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OMRON

Machine Automation Controller NJ-series

EtherCAT
Connection Guide

OMRON Corporation

E3X-ECT Sensor Communication Unit
(EtherCAT Slave)

Network
Connection
Guide

SYSMAC
always in control

P529-E1-01

Table of Contents

1. Related Manuals 1
2. Terms and Definition 2
3. Remarks 3
4. Overview 5
5. Applicable Devices and Support Software 5
5.1. Applicable Devices 5
5.2. Device Configuration 6
6. EtherCAT Settings 7
6.1. EtherCAT Communications Settings 7
6.2. Allocating the Global Variables 7
7. Connection Procedure 9
7.1. Work Flow 9
7.2. Setting Up the Sensor Communication Unit 10
7.3. Setting Up the Controller 12
7.4. Checking the Connection Status 23
8. Initialization Method 28
8.1. Controller 28
9. Revision History 29

1. Related Manuals

The table below lists the manuals related to this document.
To ensure system safety, make sure to always read and heed the information provided in all Safety Precautions, Precautions for Safe Use, and Precaution for Correct Use of manuals for each device which is used in the system.

Cat.No.	Model	Manual name
W500	NJ501-[][][][]	NJ-series CPU Unit Hardware User's Manual
W501	NJ501-[][][][]	NJ-series CPU Unit Software User's Manual
W505	NJ501-[][][][]	NJ-series CPU Unit Built-in EtherCAT Port User's Manual
W504	SYSMAC-SE2[][][]	Sysmac Studio Version 1 Operation Manual
E413	E3X-ECT	E3X-ECT EtherCAT Sensor Communications Unit Operation Manual

2. Terms and Definition

Terms	Explanation and Definition
PDO Communications (Communications using Process Data objects)	This method is used for cyclic data exchange between the master unit and the slave units. PDO data (i.e., I/O data that is mapped to PDOs) that is allocated in advance is refreshed periodically each EtherCAT process data communications cycle (i.e., the period of primary periodic task). The NJ-series Machine Automation Controller uses process data communications for commands to refresh I/O data in a fixed control period, including I/O data for EtherCAT Slave Units, and the position control data for the Servomotors. It is accessed from the NJ-series Machine Automation Controller in the following ways. •With device variables for EtherCAT slave I/O •With Axis Variables for Servo Drive and encoder input slaves to which assigned as an axis
SDO Communications (Communications using Service Data objects)	This method is used to read and write the specified slave unit data from the master unit when required. The NJ-series Machine Automation Controller uses SDO communications for commands to read and write data, such as for parameter transfers, at specified times. The NJ-series Machine Automation Controller can read/write the specified slave data (parameters and error information, etc.) with the EC_CoESDORead (Read CoE SDO) instruction or the EC_CoESDOWrite (Write CoE SDO) instruction.
Slave	There are various types of slaves such as Servo Drives that handle position data and I/O terminals that control the bit signals. The slave receives output data sent from the master, and transmits input data to the master.
Node address	An address to identify the unit connected to EtherCAT.
ESI file (EtherCAT Slave Information file)	The ESI files contain information unique to the EtherCAT slaves in XML format. Install an ESI file into the Sysmac Studio, to allocate slave process data and make other settings.

3. Remarks

(1) Understand the specifications of devices which are used in the system. Allow some margin for ratings and performance. Provide safety measures, such as installing safety circuit in order to ensure safety and minimize risks for abnormally occurrence.

(2) To ensure system safety, always read and heed the information provided in all Safety Precautions, Precautions for Safe Use, and Precaution for Correct Use of manuals for each device which is used in the system.

(3) The users are encouraged to confirm the standards and regulations that the system must conform to.

(4) It is prohibited to copy, to reproduce, and to distribute a part of or whole part of this document without the permission of OMRON Corporation.

(5) This document provides the latest information as of March 2013. The information on this manual is subject to change for improvement without notice.

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Windows is a registered trademark of Microsoft Corporation in the USA and other countries.
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The following notation is used in this document.

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.

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

Indicates precautions on what to do and what not to do to ensure using the product safely.

Precautions for Correct Use

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

Additional Information

Provides useful information.
Additional information to increase understanding or make operation easier.

4. Overview

This document describes the procedure for connecting the Sensor Communication Unit (E3X-ECT) of OMRON Corporation (hereinafter referred to as OMRON) to NJ-series Machine Automation Controller (hereinafter referred to as Controller) on EtherCAT and provides the procedure for checking their connection.
Refer to *Section 7 Connection Procedure* to understand the setting method and key points to connect the devices via EtherCAT.

5. Applicable Devices and Support Software

5.1. Applicable Devices

The following devices can be connected.

Manufacturer	Name	Model	Version
OMRON	NJ series CPU Unit	NJ501-[][][][]	-
OMRON	Sensor Communications Unit (EtherCAT slave)	E3X-ECT	-
OMRON	Standard Fiber Sensor	E3X-HD0	-
OMRON	2CH Fiber Sensor	E3X-MDA0	-
OMRON	High-function Fiber Sensor	E3X-DA0-S	-
OMRON	Laser Amplifier	E3C-LDA0	-
OMRON	Proximity Sensor Amplifier	E2C-EDA0	-

Additional Information

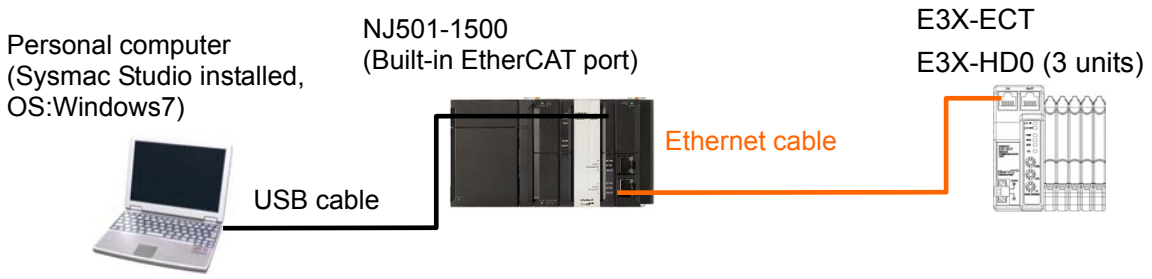
As applicable devices above, the devices listed in Section 5.2. are actually used in this document to check the connection. When using devices not listed in Section 5.2, check the connection by referring to the procedure in this document.

Additional Information

This document describes the procedure to establish the network connection. It does not provide information about operation, installation nor wiring method of each device.
For details on above products (other than communication connection procedures), refer to the manuals for the corresponding products or contact your OMRON representative.

5.2. Device Configuration

The hardware components to reproduce the connection procedure of this document are as follows.



Manufacturer	Name	Model	Version
OMRON	CPU Unit (Built-in EtherCAT port)	NJ501-1500	
OMRON	Power Supply Unit	NJ1W-PA3001	
OMRON	Sysmac Studio	SYSMAC-SE2[][][]	Ver.1.01
-	Personal computer (OS:Windows7)		
-	USB cable (USB 2.0 type B connector)		
OMRON	Ethernet cable (with industrial Ethernet connector)	XS5W-T421-[]M[]-K	
OMRON	Sensor Communications Unit (EtherCAT slave)	E3X-ECT	
OMRON	Fiber Sensor	E3X－HD0	

Precautions for Correct Use

The connection line of EtherCAT communication cannot be shared with other networks, such as Ethernet or EtherNet/IP.
The switching hub for Ethernet cannot be used for EtherCAT.
Please use the cable of Category 5 or higher, double-shielded with aluminum tape and braided shielding and the shielded connector of Category 5 or higher.
Connect the cable shield to the connector hood at both ends of the cable.

Additional Information

For information on the specifications of the Ethernet cable and network wring, refer to *Section 4 EtherCAT Network Wiring* in the *NJ-series CPU Unit Built-in EtherCAT Port User's Manual* (Cat. No. W505).

Additional Information

The system configuration in this document uses USB for the connection between the personal computer and the NJ-series CPU Unit. For information on how to install a USB driver, refer to *A-1 Driver Installation for Direct USB Cable Connection* of the *Sysmac Studio Operation Manual* (Cat.No. W504).

6. EtherCAT Settings

This section describes the specifications such as communication parameters and variables that are set in this document.

6.1. EtherCAT Communications Settings

The following is the setting of the destination device.

	E3X-ECT
Node address	001

6.2. Allocating the Global Variables

The device variables of the destination device are allocated to the Controller's global variables.
The relationship between the device data and the global variables is shown below.

■Input area (Controller ← Destination device)

Destination device data		Global variable name	Data type
Input bits 00 to 15		E001_Read_input_1st_word	WORD
	Sensor 1 output 1	E001_In_Bit00	BOOL
	Sensor 1 output 2	E001_In_Bit01	BOOL
	Sensor 2 output 1	E001_In_Bit02	BOOL
	Sensor 2 output 2	E001_In_Bit03	BOOL
	Sensor 3 output 1	E001_In_Bit04	BOOL
	Sensor 3 output 2	E001_In_Bit05	BOOL
	Sensor 4 output 1	E001_In_Bit06	BOOL
	Sensor 4 output 2	E001_In_Bit07	BOOL
	Sensor 5 output 1	E001_In_Bit08	BOOL
	Sensor 5 output 2	E001_In_Bit09	BOOL
	Sensor 6 output 1	E001_In_Bit00	BOOL
	Sensor 6 output 2	E001_In_Bit11	BOOL
	Sensor 7 output 1	E001_In_Bit12	BOOL
	Sensor 7 output 2	E001_In_Bit13	BOOL
	Sensor 8 output 1	E001_In_Bit14	BOOL
	Sensor 8 output 2	E001_In_Bit15	BOOL

Destination device data		Global variable name	Data type
Input bits 16 to 31		E001_Read_input_2nd_word	WORD
	Sensor 9 output 1	E001_In_Bit16	BOOL
	Sensor 9 output 2	E001_In_Bit17	BOOL
	Sensor 10 output 1	E001_In_Bit18	BOOL
	Sensor 10 output 2	E001_In_Bit19	BOOL
	Sensor 11 output 1	E001_In_Bit20	BOOL
	Sensor 11 output 2	E001_In_Bit21	BOOL
	Sensor 12 output 1	E001_In_Bit22	BOOL
	Sensor 12 output 2	E001_In_Bit23	BOOL
	Sensor 13 output 1	E001_In_Bit24	BOOL
	Sensor 13 output 2	E001_In_Bit25	BOOL
	Sensor 14 output 1	E001_In_Bit26	BOOL
	Sensor 14 output 2	E001_In_Bit27	BOOL
	Sensor 15 output 1	E001_In_Bit28	BOOL
	Sensor 15 output 2	E001_In_Bit29	BOOL
	Sensor 16 output 1	E001_In_Bit30	BOOL
	Sensor 16 output 2	E001_In_Bit31	BOOL
Sensor Communications Status 8 bits		E001_Sensor_Communication_Status	BYTE
	Sensor communication busy	E001_Sensor_Communication_Busy	BOOL
	Sensor communication error	E001_Sensor_Communication_Error	BOOL
Number of Sensors setting		E001_Number_of_Sensors_Setting	USINT
Number of Sensors (incl. dummy)		E001_Number_of_Sensors_with_Dummy	USINT

■Details of the status allocation (Controller ← Destination device)

Destination device data		Global variable name	Data type
Sysmac Error Status		E001_Sysmac_Error_Status	BYTE
	Error information at observation level	E001_Observation	BOOL
	Error information at minor fault level	E001_Minor_Fault	BOOL

7. Connection Procedure

This section describes how to connect the Sensor Communication Unit via EtherCAT.

This document explains the procedures for setting up the Controller and Sensor Communication Unit from the factory default setting. For the initialization, refer to *Section 8 Initialization Method*.

7.1. Work Flow

The following is the procedure for connecting to EtherCAT.

7.2 Setting Up the Sensor Communication Unit	Set up the Sensor Communication Unit.
↓	
7.2.1 Hardware Settings	Check the hardware switches on the Sensor Communication Unit.
↓	
7.3 Setting Up the Controller	Set up the Controller.
↓	
7.3.1 Starting the Sysmac Studio and Setting the EtherCAT network configuration	Start the Automation Software Sysmac Studio and set the EtherCAT network configuration.
↓	
7.3.2 Setting the Global Variables	Set global variables to use for the EtherCAT Slave Unit.
↓	
7.3.3 Transferring the Project Data	Transfer the project data from the Sysmac Studio to the Controller.
↓	
7.3.4 Setting the Number of Connected Sensors	Set the number of Sensors connected to the Sensor Communication Unit.
↓	
7.4 Checking the Connection Status	Check the EtherCAT network connection status.
↓	
7.4.1 Checking the Connection Status	Check that the EtherCAT communication is normally performed.
↓	
7.4.2 Checking Data that are Sent and Received	Check if the correct data are sent and received.

7.2. Setting Up the Sensor Communication Unit

Set up the Sensor Communication Unit.

7.2.1. Hardware Settings

Check the hardware switches on the Sensor Communication Unit.

Precautions for Correct Use

Make sure that the power supply is OFF when you perform the settings.

1	Make sure that the power supply of the Sensor Communication Unit is turned OFF. *If the power supply is turned ON, settings may not be applicable as described in the following procedure.
2	Mount the Sensor Communication Unit and Sensor Amplifier. *For information on mounting method, refer to *4-1-1 Mounting Method* in the *E3X-ECT EtherCAT Sensor Communications Unit Operation Manual* (Cat. No. E413).

3	Refer to the right figure and check the hardware switches located on the front panel of the Sensor Communication Unit. Set the NODE ADDRESS switches as follows: x 100 to 0 x 10 to 0 x 1 to 1 Set the node address to 001.	
4	Connect the Ethernet Communication cable to the built-in EtherCAT port on the front panel of the Sensor Communication Unit. Connect the power supply to the power supply connector.	

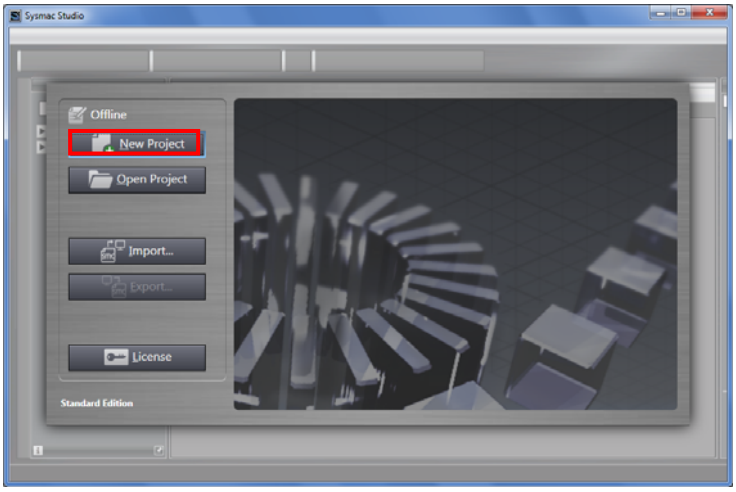
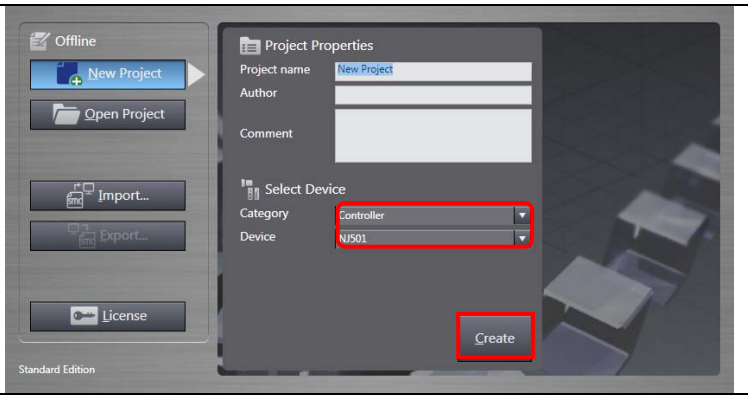
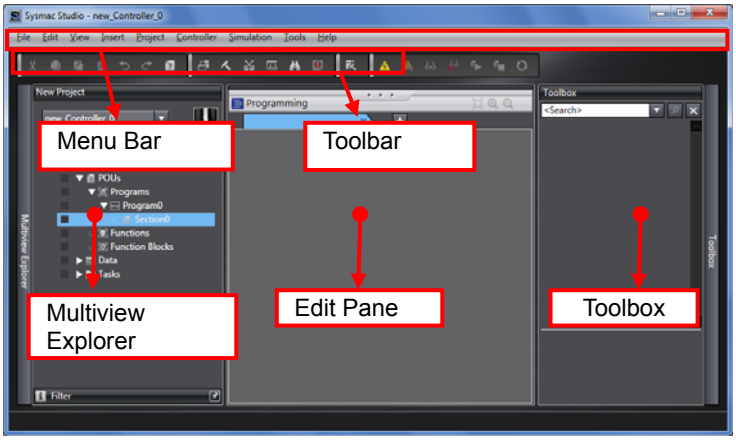
7.3. Setting Up the Controller

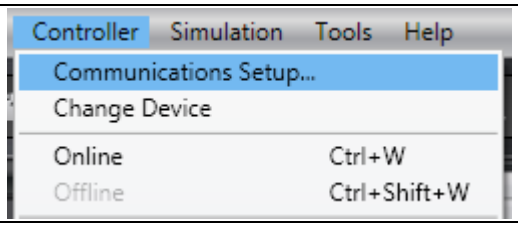
Set up the Controller.

7.3.1. Starting the Sysmac Studio and Setting the EtherCAT Network Configuration

Start the Automation Software Sysmac Studio and set the EtherCAT network configuration.

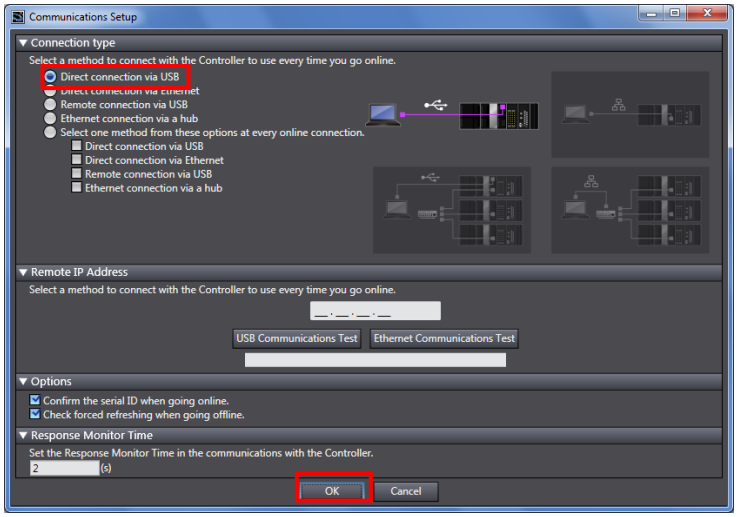
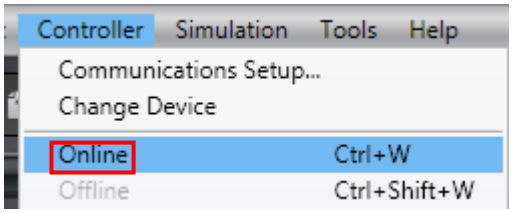
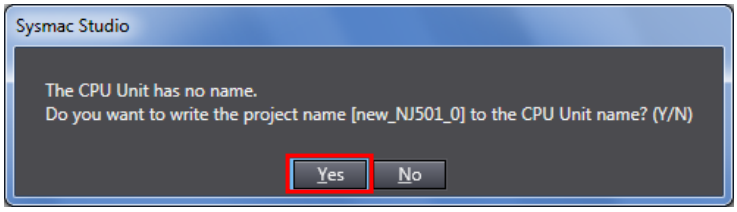
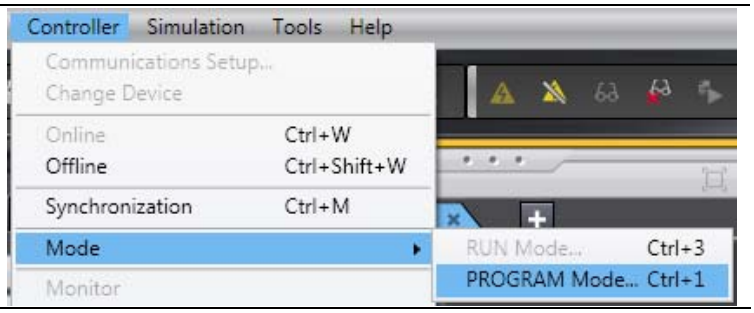
Install the software and USB driver beforehand.

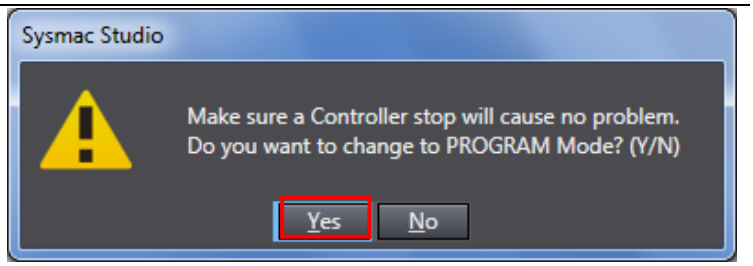
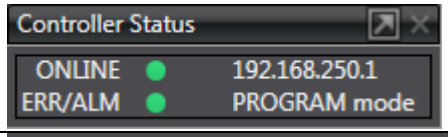
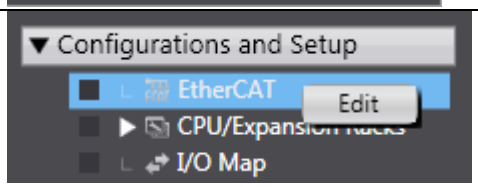
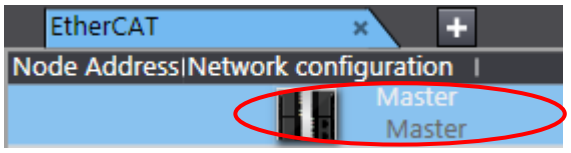
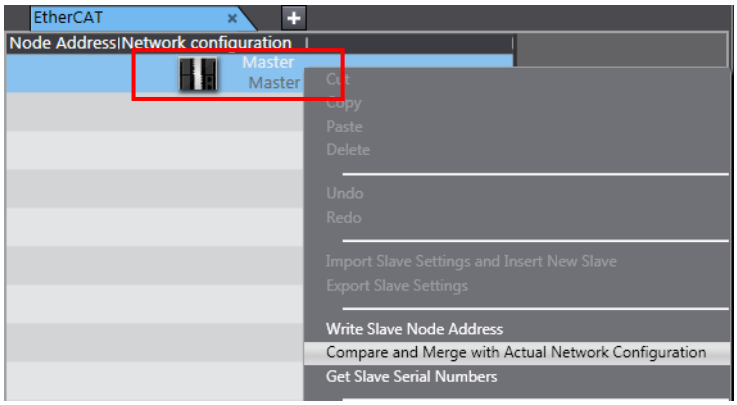
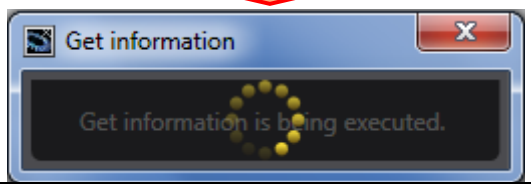
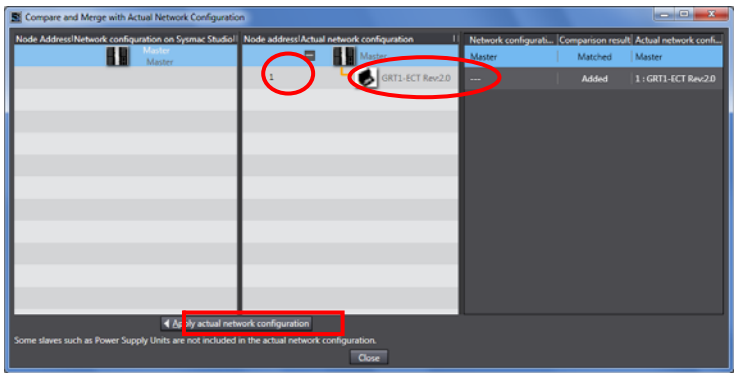
1	Start the Sysmac Studio. Click the **New Project** Button.	
2	The Project Properties Window is displayed. Check that Controller is selected from the category and NJ501 is selected from the device in the Select Device Field. Then, click the **Create** Button. *In this document, New Project is set as the project name.	
3	The New Project is displayed. There are Menu Bar and Toolbar in the upper part of the pane. The left pane is called Multiview Explorer, the right pane is called Toolbox and the middle pane is called Edit Pane.	

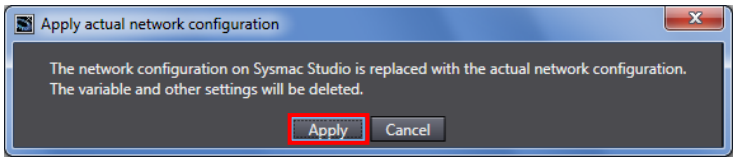
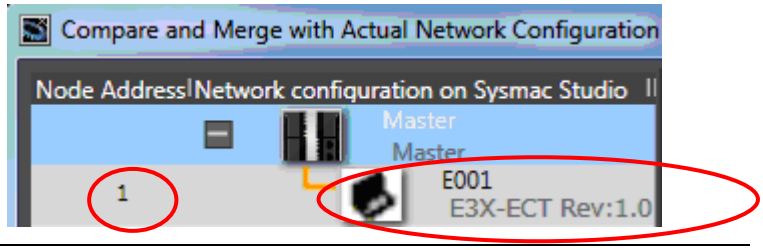
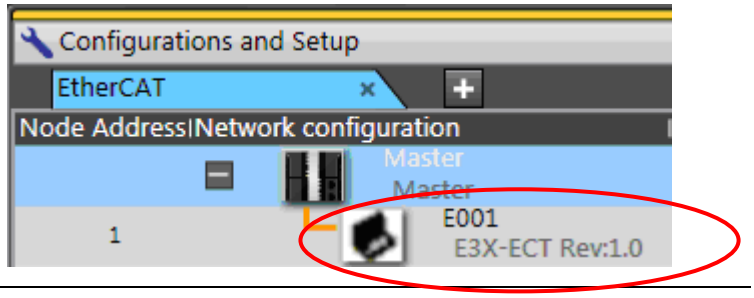
4	Select ***Communications Setup*** from the Controller Menu.	

Additional Information

For details on the online connections to a Controller, refer to *Section 5 Going Online with a Controller* in the *Sysmac Studio Version 1.0 Operation Manual* (Cat. No. W504).

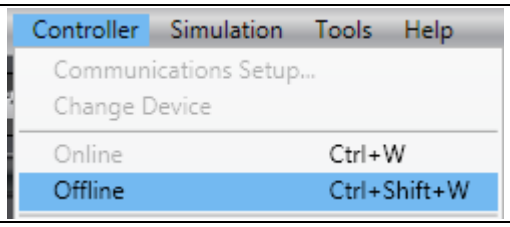
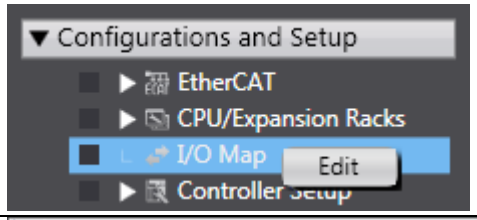
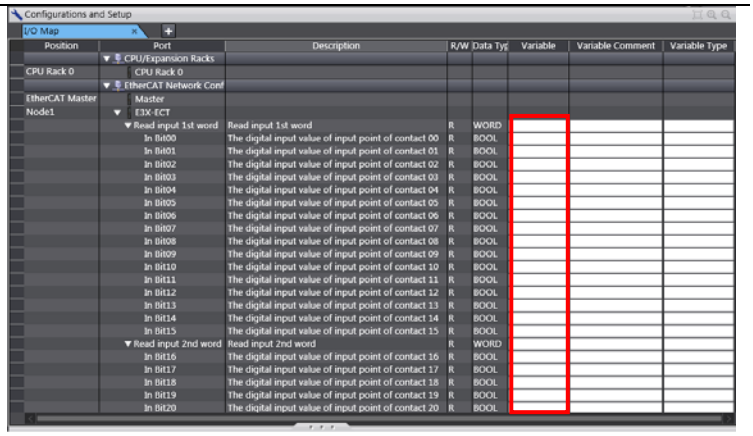
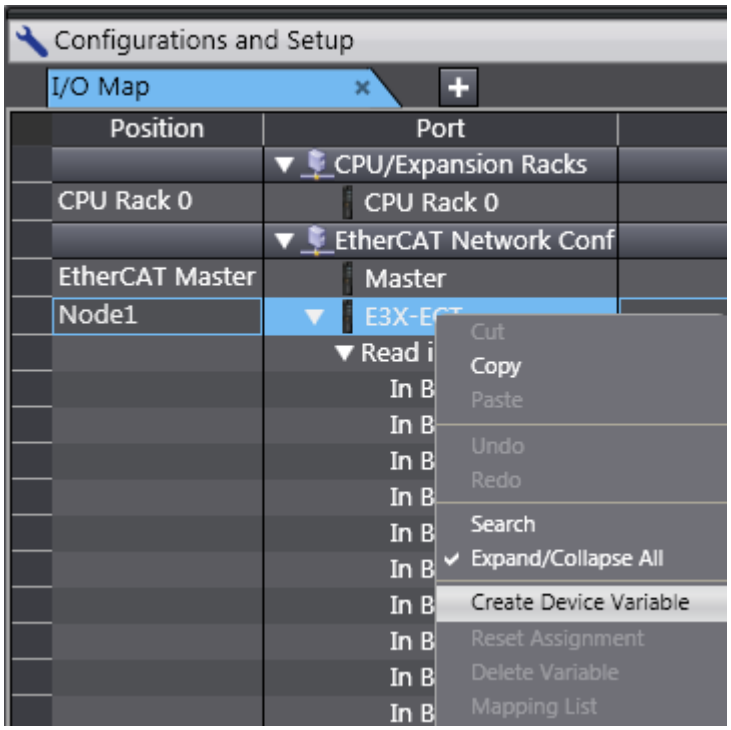
5	The Communications Setup Dialog Box is displayed. Select *Direct Connection via USB* from Connection Type. Click the **OK** Button.	
6	Select ***Online*** from the Controller Menu. A confirmation dialog is displayed. Click the **Yes** Button. *A displayed dialog depends on the status of the Controller used. Select the **Yes** Button or other button to proceed with the processing.	 
7	When an online connection is established, a yellow bar is displayed on the top of the Edit Pane.	
8	Select ***Mode*** - ***PROGRAM Mode*** from the Controller Menu.	

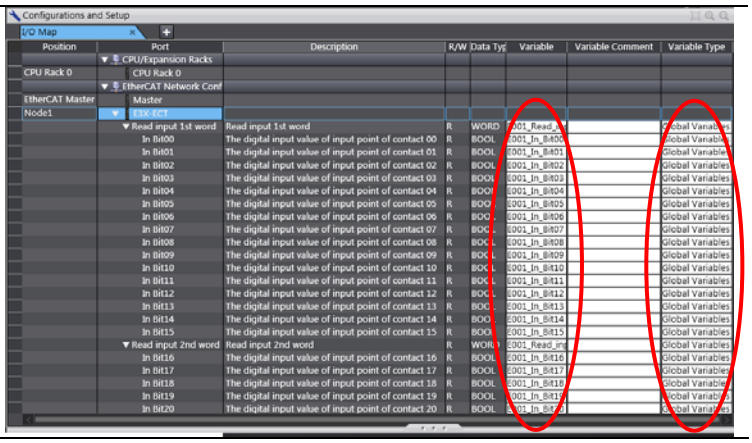
9	A confirmation dialog is displayed. Click the **Yes** Button. Check that the controller status on the Toolbox is changed to the PROGRAM mode.	 
10	Double-click **EtherCAT** under Configurations and Setup in the Multiview Explorer. Or, right-click **EtherCAT** under Configurations and Setup and select ***Edit***.	
11	The EtherCAT Tab Page is displayed in the Edit Pane.	
12	Right-click the Master Icon and select ***Compare and Merge with Actual Network Configuration***. A screen is displayed stating "Get information is being executed".	 
13	The Compare and Merge with Actual Network Configuration Pane is displayed. Node address 1 and E3X-ECT Rev:1.0 are added to the Actual network configuration after the comparison. Click the **Apply actual network configuration** Button.	

14	A confirmation dialog box is displayed. Click the **Apply** Button.	
	Check that node address 1 and E001 E3X-ECT Rev:1.0 are added to the Network configuration on Sysmac Studio.	
15	Node address 1 and E001 E3X-ECT Rev:1.0 are added to the EtherCAT Tab Page in the Edit Pane.	

7.3.2. Setting Global Variables

Set global variables to use for the EtherCAT Slave Unit.

1	Select ***Offline*** from the Controller Menu.	
2	Double-click **I/O Map** under Configurations and Setup on the Multiview Explorer, or right-click I/O Map and select ***Edit***.	
3	The I/O Map Tab is displayed on the Edit Pane. Click a column under Variable to enter a new variable.	
4	Right-click the row for Node1 and E3X-ECT. Then, select ***Create Device Variable***.	

5	The Variable names and Variable Types are automatically set.	

Additional Information

The device variable names are created automatically from a combination of the device names and the I/O port names.
For slave units, the default device names start with an "E" followed by a sequential number starting from "001".

Additional Information

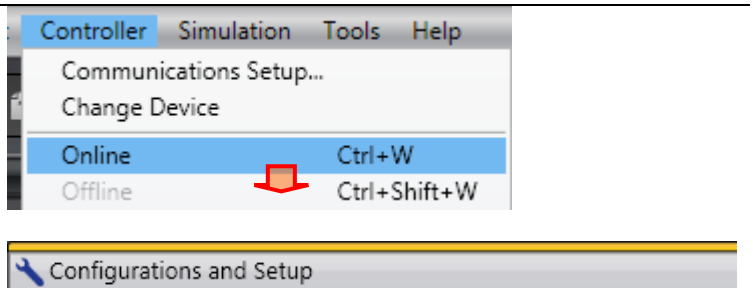
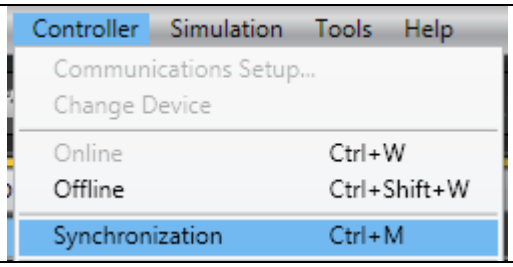
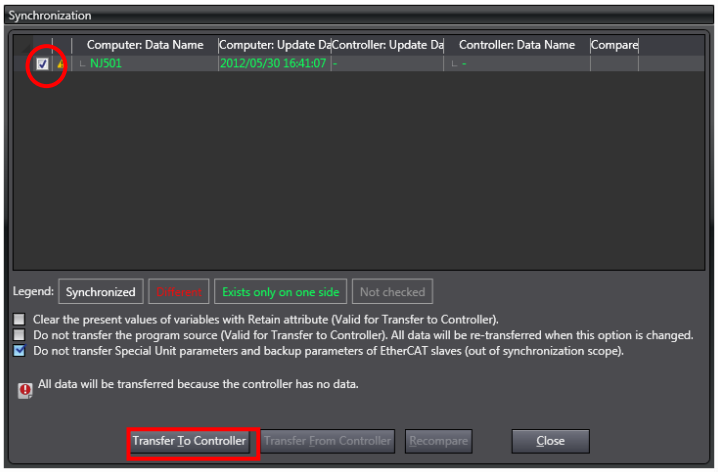
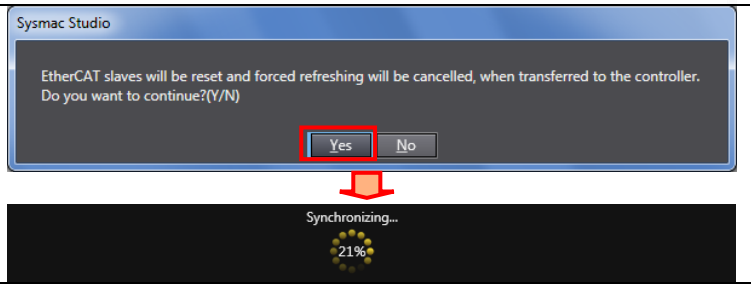
In the example above, a device variable name is automatically created for each slave. However, a name can also be automatically created for each I/O port.
Also, you can set any device variables.

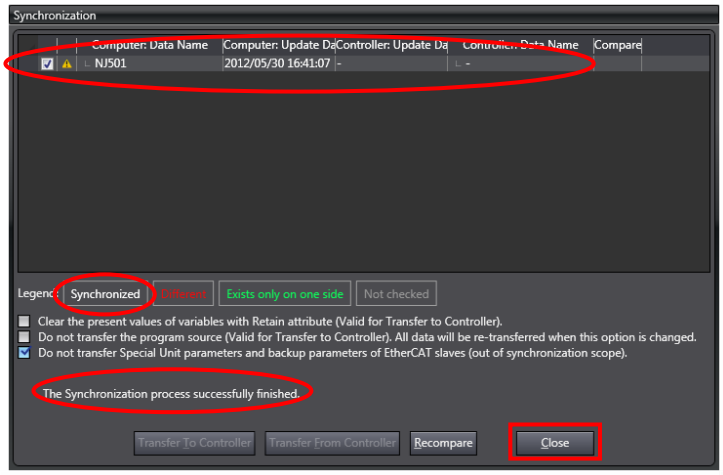
7.3.3. Transferring Project Data

Transfer the project data from the Sysmac Studio to the Controller.

⚠ WARNING

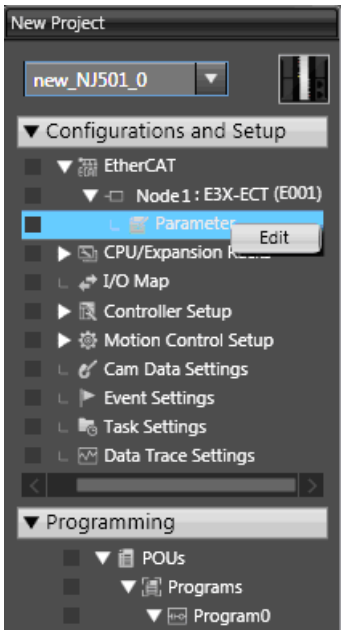
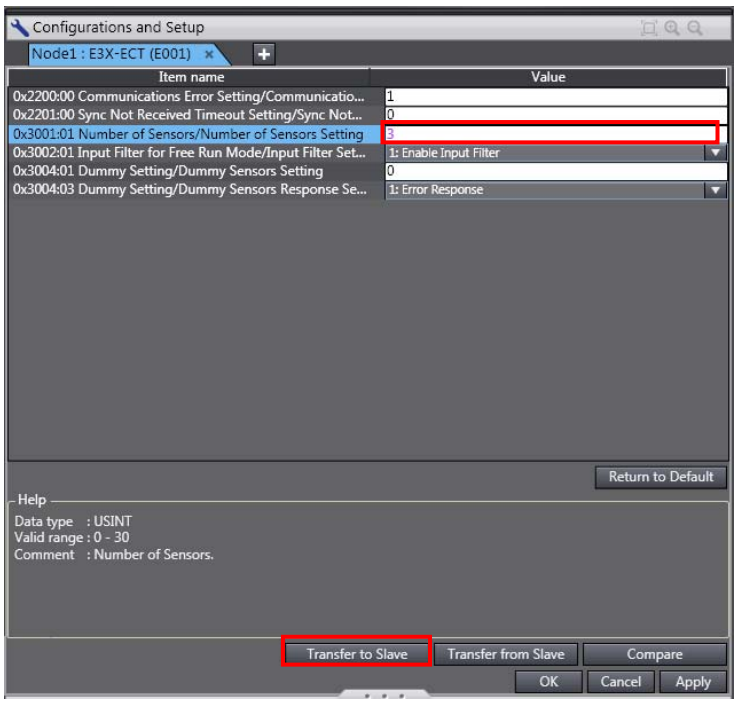
Always confirm safety at the destination node before you transfer a user program, configuration data, setup data, device variables, or values in memory used for CJ-series Units from the Sysmac Studio.
The devices or machines may perform unexpected operation regardless of the operating mode of the CPU Unit.

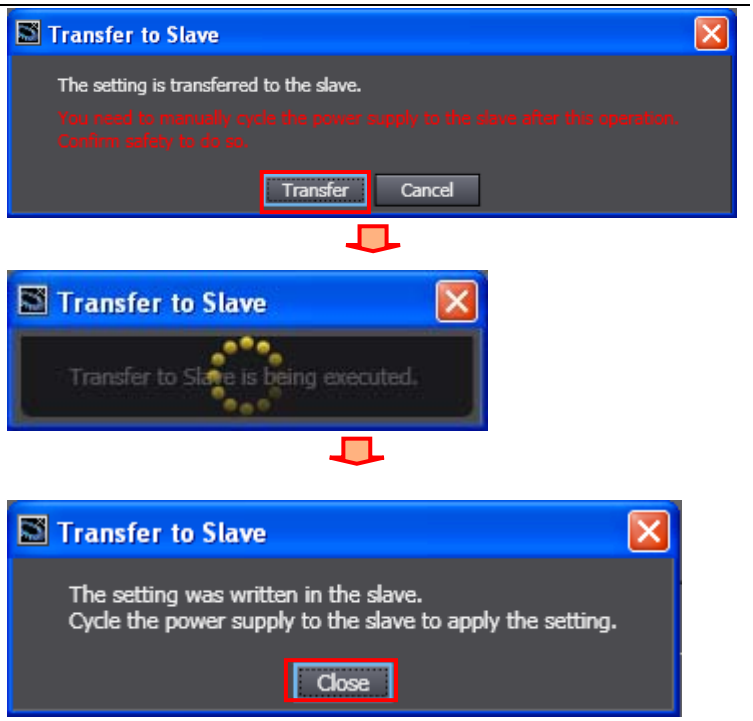
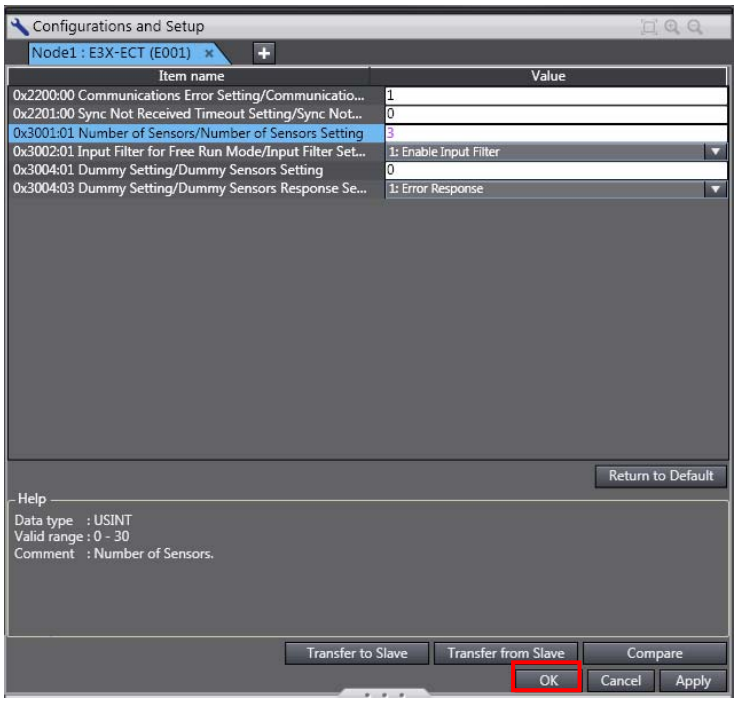
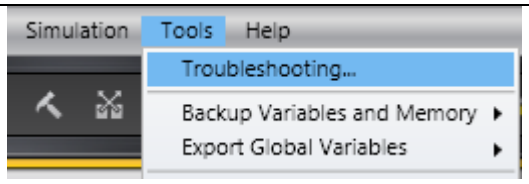
1	Select ***Online*** from the Controller Menu. When an online connection is established, a yellow bar is displayed on the top of the Edit Pane.	
2	Select ***Synchronization*** from the Controller Menu.	
3	The Synchronization Dialog Box is displayed. Check that the data to transfer (NJ501 in the right figure) is selected. Then, click the **Transfer to Controller** Button.	
4	A confirmation dialog is displayed. Click the **Yes** Button. A screen stating "Synchronizing" is displayed.	

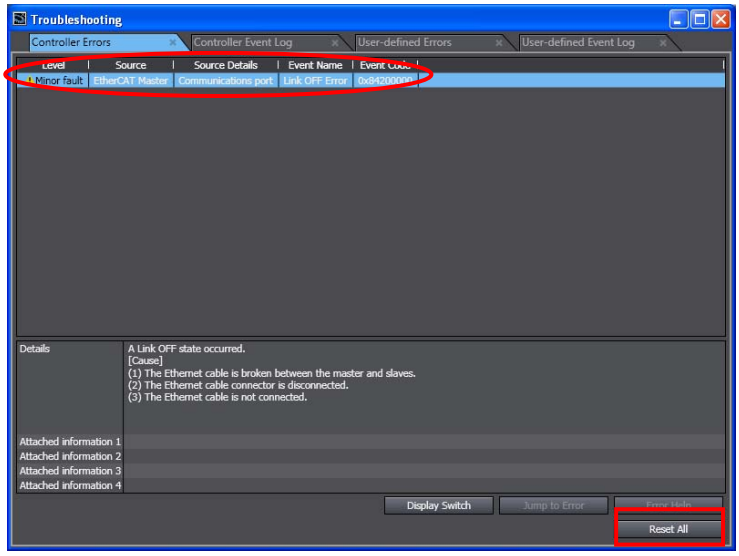
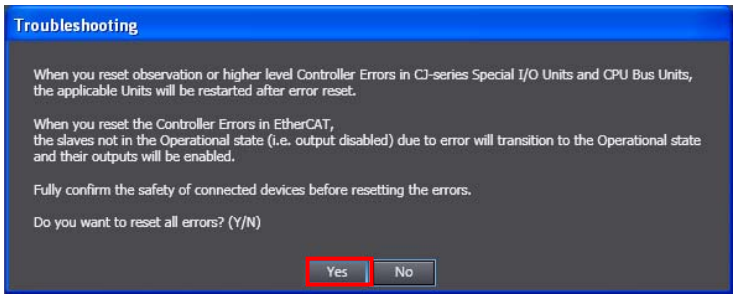
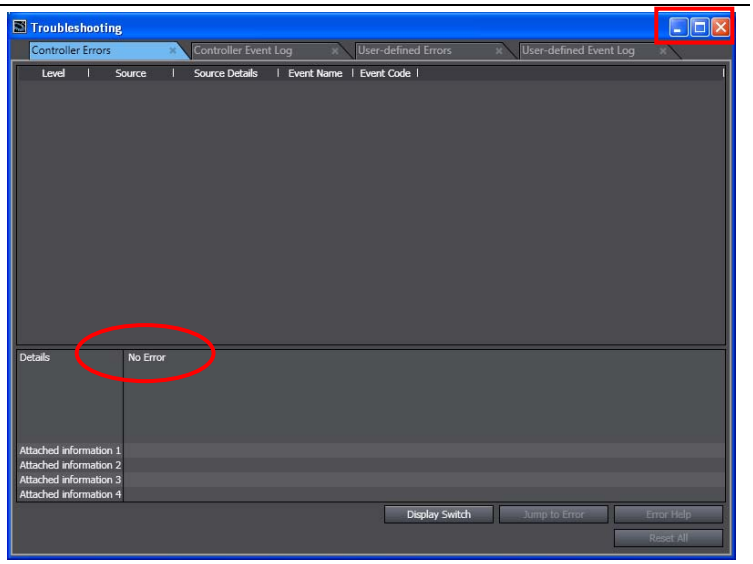
5	Check that the synchronized data is displayed with the color specified by “Synchronized”, and that a message is displayed stating "The synchronization process successfully finished". If there is no problem, click the **Close** Button. *If the synchronization fails, check the wiring and repeat the procedure described in this section.	

7.3.4. Setting the Number of Sensors to Connect

Set the number of Sensors connected to the Sensor Communication Unit

1	Double-click the **Parameter** under Configurations and Setup - EtherCAT - Node1:E3X-ECT(E001) in the Multiview Explorer or right-click **Parameter** and select ***Edit*** from the menu.	
2	Node1:E3X-ECT(E001) Tab Page is displayed in the Edit Pane. In the 0x3001:01 Number of Sensors/Number of Sensors Setting, set the number of Sensors connected to the Sensor Communication Unit (in this document, 3 is set). Click the **Transfer to Slave** Button.	

3	A confirmation dialog box is displayed. Click the **Transfer** Button. A screen is displayed indicating the transfer is being performed. A screen is displayed indicating the setting was written in the salve. Click the **Close** Button.	
4	After the transfer is completed, click the **OK** Button. Turn OFF the power supply to the Sensor Communication Unit. Turn ON the power supply again.	
5	Clear a Link OFF error that occurs when communications with the Sensor Communication Unit is disconnected. Select ***Troubleshooting*** from the Tools Menu.	

6	The Troubleshooting Dialog Box is displayed. A link OFF error is occurring. Click the **Reset All** Button.	
7	A confirmation dialog is displayed. Click the **Yes** Button.	
8	Check that a message stating No error is displayed. Click the button to exit.	

7.4. Checking the Connection Status

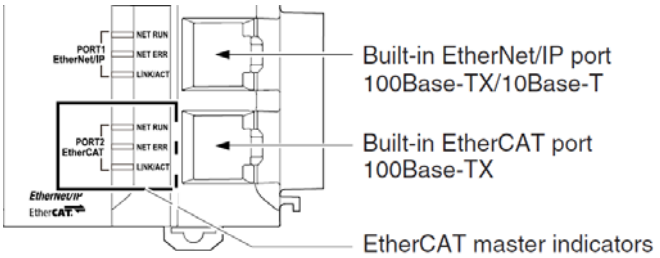
Check the EtherCAT network connection status.

7.4.1. Checking the Connection Status

Check that the EtherCAT communication is normally performed.

1 Check the LED indicators on the Controller and confirm that the EtherCAT communications are performed normally.

LED indicators in normal status.
[NET RUN]: Lit green
[NET ERR]: Not lit
[LINK/ACT]: Flashing yellow



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.

2 Check the indicators on the Sensor Communication Unit.
LED indicators in normal status:
[L/A IN] :Flashing
[PWR]: :Lit green
[RUN]: :Lit green
[ERR]: :Not lit
[SS] :Lit green

■LED indicators on the Sensor Communication Unit

Color	Status	Description
[PWR] indicator		
-	Not lit	Unit power OFF state
Green	Lit	The unit power (24 VDC) is supplied to the Slave Unit.
[ERR] indicator		
-	Not lit	No error
Red	Blinking	Communications Setting Error
Red	Single flash	Communications data error
Red	Double flash	Application WDT timeout
Red	Flashing	Boot error
Red	Lit	PDI WDT timeout

Color	Status	Description
[L/A IN] indicator		
-	Not lit	Link not established in physical layer
Green	Flashing	In operation after establishing link
Green	Lit	Link established in physical layer
[RUN] indicator		
-	Not lit	Link not established in physical layer
Green	Blinking	Pre-Operational state
Green	Single flash	Safe-Operational state
Green	Lit	Operational state

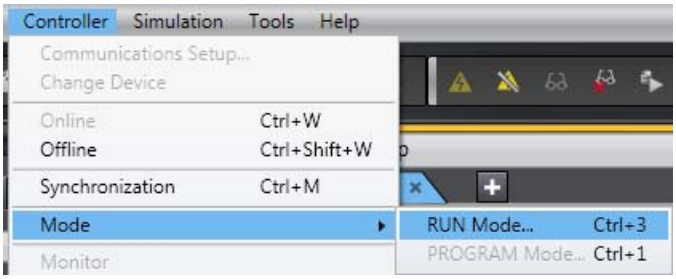
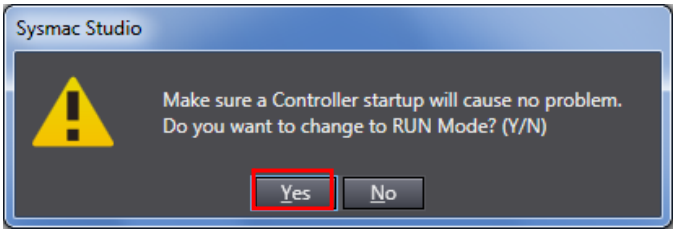
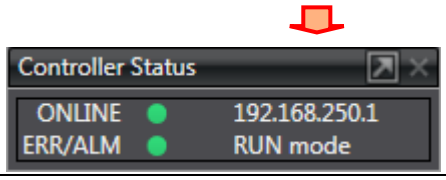
Color	Status	Description
[L/A OUT] indicator		
-	Not lit	Link not established in physical layer
Green	Flashing	In operation after establishing link
Green	Lit	Link established in physical layer
[SS] indicator		
-	Not lit	Power OFF or power supply ON is being initial confirmed.
Green	Lit	Normal: The number of connected Sensors agrees with the setting.
Red	Lit	Sensor Error: The number of connected Sensors is different from the setting.

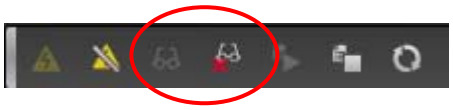
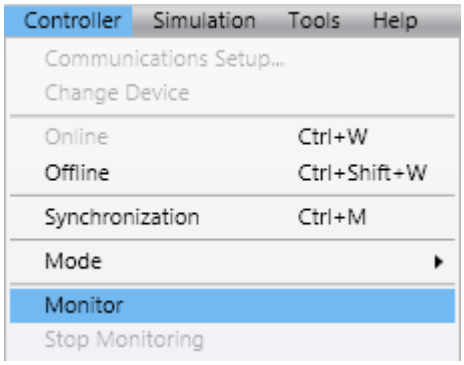
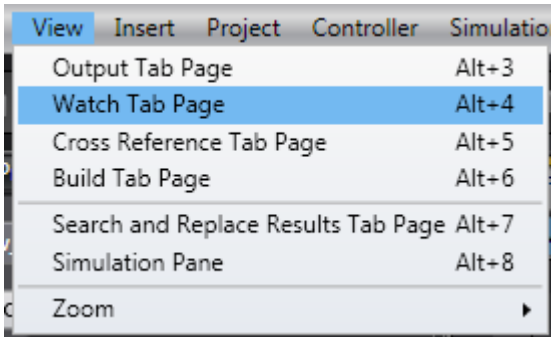
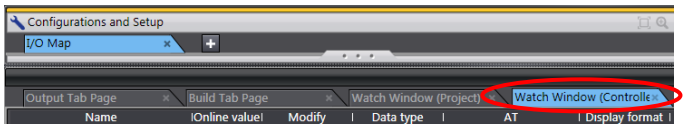
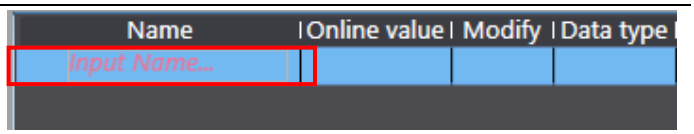
7.4.2. Checking Data That Are Sent and Received

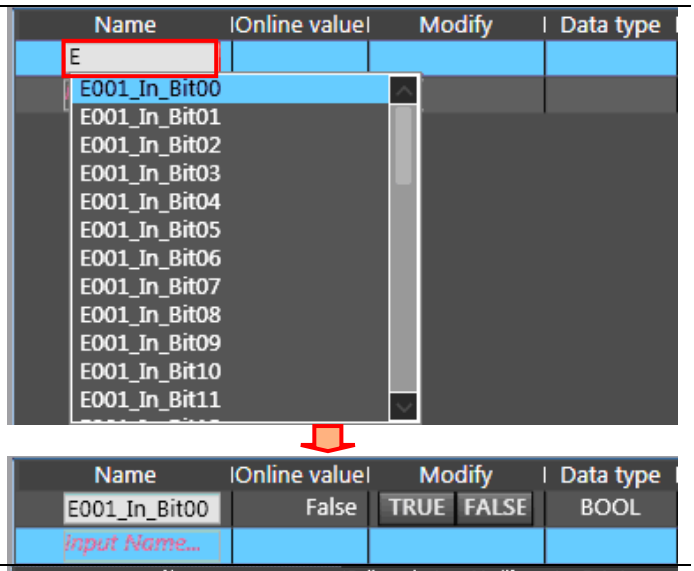
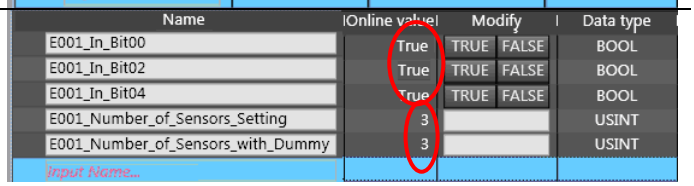
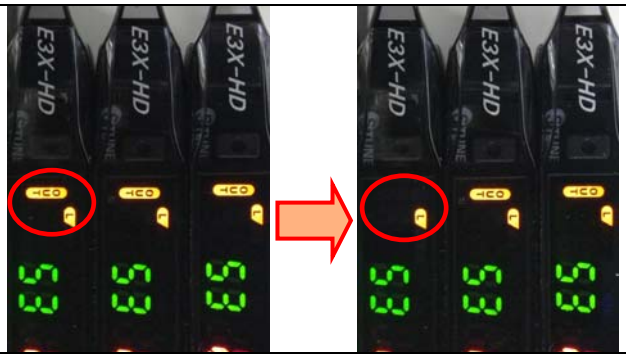
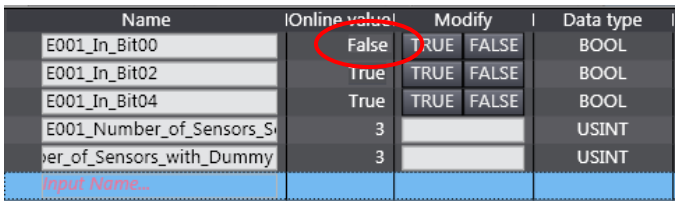
Check if the correct data are sent and received.

⚠ Caution

Sufficiently confirm safety before you change the values of variables on a Watch Tab Page when the Sysmac Studio is online with the CPU Unit. Incorrect operation may cause the devices that are connected to Output Units to operate regardless of the operating mode of the Controller.

1	Select ***Mode*** - ***RUN Mode*** from the Controller Menu.	
2	A confirmation dialog is displayed. Click the **Yes** Button. Check that the controller status on the Toolbox is changed to the RUN mode.	 

3	Check the Monitor Button and Stop Monitoring Button on the toolbar of the Sysmac Studio to see if the Controller is in monitor status. Check that the Monitor Button is selected and is not selectable and that the Stop Monitoring Button is selectable (monitor status) as shown in the right figure. *If the Controller is not in monitor status, select ***Monitor*** from the Controller Menu of the Sysmac Studio. *If the Sysmac Studio is offline, go online by following steps 4 to 7 of 7.3.1.	 Monitor Stop Monitoring 
4	Select ***Watch Tab Page*** from the View Menu.	
5	The Watch Window (Controller) Tab Page is displayed in the lower section of the Edit Pane.	
6	Click the cell that states Input Name at the bottom of the Watch Tab Page.	

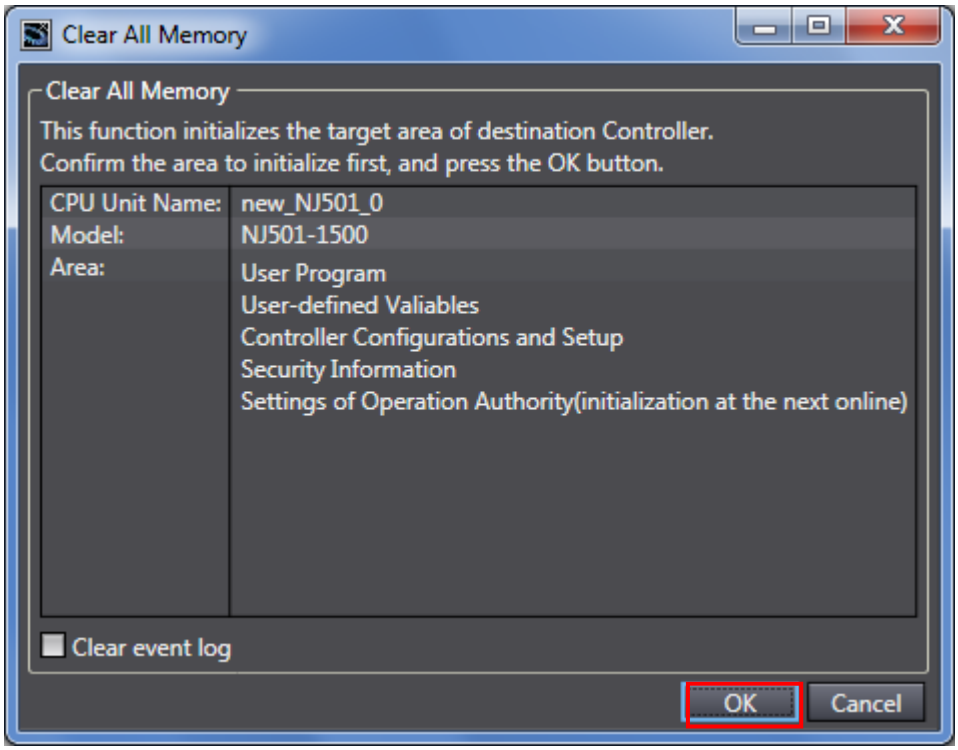
7	Now, characters can be entered. Enter the device variable name. Enter *E001_In_Bit00* (input 00). Type the first character E. A list of device variables starting with E is displayed. Double-click *E001_In_Bit00*. *E001_In_Bit00* is entered in the Name Column.	
8	Click the cell that states Input Name at the bottom of the Watch Tab Page. Enter *E001_In_Bit02* (input 02), *E001_In_Bit04* (input 04), *E001_Number_of_Sensors_Setting* (number of Sensors setting), and *E001_Number_of_Sensors_with_Dummy* (number of Sensors (incl. dummy). Check the status of the inputs and the number of the Sensors. In this example, the number of Sensors is 3 and all inputs are TRUE (ON).	
9	Operate the Sensor (Sensor 1) on the far left. In the example on the right, OUT is turned OFF.	
10	Check that the online value of *E001_In_Bit00* (input 00) is changed from True to False.	

8. Initialization Method

This document explains the setting procedure from the factory default setting.
If the device settings have been changed from the factory default setting, some settings may not be applicable as described in this procedure.

8.1. Controller

To initialize the settings of the Controller, select ***Clear All Memory*** from the Controller Menu of the Sysmac Studio.



9. Revision History

Revision code	Date of revision	Revision reason and revision page
01	Mar. 26, 2013	First edition

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