different	Matches	None	Network configuration verification error
4	Different	Different	None	Network configuration verification error

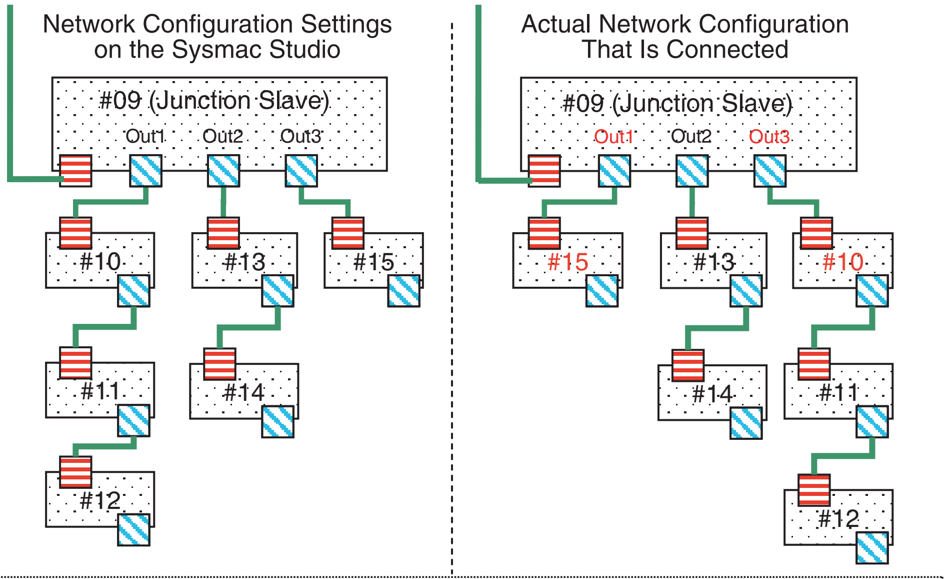
5-5 Comparing and Merging EtherCAT Network Configurations

5-5-1 Comparing and Merging with the Actual Network Configuration from the Sysmac Studio

Use the Sysmac Studio to compare the network configuration information settings in the Sysmac Studio with the actual network configuration that is connected, including branch lines and branch locations. The following items are compared.

- Node addresses
- Vendor IDs
- Product codes
- Revisions
- Connected ports

If the settings in the Sysmac Studio and the actual network configuration match completely, it is possible to determine the locations of errors when they occur. If differences are shown in the comparison results, merge the configurations from the Sysmac Studio.



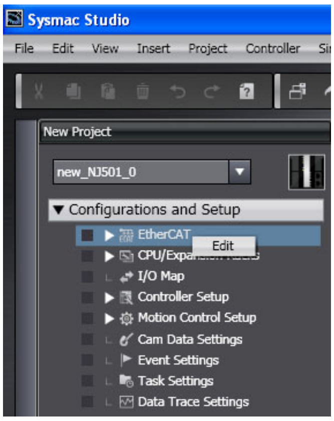
The output port numbers for the branches do not match the node addresses for the connected slaves. In this example, the settings on the Sysmac Studio and the slaves connected to Out1 and Out3 on node #09 in the actual network configuration do not match.

▤ Input port ▨ Output port "#" indicates a node address.

Use the following procedure to compare and merge the network configuration settings on the Sysmac Studio and the actual network configuration.

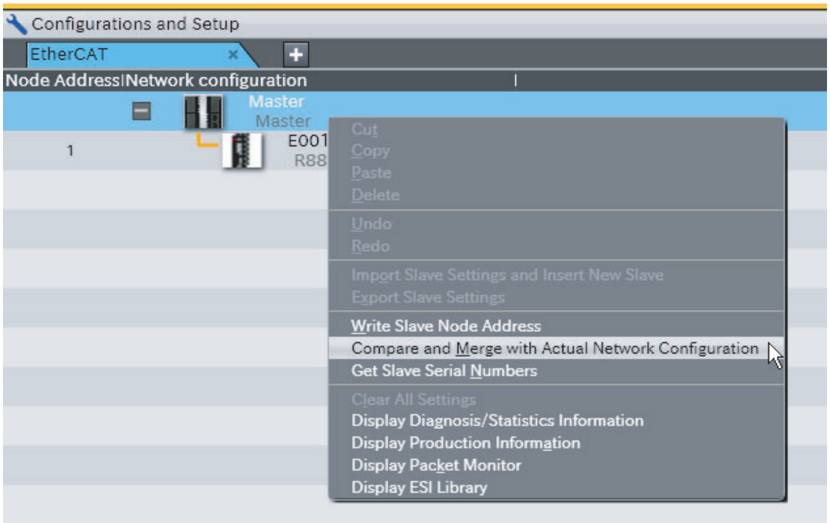
1 Start the Sysmac Studio and go online with the Controller.

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

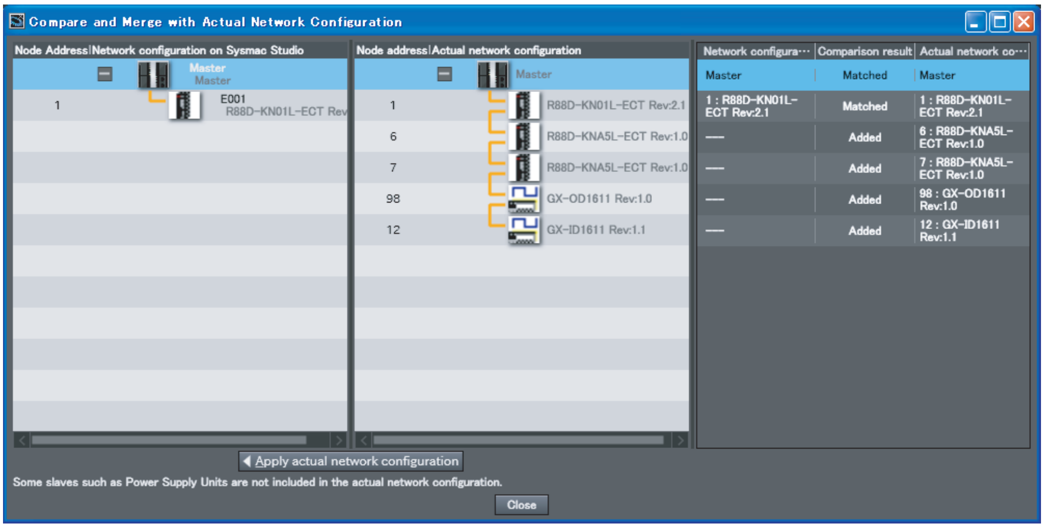


The Edit Pane is displayed.

3 Right-click the EtherCAT master that is displayed in the Edit Pane and select ***Compare and Merge with Actual Network Configuration***.



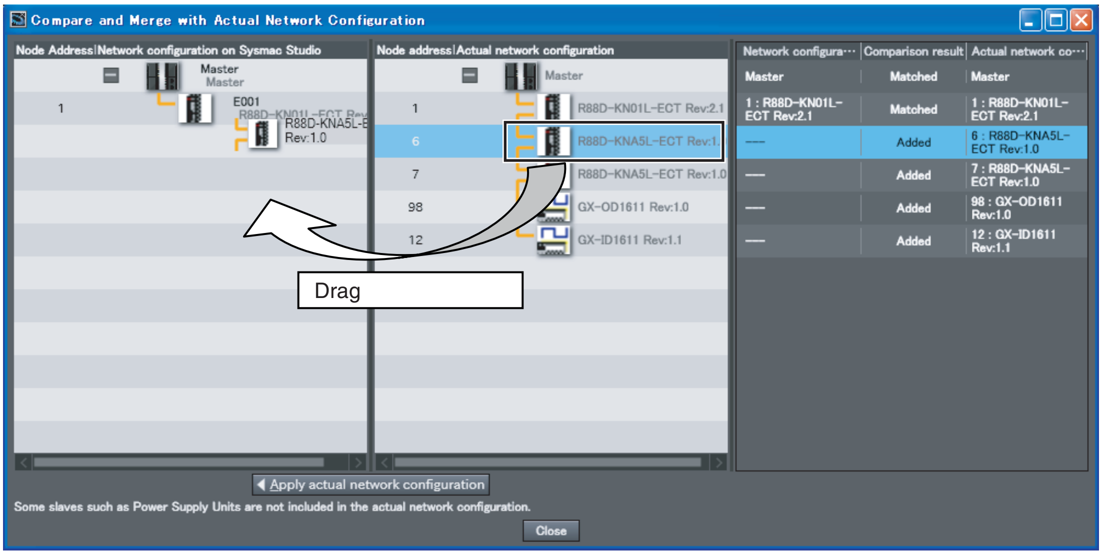
The Compare and Merge with Actual Network Configuration Dialog Box is displayed. The results of comparing the settings on the Sysmac Studio with the actual network configuration are displayed in the *Comparison results* Column.


Compare and Merge with Actual Network Configuration
Node Address|Network configuration on Sysmac Studio
Master
Master
1
E001
R88D-KN01L-ECT Rev
Node address|Actual network configuration
Master
1
R88D-KN01L-ECT Rev:2.1
6
R88D-KNA5L-ECT Rev:1.0
7
R88D-KNA5L-ECT Rev:1.0
98
GX-OD1611 Rev:1.0
12
GX-ID1611 Rev:1.1
◀ Apply actual network configuration
Close

Network configura···	Comparison result	Actual network co···
Master	Matched	Master
1 : R88D-KN01L-ECT Rev:2.1	Matched	1 : R88D-KN01L-ECT Rev:2.1
——	Added	6 : R88D-KNA5L-ECT Rev:1.0
——	Added	7 : R88D-KNA5L-ECT Rev:1.0
——	Added	98 : GX-OD1611 Rev:1.0
——	Added	12 : GX-ID1611 Rev:1.1

Some slaves such as Power Supply Units are not included in the actual network configuration.

4 If there is a slave that exists only on the actual network, “Added” is displayed in the *Comparison results* Column. Drag the slave in the actual network configuration to the Sysmac Studio network configuration.



Compare and Merge with Actual Network Configuration

Node Address	Network configuration on Sysmac Studio
	Master Master
1	E001 R88D-KN01L-ECT Rev
	R88D-KNA5L-E Rev:1.0

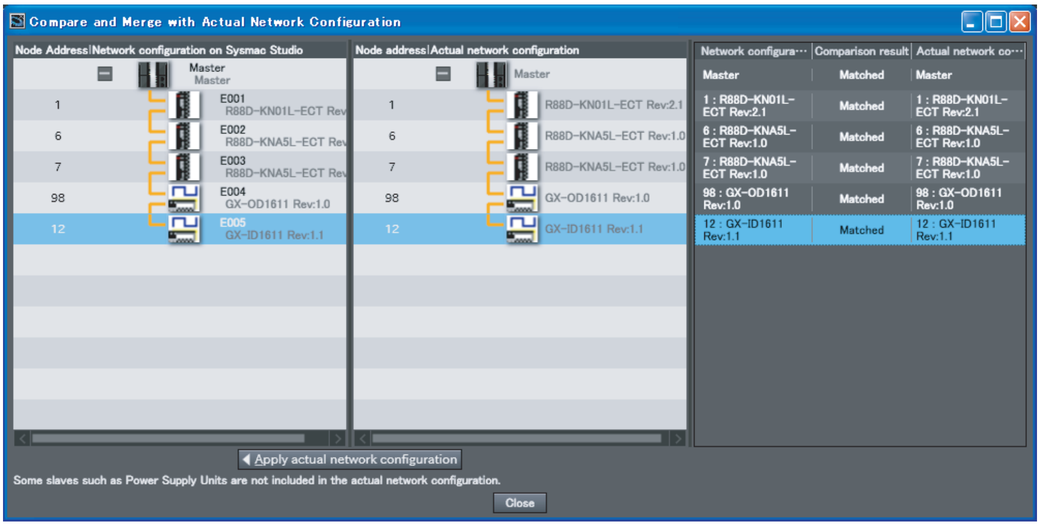
Node address	Actual network configuration
	Master
1	R88D-KN01L-ECT Rev:2.1
6	R88D-KNA5L-ECT Rev:1.
7	R88D-KNA5L-ECT Rev:1.0
98	GX-OD1611 Rev:1.0
12	GX-ID1611 Rev:1.1

Network configura···	Comparison result	Actual network co···
Master	Matched	Master
1 : R88D-KN01L-ECT Rev:2.1	Matched	1 : R88D-KN01L-ECT Rev:2.1
----	Added	6 : R88D-KNA5L-ECT Rev:1.0
----	Added	7 : R88D-KNA5L-ECT Rev:1.0
----	Added	98 : GX-OD1611 Rev:1.0
----	Added	12 : GX-ID1611 Rev:1.1

Some slaves such as Power Supply Units are not included in the actual network configuration.

After you drag the missing slaves and add them to the network configuration on the Sysmac Studio, the *Comparison results* Column will show that everything in the configurations matches.

5 Click the **Close** Button.



Compare and Merge with Actual Network Configuration

Node Address	Network configuration on Sysmac Studio
	Master Master
1	E001 R88D-KN01L-ECT Rev
6	E002 R88D-KNA5L-ECT Rev
7	E003 R88D-KNA5L-ECT Rev
98	E004 GX-OD1611 Rev:1.0
12	E005 GX-ID1611 Rev:1.1

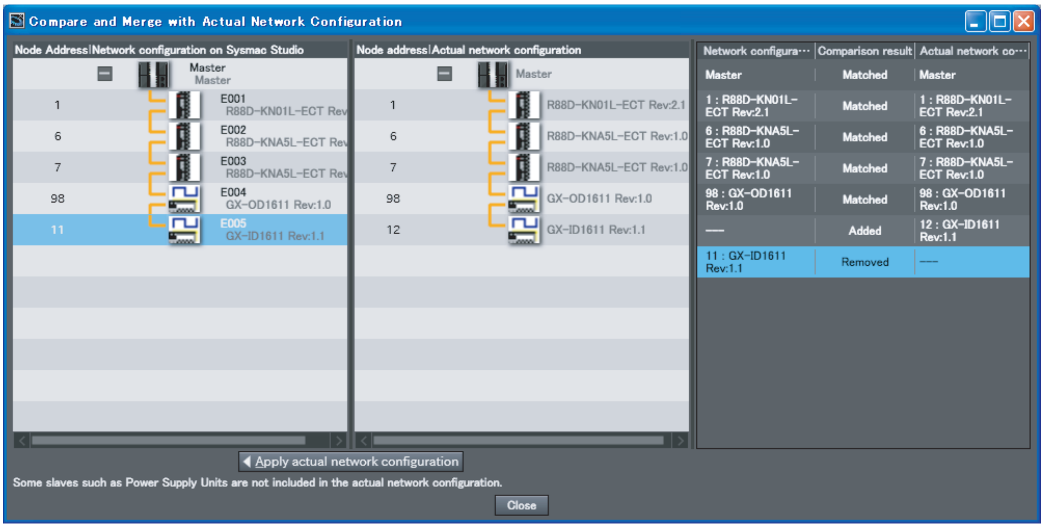
Node address	Actual network configuration
	Master
1	R88D-KN01L-ECT Rev:2.1
6	R88D-KNA5L-ECT Rev:1.0
7	R88D-KNA5L-ECT Rev:1.0
98	GX-OD1611 Rev:1.0
12	GX-ID1611 Rev:1.1

Network configura···	Comparison result	Actual network co···
Master	Matched	Master
1 : R88D-KN01L-ECT Rev:2.1	Matched	1 : R88D-KN01L-ECT Rev:2.1
6 : R88D-KNA5L-ECT Rev:1.0	Matched	6 : R88D-KNA5L-ECT Rev:1.0
7 : R88D-KNA5L-ECT Rev:1.0	Matched	7 : R88D-KNA5L-ECT Rev:1.0
98 : GX-OD1611 Rev:1.0	Matched	98 : GX-OD1611 Rev:1.0
12 : GX-ID1611 Rev:1.1	Matched	12 : GX-ID1611 Rev:1.1

Some slaves such as Power Supply Units are not included in the actual network configuration.

The Sysmac Studio returns to the Edit Pane. This completes the operation to compare and merge with the actual network configuration.

“Removed” is displayed in the *Comparison results* Column for a slaves that exist only in the settings on the Sysmac Studio. The following example shows a case where a node address is different in the settings on the Sysmac Studio and in the actual network configuration. As a result, “Added” and “Removed” are displayed in the *Comparison results* Column.



Compare and Merge with Actual Network Configuration

Node Address	Network configuration on Sysmac Studio
	Master Master
1	E001 R88D-KN01L-ECT Rev
6	E002 R88D-KNA5L-ECT Rev
7	E003 R88D-KNA5L-ECT Rev
98	E004 GX-OD1611 Rev:1.0
11	E005 GX-ID1611 Rev:1.1

Node address	Actual network configuration
	Master
1	R88D-KN01L-ECT Rev:2.1
6	R88D-KNA5L-ECT Rev:1.0
7	R88D-KNA5L-ECT Rev:1.0
98	GX-OD1611 Rev:1.0
12	GX-ID1611 Rev:1.1

Network configura···	Comparison result	Actual network co···
Master	Matched	Master
1 : R88D-KN01L-ECT Rev:2.1	Matched	1 : R88D-KN01L-ECT Rev:2.1
6 : R88D-KNA5L-ECT Rev:1.0	Matched	6 : R88D-KNA5L-ECT Rev:1.0
7 : R88D-KNA5L-ECT Rev:1.0	Matched	7 : R88D-KNA5L-ECT Rev:1.0
98 : GX-OD1611 Rev:1.0	Matched	98 : GX-OD1611 Rev:1.0
—	Added	12 : GX-ID1611 Rev:1.1
11 : GX-ID1611 Rev:1.1	Removed	—

Some slaves such as Power Supply Units are not included in the actual network configuration.

Here, either correct the node address in the network configuration on the Sysmac Studio or the node address in the physical slave in the actual network configuration, and then repeat the compare and merge operation to confirm that the configurations are the same.

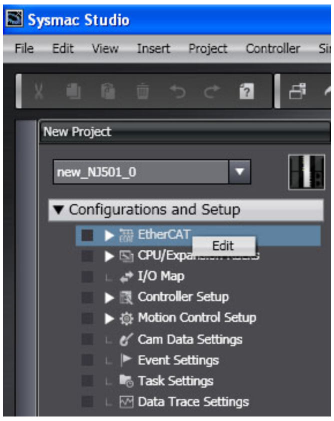
Additional Information

- Make sure that the communications cables between the master and slaves are connected correctly before you perform the compare and merge operation. The Compare and Merge with Actual Network Configuration Dialog Box is not displayed if the connections are not correct.
- The Compare and Merge with Actual Network Configuration Dialog Box is not displayed if there is a slave in the actual network configuration for which the node address is not set or if the same address is set for more than one slave in the actual network configuration. Make sure that node addresses are set correctly for the slaves in the actual network configuration before you perform the compare and merge operation.
- When the compare and merge operation is performed, the synchronization between the Sysmac Studio and the Controller is lost. Synchronize the Sysmac Studio and Controller before you perform any online operations for the slaves. Refer to the *Sysmac Studio Version 1 Operation Manual* (Cat. No. W504) for information on synchronization.

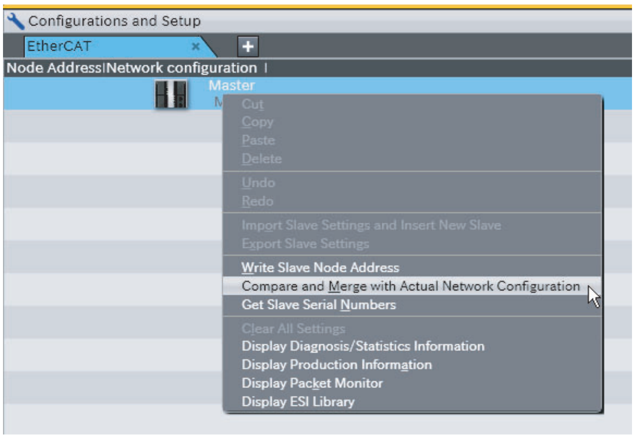
5-5-2 Automatically Creating the Network Configuration

Instead of manually setting the network configuration offline, you can also automatically create the network configuration on the Sysmac Studio based on the actual network configuration. Use the following procedure to automatically duplicate the actual network configuration on the Sysmac Studio.

1. Start the Sysmac Studio and go online with the Controller.
2. Double-click **EtherCAT** under **Configurations and Setup** in the Multiview Explorer. Or, right-click **EtherCAT** under **Configurations and Setup** and select ***Edit***.

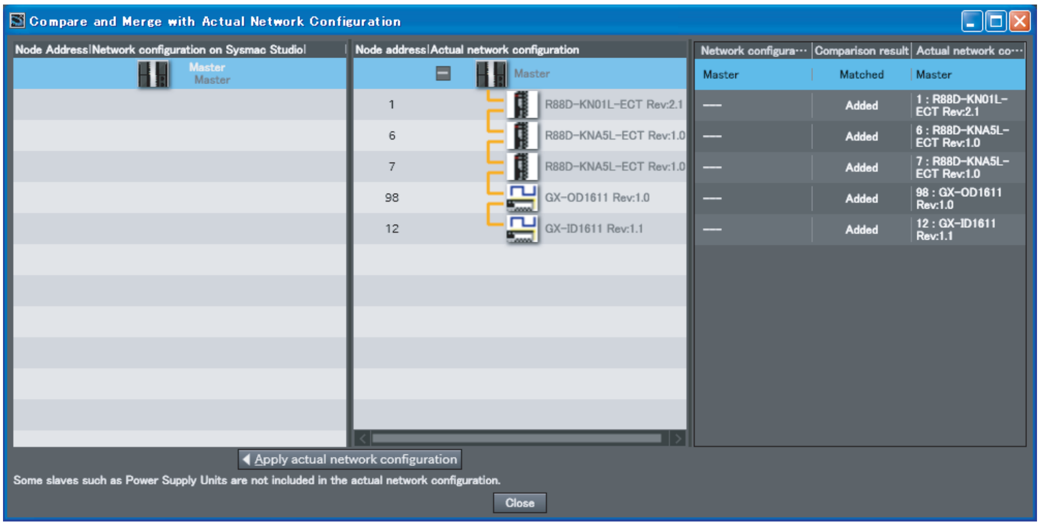


3 Right-click the EtherCAT master that is displayed in the Edit Pane and select ***Compare and Merge with Actual Network Configuration***.


Configurations and Setup
EtherCAT
Node Address|Network configuration
Master
Cut
Copy
Paste
Delete
Undo
Redo
Import Slave Settings and Insert New Slave
Export Slave Settings
Write Slave Node Address
Compare and Merge with Actual Network Configuration
Get Slave Serial Numbers
Clear All Settings
Display Diagnosis/Statistics Information
Display Production Information
Display Packet Monitor
Display ESI Library

The Compare and Merge with Actual Network Configuration Dialog Box is displayed.

4 Click the **Apply actual network configuration** Button.


Compare and Merge with Actual Network Configuration
Node Address|Network configuration on Sysmac Studio|
Master
Master

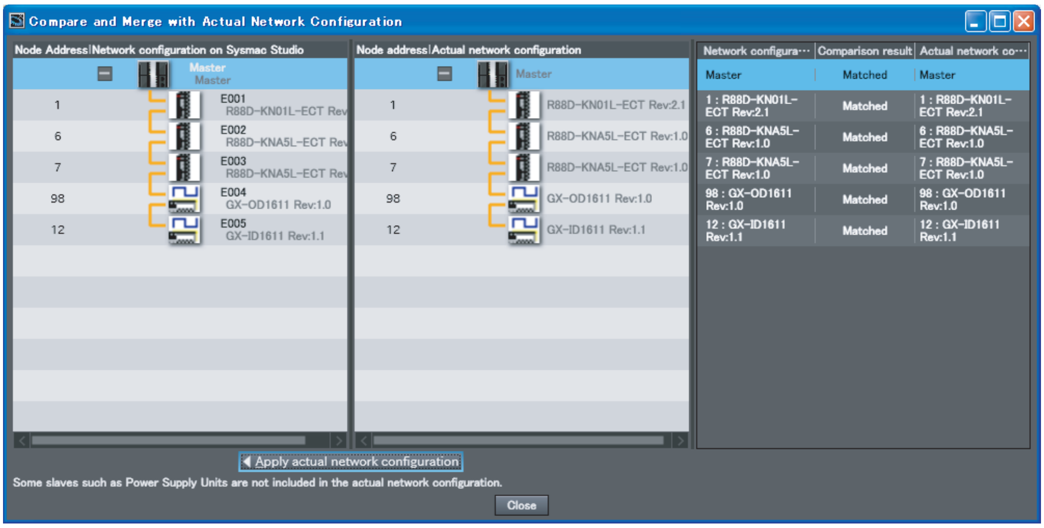
Node address	Actual network configuration
	Master
1	R88D-KN01L-ECT Rev:2.1
6	R88D-KNA5L-ECT Rev:1.0
7	R88D-KNA5L-ECT Rev:1.0
98	GX-OD1611 Rev:1.0
12	GX-ID1611 Rev:1.1

Network configura···	Comparison result	Actual network co···
Master	Matched	Master
—	Added	1 : R88D-KN01L-ECT Rev:2.1
—	Added	6 : R88D-KNA5L-ECT Rev:1.0
—	Added	7 : R88D-KNA5L-ECT Rev:1.0
—	Added	98 : GX-OD1611 Rev:1.0
—	Added	12 : GX-ID1611 Rev:1.1

Some slaves such as Power Supply Units are not included in the actual network configuration.

The actual network configuration is duplicated in the network configuration on Sysmac Studio, and the *Comparison results* Column shows that everything in the configurations matches. (The network configuration on the Sysmac Studio is created based on the actual network configuration.)

5 Click the **Close** Button.


Compare and Merge with Actual Network Configuration
Apply actual network configuration
Close

Node Address	Network configuration on Sysmac Studio
	Master Master
1	E001 R88D-KN01L-ECT Rev
6	E002 R88D-KNA5L-ECT Rev
7	E003 R88D-KNA5L-ECT Rev
98	E004 GX-OD1611 Rev:1.0
12	E005 GX-ID1611 Rev:1.1

Node address	Actual network configuration
	Master
1	R88D-KN01L-ECT Rev:2.1
6	R88D-KNA5L-ECT Rev:1.0
7	R88D-KNA5L-ECT Rev:1.0
98	GX-OD1611 Rev:1.0
12	GX-ID1611 Rev:1.1

Network configura···	Comparison result	Actual network co···
Master	Matched	Master
1 : R88D-KN01L-ECT Rev:2.1	Matched	1 : R88D-KN01L-ECT Rev:2.1
6 : R88D-KNA5L-ECT Rev:1.0	Matched	6 : R88D-KNA5L-ECT Rev:1.0
7 : R88D-KNA5L-ECT Rev:1.0	Matched	7 : R88D-KNA5L-ECT Rev:1.0
98 : GX-OD1611 Rev:1.0	Matched	98 : GX-OD1611 Rev:1.0
12 : GX-ID1611 Rev:1.1	Matched	12 : GX-ID1611 Rev:1.1

Some slaves such as Power Supply Units are not included in the actual network configuration.

6 Go offline, and then assign device variables, set the axis parameters, set up the tasks, and set the master and slave parameters.

Additional Information

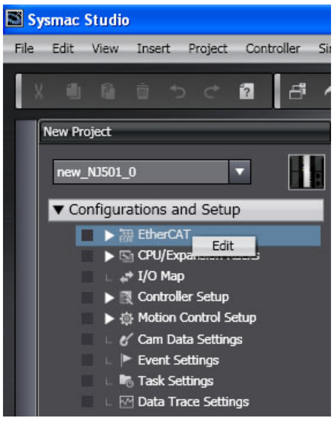
- Make sure that the communications cables between the master and slaves are connected correctly before you perform this operation. The Compare and Merge with Actual Network Configuration Dialog Box is not displayed if the connections are not correct.
- The Compare and Merge with Actual Network Configuration Dialog Box is not displayed if there is a slave in the actual network configuration for which the node address is not set or if the same address is set for more than one slave in the actual network configuration. Make sure that node addresses are set correctly for the slaves in the actual network configuration before you perform this operation.
- Even if you have previously set them on the Sysmac Studio, the following configuration and settings are discarded when you automatically create the network configuration on the Sysmac Studio based on the actual network configuration: network configuration, master settings, and any slave settings (including enable settings, PDO map settings, setting parameter settings, backup parameter settings, device variable assignments in the I/O map, slave assignments to Axes Variables registered in the axis settings, and master settings to control slaves that are registered in the task setup). To merge the actual network configuration information without losing the current settings in the Sysmac Studio, use the compare and merge operation to create the network configuration. Refer to *5-5-1 Comparing and Merging with the Actual Network Configuration from the Sysmac Studio* for information on the operation to compare and merge with the actual network configuration on the Sysmac Studio.
- When the compare and merge operation is performed, the synchronization between the Sysmac Studio and the Controller is lost. Synchronize the Sysmac Studio and Controller before you perform any online operations for the slaves. Refer to the *Sysmac Studio Version 1 Operation Manual* (Cat. No. W504) for information on synchronization.

5-5-3 Using the Sysmac Studio to Obtain Serial Numbers from the Actual Network Configuration

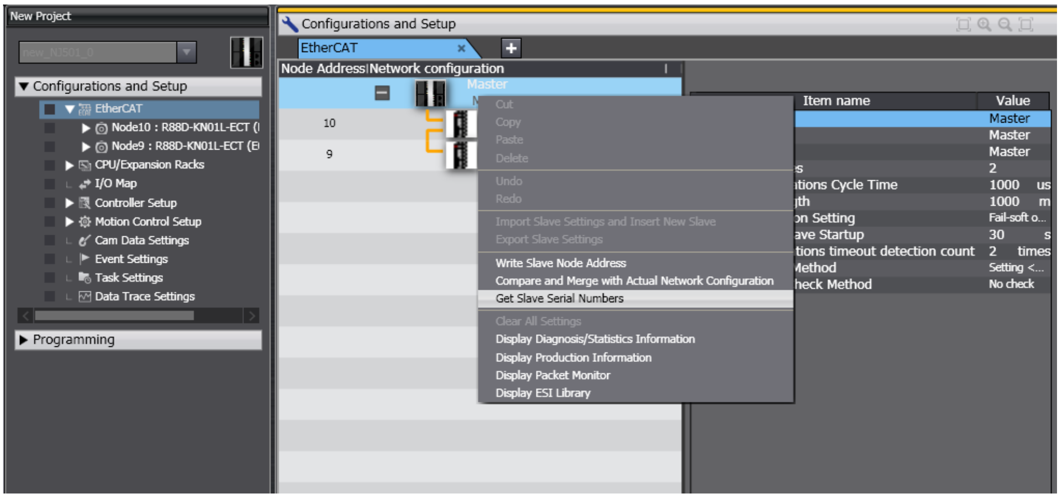
If the Serial Number Check Method in the EtherCAT master settings is set to *Setting = Actual device*, you must download the network configuration information in which the slave serial numbers are set to the CPU Unit. Use the following procedure to get the serial numbers of the physical slaves and apply them as the serial numbers of the slaves in the settings on the Sysmac Studio.

1 Start the Sysmac Studio and go online with the Controller.

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



3 Right-click the EtherCAT master that is displayed in the Edit Pane and select ***Get Slave Serial Numbers***.



The serial numbers of the physical slaves are saved as the serial numbers in the slave settings on the Sysmac Studio.

Additional Information

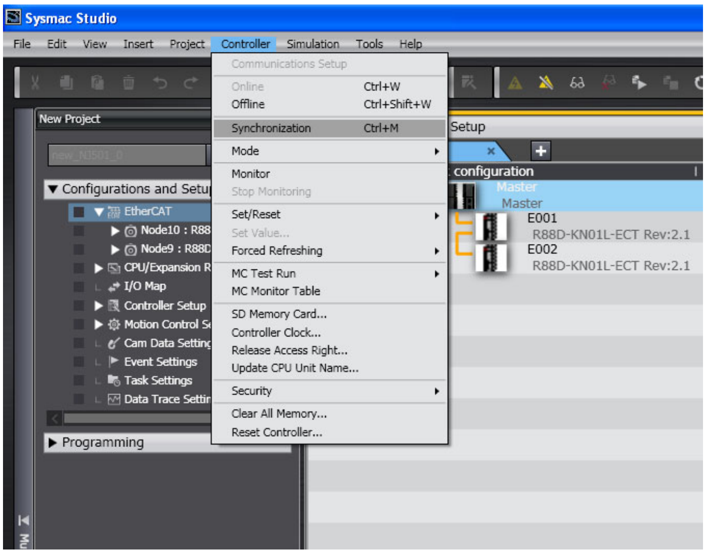
- Make sure that the communications cables between the master and slaves are connected correctly before you perform this operation. You cannot get the serial numbers of the slaves unless the connections are correct.
- You cannot get the serial numbers of the slaves if there is a slave in the actual network configuration for which the node address is not set or if the same address is set for more than one slave in the actual network configuration. Make sure that node addresses are set correctly for the slaves in the actual network configuration before you perform this operation.
- You cannot get the serial numbers of the slaves unless the Compare and Merge with Actual Network Configuration Dialog Box shows that the entire slave configurations agree. Make sure that the Compare and Merge with Actual Network Configuration Dialog Box shows that the entire slave configurations agree before you perform this operation. However, you can get the serial numbers of the slaves even if the entire slave configurations do not agree if there are slaves in the Sysmac Studio settings that are disabled.
- If you get the serial numbers of the slaves when there are disabled slaves that do not exist in the actual network configuration, the serial numbers of the disabled slaves will be cleared to 0x00000000 in the settings on the Sysmac Studio. If the disabled slaves exist in the actual network configuration, the serial numbers of the slaves in the actual network configuration are saved in the settings on the Sysmac Studio.
- Any serial numbers that are set for slaves in the settings on the Sysmac Studio are overwritten when the serial numbers are obtained from the actual network configuration. Make sure that it is OK to overwrite the serial numbers on the Sysmac Studio before you perform this operation.
- When you get the serial numbers from the slaves on the actual network configuration, the synchronization between the Sysmac Studio and the Controller is lost. Synchronize the Sysmac Studio and Controller before you perform any online operations for the slaves. Refer to the *Sysmac Studio Version 1 Operation Manual* (Cat. No. W504) for information on synchronization.

5-6 Downloading the Network Configuration Information

5-6-1 Downloading the Network Configuration Information from the Sysmac Studio

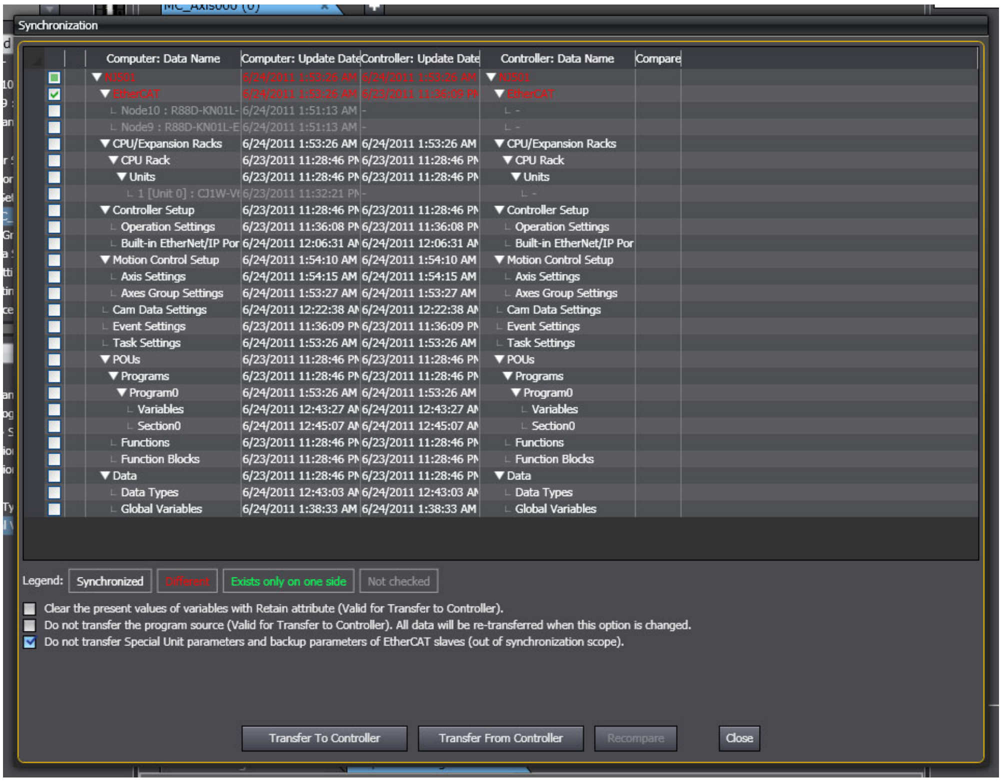
You must download the network configuration information in the project from the Sysmac Studio to the NJ-series CPU Unit. Use the synchronize operation to download the network configuration information. Refer to the *Sysmac Studio Version 1 Operation Manual* (Cat. No. W504) for information on synchronization.

1 Go online and select ***Synchronization*** from the Controller Menu.



The Synchronization Dialog Box is displayed.

2 Select the *EtherCAT* Check Box in the Synchronization Dialog Box and then click the **Transfer to Controller** Button.



Synchronization

	Computer: Data Name	Computer: Update Date	Controller: Update Date	Controller: Data Name	Compare
■	▼ NJ501	6/24/2011 1:53:26 AM	6/24/2011 1:53:26 AM	▼ NJ501	
☑	▼ EtherCAT	6/24/2011 1:53:26 AM	6/23/2011 11:36:09 PM	▼ EtherCAT	
□	∟ Node10 : R88D-KN01L-	6/24/2011 1:51:13 AM	-	∟ -	
□	∟ Node9 : R88D-KN01L-E	6/24/2011 1:51:13 AM	-	∟ -	
□	▼ CPU/Expansion Racks	6/24/2011 1:53:26 AM	6/24/2011 1:53:26 AM	▼ CPU/Expansion Racks	
□	▼ CPU Rack	6/23/2011 11:28:46 PM	6/23/2011 11:28:46 PM	▼ CPU Rack	
□	▼ Units	6/23/2011 11:28:46 PM	6/23/2011 11:28:46 PM	▼ Units	
□	∟ 1 [Unit 0] : CJ1W-V	6/23/2011 11:32:21 PM	-	∟ -	
□	▼ Controller Setup	6/23/2011 11:28:46 PM	6/23/2011 11:28:46 PM	▼ Controller Setup	
□	∟ Operation Settings	6/23/2011 11:36:08 PM	6/23/2011 11:36:08 PM	∟ Operation Settings	
□	∟ Built-in EtherNet/IP Por	6/24/2011 12:06:31 AM	6/24/2011 12:06:31 AM	∟ Built-in EtherNet/IP Por	
□	▼ Motion Control Setup	6/24/2011 1:54:10 AM	6/24/2011 1:54:10 AM	▼ Motion Control Setup	
□	∟ Axis Settings	6/24/2011 1:54:15 AM	6/24/2011 1:54:15 AM	∟ Axis Settings	
□	∟ Axes Group Settings	6/24/2011 1:53:27 AM	6/24/2011 1:53:27 AM	∟ Axes Group Settings	
□	∟ Cam Data Settings	6/24/2011 12:22:38 AM	6/24/2011 12:22:38 AM	∟ Cam Data Settings	
□	∟ Event Settings	6/23/2011 11:36:09 PM	6/23/2011 11:36:09 PM	∟ Event Settings	
□	∟ Task Settings	6/24/2011 1:53:26 AM	6/24/2011 1:53:26 AM	∟ Task Settings	
□	▼ POUs	6/23/2011 11:28:46 PM	6/23/2011 11:28:46 PM	▼ POUs	
□	▼ Programs	6/23/2011 11:28:46 PM	6/23/2011 11:28:46 PM	▼ Programs	
□	▼ Program0	6/24/2011 1:53:26 AM	6/24/2011 1:53:26 AM	▼ Program0	
□	∟ Variables	6/24/2011 12:43:27 AM	6/24/2011 12:43:27 AM	∟ Variables	
□	∟ Section0	6/24/2011 12:45:07 AM	6/24/2011 12:45:07 AM	∟ Section0	
□	∟ Functions	6/23/2011 11:28:46 PM	6/23/2011 11:28:46 PM	∟ Functions	
□	∟ Function Blocks	6/23/2011 11:28:46 PM	6/23/2011 11:28:46 PM	∟ Function Blocks	
□	▼ Data	6/23/2011 11:28:46 PM	6/23/2011 11:28:46 PM	▼ Data	
□	∟ Data Types	6/24/2011 12:43:03 AM	6/24/2011 12:43:03 AM	∟ Data Types	
□	∟ Global Variables	6/24/2011 1:38:33 AM	6/24/2011 1:38:33 AM	∟ Global Variables	

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 program source (Valid for Transfer to Controller). All data will be re-transferred when this option is changed.

☑ Do not transfer Special Unit parameters and backup parameters of EtherCAT slaves (out of synchronization scope).

The network configuration information is downloaded from the Sysmac Studio to the Controller.

Precautions for Correct Use

- After you transfer the user program, the CPU Unit is restarted. Communications with the EtherCAT slave are cut off for up to 45 seconds. During that period, the slave outputs behave according to the slave settings. Before you transfer the user program, confirm the safety of the controlled system.
- Use the Synchronization Menu of the Sysmac Studio to upload and download the project.

Additional Information

The backup parameters of EtherCAT slaves are out of the scope of synchronization and are not downloaded to the slaves for the default settings. To transfer the backup parameters, clear the selection of the *Do not transfer Special Unit parameters and backup parameters of EtherCAT slaves (out of synchronization scope).* Check Box in the Synchronization Pane.

5-7 Confirming Communications after Completing EtherCAT Configuration and Settings

If normal network configuration information is downloaded to the CPU Unit, EtherCAT communications start automatically regardless of the operating mode of the CPU Unit.
EtherCAT communications are in operational state (normal communications state) if the EtherCAT NET RUN indicator on the front of the NJ-series CPU Unit is lit green.
Refer to *9-2-3 Resetting Errors* if the EtherCAT NET RUN indicator is not lit green.
If network configuration information is not downloaded to the CPU Unit, the EtherCAT master will not perform process data communications. Because of this, notification of errors will not occur. The EtherCAT communications will be in the Init state (where both process data communications and SDO communications are disabled).

You can check from the user program to see if I/O refreshing is normal by checking the system-defined variable *_EC_PDSlavTbl* (Process Data Communicating Slave Table).

Precautions for Safe Use

- EtherCAT communications are not always established immediately after the power supply is turned ON. Use the system-defined variable in the user program to confirm that communications are established before you attempt to control device variables and Axis Variables.
- After you change any EtherCAT slave or Special Unit settings, carefully check the safety of the controlled system before you restart the Unit.

Precautions for Correct Use

When you change the EtherCAT slave configuration and reconfigure the axis allocation settings, you must download the network configuration information again.

6

Process Data Communications and SDO Communications

This section describes the timing of communications, response times, and special instructions for process data communications and SDO communications. It also provides sample programming.

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6-1-1 Allocated Variables for Process Data Communications 6-2

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6-1 Process Data Communications (PDO Communications)

Process data communications cyclically exchanges data between the master and slaves in the process data communications cycle (i.e., the task period of primary periodic task).
From the user program in the NJ-series CPU Unit, slave data is accessed through allocated variables.

6-1-1 Allocated Variables for Process Data Communications

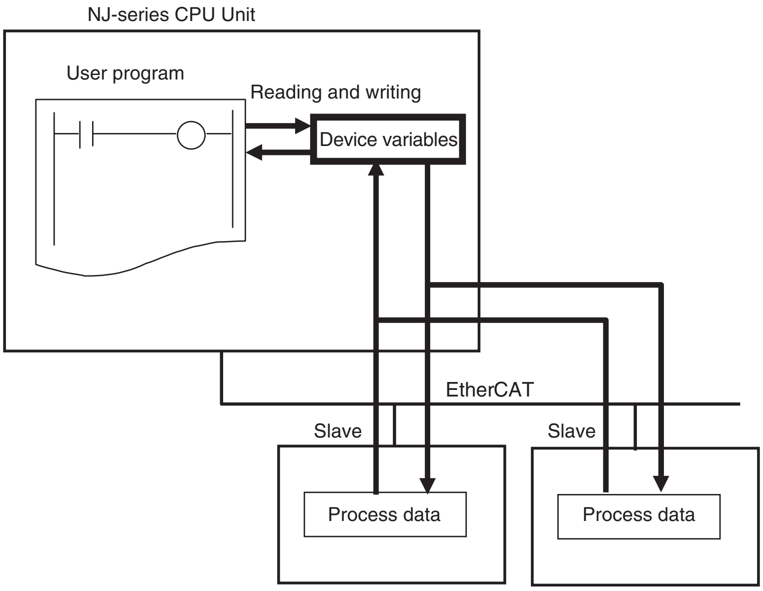
The variables that are allocated depend on the slave type as shown in the following table.

Slave type	Allocated variables	Operation in Sysmac Studio
EtherCAT slaves	Device variables	I/O Map
Only Servo Drive and encoder input slaves	Axis Variables (structures)	Axis Settings

Allocated variables are specified for instructions in the user program.

All EtherCAT Slaves

The user program in an NJ-series CPU Unit can read and write EtherCAT slave process data by reading and writing device variables. (The slave process data is I/O data that is exchanged between the master and slaves in each period.)



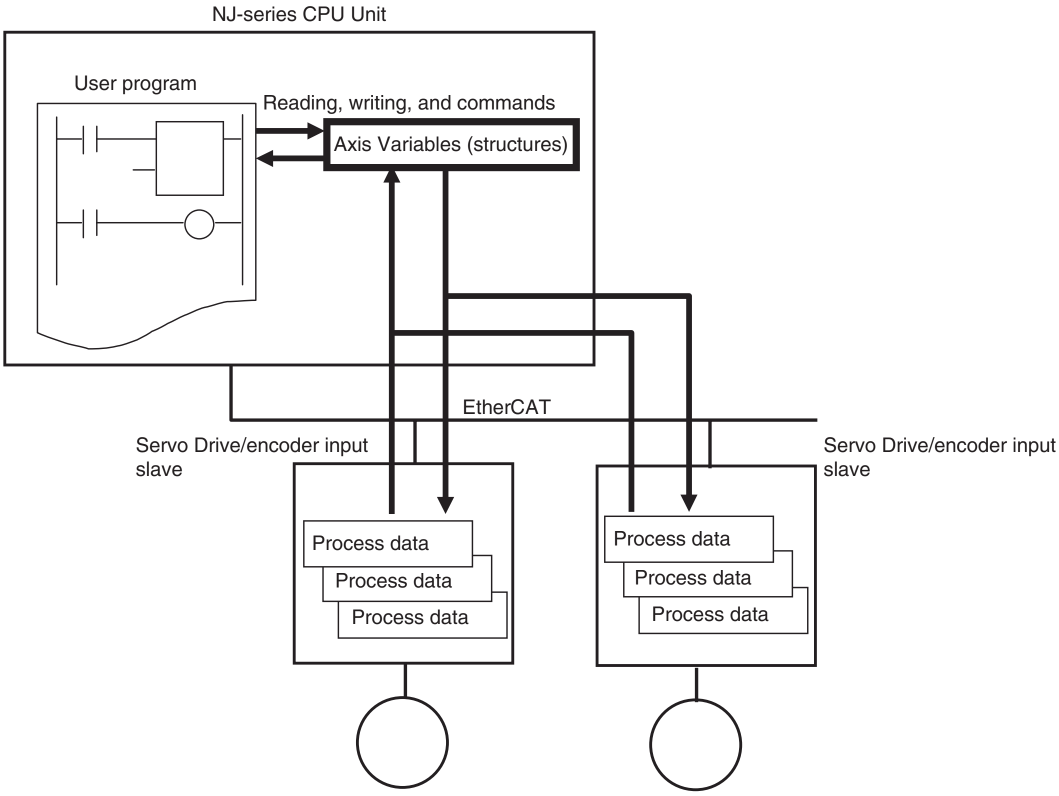
Only Servo Drive and Encoder Input Slaves

Servo Drive and encoder input slave on EtherCAT can be controlled by specifying Axis Variables (structures) as parameters for motion control instruction in-out variables.

Axis Variables (structures) consist of the following data.

- Parameters: Maximum acceleration rate, software limits, etc.
- I/O: Home proximity input, Servo ON, etc.
- Operating status: Accelerating, waiting for in-position state, etc.

- Error and warning status: Excessive following error, acceleration error, etc.


NJ-series CPU Unit
User program
Reading, writing, and commands
Axis Variables (structures)
EtherCAT
Servo Drive/encoder input slave
Servo Drive/encoder input slave
Process data
Process data
Process data
Process data
Process data
Process data

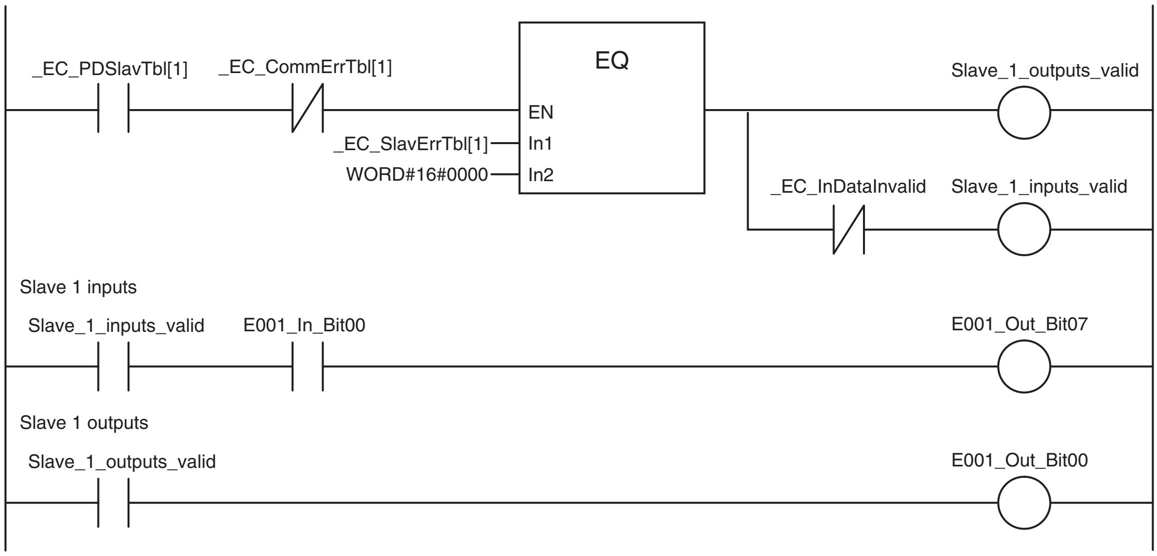
6-1-2 Sample Programming

Individual Interlocks

This sample programs individual interlocks to check the validity of the process data from each slave.

The *_EC_PDSlavTbl[1..192]* (Process Data Communicating Slave Table) system-defined variables are used to see if the process data inputs and outputs are valid for the relevant slave (slave 1).

LD



ST

```
IF _EC_PDSlavTbl[1]=TRUE AND _EC_CommErrTbl[1]=FALSE AND
_EC_SlavErrTbl[1]=WORD#16#0 THEN
    A:=TRUE;
  ELSE
    A:=FALSE;
  END_IF;

(* Output valid condition *)
IF A=TRUE THEN
    Slav_Out:=TRUE;
  ELSE
    Slav_Out:=FALSE;
  END_IF;

(* Input valid condition *)
IF A=TRUE AND InDataInvalid=FALSE THEN
    Slav_In:=TRUE;
  ELSE
    Slav_In:=FALSE;
  END_IF;

(* Output data valid *)
IF Slav_Out=TRUE THEN
    E001_Out_Bit00:=TRUE;
  ELSE
    E001_Out_Bit00:=FALSE;
  END_IF;

(* Input data valid *)
IF Slav_In=TRUE AND E001_In_Bit00=TRUE  THEN
    E001_Out_Bit07:=TRUE;
  ELSE
    E001_Out_Bit07:=FALSE;
  END_IF;
```

Precautions for Safe Use

If you disconnect the cable from an EtherCAT slave to disconnect it from the network (e.g., to replace it), any current communications frames may be lost. If frames are lost, slave I/O data is not communicated, and the intended operation is sometimes not achieved. If slave replacement is required, program the *_EC_InDataInvalid* (Input Data Disable) system-defined variable as an interlock condition.

Additional Information

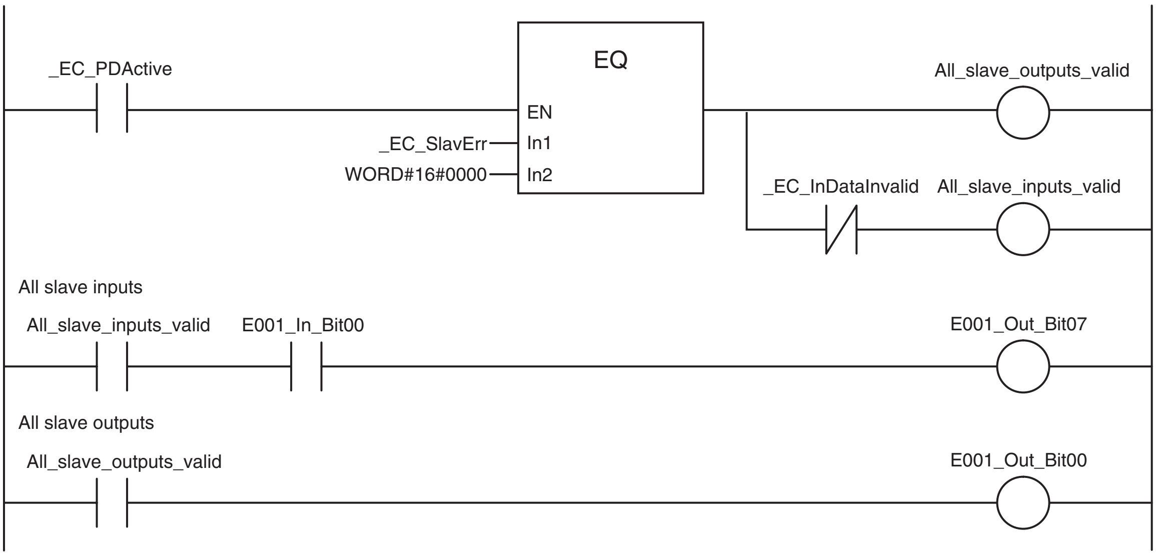
You can read the status of the *_EC_PDSlavTbl[1..192]* (Process Data Communicating Slave Table) system-defined variables from the user program to see if I/O refreshing is normal.

● Overall Interlock

This sample programs an interlock to check the validity of the process data from all of the slaves that are connected to the network.

The *_EC_PDActive* (Process Data Communications Status) system-defined variable is used to see if the process data inputs and outputs are valid for all of the slaves.

LD



ST

```
IF _EC_PDActive=TRUE AND _EC_SlavErr=WORD#16#0 THEN
    A:=TRUE;
  ELSE
    A:=FALSE;
  END_IF;

(* Output valid condition *)
IF A=TRUE THEN
    AllSlav_Out:=TRUE;
  ELSE
    AllSlav_Out:=FALSE;
  END_IF;

(* Input valid condition *)
IF A=TRUE AND InDataInvalid=FALSE THEN
    AllSlav_In:=TRUE;
  ELSE
    AllSlav_In:=FALSE;
  END_IF;

(* Output data valid *)
IF ALLSlav_Out=TRUE THEN
    E002_Out_Bit00:=TRUE;
  ELSE
    E002_Out_Bit00:=FALSE;
  END_IF;

(* Input data valid *)
IF ALLSlav_In=TRUE AND E002_In_Bit00=TRUE THEN
    E002_Out_Bit07:=TRUE;
  ELSE
    E002_Out_Bit07:=FALSE;
  END_IF;
```

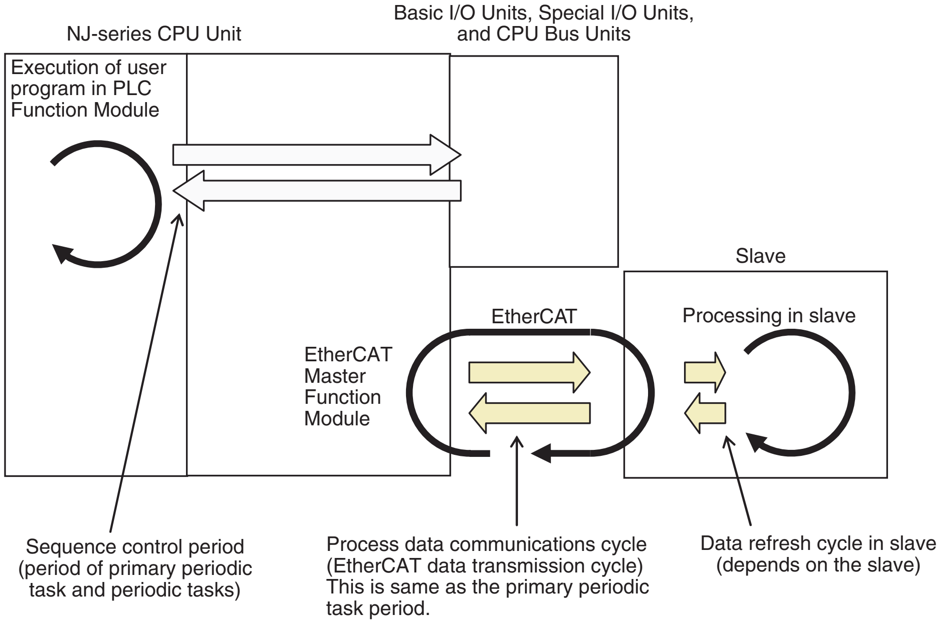
Precautions for Safe Use

If you disconnect the cable from an EtherCAT slave to disconnect it from the network (e.g., to replace it), any current communications frames may be lost. If frames are lost, slave I/O data is not communicated, and the intended operation is sometimes not achieved. If slave replacement is required, program the *_EC_InDataInvalid* (Input Data Disable) system-defined variable as an interlock condition.

6-1-3 Process Data Communications Timing

The EtherCAT communications cycle is the same as period of the primary periodic task for sequence control. It is also the same as the motion control period.

The relationships between sequence processing, motion control processing, and data exchange in EtherCAT communications are shown below.

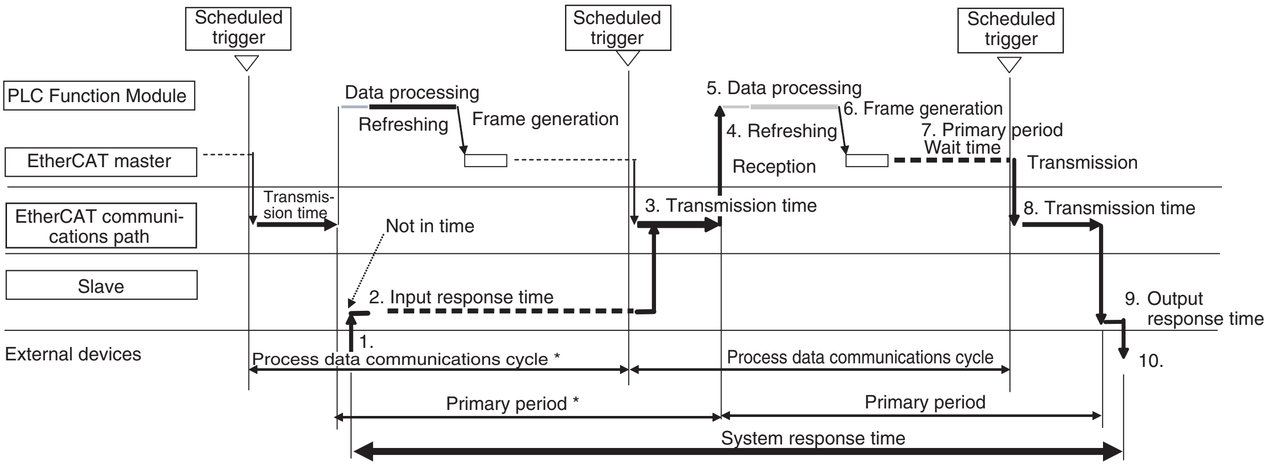

NJ-series CPU Unit
Basic I/O Units, Special I/O Units, and CPU Bus Units
Execution of user program in PLC Function Module
Slave
EtherCAT
Processing in slave
EtherCAT Master Function Module
Sequence control period (period of primary periodic task and periodic tasks)
Process data communications cycle (EtherCAT data transmission cycle) This is same as the primary periodic task period.
Data refresh cycle in slave (depends on the slave)

Primary periodic task period = Motion control period = Process data communications cycle

6-1-4 System Response Time in Process Data Communications

● Standard Synchronization Timing

Here, sequence control and motion control are performed within the task period of the primary periodic task in which EtherCAT communications were refreshed.



* Process data communications cycle = Primary period

System's maximum input and output response time = Primary period (i.e., the process data communications cycle) x 2 + Slave input response time + Slave output response time

(1) Sensor and other inputs are input to the slave.

(2) Signals are detected by the slave after the input response time.

(3) Process data is transmitted from the slave to the EtherCAT communications line.

(4) The EtherCAT master reads (refreshes) the data and passes it to the PLC Function Module.

(5) Sequence processing is performed by the CPU Unit based on the input data. When a motion control instruction is executed, the Motion Control Function Module is asked to perform the processing, and the motion control processing is performed.

(6) Output data is determined and the send frame is generated.

(7) There is wait time during the primary period.

(8) On the scheduled trigger, the frame is transmitted to the EtherCAT communications line.

(9) Signals are input to the slave.

(10) Signals are output after the output response time.

Additional Information

The communications jitter in EtherCAT communications is 10 µs max. (The communications jitter is the deviation in the process data communications cycle.) If the communications jitter exceeds 10 µs, a process data send error (a Controller error in the minor fault level) occurs. This error is recorded in the event log.

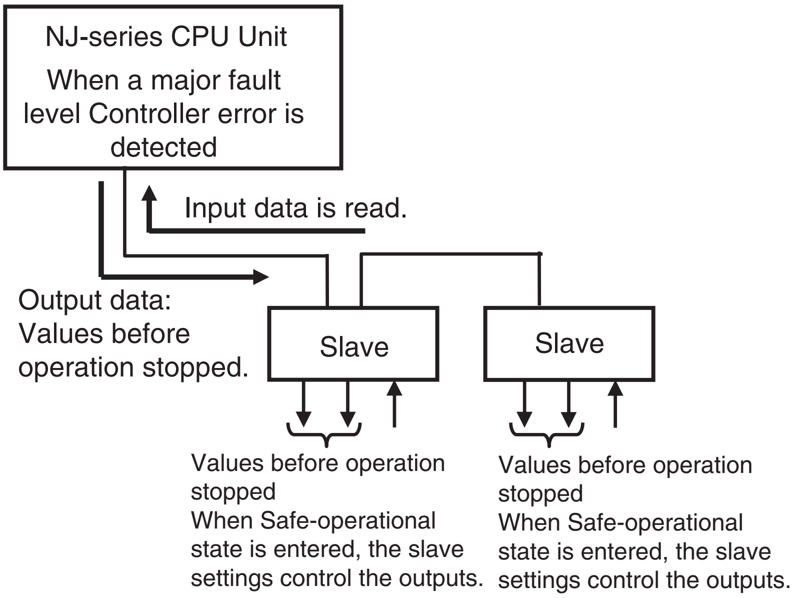
- If the fail-soft operation is set to stop operation, the EtherCAT master will change to the pre-operational state and process data communications will stop.
- If the fail-soft operation is set to fail-soft operation, the EtherCAT master will remain in operational state and process data communications will continue.

In either case, the _EC_PDSendErr (Process Data Send Error) system-defined variables will change to TRUE.
If this happens, increase the task period of the primary periodic task and execute communications again.

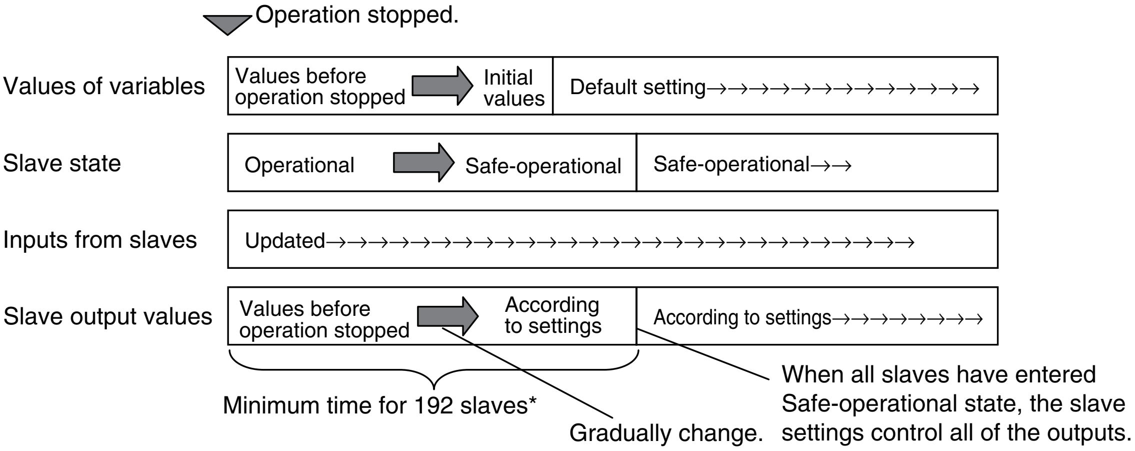
6-1-5 I/O Operations for Major Fault Level Controller Errors and I/O Refreshing with Specified Values

I/O Operations for Major Fault Level Controller Errors

If the NJ-series CPU Unit detects a major fault level Controller error, all slave outputs will retain the process data values from before operation stopped in Operational state. Then the slaves will gradually move to Safe-operational state and the slave settings will control the slave outputs. The process data is still acquired for the slave inputs.*


NJ-series CPU Unit
When a major fault level Controller error is detected
Input data is read.
Output data: Values before operation stopped.
Slave
Slave
Values before operation stopped
When Safe-operational state is entered, the slave settings control the outputs.
Values before operation stopped
When Safe-operational state is entered, the slave settings control the outputs.

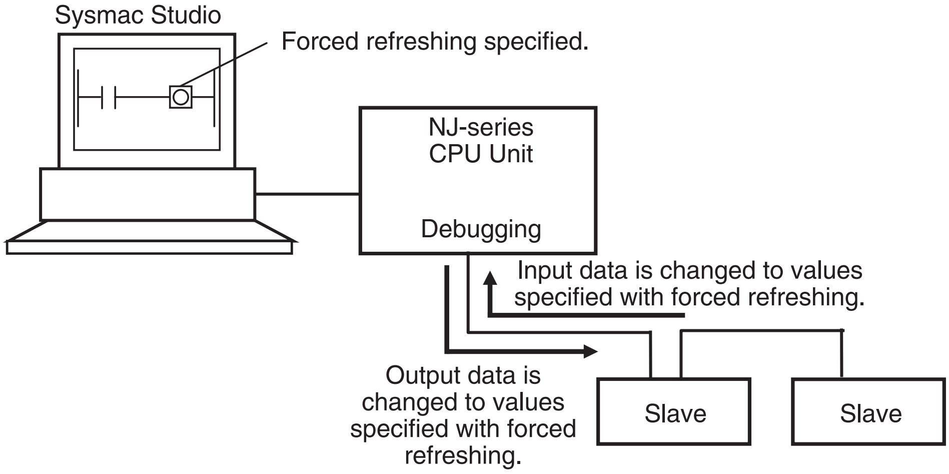
When a major fault level Controller error occurs, the values of the variables are not output to the slaves even if they are initialized. The slave settings will control the slave outputs.


Operation stopped.
Values of variables
Values before operation stopped
Initial values
Default setting→→→→→→→→→→→→→
Slave state
Operational
Safe-operational
Safe-operational→→
Inputs from slaves
Updated→→→→→→→→→→→→→→→→→→→→→→→→→→→→
Slave output values
Values before operation stopped
According to settings
According to settings→→→→→→→→
Minimum time for 192 slaves*
Gradually change.
When all slaves have entered Safe-operational state, the slave settings control all of the outputs.

* If there are 192 slaves connected, the maximum time required for all outputs to be controlled by the slave settings (i.e., the time to enter Safe-operational state) is the communications cycle multiplied by 20 plus the slave Safe-operational state transition time (10 ms max. or OMRON slaves).

Forced Refreshing

You can specify forced refreshing from the Sysmac Studio for debugging. This allows you to change process data output values to the slaves and input values from the slaves to the values that you specify in advance.


Sysmac Studio
Forced refreshing specified.
NJ-series CPU Unit
Debugging
Input data is changed to values specified with forced refreshing.
Output data is changed to values specified with forced refreshing.
Slave
Slave

Relationship between Major Fault Level Controller Errors, Normal Operation, and Forced Refreshing

Forced refreshing functions as shown in the following table for major fault level Controller errors and for normal operation.

Condition		Major fault level controller error*	Normal operation
Forced refreshing	Enabled	Output data: Values from before operation stopped (Operational state). Slave settings control the outputs (Safe-operational state). Input data: Process data	Output data: Forced refreshing values Input data: Forced refreshing values
	Disabled	Output data: Values from before operation stopped (Operational state). Slave settings control the outputs (Safe-operational state). Input data: Process data	Output data: Process data Input data: Process data

* If a major fault level Controller error occurs, the output values from before operation stopped are retained while the slaves are in Operational state and the slave settings control the outputs after the slaves enter Safe-operational state.

Precautions for Safe Use

- You can select whether the master continues or stops communications with all slaves when a communications error occurs. Refer to *5-4-1 Setting EtherCAT Master* for details.
- Frames that are sent to EtherCAT slave are sometimes lost due to noise or other factors. If frames are lost, slave I/O data is not communicated, and the intended operation is sometimes not achieved. If noise countermeasures are required, program the *_EC_InDataInvalid* (Input Data Disable) system-defined variable as an interlock condition. Refer to *6-1-2 Sample Programming* for a sample of programming interlocks.
- If a communications error prevents the slaves from receiving signals from the master, the slave settings will control the slave outputs. During the time that is required to change from normal operation to a communications error status, frames will be lost. The outputs for lost frames are different for synced slaves (Servo Drives and encoders) and non-synced slaves. The slave settings will control the slave outputs for synced slaves. The previous values are retained for the slave outputs for non-synced slaves.

	Normal operation	Frames lost	Communications error status
Outputs from synced slaves (Servo Drives and encoders)	Controlled by the values of device variables.	Controlled by the slave settings.	Controlled by the slave settings.
Outputs from non-synced slaves	Controlled by the values of device variables.	The previous values are output.	Controlled by the slave settings.

For details, refer to relevant manuals for each slave.

Additional Information

You can check from the user program to see if I/O refreshing is normal by checking one of the system-defined variables *_EC_PDSlavTbl[1..192]* (Process Data Communicating Slave Table).

6-2 SDO Communications

SDO communications are performed by using EtherCAT instructions to access SDO data in slaves when required.

6-2-1 EtherCAT Instructions

You can perform the following SDO communications with EtherCAT instructions.

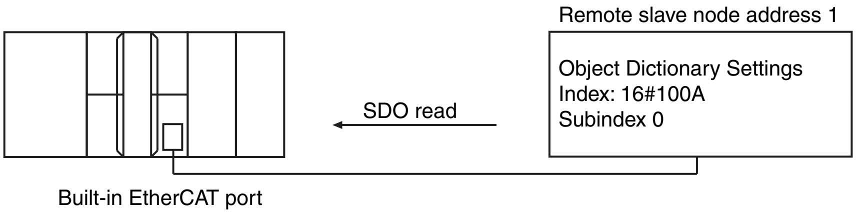
- Reading and writing of SDO data

Reading and Writing SDO Data

Function	Instruction	Description
CoE messages (Read CoE SDO)	EC_CoESDORead	You set parameters to read data from the slave's object dictionary (SDO data).
CoE messages (Write CoE SDO)	EC_CoESDOWrite	You set parameters to write data to the slave's object dictionary (SDO data).

6-2-2 Sample Programming

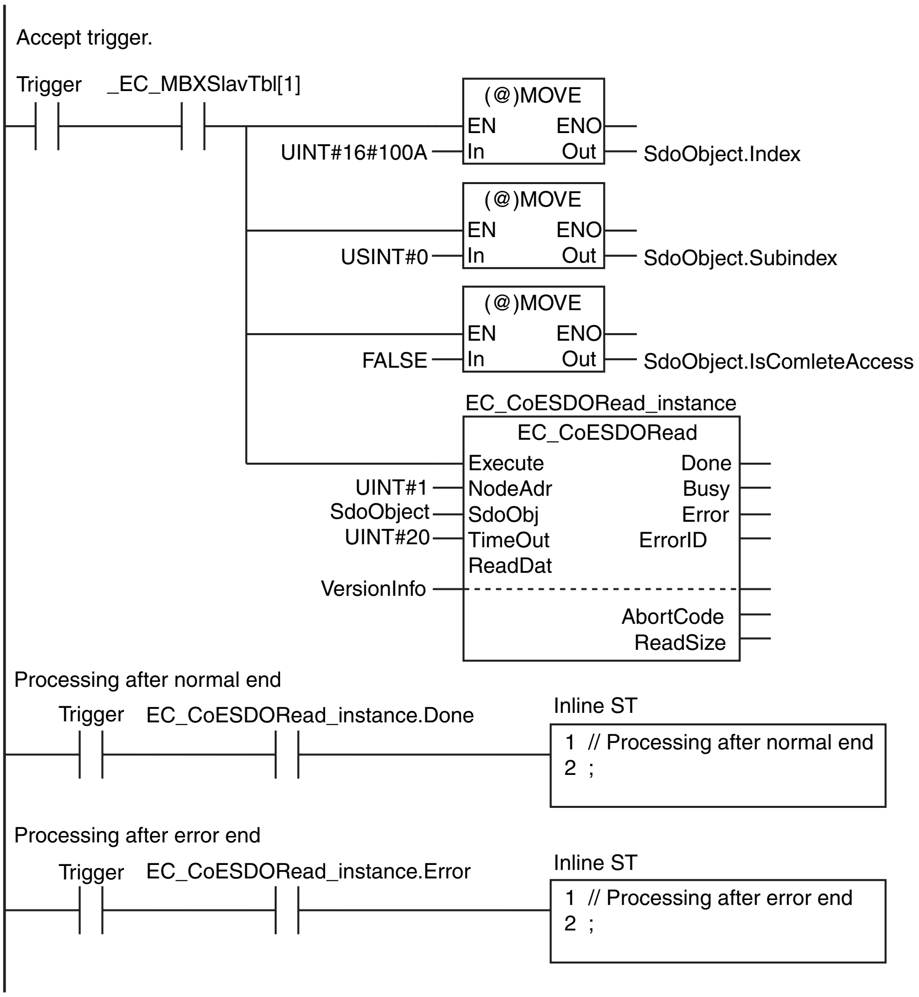
This sample uses an EtherCAT SDO message to read the software version of an OMRON V1.02 R88D-KN01L-ECT Servo Drive. The node address of the slave is 1.
The object index for the software version is 16#100A. The subindex is 0. The read value is stored in STRING variable *VersionInfo*.



LD

Internal Variables	Variable	Data type	Initial value	Comment
	Trigger	BOOL	False	Execution condition
	SdoObject	_sSDO_ACCESS	(Index:=0, Subindex:=0, IsCompleteAccess:=False)	SDO parameter
	VersionInfo	STRING[256]	‘’	Read data
	EC_CoESDORead_instance	EC_CoESDORead		

External Variables	Variable	Data type	Constant	Comment
	_EC_MBXSlavTbl	ARRAY[1..192] OF BOOL	☑	Message Communications Enabled Slave Table



ST

Internal Variables	Variable	Data type	Initial value	Comment
	Trigger	BOOL	False	Execution condition
	SdoObject	_sSDO_ACCESS	(Index:=0, Subindex:=0, IsCompleteAccess:=False)	SDO parameter
	DoSdoRead	BOOL	False	Processing
	VersionInfo	STRING[256]	‘’	Read data
	NormalEnd	UINT	0	Normal end
	ErrorEnd	UINT	0	Error end
	EC_CoESDORead_instance	EC_CoESDORead		

External Variables	Variable	Data type	Constant	Comment
	_EC_MBXSlavTbl	ARRAY[1..192] OF BOOL	☑	Message Communications Enabled Slave Table

```
// Detect when Trigger changes to TRUE.
IF ( (Trigger=TRUE) AND (DoSdoRead=FALSE) AND (_EC_MBXSlavTbl[1]=TRUE) ) THEN
    DoSdoRead                  :=TRUE;
    SdoObject.Index            :=UINT#16#100A;
    SdoObject.Subindex         :=USINT#0;
    SdoObject.IsCompleteAccess:=FALSE;
    EC_CoESDORead_instance(
        Execute:=FALSE,            // Initialize instance.
        ReadDat:=VersionInfo);     // Dummy
END_IF;

// Execute EC_CoESDORead instruction.
IF (DoSdoRead=TRUE) THEN
    EC_CoESDORead_instance(
        Execute  :=TRUE,
        NodeAdr :=UINT#1,          // Node address 1
        SdoObj   :=SdoObject,      // SDO parameter
        TimeOut :=UINT#20,         // Timeout time: 2.0 s
        ReadDat:=VersionInfo);     // Read data

    IF (EC_CoESDORead_instance.Done=TRUE) THEN
        // Processing after normal end
        NormalEnd:=NormalEnd+UINT#1;
    ELSIF (EC_CoESDORead_instance.Error=TRUE) THEN
        // Processing after error end
        ErrorEnd    :=ErrorEnd+UINT#1;
    END_IF;

END_IF;
```

6-2-3 Execution Timing of SDO Communications

SDO communications are executed in the system service time of the NJ-series CPU Unit. System services are executed in the period between execution of all of the tasks.

Refer to the *NJ-series CPU Unit Software User's Manual* (Cat. No. W501) for details on the execution timing of system services.

6-2-4 Message Response Time for SDO Communications

The message response time for SDO communications is the time from when the SDO communications instruction is executed in the user program until execution of the instruction is completed.

When the instruction is executed in the user program, the master sends a frame to the slave in the system service. When the slave receives the frame, it processes it. When the slave completes processing, the master receives a response from the slave to complete execution of the instruction.

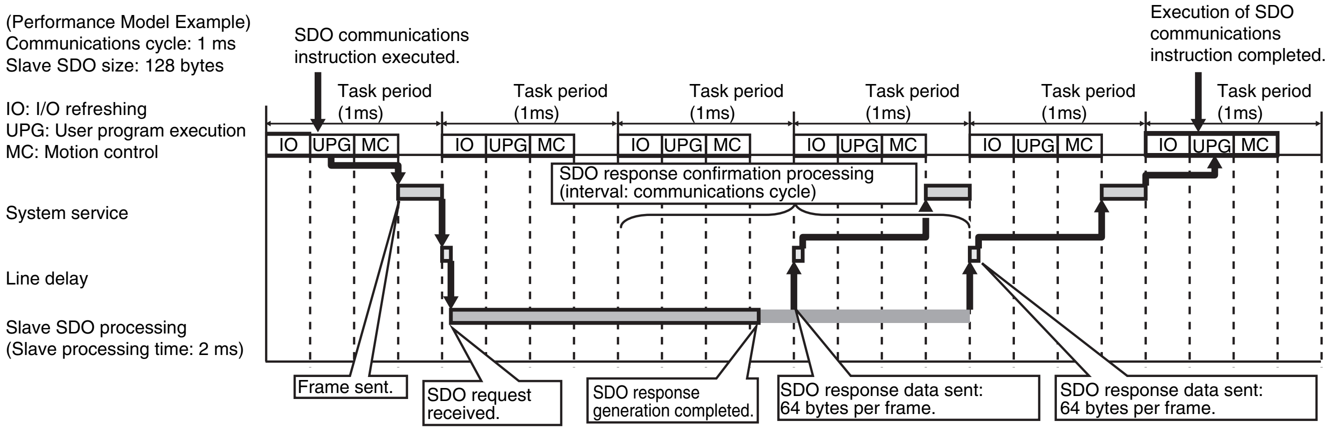
Calculating the Message Response Time

Message response time = Task period + (Slave SDO processing time/Task period + 1[*1]) × Task period + (SDO response data size/64 bytes + 1[*2]) × Task period + Task period

*1 If the slave SDO processing time divides evenly by the task period, then "+1" is not required.

*2 If the SDO response data size divides evenly by 64 bytes, then "+1" is not required.

The following timing chart shows an example of the timing from execution of the instruction for SDO message communications to the completion of instruction execution (i.e., until a response is received).


(Performance Model Example)
Communications cycle: 1 ms
Slave SDO size: 128 bytes
IO: I/O refreshing
UPG: User program execution
MC: Motion control
System service
Line delay
Slave SDO processing
(Slave processing time: 2 ms)
SDO communications instruction executed.
Execution of SDO communications instruction completed.
Task period (1ms)
Task period (1ms)
Task period (1ms)
Task period (1ms)
Task period (1ms)
Task period (1ms)
IO
UPG
MC
SDO response confirmation processing (interval: communications cycle)
Frame sent.
SDO request received.
SDO response generation completed.
SDO response data sent: 64 bytes per frame.
SDO response data sent: 64 bytes per frame.

Performance Model Example

Task period (ms)	1
SDO size (bytes)	128
Slave SDO processing time (ms)	2
Message response time (ms)	6

Additional Information

The message response time depends on the unused time in task execution, slave SDO size, and slave SDO processing time. The above timing chart is for reference only.

6-3 Instructions Used in EtherCAT Communications

6-3-1 EtherCAT Instructions

Function	Instruction	Description
Start EtherCAT Packet Monitor	EC_StartMon	Starts packet monitoring of the EtherCAT master built into the NJ-series CPU Unit.
Stop EtherCAT Packet Monitor	EC_StopMon	Stops packet monitoring of the EtherCAT master built into the NJ-series CPU Unit.
Save Packet Data File	EC_SaveMon	Saves captured data in a file in the system of the NJ-series CPU Unit. The packet monitor is a function of the EtherCAT master built into the NJ-series CPU Unit. The captured files in the system of the NJ-series CPU Unit are not retained when the power is interrupted.
Copy Packet Data File to SD Memory Card	EC_CopyMon	Copies the captured data that was saved in the system of the NJ-series CPU Unit to a file on an SD Memory Card. The captured data is previously saved from EtherCAT master built into the NJ-series CPU Unit into the system of the NJ-series CPU Unit. The files saved to an SD Memory Card are retained after the power is interrupted.
Disconnect EtherCAT Slave	EC_DisconnectSlave	Temporarily disconnects a slave from the EtherCAT network for maintenance, such as replacement of the slave.
Connect EtherCAT Slave	EC_ConnectSlave	Reconnects a temporarily disconnected slave to the EtherCAT network after maintenance, such as replacement of the slave.
Get EtherCAT Error Status	GetECError	Gets the status of Controller errors (partial faults or minor faults) that occur in the EtherCAT master and the highest-level event code for the current errors.
Reset EtherCAT Controller Error	ResetECError	Resets Controller errors in the EtherCAT master. (Execute this instruction only after eliminating the cause of the error.)

7

System-defined Variables That Are Related to the Built-in EtherCAT Port

This section describes the system-defined variables that are related to the built-in EtherCAT port.

7-1 System-defined Variables That Are Related to the Built-in EtherCAT Port 7-2

7-1-1 What Are System-defined Variables? 7-2

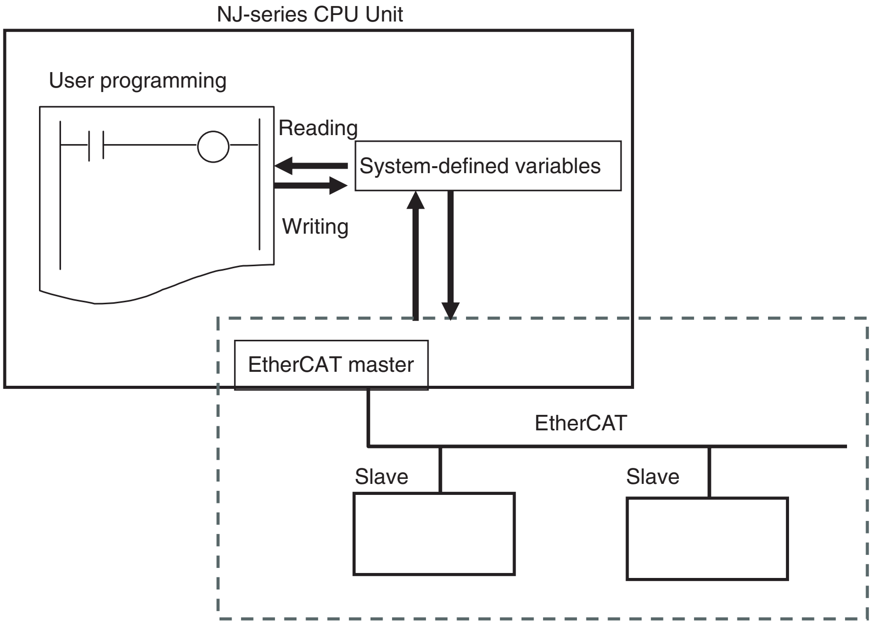
7-1-2 System-defined Variables 7-2

7-1-3 EtherCAT Master Function Module, Category Name: _EC 7-6

7-1 System-defined Variables That Are Related to the Built-in EtherCAT Port

7-1-1 What Are System-defined Variables?

System-defined variables are variables that are defined by the system for use with EtherCAT communications. These are provided in advance in the global variable table.
The user program can input status and set parameters for the EtherCAT master and slaves by reading and writing system-defined variables.



7-1-2 System-defined Variables

● Functional Classification: EtherCAT Communications Errors

Variable name	Meaning	Function	Data type	Range of values	Reference
_EC_ErrSta	Built-in EtherCAT Error	This system-defined variable provides the collective status of errors in the EtherCAT Master Function Module. Refer to *Meanings of Error Status Bits* given later for the meaning of individual bits.	WORD	16#0000 to 16#00F0	page 7-6
_EC_PortErr	Communications Port Error	This system-defined variable provides the collective status of errors in the communications ports for the EtherCAT master. Refer to *Meanings of Error Status Bits* given later for the meaning of individual bits.	WORD	16#0000 to 16#00F0	page 7-6
_EC_MstrErr	Master Error	This system-defined variable provides the collective status of EtherCAT master errors and slave errors detected by the EtherCAT master. Refer to *Meanings of Error Status Bits* given later for the meaning of individual bits.	WORD	16#0000 to 16#00F0	page 7-7

Variable name	Meaning	Function	Data type	Range of values	Reference
_EC_SlavErr	Slave Error	This system-defined variable provides the collective status of all the error status for EtherCAT slaves. Refer to *Meanings of Error Status Bits* given later for the meaning of individual bits.	WORD	16#0000 to 16#00F0	page 7-7
_EC_SlavErrTbl	Slave Error Table	This system-defined variable gives the error status for each EtherCAT slave. The error status is given for each slave in the actual system configuration. This variable array indicates slaves in which there are errors. Status is provided for each EtherCAT slave node address (1 to 192). Refer to *Meanings of Error Status Bits* given later for the meaning of individual bits.	ARRAY [1..192] OF WORD	16#0000 to 16#00F0	page 7-7
_EC_MacAdrErr	MAC Address Error	TRUE if there is an illegal MAC address.	BOOL	TRUE or FALSE	page 7-7
_EC_LanHwErr	Communications Controller Error	TRUE if there is a communications controller hardware error.	BOOL	TRUE or FALSE	page 7-8
_EC_LinkOffErr	Link OFF Error	TRUE if the communications controller link is not established.	BOOL	TRUE or FALSE	page 7-8
_EC_NetCfgErr	Network Configuration Information Error	TRUE if there is illegal network configuration information.	BOOL	TRUE or FALSE	page 7-8
_EC_NetCfgCmpErr	Network Configuration Verification Error	TRUE if the network configuration information does not match the actual network configuration.	BOOL	TRUE or FALSE	page 7-8
_EC_NetTopologyErr	Network Configuration Error	TRUE if there is a network configuration error (too many devices connected or ring connection).	BOOL	TRUE or FALSE	page 7-8
_EC_PDCommErr	Process Data Communications Error	TRUE if there is an unexpected slave disconnection or connection or if a slave WDT error is detected during process data communications.	BOOL	TRUE or FALSE	page 7-8
_EC_PDTimeoutErr	Process Data Reception Timeout	TRUE if a timeout occurs while receiving process data.	BOOL	TRUE or FALSE	page 7-9
_EC_PDSendErr	Process Data Transmission Error	TRUE if there is a process data transmission error (cannot send within the process data communications cycle or transmission jitter is over the limit).	BOOL	TRUE or FALSE	page 7-9
_EC_SlavAdrDupErr	Slave Node Address Duplicated Error	TRUE if the same node address is set for more than one slave.	BOOL	TRUE or FALSE	page 7-9
_EC_SlavInitErr	Slave Initialization Error	TRUE if there is an error in an initialization command addressed to a slave.	BOOL	TRUE or FALSE	page 7-9
_EC_SlavAppErr	Slave Application Error	TRUE if there is an error in the slave's application status register.	BOOL	TRUE or FALSE	page 7-9
_EC_MsgErr	EtherCAT Message Error	TRUE when a message is sent to a slave that does not support messages or when there is an error in the format of the response to a message that was sent to a slave.	BOOL	TRUE or FALSE	page 7-9
_EC_SlavEmergErr	Emergency Message Detected	TRUE if the master detects an emergency message that was sent by a slave.	BOOL	TRUE or FALSE	page 7-10
_EC_CommErrTbl	Communications Error Slave Table	Slaves are given in the table in the order of slave node addresses. The corresponding slave element is TRUE if the master detected an error for the slave.	ARRAY [1..192] OF BOOL	TRUE or FALSE	page 7-10

Additional Information

Typical Relationships for the Built-in EtherCAT Error Flags

Variable Name	Meaning	Variable Name	Meaning	Variable Name	Meaning	Event level
_EC_ErrSta	Built-in EtherCAT Error	_EC_PortErr	Communications Port Error	_EC_MacAdrErr	MAC Address Error	Partial fault level
				_EC_LanHwErr	Communications Controller Error	
				_EC_LinkOffErr	Link OFF Error	Minor fault level
		_EC_MstrErr	Master Error	_EC_NetCfgErr	Network Configuration Information Error	
				_EC_NetCfgCmpErr	Network Configuration Verification Error	
				_EC_NetTopologyErr	Network Configuration Error	
				_EC_PDCommErr	Process Data Communications Error	
				_EC_PDTimeoutErr	Process Data Reception Timeout	
				_EC_PDSendErr	Process Data Transmission Error	
				_EC_SlavAdrDupErr	Slave Node Address Duplicated Error	
				_EC_SlavInitErr	Slave Initialization Error	
				_EC_SlavAppErr	Slave Application Error	
				_EC_CommErrTbl	Communications Error Slave Table	
				_EC_MsgErr	EtherCAT Message Error	Observation
				_EC_SlavEmergErr	Emergency Message Detected	
		_EC_SlavErr	Slave Error	_EC_SlavErrTbl	Slave Error Table	Defined by the slave.

Note The values of all system-defined variables that are related to errors in EtherCAT communications do not change until the cause of the error is removed and then the error in the Controller is reset with the troubleshooting functions of the Sysmac Studio or the ResetECError instruction.

● Functional Classification: EtherCAT Communications Status

Variable name	Meaning	Function	Data type	Range of values	Reference
_EC_RegSlavTbl	Registered Slave Table	This table indicates the slaves that are registered in the network configuration information. Slaves are given in the table in the order of slave node addresses. The element for a slave is TRUE if the corresponding slave is registered.	ARRAY [1..192] OF BOOL	TRUE or FALSE	page 7-10
_EC_EntrySlavTbl	Network Connected Slave Table	This table indicates which slaves are connected to the network. Slaves are given in the table in the order of slave node addresses. The element for a slave is TRUE if the corresponding slave has entered the network.	ARRAY [1..192] OF BOOL	TRUE or FALSE	page 7-10
_EC_MBXSlavTbl	Message Communications Enabled Slave Table	This table indicates the slaves that can perform message communications. Slaves are given in the table in the order of slave node addresses. The element for a slave is TRUE if message communications are enabled for it (pre-operational, safe-operation, or operational state). **Note** Use this variable to confirm that message communications are possible for the relevant slave before you execute message communications with an EtherCAT slave.	ARRAY [1..192] OF BOOL	TRUE or FALSE	page 7-11
_EC_PDSlavTbl	Process Data Communicating Slave Table	This table indicates the slaves that are performing process data communications. Slaves are given in the table in the order of slave node addresses. The element for a slave is TRUE if process data of the corresponding slave is enabled (operational) for both slave inputs and outputs. **Note** Use this variable to confirm that the data for the relevant slave is valid before controlling an EtherCAT slave.	ARRAY [1..192] OF BOOL	TRUE or FALSE	page 7-11
_EC_DisconnSlavTbl	Disconnected Slave Table	Slaves are given in the table in the order of slave node addresses. The element for a slave is TRUE if the corresponding slave was disconnected.	ARRAY [1..192] OF BOOL	TRUE or FALSE	page 7-11
_EC_DisableSlavTbl	Disabled Slave Table	Slaves are given in the table in the order of slave node addresses. The element for a slave is TRUE if the corresponding slave is disabled.	ARRAY [1..192] OF BOOL	TRUE or FALSE	page 7-11
_EC_PDActive	Process Data Communications Status	TRUE when process data communications are performed with all slaves.	BOOL	TRUE or FALSE	page 7-12
_EC_PktMonStop	Packet Monitoring Stopped	TRUE when packet monitoring is stopped.	BOOL	TRUE or FALSE	page 7-12
_EC_LinkStatus	Link Status	TRUE if the communications controller link status is Link ON.	BOOL	TRUE or FALSE	page 7-12
_EC_PktSaving	Saving Packet Data File	Shows whether a packet data file is being saved. TRUE: Packet data file being saved. FALSE: Packet data file not being saved.	BOOL	TRUE or FALSE	page 7-12
_EC_InDataInvalid	Input Data Invalid	TRUE when process data communications are not normal and the input data is not valid.	BOOL	TRUE or FALSE	page 7-12

Note All system-defined variables that are related to the status of EtherCAT communications give the current status.

● Meanings of Error Status Bits

The meanings of the individual bits in the above error status variables are given below.

Bit	Name	Description	Value	Meaning
15	Master Detection[*1]	This bit indicates whether the master detected an error in the slaves that it manages.	TRUE	Error
			FALSE	No error
14	Slave Summary[*2]	Indicates whether there is an error at a level below the function module.	TRUE	Error
			FALSE	No error
8 to 13	Not used.			
7	Major Fault	Indicates if there is a major fault level error.	TRUE	Error
			FALSE	No error
6	Partial Fault	Indicates if there is a partial fault level error.	TRUE	Error
			FALSE	No error
5	Minor Fault	Indicates if there is a minor fault level error.	TRUE	Error
			FALSE	No error
4	Observation	Indicates if there is an observation level error.	TRUE	Error
			FALSE	No error
0 to 3	Not used.			

[*1] For the EtherCAT Master Function Module, only *_EC_SlavErrTbl* (Slave Error Table) is used.

[*2] For the EtherCAT Master Function Module, only *_EC_ErrSta* (Built-in EtherCAT Error) is used.

7-1-3 EtherCAT Master Function Module, Category Name: _EC

● Functional Classification: EtherCAT Communications Errors

Variable name	_EC_ErrSta				
Meaning	Built-in EtherCAT Error			Global/local	Global
Function	This system-defined variable provides the collective status of errors in the EtherCAT Master Function Module. Refer to *Meanings of Error Status Bits* provided above for the meanings of the error status bits.				
Data type	WORD			Range of values	16#0000 to 16#00F0
R/W access	R	Retained	Not retained.	Network Publish	Published.
Usage in user program	Possible.	Related instructions	Get EtherCAT Error Status • GetECError Reset EtherCAT Controller Error • ResetECError		

Variable name	_EC_PortErr				
Meaning	Communications Port Error			Global/local	Global
Function	This system-defined variable provides the collective status of errors in the communications ports for the EtherCAT master. Refer to *Meanings of Error Status Bits* provided above for the meanings of the error status bits.				
Data type	WORD			Range of values	16#0000 to 16#00F0
R/W access	R	Retained	Not retained.	Network Publish	Published.
Usage in user program	Possible.	Related instructions	Get EtherCAT Error Status • GetECError Reset EtherCAT Controller Error • ResetECError		

Variable name	_EC_MstrErr				
Meaning	Master Error			Global/local	Global
Function	This system-defined variable provides the collective status of EtherCAT master errors and slave errors detected by the EtherCAT master. Refer to *Meanings of Error Status Bits* provided above for the meanings of the error status bits.				
Data type	WORD			Range of values	16#0000 to 16#00F0
R/W access	R	Retained	Not retained.	Network Publish	Published.
Usage in user program	Possible.	Related instructions	Get EtherCAT Error Status • GetECError Reset EtherCAT Controller Error • ResetECError		

Variable name	_EC_SlavErr				
Meaning	Slave Error			Global/local	Global
Function	This system-defined variable provides the collective status of all the error status for EtherCAT slaves. Refer to *Meanings of Error Status Bits* provided above for the meanings of the error status bits.				
Data type	WORD			Range of values	16#0000 to 16#00F0
R/W access	R	Retained	Not retained.	Network Publish	Published.
Usage in user program	Possible.	Related instructions	Get EtherCAT Error Status • GetECError Reset EtherCAT Controller Error • ResetECError		

Variable name	_EC_SlavErrTbl				
Meaning	Slave Error Table			Global/local	Global
Function	This system-defined variable gives the error status for each EtherCAT slave. The error status is given for each slave in the actual system configuration. This variable array indicates slaves in which there are errors. Status is provided for each EtherCAT slave node address (1 to 192). Refer to *Meanings of Error Status Bits* provided above for the meanings of the error status bits.				
Data type	Array [1..192] OF WORD			Range of values	16#0000 to 16#00F0
R/W access	R	Retained	Not retained.	Network Publish	Published.
Usage in user program	Possible.	Related instructions	Get EtherCAT Error Status • GetECError Reset EtherCAT Controller Error • ResetECError		

Variable name	_EC_MacAdrErr				
Meaning	MAC Address Error			Global/local	Global
Function	TRUE if there is an illegal MAC address.				
Data type	BOOL			Range of values	TRUE or FALSE
R/W access	R	Retained	Not retained.	Network Publish	Published.
Usage in user program	Possible.	Related instructions	Reset EtherCAT Controller Error • ResetECError		

Variable name	_EC_LanHwErr				
Meaning	Communications Controller Error			Global/local	Global
Function	TRUE if there is a communications controller hardware error.				
Data type	BOOL			Range of values	TRUE or FALSE
R/W access	R	Retained	Not retained.	Network Publish	Published.
Usage in user program	Possible.	Related instructions	Reset EtherCAT Controller Error • ResetECError		

Variable name	_EC_LinkOffErr				
Meaning	Link OFF Error			Global/local	Global
Function	TRUE if the communications controller link is not established.				
Data type	BOOL			Range of values	TRUE or FALSE
R/W access	R	Retained	Not retained.	Network Publish	Published.
Usage in user program	Possible.	Related instructions	Reset EtherCAT Controller Error • ResetECError		

Variable name	_EC_NetCfgErr				
Meaning	Network Configuration Information Error			Global/local	Global
Function	TRUE if there is illegal network configuration information.				
Data type	BOOL			Range of values	TRUE or FALSE
R/W access	R	Retained	Not retained.	Network Publish	Published.
Usage in user program	Possible.	Related instructions	Reset EtherCAT Controller Error • ResetECError		

Variable name	_EC_NetCfgCmpErr				
Meaning	Network Configuration Verification Error			Global/local	Global
Function	TRUE if the network configuration information does not match the actual network configuration.				
Data type	BOOL			Range of values	TRUE or FALSE
R/W access	R	Retained	Not retained.	Network Publish	Published.
Usage in user program	Possible.	Related instructions	Reset EtherCAT Controller Error • ResetECError		

Variable name	_EC_NetTopologyErr				
Meaning	Network Configuration Error			Global/local	Global
Function	TRUE if there is a network configuration error (too many devices connected or ring connection).				
Data type	BOOL			Range of values	TRUE or FALSE
R/W access	R	Retained	Not retained.	Network Publish	Published.
Usage in user program	Possible.	Related instructions	Reset EtherCAT Controller Error • ResetECError		

Variable name	_EC_PDCommErr				
Meaning	Process Data Communications Error			Global/local	Global
Function	TRUE if there is an unexpected slave disconnection or connection or if a slave WDT error is detected during process data communications.				
Data type	BOOL			Range of values	TRUE or FALSE
R/W access	R	Retained	Not retained.	Network Publish	Published.
Usage in user program	Possible.	Related instructions	Reset EtherCAT Controller Error • ResetECError		

Variable name	_EC_PDTimeoutErr				
Meaning	Process Data Reception Timeout Error			Global/local	Global
Function	TRUE if a timeout occurs while receiving process data.				
Data type	BOOL			Range of values	TRUE or FALSE
R/W access	R	Retained	Not retained.	Network Publish	Published.
Usage in user program	Possible.	Related instructions	Reset EtherCAT Controller Error • ResetECError		

Variable name	_EC_PDSendErr				
Meaning	Process Data Transmission Error			Global/local	Global
Function	TRUE if there is a process data transmission error (cannot send within the process data communications period or transmission jitter is over the limit).				
Data type	BOOL			Range of values	TRUE or FALSE
R/W access	R	Retained	Not retained.	Network Publish	Published.
Usage in user program	Possible.	Related instructions	Reset EtherCAT Controller Error • ResetECError		

Variable name	_EC_SlavAdrDupErr				
Meaning	Slave Node Address Duplicated Error			Global/local	Global
Function	TRUE if the same node address is set for more than one slave.				
Data type	BOOL			Range of values	TRUE or FALSE
R/W access	R	Retained	Not retained.	Network Publish	Published.
Usage in user program	Possible.	Related instructions	Reset EtherCAT Controller Error • ResetECError		

Variable name	_EC_SlavInitErr				
Meaning	Slave Initialization Error			Global/local	Global
Function	TRUE if there is an error in an initialization command addressed to a slave.				
Data type	BOOL			Range of values	TRUE or FALSE
R/W access	R	Retained	Not retained.	Network Publish	Published.
Usage in user program	Possible.	Related instructions	Reset EtherCAT Controller Error • ResetECError		

Variable name	_EC_SlavAppErr				
Meaning	Slave Application Error			Global/local	Global
Function	TRUE if there is an error in the slave's application status register.				
Data type	BOOL			Range of values	TRUE or FALSE
R/W access	R	Retained	Not retained.	Network Publish	Published.
Usage in user program	Possible.	Related instructions	Reset EtherCAT Controller Error • ResetECError		

Variable name	_EC_MsgErr				
Meaning	EtherCAT Message Error			Global/local	Global
Function	TRUE when a message is sent to a slave that does not support messages or when there is an error in the format of the response to a message that was sent to a slave.				
Data type	BOOL			Range of values	TRUE or FALSE
R/W access	R	Retained	Not retained.	Network Publish	Published.
Usage in user program	Possible.	Related instructions	CoE messages (Read CoE SDO) • EC_CoESDORead CoE messages (Write CoE SDO) • EC_CoESDOWrite		

Variable name	_EC_SlavEmergErr				
Meaning	Emergency Message Detected			Global/local	Global
Function	TRUE if the master detects an emergency message that was sent by a slave.				
Data type	BOOL			Range of values	TRUE or FALSE
R/W access	R	Retained	Not retained.	Network Publish	Published.
Usage in user program	Possible.	Related instructions	Reset EtherCAT Controller Error • ResetECError		

Variable name	_EC_CommErrTbl				
Meaning	Communications Error Slave Table			Global/local	Global
Function	Slaves are given in the table in the order of slave node addresses. The corresponding slave element is TRUE if the master detected an error for the slave.				
Data type	Array [1..192] OF BOOL			Range of values	TRUE or FALSE
R/W access	R	Retained	Not retained.	Network Publish	Published.
Usage in user program	Possible.	Related instructions	Reset EtherCAT Controller Error • ResetECError		

Note The values of all system-defined variables that are related to errors in EtherCAT communications do not change until the cause of the error is removed and then the error in the Controller is reset with the troubleshooting functions of the Sysmac Studio or the ResetECError instruction.

● Functional Classification: EtherCAT Communications Status

Variable name	_EC_RegSlavTbl				
Meaning	Registered Slave Table			Global/local	Global
Function	This table indicates the slaves that are registered in the network configuration information. Slaves are given in the table in the order of slave node addresses. The element for a slave is TRUE if the corresponding slave is registered.				
Data type	Array [1..192] OF BOOL			Range of values	TRUE or FALSE
R/W access	R	Retained	Not retained.	Network Publish	Published.
Usage in user program	Possible.	Related instructions	---		

Variable name	_EC_EntrySlavTbl				
Meaning	Network Connected Slave Table			Global/local	Global
Function	This table indicates which slaves are connected to the network. Slaves are given in the table in the order of slave node addresses. The element for a slave is TRUE if the corresponding slave has entered the network.				
Data type	Array [1..192] OF BOOL			Range of values	TRUE or FALSE
R/W access	R	Retained	Not retained.	Network Publish	Published.
Usage in user program	Possible.	Related instructions	---		

Variable name	_EC_MBXSlavTbl				
Meaning	Message Communications Enabled Slave Table			Global/local	Global
Function	This table indicates the slaves that can perform message communications. Slaves are given in the table in the order of slave node addresses. The element for a slave is TRUE if message communications are enabled for it (pre-operational, safe-operation, or operational state). **Note** Use this variable to confirm that message communications are possible for the relevant slave before you execute message communications with an EtherCAT slave.				
Data type	Array [1..192] OF BOOL			Range of values	TRUE or FALSE
R/W access	R	Retained	Not retained.	Network Publish	Published.
Usage in user program	Possible.	Related instructions	Disconnect EtherCAT Slave • EC_DisconnectSlave Connect EtherCAT Slave • EC_ConnectSlave		

Variable name	_EC_PDSlavTbl				
Meaning	Process Data Communicating Slave Table			Global/local	Global
Function	This is a table that indicates the slaves that are performing process data communications. Slaves are given in the table in the order of slave node addresses. The element for a slave is TRUE if process data of the corresponding slave is enabled (operational) for both slave inputs and outputs. **Note** Use this variable to confirm that the data for the relevant slave is valid before controlling an EtherCAT slave.				
Data type	Array [1..192] OF BOOL			Range of values	TRUE or FALSE
R/W access	R	Retained	Not retained.	Network Publish	Published.
Usage in user program	Possible.	Related instructions	Disconnect EtherCAT Slave • EC_DisconnectSlave Connect EtherCAT Slave • EC_ConnectSlave		

Variable name	_EC_DisconnSlavTbl				
Meaning	Disconnected Slave Table			Global/local	Global
Function	Slaves are given in the table in the order of slave node addresses. The element for a slave is TRUE if the corresponding slave was disconnected.				
Data type	Array [1..192] OF BOOL			Range of values	TRUE or FALSE
R/W access	R	Retained	Not retained.	Network Publish	Published.
Usage in user program	Possible.	Related instructions	Disconnect EtherCAT Slave • EC_DisconnectSlave Connect EtherCAT Slave • EC_ConnectSlave		

Variable name	_EC_DisableSlavTbl				
Meaning	Disabled Slave Table			Global/local	Global
Function	Slaves are given in the table in the order of slave node addresses. The element for a slave is TRUE if the corresponding slave is disabled.				
Data type	Array [1..192] OF BOOL			Range of values	TRUE or FALSE
R/W access	R	Retained	Not retained.	Network Publish	Published.
Usage in user program	Possible.	Related instructions	---		

Variable name	_EC_PDActive				
Meaning	Process Data Communications Status			Global/local	Global
Function	TRUE when process data communications are performed with all slaves.				
Data type	BOOL			Range of values	TRUE or FALSE
R/W access	R	Retained	Not retained.	Network Publish	Published.
Usage in user program	Possible.	Related instructions	Disconnect EtherCAT Slave • EC_DisconnectSlave Connect EtherCAT Slave • EC_ConnectSlave		

Variable name	_EC_PktMonStop				
Meaning	Packet Monitoring Stopped			Global/local	Global
Function	TRUE when packet monitoring is stopped.				
Data type	BOOL			Range of values	TRUE or FALSE
R/W access	R	Retained	Not retained.	Network Publish	Published.
Usage in user program	Possible.	Related instructions	Stop Packet Monitor • EC_StopMon Start Packet Monitor • EC_StartMon		

Variable name	_EC_LinkStatus				
Meaning	Link Status			Global/local	Global
Function	TRUE if the communications controller link status is Link ON.				
Data type	BOOL			Range of values	TRUE or FALSE
R/W access	R	Retained	Not retained.	Network Publish	Published.
Usage in user program	Possible.	Related instructions	---		

Variable name	_EC_PktSaving				
Meaning	Saving Packet Data File			Global/local	Global
Function	Shows whether a packet data file is being saved. TRUE: Packet data file being saved. FALSE: Packet data file not being saved.				
Data type	BOOL			Range of values	TRUE or FALSE
R/W access	R	Retained	Not retained.	Network Publish	Published.
Usage in user program	Possible.	Related instructions	Saving Packet Data File • EC_SaveMon		

Variable name	_EC_InDataInvalid				
Meaning	Input Data Invalid			Global/local	Global
Function	TRUE when process data communications are not normal and the input data is not valid.				
Data type	BOOL			Range of values	TRUE or FALSE
R/W access	R	Retained	Not retained.	Network Publish	Published.
Usage in user program	Possible.	Related instructions	---		

Note All system-defined variables that are related to the status of EtherCAT communications give the current status.

8

Example of Operations for EtherCAT Communications

This section provides a series of example operations for when an NJ-series CPU Unit is connected to slaves.

8-1 Example of Operations for EtherCAT Communications 8-2

8-1-1 System Configuration Example 8-2

8-1-2 Wiring and Settings 8-2

8-1-3 Setting the EtherCAT Network Configuration 8-3

8-1-4 Programming 8-4

8-1-5 Offline Debugging 8-5

8-1-6 Turning the Power ON 8-5

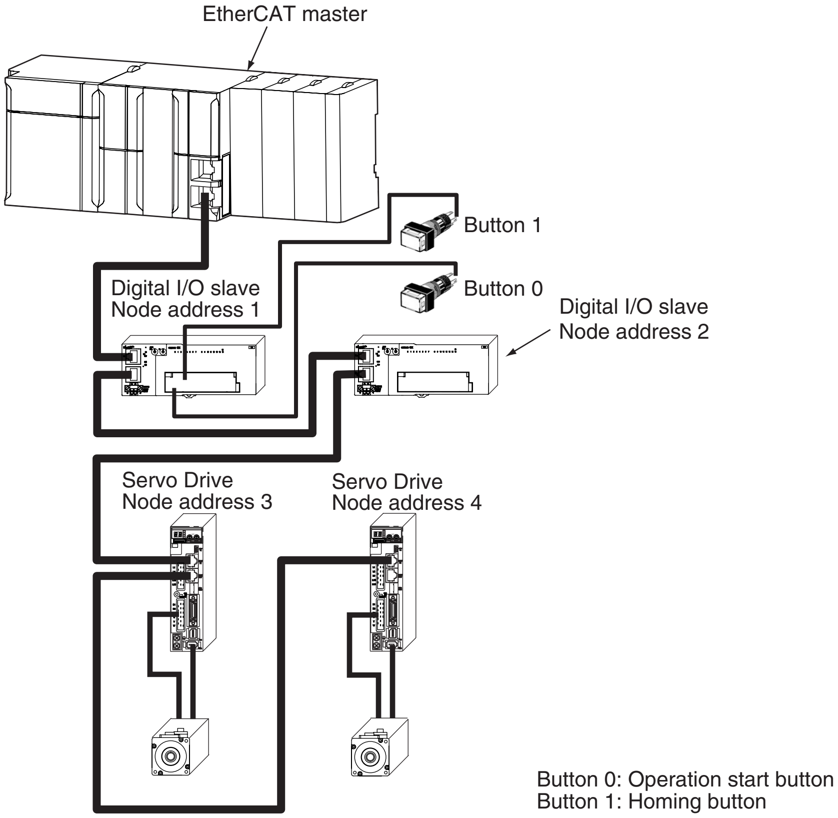
8-1-7 Online Debugging 8-5

8-1-8 Downloading the Network Configuration Information and the User Program . 8-5

8-1-9 Confirming the Start of Communications 8-5

8-1 Example of Operations for EtherCAT Communications

8-1-1 System Configuration Example



There are no restrictions on the order of node addresses.

8-1-2 Wiring and Settings

Wiring

- Install the NJ-series CPU Unit and slaves.
- Connect communications cables to the EtherCAT master and slaves.
- Connect the power supply.

Settings

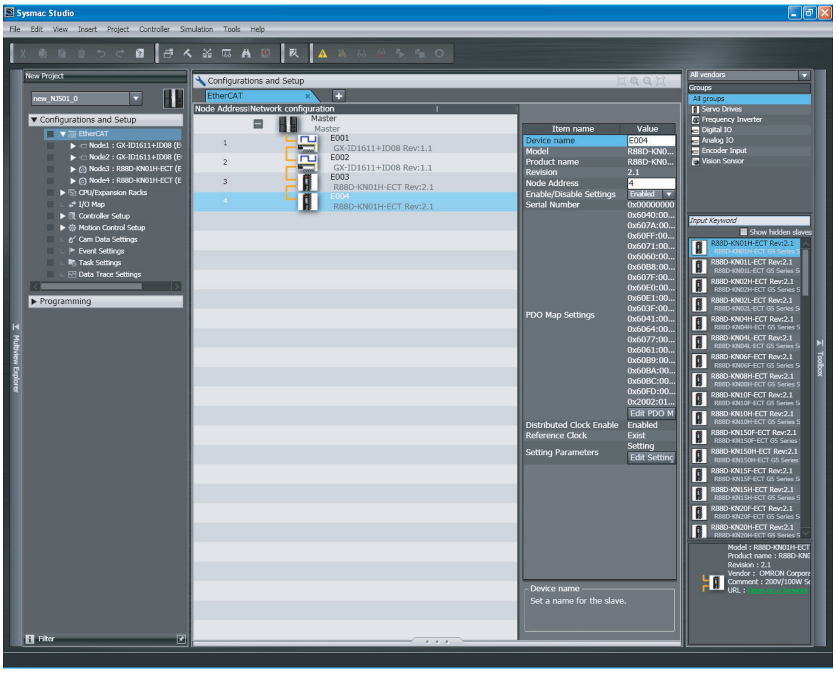
- Set the node address for each slave.

8-1-3 Setting the EtherCAT Network Configuration

Start the Sysmac Studio and make the following settings.

● Creating the EtherCAT Network Configuration

Use the EtherCAT Configuration Editor to create the slave configuration.



Node Address	Network configuration
	Master Master
1	E001 GX-ID1611+ID08 Rev:1.1
2	E002 GX-ID1611+ID08 Rev:1.1
3	E003 R88D-KN01H-ECT Rev:2.1
4	E004 R88D-KN01H-ECT Rev:2.1

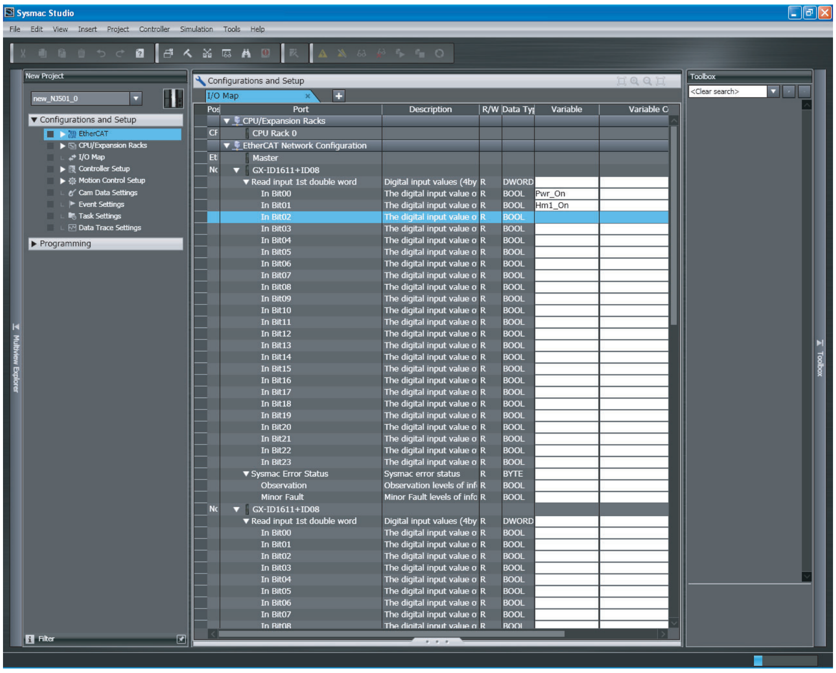
Item name	Value
Device name	E004
Model	R88D-KN0...
Product name	R88D-KN0...
Revision	2.1
Node Address	4
Enable/Disable Settings	Enabled
Serial Number	0x00000000
PDO Map Settings	0x6040:00... 0x607A:00... 0x60FF:00... 0x6071:00... 0x6060:00... 0x60B8:00... 0x607F:00... 0x60E0:00... 0x60E1:00... 0x603F:00... 0x6041:00... 0x6064:00... 0x6077:00... 0x6061:00... 0x60B9:00... 0x60BA:00... 0x60BC:00... 0x60FD:00... 0x2002:01... Edit PDO M
Distributed Clock Enable	Enabled
Reference Clock	Exist
Setting Parameters	Setting Edit Setting

Device name
Set a name for the slave.

In this example, digital I/O slaves are set to node addresses 1 and 2 and Servo Drives are set to node addresses 3 and 4.

● Assigning Device Variables to Digital I/O Slaves (Node Addresses 1 and 2)

Use the I/O Map to assign device variables to the I/O ports of the slaves.



Pos	Port	Description	R/W	Data Typ	Variable	Variable C
	▼ CPU/Expansion Racks					
CF	CPU Rack 0					
	▼ EtherCAT Network Configuration					
Et	Master					
Nc	▼ GX-ID1611+ID08					
	▼ Read input 1st double word	Digital input values (4by	R	DWORD		
	In Bit00	The digital input value o	R	BOOL	Pwr_On	
	In Bit01	The digital input value o	R	BOOL	Hm1_On	
	In Bit02	The digital input value o	R	BOOL		
	In Bit03	The digital input value o	R	BOOL		
	In Bit04	The digital input value o	R	BOOL		
	In Bit05	The digital input value o	R	BOOL		
	In Bit06	The digital input value o	R	BOOL		
	In Bit07	The digital input value o	R	BOOL		
	In Bit08	The digital input value o	R	BOOL		
	In Bit09	The digital input value o	R	BOOL		
	In Bit10	The digital input value o	R	BOOL		
	In Bit11	The digital input value o	R	BOOL		
	In Bit12	The digital input value o	R	BOOL		
	In Bit13	The digital input value o	R	BOOL		
	In Bit14	The digital input value o	R	BOOL		
	In Bit15	The digital input value o	R	BOOL		
	In Bit16	The digital input value o	R	BOOL		
	In Bit17	The digital input value o	R	BOOL		
	In Bit18	The digital input value o	R	BOOL		
	In Bit19	The digital input value o	R	BOOL		
	In Bit20	The digital input value o	R	BOOL		
	In Bit21	The digital input value o	R	BOOL		
	In Bit22	The digital input value o	R	BOOL		
	In Bit23	The digital input value o	R	BOOL		
	▼ Sysmac Error Status	Sysmac error status	R	BYTE		
	Observation	Observation levels of inf	R	BOOL		
	Minor Fault	Minor Fault levels of info	R	BOOL		
Nc	▼ GX-ID1611+ID08					
	▼ Read input 1st double word	Digital input values (4by	R	DWORD		
	In Bit00	The digital input value o	R	BOOL		
	In Bit01	The digital input value o	R	BOOL		
	In Bit02	The digital input value o	R	BOOL		
	In Bit03	The digital input value o	R	BOOL		
	In Bit04	The digital input value o	R	BOOL		
	In Bit05	The digital input value o	R	BOOL		
	In Bit06	The digital input value o	R	BOOL		
	In Bit07	The digital input value o	R	BOOL		
	In Bit08	The digital input value o	R	BOOL		

In this example, *Pwr_On* is assigned to bit 0 of slave 1 and *Hm1_On* is assigned to bit 1 of slave 1.

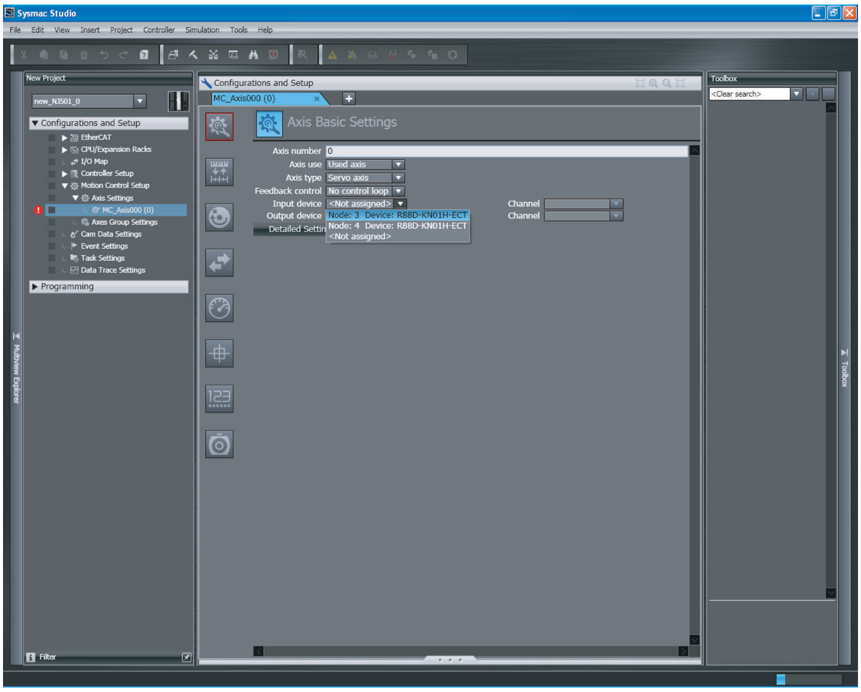
8-1 Example of Operations for EtherCAT Communications

8

8-1-3 Setting the EtherCAT Network Configuration

● Axis Settings for the Servo Drives (Node Addresses 3 and 4)

Add an axis to the Motion Control Setup and then assign the Servo Drive with node address 3 to the axis to set the axis.



Axis Basic Settings

Axis number: 0
Axis use: Used axis
Axis type: Servo axis
Feedback control: No control loop
Input device: <Not assigned>
Output device:
Node: 3 Device: R88D-KN01H-ECT
Node: 4 Device: R88D-KN01H-ECT
<Not assigned>
Channel
Channel
Detailed Settin

In the same way, add an axis and assign the Servo Drive with node address 4 to it.

● Setting EtherCAT Master Parameters

Set the parameters for the EtherCAT master from the EtherCAT master settings.

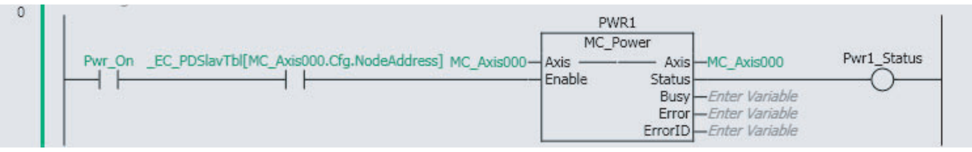
● Setting Slave Parameters

Set the slave parameters from the EtherCAT configuration slave settings. If a communications error prevents the slaves from receiving signals from the EtherCAT master, the slave settings will control the slave outputs.

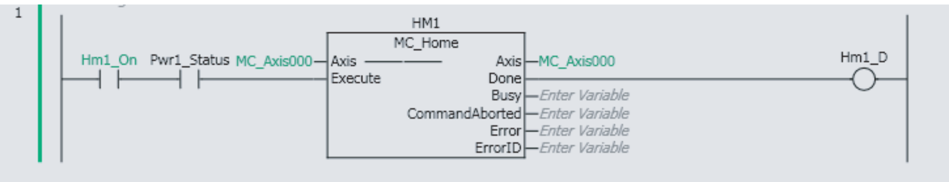
8-1-4 Programming

● Programming

When the operation start button is pressed, the Pwr_On variable changes to TRUE and axis control is enabled. (See rung 0.)



When the homing button is pressed, the *Hm1_On* variable changes to TRUE and homing is performed. (See rung 1.)



● Program Assignments

The Program Assignments are used to assign the programs to tasks and set the program execution order.

8-1-5 Offline Debugging

You can use the Simulator to check the program and task execution times with offline debugging.

8-1-6 Turning the Power ON

Turn ON the following power supplies.

- Slave unit power supply (The PWR indicator on the slave will light when the power supply turns ON.)
- Slave I/O power supply
- NJ-series Controller power supply

8-1-7 Online Debugging

Compare and merge the network configuration that was set on the Sysmac Studio and the actual configuration.

8-1-8 Downloading the Network Configuration Information and the User Program

Download the network configuration information and the user program that were created on the Sysmac Studio to the NJ-series Controller.

Note Use the synchronization operation of the Sysmac Studio to download the data.

8-1-9 Confirming the Start of Communications

Check to make sure that all registered slaves are participating in the network and that communications start.

Make sure that the master indicators are in the following status.

NET RUN indicator	Lit
NET ERR indicator	Not lit
LINK/ACT indicator (physical layer LINK)	Flashing

Make sure that the status indicators on all slaves are in the following status.

PWR indicator	Lit
RUN indicator	Lit
ERR indicator	Not lit
L/A IN (physical layer LINK inputs)	Flashing
L/A OUT (physical layer LINK outputs)	Flashing (Not lit on the last slave.)

Troubleshooting

This section describes the event codes, error confirmation methods, and corrections for errors that can occur for EtherCAT communications. It also describes how to replace slaves.

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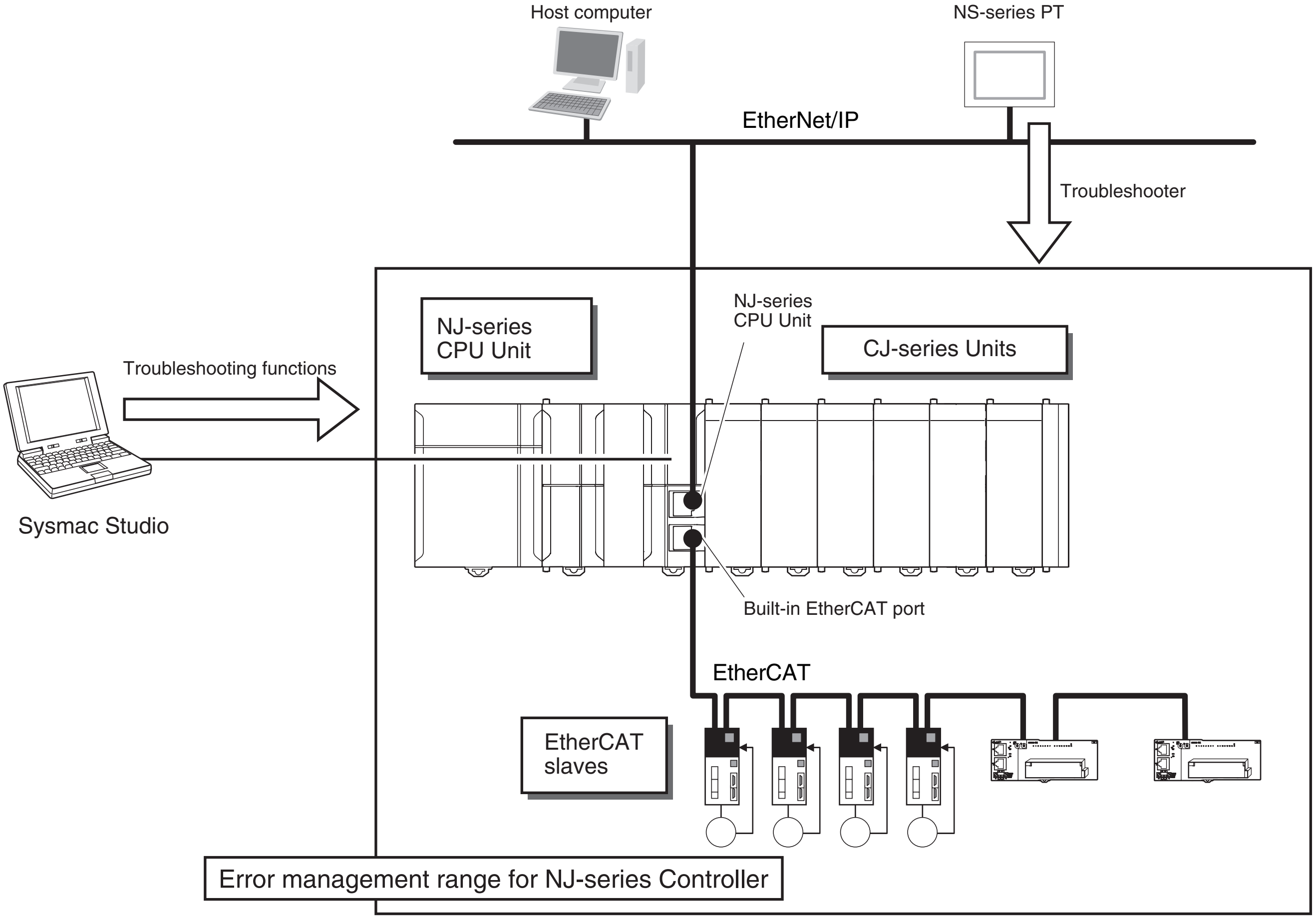
9-1 Overview of Errors

You manage all of the errors that occur on the NJ-series Controller as events. The same methods are used for all events. This allows you to see what errors have occurred and find corrections for them with the same methods for the entire range of errors that is managed (i.e., CPU Unit, EtherCAT slaves,* and CJ-series Units).

* The EtherCAT slaves (Sysmac devices) must support NJ-series error management.



You can use the troubleshooting functions of the Sysmac Studio or the Troubleshooter on an NS-series PT to quickly check for errors that have occurred and find corrections for them.

This manual describes the errors that originate in the EtherCAT Master Function Module. Refer to the *NJ-series Troubleshooting Manual* (Cat. No. W503) for specific corrections when errors occur and for troubleshooting information on the entire NJ-series Controller.

9-1-1 How to Check for Errors

You can check to see if an error has occurred with the following methods.

Checking method	What you can check
Checking the indicators	You can check the error status of the CPU Unit and EtherCAT Master Function Module.
Troubleshooter of the Sysmac Studio	You can check for current Controller errors, a log of past Controller errors, error sources, error causes, and corrections.
Checking with the Troubleshooter of an NS-series PT	You can check for current Controller errors, a log of past Controller errors, error sources, causes, and corrections.
Checking with instructions that read function module error status	You can check the highest-level status and highest-level event code in the current Controller errors.
Checking with system-defined variables	You can check the current Controller error status for each function module.

This section describes the above checking methods.

Checking the Indicators

- **CPU Unit Operating Status**

You can use the PWR indicator on the Power Supply Unit and the RUN and ERROR indicators on the CPU Unit to determine the event level for an error. The following table shows the relationship between the Controller's indicators and the event level.

Indicators			CPU Unit operating status	Error confirmation with the Sysmac Studio or an NS-series PT
PWR	RUN	ERROR		
Not lit	Not lit	Not lit	Power Supply Error	Not possible: Refer to the *NJ-series Troubleshooting Manual* (Cat. No. W503).
Lit	Not lit	Not lit	CPU Unit Reset*1	
Lit	Flashing	Lit	Incorrect Power Supply Unit Connected	
Lit	Not lit	Lit	CPU Unit Watchdog Timer Error*2	
Lit	Not lit	Lit	Major fault level	Possible: Connect the Sysmac Studio or an NS-series PT and check the cause of and correction for the error in the troubleshooting functions of the Sysmac Studio or the Troubleshooter of the NS-series PT.
Lit	Lit	Flashing	Partial fault level*2	
Lit	Lit	Flashing	Minor fault level	
Lit	Lit	Not lit	Observation	
Lit	Lit	Not lit	Normal operation in RUN mode	---
Lit	Not lit	Not lit	Normal operation in PROGRAM mode*1	---
Lit	Flashing	Not lit	Normal operation in startup state	---

*1 If you can connect communications to the CPU Unit from the Sysmac Studio with a direct connection via USB, the CPU Unit is in PROGRAM mode. If you cannot connect communications, the CPU Unit is being reset.*3

*2 If you can connect communications to the CPU Unit from the Sysmac Studio with a direct connection via USB, a major fault level error has occurred. If you cannot connect communications, a watchdog timer error has occurred in the CPU Unit.*3

*3 If you cannot connect communications to the CPU Unit from the Sysmac Studio, it is also possible that the USB cable is faulty or that the connection type on the Sysmac Studio is not set for a direct connection via USB. Refer to the *NJ-series Troubleshooting Manual* (Cat. No. W503) if you cannot connect communications to the CPU Unit.

● EtherCAT Master Function Module Error Status

If the EtherCAT NET ERR indicator is also lit in addition to the PWR, RUN, and ERROR indicators, then an error in the minor fault level or a higher level has occurred in the EtherCAT Master Function Module. The indicator lets you check the status given in the following table.

Indicator	Indicated status
EtherCAT NET ERR	EtherCAT Master Function Module Status • Lit: An error for which normal status cannot be recovered through user actions (i.e., errors for which you must replace the CPU Unit or contact your OMRON representative) has occurred. • Flashing: An error for which normal status can be recovered through user actions has occurred. • Not lit: There is no minor fault level or higher-level error.

Checking with the Troubleshooting Function of Sysmac Studio

When an error occurs, you can connect the Sysmac Studio online to the Controller to check current Controller errors and the log of past Controller errors. You can also check the cause of the error and corrections.

Refer to the *NJ-series Troubleshooting Manual* (Cat. No. W503) for the procedures to check for errors with the Sysmac Studio.

Checking with the Troubleshooter of an NS-series PT

If you can connect communications between an NS-series PT and the Controller when an error occurs, you can check for current Controller errors and the log of past Controller errors. You can also check the cause of the error and corrections.

Refer to the *NJ-series Troubleshooting Manual* (Cat. No. W503) for the procedures to check for errors with an NS-series PT.

Checking with Instructions That Read Error Status

You can use instructions in the user program to check the error status of each function module. The following instruction is used to read the error status of the EtherCAT Master Function Module.

Instruction	Name	Outline of function
GetECError	Get EtherCAT Error Status	The GetECError instruction gets the highest level status (partial fault or minor fault) and highest level event code of the current Controller errors in the EtherCAT Master Function Module.

For details on the instructions that get error status, refer to the *NJ-series Instructions Reference Manual* (Cat. No. W502).

Checking with System-defined Variables

You can use system-defined variables to check for errors in the EtherCAT Master Function Module.

● Error Status Variables

You can check for errors in each function module of the NJ-series Controller with error status variables. The following variables show the error status of the EtherCAT Master Function Module.

Variable name	Data type	Meaning	Function
_EC_ErrSta	WORD	Built-in EtherCAT Error	Gives the collective error status of all error status for the EtherCAT Master Function Module.
_EC_PortErr	WORD	Communications Port Error	Gives the collective error status of all error status for the EtherCAT communications port.
_EC_MstrErr	WORD	Master Error	Gives the collective error status of the EtherCAT master error status and slave error status detected by the EtherCAT master.
_EC_SlavErr	WORD	Slave Error	Gives the collective error status of the error status for all EtherCAT slaves.
_EC_SlavErrTbl	ARRAY[1..192] OF WORD	Slave Error Table	Gives the error status for each EtherCAT slave.

The meanings of the individual bits in the above error status variables are given below.

Bit	Name	Description	Value	Meaning
15	Master Detection[*1]	This bit indicates whether the master detected an error in the slaves that it manages.	TRUE	Error
			FALSE	No error
14	Slave Summary[*2]	Indicates whether there is an error at a level below the function module.	TRUE	Error
			FALSE	No error
8 to 13	Not used.			
7	Major Fault	Indicates if there is a major fault level error.	TRUE	Error
			FALSE	No error
6	Partial Fault	Indicates if there is a partial fault level error.	TRUE	Error
			FALSE	No error
5	Minor Fault	Indicates if there is a minor fault level error.	TRUE	Error
			FALSE	No error
4	Observation	Indicates if there is an observation level error.	TRUE	Error
			FALSE	No error
0 to 3	Not used.			

[*1] For the EtherCAT Master Function Module, only *_EC_SlavErrTbl* (Slave Error Table) is used.

[*2] For the EtherCAT Master Function Module, only *_EC_ErrSta* (Built-in EtherCAT Error) is used.

● Other System-defined Variables Related to Errors

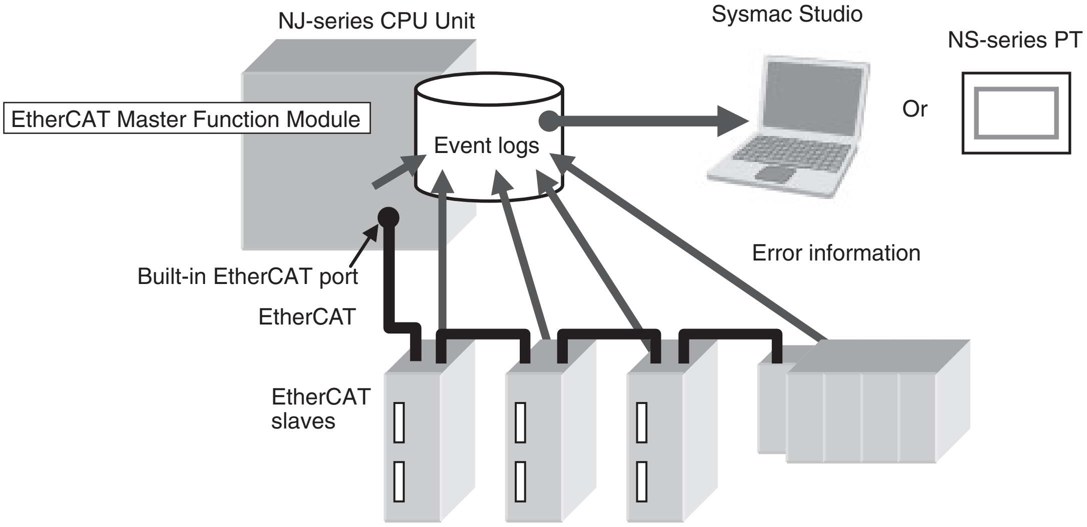
For the EtherCAT Master Function Module, there are other system-defined variables that show error status in addition to the error status variables. Refer to *7-1-2 System-defined Variables* for system-defined variables that are related to errors.

9-1-2 Errors Related to the EtherCAT Master Function Module

This section describes the errors that are related to the EtherCAT Master Function Module.

Locations of Errors in the EtherCAT Master Function Module

Errors can occur internally in the EtherCAT Master Function Module, or they can occur in the built-in EtherCAT port or in EtherCAT slaves.



Additional Information

If any one of the following errors occurs at the same time for more than one slave, only the error for the slave that is closest to the master is recorded in the event log. The same error is not recorded in the event log for slaves that are connected further from the master.

- Network Configuration Verification Error
- Process Data Communications Errors (when caused by a disconnected cable)
- Slave Node Address Duplicated
- Slave Initialization Error

Classifications

There are the following three sources of errors in the EtherCAT Master Function Module.

Classification	Description
Communications port errors	If an error is detected in overall EtherCAT communications, the corresponding bit in the Communications Port Error status variable shows the error.
EtherCAT master errors	If the EtherCAT master detects an error in its own settings or processing, the corresponding bit in the Master Error status variable shows the error. If the EtherCAT master detects an error in a slave, the corresponding bit in the Master Error status variable shows the error.
EtherCAT slave errors	If the EtherCAT master detects an error in a slave, the error status for the slave will show that the master detected an error.[*1][*2]

[*1] The EtherCAT master periodically reads error status information from the slaves. It updates the system-defined variables at the same time as the I/O data.

[*2] The EtherCAT master will set the bits for EtherCAT slaves that do not report error status to FALSE in the Slave Error Table.

Event Levels

This section describes the operation of the EtherCAT Master Function Module for each event level.

Event level of the error	Operation
Major fault	All NJ-series Controller control operations stop for errors in this event level.
Partial fault	All control operations for one of the function modules in the NJ-series Controller stop for errors in this event level. If a partial fault level error occurs in the EtherCAT Master Function Module, all functions of the EtherCAT Master Function Module stop.
Minor fault	Some of the control operations for one of the function modules in the NJ-series Controller stop for errors in this event level. If a minor fault level error occurs for the EtherCAT Master Function Module, EtherCAT communications are possible, but control may be affected. User action is required.
Observation	Errors in the observation level do not affect NJ-series Controller control operations. Observations are reported in order to prevent them from developing into errors at the minor fault level or higher.
Information	Events that are classified as information provide information that do not indicate errors.

EtherCAT Master Function Module Errors by Source

The following tables list the errors in each event level that can occur for each source.

Source Level	Communications port	EtherCAT master	EtherCAT slaves
Major fault	• User Program/Controller Configurations and Setup Transfer Errors (No Source Classification)		
Partial fault	• Communications Controller Error • MAC Address Error	• EtherCAT Processing Error	• None
Minor fault	• Link OFF Error	• Network Configuration Information Error • Network Configuration Verification Error • Network Configuration Error • Process Data Reception Timeout Error • Process Data Transmission Error • Slave Node Address Duplicated • Slave Initialization Error	• Network Configuration Verification Error • Process Data Communications Error • Slave Node Address Duplicated • Slave Initialization Error • Slave Application Error
Observation	• None	• EtherCAT Message Error	• Emergency Message Detected
Information	• None	• Errors Reset	• Slave Disconnected • Slave Connected

* Slave errors that are detected by the master are listed. There will also be a master error if any of these errors occurs. For slave errors that are not detected by the master, the errors and levels are defined by the individual slaves. Refer to the manual for the slave.

9-2 Troubleshooting

This section describes the errors that can occur and the corrections for them.

9-2-1 Error Table

The errors (i.e., events) that can occur in the Built-in EtherCAT Master Function Module are given on the following pages. Event levels are given as following in the tables:

Maj: Major fault level

Par: Partial fault level

Min: Minor fault level

Obs: Observation

Info: Information

Refer to *9-2-2 Error Descriptions* for details on individual errors.

Refer to the *NJ-series Troubleshooting Manual* (Cat. No. W503) for all of the event codes that may occur in an NJ-series Controller.

Event code	Event name	Meaning	Assumed cause	Level					Reference
				Maj	Prt	Min	Obs	Info	
10200000 hex	User Program/Controller Configurations and Setup Transfer Error	The user program or Controller Configurations and Setup were not transferred correctly.	• The program or the Controller Configrations and Setup is illegal because the power supply to the Controller was interrupted or communications with the Sysmac Studio were disconnected while downloading the user program or the Controller Configurations and Setup. • The program or the Controller Configrations and Setup is illegal because the power supply to the Controller was interrupted or communications with the Sysmac Studio were disconnected during online editing. • The user program or Controller Configurations and Setup are not correct because the power supply to the Controller was interrupted during a Clear All Memory operation. • Non-volatile memory failed.	√					page 9-12
04400000 hex	Communications Controller Failure	An error was detected in the hardware test at startup.	• The CPU Unit has failed.		√				page 9-13
14400000 hex	MAC Address Error	The MAC address is incorrect.	• The CPU Unit has failed.		√				page 9-13
44010000 hex	EtherCAT Fault	A fatal error was detected in the EtherCAT Master Function Module.	• Software is corrupted.		√				page 9-14

Event code	Event name	Meaning	Assumed cause	Level					Reference
				Maj	Prt	Min	Obs	Info	
24200000 hex	Slave Node Address Duplicated	The same slave address is used for two nodes.	• The same node address is set for more than one slave.			√			page 9-15
34400000 hex	Network Configuration Information Error	There is an error in the network configuration information.	• The power supply to the Controller was interrupted or communications with the Sysmac Studio were disconnected while downloading the network configuration information.			√			page 9-16
84200000 hex	Link OFF Error	A Link OFF state occurred.	• The Ethernet cable is broken between the master and slaves. • The Ethernet cable connector is disconnected. • The Ethernet cable is not connected.			√			page 9-17
84210000 hex	Network Configuration Error	The EtherCAT network configuration is incorrect.	• Slave output ports are connected to each other. • The master and slave are connected with the slave output port. • The number of connected slaves exceeded the maximum number of slaves, 192 nodes, for the EtherCAT master.			√			page 9-18
842200000 hex	Network Configuration Verification Error	A slave that is in the network configuration information is not connected. Or, a slave that is not in the network configuration information is connected.	• A slave that is in the network configuration information is not connected. • There is a node address mismatch. • A different slave from the one that is specified in the network configuration information is connected. • A slave that is not in the network configuration information is connected. • The Ethernet physical layer is broken between two slaves.			√			page 9-19
84230000 hex	Slave Initialization Error	Slave initialization failed.	• An error occurred in EtherCAT master processing. • An initialization error occurred in the EtherCAT slave.			√			page 9-20
84280000 hex	Slave Application Error	An error occurred in the slave application.	• An error was detected in the slave's application layer status register.			√			page 9-21
84290000 hex	Process Data Transmission Error	Sending process data failed.	• It was not possible to send the EtherCAT frame during the EtherCAT communications period. • The frame transmission jitter exceeded the limit.			√			page 9-22

Event code	Event name	Meaning	Assumed cause	Level					Reference
				Maj	Prt	Min	Obs	Info	
842B0000 hex	Process Data Reception Timeout	Process data reception timed out.	• The Ethernet cable is broken. • The Ethernet cable for EtherCAT is disconnected. • A general-purpose Ethernet hub is connected. • The master failed. • The slave failed. • The Ethernet cable is too long. • The CPU Unit task period is too short. • Noise			√			page 9-23
842C0000 hex	Process Data Communications Error	An error occurred in process data communications.	• A slave left the network even though the disconnection operation was not performed. • Noise • The slave failed.			√			page 9-24
64200000 hex	Emergency Message Detected	An emergency message was detected.	• An emergency message was received from a slave.				√		page 9-25
842D0000 hex	EtherCAT Message Error	An error occurred in a message communications with the slave.	• Refer to the attached information to check the error.				√		page 9-25
94400000 hex	Slave Disconnected	A slave was disconnected for a disconnection command.	• An operation to disconnect the slave was executed from the Sysmac Studio. • The EC_DisconnectSlave instruction was executed.					√	page 9-26
94410000 hex	Slave Connected	A slave was reconnected for a reconnection command.	• An operation to reconnect the slave was executed from the Sysmac Studio. • The EC_ConnectSlave instruction was executed.					√	page 9-27
94430000 hex	Errors Reset	A command was received to reset errors.	• An error reset operation was performed from the Sysmac Studio. • The ResetECError instruction was executed.					√	page 9-28

9-2-2 Error Descriptions

This section describes the information that is given for individual errors.

Controller Error Descriptions

The items that are used to describe individual errors (events) are described in the following copy of an error table.

Event name	Gives the name of the error.			Event code	Gives the code of the error.	
Meaning	Gives a short description of the error.					
Source	Gives the source of the error.		Source details	Gives details on the source of the error.	Detection timing	Tells when the error is detected.
Error attributes	Level	Tells the level of influence on control.*1	Recovery	Gives the recovery method.*2	Log category	Tells which log the error is saved in.*3
Effects	User program	Tells what will happen to execution of the user program.*4	Operation	Provides special information on the operation that results from the error.		
Indicators	Gives the status of the built-in EtherNet/IP port and built-in EtherCAT port indicators. Indicator status is given only for errors in the EtherCAT Master Function Module and the EtherNet/IP Function Module.					
System-defined variables	Variable		Data type		Name	
	Lists the variable names, data types, and meanings for system-defined variables that provide direct error notification, that are directly affected by the error, or that contain settings that cause the error.					
Cause and correction	Assumed cause		Correction		Prevention	
	Lists the possible causes, corrections, and preventive measures for the error.					
Attached information	This is the attached information that is displayed by the Sysmac Studio or an NS-series PT.					
Precautions/ Remarks	Provides precautions, restrictions, and supplemental information.					

*1 One of the following:
Major fault: Major fault level
Partial fault: Partial fault level
Minor fault: Minor fault level
Observation
Information

*2 One of the following:
Automatic recovery: Normal status is restored automatically when the cause of the error is removed.
Error reset: Normal status is restored when the error is reset after the cause of the error is removed.
Cycle the power supply: Normal status is restored when the power supply to the Controller is turned OFF and then back ON after the cause of the error is removed.
Controller reset: Normal status is restored when the Controller is reset after the cause of the error is removed.
Depends on cause: The recovery method depends on the cause of the error.

*3 One of the following:
System: System event log
Access: Access event log

*4 One of the following:
Continues: Execution of the user program will continue.
Stops: Execution of the user program stops.
Starts: Execution of the user program starts.

Errors Related to Tasks

Event name	User Program/Controller Configurations and Setup Transfer Error			Event code	10200000 hex	
Meaning	The user program or Controller Configurations and Setup were not transferred correctly.					
Source	PLC Function Module Motion Control Function Module EtherCAT Master Function Module EtherNet/IP Function Module		Source details	None	Detection timing	At power ON or Controller reset
Error attributes	Level	Major fault	Recovery	Cycle the power supply or reset the Controller.	Log category	System
Effects	User program	Stops.	Operation	All outputs are stopped.		
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Correction		Prevention	
	The user program or Controller Configurations and Setup are not correct because the power supply to the Controller was interrupted or communications with the Sysmac Studio were disconnected during a download of the user program or the Controller Configurations and Setup.		Clear all of memory and then download the project from the Sysmac Studio. If attached information is registered, cycle the power supply to the Controller and then implement the above correction.		Do not turn OFF the power supply to the Controller or disconnect communications with the Sysmac Studio during a download of the user program or the Controller Configurations and Setup.	
	The user program or Controller Configurations and Setup are not correct because the power supply to the Controller was interrupted during online editing.				Do not interrupt the power supply to the Controller during online editing.	
	The user program or Controller Configurations and Setup are not correct because the power supply to the Controller was interrupted during a Clear All Memory operation.				Do not interrupt the power supply to the Controller during a Clear All Memory operation.	
	Non-volatile memory failed.		If the error persists even after you make the above correction, replace the CPU Unit.		None	
Attached information	Attached Information 1: Cause Details None: Power was interrupted or communications were disconnected during a download or power was interrupted during online editing. Downloading/Predownloading: For other causes, the timing of error occurrence (during download or during download preparations) is given.					
Precautions/ Remarks	None					

Event name	Communications Controller Failure			Event code	04400000 hex	
Meaning	An error was detected in the hardware test at startup.					
Source	Built-in EtherCAT port		Source details	Communications port	Detection timing	At power ON or Controller reset
Error attributes	Level	Partial fault	Recovery	Cycle the power supply or reset the Controller.	Log category	System
Effects	User program	Continues.	Operation	Master: The master waits in the Init state. Slave: Parameter setting is not possible. Process data communications are not possible.		
Indicators	EtherCAT NET RUN		EtherCAT NET ERR		EtherCAT LINK/ACT	
	---		Lights.		---	
System-defined variables	Variable		Data type		Name	
	_EC_LanHwErr		BOOL		Communications Controller Error	
Cause and correction	Assumed cause		Correction		Prevention	
	The CPU Unit has failed.		Replace the CPU Unit.		None	
Attached information	None					
Precautions/ Remarks	None					

Event name	MAC Address Error			Event code	14400000 hex	
Meaning	The MAC address is incorrect.					
Source	EtherCAT Master Function Module		Source details	Communications port	Detection timing	At power ON or Controller reset
Error attributes	Level	Partial fault	Recovery	Cycle the power supply or reset the Controller.	Log category	System
Effects	User program	Continues.	Operation	Master: The master waits in the Init state. Slave: Parameter setting is not possible. Process data communications are not possible.		
Indicators	EtherCAT NET RUN		EtherCAT NET ERR		EtherCAT LINK/ACT	
	---		Lights.		---	
System-defined variables	Variable		Data type		Name	
	_EC_MacAdrErr		BOOL		MAC Address Error	
Cause and correction	Assumed cause		Correction		Prevention	
	The CPU Unit has failed.		Replace the CPU Unit.		None	
Attached information	None					
Precautions/ Remarks	None					

Event name	EtherCAT Fault			Event code	44010000 hex	
Meaning	A fatal error was detected in the EtherCAT Master Function Module.					
Source	EtherCAT Master Function Module		Source details	Master	Detection timing	During communications
Error attributes	Level	Partial fault	Recovery	Cycle the power supply or reset the Controller.	Log category	System
Effects	User program	Continues.	Operation	Master: The EtherCAT Master Function Module stops. Slave: Parameter setting is not possible. Process data communications are not possible. If the error occurred during synchronized communications between the master and slave, then the error occurred at the slave. The error is processed according to settings in the slave.		
Indicators	EtherCAT NET RUN		EtherCAT NET ERR		EtherCAT LINK/ACT	
	---		Lights.		---	
System-defined variables	Variable		Data type		Name	
	None		---		---	
Cause and correction	Assumed cause		Correction		Prevention	
	Software is corrupted.		Replace the CPU Unit.		None	
Attached information	Attached information 1: System information 1 Attached information 2: System information 2 Attached information 3: System information 3 Attached information 4: System information 4					
Precautions/ Remarks	None					

Event name	Slave Node Address Duplicated			Event code	24200000 hex	
Meaning	The same slave address is used for two nodes.					
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	At power ON, at Controller reset, or during communications
Error attributes	Level	Minor fault	Recovery	Error Reset	Log category	System
Effects	User program	Continues.	Operation	Master: • If error is detection when the master is started: Communications stop. The master waits in the Init state. • When the Fail-soft operation is set to *Fail-soft* and the error is detected during operation: Slaves that were normal continue to operate. Slaves after the new slave that caused the duplicated address error remain in the Init state. • When the Fail-soft operation is set to *Stop* and the error is detected during operation: The slaves that were normal enter the Pre-operational state. Slaves after the new slave that caused the duplicated address error remain in the Init state. Slave: • No error occurred. Parameters other than the node address cannot be set and process data communications cannot be performed for the new slave that caused the duplicated address error and all slaves after it.		
Indicators	EtherCAT NET RUN		EtherCAT NET ERR		EtherCAT LINK/ACT	
	---		Flashes at 1-s intervals.		---	
System-defined variables	Variable		Data type		Name	
	_EC_SlavAdrDupErr		BOOL		Duplicated Slave Node Address Error	
Cause and correction	Assumed cause		Correction		Prevention	
	The same node address is set for more than one slave.		Check the node address switch or node address set value of the slave, and change it to prevent address duplication.		Set the node address of the slave to prevent duplication.	
Attached information	None					
Precautions/ Remarks	The slave cannot be used unless the slave node address is set.					

Event name	Network Configuration Information Error			Event code	34400000 hex	
Meaning	There is an error in the network configuration information.					
Source	EtherCAT Master Function Module		Source details	Master	Detection timing	At power ON or Controller reset
Error attributes	Level	Minor fault	Recovery	Automatic recovery	Log category	System
Effects	User program	Continues.	Operation	Master: The master waits in the Init state. Slave: Parameter setting is not possible. Process data communications are not possible.		
Indicators	EtherCAT NET RUN		EtherCAT NET ERR		EtherCAT LINK/ACT	
	---		Flashes at 1-s intervals.		---	
System-defined variables	Variable		Data type		Name	
	_EC_NetCfgErr		BOOL		Network Configuration Information Error	
Cause and correction	Assumed cause		Correction		Prevention	
	The power supply to the Controller was interrupted or communications with the Sysmac Studio were disconnected while downloading the network configuration information.		Clear memory, set the network configuration information, and then save it in the master again.		Do not turn OFF the power supply to the Controller or disconnect communications with the Sysmac Studio while downloading the network configuration information.	
Attached information	Attached Information 1: Error Details (0001 hex: Illegal parameter, 0014 hex: Error opening file)					
Precautions/ Remarks	None					

Event name	Link OFF Error			Event code	84200000 hex	
Meaning	A Link OFF state occurred.					
Source	EtherCAT Master Function Module		Source details	Communications port	Detection timing	At power ON, at Controller reset, or during communications
Error attributes	Level	Minor fault	Recovery	Error Reset	Log category	System
Effects	User program	Continues.	Operation	Master: Other communications errors caused by this error are not detected. Slave: Parameter setting is not possible. Process data communications are not possible. If the error occurred during synchronized communications between the master and slave, then the error occurred at the slave. The error is processed according to settings in the slave.		
Indicators	EtherCAT NET RUN		EtherCAT NET ERR		EtherCAT LINK/ACT	
	---		Flashes at 1-s intervals.		---	
System-defined variables	Variable		Data type		Name	
	_EC_LinkOffErr		BOOL		Link OFF Error	
	_EC_LinkStatus		BOOL		Link Status	
Cause and correction	Assumed cause		Correction		Prevention	
	The Ethernet cable is broken between the master and slaves.		Check the Ethernet cable between the master and slave to see if they are damaged or disconnected and replace the cable if necessary.		Check the Ethernet cable to see if it is operating properly.	
	The Ethernet cable connector is disconnected.		Reconnect the connector and make sure it is mated correctly.		Confirm that the Ethernet cable is connected securely.	
	The Ethernet cable is not connected.		Confirm that all Ethernet cables are connected and connect any cables that are not connected.			
Attached information	None					
Precautions/ Remarks	None					

Event name	Network Configuration Error			Event code	84210000 hex	
Meaning	The EtherCAT network configuration is incorrect.					
Source	EtherCAT Master Function Module		Source details	Master	Detection timing	At power ON, at Controller reset, or during communications
Error attributes	Level	Minor fault	Recovery	Error Reset	Log category	System
Effects	User program	Continues.	Operation	Master: • When error is detected at power ON or Controller reset: All slaves remain in the Init state and communications stop. • When the error is detected during operation while Fail-soft operation is set to *Fail-soft*: The slaves that are normal continue to operate. If you are using distributed clocks to synchronize the slaves, a Synchronization Error may occur between the slaves. Slave: • No error occurred. • When error is detected at power ON or Controller reset: All slaves are initialized. Parameter setting is not possible. Process data communications are not possible. • When the Fail-soft operation is set to *Fail-soft* and the error is detected during operation: Process data communications are possible for the slaves that are normal. If you are using distributed clocks to synchronize the slaves and a Synchronization Error is detected, only input refreshing is enabled.		
Indicators	EtherCAT NET RUN		EtherCAT NET ERR		EtherCAT LINK/ACT	
	---		Flashes at 1-s intervals.		---	
System-defined variables	Variable		Data type		Name	
	_EC_NetTopologyErr		BOOL		Network Configuration Error	
Cause and correction	Assumed cause		Correction		Prevention	
	Slave output ports are connected to each other.		Correct the Ethernet cable connections.		Confirm that there are no incorrect Ethernet cable connections.	
	The master and slave are connected with the slave output port.					
	The number of connected slaves exceeded the maximum number of slaves, 192 nodes, for the EtherCAT master.		Disconnect unnecessary slaves and keep the number below the maximum number.		Confirm that no more than 192 nodes are connected to the EtherCAT network.	
Attached information	Error Details: 0000 hex: Too many slaves, 0001 hex: Incorrect connections, such as a ring connection					
Precautions/ Remarks	There are restrictions on the number of slave node addresses, and not on the number of slaves per se. This is because there are slaves, such as Junction Slaves, that use more than one node. Also, if 192 nodes are connected and an attempt is made to make a ring connection, a Too Many Slaves error (0000 hex) occurs.					

Event name	Network Configuration Verification Error			Event code	842200000 hex	
Meaning	A slave that is in the network configuration information is not connected. Or, a slave that is not in the network configuration information is connected.					
Source	EtherCAT Master Function Module		Source details	Master/Slave	Detection timing	At power ON, at Controller reset, or during communications
Error attributes	Level	Minor fault	Recovery	Error Reset	Log category	System
Effects	User program	Continues.	Operation	When Fail-soft Operation Is Set to *Fail-soft* Master: Slaves that are consistent with the network configuration information enter the Operational state. Slaves that are not consistent with the network configuration information and all subsequent slaves remain in Init state. Slave: Depends on the slave communications status. When Fail-soft Operation Is Set to *Stop* Master: All slaves remain in the Init state and operation stops. Slave: Init state		
Indicators	EtherCAT NET RUN		EtherCAT NET ERR		EtherCAT LINK/ACT	
	---		Flashes at 1-s intervals.		---	
System-defined variables	Variable		Data type		Name	
	_EC_NetCfgCmpErr		BOOL		Network Configuration Verification Error	
	When Inconsistencies Are Found in Verification _EC_CommErrTbl		Array [1..192] of BOOL		Communications Error Slave Table	
Cause and correction	Assumed cause		Correction		Prevention	
	A slave that is in the network configuration information is not connected.		Connect the slaves that are in the network configuration information. Or, connect the Sysmac Studio and set and save the network configuration information with the slave deleted in the master.		Set and save the network configuration information for the configuration actually connected in the master.	
	There is a node address mismatch.		Make the slave node address settings consistent with the network configuration information.			
	A different slave from the one that is specified in the network configuration information is connected.		Connect the slave that is specified in the network configuration information. Or, connect the Sysmac Studio and set and save the network configuration information with the correct slaves in the master.			
	A slave that is not in the network configuration information is connected.		Disconnect the slave that is not in the network configuration information from the network. Or, connect the Sysmac Studio and set and save the network configuration information with the slave added in the master.			
	The Ethernet physical layer is broken between two slaves.		In cases not caused by the above causes, confirm the location of the break in the Ethernet cable and replace the cable.		None	
Attached information	None					
Precautions/ Remarks	If you add check items in the options for network configuration verification, check whether the items match.					

Event name	Slave Initialization Error			Event code	84230000 hex	
Meaning	Slave initialization failed.					
Source	EtherCAT Master Function Module		Source details	Master/Slave	Detection timing	At power ON, Controller reset, or error reset
Error attributes	Level	Partial fault	Recovery	Error reset/hardware replacement	Log category	System
Effects	User program	Continues.	Operation	When Fail-soft Operation Is Set to *Fail-soft* Master: • When the master fails to enter Pre-operational state after initialization: Communications stop in the Init state at the slave where the error occurred. Slaves in topology up to the slave where the error occurred enter Operational state and continue to operate. • When the master fails to enter states after Pre-operational state: Only the slave where the error occurred enters the Init state and communications stop for it. The normal slaves enter the Operational state and continue to operate. Slave: This depends on the slave communications status. When Fail-soft Operation Is Set to *Stop* Master: • When the master fails to enter Pre-operational state after initialization: All slaves enter the Init state and communications stop. • When the master fails to enter states after Pre-operational state: All slaves enter the Pre-operational state and communications stop. Slave: This depends on the slave communications status.		
Indicators	EtherCAT NET RUN		EtherCAT NET ERR		EtherCAT LINK/ACT	
	---		Flashes at 1-s intervals.		---	
System-defined variables	Variable		Data type		Name	
	_EC_SlavInitErr		BOOL		Slave Initialization Error	
	_EC_CommErrTbl		Array [1..192] of BOOL		Communications Error Slave Table	
Cause and correction	Assumed cause		Correction		Prevention	
	An error occurred in EtherCAT master processing.		Connect the Sysmac Studio and reconfigure and save the network configuration information in the master again. If this error occurs again, check that there are no errors in the slave synchronization settings and the PDO mapping information, and correct any errors that are found.		Correctly set the slave synchronization settings, PDO mapping information, and configure and save network configuration information in the master.	
	An initialization error occurred in the EtherCAT slave.		Cycle the power supply to the EtherCAT slave. If this error persists, replace the EtherCAT slave.		None	
Attached information	None					
Precautions/ Remarks	None					

Event name	Slave Application Error			Event code	84280000 hex	
Meaning	An error occurred in the slave application.					
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	During communications
Error attributes	Level	Minor fault	Recovery	Error Reset	Log category	System
Effects	User program	Continues.	Operation	When Fail-soft Operation Is Set to *Fail-soft* Master: The slave communications status is not manipulated, but operation continues. The status of slaves with an application layer status error is also not manipulated. Slave: An error occurred. Operation is according to the state transition behavior of the slave where the error occurred. When Fail-soft Operation Is Set to *Stop* Master: All slaves enter the Pre-operational state when an application layer status error occurs. Slave: An error occurred. All slaves enter the Pre-operational state.		
Indicators	EtherCAT NET RUN		EtherCAT NET ERR		EtherCAT LINK/ACT	
	---		Flashes at 1-s intervals.		---	
System-defined variables	Variable		Data type		Name	
	_EC_SlavAppErr		BOOL		Slave Application Error	
	_EC_CommErrTbl		Array [1..192] of BOOL		Communications Error Slave Table	
Cause and correction	Assumed cause		Correction		Prevention	
	An error was detected in the slave's application layer status register.		Clear the error from the EtherCAT slave where the application error occurred. Use the procedure given in the slave documentation.		None	
Attached information	Attached Information 1: AL status code for the slave where the error was detected.					
Precautions/ Remarks	None					

Event name	Process Data Transmission Error			Event code	84290000 hex	
Meaning	Sending process data failed.					
Source	EtherCAT Master Function Module		Source details	Master	Detection timing	During communications
Error attributes	Level	Minor fault	Recovery	Error Reset	Log category	System
Effects	User program	Continues.	Operation	When Fail-soft Operation Is Set to *Fail-soft* Master: Operation continues. Slave: The error occurs only with synced slaves. When Fail-soft Operation Is Set to *Stop* Master: All slaves enter the Pre-operational state. Slave: Errors only occur in synced slaves.		
Indicators	EtherCAT NET RUN		EtherCAT NET ERR		EtherCAT LINK/ACT	
	---		Flashes at 1-s intervals.		---	
System-defined variables	Variable		Data type		Name	
	_EC_PDSendErr		BOOL		Process Data Transmission Error	
Cause and correction	Assumed cause		Correction		Prevention	
	It was not possible to send the EtherCAT frame during the EtherCAT communications period.		Connect the Sysmac Studio, increase the task period setting of the primary periodic task, and set and save the network configuration information in the EtherCAT master.		Set the task period of the primary periodic task to a value that provides sufficient processing time. Use the Simulator to check the necessary EtherCAT communications period.	
	The frame transmission jitter exceeded the limit.					
Attached information	Attached Information 1: Error Details (Frame generation was late for the transmission timing: 0000 hex, If the transmission jitter exceeds the limit of 10 µs: 0001 hex) Attached Information 2: Transmission jitter (ns): 0 to 4294967295					
Precautions/ Remarks	None					

Event name	Process Data Reception Timeout			Event code	842B0000 hex	
Meaning	Process data reception timed out.					
Source	EtherCAT Master Function Module		Source details	Master	Detection timing	During communications
Error attributes	Level	Minor fault	Recovery	Error reset	Log category	System
Effects	User program	Continues.	Operation	When Fail-soft Operation Is Set to *Fail-soft* Master: Operation continues. Slave: Errors only occur in synced slaves. Operational state continues. Safe-operational state is entered if the state transition is made at the slave. When Fail-soft Operation Is Set to *Stop* Master: All slaves enter the Pre-operational state. Slave: Errors only occur in synced slaves.		
Indicators	EtherCAT NET RUN		EtherCAT NET ERR		EtherCAT LINK/ACT	
	---		Flashes at 1-s intervals.		---	
System-defined variables	Variable		Data type		Name	
	_EC_PDTimeoutErr		BOOL		Process Data Reception Timeout	
Cause and correction	Assumed cause		Correction		Prevention	
	The Ethernet cable is broken.		The causes given on the left are possible if the error occurs from when the system starts operation or if it always occurs after a specific time after the system starts operation. If the Ethernet cable between the master and slave is broken, replace it. Or, reconnect the connector and make sure it is mated correctly. If a general-purpose Ethernet hub is connected, replace it with an EtherCAT Junction Slave. If the CPU Unit or an EtherCAT slave fails, replace it.		None	
	The Ethernet cable for EtherCAT is disconnected.				Confirm that the Ethernet cable connector is mated securely.	
	A general-purpose Ethernet hub is connected.				When branching an EtherCAT network, use an EtherCAT Junction Slave.	
	The master failed.				None	
	The slave failed.				None	
	The Ethernet cable is too long.		The causes given on the left are possible if the error occurs from when the system starts operation. If the Ethernet cable is too long, shorten it. If the error still occurs, connect the Sysmac Studio, increase the task period of the primary periodic task, and reconfigure the Controller.		Make the Ethernet cable as short as possible.	
	The CPU Unit task period is too short.				If there is a large number of EtherCAT slaves connected, increase the task period of the primary periodic task.	
	Noise		If this error occurs irregularly, implement noise countermeasures.		Implement noise countermeasures.	
Attached information	None					
Precautions/ Remarks	None					

<table>
<tr><td>Event name</td><td colspan="3">Process Data Communications Error</td><td>Event code</td><td colspan="2">842C0000 hex</td></tr>
<tr><td>Meaning</td><td colspan="6">An error occurred in process data communications.</td></tr>
<tr><td>Source</td><td colspan="2">EtherCAT Master Function Module</td><td>Source details</td><td>Slave</td><td>Detection timing</td><td>During communications</td></tr>
<tr><td>Error attributes</td><td>Level</td><td>Minor fault</td><td>Recovery</td><td>Error reset</td><td>Log category</td><td>System</td></tr>
<tr><td>Effects</td><td>User program</td><td>Continues.</td><td>Operation</td><td colspan="3">When Fail-soft Operation Is Set to *Fail-soft*
Master:
Operation continues.
Slave:
An error occurred. Operational state continues. If a PDI watchdog error occurs in a slave, the slave enters the Init state. Check for communications errors for each slave in system-defined variables *_EC_CommErrTbl [1]* to *_EC_CommErrTbl [192]*.

When Fail-soft Operation Is Set to *Stop*
Master:
All slaves enter the Pre-operational state.
Slave:
An error occurred. When operation stops, all slaves enter the Pre-operational state. If a PDI watchdog error occurs in a slave, the slave enters the Init state.</td></tr>
<tr><td rowspan="2">Indicators</td><td colspan="2">EtherCAT NET RUN</td><td colspan="2">EtherCAT NET ERR</td><td colspan="2">EtherCAT LINK/ACT</td></tr>
<tr><td colspan="2">---</td><td colspan="2">Flashes at 1-s intervals.</td><td colspan="2">---</td></tr>
<tr><td rowspan="4">System-defined variables</td><td colspan="2">Variable</td><td colspan="2">Data type</td><td colspan="2">Name</td></tr>
<tr><td colspan="2">_EC_PDCommErr</td><td colspan="2">BOOL</td><td colspan="2">Process Data Communications Error</td></tr>
<tr><td colspan="2">_EC_CommErrTbl</td><td colspan="2">Array [1..192] of BOOL</td><td colspan="2">Communications Error Slave Table</td></tr>
<tr><td colspan="2">_EC_PDActive</td><td colspan="2">BOOL</td><td colspan="2">Process Data Communications Status</td></tr>
<tr><td rowspan="4">Cause and correction</td><td colspan="2">Assumed cause</td><td colspan="2">Correction</td><td colspan="2">Prevention</td></tr>
<tr><td colspan="2">A slave left the network even though the disconnection operation was not performed.</td><td colspan="2">Perform the disconnection operation before removing the slave from the network. If the Ethernet cable is broken, replace it.</td><td colspan="2">Perform the disconnection operation before removing the slave from the network.</td></tr>
<tr><td colspan="2">Noise</td><td colspan="2">Implement noise countermeasures if there is excessive noise.</td><td colspan="2">Implement noise countermeasures if there is excessive noise.</td></tr>
<tr><td colspan="2">Moving Slaves</td><td colspan="2">If this error occurs again even after the above correction, replace the slave.</td><td colspan="2">None</td></tr>
<tr><td>Attached information</td><td colspan="6">Attached Information 1: Error Details (0001 hex: Slave WDT error, 0002 hex: Slave disconnected)</td></tr>
<tr><td>Precautions/ Remarks</td><td colspan="6">None</td></tr>
</table>

Event name	Emergency Message Detected			Event code	64200000 hex	
Meaning	An emergency message was detected.					
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	During communications
Error attributes	Level	Observation	Recovery	---	Log category	System
Effects	User program	Continues.	Operation	Slave: An error occurred. Other operation is not affected.		
Indicators	EtherCAT NET RUN		EtherCAT NET ERR		EtherCAT LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	_EC_SlavEmergErr		BOOL		Emergency Message Detected	
Cause and correction	Assumed cause		Correction		Prevention	
	An emergency message was received from a slave.		Clear the error from the EtherCAT slave where the application error occurred. Use the procedure given in the slave documentation.		Refer to the information given in the manual for the slave and implement countermeasures to prevent the problem.	
Attached information	Attached Information 1: Slave emergency code Attached information 2: Slave error register object value Attached Information 3: Slave emergency data. Only the lower five bytes are valid.					
Precautions/ Remarks	None					

Event name	EtherCAT Message Error			Event code	842D0000 hex	
Meaning	An error occurred in a message communications with the slave.					
Source	EtherCAT Master Function Module		Source details	Master	Detection timing	During communications
Error attributes	Level	Minor fault	Recovery	---	Log category	System
Effects	User program	Continues.	Operation	Slave: An error occurred. Other operation is not affected.		
Indicators	EtherCAT NET RUN		EtherCAT NET ERR		EtherCAT LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	_EC_MsgErr		BOOL		EtherCAT Message Error	
Cause and correction	Assumed cause		Correction		Prevention	
	Refer to the attached information to check the error.		Send messages only to slaves that support the message protocol. Identify the error message with the error details that are given in the attached information, and correct the message.		Use messages that match the slave specifications. Also check to make sure that messages are addressed to the correct node.	
Attached information	Attached Information 1: Error Details 1st byte: 00 hex: Error message reception, 02 hex: Illegal or unsupported message discarded 2nd byte: For Transmission: 00 hex: Error, 01 hex: VoE (AoE), 02 hex: EoE, 03 hex: CoE, 04 hex: FoE, 05 hex: SoE, 0F hex: VoE For Reception: 80 hex: Error, 81 hex: VoE (AoE), 82 hex: EoE, 83 hex: CoE, 84 hex: FoE, 85 hex: SoE, 8F hex: VoE, Attached information 2: Source node address. If the source is the master: 0 Attached Information 3: Transmission destination node address. If the destination is the master: 0 Attached information 4: Error service data. This data is valid only when byte 2 of attached information 1 is 00 or 80 hex.					
Precautions/ Remarks	None					

Event name	Slave Disconnected			Event code	94400000 hex	
Meaning	A slave was disconnected for a disconnection command.					
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	When slave disconnection is specified during communications
Error attributes	Level	Information	Recovery	---	Log category	System
Effects	User program	Continues.	Operation	Master: Process data communications are stopped for the slave and all slaves after it. Monitoring of topology changes is stopped for the slave and all slaves after it. Slave: The slave enters the Init state. You can back up and restore parameters with the Sysmac Studio. Process data communications are not possible.		
Indicators	EtherCAT NET RUN		EtherCAT NET ERR		EtherCAT LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	_EC_DisconnSlavTbl		Array [1..192] of BOOL		Disconnected Slave Table	
	_EC_PDSlavTbl		Array [1..192] of BOOL		Process Data Communicating Slave Table	
	_EC_MBXSlavTbl		Array [1..192] of BOOL		Message Communications Enabled Slave Table	
Cause and correction	Assumed cause		Correction		Prevention	
	An operation to disconnect the slave was executed from the Sysmac Studio.		---		---	
	The EC_DisconnectSlave instruction was executed.		---		---	
Attached information	None					
Precautions/ Remarks	None					

Event name	Slave Connected			Event code	94410000 hex	
Meaning	A slave was reconnected for a reconnection command.					
Source	EtherCAT Master Function Module		Source details	Slave	Detection timing	When slave reconnection is specified during communications
Error attributes	Level	Information	Recovery	---	Log category	System
Effects	User program	Continues.	Operation	Master: The slave enters the Operational state again, and process data communications restart. Slave: Enters Operational state.		
Indicators	EtherCAT NET RUN		EtherCAT NET ERR		EtherCAT LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	_EC_DisconnSlavTbl		Array [1..192] of BOOL		Disconnected Slave Table	
	_EC_PDSlavTbl		Array [1..192] of BOOL		Process Data Communicating Slave Table	
	_EC_MBXSlavTbl		Array [1..192] of BOOL		Message Communications Enabled Slave Table	
Cause and correction	Assumed cause		Correction		Prevention	
	An operation to reconnect the slave was executed from the Sysmac Studio.		---		---	
	The EC_ConnectSlave instruction was executed.		---		---	
Attached information	None					
Precautions/ Remarks	None					

Event name	Errors Reset			Event code	94430000 hex	
Meaning	A command was received to reset errors.					
Source	EtherCAT Master Function Module		Source details	Master	Detection timing	When errors are reset
Error attributes	Level	Information	Recovery	---	Log category	System
Effects	User program	Continues.	Operation	Master: The current errors are reset and the network is verified again. If the Fail-soft operation was performed, process data communications with the slaves that were in Fail-soft operation are restarted. Slave: The slave where the error occurred enters the Operational state.		
Indicators	EtherCAT NET RUN		EtherCAT NET ERR		EtherCAT LINK/ACT	
	---		---		---	
System-defined variables	Variable		Data type		Name	
	_EC_PDSlavTbl		Array [1..192] of BOOL		Process Data Communicating Slave Table	
	_EC_MBXSlavTbl		Array [1..192] of BOOL		Message Communications Enabled Slave Table	
Cause and correction	Assumed cause		Correction		Prevention	
	An error reset operation was performed from the Sysmac Studio.		---		---	
	The ResetECError instruction was executed.		---		---	
Attached information	None					
Precautions/ Remarks	None					

9-2-3 Resetting Errors

There are three methods to reset errors.

- Sysmac Studio
- NS-series PT
- Execution of the Reset EtherCAT System Error (ResetECError) instruction

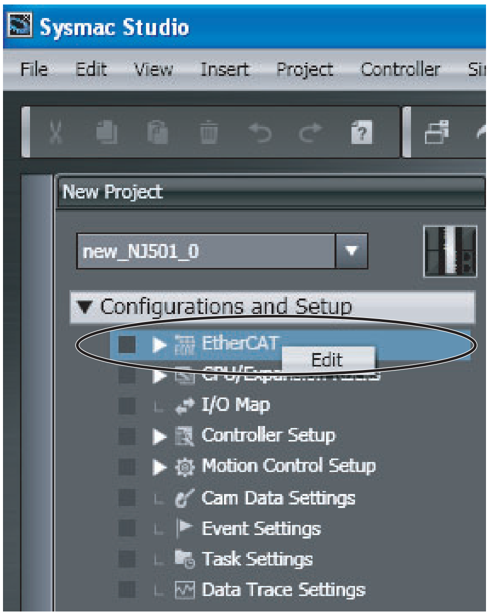
Refer to the *NJ-series Troubleshooting Manual* (Cat. No. W503) for the resetting procedures from the Sysmac Studio or an NS-series PT. Refer to the *NJ-series Instructions Reference Manual* (Cat. No. W502) for details on the Reset EtherCAT System Error (ResetECError) instruction.

9-2-4 Diagnostic and Statistical Information

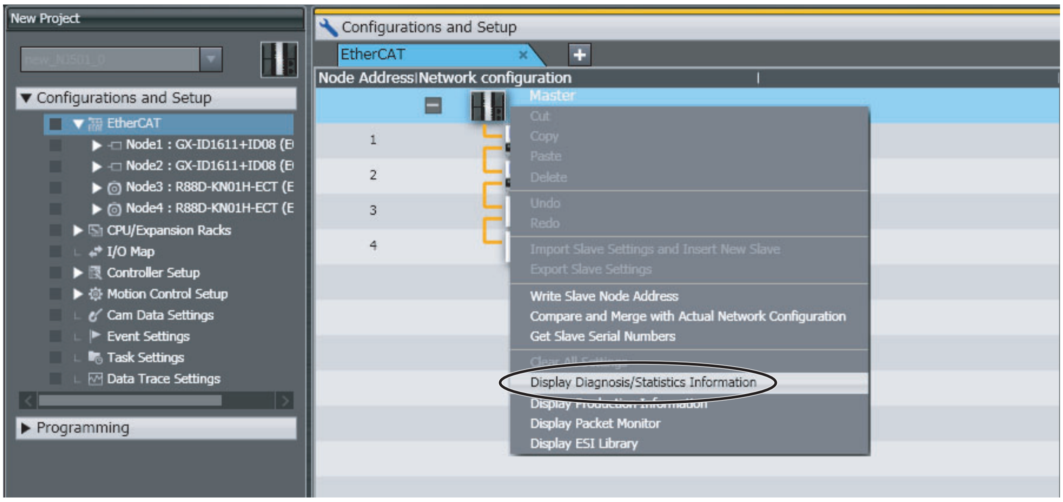
The EtherCAT master provides the following diagnostic and statistical information. You can refer to these to help isolate the cause of errors and obtain the status of the network. You can access this information from the Sysmac Studio with the following procedure.

1 Start the Sysmac Studio and go online with the Controller.

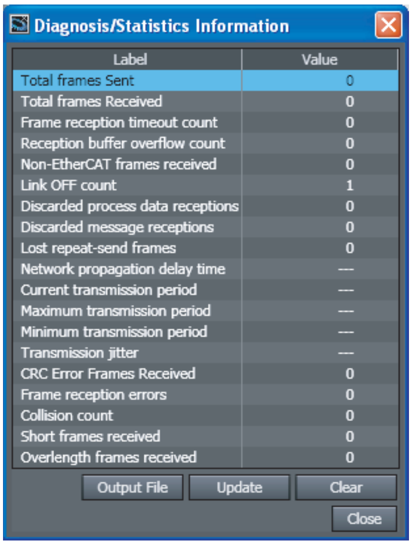
2 Double-click **EtherCAT** under **Configurations and Setup** in the Multiview Explorer. Or, right-click **EtherCAT** under **Configurations and Setup** and select ***Edit***.



3 Right-click in the EtherCAT Network Configuration Tab Page and select ***Display Diagnosis/Statistics Information*** from the menu.



The Diagnosis/Statistics Information Dialog Box is displayed.


Diagnosis/Statistics Information

Label	Value
Total frames Sent	0
Total frames Received	0
Frame reception timeout count	0
Reception buffer overflow count	0
Non-EtherCAT frames received	0
Link OFF count	1
Discarded process data receptions	0
Discarded message receptions	0
Lost repeat-send frames	0
Network propagation delay time	---
Current transmission period	---
Maximum transmission period	---
Minimum transmission period	---
Transmission jitter	---
CRC Error Frames Received	0
Frame reception errors	0
Collision count	0
Short frames received	0
Overlength frames received	0

Item	Description
Output File	Outputs the information to a CSV file.
Update	Gets the diagnosis/statistics information from the Controller and updates the display.
Clear	Clears the diagnosis/statistics information from the Controller to all zeros.

Diagnostic and statistical information is cleared to all zeros when the power supply is turned ON.

Diagnostic and Statistical Information	Description
Total frames Sent	The total number of EtherCAT frames sent by the master.
Total frames Received	The total number of EtherCAT frames received by the master.
Frame reception timeout count	The number of frame reception timeouts that occurred.
Reception buffer overflow count	The number of frames discarded due to buffer overflows when receiving data.
Non-EtherCAT frames received	The number of frames received other than EtherCAT frames.
Link OFF count	The number of times link OFF was detected.
Discarded process data receptions	The number of process data packets discarded when receiving process data.

Diagnostic and Statistical Information	Description
Discarded message receptions	The number of messages discarded in mailbox reception.
Lost repeat-send frames	The number of frames that could not be received in relation to the number of repeat frames sent.
Network propagation delay time[*1]	The propagation delay time for a frame to travel from the slave connected to the master to the last slave when using two or more synchronized slaves.
Current transmission cycle[*2]	The present value of the process data transmission period (ns).
Maximum transmission cycle[*2]	The maximum value of the process data transmission period (ns).
Minimum transmission cycle[*2]	The minimum value of the process data transmission period (ns).
Transmission jitter[*2]	The jitter in the process data transmission period (ns).
CRC Error Frames Received	The number of frames received that resulted in CRC errors.
Frame reception errors	The number of frames resulting in reception errors from the Ethernet controller (EtherMAC).
Collision count	The number of delay collisions on the line after start of transmissions.
Short frames received	The number of frames received with less than 64 bytes.
Overlength frames received	The number of frames received with more than 1,522 bytes.

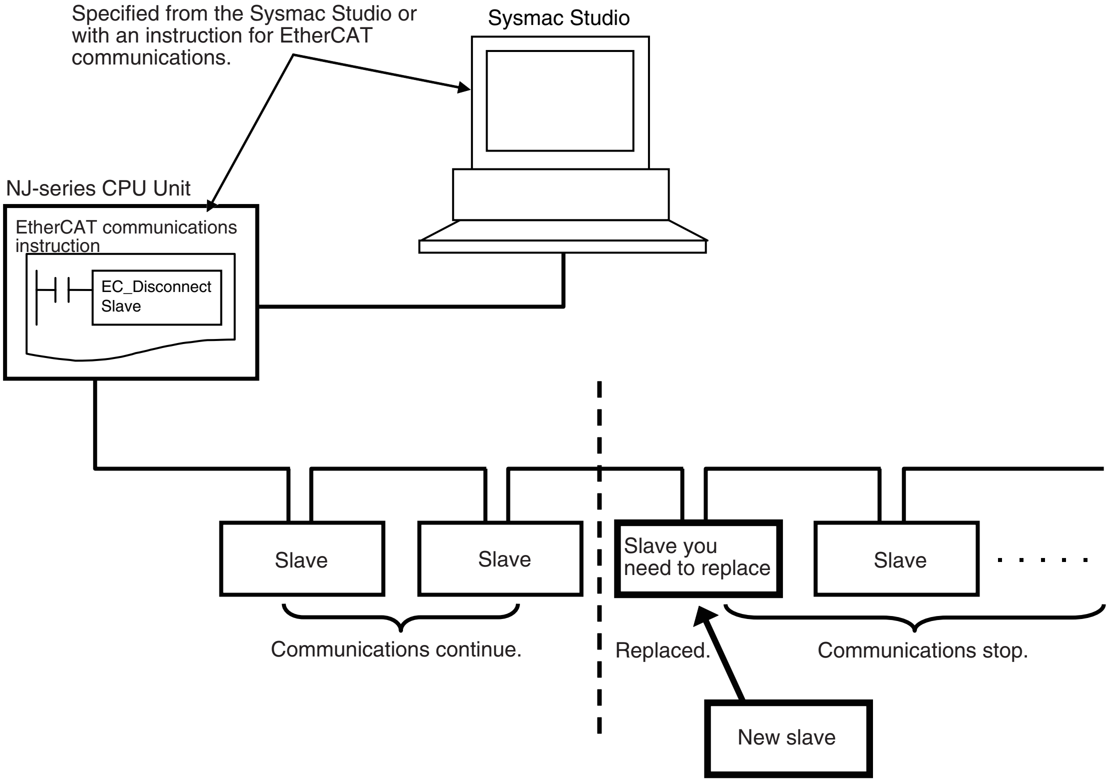
*1 This value cannot be cleared to zero from the Sysmac Studio.

*2 This information is valid only for slaves that support a distributed clock.
If a slave does not support a distributed clock, --- is displayed.

9-3 Replacing Slaves during Communications

9-3-1 Introduction

You can temporarily stop and start communications with a specified slave and all subsequent slaves without stopping the entire communications system. This makes it possible to replace slaves during communications for maintenance, or for replacement when a slave malfunctions.


Specified from the Sysmac Studio or with an instruction for EtherCAT communications.
Sysmac Studio
NJ-series CPU Unit
EtherCAT communications instruction
EC_Disconnect Slave
Slave
Slave
Slave you need to replace
Slave
Communications continue.
Replaced.
Communications stop.
New slave

Precautions for Correct Use

- A Process Data Communications Error occurs if you physically disconnect a slave from the network without executing the disconnection instruction.
- A Network Configuration Verification Error occurs if the correct node address is not set for a slave that was replaced with the disconnection instruction and a connection is made to a different port than the one that was used for the disconnection instruction.

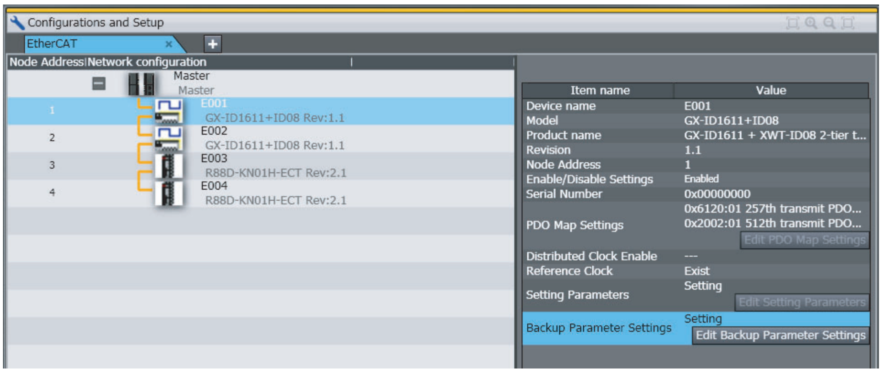
9-3-2 Slave Replacement Methods

The slave to be replaced is first disconnected from the network and then reconnected after you replace it. Use one of the following methods to disconnect and reconnect the slave.

Method 1: Connecting and Reconnecting Specified Slaves from the Sysmac Studio
Method 2: Execute the Disconnect EtherCAT Slave and Connect EtherCAT Slave instructions.
Execute the following instructions in the user program. You can use a pushbutton or a PT to input the execution condition.

Function	Instruction	Description
Disconnect EtherCAT Slave	EC_DisconnectSlave	Temporarily disconnects a slave from the EtherCAT network for maintenance, such as replacement of the slave.
Connect EtherCAT Slave	EC_ConnectSlave	Reconnects a temporarily disconnected slave to the EtherCAT network after maintenance, such as replacement of the slave.

If the EtherCAT slave to replace has backup parameters, we recommend that you use the Sysmac Studio to replace the slave. (You can specify backing up the parameters in the EtherCAT slave from the Sysmac Studio.)



1 E001 GX-ID1611+ID08 Rev:1.1
2 E002 GX-ID1611+ID08 Rev:1.1
3 E003 R88D-KN01H-ECT Rev:2.1
4 E004 R88D-KN01H-ECT Rev:2.1

Item name	Value
Device name	E001
Model	GX-ID1611+ID08
Product name	GX-ID1611 + XWT-ID08 2-tier t...
Revision	1.1
Node Address	1
Enable/Disable Settings	Enabled
Serial Number	0x00000000
PDO Map Settings	0x6120:01 257th transmit PDO... 0x2002:01 512th transmit PDO... Edit PDO Map Settings
Distributed Clock Enable	---
Reference Clock	Exist
Setting Parameters	Setting Edit Setting Parameters
Backup Parameter Settings	Setting Edit Backup Parameter Settings

Additional Information

The disconnection and reconnection operations are not required for slaves that are disabled with the EtherCAT Slave Enable/Disable Settings. You therefore cannot disconnect and reconnect them from the Sysmac Studio. If you execute the disconnection and connection instructions, they will result in errors.

9-3-3 Backing Up Settings

Before you replace an EtherCAT slave that is currently performing communications, the settings of the EtherCAT slave to replace are backed up. The settings of an EtherCAT slave are divided according to the storage locations and setting methods into initial parameters and backup parameters, as shown in the following table.

Slave settings	Storage location	Slave setting method
Initial parameters	EtherCAT master	These parameters are set automatically from the EtherCAT master when EtherCAT communications start or when a slave is connected.
Backup parameters	EtherCAT slaves	You set these parameters by transferring them to the slaves from the Backup Parameter Settings Tab Page of the Sysmac Studio. The data can also be transferred from the EtherCAT Drive Tab Page.

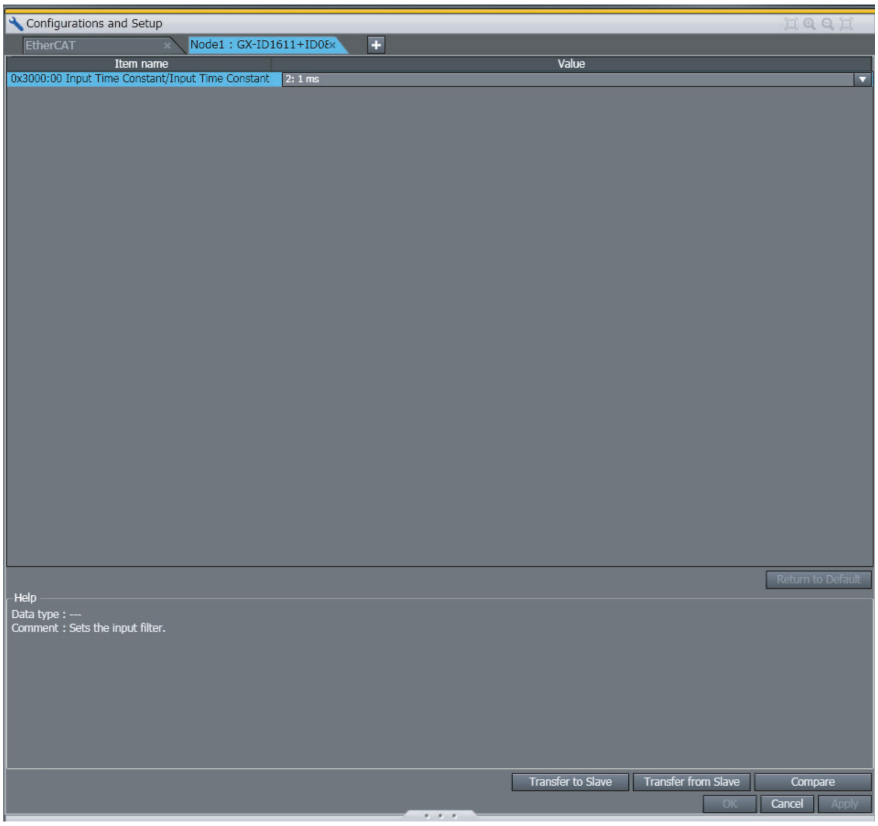
To replace an EtherCAT slave, you first back up the backup parameters that are stored in the EtherCAT slave.

1 Click the **Edit Backup Parameter Settings** Button in the EtherCAT Slave Setting Tab Page.

The Backup Parameter Settings Tab Page is displayed.

2 Click the **Transfer from Slave** Button.

All of the backup parameters that are stored in the EtherCAT slave and displayed in the list are transferred from the EtherCAT slave.



Item name	Value
0x3000:00 Input Time Constant/Input Time Constant	2: 1 ms

Help
Data type : ---
Comment : Sets the input filter.

3 Click the **Compare** Button.

Check to be sure that you have correctly obtained the backup parameters in step 2.

Additional Information

- You can back up the EtherCAT slave settings for any EtherCAT slave that is connected to the network (i.e., whenever the *_EC_EntrySlavTbl[1..192]* (Network Connected Slave Table) system-defined variable is TRUE) either before of after the disconnection command is sent to the EtherCAT slave.
- You can also set the EtherCAT drive slaves from the EtherCAT Drive Tab Page. Back up the settings information from the EtherCAT Drive Tab Page. Refer to the *Sysmac Studio Version 1 Operation Manual* (Cat. No. W504) for the applicable EtherCAT drive slaves.
- You do not need to back up the settings to replace an EtherCAT slave that does not have backup parameters.

9-3-4 Restoring Settings

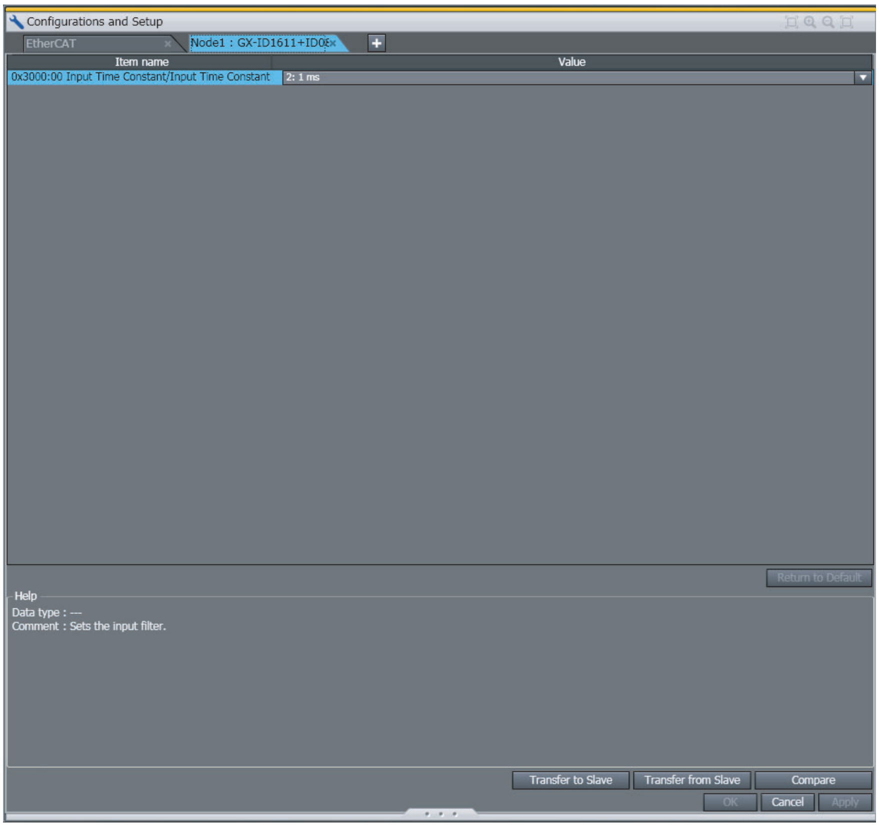
After you replace the EtherCAT slave, you restore the settings that you backed up before you replaced the slave. The backup parameters that were backed up are restored to the EtherCAT slave.

1 Click the **Edit Backup Parameter Settings** Button in the EtherCAT Slave Setting Tab Page.

The Backup Parameter Settings Tab Page is displayed.

2 Click the **Transfer to Slave** Button.

All of the backup parameters that are stored in the EtherCAT slave and displayed in the list are downloaded to the EtherCAT slave.



Item name	Value
0x3000:00 Input Time Constant/Input Time Constant	2: 1 ms

Help
Data type : ---
Comment : Sets the input filter.

3 Click the **Compare** Button.

Check to be sure that you have correctly transferred the backup parameters in step 2.

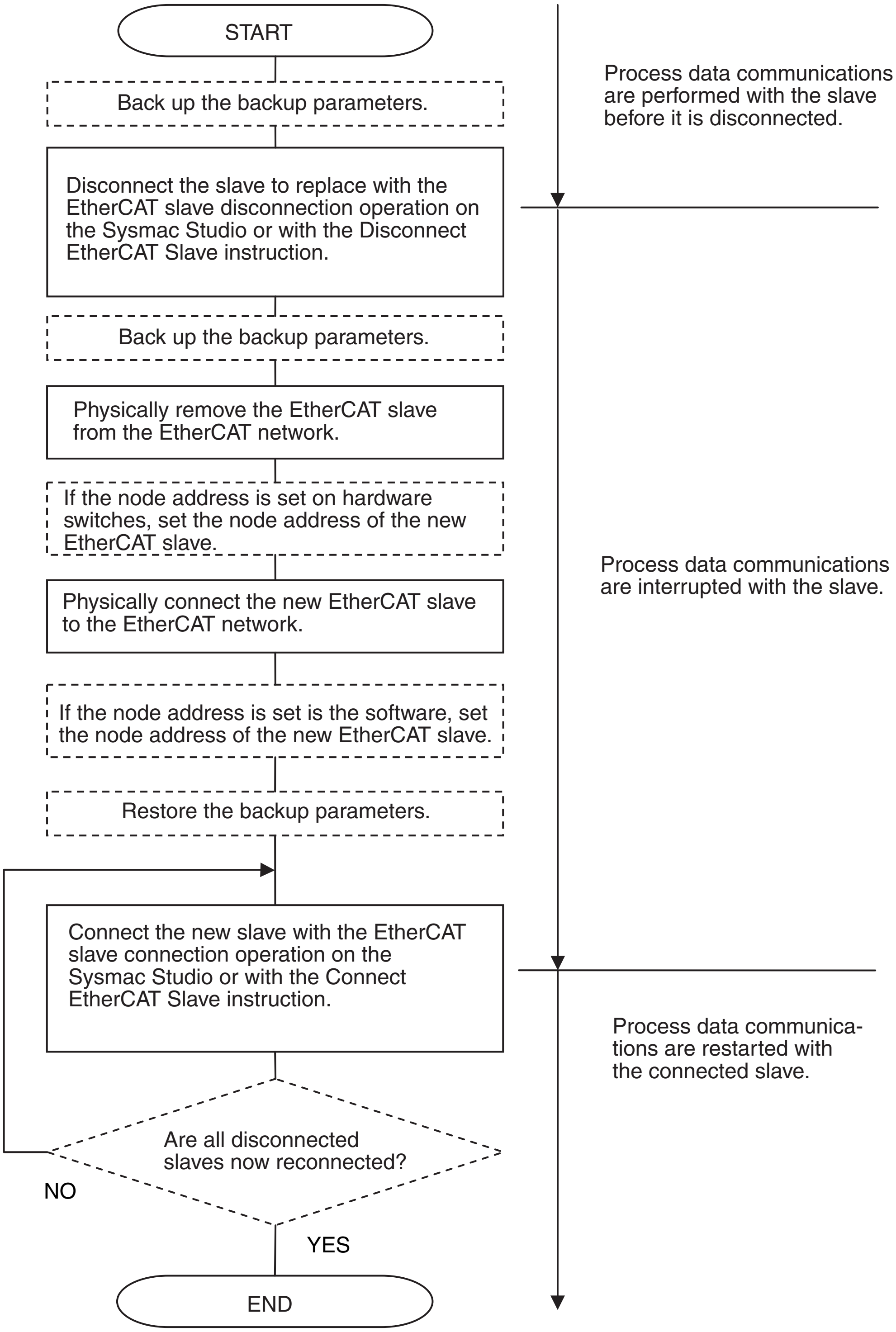
Precautions for Correct Use

Restore the settings to the EtherCAT slave before you connect the EtherCAT slave to restart process data communications. Restore the EtherCAT slave settings while the slave is connected to the network (i.e., whenever the *_EC_EntrySlavTbl[1..192]* (Network Connected Slave Table) system-defined variable is TRUE). Restore the EtherCAT slave settings while the slave is connected to the network (i.e., whenever the _EC_EntrySlavTbl[1..192] (Network Connected Slave Table) system-defined variable is TRUE).

Additional Information

- You can set the EtherCAT drive slaves from the EtherCAT Drive Tab Page. Restore the settings information from the EtherCAT Drive Tab Page. Refer to the *Sysmac Studio Version 1 Operation Manual* (Cat. No. W504) for the applicable EtherCAT drive slaves.
- You do not need to restore the settings to replace an EtherCAT slave that does not have backup parameters.

9-3-5 Replacement Procedure


START
Back up the backup parameters.
Disconnect the slave to replace with the EtherCAT slave disconnection operation on the Sysmac Studio or with the Disconnect EtherCAT Slave instruction.
Back up the backup parameters.
Physically remove the EtherCAT slave from the EtherCAT network.
If the node address is set on hardware switches, set the node address of the new EtherCAT slave.
Physically connect the new EtherCAT slave to the EtherCAT network.
If the node address is set is the software, set the node address of the new EtherCAT slave.
Restore the backup parameters.
Connect the new slave with the EtherCAT slave connection operation on the Sysmac Studio or with the Connect EtherCAT Slave instruction.
Are all disconnected slaves now reconnected?
NO
YES
END
Process data communications are performed with the slave before it is disconnected.
Process data communications are interrupted with the slave.
Process data communications are restarted with the connected slave.

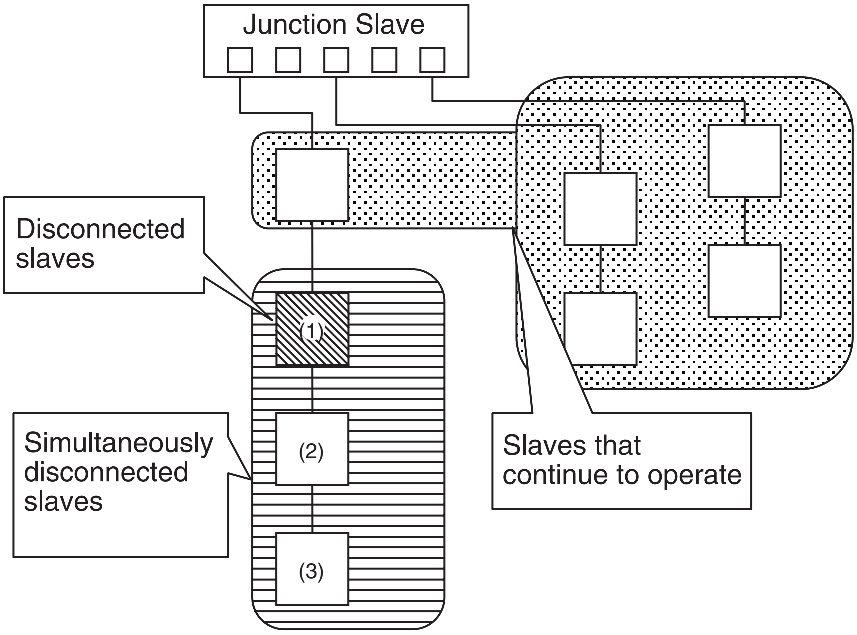
Note: Steps shown in dotted boxes depend on the system.

Precautions for Safe Use

- When an EtherCAT slave is disconnected from the Sysmac Studio or with an instruction, communications will stop and control of the outputs will be lost not only for the disconnected slave, but for all slaves connected after it. Always confirm system safety before you disconnect an EtherCAT slave.
- If you disconnect the cable from an EtherCAT slave to disconnect it from the network (e.g., to replace it), any current communications frames may be lost. If frames are lost, slave I/O data is not communicated, and unintended operation may occur. Perform the following processing for a slave that needs to be replaced.
  - Program the _EC_InDataInvalid (Input Data Disable) system-defined variable as an interlock condition. Refer to *6-1-2 Sample Programming* for a sample of programming interlocks.
  - Set the *PDO communications timeout detection count* setting in the EtherCAT master to at least 2. Refer to *5-4-1 Setting EtherCAT Master* for the setting procedure.

Disconnecting Slaves

If a slave is disconnected, slaves connected after the designated slave (on the output side) in a daisy chain are disconnected at the same time. Slaves connected before the disconnected slave (on the input side) and slaves connected beyond Junction Slaves continue to operate. (If (1) is disconnected in the following figure, (2) and (3) are also disconnected.)


Junction Slave
Disconnected slaves
(1)
Simultaneously disconnected slaves
(2)
(3)
Slaves that continue to operate

The status of the system-defined variables for disconnected slaves are listed in the following table. The status in the following table are reached immediately after disconnection. This status does not change even if a slave is physically removed from the actual network configuration or physically connected to the actual network configuration again. The corresponding element in the Network Connected Slave Table changes to FALSE when the slave is physically removed from the actual network configuration.

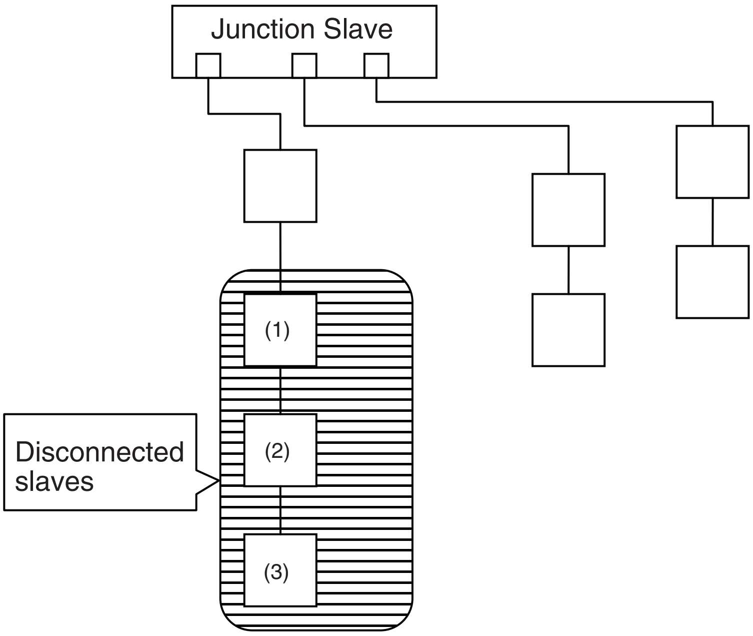
System-defined variable name	Description	Value
_EC_RegSlavTbl[1..192] (Registered Slave Table)	This variable shows the slaves that are registered in the network configuration information.	Remains TRUE.
_EC_EntrySlavTbl[1..192] (Network Connected Slave Table)	This variable shows the slaves that are registered in the network configuration information and connected to the network.	The corresponding element changes to FALSE when the slave is removed from the actual network configuration.
_EC_MBXSlavTbl[1..192] (Message Communications Enabled Slave Table)	This variable shows the slaves that are registered in the network configuration information and able to perform message communications.	The corresponding element changes to FALSE after the EtherCAT slave is disconnected from the Sysmac Studio or with an instruction.
_EC_PDSlavTbl[1..192] (Process Data Communicating Slave Table)	This variable shows the slaves that are registered in the network configuration information and performing process data communications.	The corresponding element changes to FALSE after the EtherCAT slave is disconnected from the Sysmac Studio or with an instruction.
_EC_DisconnSlavTbl[1..192] (Disconnected Slave Table)	This variable shows the slaves that are registered in the network configuration information and disconnected from the network.	The corresponding element changes to TRUE after the EtherCAT Slave is disconnected from the Sysmac Studio or with an instruction.

Reconnecting Slaves

When reconnecting disconnected slaves after replacement or inspection, make sure that the following conditions are met and then reconnect them. If they are reconnected without meeting following conditions, process data communications with the slaves will not start again, and a network configuration verification error will occur. If the conditions are met, *_EC_EntrySlavTbl* will be TRUE.

- Make sure that the slave's node address is set correctly.
- Make sure that there are no errors in the order that the slaves are connected.

There are no restrictions on the order when reconnecting slaves that are in a daisy chain. For example, even if slaves (1) to (3) in a configuration such as the one shown in the following figure are disconnected, there are no restriction on the reconnection order of slaves (1) to (3). (For example, the slaves can be reconnected in the order (3), (2), (1) or (1), (3), (2).)



The status of the system-defined variables for disconnected slaves that have been successfully reconnected are listed in the following table.

System-defined variable name	Description	Value
_EC_RegSlavTbl[1..192] (Registered Slave Table)	This variable shows the slaves that are registered in the network configuration information.	Remains TRUE.
_EC_EntrySlavTbl[1..192] (Network Connected Slave Table)	This variable shows the slaves that are registered in the network configuration information and connected to the network.	Shows actual network configuration (changes to FALSE for disconnection and to TRUE for connection).
_EC_MBXSlavTbl[1..192] (Message Communications Enabled Slave Table)	This variable shows the slaves that are registered in the network configuration information and able to perform message communications.	The corresponding element changes to TRUE after the EtherCAT slave is connected from the Sysmac Studio or with an instruction
_EC_PDSlavTbl[1..192] (Process Data Communicating Slave Table)	This variable shows the slaves that are registered in the network configuration information and performing process data communications.	The corresponding element changes to TRUE after the EtherCAT slave is connected from the Sysmac Studio or with an instruction
_EC_DisconnSlavTbl[1..192] (Disconnected Slave Table)	This variable shows the slaves that are registered in the network configuration information and disconnected from the network.	The corresponding element changes to FALSE after the EtherCAT Slave is disconnected from the Sysmac Studio or with an instruction.

Additional Information

Synchronization correction processing is performed to reconnect synced slaves. Therefore, several seconds may be required per slave until reconnection is completed.

App

Appendices

The appendices describe the relation of EtherCAT communications to overall CPU Unit status, packet monitoring functions, and multi-vendor application.

A-1 EtherCAT Status in Relation to CPU Unit Status A-2

A-1-1 Startup A-2

A-1-2 CPU Unit Operating Modes A-3

A-1-3 Controller Errors Other Than Errors in the Built-in EtherCAT Master A-4

A-1-4 Others A-5

A-2 Monitoring Packets A-7

A-2-1 Sample Programming A-10

A-3 Multi-vendor Environments A-15

A-3-1 EtherCAT Slave Information File (ESI Files) A-15

A-3-2 Connecting Slaves from Other Manufacturers to an OMRON Master A-16

A-3-3 Installing ESI Files A-16

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A-1 EtherCAT Status in Relation to CPU Unit Status

The status of EtherCAT master memory, the ability to download master and slave settings, and the slave status are given below for different CPU Unit operating modes, Controller errors, and other status.

A-1-1 Startup

Memory related to EtherCAT master				Downloading master and slaves settings	Slaves	
Device variables	Category _EC system-defined variables	Network configuration information	Diagnostic and statistical information		Slave outputs	Slave communications status
Devices variables that are not retained: Initial settings	Default settings (Default settings are set in the EtherCAT master.)	---	Cleared to all zeros.	---	The status of slave outputs before the start of EtherCAT communications depend on the slave. Slaves output values of device variables after EtherCAT communications start.	The EtherCAT master moves slaves into the operational state according to the network configuration information.

A-1-2 CPU Unit Operating Modes

CPU Unit status	Memory related to EtherCAT master				Downloading master and slaves settings	Slaves	
	Device variables	Category _EC system-defined variables	Network configuration information	Diagnostic and statistical information		Slave outputs	Slave communications status
PROGRAM mode	Normal EtherCAT communications are performed and I/O is refreshed.	Continually show EtherCAT communications status.	Nothing is performed (does not depend on the operating mode of the CPU Unit).	Does not depend on the operating mode of the CPU Unit. Continually show EtherCAT communications status.	• Master settings: OK • Slave settings: OK (However, setting may not be possible depending on the status of the slave.)	Does not depend on the operating mode of the CPU Unit. Continually show the output data sent from the EtherCAT master.	Does not depend on the operating mode of the CPU Unit.
Switching between PROGRAM and RUN mode	Device variables that are not retained: Default settings	Not initialized (Communications status is still updated by the EtherCAT master regardless of the operating mode of the CPU Unit).			---		
RUN mode	Normal EtherCAT communications are performed and I/O is refreshed.	Continually show EtherCAT communications status.			• Master settings: Not possible. • Slave settings: OK (However, setting may not be possible depending on the status of the slave.)		

A-1-3 Controller Errors Other Than Errors in the Built-in EtherCAT Master

CPU Unit status	Memory related to EtherCAT master				Downloading master and slaves settings	Slaves	
	Device variables	Category _EC system-defined variables	Network configuration information	Diagnostic and statistical information		Slave outputs	Slave communications status
A major fault level Controller error occurs.	Device variables that are not retained: Default settings	Does not depend on the operating mode of the CPU Unit. Continually show EtherCAT communications status.	Nothing is performed (does not depend on the operating mode of the CPU Unit).	Does not depend on the operating mode of the CPU Unit. Continually show EtherCAT communications status.	---	In Operational state, the values from before operation stopped are output. When the slaves have entered Safe-operational state, the slave settings control all of the outputs. Inputs are enabled.	The EtherCAT master moves the slaves into the safe-operational state.
A partial fault level Controller error occurs.	Normal EtherCAT communications are performed and I/O is refreshed.					Does not depend on the operating mode of the CPU Unit. Continually show the output data sent from the EtherCAT master.	Does not depend on the operating mode of the CPU Unit.
A minor fault level Controller error occurs.							

Refer to *9-1 Overview of Errors* if a Controller error occurs in the built-in EtherCAT master.

A-1-4 Others

CPU Unit status	Memory related to EtherCAT master				Downloading master and slaves settings	Slaves	
	Device variables	Category _EC system-defined variables	Network configuration information	Diagnostic and statistical information		Slave outputs	Slave communications status
Memory all clear	Cleared to all zeros.	Initialized to default values (0).	Deleted.	Cleared to all zeros.	---	EtherCAT communications stop. (Output values depend on the slave.)	EtherCAT communications stop.

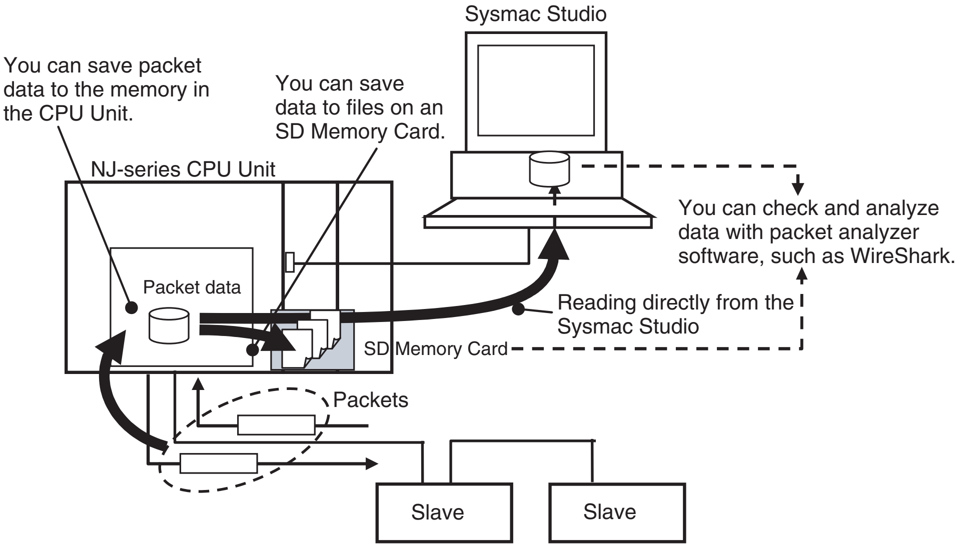
A-2 Monitoring Packets

Packet monitoring stores a certain number of the most recent packets sent and received by the EtherCAT master along with time information.
You can use an EtherCAT communications instruction or the Sysmac Studio to save the captured packet data in packet data files in the system in the CPU Unit.

You can use any of the following methods to obtain the packet data saved in the system memory in the CPU Unit.

- Reading directly from the Sysmac Studio
- Saving to an SD Memory Card inserted in the CPU Unit

You can view the captured packet data with packet analyzer software, such as WireShark. You can also use the data for analysis applications, such as error analysis and data mining.


Sysmac Studio
You can save packet data to the memory in the CPU Unit.
You can save data to files on an SD Memory Card.
NJ-series CPU Unit
Packet data
You can check and analyze data with packet analyzer software, such as WireShark.
Reading directly from the Sysmac Studio
SD Memory Card
Packets
Slave
Slave

Starting and Stopping Packet Monitor

You can start and stop packet monitoring either with instructions in the user program or with operations on the Sysmac Studio.

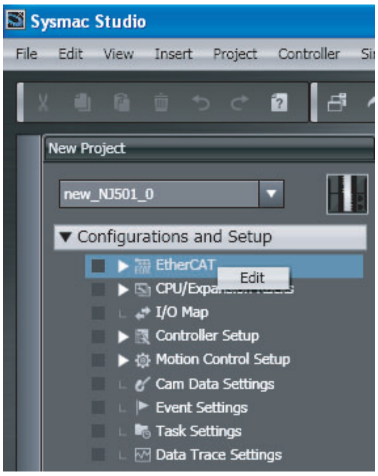
● Using Instructions in the User Program

- EC_StartMon (Start EtherCAT Packet Monitor) instruction: Starts the execution of packet monitoring and continues to update a fixed number of packets.
- EC_StopMon (Stop EtherCAT Packet Monitor) instruction: Stops the execution of packet monitoring.

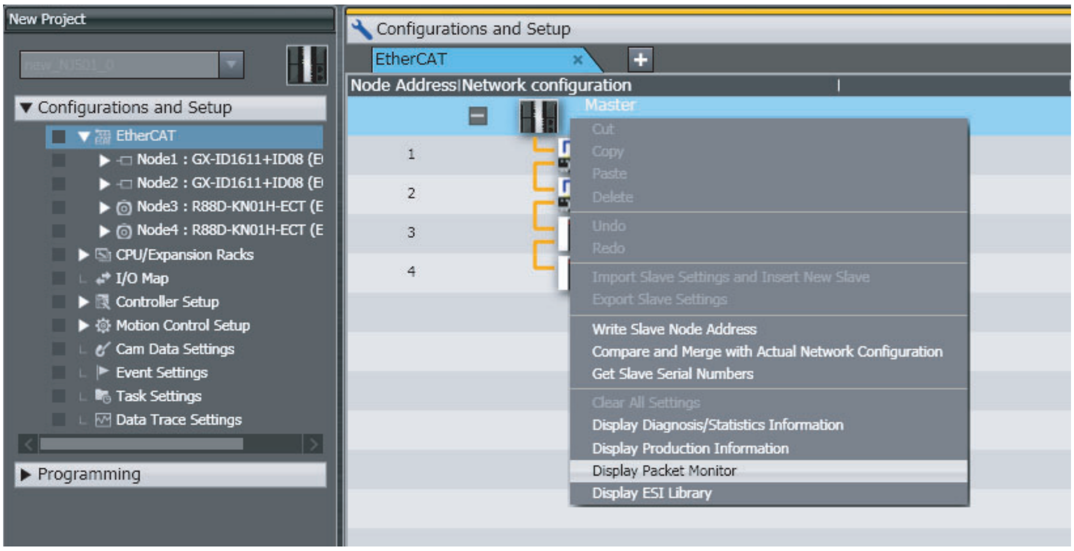
● Operation from the Sysmac Studio

1 Start the Sysmac Studio and go online with the Controller.

2 Double-click **EtherCAT** under **Configurations and Setups** in the Multiview Explorer. Or, right-click **EtherCAT** under **Configurations and Setups** and select ***Edit***.

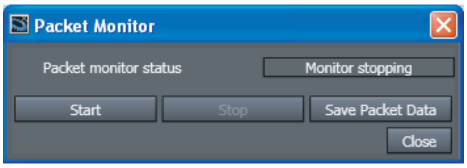


3 Right-click in the EtherCAT Network Configuration Tab Page and select ***Display Packet Monitor*** from the menu.



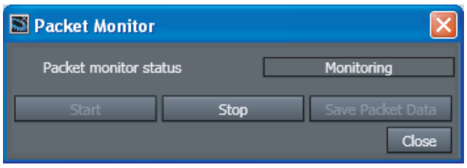
The Packet Monitor Dialog Box is displayed.

4 Click the **Start** Button to begin monitoring packets.



Packet monitor status: Monitor stopping

5 Click the **Stop** Button to stop monitoring packets.



Packet monitor status: Monitoring

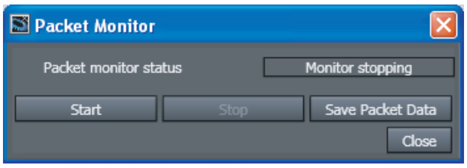
Saving Packet Data

● Reading Data from the Sysmac Studio

After you stop packet monitoring, you can use the Sysmac Studio to read the packet data and save it in a file.

1 Stop monitoring packets.

2 Click the **Save Packet Data** Button to save the packet data.



The Save Dialog Box is displayed.

3 Input a file name, and then click the **Save** Button.

A TCPDump packet data file with a .cap extension is saved.

● Saving to an SD Memory Card from Memory in the CPU Unit

Stop monitoring packets, and then execute the EC_SaveMon (Save EtherCAT Packets) instruction to save a given quantity of collected packet data in memory in the CPU Unit. Then, execute the EC_CopyMon (Transfer EtherCAT Packets) instruction to save the packet data that was saved in the CPU Unit to a file on an SD Memory Card inserted into the CPU Unit. You can specify the name of the file that is saved in the SD Memory Card. The number of files is limited only by the space that is available on the SD Memory Card.

Additional Information

- Packet data in the CPU Unit's memory is not retained when the power is interrupted.
- Packet data cannot be saved while packets are being monitored.
- Packet monitoring cannot be started while saving packet data.
- If an SD Memory Card is not inserted and you execute the instruction to copy the data to the SD Memory Card, then an error is returned. If there is no SD Memory Card, only the one file in the CPU Unit's memory can be read to the Sysmac Studio.
- Packet monitoring starts when the power is turned ON.

Packet Monitoring Specifications

Item	Specification
Maximum data size of one packet data file	12 MB
Maximum number of packets that can be obtained	3,904 packets
Format of packet data file	TCPDump format (cap)
Time information	Recorded (unit: µs) The elapsed time starting when packet monitoring begins is recorded. (Packet monitoring can be started when power turns ON, for an EtherCAT instruction, or for a Sysmac Studio operation.)
Save location for packet data file	CPU Unit's system: 1 file SD Memory Card inserted in CPU Unit: Multiple files (up to capacity of SD Memory Card)

A-2-1 Sample Programming

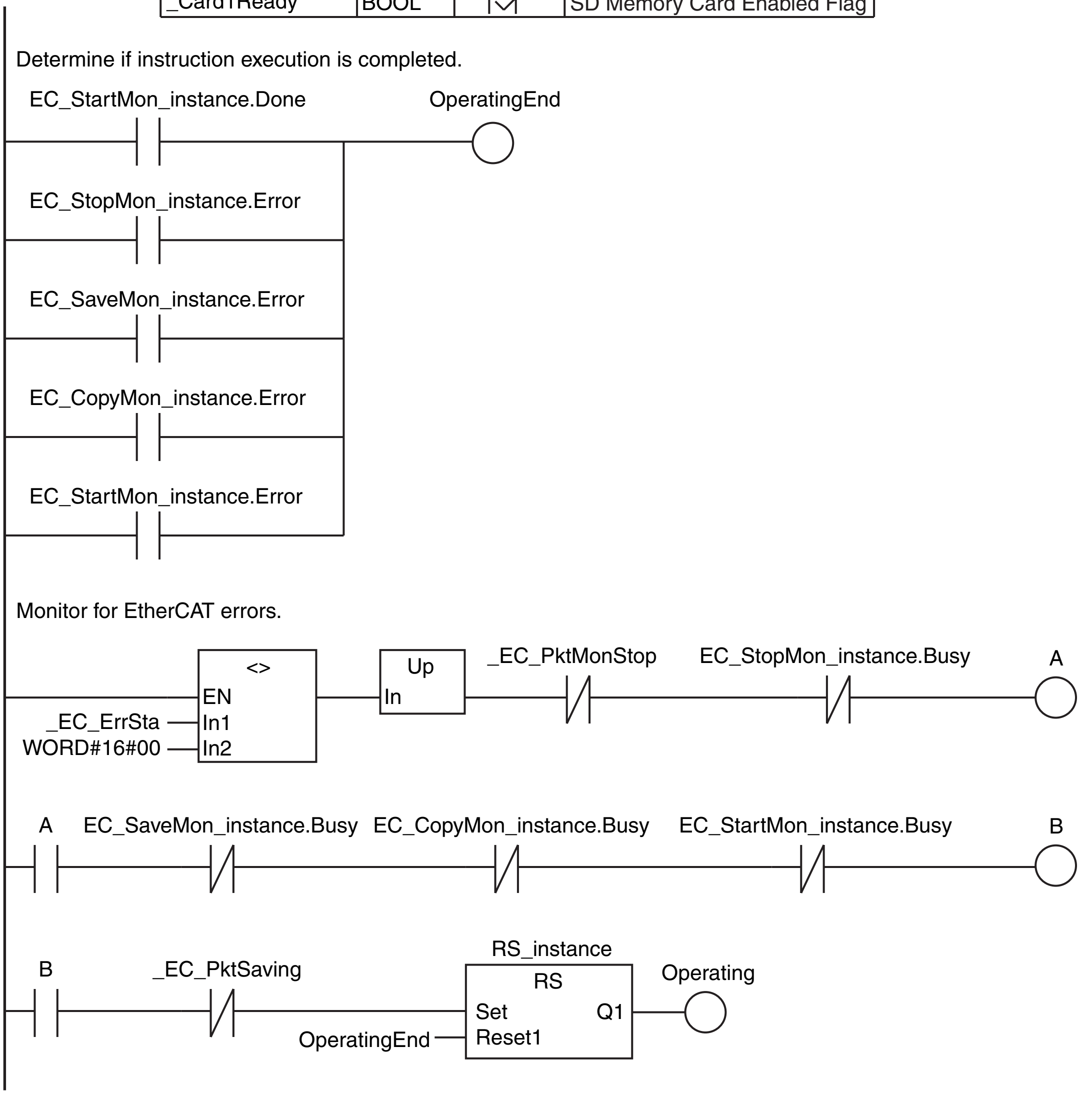
This sample transfers EtherCAT communications packets to an SD Memory Card when an EtherCAT slave error occurs. The file name is ‘PacketFile.’ The processing procedure is as follows:

1. The system-defined variable *_EC_ErrSta* (EtherCAT Error) is monitored and processing is started if an error occurs.
2. The EC_StopMon instruction is used to stop execution of packet monitoring for EtherCAT communications.
3. The EC_SaveMon instruction is used to save EtherCAT communications packet data to a file in the system of the CPU Unit.
4. The EC_CopyMon instruction is used to copy that file to the SD Memory Card.
5. The EC_StartMon instruction is used to restart execution of packet monitoring for EtherCAT communications.

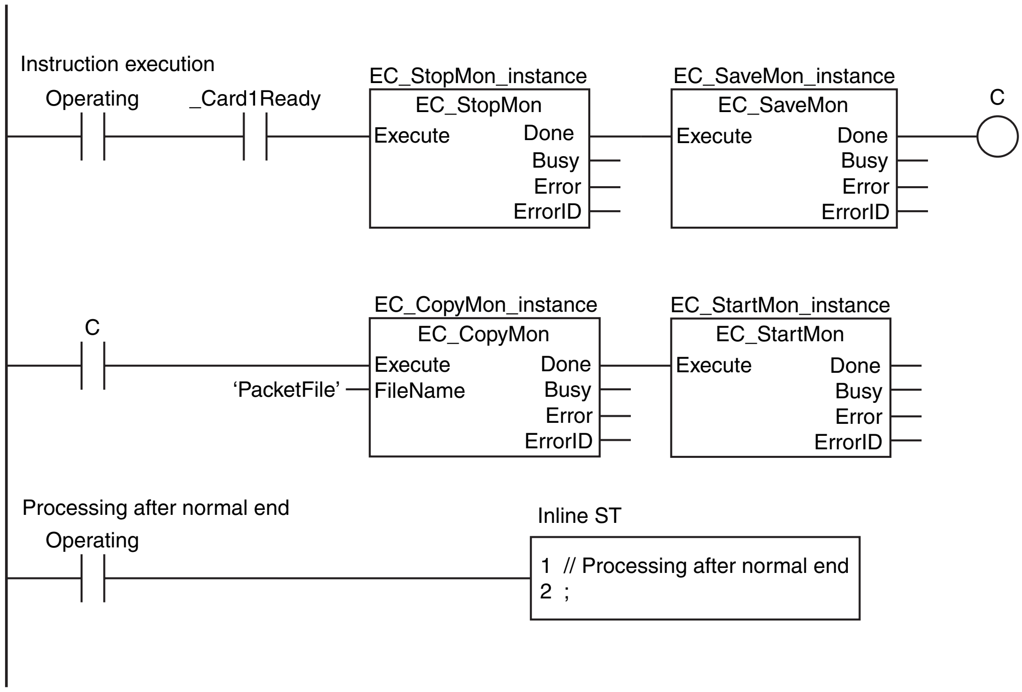
LD

Internal Variables	Variable	Data type	Initial value	Comment
	OperatingEnd	BOOL	False	Processing completed
	Operating	BOOL	False	Execution condition
	A	BOOL	False	
	B	BOOL	False	
	C	BOOL	False	
	RS_instance	RS		
	EC_StopMon_instance	EC_StopMon		
	EC_SaveMon_instance	EC_SaveMon		
	EC_CopyMon_instance	EC_CopyMon		
	EC_StartMon_instance	EC_StartMon		

External Variables	Variable	Data type	Constant	Comment
	_EC_ErrSta	WORD	☑	Built-in EtherCAT Error
	_EC_PktMonStop	BOOL	☑	Packet Monitoring Stopped
	_EC_PktSaving	BOOL	☑	Saving Packet Data File
	_Card1Ready	BOOL	☑	SD Memory Card Enabled Flag


Determine if instruction execution is completed.

Monitor for EtherCAT errors.


Instruction execution
Operating
_Card1Ready
EC_StopMon_instance
EC_StopMon
Execute
Done
Busy
Error
ErrorID
EC_SaveMon_instance
EC_SaveMon
Execute
Done
Busy
Error
ErrorID
C
C
EC_CopyMon_instance
EC_CopyMon
Execute
FileName
‘PacketFile’
Done
Busy
Error
ErrorID
EC_StartMon_instance
EC_StartMon
Execute
Done
Busy
Error
ErrorID
Processing after normal end
Operating
Inline ST
1 // Processing after normal end
2 ;

ST

Internal Variables	Variable	Data type	Initial value	Comment
	EC_Err	BOOL	False	Controller error in the EtherCAT Master Function Module.
	EC_Err_Trigger	BOOL	False	Detect when *EC_Err* changes to TRUE.
	DoEC_PktSave	BOOL	False	Processing
	Stage	INT	0	Stage change
	R_TRIG_instance	R_TRIG		
	EC_StopMon_instance	EC_StopMon		
	EC_SaveMon_instance	EC_SaveMon		
	EC_CopyMon_instance	EC_CopyMon		
	EC_StartMon_instance	EC_StartMon		

External Variables	Variable	Data type	Constant	Comment
	_EC_ErrSta	WORD	☑	Built-in EtherCAT Error
	_EC_PktMonStop	BOOL	☑	Packet Monitoring Stopped
	_EC_PktSaving	BOOL	☑	Saving Packet Data File
	_Card1Ready	BOOL	☑	SD Memory Card Enabled Flag

```
// Start sequence when _EC_ErrSta changes to TRUE.
EC_Err:=(_EC_ErrSta <> WORD#16#00);
R_TRIG_instance(Clk:=EC_Err, Q=>EC_Err_Trigger);

IF ( (EC_Err_Trigger=TRUE) AND (DoEC_PktSave=FALSE) AND (_EC_PktMonStop=FALSE)
    AND (_EC_PktSaving=FALSE) AND (_Card1Ready=TRUE) ) THEN
    DoEC_PktSave:=TRUE;
    Stage           :=INT#1;
    EC_StopMon_instance(Execute:=FALSE);    // Initialize instance.
    EC_SaveMon_instance(Execute:=FALSE);
    EC_CopyMon_instance(Execute:=FALSE);
    EC_StartMon_instance(Execute:=FALSE);
END_IF;

// Instruction execution
IF (DoEC_PktSave=TRUE) THEN
    CASE Stage OF
    1 :                        // Stop EtherCAT packet monitor.
        EC_StopMon_instance(
            Execute    :=TRUE);

        IF (EC_StopMon_instance.Done=TRUE) THEN
            Stage:=INT#2;                 // Normal end
        ELSIF (EC_StopMon_instance.Error=TRUE) THEN
            Stage:=INT#10;                // Error end
        END_IF;

    2 :                        // Save EtherCAT packet data to file in system.
        EC_SaveMon_instance(
            Execute :=TRUE);

        IF (EC_SaveMon_instance.Done=TRUE) THEN
            Stage:=INT#3;                 // Normal end
        ELSIF (EC_SaveMon_instance.Error=TRUE) THEN
            Stage:=INT#20;                // Error end
        END_IF;

    3 :                        // Copy EtherCAT packet data file to the SD Memory Card.
        EC_CopyMon_instance(
            Execute  :=TRUE,
            FileName:='PacketFile');

        IF (EC_CopyMon_instance.Done=TRUE) THEN
            Stage:=INT#4;                 // Normal end
        ELSIF (EC_CopyMon_instance.Error=TRUE) THEN
            Stage:=INT#30;                // Error end
        END_IF;
    4 :        // Restart EtherCAT packet monitoring.
        EC_StartMon_instance(
            Execute  :=TRUE);

        IF (EC_StartMon_instance.Done=TRUE) THEN
            Stage:=INT#0;   // Normal end
        ELSIF (EC_StartMon_instance.Error=TRUE) THEN
            Stage:=INT#40;  // Error end
        END_IF;

    0 :                     // Processing after normal end
        DoEC_PktSave:=FALSE;

    ELSE                    // Processing after error end
        DoEC_PktSave:=FALSE;
    END_CASE;
END_IF:
```

A-3 Multi-vendor Environments

This section provides precautions and describes documentation for multi-vendor environments.

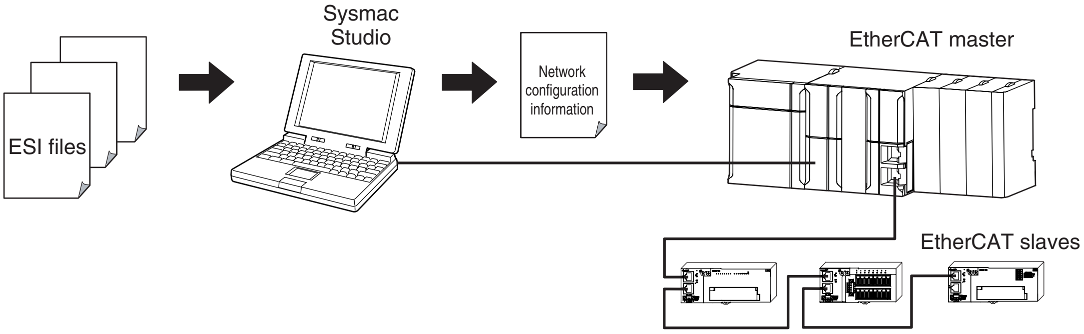
A-3-1 EtherCAT Slave Information File (ESI Files)

Setting information for EtherCAT is defined in EtherCAT slave information (ESI) files. These files are provided by the individual slave manufacturers. Various EtherCAT communications settings are defined based on the ESI definitions of connected slaves.

You can install the ESI files in the Sysmac Studio to use them to edit the EtherCAT configuration in the Sysmac Studio and create the network configuration information.

You can download the network configuration information to the EtherCAT master to configure the EtherCAT network.

Contact the manufacturer or the point of purchase to obtain the most recent ESI files for slaves that are manufactured by other companies.



Communications are started according to the communications settings and the network configuration in the ESI files that are installed.

Additional Information

ESI file versions that are lower than ESI version-1.0.1 specifications are not supported. If you install an ESI file version that is not supported, a message saying that you cannot use the slave is displayed by the Sysmac Studio.

The NJ-series CPU Units do not support the following data types for variables. If variables with any of these data types are included in the slave information (ESI), you cannot use the slave.

Bit data types:	BIT1, BIT2, BIT3, BIT4, BIT5, BIT6, BIT7, and BIT8
Integer data types:	INT24, INT40, INT48, and INT56
Unsigned integer data types:	UINT24, UINT40, UINT48, and UINT56

If variables with any of these data types are included in the slave information (ESI), a message saying that you cannot use the slave is displayed in the ESI Library Dialog Box of the Sysmac Studio.

A-3-2 Connecting Slaves from Other Manufacturers to an OMRON Master

You can install the ESI file for a slave from another manufacturer in the Sysmac Studio to handle the slave in the same way as an OMRON slave. (Only the ESI files for OMRON slaves for which connectability has been confirmed are installed in the Sysmac Studio in advance.)

When connecting a slave from another manufacturer to an OMRON master, refer to the manuals for the other manufacturer's slaves, and then ask your OMRON representative if you have any questions.

Additional Information

EtherCAT setup software that is provided by other manufacturers cannot be connected to NJ-series CPU Units.

A-3-3 Installing ESI Files

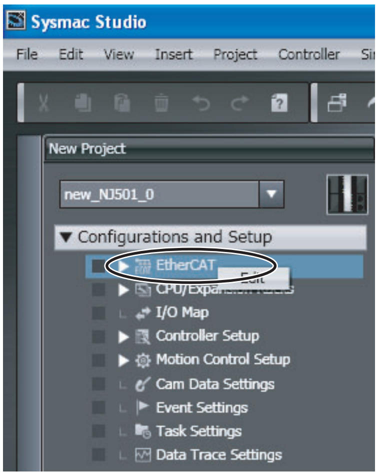
● Procedure

An ESI (EtherCAT slave information) file is an XML file that describes the connection information and profile of the EtherCAT slave.

To connect an EtherCAT slave that is manufactured by other company to an NJ-series master, you must install the ESI file for that slave in the Sysmac Studio to enable setting the slave.

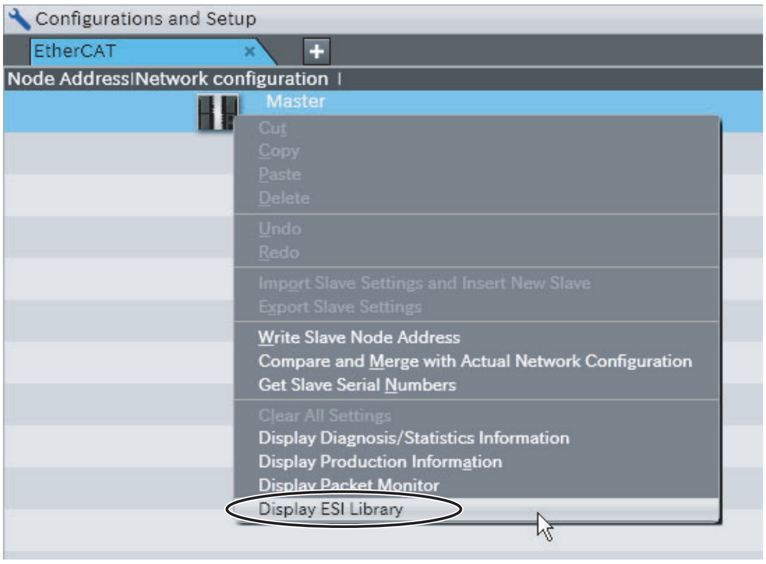
Use the following procedure to install an ESI file.

1 Double-click **EtherCAT** under **Configurations and Setup** in the Multiview Explorer. Or, right-click **EtherCAT** under **Configurations and Setup** and select ***Edit***.



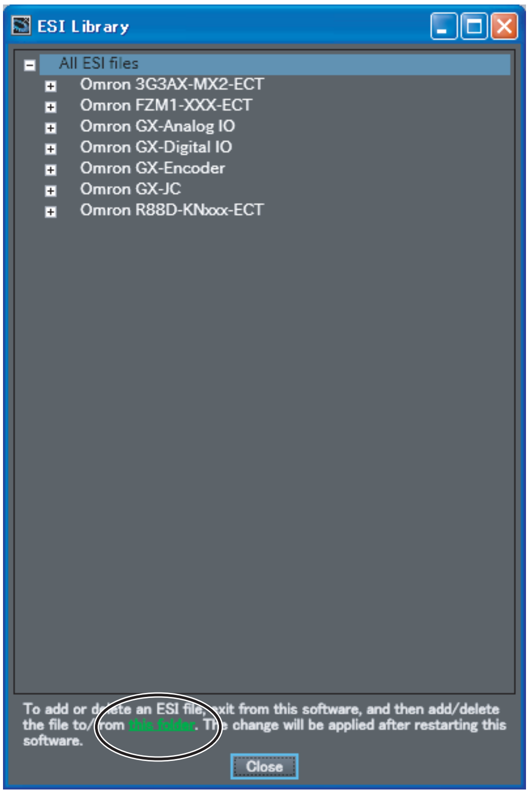
The edit pane is displayed.

2 Right-click the EtherCAT master that is displayed in the edit pane and select ***Display ESI Library***.


Configurations and Setup
EtherCAT
Node Address|Network configuration
Master
Cut
Copy
Paste
Delete
Undo
Redo
Import Slave Settings and Insert New Slave
Export Slave Settings
Write Slave Node Address
Compare and Merge with Actual Network Configuration
Get Slave Serial Numbers
Clear All Settings
Display Diagnosis/Statistics Information
Display Production Information
Display Packet Monitor
Display ESI Library

The ESI Library Dialog Box is displayed.

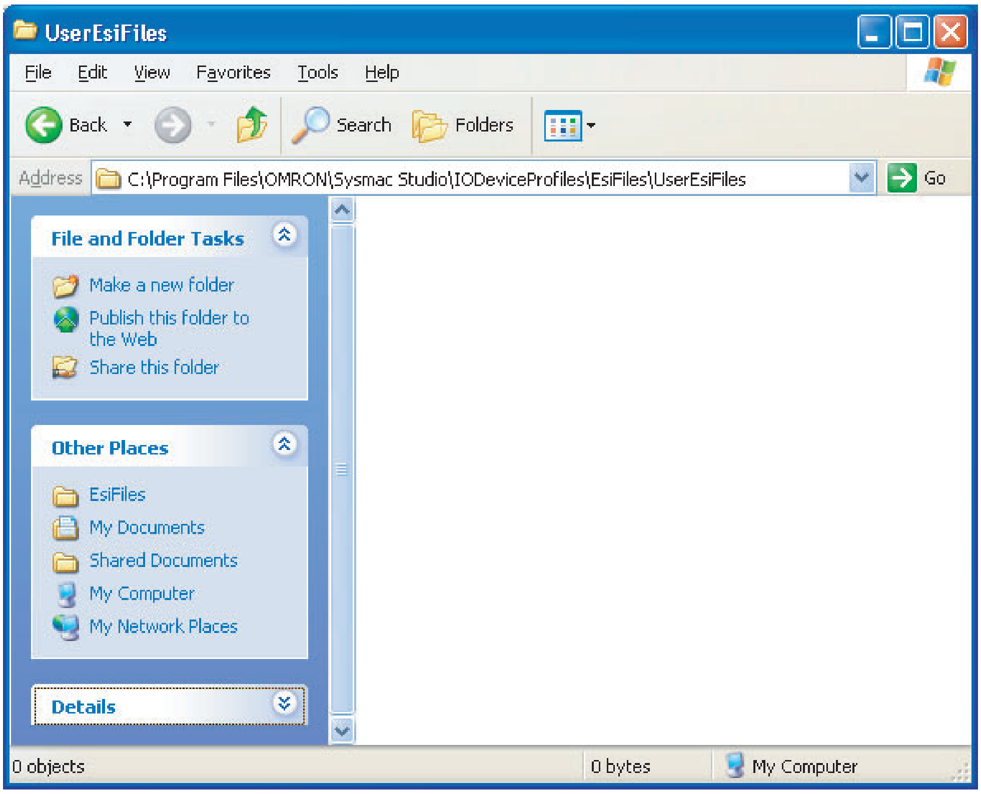
3 Click the **this folder** link in the ESI Library Dialog Box.



To add or delete an ESI file, exit from this software, and then add/delete the file to/from this folder. The change will be applied after restarting this software.

The contents of the EsiFiles folder are displayed.

4 Copy the ESI file for the EtherCAT slave that is manufactured by another company and paste it in the EsiFiles folder. Obtain the ESI file from the slave manufacturer. The ESI file must conform to the most recent ETG ESI specifications.



Address: C:\Program Files\OMRON\Sysmac Studio\IODeviceProfiles\EsiFiles\UserEsiFiles

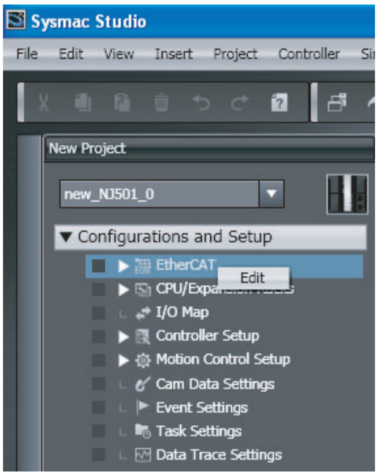
5 Restart the Sysmac Studio.

The ESI file that you installed is displayed in the ESI Library Dialog Box after you restart the Sysmac Studio.

● Procedure to Confirm ESI File Installation

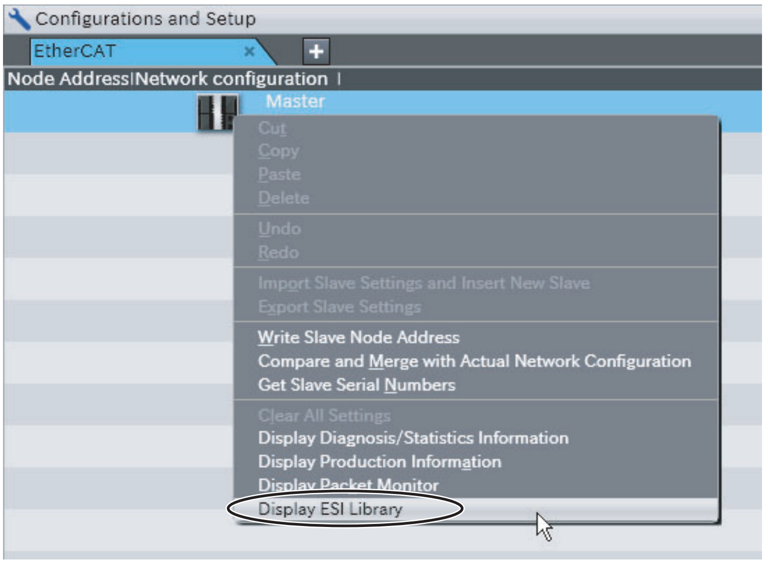
Use the following procedure to confirm that an ESI file was installed correctly

1 Double-click **EtherCAT** under **Configurations and Setup** in the Multiview Explorer. Or, right-click **EtherCAT** under **Configurations and Setup** and select ***Edit***.



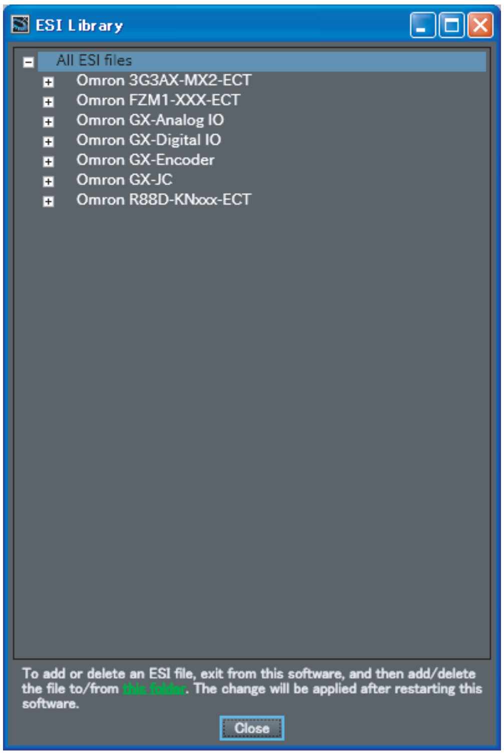
The edit pane is displayed.

2 Right-click the EtherCAT master that is displayed in the edit pane and select ***Display ESI Library***.


Configurations and Setup
EtherCAT
Node Address|Network configuration
Master
Cut
Copy
Paste
Delete
Undo
Redo
Import Slave Settings and Insert New Slave
Export Slave Settings
Write Slave Node Address
Compare and Merge with Actual Network Configuration
Get Slave Serial Numbers
Clear All Settings
Display Diagnosis/Statistics Information
Display Production Information
Display Packet Monitor
Display ESI Library

The ESI Library Dialog Box is displayed.

3 Click the + Icon to the left of the name of the ESI file that was added.



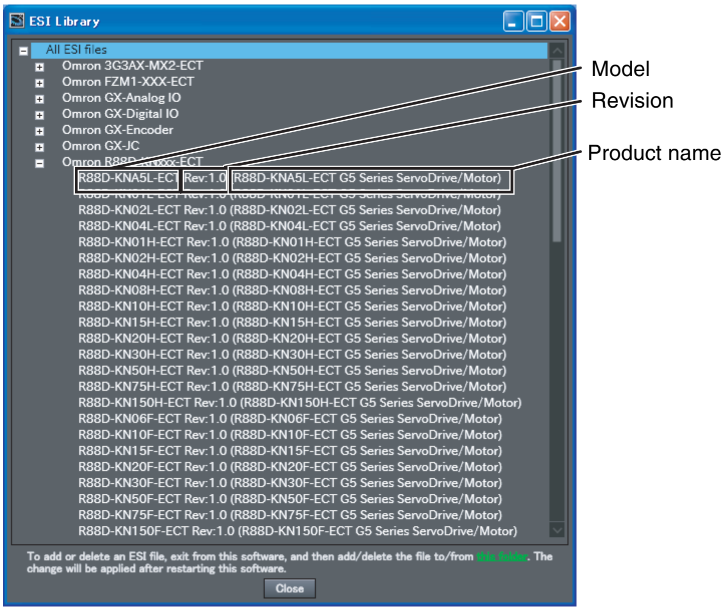
ESI Library

All ESI files
- Omron 3G3AX-MX2-ECT
- Omron FZM1-XXX-ECT
- Omron GX-Analog IO
- Omron GX-Digital IO
- Omron GX-Encoder
- Omron GX-JC
- Omron R88D-KNxxx-ECT

To add or delete an ESI file, exit from this software, and then add/delete the file to/from this folder. The change will be applied after restarting this software.

The slave definitions in the ESI file are expanded so that you can check the following items.

- Model
- Revision
- Product name

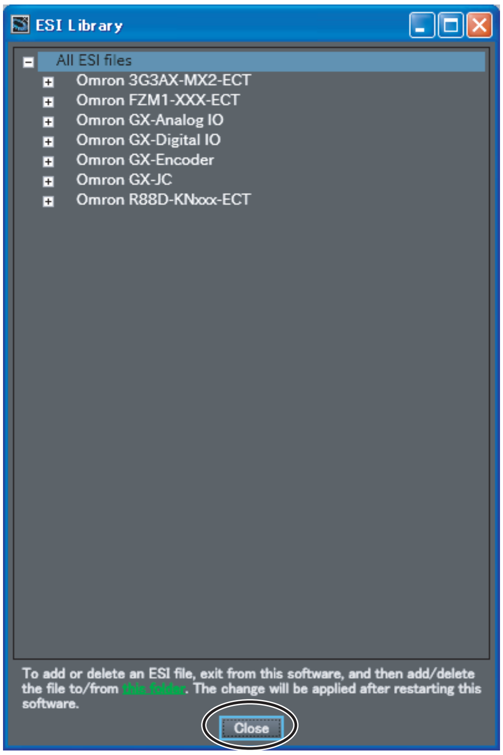


ESI Library

All ESI files
- Omron 3G3AX-MX2-ECT
- Omron FZM1-XXX-ECT
- Omron GX-Analog IO
- Omron GX-Digital IO
- Omron GX-Encoder
- Omron GX-JC
- Omron R88D-KNxxx-ECT
  - R88D-KNA5L-ECT Rev:1.0 (R88D-KNA5L-ECT G5 Series ServoDrive/Motor)
  - R88D-KN01L-ECT Rev:1.0 (R88D-KN01L-ECT G5 Series ServoDrive/Motor)
  - R88D-KN02L-ECT Rev:1.0 (R88D-KN02L-ECT G5 Series ServoDrive/Motor)
  - R88D-KN04L-ECT Rev:1.0 (R88D-KN04L-ECT G5 Series ServoDrive/Motor)
  - R88D-KN01H-ECT Rev:1.0 (R88D-KN01H-ECT G5 Series ServoDrive/Motor)
  - R88D-KN02H-ECT Rev:1.0 (R88D-KN02H-ECT G5 Series ServoDrive/Motor)
  - R88D-KN04H-ECT Rev:1.0 (R88D-KN04H-ECT G5 Series ServoDrive/Motor)
  - R88D-KN08H-ECT Rev:1.0 (R88D-KN08H-ECT G5 Series ServoDrive/Motor)
  - R88D-KN10H-ECT Rev:1.0 (R88D-KN10H-ECT G5 Series ServoDrive/Motor)
  - R88D-KN15H-ECT Rev:1.0 (R88D-KN15H-ECT G5 Series ServoDrive/Motor)
  - R88D-KN20H-ECT Rev:1.0 (R88D-KN20H-ECT G5 Series ServoDrive/Motor)
  - R88D-KN30H-ECT Rev:1.0 (R88D-KN30H-ECT G5 Series ServoDrive/Motor)
  - R88D-KN50H-ECT Rev:1.0 (R88D-KN50H-ECT G5 Series ServoDrive/Motor)
  - R88D-KN75H-ECT Rev:1.0 (R88D-KN75H-ECT G5 Series ServoDrive/Motor)
  - R88D-KN150H-ECT Rev:1.0 (R88D-KN150H-ECT G5 Series ServoDrive/Motor)
  - R88D-KN06F-ECT Rev:1.0 (R88D-KN06F-ECT G5 Series ServoDrive/Motor)
  - R88D-KN10F-ECT Rev:1.0 (R88D-KN10F-ECT G5 Series ServoDrive/Motor)
  - R88D-KN15F-ECT Rev:1.0 (R88D-KN15F-ECT G5 Series ServoDrive/Motor)
  - R88D-KN20F-ECT Rev:1.0 (R88D-KN20F-ECT G5 Series ServoDrive/Motor)
  - R88D-KN30F-ECT Rev:1.0 (R88D-KN30F-ECT G5 Series ServoDrive/Motor)
  - R88D-KN50F-ECT Rev:1.0 (R88D-KN50F-ECT G5 Series ServoDrive/Motor)
  - R88D-KN75F-ECT Rev:1.0 (R88D-KN75F-ECT G5 Series ServoDrive/Motor)
  - R88D-KN150F-ECT Rev:1.0 (R88D-KN150F-ECT G5 Series ServoDrive/Motor)

To add or delete an ESI file, exit from this software, and then add/delete the file to/from this folder. The change will be applied after restarting this software.

4 If an exclamation mark is not displayed, click the **Close** Button.



All ESI files
- Omron 3G3AX-MX2-ECT
- Omron FZM1-XXX-ECT
- Omron GX-Analog IO
- Omron GX-Digital IO
- Omron GX-Encoder
- Omron GX-JC
- Omron R88D-KNxxx-ECT

To add or delete an ESI file, exit from this software, and then add/delete the file to/from this folder. The change will be applied after restarting this software.

Additional Information

If an ESI file for a slave cannot be used in the Sysmac Studio, an exclamation mark is displayed to the left of the file name. If an exclamation mark is displayed, obtain an ESI file with the cause corrected from the slave manufacturer, and then install the ESI file again.

A-4 Glossary

Use the following list of EtherCAT terms for reference.

Term	Abbreviation	Description
AL status (application layer status)	–	Status for indicating information on errors that occur in an application on a slave.
CAN application protocol over EtherCAT	CoE	A CAN application protocol service implemented on EtherCAT.
CAN in Automation	CiA	CiA is the international users' and manufacturers' group that develops and supports higher-layer protocols.
device profile	–	Collection of device dependent information and functionality providing consistency between similar devices of the same device type.
device variables	–	Variables in the NJ-series CPU Unit to which process data on EtherCAT slaves are allocated. Slave process data is accessed by directly reading and writing these device variables from user applications on the NJ-series CPU Unit.
distributed clocks	DC	Clock distribution mechanism used to synchronize EtherCAT Slave Units and the EtherCAT Master Units.
EtherCAT Master Function Module	–	One of the function modules. This module controls the EtherCAT slaves as the EtherCAT master.
EtherCAT slave controller	ESC	A controller for EtherCAT slave communication.
EtherCAT slave information	ESI	An XML file that contains setting information for an EtherCAT Slave Unit.
EtherCAT state machine	ESM	An EtherCAT communication state machine.
EtherCAT Technology Group	ETG	The ETG is a global organization in which OEM, End Users and Technology Providers join forces to support and promote the further technology development.
index	–	Address of an object within an application process.
network configuration information	–	The EtherCAT network configuration information held by the EtherCAT master.
object	–	Abstract representation of a particular component within a device, which consists of data, parameters, and methods.
object dictionary	OD	Data structure addressed by Index and Sub-index that contains description of data type objects, communication objects and application objects.
Operational	–	A state in EtherCAT communications where SDO communications and I/O are possible.
packet monitoring	–	A function that enables the EtherCAT master to capture packets flowing over an EtherCAT line and store them in the master. You can start and stop capturing packets from the Sysmac Studio or with EtherCAT communications instructions.
PDO communications	–	An acronym for process data communications.
Pre-operational	–	A state in EtherCAT communications where only SDO communications are possible without being able to perform I/O.
process data	–	Collection of application objects designated to be downloaded cyclically or acyclically for the purpose of measurement and control.
process data communications	–	One type of EtherCAT communications that uses process data objects (PDOs) to exchange information in realtime with a fixed cycle. This is also called PDO communications.
process data object	PDO	Structure described by mapping parameters containing one or several process data entities.
receive PDO	RxPDO	A process data object received by an EtherCAT Slave Unit.

Term	Abbreviation	Description
Safe operational	–	A state in EtherCAT communications where only SDO communications and reading input data from slaves are possible. Outputs from slaves are not performed.
SDO communications	–	One type of EtherCAT communications that uses service data objects (SDOs) for communicating information when required.
service data object	SDO	CoE asynchronous mailbox communications where all objects in the object dictionary can be read and written.
Slave Information Interface	SII	Slave information that is stored in non-volatile memory in the slave.
subindex	–	Sub-address of an object within the object dictionary.
sync manager	SM	Collection of control elements to coordinate access to concurrently used objects.
system-defined variable	–	A variable in the NJ-series CPU Unit for providing information such as the EtherCAT communications status and error status. Status information about EtherCAT communications is obtained by reading system-defined variables from user applications in the NJ-series CPU Unit.
transmit PDO	TxPDO	A process data object sent from an EtherCAT Slave Unit.
WireShark	–	Freeware for monitoring and capturing packets.

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_EC_SlavAdrDupErr 7-3, 7-9
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