OMRON

Programmable Multi-Axis Controller

Startup Guide for EtherCAT® Communication Coupler Digital I/O Units

CK3E-□□□□
NY51□-A□□□

SYSMAC always in control

O024-E1-01

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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-□□□□	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	W521-E1	Model NX-ID□□□□ Model NX-OD□□□□	NX-ID/IA/OC/OD/MD Digital I/O Unit User's 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 OMRON High EtherCAT Coupler Unit model NX-ECC203 (hereafter referred to as the Slave) 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

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

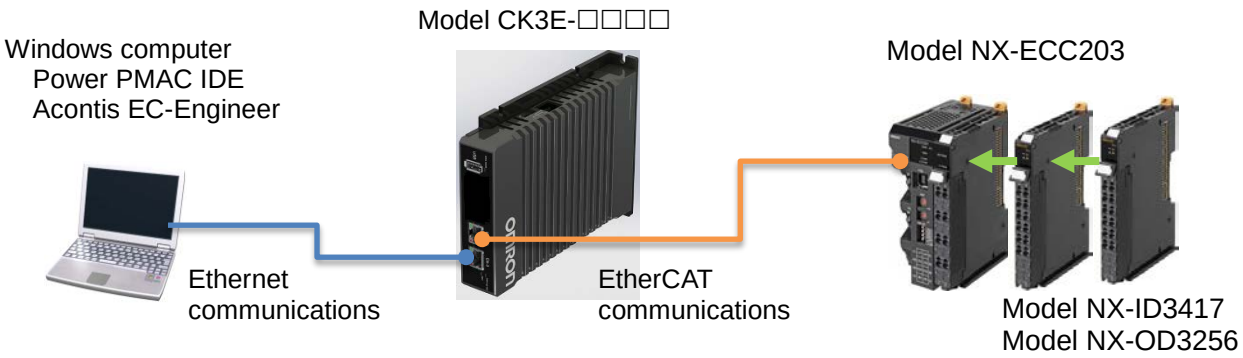
In this document, the devices with models and versions listed in *Section 5.2* are used as examples of applicable devices to describe the procedures to connect the devices and check their connections.
You cannot use devices with versions lower than the versions listed in *Section 5.2*.
To use the devices 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	Digital Input Unit	Model NX-ID3417	Ver.1.0
OMRON	Digital Output Unit	Model NX-OD3256	Ver.1.0
OMRON	Ethernet cable (with industrial Ethernet connector)	Model XS5W-T421-□M□-K	
-	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

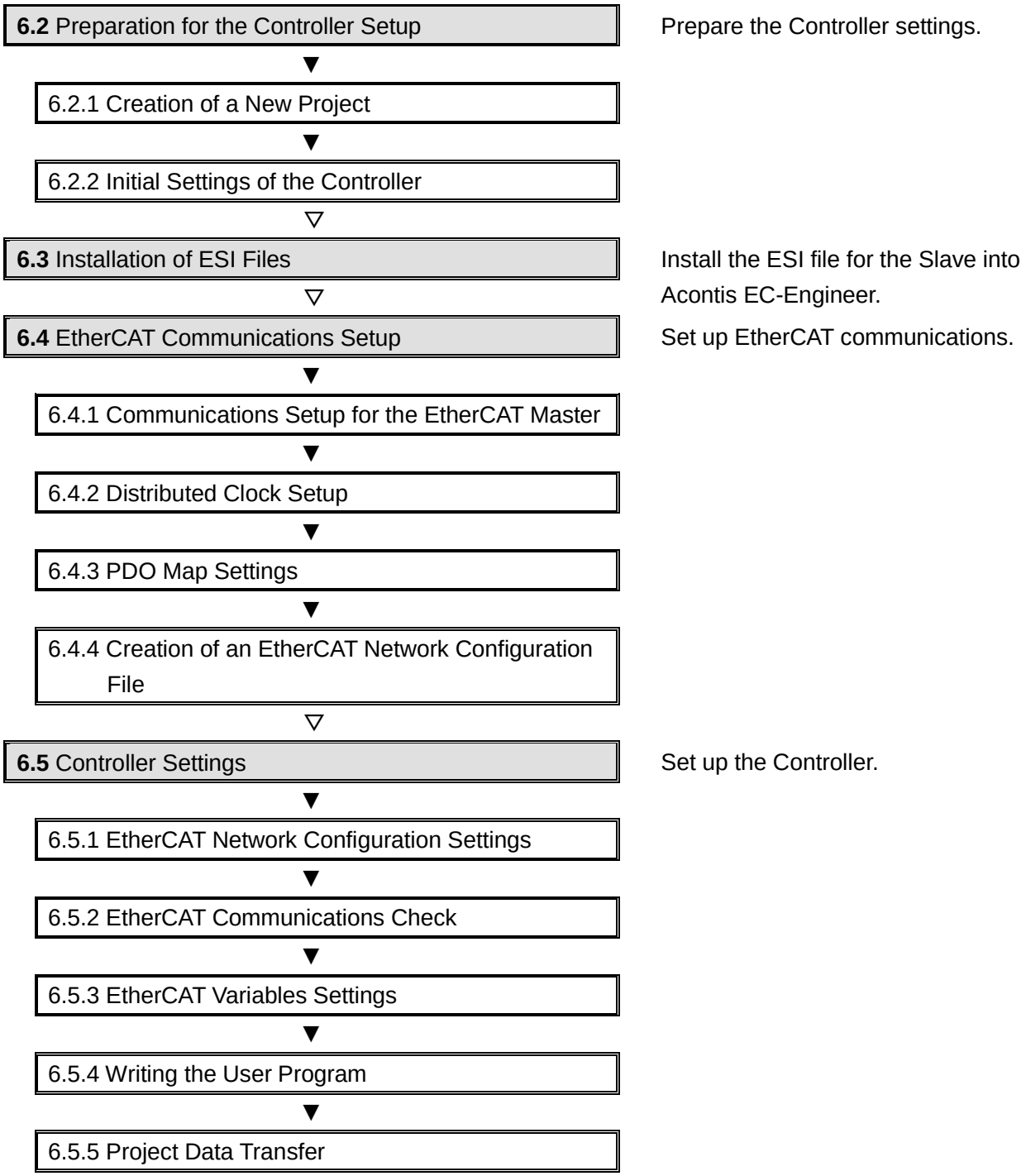
This document describes model CK3E-□□□□ as an example. The same procedures can apply to model NY51□-A□□□.

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.

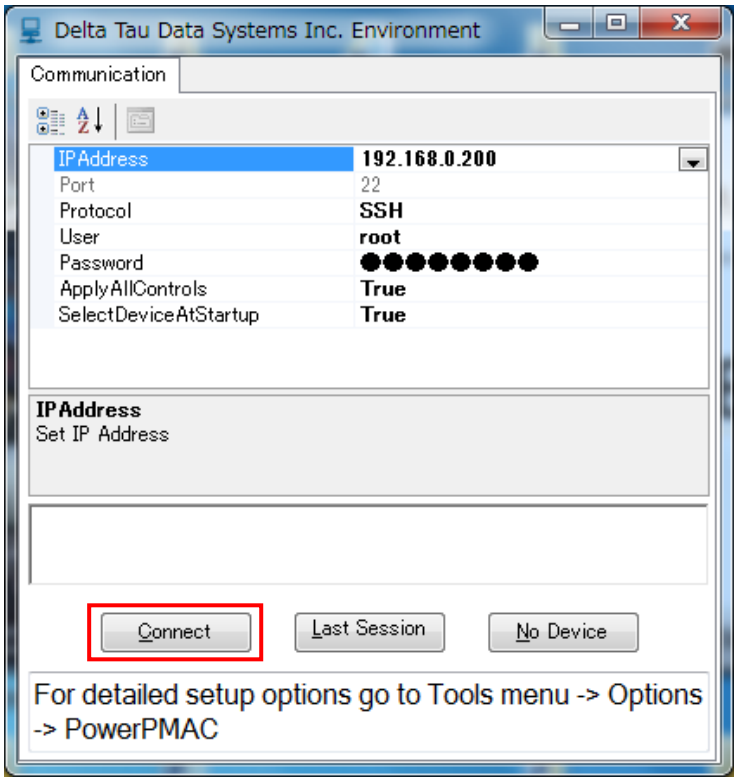


6.2. Preparation for the Controller Setup

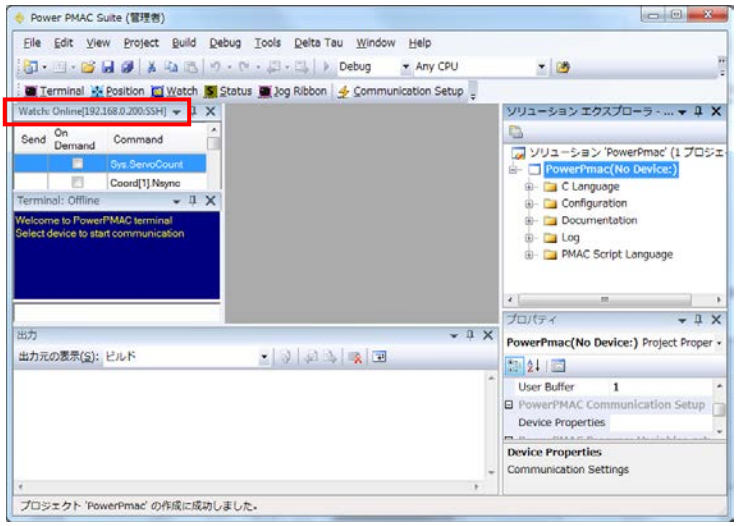
Prepare the Controller settings.

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

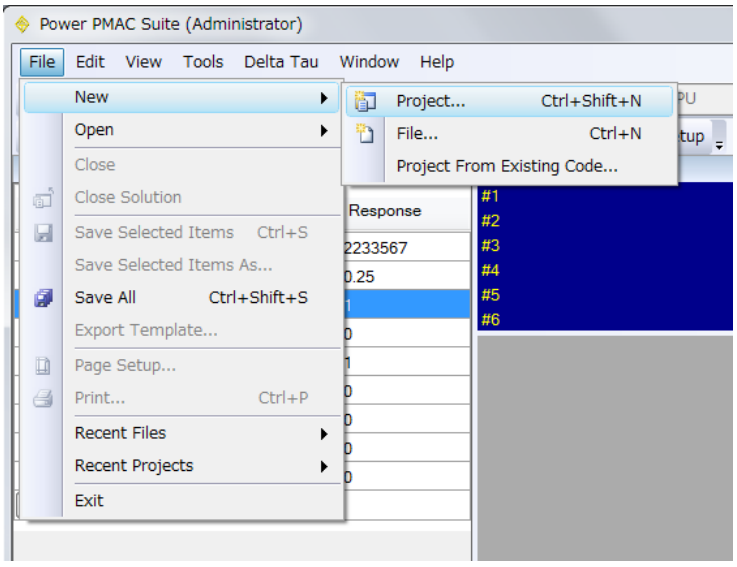
6.2.1. Creation of a New Project

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”.	

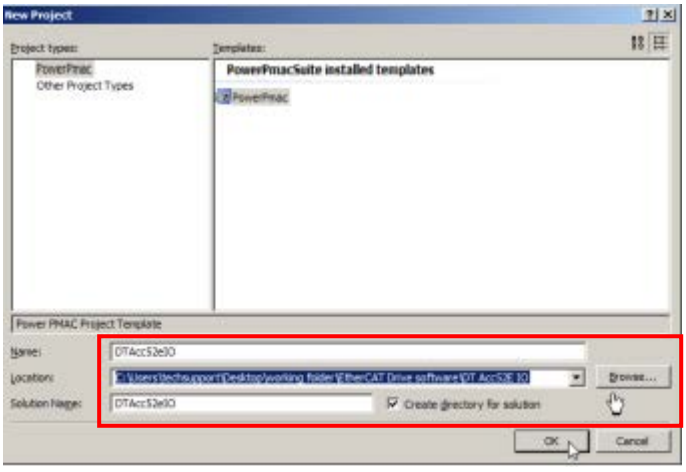
5 Power PMAC IDE starts, and is online to the Controller.



6 From the **File** menu, select **New** then **Project**.



7 Enter a project name and location, and select **OK**.

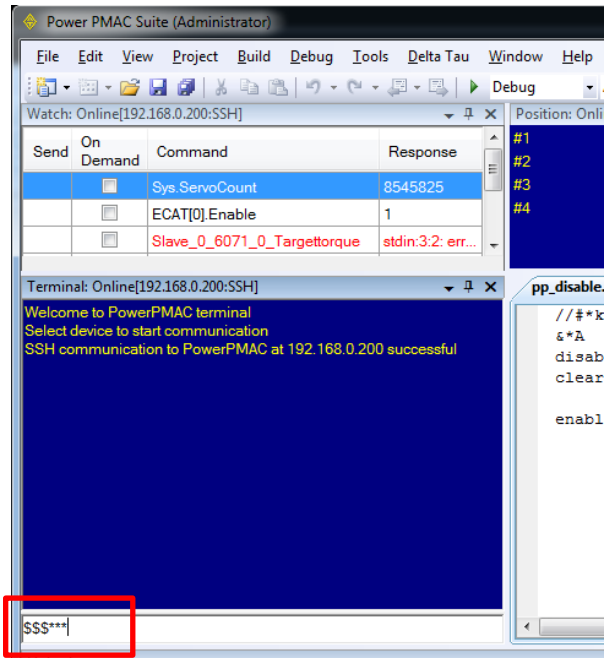
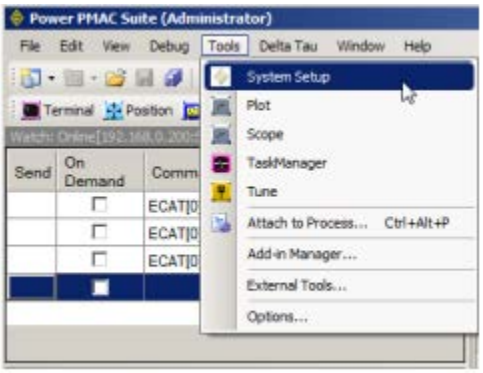
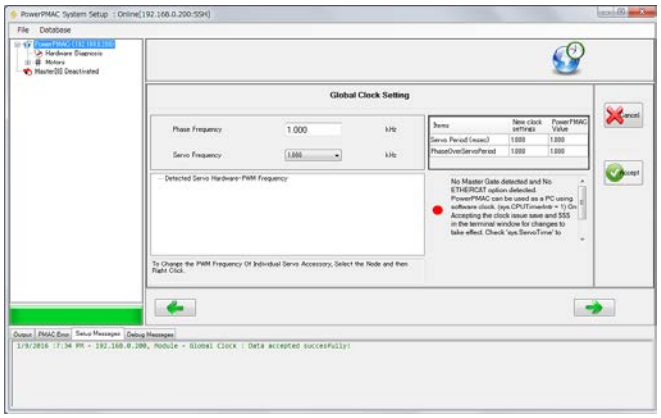


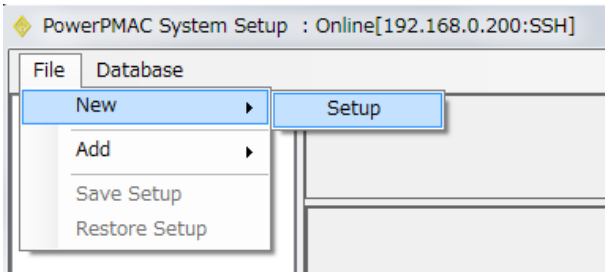
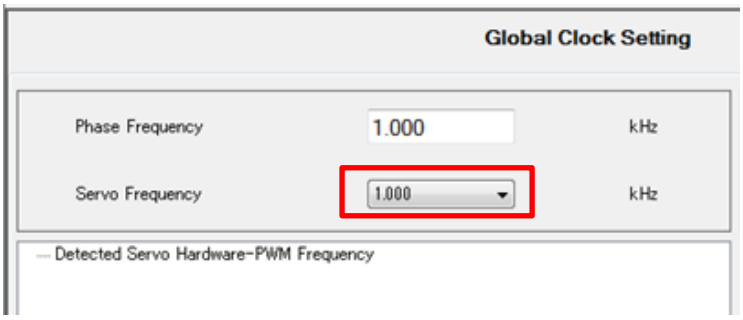
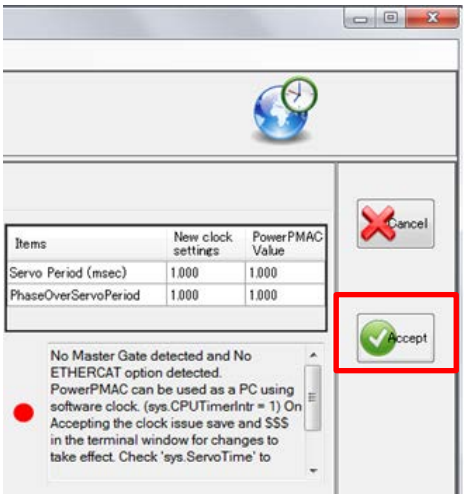
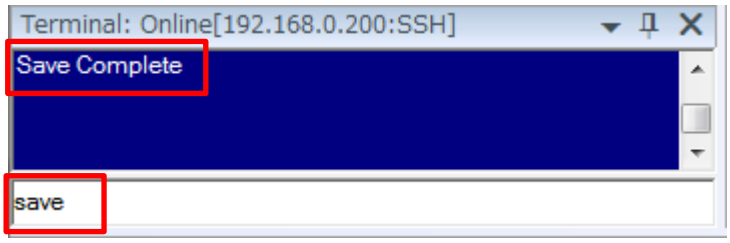
6.2.2. Initial Settings of the Controller

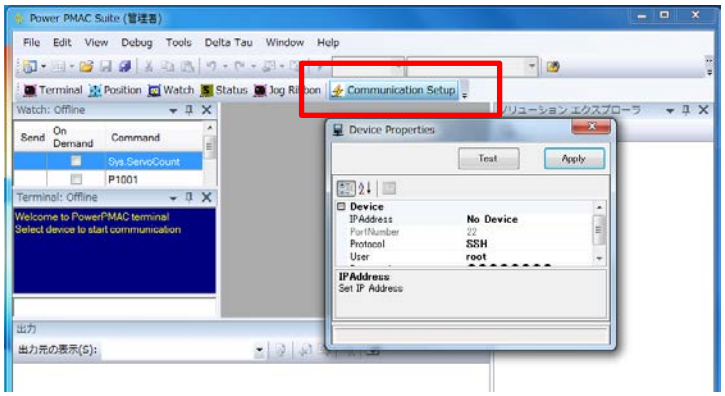
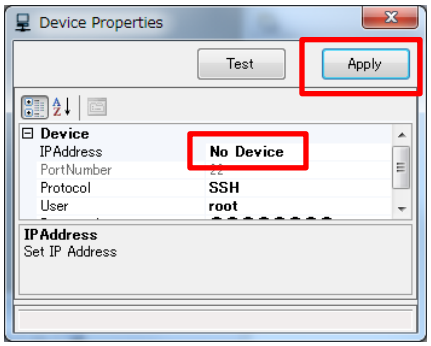
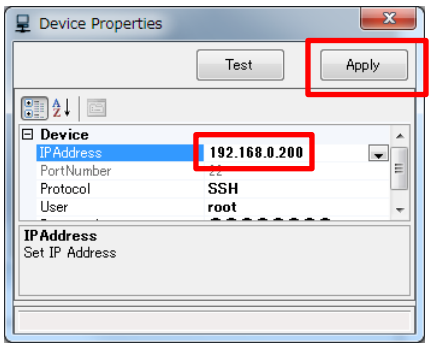
Configure the initial settings for the Controller.

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.	

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.	

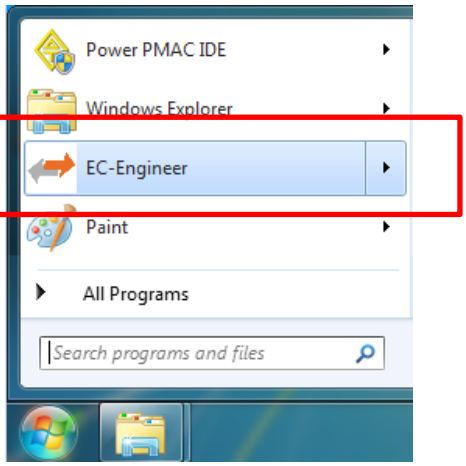
6.3. Installation of ESI Files

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

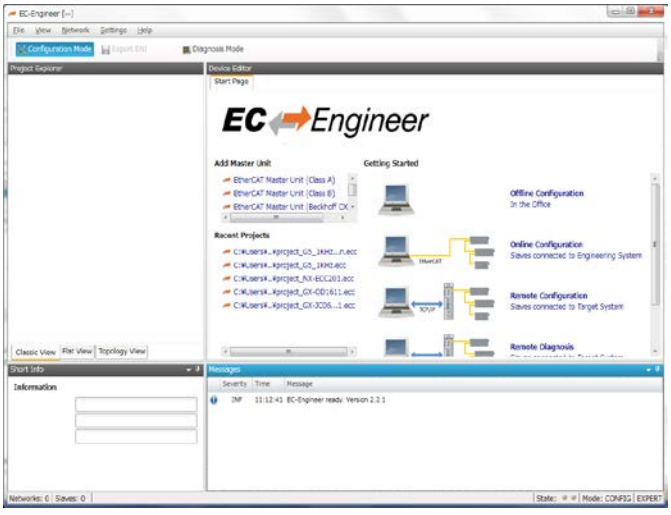
Precautions for Correct Use

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.

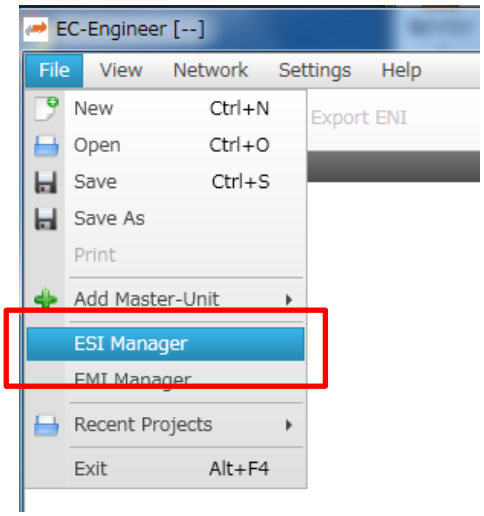


EC-Engineer screen:

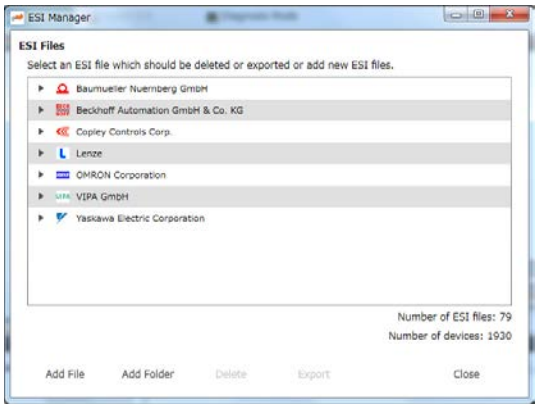


2 From the **File** menu of EC-Engineer, select **ESI Manager**.

The ESI Manager appears.

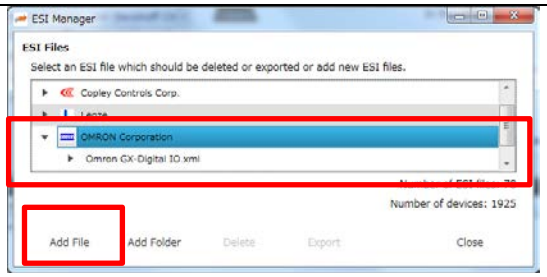


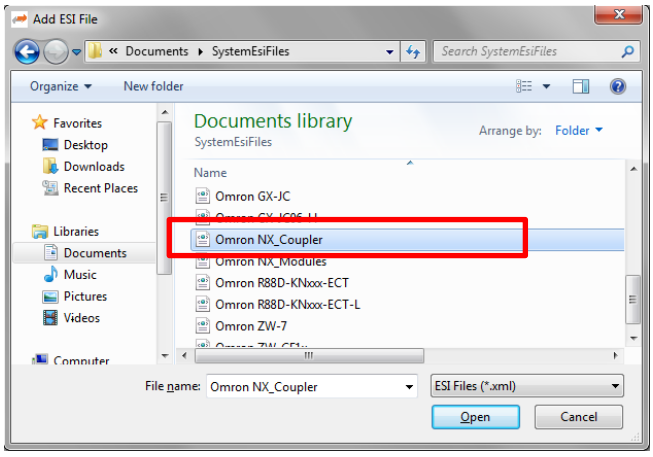
Example of the ESI Manager



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.

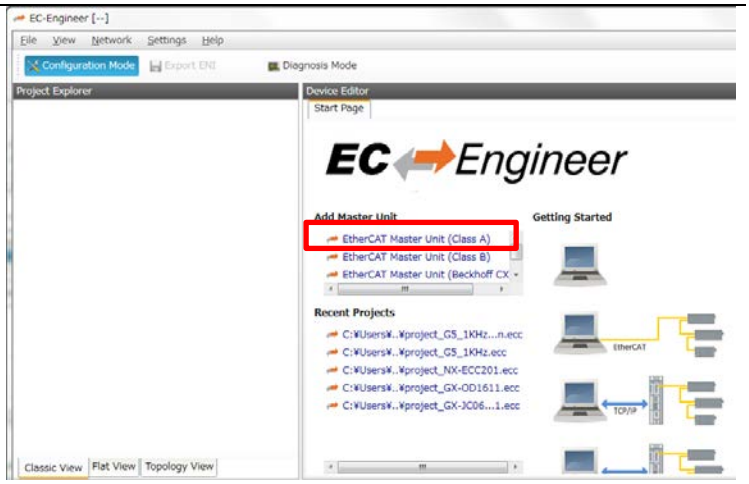
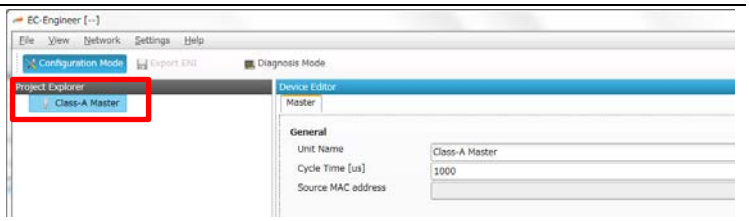
6.4. EtherCAT Communications Setup

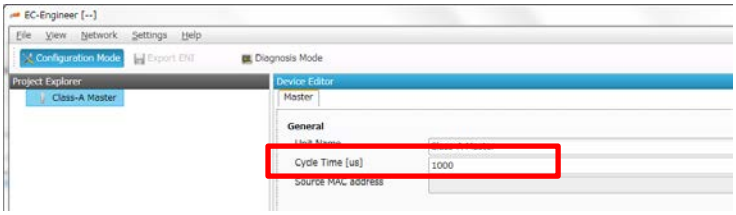
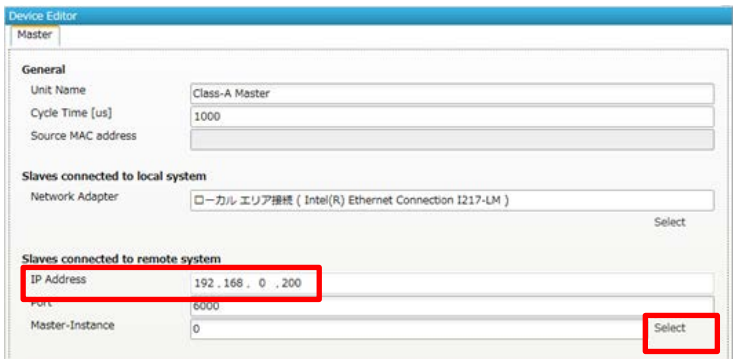
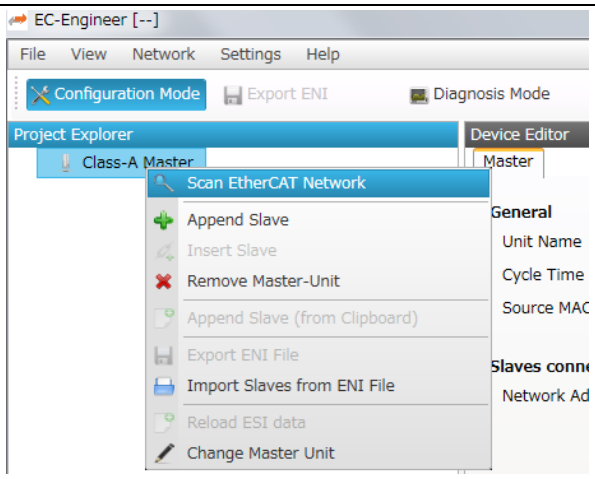
Set up EtherCAT communications.

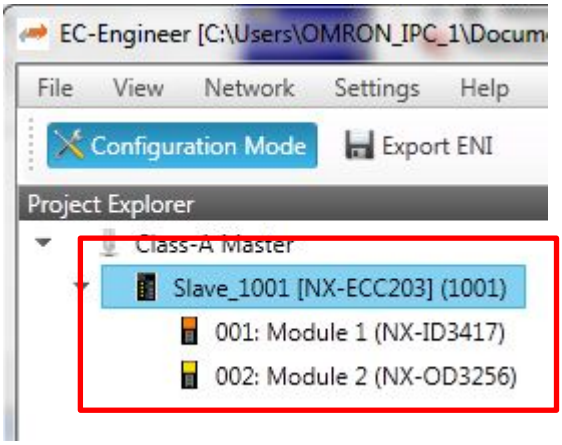
Precautions for Correct Use

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.

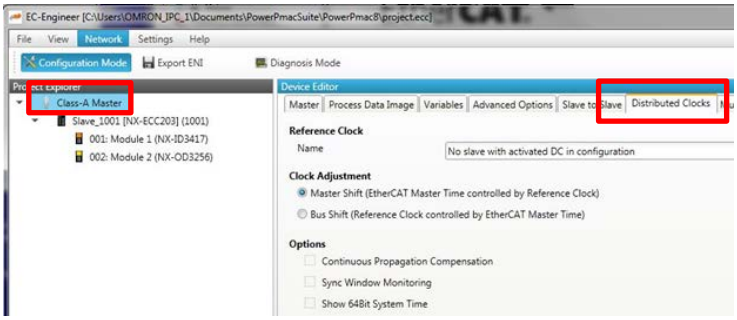
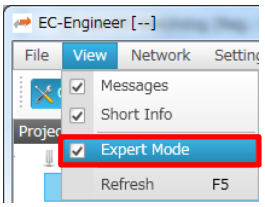
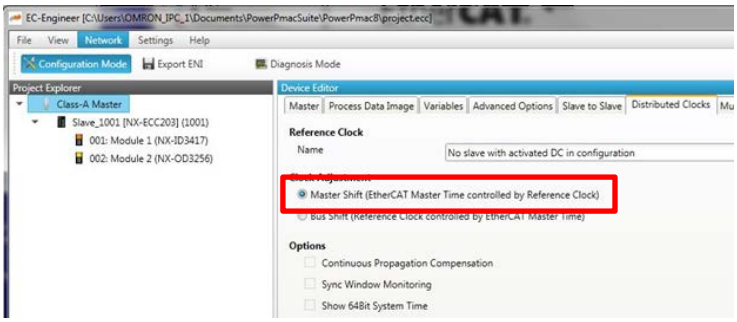
6.4.1. Communications Setup for the EtherCAT Master

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.	

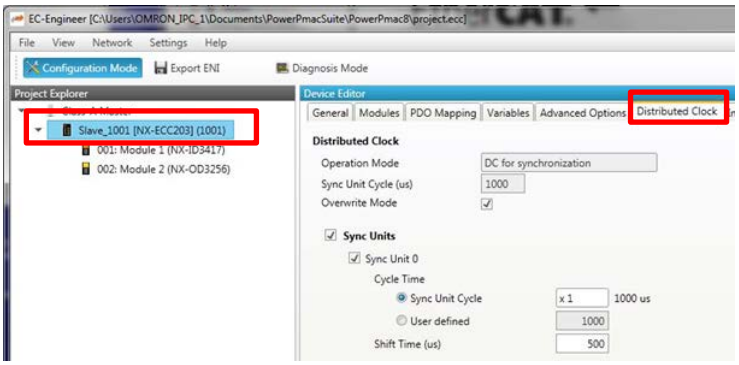
6.4.2. Distributed Clock Setup

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)**.	

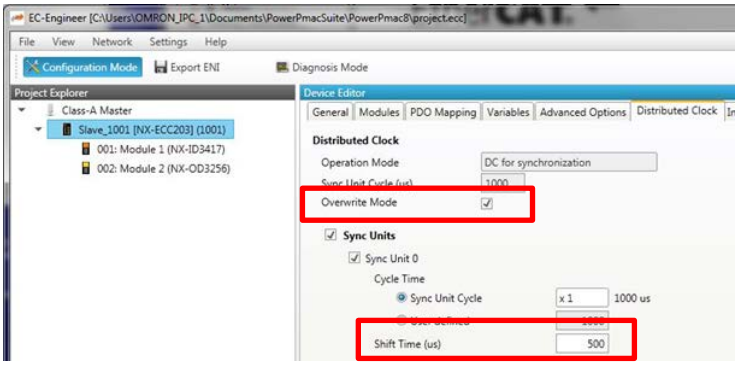
■ When using in DC mode

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**.

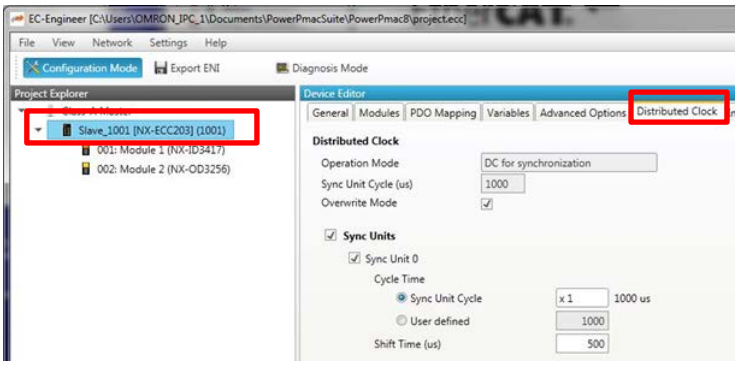


Correspondence between the servo frequencies of the Controller and **Shift Time** values is as follows:
4 kHz : 125 us
2 kHz : 250 us
1 kHz : 500 us

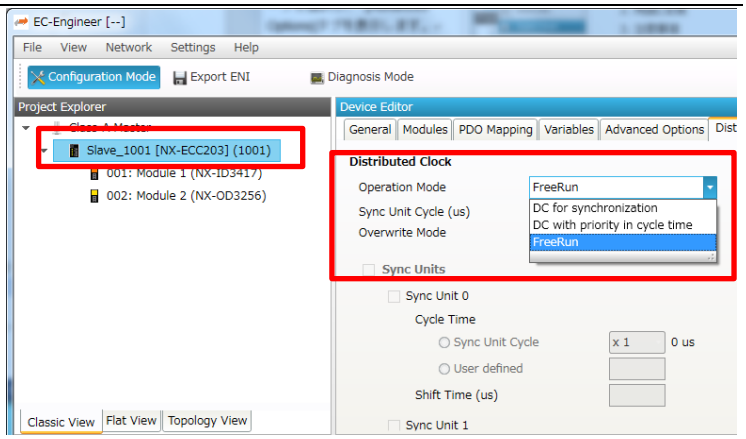
■ When using in Free-Run mode

3 Setting Distributed Clock (DC) for the Slave

In the Project Explorer, select the target slave to display the Distributed Clock tab page.

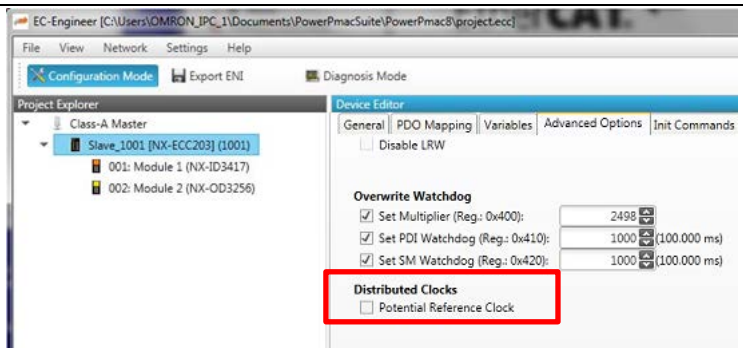


4 Select *FreeRun* from the drop down list for **Operation Mode**.



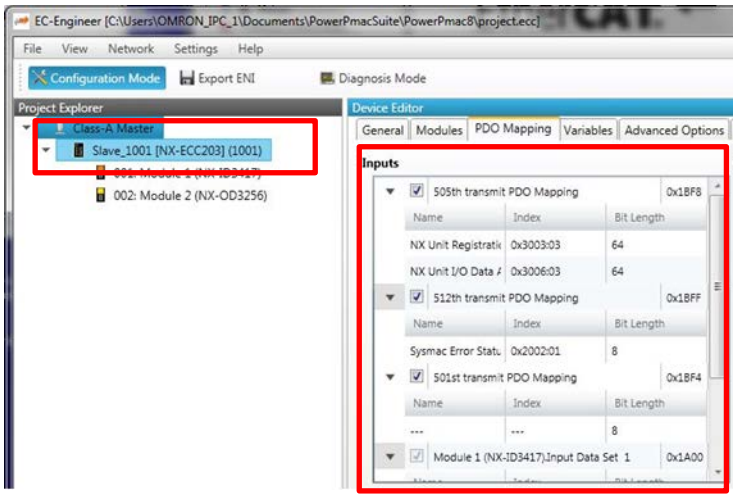
5 Display the Advanced Options tab page.

Clear the **Potential Reference Clock** check box.



6.4.3. PDO Map Settings

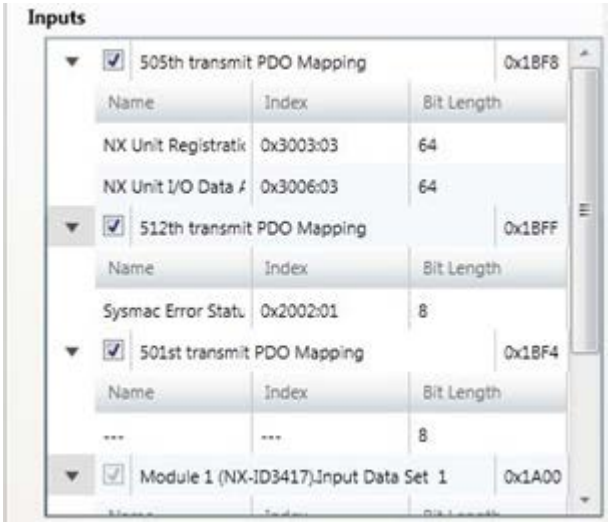
1 In the Project Explorer, select the target slave to display the PDO Mapping tab page.



2 Setting PDO mapping (Inputs)

Confirm the check boxes in the Inputs field.

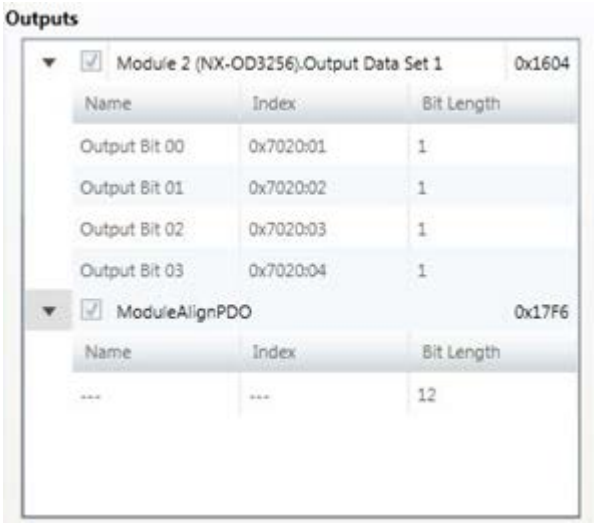
* If you do not want to use data in the Inputs field, clear the currently displayed check boxes.



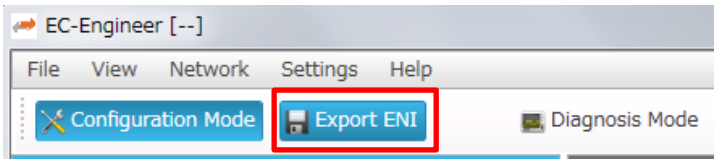
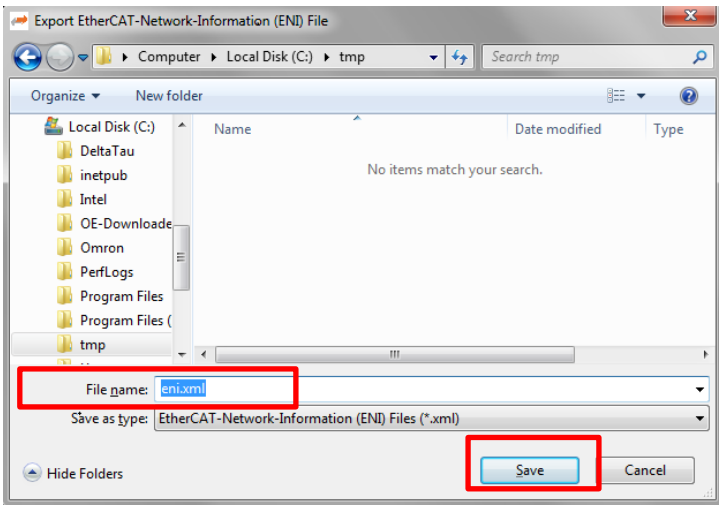
3 Setting PDO mapping (Outputs)

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.



6.4.4. 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.	

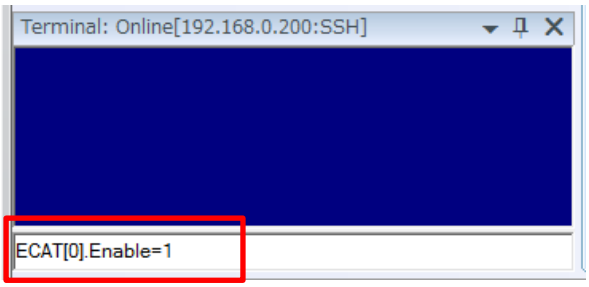
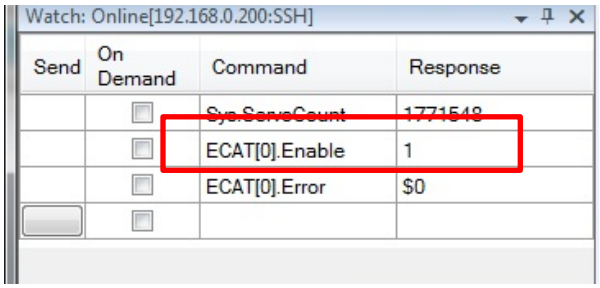
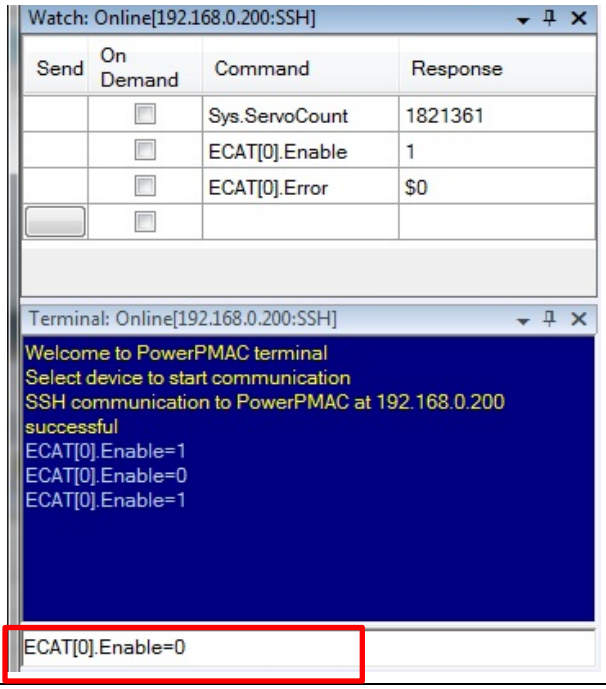
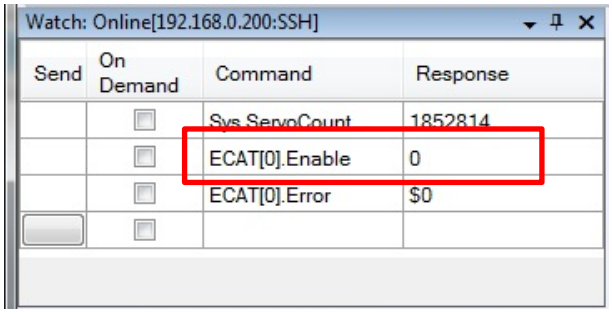
6.5. Controller Settings

6.5.1. EtherCAT Network Configuration Settings

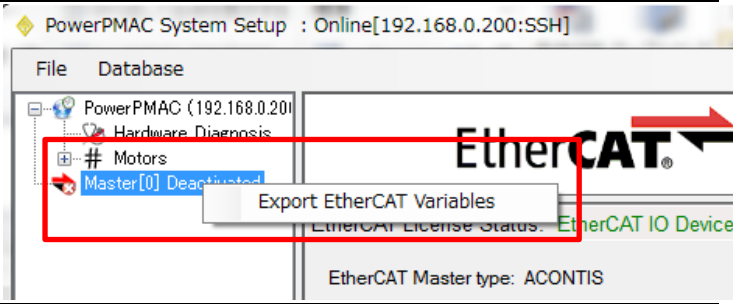
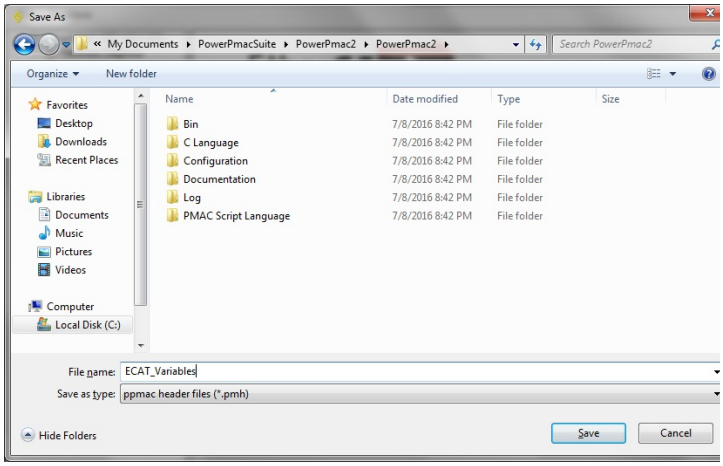
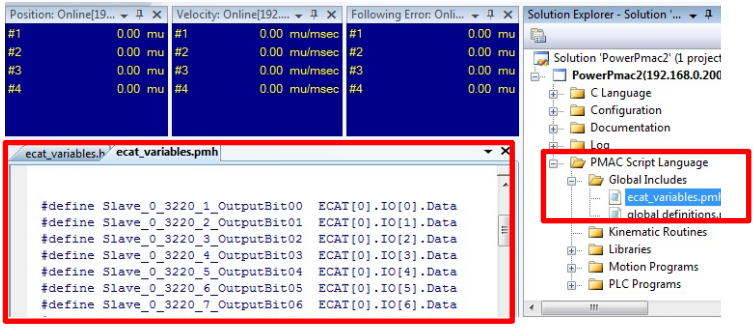
1	From the **Tools** menu of Power PMAC IDE, select **System Setup** to display **System Setup**.	
2	Click **Browse**, and load the EtherCAT network configuration file created in *6.4.4 Creation of an EtherCAT Network Configuration File*.	
3	Click **Download ENI file** to download the EtherCAT network configuration to the Controller.	

6.5.2. 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.	
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*.	

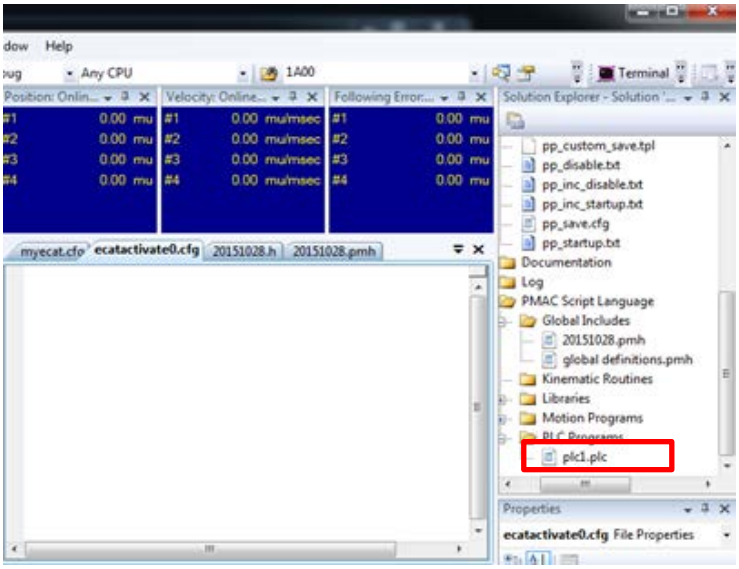
6.5.3. EtherCAT Variables Settings

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.	

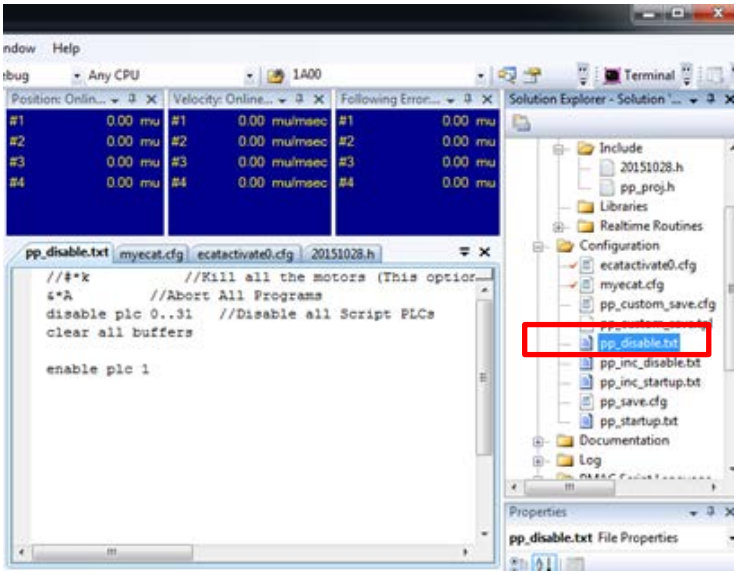
6.5.4. Writing the User Program

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_7020_2_OutputBit01 = 1;
		
		P1000=Sys.Time+1;
		while(P1000>Sys.Time){};
		
		Slave_0_7020_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;

6.5.5. Project Data Transfer

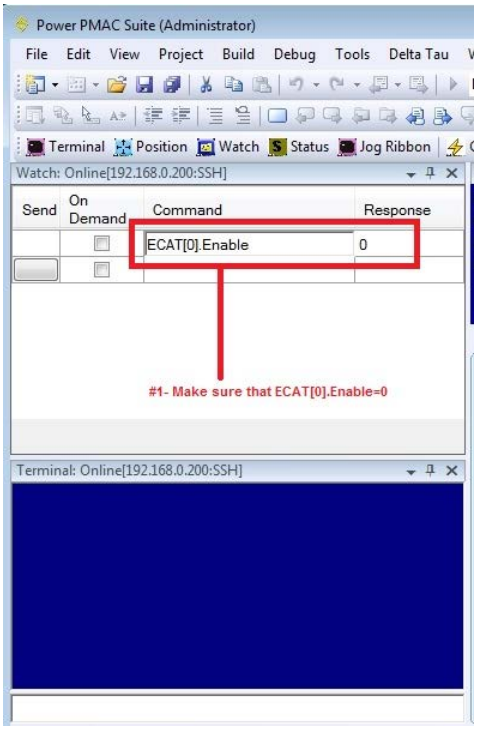
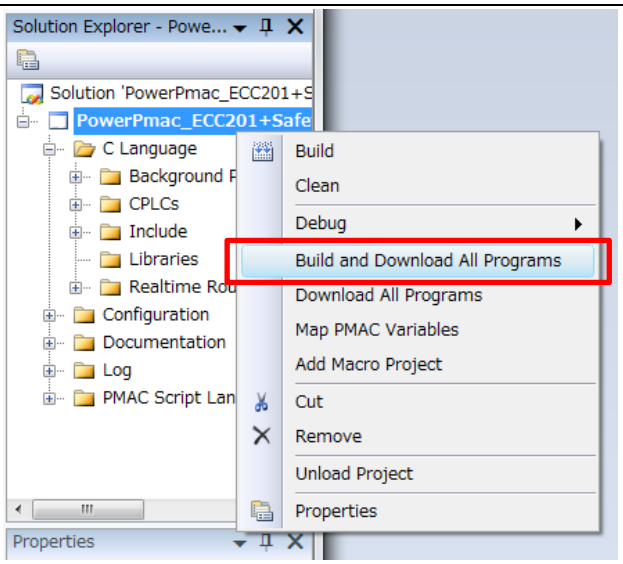
Transfer the created project data to the Controller.

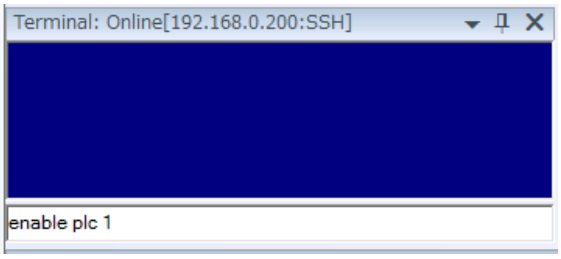
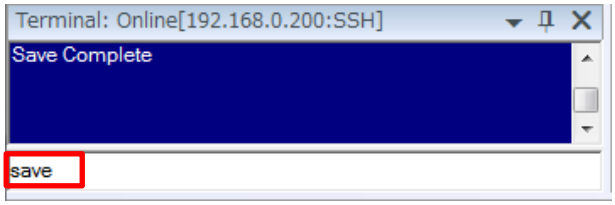
⚠ WARNING

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.

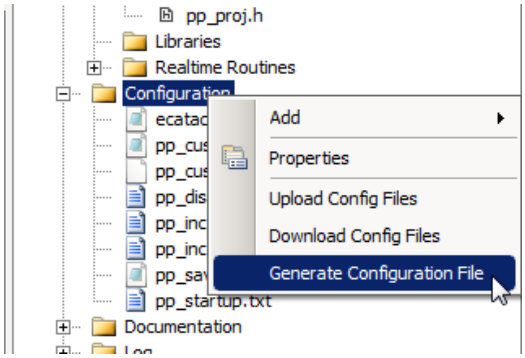
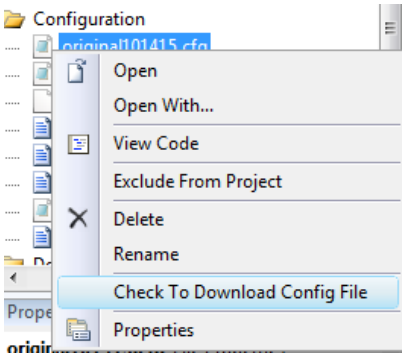
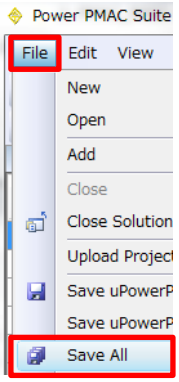
1	In the Terminal or Watch pane, make sure that the ECAT[0].Enable value is *0*. If the value is *1*, run the ECAT[0].Enable=0 command from the Terminal pane to stop EtherCAT communications.	
2	Downloading a project Right-click the project name in the Solution Explorer pane on the upper right of the 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	
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.	

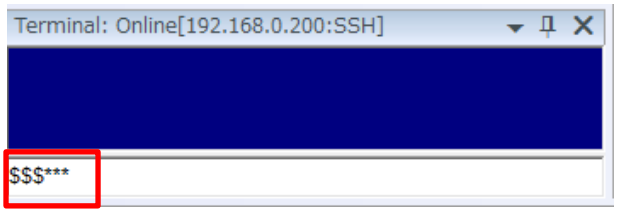
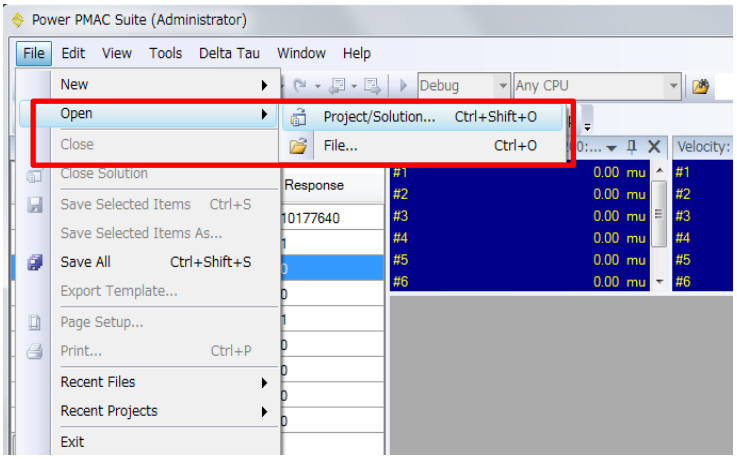
7. Appendix Saving and Loading a Project

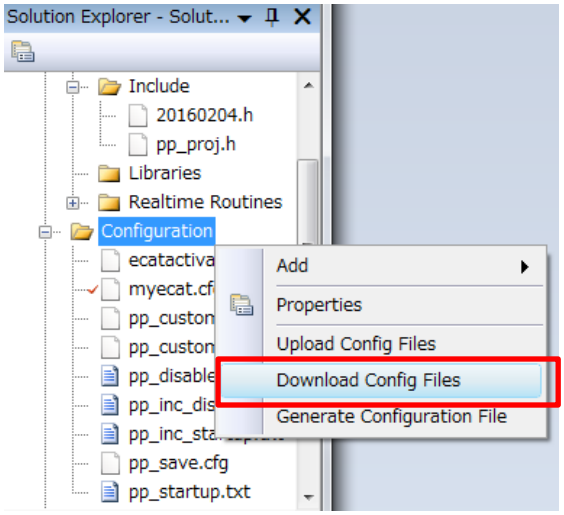
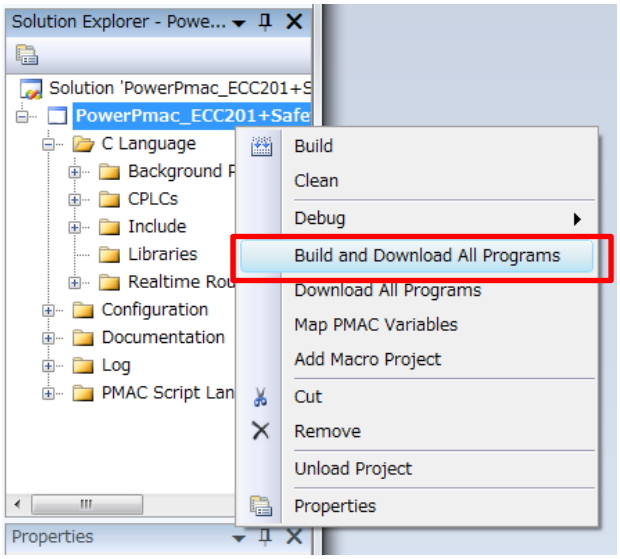
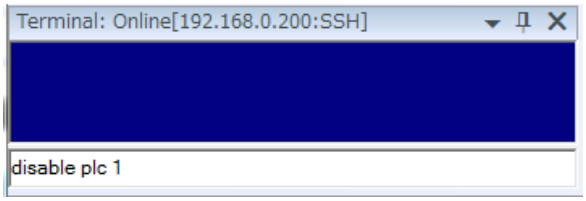
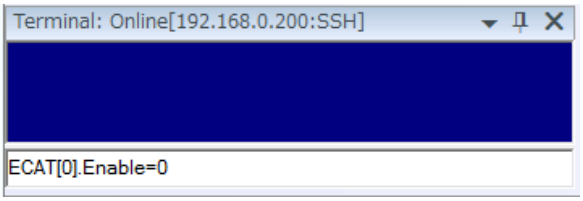
The following describes the procedures to save a Power PMAC IDE project on the computer, and to reuse it.

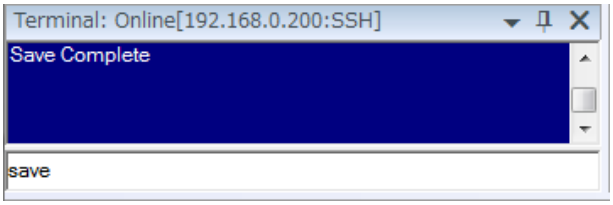
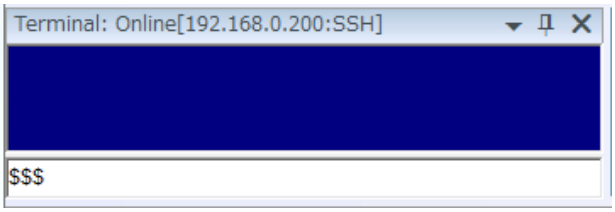
7.1. Saving a Project

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 *6.4.4 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 *6.4 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 *6.4.2 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.

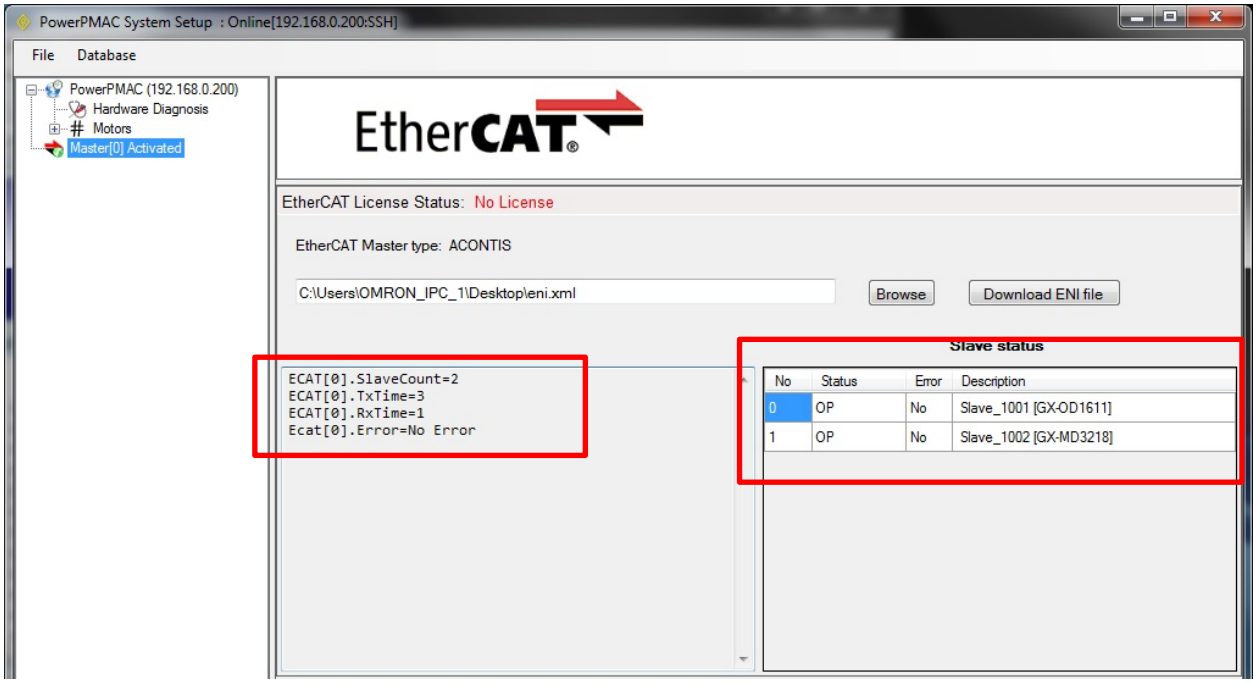
8.2. How to Check for Errors

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.

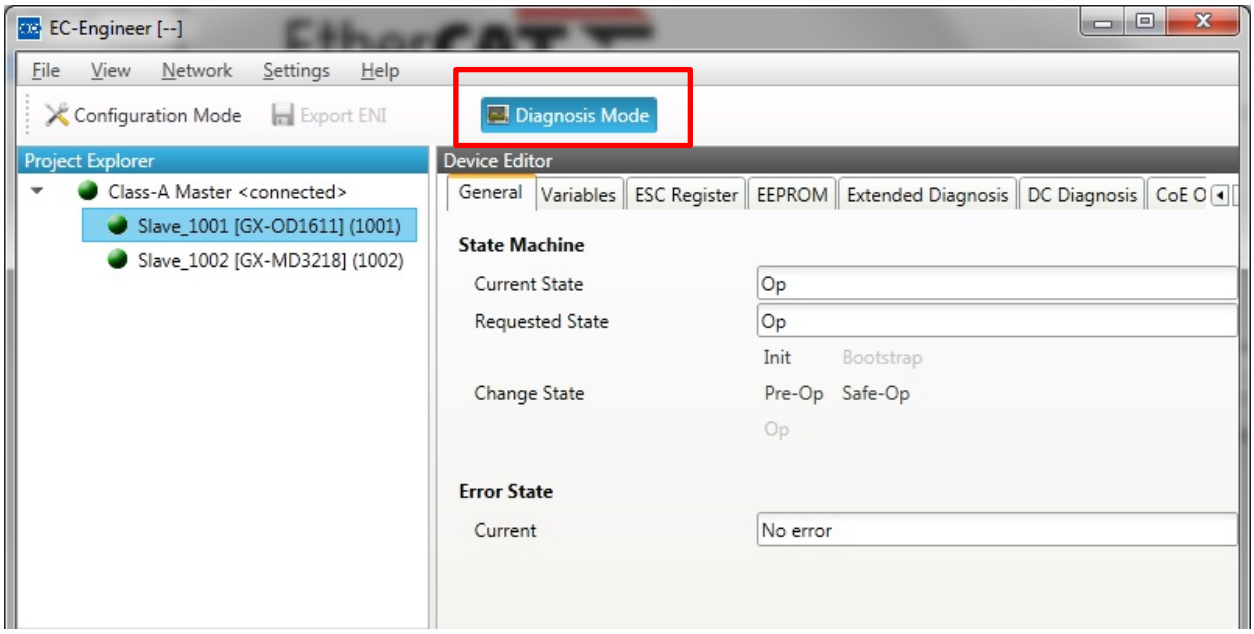
■ **System Setup** of Power PMAC IDE

You can check the status of the EtherCAT master and slaves in the System Setup page of Power PMAC IDE.

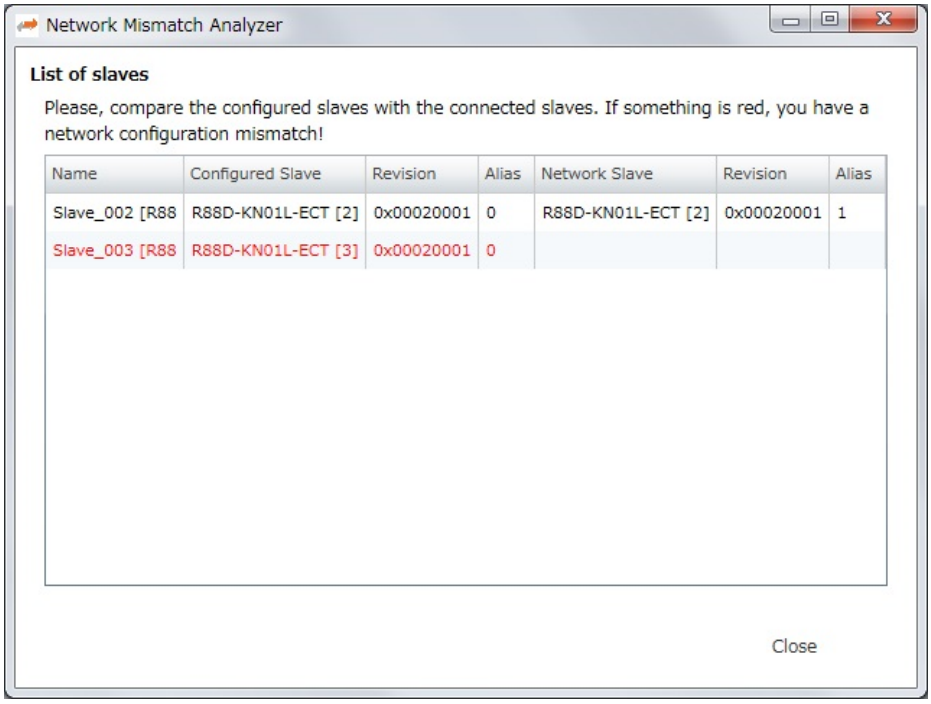


■ **Diagnosis Mode** of Acontis EC-Engineer

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.



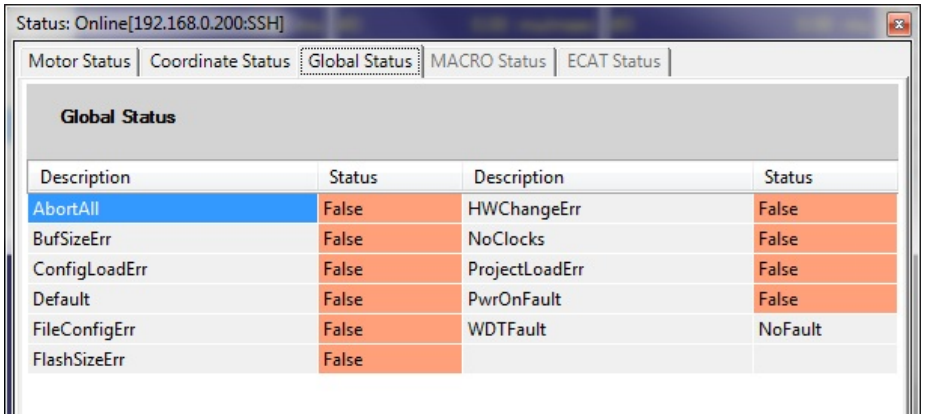
8.2.2. Checking the Controller Status

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.

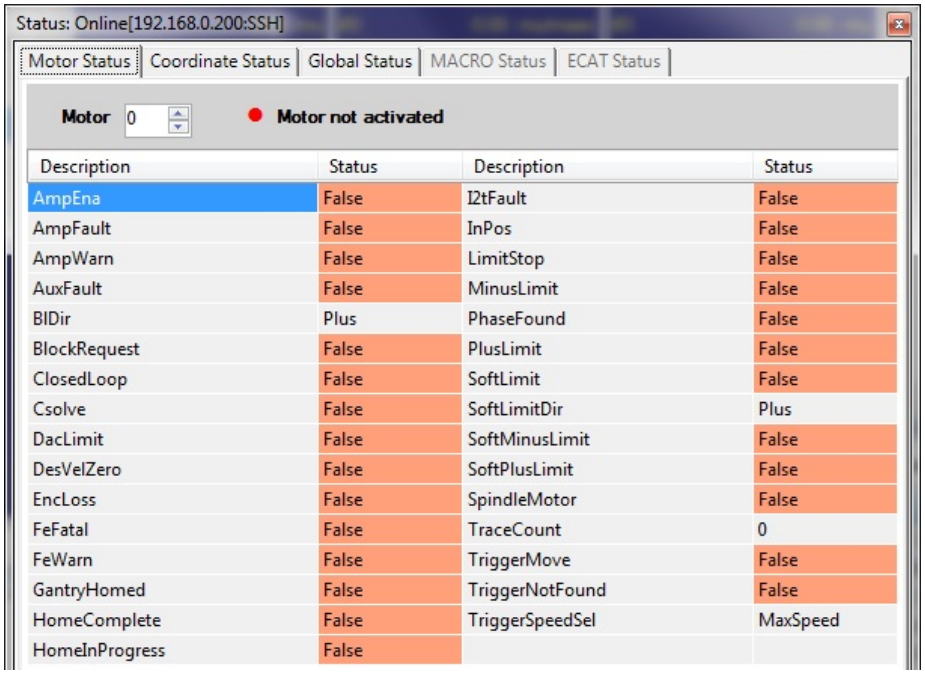
■ Global Status

You can check system errors such as the WDT error.



■ Motor Status

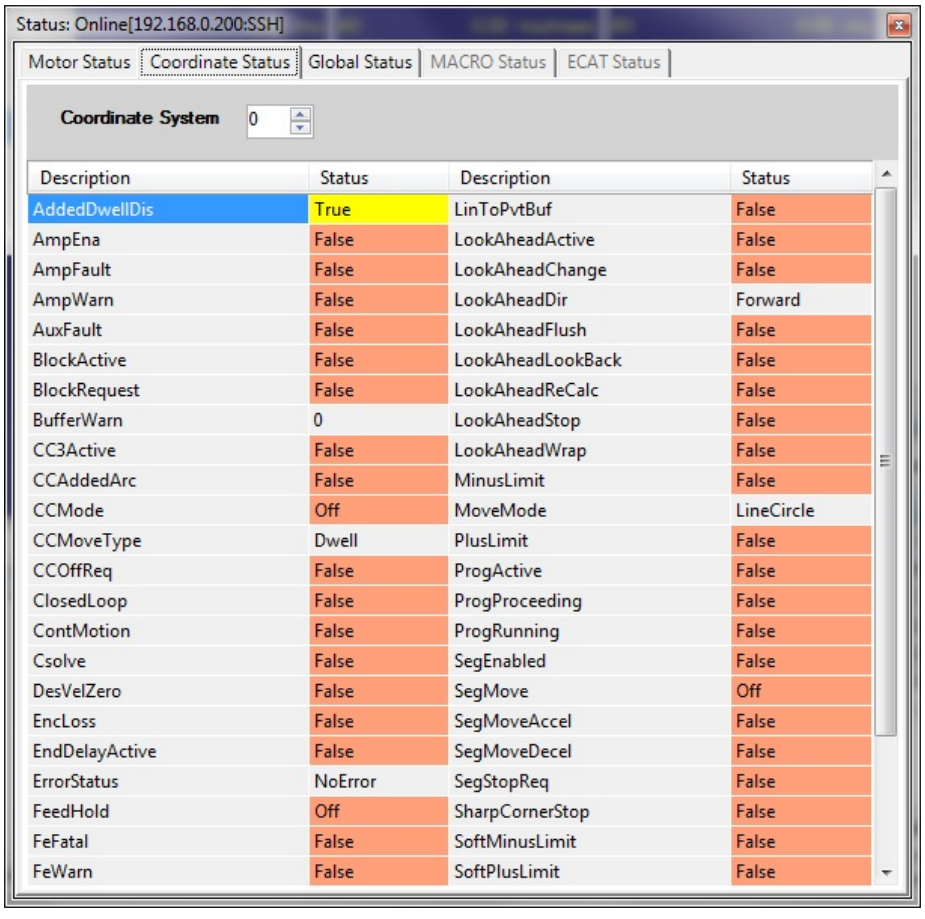
You can check deviation errors, limit errors, and other states of the motor.



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

■ 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	SegMove	Off
EncLoss	False	SegMoveAccel	False
EndDelayActive	False	SegMoveDecel	False
ErrorStatus	NoError	SegStopReq	False
FeedHold	Off	SharpCornerStop	False
FeFatal	False	SoftMinusLimit	False
FeWarn	False	SoftPlusLimit	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	May 18, 2016	First edition

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