MITSUBISHI

MOTION CONTROLLER (SV21)

Reference Manual

type A373CPU (P21/R21)-S3 (Virtual mode)

MITSUBISHI ELECTRIC

REVISIONS

* The manual number is given on the bottom left of the back cover.

Print Date	*Manual Number	Revision
May, 1993	IB (NA) 66423-A	First edition

INTRODUCTION

Thank you for choosing the Mitsubishi MELSEC-A Series of General Purpose Programmable Controllers. Please read this manual carefully so that the equipment is used to its optimum. A copy of this manual should be forwarded to the end User.

CONTENTS

1. GENERAL DESCRIPTION

A multi-axis positioning control system comprised of an A373CPU installed with SV21 operating system operates in real mode or virtual mode.

This manual gives explanations about mechanical system programs required for using a multi-axis positioning control system in virtual mode.
To perform positioning control in virtual mode, it is necessary to prepare mechanical system programs, positioning parameters, servo programs, and positioning sequence programs which are explained in the manual mentioned below.

- A373CPU (P21/R21) Maintenance Manual IB-66405

Section 2.3 gives differences between real mode and virtual mode.
Before performing positioning control in virtual mode, make sure of the differences between real mode and virtual mode referring to Section 2.3.

REMARK

SV21 is the name of an operating system for A373CPU.
Use an IBM PC/AT (hereinafter called PC/AT) started up with SW0IX-GSV21PE to install SV21 to an A373CPU.
(IBM is a registered trademark of the International Business Machines Corporation.)

1.1 General Description of Real Mode and Virtual Mode

(1) Real mode

(a) Real mode is an operation mode in which a system using servo motors is controlled directly by using servo programs.

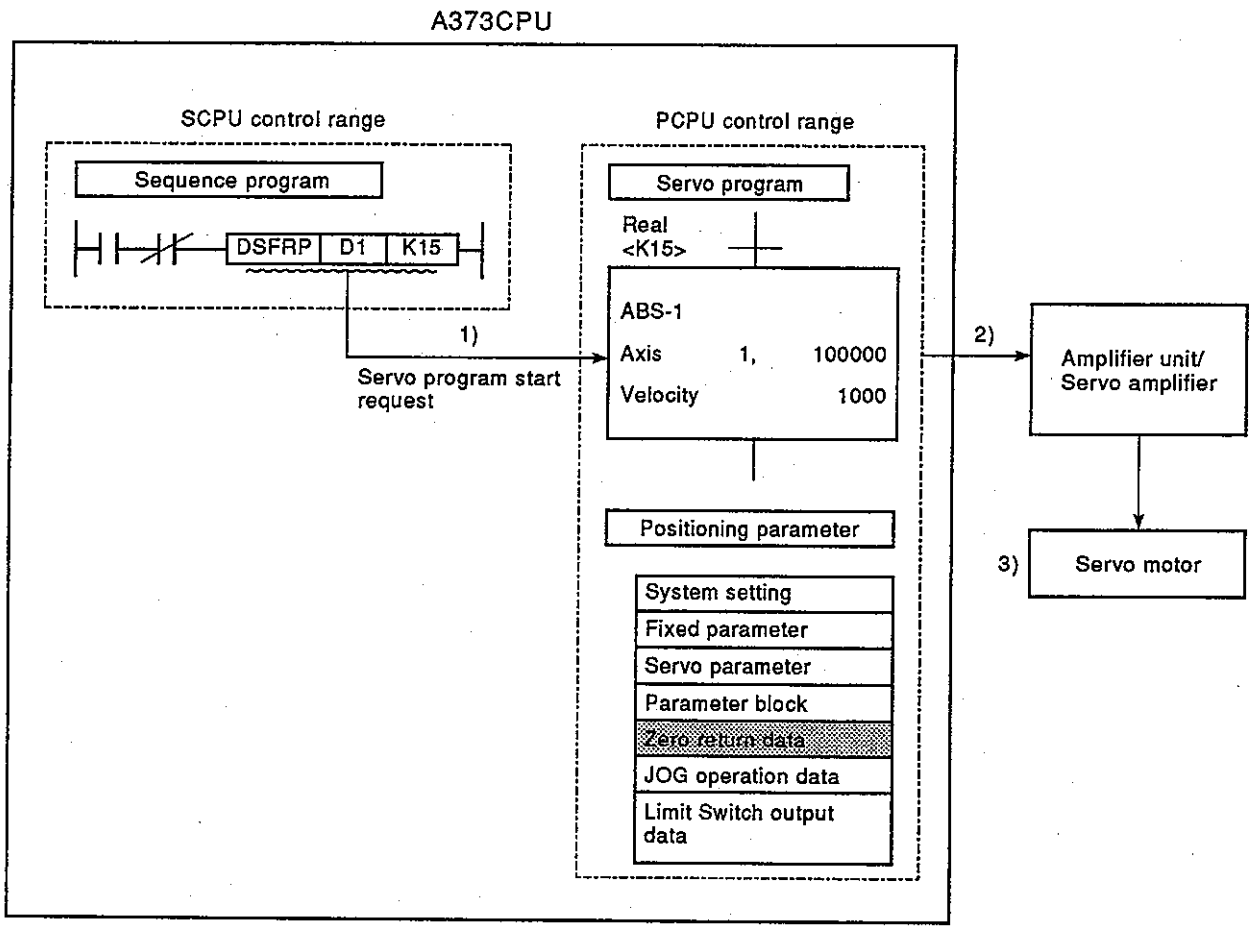
(b) In real mode, positioning parameters need to be set and servo programs and positioning sequence programs need to be created.

(c) The positioning control procedure in real mode is as mentioned below.

1) A request to start a real mode servo program is made by using DSFRP of a positioning sequence program.

2) Positioning control is executed by using a designated servo program (output to amplifier units/servo amplifiers).

3) Servo motors are controlled.



(2) Virtual mode

(a) Virtual mode is an operation mode in which synchronous control processing is executed by a mechanical system program which is comprised of virtual main shafts and mechanical modules.
By using virtual mode, synchronous control which conventionally was done using a mechanical system comprised of main shafts, gears, and cams can be replaced by positioning control using servo motors.

(b) In virtual mode, a mechanical system program is needed in addition to the positioning parameters, servo programs, and positioning sequence programs which are used in real mode.

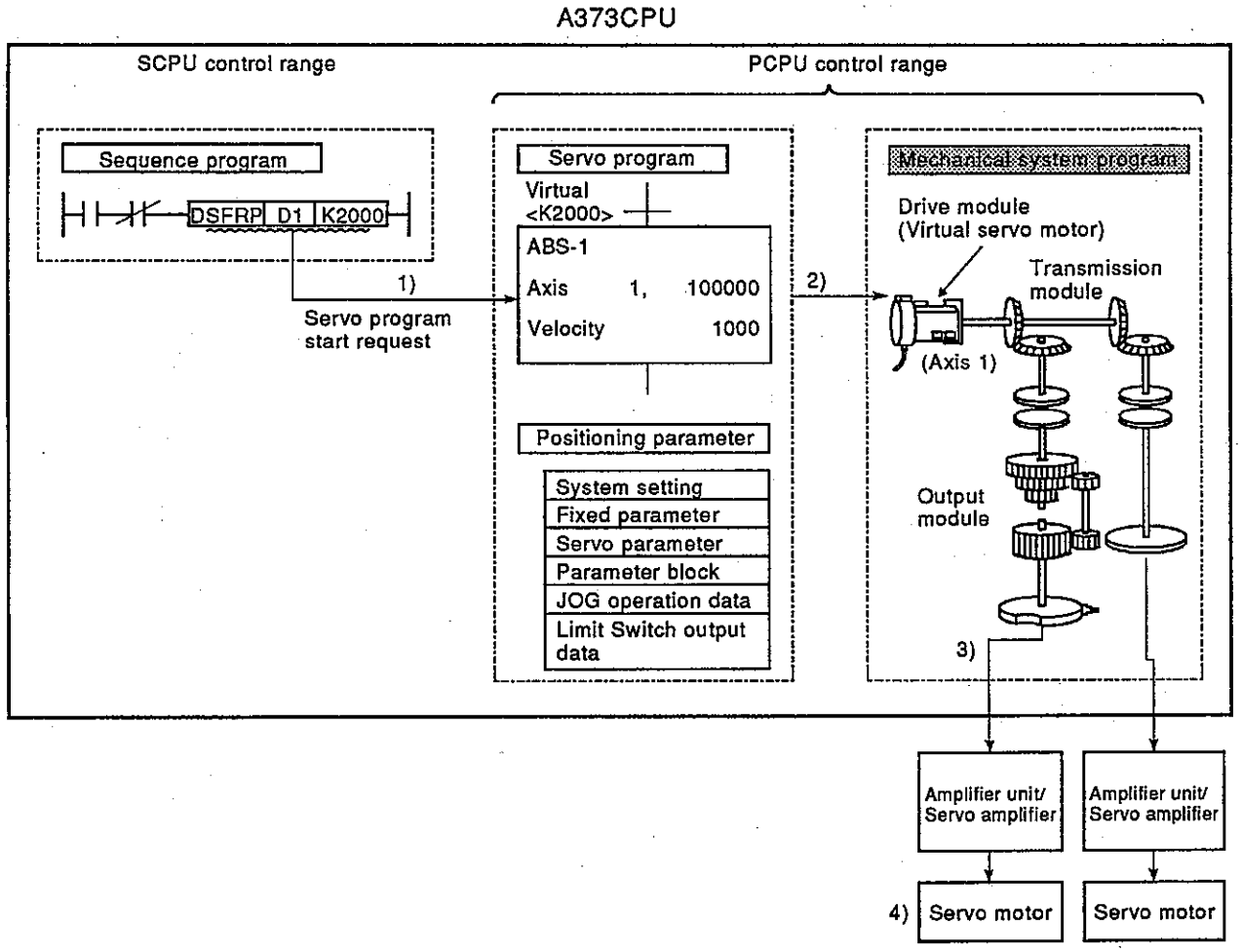
(c) The positioning control procedure in virtual mode is as mentioned below.

1) A request to start a virtual mode servo program is made by using DSFRP of a positioning sequence program.

2) Virtual servo motors of mechanical system program start.

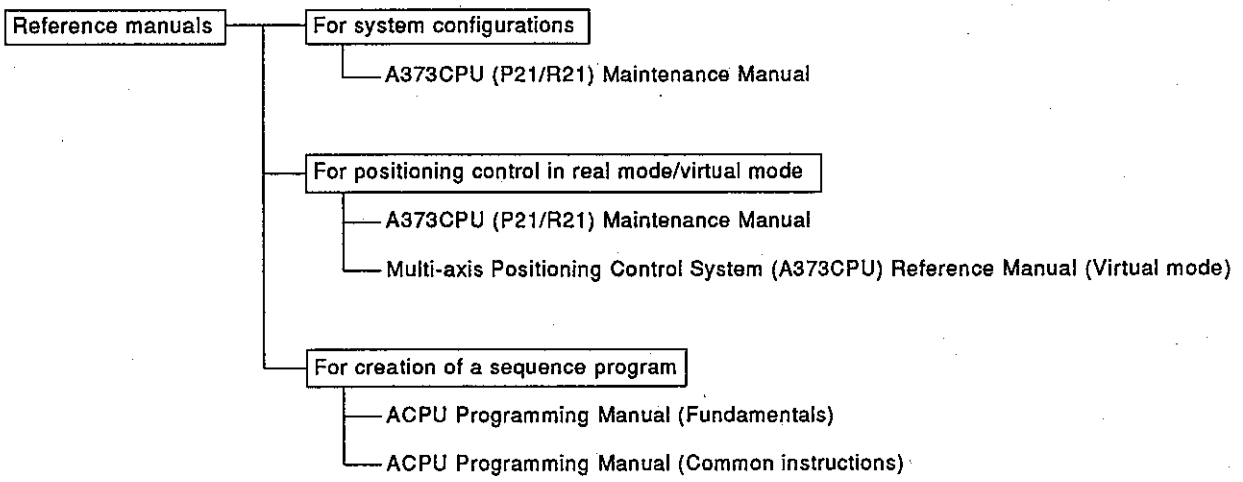
3) Operation result which passed through a transmission module is output to an amplifier unit/servo amplifier which is set to the output module.

4) Servo motors are controlled.



1.2 Reference Manuals

The following are the reference manuals which are useful when a multi-axis positioning control system is used.

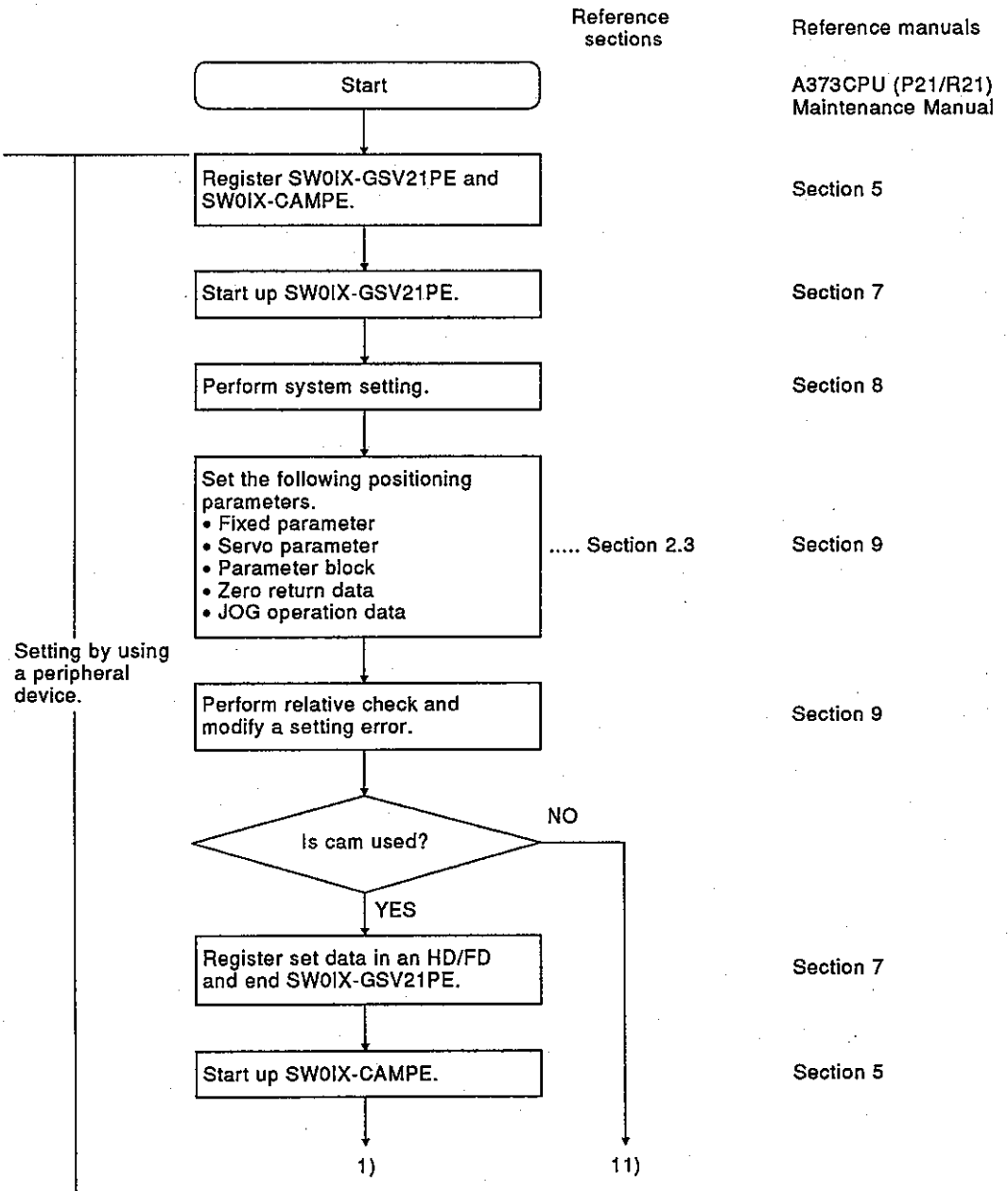


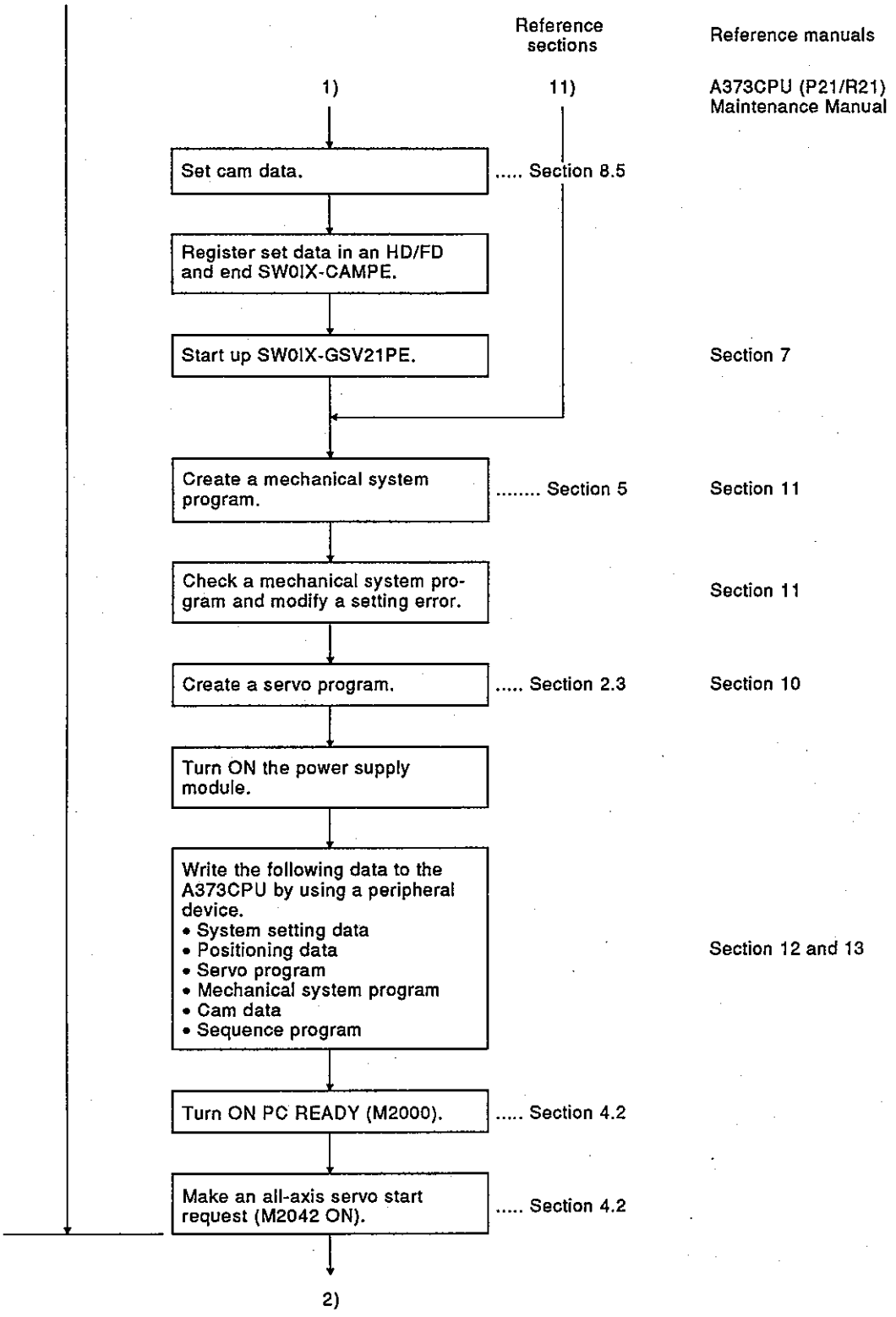
2. PROCEDURE FOR POSITIONING CONTROL IN VIRTUAL MODE

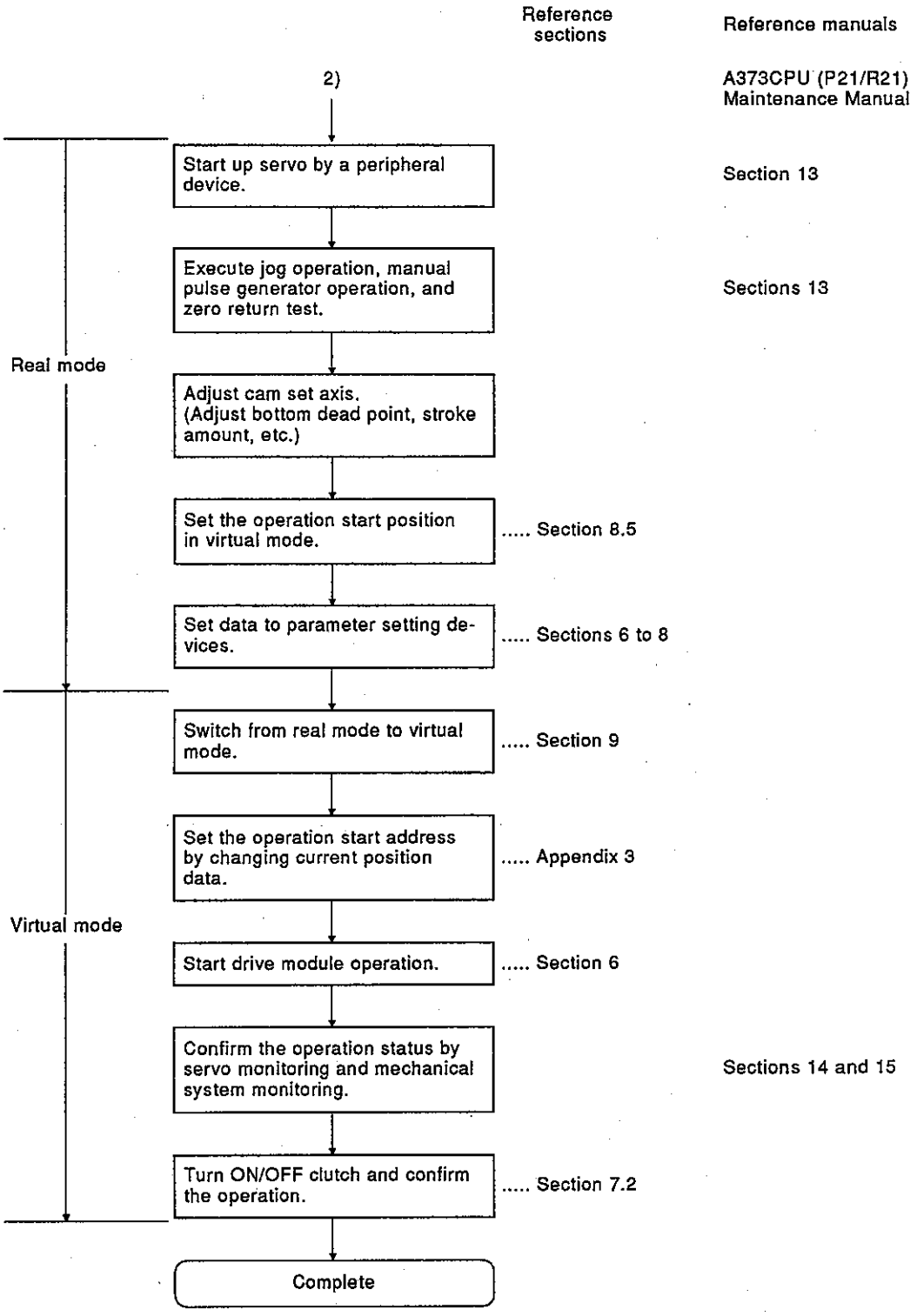
This section explains the procedure for positioning control in virtual mode.

2.1 System Start-Up

The following shows the procedure for starting up a positioning control system for virtual mode.




Reference sections
Reference manuals
1)
11)
A373CPU (P21/R21) Maintenance Manual
Set cam data.
..... Section 8.5
Register set data in an HD/FD and end SW0IX-CAMPE.
Start up SW0IX-GSV21PE.
Section 7
Create a mechanical system program.
..... Section 5
Section 11
Check a mechanical system program and modify a setting error.
Section 11
Create a servo program.
..... Section 2.3
Section 10
Turn ON the power supply module.
Write the following data to the A373CPU by using a peripheral device.
• System setting data
• Positioning data
• Servo program
• Mechanical system program
• Cam data
• Sequence program
Section 12 and 13
Turn ON PC READY (M2000).
..... Section 4.2
Make an all-axis servo start request (M2042 ON).
..... Section 4.2
2)

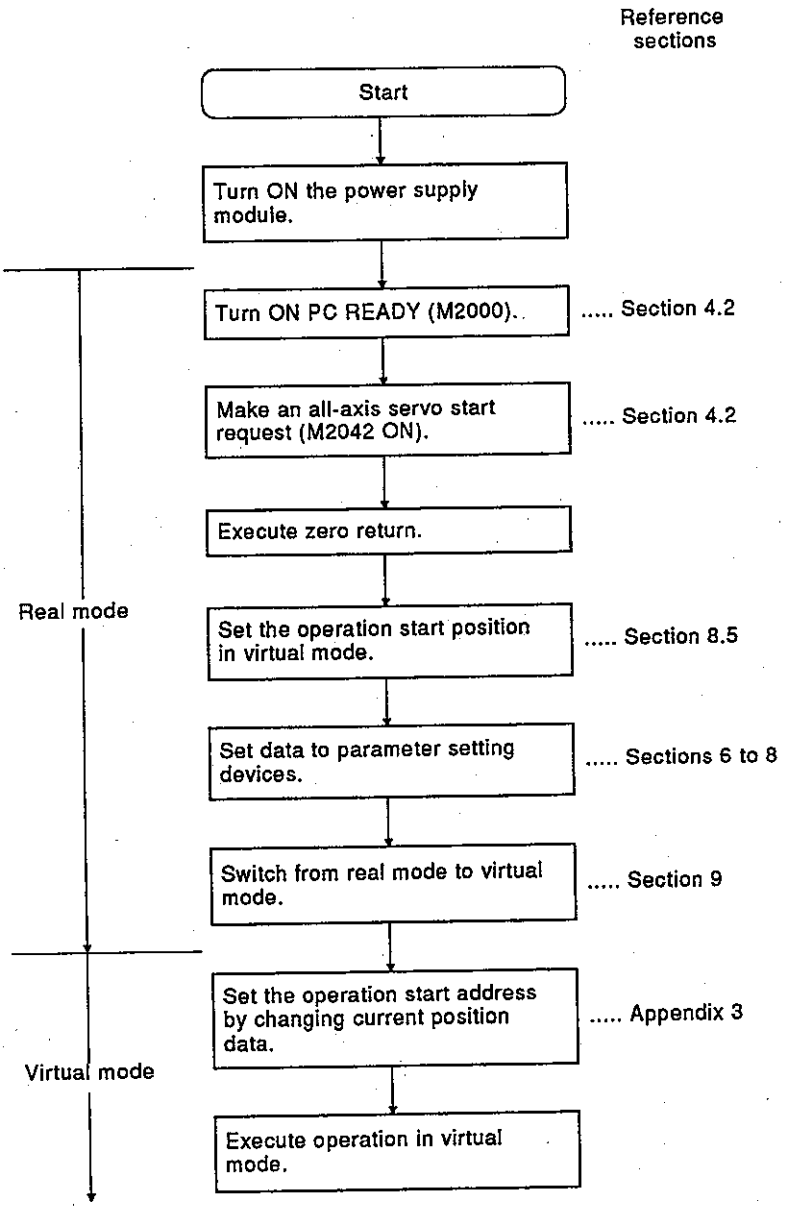

Reference sections
Reference manuals
2)
A373CPU (P21/R21) Maintenance Manual
Start up servo by a peripheral device.
Section 13
Execute jog operation, manual pulse generator operation, and zero return test.
Sections 13
Real mode
Adjust cam set axis. (Adjust bottom dead point, stroke amount, etc.)
Set the operation start position in virtual mode.
..... Section 8.5
Set data to parameter setting devices.
..... Sections 6 to 8
Switch from real mode to virtual mode.
..... Section 9
Set the operation start address by changing current position data.
..... Appendix 3
Virtual mode
Start drive module operation.
..... Section 6
Confirm the operation status by servo monitoring and mechanical system monitoring.
Sections 14 and 15
Turn ON/OFF clutch and confirm the operation.
..... Section 7.2
Complete

2.2 Operation

This section describes the procedure to execute operation in virtual mode.

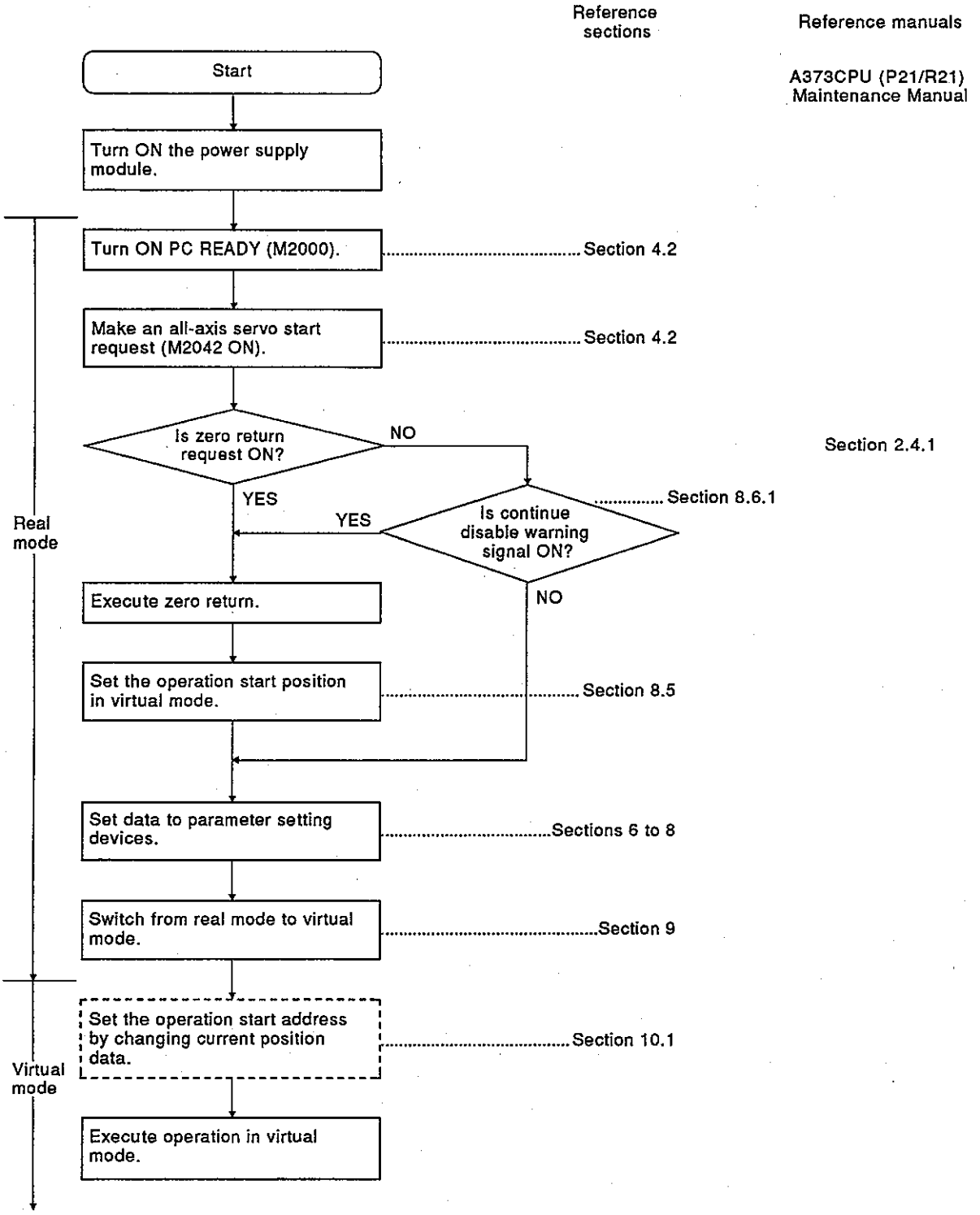
2.2.1 Increment system

The following shows the operation procedure when an increment system is used.



2.2.2 Absolute system

The following shows the operation procedure when an absolute system is used.



2.3 Differences between Real Mode and Virtual Mode

Some of the specifications of positioning data, positioning devices, and servo programs used in real mode are different from those used in virtual mode. Confirm such differences and read the Multi-Axis Positioning Control System (A373CPU) Reference Manual (Real Mode) before starting operation in virtual mode.

2.3.1 Positioning data

Table 2.1 shows positioning data used in virtual mode.

Table 2.1 Positioning Data List

Items	Real Mode	Virtual Mode	Remarks
System setting	O	O	
Fixed parameter	O	Δ	Unit of use varies according to type of output module.
Servo parameter	O	O	
Parameter block	O	Δ	Pulse unit can only be used.
Zero return data	O	—	
JOG operation data	O	—	
Limit switch output data	O	Δ	

O: Used Δ: Used (with restriction) —: Not used

2.3.2 Positioning devices

Table 2.2 shows the positioning device ranges used in virtual mode.

Table 2.2 Positioning Device Ranges

Device Names	Real Mode	Virtual Mode
I/O	X/Y0 to 17F *	X/Y0 to 17F
Internal relay	M2000 to M2047	
Special relay	M9073 to M9079	
Data register	D800 to D1023	D700 to D1023
Special register	D9180 to D9199	

*: Device ranges X/Y0 to 17F are allocated for positioning I/Os in SV21. When only real mode is used, device range X/Y100 and after can be allocated for user's purposes by allocating slots 0 to 15 to vacant 16 points from a peripheral device.

2.3.3 Servo program

(1) Servo program area

The same servo program area cannot be shared for operations in real mode and virtual mode. The servo program area used in virtual mode must be set before starting operation.
(Area setting can be done by using a PC/AT started up with SW0IX-GSV21PE.)

(2) Servo instructions

(a) In virtual mode, zero return and velocity/position switching control cannot be executed.

(b) The following servo program positioning data are not used, parameter block control and torque limit value.

(3) Table 2.3 shows the differences in servo instructions between real mode and virtual mode.

Table 2.3 Differences in Servo Instructions

Items			Real Mode	Virtual Mode	Remarks
Servo instruction	Velocity-position control	VPF	O	×	
		VPR			
		VPSTART			
	Zero return	ZERO	O	×	Execute zero return in real mode, and then, switch to virtual mode.
Positioning data	Parameter block	Control unit	O	—	Fixed to pulse.
		Torque limit	O	—	Set by using drive module parameters.

O: Used ×: Used (with restriction) —: Not used

2.3.4 Control changes (current position data change and velocity change)

When a control change is made in virtual mode, feed position data/velocity of a drive module is changed.

Control change cannot be executed to an output module.

Table 2.4 gives the differences in control change allowed respectively in real mode and virtual mode.

Table 2.4 Differences in control change

Items	Real Mode	Virtual Mode			Remarks
		Drive Module		Output Module	
		Virtual Servo Motor	Synchronous Encoder		
Current position data change	○	○	△	×	Programming for current position data change of synchronous encoder takes different procedures. (See App. 3.)
Velocity change	○	○	×	× *	

REMARKS

1) Symbols in Table 2.4 represent the following:
   ○ : Setting/execution possible
   △ : Execution possible, but programming is different.
   × : Setting/execution impossible

2) * : When an output module is a roller and a reduction gear is used, velocity change is possible by changing velocity changing ratio of the change gear.

3) The following sections give details of a drive module and output module:
   • Drive module: Sections 5 and 6
   • Output module: Sections 5 and 8

3. SPECIFICATIONS

Table 3.1 gives the performance specifications of an A373CPU.

Table 3.1 PCPU Performance Specifications

<table>
<tr><th colspan="3">Items</th><th colspan="6">PCPU Performance Specifications</th></tr>
<tr><td colspan="3">Number of control axes</td><td colspan="6">8 axes (simultaneous 2 axes, simultaneous 3 axes and independent 8 axes)</td></tr>
<tr><td colspan="3">Interpolation functions</td><td colspan="6">Straight line interpolation (2 axes and 3 axes) and circular-arc supplement (2 axes)</td></tr>
<tr><td colspan="3">Control modes</td><td colspan="6">PTP (Point to point) velocity control, fixed-rate transmission, constant velocity control, synchronous control</td></tr>
<tr><td colspan="3" rowspan="5">Control units</td><td rowspan="2">Drive module</td><td>Virtual servo motor</td><td colspan="4" rowspan="2">pulse</td></tr>
<tr><td>Synchronous encoder</td></tr>
<tr><td rowspan="3">Output module</td><td>Roller</td><td colspan="4" rowspan="2">mm, inch</td></tr>
<tr><td>Ball screw</td></tr>
<tr><td>Rotary table</td><td colspan="4">Fixed to degree</td></tr>
<tr><td>Cam</td><td colspan="4">mm, inch, pulse</td></tr>
<tr><td rowspan="4">Program</td><td colspan="2">Languages</td><td colspan="6">Dedicated instructions</td></tr>
<tr><td colspan="2">Capacity</td><td colspan="6">13 Ksteps (13312 steps)</td></tr>
<tr><td colspan="2">Positioning number of points</td><td colspan="6">Approx. 400 points/axis (depending on the program)
Positioning data can be indirectly designated.</td></tr>
<tr><td colspan="2">Setting method</td><td colspan="6">Use a PC/AT started up with SW0IX-GSV21PE.</td></tr>
<tr><td rowspan="12">Mechanical system program</td><td colspan="2"></td><td>Mechanical module</td><td colspan="2">Number of modules per A373CPU</td><td colspan="2">Number of modules per block</td></tr>
<tr><td colspan="2"></td><td></td><td colspan="2"></td><td>On connecting axis</td><td>On aux. input axis</td></tr>
<tr><td rowspan="2">Drive module</td><td>Virtual servo motor</td><td>8</td><td rowspan="2">Total 11</td><td colspan="2" rowspan="2">—</td><td rowspan="2">—</td></tr>
<tr><td>Synchronous encoder</td><td>3</td></tr>
<tr><td rowspan="2">Virtual axes</td><td>Virtual main shaft</td><td>8</td><td rowspan="2">Total 16</td><td colspan="2" rowspan="2">—</td><td rowspan="2">—</td></tr>
<tr><td>Virtual aux. input axis</td><td>8</td></tr>
<tr><td rowspan="4">Transmission module</td><td>Gear</td><td colspan="3">16</td><td>1</td><td>1</td></tr>
<tr><td>Clutch</td><td colspan="3">16</td><td>1</td><td>1</td></tr>
<tr><td>Velocity change gear</td><td colspan="3">16</td><td>1</td><td>1</td></tr>
<tr><td>Differential gear</td><td colspan="3">8</td><td>1</td><td>—</td></tr>
<tr><td rowspan="4">Output module</td><td>Cam</td><td>8</td><td rowspan="4">Total 8</td><td colspan="2" rowspan="4">1</td></tr>
<tr><td>Roller</td><td>8</td></tr>
<tr><td>Ball screw</td><td>8</td></tr>
<tr><td>Rotary table</td><td>8</td></tr>
<tr><td rowspan="4">Cam</td><td colspan="2">Number of types</td><td colspan="6">Max. 64</td></tr>
<tr><td colspan="2">1 cycle resolution</td><td colspan="6">256, 512, 1024, 2048</td></tr>
<tr><td colspan="2">Memory capacity</td><td colspan="6">32 Kbytes (Stored in extension file register area block numbers 10 and after in the memory cassette.) *</td></tr>
<tr><td colspan="2">Stroke amount resolution</td><td colspan="6">32767</td></tr>
<tr><td colspan="2">Control mode</td><td colspan="6">Reciprocator cam, feed cam</td></tr>
</table>

POINT

*: The following memory cassettes can only be used when a cam is used in virtual mode:

- A3NMCA24 (192 Kbytes)
- A3NMCA40 (320 Kbytes)
- A3NMCA56 (448 Kbytes)

Table 3.1 PCPU Performance Specifications (continued)

Items		PCPU Performance Specifications	
Positioning	Method	PTP ..... Selection of an absolute system/increment method Fixed-rate transmission ..... Increment method Constant velocity control ..... Absolute systems and increment methods can be used together.	
	Position command	Setting range	–2147483648 to 2147483647 (pulse)
		Max. set value	4294967296 (pulse)
	Velocity command (command unit)	1 to 1000000 (pulse/s)	
	Velocity adjustment processing	Automatic trapezoid velocity adjustment Acceleration time (msec) .....1 to 65535 (msec) Deceleration time (msec) .....1 to 65535 (msec)	
Compensation	Electronic gear	(0 to 65535) × position command unit (0 to 255 pulses when unit is converted to pulse)	
	Backlash compensation	Error compensation function of the actual travel distance for a command value	
Zero return function		When an absolute position system is not used Selection of either a near-zero-point dog type/count type When an absolute position system is used Data set type	
JOG operation function		Provided	
M function		With the M code output function	
Limit switch output function		8 points/axis ON/OFF setting point can be set up to 10 points.	
Absolute position system		Available (when an A362ES is used)	

4. DEVICES OF A373CPU

This section describes the A373CPU's devices which are used for positioning control in virtual mode.

Section 4.1 gives the memory map of the devices used for positioning control in virtual mode.
Sections 4.2 and after give details of common devices (internal relays, special relays, and special registers).
Details of devices (input/output, data registers) applicable to mechanical modules are given in the following sections:

- Drive module: Section 6.3
- Output module: Section 8.6

4.1 Device List

(1) I/O (X/Y)
An A373CPU has 384 I/O device points from X/Y0 to X/Y17F in virtual mode.

Table 4.1 gives the I/O signal names used for positioning control in virtual mode.

Table 4.1 I/O Signal List

Device Numbers	Signal Direction: PCPU → SCPU	Reference Section	Signal Direction: SCPU → PCPU	Reference Section
	Input Signal (X)		Output Signal (Y)	
X/Y 000 to 07F	Output module status signal (axes 1 to 8)	8.6.1	Output module command signal (axes 1 to 8)	8.6.1
080 to 0CF	Unusable by the user	—	Unusable by the user	—
0D0 to 0D7	Output module torque limiting signal (axes 1 to 8)	8.6.1		
0D8 to 0DF	Unusable by the user	—		
0E0 to 0E2	Synchronous encoder error detection signal (P1 to P3)	6.3.1	Synchronous encoder error reset signal (P1 to P3)	6.3.1
0E3 to 0EF	Unusable by the user	—	Unusable by the user	—
0F0 to 0FA	Virtual mode continuous operation disable signal (virtual axes 1 to 8, P1 to P3)	6.3.1		
0FB to 0FF	Unusable by the user	—		
100 to 17F	Drive module status signal (virtual axes 1 to 8)	6.3.1	Drive module command signal (virtual axes 1 to 8)	6.3.1

(2) Internal relays (M)
An A373CPU has 48 internal relay points from M2000 to M2047 which are used for positioning control in virtual mode.

Table 4.2 gives the internal relay names used for positioning control in virtual mode.

Table 4.2 Internal Relay List

Device Numbers	Internal Relay	Reference Section
M2000	PC READY flag	4.2.1
M2001 to M2008	Virtual servo motor start accept flag	4.2.2
M2009	All-axis servo start accept flag	4.2.3
M2010	Unusable by the user	—
M2011		
M2012 to M2014	Manual pulse generator enable flag	4.2.4
M2015	JOG simultaneous start command	4.2.5
M2016	Cam data change request flag	4.2.6
M2017	Cam data change-completed flag	4.2.7
M2018	Cam data change error flag	4.2.8
M2019	Unusable by the user	—
M2020	Start buffer full	4.2.9
M2021 to M2028	Velocity change flag	4.2.10
M2029	Unusable by the user	—
M2030		
M2031 to M2033	Synchronous encoder axis current value change flag	4.2.11
M2034 to M2041	Unusable by the user	—
M2042	All-axis servo start command	4.2.12
M2043	Real mode/virtual mode switch request flag	4.2.13
M2044	Real mode/virtual mode status	4.2.14
M2045	Real mode/virtual mode switch error detection flag	4.2.15
M2046	Synchronization step out warning flag	4.2.16
M2047	Option slot unit fault detection flag	4.2.17

(3) Special relays
Table 4.3 gives the special relay names used for positioning control in virtual mode.

Table 4.3 Special Relay List

Device Number	Special Relay	Reference Section
M9073	WDT error flag	4.3.1
M9074	PCPU READY-completed flag	4.3.2
M9075	In-test-mode flag	4.3.3
M9076	External emergency stop input flag	4.3.4
M9077	Manual pulse generator axis setting error flag	4.3.5
M9078	Test mode request error flag	4.3.6
M9079	Servo program setting error flag	4.3.7

(4) Data registers
Table 4.4 gives the data register names used for positioning control in virtual mode.

Table 4.4 Data Register List

Device Numbers	Data Register	Reference Section
D700 to D747	Virtual servo motor monitoring area	6.3.2
D748 to D759	Synchronous encoder monitoring area	6.3.2
D760 to D799	Cam monitoring area	8.6.2
D800 to D959	Output module monitoring area	8.6.2
D960 to D1007	Virtual servo motor control change area	6.3.2
D1008 to D1011	Limit switch output enable/disable setting	8.6.2
D1012 to D1014	Manual pulse generator axis setting	6.3.2
D1015	JOG operation simultaneous start axis setting	6.3.2
D1016 to D1023	Manual pulse generator 1 pulse input magnification setting	6.3.2

(5) Special registers
Table 4.5 gives the special register names used for positioning control in virtual mode.

Table 4.5 Special Register List

Device Numbers	Special Register	Reference Section
D9180 to D9183	Limit switch output status storage area (Axis1, Axis2)	4.4.1
D9184	PCPU error cause storage area	4.4.2
D9185	Servo amplifier type storage area	4.4.3
D9186		
D9187	Manual pulse generator axis setting error cause storage area	4.4.4
D9188	Test mode request error cause storage area	4.4.5
D9189	Error program number storage area	4.4.6
D9190	Error item information storage area	4.4.7
D9191	Servo amplifier and option slot loading information storage area	4.4.8
D9192 to D9194	Manual pulse generator smoothing magnification storage area (P1 to P3)	4.4.9
D9195	Real mode/virtual mode switching error information storage area	4.4.10
D9196 to D9199	Unusable by the user	—

4.2 Internal Relays (M)

An A373CPU has 2048 internal relay/latch relay points from M/L0 to M/L2047. M2000 to M2047 are used for positioning control. Those uses are indicated in the following table.

Table 4.6 Internal Relay List

Device Numbers	Signal Name	Mode		Signal Direction
		Real Mode	Virtual Mode	
M2000	PC READY flag	O	O	SCPU → PCPU
M2001	Virtual axis 1 start accept flag	O	O	PCPU → SCPU
M2002	Virtual axis 2 start accept flag			
M2003	Virtual axis 3 start accept flag			
M2004	Virtual axis 4 start accept flag			
M2005	Virtual axis 5 start accept flag			
M2006	Virtual axis 6 start accept flag			
M2007	Virtual axis 7 start accept flag			
M2008	Virtual axis 8 start accept flag			
M2009	All-axis servo start accept flag			
M2010 to M2011	Unusable by the user	—	—	—
M2012	Manual pulse generator 1 enable flag	O	—	SCPU → PCPU
M2013	Manual pulse generator 2 enable flag			
M2014	Manual pulse generator 3 enable flag			
M2015	JOG simultaneous start command	O	O	
M2016	Cam data change request flag	—	O	SCPU → PCPU
M2017	Cam data change-completed flag	—	O	PCPU → SCPU
M2018	Cam data change error flag			
M2019	Unusable by the user	—	—	—
M2020	Start buffer full	O	O	PCPU → SCPU
M2021	Virtual axis 1 velocity change flag	O	O	
M2022	Virtual axis 2 velocity change flag			
M2023	Virtual axis 3 velocity change flag			
M2024	Virtual axis 4 velocity change flag			
M2025	Virtual axis 5 velocity change flag			
M2026	Virtual axis 6 velocity change flag			
M2027	Virtual axis 7 velocity change flag			
M2028	Virtual axis 8 velocity change flag			
M2029 to M2030	Unusable by the user	—	—	—
M2031	Synchronous encoder (P1) axis current value changing	—	O	
M2032	Synchronous encoder (P2) axis current value changing			
M2033	Synchronous encoder (P3) axis current value changing			
M2034 to M2041	Unusable by the user	—	—	—
M2042	All-axis servo start command	—	—	—
M2043	Real mode/virtual mode switching request	O	O	SCPU → PCPU
M2044	Real mode/virtual mode status			PCPU → SCPU
M2045	Real mode/virtual mode switching error detection			
M2046	Unusable by the user	—	—	—
M2047				

O: used —: unused

POINTS

(1) The internal relays for positioning control are not latched even when they are set in the latch range. In this manual, such internal relays are represented as M2000 to M2047 to indicate that they are not latched.

(2) Internal relays for positioning control are displayed as follows when monitored by a peripheral device:

(a) On a PC/AT started up with SW0IX-GSV21PE, such relays are displayed as M2000 to M2047 regardless of latch range setting.

(b) On the following peripheral devices, device symbols become M, L, and S according to latch range setting.
- A7PU, A7PUS, A8PUE
- PC/AT started up with GPP function

4.2.1 PC READY flag (M2000) ..... Signal from SCPU to PCPU

(a) This is a signal used to inform the PCPU that the SCPU is normal. This signal is turned ON/OFF by a sequence program.

1) When M2000 is ON, positioning control or zero return by a servo program designated by a sequence program and jog operation by a sequence program can be performed.

2) When M2000 is OFF the control mentioned in 1) above is not performed. Also, in a peripheral device's test mode (test mode flag (M9075) is ON)* , even if M2000 is on, the control mentioned in 1) above is not performed.

(b) Fixed parameter, servo parameter, and limit switch output data can be changed by a peripheral device only when M2000 is OFF.
If above data change is made when M2000 is ON, an error will occur.

(c) When M2000 status is switched from OFF to ON, the following processing is executed:

1) Processing

a) Servo parameters are transferred to a servo amplifier.

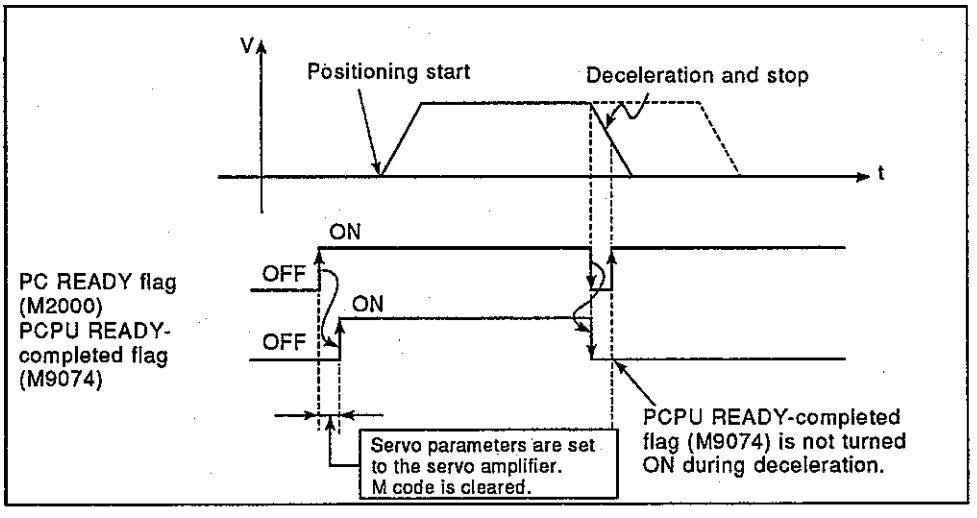
b) The M code storage areas for all axes are cleared.

c) Default 300% is set in the torque limit storage area.

d) PCPU READY flag (M9074)* is turned ON.

2) When an axis is in the starting state, an error occurs and the processing in above (c) 1) is not executed.

3) In test mode, the processing in above (c) 1) is not executed. When test mode is exited and M2000 is ON, the processing in above (c) 1) is executed.



REMARK

1) *: Section 4.3 gives details of in-test-mode flag and PCPU READY-completed flag.

(d) When M2000 status is switched from OFF to ON, the following processing is executed:

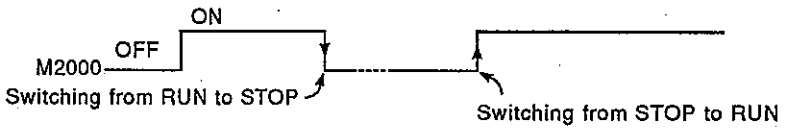
1) Processing

a) PCPU READY flag (M9074) is turned OFF.

b) Starting axis is decelerated and stopped.

POINT

PC READY (M2000) is turned OFF when A373CPU is in the STOP state. When it is switched to the RUN state, the PC READY signal returns to the state before STOP.

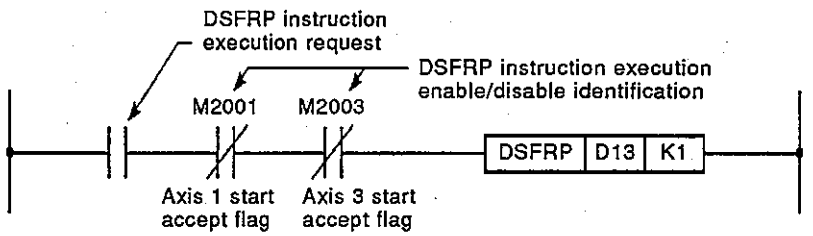


4.2.2 Virtual servo motor start accept flag (M2000 to M2008) ..... Signal from PCPU to SCPU

(a) A start accept flag is turned ON when a positioning start instruction (DSFRP)*2 of a sequence program is executed. This is used for the execution enable/disable interlock of a DSFRP instruction.

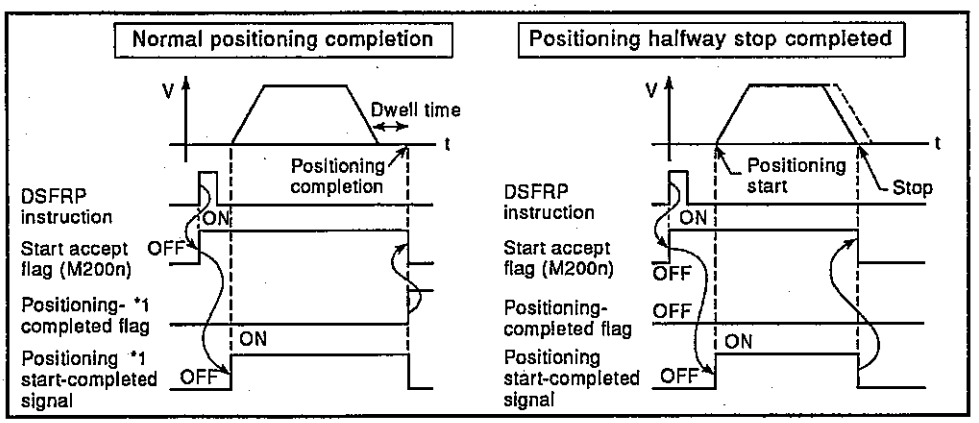
Example

The following start accept flag is used when making a request for servo program execution for positioning of axes 1 and 3:



(b) Start accept flag ON/OFF processing is as follows:

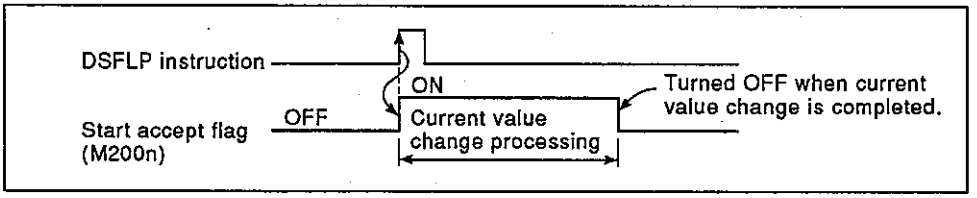
1) When a sequence program DSFRP instruction is executed, the start accept flag which corresponds to the axis designated by the DSFRP instruction is turned ON, and it is turned OFF when positioning is completed.
The start accept flag is turned OFF also when positioning is stopped halfway.



2) When positioning control is executed by the ON of a jog operation command *1, the start accept flag is turned OFF when positioning is stopped by the OFF of a jog operation command.

3) The start accept flag is ON when the manual pulse generator enable (M2015) is ON.
The start accept flag is OFF when the manual pulse generator disable (M2015) is OFF.

4) The start accept flag is ON when current value change is executed by a DSFLP instruction of a sequence program.
It is turned OFF when current value change is completed.



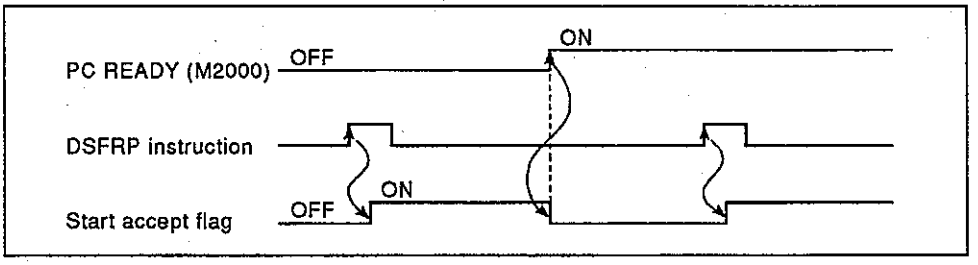
POINTS

Do not turn ON/OFF a start accept flag by using a user's program.

(1) If a start accept flag is turned OFF by using a sequence program or peripheral device, positioning operation cannot be guaranteed even though an error does not occur.

(2) If a start accept flag is turned ON by a sequence program or peripheral device when the start accept flag is OFF, the "start accept ON error" occurs and start cannot be executed at the next start even though an error does not occur.

(c) When M2000 is OFF, the start accept flag is turned ON by the execution of a DSFRP instruction *2, and the start accept flag is turned OFF when M2000 is turned ON.



REMARKS

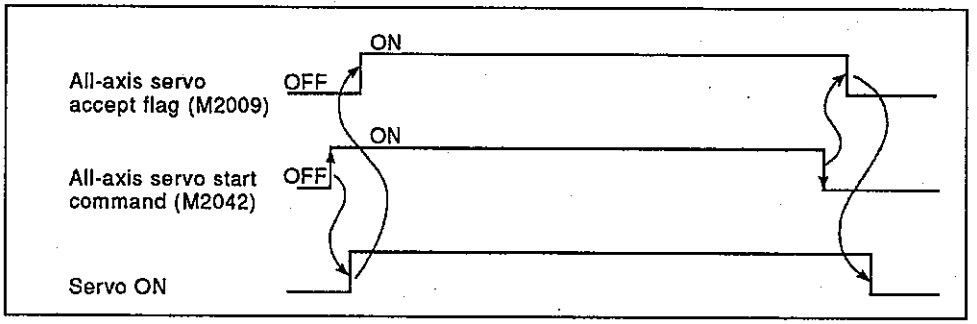
1) *1: Section 8.6.1 gives details of positioning completed start signal, positioning completed signal, and jog operation command.

2) *2: ACPU Programming Manual (Common instructions) gives details of DSFRP instruction.

4.2.3 All-axis servo start accept flag (M2009) ..... Signal from PCPU to SCPU

The all-axis servo start accept flag is used to inform that the servo operation is enabled.

1) ON: Servo operation is possible.
2) OFF: Servo operation is impossible.



4.2.4 Manual pulse generator enable flag (M2012, M2013, M2014) ..... Signal from SCPU to PCPU

The manual pulse generator enable flag is used for enable/disable setting of positioning by pulse inputs from manual pulse generators connected to P1 to P3 of A336PX.

1) ON : Positioning control is performed by the input from manual pulse generator.
2) OFF : Input from manual pulse generators is ignored so positioning control using a manual pulse generator is impossible.

4.2.5 JOG operation simultaneous start command (M2015) ..... Signal from SCPU to PCPU

(a) When M2015 is turned ON, jog simultaneous start is executed according to the jog operation execution axis (axis 1 to 8) set in the jog operation simultaneous start axis area.

(b) When M2015 is turned OFF, jog operation axis is decelerated and stopped.

4.2.6 Cam data change request flag (M2016) ..... Signal from SCPU to PCPU

(a) This flag is used to change cam data taken in when the power was turned ON or the A373CPU was reset to other cam data.
(Cam data change can be made only in real mode.)

1) When M2016 is switched from OFF to ON, cam data stored in extension file registers No. 10 and after is input by the PCPU. Cam data input is enabled by the leading edge of M2016 (OFF to ON) and cannot be suspended by turning M2016 OFF.

2) This flag must be reset when cam data input is normally completed or an error is detected.

a) Normally completed: M2017 ON

b) Error is detected: M2018 ON

(b) Section 8.5.6 gives details of cam data change.

4.2.7 Cam data change-completed flag (M2017) ..... Signal from PCPU to SCPU

(a) This flag is used to confirm normal completion of cam data change.

1) This flag is turned ON when cam data change is normally completed.

2) When M2016 is turned OFF, M2017 is also turned OFF.

(b) During cam data input, mode switching from real mode to virtual mode is impossible.
Use M2016 as an interlock for switching to virtual mode.

4.2.8 Cam data change error flag (M2018) ..... Signal from PCPU to SCPU

(a) This flag is used to check error presence/absence during cam data change.

1) This remains OFF when no error is present during cam data change.

2) This is turned ON when an error is detected during cam data change.

(b) When M2016 is turned OFF, M2018 is also turned OFF.

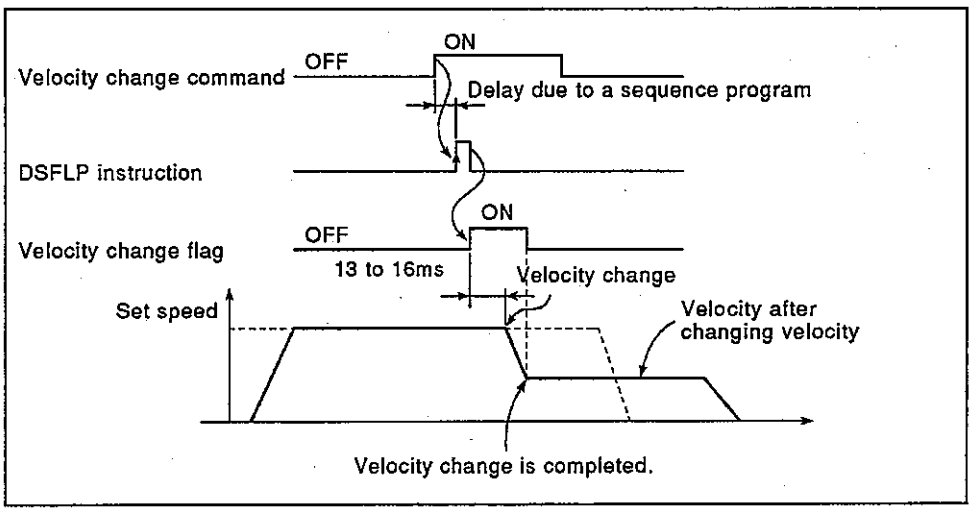
4.2.9 Start buffer full (M2020) ..... Signal from PCPU to SCPU

(a) This flag is turned ON when the PCPU cannot process requests when more than 15 requests are made by a positioning start instruction (DSFRP) and a control change instruction (DSFLP) of a sequence program.

(b) M2020 must be reset by using a sequence program.

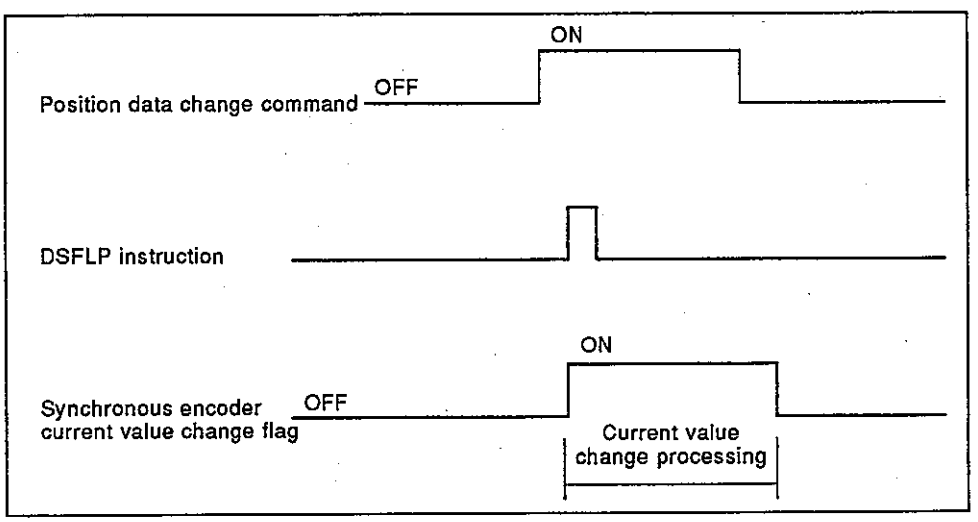
4.2.10 Velocity change flag (M2021 to M2028) ..... Signal from PCPU to SCPU

This flag is turned ON when velocity change is executed by a control change instruction (DSFLP) of a sequence program. Use this as an interlock for a velocity change program.



4.2.11 Synchronous encoder current value change flag (M2031 to M2033) ..... Signal from PCPU to SCPU

This flag is turned ON when the synchronous encoder current value is changed by a control change instruction (DSFLP) of a sequence program.
Use this as an interlock for a synchronous encoder current value change program.

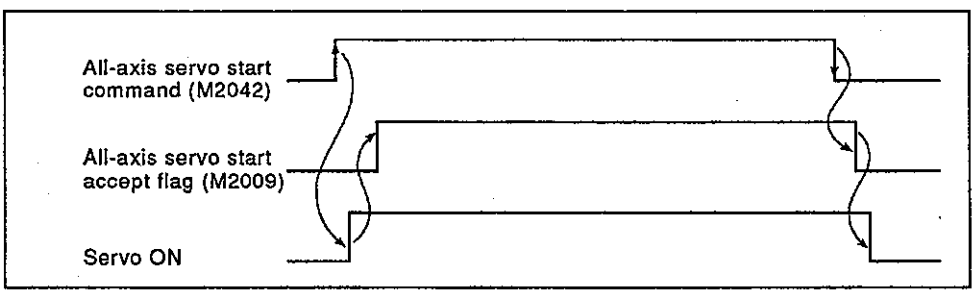


4.2.12 All-axis servo start command (M2042) ..... Signal from SCPU to PCPU

This command is used to make servo operation possible.

1) Servo operation possible : M2042 is turned ON when a servo OFF signal (YnF) is OFF and no servo error is present.

2) Servo operation impossible: M2042 is turned OFF.
   - Servo OFF signal (YnF) is ON.
   - Servo error



POINT

When M2042 is turned ON, M2042 is not turned OFF even though the CPU is set to STOP.

4.2.13 Real mode/virtual mode switching request flag (M2043) ..... Signal from SCPU to PCPU

This flag is used to switch modes from real mode to virtual mode or from virtual mode to real mode.

1) To switch from real mode to virtual mode, M2043 must be turned ON after a M9074 PCPU ready flag is turned ON.
   - Error check is executed when M2043 is switched from OFF to ON. When no error is detected, mode is switched to virtual mode and M2044 real mode/virtual mode identification flag is turned ON.
   - When an error is detected, mode is not switched to virtual mode. At this time, M2045 real mode/virtual mode switch error flag is turned ON, and the error code is stored in D9195 real mode/virtual mode switch error code storage register.

2) To switch from virtual mode to real mode, M2043 must be turned OFF.
   - When all virtual servo motors are stopped, mode is switched to real mode and M2044 is turned OFF.
   - When any virtual servo motor is starting, mode is not switched to real mode.
     At this time, M2045 is turned ON and the error code is stored in D9195.

3) Section 9 gives details of switching between real mode and virtual mode.

4.2.14 Real mode/virtual mode status flag (M2044)..... Signal from PCPU to SCPU

This flag is used to check completion of switching between real mode and virtual mode and to check current mode.

- This flag is turned OFF when switching from real mode execution/virtual mode to real mode is completed.
- This flag is turned ON when switching from virtual mode to real mode is completed.

Use this flag as an interlock when a servo program is started or control change (velocity change, current value change) is executed.

4.2.15 Real mode/virtual mode switching error detection flag (M2045) .. Signal from PCPU to SCPU

This flag is used to check error presence/absence during mode switching (from real mode to virtual mode or vice versa).
- When no error is detected, this flag remains OFF.
- When an error is detected, this flag is turned ON.

The error code is stored in D9195.

4.2.16 Synchronization step out warning flag (M2046)..... Signal from PCPU to SCPU

(a) This flag is turned ON when a synchronizing position between a drive module and an output module has stepped out during virtual mode operation. This is used for operation continuation enable/disable judgment when a drive module is stopped.
- M2046: ON .....continuous operation disable
- M2046: OFF .....continuous operation enable

(b) The synchronization step out warning flag is turned ON in the following cases:
- When stopped by an external emergency stop (EMG)
- When a servo error occurred in an output module

(c) When a synchronization step out warning flag is turned ON, restart operation as follows.
1) Return to real mode and remove cause of the error.
↓
2) Adjust synchronizing positions of each axis.
↓
3) Turn OFF the synchronization position step out warning flag (M2046).
↓
4) Switch to virtual mode.
↓
5) Restart operation.

4.2.17 Option slot unit error detection flag (M2047) ..... Signal from PCPU to SCPU

This flag is used for normal/abnormal judgment of the unit installed to an option slot (OP1, OP2).

- Remains OFF when normal.
- Turned ON when a mismatch (error) is found in unit information of the option slot when power is turned ON/reset.
  Positioning control is continued.
  The "OP[ ] UNIT ERROR" message is displayed on the LED display of the A373CPU front.

POINT

Positioning control is continued even when an option slot unit error is found.
To stop a starting axis and turn servo OFF when an error is found, use a user's sequence program.

4.3 Special Relays (SP. M)

An A373CPU has 256 special relay points from M9000 to M9255.
The 7 points from M9073 to M9097 are used for positioning control and their applications are shown in Table 4.7.

Table 4.7 Special Relay List

Device Number	Special Relay	Mode		Signal Direction
		Real Mode	Virtual Mode	
M9073	WDT error flag	O	O	PCPU → SCPU
M9074	PCPU READY-completed flag			
M9075	In-test-mode flag			
M9076	External emergency stop input flag			
M9077	Manual pulse generator axis setting error flag			
M9078	Test mode request error flag			
M9079	Servo program setting error flag			

O: used

4.3.1 WDT error flag (M9073) ..... Signal from PCPU to SCPU

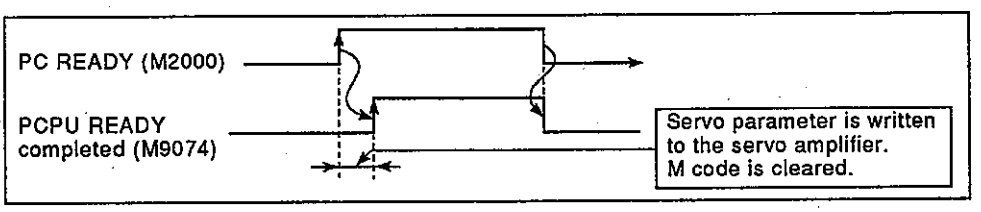
This flag is turned ON when a "watchdog timer error" is found by the PCPU's self-diagnosis check.
When the PCPU detects a WDT error, it decelerates or emergency stops a starting axis.
When a WDT error flag is turned ON, reset the A373CPU by using a reset key switch.
If M9073 is turned ON again after resetting, the PCPU has a problem.

4.3.2 PCPU READY-completed flag (M9074) ..... Signal from PCPU to SCPU

This flag is used for normal/abnormal judgment of PCPU by a sequence program.

(a) When a PC READY (M2000) signal state is switched from OFF to ON, fixed parameter, servo parameter, limit switch output data, etc. are checked. When no error is found, this flag is turned ON. Servo parameter is written to a servo amplifier, and M codes are cleared.

(b) When the PC READY (M2000) is turned OFF, this flag is turned OFF.



4.3.3 In-test-mode flag (M9075) ..... Signal from PCPU to SCPU

(a) This flag is used for judging whether or not the PCPU is in test mode requested by a peripheral device.
Use this flag as an interlock during starting of a servo program by a DSFRP instruction *1 of a sequence program.
1) OFF..... Other than test mode
2) ON..... In test mode

(b) When test mode requested by a peripheral device is not enabled, a test mode request error flag (M9078) is turned ON.

4.3.4 External emergency stop input flag (M9076) ..... Signal from PCPU to SCPU

This flag is used to confirm ON/OFF of an external emergency stop input to the EMG terminal of the power supply module.
1) OFF..... External emergency stop input ON
2) ON..... External emergency stop input OFF

4.3.5 Manual pulse generator axis setting error flag (M9077) ..... Signal from PCPU to SCPU

(a) This flag is used for normal/abnormal judgment of the setting of P1 to P3 manual pulse generator axis setting registers (D1012 to D1014) *2.
1) OFF..... All of D1012 to D1014 are normal.
2) ON..... Any of D1012 to D1014 is abnormal.

(b) When M9077 is turned ON, the error information is stored in a manual pulse generator axis setting error storage register (D9187).

4.3.6 Test mode request error flag (M9078) ..... Signal from PCPU to SCPU

(a) When test mode requested by a peripheral device is not enabled, this flag is turned ON.

(b) When M9078 is turned ON, the error information is stored in a test mode request error storage register (D9188).

4.3.7 Servo program setting error flag (M9079) ..... Signal from PCPU to SCPU

This flag is used for normal/abnormal judgment of positioning data of the servo program designated by the DSFRP instruction *1 .
1) OFF..... Normal
2) ON..... Abnormal

REMARKS

1) *1:ACPU Programming Manual (Common instructions) gives details of DSFRP instruction.
2) *2:Section 6.3.2 gives details of manual pulse generator axis setting register.

4.4 Special Registers (SP.D)

An A373CPU has 256 special register points from D9000 to D9255.
The 20 points from D9180 to D9199 are used for positioning control and their applications are as shown in the following table. (ACPU Programming Manual (Common instructions) describes the applications of special registers other than D9180 to D9199.)

Table 4.8 Special Register List

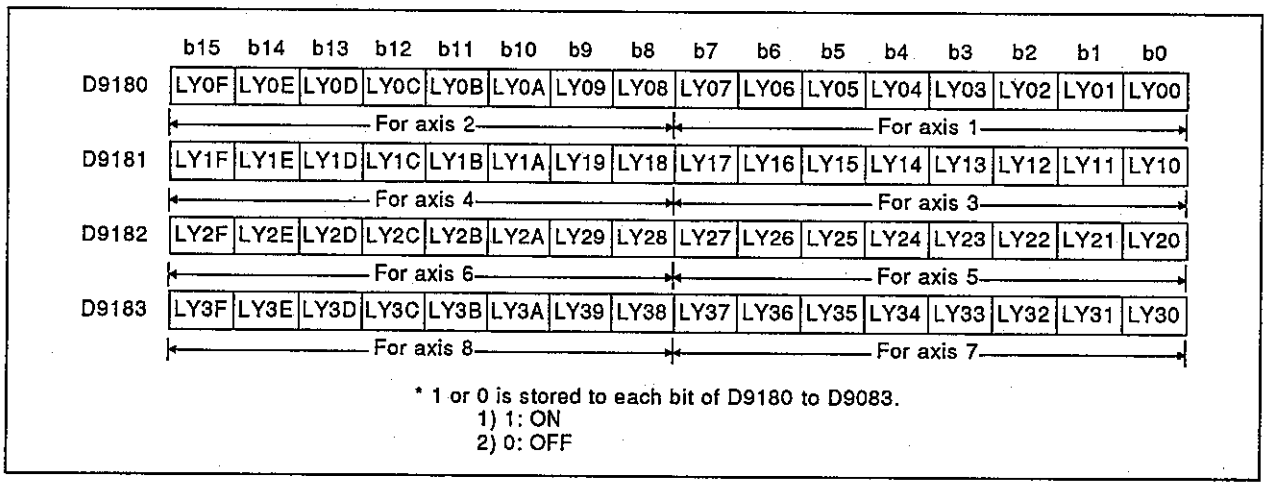
Device Numbers	Signal	Mode	
		Real Mode	Virtual Mode
D9180	Limit switch output status storage area for axis 1 and axis 2	O	O
D9181	Limit switch output status storage area for axis 3 and axis 4		
D9182	Limit switch output status storage area for axis 5 and axis 6		
D9183	Limit switch output status storage area for axis 7 and axis 8		
D9184	PCPU error cause	O	O
D9185	Servo amplifier type	O	O
D9186			
D9187	Manual pulse generator axis setting error	O	O
D9188	Test mode request error	O	O
D9189	Error program number	O	O
D9190	Error item information	O	O
D9191	Servo amplifier and option slot loading information	O	O
D9192	Manual pulse generator (P1) smoothing magnification setting area	O	O
D9193	Manual pulse generator (P2) smoothing magnification setting area		
D9194	Manual pulse generator (P3) smoothing magnification setting area		
D9195	Real mode/virtual mode switching error information	O	O
D9196 to D9199	Unusable	—	—

O: used

4.4.1 Limit switch output status storage area (D9180 to D9183)..... Data form PCPU to SCPU

(a) The output status (ON/OFF) of limit switch output set by a peripheral device to AY42 is stored as 1 or 0.
1) 1: ON
2) 0: OFF

(b) This is used when limit switch output data is output to a peripheral device by using a sequence program.



* 1 or 0 is stored to each bit of D9180 to D9083.
1) 1: ON
2) 0: OFF

REMARK

LY of LY □□ of D9180 to D9183 shows the limit switch output.

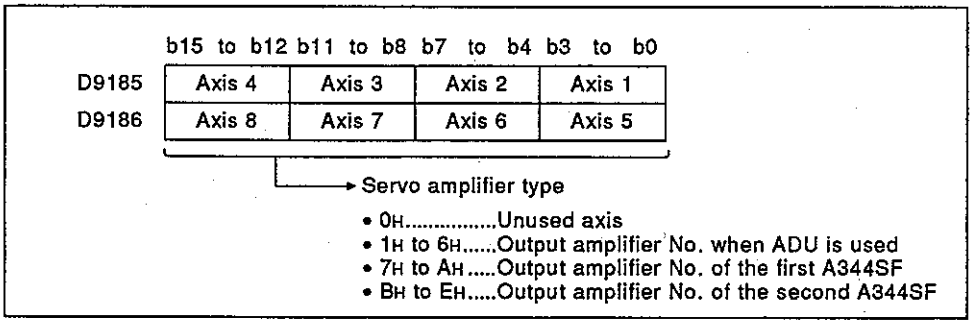
4.4.2 PCPU error cause (D9184)..... Data from PCPU to SCPU

This is used for judging error content in the PCPU by using a sequence program.

Error Code	Error Cause
0	Normal
1, 2, or 10	A373CPU H/W error
11	Option slot 1 unit error
12	Option slot 2 unit error

4.4.3 Servo amplifier type (D9185, D9186)..... Data from PCPU to SCPU

The servo amplifier type set by system setting is stored when an A373CPU is turned ON or reset.

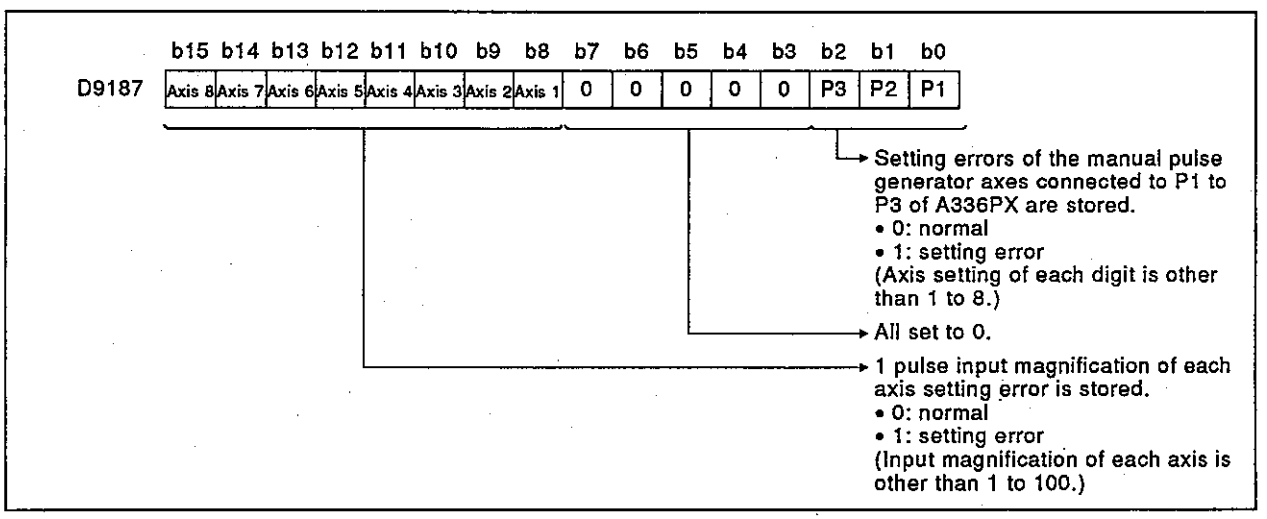


REMARK

Section 8.1.1 gives details of output amplifier number.

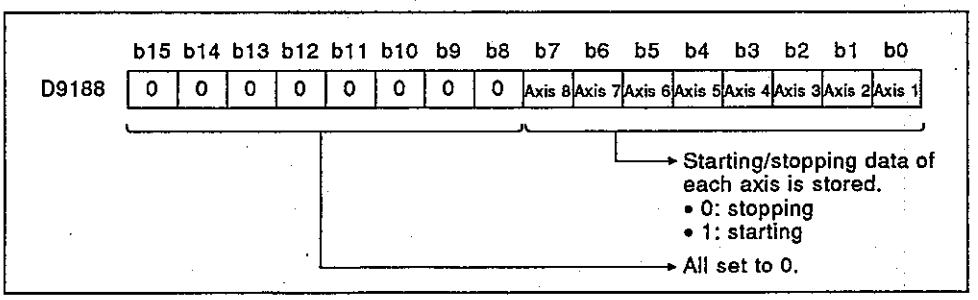
4.4.4 Manual pulse generator axis setting error (D9187)..... Data from PCPU to SCPU

When manual pulse axis setting error (M9077) is turned ON, the error information of manual pulse generator is stored in a manual pulse generator axis setting error.



4.4.5 Test mode request error (D9188)..... Data from PCPU to SCPU

When a test mode request error flag (M9078) is turned ON, starting axis data is stored.



4.4.6 Error program number (D9198) ..... Data from PCPU to SCPU

(a) When a servo program setting error flag (M9079)*1 is turned ON, the error servo program number (0 to 4095) is stored.

(b) When an error has occurred in a servo program operation when an error program number is stored, the program number with which the new error occurred is stored.

4.4.7 Error item information (D9190) ..... Data from PCPU to SCPU

When a servo program setting error flag (M9079) is turned ON, the error code that corresponds to the error setting item is stored.

Error Codes	Error Description
900	A servo program set by a DSFRP instruction does not exist.
901	Discrepancy between an axis No. set by a DSFRP instruction and an axis No. set by a servo program.
902	Instruction code cannot be decoded. (erroneous instruction code exists.)
Error item data	An error exists in the servo program setting items set by a DSFRP instruction.*2

REMARKS

1) *1: Section 4.3.7 gives details of servo program setting error flag.

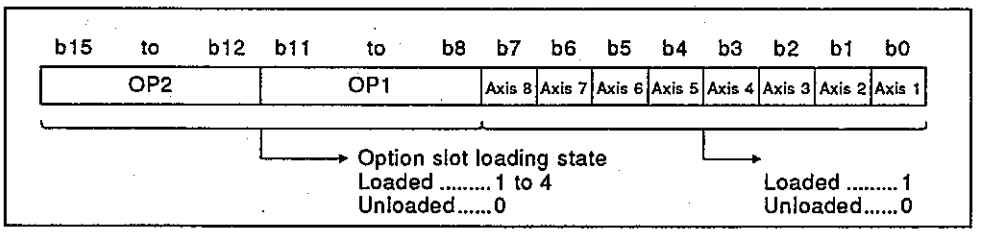
2) *2: A373CPU (P21/R21) Maintenance Manual gives details of error item data.

4.4.8 Servo amplifier loading information (D9191) ..... Data from PCPU to SCPU

State of loading of servo amplifiers and option slots is checked when an A373CPU is turned ON or reset, and the check result is stored.

Higher 8 bits: Option slot loading state
Lower 8 bits : Servo amplifier loading state
b8 to b11 : Option slot 1 (OP1)
b12 to b15: Option slot 2 (OP2)

When an axis state changed from unloaded to loaded after the power is turned ON, the loaded state is stored. However, when the axis state changed from loaded to unloaded, the loaded state is stored.



(1) Servo amplifier loading state

(a) Loaded/unloaded state

1) Loaded.....Either AC motor drive unit or MR-SB and MR-SD are in normal state (communications with servo amplifier are normally done).
2) Unloaded..... Servo amplifier is not loaded.
Servo amplifier power supply is OFF.
Normal communications with servo amplifier cannot be made due to connecting cable fault.

(b) System setting and servo amplifier loading states are as follows.

System setting	AC motor drive module		MR-SB/MR-SD	
	Loaded	Unloaded	Loaded	Unloaded
Used (axis number setting)	1 is stored.	High error	1 is stored.	0 is stored.
Unused	0 is stored.	0 is stored.	0 is stored.	0 is stored.

(2) Option slot loading state

1) 1 ..... A336PX
2) 2 ..... A336EX
3) 3 ..... A344SF
4) 4 ..... AY42

4.4.9 Manual pulse generator smoothing magnification setting area (D9192 to D9194)

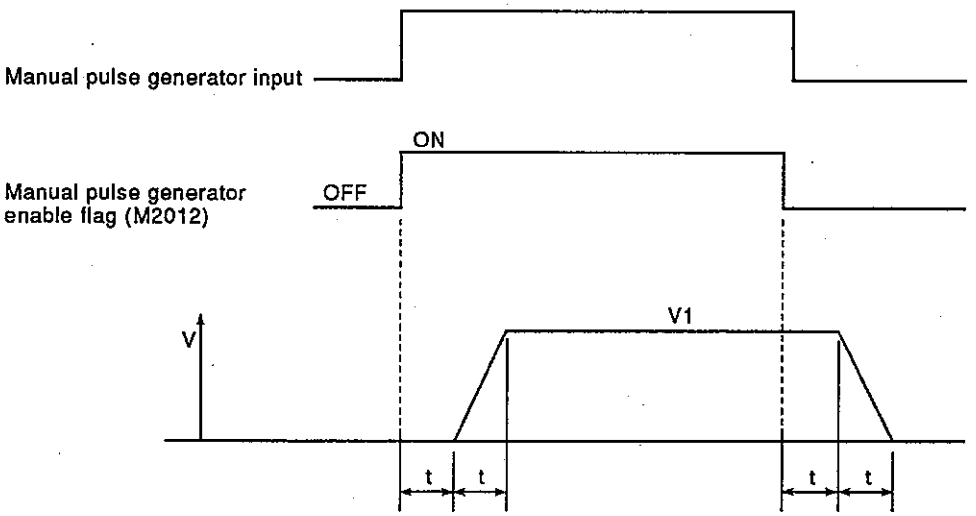
..... Data from SCPU to PCPU

(1) These devices are used for setting the smoothing constant of a manual pulse generator.

(2) Smoothing magnification can be set in the 0 to 59 range.

(3) By setting smoothing magnification, the smoothing constant is expressed as follows:
Smoothing constant (t) = (Smoothing magnification + 1) *56.8 [msec]

(4) Operation



$$\left(\begin{array}{l}\text{Output}\\ \text{Velocity (V1)}\end{array}\right) = \left(\frac{\text{Number of input pulses}}{\text{msec}}\right) * \left(\begin{array}{l}\text{Manual pulse generator}\\ \text{1 pulse input}\\ \text{magnification setting}\end{array}\right)$$

$$\left(\begin{array}{l}\text{Travel}\\ \text{distance (L)}\end{array}\right) = \left(\begin{array}{l}\text{Travel}\\ \text{distance}\\ \text{per pulse}\end{array}\right) * \left(\begin{array}{l}\text{Number}\\ \text{of input}\\ \text{pulses}\end{array}\right) * \left(\begin{array}{l}\text{Manual pulse generator}\\ \text{1 pulse input}\\ \text{magnification setting}\end{array}\right)$$

REMARKS

1) The amount of movement per pulse of a manual pulse generator is as follows:

- Setting unit
  - mm : 0.1μm
  - inch : 0.00001 inch
  - degree : 0.00001 degree
  - pulse : 1 pulse

2) Smoothing constant: 56.8 to 3408 msec.

4.4.10 Real mode/virtual mode switching error information (D9195) ..... Data from PCPU to SCPU

(1) Error information (error code) is stored during mode switching (from real mode to virtual mode or vice versa).
Section 10.6 gives details of error code to be stored.

5. MECHANICAL SYSTEM PROGRAM

This section describes a mechanical system program used for control in virtual mode.
A mechanical system program is comprised of a mechanical module connection diagram and mechanical module parameters.

- A mechanical module connection diagram is a representation of a virtual mechanical system in which virtual mechanical modules are connected.
- Mechanical module parameters are used to control mechanical modules which appear in the mechanical module connection diagram.

The mechanical module parameter lists in Sections 6 to 8 give details of mechanical module parameters.

5.1 Mechanical Module Connection Diagram

A mechanical module connection diagram represents a virtual mechanical system in which virtual mechanical modules are connected.
Fig. 5.1 shows a structure of a mechanical module connection diagram.

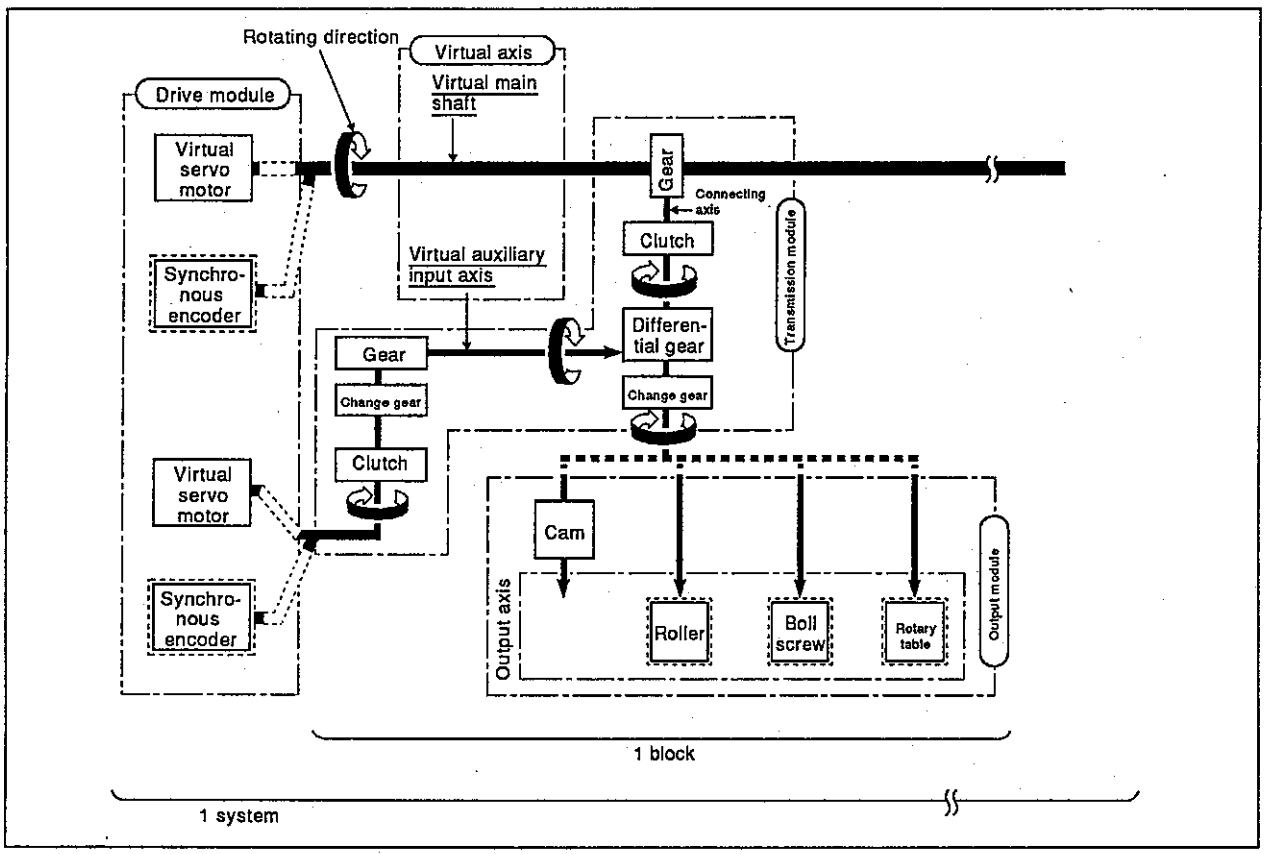


Fig 5.1 Structure of a Mechanical Module Connection Diagram

POINTS

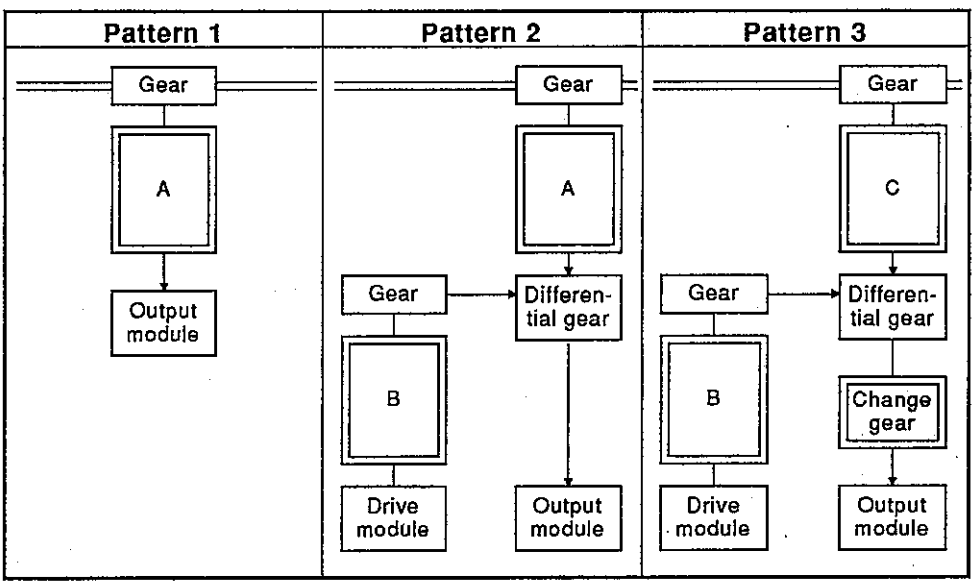
(1) Either a virtual servo motor or a synchronous encoder can be connected to a drive module.

(2) Either a cam, roller, ball screw, or rotary table can be connected to an output module.

(1) Block
A block is a continued section from a virtual transmission module (gear) connected to a virtual main shaft to an output module.
Table 5.1 gives the number of mechanical modules which can be connected to one block.

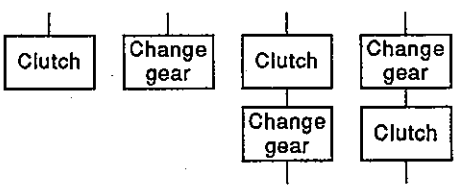
(2) System
A system is a collective body of blocks connected to one virtual main shaft.
Up to 8 blocks can be connected to one system.

(3) Connection of transmission modules
Transmission modules can be connected in the following 3 patterns:
- Pattern 1: Differential gear: Not used
- Pattern 2: Change gear on the differential gear output side: Not used
- Pattern 3: Change gear on the differential gear output side: Used



(a) Transmission modules which can be connected to A and B

1) A clutch, change gear, or a pair comprising of a clutch and change gear can be connected to A and B.
2) When a pair comprising of a clutch and change gear is connected, either one can be connected first.

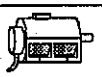
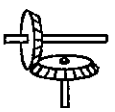
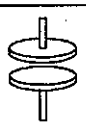
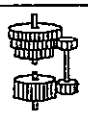


(b) Transmission modules which can be connected to C
Only a clutch can be connected to C.

5.2 Mechanical Module List

Table 5.1 gives general description of mechanical modules used in the mechanical module connection diagram for virtual mode.
Sections 6 to 8 give details of each mechanical module.

Table 5.1 Mechanical Module List

Mechanical Category	Mechanical Module		Number of modules usable						Functions	Reference Sections
	Names	Appearance	Number of modules per one A373CPU		Number of modules per one system		Number of modules per one block			
							Connecting axis side	Aux. input axis side		
Drive module	Virtual servo motor		8	Total 11	8	Total 11	—	—	• Used to drive a virtual axis of a mechanical system program by a servo program or jog start.	6.1
	Synchronous encoder		3		3		—	—	• Used to drive a virtual axis by input pulses from an external synchronous encoder.	6.2
Virtual axis	Virtual main shaft	—	8	Total 16	1		—	—	• A virtual connecting axis. • This transmits the drive module's rotation to the transmission module.	—
	Virtual auxiliary input axis	—	8		8		—	—	• An aux. input axis for the differential gear of a transmission module. • This is automatically displayed when a differential gear is connected to a gear.	—
Transmission module	Gear		16		16		1	1	• This transmits the drive module's rotation to the output axis. • The amount of movement (pulses) input from a drive module is multiplied by set gear ratio and transmitted to the output axis in set rotating direction.	7.1
	Direct clutch		16		16		1	1	• Used to transmit/disconnect the drive module's rotation to/from an output module. • A direct clutch is used to transmit rotation directly at clutch ON/OFF switching. A smoothing clutch is used to transmit rotation while executing acceleration/deceleration processing according to setting of the smoothing constant. • ON/OFF mode, address mode, and external input mode can be selected.	7.2
	Smoothing clutch									
	Change gear		16		16		1	1	• Used to change the output module (roller) speed. • The input axis speed is multiplied by set change ratio and then transmitted to the output axis.	7.3
	Differential gear		8		8		1	—	• Rotation of an aux. input axis is subtracted from a virtual main shaft, and the result is transmitted to the output axis.	7.4
Output module	Roller		8	Total 8	8	Total 8	1	1	• Used when the final output executes velocity control.	8.2
	Ball screw		8		8				• Used when the final output executes linear positioning.	8.3
	Rotary table		8		8				• Used when the final output axis executes angular control.	8.4
	Cam		8		8				• Used when the final output axis executes control other than the above. Position control is executed according to set cam pattern data. • Either reciprocating cam mode or feed cam mode is available.	8.5

6. DRIVE MODULE

A drive module is the driving source of virtual axes.
The following 2 kinds of drive modules are provided:
- Virtual servo motor ..... See Section 6.1.
- Synchronous encoder .... See Section 6.2.

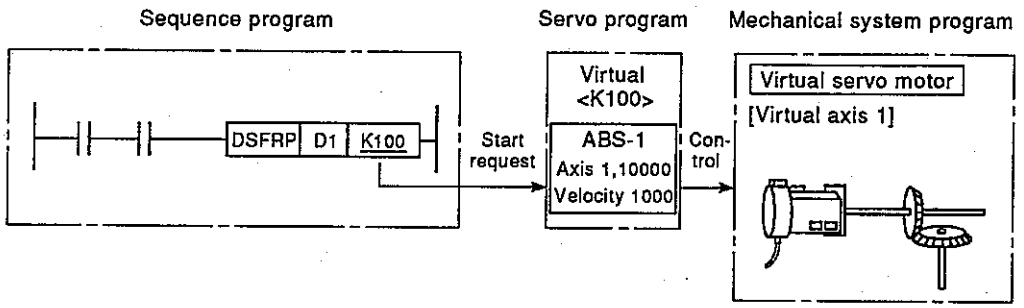
6.1 Virtual Servo Motor

Used for driving a virtual axis by using a servo program or JOG operation.
The following explains the operations of virtual servo motor and parameters.

6.1.1 Operation

(1) Starting method
A virtual servo motor is started by using a servo program or JOG operation.

(a) Started by using a servo program
A DSFRP instruction of a servo program is used to start a servo program.
A start accept flag *1 (M2001 to M2008) of the started axis is turned ON.
ACPU Programming Manual (Common instractions) gives details of DSFRP instruction.



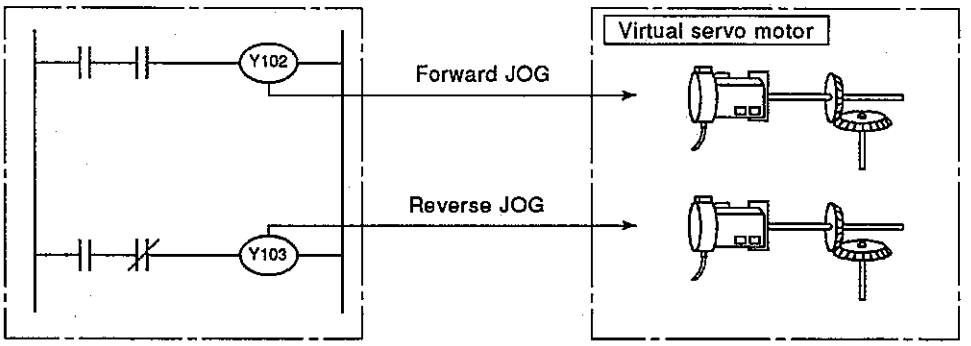
REMARK

1) *1: Section 4.2 gives details of start accept flag.

(b) Starting by JOG operation
Either individual start or simultaneous start can be executed in the JOG operation.

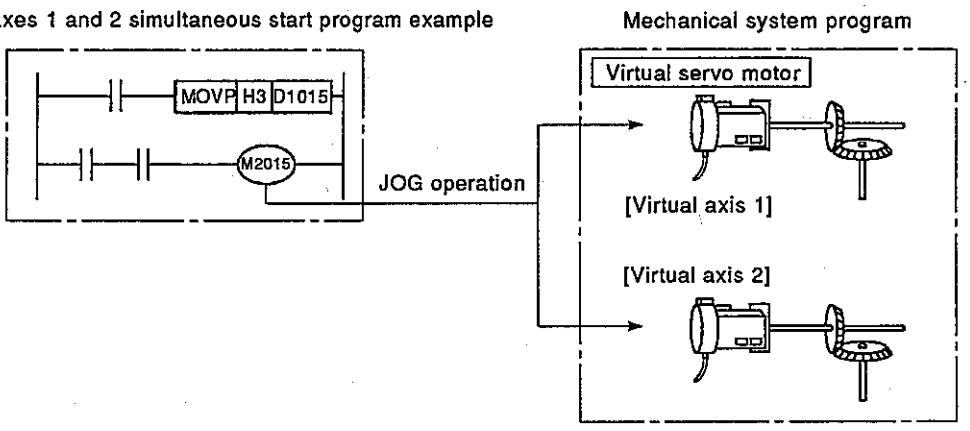
1) Individual start
Start is executed by turning ON the forward JOG command/reverse JOG command*1 for each axis.

Virtual axis 1 individual start program example



2) Simultaneous start
Start is executed by setting the axis numbers and directions (forward/reverse) of the axes of simultaneous start by using a JOG simultaneous start axis setting register (D1015)*2 and by turning ON the JOG simultaneous start command flag (M2015)*2.

Virtual axes 1 and 2 simultaneous start program example



REMARKS

1) *1: Section 6.3.1 gives details of forward JOG command/reverse JOG command.

2) *2: Section 6.3.2 gives details of JOG simultaneous start register and Section 4.5.2 gives details of JOG simultaneous start command flag.

(2) Halfway stop
To stop a virtual servo motor halfway after start, use a sequence program and turn ON a stop command/rapid stop command.
(External stop factors such as STOP, FLS, and RLS are not provided for virtual servo motors.)

(3) Control contents

(a) During positioning control, the backlash compensation amount "0" is used for controlling a virtual servo motor.

(b) Since a virtual servo motor does not give feedback pulses, "deviation counter value" and "actual position data" are not stored.

(c) Feed position data of a virtual servo motor is backed up, and it is regenerated when mode is switched from real mode to virtual mode after the power has been turned ON.

1) When an output module uses an absolute positioning system (position detection unit/servo amplifier is used), continuous operation can be executed.
However, when a servo motor of an output module connected to a virtual servo motor is operated when the power is OFF, continuous operation cannot be executed even though an absolute positioning system is used.
At this time, a virtual mode continuous operation disable warning signal *1 is turned ON.
Adjust the position of a virtual servo motor or output module's servo motor to a position where synchronous operation is possible.

2) When an output module does not use an absolute positioning system, switch mode from real mode to virtual mode and correct feed position data by the position data change function.

(4) Control change
Position data change and velocity change can be enabled for a virtual servo motor.
These control changes are executed by using a DSFLP instruction.
ACPU Programming Manual (Common instructions) gives details of DSFLP instruction.

REMARK

1) *1: Section 6.3.1 gives details of virtual mode continuous operation disable warning signal.

6.1.2 Parameter list

Table 6.1 gives parameters for a virtual servo motor, and following items (1) to (4) give explanations of each item in Table 6.1.
A373CPU (P21/R21) Maintenance Manual gives details of virtual servo motor parameter setting.

Table 6.1 Parameter List

No.	Setting Item	Default Value	Setting Range
1	Virtual axis number	———	1 to 8
2	Stroke upper limit	$2^{31}-1$ pulse	-2^{31} to $2^{31}-1$ pulse
3	Stroke lower limit	0 pulse	-2^{31} to $2^{31}-1$ pulse
4	In-position range	100 pulse	1 to 32767 pulse
5	JOG velocity limit value	20000 pulse/s	1 to 1000000 pulse/s
6	Parameter block	1	1 to 16

(1) Virtual axis number setting
Virtual axis numbers are set by using a servo program in the virtual mode operation.
Set virtual servo motor axis numbers connected to a virtual main shaft or virtual aux. input axis.

(2) Stroke upper/lower limit setting

(a) Stroke upper/lower limit setting is used to set the upper and lower limits of the range of virtual axis movement.

(b) A stroke limit range check is executed when the following positioning control is started or being started.

Start	Checked/ not checked	Remarks
Positioning control	Checked	• Checked whether or not feed position data is within the stroke limit range when positioning is started. If it is out of the range, an error (error code: 106) occurs and positioning is not executed. • If an interpolation route exceeds the stroke limit range during arc interpolation start, an error (error code: 207, 208) occurs and operation is decelerated and stopped.
Fixed-rate transmission control	Checked	• Checked whether or not feed position data is within the stroke limit range when positioning is started. If it is out of the range, an error (error code: 106) occurs and positioning is not executed.
Velocity switching control	Checked	• Checked whether or not feed position data is within the stroke limit range when positioning is started. If it is out of the range, an error (error code: 106) occurs and positioning is not executed.
Constant velocity control	Checked	• If position data exceeds the stroke limit range during starting, an error (error code: 207) occurs and operation is decelerated and stopped.
Velocity control	Not checked	• Position data becomes "0" and operation continues until a stop command/rapid stop command is turned ON.
JOG operation	Not checked	• Though position data is within the stroke limit range, operation continues until a JOG signal is turned OFF or a stop command/rapid stop command is turned ON.

(3) Command in-position range
A command in-position value is a difference between a positioning address (command position) and feed position data.
By setting a command in-position value, a command in-position signal is turned ON when the difference between a command position and feed position data becomes within the set range [(command position – feed position data) ≤ (command in-position range)].
A command in-position range check is executed always during positioning control.
(A command in-position range check is not executed during velocity control and JOG operation.)

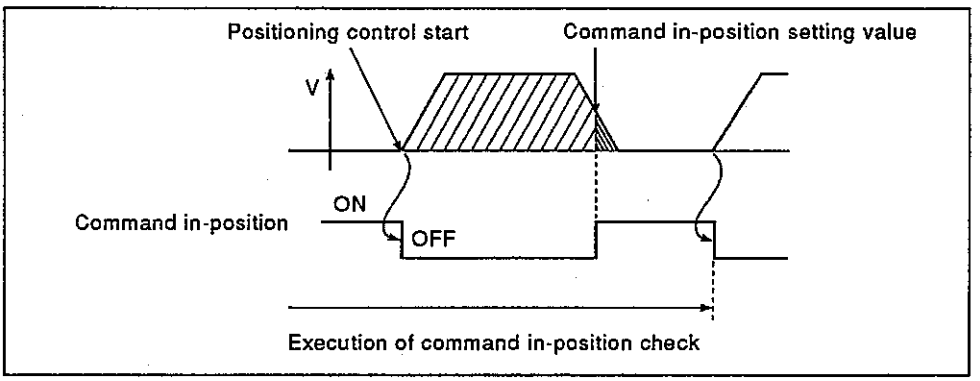


Fig. 6.1 Command In-Position Range

(4) JOG velocity limit value and parameter block settings
The JOG velocity limit value and parameter block settings used for JOG operation are as follows:

(a) JOG velocity limit value
This sets the maximum velocity of JOG operation of a virtual axis.
If JOG velocity setting exceeds the JOG velocity limit value, the JOG velocity limit value (set value) is used as the limit value.

(b) Parameter block setting
This sets the parameter block numbers used in JOG operation.
Among the parameter block data used in JOG operation are the 4 items of acceleration time, deceleration time, rapid stop deceleration time, and deceleration processing at STOP input are valid.

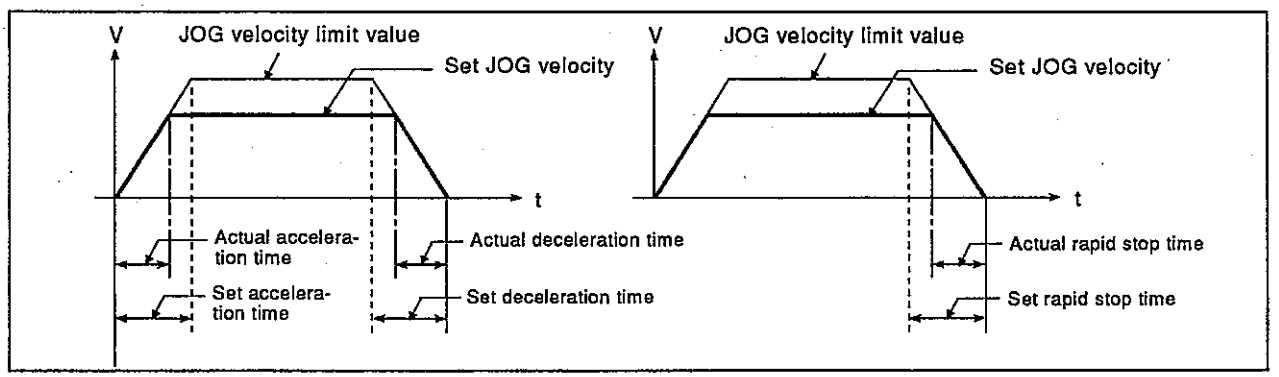


Fig. 6.2 Relationship Between JOG Velocity Limit Value, Acceleration Time, Deceleration Time, and Rapid Stop Time

POINT

For JOG operation, the setting unit is fixed to pulses regardless of parameter block interpolation limit unit setting.

6.2 Synchronous

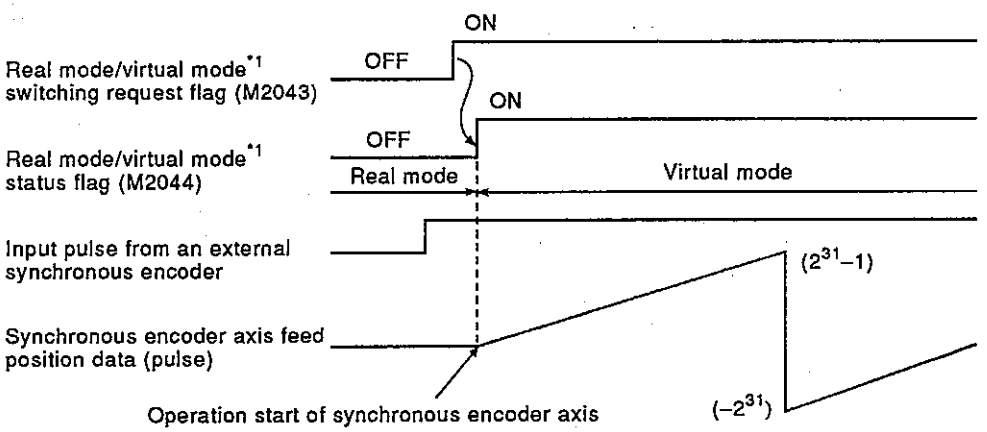
An encoder used for driving a virtual axis by using an external input pulse. The following explains the operations of synchronous encoder and parameters.

6.2.1 Operation

(1) Operation start
The operation start timing of a synchronous encoder axis means the fetching timing of the input pulse from an external synchronous encoder. The fetching timing of the input pulse from an external synchronous encoder can be set at the time of switching from real mode to virtual mode and at the time of input of an external signal (TREN: synchronous encoder input start signal)*2.

(a) To fetch input pulses when real mode is switched to virtual mode:

1) Input pulses from an external synchronous encoder are fetched when real mode is switched to virtual mode.



2) This is the operation when the clutch control mode *3 is in the ON/OFF mode and address mode. This operation can be used with a synchronous encoder of increment type and absolute type.

3) Whether synchronous encoder operation is transmitted or not transmitted to an output module depends on the state of connected clutch.

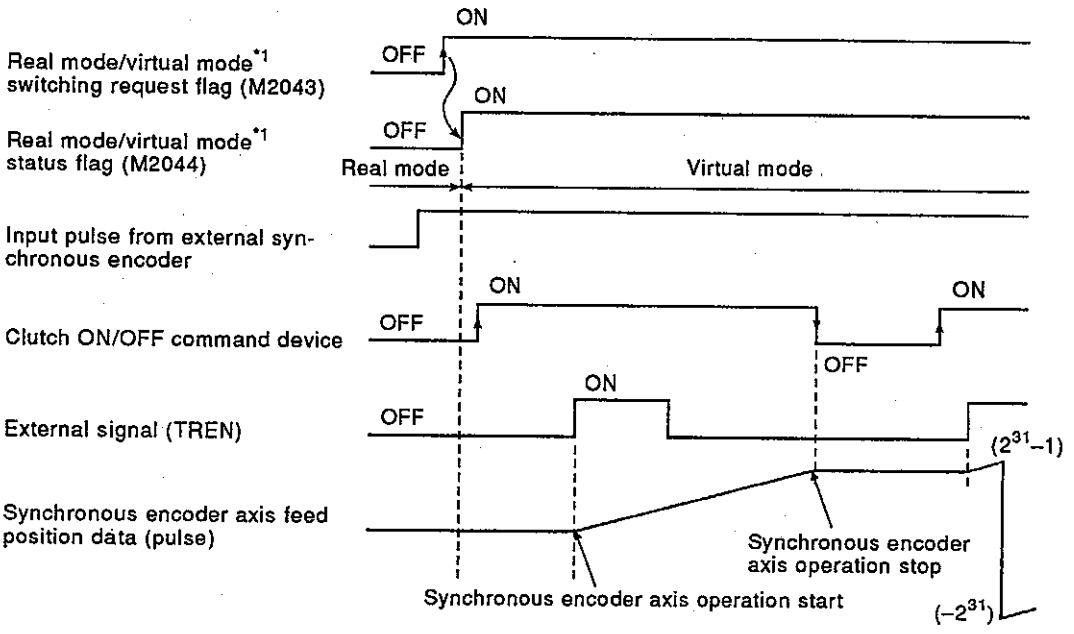
- When clutch is ON.....Transmitted to an output module.
- When clutch is OFF.....Not transmitted to an output module.

POINT

To switch real mode to virtual mode with the clutch set in the ON state, use a smoothing clutch.
When a direct clutch is used when real mode is switched to virtual mode with the clutch set in the ON state, the output module axis makes extreme acceleration. This may cause a servo error or give shocks to mechanical equipment.

(b) To fetch input pulses from a synchronous encoder by using an external signal:

1) Input pulses from an external synchronous encoder are fetched when the clutch is set to the ON state.



2) This is the operation when the clutch control mode *3 is in the external input mode. The synchronous encoder operation corresponds with clutch operation.

(2) Operation completion

(a) The synchronous encoder axis operation is completed when a virtual mode to real mode switching request (M2043 ON to OFF) is executed and mode is switched to real mode.

(b) Follow the procedure below to complete the synchronous encoder operation.

1) Stop the output module.
   - Stop external synchronous encoders.
   - Set connecting clutches to the OFF state.

2) Switch virtual mode to real mode.

(c) When virtual mode is switched to real mode when a connecting output module is operating and the synchronous encoder axis is operating, the output module makes an immediate stop. This may cause a servo error or give shocks to mechanical equipment.

REMARKS

1) *1: Section 4.2 gives details of real mode/virtual mode switching request flag and real mode/virtual mode switching status flag.

2) Section 9 gives details of switching between real mode and virtual mode.

3) *2: A synchronous encoder input start signal is input to the TREN terminal of the A336PX.

4) *3: Section 7.2.1 gives details of control mode of clutch.

(3) Stopping method
To stop a synchronous encoder after start, stop an external synchronous encoder. (External inputs such as FLS, RLS, and STOP, as well as sequence program stop command and rapid stop command are not provided for synchronous encoder.)

(4) Control contents

(a) Since a synchronous encoder does not give feedback pulses, "deviation counter value" and "actual position data" are not stored.

(b) Position data of a synchronous encoder is backed up, and it is regenerated when mode is switched from real mode to virtual mode after the power has been turned ON.

1) When an output module uses an absolute positioning system (position detection unit/servo amplifier is used), continuous operation can be executed.
However, when a servo motor of an output module connected to a synchronous encoder is operated when the power is OFF, continuous operation cannot be executed even though an absolute positioning system is used.
At this time, a virtual mode continuous operation disable warning signal *1 is turned ON. Adjust the position of an output module's servo motor to a position where synchronous operation is possible.

2) When an output module does not use an absolute positioning system, switch mode from real mode to virtual mode and correct feed position data by the position data change function.

(5) Control change
Position data change and velocity change are enabled for a virtual servo motor.
These control changes are executed by using a DSFLP instruction.
ACPU Programming Manual (Common instructions) gives details of DSFLP instruction.

POINT

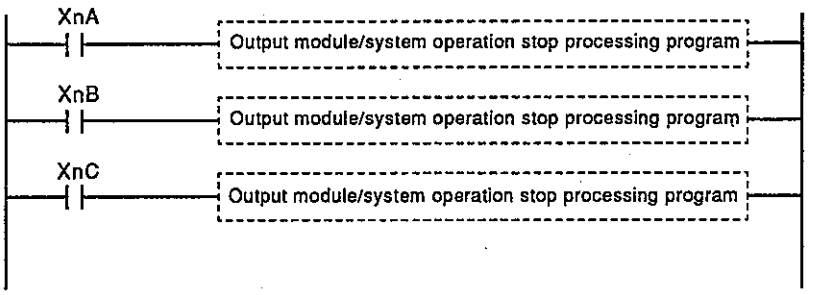
When the OS makes stop processing with only one axis during synchronous operation using drive modules (virtual servo motors/synchronous encoders) in virtual mode, there is sometimes a problem in the control of the whole system. To avoid this, error processing is executed when an external upper limit switch (FLS) or lower limit switch (RLS) signal is turned OFF or a STOP input is turned ON. However, stop processing for corresponding output module axis is not executed. (Corresponding output module continues operation.)

- Error processing: Error detection signal (Xn7) is ON.
  Error code is stored to a high error code storage area.

The FLS, RLS, and STOP input states can be checked by the input signals (XnA, XnB, XnC) of the output module. Use a sequence program to continue/stop the operation of the output module/system by the above external signals.

- Stop processing: Output module stop..... Clutch OFF,
  System stop..... drive module stop

[Program example]



6.2.2 Parameter list

Table 6.2 gives the symchronous encoder parameter for a virtual servo motor, and following item (1) gives an explanation of Table 6.2.
A373CPU (P21/R21) Maintenance Manual gives details of virtual servo motor parameter setting.

Table 6.2 Synchronous Encoder Parameter List

No.	Setting Item	Default Value	Setting Range
1	Encoder number	————	1 to 3

(1) Encoder number

(a) Encoder number

1) Set the synchronous encoder number connected to the servo input unit.

Servo input unit connecting position	Encoder number
P1	1
P2	2
P3	3

6.3 Common Devices (I/O, data register)

The following explains the I/Os and data registers used with drive modules.

6.3.1 I/O

Drive module uses X/YE0 to X/YE2, XF8 to XFA, and X/Y100 to X/Y17F of A373CPU's I/O points.

- Input (XE0 to XE2, XF8 to XFA, X100 to X17F)
  An input is data to be set in the PCPU. These can be used to check the control status of each axis with a sequence program and to instruct the next positioning.
- Output (YE0 to YE2, Y100 to Y17F)
  These are used to set an output with a sequence program and output positioning commands to the PCPU.

Table 6.3 I/O List

	Device										Signal	Virtual Servo Motor	Synchronous Encoder
	Synchronous Encoder			Virtual Servo Motor									
	P1	P2	P3	Axis 1	Axis 2	Axis 3	Axis 4	Axis 5	Axis 6	Axis 7	Axis 8			
Input	XE0	XE1	XE2	—	—	—	—	—	—	—	—	Error detection	—	O
	XF8	XF9	XFA	XF0	XF1	XF2	XF3	XF4	XF5	XF6	XF7	Virtual mode continuous operation disable warning	O	
	—	—	—	X100	X110	X120	X130	X140	X150	X160	X170	Positioning start completed	O	—
				X101	X111	X121	X131	X141	X151	X161	X171	Positioning completed		
				X102	X112	X122	X132	X142	X152	X162	X172	Unusable		
				X103	X113	X123	X133	X143	X153	X163	X173	In-position		
				X104	X114	X124	X134	X144	X154	X164	X174	Velocity controlling		
				X105	X115	X125	X135	X145	X155	X165	X175	Unusable		
				X106	X116	X126	X136	X146	X156	X166	X176			
				X107	X117	X127	X137	X147	X157	X167	X177	Error detection		
				X108 to X10F	X118 to X11F	X128 to X12F	X138 to X13F	X148 to X14F	X158 to X15F	X168 to X16F	X178 to X17F	Unusable		
Output	YE0	YE0	YE2	—	—	—	—	—	—	—	—	Error reset		O
	—	—	—	Y100	Y110	Y120	Y130	Y140	Y150	Y160	Y170	Stop command	O	—
				Y101	Y111	Y121	Y131	Y141	Y151	Y161	Y171	Rapid stop command		
				Y102	Y112	Y122	Y132	Y142	Y152	Y162	Y172	Forward JOG operation		
				Y103	Y113	Y123	Y133	Y143	Y153	Y163	Y173	Reverse JOG operation		
				Y104	Y114	Y124	Y134	Y144	Y154	Y164	Y174	End signal OFF command		
				Y105	Y115	Y125	Y135	Y145	Y155	Y165	Y175	Unusable		
				Y106	Y116	Y126	Y136	Y146	Y156	Y166	Y176			
				Y107	Y117	Y127	Y137	Y147	Y157	Y167	Y177	Error reset		
				Y108	Y118	Y128	Y138	Y148	Y158	Y168	Y178	Unusable		
				Y109	Y119	Y129	Y139	149	Y159	Y169	Y179	STOP input valid/invalid		
				Y10A to Y10F	Y11A to Y11F	Y12A to Y12F	Y13A to Y13F	Y14A to Y14F	Y15A to Y15F	Y16A to Y16F	Y17A to Y17F	Unusable		

O: Used —: Not used

(1) Error detection signal (XE0, XE1, XE2, X1n7)*1

(a) An error detection signal is turned ON when a high error or low error in a drive module or in an output module connected to a drive module is found.
Existence of an error can be identified by the ON/OFF of an error detection signal.

(b) When an error detection signal is turned ON, corresponding error code is stored to the error code storage area.

1) Low error code*2 .... Stored to low error code storage area.*3

2) High error code*2 .... Stored to high error code storage area.*3

Source (drive module/output module) of a detected error can be identified by error code information or by the ON/OFF of an error detection signal of an output module.

(c) When an error reset command (Y1n7)*1 is turned ON when a drive module or an output module connected to the drive module is in the normal state, the error detection signal is turned OFF.

(2) Virtual mode continuous operation disable warning signal (XF0 to XFA)

(a) This signal is turned ON when there is a discrepancy between the position data fetched when the power is ON and the position data memorized when the power is OFF such as when the output module's servo motor is operated when the power is OFF.
This signal is used to check feasibility of continuous operation in virtual mode when the power is ON or the A373CPU is reset.

(b) This is checked only when a synchronous encoder is connected to an absolute positioning servo input unit (A336EX).

REMARKS

1) *1: "n" of X/Y1n7 represents the numerical value (0 to 7) that corresponds to the virtual axis number.

n	0	1	2	3	4	5	6	7
Virtual axis No.	1	2	3	4	5	6	7	8

2) * : Section 10.3 gives details of low/high error code of drive module.
Section 10.5 gives details of low/high error code of output module.

3) *4: Section 6.3.2 gives details of low error code storage area and high error code storage area.

(3) Positioning start-completed signal (X1n0)*1

(a) This signal is turned ON when the position control start is completed with the axis designated by a DSFRP instruction of a sequence program.
This is not turned ON during JOG operation or when started by velocity control.
This is used to read M codes when positioning is started.

(b) A positioning start-completed signal is turned OFF at the leading edge (OFF to ON) of a completion signal OFF command (Y1n4)*1 or when positioning is completed.

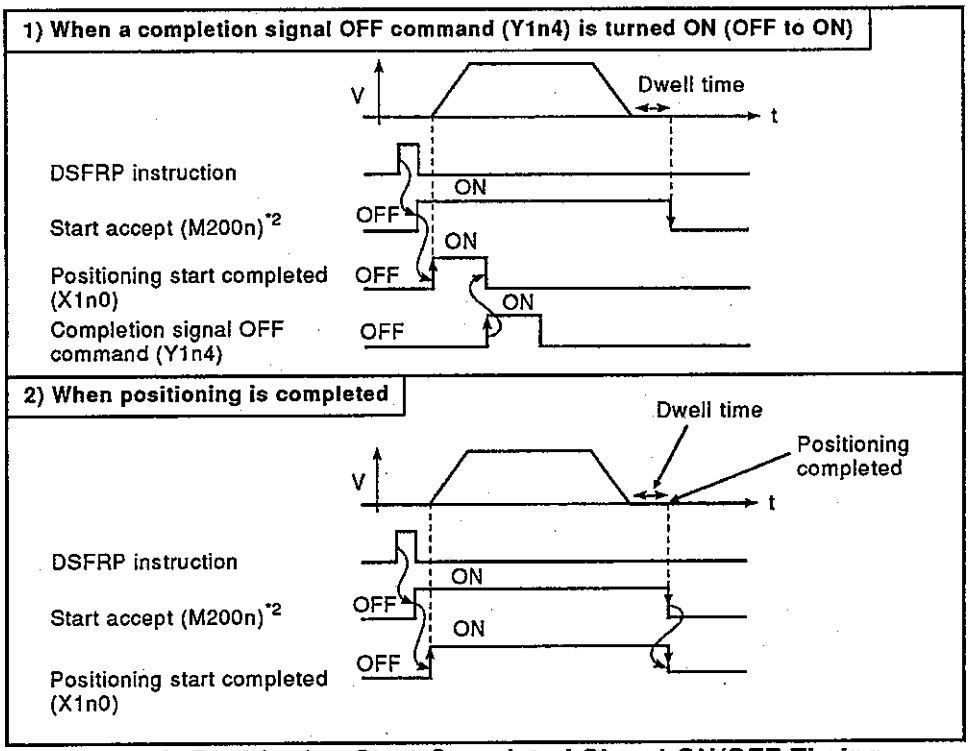


Fig. 6.3 Positioning Start-Completed Signal ON/OFF Timing

REMARKS

1) *1 : "n" of X1n0/Y1n4 represents the numerical value (0 to 7) that corresponds to the virtual axis number.

n	0	1	2	3	4	5	6	7
Virtual axis No.	1	2	3	4	5	6	7	8

2) *2 : "n" of M200n represents the virtual axis numbers 1 to 8.

(4) Positioning-completed signal (X1n1) *1

(a) This signal is turned ON when the position control start is completed with the axis designated by a DSFRP instruction of a sequence program.
This is not turned ON during JOG operation, when started by velocity control or when stopped halfway.
This is not turned ON when operation is stopped halfway during positioning.
This is used to read M codes when positioning is completed.

(b) A positioning-completed signal is turned OFF at the leading edge (OFF to ON) of a completion signal OFF command (Y1n4)*1 or when operation start is completed.

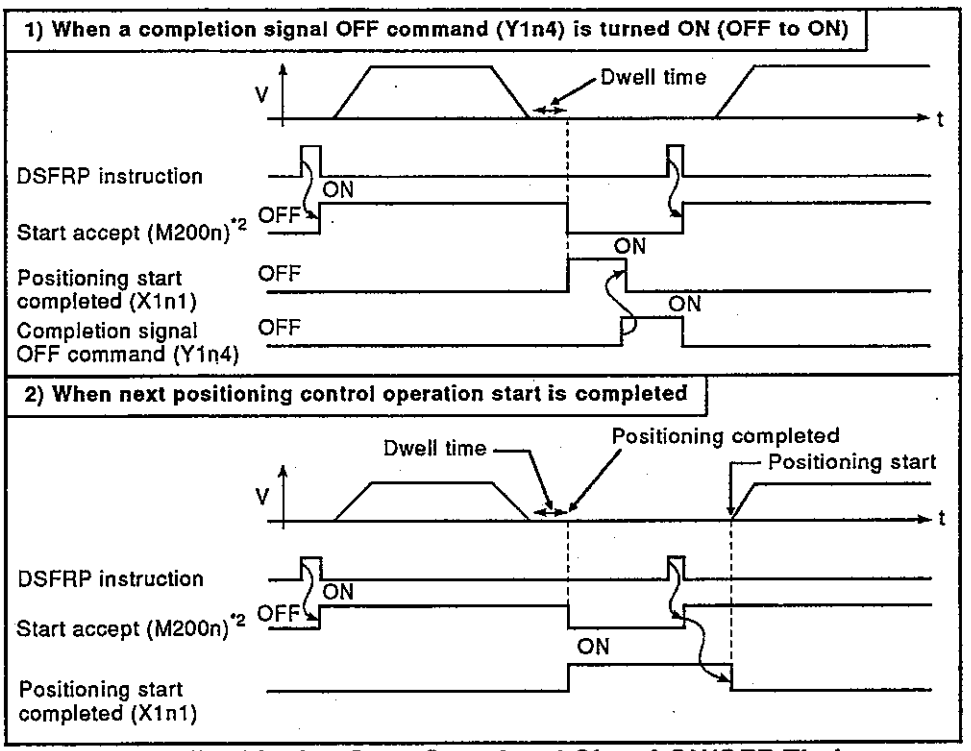


Fig. 6.4 Positioning Start-Completed Signal ON/OFF Timing

REMARKS

1) *1 : "n" of X1n1/Y1n4 represents the numerical value (0 to 7) that corresponds to the virtual axis number.

n	0	1	2	3	4	5	6	7
Virtual axis No.	1	2	3	4	5	6	7	8

2) *2 : "n" of M200n represents the virtual axis numbers 1 to 8.

(5) Command in-position signal (X1n3) *1

(a) This signal is turned ON when the absolute value of the difference between a command position and feed position data has become smaller than the "command in-position range" set with the parameters for a virtual servo motor (Section 6.1.2). This signal is turned OFF in the following cases:

1) Positioning control start

2) Velocity control

3) JOG operation

(b) A command in-position check is executed always during positioning control.
This check is not executed during velocity control.

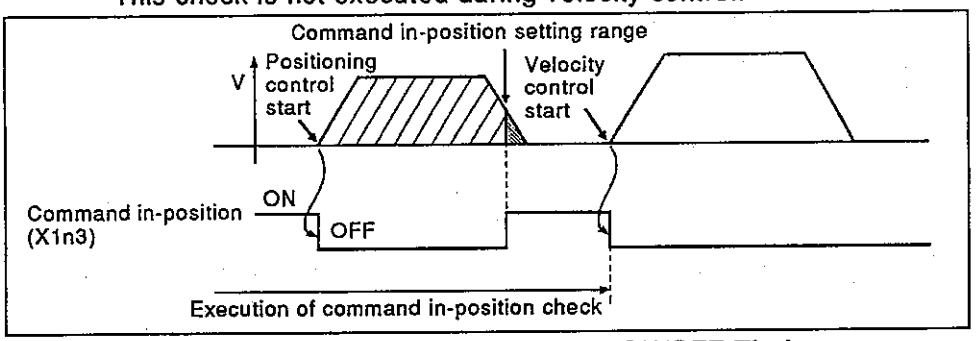


Fig 6.5 Command In-Position Signal ON/OFF Timing

(6) Velocity controlling signal (X1n4) *1

(a) This signal is turned ON during velocity control and can be used for judging whether velocity control or positioning control is being executed.
After turned ON during velocity control, this signal is turned OFF when the next positioning control is started.

(b) This signal is turned OFF when the power is turned ON or during positioning control.

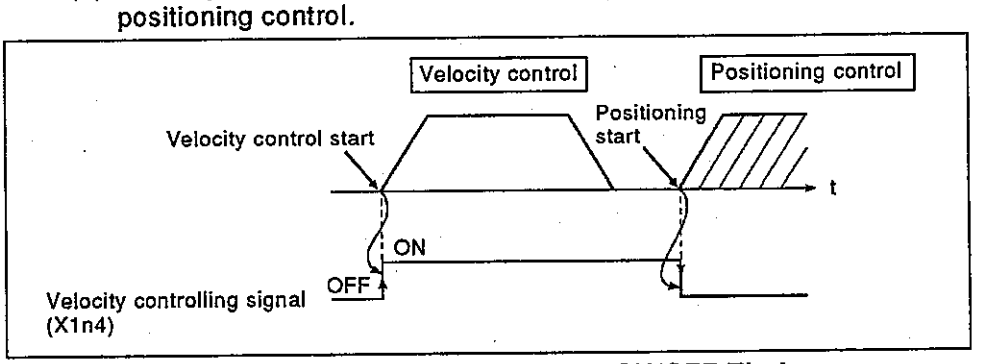


Fig 6.6 Velocity Controlling Signal ON/OFF Timing

REMARK

1) *1 : "n" of X1n3/Y1n4 represents the numerical value (0 to 7) that corresponds to the virtual axis number.

n	0	1	2	3	4	5	6	7
Virtual axis No.	1	2	3	4	5	6	7	8

(7) Error reset command (YE0, YE1, YE2, Y1n7) *1

(a) An error reset command is used to clear the low error code storage area and the high error code storage area for a drive module of the axis with which a servo error is found and to reset a servo error detection signal.

(b) Table 6.4 gives the correspondence between the error reset signals and error detection signals.

Table 6.4 Error Detection Signals and Error Reset Signals List

Drive Module		Error Detection Signal	Error Reset Signal
Synchronous encoder	P1	XE0	YE0
	P2	XE1	YE1
	P3	XE2	YE2
Virtual servo motor	Virtual axis 1	X107	Y107
	Virtual axis 2	X117	Y117
	Virtual axis 3	X127	Y127
	Virtual axis 4	X137	Y137
	Virtual axis 5	X147	Y147
	Virtual axis 6	X157	Y157
	Virtual axis 7	X167	Y167
	Virtual axis 8	X177	Y177

(c) When an error reset command is turned ON, the following processing is executed.

1) When a drive module and an output module are normal, the low error code storage area and the high error code storage area are cleared, and a servo error detection signal is reset.

2) When errors of a drive module and output module have not been reset, corresponding error codes are again stored to the low error code storage area and high error code storage area.
At this time, an error detection signal (XE0 to XE2, X1n7)*1 remains ON.

POINT

Do not turn ON an error reset command (YE0 to YE2, Y1n7) by using a PLS instruction.
If it is turned ON by using a PLS instruction, error reset sometimes cannot be executed.

REMARK

1) *1 :"n" of X1n7/Y1n7 represents the numerical value (0 to 7) that corresponds to the virtual axis number.

n	0	1	2	3	4	5	6	7
Virtual axis No.	1	2	3	4	5	6	7	8

(8) Stop command (Y1n0) *1

(a) This external signal is used to stop a starting axis and is valid when it is switched from OFF to ON. (An axis for which a stop command has been ON cannot be started.)

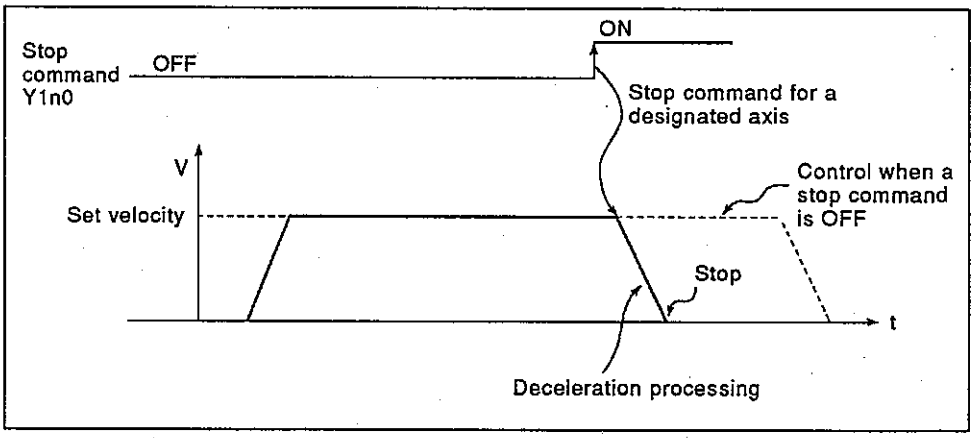


Fig. 6.7 Stop Processing by a Stop Command

(b) This command can be used also as a stop command during velocity command execution.

(c) Table 6.5 gives the contents of stop processing when a stop command is turned ON.

Table 6.5 Stop Processing Contents when a Stop Command is Turned ON

Executing control	Processing when a stop command is ON	
	During control execution	During deceleration stop processing
Positioning control	Operation decelerates and stops in a deceleration time set with a parameter block or servo program.	Stop command is ignored and deceleration stop processing is continued.
Velocity control		
JOG operation		

REMARK

1) *1 : "n" of X1n0 represents the numerical value (0 to 7) that corresponds to the virtual axis number.

n	0	1	2	3	4	5	6	7
Virtual axis No.	1	2	3	4	5	6	7	8

(9) Rapid stop command (Y1n1) *1

(a) This external signal is used to rapidly stop a starting axis and is valid when it is switched from OFF to ON. (An axis for which a rapid stop command has been ON cannot be started.)

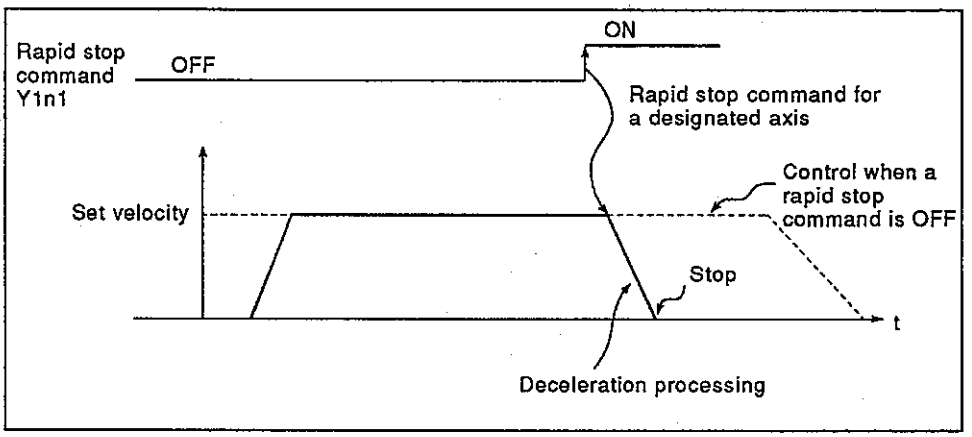


Fig. 6.8 Rapid Stop Processing by a Rapid Stop Command

(b) Table 6.6 gives the contents of stop processing when a rapid stop command is turned ON

Table 6.6 Stop Processing Contents when a Rapid Stop Command is Turned ON

Executing control	Processing when a rapid stop command is ON	
	During control execution	During deceleration stop processing
Positioning control	Operation decelerates and stops in a rapid stop deceleration time set with a parameter block or servo program.	Deceleration processing is stopped and rapid stop processing is executed.
Velocity control		
JOG operation		

REMARK

1) *1 :"n" of X1n1 represents the numerical value (0 to 7) that corresponds to the virtual axis number.

n	0	1	2	3	4	5	6	7
Virtual axis No.	1	2	3	4	5	6	7	8

(10) Forward JOG start command (Y1n2)*1/reverse JOG start command (Y1n3)*1

(a) When Y1n2 is turned ON by a sequence program, JOG operation is executed in an address-increasing direction.
When Y1n2 is turned OFF, deceleration stop is executed in a deceleration time set with a parameter block.

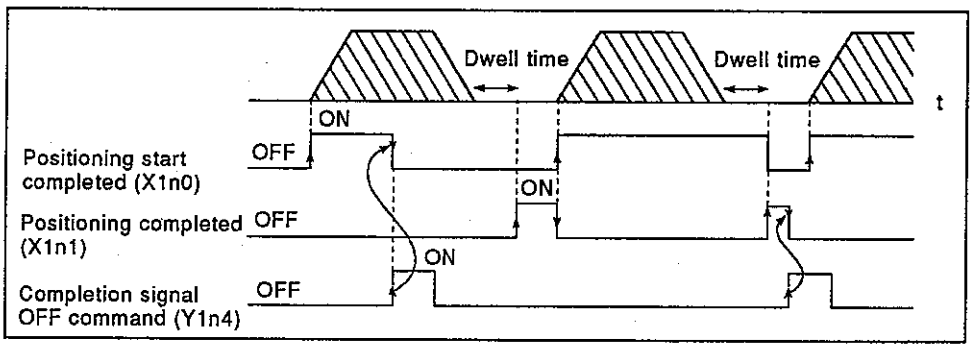
(b) When Y1n3 is turned ON by a sequence program, JOG operation is executed in an address-decreasing direction.
When Y1n3 is turned OFF, deceleration stop is executed in a deceleration time set with a parameter block.

POINT

Provide an interlock by a sequence program so a forward JOG start (Y1n2) and a reverse JOG start (Y1n3) are not turned ON simultaneously.

(11) Completion signal OFF command (Y1n4) *1

(a) This command is used to turn OFF a positioning start-completed signal (X1n0)*1 and a positioning-completed signal (X1n1)*1 by a sequence program.



POINT

Do not turn ON a completion signal OFF command by using a PLS instruction.
If it is turned ON by using a PLS instruction, positioning start-completed signal (X1n0) and positioning-completed signal (X1n1) cannot be turned OFF.

(12) External STOP input invalidate command (Y1n9) *1
This command is used for valid/invalid setting of an external STOP input.

1) ON: External STOP input is set to invalid. An axis for which a STOP input is turned ON can be started.

2) OFF: External STOP input is set to valid. An axis for which a STOP input is turned ON cannot be started.

POINT

To stop an axis by an external STOP input after it is started by turning ON Y1n9, turn the STOP input from OFF to ON (from ON to OFF to ON when the STOP input is ON when started).

REMARK

1) *1 :"n" of X1n0. X1n1, Yn13, Y1n4, and Y1n9 represents the numerical value (0 to 7) that corresponds to the virtual axis number.

n	0	1	2	3	4	5	6	7
Virtual axis No.	1	2	3	4	5	6	7	8

6.3.2 Data registers

For drive modules, data registers D700 to D759 and D960 to D1007 of an A373CPU are used.

Table 6.7 Data Registers List

Device											Data Register	Virtual Servo Motor	Synchronous Encoder
P1	P2	P3	Axis 1	Axis 2	Axis 3	Axis 4	Axis 5	Axis 6	Axis 7	Axis 8			
—	—	—	D700	D706	D712	D718	D724	D730	D736	D742	Feed position data	○	—
			D701	D707	D713	D719	D725	D731	D737	D743			
			D702	D708	D714	D720	D726	D732	D738	D744	Low error code		
			D703	D709	D715	D721	D727	D733	D739	D745	High error code		
			D704	D710	D716	D722	D728	D734	D740	D746	Execution program number		
			D705	D711	D717	D723	D729	D735	D741	D747	M code		
D748	D752	D756	—	—	—	—	—	—	—	—	Position data	—	○
D749	D753	D757	—	—	—	—	—	—	—	—			
D750	D754	D758	—	—	—	—	—	—	—	—	Low error code		
D751	D755	D759	—	—	—	—	—	—	—	—	High error code		
—	—	—	D960	D966	D972	D978	D984	D990	D996	D1002	Position data change	○	—
			D961	D967	D973	D979	D985	D991	D997	D1003			
			D962	D968	D974	D980	D986	D992	D998	D1004	Velocity change		
			D963	D969	D975	D981	D987	D993	D999	D1005			
			D964	D970	D976	D982	D988	D994	D1000	D1006	JOG velocity setting		
			D965	D971	D977	D983	D989	D995	D1001	D1007			
D1012	D1013	D1014	—	—	—	—	—	—	—	—	Manual pulse generator shaft setting	○	—
—	—	—	D1015								JOG operation simultaneous start shaft setting		
—	—	—	D1016	D1017	D1018	D1019	D1020	D1021	D1022	D1023	Manual pulse generator 1 pulse input magnification setting		

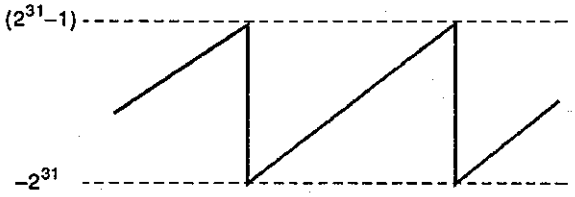
○ : used — : unused

(1) Feed position data storage register .... Data from PCPU to SCPU

(a) The target addresses output to virtual servo motors are stored to these registers according to the positioning addresses and movement amount designated by a servo program.

(b) A stroke range check is executed by using this feed position data.

(c) Ring addresses of -2^{31} pulse to $(2^{31}-1)$ pulse are used.



(d) Data in the feed position data storage registers is backed up when the power is turned OFF or the A373CPU is reset.

(2) Low error code storage register ..... Data from PCPU to SCPU

(a) When a low error is generated in a virtual servo motor, synchronous encoder, or output module, corresponding error code (Section 10.3) is stored.
When another low error is generated after an error code is stored, a new error code is written over the old one.

(b) Use an error reset command*1 for a drive module to clear a low error code which was generated in a virtual servo motor or synchronous encoder.
Use an error reset command*2 for an output module to clear a low error code which was generated in an output module.

(3) High error code storage register ..... Data from PCPU to SCPU

(a) When a high error is generated in a virtual servo motor, synchronous encoder, or output module, corresponding error code (Section 10.3) is stored.
When another high error is generated after an error code is stored, a new error code is written over the old one.

(b) Use an error reset command*1 for a drive module to clear a high error code which was generated in a virtual servo motor or synchronous encoder.
Use an error reset command*2 for an output module to clear a high error code which was generated in an output module.

(4) Execution servo program number storage register
..... Data from PCPU to SCPU

(a) A program No. being started is stored when a DSFRP instruction is executed.

(b) The following values are stored in cases other than a DSFRP instruction execution.

1) JOG operation ..... $FFFF_H$

2) When power supply is turned ON ..... $FF00_H$

3) When real mode is switched to virtual mode ..... $FF00_H$

REMARKS

1) *1 : Section 6.3.1 gives details of error reset command of drive module.

2) *2 : Section 8.6.1 gives details of error reset command of output module.

(5) M code storage register ..... Data from PCPU to SCPU

(a) The M codes set in an execution servo program are stored when positioning is started.
If no M code has been set in a servo program, "0" is stored.

(b) This register state does not change in cases other than the positioning start by a servo program.

(c) When a PC READY (M2000) is turned ON or when real mode is switched to virtual mode, "0" is stored.

(6) Position data storage register ..... Data from PCPU to SCPU

(a) Position data of a synchronous encoder of a virtual drive module is stored.

(b) Ring addresses of -2147483648 (-2^{31}) pulse to 2147483647 ($2^{31}-1$) pulse are used.

(c) Data in the position data storage registers is backed up when the power is turned OFF or the A373CPU is reset.

(7) Position data change register ..... Data from SCPU to PCPU

(a) Feed position data after change when such change is made when an axis is at a stop is stored to these registers.

(b) Setting range for the position data change register is -2147483648 (-2^{31}) pulse to 2147483647 ($2^{31}-1$) pulse.

(c) When a positioning control change instruction (DSFLP)*1 is executed, data set to the position data change register becomes feed position data.

(8) Velocity change register ..... Data from SCPU to PCPU

(a) Velocity after change when such change is made when an axis is starting is stored to these registers.

(b) Setting range for the velocity change register is 1 to 1000000 pulse/s.

(c) When a positioning control change instruction (DSFLP)*1 is executed, data set to the velocity change register becomes positioning velocity.

REMARK

1) *1 :ACPU Programming Manual (Common instructions) gives details of positioning control change instruction.

(9) JOG velocity setting register ..... Data from SCPU to PCPU

(a) JOG velocity at JOG operation is stored to these registers.

(b) Setting range for the JOG velocity is 1 to 1000000 pulse/s.

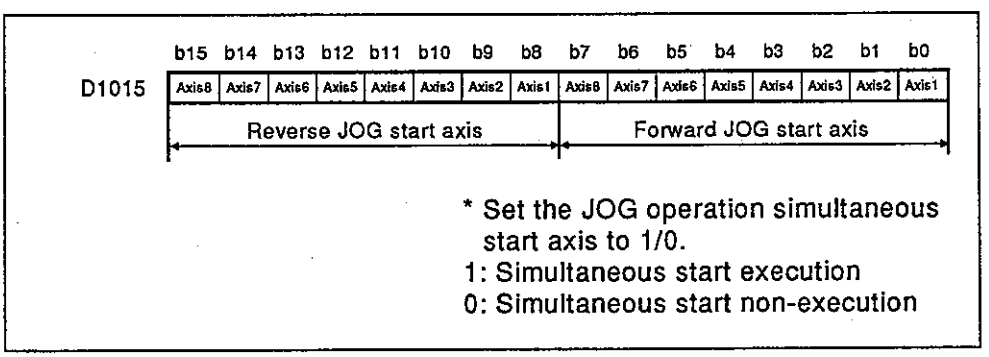
(c) When a JOG start signal is switched from OFF to ON, JOG velocity becomes JOG velocity stored in the JOG velocity setting register. JOG velocity cannot be changed by changing data during JOG operation.

(10) Manual pulse generator setting register ..... Data from SCPU to PCPU

(a) These are the registers to store axis numbers to be controlled by the P1 to P3 manual pulse generators.

(11) JOG operation simultaneous start axis setting register ..... Data from SCPU to PCPU

(a) This is a register to set the axis number by which simultaneous start of the JOG operation is executed and directed.



(12) Manual pulse generator 1 pulse input magnification setting register
..... Data from SCPU to PCPU

(a) These are the registers to set the magnification (1 to 100) per pulse of the input number of pulses from the manual pulse generator during manual pulse generator operations.

7. TRANSMISSION MODULE

The following 4 kinds of transmission modules are provided:

- Gear ..... Section 7.1
- Clutch ..... Section 7.2
- Velocity change gear .. Section 7.3
- Differential gear ..... Section 7.4

7.1 Gear

The following explains the operations of gear and parameters.

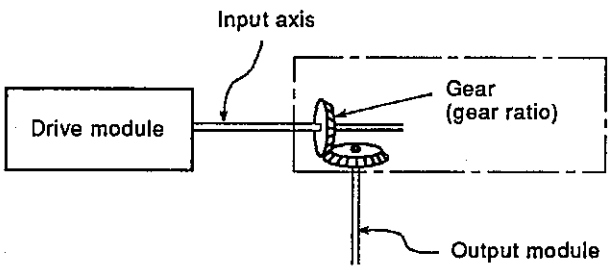
7.1.1 Operation

The following explains the operation of the gear.

(1) The travel distance (the number of pulses) of a drive module (virtual servo motor and synchronous encoder) is multiplied by the gear ratio set in the parameter. The gear transfers the number of pulses required resulting from this calculation to the output axis.

[Number of pulses on the output axis] = [Number of pulses on the input axis] x [Gear ratio] (Unit: pulse)

(2) The rotating direction of an output axis is set in the gear parameter.



REMARK

1) Section 7.1.2 gives details of the gear parameter.

7.1.2 Parameter

The gear parameter is shown in Table 7.1. Each item of Table 7.1 is explained in (1) and (2).

Table 7.1 Parameter List

No.	Setting Item		Default Value	Setting Range
1	Gear ratio	Number of gear teeth on the input axis (Gi)	1	1 to 65535
		Number of gear teeth on the output axis (Go)	1	1 to 65535
2	Output axis rotating direction (Gs)		Forward	Forward reverse

(1) Gear ratio

(a) This is the number of pulses that is transferred to an output axis under 1 pulse from the drive module.

(b) The gear ratio is determined by the number of gear teeth on the input axis (Gi) and the number of gear teeth on the output axis (Go).

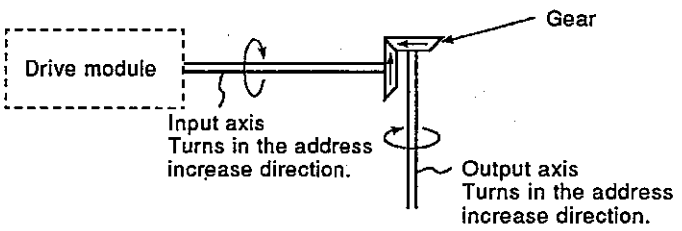
$$\text{Gear ratio} = \frac{\text{Number of gear teeth on the output axis (Go)}}{\text{Number of gear teeth on the input axis (Gi)}}$$

(2) Output axis rotating direction

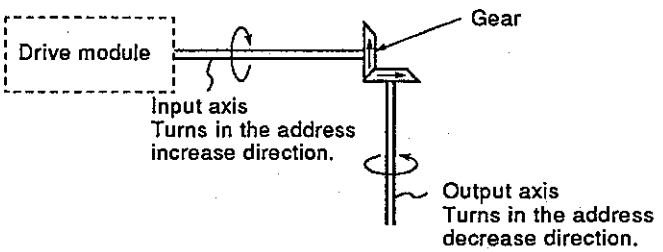
(a) This is the rotating direction of the output axis for the rotating direction of the input axis.

(b) The rotating directions of the output axis are forward and reverse.

1) Forward
When the input axis turns in the address increase direction, the output axis also turns in the address increase direction.



2) Reverse
When the input axis turns in the address increase direction, the output axis turns in the address decrease direction.



7.2 Clutch

These are two types of clutches: smoothing clutch and direct clutch. Both the smoothing clutch and the direct clutch operate in the same way. With the smoothing clutch, the velocity adjustment processing is executed. With the direct clutch, it is not executed in this way.

(1) Smoothing clutch and direct clutch

(a) Smoothing clutch
When the clutch is turned ON/OFF, velocity adjustment processing (smoothing processing) by the smoothing constant set in the clutch parameter is executed, and pulse is output to the output axis.

(b) Direct clutch
When a clutch is turned ON/OFF, velocity adjustment processing is not executed, and pulse is output to the output axis.

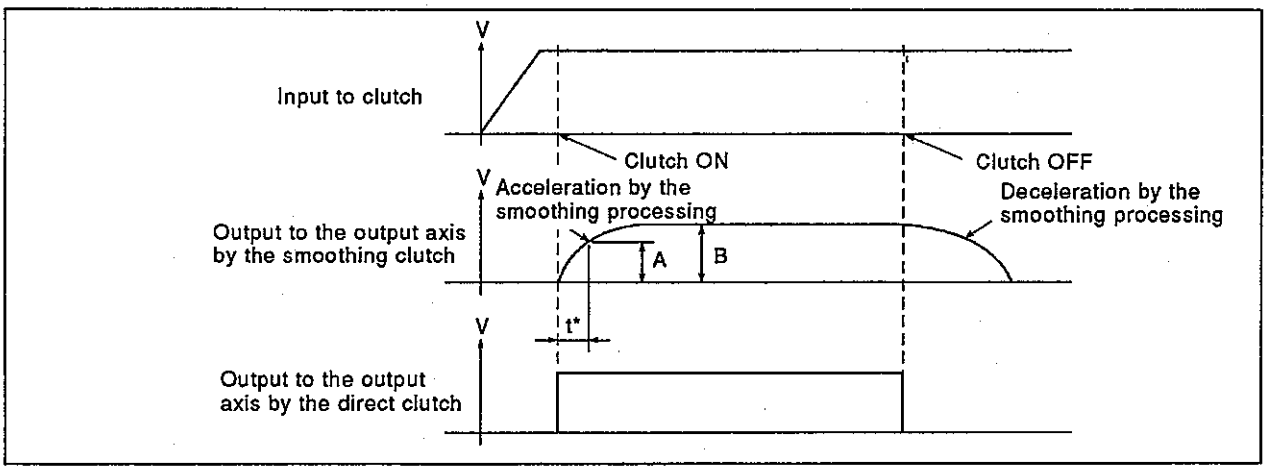
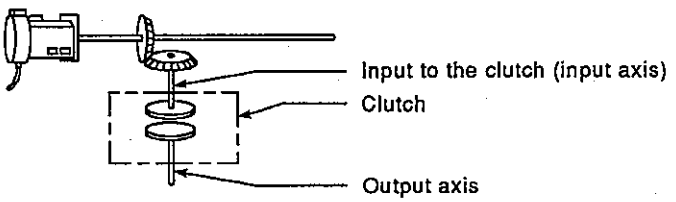


Fig. 7.1 Output to the Output Axis with the Smoothing and Direct Clutches

REMARK

1) Clutch ON/OFF state

- Clutch ON state····· Pulse input to the clutch is output to the output axis.
- Clutch OFF state ····· Pulse input to the clutch is not output to the output axis.



2) * ····· t :Smoothing constant

$$\frac{A}{B} \times 100 = 63\%$$

7.2.1 Operation

The following 3 kinds of clutch operation modes are provided:
- ON/OFF mode
- Address mode
- External input mode

The clutch modes are explained below.

(1) ON/OFF mode

(a) ON/OFF mode is used to turn ON/OFF a clutch by turning ON/OFF the clutch ON/OFF command device.

1) The clutch goes into the ON state when the clutch ON/OFF command device turns ON.

2) The clutch goes into the OFF state when the clutch ON/OFF command device turns OFF.

(b) In ON/OFF mode, after the clutch ON/OFF command device is turned ON/OFF, the clutch goes into the ON/OFF state in max. 28.8 msec. If precision is needed, use the address mode.

(c) The clutch ON/OFF state can be checked by using the clutch status device.

Clutch state	Clutch status device
ON	ON
OFF	OFF

(d) The clutch status device is turned ON/OFF during the END processing of the scan in which the clutch state changed to ON/OFF.

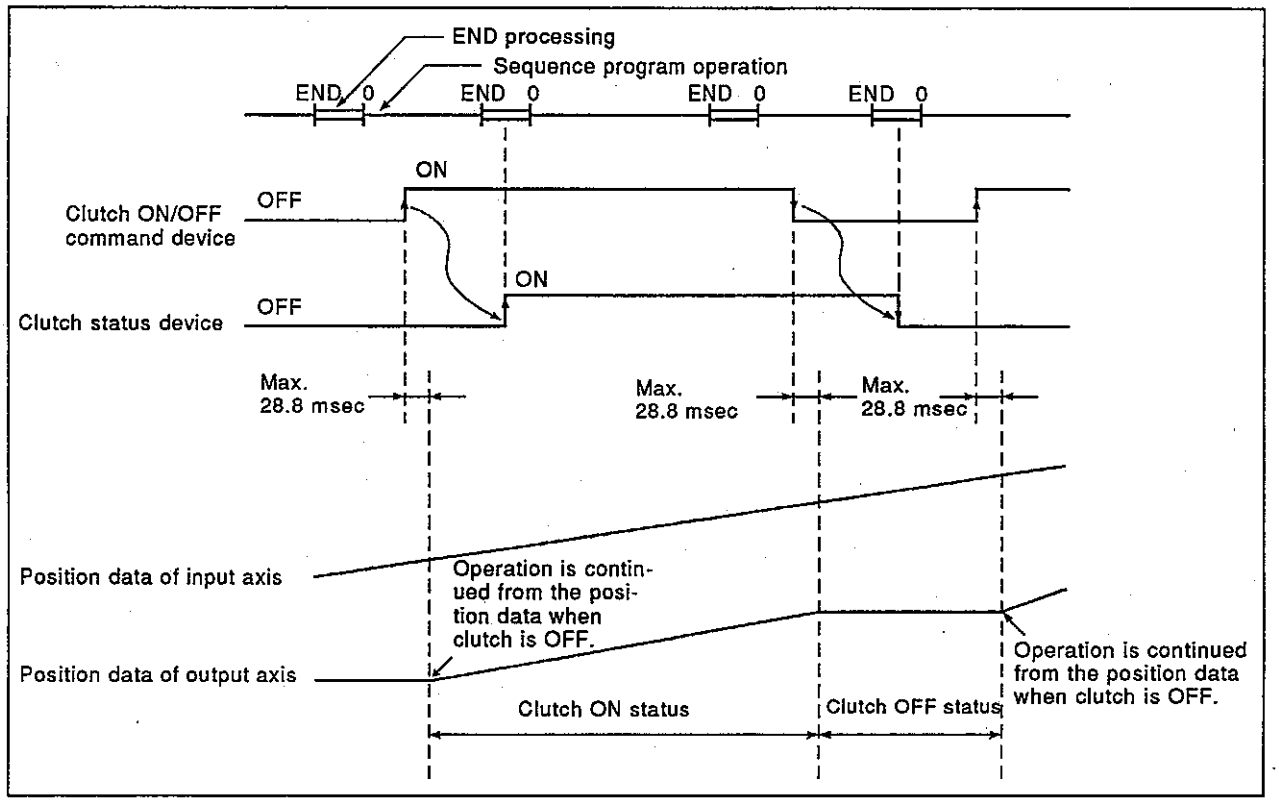


Fig. 7.2 Operation Timing in ON/OFF Mode

(2) Address mode

(a) Address mode is used to turn ON/OFF a clutch by the clutch ON/OFF command device and the position data of virtual axis. (When the mode setting device value is 1.)

1) When the position data value is the designated clutch ON address when a clutch ON/OFF command is ON, the clutch changes to ON.

2) When the position data value is the designated clutch OFF address when a clutch ON/OFF command is OFF, the clutch changes to OFF.

(b) Turn ON/OFF the clutch ON/OFF command device so that a clutch ON/OFF address can be accepted before the position data of a virtual axis is a clutch ON/OFF address. In address mode, after the clutch ON/OFF command device is turned ON/OFF, the clutch ON/OFF address can be accepted in max. 28.8 msec.

1) When the clutch ON/OFF device is OFF, the clutch does not go ON even if the position data value is the clutch ON address.

2) When the clutch ON/OFF device is ON, the clutch does not go OFF even if the position data value is the clutch OFF address.

(c) The clutch ON/OFF state can be checked by using the clutch status device.

Clutch state	Clutch status device
ON	ON
OFF	OFF

(d) The clutch status device is turned ON/OFF during the END processing of the scan in which the clutch state changed to ON/OFF. (The clutch status device does not turn ON/OFF when the clutch ON/OFF command device turns ON/OFF.)

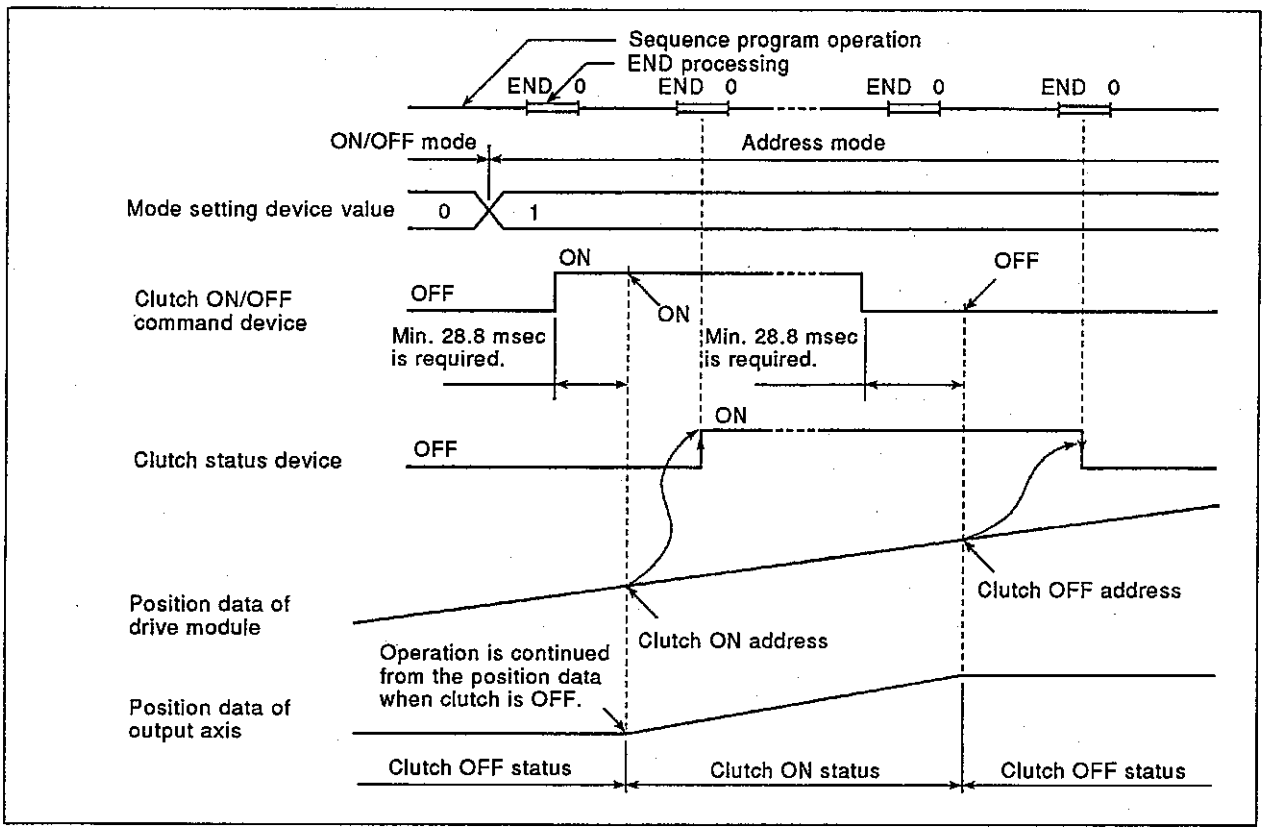


Fig. 7.3 Operation Timing in Address Mode

POINTS

(1) When the mode setting device is set to a value other than 0 and 1, an error occurs, and operation is controlled according to the last setting.

(2) The value of the clutch ON/OFF address setting device is fetched by the END processing of a sequence program.

(3) Change of the control mode (mode setting device value: 0 ↔ 1) is always valid.

(3) External input mode

(a) External input mode is used to turn ON/OFF a clutch by the clutch ON/OFF command bit device and an external input (synchronous TREN signal: encoder start signal).
The input pulse from the synchronous encoder is counted by the leading edge of an external input.
Therefore, the clutch responds at a high speed and is highly precise.

1) After the clutch ON/OFF command bit device turns ON, the clutch is put into ON state by the leading edge (OFF - ON) of an external input.

2) When the clutch ON/OFF command bit device turns OFF, the clutch goes into the OFF state in max. 28.8 msec.

(b) Turn ON the clutch ON/OFF command device so that an external input can be accepted before the external input (TREN signal) is turned ON. In external input mode, after the clutch ON/OFF command device is turned ON, the external input can be accepted in max. 28.8 msec.

1) When the clutch ON/OFF device is OFF, the clutch does not go ON even if the position data value is the clutch ON address.

2) When an external input is ON, the clutch does not go ON even if the clutch ON/OFF device goes ON.

3) Even if an external input turns OFF after the clutch goes ON, the clutch remains ON.

(c) The clutch status device is turned ON/OFF during the END processing of the scan in which the clutch state changed to ON/OFF by the clutch ON/OFF command device.

Clutch ON/OFF command device	Clutch status device
ON	ON
OFF	OFF

(d) The position data of an input axis (virtual axis) is changed only when the clutch is ON.

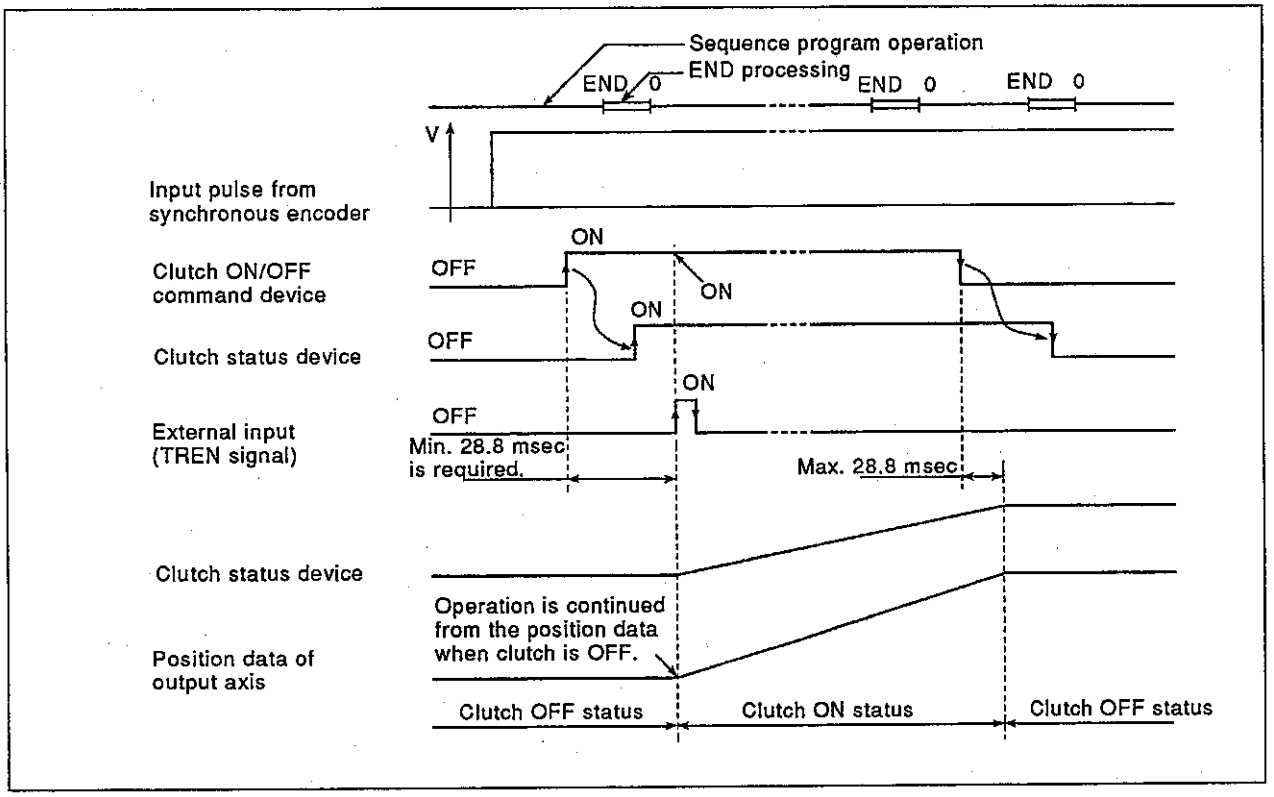


Fig. 7.4 Operation Timing in External Input Mode

(e) External input mode can be used only for an axis which has an increment type synchronous encoder (A336PX) set as its drive module. When a drive module is an absolute type synchronous encoder (A336EX), external input mode cannot be used.

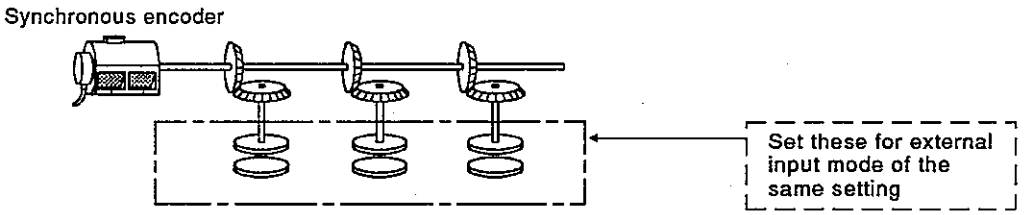
(f) Synchronous encoder, external input and external input mode clutch can be set in one to one combination. The relationship between the synchronous encoder and the external input is shown in the table below.

Synchronous Encoder	External Input (TREN signal)
P1	TREN 1
P2	TREN 2
P3	TREN 3

(g) When a clutch connected to an encoder is used in external input mode, set all clutches connected to the same encoder No. for external input mode.
However, the type of the clutch status storage device, direct clutch and smoothing clutch may be different.

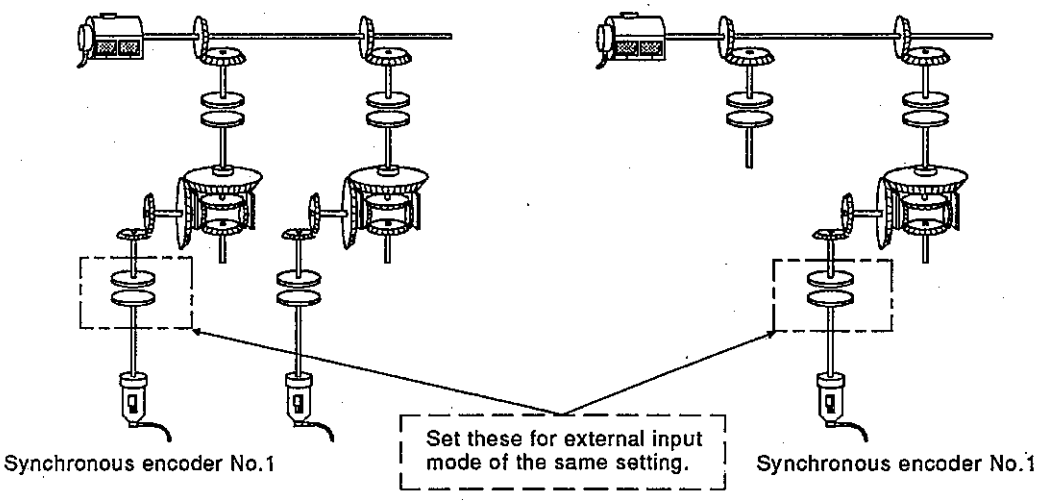
Example 1 When a synchronous encoder is connected to a drive axis

When the clutch which is set for external input mode is used, set all clutches connected to the encoder for external input mode.



Example 2 When the same synchronous encoder is connected to an auxiliary input axis

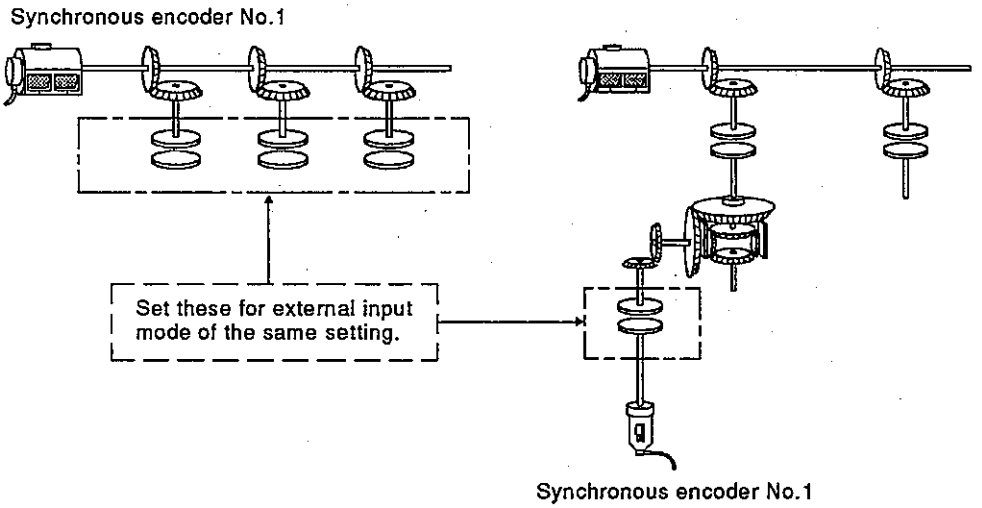
Set all clutches connected to the same encoder No. for external input mode.



Example 3

When the same synchronous encoder is connected to a drive axis and an auxiliary input axis

Set all connected clutches for external input mode. (See examples 1 and 2.)



7.2.2 Parameter

The clutch parameter is shown in Table 7.2. Each item of Table 7.2 is explained in (1) to (6).

Table 7.2 Parameter List

No.	Setting Item	Default Value	Setting Range			Set Enable/Disable	
1	Control mode	ON/OFF mode	ON/OFF mode	ON/OFF mode / Address mode } Share	External input mode	Direct clutch	Smoothing clutch
2	Mode setting device	—	—	Word device	—	O	O
3	Clutch ON/OFF command device	—	Bit device			O	O
4	Clutch ON address setting device	—	—	Word device	—	O	O
5	Clutch OFF address setting device						
6	Clutch status storage device	—	- / Bit device			O	O
7	Smoothing constant	0	0 to 65535 msec			—	O

(1) Control mode

(a) This is the mode that is used to turn ON/OFF a clutch.
The following 3 kinds of modes can be set.

- ON/OFF mode
- ON/OFF mode, address mode shared
- External input mode

See Section 7.2.1 for details of control modes.

(b) When a synchronous encoder is used for a drive module, the control mode that can be set is different according to the model name of the servo input module to be used.

Servo Input Module	Clutch Control Mode		
	ON/OFF Mode	Address Mode	External Input Mode
A336PX (increment type)	O	O	O
A336EX (absolute position type)	O	O	× *1

o: setting enabled x: setting disabled

REMARK

1) *1:A336EX does not have the TREN input for an external input.Therefore,external input mode cannot be used.

(2) Mode setting device (can be set only when ON/OFF mode and address mode are shared.)

1) This is a device to switch ON/OFF mode and address mode.
The mode setting device is as follows:
- 0: ON/OFF mode
- 1: Address mode

When a value other than 0 and 1 is set, an error occurs, and the mode remains at the last setting.

2) The following devices can be used as mode devices.

- Data register: D0 to D799(When a cam is used for an output module, it is impossible to set an area used for a cam.)
- Link register : W0 to W3FF

(3) Clutch ON/OFF command device

1) This is a device that is used to do a clutch ON/OFF command.

2) The following devices can be used as clutch ON/OFF command devices:

• Input	: X180 to X7FF
• Output	: Y180 to Y7FF
• Internal relay/latch relay	: M/L0 to M/L1999
• Timer	: TC0 to TC255 (timer coil) TT0 to TT225 (timer contact)
• Counter	: CC0 to CC255 (counter coil) CT0 to CT255 (counter contact)
• Link relay	: B0 to B3FF
• Annunciator	: F0 to F255

(4) Clutch ON/OFF address setting device (can be set only when ON/OFF mode and address mode are shared.)

1) This is a device to switch a clutch ON/OFF in address mode.

2) The following devices can be used as clutch ON/OFF address setting devices.
- Data register: D0 to D799(When a cam is used for an output module, it is impossible to use a device used for a cam. See Section 8.6.2.)
- Link register : W0 to W3FF

3) A clutch ON/OFF address can be set in the range of -2147483648(-2^{31}) to 2147483647(2^{31}-1) pulses.

(5) Clutch status

1) This is a device to check a clutch ON/OFF state. The clutch status device is turned ON/OFF by the END processing of a scan during which the clutch state changed to ON/OFF. (See Section 7.2.1 (1).)

2) The following devices can be used as clutch status devices.

- Internal relay/latch relay : M/L0 to M/L1999
- Timer : TT0 to TT225 (timer contact)
- Counter : CT0 to CT255 (counter contact)
- Link relay : B0 to B3FF
- Annunciator : F0 to F255

(6) Smoothing constant
This is time required for position data to reach 63 % of the output axis velocity.

7.3 Velocity Change Gear

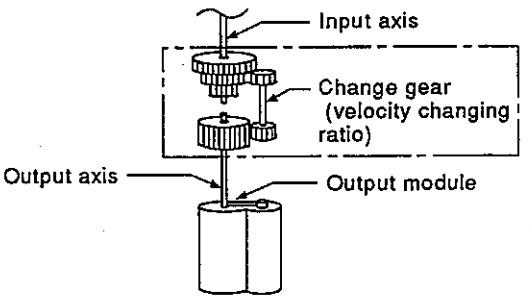
The following explains the operations of velocity change gear and parameters.

7.3.1 Operation

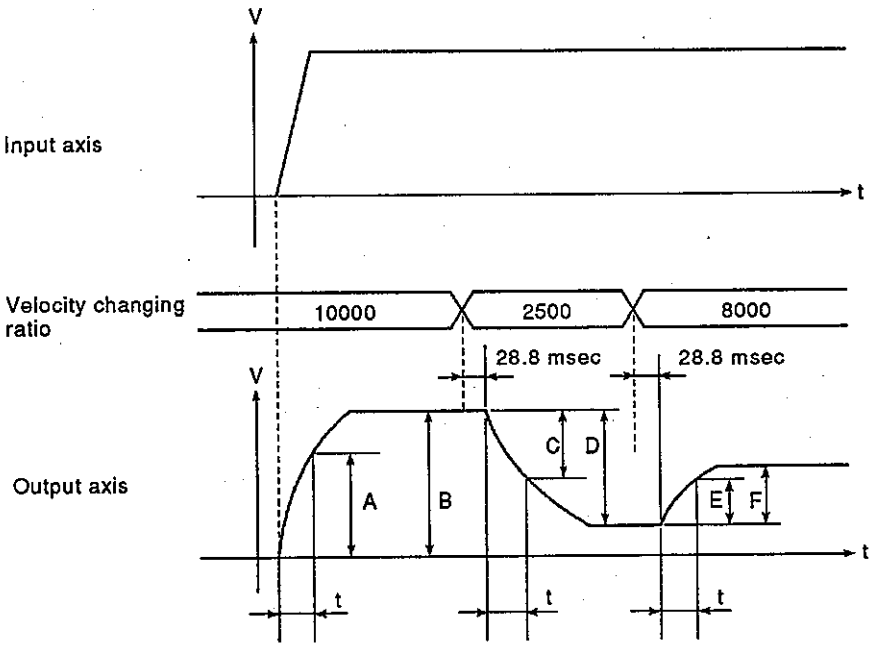
The following explains the operation of the velocity change gear.

(1) The input axis velocity is multiplied by the velocity changing ratio set in the velocity changing ratio setting device.
The velocity required by this calculation is transferred to the output axis.

$$[\text{Output axis velocity}] = [\text{Input axis velocity}] \times \frac{[\text{Velocity changing ratio}]}{10000} \text{ (unit: pulse/s)}$$



(2) When the velocity changing ratio changes, velocity adjustment processing is executed according to the smoothing constant (t) set in the change gear parameter.



REMARK

1) $\frac{A}{B} \times 100 = \frac{C}{D} \times 100 = \frac{E}{F} \times 100 = 63\%$

POINT

The change gear is used to change the velocity of the roller of an output module. Do not use a change gear in other output modules.

7.3.2 Parameter list

The velocity change gear parameter is shown in Table 7.3. Each item of Table 7.3 is explained in (1) to (3).

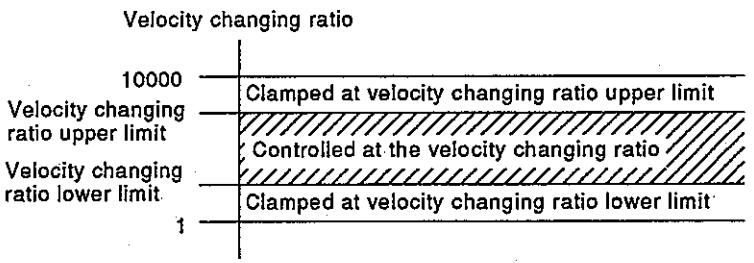
Table 7.3 Velocity Change Gear Parameter List

No.	Setting Item	Default Value	Setting Range
1	Velocity changing ratio upper limit	10000	1 to 10000
2	Velocity changing ratio lower limit	1	1 to 10000
3	Velocity changing ratio setting device	—	D0 to D799 W0 to W3FF
4	Smoothing constant	0	0 to 65535 (msec)

(1) Velocity changing ratio upper limit/lower limit

(a) This is the effective range (0.01% to 100%) of the velocity changing ratio set in the velocity changing ratio setting device.

(b) When the value of the velocity changing ratio setting device exceeds the velocity changing ratio upper limit, an operation is processed at the velocity changing ratio upper limit.



(c) Set the velocity changing ratio upper limit/lower limit to a value from 1 to 10000 by multiplying 0.01 % to 100% by 100.

(d) Set the velocity changing ratio upper limit/lower limit as the following expression.

$$1 \leq [\text{Velocity changing ratio lower limit}] \leq [\text{Velocity changing ratio upper limit}] \leq 10000$$

(2) Velocity changing ratio setting device

(a) This is the device to which the velocity changing ratio of a change gear is set.

(b) The following devices can be used as velocity changing ratio setting devices.

- Data register: D0 to D799
- Link register: W0 to W3FF

(c) The setting range is from the velocity changing ratio lower limit to the velocity changing ratio upper limit.

(3) Smoothing constant

This is time required for position data to reach 63 % of the output axis velocity.

7.4 Differential Gear

The differential gear is used for the following:
- Compensation of the position displacement of an output module
- Single operation separated from the virtual main shaft

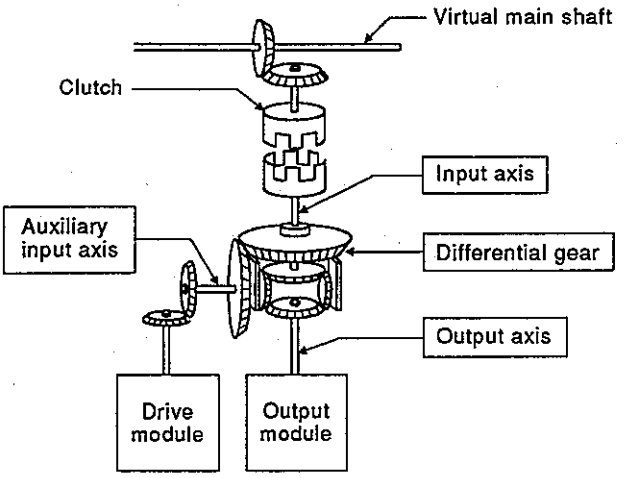
7.4.1 Operation

(1) When the input axis clutch turns ON.

The travel distance of the auxiliary input axis is subtracted from that of the input axis.

The differential gear transfers the travel distance resulting from the calculation to the output axis.

[Travel distance on the output axis] = [Travel distance on the input axis] - [Travel distance on the auxiliary axis] (Unit: pulse)



(2) When the input axis clutch turns OFF.

The differential gear transfers only the travel distance to the output axis from the auxiliary input axis. Therefore, a single operation can be performed with an auxiliary input axis.

7.4.2 Parameter

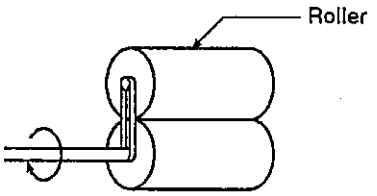
The differential gear does not have the setting parameter.

8. OUTPUT MODULE

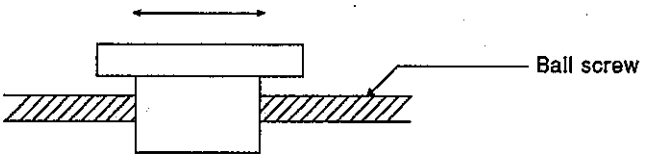
Output modules are classified as follows:
- Roller ..... Section 8.2
- Ball screw ..... Section 8.3
- Rotary table ..... Section 8.4
- Cam ..... Section 8.5

Set the parameters according to the mechanism of each output module.

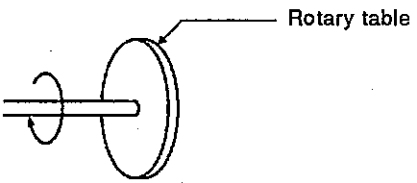
(1) Roller
This is used when velocity is controlled by a final output (axis).



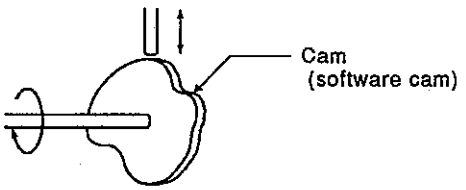
(2) Ball screw
This is used when linear positioning is controlled by a final output (axis).



(3) Rotary table
This is used when angle is controlled by a final output (axis).



(4) Cam
This is used when operation is controlled by connecting a software cam to a final output (axis).



8.1 Common Output Module Items

8.1.1 Output amplifier number

This sets the output amplifier No. for the axis used in an actual system.
In virtual mode, amplifier numbers are used for the output module to differentiate them from the axis numbers of the virtual servo motor.

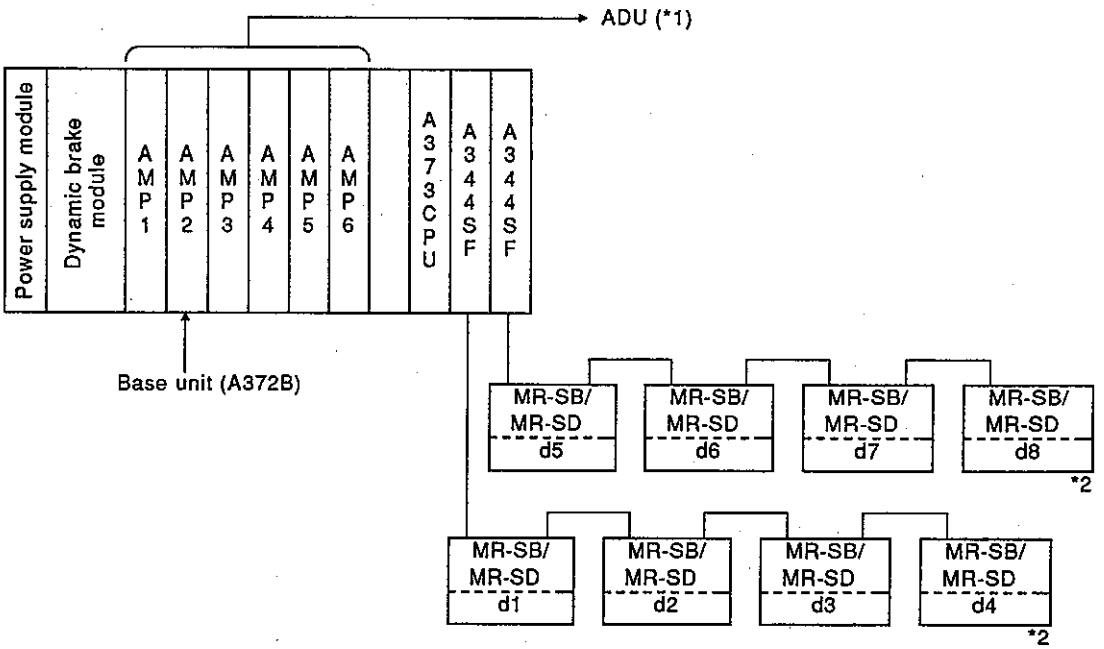


Table 8.1 Output Amplifier Number Setting List

ADU	Output Amplifier No.	MR-SB/MR-SD		Output Amplifier No.
		First A344SF	Second A344SF	
AMP1	1	d1	—	7
AMP2	2	d2	—	8
AMP3	3	d3	—	9
AMP4	4	d4	—	10
AMP5	5	—	d5	11
AMP6	6	—	d6	12
		—	d7	13
		—	d8	14

*1 : AMP1-AMP6 correspond to the numbers silk-printed on the base unit.

*2 : d1 to d8 correspond to the MR-SB/MR-SD rotary switch settings 0 to 3.
- d1/d5: 0
- d2/d6: 1
- d3/d7: 2
- d4/d8: 3

*3 : When two A344SFs are used, the left side (OP1) of the optional slot of the base unit is the first A344SF, and the right side (OP2) is the second A344SF.

8.2 Roller

The following explains the operations of roller and parameters.

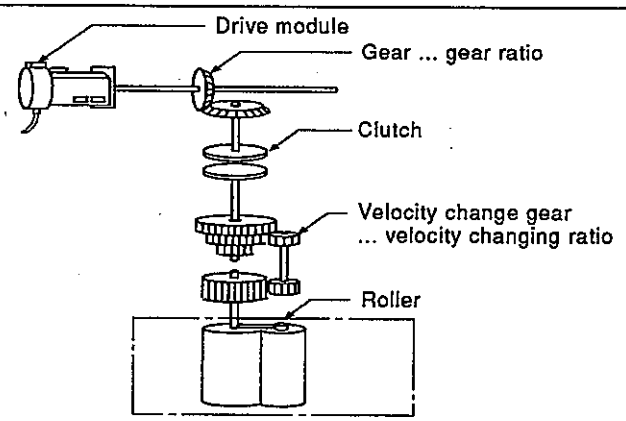
8.2.1 Operation

The following explains the operation of the roller.

(1) Operation

(a) The drive module velocity is multiplied by the gear ratio and the velocity changing ratio of the transfer module. The roller turns at the velocity resulting from this calculation.

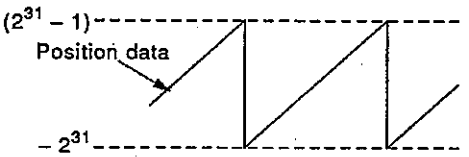
$$[\text{Roller velocity}] = \left[\begin{array}{l}\text{Drive module}\\ \text{velocity (pulse/s)}\end{array}\right] \times [\text{gear ratio}] \times \left[\begin{array}{l}\text{Velocity}\\ \text{changing ratio}\end{array}\right] \text{(unit: pulse/s)}$$



(b) When a clutch is used, the roller is controlled after the clutch is turned ON.

(2) Control contents

(a) The roller does not have position data.
However, the mode is switched from virtual to real. The position data corresponds to the position after movement in virtual mode.
[Position data is ring addresses of $-2147483648(-2^{31})$ pulse to $2147483647(2^{31}-1)$ pulse.]



(b) Backlash compensation is processed continuously at the set value of the fixed parameter even if real mode and virtual mode are changed.

(c) The roller peripheral velocity can be monitored by a peripheral device and the roller peripheral velocity storage register.
Section 8.2.2 gives the expression of the roller peripheral velocity.
Section 8.6.2 gives the details of the roller peripheral velocity storage register.

8.2.2 Parameter list

The roller parameter is shown in Table 8.2. Each item of Table 8.2 is explained in (1) to (6).

Table 8.2 Parameter List

No.	Setting Item	Default Value	Setting Range	
1	Output amplifier No. (see Section 8.1.1.)	0	1 to 6: AMP1 to AMP6 (ADU) 7 to 10: d1 to d4 (A344SF: first) 11 to 14: d5 to d8 (A344SF: second) (MR-SB/SD)	
2	Unit setting	mm	mm	inch
3	Roller diameter (L)	0	0.1 to 214748364.7 μm	0.00001 to 21474.8364 inch
4	Number of pulses per roller revolution (NL)	0	1 to 2147483647 pulses	
5	Accumulated pulse allowable value	65535	1 to 65535 pulses	
6	Velocity limit value (VL)	0	0.01 to 6000000.00 mm/min	0.001 to 600000.000 inch/min
7	Torque limit value setting device	—	– (300%) / word device	
8	Comment	None	32 characters	

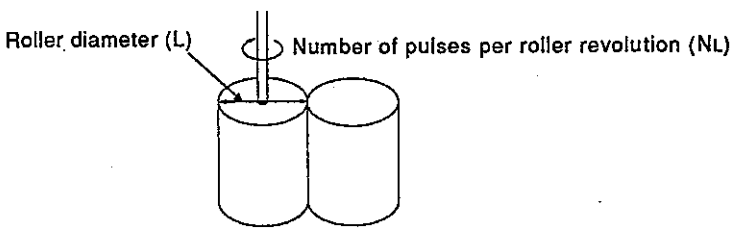
(1) Unit setting

(a) This is the unit (mm/inch) for setting the roller.

(b) The units (unit setting of a fixed parameter) in the real mode of an axis for which the roller is set, can be set to either mm, inch, degree or pulse.

(2) Roller diameter (L)/number of pulses per roller revolution (NL)

(a) This is the diameter of the roller connected to a servo motor and the number of pulses for each roller rotation.



(b) The roller peripheral velocity is calculated by the following expression using the roller diameter and the number of pulses per roller revolution.

1) When the units are mm

$$\begin{bmatrix}\text{Roller peripheral}\\ \text{velocity}\end{bmatrix} = \begin{bmatrix}\text{Number of input}\\ \text{pulses/minute}\end{bmatrix} \times \frac{\pi \times L \times 10^{-4}}{N_L} \text{ (mm/min)}$$

2) When the units are inches

$$\begin{bmatrix}\text{Roller peripheral}\\ \text{velocity}\end{bmatrix} = \begin{bmatrix}\text{Number of input}\\ \text{pulses/minute}\end{bmatrix} \times \frac{\pi \times L \times 10^{-5}}{N_L} \text{ (mm/min)}$$

An integer obtained by multiplying the value resulting from the calculations 1) and 2) by the "n"th power of 10 is stored to the roller peripheral velocity storage register.

(3) Accumulated pulse allowable value

(a) This is the accumulated pulse allowable value of deviation counter.

(b) The deviation counter value is always checked. If the deviation counter value becomes larger than the allowable accumulated pulse value, the error detection signal (Xn7) turns ON.
However, the operation of a roller axis continues. Therefore, the user must execute error processing.

(4) Velocity limit value (V_L)

(a) This is the max. speed of roller axis.

(b) Set the velocity limit value in the range of the following expression.

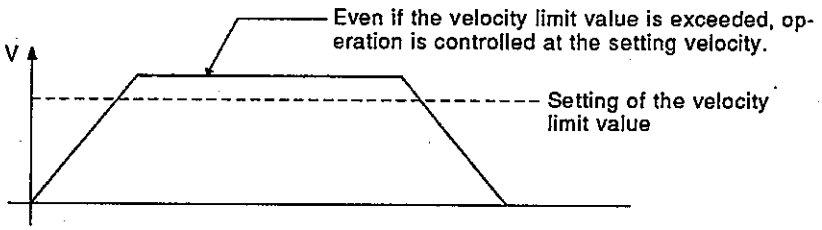
1) When the units are mm

$$1 \leq \frac{V_L \times 10^4 \times N_L}{60 \times \pi \times L} \leq 1000000 \text{ [pulse/s]}$$

2) When the units are inches

$$1 \leq \frac{V_L \times 10^5 \times N_L}{60 \times \pi \times L} \leq 1000000 \text{ [pulse/s]}$$

(c) When the velocity of the roller axis exceeds the velocity limit value, error detection signal (Xn7) turns ON.
However, clamp processing of the roller axis speed is not executed.



(5) Torque limit value setting device (1 word)

(a) This is the device that is used to set the torque limit value of the roller axis.
Torque restriction is executed at the value of a set device by device setting.
When a device is not set, torque restriction is executed at 300 %.

(b) The following devices can be used as torque limit setting devices.

- Data register: D0 to D799
- Link register : W0 to W3FF

(c) The torque limit value can be set in the range from 1 to 500 %.

(6) Comment

(a) Comments such as roller axis use are created.
Display is possible during monitoring by a peripheral device by creating a comment.

(b) Comment may be up to 32 characters long.

8.3 Ball Screw

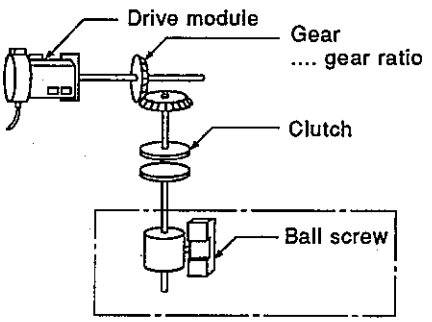
The following explains the operations of ball screw and parameters.

8.3.1 Operation

The following explains the operation of the ball screw.

(1) Operation
The travel distance of the drive module is multiplied by the gear ratio of the transmission module. The travel distance of the ball screw resulting from this calculation is output.

[Travel distance of ball screw] = [Travel distance of transmissionmodule] × [gear ratio] (unit: pulse)



When a clutch is used, the ball screw is controlled after the clutch is turned ON.

(2) Control contents

(a) The feed position data continues even if the mode is switched from virtual to real mode or vice versa.

(b) Backlash compensation is processed continuously at the set value of the fixed parameter even if real mode and virtual mode are changed.

(c) The travel distance per pulse is controlled by the ball screw parameter (ball screw pitch and number of pulses per ball screw revolution).
Set a value that is the same as a travel distance per pulse of the fixed parameter.

8.3.2 Parameter list

The ball screw parameter is shown in Table 8.3. Each item of Table 8.3 is explained in (1) to (8).

Table 8.3 Ball Screw Parameter List

No.	Setting Item	Default Value	Setting Range	
1	Output amplifier No. (see Section 8.1.1.)	0	1 to 6 : AMP1 to AMP6 (ADU) 7 to 10 : d1 to d4 (A344SF: first) 11 to 14 : d5 to d8 (A344SF: second) (MR-SB/SD)	
2	Unit setting	mm	mm	inch
3	Ball screw pitch (P)	0	0.1 to 214748364.7 μm	0.00001 to 21474.83647 inch
4	Number of pulses per ball screw revolution (NP)	0	1 to 2147483648 pulses	
5	Accumulated pulse allowable value	65535	1 to 65535 pulses	
6	Upper stroke limit	$2^{31} - 1$	0.1 to 214748364.7 μm	0.00001 to 21474.83647 inch
7	Lower stroke limit	0		
8	Velocity limit value (VL)	—	0.01 to 6000000.00 mm/min	0.001 to 600000.000 inch/min
9	Limit switch output	Unused	Used/unused	
10	Torque limit value setting device	— (c)	– (300%) / word device	
11	Comment	None	32 characters	

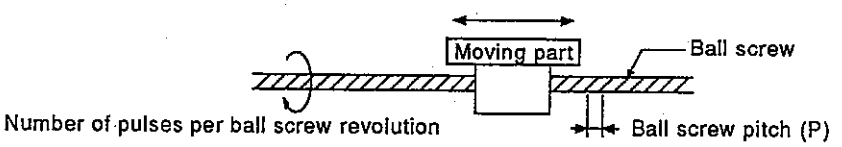
(1) Unit setting

(a) This is the unit (mm/inch) for setting the ball screw.

(b) The units of the ball screw must be same as those (unit setting of a fixed parameter) in the real mode.
If the ball screw units and the units in real mode are different, limit switch output becomes impossible, and operation cannot be switched from real to virtual mode.

(2) Ball screw pitch (P)/number of pulses per ball screw revolution (NP)

(a) This is the diameter of the roller connected to a servo motor and the number of pulses for each roller rotation.



(b) The roller peripheral velocity is calculated by the following expression using the roller diameter and the number of pulses per roller revolution.

$$[\text{Travel distance per pulse}] = \frac{P}{N_P}$$

(3) Accumulated pulse allowable value

(a) This is the accumulated pulse allowable value of deviation counter.

(b) The deviation counter value is always checked. If the deviation counter value becomes larger than the allowable accumulated pulse value, the error detection signal (Xn7) turns ON.

(4) Upper/lower stroke limit

(a) This is the stroke range in virtual mode.

(b) When the velocity of the roller axis exceeds the velocity limit value, error detection signal (Xn7) turns ON.
However, stop processing of the ball screw is not executed.

(5) Velocity limit value (V_L)

(a) This is the max. speed of ball screw axis.

(b) Set the velocity limit value in the range of the following expression.

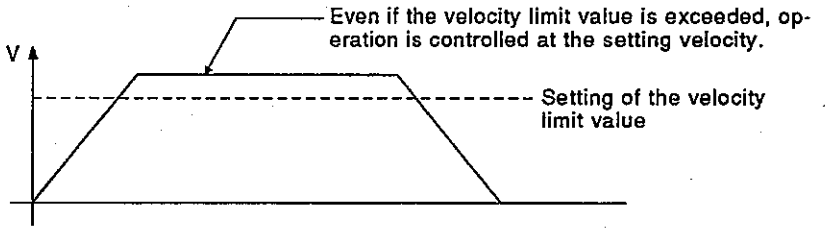
1) When the units are mm

$$1 \leq \frac{V_L \times 10^4 \times N_P}{60 \times P} \leq 1000000 \text{ [pulse/s]}$$

2) When the units are inches

$$1 \leq \frac{V_L \times 10^5 \times N_P}{60 \times P} \leq 1000000 \text{ [pulse/s]}$$

(c) When the velocity of the ball screw axis exceeds the velocity limit value, error detection signal (Xn7) turns ON.
However, clamp processing of the ball screw axis speed is not executed.



(6) Limit switch output

(a) This is the setting of use/unuse of limit switch output on the ball screw axis.

- Limit switch output use .....Limit switch output is executed on the basis of the real position data of the ball screw.
- Limit switch output unused .....Limit switch output is not executed.

(7) Torque limit value setting device (1 word)

(a) This is the device that is used to set the torque limit value of the ball screw axis.
Torque restriction is executed at the value of a set device by device setting.
When a device is not set, torque restriction is executed at 300 %.

(b) The following devices can be used as torque limit setting devices.

- Data register: D0 to D799
- Link register : W0 to W3FF

(c) The torque limit value can be set in the range from 1 to 500 %.

(8) Comment

(a) Comments such as ball screw axis use are created.
Display is possible during monitoring by a peripheral device by creating a comment.

(b) Comment may be up to 32 characters long.

8.4 Rotary Table

The following explains the operations of rotary table and parameters.

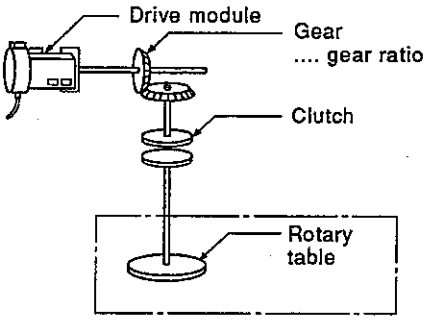
8.4.1 Operation

The following explains the operation of the rotary table.

(1) Operation

(a) The travel distance of the drive module is multiplied by the gear ratio of the transmission module. The travel distance of the rotary table resulting from this calculation is output.

$$\left[\begin{array}{l}\text{Travel distance}\\ \text{of rotary table}\end{array}\right] = \left[\begin{array}{l}\text{Travel distance}\\ \text{of drive module}\end{array}\right] \times \text{[gear ratio] (unit: pulse)}$$



(b) When the clutch is used, the rotary table is controlled after the clutch is turned ON.

(2) Control contents

(a) The feed position data continues even if the mode is switched from virtual to real mode or vice versa.

(b) Backlash compensation is processed continuously at the set value of the fixed parameter even if real mode and virtual mode are changed.

(c) The travel distance per pulse is controlled by the rotary table parameter (ball screw pitch and number of pulses per rotary table revolution).
Set a value that is the same as a travel distance per pulse of the fixed parameter.

8.4.2 Parameter list

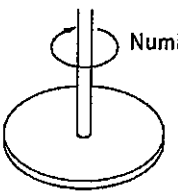
The rotary table parameter is shown in Table 8.4. Each item of Table 8.4 is explained in (1) to (7).

Table 8.4 Parameter List

No.	Setting Item	Default Value	Setting Range
1	Output amplifier No. (see Section 8.1.1.)	0	1 to 6: AMP1 to AMP6 (ADU/PDU) 7 to 10: d1 to d4 (A344SF: first) 11 to 14: d5 to d8 (A344SF: second) } (MR-SB/SD)
2	Number of pulses per rotary table revolution (ND)	—	1 to 2147483647 (pulse)
3	Accumulated pulse allowable value	65535	1 to 65535 (pulse)
4	Upper stroke limit	0	0 to 359.99999 (degree)
5	Lower stroke limit	0	0 to 359.99999 (degree)
6	Velocity limit value (VL)	0	0.001 to 600000.000 (degree/min)
7	Limit switch output	Unused	Used/unused
8	Torque limit value setting device	—	– (300%) / word device
9	Comment	None	32 characters

(1) Number of pulses per rotary table revolution (ND)

(a) This is the diameter of the rotary table connected to a servo motor and the number of pulses for each roller rotation.



(b) The roller peripheral velocity is calculated by the following expression using the roller diameter and the number of pulses per roller revolution.

$$[\text{Travel distance per pulse}] = \frac{360}{N_D} \text{ (degree)}$$

(2) Accumulated pulse allowable value

(a) This is the accumulated pulse allowable value of deviation counter.

(b) The deviation counter value is always checked. If the deviation counter value becomes larger than the allowable accumulated pulse value, the error detection signal (Xn7) turns ON.

(3) Upper/lower stroke limit

(a) This is the stroke range in virtual mode.
The stroke limit can be set to valid/invalid. The stroke limit becomes invalid when (the upper stroke limit) = (the lower stroke limit).

(b) When the velocity of the roller axis exceeds the velocity limit value, error detection signal (Xn7) turns ON.
However, stop processing of the rotary table is not executed.

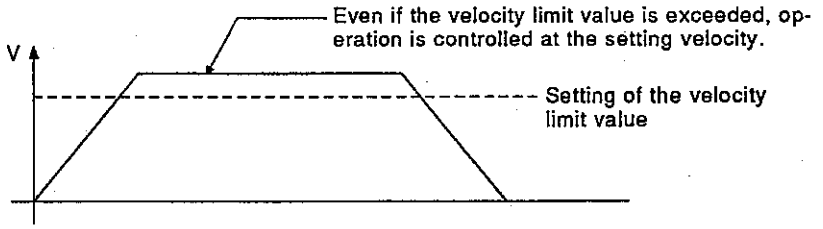
(4) Velocity limit value (VL)

(a) This is the max. speed of rotary table axis.

(b) Set the velocity limit value in the range of the following expression.

$$1 \leq \frac{V_L \times 10^5 \times N_D}{60 \times 360 \times 10^5} \leq 1000000\,[\text{pulse/s}]$$

(c) When the velocity of the rotary table axis exceeds the velocity limit value, error detection signal (Xn7) turns ON.
However, clamp processing of the rotary table axis speed is not executed.



(5) Limit switch output

(a) This is setting of use/unuse of limit switch output on the rotary table axis.

- Limit switch output use .....Limit switch output is executed on the basis of the real position data of the rotary table.
- Limit switch output unused .....Limit switch output is not executed.

(6) Torque limit value setting device (1 word)

(a) This is the device that is used to set the torque limit value of the rotary table axis. Torque restriction is executed at the value of a set device by device setting. When a device is not set, torque restriction is executed at 300 %.

(b) The following devices can be used as torque limit setting devices.

- Data register: D0 to D799
- Link register : W0 to W3FF

(c) The torque limit value can be set in the range from 1 to 500 %.

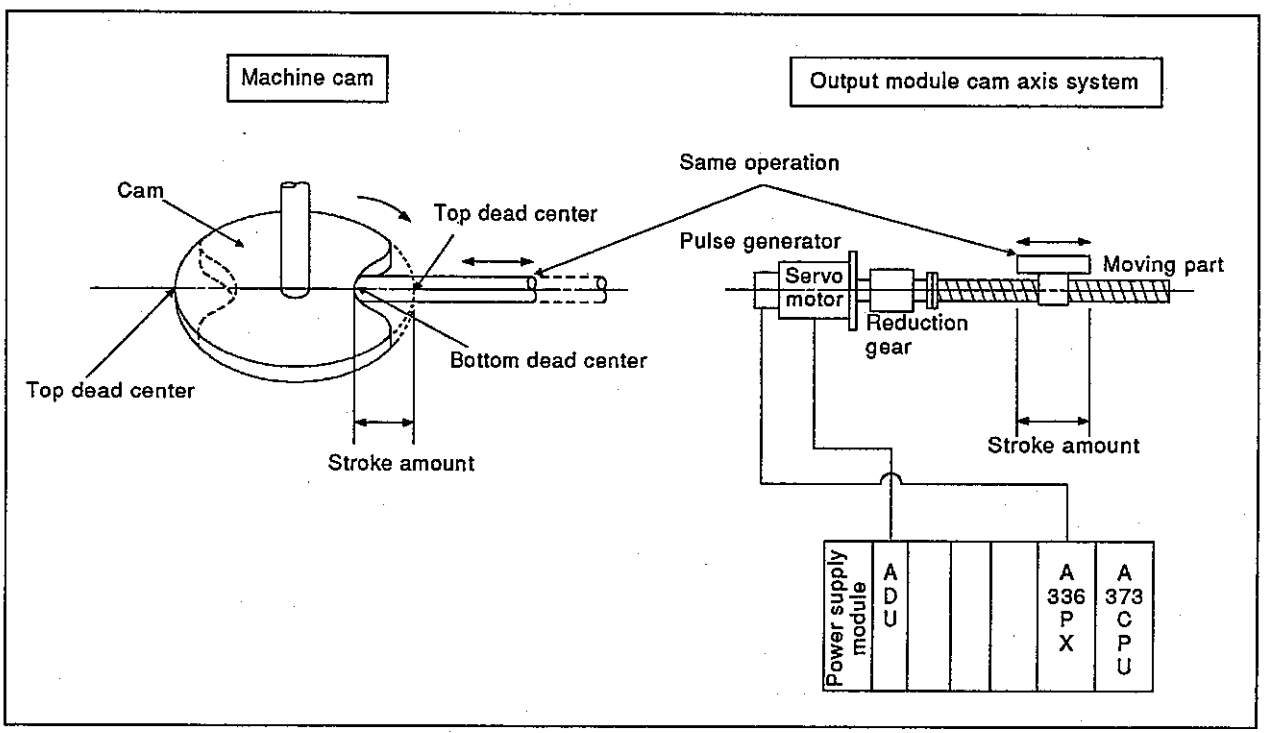
(7) Comment

(a) Comments such as rotary table axis use are created.
Display is possible during monitoring by a peripheral device by creating a comment.

(b) Comment may be up to 32 characters long.

8.5 Cam

(1) The axis for which a cam is set as an output module makes the movement similar to the cam by using a ball screw.



(2) The following 2 kinds of data are necessary to use a cam.

- Setting item when creating cam data
  This is data to be set when creating cam data (cam curve) by using a PC/AT started up with SW0IX-DAMPE.
  (see Section 8.5.2)
- Cam parameter
  This is a parameter when a cam is set as an output module in the mechanical system program of PC/AT started up with SW0IX-GSV21PE.
  (see Section 8.5.3)

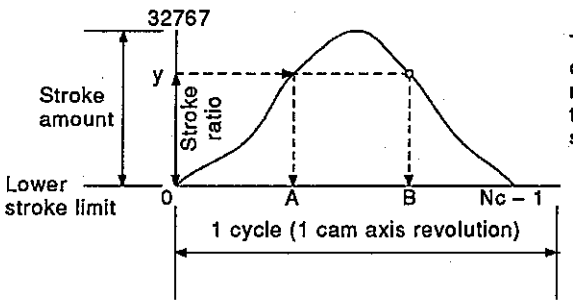
8.5.1 Operation

The following explains the operation of the cam.

(1) Processing when switching from real mode to virtual mode
When switching from real mode to virtual mode, position data of 1 cam axis revolution is deduced on the basis of the feed position data, stroke lower limit, stroke quantity and cam No..
The lower stroke limit becomes a position data item when switching from real mode to virtual mode after turning ON the cam reference position setting signal (YnE)*1.

(Feed position data)
= (Stroke amount) × (Stroke ratio) + (Lower stroke limit)

The stroke ratio that applies to this expression is calculated, and the cam table of setting cam No. is searched from the beginning of 1 cycle. Then, the position data in 1 rotation of the cam axis that corresponds to the searched point is calculated.
The position data in 1 cam axis revolution is searched from the beginning of 1 cycle. Therefore, take care when there are several identical stroke ratios in 1 cycle.
(Adjust the position when switching from real mode to virtual mode.)



There are 2 points, A and B, that correspond to the calculated stroke ratio (y) in 1 cycle in the figure on the left. However, the point is considered as point A.

(2) Operation
A value calculated by the stroke ratio of the cam data table is output on the basis of the position data in 1 cam axis revolution.
The travel distance of the drive module is multiplied by the gear of the transmission module. The position data in 1 cam axis revolution is determined by the travel distance resulting from this calculation.
The number of pulses per stroke amount is controlled on the basis of the travel distance per pulse set in the fixed parameter in real mode.

REMARK

1) *1: "n" of YnE represents the numerical value (0 to 7) that corresponds to the axis number of output module in real mode.

n	0	1	2	3	4	5	6	7
Virtual axis No.	1	2	3	4	5	6	7	8

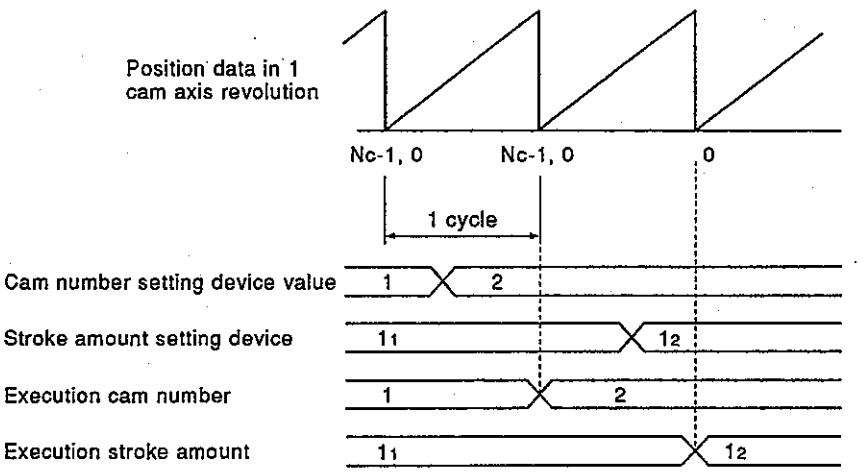
(3) Switching stroke amount and cam No. during operation

(a) The cam stroke amount and the execution cam No. can be switched with a sequence program during cam operation.

(b) The switching stroke amount and cam No. are executed at the address set by the stroke amount and cam No. switching position of a setting item when cam data is created.
When the position data exceeds the stroke amount and the cam No. switching position, the stroke amount and cam No. are switched on the basis of the stroke amount setting device and cam No. setting device values set in the cam parameter.

Example

Switching cam No. 1 and No. 2 when the stroke amount and cam No. switching position are set to 0.



POINTS

(1) Cam No. and stroke amount are fetched into the PCPU by the switching from real mode to virtual mode/END processing of a sequence program.
A relative check is executed when cam No. and stroke amount are fetched into the PCPU. An error occurs in the following cases. The error detection signal (Yn7) turns ON, and an error code is stored in the low error code storage register.

(a) The set cam No. is different from the "use cam No." designated in the cam parameter.

(b) The stroke amount is outside the range of 1 to 2147483647 ($2^{31}-1$).

(c) The (lower stroke limit) + (stroke amount) ≤ 2147483647 ($2^{31}-1$) is not satisfied in reciprocation cam mode.

(d) The control mode of set cam No. does not agree.
(When data is written to the A373CPU without executing a relative check when creating a mechanical system program)

(2) When there is a cam No. or stroke amount error, the following operation is executed.

(a) When an error occurs at start-up, the related system (Section 10.1) is not started.

(b) If an error occurs when the position data reaches the set stroke amount and the cam No. switching position, operation is continued without switching to the set stroke amount/cam No.. Reset the error detection signal and the low error code storage register by using the error reset command (Yn7).

(3) If the stroke amount/cam No. is rewritten to the correct value after detecting an error, the related system starts, or the stroke amount/cam No. is switched.
However, the error detection signal and the low error code storage register are not reset.

(4) Control contents

(a) The feed position data of cam continues even if the mode is switched from virtual to real mode or vice versa.

(b) Backlash compensation is processed continuously at the set value of the fixed parameter even if real mode and virtual mode are changed.

(c) The upper/lower stroke limit check and the velocity limit value check are not executed.

8.5.2 Settings when creating cam data

The following explains the items set when creating cam data by using a peripheral device.

Table 8.5 Settings List When Creating Cam Data

	Setting Item	Default Value	Setting Range
1	Cam No.	—	1 to 64
2	Resolution	256	256, 512, 1024, 2048
3	Stroke amount and cam No. switching position	0	0 to (resolution – 1)
4	Control mode	Reciprocation cam mode	• Reciprocation cam mode • Feed cam mode
5	Cam data table	0	0 to 32767

(1) Cam No.
This is the number of cam data items.
Operation is controlled by the cam No. set with a sequence program.

(2) Resolution

(a) This is used to set the number of divisions of a cam curve in one cycle.

(b) The required time per cycle for outputting all point data that correspond to the resolution is as follows:

3.5 msec × (Setting resolution)

(3) Stroke amount and cam No. switching position

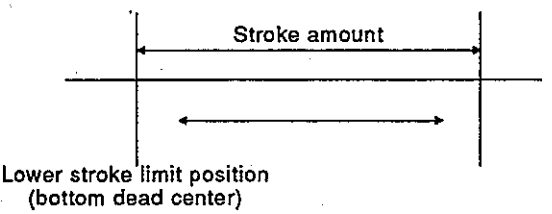
(a) This is the stroke amount switching position of stroke amount and cam No. during operation.

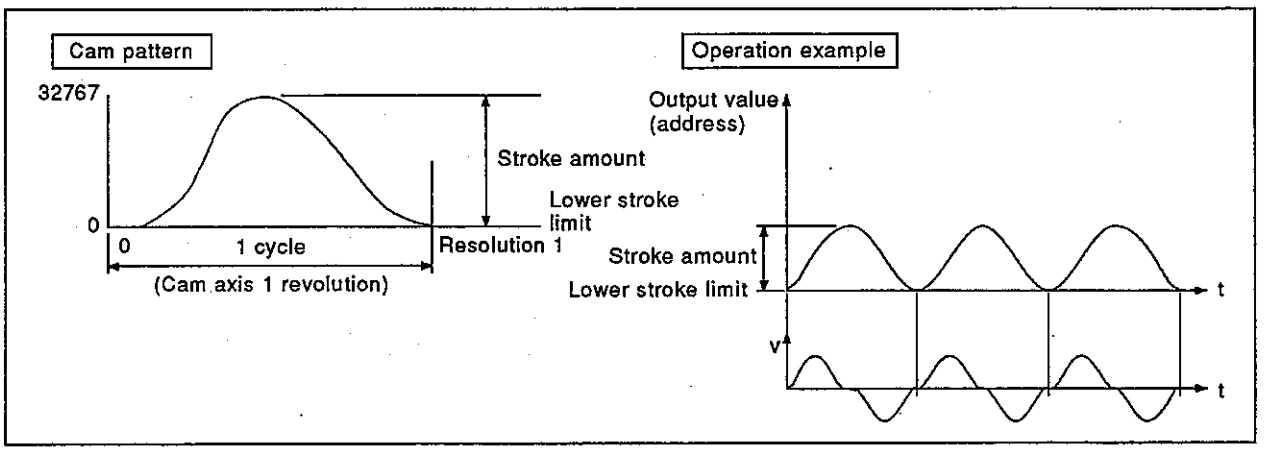
(b) If the stroke amount and cam No. are normal when the position data reaches the set switching position [0 to (resolution - 1)], they are switched to the set stroke amount and cam No.

(4) Control mode

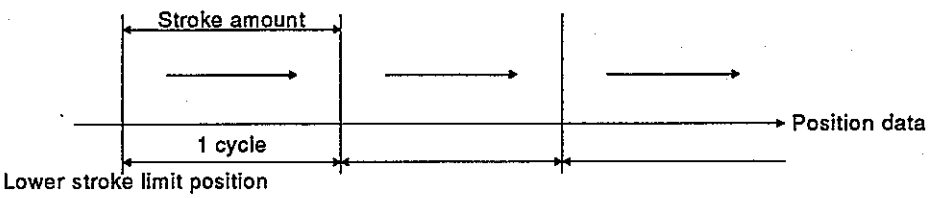
(a) This is either reciprocation cam mode or feed cam mode.

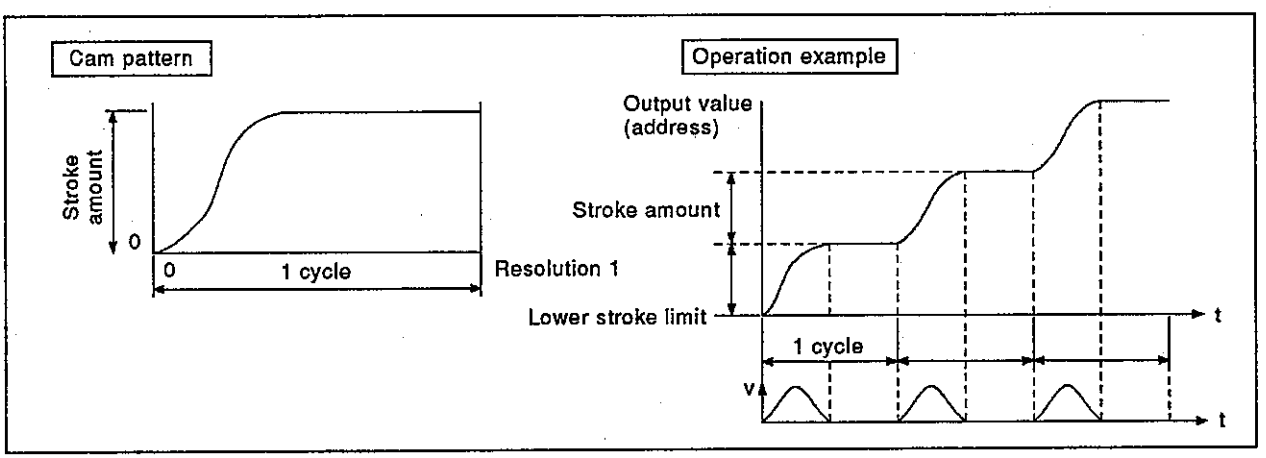
1) Reciprocation cam mode
Reciprocation operation in the range set by the stroke amount from the lower stroke limit position (bottom dead center) is continued.





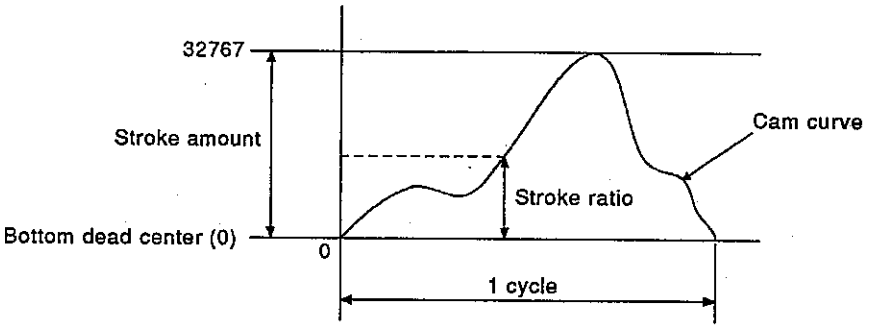
2) Feed cam mode
The lower stroke limit position (bottom dead center) is set as an operation position, and positioning is executed in the set direction in 1 cycle for the setting stroke amount.





(5) Cam data table

(a) This is the setting of the stroke ratio (value when the stroke amount is divided by 32767) of each point of a set resolution.



(b) The cam data table is generated automatically by creating a cam curve using a peripheral device.
The cam curves that can be used for the A373CPU are shown in Section 8.5.4.

8.5.3 Parameter list

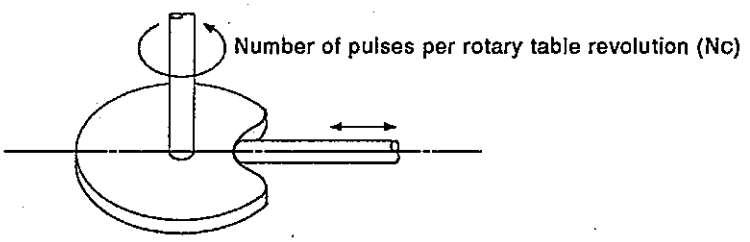
The cam parameter is shown in Table 8.6. Each item of Table 8.6 is explained in (1) to (9).

Table 8.6 Parameter List

No.	Setting Item	Default Value	Setting Range		
1	Output amplifier No. (see Section 8.1.1.)	0	1 to 6: AMP1 to AMP6 (ADU) 7 to 10: d1 to d4 (A344SF: first) 11 to 14: d5 to d8 (A344SF: second) } (MR-SB/SD)		
2	Number of pulses per rotary table revolution (Nc)	0	1 to 2147483647 (pulse)		
3	Use cam No.	0	1 to 64 (Max. 16/output module)		
4	Cam No. setting device	—	Word device		
5	Accumulated pulse allowable value	65535 (pulse)	1 to 65535 (pulse)		
6	Unit setting	mm	mm	inch	pulse
7	Stroke amount setting device	—	Word device		
8	Limit switch output	Unused	Used/unused		
9	Torque limit value setting device	—	– (300%) / word device		
10	Comment	None	32 characters		

(1) Number of pulses per rotary table revolution (Nc)

(a) This is the number of pulses required for 1 cam cycle.



(b) The setting of the number of pulses per cam axis revolution is not related to the travel distance per pulse (fixed parameter setting).

(2) Use cam No.

(a) This is the cam No. (cam data No.) to be used as the output module.

(b) Max. 16 use cam Nos. can be set in 1 output module.
However, only the cam No. with the same control mode (reciprocation cam/feed cam) can be set.
When the control mode is different, an error occurs when a relative check is executed by a peripheral device.

(c) Cam Nos. 1 to 64 can be set.

(3) Cam No. setting device (1 word)

(a) This is the device that is used to set control of an operation which uses the "use cam No." set by a sequence program.

(b) The following devices can be used as cam No. setting devices.

- Data register: D0 to D799
- Link register : W0 to W3FF

(c) When the cam No. is changed during operation, it is switched to the cam No. changed by the stroke amount set when creating the cam data and the cam No. switching position.

(4) Accumulated pulse allowable value

(a) This is the accumulated pulse allowable value of deviation counter.

(b) The deviation counter value is always checked. If the deviation counter value becomes larger than the allowable accumulated pulse value, the error detection signal (Xn7) turns ON.

(5) Unit setting

(a) This is the unit (mm/inch/pulse) for setting the cam.

(b) The units of axis at which cam is set must be the same as those (unit setting of a fixed parameter) in the real mode.

(6) Stroke amount setting device (2 words)

(a) This is the device that is used to set the cam stroke amount.

(b) The following devices can be used as stroke amount setting devices.

- Data register: D0 to D799
- Link register : W0 to W3FF

(c) Set the stroke amount in the following range.

Setting range
mm : Lower stroke limit + Stroke amount $\leq 2147483647 \times 10^{-1}$ μm
inch : Lower stroke limit + Stroke amount $\leq 2147483647 \times 10^{-5}$ inch
Pulse: Lower stroke limit + Stroke amount ≤ 2147483647 pulse

(7) Limit switch output

(a) This is the setting of use/unuse of limit switch output on the cam axis.

- Limit switch output use .....Limit switch output is executed on the basis of the real position data of the cam.
- Limit switch output unuse .....Limit switch output is not executed.

(8) Torque limit value setting device (1 word)

(a) This is the device that is used to set the torque limit value of the cam axis.
Torque restriction is executed at the value of a set device by device setting.
When a device is not set, torque restriction is executed at 300 %.

(b) The following devices can be used as torque limit setting devices.

- Data register: D0 to D799
- Link register : W0 to W3FF

(c) The torque limit value can be set in the range from 1 to 500 %.

(9) Comment

(a) Comments such as cam axis use are created.
Display is possible during monitoring by a peripheral device by creating a comment.

(b) Comment may be up to 32 characters long.

8.5.4 Cam curve list

The following shows the cam curves that can be used in virtual mode.

(1) Cam curve comparison
Table 8.7 shows the cam curve comparison.

Table 8.7 Cam Curve Comparison

Classification		Cam curve name	Shape of acceleration curve	Vm	Am	(A·V)m	(V·V)m	(S·V)m	Remark
Discontinuous curve		Uniform velocity		1.00			1.00	1.00	
		Uniform acceleration		2.00	± 4.00	± 8.00	4.00	1.09	
Both-side stationary curve	Symmetrical curve	Fifth order curve		1.88	± 5.77	± 6.69	3.52	1.19	
		Cycloid		2.00	± 6.28	± 8.16	4.00	1.26	
		Transformation trapezoid		2.00	± 4.89	± 8.09	4.00	1.20	Ta = 1/8
		Transformation sine		1.76	± 5.53	± 5.46	3.10	1.13	Ta = 1/8
		Transformation uniform velocity		1.28	± 8.01	± 5.73	1.63	1.07	Ta = 1/16 Ta = 1/4
	Asymmetrical curve	Trapecloid		2.18	± 6.17	± 10.84	4.76	1.28	m = 1
One-side stationary curve		Double chord		2.04	+ 5.55 − 9.87	+ 7.75 − 9.89	4.16	1.39	
Non-stationary curve		Single chord		1.57	± 4.93	± 3.88	2.47	1.02	

(2) Free-form curve
Cam curve can be created by using a free-form curve by spline interpolation.

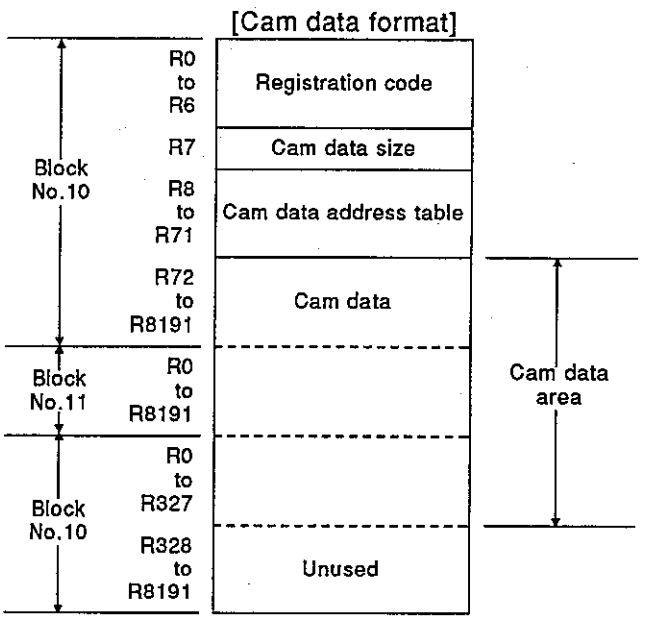
8.5.5 Creation of cam data by the user

The user can create cam data by the following 2 methods.
- PC/AT started by SW0IX-CAMPE
- Personal computer

(1) When creating cam data by using a PC/AT started up with SW0IX-CAMPE
Create cam data by creating the cam curve per cam revolution using the cam curves and free-form curve shown in Section 8.5.4.
SW0IX-GSV21PE/SW0IX-CAMPE Operating Manual explains the operation of the PC/AT started up with SW0IX-CAPME.

(2) When creating cam data by using a personal computer
Create cam data according to the cam data format of the extension file register area of the memory cassette to be stored in Nos. 10 to 12.

(a) Cam data format
The extension file register cam data format to be stored in Nos. 10 to 12 is shown in the figure below.



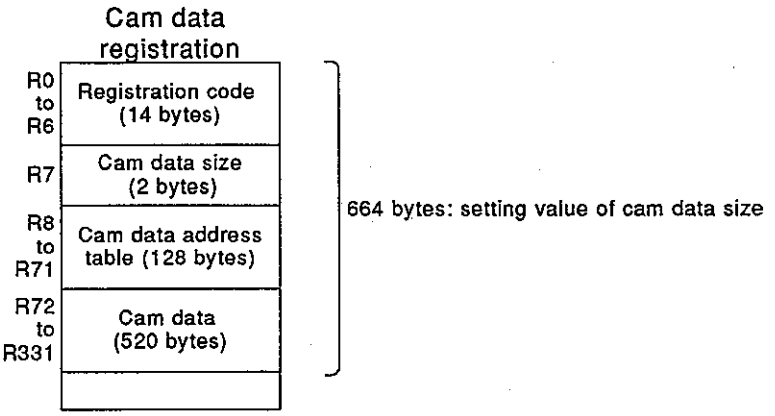
1) Registration code
This is used to indicate whether or not there is cam data stored.
For the registration code, store the following data in R0 to R6.

R0	00FFH
R1	11EEH
R2	22DDH
R3	33CCH
R4	44BBH
R5	55AAH
R6	6699H

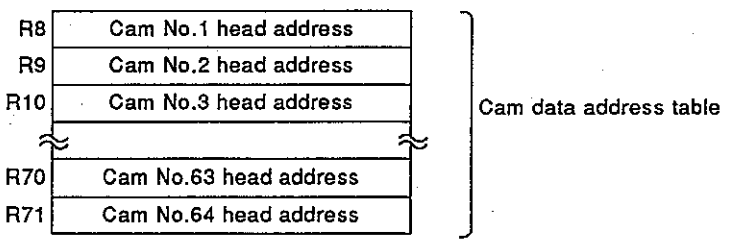
Registration code

2) Cam data size
This is the total length of an extension containing cam data.
Set the cam data size by converting the area from the block No. 10 R0 to the file register No. of the final data into bytes.
(File register 1 point = 2 bytes)

Example When the cam data of which resolution is 256 is stored, the cam data size is as follows.



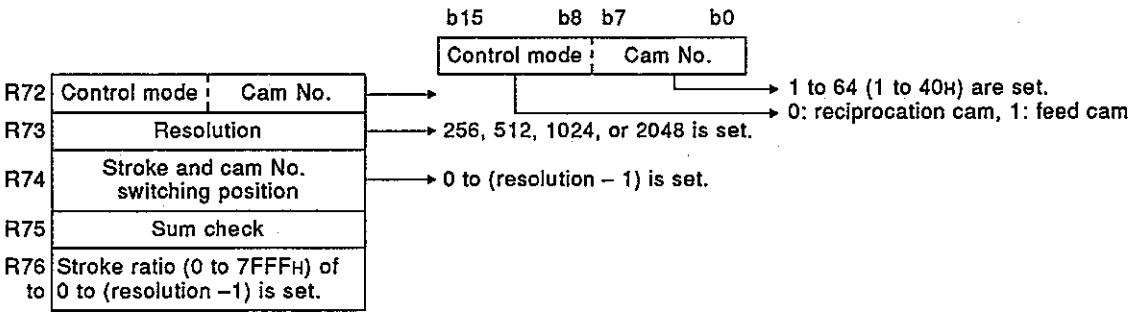
3) Cam data address table
This is the first address of cam data of cam Nos. 1 to 64.
Set by converting the first address of each cam No. into the number of bytes from the block No. 10 R0.
Set 0 at the first address of cam No. that has not been registered.



4) Cam data

a) This is the setting of cam data Nos. 1 to 64.
Cam data does not need to be stored in the order of cam number.

b) Set each cam data at the stroke ratio (integer) of 0 to 7FFFH(32767).
The point of 0 and 7FFFH(32767) is necessary for cam data.
Control mode, cam No. and stroke amount and cam No. switching position are stored in the head of cam data. (See Section 8.5.2.)



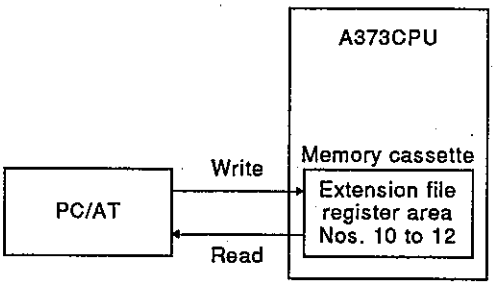
8.5.6 Changing cam data

The A373CPU's PCPU fetches cam data of the extension file register area of a memory cassette stored in register Nos. 10 to 12 and controls operation. These occur when the power supply is turned on or when the system is reset. Cam data fetched by the PCPU can be changed with a sequence program. Change cam data according to the following procedure.

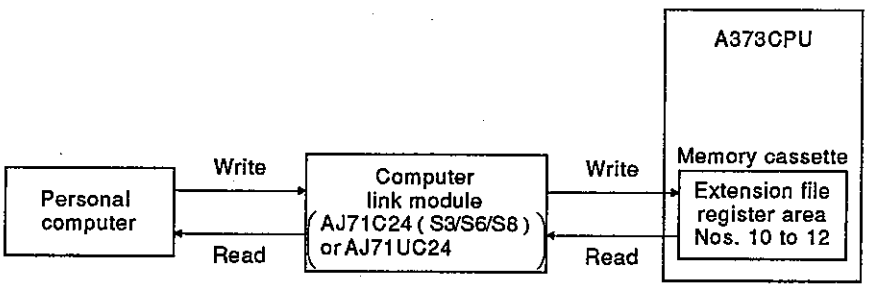
1) Write cam data to extension file register area Nos. 10 to 12.
↓
2) Switch from virtual mode to real mode.
↓
3) Make the cam data change request. (M2016: OFF → ON)
↓
4) Cam data change processing
↓
5) Reset cam data change request (M2016).
↓
6) Switch from real mode to virtual mode.

(1) Writing cam data to extension file register area Nos. 10 to 12
Cam data can be written by using a peripheral device or a personal computer.

(a) Writing with a peripheral device
Cam data is written in servo PC mode by a PC/AT started up with SW0IX-GSV21PE. For PC/AT operation, see A373CPU (P21/R21) Maintenance Manual.

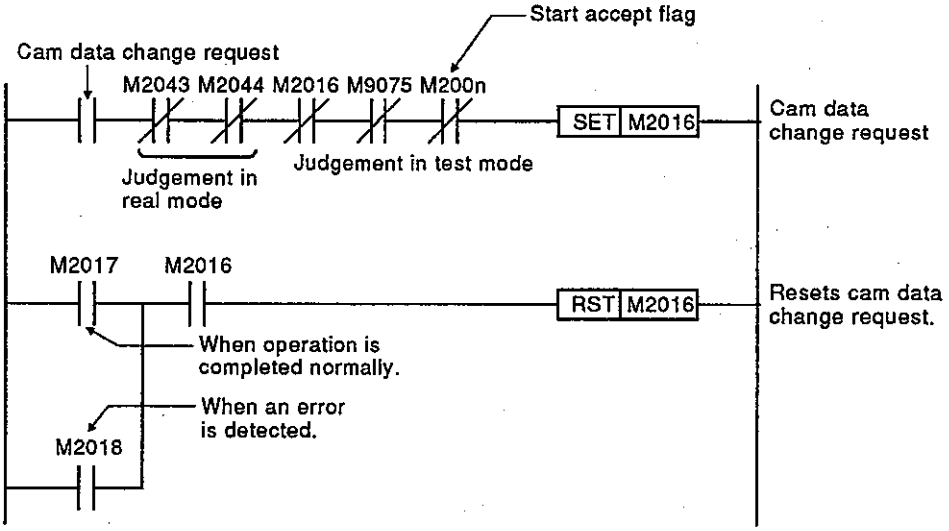


(b) Writing with a personal computer
Cam data stored in a personal computer is written to extension file register area Nos. 10 to 12 through a computer link.



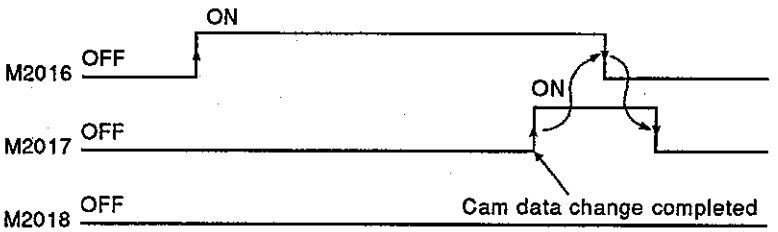
(2) Cam data change program
The following shows a sequence program which is used to write cam data stored in storage file register area Nos. 10 to 12 to PCPU.

[Sequence program]

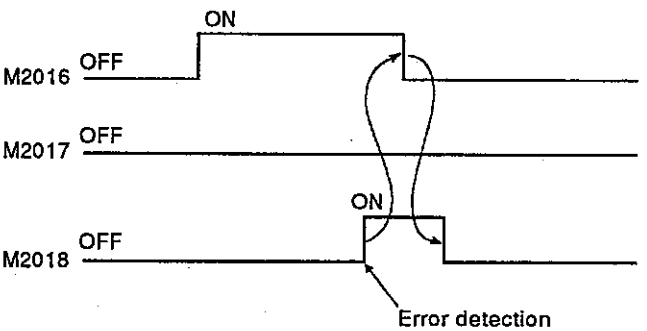


[Operation timing]

• Normal



• When an error is detected



(3) Precaution

(a) In test mode, cam data change requests from peripheral devices are invalid.
Provide In-test-mode(M9075) for the cam data change request program as an interlock.

(b) While cam data is being fetched into the PCPU (M2016: ON), the system cannot be switched from real mode to virtual mode.
Provide cam data change request flag (M2016) for the program for switching real to virtual mode as an interlock.

(c) While cam data is being fetched into the PCPU, a servo program cannot be started.
Provide cam data change request flag (M2016) for the servo program start request program as an interlock.

(d) During start up of a servo program, cam data change request (M2016: OFF → ON) is impossible.
Provide start accept flag (M2001 to M2008) for the cam data change request program as an interlock.

(4) Error factors
Errors which occur when cam data change requests (M2016: OFF → ON) are made as shown below.

(a) During cam data writing by using a peripheral device

(b) The extension file register area registration code Nos. 10 R0 to R6 are not normal.

(c) The cam data size of extension file register area No.10 R7 is outside the range 144 to 33434. Or it has an odd number of bytes.

8.6 Common Devices (I/O, data register)

This section explains I/O and data registers which are used for output module.

8.6.1 I/O

I/O points from X/Y0 to X/Y7F of A373CPU are used for output module.

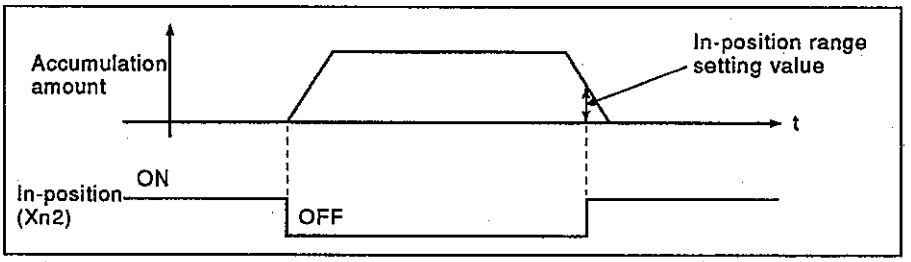
- Input (X0 to X7F)
  An input is data to be set in the PCPU or external input signal (FLS/RLS, STOP). These can be used to check the control status of each axis with a sequence program and to instruct the next positioning.
- Output (Y0 to Y7F)
  These are used to set an output with a sequence program and output positioning commands to the PCPU.

Table 8.8 I/O List

	Device								Signal		Roller	Ball Screw	Rotary Table	Cam
	Axis 1	Axis 2	Axis 3	Axis 4	Axis 5	Axis 6	Axis 7	Axis 8						
Input	X0	X10	X20	X30	X40	X50	X60	X70	Vacant (OFF)		—	—	—	—
	X1	X11	X21	X31	X41	X51	X61	X71						
	X2	X12	X22	X32	X42	X52	X62	X72	In-position		O	O	O	O
	X3	X13	X23	X33	X43	X53	X63	X73	Vacant (OFF)		—	—	—	—
	X4	X14	X24	X34	X44	X54	X64	X74						
	X5	X15	X25	X35	X45	X55	X65	X75						
	X6	X16	X26	X36	X46	X56	X66	X76	Zero pass		O	O	O	O
	X7	X17	X27	X37	X47	X57	X67	X77	Error detection		O	O	O	O
	X8	X18	X28	X38	X48	X58	X68	X78	Servo error detection		O	O	O	O
	X9	X19	X29	X39	X49	X59	X69	X79	Zero return request		O	O	O	O
	XA	X1A	X2A	X3A	X4A	X5A	X6A	X7A	Zero return completed		O	O	O	O
	XB	X1B	X2B	X3B	X4B	X5B	X6B	X7B	External signal	FLS	O	O	O	O
	XC	X1C	X2C	X3C	X4C	X5C	X6C	X7C		RLS	O	O	O	O
	XD	X1D	X2D	X3D	X4D	X5D	X6D	X7D		STOP	O	O	O	O
	XE	X1E	X2E	X3E	X4E	X5E	X6E	X7E		DOG/CHANGE	O	O	O	O
	XF	X1F	X2F	X3F	X4F	X5F	X6F	X7F	Servo ON/OFF state		O	O	O	O
Output	Y0	Y10	Y20	Y30	Y40	Y50	Y60	Y70	Vacant		—	—	—	—
	Y1	Y11	Y21	Y31	Y41	Y51	Y61	Y71						
	Y2	Y12	Y22	Y32	Y42	Y52	Y62	Y72						
	Y3	Y13	Y23	Y33	Y43	Y53	Y63	Y73						
	Y4	Y14	Y24	Y34	Y44	Y54	Y64	Y74						
	Y5	Y15	Y25	Y35	Y45	Y55	Y65	Y75						
	Y6	Y16	Y26	Y36	Y46	Y56	Y66	Y76	Limit switch output enable			O	O	O
	Y7	Y17	Y27	Y37	Y47	Y57	Y67	Y77	Error reset		O	O	O	O
	Y8	Y18	Y28	Y38	Y48	Y58	Y68	Y78	Vacant		—	—	—	—
	Y9	Y19	Y29	Y39	Y49	Y59	Y69	Y79						
	YA	Y1A	Y2A	Y3A	Y4A	Y5A	Y6A	Y7A						
	YB	Y1B	Y2B	Y3B	Y4B	Y5B	Y6B	Y7B						
	YC	Y1C	Y2C	Y3C	Y4C	Y5C	Y6C	Y7C						
	YD	Y1D	Y2D	Y3D	Y4D	Y5D	Y6D	Y7D						
	YE	Y1E	Y2E	Y3E	Y4E	Y5E	Y6E	Y7E	Cam reference position setting		—	—	—	O
	YF	Y1F	Y2F	Y3F	Y4F	Y5F	Y6F	Y7F	Servo OFF		O	O	O	O

(1) In-position signal (Xn2)

(a) This signal is turned ON when the deviation counter accumulation amount has become smaller than the "in-position range" set with the servo parameters.
This signal is turned OFF at the beginning of start operation.



(b) An in-position check is executed in the following cases:

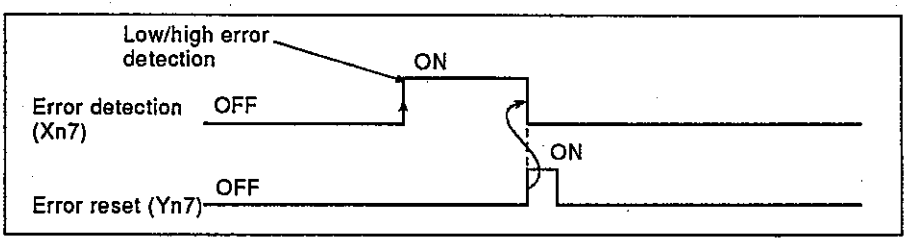
1) The servo power supply was turned ON.
2) After automatic deceleration starts during positioning control
3) After deceleration starts because the JOG start signal is turned OFF
4) During manual pulse generator operation
5) After near-zero-point DOG turns ON during zero return
6) After deceleration starts in response to a stop command

(2) Zero pass signal (Xn6)
This signal is turned ON when current position data passes zero after turning on the power supply of a servo amplifier.
Once it passes zero, it remains ON until a CPU is reset.

(3) Error detection signal (Xn7)

(a) An error detection signal is turned ON when a high error or low error is found. Existence of an error can be identified by the ON/OFF of an error detection signal.
When a low error is detected, corresponding error code *1 is stored to low error code storage area. (See Section 8.6.2.)
When a high error is detected, corresponding error code *1 is stored to high error code storage area. (See Section 8.6.2.)

(b) If an error reset signal (Yn7) is turned ON, this signal turns OFF.



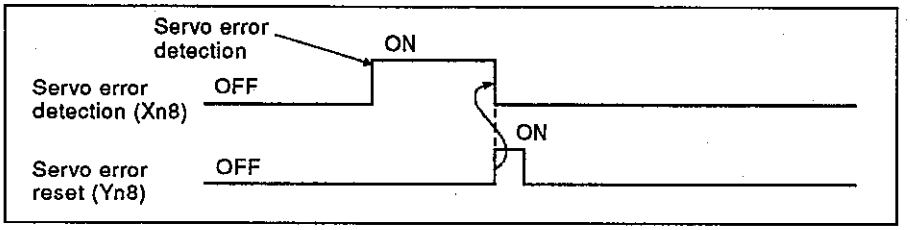
REMARK

1) *1: Section 10.5 gives details of low/high error code.

(4) Servo error detection signal (Xn8)

(a) This signal is turned ON when an error (except a warning error or an emergency stop) is detected on the servo amplifier side. Existence of an error can be identified by the ON/OFF of a servo error detection signal.
When an error is detected on the servo amplifier side, a corresponding error code is stored in the servo error code *1 storage area.

(b) This signal is turned OFF by turning ON the servo error reset signal (Yn8) and turning on the servo power supply again.



(5) Zero return request signal (Xn9)
This signal turns ON when it is necessary to check a zero point address when the power supply is turned on or during positioning control.

(a) When an absolute value system is not used

1) The zero return request signal turns ON in the following cases:
a) When the power supply is turned on or when the A373CPU is reset
b) During zero return
2) The zero return request signal turns OFF when zero return is completed.

(b) When an absolute value system is used

1) The zero return request signal turns ON in the following cases:
a) During zero return
b) When a sum check error of back up data (reference value) occurs (when the power is turned on)
2) The zero return request signal turns OFF when zero return is completed.

REMARK

1) *1: Section 10.4 gives details of the error codes of errors detected on the servo amplifier side.

(6) Zero return-completed signal (XnA)

(a) This signal is turned ON when zero return with a servo program is completed normally.

(b) This signal is turned OFF when positioning starts, when JOG operation starts or when the manual pulse generator operation starts.

(c) If zero return is executed by a servo program when the zero return-completed signal is ON, a continuous zero return start error occurs, and zero return start is not executed.

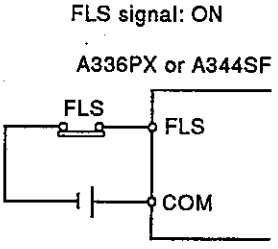
(7) FLS signal (XnB)

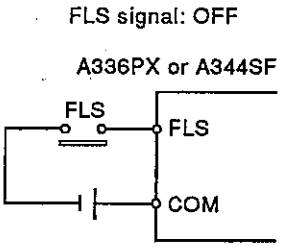
(a) This signal is controlled by turning ON/OFF the upper limit switch input (FLS) to the A336PX, A344SF.

(a) When the upper limit switch input is OFF .....FLS signal: ON

(b) When the upper limit switch input is ON .....FLS signal: OFF

(b) The following shows the state of the upper limit switch (FLS) when the FLS signal is ON/OFF.





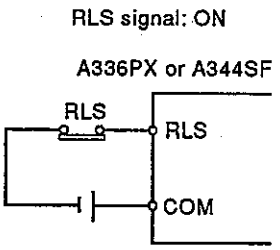
(8) RLS signal (XnC)

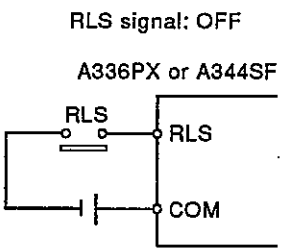
(a) This signal is controlled by turning ON/OFF the lower limit switch input (FLS) to the A336PX, A344SF.

(a) When the lower limit switch input is OFF.....RLS signal: ON

(b) When the lower limit switch input is ON.....RLS signal: OFF

(b) The following shows the state of the lower limit switch (RLS) when the RLS signal is ON/OFF.





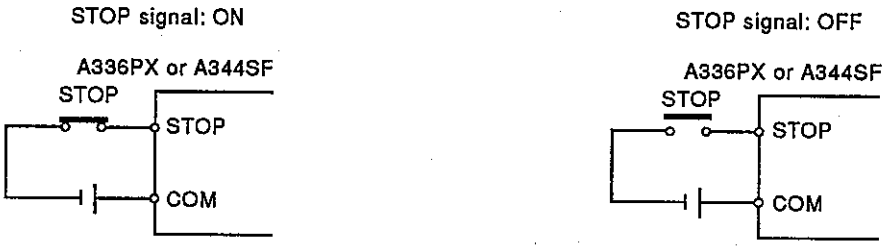
(9) STOP signal (XnD)

(a) This signal is controlled by turning ON/OFF the stop signal (STOP) to the A336PX, A344SF.

(a) When the stop signal is OFF ..... STOP signal: ON

(b) When the stop signal is ON ..... STOP signal: OFF

(b) The following shows the state of the external stop switch (STOP) when the STOP signal is ON/OFF.



(10) DOG/CHANGE signal (XnE)

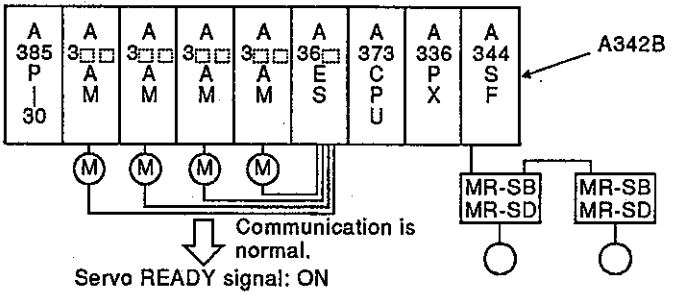
(a) This signal is controlled by turning ON/OFF the velocity-position control switching input (DOG/CHANGE) to the A336PX, A344SF.
  (a) When the velocity-position switching input is OFF
  .....DOG/CHANGE signal: OFF
  (b) When the velocity-position switching input is ON
  .....DOG/CHANGE signal: ON

(b) The following shows the state of the velocity change switch (DOG/CHANGE) when the DOG/CHANGE signal is ON/OFF.

(11) Servo READY signal (XnF)

(a) This signal is turned ON when the servo amplifier connected to each axis is in the READY state.

(b) This signal is turned OFF in the following cases:
  1) A servo amplifier is unloaded.
  2) A servo parameter is not set.
  3) An external emergency stop input to the power supply module is turned ON.
  4) YnF was turned ON, and a servo was turned OFF.
  5) A servo error occurred. (Section 15.4 Servo Errors gives details.)



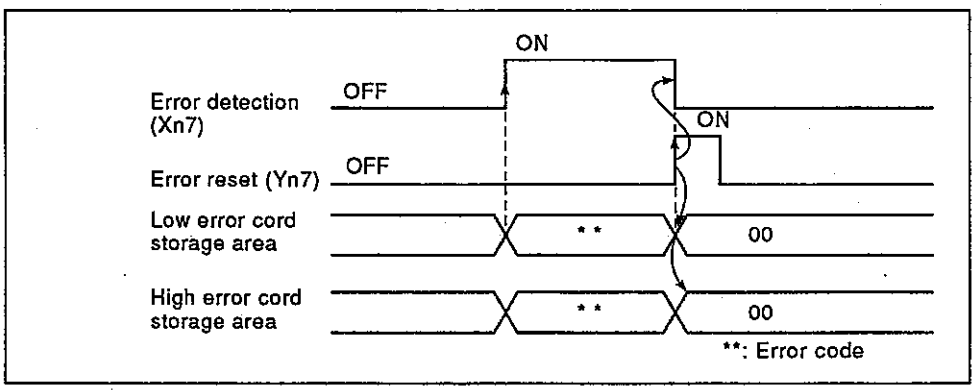
POINT

When servo for any axes used for the AC motor drive module is turned OFF, servo for all axes is turned OFF. And when servo for axis used for MR-SB/SD is turned OFF, servo for corresponding axis is turned OFF.

(12) Limit switch output enable command (Yn6)
This signal is used to enable limit switch output.

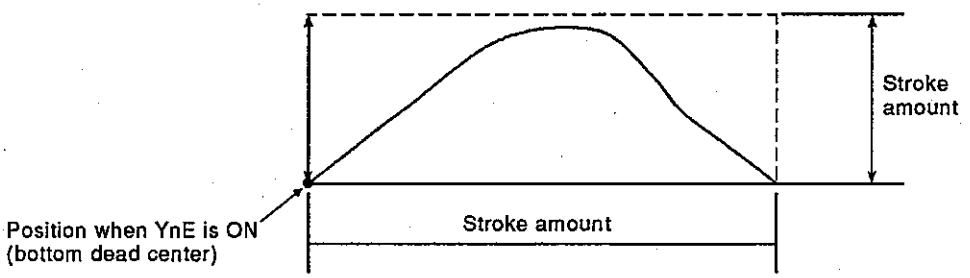
1) ON .....ON/OFF pattern of the limit switch output can be output from AY42.
2) OFF .....The limit switch output from AY42 goes OFF.

(13) Error reset command (Yn7) *
An error reset command is used to clear the low error code storage area and the high error code storage area for a drive module of the axis with which a servo error is found and to reset a servo error detection signal.



(14) Cam reference position setting signal (YnE)
Valid only when the output module is a cam.

(a) This signal is used to set the standard position (bottom dead center and 1 cycle start position) of cam operation.
After moving to the bottom dead center position in real mode and turning ON YnE, switch real mode to virtual mode.



(b) If real mode is switched to virtual mode when YnE is OFF, operation is continued at the last bottom dead center position.

POINT

After starting up the system and adjusting the position to the bottom dead center, turn ON YnE only after first switching real mode to virtual mode.
When bottom dead center is set, operation can be continued by switching real mode to virtual mode if YnE is OFF.
(The bottom dead center position is backed up even if virtual mode is switched to real mode.)

(15) Servo OFF command (YnF)
This command is used to execute servo OFF (free RUN state).

1) YnF: OFF .....servo ON
2) YnF: ON .....servo OFF (free RUN state)
This is invalid during positioning. Execute servo OFF command after positioning is completed.

IMPORTANT

The servo motor may only be turned by hand, after turning OFF the servo power supply.
When M2042 is turned ON after the servo motor is manually turned when A373CPU's M2000 and M2042 are OFF and the power to the servo is ON, the servo motor turns rapidly the number of revolutions made manually.

8.6.2 Data registers

For drive modules, data registers D760 to D959 of an A373CPU are used.

Table 8.9 Data Registers List

Device								Data Register	Roller	Ball Screw	Rotary Table	Cam
Axis 1	Axis 2	Axis 3	Axis 4	Axis 5	Axis 6	Axis 7	Axis 8					
D760	D765	D770	D775	D780	D785	D790	D795	Execution cam No.	—	—	—	O
D761	D766	D771	D776	D781	D786	D791	D796	Execution stroke amount	—	—	—	O
D762	D767	D772	D777	D782	D787	D792	D797					
D763	D768	D773	D778	D783	D788	D793	D798	Position data in 1 cam axis revolution	—	—	—	O
D764	D769	D774	D779	D784	D789	D794	D799					
D800	D820	D840	D860	D880	D900	D920	D940	Roller peripheral velocity	O	—	—	—
D801	D821	D841	D861	D881	D901	D921	D941					
D800	D820	D840	D860	D880	D900	D920	D940	Feed position data	—	O	O	O
D801	D821	D841	D861	D881	D901	D921	D941					
D802	D822	D842	D862	D882	D902	D922	D942	Actual position data	—	O	O	O
D803	D823	D843	D863	D883	D903	D923	D943					
D804	D824	D844	D864	D884	D904	D924	D944	Deviation counter value	O	O	O	O
D805	D825	D845	D865	D885	D905	D925	D945					
D806	D826	D846	D866	D886	D906	D926	D946	Low error code	O	O	O	O
D807	D827	D847	D867	D887	D907	D927	D947	High error code	O	O	O	O
D808	D828	D848	D868	D888	D908	D928	D948	Servo error code	O	O	O	O
D809	D829	D849	D869	D889	D909	D929	D949	(Travel distance after DOG/ CHANGE is turned ON)	Data in real mode is held.			
D810	D830	D850	D870	D890	D910	D930	D950					
D811	D831	D851	D871	D891	D911	D931	D951	(Zero return re-travel distance)				
D812	D832	D852	D872	D892	D912	D932	D952	(Execution program No.)	No change from 0			
D813	D833	D853	D873	D893	D913	D933	D953	(M code)				
D814	D834	D854	D874	D894	D914	D934	D954	Torque limit value	O	O	O	O
D815	D835	D855	D875	D895	D915	D935	D955	(Travel distance change register)	Ignored			
D816	D836	D856	D876	D896	D916	D936	D956					
D817	D837	D857	D877	D897	D917	D937	D957	(Actual position data when STOP is input)	Data in real mode is held.			
D818	D838	D858	D878	D898	D918	D938	D958					
D819	D839	D859	D879	D899	D919	D939	D959	Vacant	—			

POINT

The storage of data to the monitoring data area (other than M code and travel distance change register) is delayed at the times shown below in accordance with the ON/OFF state of the positioning device (input, internal relay, or special relay).

(a) When the scan time of a sequence program is 80 msec or less ..... 80 msec

(b) When the scan time of a sequence program exceeds 80 msec ..... 1 scan time

(1) Execution cam No. storage register ..... Signal from PCPU to SCPU

(a) The currently controlled cam No. is stored in binary in the execution cam No. storage register.
Cam No. is updated by END processing of a sequence program.

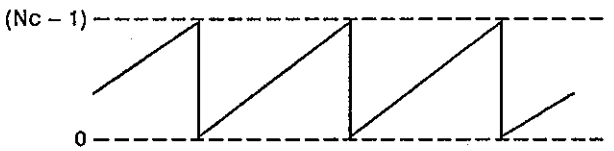
(b) The cam No. in execution cam No. storage register is saved until the following cam is executed.
(The cam No. is not cleared even if cam control is completed.)

(2) Execution stroke amount storage register ..... Signal from PCPU to SCPU

(a) The currently controlled stroke amount is stored in binary.
Stroke amount is updated by END processing of a sequence program.

(3) Position data in 1 cam axis revolution storage register
..... Signal from PCPU to SCPU

(a) The position within the number of pulses per cam revolution is stored.
Position data is ring addresses of 0 to [number of pulses per cam axis revolution (Nc) – 1].



Position data is updated by END processing of a sequence program.

(4) Roller peripheral velocity storage register ..... Signal from PCPU to SCPU

(a) Roller peripheral velocity is stored.
The roller peripheral velocity is updated by the END processing of a sequence program.
The peripheral velocity is stored in the roller peripheral velocity storage register in the following range.

Setting Unit	Storage Range	Actual Roller Peripheral Velocity
mm	1 to 600000000	0.01 to 6000000.00 mm/min
inch		0.001 to 600000.000 inch/min

(5) Feed position data storage register ..... Signal from PCPU to SCPU

(a) The target addresses output to servo amplifier are stored to these registers according to the positioning addresses and movement amount designated by a servo program.

(b) A stroke range check is executed by using this feed position data.

(6) Actual position data storage register ..... Signal from PCPU to SCPU

(a) Position data (feed position data – deviation counter accumulation amount) that actually moved is stored.

1) The travel distance from 0 is stored after starting by fixed-rate feed control.
2) The position data is stored from the address at the time of starting by velocity-position switching control.
3) 0 is stored during the velocity control.

(b) Feed position data is equal to the actual position data in the stop state.

(7) Deviation counter value storage register ..... Signal from PCPU to SCPU
The difference between feed position data and actual position data is stored.

(8) Low error code storage register ..... Signal from PCPU to SCPU

(a) When a low error is generated, corresponding error code (Section 10.5) is stored.
When another low error is generated after an error code is stored, a new error code is written over the old one.

(b) Use an error reset command (Yn7) to clear a low error code.

(9) High error code storage register ..... Signal from PCPU to SCPU

(a) When a high error is generated, corresponding error code (Section 10.5) is stored.
When another high error is generated after an error code is stored, a new error code is written over the old one.

(b) Use an error reset command (Yn7) to clear a high error code.

(10) Servo error code storage register ..... Signal from PCPU to SCPU

(a) When a servo error is generated, corresponding error code (Section 10.4) is stored.
When another high error is generated after an error code is stored, a new error code is written over the old one.

(b) Use a servo error reset command (Yn8) to clear a servo error code.

(11) Torque limit value storage register ..... Signal from PCPU to SCPU
The torque limit value that controls the servo is stored.
300 % is stored when the servo power supply is turned on or at the time of the leading edge of PC READY (M2000).

9. REAL MODE/VIRTUAL MODE SWITCHING

This section explains the check contents when switching real mode and virtual mode, and the switching method.

(1) Switching of real mode and virtual mode
Real mode and virtual mode are switched by the ON/OFF of M2043 (virtual real mode/mode switching request flag).

- When switching to real mode ..... M2043: OFF
- When switching to virtual mode ..... M2043: ON

(2) Confirmation of real mode and virtual mode
The control mode executed at present (real mode or virtual mode) can be checked by an ON/OFF of M2044 (virtual real mode/mode status).

- M2044: OFF ..... Real mode
- M2044: OFF ..... Virtual mode

9.1 Switching from Real Mode to Virtual Mode

When the switching request (M2043: OFF - ON) from real mode to virtual mode is made, the following checks are executed.

- Check whether switching to virtual mode is possible ....See Table 9.1.
- Output module check .....See Table 9.2.
- Synchronous encoder axis check .....See Table 9.3.

When switching real mode to virtual mode, confirm the check items of Tables 9.1 to 9.3, and switch in the normal state.

(1) Check whether switching to virtual mode is possible

(a) This checks whether or not switching to virtual mode is possible, and all items in Table 9.1 are checked.
When all items in Table 9.1 are normal, real mode is switched to virtual mode.

(b) When any of the items in Table 9.1 has an error, M9045*1 is turned ON, and an error code is stored in D9195*1.
Section 10.6 gives details of error codes to be stored in D9195.

REMARK

1) *1: The names of M9045 and D9195 are as follows.
- M9045 .... Real mode/virtual mode switching error detection flag
- M9046 .... Real mode/virtual mode switching error information storage register

Table 9.1 Check Item List When Switching from Virtual Mode to Real Mode

Check Order	Check Contents	Output Module to be Checked				Condition at Normal	Condition at Error
		Roller	Ball Screw	Rotary Table	Cam		
1.	• Are PC READY flag (M2000) and PCPU READY-completed flag (M9074) ON?	O	O	O	O	ON	OFF
2.	• Have all axes stopped? (Are M2001 to M2008 OFF?)	O	O	O	O	All axes stop	ON with on axis
3.	• Is cam data being changed by a sequence program?	O	O	O	O	Not changed	Changed
4.	• Has a mechanical system program been registered?	O	O	O	O	Registered	Not registered
	• Does axis No. set in the system agree with the output axis set by a mechanical system program?	O	O	O	O	Agree	Disagree
5.	• Is the all-axis servo ON command (M2042) ON?	O	O	O	O	ON	OFF
6.	• Is the axis used for the amplifier unit executing servo start-up processing by error reset?	O	O	O	O	Servo start completion	During servo start processing
7.	• Is the external encoder normal?	O	O	O	O	Normal	Error
8.	• Has an external emergency stop (EMG) been input?	O	O	O	O	Not input	During input
9.	• Is all-axis servo error detection (Xn8) ON?	O	O	O	O	OFF	ON with on axis
10.	• Is all-axis zero return request (Xn9) ON?	—	O	O	O	OFF	ON with on axis
11.	• Does the unit set in the fixed parameter match with the unit set in the output module?	—	O	O	O	Match	Mismatch
12.	• Has cam data been registered?	—	—	—	O	Registered	Not registered
13.	• Is the use cam No. set at a cam parameter?	—	—	—	O	Set	Not set
	• Has cam data of the cam No. set at the cam parameter been registered?					Registered	Not registered
14.	• Is the cam No. set at the cam No. setting device set in the cam parameter?	—	—	—	O	Set	Not set
	• Is the set cam NO. set at "use cam No."?	—	—	—	O	In range	Out of range
15.	• Is the stroke amount (1 to ($2^{31}-1$)) set at the stroke amount setting device also set in the cam parameter?	—	—	—	O	Set	Not set

(2) Output module check

(a) The items of Table 9.2 are checked by determining the state of the output module.
It is possible to switch to virtual mode even if an error is detected. However, the cause of the error can be modified only in real mode. Therefore, correct the error after switching to real mode again.

(b) When an error is detected, the error detection signal (Xn7) of the corresponding output module is turned ON, and an error code is stored in the low error/high error code storage register.

Table 9.2 Output Module Check Item List

	Check Contents	Output Module to be Checked				Condition at Normal	Condition at Error
		Roller	Ball Screw	Rotary Table	Cam		
1.	• Is the feed position data within the stroke limit range?	—	O	O	—	In range	Out of range
	• Is the feed position data in the range from the stroke amount lower limit to the stroke amount?	—	—	—	O		
2.	• Does the lower stroke limit + stroke amount exceed $2^{31}-1$ in reciprocation cam mode?	—	—	—	O	$2^{31}-1$ or less	More than $2^{31}-1$
3.	• When a clutch for which drive module is connected by using a synchronous encoder is set to external input mode, whether or not a same device is used for clutch ON/OFF is checked.	O	O	O	O	Same device	Several devices
	• Is a servo input module A336PX?	O	O	O	O	A336PX	A336EX
4.	• Is an output module whose virtual main shaft or virtual aux. input axis is set to "no clutch" or "clutch ON command" set to servo ON (XnF is ON)?	O	O	O	O	ON	OFF
	• Is external input signal "STOP" of an output module whose main shaft or aux. input axis is set to "no clutch" or "clutch ON command" turned OFF?	O	O	O	O	OFF	ON
5.	• Can position data in 1 cam axis revolution be calculated in reciprocation cam mode?	—	—	—	O	Normal	Error

(3) Synchronous encoder axis check item

(a) The items of Table 9.3 are checked by determining the state of the synchronous encoder.
It is possible to switch to virtual mode even if an error is detected. However, the cause of the error can be modified only in real mode. Therefore, correct the error after switching to real mode again.

(b) When an error is detected, the error detection signal (Xn7) of the corresponding output module is turned ON, and an error code is stored in the low error/high error code storage register.

Table 9.3 Synchronous Encoder Axis Check Item List

Check Order	Check Contents	Module to be Checked		Condition at Normal	Condition at Error
		External Synchronous Encoder	Output Module		
1.	• Is a synchronous encoder connected to A336EX?	O	—	Connected	Not connected Cable disconnection

9.2 Switching from Virtual Mode to Real Mode

Virtual mode is switched to real mode by the user or OS.

- Switching by the user — Turn OFF M2043.
- Switching by OS — When an error is detected, virtual mode is switched automatically.

9.2.1 Switching from virtual mode to real mode by the user

(1) When a request (M2043: ON → OFF) for switching from virtual mode to real mode is made, Table 9.4 is checked.
Then, switching to real mode is executed when the result of the check is normal.

(2) When an error is detected, M2045 is turned ON, and an error code is stored in D9195*1. (See Section 10.6.)

Table 9.4 Check Item List When Switching from Virtual Mode to Real Mode

Check Order	Check Contents	Condition at Normal	Condition at Error
1	Have all axes stopped? (Are M2001 to 2008 OFF?)	OFF	ON with on axis

9.2.2 Switching from virtual mode to real mode by OS

(1) If any of the following items are detected in virtual mode, the OS switches from virtual mode to real mode.

(a) Input of external emergency stop (EMG)

(b) Servo error detection signal (Xn8) is turned ON for any axis.

(c) PC READY (M2000) is turned OFF.

(2) When virtual mode is returned to real mode, an error code is stored in D9195. However, M2045 is not turned ON.

REMARK

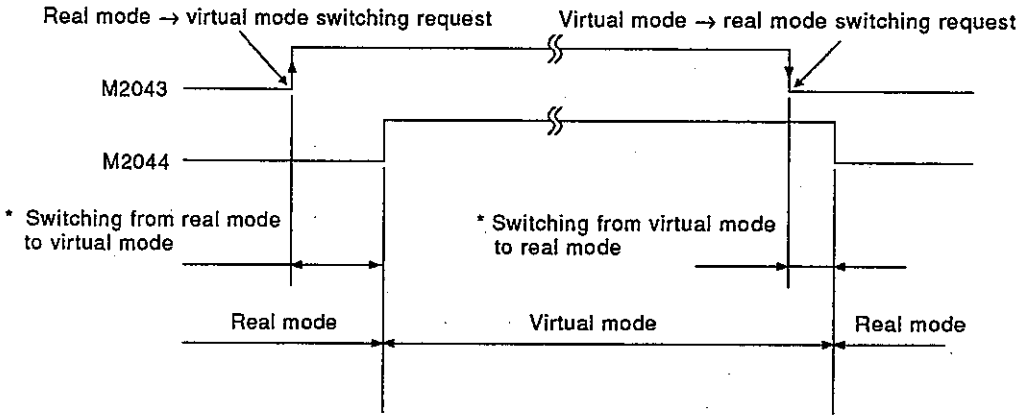
1) *1: The names of M9045 and D9195 are as follows.
- M9045 .... Real mode/virtual mode switching error detection flag
- M9195 .... Real mode/virtual mode switching error information storage register

9.3 Precautions On Switching Real Mode/Virtual Mode

The following explains the precautions when switching from real mode to virtual mode or vice versa.

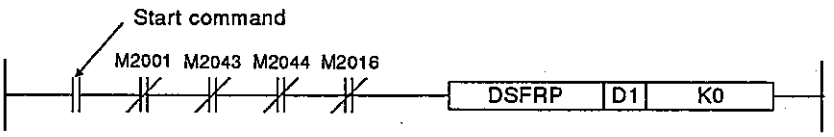
(1) Execution of DSFRP and DSFLP instructions is impossible during mode switching
If DSFRP and DSFLP instructions are executed during the switching from real mode to virtual mode or vice versa (at "*" part in the timing chart), an error occurs at start.
When DSFRP and DSFLP instructions are executed, use M2043 and M2044 as interlocks.

[Timing chart]

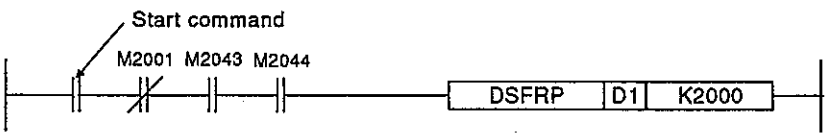


[Program example]

(a) Servo program start request in real mode



(b) Servo program start request in virtual mode



REMARKS

1) The following manual gives details of DSFRP and DSFLP instructions.
- ACPU Programming Manual (Common instructions)

2) The names of M2043, M2044 and M2016 are as follows.
- M2043 .... Real mode/virtual mode switching request flag
- M2044 .... Real mode/virtual mode status flag

(See Section 4.2.)

- M2016 .... Cam data change request flag (See Sections 4.2 and 8.5.6.)

(2) Processing of M2043 in test mode by using a peripheral device
The ON/OFF switching (real mode/virtual mode switching request) of M2043 is ignored in test mode by using a peripheral device.

Real mode/virtual mode can be switched in test mode by using a peripheral device.
M2044 is turned ON/OFF by real/virtual mode switching.

REMARK

A check same as that executed at M2043 OFF → ON/ON → OFF switching is executed also at real/virtual mode switching by a peripheral device. (See Sections 9.1 and 9.2.)

10. ERROR CODES STORED TO PCPU

Servo program setting errors, positioning errors and control mode switching errors are detected on the PCPU side.

(1) Servo program setting error
A servo program setting error is an error in the positioning data set by a servo program, and it is checked when each servo program is started up.
If positioning data is designated indirectly, an error occurs.
If an error occurs, the following processing is performed.

1) The servo program setting error flag (M9079) is turned ON.

2) The error occurrence program is stored to the error program number storage register (D9189).

3) The error code is stored to the error item information storage register (D9190).

(2) Positioning error

(a) A positioning error is an error that occurs when positioning is started up or during start up, and can be a low error, a high error and a servo error.

1) Low error .....This is an error with a PC program or a servo program. The drive module uses error codes 1 to 999. The output module uses error codes 4000 to 6990. Remove the cause of error by checking the error code and modifying the sequence and servo programs.

2) High error .....This is an error of the external input signal or the control command from the SCPU. The drive module uses error codes 1000 to 1999. The output module uses error codes 10000 to 11990. Check the error code, and remove the cause of the external input signal or sequence program error.

3) Servo error ...This is an error detected by a servo amplifier. Error codes 2000 to 2999 are used. Check the error code, and remove the cause of error on the servo side.

		Error Code Storage Registers	
Error Category	Classification	Drive module	Output module
Low error	Setting data	1 to 99	4000 to 4990
	At start-up	100 to 199	5000 to 5990
	During start-up	200 to 299	6000 to 6990
	During control change	300 to 399	—
High error	At start-up	1000 to 1099	10000 to 10990
	During start-up	1100 to 1199	11000 to 11990
	Absolute value	1200 to 1299	—
	System	1300 to 1399	—
Servo error	Servo amplifier	—	2000 to 2999 (2100 and after are for warning.)

(b) If an error occurs, the error detection signal of the axis where the error occurred turns ON. Then, the error code is stored in the low error code, high error code, or servo error code storage register.

		Error Code Storage Resister								Error Detection Signal	Error Reset Flag
		Axis 1	Axis 2	Axis 3	Axis 4	Axis 5	Axis 6	Axis 7	Axis 8		
Virtual servo motor	Low error code	D702	D708	D714	D720	D726	D732	D738	D744	X1n7	Y1n7
	High error code	D703	D709	D715	D721	D727	D733	D739	D745		
Synchronous encoder	Low error code	D750	D754	D758						X0E0 to X0E2	Y0E0 to Y0E2
	High error code	D751	D755	D759							
Output module	Low error code	D806	D826	D846	D866	D886	D906	D926	D946	X0n7	Y0n7
	High error code	D807	D827	D847	D867	D887	D907	D927	D947		
	Servo error code	D808	D828	D848	D868	D888	D908	D928	D948	X0n8	Y0n8

(c) When other errors occur, the latest error code overwrites the previous on.
However, the error history can be checked by using a peripheral device (PC/AT started up with SW0IX-GSV21PE).

(d) The error detection flag and the error code are maintained until the error reset signal or the servo error reset signal turns ON.

POINTS

(1) Even if a servo error is reset (Xn8: ON) when a servo error occurs, the same servo error code is sometimes stored again.

(2) If a servo error occurs, reset the servo error after removing the cause of error on the servo side.

(3) Error when switching between real mode/virtual mode
An error at the time of switching between real mode/virtual mode is checked when real mode/virtual mode switching request flag (M2043) is changed.
If an error is detected by the check described in Sections 9.1 and 9.2, the following processing is performed.

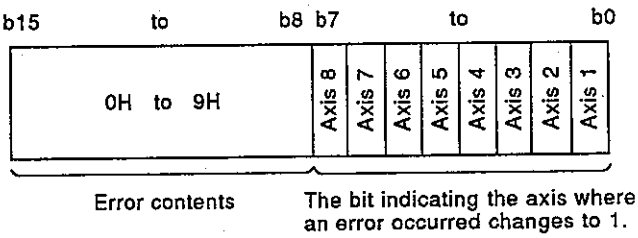
1) Real mode/virtual mode is not switched, and the present mode is kept.

2) The real mode/virtual mode switching error detection flag (M2045) is turned ON.

3) An error code is stored in the real mode/virtual mode switching error information register (D9195).

POINT

The error code stored in D9195, corresponding to an axis, is as follows:



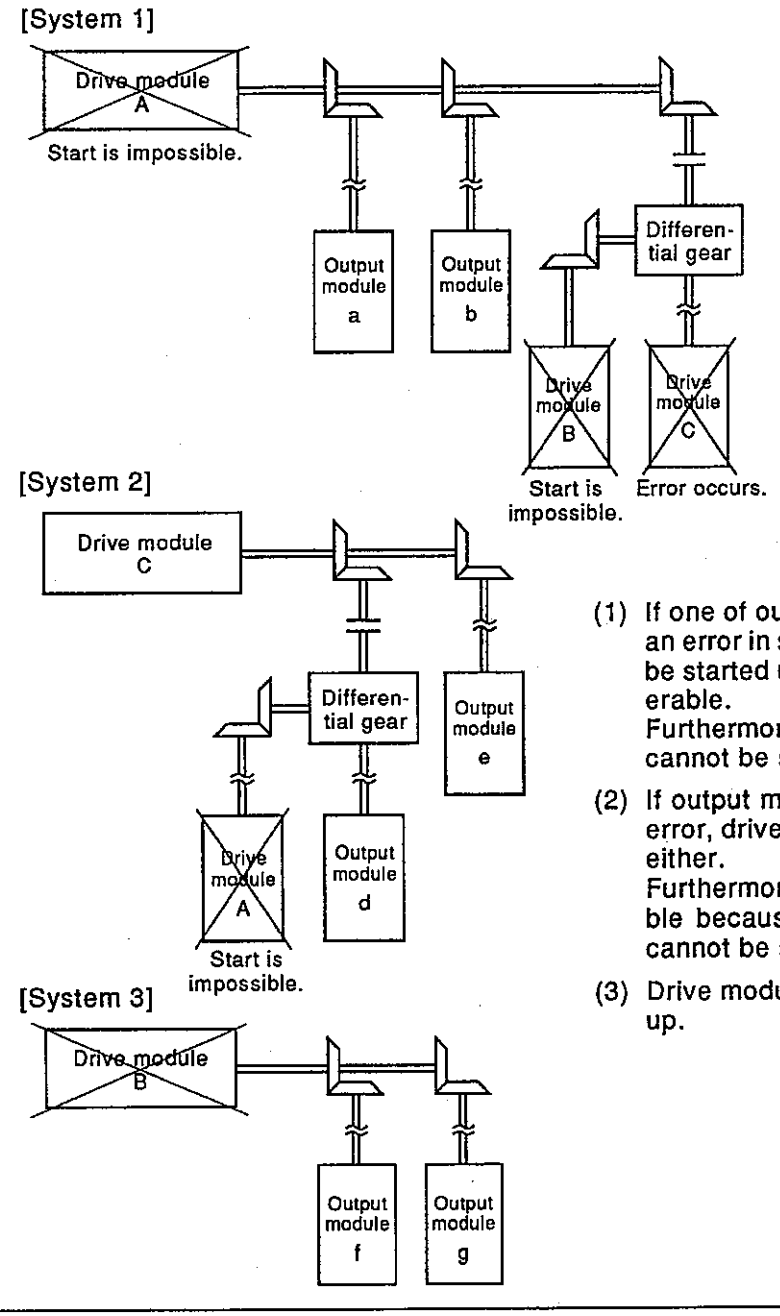
10.1 Related System and Processing

When An Error Occurs Virtual mode has the following 2 kinds of related systems.

1) System using drive modules and output modules
2) Several systems using the same drive module

If an error is detected in the output module, the operating status changes as follows.

1) If an error is detected in one of the output modules, the drive module cannot be started up and the system becomes inoperable.
   The auxiliary input axis of an output module where an error occurred becomes inoperable.
2) Other systems using a drive module which is disabled by an output module error become inoperable.



(1) If one of output modules a, b and c causes an error in system 1, drive module A cannot be started up, and system 1 becomes inoperable.
Furthermore, drive module A of system 2 cannot be started up, either.

(2) If output module C of system 1 causes an error, drive module B cannot be started up, either.
Furthermore, system 3 becomes inoperable because drive module B of system 3 cannot be started up.

(3) Drive module C of system 2 can be started up.

10.2 Servo Program Setting Errors

Error codes, error contents and corrective actions for servo program setting errors are shown in Table 10.1.
In error codes indicated by * in Table 10.1, "n" indicates the axis number (1 to 8).

Table 10.1 Servo Program Setting Errors List

<table>
<tr><th>Error Codes Stored in D9190</th><th>Error Names</th><th>Error Contents</th><th>Error Processing</th><th>Corrective Action(s)</th></tr>
<tr><td>1</td><td>Parameter block number setting error</td><td>The parameter block number is designated outside the range from 1 to 16.</td><td>Servo program is executed setting the parameter block number to the default value 1.</td><td>Designate a parameter block number in the range from 1 to 16.</td></tr>
<tr><td rowspan="2">n03*</td><td rowspan="2">Address/travel distance setting error (Excluding velocity control and velocity /position control)</td><td>(1) Address is set outside the specified range when doing absolute positioning control.
<table><tr><th>Unit</th><th colspan="2">Address setting range</th></tr><tr><td>degree</td><td>0 to 35999999</td><td>X10^{-5}degree</td></tr></table></td><td rowspan="2">(1) The axis does not start. (When doing interpolation control, no interpolation control axes start.)
(2) If an error is detected during velocity switching control or constant velocity control, the axis decelerates and stops.
(3) While multiple servo programs are being executed simultaneously, no servo program is executed when an error occurs in one servo program.</td><td>(1) If the control unit is degree, set the address in the range from 0 to 35999999.</td></tr>
<tr><td>(2) When doing increment positioning control, the travel distance is set at -2147483648 (H80000000).</td><td>(2) Set the travel distance in the range from 0 to ±(2147483647).</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">Command velocity error</td><td>(1) Command velocity is set outside the range from 1 to the velocity limit value.</td><td rowspan="2">(1) The axis does not start if the command velocity is set at 0 or less.
(2) Control is done at the velocity limit value if the command velocity is set exceeding the velocity limit value.</td><td rowspan="2">(1) Set the command velocity in the range from 1 to the velocity limit value.</td></tr>
<tr><td>(2) Command velocity is set outside the setting range.
<table><tr><th>Unit</th><th colspan="2">Address setting range</th></tr><tr><td>mm</td><td>1 to 600000000</td><td>X10^{-2}mm/min</td></tr><tr><td>inch</td><td>1 to 600000000</td><td>X10^{-3}inch/min</td></tr><tr><td>degree</td><td>1 to 600000000</td><td>X10^{-3}degree/min</td></tr><tr><td>PULSE</td><td>1 to 1000000</td><td>PLS/sec</td></tr></table></td></tr>
<tr><td>5</td><td>Dwell time setting error</td><td>Dwell time is set outside the range from 0 to 5000.</td><td>Control is done using default value (0).</td><td>Set the dwell time in the range from 0 to 5000.</td></tr>
<tr><td>6</td><td>M code setting error</td><td>M code is set outside the range from 0 to 255.</td><td>Control is done using default value (0).</td><td>Set the M code in the range from 0 to 255.</td></tr>
<tr><td>7</td><td>Torque limit value setting error</td><td>Torque limit value is set outside the range from 1 to 500.</td><td>Control is done using the torque limit value of the designated parameter block.</td><td>Set the torque limit value in the range from 1 to 500.</td></tr>
</table>

Table 10.1 Servo Program Setting Errors List (Continued)

<table>
<tr><th>Error Codes Stored in D9190</th><th>Error Names</th><th>Error Contents</th><th>Error Processing</th><th>Corrective Action(s)</th></tr>
<tr><td rowspan="2">n08*</td><td rowspan="2">Assist point setting error
(When doing circular interpolation with the assist point)</td><td>(1) Address is set outside the specified range when doing absolute positioning control.
<table><tr><th>Unit</th><th>Address setting range</th><th></th></tr><tr><td>degree</td><td>0 to 35999999</td><td>X10^{-5}degree</td></tr></table></td><td rowspan="2">The axis does not start.</td><td>(1) If the control unit is degree, set the address in the range from 0 to 35999999.</td></tr>
<tr><td>(2) Travel distance is set at -214 7483648(H80000000) when doing increment positioning control.)</td><td>(2) Set the travel distance in the range from 0 to ±2147483647.</td></tr>
<tr><td rowspan="2">n09*</td><td rowspan="2">Radius setting error
(When doing circular interpolation with the radius)</td><td>(1) Address is set outside the specified range when doing absolute positioning control.
<table><tr><th>Unit</th><th>Address setting range</th><th></th></tr><tr><td>degree</td><td>0 to 35999999</td><td>X10^{-5}degree</td></tr></table></td><td rowspan="2">The axis does not start.</td><td>(1) If the control unit is degree, set the address in the range from 0 to 35999999.</td></tr>
<tr><td>(2) Travel distance is set at -214 7483648(H80000000) when doing increment positioning control.</td><td>(2) Set the travel distance in the range from 0 to ±2147483647.</td></tr>
<tr><td rowspan="2">n10*</td><td rowspan="2">Center point setting error
(When doing circular interpolation with the center)</td><td>(1) Address is set outside the specified range when doing absolute positioning control.
<table><tr><th>Unit</th><th>Address setting range</th><th></th></tr><tr><td>degree</td><td>0 to 35999999</td><td>X10^{-5}degree</td></tr></table></td><td rowspan="2">The axis does not start.</td><td>(1) If the control unit is degree, set the address in the range from 0 to 35999999.</td></tr>
<tr><td>(2) Travel distance is set at -214 7483648(H80000000) when doing increment positioning control.</td><td>(2) Set the travel distance in the range from 0 to ±214783647</td></tr>
</table>

Table 10.1 Servo Program Setting Errors List (Continued)

<table>
<tr><th>Error Codes Stored in D9190</th><th>Error Names</th><th>Error Contents</th><th>Error Processing</th><th>Corrective Action(s)</th></tr>
<tr><td>11</td><td>Interpolation control unit setting error</td><td>The interpolation control unit is set outside the range from 0 to 3.</td><td>Control is done at the default value (3).</td><td>Set the interpolation control unit in the range from 0 to 3.</td></tr>
<tr><td>12</td><td>Velocity limit value setting error</td><td>The velocity limit value is set outside the set range.</td><td>Control is done at the default value (200000PLS/sec).</td><td>Set the velocity limit value in the specified range.</td></tr>
<tr><td>13</td><td>Acceleration time setting error</td><td>The acceleration time is set at 0.</td><td rowspan="3">Control is done at the default value (1000).</td><td>Set the acceleration time in the range from 1 to 65535.</td></tr>
<tr><td>14</td><td>Deceleration time setting error</td><td>The deceleration time is set at 0.</td><td>Set the deceleration time in the range from 1 to 65535.</td></tr>
<tr><td>15</td><td>Deceleration time for an immediate stop setting error</td><td>The deceleration time for an immediate stop is set at 0.</td><td>Set the deceleration time for an immediate stop in the range from 1 to 65535.</td></tr>
<tr><td>16</td><td>Torque limit value setting error</td><td>The torque limit value is set outside the range from 1 to 500.</td><td>Control is done at the default value (300 %).</td><td>Set the torque limit value in the range from 1 to 500.</td></tr>
<tr><td>17</td><td>Circular interpolation tolerance setting error</td><td>The circular interpolation tolerance is set outside the specified range.
<table>
<tr><th>Unit</th><th colspan="2">Address setting range</th></tr>
<tr><td>mm</td><td rowspan="4">1 to 100000</td><td>$X10^{-1}\mu m$</td></tr>
<tr><td>inch</td><td>$X10^{-5}$inch</td></tr>
<tr><td>degree</td><td>$X10^{-5}$degree</td></tr>
<tr><td>PULSE</td><td>PLS</td></tr>
</table></td><td>Control is done at the default value (100PLS).</td><td>Set the circular interpolation tolerance in the specified range.</td></tr>
<tr><td>18</td><td>Repeat count setting error</td><td>The repeat count is set outside the range from 1 to 32767.</td><td>Control is done by setting the repeat count at 1.</td><td>Set the repeat count in the range from 1 to 32767.</td></tr>
<tr><td rowspan="3">19</td><td rowspan="3">START command setting error</td><td>(1) The servo program designated by the START command does not exist.</td><td rowspan="3">The axis does not start.</td><td>(1) Change the servo program number designated by the START command by using peripheral devices.</td></tr>
<tr><td>(2) There is a "START" command in the designated servo program.</td><td>(2) Create a servo program designated by the START command.</td></tr>
<tr><td></td><td>(3) Delete the servo program containing the START command.</td></tr>
</table>

10.3 Drive Module Errors

Table 10.2 Drive Module Errors List (100 to 1399)

Error classification	Error Codes	Control Mode of Virtual Servo Axis							Error Causes	Error Processing	Corrective Action(s)
		Positioning	Incremental Feed	Velocity	Velocity Change	Constant Velocity	JOG	Man. Pulse Gen. / Synchronous Encoder Axis			
Low error	100	O	O	O	O	O	O	O	• PC READY flag (M2000) or PCPU READY flag (M9074) was reset.	Positioning control does not start.	• Set the A373CPU to RUN. • Set the PC READY flag (M2000).
	101	O	O	O	O	O	O	O	• Start receive flag (M2001 to M2008) of the corresponding axis was set.		• Provide an interlock in the program not to start the corresponding axis (use the start receive reset as an interlock condition).
	103	O	O	O	O	O	O	O	• Stop command of the corresponding axis was turned ON.		• Turn OFF the stop command before starting positioning.
	104	O	O	O	O	O	O	O	• Immediate stop command of the corresponding axis was turned ON.		• Turn OFF the immediate stop command before starting positioning.
	106	O	O			O			• Positioning outside the stroke limit was called.		• Positioning end (destination) point must be within the specified stroke limit.
	107	O				O			• An address making no arc was designated during circular interpolation with an assist point. [The designated start point address, assist point address, and/or end point address has an error.]		• Designate correct addresses (servo program).
	108	O				O			• An address making no arc was designated during circular interpolation with the radius. [The designated start point address, assist point address, and/or end point address has an error.]		
	109*	O				O			• An address making no arc was designated during circular interpolation with the center. [The designated start point address, assist point address, and/or end point address has an error.]		
	110	O				O			• The difference between the end point address and the ideal end point exceeded the circular interpolation tolerance.		
	116						O		• The JOG velocity is set at 0.	Positioning control does not start	• Set a correct speed (within the specified range).
									• The set JOG velocity is outside the specified range.	Controlled in the specified range.	

*: The error codes of all corresponding interpolation axes are stored in the error code storage area during interpolation.

Table 10.2 Drive Module Errors List (100 to 1399) (Continued)

Error classification	Error Codes	Control Mode of Virtual Servo Axis								Error Causes	Error Processing	Corrective Action(s)
		Positioning	Incremental Feed	Velocity	Velocity Change	Constant Velocity	JOG	Man. Pulse Gen.	Synchronous Encoder Axis			
Low error	117						O			• A set data error occurred when simultaneously starting JOG operations programs. (Forward/reverse rotation restart is designated for the same axis.)	Positioning control starts in the forward direction.	• Set the data correctly.
	118				O					• The velocity change point is beyond the end point address. • An address was set so that positioning would be performed in the opposite direction.	Positioning control does not start.	• Set the velocity change point within the range of the preceding velocity change point or start point and the end point.
	125	O								• At simultaneous starting, positioning cannot be done because positioning is being done by other programs.		
	150									• Operation disable instruction is started in the virtual mode. (Velocity-position change or zero return)	Positioning control does not start.	• Correct the error cause, reset the virtual mode, and start.
	151									• Start disable axis is started in the virtual mode. [System cannot be started because of an error caused by switching from real to virtual.]		
	152									• Started during deceleration by all axes servo OFF. (M2042 flag: OFF)		
	153									• Started during deceleration by an output module servo error.		
	200	O	O	O	O	O	O	O		• The PC READY flag (M2000) was reset while starting positioning in response to a start request given by using a sequence program.	The axis decelerates and stops.	• Set the PC READY flag (M2000) after all axes have stopped.
	204	O	O	O	O	O	O	O		• The PC READY flag (M2000) was set during deceleration by the PC READY OFF (M2000).	No processing	• Set the PC READY flag after all axes have stopped. (The PC READY flag (M2000) set while decelerating is ignored.)
	207	O				O				• The command position data exceeded the stroke limit. In the case of circular interpolation, only error codes for axes where the command position data exceeded the stroke limit are stored. In the case of linear interpolation, error codes for all interpolation axes are stored.	The axis decelerates and stops.	• Set the command position data or modify the set travel distance so that positioning is performed within the stroke limit.
	208	O				O				• The command position data of the other axis exceeded the stroke limit during circular interpolation (other axis error).	The axis decelerates and stops.	• Set the command position data or modify the set travel distance so that positioning is performed within the stroke limit.

Table 10.2 Drive Module Errors List (100 to 1399) (Continued)

Error classification	Error Codes	Control Mode of Virtual Servo Axis								Error Causes	Error Processing	Corrective Action(s)
		Positioning	Incremental Feed	Velocity	Velocity Change	Constant Velocity	JOG	Man. Pulse Gen.	Synchronous Encoder Axis			
Low error	211					O				• During positioning, an overrun occurs because the deceleration distance for the corresponding output velocity is not attained at the point when the final positioning address is detected.	The axis accelerates and stops	(1) Set a velocity at which overrun does not occur. (2) Set a travel distance at which overrun does not occur.
	215				O					• The velocity change point address is greater than the end point address.		• Set the velocity change point within the range of the preceding velocity change point and the end point.
										• An address to control positioning in the opposite direction was set.		
										• The same servo program was re-executed.		• Modify the sequence program.
										• The velocity change point address is greater than the end point address.	The axis does not start.	• Set the velocity change point within the range of the preceding velocity change point and the end point.
										• An address to control positioning in the opposite direction was set during velocity control.		
	300	O	O	O	O	O	O	O		• An attempt was made to change the positioning data for an axis being moved.	The positioning data is not changed.	• Modify the sequence program so as to use the following devices as an interlock to change the positioning data: (1) Reset state of the start receive flag (M2001 to M2008) (2) ON state of the servo start-up signal
										• An attempt was made to change the positioning data for an axis that was not yet booted.		
	302	O								• An attempt was made to change the velocity of the axis being circularly interpolated.	The velocity is not changed.	• The velocity of the axis being circularly interpolated cannot be changed.
	303	O	O		O	O				• An attempt was made to change the velocity of an axis after automatic deceleration has started.		• The velocity of an axis cannot be changed after automatic deceleration has started.
	304						O			• An attempt was made to change the velocity of an axis while the axis is decelerating with the JOG operation start signal OFF.		• The velocity of an axis cannot be changed while the axis is decelerating with the JOG operation signal OFF.
	305	O	O	O	O	O	O			• The velocity was set outside the allowable range (1 to velocity limit value).	0 : Velocity change processing is ignored.	• Set the velocity within the range from 1 to the velocity limit value.
											Not 0 : Controlled at the velocity limit value.	

Table 10.2 Drive Module Errors List (100 to 1399) (Continued)

Error classification	Error Codes	Control Mode of Virtual Servo Axis								Error Causes	Error Processing	Corrective Action(s)
		Positioning	Incremental Feed	Velocity	Velocity Change	Constant Velocity	JOG	Man. Pulse Gen.	Synchronous Encoder Axis			
High error	1201									• A sum check error occurred with the backup data when the power was turned ON.	Positioning does not start.	• The service life of the A373CPU internal memory (EEPROM) has expired. Replace the A373CPU. This error may occur when the A373CPU is being used for the first time. Do zero return.
	1300									• The actual amplifier installation is inconsistent with the system setting. • AC motor drive unit fault	Operation does not start.	• Check the parameter. • Replace the AC motor drive unit.
	1301									• AC motor drive unit has not been installed. • Setting was not done to use the AC motor drive unit in the system setting.		• Check the system setting. • The machine cannot be operated when the AC motor drive unit has not been installed, even if an MR-SB/SD is used.
	1302									• The loaded position detection module (ES) is inconsistent with the system setting.		• Check the system setting.
	1310 to 1326									• System setting error or servo parameter error • A373CPU fault		• Check the parameter. • Replace the A373CPU.

10.4 Servo Errors

Servo errors are those detected by the servo amplifier. The error codes for servo errors are 2000 to 2999.
Servo errors are errors that occur in the AC motor drive unit and errors that occur in an MR-SB/MR-SD.
In the following table, the AC motor drive unit is abbreviated (A), and an MR-SB/MR-SD is abbreviated (M).
A servo error detection signal goes ON, when a servo error occurs. Remove the cause of an error, reset the servo error by turning the servo error reset signal ON, and restart operations.

Notes 1. When excessive regeneration (2030), overload 1 (2050) and/or overload 2 (2051) errors occur, the state when the error occurred is stored in the servo amplifier even after the protection circuit has operated. The memory contents are cleared if the external power supply is turned OFF, but are not cleared by the RES signal.
2. When reset by turning OFF the external power supply is done repeatedly when error codes 2030, 2050, and/or 2051 occur, the element may be broken due to overheating. Only restart operations after removing the cause of the error.

Servo error contents are shown in Table 10.3.

Table 10.3 Servo Errors List (2000 to 2999)

Error Codes	Amplifiers	Error Causes		Error Check Points in Time	Error Processing	Corrective Action(s)
		Error Names	Error Contents			
2010	(A) (M)	Low voltage	• The voltage to the power supply module was lower than 3ϕ VAC 200/220 (+10%/–15%). • The voltage to an MR-SB/SD became lower than 3ϕ VAC 200/200 (± 10%). • Power supply stopped momentarily. • Load was too large. • A fault was detected in the power supply module.	Anytime during operations	Operation is stopped immediately.	• Check the power supply equipment. • Lower the load. • Replace the power supply module.
2012	(A) (M)	Internal memory error	• EPROM check sum, SRAM check, and/or 2-port RAM check error. • EPROM, SRAM, and/or 2-port RAM error. • A373CPU fault	• When turning ON the power supply of the servo amplifier • When starting up PC READY flag (M2000)		• Replace the servo amplifier. • Replace the A373CPU.
2013	(A) (M)	External clock error	• Data processing of the position command from the A373CPU was not completed in the normal time. • Error in a timing signal (BCLK, SCLK) from an A373CPU. • A373CPU fault.	Anytime during operation		• Reset the A373CPU, and confirm if it operates correctly. • Replace the A373CPU.
2014	(A) (M)	Watchdog	• Timing signal from an A373CPU or the 2-port RAM error. • A373CPU fault.			

* Servo parameter (OPT) : Increment/absolute setting, regeneration resistance setting

Table 10.3 Servo Error List (2000 to 2999) (Continued)

Error Codes	Amplifiers	Error Causes		Error Check Points in Time	Error Processing	Corrective Action(s)
		Error Names	Error Contents			
2015	(M)	2-port memory error	• 2-port memory RAM check error occurred, or parity error was detected when receiving initial parameters. • Fault of the cable that links the position detection module and the servo input unit, or fault of the 2-port RAM. • A373CPU fault	• When the power supply of the servo amplifier was turned ON • When starting up the PC READY flag (M2000)	Operation is stopped immediately.	• Reset the A373CPU, and confirm if it operates correctly. • Replace the A373CPU.
2016	(A) (M)	Magnetic pole position detection error	• When an initial magnetic pole position detection was done, the magnetic pole position detection was not made normally (error in U, V, or W). • Position detection module fault • Cable or encoder fault • Improper setting of servo parameter (OPT)			• Reset the A373CPU, and make sure it operates correctly. • Replace the position detection module and the servo motor (encoder). • Modify the servo parameter.
2017	(A) (M)	PC board error	• The value of the AD converter is not normal (æ 0.5 or more) during initialization. • Fault around the A/D converter • Fault of the power supply module • A373CPU fault	• When turning ON the power supply of the servo amplifier • When starting up the PC READY flag (M2000)		• Reset the A373CPU and make sure it operates correctly. • Replace the power supply module or the A373CPU.
2020	(A) (M)	No-signal ME	• The connector which links the encoder and the position detection module has come loose. • Cable or encoder fault • Error of the signals from the encoder connected to RF01 (U, V, W, A, B, or Z error)	Anytime during operations		• Replace the servo motor (encoder).
2021	(M)	No-signal AE	• Signal errors of the encoder connected to the RF31 card or the RF33 card. • Cable or encoder fault			
2022	(M)	No-signal IX	• Signal error of the resolver connected to the RF32 card or the RF33 card • Fault of the cable or the resolver, or excitation signal error			• Replace the servo motor (resolver).
2023	(A)	Module not installed	• Module set by the system setting has not been installed. • AC motor drive unit fault • Power supply module fault • Power is not supplied to the AC motor drive unit from the power supply module. (The AC motor drive unit and the power supply module are not connected.) • A373CPU fault • Position detection module fault	• When turning ON the power supply to the servo amplifier • When starting up the PC READY flag (M2000)		• Install the module as set in the system setting. • Replace the AC motor drive unit. • Replace the power supply module. • Connect the AC motor drive unit and the power supply module. • Replace the A373CPU. • Replace the position detection module.

Table 10.3 Servo Error List (2000 to 2999) (Continued)

Error Codes	Amplifiers	Error Causes		Error Check Points in Time	Error Processing	Corrective Action(s)
		Error Names	Error Contents			
2024	(M)	Main ladder error	• U, V, or W of the servo amplifier output grounded.	Anytime during operation	Operation is stopped immediately.	• Use a tester to check between U, V, or W of the terminal block and the case. • Use a tester and megger to check between U, V, or W of the motor and the core.
			• Damage to the servo amplifier transistor			• Use a tester to measure the resistance between the transistor module terminals.
			• Insufficient charging to the bus.			• Insufficient power supply. • The power transistor for regeneration was damaged.
2025	(A) (M)	Battery alarm	• The voltage of the battery for an absolute position detection ladder backup for the RF32 and RF33 cards (M) and A362ES (A) dropped. • There is a possibility of losing the absolute position, which requires to redo zero return. (This error is detected only in the absolute system.)	• When turning ON the power supply of the servo amplifier • When starting up the PC READY flag (M2000)	Zero return request signal goes ON, and the operation is stopped immediately.	• Replace the battery. • Turn the power supply OFF, and turn ON. Establish the absolute position by doing zero return.
2026	(A)	Unit mismatch	• The specifications of a servo parameter (MSR, MTY), and those of servo amplifier or servo motor do not match. • AC motor drive unit fault • Position detection module fault • The servo parameter (OPT) and the position detection module do not match.		Operation is stopped immediately.	• Check the servo parameter. • Replace the AC motor drive unit and the position detection module.
2027	(A)	Initial communications error	• Communications error with the absolute encoder connected to the position detection module (A362ES). • Absolute encoder fault • Encoder cable fault • A362ES fault			• Replace the position detection module and the servo motor (absolute encoder).
2030	(A) (M)	Excessive regeneration	• The power transistor for regenerative control goes ON and OFF too frequently. (Regenerative resistance sometimes cause overheating.) • The power transistor for regenerative control was short circuited and damaged. • Incorrect setting of the servo parameter (OPT) • Incorrect wiring of regenerative resistance	Anytime during operation		• Lower the frequency of the velocity adjustment or lower the velocity. • Replace the power supply module. • Check the servo parameter. • Modify the wiring.

* Servo parameter (MSR): Motor type setting
(MTY): Motor capacity setting
(OPT): Increment/absolute setting, regenerative resistance setting
(ENC): Setting of number of feedback pulses per 1 rotation of the motor

Table 10.3 Servo Error List (2000 to 2999) (Continued)

Error Codes	Amplifiers	Error Causes		Error Check Points in Time	Error Processing	Corrective Action(s)
		Error Names	Error Contents			
2031	(A) (M)	Overspeed	• The command velocity is too high. • An overshoot occurred during acceleration. • Encoder fault • Encoder cable fault or incorrect wiring • Incorrect setting of the servo parameter (ENC) • Position detection module fault	Anytime during operation	Operation is stopped immediately.	• Replace the encoder. • Check the servo parameter. • Replace the position detection module.
2032	(A) (M)	Overcurrent	• A servo motor different from the setting has been connected. • U, V, or W of the servo amplifier output were short circuited or grounded. • Incorrect wiring of U, V, or W of the servo amplifier output • Damage to the transistor module of the servo amplifier • Insufficient coupling of the servo motor and the encoder. • Encoder cable fault or incorrect wiring • Position detection module fault • Incorrect setting of the servo parameters (OPT, ENC) • The servo motor oscillated.			• Match the specifications of the servo parameter and the motor. • Replace the servo motor or the cable. • Modify the wiring. • Replace the servo amplifier or the servo motor. • Replace the position detection module. • Modify the servo parameter.
2033	(A) (M)	Overvoltage	• The current bus voltage became 400 V or more. • Regenerative ability was exceeded because the velocity adjustment frequency was too high. • Incorrect connection of the terminal block for regenerative resistance • Regenerative resistance is cut. • The power transistor for regeneration has been damaged. • Incorrect wiring of terminal block P, D, or C of the power supply module			• Replace the power supply module. • Replace the regenerative resistance. • Modify the wiring.
2034	(M)	Communications error	• When receiving data from an A373CPU, a parity occurred. • Cable fault or noise			• Replace the A373CPU.
2035	(A) (M)	Data error	• Change rate of the command position from an A373CPU is too large. • The command velocity is too high. Cable fault or noise. • Incorrect setting of the servo parameter (ENC) • Fault of the A373CPU			• Replace the A373CPU. • Modify the servo parameter.
2036	(A) (M)	Transmission error	• Communications with an A373CPU cannot be done. • Cable fault • Noise occurred, or an MCP processing error occurred. • A373CPU fault			• Replace the A373CPU.

* Servo parameter (OPT) : Increment/absolute setting, regenerative resistance setting
(ENC) : Setting of the number of feedback pulses per 1 rotation of the motor

Table 10.3 Servo Error List (2000 to 2999) (Continued)

Error Codes	Amplifiers	Error Causes		Error Check Points in Time	Error Processing	Corrective Action(s)
		Error Names	Error Contents			
2037	(A) (M)	Parameter error	• The parameter transmitted at initialization is not correct.	• When turning ON the power supply of the servo amplifier • When starting up the PC READY flag (M2000)	Operation is stopped immediately.	• Replace the A373CPU.
2040	(A)	Power supply error	• Short circuit of the VD C24 output of the power supply module • Fault of the VDC24 power supply ladder of the power supply module • Fault of the VDC24 detection ladder	Anytime during operation		• Check the wiring. • Replace the power supply module or the A373CPU.
2045	(A) (M)	Fin overheating	• The fin is stopped. • The continuous output current of the servo amplifier is exceeded. • Insufficient contact between the radiation fin and the servo amplifier. • Insufficient contact between the module and the bracket (fin) of the servo amplifier. • The thermal protector of the fin of the servo amplifier operated. • Thermal sensor fault			• Replace the fan. • Lower the load. • Install the servo amplifier on the base firmly. • Replace the servo amplifier.
2046	(A) (M)	Motor overheating	• The thermal protector incorporated in the motor operated. • The continuous output of the motor has been exceeded.			• Replace the servo motor.
2047	(A)	Amplifier power supply overheating	• The fan is stopped. • The continuous output current of the power supply has been exceeded. • Insufficient contact between the radiation fin and the power supply module. • Thermal sensor fault			• Replace the fan. • Lower the load. • Install the power supply module on the radiation fin firmly. • Replace the power supply module.
2050	(A) (M)	Overload 1	• The rated current of the motor has been exceeded. • Incorrect setting of the servo parameters (MSR, MTY) • The load inertia and friction are too large, or hunting occurred by setting the parameter improperly.			• Lower the load. • Check the servo parameter.
2051	(M)	Overload 2	• The command requiring current of 95% or more of the current limit value lasted more than 0.5 second or more. • The machine collided, or the load inertia too large.			

* Servo parameter (MSR): Motor type setting
(MTY): Motor capacity setting
(ENC): Setting of the number of feedback pulse per each rotation of the motor

Table 10.3 Servo Error List (2000 to 2999) (Continued)

Error Codes	Amplifiers	Error Causes		Error Check Points in Time	Error Processing	Corrective Action(s)
		Error Names	Error Contents			
2052	(A) (M)	Excessive error	• The real position for a command exceeded the set value. • Incorrect setting of servo parameters (MSR, MTY, or ENC) • Acceleration cannot be done sufficiently because the inertia is too large, or an overshoot occurred. • Hunting occurred. • Fault of the encoder or the cable.	Anytime during operation	Operation is stopped immediately.	• Do zero return. • Check servo parameters. • Replace the servo motor (encoder) and the cable.
2054	(A)	Amplifier power supply overload	• The power supply capacity is insufficient. • Hunting occurred.			• Replace the amplifier power supply with one having larger capacity. • Lower the load. • Check the servo parameter.
2055	(M)	External emergency stop	• Continuity across B and R of the servo amplifier terminal block was opened.			• Short circuit B and R.
2057	(A)	Hardware fault	• Hardware fault of an A373CPU.			• Replace the A373CPU.
2100	(A) (M)	Initial communications warning	• When power is supplied to an A373CPU, an error occurred in the serial signal. Or, the value of the absolute position counter after a retry is not the same as the one before the retry.		Operation is continued.	• Replace the cable and the card. • Replace the servo motor (encoder).
2101	(A) (M)	Serial communications warning	• Error occurred in the communication of serial signal of an absolute position detection device during operation.			
2102	(A) (M)	Battery warning	• The voltage of the battery installed to the RF371 card is lower than 3.2 ± 0.2 V.			• Charge or replace the battery. • Connect the battery.
2103	(A) (M)	Battery disconnection warning	• The power supply voltage supplied to an absolute position detector is lower than 2.8 ± 0.2 V.			
2104	(A) (M)	Position offset warning	• Relationship between the feedback position and the encoder Z-phase is not correct.			• Replace the servo motor (encoder).
2140	(A)	Excessive regeneration warning	• Excessive regeneration error (2030) is likely to occur. (80% level was detected.)			• See the contents of the excessive regeneration error (2030).
2141	(A)	Overload warning	• Overload errors (2050, 2051) are likely to occur. (80% level was detected.)			• See the contents of overload errors (2050, 2051).
2142	(A)	Amplifier power supply overload warning	• Amplifier power supply overload error (2054) is likely to occur. (80% level was detected.)			• See the contents of an amplifier power supply overload error (2054).

Table 10.3 Servo Error List (2000 to 2999) (Continued)

Error Codes	Amplifiers	Error Causes		Error Check Points in Time	Error Processing	Corrective Action(s)
		Error Names	Error Contents			
2143	(A) (M)	Absolute position counter warning	• RG510 printed board fault • A362ES fault • The deviation between the feedback position and the data transmitted from the encoder is too large.	Anytime during operation	Operation is continued.	• Replace the RG510 or A362ES printed board.
			• Encoder fault			• Replace the encoder.
			• Malfunction occurred due to noise, etc.			• Do zero point initial setting, and turn ON the power supply again.
			• Power OFF (momentary power failure) or CPU reset was done while the motor was rotating.			• While the motor is rotating with the up and down axis, etc., do not turn the power ON (a momentary power failure) or reset the CPU.
2144	(A) (M)	Parameter error	• Incorrect parameter was set.			• Check the parameters. (Servo is not turned OFF.) • Reset the A373CPU.

10.5 Output Module Error

Table 10.4 Output Module Errors List (1000 to 11990)

Error classification	Error Codes: Output Module	Error Codes: Drive Modules	Output Modules: Roller	Output Modules: Ball Screw	Output Modules: Rotary Table	Output Modules: Cam	Error Causes	Error Processing	Corrective Action(s)
Low error	4050	4050				O	• "Lower stroke limit setting device" value + "stroke setting device" value exceeds "$2^{31} - 1$ (set unit)" (in the return cam mode).	Related system does not start.	• Return to the real mode, and do positioning in the stroke range.
	4060	4060	O	O	O	O	• When the drive module is a synchronous encoder connected to the A336PX and the connection clutch is in the external input mode, more than one ON/OFF command bit devices are set.		• When an A336PX is used, the "external input mode" clutch can be set in a one-to-one combination only with a synchronous encoder. • Return to the real mode, reset the PC READY flag, and correct the clutch setting.
	5000	5000		O	O	O	• The command position data exceeded the stroke limit range. In the case of a cam, the command position data is out of the range from the lower stroke limit to the stroke (in the return cam mode). (Current value in cam 1 rotation cannot be calculated.)		• Return to the real mode, and do positioning in the stroke limit range.
	5060	5060				O	• Though the feed position data is in the stroke range, a current value in one cam shaft rotation cannot be calculated. (Cam table error)	A related system cannot be started.	• Correct a cam table. • For the cam table, set the stroke amount from the stroke lower limit in the ratio of 0 to 7FFFH. Put the point of 0 to 7FFFH in a cam table.
	5080	5080	O	O	O	O	• Torque limit setting outside the range error	Control with default 300%	• Set data within the range.
	6000	600□	O	O	O	O	• The servo OFF command went ON during operations.	Operation is continued.	• The servo maintains ON state. • Turn OFF the servo after turning OFF the clutch.
	6010	601□	O	O	O		• Output velocity exceeds the velocity limit during operations. (Velocity clamp processing by using the velocity limit is not executed.)		• Correct the speed, gear ratio, and speed change ratio of a drive module so the speed becomes within a speed limit value.
	6020	602□	O	O	O	O	• The error counter value exceeds the accumulated pulse allowable value during operations.		• After stopping the drive module, correct the speed, gear ratio, and speed change ratio of a drive module so the speed becomes within a speed limit value.
	6030	603□		O	O		• The command position data exceeds the stroke limit range during operations.		
	6040	604□				O	• Cam number setting device value is outside the range of the cam number used. Operations continue with the current cam number.		• Correct setting of cam No. .

Table 10.4 Output Module Errors List (1000 to 11990)

Error classification	Error Codes: Output Module	Error Codes: Drive Modules	Output Modules: Roller	Output Modules: Ball Screw	Output Modules: Rotary Table	Output Modules: Cam	Error Causes	Error Processing	Corrective Action(s)
Low error	6050	605□				O	• The stroke setting device value is outside the range from 1 to $2^{31}-1$. • The "lower stroke limit setting device" value + "stroke setting device" value exceeds "$2^{31}-1$ (set unit)". Operations continue with the current • cam number.)	Operation is continued.	• Correct setting of a stroke quantity.
	6060	606□				O	• When switching the cam number, the control modes before and after switching do not match. • Operations continue with the current cam number.	Operation is continued.	• Modify the control mode after stopping a drive module.
	6080	608□	O	O	O	O	• The torque limit is outside the setting range. • Operations are controlled with the default (300%).		• Set a torque limit value in the setting range.
	6500	650□	O	O	O	O	• Servo was OFF when the clutch ON command was given.	The clutch maintains OFF state.	• Execute clutch ON command again after returning to clutch OFF command and executing servo ON command.
	6510	651□				O	• When the cam axis servo ON command was given (Y0*F was turned OFF), command position data was outside the stroke range (in the return cam mode). • During follow up, command position data is outside the stroke range.	The servo maintains OFF state.	• Execute servo ON command again after returning a feed position data in the stroke range.
	6520	652□				O	• When the cam axis servo ON command was given (Y0*F was turned OFF), "the lower stroke limit setting device" value + "stroke setting device" value exceeded "$2^{31}-1$ (set unit)" (in the return cam mode).		• Set a stroke lower limit + stroke amount within ($2^{31}-1$).
	6530	6530	O	O	O	O	• When clutch ON command is executed, zero return request signal (Xn9) has turned ON. (The power supply of MR-SB/SD was switched from OFF to ON.)	The clutch maintains OFF state.	• Return to real mode, and after executing a zero return, switch to virtual mode.
	6560	6560				O	• When servo ON command is executed, a current value in the cam axis 1 rotation cannot be calculated though the feed position data is in the stroke limit range. (Cam table error)	The servo maintains OFF state.	• Return to the real mode, and correct setting of cam data. • Set the stroke amount from the stroke lower limit in the ratio of 0 to 7FFFH. Put points 0 to 7FFFH in a cam table.

Table 10.4 Output Module Errors List (1000 to 11990)

Error classification	Error Codes: Output Module	Error Codes: Drive Modules	Output Modules: Roller	Output Modules: Ball Screw	Output Modules: Rotary Table	Output Modules: Cam	Error Causes	Error Processing	Corrective Action(s)
High error	10000	1000□	O	O	O	O	• Zero return required signal (X0n9) is ON.	Related system does not start.	• Return to the real mode and execute zero return operations. • All axes must complete zero return and positioning. Otherwise, the operations are impossible in the virtual mode.
	10010	1001□	O	O	O	O	• The servo error detection signal (X0n8) is ON.		• Reset the servo error in the real mode.
	10020	1002□	O	O	O	O	• The servo ON/OFF signal (X0nF) of the output module connected to the main shaft or the auxiliary input axis is turned OFF.		• Turn OFF the clutch and give the servo ON command.
	10030	1003□	O	O	O	O	• The external input signal STOP signal of the output module connected to the main shaft or the auxiliary input axis is turned ON.		• Turn OFF the stop signal (STOP).
	11000	1100□	O	O	O	O	• The servo error detection signal (X0n8) was turned ON during operations. (The corresponding output module stops immediately and the servo goes OFF.)	After a corresponding output module stops immediately, the servo OFF state is established.	• Remove the factor of a servo error. (See Section 10.3)
	11010	1101□	O	O	O	O	• The servo was turned OFF (X0nF was turned OFF). • Power to the MR-SB/SD was turned OFF. • A servo error was detected in another ADU axis.		
	11020	1102□	O	O	O	O	• The stop signal (STOP) was turned ON.	Operation is continued.	• Perform stop processing with a user's sequence program.
	11030	1103□	O	O	O	O	• When positioning was being moved in the forward direction (addresses increasing), the upper limit LS signal (FLS) was turned OFF.		
	11040	1104□	O	O	O	O	• When positioning was being moved in the reverse direction (addresses decreasing), the lower limit LS signal (RLS) was turned OFF.		

10.6 Errors when Switching Real Mode/Virtual Mode

Table 10.5 Error Code List When Switching Real Mode/Virtual Mode

Error code stored in D9195		Error description	Corrective action
Decimal display	Hexadecimal display		
1 to 255	0001 to 00FF	• When all axes were not at a complete stop, M2043 was switched from OFF to ON.	• When M2001 to M2008 turn OFF, switch M2043 from OFF to ON.
257 to 511	0101 to 01FF	• When all axes were not at a complete stop, M2043 was switched from ON to OFF.	• When M2001 to M2008 turn OFF, switch M2043 from ON to OFF.
512	0200	• When a mechanical system program was not registered, M2043 was switched from OFF to ON.	• Write a mechanical system program to the A373CPU.
		• When axis No. set in the system and amplifier No. set with a mechanical system program did not agree, M2043 was switched from OFF to ON.	• Make axis No. of system setting and amplifier No. of a mechanical system program the same, and write it to the A373CPU.
513	0201	• When PC ready (M2000) or PCPU ready completion flag (M9074) was OFF state, M2043 was switched from OFF to ON.	• After a PC ready and the PCPU ready completion flag turn ON, switch M2043 from OFF to ON.
514	0202	• When all axes servo start command flag (M2042) was OFF state, M2043 was switched from OFF to ON.	• After M2042 and all axes servo start receive flag turn ON, switch M2043 from OFF to ON.
515	0203	• When external emergency stop (EMG) was ON state, M2043 was switched from OFF to ON.	• Switch M2043 from OFF to ON after turning OFF an external emergency stop.
516	0204	• While the ADU axis was processing a servo leading edge by servo error reset command (Yn8), M2043 was switched from OFF to ON.	• After servo error detection signal (Xn8) turns OFF, when Yn8 is turned ON, and a servo error is reset, switch M2034 from OFF to ON.
518	0206	• When there was an error in an external synchronous encoder, M2043 was switched from OFF to ON.	• Check an external synchronous encoder and wiring.
519	0207	• While processing cam data change (M2016: ON) with a sequence program, M2043 was switched from OFF to ON.	• After cam data change completion flag (M2017) turns ON, when 2016 is turned ON, and cam data is changed, switch M2043 from OFF to ON.
769 to 1023	0301 to 03FF	• When a zero return request signal was ON when an output module other than a roller axis was used, M2043 was switched from OFF to ON.	• After a zero return (servo program ZERO execution) is executed, and zero return signal (Xn9) turns OFF, switch M2043 from OFF to ON.
1025 to 1279	0401 to 04FF	• When all axes of ADU and MR-SB/SD were not normal (Xn8: ON), M2043 was switched from OFF to ON.	• Check ADU, MR-SB/SD, a servo motor, wiring, etc..
1281 to 1535	0501 to 05FF	• When an output module other than a roller axis was used and when fixed parameter and the unit set in the output module did not agree, M2043 was switched from OFF to ON.	• Correct a fixed parameter or unit setting of an output module, and write it to the A373CPU.
1537 to 1791	0601 to 06FF	• When cam data was not registered though a cam is set at an output module, M2043 was switched from OFF to ON.	• Write cam data to the A373CPU.
1793 to 2047	0701 to 07FF	• When cam No. set with use cam No. of the parameter of a cam was not registered, M2043 was switched from OFF to ON.	• Correct use cam No. of the parameter of a cam, and write it to the A373CPU.
			• Write data of cam No. set with use cam No. of the parameter of a cam in the A373CPU.
		• When use cam No. of the parameter of a cam was not set, M2043 was switched from OFF to ON.	• Correct use cam No. of the parameter of a cam, and write it to the A373CPU.

Table 10.5 Error Code List When Switching Real Mode/Virtual Mode (Continued)

Error code stored in D9195		Error description	Corrective action
Decimal display	Hexadecimal display		
2049 to 2303	0801 to 08FF	• When cam No. was not set at cam No. setting device, M2043 was switched from OFF to ON.	• Switch M2043 from OFF to ON after writing cam No. set at cam No. setting device by using No. the parameter of a cam.
		• When cam No. that is not set with use cam No. of the parameter of a cam was set in cam No. setting device, M2043 was switched from OFF to ON.	
2305 to 2559	0901 to 09FF	• The set value of the stroke amount setting device of a cam is outside the range of 1 to $(2^{31}-1)$.	• Switch M2043 from OFF to ON after setting a value within 1 to $(2^{31}-1)$ at the stroke amount setting device of a cam.
– 4094	F002	• PC ready (M2000) turned OFF in virtual mode and returned to the real mode.	• Turn ON M2000.
		• The A373CPU was switched to the STOP state in virtual mode.	• Make the A373 CPU RUN state.
– 4095	F001	• Servo error signal (Xn8) turned ON in virtual mode and returned to real mode.	• Confirm a cause of error of an axis that a servo error is occurring by a servo error code storage register, and remove a cause of error. (See Section 10.4)
– 4096	F000	• External emergency stop (EMG) turned ON in virtual mode and returned to real mode.	• Turn OFF an external emergency stop.

APPENDICES

APPENDIX 1. PROCESSING TIME

This section explains the processing time for executing positioning control in the A373CPU.

(1) Processing time of a sequence program
The processing time of the sequence instruction, basic instruction, and application instruction used with the A373CPU sequence program is the same as that of the A3NCPU (except the following instructions). For the processing time of the sequence instruction, basic instruction and application instruction, see the ACPU Programming Manual (Common instructions).

(a) Servo program start request instruction (DSFRP)

(b) Control change instruction (DSFLP)

(c) Program end (END)

Table 1.1 Processing Time of DSFRP, DSFLP and END Instructions

Instruction	Condition		Processing time (μs)	
			Direct method	Refresh method
DSFRP	Start of 1 axis		180	
	Interpolation start of axes 2 and 3		200	
	At error		850	
DSFLP	Current value change	At normal	120	
		At error	770	
	Velocity change	At normal	80	
		At error	700	
END			7600	

(2) PCPU processing time
Table 1.2 shows the PCPU processing time after start request and PC READY (M2000) are turned ON by a sequence program.

Table 1.2 PCPU Processing Time

Condition	Processing Time (msec)
Servo program processing time*1	10 to 21
Velocity change response time	13 to 16
PC READY(M2000) is turned ON → PCPU READY-completed flag (M9074) is turned ON	80 to 400
Simultaneous automatic operation command time*2	23 to 27

POINTS

(1) *1 ..... The start times of FEED, VPF and VPR vary greatly (1000 msec at worst).

(2) *2 ..... The time of a simultaneous start varies according to the number of axes and the combination of instructions. Use No. 4 as a standard value.

APPENDIX 2. CAM CURVE

The acceleration curve expression of the cam curve that can be used in virtual mode is shown below.

(1) Acceleration curve expression
< Symbol explanation >

- A : Dimensionless acceleration
- Am : Dimensionless maximum acceleration
- T : Dimensionless time
- Ta, Tb, Tc : Boundary line of T at the time of dividing a section

(a) Discontinuous curve

1) Uniform velocity curve
$A=C0$

2) Uniform acceleration curve
Section I ($0 \leq T \leq 0.5$)
$A=4+C0$

Section II ($0.5 < T \leq 1$)
$A=-4+C0$

(b) Both-side stationary symmetrical curve

1) Curve of the fifth order
$A=120T^3-180T^2+60T+C0$

2) Cycloid curve
$Am=2\pi$
$A=2\pi \sin 2\pi T+C0$

3) Transformation trapezoid curve
$Ta=\frac{1}{8}$

$Am=\frac{1}{\frac{1}{4}-Ta+\frac{2}{\pi}Ta}$

Section I ($0 \leq T \leq Ta$)

$A=Am\sin\frac{\pi}{2Ta}T+C0$

Section II ($Ta < T \leq 0.5-Ta$)
$A=Am+C0$

Section III ($0.5-Ta < T \leq 0.5+Ta$)
$A=Am\overline{\cos}\frac{\pi(T-0.5+Ta)}{2Ta}+C0$

Section IV ($0.5+Ta < T \leq 1-Ta$)
$A=-Am+C0$

Section V ($1-Ta < T \leq 1$)
$A=-Am\overline{\cos}\frac{\pi(T-1+Ta)}{2Ta}+C0$

4) Transformation sine curve

$Ta=\frac{1}{8}$

$Am=\frac{1}{\frac{2Ta}{\pi}+\frac{2-8Ta}{\pi^2}}$

Section I ($0\leq T\leq Ta$)

$A=Amsin\frac{\pi T}{2Ta}+C0$

Section II ($Ta<T\leq 1-Ta$)

$A=Amcos\frac{\pi (T-Ta)}{1-2Ta}+C0$

Section III ($1-Ta<T\leq 1$)

$A=-Amcos\frac{\pi (T-1+Ta)}{2Ta}+C0$

5) Transformation uniform velocity curve

$Ta=\frac{1}{16}$

$Tb=\frac{1}{4}$

$Am=\frac{1}{\frac{2}{\pi}\{(2-\frac{8}{\pi})TaTb+(\frac{4}{\pi}-2)Tb^2+Tb\}}$

Section I ($0\leq T\leq Ta$)

$A=Amsin\frac{\pi T}{2Ta}+C0$

Section II ($Ta<T\leq Tb$)

$A=Amcos\frac{\pi (T-Ta)}{2(Tb-Ta)}+C0$

Section III ($Tb<T\leq 1-Tb$)

$A=0+A0$

Section IV ($1-Tb<T\leq 1-Ta$)

$A=-Amsin\frac{\pi (T-1+Tb)}{2(Tb-Ta)}+C0$

Section V ($1-Ta<T\leq 1$)

$A=-Amcos\frac{\pi (T-1+Ta)}{2Ta}+C0$

(c) Both-side stationary asymmetrical curve

1) Trapecloid curve Section I Section II Section III Section IV

$$Ta=\frac{1}{8}$$

$$Tb=\frac{2-6Ta+\pi Ta}{2+\pi}$$

$$Tc=\frac{2-2Ta+3\pi Ta}{2+\pi}$$

$$Am=\frac{1}{(-\frac{3}{2}+\frac{4}{\pi}+\frac{4}{\pi^2})T^2a+(1+\frac{2}{\pi})TaTb+\frac{1}{2}T^2b+(\frac{2}{\pi}-\frac{4}{\pi^2})(1-Tc)^2}$$

Section I ($0\leq T\leq Ta$)

$$A=Amsin\frac{\pi T}{2Ta}+C0$$

Section II ($Ta<T\leq Tb$)

$$A=Am+C0$$

Section III ($Tb<T\leq Tc$)

$$A=Amcos\frac{\pi(T-T6)}{2Ta}+C0$$

Section IV ($Tc<T\leq 1$)

$$A=-Amcos\frac{\pi(T-Tc)}{2(1-Tc)}+C0$$

2) Reverse trapecloid curve

$$Ta=\frac{1}{8}$$

$$Tb=\frac{2-6Ta+\pi Ta}{2+\pi}$$

$$Tc=\frac{2-2Ta+3\pi Ta}{2+\pi}$$

$$Am=\frac{1}{(-\frac{3}{2}+\frac{4}{\pi}+\frac{4}{\pi^2})T^2a+(1+\frac{2}{\pi})TaTb+\frac{1}{2}T^2b+(\frac{2}{\pi}-\frac{4}{\pi^2})(1-Tc)^2}$$

$$Va=\frac{2TaAm}{\pi}$$

$$Vb=Am(Tb-Ta)+Va$$

$$Sa=\frac{2T^2aAm}{\pi}-\frac{4T^2aAm}{\pi^2}$$

$$Sb=\frac{Am}{2}(Tb-Ta)^2+Va(Tb-Ta)+Sa$$

$$Sc=\frac{8T^2aAm}{\pi^2}+2VbTa+Sb$$

Section I ($0\leq T\leq 1-Tc$)

$$A=Amcos\frac{\pi(1-Tc-T)}{2(1-Tc)}+C0$$

Section II ($1-Tc<T\leq 1-Tb$)

$$A=-Amcos\frac{\pi(1-Tb-T)}{2Ta}+C0$$

Section III ($1-Tb<T\leq 1-Ta$)

$$A=-Am+C0$$

Section IV ($1-Ta<T\leq 1$)

$$A=Amsin\frac{\pi(1-T)}{2Ta}+C0$$

(d) One-side stationary curve

1) Double chord curve

$$A=\frac{\pi^2}{2}(\cos\pi T-\cos 2\pi T)+C0$$

(e) Non-stationary curve

1) Single chord curve

$$A=\frac{\pi^2}{2}\cos\pi T+C0$$

(2) Cam curve coefficient

Transformation trapezoid

Section I

0 < Section I < 0.25(1/4) Default value 0.125(1/8)

Transformation sine

Section I

0 < Section I < 0.5(1/2) Default value 0.125(1/8)

Transformation uniform velocity Section I < Section II

Section I

0 < Section I < 0.125(1/4) Default value 0.0625(1/16)

Section II

0 < Section II < 0.5(1/2) Default value 0.25(1/4)

Trapecloid

Section I

0 < Section I < 0.25(1/4) Default value 0.125(1/8)

Reverse trapecloid

Section I

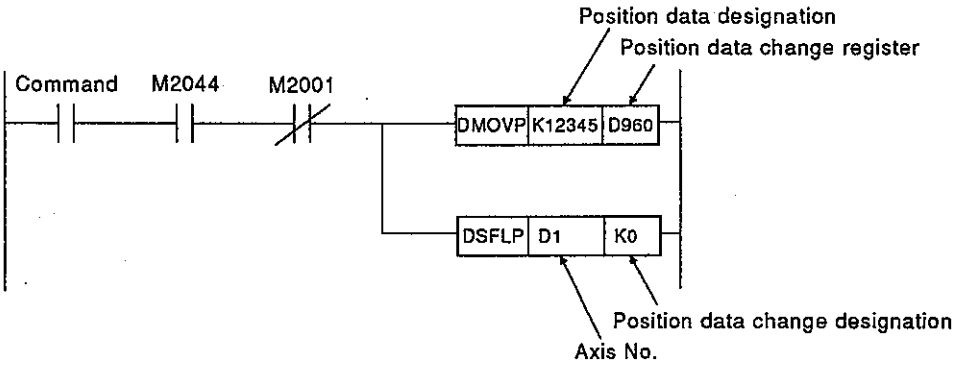
0 < Section I < 0.25(1/4) Default value 0.125(1/8)

APPENDIX 3. POSITION DATA/VELOCITY CHANGE

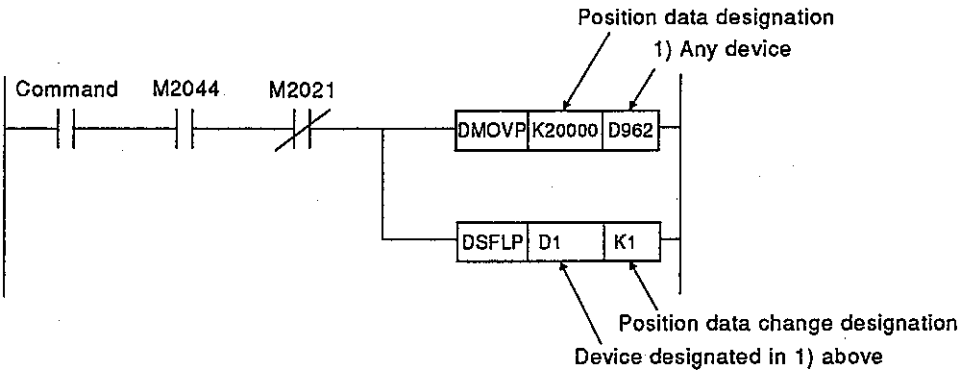
This section explains the position data/velocity change of a virtual servo motor, and the position data change of a synchronous encoder.

Position data/velocity change is executed by the DSFLP instruction.
ACPU Programming Manual (Common instructions) gives details of DSFLP instruction.

(1) Virtual servo motor position data change program (axis 1)



(2) Virtual servo motor velocity change program (axis 1)



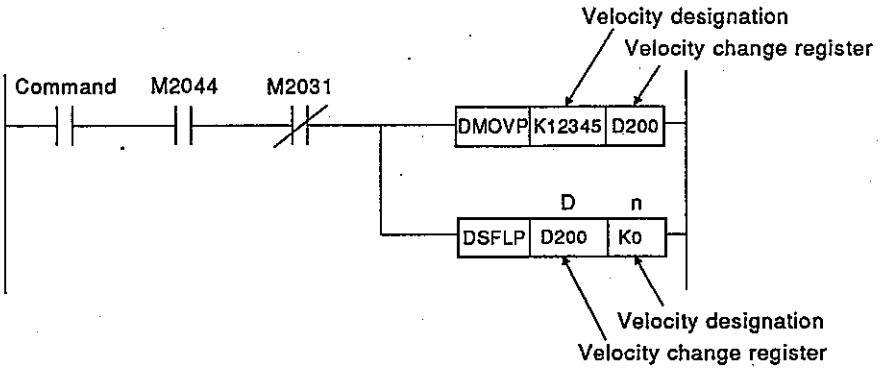
REMARKS

1) M2001: Start accept flag (See Section 4.2.2.)

2) M2044: Real mode/virtual mode status flag (See Section 4.2.14.)

3) M2021: Velocity change flag (See Section 4.2.10.)

(3) Synchronous encoder position data change program (encoder No.1 (P1))



(a) The following devices can be used for D and n in the above program.

- D ..... Data register (D)
  Link register (W)
  File register (R)
  Timer (T)
  Counter (C)
- n ..... Decimal constant (K)
  Hexadecimal constant (H)

(b) The method of designating the encoder No. is as follows.

- Encoder No.1 ..... K2/H2
- Encoder No.2 ..... K3/H3
- Encoder No.3 ..... K4/H4

(c) Precautions

- When the position data of a synchronous encoder is changed in real mode, an error occurs and position data is not changed.
- Position data change of a synchronous encoder is executed even during virtual mode operation (while pulses are being input from the synchronous encoder).
  If position data change is executed, feed position data of synchronous encoder starts with the changed position data.
- Even if position data of the synchronous encoder is changed, the position data of the output module is not affected.

REMARKS

1) M2044: Real mode/virtual mode status flag (See Section 4.2.14.)

2) M2031: Velocity change flag (See Section 4.2.10.)

IMPORTANT

(1) Design the configuration of a system to provide an external protective or safety inter locking circuit for the PCs.

(2) The components on the printed circuit boards will be damaged by static electricity, so avoid handling them directly. If it is necessary to handle them take the following precautions.

(a) Ground human body and work bench.

(b) Do not touch the conductive areas of the printed circuit board and its electrical parts with and non-grounded tools etc.

Under no circumstances will Mitsubishi Electric be liable or responsible for any consequential damage that may arise as a result of the installation or use of this equipment.

All examples and diagrams shown in this manual are intended only as an aid to understanding the text, not to guarantee operation. Mitsubishi Electric will accept no responsibility for actual use of the product based on these illustrative examples.

Owing to the very great variety in possible applications of this equipment, you must satisfy yourself as to its suitability for your specific application.

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IB (NA) 66423-A (9305) MEE Printed in Japan