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Mitsubishi Electric Programmable Controller Training Manual MELSEC iQ-R Motion Controller (for MT Works2)

● Safety Precautions ●

(Always read before performing practical work.)

When designing systems, always read related manuals and give sufficient consideration to safety.
Pay due attention to the following points when performing practical work, and ensure correct handling of the product.

[Practical work precautions]

⚠ WARNING

- Do not touch terminals while the power is ON. Failure to observe this may result in electric shock.
- When removing the safety cover, either turn OFF the power, or ensure that sufficient attention is paid to safety.

⚠ CAUTION

- Carry out practical work in accordance with the instructions of your teacher.
- Do not remove the demonstration machine, or make changes to the wiring.
  Failure to observe this may result in a fault, malfunction, injury, or fire.
- Turn OFF the power before attaching or removing the module.
  Removing or attaching the module with the power ON may result in a module fault or electric shock.
- If the demonstration machine emits an abnormal odor or noise, press the [Power] button or [EMERGENCY STOP] button to stop the module.
- If an error occurs, notify your teacher immediately.

Revision History

* The text number is indicated in the lower left of the rear cover of this manual.

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Introduction

This document is a schooling text created for the purpose of helping users understand the motion controller developed to easily control multi-axis positioning.
This manual provides an overview of the motion controller, and describes how to specify data settings to perform positioning, and create servo programs and sequence programs using a Windows® computer and engineering tool (MT Works2).

The following related manuals are available.

	Model	Model code
(1) User's manual		
• R16MTCPU/R32MTCPU	IB(NA)-0300235	1XB002
Describes the motion controller hardware (exterior, wiring, etc.).		
(2) Programming manuals		
• R16MTCPU/R32MTCPU Common	IB(NA)-0300237	1XB004
• R16MTCPU/R32MTCPU Program Design	IB(NA)-0300239	1XB006
• R16MTCPU/R32MTCPU Advanced Synchronous Control	IB(NA)-0300243	1XB010
• R16MTCPU/R32MTCPU Positioning Control	IB(NA)-0300241	1XB008
Describes parameters for positioning control, dedicated positioning devices, positioning methods, and motion SFC, etc.		
(3) Software manual		
• MELSOFT MT Works2 Installation Instructions	BCN-B62008-364	———
(4) Sequence programming manuals		
• Programming Manual (Instructions, Standard Functions/Function Blocks)	SH(NA)-081226ENG	R-P-MF-E
• Programming Manual (Program Design)	SH(NA)-081265ENG	R-P-PS-E
• CPU Module User's Manual (Application)	SH(NA)-081264ENG	RCPU-U-OU-E
Describes devices and all commands required to create sequence programs.		
(5) GX Works3 related manuals		
• GX Works3 Operating Manual	SH(NA)-081215ENG	GXW3-O-E
(6) Technical document collections		
• MR-J4-□B Servo Amp Technical Document Collection	SH(NA)-030106	1CW805
Describes SSCNET III (/H) servo amp handling and error displays, etc.		
• MELSERVO-J4 Servo Amp Technical Document Collection (Troubleshooting Edition)	SH(NA)-030109	1CW808

SSCNET is an abbreviation of Servo System Controller Network.

Chapter 1 Overview

1.1 Motion Controller Features

The motion controller has the following features.

(1) PLC CPU and multiple CPU System

Processing loads can be balanced to realize a flexible system construction by using the motion CPU module for complex servo control, and the PLC CPU module for all other machine and information control.

(2) Full range of controllers for all applications

The following motion controller models are available to suit the scale of the systems required to perform multi-axis positioning.

•R16MTCPU	(Multi-axis positioning function for 1 to 16 axes)	SSCNET III (/H)
•R32MTCPU	(Multi-axis positioning function for 1 to 32 axes)	

(3) Control is possible with an MR-J4-☐B servo amplifier.

Servo motors can be controlled by externally connecting an MR-J4-☐B servo amplifier with motion network SSCNET III/H.
(Using the R16MTCPU or R32MTCPU, up to 16 or 32 servo motors can be controlled, respectively.)

(4) High-speed serial communication with servo amplifiers is possible.

Servo data can be collected, changes can be made to servo parameters, servo tests can be carried out, servos can be monitored, and mechanical system programs can be monitored through motion network SSCNET III/H high-speed serial communication.
Furthermore, SSCNET III/H communication offers a maximum communication speed of 150 Mbps, accelerated command communication synchronization of 0.222 ms, and high-speed, high-accuracy positioning.

(5) An absolute position system is possible.

An absolute position system is possible using servo motors equipped with absolute position detector. (Home position return is unnecessary even in the event of a power outage.)

(6) A Windows® computer is used as the programming tool for positioning.

Motion SFC programming, servo control programming, monitoring, and testing can be performed using a Windows® computer and dedicated software package.
Windows® computer peripheral software package: MT Works2

(7) Software cam

By replacing the cam mechanism for which synchronous control was being performed mechanically with software, and then setting synchronous control parameters, the following features can be obtained by synchronizing control with input axes.

1: Cam curved line data can be created easily with cam curved line creation software, eliminating the need to manufacture cam parts.

2: Cams can be replaced easily by changing the cam No. from the Motion SFC program or sequence program.

3: There is no need to consider the wear or short life characteristic of cams.

(8) Teaching function

Gauging servo programs can be created with the current value teaching function.

(9) Limit switch function

This function outputs ON/OFF signals corresponding to the data range for watch data set for each output device (X, Y, M, L, B).
Output devices for up to 64 points can be set.

(10) PERIPHERAL I/F (Ethernet)

With the PERIPHERAL I/F built-in Motion CPU, connections can be made to a wide range of devices such as GOT and COGNEX vision systems via Ethernet.

(11) Support for 4 million pulse synchronous encoder as standard

The "Q171ENC-W8" 4 million (22-bit) pulse synchronous encoder is supported as standard, meaning significant improvements in synchronized operation accuracy (16 times higher than previous system). High-accuracy control can be achieved in combination with an MR-J4-B servo amplifier (standard motor resolution of 4 million (22-bit) pulses).

1.2 Control Overview

1.2.1 Positioning control

(a) Systems using servo motors are controlled directly with a servo program.

(b) Positioning parameters must be set, and servo programs and Motion SFC programs must be created.

(c) The procedure when performing positioning control is as follows.

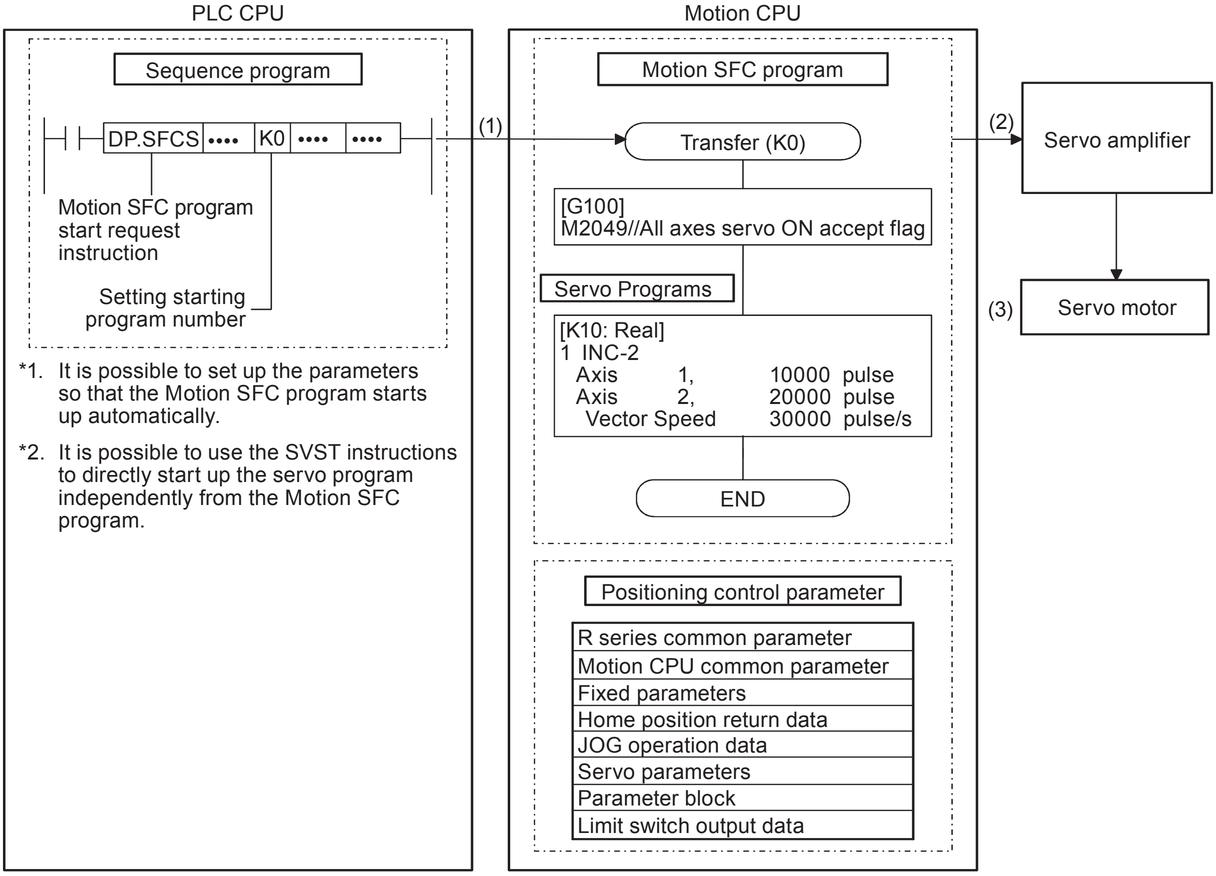
(1) Issue a Motion SFC program start request with a sequence program SFCS instruction.

↓

(2) Perform positioning control with the specified Motion SFC program.

↓

(3) Servo motors are controlled.



1.2.2 Advanced synchronous control

(a) Performs the same control by replacing the mechanism used to perform mechanical synchronous control using devices such as gears, shafts, transmissions, and cams with software.

(b) In addition to the positioning parameters, servo programs and Motion SFC program, the synchronous control parameters are necessary.

(c) The procedure for positioning control with advanced synchronous control is as follows.

(1) Issue an advanced synchronous control Motion SFC program start request with a sequence program SFCS instruction.

↓

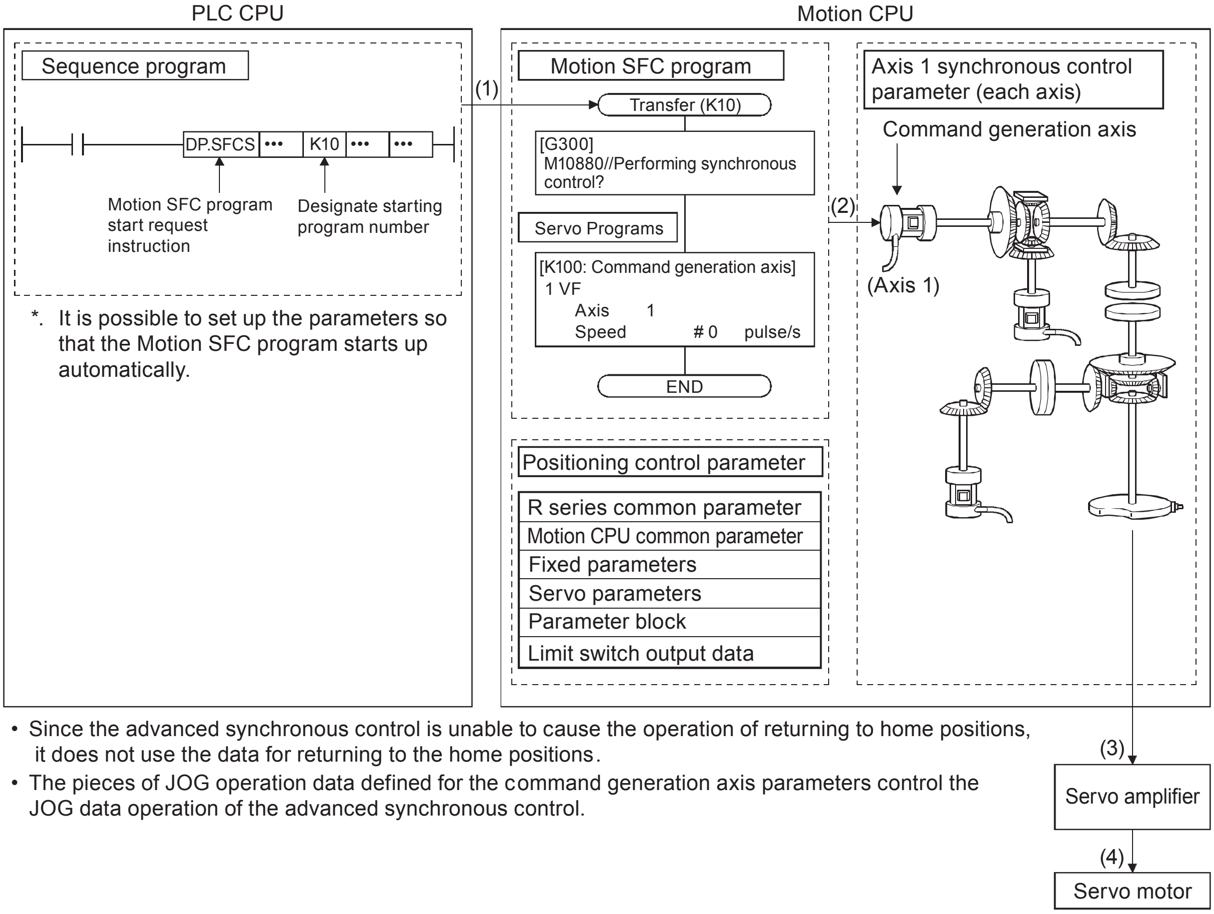
(2) The advanced synchronous control command generation axis starts up.

↓

(3) Output synchronous control parameters to the servo amplifier for each axis.

↓

(4) Servo motors are controlled.



*. It is possible to set up the parameters so that the Motion SFC program starts up automatically.

- Since the advanced synchronous control is unable to cause the operation of returning to home positions, it does not use the data for returning to the home positions.
- The pieces of JOG operation data defined for the command generation axis parameters control the JOG data operation of the advanced synchronous control.

1.3 System Startup Requirements

—— The steps inside the boxes with unbroken lines must be carried out.

- - - The steps inside the boxes with broken lines should be carried out as required.

Refer to Chapter 8 for details on system startup.

1	Motion controller device selection system assembly, wiring	Select devices such as base unit, power supply modules, Motion CPU, PLC CPU, motion module, servo amplifiers, servo motors, and cables, and assemble and wire the system.
2	To Windows® computer Software package registration	Register the software package (MT Works2, GX Works3).
3	PLC CPU multiple CPU settings	Create with GX Works3.
4	Sequence program creation	Create with GX Works3.
5	Data writing to the PLC CPU	Write the sequence program and parameters at the PLC.
6	Cam creation	Create cams when using for the output module.
7	New project creation	Start the software package used, and then create a new project. Import the system parameters from the project crated by GX Works3.
8	Setting common parameters	Create system basic settings, servo network settings and so on as the motion controller system.
9	Servo data creation • Fixed parameters • Home position return data • JOG operation data • Servo parameters • Parameter blocks	• Set unit settings, travel value per pulse, stroke limit values, etc. • Set the home position return direction, method, address, speed, etc. • Set the JOG speed limit value, parameter block numbers, etc. • Set the rotation direction, auto tuning, etc. • Set the speed limit values, acceleration/deceleration time, torque limit values, etc. (Set servo parameters at MT Works2 (MT Developer2, MR Configurator2).)
10	Servo data creation • Limit switch data	Set only when using the limit switch output function.
11	Motion SFC program creation	
12	Synchronous control parameter setting	Create and set when performing synchronous control.
13	Cable connection to Motion CPU	Use Ethernet to connect to the Windows® computer, and use Ethernet, or USB to connect to the PLC CPU.
14	Data writing to the Motion CPU	Write the Motion SFC program, servo data, servo program, synchronous control parameters, and cam data.
15	Resetting the PLC CPU	Press the PLC CPU [RUN/STOP/RESET] switch.
16	Running the PLC CPU, Motion CPU	Press the PLC CPU, Motion CPU [RUN] switch.

Chapter 2 Function Description

This section describes the system functions.

2.1 Specifications List

2.1.1 Motion control specifications list

Item \ Model	R32MTCPU	R16MTCPU
External dimensions [mm]	106.0 (H) ×27.8 (W) ×110.0 (D)	
Number of control axes	Up to 32 axes	Up to 16 axes
Operation cycle (default)	0.222 ms/1 to 2 axes 0.444 ms/3 to 8 axes 0.888 ms/9 to 20 axes 1.777 ms/21 to 32 axes	0.222 ms/1 to 2 axes 0.444 ms/3 to 8 axes 0.888 ms/9 to 16 axes
Interpolation functions	Linear interpolation (Up to 4 axes), Circular interpolation (2 axes), Helical interpolation (3 axes)	
Control modes	PTP(Point to Point) control, Speed control, Speed-position switching control, Fixed-pitch feed, Continuous trajectory control, Position follow-up control, Speed control with fixed position stop, High-speed oscillation control, Speed-torque control, Pressure control*1, Advanced synchronous control	
Acceleration/deceleration control	Trapezoidal acceleration/deceleration, S-curve acceleration/deceleration, Advanced S-curve acceleration/deceleration	
Compensation	Backlash compensation, Electronic gear, Phase compensation	
Program language	Motion SFC, Dedicated instructions	
Servo program capacity	32k steps	
Number of positioning points	6400 points (Positioning data can be designated indirectly)	
Peripheral I/F	PERIPHERAL I/F	
Home position return function	Proximity dog method (2 types), Count method (3 types), Data set method (2 types), Dog cradle method, Stopper method (2 types), Limit switch combined method, Scale home position signal detection method, Dogless home position signal reference method, Driver home position return method (Home position return re-try function provided, home position shift function provided)	
JOG operation function	Provided	
Manual pulse generator operation function	Possible to connect 3 modules (High-speed counter module use)	
Synchronous encoder operation function	Possible to connect 12 modules (Via module (High-speed counter module use) + Via servo amplifier*2 + Via device + Multiple CPU advanced synchronous control)	
M-code function	M-code output function provided, M-code completion wait function provided	
Limit switch output function	Number of output points 64 points × 2 settings Output timing compensation Watch data: motion control data/word device	
ROM operation function	Provided	
Absolute position system	Made compatible by setting battery to servo amplifier. (Possible to select the absolute data method or incremental method for each axis)	

*1. Servo amplifier (MR-J4-□B-LL) only.
*2. Servo amplifier (MR-J4-□B-RJ) only.

2.1.2 Motion SFC performance specifications list

Item				R32MTCPU/R16MTCPU
Motion SFC program capacity	Code total (Motion SFC chart + Operation control + Transition)			4096k bytes
Motion SFC program	Number of Motion SFC programs			256 (No. 0 to 255)
	Motion SFC chart size/program			Up to 64k bytes (Included Motion SFC chart comments)
	Number of Motion SFC steps/program			Up to 4094 steps
	Number of selective branches/branch			255
	Number of parallel branches/branch			255
	Parallel branch nesting			Up to 4 levels
Operation control program (F/FS) / transition program (G)	Number of operation control programs			4096 with F(Once execution type) and FS (Scan execution type) combined. (F/FS0 to F/FS4095)
	Number of transition programs			4096 (G0 to G4095)
	Code size/program			Up to approx. 128k bytes (65534 steps)
	Number of blocks (lines)/program			Up to 8192 blocks (in the case of 8 steps (min)/blocks)
	Number of characters/block (line)			Up to 1020 (comment included)
	Number of operands/block			Up to 510 (operand: constants, word device, bit devices)
	( ) nesting/block			Up to 32 levels
	Descriptive expression	Operation control program		Calculation expression, bit conditional expression, branch/repetition processing
		Transition program		Calculation expression, bit conditional expression, comparison conditional expression
Execution specification	Number of multi execute programs			Up to 256
	Number of multi active steps			Up to 256 steps/all programs
	Execution task	Normal task		Execute in main cycle of Motion CPU
		Event tasks (Execution can be masked.)	Fixed cycle	Execute in fixed cycle (0.222 ms, 0.444 ms, 0.888 ms, 1.777 ms, 3.555 ms, 7.111 ms, 14.222 ms)
			External interrupt	Executes when the input set to the event task factor in the input module controlled by the Motion CPU (16 points) turns ON.
			PLC interrupt	Execute with interrupt instruction (M(P).GINT/D(P).GINT) from PLC CPU.
		NMI task		Executes when the input set to the NMI task factor in the input module controlled by the Motion CPU (16 points) turns ON.

Item		R32MTCPU/R16MTCPU
Number of devices	Input and output (X/Y)	12288 points
	Number of internal relays (M)	12288 points
	Number of link relays (B)	8192 points
	Number of annunciators (F)	2048 points
	Number of special relays (SM)	4096 points
	Number of data registers (D)	20480 points
	Number of link registers (W)	8192 points
	Number of special registers (SD)	4096 points
	Number of motion registers (#)	12288 points
	CPU buffer memory (U3E□\G)	Up to 2097152 points
	CPU buffer memory (Fixed scan communication area) (U3E□\HG)	Up to 12288 points
	Module access (U□\G)	Up to 268435456 points

2.1.3 System configuration device list

(1) Motion controller OS software

Motion CPU	Model
R32MTCPU	SW10DNC-RMTFW
R16MTCPU	

*1. The operating system software is installed at the time of product purchases

(2) Engineering software

■ Motion Controller engineering software

Software name	Model
MELSOFT MT Works2 • MT Developer2[*1] • MR Configurator2[*2]	SW1DND-MTW2-E

*1. This programming software is included in motion controller engineering software "MELSOFT MT Works2".
*2. The servo setup software "MR Configurator2" comes with the MELSOFT MT Works2 in its package.

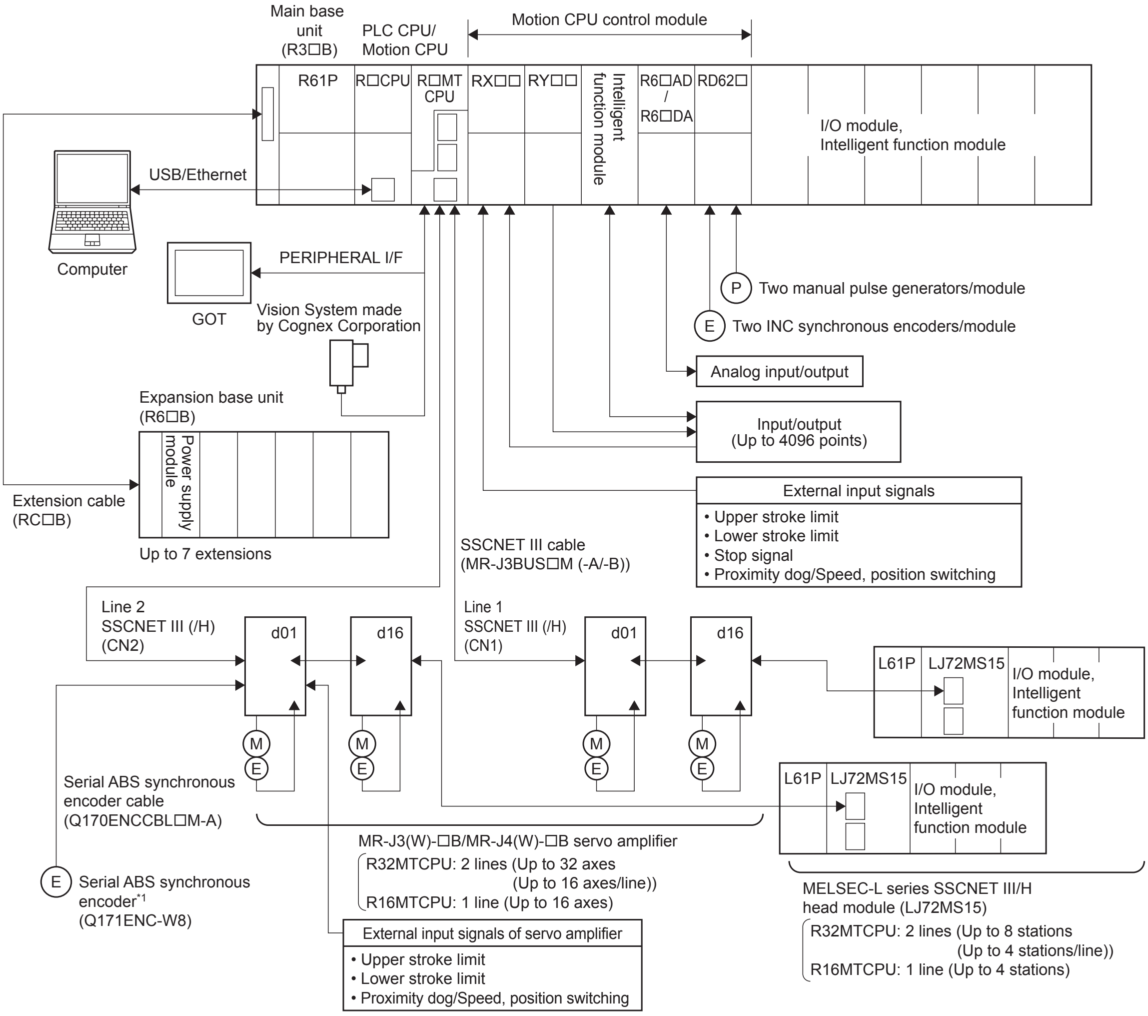
■ PLC engineering software

Software name	Model
MELSOFT GX Works3	SW1DND-GXW3-E

2.2 System Configuration Diagrams

Refer to the User's Manual for details on wiring.

2.2.1 R32MTCPU/R16MTCPU system overall configuration



*1. MR-J4-☐B-RJ only

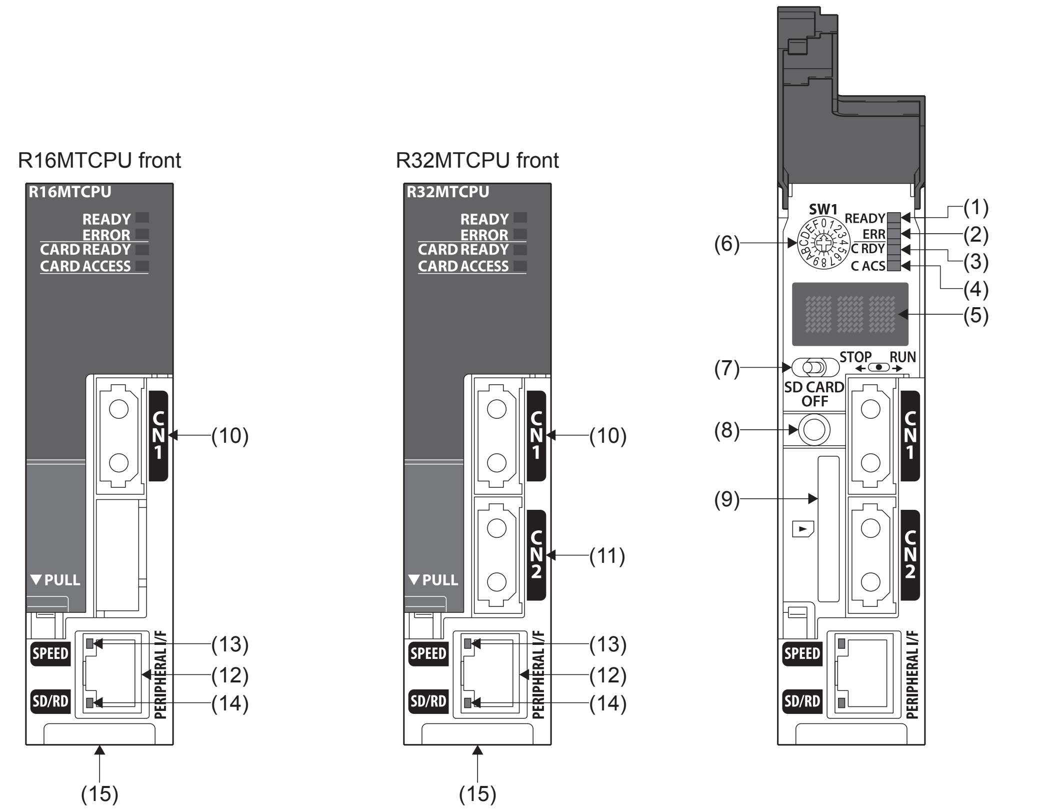
⚠CAUTION
• If the operation performed when an error occurs and the system safe direction operation differs for the controller and servo amplifier, construct a countermeasure circuit outside the servo amplifier. • Use parts used in the system (other than controller, servo amplifiers, servo motors) with rating and characteristics suited to the controller, servo amplifiers, and servo motors. • Set parameter values applicable to the controller, servo amplifier, servo motor, regenerative resistor models, and system application. Safeguards may fail to function if settings are specified incorrectly.

2.3 Name of Each Part

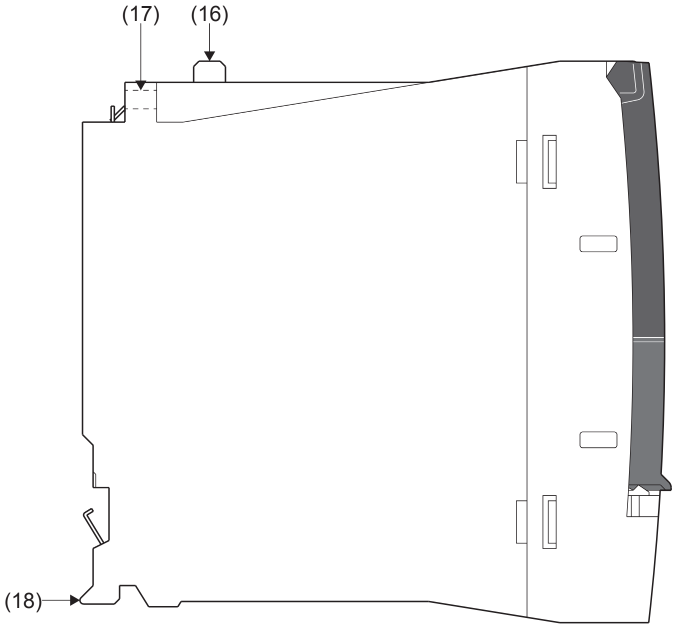
This section describes the names and settings of all R16MTCPU/R32MTCPU parts.

(1) Names of R16MTCPU/R32MTCPU parts

Condition viewed with the front cover open



Side



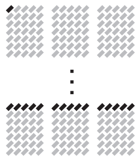
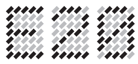
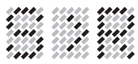
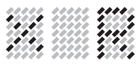
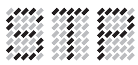
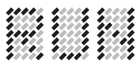
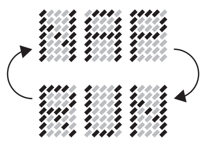
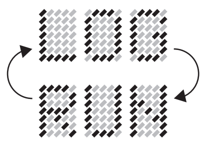
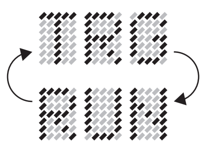
No.	Name	Details
(1)	READY LED	Indicates the operating status of the Motion CPU. ON: Operating normally Flickering: Initializing OFF: Hardware error
(2)	ERROR LED	Indicates an error occurrence in the Motion CPU module. ON, flickering: Hardware error, or error occurrence OFF: Operating normally
(3)	CARD READY LED	Indicates whether SD memory card is usable or not. ON: SD memory card is usable Flickering: Preparing OFF: No SD memory card inserted
(4)	CARD ACCESS LED	Indicates the access status of SD memory card. ON: Accessing SD memory card OFF: Not accessing SD memory card
(5)	Dot matrix LED	Indicates the operating status and error information.
(6)	Mode select rotary switch	• Set the operation mode. (Normal mode, Installation mode, etc.) • Each switch setting is 0 to F. (Factory default: 0)
(7)	RUN/STOP switch	Move RUN/STOP to change the operating state of the Motion CPU module. RUN: Program is started STOP: Program is stopped
(8)	SD memory card access control switch	Switch for stopping card access when removing the SD memory card.
(9)	SD memory card slot	Slot for inserting the SD memory card.
(10)	SSCNET III CN1 connector*1	Connector to connect the servo amplifier (16 axes) of line 1.
(11)	SSCNET III CN2 connector*1*2	Connector to connect the servo amplifier (16 axes) of line 2.
(12)	PERIPHERAL I/F connector	For communication I/F with peripheral devices.
(13)	SPEED LED	ON: Communicating at 100M bps OFF: Communicating at 10M bps, or not connected
(14)	SD/RD LED	Flickering: Communicating data OFF: Not communicating data
(15)	Production information marking	Displays the production information described on the rating plate.
(16)	Module fixing hook	Hook used to fix the module to the base unit.
(17)	Module fixing screw hole	Screw hole used to fix to the base unit. (M3×12 screws supplied by user)
(18)	Module fixing projection	Projection used to fix to the base unit.

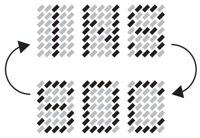
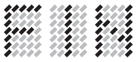
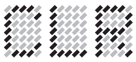
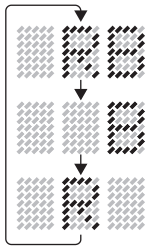
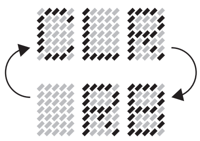
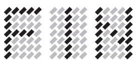
*1. Put the SSCNET III cable in the duct or fix the cable at the closest part to the Motion CPU module with bundle material in order to prevent SSCNET III cable from putting its own weight on SSCNET III connector.

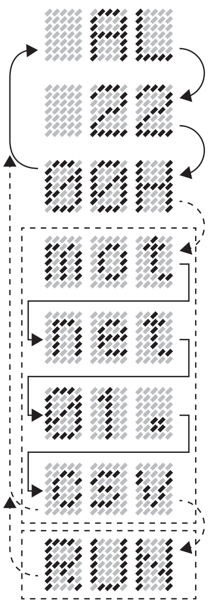
*2. R32MTCPU only

(2) Dot matrix LED display

The LED displays/flashes in the combination with errors.

Item		Dot matrix LED		Details
Normal mode	Start		Progress display	It takes about 10 seconds to initialize (RUN/STOP display). After startup, each CPU requires time for initializing. Execute the power cycle of the Motion controller if the operation stops at initializing for several minutes. If the Motion controller continues to stop at initializing, it may be Motion controller's hardware fault. Explain the error symptom (LED display) and get advice from our sales representative for the modules with failure.
			"E□□" is displayed	Hardware error or software error during initializing. □ indicates the error code. Explain the error symptom (LED display) and get advice from our sales representative for the modules with failure.
			"Source > Destination" is displayed (Left: When files are transmitted from the SD memory card to the standard ROM)	Executes file transmission at boot. The following are used to indicate the source, destination, delete target. R: Standard ROM S: SD memory card
			"× delete target" is displayed (Left: When files on the standard ROM are deleted)	
	STOP		"STP" is displayed	Stopped the program with the "[Rq.1120] PLC ready flag (M2000)" OFF.
	RUN		"RUN" is displayed	Executed the program with the "[Rq.1120] PLC ready flag (M2000)" ON.
	Test mode RUN		"TES" is displayed	Mode to test Motion CPU operation.
	Amplifier-less operation mode		Displays "NAP" and "Mode" alternately. (Left: When mode is "RUN")	Mode to operate without connecting servo amplifiers. The mode displayed is the mode that the Motion CPU is operating. ("STP", "RUN", "TES")
	Digital oscilloscope RUN		Displays "LOG" and "Mode" alternately. (Left: When mode is "RUN")	Displays the status of the digital oscilloscope wait for trigger. The mode displayed is the mode that the Motion CPU is operating. ("STP", "RUN", "TES")
			Displays "TRG" and "Mode" alternately. (Left: When mode is "RUN")	Displays the status after the digital oscilloscope trigger issue. The mode displayed is the mode that the Motion CPU is operating. ("STP", "RUN", "TES")

Item		Dot matrix LED		Details
Ethernet information display mode		Refer to Ethernet information display mode for details of the dot matrix LED display.		Displays information of IP address, subnet mask, default router address, MAC address, link status.
Installation mode			"INS" is displayed	Mode to install the operating system software.
			Displays "INS" → "SDC" alternately.	Displays the status of the operating system software installation from the SD memory card.
			"FIN" is displayed	Displays when the operating system software installation from the SD memory card is completed normally.
			"ER□" is displayed (Left: When there is a "SD memory card access error")	Displays when there was an error in operating system software installation from the SD memory card. □ indicates the following errors. 0: SD memory card access error 1: Install file error 2: Built-in ROM access error
Built-in memory clear			"CLR" is displayed	Mode to clear the built-in memory (standard ROM, backup RAM). After displaying for 3 seconds, the display switches to the target memory.
			Target memory is displayed.	The target memory for built-in memory clear is displayed. The following are the displays for the target memory. RB: Standard ROM and backup RAM B: Backup RAM R: Standard ROM • Switch the memory displayed by pushing the SD memory card access control switch.
			Displays "CLR" → "Target memory" alternately. (Left: When target memory is "standard ROM and backup RAM")	Displays the status of the built-in memory clear.
			"FIN" is displayed	Displays when built-in memory clear is completed normally.
			"ERR" is displayed	Displays when an error occurred during built-in memory clear.
Operating system software	Not installed		"A00" is flickering	It becomes the status of installation mode when the operating system software is not installed.
	File error		"A01" is flickering	Displays when there is a file error in the operating system software that was installed.
WDT error			"W□□" is displayed	Hardware error or software error. □ displays the error code of "Motion CPU WDT error cause (SD512)".

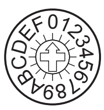
Item	Dot matrix LED		Details
Self-diagnostic error (Major/Moderate/Minor error)		" AL" flickers 3 times ↓ 4-digits error code is displayed in two sequential displays of 2-digits each. (Left: error code [2200H]) ↓ Scrolled display of the file name. (Left: When file name is "motnet01.csv") ↓ When a continuous error occurred, the mode is displayed. (Left: When mode is "RUN")	Displays when a self-diagnostic error occurs (major/moderate/minor error). • Displays the applicable file name when a parameter, or file error is detected. • The mode that the Motion CPU is operating. ("STP", "RUN", "TES") is displayed only for a continuous error.

POINT

When an error is displayed on the dot matrix LED, confirm the error code etc. using MT Developer2.

(3) Rotary switch setting and operation mode

■ Rotary switch setting

Rotary switch	Setting*1	Mode	Details
	0	Normal mode	Normal operation mode
	8	Ethernet information display mode	Displays IP address, MAC address, and Ethernet link status.
	A	Installation mode	Installed the operating system software using MT Developer2.
	C	Built-in memory clear	Initializes the built-in memory of the standard ROM and backup RAM.

*1. Do not set other than the above setting.

⚠CAUTION

Be sure to turn OFF the Multiple CPU system power supply before the rotary switch setting change.

Chapter 3 PLC Multiple CPU

I/O module and intelligent function module sequence control, and calculation with application instructions and dedicated instructions are performed with sequence programs.
Furthermore, they are also used to execute SFCS (Motion SFC start request) instructions used to start Motion SFC programs, GINT instructions used to perform interrupts for Motion CPUs, DDRD and DDWR instructions used to perform direct device reading and writing for Motion CPUs, SVST instructions used to issue servo program startup request, CHGA current value change instructions, CHGV speed change instructions, and CHGT torque limit value change instructions.
The motion dedicated instructions transmit through the CPU buffer memory or through the transmission area of the dedicated instructions between the CPUs on the system area of the CPU buffer memory (fixed cycle communication area).
The memory areas used for the transmission depend on the instructions as follows. Also, see below for the cycles for the Motion CPUs to receive instructions.

Instructions	Memories used	Cycles for the Motion CPU side to receive commands
M (P). □ instruction	CPU buffer memory	Non-fixed cycle (immediate)
D (P). □ instruction	CPU buffer memory (fixed cycle communication area)	Fixed cycle (communication cycle between CPUs)

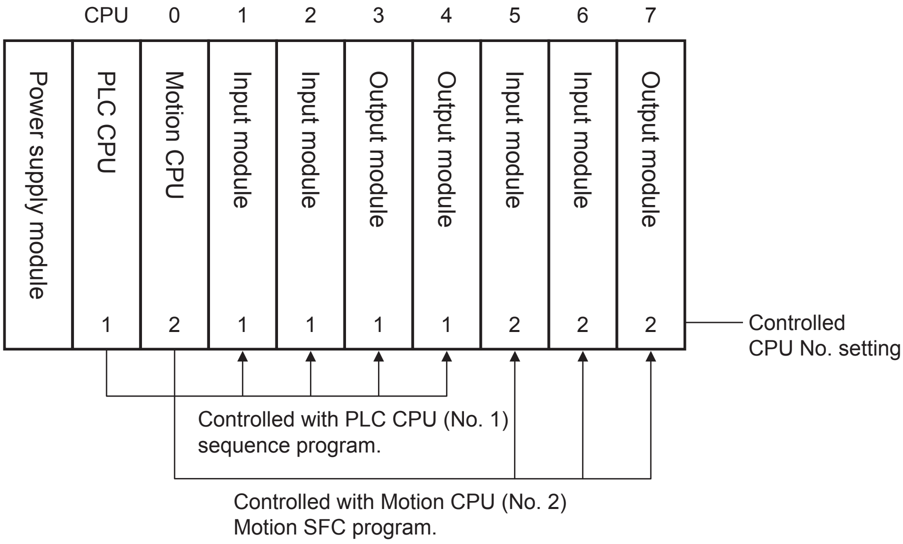
Refer to the Motion Controller Programming Manual (Program Design) for the details of the instructions.

3.1 Multiple CPU System

The multiple CPU system incorporates multiple (max. 4) PLC CPU/Motion CPUs on a main base unit, and is used to control I/O modules and intelligent function modules with each PLC CPU/Motion CPU.
Processing loads can be balanced by using the Motion CPU for complex servo control, and the PLC CPU for all other machine and information control.

3.1.1 Multiple CPU system settings

With the multiple CPU system, it is necessary to set (control CPU settings) which I/O modules and intelligent function modules are to be controlled with which PLC CPU/Motion CPU, and the number of installed PLC CPU/Motion CPU for all PLC CPU/Motion CPUs. (The multiple CPU setting method is described in section 8.2.2.)



Whether the same setting is configured for between the system parameter of each CPU module and multiple CPU refresh number of points of CPU parameter is checked by the multiple CPU system at the timing shown below. However, as for the fixed scan communication setting and inter-module synchronization setting, checking is done only for the module using the functions.

- Powered-on
- When the CPU No.1 is reset
- STOP→RUN state after parameter was changed

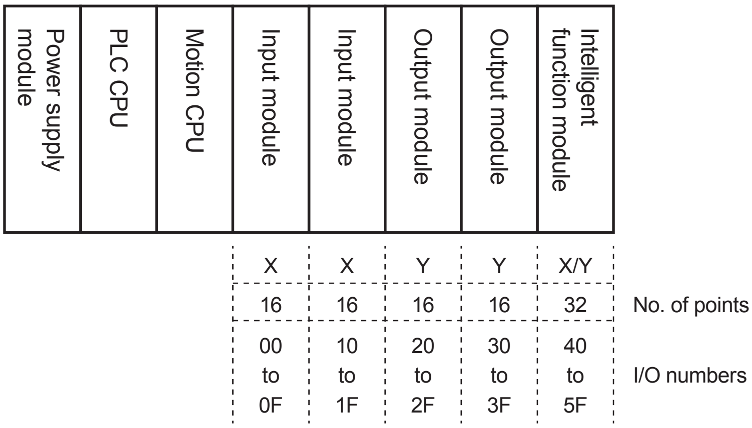
Timing	Parameters targeted for checking	Checking conditions for CPU No.1	Checking conditions for CPU No.2 and over
When power is on or the CPU No.1 is reset	System parameters (other than fixed scan communication setting and inter-module synchronous setting)	Checking is not conducted.	Compares with the parameters of the CPU of the lowest number.
	Settings of fixed scan communication	Checking is not conducted by the CPU module of the number for which the fixed scan communication setting is not configured. The CPU module of the number for which the fixed scan communication setting is configured will compare the parameters with those of the CPU of the lowest number.	
	Inter-module synchronization setting	Checking is not conducted by the CPU module of the number for which the Inter-module synchronization setting is not configured. The CPU module of the number for which the Inter-module synchronization setting has been configured will compare the parameters with those of the CPU of the lowest number.	
	CPU parameters (number of points of refresh settings)	Checking is not conducted by the CPU module of the number for which the fixed scan communication setting is not configured. The CPU module of the number for which the fixed scan communication setting is configured will compare the parameters with those of the CPU of the lowest number.	
STOP→RUN state after parameter was changed	-	Compares with the parameters of the host CPU module before parameters are changed.	

3.1.2 PLC CPU, Motion CPU installation locations

The Motion CPU module alone is not available for use. CPU No. 1 has to be a PLC CPU module of the MELSEC iQ-R series.
Up to four PLC CPU modules or Motion CPU modules of MELSEC iQ-R series can be installed from the main base unit CPU slot (slot to right of power supply module) to slot 6. These particular CPU modules are identified as CPU No. 1 through CPU No. 4. There are no restrictions in the installation order for CPU module No. 2 to No. 4. For the CPU other than CPU No. 1, you can reserve CPU settings (in other words, you can assign the CPU Nos. even without actually installing CPU modules.).
It takes approximately 10 seconds for the Motion CPU to start up (or to become ready for control). Then, it takes some more time to initialize each CPU. If your system is such that it starts executing the programs even before other CPUs have started up, change the setting for the synchronous startup between multiple CPUs.

3.1.3 I/O numbers

The I/O numbers are hexadecimal numbers to be assigned so that the I/O modules and intelligent function modules can communicate data with the CPU modules. The system uses input and output for communicating ON/OFF data where the input number has a prefix of "X" and the output has a prefix "Y" at the beginning (start) of the I/O numbers.
The I/O numbers begin with "0H" assigned to the immediate right to the CPU module and are assigned automatically increases serially.



When laying out modules according to the GX Works3 "Module Configuration Diagram", the system automatically assigns I/O numbers depending on the number of points occupied by the modules.
Even if you change the position of module installation, the I/O numbers assigned to the modules remain unchanged.

POINT

The GX Works3 "System monitor" enables you to confirm the modules that are actually installed and their I/O numbers.

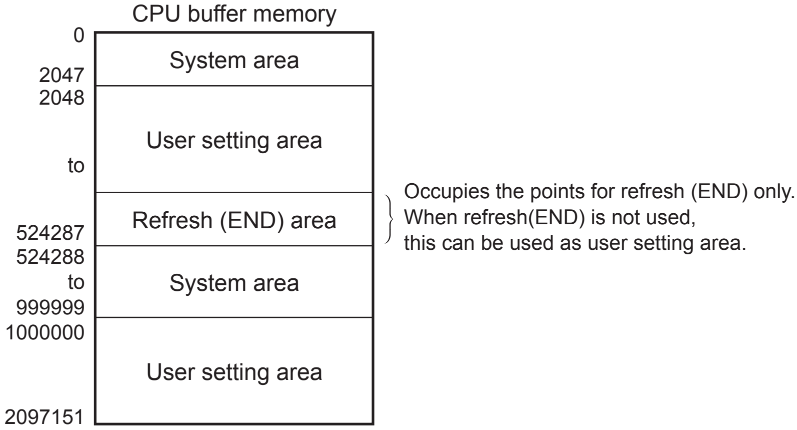
3.1.4 Data communication between CPU modules

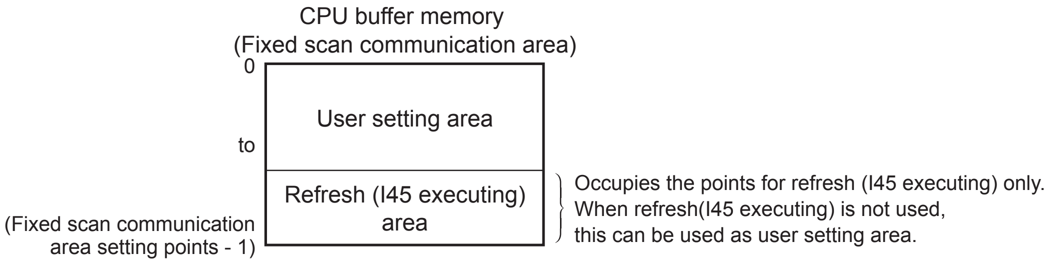
CPU modules within a multiple CPU system can send and transfer data to each other. The refresh communication and direct access communication enable data writing or reading between CPU modules. Indicates the Data communication method.

Communication method	Application	Details
Data communication with CPU buffer memory	Used when data is sent or received at the timing of each CPU module.	The CPU module for sending the data writes data into the CPU Buffer memory of the host CPU module. The CPU module for receiving data reads data from the CPU Buffer memory of the sender CPU module (other CPU modules)..
Data communication with fixed scan communication area	Used when data is sent or received through adjusting the timing between CPU modules.	The CPU module for sending the data writes data into the fixed scan communication area (send area) of the host CPU module. The CPU module for receiving data reads data from the fixed scan communication area (receive area) of the host CPU module of the send source CPU module.

(1) Memory configuration of CPU buffer memory

The memory configuration of the CPU buffer memory of the Motion CPU is as follows.





Memory	Communication method	Details	Area size
CPU buffer memory	Communication by direct access	Data reading and writing is performed for the self CPU or other CPU area.	PLC CPU: 512k words Motion CPU: 2M words
Refresh area	Communication by refresh	Data communication is performed by refreshing at END processing.	
Fixed scan communication area	Communication by direct access	Data reading and writing is performed for the self CPU fixed scan communication area, and self CPU and other CPU data transfer is performed in fixed scan communication cycles.	Changes can be made within an overall range of 0 to 24k words. The transmission area per module can be set in the 0 to 12k word range.
Refresh area	Communication by refresh	Refresh is performed in fixed scan communication cycles.	

Remarks

- The system area is determined by the allocation in the system. Use the user area for communicating user data.
- The refresh (END, I45 executing) area is used with the Multiple CPU refresh. Do not directly change this area with a program.

3.1.5 Refresh function

(1) What is the refresh function?

The refresh function causes the data communication to take place at the time of END or executing I45.

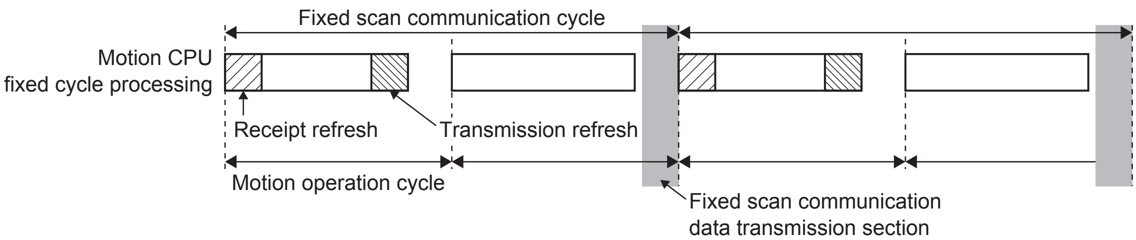
The refresh types and refresh timing are as follows.

Refresh type		Memory used	Refresh timing	
			PLC CPU side	Motion CPU side
MELSEC iQ-R series	Refresh (END)	CPU buffer memory	At END processing	Main cycle
	Refresh (Q compatibility high speed refresh)*1			Operation cycle and main cycle*2
	Refresh (I45 executing)	Fixed scan communication area	When executing Multiple CPU synchronous interrupt program (I45)	The longer of the operation cycle or fixed scan communication cycle*3

*1. This is an interchangeable setting equivalent to the MELSEC Q series “High-speed refresh” setting.

*2. The order of processing inside the Motion CPU is as follows.
"Motion SFC event task → Receipt refresh → Motion operation → Transmission refresh"

*3. The order of processing inside the Motion CPU is as follows.
"Receipt refresh → Motion SFC event task → Motion operation → Transmission refresh"
If the operation cycle is shorter than the cycle of the fixed cycle communication, the receiving refresh and transmission refresh take place at the operation cycle immediately after the fixed cycle communication timing.

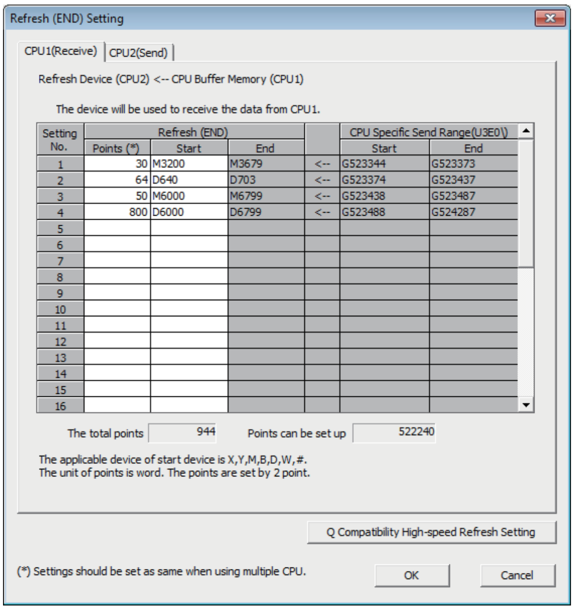


POINT
If using refresh (fixed scan communication), it is recommended that fixed scan communication cycles and Motion operation cycles be aligned.

(2) Multiple CPU refresh setting

Setting for communicating by refresh.

In the refresh settings, up to 32 setting ranges (refresh (END) and refresh (I45 executing)) can be set for each CPU module.



POINT

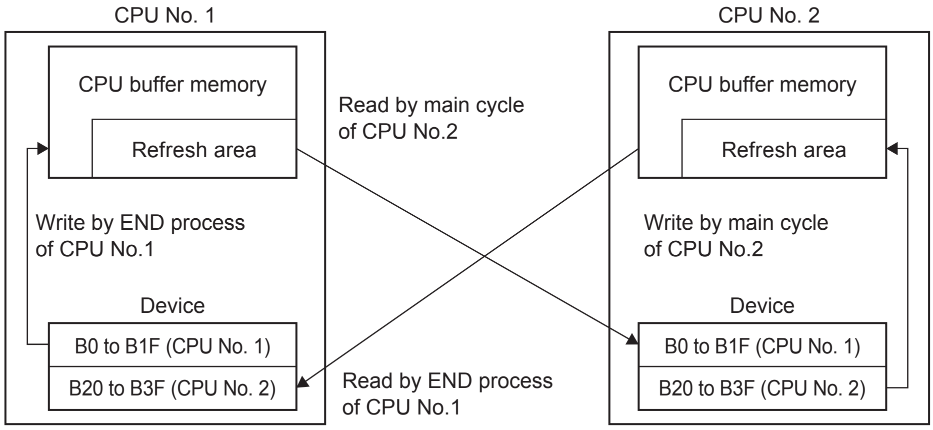
(1) Parameters set at GX Works3 are read at MT Developer2, and therefore there is no need to specify the refresh (END) and refresh (I45 executing) settings, however, they should be set in the following cases.
- When a Motion register (#) is set to the transmitting device.
- When the Q compatibility high-speed refresh setting is used.

If specifying the Refresh (I45 executing) setting, specify the following settings in the GX Works3 [System Parameter] → [Multiple CPU Setting] → “Communication setting between CPU”.
- Set the “Fixed scan communication function” to “Use”.
- Set the send area range for each CPU in the “Fixed scan communication area setting”.
- Set the fixed scan interval setting of fixed scan communication (0.222ms/0.444ms/0.888ms/1.777ms/3.555ms/7.111ms) in “Fixed scan communication settings”.

(2) Refresh processing performance is improved by setting the first device beginning with a 2-word unit or 4-word unit..

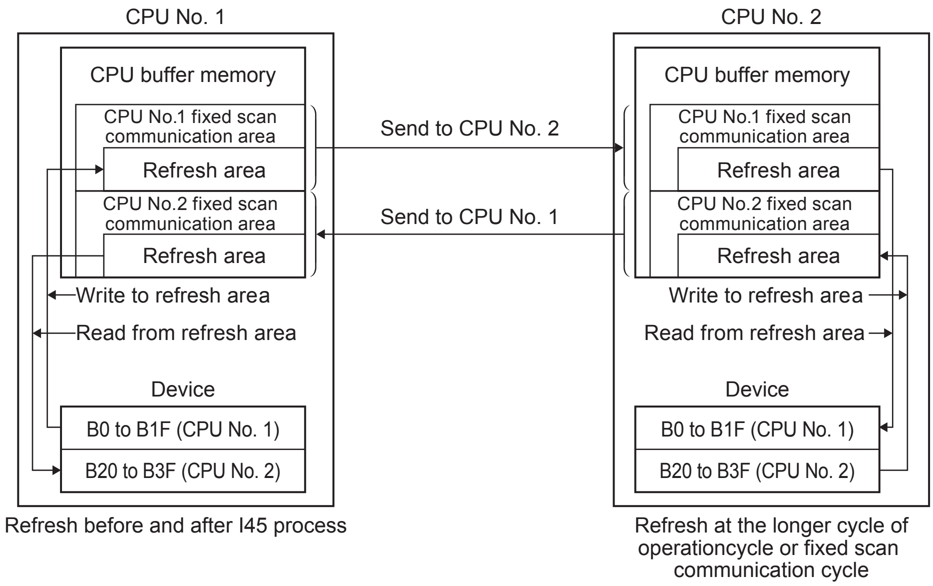
- Operation example of refresh (END) that uses CPU buffer memory

  A refresh (END) operation example using the CPU buffer memory is shown below.



- Refresh (I45 executing) operation example using fixed scan communication area

  A refresh (I45 executing) operation example using the fixed scan communication area is shown below.



- Application example of refresh setting (I45 executing)

  Refresh setting (I45 executing) is used as in the following applications.

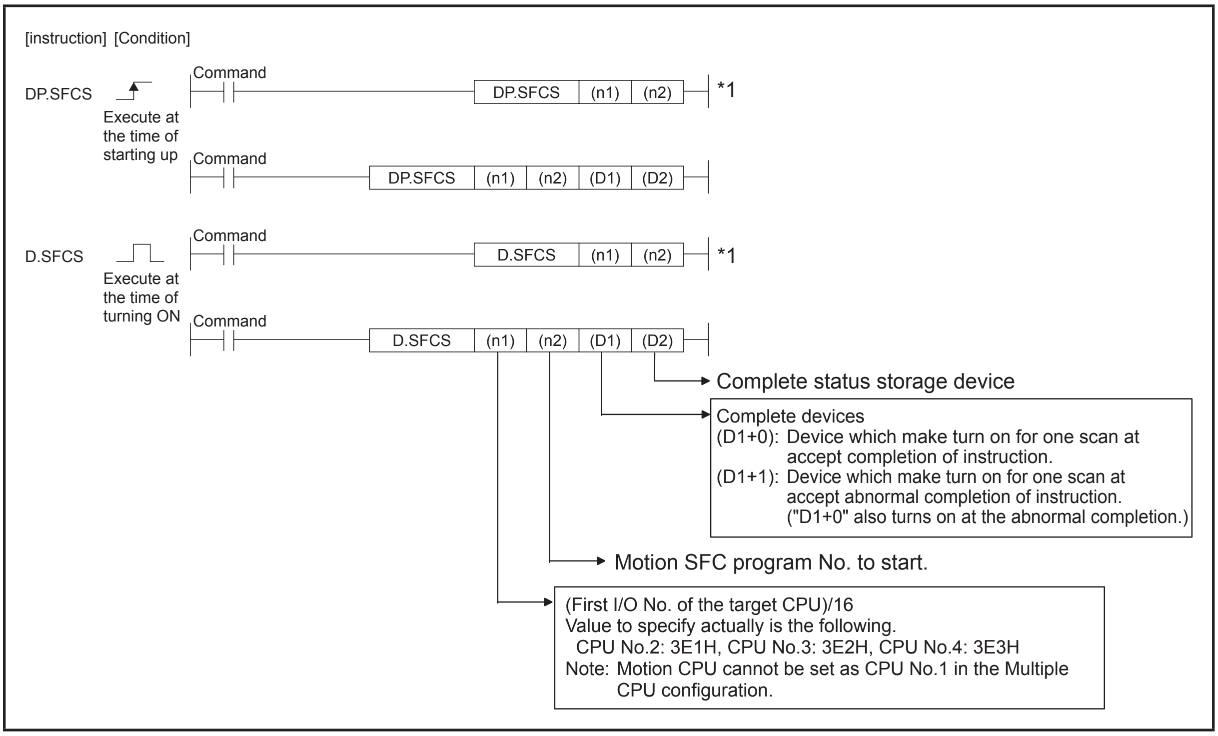
  - Read the data such as the real current value and synchronous encoder current value with PLC CPU at high speed.
  - Exchange the FIN waiting signal at high speed.

3.2 Dedicated Multiple CPU Motion Instructions

This section describes dedicated instructions (SFCS, SVST) for multiple CPUs.
For other instructions, refer to the Motion Controller Programming Manual (Program Design).

3.2.1 SFCS Motion SFC program start instruction

This is an SFCS (SFC start) instruction used to start the specified Motion SFC program.



*1. Omission possible with both of (D1) and (D2) omission.

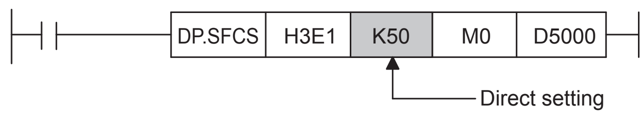
(1) Motion SFC program No. setting

The Motion SFC program No. can be set directly or indirectly.

(a) Direct setting involves setting the Motion SFC program No. directly with a numerical value (K0 to K255).

Example

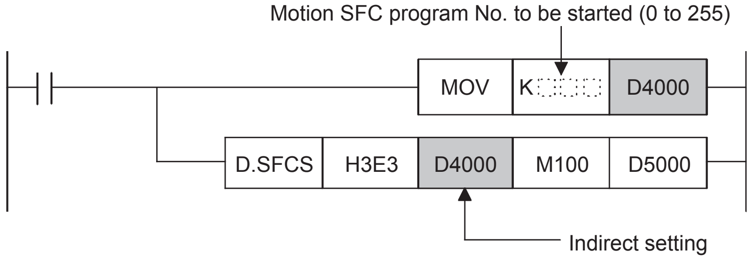
Motion SFC program No. 50 is set as follows.



(b) Indirect setting involves setting the Motion SFC program No. with word device (D0 to D8191, W0 to W1FF) content.

Example

When setting D4000

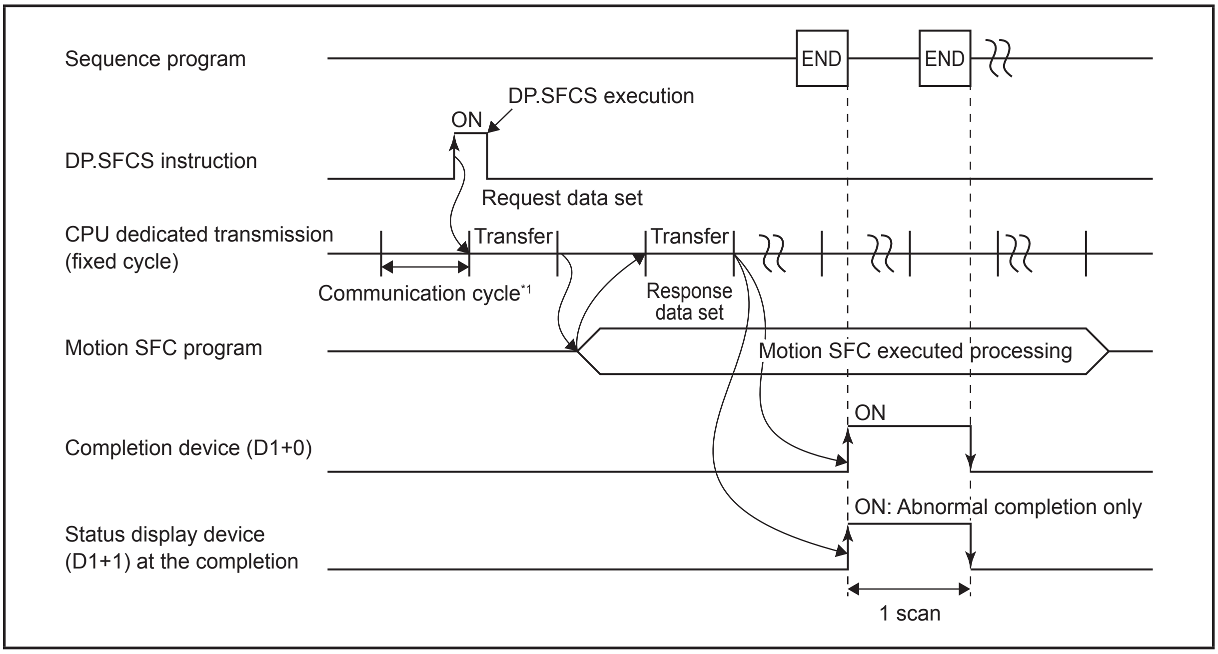


(2) Execution timing

A start request for the specified Motion SFC program is made when the SFCS instruction execution command turns ON.

The Motion SFC program can start any task setting of the normal task, event task and NMI task.

Outline operation between CPUs at the DP.SFCS instruction execution is shown below.



*1. Set in [System Parameter] → [Multiple CPU settings] in GX Works3

(3) Operation error

The abnormal completion in the case shown below, and the error code is stored in the device specified with the complete status storage device (D2). If the complete status storage device (D2) is omitted, an error is not detected and operation becomes “No operation”.

Complete status*1 (Error code) (H)	Error factor	Corrective action
0010	Instruction request to Motion CPU from PLC CPU exceeds the permissible value.	Check the sequence program, and correct it.
2100	There are 65 or more simultaneous M(P).SFCS/D(P).SFCS instruction requests to the Motion CPU from the PLC CPU, therefore the Motion CPU cannot process them.	
2200	The Motion SFC program No. to start is outside the range of 0 to 255.	

*1. 0000H (normal)

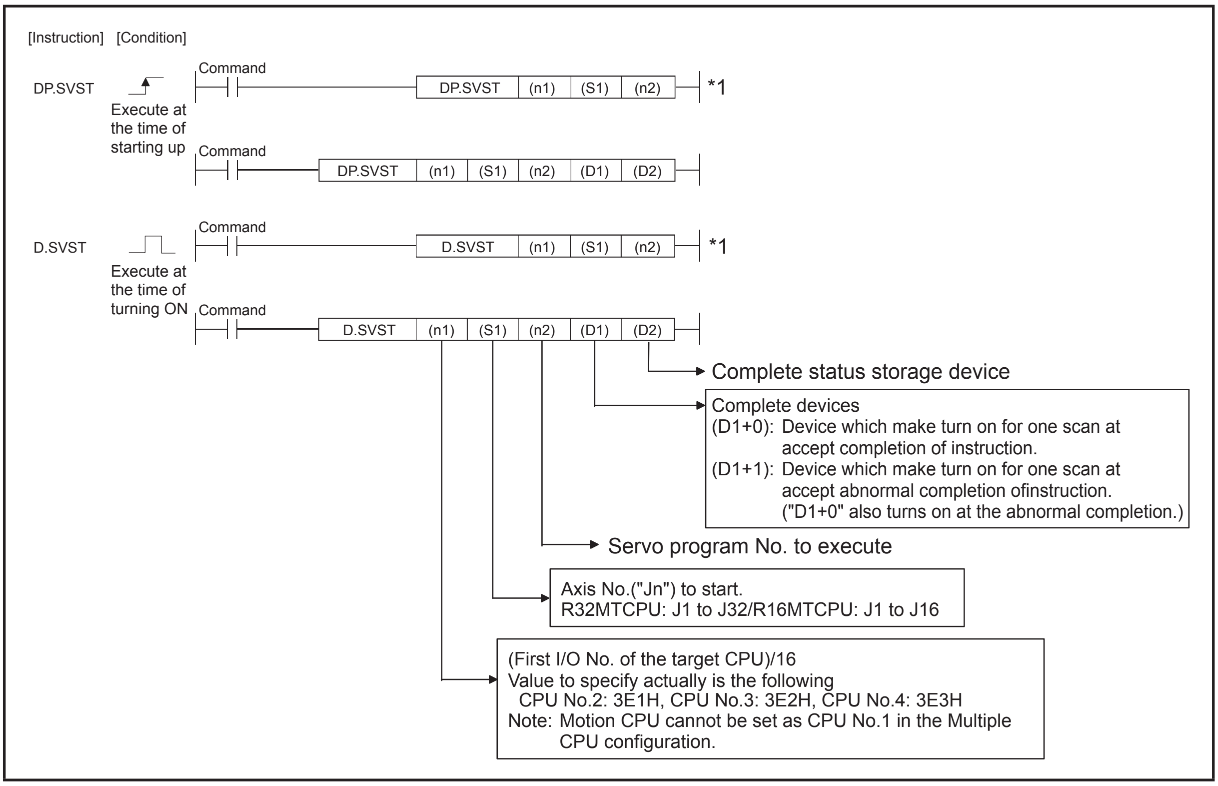
An operation error occurs, “Latest self-diagnosis error detection (SM0)” is turned on, and an error code is stored in “Latest self-diagnosis error (SD0)” in the cases shown below.

Error code (H)*2	Error factor	Corrective action
2800	The start I/O number (the first 3 digits when expressed in 4-digit hexadecimal) of the specified other CPU module is outside the range of 3E0H to 3E3H.	Check the sequence program, and correct it.
2801	The specified other CPU module is wrong. • The reserved CPU is specified. • The uninstalled CPU is specified.	

*2. 0000H (normal)

3.2.2 SVST servo program start request instruction

This instruction is used to request the start of the specified servo program.

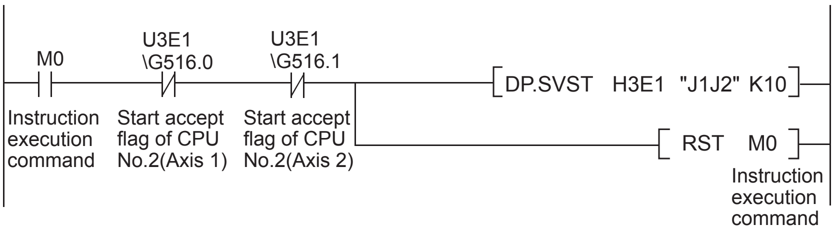


*1. Omission possible with both of (D1) and (D2) omission.

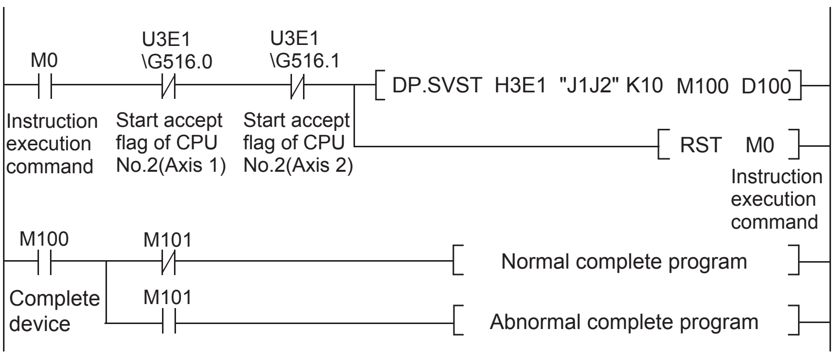
(1) SVST instruction program example

Program which requests to start of the servo program No.10 toward Axis 1, Axis 2 of the Motion CPU (CPU No.2), when M0 turned ON

<Example 1> Program which omits the complete device and complete status.

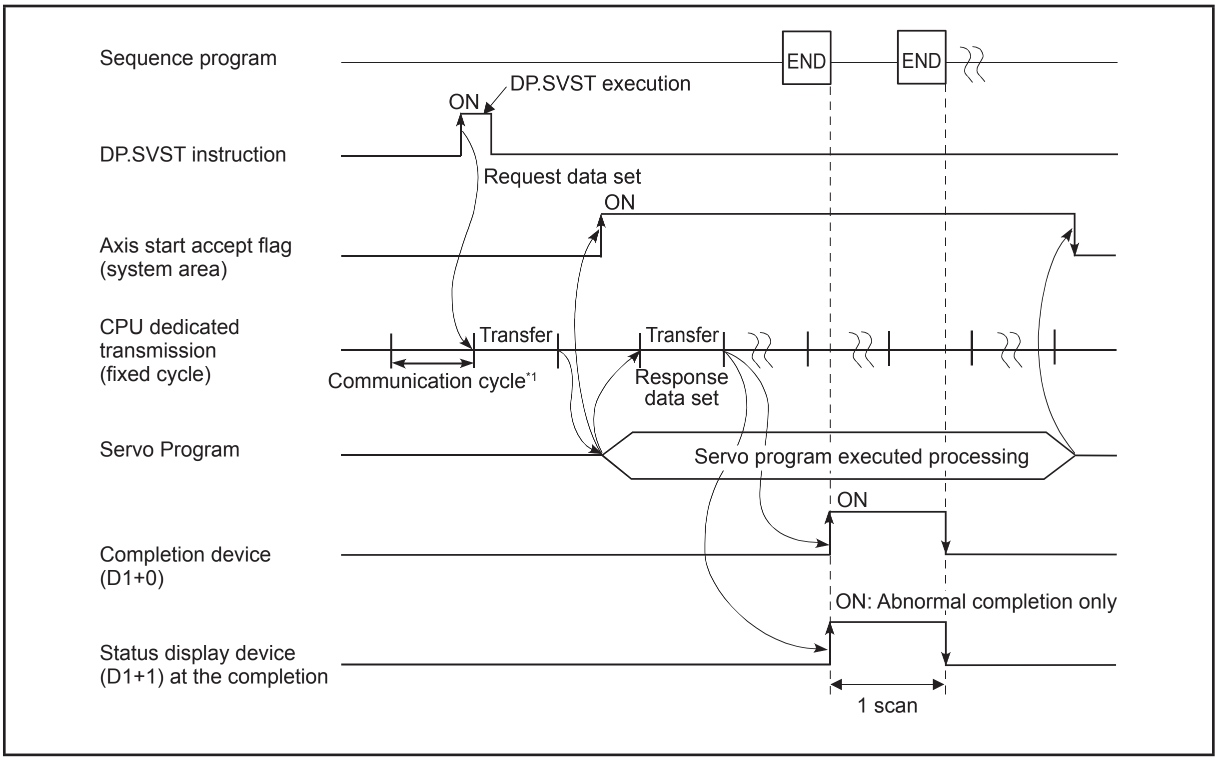


<Example 2> Program which uses the complete device and complete status.



(2) Execution timing

A start request for the specified servo program is issued when the SVST instruction execution command turns ON.



*1. Omission possible with both of (D1) and (D2) omission.

(3) Operation error

The abnormal completion in the case shown below, and the error code is stored in the device specified with the complete status storage device (D2). If the complete status storage device (D2) is omitted, an error is not detected and operation becomes "No operation".

Complete status*1 (Error code) (H)	Error factor	Corrective action
0010	Instruction request to Motion CPU from PLC CPU exceeds the permissible value.	Check the sequence program, and correct it.
2100	There are 257 or more simultaneous M(P).SVST/D(P).SVST/ M(P).SVSTD/D(P).SVSTD/M(P).CHGA/D(P).CHGA/M(P). CHGAS/D(P).CHGAS instruction requests to the Motion CPU from the PLC CPU, therefore the Motion CPU cannot process them	
2201	The servo program No. to execute is outside the range of 0 to 4095.	
2202	Axis No. set by M(P).SVST/D(P).SVST instruction is wrong.	

*1. 0000H (normal)

An operation error occurs, "Latest self-diagnosis error detection (SM0)" is turned on, and an error code is stored in "Latest self-diagnosis error (SD0)" in the cases shown below.

Error code (H)*2	Error factor	Corrective action
2800	The start I/O number (the first 3 digits when expressed in 4-digit hexadecimal) of the specified other CPU module is outside the range of 3E0H to 3E3H.	Check the program, and then change to the correct sequence program.
2801	The specified other CPU module is wrong. • The reserved CPU is specified. • The uninstalled CPU is specified.	

*2. 0000H (normal)

Chapter 4 Motion CPU

Motion CPUs hold system settings data and servo data, and run the servo programs required to perform multi-axis positioning.

Motion CPUs hold the following types of data. The default values are set, and therefore it is necessary to make changes to the data to suit the system.
Data is stored in the Motion CPU built-in memory.

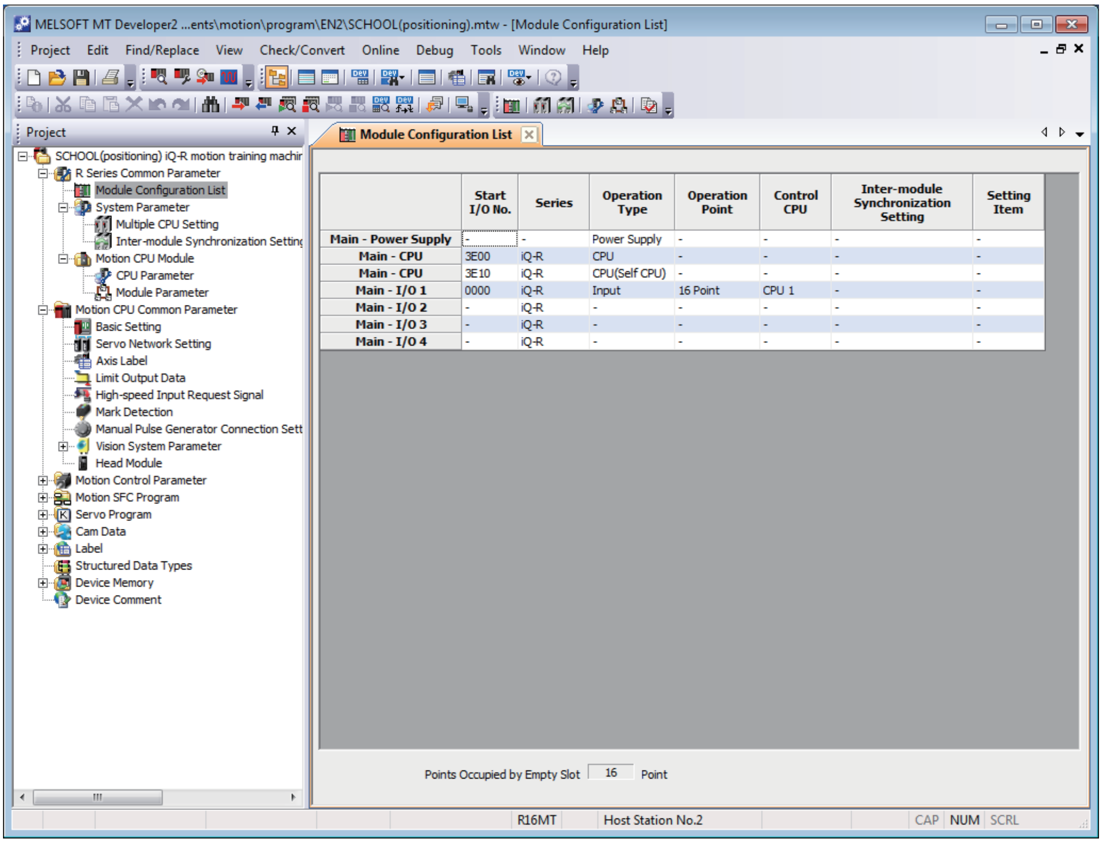
- Data
  - R series common parameter
    - Module configuration list ······· Carry out the setting here for the module control by the Motion CPU.
    - System parameter ······ Carry out the setting here for the module configuration and common parameters for the multiple CPU system.
    - Motion CPU module ····· Set up the Motion CPU parameters.
  - Motion CPU common parameter
    - Basic setting ··········· Set up the basic parameters for the motion system such as an operation cycle and an emergency stop input.
    - Servo network settings ··· Set up the type of servo network, a servo amplifier to be connected and an SSCNETIII/H head module.
    - Manual pulse generator connection setting ··· Set up the pieces of data for connecting the manual pulsar (pulse generator) to the module.
  - Motion control parameter
    - Axis setting parameter ··········· Specifies setting relating to machine characteristic values, home position return, and JOG operation.
    - Servo parameters (axis 1 to 32) ······· Sets servo characteristic values required for servo operation.
    - Parameter block (block No. 1 to 64) ······· Parameter blocks contain data such as acceleration/deceleration time used in home position return data, JOG operation data, and servo programs.

4.1 R series common parameters

Define the parameters that are common to the CPU modules of the MELSEC iQ-R series that are used in the multiple CPU system.

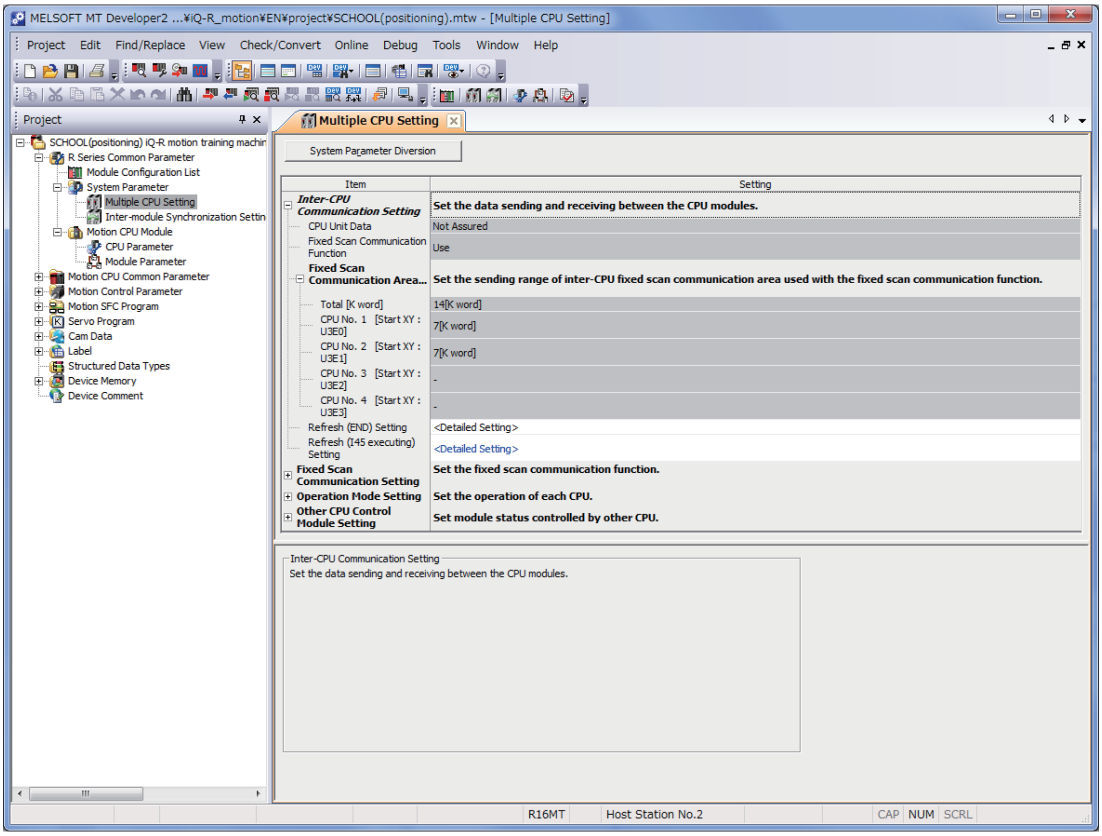
4.1.1 Module configuration list

The MT Developer2 retrieves the parameters established in the "Module Configuration" of the GX Works3 and "System Parameter". The MT Developer2 does not define the system configuration and the common parameters. As for the module parameters of the module where you have designated the Motion CPU as the control CPU, you use the "Module Configuration List" screen of the MT Developer2 to define such parameters.



4.1.2 System parameters

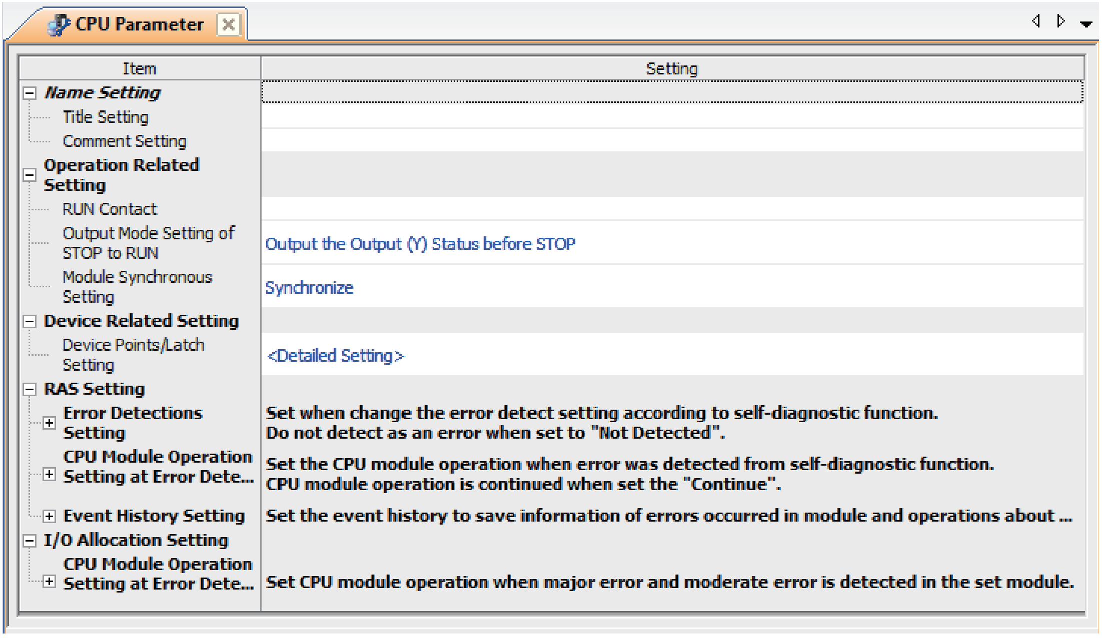
This screen enables you to define the system configuration of a multiple CPU system and the system common parameters. Have the system parameters agree among the CPU modules of the multiple CPU system. Since the MT Developer2 retrieves the parameters established in the "Module Configuration" of the GX Works3 and "System Parameter", no setting is necessary. Define the "Refresh (END) Setting", "Refresh (I45 executing) Setting" and "Q Compatibility High-speed Refresh Setting", which are the communication setting between the CPUs, depending on the Motion CPU settings.



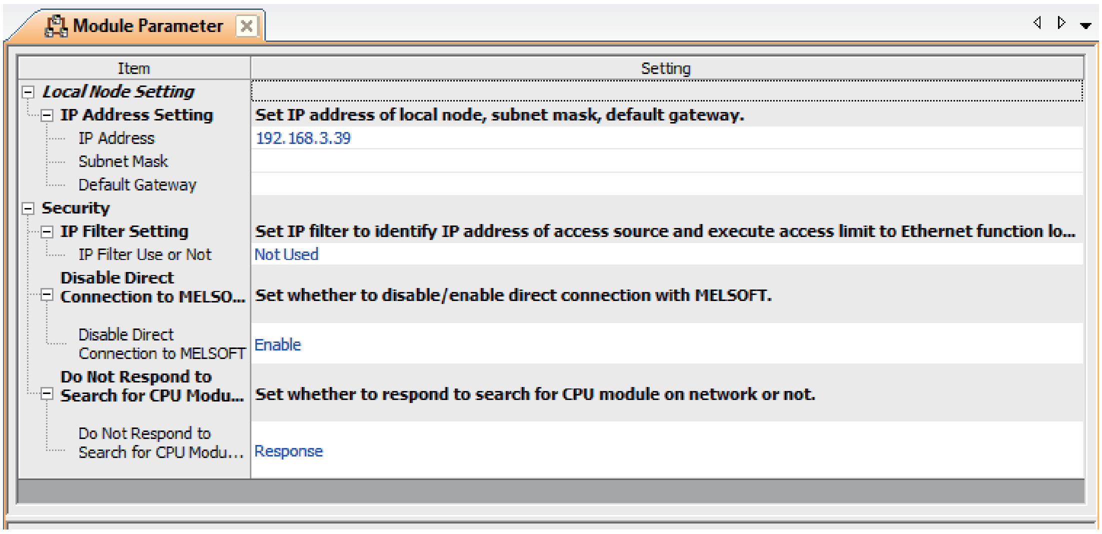
4.1.3 Motion CPU module

This screen enables you to define the Motion CPU parameters.

CPU parameters



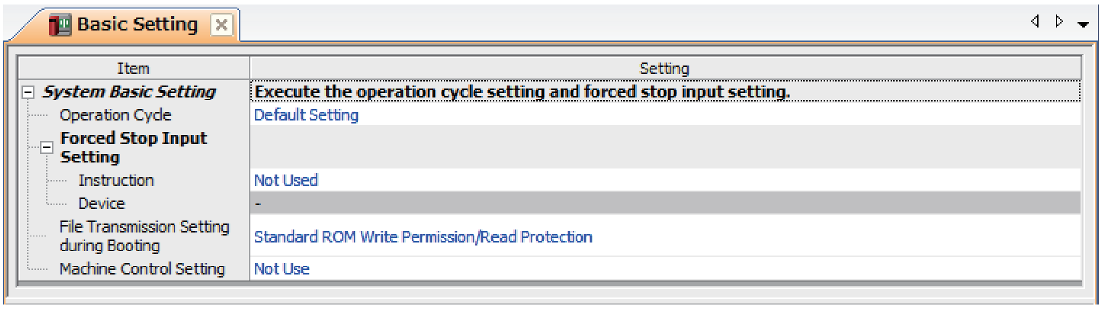
Module parameters



4.2 Motion CPU common parameters

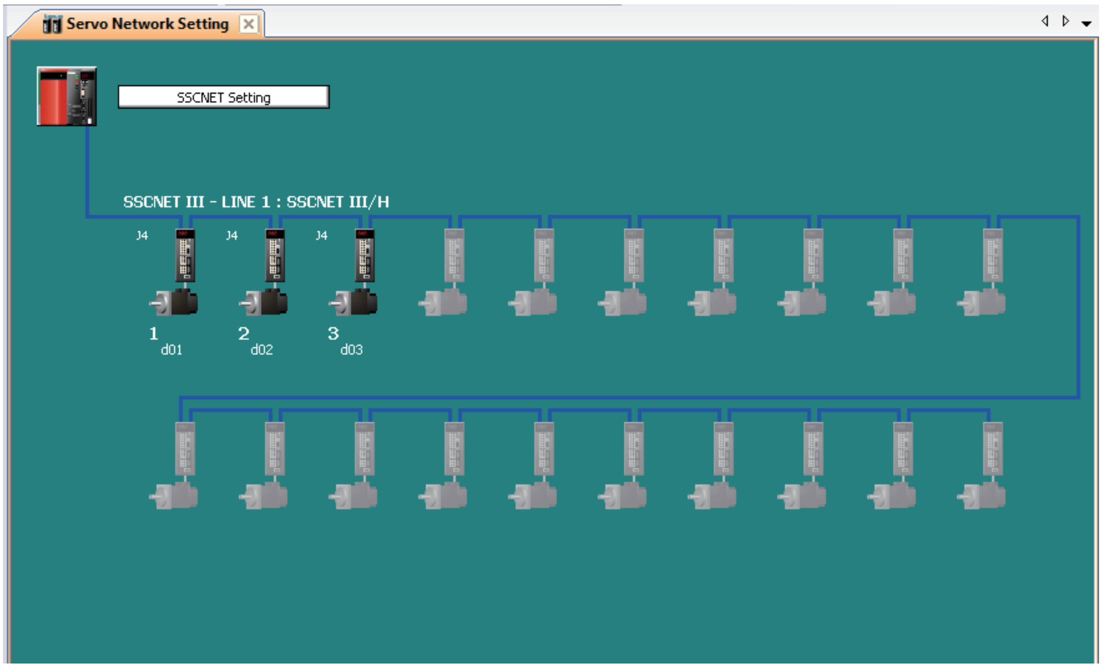
4.2.1 Basic setting

Use this screen to define the basic parameters of the motion system such as an operation cycle and external forced stop input.



4.2.2 Servo network setting

This screen enables you to define the type of servo network, and the servo amplifier to be connected and SSCNET III/H head unit.

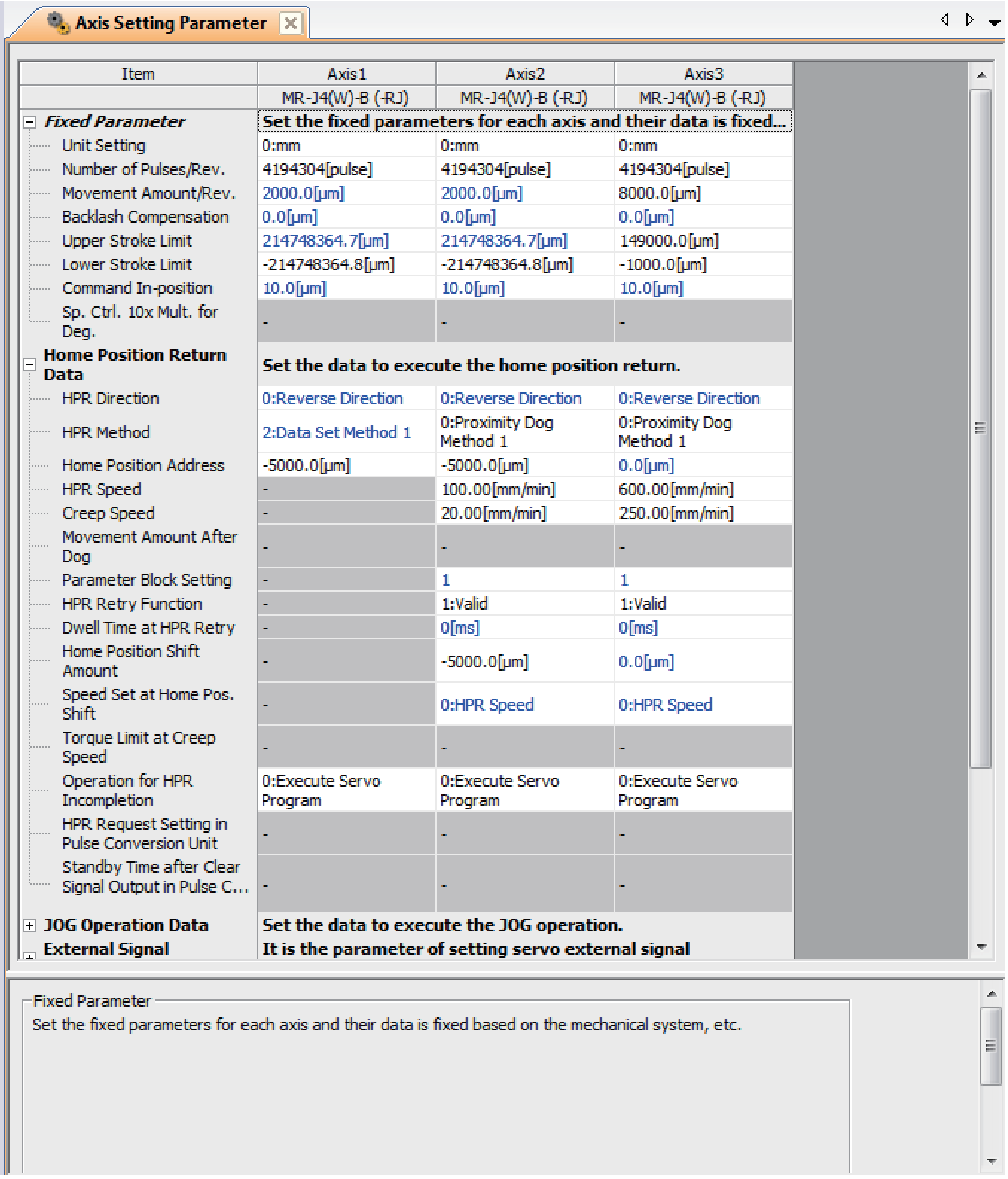


4.3 Motion control parameters

Define the pieces of servo data necessary for exercising the positioning control over the axes defined by the Motion CPU common parameters.

4.3.1 Axis setting parameters

Specifies setting relating to machine characteristic values, home position return, and JOG operation.



Axis Setting Parameter

Item	Axis1	Axis2	Axis3
	MR-J4(W)-B (-RJ)	MR-J4(W)-B (-RJ)	MR-J4(W)-B (-RJ)
Fixed Parameter	**Set the fixed parameters for each axis and their data is fixed...**		
Unit Setting	0:mm	0:mm	0:mm
Number of Pulses/Rev.	4194304[pulse]	4194304[pulse]	4194304[pulse]
Movement Amount/Rev.	2000.0[μm]	2000.0[μm]	8000.0[μm]
Backlash Compensation	0.0[μm]	0.0[μm]	0.0[μm]
Upper Stroke Limit	214748364.7[μm]	214748364.7[μm]	149000.0[μm]
Lower Stroke Limit	-214748364.8[μm]	-214748364.8[μm]	-1000.0[μm]
Command In-position	10.0[μm]	10.0[μm]	10.0[μm]
Sp. Ctrl. 10x Mult. for Deg.	-	-	-
Home Position Return Data	**Set the data to execute the home position return.**		
HPR Direction	0:Reverse Direction	0:Reverse Direction	0:Reverse Direction
HPR Method	2:Data Set Method 1	0:Proximity Dog Method 1	0:Proximity Dog Method 1
Home Position Address	-5000.0[μm]	-5000.0[μm]	0.0[μm]
HPR Speed	-	100.00[mm/min]	600.00[mm/min]
Creep Speed	-	20.00[mm/min]	250.00[mm/min]
Movement Amount After Dog	-	-	-
Parameter Block Setting	-	1	1
HPR Retry Function	-	1:Valid	1:Valid
Dwell Time at HPR Retry	-	0[ms]	0[ms]
Home Position Shift Amount	-	-5000.0[μm]	0.0[μm]
Speed Set at Home Pos. Shift	-	0:HPR Speed	0:HPR Speed
Torque Limit at Creep Speed	-	-	-
Operation for HPR Incompletion	0:Execute Servo Program	0:Execute Servo Program	0:Execute Servo Program
HPR Request Setting in Pulse Conversion Unit	-	-	-
Standby Time after Clear Signal Output in Pulse C...	-	-	-
JOG Operation Data	**Set the data to execute the JOG operation.**		
External Signal	**It is the parameter of setting servo external signal**		

Fixed Parameter

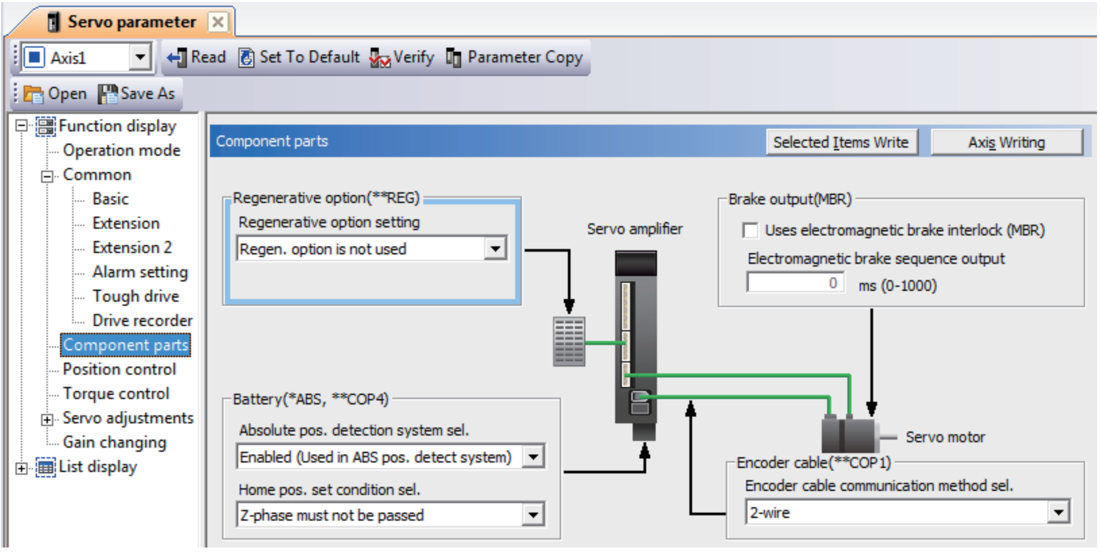
Set the fixed parameters for each axis and their data is fixed based on the mechanical system, etc.

4.3.2 Servo parameters

Servo parameters contain data determined by the specifications of servo amplifiers and servo motors controlled with parameters set for each axis, as well as data required to control servo motors.

Servo parameters are set with the setup software (MR configurator2).

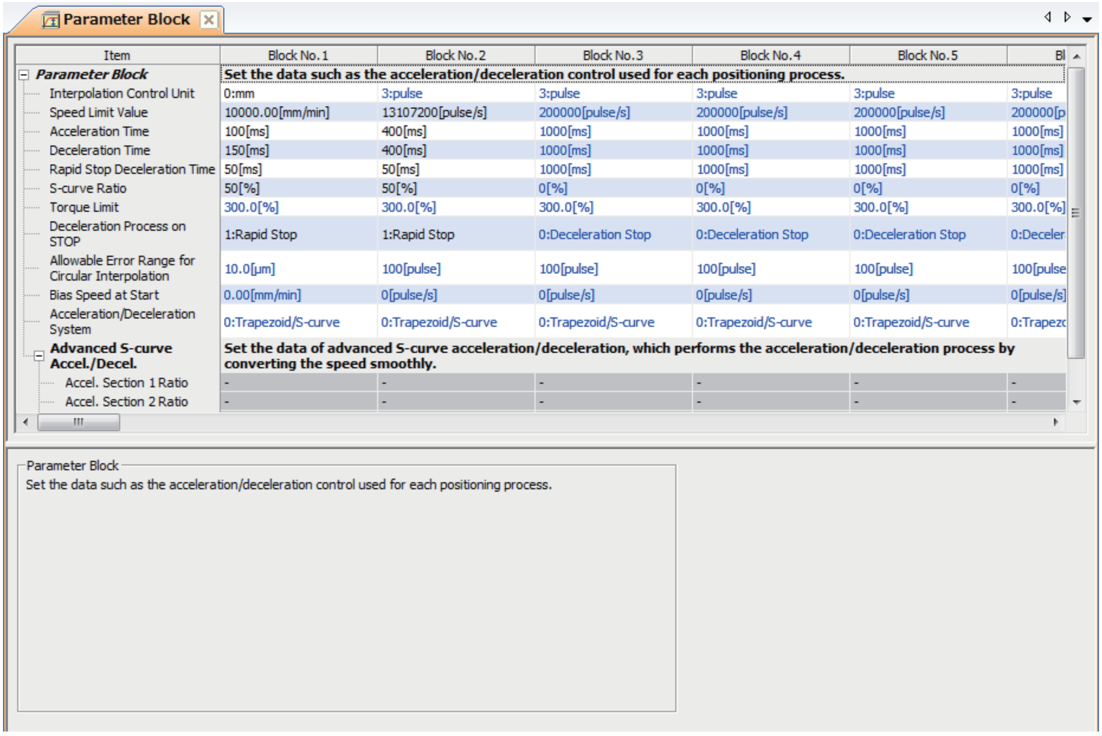
Refer to the Servo amplifier Technical Document Collection for details on servo parameters.



POINT
If changes are made to servo parameters that require the servo amplifier control power to be rebooted, do so after resetting or rebooting the multiple CPU system.

4.3.3 Parameter blocks

Parameter blocks contain data such as acceleration/deceleration time used in home position return data, JOG operation data, and servo programs.



4.4 Positioning Control Devices

Motion CPUs are equipped with positioning control devices for positioning information.

Of the devices in the Motion CPU, the following five devices are used for Motion CPU internal signals.

- Internal relay (M): . . . . M2000 to M3839 (1840 points)
  M8192 to M12287 (4096 points)
- Special relay (SM): . . . . SM0 to SM4095 (4096 points)
- Data register (D):. . . . . D0 to D799 (800 points)
  D10240 to D19823 (9584 points)
- Motion register (#): . . . . #8000 to #8639 (640 points)
- Special register (SD): . . . . . . SD0 to SD4095 (4096 points)

(1) Internal relay list

Device No.	Application type
M0 to	User device (2000 points)
M2000 to	Common device (320 points)
M2320 to	Unusable (80 points)
M2400 to	Axis status (20 points × 32 axes)
M3040 to	Unusable (160 points)
M3200 to	Axis command signal (20 points × 32 axes)
M3840 to	User device (4352 points)
M8192 to	System area (1608 points)
M9800 to	Command generation axis status (20 points × 32 axes)
M10440 to	Synchronous encoder axis status (10 points × 12 axes)

Device No.	Application type
M10560 to	Output axis status (10 points × 32 axes)
M10880 to	Synchronous control signal [St.380] (32 points)
M10912 to	Synchronous analysis complete signal [St.381] (32 points)
M10944 to	Unusable (16 points)
M10960 to	Command generation axis command signal (20 points × 32 axes)
M11600 to	Synchronous encoder axis command signal (4 points × 12 axes)
M11648 to	Unusable (32 points)
M11680 to	Output axis command signal (10 points × 32 axes)
M12000 to	Synchronous control start signal [Rq.380] (32 points)
M12032 to	Synchronous analysis request signal [Rq.381] (32 points)
M12064 to M12287	Unusable (224 points)

☐ can be used with user devices.

POINT

- Total number of user device points: 6352 points
- If using the R16MTCPU, devices for 16 axes are used.

(2) Data register list

Device No.	Application type	Device No.	Application type
D0 to	Axis monitor device (20 points × 32 axes)	D13600 to	Output axis monitor device (30 points × 32 axes)
D640 to	JOG speed setting register (2 points × 32 axes)	D14560 to	Unusable (40 points)
D704 to	Common device (command signal) (54 points)	D14600 to	Servo input axis control device (2 points × 32 axes)
D758 to	Unusable (42 points)	D14664 to	Unusable (16 points)
D800 to	User device (9440 points)	D14680 to	Command generation axis control device (4 points × 32 axes)
D10240 to	System area (2040 points)	D14808 to	Unusable (12 points)
D12280 to	Servo input axis monitor device (10 points × 32 axes)	D14820 to	Synchronous encoder axis control device (10 points × 12 axes)
D12600 to	Command generation axis monitor device (20 points × 32 axes)	D14940 to	Unusable (60 points)
D13240 to	Synchronous encoder axis monitor device (20 points × 12 axes)	D15000 to	Output axis control device (150 points × 32 axes)
D13480 to	Unusable (120 points)	D19800 to D19823	Unusable (24 points)

can be used with user devices.

POINT

- Total number of user device points: 9440 points
- If using the R16MTCPU, devices for 16 axes are used.

4.4.1 Internal relays (status/command signals)

The R16MTCPU/R32MTCPU is equipped with an internal relay with 12288 points from M0 to M12287.

Of these, M2400 to M3839 are used for data transfer for each axis, and the signal names and I/O Nos. for each axis are fixed as shown in the following tables.

(1) Axis status list

Axis No.	Device No.
1	M2400 to M2419
2	M2420 to M2439
3	M2440 to M2459
4	M2460 to M2479
5	M2480 to M2499
6	M2500 to M2519
7	M2520 to M2539
8	M2540 to M2559
9	M2560 to M2579
10	M2580 to M2599
11	M2600 to M2619
12	M2620 to M2639
13	M2640 to M2659
14	M2660 to M2679
15	M2680 to M2699
16	M2700 to M2719
17	M2720 to M2739
18	M2740 to M2759
19	M2760 to M2779
20	M2780 to M2799
21	M2800 to M2819
22	M2820 to M2839
23	M2840 to M2859
24	M2860 to M2879
25	M2880 to M2899
26	M2900 to M2919
27	M2920 to M2939
28	M2940 to M2959
29	M2960 to M2979
30	M2980 to M2999
31	M3000 to M3019
32	M3020 to M3039

Signal name

	Symbol	Signal name		Refresh cycle	Fetch cycle	Signal type
0	St. 1060	Positioning start complete		Operation cycle		Status signal
1	St. 1061	Positioning complete				
2	St. 1062	In-position				
3	St. 1063	Command in-position				
4	St. 1064	Speed controlling				
5	St. 1065	Speed, position switching latch				
6	St. 1066	Zero pass				
7	St. 1067	Error detection		Immediate		
8	St. 1068	Servo error detection		Operation cycle		
9	St. 1069	Home position return request		Main cycle		
10	St. 1070	Home position return complete		Operation cycle		
11	St. 1071	External signals	FLS			
12	St. 1072		RLS			
13	St. 1073		STOP			
14	St. 1074		DOG/CHANGE			
15	St. 1075	Servo ready				
16	St. 1076	Torque limiting				
17	-	Unusable		-	-	-
18						
19	St. 1079	M-code outputting		Operation cycle		Status signal

POINT

(1) With the R16MTCPU, the axis No. 1 to 16 range is valid.

(2) With the R16MTCPU, device areas of 17 axes or greater can be used as user devices. However, if an R16MTCPU project is replaced with an R32MTCPU project, it will no longer be able to be used as a user device.

(2) Axis command signal list

Axis No.	Device No.
1	M3200 to M3219
2	M3220 to M3239
3	M3240 to M3259
4	M3260 to M3279
5	M3280 to M3299
6	M3300 to M3319
7	M3320 to M3339
8	M3340 to M3359
9	M3360 to M3379
10	M3380 to M3399
11	M3400 to M3419
12	M3420 to M3439
13	M3440 to M3459
14	M3460 to M3479
15	M3480 to M3499
16	M3500 to M3519
17	M3520 to M3539
18	M3540 to M3559
19	M3560 to M3579
20	M3580 to M3599
21	M3600 to M3619
22	M3620 to M3639
23	M3640 to M3659
24	M3660 to M3679
25	M3680 to M3699
26	M3700 to M3719
27	M3720 to M3739
28	M3740 to M3759
29	M3760 to M3779
30	M3780 to M3799
31	M3800 to M3819
32	M3820 to M3839

Signal name

	Symbol	Signal name	Refresh cycle	Fetch cycle	Signal type
0	Rq. 1140	Stop command		Operation cycle	Command signal
1	Rq. 1141	Rapid stop command			
2	Rq. 1142	Forward rotation JOG start command		Main cycle	
3	Rq. 1143	Reverse rotation JOG start command			
4	Rq. 1144	Complete signal OFF command			
5	Rq. 1145	Speed/position switching enable command		Operation cycle	
6	-	Unusable	-	-	-
7	Rq. 1147	Error reset command		Main cycle	Command signal
8	Rq. 1148	Servo error reset command			
9	Rq. 1149	External stop input disable at start command		At start	
10	-	Unusable	-	-	-
11					
12	Rq. 1152	Feed current value update command		At start	Command signal
13	-	Unusable		-	-
14					
15	Rq. 1155	Servo OFF command		Operation cycle	Command signal
16	Rq. 1156	Gain changing command		Operation cycle *1	
17	Rq. 1157	PI-PID changing command			
18	Rq. 1158	Control loop changing command		Operation cycle	
19	Rq. 1159	FIN signal			

*1. Every 3.555 [ms] if the operation cycle is 7.111 [ms] or more.

POINT

(1) With the R16MTCPU, the axis No. 1 to 16 range is valid.
(2) With the R16MTCPU, device areas of 17 axes or greater can be used as user devices. However, if an R16MTCPU project is replaced with an R32MTCPU project, it will no longer be able to be used as a user device.

(3) Command generation axis status list

Axis No.	Device No.
1	M9800 to M9819
2	M9820 to M9839
3	M9840 to M9859
4	M9860 to M9879
5	M9880 to M9899
6	M9900 to M9919
7	M9920 to M9939
8	M9940 to M9959
9	M9960 to M9979
10	M9980 to M9999
11	M10000 to M10019
12	M10020 to M10039
13	M10040 to M10059
14	M10060 to M10079
15	M10080 to M10099
16	M10100 to M10119
17	M10120 to M10139
18	M10140 to M10159
19	M10160 to M10179
20	M10180 to M10199
21	M10200 to M10219
22	M10220 to M10239
23	M10240 to M10259
24	M10260 to M10279
25	M10280 to M10299
26	M10300 to M10319
27	M10320 to M10339
28	M10340 to M10359
29	M10360 to M10379
30	M10380 to M10399
31	M10400 to M10419
32	M10420 to M10439

Signal name

	Symbol	Signal name	Refresh cycle	Fetch cycle	Signal type
0	St. 340	Command generation axis positioning start complete	Operation cycle		Status signal
1	St. 341	Command generation axis positioning complete			
2	-	Unusable	-	-	-
3	St. 342	Command generation axis command in-position	Operation cycle		Status signal
4	St. 343	Command generation axis speed controlling			
5	-	Unusable	-	-	-
6					
7	St. 344	Command generation axis error detection	Immediate		Status signal
8	-	Unusable	-	-	-
9					
10	St. 345	Command generation axis start accept flag	Operation cycle		Status signal
11	St. 346	Command generation axis speed change accepting flag			
12	St. 347	Command generation axis speed change "0" accepting flag			
13	St. 348	Command generation axis automatic decelerating flag			
14	-	Unusable	-	-	-
15					
16					
17					
18					
19	St. 349	Command generation axis M-code outputting	Operation cycle		Status signal

POINT

(1) With the R16MTCPU, the axis No. 1 to 16 range is valid.

(2) With the R16MTCPU, device areas of 17 axes or greater can be used as user devices. However, if an R16MTCPU project is replaced with an R32MTCPU project, it will no longer be able to be used as a user device.

(4) Command generation axis command signal list

Axis No.	Device No.
1	M10960 to M10979
2	M10980 to M10999
3	M11000 to M11019
4	M11020 to M11039
5	M11040 to M11059
6	M11060 to M11079
7	M11080 to M11099
8	M11100 to M11119
9	M11120 to M11139
10	M11140 to M11159
11	M11160 to M11179
12	M11180 to M11199
13	M11200 to M11219
14	M11220 to M11239
15	M11240 to M11259
16	M11260 to M11279
17	M11280 to M11299
18	M11300 to M11319
19	M11320 to M11339
20	M11340 to M11359
21	M11360 to M11379
22	M11380 to M11399
23	M11400 to M11419
24	M11420 to M11439
25	M11440 to M11459
26	M11460 to M11479
27	M11480 to M11499
28	M11500 to M11519
29	M11520 to M11539
30	M11540 to M11559
31	M11560 to M11579
32	M11580 to M11599

Signal name

	Symbol	Signal name	Refresh cycle	Fetch cycle	Signal type
0	Rq. 341	Command generation axis stop command		Operation cycle	Command signal
1	Rq. 342	Command generation axis rapid stop command			
2	Rq. 343	Command generation axis forward rotation JOG start command		Main cycle	
3	Rq. 344	Command generation axis reverse rotation JOG start command			
4	Rq. 345	Command generation axis complete signal OFF command			
5	-	Unusable	-	-	-
6					
7	Rq. 346	Command generation axis error reset command		Main cycle	Command signal
8	-	Unusable	-	-	-
9					
10					
11					
12	Rq. 347	Feed current value update request command		At start	Command signal
13	-	Unusable	-	-	-
14					
15					
16					
17					
18					
19	Rq. 348	Command generation axis FIN signal		Operation cycle	Command signal

POINT

(1) With the R16MTCPU, the axis No. 1 to 16 range is valid.

(2) With the R16MTCPU, device areas of 17 axes or greater can be used as user devices. However, if an R16MTCPU project is replaced with an R32MTCPU project, it will no longer be able to be used as a user device.

(5) Synchronous encoder axis status list

Axis No.	Device No.
1	M10440 to M10449
2	M10450 to M10459
3	M10460 to M10469
4	M10470 to M10479
5	M10480 to M10489
6	M10490 to M10499
7	M10500 to M10509
8	M10510 to M10519
9	M10520 to M10529
10	M10530 to M10539
11	M10540 to M10549
12	M10550 to M10559

Signal name

	Symbol	Signal name	Refresh cycle	Fetch cycle	Signal type
0	St. 320	Synchronous encoder axis setting valid flag	At power on		Status signal
1	St. 321	Synchronous encoder axis connecting valid flag	Operation cycle		Status signal
2	St. 322	Synchronous encoder axis counter enable flag	Operation cycle		Status signal
3	St. 323	Synchronous encoder axis current value setting request flag	Operation cycle		Status signal
4	St. 324	Synchronous encoder axis error detection flag	Immediate		Status signal
5	-	Unusable	-	-	-
6	St. 325	Synchronous encoder axis control complete flag	Immediate		Status signal
7	-	Unusable	-	-	-
8	-	Unusable	-	-	-
9	-	Unusable	-	-	-

(6) Synchronous encoder axis command signal list

Axis No.	Device No.
1	M11600 to M11603
2	M11604 to M11607
3	M11608 to M11611
4	M11612 to M11615
5	M11616 to M11619
6	M11620 to M11623
7	M11624 to M11627
8	M11628 to M11631
9	M11632 to M11635
10	M11636 to M11639
11	M11640 to M11643
12	M11644 to M11647

Signal name

	Symbol	Signal name	Refresh cycle	Fetch cycle	Signal type
0	Rq. 323	Synchronous encoder axis error reset		Main cycle	Command signal
1	Rq. 320	Synchronous encoder axis control request		Operation cycle	Command signal
2	Rq. 324	Connection command of synchronous encoder via device/master CPU		Main cycle	Command signal
3	-	Unusable	-	-	-

(7) Output axis status list

Axis No.	Device No.
1	M10560 to M10569
2	M10570 to M10579
3	M10580 to M10589
4	M10590 to M10599
5	M10600 to M10609
6	M10610 to M10619
7	M10620 to M10629
8	M10630 to M10639
9	M10640 to M10649
10	M10650 to M10659
11	M10660 to M10669
12	M10670 to M10679
13	M10680 to M10689
14	M10690 to M10699
15	M10700 to M10709
16	M10710 to M10719
17	M10720 to M10729
18	M10730 to M10739
19	M10740 to M10749
20	M10750 to M10759
21	M10760 to M10769
22	M10770 to M10779
23	M10780 to M10789
24	M10790 to M10799
25	M10800 to M10809
26	M10810 to M10819
27	M10820 to M10829
28	M10830 to M10839
29	M10840 to M10849
30	M10850 to M10859
31	M10860 to M10869
32	M10870 to M10879

Signal name

	Symbol	Signal name	Refresh cycle	Fetch cycle	Signal type
0	St. 420	Main shaft clutch ON/OFF status	Operation cycle		Status signal
1	St. 421	Main shaft clutch smoothing status			
2	St. 423	Auxiliary shaft clutch ON/OFF status			
3	St. 424	Auxiliary shaft clutch smoothing status			
4	-	Unusable	-	-	-
5					
6	St. 426	Control change complete	Operation cycle		Status signal
7	-	Unusable	-	-	-
8					
9					

POINT

(1) With the R16MTCPU, the axis No. 1 to 16 range is valid.

(2) With the R16MTCPU, device areas of 17 axes or greater can be used as user devices. However, if an R16MTCPU project is replaced with an R32MTCPU project, it will no longer be able to be used as a user device.

(8) Output axis command signal list

Axis No.	Device No.	Signal name
1	M11680 to M11689	
2	M11690 to M11699	
3	M11700 to M11709	
4	M11710 to M11719	
5	M11720 to M11729	
6	M11730 to M11739	
7	M11740 to M11749	
8	M11750 to M11759	
9	M11760 to M11769	
10	M11770 to M11779	
11	M11780 to M11789	
12	M11790 to M11799	
13	M11800 to M11809	
14	M11810 to M11819	
15	M11820 to M11829	
16	M11830 to M11839	
17	M11840 to M11849	
18	M11850 to M11859	
19	M11860 to M11869	
20	M11870 to M11879	
21	M11880 to M11889	
22	M11890 to M11899	
23	M11900 to M11909	
24	M11910 to M11919	
25	M11920 to M11929	
26	M11930 to M11939	
27	M11940 to M11949	
28	M11950 to M11959	
29	M11960 to M11969	
30	M11970 to M11979	
31	M11980 to M11989	
32	M11990 to M11999	

	Symbol	Signal name	Refresh cycle	Fetch cycle	Signal type
0	Rq. 400	Main shaft clutch command		Operation cycle	Command signal
1	Rq. 401	Main shaft clutch control invalid command			
2	Rq. 402	Main shaft clutch forced OFF command			
3	-	Unusable	-	-	-
4	Rq. 403	Auxiliary shaft clutch command		Operation cycle	Command signal
5	Rq. 404	Auxiliary shaft clutch control invalid command			
6	Rq. 405	Auxiliary shaft clutch forced OFF command			
7	-	Unusable	-	-	-
8	Rq. 406	Control change request command		Operation cycle	Command signal
9	-	Unusable	-	-	-

POINT

(1) With the R16MTCPU, the axis No. 1 to 16 range is valid.

(2) With the R16MTCPU, device areas of 17 axes or greater can be used as user devices. However, if an R16MTCPU project is replaced with an R32MTCPU project, it will no longer be able to be used as a user device.

(9) Synchronous control signal list

Axis No.	Device No.	Symbol	Signal name	Refresh cycle	Fetch cycle	Signal type
1	M10880	St. 380	Synchronous control	Operation cycle		Status signal
2	M10881					
3	M10882					
4	M10883					
5	M10884					
6	M10885					
7	M10886					
8	M10887					
9	M10888					
10	M10889					
11	M10890					
12	M10891					
13	M10892					
14	M10893					
15	M10894					
16	M10895					
17	M10896					
18	M10897					
19	M10898					
20	M10899					
21	M10900					
22	M10901					
23	M10902					
24	M10903					
25	M10904					
26	M10905					
27	M10906					
28	M10907					
29	M10908					
30	M10909					
31	M10910					
32	M10911					

POINT

(1) With the R16MTCPU, the axis No. 1 to 16 range is valid.

(2) With the R16MTCPU, device areas of 17 axes or greater can be used as user devices. However, if an R16MTCPU project is replaced with an R32MTCPU project, it will no longer be able to be used as a user device.

(10) Synchronous analysis complete signal list

Axis No.	Device No.	Symbol	Signal name	Refresh cycle	Fetch cycle	Signal type
1	M10912	St. 381	Synchronous analysis complete	Operation cycle		Status signal
2	M10913					
3	M10914					
4	M10915					
5	M10916					
6	M10917					
7	M10918					
8	M10919					
9	M10920					
10	M10921					
11	M10922					
12	M10923					
13	M10924					
14	M10925					
15	M10926					
16	M10927					
17	M10928					
18	M10929					
19	M10930					
20	M10931					
21	M10932					
22	M10933					
23	M10934					
24	M10935					
25	M10936					
26	M10937					
27	M10938					
28	M10939					
29	M10940					
30	M10941					
31	M10942					
32	M10943					

POINT

(1) With the R16MTCPU, the axis No. 1 to 16 range is valid.

(2) With the R16MTCPU, device areas of 17 axes or greater can be used as user devices. However, if an R16MTCPU project is replaced with an R32MTCPU project, it will no longer be able to be used as a user device.

(11) Synchronous control start signal list

Axis No.	Device No.	Symbol	Signal name	Refresh cycle	Fetch cycle	Signal type
1	M12000	Rq. 380	Synchronous control start		Operation cycle	Command signal
2	M12001					
3	M12002					
4	M12003					
5	M12004					
6	M12005					
7	M12006					
8	M12007					
9	M12008					
10	M12009					
11	M12010					
12	M12011					
13	M12012					
14	M12013					
15	M12014					
16	M12015					
17	M12016					
18	M12017					
19	M12018					
20	M12019					
21	M12020					
22	M12021					
23	M12022					
24	M12023					
25	M12024					
26	M12025					
27	M12026					
28	M12027					
29	M12028					
30	M12029					
31	M12030					
32	M12031					

POINT

(1) With the R16MTCPU, the axis No. 1 to 16 range is valid.

(2) With the R16MTCPU, device areas of 17 axes or greater can be used as user devices. However, if an R16MTCPU project is replaced with an R32MTCPU project, it will no longer be able to be used as a user device.

(12) Synchronous analysis request signal list

Axis No.	Device No.	Symbol	Signal name	Refresh cycle	Fetch cycle	Signal type
1	M12032	Rq. 381	Synchronous analysis request		At start of synchronous control	Command signal
2	M12033					
3	M12034					
4	M12035					
5	M12036					
6	M12037					
7	M12038					
8	M12039					
9	M12040					
10	M12041					
11	M12042					
12	M12043					
13	M12044					
14	M12045					
15	M12046					
16	M12047					
17	M12048					
18	M12049					
19	M12050					
20	M12051					
21	M12052					
22	M12053					
23	M12054					
24	M12055					
25	M12056					
26	M12057					
27	M12058					
28	M12059					
29	M12060					
30	M12061					
31	M12062					
32	M12063					

POINT

(1) With the R16MTCPU, the axis No. 1 to 16 range is valid.

(2) With the R16MTCPU, device areas of 17 axes or greater can be used as user devices. However, if an R16MTCPU project is replaced with an R32MTCPU project, it will no longer be able to be used as a user device.

4.4.2 Internal relays (common devices)

The R16MTCPU/R32MTCPU is equipped with an internal relay with 12288 points from M0 to M12287.

Of these, M2000 to M2319 is used for positioning control, and their respective applications are fixed as shown in the following tables.

(1) Common devices

Device No.	Symbol	Signal name
M2000	Rq. 1120	PLC ready flag
M2001 to M2032	St. 1040	Axis 1 start accept flag*1*2 to Axis 32 start accept flag
M2033 to M2037	-	Unusable
M2038	St. 1041	Motion SFC debugging flag
M2039	-	Unusable
M2040	Rq. 1122	Speed switching point specified flag
M2041	-	Unusable
M2042	Rq. 1123	All axes servo ON command
M2043 to M2047	-	Unusable
M2048	Rq. 1124	JOG operation simultaneous start command
M2049	St. 1045	All axes servo ON accept flag
M2050	-	Unusable
M2051	Rq. 1125	Manual pulse generator 1 enable flag
M2052	Rq. 1126	Manual pulse generator 2 enable flag
M2053	Rq. 1127	Manual pulse generator 3 enable flag
M2054	St. 1046	Operation cycle over flag
M2055 to M2060	-	Unusable
M2061 to M2092	St. 1047	Axis 1 speed change accepting flag*1*2 to Axis 32 speed change accepting flag
M2093 to M2127	-	Unusable
M2128 to M2159	St. 1048	Axis 1 automatic decelerating flag*1*2 to Axis 32 automatic decelerating flag
M2160 to M2239	-	Unusable
M2240 to M2271	St. 1049	Axis 1 speed change "0" accepting flag*1*2 to Axis 32 speed change "0" accepting flag
M2272 to M2303	St. 1050	Axis 1 control loop monitor status*1*2 to Axis 32 control loop monitor status
M2304 to M2319	-	Unusable

*1. With the R16MTCPU, the axis No. 1 to 16 range is valid.
*2. With the R16MTCPU, device areas of 17 axes or greater cannot be used.

4.4.3 Data register (monitor device/control change register)

There are 19824 data registers in the R16MTCPU/R32MTCPU, from D0 to D19823.
Of these, 800 points from D0 to D799 are used for positioning control, and 9584 points from D10240 to D19823 are used for synchronous control, and their respective applications are fixed as shown in the following tables.

(1) Axis monitor device list

Axis No.	Device No.
1	D0 to D19
2	D20 to D39
3	D40 to D59
4	D60 to D79
5	D80 to D99
6	D100 to D119
7	D120 to D139
8	D140 to D159
9	D160 to D179
10	D180 to D199
11	D200 to D219
12	D220 to D239
13	D240 to D259
14	D260 to D279
15	D280 to D299
16	D300 to D319
17	D320 to D339
18	D340 to D359
19	D360 to D379
20	D380 to D399
21	D400 to D419
22	D420 to D439
23	D440 to D459
24	D460 to D479
25	D480 to D499
26	D500 to D519
27	D520 to D539
28	D540 to D559
29	D560 to D579
30	D580 to D599
31	D600 to D619
32	D620 to D639

Signal name

	Symbol	Signal name	Refresh cycle	Fetch cycle	Signal type
0 1	Md. 20	Feed current value	Operation cycle		Monitor device
2 3	Md. 101	Real current value			
4 5	Md. 102	Deviation counter value			
6	Md. 1003	Warning code	Immediate		
7	Md. 1004	Error code			
8	Md. 1005	Servo error code	Main cycle		
9	Md. 1006	Home position return re-travel value	Operation cycle		
10 11	Md. 34	Travel value after proximity dog ON			
12	Md. 1008	Execute program No.	At start		
13	Md. 25	M-code	Operation cycle		
14	Md. 35	Torque limit value			
15	Md. 1011	Data set pointer for continuous trajectory control	At start/ during start		
16 17	-	Unusable *1	-	-	-
18 19	Md. 1012	Real current value at stop input	Operation cycle		Monitor device

*1. Can be used as the travel value change register. The travel value change register can be set for the desired device in the servo program.

POINT

(1) With the R16MTCPU, the axis No. 1 to 16 range is valid.
(2) With the R16MTCPU, device areas of 17 axes or greater can be used as user devices. However, if an R16MTCPU project is replaced with an R32MTCPU project, it will no longer be able to be used as a user device.

(2) JOG speed setting register list

Axis No.	Device No.	Signal name
1	D640, D641	
2	D642, D643	
3	D644, D645	
4	D646, D647	
5	D648, D649	
6	D650, D651	
7	D652, D653	
8	D654, D655	
9	D656, D657	
10	D658, D659	
11	D660, D661	
12	D662, D663	
13	D664, D665	
14	D666, D667	
15	D668, D669	
16	D670, D671	
17	D672, D673	
18	D674, D675	
19	D676, D677	
20	D678, D679	
21	D680, D681	
22	D682, D683	
23	D684, D685	
24	D686, D687	
25	D688, D689	
26	D690, D691	
27	D692, D693	
28	D694, D695	
29	D696, D697	
30	D698, D699	
31	D700, D701	
32	D702, D703	

	Symbol	Signal name	Refresh cycle	Fetch cycle	Signal type
0 1	Cd. 1110	JOG speed setting		At start	Command device

POINT

(1) With the R16MTCPU, the axis No. 1 to 16 range is valid.

(2) With the R16MTCPU, device areas of 17 axes or greater can be used as user devices. However, if an R16MTCPU project is replaced with an R32MTCPU project, it will no longer be able to be used as a user device.

(3) Servo input axis monitor device list

Axis No.	Device No.	Signal name
1	D12280 to D12289	
2	D12290 to D12299	
3	D12300 to D12309	
4	D12310 to D12319	
5	D12320 to D12329	
6	D12330 to D12339	
7	D12340 to D12349	
8	D12350 to D12359	
9	D12360 to D12369	
10	D12370 to D12379	
11	D12380 to D12389	
12	D12390 to D12399	
13	D12400 to D12409	
14	D12410 to D12419	
15	D12420 to D12429	
16	D12430 to D12439	
17	D12440 to D12449	
18	D12450 to D12459	
19	D12460 to D12469	
20	D12470 to D12479	
21	D12480 to D12489	
22	D12490 to D12499	
23	D12500 to D12509	
24	D12510 to D12519	
25	D12520 to D12529	
26	D12530 to D12539	
27	D12540 to D12549	
28	D12550 to D12559	
29	D12560 to D12569	
30	D12570 to D12579	
31	D12580 to D12589	
32	D12590 to D12599	

	Symbol	Signal name	Refresh cycle	Fetch cycle	Signal type
0	Md. 300	Servo input axis current value	Operation cycle		Monitor device
1					
2	Md. 301	Servo input axis speed			
3					
4	Md. 302	Servo input axis phase compensation amount			
5					
6	Md. 303	Servo input axis rotation direction restriction amount			
7					
8	-	Unusable	-	-	-
9					

POINT

(1) With the R16MTCPU, the axis No. 1 to 16 range is valid.

(2) With the R16MTCPU, device areas of 17 axes or greater can be used as user devices. However, if an R16MTCPU project is replaced with an R32MTCPU project, it will no longer be able to be used as a user device.

(4) Servo input axis control device list

Axis No.	Device No.	Signal name
1	D14600, D14601	
2	D14602, D14603	
3	D14604, D14605	
4	D14606, D14607	
5	D14608, D14609	
6	D14610, D14611	
7	D14612, D14613	
8	D14614, D14615	
9	D14616, D14617	
10	D14618, D14619	
11	D14620, D14621	
12	D14622, D14623	
13	D14624, D14625	
14	D14626, D14627	
15	D14628, D14629	
16	D14630, D14631	
17	D14632, D14633	
18	D14634, D14635	
19	D14636, D14637	
20	D14638, D14639	
21	D14640, D14641	
22	D14642, D14643	
23	D14644, D14645	
24	D14646, D14647	
25	D14648, D14649	
26	D14650, D14651	
27	D14652, D14653	
28	D14654, D14655	
29	D14656, D14657	
30	D14658, D14659	
31	D14660, D14661	
32	D14662, D14663	

	Symbol	Signal name	Refresh cycle	Fetch cycle	Signal type
0 1	Pr. 302	Servo input axis phase compensation advance time		Operation cycle	Command device

POINT

(1) With the R16MTCPU, the axis No. 1 to 16 range is valid.

(2) With the R16MTCPU, device areas of 17 axes or greater can be used as user devices. However, if an R16MTCPU project is replaced with an R32MTCPU project, it will no longer be able to be used as a user device.

(5) Command generation axis monitor device list

Axis No.	Device No.
1	D12600 to D12619
2	D12620 to D12639
3	D12640 to D12659
4	D12660 to D12679
5	D12680 to D12699
6	D12700 to D12719
7	D12720 to D12739
8	D12740 to D12759
9	D12760 to D12779
10	D12780 to D12799
11	D12800 to D12819
12	D12820 to D12839
13	D12840 to D12859
14	D12860 to D12879
15	D12880 to D12899
16	D12900 to D12919
17	D12920 to D12939
18	D12940 to D12959
19	D12960 to D12979
20	D12980 to D12999
21	D13000 to D13019
22	D13020 to D13039
23	D13040 to D13059
24	D13060 to D13079
25	D13080 to D13099
26	D13100 to D13119
27	D13120 to D13139
28	D13140 to D13159
29	D13160 to D13179
30	D13180 to D13199
31	D13200 to D13219
32	D13220 to D13239

Signal name

	Symbol	Signal name	Refresh cycle	Fetch cycle	Signal type
0 1	Md. 340	Command generation axis feed current value	Operation cycle		Monitor device
2	Md. 341	Command generation axis warning code	Immediate		Monitor device
3	Md. 342	Command generation axis error code	Immediate		Monitor device
4	Md. 343	Command generation axis execute program No.	At start		Monitor device
5	Md. 344	Command generation axis M-code	Operation cycle		Monitor device
6 7	Md. 345	Command generation axis accumulative current value	Operation cycle		Monitor device
8	-	Unusable	-	-	-
9	Md. 346	Command generation axis data set pointer for constant-speed control	At start/ during start		Monitor device
10 11	Md. 347	Command generation axis current value per cycle	Operation cycle		Monitor device
12 13	Md. 348	Command generation axis command speed	Operation cycle		Monitor device
14 15 16 17 18 19	-	Unusable	-	-	-

POINT

(1) With the R16MTCPU, the axis No. 1 to 16 range is valid.

(2) With the R16MTCPU, device areas of 17 axes or greater can be used as user devices. However, if an R16MTCPU project is replaced with an R32MTCPU project, it will no longer be able to be used as a user device.

(6) Command generation axis control device list

Axis No.	Device No.	Signal name
1	D14680 to D14683	
2	D14684 to D14687	
3	D14688 to D14691	
4	D14692 to D14695	
5	D14696 to D14699	
6	D14700 to D14703	
7	D14704 to D14707	
8	D14708 to D14711	
9	D14712 to D14715	
10	D14716 to D14719	
11	D14720 to D14723	
12	D14724 to D14727	
13	D14728 to D14731	
14	D14732 to D14735	
15	D14736 to D14739	
16	D14740 to D14743	
17	D14744 to D14747	
18	D14748 to D14751	
19	D14752 to D14755	
20	D14756 to D14759	
21	D14760 to D14763	
22	D14764 to D14767	
23	D14768 to D14771	
24	D14772 to D14775	
25	D14776 to D14779	
26	D14780 to D14783	
27	D14784 to D14787	
28	D14788 to D14791	
29	D14792 to D14795	
30	D14796 to D14799	
31	D14800 to D14803	
32	D14804 to D14807	

	Symbol	Signal name	Refresh cycle	Fetch cycle	Signal type
0 1	Cd. 340	Command generation axis JOG speed setting		At start of JOG operation	Command device
2	Pr. 348	Command generation axis JOG operation parameter block setting		At start of JOG operation	Command device
3	-	Unusable	-	-	-

POINT

(1) With the R16MTCPU, the axis No. 1 to 16 range is valid.

(2) With the R16MTCPU, device areas of 17 axes or greater can be used as user devices. However, if an R16MTCPU project is replaced with an R32MTCPU project, it will no longer be able to be used as a user device.

(7) Synchronous encoder axis monitor device list

Axis No.	Device No.
1	D13240 to D13259
2	D13260 to D13279
3	D13280 to D13299
4	D13300 to D13319
5	D13320 to D13339
6	D13340 to D13359
7	D13360 to D13379
8	D13380 to D13399
9	D13400 to D13419
10	D13420 to D13439
11	D13440 to D13459
12	D13460 to D13479

Signal name

	Symbol	Signal name	Refresh cycle	Fetch cycle	Signal type
0 1	Md. 320	Synchronous encoder axis current value	Operation cycle		Monitor device
2 3	Md. 321	Synchronous encoder axis current value per cycle	Operation cycle		Monitor device
4 5	Md. 322	Synchronous encoder axis speed	Operation cycle		Monitor device
6 7	Md. 323	Synchronous encoder axis phase compensation amount	Operation cycle		Monitor device
8 9	Md. 324	Synchronous encoder axis rotation direction restriction amount	Operation cycle		Monitor device
10	Md. 327	Synchronous encoder axis warning code	Immediate		Monitor device
11	Md. 326	Synchronous encoder axis error code	Immediate		Monitor device
12 13 14 15 16 17 18 19	-	Unusable	-	-	-

(8) Synchronous encoder axis control device list

Axis No.	Device No.
1	D14820 to D14829
2	D14830 to D14839
3	D14840 to D14849
4	D14850 to D14859
5	D14860 to D14869
6	D14870 to D14879
7	D14880 to D14889
8	D14890 to D14890
9	D14900 to D14909
10	D14910 to D14919
11	D14920 to D14929
12	D14930 to D14939

Signal name

	Symbol	Signal name	Refresh cycle	Fetch cycle	Signal type
0 1	Pr. 326	Synchronous encoder axis phase compensation advance time		Operation cycle	Command device
2	Cd. 320	Synchronous encoder axis control start condition		At synchronous encoder axis control start	Command device
3	Cd. 321	Synchronous encoder axis control method		At synchronous encoder axis control start	Command device
4 5	Cd. 322	Synchronous encoder axis current value setting address		At synchronous encoder axis control start	Command device
6 7	Cd. 325	Input value for synchronous encoder via device		Operation cycle	Command device
8 9	-	Unusable	-	-	-

(9) Output axis monitor device list

Axis No.	Device No.
1	D13600 to D13629
2	D13630 to D13659
3	D13660 to D13689
4	D13690 to D13719
5	D13720 to D13749
6	D13750 to D13779
7	D13780 to D13809
8	D13810 to D13839
9	D13840 to D13869
10	D13870 to D13899
11	D13900 to D13929
12	D13930 to D13959
13	D13960 to D13989
14	D13990 to D14019
15	D14020 to D14049
16	D14050 to D14079
17	D14080 to D14109
18	D14110 to D14139
19	D14140 to D14169
20	D14170 to D14199
21	D14200 to D14229
22	D14230 to D14259
23	D14260 to D14289
24	D14290 to D14319
25	D14320 to D14349
26	D14350 to D14379
27	D14380 to D14409
28	D14410 to D14439
29	D14440 to D14469
30	D14470 to D14499
31	D14500 to D14529
32	D14530 to D14559

Signal name

	Symbol	Signal name	Refresh cycle	Fetch cycle	Signal type
0 1	Md. 400	Current value after composite main shaft gear	Operation cycle		Monitor device
2 3	Md. 401	Current value per cycle after main shaft gear			
4 5	Md. 402	Current value per cycle after auxiliary shaft gear			
6 7	Md. 422	Main shaft clutch slippage (accumulative)			
8 9	Md. 425	Auxiliary shaft clutch slippage (accumulative)			
10 11	Md. 406	Cam axis phase compensation amount			
12 13	Md. 407	Cam axis current value per cycle			
14 15	Md. 408	Cam reference position			
16 17	Md. 409	Cam axis feed current value			
18	Md. 410	Execution cam No.			
19	-	Unusable	-	-	-
20 21	Md. 411	Execute cam stroke amount	Operation cycle		Monitor device
22 23	Md. 412	Execute cam axis length per cycle			
24 25 26 27 28 29	-	Unusable	-	-	-

POINT

(1) With the R16MTCPU, the axis No. 1 to 16 range is valid.
(2) With the R16MTCPU, device areas of 17 axes or greater can be used as user devices. However, if an R16MTCPU project is replaced with an R32MTCPU project, it will no longer be able to be used as a user device.

(10) Output axis control device list

Axis No.	Device No.
1	D15000 to D15149
2	D15150 to D15299
3	D15300 to D15449
4	D15450 to D15599
5	D15600 to D15749
6	D15750 to D15899
7	D15900 to D16049
8	D16050 to D16199
9	D16200 to D16349
10	D16350 to D16499
11	D16500 to D16649
12	D16650 to D16799
13	D16800 to D16949
14	D16950 to D17099
15	D17100 to D17249
16	D17250 to D17399
17	D17400 to D17549
18	D17550 to D17699
19	D17700 to D17849
20	D17850 to D17999
21	D18000 to D18149
22	D18150 to D18299
23	D18300 to D18449
24	D18450 to D18599
25	D18600 to D18749
26	D18750 to D18899
27	D18900 to D19049
28	D19050 to D19199
29	D19200 to D19349
30	D19350 to D19499
31	D19500 to D19649
32	D19650 to D19799

Signal name

	Symbol	Signal name	Refresh cycle	Fetch cycle	Signal type
0	Pr. 400	Main input axis No.		At start of synchronous control	Command device
1	Pr. 401	Sub input axis No.			
2	Pr. 402	Composite main shaft gear		Operation cycle	
3	-	Unusable	-	-	-
4 5	Pr. 403	Main shaft gear: Numerator		At start of synchronous control	Command device
6 7	Pr. 404	Main shaft gear: Denominator			
8	Pr. 405	Main shaft clutch control setting		Operation cycle	
9	Pr. 406	Main shaft clutch reference address setting		At start of synchronous control	
10 11	Pr. 407	Main shaft clutch ON address		Operation cycle	
12 13	Pr. 408	Travel value before main shaft clutch ON		At completing clutch ON condition	
14 15	Pr. 409	Main shaft clutch OFF address		Operation cycle	
16 17	Pr. 410	Travel value before main shaft clutch OFF		At completing clutch OFF condition	
18	Pr. 411	Main shaft clutch smoothing method		At start of synchronous control	
19	Pr. 412	Main shaft clutch smoothing time constant			
20 21	Pr. 413	Slippage amount at main shaft clutch ON		At turning clutch ON	
22 23	Pr. 414	Slippage amount at main shaft clutch OFF		At turning clutch OFF	
24	Pr. 418	Auxiliary shaft axis No.		At start of synchronous control	
25	Pr. 419	Composite auxiliary shaft gear		Operation cycle	
26 27	Pr. 420	Auxiliary shaft gear: Numerator		At start of synchronous control	
28 29	Pr. 421	Auxiliary shaft gear: Denominator			
30	Pr. 422	Auxiliary shaft clutch control setting		Operation cycle	
31	Pr. 423	Auxiliary shaft clutch reference address setting		At start of synchronous control	
32 33	Pr. 424	Auxiliary shaft clutch ON address		Operation cycle	
34 35	Pr. 425	Travel value before auxiliary shaft clutch ON		At completing clutch ON condition	
36 37	Pr. 426	Auxiliary shaft clutch OFF address		Operation cycle	
38 39	Pr. 427	Travel value before auxiliary shaft clutch OFF		At completing clutch OFF condition	
40	Pr. 428	Auxiliary shaft clutch smoothing method		At start of synchronous control	
41	Pr. 429	Auxiliary shaft clutch smoothing time constant			
42 43	Pr. 430	Slippage amount at auxiliary shaft clutch ON		At turning clutch ON	

Output axis control device list (cont.)

Axis No.	Device No.
1	D15000 to D15149
2	D15150 to D15299
3	D15300 to D15449
4	D15450 to D15599
5	D15600 to D15749
6	D15750 to D15899
7	D15900 to D16049
8	D16050 to D16199
9	D16200 to D16349
10	D16350 to D16499
11	D16500 to D16649
12	D16650 to D16799
13	D16800 to D16949
14	D16950 to D17099
15	D17100 to D17249
16	D17250 to D17399
17	D17400 to D17549
18	D17550 to D17699
19	D17700 to D17849
20	D17850 to D17999
21	D18000 to D18149
22	D18150 to D18299
23	D18300 to D18449
24	D18450 to D18599
25	D18600 to D18749
26	D18750 to D18899
27	D18900 to D19049
28	D19050 to D19199
29	D19200 to D19349
30	D19350 to D19499
31	D19500 to D19649
32	D19650 to D19799

Signal name

	Symbol	Signal name	Refresh cycle	Fetch cycle	Signal type
44 45	Pr. 431	Slippage amount at auxiliary shaft clutch OFF		When starting clutch OFF	Command device
46	Pr. 434	Speed change gear 1		At start of synchronous control	
47	Pr. 435	Speed change gear 1 smoothing time constant			
48 49	Pr. 436	Speed change ration 1: Numerator		Operation cycle	
50 51	Pr. 437	Speed change ration 1: Denominator			
52	Pr. 490	Speed change gear 2 allocation		At start of synchronous control	
53	Pr. 491	Speed change gear 2 smoothing time constant			
54 55	Pr. 492	Speed change ration 2: Numerator		Operation cycle	
56 57	Pr. 493	Speed change ration 2: Denominator			
58	Pr. 438	Cam axis cycle unit setting		At start of synchronous control	
59	Pr. 442	Cam axis length per cycle change setting			
60 61	Pr. 439	Cam axis length per cycle			
62	Pr. 440	Cam No.		At start of synchronous control, At passing through the 0th point of cam data	
63	-	Unusable	-	-	-
64 65	Pr. 441	Cam stroke amount		At start of synchronous control, At passing through the 0th point of cam data	Command device
66 67	Pr. 444	Cam axis phase compensation advance time		Operation cycle	
68	Pr. 445	Cam axis phase compensation time constant		At start of synchronous control	
69	Pr. 448	Synchronous control parameter block No.			
70	Pr. 447	Output axis smoothing time constant			
71 72 73 74 75 76 77 78 79 80 81	-	Unusable	-	-	-

Output axis control device list (cont.)

Axis No.	Device No.
1	D15000 to D15149
2	D15150 to D15299
3	D15300 to D15449
4	D15450 to D15599
5	D15600 to D15749
6	D15750 to D15899
7	D15900 to D16049
8	D16050 to D16199
9	D16200 to D16349
10	D16350 to D16499
11	D16500 to D16649
12	D16650 to D16799
13	D16800 to D16949
14	D16950 to D17099
15	D17100 to D17249
16	D17250 to D17399
17	D17400 to D17549
18	D17550 to D17699
19	D17700 to D17849
20	D17850 to D17999
21	D18000 to D18149
22	D18150 to D18299
23	D18300 to D18449
24	D18450 to D18599
25	D18600 to D18749
26	D18750 to D18899
27	D18900 to D19049
28	D19050 to D19199
29	D19200 to D19349
30	D19350 to D19499
31	D19500 to D19649
32	D19650 to D19799

Signal name

	Symbol	Signal name	Refresh cycle	Fetch cycle	Signal type
82 to 99	-	Unusable	-	-	-
100	Pr. 460	Setting method of current value per cycle after main shaft gear		At start of synchronous control	Command device
101	Pr. 461	Setting method of current value per cycle after auxiliary shaft gear		At start of synchronous control	Command device
102	Pr. 462	Cam axis position restoration object		At start of synchronous control	Command device
103	Pr. 463	Setting method of cam reference position		At start of synchronous control	Command device
104	Pr. 464	Setting method of cam axis current value per cycle		At start of synchronous control	Command device
105	-	Unusable	-	-	-
106, 107	Pr. 465	Current value per cycle after main shaft gear (Initial setting)		At start of synchronous control	Command device
108, 109	Pr. 466	Current value per cycle after auxiliary shaft gear (Initial setting)		At start of synchronous control	Command device
110, 111	Pr. 467	Cam reference position (Initial setting)		At start of synchronous control	Command device
112, 113	Pr. 468	Cam axis current value per cycle (Initial setting)		At start of synchronous control	Command device
114 to 124	-	Unusable	-	-	-

Output axis control device list (cont.)

Axis No.	Device No.
1	D15000 to D15149
2	D15150 to D15299
3	D15300 to D15449
4	D15450 to D15599
5	D15600 to D15749
6	D15750 to D15899
7	D15900 to D16049
8	D16050 to D16199
9	D16200 to D16349
10	D16350 to D16499
11	D16500 to D16649
12	D16650 to D16799
13	D16800 to D16949
14	D16950 to D17099
15	D17100 to D17249
16	D17250 to D17399
17	D17400 to D17549
18	D17550 to D17699
19	D17700 to D17849
20	D17850 to D17999
21	D18000 to D18149
22	D18150 to D18299
23	D18300 to D18449
24	D18450 to D18599
25	D18600 to D18749
26	D18750 to D18899
27	D18900 to D19049
28	D19050 to D19199
29	D19200 to D19349
30	D19350 to D19499
31	D19500 to D19649
32	D19650 to D19799

Signal name

	Symbol	Signal name	Refresh cycle	Fetch cycle	Signal type
125 126 127 128 129	-	Unusable	-	-	-
130	Cd. 407	Synchronous control change command		At requesting synchronous control change	Command device
131	Cd. 409	Synchronous control reflection time			
132 133	Cd. 408	Synchronous control change value			
134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149	-	Unusable	-	-	-

POINT

(1) With the R16MTCPU, the axis No. 1 to 16 range is valid.

(2) With the R16MTCPU, device areas of 17 axes or greater can be used as user devices. However, if an R16MTCPU project is replaced with an R32MTCPU project, it will no longer be able to be used as a user device.

(12) Common device list

Device No.	Symbol	Signal name	Refresh cycle	Fetch cycle	Signal type
D704	-	Unusable (6 points)			
D705					
D706					
D707					
D708					
D709					
D710	Cd. 1096	JOG operation simultaneous start axis setting register (forward rotation JOG)		At start	Command device
D711					
D712	Cd. 1097	JOG operation simultaneous start axis setting register (reverse rotation JOG)			
D713					
D714	Cd. 1098	Manual pulse generator axis 1 No. setting register		At the manual pulse generator enable flag ↑	
D715					
D716	Cd. 1099	Manual pulse generator axis 2 No. setting register			
D717					
D718	Cd. 1100	Manual pulse generator axis 3 No. setting register			
D719					
D720	Cd. 1101	Axis 1 (Manual pulse generators 1 pulse input magnification setting register*1*2)			
D721		Axis 2			
D722		Axis 3			
D723		Axis 4			
D724		Axis 5			
D725		Axis 6			
D726		Axis 7			
D727		Axis 8			
D728		Axis 9			
D729		Axis 10			
D730		Axis 11			
D731		Axis 12			
D732		Axis 13			
D733		Axis 14			
D734		Axis 15			
D735		Axis 16			
D736		Axis 17			
D737		Axis 18			
D738		Axis 19			
D739		Axis 20			
D740		Axis 21			
D741		Axis 22			
D742		Axis 23			
D743		Axis 24			
D744		Axis 25			
D745		Axis 26			
D746		Axis 27			
D747		Axis 28			
D748		Axis 29			
D749		Axis 30			
D750		Axis 31			
D751		Axis 32			

Device No.	Symbol	Signal name	Refresh cycle	Fetch cycle	Signal type
D752	Cd. 1102	Manual pulse generator 1 smoothing magnification setting register		At the manual pulse generator enable flag ↑	Command device
D753	Cd. 1103	Manual pulse generator 2 smoothing magnification setting register			
D754	Cd. 1104	Manual pulse generator 3 smoothing magnification setting register			
D755	-	Unusable (45 points)			
D756					
D757					
D758					
D759					
D760					
D761					
D762					
D763					
D764					
D765					
D766					
D767					
D768					
D769					
D770					
D771					
D772					
D773					
D774					
D775					
D776					
D777					
D778					
D779					
D780					
D781					
D782					
D783					
D784					
D785					
D786					
D787					
D788					
D789					
D790					
D791					
D792					
D793					
D794					
D795					
D796					
D797					
D798					
D799					

*1. With the R16MTCPU, the axis No. 1 to 16 range is valid.
*2. With the R16MTCPU, device areas for axis 17 and above are unusable.

4.4.4 Special relays

The R16MTCPU/R32MTCPU has 4096 special relays from SM0 to SM4095.
Six of these are used for positioning control, and their respective applications are fixed as shown in the following tables.

Device No.	Signal name	Refresh cycle	Signal type
SM500	PCPU READY complete flag	Main cycle	Status signal
SM501	Test mode flag		
SM502	External forced stop input flag	Operation cycle	
SM506	External forced stop input ON latch flag		
SM508	Amplifier-less operation status flag	Main cycle	
SM512	Motion CPU WDT error flag		

4.4.5 Special Registers

There are 4096 special registers in the R16MTCPU/R32MTCPU, from SD0 to SD4095.
Nine of these are used for positioning control, and their respective applications are fixed as shown in the following tables.

Device No.	Signal name	Refresh cycle	Fetch cycle	Signal type
SD200	Switch status	Main cycle		Monitor device
SD502	Servo amplifier loading information	When power turned ON and when performing operation cycle		
SD503				
SD508	SSCNET control (Status)	Main cycle		
SD512	Motion CPU WDT error cause	When Motion CPU WDT error occurs		
SD522	Motion operation cycle	Operation cycle		
SD523	Operation cycle of the Motion CPU setting	When power turned ON		
SD524	Maximum motion operation cycle	Operation cycle		
SD803	SSCNET control (Command)		Main cycle	Command device

The 3 points in the table below are coasting timers.

Device No.	Name	Details
SD718 SD719	888 μs coasting timer	These are coasting timers. Read out a device every 2-word unit.
SD720 SD721	444 μs coasting timer	
SD722 SD723	222 μs coasting timer	

4.5 Motion Devices

Motion registers (#0 to #12287) are used as dedicated Motion CPU devices.
These can be used for operation control (F/FS) programs or transition (G) programs.
(Direct access is not possible from PLCs, and therefore Motion CPUs should be accesses after substituting the PLC device if using at the PLC side.)

4.5.1 Motion register (#0 to #12287)

	Item	R32MTCPU/R16MTCPU
Number of motion registers (#)	No. of points	12288 points (#0 to #12287)
	Data size	16 bits/point
	Latch	Only user devices are latched. (All points are cleared with the latch clear operation.)
	Usable tasks	Normal, event, NMI
	Access	Complete range Read, Write possible

(1) Motion register list

Device No.	Application type	Remarks
#0 to	User device (8000 points)	Cleared with the latch clear operation.
#8000 to	Axis monitor device 2 (640 points)	Cleared only when the power is turned ON or when reset.
#8640 to #12287	System area (3648 points)	

(2) Monitor devices (#8000 to #8639)

Monitor devices store information for each axis. Details of the stored data are as follows.

Axis No.	Device No.
1	#8000 to #8019
2	#8020 to #8039
3	#8040 to #8059
4	#8060 to #8079
5	#8080 to #8099
6	#8100 to #8119
7	#8120 to #8139
8	#8140 to #8159
9	#8160 to #8179
10	#8180 to #8199
11	#8200 to #8219
12	#8220 to #8239
13	#8240 to #8259
14	#8260 to #8279
15	#8280 to #8299
16	#8300 to #8319
17	#8320 to #8339
18	#8340 to #8359
19	#8360 to #8379
20	#8380 to #8399
21	#8400 to #8419
22	#8420 to #8439
23	#8440 to #8459
24	#8460 to #8479
25	#8480 to #8499
26	#8500 to #8519
27	#8520 to #8539
28	#8540 to #8559
29	#8560 to #8579
30	#8580 to #8599
31	#8600 to #8619
32	#8620 to #8639

Signal name

	Symbol	Signal name	Refresh cycle	Signal type
0	Md. 1014	Servo amplifier type	When the servo amplifier power-on	Monitor device
1	Md. 104	Motor current	Operation cycle of 1.777 [ms] or less: Operation cycle Operation cycle of 3.555 [ms] or more: 3.555 [ms]	
2 3	Md. 103	Motor speed		
4 5	Md. 28	Command speed	Operation cycle	
6 7	Md. 100	Home position return re-travel value	At home position return re-travel	
8	Md. 1019	Servo amplifier display Servo error code	Main cycle	
9	Md. 107	Parameter error No.		
10	Md. 108	Servo status 1	Operation cycle of 1.777 [ms] or less: Operation cycle Operation cycle of 3.555 [ms] or more: 3.555 [ms]	
11	Md. 1022	Servo status 2		
12	Md. 125	Servo status 3		
13 14 15	-	Unusable	-	-
16	Md. 1027	Servo amplifier vendor ID	At servo amplifier power supply ON	Monitor device
17 18 19	-	Unusable	-	-

Chapter 5 Motion SFC program

This section describes the configuration and each element of Motion SFC programs.
Previously, machine operations were managed at the PLC CPU side, and the starting and stopping of Motion SFC programs was controlled at the Motion CPU side with start and stop commands from the PLC. Consequently, the time taken from the point command conditions were established until commands were issued was delayed by at most the number of sequences taken to perform a single scan, and the resultant variations in this time restricted applications which demanded responsiveness and short tact time.
With the motion controller, programs at the motion side are described with an SFC (Sequential Function Chart), enabling the control of machine operations. Furthermore, it is now also possible to control events that require program execution when interrupts are input from external sensors.

5.1 Features

(1) By breaking up machine sequential operations into individual steps, anyone can create easy-to-understand programs in flowchart format, resulting in improved maintenance.

(2) Transition conditions are identified and positioning started at the Motion CPU side, meaning no variations in the response time that can be influence sequence scan time.

(3) With the Motion SFC step processing method (active steps only executed), high-speed processing, and high-speed response processing can be realized.

(4) In addition to positioning control, numerical operations and device SET/RST, etc. can also be processed at the Motion CPU side, leading to reduced tact time without involving the PLC CPU.

(5) Commands can be issued to servo amplifiers when start conditions are established with a transition conditions description unique to Motion SFC.

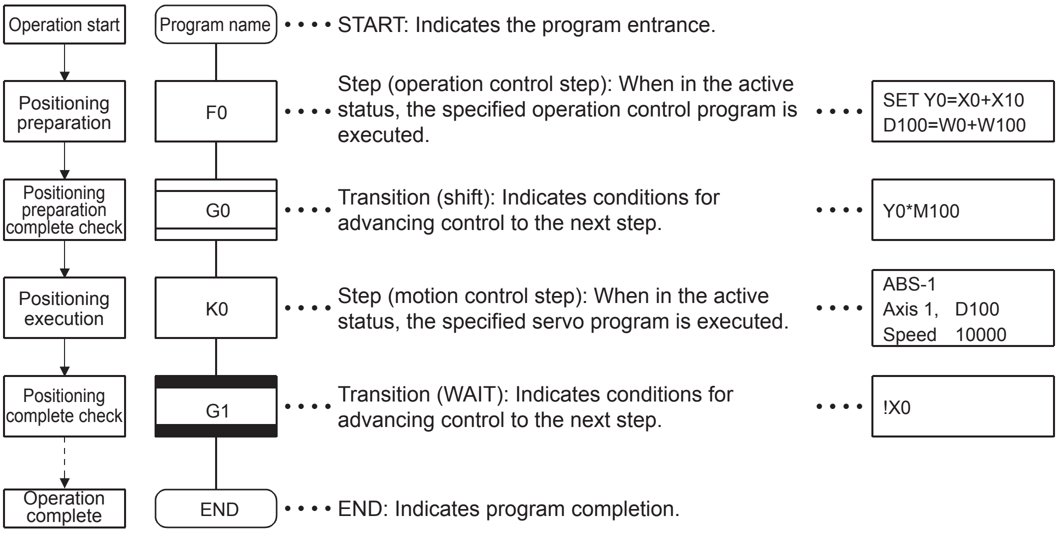
(6) Operation can proceed to the next step without waiting for positioning to be completed after starting with a transition condition description unique to Motion SFC.

(7) Motion SFC programs that respond to interrupt inputs from external sources can be executed.

(8) Motion SFC programs can be executed at regular intervals (min. 0.222 ms) by synchronizing with the motion operation cycle.

5.2 Motion SFC Program Configuration

Motion SFC programs are configured by START, step, transition, and END components and so on as shown below.



Operation for the above Motion SFC program when started is as follows.

(1) The step (F0) status becomes active, and the operation specified at the step (F0) is executed (positioning preparation). An active status step is known as an active step.

(2) A check is carried out to determine whether the conditions specified at the transition (G0) have been established (whether the positioning program can be started), the active step (F0) becomes inactive when conditions are established, and the next step (K0) becomes active (servo program K0 is started).

(3) A check is carried out at the transition (G1) to ensure that step (K0) operation is complete (servo program K0 positioning complete), and control advances to the next step when operation is complete (conditions established).

(4) As the active step advances as described in (1) to (3) above, control is executed and then completed with END.

POINT

The number of steps that can simultaneously be active steps in all Motion SFC programs is 256 or less.
If 256 is exceeded, a minor error (SFC) (error code: 33FEH) occurs.
The Motion SFC program symbols are as follows.
F/FS: operation control, K: positioning control, G: judgment

5.3 SFC Diagram Symbol List

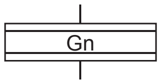
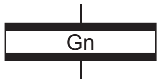
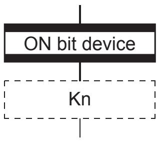
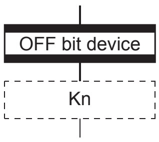
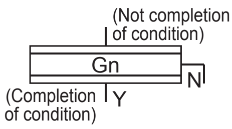
The parts that form the component elements of the Motion SFC program are as follows. The Motion SFC program expresses the operation order and transition control by joining these parts with a directed line.

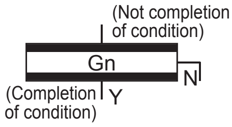
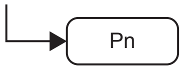
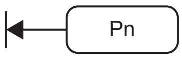
Classification	Name	Symbol (Code size (bytes))	Function
Program Start/end	START	Program name (0)	• Indicates an entry of program as a program name. • Specify this program name at a subroutine call. • Only one program name for one program.
	END	END (8)	• Indicates an end (exit) of program. • When a subroutine call was carried out, returns to the call source program. • Multiple program names or no symbols for one program.
Step	Motion control step	Kn (8)	• Starts a servo program Kn (K0 to K4095).
	Once execution type operation control step	Fn (8)	• Execute once the operation control program Fn (F0 to F4095).
	Scan execution type operation control step	FSn (8)	• Repeats an operation control program FSn (FS0 to FS4095) until the next transition condition enables.
	Subroutine call/ start step	Program name (8)	• When the next of GSUB is WAIT, performs “subroutine call” and transits control to the specified program. Control returns to the call source program at END execution. • When the next of GSUB is except WAIT, performs “subroutine start”, and starts the specified program and transits to the next (lower part). The start source and destination programs are executed simultaneously, and the call destination program ends at END execution.
	Clear step	CLR Program name (8)	• Stops and ends the specified program running. After an end, it is started from the initial (start step) by restarting the program. • When the specified program is during “subroutine call”, the subroutine program is also stopped to execute. • When the specified program is after “subroutine start”, the subroutine program is not stopped to execute. • When clearing to the subroutine by which the “subroutine call” was executed, the specified subroutine is stopped to execute, returns to the call source program, and transits to the next.

POINT

Comments can be set for each symbol in SFC diagram steps, transitions, etc.

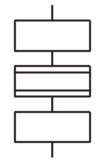
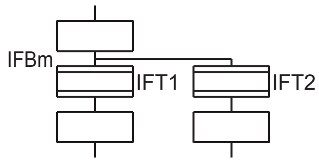
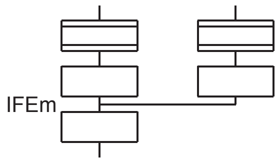
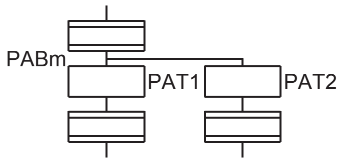
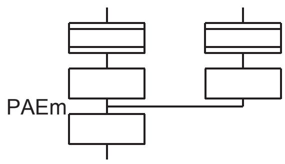
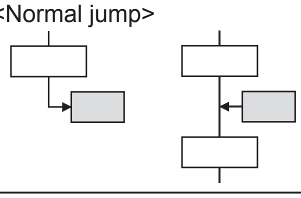
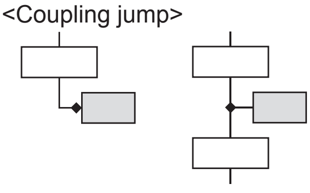
- Program start/end: Comments cannot be set.
- Step/transition comments: max. 80 half-width (40 full-width) characters, 20 characters displayed in 4 lines
- Jump/pointer comments: max. 64 half-width (32 full-width) characters, 16 characters displayed in 4 lines

Classification	Name	Symbol (Code size (bytes))	Function
Transition	Shift (Pre-read transition)	 (8)	• When just before is the motion control step, transits to the next step by formation of transition condition Gn (G0 to G4095) without waiting for the motion operating completion. • When just before is the operation control step, transits to the next step by the completion of transition condition after operating execution. • When just before is subroutine call or starting step, transits to the next step by formation of transition condition without waiting for the operating completion of subroutine.
	WAIT	 (8)	• When just before is the motion control step, waits for the motion operating completion and then transits to the next step by the completion of transition condition Gn (G0 to G4095). • When just before is the operation control step, transits to the next step by formation of transition condition after operating execution. (Same operation as Shift.) • When just before is subroutine call or starting step, waits for the operating completion of subroutine and then transits to the next step by the completion of transition condition.
	WAITON	 (14)	• Prepares for starting of the next motion control step, and issues an instruction immediately when the specified bit device turns ON. • Always pair this transition with the motion control step one-for-one.
	WAITOFF	 (14)	• Prepares for starting of the next motion control step, and issues an instruction immediately when the specified bit device turns OFF. • Always pair this transition with the motion control step one-for-one.
	Shift Y/N		• When just before is the motion control step, transits to the next step by formation of transition condition Gn (G0 to G4095) without waiting for the motion operating completion. If not formation of transition condition, transits to the right-connected step. • When just before is the operation control step, transits to the next step by the completion of transition condition after operating execution. If not the completion of transition condition, transits to the right-connected step. • When just before is "subroutine call" or "starting step", transits to the next step by the completion of transition condition without waiting for the operating of subroutine completion. If not formation of transition condition, transits to the right-connected step.

Classification	Name	Symbol (Code size (bytes))	Function
Transition	WAIT Y/N		• When just before is the motion control step, waits for the motion operating completion and then transits to the next step by formation of transition condition Gn (G0 to G4095). If not completion of transition condition, transits to the right-connected step. • When just before is the operation control step, transits to the next step by the completion of transition condition after operating execution. If not the completion of transition condition, transits to the right-connected step. (Same operation as Shift.) • When just before is subroutine call or starting step, waits for the operating completion of subroutine, and then transits to the next step by the completion of transition condition. If not formation of transition condition, transits to the right-connected step.
Jump	Jump	 (14)	• Jumps to the specified pointer Pn (P0 to P16383) of the self program.
Pointer	Pointer	 (8)	• Indicates a jump destination pointer (label). • This pointer can be set at a step, transition, branch point or coupling point. • P0 to P16383 can be set in one program. The same No. may also be used in other programs.

5.4 Branch and Coupling Diagram List

SFC diagrams show branch and coupling patterns used to specify the flow of steps and transitions.

Classi-fication	Name (Code size (bytes))	SFC symbol	Function
Basic type	Series transitions (Corresponding symbol size)		• Steps and transitions connected in series are processed in order from top to bottom. • Steps and transitions need not be lined up alternately. • When a transition is omitted, unconditional shift processing is performed.
	Selection branch ((No. of branches + 2) × 10)		• The route which transition condition enables first is executed after executing the step or transition preceding a branch. • Selective branch destinations should always be started by transitions, all of which must be Shift or WAIT. (Using Shift and WAIT together will cause a parallel branch.)
	Selective coupling (8)		• After the route branched by a selective branch has been processed, execution shifts to a coupling point. • A coupling may be preceded and followed by either a step or a transition.
	Parallel branch (No. of branches × 22 + No. of nodes × 2 + 12)		• Multiple routes (steps) connected in parallel are executed simultaneously. • Each parallel branch destination may be started by either a step or transition.
	Parallel coupling (8)		• Execution waits at the coupling point for executions of the routes branched by a parallel branch to be completed, and shifts to the next when executions of all routes are completed. • A coupling may be preceded and followed by either a step or a transition. • When this coupling is preceded by an FS step, scans are executed during waiting. After waiting is complete, scans are not executed.
	Jump transition (Corresponding symbol size)	<Normal jump>  <Coupling jump> 	(1) Normal jump • After the step or transition preceding this jump transition is executed, execution shifts to the pointer Pn specified within its own program. • The jump destination may either be a step or transition. • When a jump takes place from an FS step to a transition, scans are executed during waiting for the completion of transition condition of the jump destination. (2) Coupling jump • When a jump to the other route within a parallel branch takes place after the parallel branch, a “coupling jump” takes place and execution waits at the jump destination.

5.5 Motion SFC Program Name

The "Motion SFC program name" is set individually for Motion SFC program No. 0 to No. 255.
The Motion SFC program name is set within 16 half-width characters (8 full-width characters).
Specify this Motion SFC program name in "subroutine call/start steps (GSUB)", and "clear steps (CLR)".

POINT

(1) The Motion SFC program can be set to a random number between 0 and 255.
(2) "$ (half-width)" cannot be set for the first character of the Motion SFC program name.
(3) "\ / : ; ,. * ? " < > | (half-width)" cannot be set in the Motion SFC program name.

5.6 Steps

5.6.1 Motion control step

Motion control steps are used to start servo program Kn.

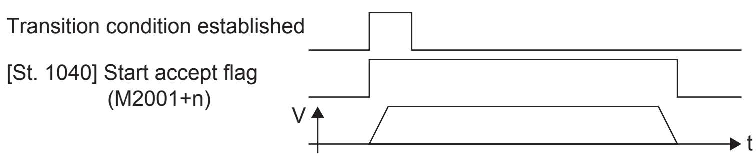
Name	Symbol	Setting range
Motion control step	Kn	K0 to K4095

(1) Operation description

(a) The start accept flag for the axis specified in the specified servo program Kn turns ON.

(b) The specified servo program Kn is started.

Execution timing



(2) Error

A minor error (SFC) (error code: 31F0H) occurs when the specified servo program Kn does not exist, and execution of the Motion SFC program is stopped the moment this error is detected.

(3) Precautions

(a) If changes are made to the current values in the Motion SFC program, specify the CHGA instruction in the servo program, and then call it with the motion control step.

(b) Even if a minor error/major error occurs and an error stop condition occurs at the servo program when the servo program specified with the motion control step is started or while starting, execution of the Motion SFC program continues. If wishing to stop the Motion SFC program when an error is detected, insert an error detection condition in the transition (transition condition).

5.6.2 Operation control step

Operation control steps are used to execute operation control program Fn/FSn.

Name	Symbol	Setting range
Operation control step	Fn/FSn	F0 to F4095/FS0 to FS4095

(1) Operation description

(a) One-time execution type operation control step Fn
Executes the specified operation control program Fn (n = 0 to 4095) once.

(b) Scan execution type operation control step FSn
Executes the specified operation control program FSn (n = 0 to 4095) repeatedly until the next transition condition is established.

(2) Error

A minor error (SFC) (error code: 31F1H) occurs when the specified operation control program Fn/FSn does not exist, and execution of the Motion SFC program is stopped the moment this error is detected.

(3) Precautions

Even if an operation error, etc. occurs during operation control program execution, execution of the Motion SFC program continues.

5.6.3 Subroutine call/start step

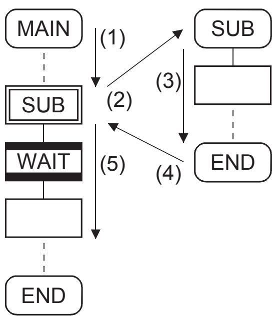
Subroutine call/start steps are used to call or start Motion SFC programs for the specified program name.

Name	Symbol	Setting range
Subroutine call/start step	Program name	Registered program name

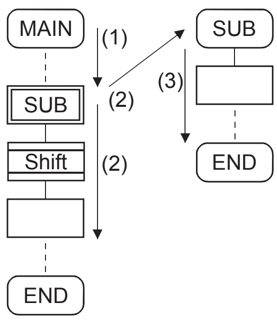
(1) Operation description

(a) Subroutine call/start steps are used to call or start Motion SFC programs for the specified program name.

(b) Control differs depending on the type of the transition linked after the subroutine call/start step.
- If WAIT: The subroutine is called.
- If other than WAIT: The subroutine is started.



If WAIT (subroutine call)



If other than WAIT (subroutine start)

(2) Error

An error occurs in the following cases and execution of the Motion SFC program is stopped.

(a) A minor error (SFC) (error code: 32F5H) occurs if the specified Motion SFC program does not exist when a subroutine is called/started, and execution of the Motion SFC program from which the call/start originated is stopped the moment this error is detected.

(b) A minor error (SFC) (error code: 32F6H) occurs if the called/started Motion SFC program has already been started when a subroutine is called/started, and execution of the Motion SFC program from which the call/start originated is stopped the moment this error is detected.

(c) A minor error (SFC) (error code: 33FAH) occurs if a self program is called/started when a subroutine is called/started, and execution of the Motion SFC program from which the call/start originated is stopped the moment this error is detected.

(d) A minor error (SFC) (error code: 33FBH) occurs when the subroutine called/started when calling/starting a subroutine is Motion SFC program 1 (called/start program) in Motion SFC program 2 called/started from Motion SFC program 1, and Motion SFC program 2 from which the called/started originated is stopped the moment this error is detected.

(3) Precautions

(a) There are no restrictions on subroutine call/start nesting depth.

(b) With subroutine starting, processing of the Motion SFC program from which the start originated continues even if an error stop occurs for the start destination Motion SFC program.

(c) With subroutine calling, when an error stop occurs for the call destination Motion SFC program, execution of the Motion SFC program from which the call originated is also stopped at the same time.

5.6.4 Clear step

Clear step are used to stop execution of Motion SFC programs for the specified program name.

Name	Symbol	Setting range
Clear step	CLR Program name	Registered program name

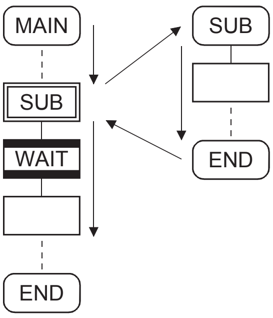
(1) Operation description

(a) Execution of the specified program currently running is stopped.

(b) Even if the Motion SFC program for which the clear step is specified is set to start automatically, it will not automatically start again after stopping.

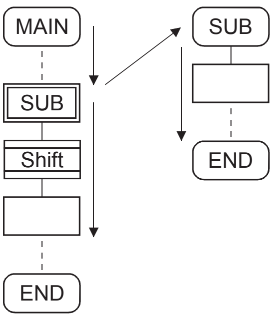
(c) The specified program can also be a self program.

(d) If the specified program is currently calling a subroutine, execution of the subroutine program being called is also stopped.



If a "subroutine is called" as shown in the diagram on the left:
- When MAIN is cleared:
  Execution of the both MAIN and subroutine (SUB) is stopped even if the subroutine (SUB) is currently running.
- When the subroutine (SUB) is cleared:
  Execution of the subroutine (SUB) is stopped if currently running, and processing returns to MAIN.

(e) If the specified program is at a point after starting the subroutine, processing of the started subroutine program continues.



If a "subroutine is started" as shown in the diagram on the left:
- When MAIN is cleared:
  Execution of MAIN is stopped even if the subroutine (SUB) is currently running, however, processing of the started subroutine (SUB) continues.
- When the subroutine (SUB) is cleared:
  Execution of only the subroutine (SUB) is stopped if currently running.

(f) If the servo program started from the specified program is currently being started, processing of the servo program continues.

(g) If waiting for conditions to be established at the WAITON/WAITOFF+ motion control step, the system waits for conditions to be established and then executes the servo program. If the servo program is not executed, enter a stop command separately for the relevant axis.

(2) Error

If you designate an SFC program that does not exist in the clear step process and if you attempt to have the MT Developer2 carry out the Motion SFC program conversion, an error occurs.

(3) Precautions

(a) When the Motion SFC program specified in the clear step has not been started, no error occurs and the condition is ignored.

(b) Even if execution of the Motion SFC program is stopped with the clear step, output is maintained.

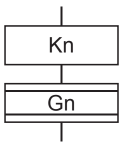
(c) If stopping the axis that is currently operating in conjunction with execution of the clear step, enter a stop command for the relevant axis separately.

5.7 Transitions

Conditional expressions and operational expressions can be described in transitions. The operational expression described here is executed repeatedly until the transitional condition is established.

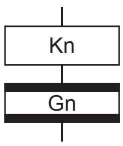
(1) Operation description

(a) Motion control step + SHIFT



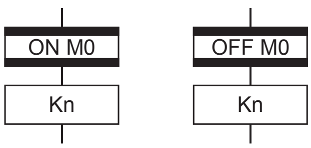
- Processing proceeds to the next step when transition condition Gn is established without waiting for the completion of operation of servo program Kn started with the motion control step.

(b) Motion control step + WAIT



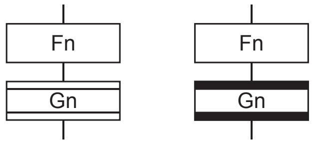
- Processing waits for the completion of operation of servo program Kn started with the motion control step, and then proceeds to the next step when transition condition Gn is established.
- No condition for the completion of operation of servo program Kn is required in transition condition Gn.
- Even if an error stop occurs when the started servo program Kn is started or while it is starting, the system deems that operation is complete.

(c) WAITON/WAITOFF + motion control step



- Processing starts immediately when the specified bit device for WAITON/WAITOFF turns ON/OFF.

(d) Combination with operation control step



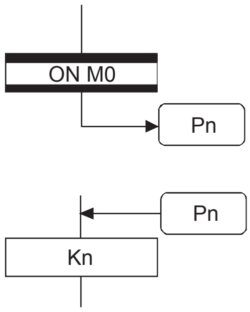
- The same operation is performed for both WAIT and SHIFT, and after executing operation control program Fn, processing proceeds to the next step when transition condition Gn is established.
- In the case of operation control steps, the same operation is performed for both WAIT and SHIFT, and after executing operation control program Fn, processing proceeds to the next step when transition condition Gn is established.

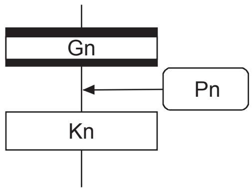
(2) Precautions

(a) Always set a one-to-one pair with the motion control step. A minor error (SFC) (error code: 33F2H) occurs if the step after WAITON/WAITOFF is not a motion control step, and execution of the Motion SFC program is stopped the moment this error is detected.

(b) When the jump destination immediately after WAITON/WAITOFF is a motion control step, no error occurs. (See lower left diagram.)

(c) It is possible for a pointer to exist immediately after WAITON/WAITOFF. (See lower right diagram.)

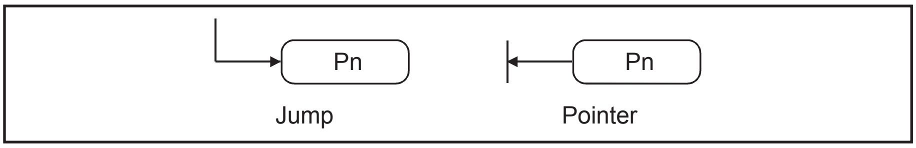




(d) If a minor error occurs when starting the servo program specified in the motion control step, preventing the program being started, execution of the Motion SFC program continues regardless of the WAITON/WAITOFF bit device status, and processing proceeds to the next step. If wishing to stop the Motion SFC program when an error is detected, insert an error detection condition in the next transition (transition condition).

(e) The following instructions can be used with motion control steps used in combination with WAITON/WAITOFF.
(Linear interpolation control, circular interpolation control, helical interpolation control, fixed-pitch feed control, continuous trajectory control, high-speed oscillating, fixed position stop speed control)

5.8 Jump and Pointer



(1) Operation description

(a) Jumps are used to jump to specified pointer Pn inside the self program.

(b) Pointers can be set for steps, transitions, branch points, and coupling points.

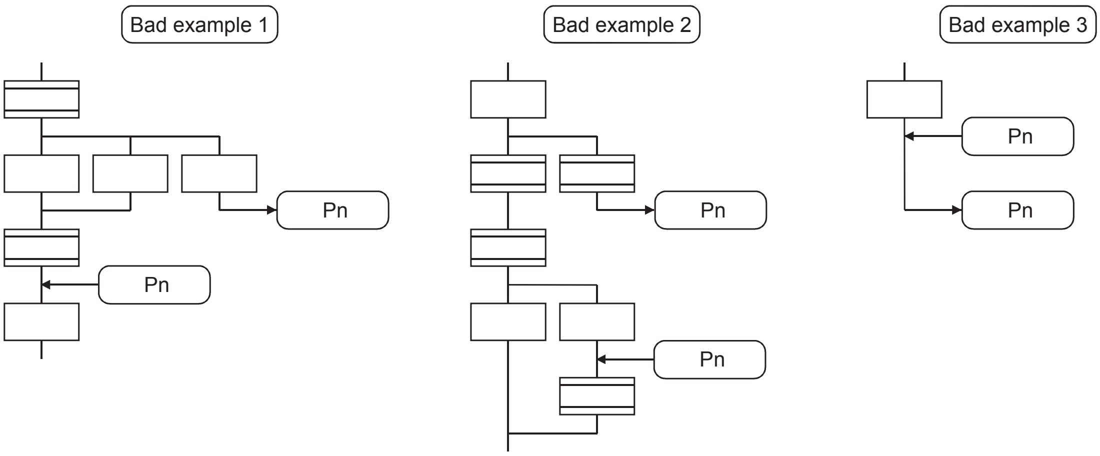
(c) Pointer Pn can be set from P0 to P16383 for a single program.

(2) Precautions

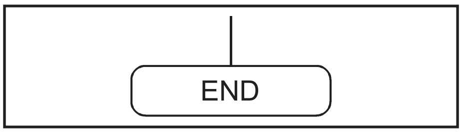
(a) It is not possible to set the kind of jumps that break from inside parallel branches to parallel coupling. (Bad example 1 below)

(b) It is not possible to set jumps inside parallel branches to parallel coupling from outside parallel branches to parallel coupling. (Bad example 2 below)

(c) Labels and jumps cannot be set consecutively. (Bad example 3 below)



5.9 END



(1) Operation description

(a) END is used to exit the program.

(b) When a subroutine is called, processing returns to the Motion SFC program from which the subroutine was called.

(2) Precautions

(a) Multiple ENDs can be set within a single program.

(b) An END cannot be set between a parallel branch and coupling.

(c) Output is maintained even after exiting a Motion SFC program with END.

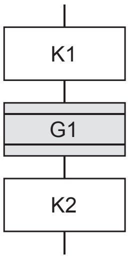
5.10 Branches and Couplings

5.10.1 Series transition

Series transitions are used to execute steps or transitions directly below those connected in series.
If wishing to start a servo program or subroutine and proceed to the next step by the following operation, set a WAIT or SHIFT in the transition.

(1) If wishing to proceed to the next step without waiting for the completion of operation:

Set a SHIFT in the transition.
In such cases, the transition (SHIFT) can be omitted.
If transitions are omitted, unconditional shift transition processing is performed.



Servo program K1 is started.

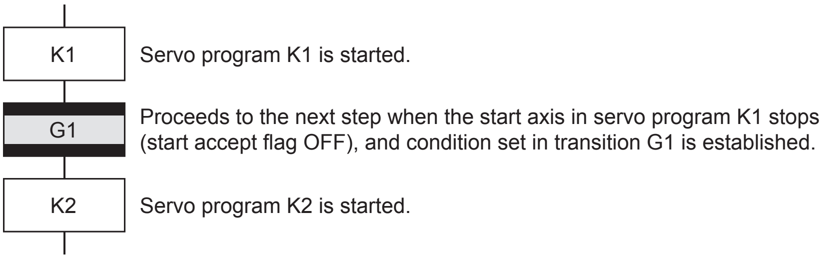
Proceeds to the next step when the condition set in transition G1 is established without waiting for the completion of the servo program K1 operation.

Servo program K2 is started.

POINT
With sub routine starting, the system processes its own program and the subroutine program in a parallel fashion.

(2) If wishing to proceed to the next step upon the completion of operation:

Set a WAIT in the transition.



POINT

(a) In the arrangement above, the start accept flag for the axis that is going to start up in the subsequent servo program K2 cannot be made as an interlock condition. If you still want it to be an interlock condition, set it by the user as the transition condition G1.

(b) If wishing to proceed to the next step upon the completion of operation, set the WAIT. If you do not have a condition in particular that has to be defined as an interlock condition, set "NOP (no process)" into the transition program (Gn).

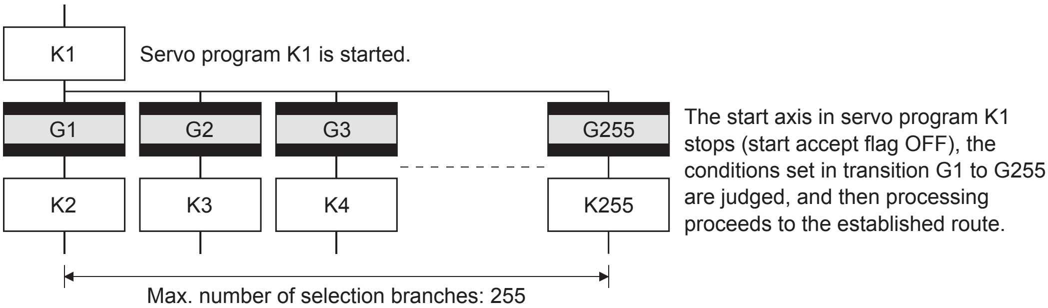
5.10.2 Selective branch and selective coupling

(1) Selection branch

Selection branches are used to judge the conditions for multiple transitions connected in series, and execute only the route for which conditions are established quickest.

Transitions are restricted to all SHIFT or all WAIT.

(Example) If WAIT



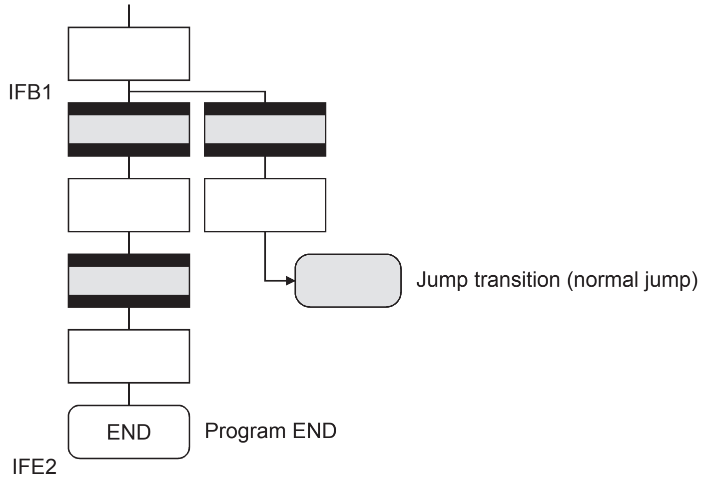
POINT

(a) The judgment of transition conditions is not necessarily performed in order from left to right.

(b) If SHIFTs and WAITs are mixed in the transition, the branch will be a parallel branch.

(2) Selective coupling

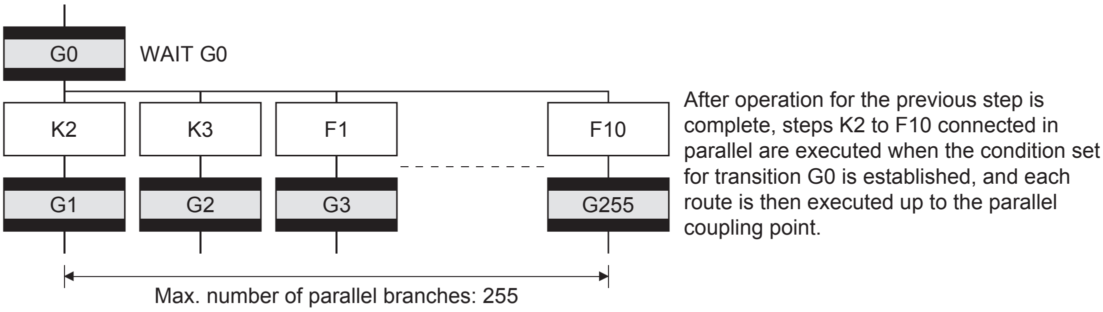
Selective coupling are used after selection branches if connecting to a single route again after completing the processing of each route, however, it is also possible to set not to be joined as shown below.



5.10.3 Parallel branch and parallel coupling

(1) Parallel branch

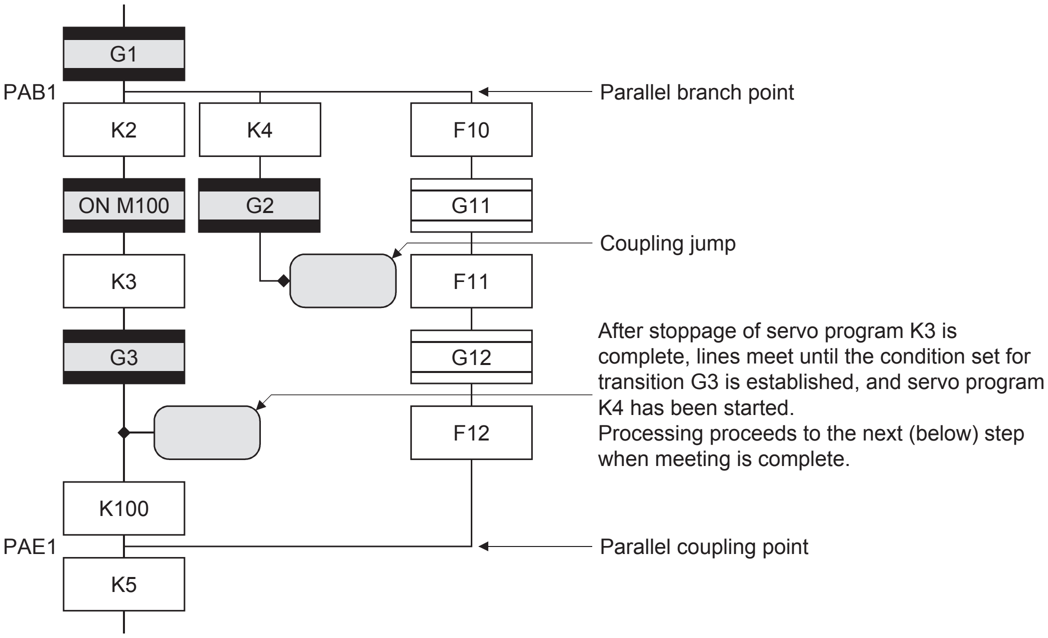
Multiple steps connected in parallel are executed simultaneously. The start of the parallel branch destination may be either a step or a transition.



POINT
A "SHIFT" or "WAIT" may also be set for transitions immediately before parallel branches. Neither "WAITON" nor "WAITOFF" can be set.

(2) Parallel coupling

If using parallel branches, always connect them to parallel coupling.
Jumps to other branch routes can be set between parallel branches and parallel coupling.
In such cases, the jump destination is a midway parallel coupling point (coupling jump).
It is not possible to set jumps that break from between parallel branches and parallel coupling.

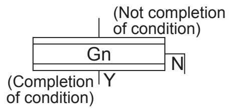
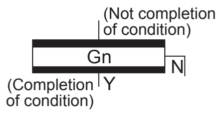


POINT

The setting is possible even if the number of the parallel branches and the number of connection of the parallel coupling point do not agree with the other. (The above example shows that the number the parallel branches is 3 while the number of the connection is 2.)

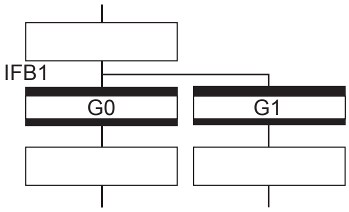
5.11 Y/N Transitions

If branching a route when transition conditions have or have not been established, it is helpful to use a "SHIFT Y/N transition" or "WAIT Y/N transition".

Name	Symbol	Function
SHIFT Y/N transition		• When a transition condition set at Gn enables, execution shifts to the lower step. When that condition disables, execution shifts to the right-connected step. • Differences between “Shift Y/N” and “WAIT Y/N” are the same as those between “Shift” and “WAIT”.
WAIT Y/N transition		

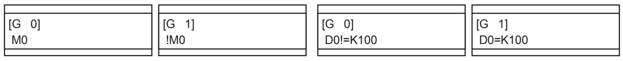
In this example, it has been made easy to describe a selection branch program for two routes as follows.

<Y/N transition not used>

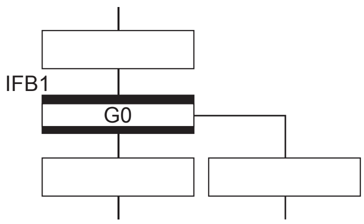


• G0 and G1 programs are restricted to cases in which the affirmation and negation in the conditional expression part differs only.

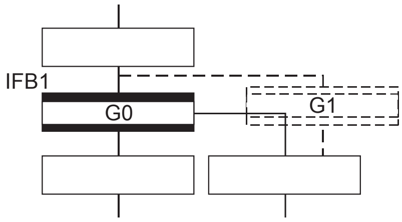
<Example 1> <Example 2>



<Y/N transition used>

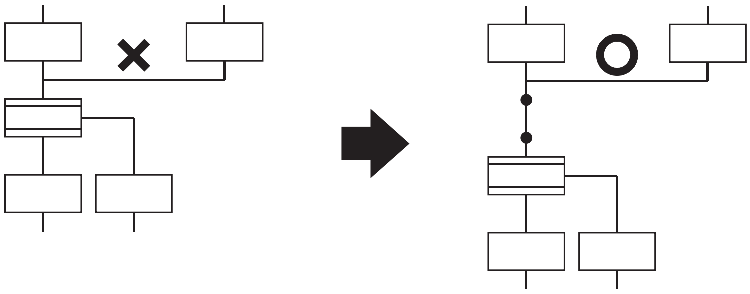


• Set the G0 program shown in <Example 1> and <Example 2> above in the G0 program.
• The Motion SFC program list and code following conversion will be the same as with the previous description. (The Motion SFC diagram expression will differ only.) Consequently, when editing the program, "an automatic search for a vacant G No. is performed, a program for which the conditional expression portion is logically negated is generated automatically", and two G programs are occupied.
If a Y/N transition is deleted when "editing the program", the automatically generated G program (G1 below) is not deleted. If deletion is necessary, delete at the "List of Used Program".



(1) Precautions

(a) If linking immediately before "SHIFT Y/N" or "WAIT Y/N", place a "consecutive coupling - branch" in between.



5.12 Task Operation

The timing at which Motion SFC programs are executed can be set for each program in the program parameters with a single task. Tasks are largely divided into three types as shown in the following table.

Task type	Details
Normal tasks	Execution during Motion CPU main cycle (spare time).
Event tasks	1. Executed at fixed cycles (0.222 ms, 0.444 ms, 0.888 ms, 1.777 ms, 3.555 ms, 7.111 ms, 14.222 ms). 2. Executed when the input set for the event task factor from among external interrupts (16 points of Interrupt pointers (I0 to I15)) is turned ON. 3. Executed with interrupt from PLC.
NMI tasks (Non-Maskable Interrupt)	Executed when the input set for the NMI task factor from among external interrupts (16 points of Interrupt pointers (I0 to I15)) is turned ON.

POINT

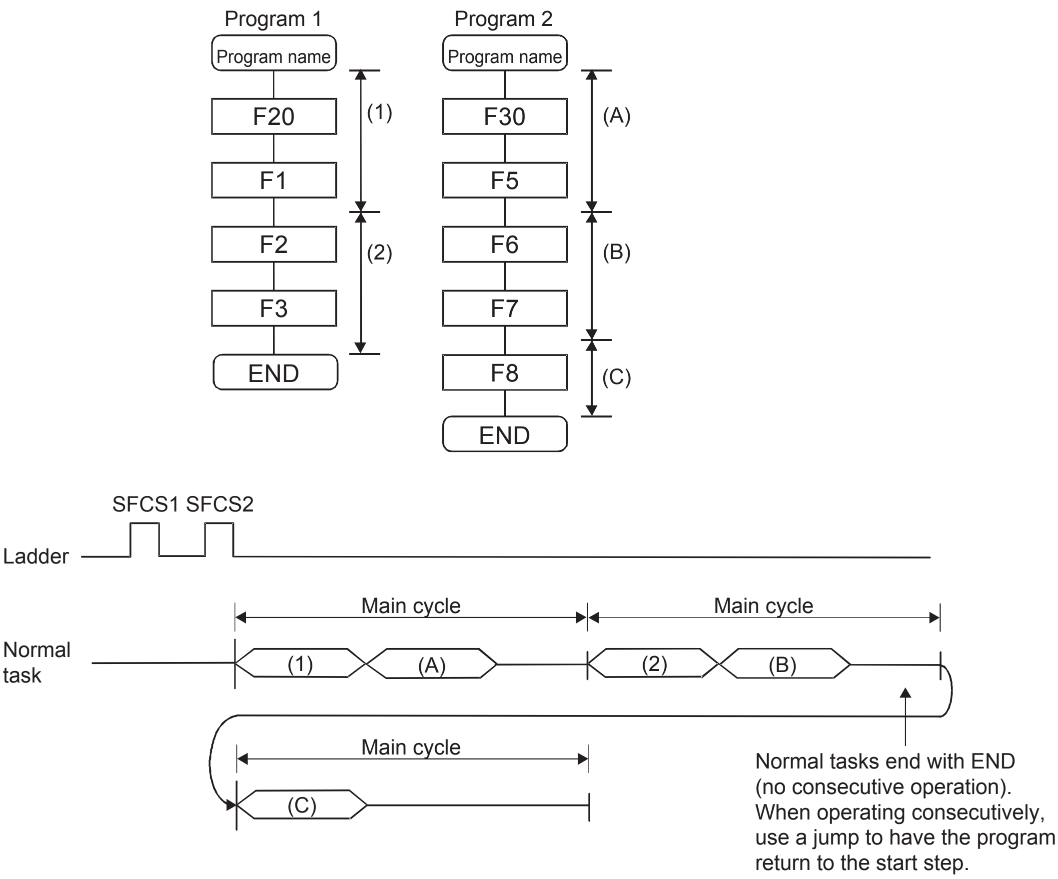
- The constant cycle event task operates independently from the operation cycle setting.
  (Example) Even if the operation cycle is set to 0.888 ms, the system still execute an event task of constant cycle 0.222 ms.
- As for setting the interrupt pointers (I0 through I15) in relation to input unit of the Motion CPU control, go to [R Series Common Parameters] → [Module Configuration List] to "Setting Item". There, press the "Details" button to call up the unit details setting screen for the intended setting.

(1) Normal tasks

[Operation description]

Motion SFC programs are executed during Motion CPU processing main cycles (spare time). The following is an overview of processing.

* Example of No. of consecutive transitions setting of Motion SFC parameter is "2"



POINT

(a) Set Motion SFC programs containing motion control steps for normal tasks.

(b) Execution of normal tasks is aborted while executing event tasks and NMI tasks.
However, with normal tasks, event task prohibition instruction (DI) can be specified in operation control steps, and therefore event task interrupts can be prohibited in parts enclosed with an event task prohibition instruction (DI) and event task enable instruction (EI). Check the "EI flag (SM752)" to see the state of the event task permission and event task prohibition.

(2) Event tasks

Event tasks trigger the execution of Motion SFC programs when events occur.
There are three types of events as follows.

(a) Fixed cycle
Fixed cycle events regularly trigger the execution of Motion SFC programs in a 0.222 ms, 0.444 ms, 0.888 ms, 1.777 ms, 3.555 ms, 7.111 ms, or 14.222 ms cycle.

(b) External interrupt (16 points from interrupt pointers (I0 to I15))
A Motion SFC program is executed when the input set for the event task from the 16 points of the interrupt pointers (I0 to I15) allocated to input unit of the Motion CPU control installed in the motion slot turns ON.

(c) Sequence interrupt
A Motion SFC program is executed when a M(P). GINT/D(P). GINT instruction is executed for a sequence program for another PLC CPU.

POINT

(1) Multiple events can be set for a single Motion SFC program. However, it is not possible to set multiple fixed cycles.
(2) It is also possible to execute multiple Motion SFC programs with a single event.
(3) Motion control steps cannot be executed inside event tasks.
(4) If event tasks are prohibited with a normal task, it will not be possible to execute event tasks. If an event occurs while event tasks are prohibited, they are executed the moment event tasks are enabled.

(3) NMI tasks

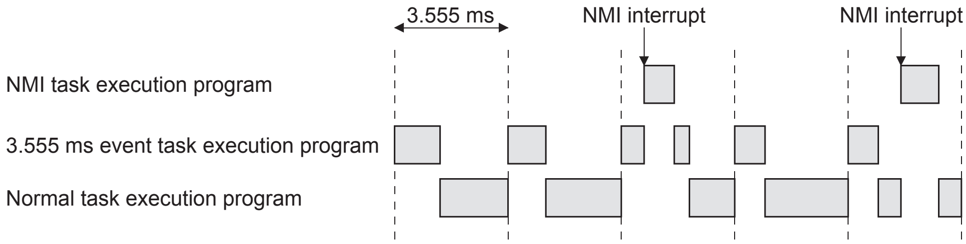
Motion SFC programs are executed when the input set for the NMI task factor from among external interrupts (16 points of the interrupt pointers (I0 to I15) allocated to input module of the Motion CPU control) is turned ON.

POINT

(1) NMI tasks are given the highest priority among normal tasks, event tasks, and NMI tasks.
(2) Even if event tasks are prohibited (DI) in a normal task, NMI task interrupts are performed without masking.
(3) When parallel branch occurs while executing an NMI task, the system will start executing the routes newly generated by the parallel branch from the time of next occurrence of an interrupt.

(4) Execution status example

The following diagram displays an example of the execution status for each Motion SFC program when Motion SFC programs are executed with multiple tasks.



If there is a program executed with an NMI task, program executed with a 3.555 ms fixed cycle event task, and a program executed with a normal task, as shown in the above diagram,

(a) 3.555 ms fixed cycle event tasks are executed every 3.555 ms,
(b) If an NMI interrupt is entered, priority is given to execution of the NMI task,
(c) And the normal task is executed during spare time.

5.13 SFC Parameters

There are two types of SFC parameters, "task parameters" used to control tasks (normal tasks, event tasks, NMI tasks), and "program parameters" set for each Motion SFC programs.

5.13.1 Task parameters

<table>
<tr><th>No.</th><th colspan="2">Item</th><th>Setting range</th><th>Default value</th><th>Remarks</th></tr>
<tr><td>1</td><td>No. of consecutive transitions</td><td>Normal tasks (Common to normal tasks)</td><td>1 to 30</td><td>3</td><td rowspan="5">This parameter reads values when the "[Rq.1120] PLC ready flag (M2000)" turns from OFF to ON, and then performs control. If setting or changing this parameter, turn the "[Rq.1120] PLC ready flag (M2000)" OFF.</td></tr>
<tr><td>2</td><td colspan="2">Interrupt setting</td><td>Sets an event task or NMI task for external interrupt input (I0 to I15).</td><td>Event task</td></tr>
<tr><td rowspan="3">3</td><td rowspan="3">Repeat control restriction count</td><td>Normal task</td><td>1 to 100000</td><td>1000</td></tr>
<tr><td>Event task</td><td>1 to 10000</td><td>100</td></tr>
<tr><td>NMI task</td><td>1 to 10000</td><td>100</td></tr>
</table>

5.13.2 Program parameters

The following parameters are set for each Motion SFC program.

<table>
<tr><th>No.</th><th>Item</th><th>Setting range</th><th>Default value</th><th>Remarks</th></tr>
<tr><td>1</td><td>Start setting</td><td>Sets whether to Start/Not start automatically.</td><td>Not start</td><td rowspan="7">This parameter reads values when the "[Rq.1120] PLC ready flag (M2000)" is ON, and then performs control. If setting or changing this parameter, turn the "[Rq.1120] PLC ready flag (M2000)" OFF.</td></tr>
<tr><td rowspan="3">2</td><td rowspan="3">Execution task</td><td>Only one from normal task, event task, NMI task</td><td>Normal task</td></tr>
<tr><td>If an event task is set, set another event to be enabled.
One of the follow 1 to 3 must be set.
1. Fixed cycle
One from 0.222 ms, 0.444 ms, 0.888 ms, 1.777 ms, 3.555 ms, 7.111 ms, or 14.222 ms, or none.
2. External interrupt (selected from those set for event task)
Multiple interrupts can be set from I0 to I15.
3. PLC interrupt
Multiple interrupts can be set from I0 to I15.
Multiple tasks can be set from 1 to 3.
This is possible even if the same event is shared with multiple Motion SFC programs.</td><td rowspan="2">None</td></tr>
<tr><td>If an NMI task is set, set another interrupt input to be enabled.
External interrupt (selected from those set for NMI task) Multiple interrupts can be set from I0 to I15.</td></tr>
<tr><td>3</td><td>No. of consecutive transitions</td><td>1 to 10
Set the No. of consecutive transitions for programs set for event tasks or NMI tasks.</td><td>1</td></tr>
<tr><td>4</td><td>END operation</td><td>End/continue
Set the END step operation mode for programs set for event tasks or NMI tasks.</td><td>End</td></tr>
<tr><td>5</td><td>Executing flag</td><td>None/bit device
Set the bit device to be turned ON during Motion SFC program execution. The following devices can be used.
X0 to X2FFF*1
Y0 to Y2FFF
M0 to M12287
B0 to B1FFF
D0 to D20479 *2
W0 to W1FFF *2
#0 to #12287 *2
U□\G10000.0 to U□\G(10000+p-1).F*2</td><td>None</td></tr>
</table>

*1. With input devices (PXn+0 to PXn+F) allocated to the Motion CPU built-in interface (DI), the PXn+4 to PXn+F range is fixed at 0, and cannot be used. (n = first input No.)

*2. These can be used only when the bit of word device is specified.

5.14 Motion SFC Program Start Method

Motion SFC programs run while "[Rq.1120] PLC ready flag (M2000)" is ON.
There are three ways of starting Motion SFC programs as follows.

(1) Automatic start

(2) Start from Motion SFC program

(3) Start with dedicated motion sequence instructions (M(P). SFCS/D(P). SFCS) from another PLC

The start method is set in the program parameters for each Motion SFC program.

(1) Automatic start

Motion SFC programs are started automatically by turning the "[Rq.1120] PLC ready flag (M2000)" ON.

(2) Start from Motion SFC program

Motion SFC programs are started by executing a subroutine call/start step in the Motion SFC program.

(3) Start with dedicated motion sequence instructions (M(P). SFCS/D(P). SFCS) from another PLC

Motion SFC programs are started by executing a M(P). SFCS/D(P). SFCS instructions with a PLC program.

5.15 Motion SFC Program Exit Method

There are three ways of exiting Motion SFC programs as follows.

(1) Motion SFC programs are exited by executing an END set in the Motion SFC program.

(2) Motion SFC programs are stopped by turning "[Rq.1120] PLC ready flag (M2000)" OFF.

(3) Motion SFC programs are exited with a clear step.

POINT

(a) Multiple ENDs can be set for a single Motion SFC program.
(b) Motion SFC programs are exited even if set to start automatically.

Chapter 6 Servo Programs

6.1 Servo Programs

A servo program is used to specify the type of positioning control required to control positioning, as well as positioning data. This section describes the servo program configuration and specification method.

> This servo program controls servo motors, and the applicable servo instructions are shown in the "Servo instructions lists".

6.1.1 Servo program configuration

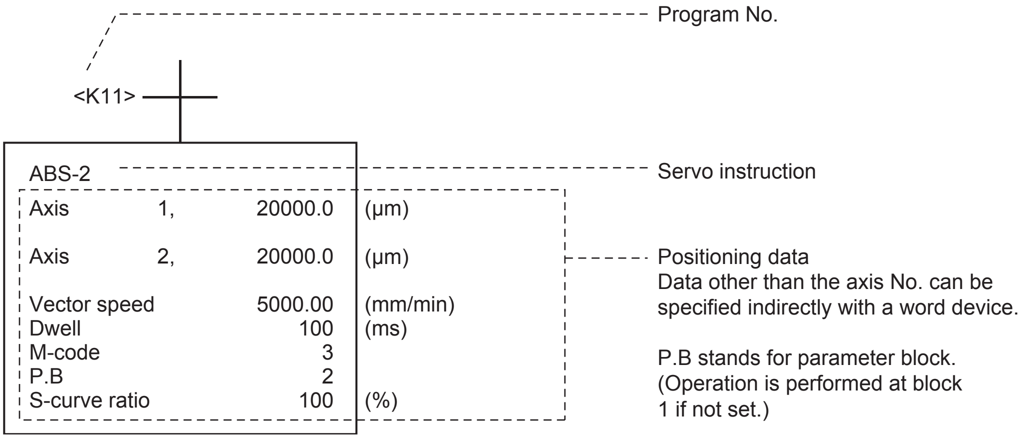
A single servo program consists of the following (1) to (3).

(1) Program No. .... This number is used to specify start requests in the sequence program, and a random number can be set from 0 to 4095.

0 to 4095

(2) Servo instruction .... Indicates the positioning control type.

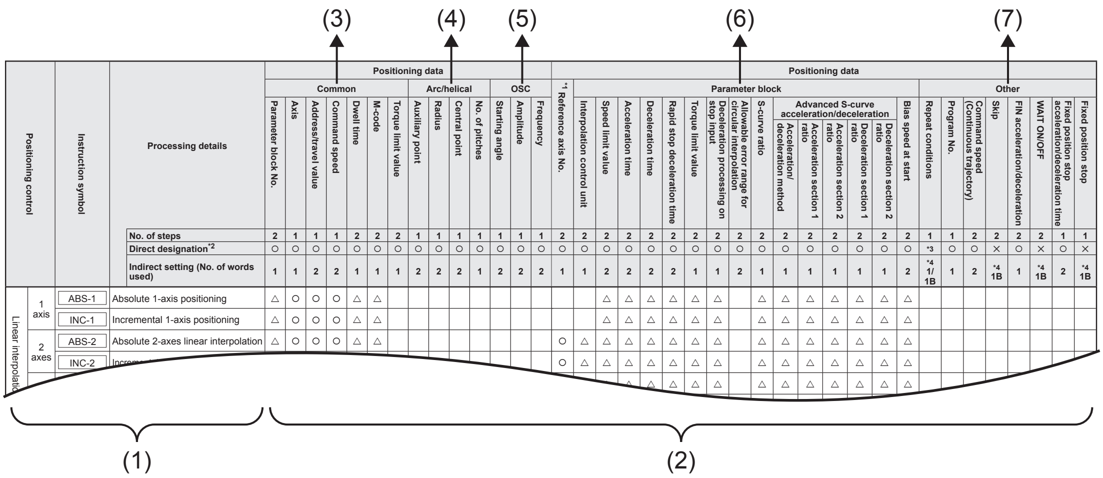
(3) Positioning data .... This is data required to execute servo instructions. The data required to execute the instructions is fixed in each servo command.



6.1.2 Servo instruction lists

Lists of servo instructions used in servo programs are shown on the following pages.

(1) Viewing the instruction lists



No.	Content	
(1)	Instruction symbol	Describes servo instructions that can be used in servo programs.
	Processing details	Provides an overview of servo instruction processing.
(2)	1: Shows positioning data that can be set in servo instructions. (a) ○: Items that must be set (Data for which it will not be possible to execute servo instructions if not set) (b) △: Items set when required (Data controlled with default value if not set)	
	2: Direct/indirect designation possible (exc. axis No.) (a) Direct designation: Set with numerical value. (b) Indirect designation: Set with word device. · Servo program execution is controlled with the content of the set word device. · 1 word data or 2 word data is used depending on the setting item. · If 2 word data, the first device No. is set.	
(3)	Items common to all servo instructions	
(4)	Items set in circular interpolation start servo programs	
(5)	High-speed oscillating setting items	
(6)	Set when performing control after changing parameter block (default values used if not set) data set at the servo program. (Parameter block data is not changed.)	
(7)	Setting items other than common, circular, parameter block (The items set will differ depending on the servo instruction.)	

MEMO

(2) Servo instruction lists

Lists of servo instructions that can be used with servo programs and positioning data set with servo instructions are shown on the following table.

Positioning control		Instruction symbol	Processing details	Positioning data													
				Common							Arc/helical				OSC		
				Parameter block No.	Axis	Address/travel value	Command speed	Dwell time	M-code	Torque limit value	Auxiliary point	Radius	Central point	No. of pitches	Starting angle	Amplitude	Frequency
			No. of steps	2	1	1	1	2	2	2	1	1	1	1	1	1	1
			Direct designation*2	○	○	○	○	○	○	○	○	○	○	○	○	○	○
			Indirect setting (No. of words used)	1	1	2	2	1	1	1	2	2	2	1	2	2	2
Linear interpolation control	1 axis	ABS-1	Absolute 1-axis positioning	△	○	○	○	△	△								
		INC-1	Incremental 1-axis positioning	△	○	○	○	△	△								
	2 axes	ABS-2	Absolute 2-axes linear interpolation	△	○	○	○	△	△								
		INC-2	Incremental 2-axes linear interpolation	△	○	○	○	△	△								
	3 axes	ABS-3	Absolute 3-axes linear interpolation	△	○	○	○	△	△								
		INC-3	Incremental 3-axes linear interpolation	△	○	○	○	△	△								
	4 axes	ABS-4	Absolute 4-axes linear interpolation	△	○	○	○	△	△								
		INC-4	Incremental 4-axes linear interpolation	△	○	○	○	△	△								
Circular interpolation control	Auxiliary point designation	ABS	Absolute auxiliary point-specified circular interpolation	△	○	○	○	△	△		○						
		INC	Incremental auxiliary point-specified circular interpolation	△	○	○	○	△	△		○						
	Radius designation	ABS	Absolute radius-specified circular interpolation less than CW 180°	△	○	○	○	△	△			○					
		ABS	Absolute radius-specified circular interpolation CW 180° or more	△	○	○	○	△	△			○					
		ABS	Absolute radius-specified circular interpolation less than CCW 180°	△	○	○	○	△	△			○					
		ABS	Absolute radius-specified circular interpolation CCW 180° or more	△	○	○	○	△	△			○					
		INC	Incremental radius-specified circular interpolation less than CW 180°	△	○	○	○	△	△			○					
		INC	Incremental radius-specified circular interpolation CW 180° or more	△	○	○	○	△	△			○					
		INC	Incremental radius-specified circular interpolation less than CCW 180°	△	○	○	○	△	△			○					
		INC	Incremental radius-specified circular interpolation CCW 180° or more	△	○	○	○	△	△			○					

	Positioning data																							
	*1 Reference axis No.	Parameter block															Other							
		Interpolation control unit	Speed limit value	Acceleration time	Deceleration time	Rapid stop deceleration time	Torque limit value	Deceleration processing on stop input	Allowable error range for circular interpolation	S-curve ratio	Advanced S-curve acceleration/deceleration					Bias speed at start	Repeat conditions	Program No.	Command speed (Continuous trajectory)	Skip	FIN acceleration/deceleration	WAIT ON/OFF	Fixed position stop acceleration/deceleration time	Fixed position stop
											Acceleration/ deceleration method	Acceleration section 1 ratio	Acceleration section 2 ratio	Deceleration section 1 ratio	Deceleration section 2 ratio									
	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	2	2	2	2	1	1
	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	*3	○	○	×	○	×	○	×
	1	1	2	2	2	2	1	1	2	1	1	1	1	1	1	2	*4 1/ 1(B)	1	2	*4 1(B)	1	*4 1(B)	2	*4 1(B)
			△	△	△	△	△	△		△	△	△	△	△	△	△								
			△	△	△	△	△	△		△	△	△	△	△	△	△								
	○	△	△	△	△	△	△	△		△	△	△	△	△	△	△								
	○	△	△	△	△	△	△	△		△	△	△	△	△	△	△								
	○	△	△	△	△	△	△	△		△	△	△	△	△	△	△								
	○	△	△	△	△	△	△	△		△	△	△	△	△	△	△								
	○	△	△	△	△	△	△	△		△	△	△	△	△	△	△								
	○	△	△	△	△	△	△	△		△	△	△	△	△	△	△								
		△	△	△	△	△	△	△	△	△	△	△	△	△	△	△								
		△	△	△	△	△	△	△	△	△	△	△	△	△	△	△								
		△	△	△	△	△	△	△	△	△	△	△	△	△	△	△								
		△	△	△	△	△	△	△	△	△	△	△	△	△	△	△								
		△	△	△	△	△	△	△	△	△	△	△	△	△	△	△								
		△	△	△	△	△	△	△	△	△	△	△	△	△	△	△								
		△	△	△	△	△	△	△	△	△	△	△	△	△	△	△								
		△	△	△	△	△	△	△	△	△	△	△	△	△	△	△								
		△	△	△	△	△	△	△	△	△	△	△	△	△	△	△								
		△	△	△	△	△	△	△	△	△	△	△	△	△	△	△								

○: Items that must be set, △: Items set when required
*1: Only when reference axis speed specified
*2: Where using the MT Developer2 for direct setting, convert the exponential notation to a floating point notation for the setting.
*3: Word device: ○
Bit device: ×
*4: (B) indicates bit device.

Positioning control		Instruction symbol	Processing details	Positioning data: Common: Parameter block No.	Axis	Address/travel value	Command speed	Dwell time	M-code	Torque limit value	Arc/helical: Auxiliary point	Radius	Central point	No. of pitches	OSC: Starting angle	Amplitude	Frequency
			No. of steps	2	1	1	1	2	2	2	1	1	1	1	1	1	1
			Direct designation*2	○	○	○	○	○	○	○	○	○	○	○	○	○	○
			Indirect setting (No. of words used)	1	1	2	2	1	1	1	2	2	2	1	2	2	2
Circular interpolation control	Center point designation	ABS	Absolute central point-specified circular interpolation CW	△	○	○	○	△	△				○				
		ABS	Absolute central point-specified circular interpolation CCW	△	○	○	○	△	△				○				
		INC	Incremental central point-specified circular interpolation CW	△	○	○	○	△	△				○				
		INC	Incremental central point-specified circular interpolation CCW	△	○	○	○	△	△				○				
Helical interpolation control	Auxiliary point designation	ABH	Absolute auxiliary point-specified helical interpolation	△	○	○	○	△	△		○			○			
		INH	Incremental auxiliary point-specified helical interpolation	△	○	○	○	△	△		○			○			
	Radius designation	ABH	Absolute radius-specified helical interpolation less than CW 180°	△	○	○	○	△	△			○		○			
		ABH	Absolute radius-specified helical interpolation CW 180° or more	△	○	○	○	△	△			○		○			
		ABH	Absolute radius-specified helical interpolation less than CCW 180°	△	○	○	○	△	△			○		○			
		ABH	Absolute radius-specified helical interpolation CCW 180° or more	△	○	○	○	△	△			○		○			
		INH	Incremental radius-specified helical interpolation less than CW 180°	△	○	○	○	△	△			○		○			
		INH	Incremental radius-specified helical interpolation CW 180° or more	△	○	○	○	△	△			○		○			
		INH	Incremental radius-specified helical interpolation less than CCW 180°	△	○	○	○	△	△			○		○			
		INH	Incremental radius-specified helical interpolation CCW 180° or more	△	○	○	○	△	△			○		○			
	Center point designation	ABH	Absolute central point-specified helical interpolation CW	△	○	○	○	△	△				○	○			
		ABH	Absolute central point-specified helical interpolation CCW	△	○	○	○	△	△				○	○			
		INH	Incremental central point-specified helical interpolation CW	△	○	○	○	△	△				○	○			
		INH	Incremental central point-specified helical interpolation CCW	△	○	○	○	△	△				○	○			

	Positioning data																							
		Parameter block															Other							
											Advanced S-curve acceleration/deceleration													
	*1 Reference axis No.	Interpolation control unit	Speed limit value	Acceleration time	Deceleration time	Rapid stop deceleration time	Torque limit value	Deceleration processing on stop input	Allowable error range for circular interpolation	S-curve ratio	Acceleration/ deceleration method	Acceleration section 1 ratio	Acceleration section 2 ratio	Deceleration section 1 ratio	Deceleration section 2 ratio	Bias speed at start	Repeat conditions	Program No.	Command speed (Continuous trajectory)	Skip	FIN acceleration/deceleration	WAIT ON/OFF	Fixed position stop acceleration/deceleration time	Fixed position stop
	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	2	2	2	2	1	1
	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	*3	○	○	×	○	×	○	×
	1	1	2	2	2	2	1	1	2	1	1	1	1	1	1	2	*4 1/ 1(B)	1	2	*4 1(B)	1	*4 1(B)	2	*4 1(B)
		△	△	△	△	△	△	△	△	△	△	△	△	△	△	△								
		△	△	△	△	△	△	△	△	△	△	△	△	△	△	△								
		△	△	△	△	△	△	△	△	△	△	△	△	△	△	△								
		△	△	△	△	△	△	△	△	△	△	△	△	△	△	△								
		△	△	△	△	△	△	△		△	△	△	△	△	△	△								
		△	△	△	△	△	△	△		△	△	△	△	△	△	△								
		△	△	△	△	△	△	△		△	△	△	△	△	△	△								
		△	△	△	△	△	△	△		△	△	△	△	△	△	△								
		△	△	△	△	△	△	△		△	△	△	△	△	△	△								
		△	△	△	△	△	△	△		△	△	△	△	△	△	△								
		△	△	△	△	△	△	△		△	△	△	△	△	△	△								
		△	△	△	△	△	△	△		△	△	△	△	△	△	△								
		△	△	△	△	△	△	△		△	△	△	△	△	△	△								
		△	△	△	△	△	△	△		△	△	△	△	△	△	△								
		△	△	△	△	△	△	△		△	△	△	△	△	△	△								
		△	△	△	△	△	△	△		△	△	△	△	△	△	△								
		△	△	△	△	△	△	△		△	△	△	△	△	△	△								
		△	△	△	△	△	△	△		△	△	△	△	△	△	△								

○: Items that must be set, △: Items set when required
*1: Only when reference axis speed specified
*2: Where using the MT Developer2 for direct setting, convert the exponential notation to a floating point notation for the setting.
*3: Word device: ○
Bit device: ×
*4: (B) indicates bit device.

Positioning control		Instruction symbol	Processing details	Positioning data													
				Common							Arc/helical				OSC		
				Parameter block No.	Axis	Address/travel value	Command speed	Dwell time	M-code	Torque limit value	Auxiliary point	Radius	Central point	No. of pitches	Starting angle	Amplitude	Frequency
			No. of steps	2	1	1	1	2	2	2	1	1	1	1	1	1	1
			Direct designation[*2]	○	○	○	○	○	○	○	○	○	○	○	○	○	○
			Indirect setting (No. of words used)	1	1	2	2	1	1	1	2	2	2	1	2	2	2
Fixed feed	1 axis	FEED-1	1-axis fixed-pitch feed start	△	○	○	○	△	△								
	2 axis	FEED-2	2-axes linear interpolation fixed-pitch feed start	△	○	○	○	△	△								
	3 axis	FEED-3	3-axes linear interpolation fixed-pitch feed start	△	○	○	○	△	△								
Speed control (I)	Forward rotation	VF	Speed control (I) forward rotation start	△	○		○		△								
	Reverse rotation	VR	Speed control (I) reverse rotation start	△	○		○		△								
Speed control (II)	Forward rotation	VVF	Speed control (II) forward rotation start	△	○		○		△	△							
	Reverse rotation	VVR	Speed control (II) reverse rotation start	△	○		○		△	△							
Speed, position switching	Forward rotation	VPF	Speed-position switching control forward rotation start	△	○	○	○	△	△	△							
	Reverse rotation	VPR	Speed-position switching control reverse rotation start	△	○	○	○	△	△	△							
	Restart	VPSTART	Speed-position switching control restart		○												
Fixed position stop speed control	Forward rotation	PVF	Speed control with fixed position stop absolute specification	△	○	○	○	△	△								
	Reverse rotation	PVR		△	○	○	○	△	△								

	Positioning data																							
		Parameter block															Other							
											Advanced S-curve acceleration/deceleration													
	*1 Reference axis No.	Interpolation control unit	Speed limit value	Acceleration time	Deceleration time	Rapid stop deceleration time	Torque limit value	Deceleration processing on stop input	Allowable error range for circular interpolation	S-curve ratio	Acceleration/ deceleration method	Acceleration section 1 ratio	Acceleration section 2 ratio	Deceleration section 1 ratio	Deceleration section 2 ratio	Bias speed at start	Repeat conditions	Program No.	Command speed (Continuous trajectory)	Skip	FIN acceleration/deceleration	WAIT ON/OFF	Fixed position stop acceleration/deceleration time	Fixed position stop
	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	2	2	2	2	1	1
	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	*3	○	○	×	○	×	○	×
	1	1	2	2	2	2	1	1	2	1	1	1	1	1	1	2	*4 1/ 1(B)	1	2	*4 1(B)	1	*4 1(B)	2	*4 1(B)
			△	△	△	△	△	△		△	△	△	△	△	△	△								
		△	△	△	△	△	△	△		△	△	△	△	△	△	△								
		△	△	△	△	△	△	△		△	△	△	△	△	△	△								
			△	△	△	△	△	△		△	△	△	△	△	△	△								
			△	△	△	△	△	△		△	△	△	△	△	△	△								
			△	△	△	△	△	△		△	△	△	△	△	△	△								
			△	△	△	△	△	△		△	△	△	△	△	△	△								
			△	△	△	△	△	△		△	△	△	△	△	△	△								
			△	△	△	△	△	△		△	△	△	△	△	△	△								
			△		△	△	△	△		△	△	△	△	△	△	△							○	○
			△		△	△	△	△		△	△	△	△	△	△	△							○	○

○: Items that must be set, △: Items set when required
*1: Only when reference axis speed specified
*2: Where using the MT Developer2 for direct setting, convert the exponential notation to a floating point notation for the setting.
*3: Word device: ○
Bit device: ×
*4: (B) indicates bit device.

Positioning control	Instruction symbol	Processing details	Positioning data														
			Common							Arc/helical				OSC			
			Parameter block No.	Axis	Address/travel value	Command speed	Dwell time	M-code	Torque limit value	Auxiliary point	Radius	Central point	No. of pitches	Starting angle	Amplitude	Frequency	
		No. of steps	2	1	1	1	2	2	2	1	1	1	1	1	1	1	
		Direct designation*2	○	○	○	○	○	○	○	○	○	○	○	○	○	○	
		Indirect setting (No. of words used)	1	1	2	2	1	1	1	2	2	2	1	2	2	2	
Continuous trajectory control	CPSTART1	1-axis continuous trajectory control start	△	○		○											
	CPSTART2	2-axis continuous trajectory control start	△	○		○											
	CPSTART3	3-axis continuous trajectory control start	△	○		○											
	CPSTART4	4-axis continuous trajectory control start	△	○		○											
	ABS-1	Continuous trajectory control passing point absolute specification		○	○			△	△								
	ABS-2			○	○			△	△								
	ABS-3			○	○			△	△								
	ABS-4			○	○			△	△								
	ABS			○	○			△	△	○							
	ABS			○	○			△	△		○						
	ABS			○	○			△	△		○						
	ABS			○	○			△	△		○						
	ABS			○	○			△	△		○						
	ABS			○	○			△	△			○					
	ABS			○	○			△	△			○					

	Positioning data																								
	*1	Parameter block															Other								
											Advanced S-curve acceleration/deceleration														
	Reference axis No.	Interpolation control unit	Speed limit value	Acceleration time	Deceleration time	Rapid stop deceleration time	Torque limit value	Deceleration processing on stop input	Allowable error range for circular interpolation	S-curve ratio	Acceleration/ deceleration method	Acceleration section 1 ratio	Acceleration section 2 ratio	Deceleration section 1 ratio	Deceleration section 2 ratio	Bias speed at start	Repeat conditions	Program No.	Command speed (Continuous trajectory)	Skip	FIN acceleration/deceleration	WAITON/OFF	Fixed position stop acceleration/deceleration time	Fixed position stop
	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	2	2	2	2	1	1
	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	*3	○	○	×	○	×	○	×
	1	1	2	2	2	2	1	1	2	1	1	1	1	1	1	2	*4 1/ 1(B)	1	2	*4 1(B)	1	*4 1(B)	2	*4 1(B)
			△	△	△	△	△	△		△	△	△	△	△	△	△					△			
		△	△	△	△	△	△	△	△	△	△	△	△	△	△	△					△			
		△	△	△	△	△	△	△	△	△	△	△	△	△	△	△					△			
		△	△	△	△	△	△	△	△	△	△	△	△	△	△	△					△			
																			△	△		△		
																			△	△		△		
																			△	△		△		
																			△	△		△		
																			△	△		△		
																			△	△		△		
																			△	△		△		
																			△	△		△		
																			△	△		△		
																			△	△		△		
																			△	△		△		

○: Items that must be set, △: Items set when required
*1: Only when reference axis speed specified
*2: Where using the MT Developer2 for direct setting, convert the exponential notation to a floating point notation for the setting.
*3: Word device: ○
Bit device: ×
*4: (B) indicates bit device.

Positioning control	Instruction symbol	Processing details	Positioning data													
			Common							Arc/helical				OSC		
			Parameter block No.	Axis	Address/travel value	Command speed	Dwell time	M-code	Torque limit value	Auxiliary point	Radius	Central point	No. of pitches	Starting angle	Amplitude	Frequency
		No. of steps	2	1	1	1	2	2	2	1	1	1	1	1	1	1
		Direct designation*2	○	○	○	○	○	○	○	○	○	○	○	○	○	○
		Indirect setting (No. of words used)	1	1	2	2	1	1	1	2	2	2	1	2	2	2
Continuous trajectory control	ABH	Continuous trajectory control passing point helical absolute specification		○	○			△	△	○			○			
	ABH			○	○			△	△		○		○			
	ABH			○	○			△	△		○		○			
	ABH			○	○			△	△		○		○			
	ABH			○	○			△	△		○		○			
	ABH			○	○			△	△			○	○			
	ABH			○	○			△	△			○	○			
	INC-1	Continuous trajectory control passing point incremental specification		○	○			△	△							
	INC-2			○	○			△	△							
	INC-3			○	○			△	△							
	INC-4			○	○			△	△							
	INC			○	○			△	△	○						
	INC			○	○			△	△		○					
	INC			○	○			△	△		○					
	INC			○	○			△	△		○					
	INC			○	○			△	△		○					
	INC			○	○			△	△			○				
	INC			○	○			△	△			○				

	Positioning data																							
		Parameter block															Other							
											Advanced S-curve acceleration/deceleration													
	*1 Reference axis No.	Interpolation control unit	Speed limit value	Acceleration time	Deceleration time	Rapid stop deceleration time	Torque limit value	Deceleration processing on stop input	Allowable error range for circular interpolation	S-curve ratio	Acceleration/ deceleration method	Acceleration section 1 ratio	Acceleration section 2 ratio	Deceleration section 1 ratio	Deceleration section 2 ratio	Bias speed at start	Repeat conditions	Program No.	Command speed (Continuous trajectory)	Skip	FIN acceleration/deceleration	WAITON/OFF	Fixed position stop acceleration/deceleration time	Fixed position stop
	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	2	2	2	2	1	1
	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	*3	○	○	×	○	×	○	×
	1	1	2	2	2	2	1	1	2	1	1	1	1	1	1	2	*4 1/ 1(B)	1	2	*4 1(B)	1	*4 1(B)	2	*4 1(B)
																			△	△		△		
																			△	△		△		
																			△	△		△		
																			△	△		△		
																			△	△		△		
																			△	△		△		
																			△	△		△		
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																			△	△		△		
																			△	△		△		
																			△	△		△		
																			△	△		△		
																			△	△		△		
																			△	△		△		
																			△	△		△		
																			△	△		△		
																			△	△		△		
																			△	△		△		

○: Items that must be set, △: Items set when required
*1: Only when reference axis speed specified
*2: Where using the MT Developer2 for direct setting, convert the exponential notation to a floating point notation for the setting.
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Bit device: ×
*4: (B) indicates bit device.

Positioning control	Instruction symbol	Processing details	Positioning data													
			Common							Arc/helical				OSC		
			Parameter block No.	Axis	Address/travel value	Command speed	Dwell time	M-code	Torque limit value	Auxiliary point	Radius	Central point	No. of pitches	Starting angle	Amplitude	Frequency
		No. of steps	2	1	1	1	2	2	2	1	1	1	1	1	1	1
		Direct designation*2	○	○	○	○	○	○	○	○	○	○	○	○	○	○
		Indirect setting (No. of words used)	1	1	2	2	1	1	1	2	2	2	1	2	2	2
Continuous trajectory control	INH	Continuous trajectory control passing point helical incremental specification		○	○			△	△	○			○			
	INH			○	○			△	△		○		○			
	INH			○	○			△	△		○		○			
	INH			○	○			△	△		○		○			
	INH			○	○			△	△		○		○			
	INH			○	○			△	△			○	○			
	INH			○	○			△	△			○	○			
	CPEND	Continuous trajectory control end					△									
	FOR-TIMES	Repeat range start setting for repeat of the same control														
	FOR-ON															
	FOR-OFF															
	NEXT	Repeat range end setting for repeat of the same control														
Position follow-up control	PFSTART	Position follow-up control start	△	○	○	○		△								
High speed oscillation	OSC	High speed oscillation	△	○				△						○	○	○
Simultaneous start	START	Simultaneous start														
Home position return	ZERO	Home position return start		○												
Current value change	CHGA	Shaft Current Value Change		○	○											

	Positioning data																							
	*1 Reference axis No.	Parameter block															Other							
		Interpolation control unit	Speed limit value	Acceleration time	Deceleration time	Rapid stop deceleration time	Torque limit value	Deceleration processing on stop input	Allowable error range for circular interpolation	S-curve ratio	Advanced S-curve acceleration/deceleration					Bias speed at start	Repeat conditions	Program No.	Command speed (Continuous trajectory)	Skip	FIN acceleration/deceleration	WAITON/OFF	Fixed position stop acceleration/deceleration time	Fixed position stop
											Acceleration/ deceleration method	Acceleration section 1 ratio	Acceleration section 2 ratio	Deceleration section 1 ratio	Deceleration section 2 ratio									
	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	2	2	2	2	1	1
	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	*3	○	○	×	○	×	○	×
	1	1	2	2	2	2	1	1	2	1	1	1	1	1	1	2	*4 1/ 1(B)	1	2	*4 1(B)	1	*4 1(B)	2	*4 1(B)
																			△	△		△		
																			△	△		△		
																			△	△		△		
																			△	△		△		
																			△	△		△		
																			△	△		△		
																			△	△		△		
																	○							
																	○							
																	○							
			△	△	△	△	△	△		△	△	△	△	△	△	△								
							△																	
																		○						

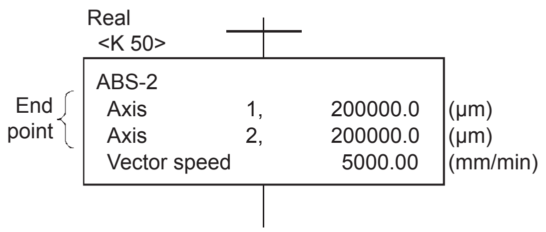
○: Items that must be set, △: Items set when required
*1: Only when reference axis speed specified
*2: Where using the MT Developer2 for direct setting, convert the exponential notation to a floating point notation for the setting.
*3: Word device: ○
Bit device: ×
*4: (B) indicates bit device.

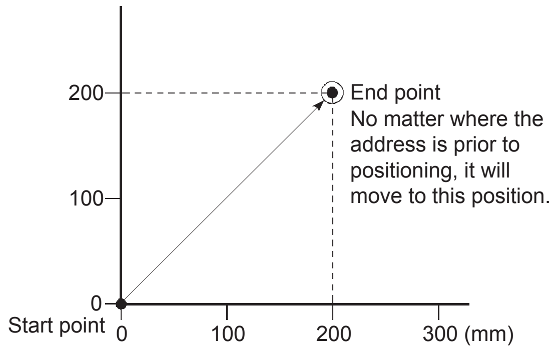
6.1.3 Linear control

Control of 1 to 4 axes with ABS-1 to ABS-4 (absolute method)

(1) Controls positioning from the current stop address (address prior to positioning) with home position as reference to the specified address.

(2) The movement direction is determined based on the current stop address and specified address.





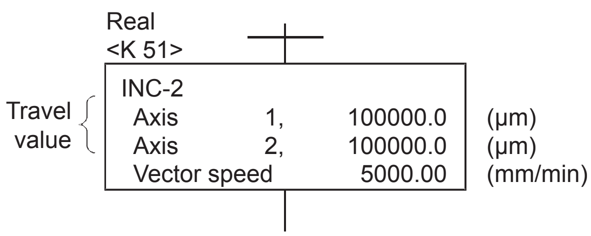
Linear control of 1 to 4 axes with INC-1 to INC-4 (incremental method)

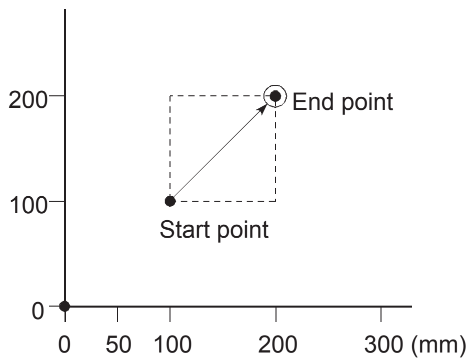
(1) Controls positioning by the specified travel value from the current stop position address.

(2) The movement direction is determined based on the movement symbol (+/-).

(a) When the movement direction is positive:
Forward direction (address increase direction) positioning

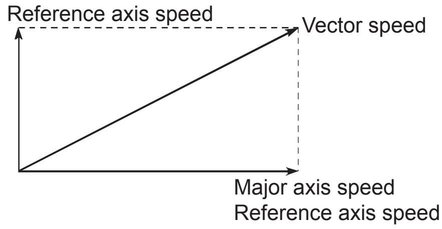
(b) When the movement direction is negative:
Reverse direction (address decrease direction) positioning





Speed designation (speed type) when performing linear 2 axis, 3 axis, and 4 axis interpolation control

1. Vector speed
   This is the speed designation for moving with interpolation.
2. Major axis speed
   This the speed for the interpolation axis with longest movement.
   (Major axes are judged and processed automatically.)
3. Reference axis speed
   This is the speed setting for the axis to be set as reference from among interpolation axes.



6.1.4 Circular interpolation control for interpolation point designation

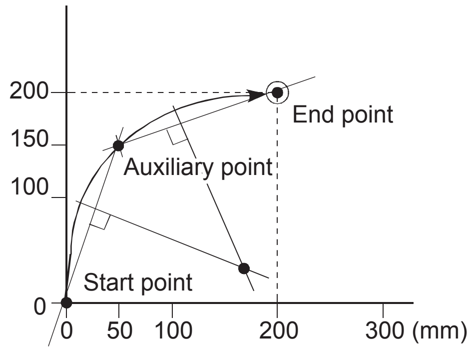
Control of 2 axes with ABS (absolute method)

(1) Performs circular interpolation from the current stop address (address prior to positioning) with home position as reference to the end point address via the specified auxiliary point address.

(2) This is an arc produced with point the start address (current stop address) and auxiliary point address intersects the auxiliary point address and end point address perpendicular bisector as the center point.

Real
<K 52>

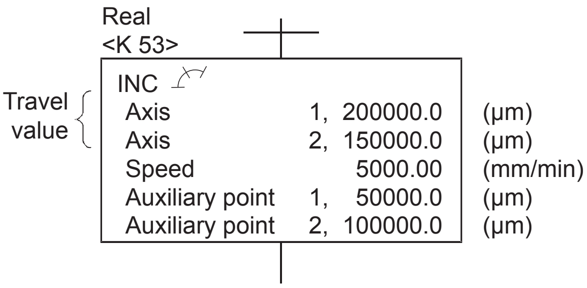
	ABS			
End point	Axis	1,	200000.0	(μm)
	Axis	2,	200000.0	(μm)
	Speed		5000.00	(mm/min)
	Auxiliary point	1,	50000.0	(μm)
	Auxiliary point	2,	150000.0	(μm)

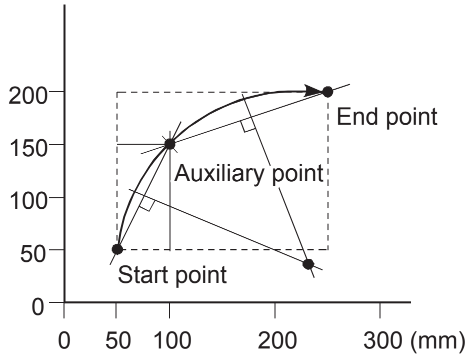


Control of 2 axes with INC (incremental method)

(1) Performs circular interpolation from the current stop address to the end point via the specified auxiliary point.

(2) This is an arc produced with point the start address (current stop address) and auxiliary point address intersects the auxiliary point address and end point address perpendicular bisector as the center point.



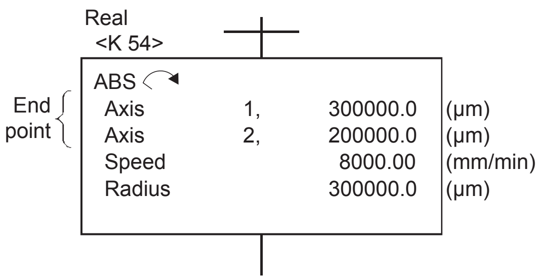


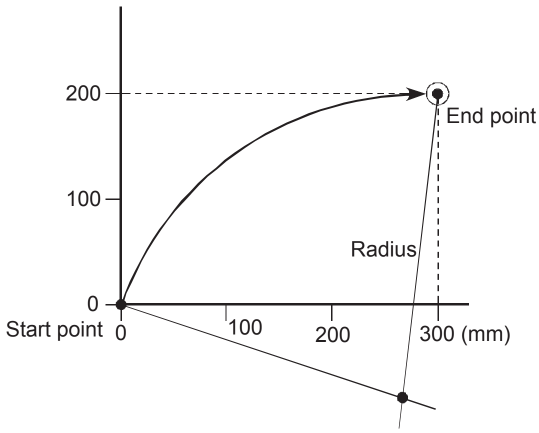
6.1.5 Circular interpolation control for radius designation

Control of 2 axes with ABS, ABS, ABS, and ABS (absolute method)

(1) Performs circular interpolation from the current stop address (address prior to positioning) with home position as reference to the specified end point address at the specified radius.

(2) This is an arc produced with the point that the start address (current stop address) and end point address perpendicular bisector intersects the specified radius as the center point.





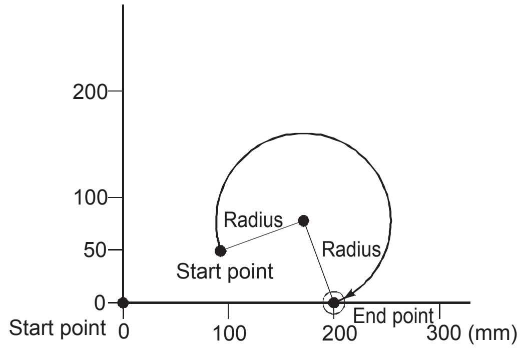
Control of 2 axes with INC , INC , INC , and INC (incremental method)

(1) Performs circular interpolation to the end point specified at the specified radius with the current stop address as the start point (0, 0).

(2) This is an arc produced with the point that the start address (current stop address) and end point address perpendicular bisector intersects the specified radius as the center point.

Real
<K 55>

	INC			
End point	Axis	1,	100000.0	(μm)
End point	Axis	2,	-50000.0	(μm)
	Speed		8000.00	(mm/min)
	Radius		70000.0	(μm)



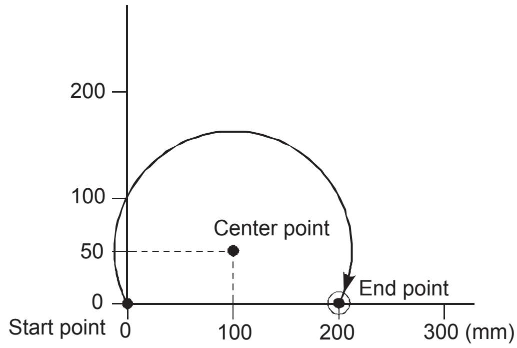
6.1.6 Circular interpolation control for center point designation

Control of 2 axes with ABS , ABS (absolute method)

(1) Performs circular interpolation with the current stop address (address prior to positioning) with home position as reference as the start point address to the end point address with arc with radius of distance to the center point.

Real
<K 56>

	ABS			
End point	Axis	1,	200000.0	(μm)
End point	Axis	2,	0.0	(μm)
	Speed		5000.00	(mm/min)
	Center	1,	100000.0	(μm)
	Center	2,	50000.0	(μm)

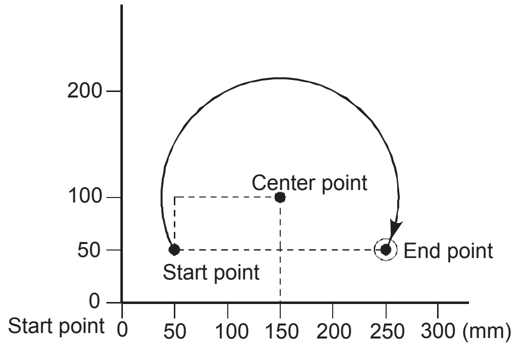


Control of 2 axes with INC , INC (incremental method)

(1) Performs circular interpolation with the current stop address as the start point (0, 0) with travel value to the end point with arc with radius of distance to the center point.

Real
<K 57>

	INC			
Travel value	Axis	1,	200000.0	(μm)
	Axis	2,	0.0	(μm)
	Speed		5000.00	(mm/min)
	Center	1,	100000.0	(μm)
	Center	2,	50000.0	(μm)



6.1.7 Fixed feeding

Control of 1 to 3 axes with FEED-1, FEED-2, FEED-3 (incremental method)

(1) Controls positioning by the specified travel value with the current stop position as 0.

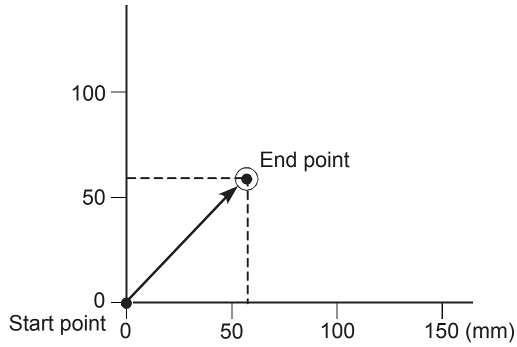
(2) The movement direction is determined based on the movement symbol.

(a) When the movement direction is positive:
Forward direction (address increase direction) positioning

(b) When the movement direction is negative:
Reverse direction (address decrease direction) positioning

Real
<K 58>

	FEED-2			
Travel value	Axis	1,	60000.0	(μm)
	Axis	2,	60000.0	(μm)
	Speed		5000.00	(mm/min)



6.1.8 Speed control

Control of 1 axis with VF, VR, VVF, VVR

(1) Performs control at a specified speed from the moment the servo motor starts until a stop command is input.

(a) VF: Starts moving in forward direction.
(b) VR: Starts moving in reverse direction.
— Servo amplifier control involves speed control that contains a position loop.

(c) VVF: Starts moving in forward direction.
(d) VVR: Starts moving in reverse direction.
— Servo amplifier control involves speed control that does not contain a position loop. Consequently, this can be used for contact positioning control and so on to prevent excessive error.

(2) The current value does not change with 0.

Real
<K 30>

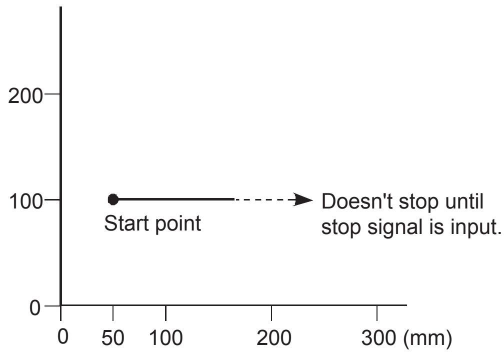
Forward rotation

VF		
Axis	1	
Speed		2500.00 (mm/min)

Real
<K 31>

Reverse rotation

VR		
Axis	1	
Speed		2500.00 (mm/min)



6.1.9 Speed, position switching control

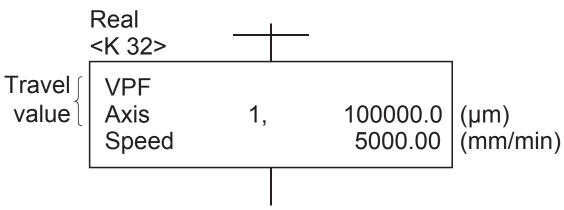
Control of 1 axis with VPF, VPR (incremental method)

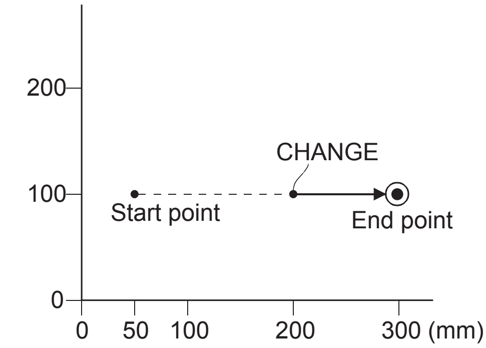
(1) Speed control is performed after the servo motor starts, switches to position control with an external CHANGE (speed, position switching) signal when the "[Rq.1145] speed/ position switching enable signal (M3205/axis 1)" turns ON, and then performs positioning with the specified travel value.

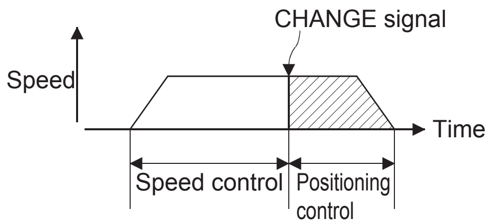
(a) VPF: Starts moving in forward direction (address increase direction).

(b) VPR: Starts moving in reverse direction (address decrease direction).

(2) The specified positioning is performed with the incremental method the moment an external CHANGE signal is input.







Remarks

There is no response delay after the external CHANGE signal is input.

6.1.10 Continuous trajectory control

Control of 1 to 4 axes with CPSTART1 to CPSTART4 and CPEND

(1) Performs positioning control at a constant speed to the end point address while relaying the pass point with a single start.

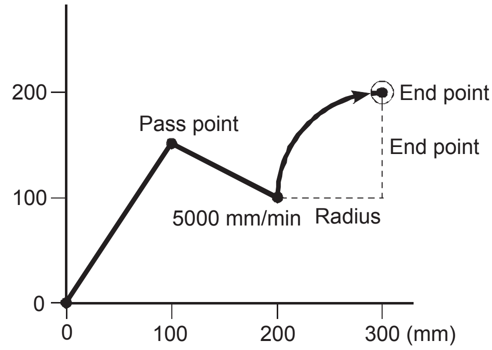
Pass point

ABS-2, ABS-3, ABS-4, ABS, ABS, ABS, ABS,
ABS, ABS, ABS, ABH, ABH, ABH,
ABH, ABH, ABH, ABH
INC-2, INC-3, INC-4, INC, INC, INC, INC,
INC, INC, INC, INH, INH, INH,
INH, INH, INH, INH

The absolute or incremental method is determined based on whether the pass point instruction is ABS or INC, and a mix of both is possible.

Real
<K 61>

	CPSTART2			
Speed designation	Axis	1,		
	Axis	2,		
	Speed		5000.00	(mm/min)
Pass point	ABS-2			
	Axis	1,	100000.0	(µm)
	Axis	2,	150000.0	(µm)
	INC-2			
	Axis	1,	100000.0	(µm)
	Axis	2,	-50000.0	(µm)
End point is before CPEND	INC			
	Axis	1,	100000.0	(µm)
	Axis	2,	100000.0	(µm)
	Radius		100000.0	(µm)
	CPEND			



6.1.11 Repeat control (for continuous trajectory control)

Control of 1 to 4 axes with FOR-TIMES, FOR-ON, FOR-OFF/NEXT

(1) Repeats continuous trajectory control pass point ABS and INC instructions.

(2) Repeat count specification method

FOR-TIMES specifies the repeat count with a numerical value from K1 to K32767, or indirectly with D, W, or #.

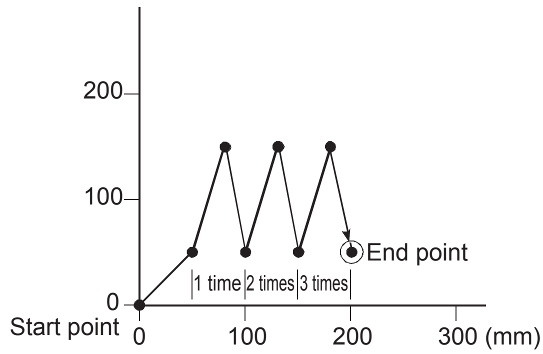
FOR-ON specifies repeat bit device X, Y, M, B, F, D, W, # or SD[*1] until the command turns ON.

FOR-ON specifies repeat bit device X, Y, M, B, F, D, W, # or SD[*1] until the command turns OFF.

*1. D, W, # or SD can be specified only when the bit is specified.

```
Real
<K 62>
CPSTART2
  Axis      1,
  Axis      2,
  Speed               5000.00    (mm/min)
ABS-2
  Axis      1,        50000.0    (μm)
  Axis      2,        50000.0    (μm)
FOR-TIMES
                      K  3
INC-2
  Axis      1,        30000.0    (μm)
  Axis      2,       100000.0    (μm)
INC-2
  Axis      1,        20000.0    (μm)
  Axis      2,      -100000.0    (μm)
NEXT
CPEND
```

Repeat 3 times.



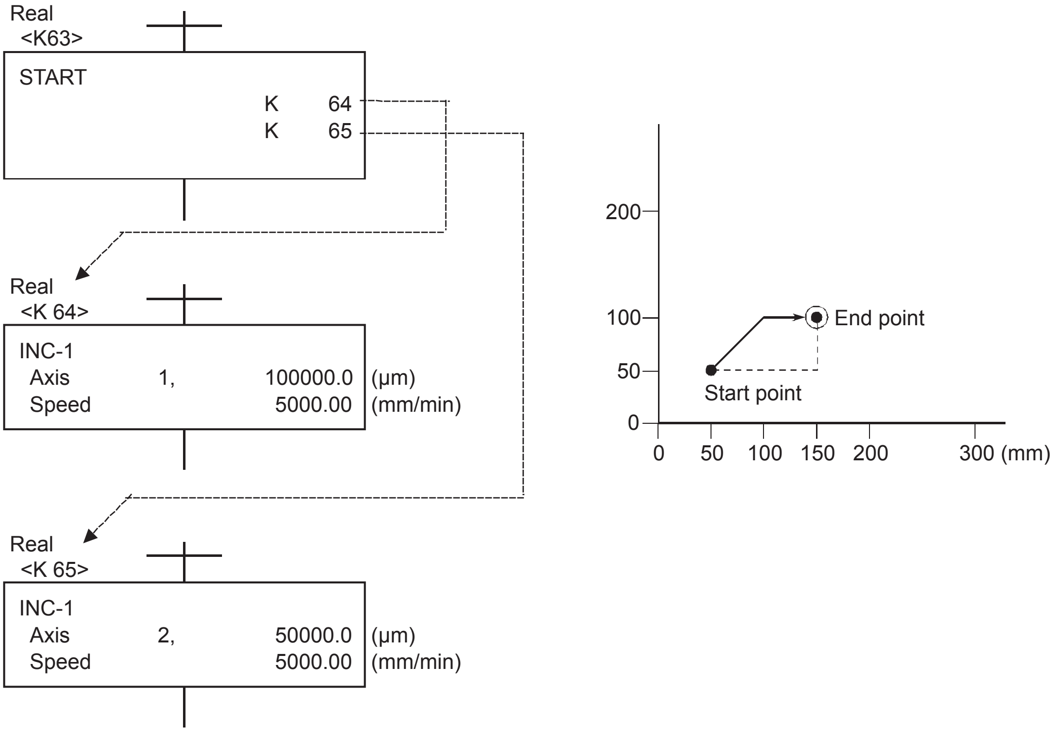
6.1.12 Simultaneous start

Simultaneous start control with START

(1) Starts two to three types of servo program (exc. START instruction) simultaneously.

(2) Up to 12 axes can be started simultaneously if three servo programs are controlling four axes.

(3) Servo program Nos. specified with a START instruction cannot be specified indirectly.



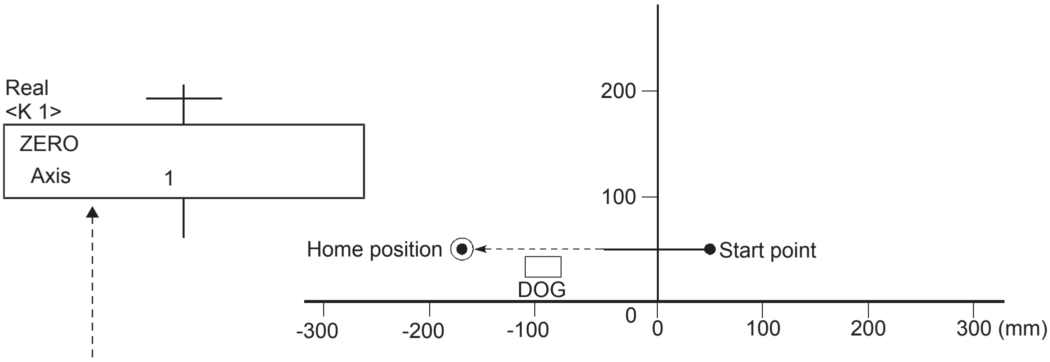
6.1.13 Home position return

1 axis home position return with ZERO

(1) Home position return is performed from the current stop position based on the home position return data return method.

(2) If the proximity dog method or count method, the axis advances in the home position return data return direction.

(3) If the data set method, the stop address is the home position, and the axis does not move.



Only 1 axis can be specified.
A separate servo program is required to perform home position return for other axes.

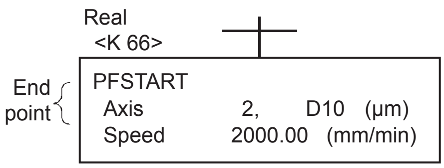
Remarks

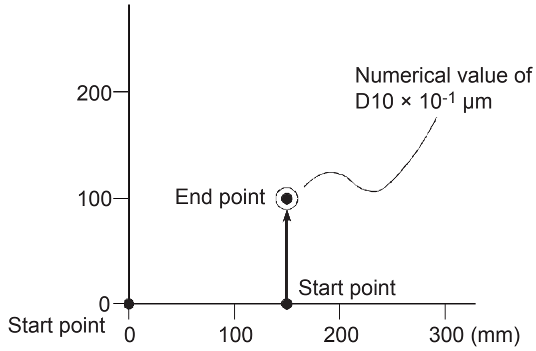
The simultaneous starting of home position return is performed with a START instruction, and ZERO instruction servo programs are started simultaneously.

6.1.14 Fixed-pitch feed control

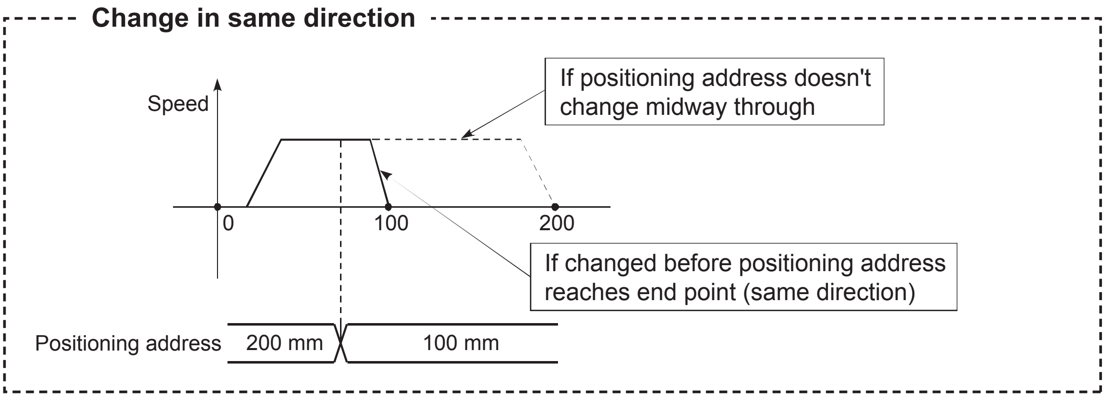
Control of 1 axis with PFSTART (absolute method)

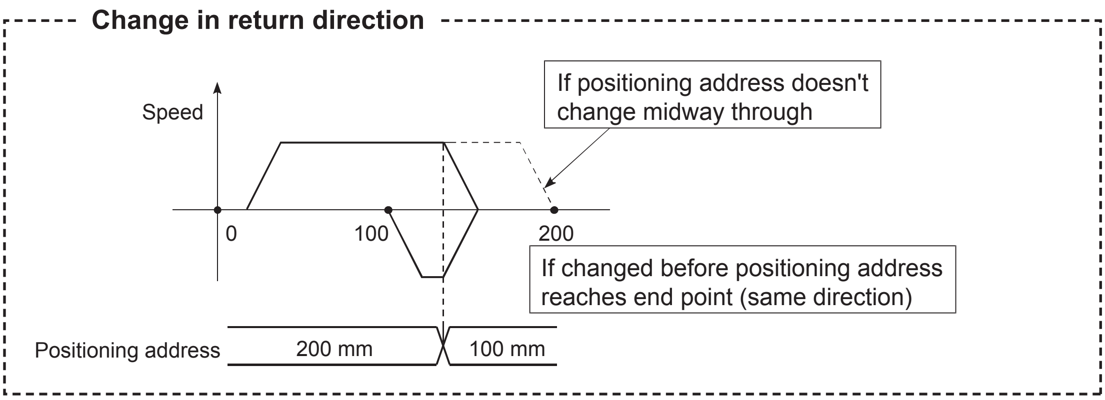
(1) The axis is positioned at the address word device (even number for D, W, #) specified in the servo program with a single start.
(Fixed-pitch feeding is performed if the content of D, W, # changes midway through.)





(2) The movement when the content of the word device changes midway through is as follows.



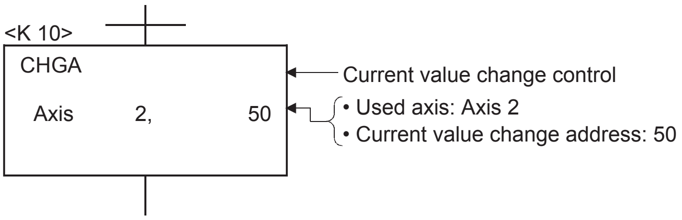


(3) Fixed-pitch feed control continues until a stop command is input.

6.1.15 Current value change

Current value change control by CHGA

Changes current values for the specified axis.



Chapter 7 Operation Control Programs

Substitute operational expressions, dedicated motion functions, and bit device control commands can be set in operation control programs.
Multiple blocks can be set in a single operation control program, however, only transition programs can be set for transition conditions.
This section describes operation control programs, and operational expressions that can be described in transition programs.

7.1 Operator, function priority order

The priority order for operators and functions is as follows.
By using parentheses, the operation order can be specified freely.

Priority order	Item (operator, function)
High	Calculation inside parentheses ((...))
	Standard function (SIN, COS, etc.), type conversion(USHORT, LONG, etc.)
	Bit inversion (¯), logical negation (!), sign inversion (-)
	Multiplication (*), division (/), remainder (%)
	Addition (+), subtraction (-)
	Bit left shift (<<), bit right shift (>>)
	Comparison operator: Less than (<), less than or equal to (<=), more than (>), more than or equal to (>=)
	Comparison operator: Equal to (==), not equal to (!=)
	Bit logical AND (&)
	Bit exclusive OR (^)
	Bit logical OR (|)
	Logical AND (*)
	Logical OR (+)
Low	Substitution (=)

7.2 Operational control, transition instruction list

Refer to Appendix 7 for details on the shaded parts in the following table.

<table>
<tr><th rowspan="2">Category</th><th rowspan="2">Symbol</th><th rowspan="2">Function</th><th rowspan="2">Format</th><th rowspan="2">No. of basic steps</th><th colspan="2">Usable program</th><th colspan="4">Usable expression</th></tr>
<tr><th>F/FS</th><th>G</th><th>Calculation formula</th><th>Bit conditional expression</th><th>Comparative conditional expression</th><th>Y/N transition conditional expression</th></tr>
<tr><td rowspan="6">Binary operation</td><td>=</td><td>Substitution</td><td>(D)=(S)</td><td>8</td><td>○</td><td>○</td><td>Only (S) usable</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>+</td><td>Addition</td><td>(S1)+(S2)</td><td>7</td><td>○</td><td>○</td><td>○</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>-</td><td>Subtraction</td><td>(S1)-(S2)</td><td>7</td><td>○</td><td>○</td><td>○</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>*</td><td>Multiplication</td><td>(S1)*(S2)</td><td>7</td><td>○</td><td>○</td><td>○</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>/</td><td>Division</td><td>(S1)/(S2)</td><td>7</td><td>○</td><td>○</td><td>○</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>%</td><td>Remainder</td><td>(S1)%(S2)</td><td>7</td><td>○</td><td>○</td><td>○</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td rowspan="6">Bit operation</td><td>~</td><td>Bit inversion (complement)</td><td>~(S)</td><td>4</td><td>○</td><td>○</td><td>○</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>&</td><td>Bit logical AND</td><td>(S1)&(S2)</td><td>7</td><td>○</td><td>○</td><td>○</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>|</td><td>Bit logical OR</td><td>(S1)|(S2)</td><td>7</td><td>○</td><td>○</td><td>○</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>^</td><td>Bit exclusive logical OR</td><td>(S1)^(S2)</td><td>7</td><td>○</td><td>○</td><td>○</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>>></td><td>Bit right shift</td><td>(S1)>>(S2)</td><td>7</td><td>○</td><td>○</td><td>○</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td><<</td><td>Bit left shift</td><td>(S1)<<(S2)</td><td>7</td><td>○</td><td>○</td><td>○</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Sign</td><td>-</td><td>Sign inversion (complement of 2)</td><td>-(S)</td><td>4</td><td>○</td><td>○</td><td>○</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td rowspan="15">Standard function</td><td>SIN</td><td>Sine</td><td>SIN(S)</td><td>4</td><td>○</td><td>○</td><td>○</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>COS</td><td>Cosine</td><td>COS(S)</td><td>4</td><td>○</td><td>○</td><td>○</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>TAN</td><td>Tangent</td><td>TAN(S)</td><td>4</td><td>○</td><td>○</td><td>○</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>ASIN</td><td>Arc sine</td><td>ASIN(S)</td><td>4</td><td>○</td><td>○</td><td>○</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>ACOS</td><td>Arc cosine</td><td>ACOS(S)</td><td>4</td><td>○</td><td>○</td><td>○</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>ATAN</td><td>Arc tangent</td><td>ATAN(S)</td><td>4</td><td>○</td><td>○</td><td>○</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>SQRT</td><td>Square root</td><td>SQRT(S)</td><td>4</td><td>○</td><td>○</td><td>○</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>LN</td><td>Natural logarithm</td><td>LN(S)</td><td>4</td><td>○</td><td>○</td><td>○</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>EXP</td><td>Exponential operation</td><td>EXP(S)</td><td>4</td><td>○</td><td>○</td><td>○</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>ABS</td><td>Absolute value</td><td>ABS(S)</td><td>4</td><td>○</td><td>○</td><td>○</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>RND</td><td>Round-off</td><td>RND(S)</td><td>4</td><td>○</td><td>○</td><td>○</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>FIX</td><td>Round-down</td><td>FIX(S)</td><td>4</td><td>○</td><td>○</td><td>○</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>FUP</td><td>Round-up</td><td>FUP(S)</td><td>4</td><td>○</td><td>○</td><td>○</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>BIN</td><td>BCD → BIN conversion</td><td>BIN(S)</td><td>4</td><td>○</td><td>○</td><td>○</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>BCD</td><td>BIN → BCD conversion</td><td>BCD(S)</td><td>4</td><td>○</td><td>○</td><td>○</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td rowspan="2">Type conversion</td><td>SHORT</td><td>Signed 16-bit integer value conversion</td><td>SHORT(S)</td><td>4</td><td>○</td><td>○</td><td>○</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>USHORT</td><td>Unsigned 16-bit integer value conversion</td><td>USHORT(S)</td><td>4</td><td>○</td><td>○</td><td>○</td><td>-</td><td>-</td><td>-</td></tr>
</table>

Category	Symbol	Function	Format	No. of basic steps	Usable program		Usable expression			
					F/FS	G	Calculation formula	Bit conditional expression	Comparative conditional expression	Y/N transition conditional expression
Type conversion	LONG	Signed 32-bit integer value conversion	LONG(S)	4	○	○	○	-	-	-
	ULONG	Unsigned 32-bit integer value conversion	ULONG(S)	4	○	○	○	-	-	-
	FLOAT	Signed 64-bit floating-point value conversion	FLOAT(S)	4	○	○	○	-	-	-
	UFLOAT	Unsigned 64-bit floating-point value conversion	UFLOAT(S)	4	○	○	○	-	-	-
	DFLT	Floating-point value conversion 32-bit into 64-bit	DFLT(S)	4	○	○	-	-	-	-
	SFLT	Floating-point value conversion 64-bit into 32-bit	SFLT(S)	4	○	○	○	-	-	-
Bit device status	None	ON (Normally open contact)	(S)	4	○	○	-	-	-	○
	!	OFF (Normally closed contact)	!(S)	4	○	○	-	-	-	○
Bit device control	SET	Device set	SET(D)	5	○	○	-	-	-	-
			SET(D) = (conditional expression)	8	○	○	-	Only (S) usable	Only (S) usable	-
	RST	Device reset	RST(D)	5	○	○	-	-	-	-
			RST(D) = (conditional expression)	8	○	○	-	Only (S) usable	Only (S) usable	-
	DOUT	Device output	DOUT(D),(S)	8	○	○	Only (S) usable	-	-	-
	DIN	Device input	DIN(D),(S)	8	○	○	-	-	-	-
	OUT	Bit device output	OUT(D) = (conditional expression)	8	○	○	-	Only (S) usable	Only (S) usable	-
Logical operation	None	Logical acknowledgement	(Conditional expression)	0	○	○	-	○	○	○
	!	Logical negation	! (conditional expression)	4	○	○	-	○	○	○
	*	Logical AND	(conditional expression) * (conditional expression)	7	○	○	-	○	○	○
	+	Logical OR	(Conditional expression) + (conditional expression)	7	○	○	-	○	○	○

Category	Symbol	Function	Format	No. of basic steps	Usable program		Usable expression			
					F/FS	G	Calculation formula	Bit conditional expression	Comparative conditional expression	Y/N transition conditional expression
Comparison operation	==	Equal to	(Calculation formula) == (calculation formula)	7	○	○	○	-	-	○
	!=	Not equal to	(Calculation formula) != (calculation formula)	7	○	○	○	-	-	○
	<	Less than	(Calculation formula) < (calculation formula)	7	○	○	○	-	-	○
	<=	Less than or equal to	(Calculation formula) <= (calculation formula)	7	○	○	○	-	-	○
	>	More than	(Calculation formula) > (calculation formula)	7	○	○	○	-	-	○
	>=	More than or equal to	(Calculation formula) >= (calculation formula)	7	○	○	○	-	-	○
Motion dedicated function	CHGV	Speed change request	CHGV ((S1), (S2))	7	○	○	Only (S2) usable	-	-	-
	CHGVS	Command generation axis speed change request	CHGVS ((S1), (S2))	7	○	○	Only (S2) usable	-	-	-
	CHGT	Torque limit value change request	CHGT ((S1), (S2), (S3))	10	○	○	Other than (S1) usable	-	-	-
	CHGP	Target position change request	CHGP ((S1), (S2), (S3))	11	○	○	-	-	-	-
Other instruction	EI	Event task enable	EI	1	○	○	-	-	-	-
	DI	Event task disable	DI	1	○	○	-	-	-	-
	NOP	No operation	NOP	1	○	○	-	-	-	-
	FMOV	Same data block transfer	FMOV(D),(S),(n)	12	○	○	-	-	-	-
	BMOV	Block transfer	BMOV(D),(S),(n)	12	○	○	-	-	-	-
	TIME	Time to wait	TIME(S)	8	-	○	-	-	-	-
	TO	Write device data to buffer memory	TO (D1), (D2), (S), (n)	14	○	○	-	-	-	-
	FROM	Read device data from buffer memory	FROM (D), (S1), (S2), (n)	14	○	○	-	-	-	-

Category	Symbol	Function	Format	No. of basic steps	Usable program		Usable expression			
					F/FS	G	Calculation formula	Bit conditional expression	Comparative conditional expression	Y/N transition conditional expression
Other	RTO	Write buffer memory data to head module	RTO (D1), (D2), (D3), (S), (n), (D4)	21	○	○	-	-	-	-
	RFROM	Read buffer memory data from head module	RFROM (D), (S1), (S2), (S3), (n), (D1)	21	○	○	-	-	-	-
Vision system dedicated function	MVOPEN	Open line	MVOPEN (S1), (S2)	8	○	○	-	-	-	-
	MVLOAD	Load a program	MVLOAD (S1), (S2)	8	○	○	-	-	-	-
	MVTRG	Send an image acquisition trigger	MVTRG (S1), (S2)	8	○	○	-	-	-	-
	MVPST	Start a program	MVPST (S1), (S2)	8	○	○	-	-	-	-
	MVIN	Input data	MVIN (S1), (S2), (D), (S3)	15 or higher	○	○	-	-	-	-
	MVOUT	Output data	MVOUT (S1), (S2), (S3), (S4)	15 or higher	○	○	-	-	-	-
	MVFIN	Reset a status storage device	MVFIN(S)	6	○	○	-	-	-	-
	MVCLOSE	Close line	MVCLOSE(S)	6	○	○	-	-	-	-
	MVCOM	Send a command for native mode	MVCOM (S1), (S2), (D), (S3), (S4)	19 or higher	○	○	-	-	-	-
Data control	SCL	16-bit integer type scaling	SCL (S1), (S2), (S3), (D)	15	○	○	Only (S2) usable	-	-	-
	DSCL	32-bit integer type scaling	DSCL (S1), (S2), (S3), (D)	15	○	○	Only (S2) usable	-	-	-

Program control	IF ~ ELSE ~ IEND	Conditional branch control	IF(S)
			:
			ELSE
			:
			IEND
				IF:8
				ELSE:5
				IEND:1
					○	○	-	○	○	-

	SELECT ~ CASE ~ SEND	Selective branch control	SELECT CASE(S1) : CEND CASE(Sn) : CEND CELSE : CEND SEND	SELECT:1 CASE:8 CEND:5 CELSE:1 SEND:1	○	○	-	○	○	-

Category	Symbol	Function	Format	No. of basic steps	Usable program		Usable expression			
					F/FS	G	Calculation formula	Bit conditional expression	Comparative conditional expression	Y/N transition conditional expression
Program control	FOR ~ NEXT	Repeat control with specified count	FOR(D)=(S1) TO(S2) STEP(S3) : NEXT	FOR:18 NEXT:15	○	○	-	-	-	-
	BREAK	Forced termination of repeat control	BREAK	5	○	○	-	-	-	-

1 program code size approximate expression for operation control program, transition program

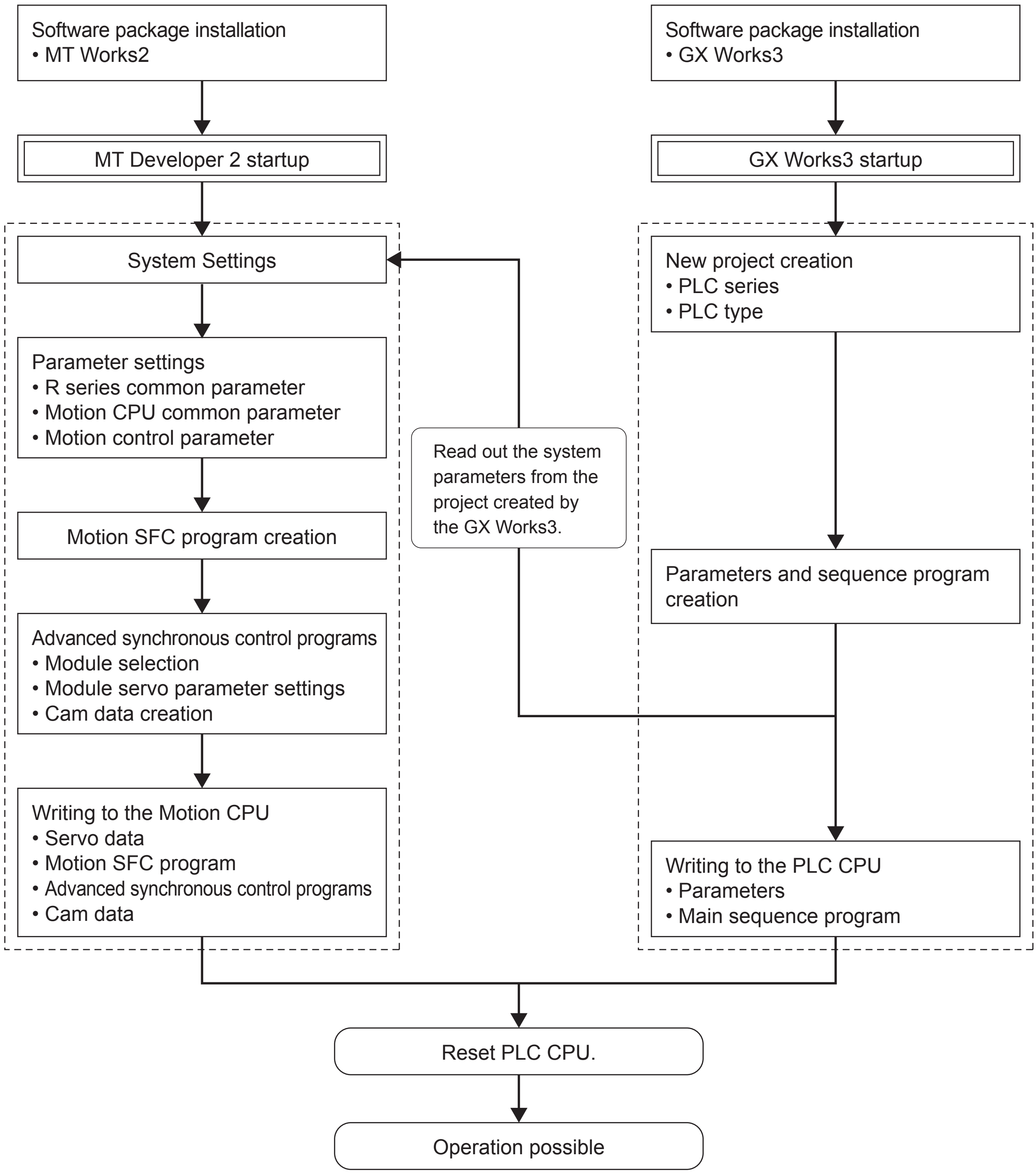
2 + (2 + total no. of basic steps in 1 block)
+ 32-bit constant qty/1 block × 1
+ 64-bit constant qty/1 block × 3) × no. of blocks (steps)
(1 step = 2 bytes)

POINT

A transition condition must be set in the final block of the transition program.

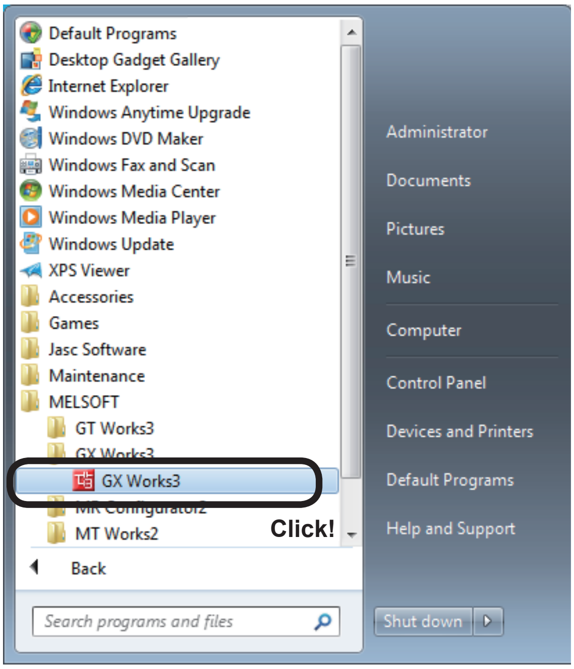
Chapter 8 Windows® Computer Operation

8.1 Data Creation Flow for Motion Controller Operation

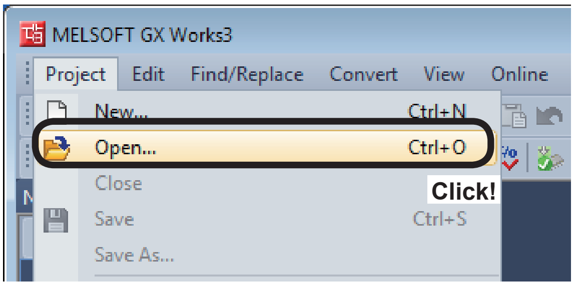


8.2 PLC CPU Settings

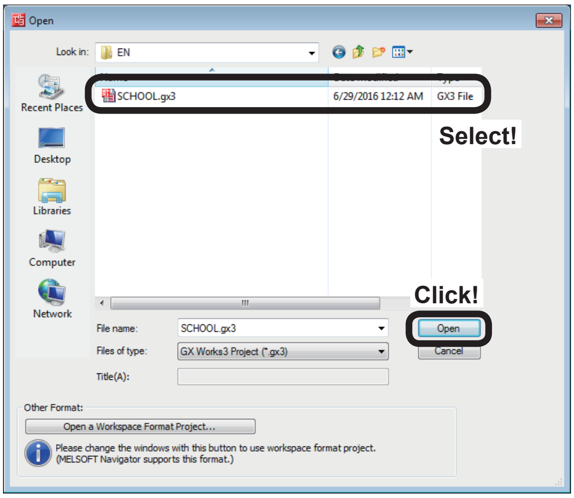
8.2.1 Opening a project



(1) Click the Windows® [start] button, and then select [All Programs] → [MELSOFT] → [GX Works3] → [GX Works3].



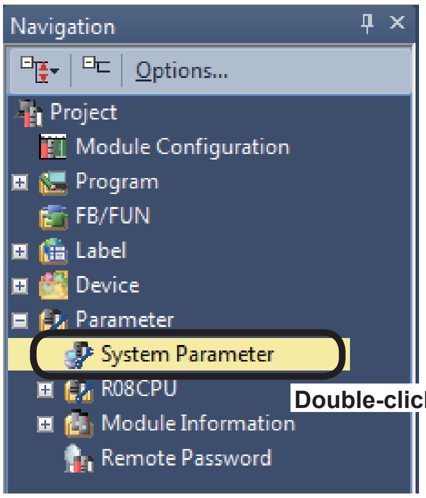
(2) When GX Works3 starts up, click [Open…] on the [Project] menu.



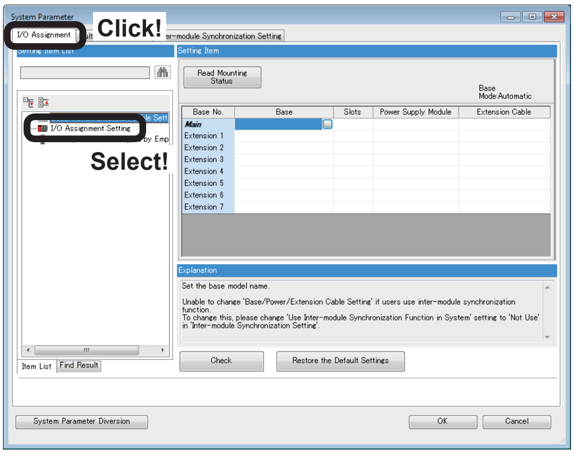
(3) A dialog box prompting the user to open a project appears. Select the project to read.

By clicking the Open button, the sequence program and CPU parameters are read.

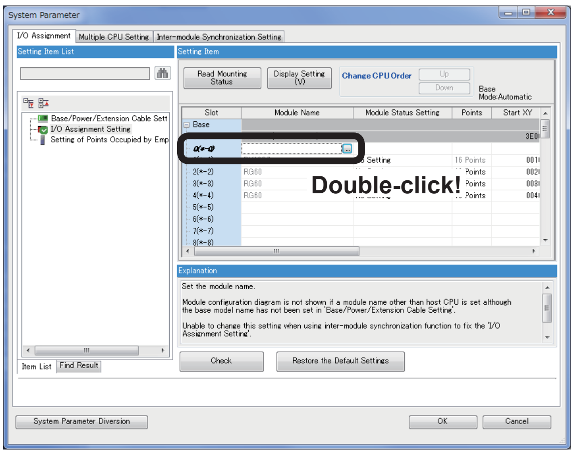
8.2.2 Multiple CPU settings



(1) Select [Parameter] in the navigation window, and then double-click [System Parameter].



(2) Double-click the [I/O Assignment] tab at the System Parameter dialog box that appears to select the [I/O Assignment Setting] of the list of setting items.



(3) Double-click on the Module Name in the slot 0 (0-0).

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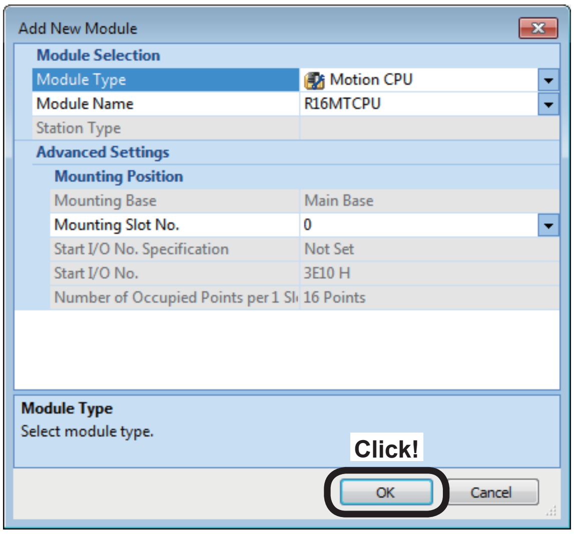
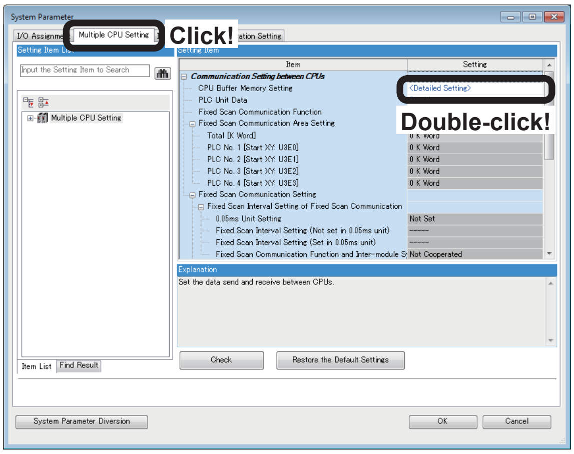


(4) The dialog box then appears to add a new module. Specify as shown below and press the OK button.

Module Type: Motion CPU

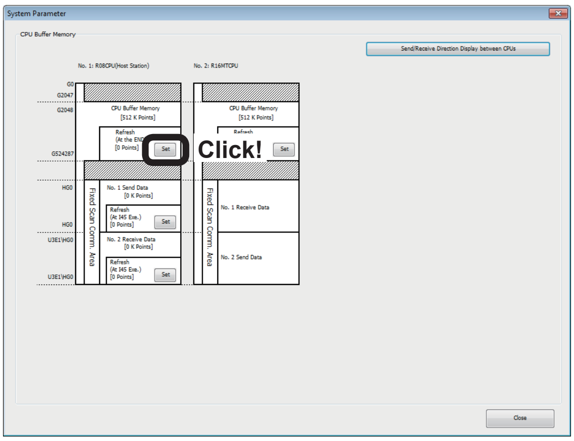
Module Name: R16MTCPU

Mounting Slot No.: 0



(5) The display then returns to the System Parameter dialog box. Click the "Multiple CPU Setting" tab.

(6) Double-click the detailed setting "CPU Buffer Memory Setting" within "Communication Setting between CPUs".



(7) The System Parameter dialog box of the CPU buffer memory that appears. Click the Set button for the Refresh (At the END) of the PLC No. 1.

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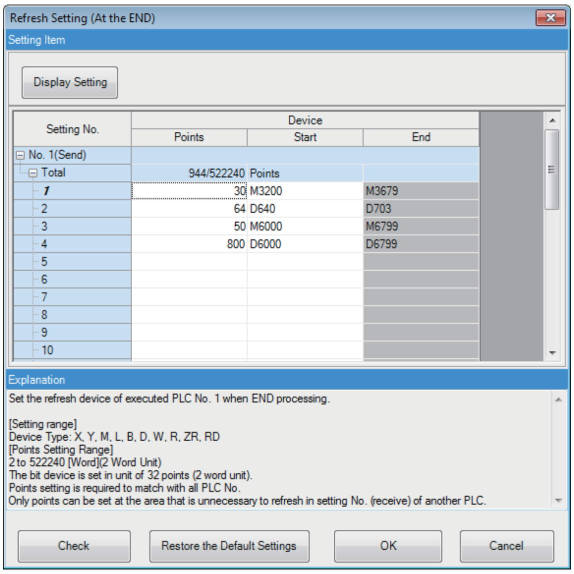
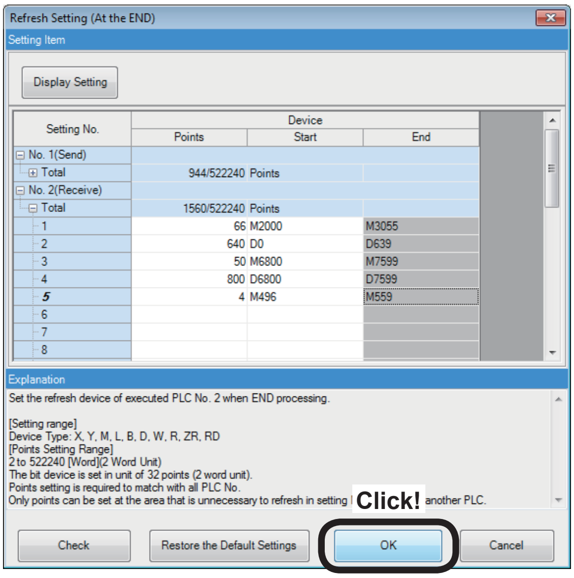


(8) An Refresh Setting (At the END) dialog box then appears. Specify the device for the CPU No. 1 (Send) as follows.

"No. 1 - Points" : "30"
"No. 1 - Start" : "M3200"
"No. 2 - Points" : "64"
"No. 2 - Start" : "D640"
"No. 3 - Points" : "50"
"No. 3 - Start" : "M6000"
"No. 4 - Points" : "800"
"No. 4 - Start" : "D6000"



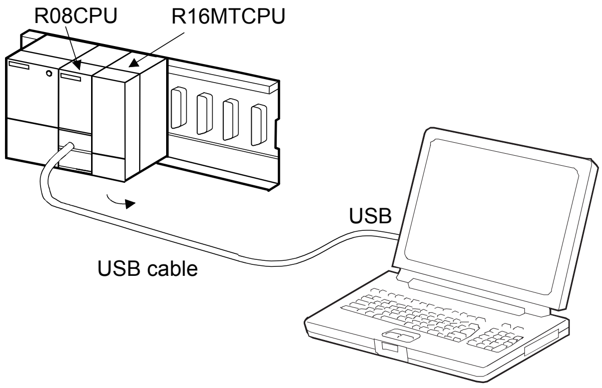
(9) Specify the device for the PLC No. 2 (Receive) as follows.

"No. 1 - Points" : "66"
"No. 1 - Start" : "M2000"
"No. 2 - Points" : "640"
"No. 2 - Start" : "D0"
"No. 3 - Points" : "50"
"No. 3 - Start" : "M6800"
"No. 4 - Points" : "800"
"No. 4 - Start" : "D6800"
"No. 5 - Points" : "4"
"No. 5 - Start" : "M496"

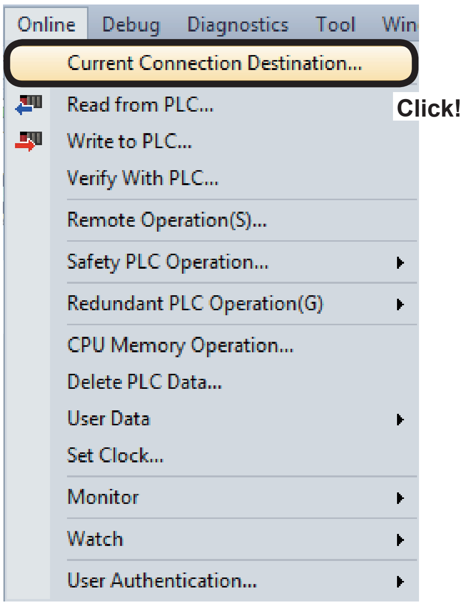
(10) When settings are complete, click the OK button.

(11) Click the Close button on the System Parameter dialog box for the CPU buffer memory. Then, click the OK button on the System Parameter dialog box.

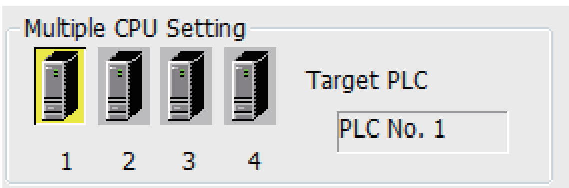
8.2.3 Writing sequence programs



(1) Click "Current Connection Destination" at "Online" in the Menu.



(2) A Specify Connection Destination Connection dialog box appears. Set the "Multiple CPU Setting" - "Target PLC" to "PLC No. 1", and then click the OK button.



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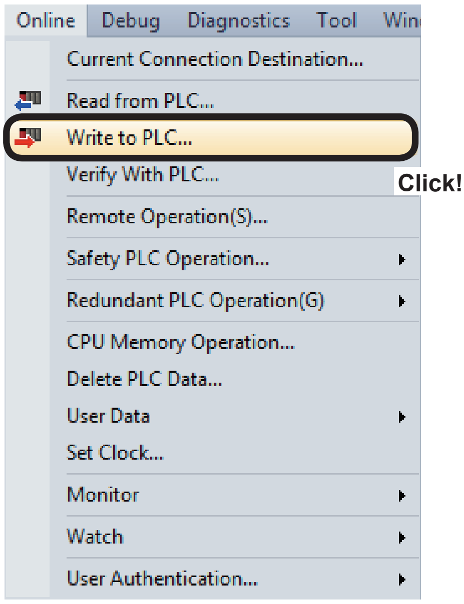
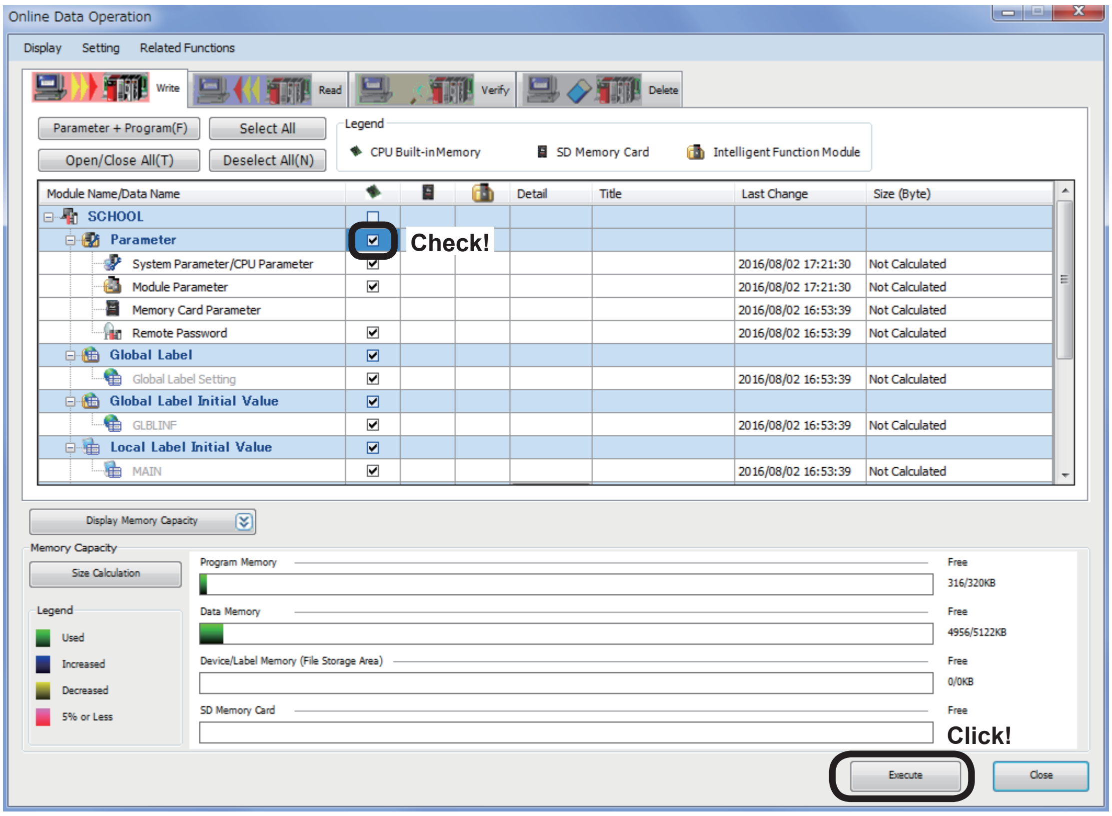


(3) Click [Write to PLC…] on the [Online] menu.



(4) Check the "Parameter" at the Online Data Operation dialog box that appears.

(5) Click the Execute button.

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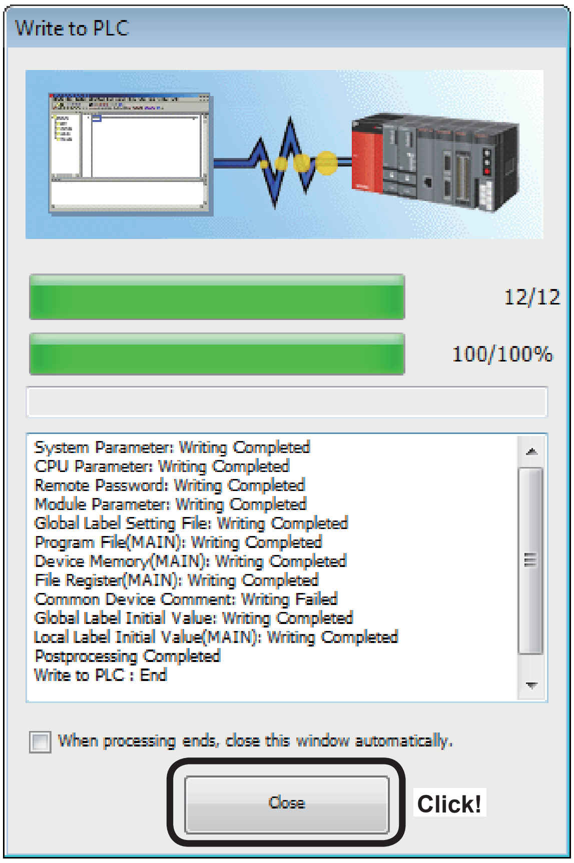
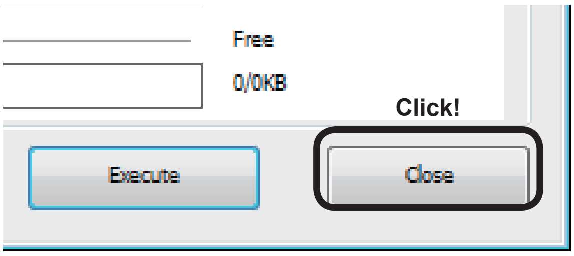


(6) A "Write to PLC: End" message appears when writing to the computer is complete. Click the Close button.

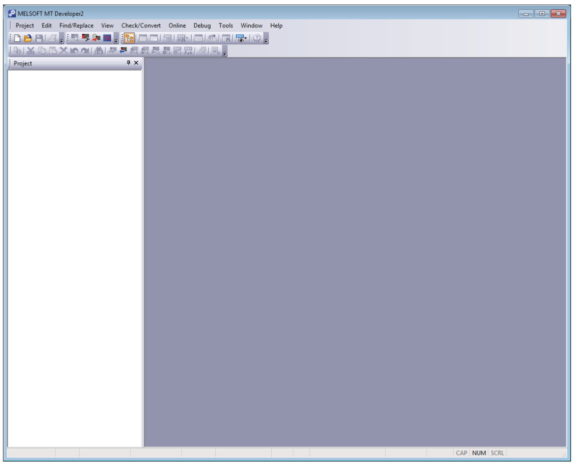


(7) Click the Close button at the Online Data Operation dialog box.

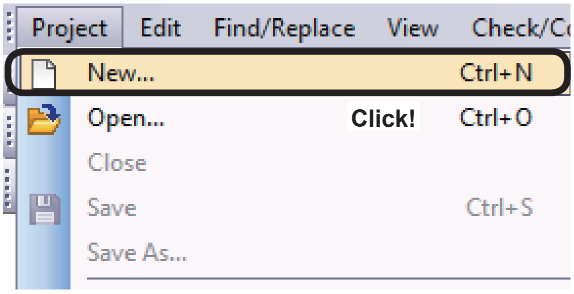
8.3 Starting MT Developer2

The following is a description of the procedure from MT Works2 startup to new project creation.

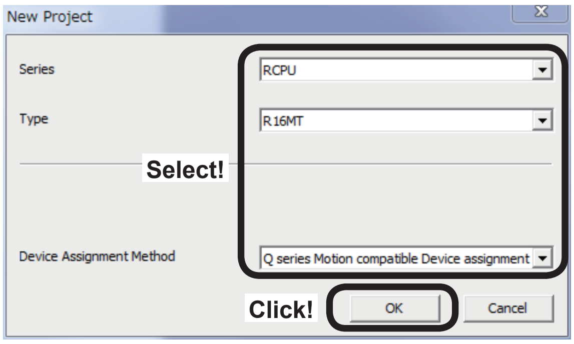
(1) Click the Windows [start] button, and then select [All Program] → [MELSOFT] → [MT Works2] → [MT Developer2].



(2) MT Developer2 starts up.



(3) Click [New…] on the [Project] menu.



(4) A Create New Project dialog box appears. Select the "Series", "Type" and "Device Assignment Method", and then click the OK button.

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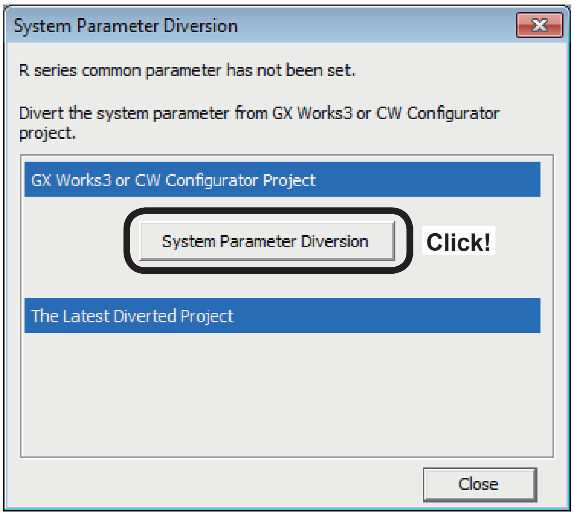
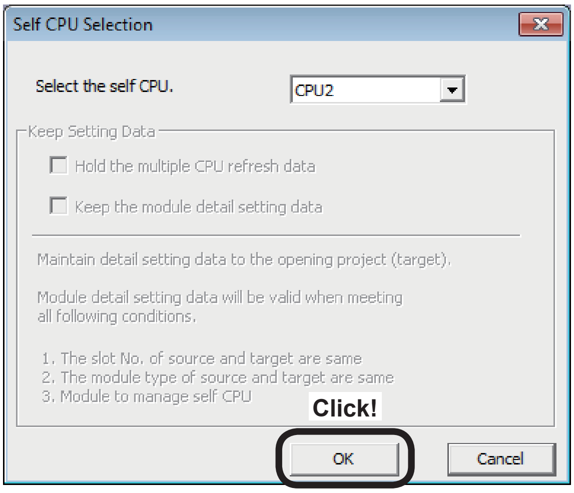
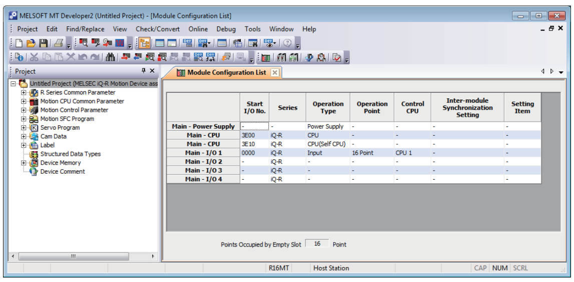


(5) The System Parameter Diversion dialog box appears. Click on the System Parameter Diversion button to open the project having been created by the GX Works3.



(6) The dialog box for Self CPU Selection appears, press the OK button.



(7) This creates the new project while the imported module configuration list appears on the screen.

Startup and new project creation are now complete.

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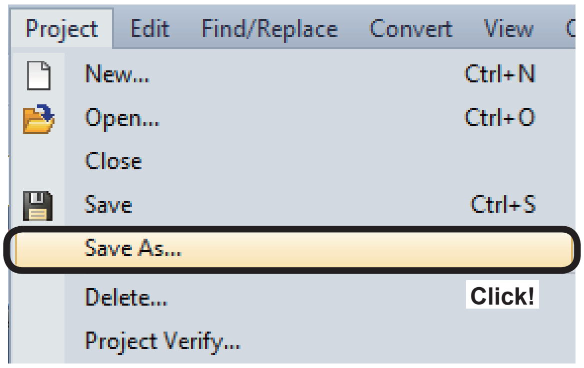


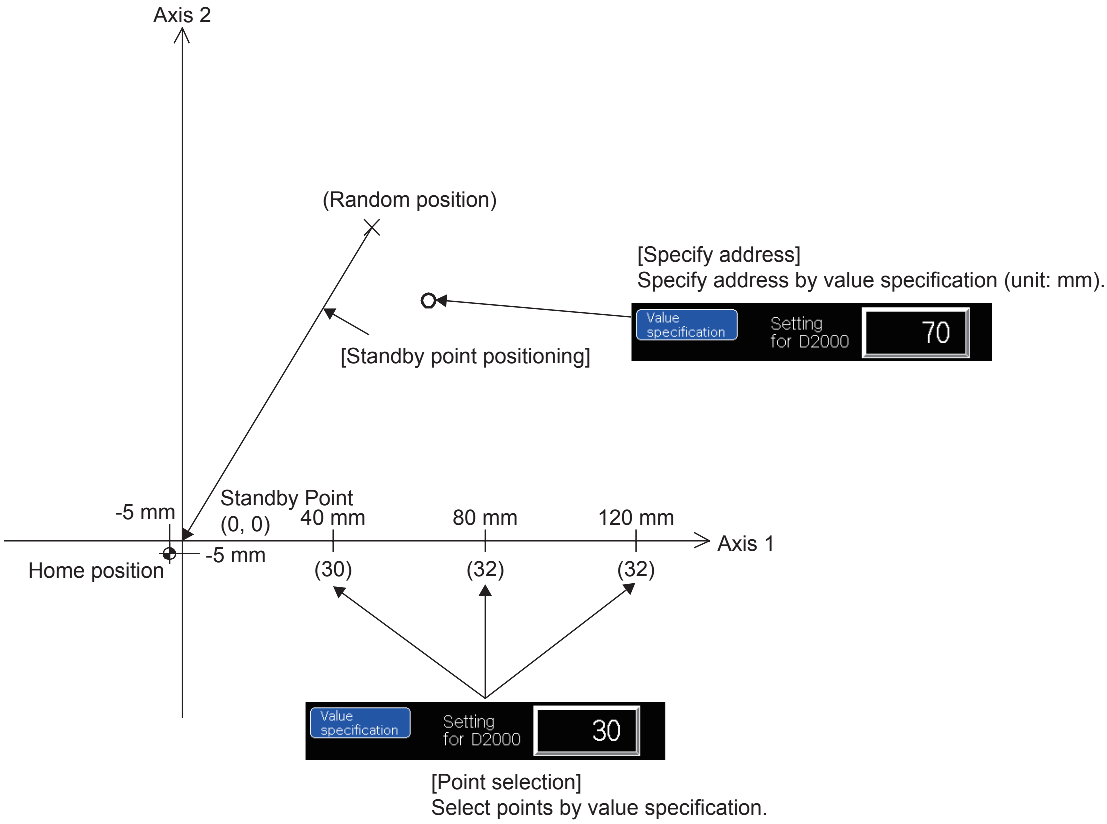
(8) Click [Save As...] on the [Project] menu, and save the project.

MEMO

Chapter 9 Basic Practice

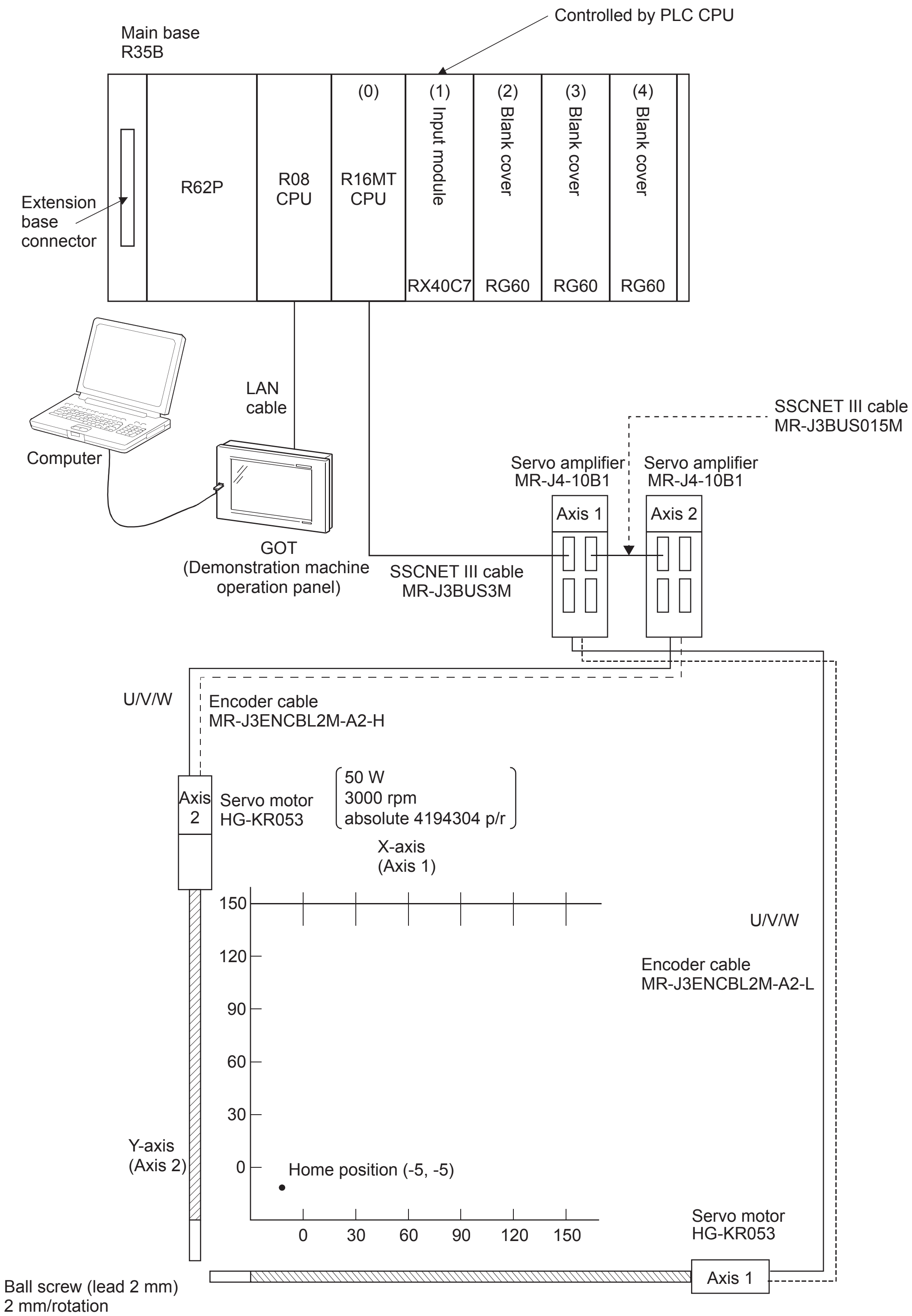
9.1 Practice Content

Basic practice involves initial processing, home position return, and JOG operation. Furthermore, this practice will be based on a basic positioning program example using a Motion SFC program.



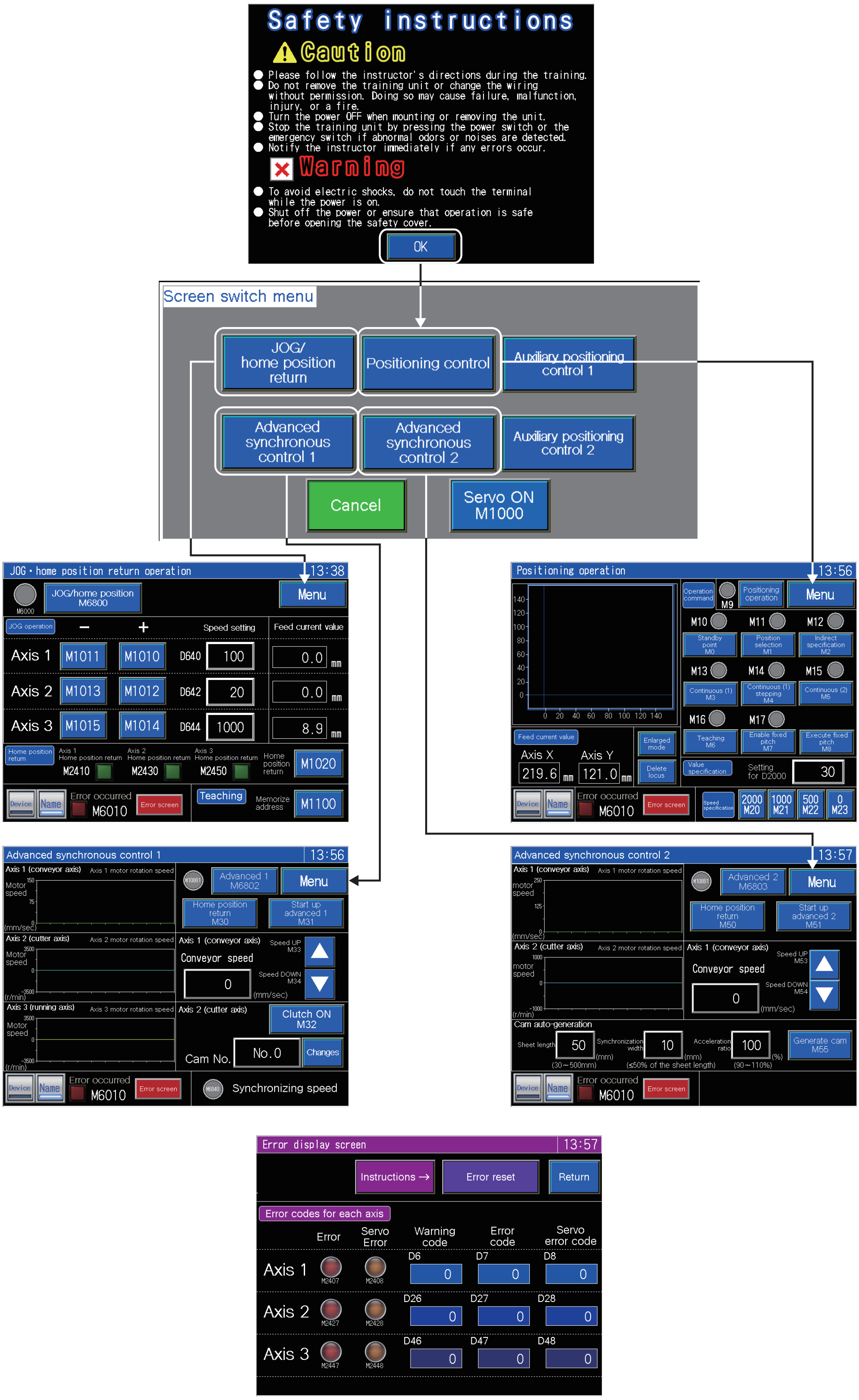
Specify an address by value specification at the demonstration machine operation panel. You will practice two positioning methods, one of which involves specifying points, and the other which involves specifying with an X, Y address.

9.2 R16MTCPU Demonstration Machine System Configuration

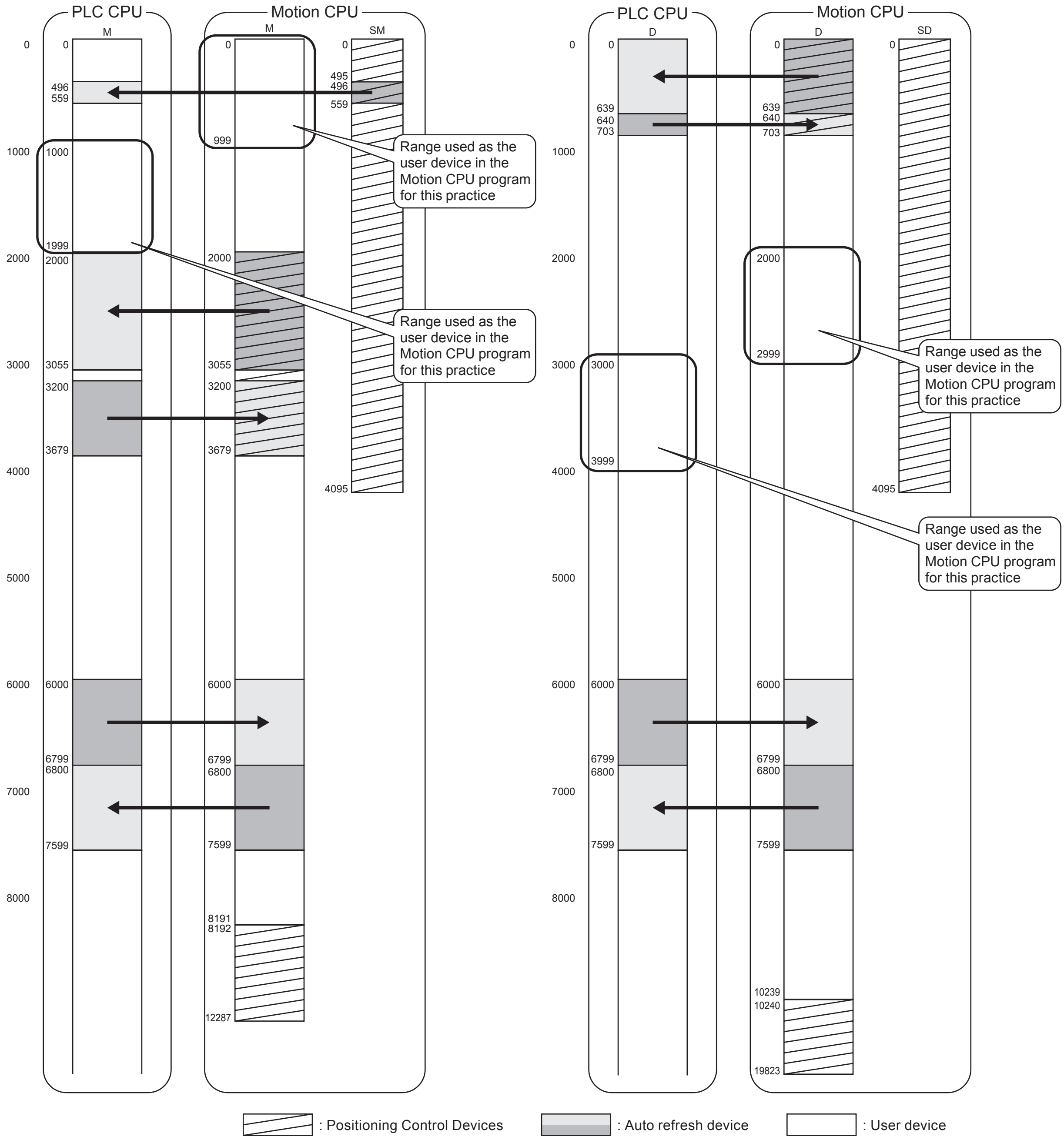


Demonstration machine operation panel

Start screen



The error display screen is common to all modes.

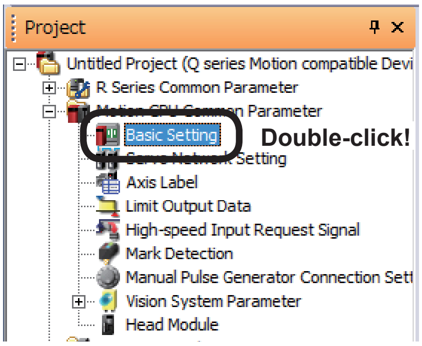


PLC CPU
M
Motion CPU
M
SM
Range used as the user device in the Motion CPU program for this practice
Range used as the user device in the Motion CPU program for this practice
PLC CPU
D
Motion CPU
D
SD
Range used as the user device in the Motion CPU program for this practice
Range used as the user device in the Motion CPU program for this practice
: Positioning Control Devices
: Auto refresh device
: User device

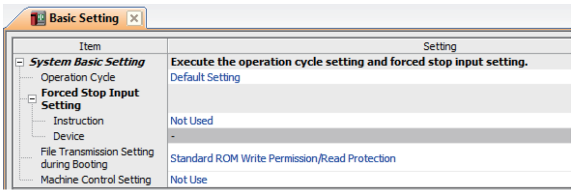
9.3 System Settings

It is first of all necessary to specify system settings at MT Developer2.

(1) System settings



(1) Double-click the [Motion CPU Common Parameter] → [Basic Setting] tab in the Project window for the new project created at section 8.3.



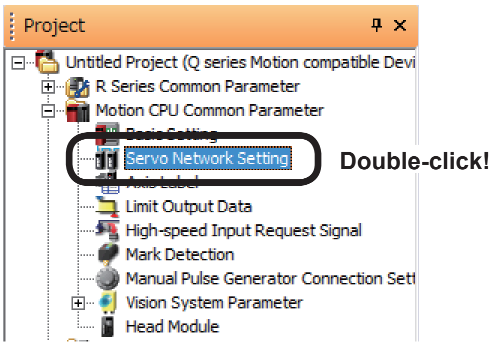
(2) The Basic Setting window appears on the screen. Check that it shows the following settings.

"Operation Cycle": Default setting

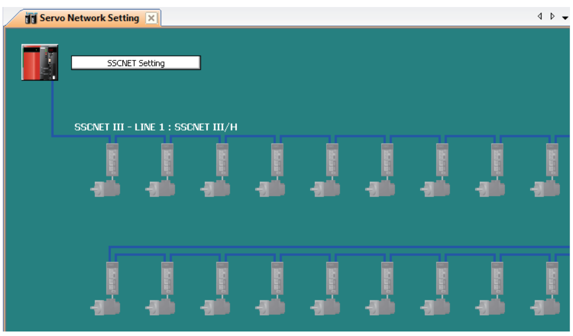
"Forced Stop Input Setting": Not used

Basic setting is now complete.

(2) Amplifier settings



(1) Double-click [Motion CPU Common Parameter] → [Servo Network Setting] in the Project window.



(2) A Servo Network Setting window appears.

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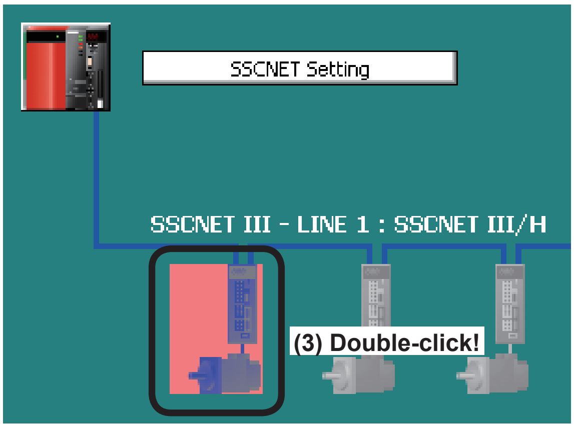
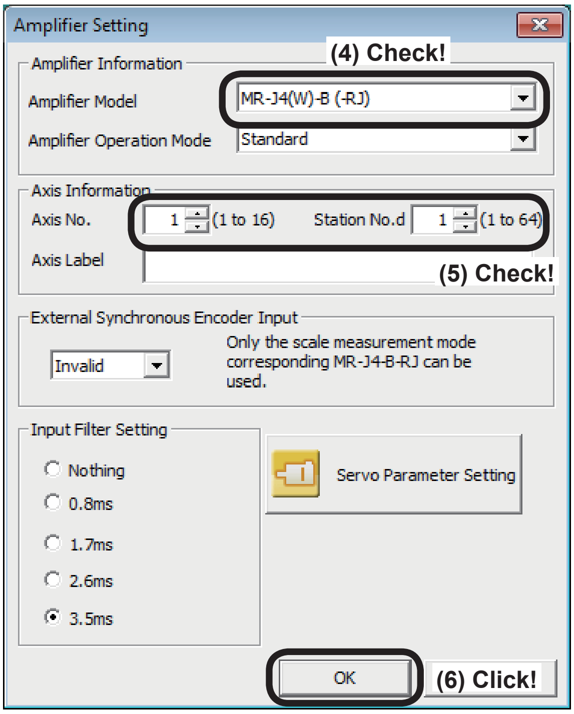


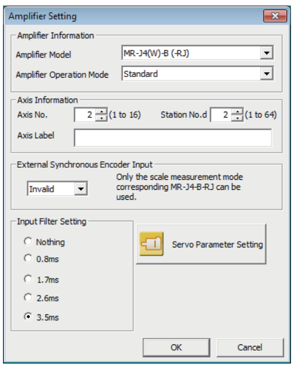
(3) To specify settings for the first servo amplifier and servo motor, double-click the first servo amplifier from the left in the SSCNET Structure window.

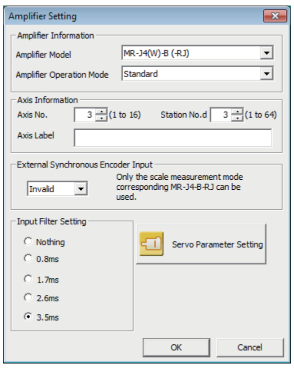


(4) An Amplifier Setting dialog box then appears. Ensure that the "Amplifier Model" is "MR-J4(W)-B(-RJ)".

(5) Ensure that the "Axis No." and "Station No. d" are "1".

(6) Once set, click the OK button at the Amplifier Setting dialog box.





(7) In the similar manner to the setting of the first module, set up the second and third servo amplifiers and servo motors as follows.

- Second amplifier
  "Amplifier Model": "MR-J4(W)-B(-RJ)"
  "Axis No.": 2
  "Station No. d": 2
- Third amplifier
  "Amplifier Model": "MR-J4(W)-B(-RJ)"
  "Axis No.": 3
  "Station No. d": 3

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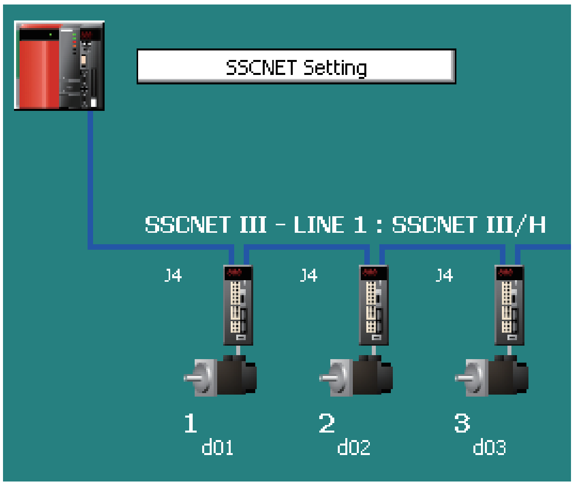
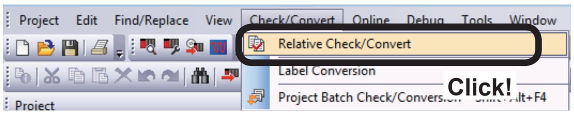
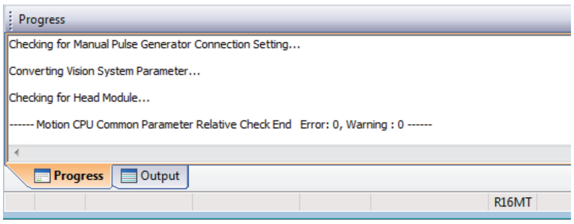


(8) Settings for the first (d01), second (d02) and third (d03) servo amplifier and servo motor are now complete.

(3) Relativity check, saving

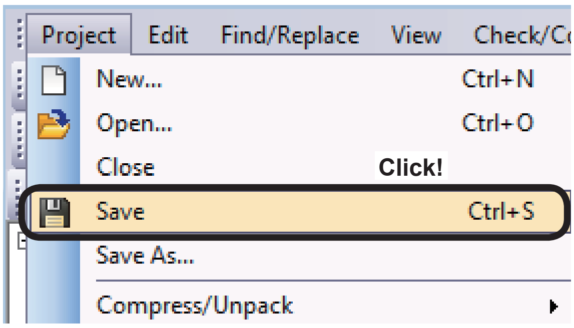


1: When system settings and amplifier settings are complete, click [Relative Check/Convert] on the [Check/Convert] menu.



2: Ensure that there are no errors at the output window.

If any error items are displayed in the output window, edit the setting(s) and retry the relativity check.

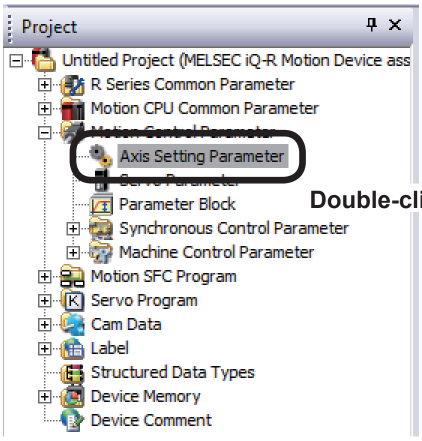


3: Click [Save] on the [Project] menu.

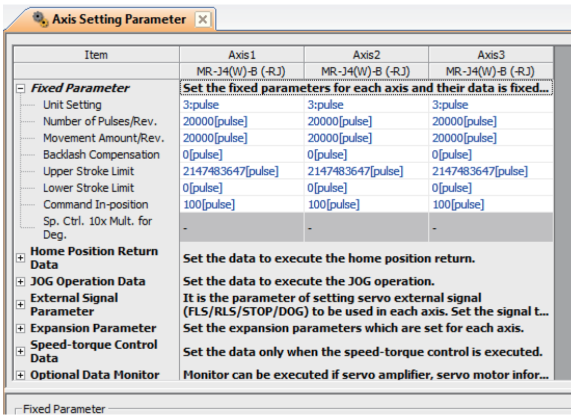
System settings are now complete.

9.4 Servo Data Input Operation

After specifying system settings, specify servo data settings.

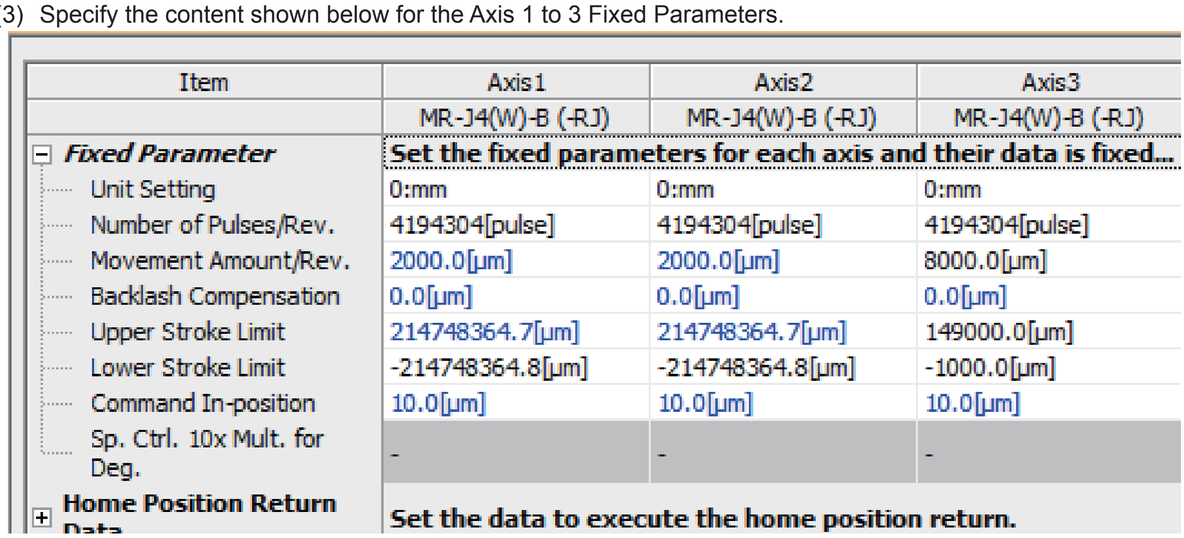


(1) Double-click [Motion Control Parameter] → [Axis Setting Parameter] in the project window.



(2) An Axis Setting Parameter window appears.

(3) Specify the content shown below for the Axis 1 to 3 Fixed Parameters.



Item	Axis1	Axis2	Axis3
	MR-J4(W)-B (-RJ)	MR-J4(W)-B (-RJ)	MR-J4(W)-B (-RJ)
Fixed Parameter	Set the fixed parameters for each axis and their data is fixed...		
Unit Setting	0:mm	0:mm	0:mm
Number of Pulses/Rev.	4194304[pulse]	4194304[pulse]	4194304[pulse]
Movement Amount/Rev.	2000.0[μm]	2000.0[μm]	8000.0[μm]
Backlash Compensation	0.0[μm]	0.0[μm]	0.0[μm]
Upper Stroke Limit	214748364.7[μm]	214748364.7[μm]	149000.0[μm]
Lower Stroke Limit	-214748364.8[μm]	-214748364.8[μm]	-1000.0[μm]
Command In-position	10.0[μm]	10.0[μm]	10.0[μm]
Sp. Ctrl. 10x Mult. for Deg.	-	-	-
Home Position Return Data	Set the data to execute the home position return.		

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From previous page

(4) Specify the content shown below for the Axis 1 to 3 Home Position Return Data settings.

Item	Axis1	Axis2	Axis3
	MR-J4(W)-B (-RJ)	MR-J4(W)-B (-RJ)	MR-J4(W)-B (-RJ)
Fixed Parameter	**Set the fixed parameters for each axis and their data is fixed...**		
Home Position Return Data	**Set the data to execute the home position return.**		
HPR Direction	0:Reverse Direction	0:Reverse Direction	0:Reverse Direction
HPR Method	2:Data Set Method 1	0:Proximity Dog Method 1	0:Proximity Dog Method 1
Home Position Address	-5000.0[μm]	-5000.0[μm]	0.0[μm]
HPR Speed	-	100.00[mm/min]	600.00[mm/min]
Creep Speed	-	20.00[mm/min]	250.00[mm/min]
Movement Amount After Dog	-	-	-
Parameter Block Setting	-	1	1
HPR Retry Function	-	1:Valid	1:Valid
Dwell Time at HPR Retry	-	0[ms]	0[ms]
Home Position Shift Amount	-	-5000.0[μm]	0.0[μm]
Speed Set at Home Pos. Shift	-	0:HPR Speed	0:HPR Speed
Torque Limit at Creep Speed	-	-	-
Operation for HPR Incompletion	0:Execute Servo Program	0:Execute Servo Program	0:Execute Servo Program
HPR Request Setting in Pulse Conversion Unit	-	-	-
Standby Time after Clear Signal Output in Pulse C...	-	-	-

(5) Specify the content shown below for the Axis 1 to 3 JOG Operation Data settings.

Item	Axis1	Axis2	Axis3
	MR-J4(W)-B (-RJ)	MR-J4(W)-B (-RJ)	MR-J4(W)-B (-RJ)
JOG Operation Data	**Set the data to execute the JOG operation.**		
JOG Speed Limit Value	6000.00[mm/min]	6000.00[mm/min]	5000.00[mm/min]
Parameter Block Setting	1	1	1

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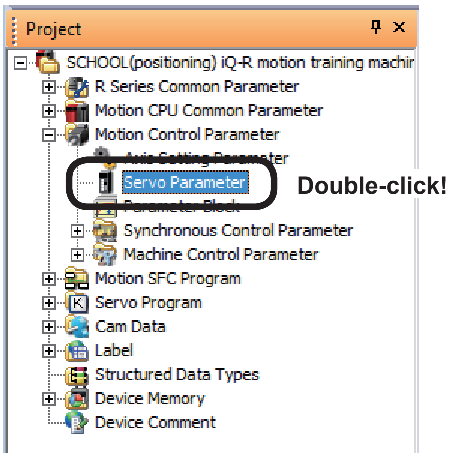
(6) Specify the content shown below for the Axis 1 to 3 External Signal Parameters.

Item	Axis1	Axis2	Axis3
	MR-J4(W)-B (-RJ)	MR-J4(W)-B (-RJ)	MR-J4(W)-B (-RJ)
External Signal Parameter	**It is the parameter of setting servo external signal (FLS/RLS/STOP/DOG) to be used in each axis. Set the signal t...**		
FLS Signal	**Set the signal type and the signal/contact used as the upper ...**		
Signal Type	0:Invalid	0:Invalid	1:Amplifier Input
Device	-	-	-
Contact	-	-	1:Normally Closed Contact
RLS Signal	**Set the signal type and the signal/contact used as the lower ...**		
Signal Type	0:Invalid	0:Invalid	1:Amplifier Input
Device	-	-	-
Contact	-	-	1:Normally Closed Contact
STOP Signal	**Set the signal type and signal contact to be used as stop sign...**		
Signal Type	0:Invalid	0:Invalid	0:Invalid
Device	-	-	-
Contact	-	-	-
DOG Signal	**Set the signal type and signal contact to be used as the proxi...**		
Signal Type	0:Invalid	1:Amplifier Input	1:Amplifier Input
Device	-	-	-
Contact	-	0:Normally Open Contact	1:Normally Closed Contact
Precision	-	0:General	0:General

(7) Double-click [Motion Control Parameter] → [Servo Parameter] in the Project window.



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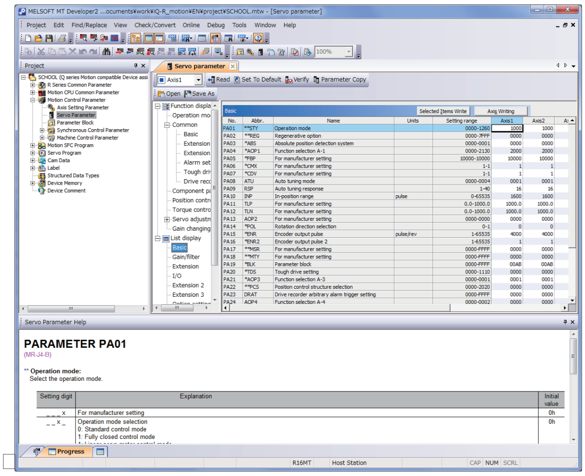
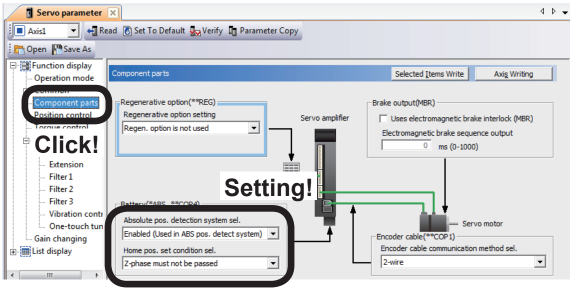
From previous page

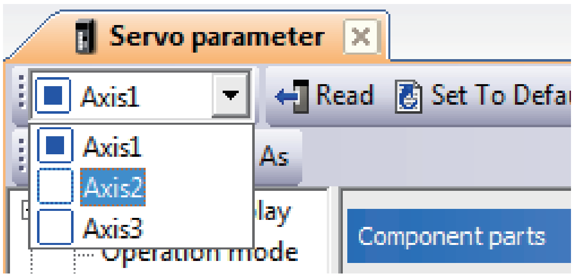


(8) A Servo Parameter Setting window appears.

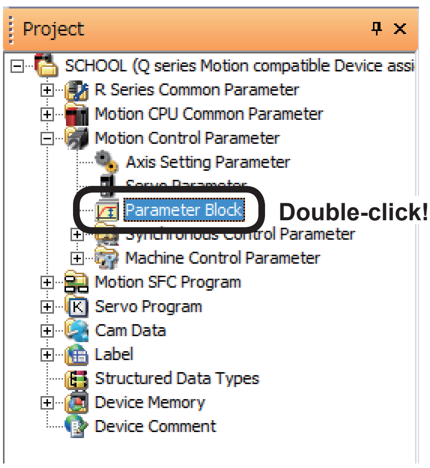


(9) Click [Function display] → [Component parts] in the Parameter Setting screen display selection tree, and then specify the following settings.

Absolute pos. detection system sel.
: Enabled (Used in ABS pos. detect system)
Home pos, set condition sel.
: Z-phase must not be passed.



(10) Switch to Axis 2 and 3, and set the parameter settings in a manner similar to Axis 1. For Axis 3, however, set the Home pos, set condition sel.: Z-pahse must be passed.



(11) Double-click [Motion Control Parameter] → [Parameter Block] in the Project window.

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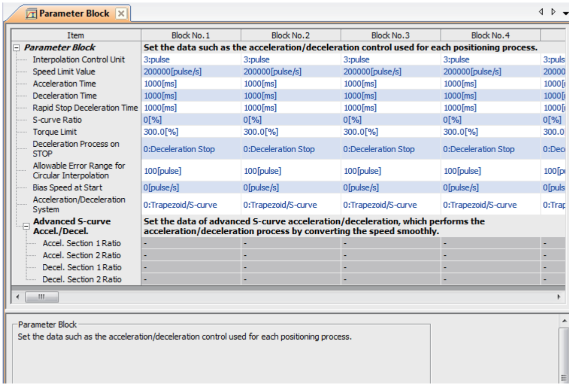
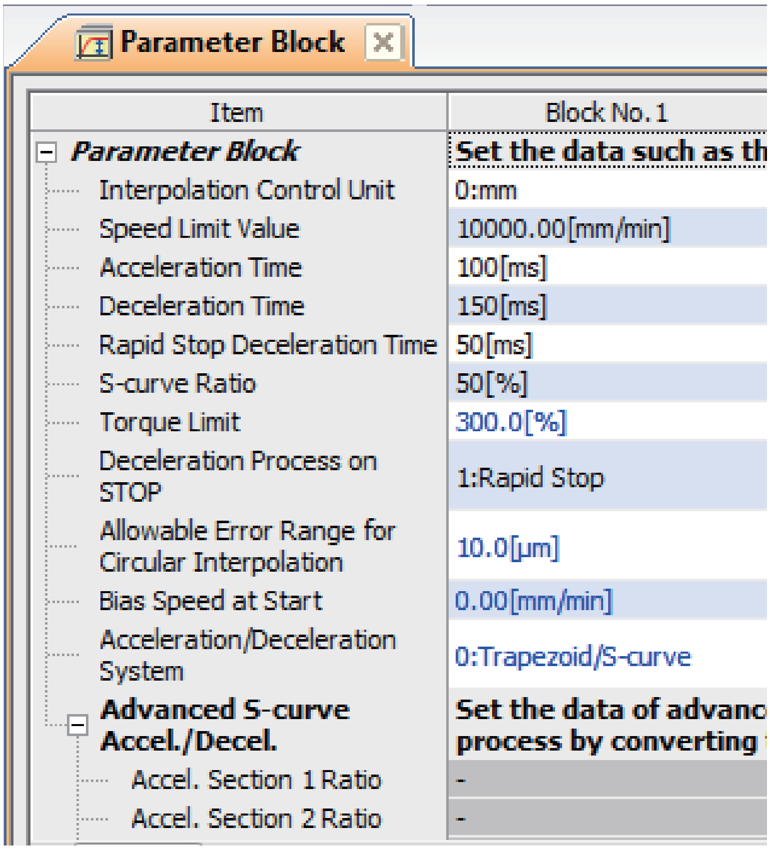


(12) The Parameter Block Setting screen appears.

(13) Specify Parameter Block No. 1 settings as shown below.



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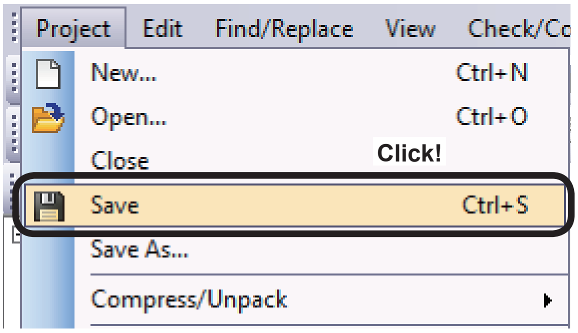
From previous page



(14) When all servo data settings are complete, click [Save] on the [Project] menu.

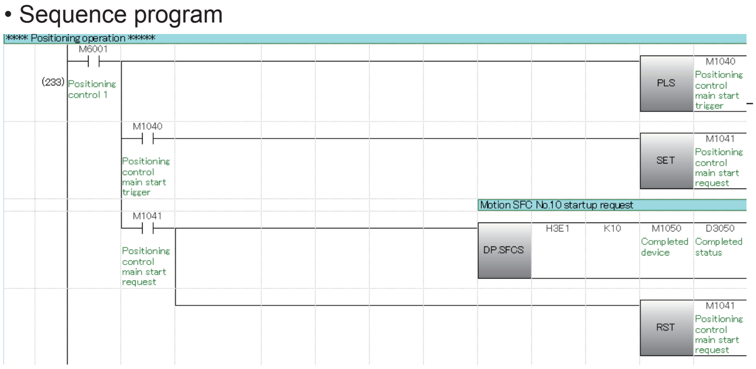
Servo data settings are now complete.

9.5 Practice Motion SFC Programs

These sequence/Motion SFC programs have been created for operation purposes on the assumption that MT Works2 (for R16MTCPU) be used.
An explanatory drawing of the demonstration machine GOT operation panel is shown in item 9.2.

9.5.1 Program list

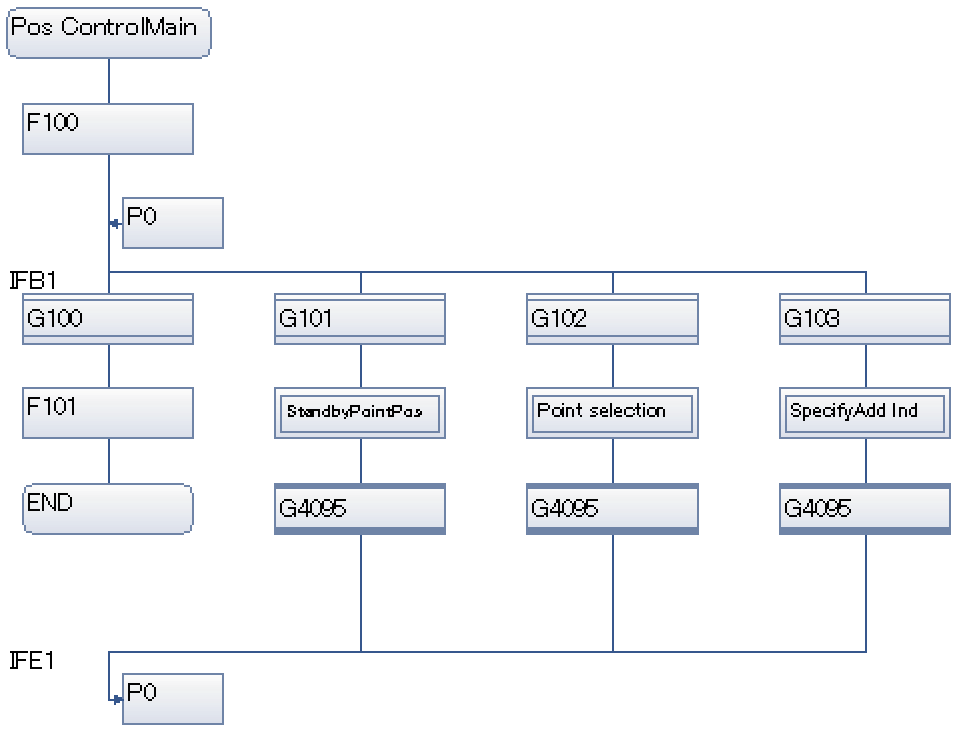
The sequence program and Motion SFC program used for practice are shown in the following list. Initial processing, operation type selection, JOG operation, home position return, and Motion SFC program startup are performed from the sequence program. Standby point positioning, positioning by selecting positioning points at the demonstration machine operation panel, and positioning by entering positioning addresses at the demonstration machine operation panel are practiced using the Motion SFC program. Refer to the respective descriptions of each program in this manual for details.

Normal execution	Startup with sequence program	Startup with Motion SFC program
• Sequence program 	[Pos ControlMain] Motion SFC program No. 10	[StandbyPointPos] Motion SFC program No. 20 [Point selection] Motion SFC program No. 30 [SpecifyAdd Ind] Motion SFC program No. 40

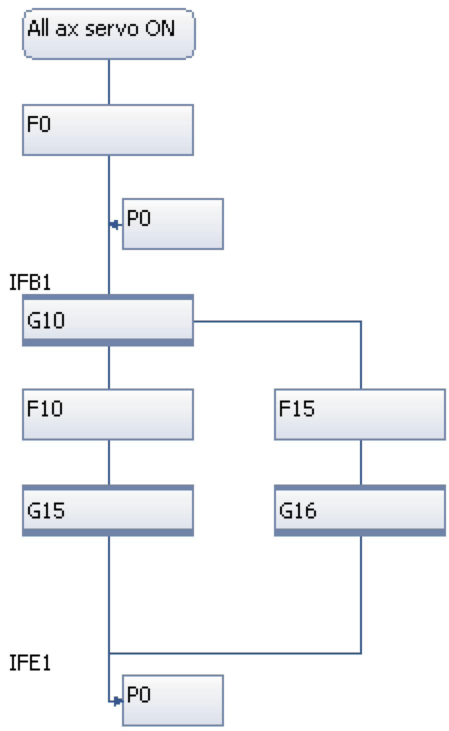
• Motion SFC program parameters

No.	Program name	Automatic start	END operation	No. of transitions	Execution timing
1	All ax servo ON	Yes	-	-	Normal
10	Pos ControlMain	No	-	-	Normal
20	StandbyPointPos	No	-	-	Normal
30	Point selection	No	-	-	Normal
40	SpecifyAdd Ind	No	-	-	Normal

- Start program from sequence program

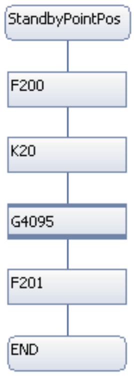


- Motion SFC program　Program that starts up automatically.

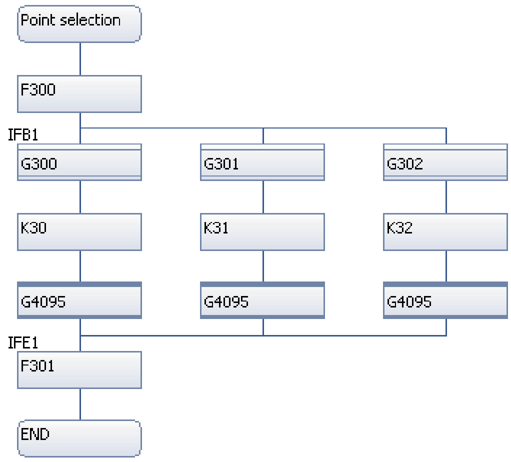


• Start program from Motion SFC program [Pos ControlMain] program No. 10

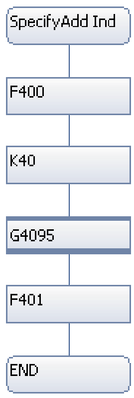
[StanbyPointPos] Program No. 20



[Point selection] Program No. 30



[SpecifyAdd Ind] Program No. 40

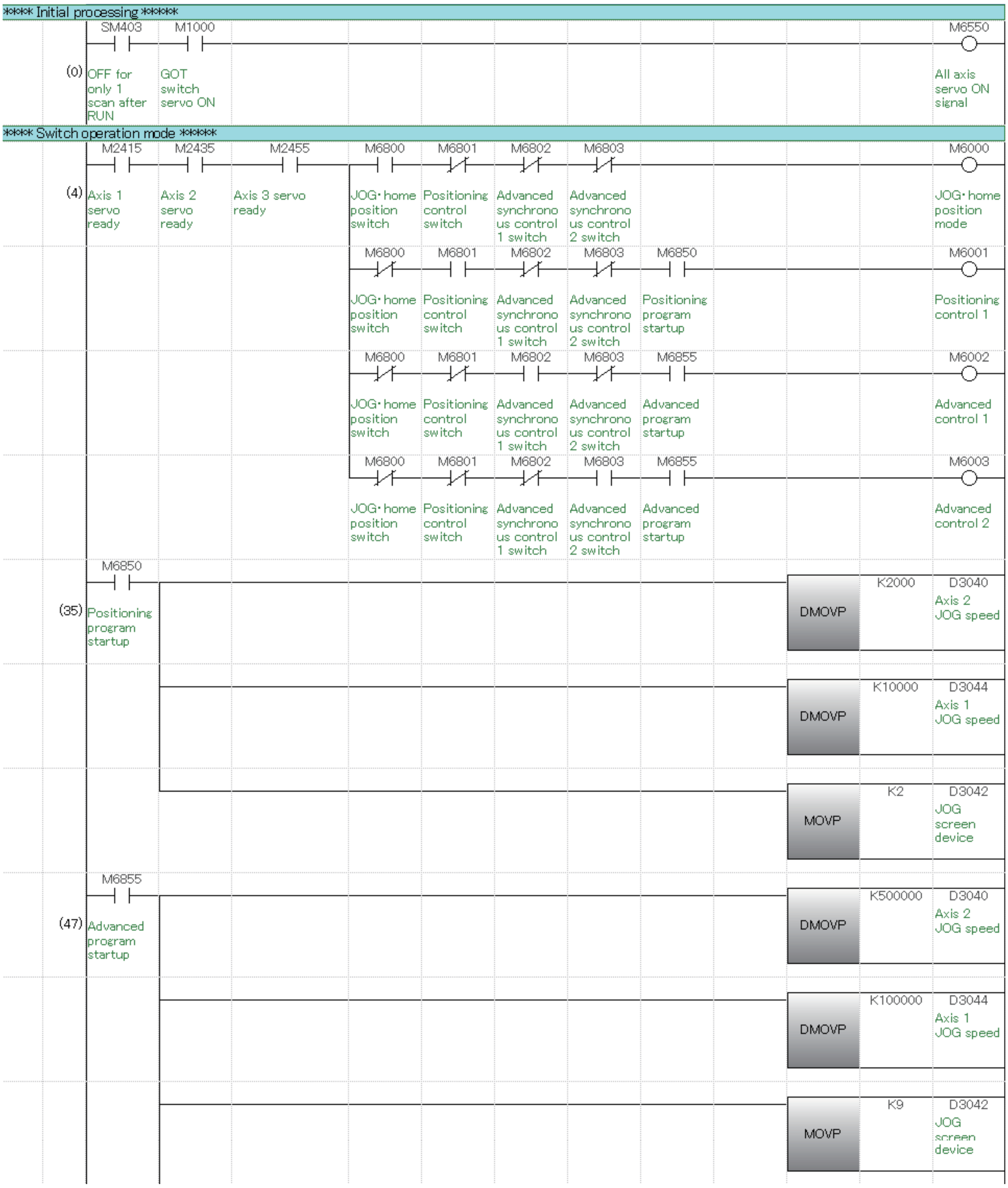


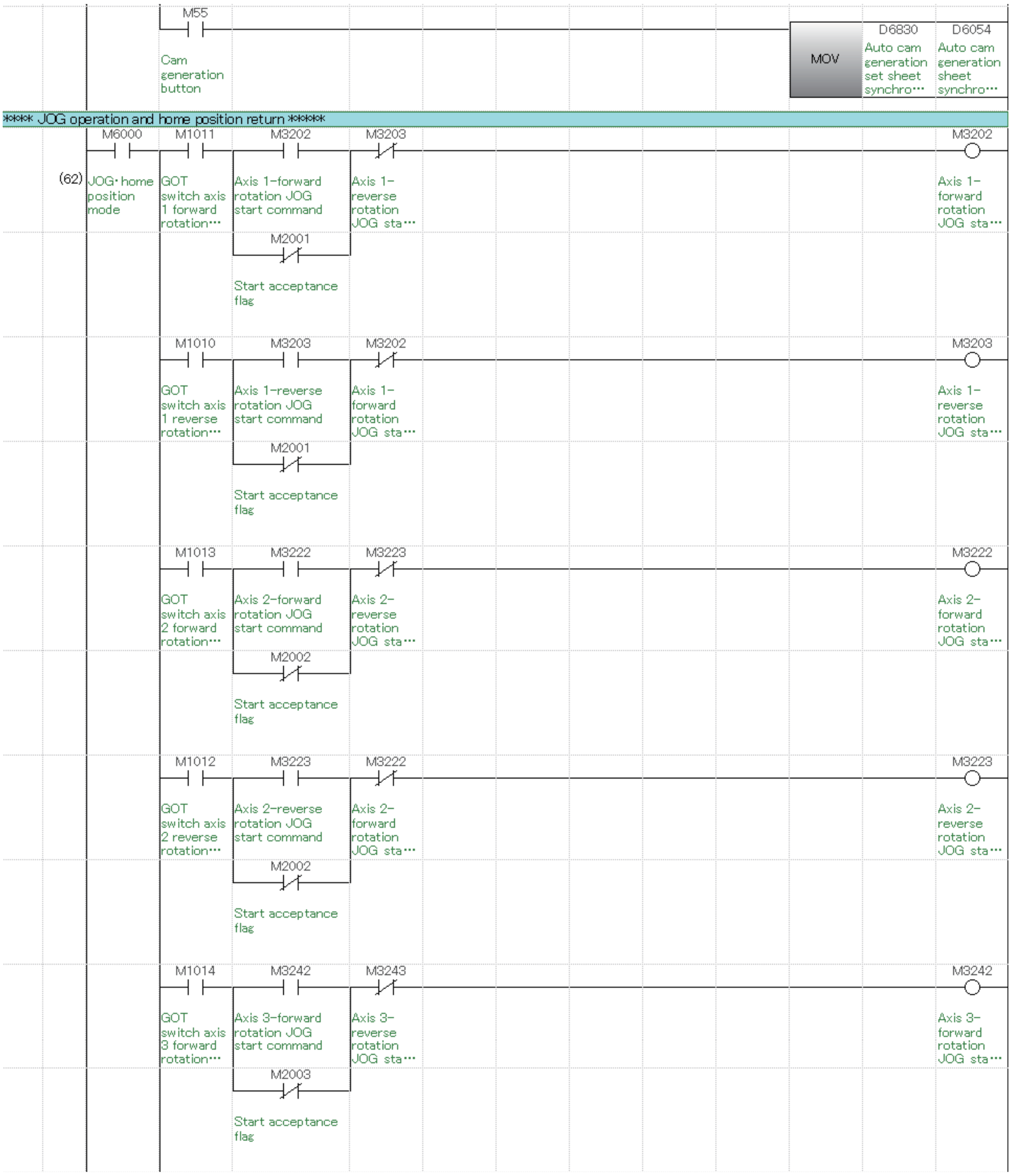
• Start program from sequence program

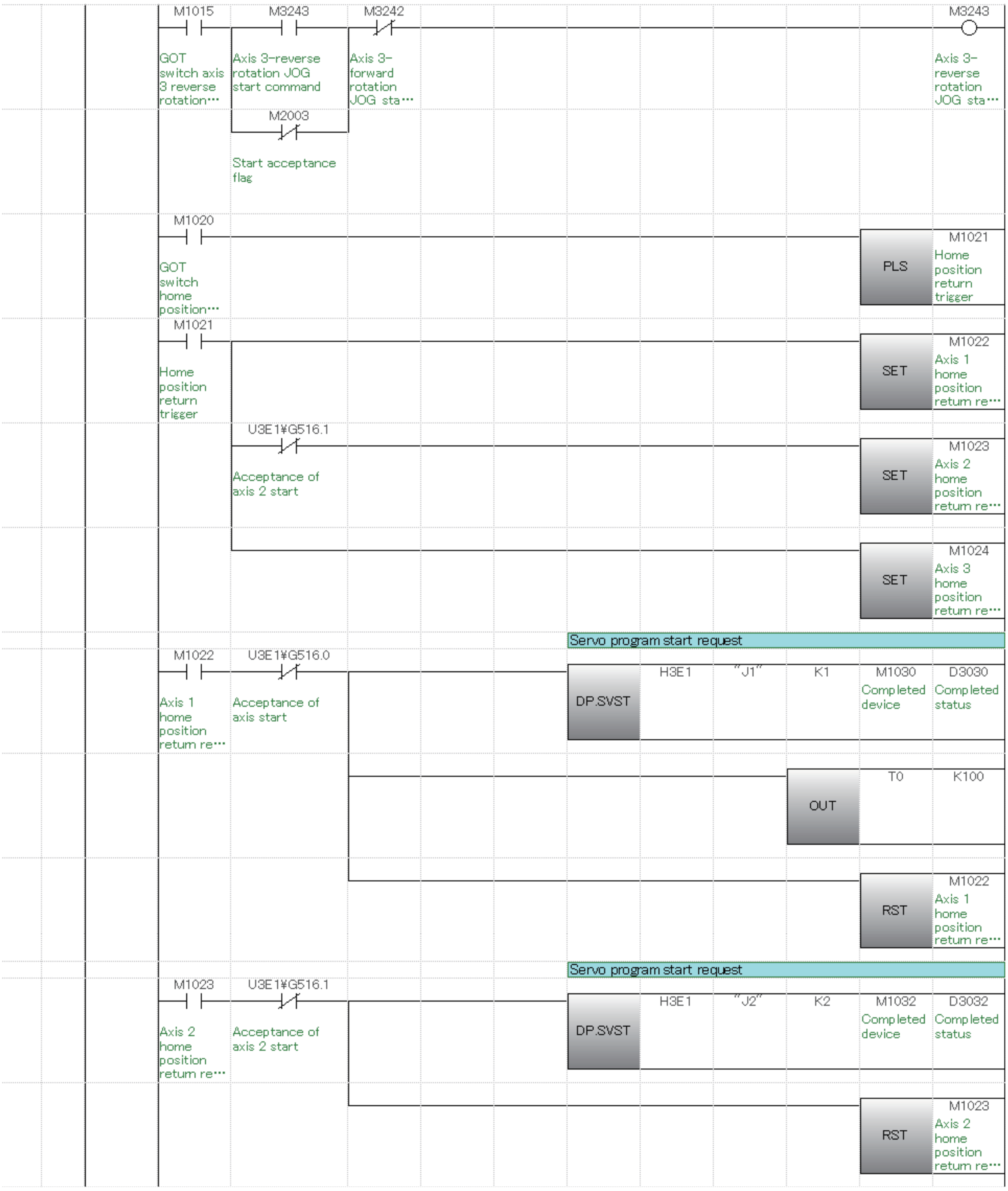
[Home position return program]
Servo program K1, K2 and K3 are started directly with an SVST instruction from the sequence program.

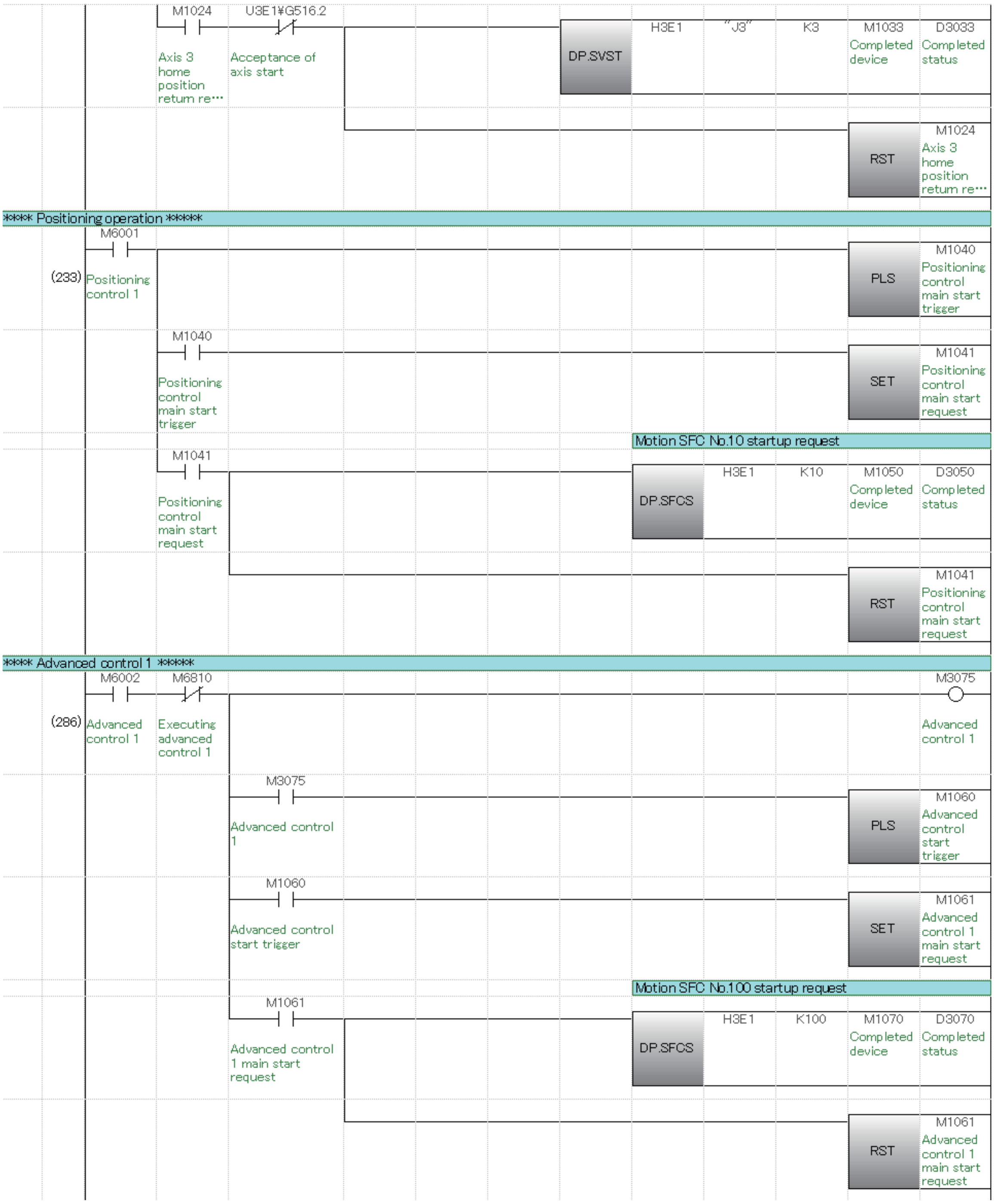
[Jog operation]
JOG start devices M3202, M3203, M3222, M3223, M3242 and M3243 are started by turning them ON directly from the sequence program.

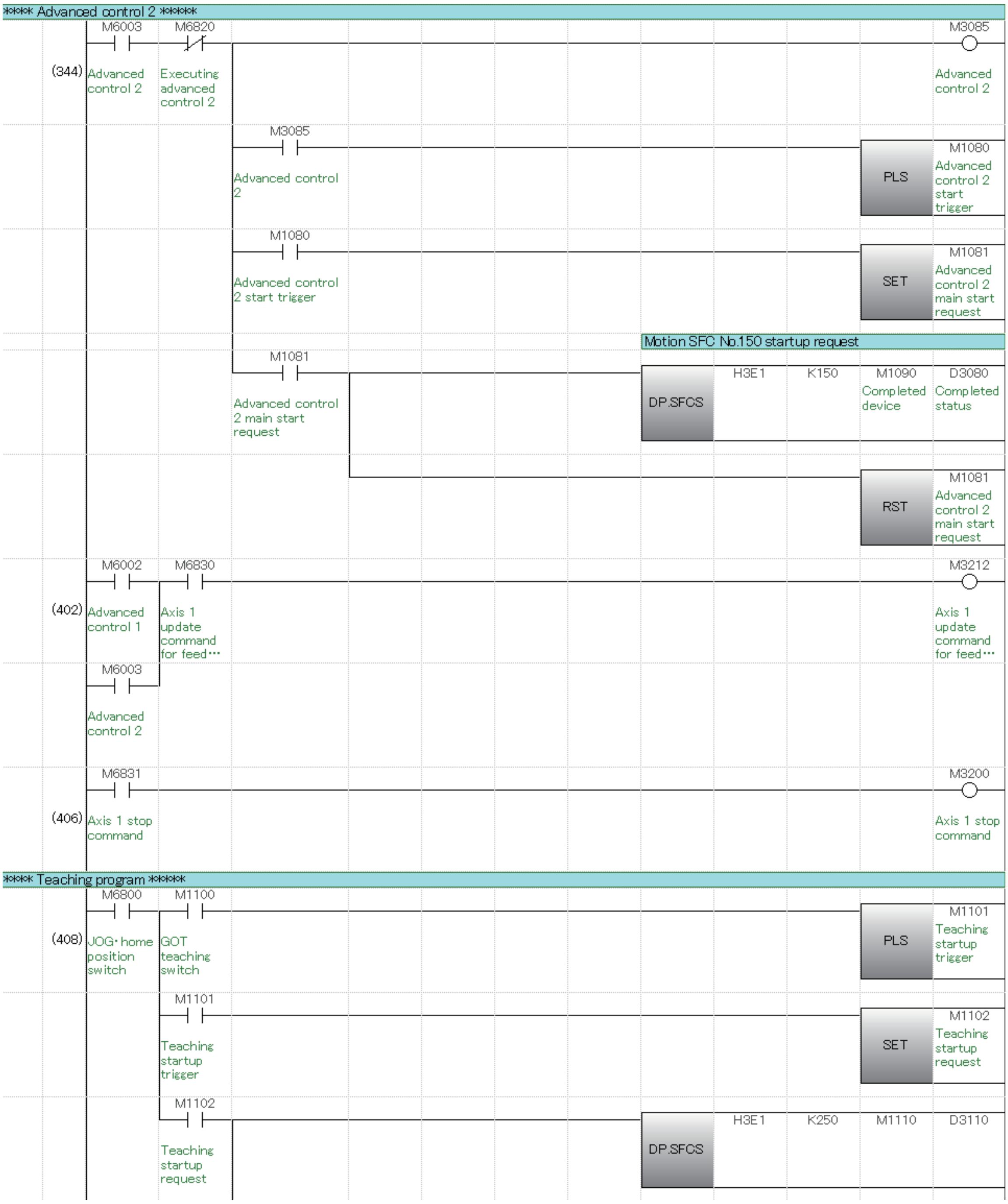
• R08CPU sequence program

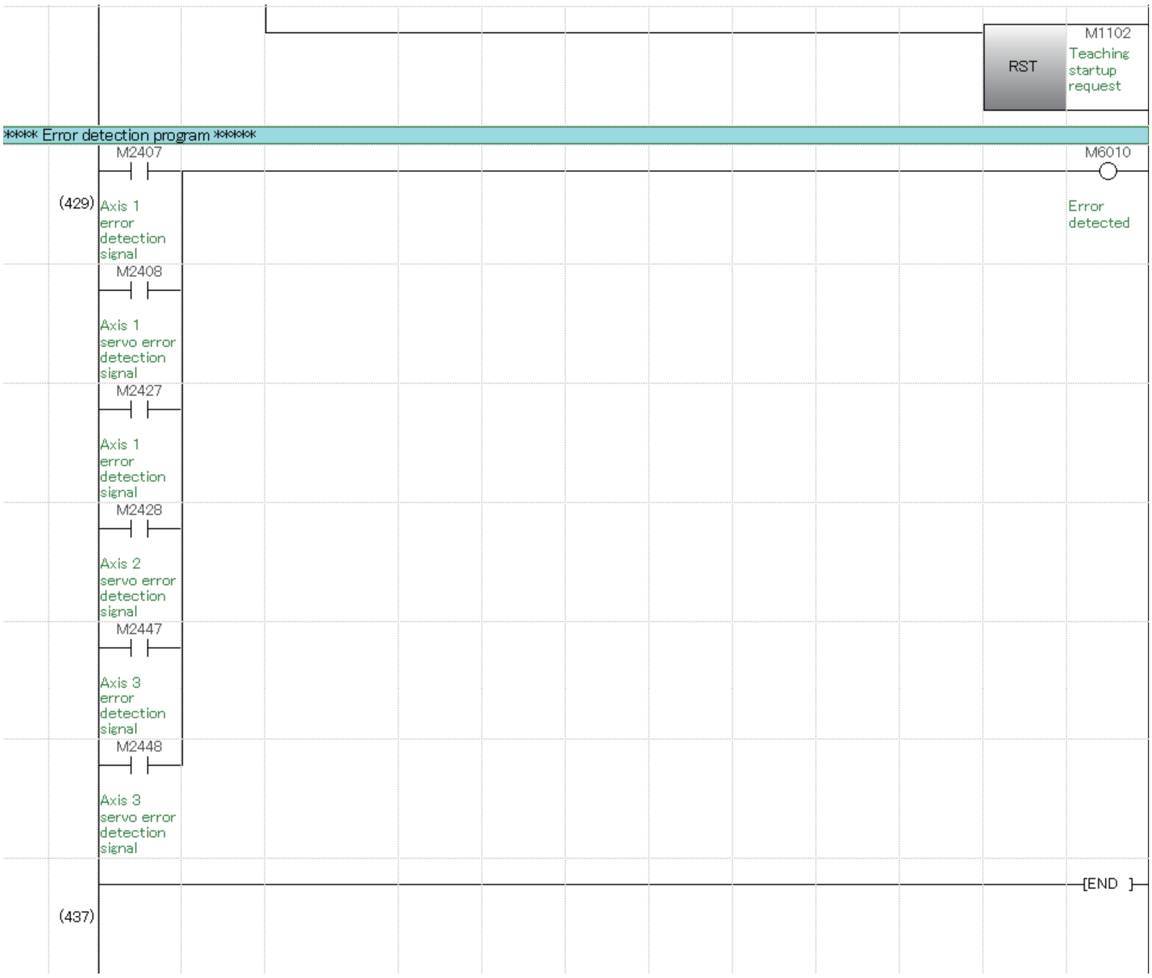



M55
Cam generation button
MOV
D6830
Auto cam generation set sheet synchro…
D6054
Auto cam generation sheet synchro…
**** JOG operation and home position return *****
(62)
M6000
JOG・home position mode
M1011
GOT switch axis 1 forward rotation…
M3202
Axis 1-forward rotation JOG start command
M3203
Axis 1-reverse rotation JOG sta…
M3202
Axis 1-forward rotation JOG sta…
M2001
Start acceptance flag
M1010
GOT switch axis 1 reverse rotation…
M3203
Axis 1-reverse rotation JOG start command
M3202
Axis 1-forward rotation JOG sta…
M3203
Axis 1-reverse rotation JOG sta…
M2001
Start acceptance flag
M1013
GOT switch axis 2 forward rotation…
M3222
Axis 2-forward rotation JOG start command
M3223
Axis 2-reverse rotation JOG sta…
M3222
Axis 2-forward rotation JOG sta…
M2002
Start acceptance flag
M1012
GOT switch axis 2 reverse rotation…
M3223
Axis 2-reverse rotation JOG start command
M3222
Axis 2-forward rotation JOG sta…
M3223
Axis 2-reverse rotation JOG sta…
M2002
Start acceptance flag
M1014
GOT switch axis 3 forward rotation…
M3242
Axis 3-forward rotation JOG start command
M3243
Axis 3-reverse rotation JOG sta…
M3242
Axis 3-forward rotation JOG sta…
M2003
Start acceptance flag


M1015
GOT switch axis 3 reverse rotation…
M3243
Axis 3-reverse rotation JOG start command
M3242
Axis 3-forward rotation JOG sta…
M3243
Axis 3-reverse rotation JOG sta…
M2003
Start acceptance flag
M1020
GOT switch home position…
PLS
M1021
Home position return trigger
M1021
Home position return trigger
SET
M1022
Axis 1 home position return re…
U3E1¥G516.1
Acceptance of axis 2 start
SET
M1023
Axis 2 home position return re…
SET
M1024
Axis 3 home position return re…
Servo program start request
M1022
Axis 1 home position return re…
U3E1¥G516.0
Acceptance of axis start
DP.SVST
H3E1
"J1"
K1
M1030
Completed device
D3030
Completed status
OUT
T0
K100
RST
M1022
Axis 1 home position return re…
Servo program start request
M1023
Axis 2 home position return re…
U3E1¥G516.1
Acceptance of axis 2 start
DP.SVST
H3E1
"J2"
K2
M1032
Completed device
D3032
Completed status
RST
M1023
Axis 2 home position return re…


M1024
U3E1¥G516.2
DP.SVST
H3E1
"J3"
K3
M1033
D3033
Completed device
Completed status
Axis 3 home position return re…
Acceptance of axis start
RST
M1024
Axis 3 home position return re…
**** Positioning operation *****
M6001
(233)
Positioning control 1
PLS
M1040
Positioning control main start trigger
M1040
Positioning control main start trigger
SET
M1041
Positioning control main start request
Motion SFC No.10 startup request
M1041
DP.SFCS
H3E1
K10
M1050
D3050
Completed device
Completed status
Positioning control main start request
RST
M1041
Positioning control main start request
**** Advanced control 1 *****
M6002
M6810
M3075
(286)
Advanced control 1
Executing advanced control 1
Advanced control 1
M3075
Advanced control 1
PLS
M1060
Advanced control start trigger
M1060
Advanced control start trigger
SET
M1061
Advanced control 1 main start request
Motion SFC No.100 startup request
M1061
DP.SFCS
H3E1
K100
M1070
D3070
Completed device
Completed status
Advanced control 1 main start request
RST
M1061
Advanced control 1 main start request

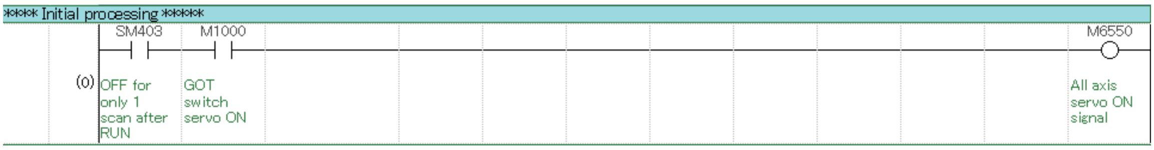

***** Advanced control 2 *****
(344)
M6003 Advanced control 2
M6820 Executing advanced control 2
M3085 Advanced control 2
M3085 Advanced control 2
PLS M1080 Advanced control 2 start trigger
M1080 Advanced control 2 start trigger
SET M1081 Advanced control 2 main start request
Motion SFC No.150 startup request
M1081 Advanced control 2 main start request
DP.SFCS H3E1 K150 M1090 D3080
Completed device
Completed status
RST M1081 Advanced control 2 main start request
(402)
M6002 Advanced control 1
M6830 Axis 1 update command for feed…
M3212 Axis 1 update command for feed…
M6003 Advanced control 2
(406)
M6831 Axis 1 stop command
M3200 Axis 1 stop command
***** Teaching program *****
(408)
M6800 JOG・home position switch
M1100 GOT teaching switch
PLS M1101 Teaching startup trigger
M1101 Teaching startup trigger
SET M1102 Teaching startup request
M1102 Teaching startup request
DP.SFCS H3E1 K250 M1110 D3110


RST
M1102
Teaching startup request
***** Error detection program *****
(429)
M2407
Axis 1 error detection signal
M6010
Error detected
M2408
Axis 1 servo error detection signal
M2427
Axis 1 error detection signal
M2428
Axis 2 servo error detection signal
M2447
Axis 3 error detection signal
M2448
Axis 3 servo error detection signal
(437)
END

9.5.2 Initial processing

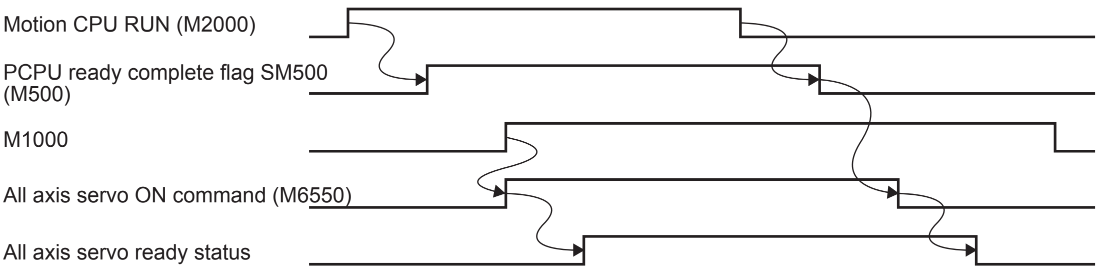
The following is an example of a program used to start all Motion CPU servo axes.
Both the PLC CPU and Motion CPU are set to the RUN status. With the settings for this practice, a servo data and servo parameter check is performed after the Motion CPU status changes from STOP to RUN. If there are no errors, the Motion CPU turns the PCPU READY complete flag (SM500) ON.
The PLC CPU receives the PCPU READY complete flag (SM500) as M500 through auto refresh. When there are no errors at either the PLC CPU or Motion CPU, by turning M1000 ON at the demonstration machine operation panel, an all axis servo ON command is sent from the PLC CPU, and Motion CPU startup is completed.

(1) Program example



Demonstration machine operation panel

[Timing chart]



9.5.3 JOG Operation

JOG operation is used to perform operation manually only while buttons are held down.
The devices shown in the table below and content (acceleration/deceleration time) of the parameter blocks set in JOG data are used.
By setting the speed in the JOG speed setting register (table below), and turning ON a forward rotation JOG start signal (M3202/axis 1) or reverse rotation JOG start signal (M3203/axis 1), JOG operation starts.
JOG operation stops when the JOG start signal is turned OFF.

(1) JOG operation speed setting register

<table>
<tr><th rowspan="3">Axis No.</th><th colspan="2">JOG operation speed setting register</th><th colspan="8">Speed setting range</th></tr>
<tr><th rowspan="2">Upper</th><th rowspan="2">Lower</th><th colspan="2">mm</th><th colspan="2">inch</th><th colspan="2">degree</th><th colspan="2">pulse</th></tr>
<tr><th>Setting range</th><th>Unit</th><th>Setting range</th><th>Unit</th><th>Setting range</th><th>Unit</th><th>Setting range</th><th>Unit</th></tr>
<tr><td>1</td><td>D641</td><td>D640</td><td rowspan="8">1 to 600000000</td><td rowspan="8">× 10^-2 mm/min</td><td rowspan="8">1 to 600000000</td><td rowspan="8">× 10^-3 inch/min</td><td rowspan="8">1 to 2147483647</td><td rowspan="8">× 10^-3 degree/min</td><td rowspan="8">1 to 2147483647</td><td rowspan="8">pulse/s</td></tr>
<tr><td>2</td><td>D643</td><td>D642</td></tr>
<tr><td>3</td><td>D645</td><td>D644</td></tr>
<tr><td>4</td><td>D647</td><td>D646</td></tr>
<tr><td>5</td><td>D649</td><td>D648</td></tr>
<tr><td>6</td><td>D651</td><td>D650</td></tr>
<tr><td>7</td><td>D653</td><td>D652</td></tr>
<tr><td>8</td><td>D655</td><td>D654</td></tr>
</table>

(2) Forward/reverse rotation JOG start signals

Control axis	Axis 1	Axis 2	Axis 3	Axis 4	Axis 5	Axis 6	Axis 7	Axis 8
Forward rotation	M3202	M3222	M3242	M3262	M3282	M3302	M3322	M3342
Reverse rotation	M3203	M3223	M3243	M3263	M3283	M3303	M3323	M3343

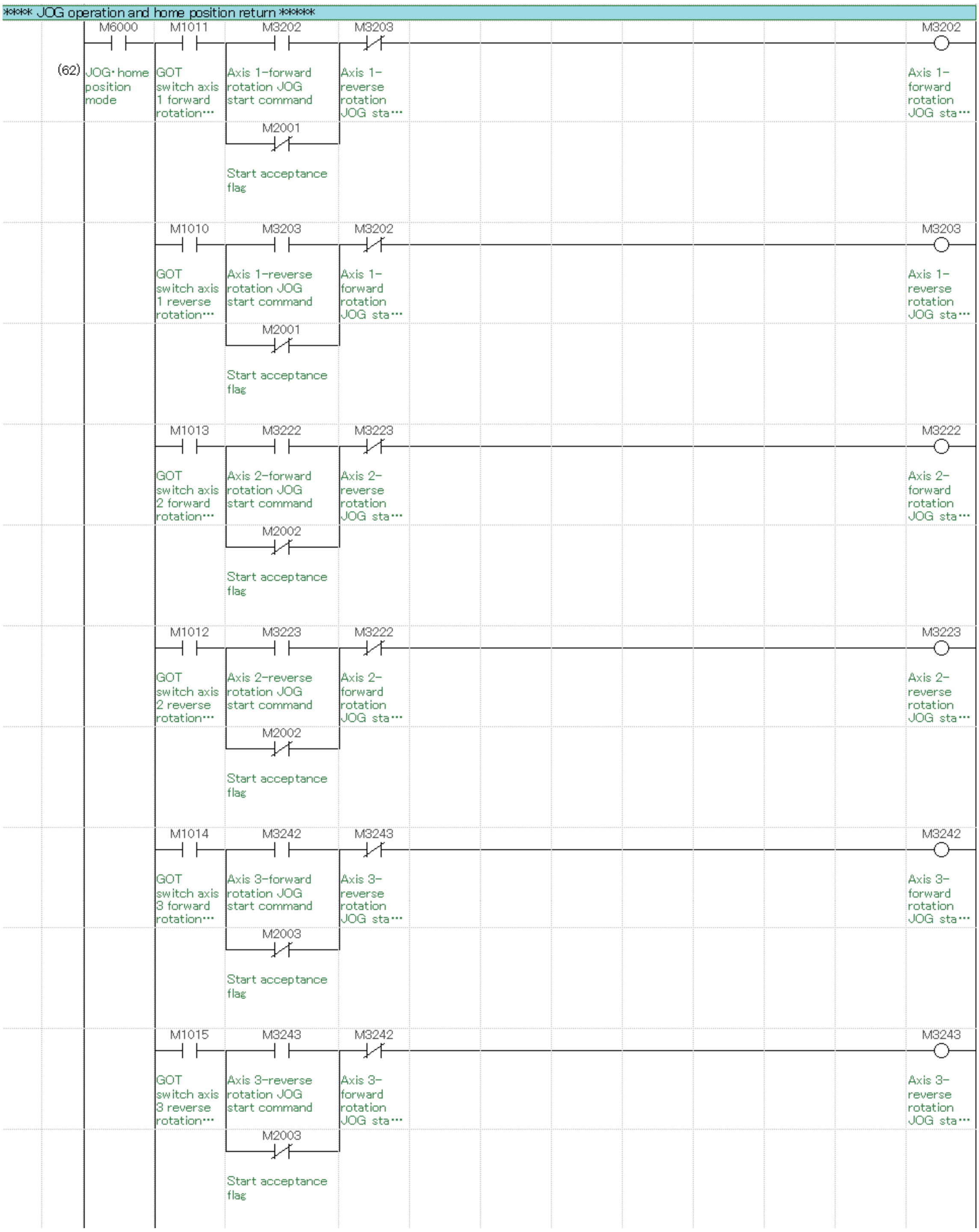
(3) Program example

1: JOG operating condition items

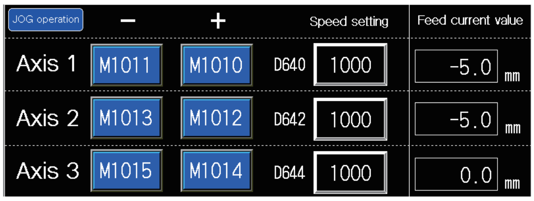
<table>
<tr><th>Item</th><th colspan="3">Condition</th></tr>
<tr><td>Control axis</td><td>Axis 1</td><td>Axis 2</td><td>Axis 3</td></tr>
<tr><td rowspan="2">JOG operation command input</td><td>Forward rotation (M1011)</td><td>Forward rotation (M1013)</td><td>Forward rotation (M1014)</td></tr>
<tr><td>Reverse rotation (M1010)</td><td>Reverse rotation (M1012)</td><td>Reverse rotation (M1015)</td></tr>
</table>

2: Example of program in which JOG operation is performed by starting axis 1, 2 and 3 independently

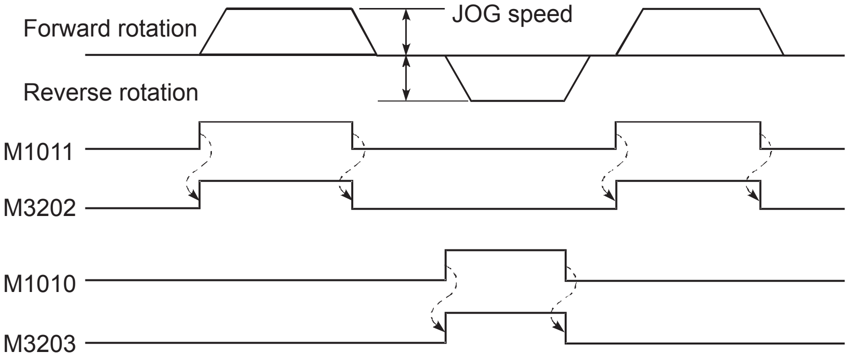
The JOG speed can be set freely from the demonstration machine operation panel.



M1011 : Axis 1 forward rotation JOG command
M1010 : Axis 1 reverse rotation JOG command
M1013 : Axis 2 forward rotation JOG command
M1012 : Axis 2 reverse rotation JOG command
M1014 : Axis 3 forward rotation JOG command
M1015 : Axis 3 reverse rotation JOG command
D641, D640 : Axis 1 JOG speed setting register
D643, D642 : Axis 2 JOG speed setting register
D645, D644 : Axis 3 JOG speed setting register



[Timing chart]



9.5.4 Home position return

The following is an example of a program in which a servo program is run and home position return is performed by executing an SVST instruction from a ladder program.
Actual details of the home position return operation are determined by the home position return data at the Motion CPU side and the parameter block (acceleration/deceleration time).
The home position return operation for each axis is as follows.
Home position return is performed by turning ON the demonstration machine operation panel M1020.

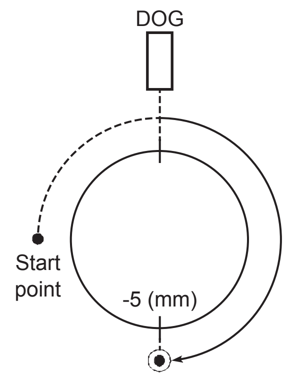
Axis 2, 3: Set with proximity dog.
After starting, the motor rotates in the home position return direction, and the rotation is complete when the home position dog changes from ON to OFF.

[Servo Programs]

Real
<K 2>

ZERO	
Axis	2

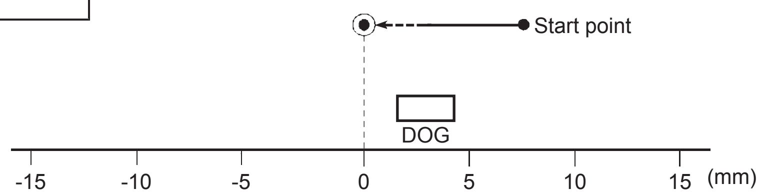
Axis 2 servo program



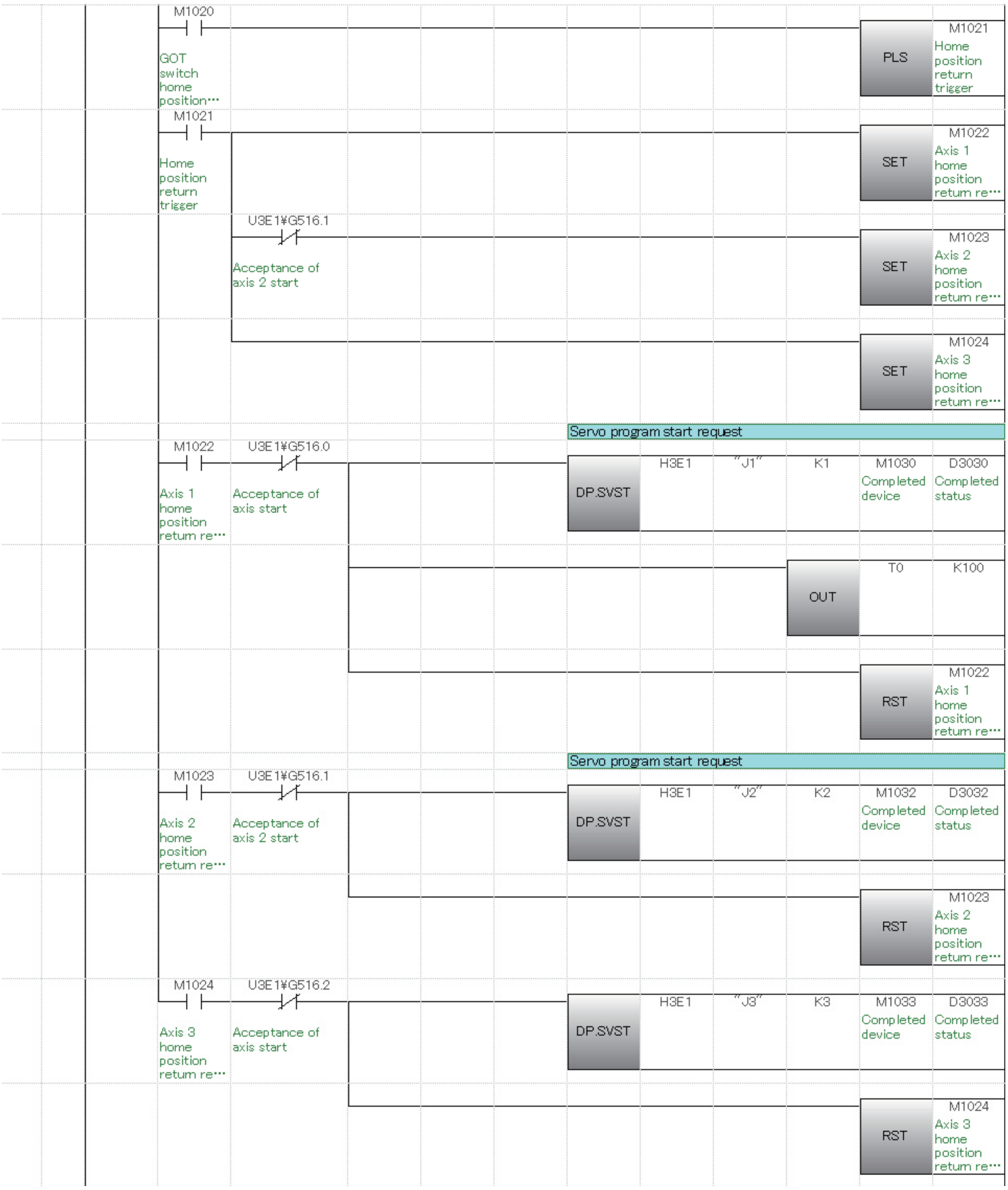
Real
<K 3>

ZERO	
Axis	3

Axis 3 servo program



[Sequence program]



9.5.5 Main routine Motion SFC program (positioning control)

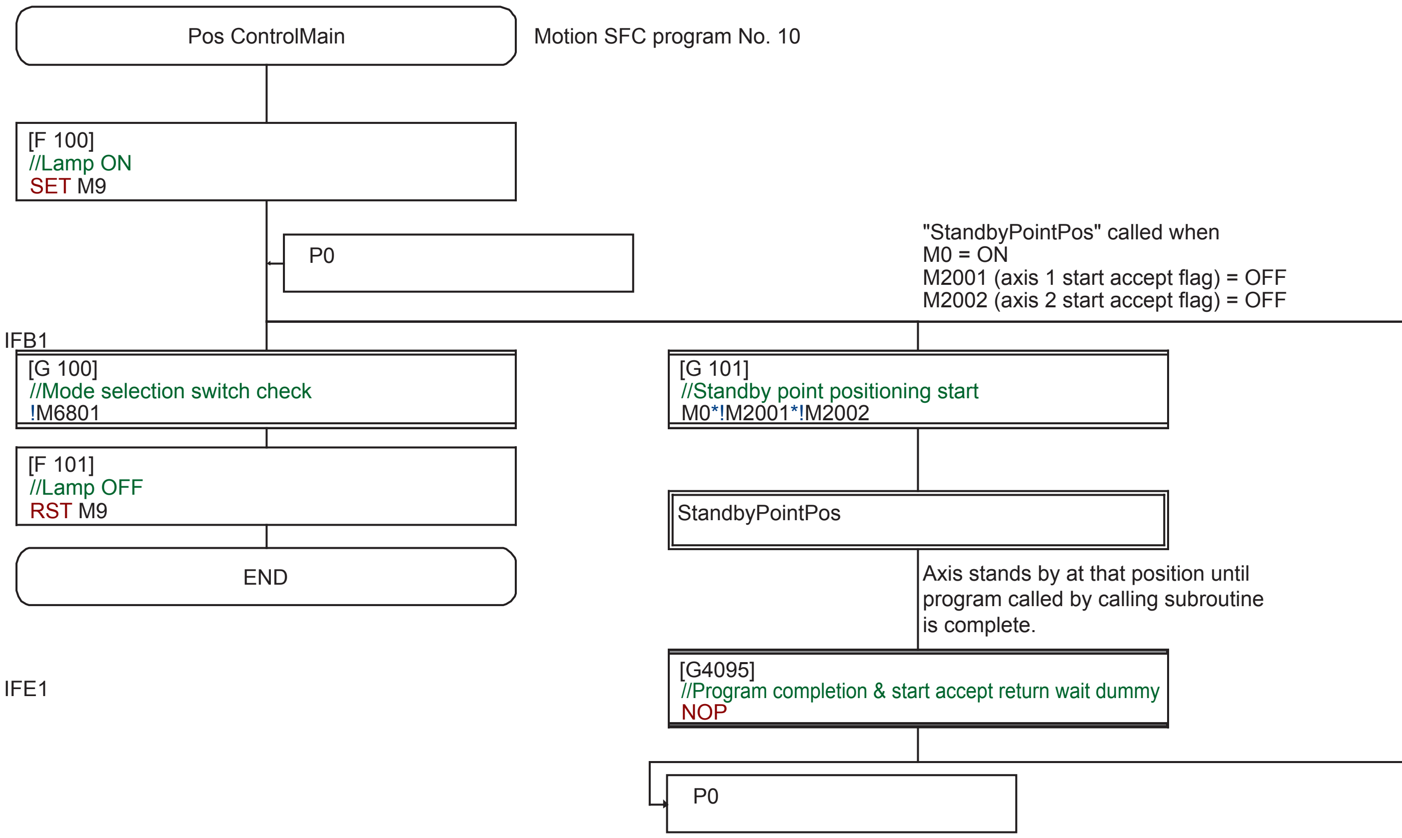
This is a Motion SFC program run as the main routine when performing positioning control operation (other than manual operation).

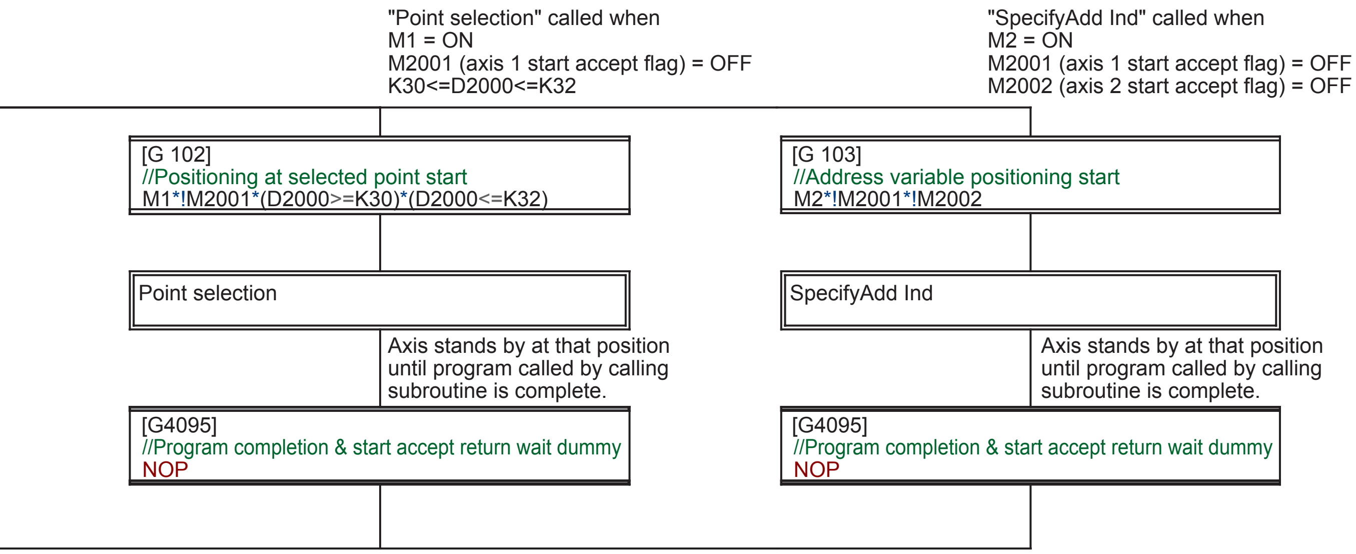
Other Motion SFC programs used to perform various types of operation when in positioning control operation from this main routine Motion SFC program are started as subroutines.

(1) Motion SFC program started from main routine Motion SFC program.

Motion SFC program No.	Program name	Reference section
20	StandbyPointPos	9.5.7
30	Point selection	9.5.8
40	SpecifyAdd Ind	9.5.9

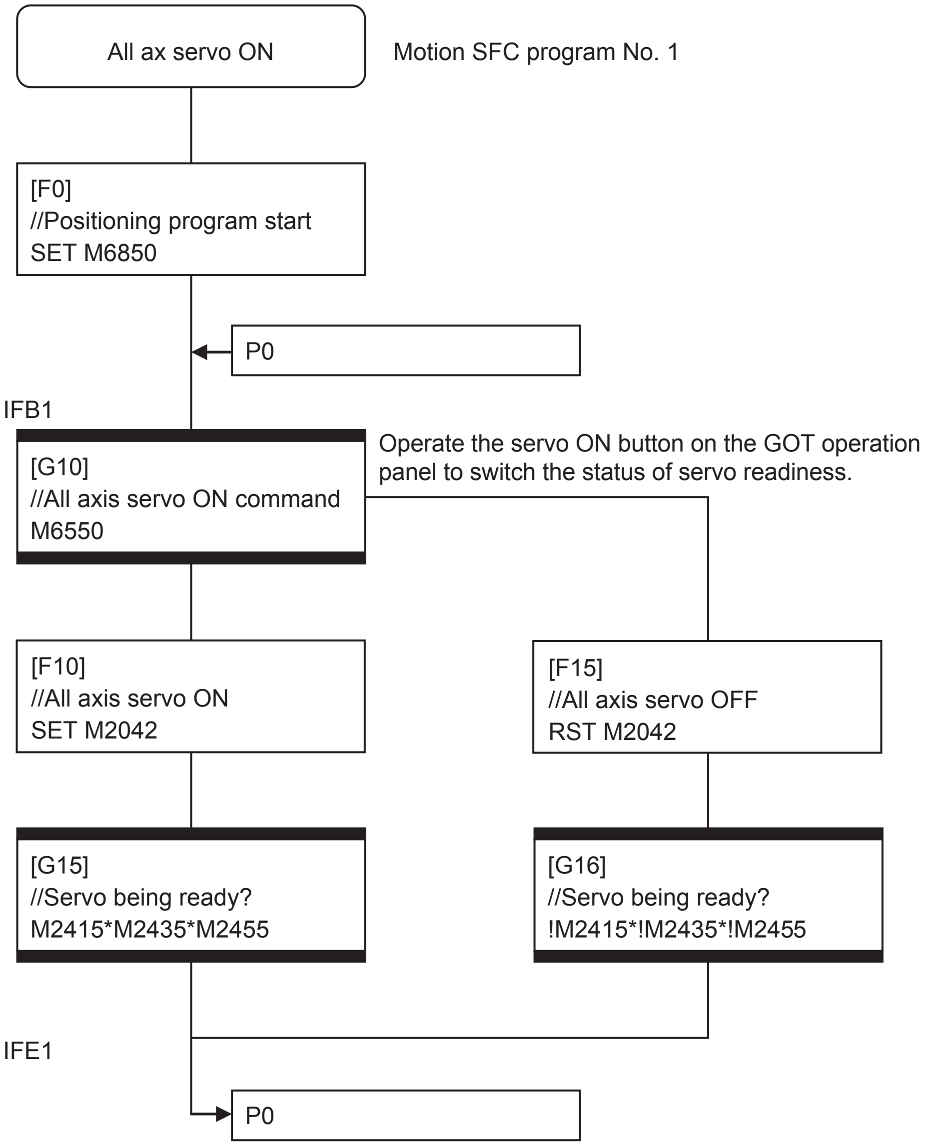
(2) Program example




"Point selection" called when
M1 = ON
M2001 (axis 1 start accept flag) = OFF
K30<=D2000<=K32
"SpecifyAdd Ind" called when
M2 = ON
M2001 (axis 1 start accept flag) = OFF
M2002 (axis 2 start accept flag) = OFF
[G 102]
//Positioning at selected point start
M1*!M2001*(D2000>=K30)*(D2000<=K32)
[G 103]
//Address variable positioning start
M2*!M2001*!M2002
Point selection
SpecifyAdd Ind
Axis stands by at that position until program called by calling subroutine is complete.
Axis stands by at that position until program called by calling subroutine is complete.
[G4095]
//Program completion & start accept return wait dummy
NOP
[G4095]
//Program completion & start accept return wait dummy
NOP

9.5.6 All axes servo ON

This program turns on all the servo amplifiers that are compatible with the respective axes. Pressing the servo ON button on the GOT operation panel gets all the servo amplifiers ready. This is not for the subroutine of the main routine Motion SFC program (No. 10 Pos ControlMain). It starts up by itself alone.



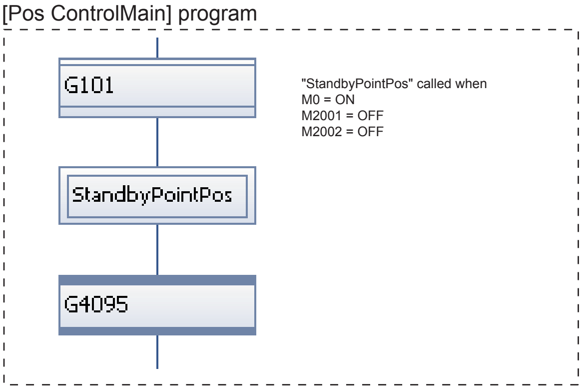
9.5.7 Standby point positioning

Standby point refers to a work standby position at other than the mechanical home position. (There may be times when the position is the same as the home position.)

In this program example, the axis returns to the standby point by specifying the standby point address and performing positioning.

By running the servo program with a Motion SFC program motion control step, operation is performed based on the content of the executed servo program data and the parameter block.

[Pos ControlMain] program



StandbyPointPos — Motion SFC program No. 20

[F200]
//Lamp ON
SET M10

[K20: Real axis]
ABS-2 (Vector-speed)
Axis 1, 0.0 μm
Axis 2, 0.0 μm
Vector speed 2000.00 mm/min
Dwell 100 ms

[G4095]
//Program completion & start accept return wait dummy
NOP

… Ensures transition to next step with "WAIT" type transition after completion of current servo program.

[F201]
//Lamp OFF
RST M10

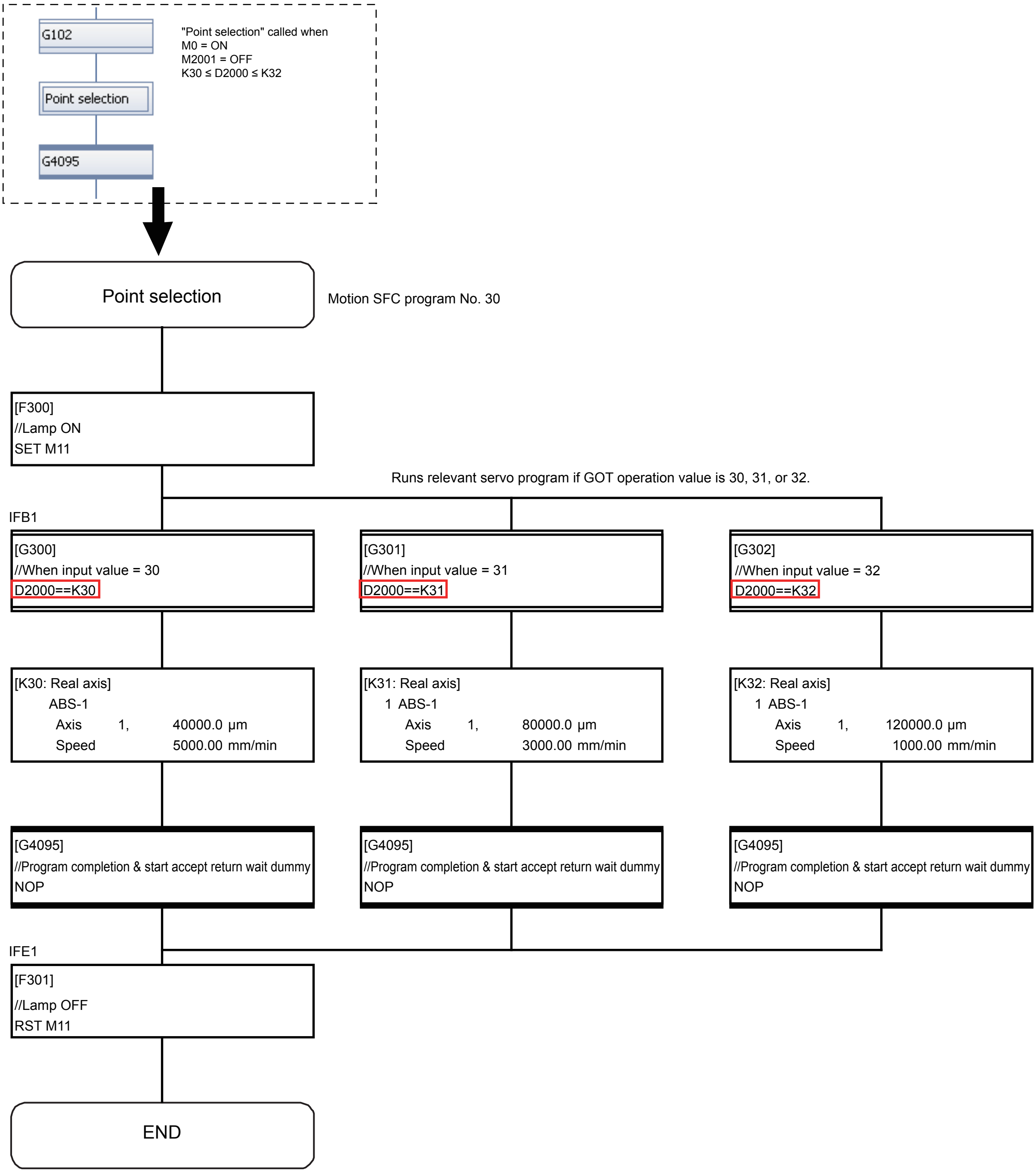
END

9.5.8 Point selection

This is an example of a basic point selection program.

By entering the point No. (servo program No. in this example) at the demonstration machine operation panel and then pressing the START button, the axis is positioned at the address registered beforehand.

[Pos ControlMain] program



Note: There are two "=" symbols in the "D2000==K30", "D2000==K31", and "D2000==K32" instructions in [G300], [G301], and [G302].

9.5.9 Specify address indirect positioning

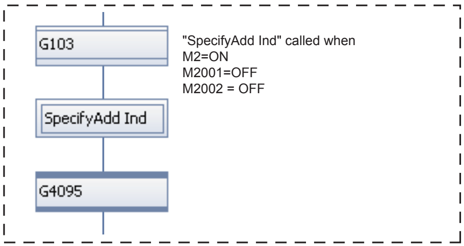
This is an example of positioning at an address other than the previously registered position. The axis 1 and axis 2 addresses are computed based on the demonstration machine operation panel values, and then stored in D2020.

Positioning is performed by pressing the START button.

Even number addresses in the unused data register D, link register W, and motion device # can be used for indirect setting.

In addition to addresses, speed, dwell, M-codes, and parameter blocks can also be set indirectly.

[Pos ControlMain] program




```
SpecifyAdd Ind                                  Motion SFC program No. 40

[F400]
//Lamp ON
SET M12
//For address designation <32 bit>
D2020L=D2000L*K10000

[K40: Real axis]
  1  ABS-2 (Vector-speed)
       Axis          1,      D2020  μm          } Axis 1, 2 addresses set as
       Axis          2,      D2020  μm          } D2020, D2021 32 bit data.
       Vector speed         1000.00 mm/min

[G4095]
//Program completion & start accept return wait dummy
NOP

[F401]
//Lamp OFF
RST M12

END
```

9.5.10 Changing the speed (CHGV) [additional practice]

This is an example of a program used to change the speed in three stages at the GOT operation panel and then temporarily stop operation.
Changes to speed are made by executing a speed change instruction (CHGV instruction) with a Motion SFC program operation control step.
When setting the speed with a CHGV instruction, operation stops temporarily when setting the speed to "0", and the remainder of the operation is performed when the speed is changed again by setting to a value other than 0.

(1) CHGV speed change request instruction

Describes the axis No. for which the speed is to be changed, and the changed speed.

CHGV (K1, K30000)

K[speed after change]
D0 to D8191
W0 to 1FFF
#0 to #7999

Axis No. (1 to 8) for which speed changed

(2) Speed change setting range

Speed change setting range							
mm		inch		degree		pulse	
Setting	Unit	Setting	Unit	Setting	Unit	Setting	Unit
-600000000 to 600000000	$\times 10^{-2}$ mm/min	-600000000 to 600000000	$\times 10^{-3}$ inch/min	-2147483647 to 2147483647	$\times 10^{-3}$ degree/min	-2147483647 to 2147483647	pulse/s

POINT

If setting the speed with the CHGV instruction, set a value 100 times (mm) or 1000 times (inch/degrees) the actual speed.

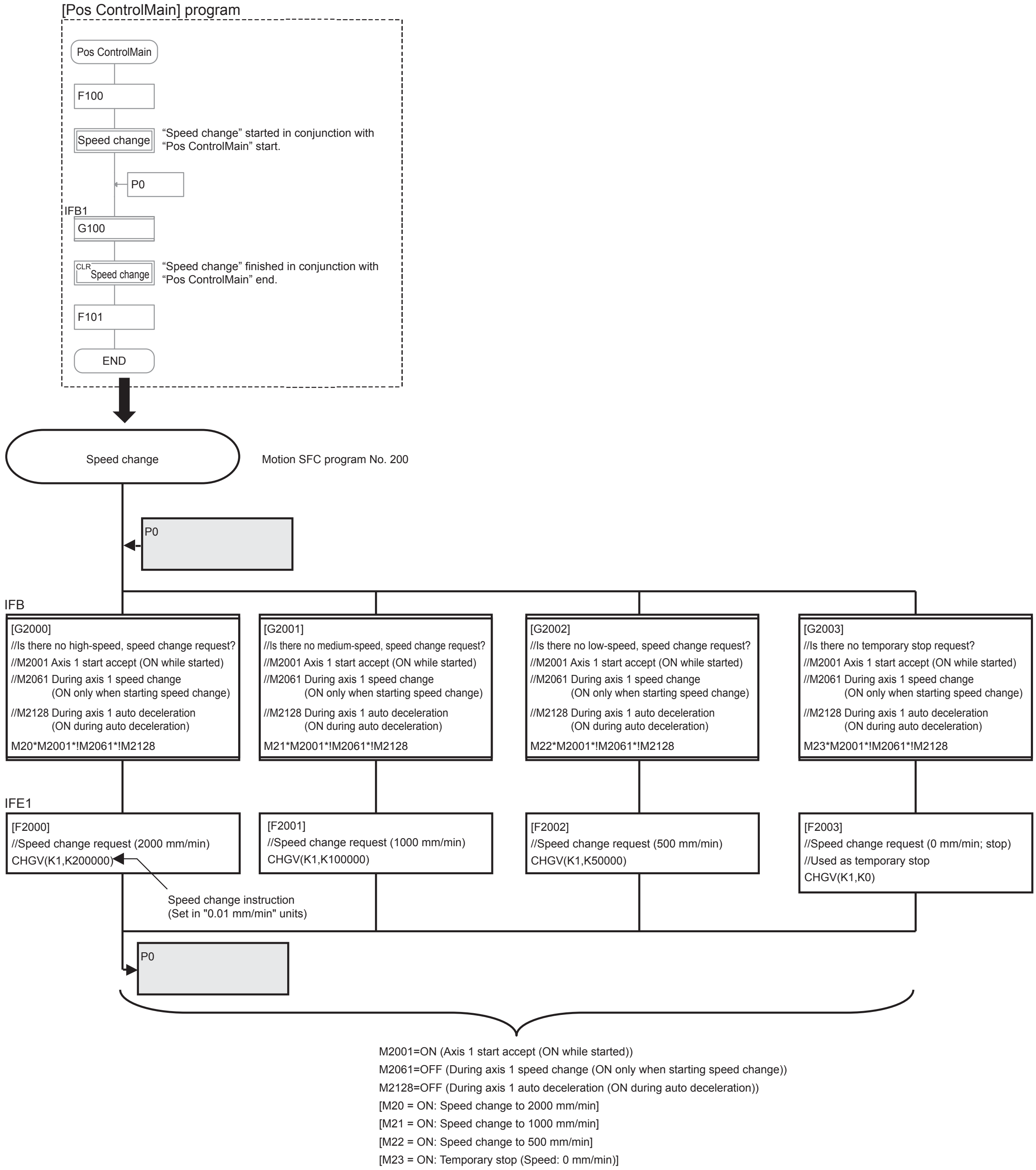
Example
If setting the speed to 10000.00 mm/min, set a value of "1000000".

(3) Program example

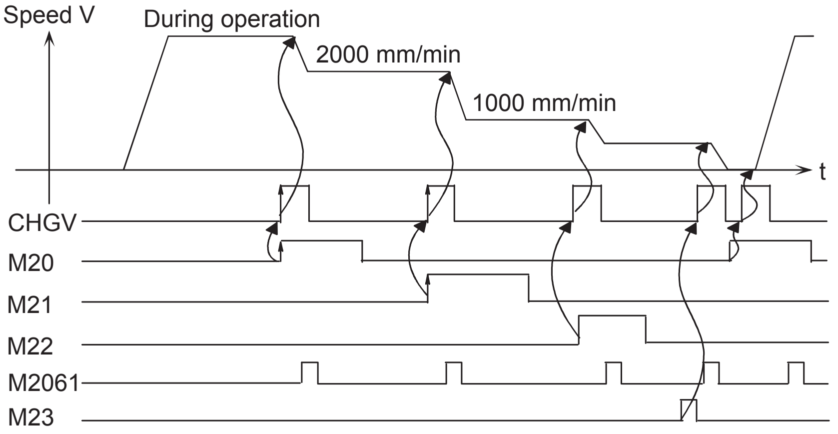
(1) Speed change conditions

Item		Condition		
Control axis		Axis 1	Axis 2	Axis 3
Speed change command input	M20	Speed after change: 2000 mm/min	—	—
	M21	Speed after change: 1000 mm/min	—	—
	M22	Speed after change: 500 mm/min	—	—
	M23	Temporary stop (0 mm/min)	—	—

(2) Speed change program example



[Timing chart]



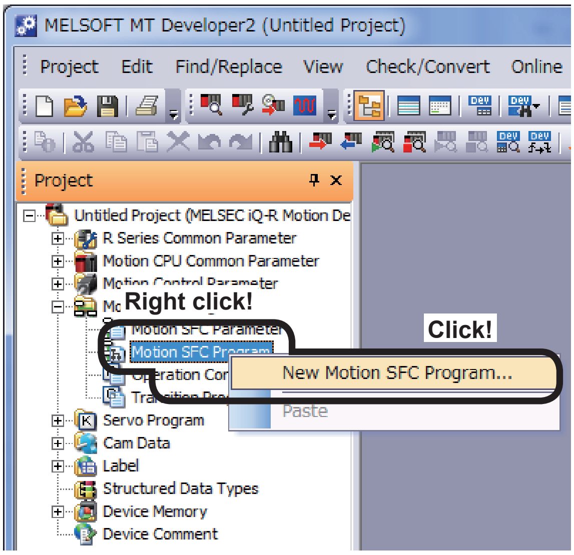
POINT
• The speed cannot be changed while the start accept flag is OFF. • The speed cannot be changed during home position return, circular interpolation, or while decelerating. • The speed can be changed within the 0 to start speed range.

9.6 Motion SFC Program Creation Procedure

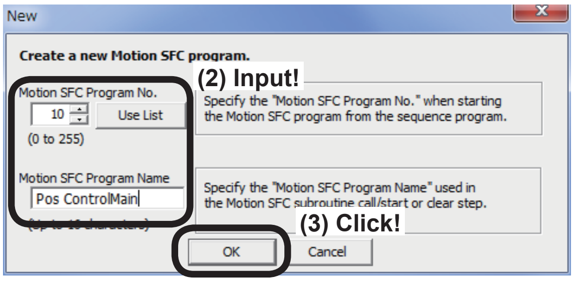
This section describes how to create Motion SFC programs used to set motion control operation.

9.6.1 Creating a new Motion SFC program

To create a new Motion SFC program, begin by specifying the "Program name".



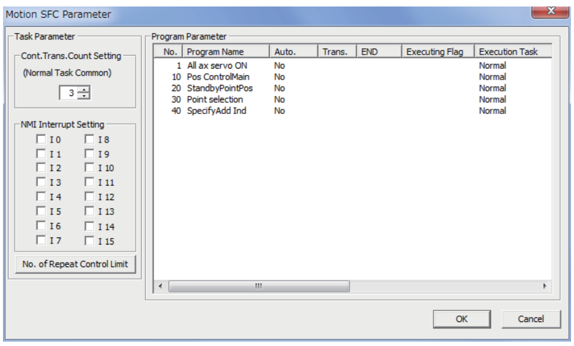
(1) Right-click [Motion SFC Program] → [Motion SFC Program] in the Project window and click [New Motion SFC Program…].



(2) A New dialog box appears. Set the program No. for the Motion SFC program being created.

Enter "10" for the "Motion SFC program No.", and "Pos ControlMain" for the "Motion SFC Program Name".

(3) Click the OK button after entering.



(4) The set Motion SFC program appears in a list of [Motion SFC Parameter].

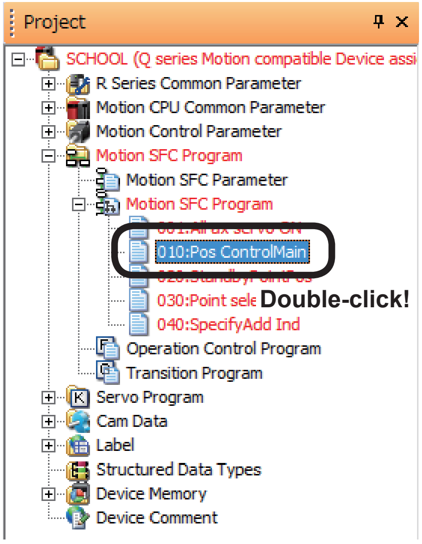
Back to step (1), and create the Motion SFC program that looks like as follows.

No.	Program name
1	All ax servo ON
10	Pos ControlMain
20	StandbyPointPos
30	Point selection
40	SpecifyAdd Ind

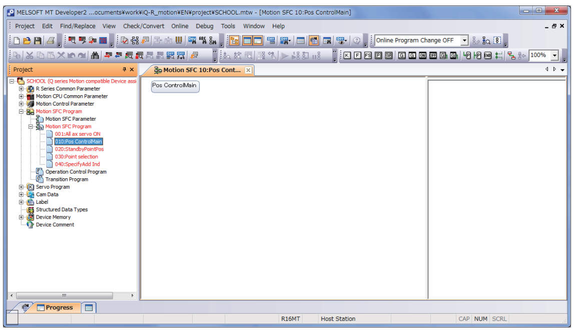
(Motion SFC programs other than No. 10 and No. 20 created here will not be described in detail. Refer to the section on Motion SFC programs for operation described later to create.)

9.6.2 SFC diagram creation procedure

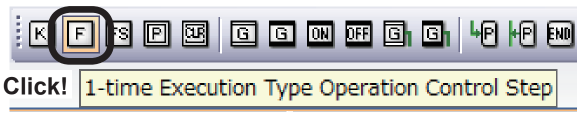
Allocate SFC diagram symbols to create an SFC diagram.



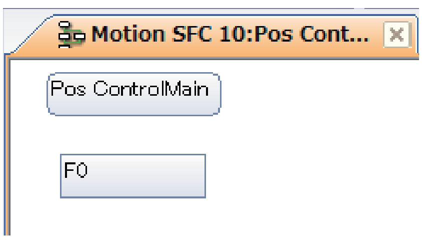
(1) Double-click "010: Pos ControlMain" from the [Motion SFC Program] → [Motion SFC Program] in the Project window.



(2) An Edit Program screen used to create individual Motion SFC programs appears.



(3) Click the 1-time Execution Type Operation Control Step tool button on the Program Edit screen.



(4) Click on a random position to allocate an SFC diagram symbol pointer.

> Multiple pointers can be allocated.
> When allocation is complete, right-click to clear the SFC diagram symbol.

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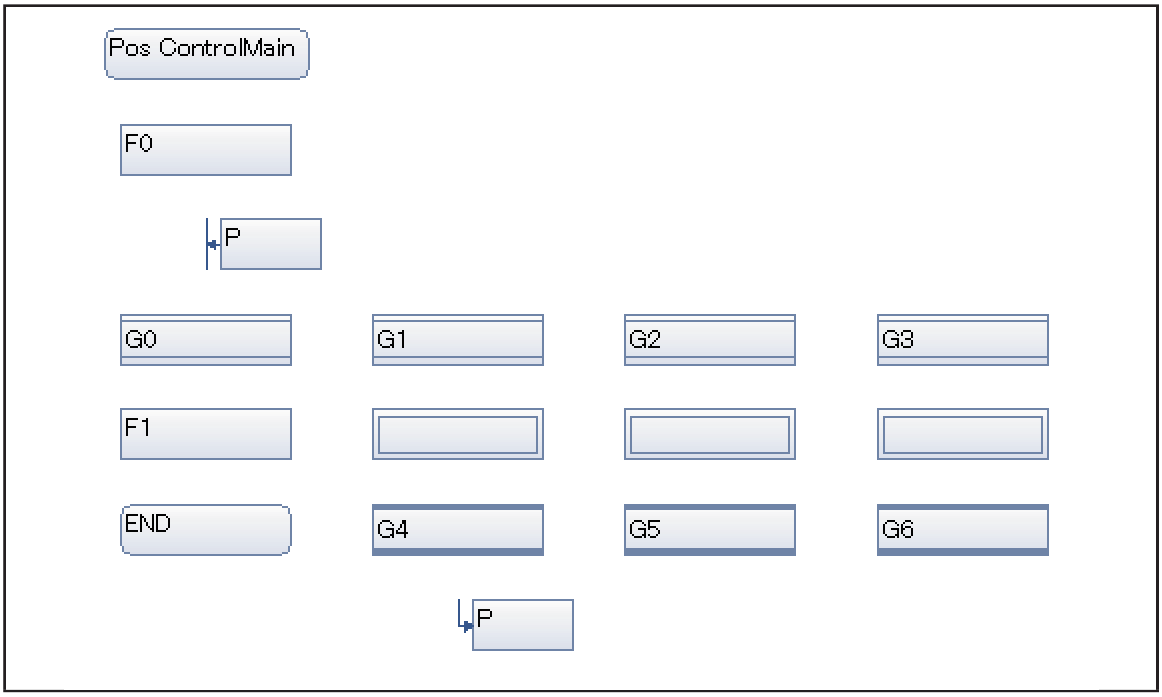
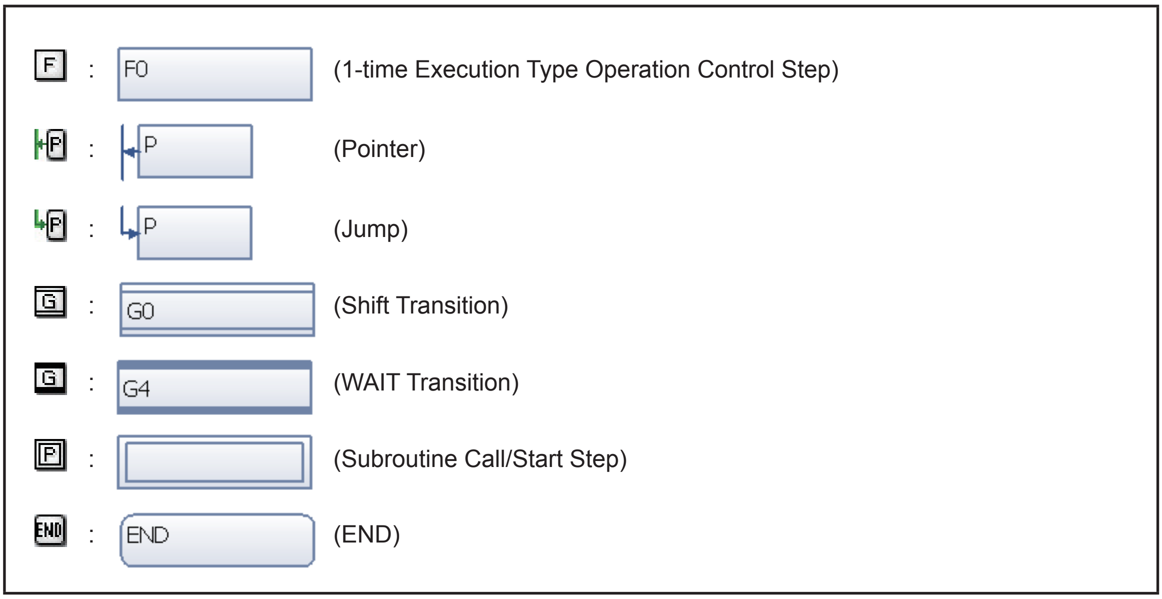
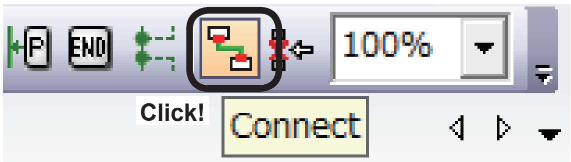
(5) Now, click each tool button in the same manner to allocate SFC diagram symbols as shown below.







(6) Connect the allocated SFC diagram symbols. Click the Connect tool button at the Edit Program screen.

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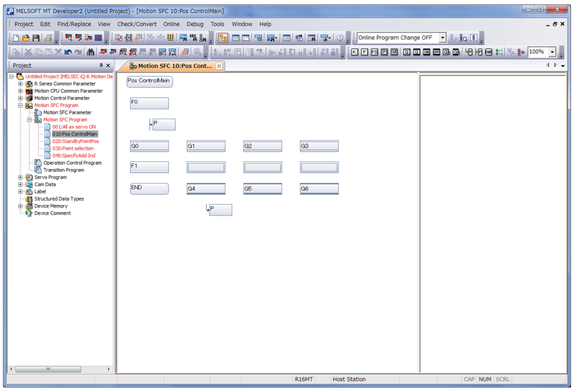
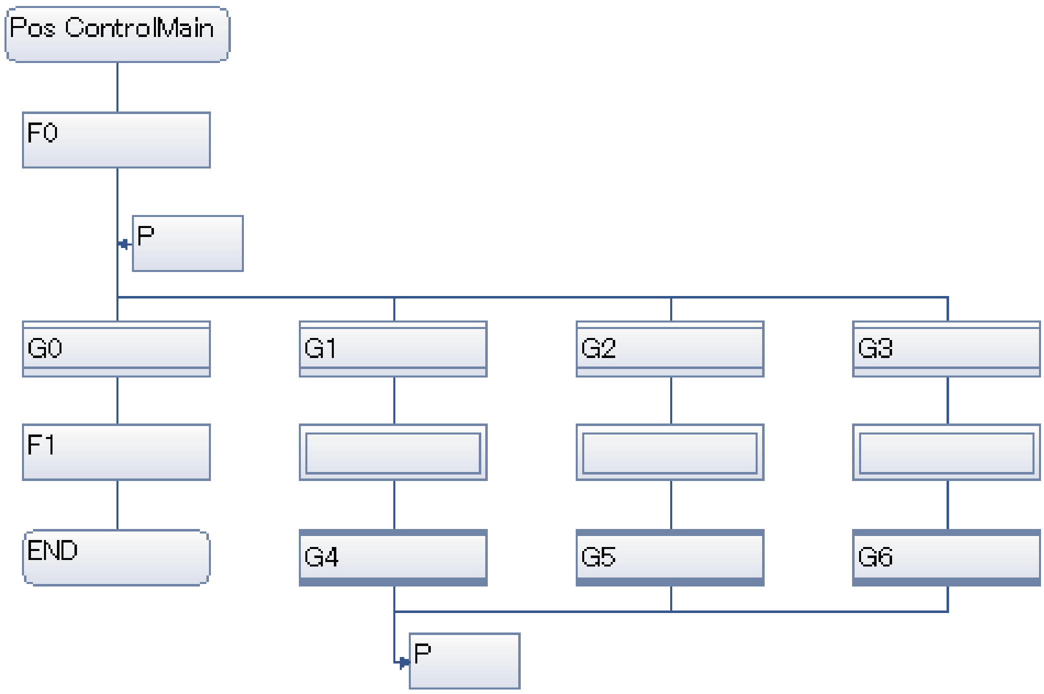
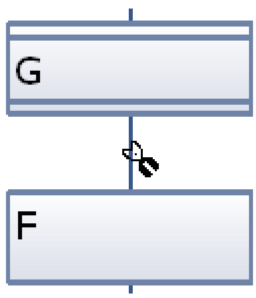


(7) By moving the mouse cursor over an SFC diagram symbol, the shape of the cursor changes.
Drag to connect the start of the Motion SFC program and pointer.

(8) Connect other SFC diagram symbols in the same manner.



If connections are mistaken, click the Select/Disconnect tool button at the Edit Program screen ( ), move the mouse cursor over the connecting line, and then click to cut the line.



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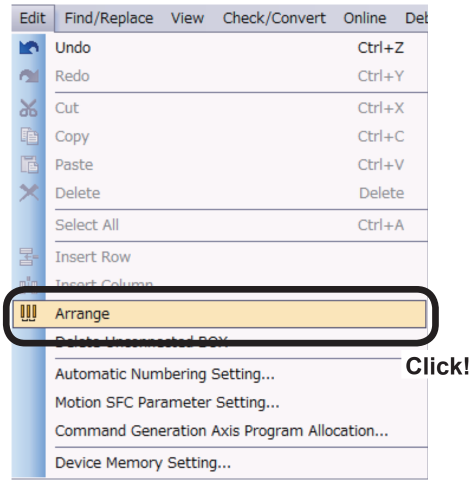
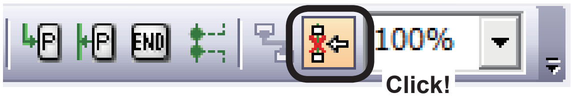
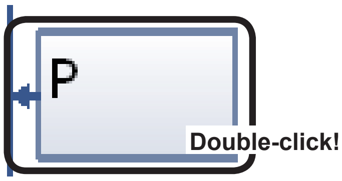


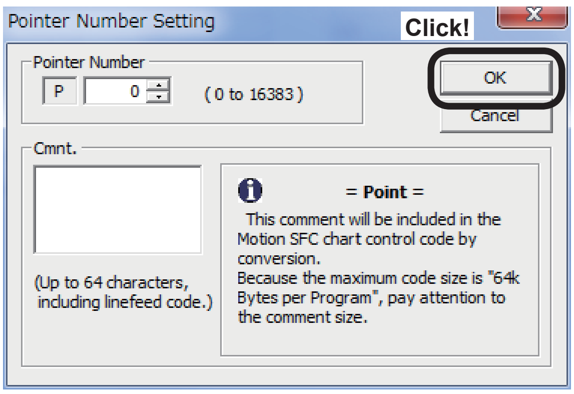
(9) Click [Arrange] on the [Edit] menu at the Edit Program window.
Arrange the allocated SFC diagram symbols.



(10) Set program Nos. and pointer Nos. for the allocated SFC diagram symbols.
Click the Select/Disconnect tool button at the Edit Program screen.



(11) Double-click a pointer (P).



(12) A Pointer Number Setting dialog box appears.
Enter "0" for the "Pointer Number", and then click the OK button.

> Pointer Nos. can be set from 0 to 16383 for each Motion SFC program.
> ("P0" for Motion SFC program No. 0 and Motion SFC program No. 10 are different.)

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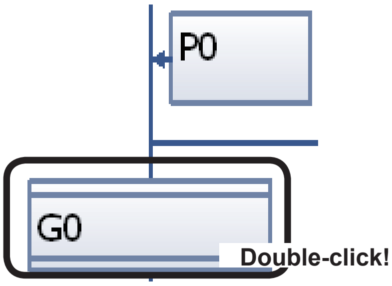
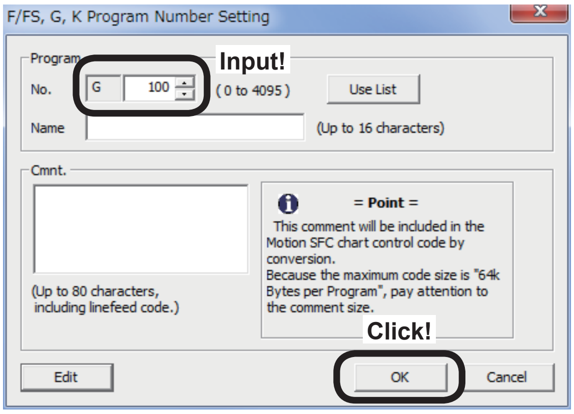
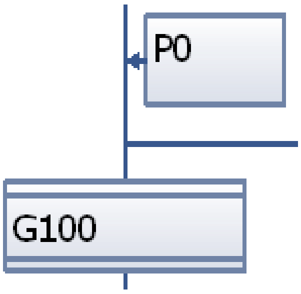


(13) Pointer No. "0" is set.
Next, double-click a transition (G0).



(14) A Program Number Setting dialog box appears.
Enter "100" for the "Program No.", and then click the OK button.

The program No. is a common number in the project.



(15) Program No. "G100" is set for the transition.
Set operation control steps (F) and transitions (G) in the same manner as shown below.

F0 → F100
F1 → F101
G1 → G101
G2 → G102
G3 → G103
G4 to 6 → G4095

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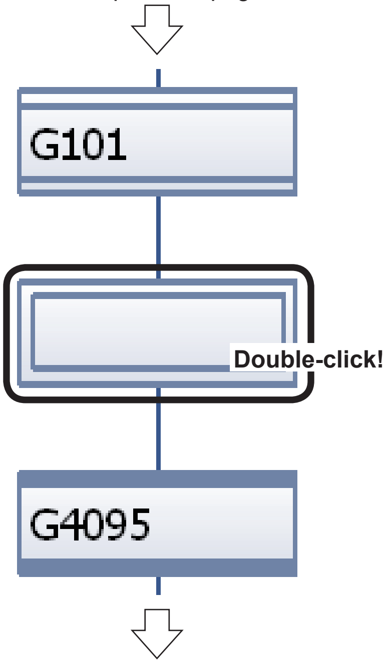
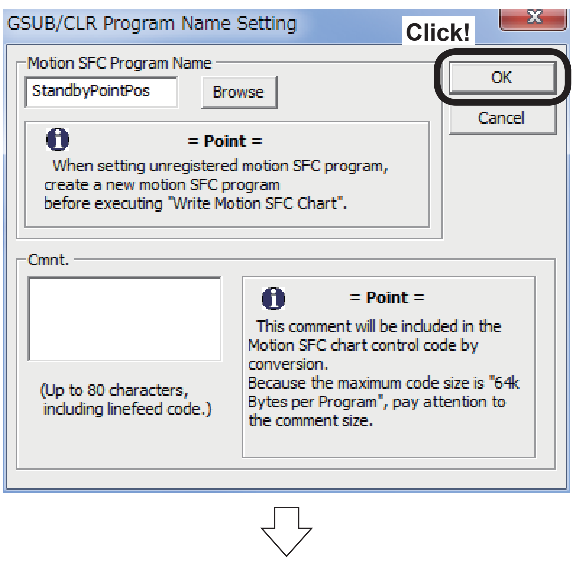


(16) Next, double-click a subroutine call/start step.



(17) A Program Name Setting dialog box appears.
Enter "StandbyPointPos" for the "Motion SFC Program Name", and then click the OK button.

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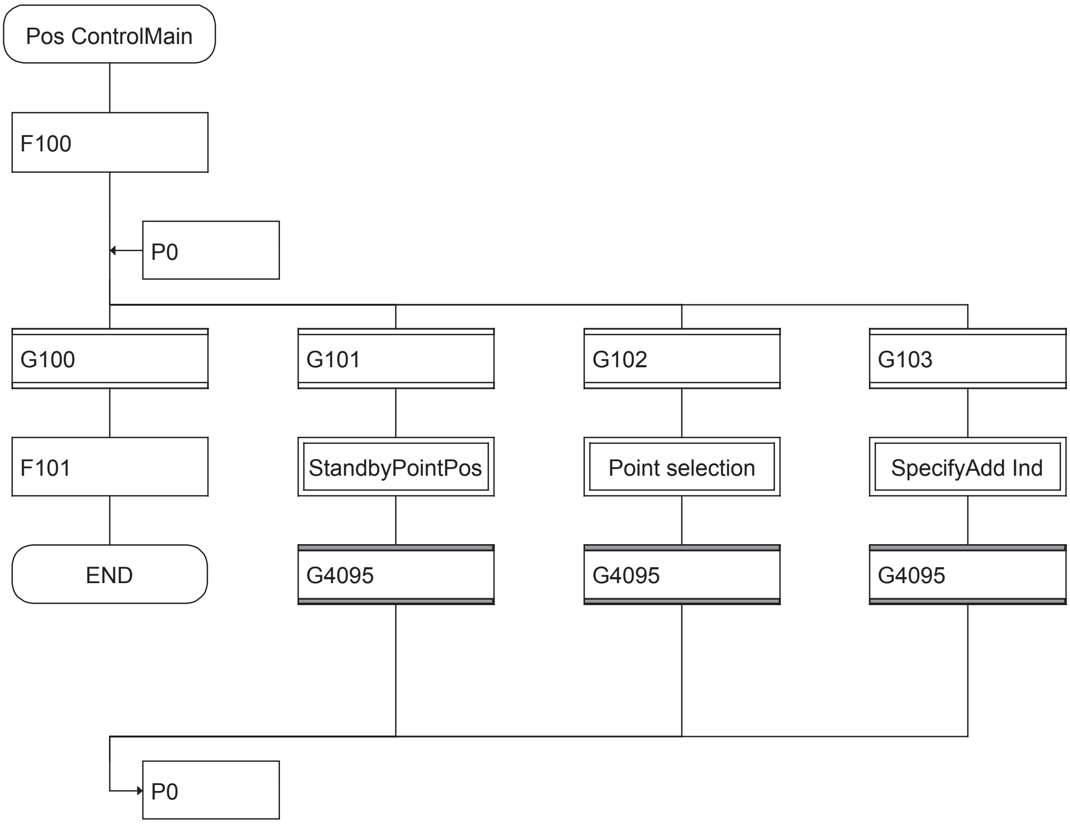
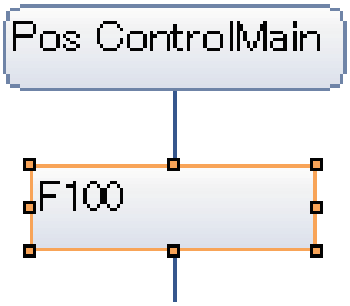
(18) Program name "StandbyPointPos" is set for the subroutine call/start step.
Set program Nos. and pointer Nos. for other SFC diagram symbols in the same manner as shown below.



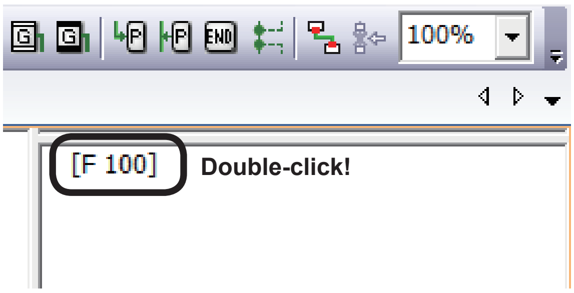
9.6.3 Entering transition and operation control steps

This section describes how to set conditional expressions and operational expressions for transitions and operation control steps allocated to SFC diagrams.

(1) Click operation control step "F100" to select.

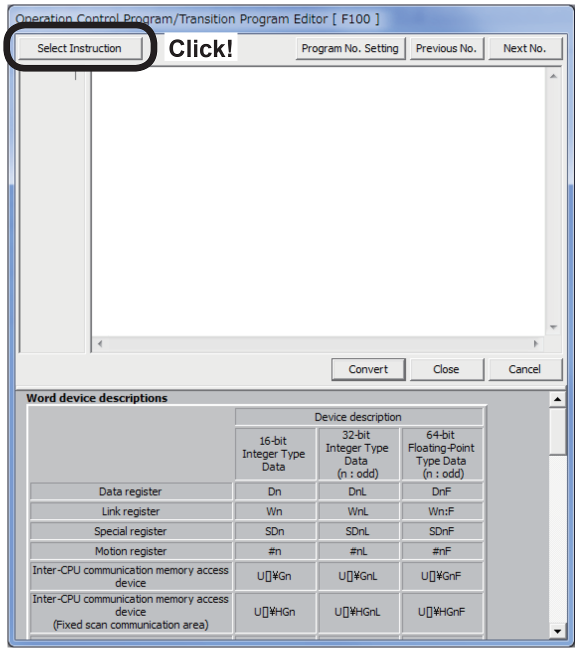


(2) When "[F100]" appears in the area on the right of the screen (step Edit Program screen), double-click.



(3) An Edit Operation Control Program/Transition Program dialog box appears.
Click the Select Instruction button.

Instructions can be set by direct entry.
If entering directly, continue from step (5).



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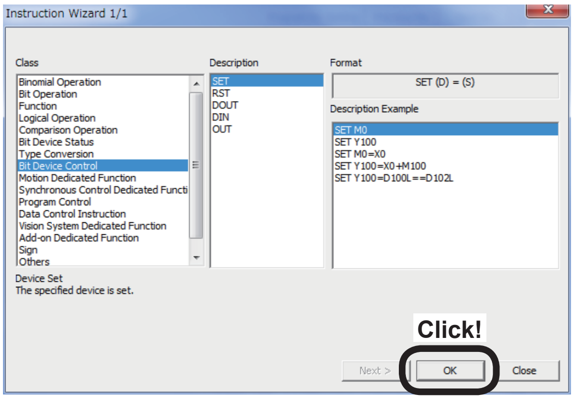
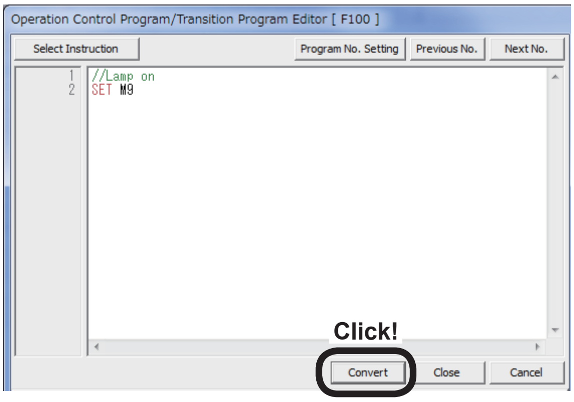


(4) An Instruction Wizard dialog box appears.
Select as follows, and then press the OK button.

Class:	Bit Device Control
Description:	SET
Description Example:	SET M0



(5) A "SET M0" instruction is set. Change "M0" to "M9".
Press the Enter key again to start a new line, and then enter a comment and instruction.
Click the Convert button after entering.

(6) Click the OK button at the conversion complete message that appears.

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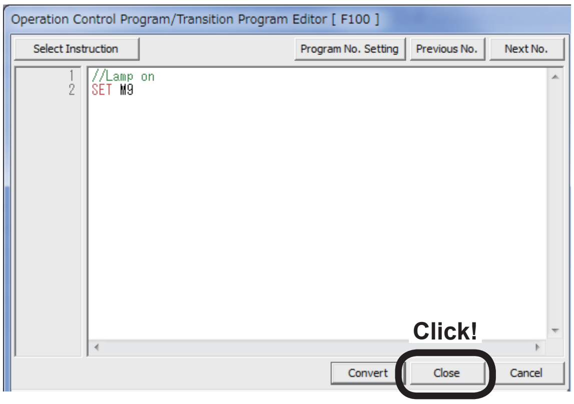
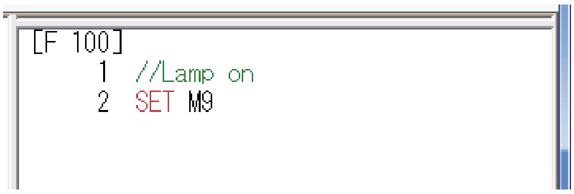


(7) Click the Close button.



(8) The set instruction appears on the step Edit Program screen.

(9) Set the operational expression and conditional expression for the following operation control programs and transition programs in the same manner.

[G100]	//Mode selection switch check !M6801
[G101]	//Standby point positioning start M0*!M2001*!M2002
[G102]	//Positioning at selected point start M1*!M2001*(D2000>=K30)*(D2000<=K32)
[G103]	//Address variable positioning start M2*!M2001*!M2002
[G4095]	//Program completion & start accept return wait dummy NOP
[F100]	//Lamp ON SET M9
[F101]	//Lamp OFF RST M9

*(Logical product)
!(Logical negation)

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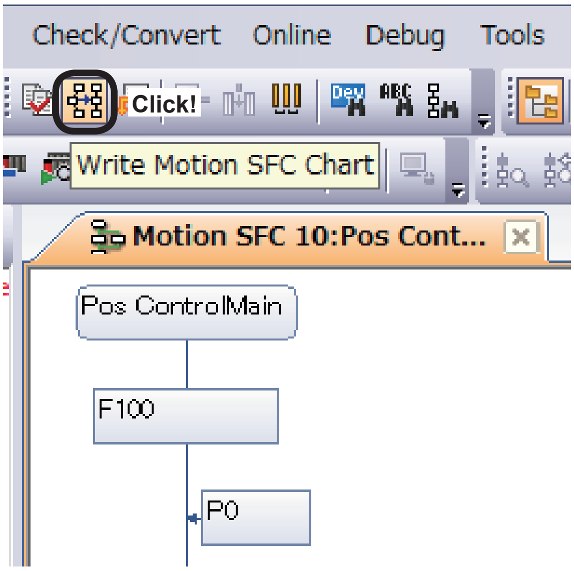
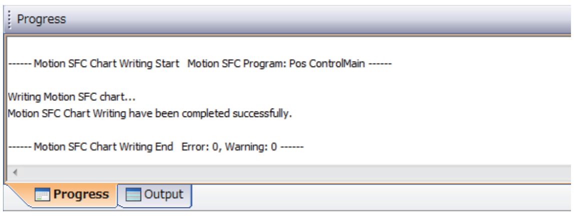
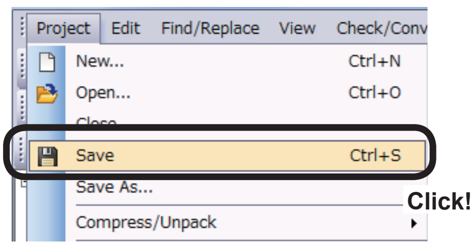


(10) Click the Write Motion SFC Chart button at the Edit Program screen.



(11) When conversion is complete, a "Successful completion" message appears in the output window.



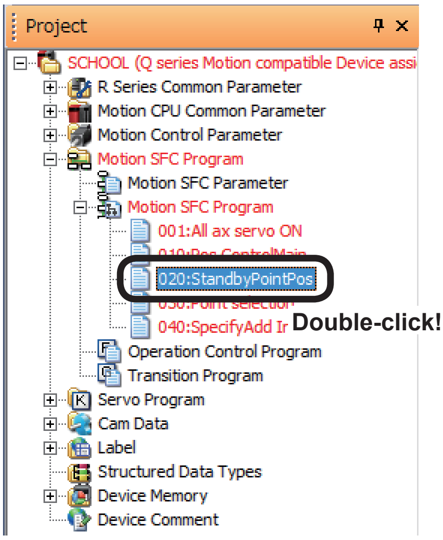
(12) Click [Save] on the [Project] menu at the Edit Program window.

Real mode main creation is now complete.

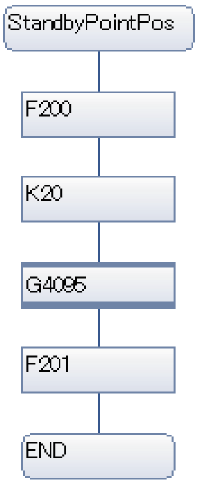
9.6.4 Entering motion control steps

This section describes how to specify motion control steps used to perform positioning control and so on.

Here, a Motion SFC program for standby point positioning is created first.



(1) Double-click "020: StandbyPointPos" from the [Motion SFC Program] → [Motion SFC Program] in the project window.



(2) Create a Motion SFC program for standby point positioning as follows.

(a) Allocate SFC diagram symbols.

Use the following tool buttons to allocate SFC diagram symbols.

K : K (Motion Control Step)

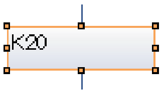
G : G (WAIT Transition)

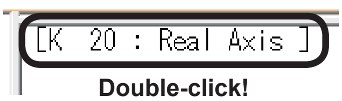
F : F (1-time Execution Type Operation Control Step)

END : END (END)

(b) Connect the SFC diagram symbols with the Connect tool button.

(c) Select the servo program No. with the Select/Disconnect tool button, and then set.





(3) Click motion control step "K20" to select it, and then double-click the Edit Program screen.

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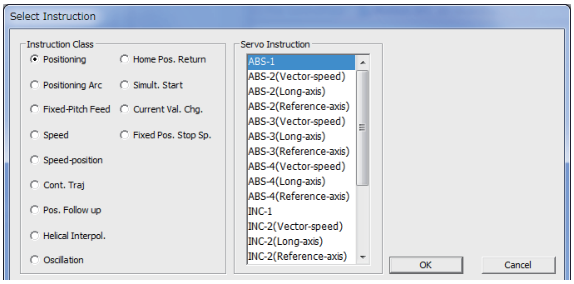
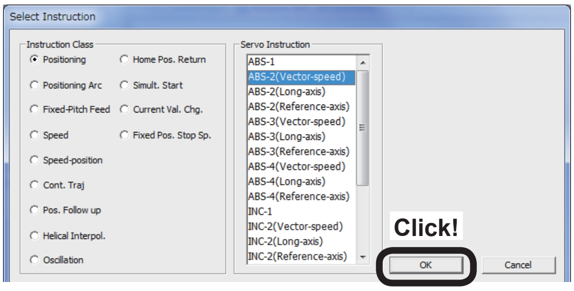
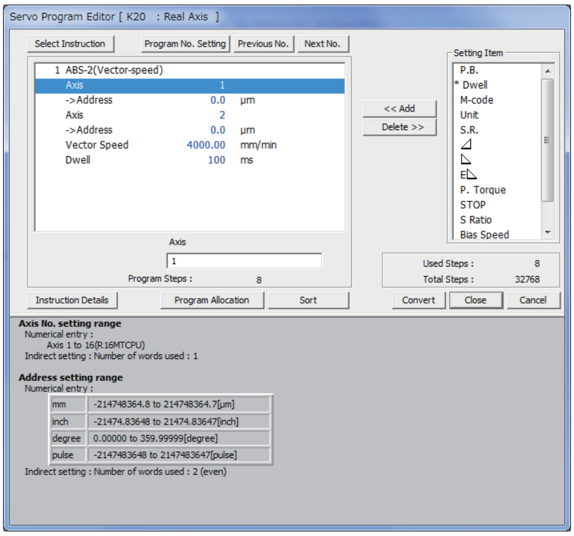


(5) A Select Instruction dialog box is displayed at the Servo Program Editor dialog box.



(6) Select "Positioning" for the "Instruction Class", and "ABS-2 (Vector-speed)" for the "Servo Instruction" at the Select Instruction dialog box, and then click the OK button.

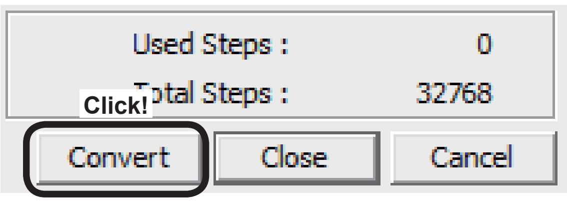


(7) Enter "1" and "0.0" in the "Axis" and "Address" text boxes.

Enter "2" and "0.0" in the next "Axis" and "Address" text boxes.

Enter "4000.00" for "Vector speed".

Add "Dwell" from the setting items, and then enter "100".



(8) Click the Convert button.

"K20" motion control step settings are now complete.

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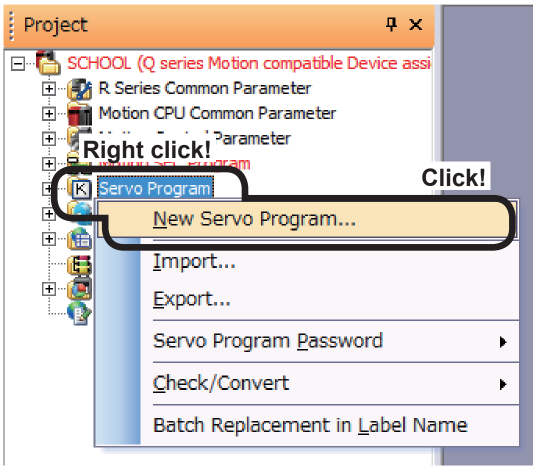
(9) Use the same procedure now to create steps used at other Motion SFC programs from the following page.

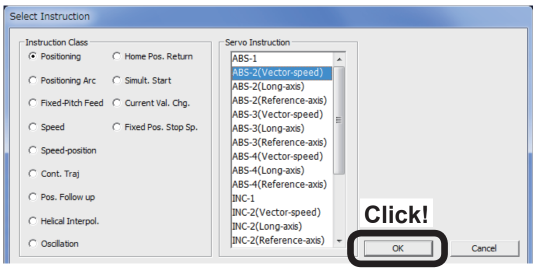
Motion control step editing schematic procedure

1: Right-click "Servo Program" in the Project window, and then click "New Servo Program…".

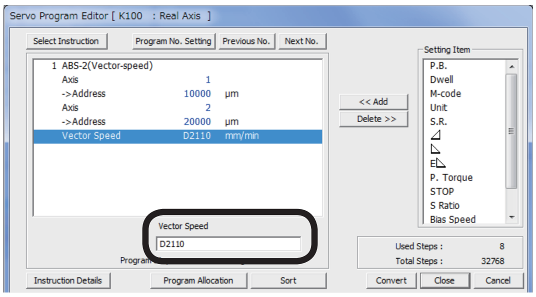


2: Enter the program No. at the New Servo Program dialog box, and then click the OK button.

3: Select "Positioning" for the "Instruction Class", and "ABS-2 (Vector-speed)" for the "Servo Instruction" at the Select Instruction dialog box, and then click the OK button.



4: Select instruction setting items and enter the values into the text boxes.



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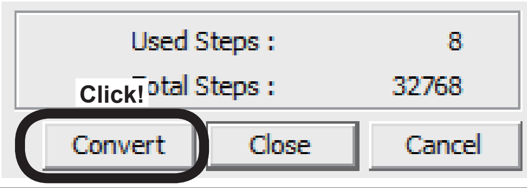
5: Click the Convert button.



Home position return
(axis 1)

```
[K   1 : Real Axis ]
  1   ZERO
        Axis                          1
```

Home position return
(axis 2)

```
[K   2 : Real Axis ]
  1   ZERO
        Axis                          2
```

Home position return
(axis 3)

```
[K   3 : Real Axis ]
  1   ZERO
        Axis                          3
```

Positioning
(1-axis linear)

```
[K  30 : Real Axis ]
  1   ABS-1
        Axis                   1
        ->Address        40000.0   μm
        Speed            5000.00   mm/min
```

Positioning
(1-axis linear)

```
[K  31 : Real Axis ]
  1   ABS-1
        Axis                   1
        ->Address        80000.0   μm
        Speed            3000.00   mm/min
```

Positioning
(1-axis linear)

```
[K  32 : Real Axis ]
  1   ABS-1
        Axis                   1
        ->Address       120000.0   μm
        Speed            1000.00   mm/min
```

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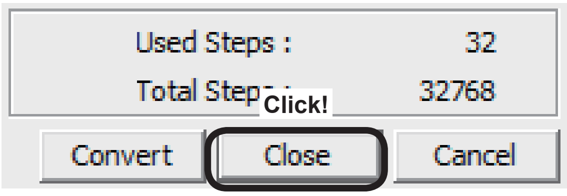
Positioning
(2-axis linear interpolation)

```
[K  40 : Real Axis ]
  1   ABS-2(Vector-speed)
        Axis                  1
        ->Address         D2020  μm
        Axis                  2
        ->Address         D2020  μm
        Vector Speed    1000.00  mm/min
```



(10) After creating motion control steps, click the Close button to close the Edit Servo Program dialog box.

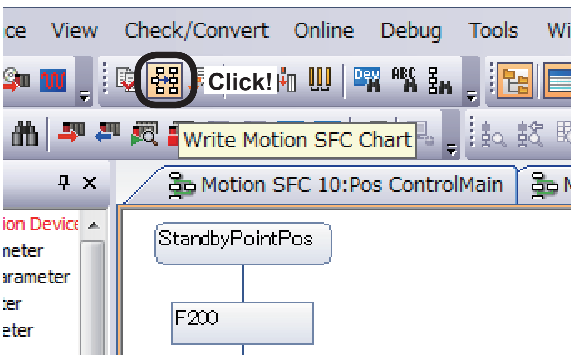
```
[K  20 : Real Axis ]
  1   ABS-2(Vector-speed)
        Axis                  1
        ->Address           0.0  μm
        Axis                  2
        ->Address           0.0  μm
        Vector Speed    4000.00  mm/min
        Dwell               100  ms
```

(11) The set motion control steps appear in the area on the right of the screen (step Edit Program screen).

```
[F 200]
    1  //Lamp on
    2  SET M10
```

```
[F 201]
    1  //Lamp off
    2  SET M10
```

(12) Set the operation control program shown on the left.



(13) Click the Program Editor dialog box Write Motion SFC Chart button to convert to a Motion SFC program.

Refer to section 9.5.6, 9.5.8 and 9.5.9 and use the same procedure to create Motion SFC programs with the following numbers.
1 30 40

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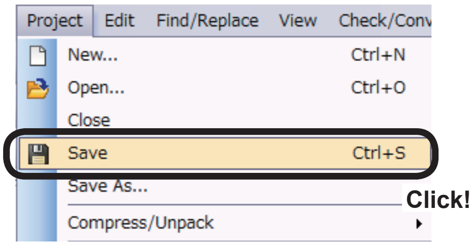
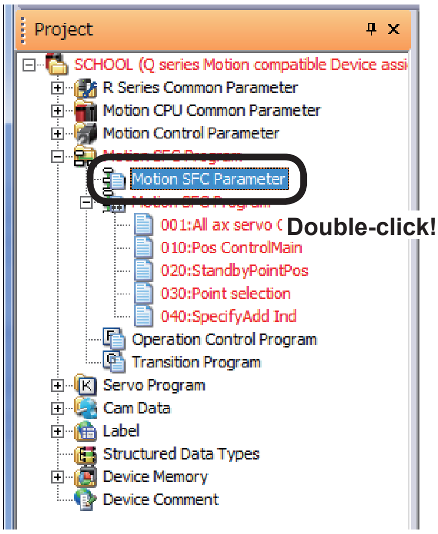


(14) Click [Save] on the [Project] menu at the Program Editor window.

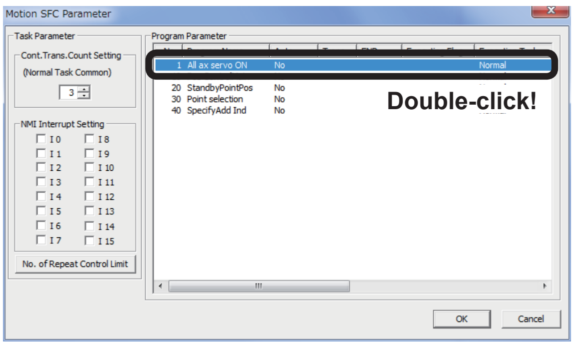
Motion control step entry is now complete.

9.6.5 Motion SFC program parameter settings, batch conversion

Specify parameter settings and perform batch conversion to Motion SFC programs for the created Motion SFC programs.



(1) Double-click [Motion SFC Program] → [Motion SFC Parameter] in the Project window.



(2) A Motion SFC Parameter dialog box appears.
Created Motion SFC programs appear in a list.
Double-click the program.

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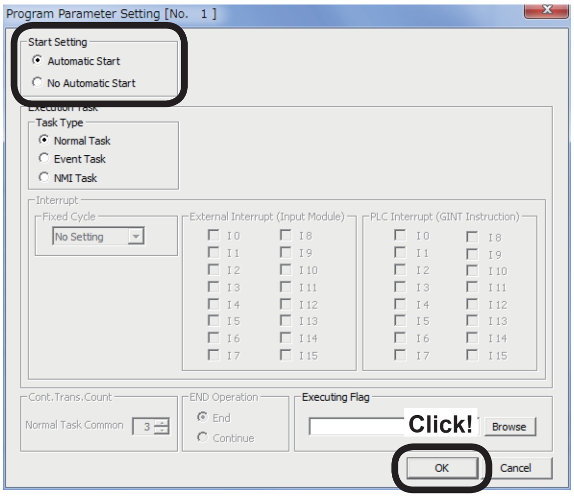
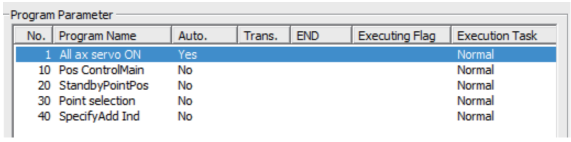




Program Parameter

No.	Program Name	Auto.	Trans.	END	Executing Flag	Execution Task
1	All ax servo ON	Yes				Normal
10	Pos ControlMain	No				Normal
20	StandbyPointPos	No				Normal
30	Point selection	No				Normal
40	SpecifyAdd Ind	No				Normal

(3) A Program Parameter Setting dialog box appears.

Set "Start setting" as shown below.

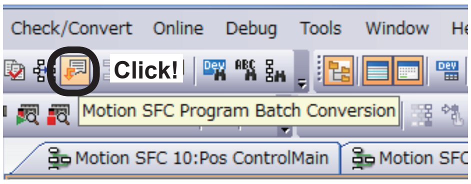
No. 1 All ax servo ON: Automatic Start

Other than No. 1 All ax servo ON: No Automatic Start

Click the OK button after setting.

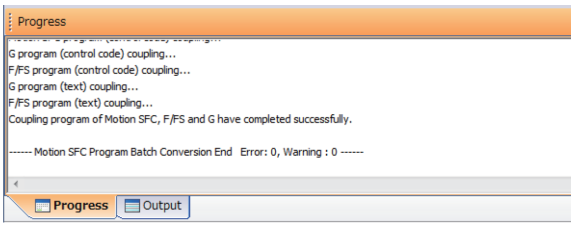
Task (execution timing) settings

1. Normal tasks
   Execution with motion cycle (spare time)
2. Event tasks
   - Execution with fixed cycle (0.222 ms, 0.444 ms, 0.888 ms, 1.777 ms, 3.555 ms, 7.111 ms, 14.222 ms)
   - Execute by entering external interrupts I0 to I15.
   - Execute with interrupts (I0 to I15) from the PLC CPU (GINT instruction).
3. NMI tasks (Non-Maskable Interrupt)
   Execute by entering external interrupts I0 to I15.
   Priority is high with event task internal interrupts, even if interrupts are prohibited (DI).



(4) Batch convert created SFC diagrams to Motion SFC programs.

Click the Motion SFC Program Batch Conversion tool button at the Program Editor screen.



(5) When conversion is complete, a "Successful completion" message appears in the output window.

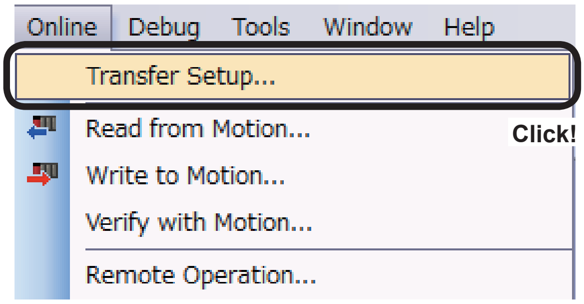
Motion SFC program creation is now complete.

Make corrections to Motion SFC programs if a caution message appears.

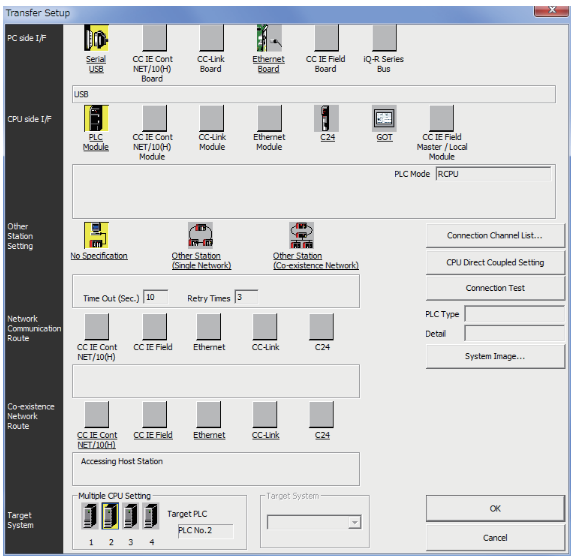
9.7 Writing to the Motion CPU

Write servo settings data and Motion SFC programs to the R16MTCPU.

(1) Set the Motion CPU to "STOP".

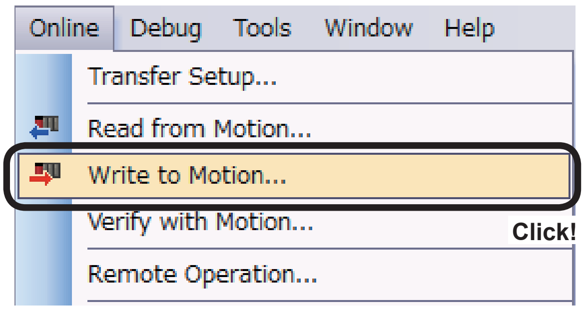


(2) Click [Transfer Setup] on the [Online] menu at the Program Editor window.



(3) Specify the following settings at the Transfer Setup dialog box that appears, and then click the OK button.

- PC side I/F: Serial USB
- CPU side I/F: PLC module
- Other Station Setting: No Specification
- Target system: Multiple CPU Setting PLC No. 2



(4) Click [Write to Motion] on the [Online] menu at the Program Editor window.

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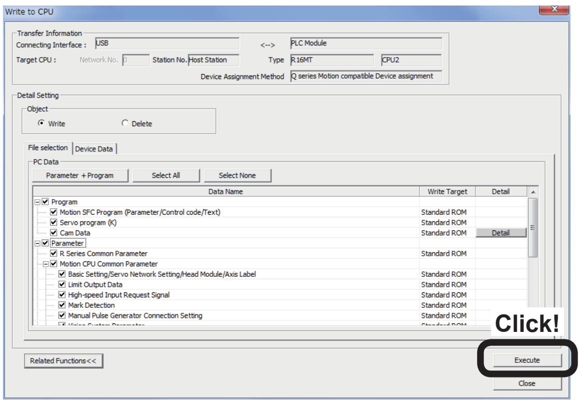
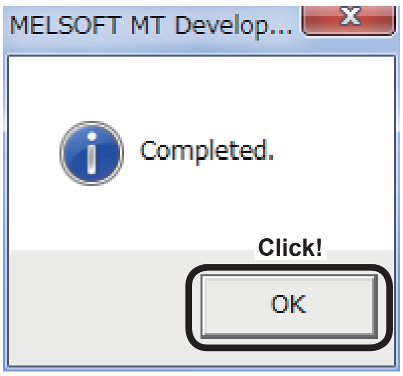


(5) Select the "Programs" and "Parameters" check boxes at the CPU Write dialog box that appears, and then click the Execute button.



(6) When a "Completed." message appears, click the OK button.

(7) Reset the PLC CPU.

(8) Run the PLC CPU and Motion CPU.

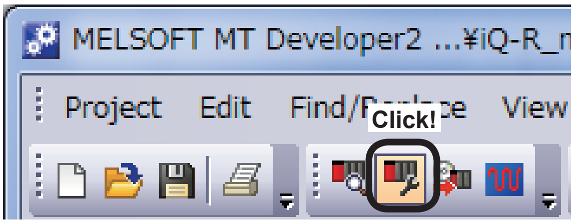
If the R08CPU RUN lamp and R16MTCPU RUN and M.RUN lamps light up, writing is successful.

9.8 Test Operation

For the test operation, the CPU has to switch to STOP from RUN (RUN → STOP).

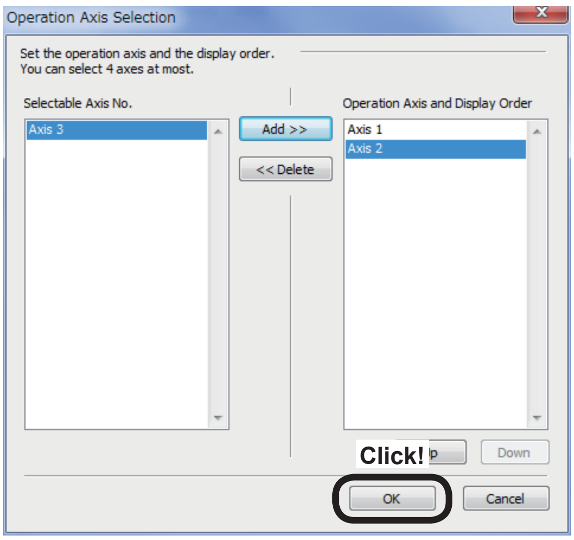
Set the Motion CPU to "STOP", followed by the PLC CPU.

9.8.1 JOG Operation



(1) Click the Test tool button at the Program Editor window.

(2) Click Yes at the test mode start request confirmation screen that appears when the Test window appears.



(3) The Selecting operation axis window appears.

Add axis 1, 2 and 3 of "Operable axis No." to "Operation axis and order of appearance". Then, click on the OK button.

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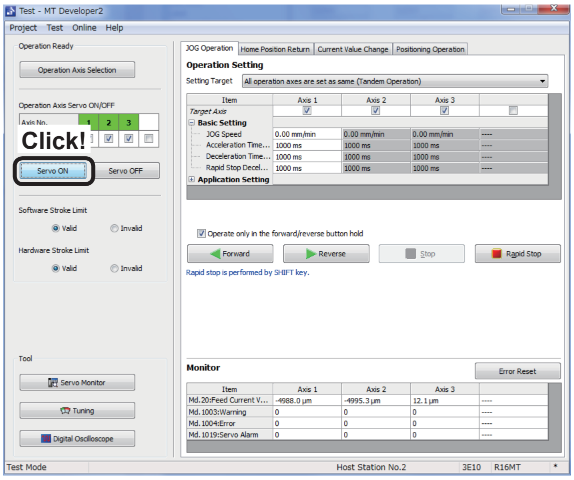
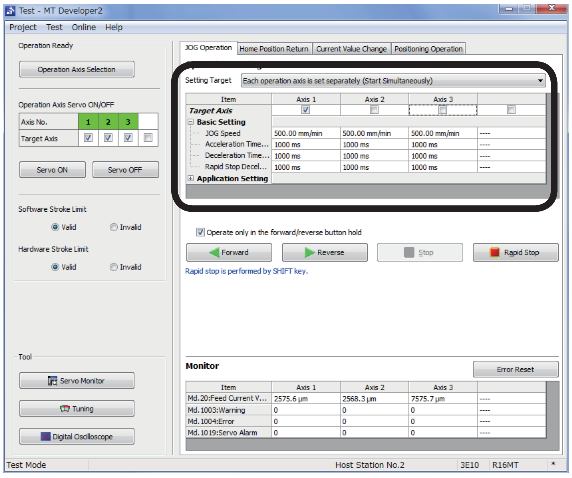


(4) When the Motion CPU is in test mode, all test function tool buttons are enabled.

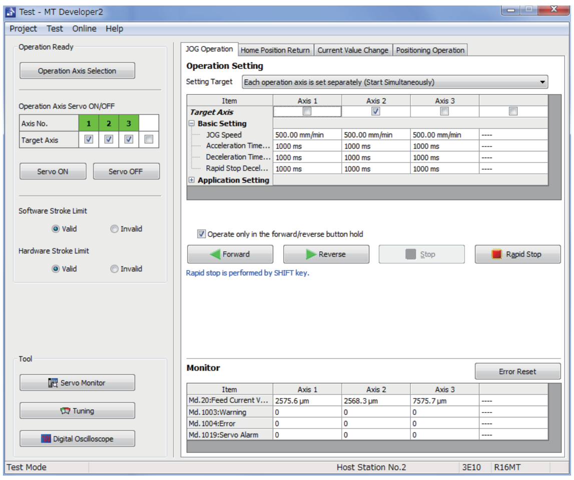
Press the Servo ON button to turn the servo ON for all axes.



(5) On the JOG operation setting screen, select "Each operation axis is set separately (Start Simultaneously)" in "Setting Target" of the operation setting. Remove the check marks for the axes other than axis 1 of the "Target Axis".

When setting the JOG speed of "Basic Setting" to 500.00 mm/min, clicking on the Forward button or the Reverse button keeps the JOG operation going while you keep pressing the button.

If you remove the check mark for "Operate only in the forward/reverse button hold", the JOG operation continues until you click the Stop or Rapid stop button.

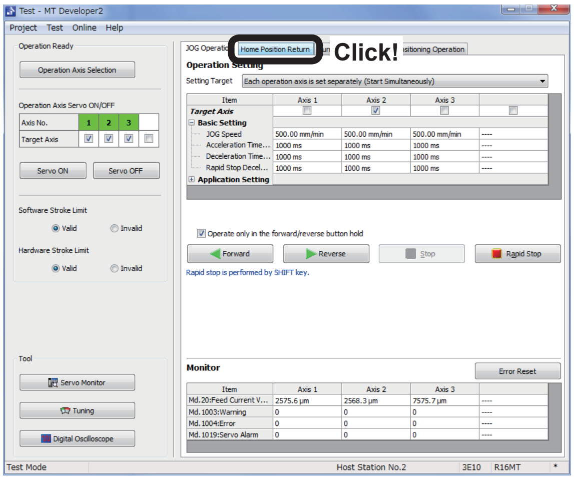


(6) The axis 2 and 3 carry out the JOG operation in a similar manner to axis 1.

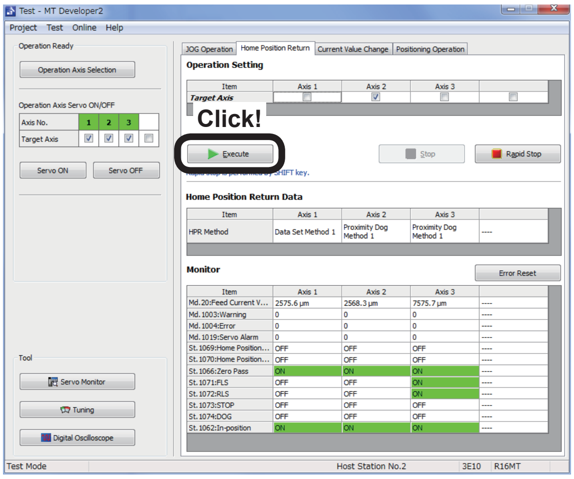
(7) When Jog operation is checked for all axes, test of JOG operation is now complete.

9.8.2 Proximity dog type home position return execution

This carries out the operation of home position return using a dog in the test mode.



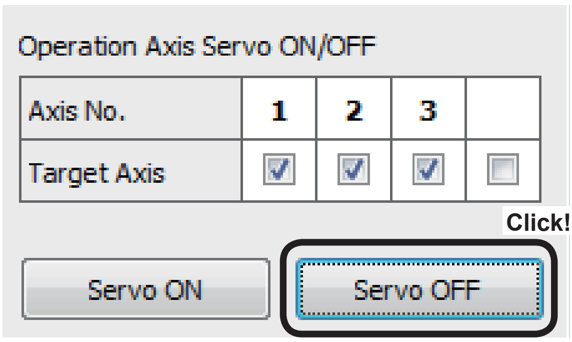
(1) Click the Home Position Return tab.



(2) A Home Position Return setting screen appears.

As for the axis with its "Target Axis" checked, click the Execute causes this axis home position return.

Axis 2 and 3 are possible of home position return (proximity dog type) because the dogs are in active. However, it is not possible to return both Axis 2 and 3 simultaneously.



(3) Press the Servo OFF button to turn the servo OFF for all axes.

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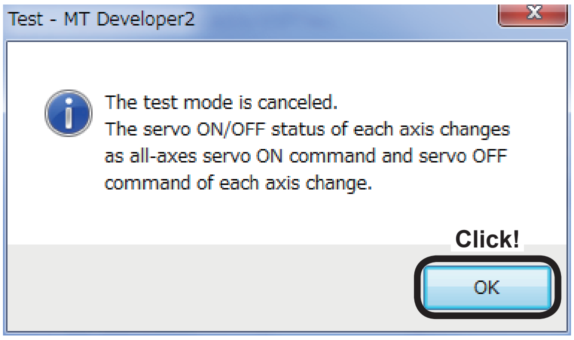


(4) Closing the Test window calls up a message box that prompts you to confirm whether resetting the test mode. Press the OK button.

This completes the test operation.

9.9 Demonstration Machine Operation

9.9.1 Operation

Servo motors are run and servo motor operation is monitored with MT Developer2.

Set the PLC CPU and Motion CPU RUN/STOP switch to "RUN".

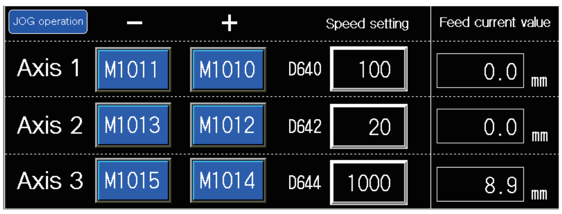
[Servo ON]

Press Servo ON at the demonstration machine operation panel.
The servo status for axis 1 to 3 changes to ready.

Demonstration machine operation panel

[JOG operation execution]

Demonstration machine operation panel (GOT)



Press JOG/home position return at the demonstration machine operation panel.

Press JOG/home position at the JOG/home position return operation panel to turn ON the running lamp.

JOG operation is possible while the JOG operation buttons are ON.

Item	Condition		
Control axis	Axis 1	Axis 2	Axis 3
JOG operation command input	Forward rotation (M1011)	Forward rotation (M1013)	Forward rotation (M1014)
	Reverse rotation (M1010)	Reverse rotation (M1012)	Reverse rotation (M1015)

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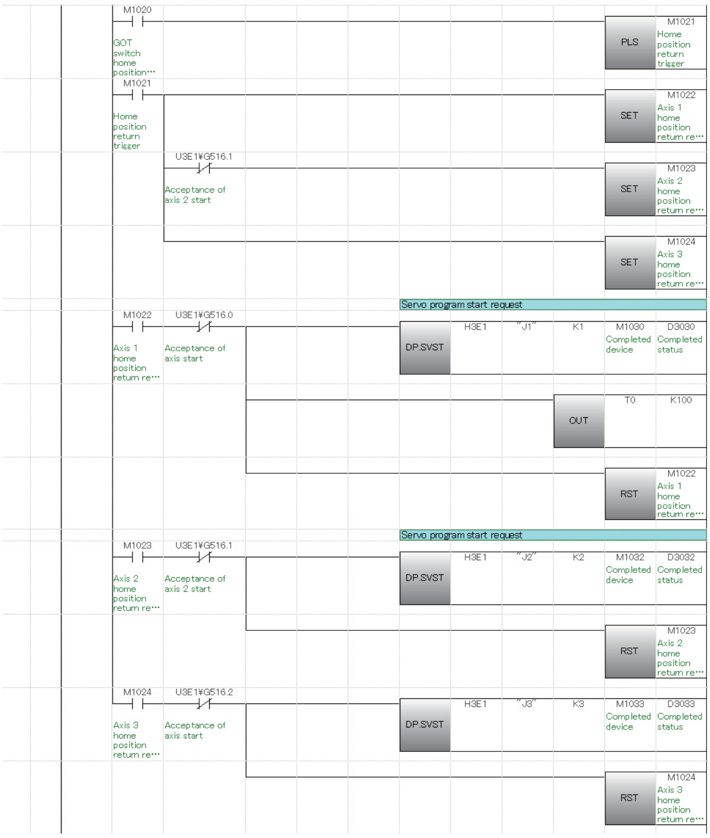
[Home position return execution]

Press [JOG/home position return] at the demonstration machine operation panel.

Press [JOG/home position] at the JOG/home position return operation panel to turn ON the running lamp.

Axis 1 uses data set type 1 and Axes 2 and 3 use proximity dog type 1. Operation is as follows.

• Press Home position return [M1020]: Movement starts in the home position return direction.



Axis 1 home position return

[K 1 : Real]
1 ZERO
Axis 1

The axis 1 current value becomes -5.0 mm.

Axis 2 home position return

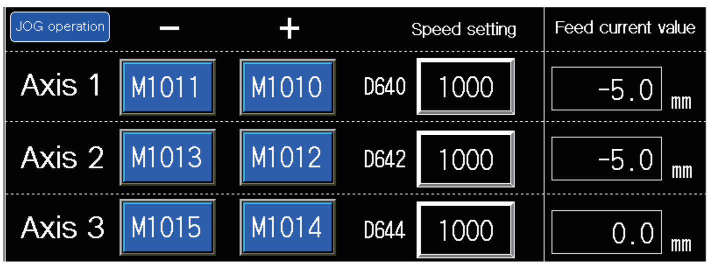
[K 2 : Real]
1 ZERO
Axis 2

The axis 2 current value becomes -5.0 mm.

Axis 3 home position return

[K 3 : Real]
1 ZERO
Axis 3

The axis 3 current value becomes 0 mm.



POINT

Checks to be performed when there is no movement
- Are the servos ON?
- Are the PLC CPU and Motion CPU switches set to "RUN"?
- Is the Motion CPU in test mode? (If in test mode, cancel.)
- Has an alarm occurred? (If so, eliminate the cause.)

[Standby point positioning]

Press **Positioning control** at the demonstration machine operation panel.

(1) Press **Positioning operation** at the Positioning operation screen to turn ON the running lamp.

(2) Pressing the standby point causes axes 1 and 2 to position themselves at address (0) of the **Standby point**.

[Pos ControlMain] program (Motion SFC program No. 10)

Pos ControlMain

[G 100]
//Mode selection switch check
! M6801

CLR
Speed change

[G 101]
//Standby point positioning start
M0*!M2001*!M2002

StandbyPointPos

"StandbyPointPos" called when
M0=ON
M2001 (axis 1 start accept flag) = OFF
M2002 (axis 2 start accept flag) = OFF

[StandbyPointPos] program (Motion SFC program No. 20)

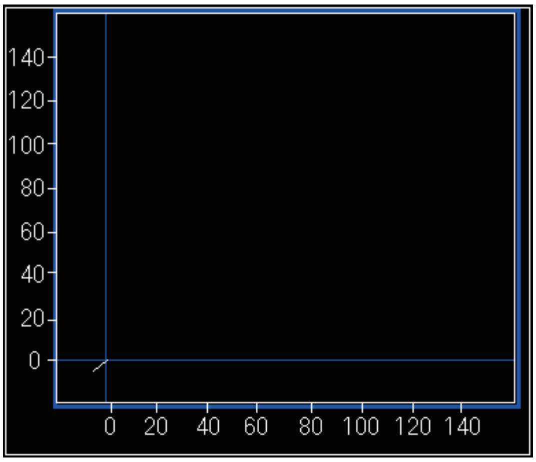
StandbyPointPos

[F200]
//Switch LED ON
SET M10

[K20: Real axis]

1 ABS-2 (Vector-speed)
Axis 1, 0.0 μm
Axis 2, 0.0 μm
Vector speed 2000.00 mm/min
Dwell 100 ms

…Servo program No. 20 executed.
(2-axis linear interpolation)



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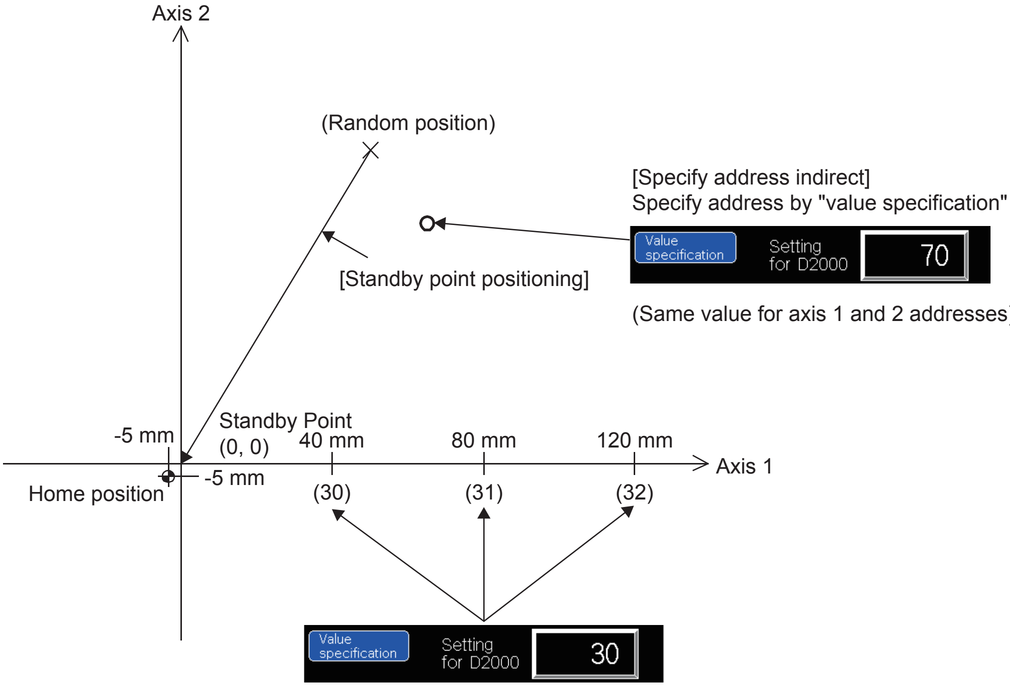
[Positioning control main]
[Point selection] [Specify address indirect]

Execute [Point selection]

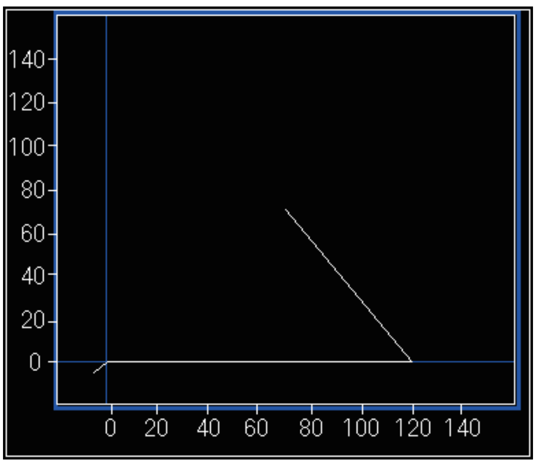
Enter either 30, 31 or 32 into the D2000 and turn on the Position selection from the operation panel of the training machine. And the axis 1 positions itself while following the locus of [Point selection].
The positions corresponding to the data input are as follows.
30: 40mm, 31: 80mm, 32: 120mm

Execute [Specify address indirect]

Enter the data into the D2000 and turn on the Indirect specification from the operation panel of the training machine. And the axes 1 and 2 position themselves according to the [Specify address indirect].
Both axes 1 and 2 move over to the positions that you have entered into the D2000.
(Example) if D2000 = 70, (axis 1, axis 2) = (70, 70)



[Point selection]
Select points by "value specification".



Go to next page

From previous page

[Speed change]

Speed change/temporary stop during operation

- By turning 2000 ON, the speed will be 2000 mm/min.
- By turning 1000 ON, the speed will be 1000 mm/min.
- By turning 500 ON, the speed will be 500 mm/min.
- By turning 0 ON, operation will temporarily stop.

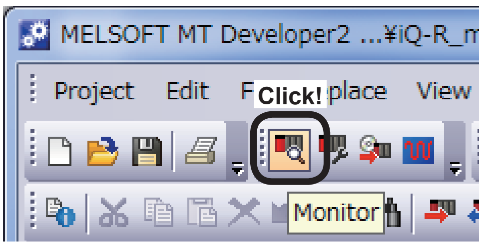
(The speed may be changed multiple times during operation.
However, do not perform operation during home position return, circular interpolation, or during deceleration. A minor error will occur.)

Operation complete

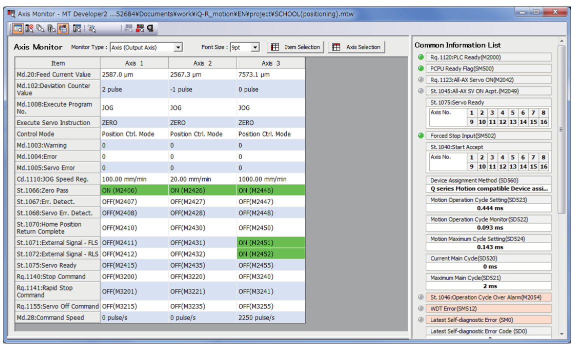
9.9.2 Monitor operation with monitor screen

Current values and error causes and so on can be checked using the Monitor screen.

(1) Monitor startup

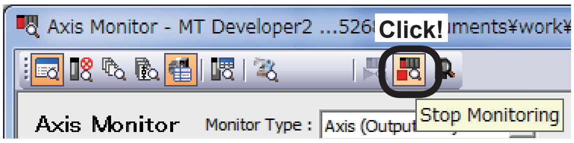


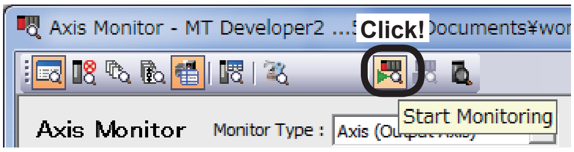
1: Click the monitor icon on the toolbar.



2: The monitor starts up.

(2) Stopping/starting the monitor

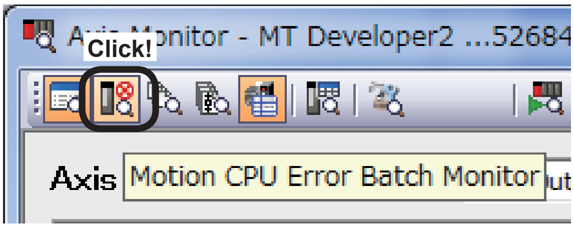


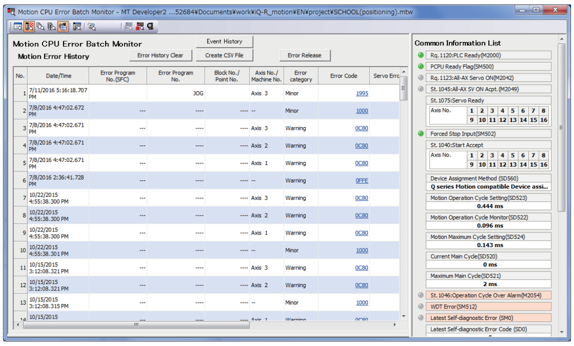


1: To stop the monitor, click the "Stop Monitoring" button on the Monitor screen toolbar.

2: To start the monitor again, click the "Start Monitoring" button on the Monitor screen toolbar.

(3) Motion CPU error batch monitor





1: Click the "Motion CPU Error Batch Monitor" button on the Monitor screen toolbar.

2: The Motion CPU Error Batch Monitor appears.

POINT

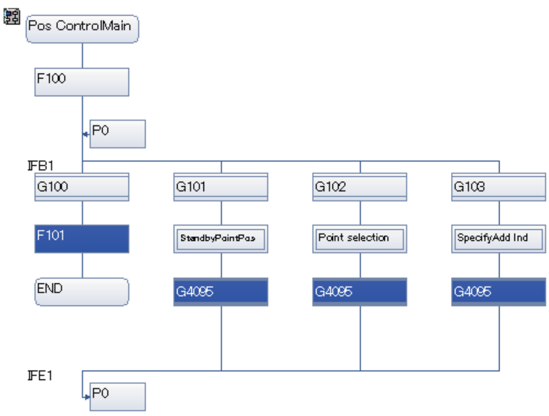
By using the Motion CPU Error Batch Monitor, all Motion CPU error information is displayed on the monitor.

9.9.3 Motion SFC program monitor

This section describes how to display the Motion CPU program monitor. The start and stop status of each program, and current device values can be monitored and so on.

(1) Mode change

1: Click the "Monitor Mode" button at the Program Editor screen.



2: The Motion SFC program changes to monitor mode.

: Executing

: Stopped

: Taking break

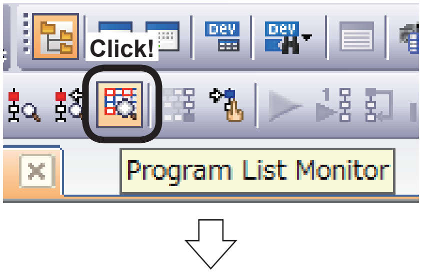
(Blue): Active

(Red): Awaiting parallel connection

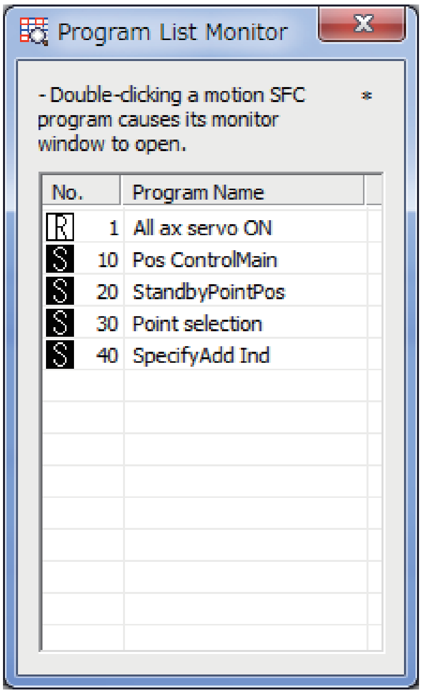
3: By clicking the "Edit Mode" button at the Edit Program screen, the mode changes to edit mode.

(2) Program List Monitor

Displays the program start and stop statuses in a list.



1: Click the Program List Monitor button.



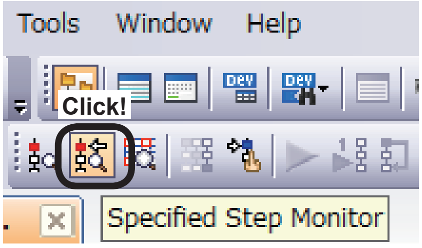
2: The Program List Monitor appears.

R: Executing

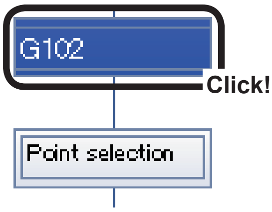
S: Stopped

(3) Specific step monitor

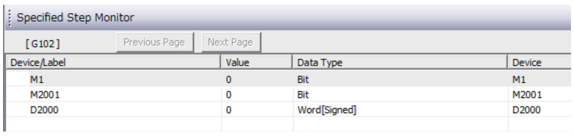
Values for devices used at selected steps can be monitored.



1: Click the Specified Step Monitor button.



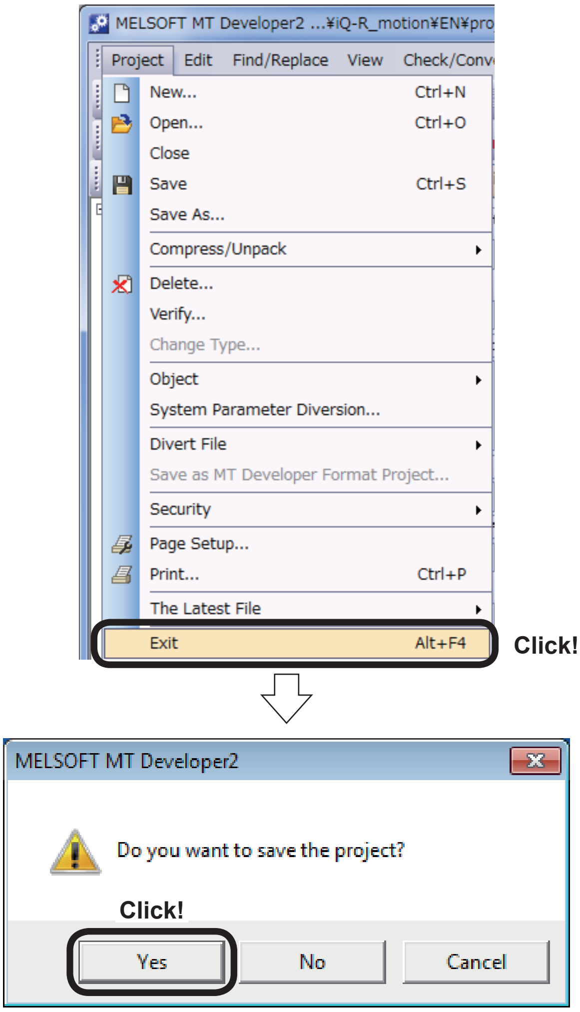
2: Click the step to be monitored.



3: Values for devices at specific steps can be monitored.

9.10 Exit Operation

9.10.1 Exiting MT Works2

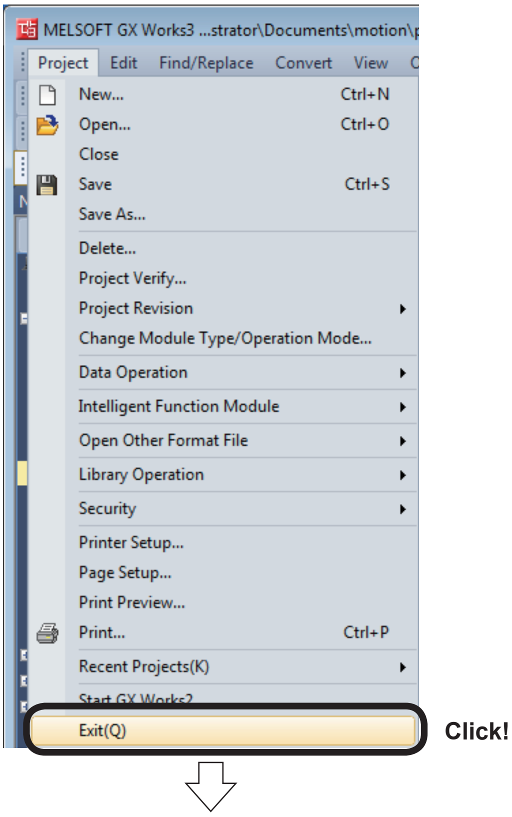


(1) Click [Exit] on the [Project] menu.

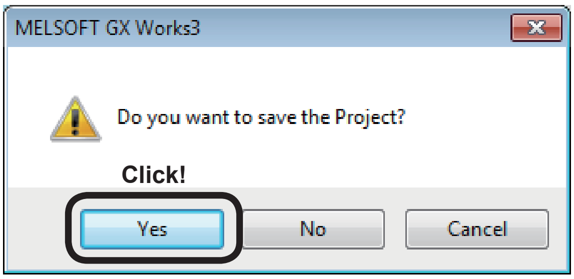
(2) If any changes have been made to setting data, a message appears to confirm whether to save the project.
Click the Yes button.

9.10.2 Exiting GX Works3

(1) Click [Exit] on the GX Works3 [Project] menu.

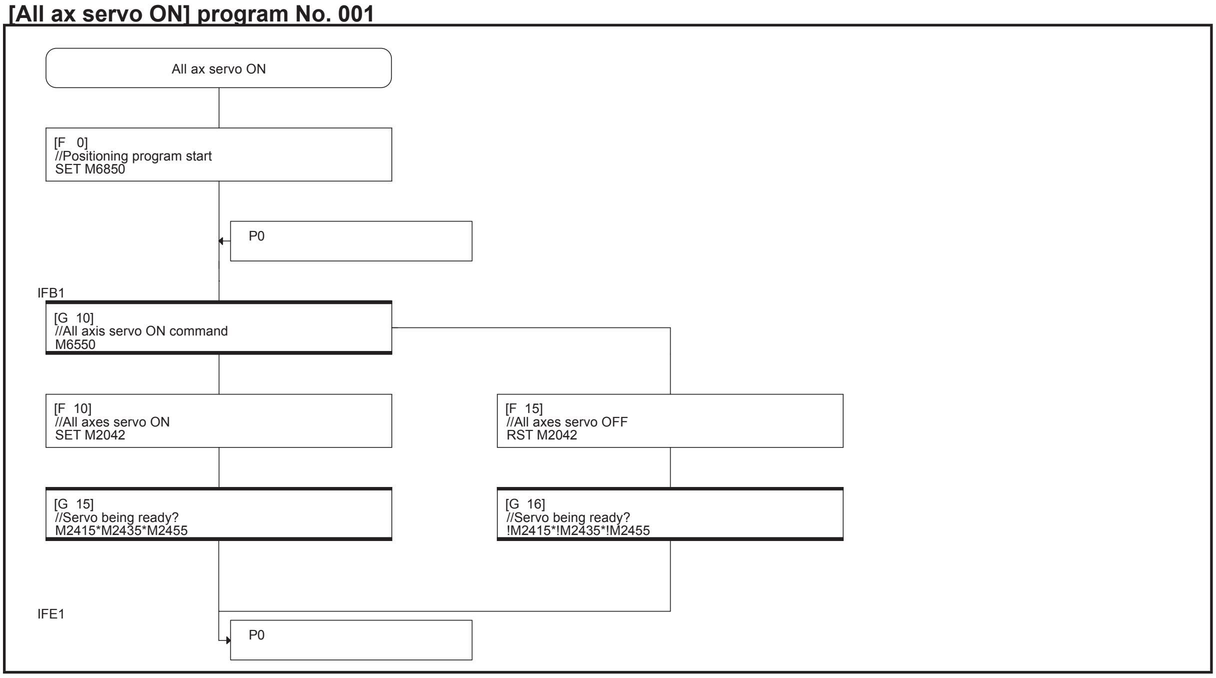


(2) If the project has not been saved, a message appears to confirm whether to save the project. Click the Yes button.

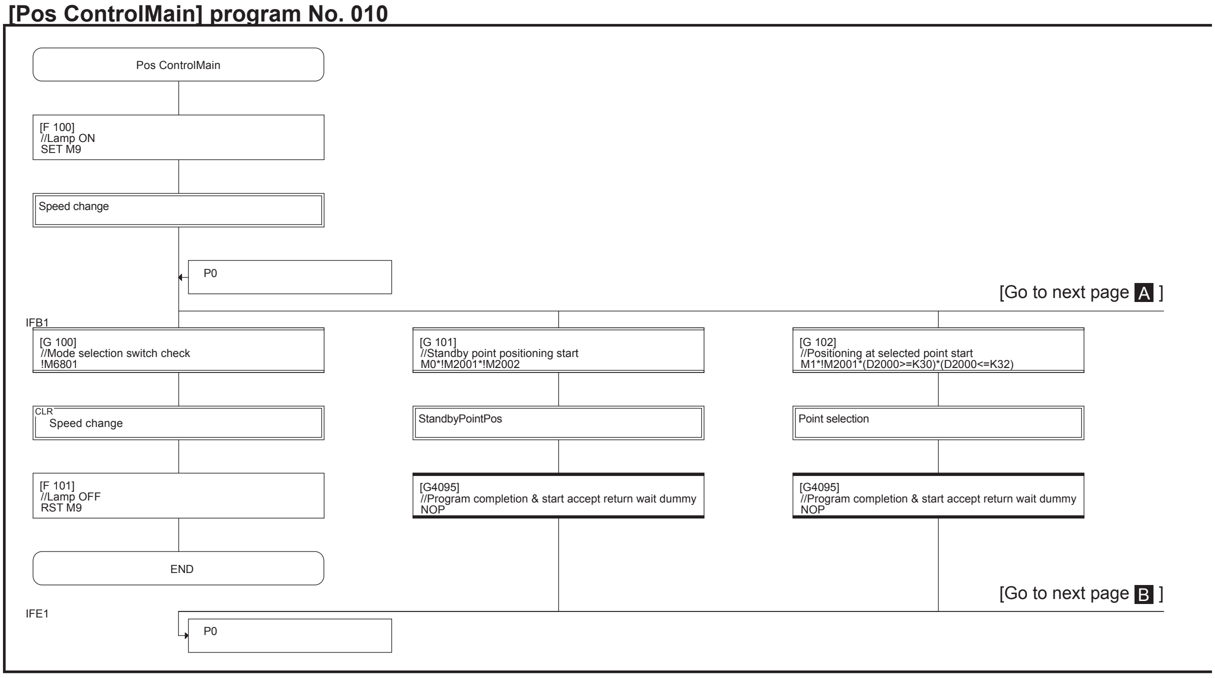


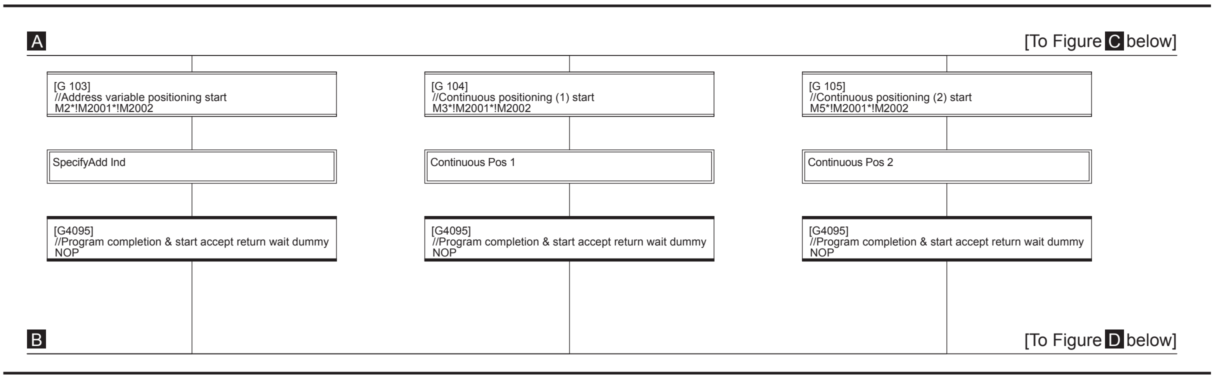
9.11 SFC program list

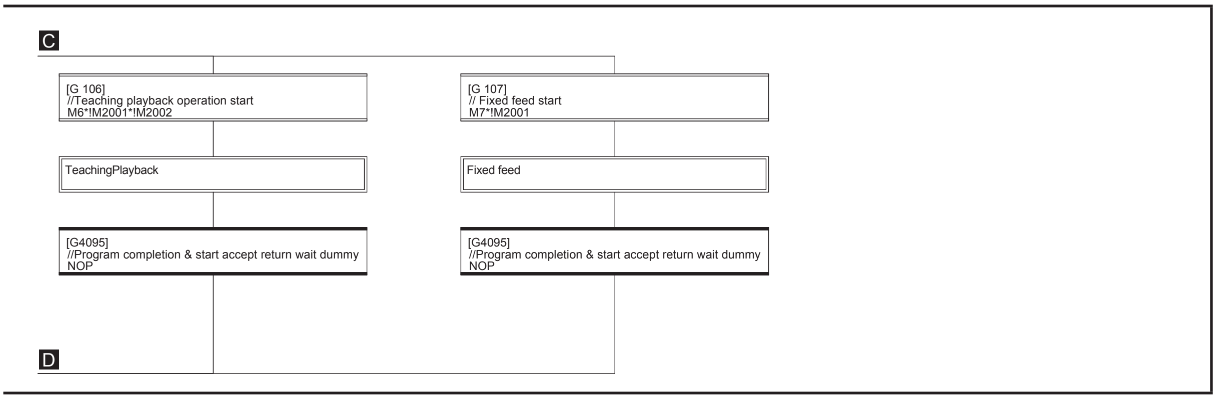
[All ax servo ON] program No. 001



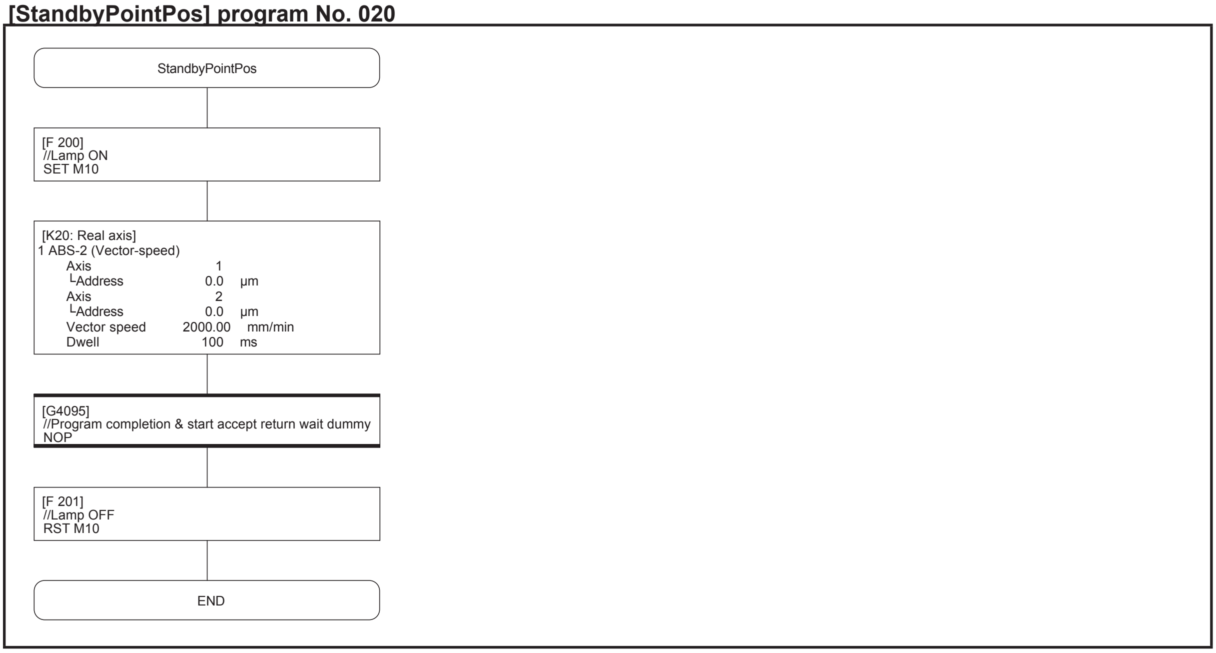
[Pos ControlMain] program No. 010



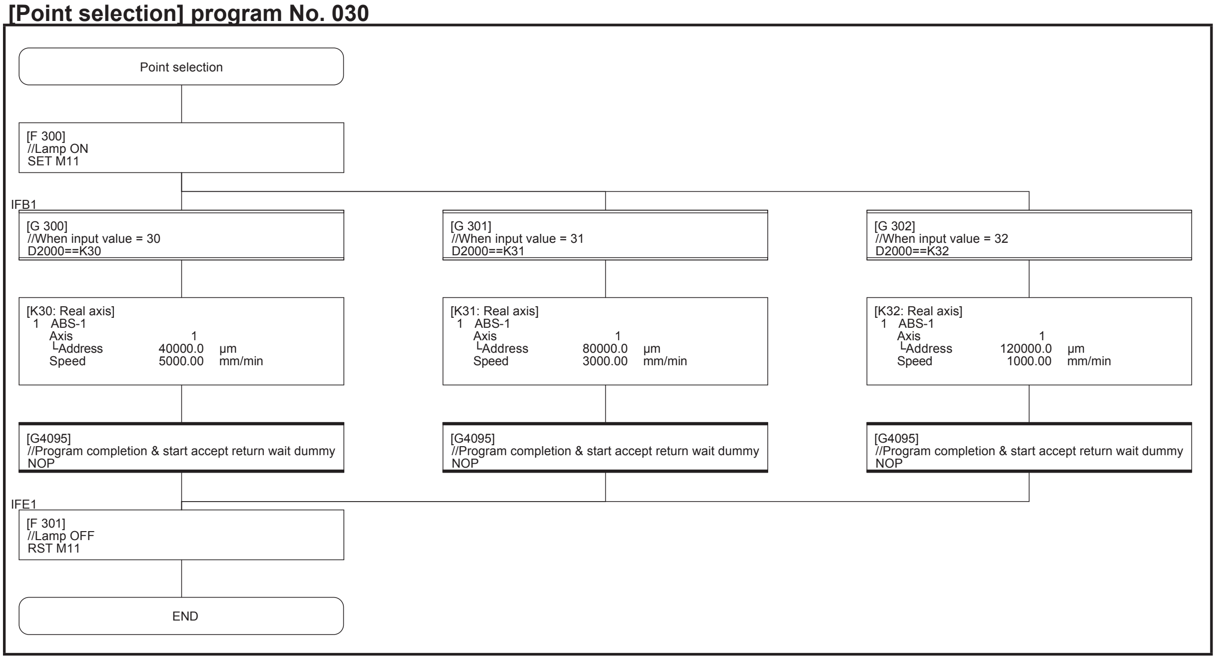




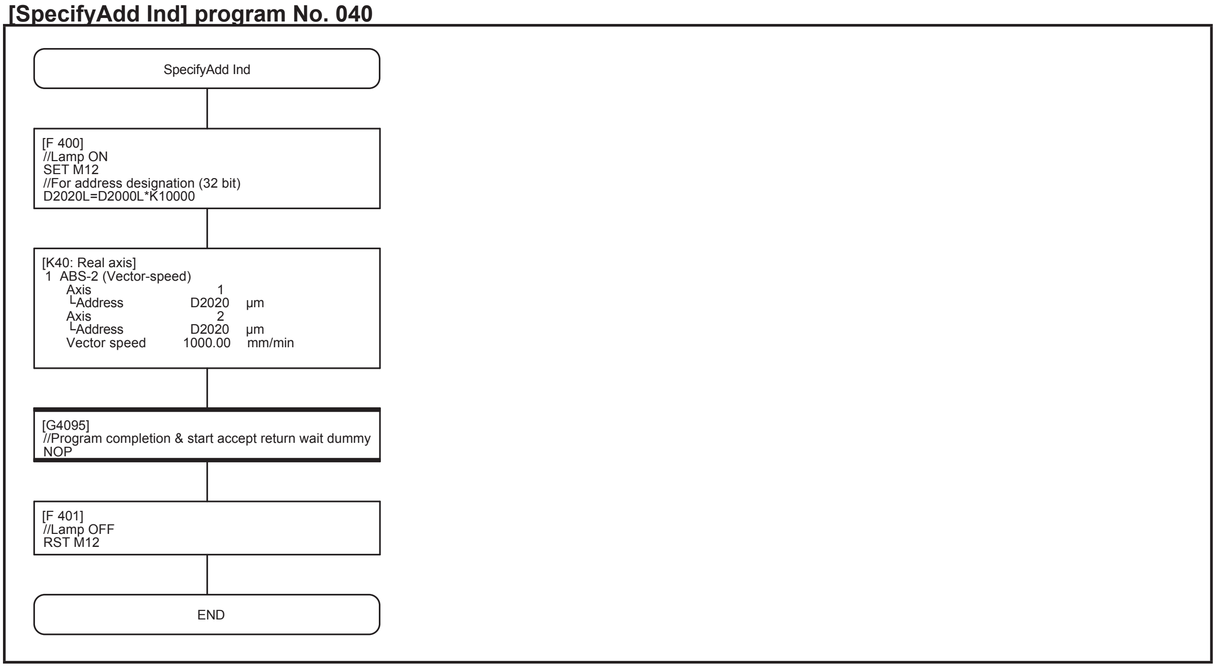
[StandbyPointPos] program No. 020



[Point selection] program No. 030



[SpecifyAdd Ind] program No. 040



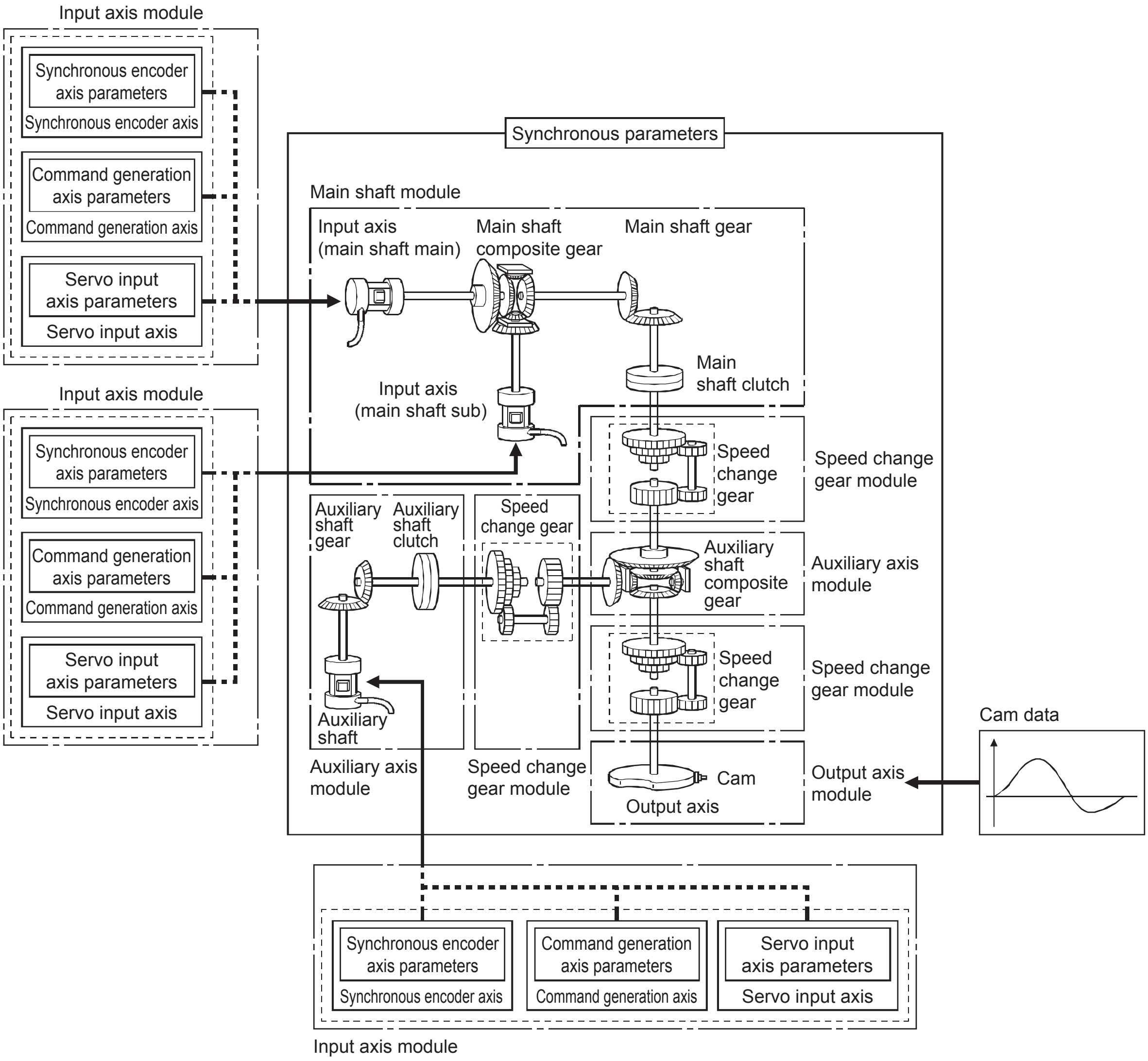
Chapter 10 Advanced Synchronous Control Practice

10.1 Synchronous Control Parameters

By starting synchronous control for each output axis, control is synchronized for input axes (servo input axis, command generation axis, synchronous encoder axis).

10.1.1 Synchronous control modules

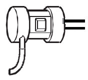
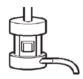
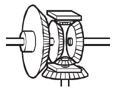
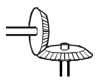
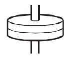
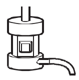
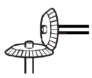
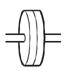
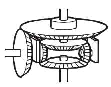
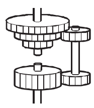
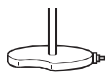
The modules used with synchronous control are shown below.



POINT
• Input axis module can be set to one of servo input axis, command generation axis or synchronous encoder axis. • Speed change gear can be arranged on two of main shaft side, auxiliary shaft side or after composite auxiliary shaft gear. • Set the travel value of input axis module so large as possible to prevent the speed fluctuation of output axis module in the synchronous control. If the travel value of input axis module is small, the speed fluctuation of output axis module may occur depending on the setting for synchronous parameter. • All synchronous control monitor data, and the rotation direction of the main shaft main input axis, main shaft sub input axis, auxiliary shaft, output axis (cam axis feed current value) can be monitored in the MT Developer2 synchronous control image screen.

10.1.2 Synchronous control module list

The number of modules that can be used with synchronous control is shown below.
(Indicates the number of modules for R16MTCPU.)

Classification	Name	Parts	Maximum number of usable	
			Number per module	Number per axis
Input axis module	Servo input axis	-	16	-
	Command generation axis	-	16	-
	Synchronous encoder axis	-	12	-
Main shaft module	Main shaft main input axis		16	1
	Main shaft sub input axis		16	1
	Composite main shaft gear		16	1
	Main shaft gear		16	1
	Main shaft clutch		16	1
Auxiliary axis module	Auxiliary shaft axis		16	1
	Auxiliary shaft gear		16	1
	Auxiliary shaft clutch		16	1
	Composite auxiliary shaft gear		16	1
Speed change gear module	Speed change gear		32	2
Output axis module	Output axis		16	1
Cam data	Cam data	-	Up to 1024	-

10.1.3 Servo input axes

Servo input axes are used to drive input axes based on the position of servo motors controlled with the Motion CPU (R16MTCPU/R32MTCPU).

Symbol	Setting item	Setting details	Setting value	Load cycle	Default	Device No.
Pr.300	Servo input axis type	Sets the current value type from which the servo input axis input value is generated.	0: Disable 1: Feed current value 2: Real current value 3: Servo command value 4: Feedback value	When power turned ON	0	-
Pr.301	Servo input axis smoothing time constant	Set if performing smoothing processing for input values.	0 to 5000 [ms]		0 [ms]	-
Pr.302	Servo input axis phase compensation advance time	Sets the time to advance or delay the phase.	-2147483648 to 2147483647 [μs]	Operation cycle	0 [μs]	D14600+2n D14601+2n
Pr.303	Servo input axis cam axis phase compensation time constant	Sets the time to reflect phase compensation.	0 to 65535 [ms]	When power turned ON	10 [ms]	-
Pr.304	Servo input axis rotation direction restriction	Set if restricting the input travel value to a single direction.	0: No rotation direction restriction 1: Permit only when current value is increase direction 2: Permit only when current value is decrease direction		0	-

10.1.4 Command generation axis

Axes used to perform command generation only can be controlled independently of axes connected to servo amps. Command generation axes are used if driving input axes with servo programs or with JOG operation.

Symbol	Setting item	Setting details	Setting value	Load cycle	Default	Device No.
Pr.340	Command generation axis enable setting	Enables/disables the used command generation axis.	0: Disable 1: Enable	When power turned ON	0	-
Pr.341	Command generation axis unit setting	Sets the command generation axis unit.	0: mm 1: inch 2: degree 3: pulse		3	-
Pr.342	Command generation axis upper stroke limit	Sets the command generation axis upper stroke limit.	-2147483648 to 2147483647 (when degree: 0 to 35999999) [Command generation axis position unit][*1]		0	-

Symbol	Setting item	Setting details	Setting value	Load cycle	Default	Device No.
Pr.343	Command generation axis lower stroke limit	Sets the command generation axis lower stroke limit.	-2147483648 to 2147483647 (when degree: 0 to 35999999) [Command generation axis position unit] *1	When power turned ON	0	-
Pr.344	Command generation axis command in-position range	Sets the command generation axis command in-position range.	1 to 2147483647 [Command generation axis position unit] *1		100	-
Pr.345	Command generation axis degree axis speed 10 times designation	Sets whether to perform positioning control at a speed 10 times the command speed setting value when the command generation axis unit is degree.	0: Disable 1: Enable		0	-
Pr.346	Command generation axis length per cycle	Sets the command generation axis length per cycle.	0: Disable 1 to 2147483647 [Command generation axis position unit] *1		0	-
Pr.347	Command generation axis JOG speed limit value	Sets the speed limit value when performing JOG operation for a command generation axis.	1 to 2147483647 [Command generation axis speed unit]*2		20000	-
Pr.348	Command generation axis JOG operation parameter block designation	Sets the No. of the parameter block used when performing JOG operation for a command generation axis.	1 to 64	When starting JOG operation	1	D14682+4n
Pr.349	Command generation axis acceleration/ deceleration time change enable device*3	Sets the bit device used to permit acceleration/ deceleration time changes when requesting a speed change.	Bit device (X, Y, M, B, F, U□\G)	When power turned ON	-	Optional device
Pr.350	Command generation axis acceleration time change value device*3	Sets the word device used to set the acceleration time change value.	Word device (D, W, #, U□\G)		-	Optional device
Pr.351	Command generation axis deceleration time change value device*3	Sets the word device used to set the deceleration time change value.	Word device (D, W, #, U□\G)		-	Optional device

Symbol	Setting item	Setting details	Setting value	Load cycle	Default	Device No.
Pr.352	Command generation axis when degree ABS directional setting device*3	Set a word device for setting the direction of positioning at the time of positioning control of the absolute method for the degree axis.	Word device (D, W, #, U□\G)	At the time of starting up program*4	-	Optional device
Pr.353	Command generation axis override ratio setting device	Set a word device for setting the override ratio.	Word device (D, W, #, U□\G)	Operation cycle	-	Optional device

*1. Command generation axis position unit
*2. Command generation axis speed unit
*3. This setting can be omitted.
*4. During the fixed-pitch feed control, the value of the device that is indirectly set up at the time of changing positioning address is retrieved again.

10.1.5 Synchronous encoder axes

Use if driving input axes with input pulses from externally connected synchronous encoders.

Symbol	Setting item	Setting details	Setting value	Load cycle	Default	Device No.
Pr.320	Synchronous encoder axis type	• Sets the type of synchronous encoder axis used. • Sets the master CPU input axis if using as a slave CPU with multiple CPU high speed synchronous control.	0: Disable 1: Via module 101: Via servo amplifier (Connected servo amplifier Axis No.: 1 to 32) 201: Via device 301: Master CPU servo input axis (Axis No.: 1 to 32) 401: Master CPU command generation axis (Axis No.: 1 to 32) 501: Master CPU synchronous encoder axis (Axis No.: 1 to 12)	When power turned ON	0	-
Pr.321	Synchronous encoder axis unit setting	• Sets the synchronous encoder axis unit. • The position unit is set in the "×1 to 10^{-9} [control unit]" range. • The speed unit is set in the "×1 to 10^{-9} [control unit/s, or control unit/min]" range.	Control unit 0: mm 1: inch 2: degree 3: pulse		3	-
			No. of position decimal point digits 0 to 9		0	
			Speed time unit 0: sec 1: mm		0	
			No. of speed decimal point digits 0 to 9		0	

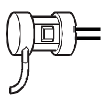
Symbol	Setting item	Setting details	Setting value	Load cycle	Default	Device No.
Pr.322	Synchronous encoder axis unit conversion numerator	Sets the numerator for converting synchronous encoder axis encoder pulses to synchronous encoder axis units.	-2147483648 to 2147483647 [Synchronous encoder axis position unit] *1	When power turned ON	1	-
Pr.323	Synchronous encoder axis unit conversion denominator	Sets the denominator for converting synchronous encoder axis encoder pulses to synchronous encoder axis units.	1 to 2147483647 [pulse]		1 [pulse]	-
Pr.324	Synchronous encoder axis length per cycle	Sets the synchronous encoder axis length per cycle.	1 to 2147483647 [Synchronous encoder axis position unit] *1		4000	-
Pr.325	Synchronous encoder axis smoothing time constant	Set if performing smoothing processing for input values.	0 to 5000 [ms]		0 [ms]	-
Pr.326	Synchronous encoder axis phase compensation advance time	Sets the time to advance or delay the phase.	-2147483648 to 2147483647 [μs]	Operation cycle	0 [μs]	D14820+10n D14821+10n
Pr.327	Synchronous encoder axis cam axis phase compensation time constant	Sets the time to reflect phase compensation.	0 to 65535 [ms]	When power turned ON	10 [ms]	-
Pr.328	Synchronous encoder axis rotation direction restriction	Set if restricting the input travel value to a single direction.	0: No rotation direction restriction 1: Permit only when current value is increase direction 2: Permit only when current value is decrease direction		0	-

Symbol	Setting item	Setting details	Setting value	Load cycle	Default	Device No.
Pr.329	Synchronous encoder via device resolution	• Sets the type of synchronous encoder axis using synchronous encoder resolution when the synchronous encoder axis type is synchronous encoder via device. • If 0 is set, processing is performed with the synchronous encoder via device input value as a 32-bit counter.	0 to 2147483647 [pulse]	When power turned ON	0 [pulse]	-
Pr.331	Input/ output No.	If the type of the synchronous encoder axis is via a module, set the I/O number of the module that is assigned to the high speed counter.	• Set in hexadecimal notation. H0000 to H0FF0 *: Set by multiple of 16.		0000h	-
Pr.332	CH No.	If the type of the synchronous encoder axis is via a module, set the channel number of the module that is assigned to the high speed counter.	1 to 2		1	-

*1. Synchronous encoder axis position unit

10.1.6 Main shaft main input axis

This is the input axis at the main shaft module main side. This is the reference for the main shaft position.

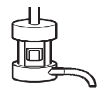


Symbol	Setting item	Setting details	Setting value	Load cycle	Default	Device No.
Pr.400	Main input axis No.	Sets the input axis No. at the main shaft input main side.	0: Disable 1 to 32: Servo input axis *1 201 to 232: Command generation axis *2 801 to 812: Synchronous encoder axis	When starting synchronous control	0	D15000+150n

*1. With the R16MTCPU, the 1 to 16 range is valid.
*2. With the R16MTCPU, the 201 to 216 range is valid.

10.1.7 Main shaft sub input axis

This is the input axis at the main shaft module sub side. This is used if entering a compensation amount for the main shaft main input axis position.

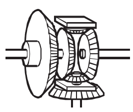


Symbol	Setting item	Setting details	Setting value	Load cycle	Default	Device No.
Pr.401	Main input axis No.	Sets the input axis No. at the main shaft input sub side.	0: Disable 1 to 32: Servo input axis *1 201 to 232: Command generation axis*2 801 to 812: Synchronous encoder axis	When starting synchronous control	0	D15001+150n

*1. With the R16MTCPU, the 1 to 16 range is valid.
*2. With the R16MTCPU, the 201 to 216 range is valid.

10.1.8 Composite main shaft gear

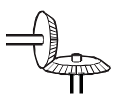
The main shaft main input axis and main shaft sub input axis travel values are compounded and transferred to the main shaft gear.



Symbol	Setting item	Setting details	Setting value	Load cycle	Default	Device No.
Pr.402	Main shaft composite gear	Selects the input value composition method from main input axis and sub input axis.	• Set in hexadecimal notation. H□□□ □ →Main input method 0: No input 1: Input + 2: Input - →Sub input method 0: No input 1: Input + 2: Input -	Operation cycle	0001h	D15002+150n

10.1.9 Main shaft gear

The gear ratio for which the travel value after the composite main shaft gear is set is converted and transferred.

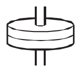


Symbol	Setting item	Setting details	Setting value	Load cycle	Default	Device No.
Pr.403	Main shaft gear numerator	Sets the main shaft gear numerator.	-2147483648 to 2147483647	When starting synchronous control	1	D15004+150n D15005+150n
Pr.404	Main shaft gear denominator	Sets the main shaft gear denominator.	1 to 2147483647		1	D15006+150n D15007+150n

10.1.10 Main shaft clutch

The main shaft travel value is turned ON and OFF with the clutch and transferred.

This is used if conveying/isolating command pulses from main shaft input to the output axis module side, and controlling servo motor operation/stoppage.



Symbol	Setting item	Setting details	Setting value	Load cycle	Default	Device No.
Pr.405	Main shaft clutch control setting	Sets the clutch control method.	• Set in hexadecimal notation. H□□ □ □ ON control mode 0: No clutch 1: Clutch command ON/OFF 2: Clutch command leading edge 3: Clutch command trailing edge 4: Address mode 5: High-speed input request OFF control mode 0: OFF control disabled 1: One shot OFF 2: Clutch command leading edge 3: Clutch command trailing edge 4: Address mode 5: High-speed input request High-speed input request signal 00 to 3F: Signal 1 to 64 High-speed input request signal	Operation cycle	0000h	D15008+150n
Pr.406	Main shaft clutch reference address setting	Sets the clutch reference address.	0: Current value after composite main shaft gear 1: Current value per cycle after main shaft gear	When starting synchronous control	0	D15009+150n
Pr.407	Main shaft clutch ON address	• Sets the address for turning ON the clutch when in address mode. (The setting is invalid when in other than address mode.) • If other than "0 to (cam axis length per cycle -1)", the clutch is controlled after converting to the "0 to (cam axis length per cycle -1)" range.	-2147483648 to 2147483647 [Main input axis position unit*1, or cam axis cycle unit*2]	Operation cycle	0	D15010+150n D15011+150n

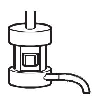
Symbol	Setting item	Setting details	Setting value	Load cycle	Default	Device No.
Pr.408	Travel value before main shaft clutch ON	• Sets the travel value until the clutch is actually turned ON after the clutch ON conditions are established. • Set a positive value for movements in the increase direction, and negative value for movements in the decrease direction.	-2147483648 to 2147483647 [Main input axis position unit*1, or cam axis cycle unit*2]	When clutch ON conditions established	0	D15012+150n D15013+150n
Pr.409	Main shaft clutch OFF address	• Sets the address for turning OFF the clutch when in address mode. (The setting is invalid when in other than address mode.) • If other than "0 to (cam axis length per cycle -1)", the clutch is controlled after converting to the "0 to (cam axis length per cycle -1)" range.	-2147483648 to 2147483647 [Main input axis position unit*1, or cam axis cycle unit*2]	Operation cycle	0	D15014+150n D15015+150n
Pr.410	Travel value before main shaft clutch OFF	• Sets the travel value until the clutch is actually turned OFF after the clutch OFF conditions are established. • Set a positive value for movements in the increase direction, and negative value for movements in the decrease direction.	-2147483648 to 2147483647 [Main input axis position unit*1, or cam axis cycle unit*2]	When clutch OFF conditions established	0	D15016+150n D15017+150n

Symbol	Setting item	Setting details	Setting value	Load cycle	Default	Device No.
Pr.411	Main shaft clutch smoothing method	Sets the clutch smoothing method.	0: Direct 1: Time constant method (index) 2: Time constant method (linear) 3: Slippage amount method (index) 4: Slippage amount method (linear) 5: Slippage amount method (Linear: following amount of input)	When starting synchronous control	0	D15018+150n
Pr.412	Main shaft clutch smoothing time constant	Sets the smoothing time constant if time constant method smoothing.	0 to 5000 [ms]		0 [ms]	D15019+150n
Pr.413	Slippage amount at main shaft clutch ON	Sets the slippage amount when the clutch is ON if slippage amount method smoothing.	0 to 2147483647 [Main input axis position unit*1, or cam axis cycle unit*2]	When starting clutch ON	0	D15020+150n D15021+150n
Pr.414	Slippage amount at main shaft clutch OFF	Sets the slippage amount when the clutch is ON if slippage amount method smoothing.	0 to 2147483647 [Main input axis position unit*1, or cam axis cycle unit*2]	When starting clutch OFF	0	D15022+150n D15023+150n

*1. Main input axis position unit
*2. Cam axis cycle unit

10.1.11 Auxiliary shafts

These are input axes for auxiliary shaft modules. Input values are generated from auxiliary shafts. Furthermore, input values can be converted to values taking the mechanical reduction ratio and rotation direction into consideration with an auxiliary shaft gear.

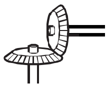


Symbol	Setting item	Setting details	Setting value	Load cycle	Default	Device No.
Pr.418	Auxiliary shaft No.	Sets the auxiliary shaft input axis No.	0: Disable 1 to 32: Servo input axis*1 201 to 232: Command generation axis*2 801 to 812: Synchronous encoder axis	When starting synchronous control	0	D15024+150n

*1. With the R16MTCPU, the 1 to 16 range is valid.
*2. With the R16MTCPU, the 201 to 216 range is valid.

10.1.12 Auxiliary shaft gear

The auxiliary shaft travel value is converted with the set gear ratio and transferred.

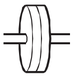


Symbol	Setting item	Setting details	Setting value	Load cycle	Default	Device No.
Pr.420	Auxiliary shaft gear numerator	Sets the auxiliary shaft gear numerator.	-2147483648 to 2147483647	When starting synchronous control	1	D15026+150n D15027+150n
Pr.421	Auxiliary shaft gear denominator	Sets the auxiliary shaft gear denominator.	1 to 2147483647		1	D15028+150n D15029+150n

10.1.13 Auxiliary shaft clutch

The auxiliary shaft travel value is turned ON and OFF with the clutch and transferred.

This is used if conveying/isolating command pulses from auxiliary shaft input to the output axis module side, and controlling servo motor operation/stoppage.



Symbol	Setting item	Setting details	Setting value	Load cycle	Default	Device No.
Pr.422	Auxiliary shaft clutch control setting	Sets the clutch control method.	• Set in hexadecimal notation. H□□ □ □ ON control mode 0: No clutch 1: Clutch command ON/OFF 2: Clutch command leading edge 3: Clutch command trailing edge 4: Address mode 5: High-speed input request OFF control mode 0: OFF control disabled 1: One shot OFF 2: Clutch command leading edge 3: Clutch command trailing edge 4: Address mode 5: High-speed input request High-speed input request signal 00 to 3F: Signal 1 to 64 High-speed input request signal	Operation cycle	0000h	D15030+150n

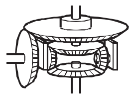
Symbol	Setting item	Setting details	Setting value	Load cycle	Default	Device No.
Pr.423	Auxiliary shaft clutch reference address setting	Sets the clutch reference address.	0: Auxiliary shaft current value 1: Current value per cycle after auxiliary shaft gear	When starting synchronous control	0	D15031+150n
Pr.424	Auxiliary shaft clutch ON address	• Sets the address for turning ON the clutch when in address mode. (The setting is invalid when in other than address mode.) • If other than "0 to (cam axis length per cycle -1)", the clutch is controlled after converting to the "0 to (cam axis length per cycle -1)" range.	-2147483648 to 2147483647 [Auxiliary input axis position unit*1, or cam axis cycle unit*2]	Operation cycle	0	D15032+150n D15033+150n
Pr.425	Travel value before auxiliary shaft clutch ON	• Sets the travel value until the clutch is actually turned ON after the clutch ON conditions are established. • Set a positive value for movements in the increase direction, and negative value for movements in the decrease direction.	-2147483648 to 2147483647 [Auxiliary input axis position unit*1, or cam axis cycle unit*2]	When clutch ON conditions established	0	D15034+150n D15035+150n
Pr.426	Auxiliary shaft clutch OFF address	• Sets the address for turning OFF the clutch when in address mode. (The setting is invalid when in other than address mode.) • If other than "0 to (cam axis length per cycle -1)", the clutch is controlled after converting to the "0 to (cam axis length per cycle -1)" range.	-2147483648 to 2147483647 [Auxiliary input axis position unit*1, or cam axis cycle unit*2]	Operation cycle	0	D15036+150n D15037+150n

Symbol	Setting item	Setting details	Setting value	Load cycle	Default	Device No.
Pr.427	Travel value before auxiliary shaft clutch OFF	• Sets the travel value until the clutch is actually turned OFF after the clutch OFF conditions are established. • Set a positive value for movements in the increase direction, and negative value for movements in the decrease direction.	-2147483648 to 2147483647 [Auxiliary input axis position unit*1, or cam axis cycle unit*2]	When clutch OFF conditions established	0	D15038+150n D15039+150n
Pr.428	Auxiliary shaft clutch smoothing method	Sets the clutch smoothing method.	0: Direct 1: Time constant method (index) 2: Time constant method (linear) 3: Slippage amount method (index) 4: Slippage amount method (linear) 5: Slippage amount method (Linear: following amount of input)	When starting synchronous control	0	D15040+150n
Pr.429	Auxiliary shaft clutch smoothing time constant	Sets the smoothing time constant if time constant method smoothing.	0 to 5000 [ms]		0 [ms]	D15041+150n
Pr.430	Slippage amount at auxiliary shaft clutch ON	Sets the slippage amount when the clutch is ON if slippage amount method smoothing.	0 to 2147483647 [Auxiliary input axis position unit*1, or cam axis cycle unit*2]	When starting clutch ON	0	D15042+150n D15043+150n
Pr.431	Slippage amount at auxiliary shaft clutch OFF	Sets the slippage amount when the clutch is OFF if slippage amount method smoothing.	0 to 2147483647 [Auxiliary input axis position unit*1, or cam axis cycle unit*2]	When starting clutch OFF	0	D15044+150n D15045+150n

*1. Auxiliary shaft position unit
*2. Cam axis cycle unit

10.1.14 Auxiliary shaft clutch

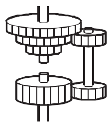
Main shaft and auxiliary shaft travel values are compounded and transferred.



Symbol	Setting item	Setting details	Setting value	Load cycle	Default	Device No.
Pr.419	Auxiliary shaft composite gear	Selects the input value composition method from the main shaft and auxiliary shaft.	• Set in hexadecimal notation. H□□□ □ Main shaft input method 0: No input 1: Input + 2: Input - Auxiliary shaft input method 0: No input 1: Input + 2: Input -	Operation cycle	0001h	D15025+150n

10.1.15 Speed change gear

The speed change gear is used if changing the input speed from the main shaft, auxiliary shaft, or composite auxiliary shaft gear during operation. If not used, set "0: No speed change gear" for [Pr.434] speed change gear 1 allocation (D15046+150n) and [Pr.490] speed change gear 2 allocation (D15052+150n).

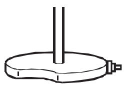


Symbol	Setting item	Setting details	Setting value	Load cycle	Default	Device No.
Pr.434	Speed change gear 1 allocation	Sets the speed change gear 1 allocation.	0: No speed change gear 1: Main shaft side 2: Auxiliary shaft side 3: After composite auxiliary shaft gear	When starting synchronous control	0	D15046+150n
Pr.435	Speed change gear 1 smoothing time constant	Sets the speed change gear 1 smoothing time constant.	0 to 5000 [ms]		0 [ms]	D15047+150n
Pr.436	Speed change ratio 1 numerator	Sets the speed change ratio 1 numerator.	-2147483648 to 2147483647	Operation cycle	1	D15048+150n D15049+150n
Pr.437	Speed change ration 1 denominator	Sets the speed change ratio 1 denominator.	1 to 2147483647		1	D15050+150n D15051+150n
Pr.490	Speed change gear 2 allocation	Sets the speed change gear 2 allocation.	0: No speed change gear 1: Main shaft side 2: Auxiliary shaft side 3: After composite auxiliary shaft gear	When starting synchronous control	0	D15052+150n

Symbol	Setting item	Setting details	Setting value	Load cycle	Default	Device No.
Pr.491	Speed change gear 2 smoothing time constant	Sets the speed change gear 2 smoothing time constant.	0 to 5000 [ms]	When starting synchronous control	0 [ms]	D15053+150n
Pr.492	Speed change ratio 2 numerator	Sets the speed change ratio 2 numerator.	-2147483648 to 2147483647	Operation cycle	1	D15054+150n D15055+150n
Pr.493	Speed change ration 2 denominator	Sets the speed change ratio 2 denominator.	1 to 2147483647		1	D15056+150n D15057+150n

10.1.16 Output axes

Output axes perform cam conversion processing based on the input travel value and set cam data, and outputs the feed current values that serve as commands to the servo amp.

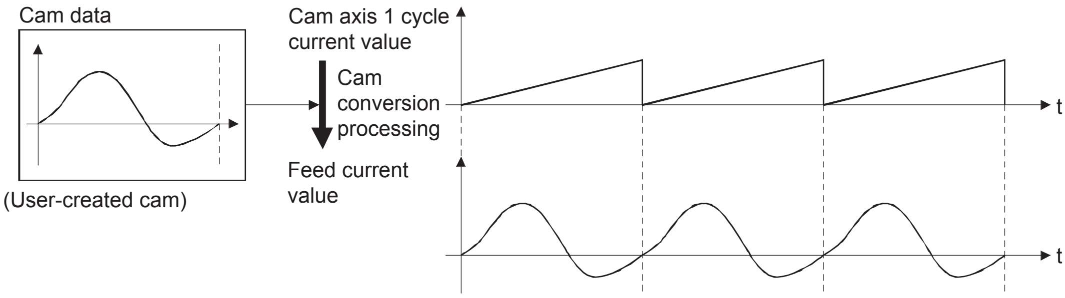


Symbol	Setting item	Setting details	Setting value	Load cycle	Default	Device No.
Pr.438	Cam axis cycle unit setting	• Sets the cam axis length per cycle unit. • This is a parameter for monitor display, and does not affect control.	• Set in hexadecimal notation. H□□□ □ Control unit 0: mm 1: inch 2: degree 3: pulse No. of decimal point digits 0 to 9 b0: Unit setting selection 0: Use main shaft main input axis unit. 1: Use this setting unit. b1 to 3: Not used	When starting synchronous control	0000h	D15058+150n
Pr.439	Cam axis 1 cycle length	Sets the input amount required for 1 cam cycle.	1 to 2147483647 [Cam axis cycle unit]*1	When starting synchronous control, when passing cam data 0 point	4194304	D15060+150n D15061+150n
Pr.440	Cam No.	Sets the cam No.	0 : Linear cam (preset) 1 to 1024: User created cams		0	D15062+150n
Pr.441	Cam stroke amount	• Sets the cam stroke amount relative to a stroke ratio of 100% for stroke ratio data format cams. • Ignored for coordinate data format cams.	-2147483648 to 2147483647 [Output axis position unit]*2		4194304	D15064+150n D15065+150n

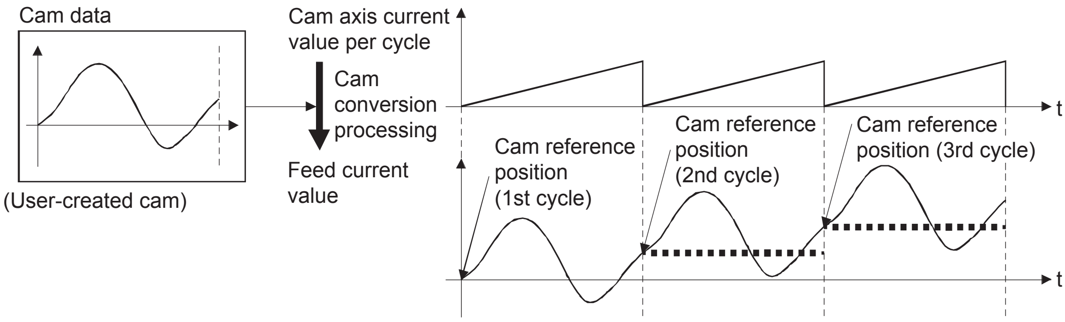
Symbol	Setting item	Setting details	Setting value	Load cycle	Default	Device No.
Pr.442	Cam axis 1 cycle length change setting	Set if changing the [Pr.439] cam axis length per cycle (D15060+150n, D15061+150n) during synchronous control.	0: Disable 1: Enable	When starting synchronous control	0	D15059+150n
Pr.444	Cam axis phase compensation advance time	Sets the time to advance or delay the cam axis phase.	-2147483648 to 2147483647 [μs]	Operation cycle	0 [μs]	D15066+150n D15067+150n
Pr.445	Cam axis phase compensation time constant	Sets the time to reflect cam axis phase compensation.	0 to 65535 [ms]	When starting synchronous control	10 [ms]	D15068+150n
Pr.448	Synchronous controlling parameter block No.	Sets the synchronous control parameter block No.	1 to 64		1	D15069+150n
Pr.447	Output axes smoothing time constant	Set if performing smoothing processing for output values.	0 to 5000 [ms]		0 [ms]	D15070+150n

[Cam data]
Synchronous control output axes are moved with cams. Output axis movement patterns (return movements, feed movements) relative to output axis module input travel values are registered in the cam data.
The movement patters are as follows.

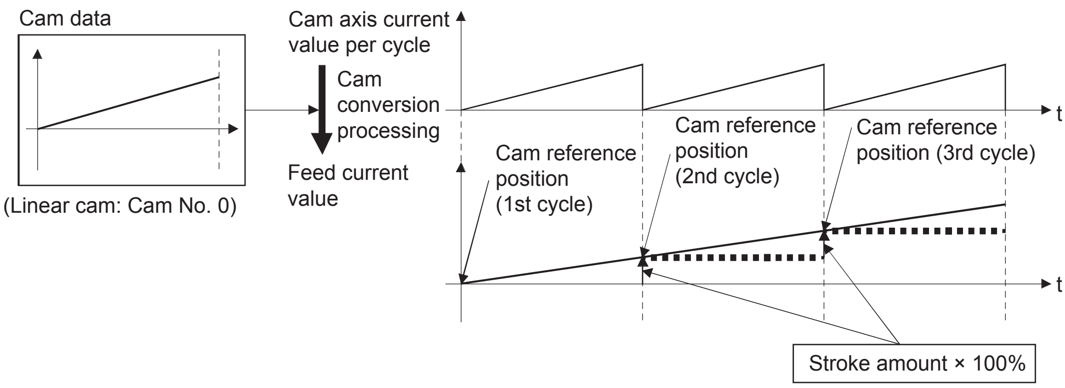
- Return movement: Return movement within fixed cam stroke range



- Feed movement: Movement that involves updating the cam reference position every 1 cycle



- Linear movement: Linear movement in which 1 cycle has a stroke ratio of 100% (Cam No. 0)



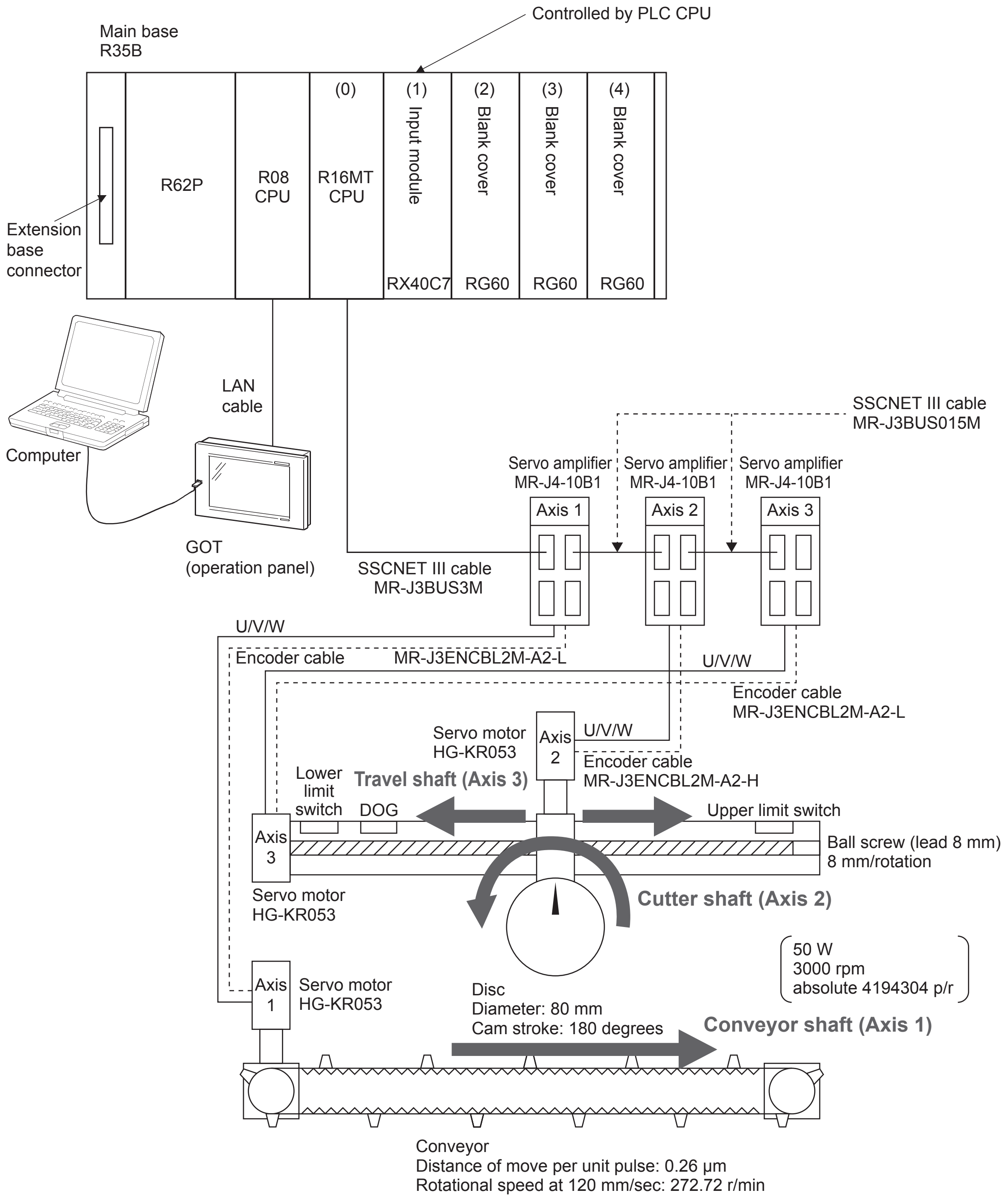
10.2 Practice Content

(1) Advanced synchronous control 1: Travel cutter

You will practice mainly the "Clutch function" that is used in the synchronous control. The travel cut takes place seamlessly by the travel of the disc axis and start of stop by the clutch function.

(2) Advanced synchronous control 2: Rotary cutter

You will practice mainly the "Cam automatic generation function" that is used in the synchronous control. The disc movements are controlled according to the automatically generated cam operation based on the parameters set up for the rotary cutter.



10.2.1 Advanced synchronous control 1: Travel cutter

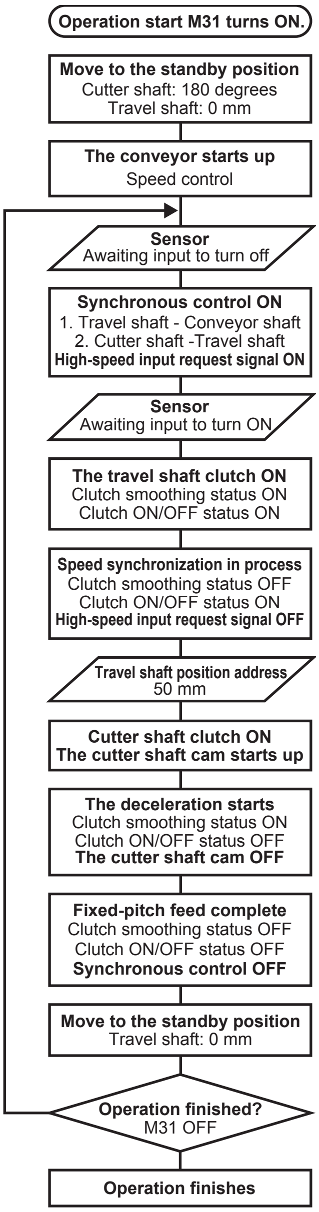
System

A sensor detects the white mark on the conveyor that travels at a constant speed. With reference to the detected white mark as a start point, the cutter shaft starts travel movement in the direction of the conveyor move. After the cutter shaft has moved a certain distance, it starts the cutting movement.

POINT

As for the "Travel movement" by the travel shaft and the "Cutting movement" where the cutter shaft rotates for simulated cutting, both of them use and learn "Synchronous control", "Clutch function" and "Cam function".

<Control flow>



Synchronous control

- Travel movement where the disc moves to the right while synchronizing the conveyor motion
- Cutting movement where the cutter shaft rotates while synchronizing the travel shaft motion

Clutch function

- The travel shaft uses this function when it starts up and stops the travel movement.
- The cutter shaft uses the clutch function when it starts and stops the cutting movement.

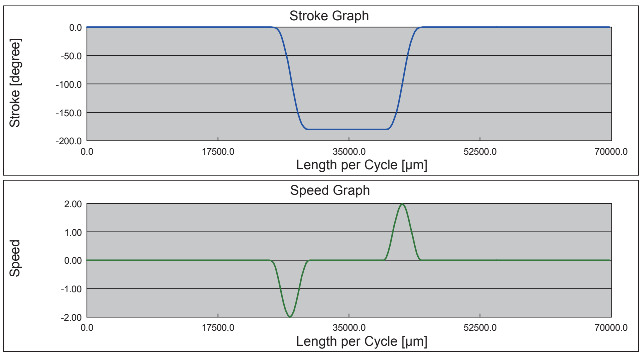
* Given the slippage amount at the time of clutch ON/OFF, the clutch function let the travel movement and cutting movement of the cutter shaft operates seamlessly smooth at the time such motions start. This demonstration machine has the slippage amounts set to 50 mm at the start of the travel movement and 5 mm at its stop. You can observe the actual motions to see how they work.

Cam function

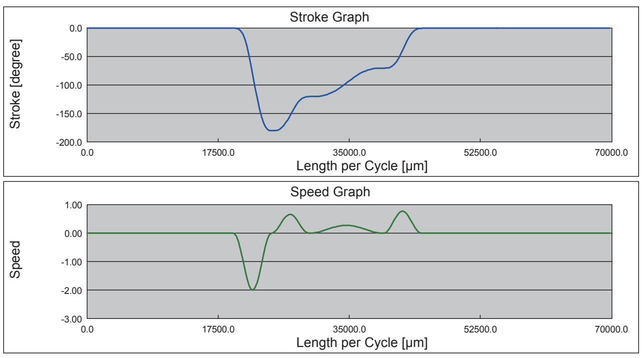
- The cutter shaft uses this function for the cutting movement.

* Here, with two sets of cam data set up in advance, you can select them on the GOT screen to see how the cam moves.

Cam No. 1



Cam No. 2



10.2.2 Advanced synchronous control 2: Rotary cutter

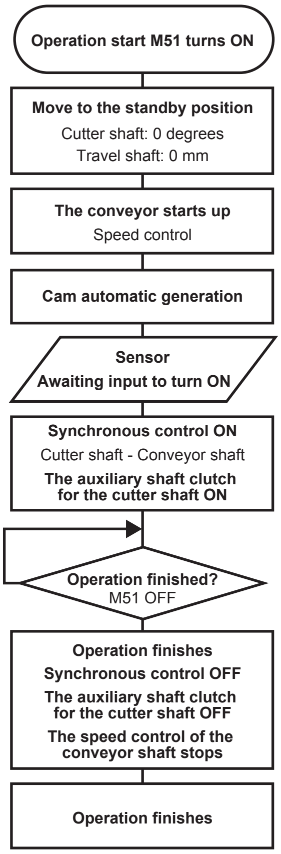
System

A sensor detects the white mark once for the first time on the conveyor that travels at a constant speed. With reference to the detected white mark as a start point, the disc rotates to carry out the operation for the simulated cutting.

POINT

As for the "Cutting movement" where the disc rotates for simulated cutting, uses and learns "Synchronous control", "Clutch function" and "Cam automatic generation function".

<Control flow>



Synchronous control

- The cutting movement where the cutter shaft rotates.
  The axis rotation follows the automatically generated cam operation.

Clutch function

- The cutter shaft uses this function when it starts the cutting movement.

* The synchronous control and the clutch function turn on at the same time as the sensor detects the white mark for the first time. The ON status remains until the operation finishes.

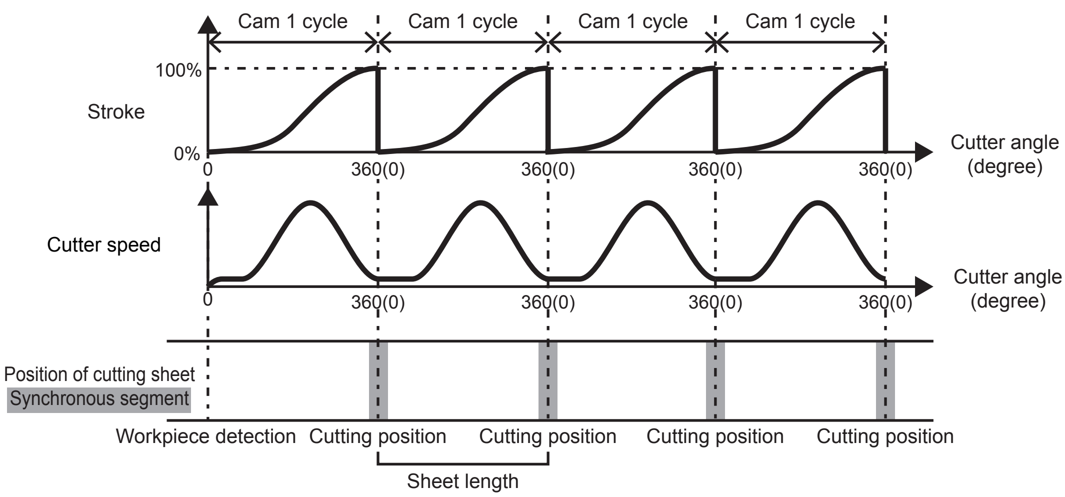
Cam automatic generation function

- The cutter shaft uses this function for the cutting movement.

<About cam automatic generation function>
The initial parameter settings are as follows.

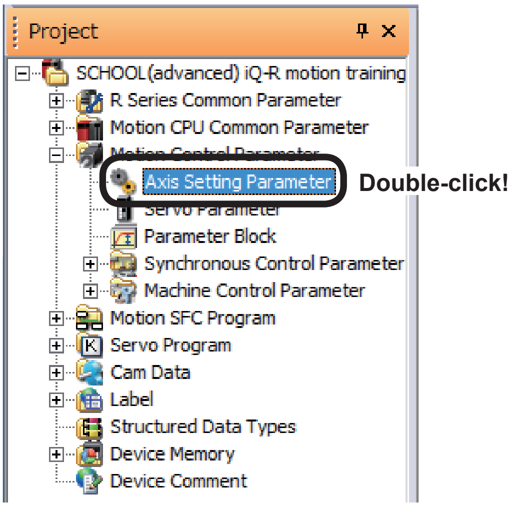
- Resolution: 512
- Automatic generation option: Acceleration and deceleration method ... Trapezoidal/synchronous axis length setting ... Diameter
- Acceleration rate over synchronous section: 100% (Reaches the same speed as the conveyor speed at the rate of 100%)
- Sheet length: 50.0 mm
- Sheet synchronous width: 10 mm
- Synchronous axis length: 80.0 mm (diameter)
- Synchronous position adjustment: 0 (Over the sheet center synchronous section)
- Acceleration/deceleration width: 10.0 mm
- Quantity of cutters: 1

<About the rotary cutter movement>
The rotary cutter rotates according to the automatically generated cam operation as shown in the figure below.

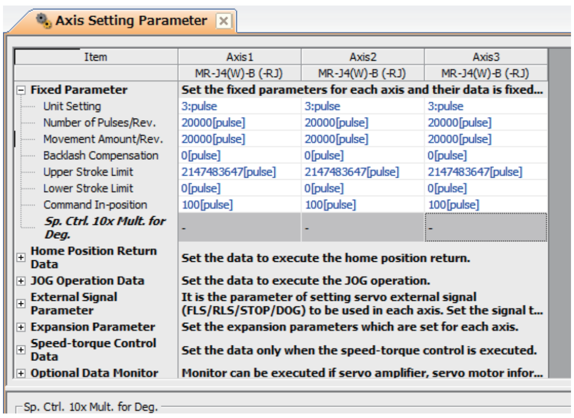


10.3 Servo Data Input Operation

Specify servo data settings when performing practical work (travel cutter and rotary cutter)



(1) Double-click [Motion Control Parameter] → [Axis Setting Parameter] in the project window.



Item	Axis1	Axis2	Axis3
	MR-J4(W)-B (-RJ)	MR-J4(W)-B (-RJ)	MR-J4(W)-B (-RJ)
Fixed Parameter	Set the fixed parameters for each axis and their data is fixed...		
Unit Setting	3:pulse	3:pulse	3:pulse
Number of Pulses/Rev.	20000[pulse]	20000[pulse]	20000[pulse]
Movement Amount/Rev.	20000[pulse]	20000[pulse]	20000[pulse]
Backlash Compensation	0[pulse]	0[pulse]	0[pulse]
Upper Stroke Limit	2147483647[pulse]	2147483647[pulse]	2147483647[pulse]
Lower Stroke Limit	0[pulse]	0[pulse]	0[pulse]
Command In-position	100[pulse]	100[pulse]	100[pulse]
Sp. Ctrl. 10x Mult. for Deg.	-	-	-
Home Position Return Data	Set the data to execute the home position return.		
JOG Operation Data	Set the data to execute the JOG operation.		
External Signal Parameter	It is the parameter of setting servo external signal (FLS/RLS/STOP/DOG) to be used in each axis. Set the signal t...		
Expansion Parameter	Set the expansion parameters which are set for each axis.		
Speed-torque Control Data	Set the data only when the speed-torque control is executed.		
Optional Data Monitor	Monitor can be executed if servo amplifier, servo motor infor...		

Sp. Ctrl. 10x Mult. for Deg.

(2) An Axis Setting Parameter window appears.

(3) Specify the content shown below for the Axis 1 to 3 Fixed Parameters.

Item	Axis1[ConveyorAxis]	Axis2[CutterAxis]	Axis3[RunningAxis]
	MR-J4(W)-B (-RJ)	MR-J4(W)-B (-RJ)	MR-J4(W)-B (-RJ)
Fixed Parameter	Set the fixed parameters for each axis and their data is fixed...		
Unit Setting	0:mm	2:degree	0:mm
Number of Pulses/Rev.	4194304[pulse]	4194304[pulse]	4194304[pulse]
Movement Amount/Rev.	110000.0[μm]	360.00000[degree]	8000.0[μm]
Backlash Compensation	0.0[μm]	0.00000[degree]	0.0[μm]
Upper Stroke Limit	0.0[μm]	0.00000[degree]	145000.0[μm]
Lower Stroke Limit	0.0[μm]	0.00000[degree]	-1000.0[μm]
Command In-position	10.0[μm]	0.00100[degree]	10.0[μm]
Sp. Ctrl. 10x Mult. for Deg.	-	0:Invalid	-

Go to next page

From previous page

(4) Specify the content shown below for the Axis 1 to 3 Home Position Return Data settings.

Item	Axis1[ConveyorAxis]	Axis2[CutterAxis]	Axis3[RunningAxis]
	MR-J4(W)-B (-RJ)	MR-J4(W)-B (-RJ)	MR-J4(W)-B (-RJ)
Home Position Return Data	**Set the data to execute the home position return.**		
HPR Direction	0:Reverse Direction	0:Reverse Direction	0:Reverse Direction
HPR Method	2:Data Set Method 1	0:Proximity Dog Method 1	0:Proximity Dog Method 1
Home Position Address	0.0[μm]	180.00000[degree]	0.0[μm]
HPR Speed	-	18000.000[degree/min]	600.00[mm/min]
Creep Speed	-	3600.000[degree/min]	250.00[mm/min]
Movement Amount After Dog	-	-	-
Parameter Block Setting	-	2	1
HPR Retry Function	-	0:Invalid	1:Valid
Dwell Time at HPR Retry	-	-	0[ms]
Home Position Shift Amount	-	0.00000[degree]	0.0[μm]
Speed Set at Home Pos. Shift	-	0:HPR Speed	0:HPR Speed
Torque Limit at Creep Speed	-	-	-
Operation for HPR Incompletion	1:Not Execute Servo Program	1:Not Execute Servo Program	1:Not Execute Servo Program
HPR Request Setting in Pulse Conversion Unit	-	-	-
Standby Time after Clear			

(5) Specify the content shown below for the Axis 1 to 3 JOG Operation Data settings.

Item	Axis1[ConveyorAxis]	Axis2[CutterAxis]	Axis3[RunningAxis]
	MR-J4(W)-B (-RJ)	MR-J4(W)-B (-RJ)	MR-J4(W)-B (-RJ)
JOG Operation Data	**Set the data to execute the JOG operation.**		
JOG Speed Limit Value	11000.00[mm/min]	36000.000[degree/min]	8000.00[mm/min]
Parameter Block Setting	1	2	3

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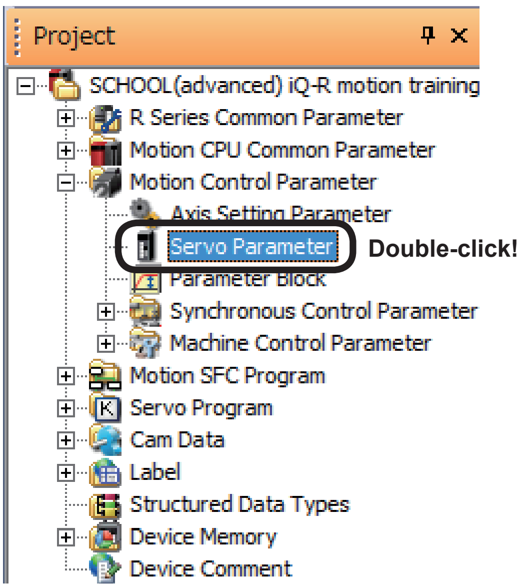
From previous page

(6) Specify the content shown below for the Axis 1 to 3 External Signal Parameters.

Item	Axis1[ConveyorAxis]	Axis2[CutterAxis]	Axis3[RunningAxis]
	MR-J4(W)-B (-RJ)	MR-J4(W)-B (-RJ)	MR-J4(W)-B (-RJ)
External Signal Parameter	**It is the parameter of setting servo external signal (FLS/RLS/STOP/DOG) to be used in each axis. Set the signal t...**		
FLS Signal	**Set the signal type and the signal/contact used as the upper ...**		
Signal Type	0:Invalid	0:Invalid	1:Amplifier Input
Device	-	-	-
Contact	-	-	1:Normally Closed Contact
RLS Signal	**Set the signal type and the signal/contact used as the lower ...**		
Signal Type	0:Invalid	0:Invalid	1:Amplifier Input
Device	-	-	-
Contact	-	-	1:Normally Closed Contact
STOP Signal	**Set the signal type and signal contact to be used as stop sign...**		
Signal Type	0:Invalid	0:Invalid	0:Invalid
Device	-	-	-
Contact	-	-	-
DOG Signal	**Set the signal type and signal contact to be used as the proxi...**		
Signal Type	0:Invalid	1:Amplifier Input	1:Amplifier Input
Device	-	-	-
Contact	-	0:Normally Open Contact	1:Normally Closed Contact
Precision	-	0:General	0:General

(7) Double-click [Motion Control Parameter] → [Servo Parameter] in the Project window.



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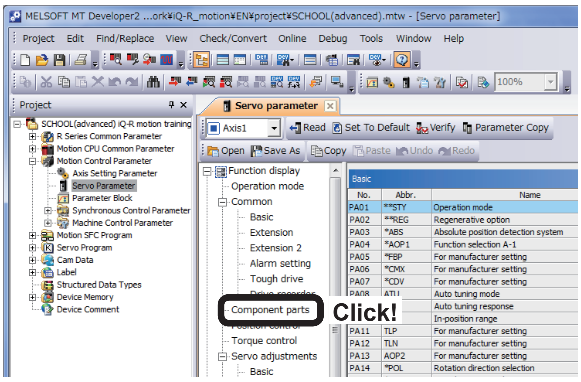
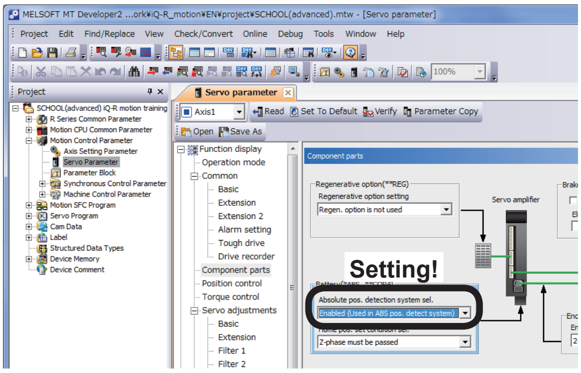
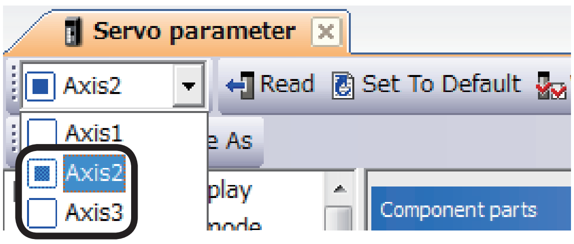


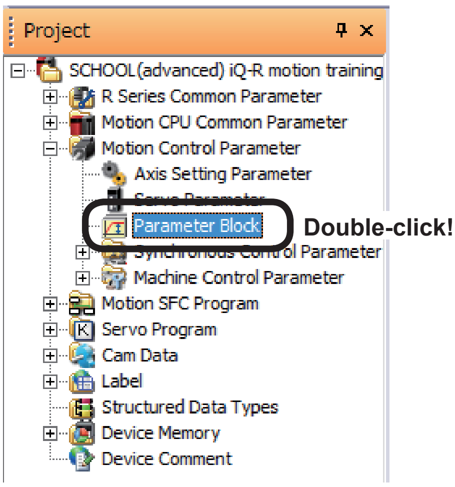
(8) A Servo Parameter Setting window appears. Click [Function display] → [Component parts] in the Parameter Setting screen display selection tree, and then specify the following settings.



(9) Absolute pos. detection system sel.
: Enabled (Used in ABS pos. detect system)



(10) Switch to Axis 2 and 3, and set the parameter settings in a manner similar to Axis 1.



(11) Double-click [Motion Control Parameter] → [Parameter Block] in the Project window.

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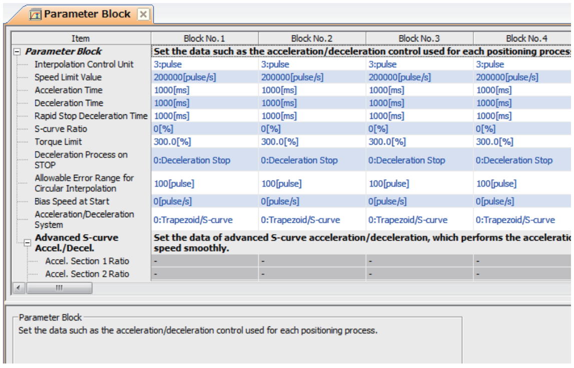
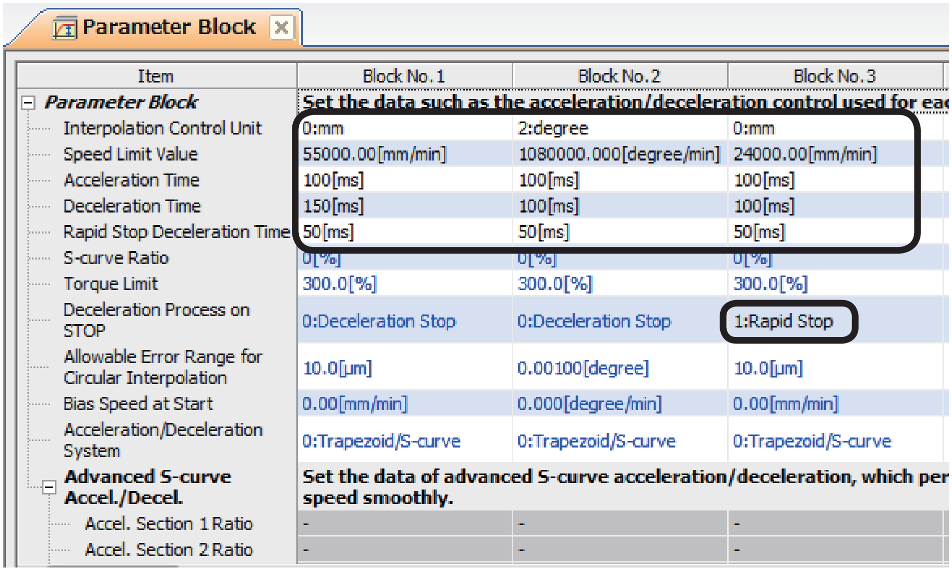
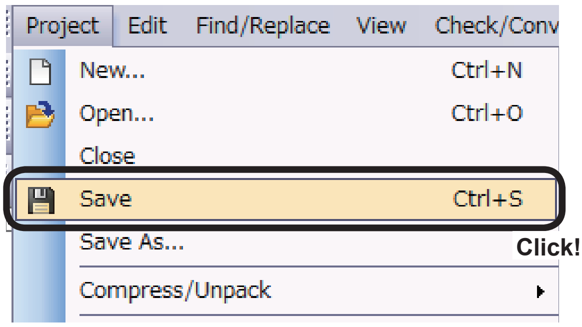


(12) The Parameter Block Setting screen appears.

(13) Specify Parameter Blocks No. 1, 2 and 3 settings as shown below.

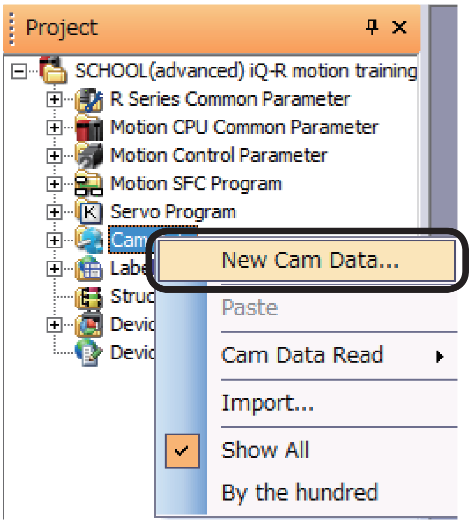




(14) When all servo data settings are complete, click [Save] on the [Project] menu.

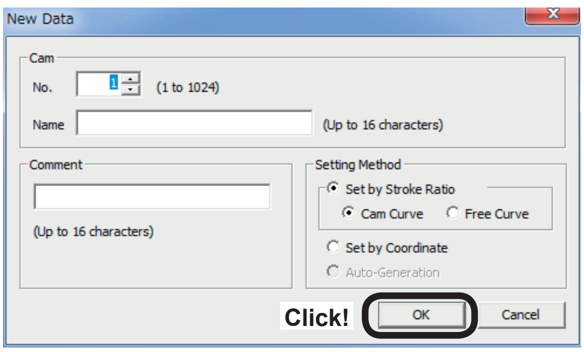
Servo data settings are now complete.

10.4 Cam Data Creation



Click!

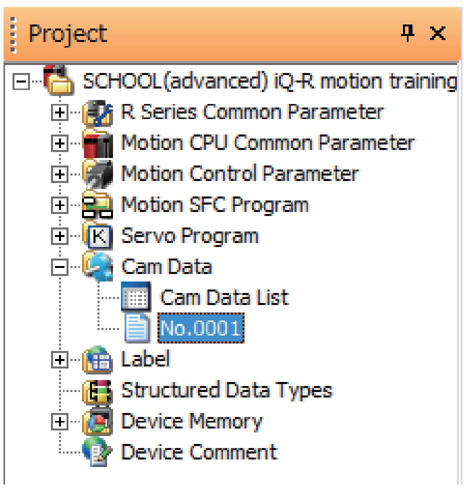
(1) Right-click "Cam Data" in the Project window, and then click "New Cam Data…".



A New Data screen appears.

- Set the cam No.
- At the "Setting Method", select "Set by Stroke Ratio" and select "Cam Curve".

After finishing the above settings, click on the OK button.



(2) Cam data is created, and a setting screen appears.

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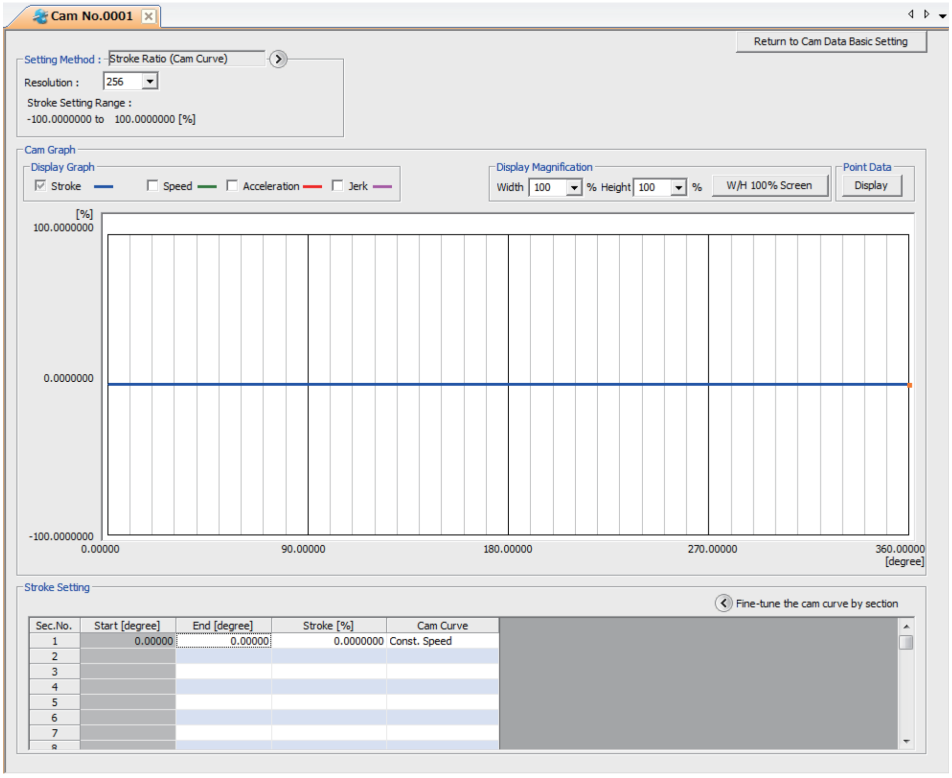


(3) Click on ">"at "Setting method" to display "Length per cycle setting" and "Stroke amount setting". Set them as shown on the right.

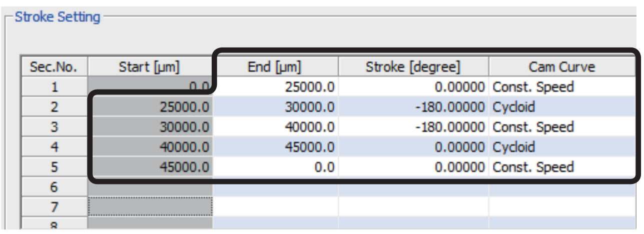
Len. per Cycle Setting

Unit: mm Len. per Cycle: 70000.0 [μm]

Stroke Amount Setting

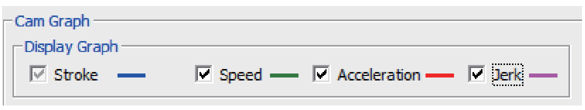
Unit: degree Stroke Amount: 360 [degree]

(4) Specify the setting screen stroke settings as follows.


Stroke Setting

Sec.No.	Start [μm]	End [μm]	Stroke [degree]	Cam Curve
1	0.0	25000.0	0.00000	Const. Speed
2	25000.0	30000.0	-180.00000	Cycloid
3	30000.0	40000.0	-180.00000	Const. Speed
4	40000.0	45000.0	0.00000	Cycloid
5	45000.0	0.0	0.00000	Const. Speed
6				
7				

Setting!



(5) Change the "Display Graph" check box selections to change the graph display in order to view the Stroke, Speed, Acceleration, and Jerk relative to the movement position in a chart.

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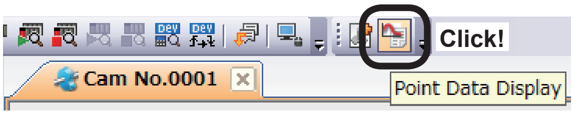
From previous page



(6) To view the stroke ratio, speed, acceleration, and jerk relative to the movement position in numerical values, click the Point Data Display tool button.

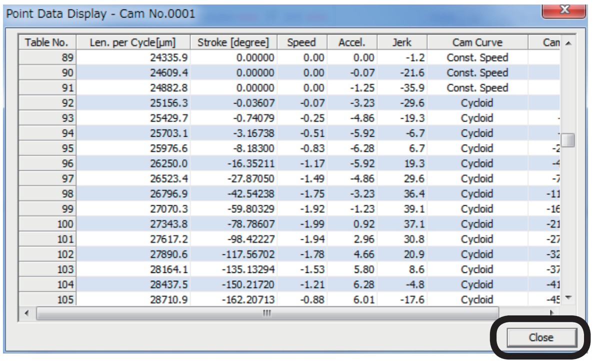
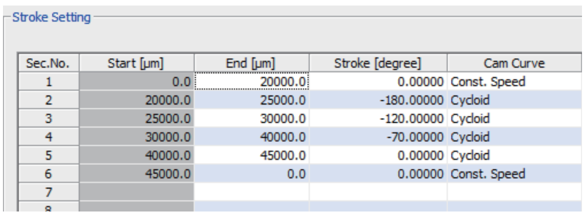


Table No.	Len. per Cycle[µm]	Stroke [degree]	Speed	Accel.	Jerk	Cam Curve	Can
89	24335.9	0.00000	0.00	0.00	-1.2	Const. Speed	
90	24609.4	0.00000	0.00	-0.07	-21.6	Const. Speed	
91	24882.8	0.00000	0.00	-1.25	-35.9	Const. Speed	
92	25156.3	-0.03607	-0.07	-3.23	-29.6	Cycloid	
93	25429.7	-0.74079	-0.25	-4.86	-19.3	Cycloid	-
94	25703.1	-3.16738	-0.51	-5.92	-6.7	Cycloid	-
95	25976.6	-8.18300	-0.83	-6.28	6.7	Cycloid	-2
96	26250.0	-16.35211	-1.17	-5.92	19.3	Cycloid	-4
97	26523.4	-27.87050	-1.49	-4.86	29.6	Cycloid	-7
98	26796.9	-42.54238	-1.75	-3.23	36.4	Cycloid	-11
99	27070.3	-59.80329	-1.92	-1.23	39.1	Cycloid	-16
100	27343.8	-78.78607	-1.99	0.92	37.1	Cycloid	-21
101	27617.2	-98.42227	-1.94	2.96	30.8	Cycloid	-27
102	27890.6	-117.56702	-1.78	4.66	20.9	Cycloid	-32
103	28164.1	-135.13294	-1.53	5.80	8.6	Cycloid	-37
104	28437.5	-150.21720	-1.21	6.28	-4.8	Cycloid	-41
105	28710.9	-162.20713	-0.88	6.01	-17.6	Cycloid	-45

There are tables from No. 1 to 256.
Scroll to view all tables.

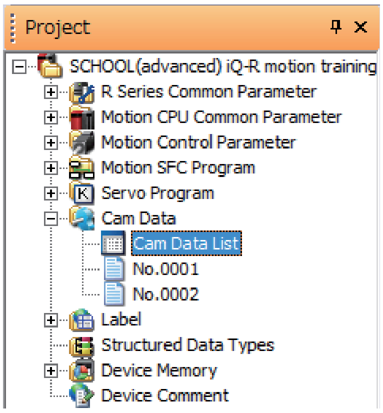
After checking, click the Close button.

Click!



Sec.No.	Start [µm]	End [µm]	Stroke [degree]	Cam Curve
1	0.0	20000.0	0.00000	Const. Speed
2	20000.0	25000.0	-180.00000	Cycloid
3	25000.0	30000.0	-120.00000	Cycloid
4	30000.0	40000.0	-70.00000	Cycloid
5	40000.0	45000.0	0.00000	Cycloid
6	45000.0	0.0	0.00000	Const. Speed
7				

(7) Create cam data for cam No. 0002 using the same procedure as that for cam No. 0001. Specify the setting screen stroke settings shown on the left.



(8) Cam data creation is now complete.

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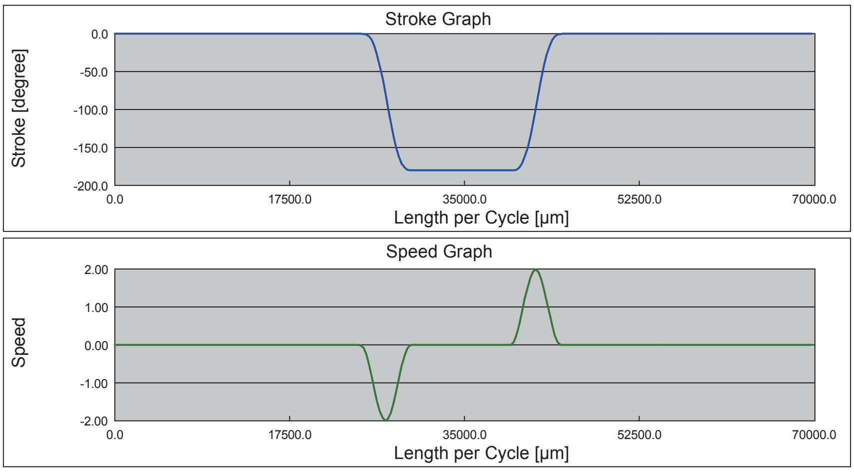
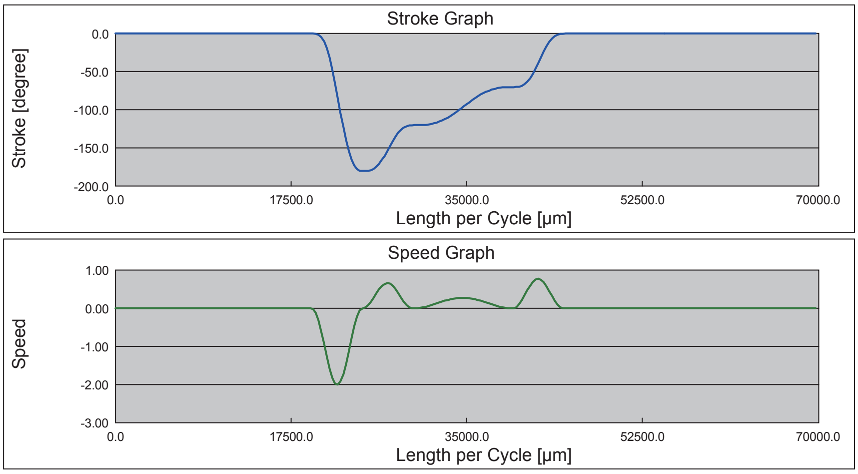
Cam No. 1



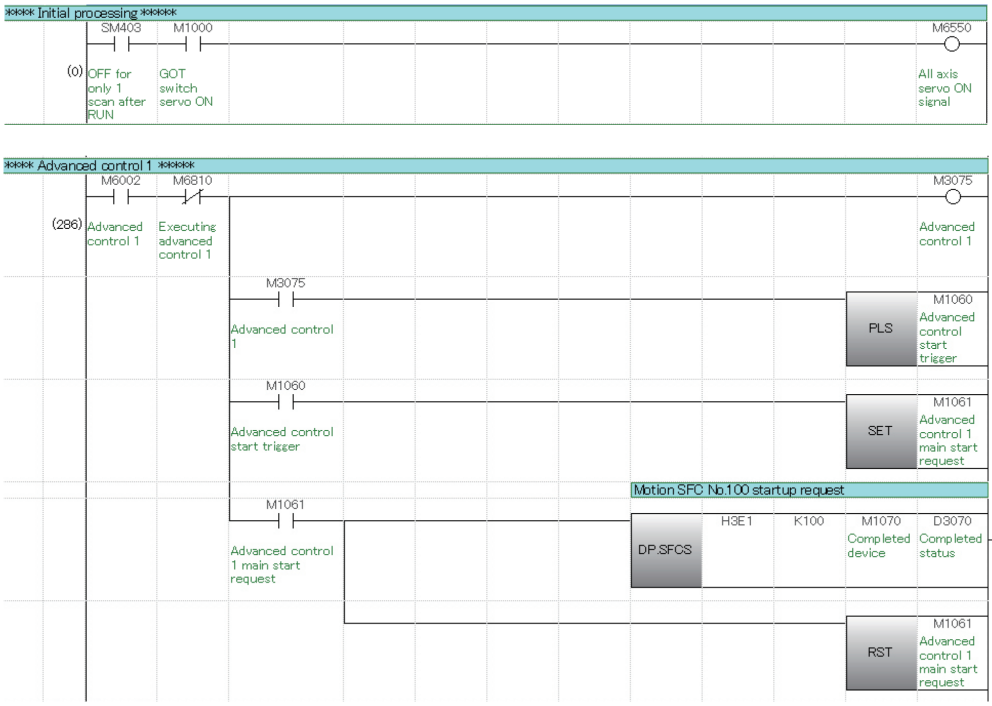
Cam No. 2



10.5 Advanced Synchronous Control Programs

10.5.1 Advanced synchronous control 1: Travel cutter program

The sequence program and Motion SFC programs used with advanced synchronous control 1 are shown in the following table.

<table>
<tr><th>Normal execution</th><th>Startup with sequence program</th></tr>
<tr><td>


</td><td>→[Advanced sync 1]
Motion SFC program No. 100</td></tr>
</table>

No.	Program name	Automatic start	END operation	No. of transitions	Execution timing
001	All ax servo ON	Yes	-	-	Normal
100	Advanced sync 1	No	-	-	Normal
110	Clutch	No	-	-	Normal
120	Speed sync	No	-	-	Normal
230	ConveyorSpd Chg1	No	-	-	Normal
255	Disp SpdWaveform	Yes	-	-	Normal

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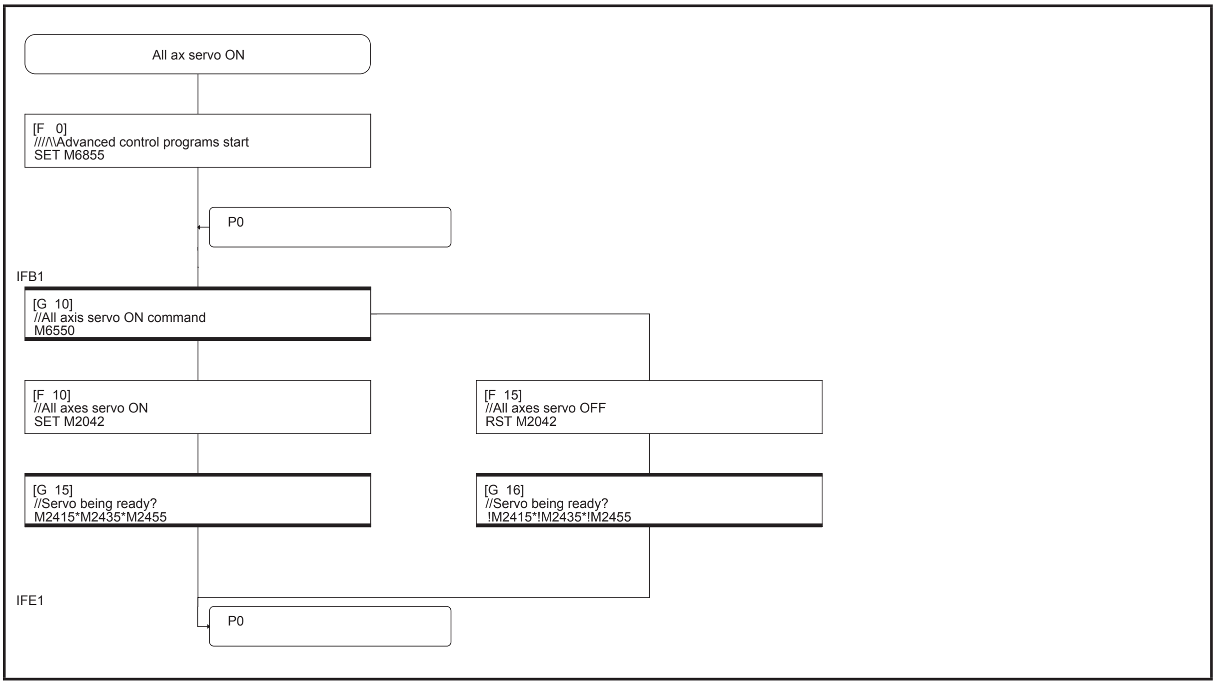
[All ax servo ON] program No. 001 Start up automatically



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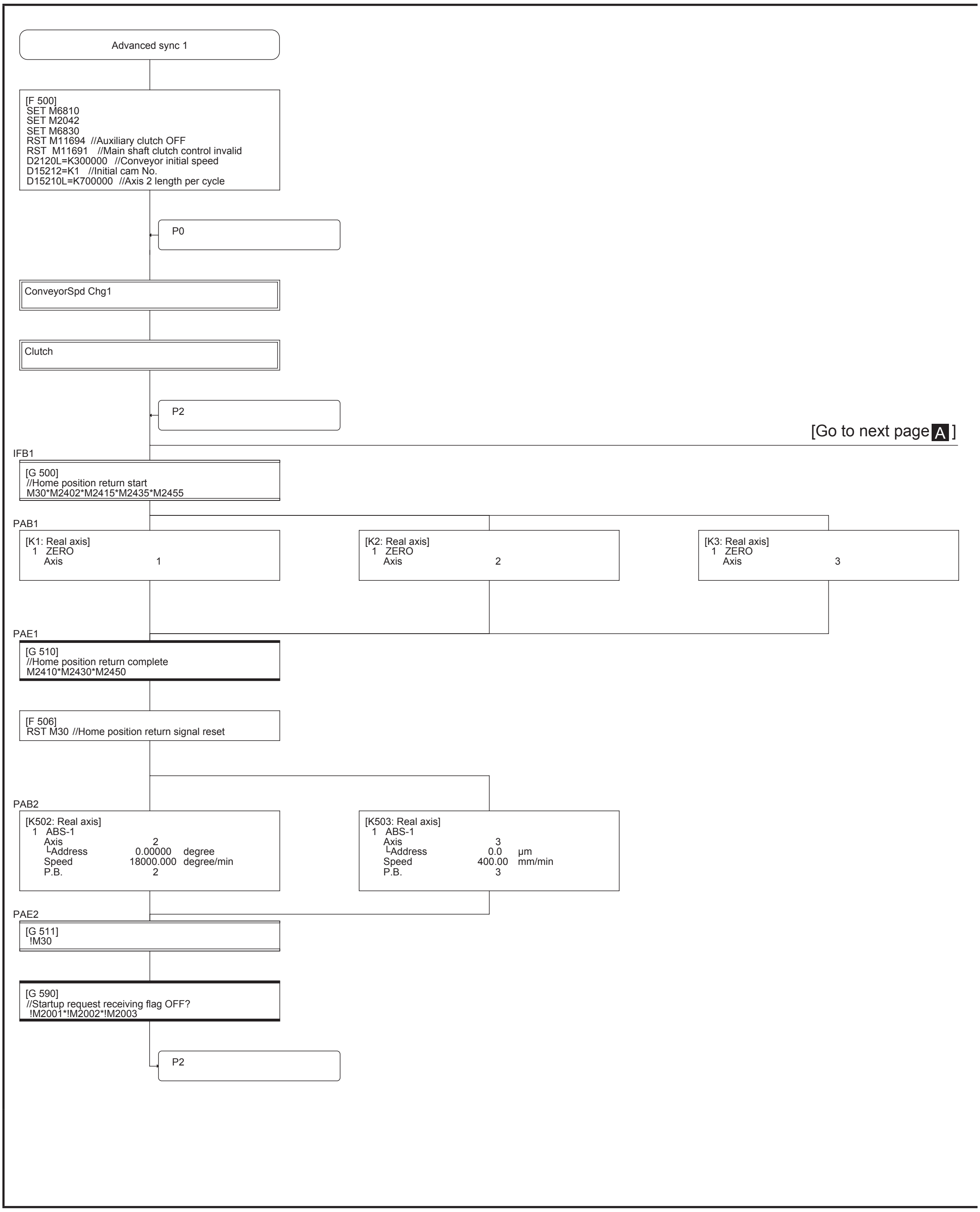
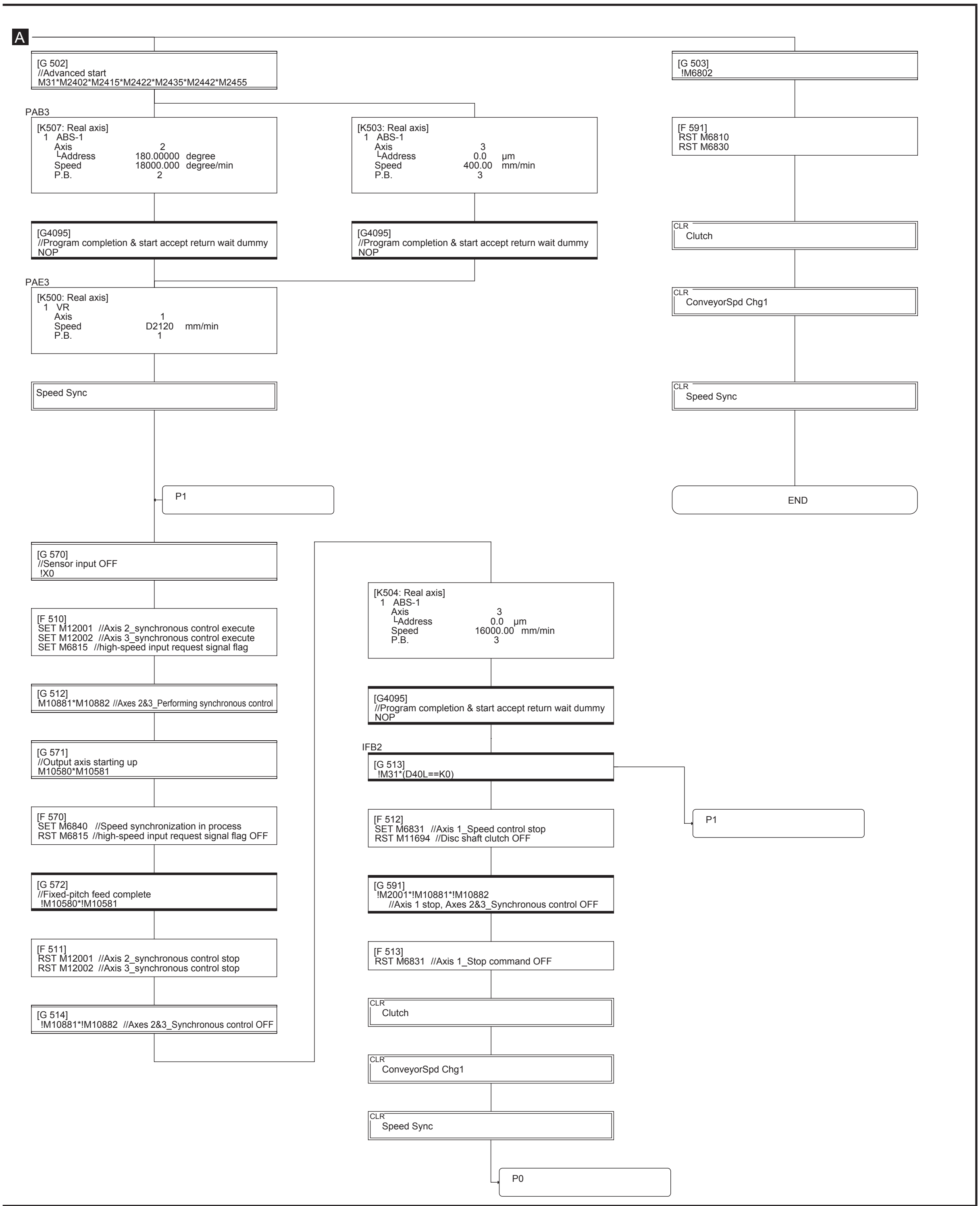
Start program from sequence program
[Advanced sync 1] program No. 100

Started with sequence program



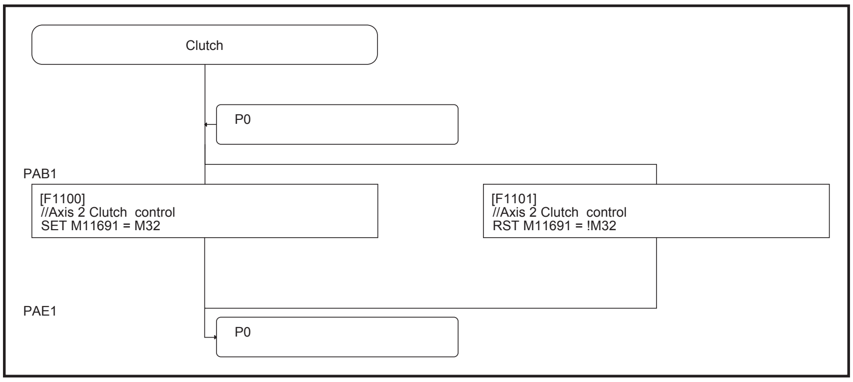
Go to next page

From previous page



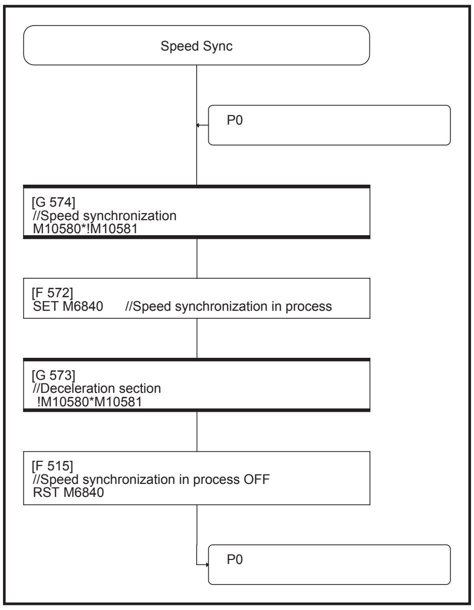
Start program from Motion SFC program
[Clutch] program No. 110 (This program turns ON/OFF the cutter shaft clutch).

Started with No. 100



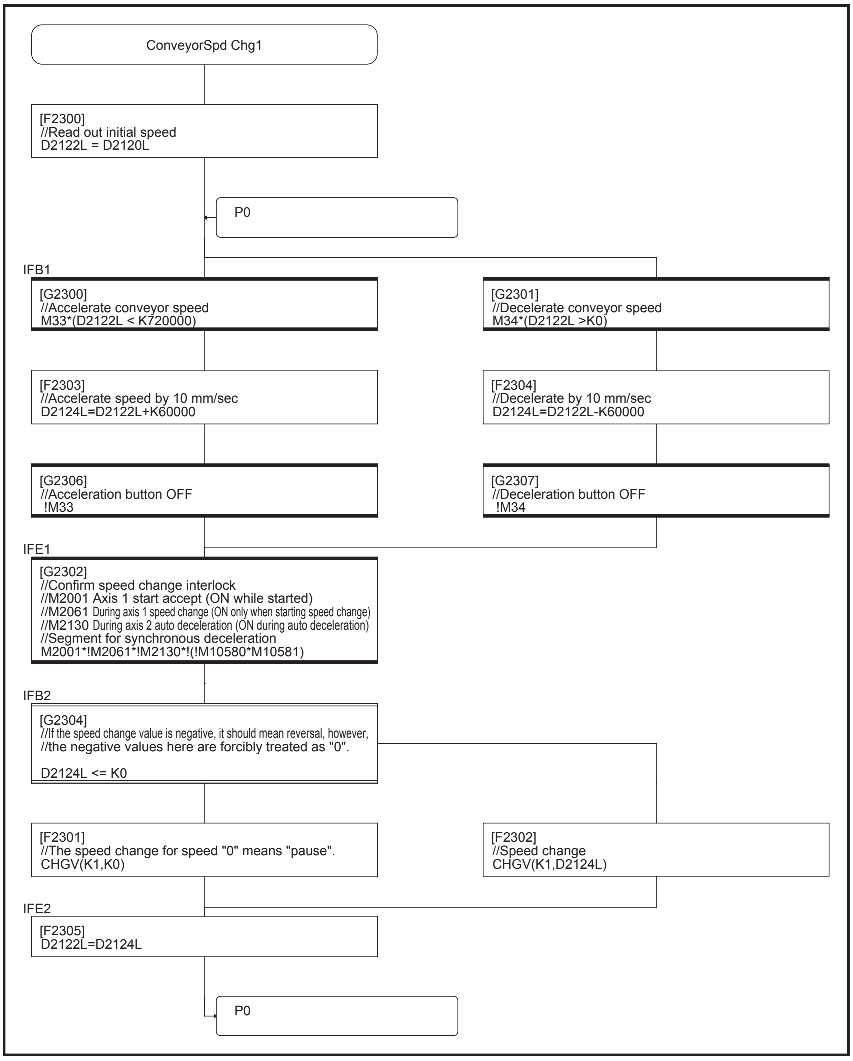
Start program from Motion SFC program
[Speed Sync] program No. 120 (This program carries out the cutter shaft speed synchronization)

Started with No. 100

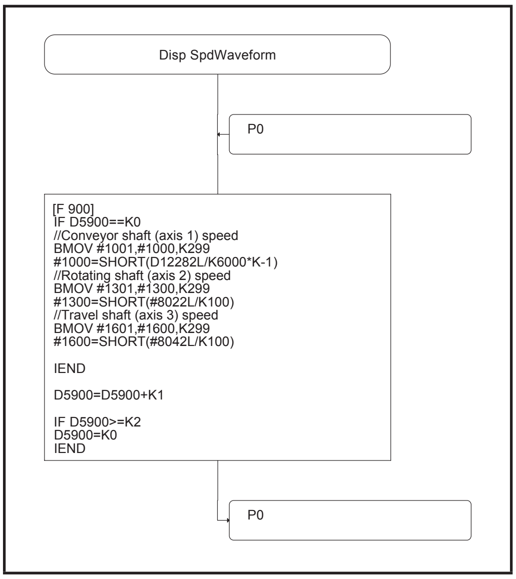


Start program from Motion SFC program
[ConveyorSpd Chg1] program No. 230 (This program changes the servo input axis speed)

Started with No. 100

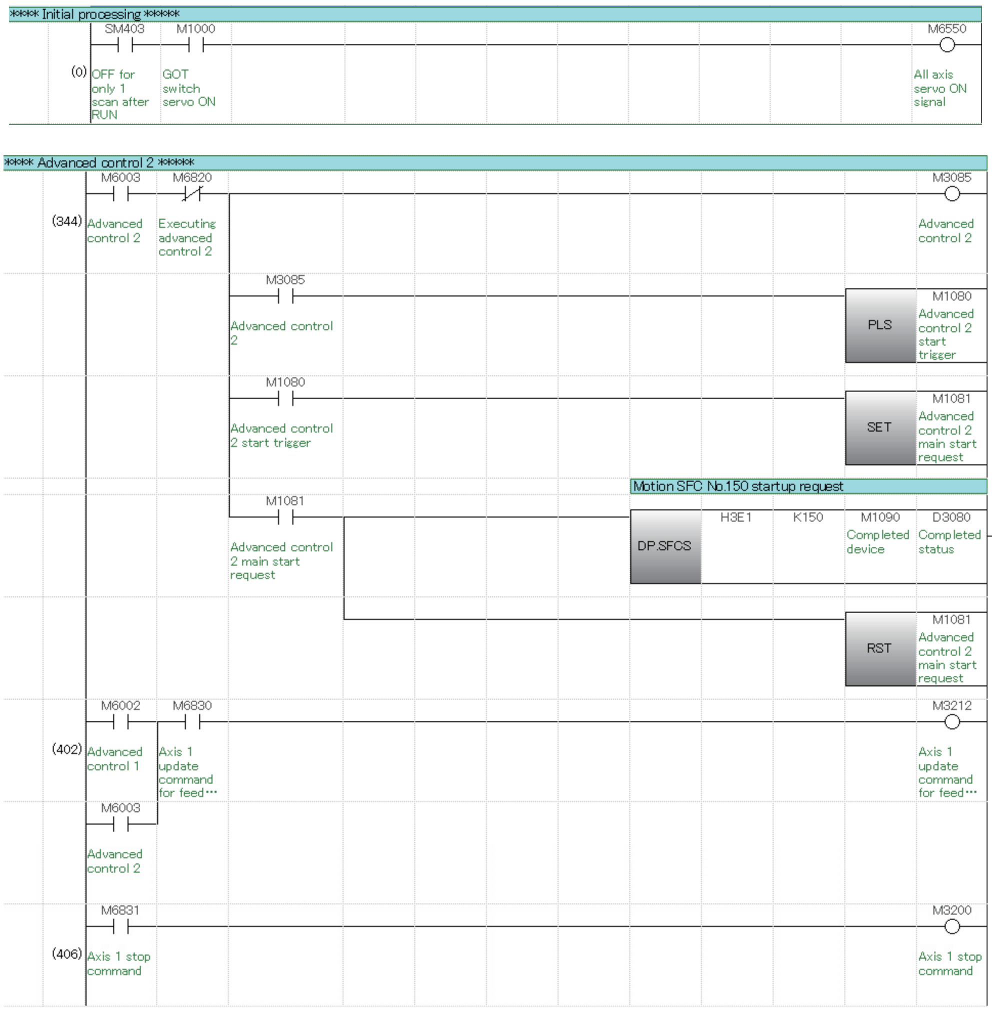


[Disp SpdWaveform] program No. 255
Start up automatically (This program displays graphs on the demonstration machine operation panel)



10.5.2 Advanced synchronous control 2: Rotary cutter program

The sequence program and Motion SFC programs used with advanced synchronous control 2 are shown in the following table.

Normal execution	Started with sequence program
	[Advanced sync 2] Motion SFC program No. 150

No.	Program name	Automatic start	END operation	No. of transitions	Execution timing
001	All ax servo ON	Yes	-	-	Normal
150	Advanced sync 2	No	-	-	Normal
240	ConveyorSpd Chg2	No	-	-	Normal
250	CamAuto-generate	No	-	-	Normal
255	Disp SpdWaveform	Yes	-	-	Normal

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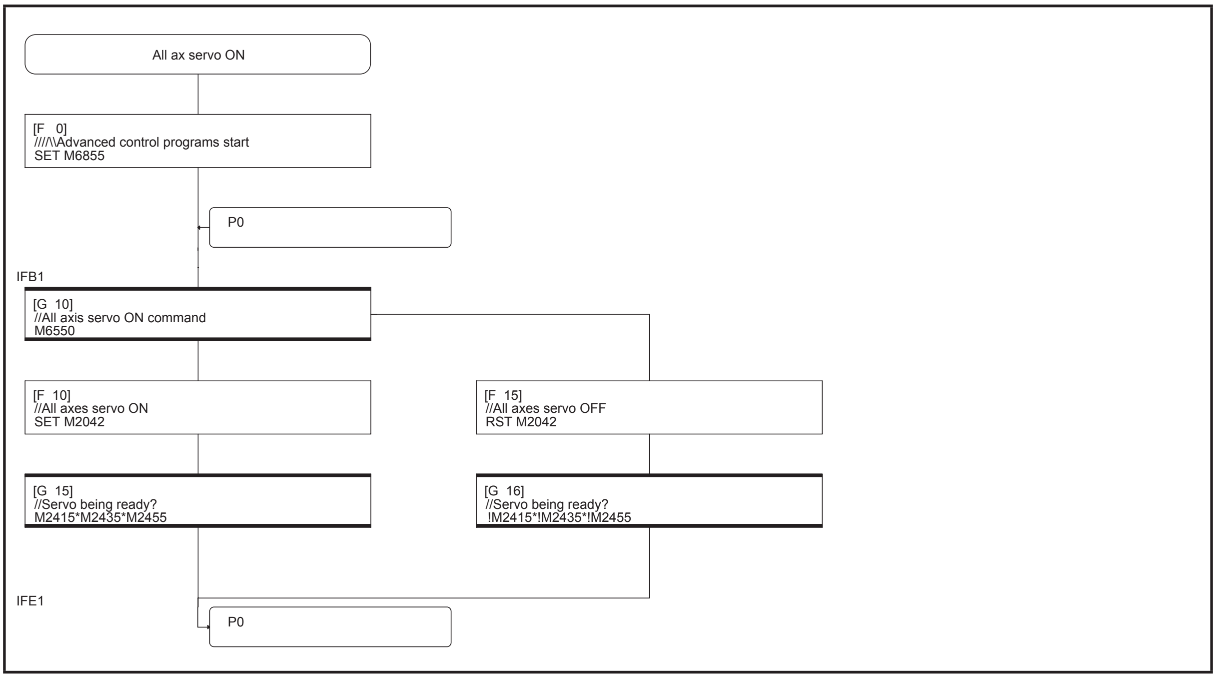
[All ax servo ON] program No. 001 Start up automatically



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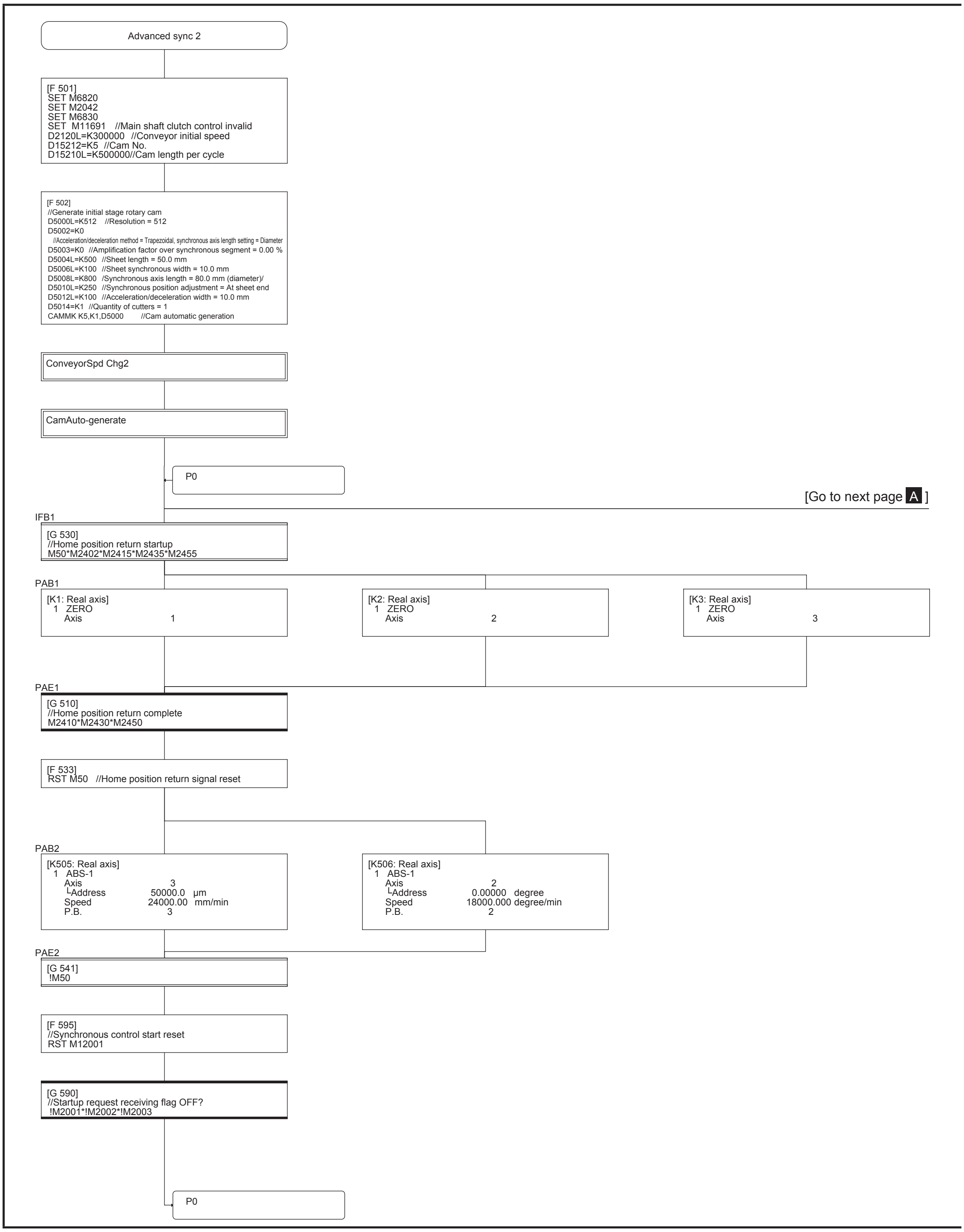
Start program from sequence program
[Advanced sync 2] program No. 150

Started with sequence program



A

[G 532]
//Advanced start
M51*M2402*M2415*M2422*M2435*M2442*M2455

PAB3

[K506: Real axis]
1 ABS-1
Axis 2
└Address 0.00000 degree
Speed 18000.000 degree/min
P.B. 2

[K505: Real axis]
1 ABS-1
Axis 3
└Address 50000.0 μm
Speed 24000.00 mm/min
P.B. 3

[G4095]
//Program completion & start accept return wait dummy
NOP

[G4095]
//Program completion & start accept return wait dummy
NOP

PAE3

[K500: Real axis]
1 VR
Axis 1
Speed D2120 mm/min
P.B. 1

[G 575]
//Sensor input ON
X0

[F 530]
SET M12001 //Axis 2_synchronous control execute

[G 542]
M10881 //Axis 2_Performing synchronous control

[F 571]
//Disc shaft auxiliary clutch ON
SET M11694

[G 543]
!M51

[F 512]
SET M6831 //Axis 1_Speed control stop
RST M11694 //Disc shaft clutch OFF

[F 531]
RST M12001 //Axis 2_synchronous control stop

[G 514]
!M10881*!M10882 //Axes 2&3_Synchronous control OFF

[G 592]
!M2001*!M10881 //Axis 1 stop, Axis 2_Synchronous control OFF

[F 513]
RST M6831 //Axis 1_Stop command OFF

P0

[G 533]
!M6803

[F 592]
RST M6820
RST M6830

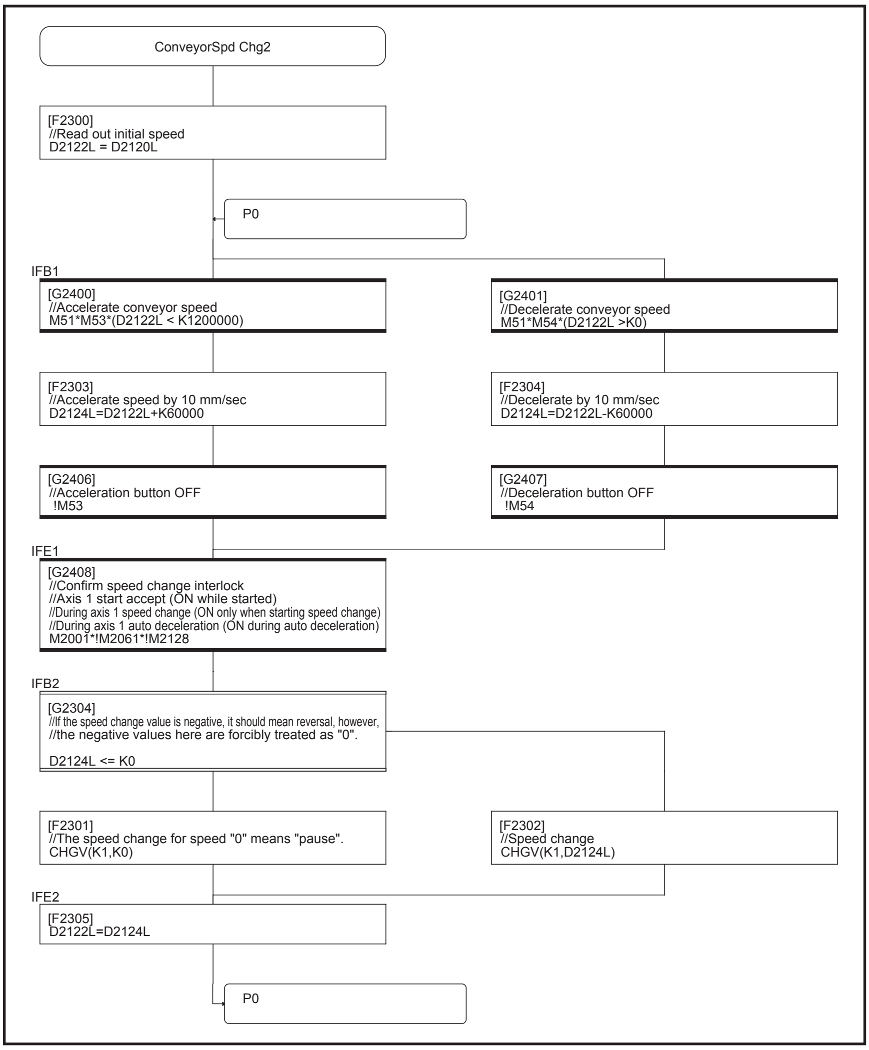
CLR
ConveyorSpd Chg2

CLR
CamAuto-generate

END

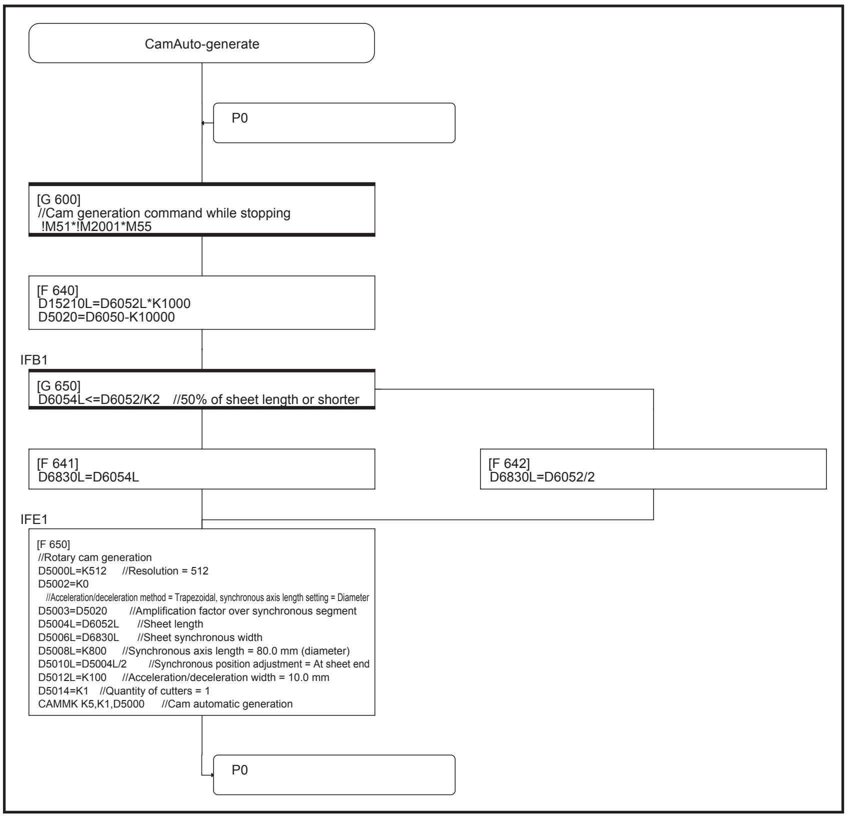
Start program from Motion SFC program
[ConveyorSpd Chg2] program No. 240 (This program changes the conveyor shaft speed)

Started with No. 150

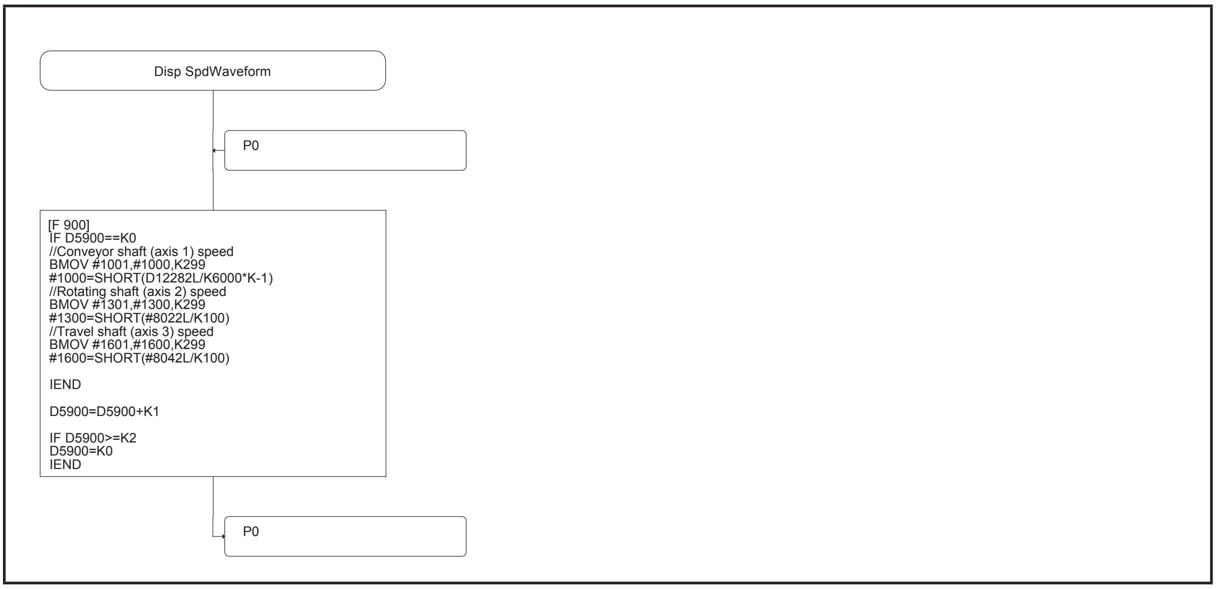


Start program from Motion SFC program
[CamAuto-generate] program No. 250 (This program automatically generates a cutter shaft cam)

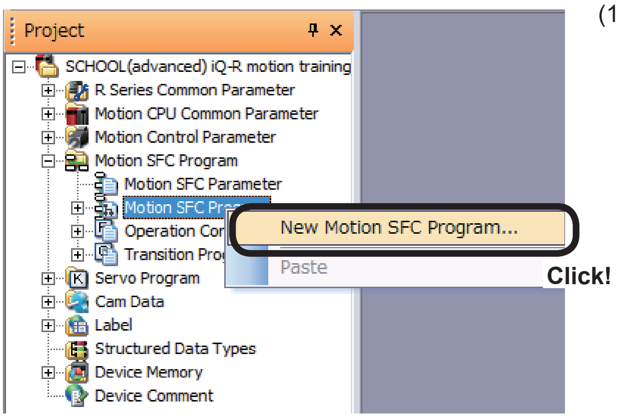
Started with No. 150



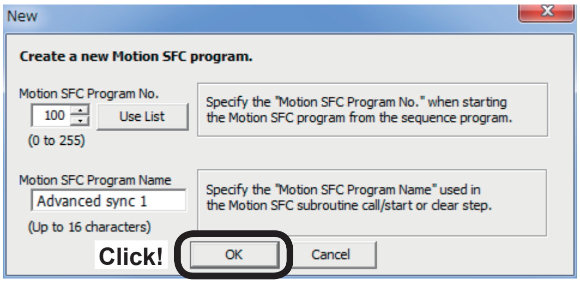
[Disp SpdWaveform] program No. 255
Start up automatically (This program displays graphs on the demonstration machine operation panel)



10.5.3 Creating new advanced synchronous control Motion SFC programs

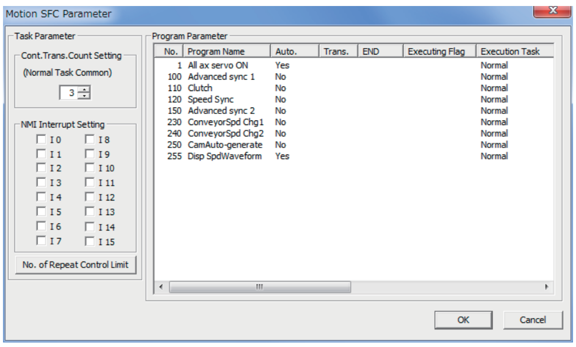


(1) Right-click [Motion SFC Program] → [Motion SFC Program] in the Project window, and then click "New Motion SFC Program…".



(2) A New dialog box appears. Set the program No. for the Motion SFC program being created. Enter "100" for the "Motion SFC Program No.", and "Advanced sync 1" for the "Motion SFC Program Name".

(3) Click the OK button after entering.



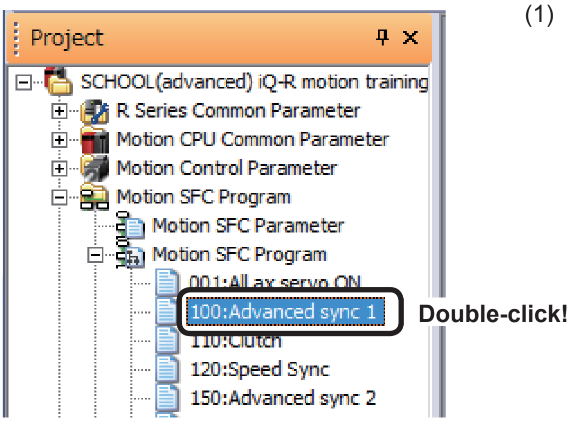
(4) The set Motion SFC program appears in a list of "Motion SFC Parameter".
Back to step (1), and create the Motion program that looks like as follows.

No.	Program name
001	All ax servo ON
100	Advanced sync 1
110	Clutch
120	Speed sync
150	Advanced sync 2
230	ConveyorSpd Chg1
240	ConveyorSpd Chg2
250	CamAuto-generate
255	Disp SpdWaveform

Motion SFC programs other than No. 100 created here will not be described in detail. Refer to the section on motion SFC programs for operation described later to create.

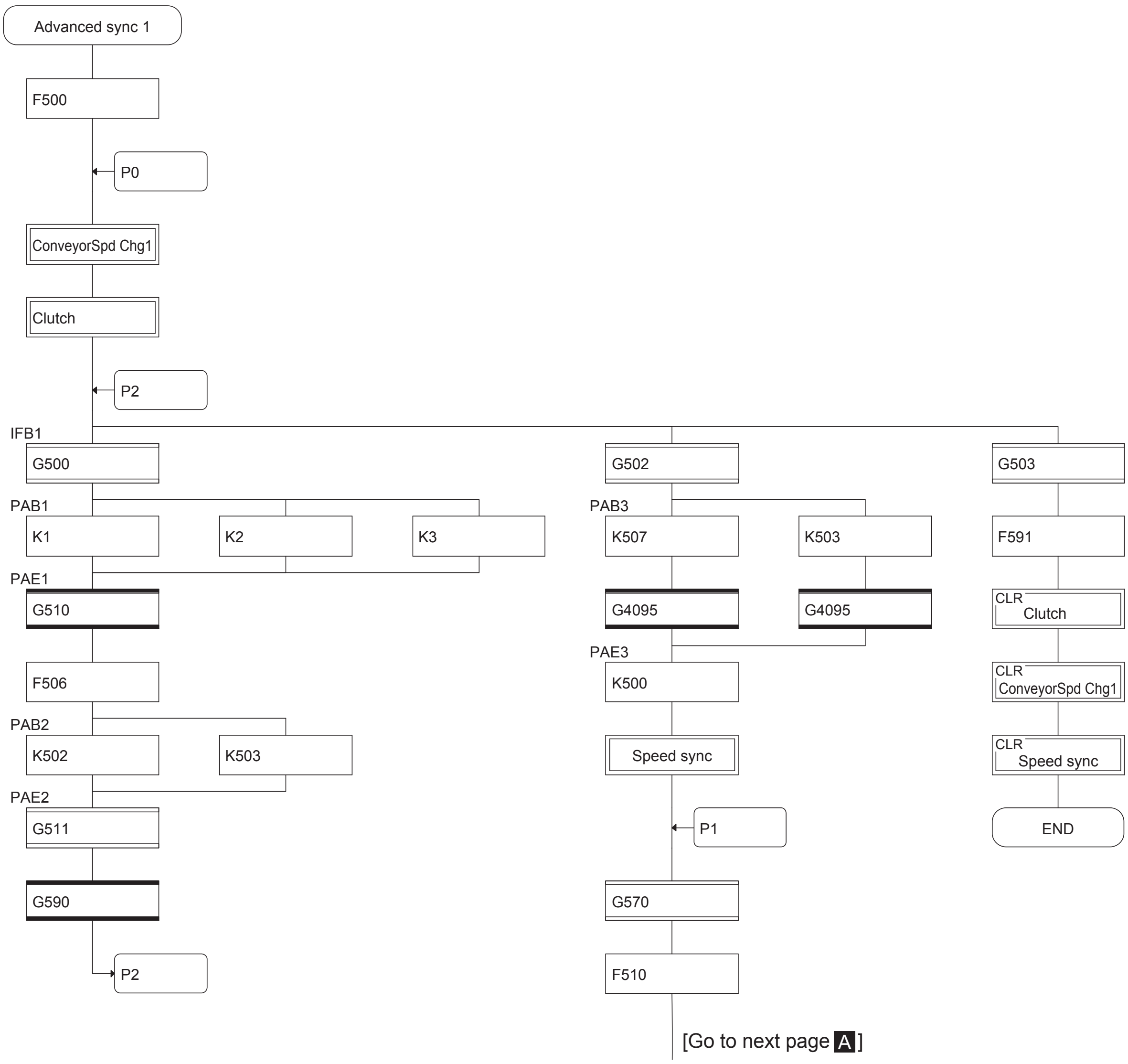
10.5.4 Entering motion control steps for advanced synchronous control

Sets motion control steps for advanced synchronous control.



(1) Create a servo program Motion SFC program. Double-click "100: Advanced sync 1" from the [Motion SFC Program] in the Project window.

(2) Create the SFC diagram shown below.



[Go to next page A]

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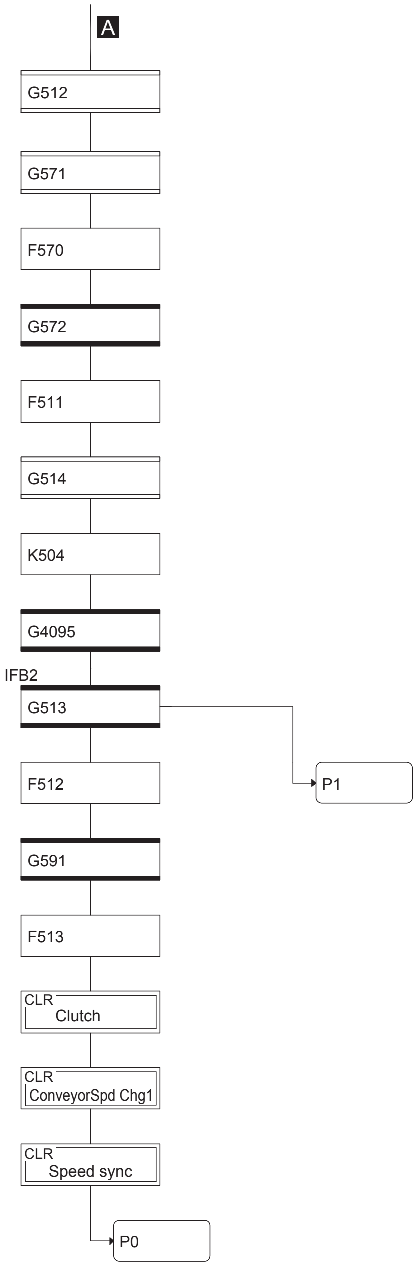

(3) Set the following transition programs.

[G500]	//Home position return start M30*M2402*M2415*M2435*M2455
[G502]	//Advanced start M31*M2402*M2415*M2422*M2435* M2442*M2435
[G503]	!M6802
[G510]	//Home position return complete M2410*M2430*M2450
[G511]	!M30
[G512]	M10881*M10882 //Axis 2&3_Performing synchronous control
[G514]	!M10881*!M10882 //Axis 2&3_Synchronous control OFF
[G570]	//Sensor input OFF !X3
[G571]	//Output axis starting up M10580*M10581
[G590]	//Startup request receiving flag OFF? !M2001*!M2002*!M2003
[G591]	!M2001*!M10881*!M10882 //Axis 1 stop, Axis 2&3_Synchronous control OFF
[G4095]	//Program completion & start accept return wait NOP

[F500]	SET M6810
	SET M2042
	SET M6830
	RST M11694 //Auxiliary clutch OFF
	RST M11691 //Main shaft clutch control invalid
	D2120L=K300000 //Conveyor initial speed
	D15212=K1 //Initial cam No.
	D15210L=K700000 //Axis 2 length per cycle

[F510]	SET M12001
	//Axis 2_synchronous control execute
	SET M12002
	//Axis 3_synchronous control execute
	SET M6815
	//High-speed input request signal flag

[F511]	RST M12001
	//Axis 2_synchronous control stop
	RST M12002
	//Axis 3_synchronous control stop

[F512]	SET M6831 //Axis 1_Speed control stop RST M11694 //Disc shaft clutch OFF
[F513]	RST M6831//Axis 1_Stop command OFF
[F590]	//Synchronous control start reset RST M12001 RST M12002
[F591]	RST M6810

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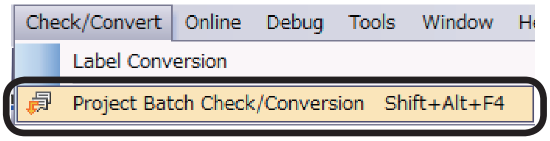
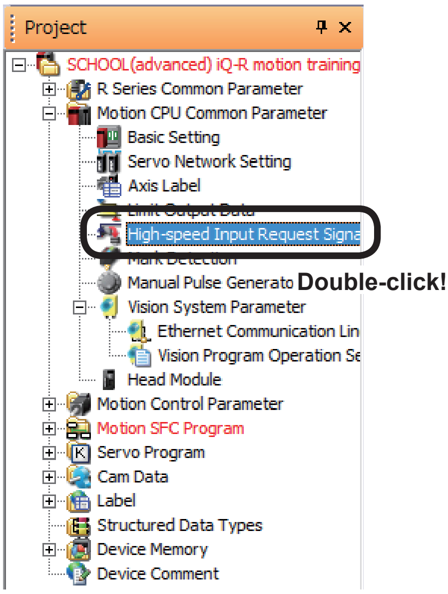
(4) Create and edit programs 001, 110, 120, 150, 230, 240, 250, and 255 in a similar manner. (Refer to the Section "SFC program list" that will come up later.)



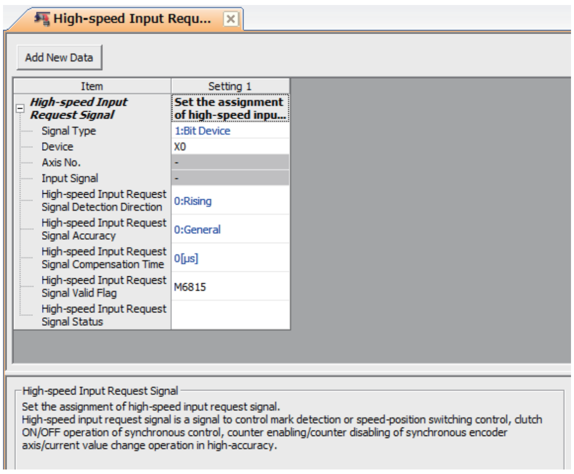
Click!

(5) Batch convert created SFC diagrams to Motion SFC programs.
Click [Project Batch Check/Conversion] on the [Check/Convert] menu.

10.6 Editing High-speed Input Request Signal Parameters



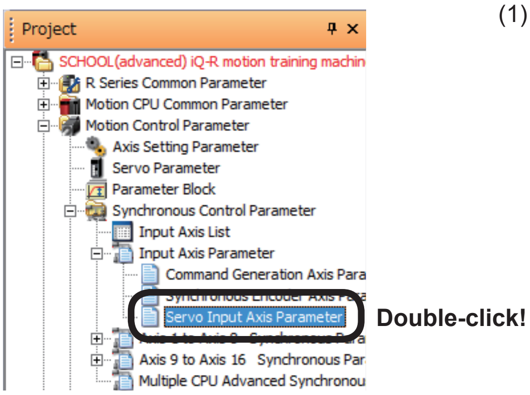
(1) Double-click [Motion CPU Common Parameter] → [High-speed Input Request Signal] in the Project window.



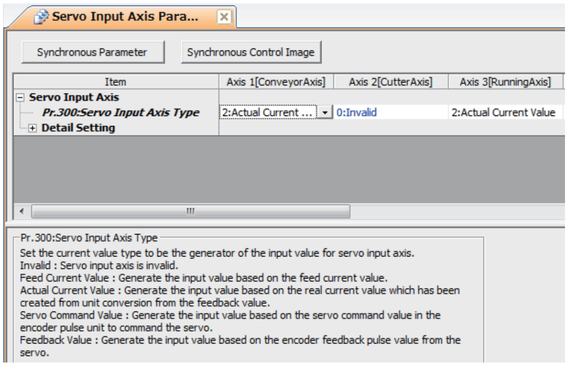
(2) A High-speed Input Request Signal Parameter dialog box appears.
Click the Add New Data button. Define the parameters in setting 1 as follows.

Device	X0
High-speed Input Request Signal Valid Flag	M6815

10.7 Editing Servo Input Axis Parameters



(1) Select [Motion Control Parameter] → [Synchronous Control Parameter] → [Input Axis Parameter] in the Project window, and then double-click [Servo Input Axis Parameter].

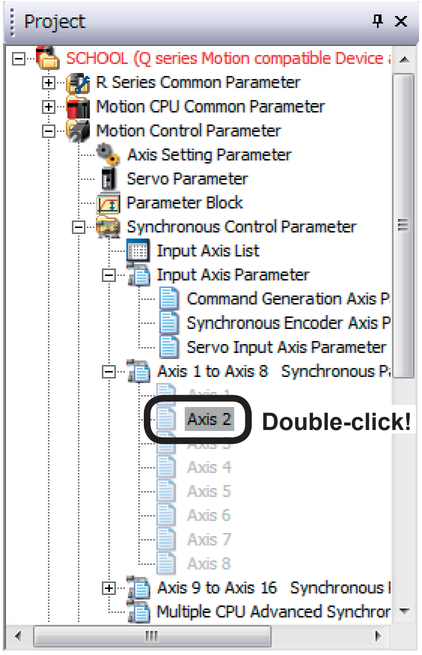


(2) A Servo Input Axis Parameter dialog box appears. Specify the following settings for axis 1 and 3.

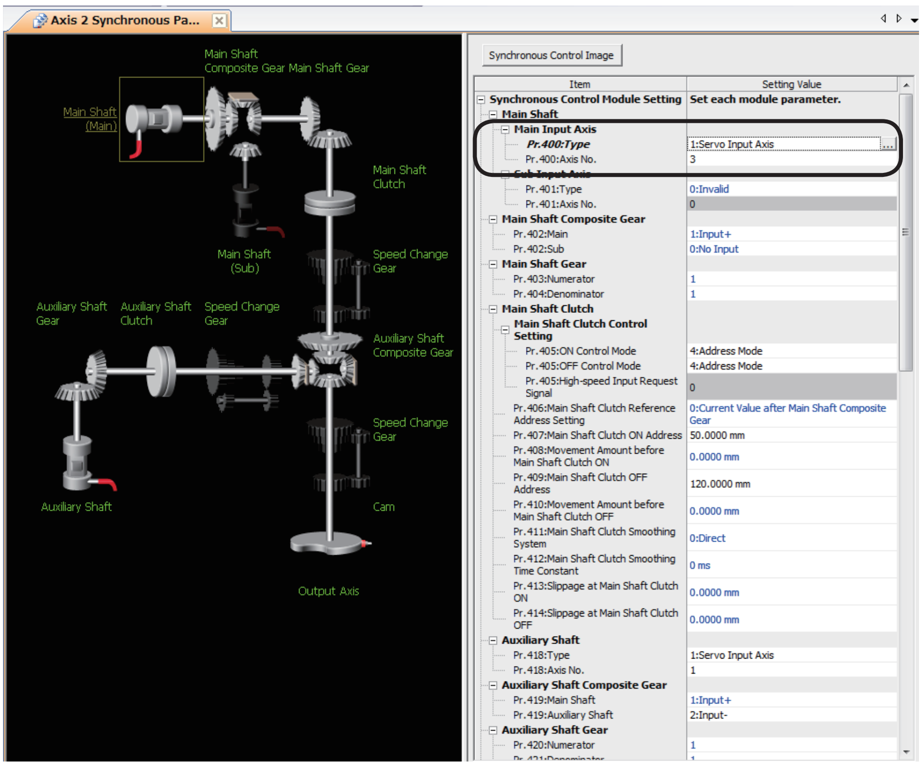
Servo Input Axis Type	2: Actual current value

10.8 Editing Synchronous Control Parameters

(1) Select [Motion Control Parameter] → [Synchronous Control Parameter] → [Axis 1 to Axis 8 Synchronous Parameter] in the Project window, and then double-click [Axis 2].



(2) An Axis 2 Synchronous Parameter dialog box appears. Set the "Type" and "Axis No." of the "Main Input Axis" as follows.



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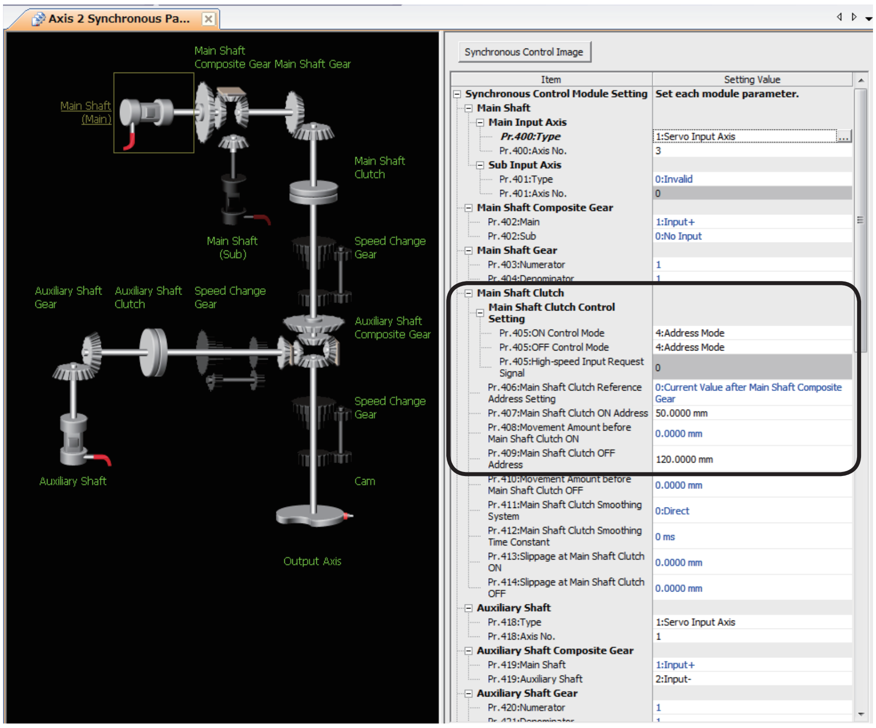
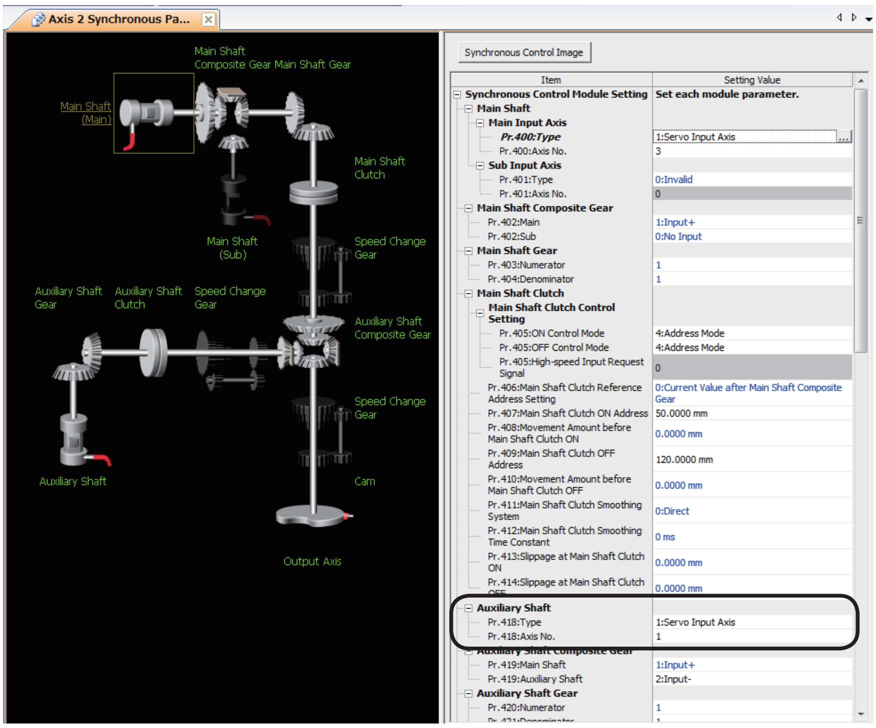
(3) Set "ON Control Mode", "OFF Control Mode", "Main Shaft Clutch ON Address" and "Main Shaft Clutch OFF Address" in the "Main Shaft Clutch Control Setting" as follows.



(4) Set the "Type" and "Axis No." of the "Auxiliary Shaft" as follows.



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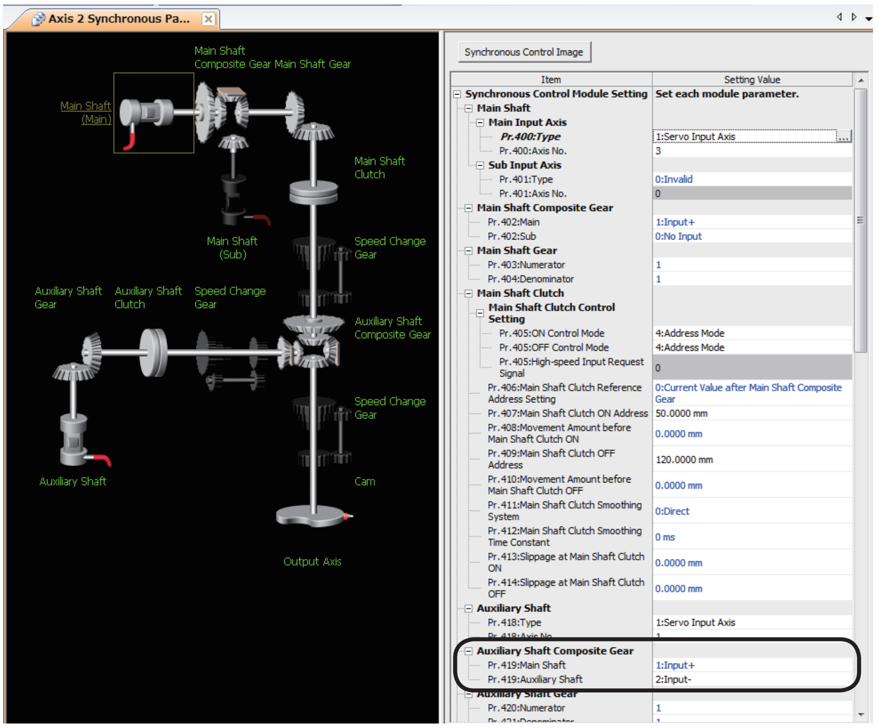
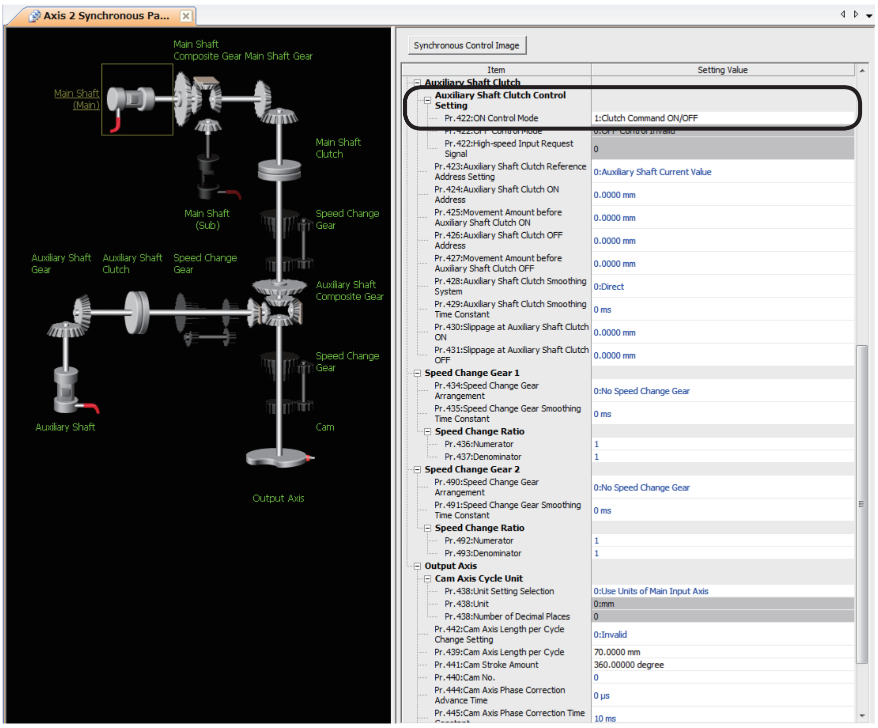
(5) Set the "Auxiliary Shaft" of the "Auxiliary Shaft Composite Gear" as follows.



(6) Set the "ON Control Mode" of the "Auxiliary Shaft Clutch Control Setting" as follows.



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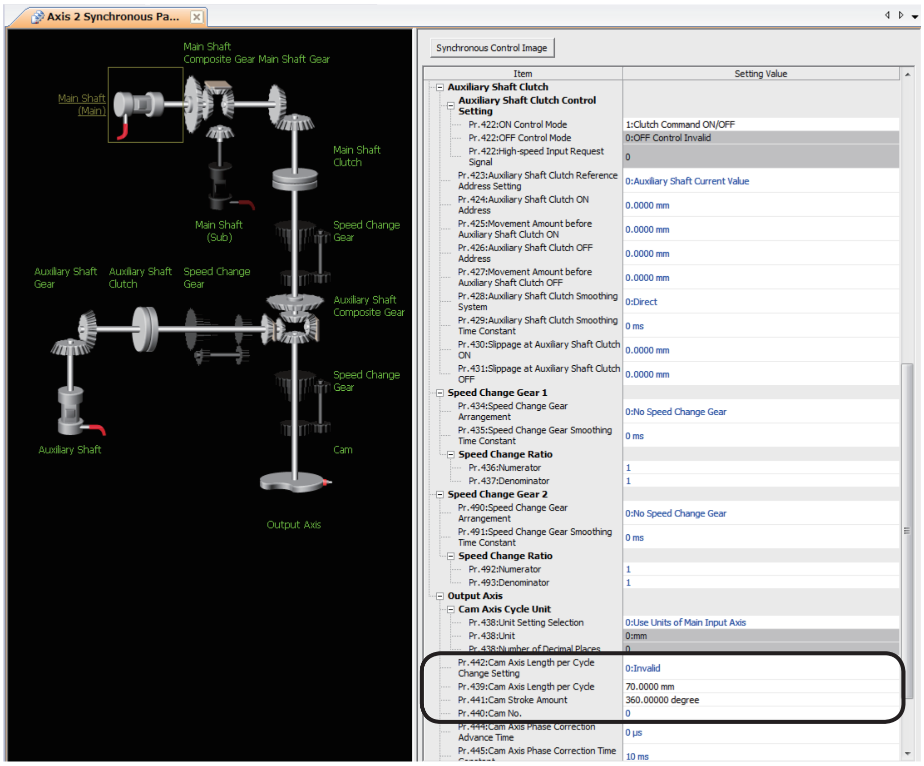
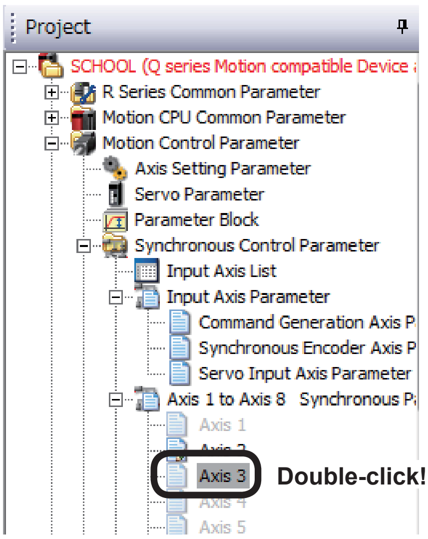
From previous page

(7) Set the "Cam Axis Length per Cycle" and "Cam Stroke Amount" as follows.
Setting of axis 2 synchronous parameter is now complete.



(8) Next, set axis 3 synchronous parameters.
Select [Motion Control Parameter] → [Synchronous Control Parameter] → [Axis 1 to Axis 8 Synchronous Parameter] in the Project window, and then double-click [Axis 3].



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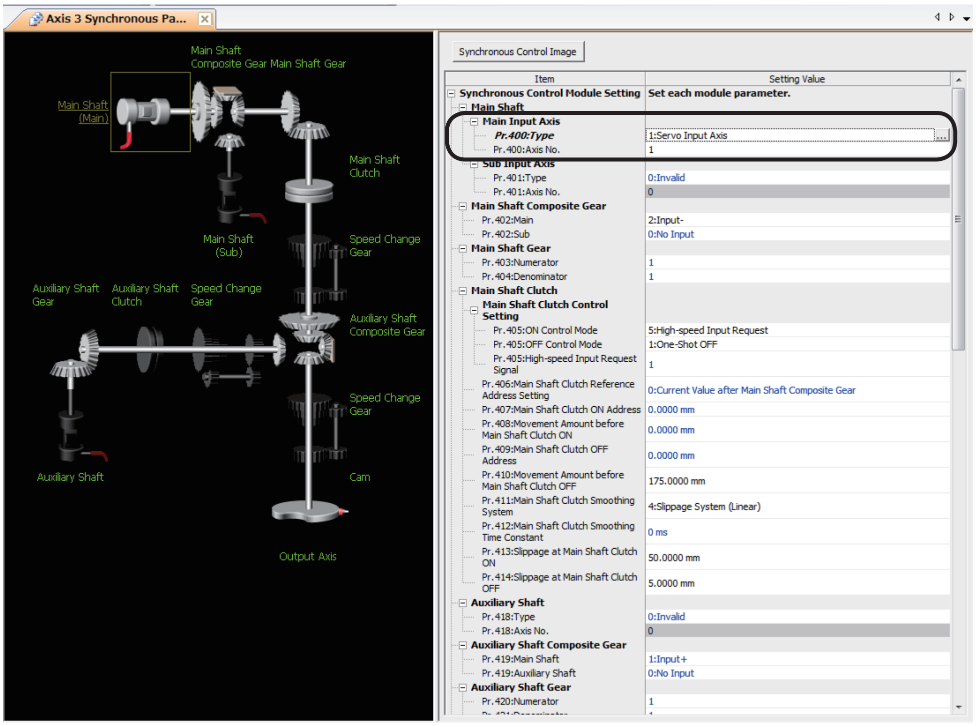
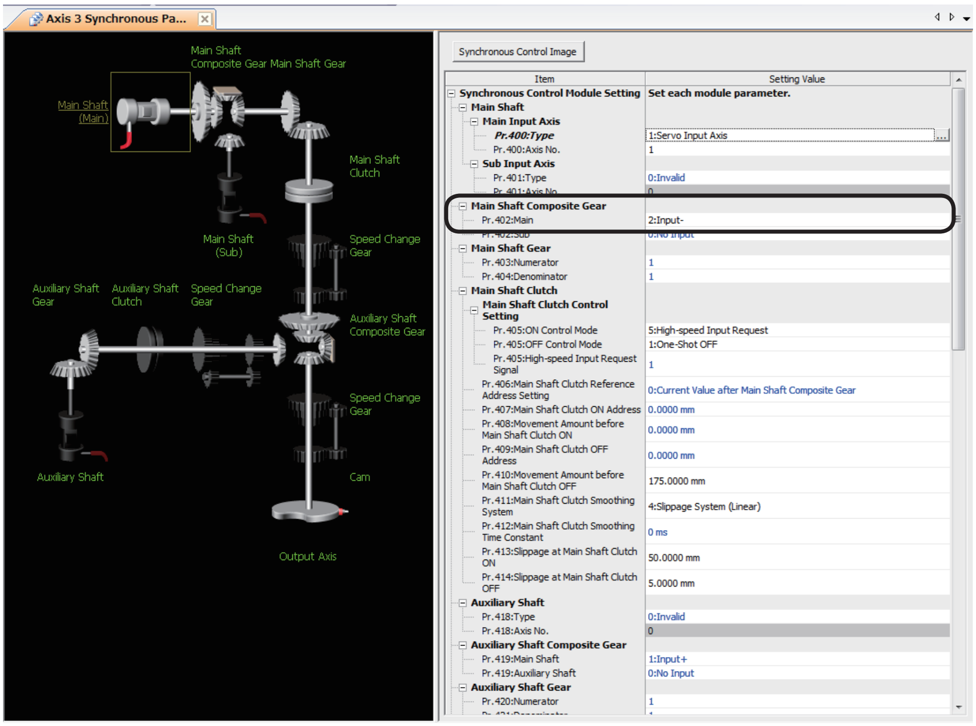
From previous page

(9) An Axis 3 Synchronous Parameter dialog box appears. Set the "Type" and "Axis No." of the "Main Input Axis" as follows.



(10) Set the "Main Shaft Composite Gear" "Main" as follows.



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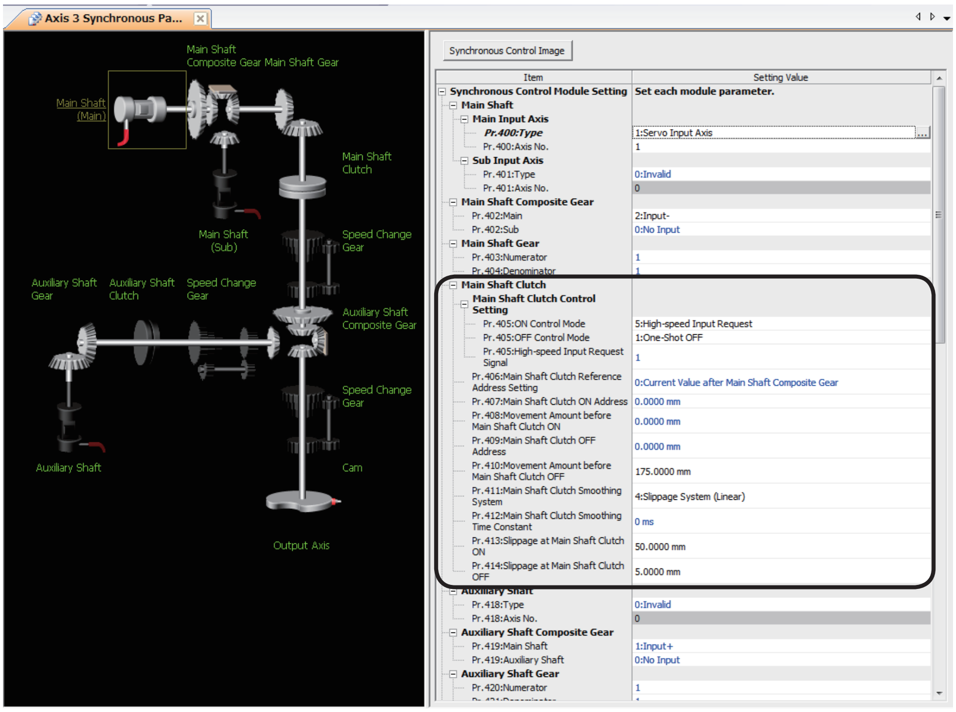
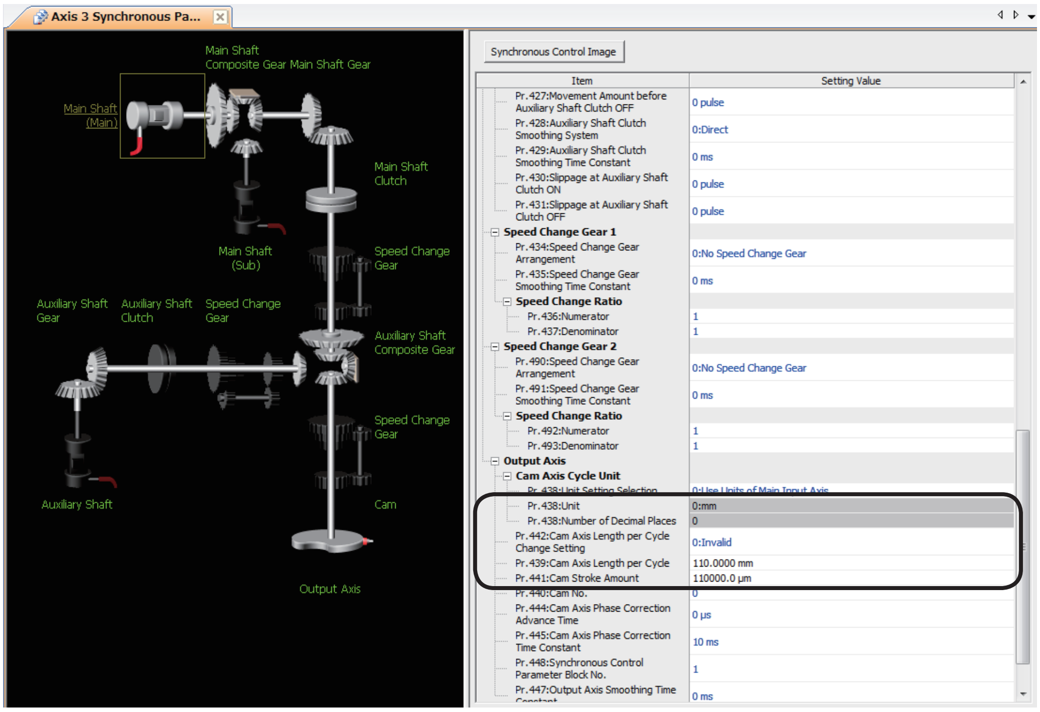
(11) Set "ON Control Mode", "OFF Control Mode", "Movement Amount before Main Shaft Clutch OFF" "Main Shaft Clutch Smoothing System" "Slippage at Main Shaft Clutch ON" and "Slippage at Main Shaft Clutch OFF" in the "Main Shaft Clutch Control Setting" as follows.



(12) Set the "Cam Axis Length per Cycle" and "Cam Stroke Amount" as follows.
Setting of axis 3 synchronous parameter is now complete.



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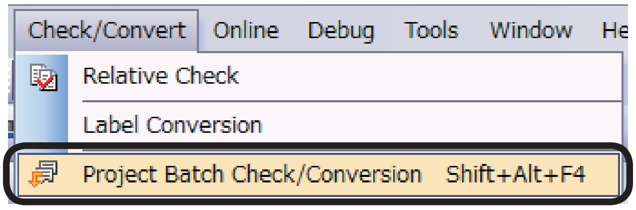
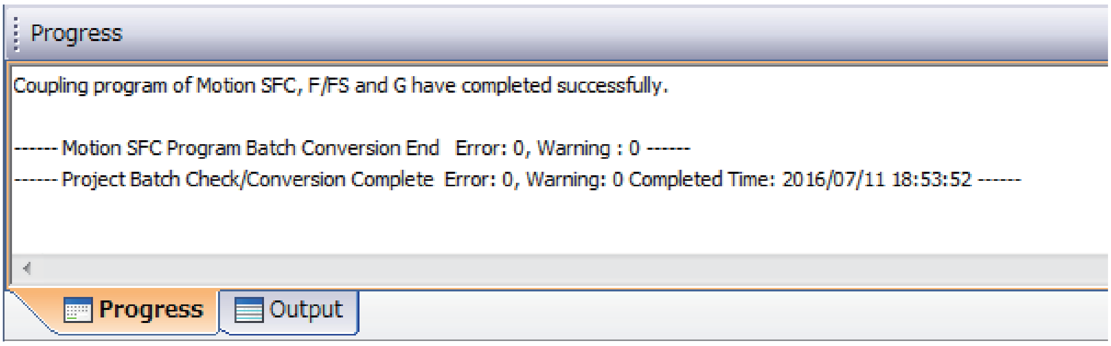
(13) Convert data for advanced synchronous control program editing to an internal code that allows the Motion CPU to function.
Click [Project Batch Check/Conversion] on the [Check/Convert] menu.



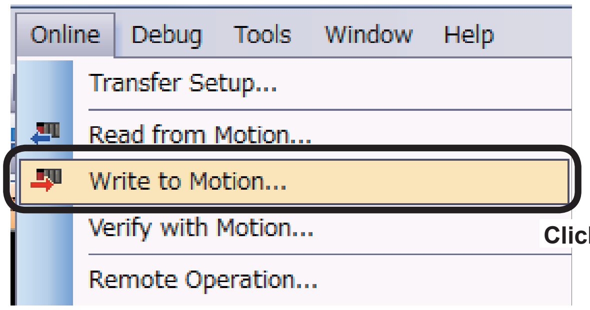
Click!

(14) The message that tells completing Motion SFC program conversion appears in the progress window.



10.9 Writing to the Motion CPU

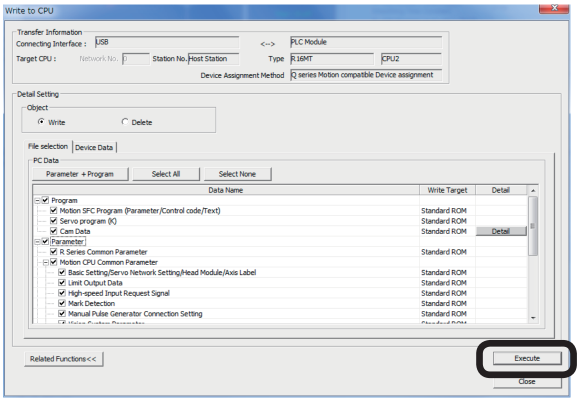
Write servo settings data and Motion SFC programs to the R16MTCPU.



Click!

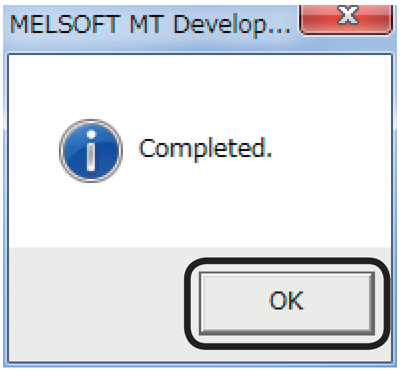
(1) Set the Motion CPU to "STOP".

(2) Click [Write to Motion] on the [Online] menu at the Program Editor window.



Click!

(3) Select the "Programs" and "Parameters" check boxes at the CPU Write dialog box that appears, and then click the Execute button.



Click!

(4) Click the OK button when the "Completed" message appears.

(5) Reset the PLC CPU.

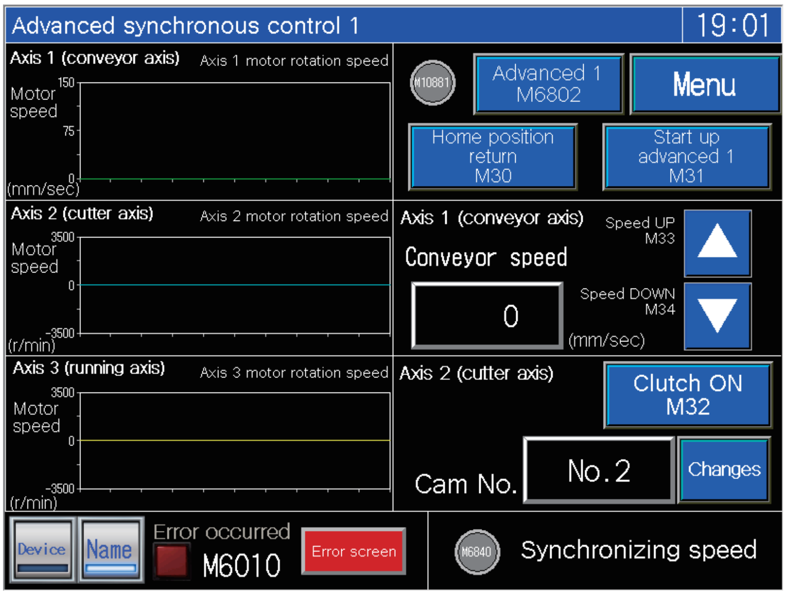
(6) Set the PLC CPU and Motion CPU to "RUN".

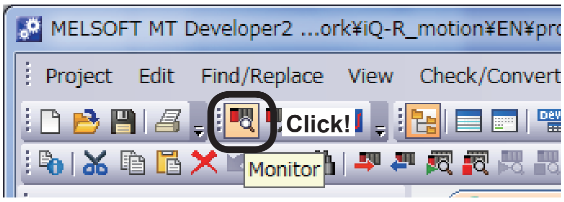
If the R08CPU RUN lamp and R16MTCPU RUN and M.RUN lamps light up, writing is successful.

10.10 Demonstration Machine Operation

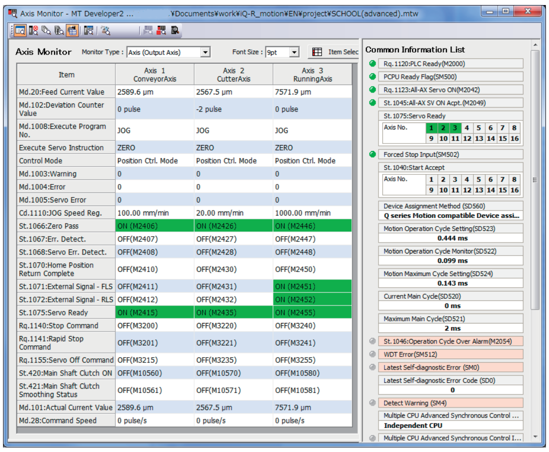
10.10.1 Advanced synchronous control 1: Travel cutter

Demonstration machine operation panel Advanced synchronous control 1 screen





(1) Click the monitor tool button.



(2) The monitor window axis monitor appears.

Go to next page

From previous page

(3) Set the PLC CPU and Motion CPU to "RUN".

[Servo ON]

(4) If the servo is not on, press [Servo ON M1000] at the demonstration machine operation panel.
The servo status for axes 1 to 3 changes to ready.

Demonstration machine operation panel

(5) Press [Advanced synchronous control 1].

[Switching to advanced synchronous control 1 and clutch operation]

(6) Press [Advanced 1 M6802] on the Advanced synchronous control 1 screen. And the, press [Home position return M30].

Next, press [Start up advanced 1 M31] to start up the demonstration machine.

Press [▲][▼] to ensure that conveyor speed change operation is possible.

Press the [Clutch ON M32] button, and ensure that clutch operation is possible.

• Press [Clutch ON M32] during operation with advanced synchronous control.
This turns off the clutch and the cutting movement (the rotation of the disc) stops.

Pressing the switch for [Clutch OFF M32] again causes the disc to start the cutting movement again.

* The clutch can turn on and off the cutter shaft only. (It does not turn on and off the travel shaft.)

Error check operation

Menu

[Online]

⇓

[Motion Monitor]

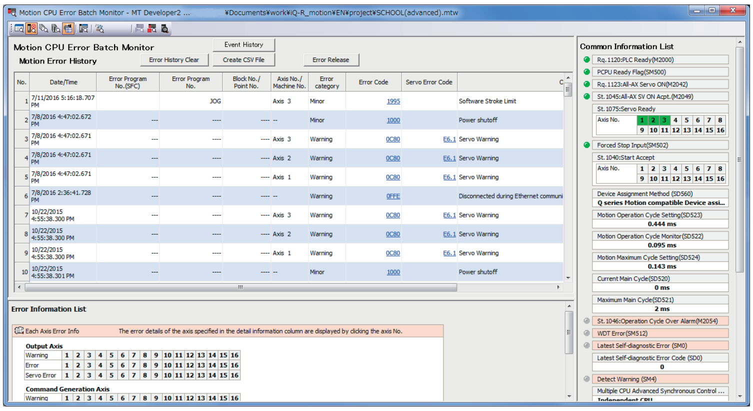
⇓

[Motion CPU Error Batch Monitor]

⇓

[Motion CPU Error Batch Monitor]

Motion CPU Error Batch Monitor screen



Go to next page

From previous page

⇩

[Set cam No. to "2"]

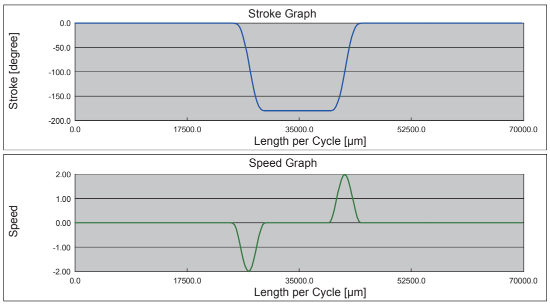
(7) Press [Changes] of the "Cam No.". The numerical input screen appears. There, change "1" to "2".

⇩

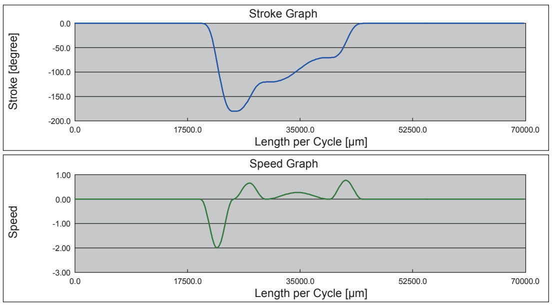
[Contents to be checked]

(8) Confirm that the disc moves differently from the cam No. 1.
Refer to the following cam data graphs.
(Note that the disc rotates in one step with the cam No. 1 while it rotates in two steps with the cam No. 2.)

Cam No. 1



Cam No. 2



⇩

[Finishing advanced synchronous control 1]

(9) Press [Start up advanced 1 M31] to end advanced 1 operation.

Press [Advanced 1 M6802] to end all operations.

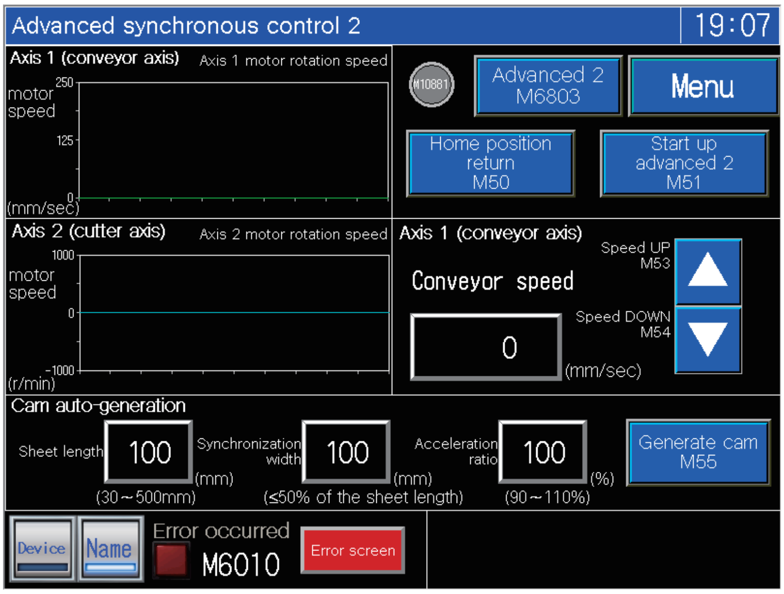
⇩

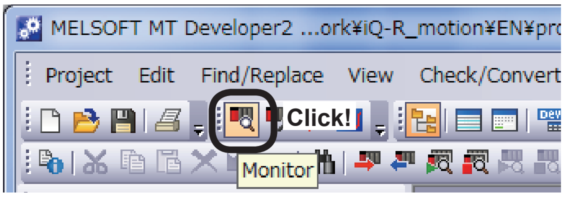
(10) Practice of the advanced control 1 is complete when all of these operations are finished.

POINT
• Check that the clutch controls to turn ON/OFF the cutting movement. • Change the conveyor speed to see that the travel shaft synchronizes with the conveyor shaft. • Observe that the disc rotates according to the cam data "No. 1" and "No. 2" and it rotates differently between the two.

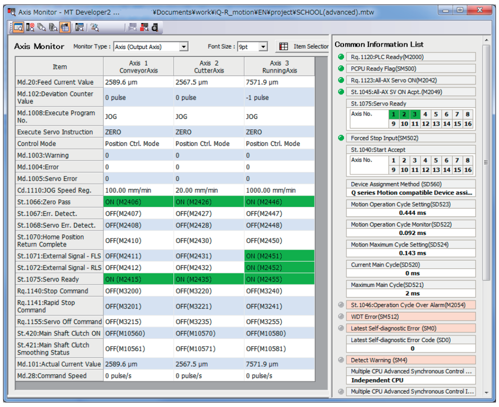
10.10.2 Advanced synchronous control 2: Rotary cutter

Demonstration machine operation panel Advanced synchronous control 2 screen





(1) Click the monitor tool button.



(2) The monitor window axis monitor appears.

Go to next page

From previous page

(3) Set the PLC CPU and Motion CPU to "RUN".

[Servo ON]

(4) If the servo is not on, press [Servo ON M1000] at the demonstration machine operation panel.
The servo status for axes 1 to 3 changes to ready.

Demonstration machine operation panel

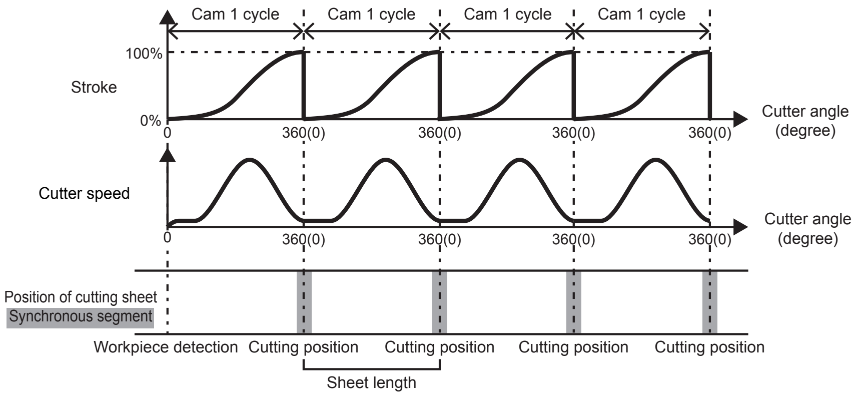
(5) Press [Advanced synchronous control 2].

[Switching to advanced synchronous control 2]

(6) Press [Advanced 2 M6803] on the Advanced synchronous control 2 screen. And the, press [Home position return M50].

Next, press [Start up advanced 2 M51] to start up the demonstration machine.

The initial setting of the cam automatic generation parameters is such that the demonstration machine carries out the cutting movement on the white marks that are laid out 50 mm apart from the others. Now, check this operation.



You may change the sheet length as you like. Note, however, that making it a multiple of 50 mm makes it easy for you to check the operation.

The initial settings of the cam automatic generation parameters on the demonstration machine motion are as follows.

- Automatic generation option: Acceleration and deceleration method ... Trapezoidal/synchronous axis length setting ... Diameter
- Acceleration rate over synchronous section: 100% (Reaches the same speed as the conveyor speed at the rate of 100%)
- Sheet length: 50.0 mm
- Sheet synchronous width: 10 mm
- Synchronous axis length: 80.0 mm (diameter)
- Synchronous position adjustment: 0 (Over the sheet center synchronous section)

Next, change the conveyor speed.

- Press [▲][▼] to ensure that conveyor speed change operation is possible.
- Check that the synchronous cutting movement continues even if the conveyor speed changes.

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From previous page

Error check operation

Menu

[Online]

⇓

[Motion Monitor]

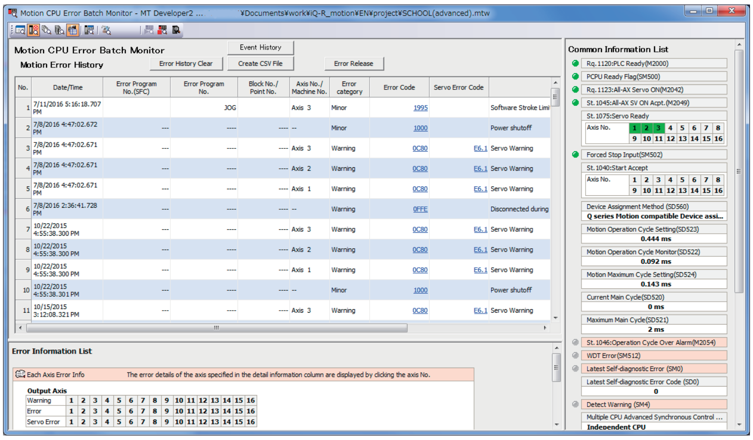
⇓

[Motion CPU Error Batch Monitor]

⇓

[Motion CPU Error Batch Monitor]

Motion CPU Error Batch Monitor screen



[Change cam automatic generation parameters]

(7) Change the three parameters as follows.

- Sheet length: (Length of sheet to be cut off)
- Sheet synchronous width: (The width of segment where the conveyor speed and the angular speed synchronize with the other when the cutter carries out the cutting movement)
- Acceleration rate over synchronous section: (The rate of increase in the angular speed of the disc with reference to the conveyor speed over the synchronous width. It reaches the same speed as the conveyor speed at the rate of 100%.)

The initial parameter settings are 50.0 mm for the sheet length, 10.0 mm for the synchronous width and 100% for the acceleration rate.

Press [Start up advanced 2 M51] to stop the demonstration machine motion. Change the sheet length to 100.0 mm and synchronous width to 30.0 mm.

In each case, press the numeric figure to call up the numerical input screen and change the parameters.

Press [Generate cam M55] to generate the cam data. Next, press [Start up advanced 2 M51] once again to start up the demonstration machine.

[Contents to be checked]

(8) Check that the demonstration machine carries out the cutting movement on every other white mark (skipping one every time).
Also, check that the synchronous section is extended.

[Finishing advanced synchronous control 2]

(9) Press [Start up advanced 2 M51] to end advanced synchronous control 2 operation.

[Advanced 2 M6803] Press ADVANCED 2 M6803 to end all operations.

(10) Practice of the advanced control 2 is complete when all of these operations are finished.

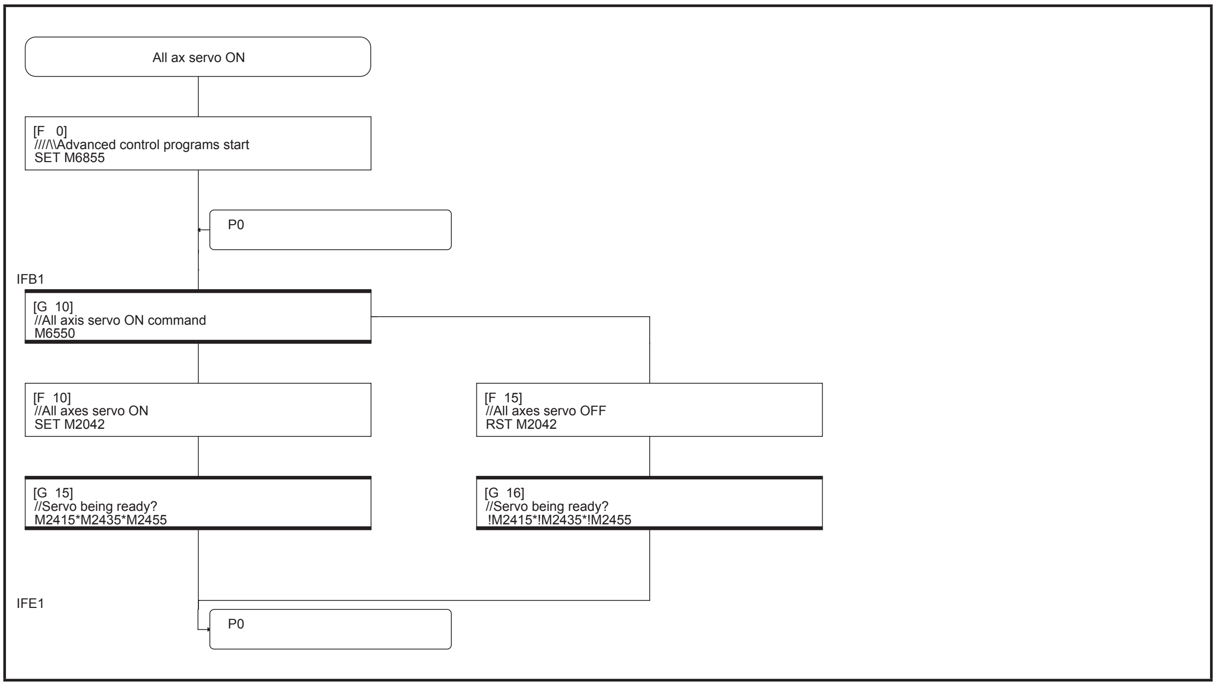
POINT

- Check that the disc follows the rotary cutter movement as show in Figure 2 above.
- Change the conveyor speed to see that the cutter synchronizes with the conveyor.
- Change the cam automatic generation parameters to see that the motion of the cutter shaft changes accordingly.

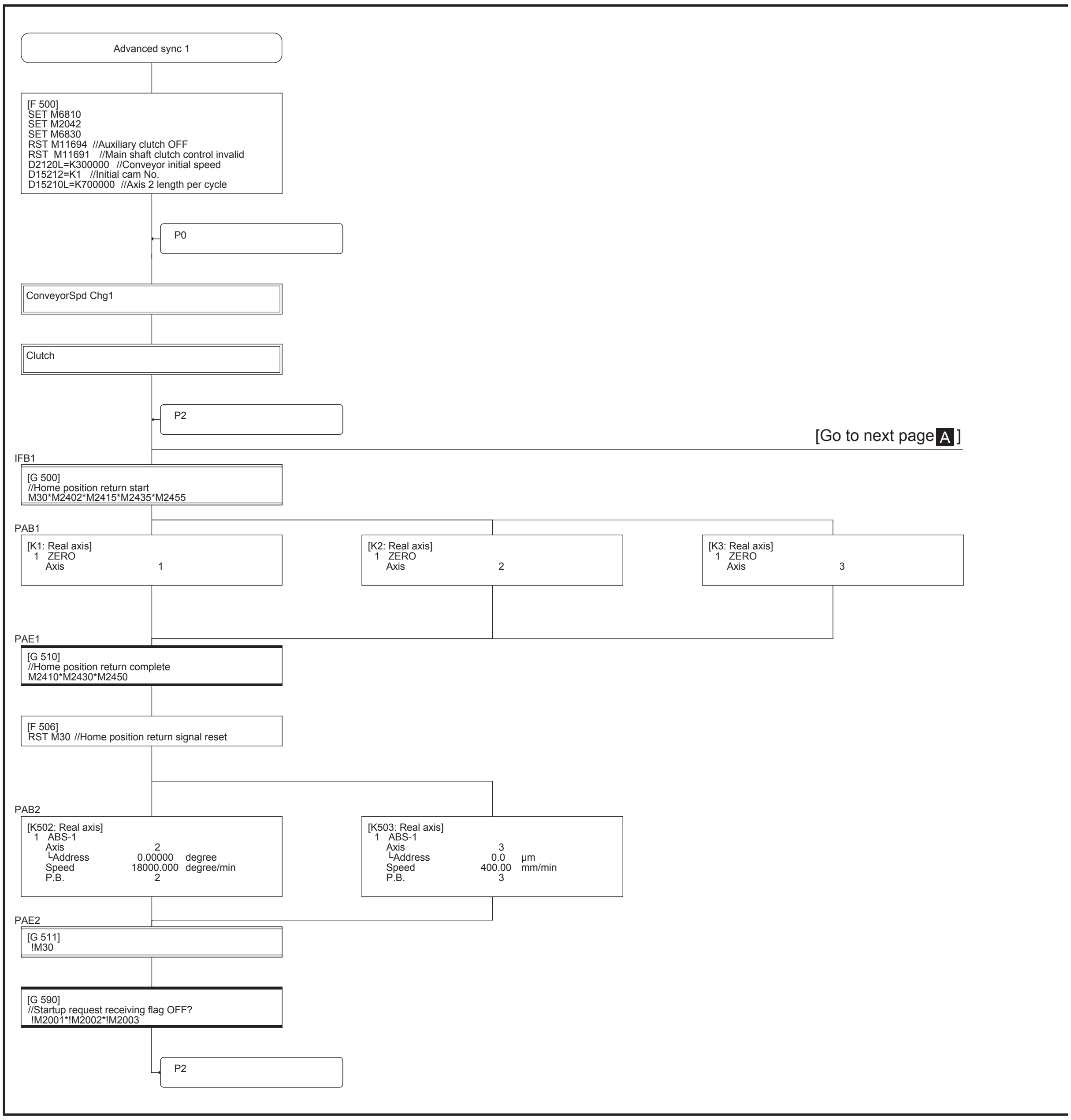
10.11 SFC program list

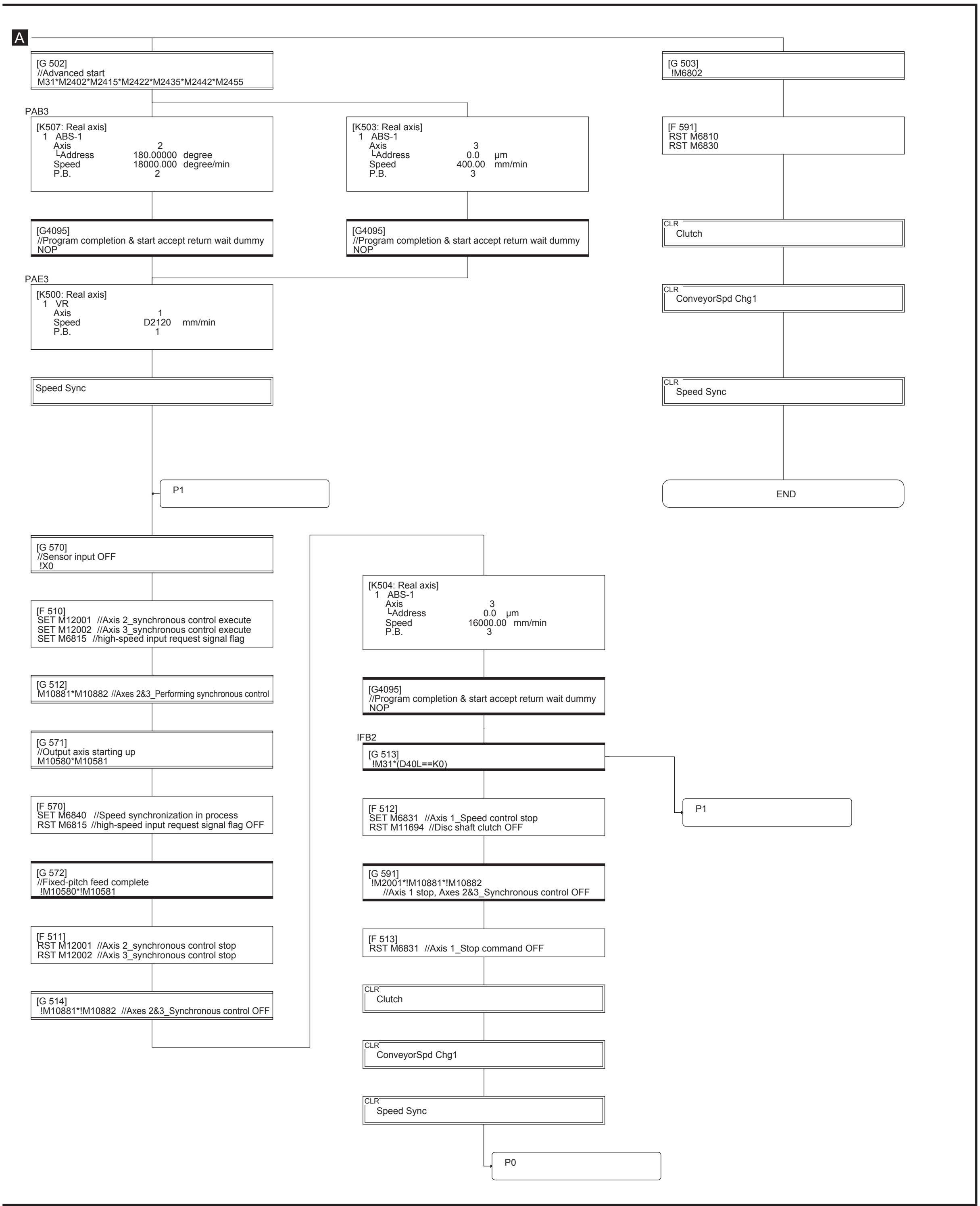
This shows a list of the SFC programs.

[All ax servo ON] program No. 001

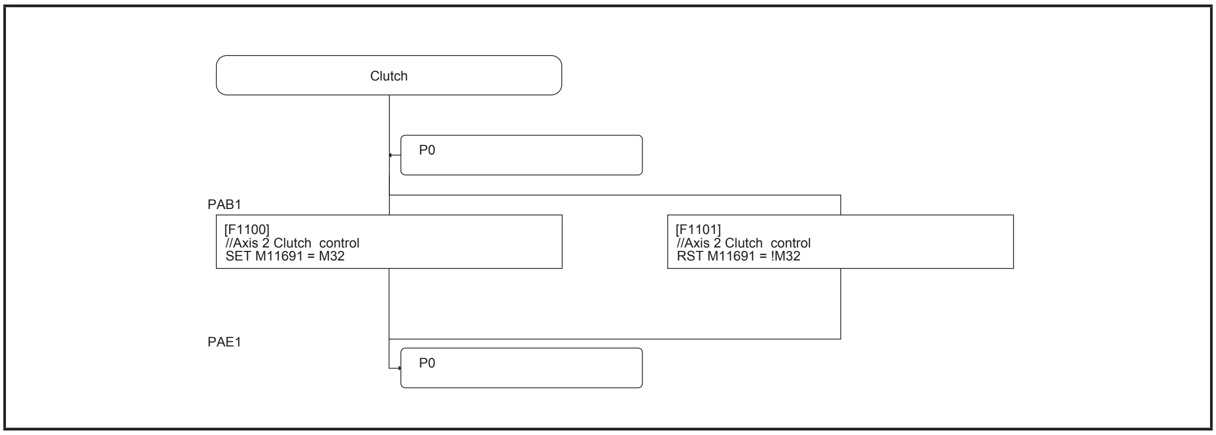


[Advanced sync 1: Travel cutter] program No. 100

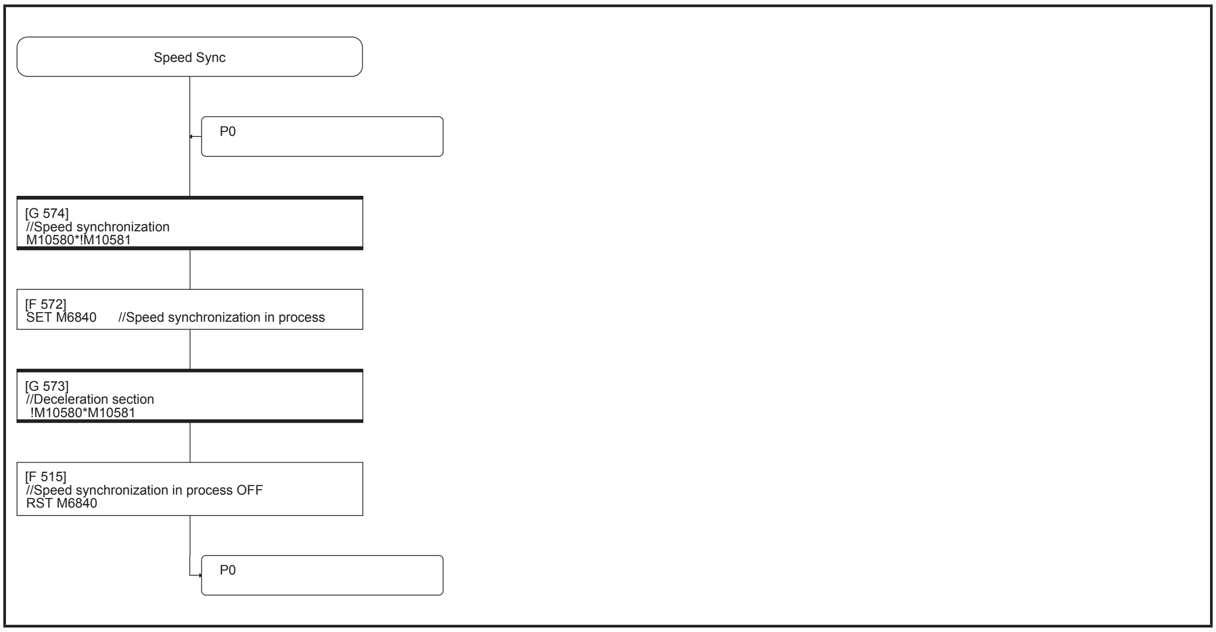



A
[G 502]
//Advanced start
M31*M2402*M2415*M2422*M2435*M2442*M2455
PAB3
[K507: Real axis]
1 ABS-1
Axis 2
└Address 180.00000 degree
Speed 18000.000 degree/min
P.B. 2
[K503: Real axis]
1 ABS-1
Axis 3
└Address 0.0 μm
Speed 400.00 mm/min
P.B. 3
[G4095]
//Program completion & start accept return wait dummy
NOP
[G4095]
//Program completion & start accept return wait dummy
NOP
PAE3
[K500: Real axis]
1 VR
Axis 1
Speed D2120 mm/min
P.B. 1
Speed Sync
P1
[G 503]
!M6802
[F 591]
RST M6810
RST M6830
CLR
Clutch
CLR
ConveyorSpd Chg1
CLR
Speed Sync
END
[G 570]
//Sensor input OFF
!X0
[F 510]
SET M12001 //Axis 2_synchronous control execute
SET M12002 //Axis 3_synchronous control execute
SET M6815 //high-speed input request signal flag
[G 512]
M10881*M10882 //Axes 2&3_Performing synchronous control
[G 571]
//Output axis starting up
M10580*M10581
[F 570]
SET M6840 //Speed synchronization in process
RST M6815 //high-speed input request signal flag OFF
[G 572]
//Fixed-pitch feed complete
!M10580*!M10581
[F 511]
RST M12001 //Axis 2_synchronous control stop
RST M12002 //Axis 3_synchronous control stop
[G 514]
!M10881*!M10882 //Axes 2&3_Synchronous control OFF
[K504: Real axis]
1 ABS-1
Axis 3
└Address 0.0 μm
Speed 16000.00 mm/min
P.B. 3
[G4095]
//Program completion & start accept return wait dummy
NOP
IFB2
[G 513]
!M31*(D40L==K0)
P1
[F 512]
SET M6831 //Axis 1_Speed control stop
RST M11694 //Disc shaft clutch OFF
[G 591]
!M2001*!M10881*!M10882
//Axis 1 stop, Axes 2&3_Synchronous control OFF
[F 513]
RST M6831 //Axis 1_Stop command OFF
CLR
Clutch
CLR
ConveyorSpd Chg1
CLR
Speed Sync
P0

[Clutch] program No. 110



[Speed Sync] program No. 120



[Advanced sync 2: Rotary cutter] program No. 150

Advanced sync 2

```
[F 501]
SET M6820
SET M2042
SET M6830
SET  M11691   //Main shaft clutch control invalid
D2120L=K300000   //Conveyor initial speed
D15212=K5  //Cam No.
D15210L=K500000//Cam length per cycle
```

```
[F 502]
//Generate initial stage rotary cam
D5000L=K512    //Resolution = 512
D5002=K0
  //Acceleration/deceleration method = Trapezoidal, synchronous axis length setting = Diameter
D5003=K0  //Amplification factor over synchronous segment = 0.00 %
D5004L=K500  //Sheet length = 50.0 mm
D5006L=K100  //Sheet synchronous width = 10.0 mm
D5008L=K800  /Synchronous axis length = 80.0 mm (diameter)/
D5010L=K250  //Synchronous position adjustment = At sheet end
D5012L=K100  //Acceleration/deceleration width = 10.0 mm
D5014=K1  //Quantity of cutters = 1
CAMMK K5,K1,D5000        //Cam automatic generation
```

ConveyorSpd Chg2

CamAuto-generate

P0

[Go to next page A]

IFB1

```
[G 530]
//Home position return startup
M50*M2402*M2415*M2435*M2455
```

PAB1

[K1: Real axis]	[K2: Real axis]	[K3: Real axis]
1 ZERO	1 ZERO	1 ZERO
Axis 1	Axis 2	Axis 3

PAE1

```
[G 510]
//Home position return complete
M2410*M2430*M2450
```

```
[F 533]
RST M50   //Home position return signal reset
```

PAB2

```
[K505: Real axis]
 1   ABS-1
     Axis                    3
      └Address         50000.0   μm
     Speed            24000.00   mm/min
     P.B.                    3
```

```
[K506: Real axis]
 1   ABS-1
     Axis                    2
      └Address         0.00000   degree
     Speed           18000.000   degree/min
     P.B.                    2
```

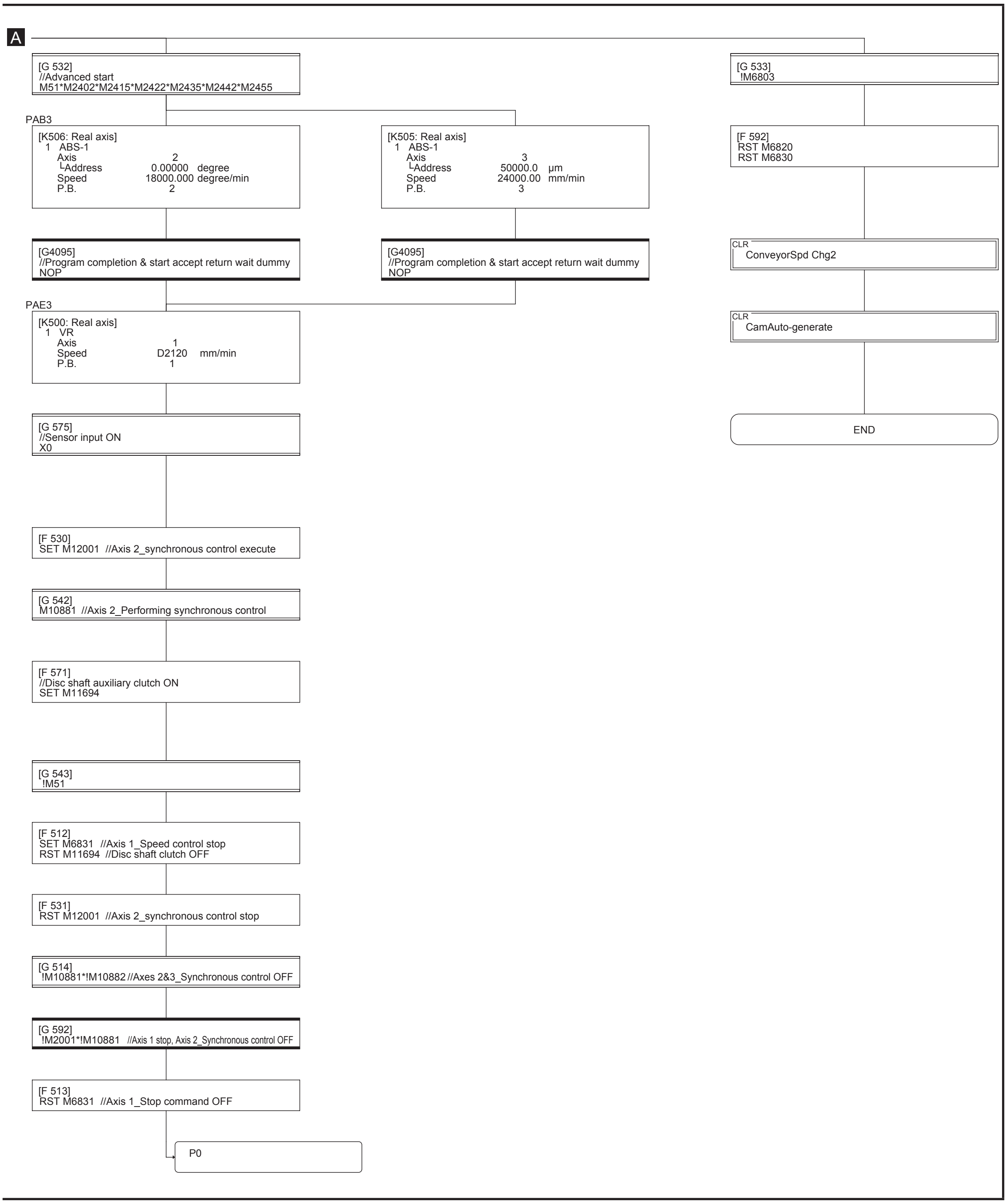
PAE2

```
[G 541]
!M50
```

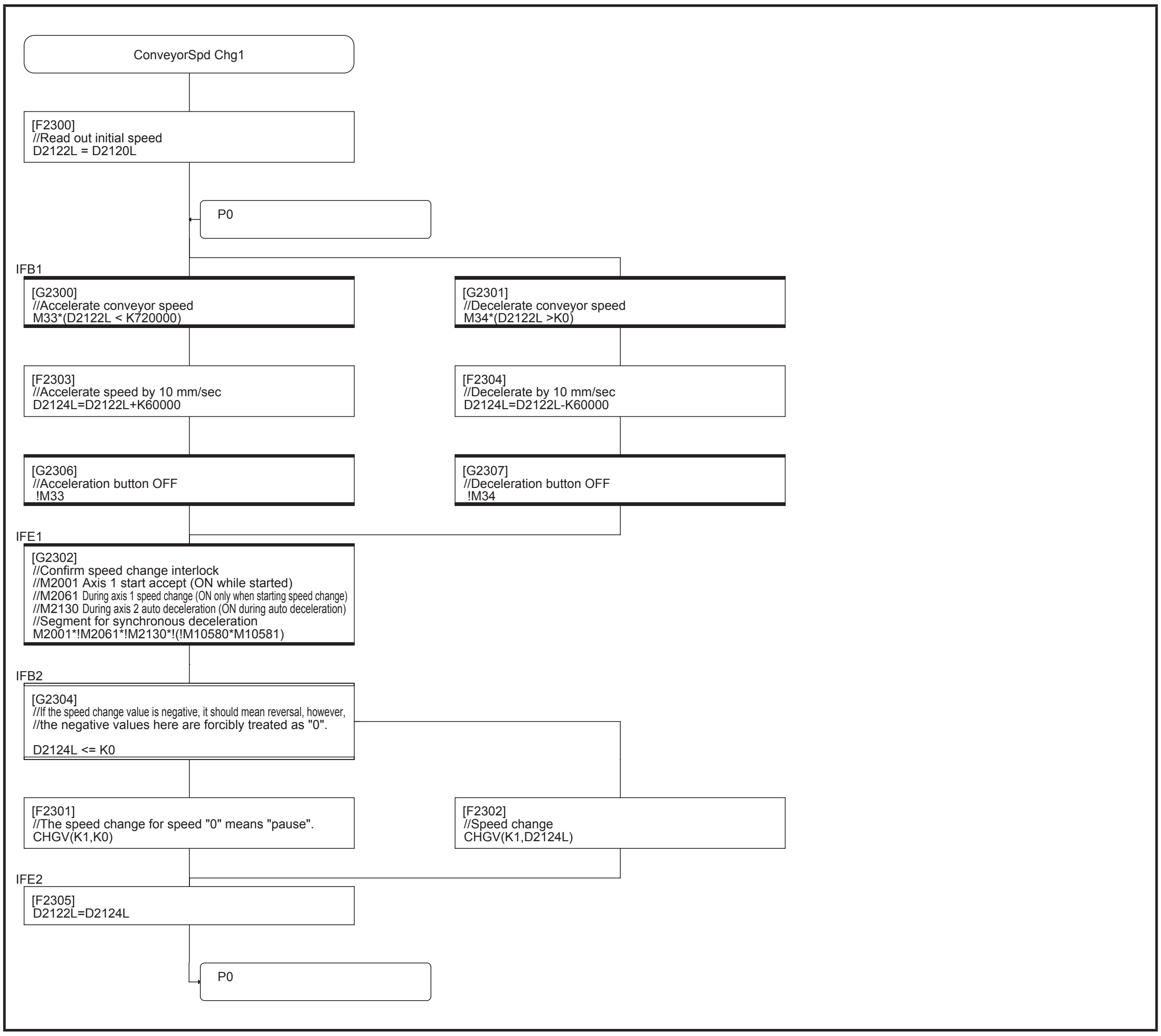
```
[F 595]
//Synchronous control start reset
RST M12001
```

```
[G 590]
//Startup request receiving flag OFF?
!M2001*!M2002*!M2003
```

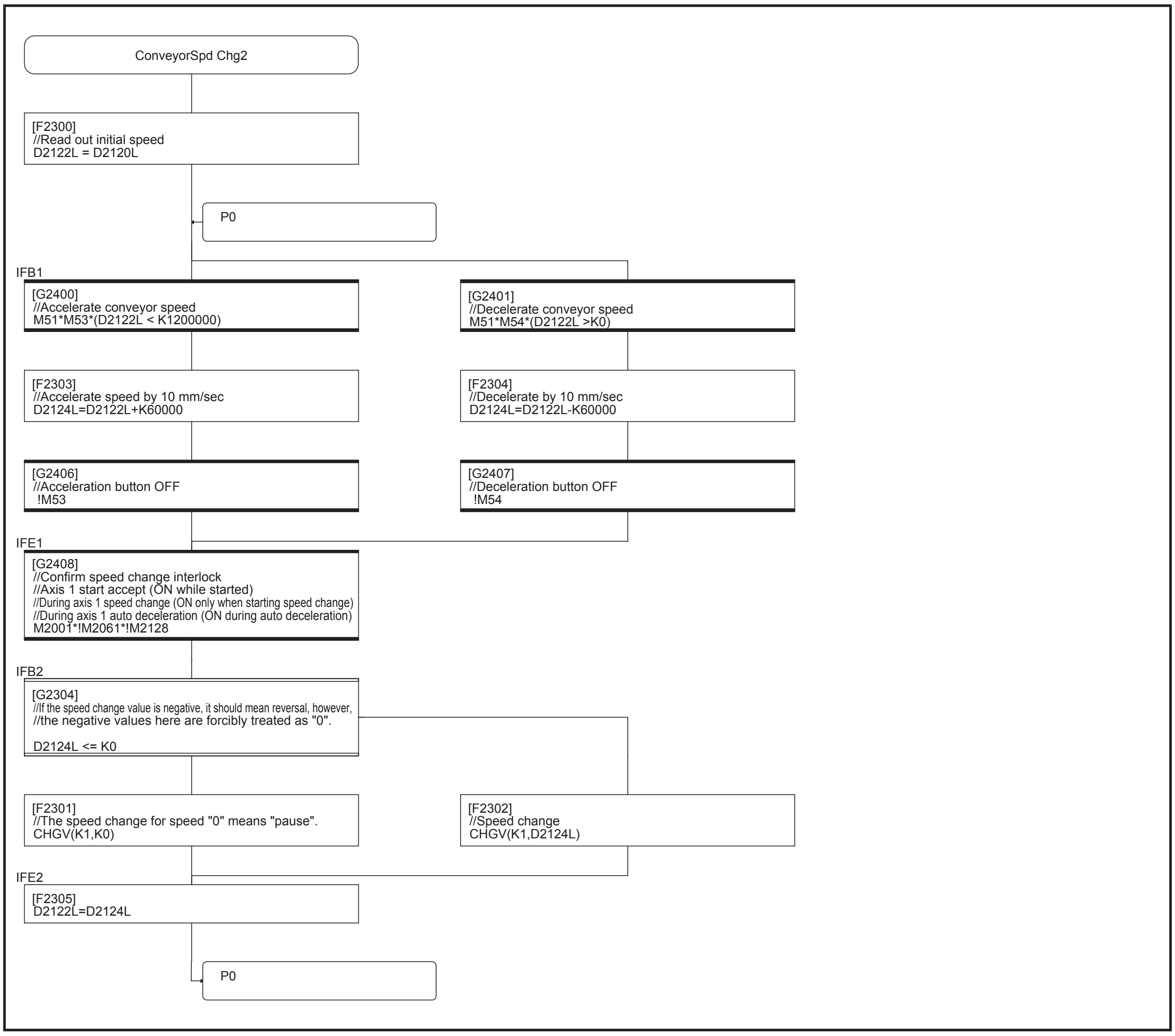
P0


A
[G 532]
//Advanced start
M51*M2402*M2415*M2422*M2435*M2442*M2455
PAB3
[K506: Real axis]
1 ABS-1
Axis 2
└Address 0.00000 degree
Speed 18000.000 degree/min
P.B. 2
[K505: Real axis]
1 ABS-1
Axis 3
└Address 50000.0 μm
Speed 24000.00 mm/min
P.B. 3
[G4095]
//Program completion & start accept return wait dummy
NOP
[G4095]
//Program completion & start accept return wait dummy
NOP
PAE3
[K500: Real axis]
1 VR
Axis 1
Speed D2120 mm/min
P.B. 1
[G 575]
//Sensor input ON
X0
[F 530]
SET M12001 //Axis 2_synchronous control execute
[G 542]
M10881 //Axis 2_Performing synchronous control
[F 571]
//Disc shaft auxiliary clutch ON
SET M11694
[G 543]
!M51
[F 512]
SET M6831 //Axis 1_Speed control stop
RST M11694 //Disc shaft clutch OFF
[F 531]
RST M12001 //Axis 2_synchronous control stop
[G 514]
!M10881*!M10882 //Axes 2&3_Synchronous control OFF
[G 592]
!M2001*!M10881 //Axis 1 stop, Axis 2_Synchronous control OFF
[F 513]
RST M6831 //Axis 1_Stop command OFF
P0
[G 533]
!M6803
[F 592]
RST M6820
RST M6830
CLR
ConveyorSpd Chg2
CLR
CamAuto-generate
END

[ConveyorSpd Chg1] program No. 230



[ConveyorSpd Chg2] program No. 240



[CamAuto-generate] program No. 250

```
CamAuto-generate

P0

[G 600]
//Cam generation command while stopping
!M51*!M2001*M55

[F 640]
D15210L=D6052L*K1000
D5020=D6050-K10000

IFB1
[G 650]
D6054L<=D6052/K2    //50% of sheet length or shorter

[F 641]
D6830L=D6054L

[F 642]
D6830L=D6052/2

IFE1
[F 650]
//Rotary cam generation
D5000L=K512     //Resolution = 512
D5002=K0
  //Acceleration/deceleration method = Trapezoidal, synchronous axis length setting = Diameter
D5003=D5020       //Amplification factor over synchronous segment
D5004L=D6052L      //Sheet length
D5006L=D6830L      //Sheet synchronous width
D5008L=K800     //Synchronous axis length = 80.0 mm (diameter)
D5010L=D5004L/2       //Synchronous position adjustment = At sheet end
D5012L=K100     //Acceleration/deceleration width = 10.0 mm
D5014=K1   //Quantity of cutters = 1
CAMMK K5,K1,D5000     //Cam automatic generation

P0
```

[Disp SpdWaveform] program No. 255

```
Disp SpdWaveform

P0

[F 900]
IF D5900==K0
//Conveyor shaft (axis 1) speed
BMOV #1001,#1000,K299
#1000=SHORT(D12282L/K6000*K-1)
//Rotating shaft (axis 2) speed
BMOV #1301,#1300,K299
#1300=SHORT(#8022L/K100)
//Travel shaft (axis 3) speed
BMOV #1601,#1600,K299
#1600=SHORT(#8042L/K100)

IEND

D5900=D5900+K1

IF D5900>=K2
D5900=K0
IEND

P0
```

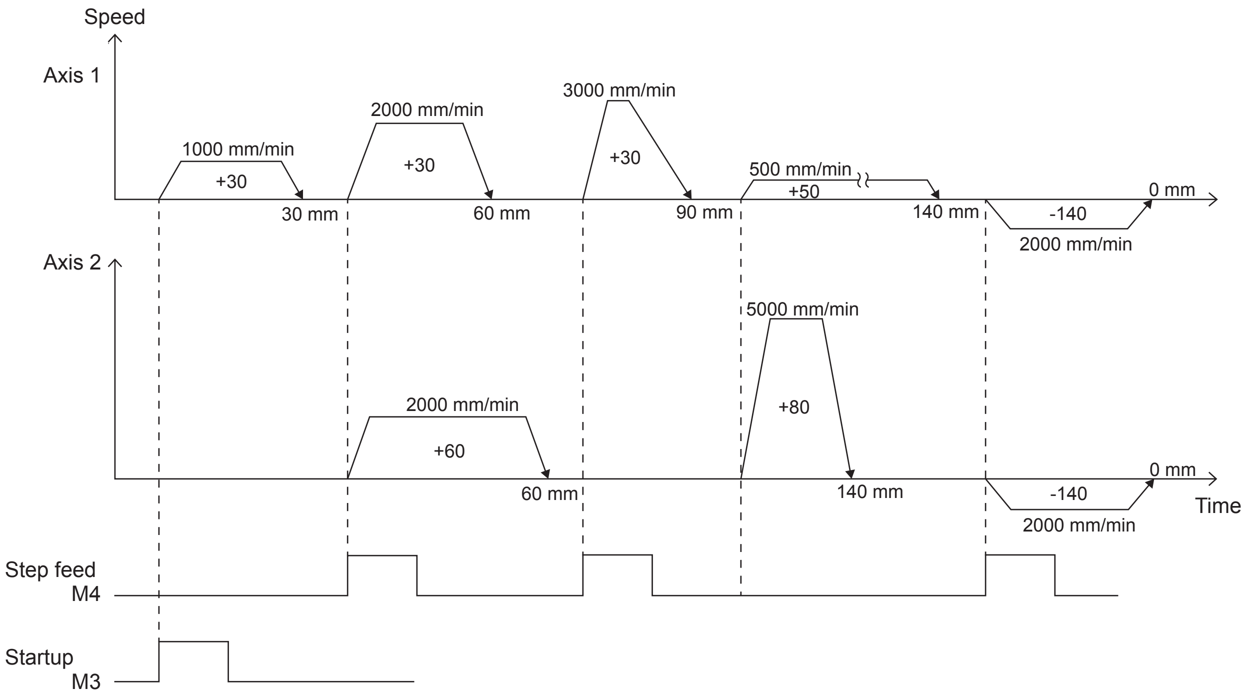
Appendices

Appendix 1 Application Practice

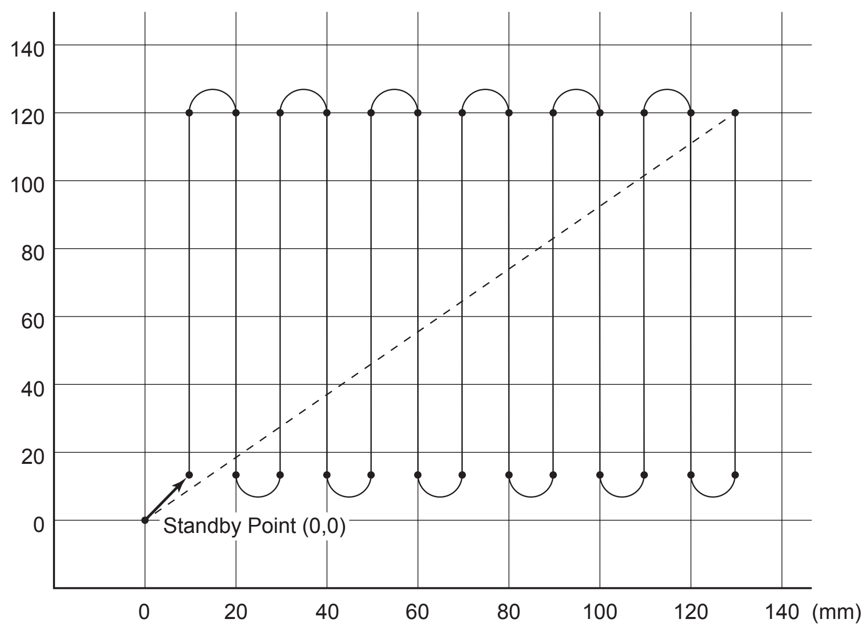
Appendix 1.1 Practice Content

Perform continuous positioning at multiple points.

Continuous positioning (1) operation diagram



Continuous positioning (2) operation diagram



Appendix 1.2 Practice Motion SFC Programs

These sequence/Motion SFC programs have been created for operation purposes on the assumption that MT Works2 (R16MTCPU) be used.

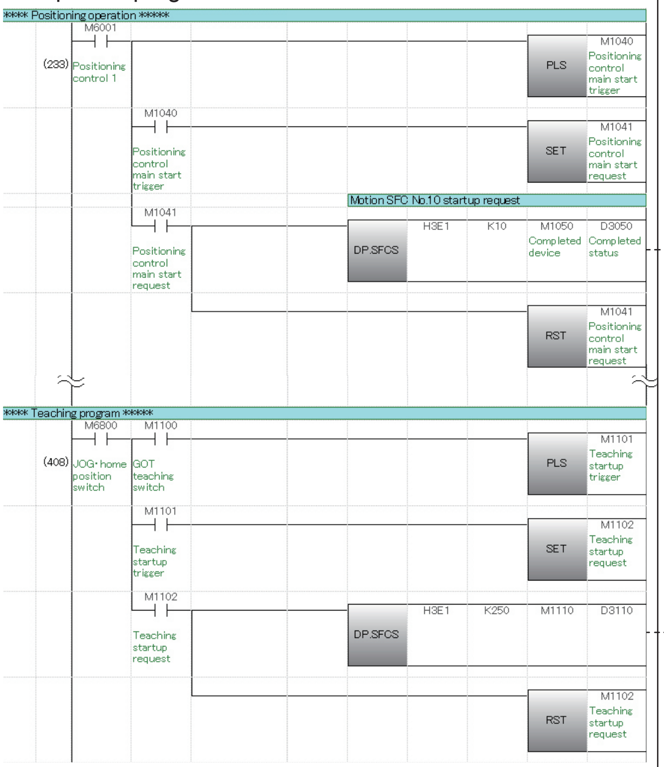
Refer to section 9.2 for an explanatory drawing of the demonstration machine operation panel.

Refer to section 9.5 for details on initial processing, JOG operation, home position return, standby point positioning, point selection positioning, and address indirect designation positioning.

Appendix 1.2.1 Program list

The sequence program and Motion SFC program used for practice are shown in the following list.

Refer to the respective descriptions of each program in this manual for details.

<table>
<tr><th>Constant execution</th><th>Startup with sequence program</th><th>Startup with Motion SFC program</th></tr>
<tr><td>• Sequence program

</td>
<td>• [Pos ControlMain]
Motion SFC
program No. 10

• [Teaching]
Motion SFC
program No. 250</td>
<td>• [StandbyPointPos]
Motion SFC
program No. 20

• [Point selection]
Motion SFC
program No. 30

• [SpecifyAdd Ind]
Motion SFC
program No. 40

• [Continuous Pos 1]
Motion SFC
program No. 50

• [Continuous Pos 2]
Motion SFC
program No. 60

• [TeachingPlayback]
Motion SFC
program No. 70

• [Fixed feed]
Motion SFC
program No. 80

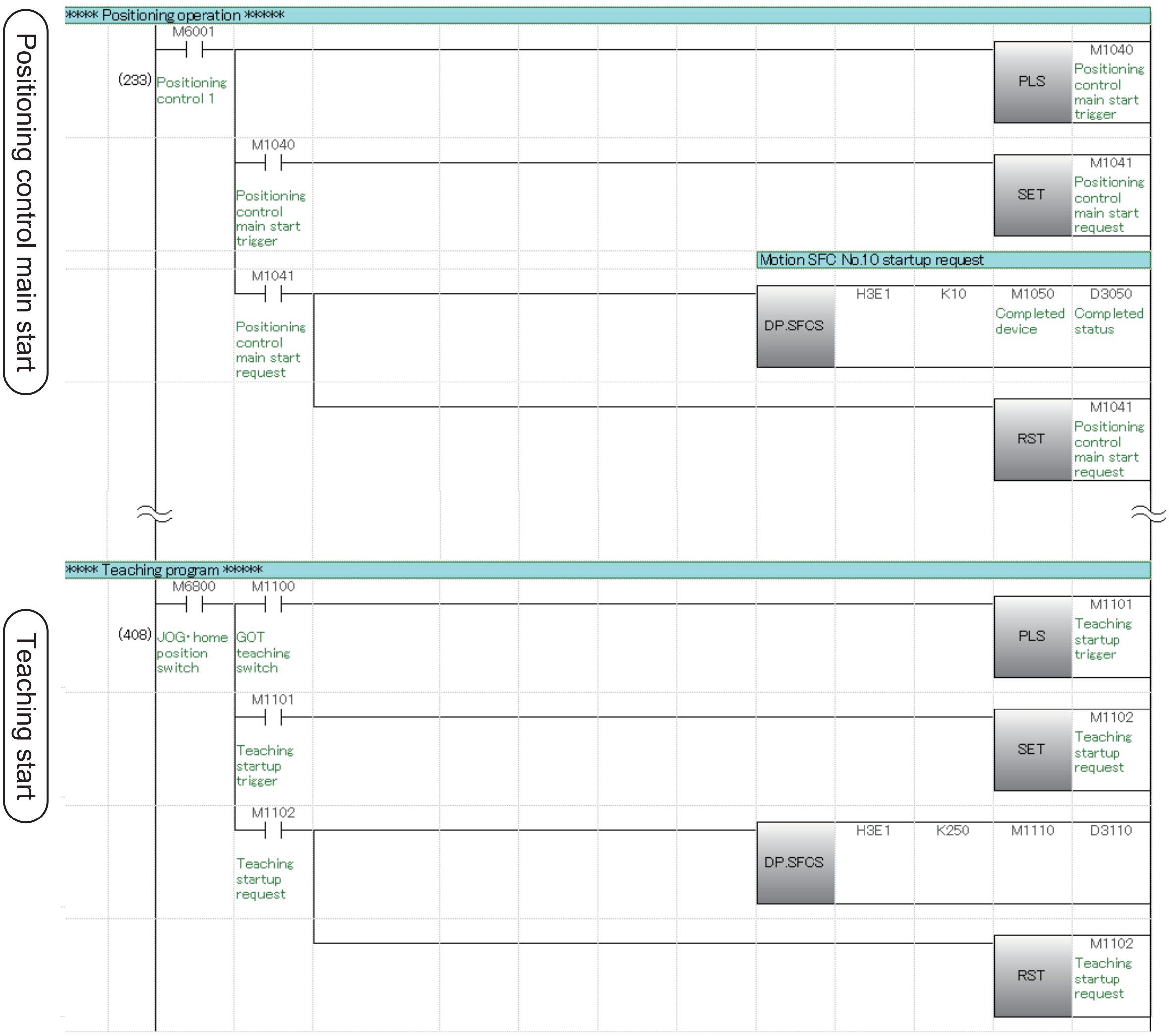
• [Fix FeedStepping]
Motion SFC
program No. 220

• [Speed change]
Motion SFC
program No. 200</td></tr>
</table>

Motion SFC program parameters

No.	Program name	Automatic start	END operation	No. of transitions	Execution timing
1	All ax servo ON	Yes	-	-	Normal
10	Pos ControlMain	No	-	-	Normal
20	StandbyPointPos	No	-	-	Normal
30	Point selection	No	-	-	Normal
40	SpecifyAdd Ind	No	-	-	Normal
50	Continuous Pos 1	No	-	-	Normal
60	Continuous Pos 2	No	-	-	Normal
70	TeachingPlayback	No	-	-	Normal
80	Fixed feed	No	-	-	Normal
200	Speed change	No	-	-	Normal
220	Fix FeedStepping	No	Continuous	1	Event (0.888 ms)
250	Teaching	No	-	-	Normal

• R08CPU sequence program



Appendix 1.2.2 Main routine Motion SFC program (positioning control operation)

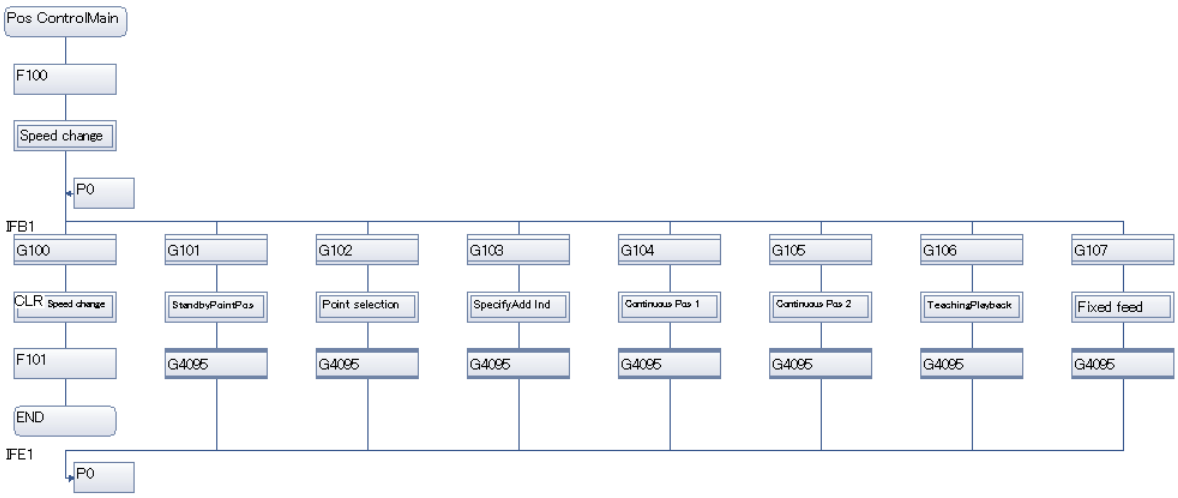
This is the main executed Motion SFC program when performing positioning control operation.

Other Motion SFC programs used to perform various types of operation from this main routine Motion SFC program are started as subroutines.

(1) Motion SFC program started from main routine Motion SFC program.

Motion SFC program No.	Program name	Reference section
20	StandbyPointPos	9.9
30	Point selection	9.9
40	SpecifyAdd Ind	9.9
50	Continuous Pos 1	Appendix 1.2.3
60	Continuous Pos 2	Appendix 1.2.4
70	TeachingPlayback	Appendix 1.2.5
80	Fixed feed	Appendix 1.2.6
200	Speed change	Appendix 1.3.1
220	Fix FeedStepping	Appendix 1.2.6
250	Teaching	Appendix 1.2.5

(2) Program example



Appendix 1.2.3 Continuous positioning (1)

This is an example of a program used to perform positioning at multiple points based on respective conditions.

The standby method if the flow is branched, and M-codes that can be used to control auxiliary machinery with sequence programs are set.

(1) Multiple servo program execution order control

To execute servo programs in the order 50 → 51, 52 → 53 → 54 → 56, 57, by using a "WAIT" type transition after the motion control step (servo program), the system waits until the servo program currently running is complete before proceeding to the next motion control step (servo program).

Furthermore, if the program is interrupted during consecutive execution, execution is resumed from the interrupted servo program.

(2) Example of servo program with M-code

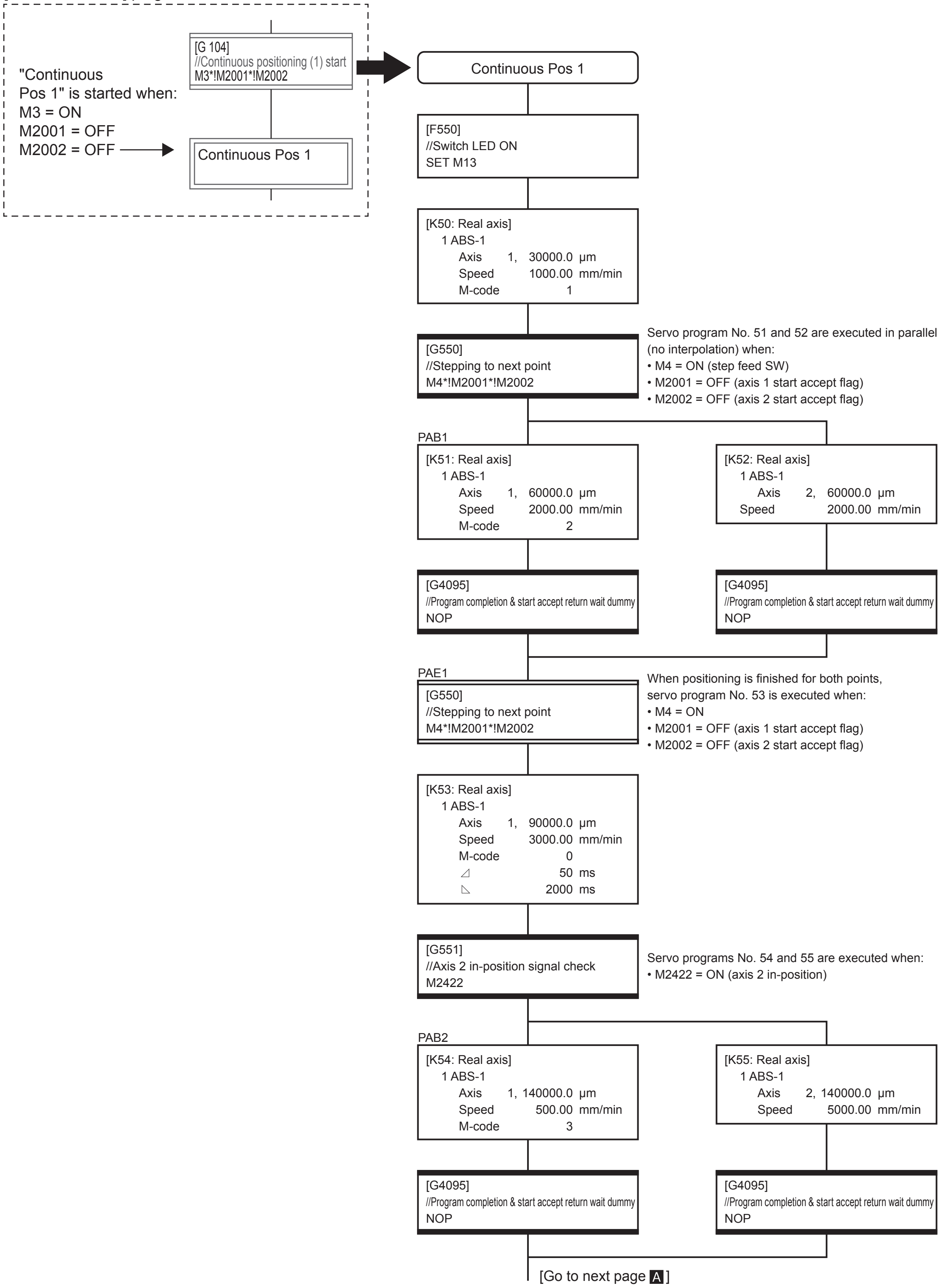
M-codes 0 to 255 are added to servo programs, and by running these programs, M-code Nos. are entered in the M-code monitor register.

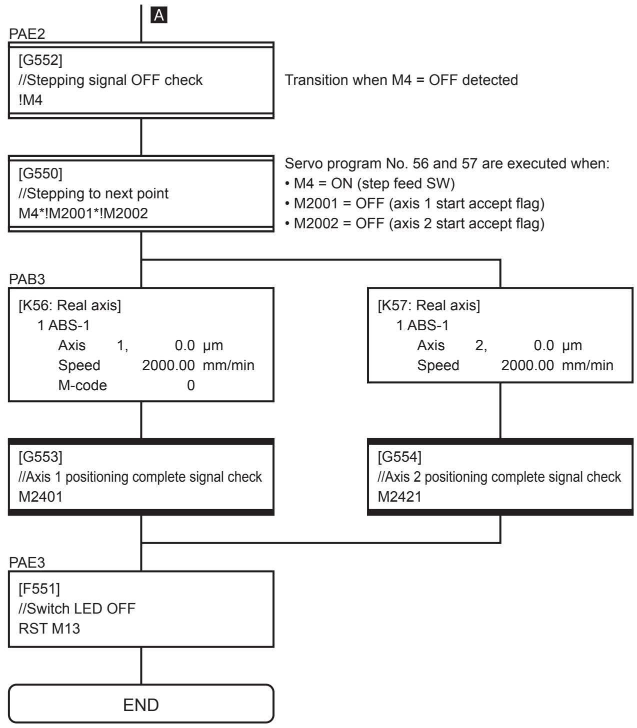
Data is also sent to the PLC CPU by setting auto refresh (user setting), and therefore if monitored with the sequence program comparison instruction, the M-code No. is known, allowing the operation determined beforehand to be performed.

```
[K 50: Real axis]
   1 ABS-1
      Axis      1,      30000.0  μm
      Speed             1000.00  mm/min
      M-code                  1  ←── M-code 1 is added.
```

(3) Motion SFC program

[Pos ControlMain] program



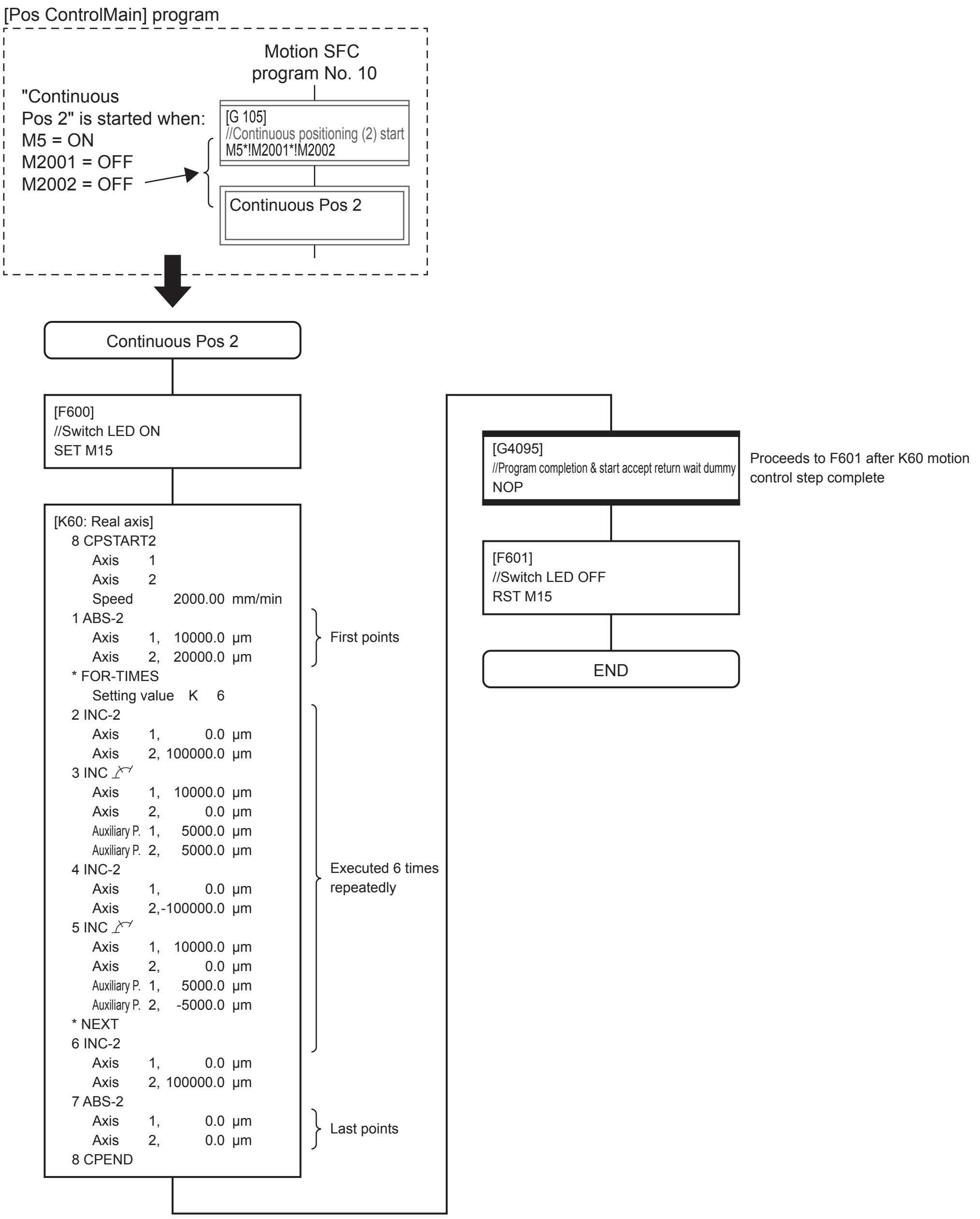

A
PAE2
[G552]
//Stepping signal OFF check
!M4
Transition when M4 = OFF detected
[G550]
//Stepping to next point
M4*!M2001*!M2002
Servo program No. 56 and 57 are executed when:
• M4 = ON (step feed SW)
• M2001 = OFF (axis 1 start accept flag)
• M2002 = OFF (axis 2 start accept flag)
PAB3
[K56: Real axis]
1 ABS-1
Axis 1, 0.0 μm
Speed 2000.00 mm/min
M-code 0
[K57: Real axis]
1 ABS-1
Axis 2, 0.0 μm
Speed 2000.00 mm/min
[G553]
//Axis 1 positioning complete signal check
M2401
[G554]
//Axis 2 positioning complete signal check
M2421
PAE3
[F551]
//Switch LED OFF
RST M13
END

Appendix 1.2.4 Continuous positioning (2)

This is an example of a program used to perform continuous interpolation between multiple points with 2-axis constant speed control.

Even with independent servo programs, multiple operations are possible if the operation pattern is fixed.

[Motion SFC program]

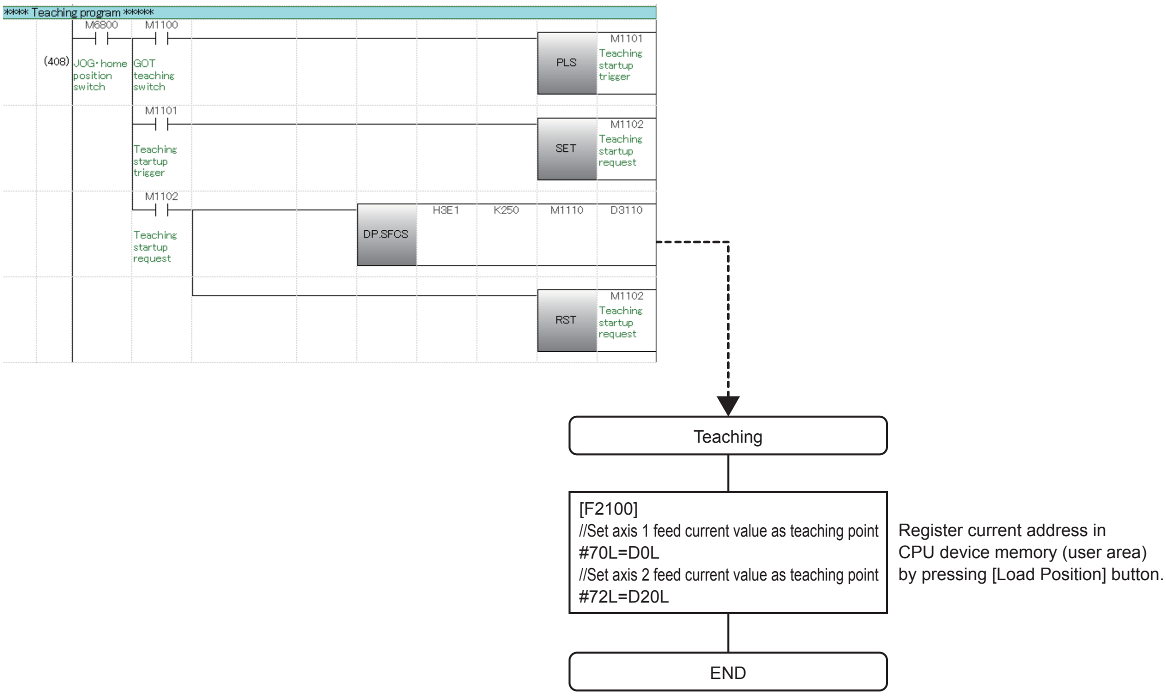


Appendix 1.2.5 Teaching, Teaching playback

Teaching programs are used to register positions (with push button operation) to which axes are moved to manually with JOG operation and so on, and teaching playback programs are used to perform position at registered addresses.

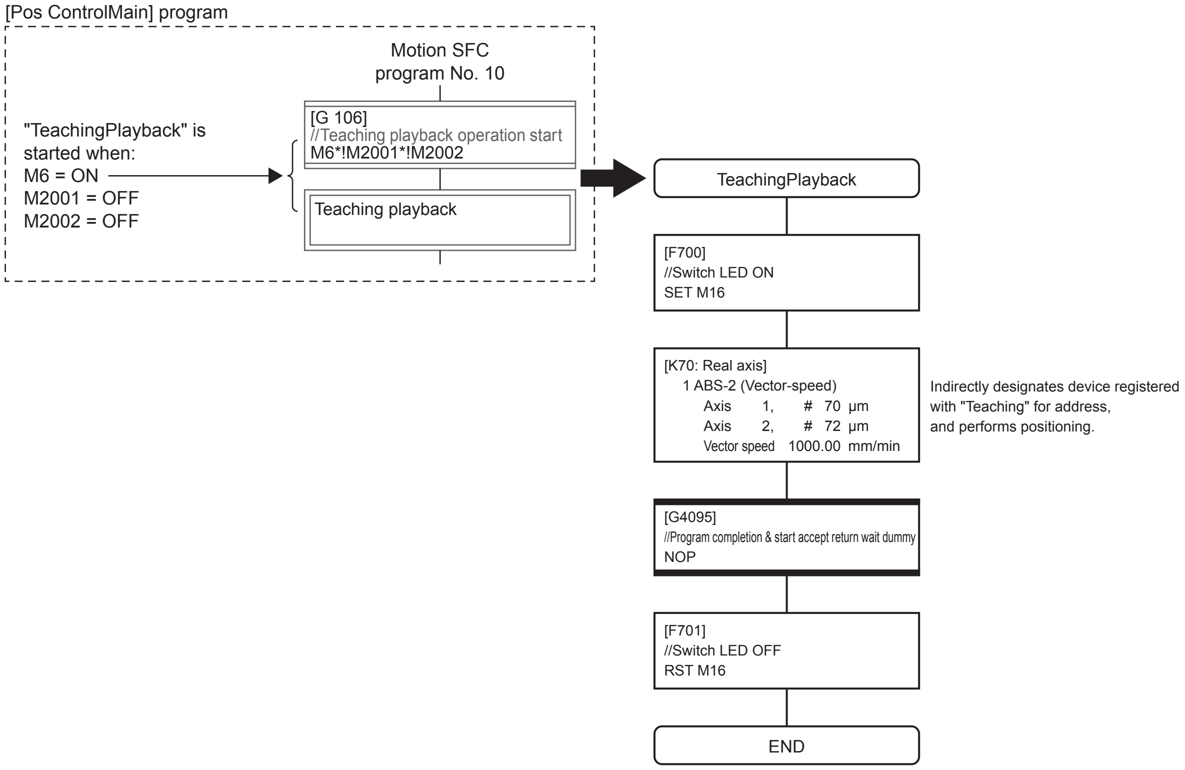
Motion SFC program No. 250 [Teaching]

Register the current address by pressing the [Load Position] button on the demonstration machine operation panel.



Motion SFC program No. 70 [TeachingPlayback]

Perform positioning at the address registered with teaching.



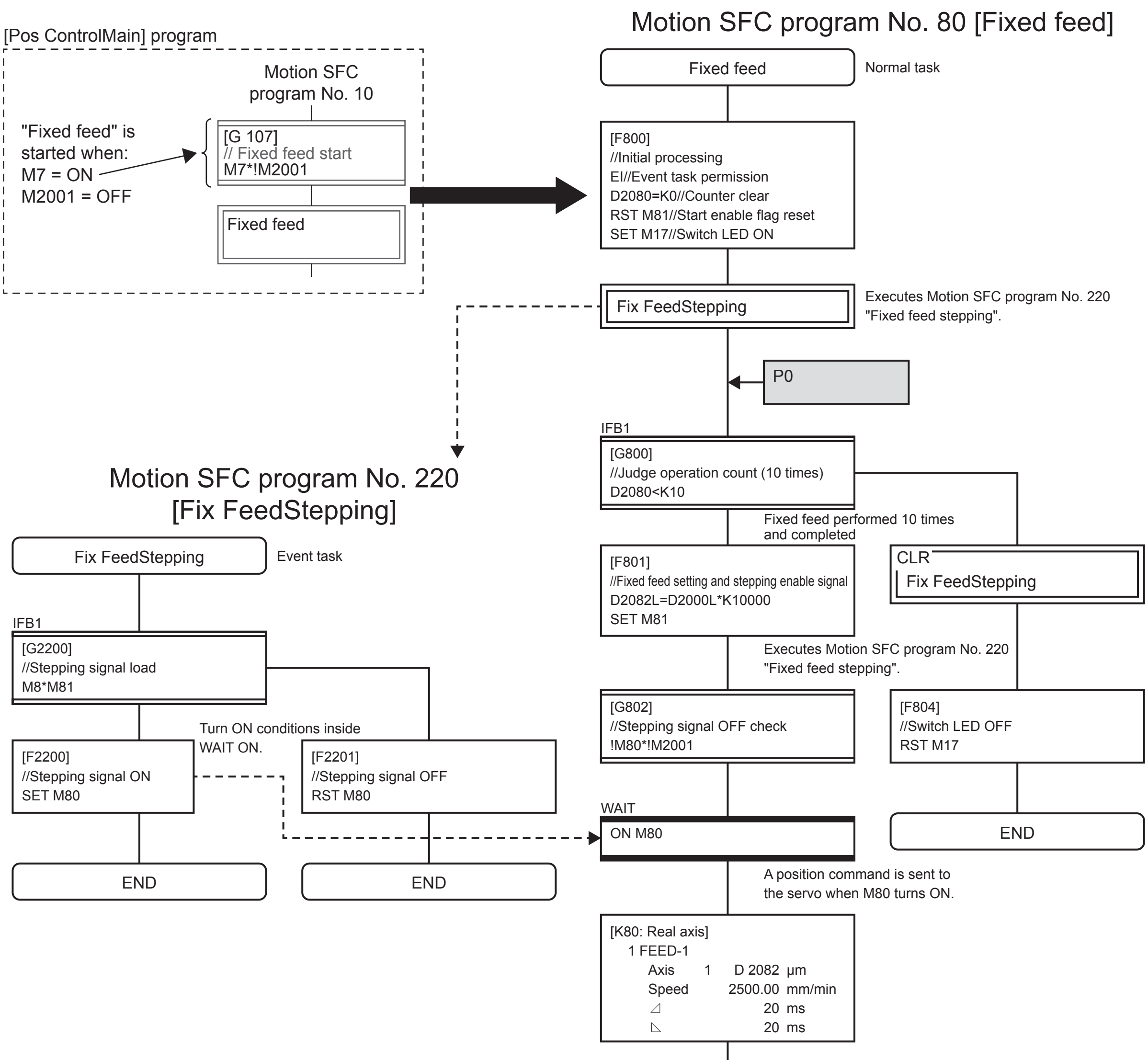
Appendix 1.2.6 Fixed feed, Fix feed stepping

Operations in which workpieces of fixed length are fed at fixed timing such as when inputting signals are known as fixed feed.

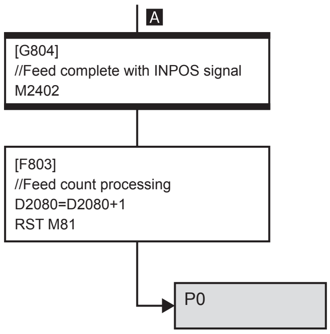
If there are many fixed feed, and the interval between signals is short, there may be times when it is necessary to shorten the start time between signal input and the start of operation.

With this program example, the following effective functions are used in such a case.

- WAIT-ON (WAIT-OFF) instruction: Performs start preparations for the next motion control step beforehand.
- Event tasks: Periodically runs a Motion SFC program at a fixed cycle (0.888 ms).



[Go to next page A]



The task type and operating conditions for each program are set in the "Motion SFC Parameter".
"Motion SFC Parameter" are located in the Project window "Motion SFC Program" → "Motion SFC Parameter".

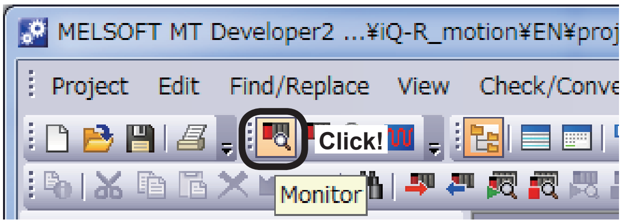
Appendix 1.3 Demonstration Machine Operation

Appendix 1.3.1 Operation

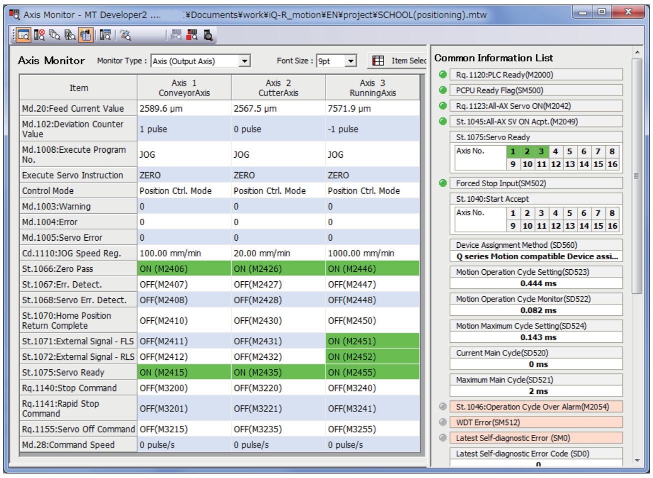
You will practice the following two operations.

1. Teaching/Teaching playback
   Run the SFC program for teaching to memorize positions of axes 1 and 2. Then, run the SFC program for teaching playback to see that return operation of axes 1 and 2 to the memorized positions.
2. Fixed feed/Fixed feed stepping
   Run the two SFC programs, fixed feed and fixed feed stepping, to see that fixed feed operation takes place normally.

First, servo motors are run and servo motor operation is monitored with MT Works2.



(1) Click the monitor tool button.



(2) The monitor window Current Value Expansion Monitor appears.

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[Teaching/TeachingPlayback]

Teaching

(1) Press [Servo ON M1000] at the demonstration machine operation panel.

(2) Press [JOG/ home position return].

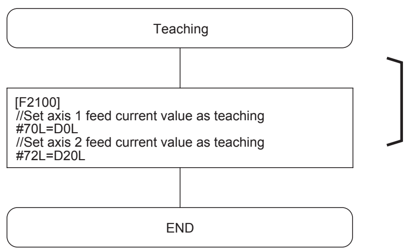
(3) Enable [JOG/home position M6800] button.

(4) Perform JOG operation using the "JOG operation" [M1010] and [M1011] buttons for axis 1 and [M1012] and [M1013] buttons for axis 2.

(5) Turn ON "Teaching" address memory [M1100] button, and register the position moved to with JOG operation.

(6) Perform JOG operation using the "JOG operation" [M1010] and [M1011] buttons for axis 1 and [M1012] and [M1013] buttons for axis 2 to move each axis to an appropriate position.

[Teaching] program (Motion SFC program No. 250)



With address memory [M1100] ON, start Motion SFC program [Teaching].
Substitute the axis 1 and 2 current values (D0, D20) for #70 and #72.

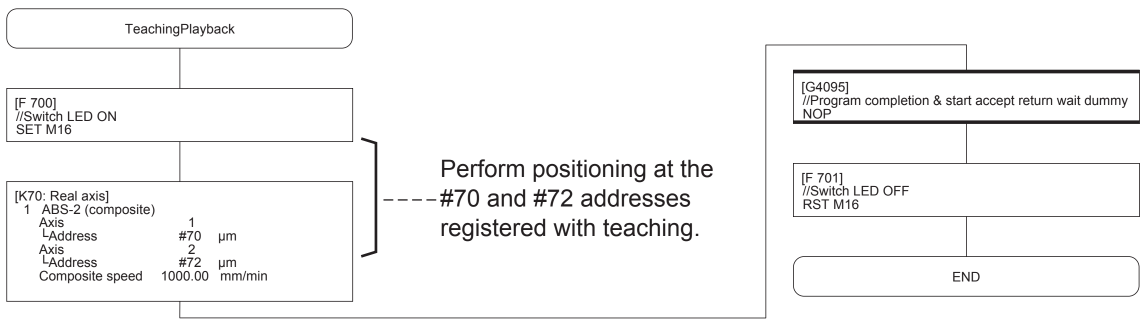
TeachingPlayback

Change to the Positioning control screen.

(1) Press [Positioning operation] to turn ON the running lamp.

(2) By pressing [Teaching M6] on the screen, positioning is performed at the registered address.

[TeachingPlayback] program (Motion SFC program No. 70)



Perform positioning at the #70 and #72 addresses registered with teaching.

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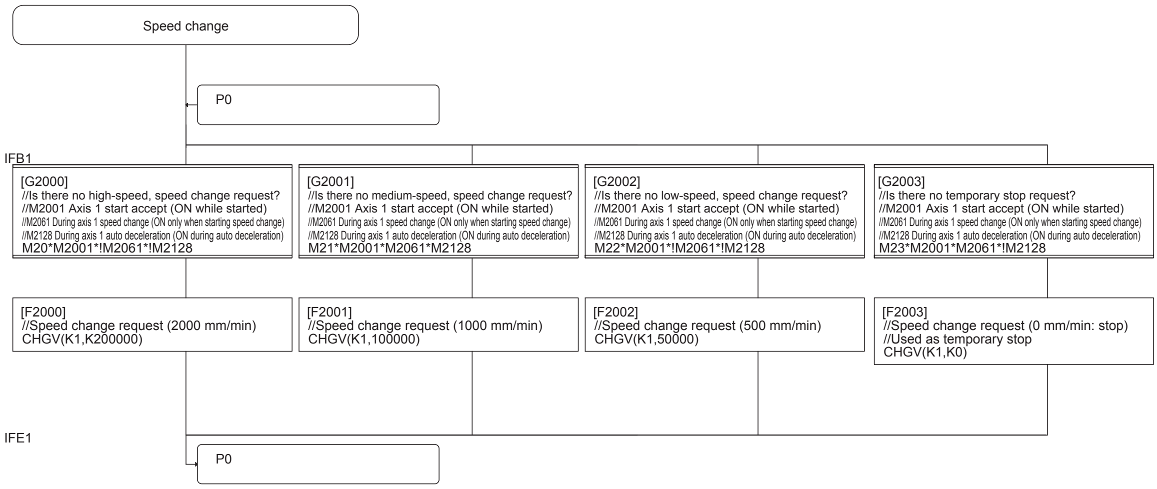
Speed change
Speed change/temporary stop during operation (operation during continuous positioning, constant speed control, speed control)

Speed change switch on the demonstration machine operation panel

- By turning ON the [2000 M20], the speed changes to 2000 mm/min.
- By turning ON the [1000 M21], the speed changes to 1000 mm/min.
- By turning ON the [500 M22], the speed changes to 500 mm/min.
- By turning ON the [0 M23], movement stops temporarily.

* The speed may be changed multiple times during operation. However, do not perform operation during home position return or during deceleration.
A minor error will occurs that lights up the error lamp.

[Speed change] program (Motion SFC program No. 200)

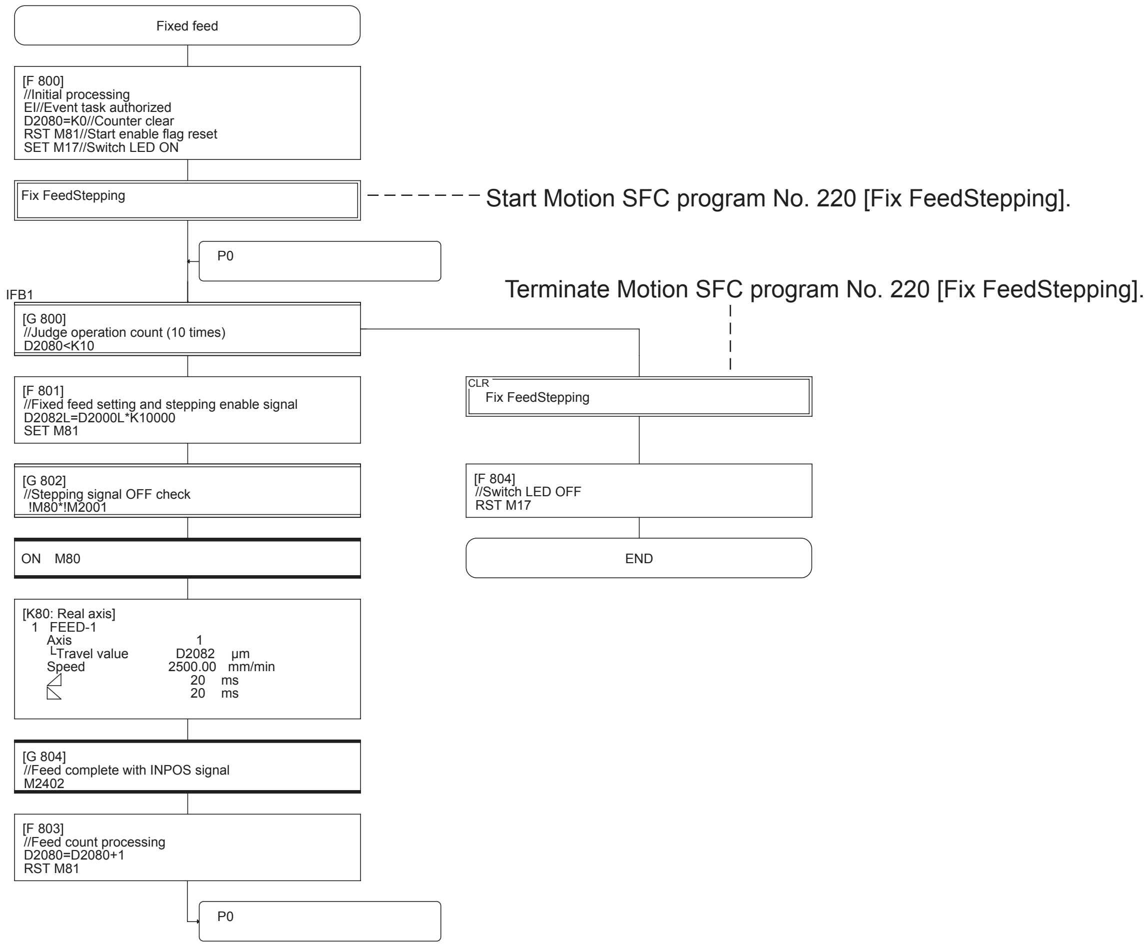


From previous page

[Fixed feed, Fix FeedStepping]

- Fixed feed, fixed feed advance
  Change to the Positioning control screen.
  (1) Press [Servo ON M1000] at the demonstration machine operation panel.
  (2) Press [Positioning operation] to turn ON the running lamp.
  (3) On the demonstration machine operation panel, set the D2000 setting of “Specify by numeric values” to “10”. (Set the No. of fixed feed to "10".)
  (4) Press the [Enable fixed pitch M7] button to permit fixed feed operation. (This provides the permission only and does not cause to move.)
  (5) Fixed feed is performed once each time the [Excute fixed pitch M8] button is pressed, and stops after ten times.

[Fixed feed] program (Motion SFC program No. 080)



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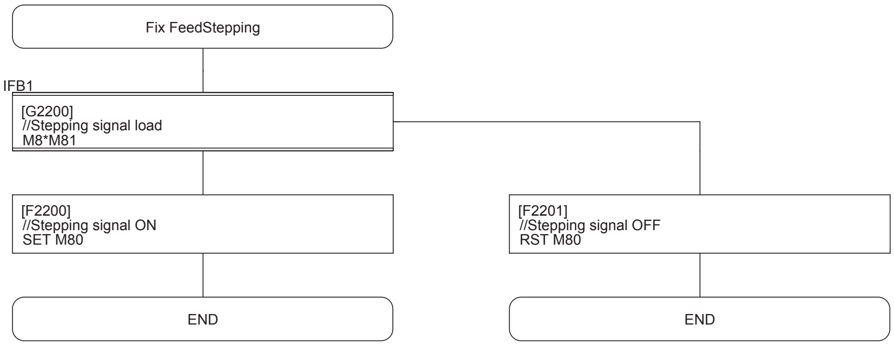
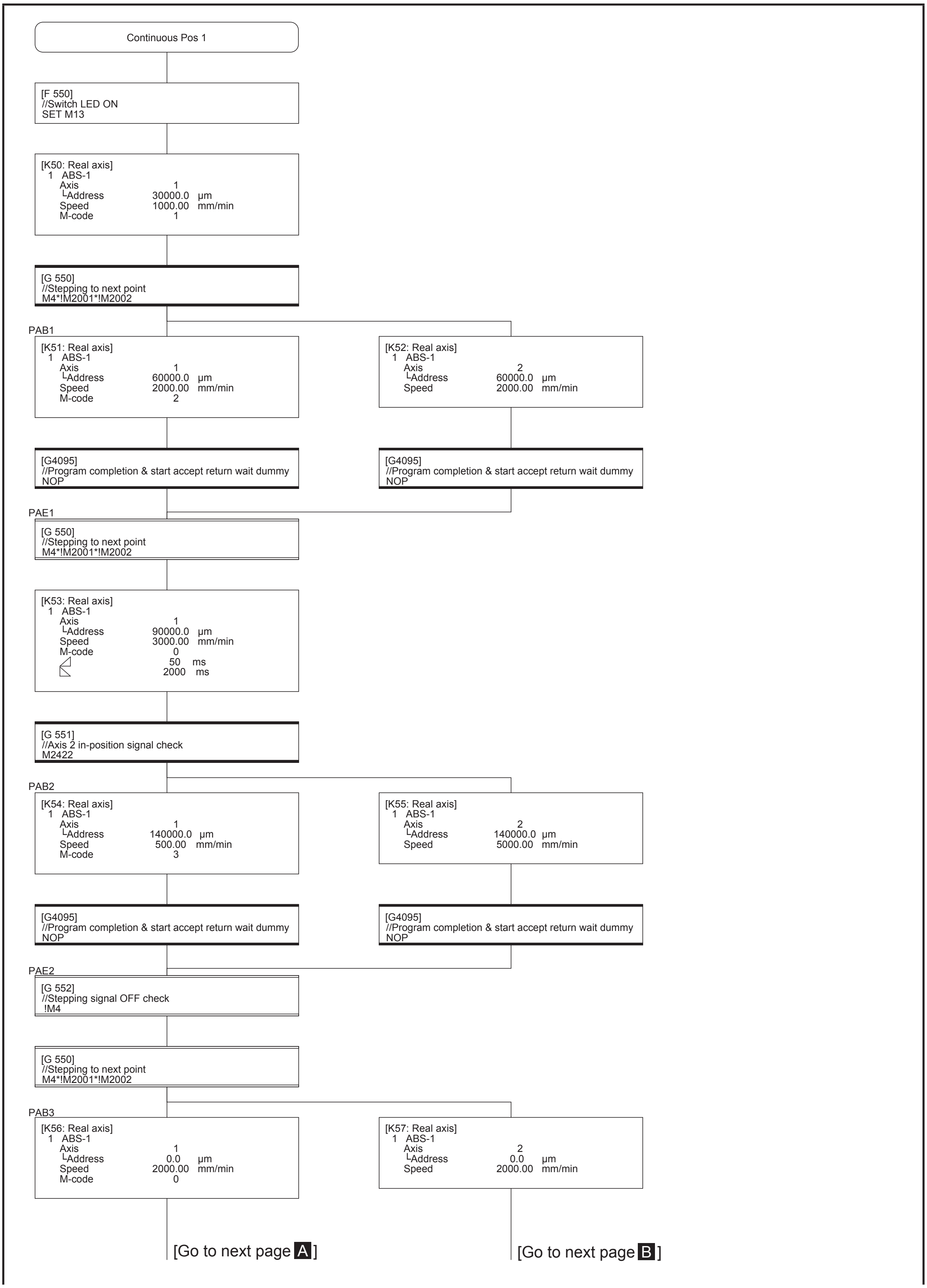
[Fix FeedStepping] program (Motion SFC program No. 220)



Operation complete

Appendix 1.4 SFC program list

[Continuous Pos 1] program No. 050

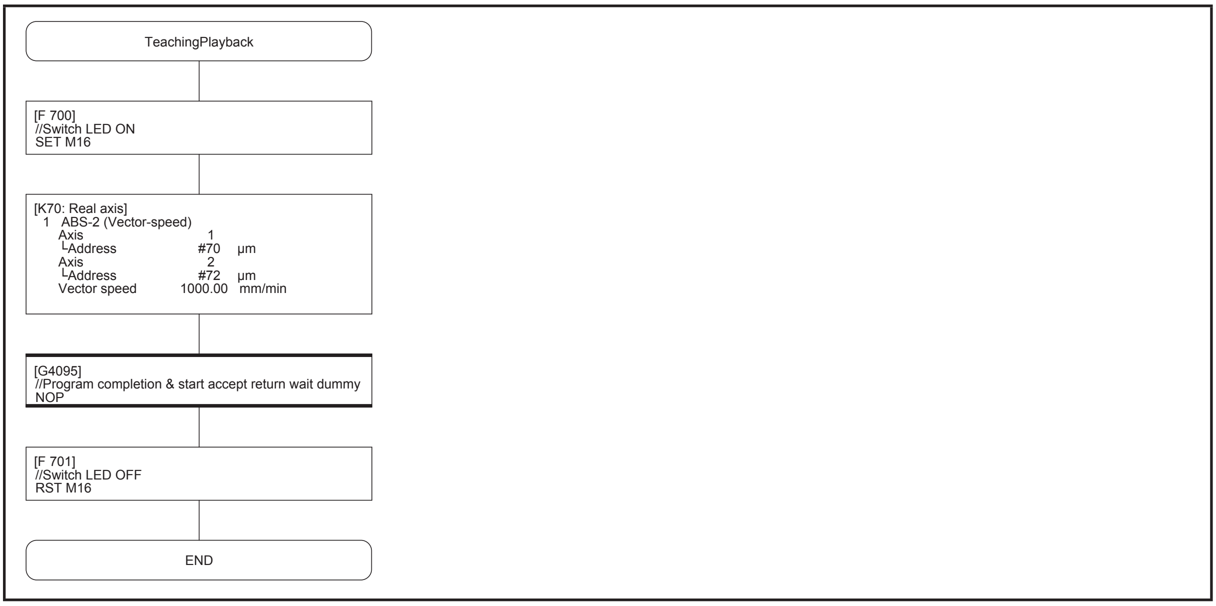


```
        [A]                                   [B]
         |                                     |
[G 553]                               [G 554]
//Axis 1 positioning complete signal check   //Axis 2 positioning complete signal check
M2401                                 M2421
         |                                     |
PAE3     +-------------------------------------+
[F 551]
//Switch LED OFF
RST M13
         |
        END
```

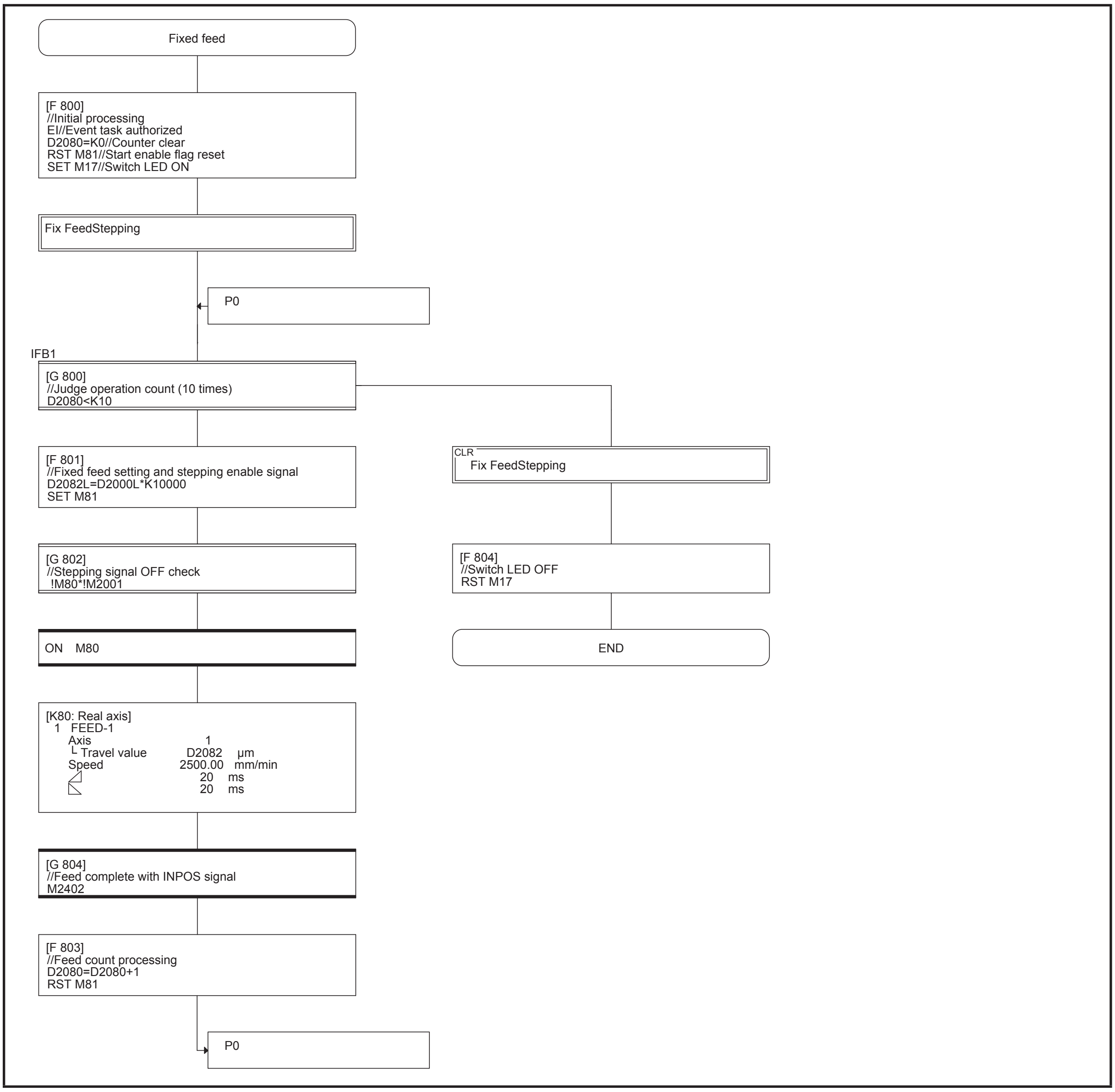
[Continuous Pos 2] program No. 060

```
Continuous Pos 2
   |
[F 600]
//Switch LED ON
SET M15
   |
[K60: Real axis]
  8   CPSTART2
      Axis                    1
      Axis                    2
      Speed                2000.00   mm/min
  1   ABS-2
      Axis                    1
       └Address           10000.0   μm
      Axis                    2
       └Address           20000.0   μm
    *FOR-TIMES
      Setting value          K6
  2   INC-2
      Axis                    1
       └Travel value          0.0   μm
      Axis                    2
       └Travel value     100000.0   μm
  3   INC ⌒
      Axis                    1
       └Travel value      10000.0   μm
      Axis                    2
       └Travel value          0.0   μm
      Auxiliary P.            1
       └Travel value       5000.0   μm
      Auxiliary P.            2
       └Travel value       5000.0   μm
  4   INC-2
      Axis                    1
       └Travel value          0.0   μm
      Axis                    2
       └Travel value    -100000.0   μm
  5   INC ⌒
      Axis                    1
       └Travel value      10000.0   μm
      Axis                    2
       └Travel value          0.0   μm
      Auxiliary P.            1
       └Travel value       5000.0   μm
      Auxiliary P.            2
       └Travel value      -5000.0   μm
    *NEXT
  6   INC-2
      Axis                    1
       └Travel value          0.0   μm
      Axis                    2
       └Travel value     100000.0   μm
  7   ABS-2
      Axis                    1
       └Address               0.0   μm
      Axis                    2
       └Address               0.0   μm
  8   CPEND
   |
[G4095]
//Program completion & start accept return wait dummy
NOP
   |
[F 601]
//Switch LED OFF
RST M15
   |
  END
```

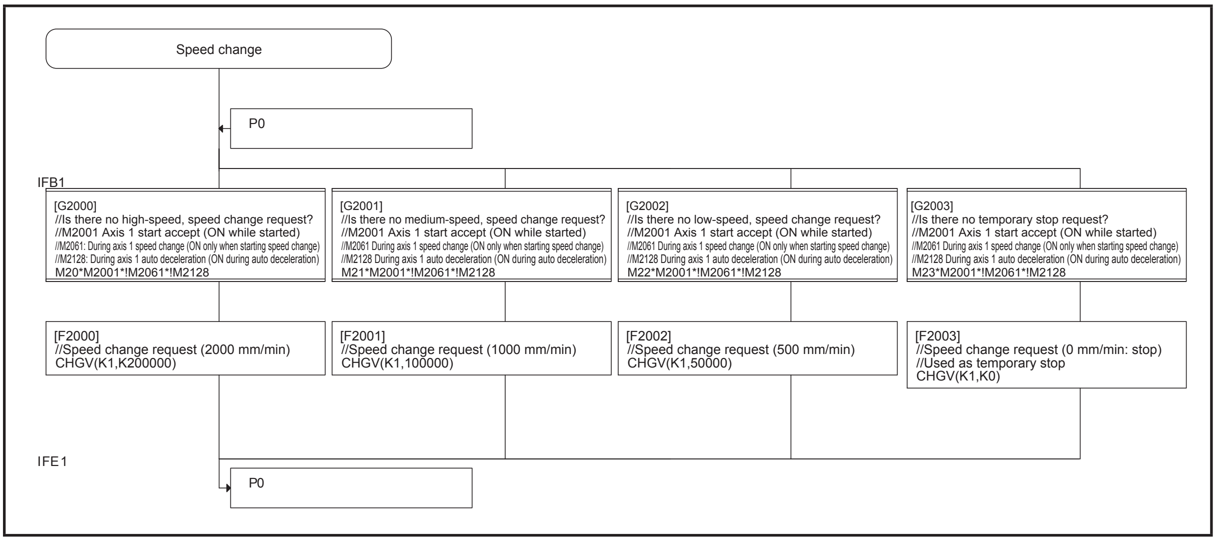
[TeachingPlayback] program No. 070



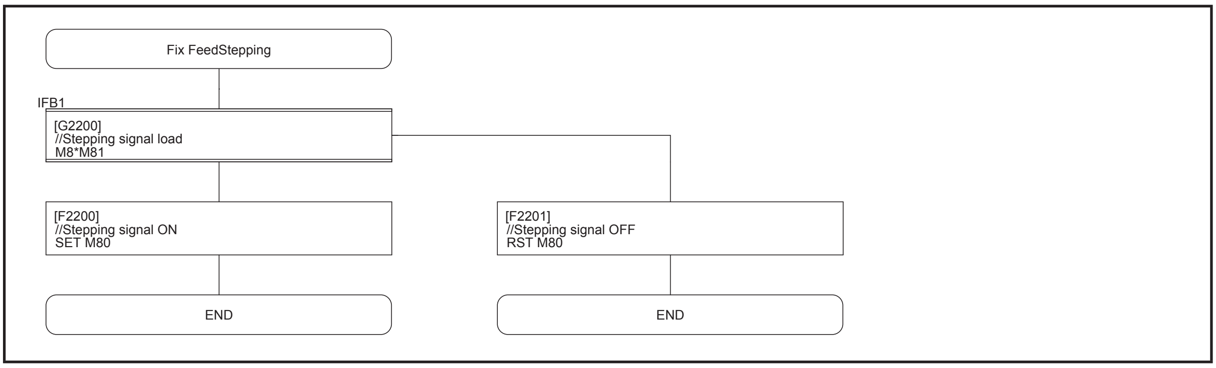
[Fixed feed] program No. 080



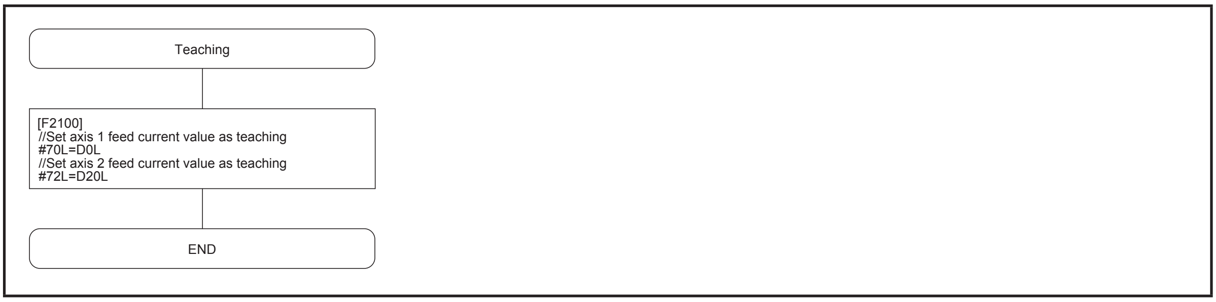
[Speed change] program No. 200



[Fix FeedStepping] program No. 220



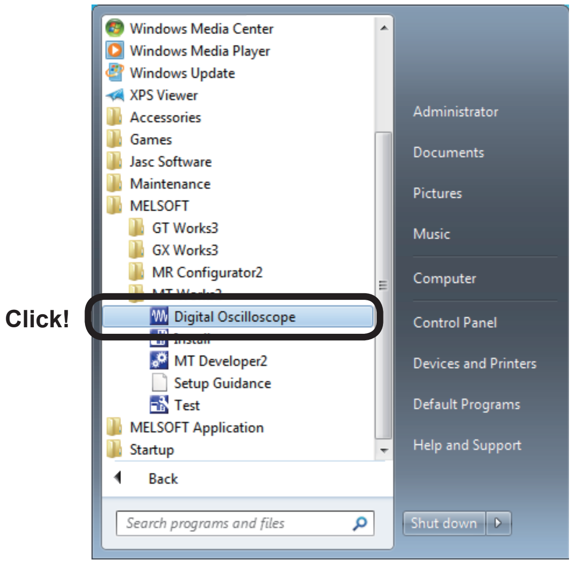
[Teaching] program No. 250



Appendix 2 Digital Oscilloscope

Position commands, position droop, motor speed, motor current, and speed commands and so on can be traced with the MT Works2 digital oscilloscope.
Refer to the performance specifications (digital oscilloscope) in the MT Developer2 Help.

(1) Communication settings



1: Click the Windows® [start] button, and then select [All Programs] → [MELSOFT] → [MT Works2] → [Digital Oscilloscope].

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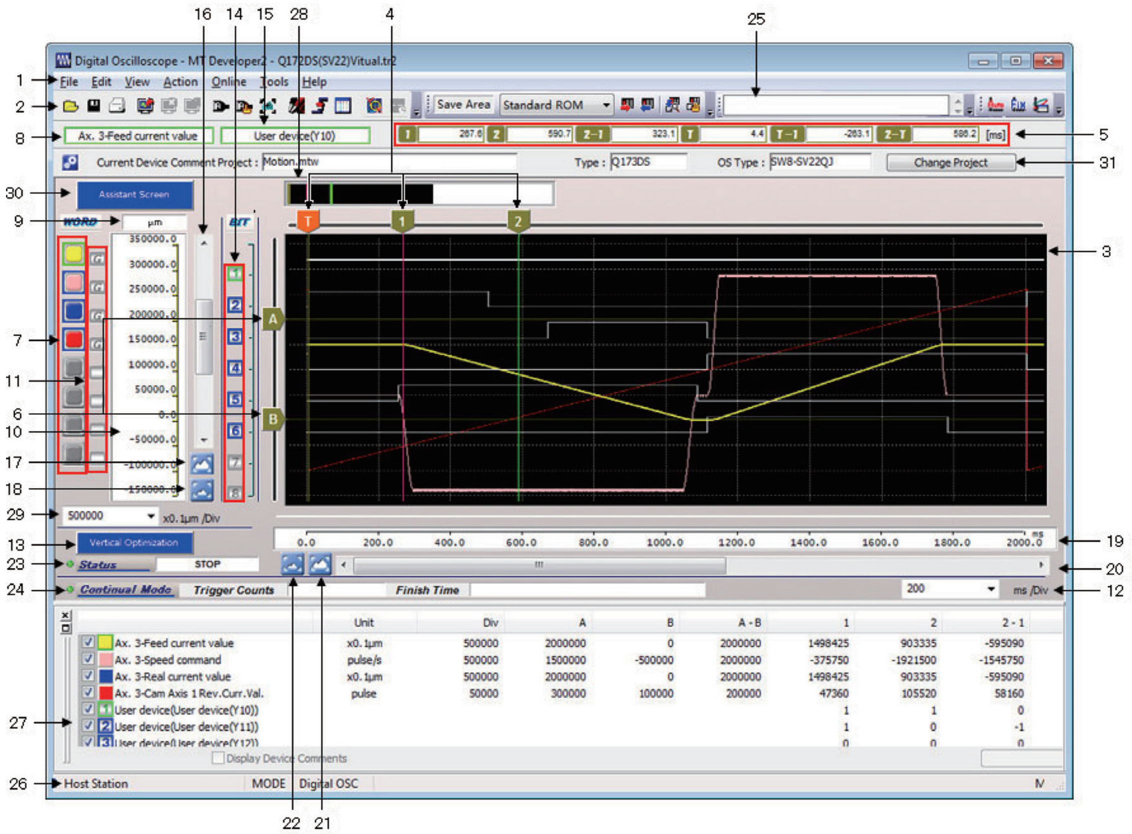
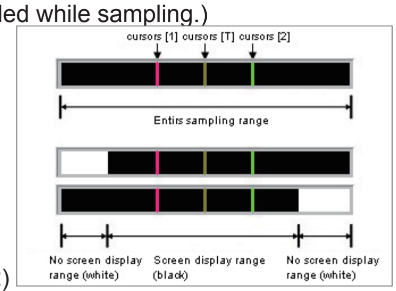
2: A Digital Oscilloscope window appears.



No.	Item	Details
1	Menu bar	This menu is used to perform each function.
2	Toolbar Save Area Standard ROM	Displays tool buttons used to perform each function. Select Read, Write, or Delete of sampling setting files from the standard ROM or the SD memory card.
3	Waveform display area (Time axis indication)	Displays word data and bit data waveforms.
	Waveform display area (Two dimensional locus display)	Two dimensional locus of X axis and Y axis appear. If the mouse cursor is in the display area, the coordinate tool hint appears at the cursor point.
4	X-axis cursors [1], [2], [T] (Time axis indication)	Displays X-axis cursors [1] and [2], and trigger cursor[T].
	X-axis cursors [1], [2] (Two dimensional locus display)	Displays X-axis cursors [1] and [2].
5	X-axis cursor position (Time axis indication)	Displays X-axis cursors [1] and [2] and trigger cursor[T] position (time), and the time between cursors. (Unit: ms)
	Cursor position (Two dimensional locus display)	Displays X-axis and Y-axis cursors [1], [2], [A], and [B] position, and the difference between the cursors.
6	Y-axis cursors [A], [B]	Displays Y-axis cursors [A] and [B].
7	Word waveform selection button	Selects the word waveform subject to operation.

No.	Item	Details
8	Word waveform item name (Time axis indication)	Displays the probe name for the word waveform selected with the word waveform selection button.
	X axis probe setting (Two dimensional locus display)	Displays the probe name selected for the X axis. (Fig. 1) 
	Y axis probe setting (Two dimensional locus display)	Displays the probe name selected for the Y axis. (Fig. 1)
9	Word waveform item unit	Displays the data unit for the word waveform selected with the word waveform selection button.
10	Word waveform selection item scale (Time axis indication)	Displays the data scale value for the word waveform selected with the word waveform selection button.
	Y-axis scale (Two dimensional locus display)	Displays the scale (unit) of the probe specified for the Y axis.
11	GND level button	Displays the GND(0) existence, and changes between the word waveform and GND level display.
12	X-axis 1 Division setting field (Displays only in FIXED grid mode.)	Changes the X-axis 1 Division setting.
13	Y-axis scale optimization button (Displays only in FIXED grid mode.)	Automatically adjusts Y-axis divisions so that the selected word waveform can be displayed inside a single screen.
14	Bit waveform selection button (Time axis indication only)	Selects the bit waveform subject to operation
15	Bit waveform selection item display field	Displays the probe name for the bit waveform selected with the word waveform selection button.
16	Y-axis waveform scrollbar	Scrolls the word waveform selected with the word waveform selection button in the Y-axis direction.
17	Vertical waveform enlarge button ()	Enlarges the scale of the word waveform selected with the word waveform selection button.
18	Vertical waveform reduce button ()	Reduces the scale of the word waveform selected with the word waveform selection button.
19	X-axis (time) scale (Time axis indication)	Displays the X-axis (time axis) scale.
	X-axis scale (Two dimensional locus display)	Displays the scale of the X axis probe.
20	X-axis waveform scrollbar	Scrolls through the entire waveform in the X-axis direction.
21	Horizontal waveform enlarge button ()	Enlarges the entire waveform in the horizontal direction.
22	Horizontal waveform reduce button ()	Reduces the entire waveform in the horizontal direction.
23	Status	Displays the status when sampling.
24	Continual mode status	Displays the status during execution in trigger type Continual mode.
25	File comment	Displays a comment for the currently displayed file.
26	Status bar	Displays digital oscilloscope status information.

No.	Item	Details
27	Docking window (Cursor window)	Displays cursor position data and the difference between cursors as the X-axis and Y-axis cursors move.
28	MAP window (Time axis indication)	Displays which area of the 100% sampling data is the data area (X-axis range) displayed in the graph display field with a black band. (Fig. 2 below) The display area is only the X-axis scale range. The Y-axis scale display area is not applicable. By left-clicking any position in the MAP window, a graph displays with the clicked X-axis position as the center (vicinity). (Enabled while sampling.) (Fig. 2) 
	Two dimensional locus display reproduction function (Two dimensional locus display)	This item reproduces the locus when a sampling result is present.
29	Word waveform scale mode display/change field (Time axis indication) (Displays only in AUTO grid mode.) 	Displays/changes the data scale mode for the word waveform selected with the word waveform selection button. • Manual scale [FIX] button: If the word waveform scale mode is changed to MANUAL, enlarge/reduce (range adjustment) the Y-axis scale, scroll the Y-axis (display area), and adjust the GND(0) position, and then press the FIX button to set the scale.
	Y-axis 1 Division setting (Time axis indication) (Displays only in FIXED grid mode.)	Changes the Y-axis 1 division setting for the selected word waveform.
	Waveform scale mode display (Two dimensional locus display)	Displays only AUTO grid mode. (Indication is AUTO)
30	Assistant screen display button	Displays the Assistant screen. The display changes from [STOP -> Assistant screen] while running.
31	Device comment project bar	Displays the set content for the current device comment project.

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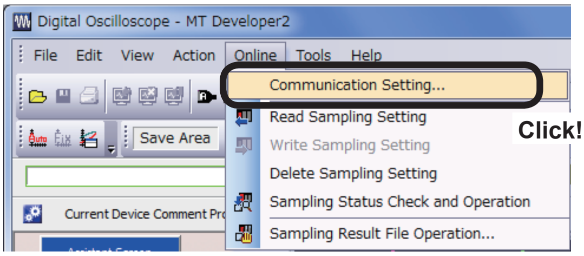
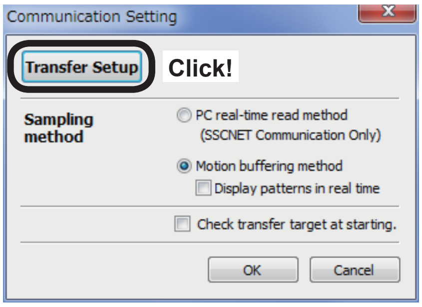
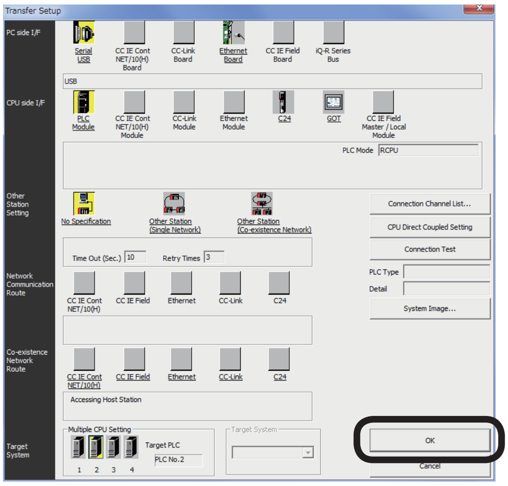


3: Click [Communication Setting…] on the digital oscilloscope [Online] menu to specify communication settings.



4: A Communication Settings dialog box appears. Select "Motion buffering method" (select the check box to display waveforms in real time) for the "Sampling method", and select "ONLINE" for the "Operation mode". When settings are complete, click the Transfer Setup button.

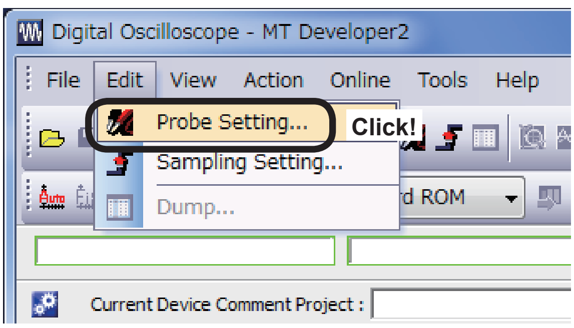


Click!

5: Specify the following settings at the Transfer Setup dialog box that appears, and then click the OK button.
- Computer I/F: Serial USB
- CPU I/F: PLC Module
- Other station Setting: No specification
- Target system: Multiple CPU Setting No. 2 CPU

6: The display then returns to the Communication Setting dialog box. Click the OK button.

(2) Waveform measurement



1: Select the item to be probed.
Click [Probe Setting...] on the [Edit] menu at the Digital Oscilloscope window.

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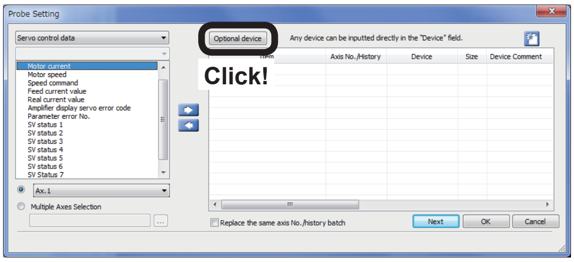
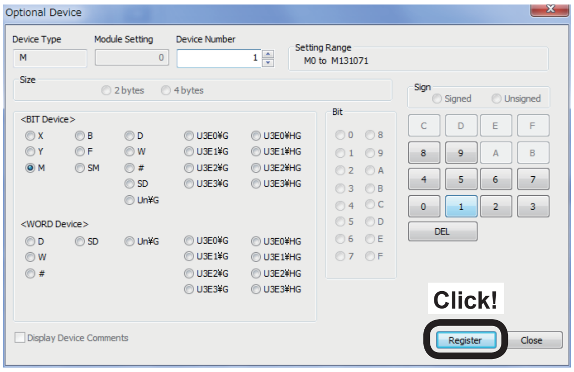
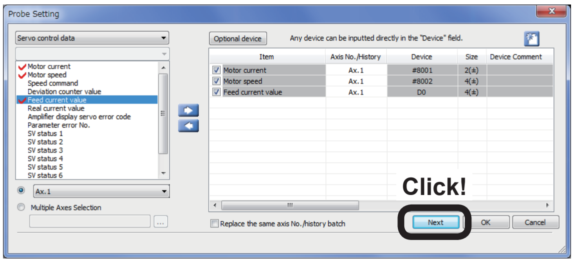


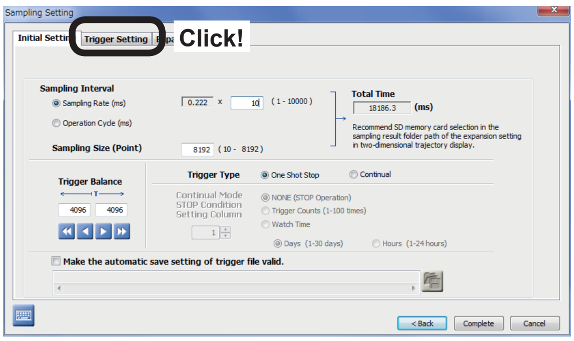
2: Click the Optional device button at the Probe Setting screen that appears.



3: Select the check box and use the ten-key pad to enter "M1" at the Optional device screen, and then click the Register button.



4: The display then returns to the Probe Setting screen. Select the item to be set, and then click [icon] to register.
Register the "Motor current", "Motor speed", and "Feed current value" here.
Click the Next button.



5: Set the trigger at the Sampling Setting screen that appears.
Specify the default settings as follows.
- Sampling Rate: 0.222 x 10 (ms)
- Sampling Size: 8192
- Trigger Type: Select "One Shot Stop".

6: Click the "Trigger Setting" tab.

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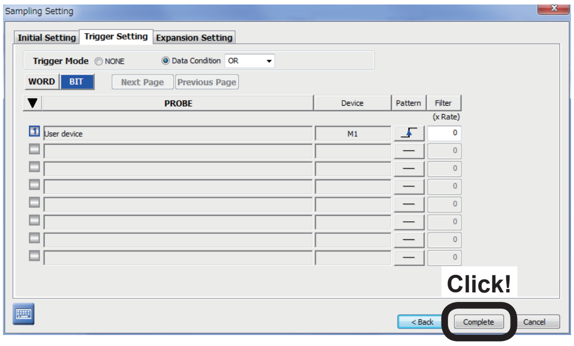
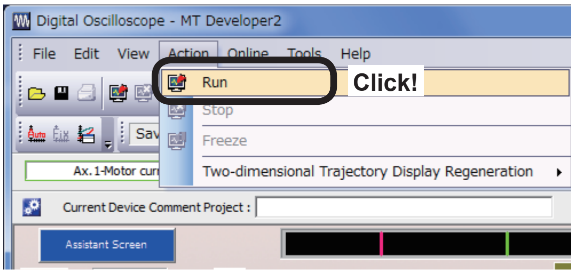


7: Specify the trigger settings as follows.
- Trigger Mode: Data Condition (OR)
- Pattern: (OFF→ON (startup))

Click the Complete button.



8: Click [Run] on the [Action] menu at the Digital Oscilloscope window.
Sampling is started.

9: Press Standby point at the demonstration machine operation panel to perform positioning to the standby point.

10: Set the setting numeric values (Setting for D2000) to "30" and press Position selection to perform positioning to the set point.
The trace monitor is executed.

11: Once buffering is complete when the trigger is established, a buffering data read dialog is displayed.

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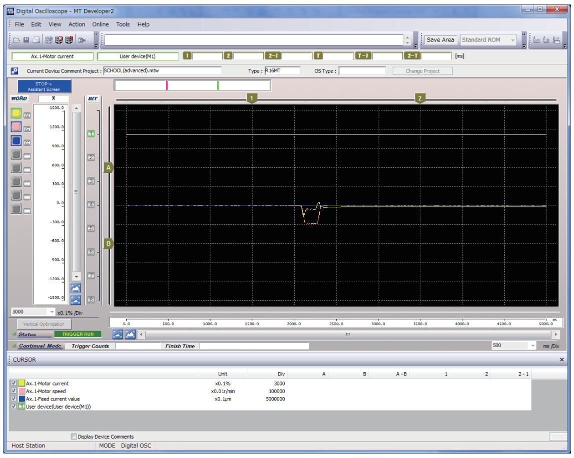


12: The waveform displays once buffering data reading is complete.

Appendix 3 Glossary

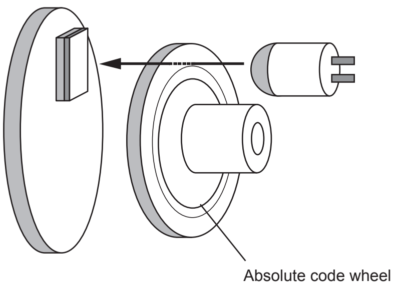
A

A acceleration

This means cam non-dimensional acceleration.
Non-dimensional acceleration is non-dimensional speed differentiated by non-dimensional time.
The maximum value is expressed with Am.
See "Am".
See "V".

Absolute encoder

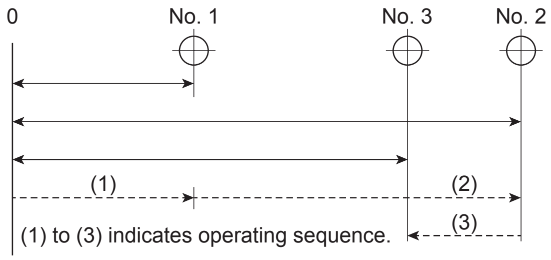
This is an absolute position detector that allows angular data contained in a single motor rotation to be output externally, and standard encoders allow 360 degrees to be extracted in 18 to 22 bits.
With incremental encoders, the axis position when a power outage occurs is lost, however, with absolute encoders, the axis position is retained, even in the event of a power outage.
See "Encoder".



Angular data contained in a single rotation is known the instant the power is turned back ON again, however, data for multiple rotations (how may rotations were made) is backed up with a battery.

Absolute mode

This is a method used to express the positioning address. This is an absolute address method.
This method expresses the distance from the reference 0. The positioning direction is determined automatically without being specified. There is also an incremental mode.



Absolute position system

By home position return once when starting up positioning control devices, current values are backed up with a battery even when the power is turned OFF, and machine displacements are compensated.
Consequently, there is no need to perform home position return after turning ON the power.
To construct this system, a servo amplifier compatible with servo motor with absolute position detector is required.

AC motor drive unit

This is a built-in servo amplifier capable of being connected to and driving a single servo motor.

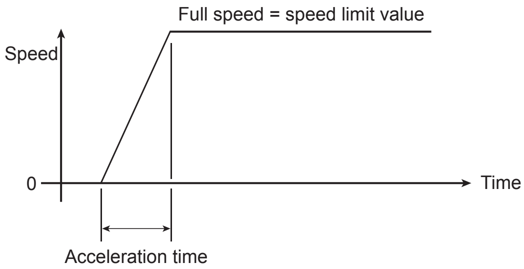
Acceleration

Acceleration is speed differentiated by time, and expresses the rate of change of speed.
Furthermore, acceleration is proportional to force.
See "A".

Acceleration time

This is the time taken to reach full speed from the stopped status with the motion controller.
The parameter acceleration time is the time taken to reach the speed limit value, and therefore becomes proportionally shorter if

the set speed is low. It is determined by such factors as the machine inertia and motor torque, and load resistance torque.

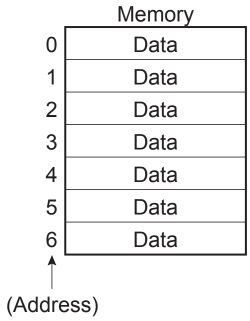


Actual current value

This is the actual servo travel amount pulse count calculated from feedback pulses.

Address

(1) Memory address. Memory holds addresses, and data is written and read by specifying these addresses.



(2) Numerical value indicating the target position when performing positioning. Units are set in mm, inches, degrees, or pulses.

Am acceleration

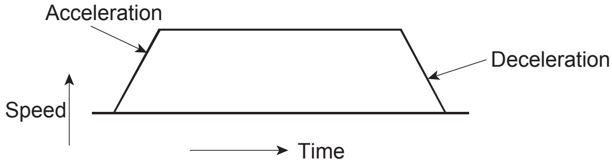
This is the cam non-dimensional acceleration maximum value.
See “A”.

Analog command

Converts command pulses inside the positioning module to analog voltage, and outputs the converted analog voltage to the servo motor drive unit.

Automatic trapezoidal acceleration/ deceleration

This is positioning movement in which the time and speed graph forms a trapezium.



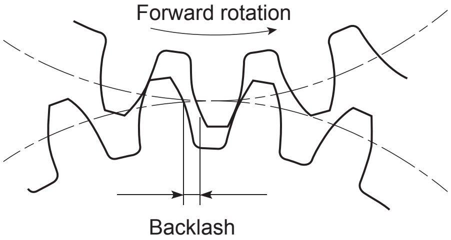
Auto tuning

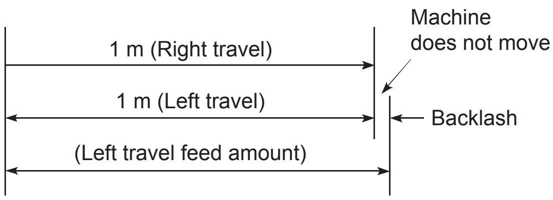
The responsiveness and stability of machines driven by servo motors is influenced by changes in the moment of inertia and rigidity resulting from changes in factors such as machine load.
This function is used to automatically adjust the speed loop gain and position loop gain based on the machine condition in order to maintain maximum machine performance.

B

Backlash compensation

Play (backlash) occurs as the movement direction changes from forward rotation to background rotation as the gears engage. The same phenomenon occurs even with screws, and it is not simply enough to feed an axis 1 m to the right when performing positioning and then feed 1 m back to the left to return the axis to its original position. The axis will not return to its original position until it has also been fed by the amount of play. This refers to the compensating of this play. This is similar to the "play" in car steering wheels.



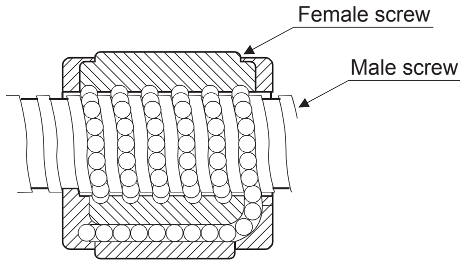


Backup function

(1) This function ensures that sequence programs and device statuses stored in the PLC CPU RAM memory are not forgotten even in the event of a power outage.
(2) This function is used on absolute position compatible systems to ensure that current values are not forgotten even in the event of a power outage.
(3) When replacing CPU modules, CPU data (servo programs, servo parameters, absolute position compatible data, etc.) is read by peripheral equipment, and then loaded following CPU replacement.

Ball screw

This is a type of screw, and has balls in the engaging part similar to ball bearings. There is very little backlash, and it can rotate with very little force, and so is used for positioning. See "Feed screw".



Base shut-off

The servo amplifier supplies power to the servo motor through power transistor switching.
Consequently, the base is shut off to stop power supply to the servo motor when the servo power turns OFF or when an alarm occurs. When this happens, servo motors are in a coasting condition.

Blank cover module

This is an empty module used to improve the appearance of vacant slots on the main base or expansion base.

Bottom dead center

This refers to the lower side of the machine installation route for the cam mechanism reciprocating motion.
This is the lower point of the cam.
See "Reciprocating cam".
See "Feed cam".

C

Cam

Machine element used to transfer anticipated movements through direct contact with a joint with contactor of simple shape such as a knife edge, roller, or planar shape.

Cam curve

The follower member motion curve moved with the cam can be set with a software package. There are various names of cam curves such as constant speed, constant acceleration, 5th power polynomial, cycloid, modified trapezoid, modified sine, modified constant velocity, trapecloid, double harmonic, and simple harmonic.

CHANGE signal

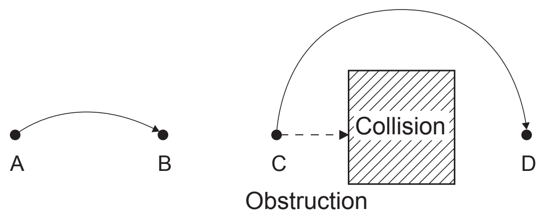
This is an external signal used to trigger position control while executing speed control.

Characteristics of cam curves

This is the speed and acceleration of cam curves.

Circular interpolation

Positioning is performed by running a horizontal direction motor and vertical direction motor simultaneously, the CPU performs the computations necessary to draw an arc, and interpolation is performed automatically.
Circles are created with auxiliary point designation, radius designation, and center point designation, and any obstructions found can be avoided.
See “Linear interpolation”.



Command in-position

This turns ON when the difference detected between the positioning address (command position) and feed current value with a signal found in the positioning data fixed parameters matches the set value.
Detection is made a little before the positioning end point address, and it is used to carry out preparatory work, etc.

Constant velocity curve

This curve is applied if necessary for axes to run at constant speed.

Constant speed control

With a single start command, positioning is performed to the end point at fixed speed while performing linear or circular specified positioning control to a predetermined pass point.
With a FOR/NEXT instruction, the same control as that for the pass point can be repeated.

Continuous pass

This is control such as constant speed control in which a route is followed without interruption.

Control unit

This is one of the basic units of positioning data, and is specified in mm, inches, degrees, or pulses.

In Japan, mm or degrees?
In the USA, inches or degrees?

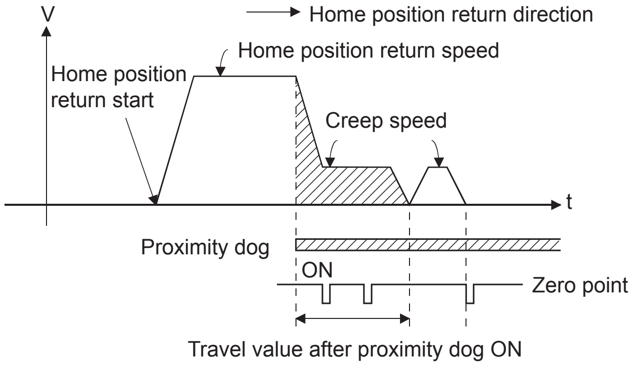
Pulses can also be used!

COPY

This means copying a part from the Edit screen to another location.

Count type home position return

The axis decelerates to creep speed when the proximity dog turns ON during home position return, and after moving the travel value after the dog turns ON, the subsequent home position signal is set as the home position address.
The proximity dog length can be ignored.
See “Home position return method”.



Creep

This is a low speed at which the axis moves a little before reaching the home position when performing home position return during positioning.
It is difficult to stop suddenly at a precise point when traveling at high speed, and therefore it is necessary to switch to creep speed.
See “Proximity dog type home position return”.

Current feed value

This is the number of calculated pulses corresponding to the travel distance output by the motion controller.

Current loop mode

This is also referred to as torque loop mode.
See “Position loop mode”.

Current value

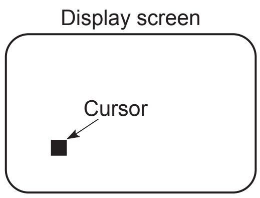
Current positioning control address

Current value change, current value rewrite

Refers to the teaching of temporary proximate values used for positioning when the machine is assembled and connected to the motion controller.
In addition, this function can be used to write temporary current values at such times as when current values are lost in the event of an accident, etc. By then performing home position return, the motion controller recognizes the home position. Changes to current values can be performed with a CHGA instruction during a positioning stoppage.

Cursor

Used to urge caution to the operator at display screens on peripheral equipment and CRTs, etc.



CUT

This means storing a part from the Edit screen to the system buffer.
Parts stored in the system buffer by cutting can be displayed on the Edit screen again by pasting.

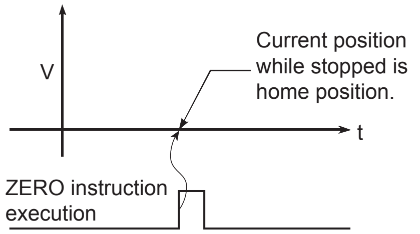
Cycloid curve

Commonly abbreviated to CY curve, this curve has been known for many years as a continuous curve, and has little excitation frequency component, making it ideal for high speed. On the downside, it has high characteristic values such as speed, acceleration, and inertia torque.

D

Data set type home position return

Sets the position at which the axis is currently stopped as the home position address.
No proximity dog switch is required.
See "Home position return".

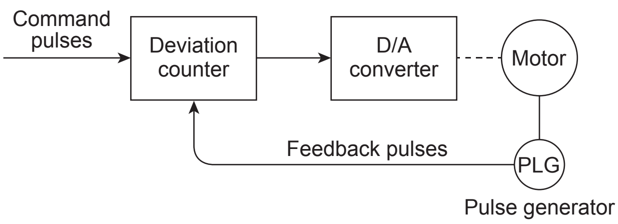


DELETE

This means deleting parts from the Edit screen.

Deviation counter

This counter is built in to the drive unit, and is used for positioning.
Feedback pulses are subtracted from motion controller command pulses, the command pulse and feedback pulse deviation value (droop pulses) are sent to the D/A converter, the motor is run, and if there are no command pulses, the motor is run until the number of droop pulses reaches 0.

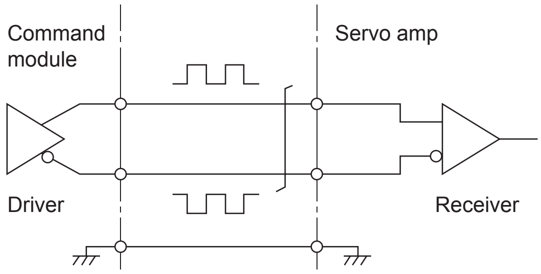


Differential gear

This is one transfer module in the virtual mode mechanical system program, and is used for auxiliary input for main shaft rotations.

Differential output

This is one type of encoder feedback pulse output.
If transferring a single signal, by transmitting signals with reversed polarity in pairs, the receipt side is able to judge by setting the signal logic, and its excellent noise resistant properties make it ideal for pulse train high speed signal transfer.



Digital bus connection

Commands output from the motion controller to servo amplifiers are generally in the form of a pulse train or analog output, however, this method involves issuing commands with digital values by connecting a bus line, facilitating the construction of highly reliable, high-speed, high-accuracy systems.

Direct clutch

This is one of the virtual mode mechanical system programs,
This transfer module clutch is a clutch with setting time of zero for which no smoothing time constant has been set.
See "Smoothing clutch".

Discontinuous curve

This is a constant speed curve or constant acceleration curve within a cam curve for which acceleration within an interval including both the start point and finish point is not continuous.

DOG signal

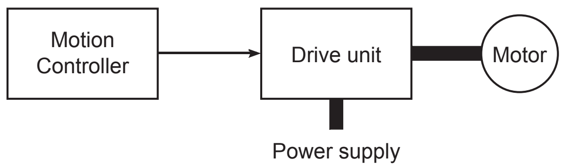
This refers to the home position proximity dog.

Drive module

This is one of the virtual mode mechanical system programs.
Refers to the pairing of a virtual servo motor and synchronous encoder used to rotate the main shaft and auxiliary input axes.

Drive unit

Commands (pulses, etc.) issued by the motion controller are of low voltage and current, resulting in insufficient energy to drive motors. This module amplifies these commands to drive motors.

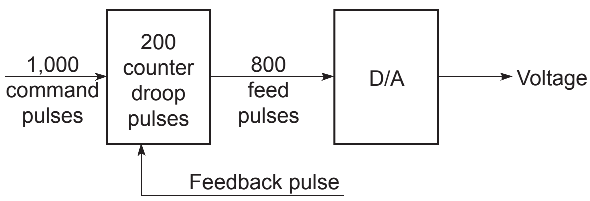


Drive unit ready

This signal indicates that the motor drive unit is ready.
The drive unit remains OFF if the power is OFF or if an accident occurs.

Droop pulses

As the machine has inertia (GD^2), if positioning module speed commands are issued as is, the machine becomes delayed and is therefore unable to keep up.
In the case of servo motors, speed command pulses are accumulated in the deviation counter to delay them. Droop pulses are these accumulated pulses. When the machine stops, the deviation counter discharges all pulses to leave the count at 0.
To be exact, the difference between feed pulses and feedback pulses is droop pulses.



Dynamic brake

When the protective circuits are triggered by a power outage or emergency stop condition (EMG signal), the dynamic brake is used to short the circuit via a resistor between servo motor terminals, consume rotation energy as heat, and stop axes suddenly without coasting the motor.
Braking power is generated only while motors capable of obtaining brake torque greater than that of electromagnetic brakes are rotating, and as there is no holding power when motors are stopped, mechanical brakes are also used to prevent vertical axes from falling.

Dwell

Dwell refers to a condition in which the axis is temporarily stopped, with no follower member displacement over the passage of a certain period of time.

Dwell period

This is the input axis rotation angle when the output axis is stopped, and the sum of this and the index period is 360°.

Dwell time

It takes time to calculate deviation counter droop pulses immediately after positioning is finished. Positioning will be inaccurate if this time is too short, and so a longer time is used for the dwell time.

E

EIA

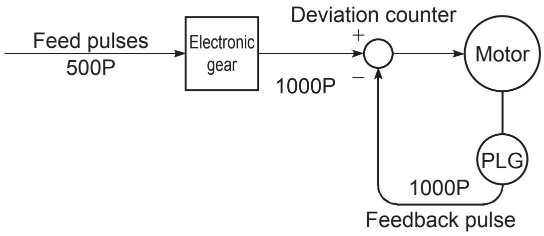
This is the EIA code (EIA standard) punched on the perforated paper tape used to instruct the NC unit to perform processing.
Other NC languages are ISO code (ISO standard) and JIS code (JIS standard).

EIA code

This is a tape code used for numerical control machine perforated paper tape stipulated by the Electronics Industries Association, and has 8 tracks including 6 bits used to show information, an odd number parity bit, and an EOB character (end of block).

Electronic gear

This function is used for positioning, and allows the feed value per feedback pulse to be changed freely. The feed pulse and feedback pulse ratio, in other words pulse rate, is selected based on the machine, however, the advantage of this function is that it can be set freely regardless of this machine system.



Electromagnetic brake

Electromagnetic brakes are installed on motors to prevent vertical axes slipping during power outages or when accidents occur, and for protection when motors are stopped.
This is a non-excitation electromagnetic brake.

Emergency stop

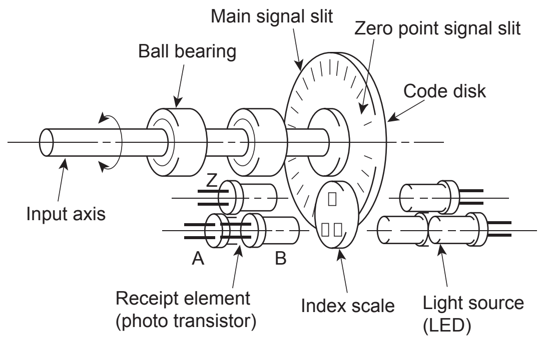
It is necessary to insert the emergency stop or stop program for safety purposes into the PLC program, and also install a circuit used to stop the machine outside the PLC.
This measure is taken in consideration of the rare event of a PLC defect occurring, or the emergency stop being disabled by the sequence program based on the timing at which the PLC power turns ON and OFF.
Note that it is better for input devices to use contact b because it allows wire damage and contact defects to be detected.
EMG signals should be used.

EMG signal

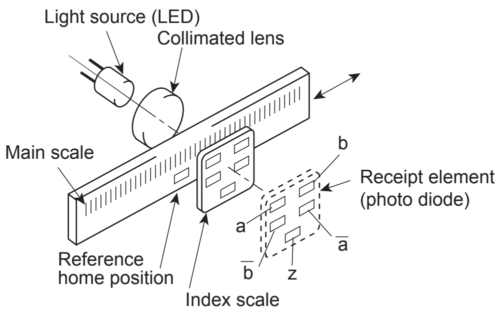
With all axes, the emergency stop external switch is normally closed contact.
Consequently, the power for the switch is normally ON.
By issuing this signal, all axes stop, the external emergency stop input flag (SM502) turns OFF, and the motor coasts.
Furthermore, addresses will be lost and so caution is required.

Encoder

Inputs position information to the control module. Pulse generator, etc. Encoding device
The diagram shows an optical encoder.



Rotary encoder
(incremental)



Linear encoder

Linear encoders employ a binary output format, and are available in incremental and absolute types.
See “Absolute encoder”.
See “Incremental encoder”.

Error compensation

The feed value is actually less than or greater than 1 m even although a 1 m command is sent from the module, the motion controller compensates for that error. For example, when the actual feed value is less than 1 m, extra pulses just enough to cover the shortfall are sent to perform the correct 1 m positioning.

External regenerative brake resistor

Referred to as regenerative brake.
When moving machinery with a motor, power is normally supplied from the amplifier to the motor, however, when the motor is decelerating or driving a down load, the rotation energy held by the motor and machinery flows back (is regenerated) to the amplifier.
This regenerative energy is consumed by resistance, and regenerative control capability is exhibited using the regenerative brake torque obtained.
This is used if performing high-frequency acceleration/deceleration.

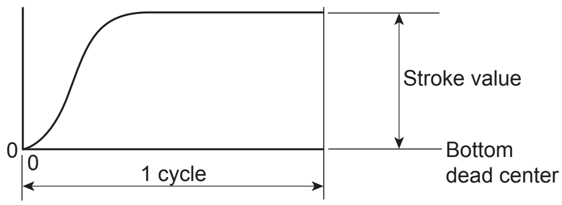
F

Feedback pulse

A command is issued during automatic control, and this pulse train is returned to confirm whether the machine is behaving in accordance with the command. If not, a correction command is issued. If a command with 10,000 pulses is issued, and 10,000 feedback pulses are returned, the balance should be 0. These are also referred to as return pulses.
See “Deviation counter”.

Feed cam

Consecutive feed motions are made by the stroke amount from the lower stroke position (bottom dead center), facilitating conveyor feed and transfer device feed.



Feed forward control

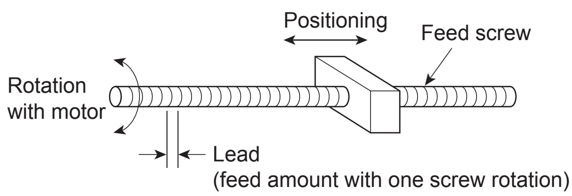
Used to minimize motor delay and improve servo tracking in response to positioning control commands. (Disabled during auto tuning.)
Set to 0 to 150%.

Feed pulse

These are pulses sent from the command device on the positioning module, etc. to the servo unit or stepping motor. These are also referred to as command pulses.

Feed screw

This is a piece of apparatus used to perform positioning by rotating a screw, and is the main screw. Ball screws are commonly used to minimize backlash and dimensional error.



File name

This is the name given when writing data or programs to a floppy disk or hard drive.
File names are made up of the system name and machine name, each with up to 8 characters, and a header is appended.
See “Machine name”.

Fixed feed

This means obtaining the dimensions required to cut sheet and rod materials in the specified dimensions when performing positioning. The incremental method is commonly used.
There are three types: FEED-1, FEED-2, and FEED-3.

Follower member

This is a general term used to refer to the part that makes contact with the cam (rod which moves back and forth), or a load system after that point.

Formatting

Refers to the initialization of the hard drive or floppy drive disk, and involves the writing of computer rules and contents, etc. to the disk. Consequently, the disk memory capacity will be reduced by the amount required for formatting.

Disks are for general use, and therefore formatting is required to tailor them for the computer. Formatting need only be performed once at the beginning.

Forward limit switch signal

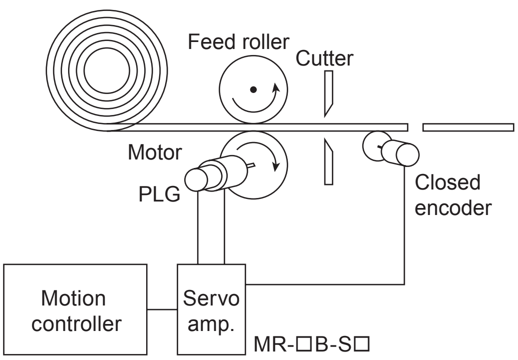
This is a positioning control device input signal used to report the triggering of the external upper limit switch (normally closed contact configuration, power normally ON) for the travel range in which positioning control is performed.

This signal turns OFF when the external FLS signal (contact b) is OFF (not conducting), and the positioning operation has stopped.

Fully closed control

The machine travel mechanism is equipped with a closed encoder, and direct travel distance is detected, allowing transfer system mechanism (gears, ball screws, timing belts, etc.) machine system errors between the motor and machine to be suppressed to a minimum.

This type of control is also ideally suited to positioning control for sliding mechanisms.



With closed encoders, the workpiece length is detected directly, ensuring a uniform workpiece cutting length regardless of feed roller slipping.

G

G-code

This is a standardized two-digit (00 to 99) number used to stipulate the NC unit axis control function, and is also referred to as G function.

Example

G01 Linear interpolation
G02 Circular interpolation (clockwise)
G04 Dwell
G28 Home position return
G50 Main shaft high speed setting

GD^2

In mechanics, this is the same concept as moment of inertia, and is a format used to express the moment of inertia for gravitational unit systems (engineering units, etc.)

"GD^2" is one of these symbols with G representing gravity, and D representing the rotational diameter.

GD^2 = [gravity] × [rotational diameter]^2 (kgf·m^2)

The unit for moment of inertia used in catalogs is J (× 10^{-4} kg·m^2).

Consequently, it is given by GD^2 = 4 × J.

Gear

This is one transfer module in the virtual mode mechanical system program, and is used to branch main shaft rotations to the output module.

The gear ratio and rotation direction can be set.

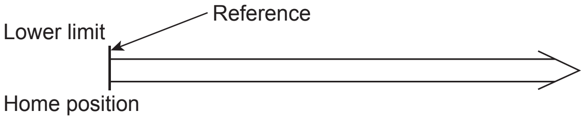
Grid

Refers to useful reference horizontal and vertical lines used for arranging parts on the mechanical system editing screen.

H

Home position

This is the position used as the reference for positioning. Positioning cannot be started without a reference point.



Home position return request

This request turns ON at the following times when using an incremental position system.

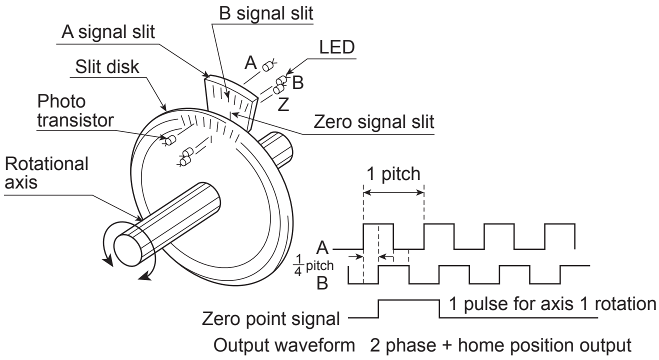
(1) When the power is turned ON.
(2) When the PLC ready signal turns ON.
(3) When parameters and home position return data from peripheral equipment is written.
(4) When the following are selected while in peripheral equipment test mode.
  Home position return
  Positioning
  JOG operation
  Manual pulse generator

The decision as to whether to perform home position return at these times is made by the user.

I

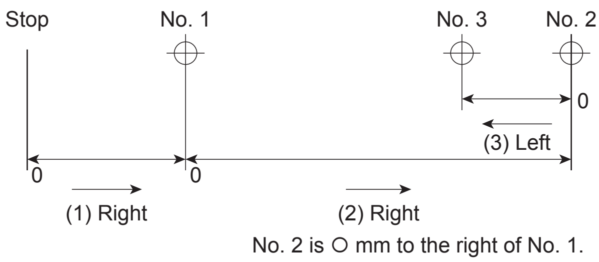
Incremental encoder

This is a device used simply to emit ON/OFF pulses as an axis rotates. Single-phase encoders emit only A pulses, and the axis rotation direction is unknown. Two phase encoders emit both A and B pulses, allowing the system to judge that the motor is rotating in the forward direction if B turns ON while A is ON, and in the reverse direction if A turns ON while B is ON.
There are also encoders with zero point signals. Incremental encoders emit between 100 and 10,000 pulses per axis rotation, and are the most commonly used encoders.
See “Encoder”.



Incremental mode

This mode is used for positioning, and expresses the position based on the specified direction and distance, with 0 as the stopping point. This is a relative address method.
This mode is used for fixed feeding, etc.
There is also an absolute mode.



Inertia

Behavior in which the current condition remains the same provided that the object is not acted upon by an external force. It is referred to as the moment of inertia.

In position

The droop pulse value (difference between position command value and position feedback from servo motor) in the deviation counter is detected with a signal in the positioning data servo parameters, and this in-position signal turns ON when the detected value matches the set value.
A few droop pulses are cut, allowing them to be used at such times as when staring subsequent positioning.

Inverter

This is a device used to convert direct current to alternating current. In order to actually change the motor speed, a commercial frequency of 50 Hz or 60 Hz is first delivered by direct current, which is then converted to a an alternating current of 5 Hz to 120 Hz to control the motor speed.

J

Jerk

This is a further differentiation of acceleration by time, and expresses the rate of change of acceleration.

JOG

JOG operation. This means moving a little at a time. Inching.
JOG operation is used for peripheral equipment test operation, and can be performed with a sequence program by writing parameters and the JOG speed.

K

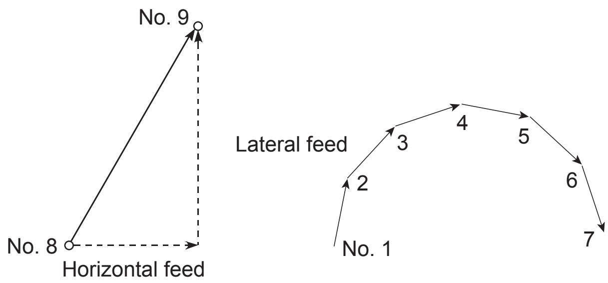
KPPS

Kilo-pulse per second
This is the number of pulses per second. 80 KPPS means 80,000 pulses per second.

L

Linear interpolation

Positioning is performed by running a horizontal direction (X) motor and vertical direction (Y) motor simultaneously, the CPU performs the computations necessary for axis travel to proceed in a straight line, and interpolation is performed automatically.
ABS-2 to ABS-4, and INC-2 to INC-4 can be used.
The following is an example of 2 axis linear interpolation.



Line monitoring

This is the monitoring of the PLC and controller control status during operation.

Load inertia ratio

GD_L^2/GD_M^2
See "GD^2".

Low inertia motor

Used when wishing to accelerate and decelerate frequently.
In order to reduce the moment of inertia from standard motors to approximately one third, the rotor diameter is reduced, and the longitudinal direction is lengthened to cover torque.
A load inertia ratio of 1 or less is ideal.

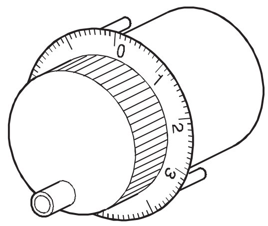
M

Machine name

Maximum eight character code applied freely by the user from a file name. Alphabet characters (upper case), numbers, and one symbol are used. The first character must be an alphabet character.
See "File name".

Manual pulse generator

Pulses are generated by manually rotating a handle.



Margin

This is the cam and cam follower ratio of contact, and should normally be 60% or higher.

M-code

This is a signal used to trigger auxiliary functions such as drill change, clamping, unclamping, raising and lowering of electrodes, and all types of display that are performed together with positioning.
Codes 1 to 255 are assigned (1: clamp, 2: unclamp, etc.) and used by users.
M is an abbreviation of machine.

Master axis

This is the side at which positioning data is prioritized when performing interpolation during positioning.
It is an interpolation control unit set in the parameter block.

Mechanical support language

Synchronous control is performed, and therefore by using software to process synchronous control operations that were previously mechanically joined with mechanisms using a main shaft, gears, and cams, processing switches to positioning control (roller output, ball screw output, rotary table output, cam output) with servo motors.
See “Mechanical system program”.

Mechanical system program

This consists of a mechanical mechanism connection drawing connecting the drive module (virtual servo motor and synchronous encoder) and virtual main shaft, transfer module (gears, clutches, speed change gear, differential gear), output module (cams, rollers, ball screws, rotary table) with the respective module parameters.

Model adaptive control

When performing actual operation, differences occur in the actual control state quantity relative to the ideal control state quantity.
Motion control enables optimum loop gain control based on those differences to ensure that control is always performed at maximum performance.

Modified constant velocity curve

Commonly abbreviated to MCV curve, this curve has a fixed speed interval in the middle of the curve, and is used when necessary to lower the maximum speed to reduce the pressure angle, or when a fixed speed portion is required.
It is applied to heavy loads traveling at medium speed.

Modified sine curve

Commonly abbreviated to MS curve, this is a commonly used standard curve. It has low maximum speed and small cam axis torque coefficient, and acceleration is comparatively low, and therefore is widely used when the nature of the load is unknown. It is applied to loads traveling at high speed.

Modified trapezoid curve

Commonly abbreviated to MT curve, this is a standard curve developed to minimize the maximum acceleration value, and is applied to light loads traveling at high speed.

Monitoring trace graph

This is a monitor function, and displays waveforms based on traced (recorded) position commands, position droop, motor speed, motor current, and speed command values during positioning.

Motion control

This refers to positioning control.

Multiplication ratio setting

This is the pulse rate.
See "Pulse rate".

N

No-dwell motion

At the operation start and end points, there is no dwell, acceleration is maintained at an arbitrary value, the reciprocating operation is repeated, and the acceleration (A) value becomes smaller.

Notch filter

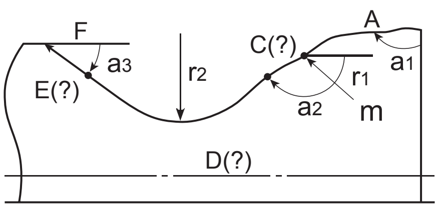
This sets the notch frequency to match the machine system resonant frequency.

Numerical Control

This is the language punched on the paper tape used to instruct the NC unit to perform processing.
Other NC languages are EIA code (EIA standard), ISO code (ISO standard) and JIS code (JIS standard).

Numerical controller

Unit offering even more advanced positioning. 3 axes or more can be controlled with high accuracy and at high speed. Control for complex curves and curved surfaces is also possible.



O

One-dwell motion, dwell-rise-dwell motion

If used to double back on the same curve on the upward and downward journey for a movement involving a stop at only the start point or finish point of that journey, acceleration can be reduced, and movement becomes smoother.

Option slot

Slot into which a motion module or MELSEC iQ-R Series can be installed to suit the intended use.

Output module

This refers to a module used to run a servo motor in virtual mode.
The output module has rollers, ball screws, rotary table, and cams.

P

Pancake motor

The axis direction dimension is 100 mm shorter than the standard shape,
and is used when there is little space to install the servo motor.

Parabolic curve

Commonly abbreviated to PB curve, it possesses the characteristic of having a non-dimensional maximum acceleration, facilitating minimum time control under the condition that the maximum acceleration value is suppressed.
On the downside, acceleration is discontinuous, and vibrations occur easily.

Parameters

Parameters stipulate PLC functions. Memory capacity, relay or timer types, status latch selection, and comment capacities and so on can be set by users as parameters. Default values are set to enable basic functionality.
There are fixed parameters and servo parameters for positioning.

Parameter block

This allows changes to be made easily to control conditions with data such as that for acceleration and deceleration control used for positioning processing.

PASTE

This means redisplaying parts cut from the Edit screen and stored in the system buffer on the Edit screen again.

PCPU

This refers to the positioning control CPU that exists as the motion controller CPU configuration.
In addition, there is also a sequence control CPU known as an SCPU.

PG0 (PG zero)

See “Home position signal”.

Plural harmonic motion

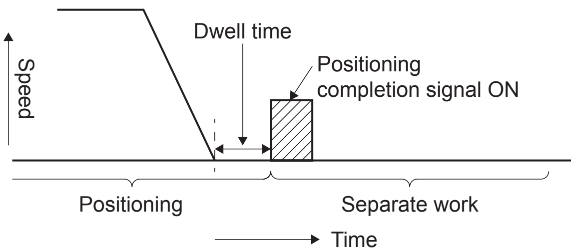
This is a cam curve,
examples of which are motions in which the acceleration pattern is the multiple perpendicular axis component of a uniform circular motion.
This has been improved to make it difficult to cause vibrations to “simple harmonic motions”.

Positioning

This refers to traveling from a certain point to the predetermined next point.
For example, determining length in mm units, outputting a drilling position, etc.
Servo motors channel power from the motion controller issuing the position commands.

Positioning completion signal

This is signal Xn1 that turns ON when the positioning dwell time is complete.
The purpose of this signal is to begin other work (clamping, etc.) after positioning.



Positioning devices

These refer to I/O signals, internal relays, data registers, special relays, and special registers used to communicate signals between the SCPU (PLC CPU) and PCPU (positioning CPU).

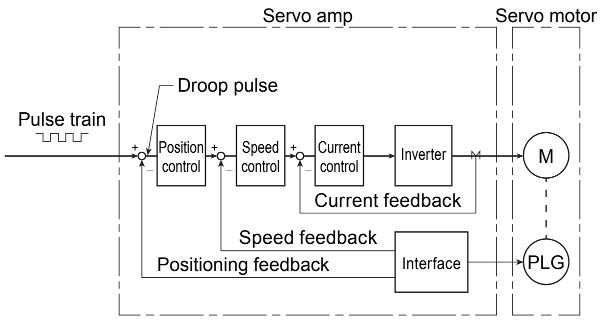
Position loop gain

Expresses the control response speed when performing positioning control at item 1 in the positioning data servo parameters. This value stipulates the number of deviation counter droop pulses during operation, and droop pulses will become smaller if the setting is high, allowing the settling time when the axis is stopped to be reduced. If too high, however, undulations will occur when the axis stops, resulting in slight vibrations. Droop pulses will increase in size if the value is small, allowing axes to come to a smooth halt as the settling time increases when the axis stops, however, the stopping error will increase.

$$\text{Position loop gain} = \frac{\text{Command pulse frequency}}{\text{Droop pulse}} \ (\text{sec}^{-1})$$

Position loop mode

This is one of the servo control modes used for positioning, and is used for position control.
In addition, there is also a speed loop mode used to perform speed control, and a torque loop mode used to perform torque control (current control).



Positioning parameters

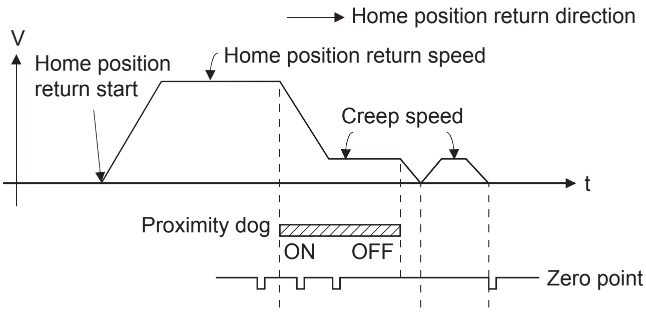
This is the basic data used for positioning control, and includes such information as system settings to match the servo motors and servo amps used, the control unit, travel value per pulse, speed limit value, upper and lower stroke limits, and acceleration/ deceleration time.

Programmable controller ready

Signal indicating that the PLC CPU is ready. Intelligent function modules are unable to function if this condition is not established.

Proximity dog type home position return

The axis starts to decelerate when the proximity dog turns ON during home position return, and after moving at creep speed until the proximity dog turns OFF, the first home position is set as the home position address. The length of the proximity dog is the point. See “Home position return method”.

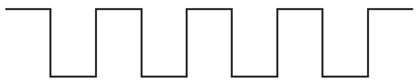


PTP point to point control

This refers to positioning control.
This is control in which pass points are specified at intervals on the route.
A request is made only to reach the target position, and control over the route during travel from a certain position to the next value is not required.

Pulse

The turning ON and OFF of current (voltage) over a short period of time. The same term is applied to the human pulse. A pulse train is a series of pulses.



Pulse generator

This is a device used to generate pulses. For example, pulses are generated as the shaft attached to the motor axis rotates. Digital device
Single-phase types emit a single pulse train, and two-phase types emit two pulse trains with phase difference. Six hundred to one million pulses are emitted per axis rotation. Furthermore, one or two pulses with home position signal are emitted per axis rotation. See “Encoder”.

Pulse instruction

This instruction turns only 1 program cycle (1 scan) ON when conditions turn ON. With MELSEC iQ-R, there is a PLS instruction that turns the 1 scan time ON with the leading edge when the signal is ON, and a PLF instruction that turns the 1 scan time ON with the trailing edge when the signal is OFF.

Pulse rate

This is a coefficient used for positioning which doubles, triples, halves, or thirds the feedback pulse per motor axis rotation, and is the ratio of feed pulses to feedback pulses.
For example, when there are 2,400 pulses per rotation and the pulse rate is 2, the result will be 1,200 pulses. The axis rotation per pulse when there are 2,400 pulses is 0.15°, however, this will be 0.3° with 1,200 pulses. Positioning accuracy drops as the pulse rate is increased.
See “Electronic gear”.

Pulse train command

By continuously emitting the number of pulses corresponding to the machine travel distance from the motion controller to the servo motor servo amplifier, it is possible to perform positioning control proportional to the number of pulses.

Q

R

Ready (SM500)

Condition in which the PCPU or servo amp is able to function normally after the power is turned ON.

Real mode

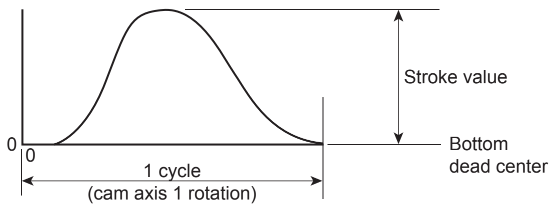
In this mode, servo motors are controlled directly with a servo program.

Real-time auto tuning

See “Auto tuning”.

Reciprocating cam

Consecutive reciprocating motions are made by the stroke amount from the lower stroke position (bottom dead center), facilitating push/return movements, up/down movements, and left/right movements.

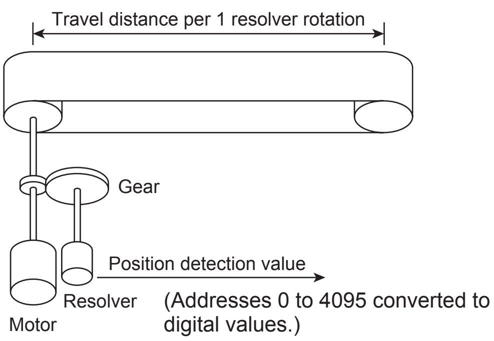


Regenerative brake option

This is an optional part, and is used to perform high-frequency acceleration and deceleration.
See “External regenerative brake resistor”.

Resolver

This is a device used to resolve angle detection into two analog voltages.
Also referred to as a two-phase synchro, as opposed to single phase voltage input, the resolver converts a single rotation of the axis rotation angle to a perpendicular two-phase voltage (analog voltage), and then outputs it.



Reverse limit switch signal

This is a positioning control device input signal used to report the triggering of the external lower limit switch (normally closed contact configuration, power normally ON) for the travel range in which positioning control is performed.
This signal turns OFF when the external RLS signal (contact b) is OFF (not conducting), and the positioning operation has stopped.

Roller

This is a cylindrical rotating object used to feed and roll paper or steel plate.
Roller output can be set as a virtual mode output module.

Rotary table

Performs positioning control while rotating the workpiece on a round table within a 360° range.

S

SCPU

This refers to the sequence CPU that exists as the motion controller CPU configuration.
In addition, there is also a positioning control CPU known as a PCPU.

Scroll

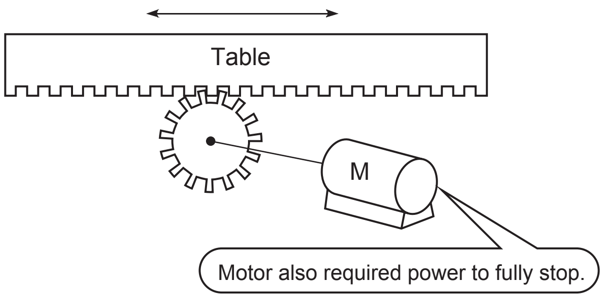
The CRT screen and so on changes repeatedly like a scroll.
The screen changes as the machine being controlled moves, and with key operations.

Servo amplifier

There is a type built in to the controller base, and an externally installed type. The servo amplifier issues speed commands to the servo motor, and controls the servo motor with received feedback pulses.

Servo lock

Force used to hold the motor at the stop position is required for positioning with servo motors and stepping motors, etc. (The motor position will be lost if moved with external forces.)
This condition is referred to as servo lock or servo lock torque.

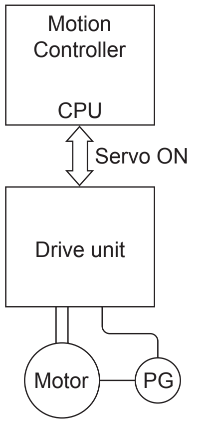


Servo motor

Motor that rotates reliably in response to commands.
These motors offer high responsiveness, high speed, and high accuracy, and are capable of frequent starting and stopping. They are produced in DC and AC types, and large capacity models are also available. AC types, and large capacity models are also available.
They are equipped with pulse generators used to detect speed, and often perform feedback control.
In other words, they move in accordance with command values, and in such a manner as to minimize differences between command values and current values while detecting current values.

Servo on

Positioning is not performed when the drive unit is normal and this servo on is not ON.



Servo parameters

See “Positioning parameters”.

Servo program

This is a program used to control servo motors, and contains such instructions as independent linear control, linear interpolation control, circular interpolation control, fixed feeding, speed control, constant speed control, and home position return.

Servo response

Sets auto turning responsiveness.
The optimum response can be selected based on the machine rigidity. The higher the machine rigidity, the higher responsiveness can be set, facilitating improved tracking in response to commands, as well as reduced settling time.

Settling time

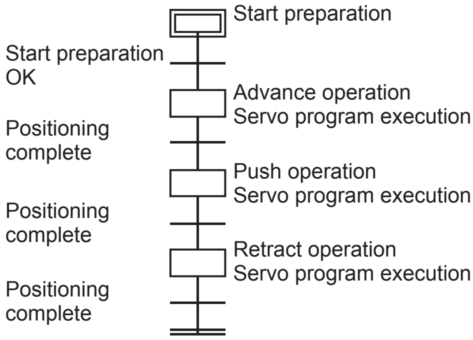
This is the delay time from the time the stop command is complete until the servo motor stops (time until droop pulse becomes ±1).

Sequence control

This refers to a sequence program used to control operations sequentially such as detecting the completion of a single movement with a switch, and using this signal to start the next operation.

SFC (sequential function chart)

This is the optimum structured programming method required to perform machine automatic control sequentially with a PLC.



Simple Harmonic motion

This is an example of a cam curve, examples of which are motions in which the acceleration pattern is the single perpendicular axis component of a uniform circular motion.
This motion generally exhibits smooth characteristics, and is therefore applied to low speeds.
On the downside, acceleration is discontinuous, and vibrations occur easily.

Simultaneous start control

Two to three types of servo program are run with a START instruction to start multiple servo motors simultaneously.
Multiple axes specified in a special register are started simultaneously with a special relay with JOG operation.

Skip function

This function allows subsequent positioning to be started even if an external STOP signal turns ON during positioning control, and the signal remains ON when stopped.
Subsequent positioning is started with an SVST instruction when the external STOP signal input disable flag is turned ON during deceleration, and the start accept flag turns OFF.

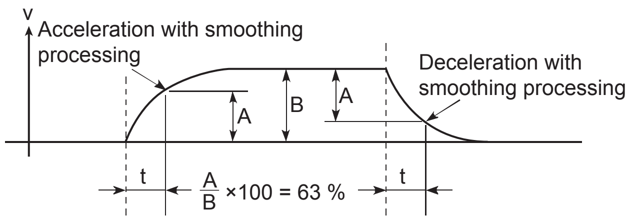
Slave axis

See “Master axis”.

Smoothing clutch

This is a clutch for which a smoothing time constant is set as a virtual mode transfer module.
The rotation can be conveyed smoothly when the clutch is ON and OFF.
It is known as a direct clutch when the smoothing time constant is zero.

Smoothing time constant t



See “Smoothing clutch”.

Speed change

See “DSFLP instruction”.

Speed change control

Axes are positioned at the travel value end point while changing speed at the speed switching point during positioning control.

Speed change gear

This is one transfer module in the virtual mode mechanical system program, and is used to change the main shaft rotation speed and transfer it to the roller output module.

Speed control

Controls the speed for endless rotations in the same direction for conveyors, etc.
Using VF forward rotation and VR reverse rotation instructions (position loop) and VVF forward rotation and VVR reverse rotation instructions (speed loop), feed current values are zeroed at the same time as axis movement starts, axes are rotated at a previously set speed, and then decelerate when a stop command is received, without increasing or decreasing the feed current value.
Note that upper and lower stroke limits are ignored.

Speed integral compensation

Frequency responses are issued when performing positioning control at item 1 in the positioning data servo parameters, and transient characteristics are improved.
It is helpful to increase this value when the overshoot when accelerating or decelerating does not get any smaller even by adjusting the speed loop gain.
The unit is ms.

Speed limit value

This is the maximum positioning speed. By setting this value in the parameters, operation is performed with speed limit values even if a larger value is set due to a mistake in other data. Note that acceleration time and deceleration time are the speed limit value times.

Speed loop gain

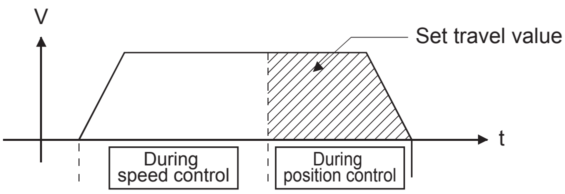
Expresses the control response speed when performing speed control at item 1 in the positioning data servo parameters.
If the control system responsiveness drops and operation becomes unstable as the load inertia moment ratio increases, stability can be improved by increasing this setting.
If increased too much, the overshoot increases when accelerating, and motor vibration noises are emitted during operation or stoppages.

Speed loop mode

See "Position loop mode".

Speed/position control

Incremental positioning control is performed when external switching signals are received during speed control.

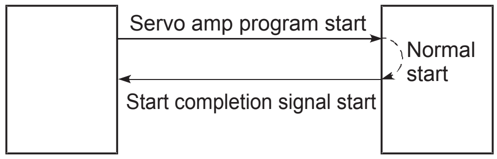


SSCNET

This is an abbreviation of Servo System Controller Network.
This is a connection method used to improve reliability between the motion controller and servo amp through high-speed serial communication.
Wiring work is simplified with a one-touch connection using a connector.

Start completion

This is a signal sent to immediately indicate that the motion controller has successfully started positioning. It does not mean that positioning is complete.



Starting axis

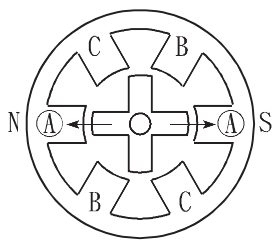
This is the axis to be started, and is axes 1 to 8/32.

Status

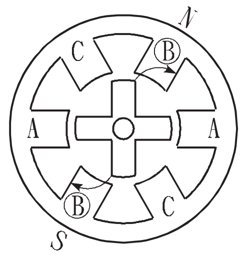
This is a device used to express the condition, and collectively refers to signals that turn ON (1) in the clutch status, virtual mode status, and when making home position return requests, etc.

Stepping motor

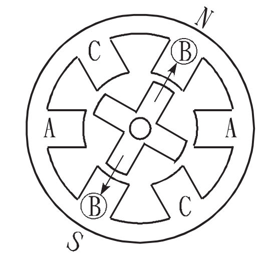
This is a motor that performs an angular rotation (e.g., 0.15°) with every pulse. Consequently, rotation proportional to the number of pulses can be obtained. Stepping motors are available in two to five-phase types, and with the three-phase type, the motor rotates by applying voltage in order from A to C. Most stepping motors are compact, and offer accurate rotation without feedback. Caution is advised with step outs, whereby the motor does not rotate accurately.



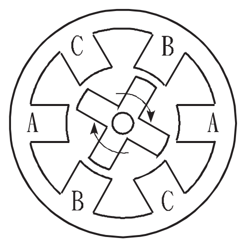
(1) First, the A phase is excited with a pulse.



(2) By then exciting the B phase, force moves in the direction indicated by the arrow.



(3) The nearest gear tooth is pulled toward the B phase, and the motor stops.

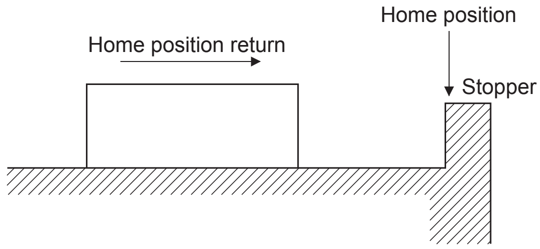


(4) By successively changing the excited phase, the rotor rotates in the clockwise direction.

Stopper-forced stop

This is a home position return method using with positioning, and involves stopping the axis when it comes into contact with a stopper installed at the home position.

The motor will burn out and the stopper damaged if the axis remains against the stopper, and therefore various methods are used to prevent this such as equipping the system with a timer allowing the motor to be turned OFF when a fixed time has elapsed, or turning the motor OFF when the system detects that the motor torque has risen suddenly when the axis is against the stopper.



STOP signal

This is a positioning control device input signal used to directly stop positioning from outside during operation.

When the external STOP signal (contact a) is ON (conducting), operation stops and XnD turns ON.

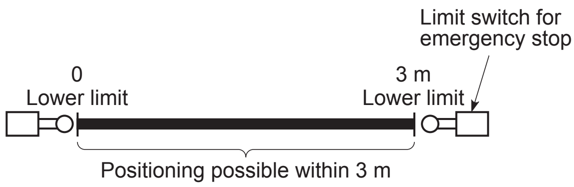
Stroke

This refers to the axis journey, and is the movement change over the distance from the point the axis starts moving until it next stops.

Stroke limit

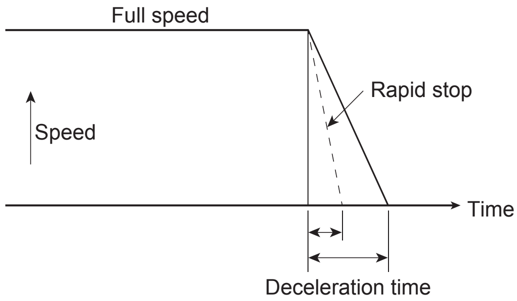
This is the range in which positioning can be performed, or the movement range beyond which the machine will be damaged. If using a feed screw, the screw length is fixed, and if using fixed feed, this is the maximum dimension that is cut.

The upper and lower limits are set in the parameters, however, to ensure safety, the machine is installed with separate limit switches wired to external signal input modules, allowing axes to be stopped automatically.



Sudden stop

This is shorter than the deceleration time set in the parameters, and is the sudden stop deceleration time taken to stop.



Synchronized control

This involves rotating the main shaft with a virtual mode drive module, and running the machine by synchronizing with multiple output modules (servo motors) through a transfer module.

Synchronous encoder

This is one type of virtual mode drive module. Pulses from encoders on external machines are input, and the system synchronizes with these pulses to drive the output module.

T

Teaching

This function is required for positioning, and involves the manual teaching of positions when addresses are unknown, or to align axes with the workpiece.
For example, it is troublesome to write the address for each point as data for complex addresses such as those in a picture, and so by tracing and teaching a model, positioning can be reproduced later.

Three-dimensional cam

This cam uses three dimensional movements, and compared to planar cams, is generally more compact, and can be used as a positive cam for positive motion.

Top dead center

This refers to the upper side of the machine installation route for the cam mechanism reciprocating motion.

Torque

This is the size of a force acting on an axis multiplied by the arm length up to the line of action for that force. N·m (kgf·m)

Torque loop mode

This is also referred to as current loop mode. See “Position loop mode”.

Torque ripple

This is the torque fluctuating range, or variations in torque.

Tracking

Travel values are entered from an external controller, and by adding these travel values to servo command values, positioning is performed at a relative speed with respect to the applicable object during travel.

Transmission module

This is one of the virtual mode mechanical system programs,
This is a module used to transfer drive module rotations to the output module, and is comprised of gears, clutches, speed change gear, and differential gear.

Trapecloid curve

Commonly abbreviated to TRP curve, residual vibrations after input is stopped can be suppressed, and seismic resistance is high.

Travel

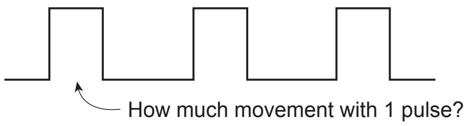
See “Stroke”.

Travel per pulse

This is data calculated from the machine side, and stipulates how much the motor axis travels per pulse when the unit is mm, inches, or pulses when performing positioning. This corresponds to the position detection unit. Positioning accuracy higher than this is not possible.

Systems are normally designed with a travel value of one rotation per axis at the motor side as a reference, and therefore the travel value per pulse is calculated as follows.

$$\frac{\text{Pulse rate}}{\text{No. of pulses per pulse generator rotation}} \times \text{travel value per rotation}$$



Two-dwell motion

Motion with dwell at both ends of the journey

U

Unit setting

This refers to changing to the actual address unit or travel value unit for which positioning is to be performed.
Units are set in mm, inches, degrees, or pulses.

Unsymmetrical

This is a cam curve in which the first half deceleration differs from the latter half ratio, and is mainly used to improve high-speed specification deceleration area characteristics.

V

V velocity

This means cam non-dimensional speed.
This is non-dimensional displacement (motion displacement from start to finish expressed with 0 to 1) differentiated by non-dimensional time (motion time from start to finish expressed with 0 to 1).
See “Vm”.

Virtual auxiliary input

This is one of the virtual mode mechanical system programs, and adds addition/ subtraction rotations from the auxiliary shaft virtual servo motor or synchronous encoder to rotations from the main shaft.

Virtual main shaft

This is one of the virtual mode mechanical system programs.
This shaft is used to connect drive module rotations directly to the transfer module gear.

Virtual mode

This is a method used to move mechanical system program drive modules with a servo program or external encoder in order to drive the servo motor.
The mode used to drive servo motors directly with a servo program is called real mode.
See “Mechanical system program”.

Virtual mode status

This is special relay M2044 used for monitoring, and is capable of confirming that the system is operating in virtual mode.

Virtual servo motor

This is one of the drive modules in the virtual mode mechanical system program, and is started with the servo program.
The main shaft is connected directly to the virtual servo motor.

Vm velocity

This is the cam non-dimensional speed maximum value.
See “V”.

W

WDT error

This is an abbreviation of watchdog timer error, and indicates a PCPU defect.
SM512 turns ON when an error occurs.

Window

Windows refers to selection menus displayed at the SW6RN-GSV22P or CAMP screen with peripheral equipment.

Word

Expresses the data unit. With the MELSEC iQ-R Series, 1 word represents 16 bits, and numerical values from -32,768 to 32,767 in decimal notation are handled. This is 0 to FFFF in hexadecimal notation.

However, there are also 32-bit instructions, where 1 word represents 32 bits, and numerical values from -2,147,483,648 to 2,147,483,647 are handled. This is 0 to FFFFFFFF in hexadecimal notation.

Word devices

This is an element in the devices inside the PLC and holds data. In this device, 1 point is 1 word. The timer (T), counter (C), and all registers (D, R, W, Z, V), etc. are word devices.

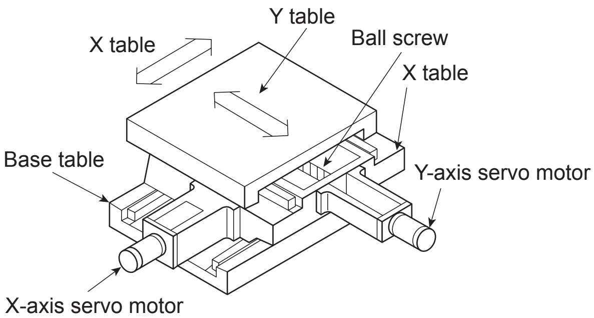
X

X-axis

2D right/left lateral direction

XY table

This is a table moved in the X (lateral) and Y (longitudinal) directions so that positioning can be performed easily.
This is used when drilling holes in plates and drawing diagrams, etc.



Y

Y-axis

2D forward/backward direction

Z

Z-axis

3D up/down direction

Zeroing method

There is a proximity dog method, count method, and data set method.

Zero point signal

This is the pulse generator (encoder) PG0 (detected once per rotation). It is also referred to as the Z phase.
See “Pulse generator”.

Zero return data

This data is required by the motion controller to return to the home position. This is determined at the machine design stage, and involves changes to the machine design in order to be changed at a later date.
This is the reference point for home position positioning, and therefore home position return is required at such times as when a power outage occurs during positioning, or an axis is moved manually with the power OFF because the current values held by the motion controller are no longer relevant. By performing home position return, the machine searches for the proximity dog, moves, and then changes to creep speed, regardless of the current value.

Z phase

Also referred to as PG zero.
See “Home position signal”.

0 to 9

5th power polynomial curve

This curve has five boundary conditions, is smooth, and possesses excellent characteristics.

Mitsubishi Electric Programmable Controller Training Manual
MELSEC iQ-R Motion Controller (for MT Works2)

MODEL	
MODEL CODE	
SH(NA)-030244ENG-A(1612)MEE	

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