

Programmable Multi-Axis Controller

Startup Guide

EtherCAT Coupler Unit

Safety CPU Unit

Safety I/O Units

(IDEv4)

CK3E-□□□□
CK3M-CPU1□1
NY51□-A□□□



Startup
Guide

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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-1□10	CK3E-series Programmable Multi-Axis Controller Hardware User's Manual
OMRON	O036-E2	Model CK3M-CPU1□1	CK3M-series Programmable Multi-Axis Controller Hardware User's Manual
OMRON	W580-E1	Model NY512-A6001XX21391 X	Industrial PC Platform NY-series IPC Programmable Multi-Axis Controller Industrial Box PC Hardware User's Manual
OMRON	W519-E1	Model NX-ECC203	EtherCAT® Coupler Unit User's Manual
OMRON	Z930-E1	Model NX-SL□□□□ Model NX-SI□□□□ Model NX-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 Power PMAC IDE, 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.

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 April 2019. 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.
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 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-□□□□/ CK3M-CPU1□1/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	Model CK3M-CPU1□1
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-SI□□□□ Model NX-SO□□□□
OMRON	Digital I/O Units	Model NX-ID□□□□ Model NX-IA□□□□ Model NX-OC□□□□ Model NX-OD□□□□ Model NX-MD□□□□



Precautions for Correct Use

Use model NX-ECC203 Version 1.5 or later for the EtherCAT Coupler Unit.
Models NX-ECC201 and NX-ECC202 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.

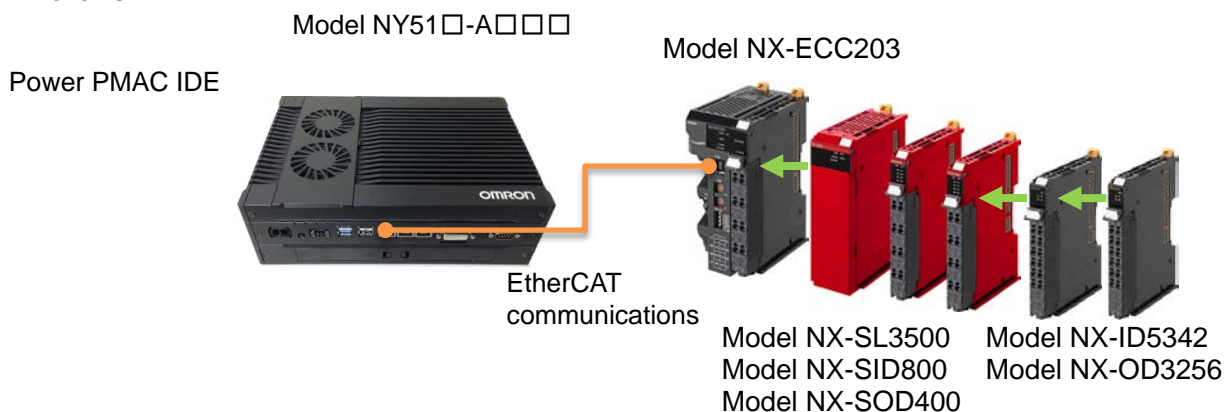


Additional Information

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 NY51□-A□□□	Ver.2.5 or later
OMRON	EtherCAT Coupler Unit	Model NX-ECC203	Ver.1.5
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	Digital Input Unit	Model NX-ID5342	-
OMRON	Digital Output Unit	Model NX-OD3256	-
OMRON	Ethernet cable (with industrial Ethernet connector)	Model XS5W-T421-□M□-K	
OMRON	Sysmac Studio	SYSMAC-SE2□□□	Ver.1.25
DT	Power PMAC IDE	-	Ver.4.2.1.19



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

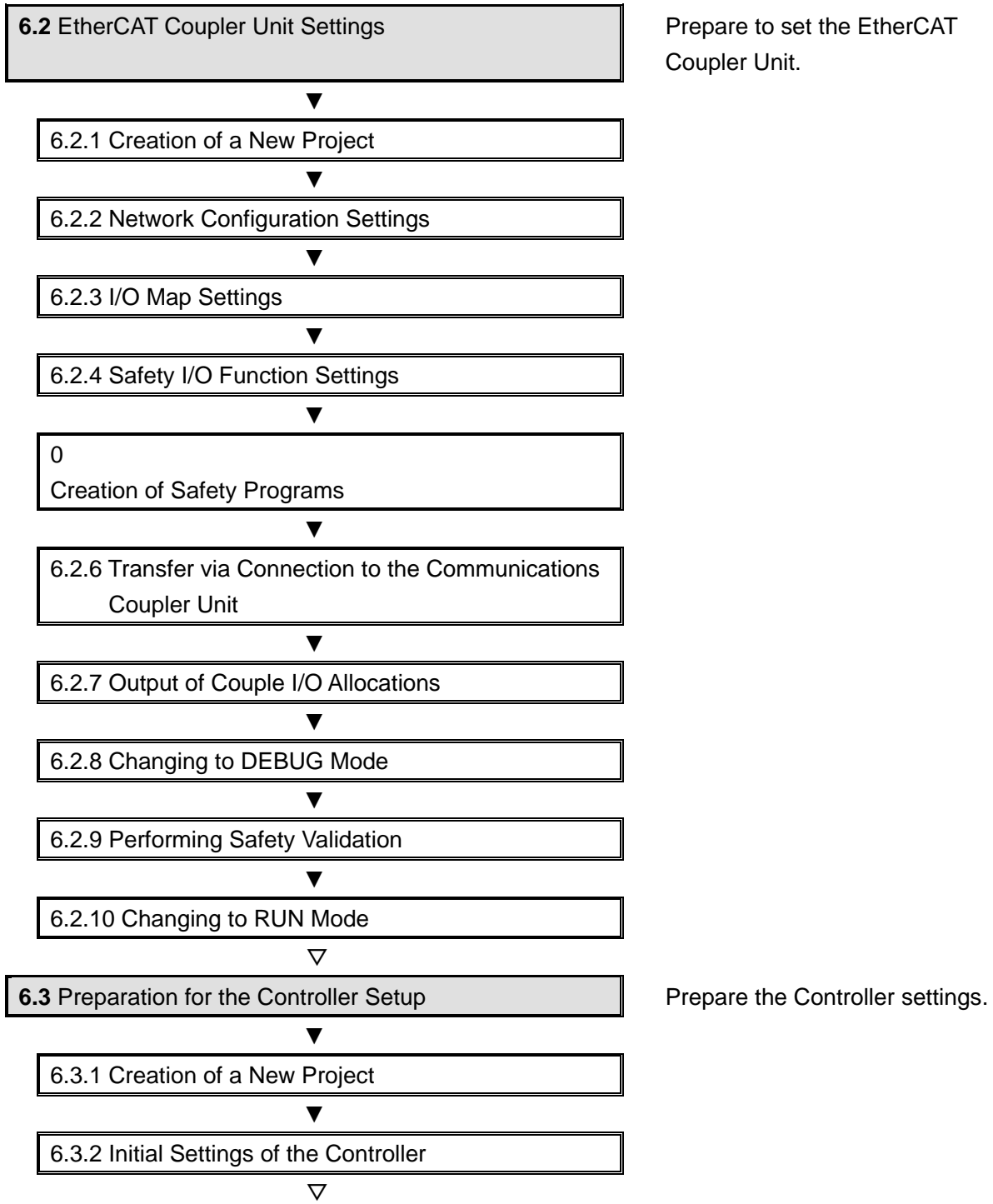
This document describes model NY51□-A□□□ as an example. The same procedures can apply to model CK3E-□□□□/ CK3M-CPU1□1.

6. EtherCAT Connection Procedure

This section describes the procedure for connecting the Controller with the Slave via EtherCAT. The description assumes that the Controller is 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.



6.4 Installation of ESI Files



6.5 EtherCAT Communications Setup



6.5.1 Communications Setup for the EtherCAT Master



6.5.2 Distributed Clock Setup



6.5.3 Safety Controller Variable Settings



6.5.4 PDO Map Settings



6.5.5 Coupler I/O and Variable Allocations



6.5.6 Creation of an EtherCAT Network Information File



6.6 Controller Settings



6.6.1 EtherCAT Communications Check



6.6.2 Writing the User Program



6.6.3 Project Data Transfer

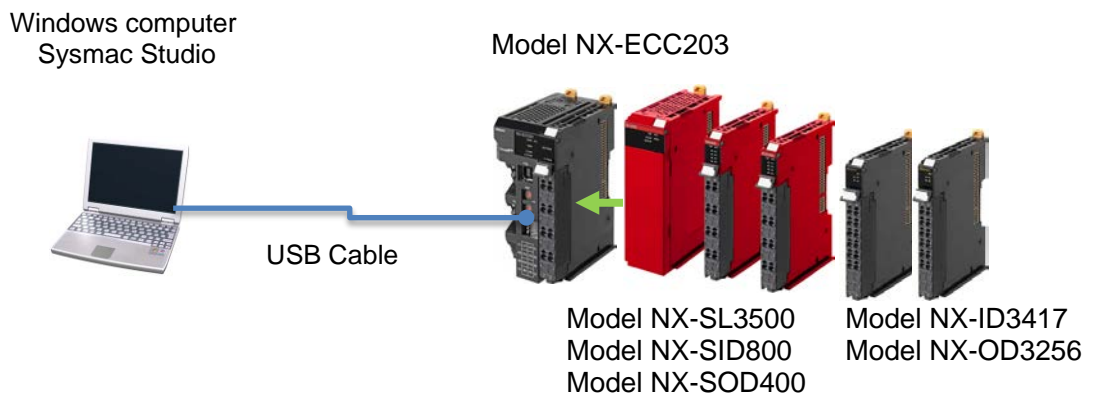
Install the ESI file for the Slave into PowerPMAC IDE.

Set up EtherCAT communications.

Set up the Controller.

6.2. EtherCAT Coupler Unit Settings

Configure the slave terminal settings for the EtherCAT Coupler Unit.
Prepare a computer with Sysmac Studio installed.

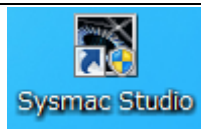


6.2.1. Creation of a New Project

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.

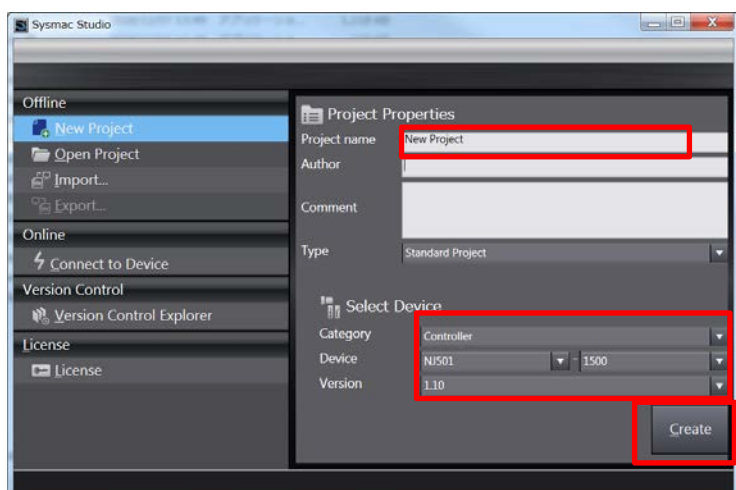
Project Properties

Enter **Project name** and other items of information.

Select Device

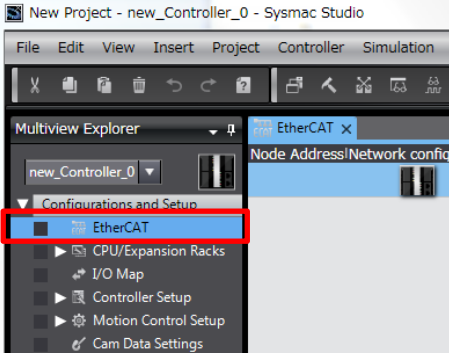
Select *controller* for **Category**.
You can specify any **Device** and **Version**. In this example, select *NJ501-1500* and *1.10*.

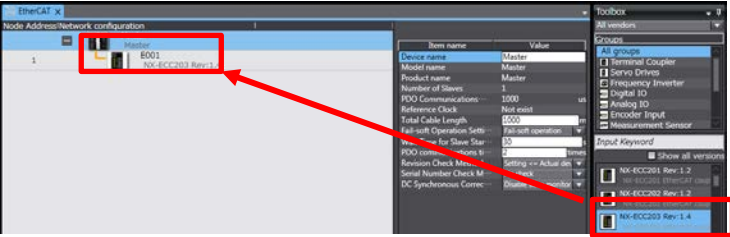
Click **Create**.

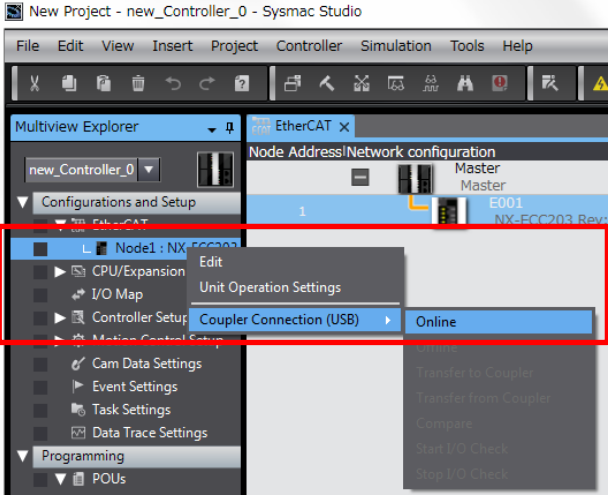


6.2.2. Network Configuration Settings

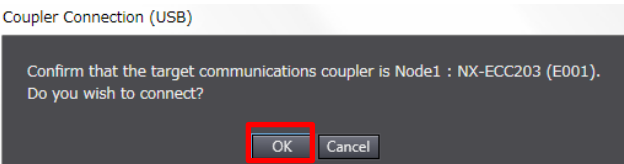
- 1 Double-click **EtherCAT** under **Configurations and Setup** in the Multiview Explorer.


- 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.

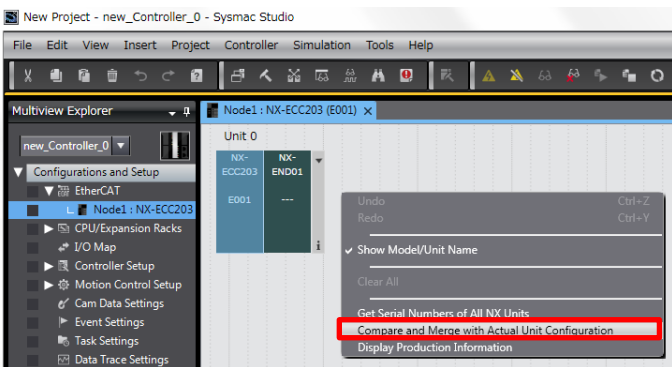

- 3 Right-click **NX-ECC203** in the Multiview Explorer, and select **Coupler Connection (USB)** then **Online**.



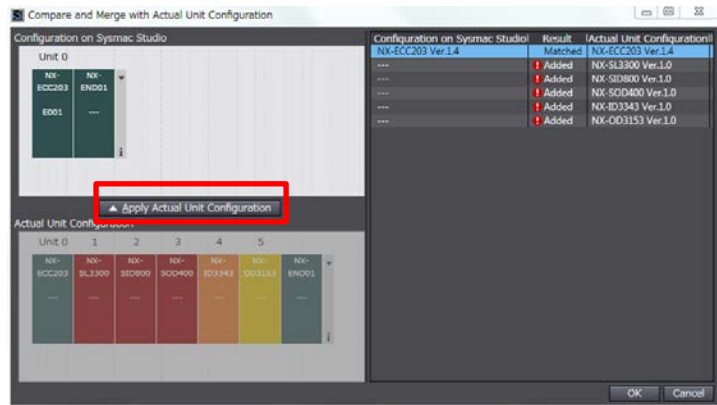
After you have confirmed the destination of the USB connection, click the **OK** button.


- 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.



- Click **Apply Actual Unit Configuration** to apply the actual unit configuration.

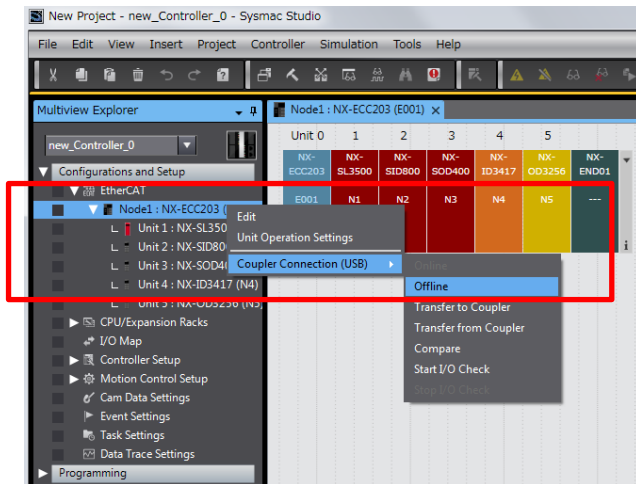


Precautions for Correct Use

You can read only the Unit configuration in the Slave Terminal by comparing and merging with the actual Unit configuration. You cannot read the I/O allocation information, Unit operation settings, and Unit application data.

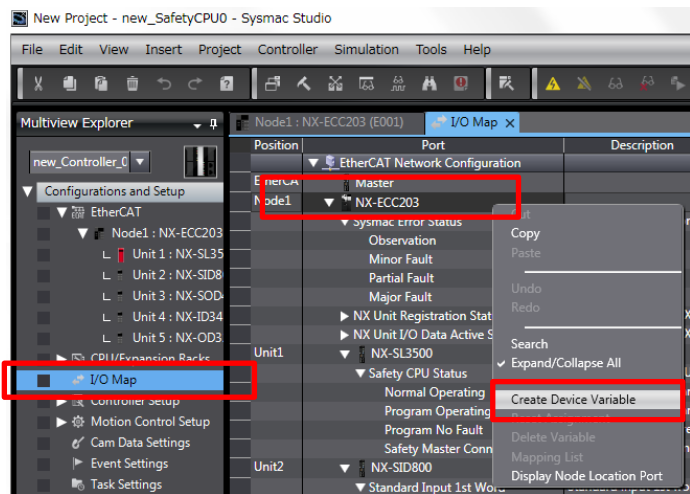
6.2.3. I/O Map Settings

- Right-click **NX-ECC203** in the Multiview Explorer, and select **Coupler Connection (USB)** then **Offline**.



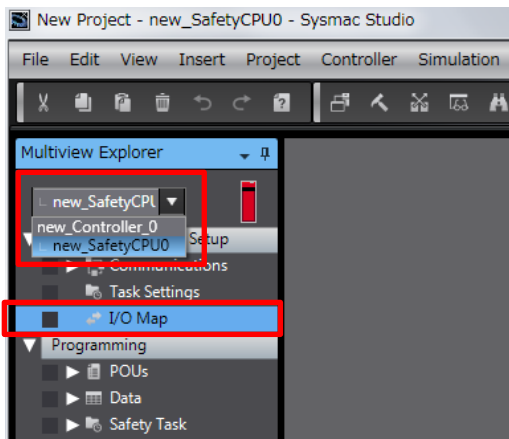
- 2 In the Multiview Explorer, select **Configurations and Setup**, then I/O map tab page to open the I/O map pane.

Right-click on **NX-ECC203**, and select **Create Device Variable** from the menu.

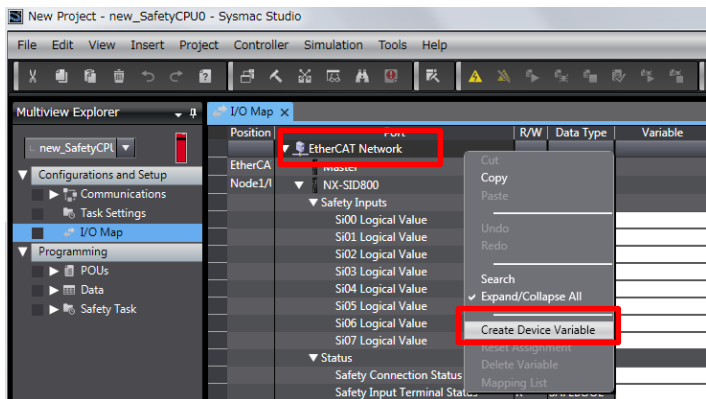


- 3 From the controller selection box in the Multiview Explorer, select the target Safety CPU Unit.

Double-click **I/O map** to open the Safety I/O map tab page.



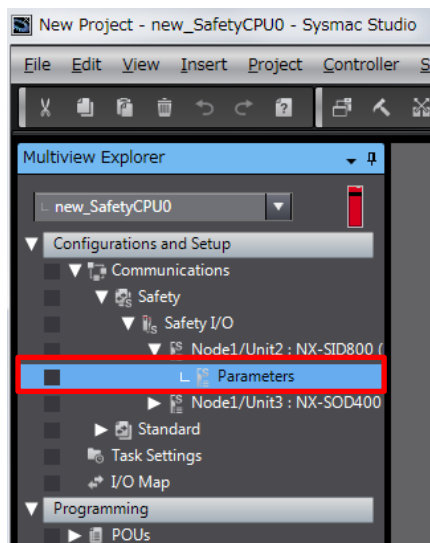
- 4 Right-click on **EtherCAT Network**, and select **Create Device Variable** from the menu.



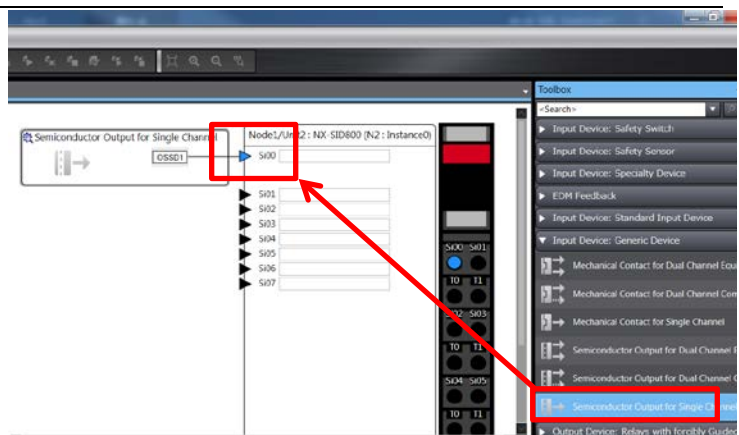
6.2.4. Safety I/O Function Settings

- 1 From the controller selection box in the Multiview Explorer, select the target Safety CPU Unit.

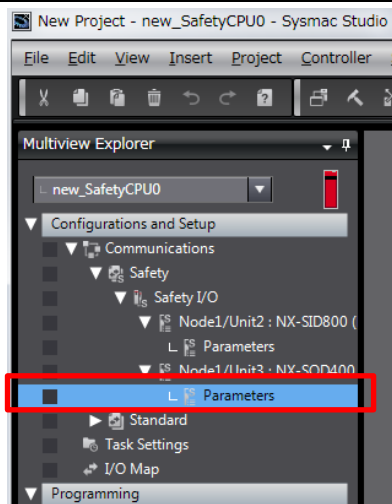
Double-click **Safety Slave Unit Parameter Settings** under NX-SID800 of **Configurations and Setup**.



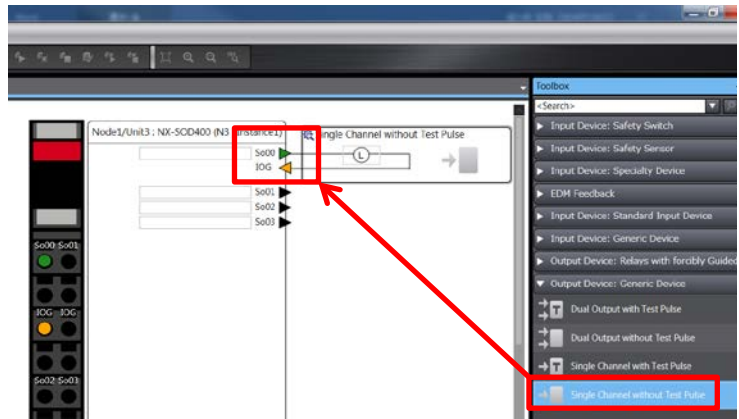
- 2 Select **Output Single-channel Semi-conductor** from the toolbox and drag and drop it on to the input terminal.



- 3 Double-click **Safety Slave Unit Parameter Settings** under NX-SO400 of **Configurations and Setup**.



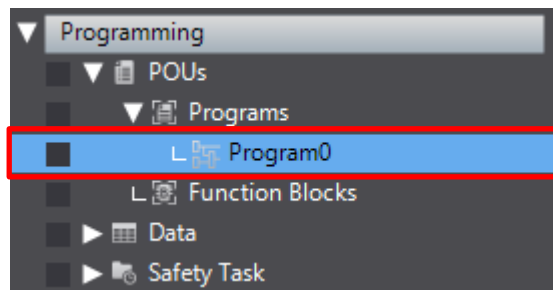
- 4 Select **Single Channel (without test pulse)** from the toolbox **Output device**, and drag and drop it on to the output terminal.



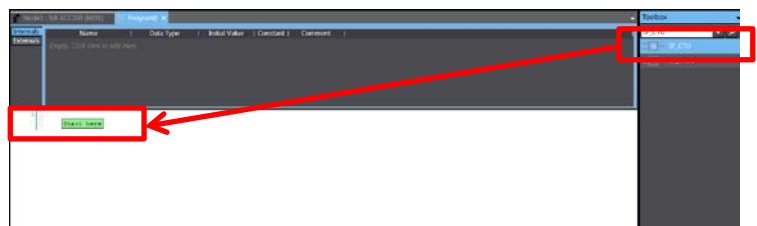
6.2.5. Creation of Safety Programs

- 1 Registering programs

Right-click **Programs** under **Programming – POU's** in the Multiview Explorer, and select **Add – Programs** from the menu.



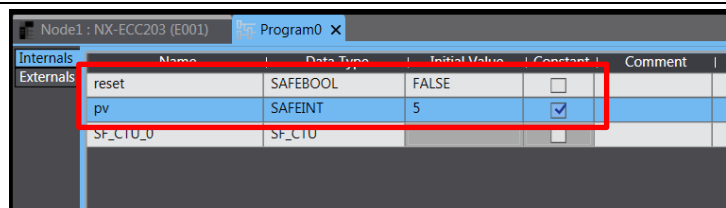
- 2 Drag a SF_CTU from the ToolBox to a new network where the words **Start Here** are displayed.



- 3 Select the tab for internal variables, and then register and edit the local variables.

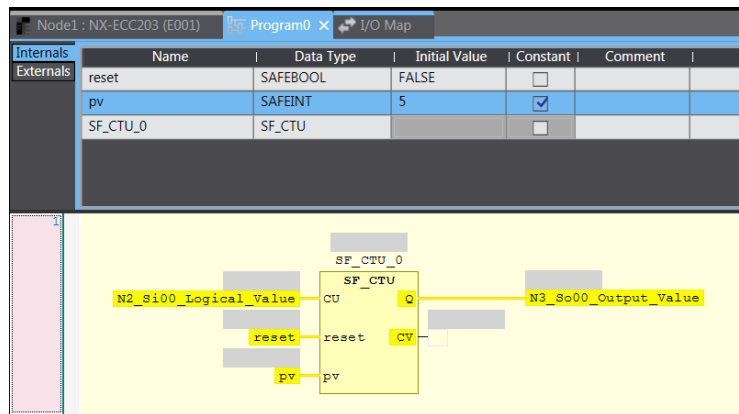
Name : reset
Data Type: SAFEBOOL
Initial Value: FALSE

Name : pv
Data Type: SAFEINT
Initial Value: 5



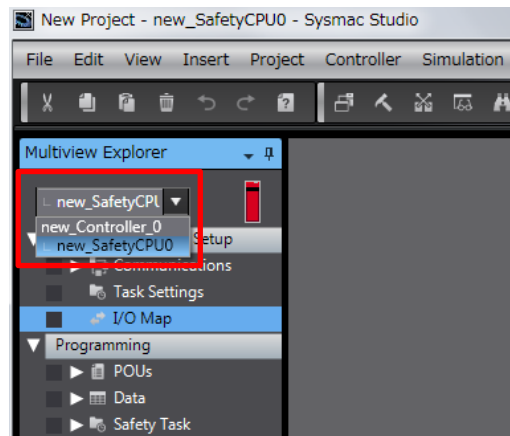
- 4 Select parameters on the FBD network and directly enter the variable names.

CU : N2_Si00_Logical_Value
Reset : reset
PV : pv
Q : N3_So00_Output_Value



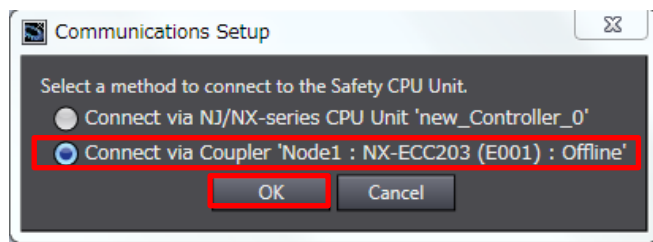
6.2.6. Transfer via Connection to the Communications Coupler Unit

- 1 From the controller selection box in the Multiview Explorer, select a Safety CPU Unit.



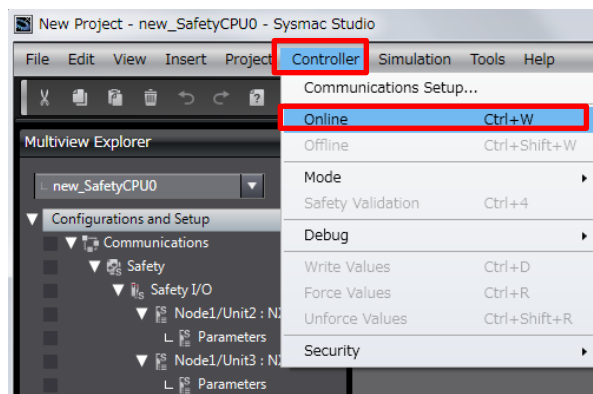
- 2 Select **Controller**, then **Communications Setup** from the menu.

Select **Connect via Coupler** in the Communications Setup dialog box, then click the **OK** button.

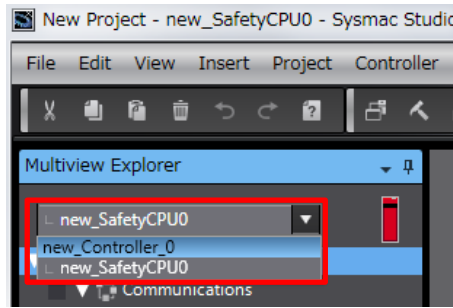


- 3 Select **Controller**, then **Online** from the menu.

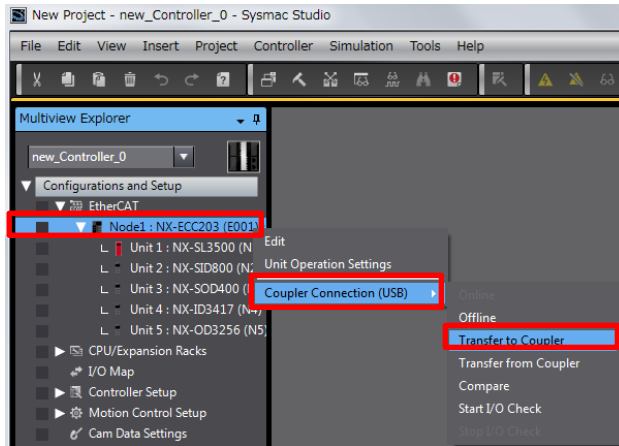
The unit is in online connection with slave terminals.



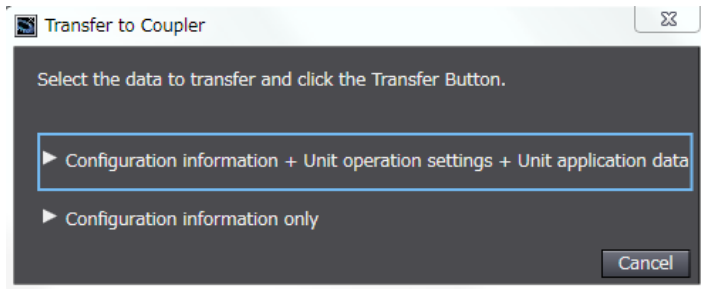
- 4 From the controller selection box in the Multiview Explorer, select a Controller Unit.



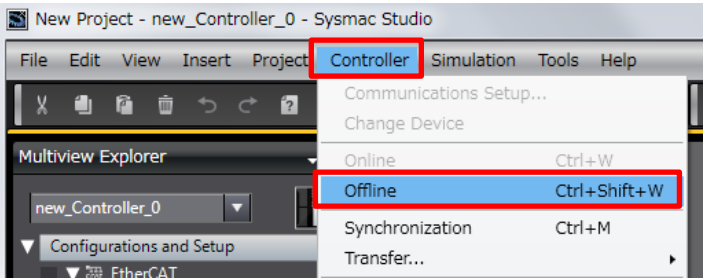
- 5 In the edit page for slave terminals, right-click the Communications Coupler Unit, then select **Coupler Connection (USB) – Transfer to Computer**.



Click **Configuration information + Unit operation setting + Unit application data**.

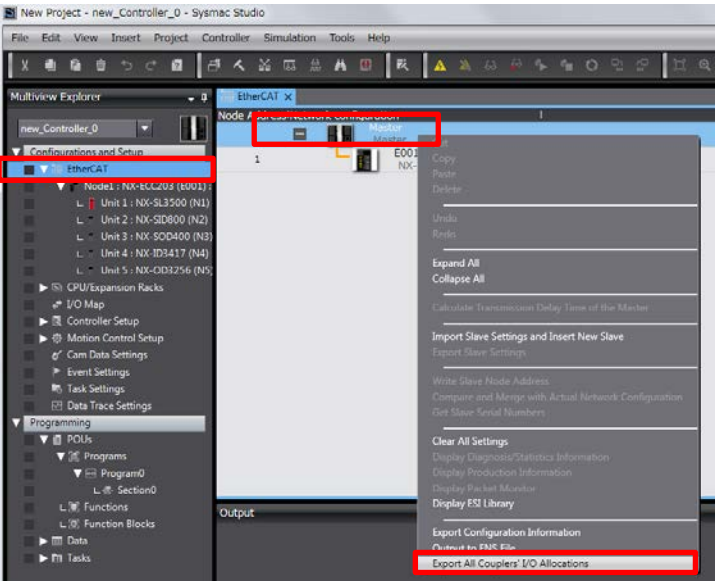


6.2.7. Output of Couple I/O Allocations

- 1 Select **Controller**, then **Offline** from the menu.
 

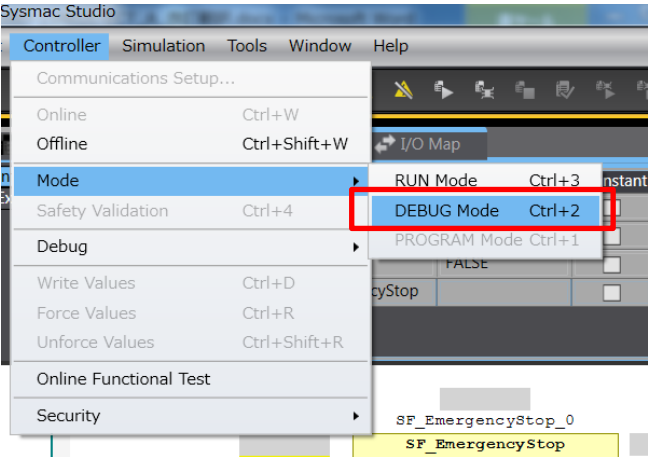
The screenshot shows the Sysmac Studio interface with the 'Controller' menu open. The 'Offline' option is highlighted with a red box, and its keyboard shortcut 'Ctrl+Shift+W' is visible. Other options in the menu include 'Online (Ctrl+W)', 'Synchronization (Ctrl+M)', and 'Transfer...'. The background shows the Multiview Explorer with 'new_Controller_0' selected.
- 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**.

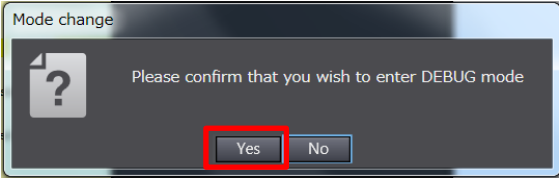
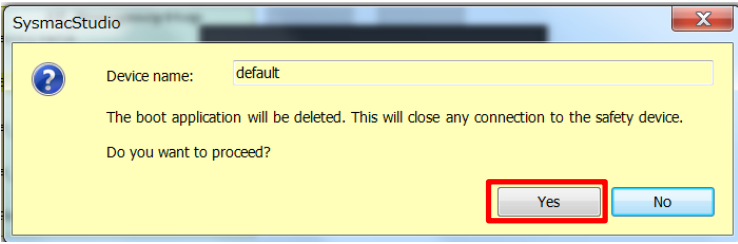
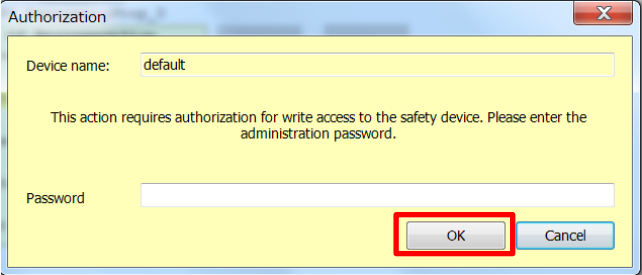
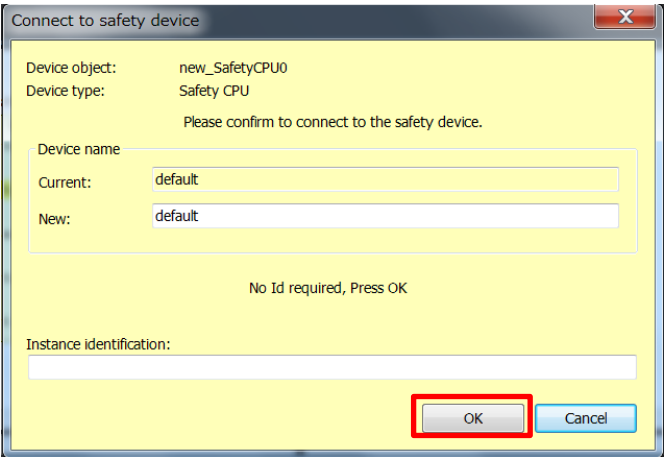


The screenshot shows the Sysmac Studio interface with the 'EtherCAT' configuration window open. The 'EtherCAT' item in the Multiview Explorer is highlighted with a red box. In the configuration window, the 'Export All Couplers' I/O Allocations option is highlighted with a red box. The background shows the Multiview Explorer with 'new_Controller_0' selected.

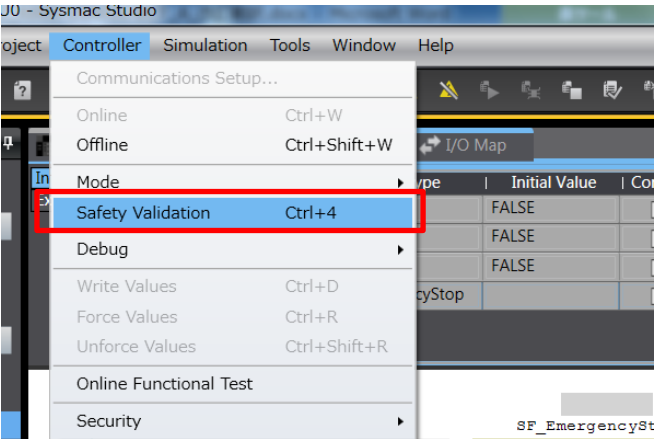
6.2.8. Changing to DEBUG Mode

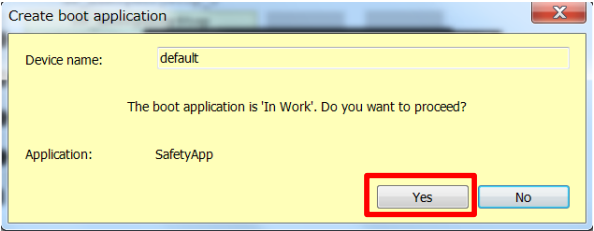
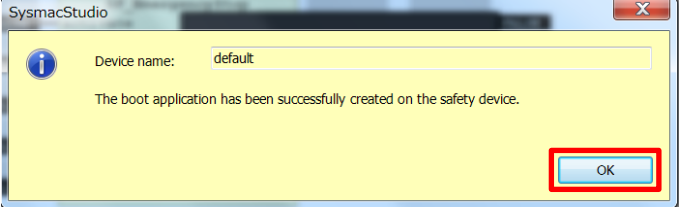
- 1 Select the Safety CPU Unit from the Controller Selection Box in the Multiview Explorer.
- 2 Select **Mode – DEBUG Mode** from **Controller** Menu.
 

The screenshot shows the Sysmac Studio interface with the 'Controller' menu open. The 'Mode' option is highlighted with a red box, and its sub-menu is open. The 'DEBUG Mode (Ctrl+2)' option is highlighted with a red box. Other options in the sub-menu include 'RUN Mode (Ctrl+3)' and 'PROGRAM Mode (Ctrl+1)'. The background shows the Multiview Explorer with 'new_Controller_0' selected.

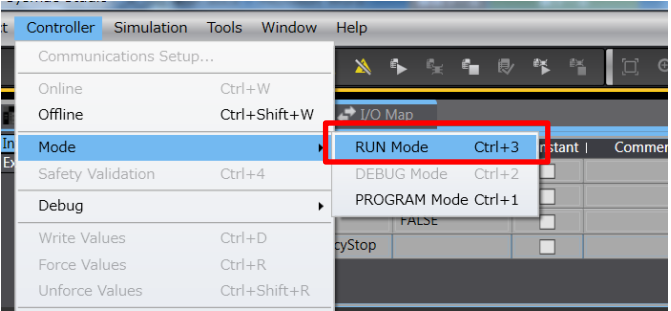
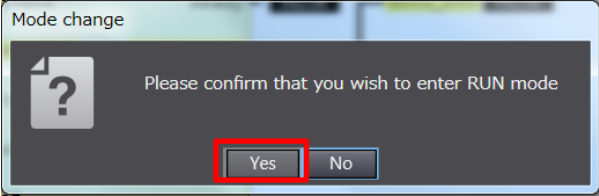
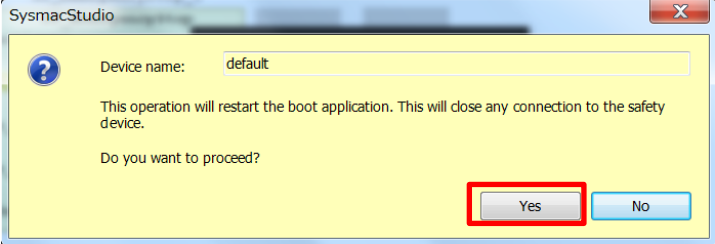
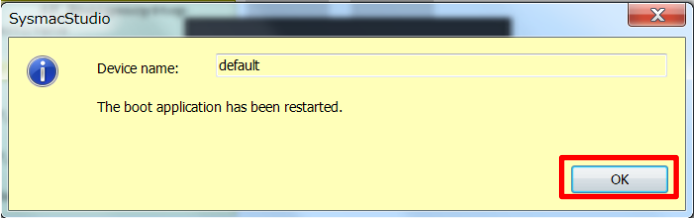
- 3 The following mode confirmation Dialog Box is displayed. Click the **Yes** Button.
 
 A dialog box titled "Mode change" with a question mark icon. The text says "Please confirm that you wish to enter DEBUG mode". There are two buttons: "Yes" and "No". The "Yes" button is highlighted with a red box.
- 4 The following Connect to Safety Device Dialog Box is displayed. Click the **Yes** Button.
 
 A dialog box titled "SysmacStudio" with a question mark icon. It contains a text field for "Device name" with "default" entered. Below it, text says "The boot application will be deleted. This will close any connection to the safety device. Do you want to proceed?". There are "Yes" and "No" buttons. The "Yes" button is highlighted with a red box.
- 5 The following transfer confirmation Dialog Box is displayed. Click the safety of the system and then click the **Yes** Button.
 
 A dialog box titled "Authorization" with a question mark icon. It contains a text field for "Device name" with "default" entered. Text says "This action requires authorization for write access to the safety device. Please enter the administration password." Below is a "Password" text field. There are "OK" and "Cancel" buttons. The "OK" button is highlighted with a red box.
- 6 The following password confirmation dialog box is displayed. When you use the DEBUG mode for the first time, or when the safety password is not specified, leave the **Password** field blank and click the **OK** button.
 
 A dialog box titled "Connect to safety device" with a question mark icon. It contains fields for "Device object" (new_SafetyCPU0), "Device type" (Safety CPU), "Device name", "Current" (default), and "New" (default). Text says "Please confirm to connect to the safety device." and "No Id required, Press OK". There are "OK" and "Cancel" buttons. The "OK" button is highlighted with a red box.

6.2.9. Performing Safety Validation

- 1 Select **Safety Validation** from the Controller Menu.
 
 A screenshot of the SysmacStudio application window. The "Controller" menu is open, showing options like "Communications Setup...", "Online", "Offline", "Mode", "Safety Validation", "Debug", "Write Values", "Force Values", "Unforce Values", "Online Functional Test", and "Security". The "Safety Validation" option is highlighted with a red box.

- 2 Click the **Yes** Button.
 
- 3 Click the **OK** Button
 

6.2.10. Changing to RUN Mode

- 1 Select **Mode – RUN Mode** from the **Controller** Menu.
 
- 2 Click the **Yes** Button.
 
- 3 Click the **Yes** Button.
 
- 4 Click the **OK** Button.
 

5 Click the **OK** Button.

Connect to safety device

Device object: new_SafetyCPU0
Device type: Safety CPU

Please confirm to connect to the safety device.

Device name

Current: default

New: default

No Id required, Press OK

Instance identification:

OK Cancel

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 Turn on the power to the Controller.

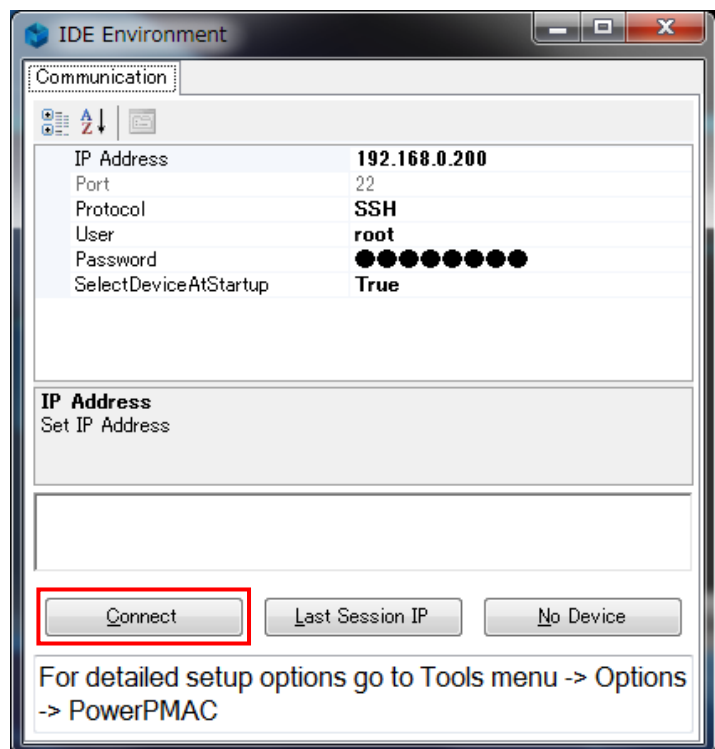
2 Start Power PMAC IDE.

* If the dialog for confirming access rights appears upon start-up, select starting of Power PMAC IDE.

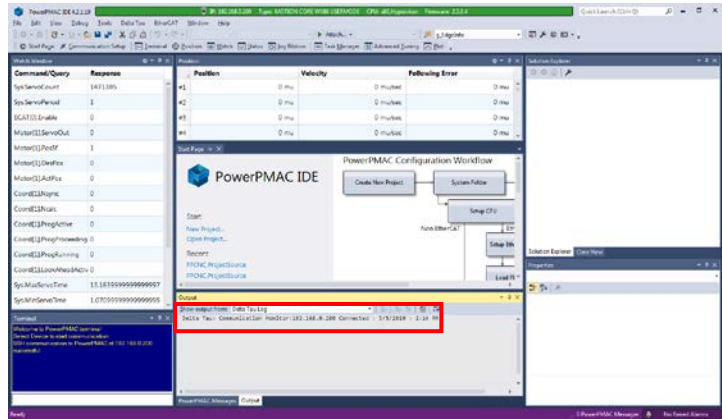


3 The Communication screen appears. Specify the IP address of the destination Controller and click **Connect**.

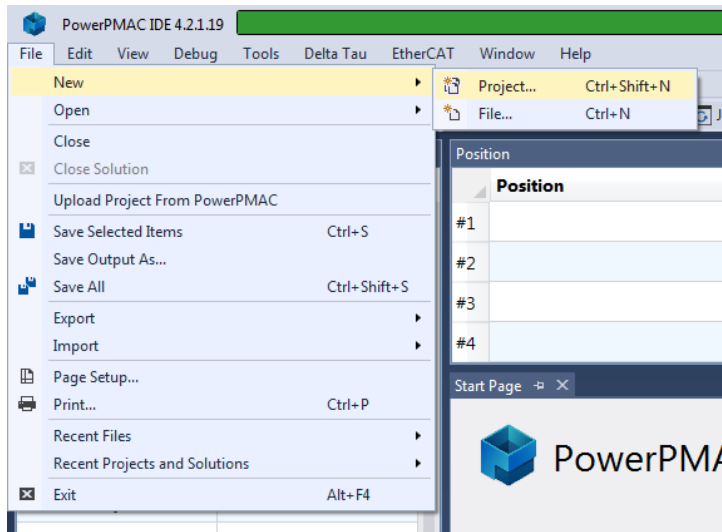
* The IP address of the Controller is set to "192.168.0.200" by default.
* If necessary, change the Windows IP address to "192.168.0.X".



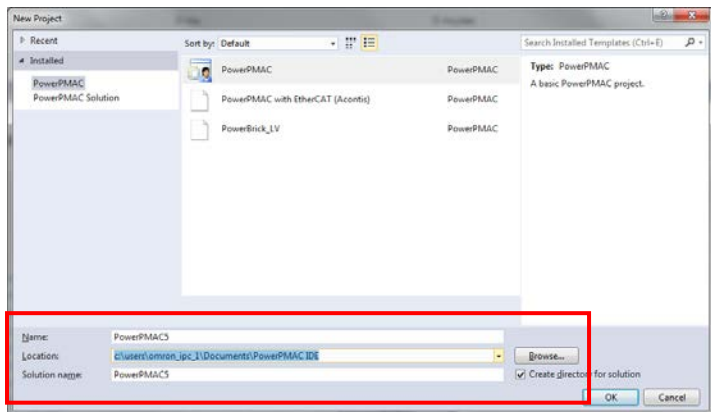
- 4 Power PMAC IDE starts, and is online to the Controller.



- 5 From the **File** menu, select **New** then **Project**.



- 6 Enter a project name and location, and select **OK**.



6.3.2. Initial Settings of the Controller

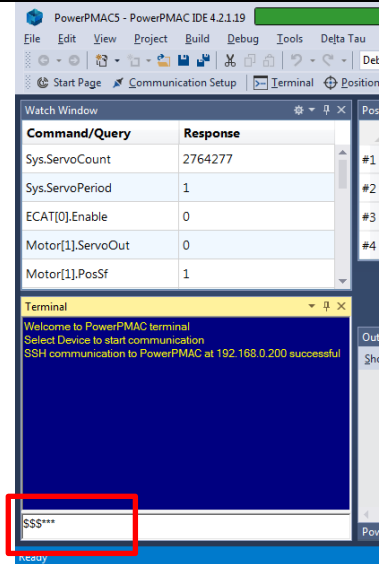
Configure the initial settings for the Controller.



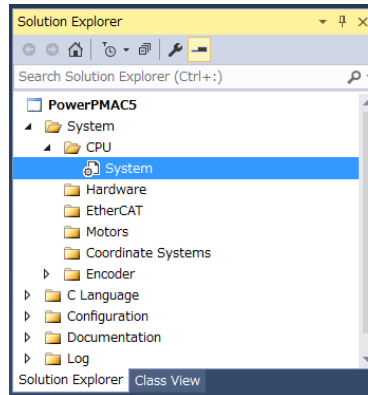
Precautions for Correct Use

Configuring the initial settings clears all data in the Controller memory. Back up necessary data in advance.

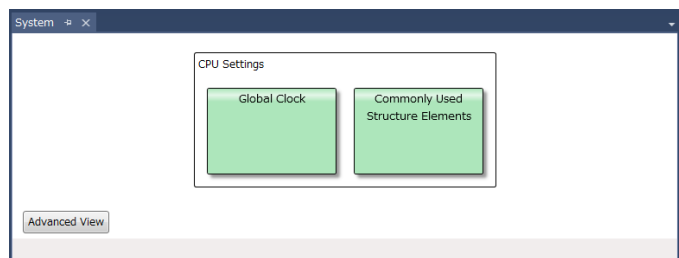
- 1 In the Terminal tab page, type the \$\$\$** command to reset the Controller to factory default.



- 2 Select **System – CPU – System** in the Solution Explorer.



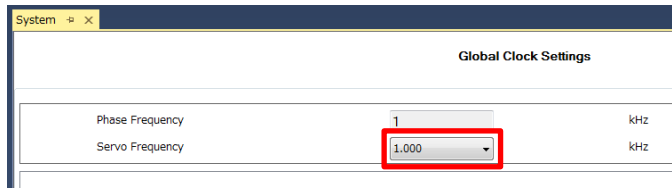
- 3 Select **Global Clock**.



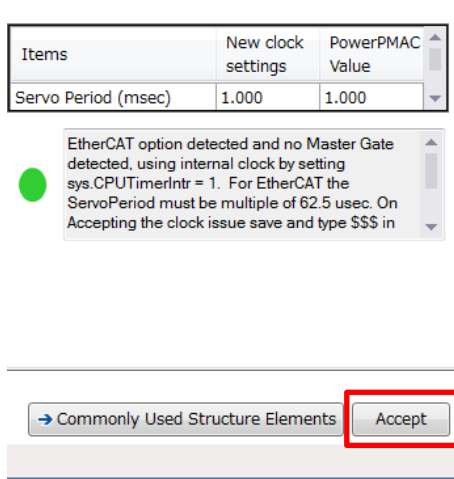
4 Specify **Servo Frequency**.

Select the **Servo Frequency** setting from 4 kHz, 2 kHz, or 1 kHz.

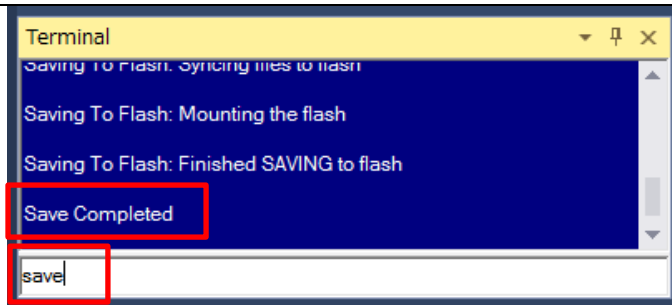
* Servo Frequency is set to 1 kHz for the example in this document.



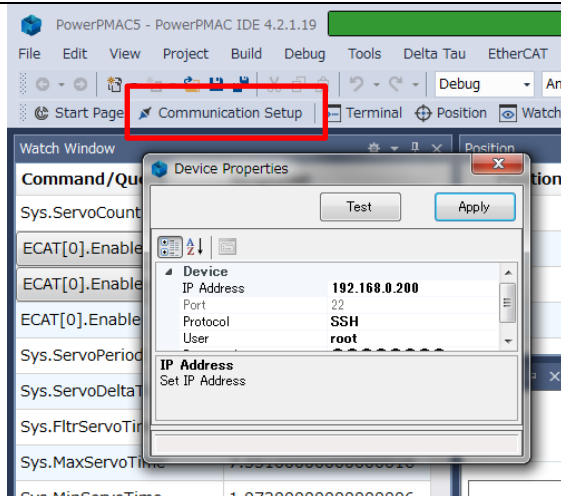
5 Click the **Accept** button.



6 If you have changed the servo frequency setting, type the SAVE command in the Terminal tab page of Power PMAC IDE. When complete, the “Save Complete” message appears in the Terminal tab page.

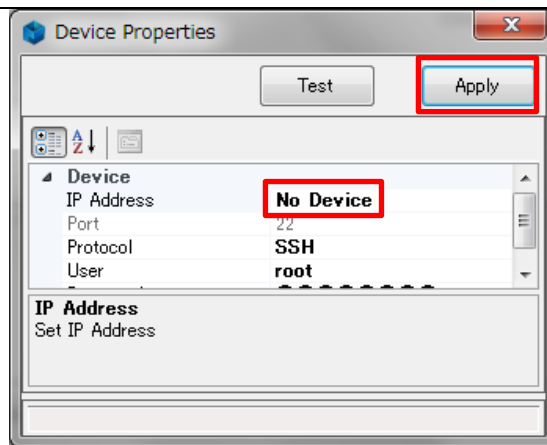


7 Click **Delta Tau – Communication Setup** on the toolbar to display the Device Properties dialog box.



- 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.

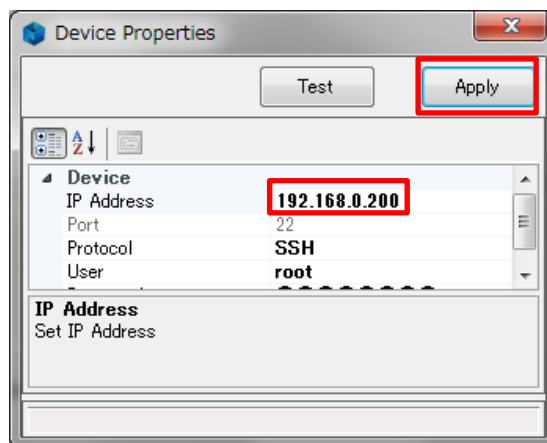


- 9 Restart the Controller.

The servo frequency that has been set is reflected.

- 10 Wait until the startup process of the Controller is complete. Then click **Delta Tau – 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

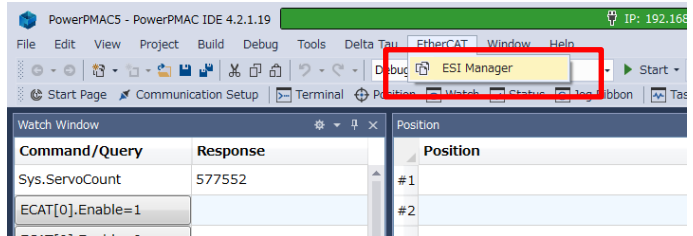
Install the ESI file for the Slave into Power PMAC IDE.



Precautions for Correct Use

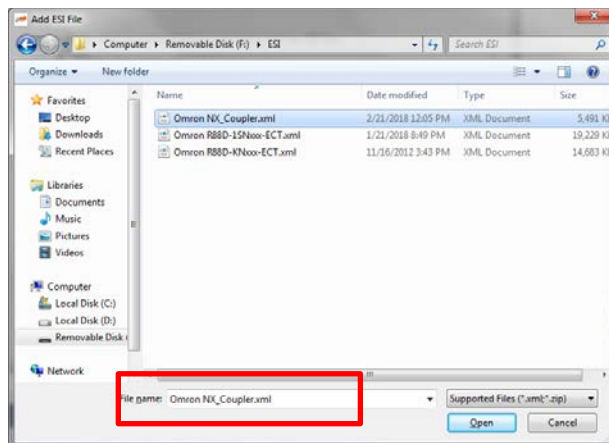
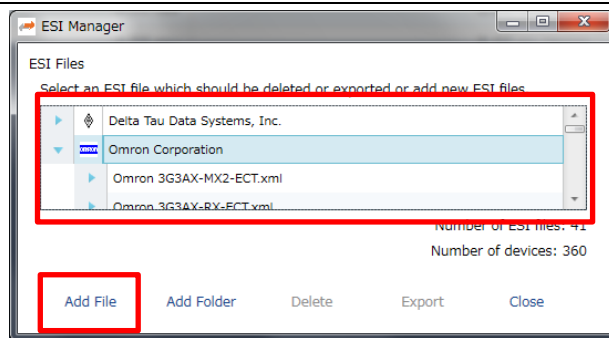
Prepare the ESI file described in this section in advance. Contact your OMRON representative for information on how to procure the ESI file.

1 Start EC-Engineer.



2 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*.



3 Click **Close** to close the ESI Manager.

6.5. EtherCAT Communications Setup

Set up EtherCAT communications.



Precautions for Correct Use

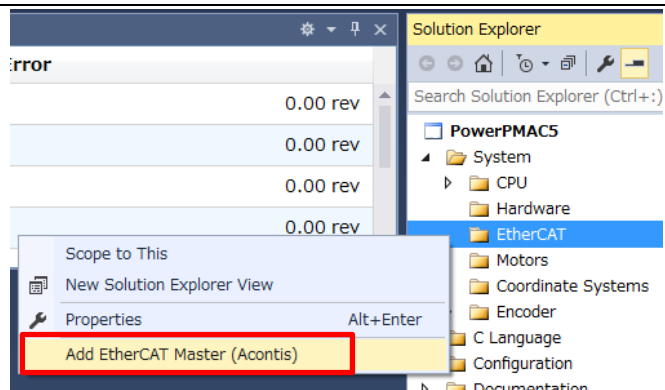
Before taking the following steps, make sure that the devices are connected via an Ethernet cable. If they are not connected, turn OFF the power to the devices, and connect the Ethernet cable.

6.5.1. Communications Setup for the EtherCAT Master

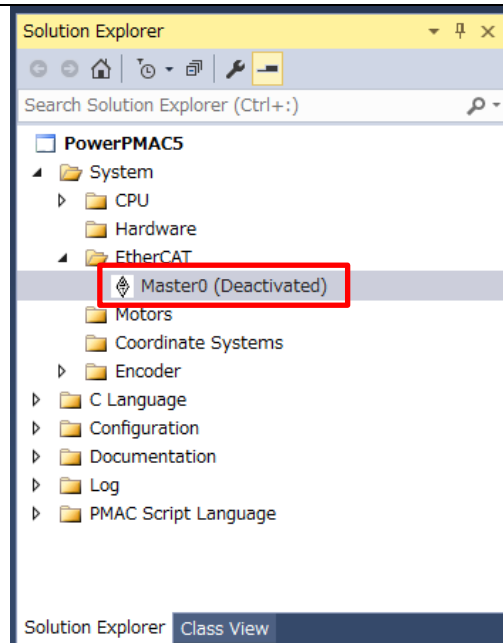
- 1 Connect the Controller with slave devices using an Ethernet cable.

* Refer to the manuals for slave devices to configure them.

- 2 Select System – **EtherCAT** in the Solution Explorer and right-click on EtherCAT, then select **Add EtherCAT Master(Acontis)**.

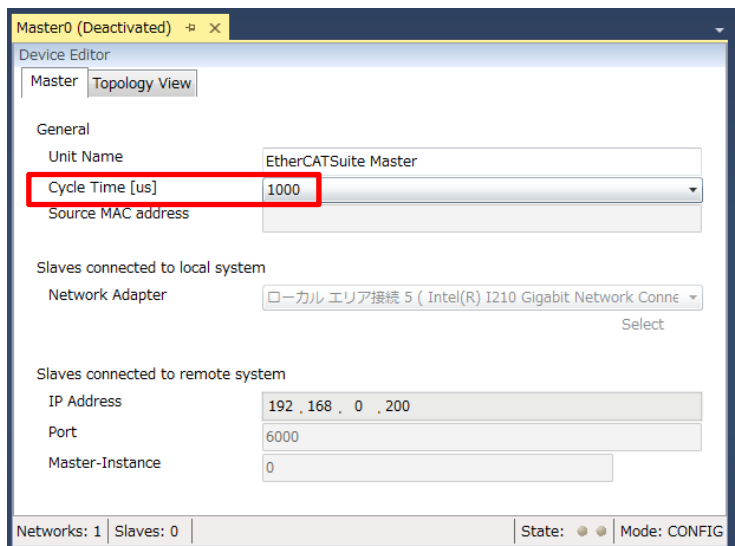


- 3 Master0 (Deactivated) is added to Solution Explorer.



4 In the Master tab 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.



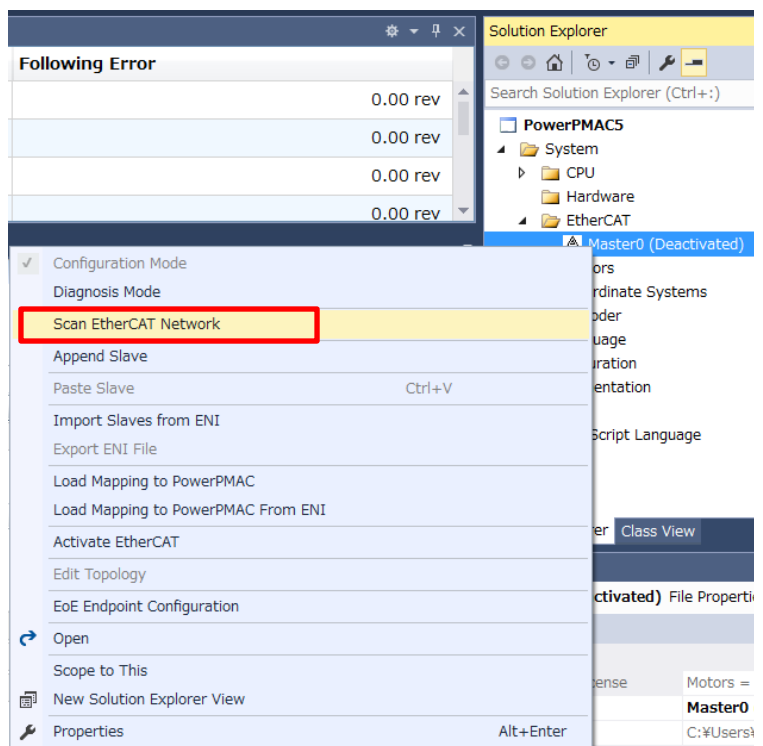
Correspondence between the servo frequencies of the Controller and communication periods is as follows:

4 kHz : 250 us

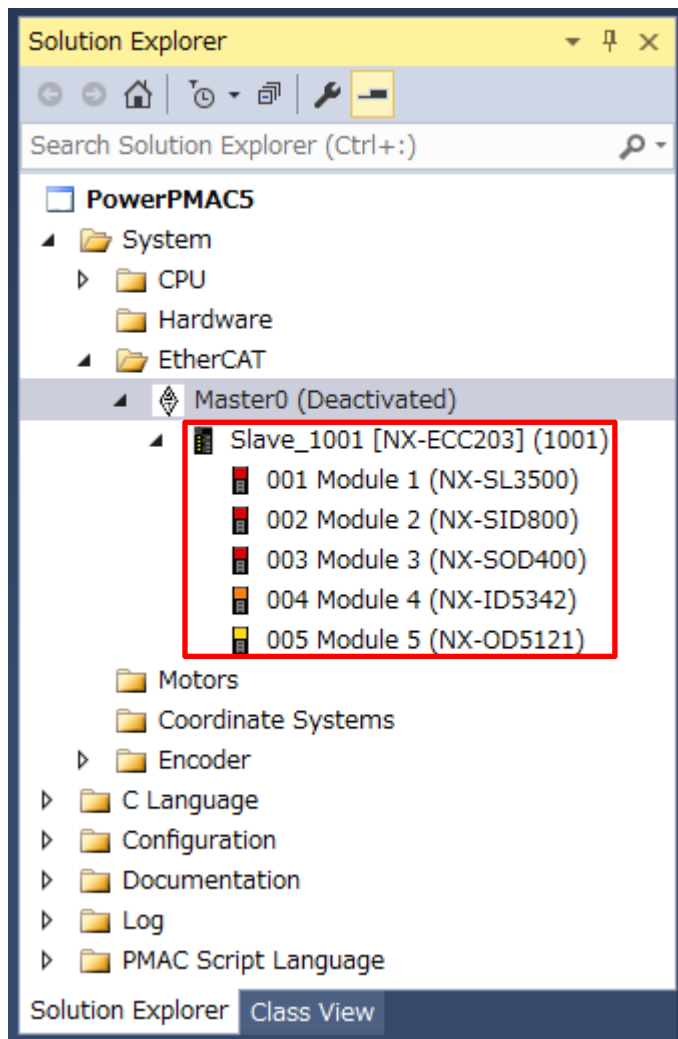
2 kHz : 500 us

1 kHz : 1000 us

5 Select **System – EtherCAT** in the Solution Explorer and right-click on **Master0 (Deactivated)**, then select **Scan EtherCAT Network**.



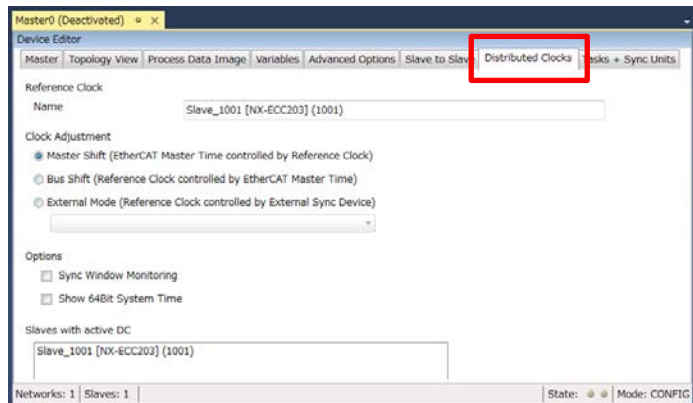
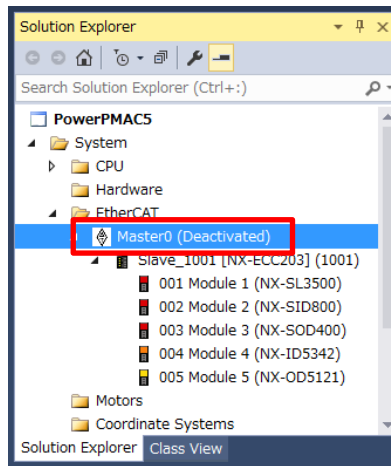
- 6 Make sure that the slave is displayed in the Solution Explorer.



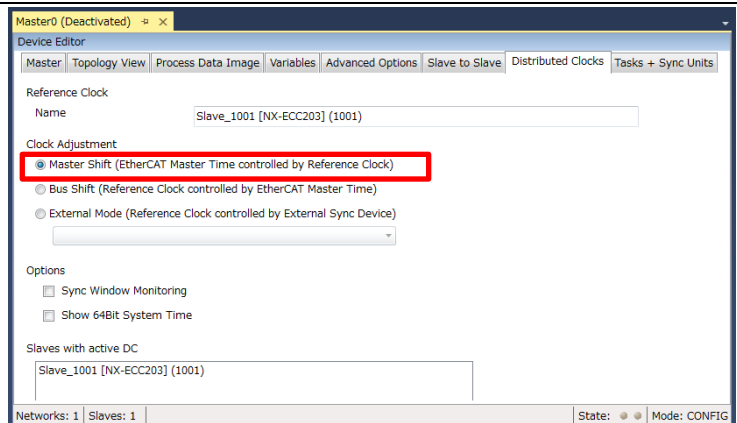
6.5.2. Distributed Clock Setup

1 Setting Distributed Clocks (DC) for Master

In the Master0 (Deactivated) tab page, select **Distributed Clocks** tab.



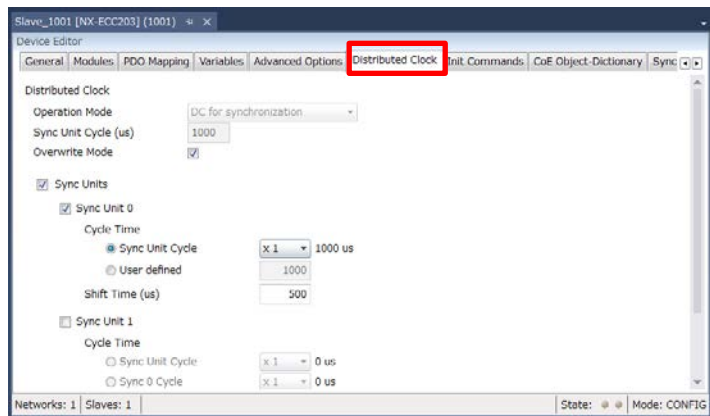
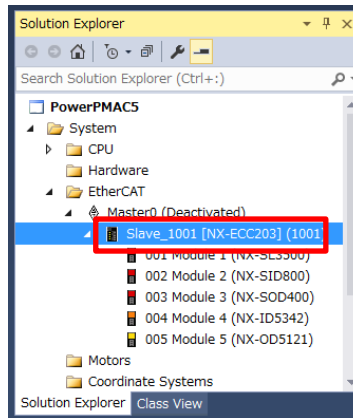
2 Select Master Shift (EtherCAT Master Time controlled by Reference Clock).



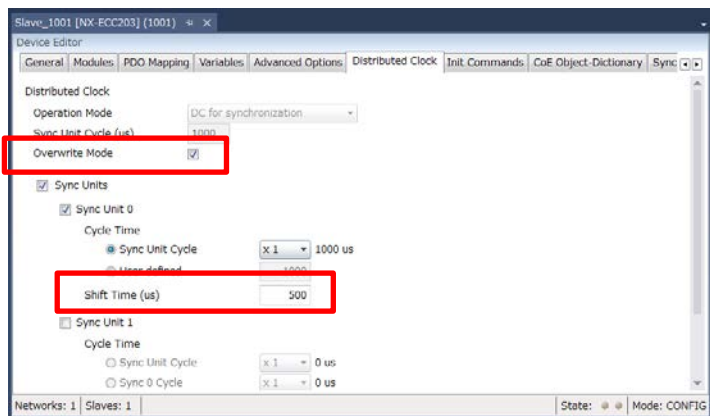
■ When using in DC mode

3 Setting Distributed Clock (DC) for the Slave

In the Solution Explorer, select the target slave and 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

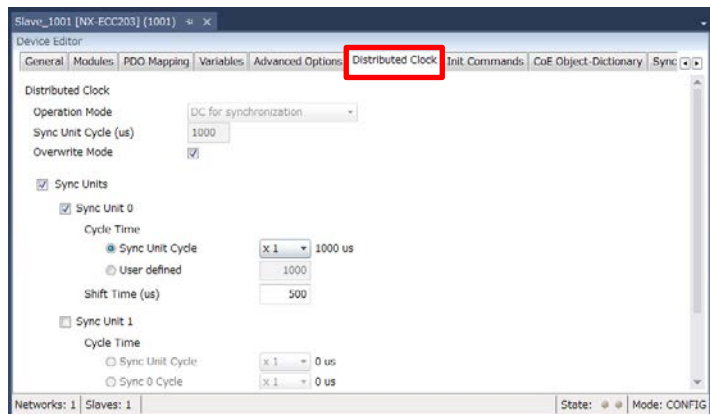
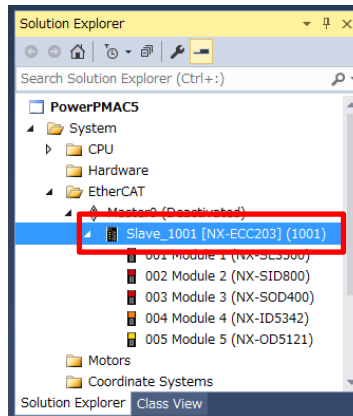
2 kHz : 250 us

1 kHz : 500 us

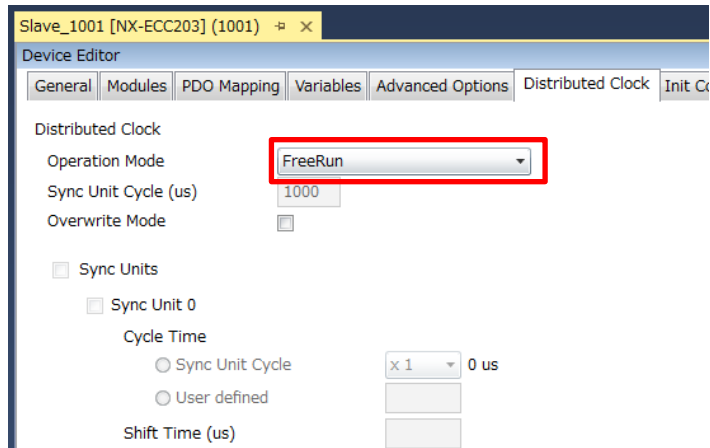
■ When using in Free-Run mode

3 Setting Distributed Clock (DC) for the Slave

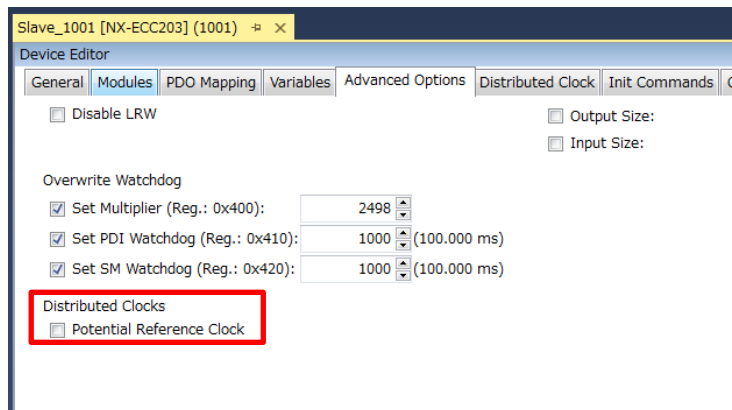
In the Solution Explorer, select the target slave and display the Distributed Clock tab page.



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.

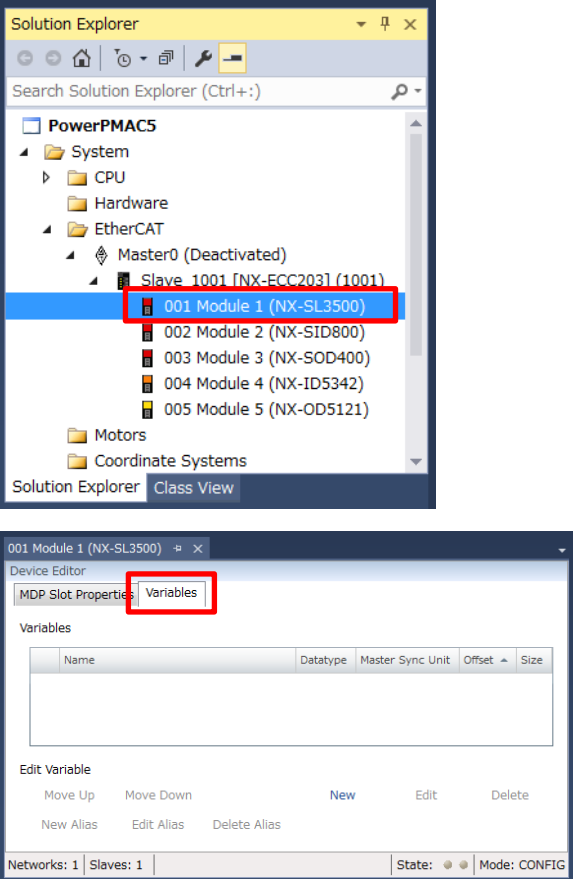
(2) Setting Input Data

Register the following input data.

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

1 Select a safety controller in the Project Explorer pane of EC-Engineer.

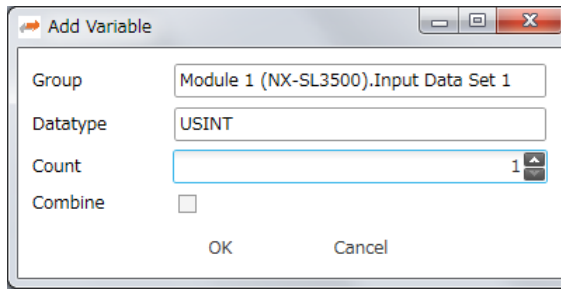
Display the Variables tab page.



The image shows two screenshots from the EC-Engineer software. The top screenshot is the Solution Explorer window, displaying a tree view of the project structure. The '001 Module 1 (NX-SL3500)' item is selected and highlighted with a blue background. The bottom screenshot is the Device Editor window for '001 Module 1 (NX-SL3500)'. The 'Variables' tab is selected and highlighted with a red box. Below the tab, there is a table with columns for Name, Datatype, Master Sync Unit, Offset, and Size. At the bottom of the window, there are buttons for 'Edit Variable' (Move Up, Move Down, New, Edit, Delete) and 'New Alias' (New Alias, Edit Alias, Delete Alias). The status bar at the bottom indicates 'Networks: 1 | Slaves: 1 | State: Mode: CONFIG'.

2 [Slot1(NX-SL3500)Input Data Set1]
 Registering Node1/Unit2
 (NX-SID800)

Click **New** in the Variables tab page, and register 4 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 4 variables shown on the right.

FSoE Slave CMD	#x6040:01	USINT
Safety Input 1st Byte	#x6041:01	USINT

Group: Module 1(NX-SL3500).Input Data Set 1
 Datatype: USINT
 Count: 2

FSoE Slave CRC_0	#x6040:03	UINT
FSoE Slave Conn_ID	#x6040:02	UINT

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.

Safety CPU Status	#x6004:01	UINT
-------------------	-----------	------

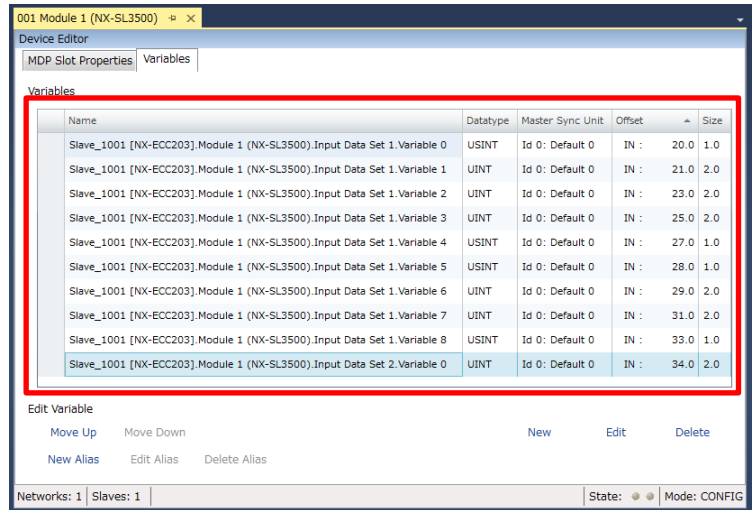
Group: Module 1(NX-SL3500).Input Data Set 2

Datatype: UINT

Count: 1

6 Checking Input Data

Make sure that the settings (Input) in the Variables tab page are correct.



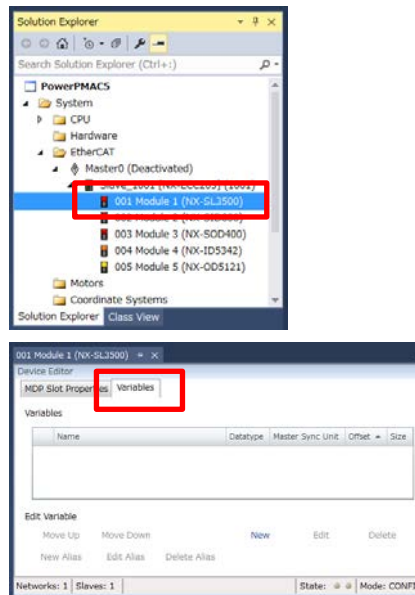
(3) Setting Output Data

Register the following output data.

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

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 4 variables shown on the right.

FSoE Master CMD	#x7020:01	USINT
-----------------	-----------	-------

Group: Module 1(NX-SL3500).Output Data Set 1

Datatype: USINT

Count: 1

Safety Output 1st Word	#x7021:01	UINT
FSoE Maste CRC_0	#x7020:03	UINT
FSoE Master Conn_ID	#x7020:02	UINT

Group: Module 1(NX-SL3500).Output Data Set 1

Datatype: UINT

Count: 3

9 [Slot1(NX-SL3500)Output Data Set1]
 Registering Node1/Unit3 (NX-SOD400)

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

Click **New** in the Variables tab page, and register 4 variables shown on the right.

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

Group: Module 1(NX-SL3500).Output Data Set 1
 Datatype: USINT
 Count: 1

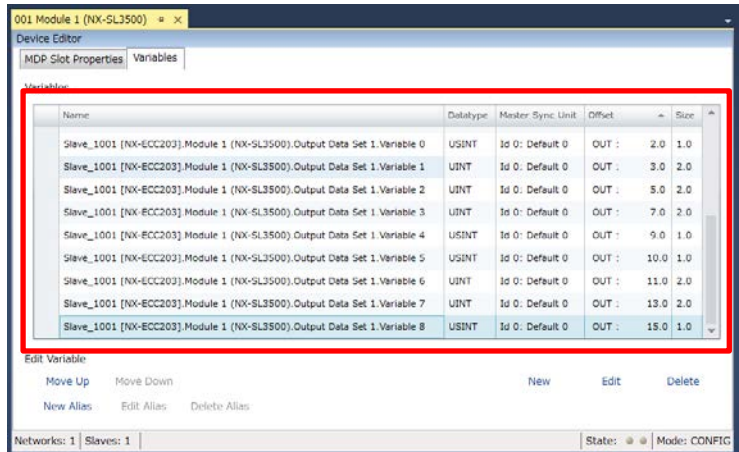
Click **New** in the Variables tab page, and register the variable shown on the right.

11 [Slot1(NX-SL3500)Output Data Set2]

* *Output Data Set2* is not used and does not need to be set.

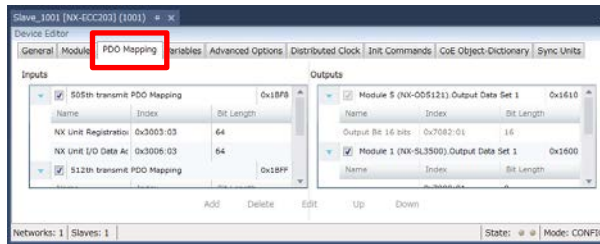
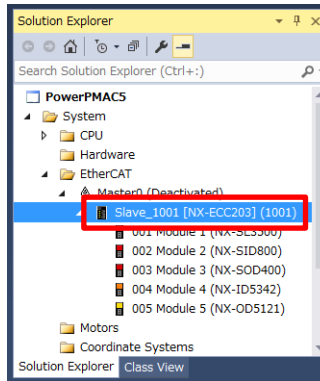
12 Checking Output Data

Make sure that the settings (Output) in the Variables tab page are correct.



6.5.4. PDO Map Settings

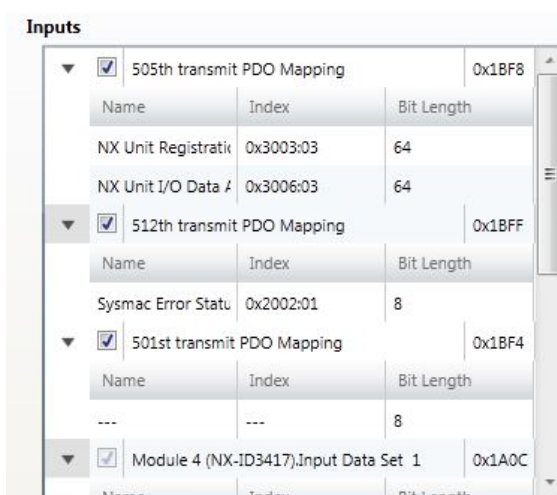
- 1 In the Project Explorer, select the target slave to display the PDO Mapping tab page.



- 2 Setting PDO mapping (Inputs)

Confirm the check boxes in the Inputs field.

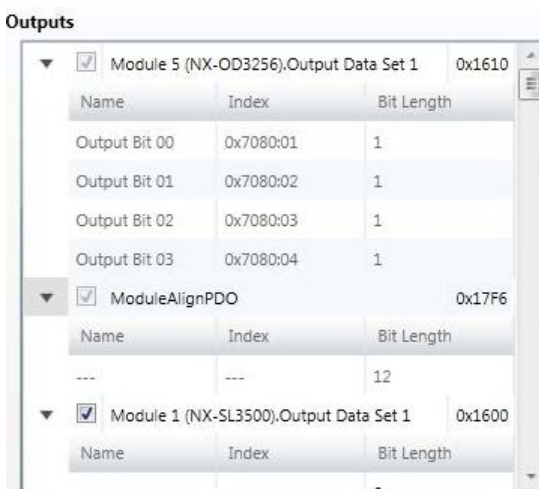
* If you do not want to use data in the Inputs field, clear the currently displayed check boxes.



- 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.

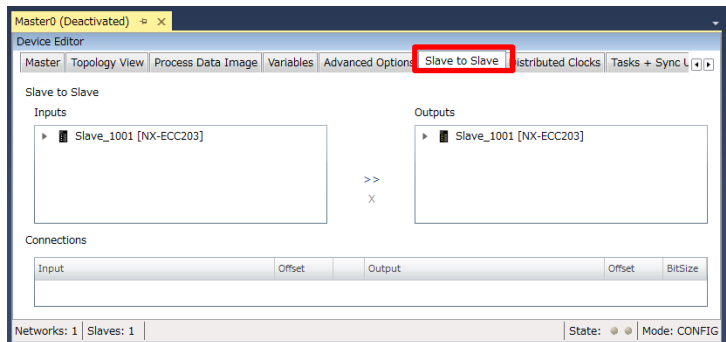
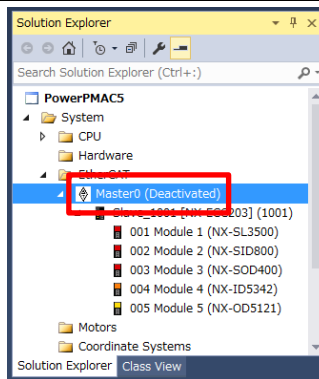
(2) Setting Input Data

Associate the following items:

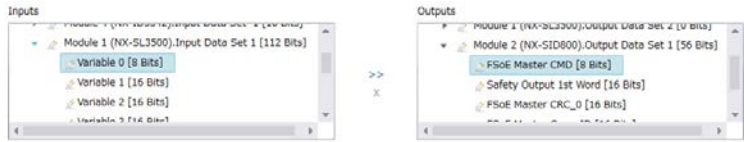
- **Module 1 (NX-SL3500).Input Data Set 1**, and **Module 2 (NX-SID800).Output Data Set 1**
- **Module 1 (NX-SL3500).Input Data Set 1**, and **Module 3 (NX-SOD400).Output Data Set 1**

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**.

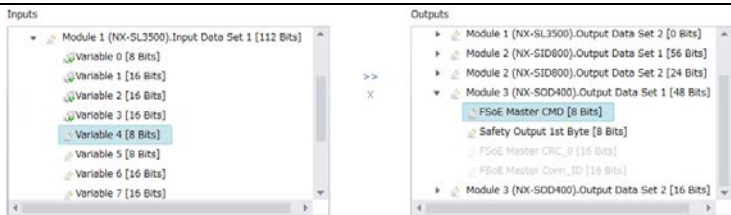


Associate the following items:

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

Select an **(NX-SL3500).Input Data Set 1** item, then select the corresponding **(NX-SID800).Output Data Set 1** item and click >>.

3 Associate the variables of Inputs **Module 1 (NX-SL3500).Input Data Set 1** with Outputs **Module 3 (NX-SOD400).Output Data Set 1**.



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

Select an **(NX-SL3500).Input Data Set 1** item, then select the corresponding **(NX-SOD400).Output Data Set 1** item and click >>.

* 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-SOD800).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 >>.

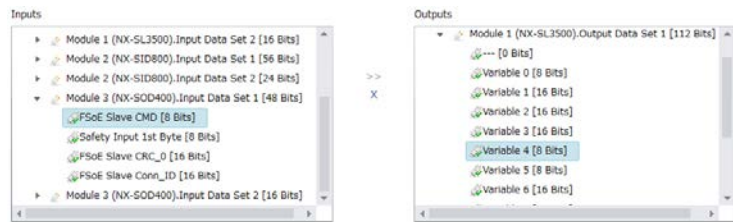


Associate the following items:

Inputs	Outputs
FSoE Slave CMD	Variable 0
Safety Input 1st Word	Variable 1
FSoE Slave CRC_0	Variable 2
FSoE Slave Conn_ID	Variable 3

5 Associate the variables of Inputs **Module 3 (NX-SOD800).Input Data Set 1** with Outputs **Module 1 (NX-SL3500).Output Data Set 1**.

Select an **(NX-SOD800).Input Data Set 1** item, then select the corresponding **(NX-SL3500).Output Data Set 1** item and click >>.



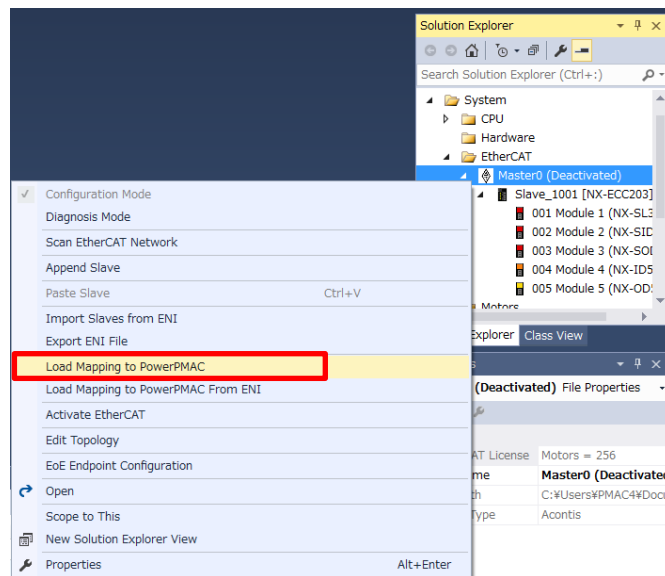
Associate the following items:

Inputs	Outputs
FSoE Slave CMD	Variable 4
Safety Input 1st Word	Variable 5
FSoE Slave CRC_0	Variable 6
FSoE Slave Conn_ID	Variable 7

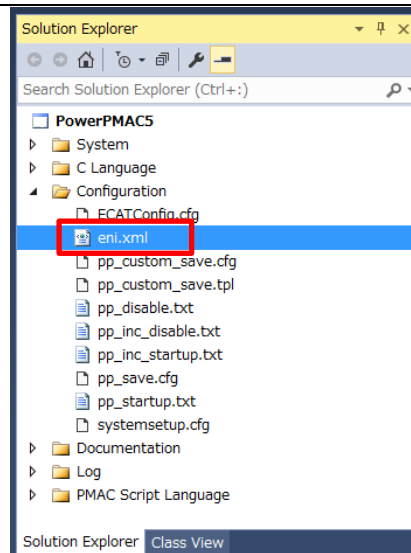
* Variable 8 does not need to be allocated.

6.5.6. Creation of an EtherCAT Network Information File

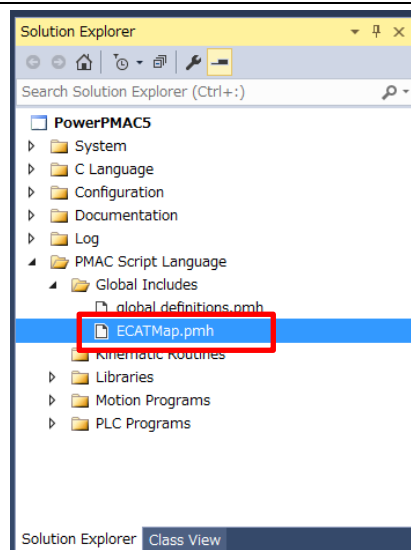
- 1 Select **System – EtherCAT** in the Solution Explorer and right-click on **Master0 (Deactivated)**, then select **Load Mapping to PowerPMAC**.



- 2 An eni.xml file is added under the **Configuration** directory in the Solution Explorer.



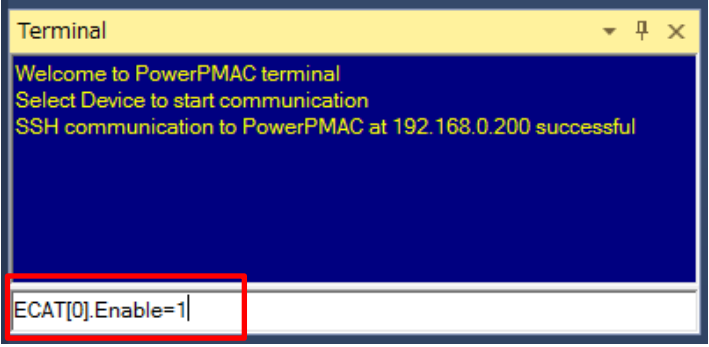
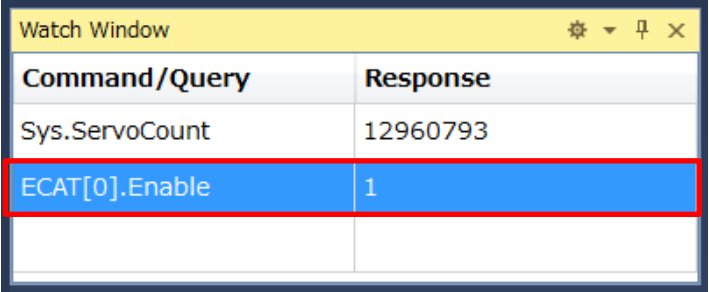
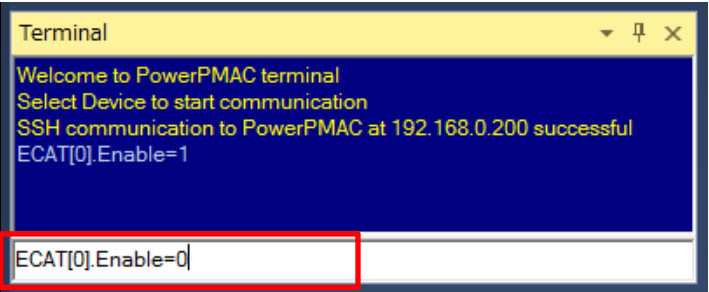
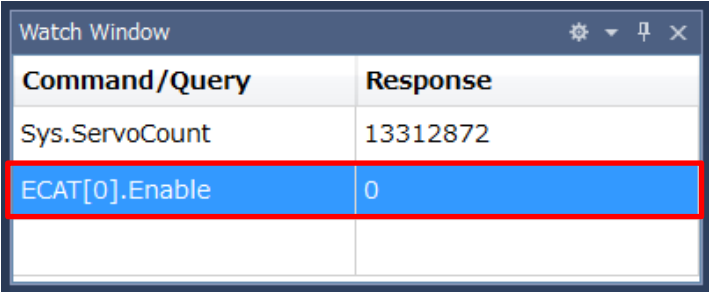
- 3 An ECATMap.pmh file is added under the **PMAC Script Language/Global Includes** directory in the Solution Explorer.



6.6. Controller Settings

6.6.1. EtherCAT Communications Check

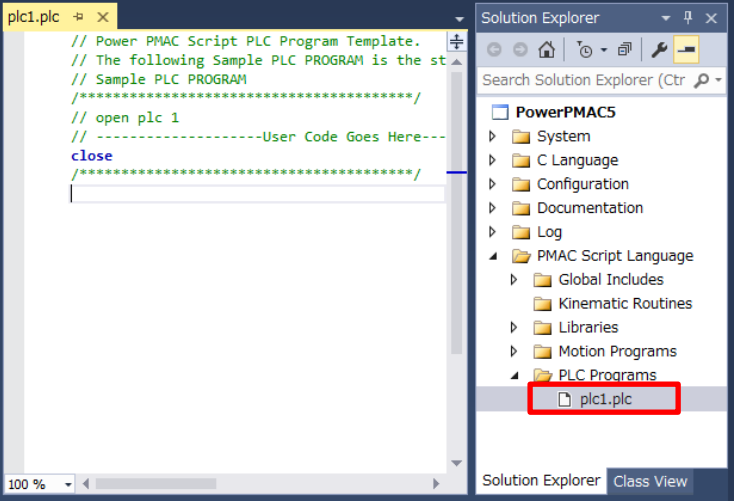
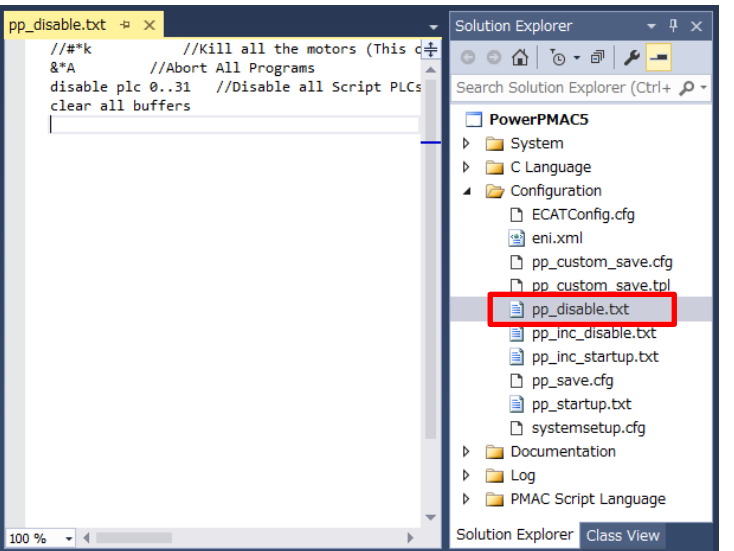
Take the following steps to ensure that EtherCAT communications are available.

1	From the Terminal pane, run the ECAT[0].Enable=1 command to start EtherCAT communications.	 <p>Terminal</p> <pre>Welcome to PowerPMAC terminal Select Device to start communication SSH communication to PowerPMAC at 192.168.0.200 successful ECAT[0].Enable=1</pre>						
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.	 <p>Watch Window</p> <table border="1"><thead><tr><th>Command/Query</th><th>Response</th></tr></thead><tbody><tr><td>Sys.ServoCount</td><td>12960793</td></tr><tr><td>ECAT[0].Enable</td><td>1</td></tr></tbody></table>	Command/Query	Response	Sys.ServoCount	12960793	ECAT[0].Enable	1
Command/Query	Response							
Sys.ServoCount	12960793							
ECAT[0].Enable	1							
3	After making sure that correct communications are available, run the ECAT[0].Enable=0 command from the Terminal pane to stop EtherCAT communications.	 <p>Terminal</p> <pre>Welcome to PowerPMAC terminal Select Device to start communication SSH communication to PowerPMAC at 192.168.0.200 successful ECAT[0].Enable=1 ECAT[0].Enable=0</pre>						
4	In the Terminal or Watch pane, make sure that the ECAT[0].Enable value turns to 0.	 <p>Watch Window</p> <table border="1"><thead><tr><th>Command/Query</th><th>Response</th></tr></thead><tbody><tr><td>Sys.ServoCount</td><td>13312872</td></tr><tr><td>ECAT[0].Enable</td><td>0</td></tr></tbody></table>	Command/Query	Response	Sys.ServoCount	13312872	ECAT[0].Enable	0
Command/Query	Response							
Sys.ServoCount	13312872							
ECAT[0].Enable	0							

6.6.2. 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.

<p>1 In the Solution Explorer pane, open Project name – PMAC Script Language – PLC Programs – plc1.plc.</p>	
<p>2 In the programming area of the plc1.plc tab page, write a program as show on the right.</p> <p>This sample program blinks the NX-OD3256 output indicator every 5 seconds.</p> <p>* In this example, PDO mapping is assumed to be the default setting. If you want to change PDO mapping, rewrite the “Slave_0....” description.</p>	<pre> open plc 1 while(Sys.EcatMasterReady == 0){} ECAT[0].Enable = 1 P1000 = Sys.Time + 5 while(P1000 > Sys.Time){} Slave_0_7080_1_OutputBit00 = 1 P1000 = Sys.Time + 5 while(P1000 > Sys.Time){} Slave_0_7080_1_OutputBit00 = 0 close </pre>
<p>3 Setting the start of the user program</p> <p>In the Solution Explorer pane, open Project name – Configuration – pp_disable.txt.</p>	

- 4 In the programming area of the pp_disable.txt tab page, add the program shown on the right to the last line.

```
enable plc 1;
```

The pp_disable.txt program is automatically executed when the Controller starts.

This example program runs the PLC1 script.

6.6.3. 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.



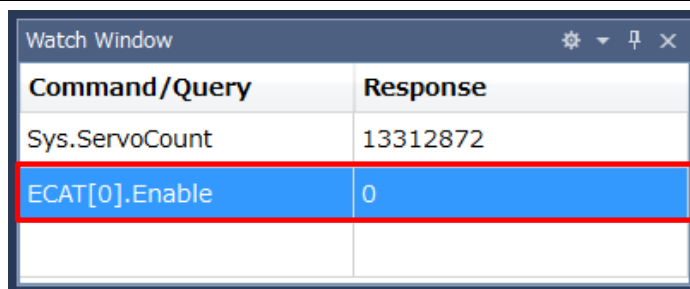
Caution

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 tab page or Watch Window, 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 tab page to stop EtherCAT communications.



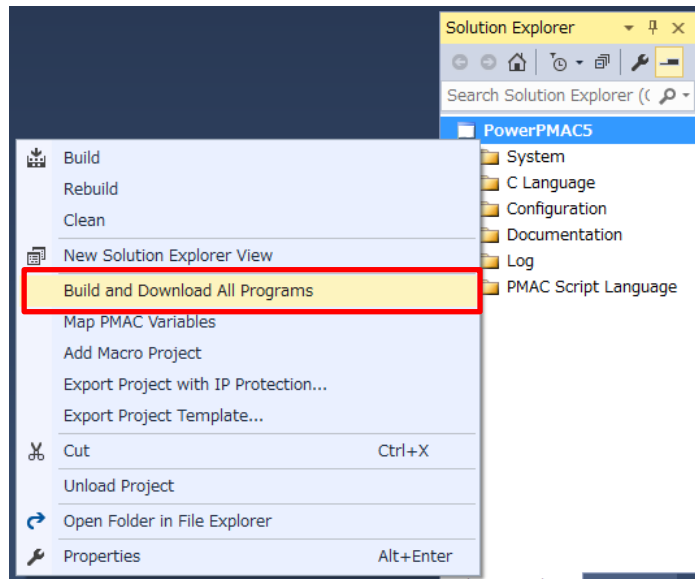
Command/Query	Response
Sys.ServoCount	13312872
ECAT[0].Enable	0

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.

* 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.



3 Make sure that there are no errors in the Output Window.

* If the transfer fails, check details of the error in the Output Window.

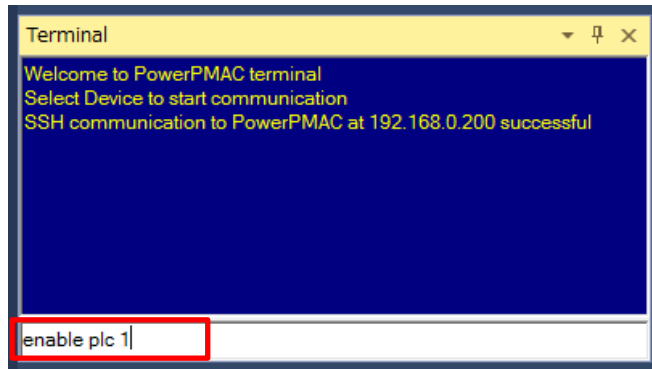
If the error is a program error, you must review the program.

If the error is related to EtherCAT settings, return to 6.5 EtherCAT Communications 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 tab page or Watch Window. If the value is 0, run the following command from the Terminal tab page.
enable plc 1



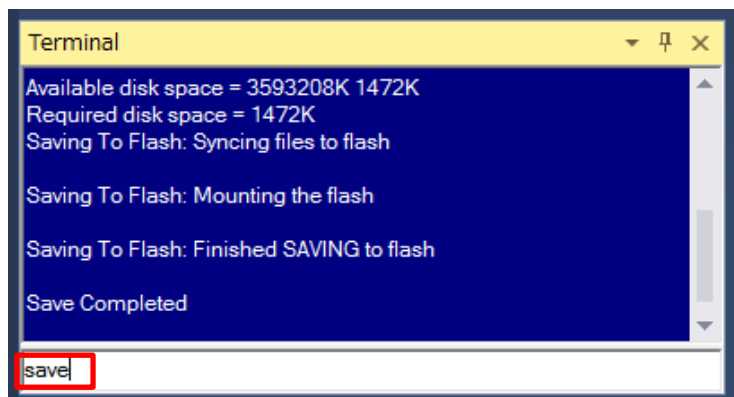
```
Terminal
Welcome to PowerPMAC terminal
Select Device to start communication
SSH communication to PowerPMAC at 192.168.0.200 successful

enable plc 1
```

- 5 After you have confirmed an appropriate operation, save the project to the Controller.

Run the save command from the Terminal tab page.

* 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.



```
Terminal
Available disk space = 3593208K 1472K
Required disk space = 1472K
Saving To Flash: Syncing files to flash

Saving To Flash: Mounting the flash

Saving To Flash: Finished SAVING to flash

Save Completed

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.

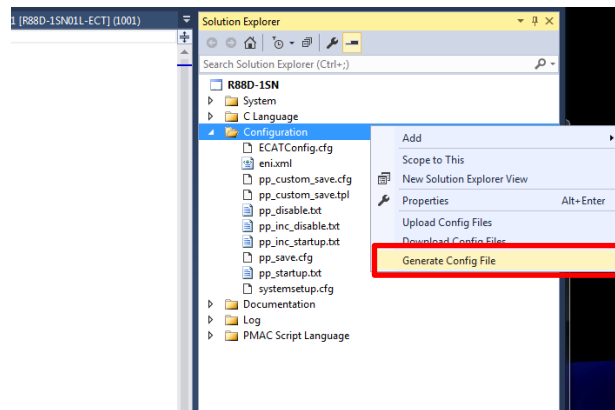
7.1. Saving a Project

1 Creating a Configuration File

Create a Configuration File to save parameters you have changed.

Right-click **Configuration** in the Solution Explorer pane, and select **Generate Configuration File**.

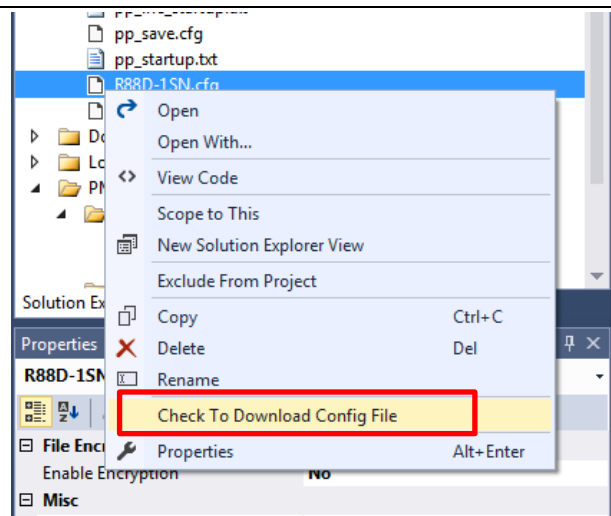
A Configuration File is added to **Configuration**.



2 Enter a file name in the textbox, then click the OK button.

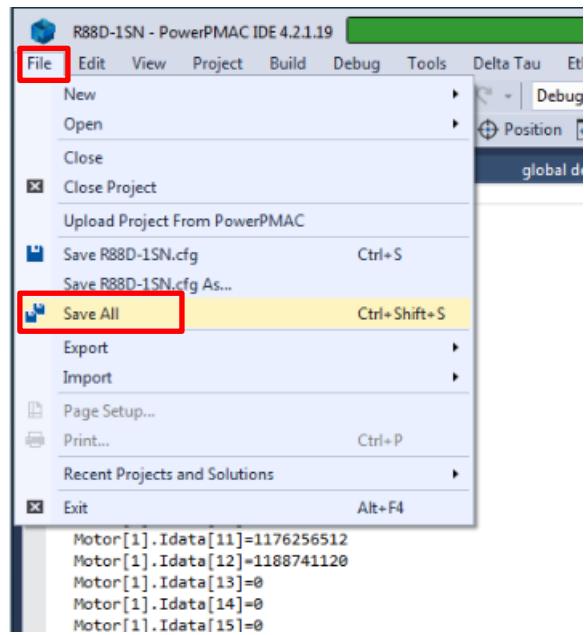


3 Right-click on the Configuration File, and from the menu, select **Check To Download Config File** to include it in files to be downloaded.



4 Saving a Project

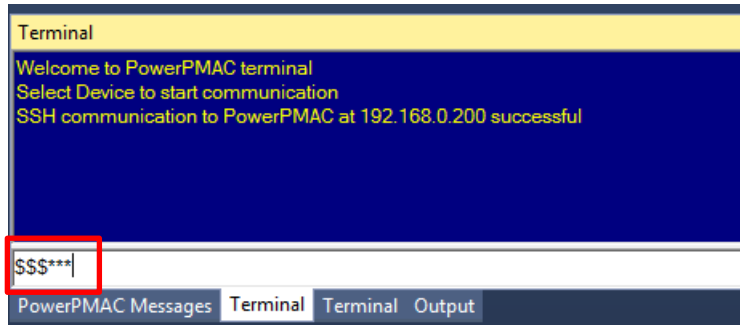
In the **File** menu, run **Save All** to save the project on the computer.



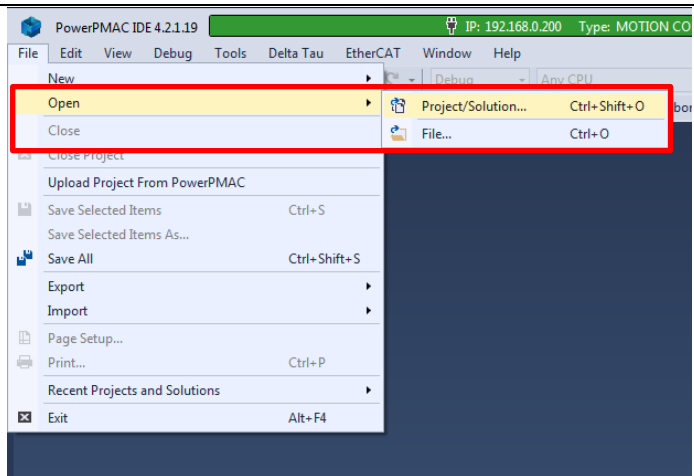
7.2. Loading and Downloading a Project

1 Start Power PMAC IDE, and connect to the Controller.

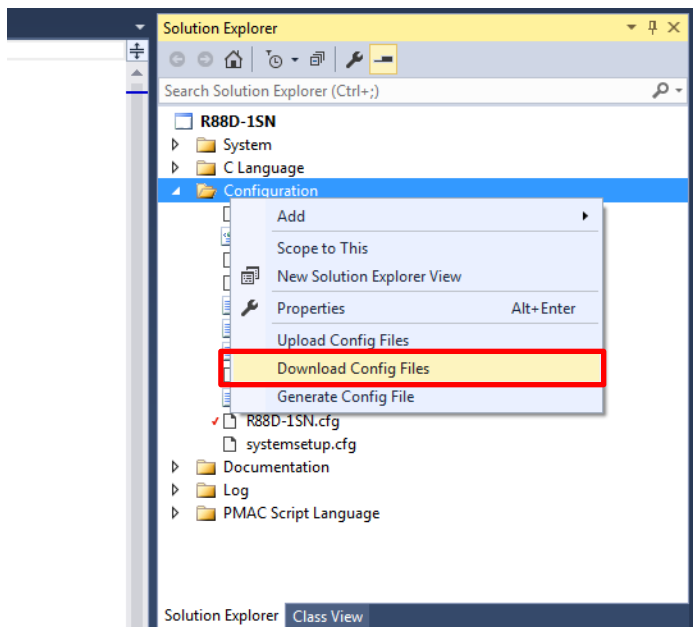
2 In the Terminal tab page, type the \$\$\$*** command to reset the Controller settings to factory default.



3 In the File menu, Click **Open – Project/Solution** to load the project that you saved.

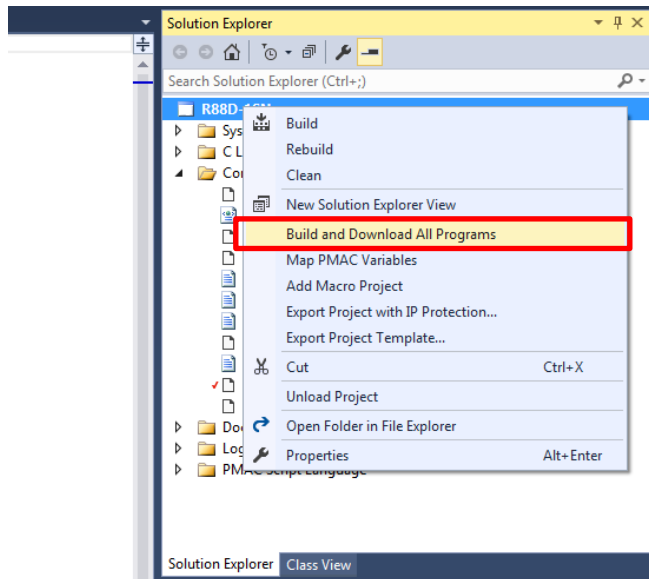


4 Right-click **Configuration** in the Solution Explorer pane, and select **Download Config Files** to download the file to the Controller.



- 5 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 Window.

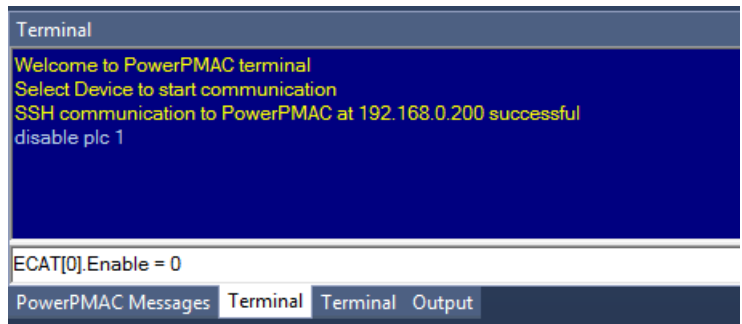
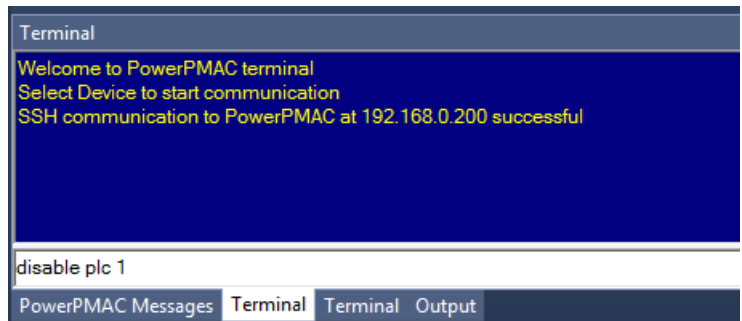


- 6 Stopping a program

If a program is running, execute the following command from the Terminal tab page to stop the program.

```
disable plc 1
```

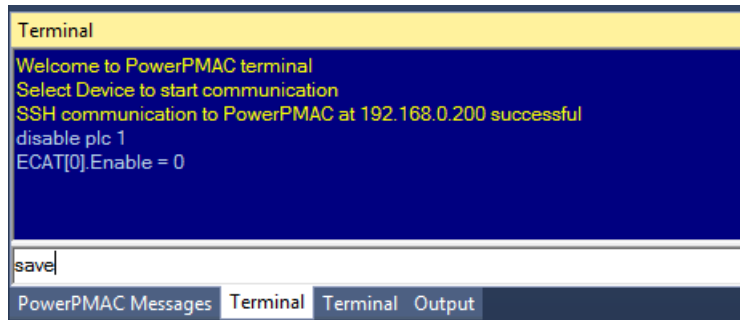
```
ECAT[0].Enable=0
```



7 Saving the downloaded settings and programs

After the download process is complete and you make sure that there are no errors in the Output Window, run the save command from the Terminal tab page.

* 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.

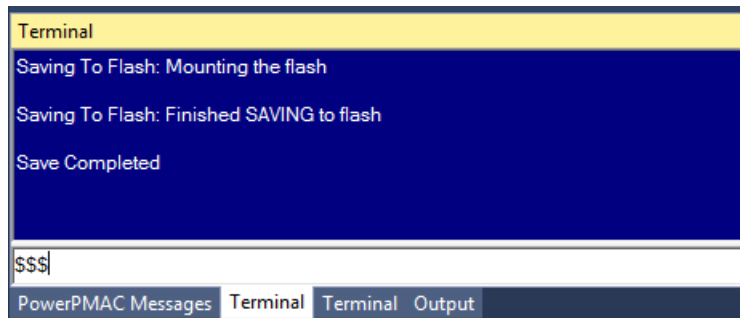


```
Terminal
Welcome to PowerPMAC terminal
Select Device to start communication
SSH communication to PowerPMAC at 192.168.0.200 successful
disable plc 1
ECAT[0].Enable = 0

save|
PowerPMAC Messages Terminal Terminal Output
```

8 Restarting after download

Run the following command from the Terminal tab page to restart the Controller with the downloaded project.
\$\$\$



```
Terminal
Saving To Flash: Mounting the flash
Saving To Flash: Finished SAVING to flash
Save Completed

$$$|
PowerPMAC Messages Terminal Terminal Output
```

8. Appendix Troubleshooting

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

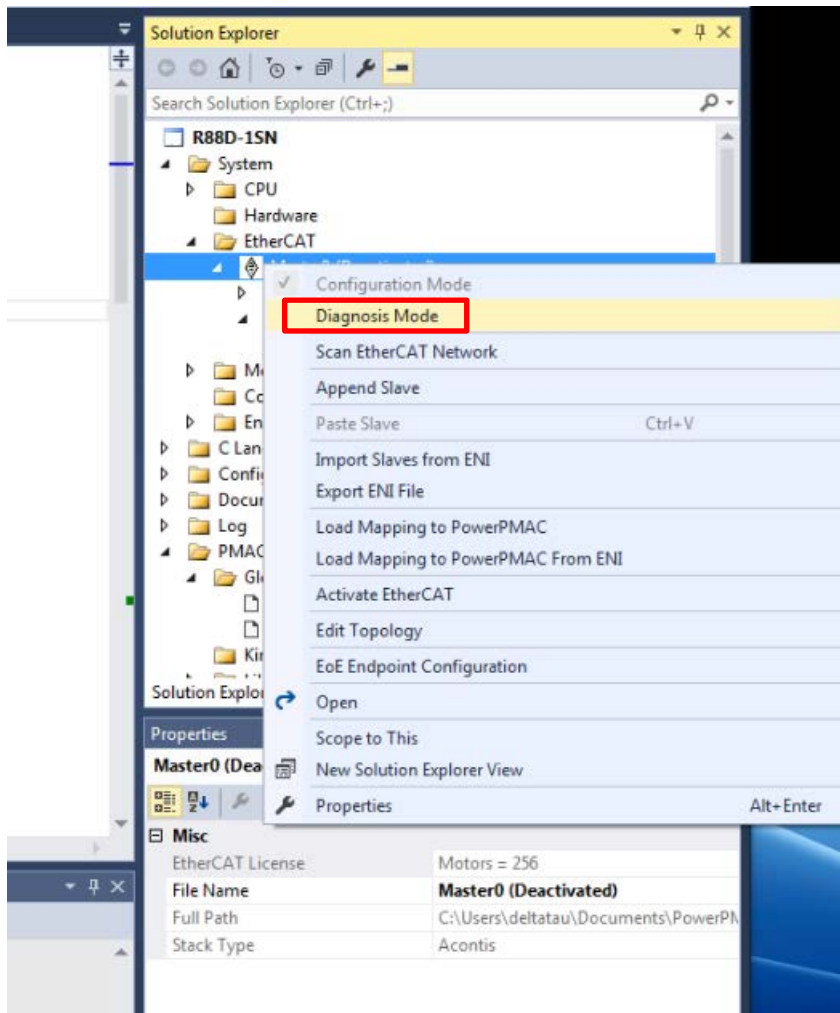
Description	Factor	Corrective Action
The link is not established.	The Ethernet cable is broken or the specified cable is not being used.	If the Ethernet cable is broken or if the specified cable was not used, replace the cable.
	A connector on the Ethernet cable used for EtherCAT communications is disconnected, 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 <i>6.5 EtherCAT Communications Setup</i> .
	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 <i>6.5.2 Distributed Clock Setup</i> .
	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

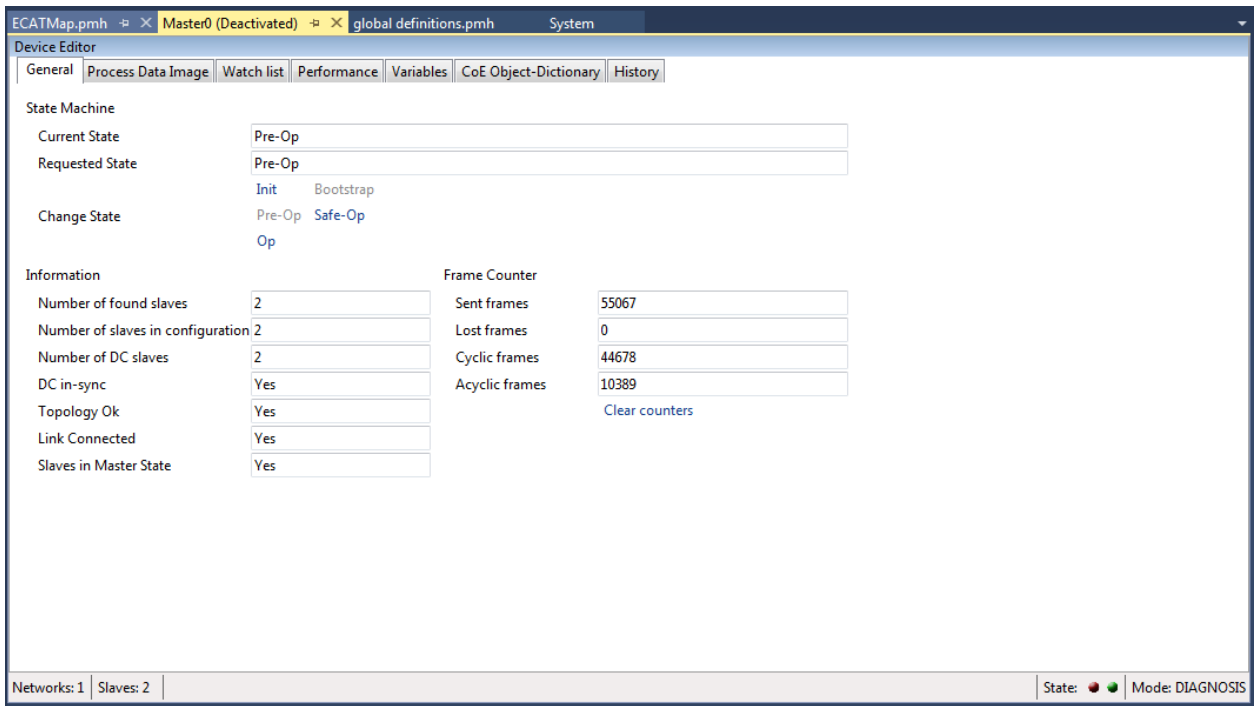
8.2.1. Checking the EtherCAT Status

You can check the EtherCAT status from **Diagnosis Mode** of Power PMAC IDE.

Right-click on **Master0 (Deactivated)** under **EtherCAT** in the Solution Explorer, then select **Diagnosis Mode** to open the Diagnosis Mode page



You can check the status of the slaves in the Diagnosis Mode page.



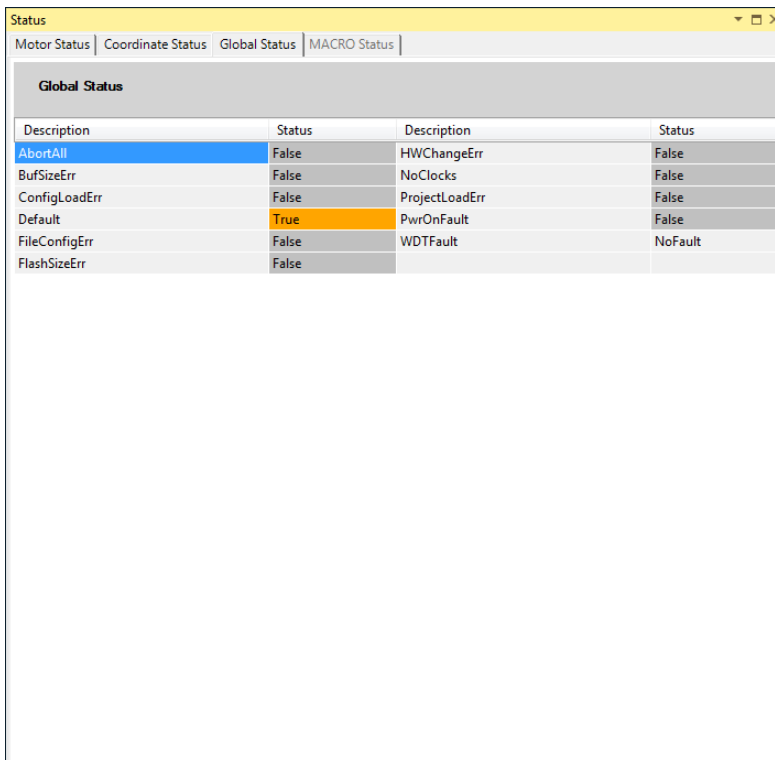
8.2.2. Checking the Controller Status

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.

Description	Status	Description	Status
AmpEna	False	I2tFault	False
AmpFault	False	InPos	False
AmpWarn	False	InterlockStop	False
AuxFault	False	LimitStop	False
BDir	Plus	MinusLimit	False
BlockRequest	False	PhaseFound	False
ClosedLoop	False	PlusLimit	False
Csolve	False	SoftLimit	False
DacLimit	False	SoftLimitDir	Plus
DesVelZero	True	SoftMinusLimit	False
EncLoss	False	SoftPlusLimit	False
FeFatal	False	SpindleMotor	False
FeWarn	False	TraceCount	0
GantryHomed	False	TriggerMove	False
HomeComplete	False	TriggerNotFound	False
HomeInProgress	False	TriggerSpeedSel	MaxSpeed

■ Coordinate Status

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

Description	Status	Description	Status
AddedDwellDis	True	LinToPvtBuf	False
AmpEna	False	LookAheadActive	False
AmpFault	False	LookAheadChange	False
AmpWarn	False	LookAheadDir	Forward
AuxFault	False	LookAheadFlush	False
BlockActive	False	LookAheadLookBack	False
BlockRequest	False	LookAheadReCalc	False
BufferWarn	0	LookAheadStop	False
CC3Active	False	LookAheadWrap	False
CCAddedArc	False	MinusLimit	False
CCMODE	Off	MoveMode	LineCircle
CCMoveType	Dwell	PlusLimit	False
CCOFFReq	False	ProgActive	False
ClosedLoop	False	ProgProceeding	False
ContMotion	False	ProgRunning	False
Csolve	False	SegEnabled	False
DesVelZero	False	SegHaltReq	False
EncLoss	False	SegMove	Off
EndDelayActive	False	SegMoveAccel	False
ErrorStatus	NoError	SegMoveDecel	False
FeedHold	Off	SegStopReq	False
FeFatal	False	SharpCornerStop	False
FeWarn	False	SoftMinusLimit	False
HomeComplete	False	SoftPlusLimit	False
HomeInProgress	False	TimerEnabled	False
I2tFault	False	TimersEnabled	False
InPos	False	TriggerMove	False
InterlockStop	False	TriggerNotFound	False

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
A	5-Apr, 2019	First edition

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

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