CONTENTS

7. POSITIONING CONTROL

This section describes the positioning control methods.

7.1 Basics of Positioning Control

This section describes the common items for positioning control, which is described in detail from Section 7.2.

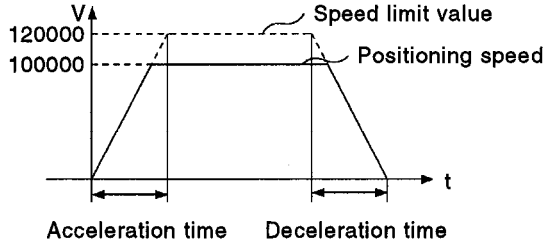
7.1.1 Positioning speed

The positioning speed is set using a servo program.
See Section 6 for details about servo programs.
The actual positioning speed is determined by the positioning speed setting in the servo program and the speed limit value, according to the following relationship:

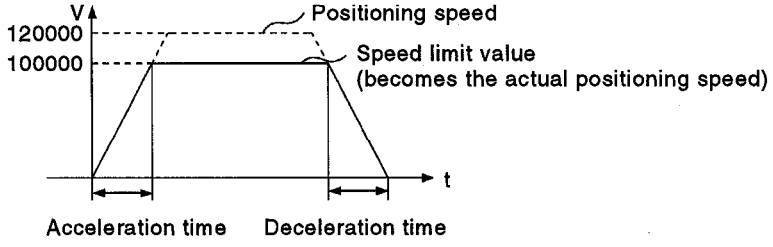
- if positioning speed setting < speed limit value
  positioning occurs at set positioning speed;
- if positioning speed setting > speed limit value
  positioning occurs at speed limit value.

Examples

(1) If the speed limit value is 120,000 mm/min. and the positioning speed setting is 100,000 mm/min., the positioning speed is controlled as follows.



(2) If the speed limit value is 100,000 mm/min. and the positioning speed setting is 120,000 mm/min., the positioning speed is controlled as follows.



7.1.2 Positioning speed under interpolation control

The positioning speed of the servo system CPU determines the travel speed of the controlled system.

(1) One-axis linear control
Under 1-axis control, the travel speed is the positioning speed of the designated axis.

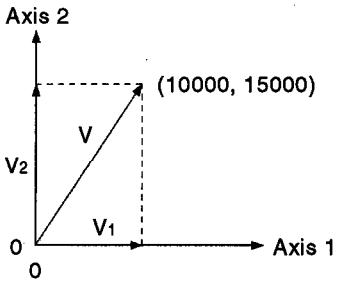
(2) Linear interpolation control
Under linear interpolation control, the controlled system is controlled at the set speed.
The positioning speed can be set for 2- to 4-axis control using one of the following three methods:
- resultant speed designation
- long-axis speed designation
- reference-axis speed designation

Details of the servo system CPU control for each of these three methods are described below.

(a) Resultant speed designation
The servo system CPU uses the travel value of each axis (D_1 to D_4) to calculate the positioning speed of each axis (V_1 to V_4) from the set positioning speed (V) of the controlled system.
The positioning speed of the controlled system is called the resultant speed.
Set the resultant speed and the travel value of each axis in the servo program.

---- Example ----

2-axis linear interpolation control



Axis 1 travel value:
D_1 = 10,000 (pulses)
Axis 2 travel value:
D_2 = 15,000 (pulses)
Resultant speed:
V = 7,000 (pulse/sec.)

[Program Example]

```
<K 50>
ABS-2
  Axis          1,      10000 (PLS)
  Axis          2,      15000 (PLS)
  Resultant speed        7000 (PLS/sec)
```

The servo system CPU calculates the positioning speed of each axis from the above conditions, using the following calculation formulas:

Axis 1 positioning speed: $V_1 = V \times D_1/\sqrt{D_1^2+D_2^2}$
Axis 2 positioning speed: $V_2 = V \times D_2/\sqrt{D_1^2+D_2^2}$

(b) Long-axis speed designation

The control of each axis is based on the positioning speed (long-axis speed: V) set for the axis whose positioning address is the greatest distance from the current position.

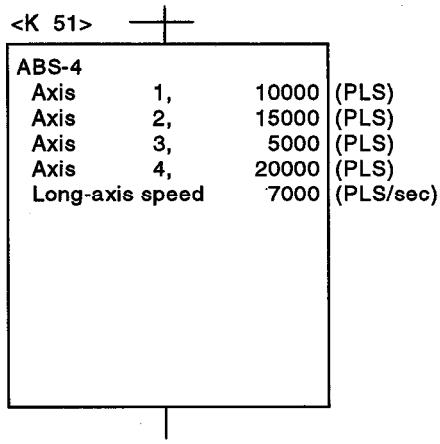
The servo system CPU uses the travel value of each of the other axes (D_1 to D_4) to calculate the positioning speed of each axis (V_1 to V_4). Set the long-axis speed and the travel value of each axis in the servo program.

Example

4-axis linear interpolation control

Axis 1 travel value:
D_1 = 10,000 pulses
Axis 2 travel value:
D_2 = 15,000 pulses
Axis 3 travel value:
D_3 = 5,000 pulses
Axis 4 travel value:
D_4 = 20,000 pulses
Long-axis speed:
V = 7,000 pulse/sec.

[Program Example]



In this example, the reference axis is Axis 4, which has the greatest travel value. The positioning speed of Axis 4 is the set long-axis positioning speed.
The servo system CPU calculates the positioning speed of each of the other axes using the following calculation formulas:

Axis 1 positioning speed: $V_1 = D_1/D_4 \times V$
Axis 2 positioning speed: $V_2 = D_2/D_4 \times V$
Axis 3 positioning speed: $V_3 = D_3/D_4 \times V$

Conversions are conducted as follows if the control units are not identical for each axis.

1) Combination of axes set in millimeters and inches
   a) If interpolation control units are millimeters
      • Travel value: For axes set to inches, the travel value is converted to millimeters using the formula: inch set value × 25.4 = mm set value.
      • Speed : Speed control of each axis is based on the long-axis speed, which is the positioning speed of the axis with the greatest travel value after conversion.
   b) If interpolation control units are inches
      • Travel value: For axes set to millimeters, the travel value is converted to inches using the formula: mm set value ÷ 25.4
      • Speed : Speed control of each axis is based on the long-axis speed, which is the positioning speed of the axis with the greatest travel value after conversion.

2) Discrepancy between interpolation control units and control units
   - Travel value: The electronic gear converts the travel value for the axis to pulses.
   - Speed : Speed control of each axis is based on the long-axis speed, which is the positioning speed of the axis with the greatest travel value after conversion.
     For axes where interpolation control units and control units match, the electronic gear converts the positioning speed to units of pulse/sec. and this speed is used as the long-axis speed.

POINTS

(1) Speed limit value and positioning speed
   - The set speed limit value applies to the long-axis speed.
   - Note that the resultant speed may exceed the speed limit value if long-axis speed designation is used.

---- Example ----

During 2-axis linear interpolation with the following settings, the resultant speed exceeds the speed limit value.

Axis 1 travel value: 100 pulses
Axis 2 travel value: 200 pulses
Long-axis speed: 50 pulse/sec.
Speed limit value: 55 pulse/sec.

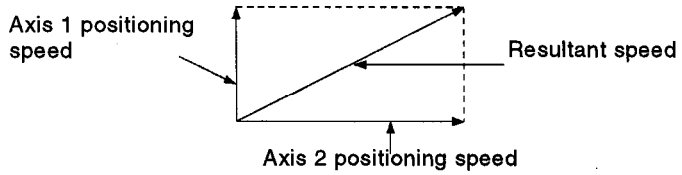
[Program Example]

<K 2>

```
INC-2
 Axis          1,        100 (PLS)
 Axis          2,        200 (PLS)
 Long-axis speed          50 (PLS/sec)
```

In this example, the reference axis is Axis 2, which has the greatest travel value; therefore the set speed limit value applies to Axis 2.
In this case, the positioning speed of each axis and the resultant speed are as follows:

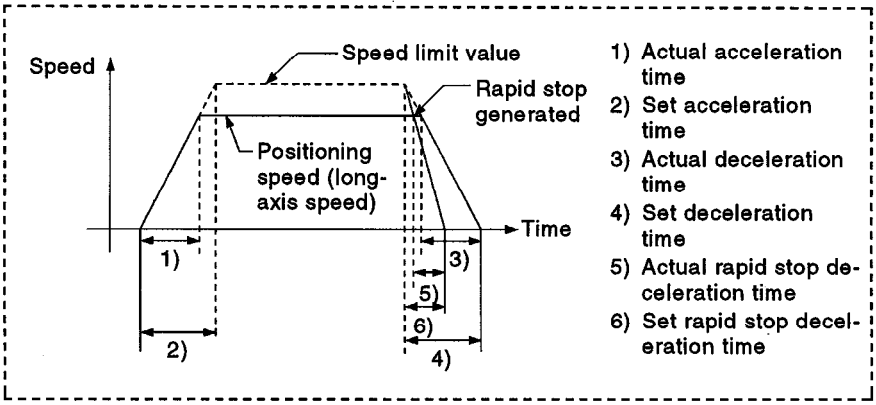
Axis 1 positioning speed: $(100/200) \times 50 = 25$ pulse/sec.
Axis 2 positioning speed: 50 pulse/sec.
Resultant speed: $\sqrt{25^2 + 50^2} = 55.9$ pulse/sec.



The resultant speed exceeds the speed limit value setting of 55.

(2) Relationship between speed limit value, acceleration time, deceleration time, and rapid stop deceleration time

- The actual acceleration time, deceleration time, and rapid stop deceleration time are determined by the long-axis speed setting.



(c) Reference-axis speed designation

The servo system CPU uses the travel value of each axis (D_1 to D_4) to calculate the positioning speed of each axis (V_1 to V_4) from the set positioning speed of the reference axis (reference axis speed: V). Set the reference axis number, reference axis speed, and the travel value of each axis in the servo program.

Example

4-axis linear interpolation control

Axis 1 travel value:
D_1 = 10,000 pulses
Axis 2 travel value:
D_2 = 15,000 pulses
Axis 3 travel value:
D_3 = 5,000 pulses
Axis 4 travel value:
D_4 = 20,000 pulses
Reference axis speed:
V = 7,000 pulse/sec.
Reference axis number: Axis 4

[Program Example]

<K 52>

```
ABS-4
  Axis          1,        10000 (PLS)
  Axis          2,        15000 (PLS)
  Axis          3,         5000 (PLS)
  Axis          4,        20000 (PLS)
  Reference axis speed 7000 (PLS/sec)
  Reference axis number    4
```

In this example, Axis 4 is set as the reference axis and the control is based on the positioning speed of Axis 4.
The servo system CPU calculates the positioning speed of each of the other axes using the following calculation formulas:

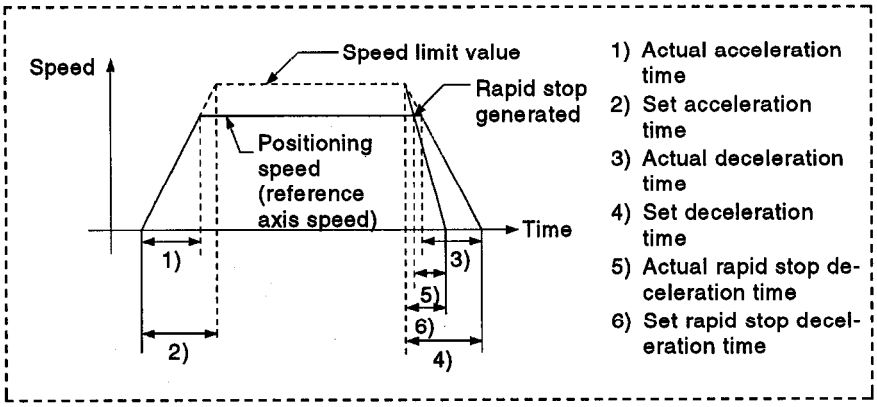
Axis 1 positioning speed: $V_1 = D_1/D_4 \times V$
Axis 2 positioning speed: $V_2 = D_2/D_4 \times V$
Axis 3 positioning speed: $V_3 = D_3/D_4 \times V$

POINTS

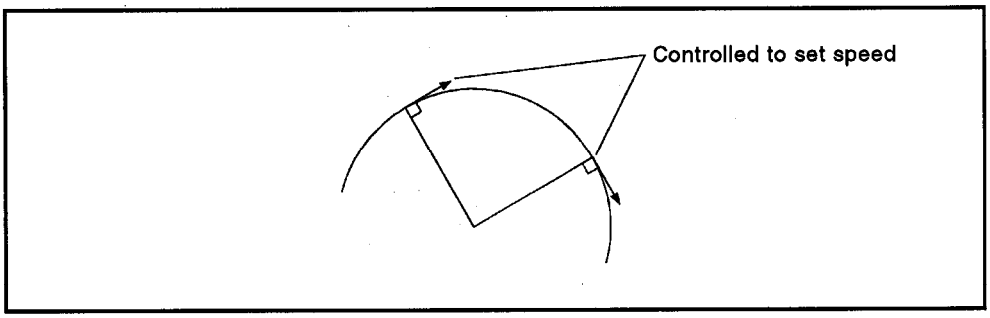
(1) Reference axis speed and positioning speed of other axes
- Note that the positioning speed of an axis with a greater travel value than the reference axis will exceed the set reference axis speed.

(2) Indirect designation of reference axis
- The reference axis can be indirectly designated using word devices D and W. See Section 6.4.2.

(3) Relationship between speed limit value, acceleration time, deceleration time, and rapid stop deceleration time
- The actual acceleration time, deceleration time, and rapid stop deceleration time are determined by the reference axis speed setting.



(3) Circular interpolation control
Under circular interpolation control, the angular speed is controlled to the set speed.



7.1.3 Control units for one-axis positioning control

Positioning control of one axis is conducted in the control units designated in the fixed parameters.
(The control unit designation in the parameter block is ignored.)

7.1.4 Control units for interpolation control

(1) The interpolation control units designated in the parameter block are checked against the control units designated in the fixed parameters. For interpolation control, the result of the interpolation control units designated in the parameter block differing from the control units designated in the fixed parameters are listed in the following table.

	Interpolation Control Units in Parameter Block				Start Method
	mm	inch	degree	PULSE	
Normal start conditions	Fixed parameters designate mm and inch control units for axes.		Fixed parameters designate degree control units for axes.	Fixed parameters designate pulse control units for axes.	Control started using interpolation control units designated in the parameter block.
Unit discrepancy error (Error code 40)	Discrepancy between fixed parameter control units and the parameter block interpolation control units for all axes.				• Control started using set control units when control units match for axes under interpolation control. • Control started using the control units with the highest order of priority (see below) when control units differ for axes under interpolation control. Order or priority Pulse > degree > inch > mm <Example> If axes are set to 1000 pulses and 10.000 inch, the 10.000 inch setting is considered to be 10,000 pulses.

(2) The possible combinations of control units for interpolation control for the axes are shown in the table below.

	mm	inch	degree	PULSE
mm	1)	2)	3)	3)
inch	2)	1)	3)	3)
degree	3)	3)	1)	3)
PULSE	3)	3)	3)	1)

Remarks

1): Same units
2): Combination of mm and inches
3): Discrepancy

(a) Same units (1))
Positioning is conducted using position commands calculated from the address, travel value, positioning speed, and electronic gear.

POINT

(1) Circular interpolation control
If control units for one axis are degrees, use degrees also for the other axis.

(b) Combination of millimeters and inches (2))

- If interpolation control units are millimeters, positioning is conducted using position commands calculated from the address, travel value, positioning speed, and electronic gear, which have been converted to millimeters using the formula: inch set value × 25.4 = mm set value.
- If interpolation control units are inches, positioning is conducted using position commands calculated from the address, travel value, positioning speed, and electronic gear, which have been converted to inches using the formula: millimeter set value ÷ 25.4 = inch set value.

(c) Discrepancy (3))

- If a discrepancy exists between interpolation control units and the control units, the travel value and positioning speed are calculated for each axis.

a) The electronic gear converts the travel value for the axis to pulses.

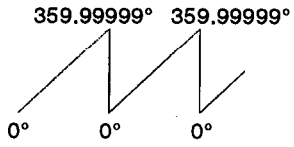
b) For axes where the units match, the electronic gear converts the positioning speed to units of pulse/sec.
Positioning is conducted using position commands calculated from travel values converted to pulses and speeds and electronic gear converted to pulses per second.

- If the interpolation control units match for two or more axes during linear interpolation with three axes or more, the positioning speed is calculated using the electronic gear for the axis with the lowest number.

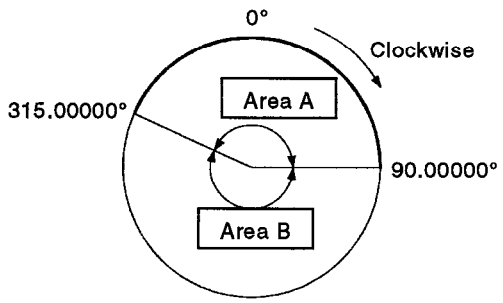
7.1.5 Control using degrees as control units

If the control units are degrees, the following items differ from when other control units are set.

(1) Present address
When degrees are set, the present addresses become ring addresses between 0° and 360°.



(2) Stroke limit valid/invalid setting
For degree settings, the upper limit value and lower limit value lie in the range between 0° and 359.99999°.
(a) If the stroke limit is valid
If the stroke limit is valid, set the stroke limit upper limit value and lower limit value in a clockwise direction.



1) For travel in area A, set the limit values as follows:
a) Stroke limit lower limit value : 315.00000°
b) Stroke limit upper limit value: 90.00000°
2) For travel in area B, set the limit values as follows:
a) Stroke limit lower limit value : 90.00000°
b) Stroke limit upper limit value: 315.00000°

(b) If the stroke limit is invalid
If the stroke limit is invalid, set the stroke limit upper limit value equal to the lower limit value.
The stroke limit settings are ignored during control.

POINT

Circular interpolation is not possible for axes set with the stroke limit invalid.

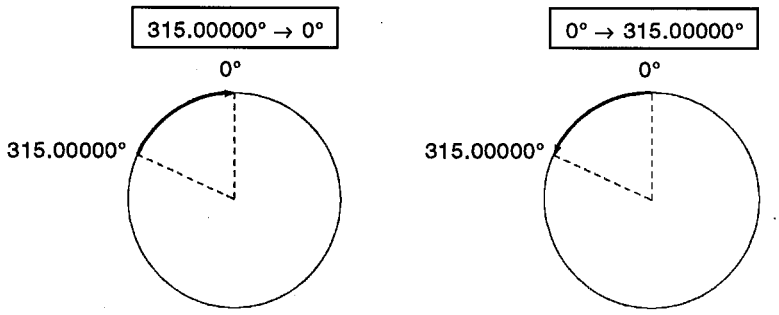
(3) Positioning control
Positioning control using degrees as control units is described below.

(a) Absolute data method (ABS □ instructions)
The absolute data method uses the present value as reference to position the axis in the shortest distance to the designated address.

---- Examples ----

(1) Positioning occurs clockwise to travel from the present value of 315.00000° to 0°.

(2) Positioning occurs counterclockwise to travel from the present value 0° to 315.00000°.

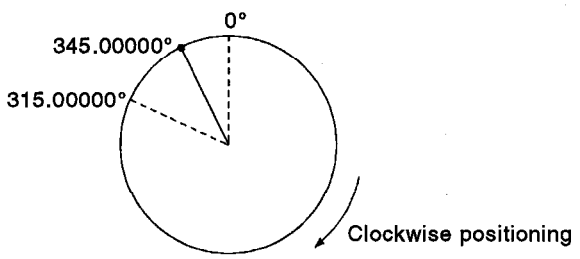


POINTS

(1) In some cases the stroke limit settings determine clockwise or counterclockwise rotation and absolute data method positioning in the shortest distance may not be possible.

---- Example ----

Travel from the present value 0° to 315.00000° must be clockwise if the stroke limit lower limit value is set to 0° and the upper limit value is set to 345.00000°.



(2) Set positioning addresses in the range between 0° and 360°.
Use the incremental method for positioning in excess of one revolution.

(b) Incremental method (INC □ instructions)
The incremental method positions the axis by a designated travel value in the designated direction.
The travel direction is designated by the sign of the travel value, as follows:

1) Positive travel value .....clockwise rotation
2) Negative travel value ....counterclockwise rotation

POINT

The incremental method permits positioning in excess of 360°.

7.1.6 Stop processing and restarting after a stop

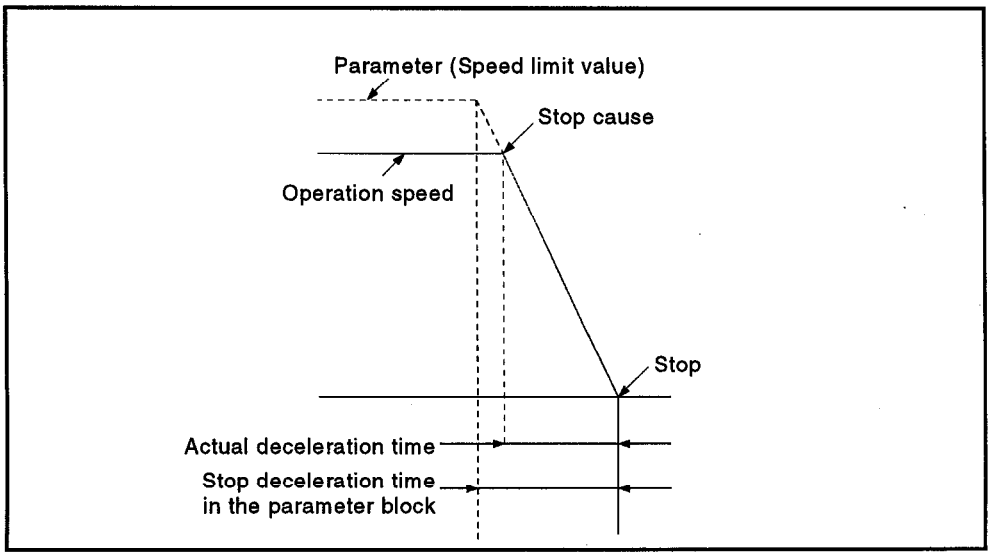
This section describes the stop processing after a stop cause is input during positioning, and restarting after a stop.

(1) Stop processing

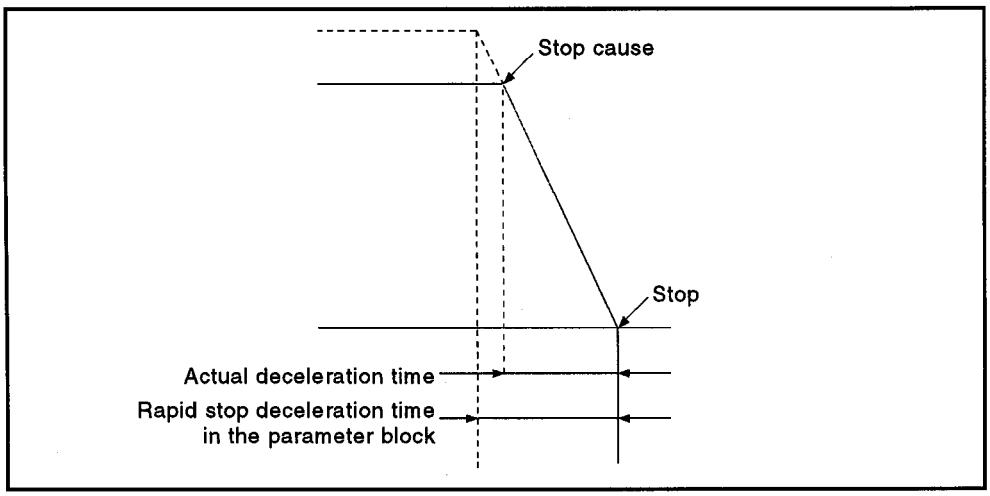
(a) Stop processing methods

Stop processing during positioning depends on the type of stop cause which was input.

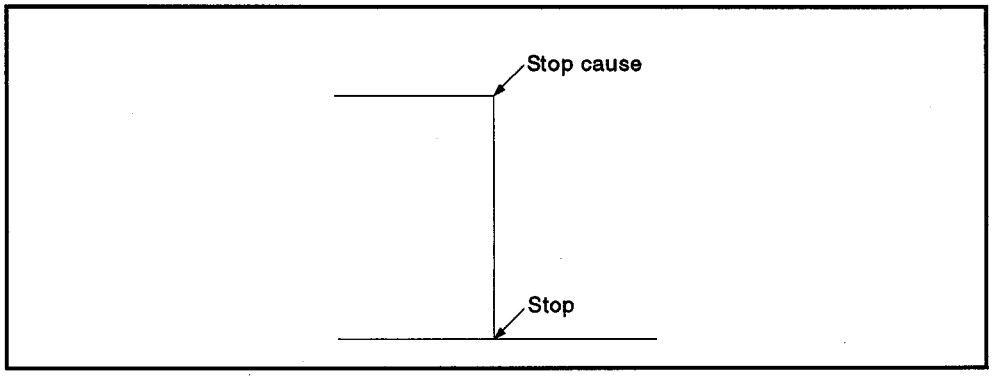
1) Deceleration stop..... Decelerates and stops according to the stop deceleration time parameter in the parameter block. (Process 1)



2) Rapid stop.....Decelerates and stops according to the rapid stop deceleration time parameter in the parameter block. (Process 2)



3) Immediate stop.....Stops without deceleration processing. (Process 3)



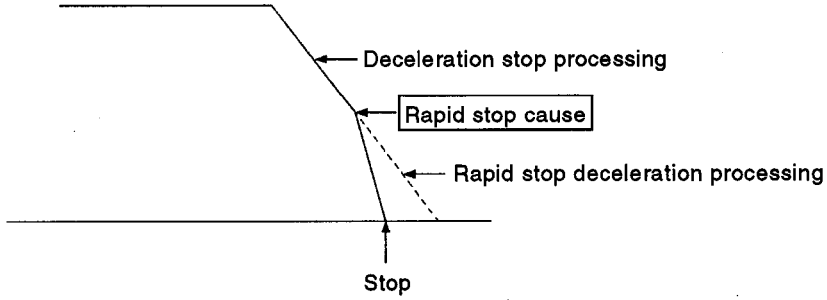
(b) Order of priority for stops
The order of priority for stops when a stop cause is input is as follows:

Process 1 < Process 2 < Process 3

Example

A rapid stop (Process 2) is started if a rapid stop cause is input during one of the following types of deceleration stop processing:

- after automatic deceleration starts during positioning control;
- during deceleration after JOG start signal turns OFF ;
- during deceleration stop processing due to a stop cause (Process 1).



(c) Stop commands and stop causes
Some stop commands and stop causes affect individual axes and others affect all axes.
However, during interpolation control, stop commands and stop causes which affect individual axes also stop the interpolation axes. For example, both Axis 1 and Axis 2 stop after input of a stop command or stop cause during interpolation control of Axis 1 and Axis 2.

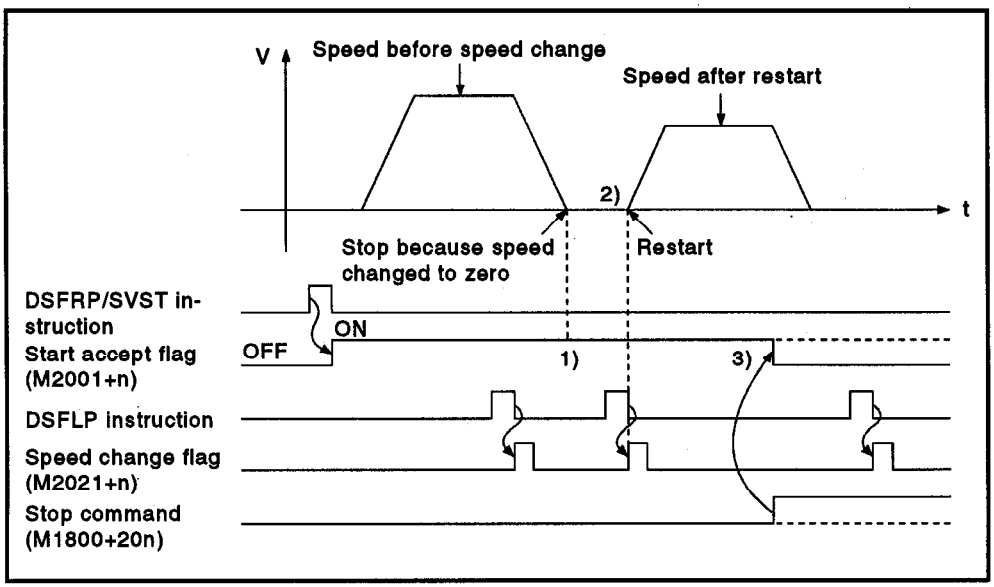
No.	Stop Cause	Individual/ All Axes	Stop					Error Processing
			Positioning Control	Speed Control	Jog Operation	Home Position Return	Manual Pulse Generator	
1	External STOP input ON	Individual	Process 1 or Process 2 (According to deceleration processing on STOP input parameter in parameter block.)				Process 3	Serious error during home position return only
2	Stop command M1800+20n/Yn0/ M3200+20n ON		Process 1					
3	Rapid stop command M1800+20n/Yn1/ M3201+20n ON		Process 2					
4	External FLS input OFF		Process 1 or Process 2 (According to deceleration processing on STOP input parameter in parameter block.)					
5	External RLS input OFF							
6	Servo error detect M1608+20n/Xn8/ M2408+20n ON		Process 3					
7	PC ready M2000 OFF	All	Process 1					
8	Emergency stop from exterior*2, BREAK key pressed		Process 2					
9	Servo system CPU stop		Process 1					
10	Servo system reset		Process 3*1					—
11	PCPU WDT error		Process 3*1					M9073 (WDT error) ON
12	SCPU WDT error		Process 1					—
13	Servo system CPU power off		Process 3*1					—
14	Servo amplifier power off	Individual	Process 3*1					Serious error at start-up (no servo)
15	Speed changed to zero	Individual*3	Process 1					—

*1: Emergency stop due to H/W
*2: Test mode
*3: Applies to all axes set to speed = 0 in servo program.

(2) Restarting after a Stop

(a) Control cannot be restarted after a stop command or stop cause (except changing speed to zero).
However, restarting is possible using the VSTART instruction after a stop due to the external STOP input, the stop command (M1800+20n) turning ON, or the rapid stop command (M1801+20n) turning ON during speed/position switching control.

(b) When the stop is caused by a speed change to speed "0"
When a speed change to speed "0" is executed in the DSFLP instruction, operation can be restarted by executing another speed change to a speed other than "0".

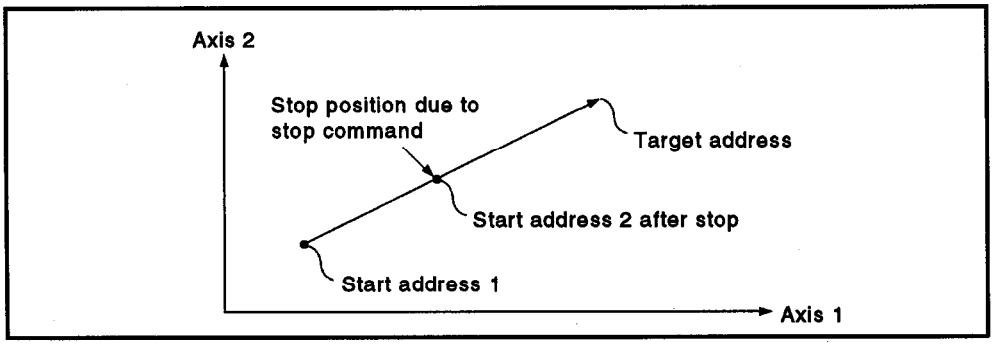


1) The start accept flag M2001+n remains ON after a stop due to changing the speed to zero.
2) Restart after changing the speed again.
3) However, control cannot be restarted after the speed is changed if the start accept flag M2001+n is turned OFF due to the stop command (M1800+20n) turning ON.

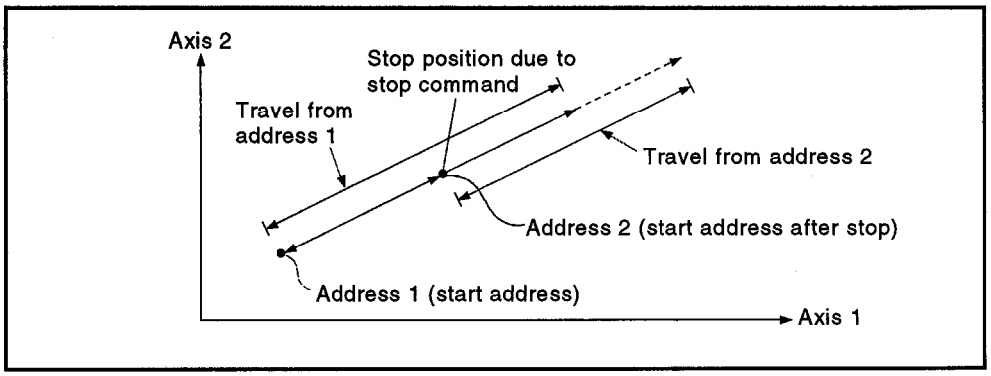
(3) Continuing positioning control
This section describes the method to continue control from the servo program number where the stop was applied by turning ON the external STOP input, the stop command (M1800+20n), or the rapid stop command (M1801+20n).

(a) One-axis linear control/2- or 3-axis linear interpolation control

1) Absolute data method...As a target address is designated, positioning control is possible from the stop address to the target address.

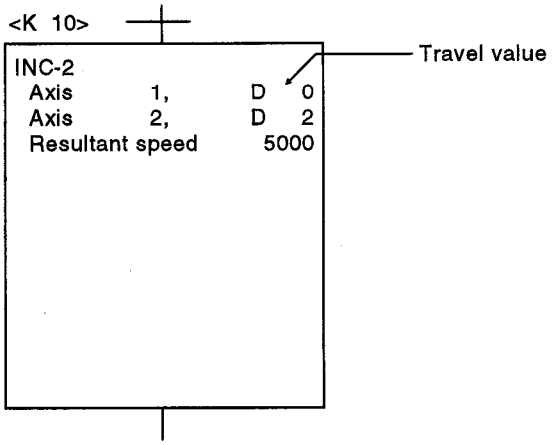


2) Incremental method.....Positioning control of the travel value from the stop address.



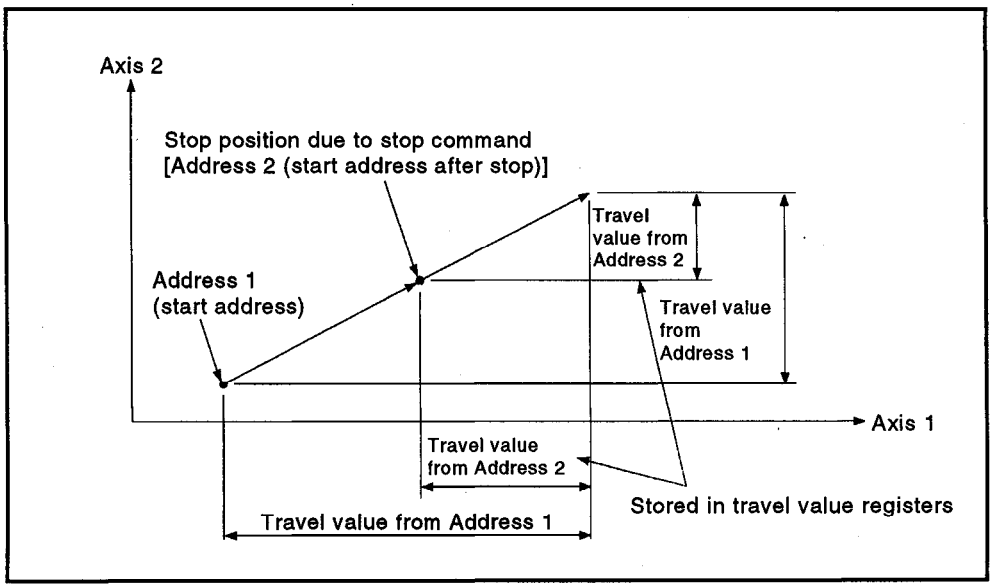
To use the incremental method to travel to the original address (calculated from start address + designated travel value) from address 2, requires the following processing in the servo program and sequence program.

[Servo Program]
Use word devices for indirect designation of the travel value in the positioning control servo program.



[Processing in the Sequence Program]

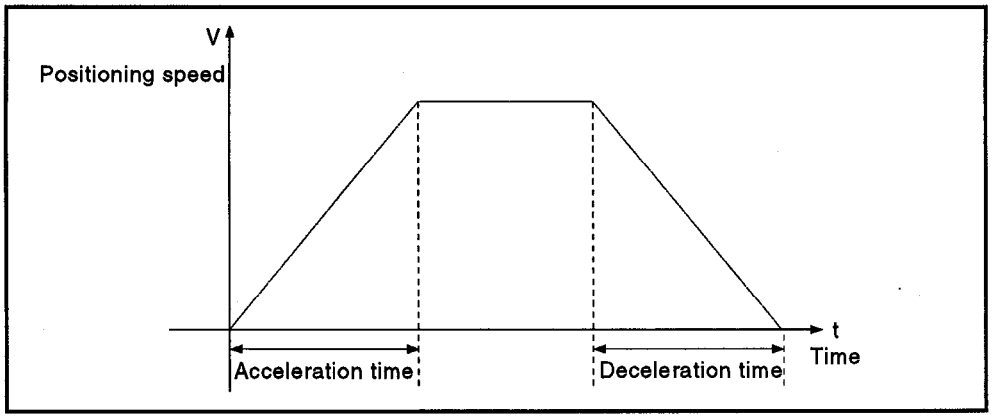
1. Before starting, transfer the start address to the servo system CPU word devices.
2. Add the travel value to the start address to calculate the target address.
3. Subtract the stop address from the target address to calculate the residual travel value.
4. Store the residual travel value in the servo program travel value register.
5. Run the servo program from the sequence program.



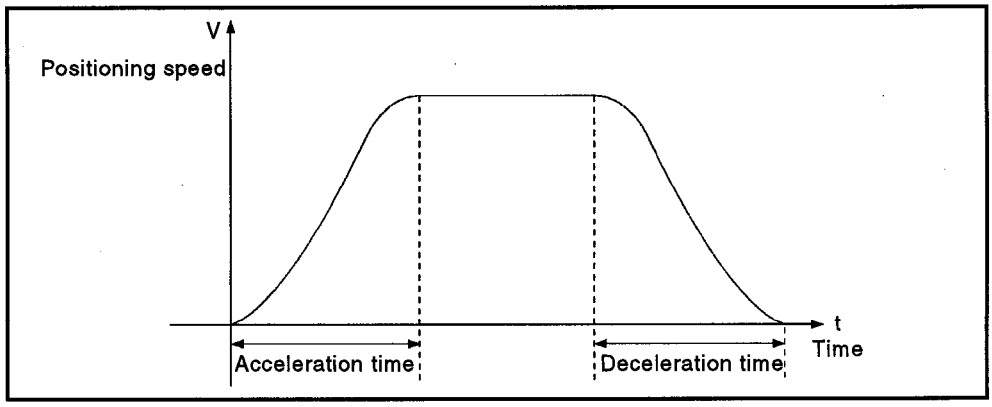
7.1.7 Acceleration and deceleration processing

Acceleration and deceleration are processed by the two methods described below.

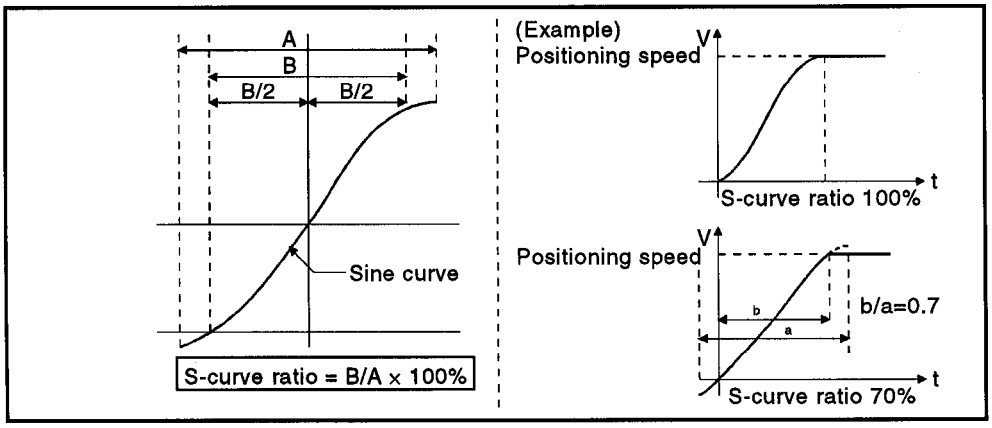
(1) Trapezoidal acceleration and deceleration processing
The conventional linear acceleration and deceleration processing. The acceleration and deceleration graph resembles a trapezoid, as shown in the diagram below.
The acceleration and deceleration times are set automatically.



(2) S-curve acceleration and deceleration processing
The S-curve ratio is set as a parameter to provide gentler acceleration and deceleration than trapezoidal processing. The acceleration and deceleration graph is sinusoidal, as shown in the diagram below.
Set the S-curve ratio in the parameter block (see Section 4.4.2) or in a servo program.

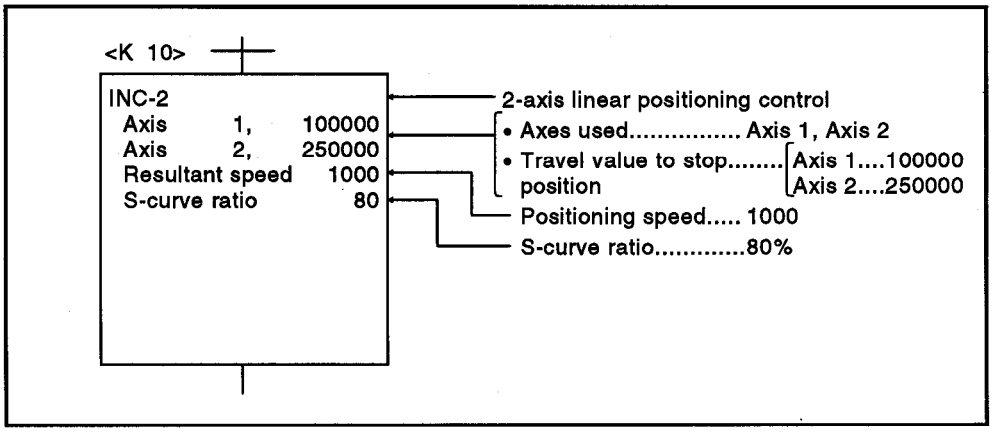


As shown in the diagram below, the S-curve ratio sets the part of the sine curve used to produce the acceleration and deceleration curve.



The S-curve ratio can be set by a servo program using one of two methods.

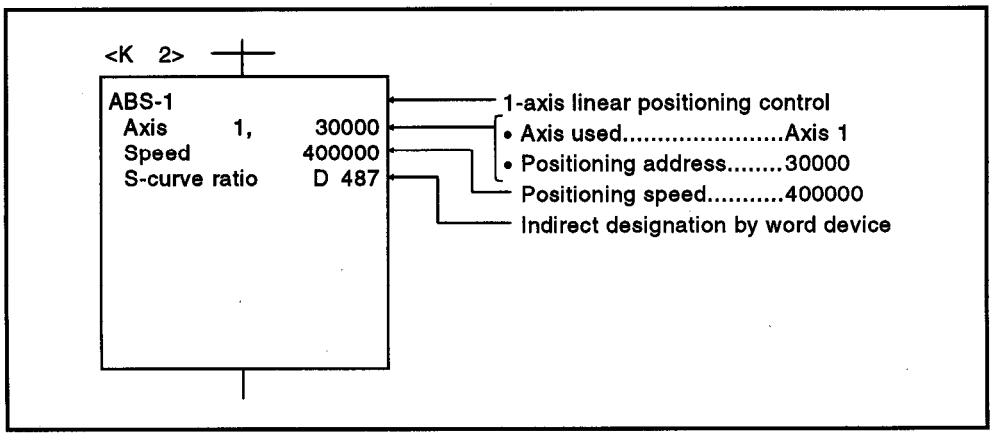
(a) Direct designation
The S-curve ratio is designated directly as a numeric value from 0 to 100.



(b) Indirect designation
The S-curve ratio is set by the contents of the data registers.
The available data registers are shown below.

Word Device	CPU		
	A171S	A273UH (8-Axis Specification)	A273UH (32-Axis Specification)
D	0 to 799	0 to 8191*1	800 to 8191
W	0 to 3FF	0 to 1FFF	0 to 1FFF

*1: Excluding 800 to 1023



7.2 One-Axis Linear Positioning Control

Positioning control of the designated axis from the present stop position to a fixed position.
Positioning control uses ABS-1 (absolute data method) and INC-1 (incremental method) servo instructions.

Servo Instruction	Positioning Method	Number of Controllable Axes	Items Set by Peripherals: Common: Parameter Block No.	Common: Axis	Common: Address/Travel Value	Common: Commanded Speed	Common: Dwell Time	Common: M Code	Common: Torque Limit Value	Arc: Auxiliary Point	Arc: Radius	Arc: Center Point	Parameter Block: Control Units	Parameter Block: Speed Limit Value	Parameter Block: Acceleration Time	Parameter Block: Deceleration Time	Parameter Block: Rapid Stop Deceleration Time	Parameter Block: Torque Limit Value	Parameter Block: Deceleration Processing on Stop Input	Parameter Block: Allowable Error Range for Circular Interpolation	Parameter Block: S-Curve Ratio	Others: Cancel	Others: Start	Speed Change
ABS-1	Absolute data	1	Δ	O	O	O	Δ	Δ						Δ	Δ	Δ	Δ	Δ	Δ		Δ	Δ	Δ	OK
INC-1	Incremental																							

O : Must be set
Δ : Set if required

[Control Details]

Control with ABS-1 (absolute data method).

(1) Positioning control from the present stop address (pre-positioning address) to the designated address, using the home position as the reference.

(2) The travel direction is determined from the present stop address and the designated address.

Example

The travel direction is shown below if the present stop address is 1000, and the designated address is 8000.

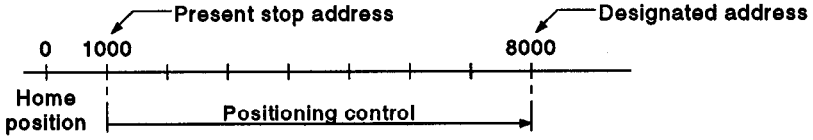


Figure 7.1 Positioning by Absolute Data Method

Control with INC-1 (incremental method)

(1) Positioning control of a designated travel value from the present stop position.

(2) The travel direction is designated by the sign of the travel value, as follows:
- Positive travel value.....forward direction (increased address)
- Negative travel value.....reverse direction (decreased address)

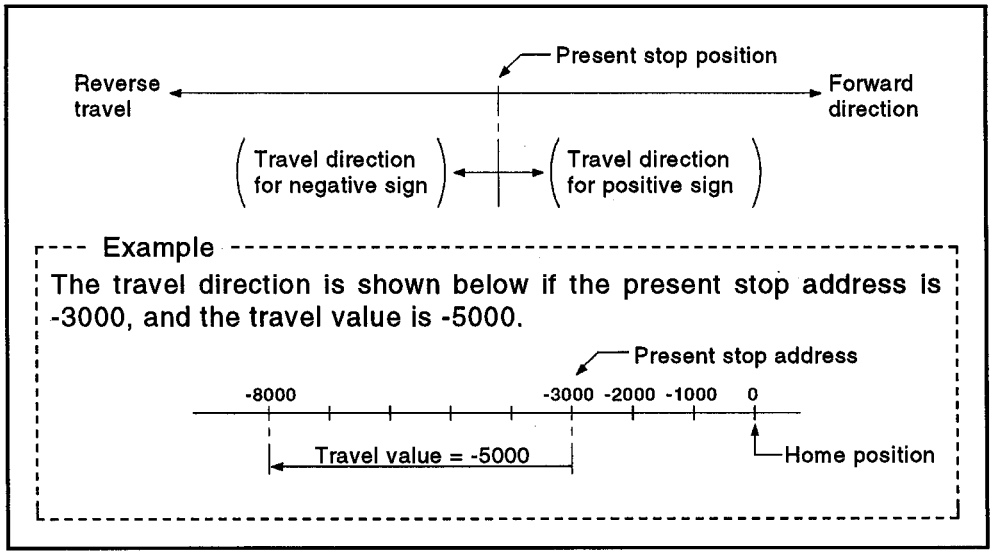
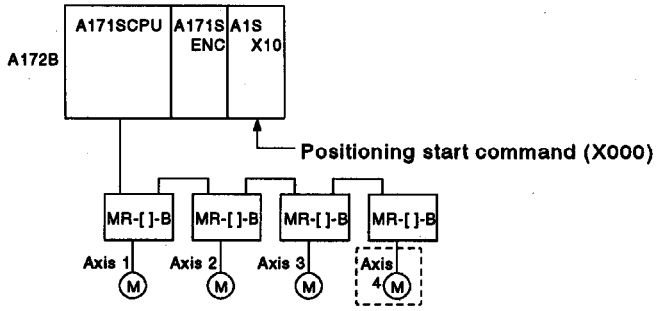


Figure 7.2 Positioning by Incremental Method

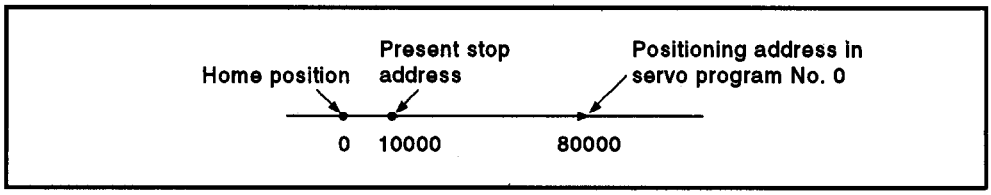
[Program Example]

This program conducts positioning control using servo program No. 0 under the conditions below.

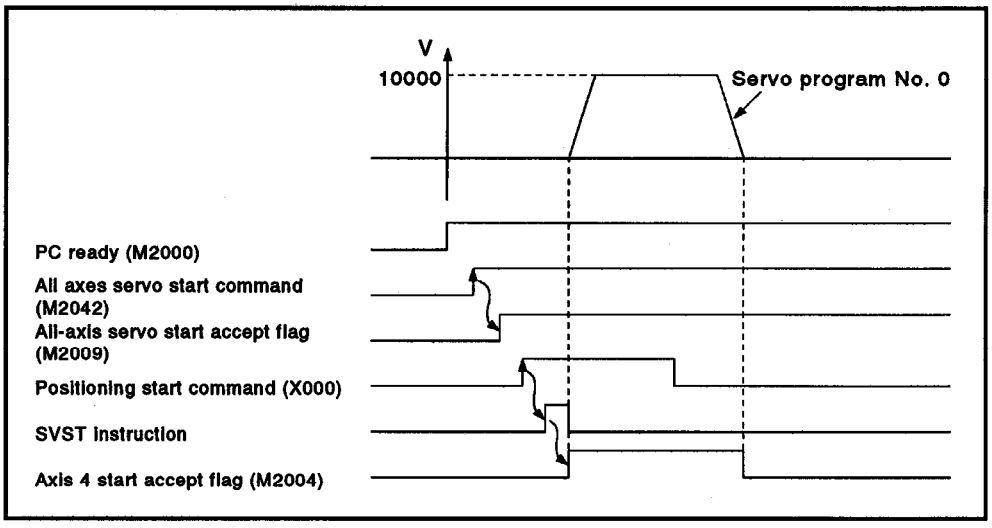
(1) System configuration
One-axis linear positioning control of Axis 4.



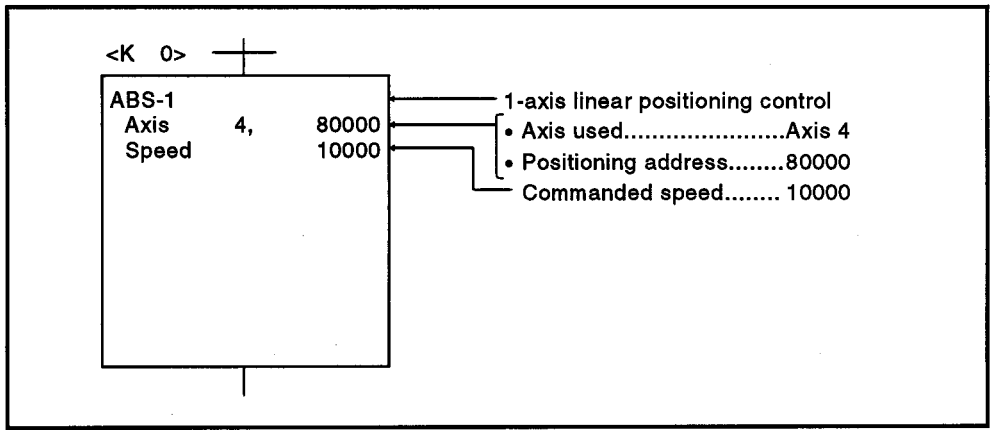
(2) Positioning details
The positioning by servo program No. 0 is shown in the diagram below.
In this example, Axis 4 is used in servo program No. 0 .



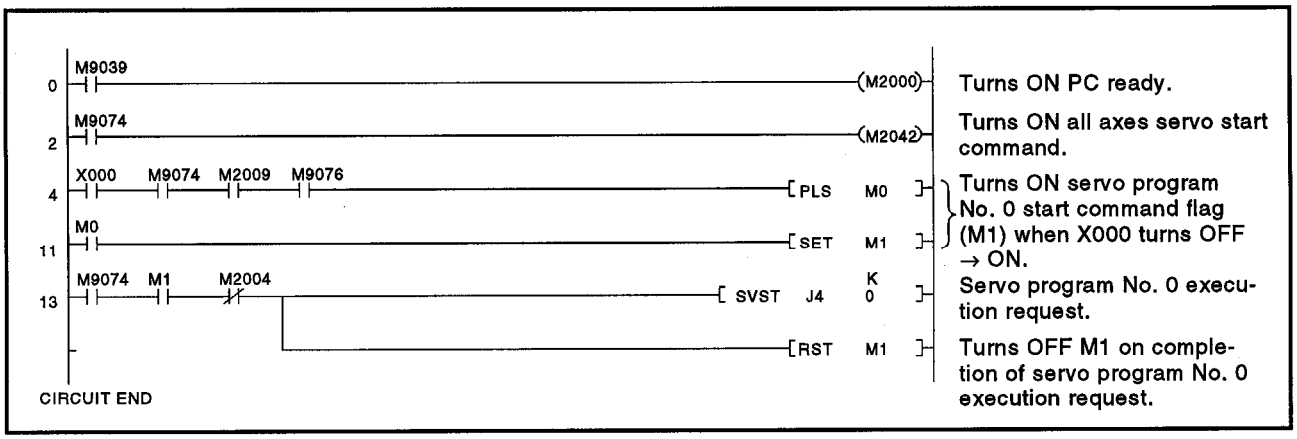
(3) Operation timing
The operation timing for servo program No. 0 is shown below.



(4) Servo program example
The servo program No. 0 for positioning control is shown below.



(5) Sequence program example
The sequence program which runs the servo program is shown below.



7.3 Two-Axis Linear Interpolation Control

Linear interpolation control from the present stop position with the two axes designated in the sequence program positioning commands.
Two-axis linear interpolation control uses ABS-2 (absolute data method) and INC-2 (incremental method) servo instructions.

Servo Instruction	Positioning Method	Number of Controllable Axes	Items Set by Peripherals																						Speed Change
			Common							Arc			Parameter Block										Others		
			Parameter Block No.	Axis	Address/Travel Value	Commanded Speed	Dwell Time	M Code	Torque Limit Value	Auxiliary Point	Radius	Center Point	Control Units	Speed Limit Value	Acceleration Time	Deceleration Time	Rapid Stop Deceleration Time	Torque Limit Value	Deceleration Processing on Stop Input	Allowable Error Range for Circular Interpolation	S-Curve Ratio	Cancel	Start	
ABS-2	Absolute data	2	Δ	O	O	O	Δ	Δ					Δ	Δ	Δ	Δ	Δ	Δ	Δ		Δ	Δ	Δ	OK
INC-2	Incremental																							

O : Must be set
Δ : Set if required

[Control Details]

Control with ABS-2 (absolute data method)

(1) Linear interpolation with two axes from the present stop address (X_1, Y_1) to the designated address (X_2, Y_2), using the home position as the reference.

(2) The travel direction is determined from the stop addresses and designated addresses for the respective axes.

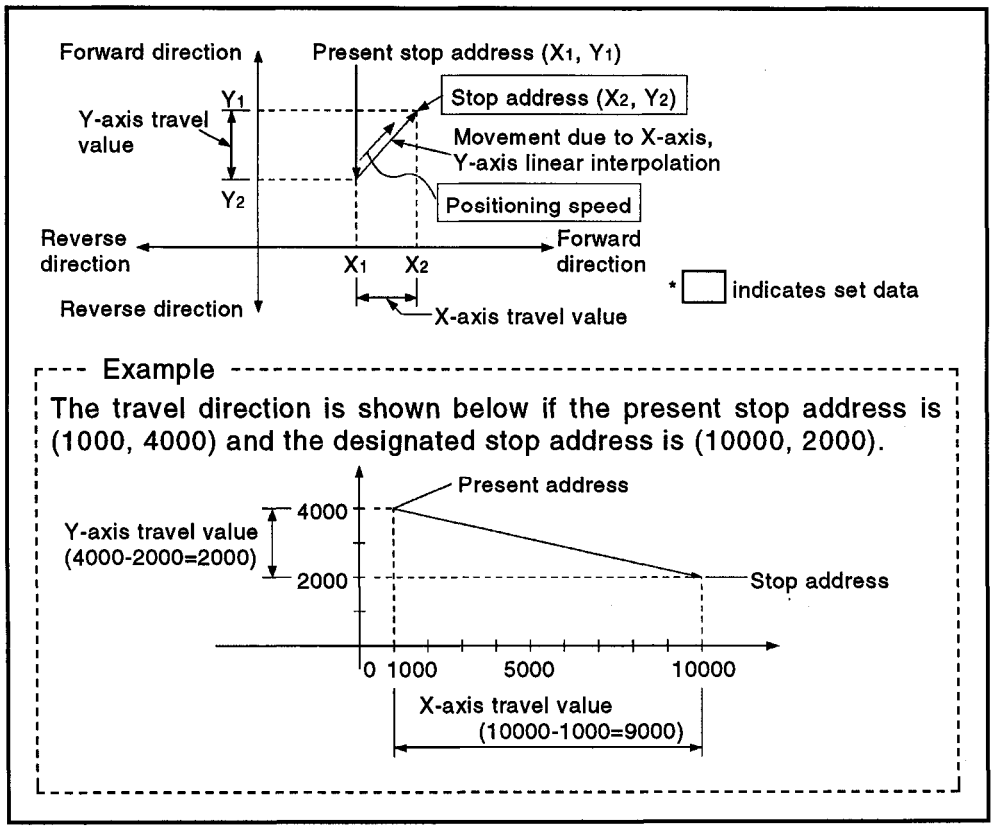


Figure 7.3 Positioning by Absolute Data Method

Control with INC-2 (incremental method)

(1) Positioning control from the present stop position to the position which is the resultant of the designated travel directions and travel values of the respective axes.

(2) The travel direction of each axis is designated by the sign of the travel value, as follows:
- Positive travel value.....forward direction (increased address)
- Negative travel value.....reverse direction (decreased address)

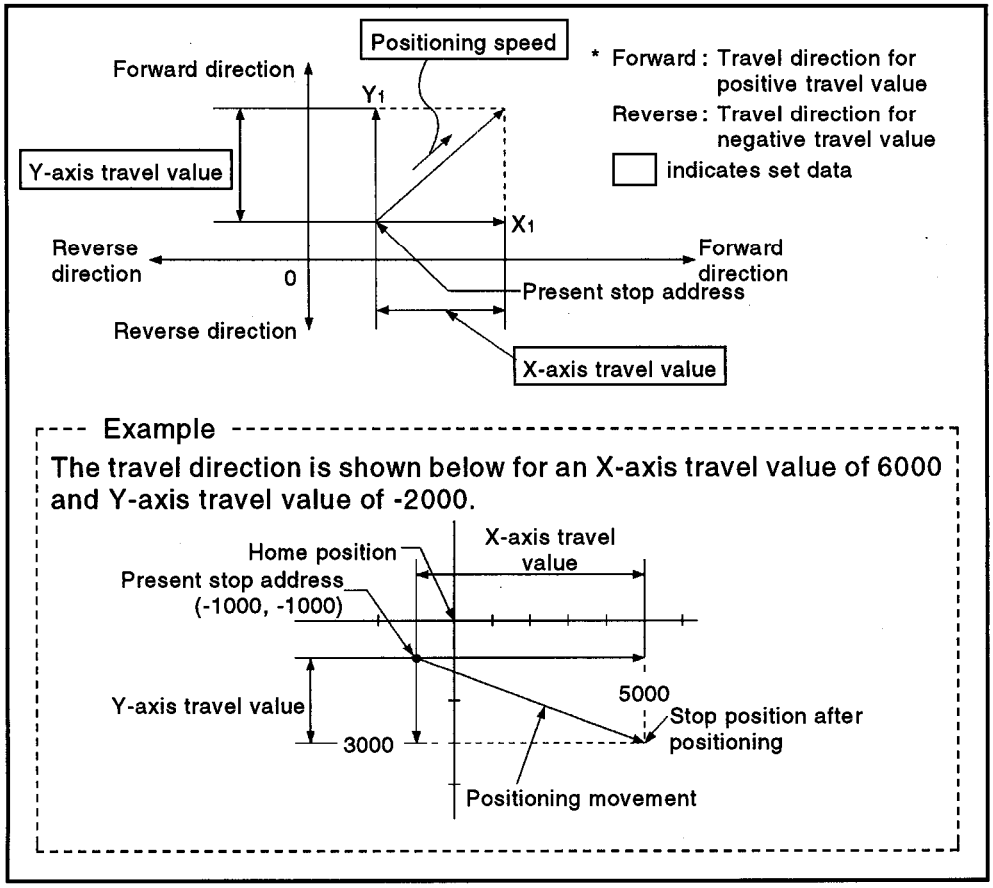
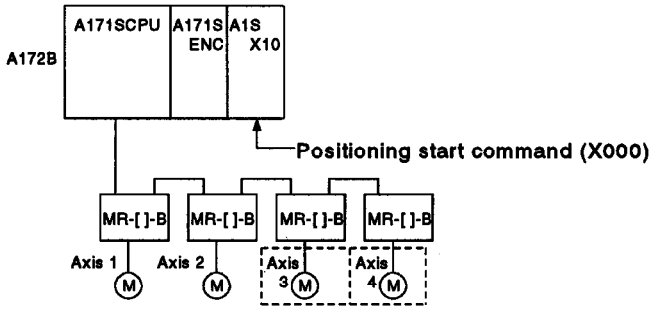


Figure 7.4 Positioning by Incremental Method

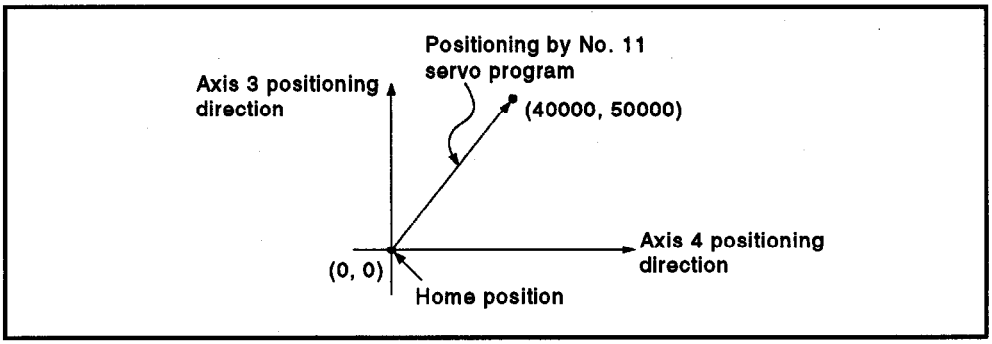
[Program Example]

This program conducts 2-axis linear interpolation control under the conditions below.

(1) System configuration
Two-axis linear interpolation control of Axis 3 and Axis 4.



(2) Positioning details
The positioning by the Axis 3 and Axis 4 servomotors is shown in the diagram below.

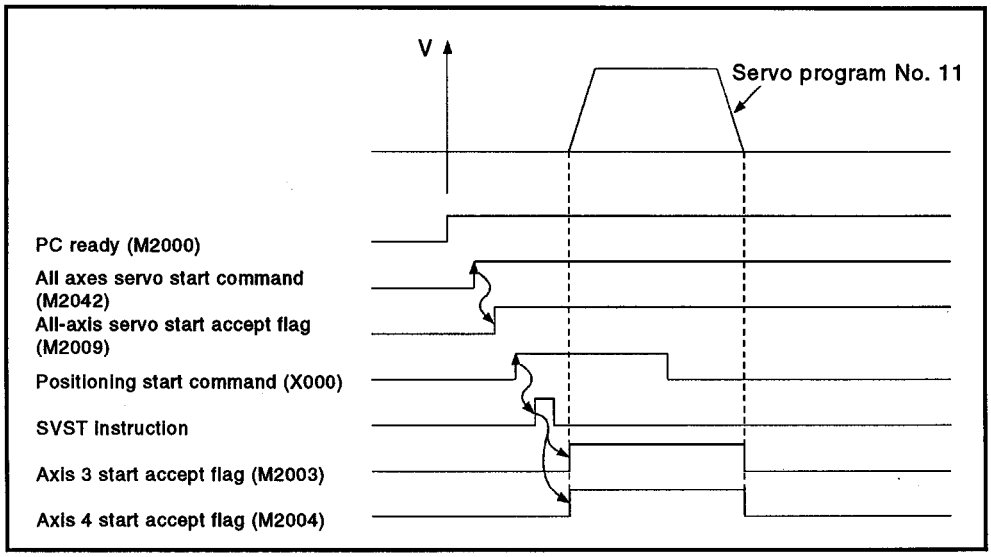


(3) Positioning conditions
(a) The positioning conditions are shown below.

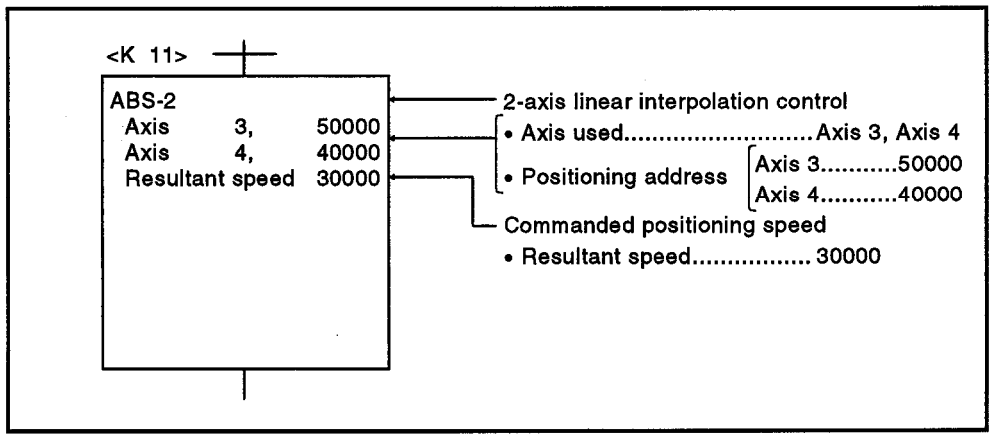
Item	Servo Program Number
	No. 11
Positioning speed	30000

(b) Positioning start..... leading edge of X000 (OFF → ON)

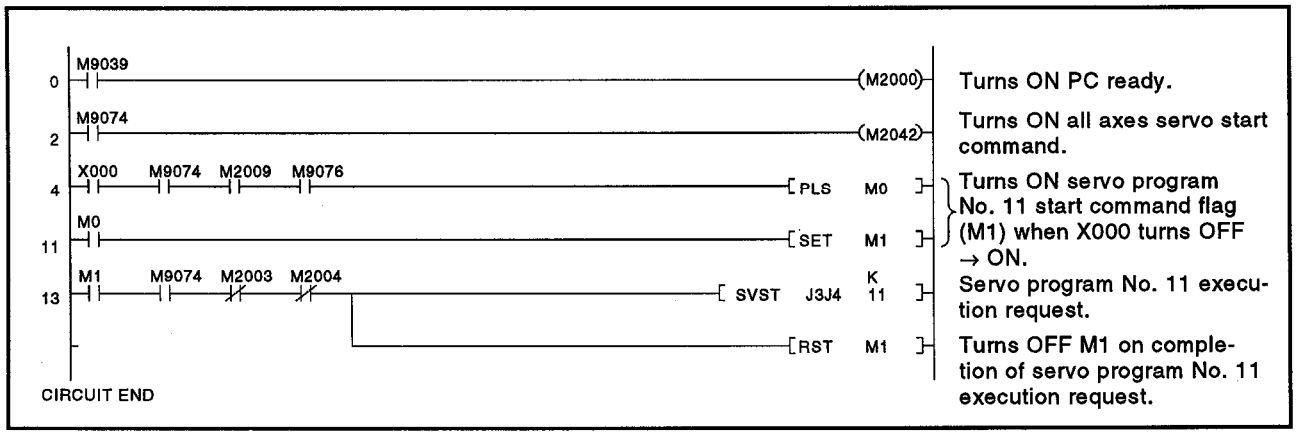
(4) Operation timing
The operation timing for 2-axis linear interpolation control is shown below.



(5) Servo program
The servo program No. 11 for 2-axis linear interpolation control is shown below.



(6) Sequence program
The sequence program which runs the servo program is shown below.



7.4 Three-Axis Linear Interpolation Control

Linear interpolation control from the present stop position with the three axes designated in the sequence program positioning commands.

Servo Instruction	Positioning Method	Number of Controllable Axes	Items Set by Peripherals: Common: Parameter Block No.	Common: Axis	Common: Address/Travel Value	Common: Commanded Speed	Common: Dwell Time	Common: M Code	Common: Torque Limit Value	Arc: Auxiliary Point	Arc: Radius	Arc: Center Point	Parameter Block: Control Units	Parameter Block: Speed Limit Value	Parameter Block: Acceleration Time	Parameter Block: Deceleration Time	Parameter Block: Rapid Stop Deceleration Time	Parameter Block: Torque Limit Value	Parameter Block: Deceleration Processing on Stop Input	Parameter Block: Allowable Error Range for Circular Interpolation	Parameter Block: S-Curve Ratio	Others: Cancel	Others: Start	Speed Change
ABS-3	Absolute data	3	Δ	O	O	O	Δ	Δ					Δ	Δ	Δ	Δ	Δ	Δ	Δ		Δ	Δ	Δ	OK
INC-3	Incremental																							

O : Must be set
Δ : Set if required

[Control Details]

Control with ABS-3 (absolute data method)

(1) Linear interpolation with three axes from the present stop address (X_1, Y_1, Z_1) to the designated address (X_2, Y_2, Z_2), using the home position as the reference.

(2) The travel direction is determined from the stop addresses and designated addresses for the respective axes.

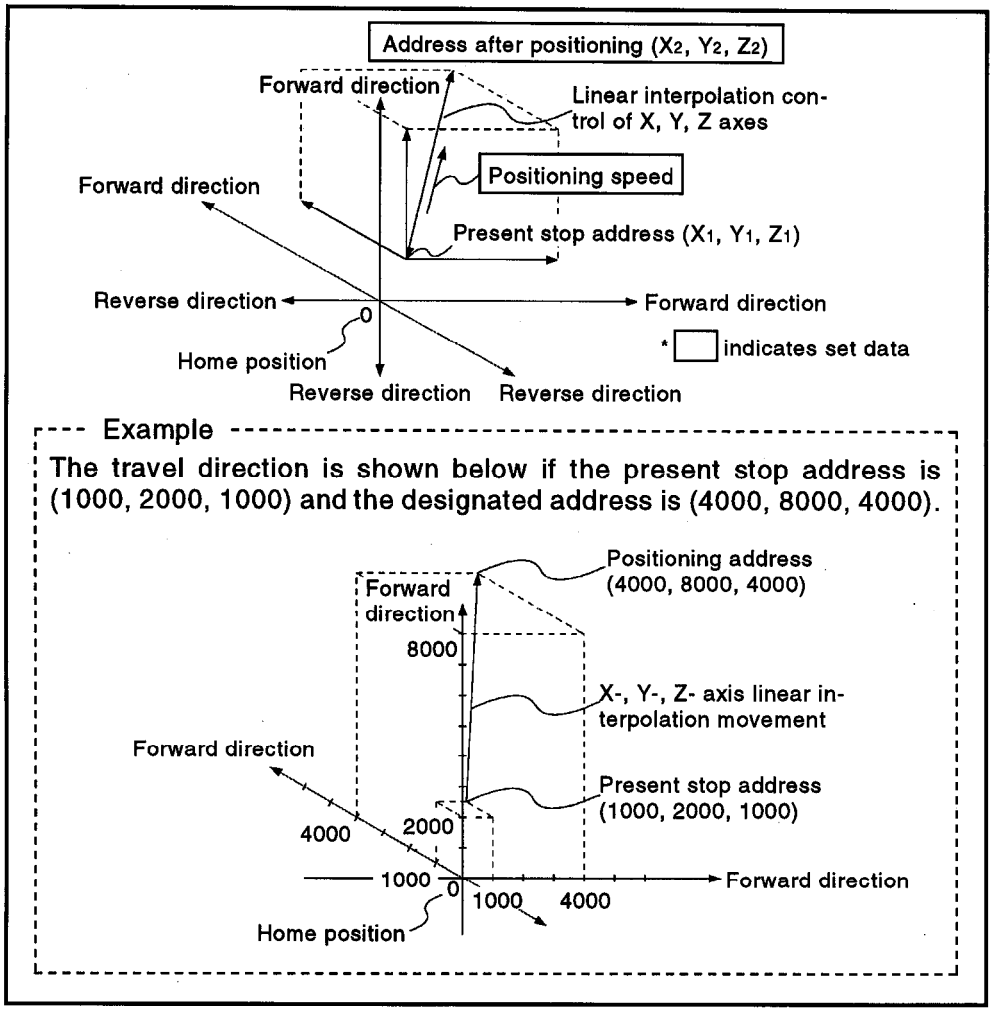
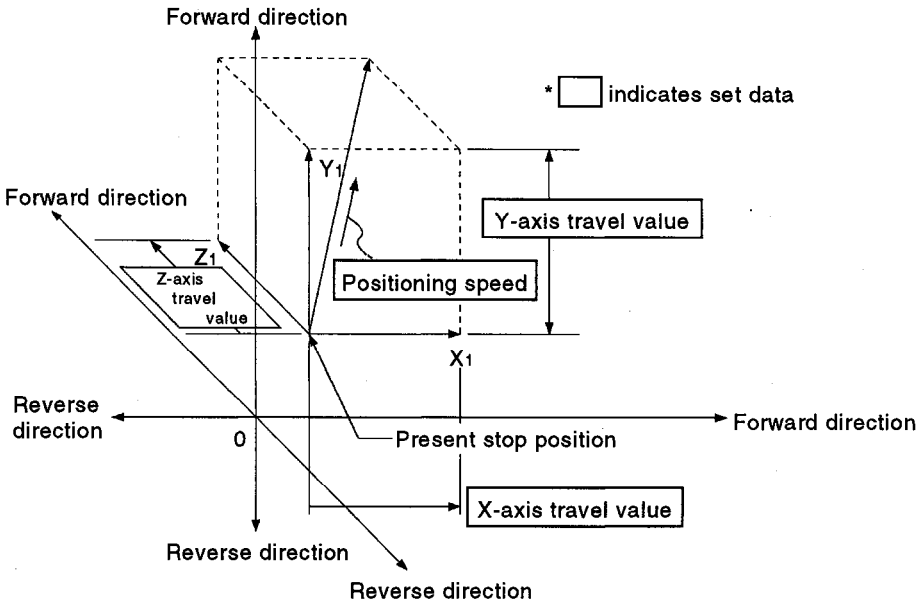


Figure 7.5 Positioning by Absolute Data Method

Control with INC-3 (incremental method)

(1) Positioning control from the present stop position to the position which is the resultant of the designated travel directions and travel values of the respective axes.

(2) The travel direction of each axis is designated by the sign of the travel value, as follows:
- Positive travel value.....forward direction (increased address)
- Negative travel value.....reverse direction (decreased address)



Example

The travel direction is shown below for an X-axis travel value of 10000, a Y-axis travel value of 5000, and a Z-axis travel value of 6000.

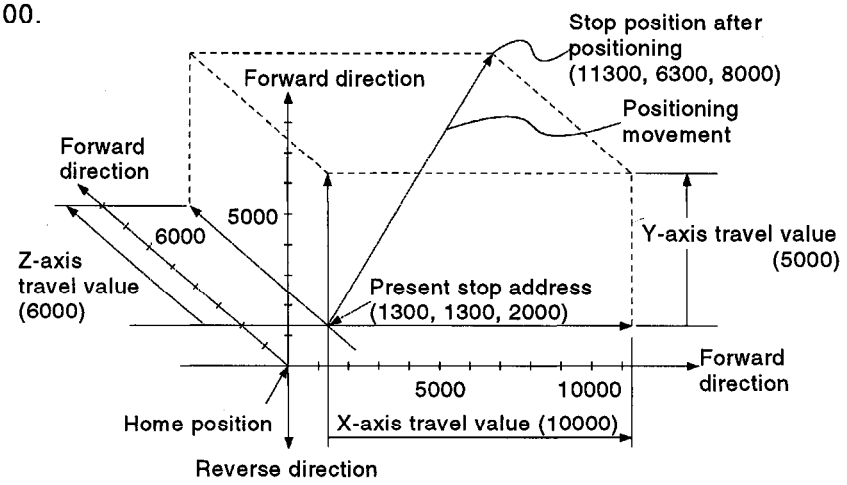
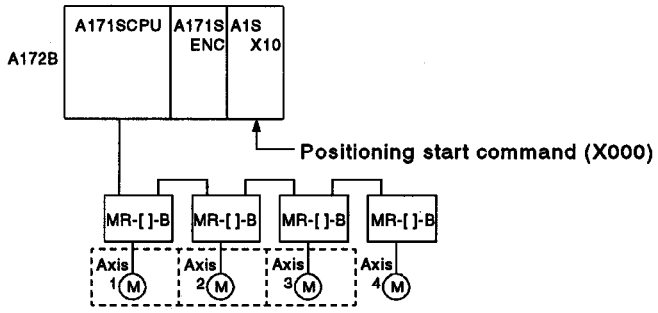


Figure 7.6 Positioning by Incremental Method

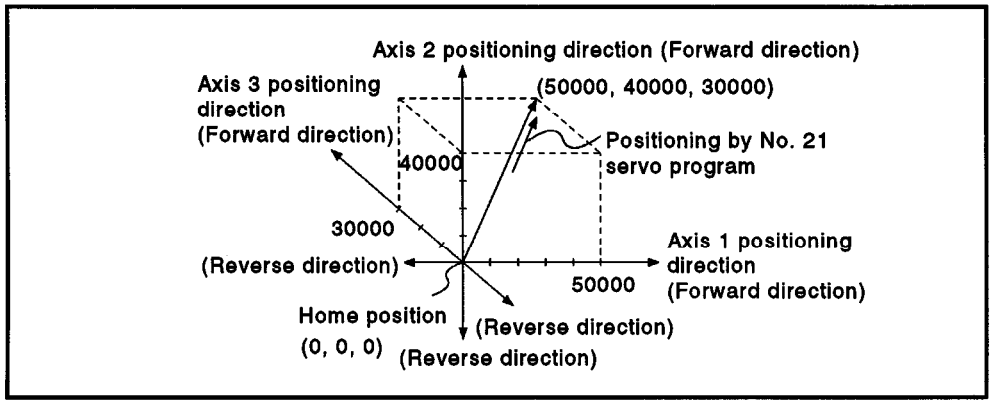
[Program Example]

This program conducts 3-axis linear interpolation control under the conditions below.

(1) System configuration
Three-axis linear interpolation control of Axis 1, Axis 2, and Axis 3.



(2) Positioning details
The positioning by the Axis 1, Axis 2, and Axis 3 servomotors is shown in the diagram below.



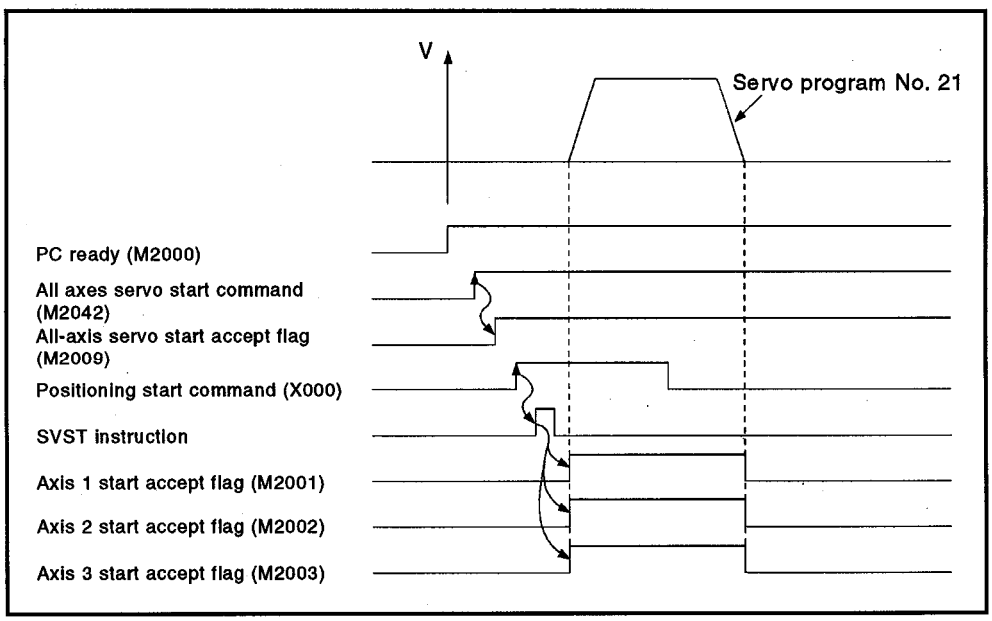
(3) Positioning conditions
(a) The positioning conditions are shown below.

Item	Servo Program Number
	No. 21
Positioning method	Absolute data
Positioning speed	1000

(b) Positioning start..... leading edge of X000 (OFF → ON)

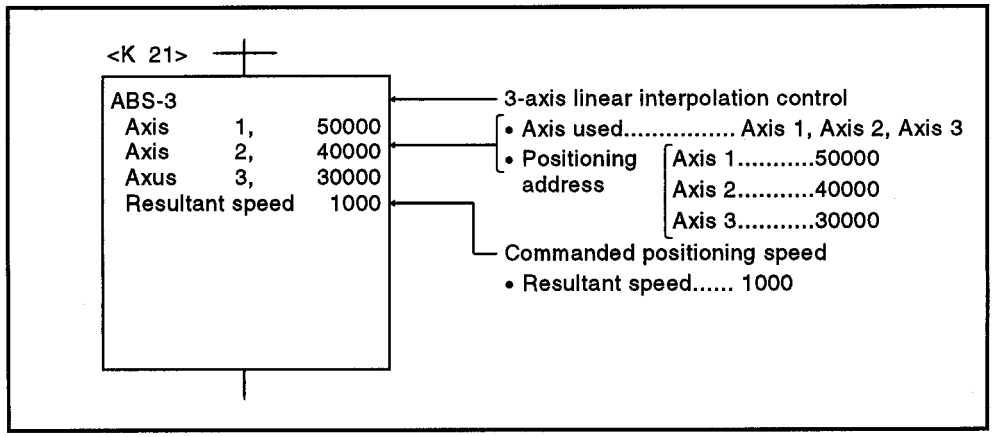
(4) Operation timing

The operation timing for 3-axis linear interpolation control is shown below.



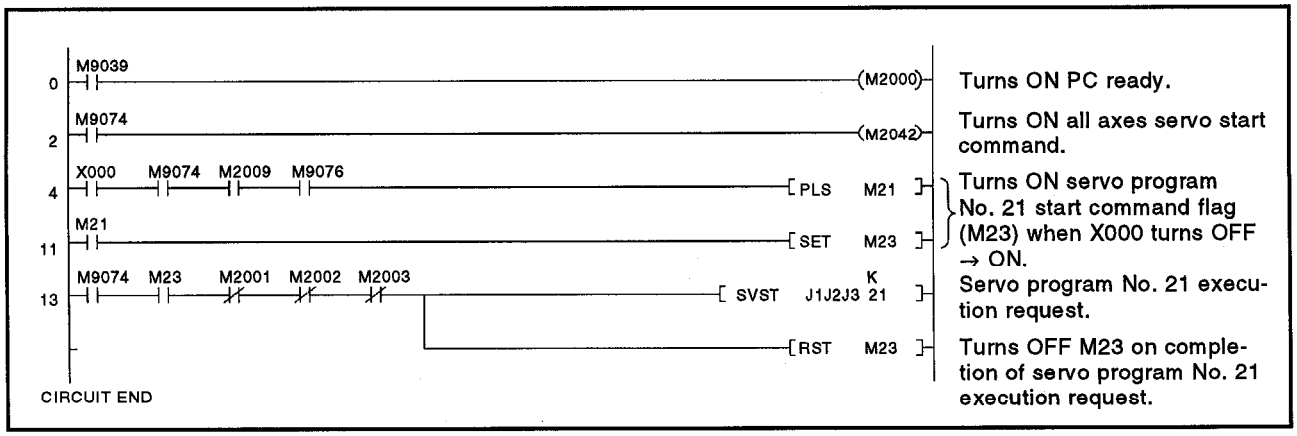
(5) Servo program

The servo program No. 21 for 3-axis linear interpolation control is shown below.



(6) Sequence program

The sequence program which runs the servo program is shown below.



7.5 Four-Axis Linear Interpolation Control

Linear interpolation control from the present stop position with the four axes designated in the sequence program positioning commands.

Servo Instruction	Positioning Method	Number of Controllable Axes	Items Set by Peripherals: Common: Parameter Block No.	Common: Axis	Common: Address/Travel Value	Common: Commanded Speed	Common: Dwell Time	Common: M Code	Common: Torque Limit Value	Arc: Auxiliary Point	Arc: Radius	Arc: Center Point	Parameter Block: Control Units	Parameter Block: Speed Limit Value	Parameter Block: Acceleration Time	Parameter Block: Deceleration Time	Parameter Block: Rapid Stop Deceleration Time	Parameter Block: Torque Limit Value	Parameter Block: Deceleration Processing on Stop Input	Parameter Block: Allowable Error Range for Circular Interpolation	Parameter Block: S-Curve Ratio	Others: Cancel	Others: Start	Speed Change
ABS-4	Absolute data	4	Δ	O	O	O	Δ	Δ					Δ	Δ	Δ	Δ	Δ	Δ	Δ		Δ	Δ	Δ	OK
INC-4	Incremental																							

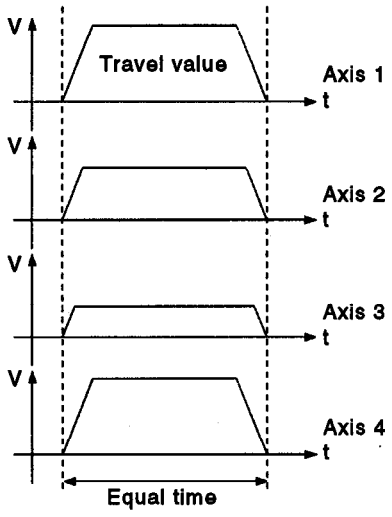
O : Must be set
Δ : Set if required

[Control Details]

Positioning control which starts and completes positioning of the four axes simultaneously.

Example

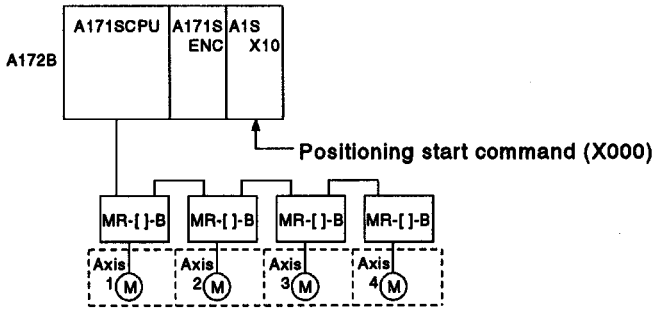
Four-axis linear interpolation



[Program Example]

This program conducts 4-axis linear interpolation control under the conditions below.

(1) System configuration
Four-axis linear interpolation control of Axis 1, Axis 2, Axis 3, and Axis 4.



(2) Positioning details
The positioning by the Axis 1, Axis 2, Axis 3, and Axis 4 servomotors is shown in the diagram below.

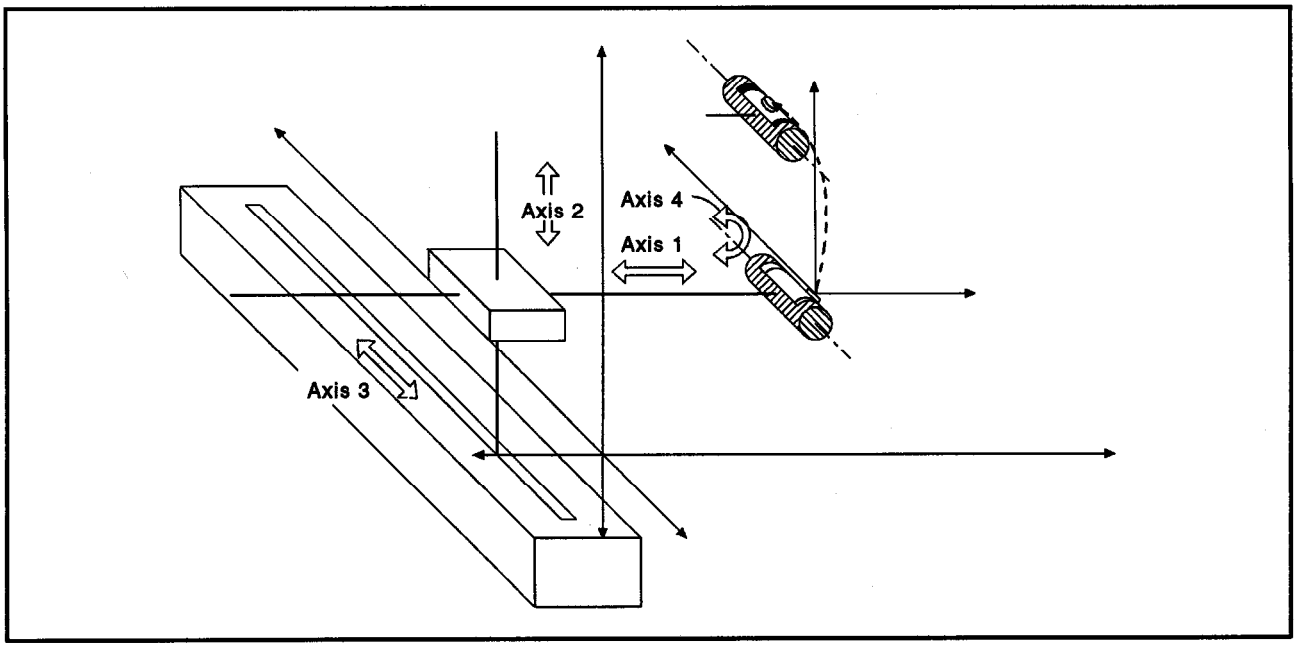


Figure 7.7 Axis Configuration

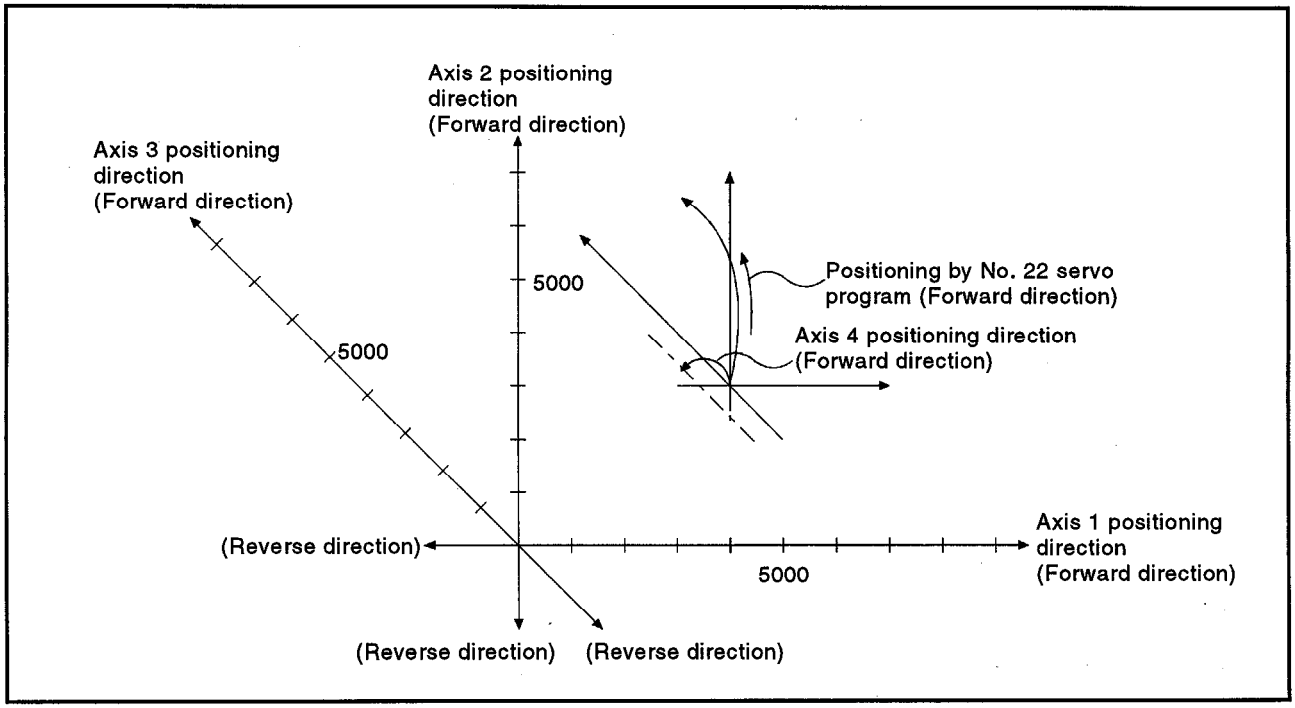


Figure 7.8 Positioning by Four-axis Linear Interpolation Control

(3) Positioning conditions

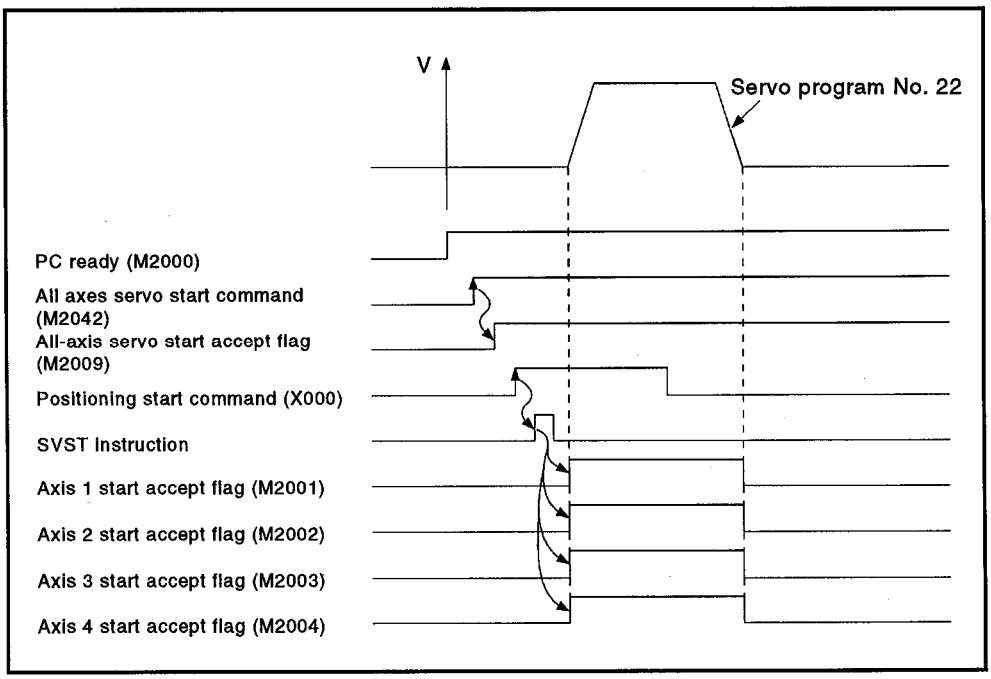
(a) The positioning conditions are shown below.

Item	Servo Program Number
	No. 22
Positioning method	Incremental
Positioning speed	1000

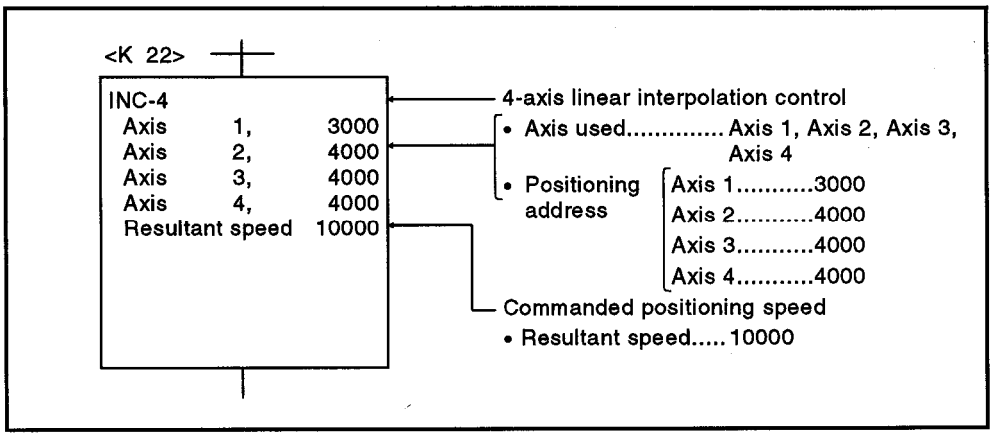
(b) Positioning start..... leading edge of X000 (OFF → ON)

(4) Operation timing

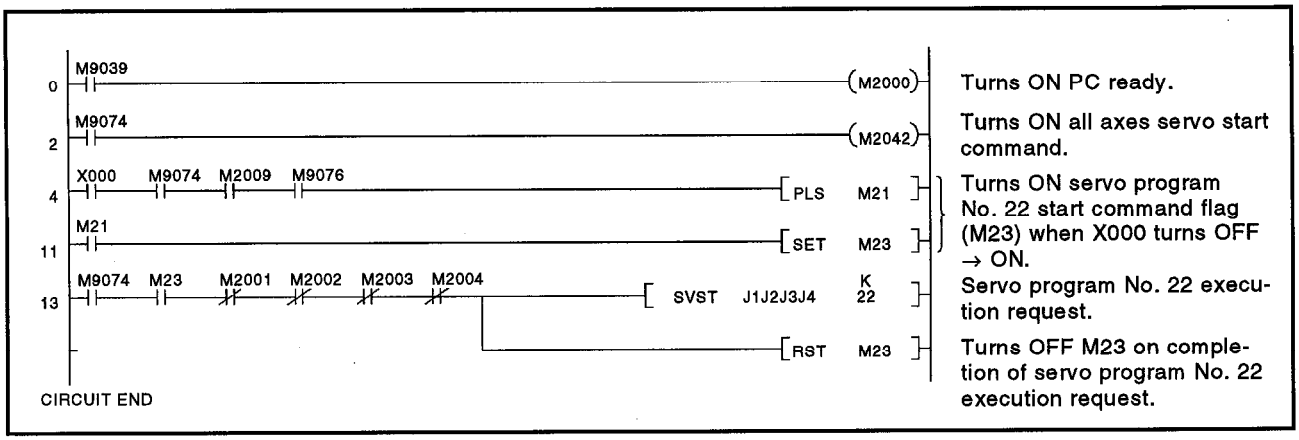
The operation timing for 4-axis linear interpolation control is shown below.



(5) Servo program
The servo program No. 22 for 4-axis linear interpolation control is shown below.



(6) Sequence program
The sequence program which runs the servo program is shown below.



7.6 Circular Interpolation Using Auxiliary Point Designation

Circular interpolation control by designating the end point address and auxiliary point address (a point on the arc).
Circular interpolation control using auxiliary point designation uses ABS (absolute data method) and INC (incremental method) servo instructions.

Servo Instruction	Positioning Method	Number of Controllable Axes	Items Set by Peripherals: Common: Parameter Block No.	Axis	Address/Travel Value	Commanded Speed	Dwell Time	M Code	Torque Limit Value	Arc: Auxiliary Point	Radius	Center Point	Parameter Block: Control Units	Speed Limit Value	Acceleration Time	Deceleration Time	Rapid Stop Deceleration Time	Torque Limit Value	Deceleration Processing on Stop Input	Allowable Error Range for Circular Interpolation	S-Curve Ratio	Others: Cancel	Start	Speed Change
ABS	Absolute data	2	Δ	O	O	O	Δ	Δ		O			Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	NG
INC	Incremental																							

O : Must be set
Δ : Set if required

[Control Details]

Control with ABS (absolute data method).

(1) Circular interpolation from the present stop address (pre-positioning address) through the designated auxiliary point address to the end point address, using the home position as the reference.

(2) The center of the arc is the point of intersection of the perpendicular bisectors of the start point address (present stop address) to the auxiliary point address, and the auxiliary point address to the end point address.

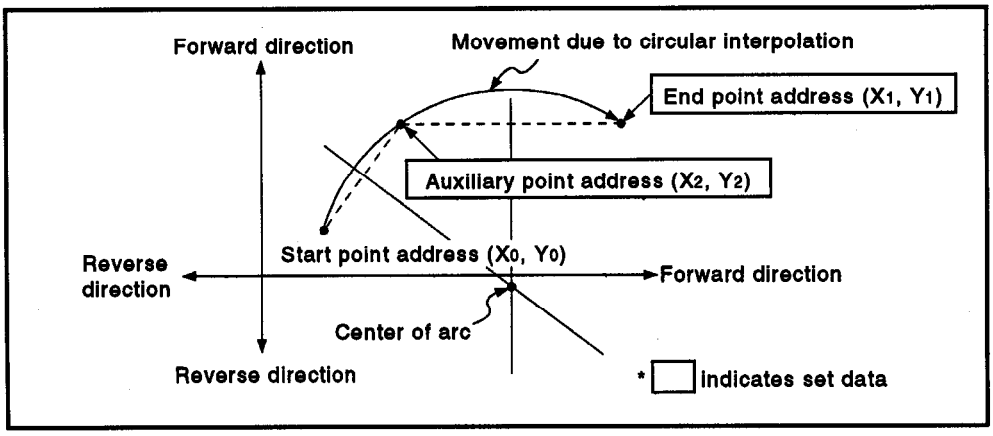


Figure 7.9 Circular Interpolation Control by Absolute Data Method

(3) The setting range for the end point address and auxiliary point address is -2^{31} to $+2^{31}-1$.

(4) The maximum arc radius is $2^{31}-1$.

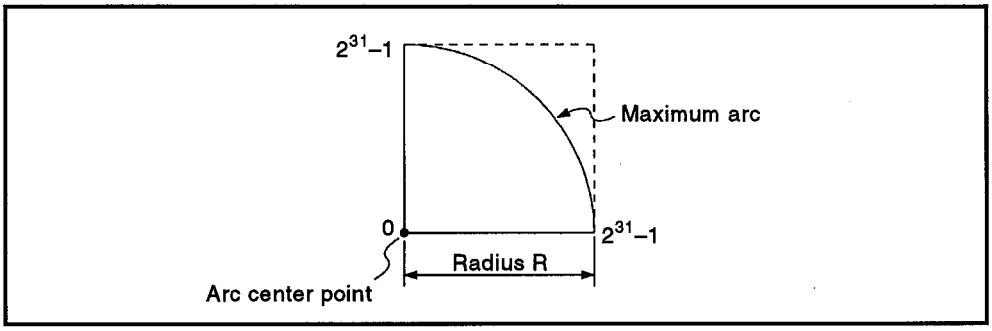


Figure 7.10 Maximum Arc

Control with INC (incremental method)

(1) Circular interpolation from the present stop address (pre-positioning address) through the designated auxiliary point address to the end point address.

(2) The center of the arc is the point of intersection of the perpendicular bisectors of the start point address (present stop address) to the auxiliary point address, and the auxiliary point address to the end point address.

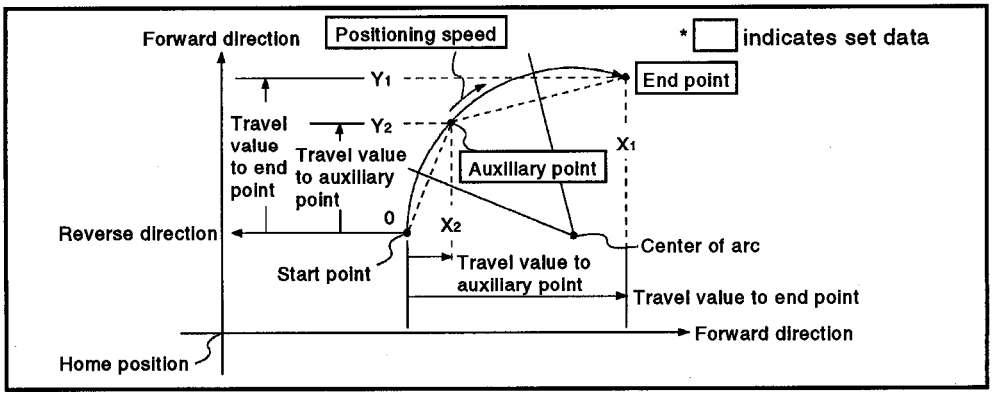
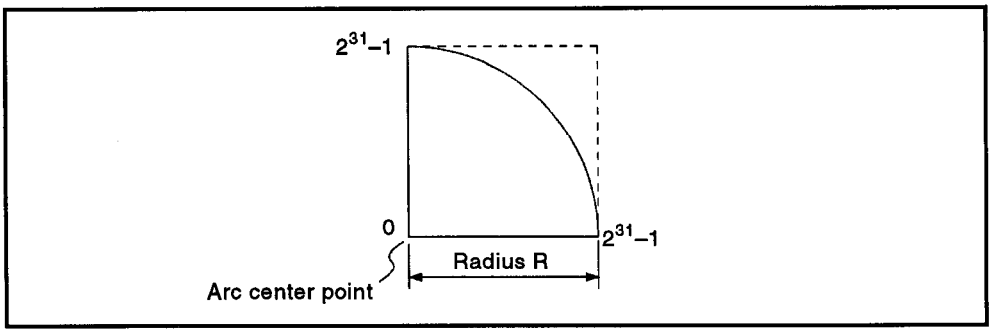


Figure 7.11 Circular Interpolation Control by Incremental Method

(3) The setting range for the travel value to the end point address and auxiliary point address is 0 to $\pm(2^{31}-1)$.

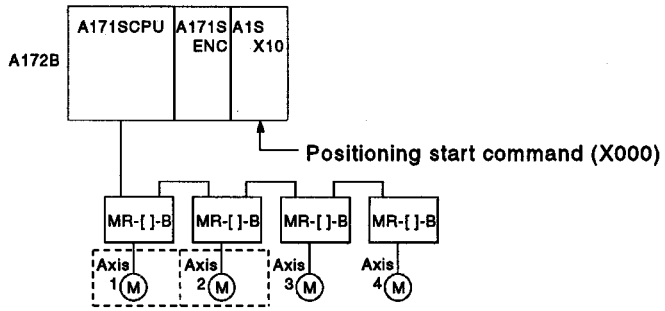
(4) The maximum arc radius is $2^{31}-1$.
If the designated end point and auxiliary point result in a radius greater than $2^{31}-1$, an error occurs at the start and error code 107 is stored in the data register.



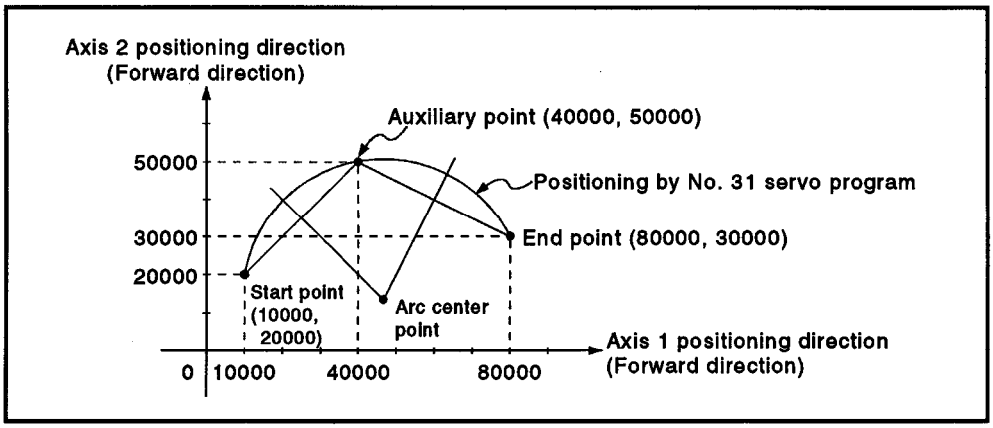
[Program Example]

This program conducts circular interpolation control using auxiliary point designation under the conditions below.

(1) System configuration
Circular interpolation control of Axis 1 and Axis 2 using auxiliary point designation.



(2) Positioning details
The positioning by the Axis 1 and Axis 2 servomotors is shown in the diagram below.



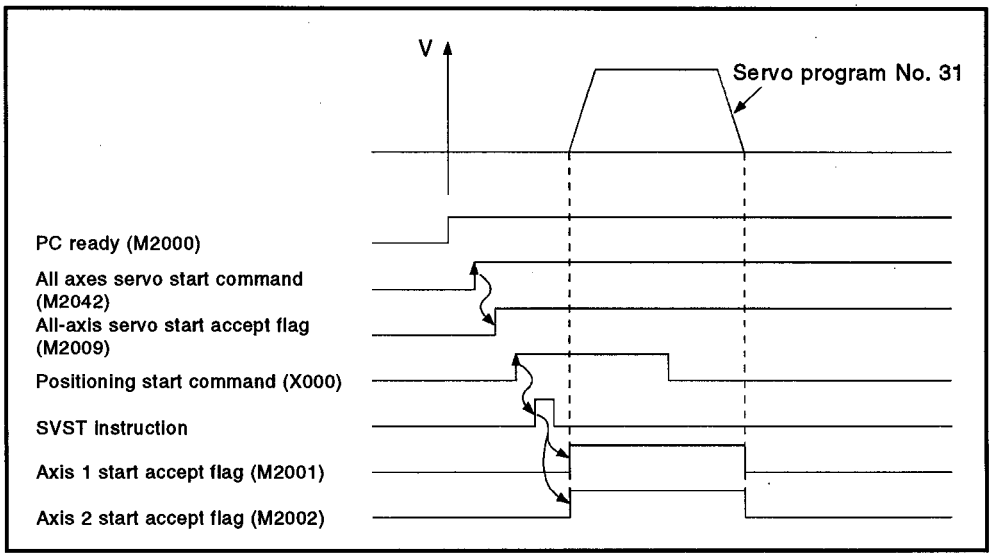
(3) Positioning conditions
(a) The positioning conditions are shown below.

Item	Servo Program Number
	No. 31
Positioning method	Absolute data
Positioning speed	1000

(b) Positioning start..... leading edge of X000 (OFF → ON)

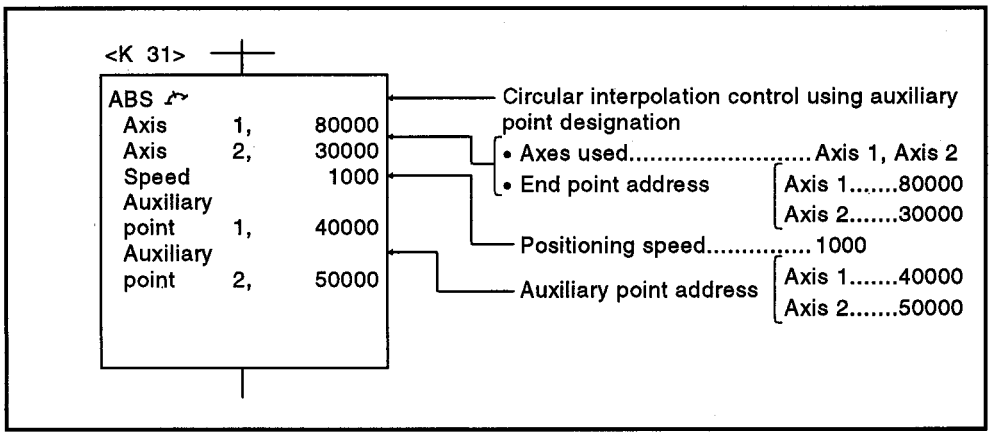
(4) Operation timing

The operation timing for circular interpolation control using auxiliary point designation is shown below.



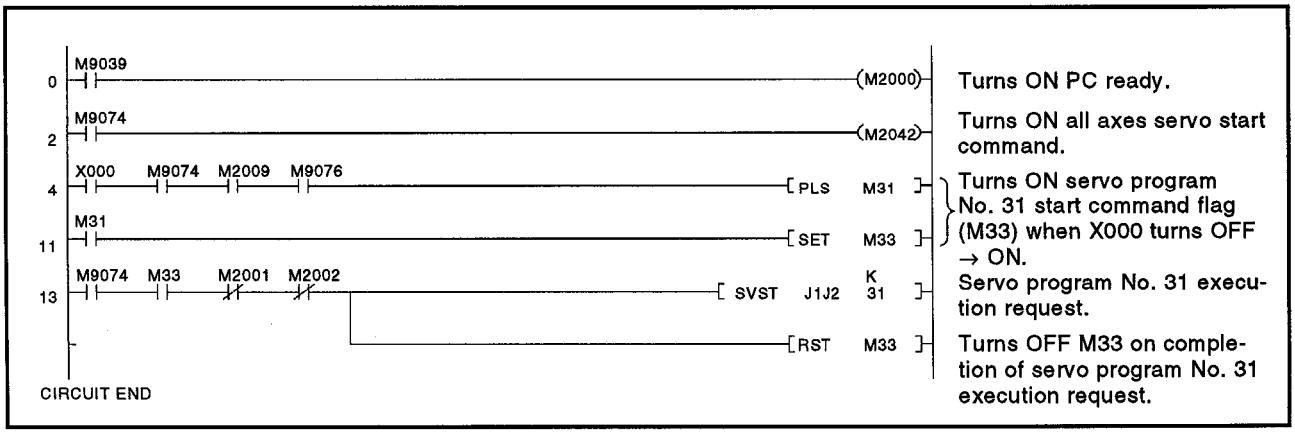
(5) Servo program

The servo program No. 31 for circular interpolation control using auxiliary point designation is shown below.



(6) Sequence program

The sequence program which runs the servo program is shown below.



7.7 Circular Interpolation Using Radius Designation

Circular interpolation control by designating the end point and arc radius. Circular interpolation control using radius designation uses ABS↷, ABS↻, ABS↶, and ABS↺ (absolute data method) and INC↷, INC↻, INC↶, and INC↺ (incremental method) servo instructions.

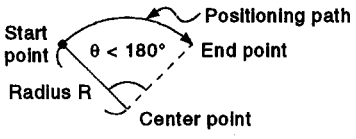
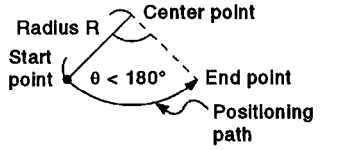
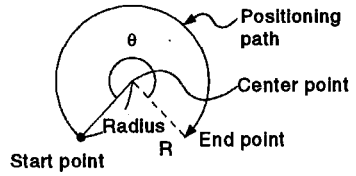
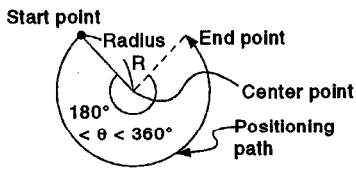
Servo Instruction	Positioning Method	Number of Controllable Axes	Items Set by Peripherals: Common: Parameter Block No.	Common: Axis	Common: Address/Travel Value	Common: Commanded Speed	Common: Dwell Time	Common: M Code	Common: Torque Limit Value	Arc: Auxiliary Point	Arc: Radius	Arc: Center Point	Parameter Block: Control Units	Parameter Block: Speed Limit Value	Parameter Block: Acceleration Time	Parameter Block: Deceleration Time	Parameter Block: Rapid Stop Deceleration Time	Parameter Block: Torque Limit Value	Parameter Block: Deceleration Processing on Stop Input	Parameter Block: Allowable Error Range for Circular Interpolation	Parameter Block: S-Curve Ratio	Others: Cancel	Others: Start	Speed Change
ABS↷	Absolute data	2	Δ	O	O	O	Δ	Δ			O		Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	NG
ABS↻																								
ABS↶																								
ABS↺																								
INC↷	Incremental																							
INC↻																								
INC↶																								
INC↺																								

O : Must be set
Δ : Set if required

7. POSITIONING CONTROL

[Control Details]

Details of control with the servo instructions are shown in the table below.

Instruction	Servomotor Direction of Rotation	Max. Controllable Angle of Arc	Positioning Path
ABS	Clockwise	0° < θ < 180°	
INC			
ABS	Counterclockwise		
INC			
ABS	Clockwise	180° ≤ θ < 360°	
INC			
ABS	Counterclockwise		
INC			

Control with ABS↶, ABS↷, ABS↙, and ABS↘ (absolute data method)

(1) Circular interpolation of an arc of the designated radius from the present stop address (pre-positioning address) to the designated end point address, using the home position as the reference.

(2) The center of the arc lies at the point of intersection of the designated radius and the perpendicular bisector of the start point address (present stop address) to the end point address.

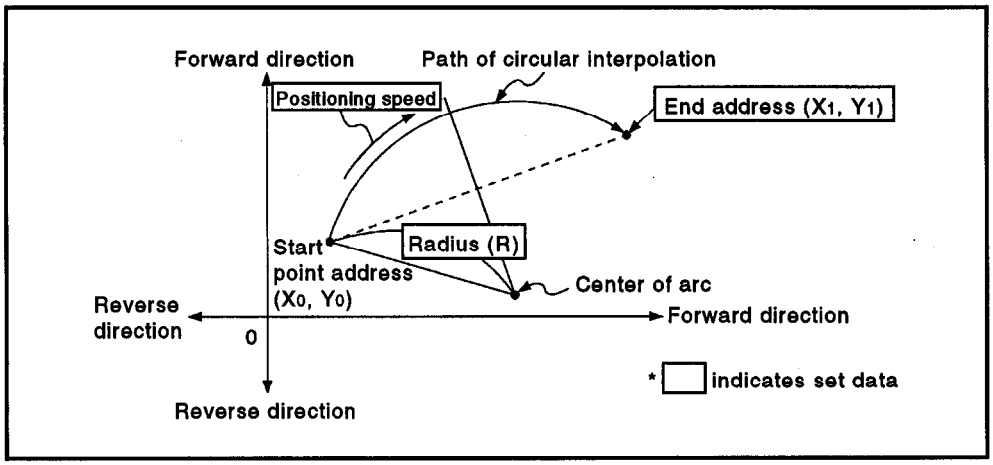


Figure 7.12 Circular Interpolation Control by Absolute Data Method

(3) The setting range for the end point address is -2^{31} to $+2^{31}-1$.

(4) The maximum arc radius is $2^{32}-1$.

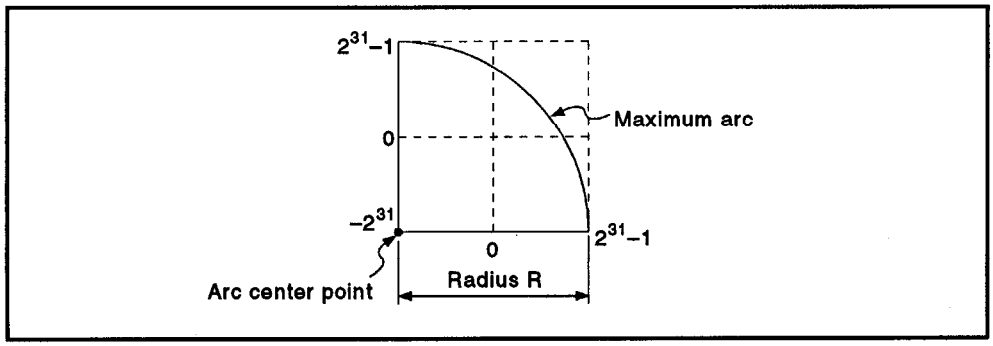


Figure 7.13 Maximum Arc

Control with INC↖, INC↗, INC↙, and INC↘ (incremental method)

(1) Circular interpolation of an arc of the designated radius from the present stop address (0, 0) to the designated end point address.

(2) The center of the arc lies at the point of intersection of the designated radius and the perpendicular bisector of the start point address (present stop address) to the end point address.

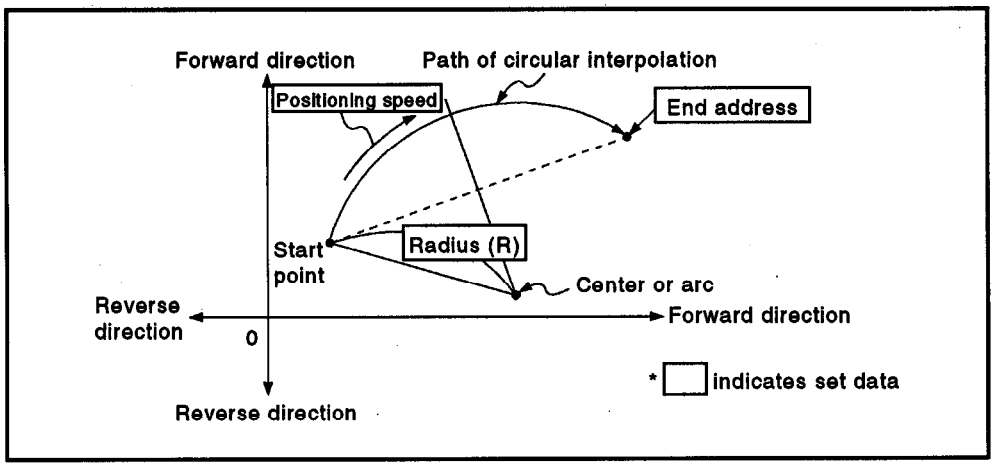


Figure 7.14 Circular Interpolation Control by Incremental Method

(3) The setting range for the end point address is -2^{31} to $+2^{31}-1$.

(4) The maximum arc radius is $2^{32}-1$.

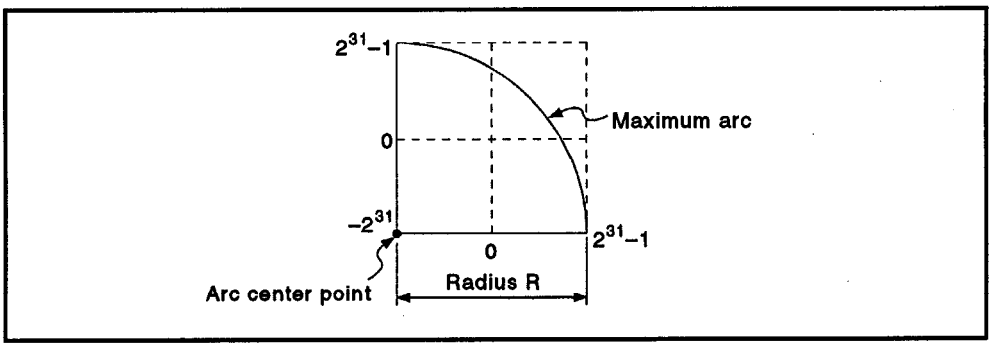
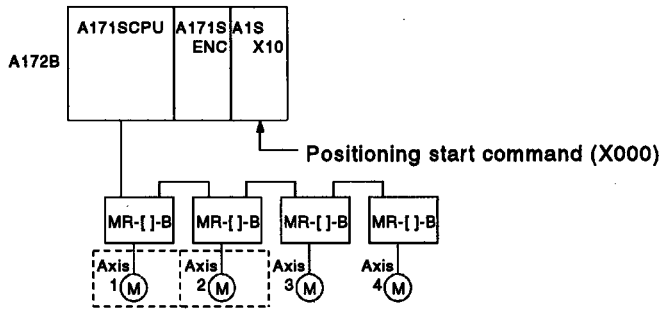


Figure 7.15 Maximum Arc

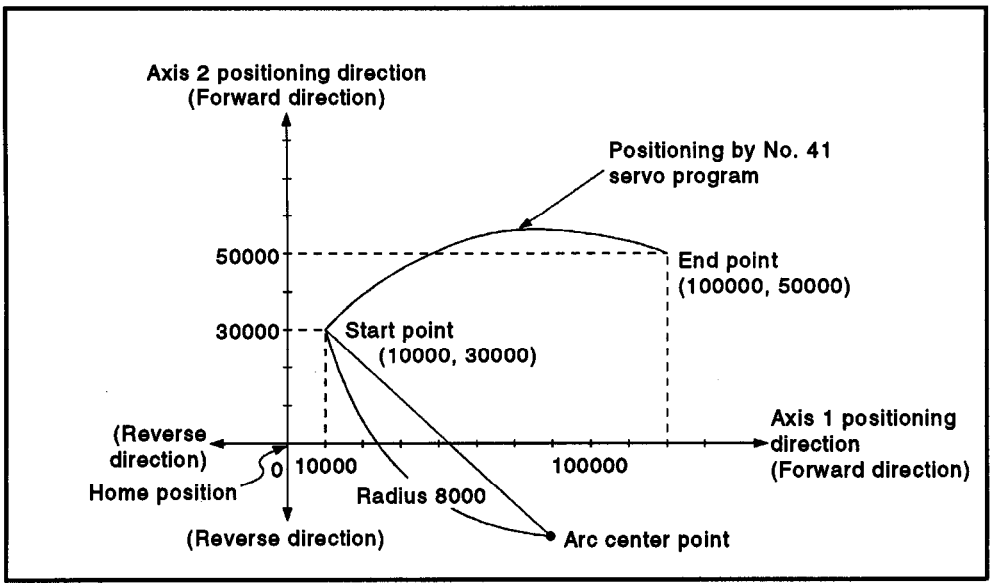
[Program Example]

This program conducts circular interpolation control using radius designation under the conditions below.

(1) System configuration
Circular interpolation control of Axis 1 and Axis 2 using radius designation.



(2) Positioning details
The positioning by the Axis 1 and Axis 2 servomotors is shown in the diagram below.



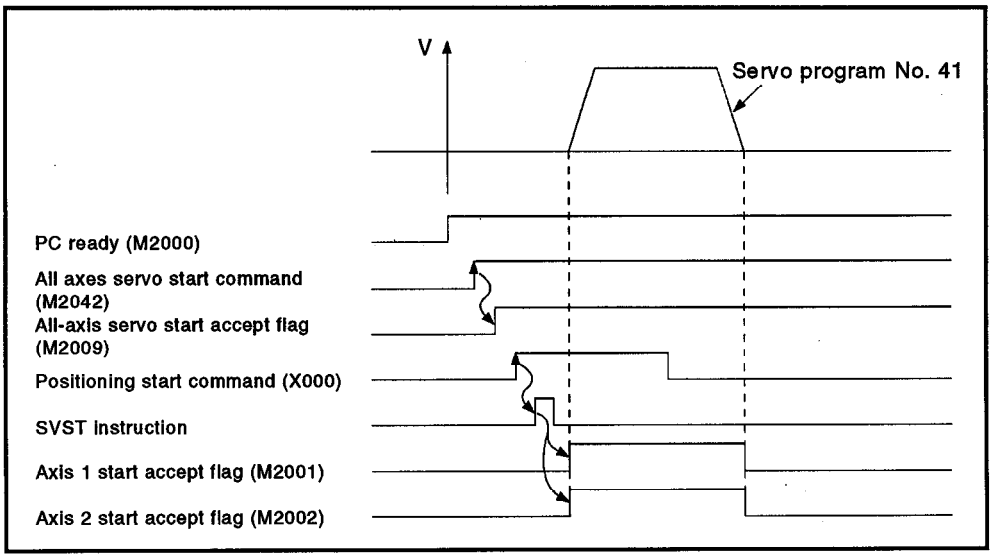
(3) Positioning conditions
(a) The positioning conditions are shown below.

Item	Servo Program Number
	No. 41
Positioning method	Absolute data
Positioning speed	1000

(b) Positioning start..... leading edge of X000 (OFF → ON)

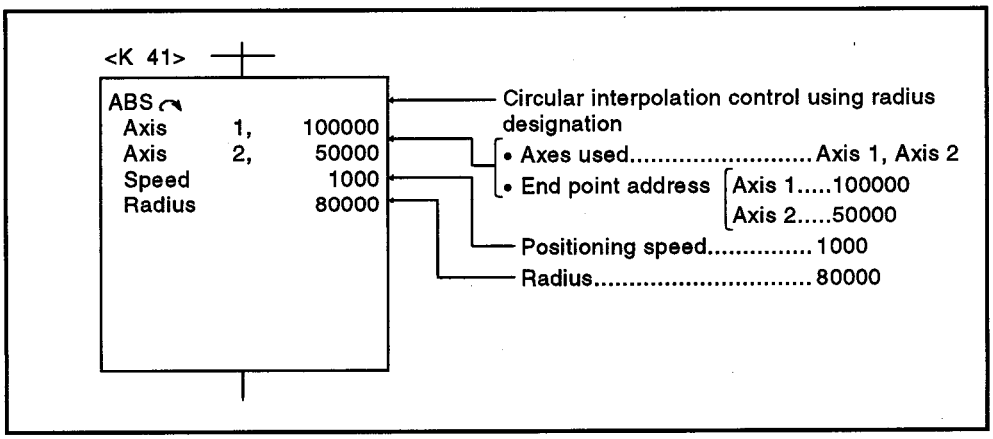
(4) Operation timing

The operation timing for circular interpolation control using radius designation is shown below.



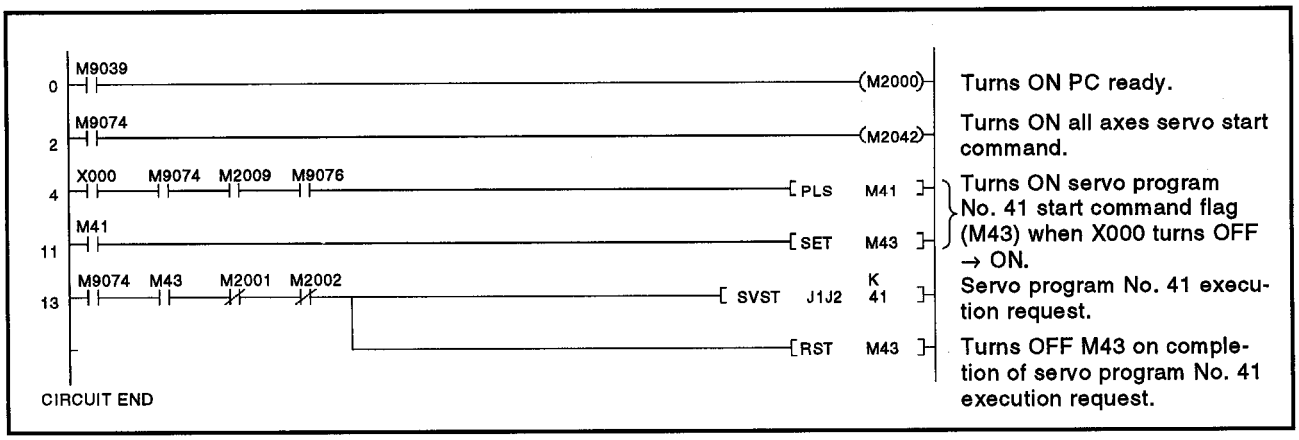
(5) Servo program

The servo program No. 41 for circular interpolation control using radius designation is shown below.



(6) Sequence program

The sequence program which runs the servo program is shown below.



7.8 Circular Interpolation Using Center Point Designation

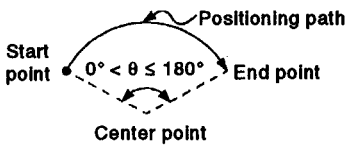
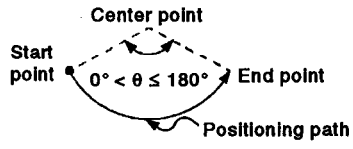
Circular interpolation control by designating the end point and arc center point.
Circular interpolation control using center point designation uses ABS↷ and ABS↶ (absolute data method) and INC↷ and INC↶ (incremental method) servo instructions.

Servo Instruction	Positioning Method	Number of Controllable Axes	Items Set by Peripherals																							
			Common							Arc			Parameter Block											Others		
			Parameter Block No.	Axis	Address/Travel Value	Commanded Speed	Dwell Time	M Code	Torque Limit Value	Auxiliary Point	Radius	Center Point	Control Units	Speed Limit Value	Acceleration Time	Deceleration Time	Rapid Stop Deceleration Time	Torque Limit Value	Deceleration Processing on Stop Input	Allowable Error Range for Circular Interpolation	S-Curve Ratio	Cancel	Start	Speed Change
ABS↷ / ABS↶	Absolute data	2	Δ	O	O	O	Δ	Δ				O	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ	NG
INC↷ / INC↶	Incremental																							

O : Must be set
Δ : Set if required

[Control Details]

Details of control with the servo instructions are shown in the table below.

Instruction	Servomotor Direction of Rotation	Max. Controllable Angle of Arc	Positioning Path
ABS↷ / INC↷	Clockwise	0° < θ ≤ 360°	
ABS↶ / INC↶	Counterclockwise		

Control with ABS↷ and ABS↶ (absolute data method)

(1) Circular interpolation of an arc with a radius equivalent to the distance between the start point and center point, between the present stop address (pre-positioning address used as the start point address) and the designated end point address, using the home position as the reference.

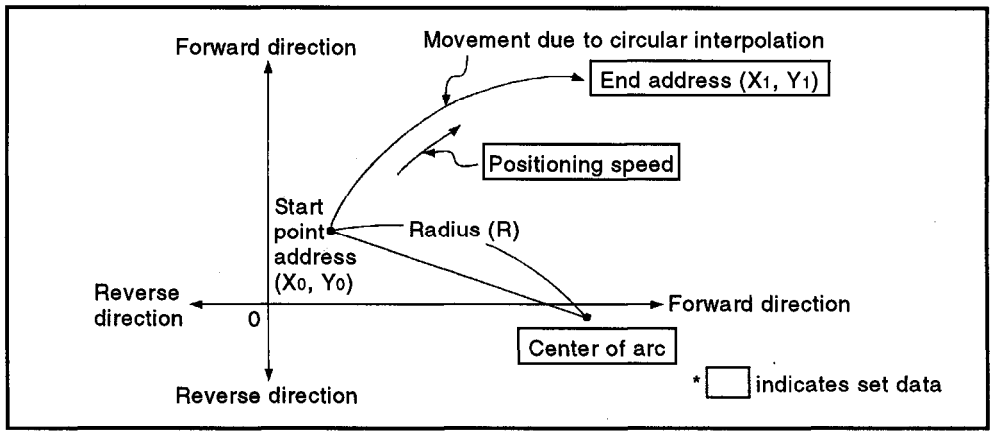


Figure 7.16 Circular Interpolation Control by Absolute Data Method

(2) To conduct positioning control of a full circle, divide the circular interpolation control into two operations.

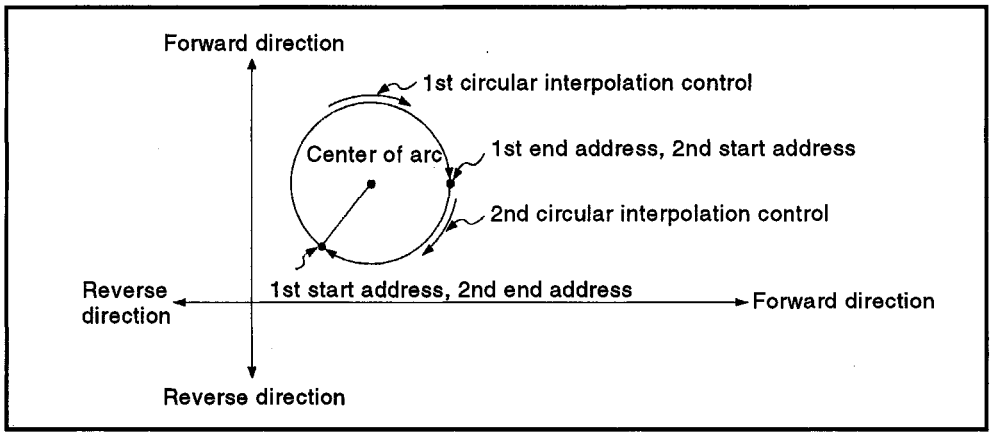


Figure 7.17 Positioning Control of a Full Circle

(3) The setting range for the end point address and arc center point is -2^{31} to $+2^{31}-1$.

(4) The maximum arc radius is $2^{31}-1$.

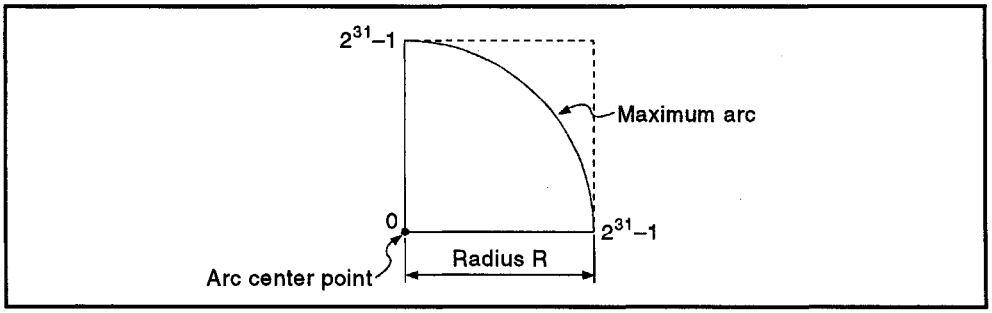


Figure 7.18 Maximum Arc

Control with INC↷ and INC↶ (incremental method)

(1) Circular interpolation of an arc from the present stop address (start point address, 0, 0) with a radius equivalent to the distance between the start point (0, 0) and center point.

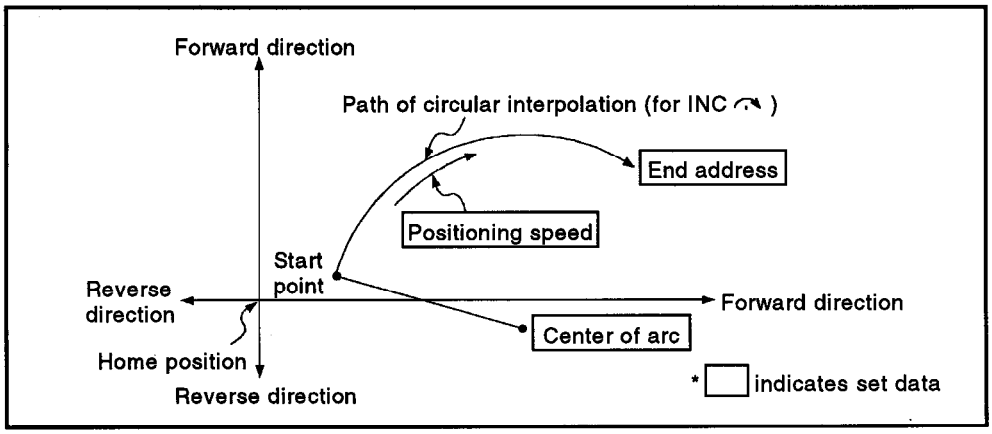


Figure 7.19 Circular Interpolation Control by Incremental Method (INC↷)

(2) To conduct positioning control of a full circle, divide the circular interpolation control into two operations.

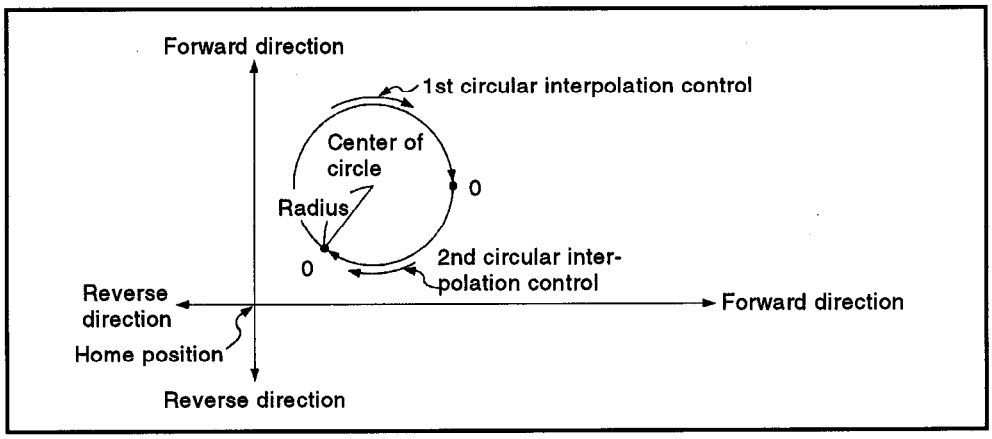


Figure 7.20 Positioning Control of a Full Circle

(3) The setting range for the center point and travel value to the end point is 0 to $\pm(2^{31}-1)$.

(4) The maximum arc radius is $2^{31}-1$.
If the designated end point and center point result in a radius greater than $2^{31}-1$, an error occurs at the start and error code 107 is stored in the data register.

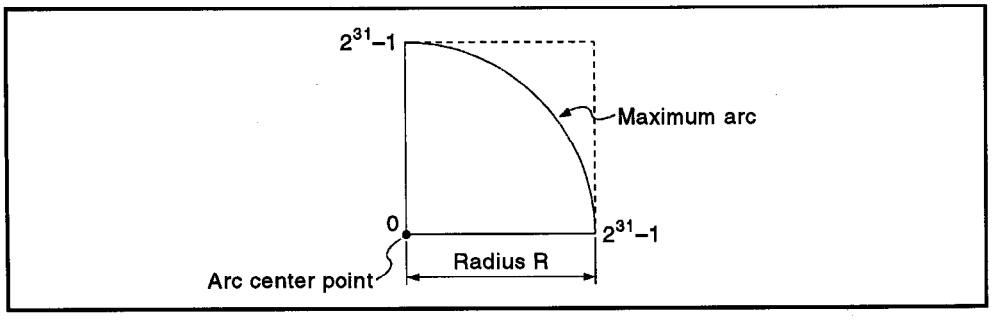


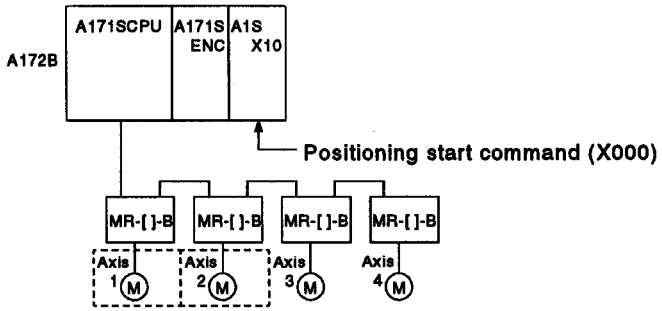
Figure 7.21 Maximum Arc Radius

[Program Example]

This program conducts circular interpolation control using center point designation under the conditions below.

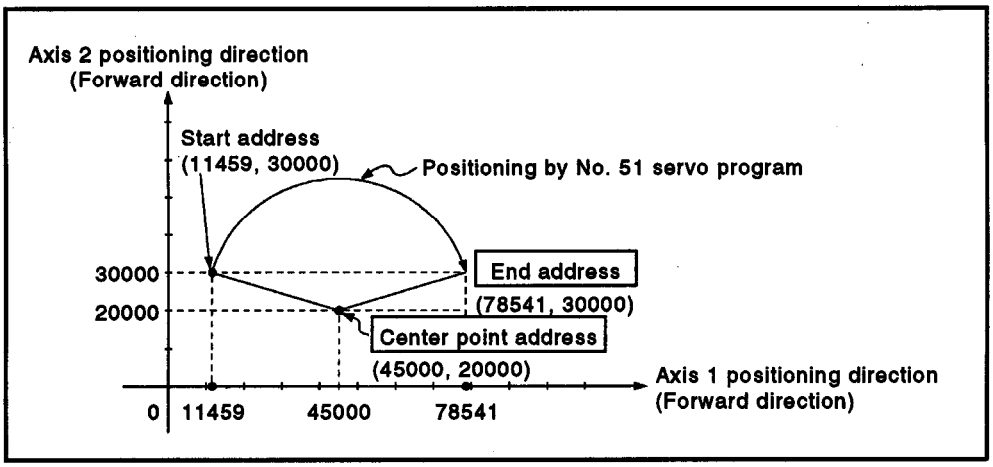
(1) System configuration

Circular interpolation control of Axis 1 and Axis 2 using center point designation.



(2) Positioning details

The positioning by the Axis 1 and Axis 2 servomotors is shown in the diagram below.



(3) Positioning conditions

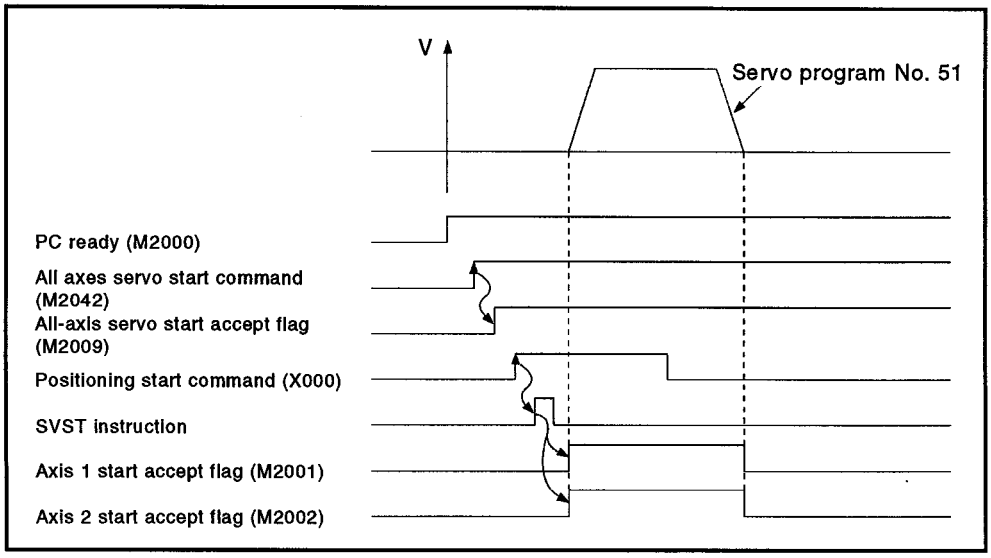
(a) The positioning conditions are shown below.

Item	Servo Program Number
	No. 51
Positioning method	Absolute data
Positioning speed	1000

(b) Positioning start..... leading edge of X000 (OFF → ON)

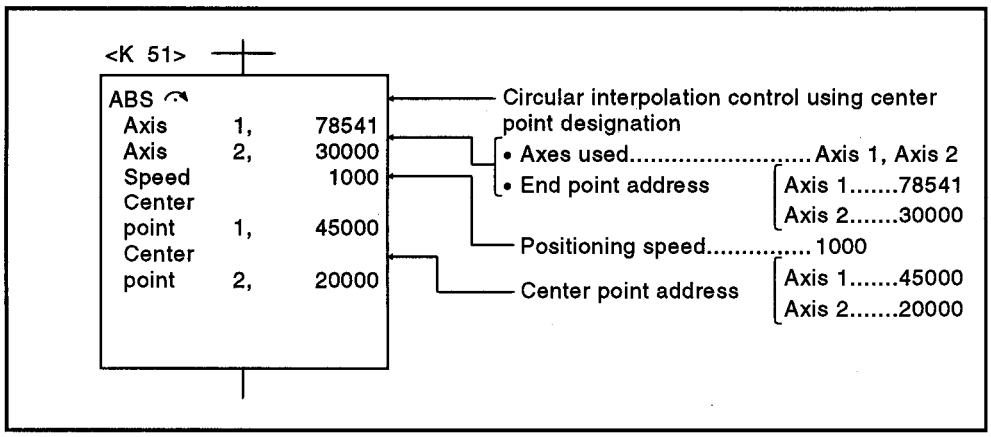
(4) Operation timing

The operation timing for circular interpolation control using center point designation is shown below.



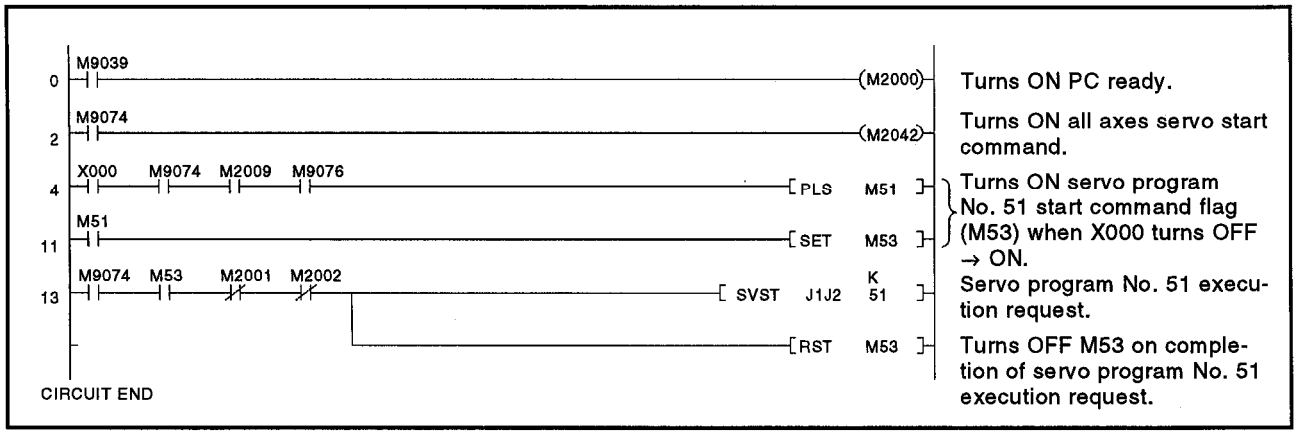
(5) Servo program

The servo program No. 51 for circular interpolation control using center point designation is shown below.



(6) Sequence program

The sequence program which runs the servo program is shown below.



7.9 One-Axis Fixed-Pitch Feed Control

Positioning control to move the axis designated with the sequence program positioning commands by the designated travel value from the present stop position.
Fixed-pitch feed control uses the FEED-1 servo instruction.

Servo Instruction	Positioning Method	Number of Controllable Axes	Items Set by Peripherals: Common: Parameter Block No.	Axis	Address/Travel Value	Commanded Speed	Dwell Time	M Code	Torque Limit Value	Arc: Auxiliary Point	Radius	Center Point	Parameter Block: Control Unit	Speed Limit Value	Acceleration Time	Deceleration Time	Rapid Stop Deceleration Time	Torque Limit Value	Deceleration Processing on Stop Input	Allowable Error Range for Circular Interpolation	S Curve Ratio	Others: Cancel	Start	Speed Change
FEED-1	Incremental	1	Δ	O	O	O	Δ	Δ						Δ	Δ	Δ	Δ	Δ	Δ		Δ	Δ	Δ	OK

O : Must be set
Δ : Set if required

[Control Details]

(1) Positioning control through the designated travel value from the present stop position (0).

(2) The travel direction is designated by the sign of the travel value, as follows:
- Positive travel value .... forward direction (increased address)
- Negative travel value ... reverse direction (decreased address)

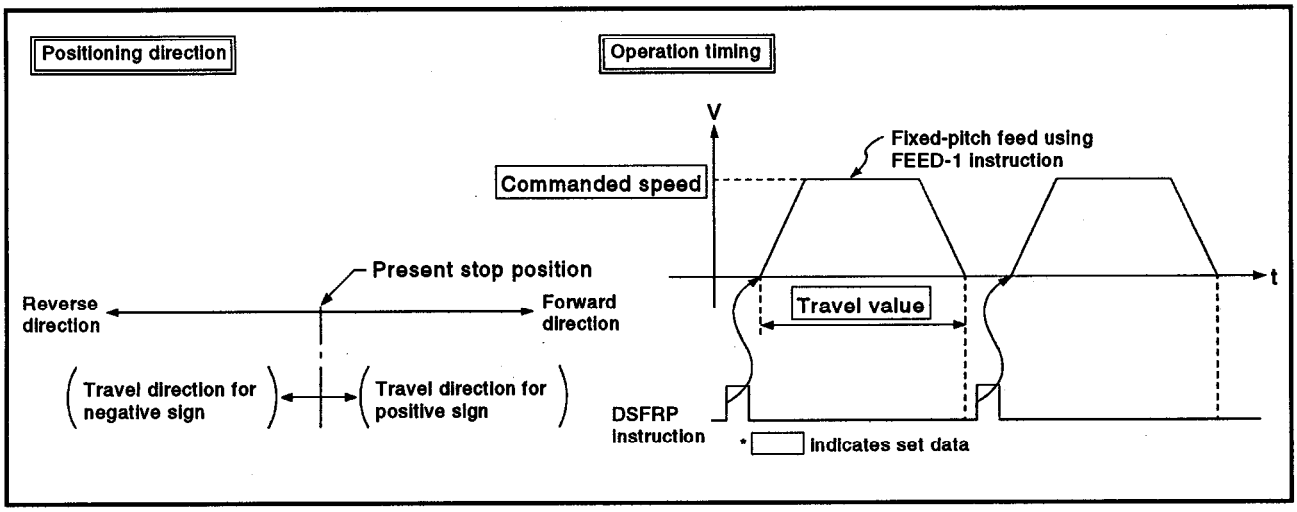


Figure 7.22 One-Axis Fixed-Pitch Feed Control

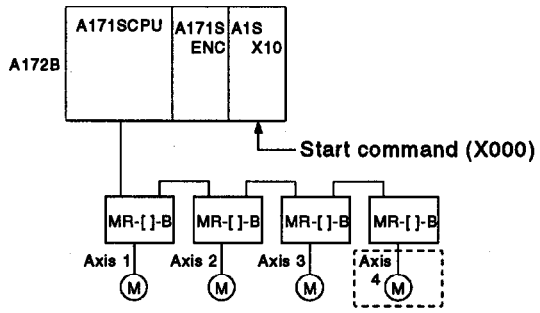
POINT

Do not set the travel value to zero for fixed-pitch feed control.
If the travel value is set to zero, fixed-pitch feed ends with no feed taking place.

[Program Example]

This program conducts repeated 1-axis fixed-pitch feed control under the conditions below.

(1) System configuration
Fixed-pitch feed control of Axis 4.



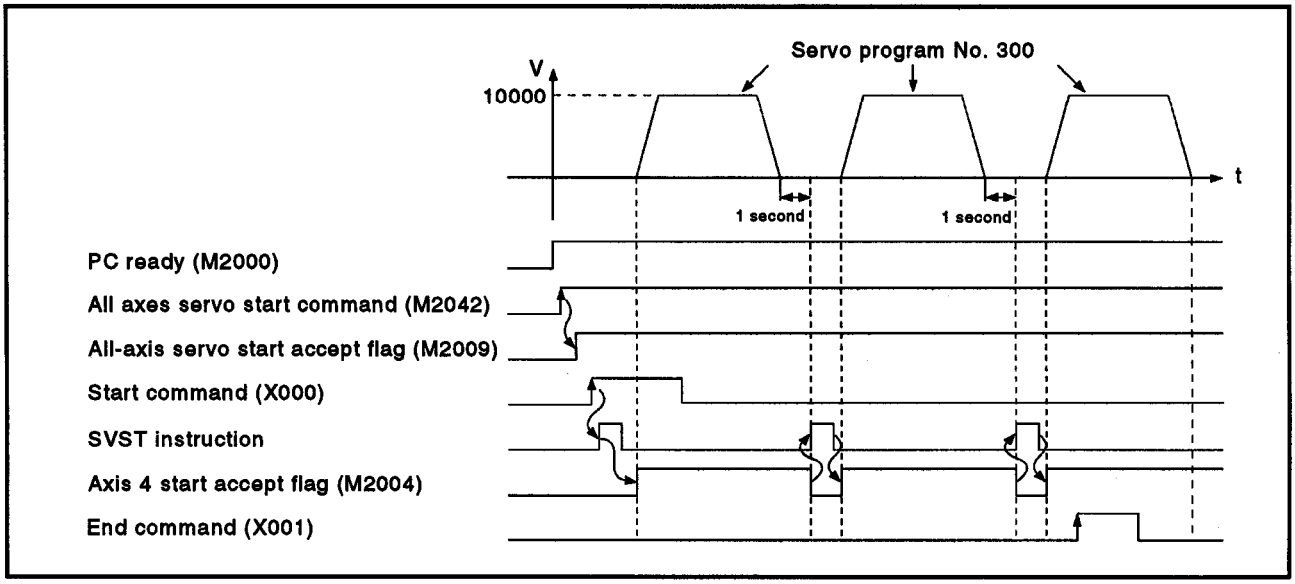
(2) Fixed-pitch feed control conditions
(a) The positioning conditions are shown below.

Item	Setting
Servo program number	No. 300
Controlled axis	Axis 4
Control speed	10000
Travel value	100000

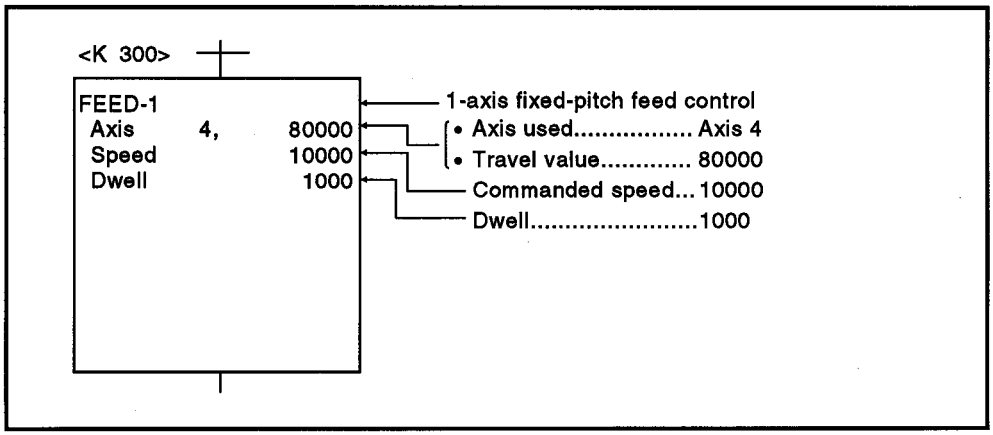
(b) Fixed-pitch feed control start command .....leading edge of X000 (OFF → ON)

(c) Fixed-pitch feed control end command .....leading edge of X001 (OFF → ON)

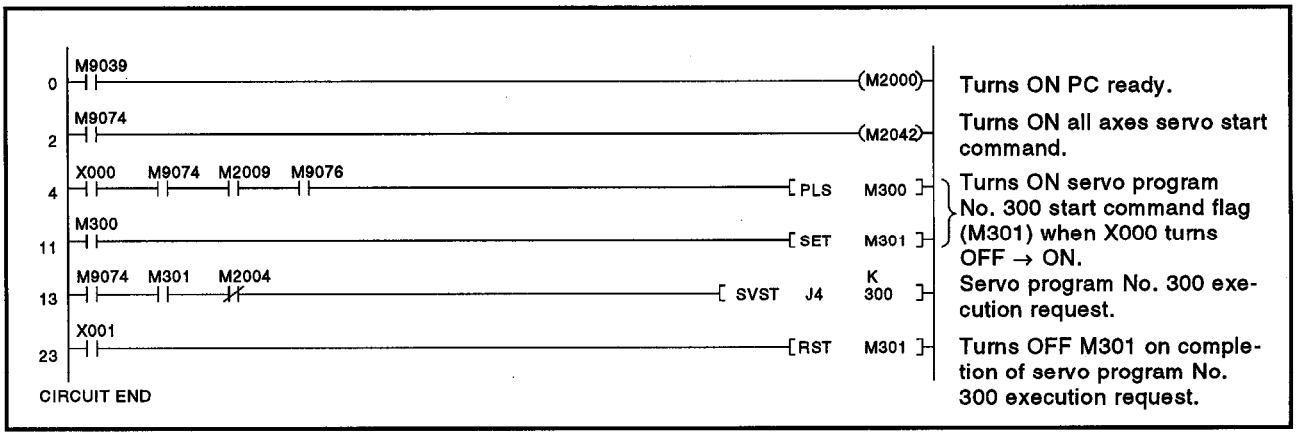
(3) Operation timing
The operation timing for fixed-pitch feed control is shown below.



(4) Servo program
The servo program No. 300 for fixed-pitch feed control is shown below.



(5) Sequence program example
The sequence program which runs the servo program is shown below.



7.10 Fixed-Pitch Feed Control Using Two-Axis Linear Interpolation

Fixed-pitch feed control using 2-axis linear interpolation from the present stop position with the two axes designated in the sequence program positioning commands.
Fixed-pitch feed control using two-axis linear interpolation uses the FEED-2 servo instruction.

Servo Instruction	Positioning Method	Number of Controllable Axes	Items Set by Peripherals: Common: Parameter Block No.	Axis	Address/Travel Value	Commanded Speed	Dwell Time	M Code	Torque Limit Value	Arc: Auxiliary Point	Radius	Center Point	Parameter Block: Control Unit	Speed Limit Value	Acceleration Time	Deceleration Time	Rapid Stop Deceleration Time	Torque Limit Value	Deceleration Processing on Stop Input	Allowable Error Range for Circular Interpolation	S Curve Ratio	Others: Cancel	Start	Speed Change
FEED-2	Incremental	2	Δ	O	O	O	Δ	Δ					Δ	Δ	Δ	Δ	Δ	Δ	Δ		Δ	Δ	Δ	OK

O : Must be set
Δ : Set if required

[Control Details]

(1) Positioning control from the present stop position (0) to the position which is the resultant of the designated travel directions and travel values of the respective axes.

(2) The travel direction is designated by the sign of the travel value, as follows:
- Positive travel value .... forward direction (increased address)
- Negative travel value ... reverse direction (decreased address)

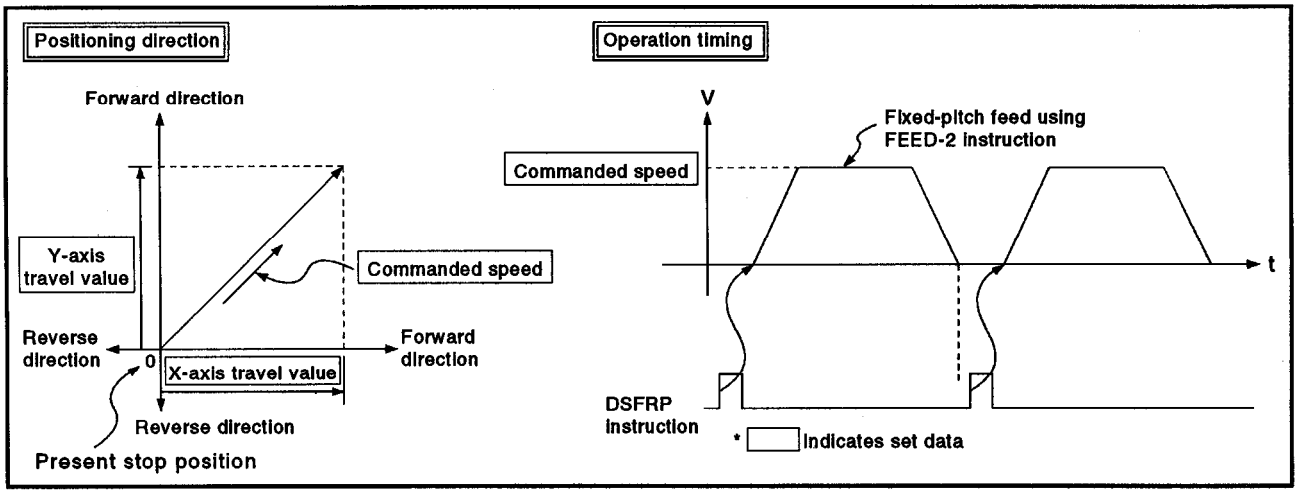


Figure 7.23 Fixed-Pitch Feed Control Using Two-Axis Linear Interpolation

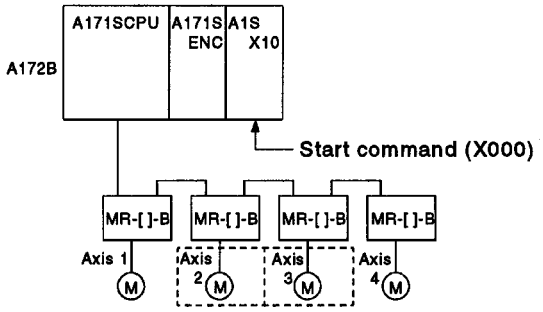
POINT

(1) Do not set the travel value to zero for fixed-pitch feed control.
The following results if the travel value is set to zero:
(a) If both axes are set to zero, the fixed-pitch feed ends with no feed taking place.
(b) If the travel value is set to zero for one axis only, fixed-pitch feed control will not occur at the normal positioning speed for the axis set to a non-zero travel value.

[Program Example]

This program conducts fixed-pitch feed control using 2-axis linear interpolation under the conditions below.

(1) System configuration
Fixed-pitch feed control using 2-axis linear interpolation of Axis 2 and Axis 3.

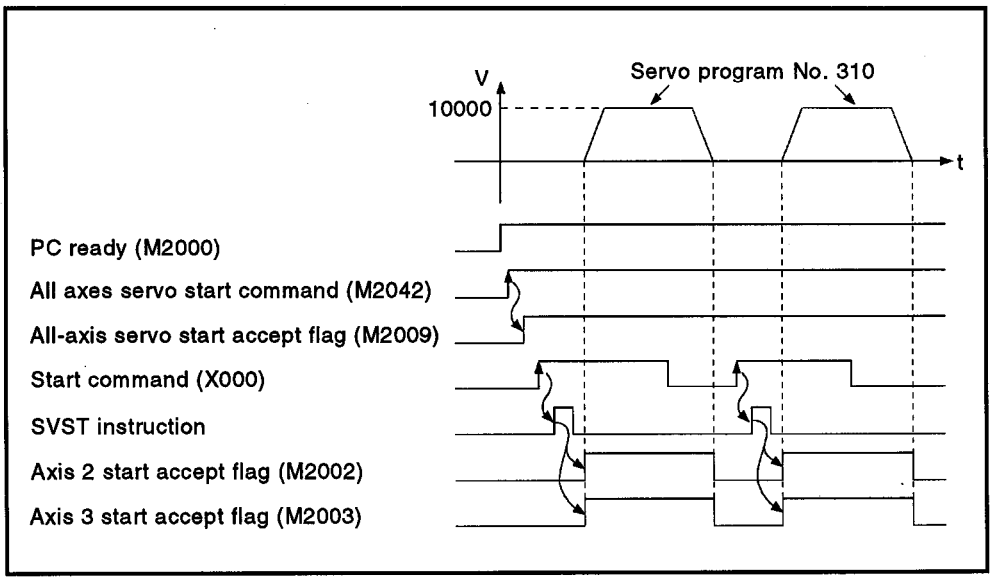


(2) Positioning conditions
The fixed-pitch feed control conditions are shown below.

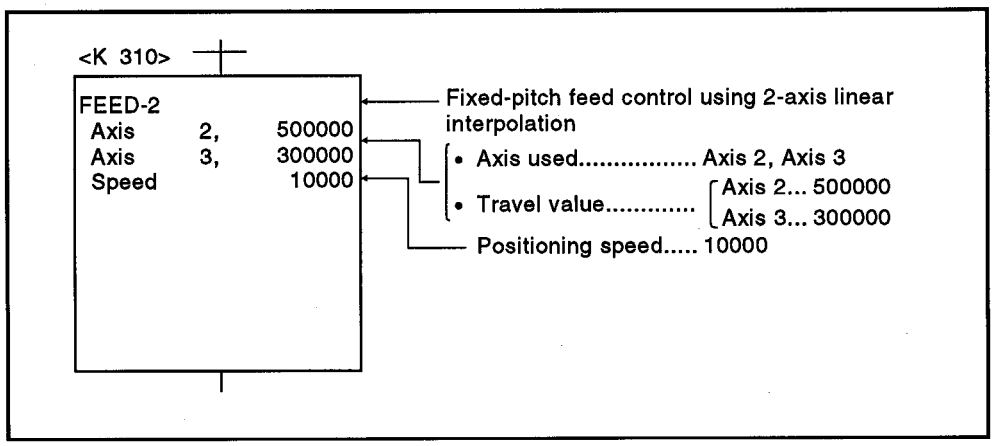
Item	Setting	
Servo program number	No. 310	
Positioning speed	10000	
Controlled axis	Axis 2	Axis 3
Travel value	500000	300000

(a) Fixed-pitch feed control start command .....leading edge of X000 (OFF → ON)

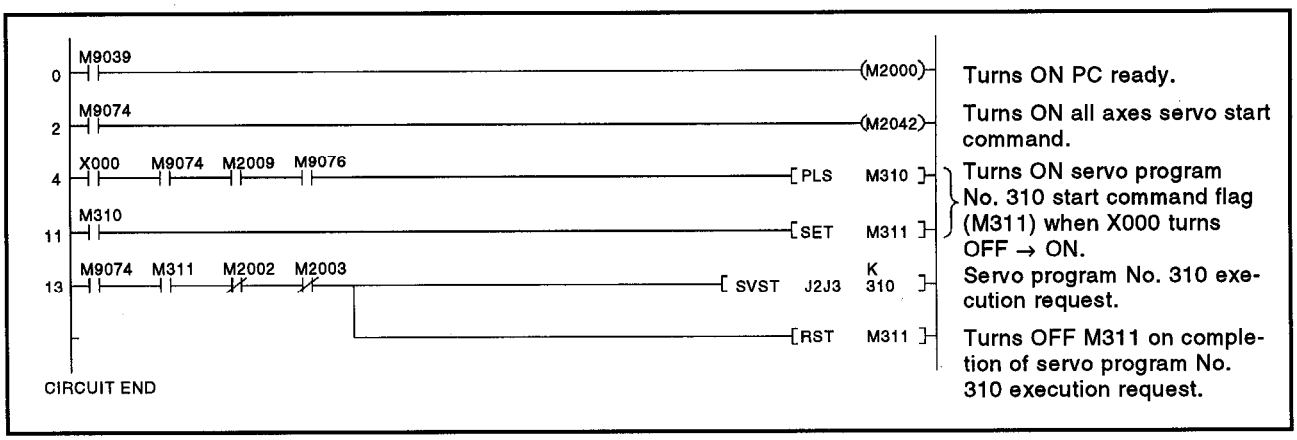
(3) Operation timing
The operation timing for fixed-pitch feed control using two-axis linear interpolation is shown below.



(4) Servo program
The servo program No. 310 for fixed-pitch feed control using two-axis linear interpolation is shown below.



(5) Sequence program
The sequence program which runs the servo program is shown below.



7.11 Fixed-Pitch Feed Control Using Three-Axis Linear Interpolation

Fixed-pitch feed control using 3-axis linear interpolation from the present stop position with the three axes designated in the sequence program positioning commands.
Fixed-pitch feed control using three-axis linear interpolation uses the FEED-3 servo instruction.

Servo Instruction	Positioning Method	Number of Controllable Axes	Items Set by Peripherals: Common: Parameter Block No.	Axis	Address/Travel Value	Commanded Speed	Dwell Time	M Code	Torque Limit Value	Arc: Auxiliary Point	Radius	Center Point	Parameter Block: Control Unit	Speed Limit Value	Acceleration Time	Deceleration Time	Rapid Stop Deceleration Time	Torque Limit Value	Deceleration Processing on Stop Input	Allowable Error Range for Circular Interpolation	S Curve Ratio	Others: Cancel	Start	Speed Change
FEED-3	Incremental	3	Δ	O	O	O	Δ	Δ					Δ	Δ	Δ	Δ	Δ	Δ	Δ		Δ	Δ	Δ	OK

O : Must be set
Δ : Set if required

[Control Details]

(1) Positioning control from the present stop position (0) to the position which is the resultant of the designated travel directions and travel values of the respective axes.

(2) The travel direction is designated by the sign of the travel value, as follows:
- Positive travel value .... forward direction (increased address)
- Negative travel value ... reverse direction (decreased address)

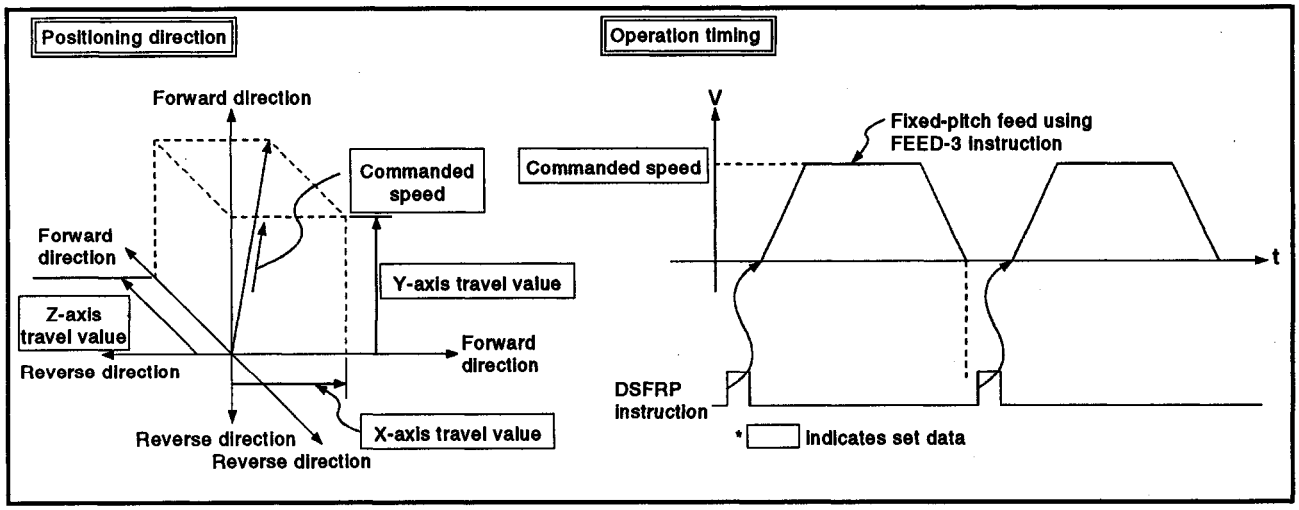


Figure 7.24 Fixed-Pitch Feed Control Using Three-Axis Linear Interpolation

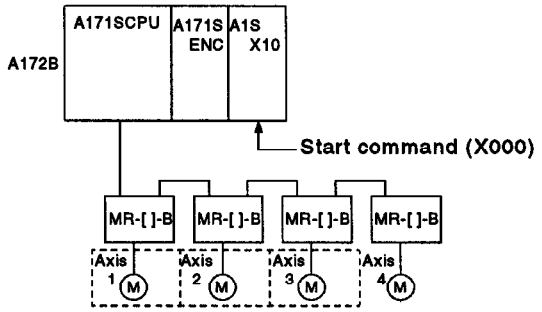
POINT

(1) Do not set the travel value to zero for fixed-pitch feed control. The following results if the travel value is set to zero:
   (a) If all three axes are set to zero, the fixed-pitch feed ends with no feed taking place.
   (b) If the travel value is set to zero for any of the three axes, fixed-pitch feed control will not occur at the normal positioning speed for the axis or axes set to a non-zero travel value.

[Program Example]

This program conducts fixed-pitch feed control using 3-axis linear interpolation under the conditions below.

(1) System configuration
Fixed-pitch feed control using 3-axis linear interpolation of Axis, 1, Axis 2, and Axis 3.

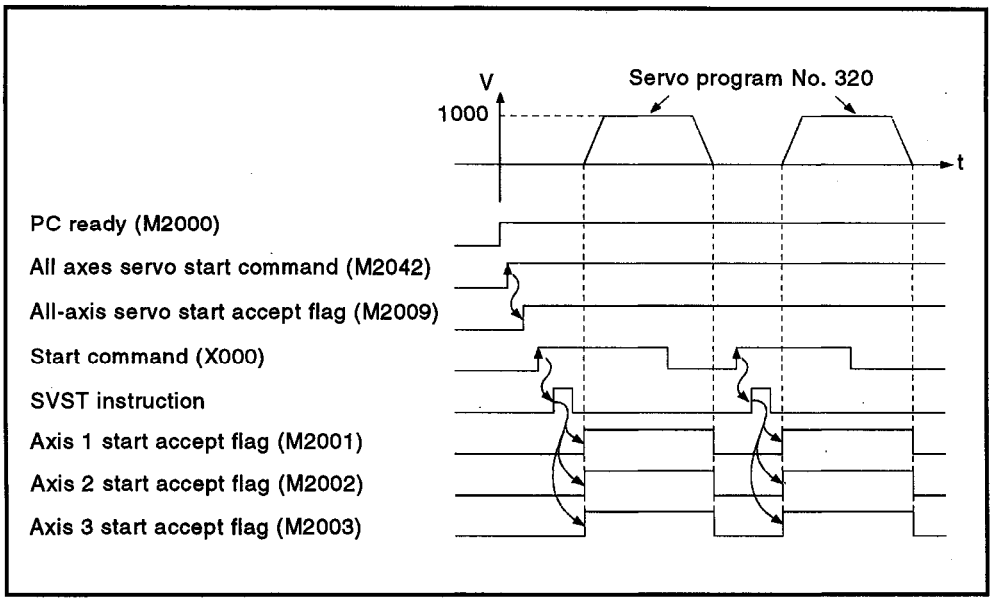


(2) System configuration
   (a) The positioning conditions are shown below.

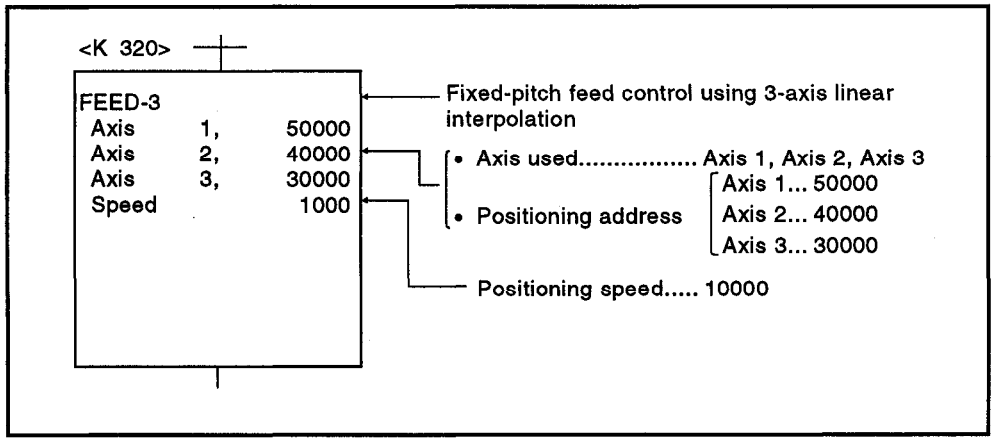
Item	Setting		
Servo program number	No. 320		
Positioning speed	1000		
Controlled axes	Axis 1	Axis 2	Axis 3
Travel value	50000	40000	30000

   (b) Fixed-pitch feed control start command .....leading edge of X000 (OFF → ON)

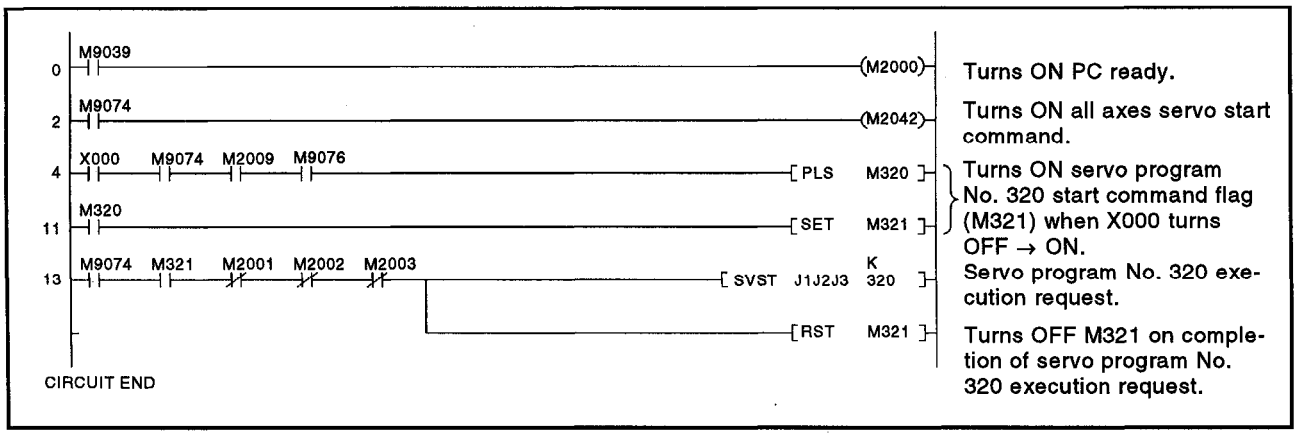
(3) Operation timing
The operation timing for fixed-pitch feed control using three-axis linear interpolation is shown below.



(4) Servo program
The servo program No. 320 for fixed-pitch feed control using three-axis linear interpolation is shown below.



(5) Sequence program The sequence program which runs the servo program is shown below.



7.12 Speed Control (I)

(1) Speed control of the axes designated in the sequence program positioning commands.

(2) Control includes positioning loops for control of servo amplifiers.

(3) Speed control (I) uses the VF (forward) and VR (reverse) servo instructions.

Servo Instruction	Positioning Method	Number of Controllable Axes	Items Set by Peripherals																						
			Common							Arc			Parameter Block										Others		
			Parameter Block No.	Axis	Address/Travel Value	Commanded Speed	Dwell Time	M Code	Torque Limit Value	Auxiliary Point	Radius	Center Point	Control Unit	Speed Limit Value	Acceleration Time	Deceleration Time	Rapid Stop Deceleration Time	Torque Limit Value	Deceleration Processing on Stop Input	Allowable Error Range for Circular Interpolation	S Curve Ratio	Cancel	Start	Speed Change
VF / VR	—	1	Δ	O		O		Δ						Δ	Δ	Δ	Δ	Δ	Δ		Δ	Δ	Δ	OK

O : Must be set
Δ : Set if required

[Control Details]

(1) Controls the axis at the designated speed between the start of servomotor operation and the input of the stop command.
- VF .....movement in forward direction
- VR .... movement in reverse direction

(2) The present value does not change at zero.

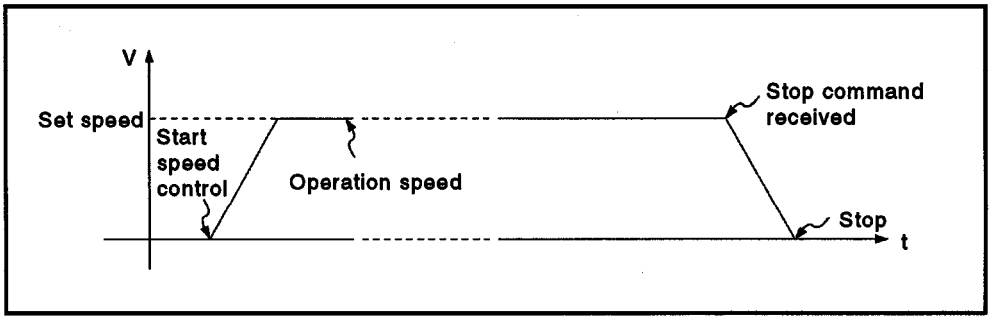


Figure 7.25 Speed Control (I)

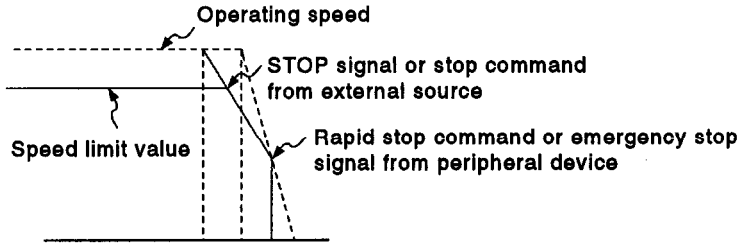
(3) Stop commands and stop processing
The stop commands and stop processing for speed control are listed in Figure 7.1.

Figure 7.1 Stop Commands and Stop Processing

Stop Command	Stop Condition	Stopped Axis	Stop Processing
External STOP signal	OFF → ON	Designated axis	Deceleration stop according to the deceleration time on STOP input designated in the parameter block or by a servo instruction.
Stop command (M1800+20n/Yn0/ M3200+20n)			Deceleration stop according to the deceleration time designated in the parameter block or by a servo instruction.
Rapid stop command* (M1801+20n/Yn1/ M3201+20n)			Deceleration stop according to the rapid stop deceleration time designated in the parameter block or by a servo instruction.
Emergency stop from peripheral device* (test mode)	Key input	All axes	Deceleration stop according to the rapid stop deceleration time designated in the parameter block or by a servo instruction.
Speed changed to 0	Value stored in speed change register	Designated axis	Deceleration stop according to the deceleration time designated in the parameter block or by a servo instruction.

POINT

*: The rapid stop command and emergency stop from a peripheral device are valid during deceleration due to input of an external STOP signal or the stop command (M1800+20n/Yn0/M3200+20n), and processing according to the rapid stop deceleration time parameter starts at the time the stop condition occurs.



[Cautions]

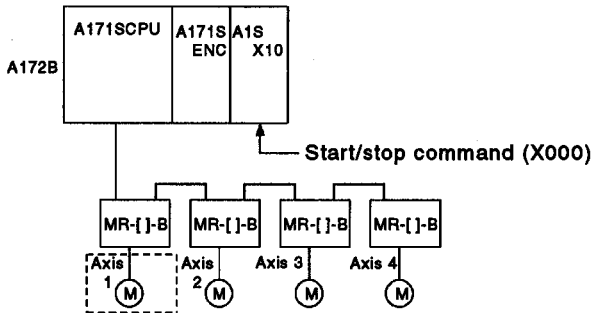
(1) After running speed control using the absolute data system, the feed present value cannot be set to zero by the following operations:
- Reset with the RUN key
- Turning on the servo power supply (OFF → ON)

(2) The dwell time cannot be set.

[Program Example]

This program conducts speed control (I) under the conditions below.

(1) System configuration
Speed control (I) of Axis 1.



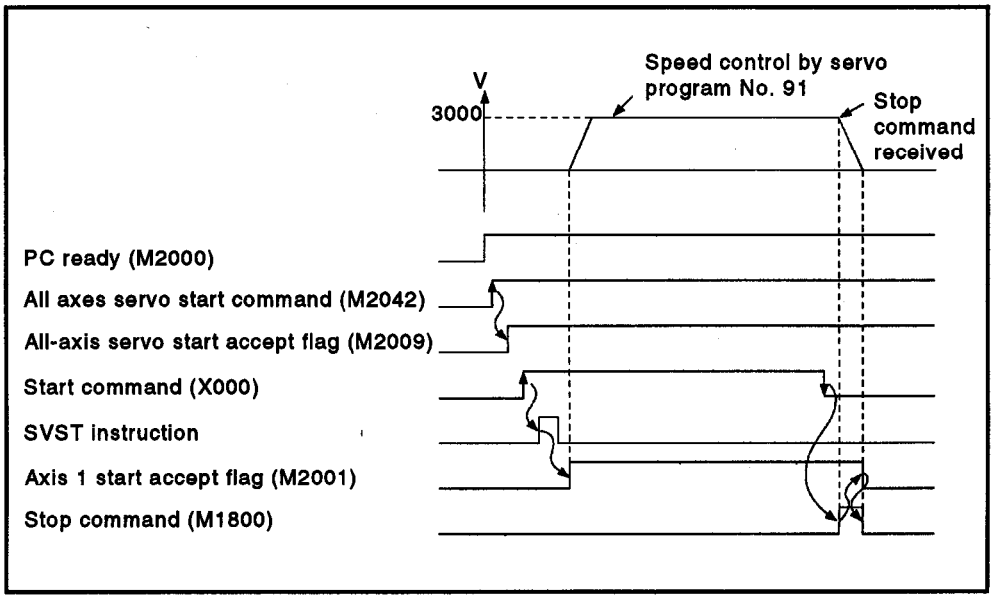
(2) Speed control (I) conditions
(a) The speed control (I) conditions are shown below.

Item	Setting
Servo program number	No. 91
Controlled axis	Axis 1
Control speed	3000
Rotation direction	Forward

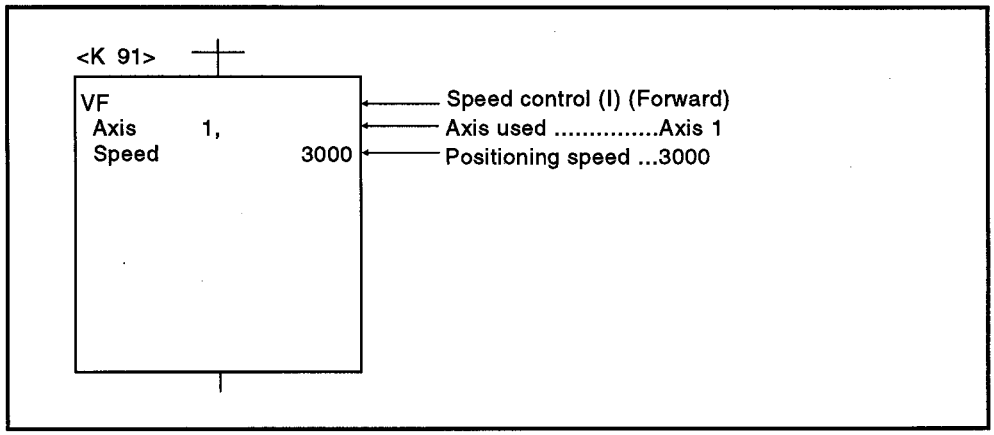
(b) Speed control (I) start command ...leading edge of X000 (OFF → ON)

(c) Speed control (I) stop command ...trailing edge of X000 (ON → OFF)

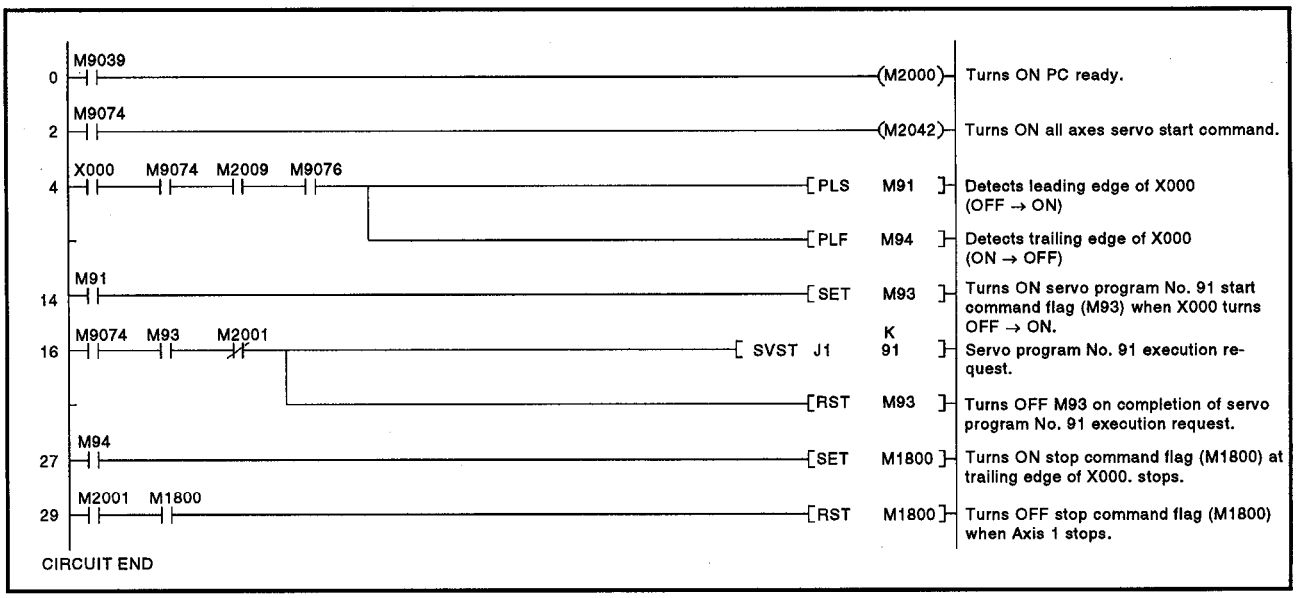
(3) Operation timing
The operation timing for speed control (I) is shown below.



(4) Servo program
The servo program No. 91 for speed control (I) is shown below.



(5) Sequence program
The sequence program which runs the servo program is shown below.



7.13 Speed Control (II)

(1) Speed control of the axes designated in the sequence program positioning commands.

(2) Control does not include positioning loops for control of servo amplifiers. Use stopper control to prevent errors becoming excessive.

(3) Speed control (II) uses the VVF (forward) and VVR (reverse) servo instructions.

Servo Instruction	Positioning Method	Number of Controllable Axes	Items Set by Peripherals																							
			Common							Arc			Parameter Block											Others		
			Parameter Block No.	Axis	Address/Travel Value	Commanded Speed	Dwell Time	M Code	Torque Limit Value	Auxiliary Point	Radius	Center Point	Control Unit	Speed Limit Value	Acceleration Time	Deceleration Time	Rapid Stop Deceleration Time	Torque Limit Value	Deceleration Processing on Stop Input	Allowable Error Range for Circular Interpolation	S Curve Ratio	Cancel	Start	Speed Change
VVF VVR	—	1	Δ	O		O		Δ	Δ					Δ	Δ	Δ	Δ	Δ	Δ		Δ	Δ	Δ	OK

O : Must be set
Δ : Set if required

[Control Details]

(1) Controls the axis at the designated speed between the start of servomotor operation and the input of the stop command.
- VVF ..... movement in forward direction
- VVR .....movement in reverse direction

(2) The present value or deviation counter do not change at zero.

(3) When the setting for "torque" is set in a servo program and an indirect designation is made, the torque limit value can be changed during operation by changing the value of the indirect device.

(4) The stop command and stop processing are the same as for speed control(I).

[Cautions]

(1) After running speed control using the absolute data system, the feed present value cannot be set to zero by resetting with the RUN key.

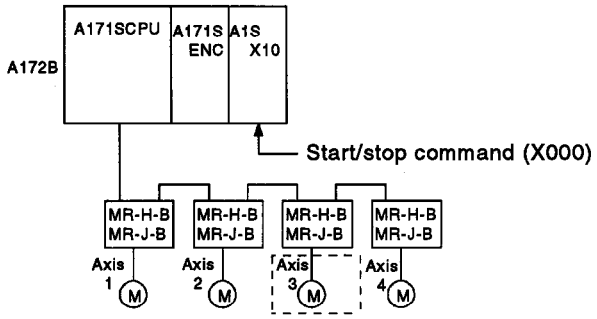
(2) The dwell time cannot be set.

(3) Cannot be used with respect to MR-J-B axes.

[Program Example]

This program conducts speed control (II) under the conditions below.

(1) System configuration
Speed control (II) of Axis 3.



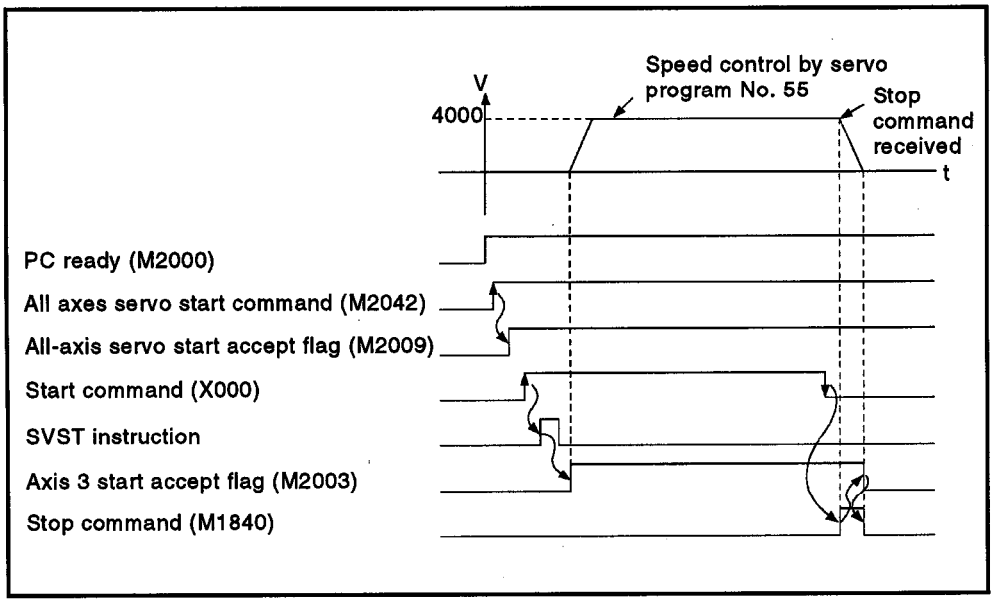
(2) Speed control (II) conditions
(a) The speed control (II) conditions are shown below.

Item	Setting
Servo program number	No. 55
Controlled axis	Axis 3
Control speed	4000
Rotation direction	Forward

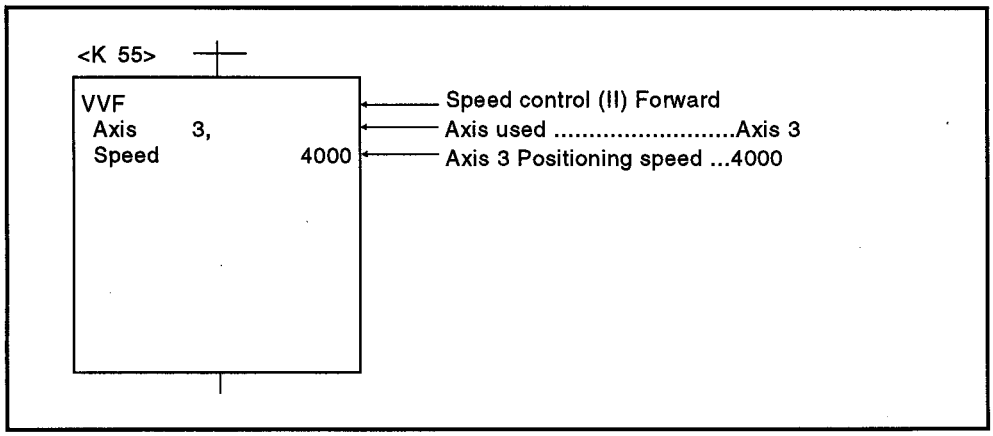
(b) Speed control (II) start command ...leading edge of X000 (OFF → ON)

(c) Speed control (II) stop command ...trailing edge of X000 (ON → OFF)

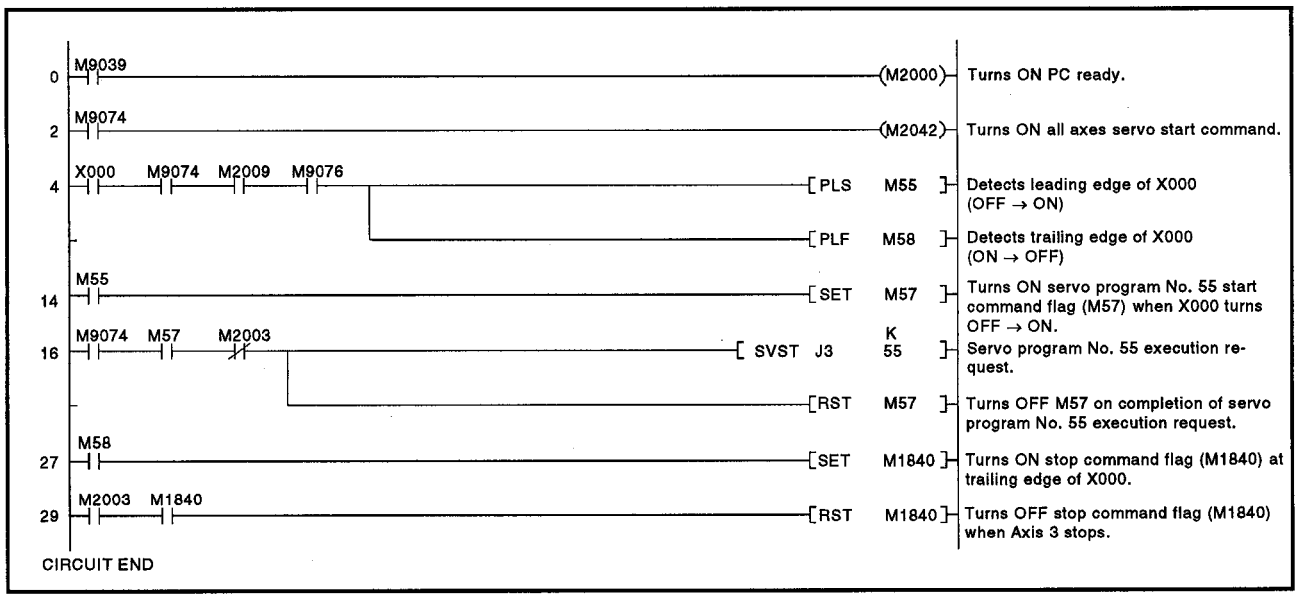
(3) Operation timing
The operation timing for speed control (II) is shown below.



(4) Servo program
The servo program No. 55 for speed control (II) is shown below.



(5) Sequence program
The sequence program which runs the servo program is shown below.



7.14 Speed/Position Switching Control

7.14.1 Starting speed/position switching control

Speed/position switching control of the axes designated in the sequence program positioning commands.
Speed/position switching control uses the VPF (forward), VPR (reverse), and VPSTART (restart) servo instructions.

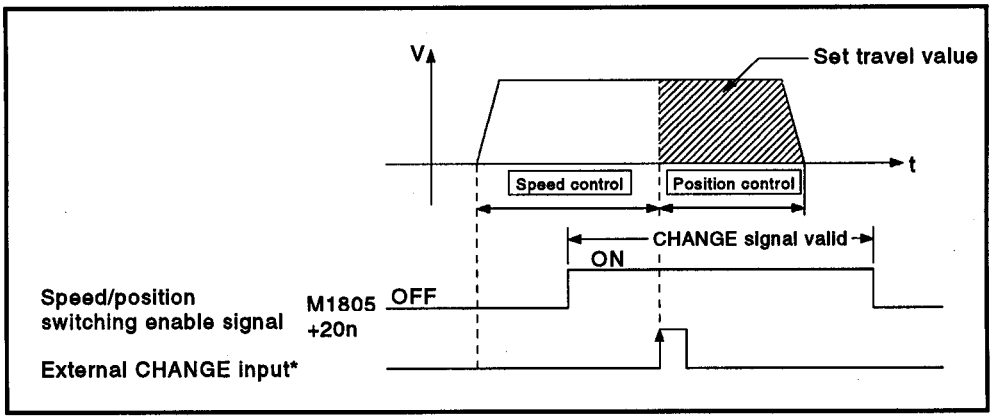
Servo Instruction	Positioning Method	Number of Controllable Axes	Items Set by Peripherals: Common: Parameter Block No.	Axis	Address/Travel Value	Commanded Speed	Dwell Time	M Code	Torque Limit Value	Arc: Auxiliary Point	Radius	Center Point	Paramter Block: Control Unit	Speed Limit Value	Acceleration Time	Deceleration Time	Rapid Stop Deceleration Time	Torque Limit Value	Deceleration Processing on Stop Input	Allowable Error Range for Circular Interpolation	Others: S Curve Ratio	Cancel	Start	Speed Change
VPF VPR	Incremental	1	Δ	O	O	O	Δ	Δ	Δ					Δ	Δ	Δ	Δ	Δ	Δ		Δ	Δ	Δ	OK

O : Must be set
Δ : Set if required

[Control Details]

(1) The servomotor starts under speed control, but on input of the external CHANGE signal the control changes from speed control to position control and the axis is positioned by the designated travel value.
- VPF ... movement in forward direction (direction in which addresses increase)
- VPR ... movement in reverse direction (direction in which addresses decrease)

(2) The external CHANGE signal is only valid when M1805+20n (Speed/position switching enable signal) is ON. If M1805+20n turns ON after the CHANGE signal turns ON, no speed/position switching occurs and speed control is continued.



REMARKS

*: 1) When using A171SCPU, the external CHANGE signal is an external input to the A171SENC DOG/CHENGE terminal. When "normally open contact input" is set in the system settings, CHANGE input occurs when the DOG/CHANGE signal comes ON, and when "normally closed contact input" is set, CHANGE input occurs when the DOG/CHANGE signal goes OFF. (See the A171SCPU Motion Controller User's Manual (IB-67276) for details.)

2) When using A273UHCPU (8/32-axis specification), the external CHANGE signal is an external input to the A278LX CHANGE terminal. (See the A273UHCPU (8/32-axis specification) Motion Controller User's Manual (IB-67262) for details.)

(3) Feed present value processing

The feed present value is determined in one of the following two ways according to the ON/OFF status of M1812+20n (feed present value update request command) when speed/position switching control is started.

(a) M1812+20n..... OFF

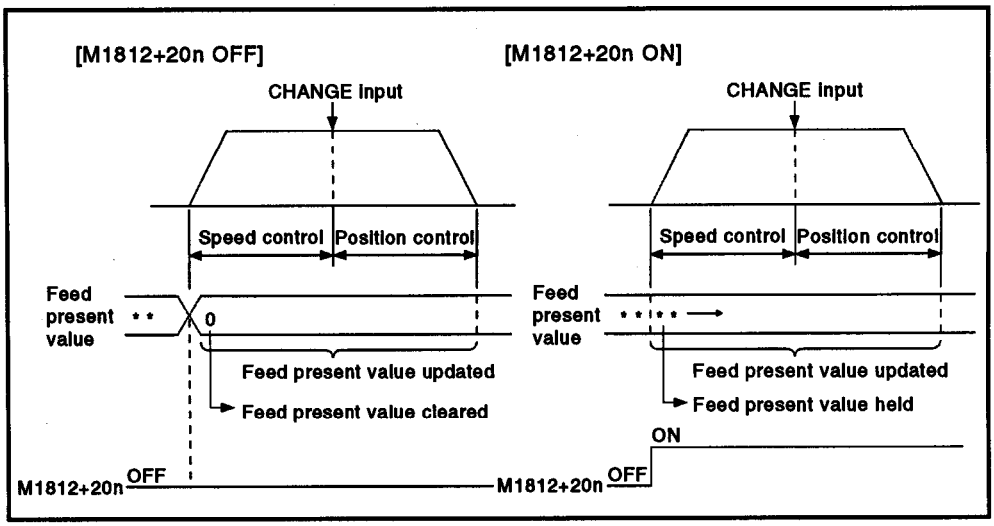
- The feed present value is cleared to zero at the start of speed/position switching control.
- The feed present value is updated from the start of control (speed control).
- The feed present value after control is stopped is as follows:

[Feed present value after stopping] = [Travel value under speed control] + [Travel value under position control]

(b) M1812+20n..... ON

- The feed present value is not cleared at start of speed/position switching control.
- The feed present value is updated from the start of control (speed control).
- The axis makes a deceleration stop if the feed present value exceeds the stroke limit.
- The feed present value after control is stopped is as follows:

[Feed present value after stopping] = [Address before speed control] + [Travel value under speed control] + [Travel value under position control]



POINT

If control is started by turning M1812+20n/YnC/M3212+20n ON, leave M1812+20n/YnC/M3212+20n ON until positioning control is completed. The feed present value cannot be guaranteed if M1812+20n /YnC/ M3212+20n is turned OFF during control.

(4) Changing travel value during speed control
After speed/position switching control is started, the travel value for position control can be changed while speed control is in progress. Follow the procedure described below to change the travel value.

(a) Indirectly designate the travel value in the servo program using the 2-word data registers shown in the table below.

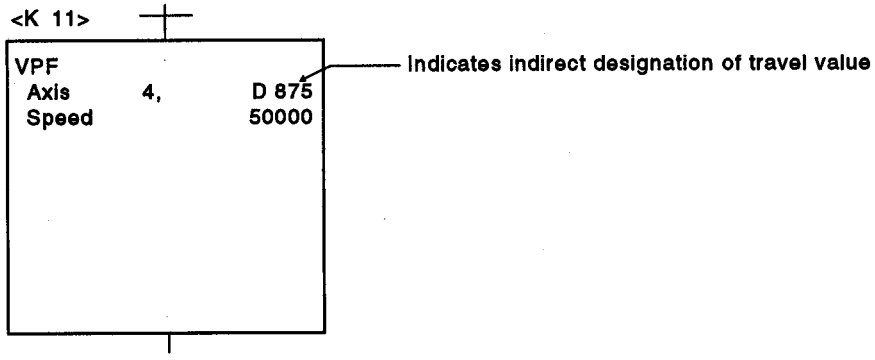
<A171SCPU>

Axis No.	Data Register Number for Indirect Designation	Data Registers to Change Travel Value	
		Most-Significant Data	Least-Significant Data
1	D815	D816	D815
2	D835	D836	D835
3	D855	D856	D855
4	D875	D876	D875

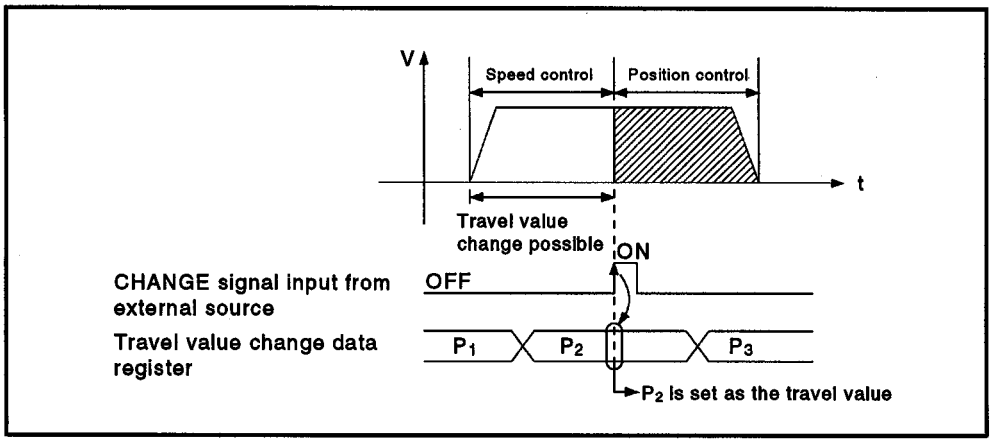
* See Sections 3.4 for the data register numbers used in indirect designation of travel values with A273UHCPU (8/32-axis specification).

---- Example ----

The following servo program moves Axis 4 in the forward direction at speed 50000 under speed control and after the external CHANGE signal turns ON, it executes position control for the travel value designated in registers D875 and D876.



(b) The sequence program sets the travel value in the travel value change data register while speed control is in progress. When the external CHANGE signal turns ON, the contents of the travel value change data register are set as the travel value.

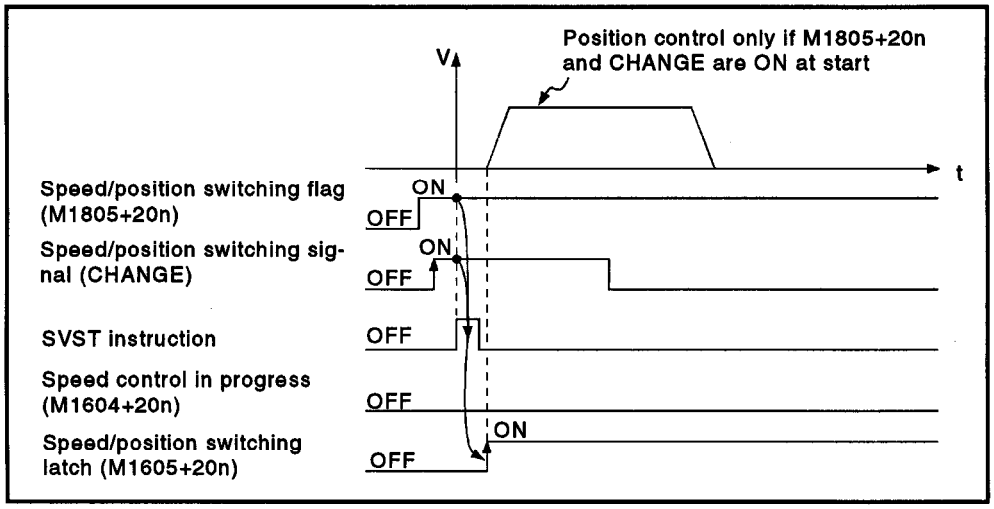


(5) Travel value area after near-zero point dog turns ON
The travel value since the position mode was selected by the external CHANGE signal is stored in the travel value area (see section 3.4.1) when the near-zero point dog turns ON.

[Cautions]

(1) Items checked when the external CHANGE signal turns ON
Speed control switches to position control when the External CHANGE signal turns ON if the following conditions are met:
- The start accept flag (M2001+1) is ON.
- Speed control is in progress after start of speed/position switching control.
- Speed/position switching enable signal (M1805+20n) is ON.

(2) To omit speed control
Position control only is executed if M1805+20n and the CHANGE signal are ON when control starts. The speed control signal (M1604+20n) does not turn ON.

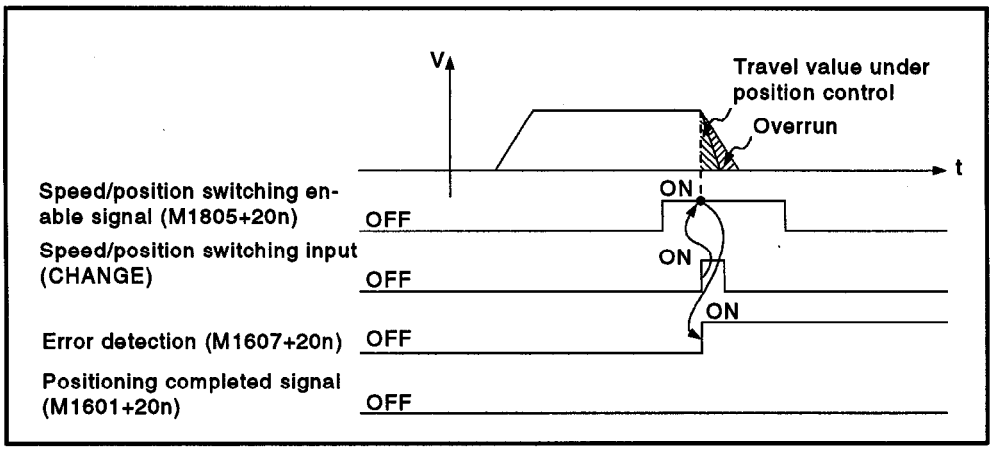


(3) If travel value under position control is less than deceleration distance

(a) If the position control travel value is less than the deceleration distance at the controlled speed, deceleration processing starts immediately when CHANGE is input.

(b) The difference between travel value for the deceleration stop and position control is the overrun. If an overrun occurs, the error detection signal (M1607+20n) turns ON and error code 209 is stored in the data register.

(c) The positioning completed signal (M1601+20n) does not turn ON.



(4) Stoke limit check

No stroke limit range check is made during the speed mode. If the travel value exceeds the stroke limit range, a minor error (error code: 210) occurs when position mode is selected, and a deceleration stop occurs.

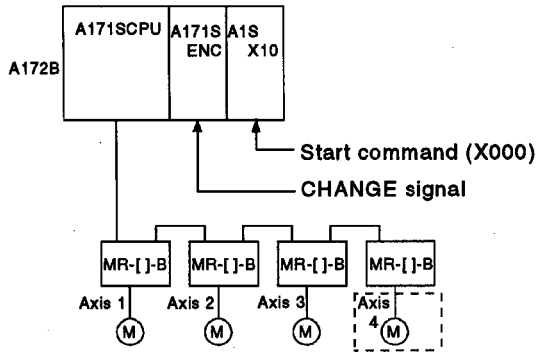
(5) Switching time from speed control to position control

Switching from speed control to position control takes 1 ms after the external CHANGE signal turns ON.

[Program Example]

This program executes speed/position switching control under the conditions below.

(1) System configuration Speed/position switching control of Axis 4.



(2) Positioning conditions

(a) The positioning conditions are shown below.

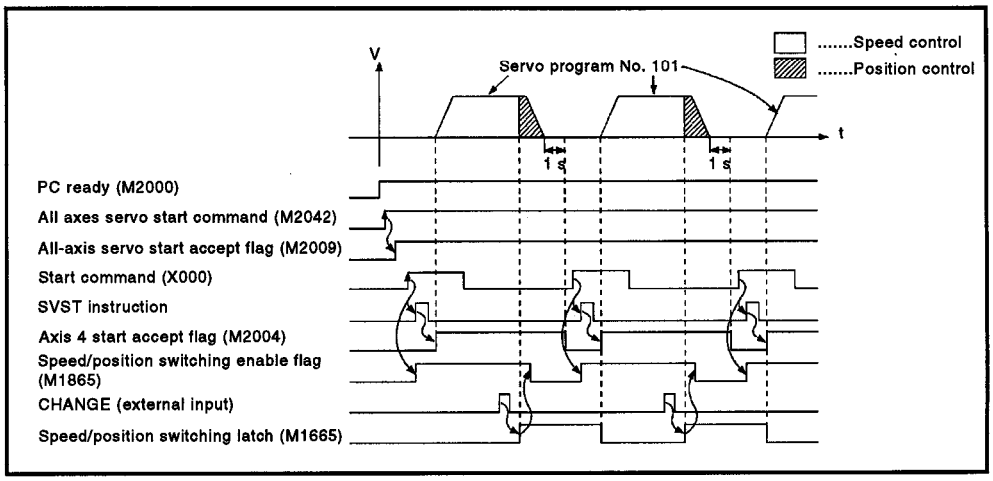
Item	Setting
Servo program number	No. 101
Controlled axis	Axis 4
Positioning control travel value	40000
Commanded speed	1000

(b) Positioning start command .....leading edge of X000 (OFF → ON)

(c) Speed/position switching enable flag M1865

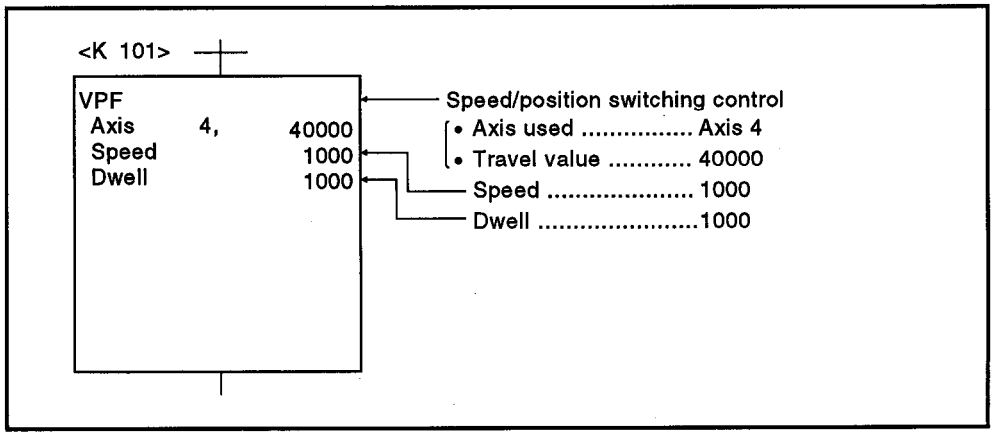
(3) Operation timing

The operation timing for speed/position switching control is shown below.

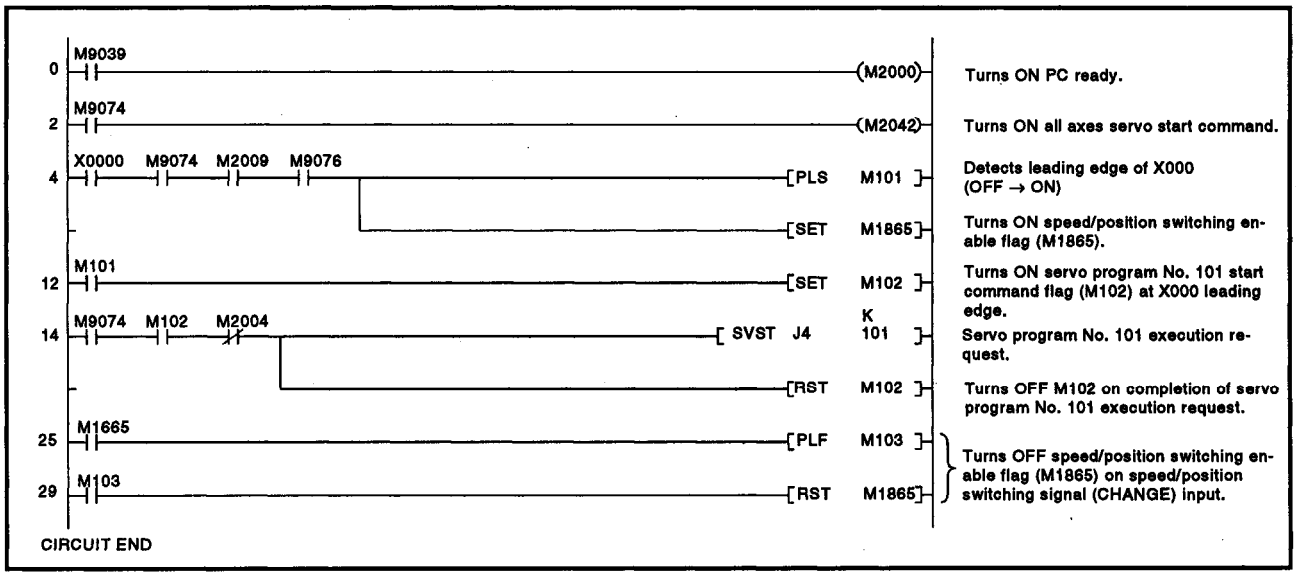


(4) Servo program

The servo program No. 101 for speed/position switching control is shown below.



(5) Sequence program
The sequence program which runs the servo program is shown below.



7.14.2 Restarting speed/position switching control

Restarting (continuing) speed/position switching control after a stop due to a stop command. Control is restarted using the VPSTART servo instruction.

Servo Instruction	Positioning Method	Number of Controllable Axes	Items Set by Peripherals: Common: Parameter Block No.	Common: Axis	Common: Address/Travel Value	Common: Commanded Speed	Common: Dwell Time	Common: M Code	Common: Torque Limit Value	Arc: Auxiliary Point	Arc: Radius	Arc: Center Point	Paramter Block: Control Unit	Paramter Block: Speed Limit Value	Paramter Block: Acceleration Time	Paramter Block: Deceleration Time	Paramter Block: Rapid Stop Deceleration Time	Paramter Block: Torque Limit Value	Paramter Block: Deceleration Processing on Stop Input	Paramter Block: Allowable Error Range for Circular Interpolation	Paramter Block: S Curve Ratio	Others: Cancel	Others: Start	Speed Change
VPSTART				o																		Δ	Δ	

o : Must be set
Δ : Set if required

[Control Details]

(1) Speed/position switching control is continued after it was stopped due to a stop command.

(2) Restarting using VPSTART is valid whether the stop occurred during speed control or position control.
   (a) If the stop occurred during speed control, then speed control continues and switches to position control when the CHANGE signal turns ON.
   (The control conditions after restarting are the same as the previous speed/position switching control conditions. See 7.14.1 "Starting Speed/Position Switcing Control".)

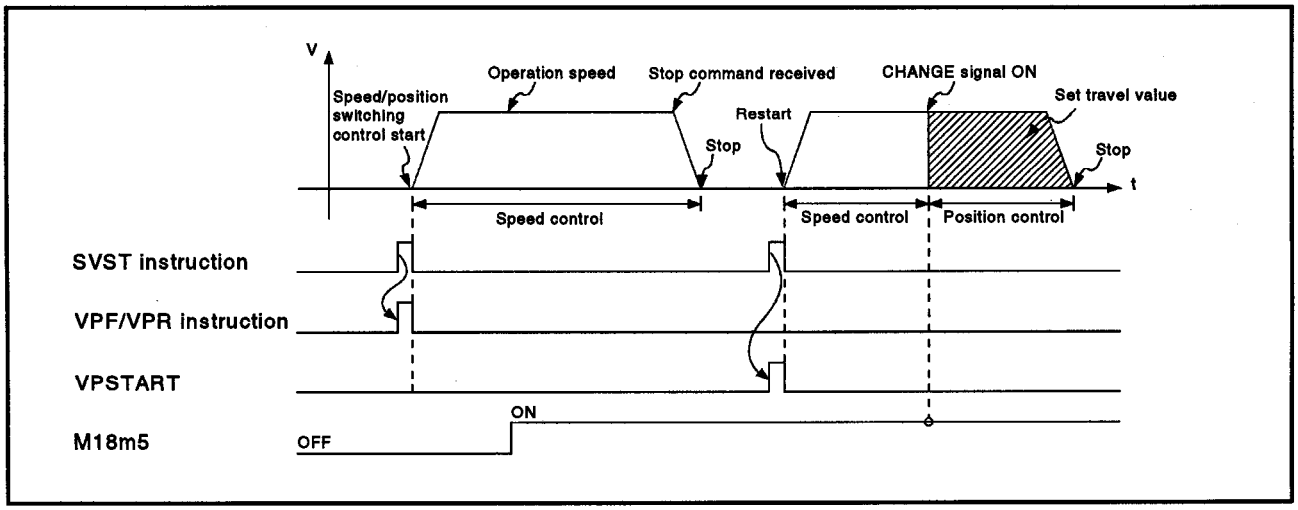


Figure 7.26 Restarting During Speed Control

(b) If the stop occurred during position control, then position control continues until the positioning reaches the set travel value.
The travel value after the restart is calculated as follows:

$$\left[\begin{array}{c}\text{Travel value after restart (P2)}\end{array}\right] = \left[\begin{array}{c}\text{Set travel value (P)}\end{array}\right] + \left[\begin{array}{c}\text{Travel value before stop (P1)}\end{array}\right]$$

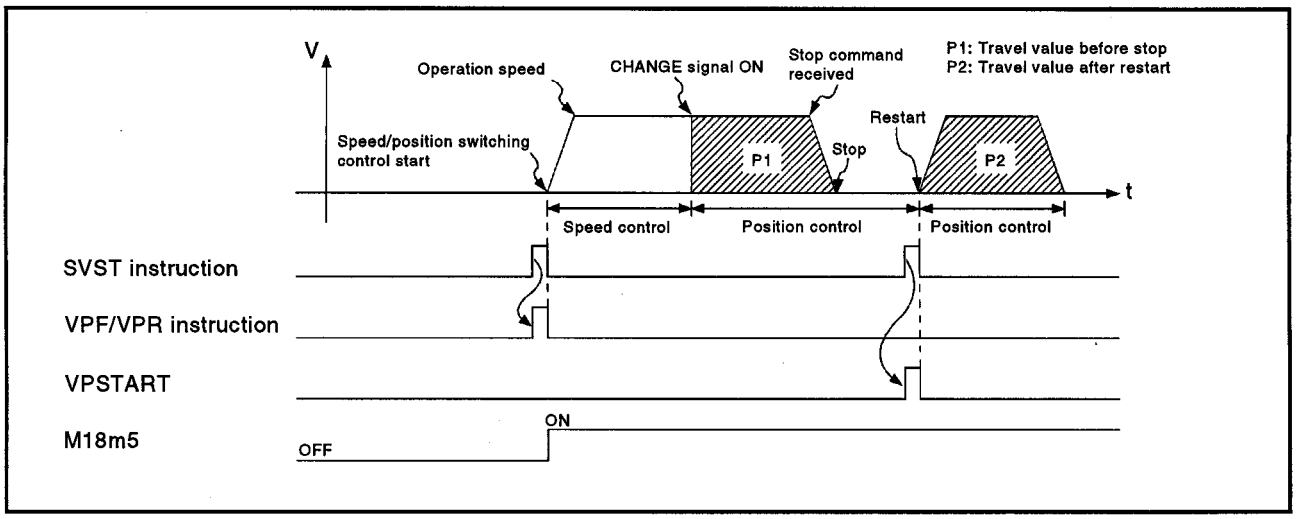


Figure 7.27 Restarting During Speed Control

(3) The speed at restart is the speed stored when the VPF/VPR instruction occurred.
Therefore, even if a speed change occurred before the stop, control restarts at the speed set at the time of VPF/VPR instruction execution.

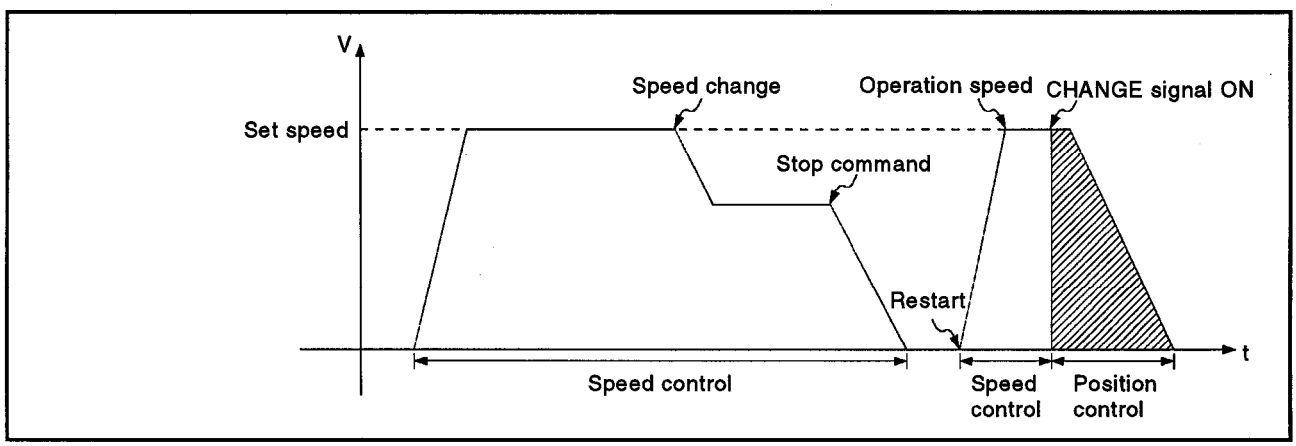
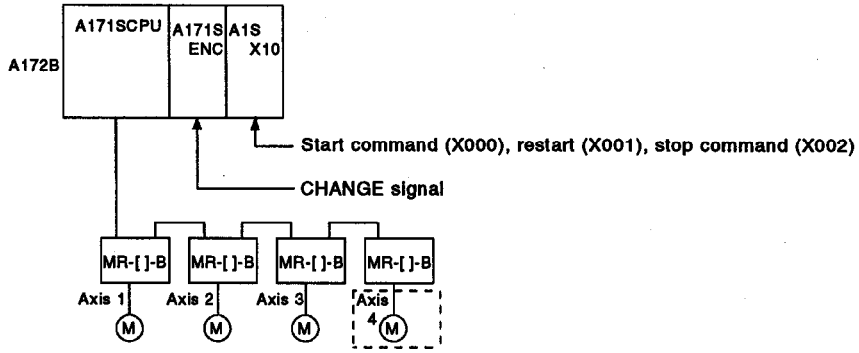


Figure 7.28 Restarting After Speed Change

[Program Example]

This program restarts speed/position switching control after a stop, under the conditions below.

(1) System configuration
Speed/position switching control of Axis 4.



(2) Positioning conditions

(a) The positioning conditions are shown below.

Item	Setting	
	Speed/Position Switching Control	Restart
Servo program number	No. 101	No. 102
Controlled axis	Axis 4	Axis 4
Positioning control travel value	40000	—
Commanded speed	1000	—

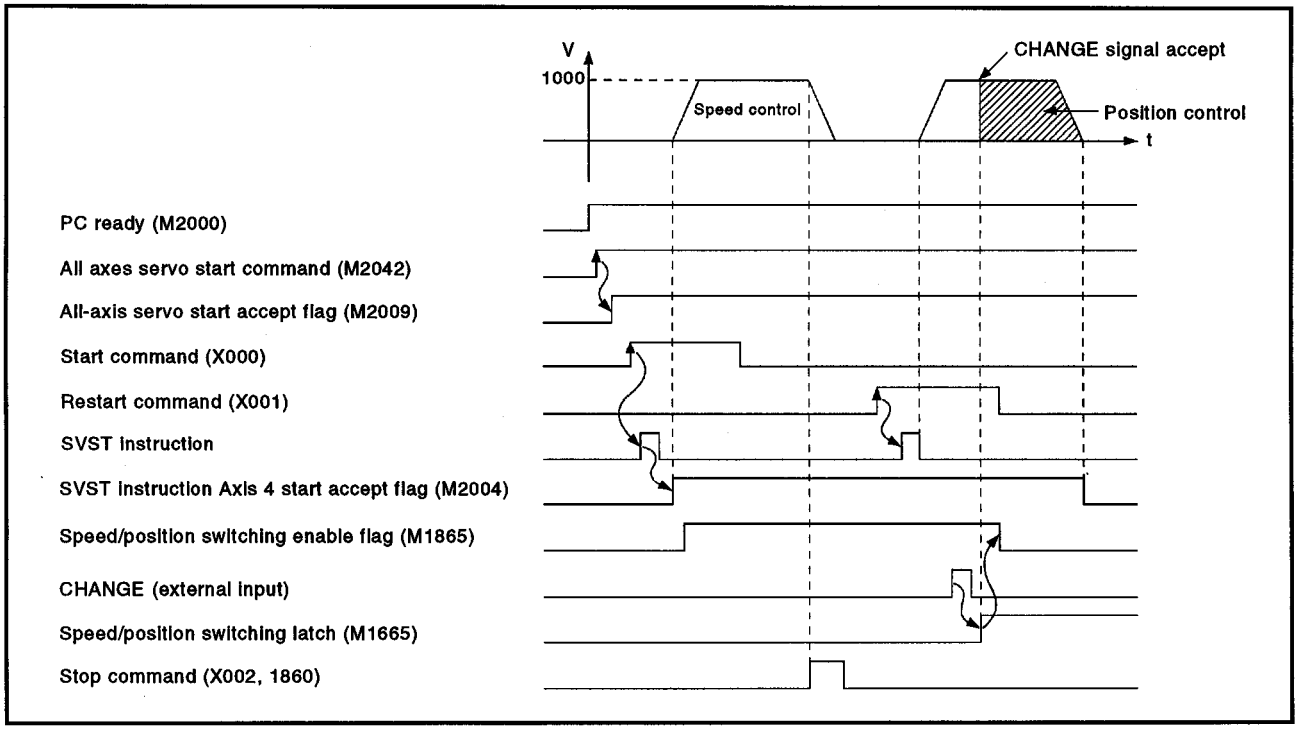
(b) Positioning start command .....leading edge of X000 (OFF → ON)

(c) Speed/position switching enable flag M1865

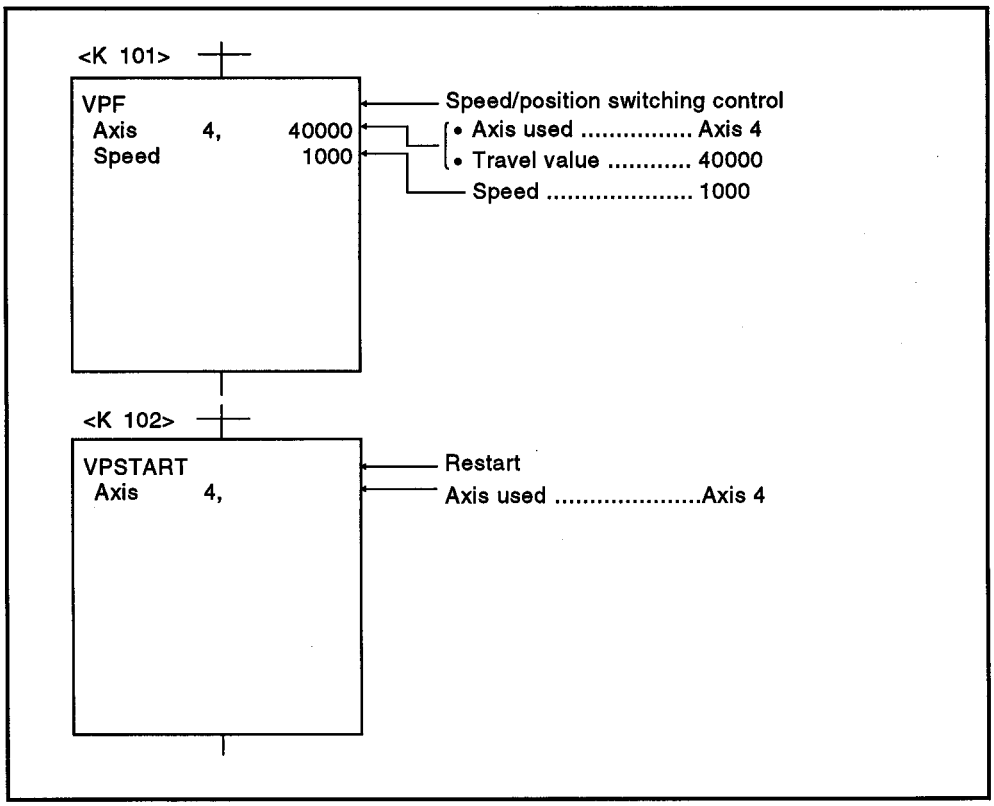
(d) Restart command .....leading edge of X001 (OFF → ON)

(e) Stop command .....leading edge of X002 (OFF → ON)

(3) Operation timing
The operation timing for speed/position switching control and restarting is shown below.

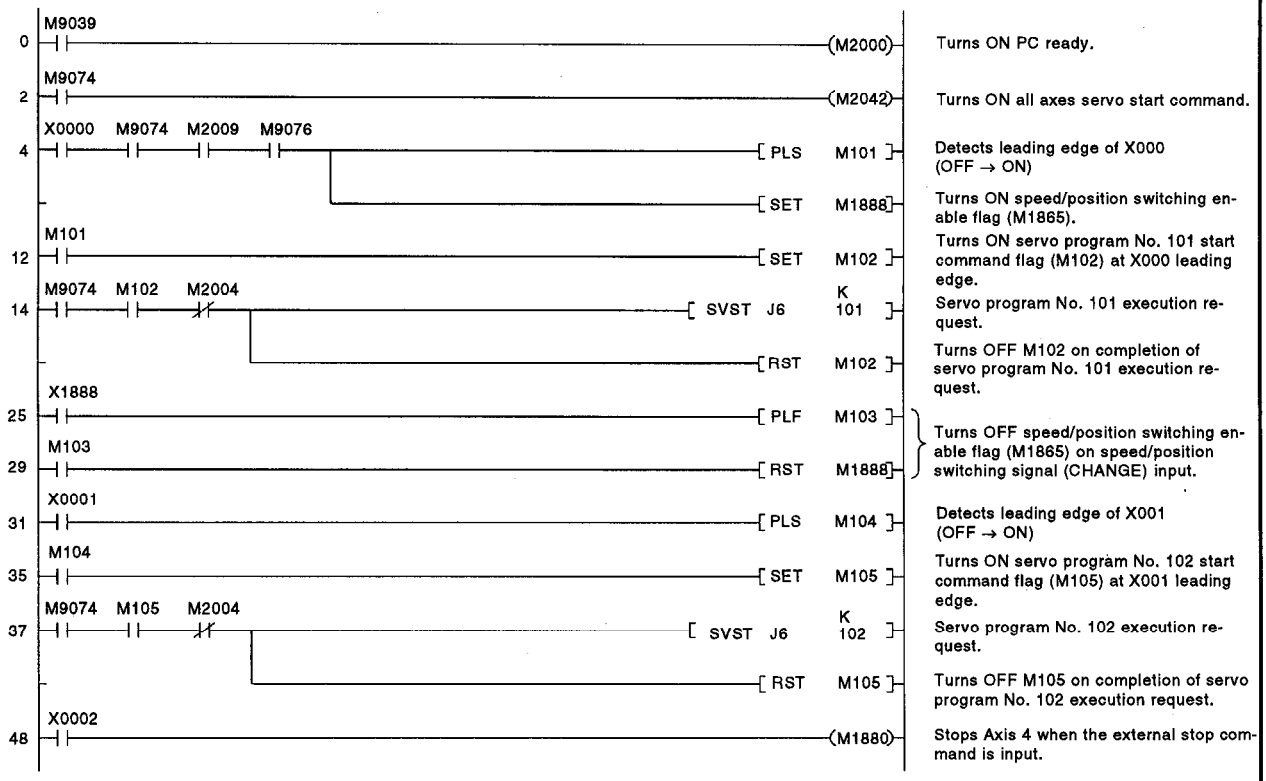


(4) Servo program
The servo program No. 101 for speed/position switching control and No. 102 for restarting are shown below.



(5) Sequence program

The sequence program which runs the servo programs is shown below.



7.15 Speed-Switching Control

(1) After a single control start, the speed is switched for positioning control to the preset speed-switching points.

(2) The speed-switching points and speed are set by the servo program.

(3) Repeated instructions permit repeated control between any speed-switching points.

(4) M codes and torque limit values can be changed at each speed-switching point.

7.15.1 Starting speed-switching control, speed-switching points, end designation

Servo Instruction		Positioning Method	Number of Controllable Axes	Items Set by Peripherals																							
				Common							Arc			Parameter Block									Others		Speed Change
				Parameter Block No.	Axis	Address/Travel Value	Commanded Speed	Dwell Time	M Code	Torque Limit Value	Auxiliary Point	Radius	Center Point	Control Unit	Speed Limit Value	Acceleration Time	Deceleration Time	Rapid Stop Deceleration Time	Torque Limit Value	Deceleration Processing on Stop Input	Allowable Error Range for Circular Interpolation	S Curve Ratio	Cancel	Start	
Start	VSTART	—	—	Δ										Δ	Δ	Δ	Δ	Δ	Δ	Δ		Δ	Δ	Δ	—
End	VEND																								
End point address	ABS-1	Absolute data	1																						
	ABS-2		2																						
	ABS-3		3		O	O	O	Δ	Δ	Δ													Δ	Δ	OK
Travel value to end point	INC-1	Incremental	1																						
	INC-2		2																						
	INC-3		3																						
Speed-switching point	VABS	Absolute data	—			O	O		Δ	Δ															—
	VABC	Incremental																							

O : Must be set
Δ : Set if required

[Control Details]

Starting and ending speed-switching control

Speed-switching control is started and ended using the following instructions:

(1) VSTART
Starts speed-switching control.

(2) VEND
Ends speed-switching control.

End address and travel value to end point

The speed-switching control end address and travel value to the end point, positioning method, and positioning speed to the end point are set using the following instructions:

(1) ABS-1/INC-1
Designate one-axis linear positioning control.
The control details are described in Section 7.2 "One-axis Linear Positioning Control".

(2) ABS-2/INC-2
Designate two-axis linear interpolation control.
The control details are described in Section 7.3 "Two-axis Linear Interpolation Control".

(3) ABS-3/INC-3
Designate three-axis linear interpolation control.
The control details are described in Section 7.4 "Three-axis Linear Interpolation Control".

Speed-switching point setting

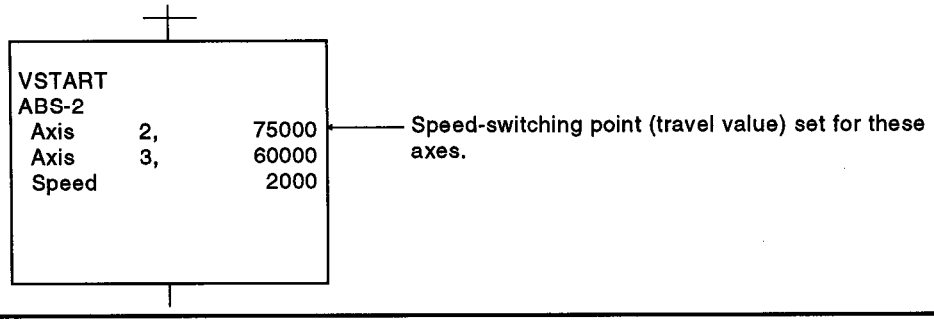
The address (travel value) to the speed-switching point and the positioning speed are set using the following instructions:

(1) VABS
Designates the speed-switching point using the absolute data method.

(2) VINC
Designates the speed-switching point using the incremental method.

POINT

The settings for speed-switching point (travel value) and the positioning speed under 2- or 3-axis linear interpolation control apply to the axes designated for speed-switching control end address and travel value to the end point (with the ABS/INC instructions).



Operation timing and the procedure to write servo programs

The method to write servo programs for speed-switching control and the operation timing are shown in Figure 7.29.

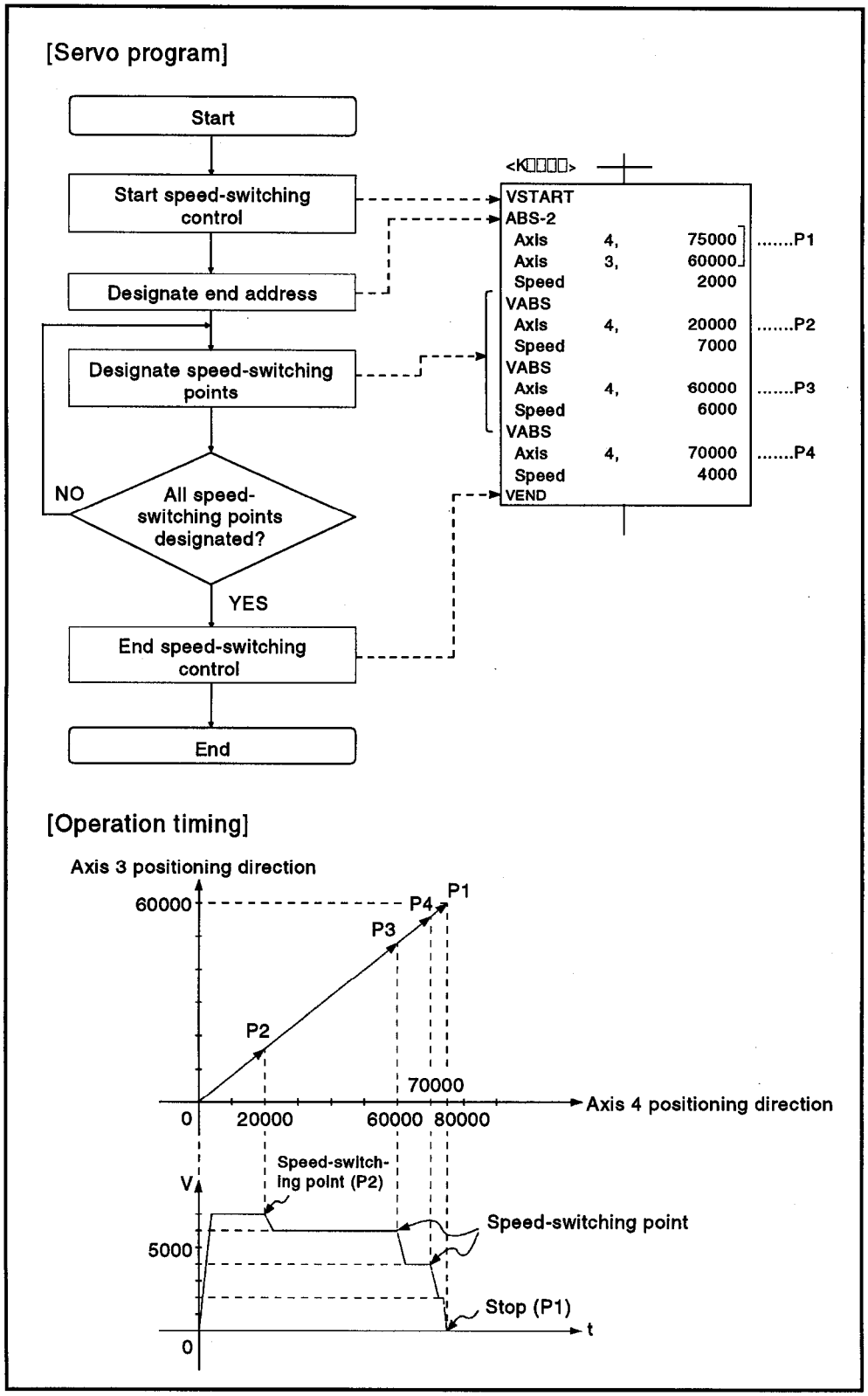


Figure 7.29 Servo Program for Speed/Position Switching Control And Operation Timing

[Cautions]

(1) The number of controllable axes cannot be changed while control is in progress.

(2) Designation of position switching points can use a combination of the absolute data method (ABS□) and the incremental method (INC□).

(3) A speed-switching point cannot be designated as an address which results in a change in travel direction. If the address results in a change in direction, the error code 215 is stored in the minor error register for the axis and a deceleration stop occurs.

(4) A maximum of 768 steps (approximately 100 points) can be designated in a speed-switching control program.

(5) When control is started a check is made to ensure that the end address lies in the stroke range.
If the check determines that positioning would result in an axis moving out of the stroke limit range, the error code 106 is stored in the minor error register for the axis and operation does not start.

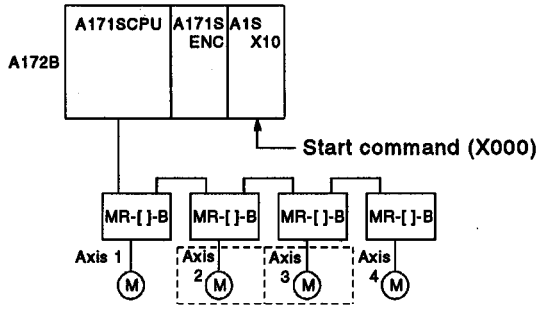
(6) Speed switching is not carried out if the travel value between speed-switching points is so short that the next speed-switching point is reached while speed switching is still in progress.

(7) If no M code is designated for a speed-switching point, the M code from the previous point is retained.

[Program Example]

This program executes speed-switching control under the conditions below.

(1) System configuration
Speed-switching control of Axis 2 and Axis 3.

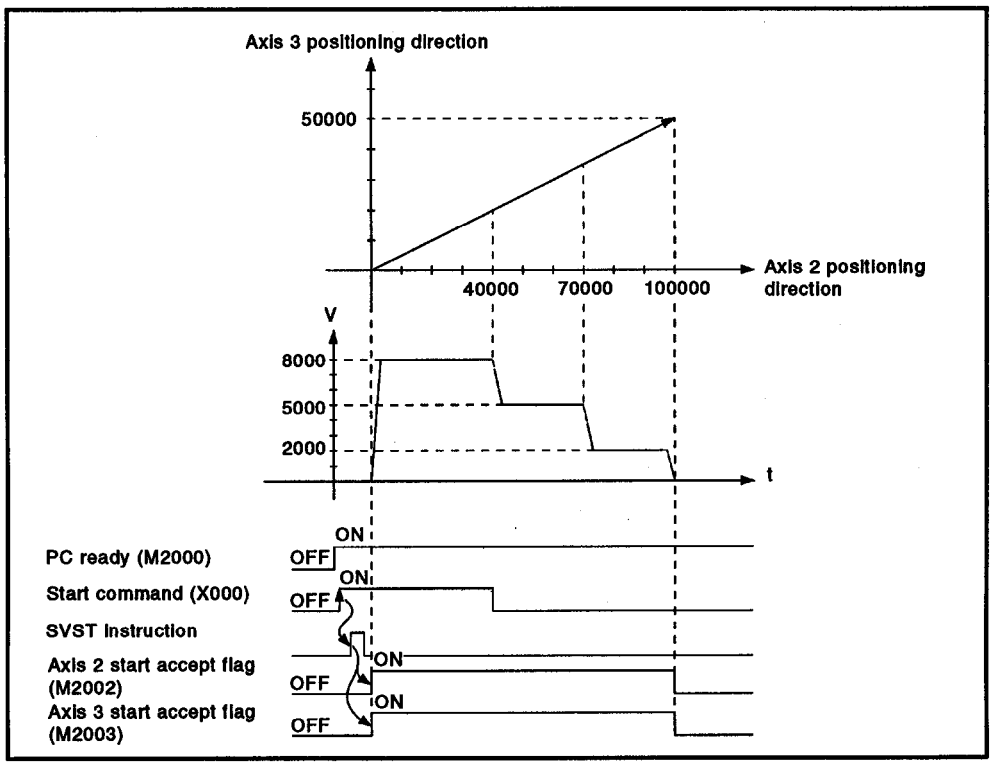


(2) Positioning conditions
(a) The speed-switching control conditions are shown below.

Item	Setting	
Servo program number	No. 500	
Controlled axes	Axis 2	Axis 3
End address	100000	50000

(b) Speed-switching control start command ....leading edge of X000 (OFF → ON)

(3) Operation timing and speed-switching positions
The operation timing for speed-switching control and the speed-switching points are shown below.



⚠ CAUTION

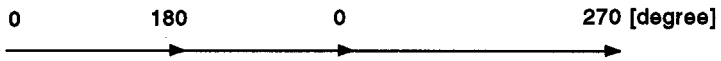
⚠ The operation that takes place on execution of a skip designated during constant speed control, when an axis for which "degree" is designated as the unit and which has no stroke range is included, is described here. If, under these conditions, there is an ABS instruction following the skip, the final positioning point and the travel distance in the program as a whole will be the same regardless of whether the skip is executed or not. Examples are presented below.

(1) When all the instructions after the skip are INC instructions:

Program example

```
CPSTART1
  Axis        1
  Speed                  10.000
INC-1
  Axis        1,        180.00000
  Skip                    X100
INC-1
  Axis        1,        180.00000
INC-1
  Axis        1,        270.00000
CPEND
```

Motion when skip is not executed



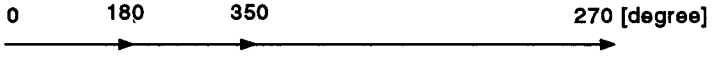
Motion when skip is executed
(when the skip occurs at 100 [degree])

(2) When the instruction immediately following the skip is an ABS instruction

Program example

```
CPSTART1
  Axis        1
  Speed                  10.000
INC-1
  Axis        1,        180.00000
  Skip                    X100
INC-1
  Axis        1,        350.00000
INC-1
  Axis        1,        270.00000
CPEND
```

Motion when skip is not executed



Motion when skip is executed
(when the skip occurs at 100 [degree])

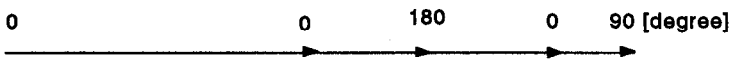
Whether or not the skip occurs, the final positioning point will be the same.

(3) When the instruction immediately following the skip is an INC instruction and there is an ABS instruction after that

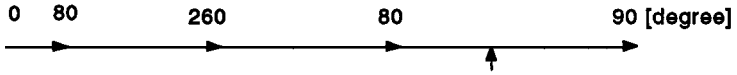
Program example

```
CPSTART1
  Axis        1
  Speed                  10.000
INC-1
  Axis        1,        360.00000
  Skip                    X100
INC-1
  Axis        1,        180.00000
INC-1
  Axis        1,        180.00000
ABS-1
  Axis        1,         90.00000
CPEND
```

Motion when skip is not executed



Motion when skip is executed
(when the skip occurs at 80 [degree])

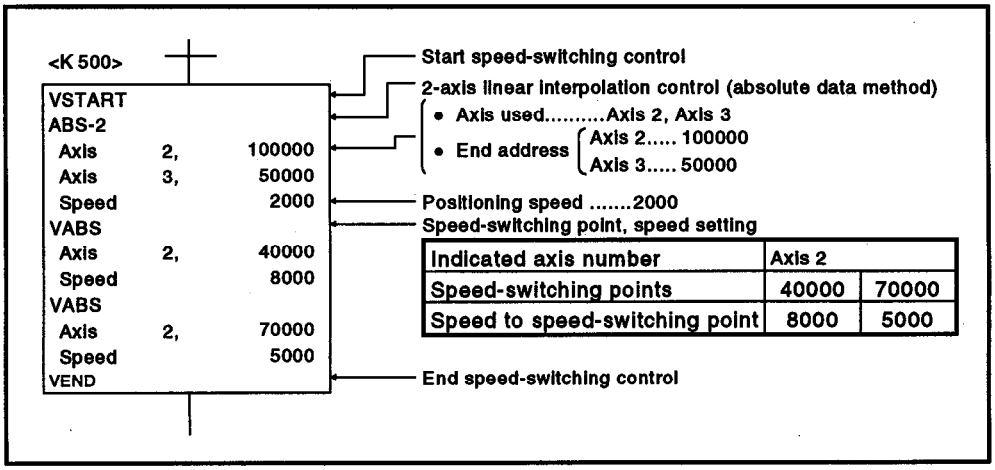


At this point there is a motion of 370 degrees, not 10 degrees.

Whether or not the skip occurs, the final positioning point will be the same.

(4) Servo program

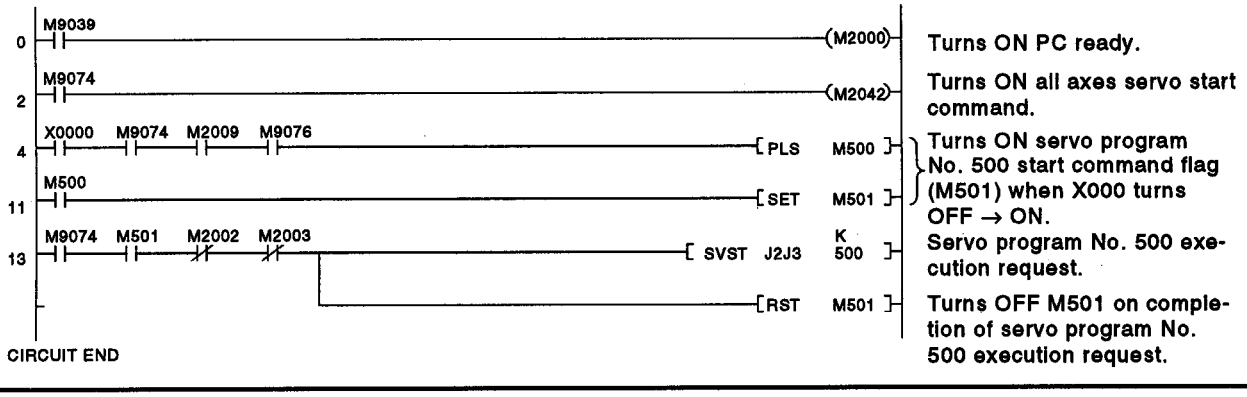
The servo program No. 500 for speed-switching control is shown below.



Indicated axis number	Axis 2	
Speed-switching points	40000	70000
Speed to speed-switching point	8000	5000

(5) Sequence program

The sequence program which runs the servo program is shown below.



7.15.2 Setting speed-switching points using repeat instructions

Repeated execution between any speed-switching points.

Servo Instruction	Positioning Method	Number of Controllable Axes	Items Set by Peripherals																									Speed Change
			Common							Arc			Parameter Block											Others				
			Parameter Block No.	Axis	Address/Travel Value	Commanded Speed	Dwell Time	M Code	Torque Limit Value	Auxiliary Point	Radius	Center Point	Control Unit	Speed Limit Value	Acceleration Time	Deceleration Time	Rapid Stop Deceleration Time	Torque Limit Value	Deceleration Processing on Stop Input	Allowable Error Range for Circular Interpolation	S Curve Ratio	Repeated Condition	Cancel	Start	
FOR-TIMES	—	—																										—
FOR-ON																						o	Δ	Δ				
FOR-OFF																												
NEXT	—	—																										

o : Must be set
Δ : Set if required

[Control Details]

Setting the Start of the Repeated Range

The start of the repeated range is designated using the following instructions:

(1) FOR-TIMES (number of loops setting)
  (a) The designated repeated range is executed the set number of times.
  (b) The setting range is (1 to 32767) .
  An out-of-range setting between -32768 and 0 is controlled as a setting of 1.
  (c) The following devices are available to set the number of repeats:
    1) Data register (D) > Indirect designation
    2) Link register (W) > Indirect designation
    3) Decimal constant (K)
    4) Hexadecimal constant (H)

(2) FOR-ON (loop-out trigger condition setting)
  (a) The set repeated range is executed while the designated bit device is ON.
  (b) The following devices are available to set the loop-out trigger condition:
    1) Input (X)
    2) Output (Y)
    3) Internal relay (M)/Special relay (SP.M)
    4) Latch relay (L)
    5) Link relay (B)
    6) Annunciator (F)

(3) FOR-OFF (loop-out trigger condition setting)

(a) The set repeated range is executed while the designated bit device is OFF.

(b) The following devices are available to set the loop-out trigger condition:

1) Input (X)
2) Output (Y)
3) Internal relay (M)/Special relay (SP.M)
4) Latch relay (L)
5) Link relay (B)
6) Annunciator (F)

Repeated operation using FOR-TIMES, FOR-ON, and FOR-OFF is shown below.

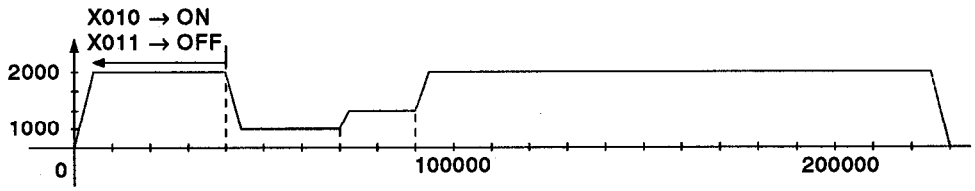
[Servo Program]

```
<K 701>
VSTART
INC-2
 Axis        1,      230000
 Axis        2,      100000
 Speed               2000
VINC
 Axis        1,      40000
 Speed               2000
[1]                  2)
VINC
 Axis        1,      30000
 Speed               500
VINC
 Axis        1,      20000
 Speed               1000
NEXT
VEND
```

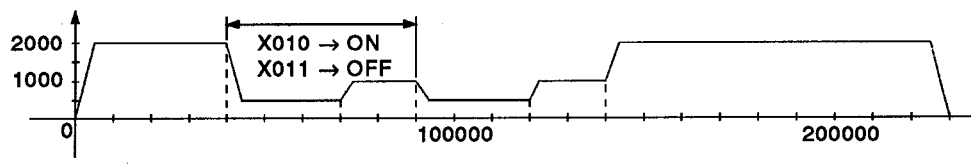
3)

1)	2)		
	Condition 1	Condition 2	Condition 3
FOR-TIMES	K1	K2	K3
FOR-ON	X010 → ON from start	X010 → ON during first execution of 3)	X010 → ON during third execution of 3)
FOR-OFF	X011 → OFF from start	X011 → OFF during first execution of 3)	X011 → OFF during third execution of 3)

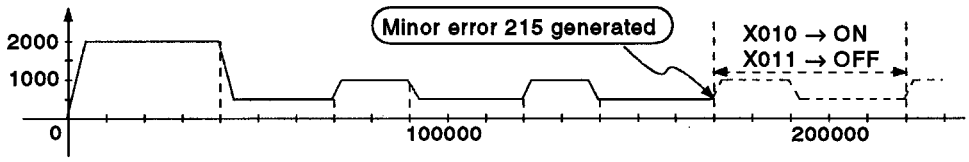
(1) Operation under condition 1



(2) Operation under condition 2



(3) Operation under condition 3

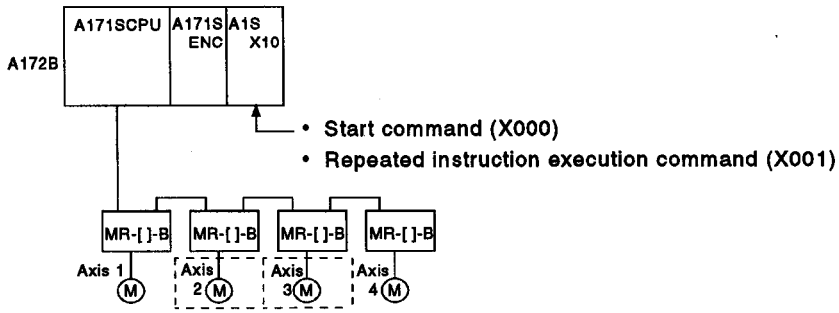


Error generated because the distance to the stop position exceeds the travel value.

[Program Example]

This program executes repeated speed-switching control under the conditions below.

(1) System configuration
Speed-switching control of Axis 2 and Axis 3.

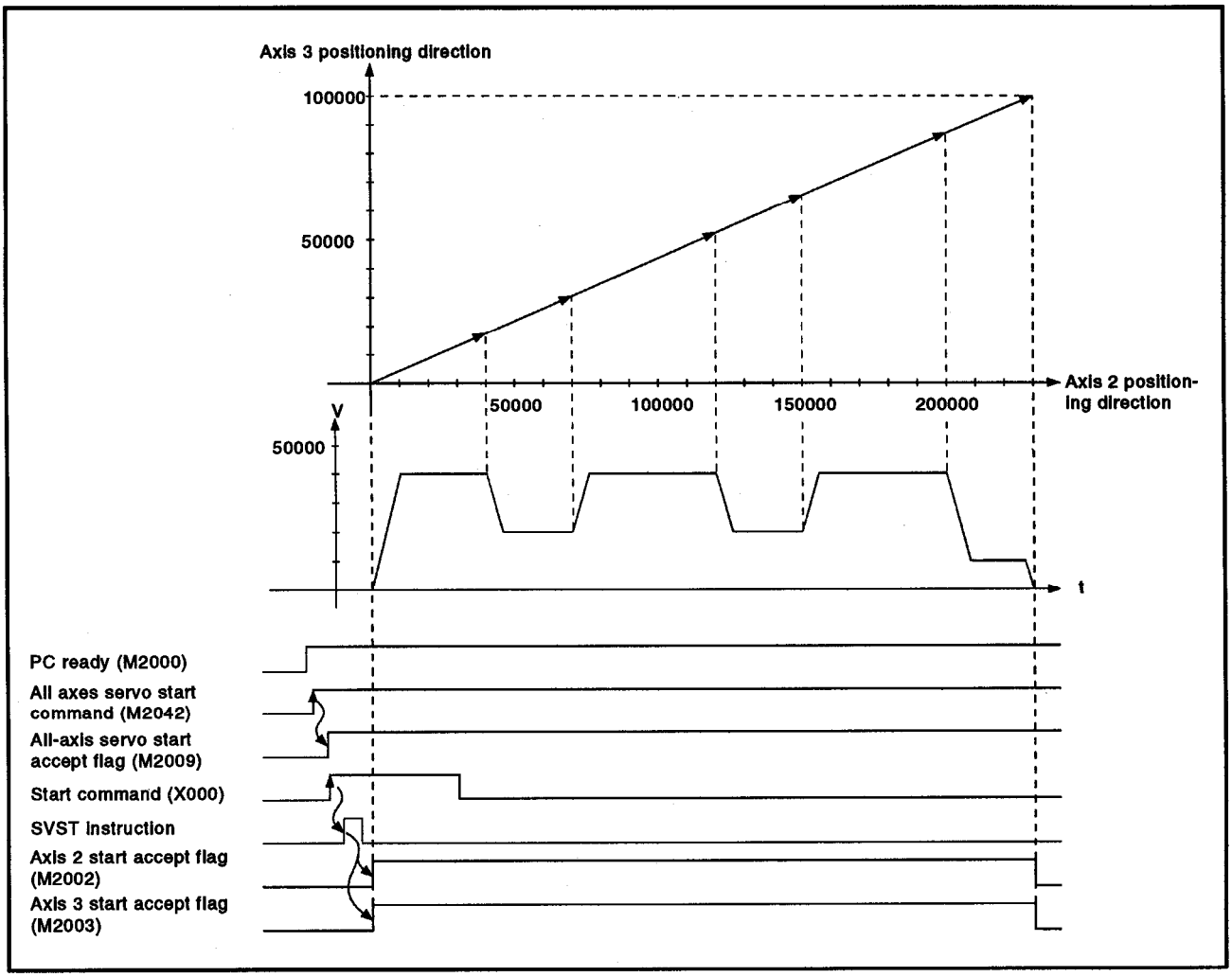


(2) Positioning conditions
(a) The speed-switching control conditions are shown below.

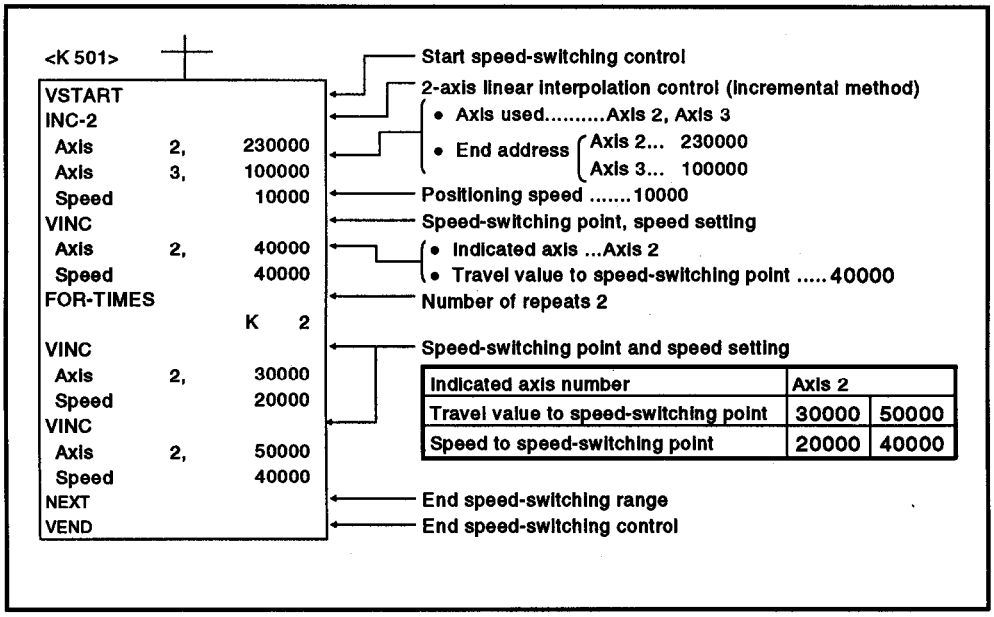
Item	Setting	
Servo program number	No. 501	
Controlled axes	Axis 2	Axis 3
End address	230000	100000

(b) Speed-switching control start command .....leading edge of X000 (OFF → ON)

(3) Operation timing and speed-switching positions
The operation timing for speed-switching control and the speed-switching points are shown below.

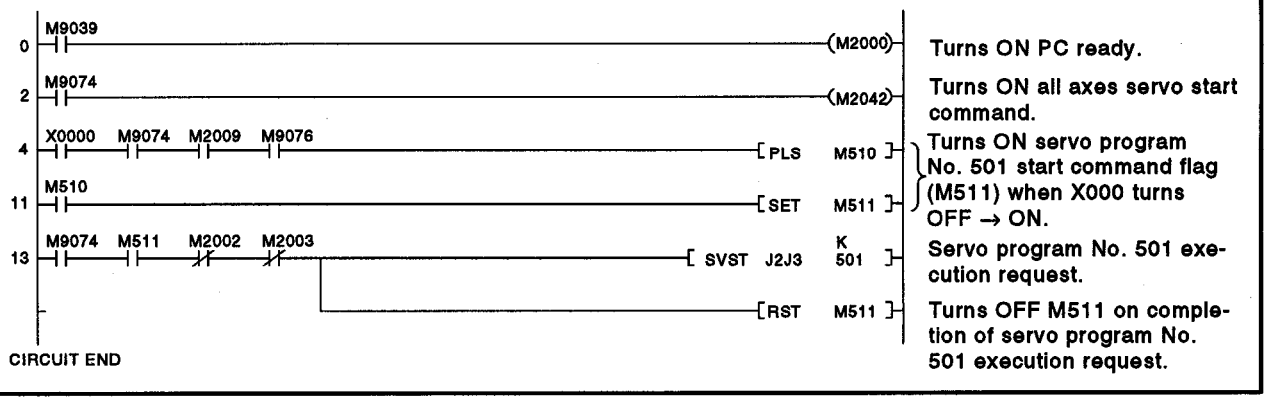


(4) Servo program
The servo program No. 501 for speed-switching control is shown below.



Indicated axis number	Axis 2	
Travel value to speed-switching point	30000	50000
Speed to speed-switching point	20000	40000

(5) Sequence program
The sequence program which runs the servo program is shown below.



7.16 Constant-Speed Control

(1) After a single control start, positioning control is executed using the designated positioning method and positioning speed to the preset pass point.

(2) The positioning method and positioning speed can be changed for each pass point.

(3) Set the following parameters with the servo program.
- pass point
- positioning method from one pass point to the next pass point.
- positioning speed from one pass point to the next pass point.

(4) Repeat instructions permit repeated control between any pass points.

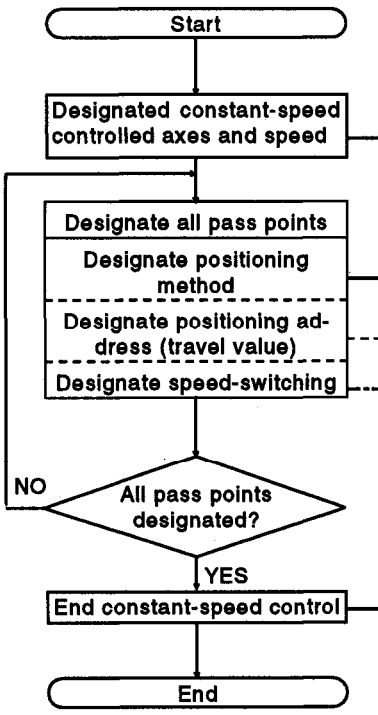
(5) M code and torque limit value can be changed at each pass point.

(6) From one to four axes can be controlled.

[Procedure to Write Servo Programs]

The method to write servo programs for constant-speed control is shown below.

[Procedure]



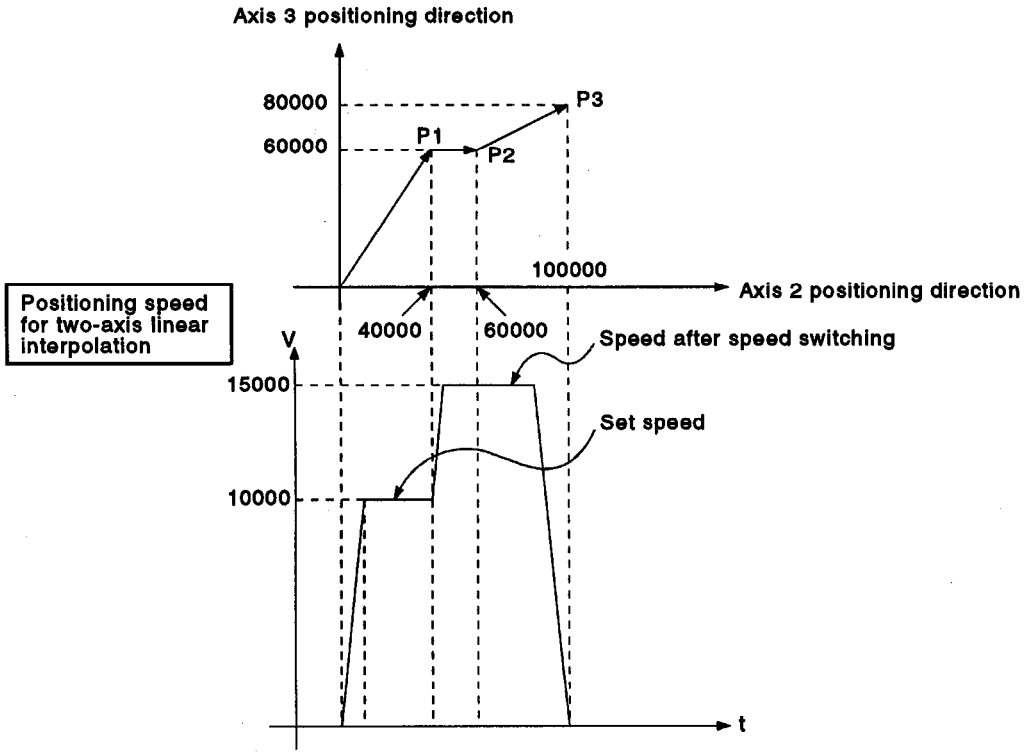
[Example: Servo program for 2-axis constant-speed control]

```
Point  <K 1>
4  CPSTART2
     Axis          2,
     Axis          3,
     Resultant speed      10000  (PLS/sec)
1  ABS-2
     Axis          2,     40000  (PLS)
     Axis          3,     60000  (PLS)
2  ABS-2
     Axis          2,     60000  (PLS)
     Axis          3,     60000  (PLS)
     Resultant speed      15000  (PLS/sec)
3  ABS-2
     Axis          2,    100000  (PLS)
     Axis          3,     80000  (PLS)
4  CPEND
```

[Operation Timing]

The operation timing for constant-speed control is shown below.

[Example: Operation timing for 2-axis constant-speed control]



[Caution]

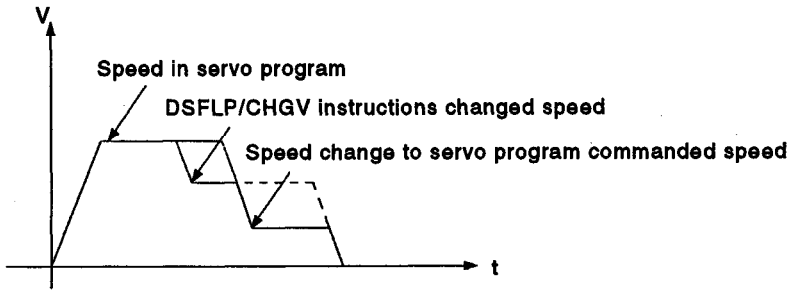
(1) The number of controllable axes cannot be changed while control is in progress.

(2) Positioning control to the pass points can use a combination of the absolute data method (ABS□) and the incremental method (INC□).

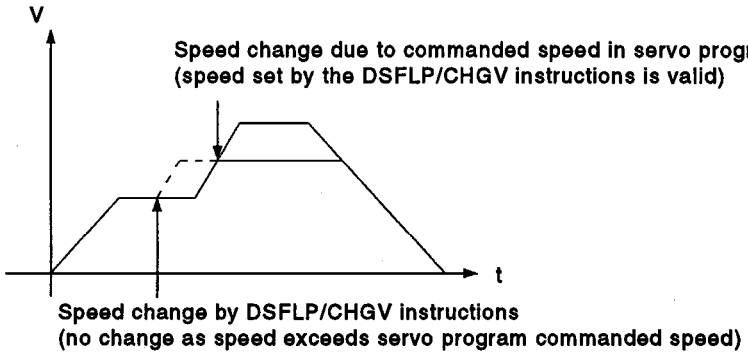
(3) A pass point can be designated as an address which results in a change in travel direction.
However, a servo error or some other error may occur if acceleration processing occurs at a pass point for 1-axis constant-speed control but no acceleration or deceleration processing occurs at the pass point for 2- to 4-axis constant-speed control.

(4) Speed change is possible after start
Note the following points when changing the speed.
(a) If constant-speed control includes circular interpolation using center point designation
Error compensation (see Section 4.4.3) may not function normally if the speed is changed when a discrepancy (within the allowable error range for circular interpolation) exists between the designated end-point address and the arc path calculated from the start address and center-point address.
Therefore, if the circular interpolation using center point designation positioning method is used under constant-speed control, ensure that the set start address, center-point address, and end address lie correctly on the arc.

(b) If both a servo program and the DSFLP/CHGV instructions are used for the speed change in the same program
The lower of the speed changed by the DSFLP/CHGV instructions and the speed set by the servo program is selected.
The DSFLP/CHGV instructions are executed if the changed speed is lower than the speed set in the servo program; otherwise the DSFLP/CHGV instructions are not executed.
1) If DSFLP/CHGV changed speed>servo program set speed
The speed set in the servo program is selected.



2) If DSFLP/CHGV changed speed<servo program set speed
The speed changed by the DSFLP/CHGV instructions is valid.



(5) An overrun occurs if the distance remaining to the final positioning point when the final positioning point is detected is less than the deceleration distance at the positioning speed (commanded speed).
If an overrun occurs, the error code 211 (overrun error) is stored in the minor error register for the axis.

(6) A maximum of 768 steps (approximately 100 points) can be designated in a constant-speed control program.

(7) If positioning moves outside the stroke limit range after control is started, the error code 106 is stored in the minor error register for the axis and a deceleration stop occurs.

(8) The minimum travel value between constant-speed control pass points is determined as follows:

Commanded speed x 0.02 < Travel distance (pulses)

Positioning speed drops if the distance between pass points is extremely short.

Example
If pass points are set at 1-pulse intervals, the positioning speed becomes 280 pps, regardless of the commanded speed setting.

7.16.1 Setting Pass points using Repeated Instructions

This section describes the method of designating the pass points used for repeated execution between pass points.

Servo Instruction	Positioning Method	Number of Controllable Axes	Items Set by Peripherals																								
			Common							Arc			Parameter Block											Others			
			Parameter Block No.	Axis	Address/Travel Value	Commanded Speed	Dwell Time	M Code	Torque Limit Value	Auxiliary Point	Radius	Center Point	Control Units	Speed Limit Value	Acceleration Time	Deceleration Time	Rapid Stop Deceleration Time	Torque Limit Value	Deceleration Processing on Stop Input	Allowable Error Range for Circular Interpolation	S-Curve Ratio	Repeated Condition	Cancel	Start	Speed Change
FOR-TIMES	—	—																									
FOR-ON																						O	Δ	Δ	—		
FOR-OFF																											
NEXT	—	—																									

O: Must be set
Δ: Set if required

[Control Details]

Setting the start of the repeated range

The start of the repeated range is designated using the following instructions:

(1) FOR-TIMES (number of loops setting)
  (a) The designated repeated range is executed the set number of times.
  (b) The setting range is (1 to 32767).
    If an out-of-range setting between –32768 and 0 is designated, control is executed with a setting of "1".
  (c) The following devices are available to set the number of repetitions:
    1) Data register (D) ⟩ Indirect designation
    2) Link register (W) ⟩
    3) Decimal constant (K)
    4) Hexadecimal constant (H)

(2) FOR-ON (loop-out trigger condition setting)
  (a) The set repeated range is executed while the designated bit device is ON.
  (b) The following devices are available to set the loop-out trigger condition:
    1) Input (X)
    2) Output (Y)
    3) Internal relay (M)/Special relay (SP.M)
    4) Latch relay (L)
    5) Link relay (B)
    6) Annunciator (F)

(3) FOR-OFF (loop-out trigger condition setting)
(a) The set repeated range is executed while the designated bit device is OFF.

(b) The following devices are available to set the loop-out trigger condition:
1) Input (X)
2) Output (Y)
3) Internal relay (M)/Special relay (SP.M)
4) Latch relay (L)
5) Link relay (B)
6) Annunciator (F)

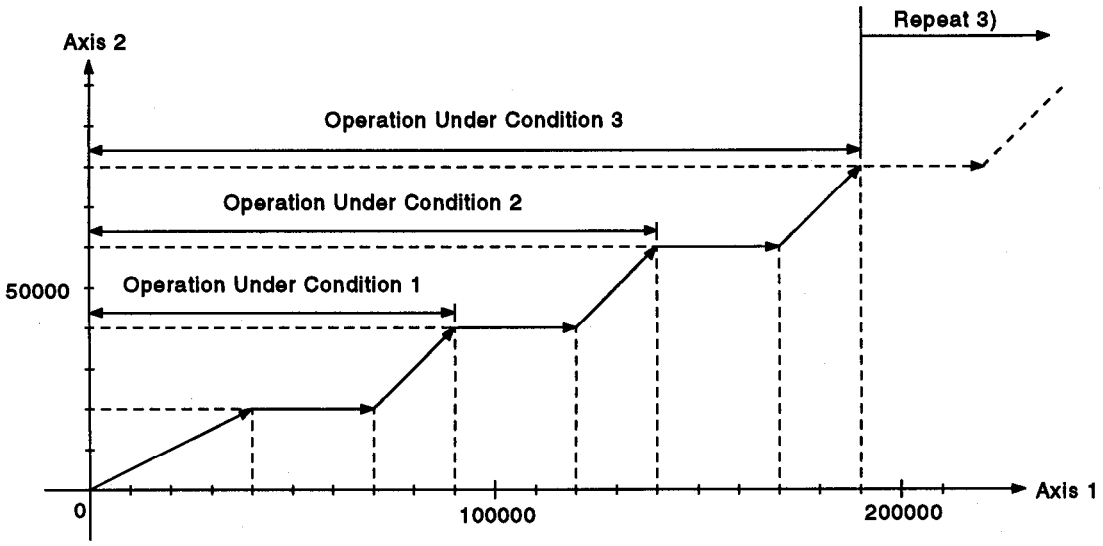
Repeated operation using FOR-TIMES, FOR-ON, and FOR-OFF is shown below.

[Servo Program]

```
CPSTART2
  Axis        1,
  Axis        2,
  Resultant speed      1000
ABS-2
  Axis        1,       40000
  Axis        2,       20000
 [ 1)]
                      [ 2)]
INC-2
  Axis        1,       30000
  Axis        2,           0
INC-2
  Axis        1,       20000
  Axis        2,       20000
NEXT
CPEND
```

3)

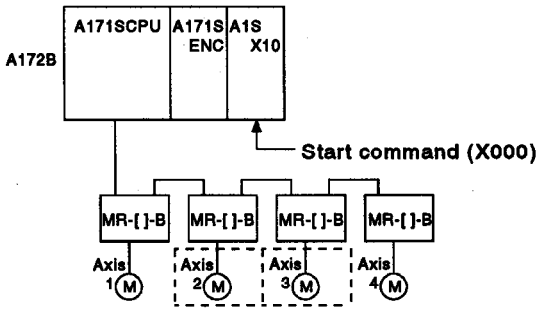
1)	2)		
	Condition 1	Condition 2	Condition 3
FOR-TIMES	K1	K2	K3
FOR-ON	X010 → ON from start	X010 → ON during first execution of 3)	X010 → ON during second execution of 3)
FOR-OFF	X011 → OFF from start	X011 → OFF during first execution of 3)	X011 → OFF during second execution of 3)



[Program Example]

This program executes repeated constant-speed control under the conditions below.

(1) System configuration
Constant-speed control of Axis 2 and Axis 3.

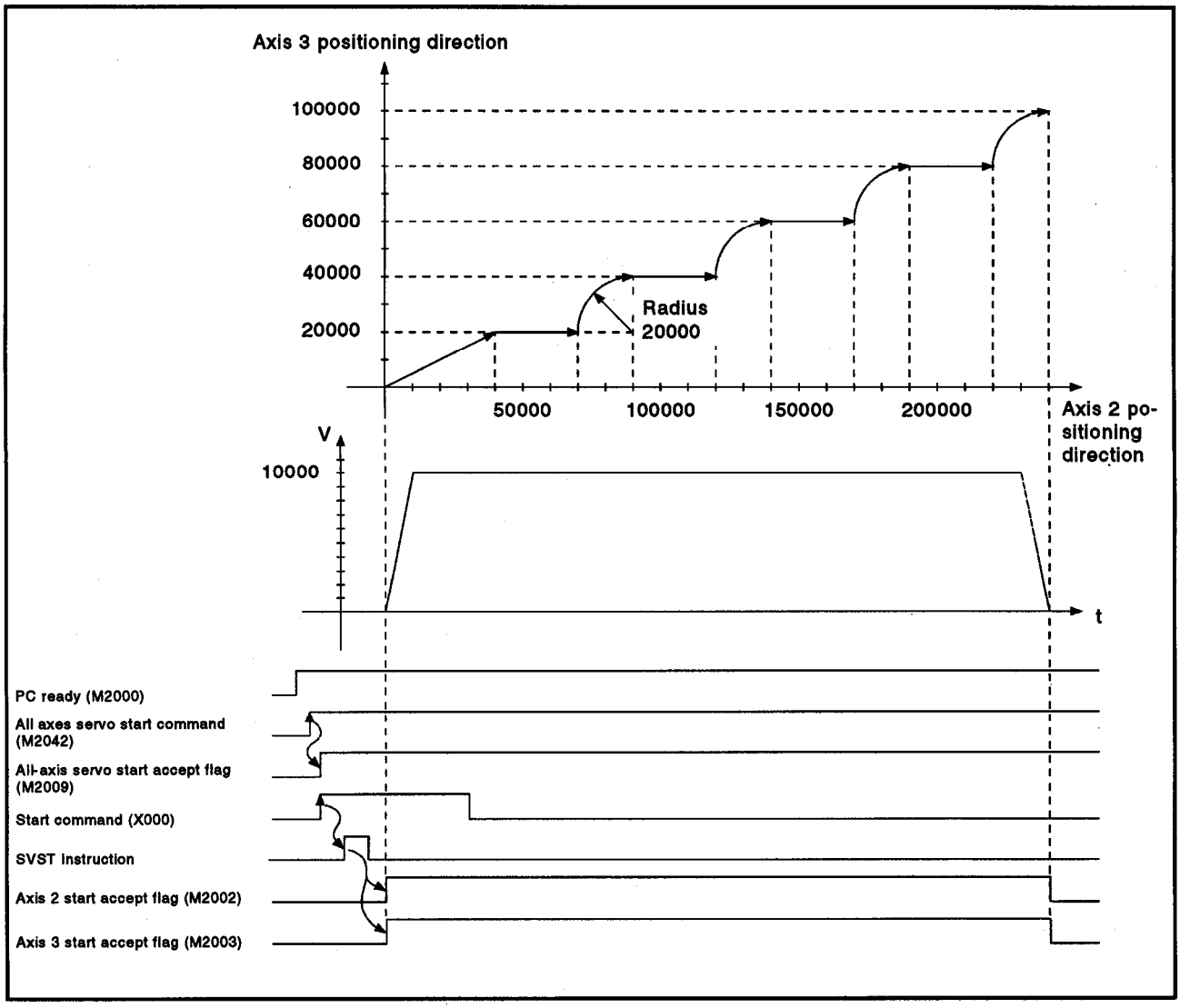


(2) Positioning conditions
(a) The constant-speed control conditions are shown below.

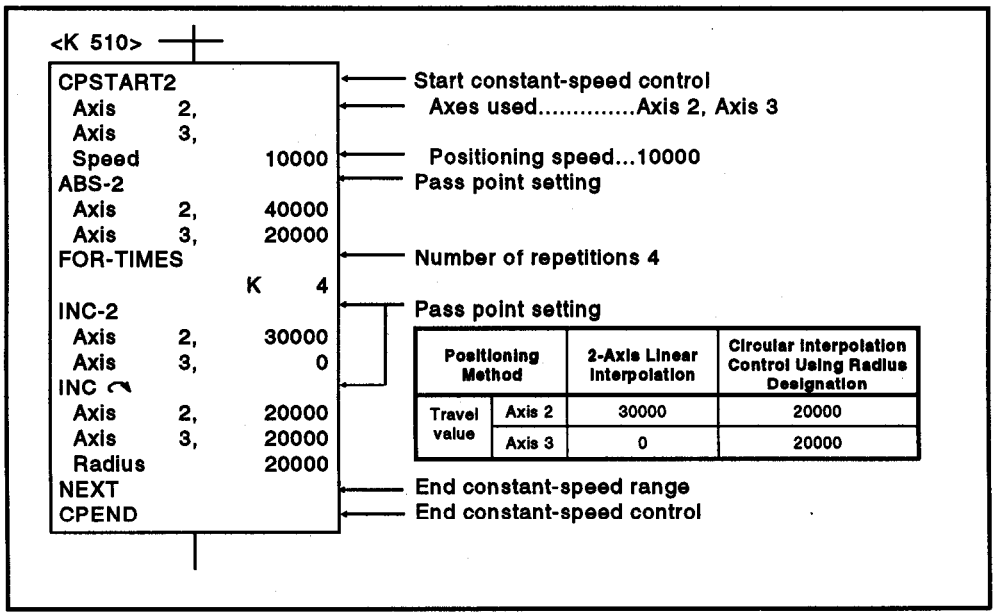
Item	Setting
Servo program number No.	510
Controlled axes	Axis 2, Axis 3
Positioning speed	10000

(b) Constant-speed control start command .... leading edge of X000 (OFF → ON)

(3) Operation timing
The operation timing for constant-speed control is shown below.

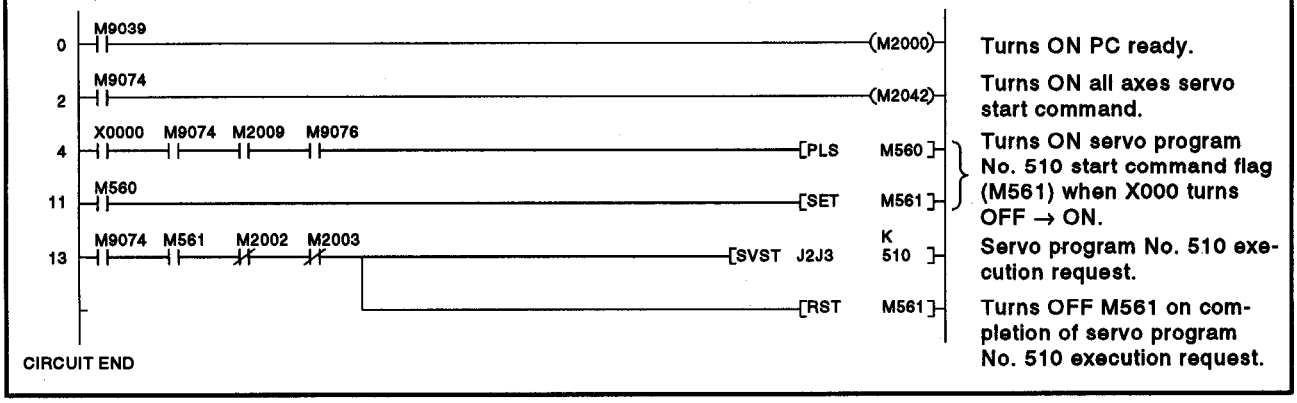


(4) Servo program
The servo program No. 510 for constant-speed control is shown below.



Positioning Method		2-Axis Linear Interpolation	Circular Interpolation Control Using Radius Designation
Travel value	Axis 2	30000	20000
	Axis 3	0	20000

(5) Sequence program
The sequence program which runs the servo program is shown below.



7.16.2 Speed switching during instruction execution

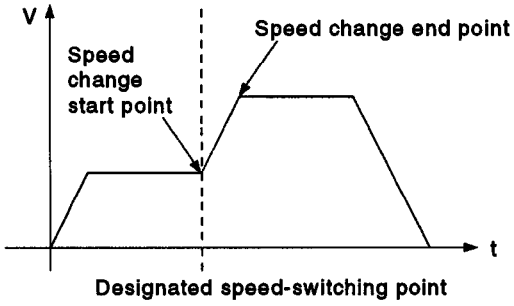
The speed can be designated for each pass point during a constant-speed control instruction.
The speed change from a point can be designated directly or indirectly in the servo program.

[Cautions]

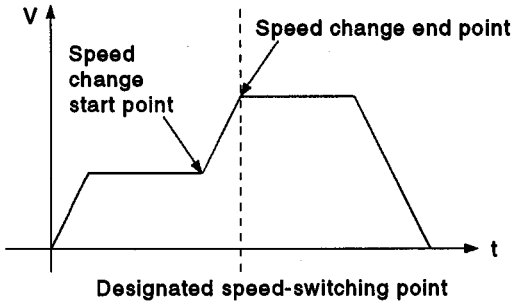
(1) The speed can be changed during servo instruction execution for 1- to 4-axis constant-speed control.

(2) The speed command can be set for each point.

(3) The speed-switching point designation flag M2016 (see Section 3.2.6) can be turned ON before control is started to set the designated speed-switching point as the end point for the speed change.
The speed change timing is shown below for the cases where the speed-switching point designation flag M2016 is ON and OFF.
(a) M2016 is OFF
The speed change starts at the designated speed-switching point.



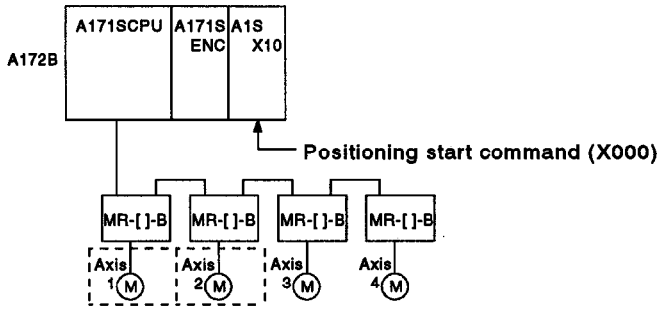
(b) M2016 is ON
The speed change ends at the designated speed-switching point.



[Program Example]

This program turns ON M2016 during constant-speed control instruction execution and changes the speed, under the conditions below.

(1) System configuration
Switches speed for Axis 1 and Axis 2.

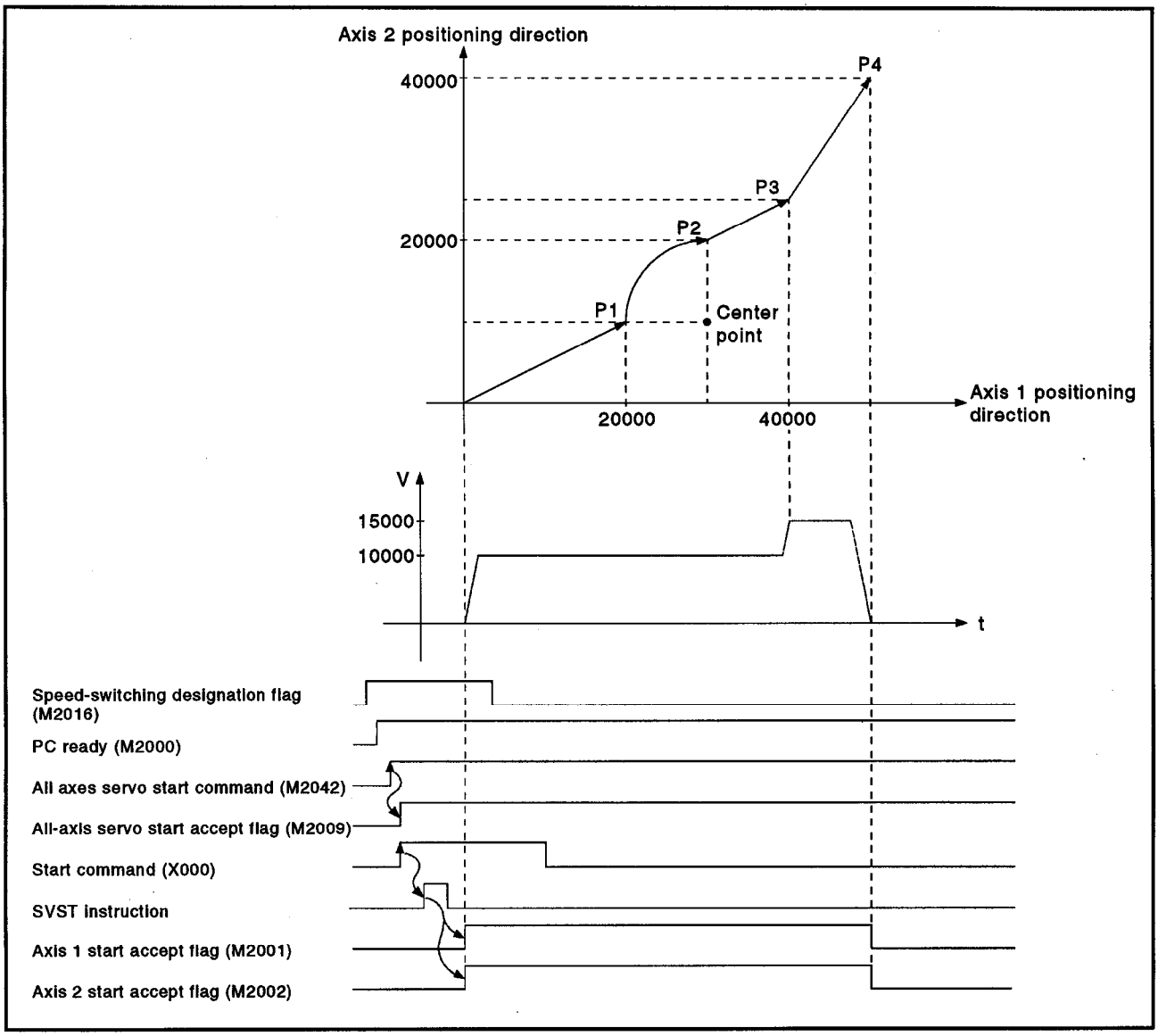


(2) Positioning conditions
(a) The speed switching conditions are shown below.

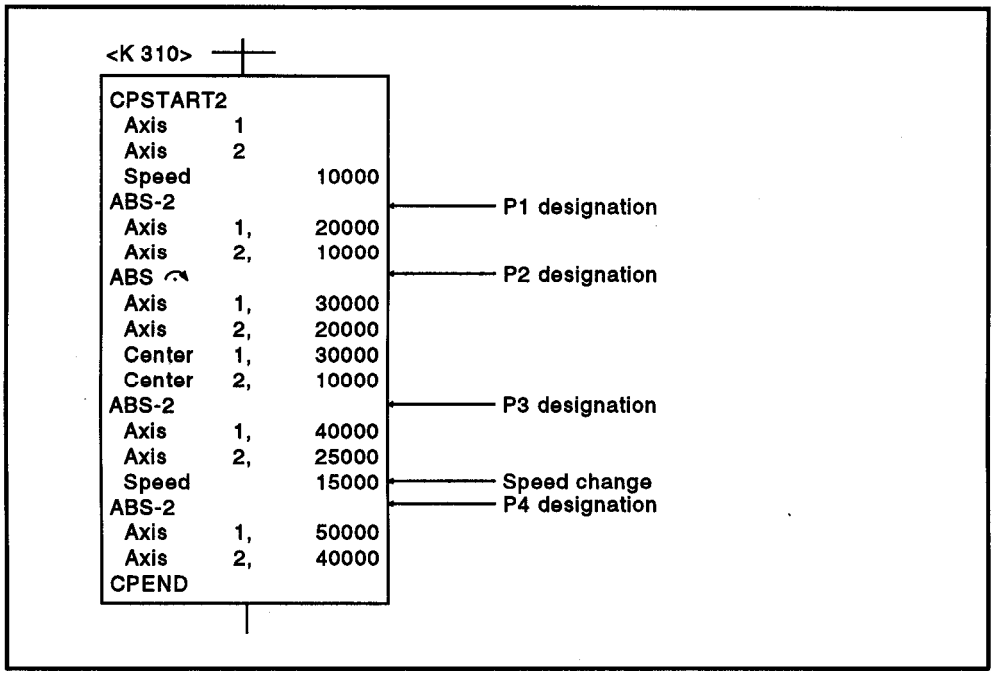
Item		Setting			
Servo program number		310			
Positioning speed		10000			
Positioning method		2-axis linear interpolation	Circular interpolation using center point designation	2-axis linear interpolation	2-axis linear interpolation
Pass point	Axis 1	20000	30000	40000	50000
	Axis 2	10000	20000	25000	40000

(b) Constant-speed control with speed switching start command .... leading edge of X000 (OFF → ON)

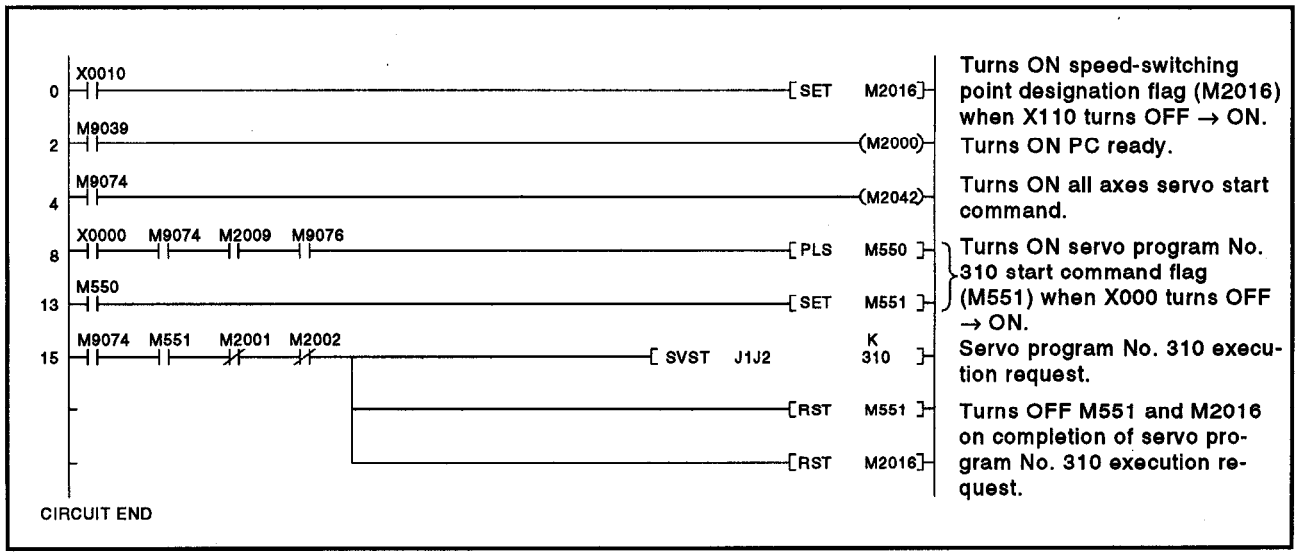
(3) Operation timing and speed-switching positions
The operation timing and positions for speed switching are shown below.



(4) Servo program
The servo program No. 310 for speed switching is shown below.



(5) Sequence program
The sequence program which runs the servo program is shown below.



7.16.3 One-axis constant-speed control

Constant-speed control for the one axis designated with the sequence program positioning commands.

Servo Instruction		Positioning Method	Number of Controllable Axes	Items Set by Peripherals: Common: Parameter Block No.	Axis	Address/Travel Value	Commanded Speed	Dwell Time	M Code	Torque Limit Value	Arc: Auxiliary Point	Radius	Center Point	Parameter Block: Control Units	Speed Limit Value	Acceleration Time	Deceleration Time	Rapid Stop Deceleration Time	Torque Limit Value	Deceleration Processing on Stop Input	Allowable Error Range for Circular Interpolation	S-Curve Ratio	Others: Commanded speed (constant-speed)	Cancel	Start	Skip	FIN acceleration	Speed Change
Start	CPSTART1	—	1	Δ	O		O								Δ	Δ	Δ	Δ	Δ	Δ		Δ		Δ	Δ		Δ	OK
End	CPEND	—	—					Δ																				
Pass point	ABS-1	Absolute data	1		O	O			Δ	Δ													Δ			Δ		
	INC-1	Incremental	1		O	O			Δ	Δ													Δ			Δ		

O : Must be set
Δ : Set if required

[Control Details]

Starting and ending one-axis constant-speed control

One-axis constant-speed control is started and ended using the following instructions:

(1) CPSTART1
Starts one-axis constant-speed control. Sets the axis number used and the commanded speed.

(2) CPEND
Ends the one-axis constant-speed control which was started using CPSTART1.

Positioning control method to the pass point

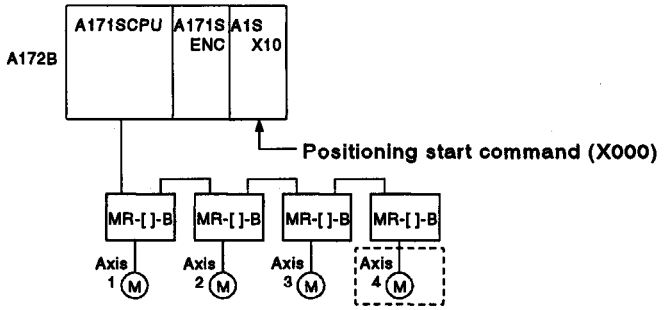
The positioning control to the point where control is changed is designated using the following instructions:

(1) ABS-1/INC-1
Designates one-axis linear positioning control.
See Section 7.2 "One-axis Linear Positioning Control" for details.

[Program Example]

This program executes repeated one-axis constant-speed control under the conditions below.

(1) System configuration
Constant-speed control for Axis 4.

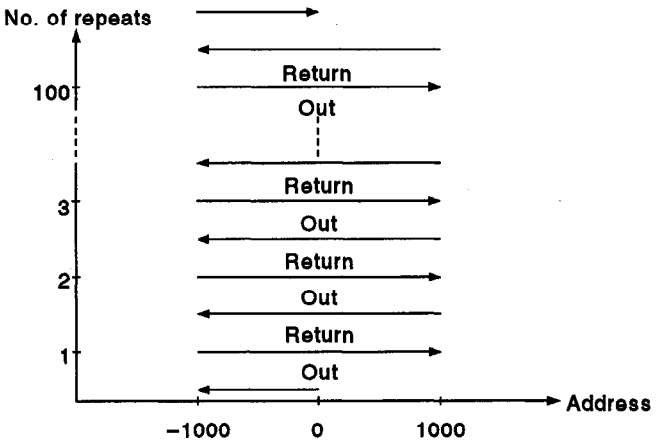


(2) Positioning conditions
(a) The constant-speed control conditions are shown below.

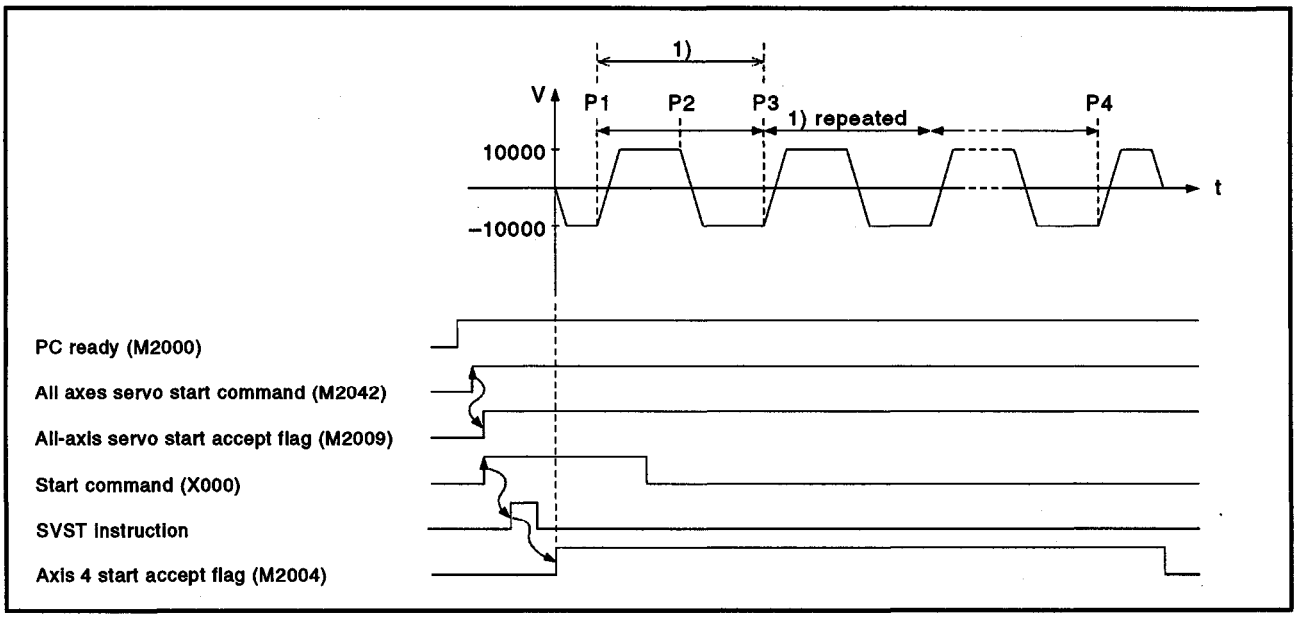
Item		Setting
Servo program number		500
Controlled axis		Axis 4
Positioning speed		10000
Number of repetitions		100
Pass point travel value	P1	-1000
	P2	2000
	P3	-2000
	P4	1000

(b) Constant-speed control start command .... leading edge of X000 (OFF → ON)

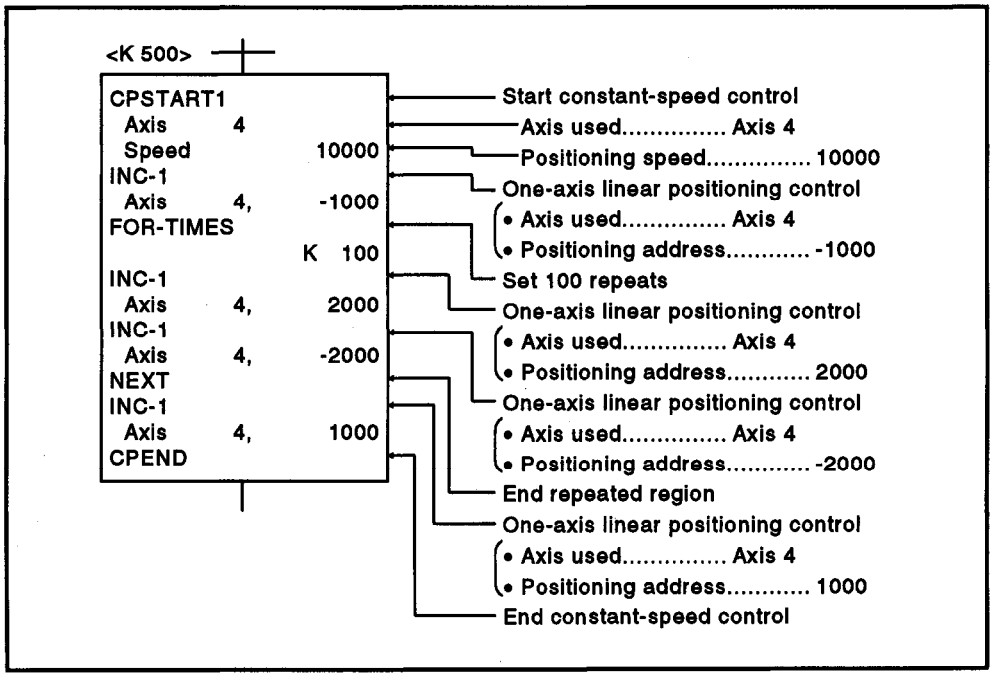
(3) Details of positioning operation



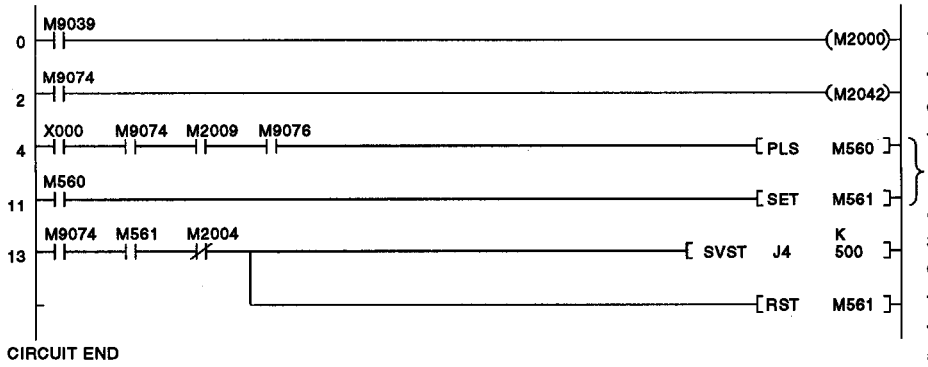
(4) Operation timing
The operation timing for servo program No. 500 is shown below.



(5) Servo program
The servo program No. 500 for constant-speed control is shown below.



(6) Sequence program
The sequence program which runs the servo program is shown below.



7.16.4 Two- to four-axis constant-speed control

Constant-speed control for the two, three, or four axes designated with the sequence program positioning commands.

Servo Instruction		Positioning Method	Number of Controllable Axes	Items Set by Peripherals: Common: Parameter Block No.	Common: Axis	Common: Address/Travel Value	Common: Commanded Speed	Common: Dwell Time	Common: M Code	Common: Torque Limit Value	Arc: Auxiliary Point	Arc: Radius	Arc: Center Point	Parameter Block: Control Units	Parameter Block: Speed Limit Value	Parameter Block: Acceleration Time	Parameter Block: Deceleration Time	Parameter Block: Rapid Stop Deceleration Time	Parameter Block: Torque Limit Value	Parameter Block: Deceleration Processing on Stop Input	Parameter Block: Allowable Error Range for Circular Interpolation	Parameter Block: S-Curve Ratio	Others: Commanded speed (constant-speed)	Others: Cancel	Others: Start	Others: Skip	Others: FIN Acceleration	Speed Change
Start	CPSTART2	—	2	Δ	O		O								Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ		Δ	Δ		Δ	
	CPSTART3		3	Δ	O		O								Δ	Δ	Δ	Δ	Δ	Δ		Δ		Δ	Δ		Δ	
	CPSTART4		4	Δ	O		O								Δ	Δ	Δ	Δ	Δ	Δ		Δ		Δ	Δ		Δ	
End	CPEND		—					Δ																				
Pass point	ABS-2	Absolute data	2		O	O			Δ	Δ													Δ			Δ		OK
	ABS-3		3		O	O			Δ	Δ													Δ			Δ		
	ABS-4		4		O	O			Δ	Δ													Δ			Δ		
	ABS		2		O	O			Δ	Δ	O															Δ		
	ABS				O	O			Δ	Δ		O											Δ			Δ		
	ABS																											
	ABS																											
	ABS																											
	ABS				O	O			Δ	Δ			O										Δ			Δ		
	ABS																											
	INC-2	Incremental	2		O	O			Δ	Δ													Δ			Δ		
	INC-3		3		O	O			Δ	Δ													Δ			Δ		
	INC-4		4		O	O			Δ	Δ													Δ			Δ		
	INC		2		O	O			Δ	Δ	O												Δ			Δ		
	INC				O	O			Δ	Δ		O											Δ			Δ		
	INC																											
	INC																											
	INC																											
	INC				O	O			Δ	Δ			O										Δ			Δ		
	INC																											

O : Must be set
Δ : Set if required

[Control Details]

Starting and Ending Two- to Four-Axis Constant-Speed Control

Two-, three-, or four-axis constant-speed control is started and ended using one of the following instructions:

(1) CPSTART2
Starts two-axis constant-speed control.
Sets the axis numbers used and the commanded speed.

(2) CPSTART3
Starts three-axis constant-speed control.
Sets the axis numbers used and the commanded speed.

(3) CPSTART4
Starts four-axis constant-speed control.
Sets the axis numbers used and the commanded speed.

(4) CPEND
Ends the two-, three-, or four-axis constant-speed control which was started using CPSTART2, CPSTART3, or CPSTART4.

Positioning Control Method to the Pass Point

The positioning control to the point where control is changed is designated using the following instructions:

(1) ABS-2/INC-2
Designates two-axis linear interpolation control.
See Section 7.3 "Two-axis Linear Interpolation Control" for details.

(2) ABS-3/INC-3
Designates three-axis linear interpolation control.
See Section 7.4 "Three-axis Linear Interpolation Control" for details.

(3) ABS-4/INC-4
Designates four-axis linear interpolation control.
See Section 7.5 "Four-axis Linear Interpolation Control" for details.

(4) ABS/INC
Designates circular interpolation control using auxiliary point designation.
See Section 7.6 "Circular Interpolation Using Auxiliary Point Designation" for details.

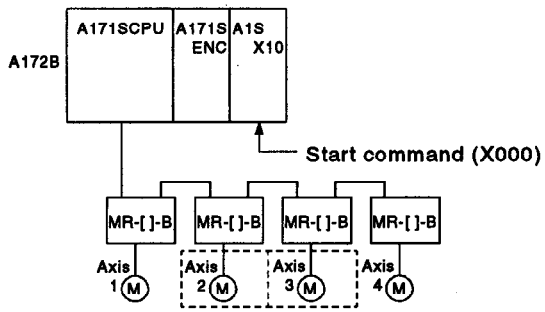
(5) ABS/INC , ABS/INC , ABS/INC , ABS/INC
Designates circular interpolation control using radius designation.
See Section 7.7 "Circular Interpolation Using Radius Designation" for details.

(6) ABS/INC , ABS/INC
Designates circular interpolation control using center point designation.
See Section 7.8 "Circular Interpolation Using Center Point Designation" for details.

[Program Example]

(1) This program executes two-axis constant-speed control under the conditions below.

(a) System configuration
Constant-speed control for Axis 2 and Axis 3.



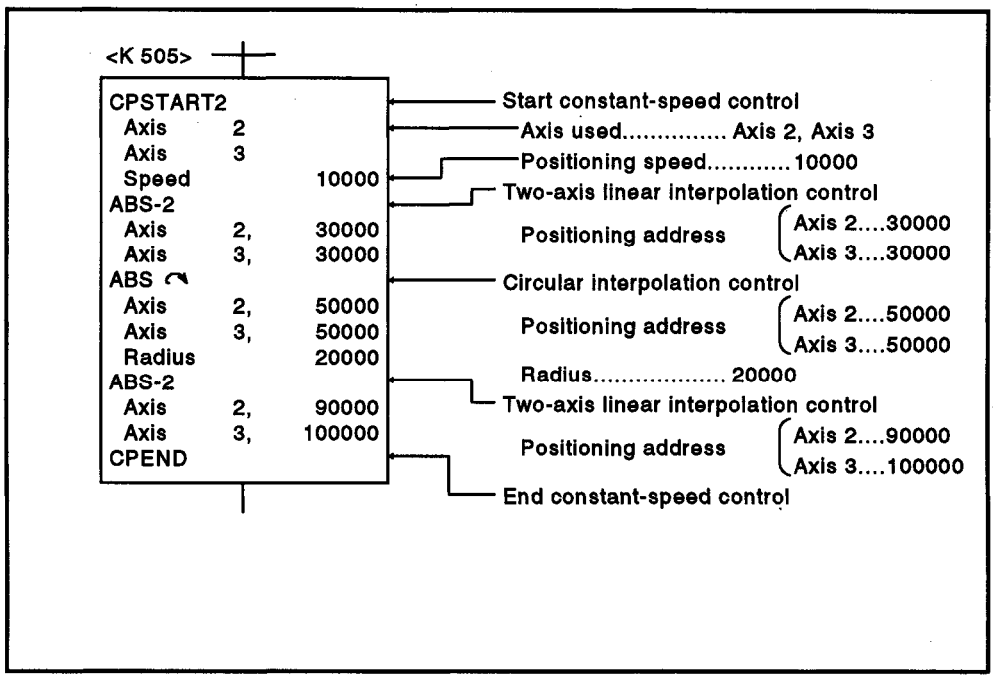
(b) Positioning conditions

1) The constant-speed control conditions are shown below.

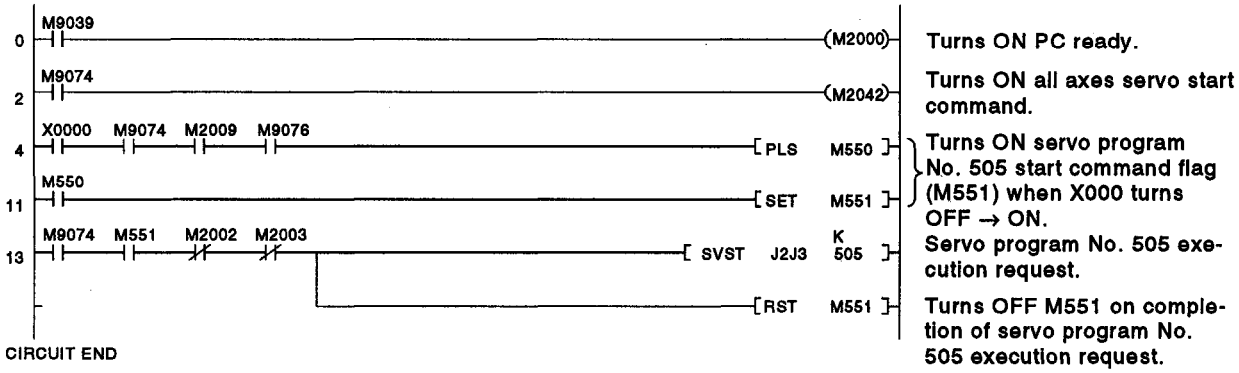
Item		Setting		
Servo program number		505		
Positioning speed		10000		
Positioning method		2-axis linear interpolation	Circular Interpolation Using Radius Designation	2-axis linear interpolation
Pass point	Axis 2	30000	50000	90000
	Axis 3	30000	50000	100000

2) Constant-speed control start command .... leading edge of X000 (OFF → ON)

(c) Servo program
Servo program No. 505 for constant-speed control is shown below.



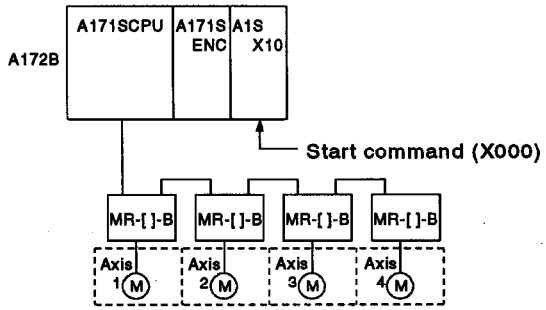
(d) Sequence program
The sequence program which runs the servo program is shown below.



[Program Example]

(2) This program executes four-axis constant-speed control under the conditions below.

(a) System configuration
Constant-speed control for Axis 1, Axis 2, Axis 3, and Axis 4.



(b) Positioning details
The positioning by the Axis 1, Axis 2, Axis 3, and Axis 4 servomotors is shown in the diagram below.

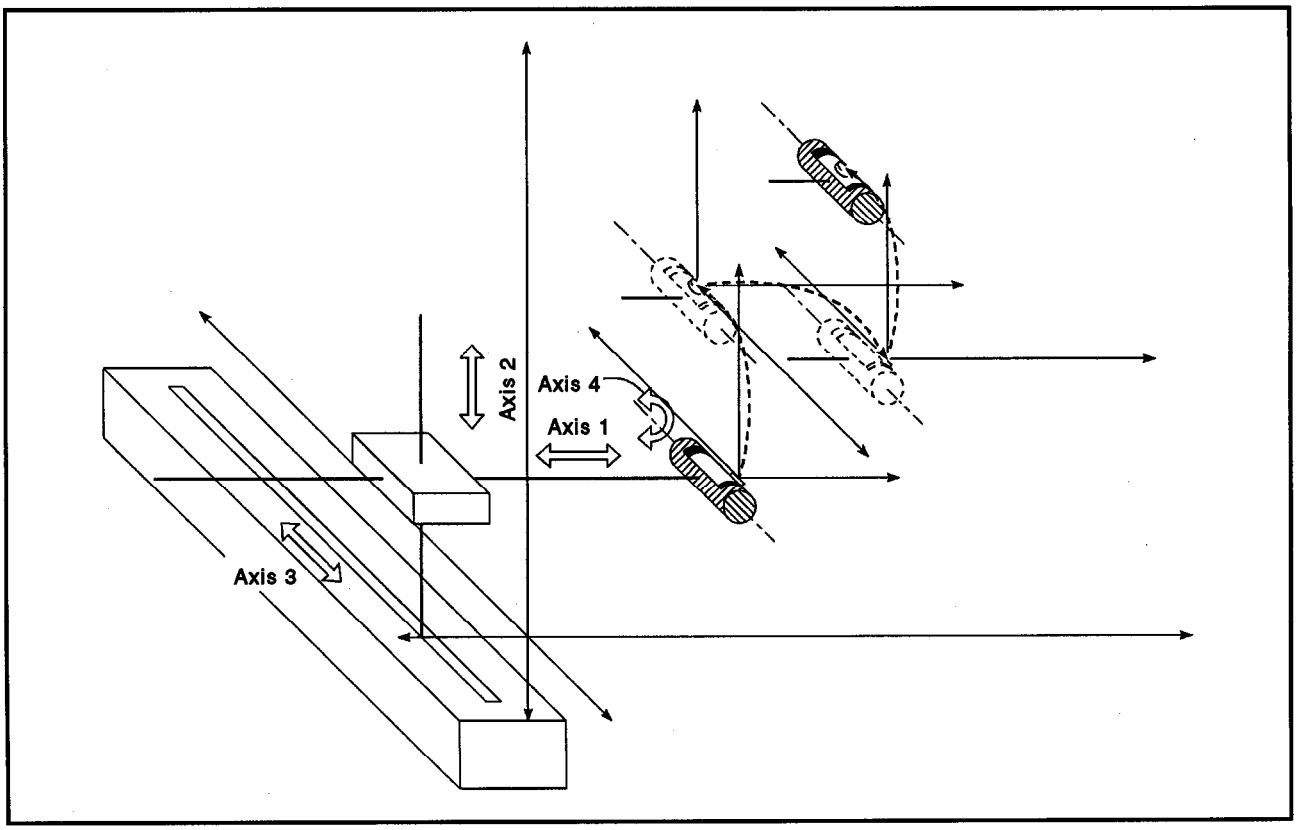


Figure 7.30 Axis Configuration

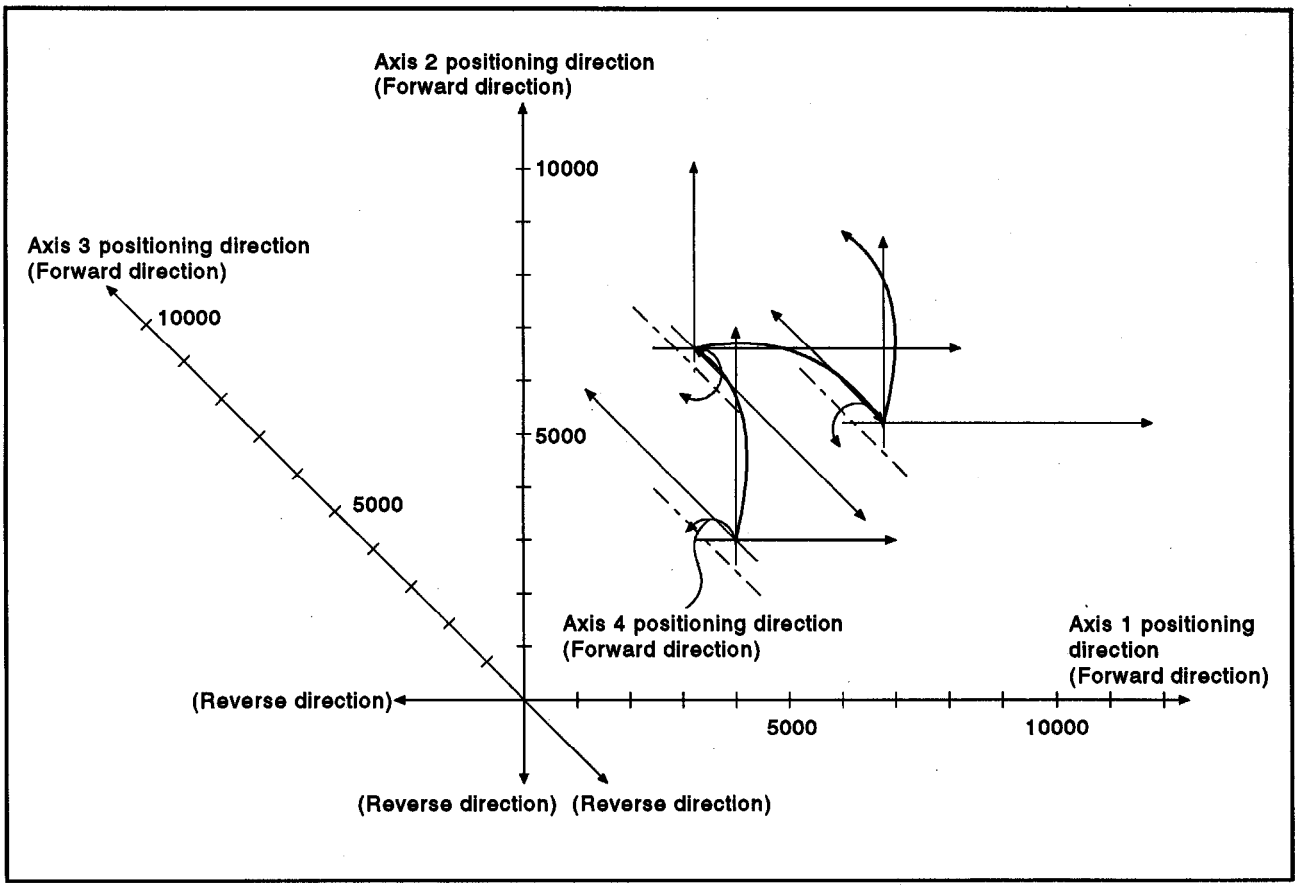


Figure 7.31 Positioning by Four-Axis Constant-Speed Control

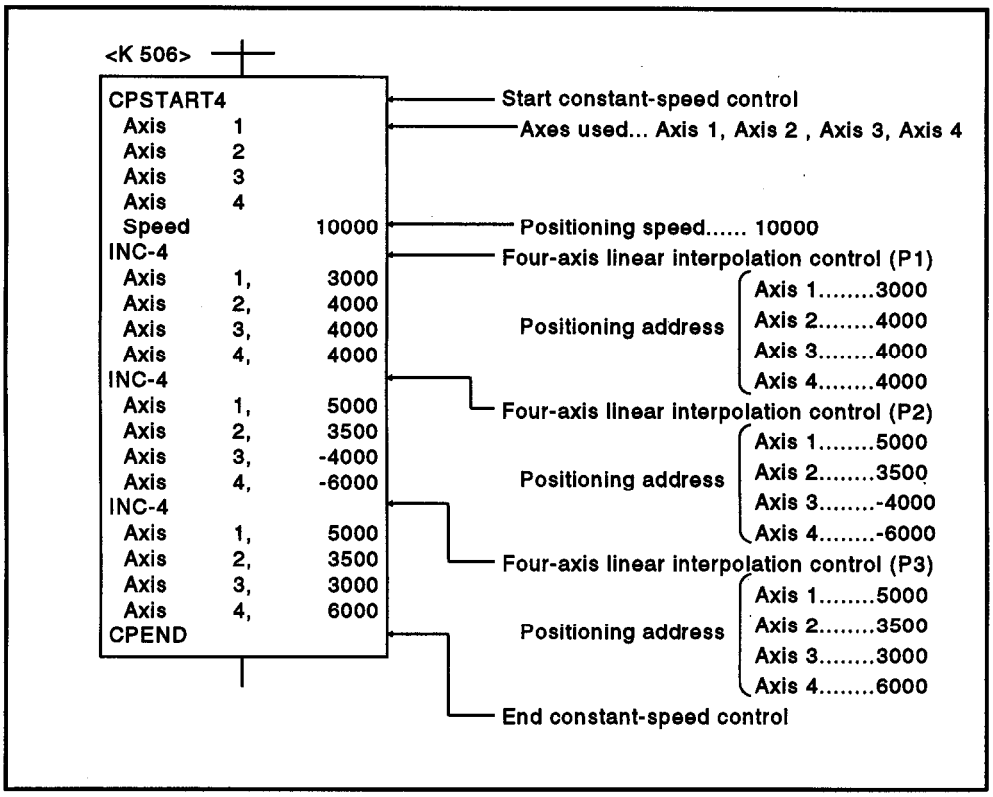
(c) Positioning conditions

1) The constant-speed control conditions are shown below.

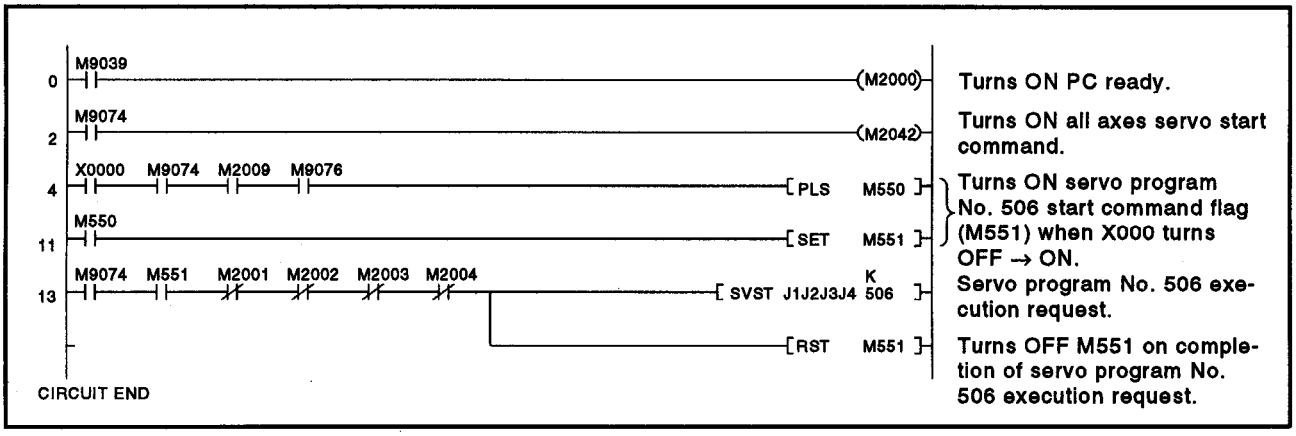
Item		Setting		
Servo program number		506		
Positioning speed		10000		
Positioning method		4-Axis Linear Interpolation	4-Axis Linear Interpolation	4-Axis Linear Interpolation
Pass point	Axis 1	3000	5000	5000
	Axis 2	4000	3500	3500
	Axis 3	4000	–4000	3000
	Axis 4	4000	–6000	6000

2) Constant-speed control start command .... leading edge of X000 (OFF → ON)

(d) Servo program
The servo program No. 506 for constant-speed control is shown below.



(e) Sequence program
The sequence program which runs the servo program is shown below.



7.16.5 Pass point skip function

This is a function whereby, by setting a skip signal for each pass point associated with a constant speed control instruction, positioning at the current point can be canceled and positioning carried out at the next point.

[Data setting]

(1) Skip signal device
The following devices can be designated as skip signal devices.
X, Y, M, TC, TT, CC, CT, B, F

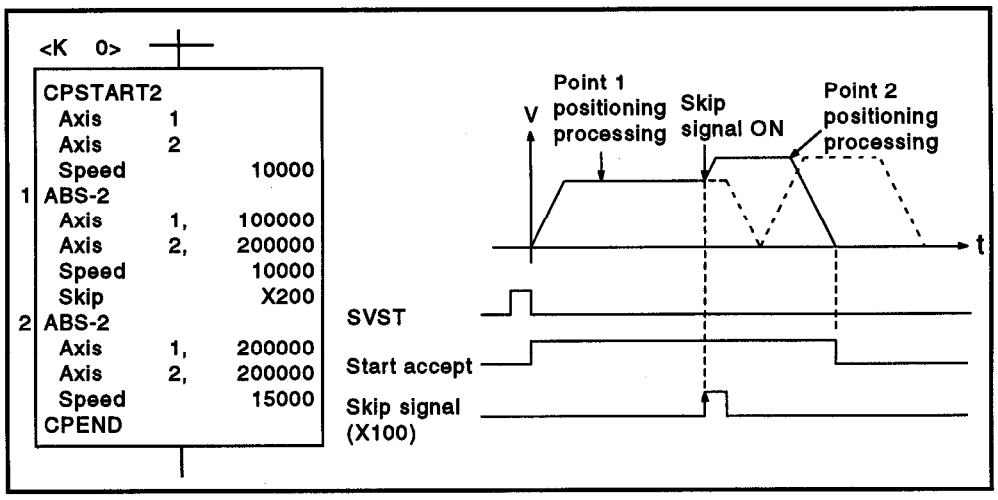
[Notes]

(1) If absolute circular interpolation is designated at or beyond the point where the skip signal was designated, set absolute linear interpolation up to that point. Otherwise, an error occurs and operation stops.

(2) When a skip signal is input at the final point, deceleration to a stop occurs at that point and the program is ended.

[Program example]

```
<K   0>
   CPSTART2
     Axis      1
     Axis      2
     Speed              10000
1  ABS-2
     Axis      1,      100000
     Axis      2,      200000
     Speed              10000
     Skip                X200
2  ABS-2
     Axis      1,      200000
     Axis      2,      200000
     Speed              15000
   CPEND
```



7.16.6 FIN signal wait function

This is a function whereby, when the FIN wait function is selected and an M code is set for each point on the way, the end of processing of each point on the way is synchronized with the FIN signal, and positioning at the subsequent point is carried out when the FIN signal comes ON.

[Data setting]

(1) When the FIN signal wait function is selected, the fixed acceleration/deceleration time method is used.
Set the acceleration/deceleration time within the range 1 ms to 5000 ms in the servo program by using the "FIN acceleration/deceleration" option.
Indirect setting is also possible by using D and W devices (1 word).

[Notes]

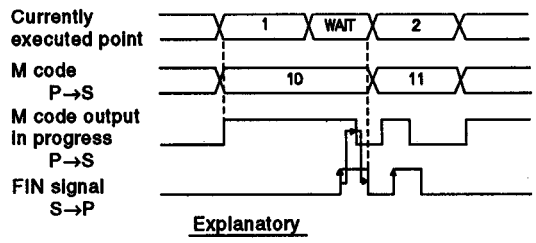
(1) If the acceleration/deceleration time designation is outside the permissible range, the servo program setting error "13" will occur on starting and control will be performed with an acceleration/deceleration time of 1000 ms.

(2) When interpolation is performed, the M code output in progress signal is output for all interpolation axes. In this case, turn ON the signal for one of the interpolating axes.

(3) When an M code is set at the final point, positioning is completed after the FIN signal has gone from OFF to ON to OFF.

[Program example]

```
<K  0>
     CPSTART2
      Axis      1
      Axis      2
      Speed                10000
      FIN acceleration/      100  [ms]
      deceleration
1    ABS-2
      Axis      1,        200000
      Axis      2,        200000
      M code                 10
2    ABS-2
      Axis      1,        300000
      Axis      2,        250000
      M code                 11
3    ABS-2
      Axis      1,        350000
      Axis      2,        300000
      M code                 12
4    ABS-2
      Axis      1,        400000
      Axis      2,        400000
     CPEND
```

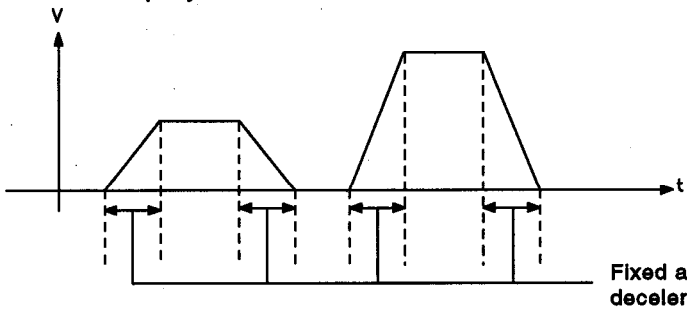


Explanatory

1. When the positioning at point 1 starts, an M code is output and the M code output in progress signal comes ON.
2. On receiving this signal, the relevant processing is performed at the PC, and then the FIN signal is switched ON. Operation does not proceed to the next point until the FIN signal comes ON.
3. When the FIN signal is turned ON from the programmable controller, the M code output in progress signal goes OFF.
4. After the M code output in progress signal has gone OFF, the FIN signal is turned OFF from the programmable controller. After that, positioning at the next point, point 2, starts.

POINT

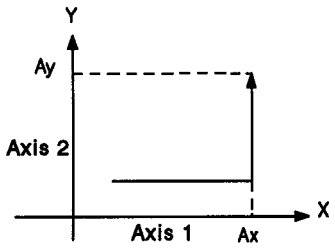
The fixed acceleration/deceleration method is a type of acceleration/deceleration processing whereby even if the command speed changes, the time taken up by acceleration/deceleration remains fixed.



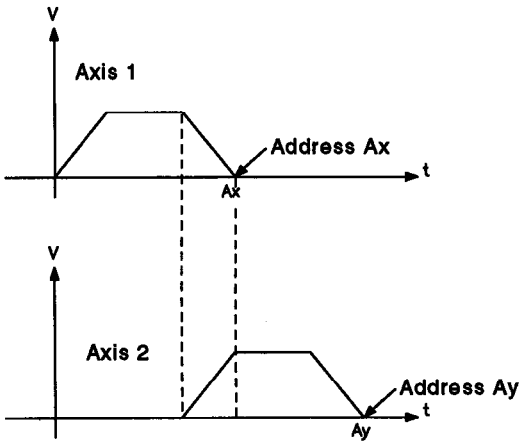
Fixed acceleration/ deceleration time.

(1) When the fixed acceleration/deceleration method is used, the following processing and parameters are invalidated.
- Rapid stop deceleration time in parameter block
- Completion point designation method for speed change point
- "S" curve acceleration/deceleration

(2) When the type of positioning operation shown below (constant speed control) is performed, the speed processing for each axis is as shown below.



Positioning operation



Constant speed control processing of each axis

7.17 Position Follow-Up Control

After a single control start, positioning occurs to the address set with the word device of the servo system CPU designated in the servo program.
Position follow-up control is started using the PFSTART servo program instruction.

Servo Instruction	Positioning Method	Number of Controllable Axes	Items Set by Peripherals																							Speed Change
			Common							Arc			Parameter Block											Others		
			Parameter Block No.	Axis	Address/Travel Value	Commanded Speed	Dwell Time	M Code	Torque Limit Value	Auxiliary Point	Radius	Center Point	Control Unit	Speed Limit Value	Acceleration Time	Deceleration Time	Rapid Stop Deceleration Time	Torque Limit Value	Deceleration Processing on Stop Input	Allowable Error Range for Circular Interpolation	S Curve Ratio	Cancel	Start	
PFSTART	Absolute	1	Δ	O	O	O		Δ						Δ	Δ	Δ	Δ	Δ	Δ		Δ	Δ	Δ	OK

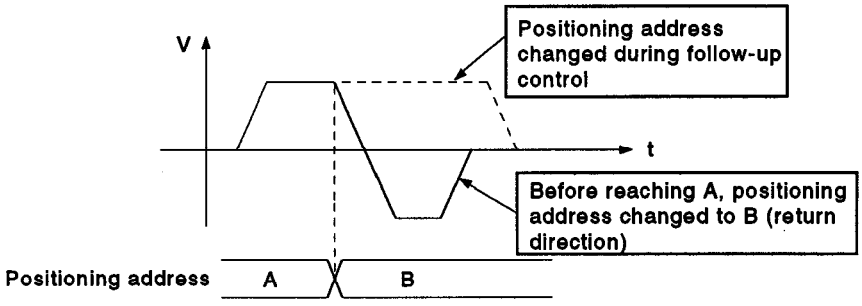
O : Must be set
Δ : Set if required

[Control Details]

Control Using PFSTART Instruction

(1) Positioning to the address set with the word device of the servo system CPU designated in the servo program.

(2) Position follow-up control is executed until the stop instruction is input. If the word device value changes while control is progress, positioning is executed to the changed address.



[Cautions]

(1) The number of controllable axes is limited to one.

(2) Only the absolute data method (ABS□) is used for positioning control to the pass points.

(3) The speed can be changed after control is started.
The changed speed remains valid until the stop command is input.

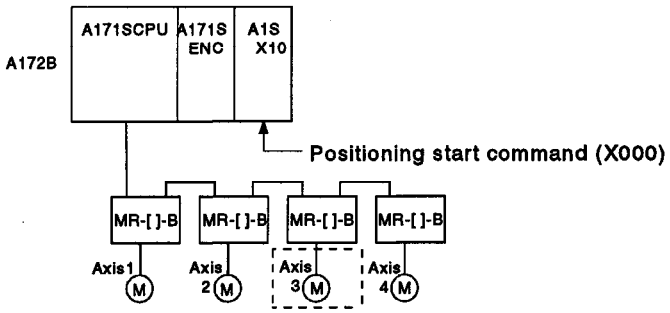
(4) Set the positioning address in the servo program using indirect designation with the word devices D and W.

(5) Use only even-numbered devices for indirect designation of positioning addresses in a servo program.
If odd-numbered devices are used, when an attempt is made to start the control error 141 occurs and control does not start.

(6) Positioning speeds can be set in the servo program using indirect designation with the word devices D and W.
However, this set speed is valid only at the start of position follow-up control (on execution of SVST, DSFRP instructions) and the speed does not change if the indirect designations are changed while control is in progress.

[Program Example]

(1) System configuration
Position follow-up control of Axis 3.

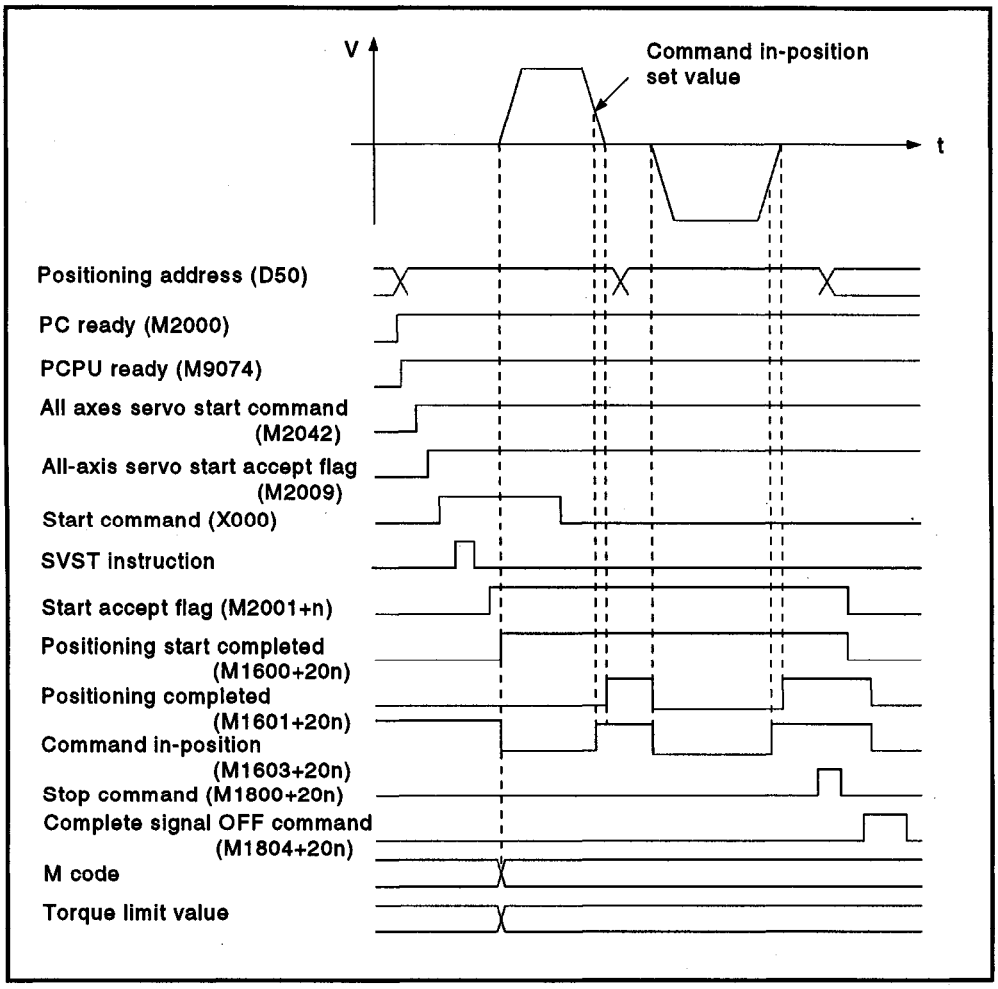


(2) Positioning conditions
(a) The position follow-up conditions are shown below.

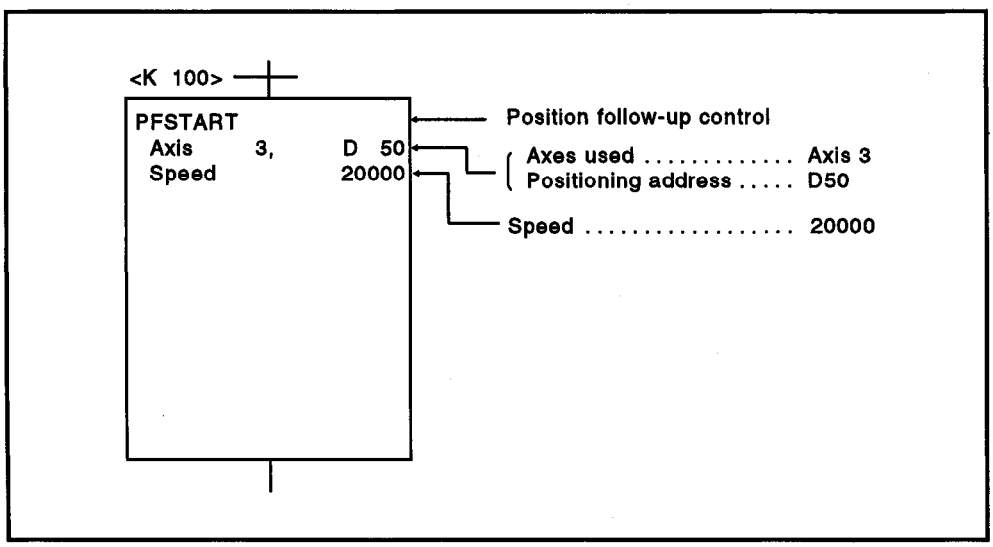
Item	Setting
Servo program number	100
Controlled axis	Axis 3
Positioning address	D50
Positioning speed	20000

(b) Position follow-up control start command .... leading edge of X000 (OFF → ON)

(3) Operation timing
The operation timing for position follow-up control is shown below.

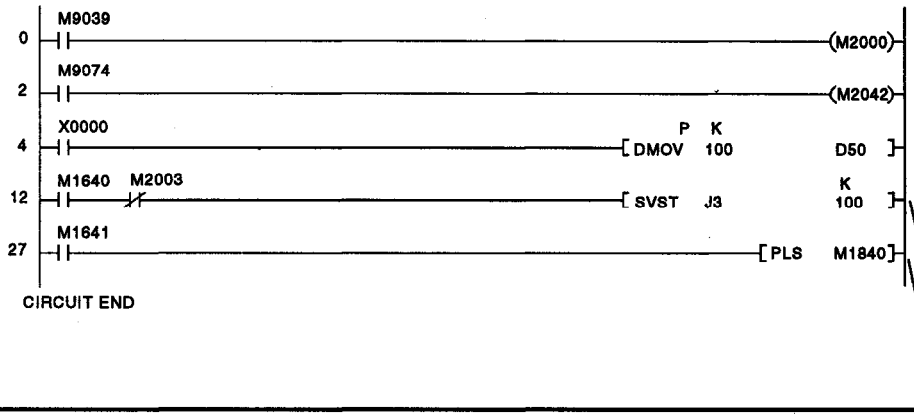


(4) Servo program
The servo program No. 100 for position follow-up control is shown below.



(5) Sequence program

The sequence program which runs the servo program is shown below.



Turns ON PC ready.

Turns ON all axes servo start command.

Transfers No. 100 servo program to D50 when X000 turns OFF → ON.

Servo program No. 100 execution request.

Turns ON the stop command on completion of servo program No. 100 execution request.

7.18 Simultaneous Start

After a single control start, the designated servo programs start simultaneously.
Use the START instruction to simultaneously start servo programs.

Servo Instruction	Positioning Method	Number of Controllable Axes	Items Set by Peripherals: Common: Parameter Block No.	Axis	Address/Travel Value	Commanded Speed	Dwell Time	M Code	Torque Limit Value	Arc: Auxiliary Point	Radius	Center Point	Parameter Block: Control Unit	Speed Limit Value	Acceleration Time	Deceleration Time	Rapid Stop Deceleration Time	Torque Limit Value	Deceleration Processing on Stop Input	Allowable Error Range for Circular Interpolation	S Curve Ratio	Others: Condition of repetitions	Program number	Speed Change
START	*	*																					O	*

O : Must be set
* : Differs according to servo program started.

[Control Details]

Control Using START Instruction

(1) Simultaneously start the designated servo programs.

(2) Any servo program can be designated, except the simultaneous start (START instruction) servo program.

(3) Up to three servo programs can be designated.

(4) After the simultaneous start, each axis is controlled by the designated servo program.

[Cautions]

(1) A check is made at the simultaneous start. An error occurs and operation does not start in the cases shown in the table below.

Error	Error Processing	Stored Codes	
		D9189	D9190
Designated servo program does not exist	Servo program setting error flag (M9079): ON Start accept flag (M2001+n): OFF	Program number causing error on simultaneous start	19
START instruction designated as servo program			
A servo program cannot start due to an error		Program number for which error occurred on simultaneous start	Error Item Data (see Section 6.3)

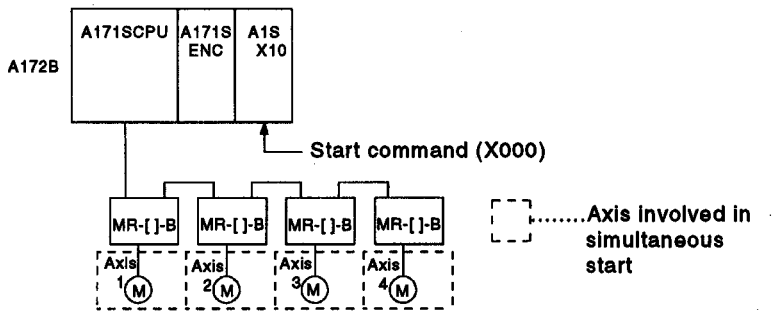
(2) The servo programs cannot be designated for the START instruction using indirect designation.

(3) If the servo programs designated for the START instruction include fixed-pitch feed control or speed/position switching control, start may be delayed a maximum of one second compared to other speed control or position control.

[Program Example]

This program executes simultaneous start under the conditions below.

(1) System configuration
Simultaneous start of Axis 1, Axis 2, Axis 3, and Axis 4.



(2) Quantity and numbers of servo programs designated
(a) Designated servo programs: 3

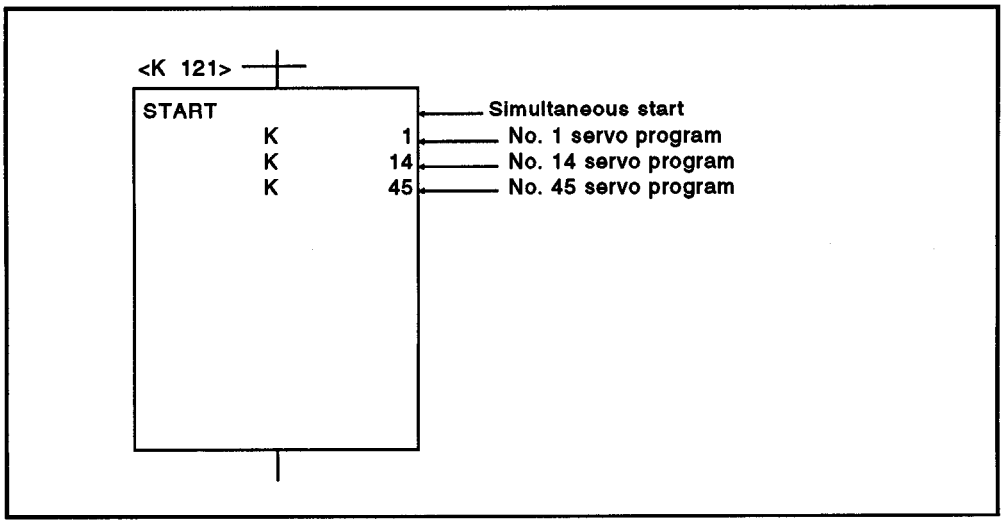
(b) Designated servo program numbers

Servo Program No.	Axis	Control Details
1	1, 2	Circular interpolation control
14	3	Speed control
45	4	Home position return control

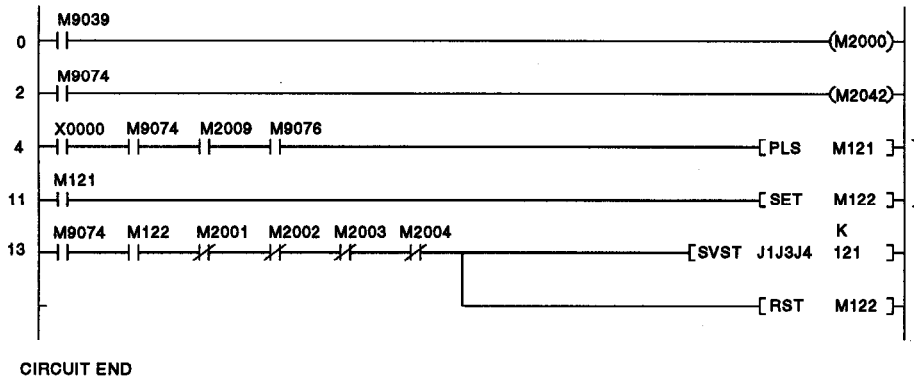
(3) Start conditions
(a) Simultaneous start servo program number.....No. 121

(b) Simultaneous start run command..... leading edge of X100 (OFF → ON)

(4) Servo program
The simultaneous start servo program No. 121 is shown below.



(5) Sequence program
The sequence program which runs the servo program is shown below.



Turns ON PC ready.

Turns ON all axes servo start command.

Turns ON servo program No. 121 start command flag (M122) when X000 turns OFF → ON.

Servo program No. 121 execution request.

Turns OFF M122 on completion of servo program No. 121 execution request.

7.19 JOG Operation

Runs the set JOG operation.
Individual start or simultaneous start can be used for JOG operation.
JOG operation can be run from a sequence program or in a peripheral device test mode.
(For information on running JOG operation in a peripheral device test mode, refer to the operation manual for the appropriate peripheral device.)
To carry out JOG operation, the JOG operation must be set for each axis.

7.19.1 JOG operation data

The JOG operation data is the data required to carry out JOG operation.
Set the JOG operation data from a peripheral device.

Table 7.2 Table of JOG Operation Data

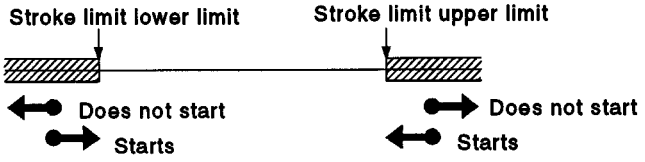
No.	Item	Setting Range								Default		Remarks	Explanatory Section
		mm		Inch		degree		PULSE		Initial Value	Units		
		Setting Range	Units	Setting Range	Units	Setting Range	Units	Setting Range	Units				
1	JOG speed limit value	0.01 to 6000000.00	mm/min	0.001 to 600000.000	inch/min	0.001 to 600000.000	degree/min	1 to 1000000	PLS/sec	20000	PLS/sec	• Sets the max. speed during JOG operation. • The JOG speed limit value becomes the JOG operation speed if the JOG operation speed is set greater than JOG speed limit value.	—
2	Parameter block setting	1 to 16 (A171/A273UHCPU (8-axis specification)) 1 to 64 (A273UHCPU (32-axis specification))								1	—	• Sets the parameter block number used for JOG operation.	4.4

(1) JOG operation data check
A relative check of the JOG operation data is executed at the following times:
- Power on
- On PC ready (M2000) leading edge (OFF→ ON)
- When test mode is selected.

(2) Data error processing
- Only data for which errors were detected during the relative check is changed to its default value for JOG operation control.
- The error code corresponding to the data for axes where an error was detected is stored in the data register.

POINT

(1) JOG operation to a position outside the fixed parameter stroke limit cannot be started.
However, JOG operation is possible in the direction from outside the stroke limit to back inside the stroke limit.



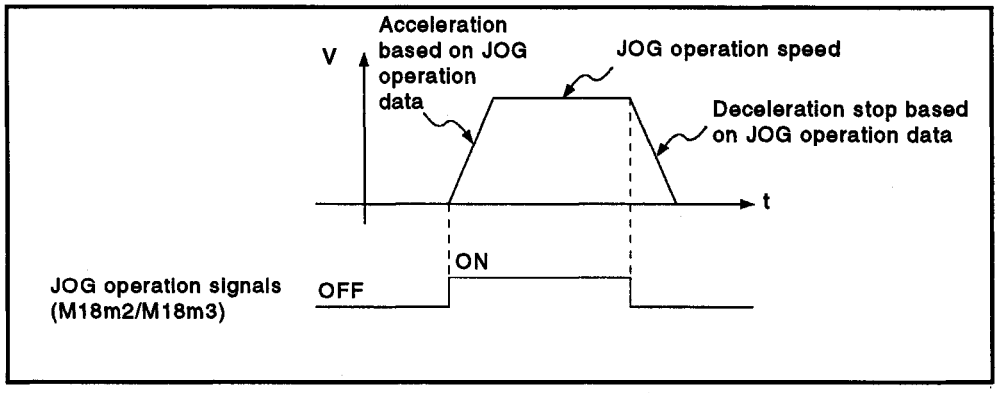
7.19.2 Individual start

Starts JOG operation for the designated axes.
JOG operation is controlled by the following JOG operation signals:

- Forward JOG operation ..... M1802+20n
- Reverse JOG operation .....M1803+20n

[Control Details]

(1) JOG operation continues at the speed value stored in the JOG operation speed setting register while the JOG operation signal remains ON and a deceleration stop occurs when the JOG operation signal turns OFF. Control of acceleration and deceleration is based on the JOG operation data settings.



JOG operation carried out for axes for which the JOG operation signal is ON.

(2) The JOG operation signal, JOG operation setting register, and setting range for each axis are shown in the table below.

<A171SCPU>

No.	JOG Operation		JOG Operation Setting Register		Setting Range							
					mm		Inch		degree		PULSE	
	Forward JOG	Reverse JOG	Most Significant	Least Significant	Setting Range	Units	Setting Range	Units	Setting Range	Units	Setting Range	Units
1	M1802	M1803	D965	D964	1 to 600000000	$\times 10^{-2}$ mm/min	1 to 600000000	$\times 10^{-3}$ mm/min	1 to 600000000	$\times 10^{-3}$ mm/min	1 to 1000000	PLS/sec
2	M1822	M1823	D971	D970								
3	M1842	M1843	D977	D976								
4	M1862	M1863	D983	D982								

* See Section 3.4.2 for the JOG operation signal and JOG operation setting register used for each axis with the A273UHCPU (8-/32-axis specification) However, the setting ranges are the same as those shown in the table above.

POINT

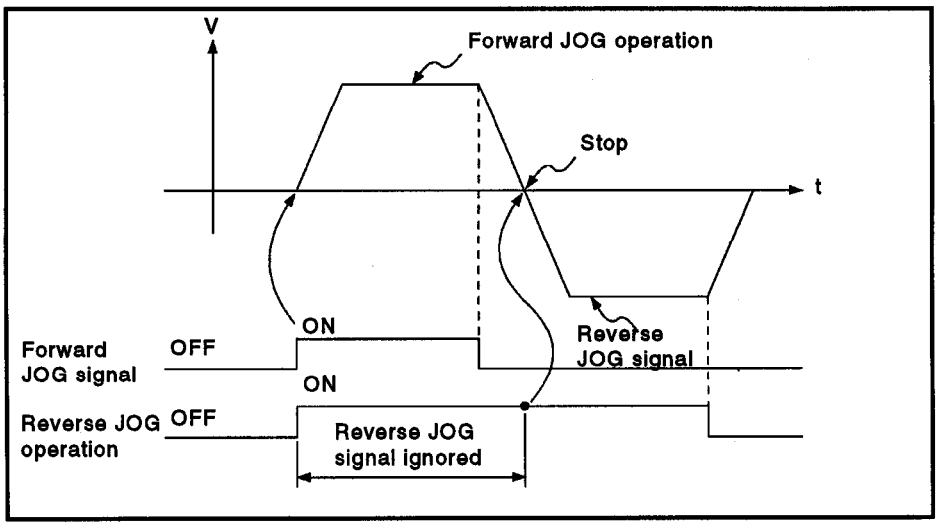
To set the JOG operation speed using a sequence program, store a value in the JOG operation speed setting register which is 100 times the actual speed in units of millimeters or 1000 times the speed in units of inches or degrees.

Example

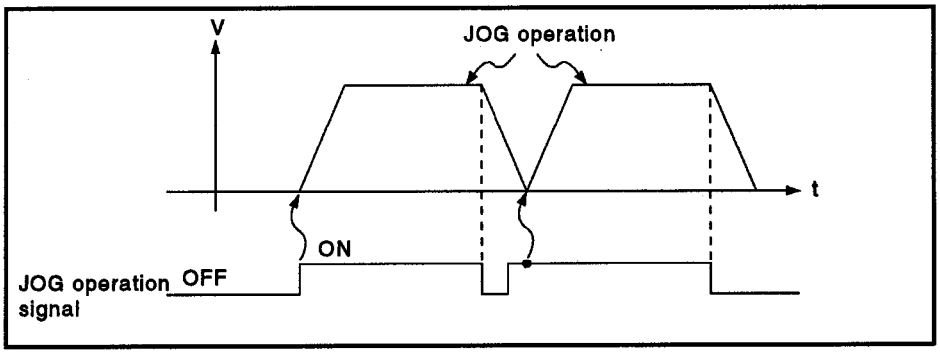
To set a JOG operation speed of 6000.00 mm/min., store the value 600000 in the JOG operation speed setting register.

[Cautions]

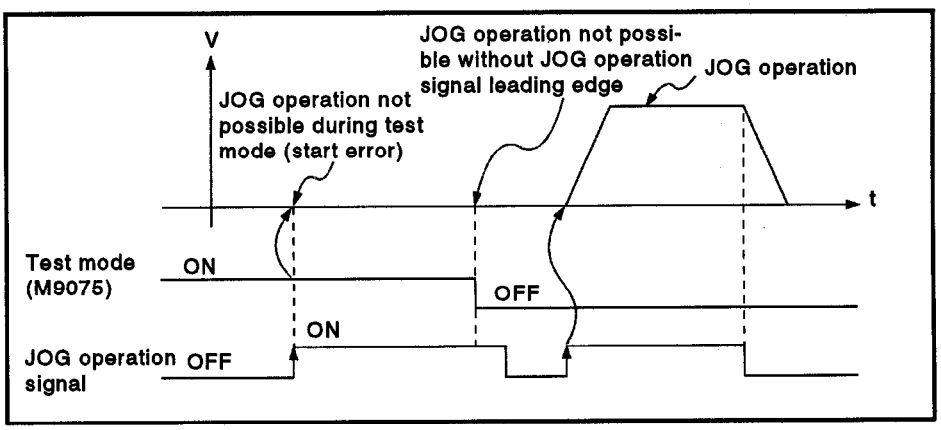
(1) Forward JOG operation occurs if the forward JOG signal (M1802+20n) and reverse JOG signal (M1803+20n) turn ON simultaneously for a single axis.
After the forward JOG signal turns OFF and deceleration stop is complete, reverse JOG operation starts if the reverse JOG operation signal remains ON.



(2) If the JOG operation signal turns back ON during deceleration after the JOG operation signal previously turned OFF, deceleration continues until the speed reaches zero before JOG operation is restarted.



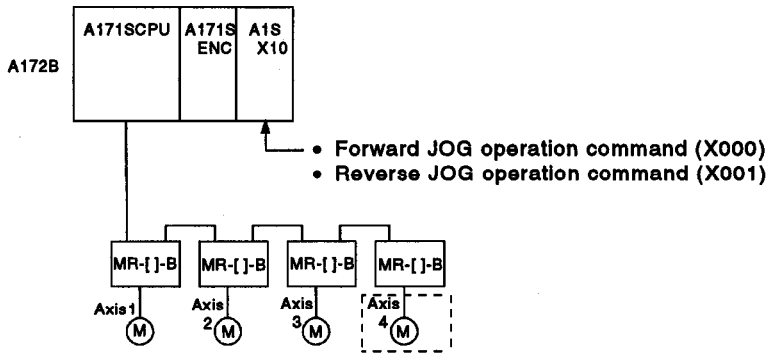
(3) JOG operation cannot be started by the JOG operation signals (M1802+20n/M1803+20n) in a peripheral device test mode.
JOG operation starts on the leading edge (OFF → ON) of the JOG operation signal after the test mode is reset.



[Program Example]

This program executes JOG operation under the conditions below.

(1) System configuration
JOG operation of Axis 4.

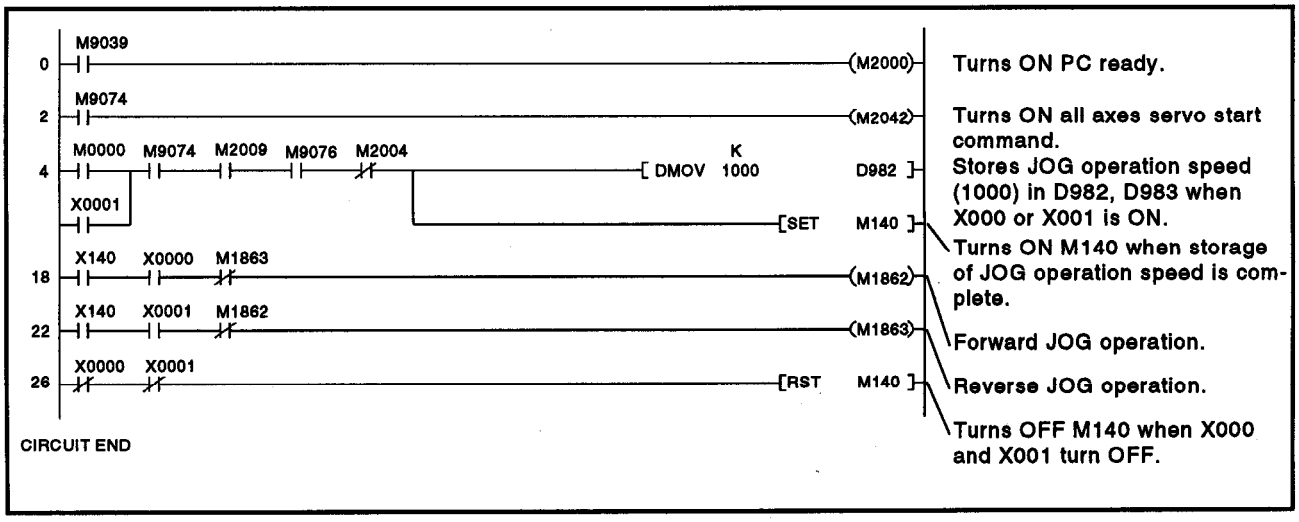


(2) JOG operation conditions
(a) Axis number ..... Axis 4

(b) JOG operation speed 1000

(c) JOG operation commands
1) Forward JOG operation .....X000 ON
2) Reverse JOG operation .....X001 ON

(3) Sequence program

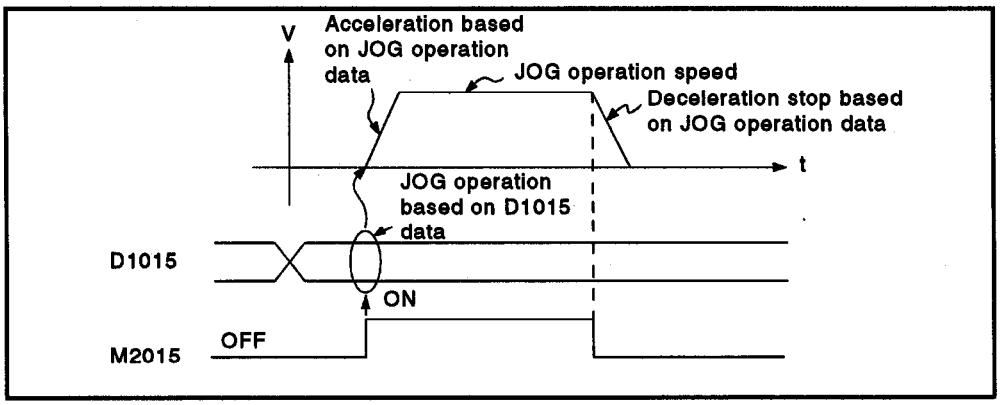


7.19.3 Simultaneous start

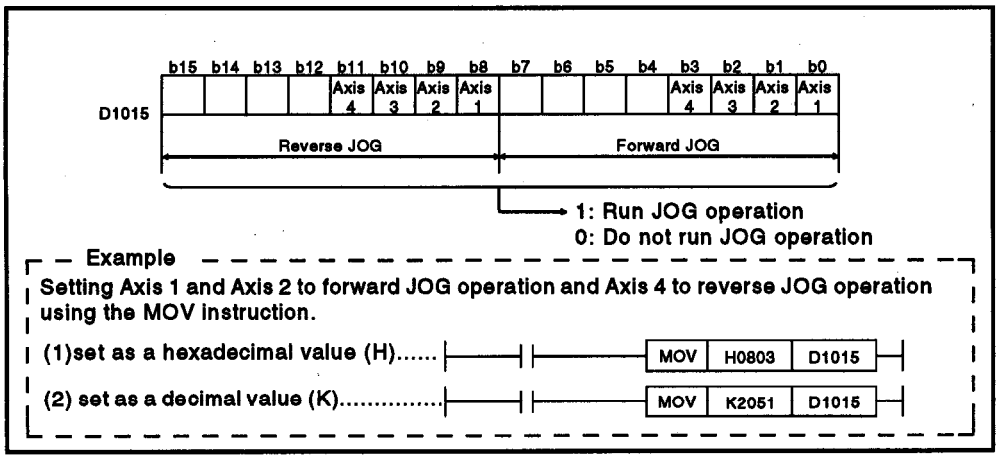
Simultaneously starts JOG operation designated for multiple axes.

[Control Details]

(1) JOG operation continues at the speed value stored in the JOG operation speed setting register for each axis while the JOG simultaneous start command (M2015) remains ON, and a deceleration stop occurs when M2015 turns OFF.
Control of acceleration and deceleration is based on the JOG operation data settings.



(2) JOG operation is carried out on the axes set in the JOG simultaneous start axis setting area (D1015).



(3) The JOG operation speed setting registers are described below.

<A171SCPU>

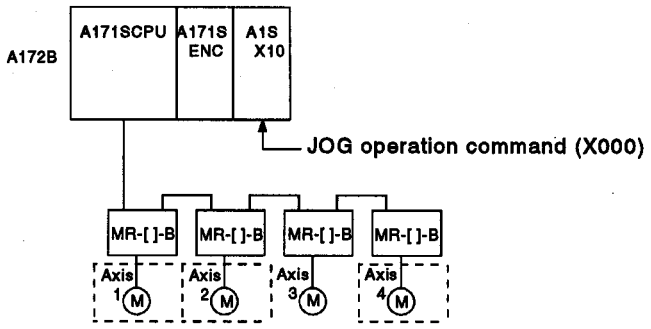
Axis No.	JOG Operation Speed Setting Register		Speed Change Value							
			mm		Inch		degree		PULSE	
	Most Significant	Least Significant	Set Range	Units	Set Range	Units	Set Range	Units	Set Range	Units
1	D965	D964	1 to 600000000	$\times 10^{-2}$ mm/min	1 to 600000000	$\times 10^{-3}$ mm/min	1 to 600000000	$\times 10^{-3}$ mm/min	1 to 1000000	PLS/sec
2	D971	D970								
3	D977	D976								
4	D983	D982								

* See Section 3.4.2 for the JOG operation speed setting register used for each axis with the A273UHCPU (8-/32-axis specification) However, the speed change values are the same as those shown in the table above.

[Program Example]

This program executes simultaneous start of JOG operations under the conditions below.

(1) System configuration
JOG operation of Axis 1, Axis 2, and Axis 4.

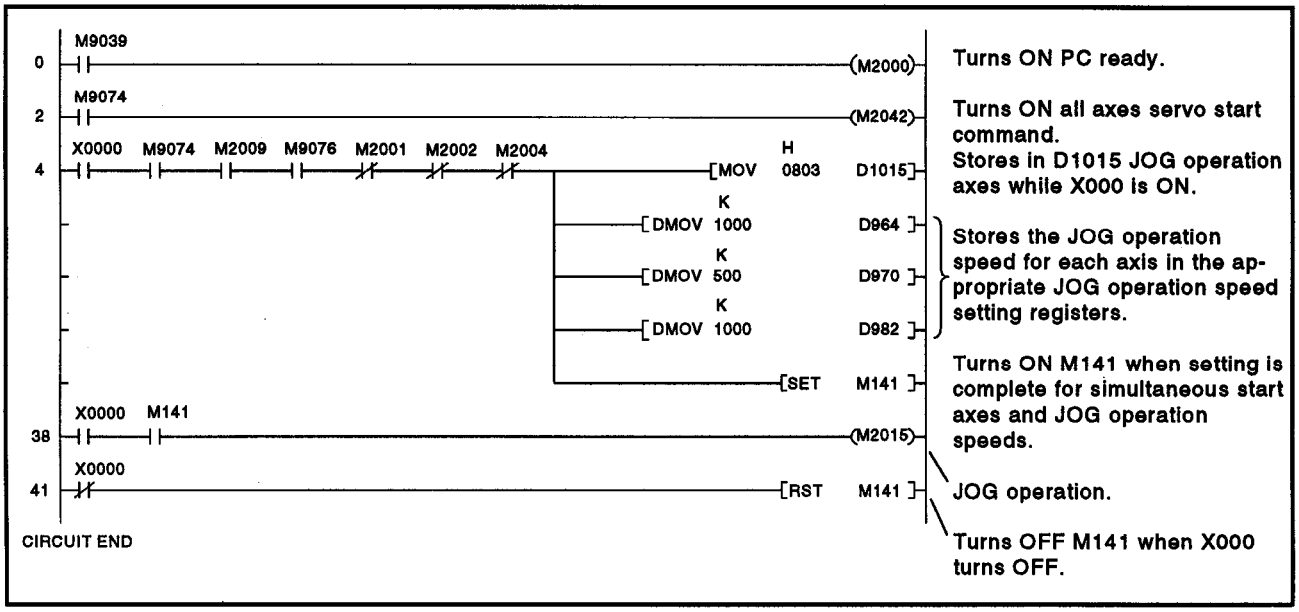


(2) JOG operation conditions
(a) The JOG operation conditions are tabled below.

Item	JOG		
Axis number	Axis 1	Axis 2	Axis 4
JOG operation speed	1000	500	1000
JOG operation direction	Forward	Forward	Reverse

(b) JOG operation command .... X000 ON

(3) Sequence program



7.20 Manual Pulse Generator Operation

Positioning control according to the number of pulses input from the manual pulse generator.
Simultaneous operation of 1 to 3 axes is possible with one manual pulse generator; the number of modules that can be connected is as shown below.

	Number Connectable to the Manual Pulse Generator
A171SCPU	1
A273UHCPU (8-/32-axis specifcation)	3

IMPORTANT

When two or more A273EX are installed, connect the manual pulse generator to the first A273EX (counting from slot 0 of the main base unit).
(Only one manual pulse generator can be used.)

[Control Details]

(1) Positioning of the axes set in the manual pulse generator axis setting register according to the pulses input from the manual pulse generator. Manual pulse generator operation is only valid while the manual pulse generator enable flag is ON.

<A171SCPU>

Manual Pulse Generator Axis Setting Register	Manual Pulse Generator Enable Flag
D1012	D2012

<A273UHCPU (8-axis specification)>

Manual Pulse Generator Connected Position	Manual Pulse Generator Axis Setting Register	Manual Pulse Generator Enable Flag
P1	D1012	M2012
P2	D1013	M2013
P3	D1014	M2014

<A273UHCPU (32-axis specification)>

Manual Pulse Generator Connected Position	Manual Pulse Generator Axis Setting Register	Manual Pulse Generator Enable Flag
P1	D714, D715	M2051
P2	D716, D717	M2052
P3	D718, D719	M2053

(2) The travel value and output speed are shown below for positioning control due to manual pulse generator output.

(a) Travel value

The travel value due to the input of pulses from a manual pulse generator is calculated using the following formula.

[travel value] = [travel value per pulse] × [number of input pulses] × [manual pulse generator input multiplication factor setting]

The travel value per pulse during manual pulse generator operation is shown in the following table.

Units	Travel Value
mm	0.1 μm
inch	0.00001 inch
degree	0.00001 degree
PLUSE	1 PULSE

For units of millimeters, the commanded travel value for input of one pulse is: (0.1 μm) × (1 pulse) × (manual pulse generator input magnification setting)

(b) Output speed

The output speed is the positioning speed corresponding to the number of pulses input from a manual pulse generator in unit time.

[output speed] = [input pulses per 1 ms] ×
[manual pulse generator input multiplication factor setting]

(3) Setting the axes controlled by the manual pulse generator

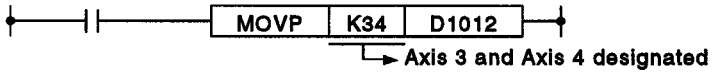
(a) The axes controlled by the manual pulse generator are set in the manual pulse generator axis setting register (D1012/D1012 to D1014/D714 to D719).

<A171SCPU/A273UHCPU (8-axis specification)>

The value is set as a maximum of three decimal digits, with each digit representing an axis from Axis 1 to Axis 4/Axis 1 to Axis 8. (The number of digits represents the number of simultaneously controlled axes.)

Example

Set the following value to control Axis 3 and Axis 4 with the manual pulse generator.

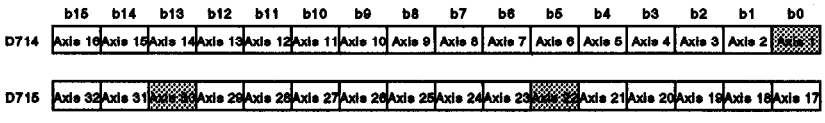


<A273UHCPU (32-axis specification)>

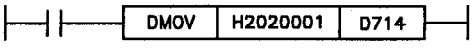
Set bits corresponding to the controlled axes (1 to 32).

Example

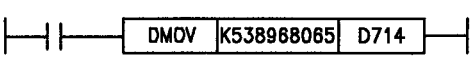
To control axis 1 and axis 22 and axis 30 with manual pulse generator 1, make the following settings.



(1) When set in hexadecimal (H).....



(2) When set in decimal (K).....



REMARK

The connected position of the manual pulse generator used with the A273UHCPU (8-/32-axis specification) indicates the A273EX connector pin (P1, P2, P3) to which the manual pulse generator is connected.
See the A273UHCPU (8/32-axis specification) Motion Controller User's Manual (IB-67262 for details about A273EX.)

(4) Manual pulse generator 1-pulse input magnification
(a) The magnification setting for a 1 pulse input from the manual pulse generator is set for each axis.

<A171SCPU>

1-pulse Input Magnification Setting Register	Corresponding Axis No.	Setting Range
D1016	Axis 1	1-100
D1017	Axis 2	
D1018	Axis 3	
D1019	Axis 4	

<A273UHCPU (8-axis)>

1-pulse Input Magnification Setting Register	Corresponding Axis No.	Setting Range
D1016	Axis 1	1-100
D1017	Axis 2	
D1018	Axis 3	
D1019	Axis 4	
D1020	Axis 5	
D1021	Axis 6	
D1022	Axis 7	
D1023	Axis 8	

<A273UHCPU (32-axis)>

1-pulse Input Magnification Setting Register	Corresponding Axis No.	Setting Range
D720	Axis 1	1-100
D721	Axis 2	
D722	Axis 3	
D723	Axis 4	
D724	Axis 5	
D725	Axis 6	
D726	Axis 7	
D727	Axis 8	
D728	Axis 9	
D739	Axis 10	
D730	Axis 11	
D731	Axis 12	
D732	Axis 13	
D733	Axis 14	
D734	Axis 15	
D735	Axis 16	
D736	Axis 17	
D737	Axis 18	
D738	Axis 19	
D739	Axis 20	
D740	Axis 21	
D741	Axis 22	
D742	Axis 23	
D743	Axis 24	
D744	Axis 25	
D745	Axis 26	
D746	Axis 27	
D747	Axis 28	
D748	Axis 29	
D749	Axis 30	
D750	Axis 31	
D751	Axis 32	

(5) At the leading edge of the manual pulse generator enable flag, a check is made in the manual pulse generator 1-pulse input magnification setting registers of the manual pulse generator input magnifications set for the appropriate axes.
If an out-of-range value is detected, the manual pulse generator axis setting error register (D9187) and manual pulse generator axis setting error flag (M9077) are set and a value of 1 is used for the magnification.

(6) Manual pulse generator smoothing magnification setting
Set a magnification to smooth the leading edge and trailing edge of manual pulse generator operation.

<A171SCPU>

Manual Pulse Generator Smoothing Magnification Setting Register	Setting Range
D9192	0 to59

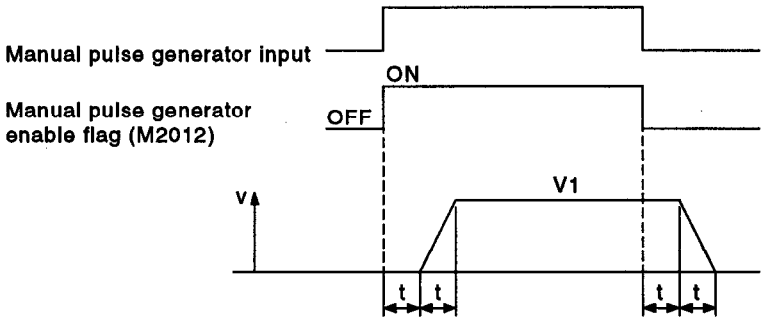
<A273UHCPU (8-axis)>

Manual Pulse Generator Smoothing Magnification Setting Register	Setting Range
Manual pulse generator 1 (P1) : D9192	0 to59
Manual pulse generator 2 (P2) : D9193	
Manual pulse generator 3 (P3) : D9194	

<A273UHCPU (32-axis)>

Manual Pulse Generator Smoothing Magnification Setting Register	Setting Range
Manual pulse generator 1 (P1) : D752	0 to59
Manual pulse generator 2 (P2) : D753	
Manual pulse generator 3 (P3) : D754	

(a) Operation



$$\text{Output speed (V1)} = \left(\begin{matrix}\text{number of input}\\ \text{pulses/ms}\end{matrix}\right) \times \left(\begin{matrix}\text{manual pulse generator 1 pulse}\\ \text{input magnification setting}\end{matrix}\right)$$

$$\text{Travel value (L)} = \left(\begin{matrix}\text{travel value}\\ \text{per pulse}\end{matrix}\right) \times \left(\begin{matrix}\text{number}\\ \text{of input}\\ \text{pulses}\end{matrix}\right) \times \left(\begin{matrix}\text{manual pulse generator 1}\\ \text{pulse input magnification}\\ \text{setting}\end{matrix}\right)$$

REMARKS

(1) The travel value per manual pulse generator pulse is as follows.

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

(2) The smoothing time constant is a value in the range 56.8 ms to 3408 ms.

(7) Details of errors occurring during the setting of data for manual pulse generator operation are shown in the table below.

Error Details	Error Processing
A digit was set outside the ranges 1-4, 1-8, or 1-32.	• Digit ignored where error occurred. • Manual pulse generator of valid axes with settings in rang es 1-4, 1-8, or 1-32.
The designated axis is set for manual pulse generator operation.	• Duplicated designated axis ignored. • Executes the manual pulse generator operation set first.
More than 4 digits set	• All set axes ignored

[Cautions]

(1) The start accept flag turns ON for axes during manual pulse generator operation.
Consequently, positioning control or home position return cannot be started by the servo system CPU or a peripheral device.
Turn OFF the manual pulse generator enable flag when manual pulse generator operation is complete.

(2) The torque limit value is fixed at 300% during manual pulse generator operation.

(3) When the manual pulse generator enable flag comes ON for a driven axis, for example one performing positioning control or JOG operation, error 214 is set for the relevant axis and manual pulse generator input is not enabled. After the axis has been stopped, the rise of the manual pulse generator enable flag is validated, the manual pulse generator input enabled status is established, the start accept flag comes ON, and input from the manual pulse generator is accepted.

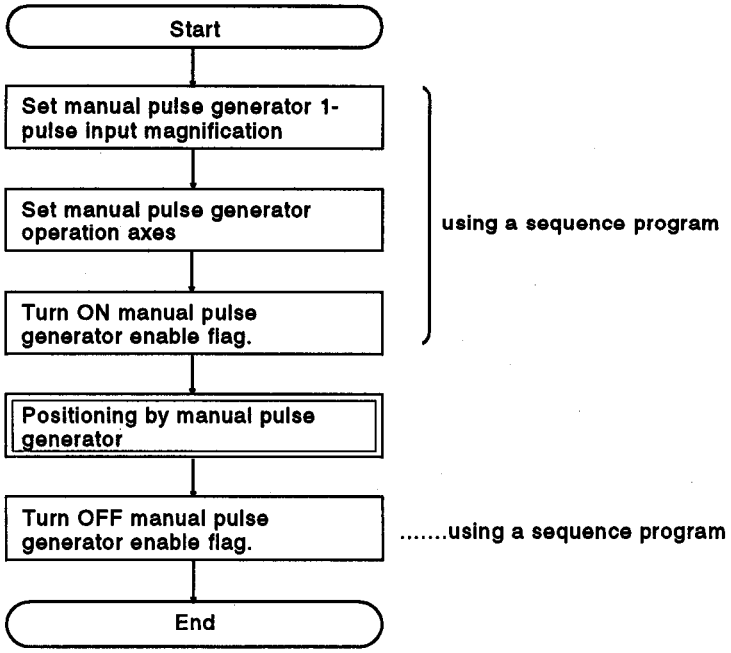
(4) If the manual pulse generator enable flag for another manual pulse generator No. is turned ON for an axis currently performing manual pulse generator operation, error 214 is set for the relevant axis and the input of that manual pulse generator is not enabled.

(5) If, after the manual pulse generator enable flag has been turned OFF, it is turned ON again for an axis that is performing smoothing deceleration, error 214 is set and manual pulse generator input is not enabled. Turn the manual pulse generator enable flag ON after smoothing deceleration to a stop (after the start accept flag has gone OFF).

(6) If, after the manual pulse generator enable flag has been turned OFF, another axis is set during smoothing deceleration and the same manual pulse generator enable flag is turned ON again, manual pulse generator input will not be enabled. In this case, the manual pulse generator axis setting error bit of the manual pulse generator axis setting error storage register (D9187) comes ON, and the manual pulse generator axis setting error flag (M9077) comes ON. Establish an interlock such that the start accept flag of the designated axis going OFF is a condition for the manual pulse generator enable flag coming ON.

[Procedure for Manual Pulse Generator Operation]

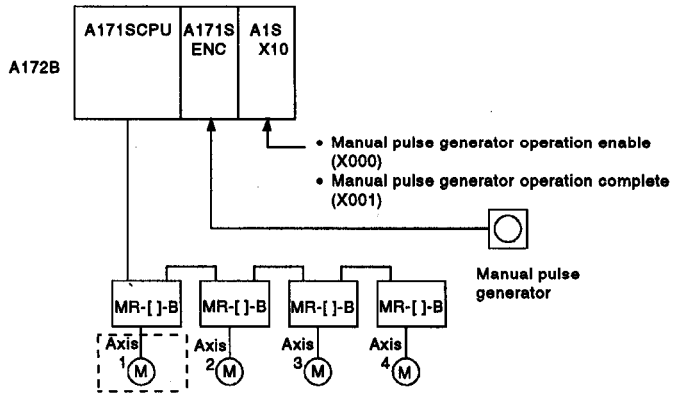
The procedure for manual pulse generator operation is shown below.



[Program Example]

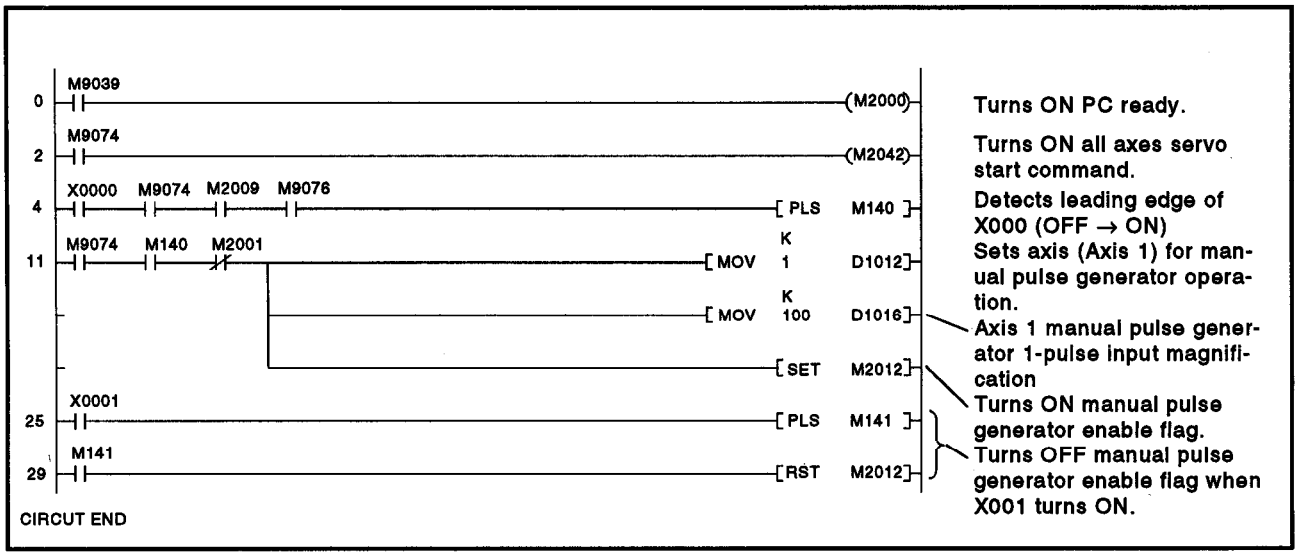
This program executes manual pulse generator operation under the conditions below.

(1) System configuration
Manual pulse generator operation of Axis 1.



(2) Manual pulse generator operation conditions
(a) Manual pulse generator operation axis.....Axis 1
(b) Manual pulse generator 1-pulse input .....100 magnification
(c) Manual pulse generator operation enable.....leading edge of X000 (OFF → ON)
(d) Manual pulse generator operation complete....leading edge of X001 (OFF → ON)

(3) Sequence program
A sequence program for manual pulse generator operation is shown below.



7.21 Home Position Return

(1) Use home position return at power on and other times where confirmation that axes are at the machine home position is required.

(2) The following three methods of home position return are available:
- Near-zero point dog method
- Count method

  Used when not using an absolute position system
- Data set method.....(Recommended for an absolute-position system)

(3) To carry out home position return, the home position return data must be set for each axis.

7.21.1 Home position return data

The home position return data is the data required to carry out home position return.
Set the home position return data from a peripheral device.

Table 7.3 Table of Home Position Return Data

No.	Item	Setting Range								Default	Remarks	Explanatory Section
		mm		inch		degree		PULSE				
		Setting Range	Units	Setting Range	Units	Setting Range	Units	Setting Range	Units	Initial Value		
1	Home position return direction	0: reverse direction (decreased address) 1: forward direction (increased address)								0	• Sets the direction for home position return. • Axis travels in designated direction after home position return is started.	—
2	Home position return method	0: near-zero point dog method 1: count method 2: data set method								0	• Sets the home position return method. • The near-zero point dog method or count method is recommended for a servo amplifier which does not support absolute data, and the data set method is recommended for a servo amplifier which supports absolute data.	—
3	Home position address	−2147483648 to 2147483647	$\times10^{-1}$ μm	−2147483648 to 2147483647	$\times10^{-5}$ inch	0 to 35999999	$\times10^{-5}$ degree	−2147483648 to 2147483647	PLS	0	• Sets the present value of the home position after home position return. • It is recommended that the home position address is set at the stroke limit upper limit or lower limit.	—
4	Home position return speed	0.01 to 6000000.00	mm/ min	0.001 to 600000.000	inch/ min	0.001 to 600000.000	degree/ min	1 to 1000000	PLS/ sec	1	• Sets the speed for home position return.	—
5	Creep speed	0.01 to 6000000.00	mm/ min	0.001 to 600000.000	inch/ min	0.001 to 600000.000	degree/ min	1 to 1000000	PLS/ sec	1	• Sets the creep speed (low speed immediately before stopping after deceleration from home position return speed) after the near-zero point dog.	—
6	Travel value after near-zero point dog	0 to 214748364.7	μm	0 to 21474.83647	inch	0 to 21474.83647	degree	0 to 2147483647	PLS	—	• Sets the travel value after the near-zero point dog for the count method. • Set greater than the deceleration distance at the home position return speed.	7.21.1 (1)
7	Parameter block setting	1 to 16 (A171S/A273UHCPU (8-axis specification)) 1 to 64 (A273UHCPU (32-axis specification))								1	• Sets the parameter block to use for home position return (see Section 4.4).	—

(1) Setting the travel value after near-zero point dog

(a) This parameter sets the travel value after the near-zero point dog turns ON for home position return using the count method.

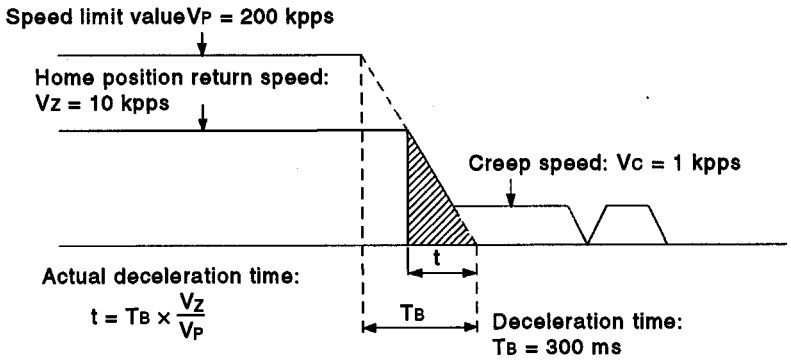
(b) After the near-zero point dog turns ON, the home position is the first zero point after travel by the set travel value is complete.

(c) Set the travel value after the near-zero point dog turns ON greater than the deceleration distance at the home position return speed.

Example

The deceleration distance is calculated as shown below from the speed limit value, home position return speed, creep speed, and deceleration time.

[Home position return operation]



[Deceleration distance (shaded area under graph)]

$$= \frac{1}{2} \times \frac{V_Z}{1000} \times t$$

↑ Change in speed per millisecond

$$= \frac{V_Z}{2000} \times \frac{T_B \times V_Z}{V_P}$$

$$= \frac{10 \times 10^3}{2000} \times \frac{300 \times 10 \times 10^3}{200 \times 10}$$

= 75.....Set greater than 75.

7.21.2 Home position return by the near-zero point dog method

(1) Near-zero point dog method
Using the near-zero point dog method, the home position is the first zero point after the near- zero point dog turns OFF.

(2) Home position return by the near-zero point dog method
The home position return operation using the near-zero point dog method is shown in Fig. 7.32.

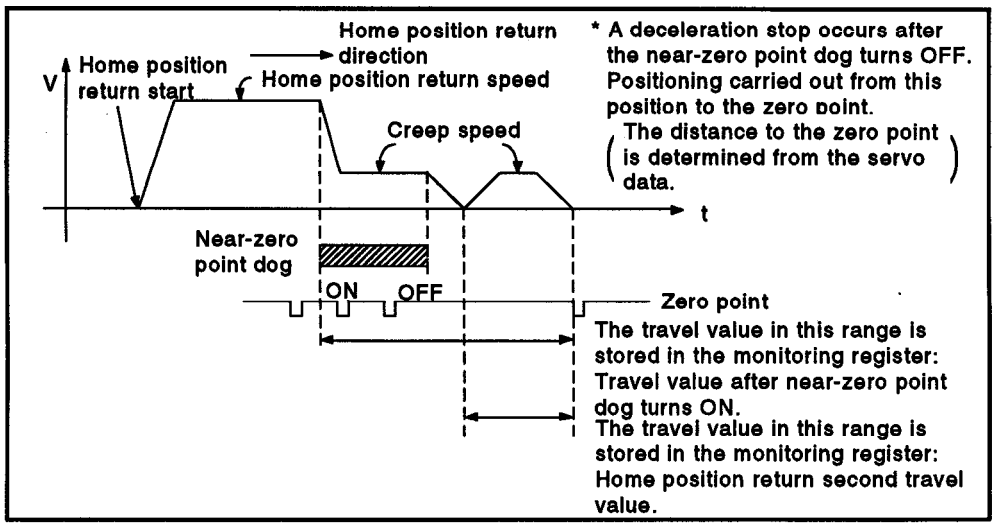
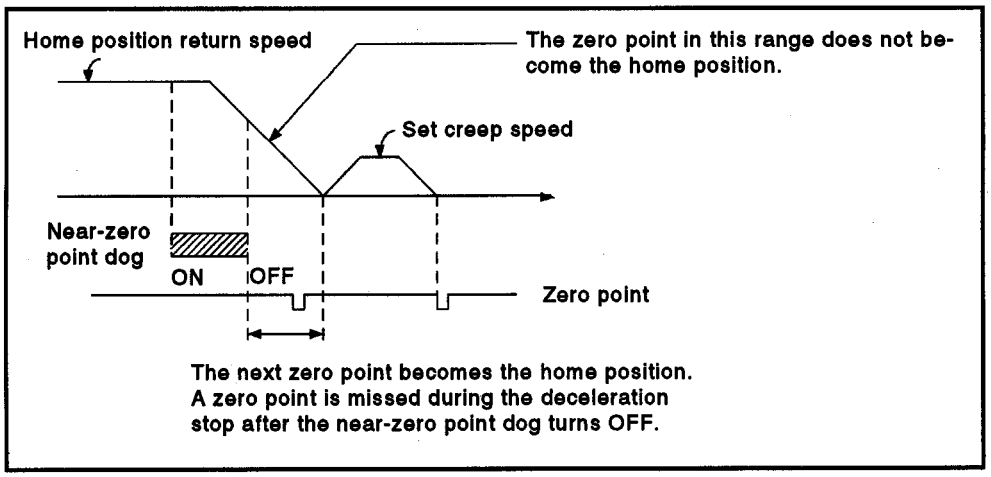


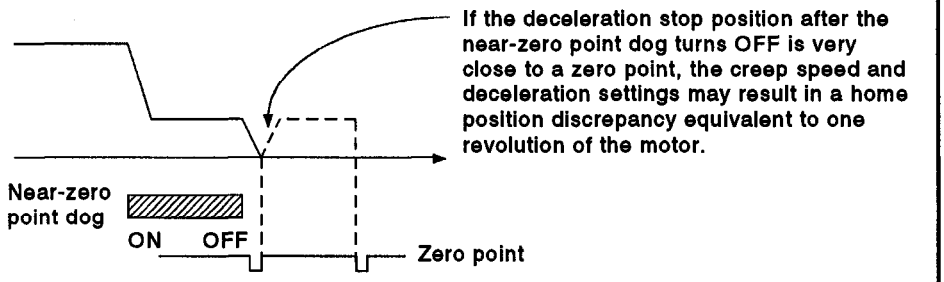
Fig. 7.32 Operation of Home Position Return by the Near-Zero Point Dog Method

(3) Running home position return
To run home position return, use the servo program described in Section 7.21.5.

(4) Cautions
Take note of the following points during home position return by the near-zero point dog method.
(a) Keep the near-zero point dog ON during deceleration from the home position return speed to the creep speed.
A deceleration stop occurs if the near-zero point dog turns OFF before deceleration to the creep speed, and the next zero point becomes the home position.



(b) Adjust the position where the near-zero point dog turns OFF, such that the home position return second travel value becomes half the travel value for one revolution of the motor.
A home position discrepancy equivalent to one revolution of the motor may occur if the home position return travel value is less than half the travel value for one revolution of the motor.



IMPORTANT

(1) In the following cases, before starting the home position return, use JOG operation or some other method to return the axis to a position before where the near-zero point dog turned ON. Home position return will not start unless the axis is returned to a position before the near-zero point dog position.

(a) Home position return from a position after the near-zero point dog turned OFF.

(b) When the power is turned ON after home position return was completed.

7.21.3 Home position return by the count method

(1) Count method
Using the count method, the home position is the first zero point after a designated distance (travel value after near-zero point dog turns ON) after the near-zero point dog turns ON.
The travel value after the near-zero point dog turns ON is set in the table of home position return data shown in section 7.21.1.

(2) Home position return by the count method
The home position return operation using the count method is shown in Fig. 7.33.

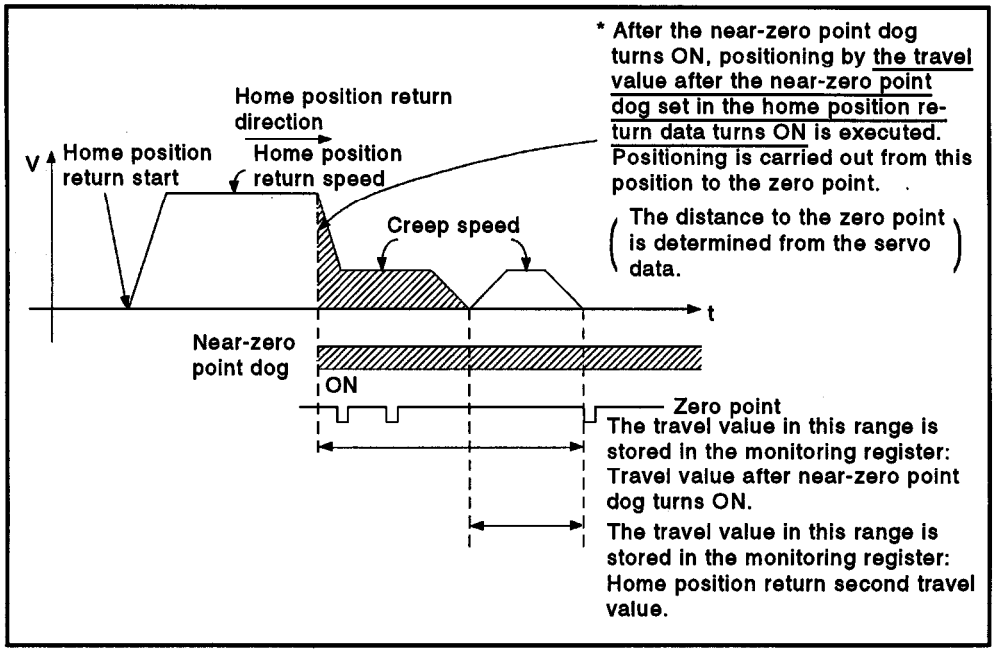


Fig. 7.33 Operation of Home Position Return by the Count Method

(3) Running home position return
To run home position return, use the servo program described in Section 7.21.5.

(4) Cautions
(a) Maintain sufficient distance between the position where the near-zero point dog turns OFF and the home position.

(b) Using the count method, home position return or resumptive start of home position return is possible when the near-zero point dog turns ON. To carry out home position return or resumptive start of home position return when the near-zero point dog turns ON, return the axis to a position where the near-zero point dog is OFF before starting the home position return.

7.21.4 Home position return by the data set method

(1) Data set method
The data set method is a home position return method which does not use the near-zero point dogs. This method can be used with the absolute position system.

(2) Home position return by the data set method
The address present value becomes the home position address when the home position return operation is run with the DSFRP instruction.

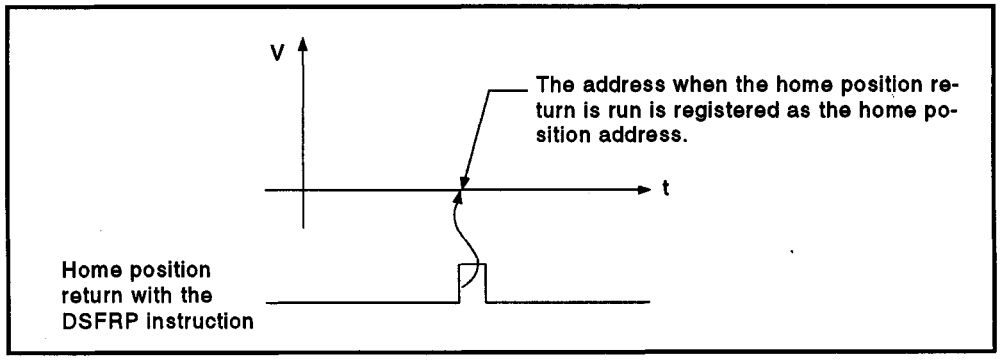


Fig. 7.34 Operation of Home Position Return by the Data Set Method

(3) Executing home position return
To execute home position return, use the servo program described in Section 7.21.5.

(4) Cautions
(a) A zero point must be passed between turning on the power and executing home position return.
A no zero point passed error occurs if home position return is executed before a zero point is passed.
After a no zero point passed error occurs, reset the error and turn the servomotor at least one revolution using JOG operation before running the home position return operation again.
Use the zero point passed signal (M16m6) to check that a zero point is passed.

(b) Starting home position return with the data set method when not using the absolute position system has the same function as the present value change command.

(c) The home position return data required for the data set method are the home position return method and home position address.

7.21.5 Home position return servo program

Home position return uses the ZERO servo instruction.

Servo Instruction	Positioning Method	Number of Controllable Axes	Items Set by Peripherals: Common: Parameter Block No.	Common: Axis	Common: Address/Travel Value	Common: Commanded Speed	Common: Dwell Time	Common: M Code	Common: Torque Limit Value	Arc: Auxiliary Point	Arc: Radius	Arc: Center Point	Parameter Block: Control Unit	Parameter Block: Speed Limit Value	Parameter Block: Acceleration Time	Parameter Block: Deceleration Time	Parameter Block: Rapid Stop Deceleration Time	Parameter Block: Torque Limit Value	Parameter Block: Deceleration Processing on Stop Input	Parameter Block: Allowable Error Range for Circular Interpolation	Parameter Block: S Curve Ratio	Parameter Block:	Parameter Block:	Speed Change
ZERO	—	1		O																				

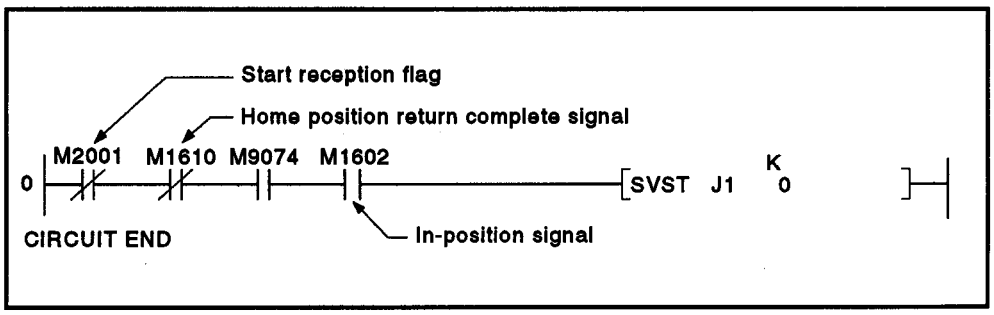
O : Must be set

[Control Details]

(1) Home position return is carried out using the method designated in the home position return data (see Section 7.21.1).
Refer to the following sections for details about the home position return methods:
- Near-zero point dog method ..... Section 7.21.2
- Count method..... Section 7.21.3
- Data set method..... Section 7.21.4

[Caution]

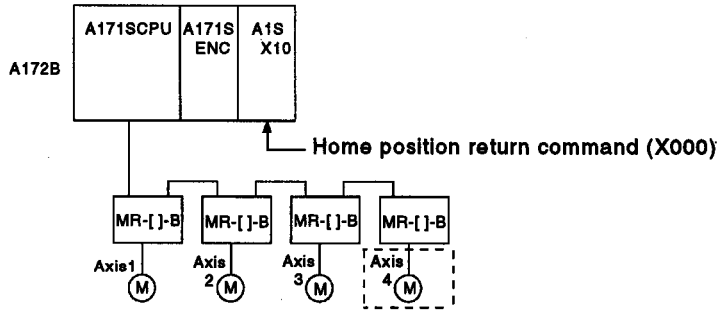
(1) If the following circuit conducts home position return using the near-zero point dog method after the PC ready flag (M2000) turns ON but before the PCPU ready flag (M9074) turns ON, another home position return request is issued after home position return is complete.
Therefore, apply interlock conditions to M9074 and X1602+20n (in-position signal) when carrying out a home position return.
(See program example.)



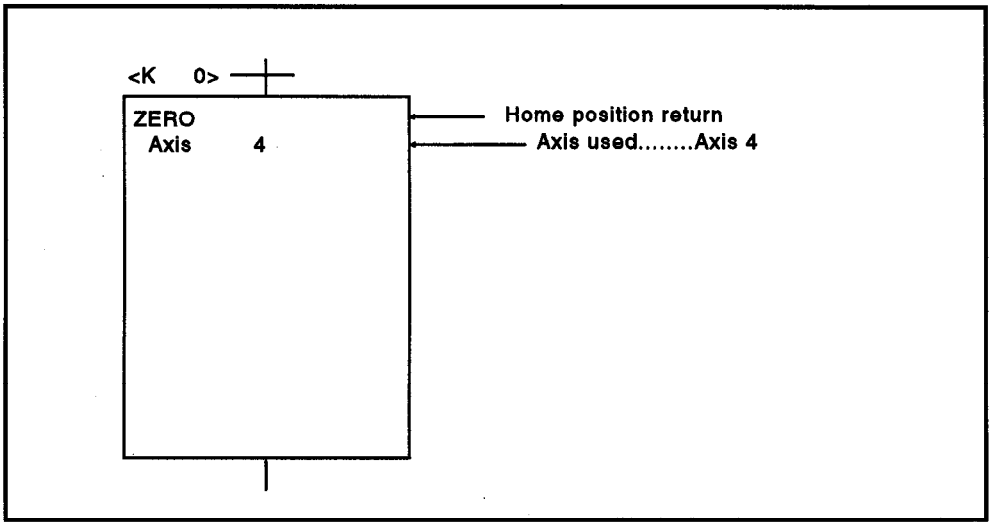
[Program Example]

This program carries out home position return using servo program No. 0, under the conditions below.

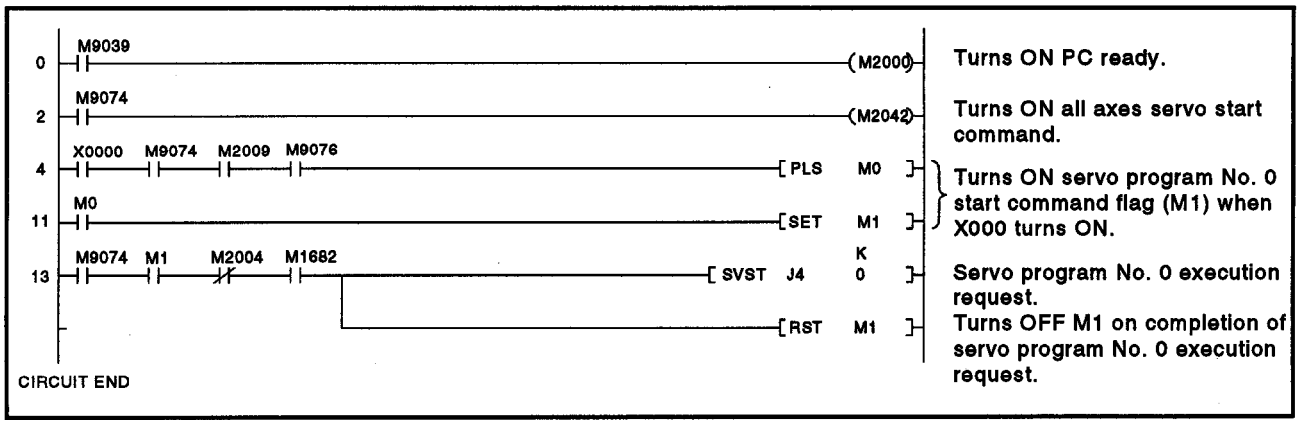
(1) System configuration
Home position return of Axis 4.



(2) Servo program example
Servo program No. 0 for home position return is shown below.



(3) Sequence program example
The sequence program which runs the servo program is shown below.



7.22 High-Speed Oscillation

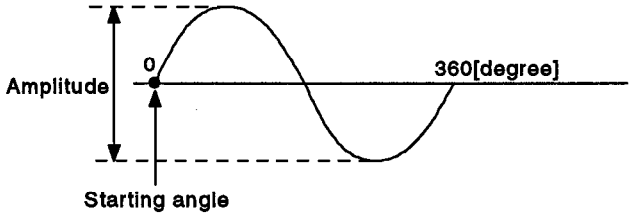
Positioning of a designated axis is performed on an oscillating sine wave.

Servo Instruction	Positioning Method	Number of Controllable Axes	Items Set by Peripherals: Common: Parameter Block No.	Common: Axis	Common: Address/Travel Value	Common: Commanded Speed	Common: Dwell Time	Common: M Code	Common: Torque Limit Value	Arc: Auxiliary Point	Arc: Radius	Arc: Center Point	Arc: Number of Pitches	Parameter Block: Control Unit	Parameter Block: Speed Limit Value	Parameter Block: Acceleration Time	Parameter Block: Deceleration Time	Parameter Block: Rapid Stop Deceleration Time	Parameter Block: Torque Limit Value	Parameter Block: Deceleration Processing at STOP Input	Parameter Block: Allowable Error Range for Circular Interpolation	Parameter Block: S ratio	Others: Cancel	Others: Start	Speed Change
OSC	—	1	Δ	O	O	O		Δ											Δ				Δ	Δ	NG

O : Must be set
Δ :Set if required

[Control details]

The designated axis is caused to oscillate on a designated sine wave.
Acceleration/deceleration processing is not performed.



(1) Amplitude
Designate the amplitude of the oscillation in the setting units.
The amplitude can be set in the range 1 to 2147483647.

(2) Starting angle
Set the angle on the sine curve at which oscillation is to start.
The setting range is 0 to 359.9 (degrees).

(3) Frequency
Set how many sine curve cycles occur in one minute.
The setting range is 1 to 5000 (CPM).

POINT

Since acceleration/deceleration processing is not performed, you should set the starting angle to 90 degrees or 270 degrees in order to avoid an abrupt start.

[Notes]

(1) If the amplitude setting is outside the permissible range, the servo program setting error "25" occurs and operation does not start.

(2) If the starting angle setting is outside the permissible range, the servo program setting error "26" occurs and operation does not start.

(3) If the frequency setting is outside the permissible range, the servo program setting error "27" occurs and operation does not start.

(4) After starting, operation is continually repeated until a stop signal is input.

(5) Speed changes during operation are not possible. Attempted speed changes will cause minor error "310".

[Example program]

An example of a program for high-speed oscillation is shown below.