MITSUBISHI ELECTRIC
Changes for the Better

Servo
SIMPLE MOTION Module

This course is available as part of an online training (e-Learning) system for those working to establish a Motion control system using a Simple Motion Module for the first time.

L(NA)00130ENG

Introduction Purpose of the Course

This course provides an opportunity for beginners who want to construct Motion control systems using Simple Motion Modules to learn all about the procedures and tasks needed for working with a Simple Motion Module for the first time from the design, installation, and wiring to operation using the MELSOFT GX Works2 Programmable Controller Engineering Software.

For this course, you will need to have a basic knowledge of the MELSEC-Q series PLCs, AC servos, and positioning control.

It is recommended that beginners to the Mitsubishi Electric FA e-learning courses take the following courses:

- MELSEC-Q series Basics course
- MELSERVO Basics course
- Introduction to FA Devices (Positioning) course

These courses will provide you with a solid foundation on FA devices and relevant topics.

Introduction Course Structure

The contents of this course are as follows.
We recommend that you start from Chapter 1.

Chapter 1 - Overview and Practical Examples of a Simple Motion Module

You will be given an overview and shown some practical examples of a Simple Motion Module in this chapter.

Chapter 2 - Equipment Configuration and Wiring

You will be shown examples of the equipment configuration as well as wiring layouts with a Simple Motion Module.

Chapter 3 - GX Works2 and the Simple Motion Module Setting Tool

You will learn how to complete settings for the Simple Motion Module system and various parameters.

Chapter 4 - Positioning Control

You will learn how to perform positioning control with a Simple Motion Module.

Chapter 5 - Construction of a Sample System (Positioning)

You will learn how to construct sample systems designed for positioning tasks.

Chapter 6 - Synchronous Control

You will learn how to perform synchronous control with a Simple Motion Module.

Chapter 7 - Construction of a Sample System (Synchronous Control)

You will learn how to construct the sample systems designed for synchronous control.

Final Test

Passing grade: 60% or higher.

Introduction How to Use This e-Learning Tool

Go to the next page		Go to the next page.
Back to the previous page		Back to the previous page.
Move to the desired page		“Table of Contents” will be displayed, enabling you to navigate to the desired page.
Exit the learning		Exit the learning. Window such as "Contents" screen and the learning will be closed.

Introduction Cautions for Use

Safety precautions

When you learn by using actual products, please carefully read the safety precautions in the corresponding manuals.

Precautions in this course

- The displayed screens of the software version that you use may differ from those in this course.

This course is for the following software version:

- GX Works2 Version 1.87R
- MR Configurator2 Version 1.12N

Reference materials

Below is a list of references related to the topics in this course. (Please note that these reference materialss are not absolutely necessary as you can still complete this course without using them.)
Click on the name of the reference file to download.

Name of reference	File format	File size
Sample program	Compressed file	473 kB
Recording paper	Compressed file	8.17 kB

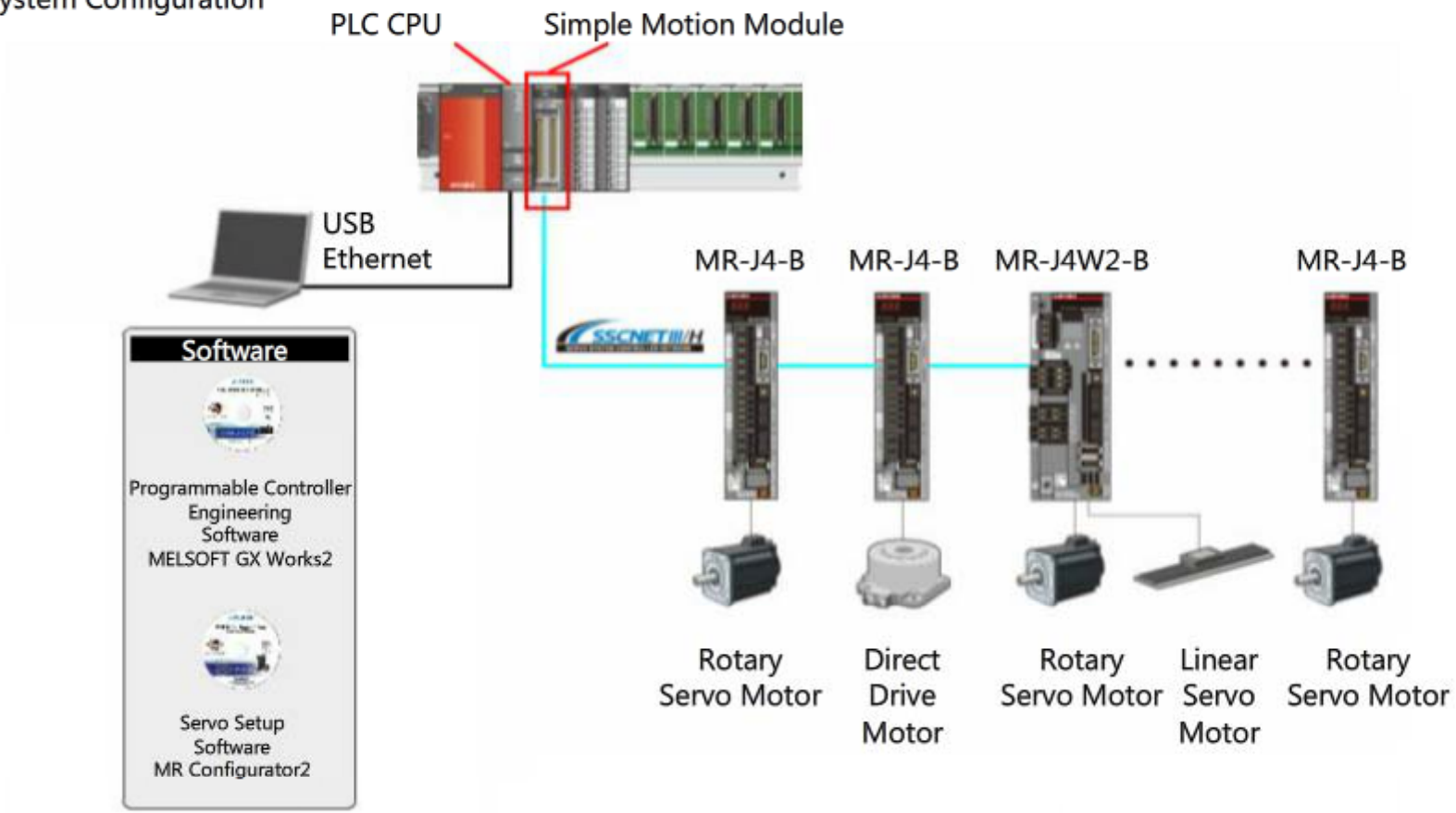
Chapter 1 Overview and Practical Examples for a Simple Motion Module

In chapter 1, you will be given an overview and shown some practical examples of a Simple Motion Module.

1.1 Overview of the Simple Motion Module

A Simple Motion Module is an intelligent function module used to provide positioning control using commands from a PLC CPU.

System Configuration



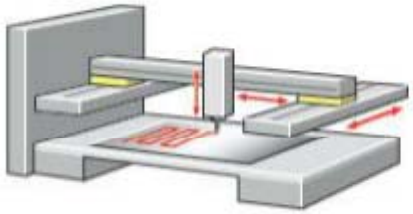
1.2 Differences between a Simple Motion Module and a regular positioning module

A Simple Motion Module is a more advanced positioning module that is backwards-compatible with previous positioning modules.
Simple Motion Modules provide standard positioning control as well as other advanced controls not available on a regular positioning module such as synchronous control and cam control with the feel of a regular positioning module.

	Simple Motion Module		Positioning module
	QD77MS	LD77MH	QD75MH
Maximum number of control axes	2 axes/4 axes/16 axes	4 axes/16 axes	1 axis/2 axes/4 axes
Compatible servo amplifiers	MR-J4 series	MR-J3 series	
Main positioning functions			
PTP control	○	○	○
Linear interpolation	○	○	○
OPR control	○	○	○
JOG operation	○	○	○
Electronic gear	○	○	○
Absolute position system	○	○	○
Advanced functions			
Synchronous control	○	○	–
Cam control	○	○	–
Speed control	○	○	–
Torque control	○	○	–

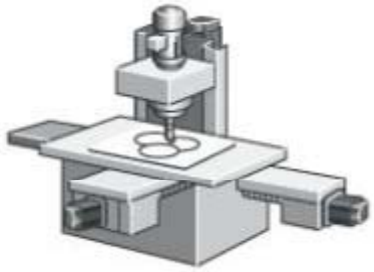
1.3 Practical Examples of Simple Motion Modules

Simple Motion Modules can be applied to systems in a variety of applications as they easily perform positioning control.



Sealing

- Continuouse orbit control
- Linear/circular interpolation
- Synchronous control
- High-speed, high-accuracy orbit calculation



X-Y table

- 2-axis linear interpolation
- 2-axis circular interpolation
- 3-axis linear interpolation
- Continuous orbit control

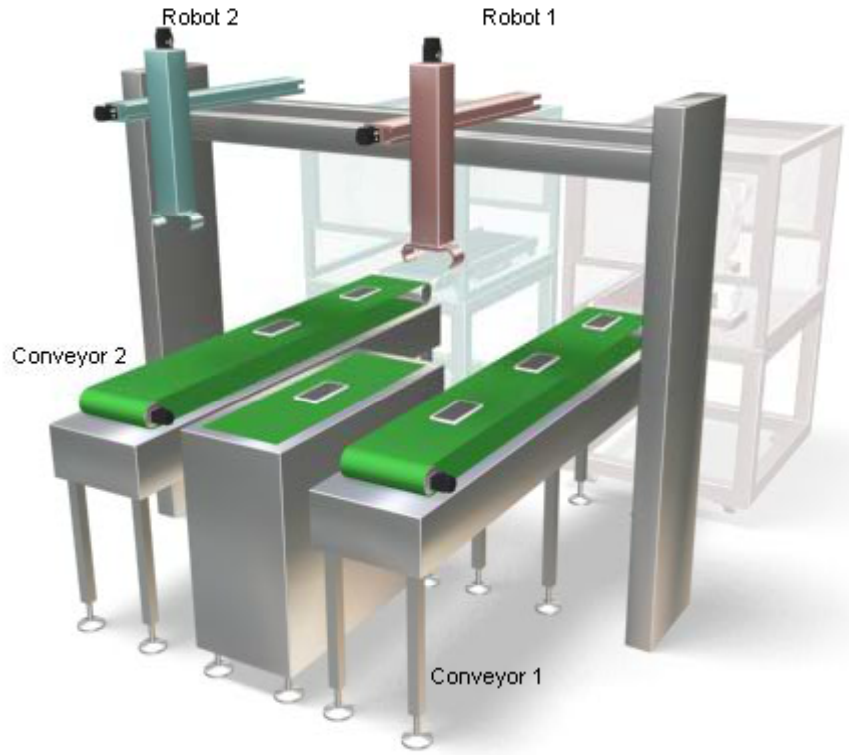
Conveyance line

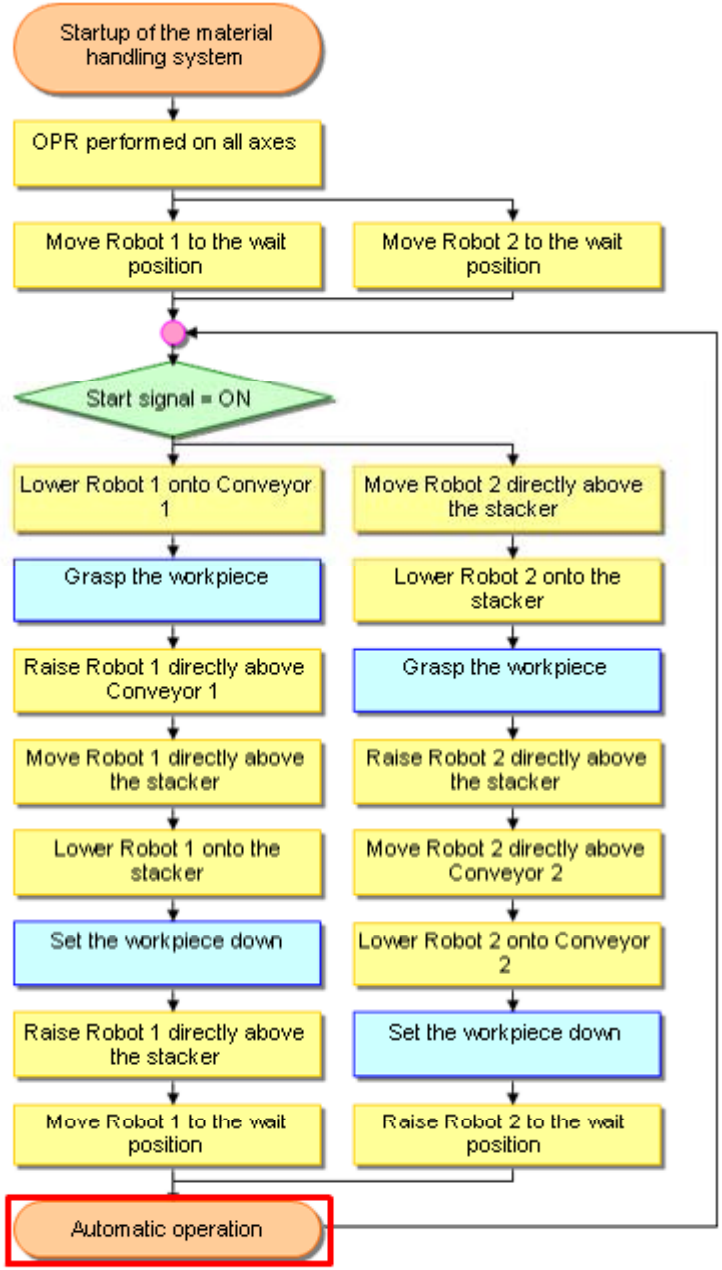
- 2-axis linear interpolation
- Continuous positioning control
- Synchronous control
- Cam control

In this course, you will learn how to construct the above conveyance lines with a QD77MS model Simple Motion Module using positioning control and synchronous/cam control.

1.4 Overview of a Sample System

Check the control details (control flow) in the sample system in this course with the provided animation.





1.5 Summary

In this chapter, you have learned:

- Overview of the Simple Motion Module
- Differences between a Simple Motion Module and a regular positioning module
- Practical Examples of Simple Motion Modules

Important points

The following points are very important, so please review them again to ensure that you have familiarized yourself with their content.

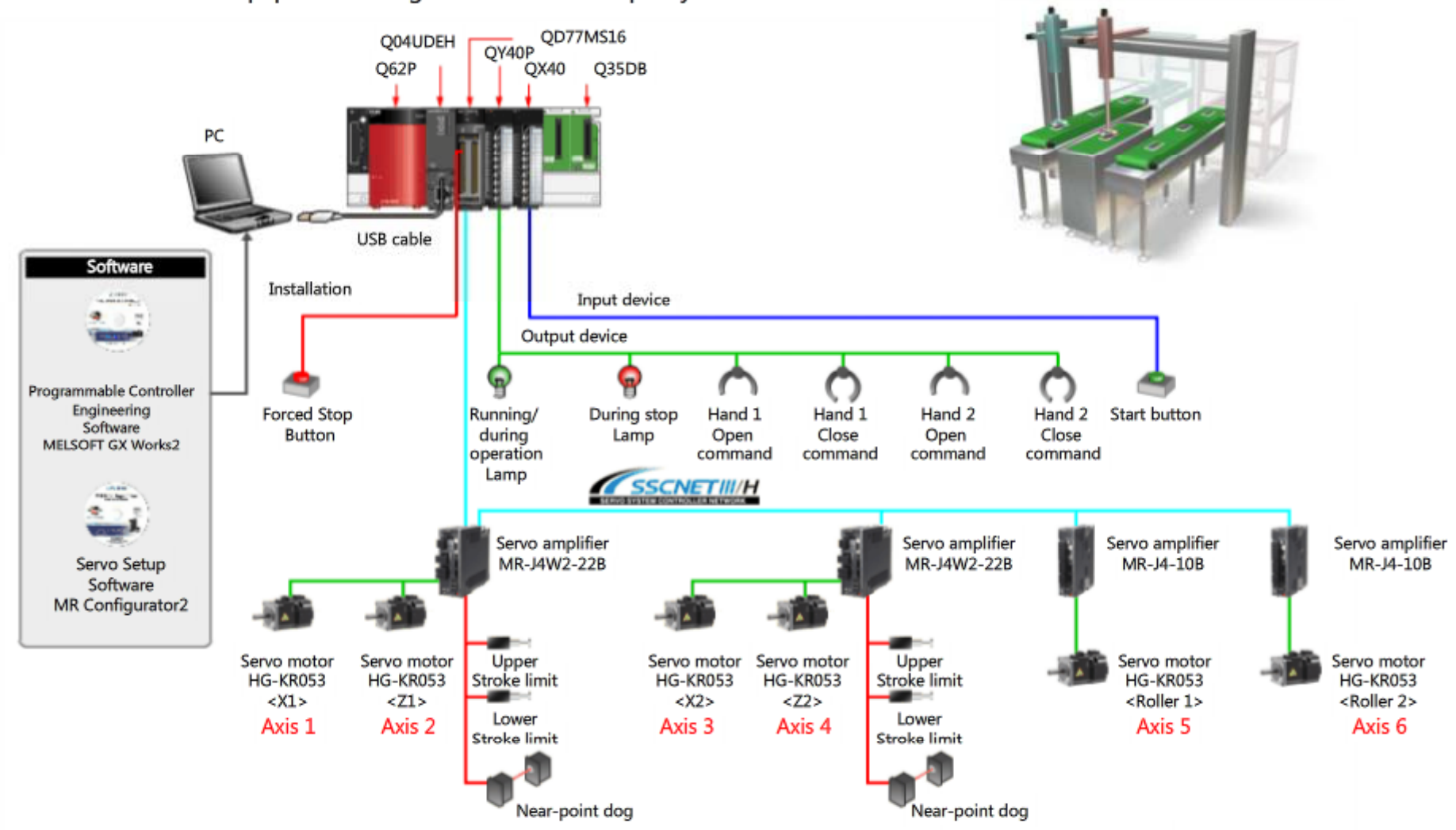
Overview of the Simple Motion Module	A Simple Motion Module is an intelligent function module used to provide simple positioning control using commands from a PLC CPU.
Differences between a Simple Motion Module and a regular positioning module	A Simple Motion Module is a more advanced positioning module that is backwards-compatible with standard positioning modules. Simple Motion Modules provide standard positioning control as well as other advanced controls not available on a regular positioning module such as synchronous control and cam control with the feel of a regular positioning module.
Practical Examples of Simple Motion Modules	Simple Motion Modules can be applied to systems in a variety of applications including sealing, X-Y tables, and conveyance lines as they easily perform positioning control.

Chapter 2 Equipment Configurations and Wiring

In Chapter 2, you will learn about equipment configurations and wiring layouts for the sample system.

2.1 Equipment configurations for sample systems

Below is shown the equipment configuration of the sample system used in this course.

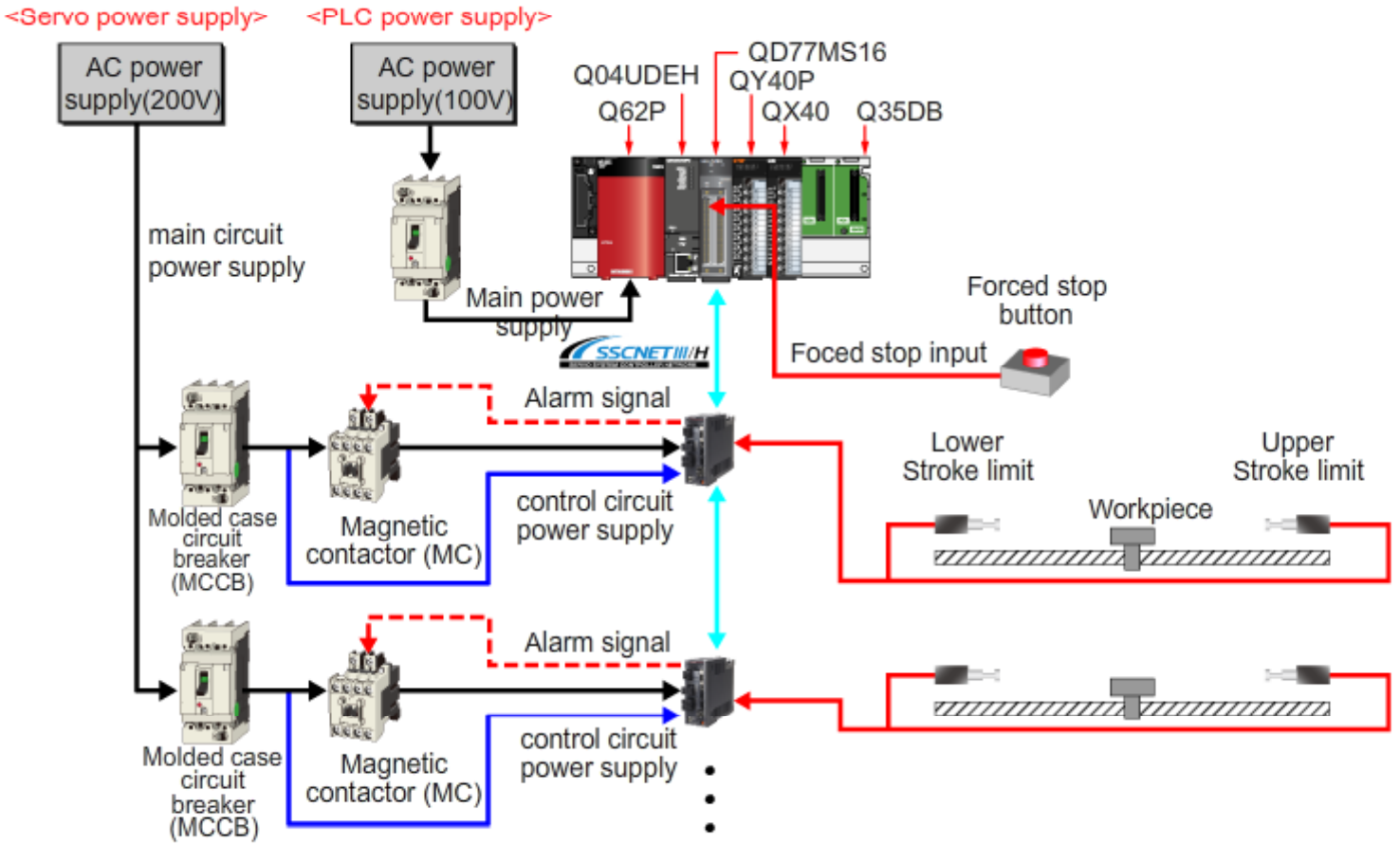


2.2 Review of safe design

Here, we will learn about safe design principles for the Motion Control System.
We will review important mechanisms in place that are designed to unfailingly stop the system in emergencies to prevent device damage and malfunction and accidents from occurring when problems arise in the system.
There are three safety measures used in the sample system in this course, which are described below.

Click the button that you would like to learn more about. (Click "Display all circuits" button to check out safety measure devices for all circuits.)

Emergency stop circuit | Forced stop circuit | Workpiece moveable range | Display all circuits



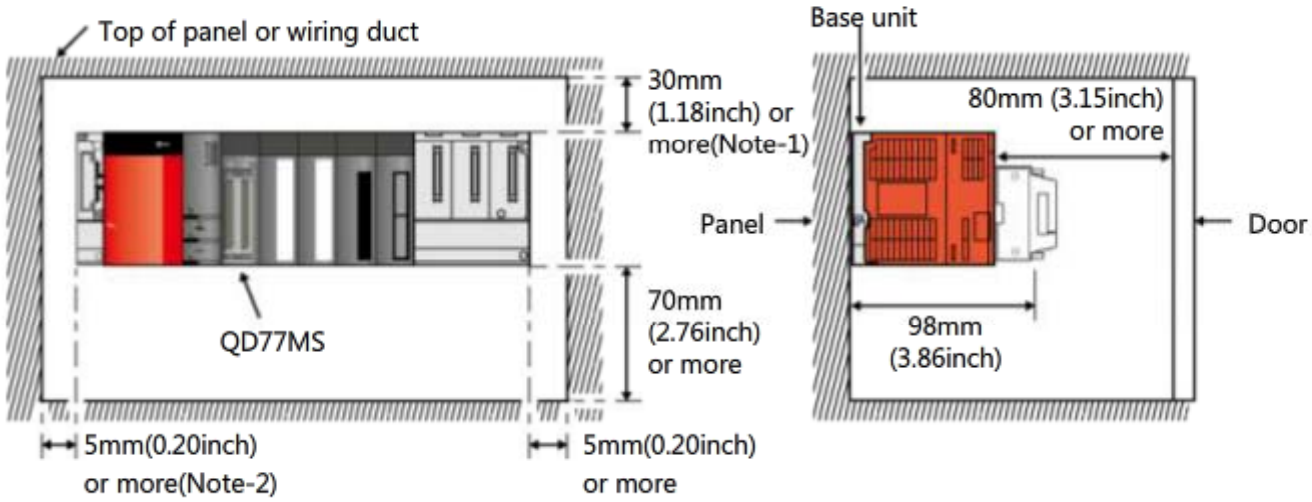
2.3 Installation

Here, we will learn about the installation of PLCs and servo amplifiers that are equipped with Simple Motion Modules.

2.3.1 Installation of PLCs

Below is the diagram for installation of PLCs equipped with Simple Motion Modules.
Leave open the amount of space indicated in the bottom diagram both above and below the modules and around structures and parts to ensure adequate ventilation to prevent overheating and to make it easier to replace parts when necessary.
You may need to leave more space than that indicated in the below diagram in some cases depending on the configuration of the system in use.

Installation of PLCs



(Note-1): For wiring duct with 50[mm] (1.97 inch) or less height.
40[mm] (1.58 inch) or more for other cases.
(Note-2): 20mm (0.79inch) or more when the adjacent module is not removed and the extension cable is connected.

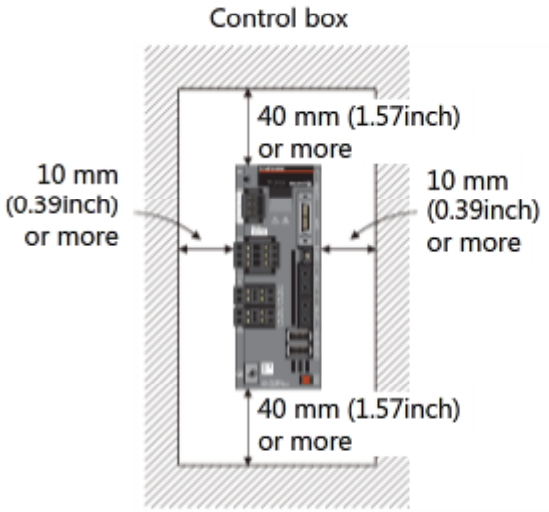
Cautions

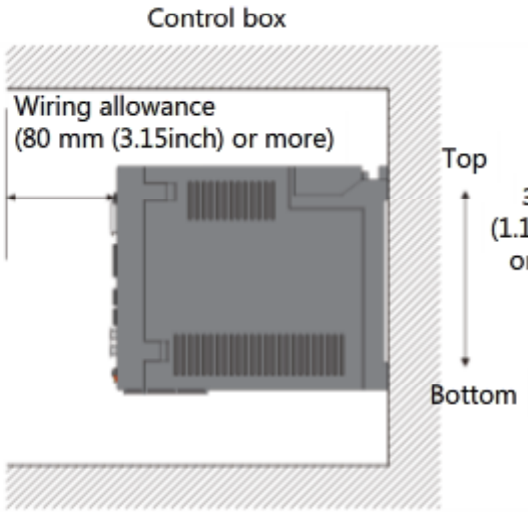
- Attach the PLCs to a vertical wall making sure to orient it correctly with the top facing up and the bottom facing down.
- Use it in an environment with a room temperature ranging from 0° C to 55° C (32° F to 131° F).

2.3.2 Installation of servo amplifiers

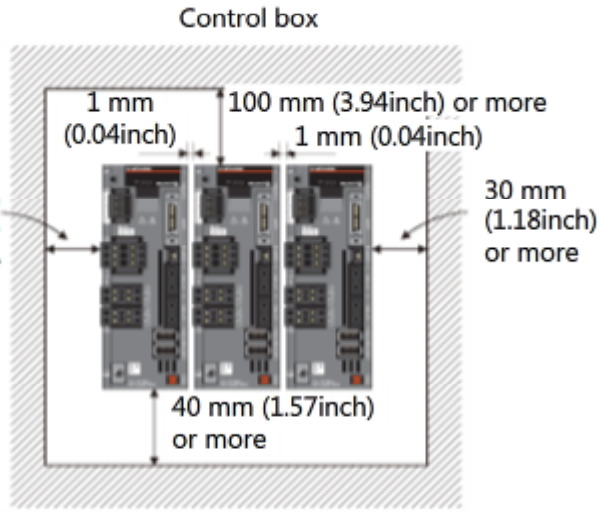
Below is instructions on how to install servo amplifiers.

Installation of servo amplifiers





If installing two or more units attached together



Cautions

- Attach the servo amplifier to a vertical wall making sure to orient it correctly with the top facing up and the bottom facing down.
- Use it in an environment with a room temperature ranging from 0° C to 55° C (32° F to 131° F).
- Use a cooling fan to prevent system overheating.
- Be careful not to allow any foreign objects or material to enter devices during assembly or from the cooling fan.
- Use an air purge system if installing servo amplifiers in locations with toxic gas fumes or high in dust (to feed in normal pressure from outside of the control box to increase the internal pressure until it is higher than the external pressure).

Cautions

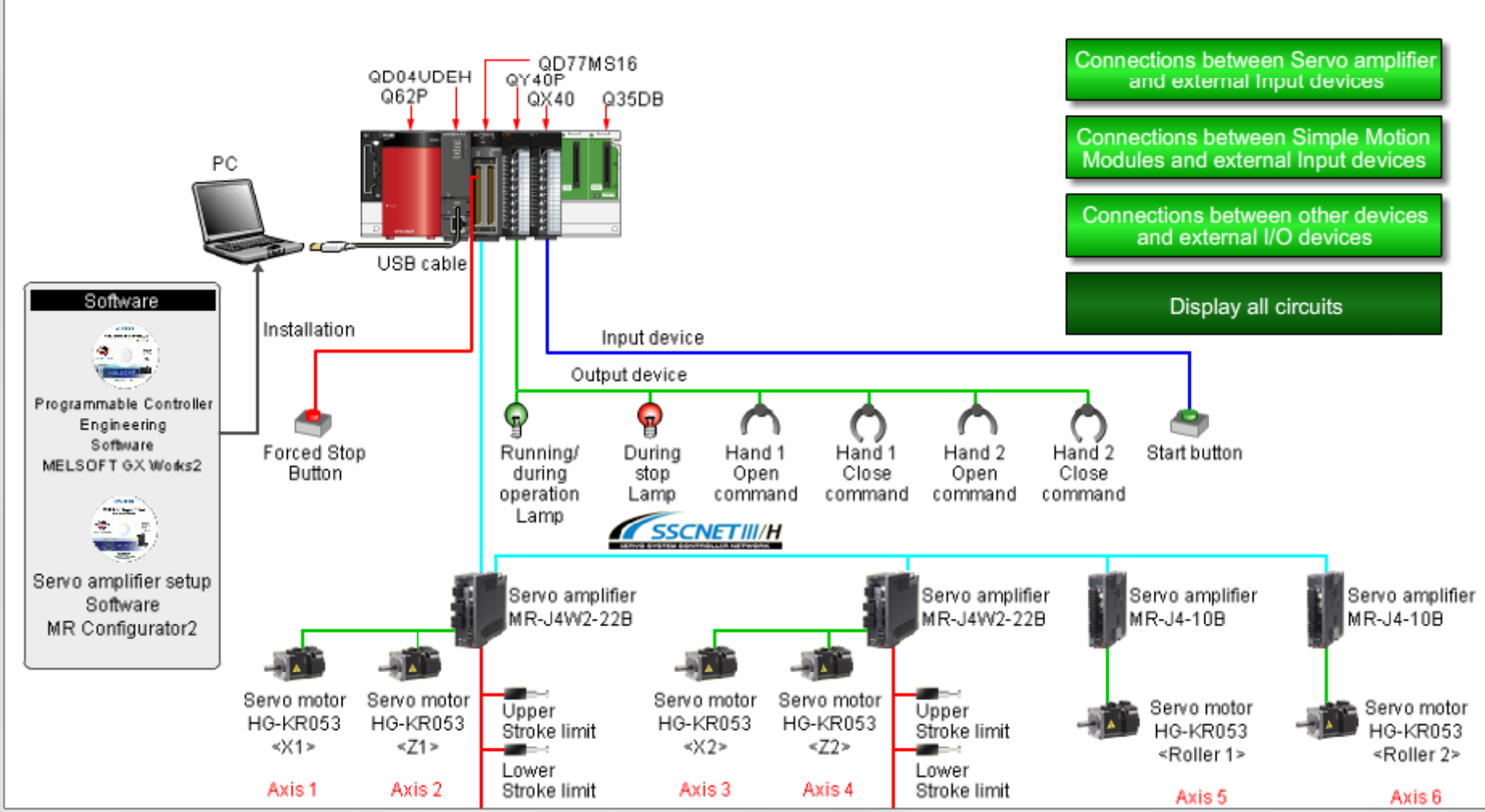
- When mounting the servo amplifiers closely, leave a clearance of 1 mm between the adjacent servo amplifiers in consideration of mounting tolerances.

2.4 Device wiring

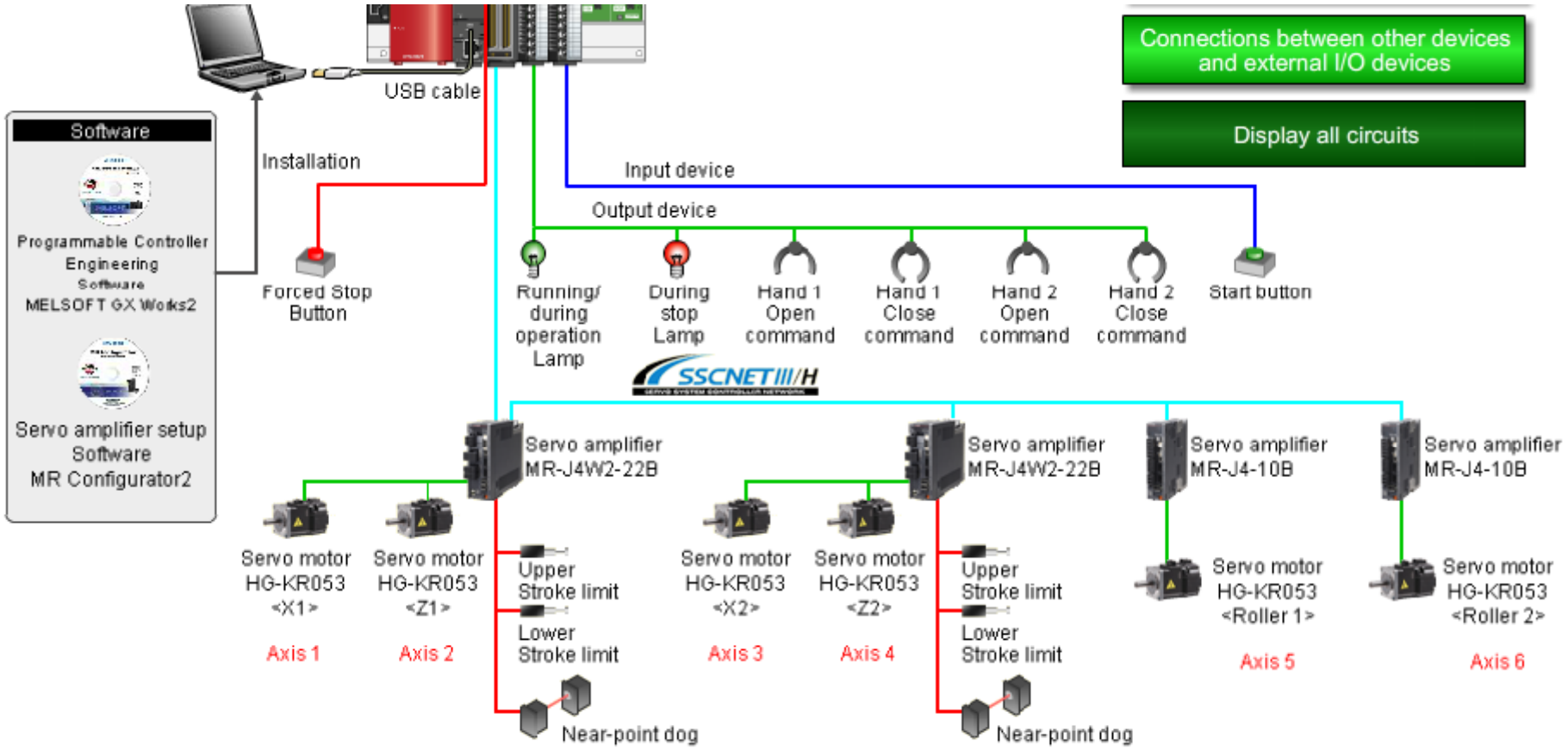
First, we will complete wiring to the PLC, servo amplifier, and servo motor.
Next, we will learn about device wiring in the sample system.

2.4.1 Connections to external I/O devices

Click the button of the connection example that you would like to check out. (Click "Display all circuits" button to check out safety measure devices for all circuits.)



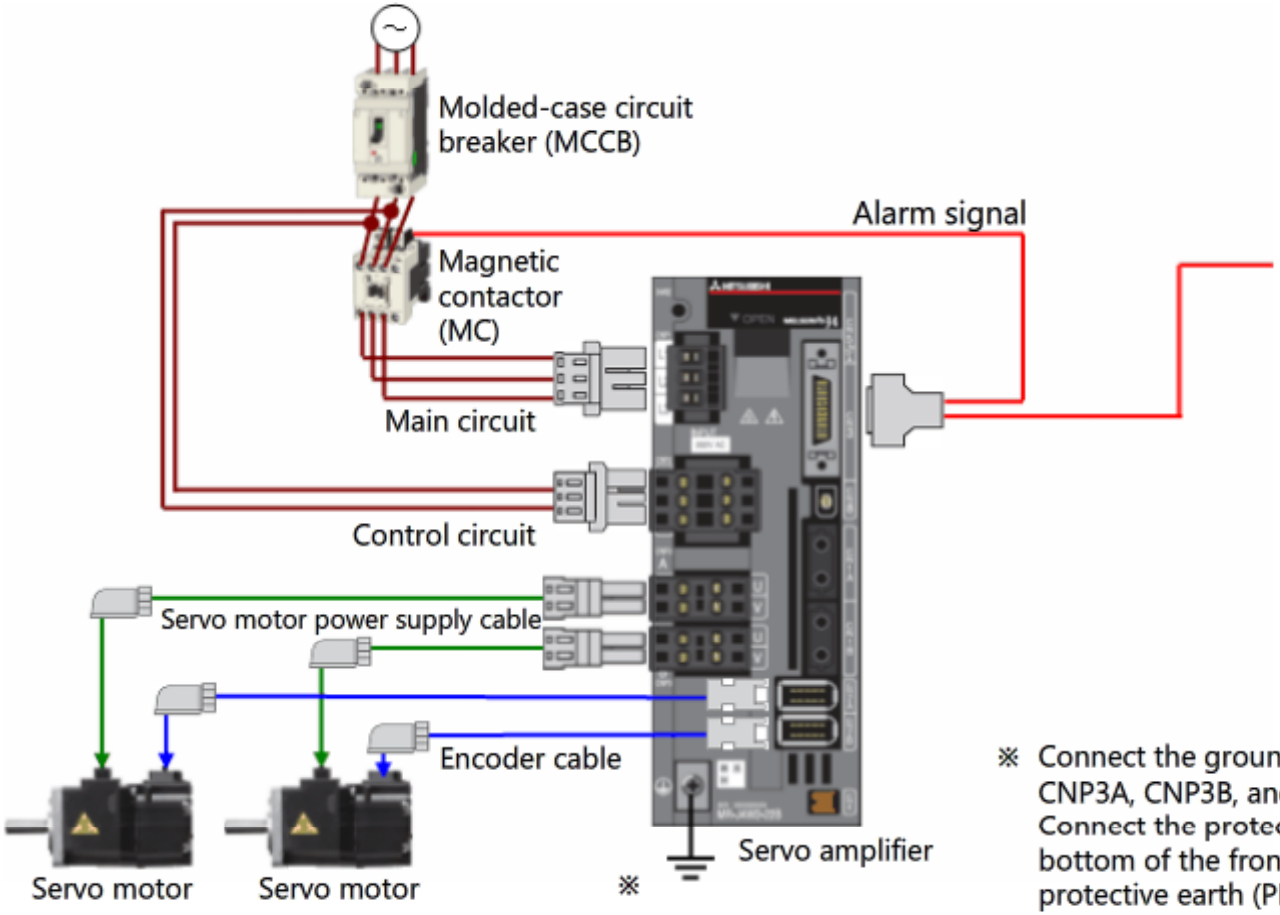
2.4 Device wiring



2.4.2 Servo amplifier wiring (Power supply, motor)

A power supply is connected to the servo amplifier with the connectors for the main circuit power and the control circuit power.
Make sure to connect a molded case circuit breaker (MCCB) to the input line of the power supply.
Make sure to also connect magnetic contactors (MCs) between the main circuit power supply and the L1, L2, and L3 terminals on the servo amplifier, and wire it so that the main circuit power supply is shut off when the magnetic contactor (MC) is turned OFF by an alarm.

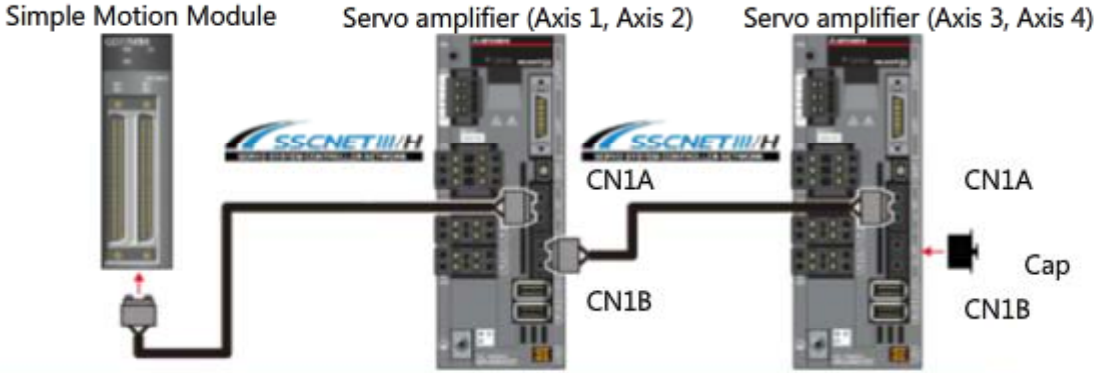
A wiring diagram is shown below for a three-phase, 200 V AC to 230 V AC power supply to an MR-J4W2-22B unit.



※ Connect the grounding terminal on the servo motor to CNP3A, CNP3B, and CNP3C protective earth terminals. Connect the protective earth (PE) terminal on the bottom of the front surface of the servo amplifier to the protective earth (PE) terminal on the control box to ground the servo amplifier.

2.4.3 SSCNET III/H Wiring

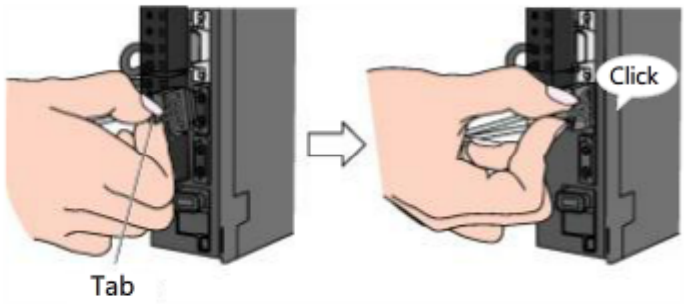
Here, we will learn about the methods for connecting a Simple Motion Module and servo amplifier.
The MR-J4W2-22B model servo amplifiers come equipped with an SSCNET III/H interface.
The SSCNET III/H provides high-speed, full duplex communications with excellent noise immunity using an optical communications system.
There is a special cable provided for connecting the devices. The cable comes with connectors that can be plugged in and unplugged easily.



Be sure to carefully observe the below precautions when handling the SSCNET III cable.

- Be careful not to strike the cable forcibly or apply pressure, pull on it, bend it sharply, twist, or otherwise apply force as doing so could cause the internal wires to become deformed or bent, which could cause optical communications to fail.
- Be careful not to use the fiber optic cable near fire or at high temperatures as it is made of a synthetic resin that could become deformed if heated, which could cause optical communications to fail.
- Be careful not to let dirt and other foreign matter collect on either end of the fiber optic cable as it could block the transmission of light and cause devices to malfunction.
- Do not attempt to look directly into the light emitted from the connector or cable terminal ends.
- For safety and protective reasons, place the accompanying caps on unused connectors (CN1B) on the servo amplifier of the final axis to block emitted light.

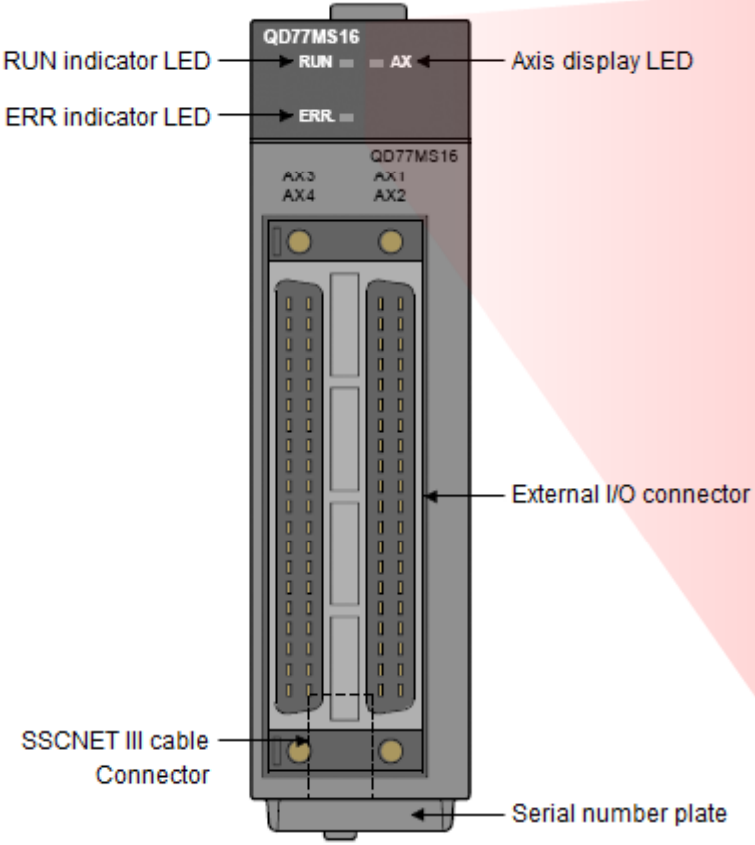
Connecting method



2.5 Display Unit for the Simple Motion Module

The display unit for the Simple Motion Module is shown below. (For the QD77MS16)

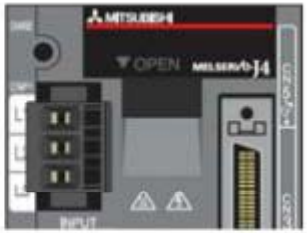
The LED display can be used to check operating conditions and statuses for the Simple Motion Module and operating axes.



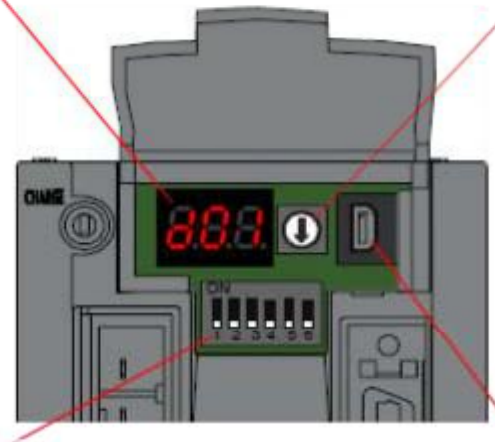
LED display	Details
RUN AX ERR.	Hardware failure watch dog timer error
RUN AX ERR.	The module operates normally
RUN AX ERR.	System error
RUN AX ERR.	During axis stop, during axis standby
RUN AX ERR.	During axis operation
RUN AX ERR.	Axis error
RUN AX ERR.	Hardware failure

2.6 Display Unit for the Servo Amplifier

The display unit for the servo amplifier is shown below. (For the MR-J4W2-_B model servo amplifier)
The display unit uses a seven-segment display to indicate axis servo conditions and provide alarm notifications.

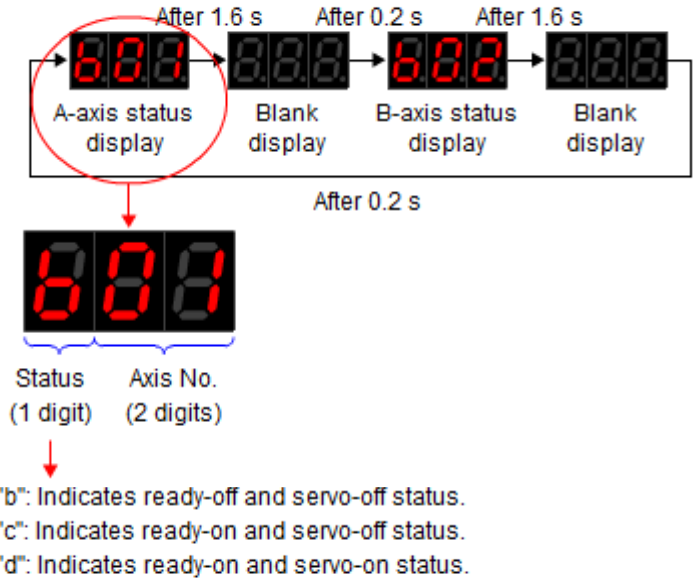


Cover opened



(1) Normal display

Axis operating status and conditions will be displayed in order if there is no alarm triggered.

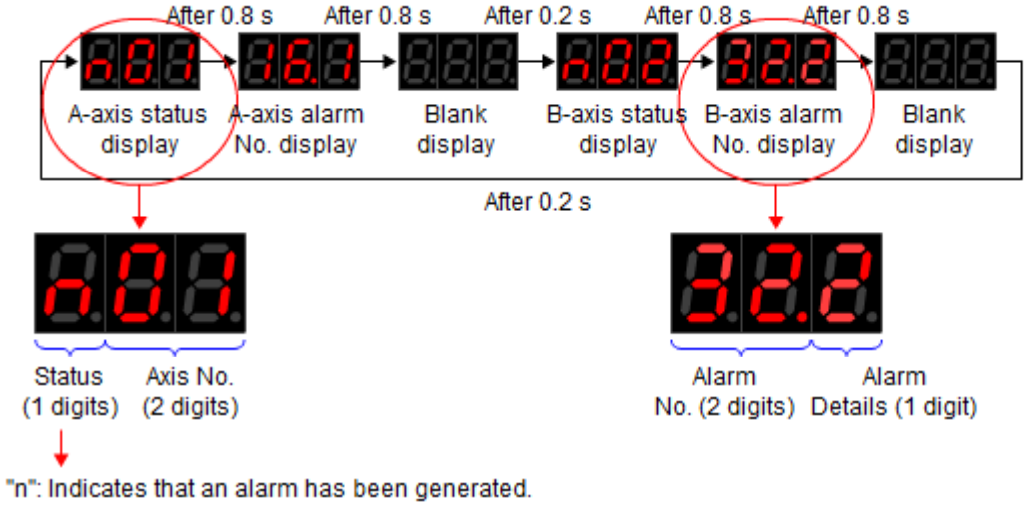


(2) Alarm display

2.6 Display Unit for the Servo Amplifier

(2) Alarm display

When an alarm occurs, after alarm status are displayed, a two-digit alarm number and a one-digit alarm detail code are displayed. The example shown here indicates that an "AL. 16 encoder initial communications error 1" has occurred on the A-axis and an "AL. 32 overcurrent error" on the B-axis.



"n": Indicates that an alarm has been generated.

2.7 Summary

In this chapter, you have learned:

- Review of safe design
- Installation of PLCs
- Installation of servo amplifiers
- Servo amplifier wiring
- SSCNET Ⅲ/H Wiring
- Display Unit for the Simple Motion Module
- Display Unit for the Servo Amplifier

Important points

The following points are very important, so please review them again to ensure that you have familiarized yourself with their content.

Review of safe design	We will review important mechanisms in place that are designed to unfailingly stop the system in emergencies to prevent device damage and malfunction and accidents from occurring when problems arise in the system.
Installation of PLCs	Leave open an adequate amount of space both above and below the modules and around structures and parts to ensure adequate ventilation to prevent overheating and to make it easier to replace parts when necessary.
Installation of servo amplifiers	• Attach the servo amplifier to a vertical wall making sure to orient it correctly with the top facing up and the bottom facing down. • Use it in an environment with a room temperature ranging from 0°C to 55°C (32°F to 131°F). (Ranging from 0°C to 45°C (32°F to 113°F) if using servo amplifiers stacked together.) • Use a cooling fan to prevent system overheating. • Be careful not to allow any foreign objects or material to enter devices during assembly or from the cooling fan. • Use an air purge system if installing servo amplifiers in locations with toxic gas fumes or high in dust. • The 200-V class servo amplifiers with a power rating of 3.5 kW or below and the 100-V class servo amplifiers with a power rating of 400 W or below can be mounted closely.

2.7 Summary

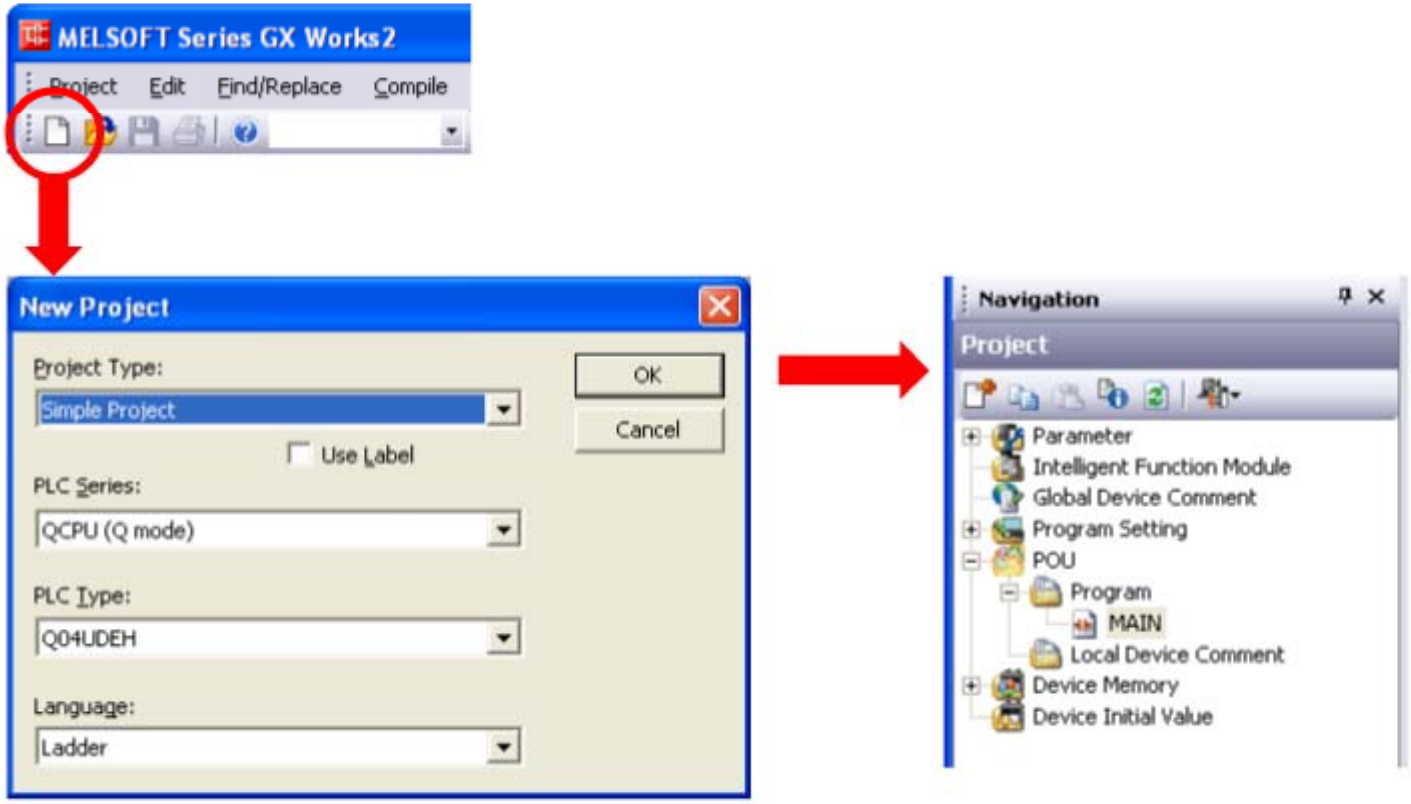
	• The 200-V class servo amplifiers with a power rating of 3.5 kW or below and the 100-V class servo amplifiers with a power rating of 400 W or below can be mounted closely. • When mounting the servo amplifiers closely, leave a clearance of 1 mm between the adjacent servo amplifiers in consideration of mounting tolerances.
Servo amplifier wiring	A power supply is connected to the servo amplifier with the connectors for the main circuit power supply and the control circuit power supply. • Make sure to connect a molded case circuit braker (MCCB) to the input line of the power supply.
SSCNET III/H Wiring	• Connect Simple Motion Moules and servo amplifiers together using the SSCNET III/H cable. • The SSCNET III/H provides high-speed, full duplex communications with excellent noise immunity using an optical communications system.
Simple Motion Module display unit	The LED display can be used to check operation statuses for the Simple Motion Module and operating axes.
Display Unit for the Servo Amplifier	• The servo amplifer display unit is located inside the cover on top of the front surface of the unit. • The display unit uses a seven-segment display to indicate axis servo conditions and provide alarm notifications.

Chapter 3 GX Works2 and the Simple Motion Module Setting Tool

In Chapter 3, we will learn how to complete settings for a Simple Motion Module system and various parameters.

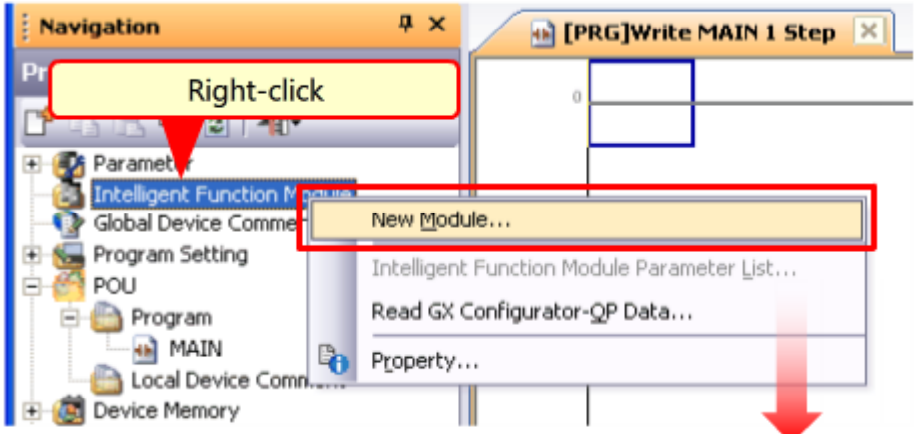
3.1 Creation of GX Works2 projects

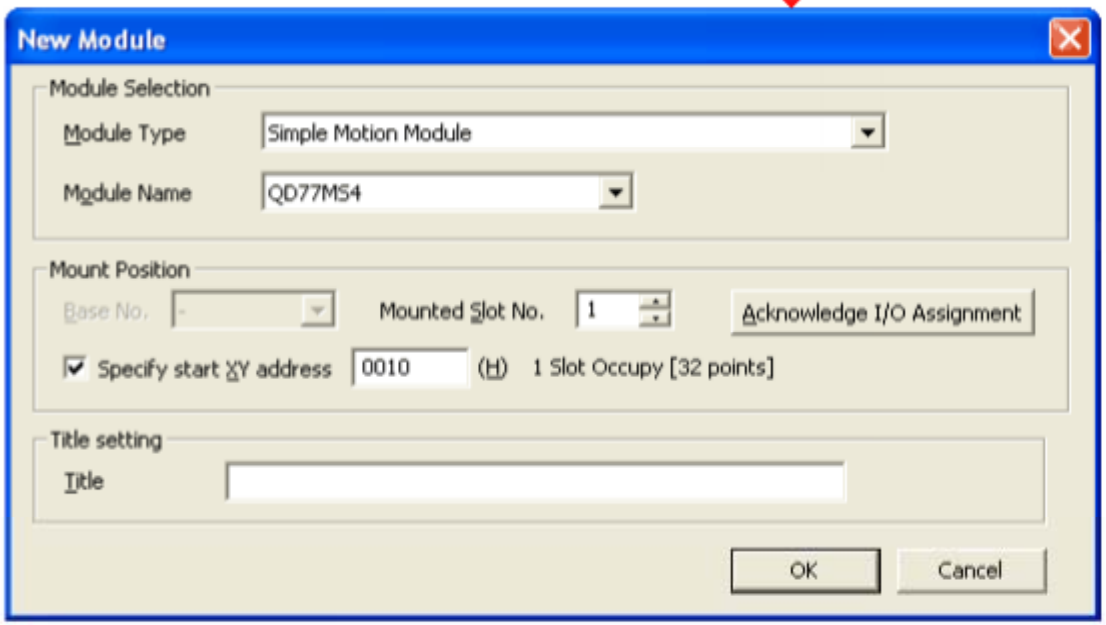
Try creating a new project in GX Works2.
Check to make sure that a project tree is created when you complete the settings shown below.

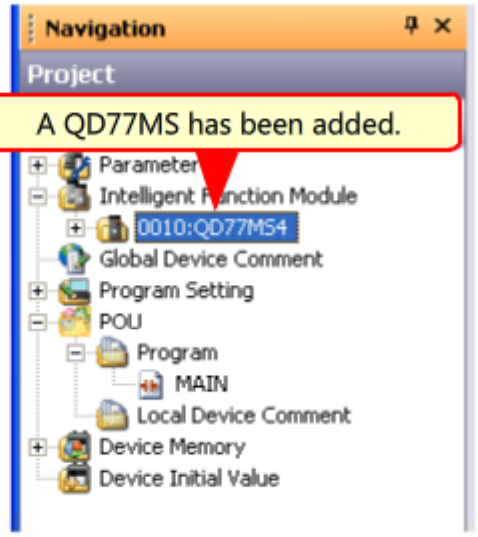


3.2 Addition of Simple Motion Modules

In this section, we will try adding a Simple Motion Module to the GX Works2 project.
Right-click on the intelligent function module in [Project] in GX Works2, select [New Module...] and then set the Module Model Type, Module Name, and Specify start XY Address on the "New Module" screen to add a Simple Motion Module to the project.

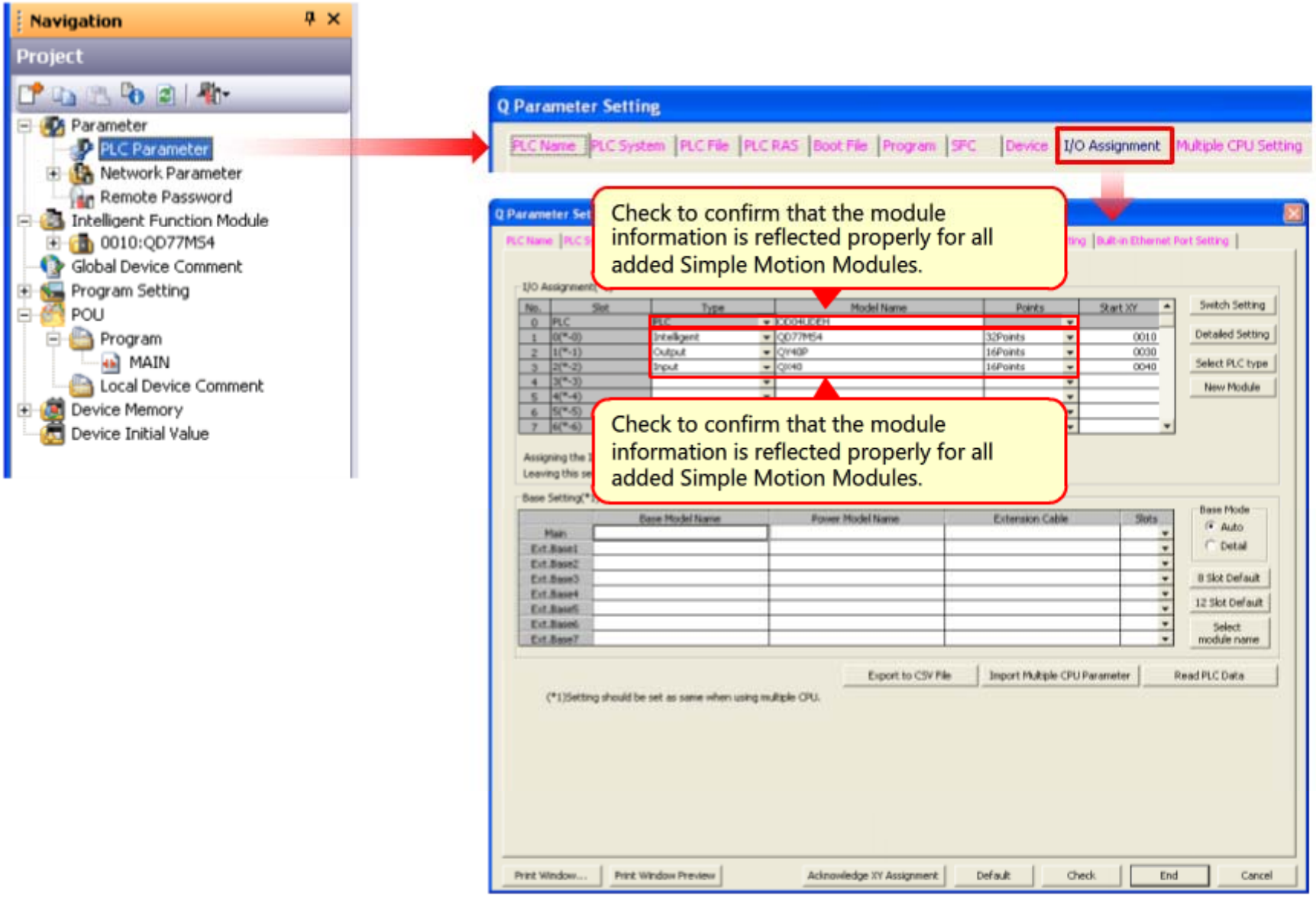






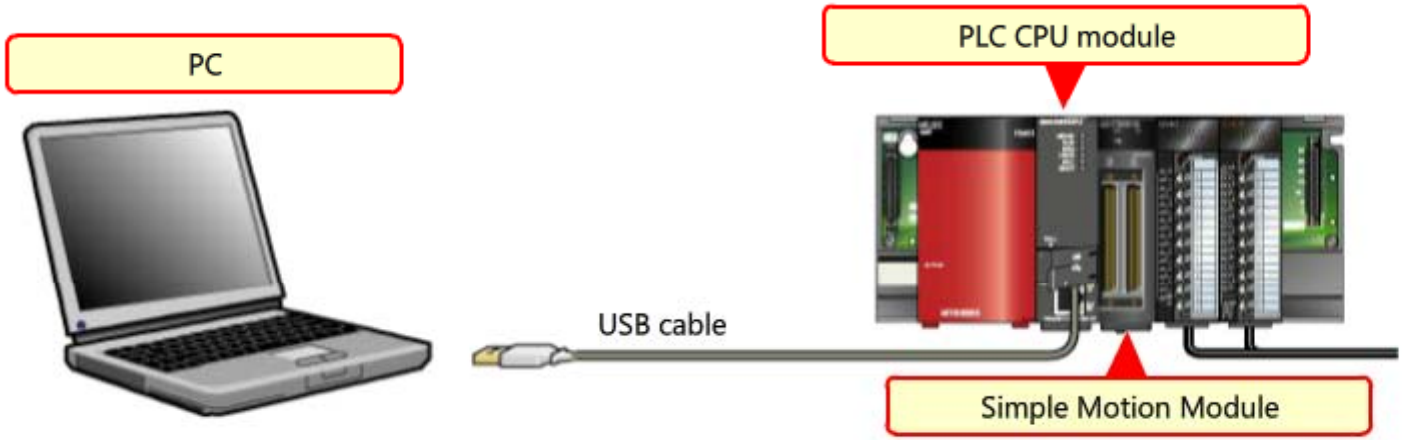
3.3 Confirmation of I/O assignments

On the PC Parameters screen, check and set the model type, model name, number of occupied I/O points, and start I/O number for each module in the base unit.



3.4 Connection between the PLC CPU and PC

Connect the PLC CPU module and USB port on the PC together using a USB cable.

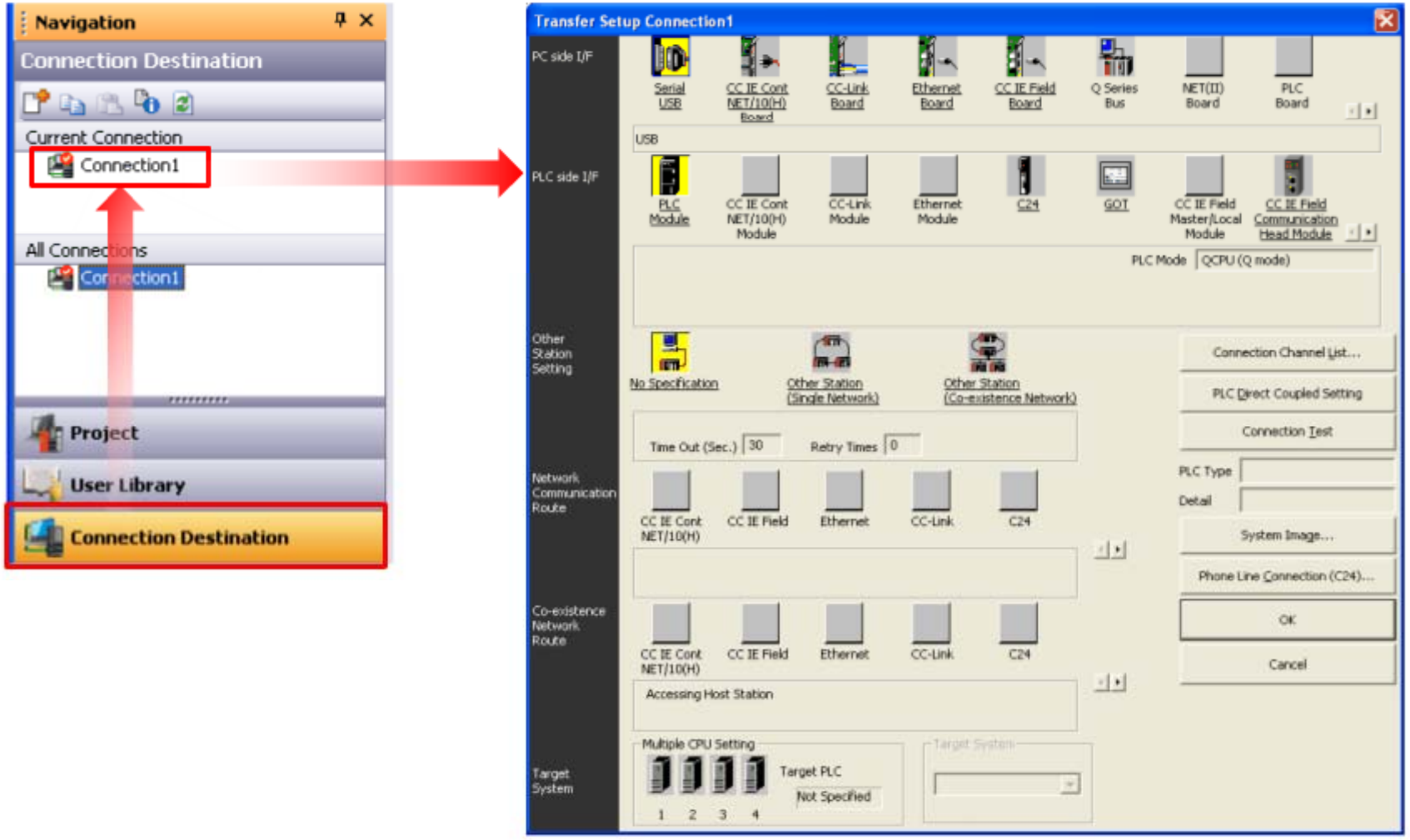


3.5 Connection Settings for the GX Works2 and PLC CPU Connection

Once you finish connecting the PC and PLC CPU together, next complete settings for the GX Works2 and PLC connection. You will not be able to start communications automatically merely by connecting GX Works2 and the PLC together using a USB cable.

To get communications to work properly, complete the "Connection Destination".

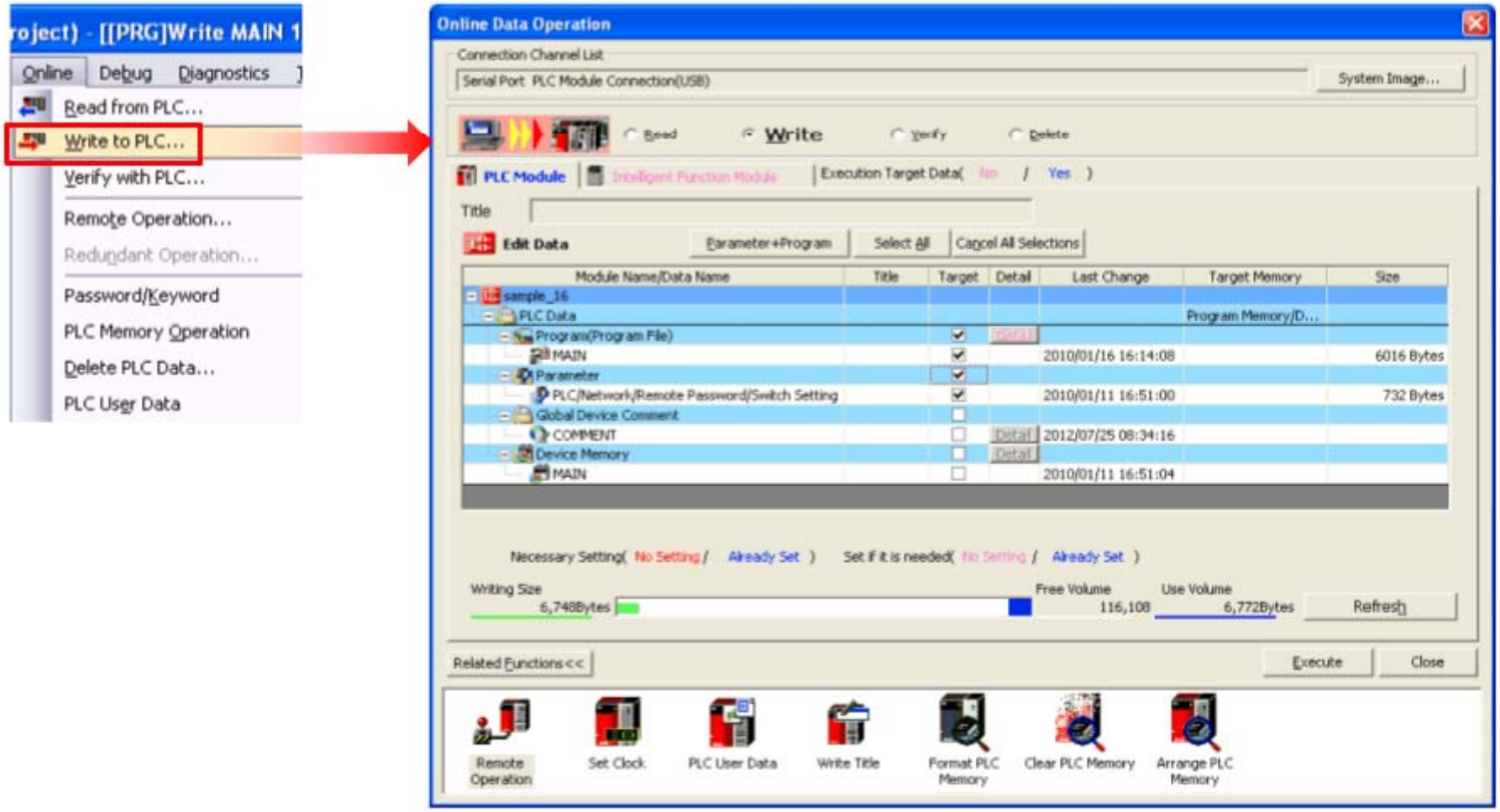
An example of the settings screen for Setting Connection Destinations is shown below.



3.6 Writing to the PLC

The PC parameters and other settings set in GX Works2 are written to the PLC CPU.
Before writing data to the PLC CPU, check to confirm that the CPU module is stopped and that the PC and CPU module are connected together properly.

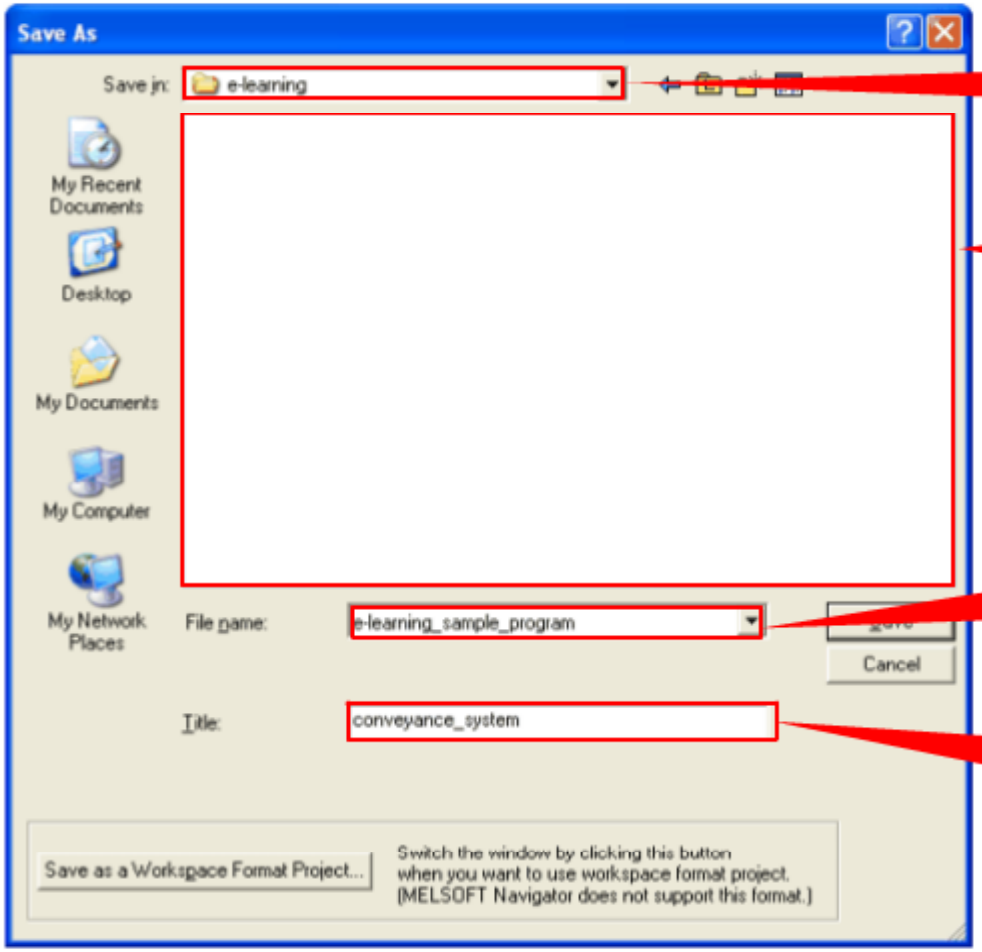
After selecting [Online] → [Write to PLC...] in GX Works2, click on [Parameter+Program] and then click [Execute] to start writing data to the PLC CPU.



3.7 Saving of GX Works2 Projects

Here, we will try saving a created GX Works2 project.
If you exit GX Works2 without saving a project, any settings that you made will be discarded without being saved.

When wanting to save a new project, set a file name.
It is recommended that you select a name that can be used to identify the content of the project (using the control details, system name, or other easily recognizable text).
Files are saved with the ".gxw" file extension.



Save folder path ***Required**
Specify a folder in which to save.
(Up to 200 characters in length including the file name and extension.)

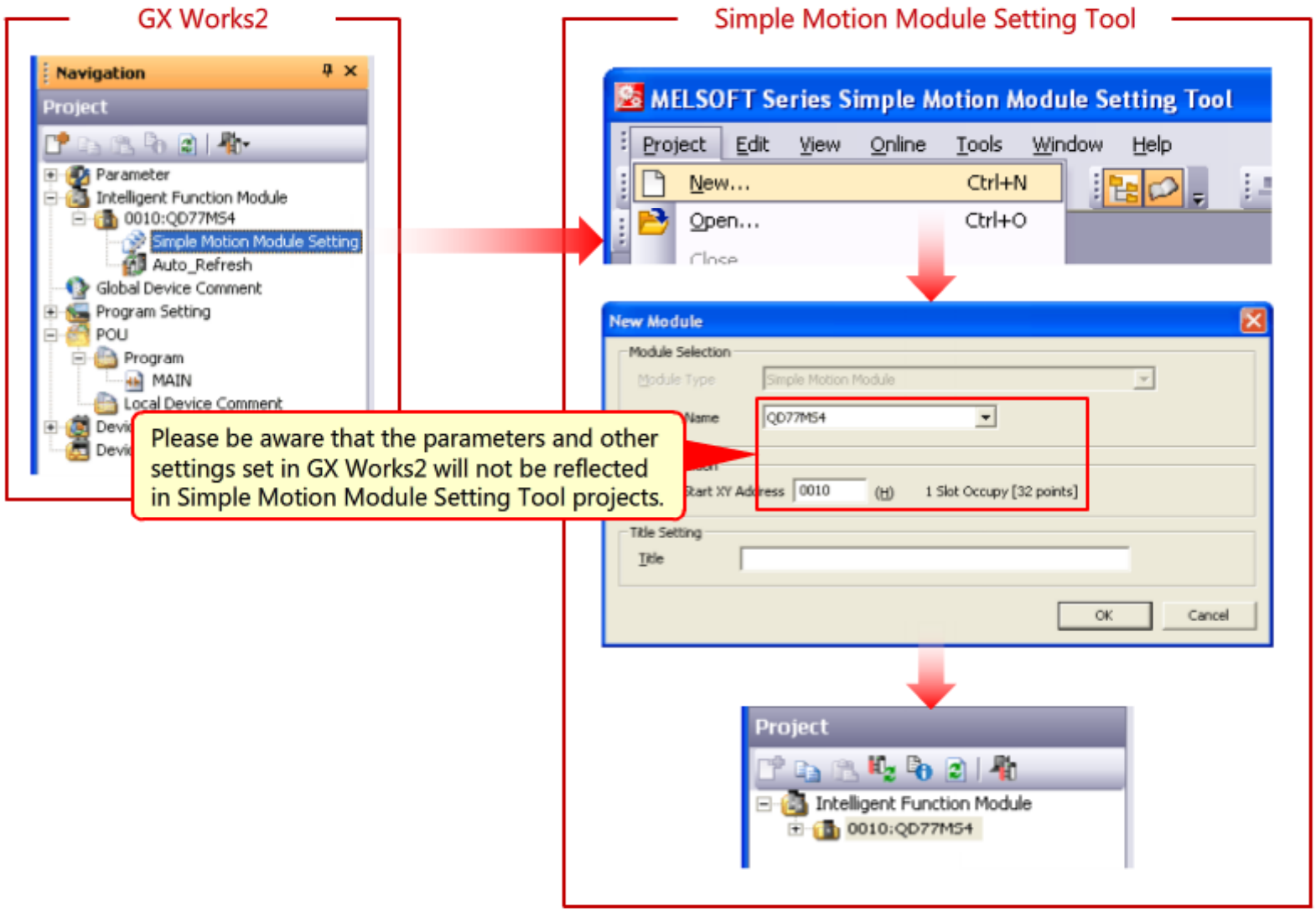
List of Files
If there are one or more files in the same save folder path, they are given in list form.

File Name ***Required**
Specify a file name. (Up to 32 characters in length, not including the file extension.)

Title
Specify a title. (Up to 128 characters in length.)
Use this when you want to use a name that exceeds 32 characters. (You can skip the title if you wish as it is not necessary.)

3.8 Creation of Setting Tool Projects

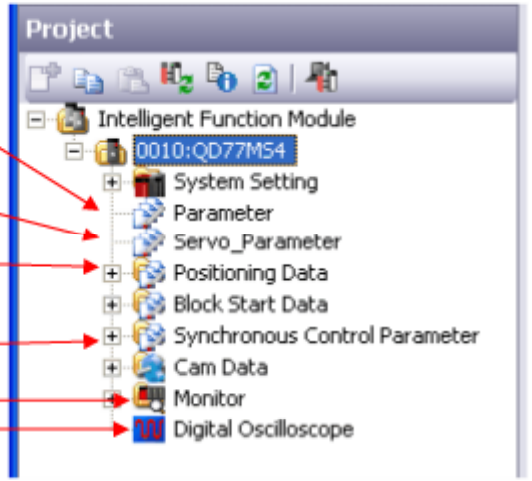
In this section, we will learn how to start the Simple Motion Module Setting Tool and create a new project.
After double clicking on Simple Motion Module Settings under [Project] in GX Works2 and starting the Simple Motion Module Setting Tool, click on [Project] → [New...] in the Simple Motion Module Setting Tool.



3.9 Simple Motion Module Settings

There are three types of data used in parameters needed for positioning control with Simple Motion Modules: Settings data, control data, and monitor data.
Settings data is set separately for each axis using the Simple Motion Module Setting Tool.

- Setting data
  - Parameters [Pr]
    - Positioning parameters
    - OPR parameter
    - Servo parameters
  - Positioning data [Da]
  - Synchronous control parameters [Pr]
- Control data
  - System control data [Cd]
  - Axis control data [Cd]
  - Synchronous control data [Cd]



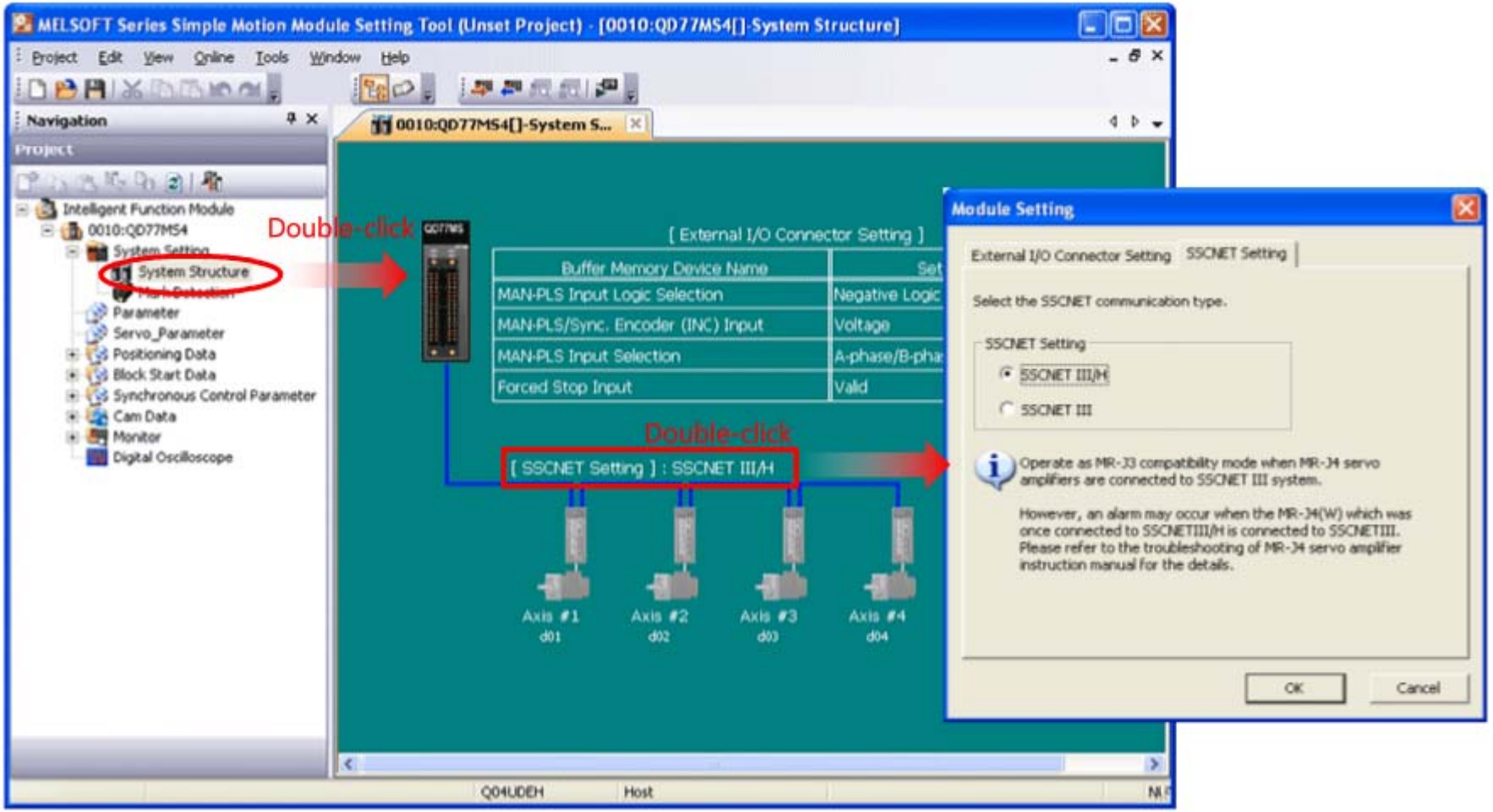
Control commands created using the control data are produced by the PLC program.

Monitor data [Md]

The monitor data can be checked on PLC program and Setting Tool monitoring.

3.10 System settings (SSCNET settings)

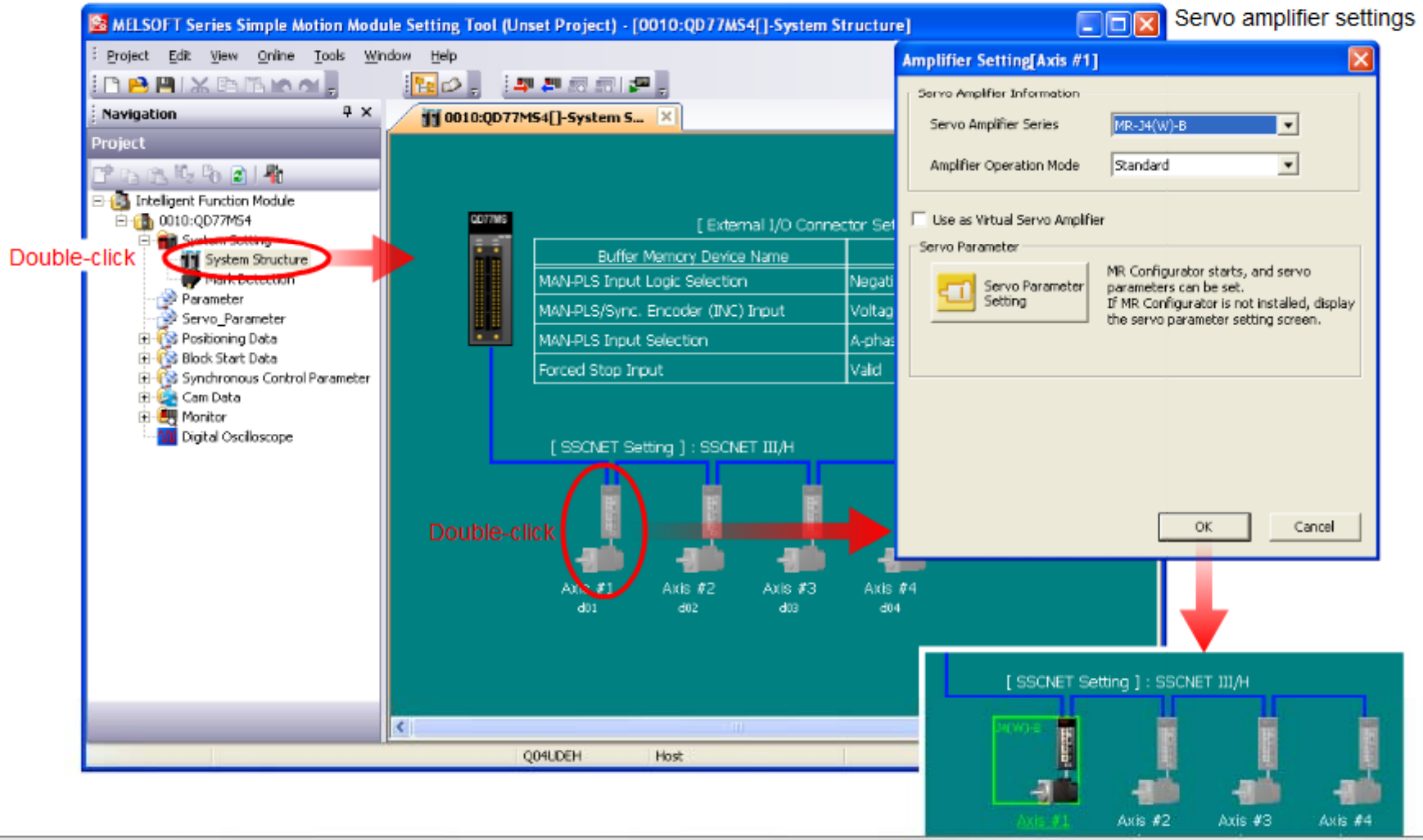
In this section, you will learn how to set the system configuration settings for a Simple Motion Module.
Double-click on [System Setting]-[System Structure] in the Project window of the Simple Motion Module Setting Tool to pull up the system configuration.
Double-click [SSCNET Setting] in the system configuration diagram of the Simple Motion Module Setting Tool to open the option that allows you to select the SSCNET communications type.



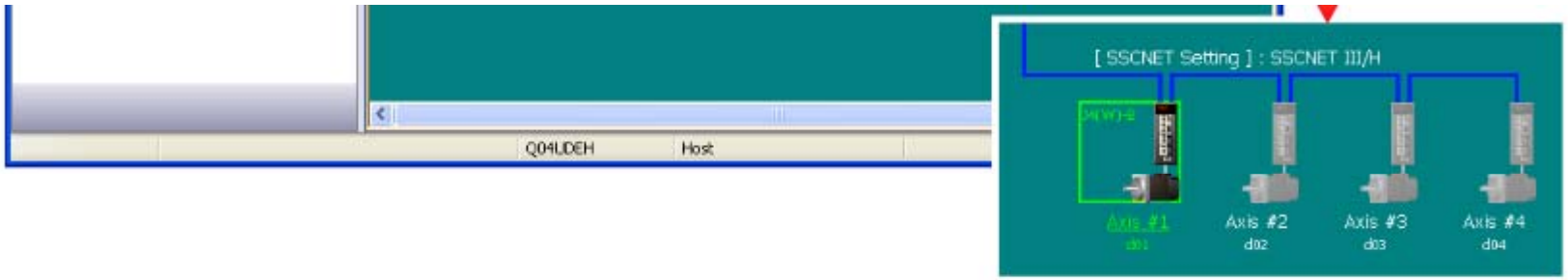
3.11 System settings (Servo amplifier settings)

Here, we will learn how to set the system configuration settings for a Simple Motion Module.
Double-click on [System Setting]-[System Structure] in the Project window of the Simple Motion Module Setting Tool to pull up the system configuration.

To set a servo amplifier, double-click on the icon for the servo amplifier of the axis that you want to set in the system configuration.

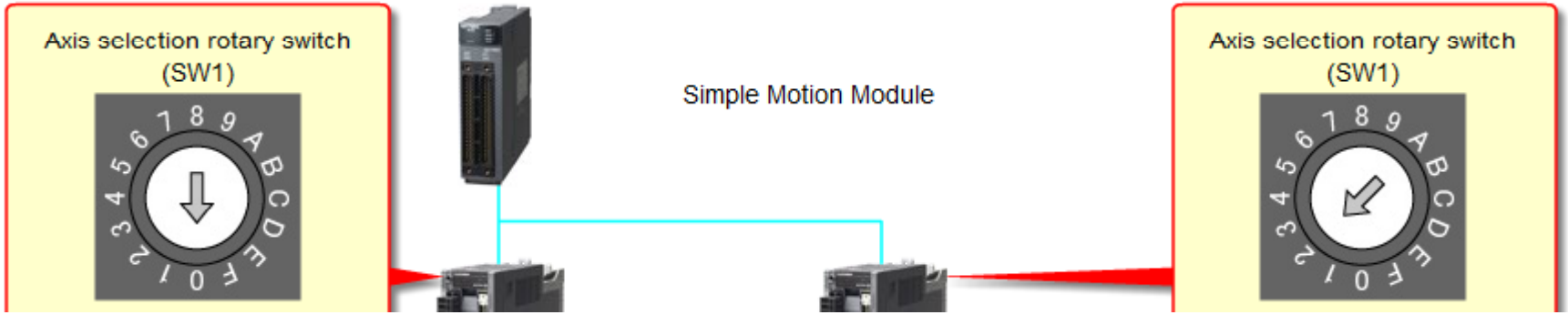


3.11 System settings (Servo amplifier settings)

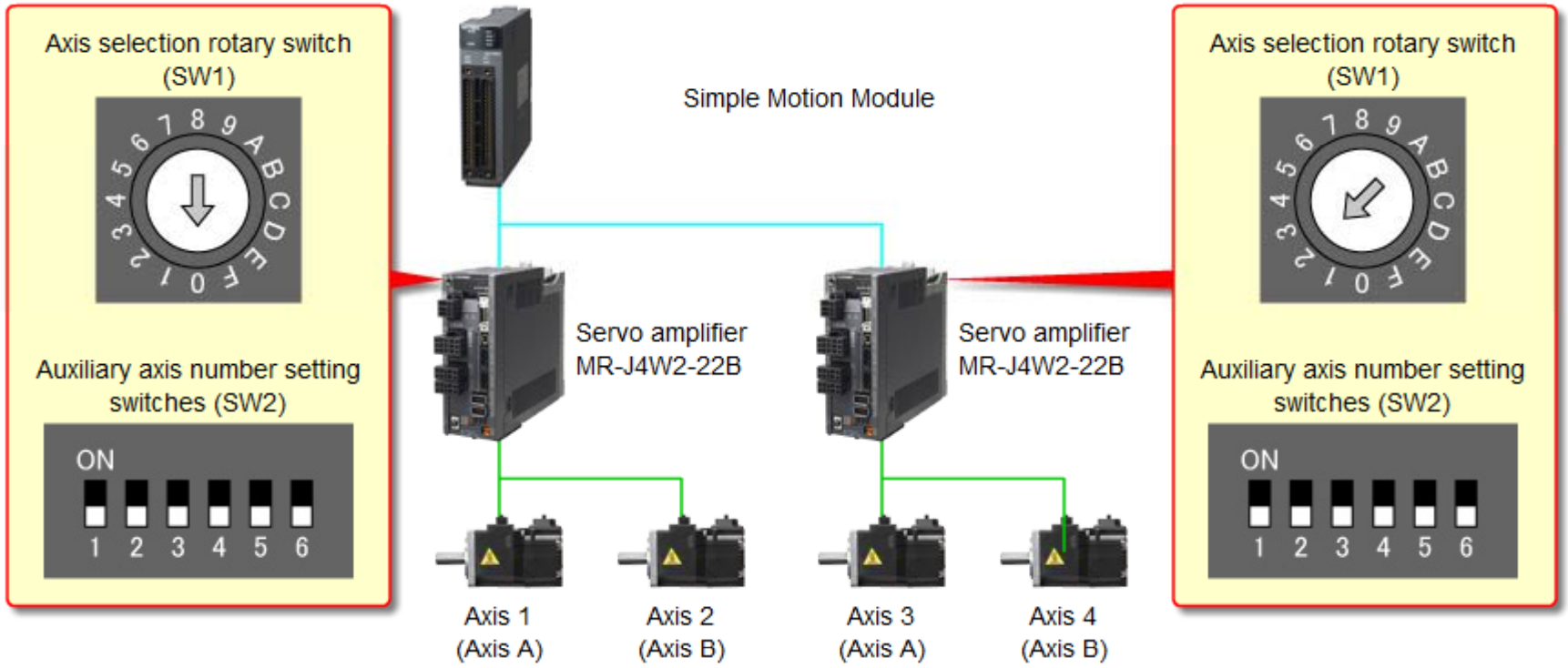


Set the proper control axis No. to the servo amplifier based on the system configuration.
Control axis numbers are assigned separately for each servo amplifier in order to identify the control axis to use.
Any number axis from Axis 1 to Axis 16 can be used independent of the order of connection.
Be careful not to assign the same control axis No. to multiple servo amplifiers within the same servo system as it could cause system operation to fail.

For the servo amplifier, set the servo control axis No. using a combination of the settings for the axis selection rotary switch (SW1) located inside the front cover on the servo amplifier and the auxiliary axis number setting switches (SW2-5, SW2-6).



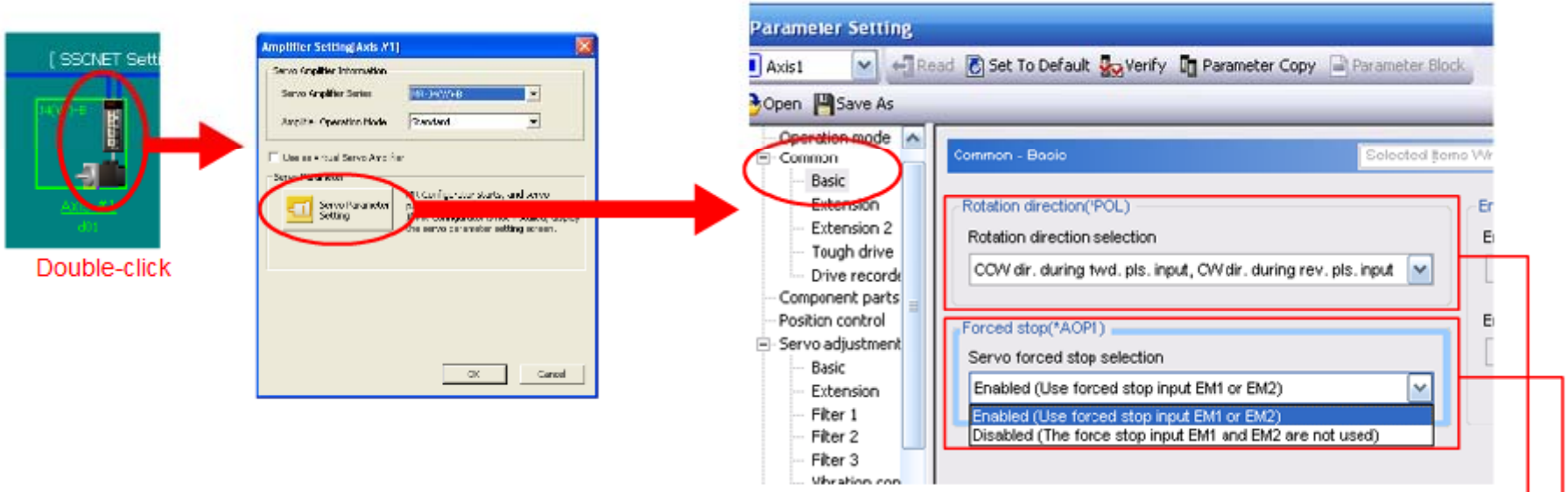
3.11 System settings (Servo amplifier settings)



* Be sure to restart the main circuit power and control circuit power of the servo amplifier after making any changes to the axis selection rotary switch (SW1) and auxiliary axis number setting switches (SW2).

3.12 Servo Parameter Settings

Set parameters specific to the servo amplifier for each axis.
It is recommended that you use the MELSOFT MR Configurator2 Servo amplifier setup software to set the servo parameters.



Servo parameter settings using MR Configurator2

Be particularly careful with the below parameters when setting

Parameter item	Function Explanation	Initial values	Settings Values for the Sample System
Rotation direction selection	Use this option to set the rotation direction of the servo motor when being moved by forward rotation commands. The rotation direction is either counter-clockwise (CCW) or clockwise (CW) as seen from the load side (side attached to the machine). 	CCW for forward rotation command,	CCW for forward rotation command,

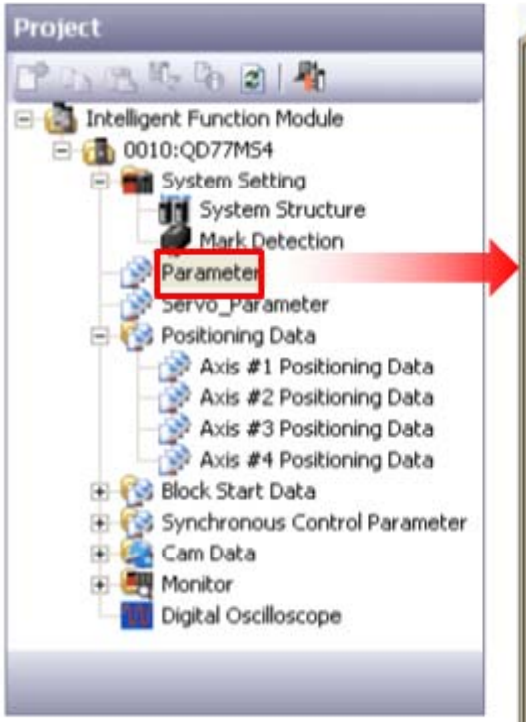
3.12 Servo Parameter Settings

Parameter item	Function Explanation	Initial values	Sample System
Rotation direction selection	Use this option to set the rotation direction of the servo motor when being moved by forward rotation commands. The rotation direction is either counter-clockwise (CCW) or clockwise (CW) as seen from the load side (side attached to the machine).   Counter-clockwise (CCW) Clockwise (CW) We will now review the rotation direction from the machine specifications. Each of the axes in the sample system are made to rotate in the counter-clockwise direction (CCW) using forward rotation commands.	CCW for forward rotation command, CW for reverse	CCW for forward rotation command, CW for reverse
Servo forced stop selection	Turn this option ON to enable use of the forced stop input (EM2 or EM1) signal. The initial value is set to [Enabled] for safety reasons. To disable the signal in the sample system, set this option to [Disabled].	Enabled (Either forced stop input EM2 or EM1 is used.)	Disabled (Neither forced stop input EM2 nor EM1 is used.)

3.13 Parameter settings

Here, you will learn how to set the Positioning parameters for the Simple Motion Module.
Set the parameters at system startup based on machine equipment and motor used and the system configuration.

Be careful not to set the Basic Parameters 1 incorrectly as it could cause the motor to rotate in the opposite direction or fail to run altogether.



0010:QD77MS4[]-Parameter

Display Filter: Display All | Compute Basic Parameters 1

Item	Axis #1	Axis #2	Axis #3	Axis #4
Basic parameters 1	**Set according to the machine and applicable motor when system is started up. (This parameter become valid when the PLC READY signal [Y0] turns from OFF to ON.)**			
Pr.1:Unit setting	0:mm	0:mm	0:mm	0:mm
Pr.2:No. of pulses per rotation	4194304 PLS	4194304 PLS	4194304 PLS	4194304 PLS
Pr.3:Movement amount per rotation	10000.0 µm	10000.0 µm	10000.0 µm	10000.0 µm
Pr.4:Unit magnification	1:x1 Times	1:x1 Times	1:x1 Times	1:x1 Times
Pr.7:Bias speed at start	0.00 mm/min	0.00 mm/min	0.00 mm/min	0.00 mm/min
Basic parameters 2	**Set according to the machine and applicable motor when system is started up.**			
Pr.8:Speed limit value	6000.00 mm/min	6000.00 mm/min	6000.00 mm/min	6000.00 mm/min
Pr.9:Acceleration time 0	1000 ms	1000 ms	1000 ms	1000 ms
Pr.10:Deceleration time 0	1000 ms	1000 ms	1000 ms	1000 ms
Detailed parameters 1	**Set according to the system configuration when the system is started up. (This parameter become valid when the PLC READY signal [Y0] turns from OFF to ON)**			
Pr.11:Backlash compensation amount	0.0 µm	0.0 µm	0.0 µm	0.0 µm
Pr.12:Software stroke limit upper limit value	214748364.7 µm	214748364.7 µm	214748364.7 µm	214748364.7 µm
Pr.13:Software stroke limit lower limit value	-214748364.8 µm	-214748364.8 µm	-214748364.8 µm	-214748364.8 µm
Pr.14:Software stroke limit selection	0:Set Software Stroke Limit to Current Feed Value	0:Set Software Stroke Limit to Current Feed Value	0:Set Software Stroke Limit to Current Feed Value	0:Set Software Stroke Limit to Current Feed Value
Pr.15:Software stroke limit valid/invalid setting	0:Valid	0:Valid	0:Valid	0:Valid
Pr.16:Command in-position width	10.0 µm	10.0 µm	10.0 µm	10.0 µm
Pr.17:Torque limit setting value	300 %	300 %	300 %	300 %
Pr.18:M code ON signal output timing	0:WITH Mode	0:WITH Mode	0:WITH Mode	0:WITH Mode
Pr.19:Speed switching mode	0:Standard Speed Switching Mode	0:Standard Speed Switching Mode	0:Standard Speed Switching Mode	0:Standard Speed Switching Mode
Pr.20:Interpolation speed designation method	0:Composite Speed	0:Composite Speed	0:Composite Speed	0:Composite Speed
Pr.21:Current feed value during speed control	0:Not Update of Current Feed Value	0:Not Update of Current Feed Value	0:Not Update of Current Feed Value	0:Not Update of Current Feed Value

3.13.1 Parameter settings (Electronic gear)

The mechanical systems (example: ball screw) connected to the servo motor use units of mm (in.), degree, and so on. Positioning control uses the same units as those of the mechanical systems.
However, as servo motor rotation is measured in units of number of pulses, quantities in commands issued to the servo motor need to be converted to pulse units.
Once the electronic gear parameters have been set, the Simple Motion Module will be set up to convert position commands issued in mechanical system units into pulse units.

Use the below parameter settings if there are any ball screws (ball screw pitch: 10 mm (0.4 in.)) connected to the servo motor (4194304 pulses/rotation).

Distance of 10 mm (0.4 in.) moved × Electronic gear = 4191304 pulses

• Electronic gear parameters

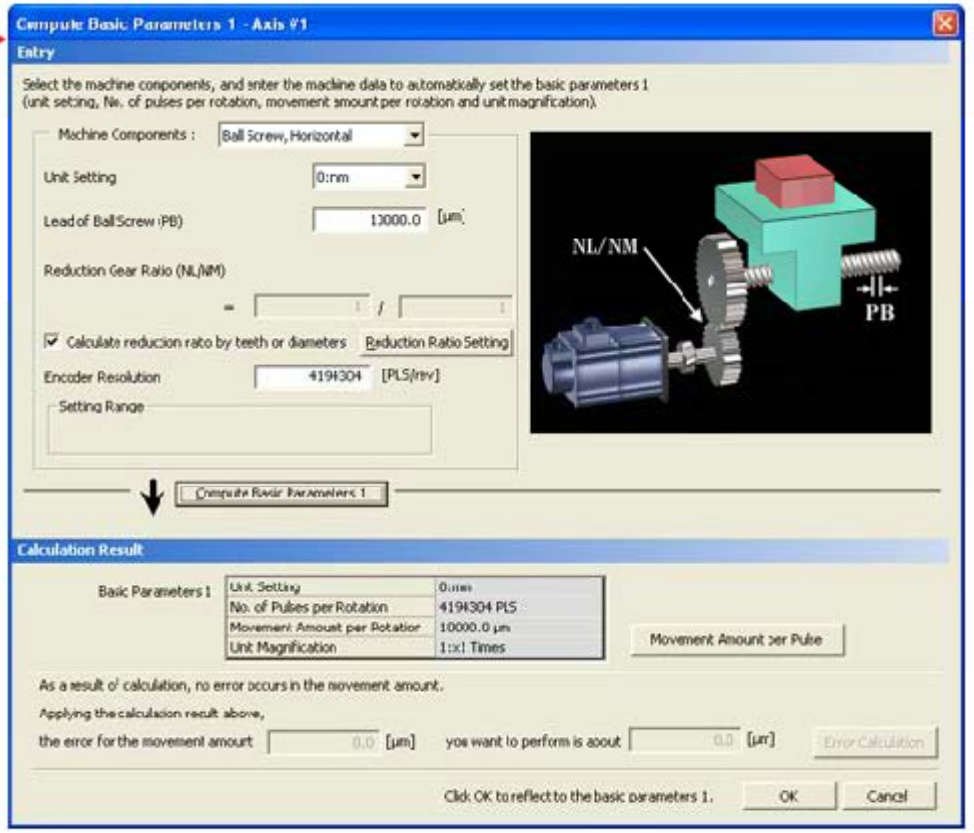
Item	Axis #1
Basic parameters 1	Set according to the m (This parameter becon
Pr.1:Unit setting	0:mm
Pr.2:No. of pulses per rotation	4194304 PLS
Pr.3:Movement amount per rotation	10000.0 µm
Pr.4:Unit magnification	1:x1 Times
Pr.7:Bias speed at start	0.00 mm/min

Parameter settings for actual machines such as rotary tables and conveyors are much more complicated as there is such a wide variety of types and there are other parts connected to the system in addition to ball screws, such as speed change gears and gears.
Use of "Compute Basic Parameter 1" will enable you to set parameter settings for the electronic gear easily.

3.13.1 Parameter settings (Electronic gear)

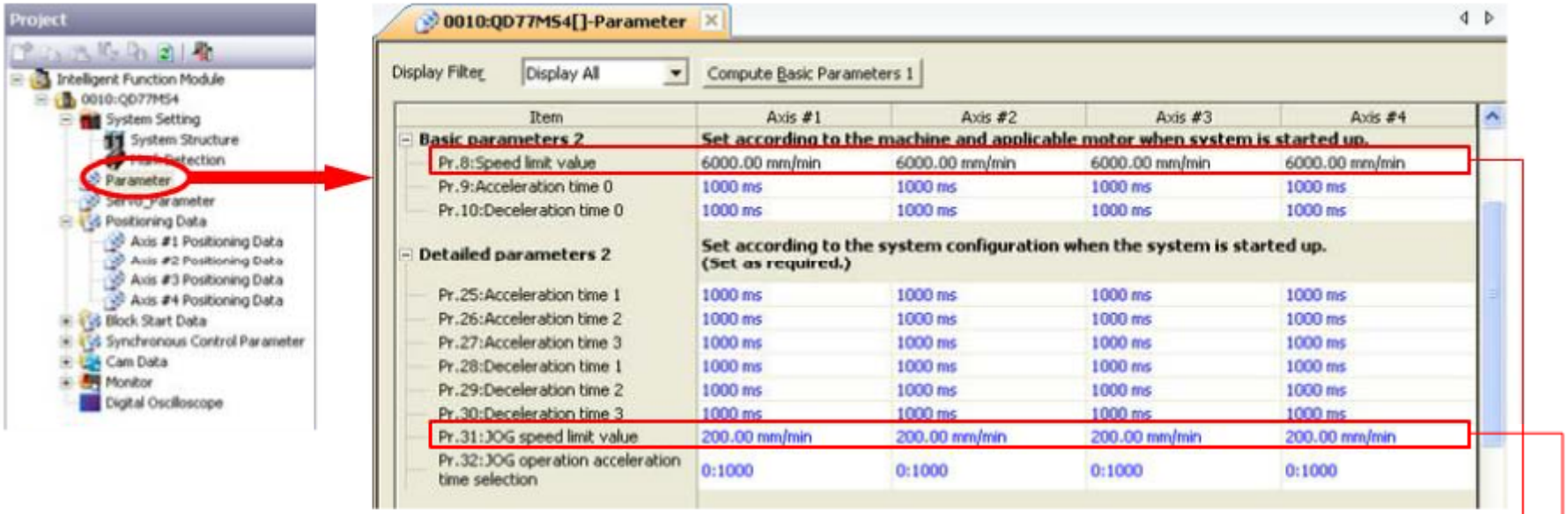
Display Filter: Display All | Compute Basic Parameters 1

Item	Axis #1	
Basic parameters 1	Set according to the machine a (This parameter become valid	
Pr.1:Unit setting	0:mm	0:mm
Pr.2:No. of pulses per rotation	4194304 PLS	4194304



3.13.2 Parameter settings (Speed limit value)

Set the maximum speed for the command speed during control mode as the "Speed limit value."



Example involving calculation of the speed limit value

Maximum rotation speed for the servo motor (HG-KR053)	×	Amount of movement per rotation of the servo motor 1
6000 r/min.		6000 r/min.

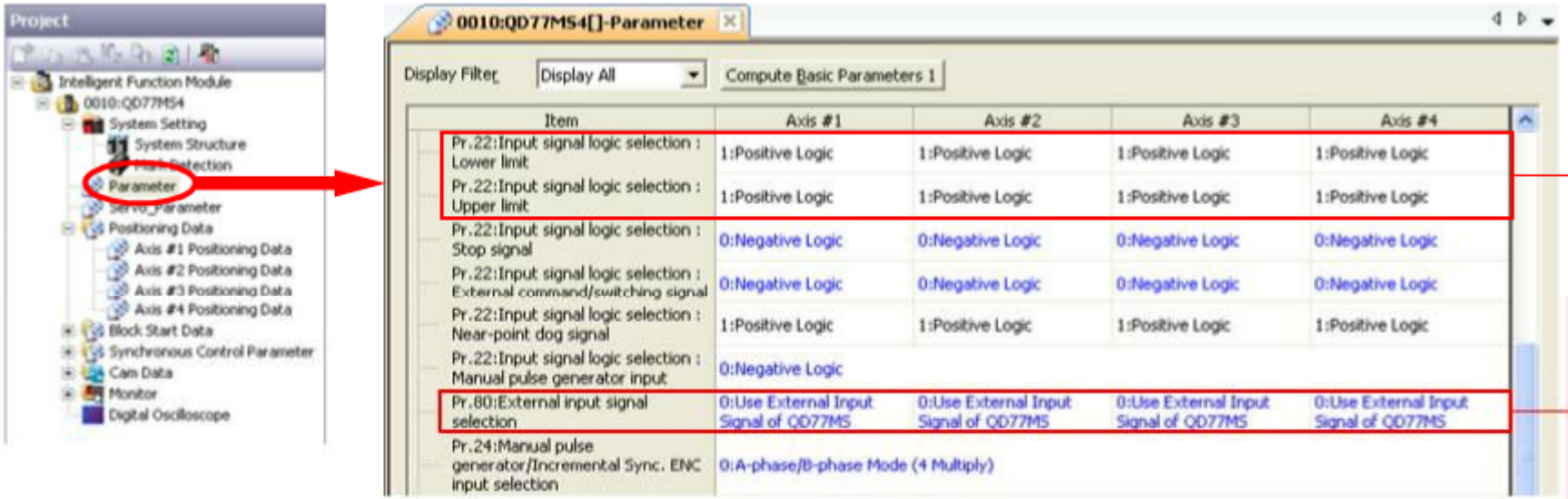
= 60000000 µm/min. (2362.2 in./min.)

= 60000 mm/min. (2362.2 in./min.)

Parameter item	Setting details
Pr. 8: Speed limit value	Set the speed limit value (maximum speed during control mode).
Pr. 31: JOG speed limit value	Set the speed limit value for the JOG operation (maximum speed during control mode). (Make sure to keep the following value: [Pr. 31: Speed limit value for JAOG operation ≤ Pr. 8 Speed limit value].)

3.13.3 Parameter settings (External input signal selection)

Set the logic and type for the external input signal.

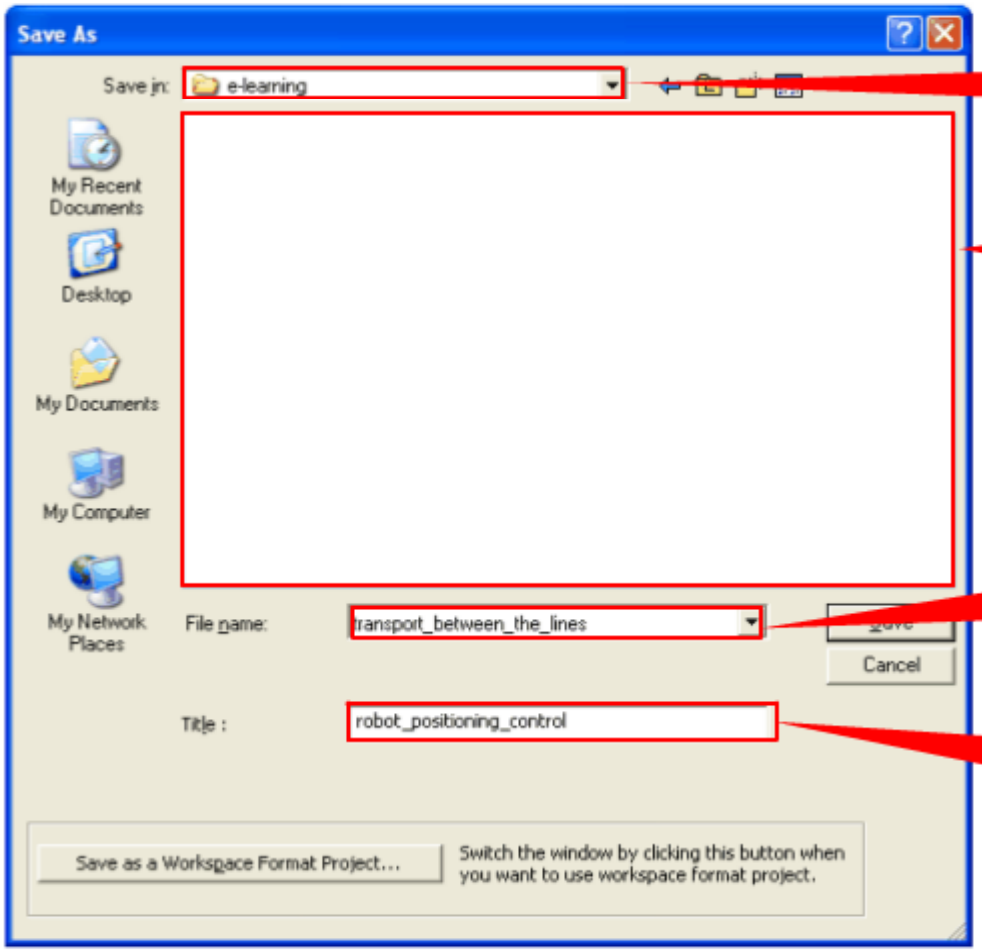


Parameter item	Setting details
Pr. 22: Input signal logic selection: Lower limit	Set the logic for the external input signals (Upper/lower limit switches) selected in Pr. 80. The initial setting value is set to [Negative Logic] for safety reasons. If not using this signal, set the type to [Positive Logic].
Pr. 22: Input signal logic selection: Upper limit	
Pr. 80: External input signal selection	Use this to select which to use for the external input signal (Upper/lower limit switches, Near-point dog signal, stop signal) from "Simple Motion Module External Input Signal/Servo Amplifier Input Signal/Simple Motion Module Buffer Memory."

3.14 Saving of Setting Tool Projects

Save a project including parameters after the parameter setting.
If you exit the Simple Motion Module Setting Tool without saving a project, the set parameter contents will be discarded.

When wanting to save a new project, set a file name.
It is recommended that you select a name that can be used to identify the content of the project (using the control details, system name, or other easily recognizable text).
Files are saved with the ".pcw" file extension.



Save folder path *Required
Specify a folder in which to save.
(Up to 200 characters in length including the file name and extension.)

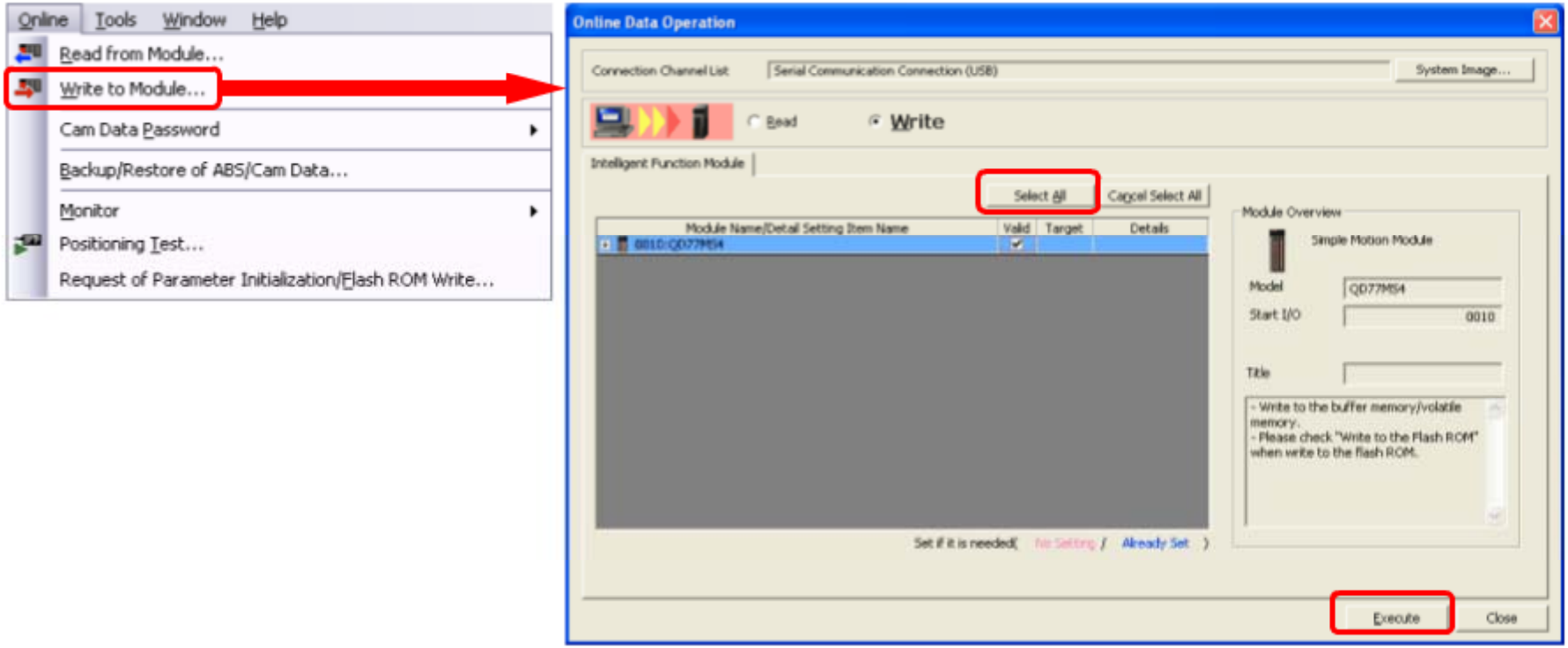
List of Files
If there are one or more files in the same save folder path, they are given in list form.

File Name *Required
Specify a file name. (Up to 30 characters in length, not including the file extension.)

Title
Specify a title. (Up to 128 characters in length.)
Use this when you want to use a name that exceeds 30 characters. (You can skip the title if you wish as it is not necessary.)

3.15 Writing to the Simple Motion Module

Use [Write to Module...] in the Setting Tool to write to the QD77MS.
The Setting Connection Destinations use the same settings as those set in GX Works2.



3.16 Summary

In this chapter, you have learned:

- System Settings
- Confirmation of I/O assignments
- Connection Settings for the GX Works2 and PLC CPU Connection
- Servo Parameter Settings
- Parameter settings (Electronic gear)
- Parameter settings (Speed limit value)
- Parameter settings (External input signal selection)

Important points

The following points are very important, so please review them again to ensure that you have familiarized yourself with their content.

System Settings	System settings for the Simple Motion Module are set using the Simple Motion Module Setting Tool in GX Works2.
Confirmation of I/O assignments	Set the model type, model name, number of occupied I/O points, and head I/O number for each module in the base unit.
Connection Settings for the GX Works2 and PLC	You will not be able to start communications automatically merely by connecting GX Works2 and the PLC together using a USB cable.
Servo Parameter Settings	Set parameters specific to the servo for each axis.It is recommended that you use the MELSOFT MR Configurator2 Servo amplifier setup software to set the servo parameters.
Parameter settings (Electronic gear)	This item is used to determine how many times the motor is to be rotated (how many pulses) with the electronic gear, which is used to move the machine the select movement amount specified by the commands.

3.16 Summary

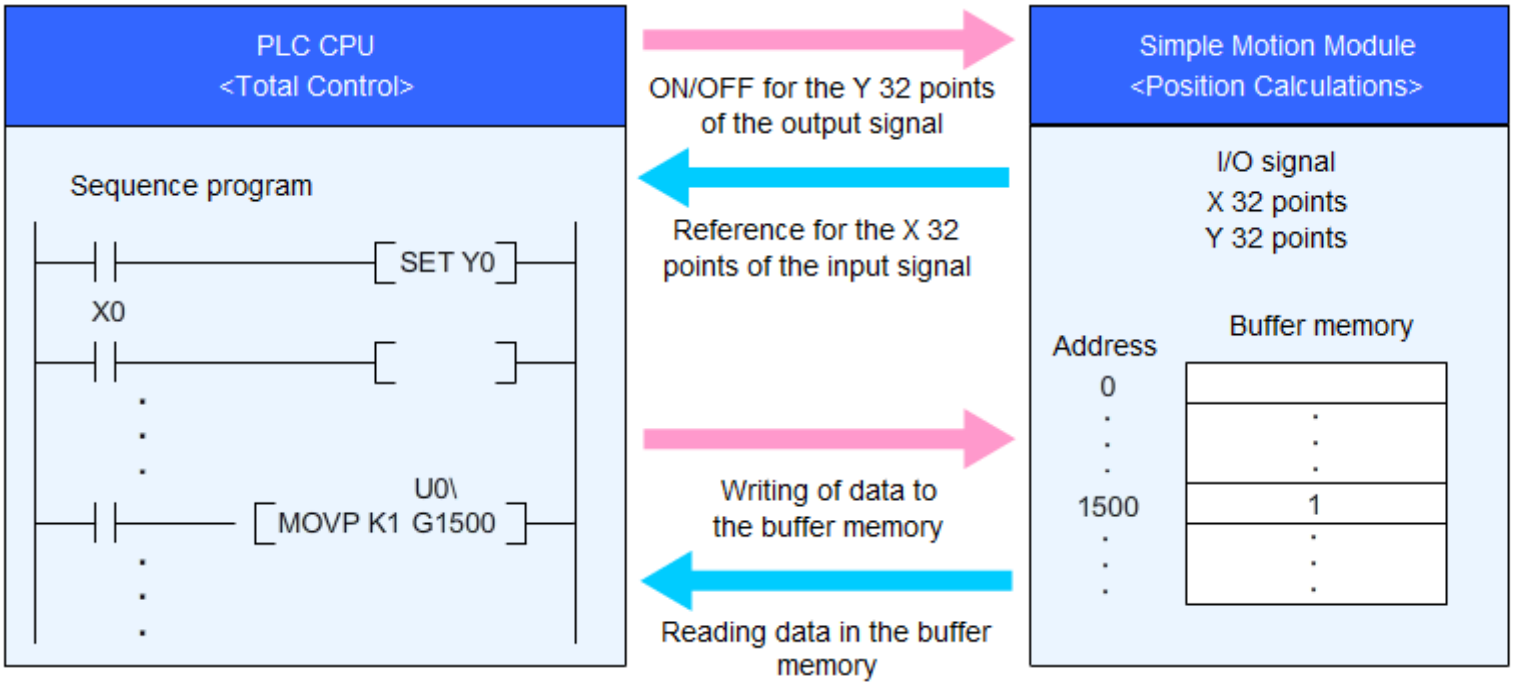
Parameter settings (Speed limit value)	Set the maximum speed for the command speed during control mode.
Parameter settings (External input signal selection)	Set the logic and type for the external input signal.

Chapter 4 Positioning Control

In Chapter 4, you will learn about positioning control using a Simple Motion Module with the QD77MS4 used as an example.

4.1 PLC CPU and Simple Motion Module

Total control is handled by the PLC CPU, and positioning control is performed by the Simple Motion Module, calculating the position.
The PLC CPU and Simple Motion Module transmit and receive data using the I/O signals and buffer memory.
*The layout of the I/O signals and buffer memory may vary depending on the model of Simple Motion Module.
Please be aware that the layouts of those for the QD77MS2/QD77MS4 and QD77MS16 in particular differ dramatically.
I/O signal List <PDF>



● Designation method for the buffer memory

Designation :U□\G□ → Buffer memory address (Set range: 0 to 65536 in decimal)

● Designation method for the buffer memory

Designation :U□\G□

→ Buffer memory address (Set range: 0 to 65536 in decimal)

→ Head I/O number for the Simple Motion Module (Set range: 00H to FFH)

Setting: First two digits of the head I/O number when expressed as a three-digit value

For X/Y010 ･･･X/Y010

Designation: 01

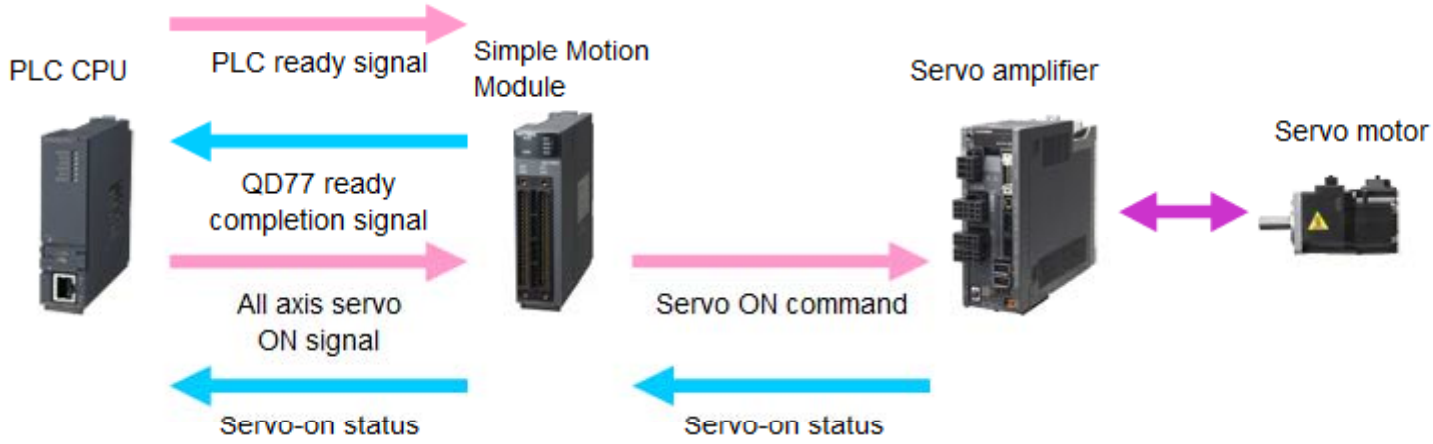
Example of buffer memory access: MOVP K1 U1 G1500

"1" is transferred to the buffer memory address 1500 of the module with the head I/O number of X/Y010

4.2 Simple Motion Module and Servo Amplifier

The Simple Motion Module controls the servo amplifier through SSCNET Ⅲ/H communications.
The Simple Motion Module generates positioning commands for every command communication cycle and transmits those commands to the servo amplifier to control positioning.

The servo amplifier must be set to the Servo-on status in order to allow it to be controlled by the Simple Motion Module.
Once the servo amplifier has been placed in the Servo-on status, the servo motor is servo-locked, and positioning control is enabled.

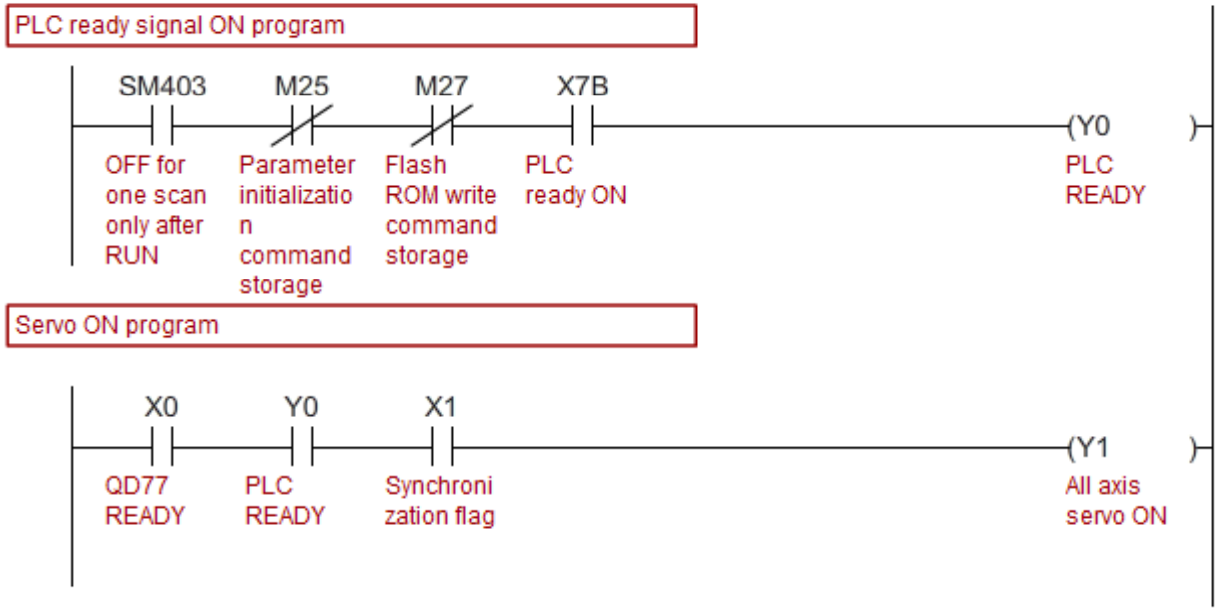


Below, a program example is shown.

PLC ready signal ON program

4.2 Simple Motion Module and Servo Amplifier

Below, a program example is shown.



4.3 JOG operation

JOG operation is a function used to manually operate a servo motor in the forward or reverse run direction at a constant speed.
It is used for a teaching or test operation when a system is constructed.

After the JOG speed and other settings have been made, turning the JOG start signal ON starts JOG operation and turning it OFF initiates deceleration and brings JOG operation to a stop.
Required signals and data produced for JOG operation using a QD77MS4 model as an example are given below.

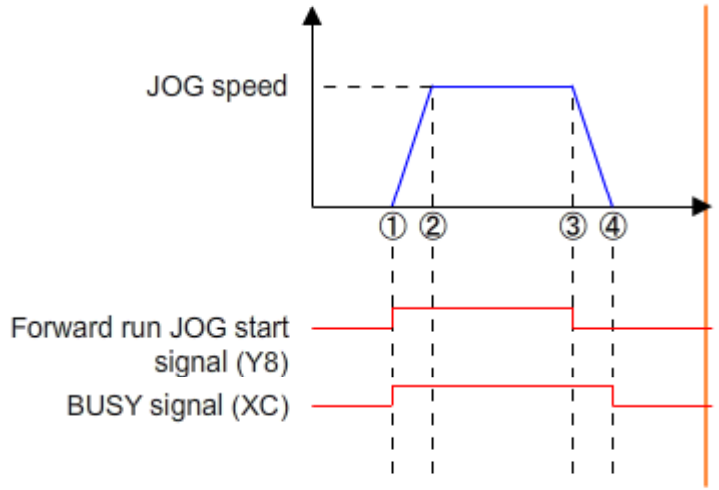
I/O signals

	Axis 1	Axis 2	Axis 3	Axis 4
Forward run JOG start signal	Y8	YA	YC	YE
Reverse run JOG start signal	Y9	YB	YD	YF

Buffer memory

	Axis 1	Axis 2	Axis 3	Axis 4
[Cd. 17] JOG speed	1518	1618	1718	1818
[Pr. 32] JOG operation acceleration time selection	50	200	350	500
[Pr. 33] JOG operation deceleration time selection	51	201	351	501

Examples of JOG operation
For JOG operation of Axis 1 in the forward run direction



① Once the start signal is turned ON, acceleration starts in the specified direction.
↓
② Once the JOG speed is reached the set speed, operation proceeds with constant speed movement.
↓
③ When the start signal is turned OFF, deceleration starts.
↓
④ Operation stops once the speed is reached 0.

4.4 Original point return (OPR)

4.4.1 Overview of Original Point Return (OPR)

Original point return (OPR) is a function that is used to move a machine to its original position and match the OP addresses of the machine and the Simple Motion Module at that position.
It is used to return machines to the original position when the power is turned on and at other times as necessary.

There are two types of OPR control for the Simple Motion Module.
- Machine OPR... Used to establish the original position for positioning control.
- Fast OPR... Used to set positioning directed toward the original position.

There are five methods available for establishing the "original position" using the machine OPR operation. Set the OPR parameters specified for the machine model.

OPR method	Operation details
Near-point dog method	The position of the zero point of the motor after the Near-point dog is switched from ON → OFF is set as the original position.
Count method ①	The position of the zero point of the motor after the Near-point dog is switched from OFF → ON and the machine moved for the specified distance is set as the original position.
Count method ②	The position at which the machine stops when moved to the set distance after the Near-point dog is switched from OFF → ON is set as the original position.
Data set method	The position at which OPR is used is set as the original position. No Near-point dog is used in this case.
Scale origin signal detection method	After the Near-point dog is switched from OFF → ON, the machine is moved in the direction opposite to the OPR direction, and the position at which the original position signal (zero point) is detected is set as the OPR.

After OPR is completed, the current feed value and machine feed value are written to the original address.

4.4.2 Start of OPR

The machine OPR operation starts after the OPR parameters are set and the positioning start No. is set to "9001," the OPR designation, which turns ON the positioning start signal.
Required signals and data needed for the start of the machine OPR operation are given below using a QD77MS4 model as an example.

I/O signals

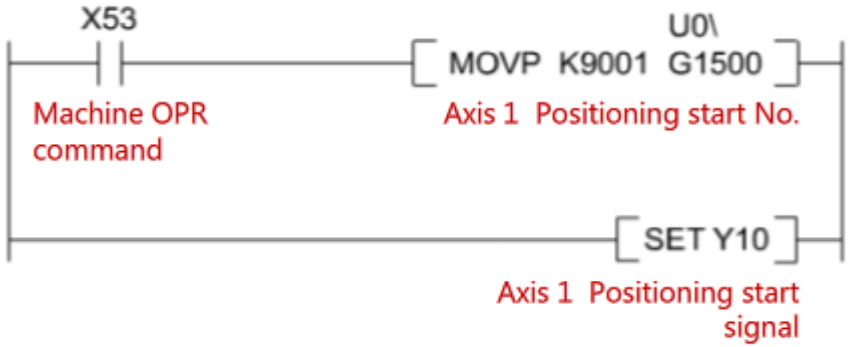
	Axis 1	Axis 2	Axis 3	Axis 4
Positioning start signal	Y10	Y11	Y12	Y13

Buffer memory

	Axis 1	Axis 2	Axis 3	Axis 4	Setting value
[Cd. 3] Positioning start No.	1500	1600	1700	1800	9001

Example of the Start of OPR
When performing machine OPR using the near-point dog method on Axis 1

• Sequence program



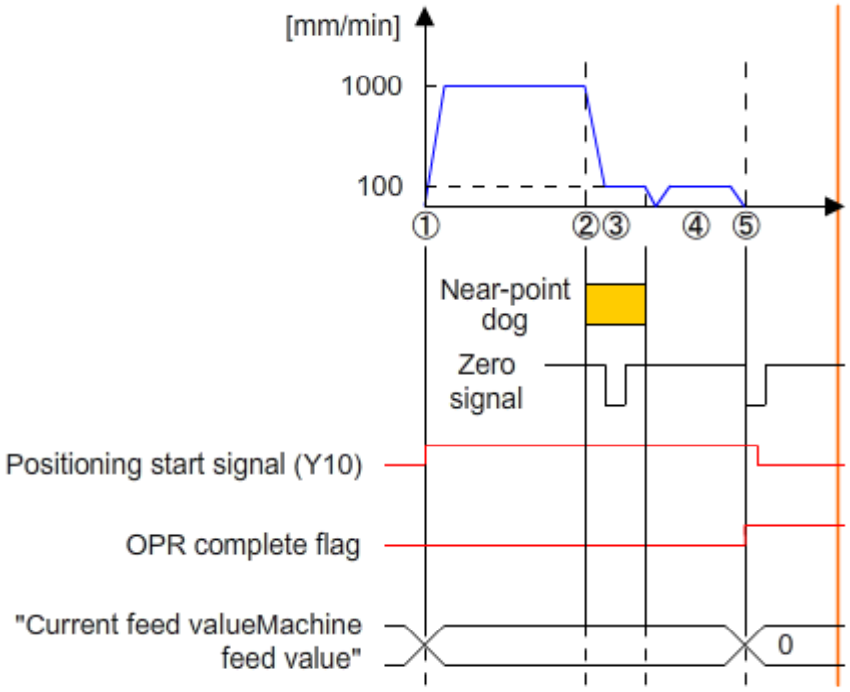
• OPR parameters

OPR basic parameters	Set the values required for c (This parameter become val
Pr.43:OPR method	0:Near-point Dog Method
Pr.44:OPR direction	0:Forward Direction(Address Increase Direction)
Pr.45:OP address	0.0 µm
Pr.46:OPR speed	1000.00 mm/min
Pr.47:Creep speed	100.00 mm/min

Set using the Simple Motion Module Setting Tool.

4.4.3 OPR operation

The operations used for near-point dog method of OPR along Axis 1 are as given below.



① The machine OPR operation starts.
The machine moves in the [Pr. 44] OPR direction at the [Pr. 46] OPR speed.

↓

② The near-point dog ON state is detected, which triggers the machine to start decelerating.

↓

③ The machine decelerates to the [Pr. 47] creep speed and then moves along at the creep speed.

↓

④ Deceleration stops after the Near-point dog is turned OFF. The machine stops at the initial motor zero point position later on.

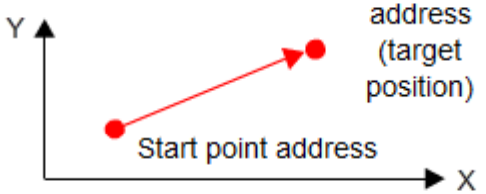
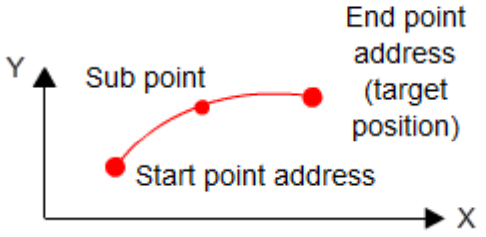
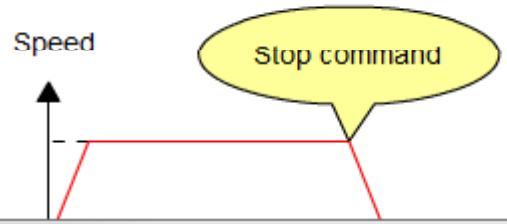
↓

⑤ The OPR complete flag (Md. 31 status: b4) switches from OFF → ON.

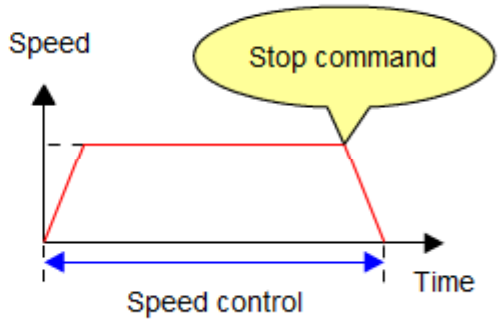
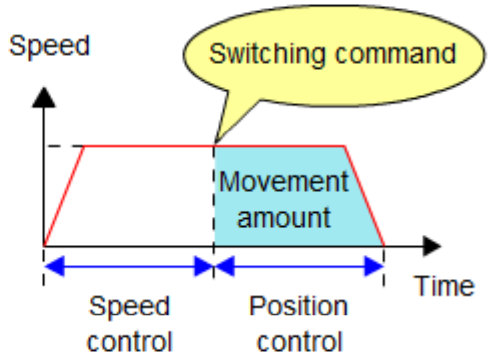
4.5 Positioning Control

4.5.1 Overview of the Positioning Control Function

The Simple Motion Module performs positioning control with the setting of the target position, command speed, and other settings to the positioning data, which triggers start up of the module.
Details for the main positioning control performed with the Simple Motion Module are as listed below.

Main positioning control		Details	Interpolation control	Operation chart
Position control	Linear control	Linear control continues from the start point address (current stop position) to the target position.	○ (Up to 4 axes)	<2-axis linear control> 
	2-axis circular interpolation control	Circular interpolation control is performed from the start point address (current stop position) to the target position using two axes. There are two kinds of circular interpolation available, one based on sub point designation and one based on center point designation.	○ (2-axis)	<2-axis circular interpolation control by sub point designation> 
Speed control		After the command is executed, control proceeds at the command speed until the stop command is input.	○ (Up to 4 axes)	

4.5 Positioning Control

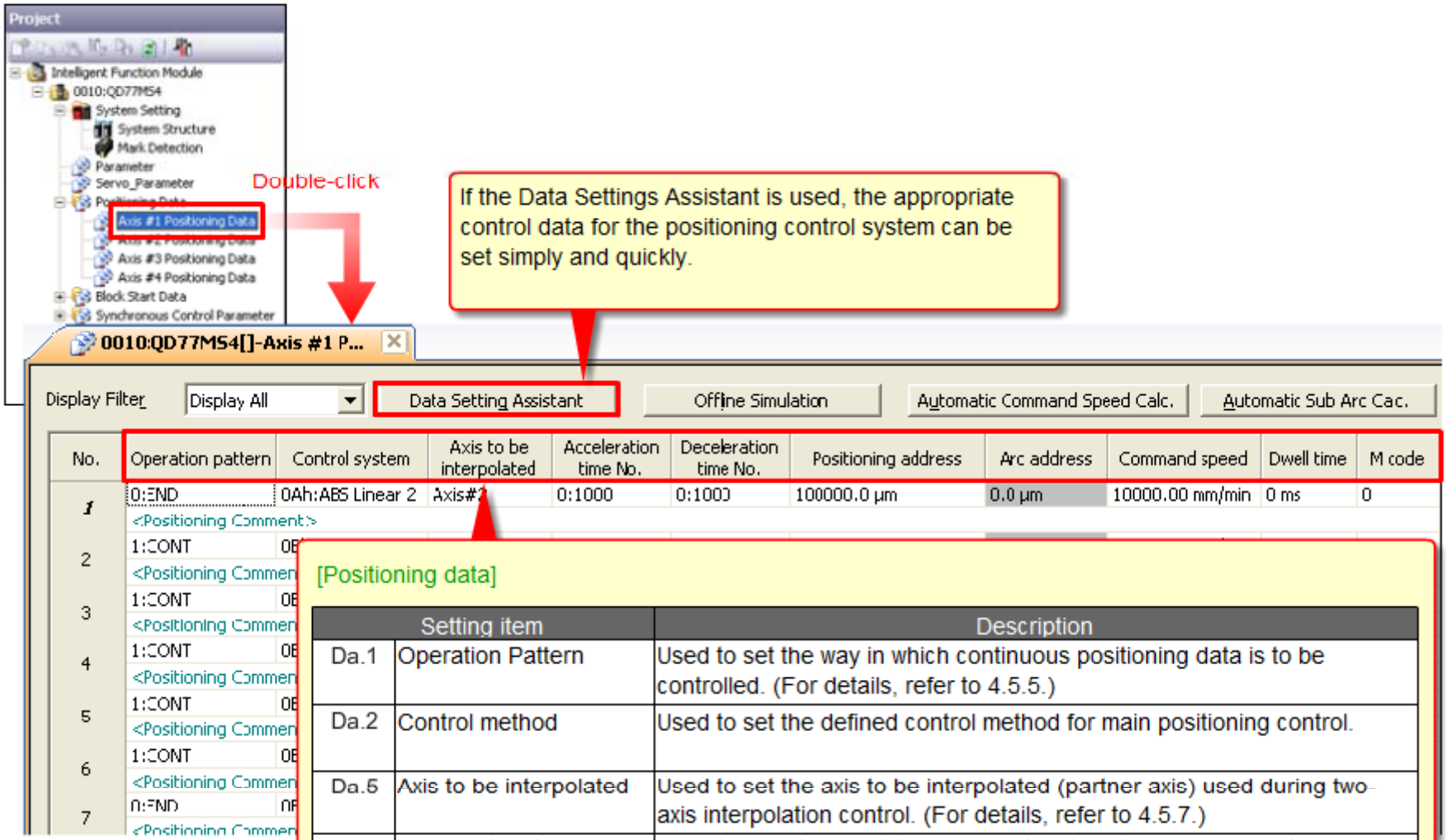
Speed control	After the command is executed, control proceeds at the command speed until the stop command is input.	○ (Up to 4 axes)	
Speed-position switching control	Positioning starts with speed control, switching to position control when the speed-position switching signal is input from external, which performs positioning for the specified movement amount.	×	

There are two methods available for specifying the target position, an absolute system and an increment system.

Absolute system (ABS)	This method specifies the original position as a standard position (absolute address).
Increment system (INC)	This method specifies the movement amount and movement distance using the current stopping position as the start point.

4.5.2 Positioning data

The positioning data settings need to be completed in order to enable main positioning control.
There are six hundered positioning data points per axis to be set using the Simple Motion Module Setting Tool.



[Positioning data]

Setting item		Description
Da.1	Operation Pattern	Used to set the way in which continuous positioning data is to be controlled. (For details, refer to 4.5.5.)
Da.2	Control method	Used to set the defined control method for main positioning control.
Da.5	Axis to be interpolated	Used to set the axis to be interpolated (partner axis) used during two-axis interpolation control. (For details, refer to 4.5.7.)
Da.3	Acceleration time No.	Used to select and set the acceleration time to use when control is started.
Da.4	Deceleration time No.	Used to select and set the deceleration time to use when control is

4.5.2 Positioning data

Da.4	Deceleration time No.	Used to select and set the deceleration time to use when control is stopped.
Da.6	Positioning address	Used to set the address for the target position for positioning control.
Da.7	Arc address	Used to set the address for the sub or center point during circular interpolation control.
Da.8	Command speed	Used to set the speed for execution of the control operation.
Da.9	Dwell time	Used to set the length of time after which the positioning complete signal is to be turned ON after positioning is completed.
Da.10	M code	Set when the M code output function is used.

4.5.3 Start of Positioning

After the positioning data settings have been made, the start of positioning control is triggered when the positioning data No. to be started is set to the positioning start No. and the positioning start signal is turned No.
Required signals and data needed for the start of positioning are given below using a QD77MS4 model as an example.

I/O signals

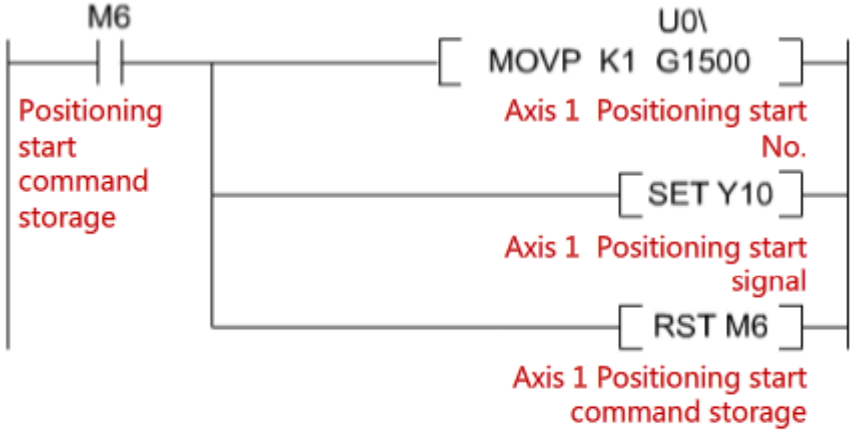
	Axis 1	Axis 2	Axis 3	Axis 4
Positioning start signal	Y10	Y11	Y12	Y13

Buffer memory

	Axis 1	Axis 2	Axis 3	Axis 4	Setting value
[Cd. 3] Positioning start Number	1500	1600	1700	1800	1 to 600

Example for the Start of Positioning
For positioning of Axis 1 to 100000 µm at 3000 mm/min.

• Sequence program



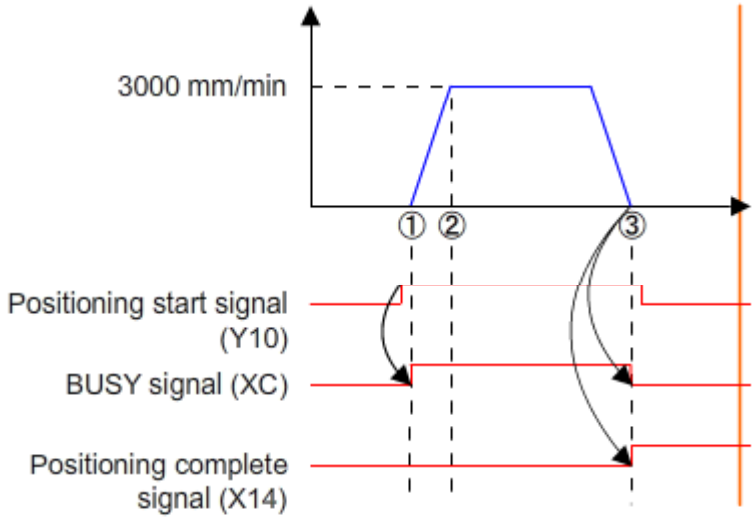
• Positioning data

No.	Operation pattern	Control system	Axis to be interpolated	Acceleration time No.	Deceleration time No.	Positioning address	Arc address	Command speed	Dwell time	M code
1	0:END	01h:ABS Linear 1	-	0:1000	0:1000	100000.0 µm	0.0 µm	3000.00 mm/min	0 ms	0
	<Positioning Comment>									

Set using the Simple Motion Module Setting Tool.

4.5.4 Positioning operation

Operation for positioning of Axis 1 to 100000 µm at 3000 mm/min proceeds as described below.



① When the start signal is turned ON, the machine accelerates in the direction of the 100000 µm address.

↓

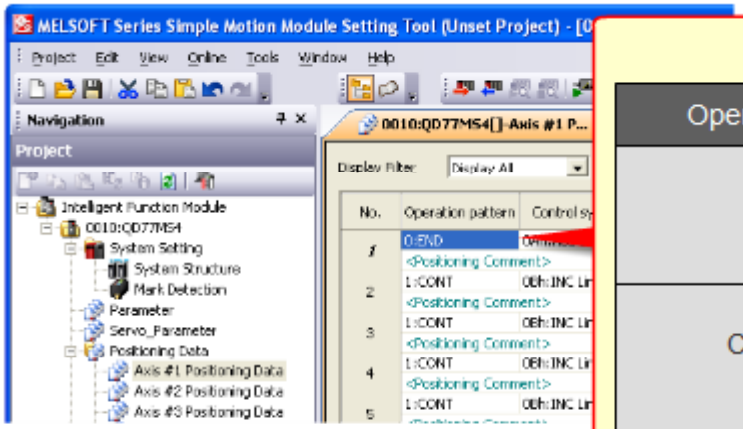
② Once the command speed of 3000 mm/min is reached, the machine continues moving with constant speed movement.

↓

③ Positioning is completed when the machine stops at the 100000 µm address. The positioning complete signal switches from OFF → ON.

4.5.5 Continuous Positioning Control

The Simple Motion Module performs continuous positioning control by starting from the positioning data No. specified by the [Cd. 3] positioning start No.
The "Operation pattern" in the positioning data is to set whether to execute the next set of positioning data.



[Operation pattern]

Operation Pattern	Description
End	Positioning of the next positioning data No. is not executed.
Continuous	After positioning is completed, the machine is stopped temporarily and then positioning of the next positioning data No. is executed. (Continuous positioning control)
Location	After positioning is completed, positioning of the next positioning data No. is executed without the machine being decelerated or stopped. (Continuous path control)

① Continuous positioning control

No.	Operation pattern	Command address	Command speed
1	Continuous	A	a

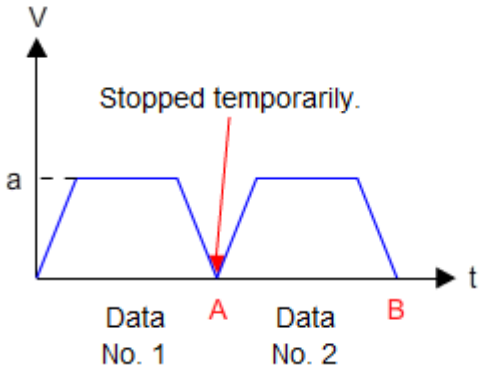
② Continuous path control

• When the speed is constant

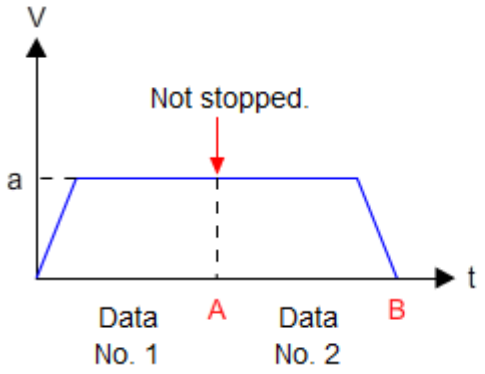
No.	Operation pattern	Command address	Command speed
1	Path	A	a

4.5.5 Continuous Positioning Control

No.	Operation pattern	Command address	Command speed
1	Continuous	A	a
2	End	B	a



No.	Operation pattern	Command address	Command speed
1	Path	A	a
2	End	B	a

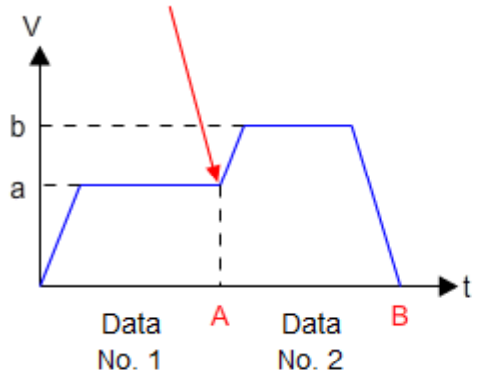


4.5.5 Continuous Positioning Control

• When the speed varies

No.	Operation pattern	Command address	Command speed
1	Path	A	a
2	End	B	b

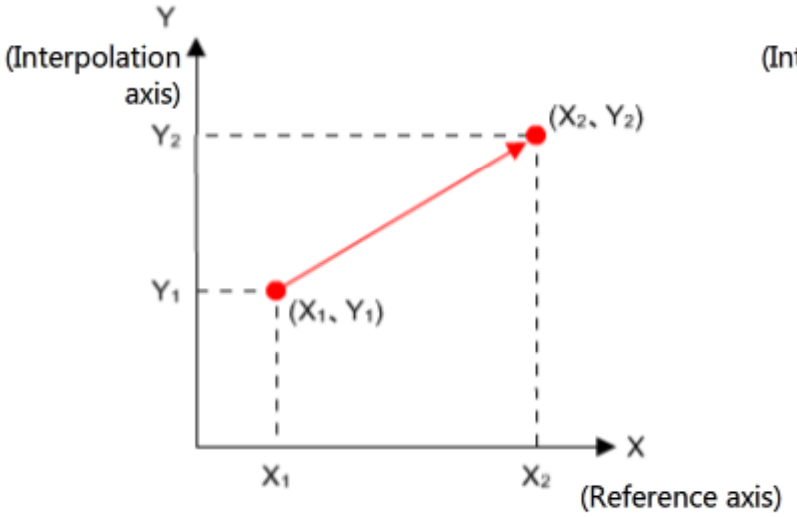
After positioning to A,
the speed is changed without the machine being stopped.



4.5.6 Interpolation control

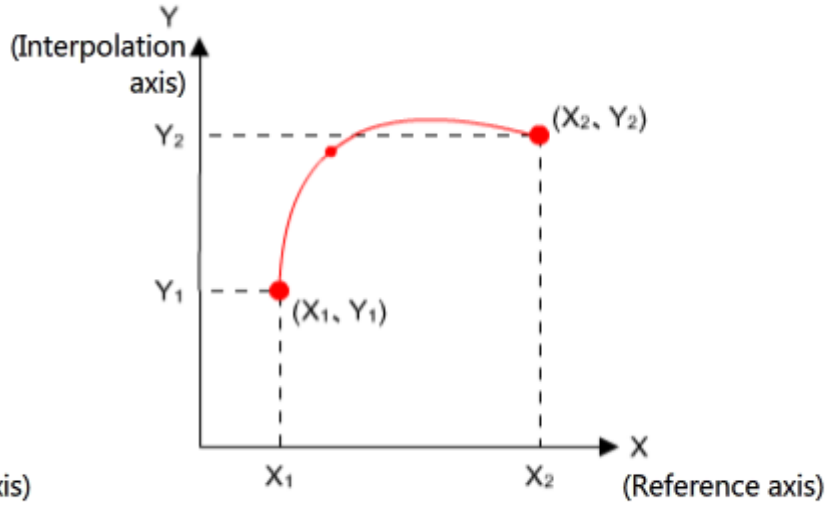
The Simple Motion Module performs interpolation control using two to four motors to control the machine such that it travels along the specified path.
There are different types of interpolation controls available including linear and circular interpolation control, the type to use being set in the control system for the positioning data. One of the axes set in the control system is referred to as the "reference axis" and the other as the "interpolation axis". The Simple Motion Module performs control of the reference axis following the positioning data set for the reference axis, with the interpolation axis being controlled along a linear or circular parth in response.

- 2-axis linear interpolation control



Linear interpolation control is performed from (X1, Y1) to (X2, Y2).

- 2-axis circular interpolation control (Sub point designation)



Circular interpolation control is performed such that the machine passes through the sub point.

4.5.7 Start of Interpolation Control

In interpolation control, the control system, positioning address, command speed, and other settings are made for the positioning data of the reference axis whereas only the positioning address is set for the same positioning data No. of the interpolation axis.
In interpolation control, after the positioning data settings are made, the positioning data No. to be started is set to the positioing start No. of the reference axis and the positioning start signal for the reference axis is turned ON, which triggers the start of interpolation control.
Required signals and data needed for the start of the interpolation control are given below using a QD77MS4 model as an example.

I/O signals (Reference axis)

	Axis 1	Axis 2	Axis 3	Axis 4
Positioning start signal	Y10	Y11	Y12	Y13

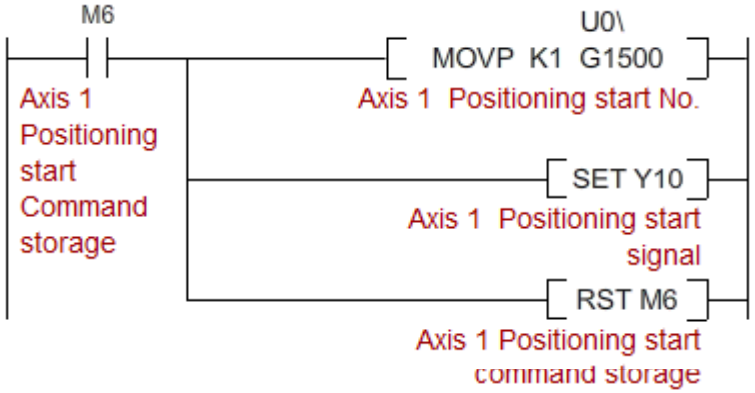
Buffer memory (Reference axis)

	Axis 1	Axis 2	Axis 3	Axis 4	Setting value
[Cd. 3] Positioning start Number	1500	1600	1700	1800	1 to 600

Example Showing the Start of Interpolation Control

When Axis 1 and 2 (100000 µ, 50000 µm respectively) are controlled by linear interpolation control at 3000 mm.min.

• Sequence program



• Positioning data

Axis 1

4.5.7 Start of Interpolation Control

• Positioning data

Axis 1

No.	Operation pattern	Control system	Axis to be interpolated	Acceleration time No.	Deceleration time No.	Positioning address	Arc address	Command speed	Dwell time	M code
1	0:END	0Ah:ABS Linear 2	Axis#2	0:1000	0:1000	100000.0 μm	0.0 μm	3000.00 mm/min	0 ms	0
	<Positioning Comment>									

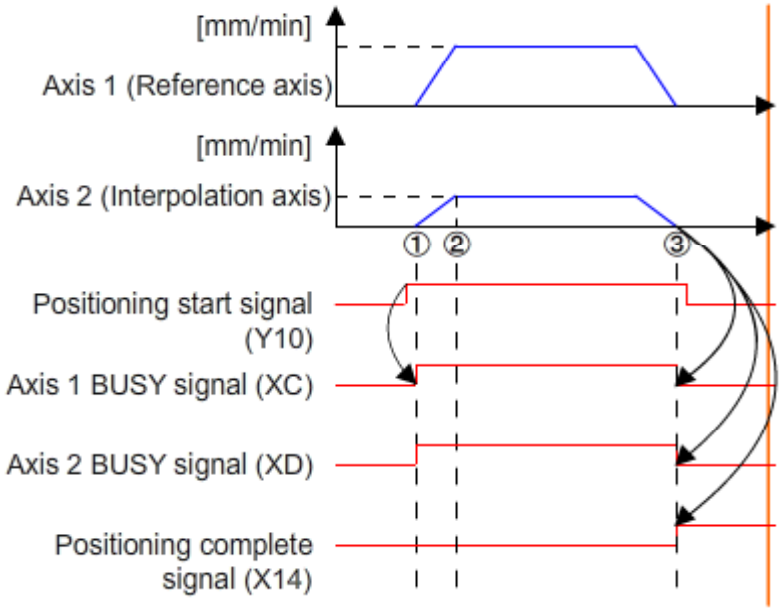
Axis 2

No.	Operation pattern	Control system	Axis to be interpolated	Acceleration time No.	Deceleration time No.	Positioning address	Arc address	Command speed	Dwell time	M code
1						50000.0 μm	0.0 μm	0.00 mm/min		
	<Positioning Comment>									

Set using the Simple Motion Module Setting Tool.

4.5.8 Interpolation Control Operation

Operation for linear interpolation control for positioning of Axis 1 to 100000 µm and Axis 2 to 50000 µm at 3000 mm/min proceeds as described below.



① When the start signal is turned ON, the machine accelerates in the directions of the positioning addresses for each axis.

↓

② Once the command speed of 3000 mm/min is reached, the machine continues moving with constant speed movement.

↓

③ Positioning is completed when the machine stops along Axis 1 at the 100000 µm address and along Axis 2 at the 50000 µm address. The positioning complete signal switches from OFF → ON.

4.6 Summary

In this chapter, you have learned:

- PLC and Simple Motion Module
- JOG operation
- Original point return (OPR)
- Positioning Control
- Positioning data
- Continuous Positioning Control
- Interpolation control

Important points

The following points are very important, so please review them again to ensure that you have familiarized yourself with their content.

PLC and Simple Motion Module	For positioning control using a Simple Motion Module, total control is handled by the PLC CPU and position calculations are performed by the Simple Motion Module.
JOG operation	JOG operation is a function used to manually operate a servo motor in the forward or reverse run direction at a constant speed.
Original point return (OPR)	Original point return (OPR) is a function that is used to move a machine to its original position and match the OP addresses of the machine and the Simple Motion Module at that position.
Positioning Control	The Simple Motion Module performs positioning control with the setting of the target position, command speed, and other settings to the positioning data, which triggers start up of the module.
Positioning data	The positioning data is used to set the operation pattern, control system, and other settings for positioning control.

4.6 Summary

Continuous Positioning Control	The Simple Motion Module starts positioning in order from the positioning data No. specified by the [Cd. 3] positioning start No. The "Operation pattern" in the positioning data sets whether to execute the next set of positioning data.
Interpolation control	There are different types of interpolation control available including linear and circular interpolation control, the type to use being set in the control system for the positioning data. One of the axes set in the control method is referred to as the "reference axis" and the other as the "interpolation axis. "The Simple Motion Module performs control of the reference axis following the positioning data set for the reference axis, with the interpolation axis being controlled along a linear or circular parth in response.

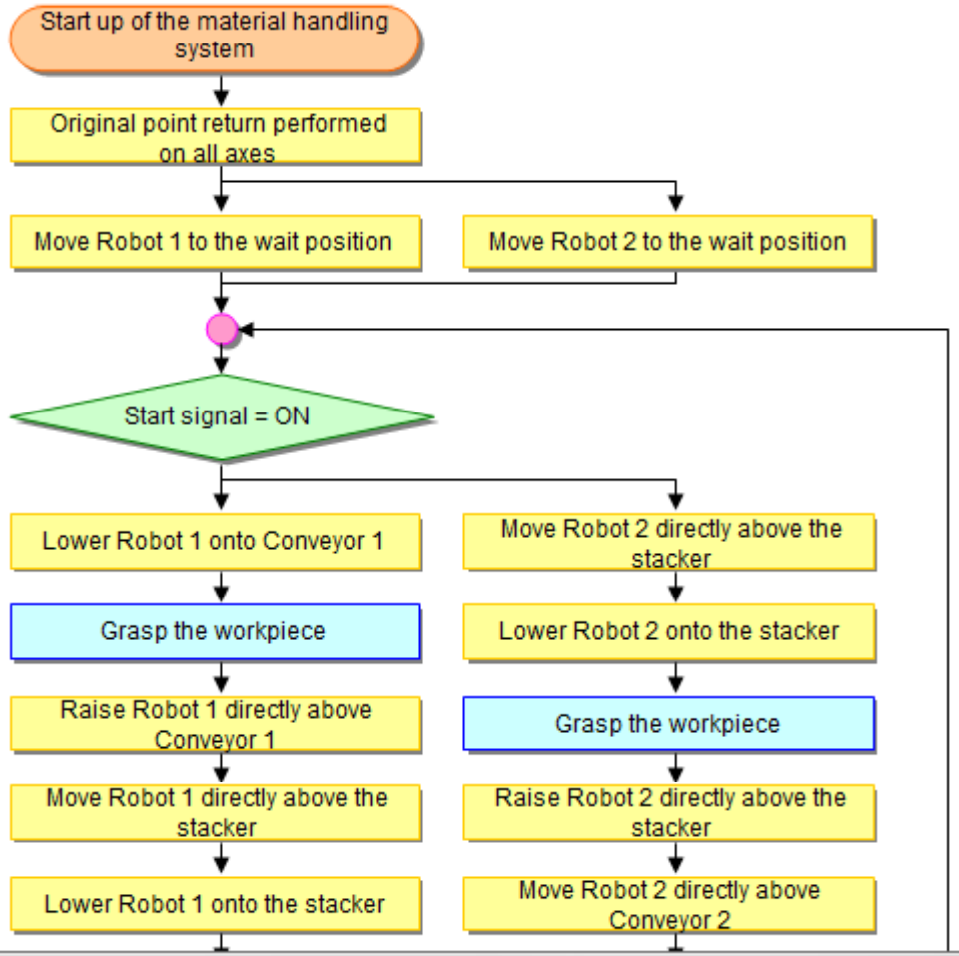
Chapter 5 Construction of the Sample System (Positioning)

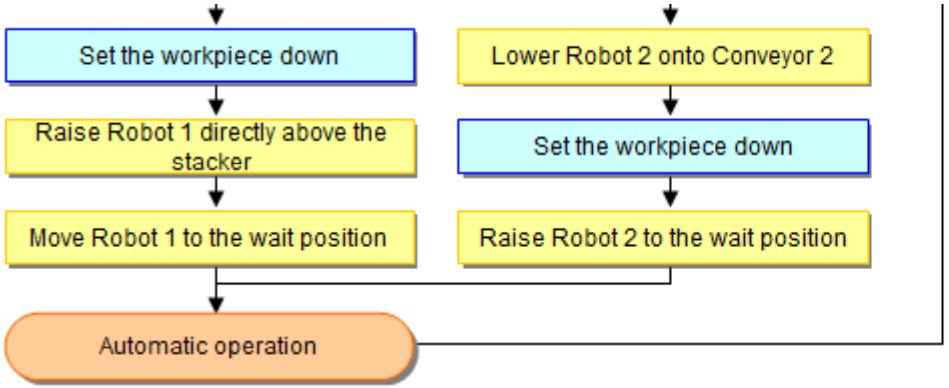
In Chapter 5, you will learn how to construct sample systems designed for positioning tasks.

5.1 Flow Chart of Control Principles

The following shows a flowchart of the control details in the sample system.

Point your mouse cursor on the flowchart to display details.




Set the workpiece down
Raise Robot 1 directly above the stacker
Move Robot 1 to the wait position
Lower Robot 2 onto Conveyor 2
Set the workpiece down
Raise Robot 2 to the wait position
Automatic operation

5.2 Assignment of Device Numbers

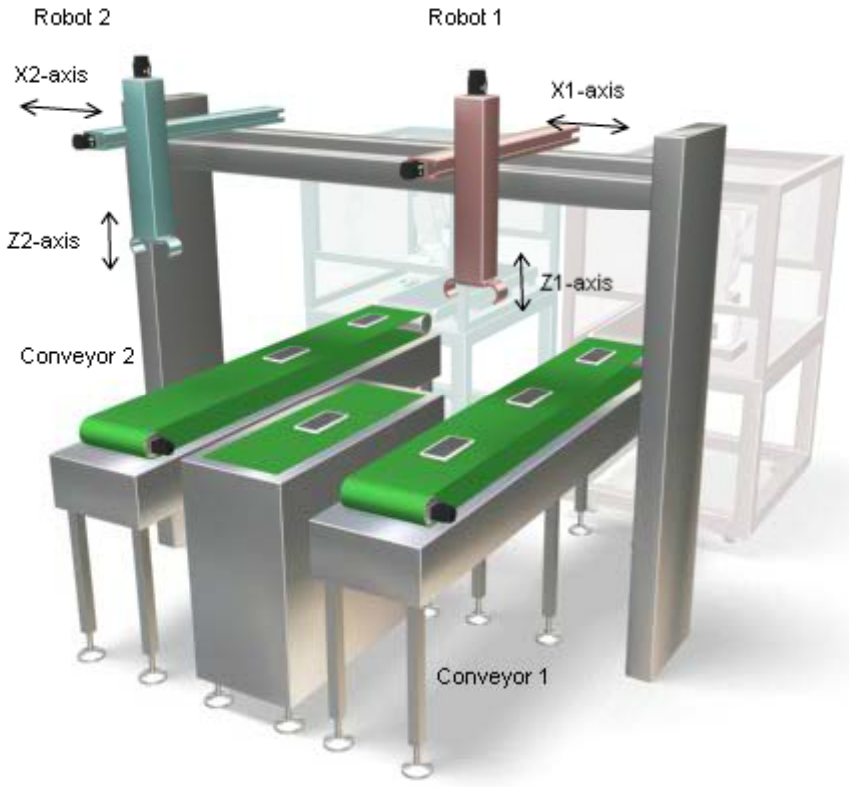
Create a correspondence table of I/O devices and device numbers to use in the sample system.
Creating a correspondence table will reduce programming glitches and streamline your programs.

You can download an example of assigned device number correspondence table for the sample system through the below link.

<PDF of Assigned Device Numbers>

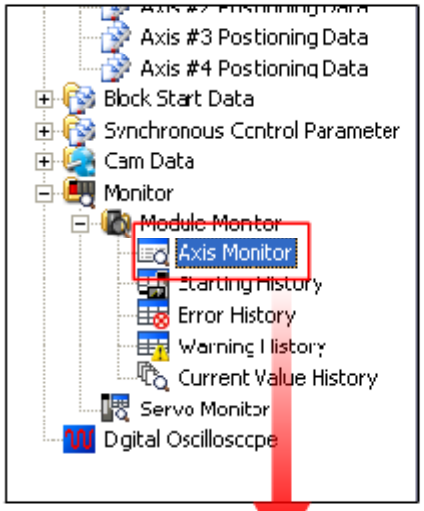
5.3 Operation of a Sample System

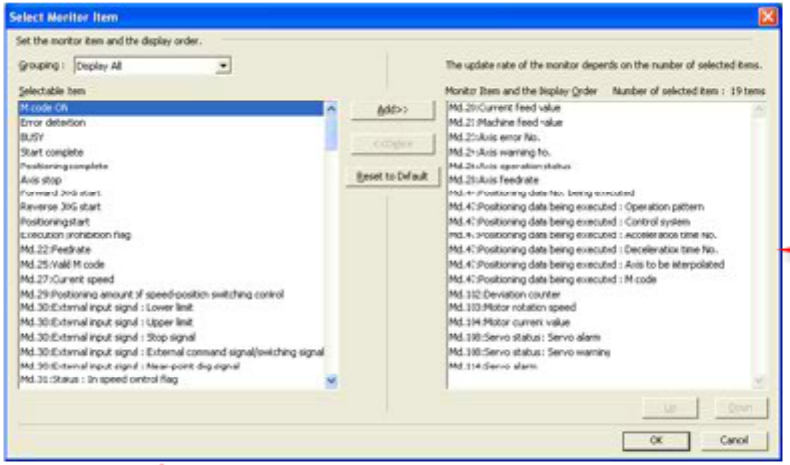
The sample system is designed to operate as shown below under normal operating conditions.



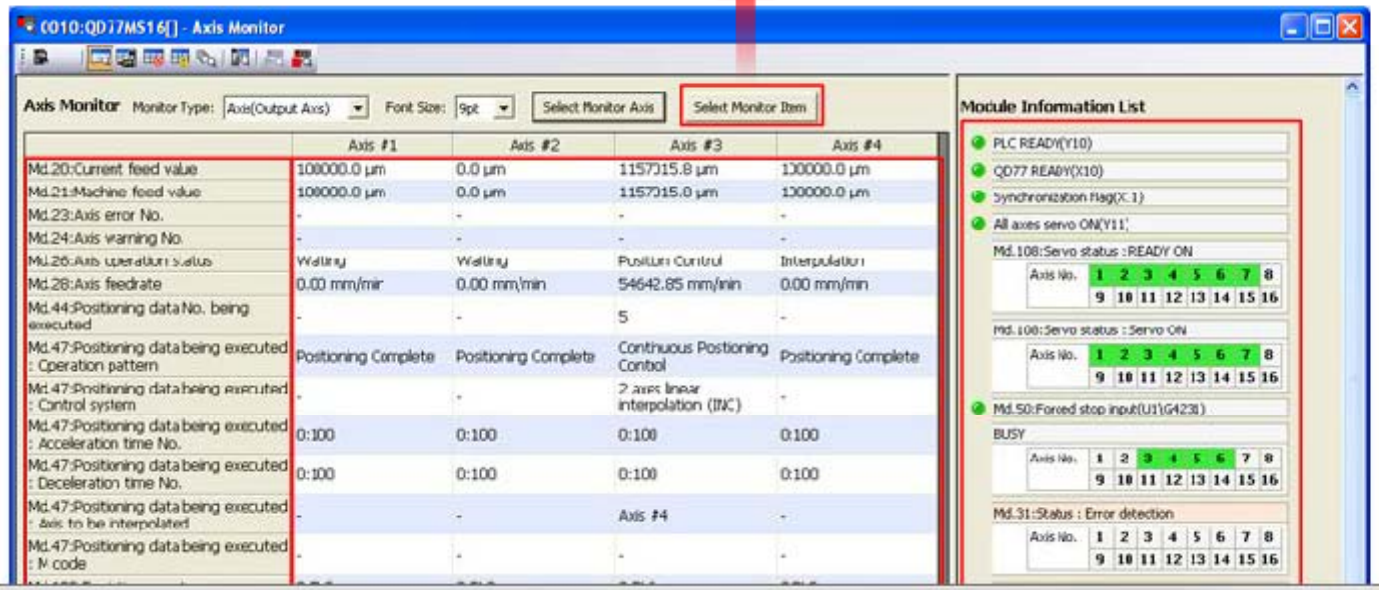
5.4 Monitoring of the sample system

You can use the monitoring function of the Simple Motion Module Setting Tool to monitor and display current locations, error codes, and other information for all axes in operation at once.

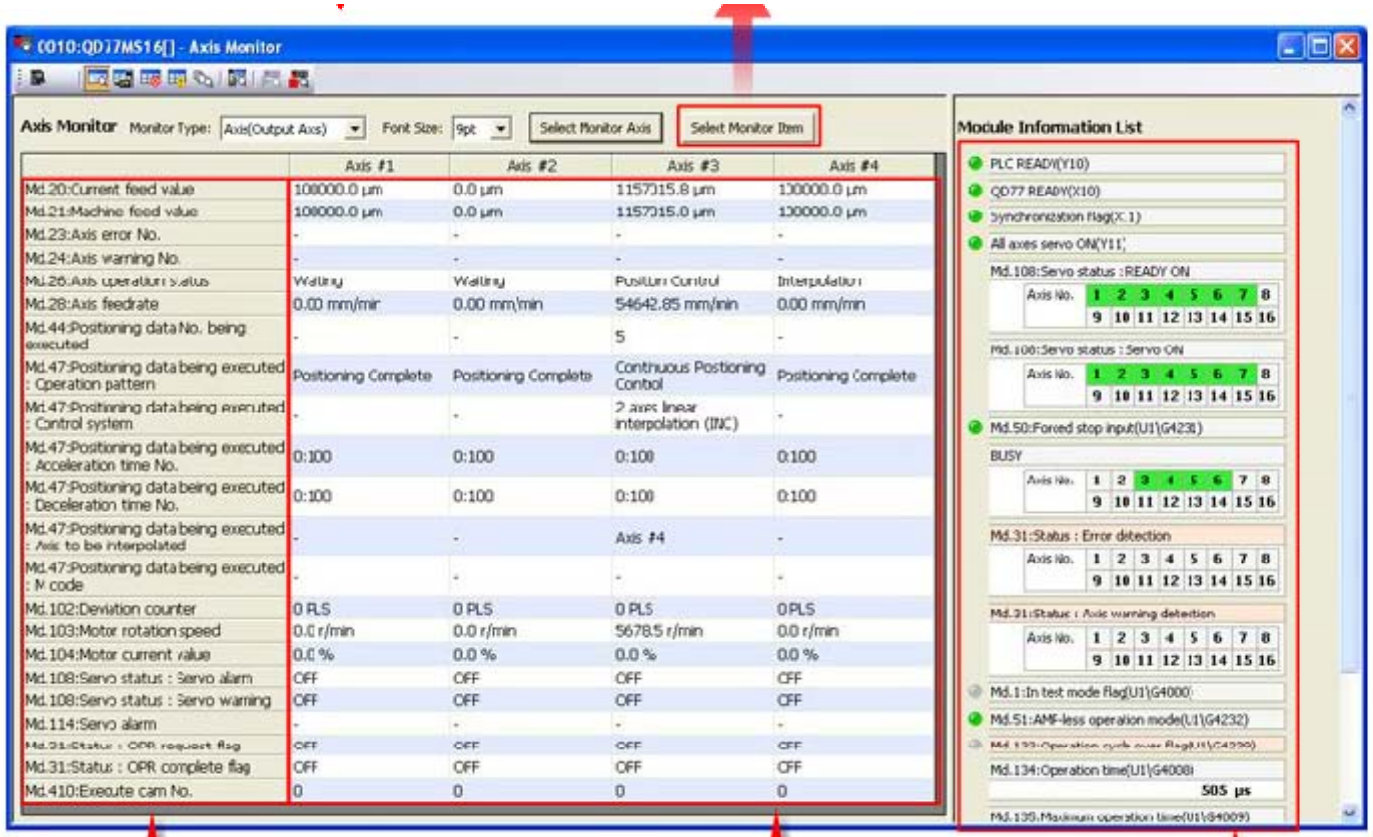




Can be used to select the monitoring item.



5.4 Monitoring of the sample system



[Monitoring item]
Display the monitoring item set in Monitoring Item Selection.

[Monitoring display column]
Display the monitoring value of the axis set in Monitoring Axis Selection.

[Module information list]
Display the module information.

5.5 Summary

In this chapter, you have learned:

- Assignment of Device Numbers
- Monitoring of the sample system

Important points

The following points are very important, so please review them again to ensure that you have familiarized yourself with their content.

Assignment of Device Numbers	Create a correspondence table of I/O devices and device numbers to use in the sample system. Creating a correspondence table will reduce programming glitches and streamline your programs.
Monitoring of the sample system	You can use the monitoring function of the Simple Motion Module Setting Tool to monitor and display current locations, error codes, and other information for all axes in operation at once.

Chapter 6 Synchronous Control

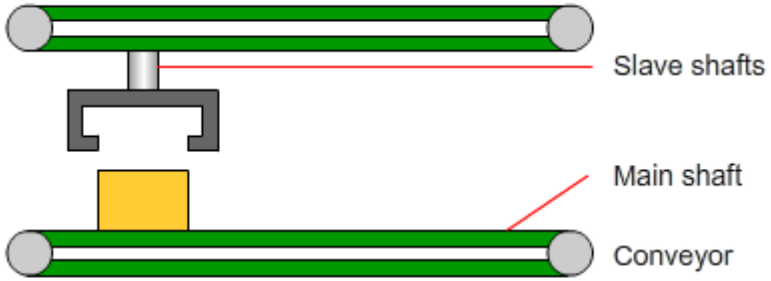
In Chapter 6, you will learn about synchronous control using a Simple Motion Module with the QD77MS4 used as an example.

6.1 Overview of Synchronous Control

Synchronous control is a type of control in which multiple other axes (slave shafts) are synchronized to the standard axis (main shaft).

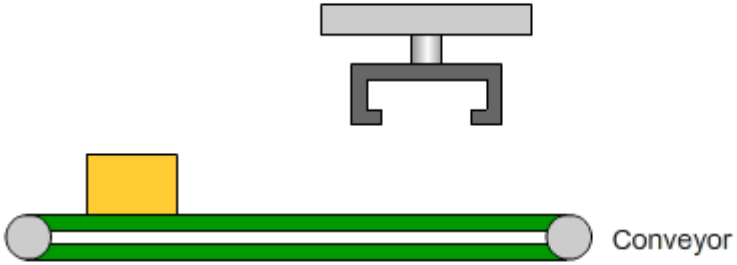
Below is given a description of general synchronous control involving a conveyance device as an example.

With synchronous control



- Objects can be continuously transported without the conveyor having to stop.

WIthout synchronous control



- The conveyor needs to be stopped every time that it transports objects.

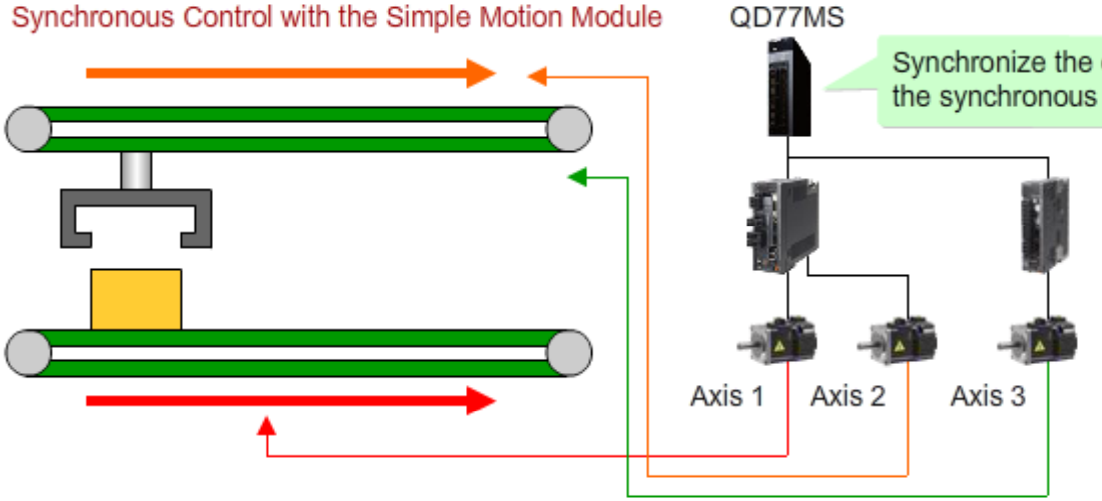
There are several advantages to use synchronous control, some of which are given below.

- Improved productivity...As there is no standby time between operations as with sequential operation, tact time can be shortened, improving productivity.
- Safe control...As the slave shafts are all synchronized to the main shaft and stopped when the main shaft is stopped, the risk of damage to the equipment can be reduced.

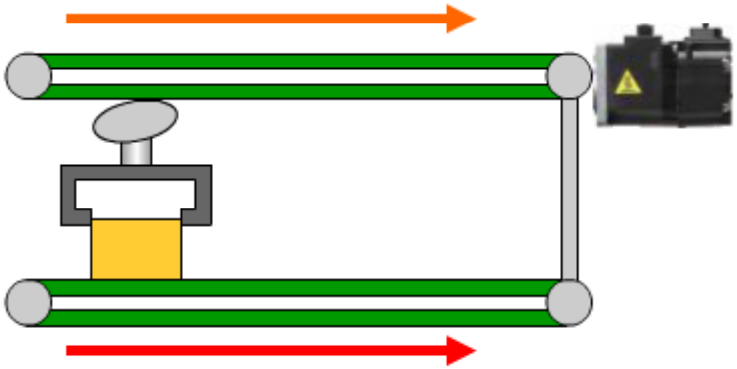
6.2 Synchronous Control with the Simple Motion Module

The Simple Motion Module is able to provide mechanical synchronous control using gears, shafts, speed change gears, cams, and other parts, quite simply with the mere setting of synchronous parameters and other such settings.

Synchronous Control with the Simple Motion Module



Traditional mechanical synchronous control

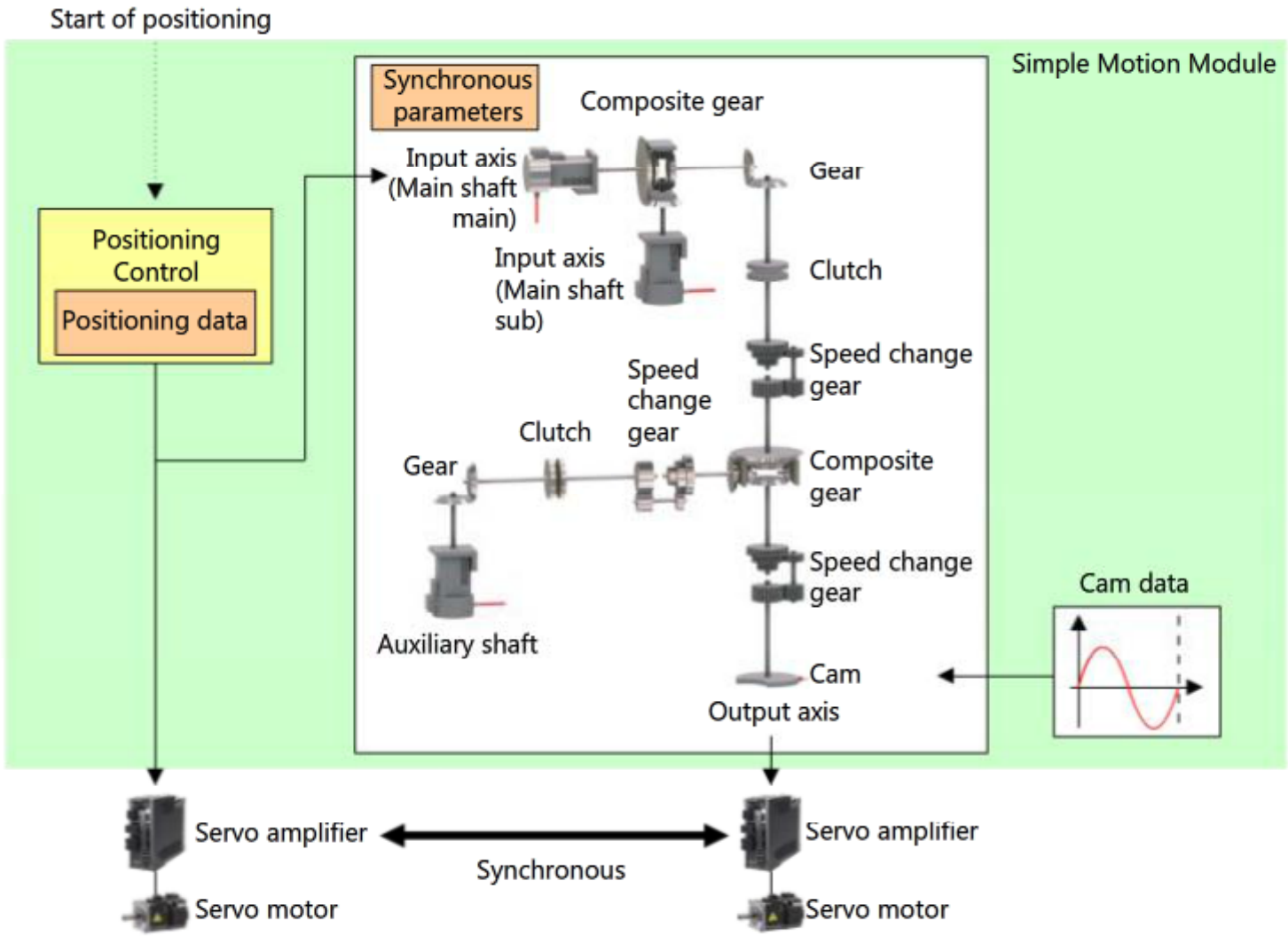


● Advantages

- Machine is more compact and costs are lower.
- There are no worries over friction and service life for the main shaft, gear and clutch.
- Changing initial setup is simple.
- There is no error caused by mechanical precision, and system performance improves.

6.3 Flow of Synchronous Control

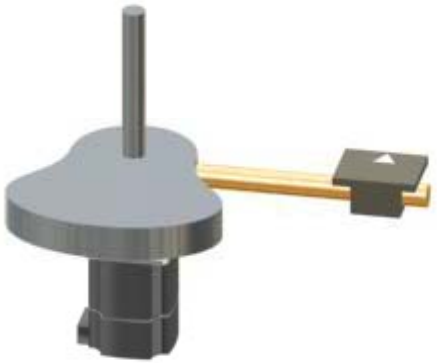
The flow of synchronous control for the Simple Motion Module is shown below.
The main shaft in the Simple Motion Module is referred to as the input axis and the axis to be synchronized as the output axis.
There are synchronous parameters to be set for each output axis that determine how the output axis is to be synchronized and to which input axis.



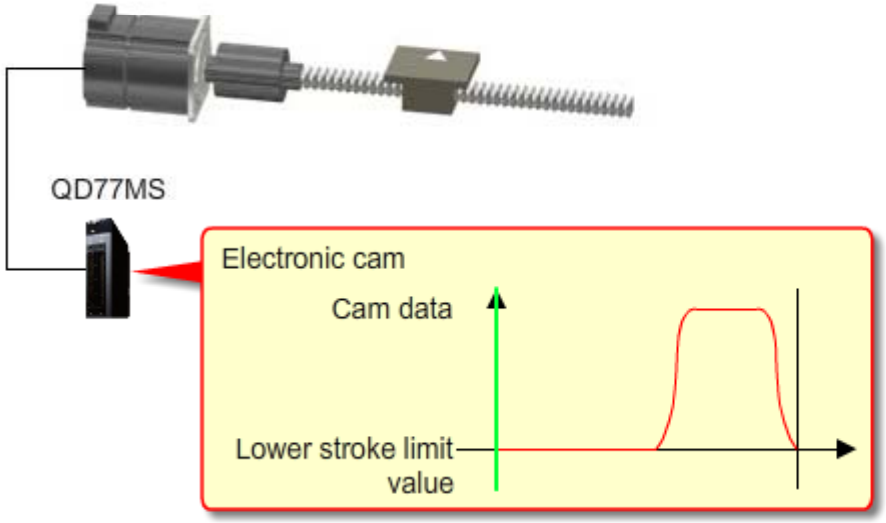
6.4 Cam control

The output axis for synchronous control uses cam operation.
Cam control performed using a traditional mechanical cam is reproduced as electronic cam control using cam data.

Control using a mechanical cam>



Control using an electronic cam



As electronic cam control for the Simple Motion Module is processed using software, the ideal cam pattern is produced without any worries caused from traditional cam control such as errors due to problems with mechanical accuracy. Replacement of the cam due to changes in the model used can be completed quite simply with mere changes to the cam pattern.

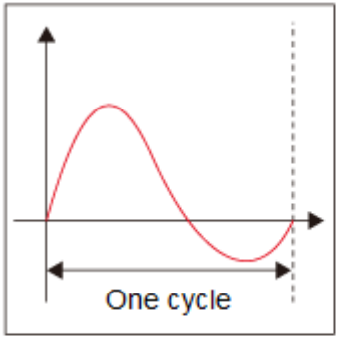
6.5 Cam data

The output axis is controlled using values (current feed values) converted from the set cam data using current values for one cycle of the cam axis as the input values.
There are three types of operations in the cam data, for the two-way cam, the feed cam, and the linear cam.

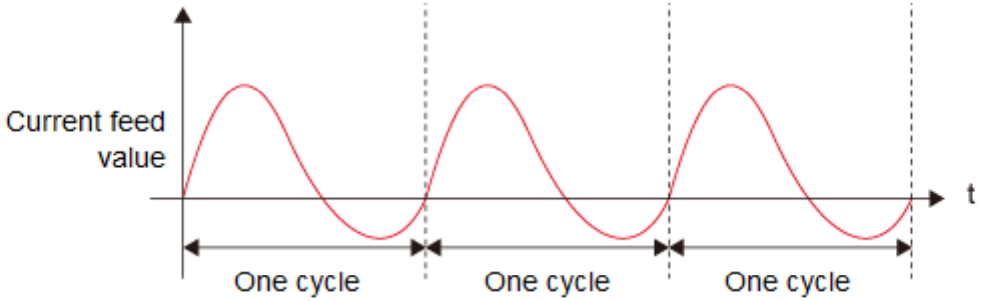
- Two-way cam

The two-way cam operates back and forth across the constant cam stroke range.

Cam data



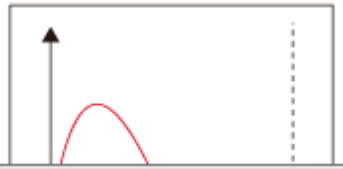
Operation Example



- Feed cam

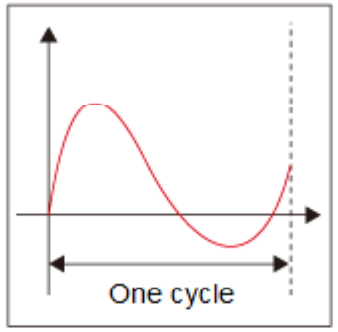
The feed cam operates to change the cam reference position for each cycle.

Cam data

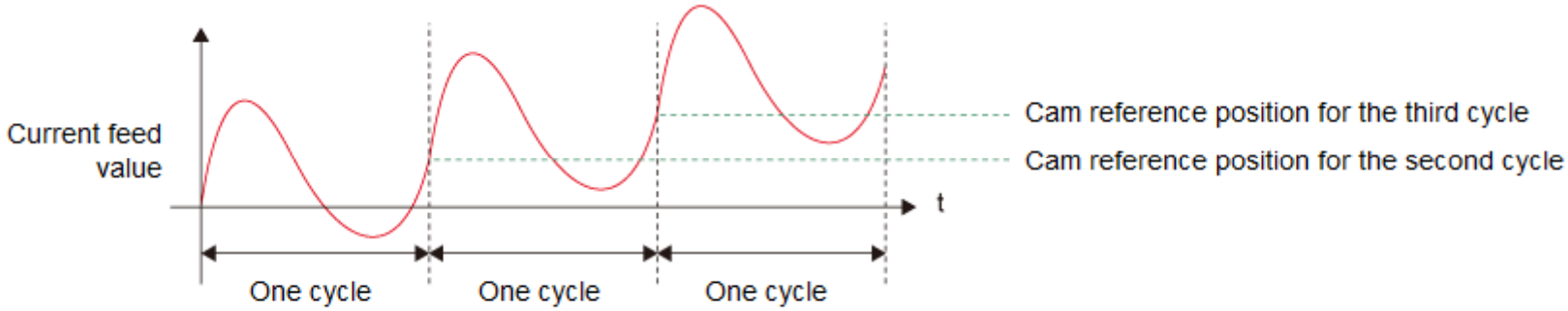


6.5 Cam data

Cam data



Operation Example

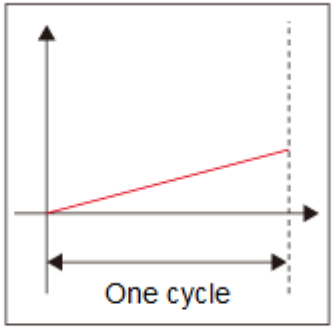


- Linear cam

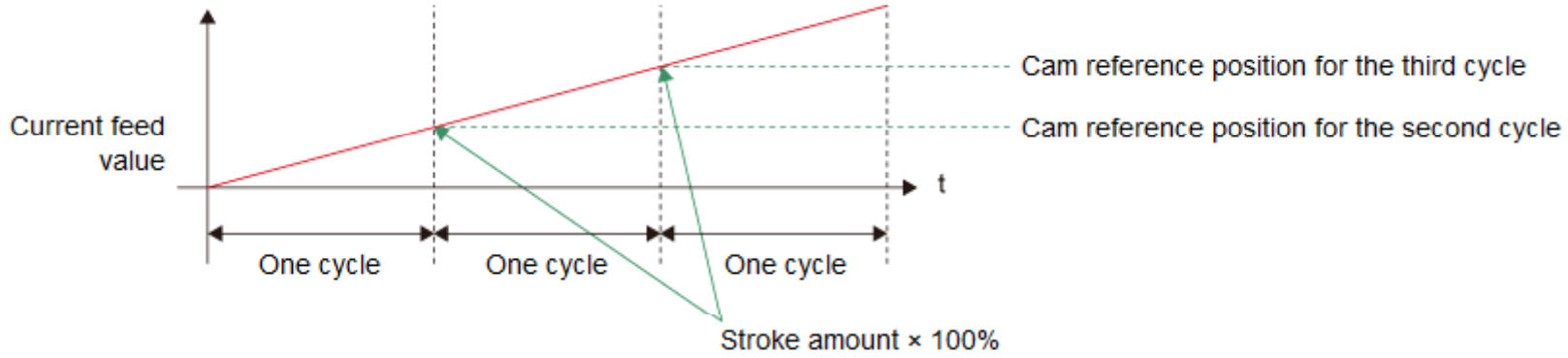
The linear cam operates along a straight line that produces a stroke ratio of 100% for one cycle.

6.5 Cam data

Cam data



Operation Example

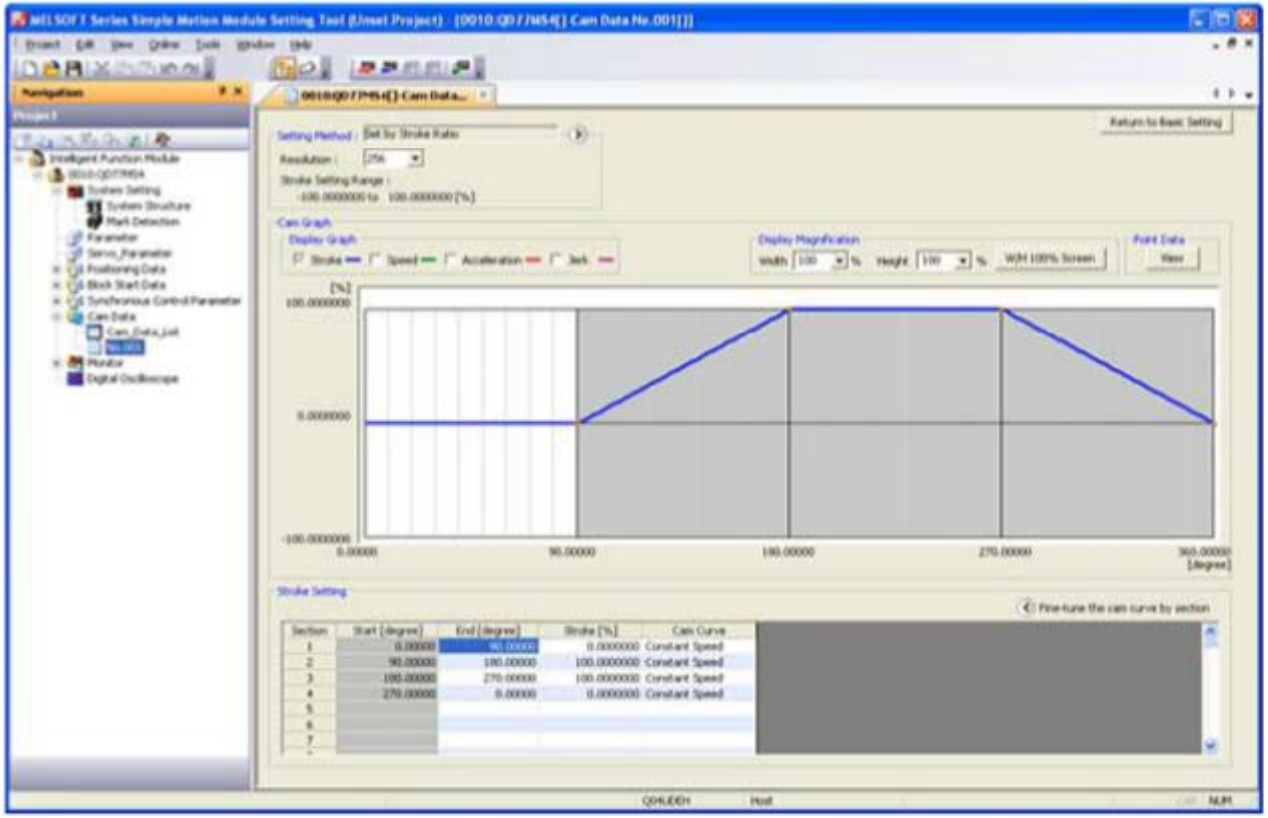


The linear cam is registered to the Simple Motion Module Setting Tool as cam No. 0.

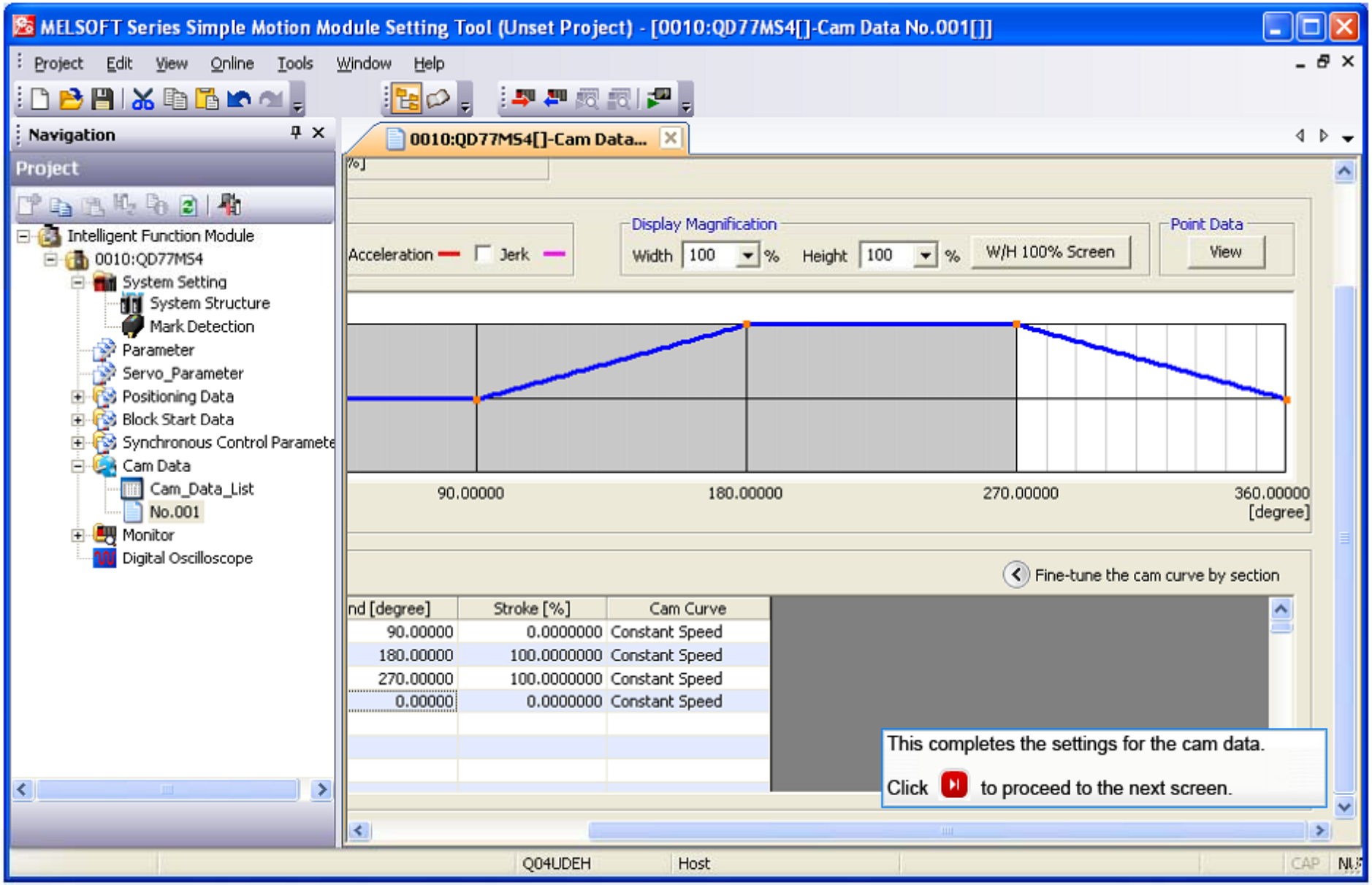
6.6 Creation of Cam Data

Cam data is created using the Simple Motion Module Setting Tool.

Let's try to create the cam data on the next screen.



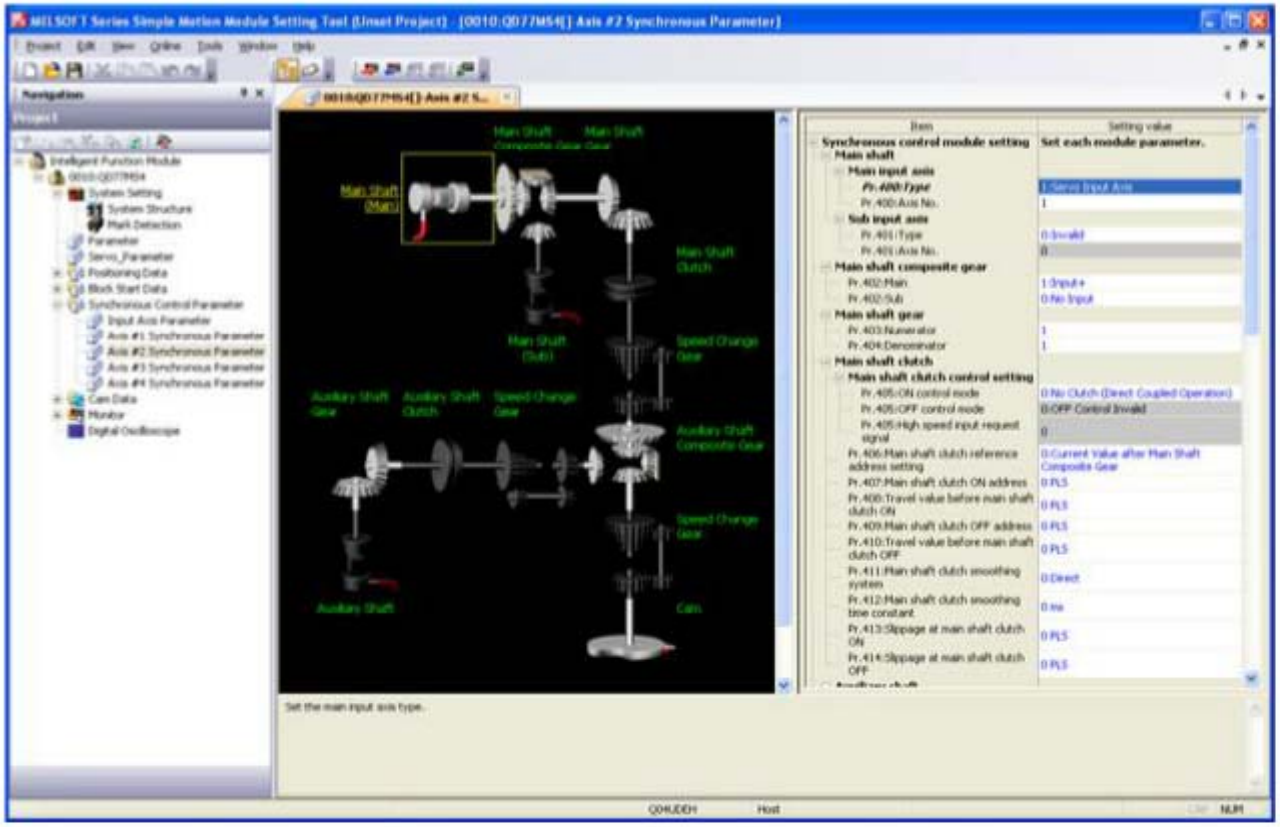
6.6 Creation of Cam Data

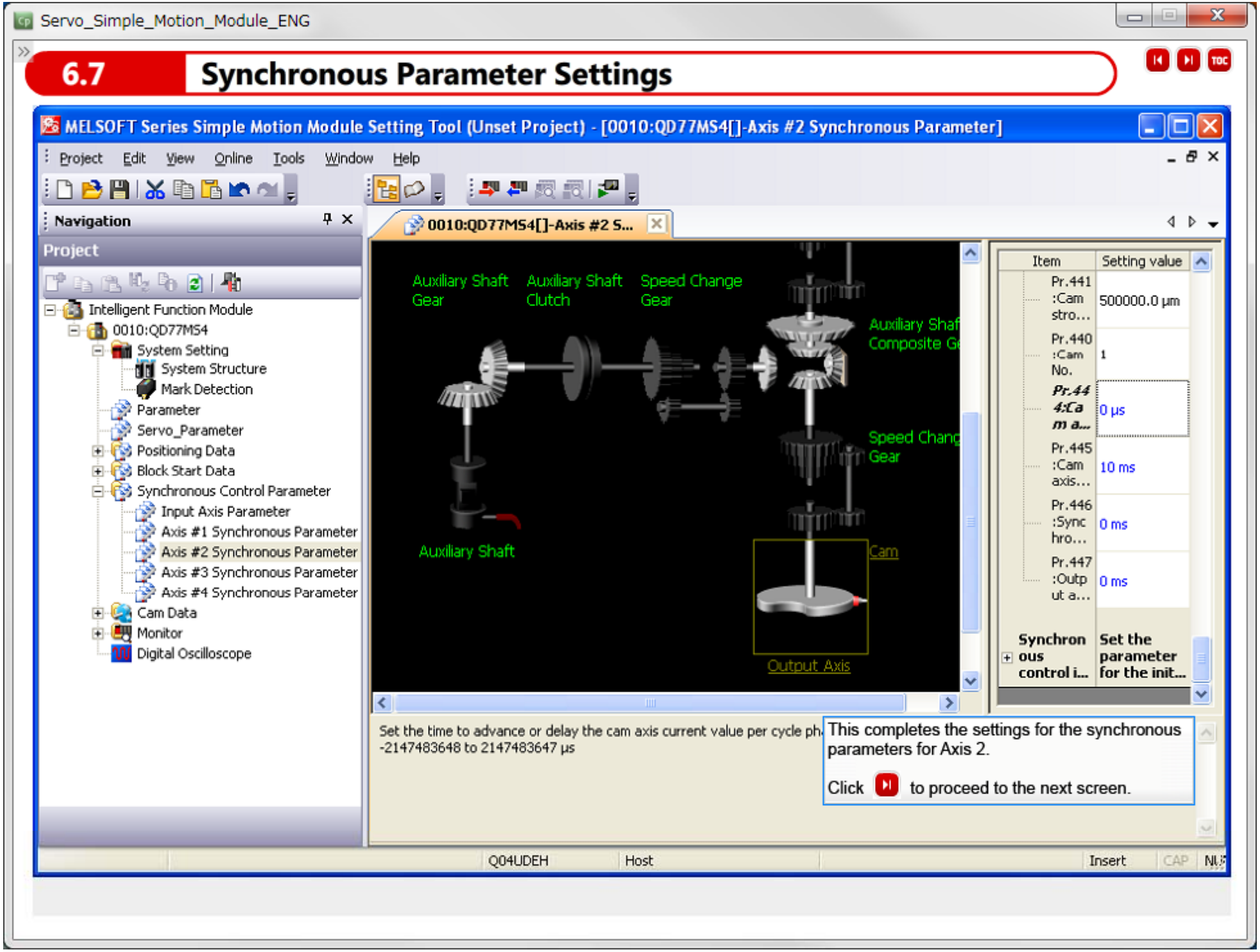


6.7 Synchronous Parameter Settings

For cam control in which Axis 2 is synchronized to Axis 1, synchronous parameters need to be set for Axis 2.
The synchronous parameters are set using the Simple Motion Module Setting Tool.

Let's try to set the synchronous parameters on the next screen.
The cam data created on the previous screen is used for cam control.




Servo_Simple_Motion_Module_ENG
6.7
Synchronous Parameter Settings
MELSOFT Series Simple Motion Module Setting Tool (Unset Project) - [0010:QD77MS4[]-Axis #2 Synchronous Parameter]
Project Edit View Online Tools Window Help
Navigation
Project
Intelligent Function Module
0010:QD77MS4
System Setting
System Structure
Mark Detection
Parameter
Servo_Parameter
Positioning Data
Block Start Data
Synchronous Control Parameter
Input Axis Parameter
Axis #1 Synchronous Parameter
Axis #2 Synchronous Parameter
Axis #3 Synchronous Parameter
Axis #4 Synchronous Parameter
Cam Data
Monitor
Digital Oscilloscope
0010:QD77MS4[]-Axis #2 S...
Auxiliary Shaft Gear
Auxiliary Shaft Clutch
Speed Change Gear
Auxiliary Shaft
Cam
Output Axis
Item
Setting value
Pr.441 :Cam stro...
500000.0 µm
Pr.440 :Cam No.
1
Pr.444:Cam a...
0 µs
Pr.445 :Cam axis...
10 ms
Pr.446 :Synchro...
0 ms
Pr.447 :Output a...
0 ms
Synchronous control i...
Set the parameter for the init...
Set the time to advance or delay the cam axis current value per cycle ph
-2147483648 to 2147483647 µs
This completes the settings for the synchronous parameters for Axis 2.
Click to proceed to the next screen.
Q04UDEH
Host
Insert
CAP

6.8 Start of Synchronous Control

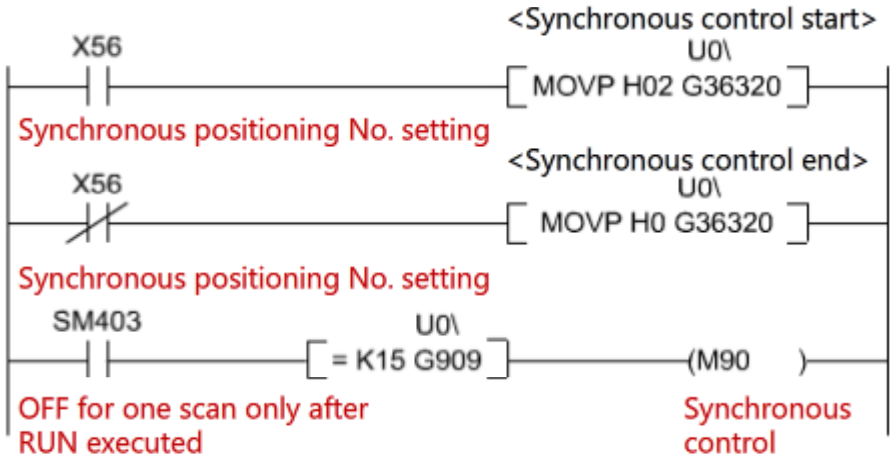
Synchronous control starts after the synchronous parameters and cam data have been set and the synchronous control start command has been turned ON. Required signals and data needed for the start of synchronous control are given below using a QD77MS4 model as an example.

Buffer memory

	Axis 1	Axis 2	Axis 3	Axis 4	Setting value
[Cd. 380] Synchronous control start	36320				Set the target axis as a four-bit code. bit 0 (Axis 1) to bit3(Axis 4) OFF: Synchronous control ends ON: Synchronous control starts
[Md. 26] Axis operation condtions	809	909	1009	1109	The axis operation conditions are stored in memory. 0: Standby 5: Analyzing 15: Synchronous control

Example Showing the Start of Synchronous Control
When Axis 2 is synchronized to Axis 1

- Sequence program



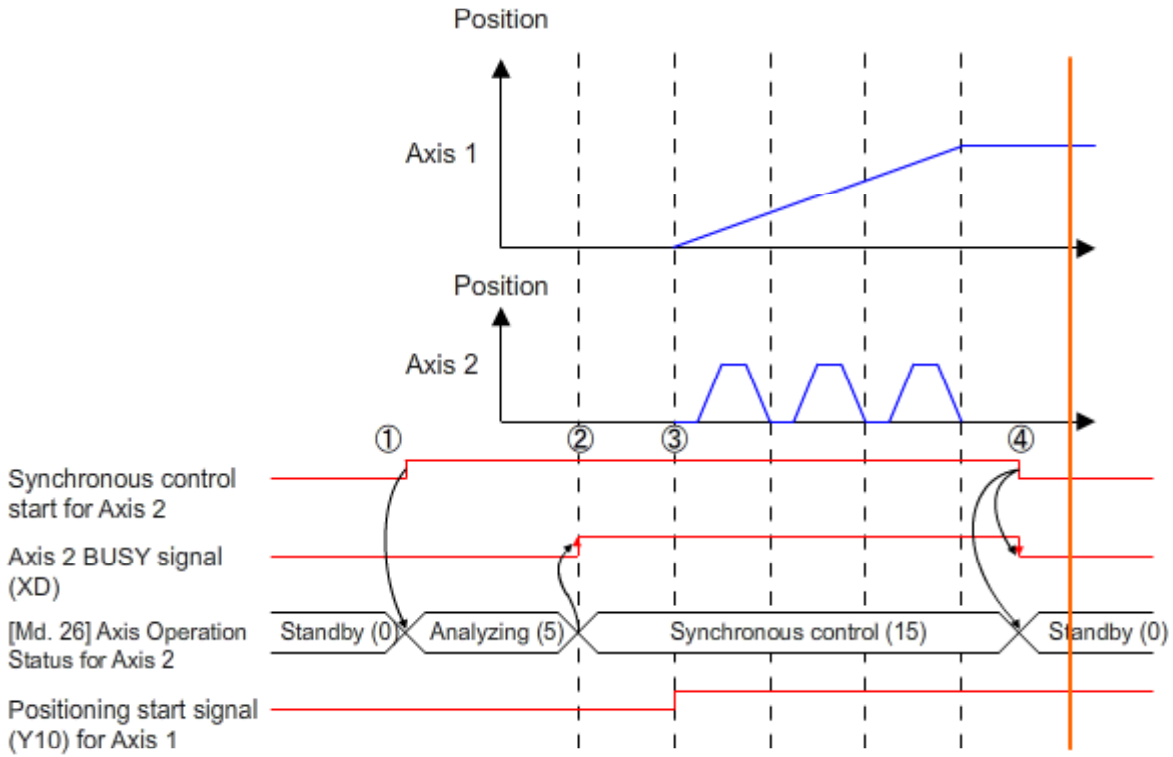
- Synchronous parameters and cam data

  Use the setting example on the previous screen.

6.9 Synchronous Control Operation

Operation for cam control in which Axis 2 is synchronized to Axis 1 proceeds as described below.

Positioning control is performed on Axis 1 using the positioning data.



① Once the synchronous control start signal is turned ON, the [Md. 26] Axis Operation Status changes to "5: Analyzing."

↓

② After the analysis is completed, the [Md. 26] Axis Operation Status changes to "15: Synchronous control," and the BUSY signal turns ON.

↓

③ After the [Md. 26] Axis Operation Status is confirmed as being "15: Synchronous control," the positioning start signal (Y10) for Axis 1 turns ON.
When the positioning of Axis 1 starts, Axis 2 is syncronized to Axis 1, and the cam starts operating.

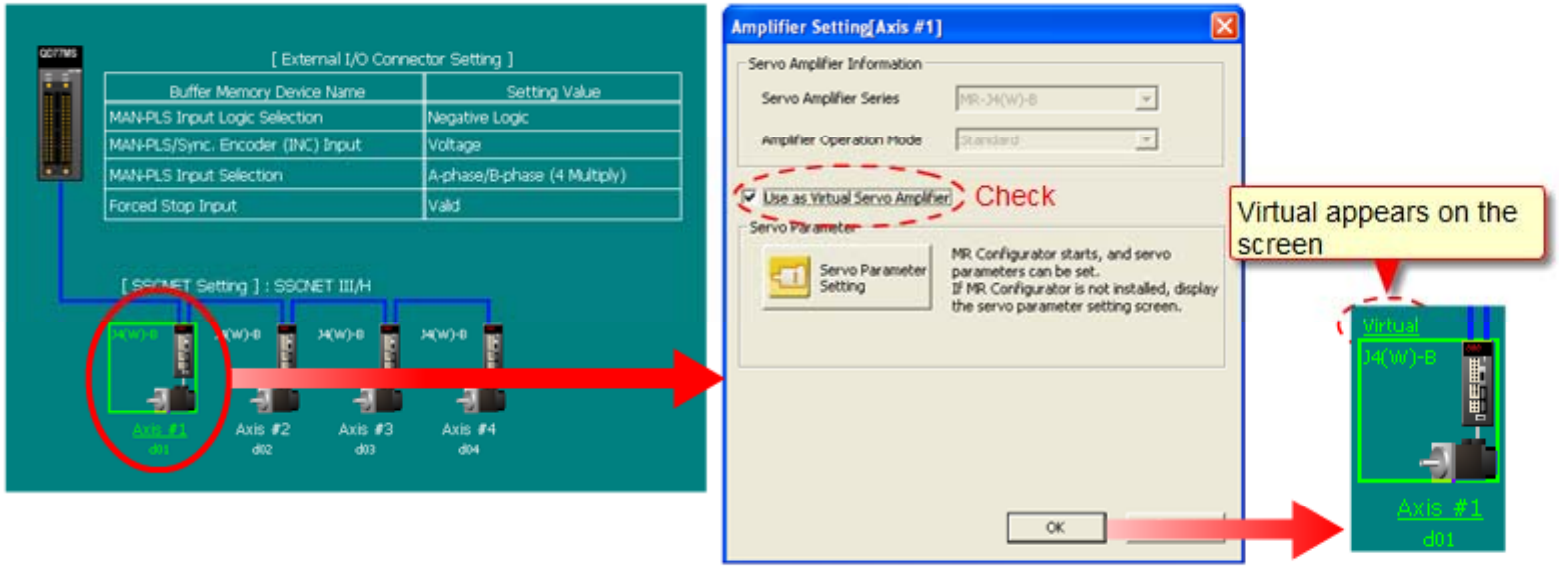
↓

④ After the synchronous control start signal is turned from ON → OFF, the BUSY signal turns OFF, and the status changes to "0: Standby."

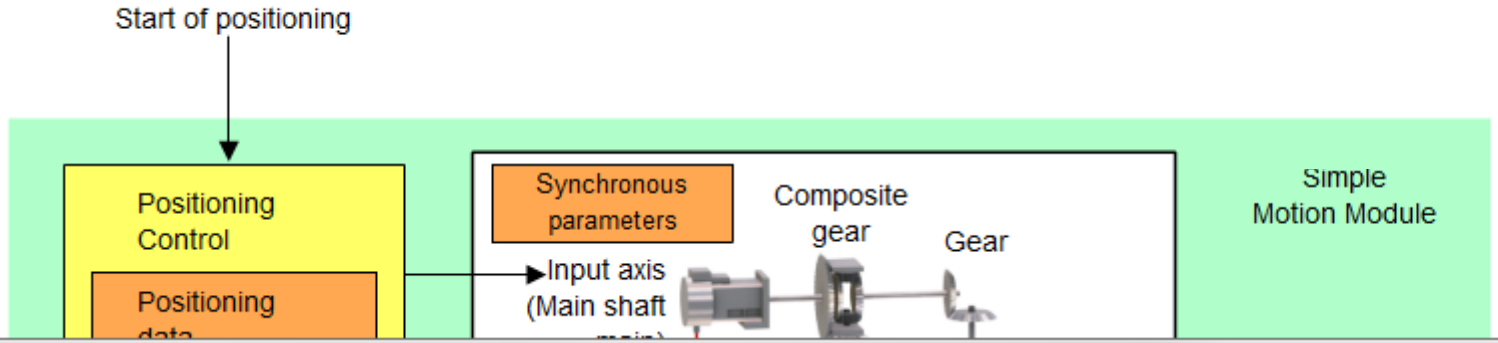
6.10 Virtual Servo Amplifier Function

The Simple Motion Module is equipped with a function that serves as an axis (a virtual servo amplifier axis) that generates only virtual commands without actual connection to a servo amplifier.
Use of the virtual servo amplifier axis as the input axis enables synchronous control using virtual input commands.

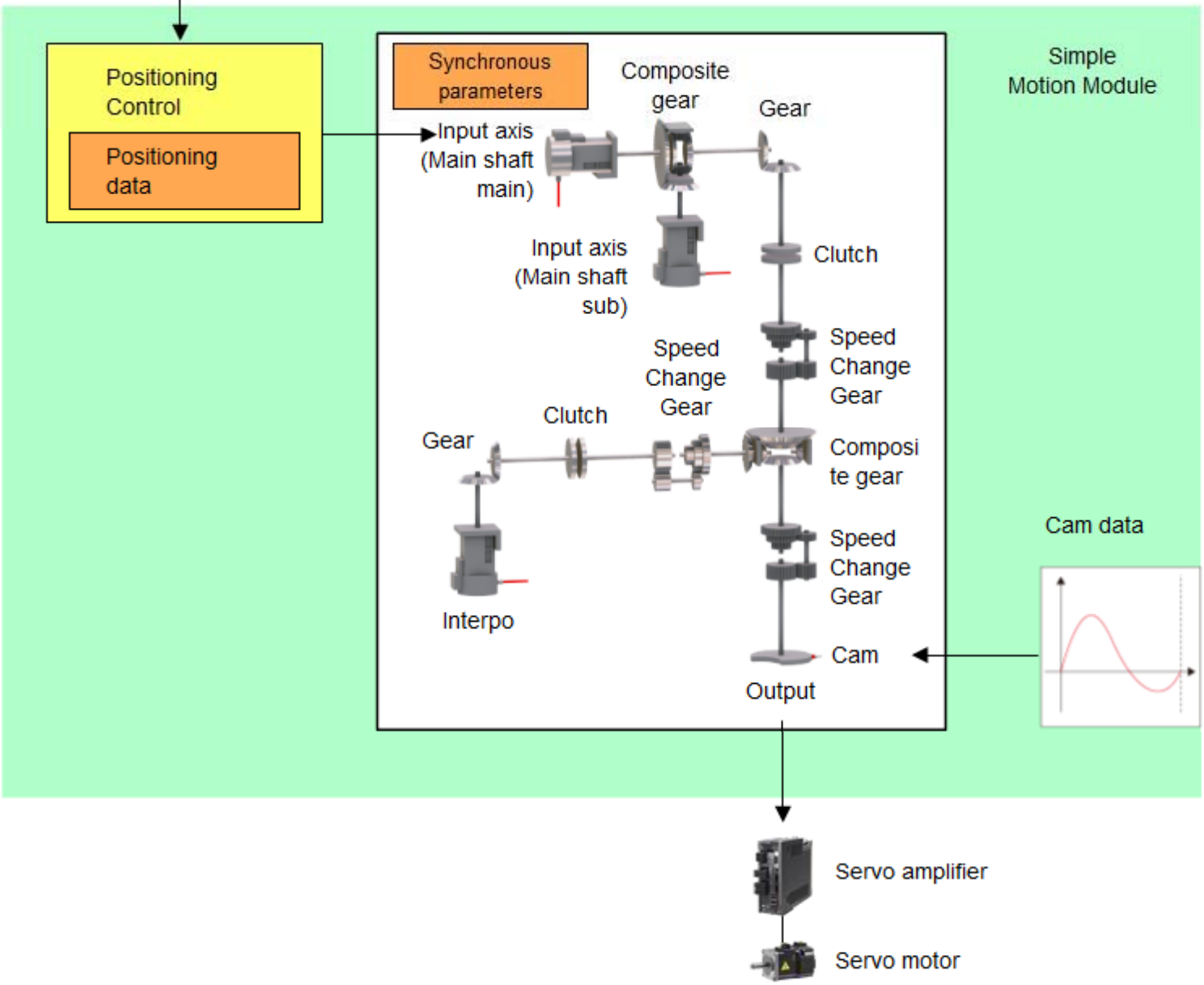
The virtual servo amplifier axis settings are completed on the Servo Amplifier Settings screen under System Configuration.



The flow of synchronous control using a virtual servo amplifier axis as the input axis is shown below.



6.10 Virtual Servo Amplifier Function



6.11 Summary

In this chapter, you have learned:

- Synchronous Control
- Synchronous parameters
- Cam control
- Cam data
- Virtual Servo Amplifier Function

Important points

The following points are very important, so please review them again to ensure that you have familiarized yourself with their content.

Synchronous Control	Synchronous control is a type of control in which multiple other axes (slave shafts) are synchronized to the standard axis (main shaft).
Synchronous parameters	The main shaft in the Simple Motion Module is referred to as the input axis and the axis to be synchronized as the output axis. There are synchronous parameters to be set for each output axis using the Simple Motion Module Setting Tool that determine how the output axis is to be synchronized and to which input axis.
Cam control	The output axis for synchronous control uses cam operation. Cam control performed using a traditional mechanical cam is reproduced as electronic cam control using cam data.
Cam data	The output axis is controlled using values (current feed values) converted from the set cam data using current values for one cycle of the cam axis as the input values.
Virtual Servo Amplifier Function	The Simple Motion Module is equipped with a function that serves as an axis (a virtual servo amplifier axis) that generates only virtual commands without actual connection to a servo amplifier. Use of the virtual servo amplifier axis as the input axis enables synchronous control , using virtual input commands.

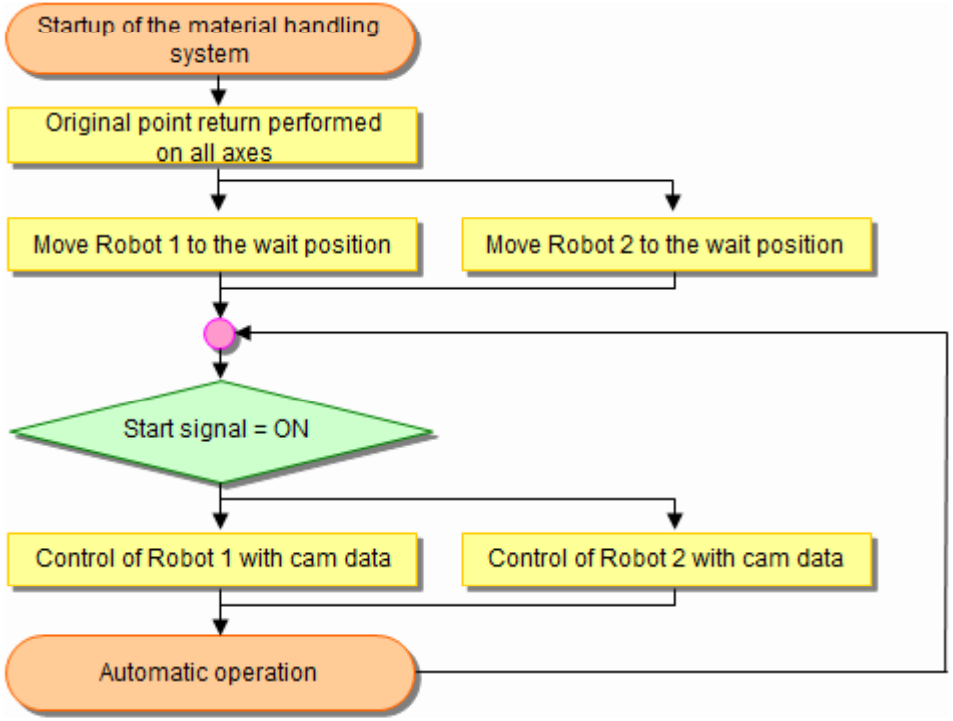
Chapter 7 Construction of a Sample System (Synchronous Control)

In Chapter 7, you will learn how to construct sample systems designed for synchronous control.

7.1 Flow Chart of Control Principles

The following shows a flowchart of the control details in the sample system.

Point your mouse cursor at the symbols in the flowchart to display details for each control details.



7.2 Assignment of Device Numbers

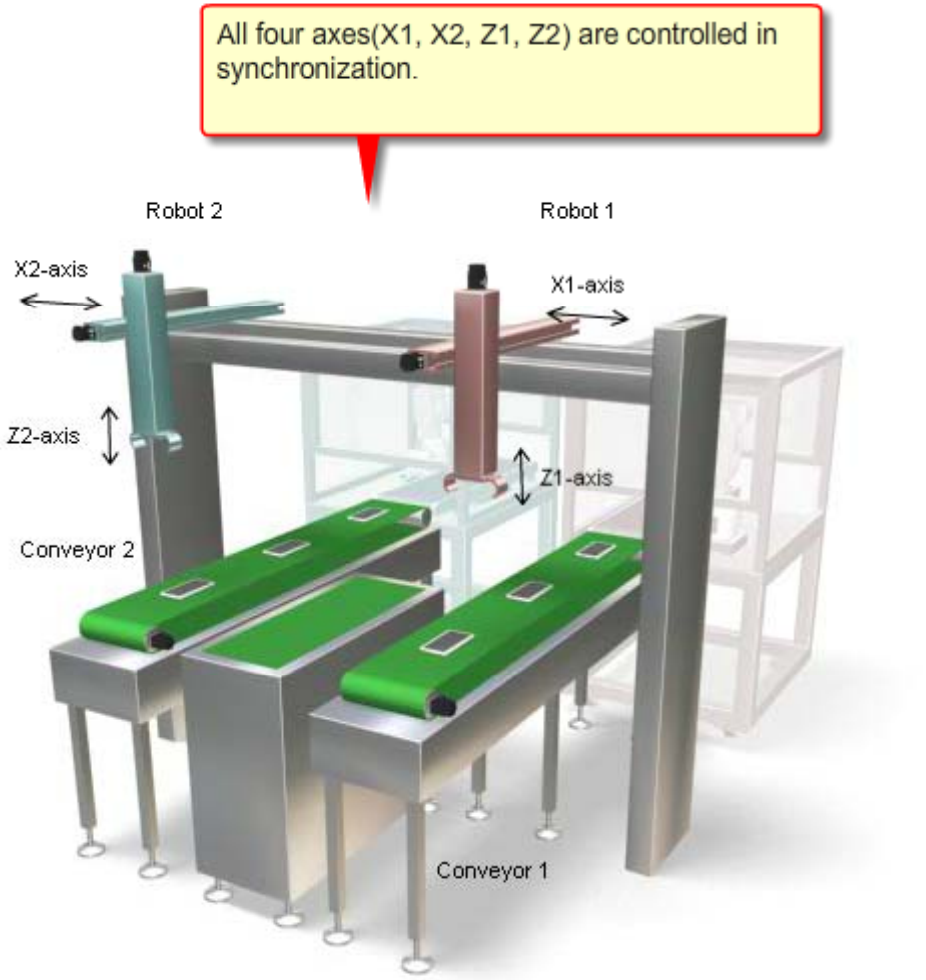
Create a correspondence table of I/O devices and device numbers to use in the sample system.
Creating a correspondence table will reduce programming glitches and streamline your programs.

You can download an example assigned device number correspondence table for the sample system through the below link.

<PDF of Assigned Device Numbers>

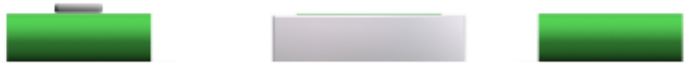
7.3 Operation of a Sample System

The sample system is designed to operate as shown below under normal operating conditions.



7.4 Cam Control in a Sample System

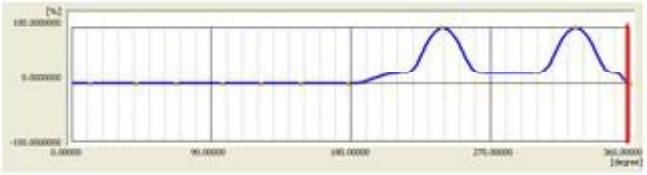
The cam data used in the sample system is as shown below.



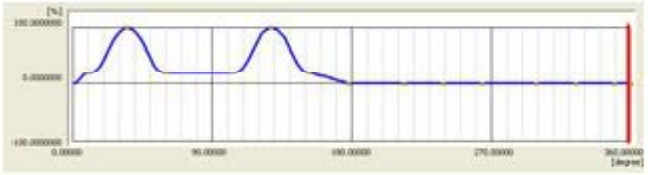
Cam data for X1

Cam data for X2

Cam data for Z1



Cam data for Z2



7.5 Summary

In this chapter, you have learned:

- Assignment of Device Numbers

Important points

The following points are very important, so please review them again to ensure that you have familiarized yourself with their content.

Assignment of Device Numbers	Create a correspondence table of I/O devices and device numbers to use in the sample system. Creating a correspondence table will reduce programming glitches and streamline your programs.

Test Final Test

Now that you have completed all of the lessons of the Servo SIMPLE MOTION Module Course, you are ready to take the final test.
If you are unclear on any of the topics covered, please take this opportunity to review those topics.
There are a total of 3 questions (7 items) in this Final Test.
You can take the final test as many times as you like.

How to score the test

After selecting the answer, make sure to click the **Answer** button. Your answer will be lost if you proceed without clicking the Answer button. (Regarded as unanswered question.)

Score results

The number of correct answers, the number of questions, the percentage of correct answers, and the pass/fail result will appear on the score page.

Correct Answers : 2

Total Questions : 9

Percentage : 22%

To pass the test, you have to answer **60%** of the questions correct.

Proceed Review Retry

- Click the **Proceed** button to exit the test.
- Click the **Review** button to review the test. (Correct answer check)
- Click the **Retry** button to retake the test again.

Test Final Test 1

Select the two software programs necessary for performing positioning control using a Simple Motion Module (select two options).

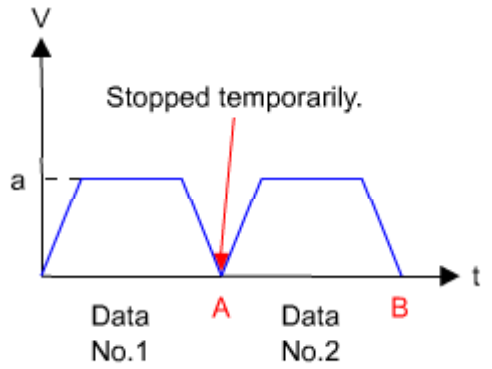
- [ ] GX Works2
- [ ] MT Works2
- [ ] GT Works3
- [ ] MR Configurator2
- [ ] PX Developer
- [ ] MX Component

Answer Back

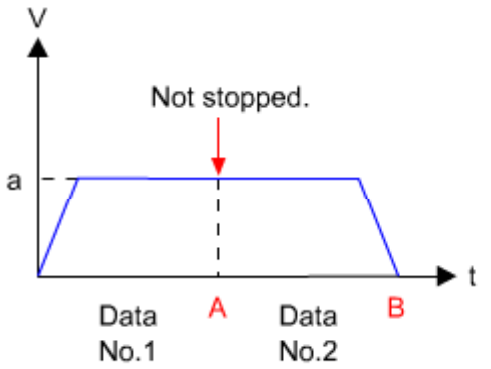
Test Final Test 2

Select the number from "Terms to select" box below the table for the correct operation pattern that matches the operating example shown below.

Continuous Positioning Control



Continuous path control



Terms to select

1. Continuous
2. Path
3. End

No.	Operation pattern	Command address	Command speed
1		A	a
2		B	a

No.	Operation pattern	Command address	Command speed
1		A	a
2		B	a

Answer Back

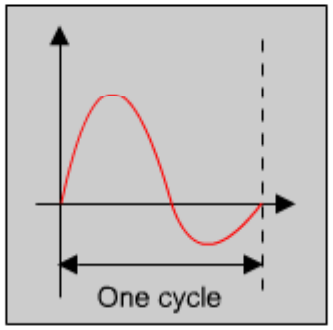
Test Final Test 3

Please answer the below questions.

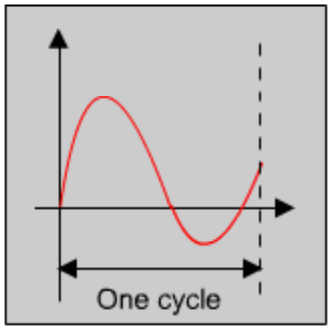
- Select the correct cam data graph for a Two-way cam from the below diagrams.

Q1

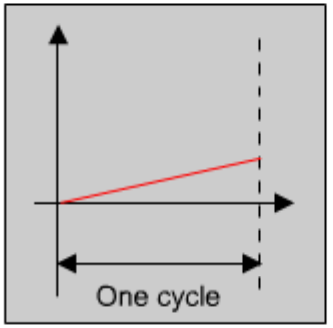
A



B



C



- Select the cam No. for a linear cam registered using the Simple Motion Module Setting Tool.

Q2 --Select--

Answer Back

Servo_Simple_Motion_Module_ENG

Test

Test Score

You have completed the Final Test. You results area as follows.
To end the Final Test, proceed to the next page.

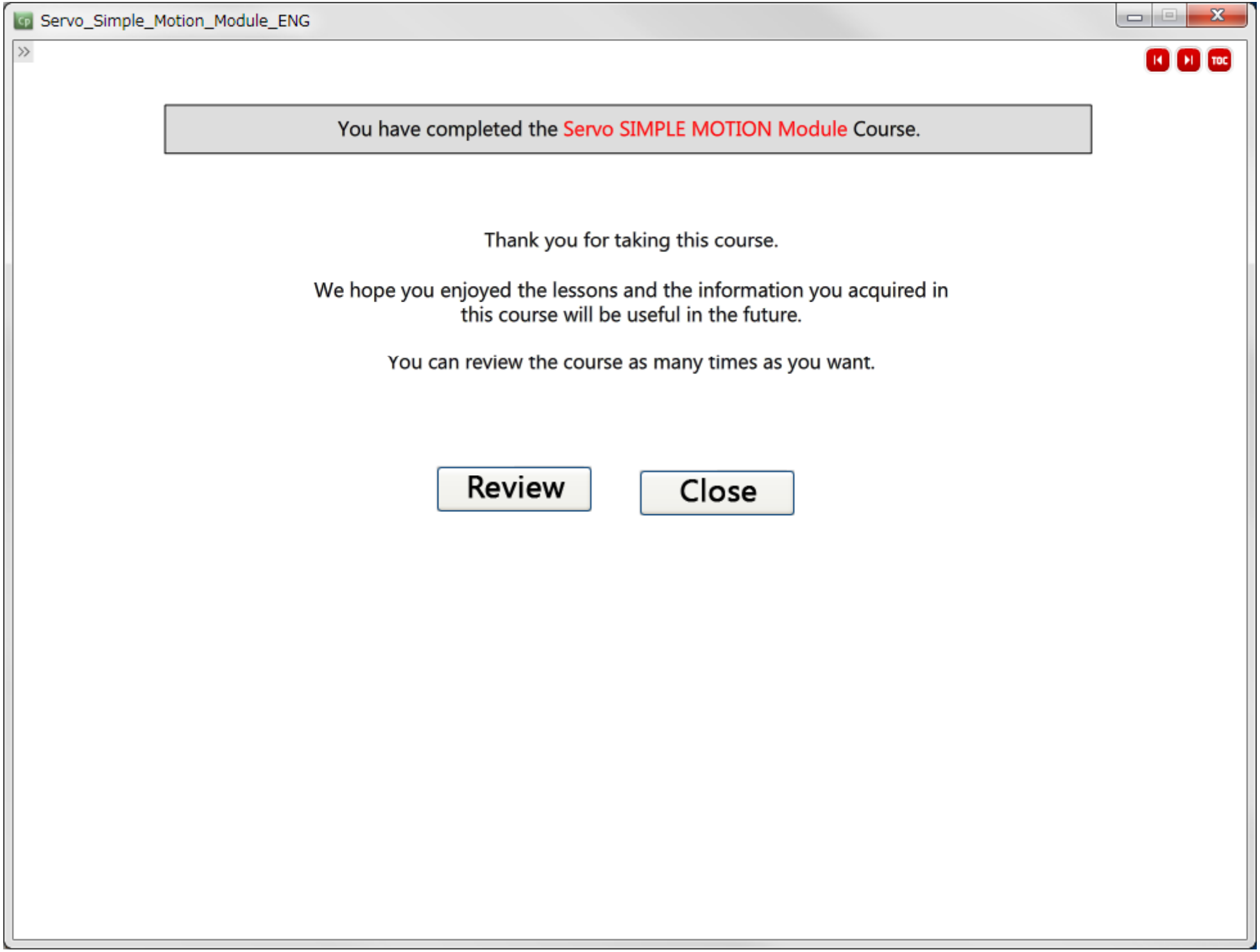
Correct answers : 0

Total questions : 3

Percentage : 0%

Proceed | Review | Retry

You failed the test.


Servo_Simple_Motion_Module_ENG
TOC
You have completed the Servo SIMPLE MOTION Module Course.
Thank you for taking this course.
We hope you enjoyed the lessons and the information you acquired in this course will be useful in the future.
You can review the course as many times as you want.
Review
Close