OMRON

Machine Automation Controller NJ-series

Startup Guide for Simulink® PLC Coder™ & Sysmac Studio

SYSMAC-SE20□□

NJ501-□□□□

NJ301-□□□□

R88D-KN□-ECT

GX-AD0471/DA0271

SYSMAC always in control

W529-E1-01

Introduction

The *NJ-series Startup Guide for Simulink® PLC Coder™ and Sysmac Studio* (hereinafter, may be referred to as “this Guide”) describes the startup procedures that are required to use a combination of Simulink® PLC Coder™ from The MathWorks® Inc. and NJ-series CPU Unit for the first time and the basic operating instructions for the Sysmac Studio. A simple single-axis positioning example is used for the discussion. You can perform the procedures that are presented in this Guide to quickly gain a basic understanding of the combination of Simulink® PLC Coder™ and NJ-series CPU Unit.

This Guide does not contain safety information and other details that are required for actual use. Thoroughly read and understand the manuals for all of the devices that are used in this Guide to ensure that the system is used safely. Review the entire contents of these materials, including all safety precautions, precautions for safe use, and precautions for correct use.

Intended Audience

This guide is intended for the following personnel.

- Personnel in charge of introducing FA systems
- Personnel in charge of designing FA systems

The personnel must also have the following knowledge.

- Knowledge of electrical systems (an electrical engineer or the equivalent)
- Knowledge of MATLAB®/Simulink® from The MathWorks® Inc.
- Knowledge of NJ-series CPU Units
- Knowledge of operation procedure of Sysmac Studio

Applicable Products

This guide covers the following products.

- CPU Units of NJ-series Machine Automation Controllers
- Sysmac Studio Automation Software
- MATLAB®/Simulink® from The MathWorks® Inc.
- Simulink® PLC Coder™ from The MathWorks® Inc.

Special Information

The icons that are used in this Guide are described below.

Precautions for Correct Use

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

Additional Information

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

Terms and Conditions Agreement

Read and understand this catalog.

Please read and understand this catalog before purchasing the products. Please consult your OMRON representative if you have any questions or comments.

Warranties.

(a) Exclusive Warranty. Omron's exclusive warranty is that the Products will be free from defects in materials and workmanship for a period of twelve months from the date of sale by Omron (or such other period expressed in writing by Omron). Omron disclaims all other warranties, express or implied.

(b) Limitations. OMRON MAKES NO WARRANTY OR REPRESENTATION, EXPRESS OR IMPLIED, ABOUT NON-INFRINGEMENT, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OF THE PRODUCTS. BUYER ACKNOWLEDGES THAT IT ALONE HAS DETERMINED THAT THE PRODUCTS WILL SUITABLY MEET THE REQUIREMENTS OF THEIR INTENDED USE. Omron further disclaims all warranties and responsibility of any type for claims or expenses based on infringement by the Products or otherwise of any intellectual property right.

(c) Buyer Remedy. Omron's sole obligation hereunder shall be, at Omron's election, to (i) replace (in the form originally shipped with Buyer responsible for labor charges for removal or replacement thereof) the non-complying Product, (ii) repair the non-complying Product, or (iii) repay or credit Buyer an amount equal to the purchase price of the non-complying Product; provided that in no event shall Omron be responsible for warranty, repair, indemnity or any other claims or expenses regarding the Products unless Omron's analysis confirms that the Products were properly handled, stored, installed and maintained and not subject to contamination, abuse, misuse or inappropriate modification. Return of any Products by Buyer must be approved in writing by Omron before shipment. Omron Companies shall not be liable for the suitability or unsuitability or the results from the use of Products in combination with any electrical or electronic components, circuits, system assemblies or any other materials or substances or environments. Any advice, recommendations or information given orally or in writing, are not to be construed as an amendment or addition to the above warranty.

See http://www.omron.com/global/ or contact your Omron representative for published information.

Limitation on Liability; Etc.

OMRON COMPANIES SHALL NOT BE LIABLE FOR SPECIAL, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, LOSS OF PROFITS OR PRODUCTION OR COMMERCIAL LOSS IN ANY WAY CONNECTED WITH THE PRODUCTS, WHETHER SUCH CLAIM IS BASED IN CONTRACT, WARRANTY, NEGLIGENCE OR STRICT LIABILITY.

Further, in no event shall liability of Omron Companies exceed the individual price of the Product on which liability is asserted.

Suitability of Use.

Omron Companies shall not be responsible for conformity with any standards, codes or regulations which apply to the combination of the Product in the Buyer's application or use of the Product. At Buyer's request, Omron will provide applicable third party certification documents identifying ratings

and limitations of use which apply to the Product. This information by itself is not sufficient for a complete determination of the suitability of the Product in combination with the end product, machine, system, or other application or use. Buyer shall be solely responsible for determining appropriateness of the particular Product with respect to Buyer's application, product or system. Buyer shall take application responsibility in all cases.

NEVER USE THE PRODUCT FOR AN APPLICATION INVOLVING SERIOUS RISK TO LIFE OR PROPERTY OR IN LARGE QUANTITIES WITHOUT ENSURING THAT THE SYSTEM AS A WHOLE HAS BEEN DESIGNED TO ADDRESS THE RISKS, AND THAT THE OMRON PRODUCT(S) IS PROPERLY RATED AND INSTALLED FOR THE INTENDED USE WITHIN THE OVERALL EQUIPMENT OR SYSTEM.

Programmable Products.

Omron Companies shall not be responsible for the user's programming of a programmable Product, or any consequence thereof.

Performance Data.

Data presented in Omron Company websites, catalogs and other materials is provided as a guide for the user in determining suitability and does not constitute a warranty. It may represent the result of Omron's test conditions, and the user must correlate it to actual application requirements. Actual performance is subject to the Omron's Warranty and Limitations of Liability.

Change in Specifications.

Product specifications and accessories may be changed at any time based on improvements and other reasons. It is our practice to change part numbers when published ratings or features are changed, or when significant construction changes are made. However, some specifications of the Product may be changed without any notice. When in doubt, special part numbers may be assigned to fix or establish key specifications for your application. Please consult with your Omron's representative at any time to confirm actual specifications of purchased Product.

Errors and Omissions.

Information presented by Omron Companies has been checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical or proofreading errors or omissions.

Precautions

- When building a system, check the specifications for all devices and equipment that will make up the system and make sure that the OMRON products are used well within their rated specifications and performances. Safety measures, such as safety circuits, must be implemented in order to minimize the risks in the event of a malfunction.
- Thoroughly read and understand the manuals for all devices and equipment that will make up the system to ensure that the system is used safely. Review the entire contents of these manuals, including all safety precautions, precautions for safe use, and precautions for correct use.
- Confirm all regulations, standards, and restrictions that the system must adhere to.
- Contact The MathWorks® Inc. for the codes that were outputted from Simulink® PLC Coder™.
- Applicability of codes that were outputted from Simulink® PLC Coder™ must be judged by the customer.
- Check the user program for proper execution before you use it for actual operation.

Trademarks

- Sysmac and SYSMAC are trademarks or registered trademarks of OMRON Corporation in Japan and other countries for OMRON factory automation products.
- EtherCAT® is registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.
- MATLAB® and Simulink® are registered trademarks of The MathWorks® Inc.
- Microsoft product screen shot(s) reprinted with permission from Microsoft Corporation.

Other company names and product names in this Guide are the trademarks or registered trademarks of their respective companies.

Software Licenses and Copyrights

The NJ-series CPU Units and Sysmac Studio incorporate certain third party software. The license and copyright information associated with this software is available at http://www.fa.omron.co.jp/nj_info_e/.

Related Manuals

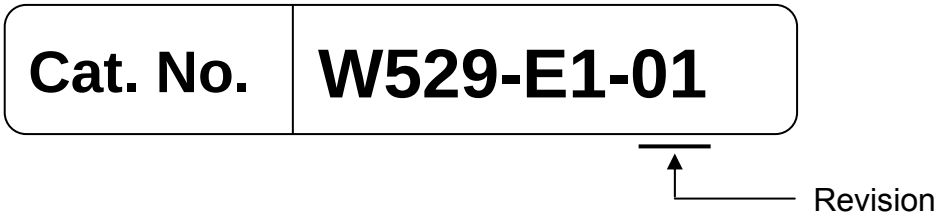
The following manuals are related to the NJ-series Controllers. Use these manuals for reference.

Manual name	Cat. No.	Model numbers	Application	Description
Sysmac Studio Version 1 Operation Manual	W504	SYSMAC-SE2□□□	Learning about the operating procedures and functions of the Sysmac Studio.	The operating procedures of the Sysmac Studio are described.
NJ-series CPU Unit Hardware User's Manual	W500	NJ501-□□□□ NJ301-□□□□	Learning the basic specifications of the NJ-series CPU Units, including introductory information, designing, installation, and maintenance. Mainly hardware information is provided.	An introduction to the entire NJ-series system is provided along with the following information on a Controller built with an NJ501 CPU Unit. ・Features and system configuration ・Introduction ・Part names and functions ・General specifications ・Installation and wiring ・Maintenance and inspection Use this manual together with the NJ-series CPU Unit Software User's Manual (Cat. No. W501).
NJ-series CPU Unit Software User's Manual	W501	NJ501-□□□□ NJ301-□□□□	Learning how to program and set up an NJ-series CPU Unit. Mainly software information is provided.	The following information is provided on a Controller built with an NJ-series CPU Unit. ・CPU Unit operation ・CPU Unit features ・Initial settings ・Programming based on IEC 61131-3 language specifications Use this manual together with the NJ-series CPU Unit Hardware User's Manual (Cat. No.W500).
NJ-series CPU Unit Motion Control USER'S MANUAL	W507	NJ501-□□□□ NJ301-□□□□	Learning about motion control settings and programming concepts.	The settings and operation of the CPU Unit and programming concepts for motion control are described. Use this manual together with the NJ-series CPU Unit Hardware User's Manual (Cat. No. W500) and NJ-series CPU Unit Software User's Manual (Cat. No. W501).

Manual name	Cat. No.	Model numbers	Application	Description
NJ-series Instructions Reference Manual	W502	NJ501-□□□□ NJ301-□□□□	Learning detailed specifications on the basic instructions of an NJ-series CPU Unit.	The instructions in the instruction set (IEC61131-3 specifications) are described. When programming, use this manual together with the NJ-series CPU Unit Hardware User's Manual (Cat. No. W500) and NJ-series CPU Unit Software User's Manual (Cat. No. W501).
NJ-series Motion Control Instructions Reference Manual	W508	NJ501-□□□□ NJ301-□□□□	Learning about the specifications of the motion control instructions that are provided by OMRON.	The motion control instructions are described. When programming, use this manual together with the NJ-series CPU Unit Hardware User's Manual (Cat. No. W500), NJ-series CPU Unit Software User's Manual (Cat. No. W501) and NJ-series CPU Unit Motion Control User's Manual (Cat. No. W507).
NJ-series Troubleshooting Manual	W503	NJ501-□□□□ NJ301-□□□□	Learning about the errors that may be detected in an NJ-series Controller.	Concepts on managing errors that may be detected in an NJ-series Controller and information on individual errors are described. Use this manual together with the NJ-series CPU Unit Hardware User's Manual (Cat. No.W500) and NJ-series CPU Unit Software User's Manual (Cat. No. W501).
AC Servomotors/Servo Drives (Built-in EtherCAT Communications) User's Manual	I576	R88D-KN□-ECT/ R88M-K	Learning detailed specifications of a G5-series Servo Drive.	This manual explains how to install and wire the Servo Drive, set parameters needed to operate the Servo Drive, and remedies to be taken and inspection methods to be used in case that problems occur.
AC Servomotors/Servo Drives EtherCAT Communications Linear Motor Type User's Manual	I577	R88D-KN□-ECT-L/R88L-EC	Learning detailed specifications of a G5-series Servo Drive.	This manual explains how to install and wire the Servo Drive, set parameters needed to operate the Servo Drive, and remedies to be taken and inspection methods to be used in case that problems occur.
EtherCAT Slave Units User's Manual	W488	GX-□□□□□□	Learning detailed specifications of a GX-series EtherCAT Slave Unit.	This manual contains information you need to know to use the EtherCAT Slave Unit.

Revision History

A manual revision code appears as a suffix to the catalog number on the front and back covers of the manual.



Revision code	Date	Revised content
A	June 2013	Original production

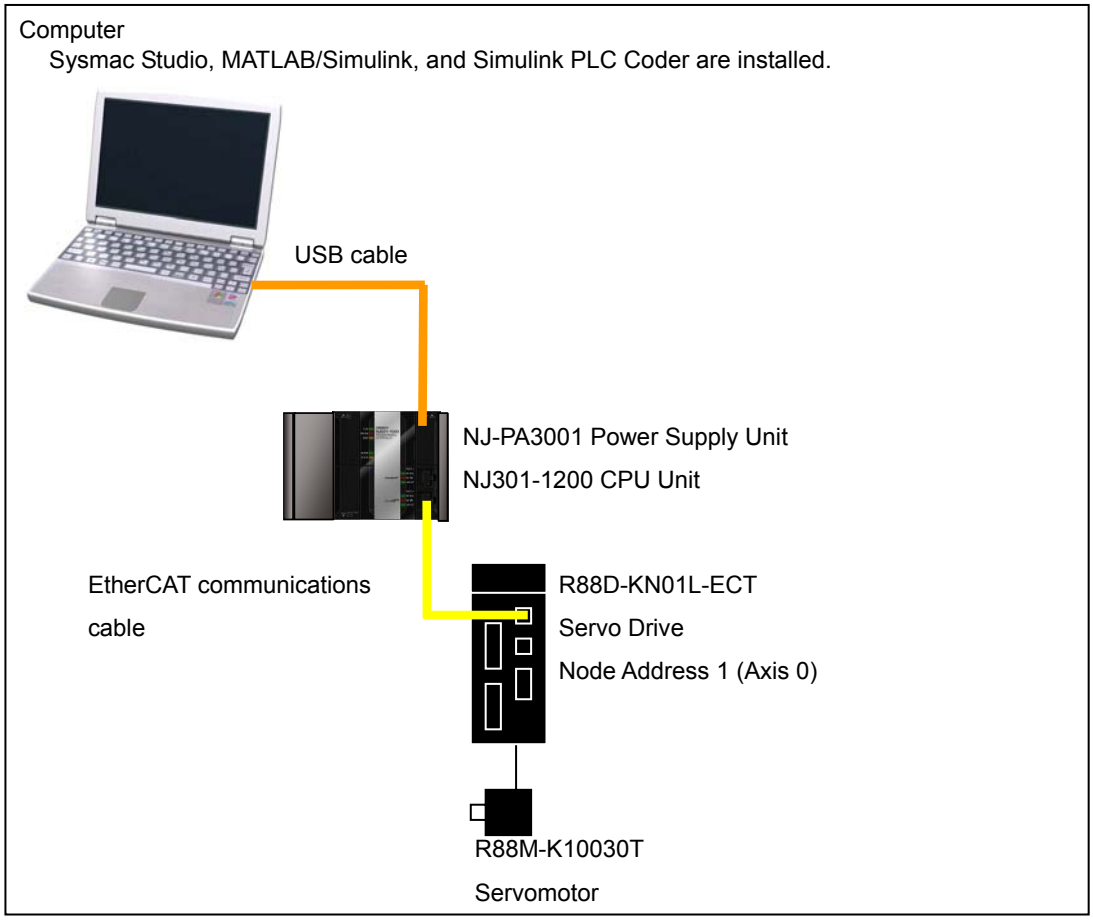
CONTENTS

1. System to Construct and Configuration Devices

1.1. System Configuration and Configuration Devices

This section describes the system configuration and configuration devices used in this Guide.

The following figure represents the system configuration.



The models of the devices that are described in this Guide are given in the following table. When selecting devices for an actual application, refer to the device manuals.

Device name	Model	Manual name
NJ-series CPU Unit	NJ301-1200 (Unit version 1.04)	NJ-series CPU Unit Hardware User's Manual (Cat. No. W500)
NJ-series Power Supply Unit	NJ-PA3001	
EtherCAT communications cables	XS5W-T421-CMD-K	
AC Servo Drives	R88D-KN01L-ECT (version 2.10)	AC Servomotors/Servo Drives (Built-in EtherCAT Communications) User's Manual (Cat. No. I576)
AC Servomotors	R88M-K10030L	
Motor Power Cables (for the AC Servo Drives)	R88A-CAKA003S	
Encoder Cables (for the AC Servo Drives)	R88A-CRKA003C	
USB cable	Commercially available USB cable*1	---

*1. Use a USB2.0 (or 1.1) cable (A connector - B connector), 5.0 m max.

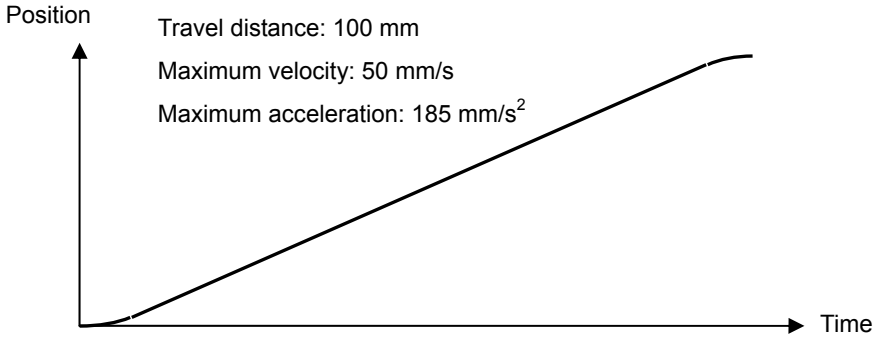
The names and versions of the software that are used in this Guide are given below. Install the following software to a computer (OS: Windows 7).

Manufacturer	Name	Version
OMRON Corporation	Sysmac Studio	Version 1.05
The MathWorks Inc.	MATLAB/Simulink	R2013a
The MathWorks Inc.	Simulink PLC Coder	R2013a

1.2. The Servo System Constructed in this Guide

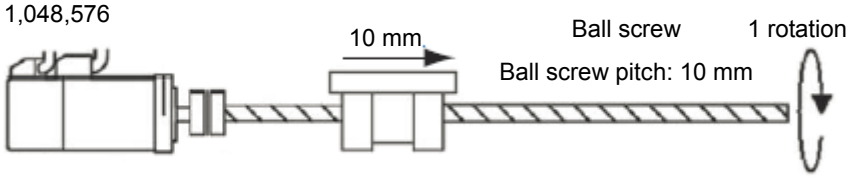
This guide describes the procedure to start up the system for single-axis positioning with a Servo Drive and Servomotor for one axis. The operations from creating the control algorithm using the Simulink® from the MathWorks® Inc. to operation check using the actual devices are given as the startup procedure.

The single-axis Servo system that is set up in this Guide performs the single-axis positioning operation on the following path.



The mechanical configuration is as shown below.

Servomotor
Rated speed: 3,000 r/min
Command pulse count per motor rotation:
20 bits = 1,048,576



2. Before You Begin

2.1. Wiring the Devices and Installing the Software

You wire the devices and install the software on the computer as described in *1.1. System Configuration and Configuration Devices*.

Additional Information

Refer to the manuals for the devices that are used in the system for wiring of the devices.

Additional Information

Refer to the *Sysmac Studio Version 1 Operation Manual* (Cat. No. W504) for installation of the Sysmac Studio.

Additional Information

Access the website of The MathWorks Inc. or refer to the *MATLAB & Simulink Installation Guide* that is provided by The MathWorks Inc. for installation of MATLAB/Simulink and Simulink PLC Coder.

2.2. Designing the Control Algorithm

You build a model for the Controller and controlled system using the Simulink. The code is created for the Controller by the Simulink PLC Coder. Therefore, you need to build the model using a block supported by the Simulink PLC Coder.

Additional Information

Access the website of The MathWorks Inc. or refer to the *Simulink User Guide* that is provided by The MathWorks Inc. for how to use the Simulink.

Additional Information

Access the website of The MathWorks Inc. or refer to the *Simulink PLC Coder User's Guide* that is provided by The MathWorks Inc. for the blocks supported by the Simulink PLC Coder.

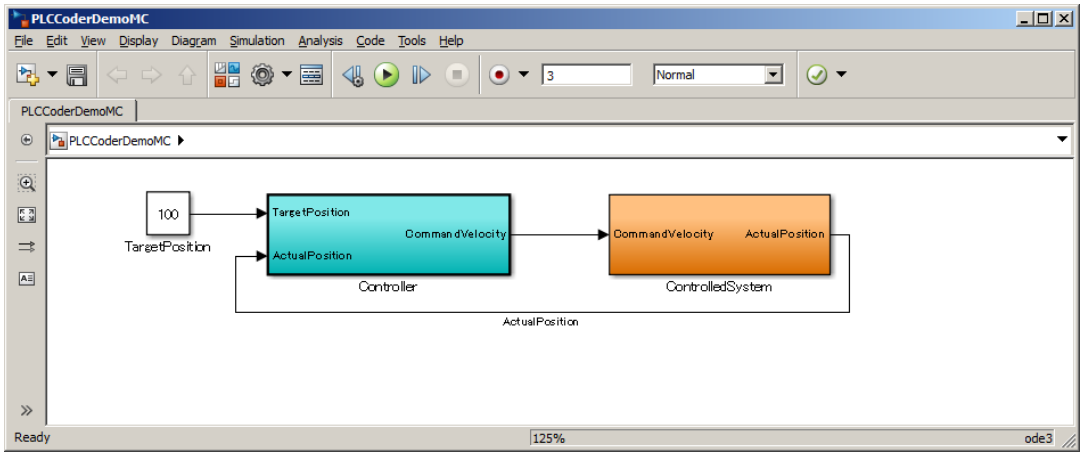
This Guide gives an example for designing the control algorithm so that an NJ-series CPU Unit controls the position and a Servo Drive controls the velocity.

In the *Sample File No. 1 PLCCoderDemoMC.mdl* that is provided separately, a model is created for the Controller (Controller block) and controlled system (ControlledSystem block) by the Simulink as shown in the following figure.

The sampling time of the Controller is set to 1 ms in the sample.

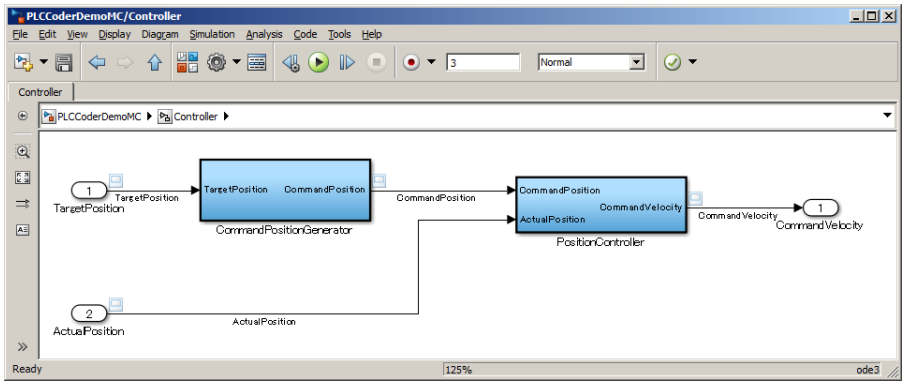
Additional Information

Set the sampling time of the Controller so that it matches the task period of the Sysmac Studio. (Primary periodic task period on the Sysmac Studio: 500 µs, 1 ms, 2 ms, or 4 ms)

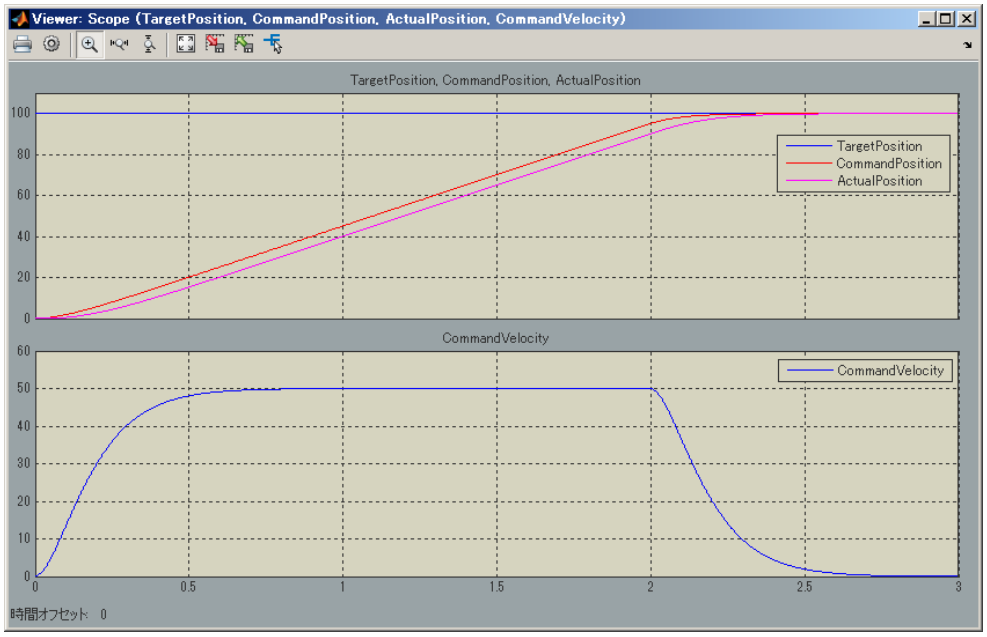


The following figure shows the inside of the Controller block.

The Controller block is composed of two blocks; the CommandPositionGenerator block for creating position command values and the PositionController block for position control.



You will get the simulation execution results as shown below.



3. Setting up the System

3.1. System Setup Procedures

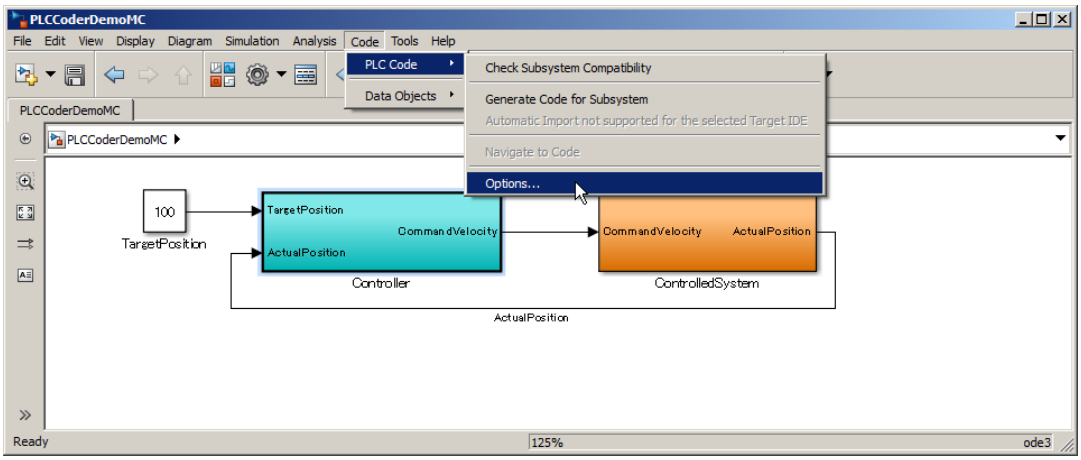
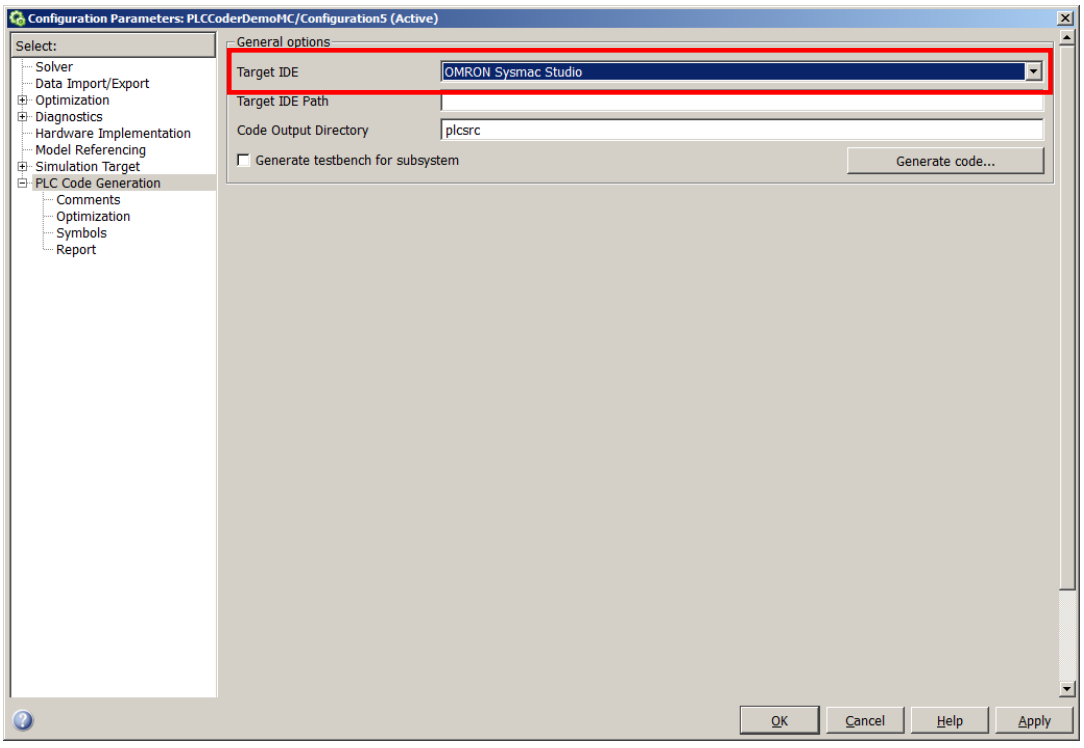
The operation procedure of Simulink and Sysmac Studio is given below.

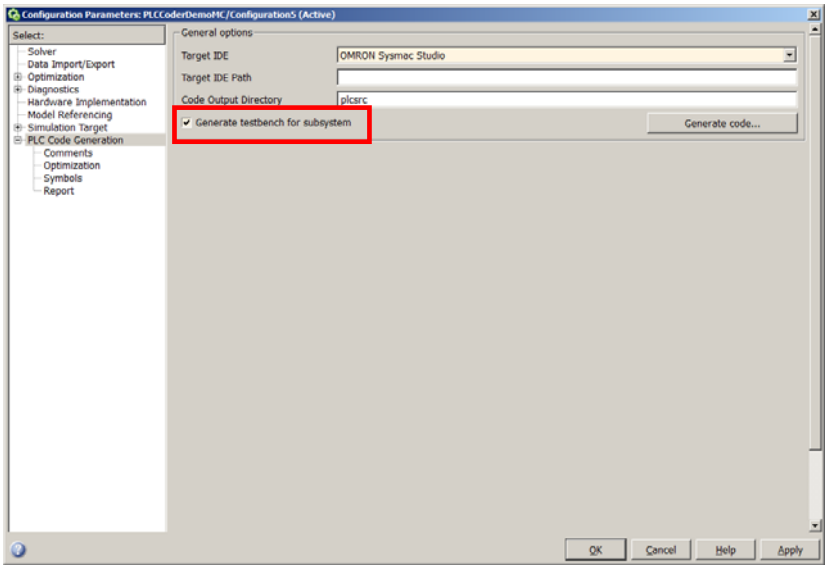
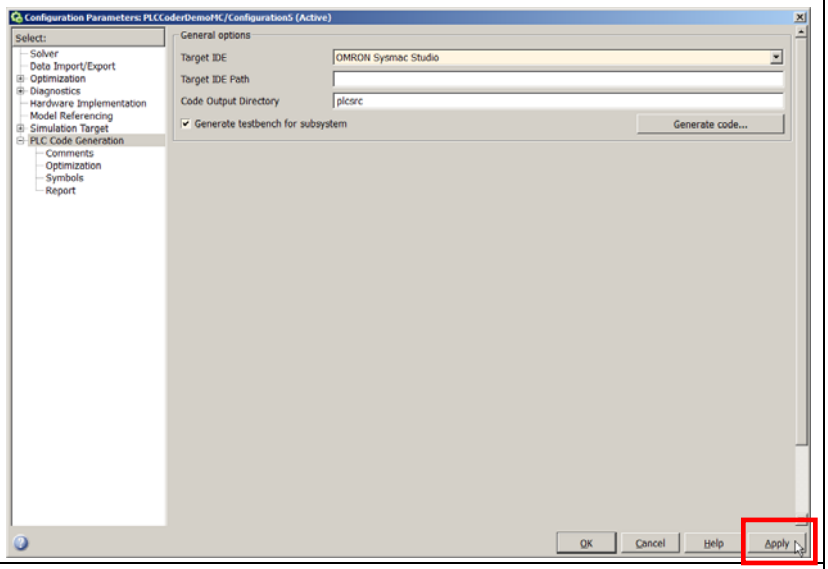
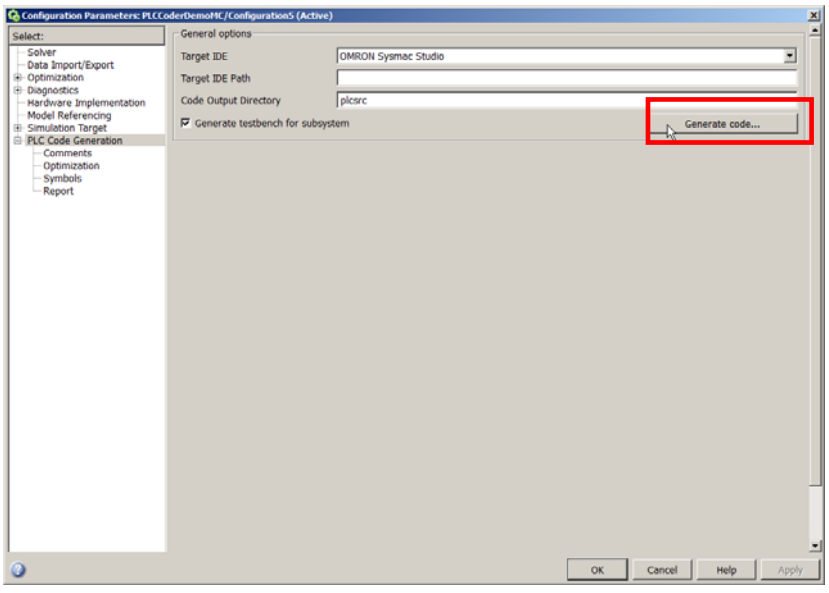
3.2.1	Outputting the Code using the Simulink PLC Coder	You make a setting for outputting the code for the Sysmac Studio and output the code with test code.
▼		
3.2.2	Importing the Code into the Sysmac Studio	You import the code outputted by the Simulink PLC Coder into the Sysmac Studio.
▼		
3.2.3	Checking the Calculation Accuracy	You confirm that the code has the same calculation accuracy as the Simulink (within the acceptable error range) by a simulation.
▼		
3.2.4	Creating the EtherCAT Network Configuration	You register a R88D-KN01L-ECT Servo Drive that operates as axis 0 on the EtherCAT network configuration.
▼		
3.2.5	Setting the Axis	You add an axis to control the Servo Drive, assign the Servo Drive to the axis, and make the axis parameter settings.
▼		
3.2.6	Creating Programs	You create a program for calling the function blocks whose code was outputted by the Simulink PLC Coder and a program for outputting command values to the Servo Drive.
▼		
3.2.7	Synchronization (Download)	You transfer the programs and parameter settings to the physical CPU Unit.
▼		
3.2.8	System Operation Check	You execute the operation according to the programs transferred to the physical CPU Unit and check the operation using the data trace function.

3.2. Simulink PLC Coder & Sysmac Studio Operation Procedure

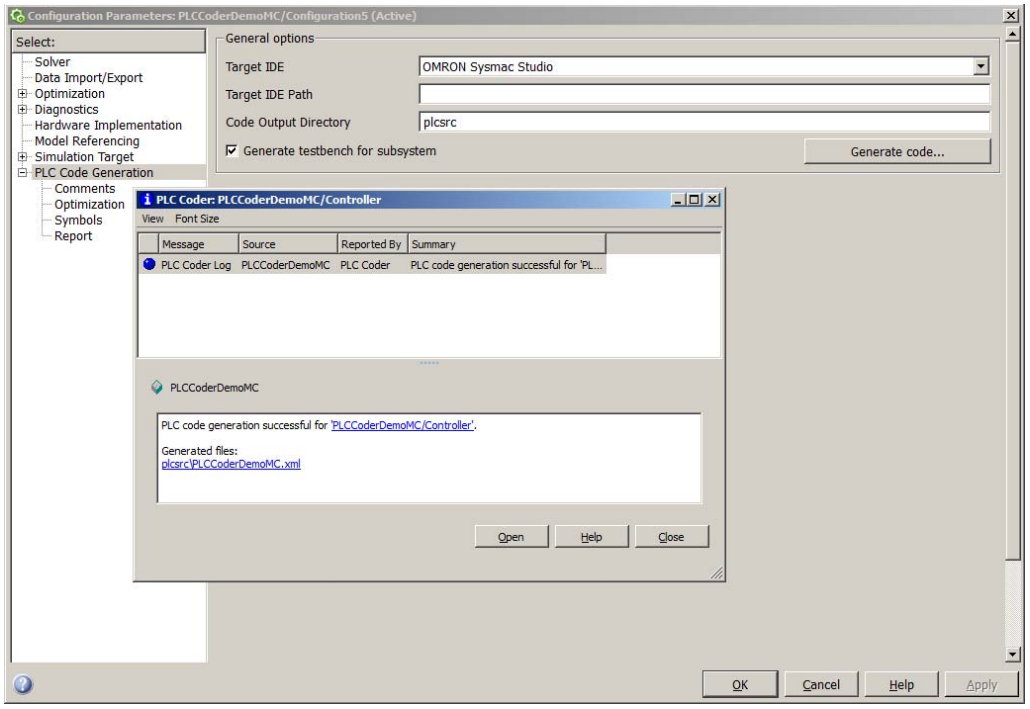
3.2.1. Outputting the Code using the Simulink PLC Coder

You make a setting for outputting the code for the Sysmac Studio and output the code with test code from the Simulink.

1	Open the *Sample File No. 1 PLCCoderDemoMC.mdl* that is provided separately on the Simulink.
2	Click the Controller block to output the code and select ***PLC Code*** - ***Options*** from the **Code** Menu. 
3	Select *PLC Code Generation*, and then select *OMRON Sysmac Studio* for *Target IDE*. 

4	Select the *Generate testbench for subsystem* check box. 
5	Click the **Apply** Button. 
6	Click the **Generate Code** Button. 

7	The PLCCoderDemoMC.xml file is saved into the *plcsrc* folder specified in *Code Output Directory*.



Additional Information

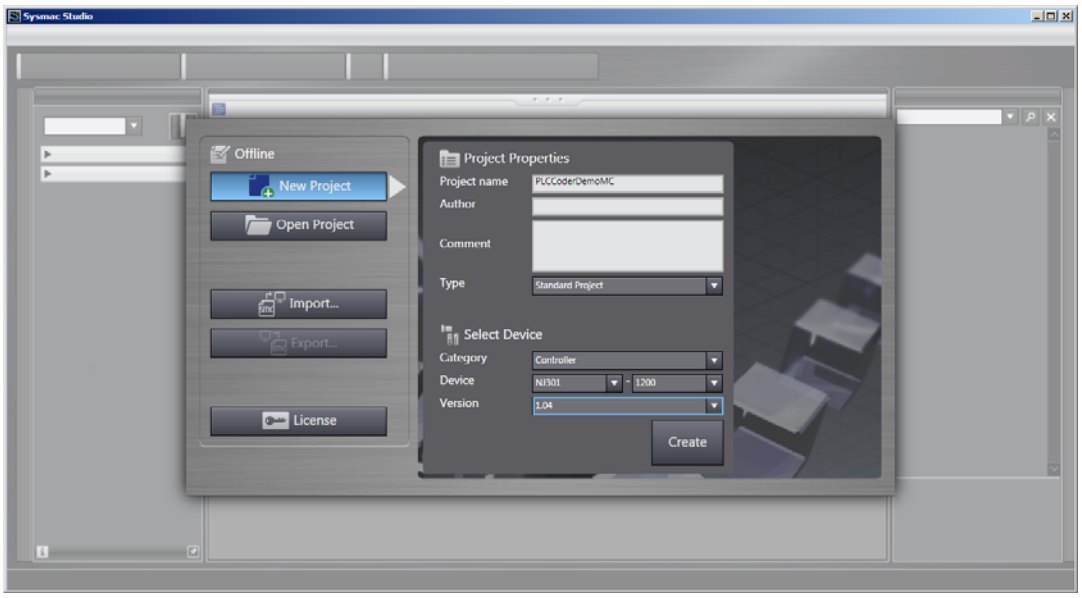
When you adjust the parameters after code generation, you generate the code as a variable, not a constant (literal). Access the website of The MathWorks Inc. or refer to the *Simulink PLC Coder User's Guide* that is provided by The MathWorks Inc. for the setting procedure.

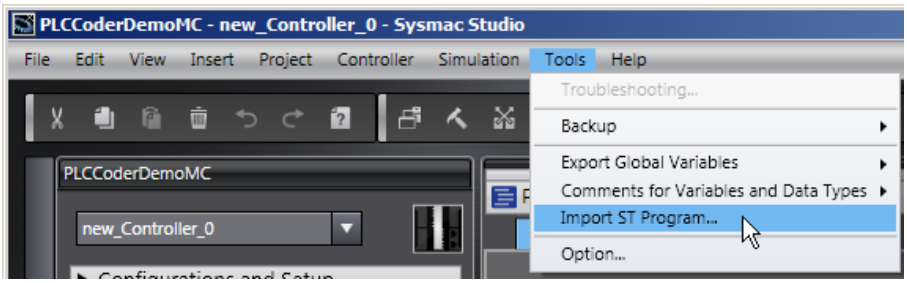
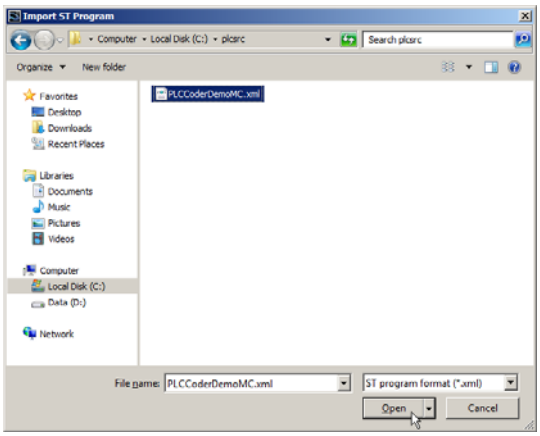
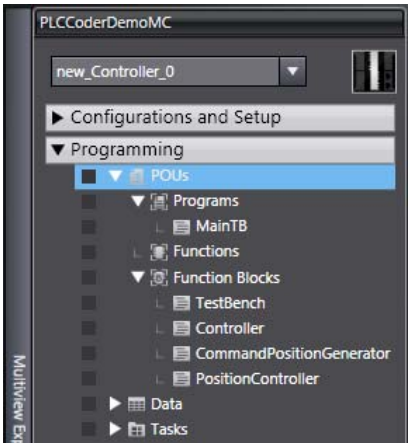
3.2.2. Importing the Code into the Sysmac Studio

You import the code outputted by the Simulink PLC Coder into the Sysmac Studio.

Additional Information

Refer to the *Sysmac Studio Version 1 Operation Manual* (Cat. No. W504) for how to use the Sysmac Studio.

1	Start the Sysmac Studio and create a new project. Set the Select Device Area as shown below. Category: Controller Device: NJ301-1200 Version: 1.04 
2	Delete the **Program0** that is automatically created when a new project is created because it is not used in this Guide. 

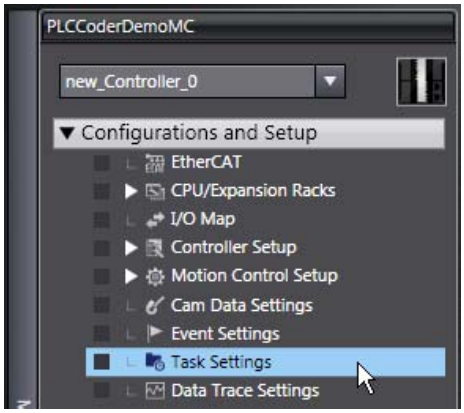
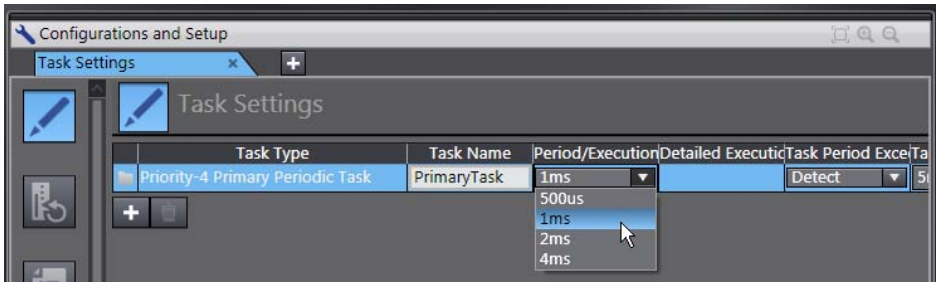
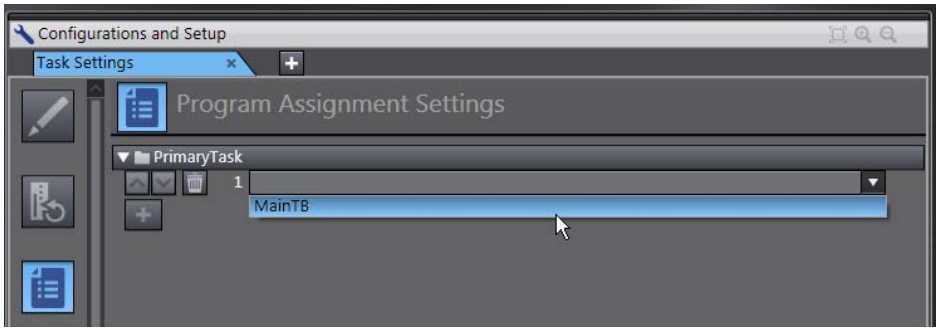
3	Select ***Import ST Program*** from the **Tools** Menu. 
4	Select the PLCCoderDemoMC.xml file that was outputted in the previous section in the Import ST Program Dialog Box.  The data is imported and the programs, functions, function blocks, data types, and global variables in the XML file are added to the project of Sysmac Studio.  The **Controller** block whose code is outputted by the Simulink PLC Coder and its internal blocks **CommandPositionGenerator** and **PositionController** are imported as function blocks of Sysmac Studio. **TestBench** is a function block for a test to call the Controller function block. **MainTB** is a program to call the TestBench function block.

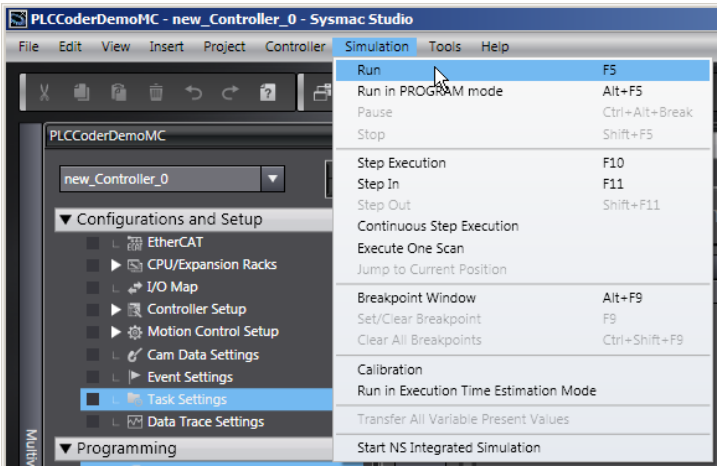
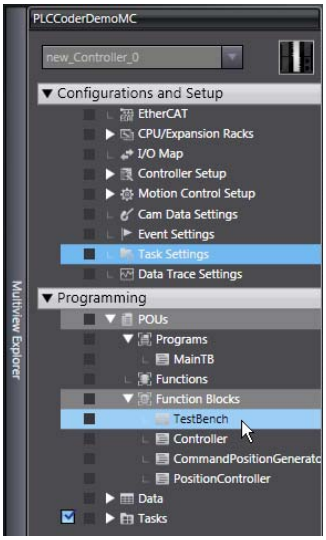
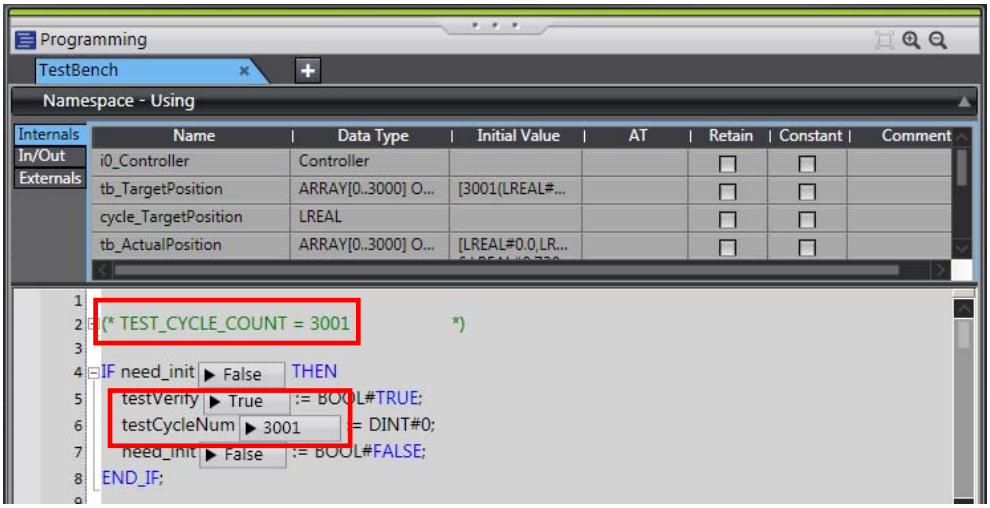
Additional Information

The TestBench function block and the MainTB program are outputted when the *Generate testbench for subsystem* check box is selected in Step 4 of *3.2.1 Outputting the Code using the Simulink PLC Coder*.

3.2.3. Checking the Calculation Accuracy

You confirm that the code has the same calculation accuracy as the Simulink (within the acceptable error range) by a simulation.

1	Double-click the **Task Settings** in the Multiview Explorer to display the Task Settings Tab Page. 
2	Set the task period to 1 ms in the Task Settings View on the Sysmac Studio so that the period matches the sampling time of the Controller on the Simulink. 
3	Select the MainTB program in the Program Assignment Settings View. 

4	Select ***Run*** from the **Simulation** Menu of the Sysmac Studio. 
5	Double-click **TestBench** in the Multiview Explorer to display the program. 
6	Confirm that *testVerify* is True and *testCycleNum* is the value of *TEST_CYCLE_COUNT* written in the comment.  You can confirm that calculation accuracy of the output data is the same level as the Simulink (within the acceptable error range) if *testVerify* is True. You can also confirm that the simulation has been completed if *testCycleNum* is the value of *TEST_CYCLE_COUNT* written in the comment.

Additional Information

The initial value of the acceptable error depends on the data type as shown below. Set an appropriate value according to the actual application.

■ Integer data: 0 (Match)

```
IF testVerify AND (out_Out1 <> cycle_Out1) THEN
   testVerify := BOOL#FALSE;
END_IF;
```

■ REAL data: 0.0001

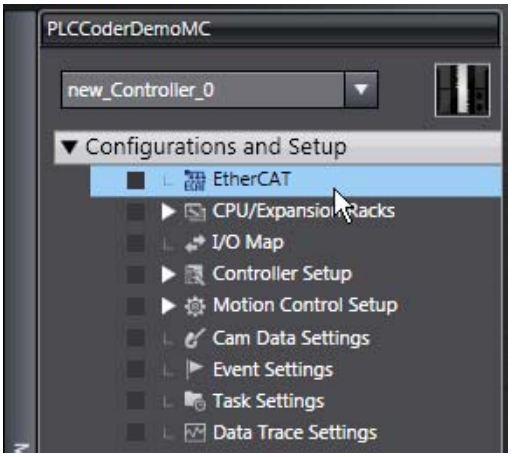
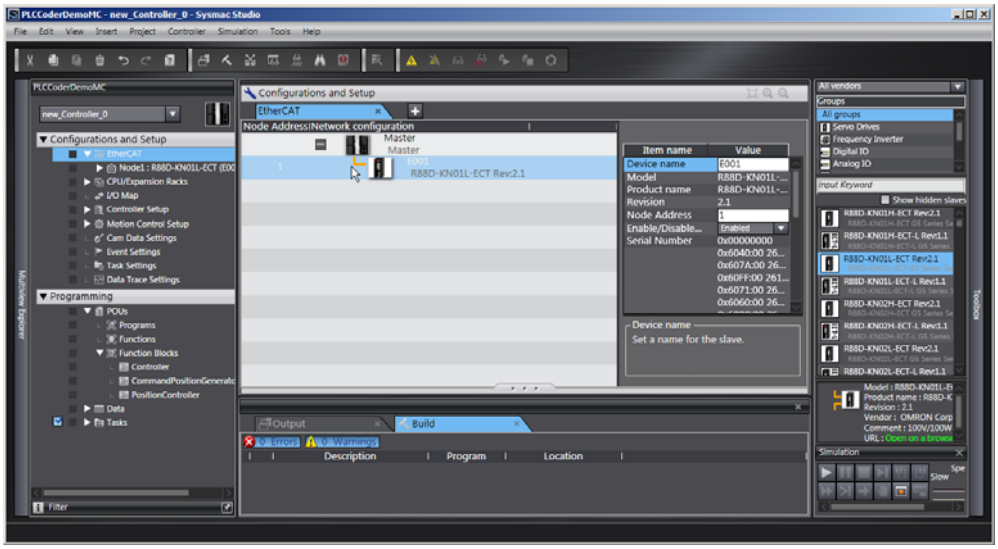
```
IF testVerify AND (ABS(out_Out1 - cycle_Out1) > REAL#0.0001) THEN
   testVerify := BOOL#FALSE;
END_IF;
```

■ LREAL data: 1.0E-5

```
IF testVerify AND (ABS(out_Out1 - cycle_Out1) > LREAL#1.0E-5) THEN
   testVerify := BOOL#FALSE;
END_IF;
```

3.2.4. Creating the EtherCAT Network Configuration

You register a R88D-KN01L-ECT Servo Drive that operates as axis 0 on the EtherCAT network configuration.

1	Double-click **EtherCAT** in the Multiview Explorer to display the EtherCAT Tab Page where you edit the EtherCAT network configuration. 
2	Drag the R88D-KN01L-ECT from the Toolbox to the master. The Servo Drive is added under the master with a node address of 1. 

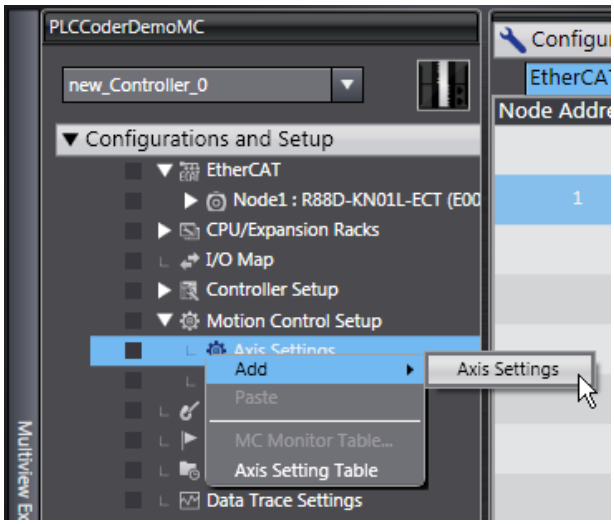
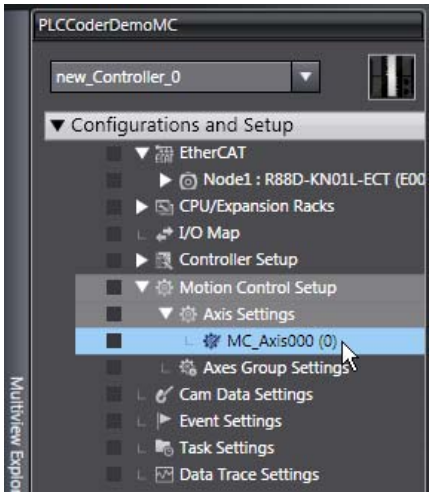
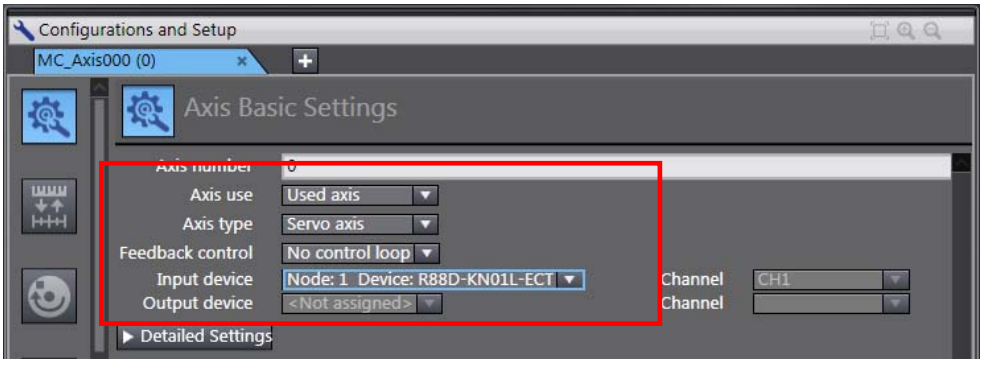
Additional Information

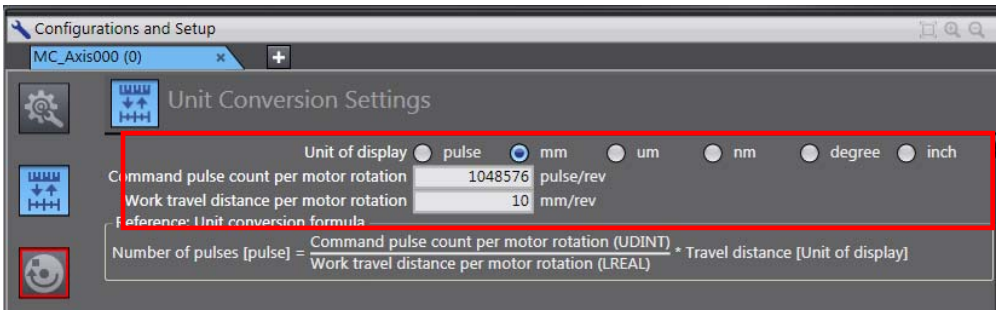
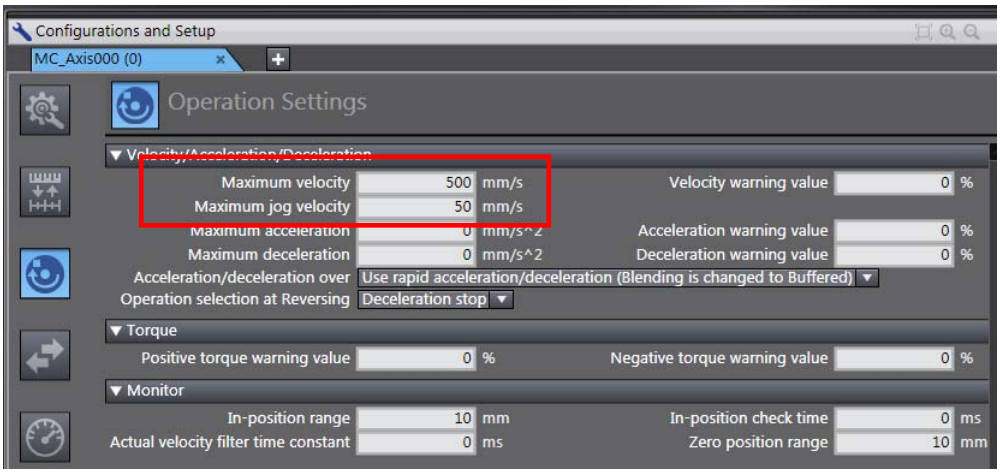
To use digital I/O devices, analog I/O devices, and encoder input devices, add the devices using the same procedure. For data access to the devices that you added, register the device variables in the I/O Map.

The examples for using GX-AD0471 Analog Input Terminal and GX-DA0271 Analog Output Terminal are provided as samples. Refer to the *Sample File No. 4 PLCCoderDemoMC_ADDA.mdl* and *No. 5 PLCCoderDemoMC_ADDA.smc* that are provided separately.

3.2.5. Setting the Axis

You add an axis to control the Servo Drive, assign the Servo Drive to the axis, and make the axis parameter settings.

1	Double-click **Motion Control Setup** in the Multiview Explorer and right-click **Axis Settings** and select ***Add*** - ***Axis Settings*** from the menu. 
2	Double-click **MC_Axis000(0)** (Axis 0) that was added under **Motion Control Setup** - **Axis Settings** in the Multiview Explorer to display the axis parameter setting view. 
3	Make the Axis Basic Settings as shown below to assign the Servo Drive to the axis. Axis type: Servo axis Input device: Node: 1 Device: R88D-KN01L-ETC 

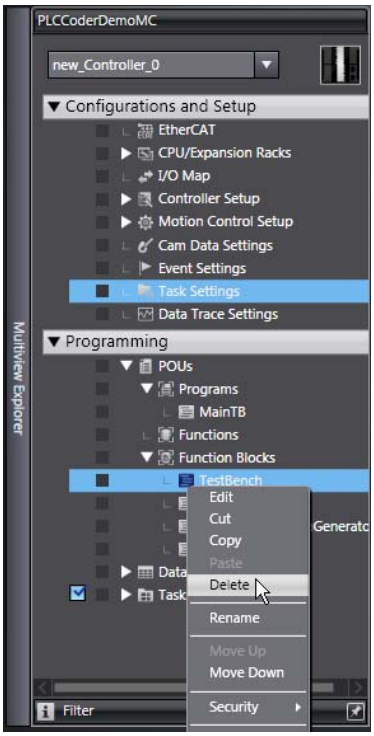
4	Make the Unit Conversion Settings according to the mechanical configuration. Unit of display: mm Command pulse count per motor rotation: 1048576 pulse/rev Work travel distance per motor rotation: 10 mm/rev 
5	Make the Operation Settings according to the mechanical configuration. Maximum velocity: 500 mm/s Maximum jog velocity: 50 mm/s 

3.2.6. Creating Programs

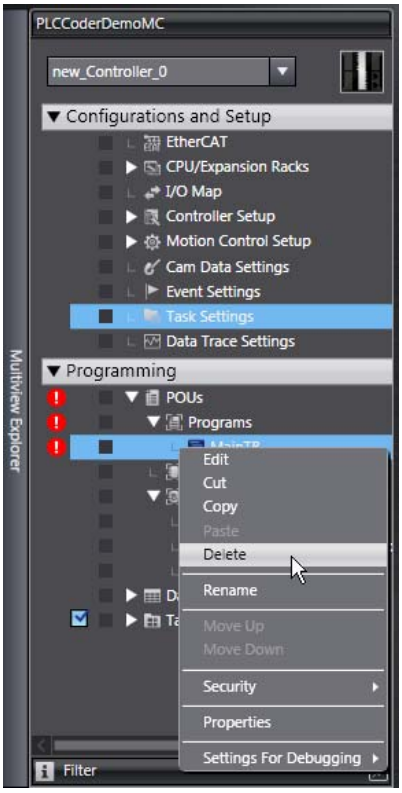
You create a program for calling the function blocks whose code was outputted by the Simulink PLC Coder and a program for outputting command values to the Servo Drive.

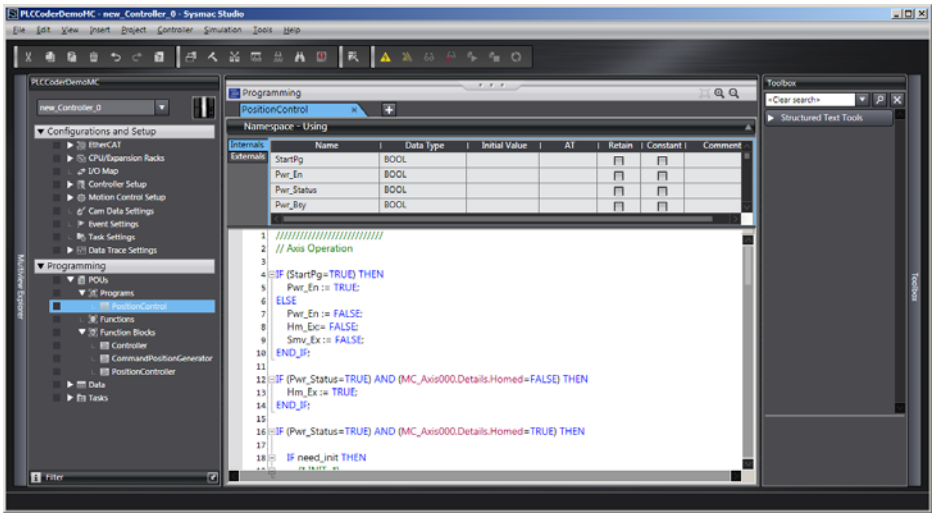
1 Delete *TestBench* and *MainTB* because they are used for the test to check the calculation accuracy.

Right-click **TestBench** in the Multiview Explorer and select ***Delete*** from the menu.



Right-click **MainTB** in the Multiview Explorer and select ***Delete*** from the menu.



2	Create the PositionControl program for the following processing. - Servo ON (by executing an MC_Power instruction) - Home definition (by executing an MC_Home instruction) - Calculation of velocity command values by the Controller function block whose code was outputted by the Simulink PLC Coder - Output of velocity command values to the Servo Drive (by executing the MC_SyncMoveVelocity instruction) 

Precautions for Correct Use

The sample programming that is provided in this Guide includes only the programming that is required to operate the Servomotors. When programming actual applications, also program EtherCAT communications, device interlocks, I/O with other devices, and other control procedures.

Additional Information

Refer to the *Sample File No. 2 PLCCoderDemoMC.smc* that is provided separately for the above program written in ST language.

Additional Information

Refer to *4.1. Programming in Ladder Diagram Language* for programming in ladder diagram language.

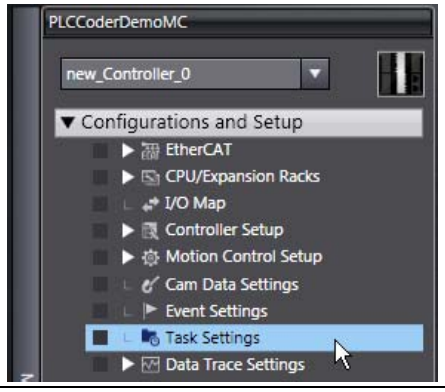
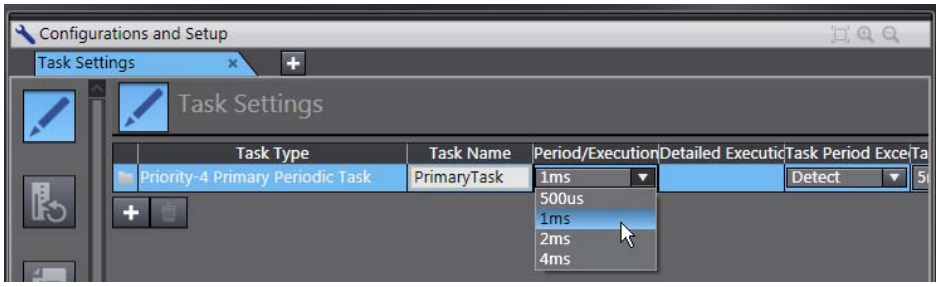
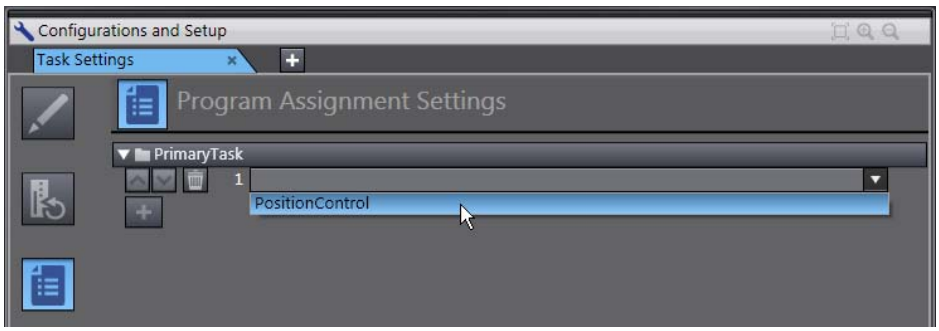
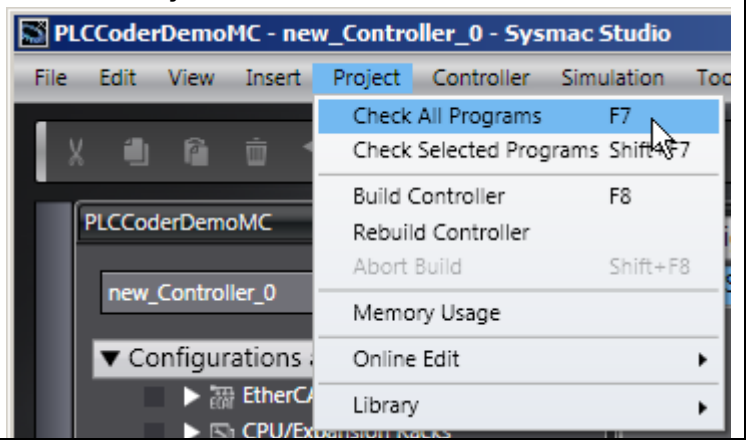
Additional Information

The instruction to use differs by the command type. Use the following instructions according to the command type.

Position command: MC_SyncMoveAbsolute
Velocity command: MC_SyncMoveVelocity
Torque command: MC_TorqueControl

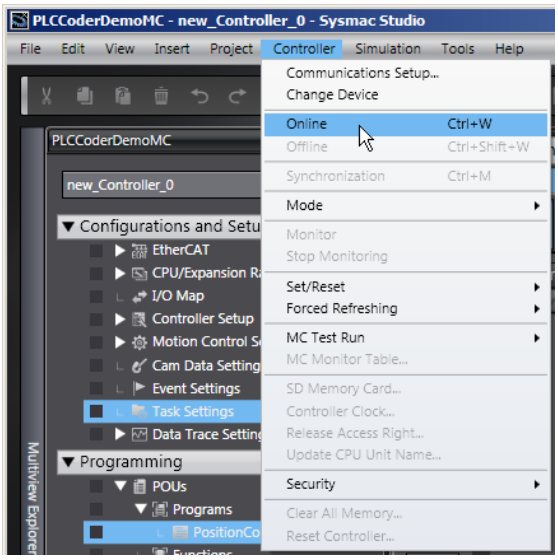
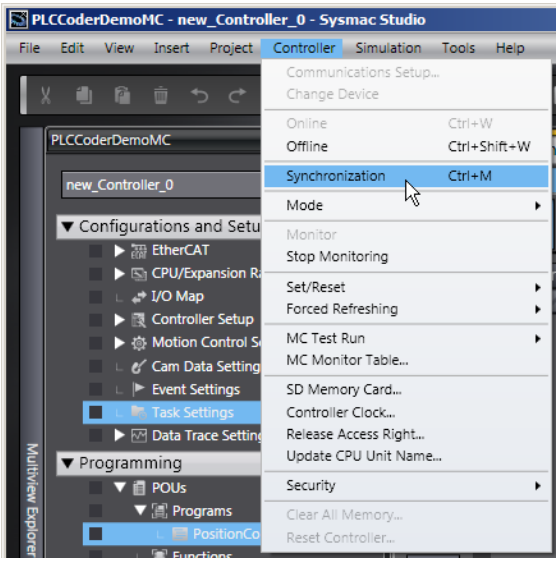
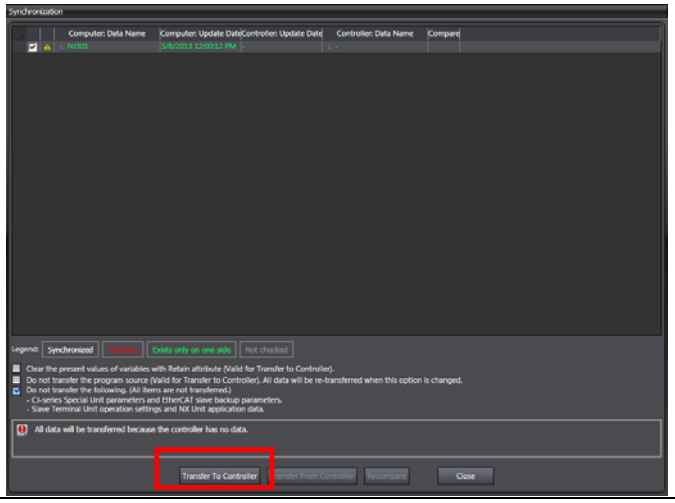
If you use an MC_TorqueControl instruction, the command values are not outputted cyclically. You need to write the program so that the command values are outputted cyclically. Refer to the *MC_mySyncTorqueControl* of the Sample File No. 3 that is provided separately for details of the program.

Assigning the PositionControl program that you created to a task.

3	Double-click the **Task Settings** in the Multiview Explorer to display the Task Settings Tab Page. 
4	Set the task period to 1ms in the Task Settings View on the Sysmac Studio so that the period matches the sampling time of the Controller on the Simulink. 
5	In the Program Assignment Settings View, select the PositionControl program that you created. 
6	Check the program that you created. Select ***Check All Programs*** from the **Project** Menu. 

3.2.7. Synchronization (Download)

You transfer the programs and parameter settings to the physical CPU Unit.

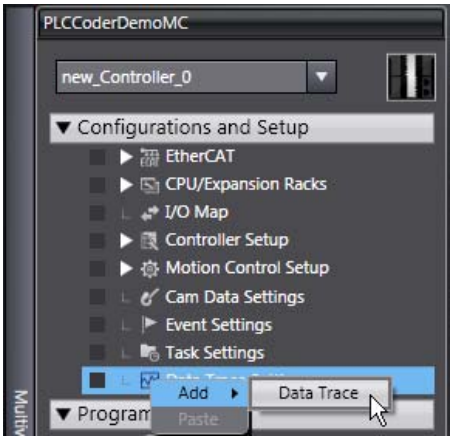
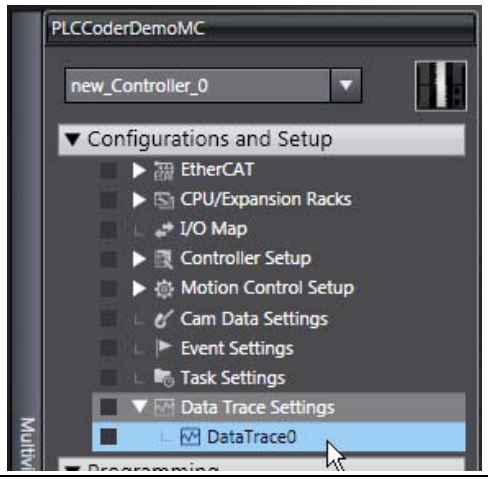
1	Select ***Online*** from the **Controller** Menu. 
2	Select ***Synchronization*** from the **Controller** Menu. 
3	Click the **Transfer to Controller** Button. 

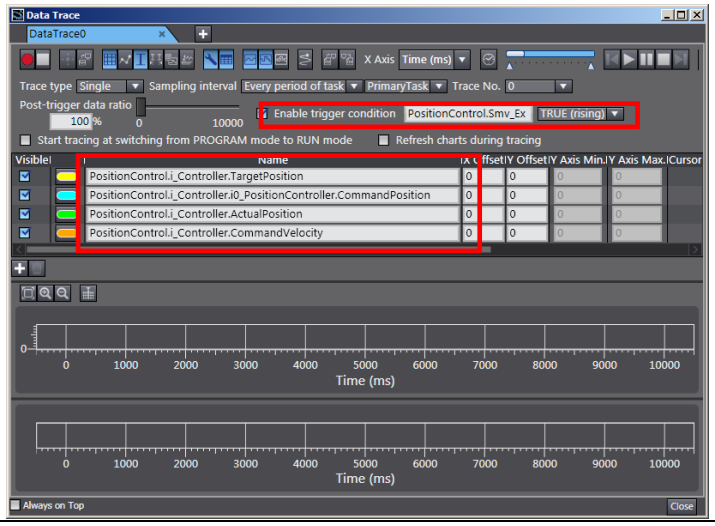
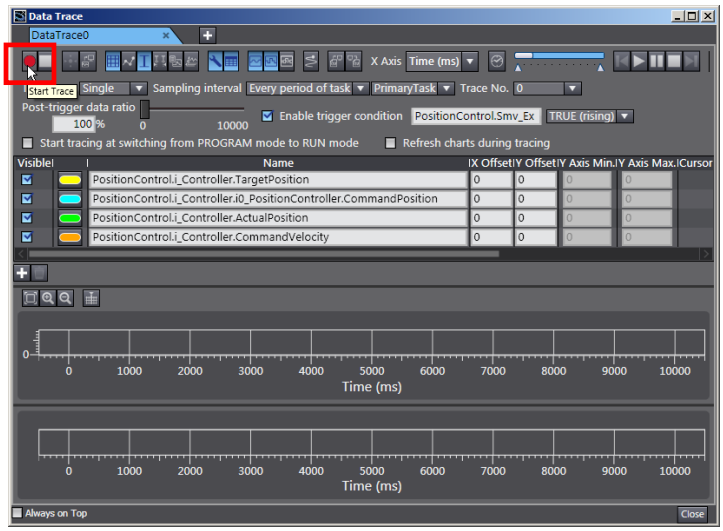
3.2.8. System Operation Check

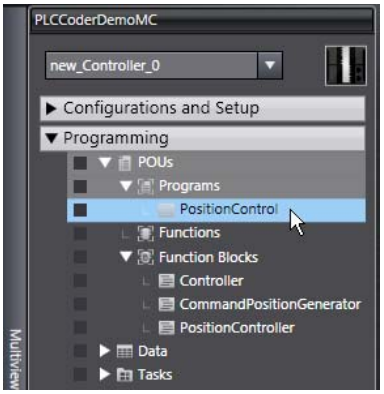
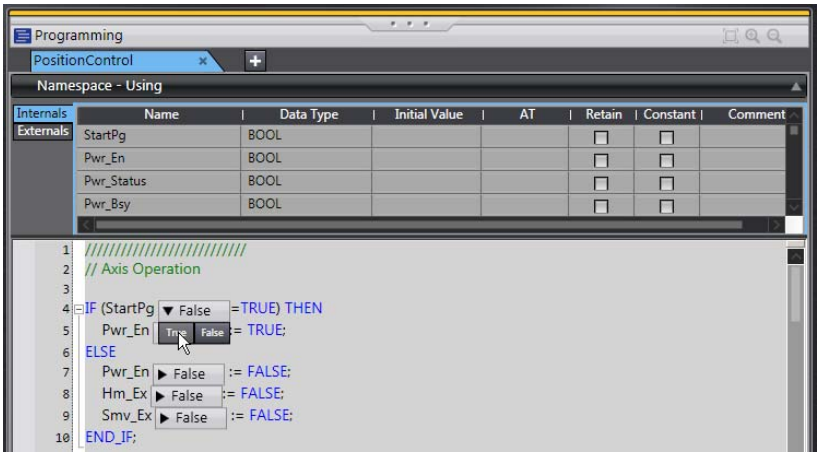
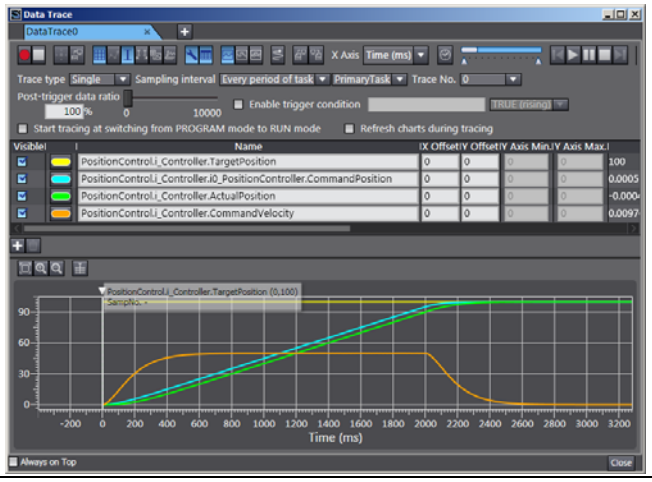
You execute the operation according to the programs transferred to the physical CPU Unit and check the operation using the data trace function.

Precautions for Correct Use

The physical motor will run. Thoroughly read and understand the manuals for all devices that make up the system to ensure that the system is used safely. Review the entire contents of these manuals, including all safety precautions, precautions for safe use, and precautions for correct use before the actual operation.

1	Right-click the **Data Trace Settings** in the Multiview Explorer and select ***Add*** - ***Data Trace*** from the menu to add DataTrace0. 
2	Double-click **DataTrace0** that you added. 

3	Make the trace settings as shown below. Trigger condition: Rising edge of PositionControl.Smv_Ex Trace target variables: PositionControl.i_Controller.TargetPosition PositionControl.i_Controller.i0_PositionController.CommandPosition PositionControl.i_Controller.ActualPosition PositionControl.i_Controller.CommandVelocity 
4	Click the **Start Trace** Button (with red filled circle icon) on the upper left part of the window to start data tracing. The data trace function is started and waits for the trigger. 

5	Double-click **PositionControl** in the Multiview Explorer to display the program. 
6	Change the value of *StartPg* variable for execution conditions of Servo ON, home definition, and command value output to True to start positioning. 
7	When you click the **Stop** Button (with write square icon) or the trace data becomes full, the data trace operation will stop and the results will be displayed. Confirm that you got the same trace results as the waveform shown in *1.2. The Servo System Constructed in this Guide* and *2.2. Designing the Control Algorithm*. 

4. Appendix

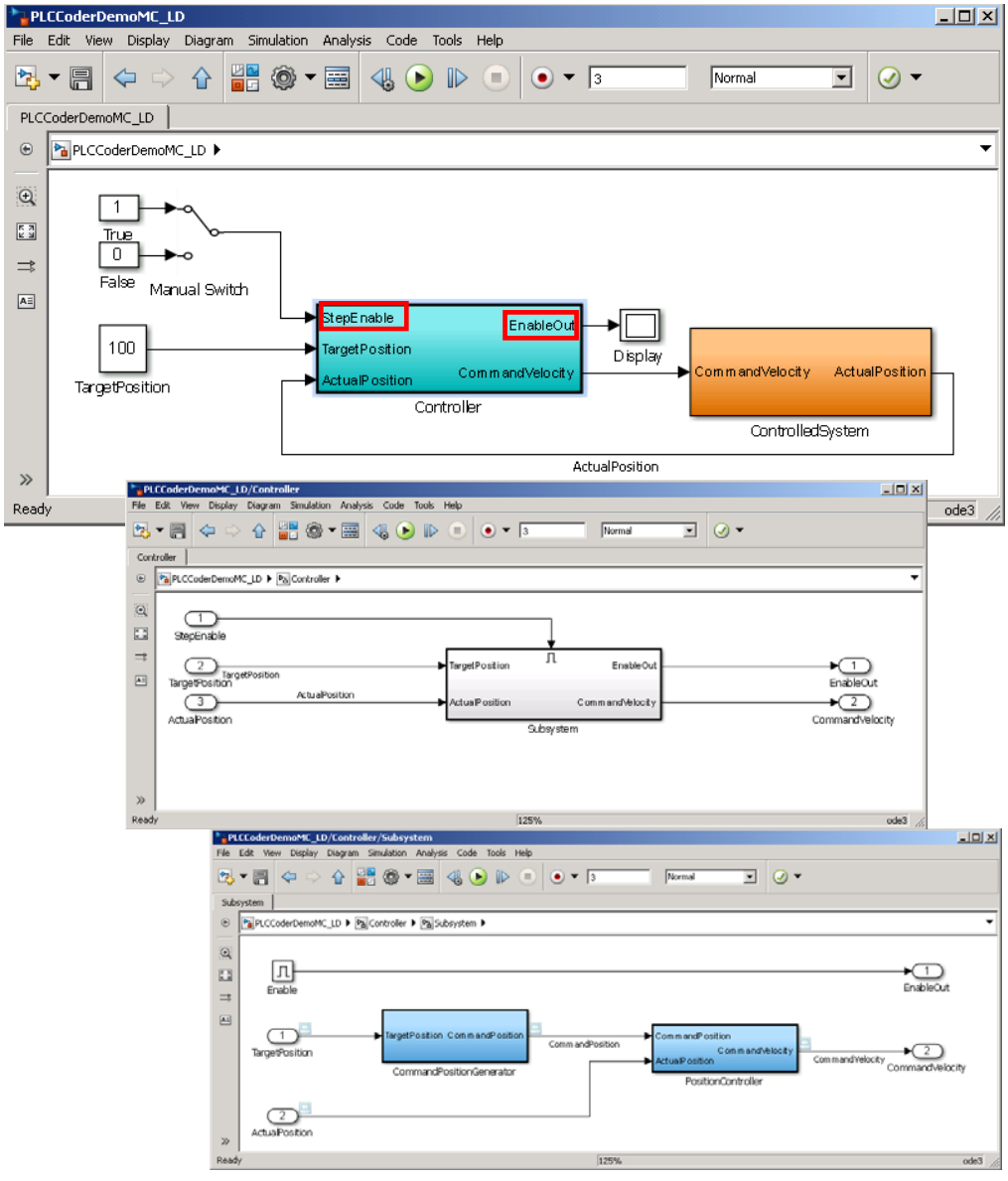
4.1. Programming in Ladder Diagram Language

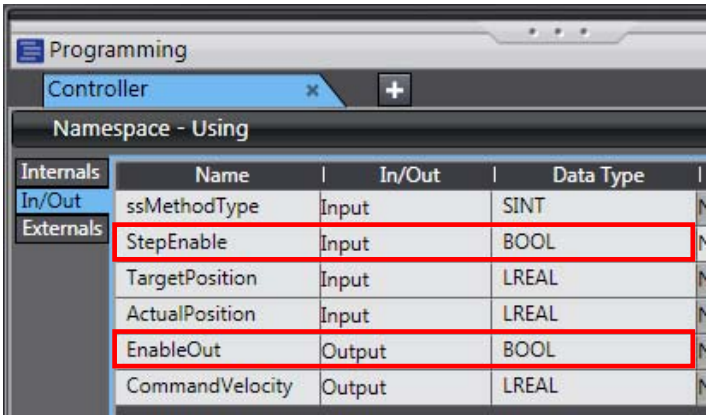
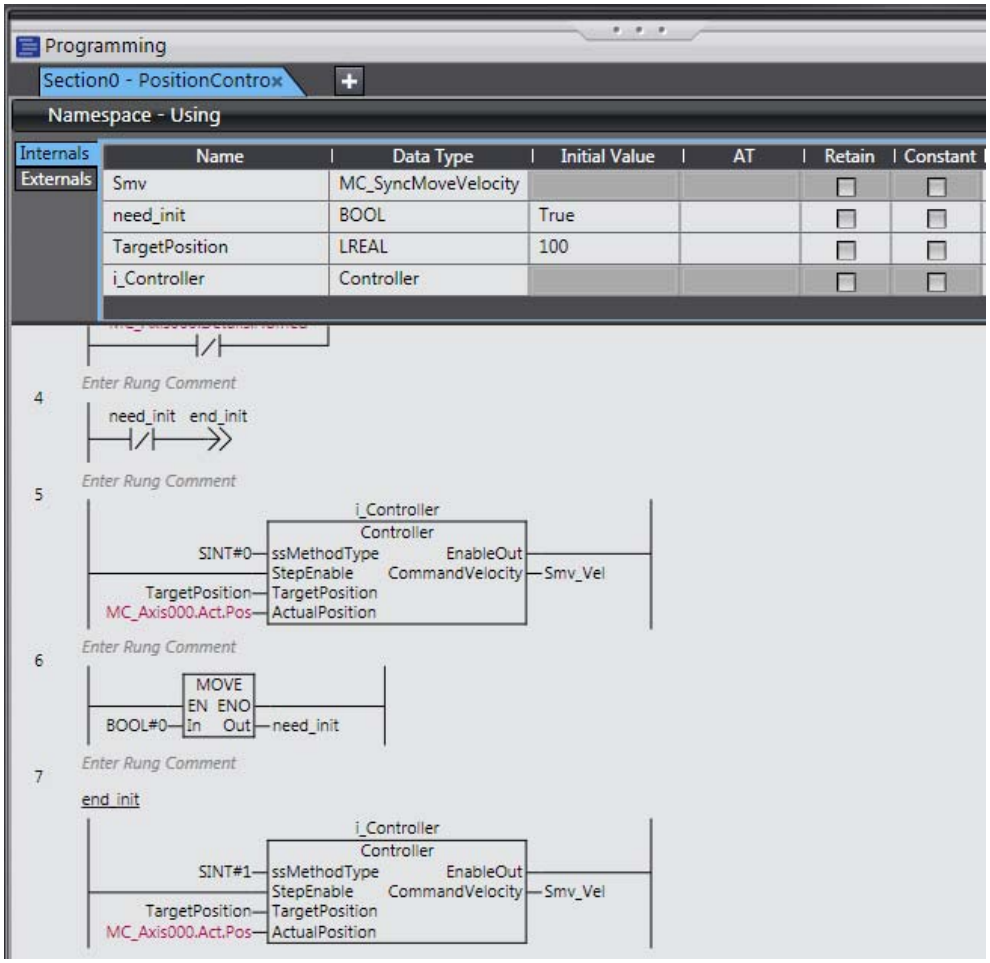
To call a function block from a program written in the ladder diagram language, the function block must have at least one BOOL input variable and one BOOL output variable.
This section describes the procedure for adding boolean signals to the block on the Simulink.

Additional Information

You also can add BOOL variables on the Sysmac Studio after importing the code without changing the block on the Simulink.

1 Add boolean signals to the Controller block on the Simulink.



2	When the code is imported to the Sysmac Studio, the BOOL variables are added as shown below. 
3	The program to call the function block is written in the ladder diagram language as shown below. 

Additional Information

Refer to the *Sample File No. 6 PLCCoderDemoMC_LD.mdl* that is provided separately for the Simulink model used in this section.

Refer to the *Sample File No. 7 PLCCoderDemoMC_LD.smc* that is provided separately for the program used in this section.

4.1. Sample File List

The following sample files are related to this Guide.
We provide the sample files separately.

No.	File Name	Description
1	PLCCoderDemoMC.mdl	File that contains the Simulink model described in *2.2. Designing the Control Algorithm* of this Guide.
2	PLCCoderDemoMC.smc	Sysmac Studio project file that contains Sysmac Studio programs described in *3.2.6 Creating Programs* of this Guide.
3	PLCCoderDemoMC_Torque.smc	Sysmac Studio project file that contains the program to output torque commands cyclically.
4	PLCCoderDemoMC_ADDA.mdl	File that contains the Simulink model that shows the usage example of GX-AD0471 Analog Input Terminal and GX-DA0271 Analog Output Terminal.
5	PLCCoderDemoMC_ADDA.smc	Sysmac Studio project file that shows the usage example of GX-AD0471 Analog Input Terminal and GX-DA0271 Analog Output Terminal.
6	PLCCoderDemoMC_LD.mdl	File that contains the Simulink model described in *4.1. Programming in Ladder Diagram Language* of this Guide.
7	PLCCoderDemoMC_LD.smc	Sysmac Studio project file that contains Sysmac Studio programs described in *4.1. Programming in Ladder Diagram Language* of this Guide.

OMRON Corporation **Industrial Automation Company**
Tokyo, JAPAN
Contact: www.ia.omron.com

Regional Headquarters
OMRON EUROPE B.V.
Wegalaan 67-69-2132 JD Hoofddorp
The Netherlands
Tel: (31)2356-81-300/Fax: (31)2356-81-388

OMRON ELECTRONICS LLC
One Commerce Drive Schaumburg,
IL 60173-5302 U.S.A.
Tel: (1) 847-843-7900/Fax: (1) 847-843-7787

OMRON ASIA PACIFIC PTE. LTD.
No. 438A Alexandra Road # 05-05/08 (Lobby 2),
Alexandra Technopark,
Singapore 119967
Tel: (65) 6835-3011/Fax: (65) 6835-2711

OMRON (CHINA) CO., LTD.
Room 2211, Bank of China Tower,
200 Yin Cheng Zhong Road,
PuDong New Area, Shanghai, 200120, China
Tel: (86) 21-5037-2222/Fax: (86) 21-5037-2200

Authorized Distributor:

Cat. No. W529-E1-01 0613(-)