Servo System Controller

Motion Control Software SWM-G for Beginners

This is an online training system (e-learning) intended for those who are considering purchasing Motion Control Software SWM-G.

Click the Forward button at the upper right of the screen to proceed to the next page.

L(NA)00267ENG

Introduction Purpose of the Course

This course is intended for beginners who are considering purchasing Motion Control Software SWM-G.

This course is available to anyone interested in Motion Control Software SWM-G.

Introduction Course Structure

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

Chapter 1 Product Overview

This chapter describes the overview of Motion Control Software SWM-G and advantages to introduce it.

Chapter 2 Features

This chapter describes the main features of Motion Control Software SWM-G.

Chapter 3 Various Functions

This chapter describes the various functions of Motion Control Software SWM-G.

Chapter 4 Extensive Motion Control (Positioning Control)

This chapter describes the positioning control of Motion Control Software SWM-G.

Final Test

5 sections in total (5 questions) 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	TOC	"Table of Contents" will be displayed, enabling you to navigate to the desired page.
Exit the learning	X	Exit the learning. Window such as "Contents" screen and the learning will be closed.

Introduction Cautions for Use

■Safety precautions

When you learn based on using actual products, please carefully read the safety precautions in the corresponding manuals and handle the product properly while taking all precautions for safety.

■Precautions in this course

The screen images shown in the course may differ from your actual software depending on the version.

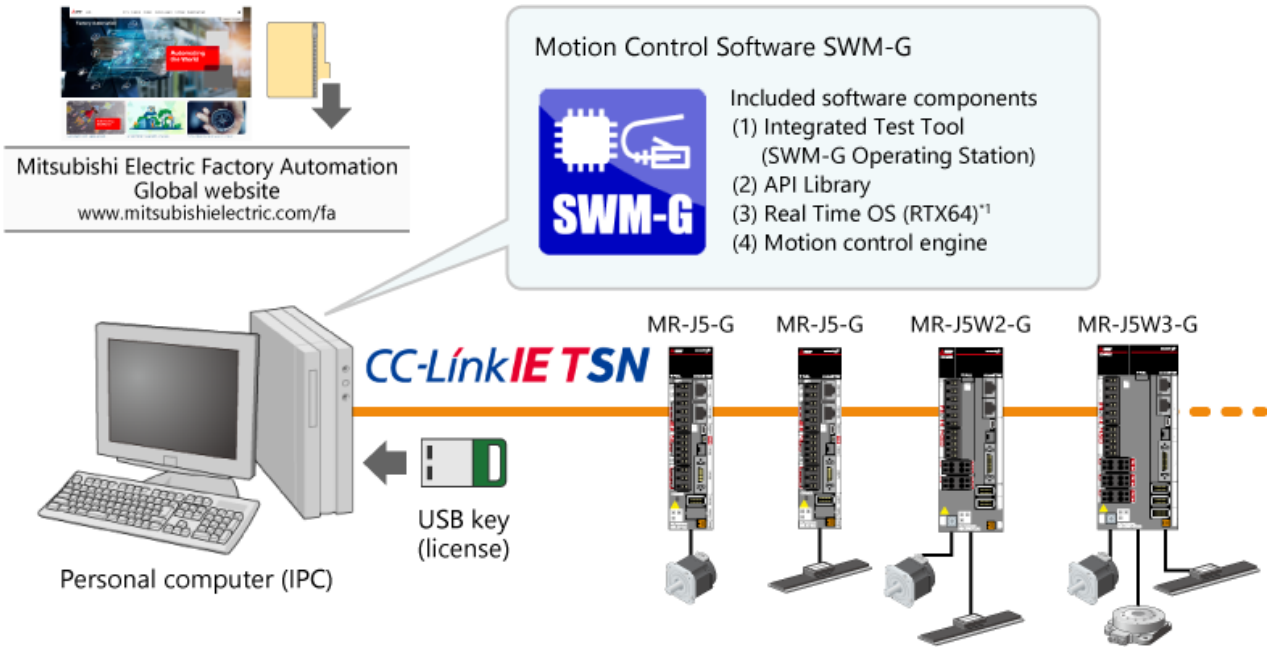
Chapter 1 Product Overview

This chapter describes the overview of Motion Control Software SWM-G and advantages to introduce it.

1.1 What Is Motion Control Software SWM-G?

Motion Control Software SWM-G is software that is installed in a personal computer to perform motion control and network control.

Motion Control Software SWM-G is available for download at Mitsubishi Electric Factory Automation Global Website.
To use the software, purchase the USB key for Motion Control Software (license).



*1 RTX64 (Real-time Extensions) is an extension by IntervalZero to transform Windows into real time system.

1.2 Product Lineup

This chapter shows the product lineup of Motion Control Software SWM-G.

■ Download module (SWM-G installer)

Motion Control Software SWM-G can be installed by downloading a download module at Mitsubishi Electric Factory Automation Global Website.

- This software is compatible with the USB key for Motion Control Software (license) of all models.
- Since this software includes software components required for motion control, it can be introduced only by purchasing the USB key for Motion Control Software (license).

Product name	Model
Motion Control Software SWM-G	SW1DNN-SWMG-M

■ USB key (license)

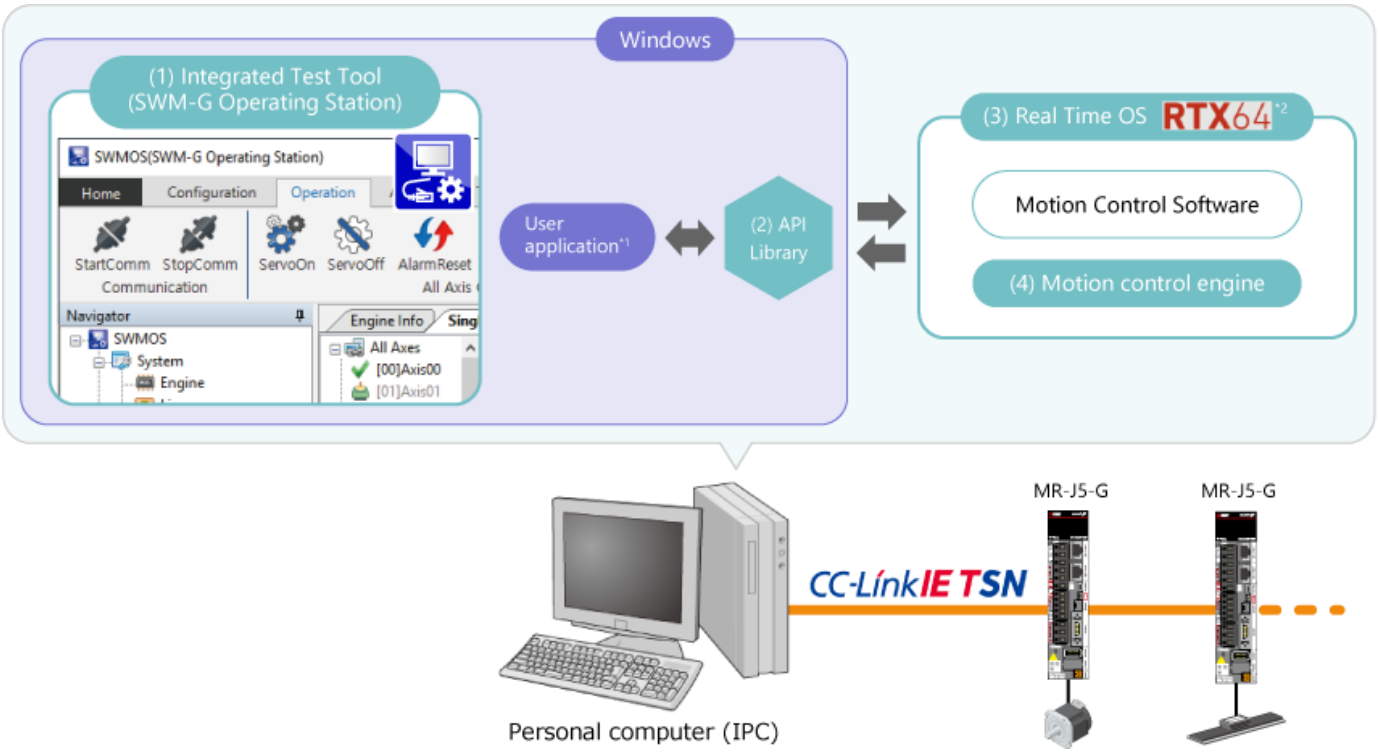
There are four types of USB key for Motion Control Software (license) depending on the maximum number of control axes, which can be selected according to the scale and purpose of your system.

Name	Maximum number of control axes	Model
USB key for Motion Control Software (license)	16	MR-SWMG16-U
	32	MR-SWMG32-U
	64	MR-SWMG64-U
	128	MR-SWMG128-U

1.3 Product Configuration

Configuration of Motion Control Software SWM-G

Motion Control Software SWM-G includes all the software components (1) to (4) shown in the following figure.
The personal computer is connected to the control target devices such as servo amplifiers via CC-Link IE TSN using an Ethernet cable.



*1 The user application must be prepared by the customer.
*2 RTX64 (Real-time Extensions) is an extension by IntervalZero to transform Windows into real time system.

1.3 Product Configuration

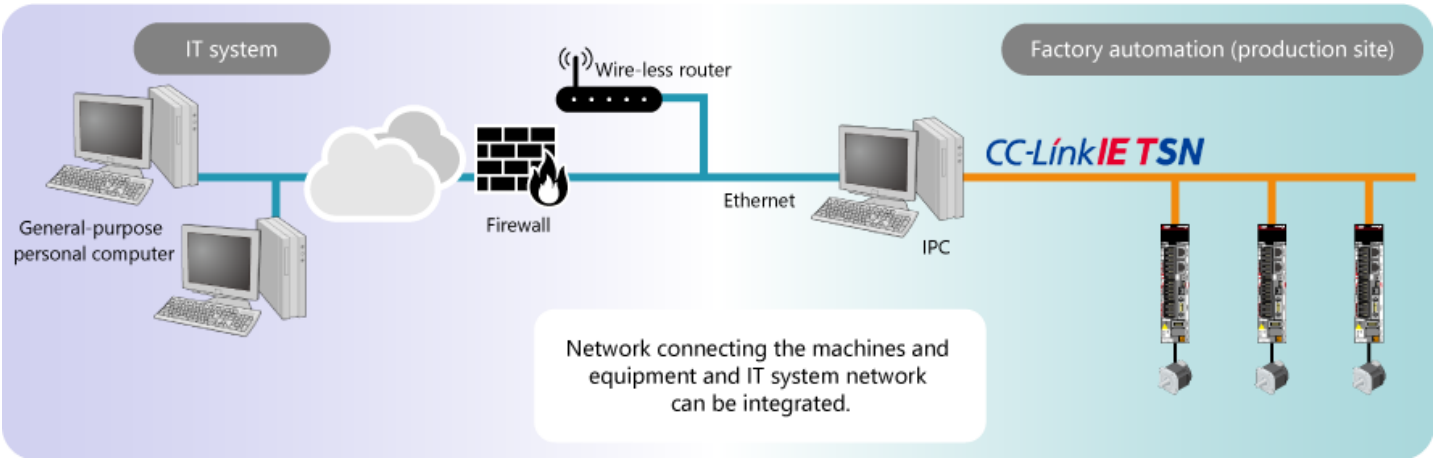
What is CC-Link IE TSN?

This section describes CC-Link IE TSN, which connects personal computers to the control target devices such as servo amplifiers.

CC-Link IE TSN is a type of network that can integrate information and communications with IT systems while ensuring real-time control by the extended Ethernet standards.

This network allows more flexible system configuration while reducing wiring costs by integrating the network that connects machines and equipment in production sites and IT system network.

*TSN: Time Sensitive Networking



1.4 Operating Environment

The operating environment of Motion Control Software SWM-G is shown in (1) to (3).

(1) Personal computer

Item	Description
OS	Windows 10 IoT Enterprise LTSC 64-bit version is recommended. Windows 10 (Home, Pro, Enterprise, or Education) 64-bit version can also be used.
CPU	Intel® Atom™ (2 GHz, 4 cores) or higher is recommended.
Memory	4 GB or more is recommended.
Free space on hard disk	At installation: 5 GB or more free space on hard disk
Communication interface	Ethernet port (Refer to (2) and (3).)

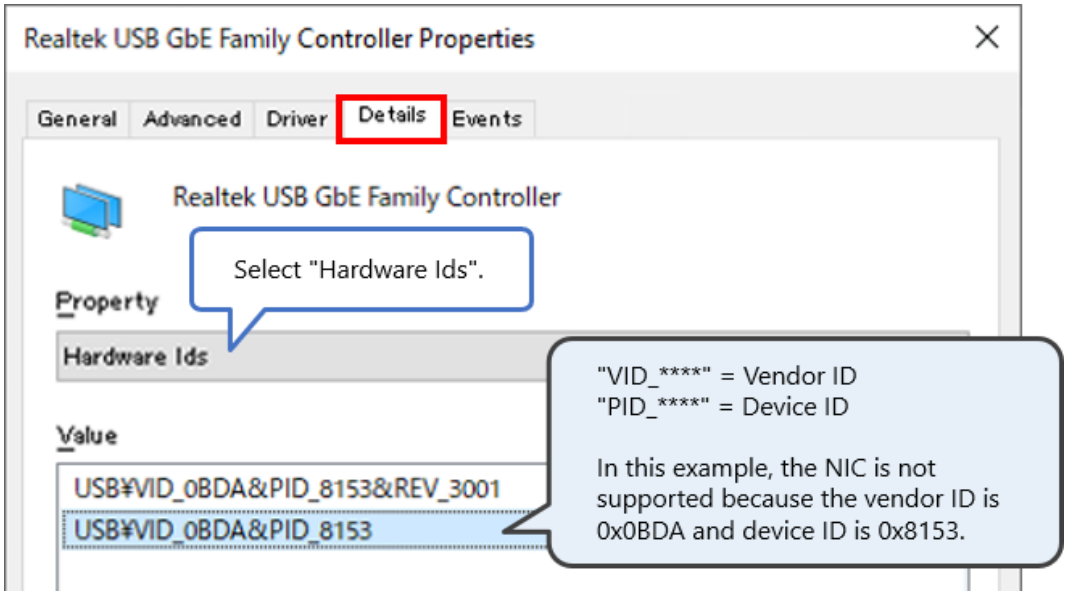
(2) Network Interface Card (NIC)

- Available NIC

Device name
Intel I210 (Vendor ID: 0x8086, Device ID: 0X1533)
Intel I350 (Vendor ID: 0x8086, Device ID: 0X1521)
Intel I211-AT (Vendor ID: 0x8086, Device ID: 0X1539)

* As of October 2023. For the latest information, refer to the latest manual (for installation).

- How to check the device ID of NIC
  You can check whether the NIC in your environment is supported as follows.
  a. Right-click the start icon at the left end of the Windows task bar, and select [Device Manager] from the context menu.
  b. Right-click the device in question under [Network adapter], and select [Properties] from the context menu.
  c. In the property window for the device, select "Hardware Ids" from the property pull-down menu in the "Details" tab and check the ID.



(3) Ethernet cable

- Specifications of the Ethernet cable to be used

Ethernet cable specifications
Category 5e or more, double shielded/STP
Straight cable

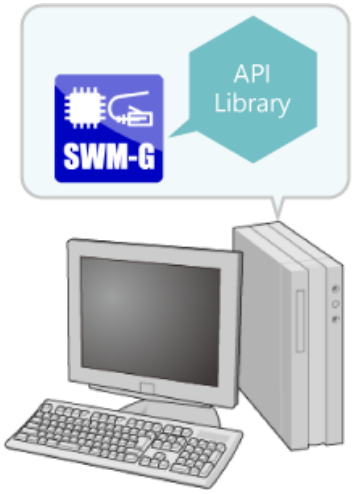
1.5 Advantages of Motion Control Software SWM-G

This chapter describes the advantages of using Motion Control Software SWM-G.

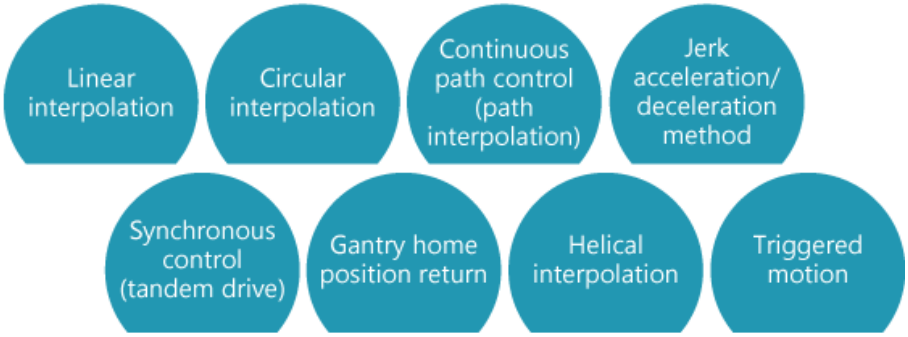
■ Ability to create control programs and user applications using C++ and C#

Control programs and user applications described below can be created using C++ and C# programming*.

- Extensive motion control
  The API library required for motion control can be used to create motion control programs such as positioning, synchronization, cam, speed, and torque.



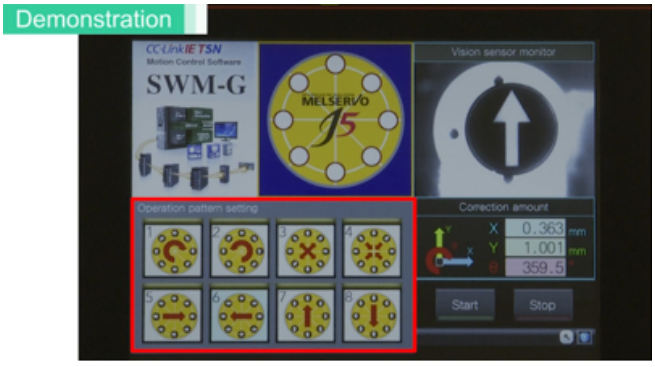
Personal computer (IPC)



* The development environment Microsoft® Visual Studio® 2017/2019 must be prepared by the customer.

■ Use of Windows GUI

- User applications can be created using Windows GUI.



User application (example)

■ Flexible options of personal computer

- You can freely select a personal computer to use as a controller as long as it meets the operating environment conditions.

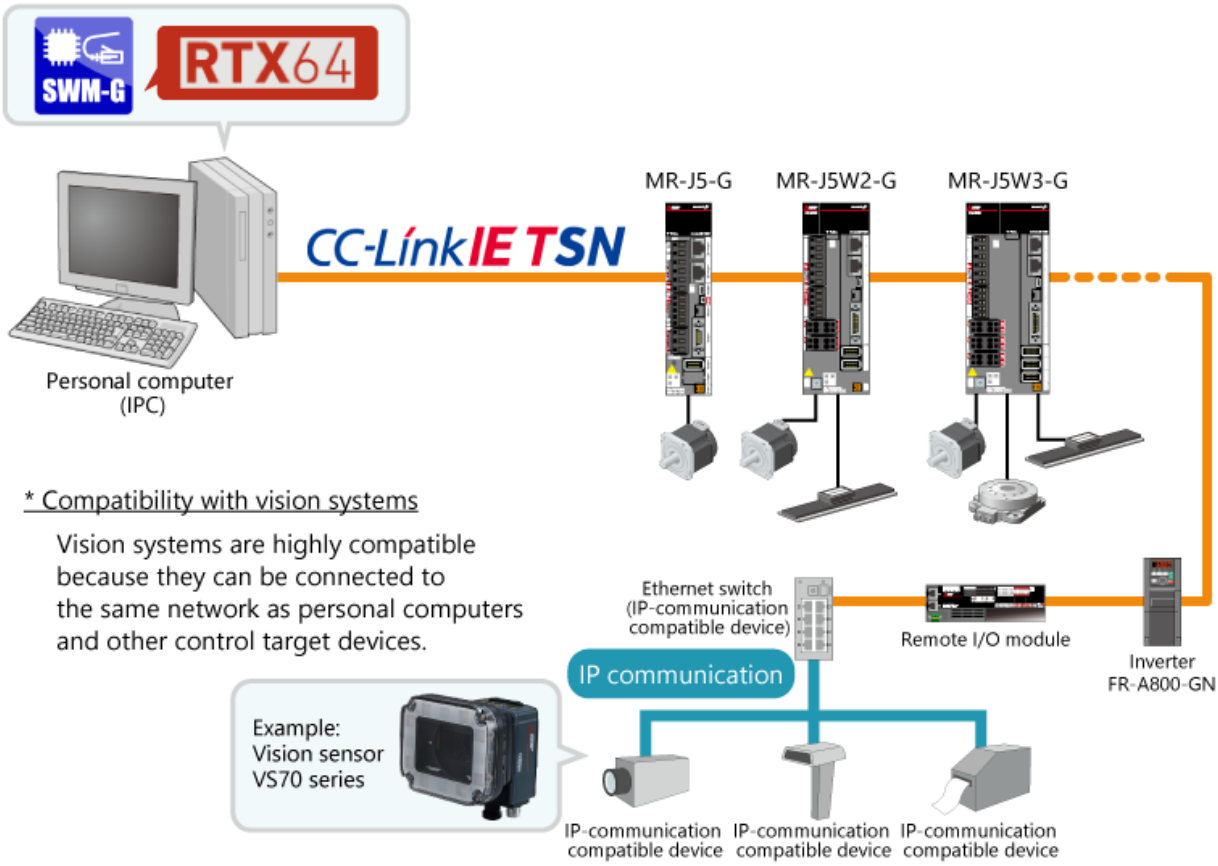
Personal computer (IPC)

■ Flexibility in system configuration

- Network control enables connection and settings of a remote I/O module or other devices to be controlled and devices compatible with IP communication.

Drive control system compatible with CC-Link IE TSN

- Real Time OS (RTX64) included in the software enables real-time processing on your personal computer, which is to be applied to a drive control system compatible with CC-Link IE TSN.



1.6 Characteristics of Motion Control Software SWM-G

This chapter describes the characteristics of Motion Control Software SWM-G.
Refer to the following when selecting the software.

Item	Description
System configuration	No sequence function (programmable controller) is provided.
Real-time performance	• Windows user applications (non-real time) and RTX64 (real time) in the IPC • Real-time performance is not ensured in user applications that run on Windows. When real-time processing is required such as for periodic position monitoring, use an API function and run the processing on RTX64.
Home position return	Controlled by the controller (IPC).
Device	All devices are defined as variables. Example) Command position: poscmd
Manual	The following manuals are required for using Motion Control Software SWM-G. User's manual/Operating manual (PDF) *1 Help manual (SWM-G User Manual) *2
Number of control axes	The maximum number of control axes differs depending on the USB key for Motion Control Software (license) used.

*1 It is available for download at Mitsubishi Electric Factory Automation Global Website.
*2 It is included in Motion Control Software SWM-G.

1.7 Performance and Specifications

This chapter describes the performance and specifications of Motion Control Software SWM-G.

Item		MR-SWMG16-U	MR-SWMG32-U	MR-SWMG64-U	MR-SWMG128-U
Number of control axes		16 axes	32 axes	64 axes	128 axes
Number of connected stations		Up to 128 stations			
CC-Link IE TSN	Communication speed	1Gbps/100Mbps*1*2			
	Communication cycle	Default: 1000 [µs] Setting value: 125 to 8000 [µs]			
	Other communication specifications	Mixture of class B, Hot Connect, SDO communication, IP communication			
	Transmission line type	Line topology, star topology, line + star topology			
I/O size		Input 8000 bytes, output 8000 bytes			
Positioning		Up to 128 axes simultaneously (absolute value command, relative value command) Override is possible.			
Acceleration/deceleration processing		Trapezoidal, S-curve, jerk ratio, parabolic, sine, advanced-S, trapezoidal moving average time, jerk-limited, jerk limited S-curve, jerk-limited advanced-S, two velocity trapezoidal, two velocity S-curve, two velocity jerk ratio, time acceleration trapezoidal, time acceleration S-curve, time acceleration jerk ratio, time acceleration parabolic, time acceleration sine, time acceleration advanced-S, constant deceleration, jerk ratio/fixed velocity-T, jerk ratio/fixed velocity-S, jerk-limited/fixed velocity-T, jerk-limited/fixed velocity-S			
Interpolation function		2- to 4-axis linear interpolation (up to 128 axes), 2-axis circular interpolation, 3-axis circular interpolation, 3-axis helical interpolation, PVT			
Continuous path		Combination of linear and circular interpolation, spline interpolation, pre-read speed automatic control, linear/circular continuous path with rotation stage			
Real-time control		Event, triggered motion, position synchronous output			
Synchronous control		Simple synchronization, synchronous gear ratio, synchronous phase offset, synchronous compensation, dynamic establishment/cancellation of synchronization, multiple pairs (up to 64 pairs) of synchronization between 1 axis and multiple axes (synchronous group)			
Electronic cam		Cam curves of eight systems can be defined, cam curve per communication cycle, phase operation, clutch			
Home position return function*3		Home position return using the Z-phase (index pulse), home position sensor, limit sensor, limit proximity sensor, external input signal, mechanical end, and gantry axis can be performed.			
Compensation function		Backlash/pitch error compensation, plane strain (straightness) compensation			

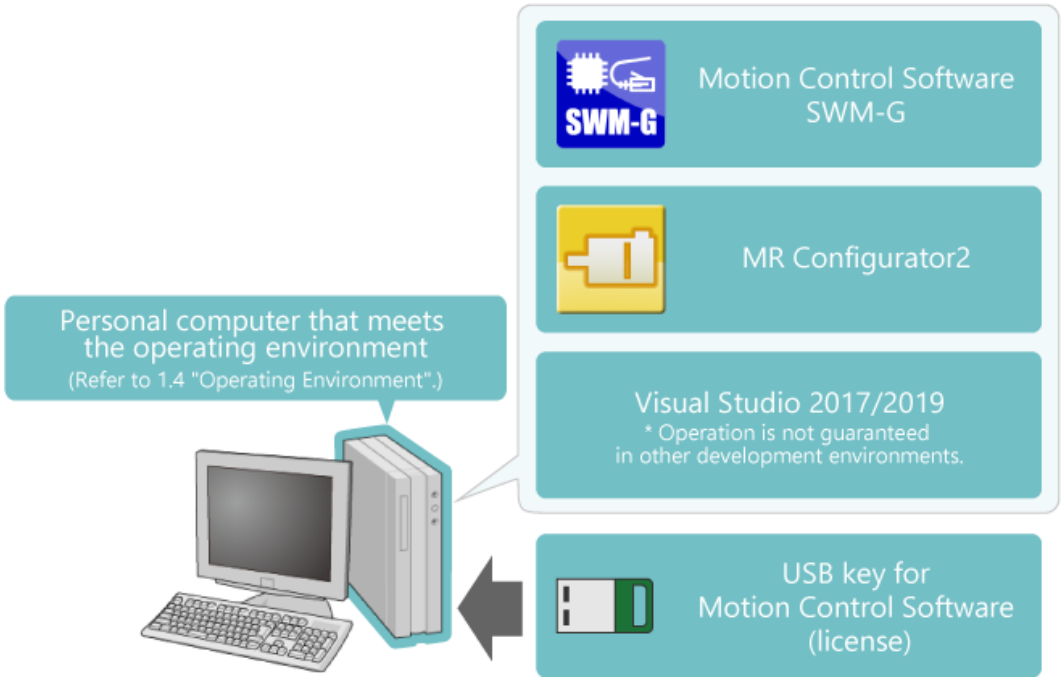
*1 When there are two ports, 1Gbps devices and 100Mbps devices can be assigned to each port.

*2 When multiple CC-Link IE TSN classes are mixed, the functionality and performance of a part of the network or the entire network are equivalent to the lower CC-Link IE TSN class.

*3 It does not support the home position return mode of the servo amplifier.

1.8 Items to Be Prepared by Customers

The following items are required to introduce Motion Control Software SWM-G.



1.9 Summary of This Chapter

In this chapter, you have learned:

- What Is Motion Control Software SWM-G?
- Product Lineup
- Product Configuration
- Operating Environment
- Advantages of Motion Control Software SWM-G
- Characteristics of Motion Control Software SWM-G
- Performance and Specifications
- Items to Be Prepared by Customers

Point

What Is Motion Control Software SWM-G?	Motion Control Software SWM-G is software that is installed in a personal computer to perform motion control and network control.
Product Lineup	The product lineup includes Motion Control Software SWM-G and USB keys for Motion Control Software (license) (numbers of axes 16, 32, 64, and 128).
Product Configuration	Motion Control Software SWM-G includes all the software components required for motion control.
Operating Environment	Check the device ID of the NIC if it is available.
Advantages of Motion Control Software SWM-G	The advantages of Motion Control Software SWM-G include ability to create control programs and user applications using C++ and C#, flexible options of personal computer, and flexibility in system configuration.
Characteristics of Motion Control Software SWM-G	Motion Control Software SWM-G is software to be installed on a personal computer to perform motion control and network control. * No sequence function (programmable controller) is provided.
Performance and Specifications	When considering purchasing Motion Control Software SWM-G, please check the performance and specifications.
Items to Be Prepared by Customers	MR Configurator2 and Visual Studio 2017/2019 must be prepared by customers because they are not included in Motion Control Software SWM-G.

Chapter 2 Features

This chapter describes the main features of Motion Control Software SWM-G.

2.1 Support for Systems with Wide Range of Numbers of Axes

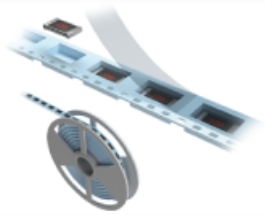
We provide four models using 16 to 128 control axes to support synchronous control of multiple axes in various scales of manufacturing equipment.

CMP system

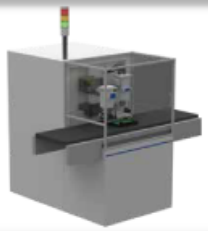
Etch system

3D printer

Taping system



Electronics assembly equipment

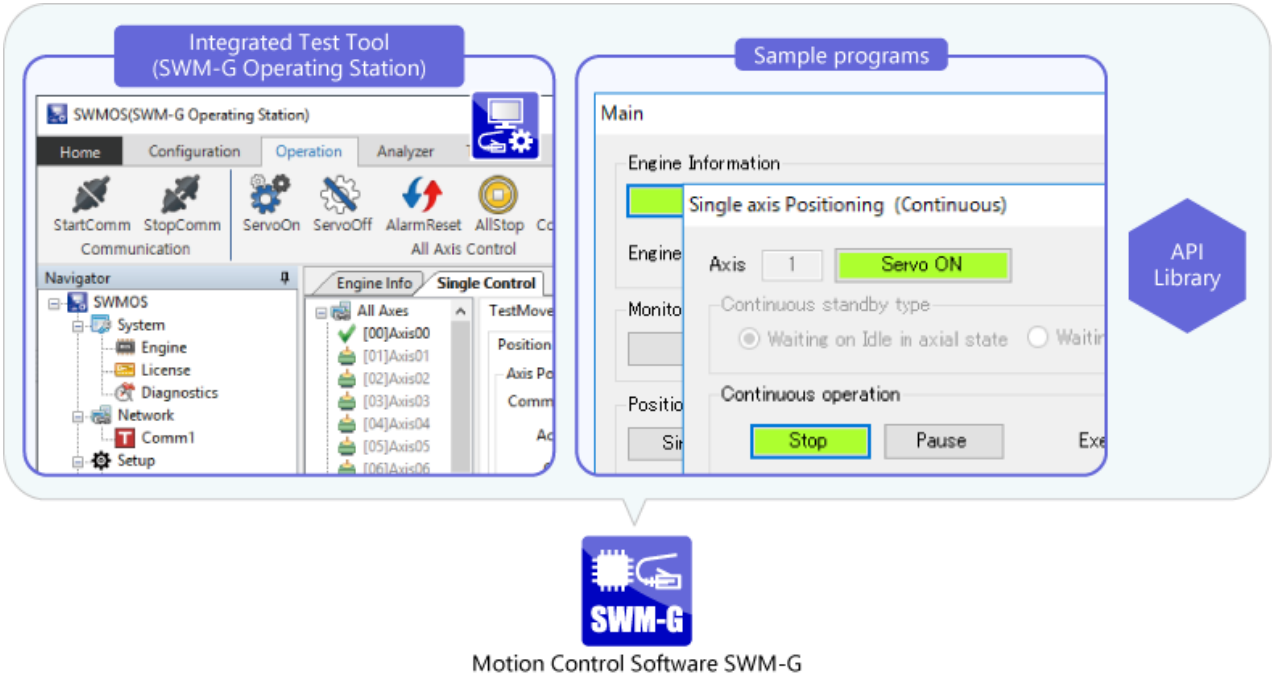


Mounter

2.2 Reduction in Equipment Design and Startup Time

Motion Control Software SWM-G includes the integrated test tool, sample programs, and API library.
These software components contribute to reducing TCO and design time as shown below.

- It contributes to reducing TCO through total support for all processes from design to verification, including test operation, verification of operation patterns, and simulation.
- It also contributes to reducing design time by checking the communication settings and communication status of the personal computer (master station) and control target device (remote station).



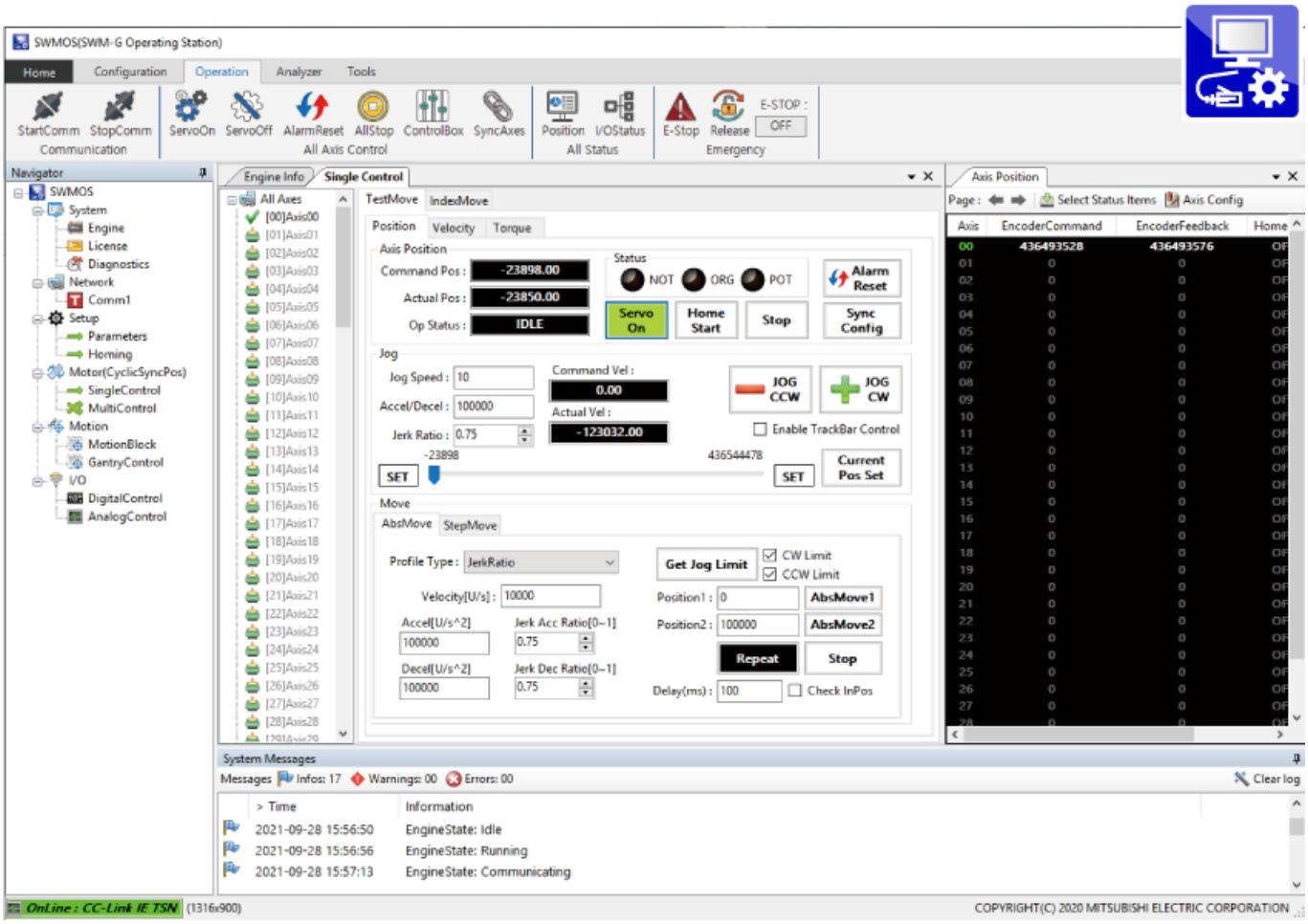
Motion Control Software SWM-G

2.3 Integrated Test Tool (SWM-G Operating Station)

This chapter describes the following functions of the integrated test tool (SWM-G Operating Station).

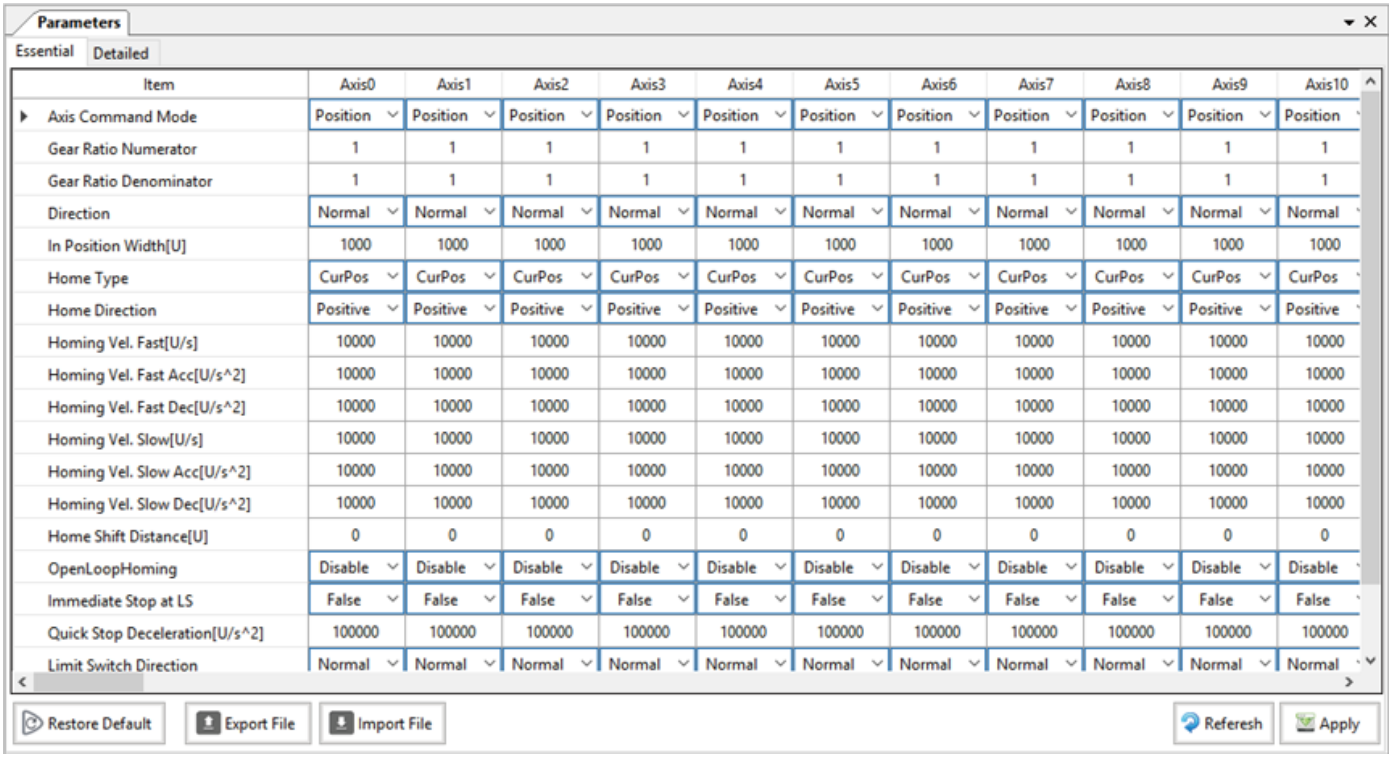
- Parameter setting
- Communication setting
- Communication monitoring of master station
- Communication monitoring of remote station
- Status display of remote station
- Test operation of single-axis control

The integrated test tool enables parameter settings required for application development and test operations such as JOG operation, inching, and positioning operation.
In addition, the tool can be used for verifying the startup timing and operation pattern with its function to display the status of each axis and sampling waveform.



2.3.1 Parameter setting

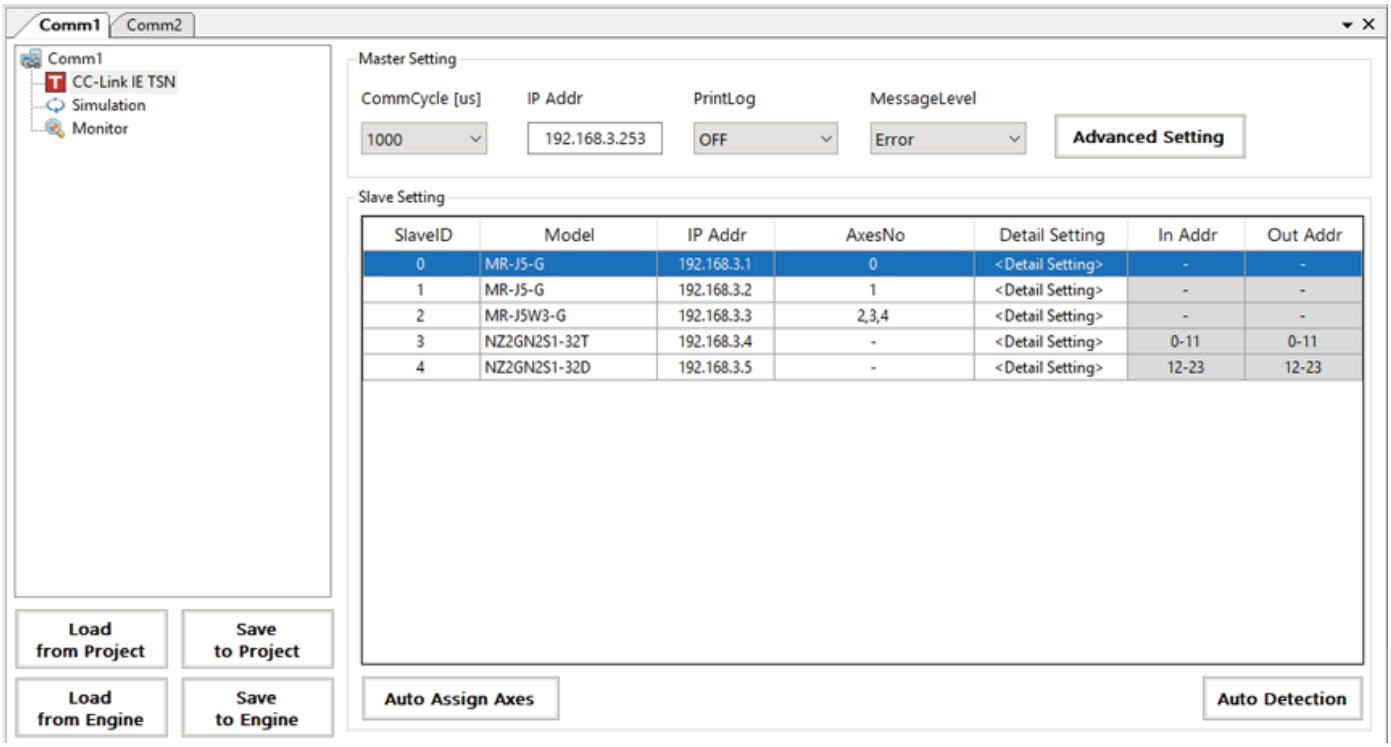
This function displays a list view for setting and checking parameters of each axis.
The settings can be imported/exported from/to a file in the personal computer.



Item	Axis0	Axis1	Axis2	Axis3	Axis4	Axis5	Axis6	Axis7	Axis8	Axis9	Axis10
Axis Command Mode	Position	Position	Position	Position	Position	Position	Position	Position	Position	Position	Position
Gear Ratio Numerator	1	1	1	1	1	1	1	1	1	1	1
Gear Ratio Denominator	1	1	1	1	1	1	1	1	1	1	1
Direction	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal
In Position Width[U]	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Home Type	CurPos	CurPos	CurPos	CurPos	CurPos	CurPos	CurPos	CurPos	CurPos	CurPos	CurPos
Home Direction	Positive	Positive	Positive	Positive	Positive	Positive	Positive	Positive	Positive	Positive	Positive
Homing Vel. Fast[U/s]	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Homing Vel. Fast Acc[U/s^2]	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Homing Vel. Fast Dec[U/s^2]	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Homing Vel. Slow[U/s]	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Homing Vel. Slow Acc[U/s^2]	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Homing Vel. Slow Dec[U/s^2]	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Home Shift Distance[U]	0	0	0	0	0	0	0	0	0	0	0
OpenLoopHoming	Disable	Disable	Disable	Disable	Disable	Disable	Disable	Disable	Disable	Disable	Disable
Immediate Stop at LS	False	False	False	False	False	False	False	False	False	False	False
Quick Stop Deceleration[U/s^2]	100000	100000	100000	100000	100000	100000	100000	100000	100000	100000	100000
Limit Switch Direction	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal

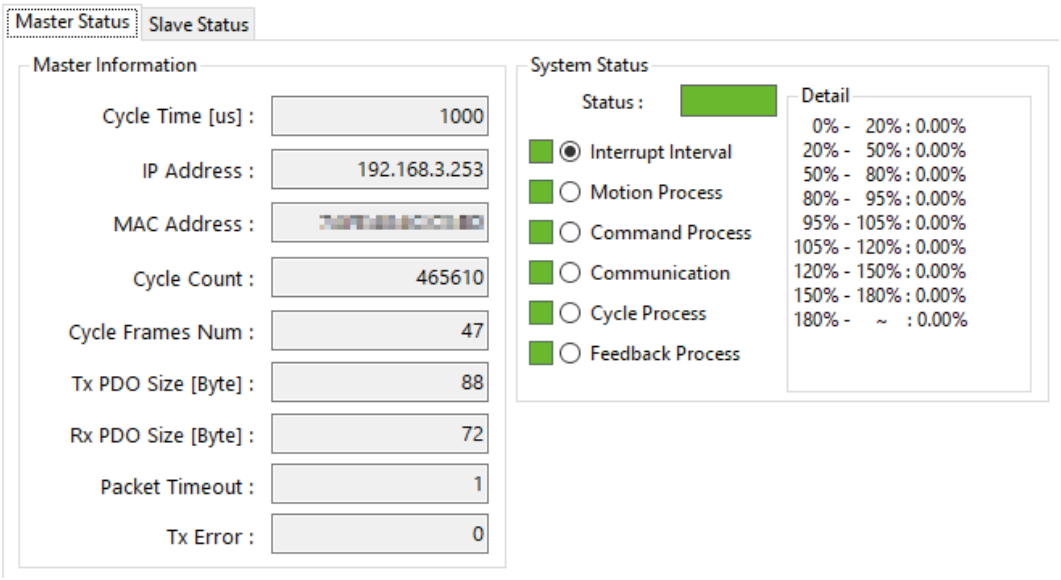
2.3.2 Communication setting

This function is for setting the IP address, axis number, and communication cycle of the remote station.
The settings can be imported/exported from/to a file in the personal computer.
Remote stations are automatically set depending on the connection status.



2.3.3 Communication monitoring of master station

This function displays a summary of communication information (settings) of the master station.
The system status display shows the communication status.



2.3.4 Communication monitoring of remote station

(1) Communication monitoring of remote station

This function displays the network status and IP address of the remote station.

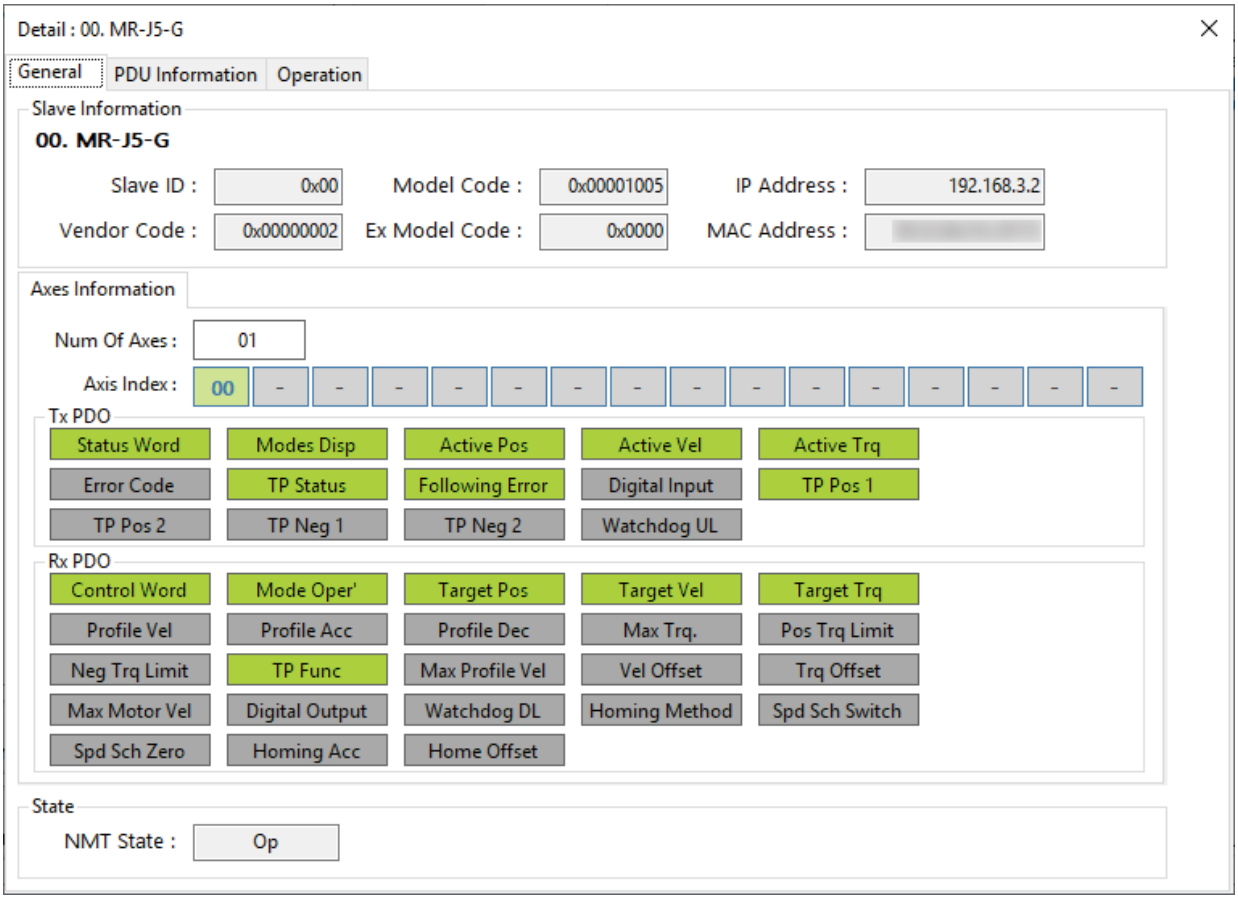
Master Status | Slave Status

SlaveID	Model	IP Addr	AxesNo	State	Detail	In Addr	Out Addr
0	MR-J5-G-RJ	192.168.3.1	0	Op	<Detail>	-	-
1	MR-J5-G-RJ	192.168.3.2	1	Op	<Detail>	-	-

2.3.4 Communication monitoring of remote station

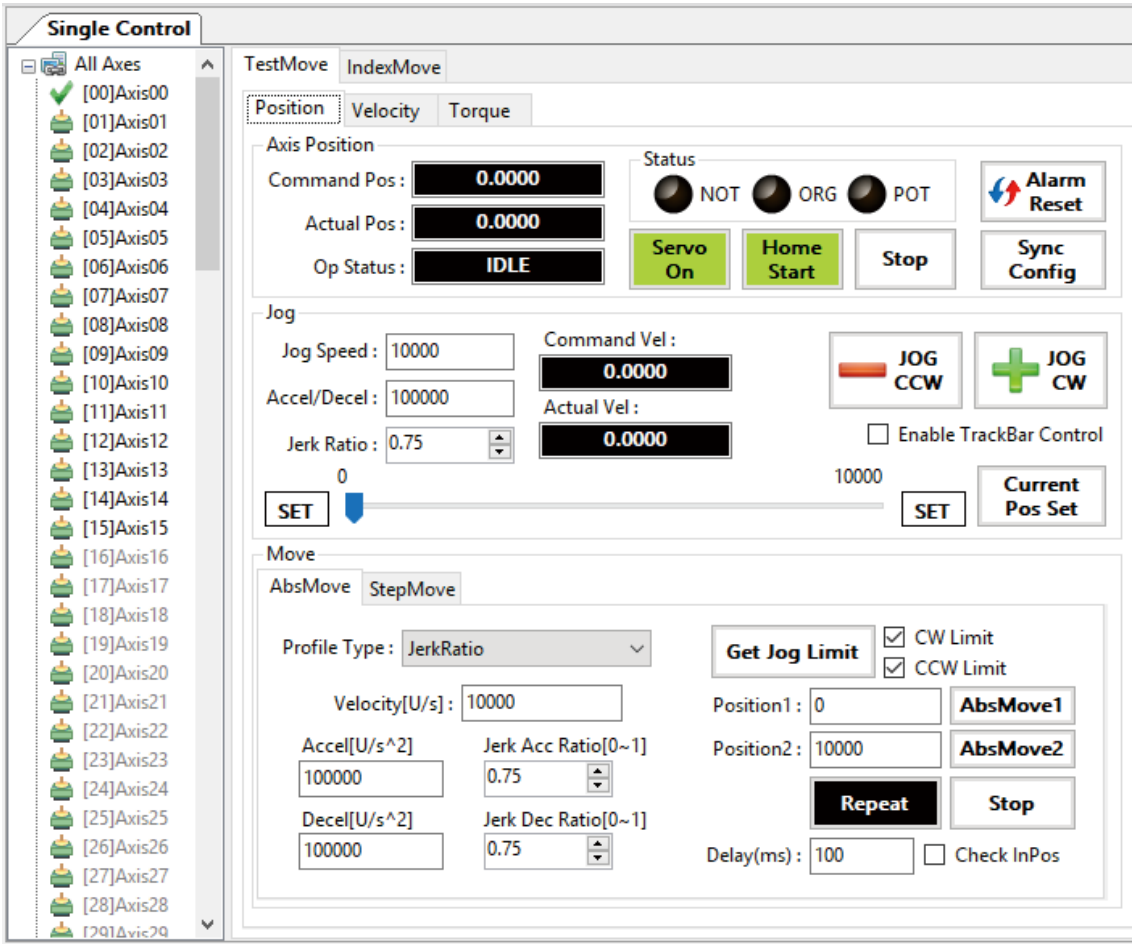
(2) Remote station status display

The detailed network status of the remote station can be displayed and test operation can be performed.



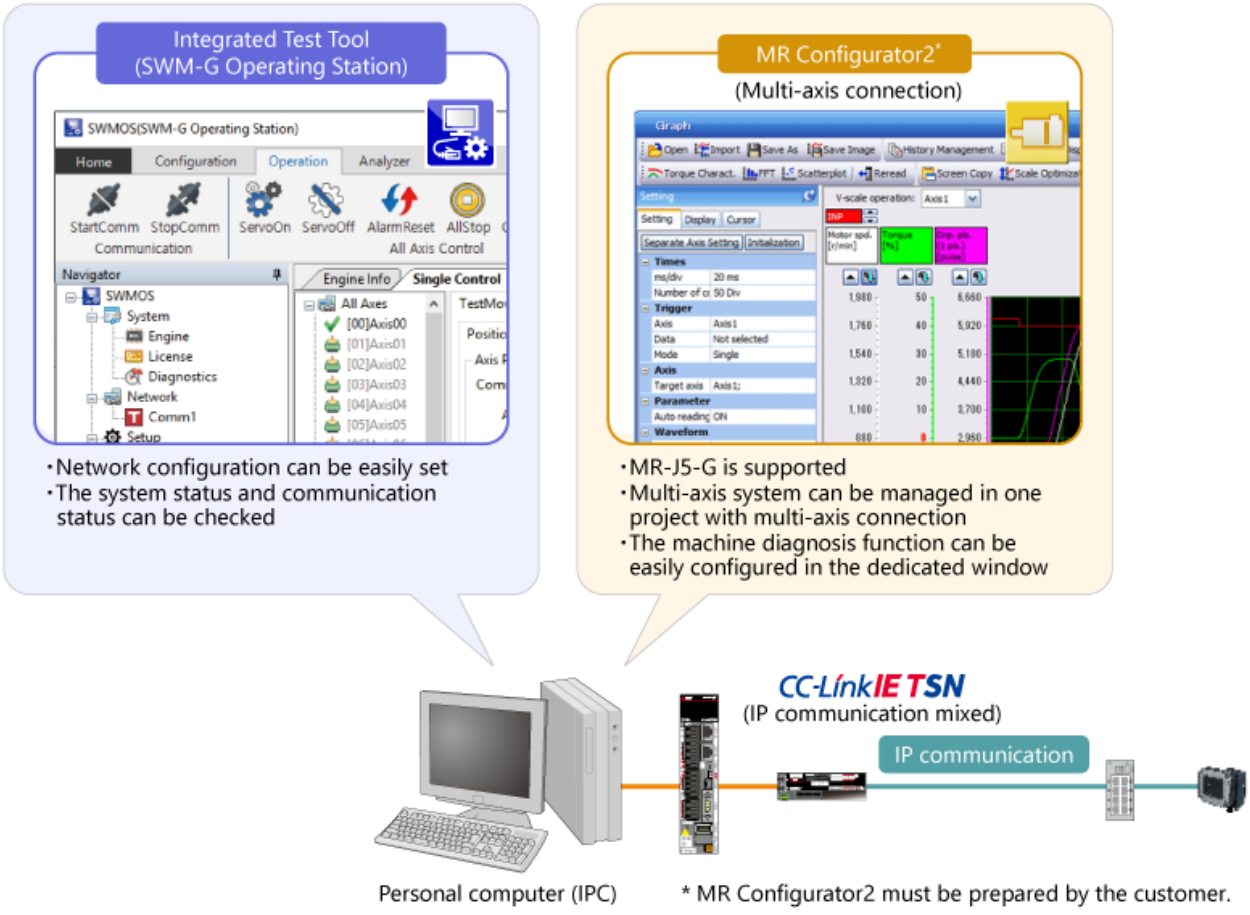
2.3.5 Test operation of single-axis control

The test operation of single-axis control can be performed.
This function supports reciprocating operation, which is frequently used in the test operation.



2.4 Servo Amplifier Setting and Adjustment in Multi-Axis Systems

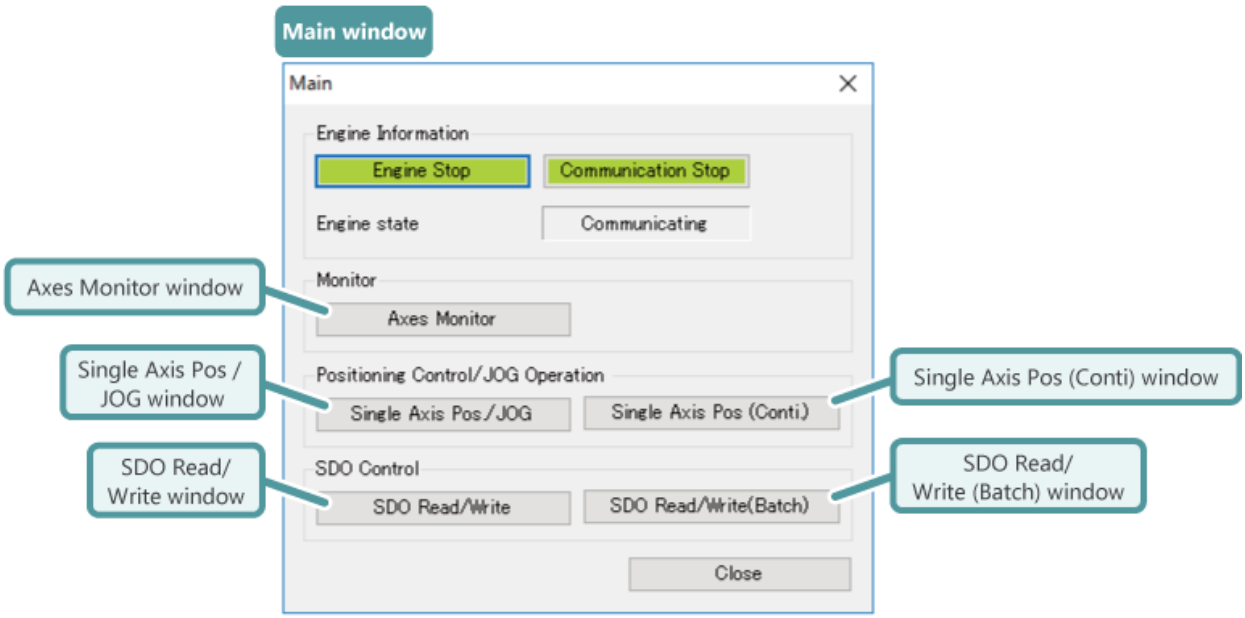
The IP communication mixed function of CC-Link IE TSN allows the ease of setting and adjustment of the servo amplifier even in multi-axis systems.
Servo adjustment is possible while checking the communication status of the servo amplifier by using the integrated test tool and MR Configurator2 together.



2.5 Sample Programs

Sample programs enable parameter settings required for application development and test operations such as JOG operation, inching, and positioning operation.
In addition, the programs can be used for verifying the startup timing and operation pattern with its function to display the status of each axis and sampling waveform.

- Click a button on the "Main" window to display the window of the corresponding function.



2.6 Summary of This Chapter

In this chapter, you have learned:

- Support for Systems with Wide Range of Numbers of Axes
- Reduction in Equipment Design and Startup Time
- Integrated Test Tool (SWM-G Operating Station)
- Servo Amplifier Setting and Adjustment in Multi-Axis Systems
- Sample Programs

Point

Support for Systems with Wide Range of Numbers of Axes	We provide four models using 16 to 128 control axes to support synchronous control of multiple axes in various scales of manufacturing equipment.
Reduction in Equipment Design and Startup Time	Motion Control Software SWM-G contributes to reduction of TCO and design time.
Integrated Test Tool (SWM-G Operating Station)	The integrated test tool enables parameter settings required for application development and test operations such as JOG operation, inching, and positioning operation.
Servo Amplifier Setting and Adjustment in Multi-Axis Systems	The IP communication mixed function of CC-Link IE TSN allows the ease of setting and adjustment of the servo amplifier even in multi-axis systems.
Sample Programs	Sample programs enable parameter settings required for application development and test operations such as JOG operation, inching, and positioning operation.

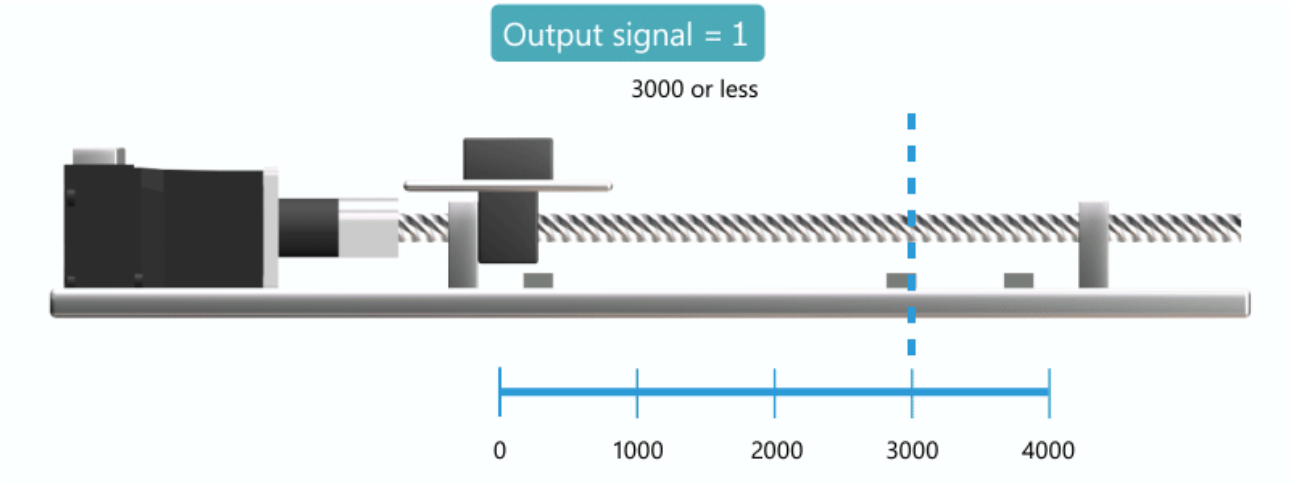
Chapter 3 Various Functions

This chapter describes some of the various functions of Motion Control Software SWM-G.

3.1 Position Synchronous Output (Cam Switch)

The position synchronous output function is used to set the output signal when a specific condition is satisfied.
This function can be substituted for the limit switch.

Example:
The figure below shows an example where the output signal is 1 when the axis position is 3000 or less, and 0 when the axis position exceeds 3000.



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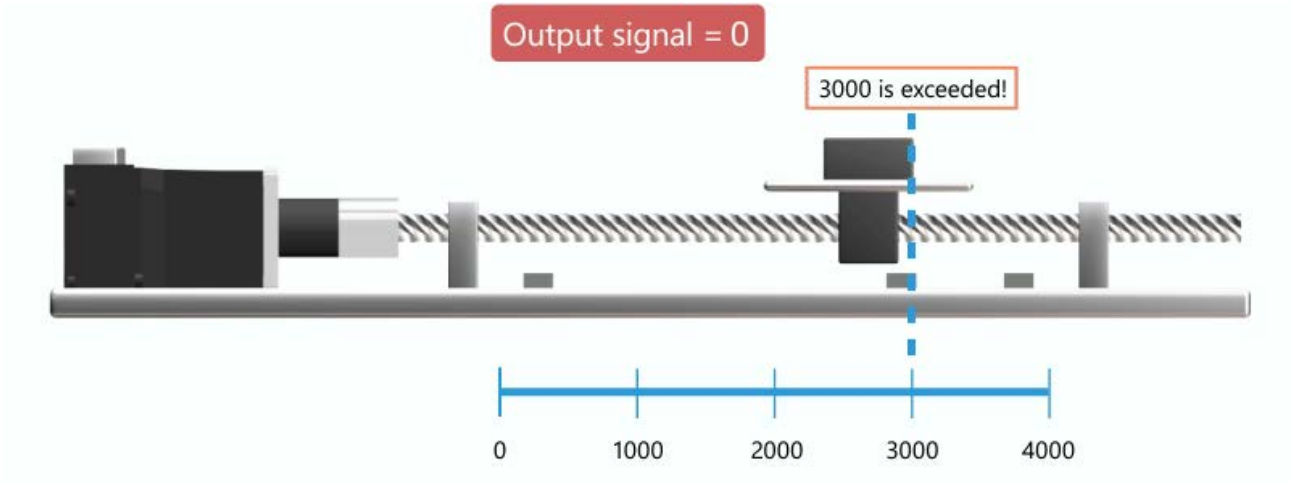

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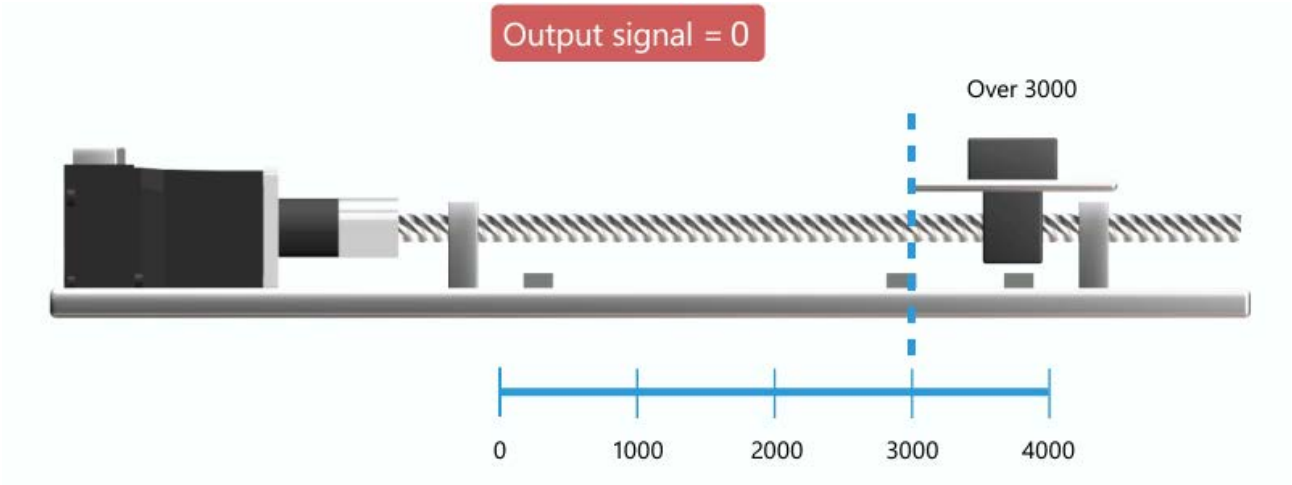
Example:
The figure below shows an example where the output signal is 1 when the axis position is 3000 or less, and 0 when the axis position exceeds 3000.

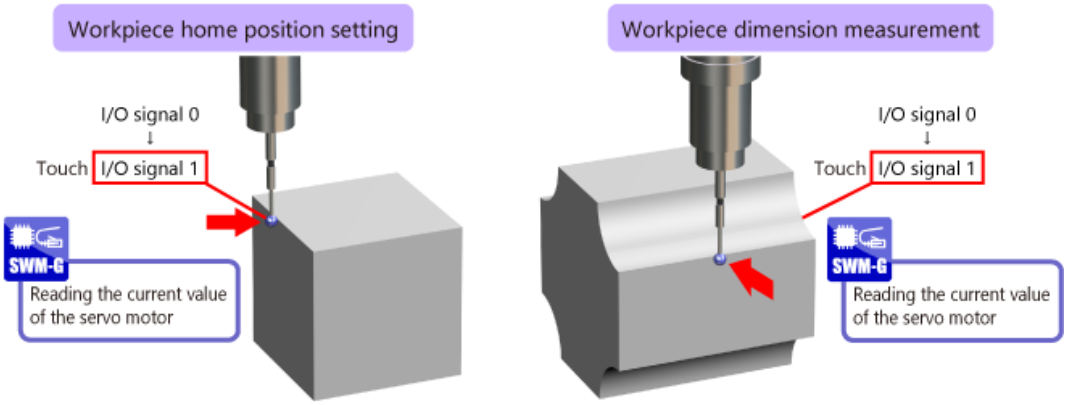


3.2 Touch Probe (Mark Detection)

The touch probe function is used to set the home position of the workpiece and measure the dimensions.
This function can be divided into two types.

- Software touch probe function
  The current position of the servo motor can be read when a touch probe signal is input.
- Hardware touch probe function
  The axis position is latched using the dedicated hardware for touch probe on the servo.
  The hardware touch probe function can latch the position data more accurately than the software touch probe function.

Example:

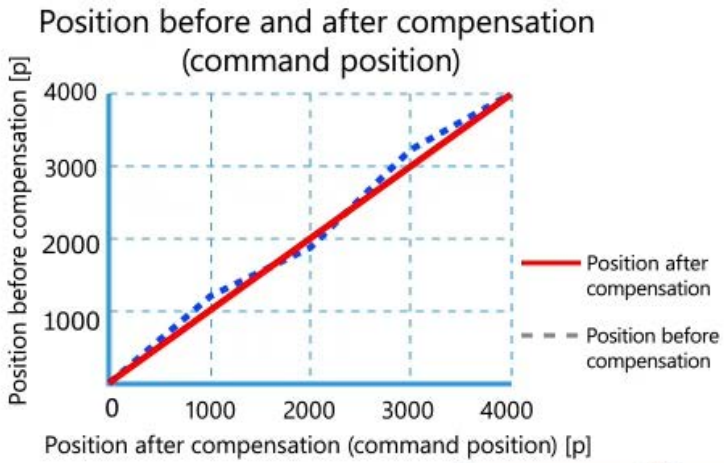


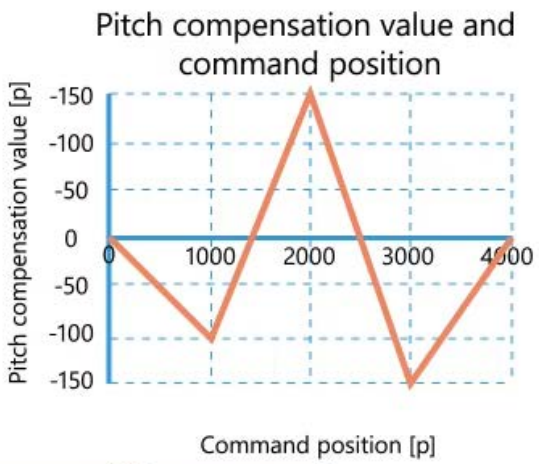
Measure the end surface of the workpiece before machining to determine the machining home position.

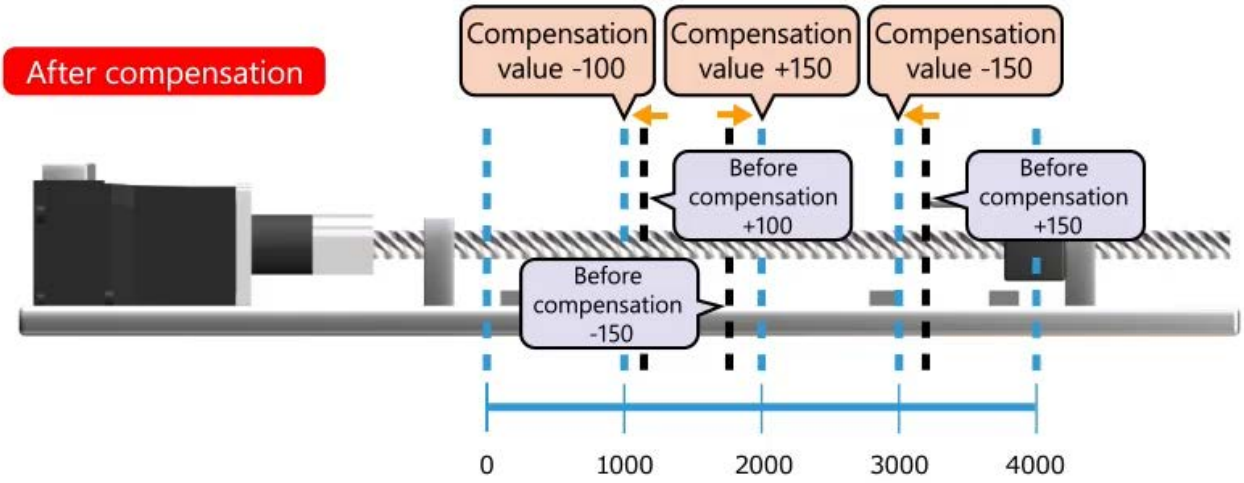
Measure the end surface of the workpiece after machining to measure the dimensions.

3.3 Pitch Error Compensation

The pitch error compensation function compensates the physical irregularities of the axes by defining the offsets measured at the command positions at regular intervals of the axes.
The ball screw can be compensated to improve accuracy.







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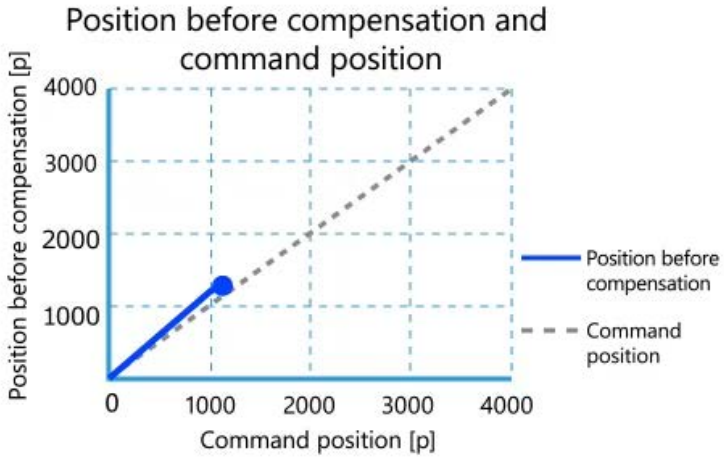

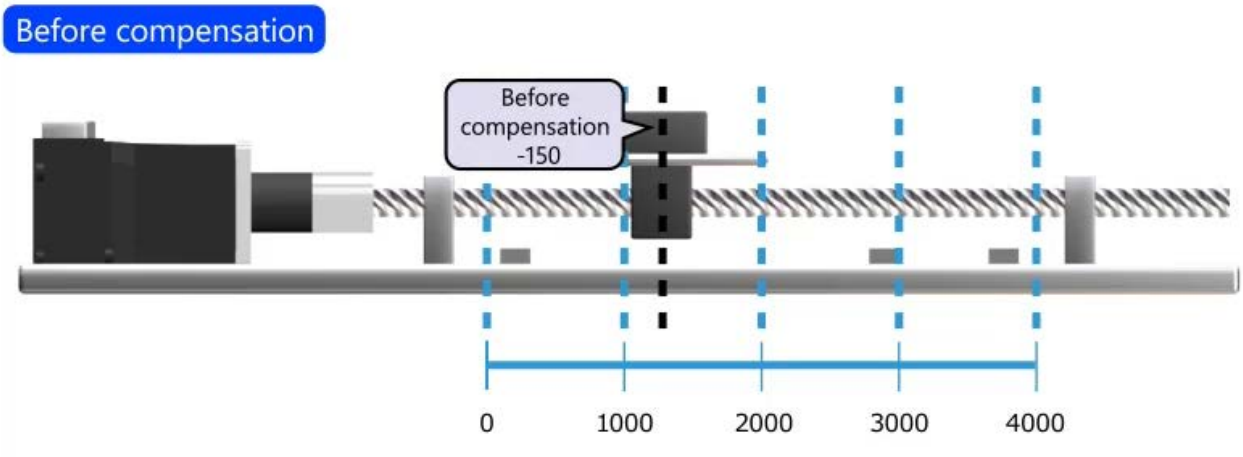

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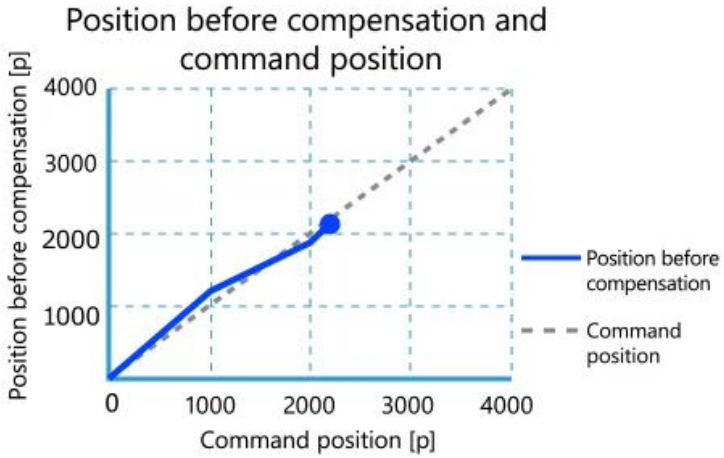

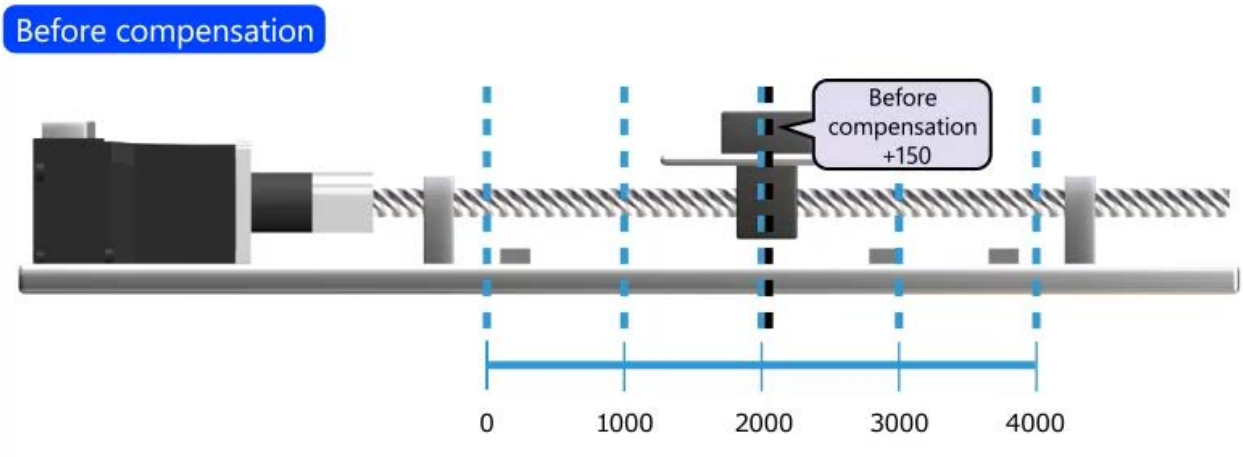

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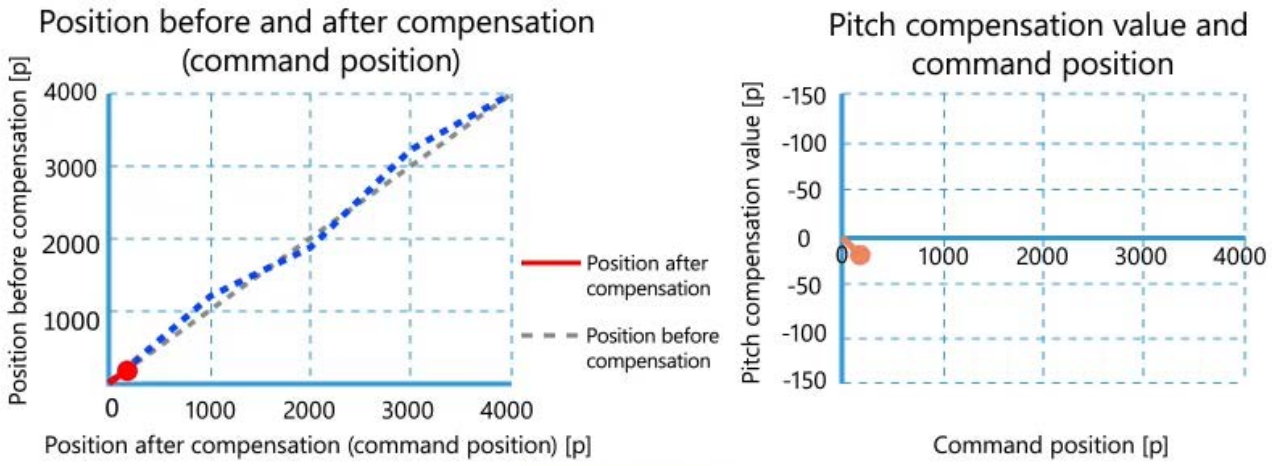

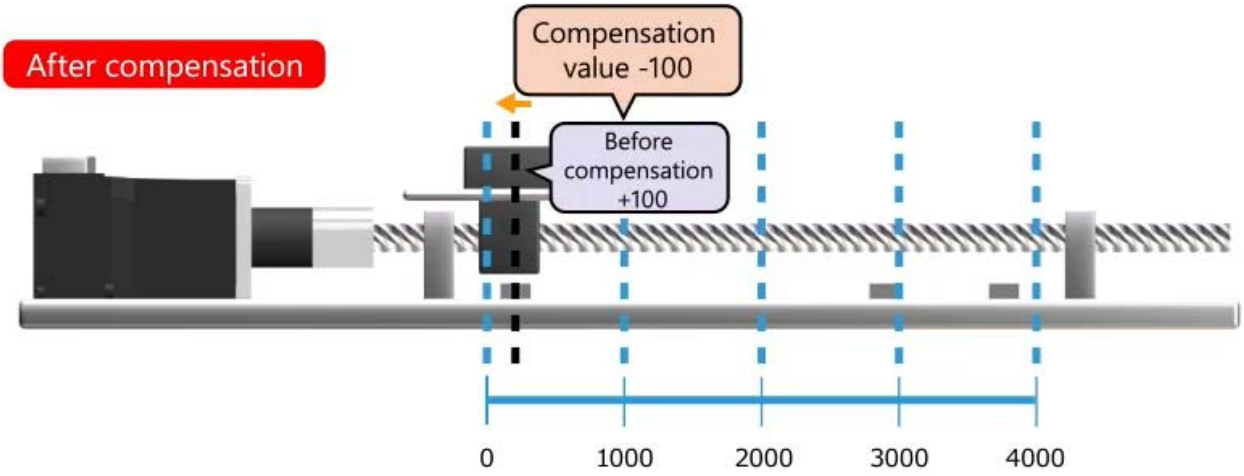

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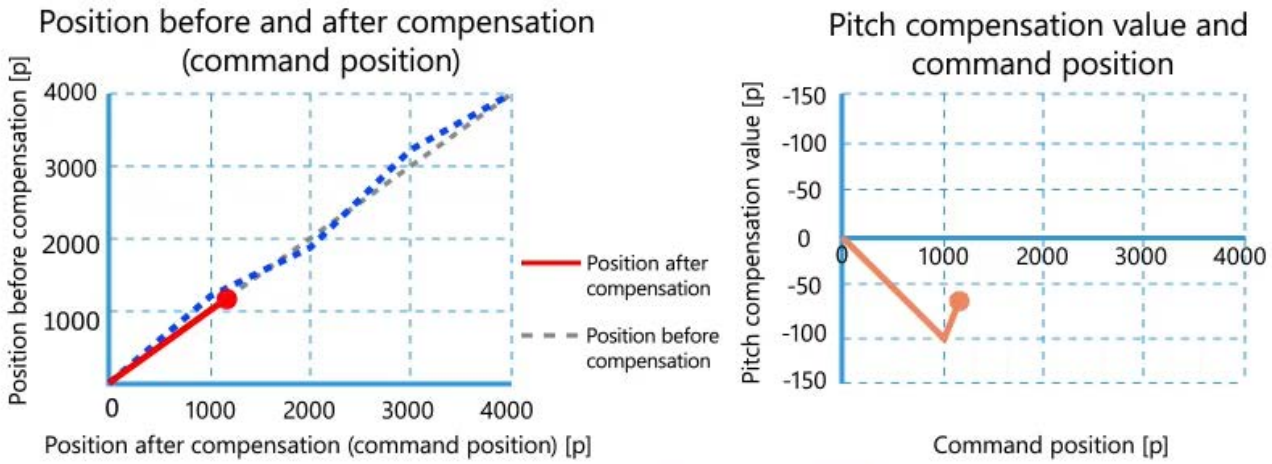

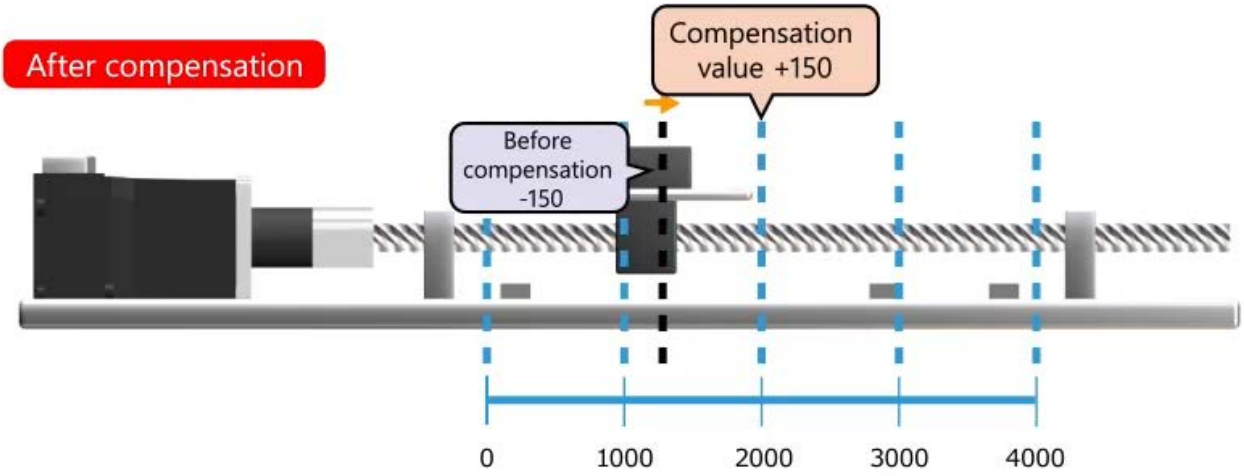

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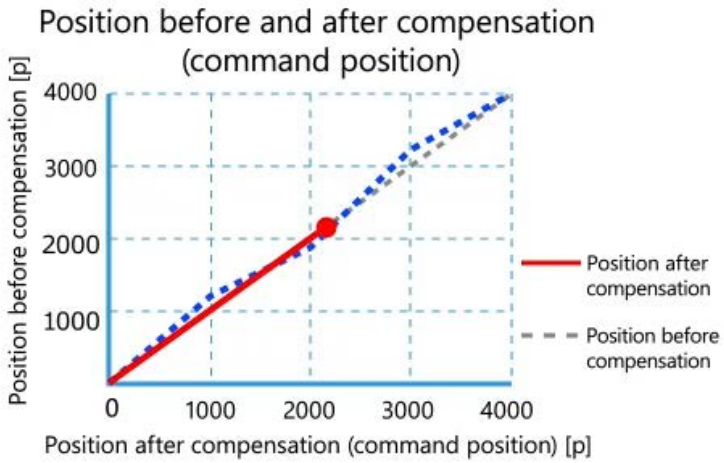

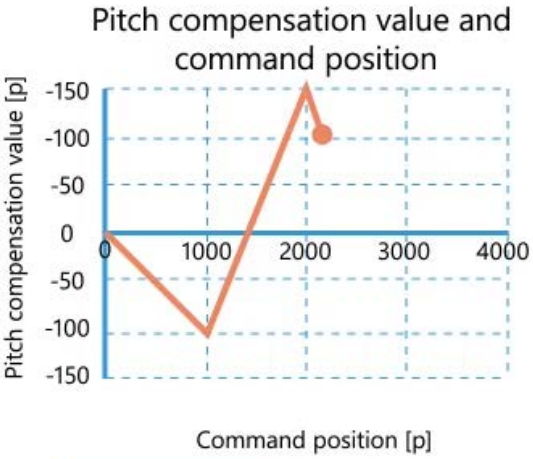

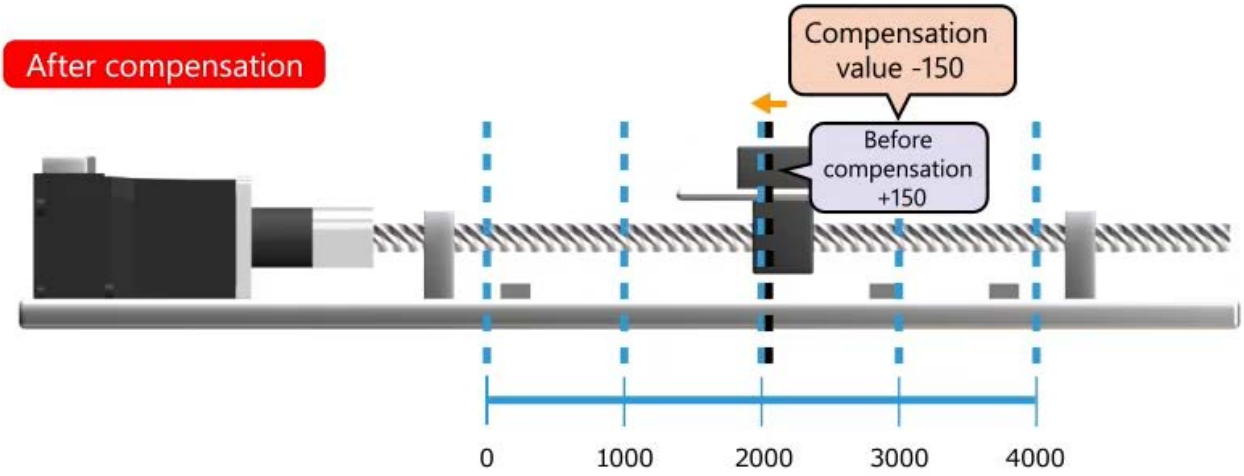

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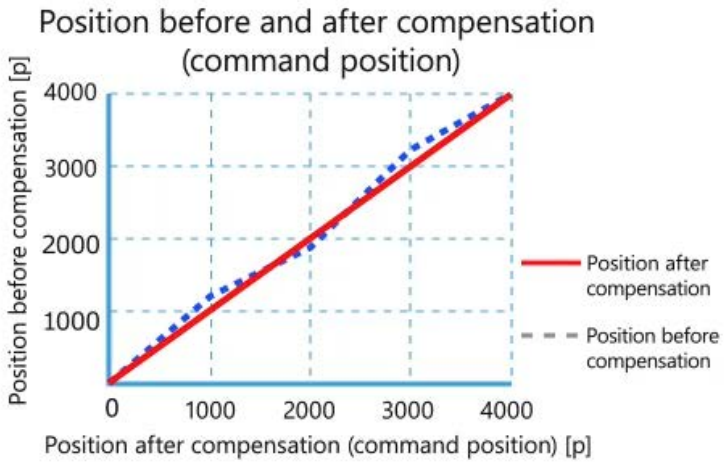
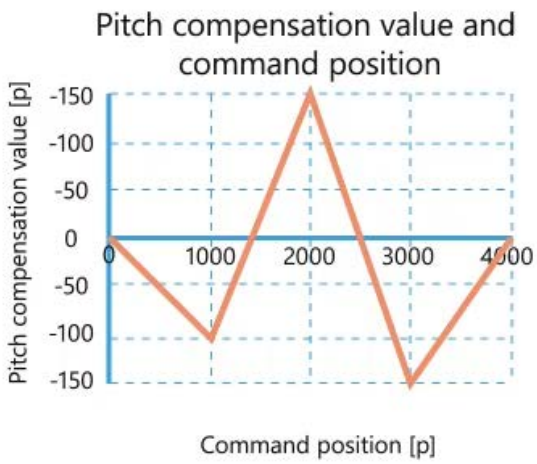
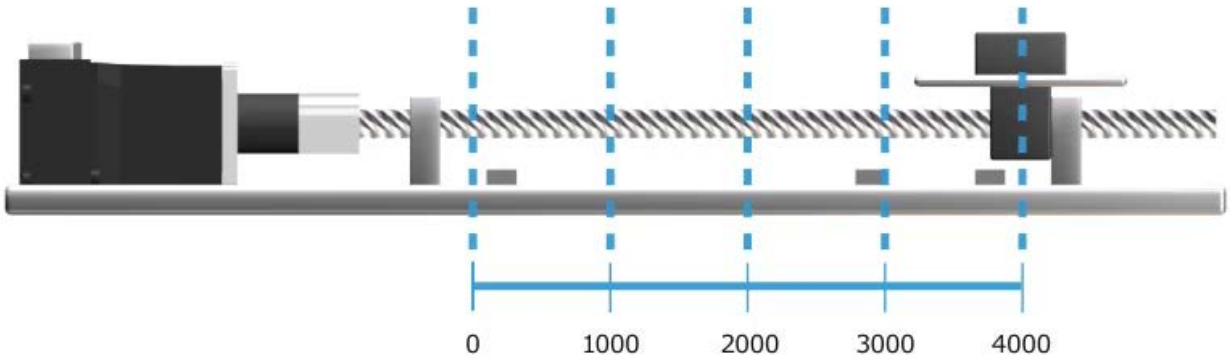
The ball screw can be compensated to improve accuracy.



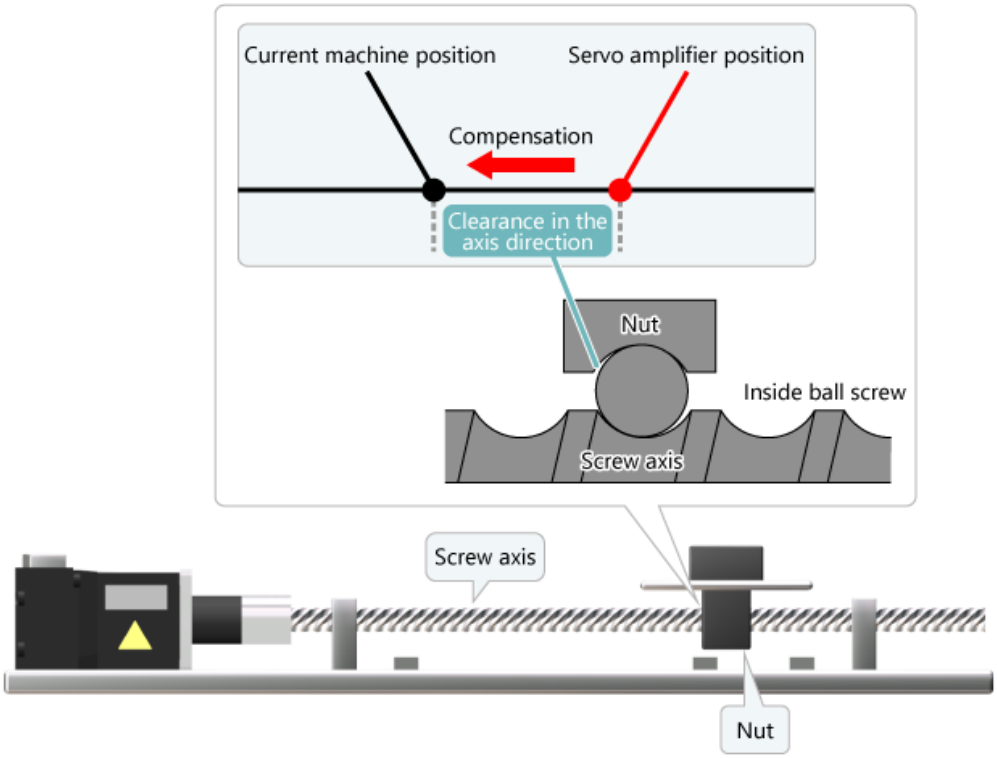


After compensation



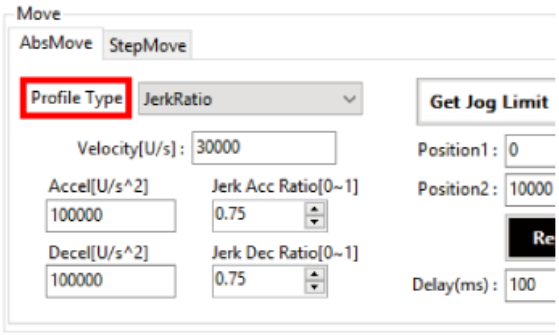
3.4 Backlash Compensation

The backlash compensation function compensates the set amount when the axis changes the movement direction. The rattle of the ball screw can be compensated to improve equipment accuracy.

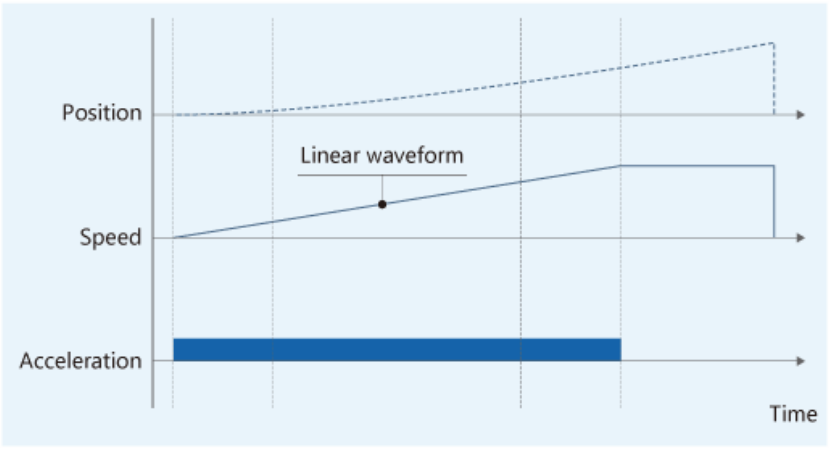


3.5 Acceleration/Deceleration Methods

There are 24 types of acceleration/deceleration methods such as the trapezoidal, S-curve, jerk ratio, parabolic, sine curve, and acceleration time specification trapezoidal.You can select the acceleration/deceleration method according to the purpose.

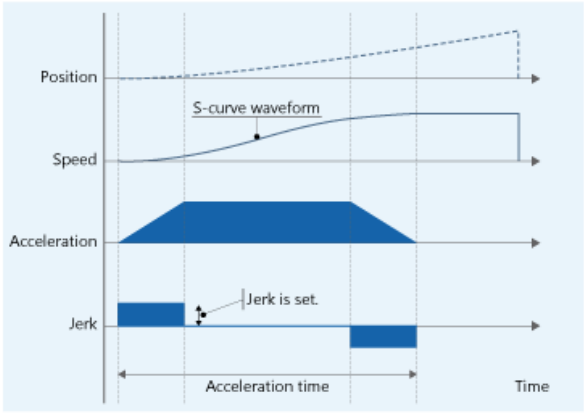


Example:
Trapezoidal acceleration/deceleration method
An acceleration/deceleration method that increases acceleration in steps.



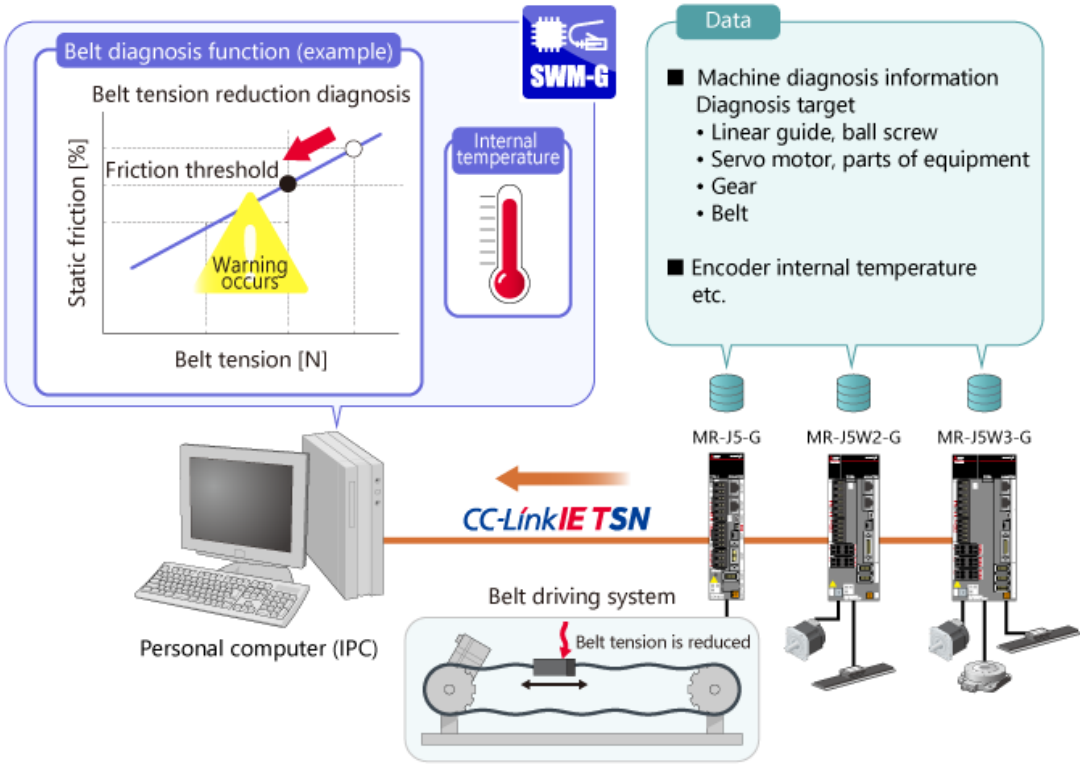
3.5 Jerk Acceleration/Deceleration Method

The jerk acceleration/deceleration method increases acceleration slowly not to cause vibration to the machine, maintains the jerk during acceleration, and restores the jerk to maintain a constant speed.
Appropriate jerk control reduces the acceleration time to the target speed while ensuring smooth acceleration.
The jerk is equivalent to the accelerator.
The speed is represented by S-curve waveform.



3.6 Monitoring of Servo Data

Motion Control Software SWM-G can acquire information such as the machine diagnosis information of the servo amplifier MR-J5-G and encoder internal temperature via CC-Link IE TSN to visualize the equipment status.



3.7 Summary of This Chapter

In this chapter, you have learned:

- Position Synchronous Output (Cam Switch)
- Touch Probe (Mark Detection)
- Pitch Error Compensation
- Backlash Compensation
- Acceleration/Deceleration Methods
- Jerk Acceleration/Deceleration Method
- Monitoring of Servo Data

Point

Position Synchronous Output (Cam Switch)	• The position synchronous output function is used to set the output signal when a specific condition is satisfied.
Touch Probe (Mark Detection)	• The touch probe function is used to set the home position of the workpiece and measure the dimensions.
Pitch Error Compensation	• The pitch error compensation function compensates the physical irregularities of the axes by defining the offsets measured at the command positions at regular intervals of the axes.
Backlash Compensation	• The backlash compensation function compensates the set amount when the axis changes the movement direction.
Acceleration/Deceleration Methods	• There are 24 types of acceleration/deceleration methods such as the trapezoidal, S-curve, jerk ratio, and jerk.
Jerk Acceleration/Deceleration Method	• The jerk acceleration/deceleration method increases acceleration slowly not to cause vibration to the machine, maintains the jerk during acceleration, and restores the jerk to maintain a constant speed.
Monitoring of Servo Data	• Motion Control Software SWM-G can acquire information such as the machine diagnosis information of the servo amplifier MR-J5-G and encoder internal temperature via CC-Link IE TSN to visualize the equipment status.

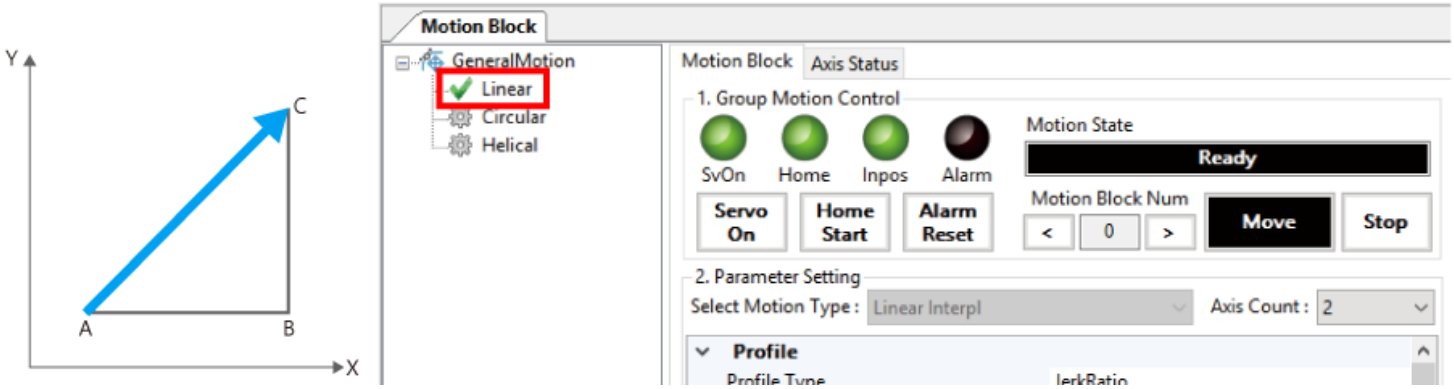
Chapter 4 Extensive Motion Control (Positioning Control)

This chapter describes the extensive motion control by Motion Control Software SWM-G.

4.1 Linear Interpolation

The linear Interpolation interpolates the axis so that it moves in a straight line in synchronization.
In the example shown below, the axis moves from point A to point C in a straight line.

In the next section, we will show you a sample video of linear interpolation.

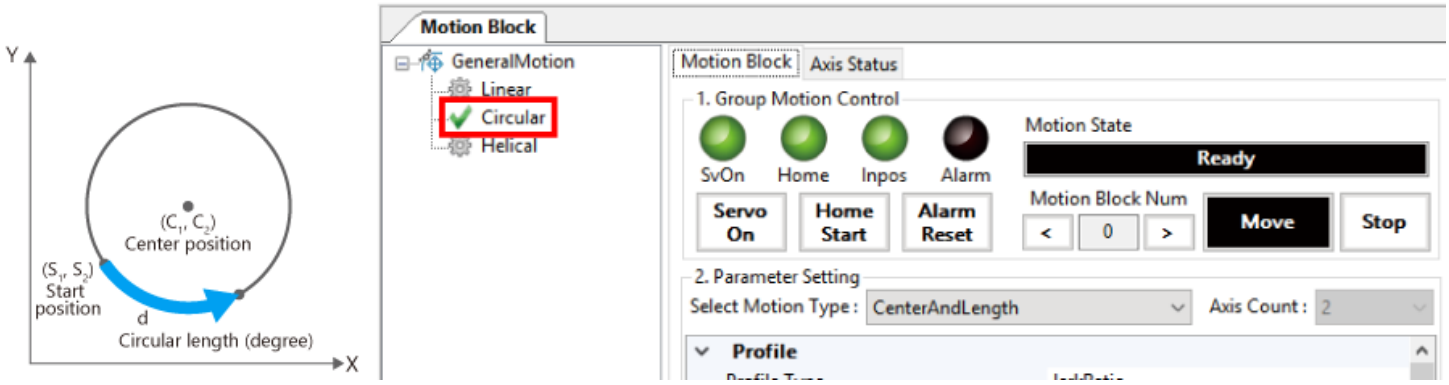


4.1.1 Linear Interpolation

The following shows the sample video of linear interpolation. Click the play button.

4.2 Circular Interpolation

The circular interpolation interpolates two axes onto a circular arc.
In the next section, we will show you a sample video of circular interpolation.



4.2.1 Circular Interpolation

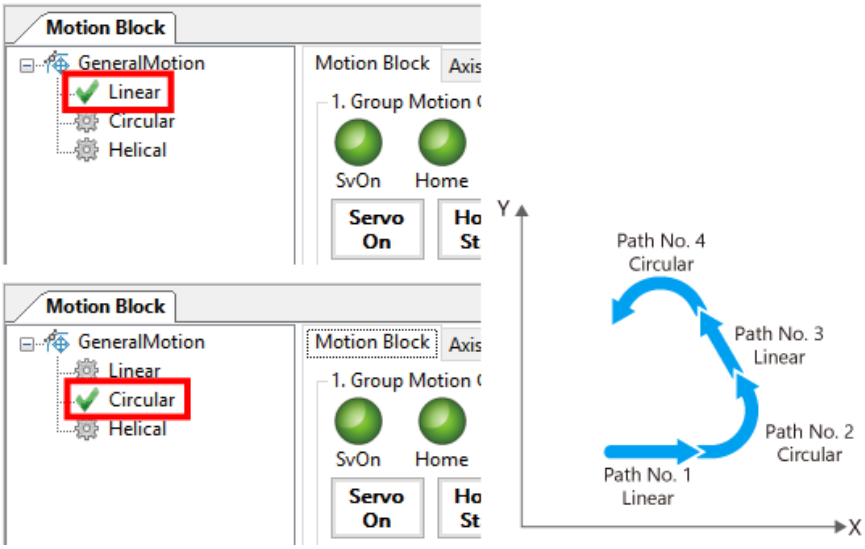
The following shows the sample video of circular interpolation. Click the play button.

4.3 Continuous Path Control (Path Interpolation)

The continuous path control (path interpolation) is a type of interpolation to make a two-dimensional path by combining some linear and circular segments.

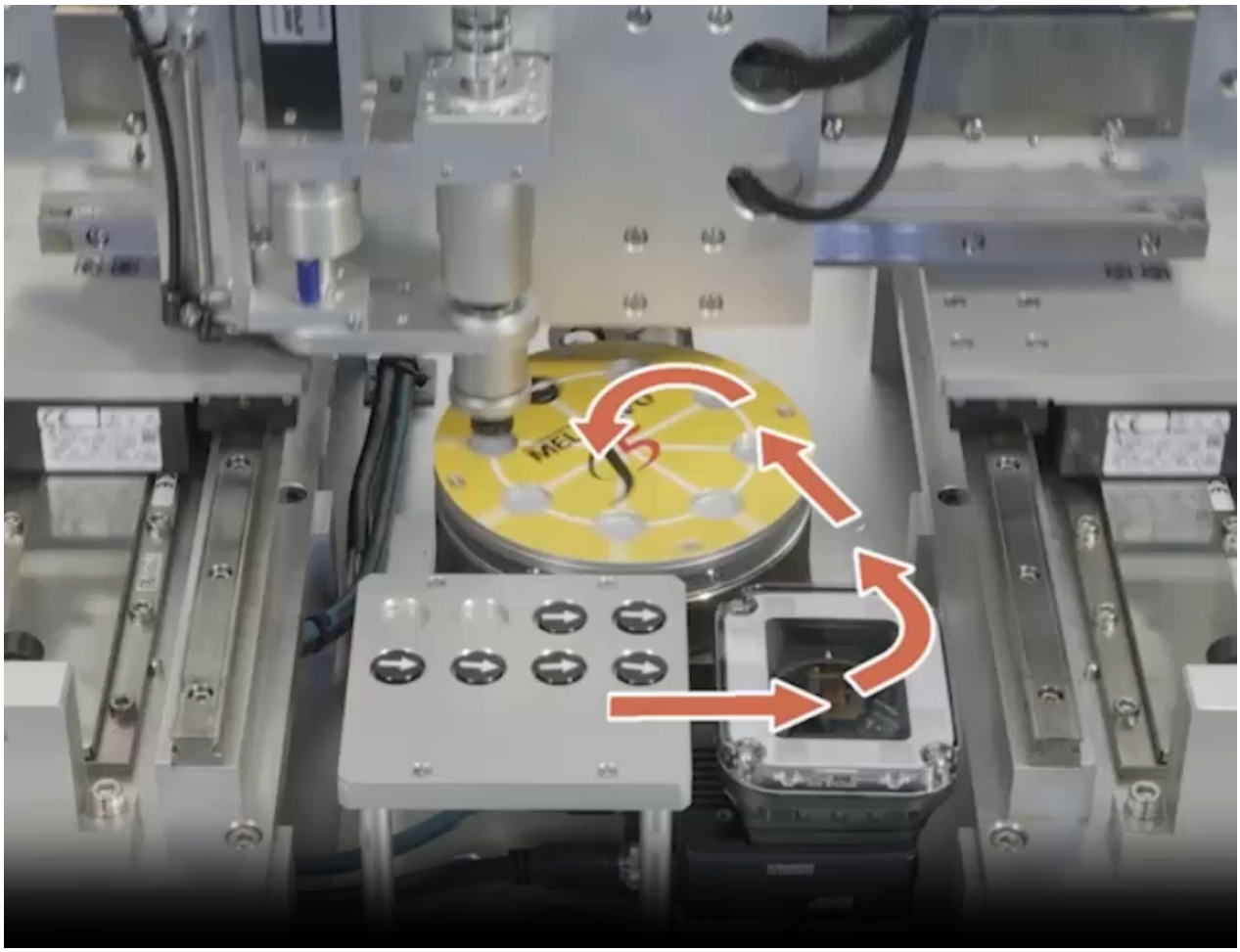
Two interpolation axes follow the defined path with either a single motion profile or different motion profiles for each segment.

In the next section, we will show you a sample video of continuous path control (path interpolation).



4.3.1 Continuous Path Control (Path Interpolation)

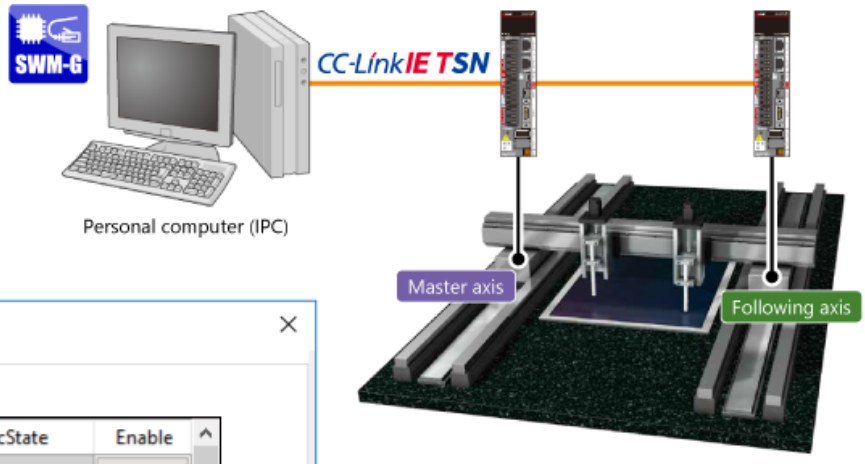
The following shows the sample video of continuous path control (path interpolation). Click the play button.

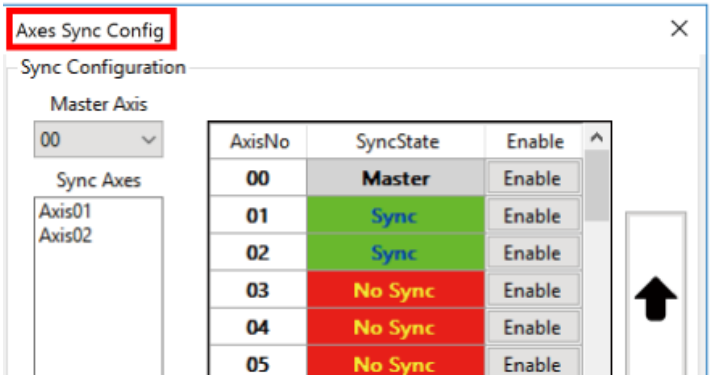


4.4 Synchronous Control (Tandem Drive)

In the synchronous control of Motion Control Software SWM-G, specify the master axis and following axis.
When the synchronous control starts, the command positions of the master axis and following axis will be synchronized.
Thereafter, when the command position of the master axis changes, the command position of the following axis also changes by the same amount.

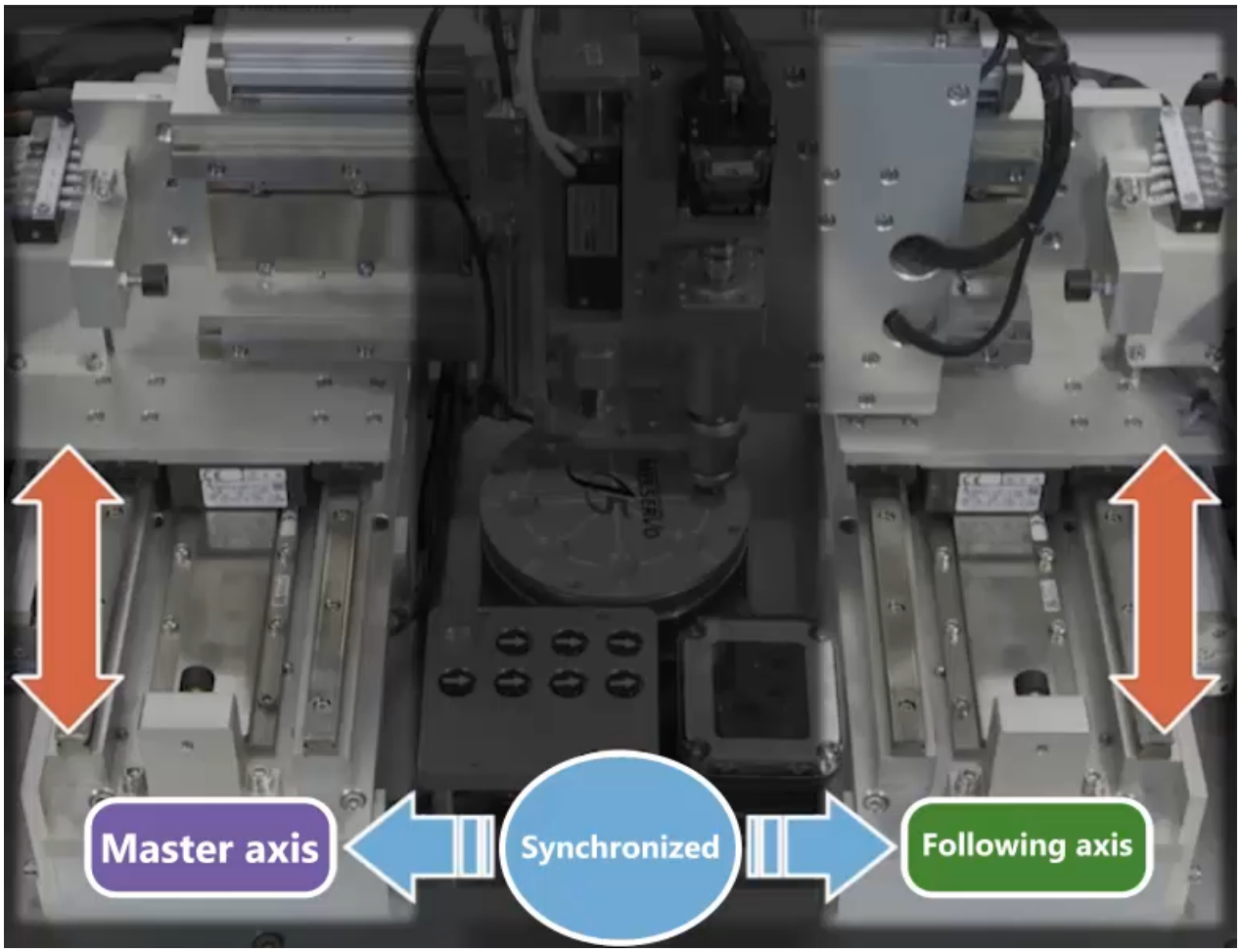
In the next section, we will show you a sample video of synchronous control (tandem drive).





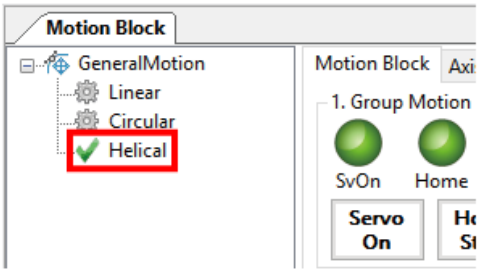
4.4.1 Synchronous Control (Tandem Drive)

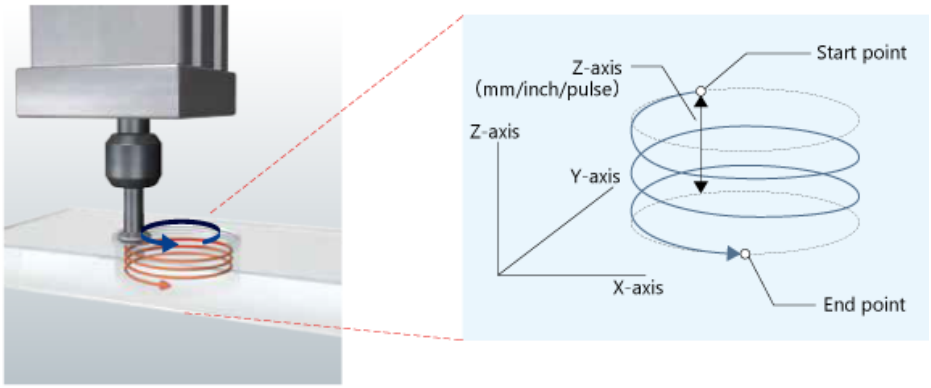
The following shows the sample video of synchronous control (tandem drive). Click the play button.



4.5 Helical Interpolation

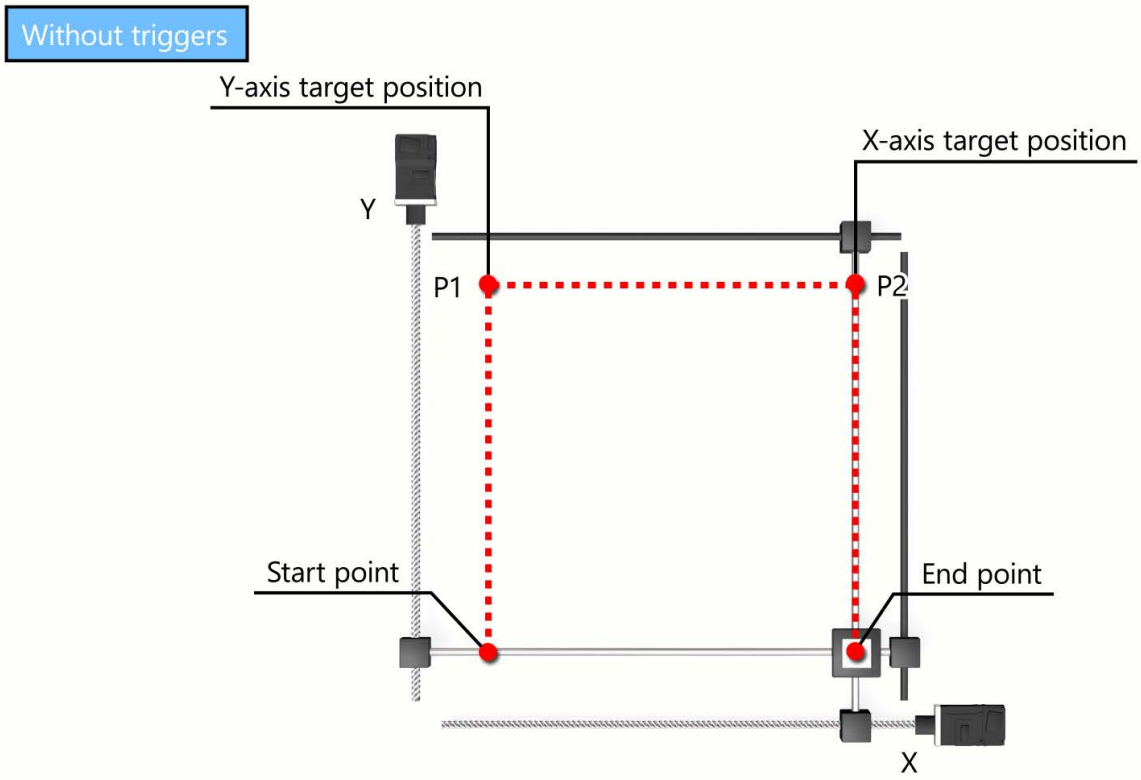
The helical interpolation interpolates the axes in three-dimensional spiral paths.
In the linear motion in the spiral movement is along with one axis, and the rotational motion in the spiral movement is along with the other two axes.





4.6 Triggered Motion

The triggered motion delays the execution of the motion command until the trigger condition is satisfied.
Specify the normal operation for the Y-axis, and immediately after that, specify the triggered motion for the X-axis.
When the trigger is turned on halfway through the Y-axis operation, the X-axis starts operation.
Because the controller automatically starts the axis, the takt time can be reduced in transportation equipment and other systems.



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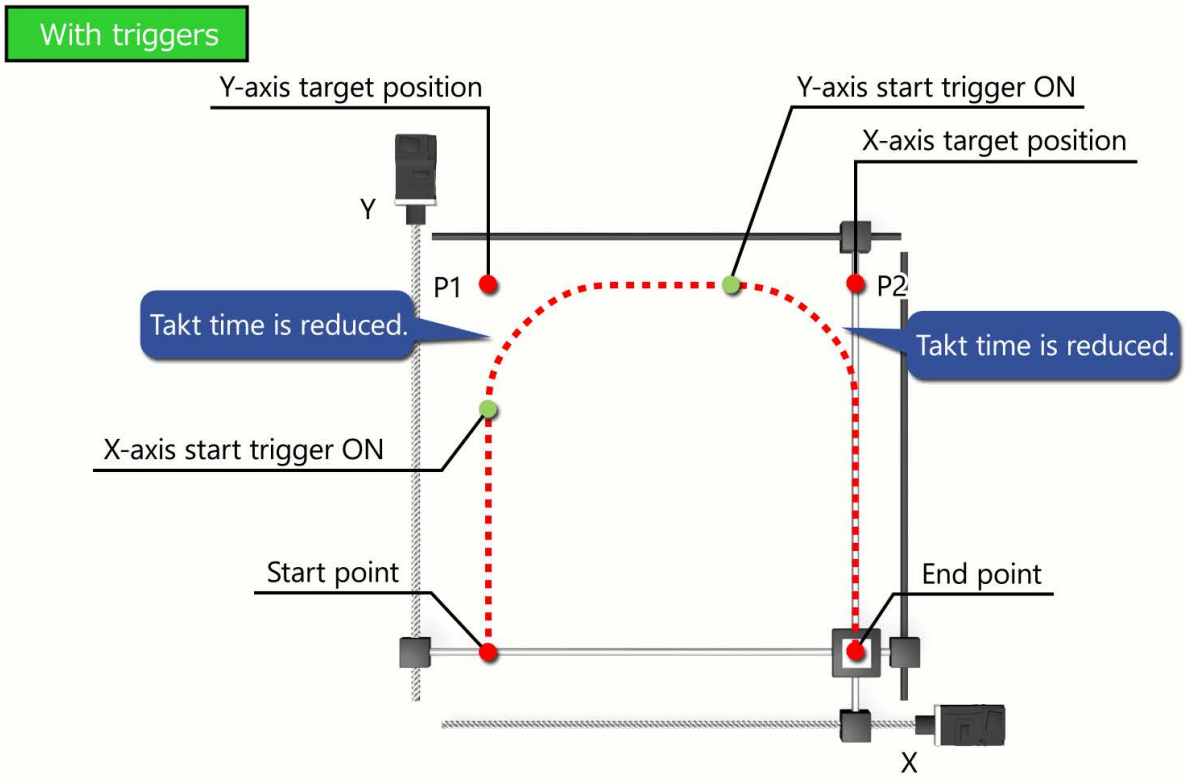


4.7 Summary of This Chapter

In this chapter, you have learned:

- Linear Interpolation
- Circular Interpolation
- Continuous Path Control (Path Interpolation)
- Synchronous Control (Tandem Drive)
- Helical Interpolation
- Triggered Motion

Point

Linear Interpolation	The linear Interpolation interpolates the axis so that it moves in a straight line in synchronization.
Circular Interpolation	The circular interpolation interpolates two axes onto a circular arc.
Continuous Path Control (Path Interpolation)	The continuous path control (path interpolation) is a type of interpolation to make a two-dimensional path by combining some linear and circular segments.
Synchronous Control (Tandem Drive)	In the synchronous control (tandem drive), the command position of the following axis changes according to the command position of the master axis by the same amount.
Helical Interpolation	The helical interpolation interpolates the axes in three-dimensional spiral paths.
Triggered Motion	The triggered motion delays the execution of the motion command until the trigger condition is satisfied.

Test Final Test

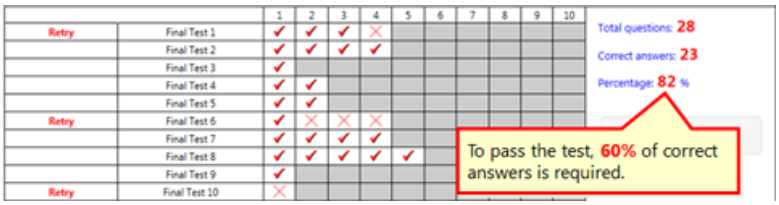
Now that you have completed all of the lessons of the **Motion Control Software SWM-G for Beginners** Course, you are ready to take the final test. If you are unclear on any of the topics covered, please take this opportunity to review those topics.

There are a total of 5 questions (5 items) in this Final Test.

You can take the final test as many times as you like.

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.



Test **Final Test 1**

Select the correct sentence to describe the product lineup of Motion Control Software SWM-G. (You may select multiple answers.)

- [ ] **Motion Control Software SWM-G is available for download at Mitsubishi Electric Factory Automation Global Website.**
- [ ] **The USB key for Motion Control Software (license) must be purchased.**
- [ ] **There are four types of USB keys for Motion Control Software (license) with the maximum numbers of axes 32, 64, 128, and 256.**

Test **Final Test 2**

Select the option that meets the operating environment of Motion Control Software SWM-G. (You may select multiple answers.)

- [ ] **Windows 10 Pro 64-bit operating system**
- [ ] **Personal computer without NIC**
- [ ] **Memory of 8 GB**
- [ ] **1 GB of free space on hard disk at installation**
- [ ] **6.00 GHz CPU with 24 cores**

Test **Final Test 3**

Select the item required for introducing Motion Control Software SWM-G. (You may select multiple answers.)

- [ ] **Personal computer that meets the operating environment of Motion Control Software SWM-G**
- [ ] **Motion Control Software SWM-G**
- [ ] **MR Configurator2**
- [ ] **Visual Studio 2022**
- [ ] **USB key for Motion Control Software (license)**

Test **Final Test 4**

Select the correct function of Motion Control Software SWM-G. (You may select multiple answers.)

- [ ] **Touch probe function**
- [ ] **Continuous path control (path interpolation)**
- [ ] **Backlash compensation**
- [ ] **Sequence function**

Test **Final Test 5**

Select the correct sentence to describe the features of Motion Control Software SWM-G. (You may select multiple answers.)

- [ ] **By using network control, control target devices such as a remote I/O module and IP communication compatible devices can be connected and set.**
- [ ] **User applications can be created using Windows GUI in C++ or C#.**
- [ ] **Real Time OS (RTX64) included in the software enables real-time processing on your personal computer, which is to be applied to a drive control system compatible with CC-Link IE TSN.**
- [ ] **The API library required for motion control can be used to apply motion control such as positioning, synchronization, cam, speed, and torque to various systems.**
- [ ] **A personal computer to use as a controller can be freely selected as long as it meets the operating environment conditions.**

Test Final Test 1

Select the correct sentence to describe the product lineup of Motion Control Software SWM-G. (You may select multiple answers.)

- [x] **Motion Control Software SWM-G is available for download at Mitsubishi Electric Factory Automation Global Website.**
- [x] **The USB key for Motion Control Software (license) must be purchased.**
- [ ] **There are four types of USB keys for Motion Control Software (license) with the maximum numbers of axes 32, 64, 128, and 256.**

Test Final Test 2

Select the option that meets the operating environment of Motion Control Software SWM-G. (You may select multiple answers.)

- [x] **Windows 10 Pro 64-bit operating system**
- [ ] **Personal computer without NIC**
- [x] **Memory of 8 GB**
- [ ] **1 GB of free space on hard disk at installation**
- [x] **6.00 GHz CPU with 24 cores**

Test Final Test 3

Select the item required for introducing Motion Control Software SWM-G. (You may select multiple answers.)

- [x] **Personal computer that meets the operating environment of Motion Control Software SWM-G**
- [x] **Motion Control Software SWM-G**
- [x] **MR Configurator2**
- [ ] **Visual Studio 2022**
- [x] **USB key for Motion Control Software (license)**

Test Final Test 4

Select the correct function of Motion Control Software SWM-G. (You may select multiple answers.)

- [x] **Touch probe function**
- [x] **Continuous path control (path interpolation)**
- [x] **Backlash compensation**
- [ ] **Sequence function**

Test **Final Test 5**

Select the correct sentence to describe the features of Motion Control Software SWM-G. (You may select multiple answers.)

- [x] **By using network control, control target devices such as a remote I/O module and IP communication compatible devices can be connected and set.**
- [x] **User applications can be created using Windows GUI in C++ or C#.**
- [x] **Real Time OS (RTX64) included in the software enables real-time processing on your personal computer, which is to be applied to a drive control system compatible with CC-Link IE TSN.**
- [x] **The API library required for motion control can be used to apply motion control such as positioning, synchronization, cam, speed, and torque to various systems.**
- [x] **A personal computer to use as a controller can be freely selected as long as it meets the operating environment conditions.**

Test **Test Score**

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

		1	2	3	4	5	6	7	8	9	10
	Final Test 1	✔									
	Final Test 2	✔									
	Final Test 3	✔									
	Final Test 4	✔									
	Final Test 5	✔									

Total questions: **5**

Correct answers: **5**

Percentage: **100** %

Clear

You have completed the "Motion Control Software SWM-G for Beginners" Course.

Thank you for taking this course.

We hope you enjoyed the lessons and the information you acquired in this course is useful for configuring systems in the future.

You can review the course as many times as you want.

Review

Close