OMRON

Programmable Multi-Axis Controller

Startup Guide
For EtherCAT® Communication Coupler
Safety Controllers and I/O Units

CK3E-□□□□
NY51□-A□□□

Startup

Guide

O025-E1-02

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Contents

1. Related Manuals

To ensure system safety, always read and follow the information provided in all *Safety Precautions* and *Precautions for Safe Use* in the manuals for the devices that are used in the system.
The following shows the manuals for OMRON Corporation (hereafter referred to as OMRON) and Delta Tau Data Systems, Inc (DT).

Manufacturer	Manual No.	Model	Manual name
OMRON	I610-E1	Model CK3E-□□□□	Programmable Multi-Axis Controller Hardware User's Manual
OMRON	W580-E1	Model NY51□-A□□□	Industrial PC Platform NY-series IPC Programmable Multi-Axis Controller Hardware User's Manual
OMRON	W519-E1	Model NX-ECC203	NX-ECC201/ECC202/ECC203 EtherCAT® Coupler Unit User's Manual
OMRON	Z930-E1	Model NX-SL□□□□ Model NX-SI□□□□ Model NX-SO□□□□	NX-SL□□□□/SI□□□□/SO□□□□ Safety Control Unit User's Manual
OMRON	W504-E1	Model SYSMAC-SE2□□□	Sysmac Studio Version 1 Operation Manual
DT	O014-E	-	Power PMAC User's Manual
DT	O015-E	-	Power PMAC Software Reference Manual
DT	O016-E	-	Power PMAC IDE Users Manual

2. Terms and Definitions

Term	Explanation and Definition
Slave	Slaves are devices connected to EtherCAT. There are various types of slaves such as servo drivers handling position data and I/O terminals handling the bit signals.
Object	Represents information such as in-slave data and parameters.
PDO communications (Communications using Process Data Objects)	One type of EtherCAT communications in which process data objects (PDOs) are used to exchange information cyclically and in realtime. This is also called "process data communications".
PDO Mapping	The association of objects used for PDO communications.
PDO Entry	PDO entries are the pointers to individual objects used for PDO mapping.
ESI file (EtherCAT Slave Information file)	An ESI file contains information unique to the EtherCAT slaves in XML format. You can load ESI files into the EC-Engineer, to easily allocate slave process data and make other settings.
ENI file (EtherCAT Network Information file)	An ENI file contains the network configuration information related to EtherCAT slaves.
Power PMAC IDE	This computer software is used to configure the Controller, create user programs, and monitor the programs. PMAC is an acronym for Programmable Multi-Axis Controller.
Acontis EC-Engineer	This computer software is used to configure the EtherCAT network and each slave.

3. Precautions

(1) Understand the specifications of devices that are used in the system. Allow some margin for ratings and performance. Provide safety measures, such as for installing a safety circuit, in order to ensure safety and minimize the risk of abnormal occurrences.

(2) To ensure system safety, always read and follow the information provided in all *Safety Precautions* and *Precautions for Safe Use* in the manuals for each device that is used in the system.

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

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

(5) The information contained in this document is current as of July 2016.
It is subject to change without prior notice for improvement purposes.

The following notations are used in this document.

⚠ WARNING	Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury, or may result in serious injury or death. 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 Correct Use

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

Additional Information

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

Symbols

The filled circle symbol indicates operations that you must carry out.
The specific operation is shown in the circle and explained in text.
This example indicates a "general precaution" for something that you must carry out.

4. Overview

This document describes the procedures used to connect the Safety CPU Unit and Safety I/O Units (hereafter referred to as the Slave) attached to OMRON High EtherCAT Coupler Unit model NX-ECC203 using OMRON Programmable Multi-Axis Controller model CK3E-□□□□/NY51□-A□□□ (hereafter referred to as the Controller) and EtherCAT, as well as for checking the connection.
Refer to *Section 6. EtherCAT Connection Procedure* to learn about the setting methods and key points to perform PDO communications via EtherCAT.

5. Applicable Devices and Device Configuration

5.1. Applicable Devices

The applicable devices are as follows:

Manufacturer	Name	Model
OMRON	Programmable Multi-Axis Controller	Model CK3E-□□□□
OMRON	Programmable Multi-Axis Controller Industrial Box PC	Model NY51□-A□□□
OMRON	EtherCAT Coupler Unit	Model NX-ECC203
OMRON	Safety CPU Unit	Model NX-SL3□00
OMRON	Safety I/O Units	Model NX-SID800 Model NX-SOD400

Precautions for Correct Use

Use model NX-ECC203 Version 1.4 or later for the EtherCAT Coupler Unit.

Models NX-ECC201 and NX-ECC202 cannot be used.

Model NX-ECC203 Version 1.3 cannot be used.

Precautions for Correct Use

In this document, the devices with models and versions listed in *Section 5.2* are used as examples of applicable devices to describe the procedures to connect the devices and check their connections.

You cannot use devices with versions lower than the versions listed in *Section 5.2*.

To use the devices mentioned above with models not listed in *Section 5.2* or versions higher than those listed in *Section 5.2*, check the differences in the specifications by referring to the manuals before operating the devices.

Additional Information

This document describes the procedures to establish the network connections. It does not provide information on operations, installations, wiring methods, device functionalities, or device operations, which are not related to the connection procedures. For more information, refer to the manuals or contact your OMRON representative.

5.2. Device Configuration

The hardware components to reproduce the connection procedures in this document are as follows:
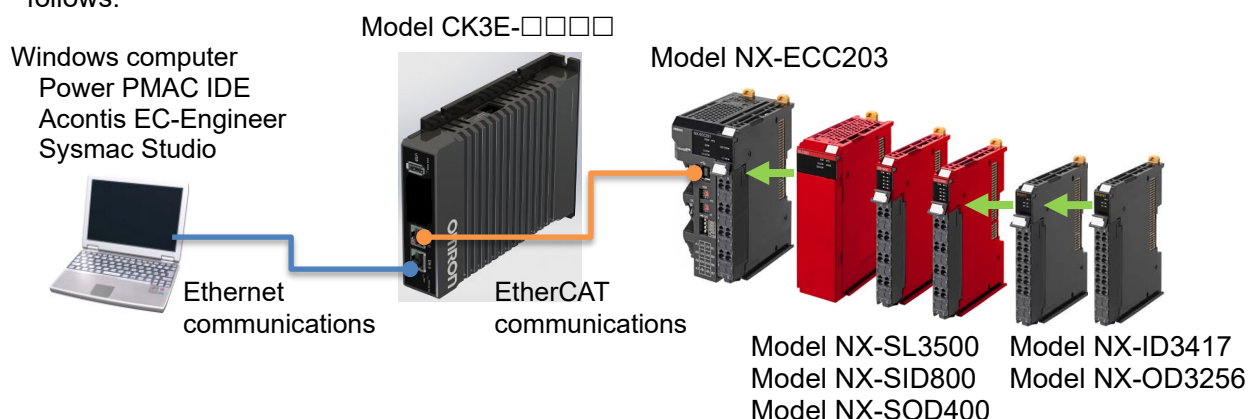
Manufacturer	Name	Model	Version
OMRON	Programmable Multi-Axis Controller	Model CK3E-□□□□	Ver.2.2
OMRON	EtherCAT Coupler Unit	Model NX-ECC203	Ver.1.4
OMRON	Safety CPU Unit	Model NX-SL3500	Ver.1.0
OMRON	Safety Input Unit	Model NX-SID800	Ver.1.0
OMRON	Safety Output Unit	Model NX-SOD400	Ver.1.0
OMRON	Ethernet cable (with industrial Ethernet connector)	Model XS5W-T421-□M□-K	
OMRON	Sysmac Studio	SYSMAC-SE2□□□	Ver.1.15
-	Windows computer	-	
DT	Power PMAC IDE	-	Ver.2.2
Acontis	Acontis EC-Engineer	-	Ver.2.4.3

📝 **Precautions for Correct Use**

Prepare the ESI file described in this section in advance. Contact your OMRON representative for information on how to procure the ESI file.

📝 **Precautions for Correct Use**

Do not share the connection line of EtherCAT communications with other Ethernet networks. Do not use devices for Ethernet such as a switching hub.
Use the Ethernet cable (double shielding with aluminum tape and braiding) of Category 5 or higher, and use the shielded connector of Category 5 or higher.
Connect the cable shield to the connector hood at both ends of the cable.

📓 **Additional Information**

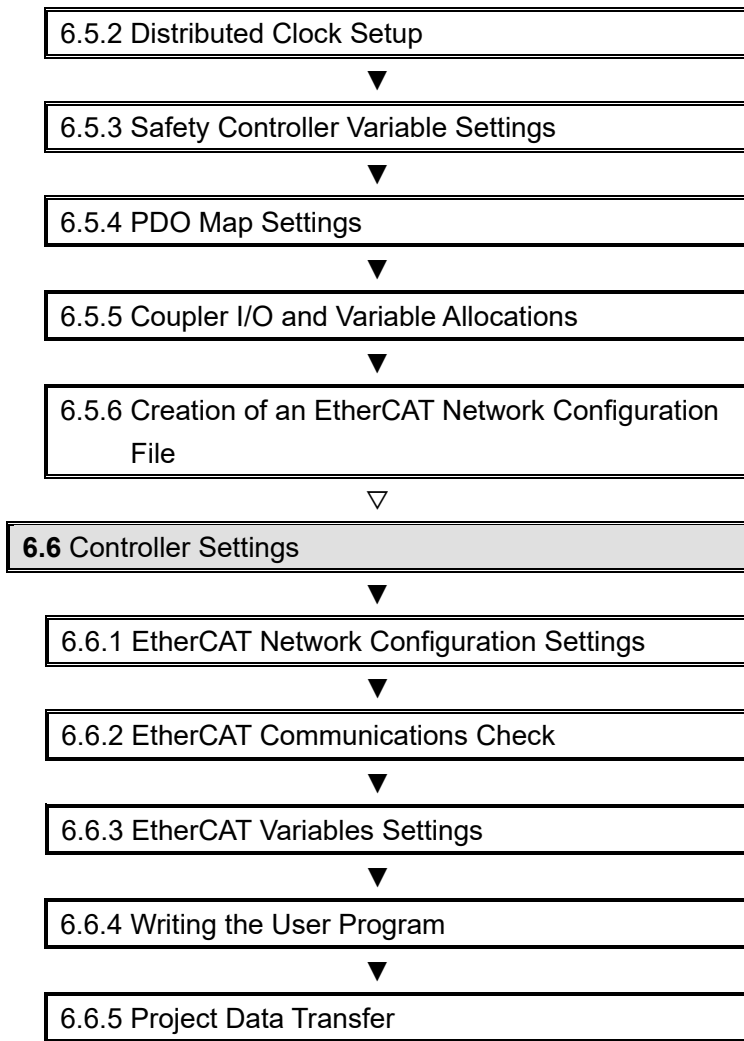This document describes model CK3E-□□□□ as an example. The same procedures can apply to model NY51□-A□□□.

6. EtherCAT Connection Procedure

This section describes the procedure for connecting the Controller with the Slave via EtherCAT. The description assumes that the Controller and the Slave are set to factory default.

6.1. Workflow

Take the following steps to operate the PDO communications via EtherCAT after connecting the Controller with the Slave via EtherCAT.
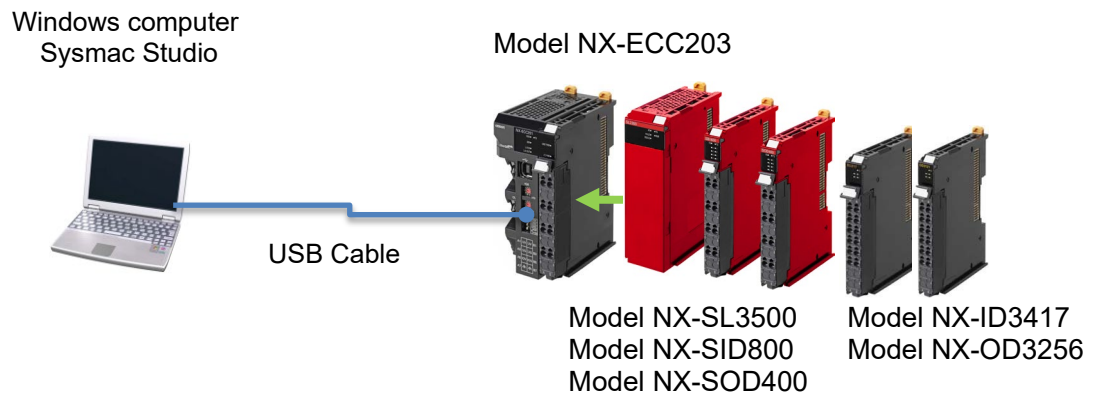
6.2 EtherCAT Coupler Unit Settings	Prepare to set the EtherCAT Coupler Unit.

▼

6.2.1 Creation of a New Project

▼

6.2.2 Network Configuration Settings

▼

6.2.3 I/O Map Settings

▼

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6.2.5 Creation of Safety Programs

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6.2.6 Transfer via Connection to the Communications Coupler Unit

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6.2.7 Output of Couple I/O Allocations

▽

6.3 Preparation for the Controller Setup	Prepare the Controller settings.

▼

6.3.1 Creation of a New Project

▼

6.3.2 Initial Settings of the Controller

▽

6.4 Installation of ESI Files	Install the ESI file for the Slave into Acontis EC-Engineer.

▽

6.5 EtherCAT Communications Setup	Set up EtherCAT communications.

▼

6.5.1 Communications Setup for the EtherCAT Master

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│ 6.5.3 Safety Controller Variable Settings       │
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6.2. EtherCAT Coupler Unit Settings

Configure the slave terminal settings for the EtherCAT Coupler Unit.

Prepare a computer with Sysmac Studio installed.

Windows computer
Sysmac Studio

Model NX-ECC203

USB Cable

Model NX-SL3500
Model NX-SID800
Model NX-SOD400

Model NX-ID3417
Model NX-OD3256

6.2.1. Creation of a New Project

1	Connect the coupler to the computer using a USB cable.
2	Turn on the power to the coupler and safety controller.
3	Start the Sysmac Studio. * If the dialog for confirming access rights appears upon start-up, select starting of Sysmac Studio.	
4	Create a project in the Sysmac Studio. **Project Properties** Enter **Project name** and other items of information. **Select Device** Select *controller* for **Category**. You can specify any **Device** and **Version**. In this example, select *NJ501-1500* and *1.10*. Click **Create**.	

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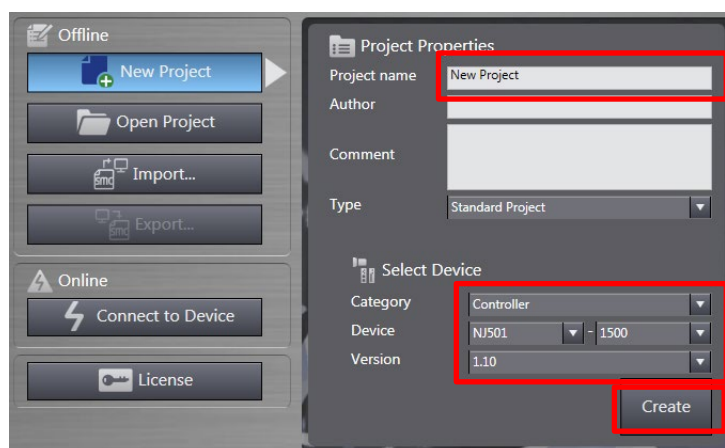
6.2.2. Network Configuration Settings
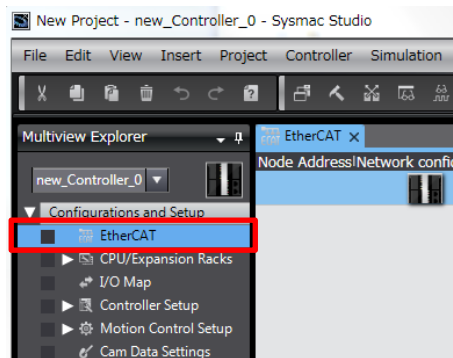
1	Double-click **EtherCAT** under **Configurations and Setup** in the Multiview Explorer.	
2	Select EtherCAT Coupler Unit **NX-ECC203** in the toolbox, and drag and drop it directly below the master in the EtherCAT Configuration Edit tab page.	
3	Right-click **NX-ECC203** in the Multiview Explorer, and select **Coupler Connection (USB)** then **Online**. After you have confirmed the destination of the USB connection, click the **OK** button.	
4	Double-click **NX-ECC203** in the Multiview Explorer to open the NX-ECC203 edit page. Right-click in the NX-ECC203 tab page and select **Compare and Merge with Actual Unit Configuration** from the menu.	
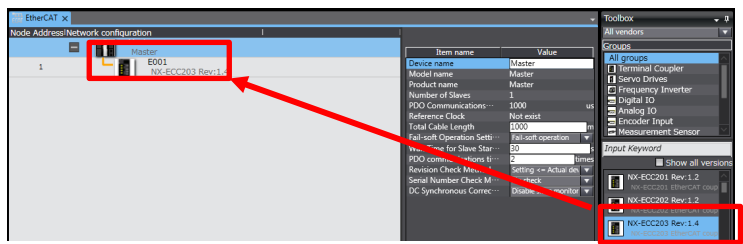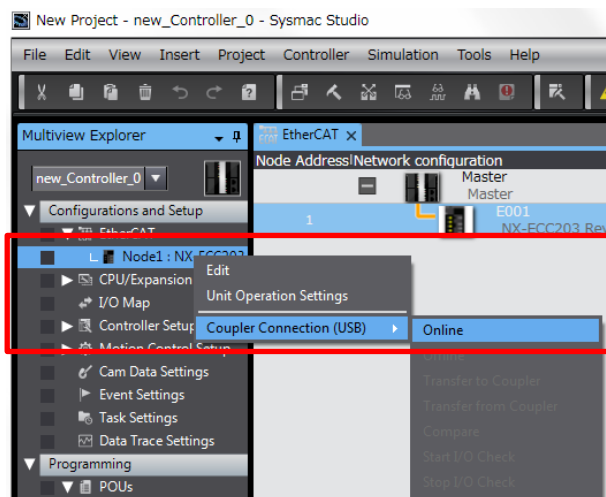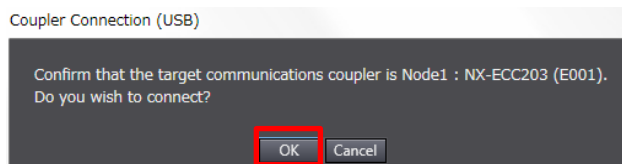
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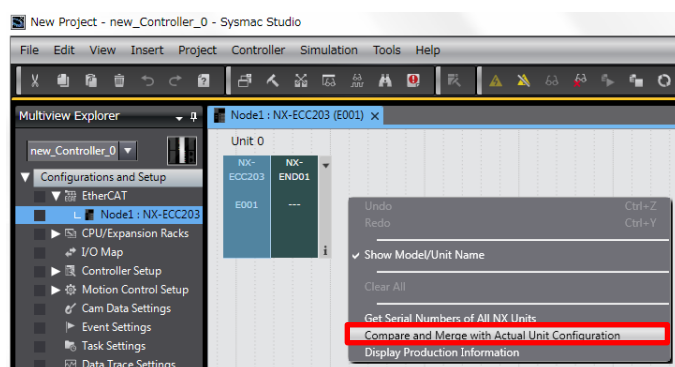
5 Click **Apply Actual Unit Configuration** to apply the actual unit configuration.
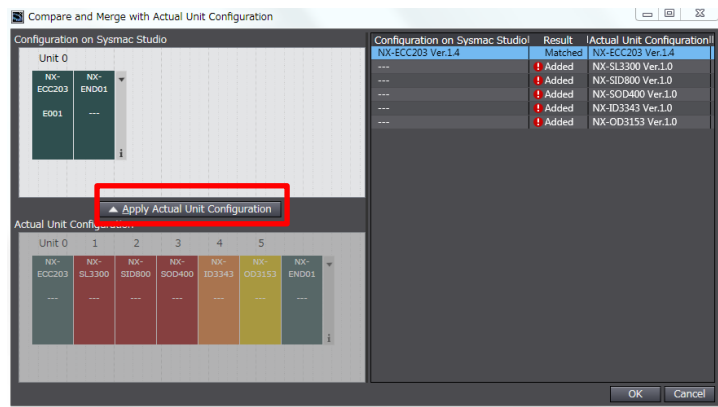
6.2.3. I/O Map Settings

1 Right-click **NX-ECC203** in the Multiview Explorer, and select **Coupler Connection (USB)** then **Offline**.
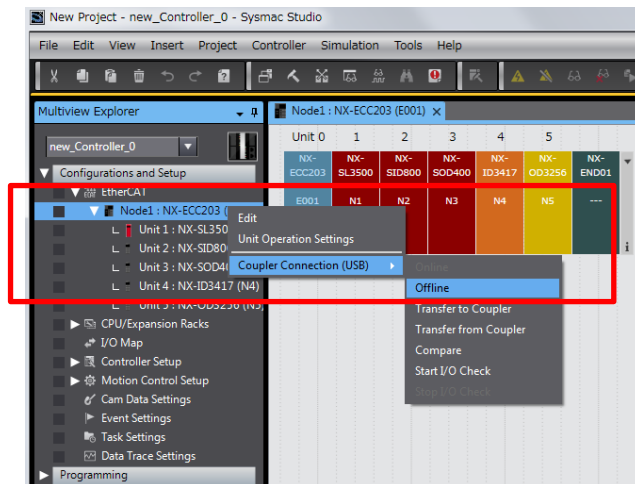
2	In the Multiview Explorer, select **Configurations and Setup**, then I/O map tab page to open the I/O map pane. Right-click on **NX-ECC203**, and select **Create Device Variable** from the menu.	
3	From the controller selection box in the Multiview Explorer, select the target Safety CPU Unit. Double-click **I/O map** to open the Safety I/O map tab page.	
4	Right-click on **EtherCAT Network**, and select **Create Device Variable** from the menu.	
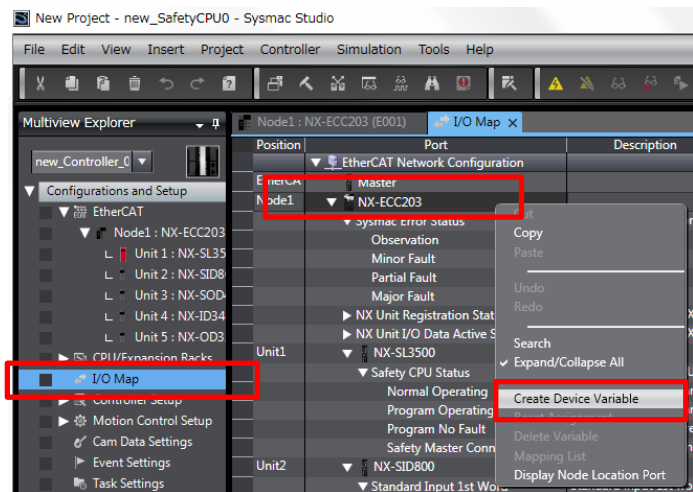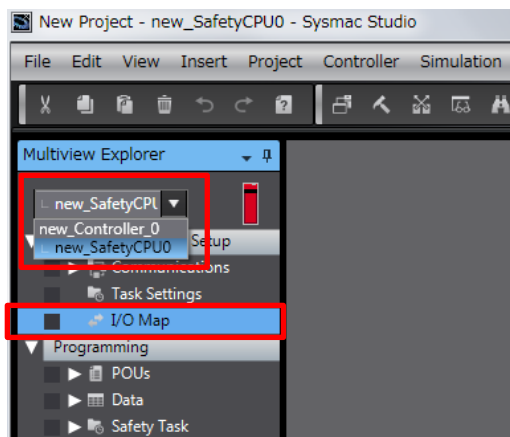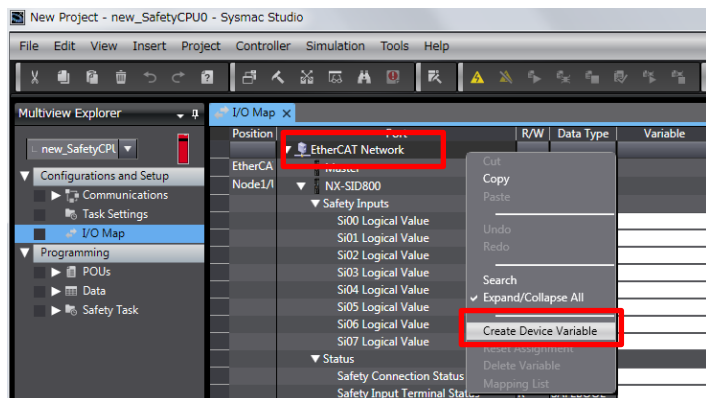
6.2.4. Safety I/O Function Settings

1	From the controller selection box in the Multiview Explorer, select the target Safety CPU Unit. Double-click **Safety Slave Unit Parameter Settings** under NX-SID800 of **Configurations and Setup**.	
2	Select **Output Single-channel Semi-conductor** from the toolbox **Input device: Semi-conductor output type**, and drag and drop it on to the input terminal.	
3	Double-click **Safety Slave Unit Parameter Settings** under NX-SO400 of **Configurations and Setup**.	
4	Select **Single Channel (without test pulse)** from the toolbox **Output device**, and drag and drop it on to the output terminal.	
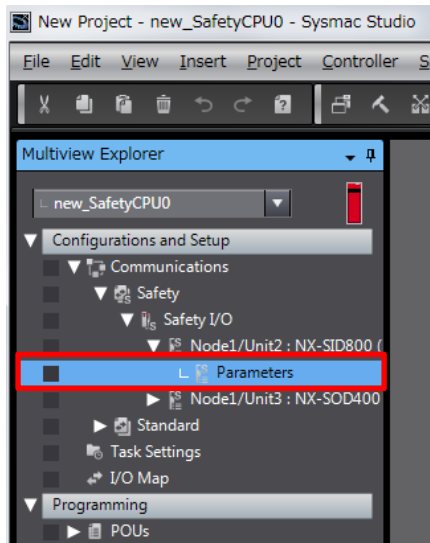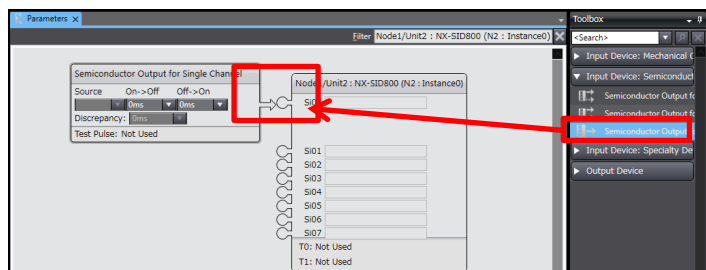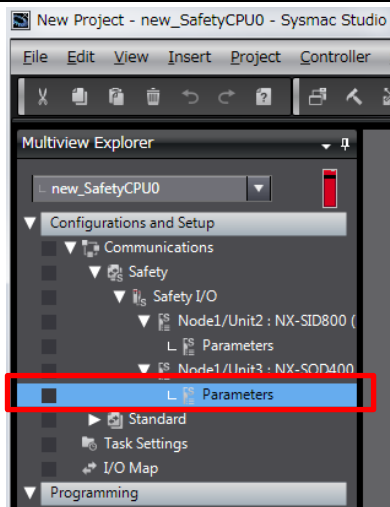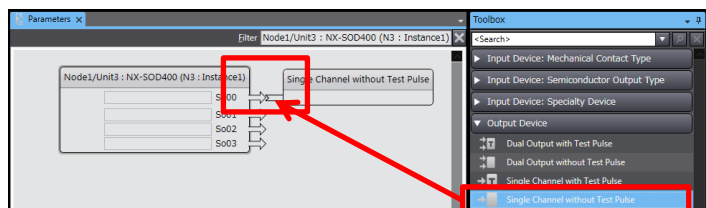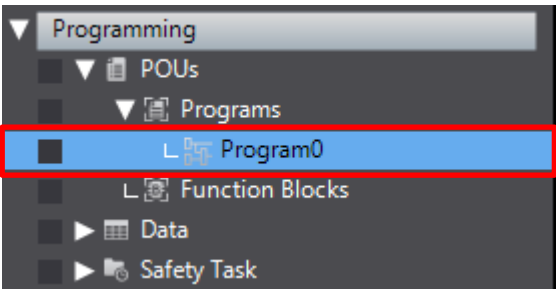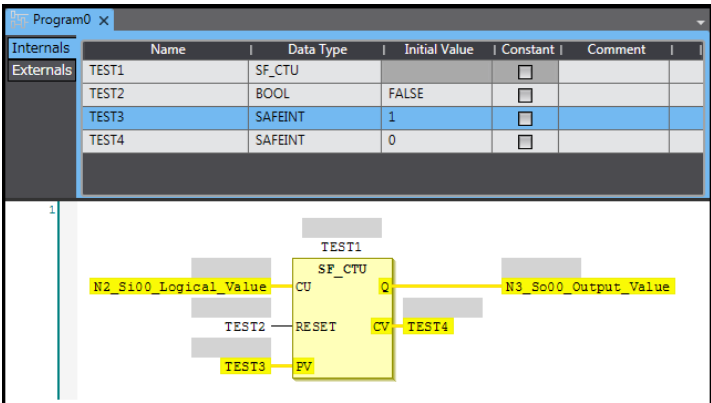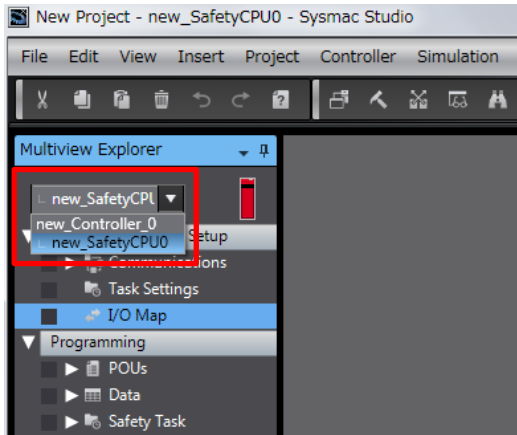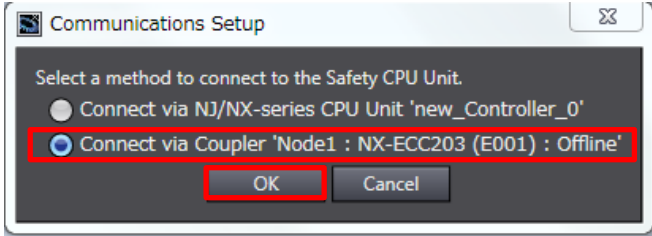
6.2.5. Creation of Safety Programs

1	Registering programs Right-click **Programs** under **Programming** – **POUs** in the Multiview Explorer, and select **Add** – **Programs** from the menu.	
2	Creating programs Refer to *Section 7 Programming* in the Safety Control Unit User's Manual to create safety programs.	

6.2.6. Transfer via Connection to the Communications Coupler Unit

1	From the controller selection box in the Multiview Explorer, select a Safety CPU Unit.	
2	Select **Controller**, then **Communications Setup** from the menu. Select **Connect via Coupler** in the Communications Setup dialog box, then click the **OK** button.	

3	Select **Controller**, then **Online** from the menu. The unit is in online connection with slave terminals.	
4	From the controller selection box in the Multiview Explorer, select a controller.	
5	In the edit page for slave terminals, right-click the Communications Coupler Unit, then select **Transfer the Settings from computer to Communications Coupler**. Click **Configuration information + Unit operation setting + Unit application data**.	
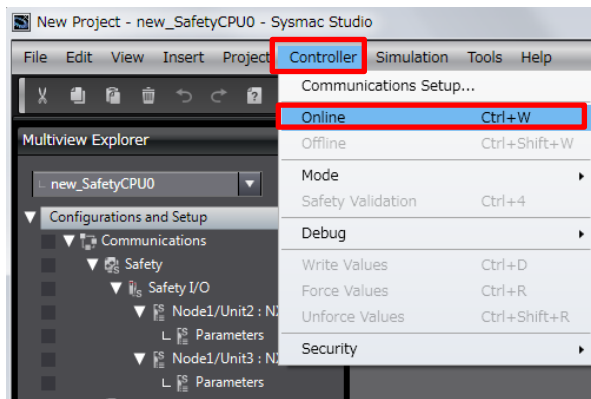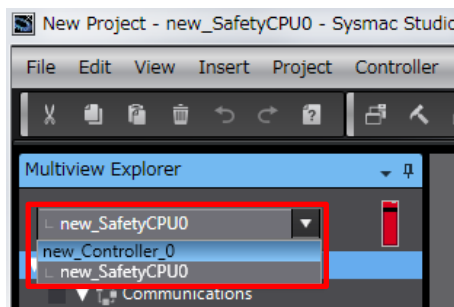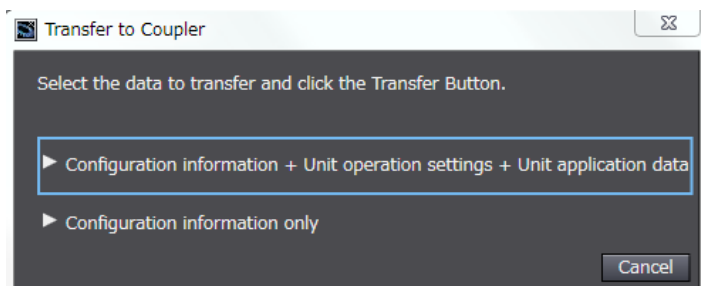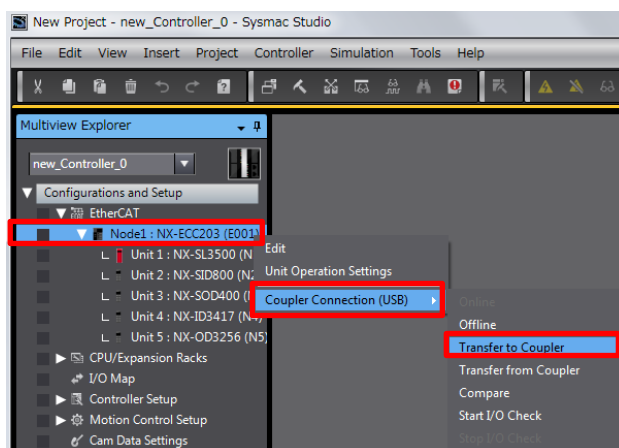
6.2.7. Output of Couple I/O Allocations

1	Select **Controller**, then **Offline** from the menu.	
2	Double-click **EtherCAT** under **Configurations and Setup** in the Multiview Explorer. Right-click on **Master**, then select **Export All Coupler's I/O Allocations**.	
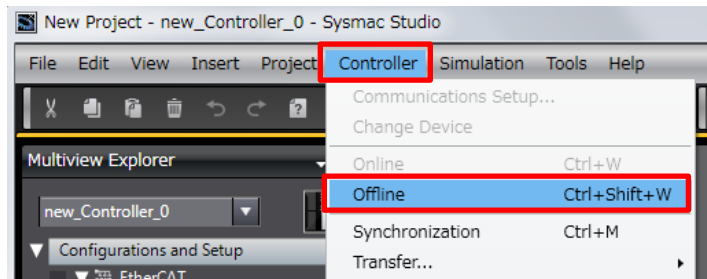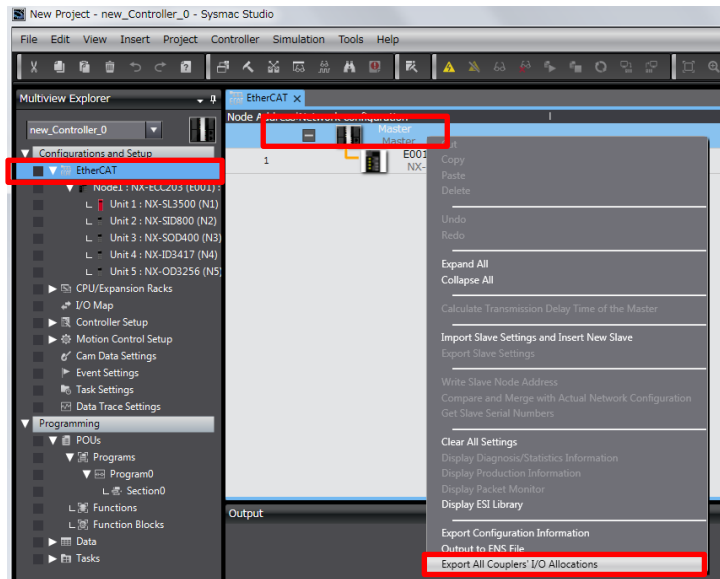
6.3. Preparation for the Controller Setup

Prepare the Controller settings.

Install Power PMAC IDE and Acontis EC-Engineer on the computer in advance.

6.3.1. Creation of a New Project

1	Connect the Controller with the computer via Ethernet cable.
2	Turn on the power to the Controller.
3	Start Power PMAC IDE. * If the dialog for confirming access rights appears upon start-up, select starting of Power PMAC IDE.
4	The Communication screen appears. Specify the IP address of the destination Controller and click **Connect**. * The IP address of the Controller is set to "192.168.0.200" by default. * If necessary, change the Windows IP address to "192.168.0.X".
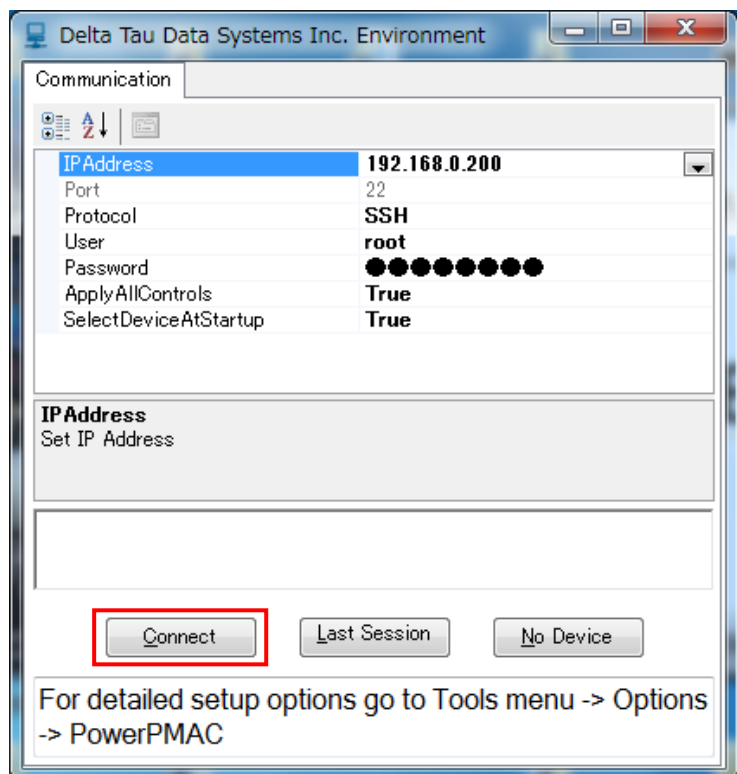
5 Power PMAC IDE starts, and is online to the Controller.
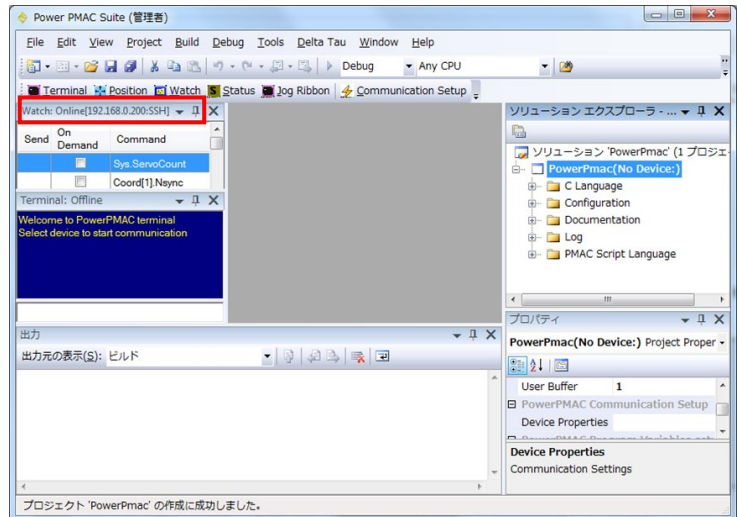
6 From the **File** menu, select **New** then **Project**.
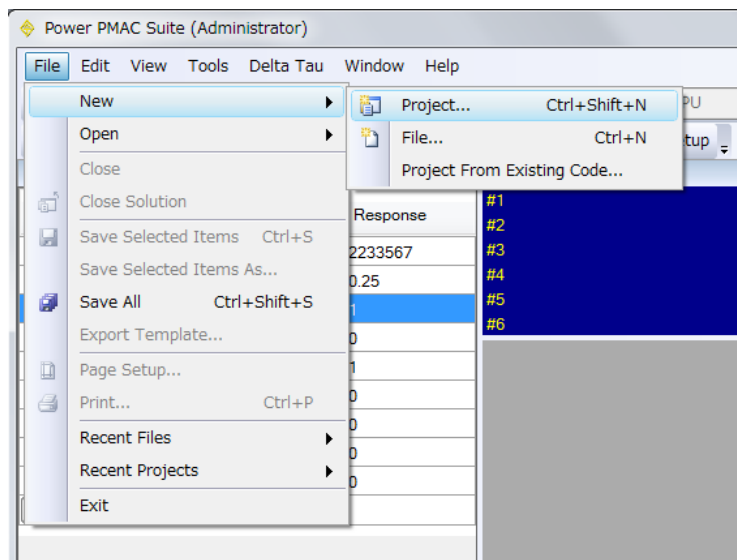
7 Enter a project name and location, and select **OK**.
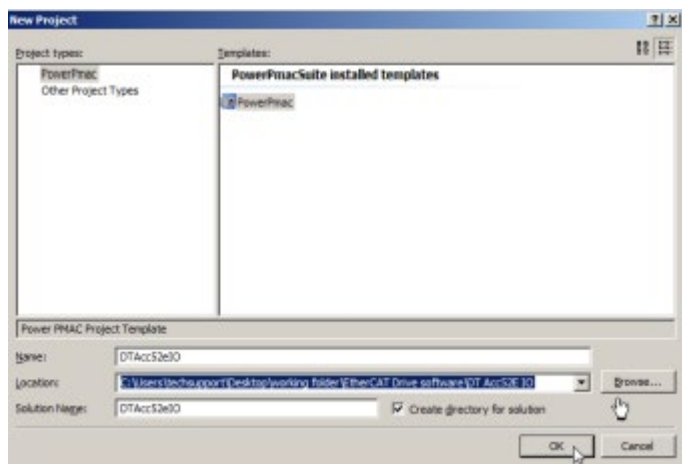
6.3.2. Initial Settings of the Controller

Configure the initial settings for the Controller.

Precautions for Correct Use

Configuring the initial settings clears all data in the Controller memory. Back up necessary data in advance.
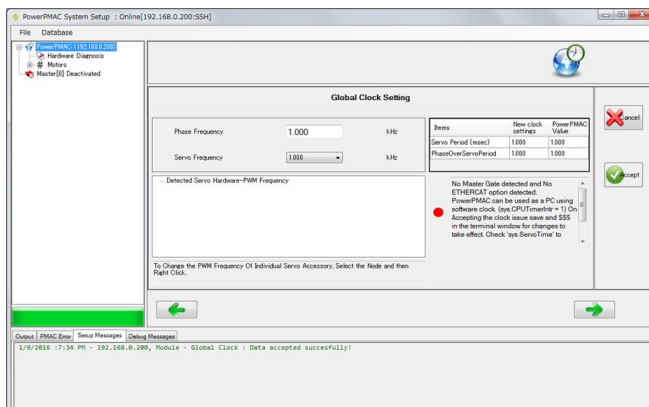
1	In the Terminal pane, type the $$$*** command to reset the Controller to factory default.	
2	From the **Tools** menu, select **System Setup** to start **System Setup**.	
	PowerPMAC System Setup starts.	
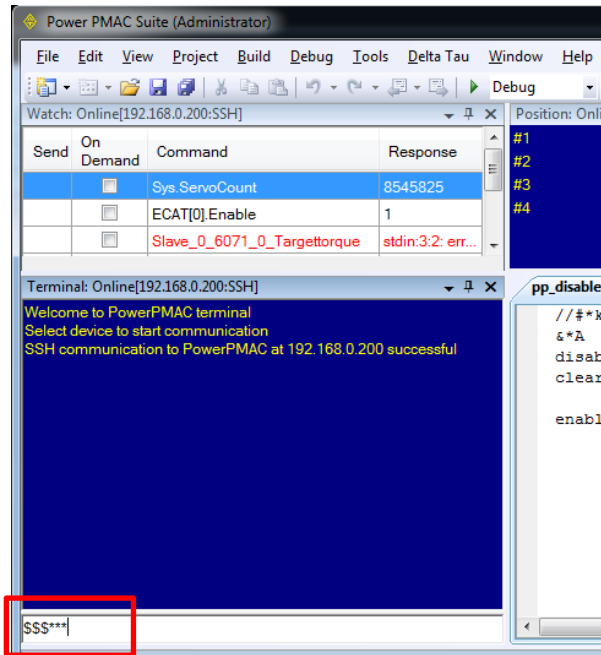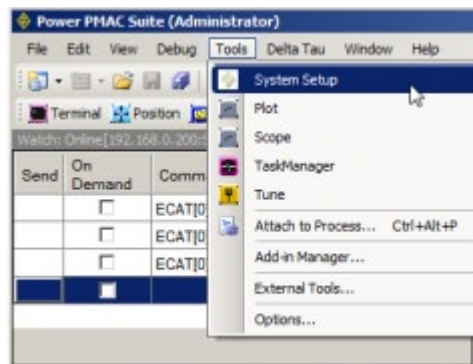
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3	From the **File** menu of PowerPMAC System Setup, select **New** then **Setup**.	
4	Specify **Servo Frequency**. Select the **Servo Frequency** setting from 4 kHz, 2 kHz, or 1 kHz. * Servo Frequency is set to 1 kHz for the example in this document.	
5	Click the **Accept** button.	
6	If you have changed the servo frequency setting, type the SAVE command in the Terminal pane of Power PMAC IDE. When complete, the "Save Complete" message appears in the Terminal pane.	
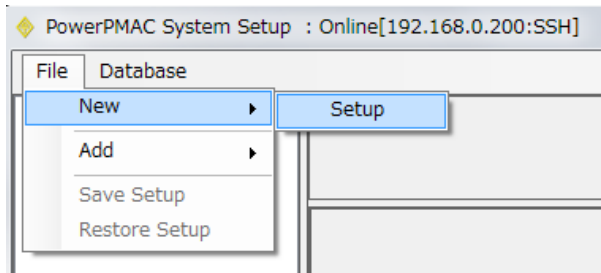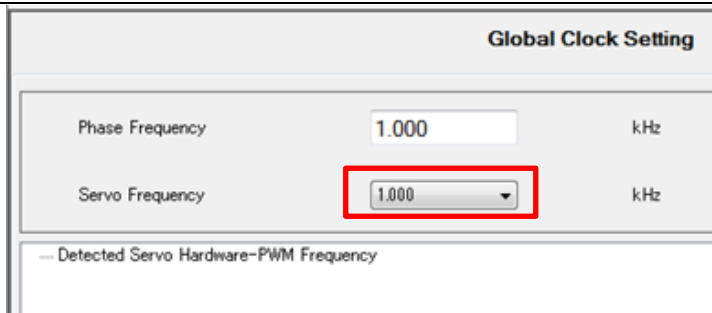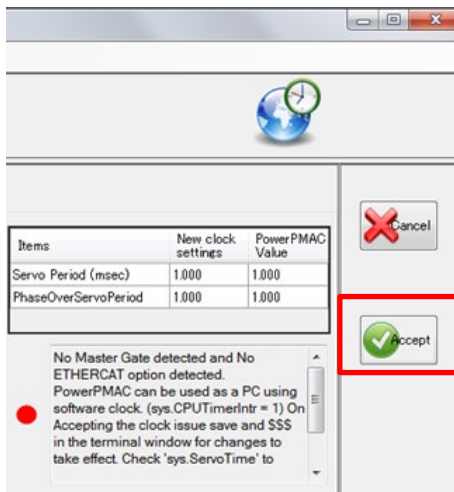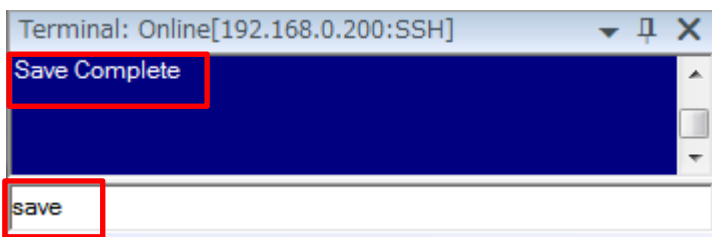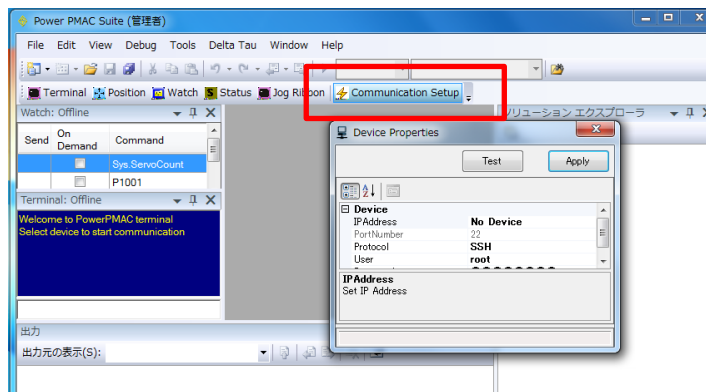
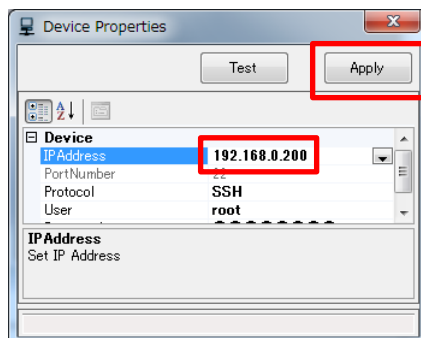| 7	Click **Communication Setup** on the toolbar to display the Device Properties dialog box.	
8	In the Device Properties dialog box, select *No Device* for IP Address, then click the **Apply** button. This operation sets the Controller to the offline state.	
9	The Controller restarts. The servo frequency that has been set is reflected.	
10	Wait until the startup process of the Controller is complete. Then click **Communication Setup** on the toolbar to display the Device Properties dialog box. In the Device Properties dialog box, return the IP Address to the previous setting, then click the **Apply** button. This operation sets the Controller to the online state.	
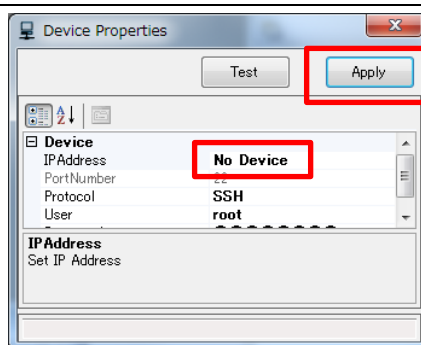
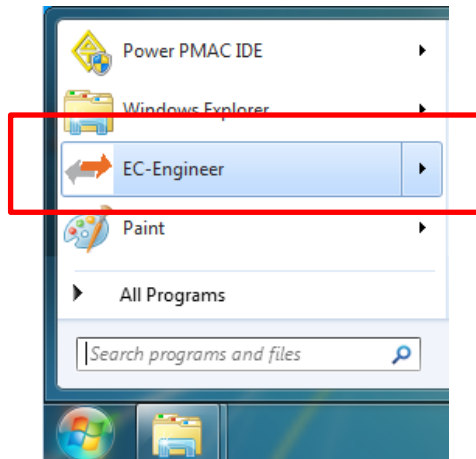## 6.4. Installation of ESI Files

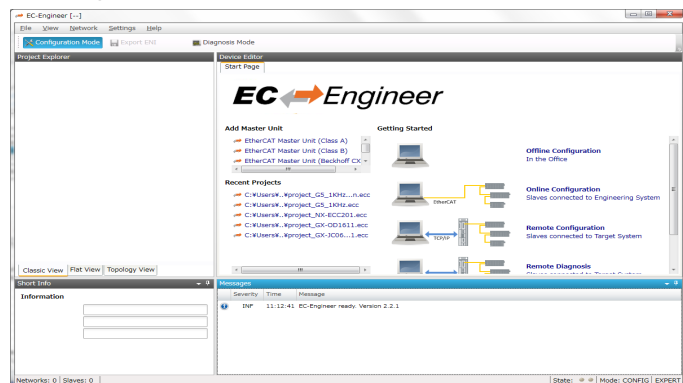Install the ESI file for the Slave into Acontis EC-Engineer.

Precautions for Correct Use

Prepare the ESI file described in this section in advance. Contact your OMRON representative for information on how to procure the ESI file.
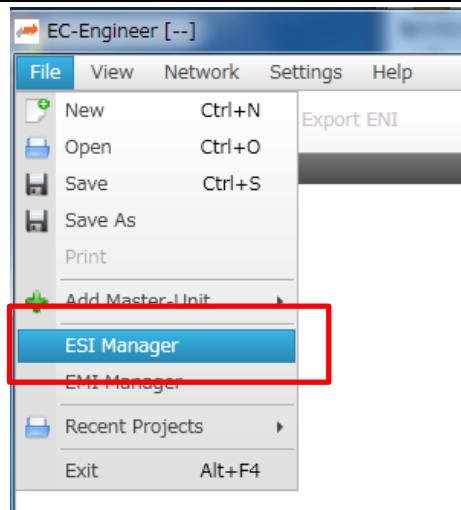
1	Start EC-Engineer.

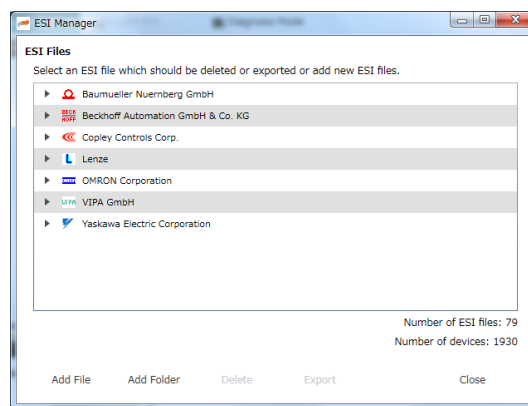EC-Engineer screen:

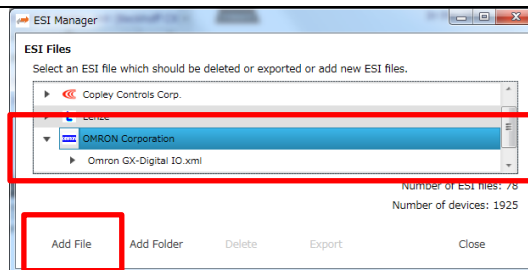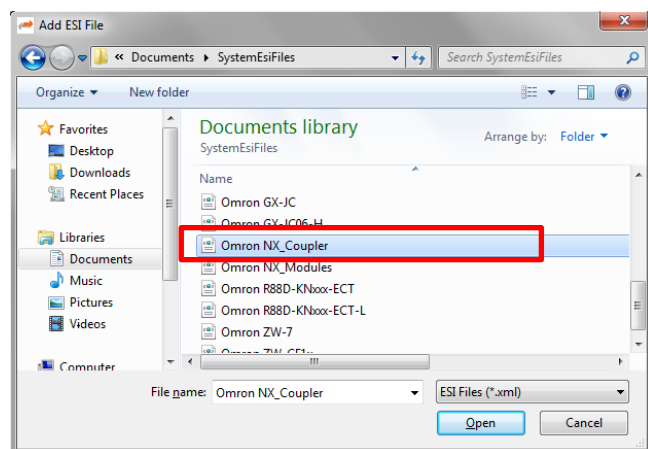| 2	From the **File** menu of EC-Engineer, select **ESI Manager**. The ESI Manager appears.	 Example of the ESI Manager
3	Confirm that *Omron NX_Coupler.xml* is registered in the ESI file list of ESI Manager. If it is not yet registered, click **Add File** and register *Omron NX_Coupler.xml*.	
4	Click **Close** to close the ESI Manager.	

6.5. EtherCAT Communications Setup

Set up EtherCAT communications.

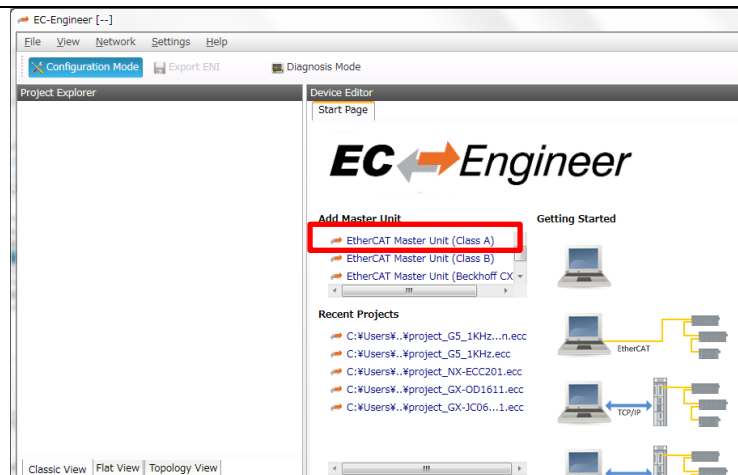📝 **Precautions for Correct Use**

Before taking the following steps, make sure that the devices are connected via an Ethernet cable. If they are not connected, turn OFF the power to the devices, and connect the Ethernet cable.

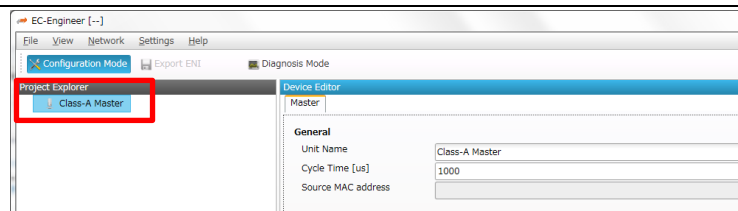### 6.5.1. Communications Setup for the EtherCAT Master

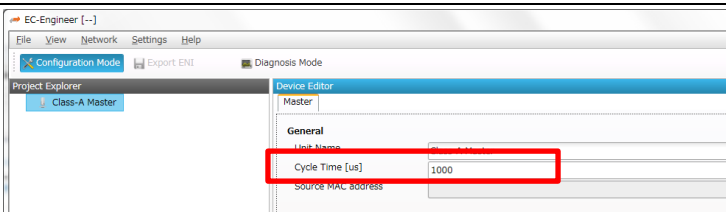| 1	Connect the Controller with slave devices using an Ethernet cable. * Refer to the manuals for slave devices to configure them.	
2	Display **Start Page** of EC-Engineer, and select **EtherCAT Master Unit (Class A)** from **Add Master Unit**.	
3	**Class-A Master** is added to the Project Explorer.	

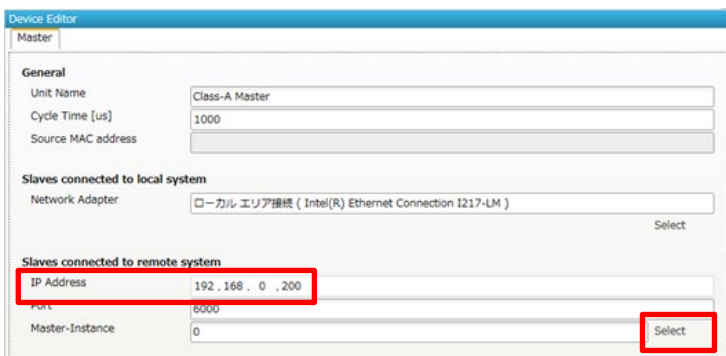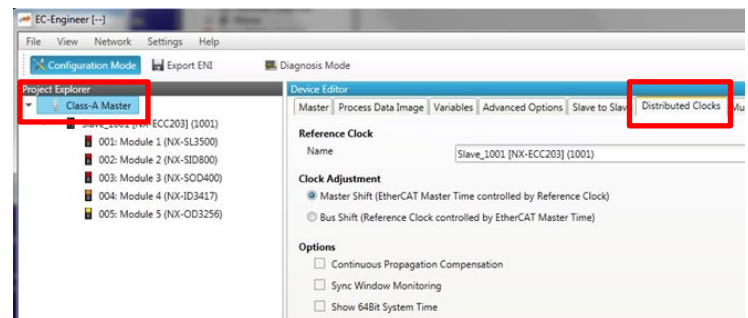|		
4	In the Master page, specify a communication period for **Cycle Time [us]**. * You must specify the communication period in accordance with the servo frequency of the Controller. 1000 us is set in this document.	 Correspondence between the servo frequencies of the Controller and communication periods is as follows: 4 kHz : 250 us 2 kHz : 500 us 1 kHz : 1000 us
5	In the Master page, set the IP address of the destination Controller in **IP Address**, and click the **Select** button to apply the setting. * Default IP address "192.168.0.200" is specified in this example. * Do not select **Slaves connected to local system** as it is not used.	
6	Right-click on **Class-A Master** in the Project Explorer, and select **Scan EtherCAT Network** from the menu.	
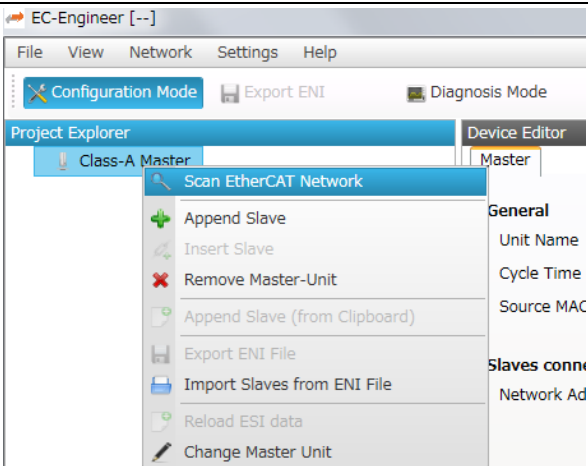
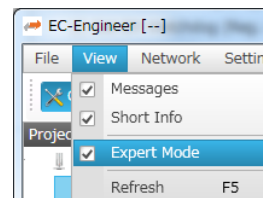| 7	Make sure that the slave is displayed in the Project Explorer.	
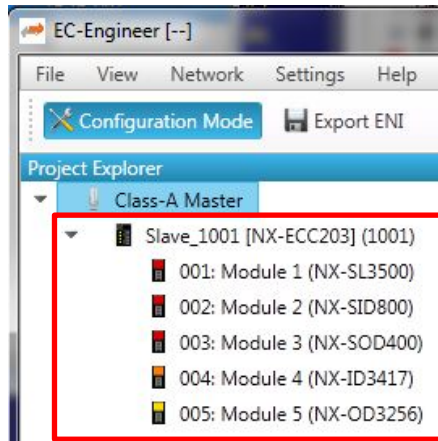
6.5.2. Distributed Clock Setup

1	Setting Distributed Clocks (DC) for Master In the Project Explorer, select **Class-A Master** to display the Distributed Clocks tab page.	
		* If the Distributed Clocks tab does not appear, select **View** then the **Expert Mode** check box.
2	Select **Master Shift (EtherCAT Master Time controlled by Reference Clock)**.	

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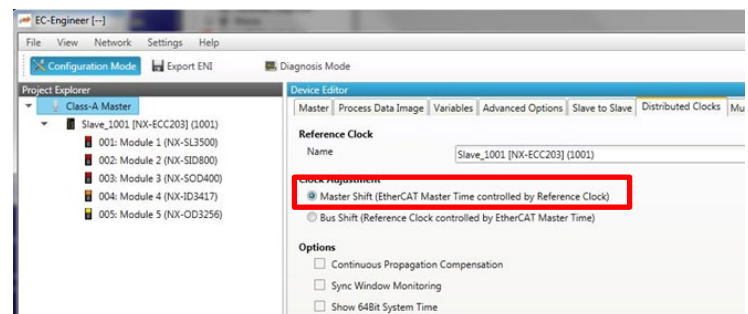
■ When using in DC mode
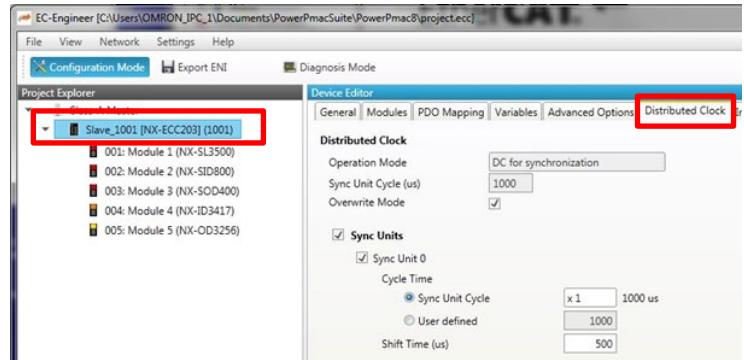
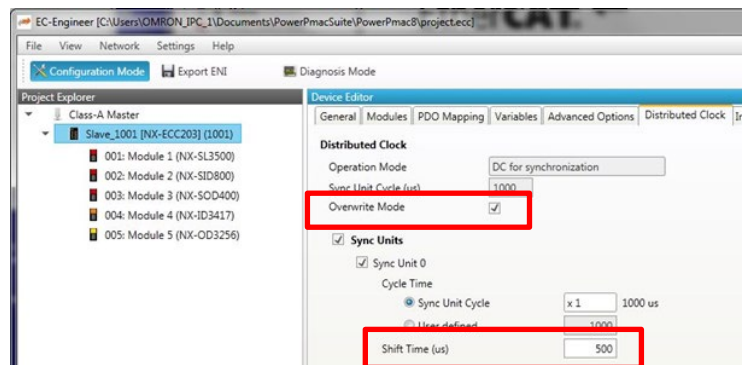|		
3	Setting Distributed Clock (DC) for the Slave In the Project Explorer, select the target slave to display the Distributed Clock tab page.	
4	Select the **Overwrite Mode** check box and specify **Shift Time**.	 Correspondence between the servo frequencies of the Controller and **Shift Time** values is as follows: 4 kHz : 125 us 2 kHz : 250 us 1 kHz : 500 us

■ When using in Free-Run mode
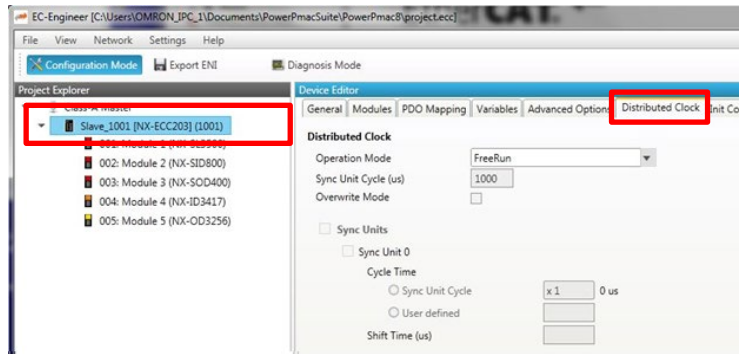
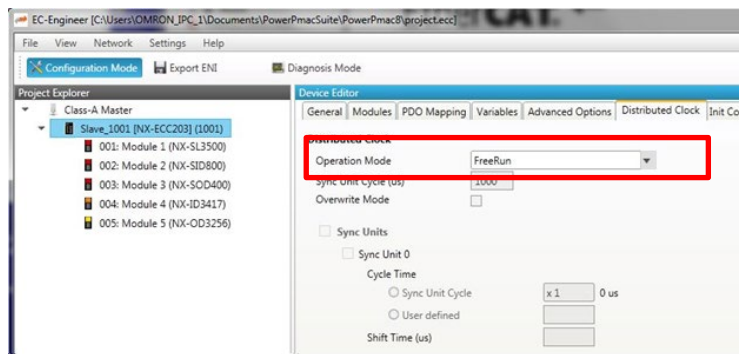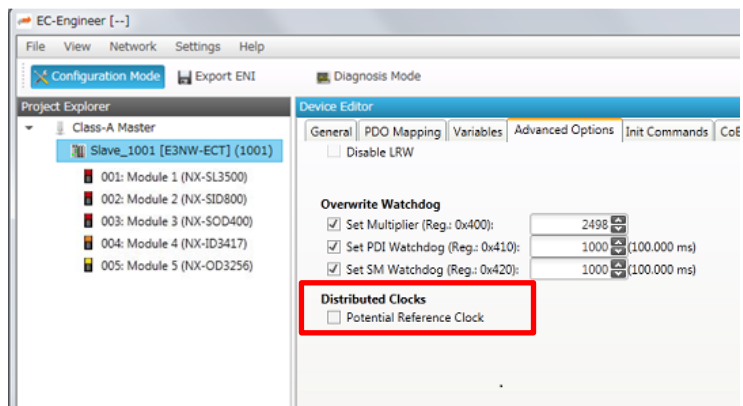| 3	Setting Distributed Clock (DC) for the Slave In the Project Explorer, select the target slave to display the Distributed Clock tab page.	
4	Select *FreeRun* from the drop down list for **Operation Mode**.	
5	In the Advanced Options tab page, clear the **Potential Reference Clock** check box.	

6.5.3. Safety Controller Variable Settings

(1) Checking the coupler I/O allocations

Decompress the ZIP file you saved in 6.2.7 Output of Couple I/O Allocations, open the expanded "CouplerMemoryMap.xml" using Internet Explorer, and check the contents.

The following is an example displayed using Internet Explorer.

Deviece	PDO Mapping					PDO entry				
Name	Name	Index	SM	Offset	Size	Name	Index	Data type	Offset	Size
E001	**TxPDO**									
	Slot0(NX-ECC203)505th transmit PDO Mapping	#x1BF8	3	0.00	16.00	NX Unit Registration Status 63	#x2003:03	ARRAY [0..7] OF BYTE	0.00	8.00
						NX Unit I/O Data Active Status 63	#x2005:03	ARRAY [0..7] OF BYTE	8.00	8.00
	Slot0(NX-ECC203)512th transmit PDO Mapping	#x1BFF	3	16.00	1.00	Sysmac Error Status	#x2001:01	USINT	16.00	1.00
	Slot0(NX-ECC203)PaddingTxPdo	#x1BF4	3	17.00	1.00	---	---	---	---	1.00
	Slot4(NX-ID3417)Input Data Set 1	#x1A0C	3	18.00	0.04	Input Bit 00	#x6060:01	BOOL	18.00	0.01
						Input Bit 01	#x6060:02	BOOL	18.01	0.01
						Input Bit 02	#x6060:03	BOOL	18.02	0.01
						Input Bit 03	#x6060:04	BOOL	18.03	0.01
	Slot0(NX-ECC203)PaddingTxPdo	#x1BF6	3	18.04	1.04	---	---	---	---	1.04
	Slot1(NX-SL3500)Input Data Set 1	#x1A00	3	20.00	14.00	Node1/Unit2	#x6000:01	ARRAY [0..6] OF BYTE	20.00	7.00
						Node1/Unit3	#x6000:02	ARRAY [0..5] OF BYTE	27.00	6.00
						Padding	#x6000:03	ARRAY [0..0] OF BYTE	33.00	1.00
	Slot1(NX-SL3500)Input Data Set 2	#x1A01	3	34.00	2.00	Safety CPU Status	#x6004:01	UINT	34.00	2.00
	Slot2(NX-SID800)Input Data Set 1	#x1A04	3	36.00	7.00	FSoE Slave CMD	#x6020:01	USINT	36.00	1.00
						Safety Input 1st Word	#x6021:01	UINT	37.00	2.00
						FSoE Slave CRC_0	#x6020:03	UINT	39.00	2.00
						FSoE Slave Conn_ID	#x6020:02	UINT	41.00	2.00
	Slot2(NX-SID800)Input Data Set 2	#x1A05	3	43.00	3.00	Standard Input 1st Word	#x6022:01	UINT	43.00	2.00
						Standard Input 2nd Byte	#x6022:02	USINT	45.00	1.00
	Slot3(NX-SOD400)Input Data Set 1	#x1A08	3	46.00	6.00	FSoE Slave CMD	#x6040:01	USINT	46.00	1.00
						Safety Input 1st Byte	#x6041:01	USINT	47.00	1.00
						FSoE Slave CRC_0	#x6040:03	UINT	48.00	2.00
						FSoE Slave Conn_ID	#x6040:02	UINT	50.00	2.00
	Slot3(NX-SOD400)Input Data Set 2	#x1A09	3	52.00	2.00	Standard Input 1st Byte	#x6042:01	USINT	52.00	1.00
						Standard Input 2nd Byte	#x6042:02	USINT	53.00	1.00
	RxPDO									
	Slot5(NX-OD3256)Output Data Set 1	#x1610	2	0.00	0.04	Output Bit 00	#x7080:01	BOOL	0.00	0.01
						Output Bit 01	#x7080:02	BOOL	0.01	0.01
						Output Bit 02	#x7080:03	BOOL	0.02	0.01
						Output Bit 03	#x7080:04	BOOL	0.03	0.01
	Slot0(NX-ECC203)PaddingRxPdo	#x17F6	2	0.04	1.04	---	---	---	---	1.04
	Slot1(NX-SL3500)Output Data Set 1	#x1600	2	2.00	14.00	Node1/Unit2	#x7000:01	ARRAY [0..6] OF BYTE	2.00	7.00
						Node1/Unit3	#x7000:02	ARRAY [0..5] OF BYTE	9.00	6.00
						Padding	#x7000:03	ARRAY [0..0] OF BYTE	15.00	1.00
	Slot1(NX-SL3500)Output Data Set 2	#x1601	2	16.00	0.00					
	Slot2(NX-SID800)Output Data Set 1	#x1604	2	16.00	7.00	FSoE Master CMD	#x7020:01	USINT	16.00	1.00
						Safety Output 1st Word	#x7021:01	UINT	17.00	2.00
						FSoE Master CRC_0	#x7020:03	UINT	19.00	2.00
						FSoE Master Conn_ID	#x7020:02	UINT	21.00	2.00
	Slot2(NX-SID800)Output Data Set 2	#x1605	2	23.00	3.00	Standard Output 1st Word	#x7022:01	UINT	23.00	2.00
						Standard Output 2nd Byte	#x7022:02	USINT	25.00	1.00
	Slot3(NX-SOD400)Output Data Set 1	#x1608	2	26.00	6.00	FSoE Master CMD	#x7040:01	USINT	26.00	1.00
						Safety Output 1st Byte	#x7041:01	USINT	27.00	1.00
						FSoE Master CRC_0	#x7040:03	UINT	28.00	2.00
						FSoE Master Conn_ID	#x7040:02	UINT	30.00	2.00
	Slot3(NX-SOD400)Output Data Set 2	#x1609	2	32.00	2.00	Standard Output 1st Byte	#x7042:01	USINT	32.00	1.00
						Standard Output 2nd Byte	#x7042:02	USINT	33.00	1.00

(2) Setting Input Data

Register the following input data.

- Slot1(NX-SL3500)Input Data Set1
- Slot1(NX-SL3500)Input Data Set2

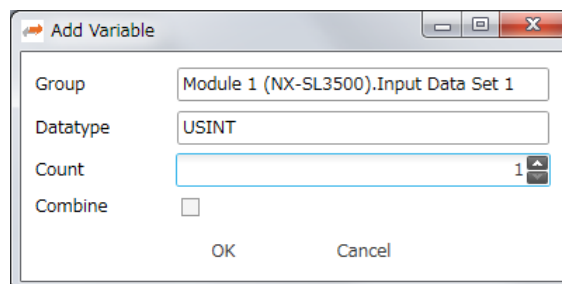|									
Slot1(NX-SL3500)Input Data Set 1	#x1A00	3	20.00	14.00	Node1/Unit2	#x6000:01	ARRAY [0..6] OF BYTE	20.00	7.00
					Node1/Unit3	#x6000:02	ARRAY [0..5] OF BYTE	27.00	6.00
					Padding	#x6000:03	ARRAY [0..0] OF BYTE	33.00	1.00
Slot1(NX-SL3500)Input Data Set 2	#x1A01	3	34.00	2.00	Safety CPU Status	#x6004:01	UINT	34.00	2.00
Slot2(NX-SID800)Input Data Set 1	#x1A04	3	36.00	7.00	FSoE Slave CMD	#x6020:01	USINT	36.00	1.00
					Safety Input 1st Word	#x6021:01	UINT	37.00	2.00
					FSoE Slave CRC_0	#x6020:03	UINT	39.00	2.00
					FSoE Slave Conn_ID	#x6020:02	UINT	41.00	2.00
Slot2(NX-SID800)Input Data Set 2	#x1A05	3	43.00	3.00	Standard Input 1st Word	#x6022:01	UINT	43.00	2.00
					Standard Input 2nd Byte	#x6022:02	USINT	45.00	1.00
Slot3(NX-SOD400)Input Data Set 1	#x1A08	3	46.00	6.00	FSoE Slave CMD	#x6040:01	USINT	46.00	1.00
					Safety Input 1st Byte	#x6041:01	USINT	47.00	1.00
					FSoE Slave CRC_0	#x6040:03	UINT	48.00	2.00
					FSoE Slave Conn_ID	#x6040:02	UINT	50.00	2.00
Slot3(NX-SOD400)Input Data Set 2	#x1A09	3	52.00	2.00	Standard Input 1st Byte	#x6042:01	USINT	52.00	1.00
					Standard Input 2nd Byte	#x6042:02	USINT	53.00	1.00
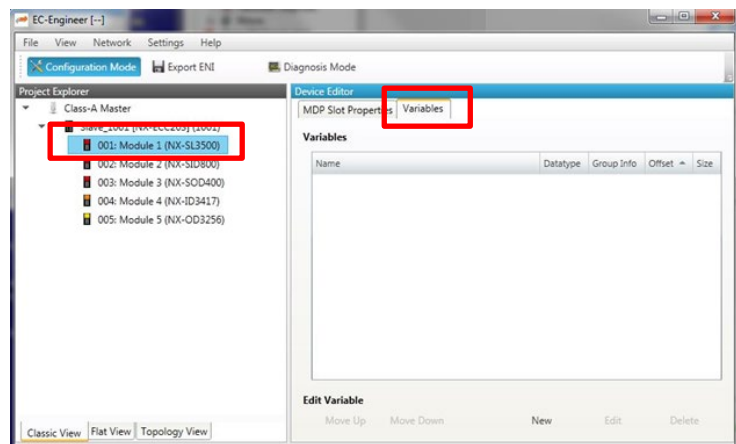
1	Select a safety controller in the Project Explorer pane of EC-Engineer. Display the Variables tab page.	
2	[Slot1(NX-SL3500)Input Data Set1] Registering Node1/Unit2 (NX-SID800) Click **New** in the Variables tab page, and register two variables shown on the right.	 | FSoE Slave CMD	#x6020:01	USINT | Group: Module 1(NX-SL3500).Input Data Set 1 Datatype: USINT Count: 1 | Safety Input 1st Word	#x6021:01	UINT
FSoE Slave CRC_0	#x6020:03	UINT
FSoE Slave Conn_ID	#x6020:02	UINT | Group: Module 1(NX-SL3500).Input Data Set 1 Datatype: UINT Count: 3

3	[Slot1(NX-SL3500)Input Data Set1] Registering Node1/Unit3 (NX-SOID400) Click **New** in the Variables tab page, and register two variables shown on the right.	<table><tr><td>FSoE Slave CMD</td><td>#x6040:01</td><td>USINT</td></tr><tr><td>Safety Input 1st Byte</td><td>#x6041:01</td><td>USINT</td></tr></table> Group: Module 1(NX-SL3500).Input Data Set 1 Datatype: USINT Count: 2 <table><tr><td>FSoE Slave CRC_0</td><td>#x6040:03</td><td>UINT</td></tr><tr><td>FSoE Slave Conn_ID</td><td>#x6040:02</td><td>UINT</td></tr></table> Group: Module 1(NX-SL3500).Input Data Set 1 Datatype: UINT Count: 2
4	[Slot1(NX-SL3500)Input Data Set1] Registering Padding Click **New** in the Variables tab page, and register the variable shown on the right.	Group: Module 1(NX-SL3500).Input Data Set 1 Datatype: USINT Count: 1
5	[Slot1(NX-SL3500)Input Data Set2] Registering Safety CPU Status Click **New** in the Variables tab page, and register the variable shown on the right.	<table><tr><td>Safety CPU Status</td><td>#x6004:01</td><td>UINT</td><td>34.00</td><td>2.00</td></tr></table> Group: Module 1(NX-SL3500).Input Data Set 2 Datatype: UINT Count: 1
6	Checking Input Data Make sure that the settings (Input) in the Variables tab page are correct.	

(3) Setting Output Data

Register the following output data.

- Slot1(NX-SL3500)Output Data Set1
- Slot1(NX-SL3500)Output Data Set2

Slot1(NX-SL3500)Output Data Set 1	#x1600	2	2.00	14.00	Node1/Unit2	#x7000:01	ARRAY [0..6] OF BYTE	2.00	7.00
					Node1/Unit3	#x7000:02	ARRAY [0..5] OF BYTE	9.00	6.00
					Padding	#x7000:03	ARRAY [0..0] OF BYTE	15.00	1.00
Slot1(NX-SL3500)Output Data Set 2	#x1601	2	16.00	0.00					
Slot2(NX-SID800)Output Data Set 1	#x1604	2	16.00	7.00	FSoE Master CMD	#x7020:01	USINT	16.00	1.00
					Safety Output 1st Word	#x7021:01	UINT	17.00	2.00
					FSoE Master CRC_0	#x7020:03	UINT	19.00	2.00
					FSoE Master Conn_ID	#x7020:02	UINT	21.00	2.00
Slot2(NX-SID800)Output Data Set 2	#x1605	2	23.00	3.00	Standard Output 1st Word	#x7022:01	UINT	23.00	2.00
					Standard Output 2nd Byte	#x7022:02	USINT	25.00	1.00
Slot3(NX-SOD400)Output Data Set 1	#x1608	2	26.00	6.00	FSoE Master CMD	#x7040:01	USINT	26.00	1.00
					Safety Output 1st Byte	#x7041:01	USINT	27.00	1.00
					FSoE Master CRC_0	#x7040:03	UINT	28.00	2.00
					FSoE Master Conn_ID	#x7040:02	UINT	30.00	2.00
Slot3(NX-SOD400)Output Data Set 2	#x1609	2	32.00	2.00	Standard Output 1st Byte	#x7042:01	USINT	32.00	1.00
					Standard Output 2nd Byte	#x7042:02	USINT	33.00	1.00

7	Select a safety controller in the Project Explorer pane of EC-Engineer. Display the Variables tab page.	
8	[Slot1(NX-SL3500)Output Data Set1] Registering Node1/Unit2 (NX-SID800) Click **New** in the Variables tab page, and register two variables shown on the right.	 Group: Module 1(NX-SL3500).Output Data Set 1 Datatype: USINT Count: 1 Group: Module 1(NX-SL3500).Output Data Set 1 Datatype: UINT Count: 3
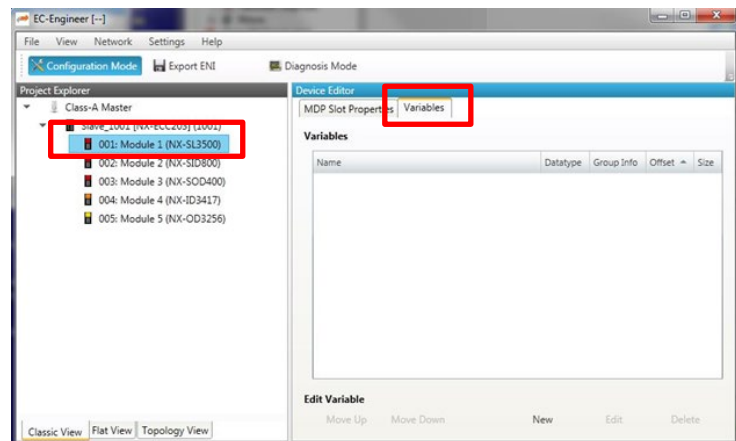
9	[Slot1(NX-SL3500)Output Data Set1] Registering Node1/Unit3 (NX-SOID400) Click **New** in the Variables tab page, and register two variables shown on the right.	FSoE Master CMD #x7040:01 USINT Safety Output 1st Byte #x7041:01 USINT Group: Module 1(NX-SL3500).Output Data Set 1 Datatype: USINT Count: 2 FSoE Master CRC_0 #x7040:03 UINT FSoE Master Conn_ID #x7040:02 UINT Group: Module 1(NX-SL3500).Output Data Set 1 Datatype: UINT Count: 2
10	[Slot1(NX-SL3500)Output Data Set1] Registering Padding Click **New** in the Variables tab page, and register the variable shown on the right.	Group: Module 1(NX-SL3500).Output Data Set 1 Datatype: USINT Count: 1
11	[Slot1(NX-SL3500)Output Data Set2] * *Output Data Set2* is not used and does not need to be set.	
12	Checking Output Data Make sure that the settings (Output) in the Variables tab page are correct.	

6.5.4. PDO Map Settings

1	In the Project Explorer, select the target slave to display the PDO Mapping tab page.	
2	Setting PDO mapping (Inputs) Confirm the check boxes in the Inputs field. * If you do not want to use data in the Inputs field, clear the currently displayed check boxes.	
3	Setting PDO mapping (Outputs) Confirm the check boxes in the Outputs field. * If you do not want to use data in the Outputs field, clear the currently displayed check boxes.	
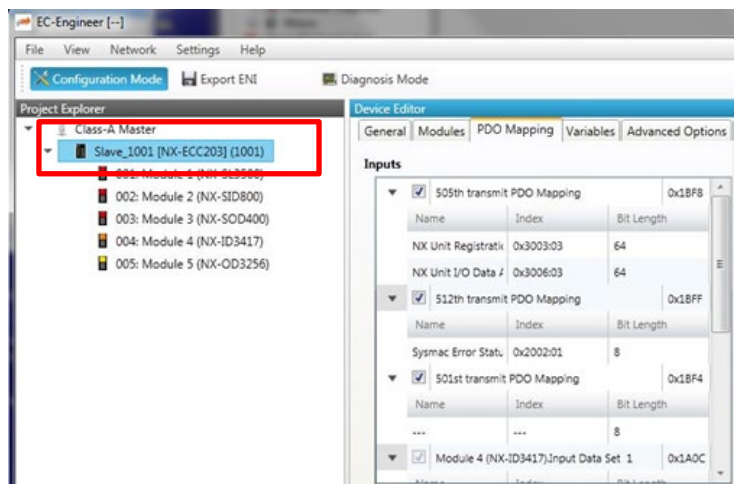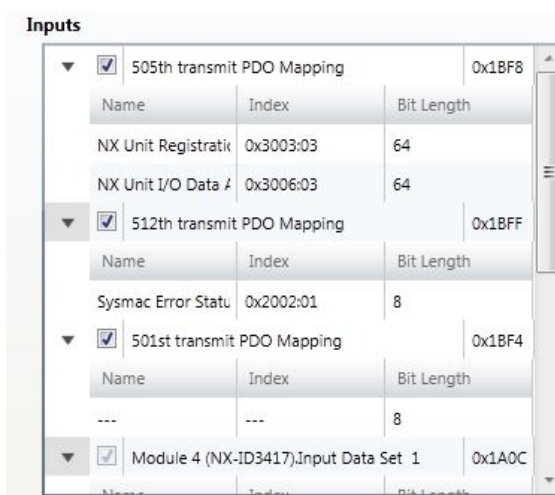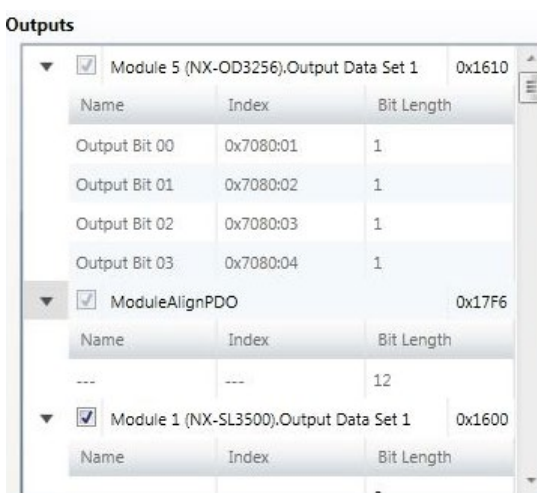
6.5.5. Coupler I/O and Variable Allocations

(1) Checking the coupler I/O allocations

Decompress the ZIP file you saved in 6.2.7 Output of Couple I/O Allocations, open the expanded "CouplerCopyInfo.xml" using Internet Explorer, and check the contents.

The following is an example displayed using Internet Explorer.

| Original device name	Original slave model	Original SM	Original bit offset	Destination device name	Destination slave model	Destination SM	Destination bit offset	Bit size
E001	NX-ECC203	3	160	E001	NX-ECC203	2	128	56
E001	NX-ECC203	3	216	E001	NX-ECC203	2	208	48
E001	NX-ECC203	3	288	E001	NX-ECC203	2	16	56
E001	NX-ECC203	3	368	E001	NX-ECC203	2	72	48

(2) Setting Input Data

Associate the following items:

- **Module 1 (NX-SL3500).Input Data Set 1**, and **Module 2 (NX-SID800).Output Data Set 1**
- **Module 1 (NX-SL3500).Input Data Set 1**, and **Module 3 (NX-SOD400).Output Data Set 1**

Copy bit size (56 bits) from the source bit offset (160 bits) to the destination bit offset (128 bits).

Original device name	Original slave model	Original SM	Original bit offset	Destination device name	Destination slave model	Destination SM	Destination bit offset	Bit size
E001	NX-ECC203	3	160	E001	NX-ECC203	2	128	56
E001	NX-ECC203	3	216	E001	NX-ECC203	2	208	48
E001	NX-ECC203	3	288	E001	NX-ECC203	2	16	56
E001	NX-ECC203	3	368	E001	NX-ECC203	2	72	48

1	Select *Class-A Master* in the Project Explorer page of EC-Engineer. Display the Slave to Slave tab page.	
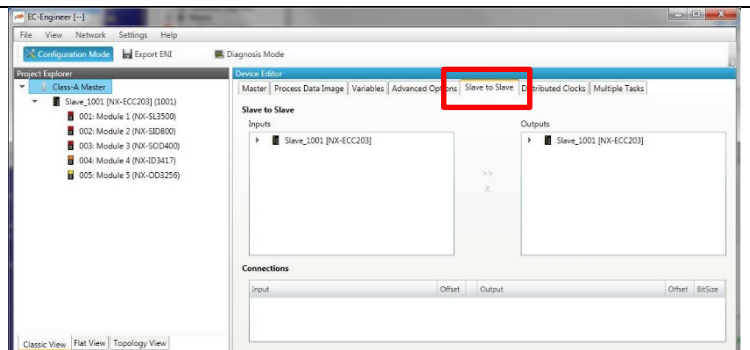
| 2 | Associate the variables of Inputs **Module 1 (NX-SL3500).Input Data Set 1** with Outputs **Module 2 (NX-SID800).Output Data Set 1**.
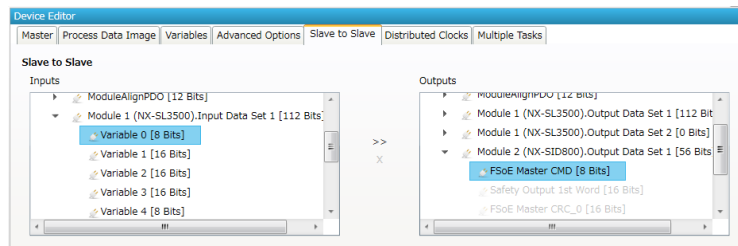
Select an **(NX-SL3500).Input Data Set 1** item, then select the corresponding **(NX-SID800).Output Data Set 1** item and click **>>**. |

Associate the following items:

| Inputs | Outputs |
| --- | --- |
| Variable 0 | FSoE Master CMD |
| Variable 1 | Safety Output 1st Word |
| Variable 2 | FSoE Master CRC_0 |
| Variable 3 | FSoE Master Conn_ID | |
| 3 | Associate the variables of Inputs **Module 1 (NX-SL3500).Input Data Set 1** with Outputs **Module 3 (NX-SOD400).Output Data Set 1**.
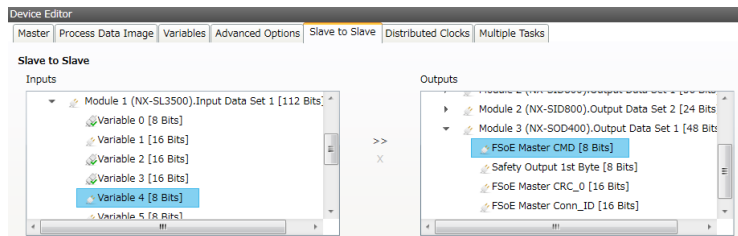
Select an **(NX-SL3500).Input Data Set 1** item, then select the corresponding **(NX-SOD400).Output Data Set 1** item and click **>>**. |

Associate the following items:

| Inputs | Outputs |
| --- | --- |
| Variable 4 | FSoE Master CMD |
| Variable 5 | Safety Output 1st Word |
| Variable 6 | FSoE Master CRC_0 |
| Variable 7 | FSoE Master Conn_ID |

* Variable 8 does not need to be allocated. |

(3) Setting Output Data

Associate the following items:

- **Module 2 (NX-SID800).Input Data Set 1**, and **Module 1 (NX-SL3500).Output Data Set 1**
- **Module 3 (NX-SOD400).Input Data Set 1**, and **Module 1 (NX-SL3500).Output Data Set 1**

4	Associate the variables of Inputs **Module 2 (NX-SID800).Input Data Set 1** with Outputs **Module 1 (NX-SL3500).Output Data Set 1**.	
	Select an **(NX-SID800).Input Data Set 1** item, then select the corresponding **(NX-SL3500).Output Data Set 1** item and click **>>**.	Associate the following items:
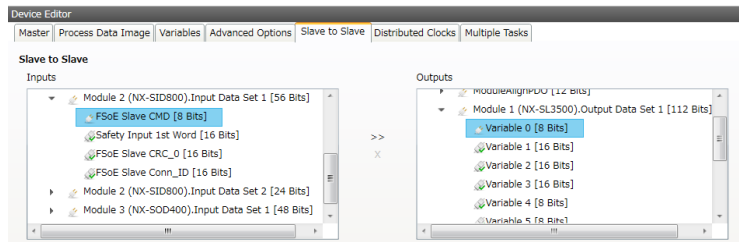
Associate the following items:

Inputs	Outputs
FSoE Master CMD	Variable 0
Safety Output 1st Word	Variable 1
FSoE Master CRC_0	Variable 2
FSoE Master Conn_ID	Variable 3

5	Associate the variables of Inputs **Module 3 (NX-SOD400).Input Data Set 1** with Outputs **Module 1 (NX-SL3500).Output Data Set 1**.	
	Select an **(NX-SOD400).Input Data Set 1** item, then select the corresponding **(NX-SL3500).Output Data Set 1** item and click **>>**.	Associate the following items:
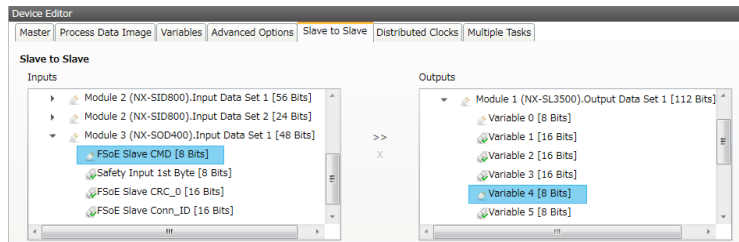
Associate the following items:

Inputs	Outputs
FSoE Master CMD	Variable 4
Safety Output 1st Word	Variable 5
FSoE Master CRC_0	Variable 6
FSoE Master Conn_ID	Variable 7

* Variable 8 does not need to be allocated.

6.5.6. Creation of an EtherCAT Network Configuration File

1	Click **Export ENI** on the upper part of the EC-Engineer page.	
2	Enter a file name, and then click **Save** to create an EtherCAT network configuration file.	
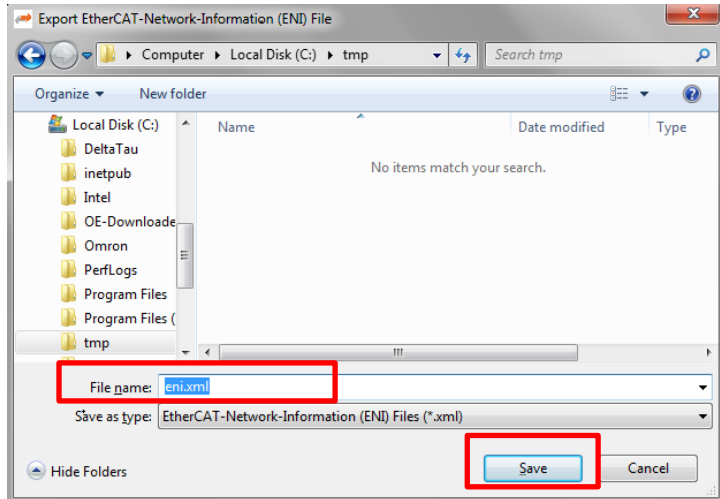
6.6. Controller Settings

6.6.1. EtherCAT Network Configuration Settings
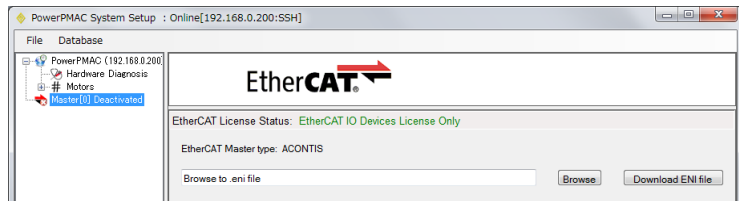
1	From the **Tools** menu of Power PMAC IDE, select **System Setup** to display **System Setup**.	
2	Click **Browse**, and load the EtherCAT network configuration file created in *6.5.6 Creation of an EtherCAT Network Configuration File*.	
3	Click **Download ENI file** to download the EtherCAT network configuration to the Controller.	
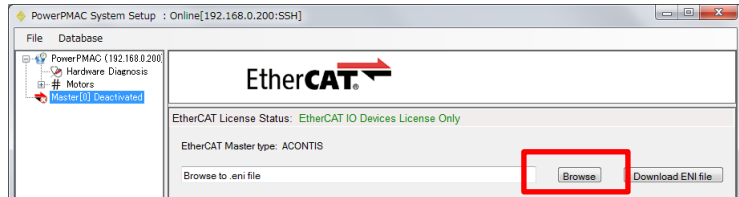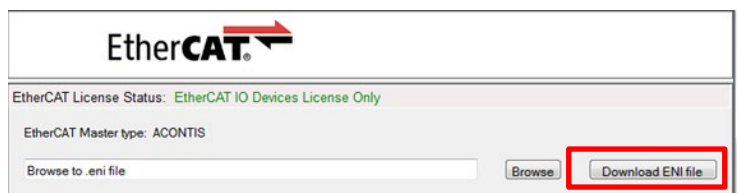
6.6.2. EtherCAT Communications Check
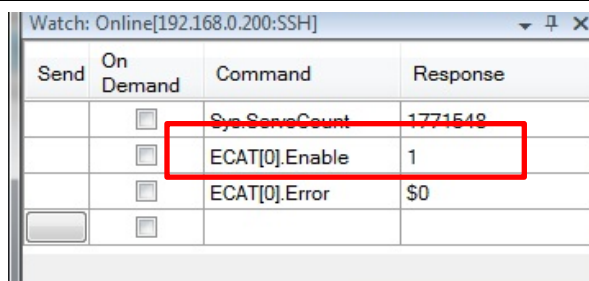
Take the following steps to ensure that EtherCAT communications are available.
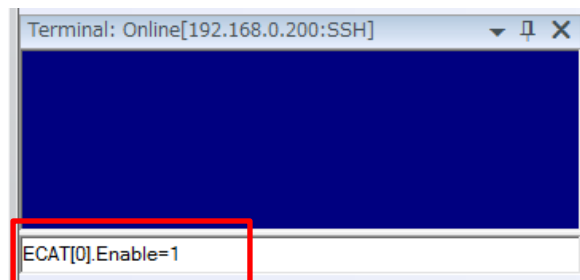
1	From the Terminal pane, run the ECAT[0].Enable=1 command to start EtherCAT communications.	
2	In the Terminal or Watch pane, make sure that the ECAT[0].Enable value turns to *1*. * The OP mode is entered and EtherCAT communications are established.	

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3	After making sure that correct communications are available, run the ECAT[0].Enable=0 command from the Terminal pane to stop EtherCAT communications.	
4	In the Terminal or Watch pane, make sure that the ECAT[0].Enable value turns to *0*.	

6.6.3. EtherCAT Variables Settings

1	In the System Setup page, right-click on **Master[0].Deactivated** to display the pop-up menu, and select **Export EtherCAT Variables**.	
2	Enter a name for the EtherCAT variable definition file for user programs into the root of the project folder.	
3	The created EtherCAT variable definition file is added to under **Global Includes** of **PMAC Script Language** in Solution Explorer.	
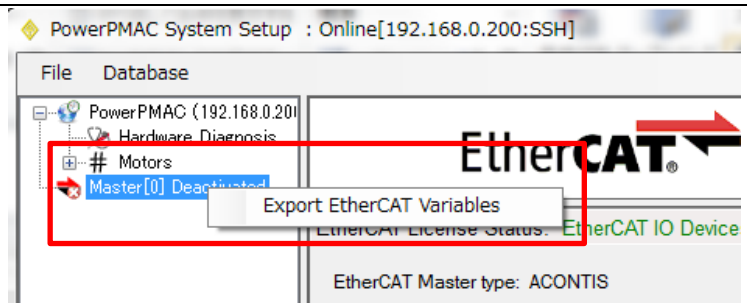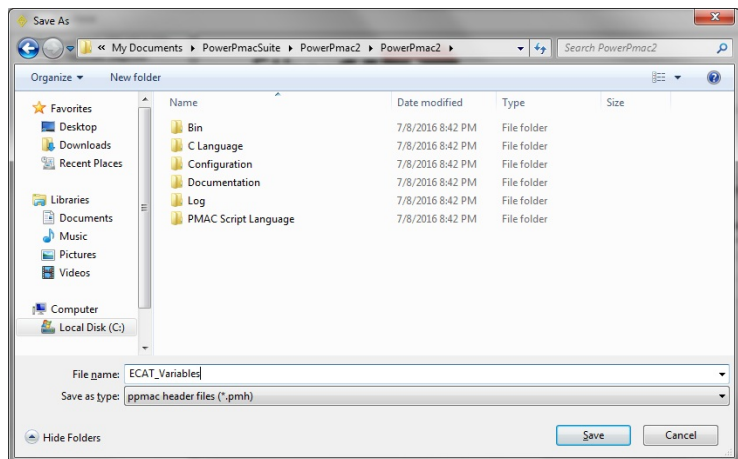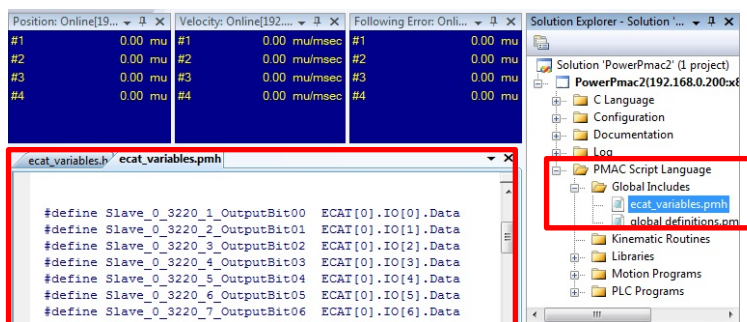
6.6.4. Writing the User Program

Create programs to be used to check operations.

A specific language is used for the operation check programs. Refer to *Power PMAC User's Manual* and *Power PMAC Software Reference Manual* for details.

1	In the Solution Explorer pane, open **Project name** – **PMAC Script Language** – **PLC Programs** – **plc1.plc**.	
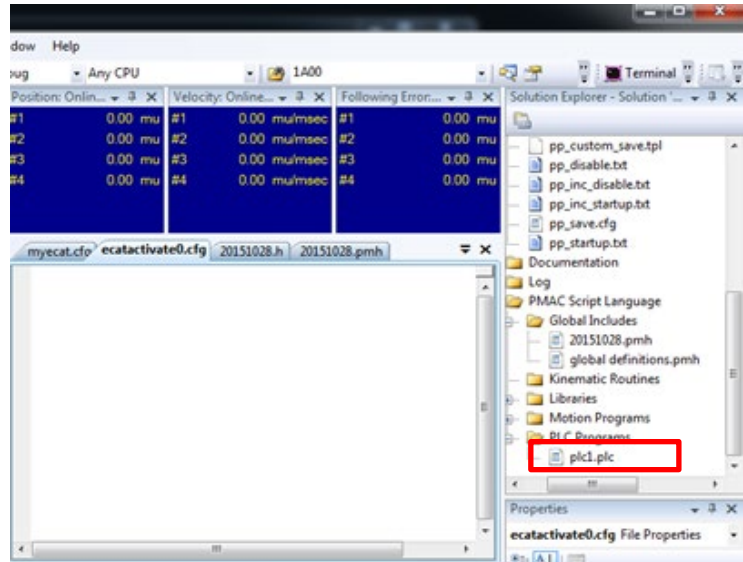
2	In the programming area of the plc1.plc tab page, write a program as show on the right.
	
	This sample program blinks the NX-OD3256 output indicator every second.
	
	* In this example, PDO mapping is assumed to be the default setting. If you want to change PDO mapping, rewrite the "Slave_0...." description.
		``
		open plc 1
		
		    while(sys.ecatMasterReady==0){};
		
		    ECAT[0].Enable = 1;
		
		    P1000=Sys.Time+1;
		    while(P1000>Sys.Time){};
		
		    Slave_0_7080_2_OutputBit01 = 1;
		
		    P1000=Sys.Time+1;
		    while(P1000>Sys.Time){};
		
		    Slave_0_7080_2_OutputBit01 = 0;
		
		close
		``

3	Setting the start of the user program In the Solution Explorer pane, open **Project name** – **Configuration** – **pp_disable.txt**.	
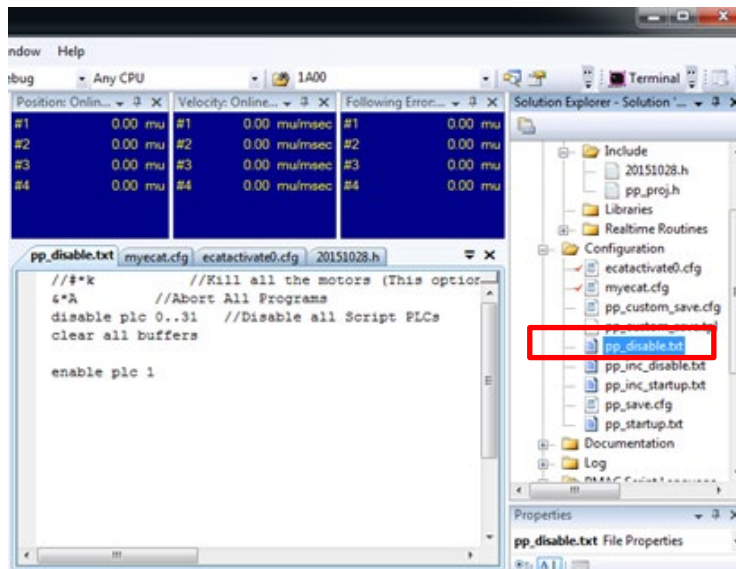
4	In the programming area of the pp_disable.txt tab page, add the program shown on the right to the last line. The pp_disable.txt program is automatically executed when the Controller starts. This example program runs the PLC1 script.	``` enable plc 1; ```

6.6.5. Project Data Transfer

Transfer the created project data to the Controller.

⚠ WARNING

When the user program and "configuration and setting" data are transferred from Power PMAC IDE, devices or the machine may perform unexpected operations. Therefore, before you transfer project data, ensure the destination slave is operating safely.

⚠ Caution

Transferring project data restarts the Controller and interrupts communications with slaves. The time that communications are interrupted depends on the EtherCAT network configuration.
Before you transfer project data, make sure that the slave settings will not adversely affect the devices.

1	In the Terminal or Watch pane, make sure that the ECAT[0].Enable value is *0*. If the value is 1, run the ECAT[0].Enable=0 command from the Terminal pane to stop EtherCAT communications.	
2	Downloading a project Right-click the project name in the Solution Explorer pane on the upper right of the IDE screen, and select **Build and Download All Programs** to run the build and download.	
3	Make sure that there are no errors in the Output tab page. * If the transfer fails, check details of the error in the Output tab page. If the error is a program error, you must review the program. If the error is related to EtherCAT settings, return to System Setup and check whether there are any incorrect settings.	
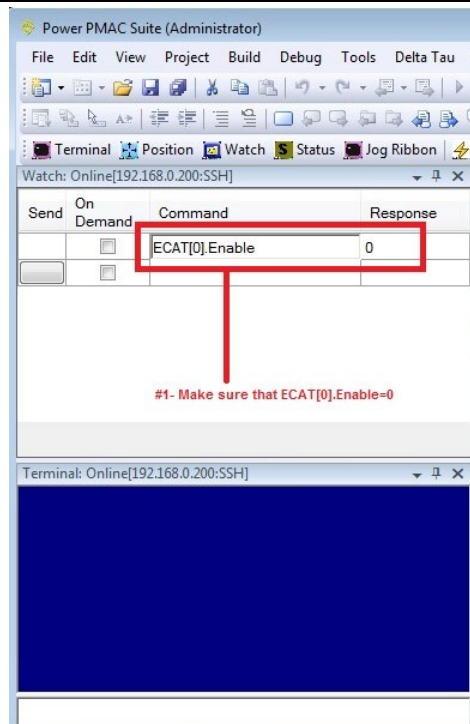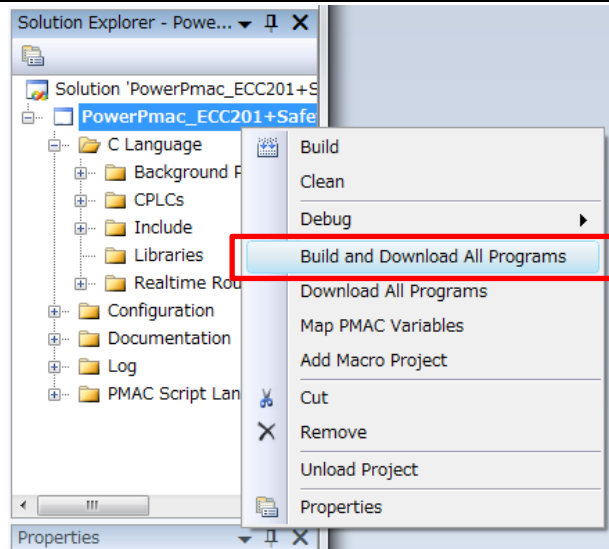
4	The program starts running when it has been downloaded successfully. EtherCAT communications are in the OP state. Make sure that the NX-OD3256 output indicator blinks. * If the indicator does not blink, check that the ECAT[0].Enable value is *1* in the Terminal or Watch pane. If the value is *0*, run the following command from the Terminal pane. enable plc 1	Terminal: Online[192.168.0.200:SSH] enable plc 1
5	After you have confirmed an appropriate operation, save the project to the Controller. Run the save command from the Terminal pane. * The transferred project is not yet saved to the Controller at this stage. If you turn OFF the power to the Controller, the transferred project will be discarded.	Terminal: Online[192.168.0.200:SSH] Save Complete save
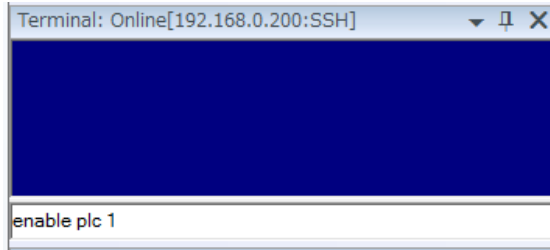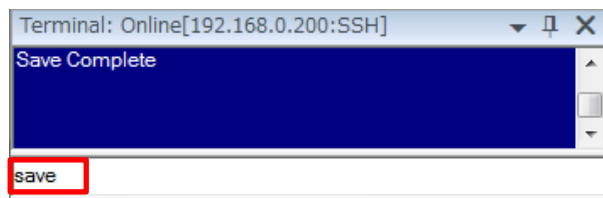
7. Appendix　Saving and Loading a Project

The following describes the procedures to save a Power PMAC IDE project on the computer, and to reuse it.

7.1. Saving a Project

1	Creating a Configuration File Create a Configuration File to save parameters you have changed in **System Setup** to the project. Right-click **Configuration** in the Solution Explorer pane, and select **Generate Configuration File**. A Configuration File is added to **Configuration**.
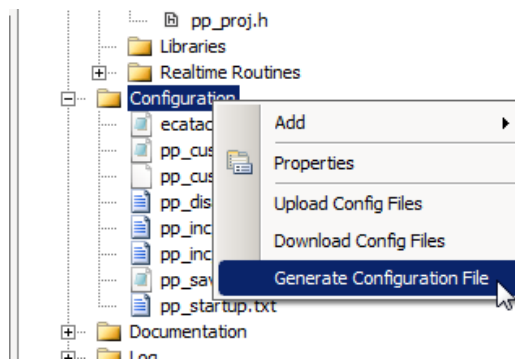
2	Right-click on the Configuration File, and from the menu, select **Check To Download Config File** to include it in files to be downloaded.
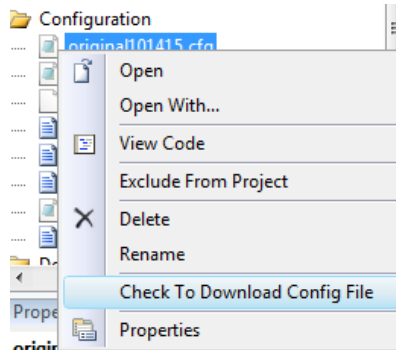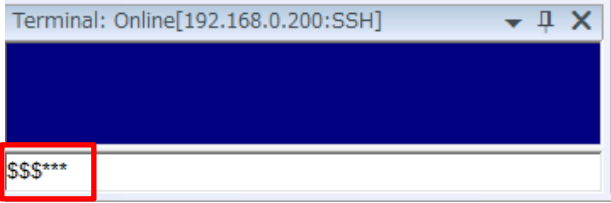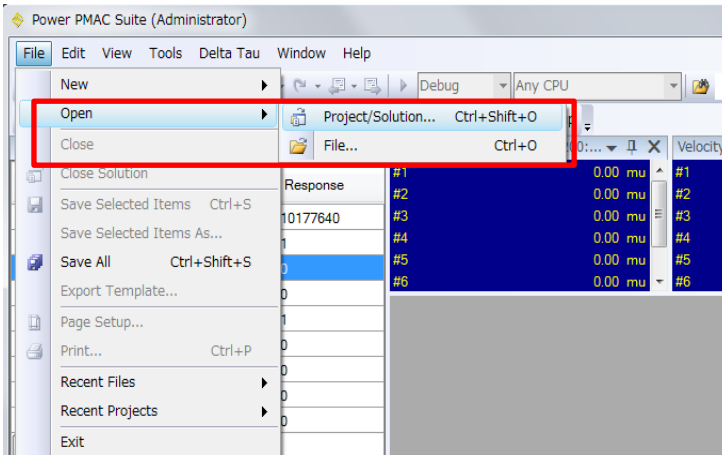
3	Saving a Project In the **File** menu, run **Save All** to save the project on the computer.
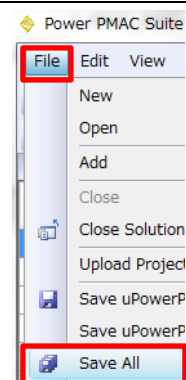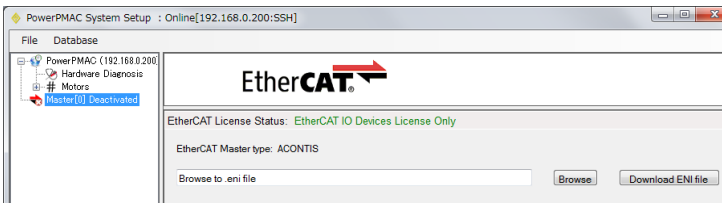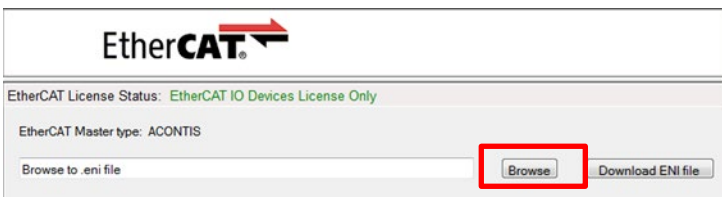
7.2. Loading and Downloading a Project
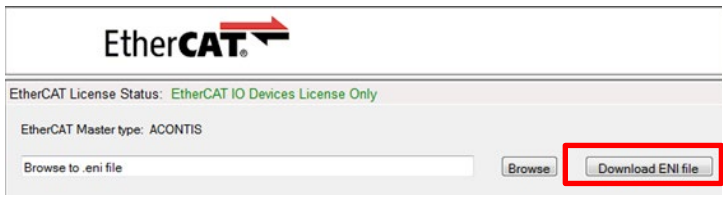
1	Start Power PMAC IDE, and connect to the Controller.	
2	In the Terminal pane, type the $$$*** command to reset the Controller settings to factory default.	
3	In the **File** menu, Click **Open** – **Project/Solution** to load the project that you saved.	
4	From the **Tools** menu of Power PMAC IDE, select **System Setup** to display **System Setup**.	
5	Click **Browse**, and load the ENI file that you created in *6.5.6 Creation of an EtherCAT Network Configuration File*.	
6	Click **Download ENI file** to download the EtherCAT network configuration to the Controller.	

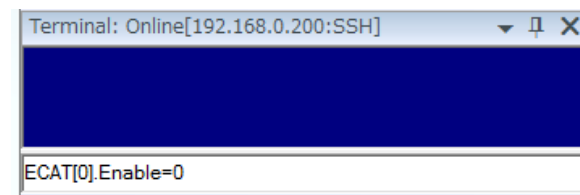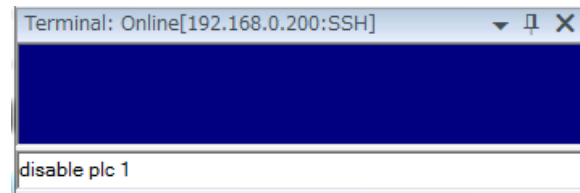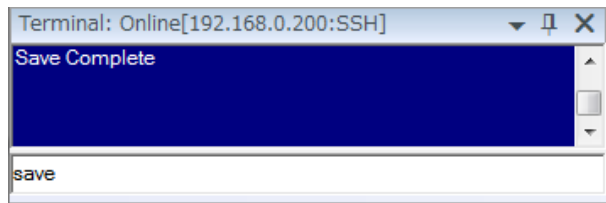|		
7	Right-click **Configuration** in the Solution Explorer pane, and select **Download Config Files** to download the file to the Controller.	
8	Right-click the project name in the Solution Explorer pane, and select **Build and Download All Programs** to run the build and download. When the download process is complete, make sure that there are no errors in the Output tab page.	
9	Stopping a program If a program is running, execute the following command from the Terminal pane to stop the program. disable plc 1 ECAT[0].Enable=0	

| 10	Saving the downloaded settings and programs After the download process is complete and you make sure that there are no errors in the Output tab page, run the save command from the Terminal pane. * The save command stores the downloaded project in the Controller. This operation saves the settings to be executed automatically when the power to the Controller is turned on.	
11	Restarting after download Run the following command from the Terminal pane to restart the Controller with the downloaded project. $$$	
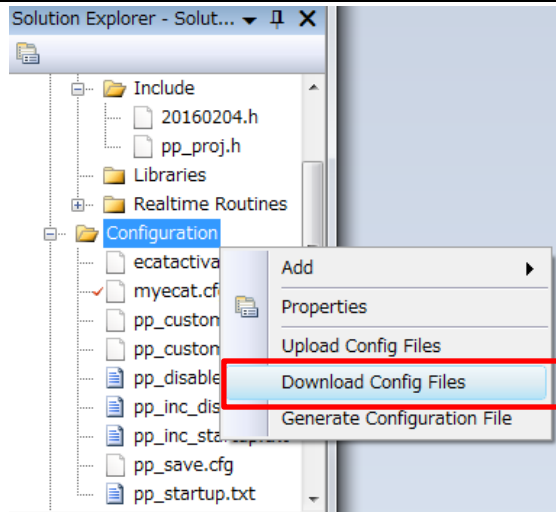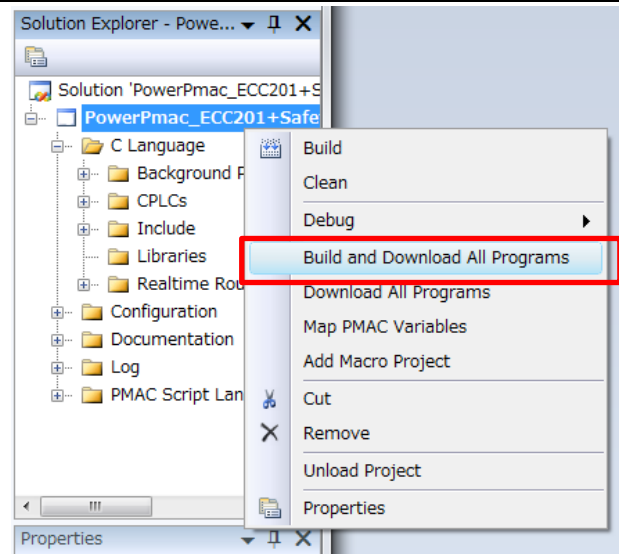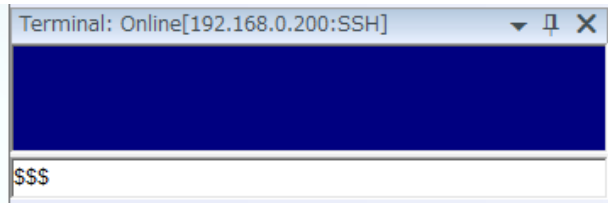
8. Appendix   Troubleshooting

8.1. Factors Causing EtherCAT Communications To Be Unavailable, and Corrective Actions

| Description	Factor	Corrective Action
The link is not established.	The Ethernet cable is broken or the specified cable is not being used.	If the Ethernet cable is broken or if the specified cable was not used, replace the cable.
	A connector on the Ethernet cable used for EtherCAT communications is disconnected, the contact is faulty, or parts are faulty.	Reconnect the connector and make sure it is mated correctly.
	A slave within the EtherCAT network configuration failed.	Replace the slave.
EtherCAT communications do not start.	ECAT[0].Enable is set to *0*.	From the Terminal pane, run the ECAT[0].Enable=1 command to start EtherCAT communications.
	The EtherCAT network configuration in the Controller does not agree with the physical network configuration.	Review the settings according to the procedures provided in *6.5 EtherCAT Communications Setup*.
	The Ethernet cable is broken at a slave in the network, or a connector is disconnected.	Connect the Ethernet cable correctly.
	Some errors have occurred, and the ECAT[0].error is set to a value other than *0*.	Check the ECAT[0].error value.
A synchronization error occurs at a slave.	The distribution clock is not set correctly.	Review the settings according to the procedures provided in *6.5.2 Distributed Clock Setup*.
	A slave in Free-Run Mode is set to the reference clock.	
	The servo task processing time exceeds the set period.	Review the program or servo frequency to adjust it, so that the servo task processing time does not exceed the period.

8.2. How to Check for Errors

8.2.1. Checking the EtherCAT Status

You can check the EtherCAT status from **System Setup** of Power PMAC IDE and **Diagnosis Mode** of Acontis EC-Engineer.
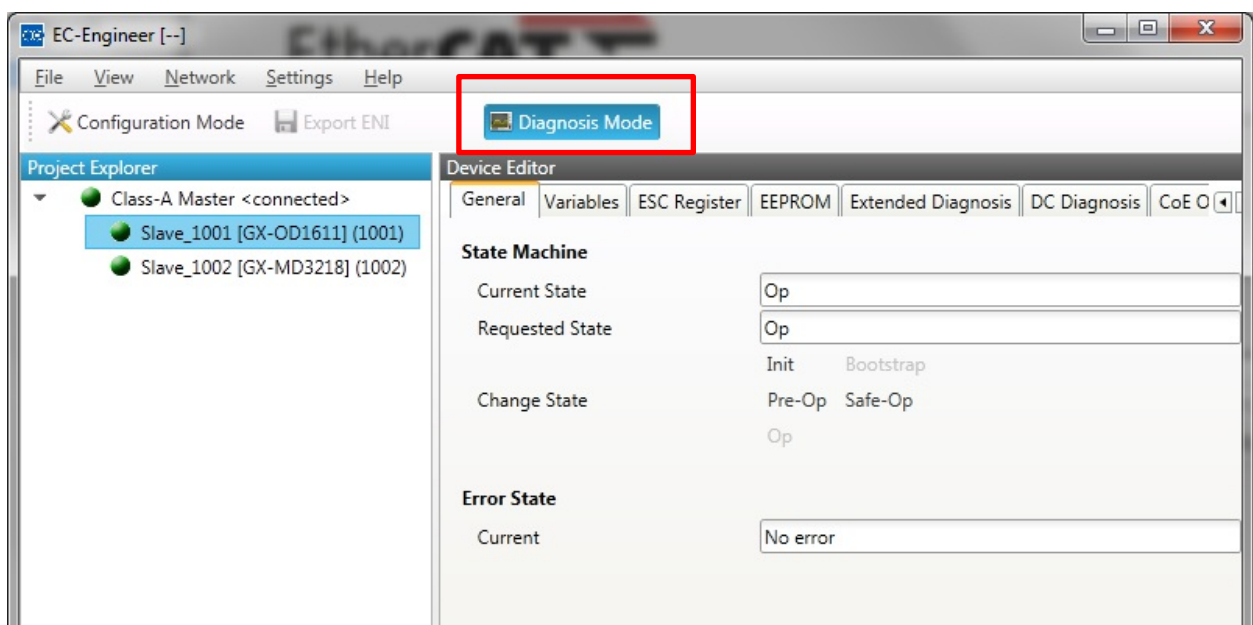
■ **System Setup** of Power PMAC IDE

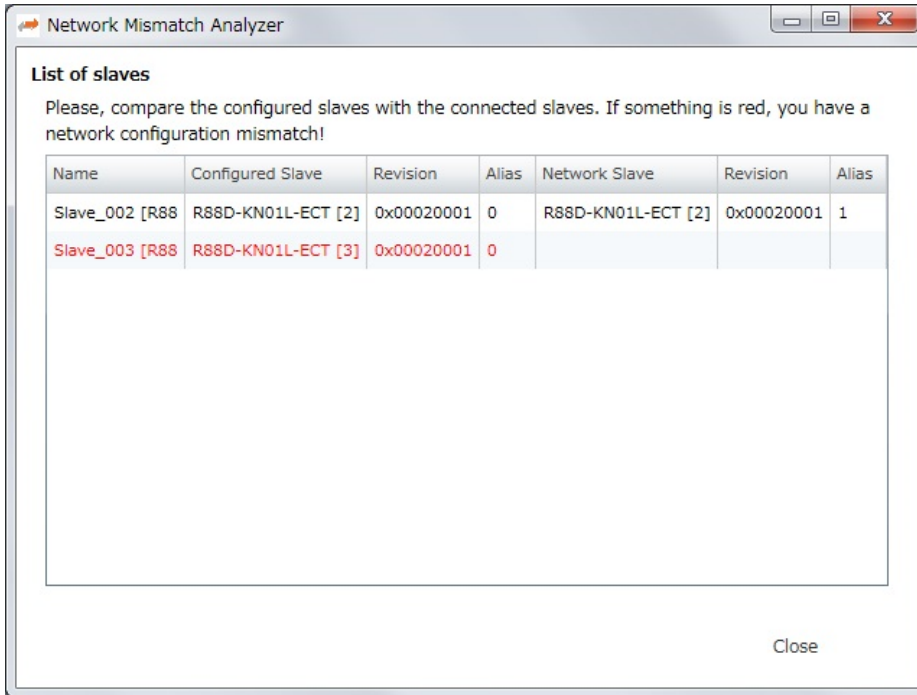You can check the status of the EtherCAT master and slaves in the System Setup page of Power PMAC IDE.
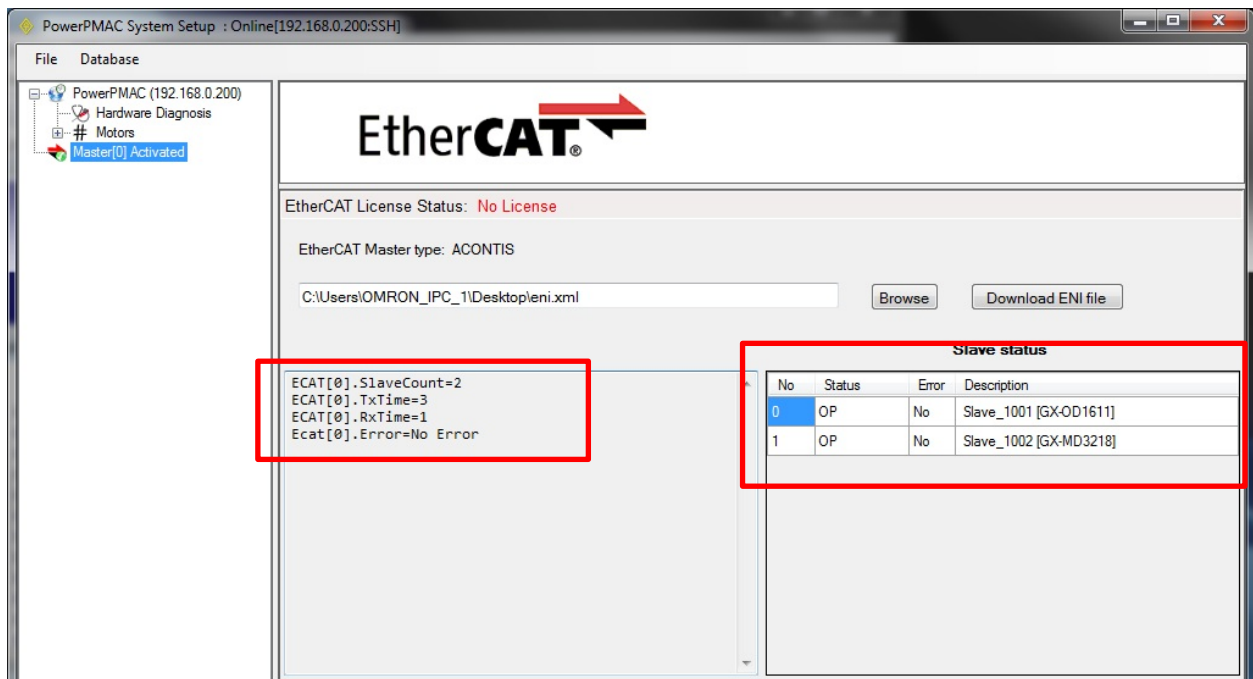
■ **Diagnosis Mode** of Acontis EC-Engineer

You can check the status of the slaves in the Diagnosis Mode page of Acontis EC-Engineer.

Select **Network** then **Network Mismatch Analyzer** from the menu to verify the network configuration.

8.2.2. Checking the Controller Status

In the Status page of Power PMAC IDE, you can check the status of the motor, coordinate system, and system.

To display the Status page, click **Status** on the toolbar.

■ Global Status

You can check system errors such as the WDT error.
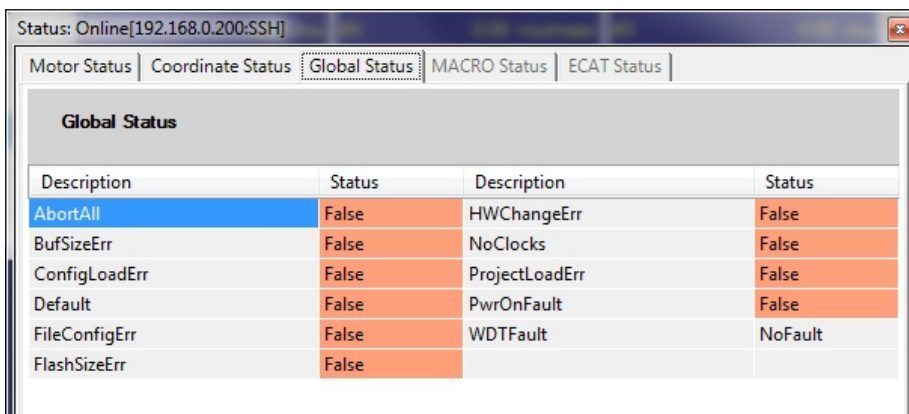
■ Motor Status

You can check deviation errors, limit errors, and other states of the motor.

■ Coordinate Status

You can check deviation errors, limit errors and other states of the coordinate system.

9. Appendix　ECAT[i] Structure Elements

The Controller uses motion controller technology developed by Delta Tau Data Systems, Inc., (hereafter referred to as DT) in the U.S., however, the ECAT[i] structure elements differ from those of DT controllers. The following table shows the major changes that have been made from DT controllers.

Element name	Description	Change
ECAT[i].Enable	Enabling the EtherCAT network	0: Disable, 1: Enable (2 and 3 are not supported.)
ECAT[i].LPIO[k]	Elements of low priority I/O module	Not supported
ECAT[i].Slave[j]	Slave elements	Not supported
ECAT[i].Error	Error code of enabling EtherCAT network	$ 9811000C: Invalid network configuration $ 9811002E: Disconnected network connection
ECAT[i].LinkUp ECAT[i].LPDomainOutputState ECAT[i].LPDomainState ECAT[i].LPRxTime ECAT[i].LPTxTime ECAT[i].MasterStat ECAT[i].RTDomainOutputState ECAT[i].RTDomainState	Status data structure elements	Not supported

10. Revision History

Revision code	Revised date	Revised content
01	July 1, 2016	First edition
02	April 10, 2023	Corrected mistakes.

Note: Do not use this document to operate the Unit.

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