

1S Series Library Easy Tuning HMI Page Samples

NX701-□□□□
NJ□01-□□□□
NA5-□W□□□□

Practices
Guide

■ Introduction

This guide provides reference information together with case examples on using the sample project for the Easy Tuning Library and merging them with the user application. It does not provide safety information.

Be sure to obtain the related manuals, read and understand the safety points and other information required for use, and test sufficiently before actually using the equipment.

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1 Related Manuals

The following manuals are related to this guide.

| Cat. No. | Model | Manual Name |
|----------|--|--|
| W501 | NX701-□□□□ NJ501-□□□□ NJ301-□□□□ NJ101-□□□□ | NJ/NX-series CPU Unit Software User's Manual |
| W504 | SYSMAC-SE2□□□ | Sysmac Studio Version 1 Operation Manual |
| W502 | NX701-□□□□ NJ501-□□□□ NJ301-□□□□ NJ101-□□□□ | NJ/NX-series Instructions Reference Manual |
| V118 | NA5-15W□□□□ NA5-12W□□□□ NA5-9W□□□□ NA5-7W□□□□ | NA-series Programmable Terminal Software User's Manual |
| V119 | NA5-15W□□□□ NA5-12W□□□□ NA5-9W□□□□ NA5-7W□□□□ | NA-series Programmable Terminal Device Connection User's Manual |
| V120 | NA5-15W□□□□ NA5-12W□□□□ NA5-9W□□□□ NA5-7W□□□□ | NA-series Programmable Terminal Startup Guide |
| I589 | SYSMAC-SE2□□□ | Sysmac Studio Drive Functions Operation Manual |
| W508 | NX701-□□□□ NJ501-□□□□ NJ301-□□□□ NJ101-□□□□ | NJ/NX-series Motion Control Instructions Reference Manual |
| W571 | SYSMAC-XR011 | Sysmac Library User's Manual for EtherCAT® 1S Series Library |

2 Precautions

- (1) When building an actual system, check the specifications of the component devices of the system, use within the ratings and specified performance, and implement safety measures such as safety circuits to minimize the possibility of an accident.
- (2) For safe use of the system, obtain the manuals of the component devices of the system and check the information in each manual, including safety precautions, precautions for safe use.
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- (6) The operation of each design template has been tested using the system configuration indicated in sections 4 and 5-2 of this guide. The display operation after incorporating the templates is not guaranteed.

Special information in this document is classified as follows:



Precautions for Safe Use

Indicates precautions on what to do and what not to do to ensure safe usage of the product.



Precautions for Correct Use

Indicates 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.

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3 Introduction

3-1 Overview

This guide describes the procedure to use, operate and partially customize the NJ/NX sample program and NA sample pages that are intended to adjust gains of the 1S-series Servo System (R88D-1SN□-ECT/R88D-1SAN□-ECT, R88M-1□) using the NJ/NX-series Machine Automation Controller (hereinafter called “NJ/NX”) and NA-series Programmable Terminal (hereinafter called “NA”).

3-2 Intended Audience

This guide is intended for the following personnel:

- Personnel considering the use of the EasyTuning Function Block
- Personnel who has already built a system using the NJ/NX and NA
- Personnel who understands basic operations, programming procedure, and procedure to create the NA data with the Sysmac Studio

3-3 Sample Project File

This guide describes the usage of the NJ/NX sample program and NA sample pages which are included in the following sample project:

- Sample Project File: HMI_Sample_EasyTuning_V1.0.0.smc2

4 Applicable Products

The sample project file described in this guide covers the following products:

| Name | Model | Version |
|--|----------------|------------------------|
| NX-series Machine Automation Controller | NX701-□□□□ | Version 1.08 or later |
| NJ-series Machine Automation Controller | NJ501-1□□□ | Version 1.08 or later |
| NA-series Programmable Terminal | NA5-12W101□ | Version 1.03 or later |
| Sysmac Studio | SYSMAC-SE2□□□ | Version 1.09 or higher |
| 1S-series AC Servo Drive | R88D-1SN□-ECT | Revision 1.0 or later |
| | R88D-1SAN□-ECT | Revision 1.0 or later |
| AC Servomotor | R88M-1□ | - |

(Cables that connect devices are not included.)

5 How To Use NA Sample Pages

This section describes how to use the NA sample pages.

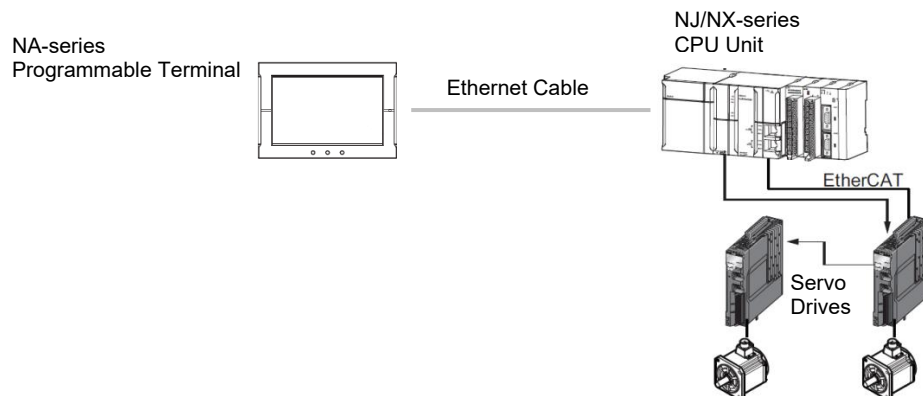
5-1 NA Sample Pages Functions

The NA sample pages include the following functions:

| Function | Description |
|-------------|--|
| Easy Tuning | This function allows you to easily adjust gains of servomotors from the NA. The optimal gains are automatically attained while the motor operation is repeated. (This function is equivalent to Easy Tuning of the Sysmac Studio drive functions.) |

5-2 System Configuration

The system configuration to use the sample project file is shown below. To use the sample project file, adjust the actual system configuration to the configuration set for the sample project file.



5-3 Startup Procedure

Connect the NJ/NX-series CPU Unit (hereinafter called “controller”) and NA by referring to *5-2 System Configuration*. Then connect them to the Sysmac Studio. For connection of NA to the Sysmac Studio, refer to the *Connecting to the HMI* in the *NA-series Programmable Terminal Software User’s Manual* (Cat. No. V118).

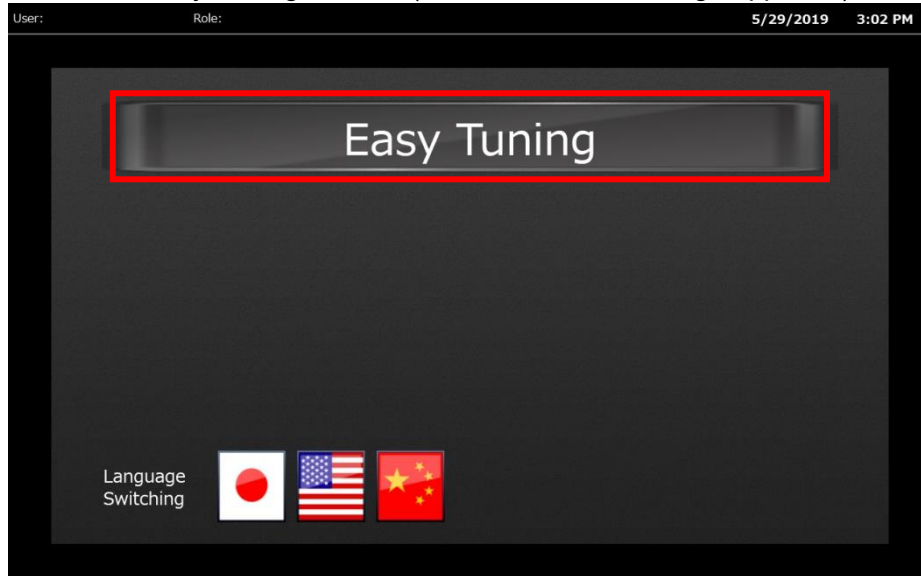
Transfer the NJ/NX sample program to the NJ/NX and the NA sample pages to the NA.

5-4 Operation Procedure for Easy Tuning




This section describes the procedure to adjust the gains of servomotors using Easy Tuning.

1. Main Menu

Press the “Easy Tuning” button. (The Axis Selection Page appears.)



Press a flag button on this page to change the display language.

| Flag button | Description |
|---|--|
|  | Change the display language to Japanese. |
|  | Change the display language to English. |
|  | Change the display language to Simplified Chinese. |

2. Axis Selection Page

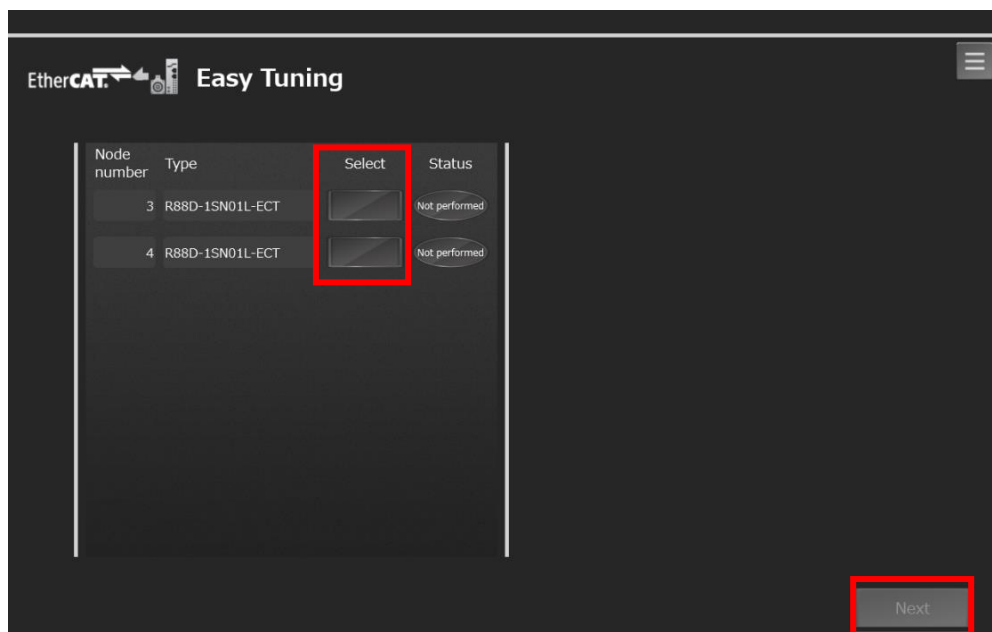
Press the “Select” button next to the type of the motor to tune.

(The selected “Select” button turns blue.)

Press the “Next” button. (The Tuning Method Selection Page appears.)

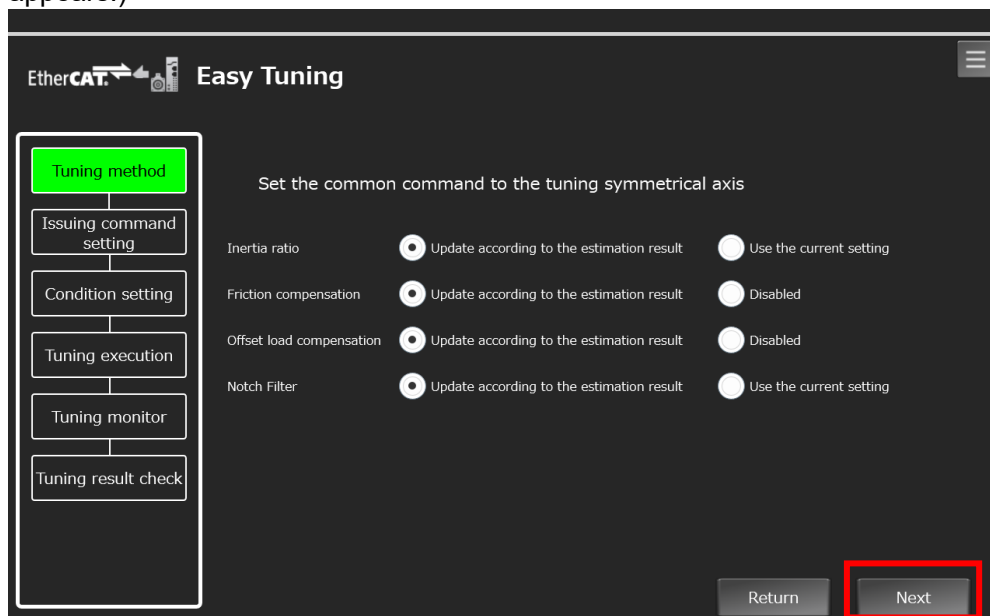
Note: 1. Refer to 6-1 *Adding and Deleting Axes* for how to add and delete axes.

2. When the “Continuous adjustment” button is pressed on the Tuning Result Check Page, the *Status* of a tuned axis changes from “Not performed” to “Performed”. When you move to the Main Menu, the *Status* of each axis changes to “Not performed”.



3. Tuning Method Selection Page

Select the tuning method and press the “Next” button. (The Issuing Command Setting Page appears.)



Tuning is performed based on the selection for the following items.

| Item | Option | Description |
|--------------------------|---|---|
| Inertia ratio | Update according to the estimation result | The amount of load inertia is automatically estimated and the setting of Inertia Ratio (3001 hex - 01 hex) is updated based on the result. |
| | Use the current setting | The drive's current setting of Inertia Ratio (3001 hex - 01 hex) is maintained. |
| Friction compensation | Update according to the estimation result | The load friction is automatically estimated and the torque compensation settings (Viscous Friction Coefficient (3310 hex - 01 hex), Positive Dynamic Friction Compensation (3310 hex - 03 hex), and Negative Dynamic Friction Compensation (3310 hex - 04 hex)) are updated based on the result. |
| | Disabled | The torque compensation values (Viscous Friction Coefficient (3310 hex - 01 hex), Positive Dynamic Friction Compensation (3310 hex - 03 hex), and Negative Dynamic Friction Compensation (3310 hex - 04 hex)) are set to 0 to disable the friction compensation. |
| Offset load compensation | Update according to the estimation result | The amount of offset load of the load is automatically estimated and the setting of the torque compensation value (Unbalanced Load Compensation (3310 hex - 02 hex)) are updated based on the result. |
| | Disabled | The torque compensation value (Unbalanced Load Compensation (3310 hex - 02 hex)) is set to 0 to disable the offset load compensation. |
| Notch Filter | Update according to the estimation result | The resonance frequency of the load is automatically estimated and the settings of Notch Filters (3321 hex to 3324 hex) are updated based on the result. After the tuning, Adaptive Notch Filter (3320 hex - 01 hex) is set to Disabled. |
| | Use the current setting | The Drive's current settings of Adaptive Notch Filter (3320 hex - 01 hex) and Notch Filters (3321 hex to 3324 hex) are maintained. |

4. Motion Profile Setting Page

Set the motor rotation direction, travel amount, command speed, and acceleration and deceleration speed during tuning*1, *2.

*1. The same motion profile is applied to all the selected axes.

*2. The command units of the axis that you selected first on the Axis Selection page are displayed as the operation command units.

Press the “Next” button after completing the setting (The Condition Setting Page appears.)

EtherCAT Easy Tuning

Set the common command to the tuning symmetrical axis

Direction of rotation

Command speed mm /s

Travel amount mm

Acceleration and deceleration speed mm /s²

Dwell time

Return Next

5. Condition Setting Page

Set the conditions for finishing the auto tuning.

When the conditions set here are satisfied, the tuning is complete.

Press the “Next” button after completing the setting (The Tuning Execution Page appears.)

EtherCAT Easy Tuning

Set the common command to the tuning symmetrical axis

Stabilization time Manual setting Automatic adjustment
 ms

Vibration detection level %

Positioning completion width Command unit

Response Focused on following performance Overshoot suppression

Motion interpolation method Curve (smooth) Linear

Save tuning results in EEPROM Perform Not perform

Return Next

Completion of the tuning is determined based on the selection for the following items.

| Item | Option | Description |
|---|----------------------------------|--|
| Stabilization time | Manual setting | Set the stabilization time that is applied as the tuning completion condition. |
| | Automatic adjustment | The function block automatically sets the stabilization time as short as possible within the range that does not cause micro vibration in the drive. |
| Vibration detection level | | Adjust the gain so that the torque vibration does not exceed this setting value. Set the percentage to the rated torque of the motor. Servo Drive Unit Version 1.0 and 1.1 do not use decimal digit resolution, whereas Servo Drive Unit Version 1.2 or later uses 1 decimal digit resolution. |
| Positioning completion width | | Set the in-position width used for measuring the stabilization time. This setting value is applied to the Positioning Completion Notification - Positioning Window (3B51 hex - 01 hex). |
| Response ^{*1} | Focused on following performance | Priority is given to reducing the stabilization time. Depending on the machine and tuning conditions, overshoot may occur. |
| | Overshoot suppression | Priority is given to suppression of overshoot in the tuning. |
| Motion interpolation method ^{*2} | Curve (smooth) | Set the interpolation method for the command in the cyclic synchronous position mode (csp) to 2nd order interpolation. |
| | Linear | Set the interpolation method for the command in the cyclic synchronous position mode (csp) to 1st order interpolation. |
| Save tuning results to EEPROM | | Select whether to save tuning results to EEPROM. If you select "Not perform", the tuning results will be lost when the power supply to the drive is turned OFF. |

*1. This item can be set when two-degree-of-freedom is set.

*2. Revised in Servo Drive Unit Version 1.2 or later.

6. Tuning Execution Page

Press the “Start” button to start auto tuning. (The Tuning Monitor Page appears.)

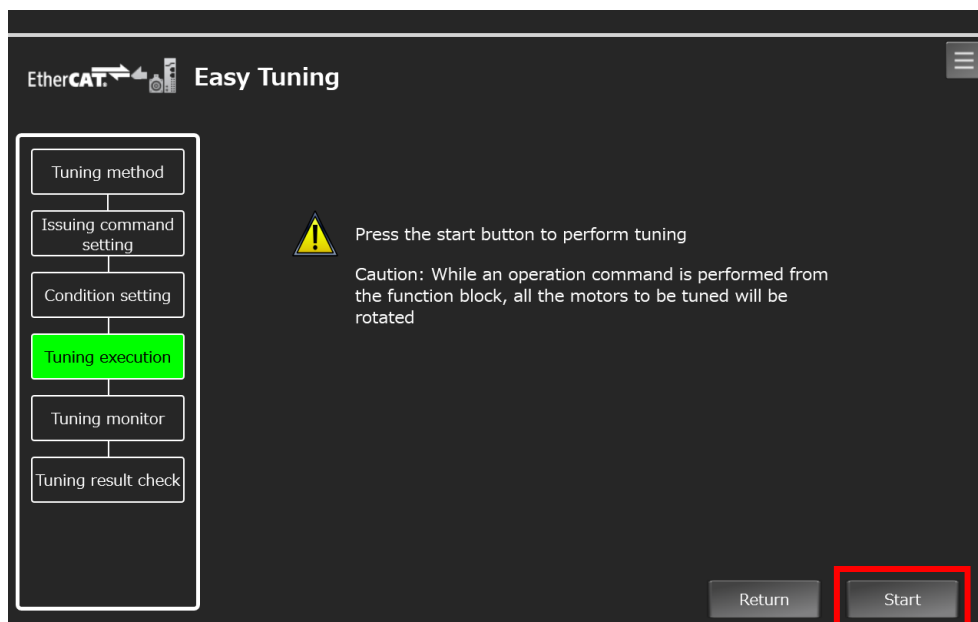
When the completion criteria are satisfied, torque is saturated*1 or torque vibration of the motor is detected, the auto tuning is finished.

*1. The Servo Drive Unit Version 1.2 or later can detect torque saturation.



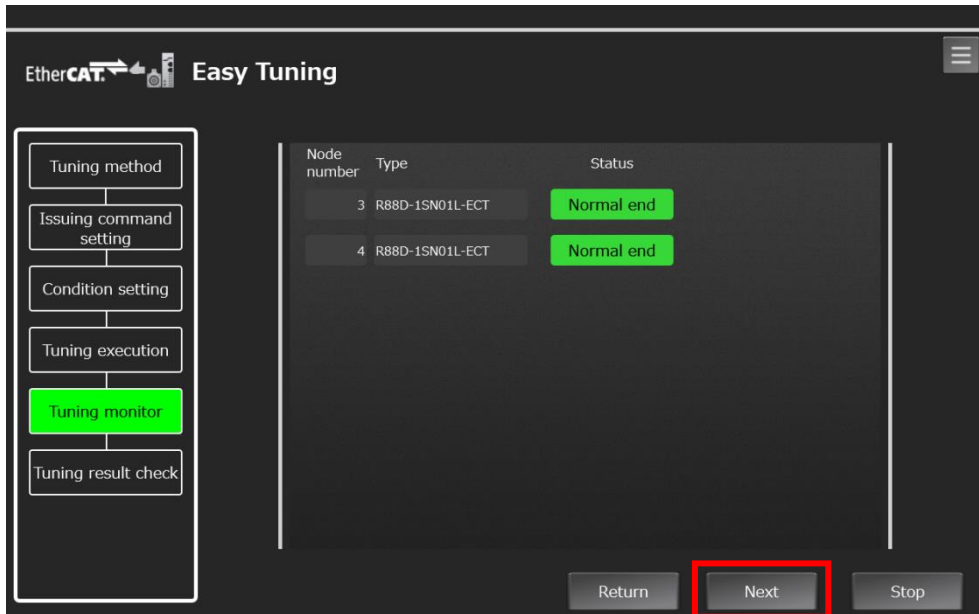
Precautions for Correct Use

Be careful because the motor will start running by pressing the “Start” button.



7. Tuning Monitor Page

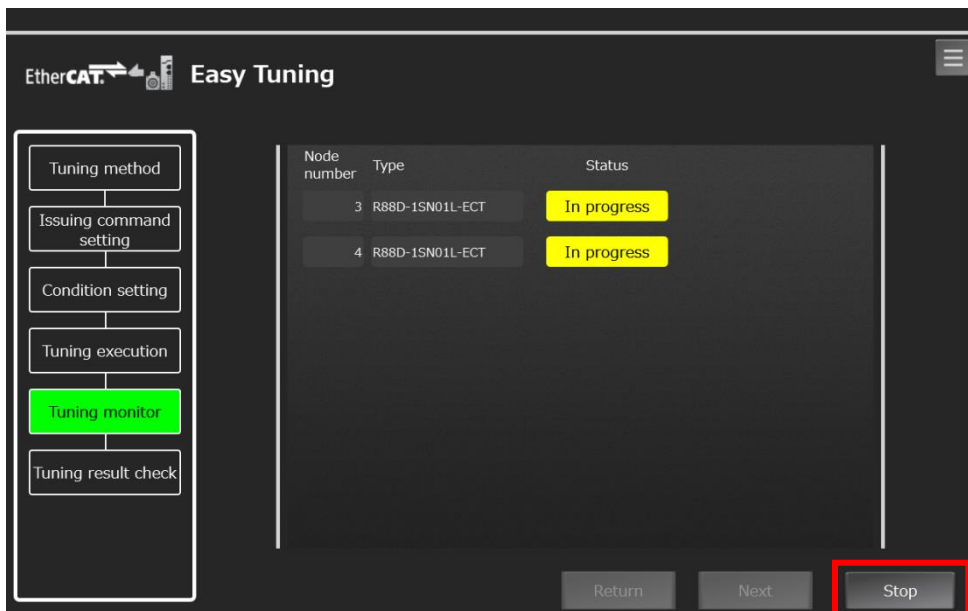
Make sure that the *Status* changed to “Normal end” and press the “Next” button.
(The Tuning Result Check Page appears.)



- Stopping the tuning

Press the “Stop” button.

The tuning and commands for the axis to tune are aborted. Please note that the motor will not stop immediately depending on the operation command.





Additional Information

Depending on the machine and tuning conditions, tuning may be aborted if torque vibration or saturation is detected in the motor during the tuning. In that case, take the following measures and perform the tuning again.

- Change the criteria for finishing the tuning

If the setting values for in-position width and/or stabilization time are too small, it is difficult to satisfy the completion criteria.

- Increase the machine rigidity
-

8. Tuning Result Check Page

A list of parameter values set as the results of tuning is displayed.

Select the node number to check the tuning results of the motor.

Press the “Complete” button after checking the results. (The Main Menu appears.)

- Performing the tuning again

Press the “Retry” button. (The Tuning Method Selection Page appears.)

- Performing the tuning for other motors

Press the “Continuous adjustment” button. (The Axis Selection Page appears.)

The *Status* of the tuned axis is displayed as “Performed” in the Axis Selection Page.

The screenshot shows the 'Easy Tuning' interface with the 'Node' dropdown set to '3'. A sidebar on the left contains a menu with 'Tuning result check' highlighted in green. The main area displays a table of tuning results:


| Description | Value | Unit |
|--|-------|------|
| Stabilization time | 263 | ms |
| Overshoot | 6 | % |
| 1st Velocity Control Gain, Proportional Gain | 25.2 | Hz |
| 1st Position Control Gain, Proportional Gain | 5.1 | Hz |
| Estimated inertia ratio | 30 | % |
| Estimated unbalanced load | -0.4 | % |
| Estimated dynamic friction | 1.6 | % |

At the bottom, there are three buttons: 'Retry', 'Continuous adjustment', and 'Complete'. The 'Complete' button is highlighted with a red box.



Additional Information

Press the “Return” button to display the previous page.

Press the  button to display the Main Menu.

6 Modifying the Program

This section describes how to modify the NJ/NX sample program. Use the Sysmac Studio to modify the program. For details on operating the Sysmac Studio, refer to the *Sysmac Studio Version 1 Operation Manual* (Cat. No. W504).

6-1 Adding and Deleting Axes

The sample project file includes the NJ/NX sample program (hereinafter called “NJ/NX project”) and the NA sample pages (hereinafter called “NA project”).

This section describes how to change the NJ/NX project to add and delete axes.

The NA page design limits the number of axes that can be set to a maximum of 16.

1. Setting EtherCAT and motion control

Go offline, and add or delete servo drives to/from the EtherCAT configuration.

Add or delete the axes in the axis settings.

* For details on adding and deleting servo drives and axes, refer to the *EtherCAT Configuration and Setup* and *Motion Control Setup* in the *Sysmac Studio Version 1 Operation Manual* (Cat. No. W504).

2. Modifying the program

Double-click **Section0** under **Programming - POUs - Programs - Program0** in the Multiview Explorer.

Add or delete the circuit parts in the 1st, 2nd, 3rd, and 4th lines of the ladder program in accordance with the number of axes, as shown below.

* For details on adding and deleting circuit parts, refer to the *Programming Ladder Diagrams* in the *Sysmac Studio Version 1 Operation Manual* (Cat. No. W504).

- 1st line

Function block (FB_1SEasyTuningReadServoInfo)

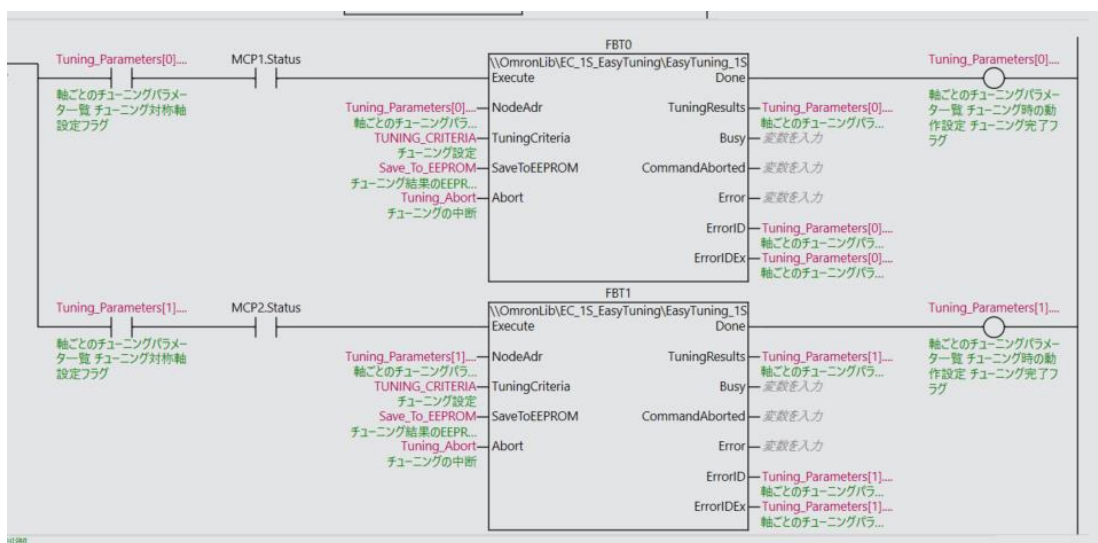
Note: When adding a circuit part, change the instance variable name of the function block, axis variable names, and number of *Tuning_Parameters[]*.*Servo_Info*.



- 2nd line

Input, output, and function block

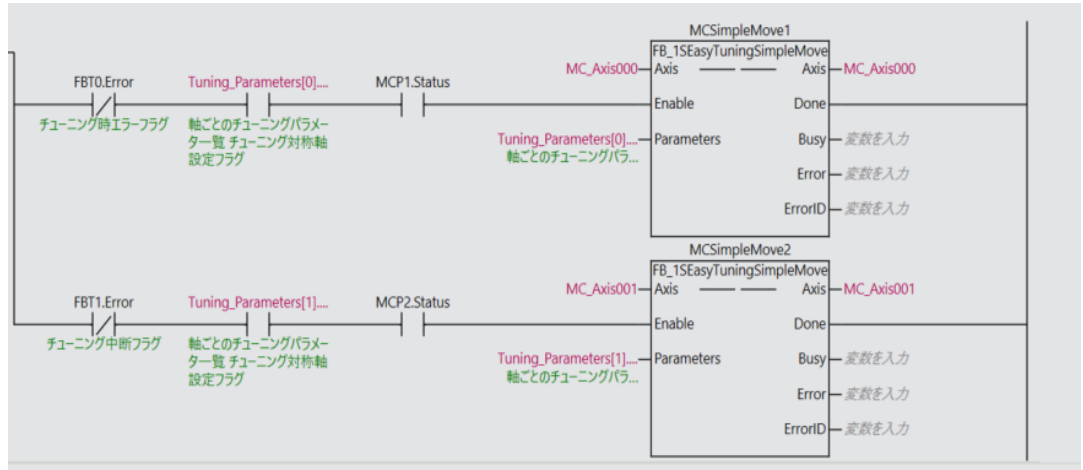
Note: When adding circuit parts, change the instance variable name of the function block, axis variable names, and number of *Tuning_Parameters[]*.



- 3rd line

Input and function block

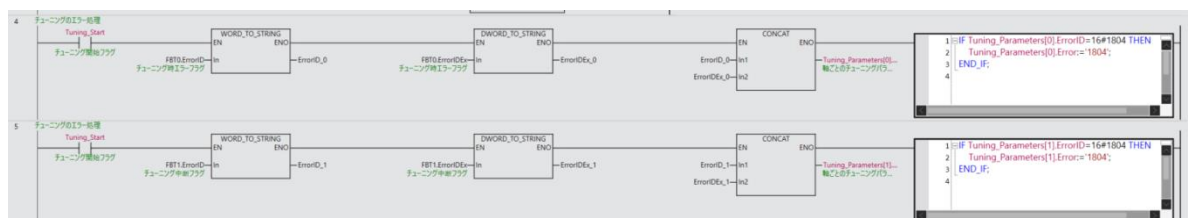
Note: When adding circuit parts, change the instance variable name of the function block, axis variable names, and number of *Tuning_Parameters*[].



- 4th and 5th lines

Add the same circuit parts as the 4th and 5th lines.

Note: Change the numbers of *ErrorID_0*, *ErrorIDEx_0*, and *Tuning_Parameters*[].



- Changing the number of displayed axes
Double-click **Global Variables** under **Programming - Data** in the Multiview Explorer.
Change the initial value of the global variable *No_Of_Axis_Used* to the number of connected axes.
Make sure that only the *Constant* check box is selected.

| Name | Data Type | Initial Value | AT | Retain | Constant | Network Publish | |
|------------------------------|---|----------------------------------|--------------|-------------------------------------|-------------------------------------|-----------------|---|
| MC_Axis000 | _sAXIS_REF | | MC://_MC_AXI | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Do not publish | |
| MC_Axis001 | _sAXIS_REF | | MC://_MC_AXI | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Do not publish | |
| Tuning_Parameters | ARRAY[0..15] OF sTun | | | <input type="checkbox"/> | <input type="checkbox"/> | Do not publish | Tuning parameter list for each axis |
| Tuning_Start | BOOL | | | <input type="checkbox"/> | <input type="checkbox"/> | Do not publish | Tuning start flag / チューニング開始 |
| Save_To_EEPROM | BOOL | | | <input checked="" type="checkbox"/> | <input type="checkbox"/> | Do not publish | Setting to save tuning result to EEPROM |
| No_Of_Axis_Used | INT | 2 | | <input type="checkbox"/> | <input checked="" type="checkbox"/> | Do not publish | Maximum number of connected axes |
| TUNING_CRITERIA | OmronLib(ECT, 's_Easy)EstimateParameterData | | | <input checked="" type="checkbox"/> | <input type="checkbox"/> | Do not publish | Tuning criteria / チューニング設定 |
| Operation_Parameters_Setting | sOperationParameter | (Direction := 0, Direction := 1) | | <input checked="" type="checkbox"/> | <input type="checkbox"/> | Do not publish | Motion profile setting at tuning |
| Tuning_Abort | BOOL | | | <input type="checkbox"/> | <input type="checkbox"/> | Do not publish | Tuning abort flag / チューニング中止 |

- Transferring data to the controller
Build the program.
After building, go online and transfer the program to the controller.
* For details on building and transferring the program, refer to the *Building and Rebuilding* and the *Transferring/Comparing Data to/from the Controller* in the *Sysmac Studio Version 1 Operation Manual* (Cat. No. W504).
- Restarting the NA.
Go offline and restart the NA.

6-2 Modifying the Operation Command Program

This section describes how to create and modify the operation command program.

Use the following procedure to change the command program in the NJ/NX project to your desired program.

- Double-click **Section0** under **Programming - POU's - Programs - Program0** in the Multiview Explorer.
- Replace the 3rd line of the ladder program with your desired program.



Additional Information

Set the dwell time in the operation command.

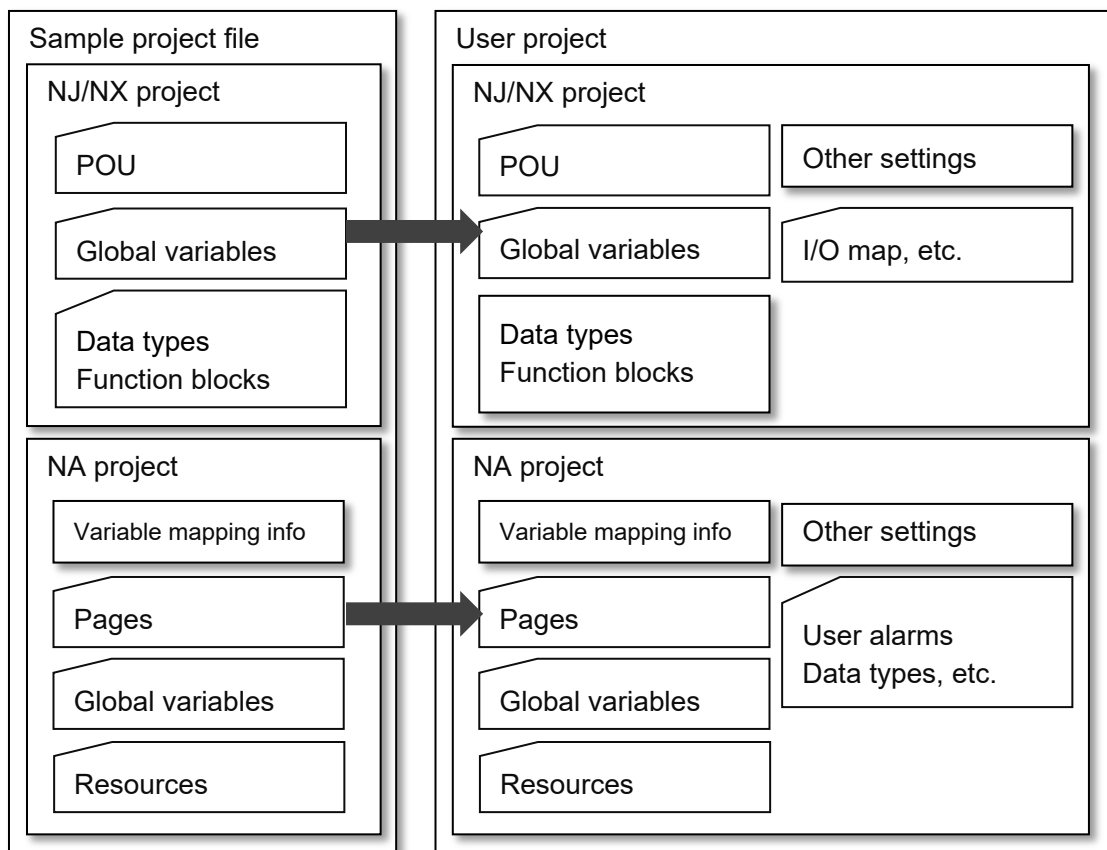
For details, refer to the *EasyTuning_1S* in the *Sysmac Library User's Manual for EtherCAT® 1S Series Library* (Cat. No. W571).

7 Merging with the User Project

This section describes how to merge the NJ/NX project and the NA project with the user-designed project (user project). Use the Sysmac Studio to merge the projects. For details on operating the Sysmac Studio, refer to the *Sysmac Studio Version 1 Operation Manual* (Cat. No. W504).

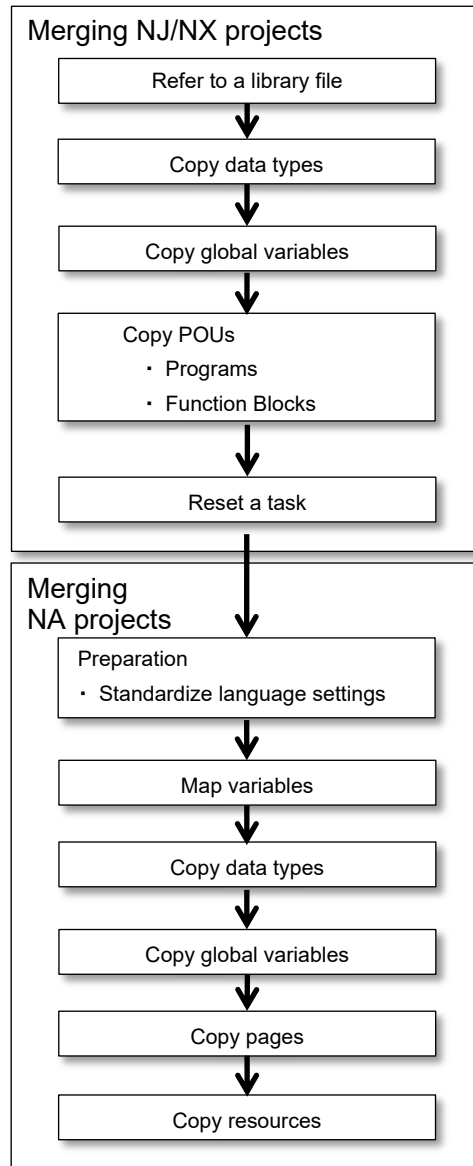
7-1 Overview

By merging the programs and settings included in the NJ/NX project and NA project in the sample project file with those in the user project, you can use the functions of this sample program in your application.



7-2 Merging Flow

The following is the procedure required to merge the NJ/NX project and NA project in the sample project file with those in the user project.



The details of each step will be described in the next sections.

7-3 Merging NJ/NX Projects

This section describes the procedure to merge the NJ/NX projects.

7-3-1 Referring to a Library File

The NJ/NX project in the sample project file employs the Easy Tuning Library. To use the Easy Tuning Library in the user project after merging, open the Library Reference Dialog Box from the user project and read the following library file.

- Library file: OmronLib_EC_1S_EasyTuning_V1_0.slr



Additional Information

When you open a project file, a dialog box may appear to confirm whether to overwrite the project with current project library data. In principle, click the **Yes** Button to overwrite the project with the project library data.

7-3-2 Copying Data Types

In the NJ/NX project in the sample project file, some data types are defined for the global variables required to interface with the NA. Copy all the information to the user project.

7-3-3 Copying Global Variables

In the NJ/NX project in the sample project file, the global variables required to interface with the NA are declared. Copy all the information to the user project.

7-3-4 Copying POUs

In the NJ/NX project in the sample project file, the following program and function block are defined. Copy them to the user project.

- Program
Program0/Section0
- Function block
FB_1SEasyTuningReadServoInfo

7-3-5 Resetting a task

The following task is set in the NJ/NX project in the sample project file.

| Task name | Task type | Period | Priority | Remarks |
|-------------|-----------------------|--------|----------|---------|
| PrimaryTask | Primary periodic task | 2 ms | 4 | |

If a task with the same settings exists in the user project, assign the merged program to the task. If no task with the same settings exists, assign to the most appropriate periodic task for your application.

7-4 Merging NA Projects

7-4-1 Checking Language Settings

If the language settings differ between the NA project in the sample project file and the NA project in the user project, the resources (e.g., text) may be lost during merging.

To avoid this, check the language settings of both the NA projects before merging, and modify the settings if necessary.



Additional Information

The NA can manage text strings on labels and other resources as multi-language resources.

When the default language is different between the merge source file and the merge destination file, the resources may not be merged correctly. Therefore, it is necessary to determine the default language of the Sysmac Studio in advance and standardize use in the default language so as to avoid having different default languages between the merged projects.

In addition to Japanese (Japan) as the default language, English (United States) and Simplified Chinese (China) are set for the NA project in the sample project file.

7-4-2 Mapping Variables

In the NA project in the sample project file, the global variables of the NA are mapped to some global variables of the NJ/NX to interface with the NJ/NX. Copy the variable name in the *Variable* column of the NJ/NX global variables mapped in the NA project in the sample project file, and paste it to the *Variable* column of the same NJ/NX global variable on the Variable Mapping Tab Page in the user project. This automatically creates necessary data types and NA global variables and maps them.

7-4-3 Copying Data Types

In the NA project in the sample project file, the data types of the global variables required to interface with the NJ/NX and to control the NA pages are declared. Copy all the information to the user project.

7-4-4 Copying Global Variables

In the NA projects in the sample project file, the global variables required to interface with the NJ/NX and to control the NA pages are declared. Copy this information to the user project. Since the variables mapped in the previous step have already been registered as the NA global variables, copy all the variables in the NA project in the sample project file that are not mapped.

7-4-5 Copying Pages

Copy all the pages included in the NA projects in the sample project file to the user project. When copying the page, make sure that the page name and index are not used for existing pages. When the name and index are already used, modify them.



Additional Information

If a dialog box to confirm whether to overwrite resources appears when you copy a page, do not overwrite. If you select to overwrite, the data already created in the user project may be affected.

7-4-6 Copying Resources

The resources (e.g., text data) used in the pages included in the NA project in the sample project file are automatically merged when the pages are merged. If there are any resources that were not copied, copy them manually.

Revision History

| Revision code | Date | Revised content |
|---------------|--------------|---------------------|
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Note: Do not use this document to operate the Unit.

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