CONTENTS

1. GENERAL DESCRIPTION .................................................. 1 - 1 - 1 - 22
   1.1 Positioning Control by the Servo System CPU ...................... 1 - 7
   1.2 Function Upgrades ..................................................... 1 - 18
      1.2.1 Improved present value management ......................... 1 - 20

2. PERFORMANCE SPECIFICATIONS ........................................... 2 - 1 - 2 - 2

3. POSITIONING SIGNALS .................................................. 3 - 1 - 3 - 73
   3.1 Axis Input/Output Signals ........................................... 3 - 2
      3.1.1 Positioning start completed signal (M1600+20n/Xn0/M2400+20n) ...... 3 - 5
      3.1.2 Positioning completed signal (M1601+20n/Xn1/M2401+20n) ............. 3 - 6
      3.1.3 In-position signal (M1602+20n/Xn2/M2402+20n) ..................... 3 - 7
      3.1.4 Command in-position signal (M1603+20n/Xn3/M2403+20n) ............. 3 - 7
      3.1.5 Speed control in progress signal (M1604+20n/Xn4/M2404+20n) ...... 3 - 8
      3.1.6 Speed/position switching latch signal (M1605+20n/Xn5/M2405+20n) .... 3 - 8
      3.1.7 Zero pass signal (M1606+20n/Xn6/M2406+20n) ..................... 3 - 9
      3.1.8 Error detection signal (M1607+20n/Xn7/M2407+20n) ................ 3 - 9
      3.1.9 Servo error detection signal (M1608+20n/Xn8/M2408+20n) ........... 3 - 9
      3.1.10 Home position return request signal (M1609+20n/Xn9/M2409+20n) .... 3 - 10
      3.1.11 Home position return completed signal (M1610+20n/XnA/M2410+20n) ... 3 - 10
      3.1.12 FLS signal (M1611+20n/XnB/M2411+20n) .......................... 3 - 10
      3.1.13 RLS signal (M1612+20n/XnC/M2412+20n) .......................... 3 - 11
      3.1.14 STOP signal (M1613+20n/XnD/M2413+20n) ....................... 3 - 11
      3.1.15 DOG/CHANGE signal (M1614+20n); when A171SCPU used .......... 3 - 11
      3.1.16 DOG signal (XnE/M2414+20n); when A273UHCPU (8/32-axis specification) is used .... 3 - 12
      3.1.17 Servo READY signal (M1615+20n/XnF/M2415+20n) .................. 3 - 12
      3.1.18 Torque control in progress signal (M1616+20n/XDn/M2416+20n) ...... 3 - 13
      3.1.19 CHANGE signal (XD8+n/M2417+20n); When A273UHCPU (8/32-axis specification) is used ...... 3 - 13
      3.1.20 Stop command (M1800+20n/Yn0/M3200+20n) ..................... 3 - 14
      3.1.21 Rapid stop command (M1801+20n/Yn1/M3201+20n) ................. 3 - 15
      3.1.22 Forward JOG start command (M1802+20n/Yn2/M3202+20n)/ Reverse JOG start command (M1803+20n/Yn3/M3203+20n) .................. 3 - 16
      3.1.23 End signal OFF command (M1804+20n/Yn4/M3204+20n) .............. 3 - 16
      3.1.24 Speed/position switching enable command (M1805+20n/Yn5/M3205+20n) .... 3 - 17
      3.1.25 Limit switch output enable command (M1806+20n/Yn6/M3206+20n) .......... 3 - 18
      3.1.26 Error reset command (M1807+20n/Yn7/M3207+20n)* ................ 3 - 18
      3.1.27 Servo error reset command (M1808+20n/Yn8/M3208+20n)* .......... 3 - 18
      3.1.28 External STOP input/invalid when starting command (M1809+20n/Yn9/M3209+20n) ........ 3 - 19
      3.1.29 Feed present value update request command (M1812+20n/YnC/M3212+20n) ...... 3 - 19
      3.1.30 Servo OFF command (M1815+20n/YnF/M3215+20n) .................. 3 - 19
3.1.31 FIN signal (M1819+20n/YC0+n/M3219+20n) ............................................. 3 – 20
3.1.32 M code output in progress signal (M1619+20n/XC0+n/M2419+20n) ......... 3 – 20

3.2 Internal Relays (M) ................................................................. 3 – 21

3.2.1 PC READY flag (M2000) ...................................................... 3 – 22
  ..... Signal sent from SCP to PCPU .................................................. 3 – 22
3.2.2 Start accept flag (M2001 to M2004/M2001 to M2008/M2001 to M2032) ...... 3 – 24
  ..... Signal sent from PCPU to SCP .............................................. 3 – 24
3.2.3 All axis servo start accept flag (M2009) ..................................... 3 – 26
  ..... Signal sent from PCPU to SCP .............................................. 3 – 26
3.2.4 Manual pulse generator enable flag (M2012/M2012 to M2014/M2051 to M2053) ... 3 – 26
  ..... Signal sent from SCP to PCPU .............................................. 3 – 26
3.2.5 JOG simultaneous start command (M2015/M2015/M2048) ................. 3 – 26
  ..... Signal sent from SCP to PCPU .............................................. 3 – 26
3.2.6 Speed switching point designation flag (M2016, M2040) .................. 3 – 27
  ..... Signal sent from SCP to PCPU .............................................. 3 – 27
3.2.7 Start buffer full (M2020/M2020/M2050) .................................... 3 – 27
  ..... Signal sent from PCPU to SCP .............................................. 3 – 27
3.2.8 Speed change flags (M2021+n/M2021+n/M2061+n) ....................... 3 – 28
  ..... Signal from PCPU to SCP ...................................................... 3 – 28
3.2.9 System setting error flag (M2041) .......................................... 3 – 28
  ..... Signal sent from PCPU to SCP .............................................. 3 – 28
3.2.10 All axes servo start command (M2042) ................................... 3 – 29
  ..... Signal from SCP to PCPU ...................................................... 3 – 29
3.2.11 Optional slot module error detection flag (M2047) ...................... 3 – 30
  ..... Signal from PCPU to SCP ...................................................... 3 – 30
3.2.12 Automatic deceleration in progress flag (M2128 to M2159): ....... 3 – 30
  when using an A273UHPCU (32 axis specification) ..................... 3 – 31
  ..... Signal sent from PCPU to SCP .............................................. 3 – 31
3.2.13 Speed change "0" accept flag : when A273UHPCU (32 axis specification) is used ...... Signal sent from PCPU to SCP ...... 3 – 32

3.3 Special Relays (SP.M) ......................................................... 3 – 35

3.3.1 WDT error flag (M9073) .................................................... 3 – 35
  ..... Signal sent from PCPU to SCP .............................................. 3 – 35
3.3.2 PCPU READY-completed flag (M9074) ................................... 3 – 35
  ..... Signal sent from PCPU to SCP .............................................. 3 – 35
3.3.3 In-test-mode (M9075) ......................................................... 3 – 36
  ..... Signal from PCPU to SCP ...................................................... 3 – 36
3.3.4 External emergency stop input flag (M9076) ................................ 3 – 36
  ..... Signal from PCPU to SCP ...................................................... 3 – 36
3.3.5 Manual pulse generator axis setting error flag (M9077) ............... 3 – 36
  ..... Signal sent from PCPU to SCP .............................................. 3 – 36
3.3.6 Test mode request error flag (M9078) .................................... 3 – 37
  ..... Signal sent from PCPU to SCP .............................................. 3 – 37
3.3.7 Servo program setting error flag (M9079) ................................ 3 – 37
  ..... Signal from PCPU to SCP ...................................................... 3 – 37

3.4 Data Registers (D) .............................................................. 3 – 38

3.4.1 Monitoring data area (D800 to D879/D800 to D959/D0 to D639) ....... 3 – 43
  ..... Data sent from PCPU to the SCP ............................................ 3 – 43
3.4.2 Data storage area for control change (D360 to D983/D360 to D1007/D640 to D703) ... 3 – 53
  ..... Data from the SCP to the PCPU ............................................. 3 – 53
3.4.3 Limit switch output disable setting register (D1008 to D1009/D1008 to D1011/D760 to D775) ...... 3 – 55
  ..... Data from the SCP to the PCPU ............................................. 3 – 55
3.4.4 Registers for setting axis numbers controlled by manual pulse generators (D1012/D1012 to D1014/D714 to D719) ...... 3 – 57
  ..... Data from the SCP to the PCPU ............................................. 3 – 57
3.4.5 JOG operation simultaneous start axis setting register (D1015/D1015/D710 to D713) ...... 3 – 58
  ..... Data from the SCP to the PCPU ............................................. 3 – 58
3.4.6 1 pulse input magnification setting registers for manual pulse generators
(D1016 to D1019/D1016 to D1023/D720 to D751)
..... Data from the SCPU to the PCPU .................................. 3 – 59
3.5 Special Register (SP.D) .................................................. 3 – 60
3.5.1 Limit switch output status storage area
(D9180 to D9181/D9180 to D9183/D776 to D791)
..... Data from the PCPU to the SCPU .................................. 3 – 63
3.5.2 PCPU error cause (D9184) ... Data from the PCPU to the SCPU .... 3 – 65
3.5.3 Servo amplifier classification
(D9185/D9185 to 9186/D792 to D799)
..... Data from the PCPU to the SCPU .................................. 3 – 67
3.5.4 Manual pulse generator axis setting error
(D9187/D9187/D9185 to D9187)
..... Data from the PCPU to the SCPU .................................. 3 – 68
3.5.5 Test mode request error
(D9188/D9188/D9182 to D9183)
..... Data from the PCPU to the SCPU .................................. 3 – 69
3.5.6 Error program No. (D9189) ..... Data from the PCPU to the SCPU .... 3 – 70
3.5.7 Error item information (D9190) ... Data from the PCPU to the SCPU .... 3 – 70
3.5.8 Servo amplifier installation information (D9191/D9191/D9191 to D9192)
..... Data from the PCPU to the SCPU .................................. 3 – 71
3.5.9 Area for setting the smoothing magnification for the manual pulse generator
(D9192/D9192 to D9194/D752 to D754)
..... Data from the SCPU to the PCPU .................................. 3 – 73

4. PARAMETERS FOR POSITIONING CONTROL .................................. 4 – 1 – 4 – 38

4.1 System Settings .......................................................... 4 – 2
4.2 Fixed Parameters .......................................................... 4 – 12
  4.2.1 Setting the number of pulses per revolution/travel value per revolution/
      unit magnification .................................................. 4 – 14
  4.2.2 Upper stroke limit value/low trunk stroke limit value .................. 4 – 16
  4.2.3 Command in-position range ........................................ 4 – 17
4.3 Servo Parameters ....................................................... 4 – 18
  4.3.1 ADU servo parameters
      (applicable only when using A273UHCP (8/32 axis specification)) .... 4 – 19
  4.3.2 MR-[ ]-B servo parameters ......................................... 4 – 21
  4.3.3 Position control gain 1, 2 ........................................ 4 – 26
  4.3.4 Position control gain 1, 2 ........................................ 4 – 27
  4.3.5 Speed integral compensation ..................................... 4 – 28
  4.3.6 In-position range .................................................. 4 – 28
  4.3.7 Feed forward gain .................................................. 4 – 28
  4.3.8 Load inertia ratio .................................................. 4 – 29
  4.3.9 Automatic tuning ................................................... 4 – 29
  4.3.10 Servo responsiveness setting .................................... 4 – 30
  4.3.11 Notch filter ...................................................... 4 – 31
  4.3.12 Electromagnetic brake sequence .................................. 4 – 31
  4.3.13 Monitor output mode .............................................. 4 – 31
  4.3.14 Optional function 1 (carrier frequency selection) .................. 4 – 31
  4.3.15 Optional function 2 (no-motor operation selection) ............... 4 – 32
  4.3.16 Monitor output 1, 2 offset ....................................... 4 – 33
  4.3.17 Pre-alarm data selection ....................................... 4 – 33
4.3.18 Zero speed .................................................. 4 – 34
4.3.19 Excessive error alarm level .................................. 4 – 34
4.3.20 Optional function 5 ........................................... 4 – 34
4.3.21 PI-PID switching position droop ......................... 4 – 34
4.3.22 Torque control compensation factor .................... 4 – 34
4.3.23 Speed differential compensation ........................ 4 – 34

4.4 Parameter Block ............................................... 4 – 35
4.4.1 Relationships among the speed limit value, acceleration time, deceleration time, and rapid stop deceleration time ... 4 – 37
4.4.2 S curve ratio ................................................... 4 – 37
4.4.3 Allowable error range for circular interpolation ........ 4 – 38

5. SEQUENCE PROGRAMS AND SFC PROGRAMS .................. 5 – 1 ~ 5 – 21

5.1 Cautions on Creating a Sequence Program or SFC Program .................................................. 5 – 1
5.2 Servo Program Start Request Instruction (DSFRP/SVST) .................................................. 5 – 3
5.2.1 Start request instruction for 1 to 3 axes (DSFRP): when using A171/SCPU/A273UH CPU (8 axis specification) .. 5 – 3
5.2.2 Start request instruction for 1 to 4/1 to 8 axes (SVST) .................................................. 5 – 6
5.3 Present Value Change and Speed Change Instructions (DSFLP/CHGA, CHGV) .......................... 5 – 9
5.3.1 DSFLP instruction (when using A171S/A273UH CPU (8-axis specification)) ................................ 5 – 9
5.3.2 CHGA/CHGV instructions ................................... 5 – 13
5.4 SFC Programs .................................................... 5 – 17
5.4.1 Starting and stopping SFC programs ....................... 5 – 17
5.4.2 Servo program start request ................................ 5 – 18

6. SERVO PROGRAMS FOR POSITIONING CONTROL ................... 6 – 1 ~ 6 – 16

6.1 Servo Program Composition and Area .................................................. 6 – 1
6.1.1 Servo program composition .................................. 6 – 1
6.1.2 Servo program area ........................................... 6 – 2
6.2 Servo Instructions ................................................ 6 – 3
6.3 Positioning Data ................................................ 6 – 8
6.4 Method for Setting Positioning Data ......................... 6 – 12
6.4.1 Setting by designating numerical values .................. 6 – 12
6.4.2 Setting by using word devices (D, W) ....................... 6 – 13
6.5 Creating Sequence Programs to Start Servo Programs .................................................. 6 – 14
6.5.1 Case where the servo program is executed once only .................................................. 6 – 14
6.5.2 Case where different servo programs are executed consecutively .................................. 6 – 15
6.5.3 Case where the same servo program is executed repeatedly .................................. 6 – 16

7. POSITIONING CONTROL ............................................. 7 – 1 ~ 7 – 149

7.1 Basics of Positioning Control ................................... 7 – 1
7.1.1 Positioning speed ........................................... 7 – 1
7.1.2 Positioning speed under interpolation control ........ 7 – 2
7.1.3 Control units for one-axis positioning control .......... 7 – 7
7.1.4 Control units for interpolation control .................... 7 – 7
7.1.5 Control using degrees as control units .................... 7 – 9
7.1.6 Stop processing and restarting after a stop ........................................ 7 – 12
7.1.7 Acceleration and deceleration processing ........................................ 7 – 18
7.2 One-Axis Linear Positioning Control .................................................. 7 – 20
7.3 Two-Axis Linear Interpolation Control ............................................... 7 – 24
7.4 Three-Axis Linear Interpolation Control ............................................ 7 – 29
7.5 Four-Axis Linear Interpolation Control .............................................. 7 – 34
7.6 Circular Interpolation Using Auxiliary Point Designation ...................... 7 – 38
7.7 Circular Interpolation Using Radius Designation .................................. 7 – 42
7.8 Circular Interpolation Using Center Point Designation ........................ 7 – 48
7.9 One-Axis Fixed-Pitch Feed Control .................................................... 7 – 53
7.10 Fixed-Pitch Feed Control Using Two-Axis Linear Interpolation .............. 7 – 56
7.11 Fixed-Pitch Feed Control Using Three-Axis Linear Interpolation .......... 7 – 59
7.12 Speed Control (I) ............................................................................. 7 – 62
7.13 Speed Control (II) ............................................................................ 7 – 66
7.14 Speed/Position Switching Control ....................................................... 7 – 69
    7.14.1 Starting speed/position switching control ................................... 7 – 69
    7.14.2 Restarting speed/position switching control ............................... 7 – 76
7.15 Speed-Switching Control .................................................................... 7 – 81
    7.15.1 Starting speed-switching control, speed-switching points, end designation 7 – 81
    7.15.2 Setting speed-switching points using repeat instructions ............. 7 – 88
7.16 Constant-Speed Control ..................................................................... 7 – 93
    7.16.1 Setting pass points using repeated instructions .......................... 7 – 97
    7.16.2 Speed switching during instruction execution .............................. 7 – 102
    7.16.3 One-axis constant-speed control .............................................. 7 – 106
    7.16.4 Two- to four-axis constant-speed control .................................. 7 – 110
    7.16.5 Pass point skip function ........................................................... 7 – 117
    7.16.6 FIN signal wait function ............................................................ 7 – 118
7.17 Position Follow-Up Control ................................................................ 7 – 120
7.18 Simultaneous Start ............................................................................ 7 – 124
7.19 JOG Operation .................................................................................. 7 – 127
    7.19.1 JOG operation data .................................................................... 7 – 127
    7.19.2 Individual start .......................................................................... 7 – 128
    7.19.3 Simultaneous start ..................................................................... 7 – 131
7.20 Manual Pulse Generator Operation ...................................................... 7 – 133
7.21 Home Position Return ........................................................................ 7 – 140
    7.21.1 Home position return data ........................................................ 7 – 140
    7.21.2 Home position return by the near-zero point dog method .......... 7 – 142
    7.21.3 Home position return by the count method ............................... 7 – 144
    7.21.4 Home position return by the data set method ............................ 7 – 145
    7.21.5 Home position return servo program ....................................... 7 – 146
7.22 High-Speed Oscillation ..................................................................... 7 – 148

8. AUXILIARY AND APPLIED FUNCTIONS ............................................ 8 – 1 – 8 – 26

8.1 Limit Switch Output Function ............................................................. 8 – 2
    8.1.1 Limit switch output data ............................................................ 8 – 2
    8.1.2 Limit switch output function ...................................................... 8 – 2
8.2 M Code Output Function ........................................... 8 – 4
8.3 Backlash Compensation Function ................................ 8 – 6
8.4 Torque Limit Function ................................................ 8 – 8
8.5 Electronic Gear Function .......................................... 8 – 10
8.6 Absolute Positioning System ..................................... 8 – 12
8.7 Speed Change ........................................................... 8 – 15
8.8 Present Value Change ................................................. 8 – 18
8.9 Skip Function ............................................................ 8 – 22
8.10 Teaching Function ...................................................... 8 – 23
8.11 High-Speed Reading of Designated Data ..................... 8 – 24
8.12 Servo Program Cancel/Start Function ......................... 8 – 25

APPENDICES ............................................................... APP – 1 ~ APP – 90

APPENDIX 1 SCPU ERROR CODE LIST .................................. APP – 1
  1.1 SCPU Error Code List .............................................. APP – 1

APPENDIX 2 ERROR CODES STORED BY THE PCPU ............ APP – 4
  2.1 Servo Program Setting Errors ................................... APP – 7
  2.2 Minor Errors .......................................................... APP – 10
  2.3 Major Errors .......................................................... APP – 17
  2.4 Servo Errors ........................................................... APP – 21
  2.5 LED Indications when Errors Occur at the PCPU ........... APP – 33

APPENDIX 3 Special Relays and Special Registers ............... APP – 36
  3.1 Special Relays (SP, M) .............................................. APP – 36
  3.2 Special Registers (SP.D) ............................................ APP – 43

APPENDIX 4 EXAMPLE PROGRAMS ....................................... APP – 63
  4.1 Word Data 1 Word Shift to Left ................................ APP – 63
  4.2 Word Data 1 Word Shift to Right ................................ APP – 65
  4.3 Reading M Codes ...................................................... APP – 67
  4.4 Error Code Reading .................................................. APP – 68

APPENDIX 5 RATED MOTOR SPEED AND NUMBER OF FEEDBACK PULSES
FOR EACH SERVOMOTOR TYPE .................................. APP – 69

APPENDIX 6 SIGNALS FOR POSITIONING .......................... APP – 70
  6.1 Internal Relays ....................................................... APP – 70
  6.2 Data Registers (D) .................................................. APP – 80

APPENDIX 7 PROCESSING TIMES ....................................... APP – 87
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. POSITIONING CONTROL

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 (D1 to D4) to calculate the positioning speed of each axis (V1 to V4) 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:
D1 = 10,000 (pulses)
Axis 2 travel value:
D2 = 15,000 (pulses)
Resultant speed:
V = 7,000 (pulse/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: \( V_2 = V \times D_2 \sqrt{D_1^2 + D_2^2} \)
7. POSITIONING CONTROL

(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 (D1 to D4) to calculate the positioning speed of each axis (V1 to V4). Set the long-axis speed and the travel value of each axis in the servo program.

Example

4-axis linear interpolation control

<table>
<thead>
<tr>
<th>Axis 1 travel value:</th>
<th>D1 = 10,000 pulses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axis 2 travel value:</td>
<td>D2 = 15,000 pulses</td>
</tr>
<tr>
<td>Axis 3 travel value:</td>
<td>D3 = 5,000 pulses</td>
</tr>
<tr>
<td>Axis 4 travel value:</td>
<td>D4 = 20,000 pulses</td>
</tr>
</tbody>
</table>

Long-axis speed:
\( V = 7,000 \text{ pulse/sec} \)

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: \( V_1 = \frac{D1}{D4} \times V \)
- Axis 2 positioning speed: \( V_2 = \frac{D2}{D4} \times V \)
- Axis 3 positioning speed: \( V_3 = \frac{D3}{D4} \times V \)

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 \( \times 25.4 = \text{mm set value} \).
      - 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 \( \div 25.4 \)
      - 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.
7. POSITIONING CONTROL

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.

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 (D1 to D4) to calculate the positioning speed of each axis (V1 to V4) 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

<table>
<thead>
<tr>
<th>Axis</th>
<th>Travel Value</th>
<th>Positioning Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>10,000 pulses</td>
<td></td>
</tr>
<tr>
<td>D2</td>
<td>15,000 pulses</td>
<td></td>
</tr>
<tr>
<td>D3</td>
<td>5,000 pulses</td>
<td></td>
</tr>
<tr>
<td>D4</td>
<td>20,000 pulses</td>
<td></td>
</tr>
</tbody>
</table>

Reference axis speed: V = 7,000 pulse/sec.
Reference axis number: Axis 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:

<table>
<thead>
<tr>
<th>Axis</th>
<th>Positioning Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axis 1</td>
<td>( V_1 = \frac{D_1}{D_4} \times V )</td>
</tr>
<tr>
<td>Axis 2</td>
<td>( V_2 = \frac{D_2}{D_4} \times V )</td>
</tr>
<tr>
<td>Axis 3</td>
<td>( V_3 = \frac{D_3}{D_4} \times V )</td>
</tr>
</tbody>
</table>

[Program Example]

<table>
<thead>
<tr>
<th>ABS-4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axis 1, 10000 (PLS)</td>
</tr>
<tr>
<td>Axis 2, 15000 (PLS)</td>
</tr>
<tr>
<td>Axis 3, 5000 (PLS)</td>
</tr>
<tr>
<td>Axis 4, 20000 (PLS)</td>
</tr>
</tbody>
</table>

Reference axis speed: 7000 (PLS/sec)
Reference axis number: 4
7. POSITIONING CONTROL

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.

![Diagram showing relationship between speed, time, and deceleration](image)

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

![Diagram showing circular interpolation](image)
7. POSITIONING CONTROL

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.

<table>
<thead>
<tr>
<th>Interpolation Control Units in Parameter Block</th>
<th>Start Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td>inch</td>
</tr>
<tr>
<td>Normal start conditions</td>
<td></td>
</tr>
<tr>
<td>Fixed parameters designate mm and inch control units for axes.</td>
<td>Control started using interpolation control units designated in the parameter block.</td>
</tr>
</tbody>
</table>
| 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.

<table>
<thead>
<tr>
<th>mm</th>
<th>Inch</th>
<th>Degree</th>
<th>PULSE</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td>1)</td>
<td>2)</td>
<td>3)</td>
<td>3)</td>
</tr>
<tr>
<td>inch</td>
<td>2)</td>
<td>1)</td>
<td>3)</td>
<td>3)</td>
</tr>
<tr>
<td>degree</td>
<td>3)</td>
<td>3)</td>
<td>1)</td>
<td>3)</td>
</tr>
<tr>
<td>PULSE</td>
<td>3)</td>
<td>3)</td>
<td>3)</td>
<td>1)</td>
</tr>
</tbody>
</table>

(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.
7. POSITIONING CONTROL

(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. POSITIONING CONTROL

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°.

![Diagram showing 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.

![Diagram showing stroke limit settings]

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
### 7. POSITIONING CONTROL

| POINT | The incremental method permits positioning in excess of 360°. |
7. POSITIONING CONTROL

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
(Process 1) stop deceleration time parameter in the parameter block.

![Diagram of stop processing process 1]

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

![Diagram of stop processing process 2]
7. POSITIONING CONTROL

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:
   \[\text{Process 1} < \text{Process 2} < \text{Process 3}\]

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.

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

\(^1\): 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 outputting 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.

```
<K 10>
INC-2
Axis 1, D 0
Axis 2, D 2
Resultant speed 5000
```
7. POSITIONING CONTROL

[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. POSITIONING CONTROL

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.

   ![Trapezoidal Diagram]

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.

   ![S-curve Diagram]

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.

   ![S-curve Ratio Diagram]
7. POSITIONING CONTROL

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.

<table>
<thead>
<tr>
<th>Word Device</th>
<th>CPU</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>0 to 799</td>
</tr>
<tr>
<td>W</td>
<td>0 to 3FF</td>
</tr>
</tbody>
</table>

*1: Excluding 800 to 1023

---

7 – 19
7. POSITIONING CONTROL

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.

<table>
<thead>
<tr>
<th>Servo Instruction</th>
<th>Positioning Method</th>
<th>Number of Controllable Axes</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABS-1</td>
<td>Absolute data</td>
<td>1</td>
</tr>
<tr>
<td>INC-1</td>
<td>Incremental</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item Set by Peripherals</th>
<th>Common</th>
<th>Arc</th>
<th>Parameter Block</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter Block No.</td>
<td>Axis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Address/Travel Value</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commanded Speed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dead Time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M Code</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Torque Limit Value</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auxiliary Point</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radius</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Center Point</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Limits</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed Limit Value</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acceleration Time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deceleration Time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Torque Limit Value</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slow Start Processing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allowable Error Range</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-Curve Ratio</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Start</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed Change</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(\Delta\) : Must be set
\(\Delta\) : 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](image)

---

7 - 20
7. POSITIONING CONTROL

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)

--- Example ---

The travel direction is shown below if the present stop address is -3000, and the travel value is -5000.

--- Figure 7.2 Positioning by Incremental Method ---
7. POSITIONING CONTROL

[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.

- M0059
- M0074
- X000 M0074 M0009 M0076
- M0
- M01
- M0974 M1 M2004
- SVST J4 K 0
- RST M1

CIRCUIT END

Turns ON PC ready.
Turns ON all axes servo start command.
Turns ON servo program No. 0 start command flag (M1) when X000 turns OFF → ON.
Servo program No. 0 execution request.
Turns OFF M1 on completion of servo program No. 0 execution request.
7. POSITIONING CONTROL

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.

<table>
<thead>
<tr>
<th>Servo Instruction</th>
<th>Positioning Method</th>
<th>Number of Controllable Axes</th>
<th>Items Set by Peripherals</th>
<th>Parameter Block</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Common</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ABS-2</td>
<td>Absolute data</td>
<td>2</td>
<td>Δ</td>
<td>Δ</td>
<td>Δ</td>
</tr>
<tr>
<td>INC-2</td>
<td>Incremental</td>
<td>2</td>
<td>Δ</td>
<td>Δ</td>
<td>Δ</td>
</tr>
</tbody>
</table>

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 (X1, Y1) to the designated address (X2, Y2), using the home position as the reference.

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

Example

The travel direction is shown below if the present stop address is (1000, 4000) and the designated stop address is (10000, 2000).

Y-axis travel value
(4000-2000=2000)

Present address

Stop address

Y-axis travel value
(10000-1000=9000)

Figure 7.3 Positioning by Absolute Data Method
7. POSITIONING CONTROL

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)

--- Example

The travel direction is shown below for an X-axis travel value of 6000 and Y-axis travel value of -2000.

---

Figure 7.4 Positioning by Incremental Method
7. POSITIONING CONTROL

[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.

<table>
<thead>
<tr>
<th>Item</th>
<th>Servo Program Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positioning speed</td>
<td>30000</td>
</tr>
</tbody>
</table>

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

(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.

| 0 | M8039       | (M2000) |
| 2 | M8074       | (M2042) |
| 4 | X000 M8074 M2009 M9076 | [PLB M0] |
| 11 | M0          | [SET M1] |
| 13 | M1 M8074 M2003 M2004 | [SVST J34 K11] |
|    |             | [RBT M1] |

CIRCUIT END

Turns ON PC ready.
Turns ON all axes servo start command.
Turns ON servo program No. 11 start command flag (M1) when X000 turns OFF → ON.
Servo program No. 11 execution request.
Turns OFF M1 on completion of servo program No. 11 execution request.
7. POSITIONING CONTROL

### 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.

<table>
<thead>
<tr>
<th>Servo Instruction</th>
<th>Positioning Method</th>
<th>Number of Controllable Axes</th>
<th>Items Set by Peripherals</th>
<th>Parameter Block</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Common</td>
<td>Arc</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Parameter Block Ref.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Axis</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Address/Travel Value</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Commanded Speed</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dead Time</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>M Code</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Torque Limit Value</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Auxiliary Point</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Center Point</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Control Units</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Speed Limit Value</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Acceleration Time</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Deceleration Time</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rapid Deceleration Time</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Torque Limit Value</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Deceleration Processing</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>on Stop Input</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Allowable Error Range</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>for Circles Interpolation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>S-Curves Ratio</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cancel</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Start</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Speed Change</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ABS-3</td>
<td>Absolute data</td>
<td>3</td>
<td>O</td>
<td>O</td>
<td>A</td>
</tr>
<tr>
<td>INC-3</td>
<td>Incremental</td>
<td>3</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
</tbody>
</table>

O: Must be set  
A: Set if required

**[Control Details]**

**Control with ABS-3 (absolute data method)**

1. Linear interpolation with three axes from the present stop address (X1, Y1, Z1) to the designated address (X2, Y2, Z2), using the home position as the reference.

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

The travel direction is shown below if the present stop address is (1000, 2000, 1000) and the designated address is (4000, 8000, 4000).

Figure 7.5 Positioning by Absolute Data Method
7. POSITIONING CONTROL

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
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.

<table>
<thead>
<tr>
<th>Item</th>
<th>Servo Program Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positioning method</td>
<td>Absolute data</td>
</tr>
<tr>
<td>Positioning speed</td>
<td>1000</td>
</tr>
</tbody>
</table>

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

(4) Operation timing
The operation timing for 3-axis linear interpolation control is shown below.

![Graph showing operation timing]

- PC ready (M2000)
- All axes servo start command (M2042)
- All-axis servo start accept flag (M2000)
- Positioning start command (X000)
- SVST instruction
- Axis 1 start accept flag (M2001)
- Axis 2 start accept flag (M2002)
- Axis 3 start accept flag (M2003)

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

![Graph showing servo program]

- ABS-3
- Axis 1, 50000
- Axis 2, 40000
- Axis 3, 30000
- Resultant speed 1000

3-axis linear interpolation control
- Axis used............ Axis 1, Axis 2, Axis 3
- Positioning address
- Axis 1........... 50000
- Axis 2........... 40000
- Axis 3........... 30000
- Commanded positioning speed
- Resultant speed...... 1000

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

![Sequence program]

| M0039 | | | | | (M2000) |
|-------|----------------------|----------------------|
| M0074 | | | | | (M2042) |
| X000 M0074 M2009 M9076 | | | | | PLS M21 |
| M21 | | | | | SET M23 |
| M9074 M23 M2001 M2002 M2003 | | | | | SVST J1 J2 J3 21 |
| | | | | | RST M23 |

CIRCUIT END

- Turns ON PC ready.
- Turns ON all axes servo start command.
- Turns ON servo program No. 21 start command flag (M23) when X000 turns OFF → ON.
- Servo program No. 21 execution request.
- Turns OFF M23 on completion of servo program No. 21 execution request.
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.

<table>
<thead>
<tr>
<th>Servo Instruction</th>
<th>Positioning Method</th>
<th>Number of Controllable Axes</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABS-4</td>
<td>Absolute data</td>
<td>4</td>
</tr>
<tr>
<td>INC-4</td>
<td>Incremental</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter Block No.</td>
<td>Δ</td>
<td>O</td>
<td>O</td>
<td>Δ</td>
<td>Δ</td>
<td>Δ</td>
<td>Δ</td>
<td>Δ</td>
<td>Δ</td>
<td>Δ</td>
<td>Δ</td>
<td>Δ</td>
<td>Δ</td>
<td>Δ</td>
<td>Δ</td>
<td>OK</td>
</tr>
</tbody>
</table>

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

![Four-axis linear interpolation diagram](image)
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.

<table>
<thead>
<tr>
<th>Item</th>
<th>Servo Program Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 22</td>
<td></td>
</tr>
<tr>
<td>Positioning method</td>
<td>Incremental</td>
</tr>
<tr>
<td>Positioning speed</td>
<td>1000</td>
</tr>
</tbody>
</table>

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

(4) Operation timing
The operation timing for 4-axis linear Interpolation control is shown below.
7. POSITIONING CONTROL

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

```
< K 22 >

INC-4
Axis 1, 3000
Axis 2, 4000
Axis 3, 4000
Axis 4, 4000
Resultant speed 10000
```

- 4-axis linear interpolation control
  - Axis used............ Axis 1, Axis 2, Axis 3, Axis 4
  - Positioning address
    - Axis 1........... 3000
    - Axis 2........... 4000
    - Axis 3........... 4000
    - Axis 4........... 4000

- Commanded positioning speed
  - Resultant speed..... 10000

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

```
0 M9039
  M9074
  X000 M9074 M2009 M9076
  M21
  11 JF JF JF JF JF
  13 JF JF JF JF JF

CIRCUIT END
```

- (M2000)
  - Turns ON PC ready.
- (M2042)
  - Turns ON all axes servo start command.
- PLS M21
  - Turns ON servo program No. 22 start command flag (M23) when X000 turns OFF → ON.
- SET M23
  - Servo program No. 22 execution request.
- SVST J1/2/3/4 K 22
  - Turns OFF M23 on completion of servo program No. 22 execution request.
- JF M23
  -
7. POSITIONING CONTROL

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 \( \Delta \) (absolute data method) and INC \( \Delta \) (incremental method) servo instructions.

<table>
<thead>
<tr>
<th>Servo Instruction</th>
<th>Positioning Method</th>
<th>Number of Controllable Axes</th>
<th>Parameter Block No.</th>
<th>Address/Travel Value</th>
<th>Commanded Speed</th>
<th>M Code</th>
<th>Torque Limit Value</th>
<th>Auxiliary Point</th>
<th>Center Point</th>
<th>Control Units</th>
<th>Speed Limit Value</th>
<th>Deceleration Time</th>
<th>Deceleration Processing or Step Input</th>
<th>Torque Limit Value</th>
<th>Allowable Error Range for Circular Interpolation</th>
<th>Braking Ratio</th>
<th>Cancel</th>
<th>Start</th>
<th>Speed Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABS ( \Delta )</td>
<td>Absolute data</td>
<td>2</td>
<td>( \Delta )</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>( \Delta )</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>INC ( \Delta )</td>
<td>Incremental</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

0: Must be set
\( \Delta \): Set if required

[Control Details]

Control with ABS \( \Delta \) (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.

![Circular Interpolation Control by Absolute Data Method](image)

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 Δ (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.

<table>
<thead>
<tr>
<th>Item</th>
<th>Servo Program Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positioning method</td>
<td>Absolute data</td>
</tr>
<tr>
<td>Positioning speed</td>
<td>1000</td>
</tr>
</tbody>
</table>

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

(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.

Table:

<table>
<thead>
<tr>
<th>M9039</th>
<th>(M2000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M9074</td>
<td>(M2042)</td>
</tr>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>X000</td>
<td>M9074</td>
</tr>
<tr>
<td>M9099</td>
<td>M9076</td>
</tr>
<tr>
<td>4</td>
<td>M31</td>
</tr>
<tr>
<td>11</td>
<td>[SET M33]</td>
</tr>
<tr>
<td>13</td>
<td>[SVST J1]</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[RST M33]</td>
</tr>
</tbody>
</table>

- Turns ON PC ready.
- Turns ON all axes servo start command.
- Turns ON servo program No. 31 start command flag (M33) when X000 turns OFF → ON.
- Servo program No. 31 execution request.
- Turns OFF M33 on completion of servo program No. 31 execution request.
## 7. POSITIONING CONTROL

### 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.

<table>
<thead>
<tr>
<th>Servo Instruction</th>
<th>Positioning Method</th>
<th>Number of Controllable Axes</th>
<th>Items Set by Peripherals</th>
<th>Parameter Block</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Common</td>
<td>Arc</td>
<td>Acceleration Time</td>
</tr>
<tr>
<td>ABS ↗</td>
<td>Absolute data</td>
<td>2</td>
<td>∆ O O O ∆ ∆</td>
<td>O</td>
<td>∆ ∆ ∆ ∆ ∆ ∆ ∆ ∆</td>
</tr>
<tr>
<td>ABS ↘</td>
<td>Absolute data</td>
<td>2</td>
<td>∆ O O O ∆ ∆</td>
<td>O</td>
<td>∆ ∆ ∆ ∆ ∆ ∆ ∆ ∆</td>
</tr>
<tr>
<td>ABS ↖</td>
<td>Absolute data</td>
<td>2</td>
<td>∆ O O O ∆ ∆</td>
<td>O</td>
<td>∆ ∆ ∆ ∆ ∆ ∆ ∆ ∆</td>
</tr>
<tr>
<td>ABS ↙</td>
<td>Absolute data</td>
<td>2</td>
<td>∆ O O O ∆ ∆</td>
<td>O</td>
<td>∆ ∆ ∆ ∆ ∆ ∆ ∆ ∆</td>
</tr>
<tr>
<td>INC ↗</td>
<td>Incremental</td>
<td>2</td>
<td>∆ O O O ∆ ∆</td>
<td>O</td>
<td>∆ ∆ ∆ ∆ ∆ ∆ ∆ ∆</td>
</tr>
<tr>
<td>INC ↘</td>
<td>Incremental</td>
<td>2</td>
<td>∆ O O O ∆ ∆</td>
<td>O</td>
<td>∆ ∆ ∆ ∆ ∆ ∆ ∆ ∆</td>
</tr>
<tr>
<td>INC ↖</td>
<td>Incremental</td>
<td>2</td>
<td>∆ O O O ∆ ∆</td>
<td>O</td>
<td>∆ ∆ ∆ ∆ ∆ ∆ ∆ ∆</td>
</tr>
<tr>
<td>INC ↙</td>
<td>Incremental</td>
<td>2</td>
<td>∆ O O O ∆ ∆</td>
<td>O</td>
<td>∆ ∆ ∆ ∆ ∆ ∆ ∆ ∆</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Instruction</th>
<th>Servomotor Direction of Rotation</th>
<th>Max. Controllable Angle of Arc</th>
<th>Positioning Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABS ⏯</td>
<td>Clockwise</td>
<td>$0^\circ &lt; \theta &lt; 180^\circ$</td>
<td><img src="https://example.com/positioning_path.png" alt="Positioning path" /></td>
</tr>
<tr>
<td>INC ⏯</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ABS ⏯</td>
<td>Counterclockwise</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INC ⏯</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ABS ⏯</td>
<td>Clockwise</td>
<td>$180^\circ &lt; \theta &lt; 360^\circ$</td>
<td><img src="https://example.com/positioning_path.png" alt="Positioning path" /></td>
</tr>
<tr>
<td>INC ⏯</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ABS ⏯</td>
<td>Counterclockwise</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INC ⏯</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Control with ABSeft, ABSeft, ABSeft, and ABSeft (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](image)

(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](image)
Control with INC⁺, INC⁻, INC₀, and INCₜ (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.

![Diagram](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 $2^{32}-1$.

![Diagram](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.

   ![Diagram of system configuration]

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

   ![Diagram of positioning details]

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

<table>
<thead>
<tr>
<th>Item</th>
<th>Servo Program Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positioning method</td>
<td>Absolute data</td>
</tr>
<tr>
<td>Positioning speed</td>
<td>1000</td>
</tr>
</tbody>
</table>

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

(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.

<table>
<thead>
<tr>
<th>M9039</th>
<th>(M2000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M9074</td>
<td>(M2042)</td>
</tr>
<tr>
<td>X000</td>
<td>M9074 M9009 M9076</td>
</tr>
<tr>
<td>M41</td>
<td>[PLS M41]</td>
</tr>
<tr>
<td>M43</td>
<td>[SET M43]</td>
</tr>
<tr>
<td>M9074 M43 M2001 M2002</td>
<td>[SVST J12 K41]</td>
</tr>
<tr>
<td></td>
<td>[CIRCUIT END]</td>
</tr>
</tbody>
</table>

CIRCUIT END

-

Turns ON PC ready.
Turns ON all axes servo start command.
Turns ON servo program No. 41 start command flag (M43) when X000 turns OFF → ON.
Servo program No. 41 execution request.
Turns OFF M43 on completion of servo program No. 41 execution request.
7. POSITIONING CONTROL

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.

<table>
<thead>
<tr>
<th>Servo Instruction</th>
<th>Positioning Method</th>
<th>Number of Controllable Axes</th>
<th>Parameter Block No.</th>
<th>Items Set by Peripherals</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABS ▲</td>
<td>Absolute data</td>
<td>2</td>
<td>△ O O A A</td>
<td>Common</td>
</tr>
<tr>
<td>ABS ▼</td>
<td>Incremental</td>
<td>2</td>
<td>△ O O A A</td>
<td>Arc</td>
</tr>
<tr>
<td>INC ▲</td>
<td>Incremental</td>
<td>2</td>
<td>△ O O A A</td>
<td>Parameter Block</td>
</tr>
<tr>
<td>INC ▼</td>
<td>Incremental</td>
<td>2</td>
<td>△ O O A A</td>
<td>Others</td>
</tr>
</tbody>
</table>

△: Must be set
△: Set if required

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

<table>
<thead>
<tr>
<th>Instruction</th>
<th>Servomotor Direction of Rotation</th>
<th>Max. Controllable Angle of Arc</th>
<th>Positioning Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABS ▲</td>
<td>Clockwise</td>
<td>0° ≤ θ ≤ 360°</td>
<td>Positioning path</td>
</tr>
<tr>
<td>INC ▲</td>
<td>Counterclockwise</td>
<td>0° ≤ θ ≤ 360°</td>
<td>Positioning path</td>
</tr>
<tr>
<td>ABS ▼</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INC ▼</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7 – 48
(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.

![Circular Interpolation Control by Absolute Data Method](image)

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.

![Positioning Control of a Full Circle](image)

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 $2^{31}-1$.
Control with INC\(^{\wedge}\) and INC\(^{\wedge}\) (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.

![Diagram of Circular Interpolation Control by Incremental Method](image)

**Figure 7.19** Circular Interpolation Control by Incremental Method (INC\(^{\wedge}\))

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

![Diagram of Positioning Control of a Full Circle](image)

**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 ±\(2^{31}-1\).

(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.

![Diagram of Maximum Arc Radius](image)

**Figure 7.21** Maximum Arc Radius
7. POSITIONING CONTROL

[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.

<table>
<thead>
<tr>
<th>Item</th>
<th>Servo Program Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positioning method</td>
<td>Absolute data</td>
</tr>
<tr>
<td>Positioning speed</td>
<td>1000</td>
</tr>
</tbody>
</table>

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

(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.

<table>
<thead>
<tr>
<th>M9039</th>
<th>(M2000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M9074</td>
<td>(M2042)</td>
</tr>
<tr>
<td>4</td>
<td>M9074 M9009 M9076</td>
</tr>
<tr>
<td>11</td>
<td>SET M53</td>
</tr>
<tr>
<td>13</td>
<td>M9074 M53 M2001 M2002</td>
</tr>
</tbody>
</table>

CIRCUIT END

Turns ON PC ready.
Turns ON all axes servo start command.
Turns ON servo program No. 51 start command flag (M53) when X000 turns OFF → ON.
Servo program No. 51 execution request.
Turns OFF M53 on completion of servo program No. 51 execution request.
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.

<table>
<thead>
<tr>
<th>Serve Instruction</th>
<th>Positioning Method</th>
<th>Number of Controllable Axes</th>
<th>Items Set by Peripherals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Common</td>
</tr>
<tr>
<td></td>
<td>Incremental</td>
<td>1</td>
<td>D O O O A A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Parameter Block</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>D A A A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Others</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>A A A A A A A A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

O : Must be set
A : 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](image)

**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.
7. POSITIONING CONTROL

[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.

![System Configuration Diagram]

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

<table>
<thead>
<tr>
<th>Item</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Servo program number</td>
<td>No. 300</td>
</tr>
<tr>
<td>Controlled axis</td>
<td>Axis 4</td>
</tr>
<tr>
<td>Control speed</td>
<td>10000</td>
</tr>
<tr>
<td>Travel value</td>
<td>100000</td>
</tr>
</tbody>
</table>

   (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.

![Operation Timing Diagram]
7. POSITIONING CONTROL

(4) Servo program

The servo program No. 300 for fixed-pitch feed control is shown below.

```
<K 300>

FEED-1
Axis 4, 80000
Speed 10000
Dwell 1000

---
1-axis fixed-pitch feed control
* Axis used................. Axis 4
* Travel value............ 80000
Commanded speed...10000
Dwell..................1000
```

(5) Sequence program example

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

```
0 M039
2 M074
4 X000 M074 M009 M076
11 M090
13 M074 M001 M004
23 X001

(M2000) (M2042) (PLS M000)

Turns ON PC ready.
Turns ON all axes servo start command.
Turns ON servo program No. 300 start command flag (M301) when X000 turns OFF → ON.
Servo program No. 300 execution request.
```

CIRCUIT END

```
(RST M001)

Turns OFF M301 on completion of servo program No. 300 execution request.
```
7. POSITIONING CONTROL

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.

<table>
<thead>
<tr>
<th>servo instruction</th>
<th>positioning method</th>
<th>number of controllable axes</th>
<th>items set by peripherals</th>
</tr>
</thead>
<tbody>
<tr>
<td>z</td>
<td>△</td>
<td>△</td>
<td>△</td>
</tr>
</tbody>
</table>

O: Must be set
△: 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)

![Diagram of positioning control and operation timing](image)

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

7 – 56
7. POSITIONING CONTROL

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.

<table>
<thead>
<tr>
<th>Item</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Servo program number</td>
<td>No. 310</td>
</tr>
<tr>
<td>Positioning speed</td>
<td>10000</td>
</tr>
<tr>
<td>Controlled axis</td>
<td>Axis 2, Axis 3</td>
</tr>
<tr>
<td>Travel value</td>
<td>500000, 300000</td>
</tr>
</tbody>
</table>

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

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

PC ready (M2000)
All axes servo start command (M2042)
All-axis servo start accept flag (M2009)
Start command (X000)
SVST instruction
Axis 2 start accept flag (M2002)
Axis 3 start accept flag (M2003)

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

< K 310 >

FEED-2
Axis 2, 500000
Axis 3, 300000
Speed 10000

Fixed-pitch feed control using 2-axis linear interpolation
- Axis used.................. Axis 2, Axis 3
- Travel value.................. Axis 2... 500000
- Axis 3... 300000
- Positioning speed.......... 10000

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

M8039                      (M2000)
M9074                      (M2042)
X000 M9074 M8009 M9076
M310
M8074 M311 M2002 M3003

CIRCUIT END

Turns ON PC ready.
Turns ON all axes servo start command.
Turns ON servo program No. 310 start command flag (M311) when X000 turns OFF → ON.
Servo program No. 310 execution request.
Turns OFF M311 on completion of servo program No. 310 execution request.
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.

<table>
<thead>
<tr>
<th>Servo Instruction</th>
<th>Positioning Method</th>
<th>Number of Controllable Axes</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEED-3</td>
<td>Incremental</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Items Set by Peripherals</th>
<th>Common</th>
<th>Arc</th>
<th>Parameter Block</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter Block No.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Axis</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Address/Travel Value</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Commanded Speed</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Detail Time</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>M Code</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Torque Limit Value</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Auxiliary Point</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Reference</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Center Point</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Control Unit</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Speed Limit Value</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Acceleration Time</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Deceleration Time</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Rapid Stop Deceleration Time</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Deceleration Processing on Step Input</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Allowable Error Range for Circular Interpolation</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>S Curve Radii</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Speed Change</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

- ☐: Must be set
- ☐: 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)

![Positioning direction and Operation timing diagram](image)

Figure 7.24 Fixed-Pitch Feed Control Using Three-Axis Linear Interpolation
7. POSITIONING CONTROL

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.

   ![Diagram of system configuration]

   - Start command (X000)

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

<table>
<thead>
<tr>
<th>Item</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Servo program number</td>
<td>No. 320</td>
</tr>
<tr>
<td>Positioning speed</td>
<td>1000</td>
</tr>
<tr>
<td>Controlled axes</td>
<td>Axis 1</td>
</tr>
<tr>
<td>Travel value</td>
<td>50000</td>
</tr>
</tbody>
</table>

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

(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.

Turns ON PC ready.
Turns ON all axes servo start command.
Turns ON servo program No. 320 start command flag (M321) when X000 turns OFF → ON.
Servo program No. 320 execution request.
Turns OFF M321 on completion of servo program No. 320 execution request.
7. POSITIONING CONTROL

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.

<table>
<thead>
<tr>
<th>Servo Instruction</th>
<th>Positioning Method</th>
<th>Number of Controllable Axes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axis</td>
<td>Commanded Speed</td>
<td>Dead Time</td>
</tr>
<tr>
<td>VF</td>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td>VR</td>
<td>—</td>
<td>1</td>
</tr>
</tbody>
</table>

○: Must be set
△: 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.

![Diagram](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**

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

**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.

![Diagram](Operating speed)

**[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.
7. POSITIONING CONTROL

[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.

<table>
<thead>
<tr>
<th>Item</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Servo program number</td>
<td>No. 91</td>
</tr>
<tr>
<td>Controlled axis</td>
<td>Axis 1</td>
</tr>
<tr>
<td>Control speed</td>
<td>3000</td>
</tr>
<tr>
<td>Rotation direction</td>
<td>Forward</td>
</tr>
</tbody>
</table>

(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.

PC ready (M2000)
All axes servo start command (M2042)
All-axis servo start accept flag (M2009)
Start command (X000)
SVST instruction
Axis 1 start accept flag (M2001)
Stop command (M1800)
7. POSITIONING CONTROL

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

```
<K 91>
VF
Axis  1,
Speed  3000
                      Speed control (I) (Forward)
                      Axis used ..........Axis 1
                      Positioning speed ...3000
```

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

```
0 | M9009 | (M2000) | Turns ON PC ready.
2 | M9074 | (M2042) | Turns ON all axes servo start command.
4 | X000 | M9074 | M2009 | M9076 | [PLS M91] | Detects leading edge of X000 (OFF → ON)
    | M91  | [PLF M94] | Detects trailing edge of X000 (ON → OFF)
14 | M9074 | M90 | M2001 | [SET M92] | K 91 | Turns ON servo program No. 91 start command flag (M93) when X000 turns OFF → ON.
    | [SVST J1] | [RST M93] | Servo program No. 91 execution request.
27 | M94  | [SET M1800] | Turns OFF M93 on completion of servo program No. 91 execution request.
29 | M2001 | M1800 | [RST M1800] | Turns ON stop command flag (M1800) at trailing edge of X000, stops.
    | CIRCUIT END |
```
# 7. POSITIONING CONTROL

## 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.

<table>
<thead>
<tr>
<th>Servo Instruction</th>
<th>Positioning Method</th>
<th>Number of Controllable Axes</th>
<th>Item Set by Peripherals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Common</td>
</tr>
<tr>
<td>VVF</td>
<td></td>
<td>1</td>
<td>Δ</td>
</tr>
<tr>
<td>VVR</td>
<td></td>
<td>1</td>
<td>Δ</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Item</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Servo program number</td>
<td>No. 55</td>
</tr>
<tr>
<td>Controlled axis</td>
<td>Axis 3</td>
</tr>
<tr>
<td>Control speed</td>
<td>4000</td>
</tr>
<tr>
<td>Rotation direction</td>
<td>Forward</td>
</tr>
</tbody>
</table>

(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.

PC ready (M2000)
All axes servo start command (M2042)
All-axis servo start accept flag (M2009)
Start command (X000)
SVST instruction
Axis 3 start accept flag (M2003)
Stop command (M1840)
7. POSITIONING CONTROL

(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.

<table>
<thead>
<tr>
<th>Circuit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>M0039, (M2000) Turns ON PC ready.</td>
</tr>
<tr>
<td>2</td>
<td>M8074, (M2042) Turns ON all axes servo start command.</td>
</tr>
<tr>
<td>4</td>
<td>X000, M8074, M2009, M9076 [PLB, M55] Detects leading edge of X000 (OFF → ON)</td>
</tr>
<tr>
<td></td>
<td>[PLF, M58] Detects trailing edge of X000 (ON → OFF)</td>
</tr>
<tr>
<td>14</td>
<td>M55, [SET, M57] Turns ON servo program No. 55 start command flag (M57) when X000 turns OFF → ON.</td>
</tr>
<tr>
<td></td>
<td>[RST, M57] Turns OFF M57 on completion of servo program No. 55 execution request.</td>
</tr>
<tr>
<td>27</td>
<td>[SET, M1840] Turns ON stop command flag (M1840) at trailing edge of X000.</td>
</tr>
<tr>
<td>29</td>
<td>[RST, M1840] Turns OFF stop command flag (M1840) when Axis 3 stops.</td>
</tr>
</tbody>
</table>
7. POSITIONING CONTROL

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.

<table>
<thead>
<tr>
<th>Servo Instruction</th>
<th>Positioning Method</th>
<th>Number of Controllable Axes</th>
</tr>
</thead>
<tbody>
<tr>
<td>VPF</td>
<td>Incremental</td>
<td>1</td>
</tr>
<tr>
<td>VPR</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **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.

---

V

Set travel value

Speed control

Position control

M1805

ON

CHANGE signal valid

Speed/position switching enable signal

External CHANGE input

---

7 – 69
7. POSITIONING CONTROL

REMARKS

*: 1) When using A171SCPU, the external CHANGE signal is an external input to the A171SEN0 DOG/CHANGE terminal. When "normally open contact input" is set in the system settings, CHANGE input occurs when the DOG/CHANGE signal goes 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 A273UHCP (8/32-axis specification), the external CHANGE signal is an external input to the A278LX CHANGE terminal. (See the A273UHCP (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:

\[
\text{Feed present value after stopping} = \text{Travel value under speed control} + \text{Travel value under position control}
\]

(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:

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

[Diagram showing feed present value processing for M1812+20n OFF and ON]
7. POSITIONING 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.

<table>
<thead>
<tr>
<th>Axis No.</th>
<th>Data Register Number for Indirect Designation</th>
<th>Data Registers to Change Travel Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>D815</td>
<td>D816 D815</td>
</tr>
<tr>
<td>2</td>
<td>D835</td>
<td>D836 D835</td>
</tr>
<tr>
<td>3</td>
<td>D855</td>
<td>D856 D855</td>
</tr>
<tr>
<td>4</td>
<td>D875</td>
<td>D876 D875</td>
</tr>
</tbody>
</table>

* 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.

\[
\text{VPF}
\text{Axis 4, D 875}
\text{Speed 50000}
\]

---

\[
\text{Indicates indirect designation of travel value}
\]
(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.
7. POSITIONING CONTROL

(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) Stroke 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.
7. POSITIONING CONTROL

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

<table>
<thead>
<tr>
<th>Item</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Servo program number</td>
<td>No. 101</td>
</tr>
<tr>
<td>Controlled axis</td>
<td>Axis 4</td>
</tr>
<tr>
<td>Positioning control travel value</td>
<td>40000</td>
</tr>
<tr>
<td>Commanded speed</td>
<td>1000</td>
</tr>
</tbody>
</table>

   (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.

<p>| | | | | | | | | | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
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<tr>
<td>2</td>
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<tr>
<td>4</td>
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<tr>
<td>12</td>
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<tr>
<td>14</td>
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<td></td>
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<tr>
<td>25</td>
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<tr>
<td>29</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CIRCUIT END

- M9039: Turns ON PC ready.
- M9074: Detects leading edge of X000 (OFF → ON)
- M2000: Turns ON all axes servo start command.
- M2042: Turns ON speed/position switching enable flag (M1685).
- M2074: Turns ON servo program No. 101 start command flag (M102) at X000 leading edge.
- M9078: Servo program No. 101 execution request.
- M102: Turns OFF M102 on completion of servo program No. 101 execution request.
- M101: Turns OFF speed/position switching enable flag (M1685) on speed/position switching signal (CHANGE) input.
- M103: Sets M103.
7. POSITIONING CONTROL

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.

<table>
<thead>
<tr>
<th>Servo Instruction</th>
<th>Positioning Method</th>
<th>Number of Controllable Axes</th>
<th>Parameter Block No.</th>
<th>Parameter Block</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>VPSTART</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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 Switching Control".

![Figure 7.26 Restarting During Speed Control](image)

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:

\[
\begin{bmatrix}
\text{Travel value after restart} \\
\text{(P2)}
\end{bmatrix} = \begin{bmatrix}
\text{Set travel value (P)}
\end{bmatrix} + \begin{bmatrix}
\text{Travel value before stop (P1)}
\end{bmatrix}
\]

\[V\]

\[t\]

\[\text{Operation speed} \quad \text{CHANGE signal ON} \quad \text{Stop command received} \quad \text{Restart} \quad \text{P1: Travel value before stop} \quad \text{P2: Travel value after restart} \]

SVST instruction
VPF/VPR instruction
VPSTART
M18m5
OFF
ON

\text{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.

\[V\]

\[t\]

\[\text{Set speed} \quad \text{Speed change} \quad \text{Operation speed} \quad \text{CHANGE signal ON} \quad \text{Stop command} \quad \text{Restart} \]

\[\text{Speed control} \quad \text{Speed control} \quad \text{Position control} \quad \text{Position control} \]

\text{Figure 7.28 Restarting After Speed Change}
7. POSITIONING CONTROL

[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.

<table>
<thead>
<tr>
<th>Item</th>
<th>Setting</th>
<th>Restart</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Speed/Position Switching Control</td>
<td></td>
</tr>
<tr>
<td>Servo program number</td>
<td>No. 101</td>
<td>No. 102</td>
</tr>
<tr>
<td>Controlled axis</td>
<td>Axis 4</td>
<td>Axis 4</td>
</tr>
<tr>
<td>Positioning control</td>
<td>40000</td>
<td></td>
</tr>
<tr>
<td>travel value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commanded speed</td>
<td>1000</td>
<td></td>
</tr>
</tbody>
</table>

(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)
7. POSITIONING CONTROL

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

PC ready (M2000)
All axes servo start command (M2042)
All-axis servo start accept flag (M2009)
Start command (X000)
Restart command (X001)
SVST instruction
SVST instruction Axis 4 start accept flag (M2004)
Speed/position switching enable flag (M1665)
CHANGE (external input)
Speed/position switching latch (M1665)
Stop command (X002, 1860)

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

<K 101>
VPF
Axis 4, 40000
Speed 1000
Speed/position switching control
* Axis used .................. Axis 4
* Travel value ................ 40000
Speed .................... 1000

<K 102>
VPSTART
Axis 4, Restart
Axis used .................. Axis 4
7. POSITIONING CONTROL

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

<table>
<thead>
<tr>
<th>M9039</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>(M2000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M9074</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(M2042)</td>
</tr>
<tr>
<td>X0000</td>
<td>M9074</td>
<td>M2009</td>
<td>M9076</td>
<td></td>
<td>PLS M101</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SET M1886</td>
</tr>
<tr>
<td>M101</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SET M102</td>
</tr>
<tr>
<td>M9074</td>
<td>M102</td>
<td>M2004</td>
<td></td>
<td></td>
<td>SVST JS K 101</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>RST M102</td>
</tr>
<tr>
<td>X1886</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PLF M103</td>
</tr>
<tr>
<td>M103</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>RST M1886</td>
</tr>
<tr>
<td>X0001</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PLS M104</td>
</tr>
<tr>
<td>M104</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SET M105</td>
</tr>
<tr>
<td>M9074</td>
<td>M105</td>
<td>M2004</td>
<td></td>
<td></td>
<td>SVST JS K 102</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>RST M105</td>
</tr>
<tr>
<td>X0002</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>M1886</td>
</tr>
</tbody>
</table>

CIRCUIT END

Turns ON PC ready.
Turns ON all axes servo start command.
Detects leading edge of X000 (OFF → ON).
Turns ON speed/position switching enable flag (M1886).
Turns ON servo program No. 101 start command flag (M102) at X000 leading edge.
Servo program No. 101 execution request.
Turns OFF M102 on completion of servo program No. 101 execution request.
Turns OFF speed/position switching enable flag (M1886) on speed/position switching signal (CHANGE) input.
Detects leading edge of X001 (OFF → ON).
Turns ON servo program No. 102 start command flag (M105) at X001 leading edge.
Servo program No. 102 execution request.
Turns OFF M105 on completion of servo program No. 102 execution request.
Stops Axis 4 when the external stop command is input.
7. POSITIONING CONTROL

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, and designation

<table>
<thead>
<tr>
<th>Servo Instruction</th>
<th>Positioning Method</th>
<th>Number of Controllable Axes</th>
<th>Items Set by Peripherals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Parameter Block No.</td>
<td>Acts</td>
</tr>
<tr>
<td>Start</td>
<td>VSTART</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>End</td>
<td>VEND</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>End point address</td>
<td>ABS-1</td>
<td>Absolute data</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>ABS-2</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>ABS-3</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>Travel value to end point</td>
<td>INC-1</td>
<td>Incremental</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>INC-2</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>INC-3</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>Speed-switching point</td>
<td>VABS</td>
<td>Absolute data</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>VABC</td>
<td>Incremental</td>
<td>-</td>
</tr>
</tbody>
</table>

O : Must be set
Δ : Set if required
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.

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).
7. POSITIONING CONTROL

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.

[Servo program]

Start

Start speed-switching control

Designate end address

Designate speed-switching points

NO

All speed-switching points designated?

YES

End speed-switching control

End

[Operation timing]

Axis 3 positioning direction

Axis 4 positioning direction

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

7 – 83
7. POSITIONING CONTROL

[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.
7. POSITIONING CONTROL

[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.

<table>
<thead>
<tr>
<th>Item</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Servo program number</td>
<td>No. 500</td>
</tr>
<tr>
<td>Controlled axes</td>
<td>Axis 2, Axis 3</td>
</tr>
<tr>
<td>End address</td>
<td>100000, 50000</td>
</tr>
</tbody>
</table>

(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:

<table>
<thead>
<tr>
<th>Program example</th>
<th>Motion when skip is not executed</th>
<th>Motion when skip is executed (when the skip occurs at 100 [degree])</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPSTART1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Axis 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed 10.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INC-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Axis 1, 180.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skip X100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INC-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Axis 1, 180.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INC-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Axis 1, 270.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CPEND</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>180</td>
<td>0</td>
</tr>
<tr>
<td>270 [degree]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Motion when skip is not executed</th>
</tr>
</thead>
<tbody>
<tr>
<td>180</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>270 [degree]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Motion when skip is executed (when the skip occurs at 100 [degree])</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
</tr>
<tr>
<td>280</td>
</tr>
<tr>
<td>190 [degree]</td>
</tr>
</tbody>
</table>

2. When the instruction immediately following the skip is an ABS instruction:

<table>
<thead>
<tr>
<th>Program example</th>
<th>Motion when skip is not executed</th>
<th>Motion when skip is executed (when the skip occurs at 100 [degree])</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPSTART1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Axis 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed 10.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INC-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Axis 1, 180.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skip X100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INC-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Axis 1, 350.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INC-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Axis 1, 270.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CPEND</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motion when skip is not executed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>180</td>
<td></td>
<td></td>
</tr>
<tr>
<td>350</td>
<td></td>
<td></td>
</tr>
<tr>
<td>270 [degree]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Motion when skip is executed (when the skip occurs at 100 [degree])</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
</tr>
<tr>
<td>350</td>
</tr>
<tr>
<td>270 [degree]</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Program example</th>
<th>Motion when skip is not executed</th>
<th>Motion when skip is executed (when the skip occurs at 80 [degree])</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPSTART1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Axis 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed 10.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INC-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Axis 1, 360.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skip X100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INC-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Axis 1, 180.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INC-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Axis 1, 180.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ABS-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Axis 1, 90.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CPEND</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motion when skip is not executed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>180</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>90 [degree]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Motion when skip is executed (when the skip occurs at 80 [degree])</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
</tr>
<tr>
<td>260</td>
</tr>
<tr>
<td>80</td>
</tr>
<tr>
<td>90 [degree]</td>
</tr>
</tbody>
</table>

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.
7. POSITIONING CONTROL

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

![Servo Program Diagram]

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

![Sequence Program Diagram]

- (M200) -
  - Turns ON PC ready.
- (M2042) -
  - Turns ON all axes servo start command.
- (M500) -
  - Turns ON servo program No. 500 start command flag (M501) when X000 turns OFF → ON.
  - Servo program No. 500 execution request.
- K
  - Turns OFF M501 on completion of servo program No. 500 execution request.
### 7.15.2 Setting speed-switching points using repeat instructions

Repeated execution between any speed-switching points.

<table>
<thead>
<tr>
<th>Servo Instruction</th>
<th>Positioning Method</th>
<th>Number of Controllable Axes</th>
<th>Items Set by Peripherals</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Parameter Block No.</td>
<td></td>
<td>Common</td>
<td>Arc</td>
</tr>
<tr>
<td></td>
<td>Axis</td>
<td></td>
<td>Address/Travel Value</td>
<td>Commanded Speed</td>
</tr>
<tr>
<td>FOR-TIMES</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FOR-ON</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FOR-OFF</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NEXT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\( O \): Must be set  
\( \Delta \): 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 \((D)\)  
     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 \((F)\)
7. POSITIONING CONTROL

(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
VINC
Axis 1, 30000
Speed 500
VINC
Axis 1, 20000
Speed 1000
NEXT
VEND
```

<table>
<thead>
<tr>
<th></th>
<th>Condition 1</th>
<th>Condition 2</th>
<th>Condition 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOR-TIMES</td>
<td>K1</td>
<td>K2</td>
<td>K3</td>
</tr>
<tr>
<td>FOR-ON</td>
<td>X010 → ON from start</td>
<td>X010 → ON during first execution of 3)</td>
<td>X010 → ON during third execution of 3)</td>
</tr>
<tr>
<td>FOR-OFF</td>
<td>X011 → OFF from start</td>
<td>X011 → OFF during first execution of 3)</td>
<td>X011 → OFF during third execution of 3)</td>
</tr>
</tbody>
</table>

(1) Operation under condition 1

```
X010 → ON
X011 → OFF
```

(2) Operation under condition 2

```
X010 → ON
X011 → OFF
```
7. POSITIONING CONTROL

(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.

   ![Diagram of system configuration]
   - Start command (X000)
   - Repeated instruction execution command (X001)

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

<table>
<thead>
<tr>
<th>Item</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Servo program number</td>
<td>No. 501</td>
</tr>
<tr>
<td>Controlled axes</td>
<td>Axis 2</td>
</tr>
<tr>
<td>End address</td>
<td>230000</td>
</tr>
<tr>
<td></td>
<td>100000</td>
</tr>
</tbody>
</table>

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

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

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

![Servo program diagram]

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

![Sequence program diagram]

- Turns ON PC ready.
- Turns ON all axes servo start command.
- Turns ON servo program No. 501 start command flag (M511) when X000 turns OFF → ON.
- Servo program No. 501 execution request.
- Turns OFF M511 on completion of servo program No. 501 execution request.
7. POSITIONING CONTROL

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]
[Operation Timing]

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

[Example: Operation timing for 2-axis constant-speed control]
7. POSITIONING 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 (INCL□).

(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 be-
comes 280 pps, regardless of the commanded speed setting.
7. POSITIONING CONTROL

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.

<table>
<thead>
<tr>
<th>Servo Instruction</th>
<th>Positioning Method</th>
<th>Number of Controllable Axes</th>
<th>Items Set by Peripherals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Parameter Block No.</td>
<td>Axis</td>
</tr>
<tr>
<td>FOR-TIMES</td>
<td></td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>FOR-ON</td>
<td></td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>FOR-OFF</td>
<td></td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>NEXT</td>
<td></td>
<td></td>
<td>O</td>
</tr>
</tbody>
</table>

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)
7. POSITIONING CONTROL

(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]

<table>
<thead>
<tr>
<th>CPSTART2</th>
<th>Axis 1, 1000</th>
<th>Axis 2, 40000</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABS-2</td>
<td>Axis 1, 20000</td>
<td>Axis 2, 20000</td>
</tr>
<tr>
<td>INC-2</td>
<td>Axis 1, 30000</td>
<td>Axis 2, 0</td>
</tr>
<tr>
<td>INC-2</td>
<td>Axis 1, 20000</td>
<td>Axis 2, 20000</td>
</tr>
<tr>
<td>NEXT CPEND</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Condition 1</th>
<th>Condition 2</th>
<th>Condition 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOR-TIMES</td>
<td>X010 → ON</td>
<td>X010 → ON</td>
</tr>
<tr>
<td></td>
<td>from start</td>
<td>during first</td>
</tr>
<tr>
<td></td>
<td></td>
<td>execution of</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3)</td>
</tr>
<tr>
<td>FOR-ON</td>
<td>X010 → ON</td>
<td>X010 → ON</td>
</tr>
<tr>
<td></td>
<td>during first</td>
<td></td>
</tr>
<tr>
<td></td>
<td>execution of</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3)</td>
</tr>
<tr>
<td>FOR-OFF</td>
<td>X011 → OFF</td>
<td>X011 → OFF</td>
</tr>
<tr>
<td></td>
<td>from start</td>
<td>during first</td>
</tr>
<tr>
<td></td>
<td></td>
<td>execution of</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>during second</td>
</tr>
<tr>
<td></td>
<td></td>
<td>execution of</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3)</td>
</tr>
</tbody>
</table>

Operation Under Condition 1
Operation Under Condition 2
Operation Under Condition 3
Repeat 3)

Axis 1
Axis 2

50000
0
100000
200000
7. POSITIONING CONTROL

[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.

<table>
<thead>
<tr>
<th>Item</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Servo program number No.</td>
<td>510</td>
</tr>
<tr>
<td>Controlled axes</td>
<td>Axis 2, Axis 3</td>
</tr>
<tr>
<td>Positioning speed</td>
<td>10000</td>
</tr>
</tbody>
</table>

   (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.

PC ready (M2000)
All axes servo start command (M2042)
All-axis servo start accept flag (M2009)
Start command (X000)
SVST Instruction
Axis 2 start accept flag (M2002)
Axis 3 start accept flag (M2003)
7. POSITIONING CONTROL

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

```
<K 510>

CPSTART2
Axis 2, 3,
Speed 10000
ABS-2
Axis 2, 40000
Axis 3, 20000
FOR-TIMES
K 4
INC-2
Axis 2, 30000
Axis 3, 0
INC 
Axis 2, 20000
Axis 3, 20000
Radius 20000
NEXT
CPEND

---
Start constant-speed control
Axes used.............Axis 2, Axis 3
Positioning speed...10000
Pass point setting
Number of repetitions 4
Pass point setting
End constant-speed range
End constant-speed control
```

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

```
0 M090               (M2000)
2 M074               (M2042)
4 X0000 M074 M2009 M076 [PLS M560 ]
11 [SET M561 ]
13 M074 M561 M2002 M2003 [SVST J233 K510 ]
                    [RST M561 ]
```

- Turns ON PC ready.
- Turns ON all axes servo start command.
- Turns ON servo program No. 510 start command flag (M561) when X000 turns OFF → ON.
- Servo program No. 510 execution request.
- Turns OFF M561 on completion of servo program No. 510 execution request.
7. POSITIONING CONTROL

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.
7. POSITIONING CONTROL

[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.

<table>
<thead>
<tr>
<th>Item</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Servo program number</td>
<td>310</td>
</tr>
<tr>
<td>Positioning speed</td>
<td>10000</td>
</tr>
<tr>
<td>Positioning method</td>
<td>2-axis linear interpolation</td>
</tr>
<tr>
<td>Pass point</td>
<td></td>
</tr>
<tr>
<td>Axis 1</td>
<td>20000</td>
</tr>
<tr>
<td>Axis 2</td>
<td>10000</td>
</tr>
</tbody>
</table>

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

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

Axis 2 positioning direction

P4

P3

P2

P1

Center point

Axis 1 positioning direction

20000

40000

20000

V

15000

10000

Speed-switching designation flag (M2018)

PC ready (M2000)

All axes servo start command (M2042)

All-axis servo start accept flag (M2009)

Start command (X000)

SVST instruction

Axis 1 start accept flag (M2001)

Axis 2 start accept flag (M2002)
(4) Servo program
The servo program No. 310 for speed switching is shown below.

```
<K 310>
<table>
<thead>
<tr>
<th>CPSTART2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axis 1</td>
</tr>
<tr>
<td>Axis 2</td>
</tr>
<tr>
<td>Speed 10000</td>
</tr>
<tr>
<td>ABS-2</td>
</tr>
<tr>
<td>Axis 1, 20000</td>
</tr>
<tr>
<td>Axis 2, 10000</td>
</tr>
<tr>
<td>ABS</td>
</tr>
<tr>
<td>Axis 1, 30000</td>
</tr>
<tr>
<td>Axis 2, 20000</td>
</tr>
<tr>
<td>Center 1, 30000</td>
</tr>
<tr>
<td>Center 2, 10000</td>
</tr>
<tr>
<td>ABS-2</td>
</tr>
<tr>
<td>Axis 1, 40000</td>
</tr>
<tr>
<td>Axis 2, 25000</td>
</tr>
<tr>
<td>Speed 15000</td>
</tr>
<tr>
<td>P1 designation</td>
</tr>
<tr>
<td>P2 designation</td>
</tr>
<tr>
<td>P3 designation</td>
</tr>
<tr>
<td>Speed change</td>
</tr>
<tr>
<td>P4 designation</td>
</tr>
<tr>
<td>CPEND</td>
</tr>
</tbody>
</table>
```

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

```
<table>
<thead>
<tr>
<th>X0010</th>
</tr>
</thead>
<tbody>
<tr>
<td>M039</td>
</tr>
<tr>
<td>M074</td>
</tr>
<tr>
<td>M0000 M0074 M2009 M0076</td>
</tr>
<tr>
<td>X0000</td>
</tr>
<tr>
<td>M551</td>
</tr>
<tr>
<td>M2001 M2002</td>
</tr>
<tr>
<td>X0100</td>
</tr>
<tr>
<td>M050</td>
</tr>
<tr>
<td>SET M2016</td>
</tr>
<tr>
<td>SET M551</td>
</tr>
<tr>
<td>[SVST J1J2]</td>
</tr>
</tbody>
</table>

Turns ON speed-switching point designation flag (M2016) when X110 turns OFF → ON.
Turns ON PC ready.
Turns ON all axes servo start command.
Turns ON servo program No. 310 start command flag (M551) when X000 turns OFF → ON.
Servo program No. 310 execution request.
Turns OFF M551 and M2016 on completion of servo program No. 310 execution request.
```
## 7. POSITIONING CONTROL

### 7.16.3 One-axis constant-speed control

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

| Serve Instruction | Positioning Method | Number of Controllable Axes | Parameter Block No. | Axis | Address/Travel Value | Commanded Speed | Feed Time | S Code | Torque Limit Value | Auxiliary Point | Radius | Centr Point | Limits | Speed Limit Value | Acceleration Time | Deceleration Time | Rapid Stop Deceleration Time | Torque Limit Value | Deceleration Processing on Stop Start | Deceleration Processing on Stop Start | Acceleration Error Range for Chopper (0-10%) | Absolute Error Ratio | Commanded Speed (constant-speed) |分辨率 | Start |mia | ZRN | Acceleration | Deceleration | Rapid Stop Deceleration | Torque Limit Value | Deceleration Processing on Stop Start | Deceleration Processing on Stop Start | Acceleration Error Range for Chopper (0-10%) | Absolute Error Ratio | Commanded Speed (constant-speed) | Start | mia | ZRN | Acceleration | Deceleration | Rapid Stop Deceleration |
|------------------|-------------------|-----------------------------|---------------------|-----|----------------------|----------------|----------|-------|-------------------|----------------|--------|-------------|--------|-------------------|----------------|----------------|-----------------------------|-----------------|-----------------------------|-------------------|-----------------|-------------------|-------------------|----------------|----------------|-------------------|----------------|-------------------|-------------------|-----------------|-------------------|-------------------|-----------------|-------------------|-------------------|----------------|----------------|-------------------|
| Start | CPSTART1 | —— | 1 | A | O | O | A | A | A | A | A | A | A | A | A | OK |
| End | CPEND | —— | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Pass | point | ABS-1 | Absolute data | 1 | O | O | A | A | — | — | — | — | — | — | — | — |
| | | INC-1 | Incremental | 1 | O | O | A | A | — | — | — | — | — | — | — | — |

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.
7. POSITIONING CONTROL

[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.

<table>
<thead>
<tr>
<th>Item</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Servo program number</td>
<td>500</td>
</tr>
<tr>
<td>Controlled axis</td>
<td>Axis 4</td>
</tr>
<tr>
<td>Positioning speed</td>
<td>10000</td>
</tr>
<tr>
<td>Number of repetitions</td>
<td>100</td>
</tr>
<tr>
<td>Pass point travel value</td>
<td></td>
</tr>
<tr>
<td>P1</td>
<td>-1000</td>
</tr>
<tr>
<td>P2</td>
<td>2000</td>
</tr>
<tr>
<td>P3</td>
<td>-2000</td>
</tr>
<tr>
<td>P4</td>
<td>1000</td>
</tr>
</tbody>
</table>

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

(3) Details of positioning operation
7. POSITIONING CONTROL

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

![Graph showing operation timing](image)

- **PC ready (M2000)**
- **All axes servo start command (M2042)**
- **All-axis servo start accept flag (M2009)**
- **Start command (X000)**
- **SVST instruction**
- **Axis 4 start accept flag (M2004)**

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

```
<K 500>
CPSTART1
Axis 4
Speed 10000
INC-1 Axis 4, K 100
FOR-TIMES
INC-1 Axis 4, 2000
INC-1 Axis 4, -2000
NEXT
INC-1 Axis 4, 1000
CPEND
```
- Start constant-speed control
- Axis used............. Axis 4
- Positioning speed........ 10000
- One-axis linear positioning control
  - Axis used............. Axis 4
  - Positioning address........ -1000
- Set 100 repeats
- One-axis linear positioning control
  - Axis used............. Axis 4
  - Positioning address........ 2000
- One-axis linear positioning control
  - Axis used............. Axis 4
  - Positioning address........ -2000
- End repeated region
- One-axis linear positioning control
  - Axis used............. Axis 4
  - Positioning address........ 1000
- End constant-speed control
(6) Sequence program
The sequence program which runs the servo program is shown below.

```
0  M8059  (M2000)  Turns ON PC ready.
   M8074  (M2042)  Turns ON all axes servo start command.

2  X000  M8074  M2009  M8076

4  M660  PLS  M560  Turns ON伺服 program.

11  M660  SET  M561  No. 500 start command flag (M561) when X000 turns OFF ON.

13  M8074  M561  M2004
     SVST  J4  K500  Servo program No. 500 execution request.

     [RST  M561]  Turns OFF M561 on completion of servo program No. 500 execution request.
```

Circuit End
### 7. POSITIONING CONTROL

#### 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.

<table>
<thead>
<tr>
<th>Serve Instruction/Positioning Method</th>
<th>Number of Controllable Axes</th>
<th>Items Set by Peripherals</th>
<th>Common</th>
<th>Arc</th>
<th>Parameter Block</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Start</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CPSTART1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CPSTART2</td>
<td>2</td>
<td></td>
<td>Δ</td>
<td>O</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>CPSTART3</td>
<td>3</td>
<td></td>
<td>Δ</td>
<td>O</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>CPSTART4</td>
<td>4</td>
<td></td>
<td>Δ</td>
<td>O</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td><strong>End</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CPEND</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Absolute data</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ABS</td>
<td>2</td>
<td></td>
<td>Δ</td>
<td>O</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>ABS</td>
<td>3</td>
<td></td>
<td>Δ</td>
<td>O</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>ABS</td>
<td>4</td>
<td></td>
<td>Δ</td>
<td>O</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td><strong>Incremental</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INC</td>
<td>2</td>
<td></td>
<td>Δ</td>
<td>O</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>INC</td>
<td>3</td>
<td></td>
<td>Δ</td>
<td>O</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>INC</td>
<td>4</td>
<td></td>
<td>Δ</td>
<td>O</td>
<td>O</td>
<td></td>
</tr>
</tbody>
</table>

- **O**: Must be set
- **Δ**: Set if required
7. POSITIONING CONTROL

[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 T
   Designates circular interpolation control using auxiliary point designation.
   See Section 7.6 "Circular Interpolation Using Auxiliary Point Designation" for details.

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

6. ABS/INC T, ABS/INC L
   Designates circular interpolation control using center point designation.
   See Section 7.8 "Circular Interpolation Using Center Point Designation" for details.
7. POSITIONING CONTROL

[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.

<table>
<thead>
<tr>
<th>Item</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Servo program number</td>
<td>505</td>
</tr>
<tr>
<td>Positioning speed</td>
<td>10000</td>
</tr>
<tr>
<td>Positioning method</td>
<td>2-axis linear interpolation</td>
</tr>
<tr>
<td>Pass point</td>
<td>Axis 2</td>
</tr>
<tr>
<td></td>
<td>Axis 3</td>
</tr>
</tbody>
</table>

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

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

```
< K 505 >
CPSTART2
Axis 2
Axis 3
Speed 10000
ABS-2
Axis 2, 30000
Axis 3, 30000
ABS-
Axis 2, 50000
Axis 3, 50000
Radius 20000
ABS-2
Axis 2, 90000
Axis 3, 100000
CPEND
```

Start constant-speed control
Axis used .......... Axis 2, Axis 3
Positioning speed .......... 10000
Two-axis linear interpolation control
Positioning address (Axis 2...30000)
(Axis 3...30000)
Circular interpolation control
Positioning address (Axis 2...50000)
(Axis 3...50000)
Radius .......... 90000
Two-axis linear interpolation control
Positioning address (Axis 2...90000)
(Axis 3...100000)
End constant-speed control

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

```
0 M9039
2 M9074
4 X0000 M9074 M2009 M9076
11 M550
13 M9074 M551 M2002 M2003

( M2000 )
( M2042 )
( PLB M550 )
( SET M551 )
( SVST J2 J3 505 )
( RST M551 )
```

Turns ON PC ready.
Turns ON all axes servo start command.
Turns ON servo program No. 505 start command flag (M551) when X000 turns OFF → ON.
Servo program No. 505 execution request.
Turns OFF M551 on completion of servo program No. 505 execution request.
7. POSITIONING CONTROL

[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.

<table>
<thead>
<tr>
<th>Item</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Servo program number</td>
<td>506</td>
</tr>
<tr>
<td>Positioning speed</td>
<td>10000</td>
</tr>
<tr>
<td>Positioning method</td>
<td>4-Axis Linear Interpolation</td>
</tr>
<tr>
<td>Pass point</td>
<td>Axis 1: 3000</td>
</tr>
<tr>
<td></td>
<td>Axis 2: 4000</td>
</tr>
<tr>
<td></td>
<td>Axis 3: 4000</td>
</tr>
<tr>
<td></td>
<td>Axis 4: 4000</td>
</tr>
</tbody>
</table>

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

(d) Servo program

The servo program No. 506 for constant-speed control is shown below.

![Servo program diagram]

(e) Sequence program

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

```
M039
M9074
X0000 M9074 M2009 M9076
M550

[PLS M550]
[SET M551]
[SVST J1J2J3J4 506]
[RSV M551]

CIRCUIT END

M2000
M2042

Turns ON PC ready.
Turns ON all axes servo start command.
Turns ON servo program No. 506 start command flag (M551) when X000 turns OFF → ON.
Servo program No. 506 execution request.
Turns OFF M551 on completion of servo program No. 506 execution request.
```
7. POSITIONING CONTROL

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]

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

Point 1 positioning processing
Skip signal ON
Point 2 positioning processing

SVST Start accept
Skip signal (X100)
```

7 – 117
7. POSITIONING CONTROL

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>

<table>
<thead>
<tr>
<th>CPSTART2</th>
<th>Currently executed point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axis 1</td>
<td></td>
</tr>
<tr>
<td>Axis 2</td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td>10000</td>
</tr>
<tr>
<td>FIN acceleration/ deceleration</td>
<td>100 [ms]</td>
</tr>
<tr>
<td>1 ABS-2</td>
<td>M code P=S</td>
</tr>
<tr>
<td>Axis 1</td>
<td>200000</td>
</tr>
<tr>
<td>Axis 2</td>
<td>200000</td>
</tr>
<tr>
<td>M code</td>
<td>10</td>
</tr>
<tr>
<td>2 ABS-2</td>
<td>M code output in progress P=S</td>
</tr>
<tr>
<td>Axis 1</td>
<td>300000</td>
</tr>
<tr>
<td>Axis 2</td>
<td>250000</td>
</tr>
<tr>
<td>M code</td>
<td>11</td>
</tr>
<tr>
<td>3 ABS-2</td>
<td>FIN signal S→P</td>
</tr>
<tr>
<td>Axis 1</td>
<td>350000</td>
</tr>
<tr>
<td>Axis 2</td>
<td>300000</td>
</tr>
<tr>
<td>M code</td>
<td>12</td>
</tr>
<tr>
<td>4 ABS-2</td>
<td></td>
</tr>
<tr>
<td>Axis 1</td>
<td>400000</td>
</tr>
<tr>
<td>Axis 2</td>
<td>400000</td>
</tr>
<tr>
<td>CPEND</td>
<td></td>
</tr>
</tbody>
</table>
```

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.
7. POSITIONING CONTROL

**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.

(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.
7. POSITIONING CONTROL

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.

<table>
<thead>
<tr>
<th>Servo Instruction</th>
<th>Positioning Method</th>
<th>Number of Controllable Axes</th>
<th>Parameter Block</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFSTART</td>
<td>Absolute</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item Set by Peripherals</th>
<th>Common</th>
<th>Arc</th>
<th>Parameter Block</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter Block No.</td>
<td>A</td>
<td>D</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Axis</td>
<td>D</td>
<td>O</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Address/Deviation Value</td>
<td>O</td>
<td>O</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Commanded Speed</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Gear Ratio</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>M Code</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Torque Limit Value</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Auxiliary Point</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Rapid Stop Time</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Deceleration Time</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Deceleration Time</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Deceleration Time</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Allowable Error Range</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>G Code Ratio</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Cancel</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Start</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>Speed Change</td>
<td>A</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
</tbody>
</table>

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.

![Diagram showing positioning address changed during follow-up control](image)

Before reaching A, positioning address changed to B (return direction)

Positioning address A

7 – 120
7. POSITIONING CONTROL

[Cautions]

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

2. Only the absolute data method (ABSC) 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.

   ![Diagram](image)

   Positioning start command (X000)

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

<table>
<thead>
<tr>
<th>Item</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Servo program number</td>
<td>100</td>
</tr>
<tr>
<td>Controlled axis</td>
<td>Axis 3</td>
</tr>
<tr>
<td>Positioning address</td>
<td>D50</td>
</tr>
<tr>
<td>Positioning speed</td>
<td>20000</td>
</tr>
</tbody>
</table>

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

(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.

<table>
<thead>
<tr>
<th>0</th>
<th>M9039</th>
<th>(M2000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>M9074</td>
<td>(M2040)</td>
</tr>
<tr>
<td>4</td>
<td>P K</td>
<td>DNO 100</td>
</tr>
<tr>
<td>12</td>
<td>M1640</td>
<td>M2003</td>
</tr>
<tr>
<td>27</td>
<td>F</td>
<td>K 100</td>
</tr>
<tr>
<td>27</td>
<td>M1641</td>
<td>[PLS M1840]</td>
</tr>
</tbody>
</table>

Circuit End

- 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. POSITIONING CONTROL

7.18 Simultaneous Start

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

<table>
<thead>
<tr>
<th>Servo Instruction</th>
<th>Positioning Method</th>
<th>Number of Controllable Axes</th>
<th>Parameter Block No.</th>
<th>Parameter Block</th>
<th>Common</th>
<th>Axis</th>
<th>Parameter Block</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>START</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Error</th>
<th>Error Processing</th>
<th>Stored Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designated servo program does not exist</td>
<td>Servo program setting error flag (M9079): ON</td>
<td>D9189</td>
</tr>
<tr>
<td>START instruction designated as servo program</td>
<td>Start accept flag (M2001+n): OFF</td>
<td>Program number causing error on simultaneous start 19</td>
</tr>
<tr>
<td>A servo program cannot start due to an error</td>
<td>Program number for which error occurred on simultaneous start</td>
<td></td>
</tr>
</tbody>
</table>

(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.
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

<table>
<thead>
<tr>
<th>Servo Program No.</th>
<th>Axis</th>
<th>Control Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1, 2</td>
<td>Circular interpolation control</td>
</tr>
<tr>
<td>14</td>
<td>3</td>
<td>Speed control</td>
</tr>
<tr>
<td>45</td>
<td>4</td>
<td>Home position return control</td>
</tr>
</tbody>
</table>

(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.

<table>
<thead>
<tr>
<th>0</th>
<th>M9039</th>
<th></th>
<th>(M2000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>M9074</td>
<td></td>
<td>(M2042)</td>
</tr>
<tr>
<td>4</td>
<td>X0000 M9074 M2009 M9076</td>
<td></td>
<td>[PLS M121]</td>
</tr>
<tr>
<td>11</td>
<td>M121</td>
<td></td>
<td>[SFT M122]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>[RST M122]</td>
</tr>
</tbody>
</table>

CIRCUIT END

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. POSITIONING CONTROL

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>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Setting Range</th>
<th>Default Value</th>
<th>Remarks</th>
<th>Explenatory Section</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>mm/min</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>JOG speed limit value</td>
<td>0.01 to 6000000.00</td>
<td>1 to 10000000</td>
<td>PLB/sec</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>inch/min</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Parameter block setting</td>
<td>1 to 16 (A17I/A273UHCPU 8-axis specification)</td>
<td>1</td>
<td></td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(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.

Stroke limit lower limit

Does not start

Starts

Stroke limit upper limit

Does not start

Starts
7. POSITIONING CONTROL

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>

<table>
<thead>
<tr>
<th>No.</th>
<th>JOG Operation Setting Register</th>
<th>Setting Range</th>
<th>Setting Range</th>
<th>Setting Range</th>
<th>Setting Range</th>
<th>Setting Range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Forward Reverse Most Significant Least Significant</td>
<td>mm</td>
<td>Inch</td>
<td>degree</td>
<td>PULSE</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>M1802 M1803 D965 D964</td>
<td>1 to $10^{-2}$ mm/min</td>
<td>1 to $10^{-3}$ mm/min</td>
<td>1 to $10^{-3}$ mm/min</td>
<td>1 to 1000000</td>
<td>PLS/sec</td>
</tr>
<tr>
<td>2</td>
<td>M1823 M1825 D971 D970</td>
<td>600000000</td>
<td>600000000</td>
<td>600000000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>M1842 M1843 D977 D976</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>M1002 M1003 D660 D662</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* 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.

POWERPOINT

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.
7. POSITIONING CONTROL

[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

<table>
<thead>
<tr>
<th>Circuit End</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0 M9039</td>
<td>(M2000)</td>
</tr>
<tr>
<td>2 M9074</td>
<td>(M2040)</td>
</tr>
<tr>
<td>4 M9000 M9074 M2009 M9078 M2004 D982</td>
<td>DMOV 1000 K</td>
</tr>
<tr>
<td>X0001</td>
<td>[SET M140]</td>
</tr>
<tr>
<td>18 X140 X0000 M1863</td>
<td>(M1862)</td>
</tr>
<tr>
<td>22 X140 X0001 M1862</td>
<td>(M1862)</td>
</tr>
<tr>
<td>26 X0000 X0001</td>
<td>[RET M140]</td>
</tr>
</tbody>
</table>

Turns ON PC ready.  
Turns ON all axes servo start command.  
Stores JOG operation speed (1000) in D982, D983 when X000 or X001 is ON.  
Turns ON M140 when storage of JOG operation speed is complete.  
Forward JOG operation.  
Reverses JOG operation.  
Turns OFF M140 when X000 and X001 turn OFF.
7. POSITIONING CONTROL

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>

<table>
<thead>
<tr>
<th>Axis No.</th>
<th>JOG Operation Speed Setting Register</th>
<th>Speed Change Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Most Significant Least Significant</td>
<td>mm</td>
</tr>
<tr>
<td>1</td>
<td>D965 D964</td>
<td>1 to 600000000 x 10^-2</td>
</tr>
<tr>
<td>2</td>
<td>D971 D970</td>
<td>1 to 60000000 x 10^-2</td>
</tr>
<tr>
<td>3</td>
<td>D977 D976</td>
<td>1 to 60000000 x 10^-2</td>
</tr>
<tr>
<td>4</td>
<td>D963 D962</td>
<td>1 to 60000000 x 10^-2</td>
</tr>
</tbody>
</table>

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

[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 tabulated below.

<table>
<thead>
<tr>
<th>Item</th>
<th>JOG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axis number</td>
<td>Axis 1</td>
</tr>
<tr>
<td>JOG operation speed</td>
<td>1000</td>
</tr>
<tr>
<td>JOG operation direction</td>
<td>Forward</td>
</tr>
<tr>
<td></td>
<td>Axis 2</td>
</tr>
<tr>
<td></td>
<td>500</td>
</tr>
<tr>
<td></td>
<td>Forward</td>
</tr>
<tr>
<td></td>
<td>Axis 4</td>
</tr>
<tr>
<td></td>
<td>1000</td>
</tr>
<tr>
<td></td>
<td>Reverse</td>
</tr>
</tbody>
</table>

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

(3) Sequence program

<table>
<thead>
<tr>
<th>Line</th>
<th>Instruction</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>M9039</td>
<td>(M2000)</td>
</tr>
<tr>
<td>2</td>
<td>M9074</td>
<td>(M2042)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[DMOV 1000]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[DMOV 500]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[DMOV 1000]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[SET M141]</td>
</tr>
<tr>
<td>38</td>
<td>X0000 M141</td>
<td>(M2016)</td>
</tr>
<tr>
<td>41</td>
<td></td>
<td>[RST M141]</td>
</tr>
</tbody>
</table>

CIRCUIT END

Turns ON PC ready.

Turns ON all axes servo start command.

Stores in D1015 JOG operation axes while X000 is ON.

Stores the JOG operation speed for each axis in the appropriate JOG operation speed setting registers.

Turns ON M141 when setting is complete for simultaneous start axes and JOG operation speeds.

JOG operation.

Turns OFF M141 when X000 turns OFF.
7. POSITIONING CONTROL

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.

<table>
<thead>
<tr>
<th></th>
<th>Number Connectable to the Manual Pulse Generator</th>
</tr>
</thead>
<tbody>
<tr>
<td>A171SCPU</td>
<td>1</td>
</tr>
<tr>
<td>A273UHCPU (8-/32-axis specification)</td>
<td>3</td>
</tr>
</tbody>
</table>

**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>**

<table>
<thead>
<tr>
<th>Manual Pulse Generator Axis Setting Register</th>
<th>Manual Pulse Generator Enable Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1012</td>
<td>D2012</td>
</tr>
</tbody>
</table>

   **<A273UHCPU (8-axis specification)>**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>D1012</td>
<td>M2012</td>
</tr>
<tr>
<td>P2</td>
<td>D1013</td>
<td>M2013</td>
</tr>
<tr>
<td>P3</td>
<td>D1014</td>
<td>M2014</td>
</tr>
</tbody>
</table>

   **<A273UHCPU (32-axis specification)>**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>D714, D715</td>
<td>M2051</td>
</tr>
<tr>
<td>P2</td>
<td>D716, D717</td>
<td>M2052</td>
</tr>
<tr>
<td>P3</td>
<td>D718, D719</td>
<td>M2053</td>
</tr>
</tbody>
</table>

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.

   \[
   \text{[travel value]} = \text{[travel value per pulse]} \times \text{[number of input pulses]} \times \text{[manual pulse generator input multiplication factor setting]}
   \]
The travel value per pulse during manual pulse generator operation is shown in the following table.

<table>
<thead>
<tr>
<th>Units</th>
<th>Travel Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td>0.1 ( \mu )m</td>
</tr>
<tr>
<td>inch</td>
<td>0.00001 inch</td>
</tr>
<tr>
<td>degree</td>
<td>0.00001 degree</td>
</tr>
<tr>
<td>PLUSE</td>
<td>1 PULSE</td>
</tr>
</tbody>
</table>

For units of millimeters, the commanded travel value for input of one pulse is: \( (0.1 \mu \text{m}) \times (1 \text{ pulse}) \times (\text{manual pulse generator input magnification setting}) \)

(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.

\[
[\text{output speed}] = [\text{input pulses per 1 ms}] \times 
[\text{manual pulse generator input multiplication factor setting}]
\]

(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.

\[
\text{MOV K34 D1012}
\]

Axis 3 and Axis 4 designated

<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.

\[
\text{DMOV H2000001 D714}
\]

(1) When set in hexadecimal (H)

\[
\text{DMOV K538968085 D714}
\]

(2) When set in decimal (K)
7. POSITIONING CONTROL

**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>

<table>
<thead>
<tr>
<th>1-pulse Input Magnification Setting Register</th>
<th>Corresponding Axis No.</th>
<th>Setting Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1016</td>
<td>Axis 1</td>
<td></td>
</tr>
<tr>
<td>D1017</td>
<td>Axis 2</td>
<td></td>
</tr>
<tr>
<td>D1018</td>
<td>Axis 3</td>
<td></td>
</tr>
<tr>
<td>D1019</td>
<td>Axis 4</td>
<td></td>
</tr>
</tbody>
</table>

### <A273UHCPU (32-axis)>

<table>
<thead>
<tr>
<th>1-pulse Input Magnification Setting Register</th>
<th>Corresponding Axis No.</th>
<th>Setting Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>D720</td>
<td>Axis 1</td>
<td></td>
</tr>
<tr>
<td>D721</td>
<td>Axis 2</td>
<td></td>
</tr>
<tr>
<td>D722</td>
<td>Axis 3</td>
<td></td>
</tr>
<tr>
<td>D723</td>
<td>Axis 4</td>
<td></td>
</tr>
<tr>
<td>D724</td>
<td>Axis 5</td>
<td></td>
</tr>
<tr>
<td>D725</td>
<td>Axis 6</td>
<td></td>
</tr>
<tr>
<td>D726</td>
<td>Axis 7</td>
<td></td>
</tr>
<tr>
<td>D727</td>
<td>Axis 8</td>
<td></td>
</tr>
<tr>
<td>D728</td>
<td>Axis 9</td>
<td></td>
</tr>
<tr>
<td>D730</td>
<td>Axis 10</td>
<td></td>
</tr>
<tr>
<td>D731</td>
<td>Axis 11</td>
<td></td>
</tr>
<tr>
<td>D732</td>
<td>Axis 12</td>
<td></td>
</tr>
<tr>
<td>D733</td>
<td>Axis 13</td>
<td></td>
</tr>
<tr>
<td>D734</td>
<td>Axis 14</td>
<td></td>
</tr>
<tr>
<td>D735</td>
<td>Axis 15</td>
<td></td>
</tr>
<tr>
<td>D736</td>
<td>Axis 16</td>
<td></td>
</tr>
<tr>
<td>D737</td>
<td>Axis 17</td>
<td></td>
</tr>
<tr>
<td>D738</td>
<td>Axis 18</td>
<td></td>
</tr>
<tr>
<td>D739</td>
<td>Axis 19</td>
<td></td>
</tr>
<tr>
<td>D740</td>
<td>Axis 20</td>
<td></td>
</tr>
<tr>
<td>D741</td>
<td>Axis 21</td>
<td></td>
</tr>
<tr>
<td>D742</td>
<td>Axis 22</td>
<td></td>
</tr>
<tr>
<td>D743</td>
<td>Axis 23</td>
<td></td>
</tr>
<tr>
<td>D744</td>
<td>Axis 24</td>
<td></td>
</tr>
<tr>
<td>D745</td>
<td>Axis 25</td>
<td></td>
</tr>
<tr>
<td>D746</td>
<td>Axis 26</td>
<td></td>
</tr>
<tr>
<td>D747</td>
<td>Axis 27</td>
<td></td>
</tr>
<tr>
<td>D748</td>
<td>Axis 28</td>
<td></td>
</tr>
<tr>
<td>D749</td>
<td>Axis 29</td>
<td></td>
</tr>
<tr>
<td>D750</td>
<td>Axis 30</td>
<td></td>
</tr>
<tr>
<td>D751</td>
<td>Axis 31</td>
<td></td>
</tr>
<tr>
<td>D752</td>
<td>Axis 32</td>
<td></td>
</tr>
</tbody>
</table>

### <A273UHCPU (8-axis)>

<table>
<thead>
<tr>
<th>1-pulse Input Magnification Setting Register</th>
<th>Corresponding Axis No.</th>
<th>Setting Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1016</td>
<td>Axis 1</td>
<td></td>
</tr>
<tr>
<td>D1017</td>
<td>Axis 2</td>
<td></td>
</tr>
<tr>
<td>D1018</td>
<td>Axis 3</td>
<td></td>
</tr>
<tr>
<td>D1019</td>
<td>Axis 4</td>
<td></td>
</tr>
<tr>
<td>D1020</td>
<td>Axis 5</td>
<td></td>
</tr>
<tr>
<td>D1021</td>
<td>Axis 6</td>
<td></td>
</tr>
<tr>
<td>D1022</td>
<td>Axis 7</td>
<td></td>
</tr>
<tr>
<td>D1023</td>
<td>Axis 8</td>
<td></td>
</tr>
</tbody>
</table>

Setting Range: 1-100
7. POSITIONING CONTROL

(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.

\[
\begin{array}{|c|c|c|c|}
\hline
\text{Manual Pulse Generator Smoothing Magnification Setting Register} & \text{Setting Range} \\
\hline
\text{D9192} & 0 \text{ to } 59 \\
\hline
\end{array}
\]

\[
\begin{array}{|c|c|c|c|}
\hline
\text{Manual Pulse Generator Smoothing Magnification Setting Register} & \text{Setting Range} \\
\hline
\text{Manual pulse generator 1 (P1): D752} & 0 \text{ to } 59 \\
\text{Manual pulse generator 2 (P2): D753} & \\
\text{Manual pulse generator 3 (P3): D754} & \\
\hline
\end{array}
\]

(a) Operation

\[
\text{Output speed (V1) } = \left( \frac{\text{number of input pulses}}{\text{ma}} \right) \times \left( \frac{\text{manual pulse generator 1 pulse input magnification setting}}{\text{manual pulse generator 1 pulse input magnification setting}} \right)
\]

\[
\text{Travel value (L) } = \left( \frac{\text{travel value per pulse}}{\text{pulse}} \right) \times \left( \frac{\text{number of input pulses}}{\text{pulse}} \right) \times \left( \frac{\text{manual pulse generator 1 pulse input magnification setting}}{\text{manual pulse generator 1 pulse input magnification setting}} \right)
\]

**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. POSITIONING CONTROL

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

<table>
<thead>
<tr>
<th>Error Details</th>
<th>Error Processing</th>
</tr>
</thead>
<tbody>
<tr>
<td>A digit was set outside the ranges 1-4, 1-8, or 1-32.</td>
<td>• Digit ignored where error occurred.</td>
</tr>
<tr>
<td>The designated axis is set for manual pulse generator operation.</td>
<td>• Manual pulse generator of valid axes with settings in range 1-4, 1-8, or 1-32.</td>
</tr>
<tr>
<td>More than 4 digits set</td>
<td>• Duplicated designated axis ignored.</td>
</tr>
<tr>
<td></td>
<td>• Executes the manual pulse generator operation set first.</td>
</tr>
<tr>
<td></td>
<td>• All set axes ignored</td>
</tr>
</tbody>
</table>

[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.

Start

Set manual pulse generator 1-pulse input magnification

Set manual pulse generator operation axes

Turn ON manual pulse generator enable flag.

Positioning by manual pulse generator

Turn OFF manual pulse generator enable flag.

......using a sequence program

End

using a sequence program
7. POSITIONING CONTROL

[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.

<table>
<thead>
<tr>
<th></th>
<th>M9039</th>
<th>M9074</th>
<th>X0000</th>
<th>M9074</th>
<th>M140</th>
<th>M2001</th>
<th>M9076</th>
<th>M2009</th>
<th>M9078</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>K</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CIRCUIT END

Turns ON PC ready.
Turns ON all axes servo start command.
Detects leading edge of X000 (OFF → ON)
Sets axis (Axis 1) for manual pulse generator operation.
Axis 1 manual pulse generator 1-pulse input magnification
Turns ON manual pulse generator enable flag.
Turns OFF manual pulse generator enable flag when X001 turns ON.
7. POSITIONING CONTROL

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 Used when not using an absolute position system
   - Count method
   - 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 | Inch | degree | PULSE | Defult Initial Value | Remarks | Explana-
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Setting Range</td>
<td>Units</td>
<td>Setting Range</td>
<td>Units</td>
<td>Setting Range</td>
<td>Units</td>
<td>Setting Range</td>
</tr>
<tr>
<td>1</td>
<td>Home position return direction</td>
<td>0: reverse direction (decreased address)</td>
<td>1: forward direction (increased address)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Home position return method</td>
<td>0: near-zero point dog method</td>
<td>1: count method</td>
<td>2: data set method</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Home position address</td>
<td>$-2.147483648 \times 10^{-1}$ to $2.147483647 \times 10^6$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Home position return speed</td>
<td>0.01 to 600000.00</td>
<td>mm/ min</td>
<td>0.001 to 600000.00</td>
<td>in/ min</td>
<td>0.001 to 600000.00</td>
<td>degree/ min</td>
<td>1 to 100000</td>
</tr>
<tr>
<td>5</td>
<td>Creep speed</td>
<td>0.01 to 600000.00</td>
<td>mm/ min</td>
<td>0.001 to 600000.00</td>
<td>in/ min</td>
<td>0.001 to 600000.00</td>
<td>degree/ min</td>
<td>1 to 100000</td>
</tr>
<tr>
<td>6</td>
<td>Travel value after near-zero point dog</td>
<td>0 to 2147483647</td>
<td>km</td>
<td>0 to 2147483647</td>
<td>inch</td>
<td>0 to 2147483647</td>
<td>degree</td>
<td>0 to 2147483647</td>
</tr>
<tr>
<td>7</td>
<td>Parameter block setting</td>
<td>1 to 16 (A1718/A273UHCPU (6-axis specification))</td>
<td>1 to 64 (A273UHCPU (52-axis specification))</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7.21.1 (1)
7. POSITIONING CONTROL

(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]

\[
\text{Speed limit value} V_P = 200 \text{ kpps}
\]

\[
\text{Home position return speed:} V_z = 10 \text{ kpps}
\]

\[
\text{Creep speed:} V_c = 1 \text{ kpps}
\]

\[
\text{Actual deceleration time:} t = T_b \times \frac{V_z}{V_P}
\]

\[
T_b = 300 \text{ ms}
\]

[Deceleration distance (shaded area under graph)]

\[
\frac{1}{2} \times \frac{V_z}{1000} \times t
\]

= \frac{V_z}{2000} \times \frac{T_b \times V_z}{V_P}

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

= 75 \text{ ............ Set greater than 75.}
7. POSITIONING CONTROL

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.

![Diagram of home position return](image)

*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.

![Diagram of home position change](image)

*The next zero point becomes the home position. A zero point is missed during the deceleration stop after the near-zero point dog turns OFF.*
(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. POSITIONING CONTROL

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 – 144
7. POSITIONING CONTROL

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.

![Diagram of home position return with 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. POSITIONING CONTROL

7.21.5 Home position return servo program

Home position return uses the ZERO servo instruction.

<table>
<thead>
<tr>
<th>Serve Instruction</th>
<th>Positioning Method</th>
<th>Number of Controllable Axes</th>
<th>Parameter Block No.</th>
<th>Axis</th>
<th>Address/Travel Value</th>
<th>Commanded Speed</th>
<th>Dwell Time</th>
<th>M Code</th>
<th>Torque Limit Value</th>
<th>Auxiliary Point</th>
<th>Center Point</th>
<th>Control Unit</th>
<th>Acceleration Time</th>
<th>Rapid Step Deceleration Time</th>
<th>Torque Limit Value</th>
<th>Deceleration Processing on Step Input</th>
<th>Allowable Error Range for Circular Interpolation</th>
<th>&amp; Curve Ratio</th>
<th>Speed Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZERO</td>
<td></td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

0 : 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.)

![Circuit Diagram]

Start reception flag
Home position return complete signal
M2001 M1610 M9074 M1602 [SVST J1 K 0]
CIRCUIT END
In-position signal

7 – 146
7. POSITIONING CONTROL

[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.

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>M9039</td>
<td>(M2003)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M9074</td>
<td>(M204D)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X0000 M9074 M9009 M9076</td>
<td></td>
<td>(PLS M0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M0</td>
<td></td>
<td>(SET M1 K)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M9074 M1 M2004 M1682</td>
<td>(GVBST J4 0)</td>
<td></td>
<td></td>
<td>(RST M1)</td>
</tr>
</tbody>
</table>

CIRCUIT END

Turns ON PC ready.

Turns ON all axes servo start command.

Turns ON servo program No. 0 start command flag (M1) when X000 turns ON.

Servo program No. 0 execution request.

Turns OFF M1 on completion of servo program No. 0 execution request.
7.22 High-Speed Oscillation

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

<table>
<thead>
<tr>
<th>Servo Instruction</th>
<th>Positioning Method</th>
<th>Number of Controllable Axes</th>
<th>Item Set by Peripherals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Common</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Arc</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Parameter Block</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Others</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter Block No.</th>
<th>Axis</th>
<th>Address/Travel Value</th>
<th>Commanded Speed</th>
<th>Drum Time</th>
<th>M Code</th>
<th>Torque Limit Value</th>
<th>Auxiliary Point</th>
<th>Center Point</th>
<th>Number of Pitches</th>
<th>Control Unit</th>
<th>Speed Limit Value</th>
<th>Acceleration Time</th>
<th>Deceleration Time</th>
<th>Rapid Stop Deceleration Time</th>
<th>Torque Limit Value</th>
<th>Deceleration Process at STOP Input</th>
<th>Allowable Error Range for Circular Interpolation</th>
<th>Slope</th>
<th>Cancel</th>
<th>Start</th>
<th>Speed Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desl</td>
<td>1</td>
<td>Δ 0 0 0 0 Δ</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Δ</td>
<td></td>
<td>Δ</td>
<td>Δ</td>
<td>NG</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.

![Diagram of sine wave]

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.

```plaintext
<K 5>

<table>
<thead>
<tr>
<th>OSC</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Axis</td>
<td>1</td>
</tr>
<tr>
<td>Start angle</td>
<td>90.0 [degree]</td>
</tr>
<tr>
<td>Amplitude</td>
<td>1000 [PLS]</td>
</tr>
<tr>
<td>Frequency</td>
<td>100 [CPM]</td>
</tr>
</tbody>
</table>
```