Machine Automation Controller NJ-series

EtherCAT Connection Guide

OMRON Corporation

GX-series Encoder Input Terminal

always in control

P519-E1-01

Table of Contents

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
W488	GX Series	EtherCAT Slave Units User's 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 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 Slave Units, and the position control data for the Servomotors. Variables are used to access 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 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 EtherCAT port built into the NJ-series CPU Unit uses SDO communications for commands to read and write data, such as for parameter transfers, at specified times. 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 slave units (parameters, error information, etc.)
Slave Unit	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 the EtherCAT network.
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 easily 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 of abnormal 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 February 2013. The information contained in this document is subject to change for improvement without notice.

About Intellectual Property Right and Trademarks

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 Encoder Input Terminal (GX-EC02[]1) of OMRON Corporation (hereinafter referred to as OMRON) to the 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	NJ5-series CPU Unit	NJ501-[][][][]	-
OMRON	Encoder Input Terminal	GX-EC0211 GX-EC0241	1.1

Additional Information

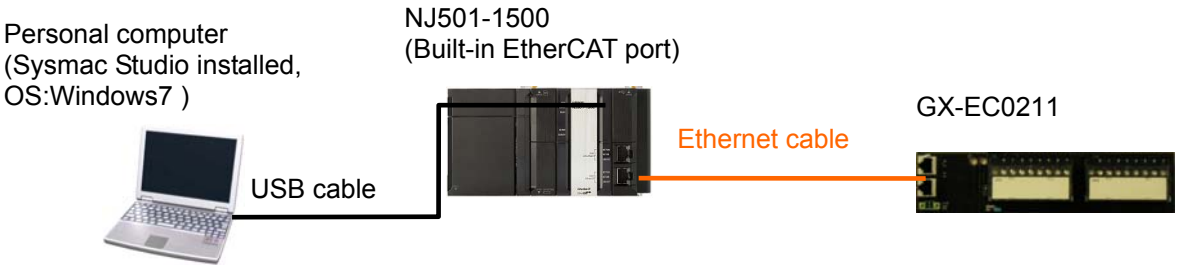
As applicable devices above, the devices listed in Section 5.2. are actually used in this document to check the connection. When using devices not listed in Section 5.2, check the connection by referring to the procedure in this document.

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 the 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.1.00
-	Personal computer (OS:Windows7)		
-	USB cable (USB 2.0 type B connector)		
OMRON	Ethernet cable (with industrial Ethernet connector)	XS5W-T421-[]M[]-K	
OMRON	Encoder Input Terminal	GX-EC0211	V1.1

Precautions for Correct Use

The connection line of EtherCAT communication cannot be shared with other network, 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.

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 provides specifications such as communications parameters and variable names that are set in this document.

6.1. EtherCAT Communications Settings

The following is the setting of the destination device.

	GX-EC0211
Node address	01

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.

▪Output area (Controller → Destination device)

Destination device data	Global variable name	Data type
CH1 Soft switch setting	E001_CH1_Instruction_Bits	WORD
CH1 Count possible command	E001_CENB1	BOOL
CH1 Present value preset execution	E001_PSET1	BOOL
CH1 Present value internal reset execution	E001_INPRES1	BOOL
CH1 Present value external reset enabled	E001_EXRESE1	BOOL
CH1 External latch A enabled	E001_EXLAE1	BOOL
CH1 External latch B enabled	E001_EXLBE1	BOOL
CH1 Clear present value external reset generation flag	E001_EXRESC1	BOOL
CH1 Clear external latch A generation flag	E001_EXLAC1	BOOL
CH1 Clear external latch B generation flag	E001_EXLBC1	BOOL
CH2 Soft switch setting	E001_CH2_Instruction_Bits	WORD
CH2 Count possible command	E001_CENB2	BOOL
CH2 Present value preset execution	E001_PSET2	BOOL
CH2 Present value internal reset execution	E001_INPRES2	BOOL
CH2 Present value external reset enabled	E001_EXRESE2	BOOL
CH2 External latch A enabled	E001_EXLAE2	BOOL
CH2 External latch B enabled	E001_EXLBE2	BOOL
CH2 Clear present value external reset generation flag	E001_EXRESC2	BOOL

Destination device data		Global variable name	Data type
	CH2 Clear external latch A generation flag	E001_EXLAC2	BOOL
	CH2 Clear external latch B generation flag	E001_EXLBC2	BOOL
CH1 Preset command value		E001_CH1_Preset_Value	UDINT
CH2 Preset command value		E001_CH2_Preset_Value	UDINT

▪Input area (Controller ← Destination device)

Destination device data		Global variable name	Data type
CH1 Status		E001_CH1_Status_Bits	BYTE
	CH1 Present value preset execution completed	E001_PACK1	BOOL
	CH1 Present value internal reset execution completed	E001_RACK1	BOOL
	CH1 External reset generation flag	E001_EXRES1	BOOL
	CH1 External latch A generation flag	E001_EXLA1	BOOL
	CH1 External latch B generation flag	E001_EXLB1	BOOL
	CH1 Present value preset set value error	E001_CERR1	BOOL
	CH1 Counter operation state	E001_CRUN1	BOOL
CH2 Status		E001_CH2_Status_Bits	BYTE
	CH2 Present value preset execution completed	E001_PACK2	BOOL
	CH2 Present value internal reset execution completed	E001_RACK2	BOOL
	CH2 External reset generation flag	E001_EXRES2	BOOL
	CH2 External latch A generation flag	E001_EXLA2	BOOL
	CH2 External latch B generation flag	E001_EXLB2	BOOL
	CH2 Present value preset set value error	E001_CERR2	BOOL
	CH2 Counter operation state	E001_CRUN2	BOOL
CH1 Present value		E001_CH1_Position_Value	UDINT
CH2 Present value		E001_CH2_Position_Value	UDINT
CH1 Latch A value		E001_CH1_Latch_Value_A	UDINT
CH2 Latch A value		E001_CH2_Latch_Value_A	UDINT
CH1 Latch B value		E001_CH1_Latch_Value_B	UDINT
CH2 Latch B value		E001_CH2_Latch_Value_B	UDINT

▪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

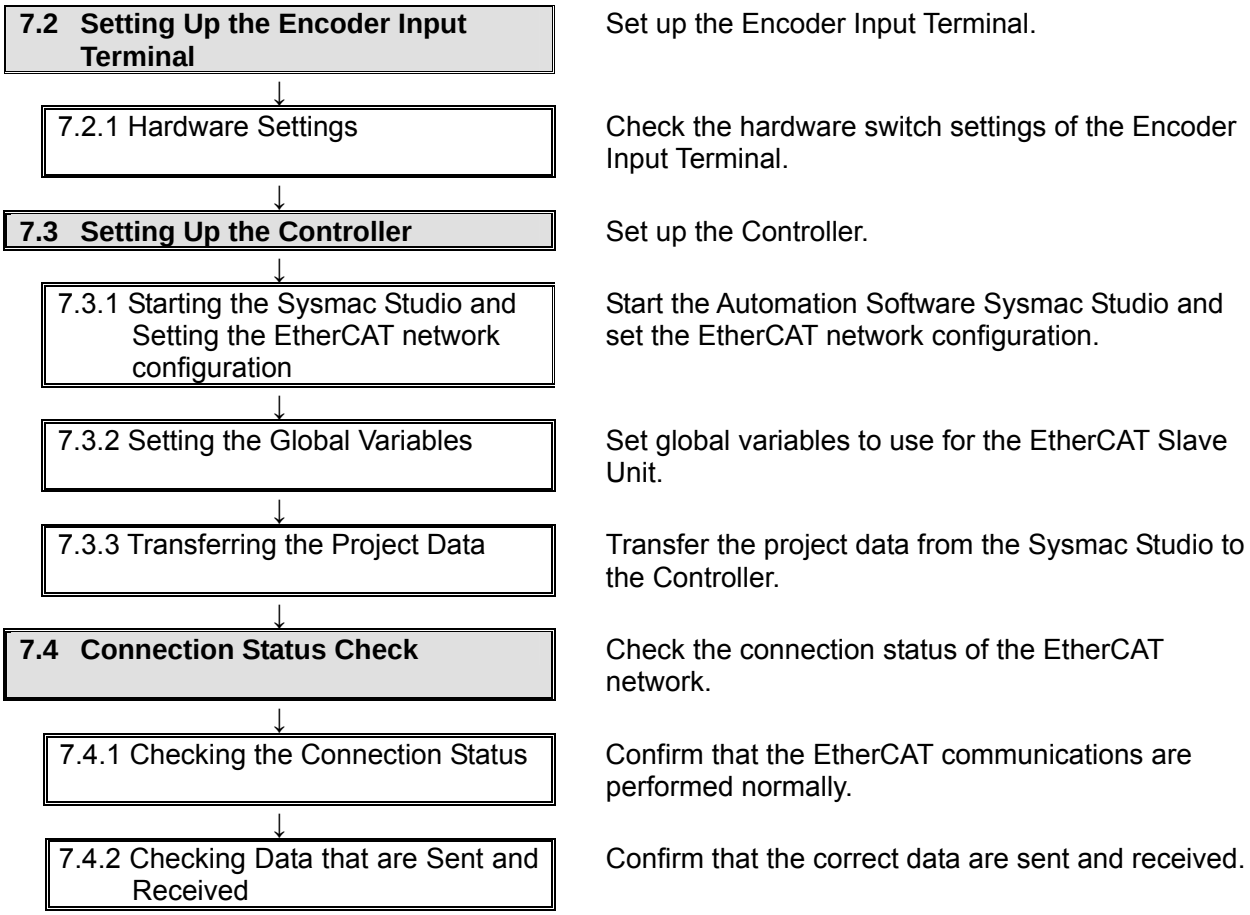
7. Connection Procedure

This section describes the procedure for connecting the Controller via EtherCAT.

This document explains the procedures for setting up the Controller and Encoder Input Terminal 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 the EtherCAT.



7.2. Setting Up the Encoder Input Terminal

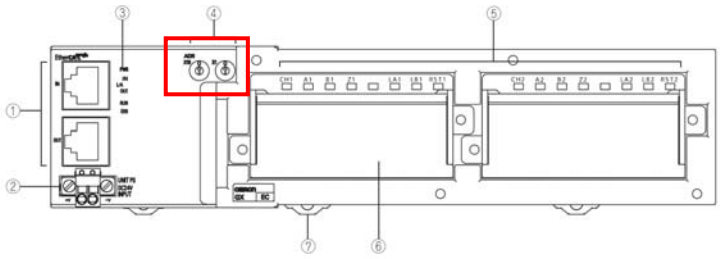
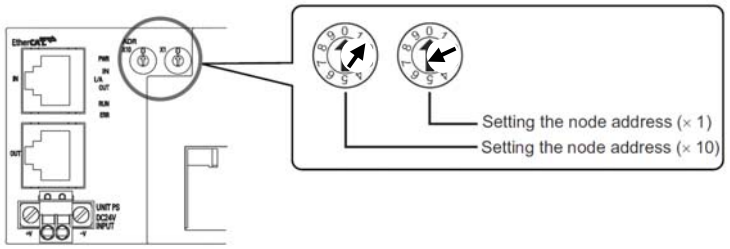
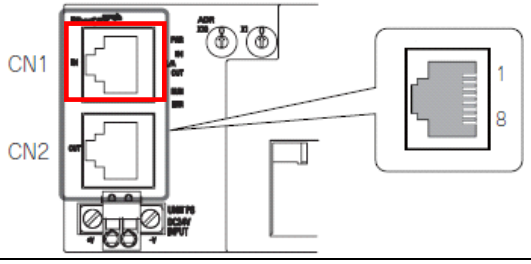
Set up the Encoder Input Terminal.

7.2.1. Hardware Setting

Check the hardware switch settings of the Encoder Input Terminal.

Precautions for Correct Use

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

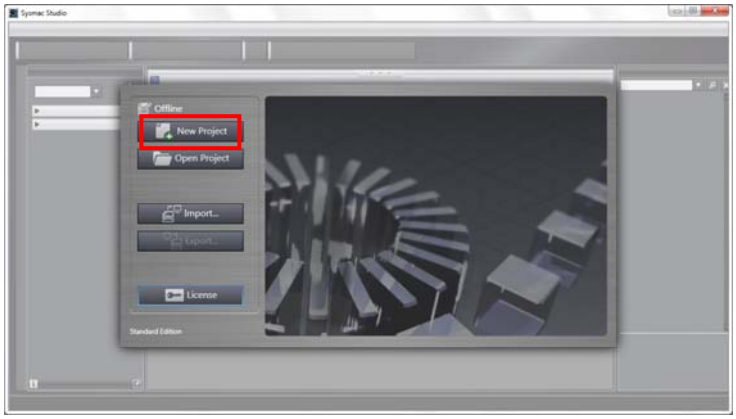
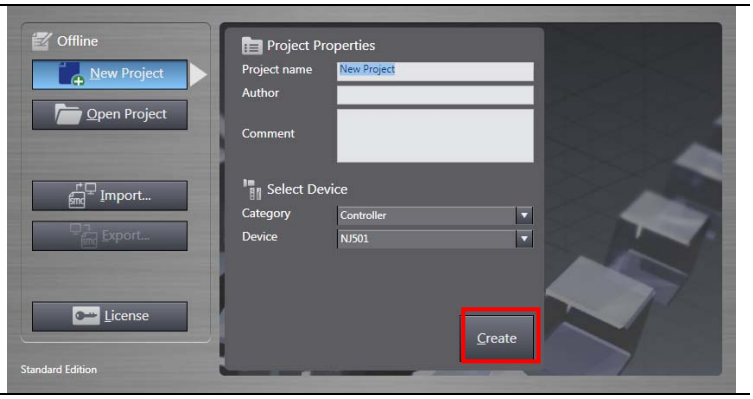
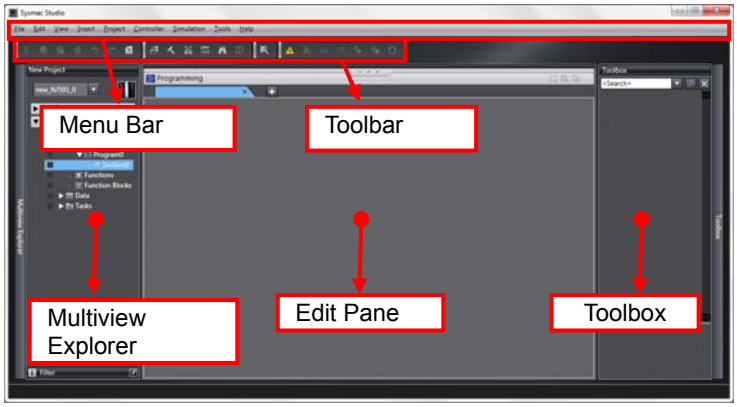
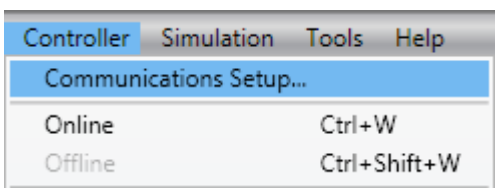
1	Confirm that the power supply to the Encoder Input Terminal is OFF. *If the power supply is turned ON, settings may not be applicable as described in the following procedure.	
2	Refer to the right figure and check the hardware switches.	 **No.** / **Name** (1) Communications connectors (2) Unit power supply connector (3) Status indicators (4) Node address switches (5) Input indicators
3	Set the node address switches as follows. x10: 0, x1: 1 *Set the node address to "01"	
4	Connect the Ethernet cable to communication connector CN1 and turn ON the power supply.	

7.3. Setting Up the Controller

Set up the Controller.

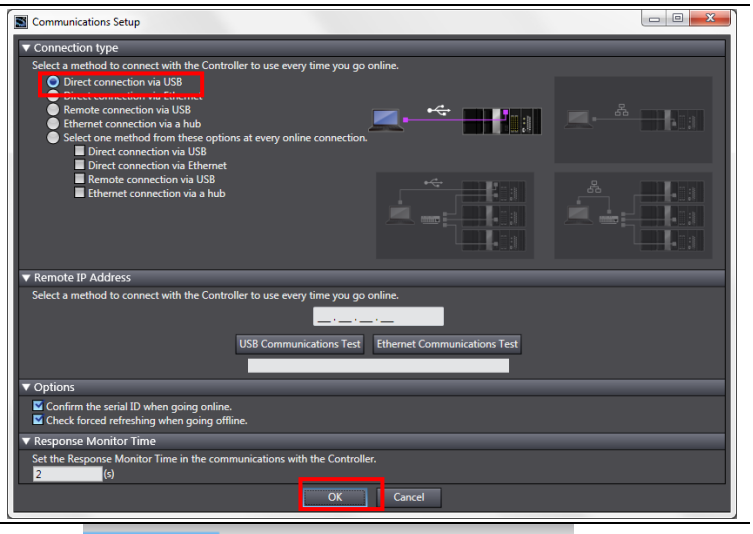
7.3.1. Starting the Sysmac Studio and Setting the EtherCAT Network Configuration

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 Dialog Box is displayed. Click the **Create** Button. *In this document, New Project is set as the project name.	
3	The New Project Pane 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.	

5 The Communications Setup Dialog Box is displayed. Select the *Direct connection via USB* Option in the Connection Type Field.

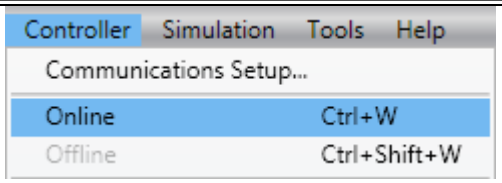
Click the **OK** Button.

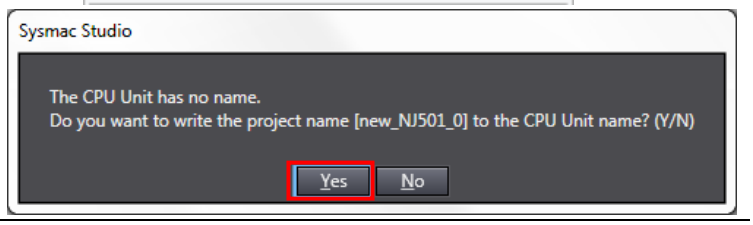


6 Select ***Online*** from the Controller Menu.

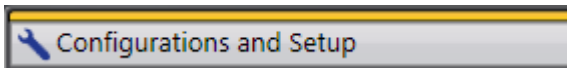
A confirmation dialog is displayed. Click the **Yes** Button.

*A displayed dialog depends on the status of the Controller used. Select the **Yes** Button or other button to proceed with the processing.





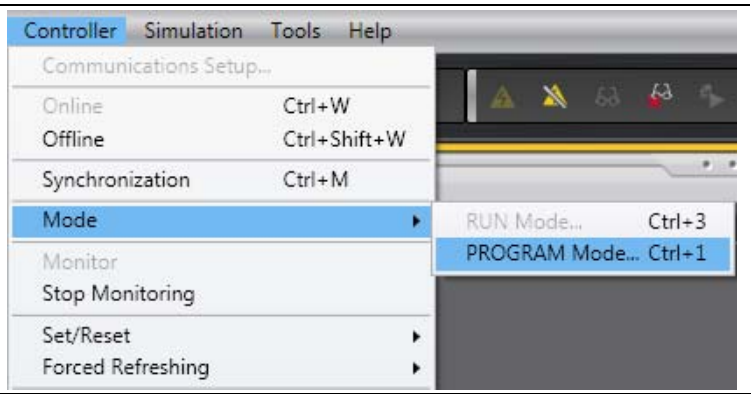
7 When an online connection is established, a yellow bar is displayed on the top of the Edit Pane.



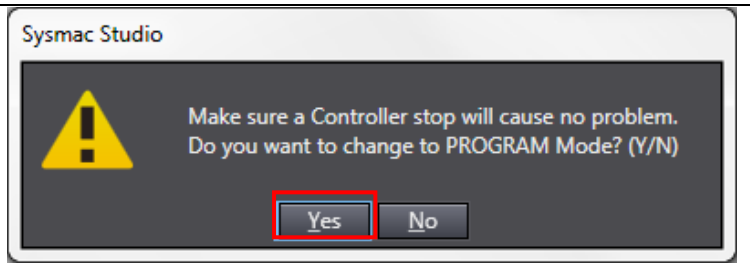
Additional Information

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).

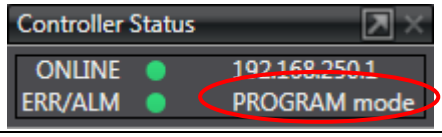
8 Select ***Mode*** - ***PROGRAM Mode*** from the Controller Menu.



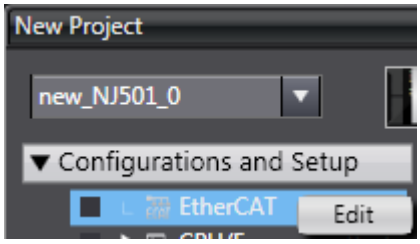
9 A confirmation dialog is displayed. Click the **Yes** Button.



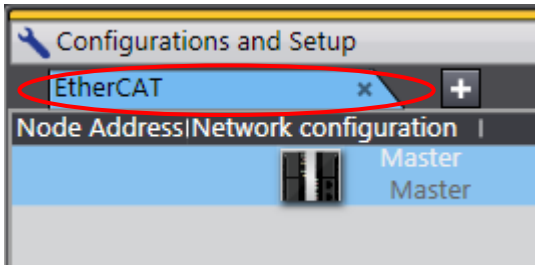
Confirm that the controller status on the Toolbox is changed to the PROGRAM mode.



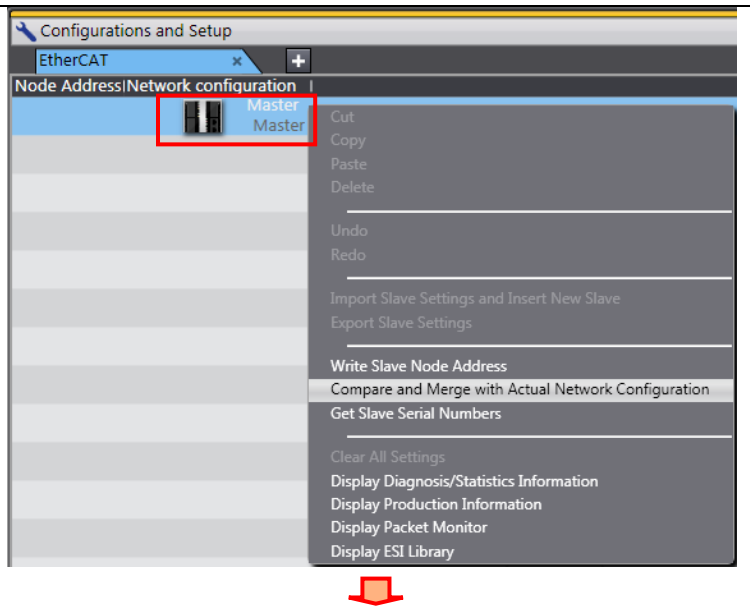
10 Double-click **EtherCAT** under Configurations and Setup in the Multiview Explorer.
Or, right-click **EtherCAT** under Configurations and Setup and select ***Edit***.



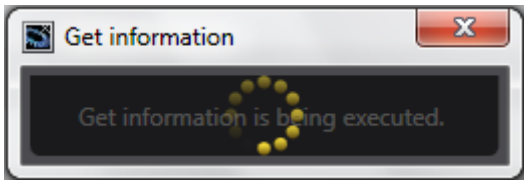
11 The EtherCAT Tab Page is displayed in the Edit Pane.

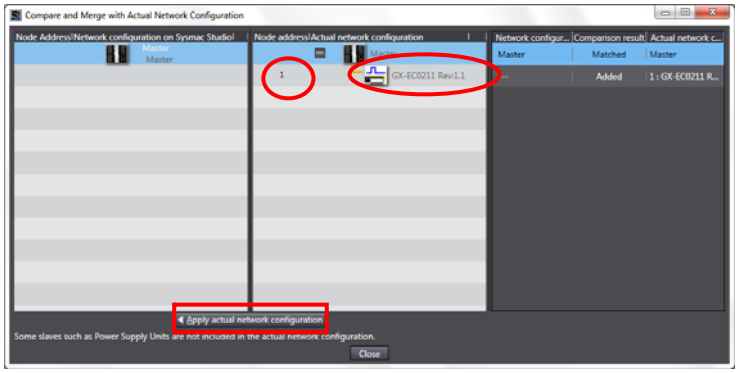
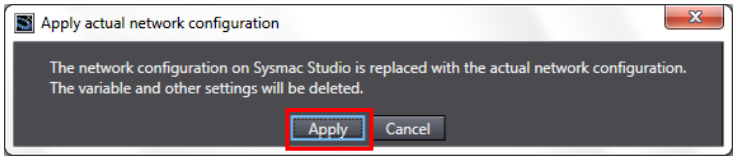
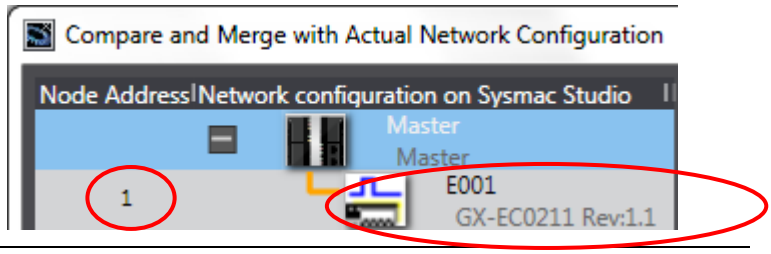
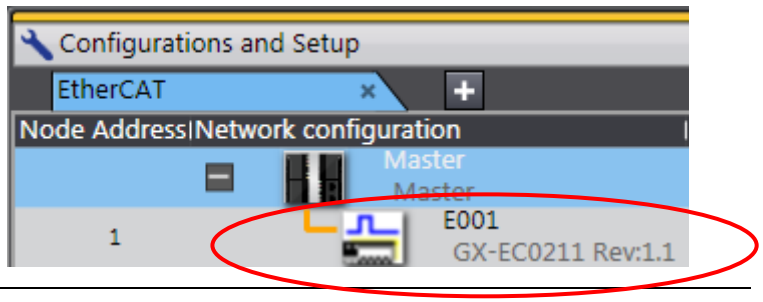


12 Right-click the Master Icon and select ***Compare and Merge with Actual Network Configuration***.



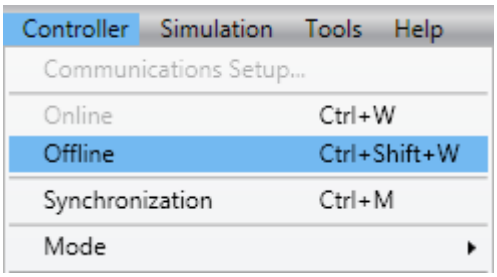
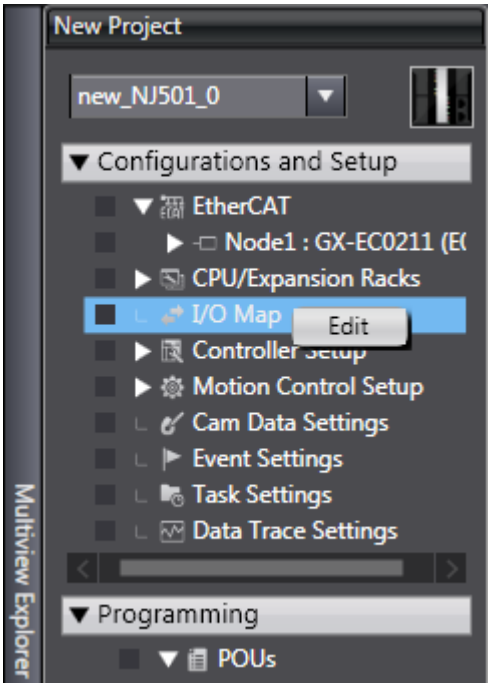
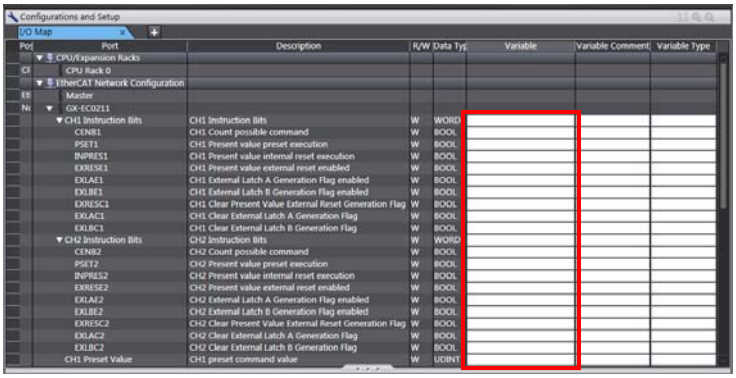
A screen is displayed stating "Get information is being executed".



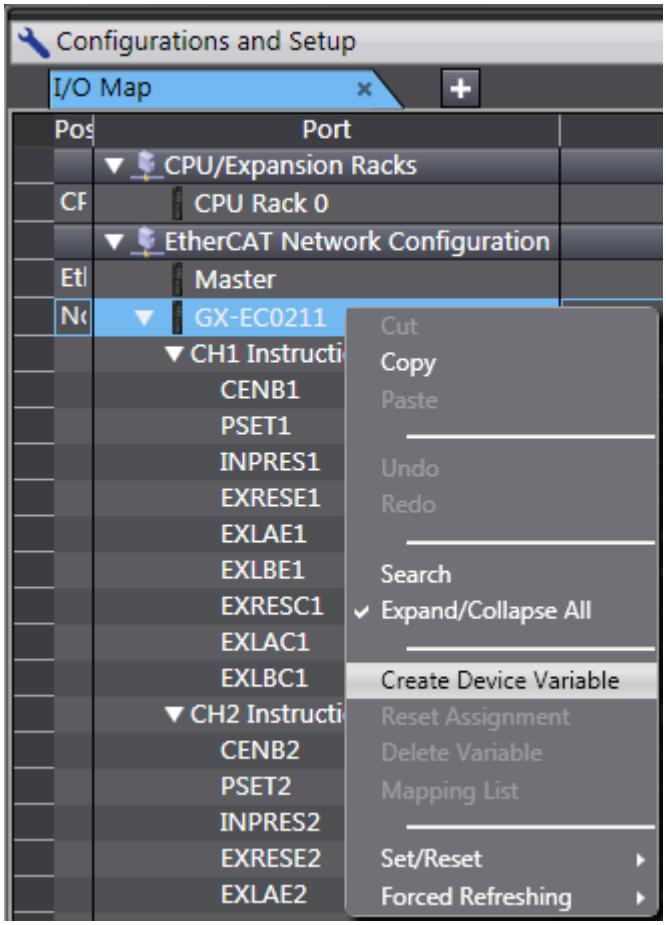
13	The Compare and Merge with Actual Network Configuration Pane is displayed. Node address 1 and GX-EC0211 Rev.1.1 are added to the actual network configuration of the comparison result. Click the **Apply actual network configuration** Button.	
14	A confirmation dialog box is displayed. Click the **Apply** Button. Confirm that node address 1 and E001 GX-EC0211 Rev.1.1 are added to the network configuration of the Sysmac Studio. Click the **Close** Button.	 
15	Node address 1 and E001 GX-EC0211 Rev:1.1 are added to the EtherCAT Tab Page in the Edit Pane.	

7.3.2. Setting Global Variables

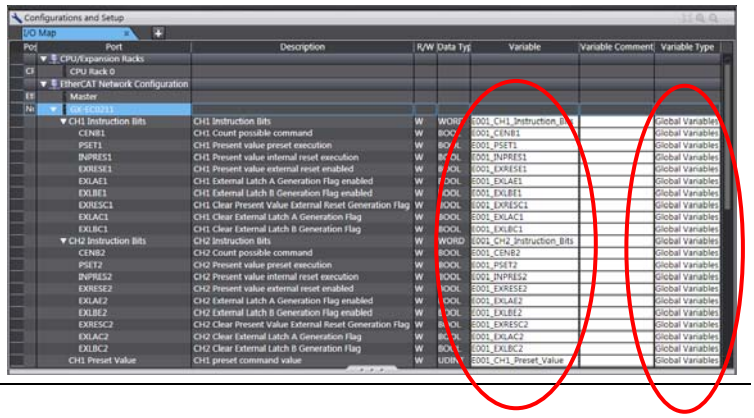
Set global variables to use for the EtherCAT Slave Unit.

1	Select ***Offline*** from the Controller Menu.	
2	Double-click **I/O Map** under Configurations and Setup on the Multiview Explorer, or right-click it and select ***Edit***.	
3	The I/O Map Tab Page is displayed on the Edit Pane. Click a column under Variable to enter a new variable.	

4 Right-click the row for Node1 and GX-EC0211. 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

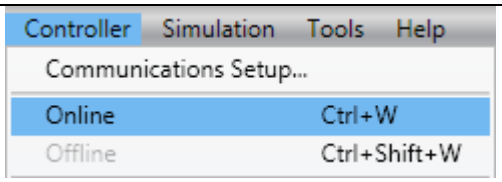
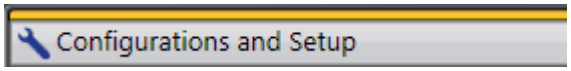
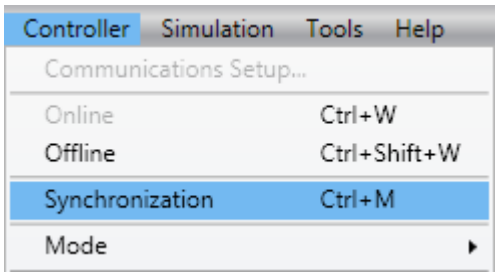
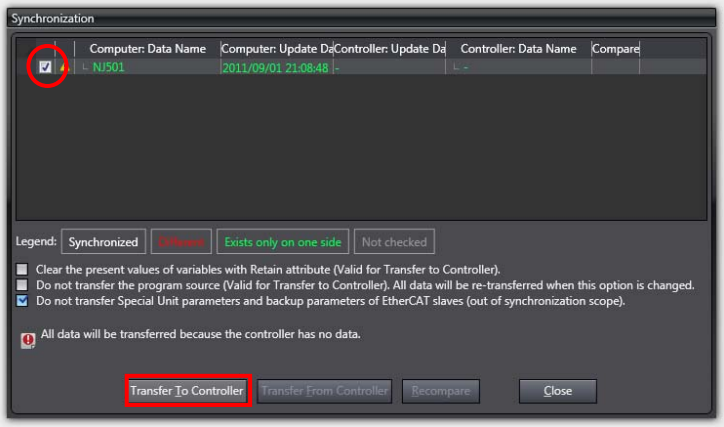
A device variable name is automatically created for each slave unit in the example above. A name can also be automatically created for each I/O port.
Also, you can set any device variables.

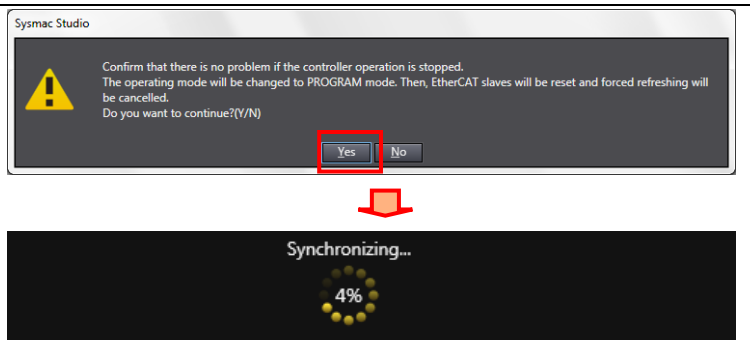
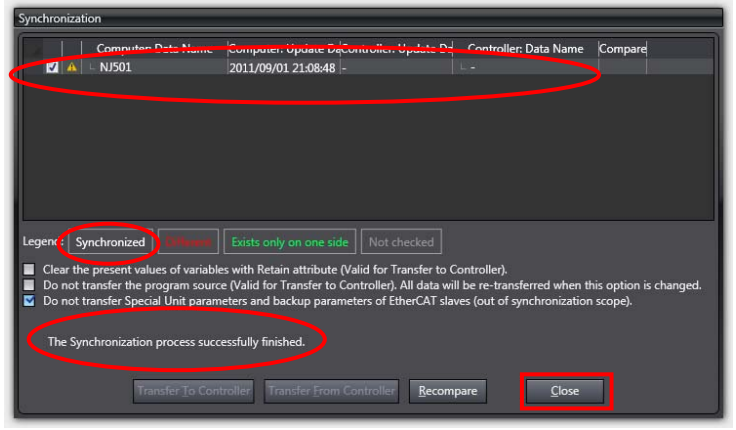
7.3.3. Transferring Project Data

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.	
2	When an online connection is established, a yellow bar is displayed on the top of the Edit Pane.	
3	Select ***Synchronization*** from the Controller Menu.	
4	The Synchronization Dialog Box is displayed. Confirm that the data to transfer (NJ501 in the right figure) is selected. Then, click the **Transfer to Controller** Button.	

5	A confirmation dialog is displayed. Click the **Yes** Button. A screen stating "Synchronizing" is displayed.	
6	Confirm 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.	

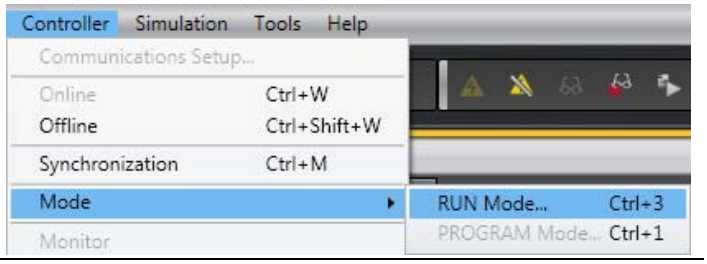
7.4. Connection Status Check

Check the connection status of the EtherCAT network.

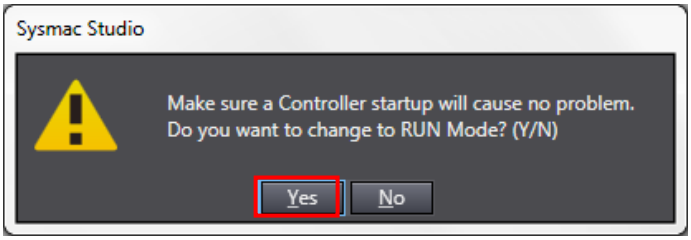
7.4.1. Checking the Connection Status

Confirm that the EtherCAT communications are performed normally.

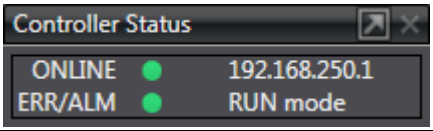
1 Select ***Mode*** - ***RUN Mode*** from the Controller Menu.



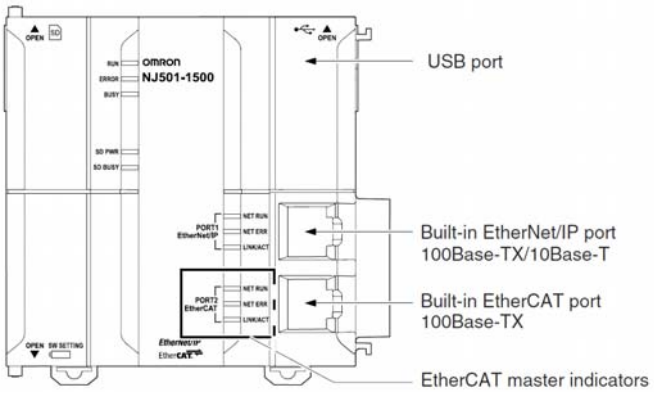
2 A confirmation dialog is displayed. Click the **OK** Button.



RUN mode is displayed on the Controller Status Pane.



3 Check the LED indicators on the Controller to confirm if EtherCAT communication is normally performed.



LED indicators in normal status.

[NET RUN]: Green ON

[NET ERR]: OFF

[LINK/ACT]: Flickering

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 function-ing. • 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, communica-tions 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.

4 Check the LED indicators of the Encoder Input Terminal.

LED indicators in normal status.

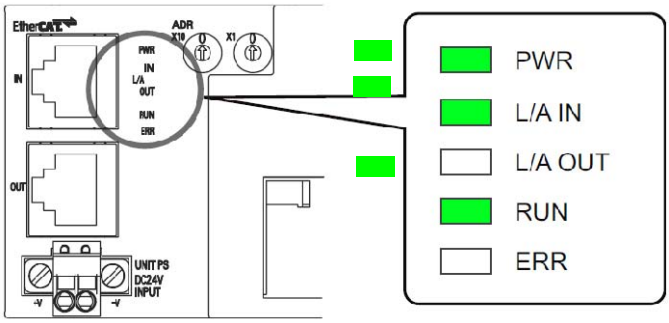
[PWR]: Green ON

[L/A IN]: Flickering

[RUN]: Green ON

[ERR]: OFF

The LED indicators flash at the same timing as those of the Controller.



[PWR] indicator

Indicates the unit power supply state.

Color	State	Contents
Green	OFF	Unit power OFF state
	ON	The unit power (24 VDC) is supplied to the Slave Unit.

[L/A IN] indicator

Indicates the communication state (input side).

Color	State	Contents
Green	OFF	Link not established in physical layer
	Flickering	In operation after establishing link
	ON	Link established in physical layer

[RUN] indicator

It indicates the operation state.

Color	State	Contents
Green	OFF	Init state
	Blinking	Pre-Operational state
	Single flash	Safe-Operational state
	ON	Operational state

For details on each state, refer to "5-3 Communications State Transitions" in page 5 - 4.

[ERR] indicator

It indicates the information of an error.

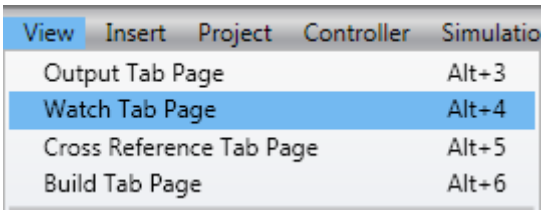
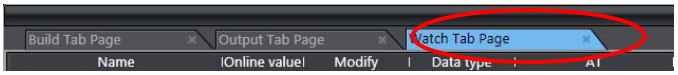
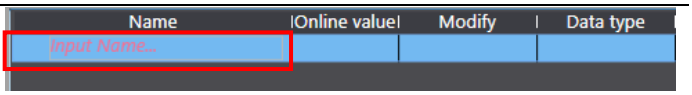
Color	State	Contents
Red	OFF	No error
	Blinking	Communications setting error
	Single flash	Synchronization error or communications data error
	Double flash	Application WDT timeout
	Flickering	Boot error
	ON	PDI WDT timeout

7.4.2. Checking Data That Are Sent and Received

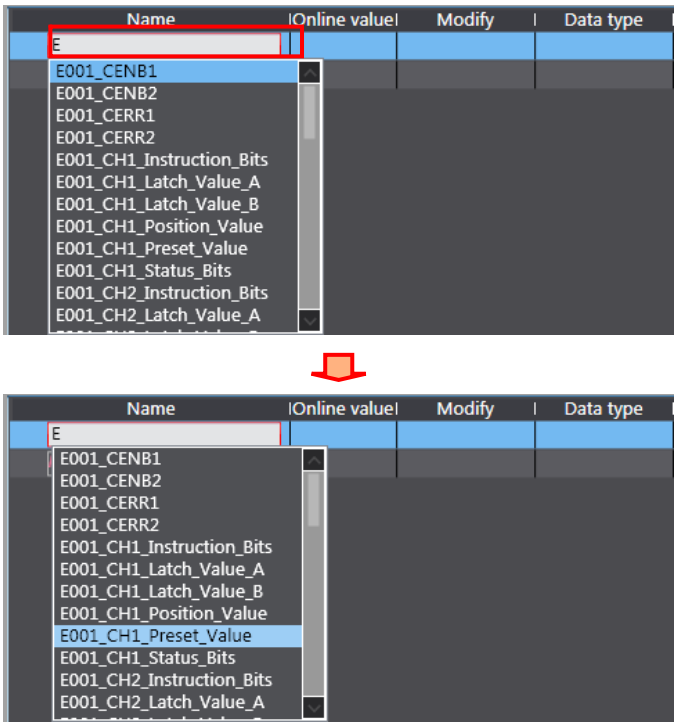
Confirm that the correct data are sent and received.

⚠ Caution

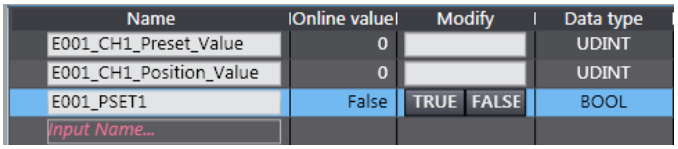
Sufficiently confirm safety before you change the values of variables on a Watch Tab Page when the Sysmac Studio is online with the CPU Unit. Incorrect operation may cause the devices that are connected to Output Units to operate regardless of the operating mode of the Controller.

1	Select ***Watch Tab Page*** from the View Menu.	
2	The Watch Tab Page is displayed in the lower section of the Edit Pane.	
3	Click the cell that states Input Name at the bottom of the Watch Tab Page.	

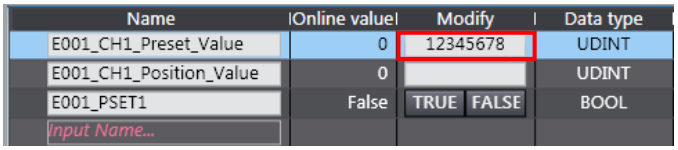
4 Now, characters can be entered. Enter the device variable name. Here, enter *E001_CH1_Preset_Value* CH1 preset command value.
Type the first character E. A list of device variables starting with E is displayed. Scroll the list and select *E001_CH1_Preset_Value*.
Double-click *E001_CH1_Preset_Value*.
E001_CH1_Preset_Value is entered in the Name Column.



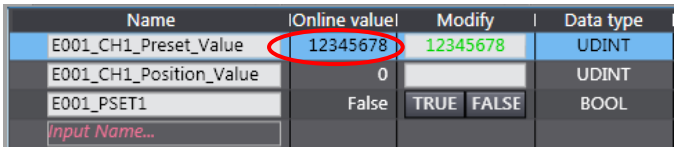
5 Similarly, enter *E001_CH1_Position_Value* CH1 preset value and *E001_PSET1* CH1 present value preset execution in the Watch Tab Page.



6 Confirm that the online value of *E001_CH1_Preset_Value* is 0 and enter 12345678 in the Modify Column.

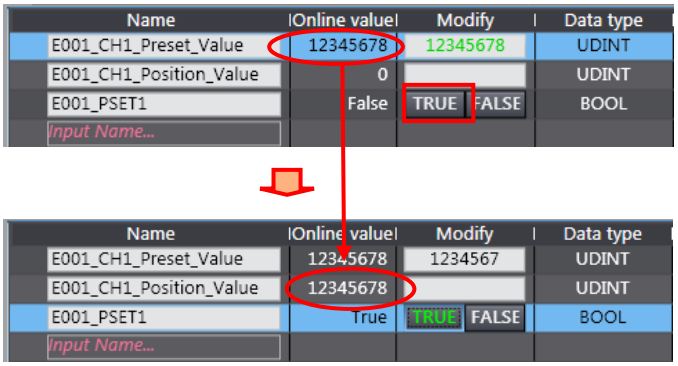


Confirm that the online value is changed to 12345678.



7 Confirm that the online value of *E001_PSET1* is False and click **TRUE** in the Modify Column.

Confirm that the online value of *E001_CH1_Position_Value* is changed to 12345678 which is the value set in step 7.

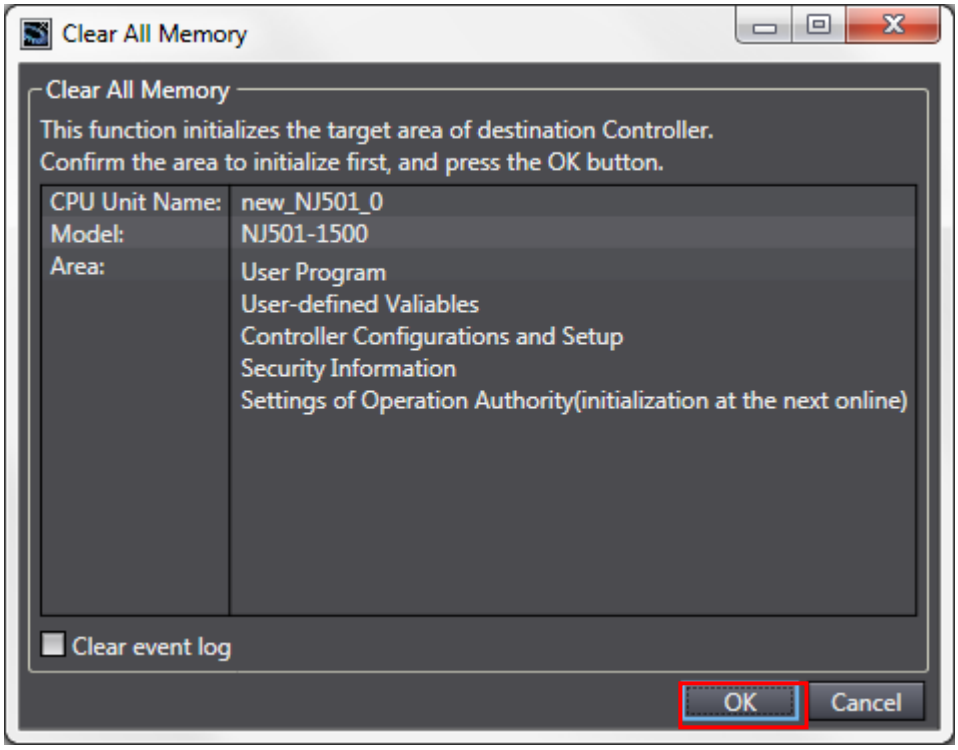


8. Initialization Method

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	Feb. 28, 2013	First edition

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