OMRON

Programmable Multi-Axis Controller

Startup Guide

for ZW Confocal Fiber Type Displacement Sensor (IDEv4)

CK5M-CPU1□1
CK3M-CPU1□1
CK3E-□□□□

O045-E1-02

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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 Model CK5M-CPU1□1	CK3M-series Programmable Multi-Axis Controller Hardware User's Manual
OMRON	Z362-E1	Model ZW-8000□ Model ZW-7000□ Model ZW-5000□	Confocal Fiber Type Displacement Sensor 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 real time. 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 November 2022.
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 Confocal Fiber Type Displacement Sensor Controller Equipped with EtherCAT model ZW-5000 (hereafter referred to as the Slave) using OMRON Programmable Multi-Axis Controller model CK3E-□□□□ /CK3M-CPU1□1/ CK5M-CPU1□1 (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 Model CK5M-CPU1□1
OMRON	Confocal Fiber Type Displacement Sensor Controller Equipped with EtherCAT	Model ZW-5000

Precautions for Correct Use

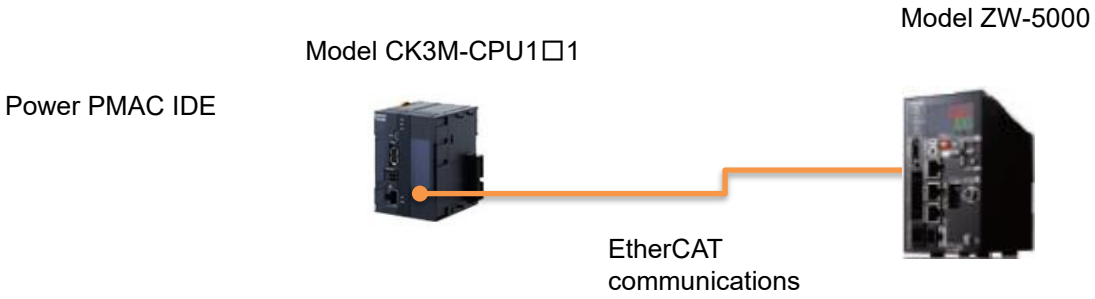
In this document, the devices with models and versions listed in *Section 5.2* are used as examples of applicable devices to describe the procedures to connect the devices and check their connections.
You cannot use devices with versions lower than the versions listed in *Section 5.2*.
To use the devices 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 CK3M-CPU1☐1	Ver.2.7
OMRON	Confocal Fiber Type Displacement Sensor Controller Equipped with EtherCAT	Model ZW-5000	Ver. 1.1
OMRON	Ethernet cable (with industrial Ethernet connector)	Model XS5W-T421-☐M☐-K	
DT	Power PMAC IDE	-	Ver.4.2

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 CK3M-CPU1☐1 as an example. The same procedures can apply to model CK3E-☐☐☐☐/ CK5M-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.

6.2 Preparation for the Controller Setup — Prepare the Controller settings.

▼

6.2.1 Creation of a New Project

▼

6.2.2 Initial Settings of the Controller

▽

6.3 Installation of ESI Files — Install the ESI file for the Slave into PowerPMAC IDE.

▽

6.4 EtherCAT Communications Setup — Set up EtherCAT communications.

▼

6.4.1 Communications Setup for the EtherCAT Master

▼

6.4.2 Distributed Clock Setup

▼

6.4.3 PDO Map Settings

▼

6.4.4 Creation of an EtherCAT Network Configuration File

▽

6.5 Controller Settings — Set up the Controller.

▼

6.5.1 EtherCAT Communications Check

▼

6.5.2 Writing the User Program

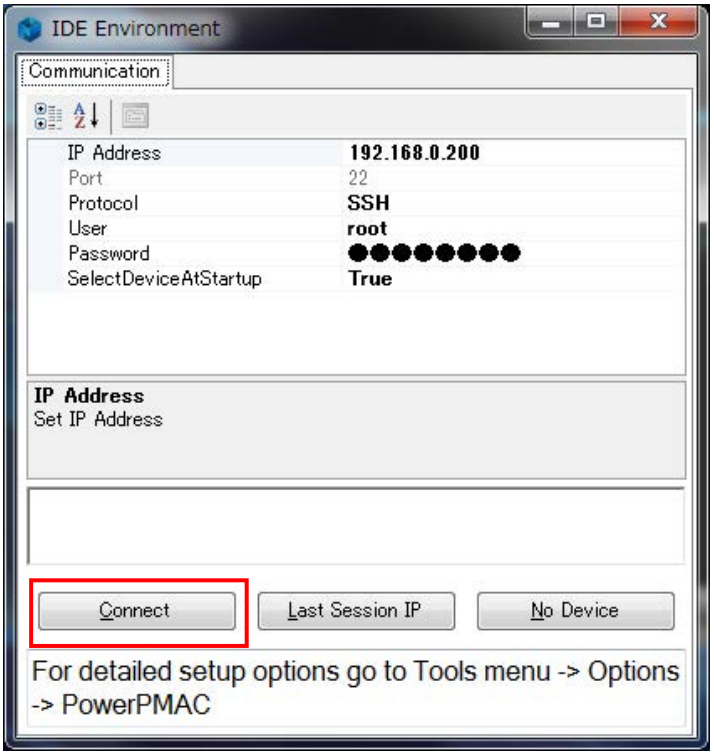
▼

6.5.3 Project Data Transfer

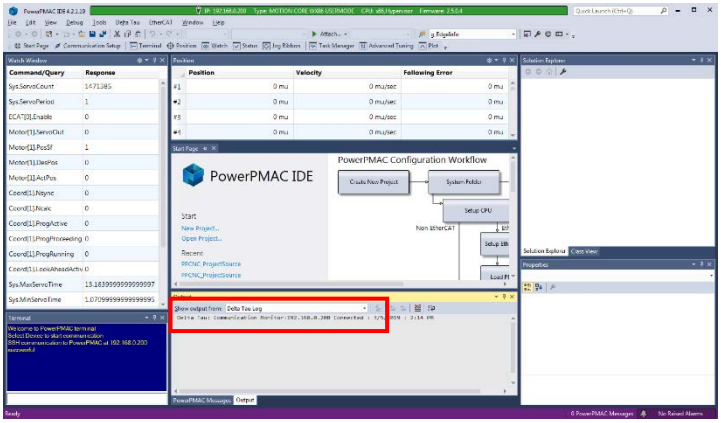
6.2. Preparation for the Controller Setup

Prepare the Controller settings.

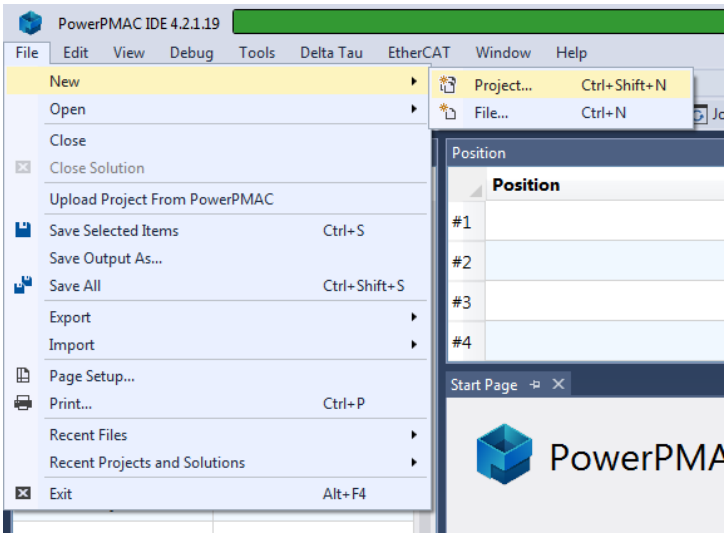
6.2.1. Creation of a New Project

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”.	

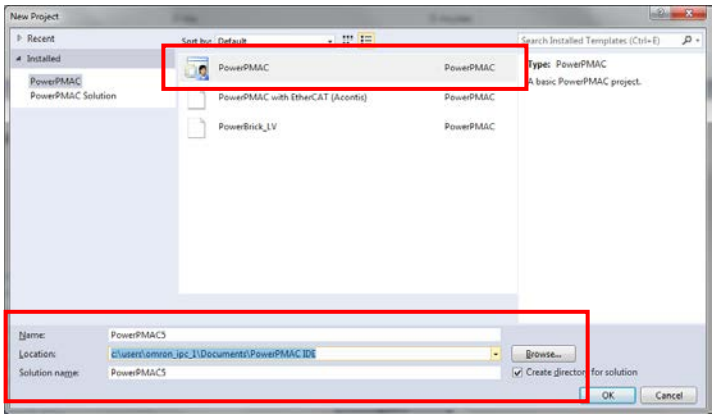
4 Power PMAC IDE starts, and is online to the Controller.



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



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



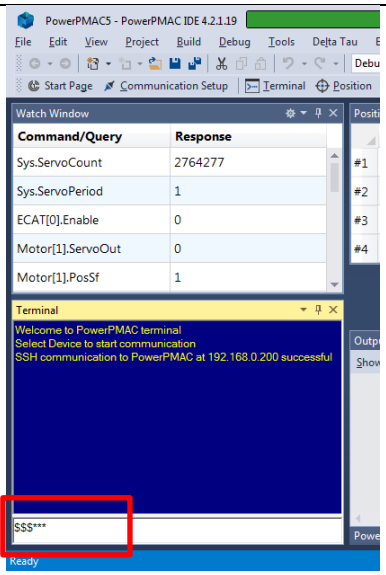
6.2.2. Initial Settings of the Controller

Configure the initial settings for the Controller.

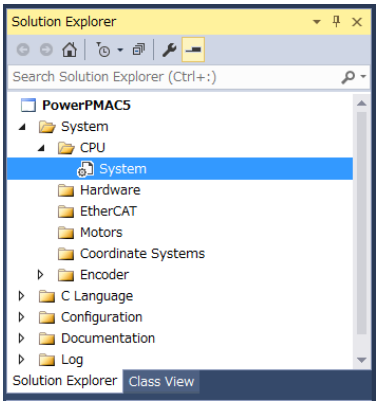
Precautions for Correct Use

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

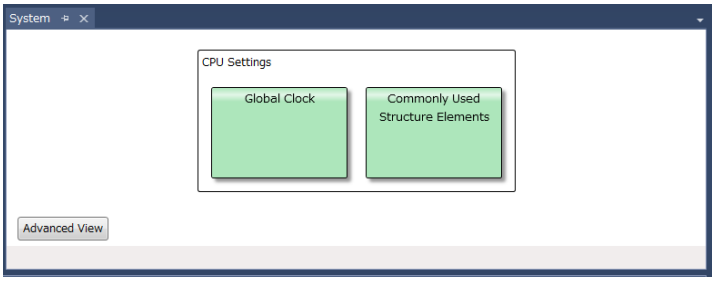
1 In the Terminal tab page, type the $$$*** command to reset the Controller to factory default.



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

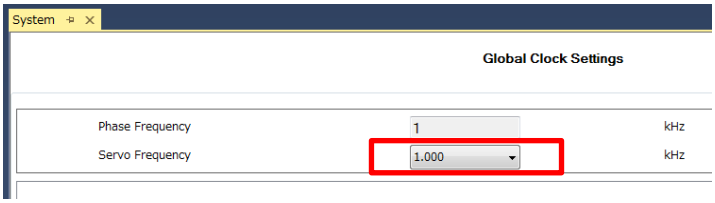


3 Select **Global Clock**.

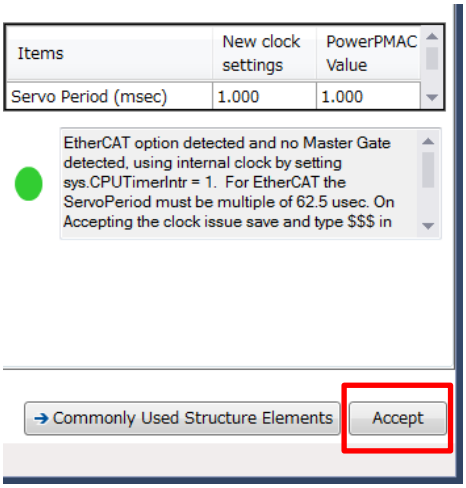


4 Specify **Servo Frequency**.

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

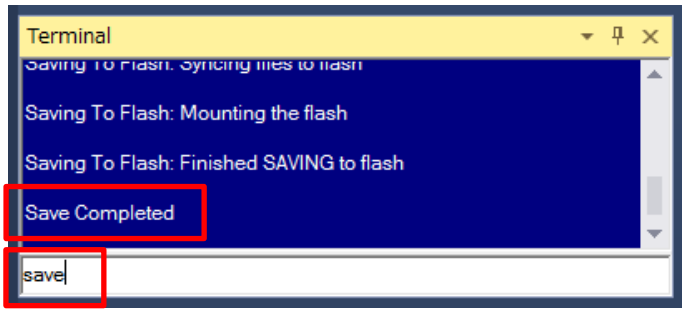


5 Click the **Accept** button.

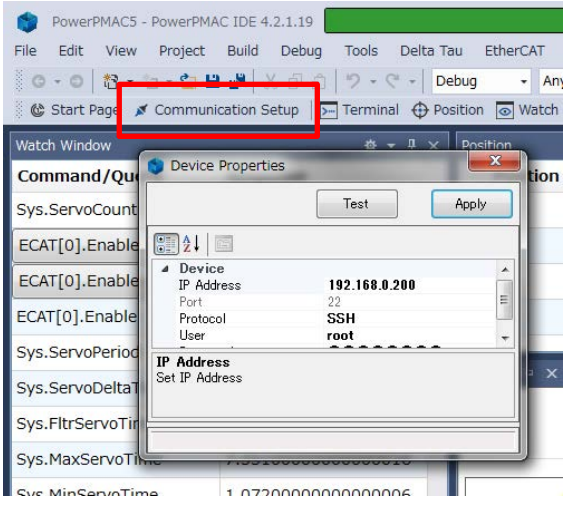


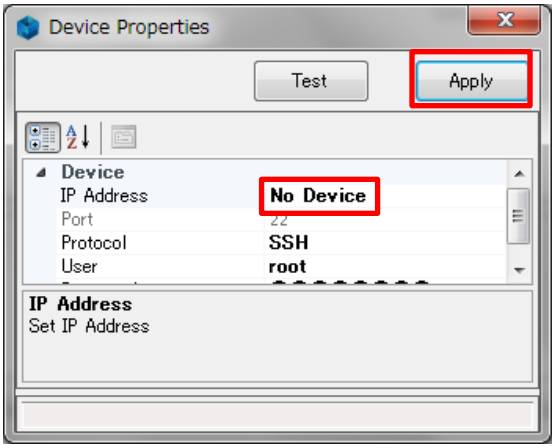
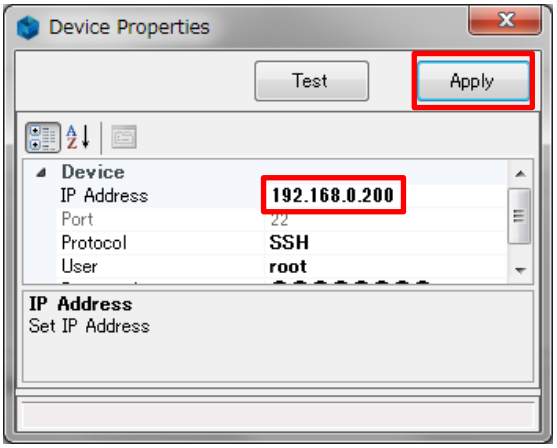
6 If you have changed the servo frequency setting, type the SAVE command in the Terminal tab page of Power PMAC IDE.

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.	

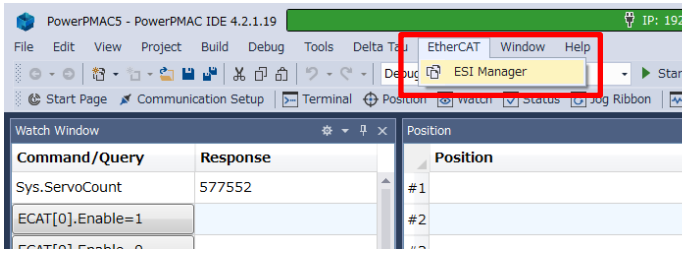
6.3. Installation of ESI Files

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

Precautions for Correct Use

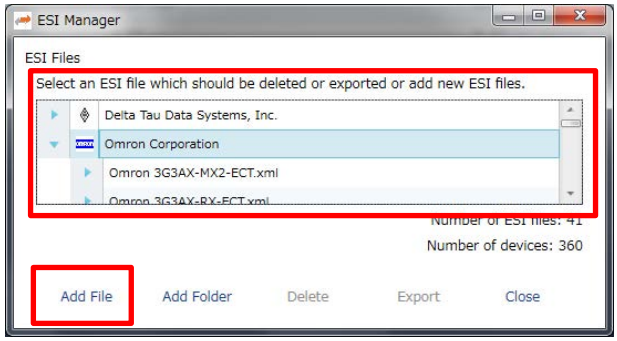
Prepare the ESI file described in this section in advance. Contact your OMRON representative for information on how to procure the ESI file.

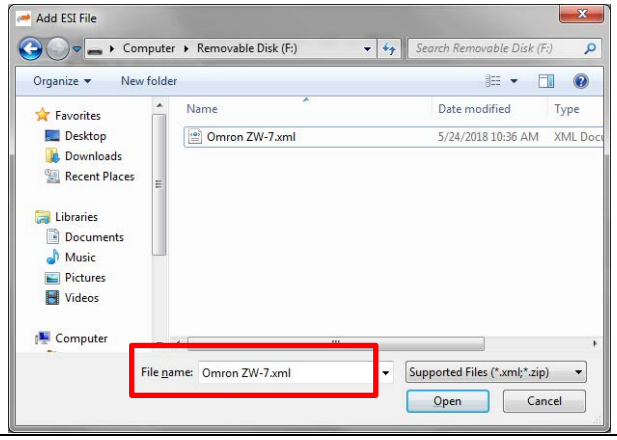
1 From the **EtherCAT** menu of Power PMAC IDE, select **ESI Manager**.



2 Confirm that *Omron ZW-7.xml* is registered in the ESI file list of ESI Manager.

If it is not yet registered, click **Add File** and register *Omron ZW-7.xml*.





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

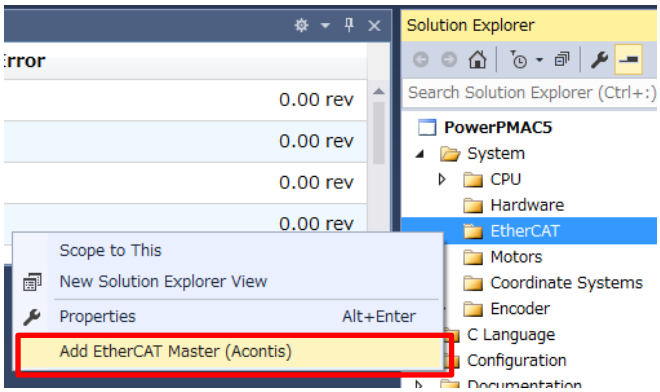
6.4. EtherCAT Communications Setup

Set up EtherCAT communications.

Precautions for Correct Use

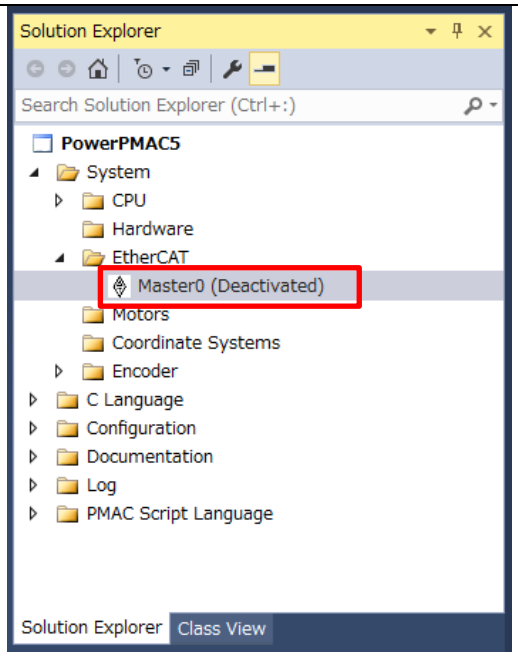
Before taking the following steps, make sure that the devices are connected via an Ethernet cable. If they are not connected, turn OFF the power to the devices, and connect the Ethernet cable.

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

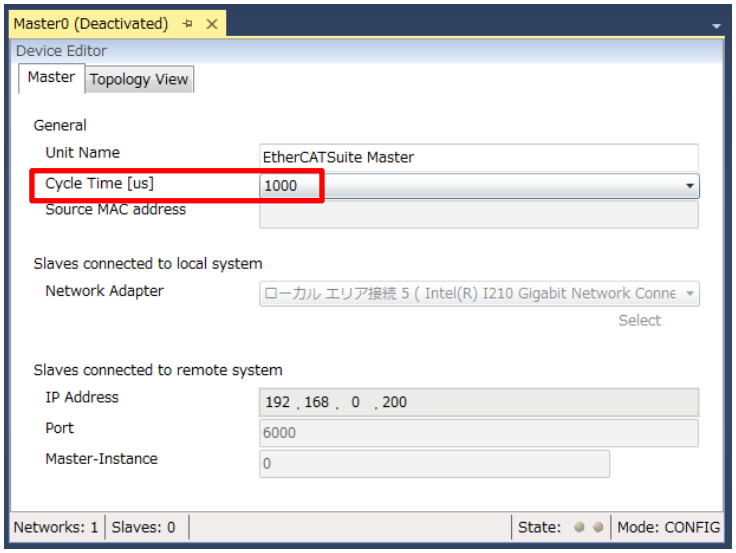
Class-A Master is added to the Project Explorer.



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.



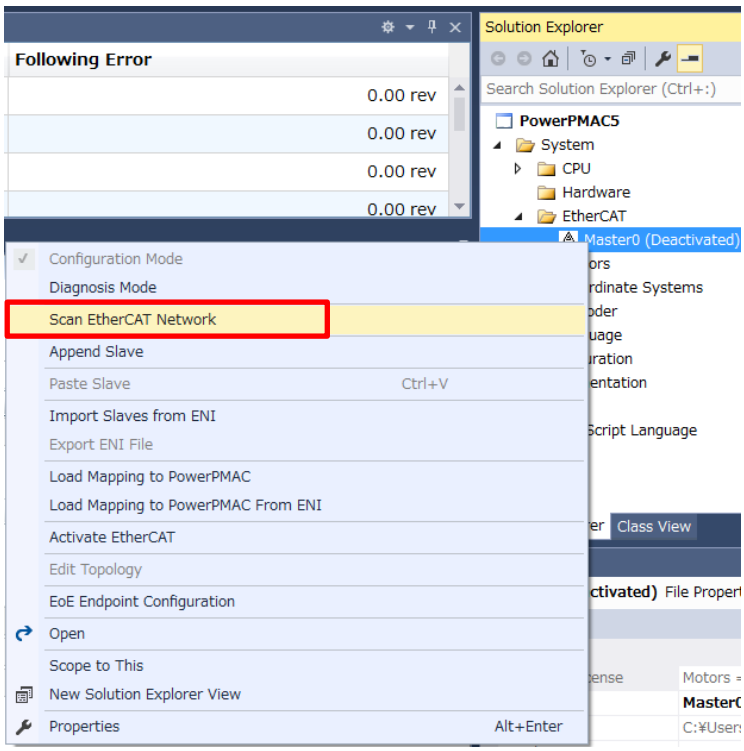
Correspondence between the servo frequencies of the Controller and communication periods is as follows:

4 kHz : 250 us

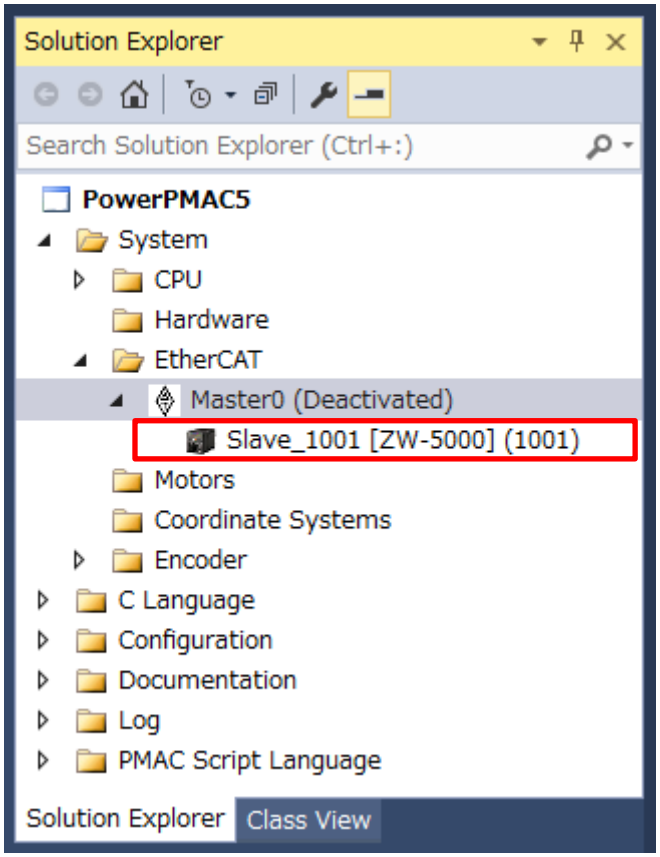
2 kHz : 500 us

1 kHz : 1000 us

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



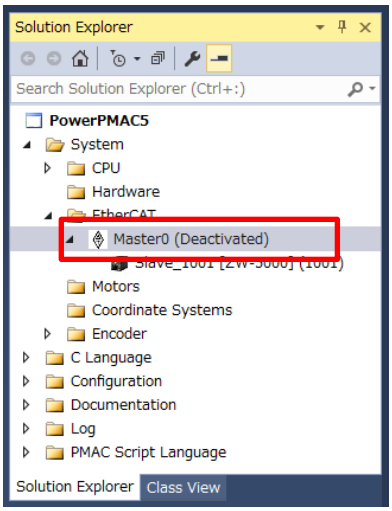
6 Make sure that the slave is displayed in the Solution Explorer.

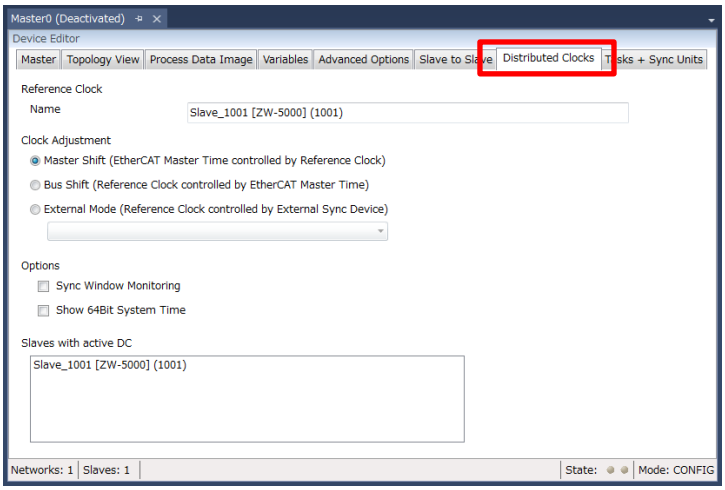


6.4.2. Distributed Clock Setup

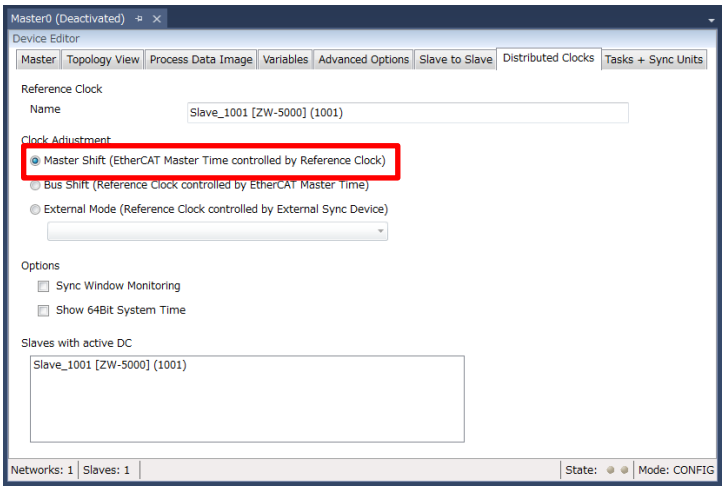
1 Setting Distributed Clocks (DC) for Master

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



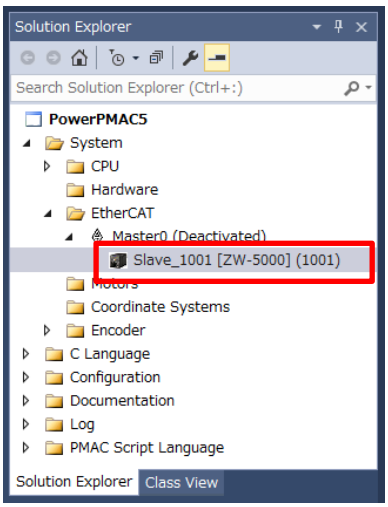


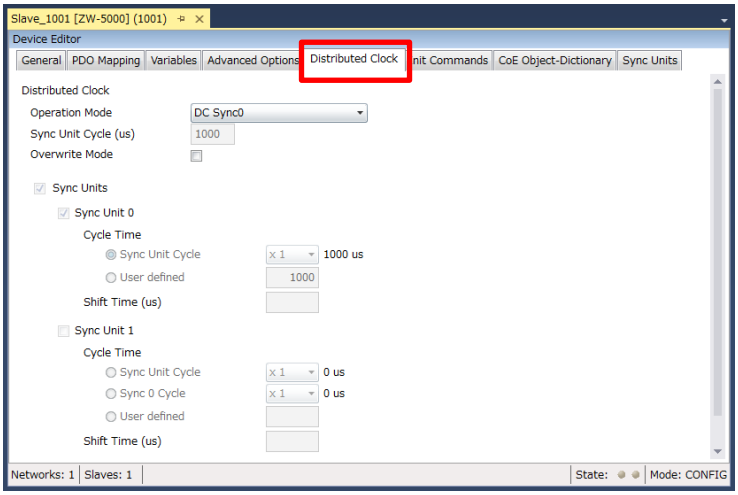
2 Select **Master Shift (EtherCAT Master Time controlled by Reference Clock)**.



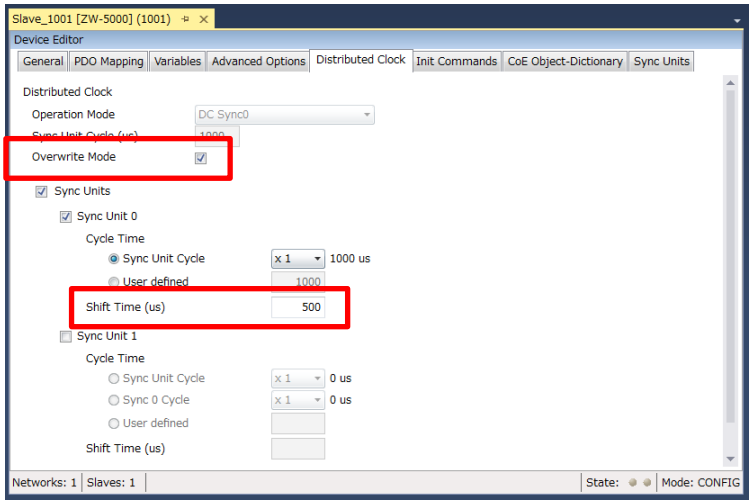
3 Setting Distributed Clock (DC) for the Slave

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





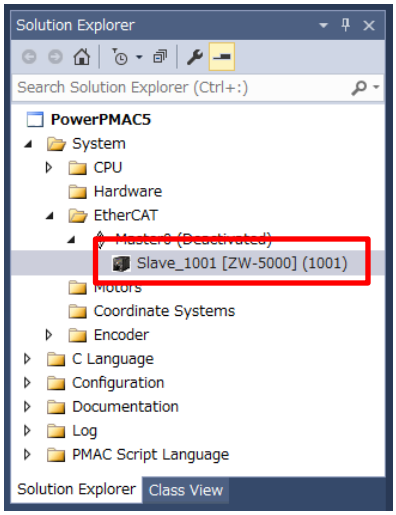
4 Select the **Overwrite Mode** check box and specify **Shift Time**.

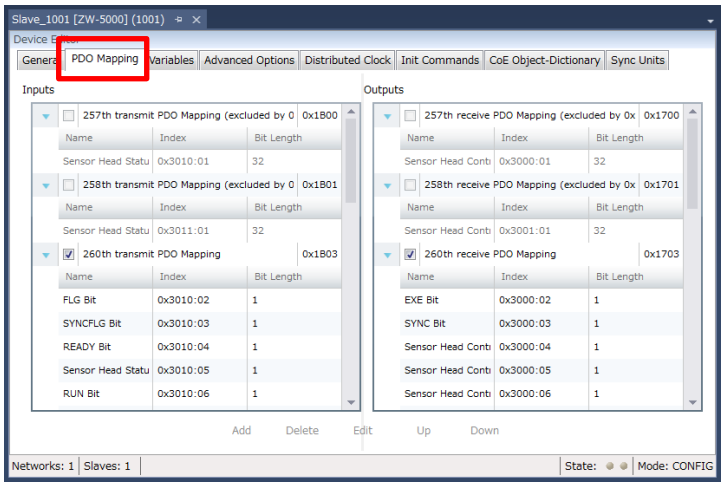


Correspondence between the servo frequencies of the Controller and **Shift Time** values is as follows:
4 kHz : 125 us
2 kHz : 250 us
1 kHz : 500 us

6.4.3. PDO Map Settings

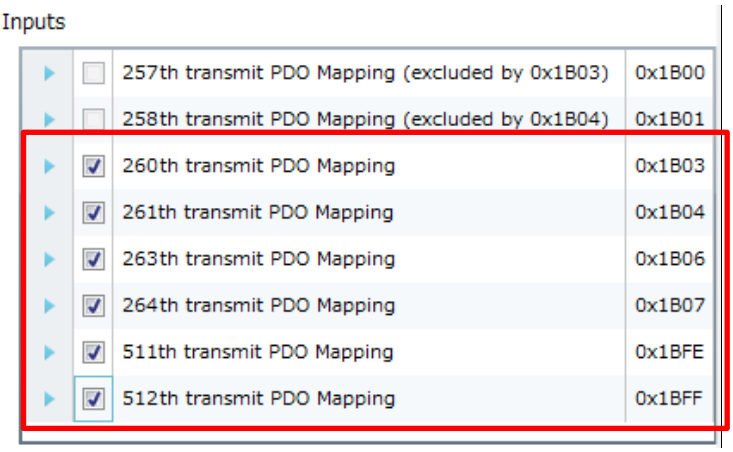
1 In the Solution Explorer, select the target slave to display the PDO Mapping tab page.

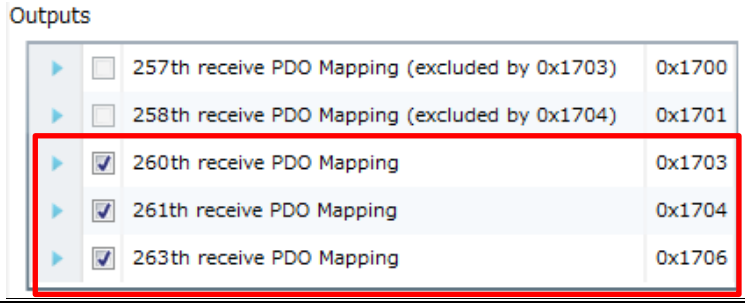




2 Check the Inputs field to make sure that the check boxes are selected as follows

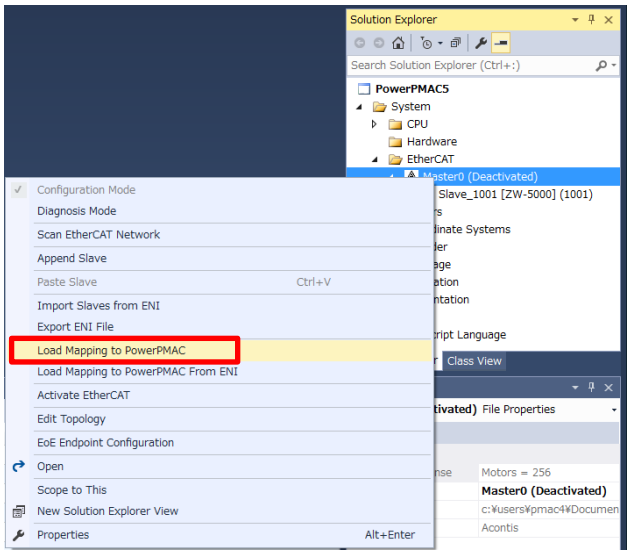
* If you want to use other data, clear the currently displayed check boxes and select other desired check boxes.



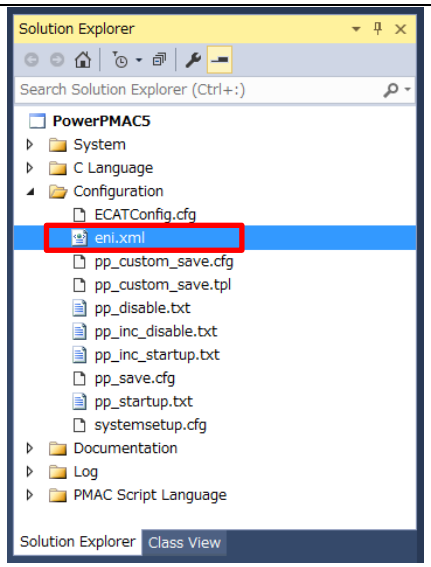
3	Check the Outputs field to make sure that the check boxes are selected as follows. * If you want to use other data, clear the currently displayed check boxes and select other desired check boxes.	

6.4.4. Creation of an EtherCAT Network Configuration File

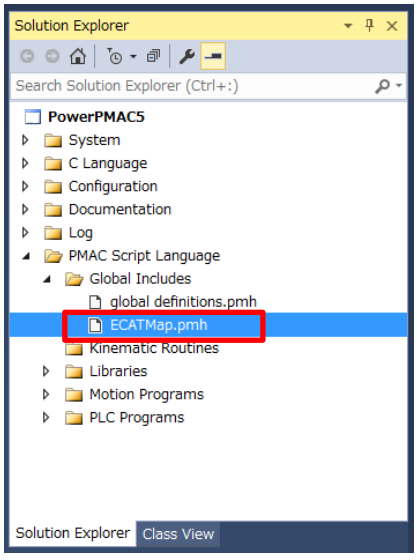
1 Select **System** – **EtherCAT** in the Solution Explorer and right-click on **Master0 (Deactivated)**, then select **Load Mapping to PowerPMAC**.



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.

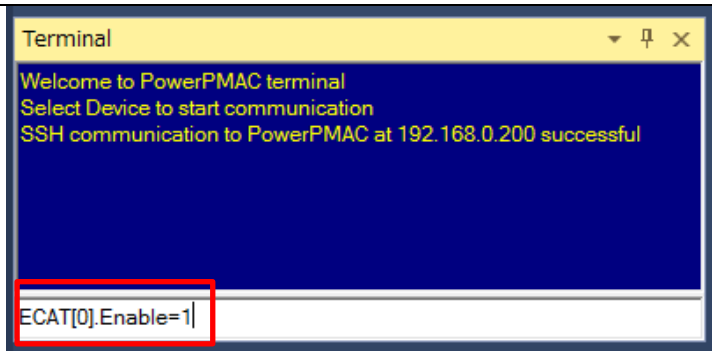


6.5. Controller Settings

6.5.1. EtherCAT Communications Check

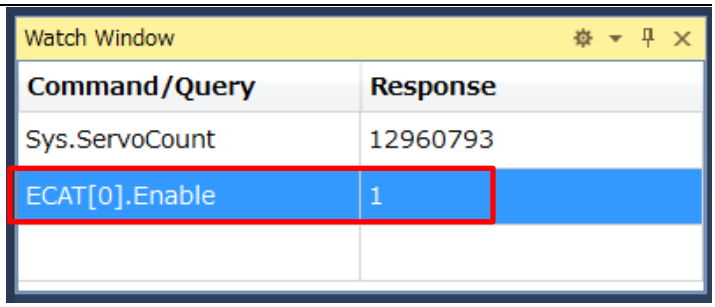
Take the following steps to ensure that EtherCAT communications are available.

1 From the Terminal tab page, run the ECAT[0].Enable=1 command to start EtherCAT communications.

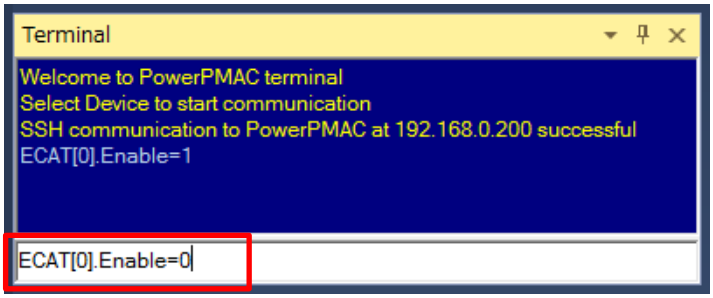


2 In the Terminal tab page or Watch Window, make sure that the ECAT[0].Enable value turns to *1*.

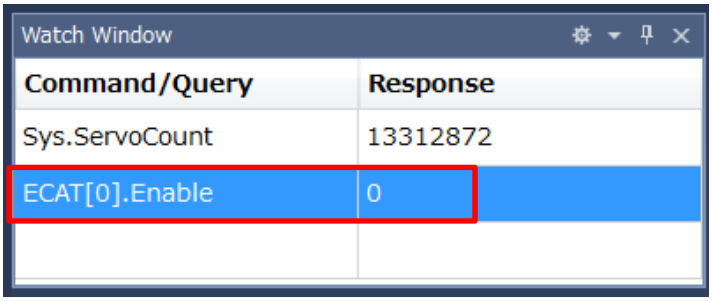
* The OP mode is entered and EtherCAT communications are established.



3 After making sure that correct communications are available, run the ECAT[0].Enable=0 command from the Terminal tab page to stop EtherCAT communications.



4 In the Terminal tab page or Watch Window, make sure that the ECAT[0].Enable value turns to *0*.

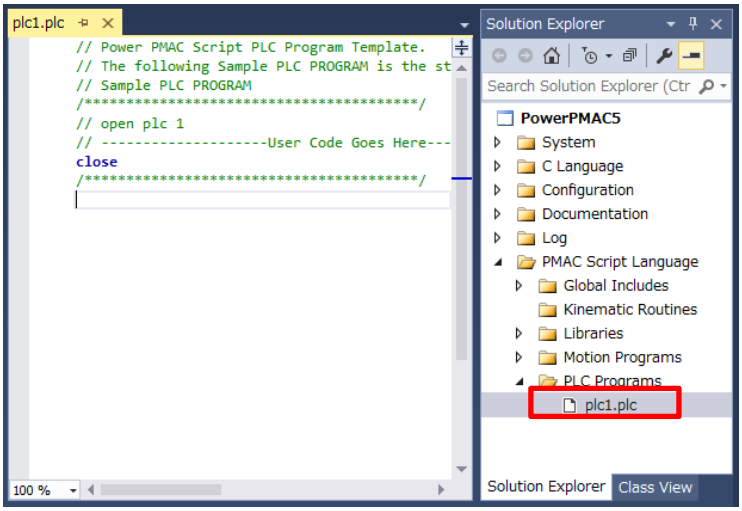


6.5.2. Writing the User Program

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.

1 In the Solution Explorer pane, open **Project name** – **PMAC Script Language** – **PLC Programs** – **plc1.plc**.

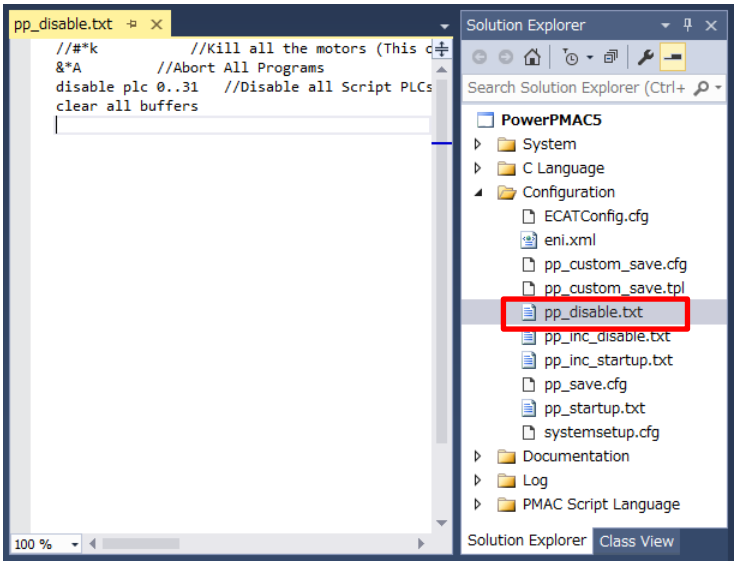


2 In the programming area of the plc1.plc tab page, write a program as shown on the right.

This sample program repeats the process of sending the command after one second, turning OFF the transmission bit after one second, sending the command after one second, then turning OFF the transmission bit after one 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_3003_0_Command = $00404000;
    Slave_0_3004_1_CommandParameter1 = 900;
    Slave_0_3000_2_EXEBit = 1;


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

    Slave_0_3000_2_EXEBit = 0;

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

    Slave_0_3003_0_Command = $00404000;
    Slave_0_3004_1_CommandParameter1 = 901;
    Slave_0_3000_2_EXEBit = 1;

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

    Slave_0_3000_2_EXEBit = 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;

6.5.3. 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.

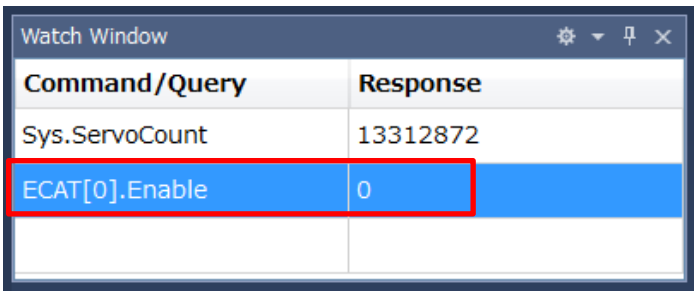
⚠ Caution

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.

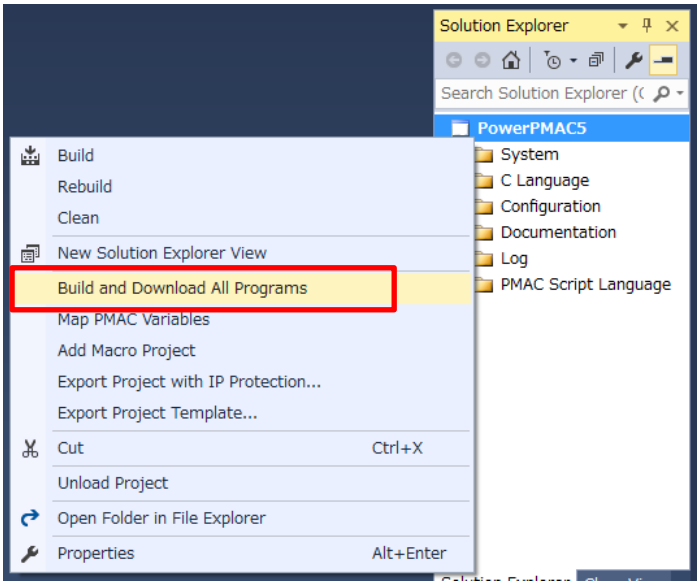


2

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.

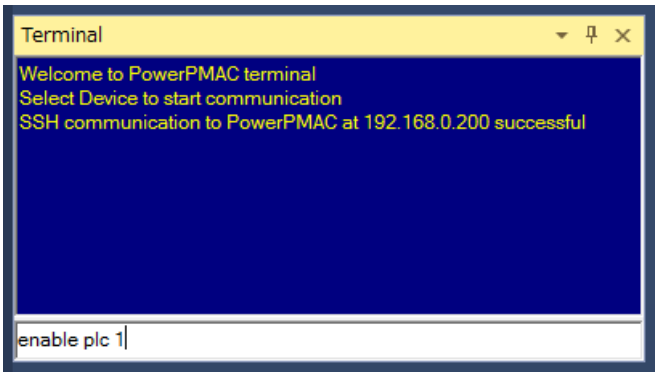
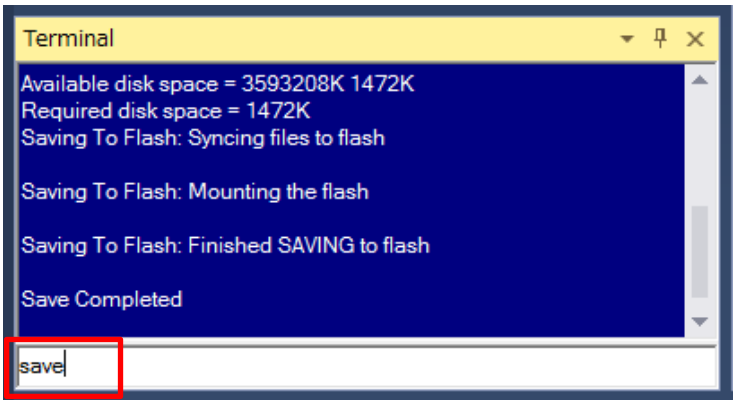
* The transferred project is not yet saved to the Controller at this stage.
If you turn OFF the power to the Controller, the transferred project will be discarded.



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 6.4 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 command is sent. * If the command is not sent, 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	
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.	

7. Appendix Saving and Loading a Project

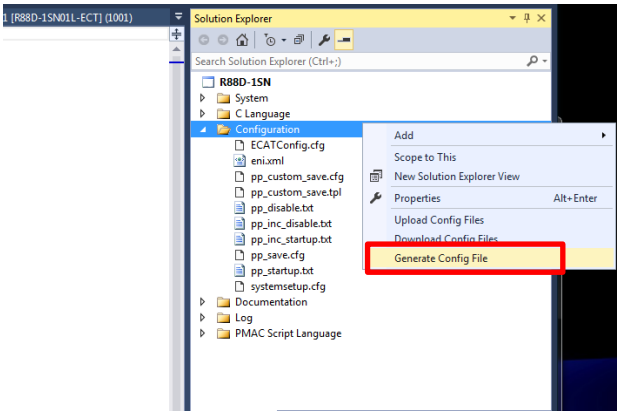
The following describes the procedures to save a Power PMAC IDE project on the computer, and to reuse it.

7.1. Saving a Project

1 Creating a Configuration File

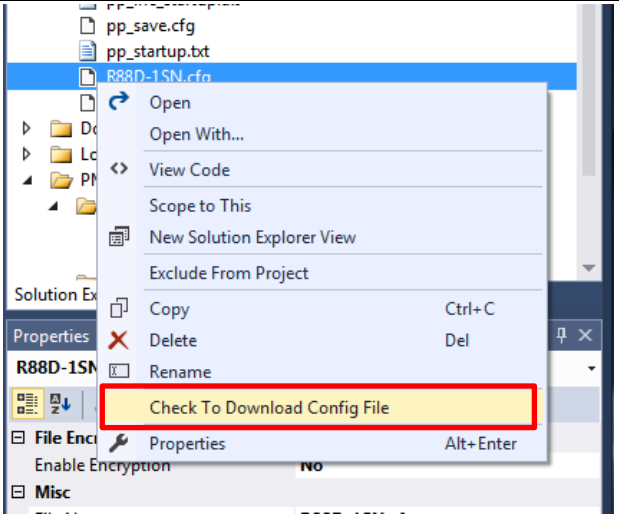
Create a Configuration File to save parameters you have changed.

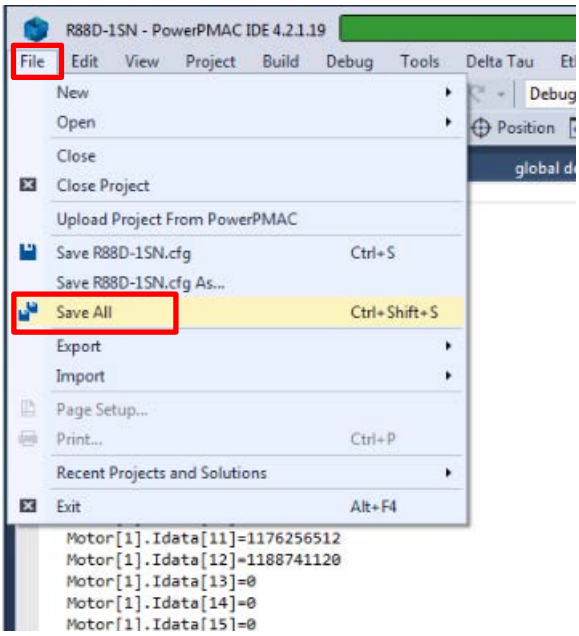
Right-click **Configuration** in the Solution Explorer pane, and select **Generate Config File**.
A Configuration File is added to **Configuration**.



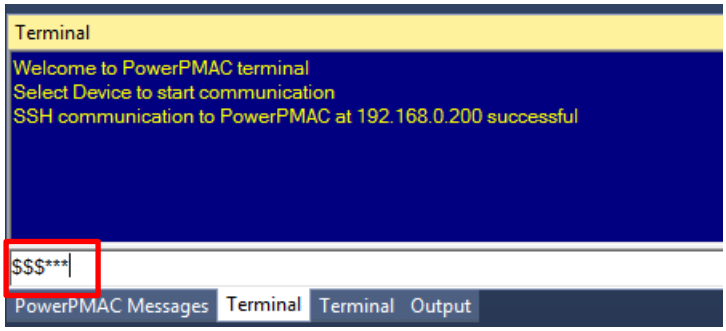
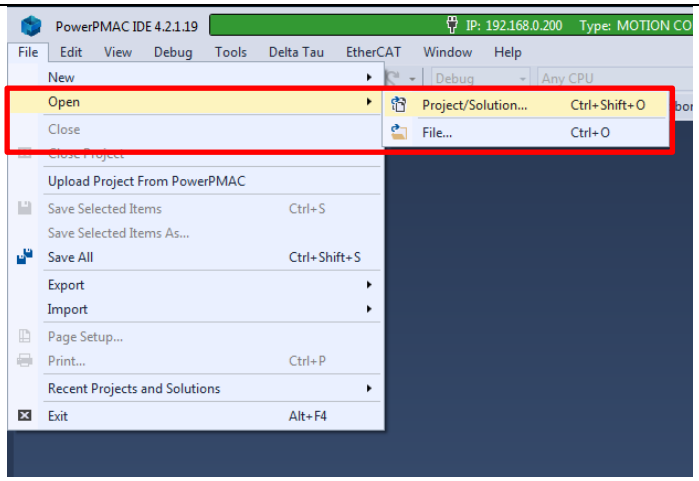
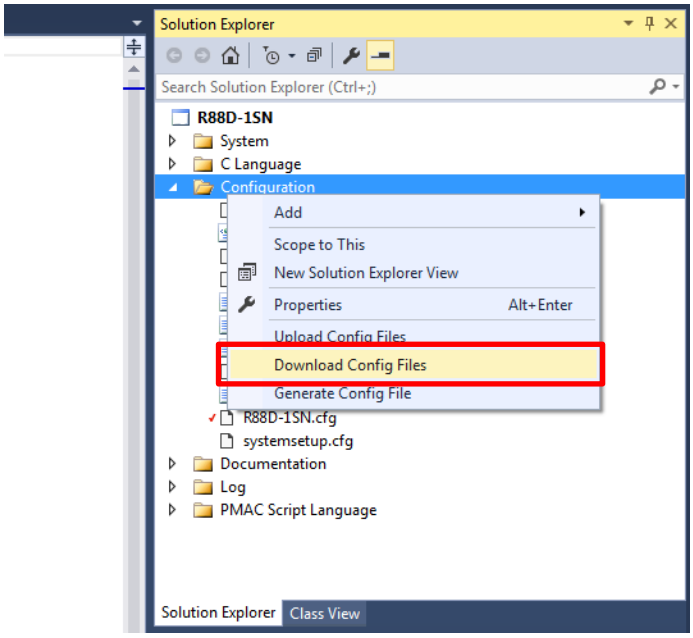
2 Enter a file name in the textbox, then click the OK button.

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.



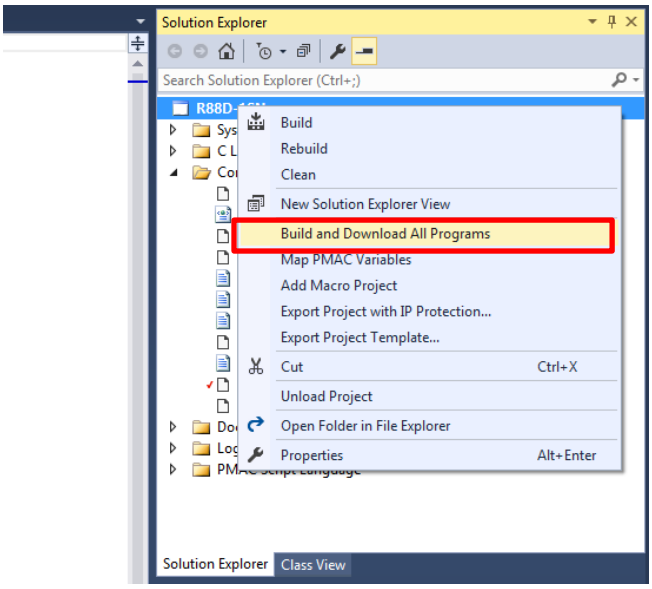
3	Saving a Project In the **File** menu, run **Save All** to save the project on the computer.	

7.2. Loading and Downloading a Project

1	Start Power PMAC IDE, and connect to the Controller.	
2	In the Terminal 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.	
4	Right-click **Configuration** in the Solution Explorer pane, and select **Download Config Files** to download the file to the Controller.	

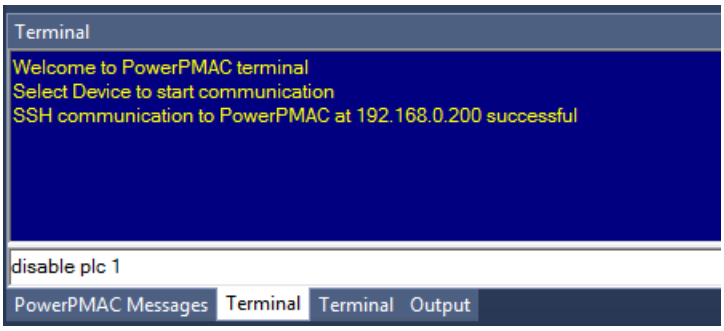
5 Right-click the project name in the Solution Explorer, and select **Build and Download All Programs** to run the build and download.

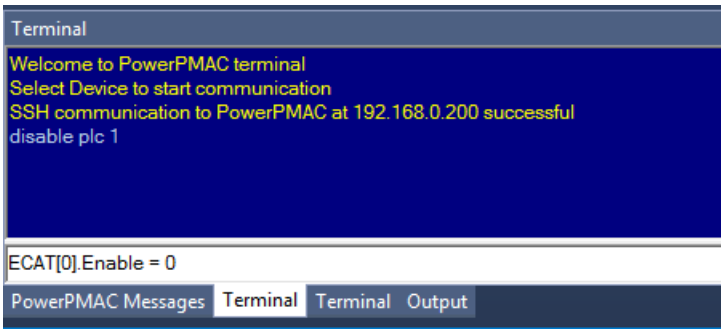
When the download process is complete, make sure that there are no errors in the Output Window.

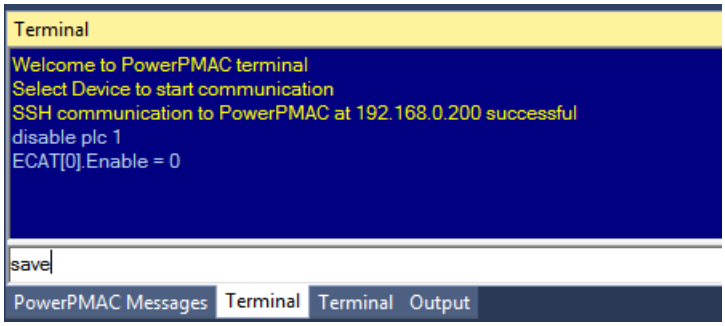
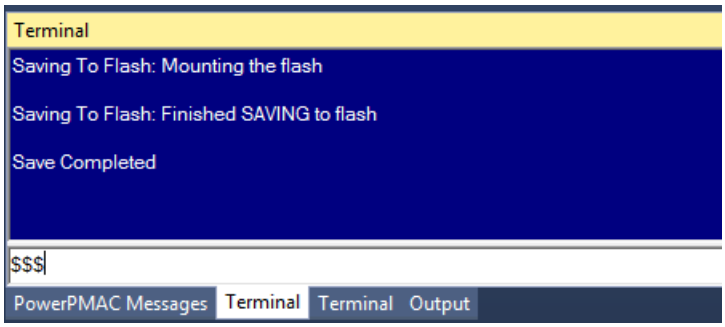


6 Stopping a program

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.	
8	Restarting after download Run the following command from the Terminal tab page to restart the Controller with the downloaded project. $$$	

8. Appendix Troubleshooting

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

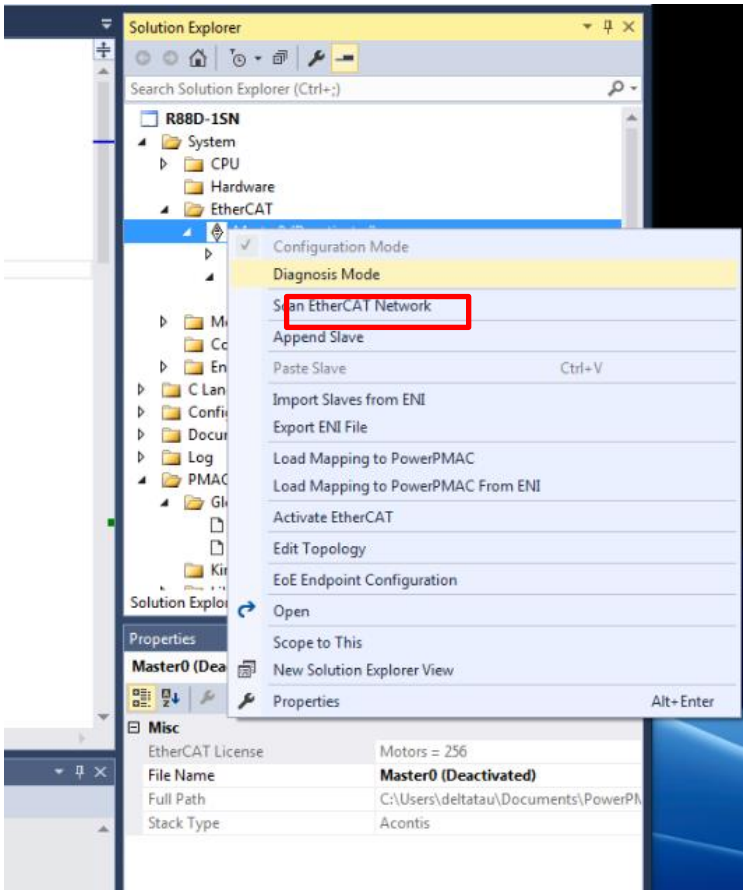
Description	Factor	Corrective Action
The link is not established.	The Ethernet cable is broken or the specified cable is not being used.	If the Ethernet cable is broken or if the specified cable was not used, replace the cable.
	A connector on the Ethernet cable used for EtherCAT communications is disconnected, 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

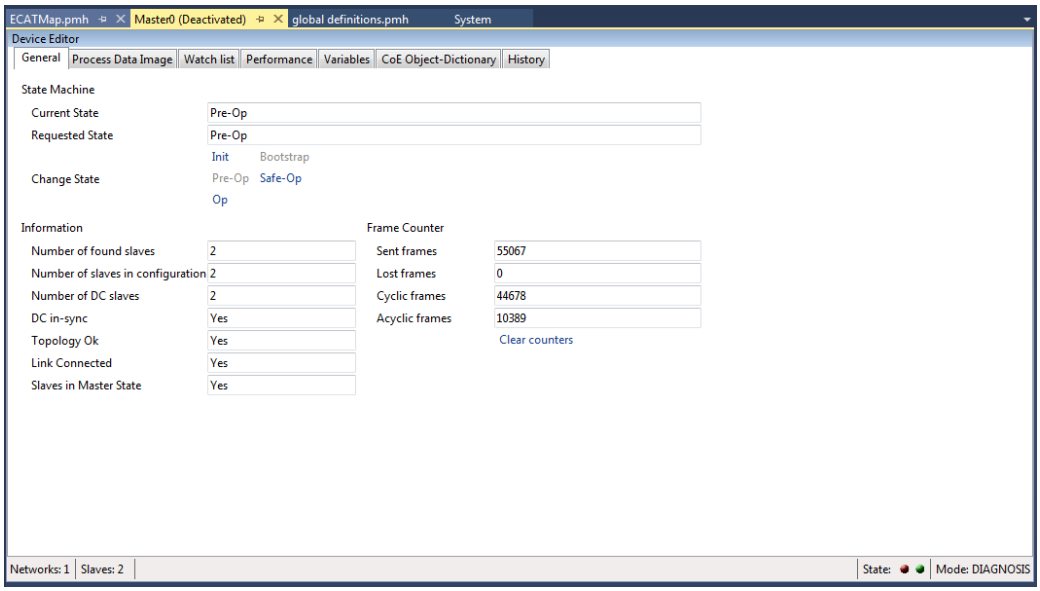
8.2.1. Checking the EtherCAT Status

You can check the EtherCAT status from **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.



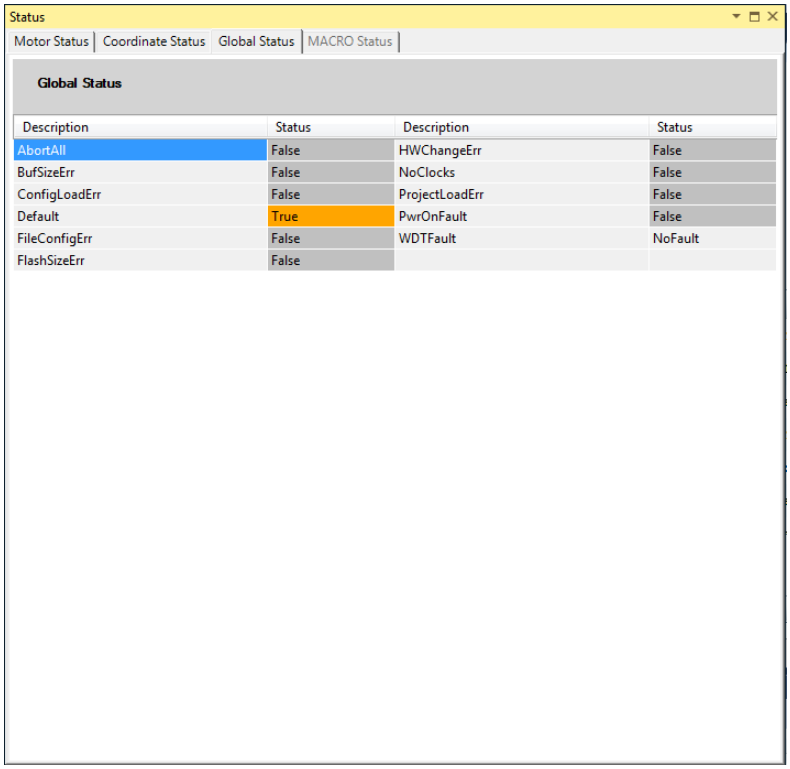
8.2.2. Checking the Controller Status

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.

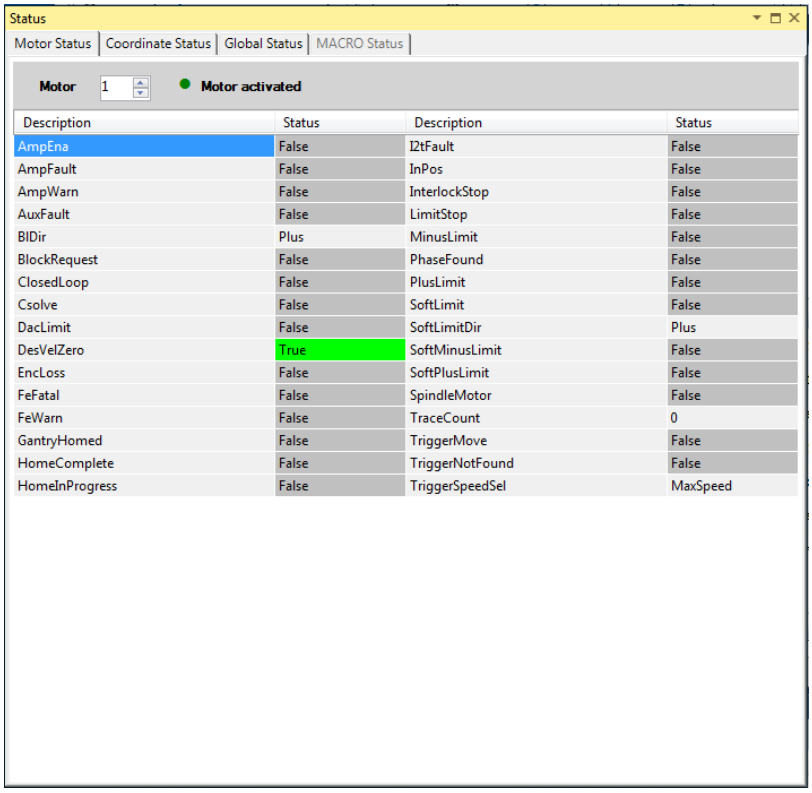
■ Global Status

You can check system errors such as the WDT error.



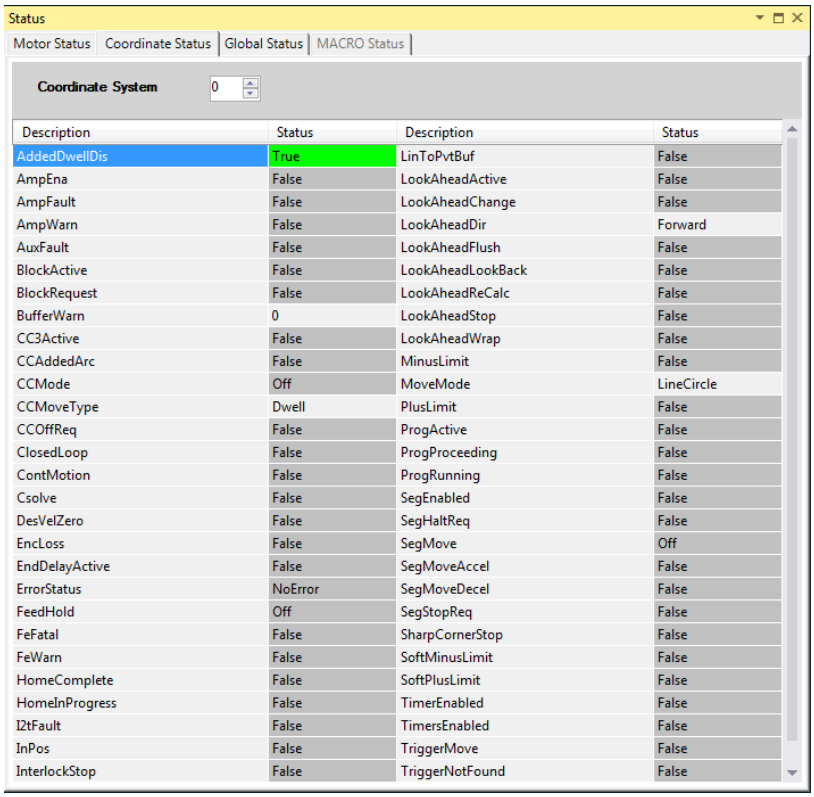
■ Motor Status

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



■ Coordinate Status

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



9. Appendix ECAT[i] Structure Elements

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

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

10. Revision History

Revision code	Revised date	Revised content
01	Apr, 2019	First edition
02	Jan, 2023	・Made changes accompanying the addition of CK5M-CPU1 ☐1 Unit.

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