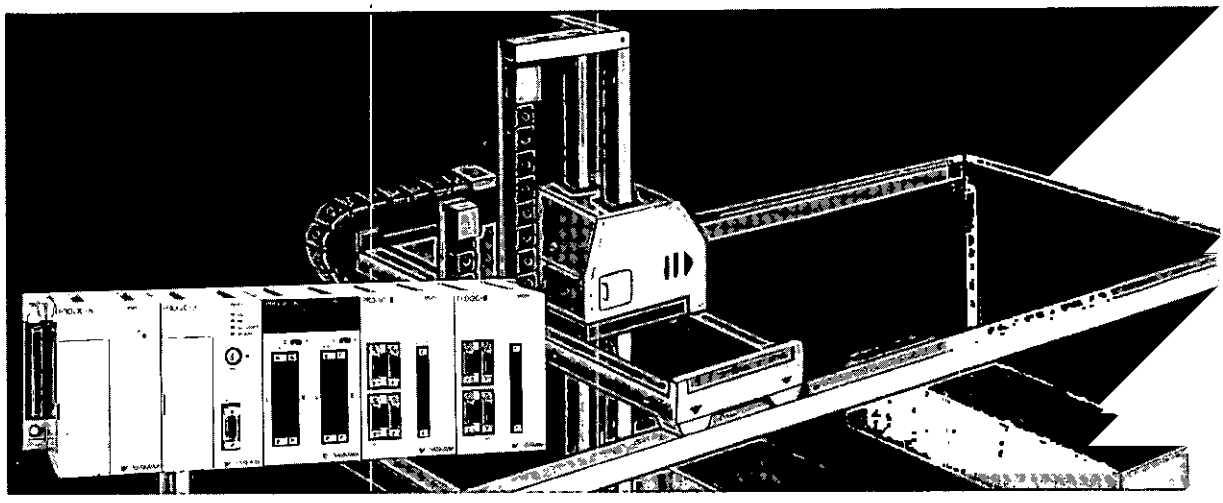
# PROGIC-8
# PROGRAMMING MANUAL FOR MC UNIT

MULTIAXES MOTION CONTROLLER



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# CONTENTS

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# 1. OUTLINE

PROGIC-8 programming manual for MC unit is outlined below.

(1) The MC unit is a compact integration of control functions for SERVOMOTORS. This unit can control four axis motion.

(2) The MC unit is connected to the PLC unit via a bus.
All commands to the MC unit are issued from the PLC unit. Monitor data such as current values can be read out on the PLC unit.

(3) Use of I/O variables in a motion program make it possible to transmit signals with a sequence program on the PLC unit. Some inputs and outputs can be assigned directly to external inputs and outputs, enabling high-speed I/O from the motion program not intervened by a sequence program.

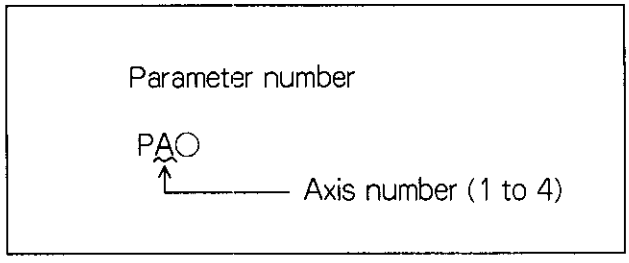
(4) From the four SERVOMOTOR axes controlled by the MC unit, any one or two axes can be selected and operated by the PLC unit independently from a motion program.
Axes assigned to this independent operation are operated only by the PLC unit, and cannot be activated by a motion program. Selection of axis cannot be changed during operation.

(5) X, Y, Z, and S axis are used in motion programs on the MC unit. Assigning axis numbers with an axis designation can be set arbitrarily. Designations A and B are assigned to independent operation axis. A and B can alse be assigned to any axis numbers.

Table 1.1 Axis Designation

| Axis No. | Axis Name | | | | | |
|---|---|---|---|---|---|---|
| | In Motion Program | | | | On the PLC | |
| 1 | X | Y | Z | S | A | B |
| 2 | X | Y | Z | S | A | B |
| 3 | X | Y | Z | S | A | B |
| 4 | X | Y | Z | S | A | B |

Notes : 1. Names cannot be duplicated.
2. Use parameters P001 to P004 set up axis designations.
3. Parameters of individual axis are referred to as PA 01 to PA99 (A for axis number 1 to 4).



## 2.1 MODE OPERATION

The MC unit supports the following four modes of operation:

① EDIT mode (EDIT)
② MANUAL mode (MANUAL)
③ AUTO mode (AUTO)
④ ONLINE-EDIT mode (ONLINE-EDIT)

To select these modes, input MOD command from the PLC unit.

(1) EDIT mode

In this mode, motion programs and parameters are loaded and saved to memory of the MC unit. Parameters are loaded and saved one by one. Programs are loaded and saved in a batch or by specifying program numbers.

(2) MANUAL mode

Jog operation and zero return are performed in this mode. To use JOG or ZRN commands on the PLC unit, input MOD command to enter MANUAL mode.

(3) AUTO mode

In this mode, a motion program stored in memory is executed. To enter AUTO mode, input MOD command used in the PLC unit. Specify a program number and a starting block number using MRS command on the PLC unit, then start up the motion program by MVL command.

(4) ONLINE-EDIT mode

When coding a program on a personal computer, current values of axis on the MC unit can be fetched in this mode. In this mode, motion by JOG command used in the PLC unit and single block operation by command from the personal computer are available. To enter ONLINE-EDIT mode, input MOD command on the PLC unit.

## 2.2 EDIT MODE (EDIT)

When all MOD command inputs on the PLC unit are OFF, the MC unit is in EDIT mode.

(1) Loading motion programs

Motion programs prepared on a personal computer can be loaded in a batch or individually by specifying program numbers. At loading, the ID code set up in advance on the MC unit (parameter P000) is compared to the ID code set up in the program file. Loading is performed if the codes coincide.

If no ID code has been set on the MC unit (that is, if 0 is set for parameter P000), ID code check is omitted. (The same ID code check is carried out at any load or save, as described below.)

(2) Saving motion programs

Motion programs stored in memory of the MC unit can be saved in a batch or individually by specifying program numbers. At saving, the ID code of the MC unit is automatically read and added to the program file.

(3) Loading parameters

Parameters prepared on a personal computer can be loaded in a batch. The same ID code check is performed in the same way as for program loading.

(4) Saving parameters

Parameters stored in memory of the MC unit can be saved in a batch. At saving, the ID code of the MC unit is automatically read and added to the parameter file.

## 2.3 MANUAL MODE (MANUAL)

Select this mode for manual operation.
To enter MANUAL mode, turn ON MOD command input 1 used in the PLC unit.

(1) Jog operation

Jog operation moves the axis selected by JOG command used in the PLC unit continuously in a specified direction at a specified speed. To start jog operation, set up axis number and speed number in the JOG command register and turn ON the forward or reverse input. Jog motion continues while the input is ON. It coasts to a stop after the input is turned OFF.

Speed numbers are common in all the axis. The speed number of the JOG command last started takes effect.

Table 2.1 Speed Number List

| Speed No. | Speed |
|---|---|
| 0 | Second feed speed set value |
| 1 | First feed speed set value × 1% |
| 2 | First feed speed set value × 2% |
| 3 | First feed speed set value × 4% |
| 4 | First feed speed set value × 6% |
| 5 | First feed speed set value × 8% |
| 6 | First feed speed set value × 10% |
| 7 | First feed speed set value × 20% |
| 8 | First feed speed set value × 30% |
| 9 | First feed speed set value × 40% |
| 10 | First feed speed set value × 50% |
| 11 | First feed speed set value × 60% |
| 12 | First feed speed set value × 70% |
| 13 | First feed speed set value × 80% |
| 14 | First feed speed set value × 90% |
| 15 | First feed speed set value × 100% |

(2) Zero return

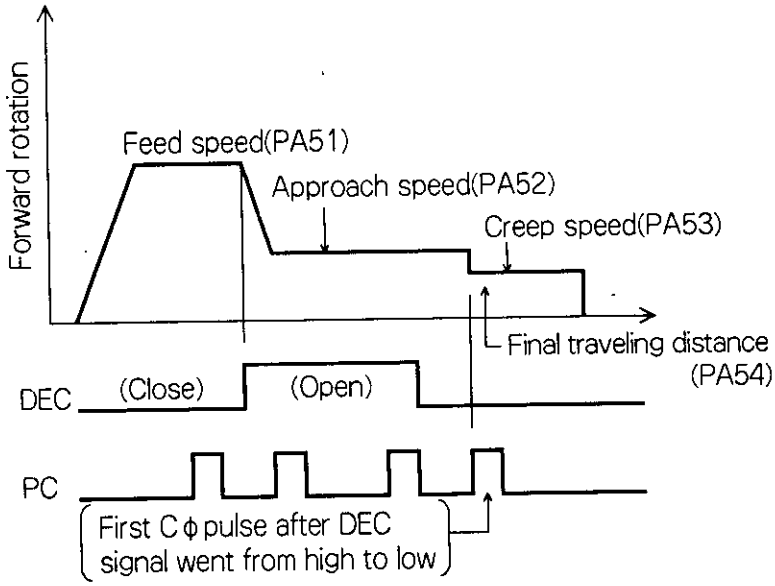
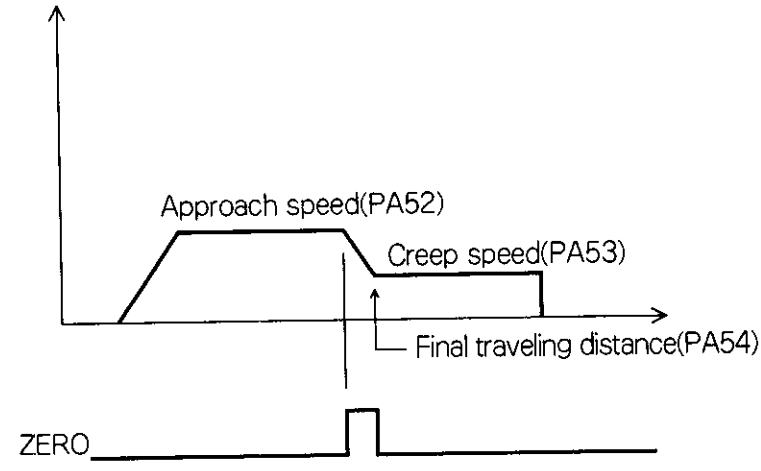
Zero return means returning the machine to the specified mechanical zero point.

Combination of a zero-pulse PG and a zero area specifying limit switch, or only a limit switch is used for zero return.

Zero return can be performed by ZRN command from the PLC unit in manual mode, or by ZRN command used in the PLC unit in manual mode, or by ZRN command in a program started from the PLC unit in auto mode. Zero return methods are switched by parameters.

● Zero return methods

Table 2.2 Zero Return Methods

| Parameter | Zero return method | |
|---|---|---|
| PA49=0, Mode Ⅰ | Three-step deceleration method using DEC signal (from deceleration LS) and Cϕ pulse signal from PG.<br><br>In mode Ⅲ (PA49=2), ZERO signal is used instead of Cϕ pulse from PG. |  |
| PA49=0, Mode Ⅱ | Two-step deceleration method using ZERO signal (from deceleration LS)<br><br>In mode Ⅳ (PA49=3), Cϕ pulse from PG is used instead of ZERO signal. |  |

◎ Zero return method 1 or 3 (parameter PA49 = 0 or 2)

① Input start command and rotation direction command of ZRN command used in the PLC unit.

② The machine moves in the specified direction at the zero return feed speed specified by parameter (PA51) .

③ The dog turns ON the deceleration limit switch, and the speed is reduced to the zero return approach speed (PA52).

④ When the first zero point pulse is detected after deceleration is completed and the dog is released from the deceleration limit switch, the speed is further reduced to the zero return creep speed (PA53).

⑤ Moving over the final traveling distance (PA54) after the zero point pulse is detected, the machine is stopped. The stop position is the specified mechanical zero point of the machine.

⑥ When zero return is completed, ZRN command completion output used in the PLC unit goes ON.

⑦ Executing ZRN command in a motion program performs the same operation, except that retracting operation is omitted in the first zero return after power-ON.

Notes: 1. After power-ON, if the machine is in area B, proper zero return is impossible. Return the machine to area A before starting zero return.
2. The dog width must be sufficient enough so that the speed can be reduced to the approach speed.
3. Either C $\phi$ pulse signal of the PG or ZERO signal from the zero point limit switch can be used for the zero point pulse.

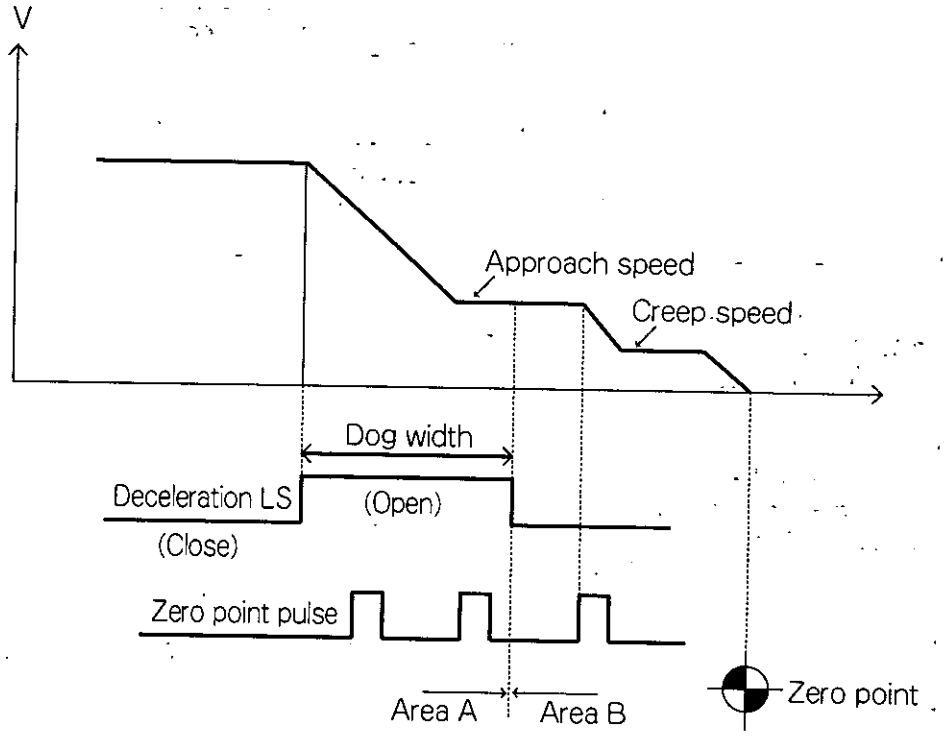



Fig. 2.1

◎ Zero return method 2or 4 (parameter PA49 = 1 or 3)

① Input start command and rotation direction command of ZRN command used in the PLC unit.

② The machine moves in the specified direction at the zero return approach speed (PA52) .

③ The dog turns ON the deceleration limit switch, and the speed is reduced to the zero return creep speed (PA53).

④ Moving over the final traveling distance (PA54) after the zero point limit switch is turned ON, the machine is stopped. The stop position is the specified mechanical zero point of the machine.

⑤ When zero return is completed, ZRN command completion output used in the PLC unit goes ON.

⑥ Executing ZRN command in a motion program performs the same operation, except that retracting operation is omitted in the first zero return after power-ON.
(See explanation on ZRN command in motion program.)

Notes: 1. After power-ON, if the machine is in area B, proper zero return is impossible.
Return the machine to area A before starting zero return.
2. Either C $\phi$ pulse signal of the PG or ZERO signal from the zero point limit switch can be used for the zero point pulse.

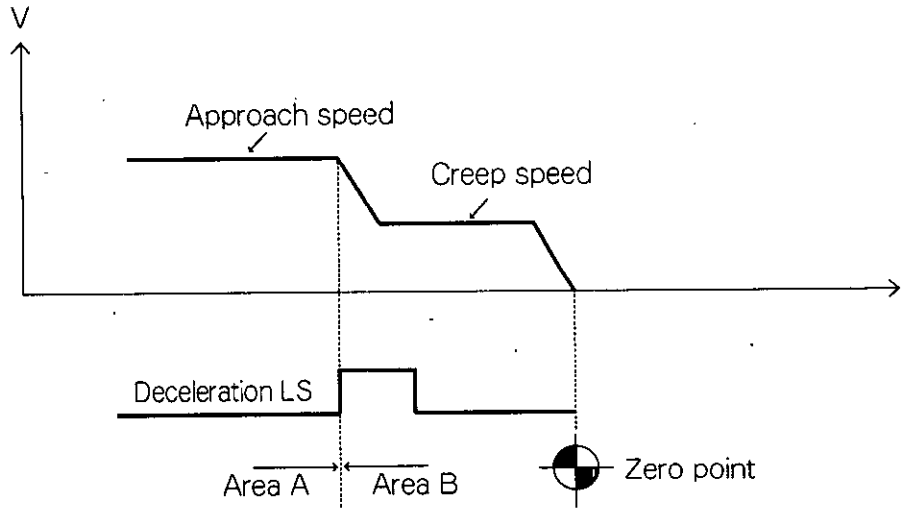



Fig. 2.2

## 2.4 AUTO MODE (AUTO)

To enter this mode, turn ON MOD command input 2 used in the PLC unit.
Select this mode to start a specified program from those in memory of the MC unit to execute automatic operation.

(1) Selecting a program

Use MRS command used in the PLC unit to set up a program number (O#) and a block number (B#) in the register, then turn ON input 1. The MC unit is reset and the specified program is selected.

(2) Starting the program

Turn ON MOD command input 2 used in the PLC unit to enter AUTO mode.
Then use MVL command used in the PLC unit to input start signal (input 1).
The program selected by MRS command is started.

(3) Halting the program

Turn ON the temporary stop signal (FEED HOLD) while the program is being executed.
The machine coasts to a stop. When the signal is turned OFF, operation is resumed.
Only motion commands are stopped while they are being executed. If FEED HOLD signal is input during operation of a non-motion command, the machine is stopped after the operation is completed.

(4) Single-block operation

A program can be executed block by block. Execute SMD command (turn ON input 1) used in the PLC unit while MVL command is being executed.
The machine completes the ongoing motion, then stops.
After that, each time MVL command input 1 is turned ON, a single block is executed.
To restart continuous operation, turn OFF SMD command input 1 and turn ON MVL command input 1.

(5) Intervention of manual operation

If manual operation intervenes in automatic operation, the original trajectory is shifted by the displacement resulting from the manual operation.
If manual mode is selected by MOD command during execution of MVL command used in the PLC unit, operation is stopped immediately.
Then axis is moved using jog operation and return to auto mode by executing MVL command. (turn ON input 1.)
Operation is restarted along the shifted trajectory regardless of selection of absolute or incremental mode.
Note that the manual operation displacement is canceled when END command is executed or MRS (reset) command used in the PLC unit is executed.

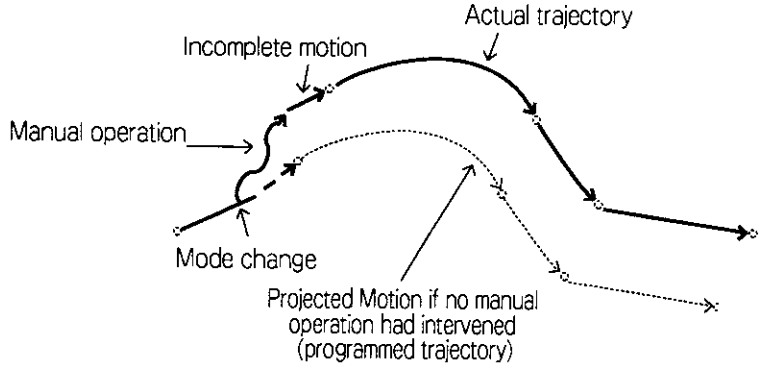



Fig. 2.3

(6) Look ahead buffer

A block is a line in a motion program. In normal operation, data of two blocks are read in advance of execution and processed to get ready. Data of up to 128 characters can be contained in a single block.

If the beginning of the block read in advance is not a SERVOMOTOR control command and there is no PFN command in the block where SERVOMOTOR control command is being executed, the read block is executed immediately.

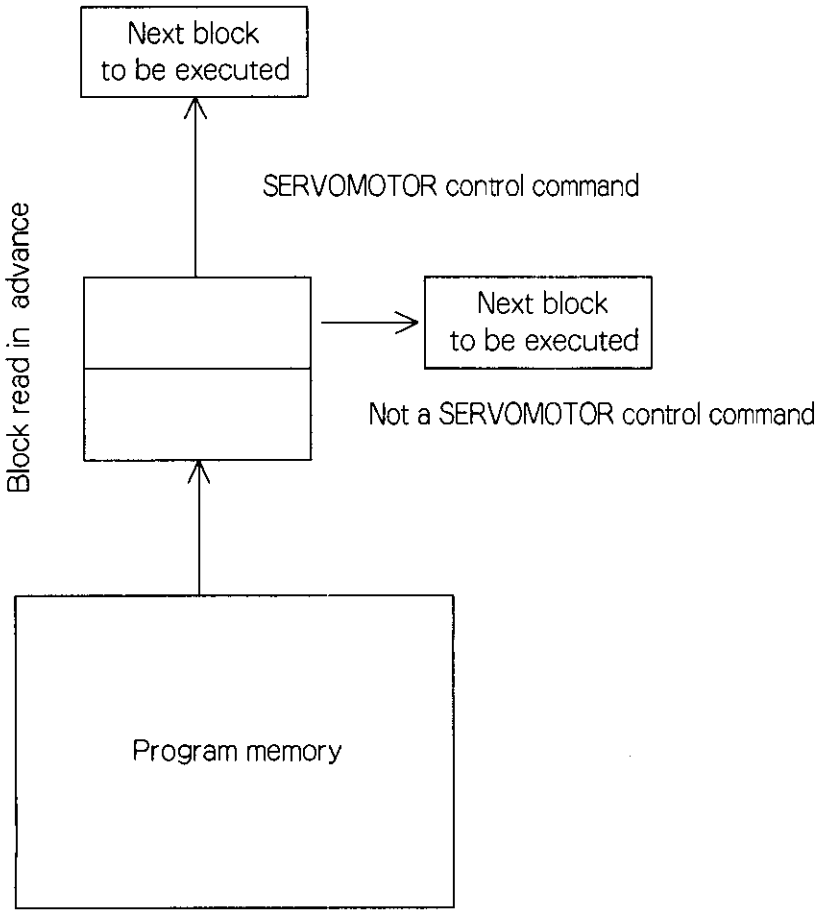



Fig. 2.4

## 2.5 ONLINE-EDIT MODE (ONLINE-EDIT)

To enter this mode, turn ON MOD command input 3 used in the PLC unit. In this mode, position moved by jog operation can be stored in the memory.
The developed program can be executed block by block in this mode.

## 2.6 AUTOMATIC ACCEL/DECEL

Different accel/decel controls are automatically applied to rapid traverse, interpolation feed and winding operation. There are exponential, 1-step linear, 2-step linear, and S-curve accel/decel controls.
Table 2.3 lists combinations of a command, accel/decel type, and override.

Table 2.3

| | Acce/decel / Operation command | Exponent | Selection by parameter | | | Override | |
|---|---|---|---|---|---|---|---|
| | | | 1-step linear | 2-step linear | S-curve | Fast traverse | Interpolation |
| MC unit | MVS | Fixed | — | — | — | — | ○ |
| | MCW/MCC | Fixed | — | — | — | — | ○ |
| | MOV | — | ○ | ○ | ○ | ○ | — |
| | ZRN | — | ○ | ○ | ○ | — | — |
| PLC unit | JOG | — | ○ | ○ | ○ | ○ | — |
| | ZRN | — | ○ | ○ | ○ | — | — |
| | MVA | — | ○ | ○ | ○ | — | — |
| | MVB | — | ○ | ○ | ○ | — | — |

Note : Three forms of accel/decel can be selected for each axis except for interpolation.
○: available
—: not available

(1) Exponential accel/decel

Exponential accel/decel is applied to interpolation operation.

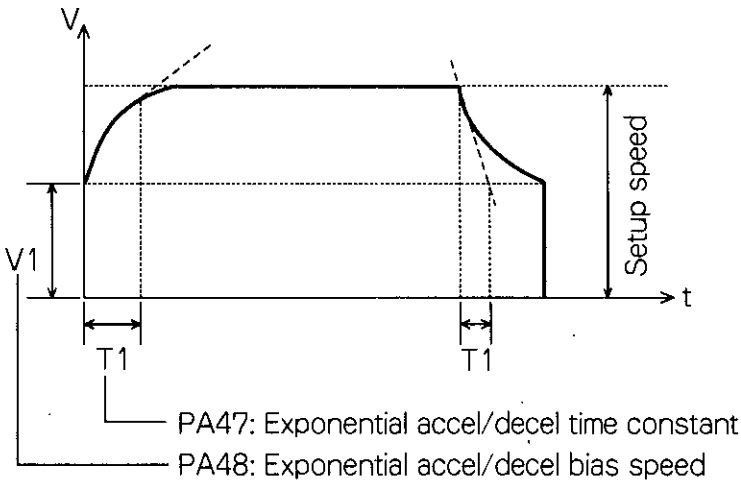



Fig. 2.5

For exponential deceleration, exponential accel/decel bias speed is set to reduce the time it takes to stop.
The exponential accel/decel time constant must be set in increments of 8 milliseconds.
The exponential accel/decel bias speed must be set in units of commands per minute.

(2) 1-step linear accel/decel

If 1-step linear accel/decel is selected, the speed changes as shown below.

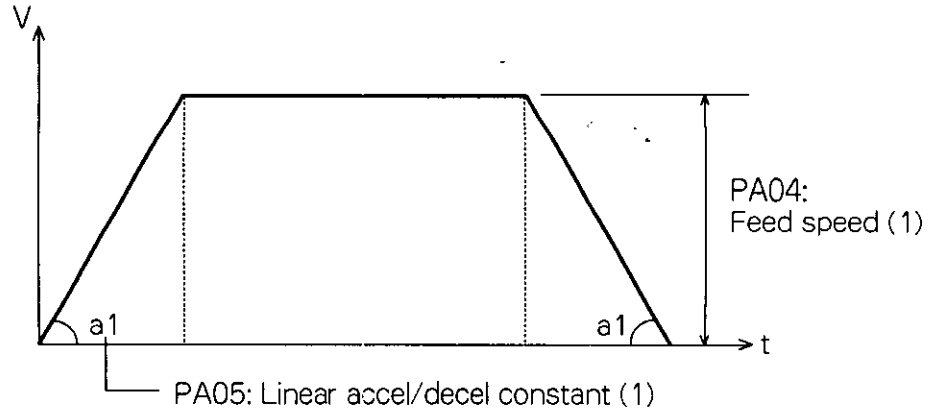



Fig. 2.6

The linear accel/decel constant must be set in increments of 15625 (command units)/$S^2$.

PA05 = PA04 / (60×15625×t)

t: Time constant to reach the PA04 speed (sec)

Set up PA05 so as to satisfy the above formula.

(3) 2-step linear accel/decel

If 2-step linear accel/decel is selected, the speed changes as shown below.

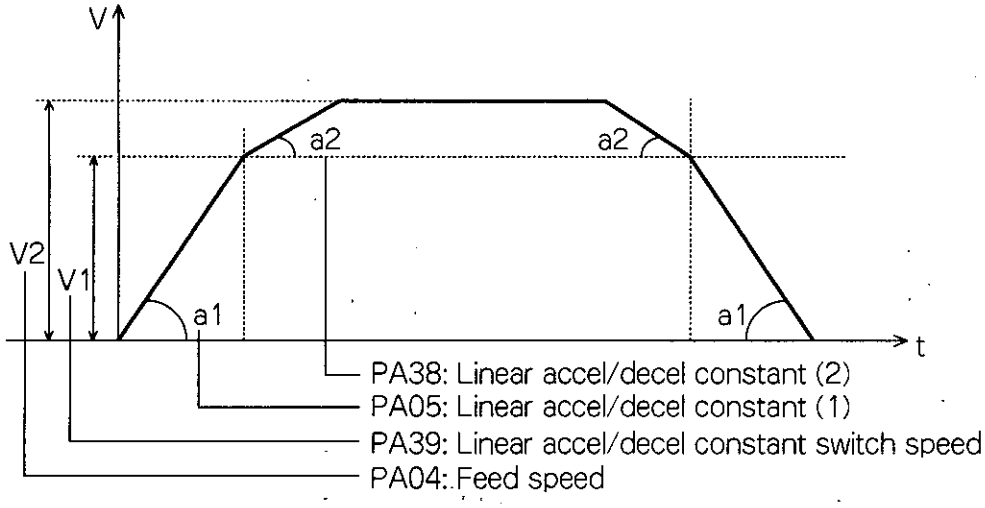



Fig. 2.7

The linear accel/decel constant must be set in increments of 15625 (command units) $S^2$.

(4) S-curve accel/decel

If S-curve accel/decel is selected, the speed changes as shown below.

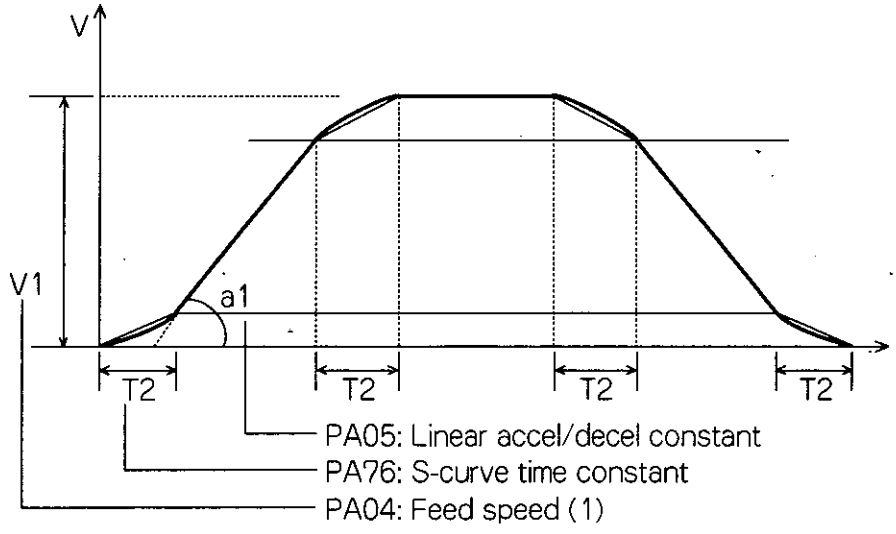



Fig. 2.8

## 2.7 INTERPOLATION SPEED SETTING

(1) Interpolation speed is specified by address F. Maximum speed may be limited by servo and mechanical systems: address F speed cannot exceed the upper limit set for each axis in the speed limit (PA46).

(2) For an address F of linear or circular interpolation using two axis, specify the speed in the tangent direction.

[Example 1] MVS X1200 Y90 F500;
$F = 500 = \sqrt{400^2+300^2}$ [mm/min.]

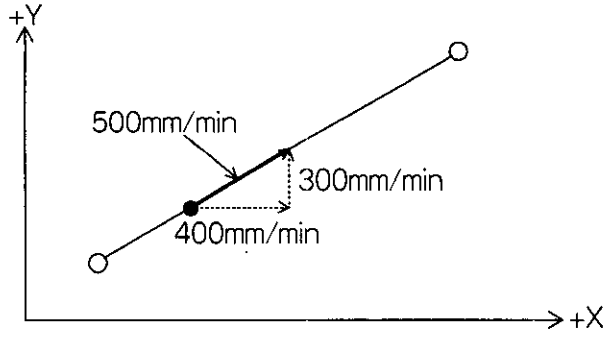



Fig. 2. 9

[Example 2] MCC X--- Y--- I--- Y--- F200;
$F = 200 = \sqrt{fx^2+fy^2}$ [mm/min.]

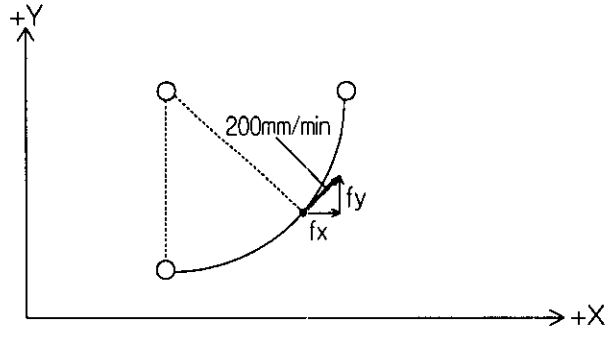



Fig. 2. 10

(3) For an address F of linear interpolation using three axis, also specify the speed in the tangent direction.

[Example ] MVS X1000 Y1000 Z1000 F400;
$F = 400 = \sqrt{fx^2+fy^2+fz^2}$ [mm/min.]

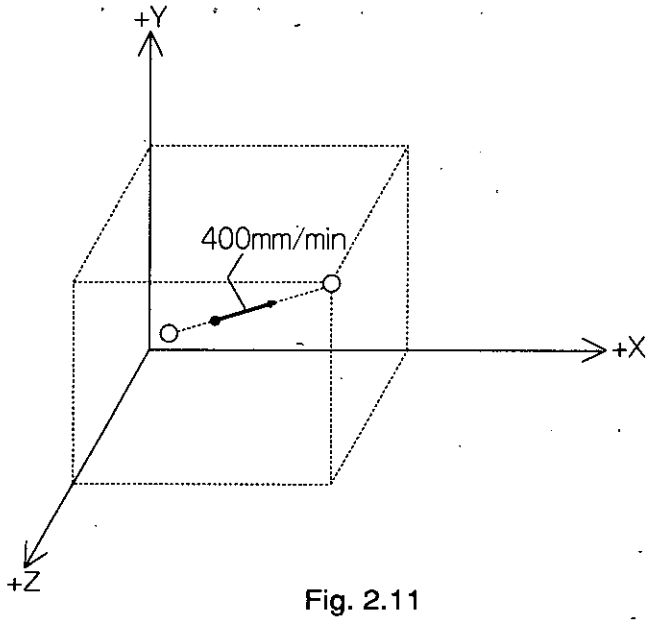



Fig. 2.11

(4) Note that if a rotation axis is included in interpolation axis, the machine tangent speed does not coincide with the speed specified in address F.

(5) Address F can be overridden. Select 50% to 200% for the interpolation feed override number in MVL command used in the PLC unit. For example, when a 50% override rate is selected, interpolation is carried out at half of the programmed speed.

Table 2.4 lists interpolation feed override numbers the modified (overridden) values.

Table 2.4

| No. | Override rate | No. | Override rate | No. | Override rate | No. | Override rate |
|---|---|---|---|---|---|---|---|
| 0 | 50% | 4 | 90% | 8 | 130% | 12 | 170% |
| 1 | 60% | 5 | 100% | 9 | 140% | 13 | 180% |
| 2 | 70% | 6 | 110% | 10 | 150% | 14 | 190% |
| 3 | 80% | 7 | 120% | 11 | 160% | 15 | 200% |

## 2.8 INDEPENDENT OPERATION AXIS CONTROL

(1) Outline

From the four axis connected to the MC unit, any two axis can be designated as independent operation axis (axes A and B).

The independent operation axis move according to operation command used in the PLC unit. (They cannot be operated by a motion program.)

Independent operation axis are selected by parameters set up in advance, and neither of the parameters can be varied during operation nor can they be modified from a motion program.

Axes other than the selected independent operation axes are operated as programmed.

Use of two units can be set at will. Operation between units cannot be synchronized.

(2) Starting

Use MVA and MVB commands used in the PLC unit to set up target coordinates and move speeds in registers, then turn ON start (input 1) to start motion.

(3) Halt

Turn ON the temporary stop signal (FEED HOLD) during motion. The machine coasts to a stop. When the signal is turned OFF, operation is continued.

(4) Command mode

Either of the incremental values (displacements) or absolute values (target coordinates) can be set as coordinate data in an MVA or MVB command, specified by the command mode (in a register).

(5) Jog operation

Jog operation is available by JOG command used in the PLC unit (by specifying axis numbers).

(6) Zero return

Zero return is available by ZRN command used in the PLC unit.

Zero return cannot be executed from a motion program.

Examples of selection of program operation axis and independent operation axis in 2-, 3-, and 4-axis systems are shown below.

(i) In a 2-axis system

| | Axis 1 | Axis 2 | Operation method |
|---|---|---|---|
| 1 | X | Y | XY program operation |
| 2 | A | B | Independent A + Independent B |

(ii) In a 3-axis system

| | Axis 1 | Axis 2 | Axis 3 | Operation method |
|---|---|---|---|---|
| 1 | X | Y | Z | XYZ program operation |
| 2 | X | Y | A | XY program operation + independent A |
| 3 | X | A | B | X program operation + independent A + independent B |

(ii) In a 4-axis system

| | Axis 1 | Axis 2 | Axis 3 | Axis 4 | Operation method |
|---|---|---|---|---|---|
| 1 | X | Y | Z | S | XYZS program operation |
| 2 | X | Y | Z | A | XYZ program operation + independent A |
| 3 | X | Y | A | B | XY program operation + independent A + independent B |

## 3.1 PARAMETER LIST

In order to build a particular system by connecting servo amplifiers, SERVOMOTORS and / or machines, control specifications of the MC unit need to be tailored for the machines so as to implement specific required operations. To do so, constants called the parameters must be set.

Table 3.1 is a list of the parameters. The parameters determine fundamental performance of motion control. Set proper values based on the mechanical and control specifications.

(1) Initial values

The initial values on the table are preset at the factory.

Checksum of the parameters is carried out after power is turned ON.

If an error occurs during the checksum, an alarm is issued and "No.79: PARAMETER SUM ERROR" is displayed, indicating that parameters need to be reset.

(2) Modification of parameters

Parameters can be modified either by ① preparing a parameter table on the programming panel and loading it to the MC unit or by ② using parameter setup command (PRM) from the sequence ladder diagram.

Method ①, data are retained after control power is turned OFF.

Method ②, unmodified data is restored after control power is turned OFF.

Note that some parameters cannot be modified from the ladder diagram. (See Table 3.1.)

Motion control parameters are classified as follows depending on how often they need to be set.

A: Need to be set up for routine operations
B: Need to be set up on occasions
C: Do not need to be set normally
D: Must not be modified (Fixed to factory setting and not supposed to be changed by the user)

(3) Related parameters

There are correlated parameters, for example, if parameter PA18 is set "not to use software limit switch", parameters PA40 and PA41 are invalid.

(4) Common parameters and parameters for individual axis

There are parameters that take effect for all axis in common and those that must be set separately for individual axis.

Common parameters are P000 to P099. Axis-specific parameters are PA01 to PA99. (A stands for axis numbers 1 to 4.)

(5) Parameter list

Table 3.1 Parameter List (Common parameters)

| Parameter No. | Name | Range | Unit | Related parameter no. | Rewrite from the ladder | Effecfive timing of change | Initial value | Parameter type |
|---|---|---|---|---|---|---|---|---|
| P000 | ID code | 4 half-size alphanumeric characters | ASCII | | × (Impossible) | Immediately | 0 | B |
| P001 | Axis 1 selection<br>b0=X<br>b1=Y<br>b2=Z<br>b3=S<br>b4=A<br>b5=B | Set 1 for just one bit from b0 to b5. (The axis is not used when all the bits are 0.) | Characters are used in personal computer P.P. | | × | Power-ON | 1 (X) | C |
| P002 | Axis 2 selection<br>b0=X<br>b1=Y<br>b2=Z<br>b3=S<br>b4=A<br>b5=B | Set 1 for just one bit from b0 to b5. (The axis is not used when all the bits are 0.) | Ditto | | × | Power-ON | 2 (Y) | C |
| P003 | Axis 3 selection<br>b0=X<br>b1=Y<br>b2=Z<br>b3=S<br>b4=A<br>b5=B | Set 1 for just one bit from b0 to b5. (The axis is not used when all the bits are 0.) | Ditto | | × | Power-ON | 4 (Z) | C |
| P004 | Axis 4 selection<br>b0=X<br>b1=Y<br>b2=Z<br>b3=S<br>b4=A<br>b5=B | Set 1 for just one bit from b0 to b5. (The axis is not used when all the bits are 0.) | Ditto | | × | Power-ON | 8 (S) | C |
| P005 | Decimal point | | | | × | Reset | 3 | B |

Table 3.1 Parameter List (Common parameters ) (Cont'd)

| Parameter No. | Name | Range | Unit | Related parameter no. | Rewrite from the ladder | Effecfive timing of change | Initial value | Parameter type |
|---|---|---|---|---|---|---|---|---|
| P006 to P009 | Reserved | | | | | | | |
| P010 | Interpolation feed maximum speed | 1 to 240000 | Command units (×1000)/min | | ○ | Immediately | 24000 | A |
| | | | | | | | | |

Table 3.1 Parameter List (Individual axis parameters) (Cont'd)

(A: axis number 1 to 4)

| Parameter No. | Name | Range | Unit | Related parameter no. | Rewrite from the ladder | Effecfive timing of change | Initial value | Parameter type |
|---|---|---|---|---|---|---|---|---|
| PA01 | Position loop gain; Kp | 0-200 | $S^{-1}$ | | ○ (Possible) | Reset | 30 | A |
| PA02 | Reserved | | | | | | | |
| PA03 | Reserved | | | | | | | |
| PA04 | Feed speed 1 | 1-240000 | Command units (X1000)/min. | | ○ | Immediately | 60 | A |
| PA05 | Linear accel/decel constant (1) | 1-32767 | 15625 (command units)/$S^2$ | | ○ | Reset | 100 | A |
| PA06 | Positioning completion range | 1-250 | Command units | 07 | ○ | Reset | 1 | A |
| PA07 | Positioning completion check time | 1-32767 | mS (multiple of 2) | 06 | ○ | Reset | 0 | A |
| PA08 | Encoder pulse | 32768 | Pulses | 63 | × | Power-ON | 2048 | C |
| PA09 | Servo tracking error | 1-99999999 | Pulses | | ○ | Reset | 30000 | A |
| PA10 | Reserved | | | | | | | |
| PA11 | Machine rotation/ command unit | 1-1500000 | Command unit | | × | Power-ON | 32768 | A |
| PA12 | Gear ratio (motor rotation speed) | 1-10000000 | Rotations | | × | Power-ON | 1 | A |
| PA13 | Gear ratio (motor rotaition speed) | 1-10000000 | Rotations | | × | Power-ON | 1 | A |
| PA14 | Mode selection<br>b0: Motor rotation direction (reverse connection)<br>b1: Finite/infinite<br>b2: Linear/rotary | 0: Forward rotation<br>1: Reverse rotation<br>0: Finite length<br>1: Infinite length<br>0: Linear type<br>1: Rotary type | ——<br>——<br>—— | —<br>18-b0<br>— | × | Power-ON | 0<br>0<br>0 | B<br>B<br>C |

Table 3.1 Parameter List (Individual axis parameters) (Cont'd)

| Parameter No. | Name | Range | Unit | Related parameter no. | Rewrite from the ladder | Effecfive timing of change | Initial value | Parameter type |
|---|---|---|---|---|---|---|---|---|
| PA15 | Reserved | | | | | | | |
| PA16 | Reserved | | | | | | | |
| PA17 | Function selection 1 | | | | × | Reset | | |
| | b1: Reserved | | | | | | | |
| | b2: 2-step accel/ decel | 0 : 1-step 1 : 2-step | —— | 38,39 | | | 0 | B |
| | b3: Speed limit | 0 : Not limited 1 : Limited | —— | 46 | | | 0 | B |
| | b4: Accel/decel type selection | 0 : Not specified 1 : Specified | —— | 68to71 76,77 47,48 | | | 0 | B |
| PA18 | Function selection 2 | | | | × | Power-ON | | |
| | b0: Soft LS | 0 : Not used; 1 : Used | —— | 40,41 | | | 0 | B |
| | b1: Backlash compensation | 0 : Not used; 1 : Used | —— | 42 | | | 0 | B |

Table 3.1 Parameter List (Individual axis parameters) (Cont'd)

| Parameter No. | Name | Range | Unit | Related parameter no. | Rewrite from the ladder | Effecfive timing of change | Initial value | Parameter type |
|---|---|---|---|---|---|---|---|---|
| PA19 | Function selection 3<br>b0: OT signal<br><br>b2: Brake release signal | <br>0 : Not masked ;<br>1 : Masked<br>0 : Not masked (used) ;<br>1 : Masked (not used) | <br>——<br>—— | <br>19-b6<br>72-b1 | × | Power-ON | | |
| PA20 | Function selection 4<br>B3: S-curve accel/decel | 0 : Not used ;<br>1 : Used | | 68,70 71 | × | Reset | 0 | B |
| PA21<br>to<br>PA30 | Reserved | | | | | | | |
| PA31 | Feed speed 2 | 1-240000 | Command units (×1000)/min. | —— | ○ | Immediately | 1 | A |
| PA32<br>to<br>PA34 | Reserved | | | | | | | |

Table 3.1 Parameter List (Individual axis parameters) (Cont'd)

| Parameter No. | Name | Range | Unit | Related parameter no. | Rewrite from the ladder | Effecfive timing of change | Initial value | Parameter type |
|---|---|---|---|---|---|---|---|---|
| PA35 | Reserved | | | | | | | |
| PA36 | Reserved | | | | | | | |
| PA37 | Reserved | | | | | | | |
| PA38 | Linear accel/decel constant (2) | 1-32767 | 15625 (command units)/$S^2$ | 4,5 39 | ○ | Reset | 100 | B |
| PA39 | Linear accel/decel constant switch speed | 1-240000 | Command units (×1000)/min. | 4,5 39 | ○ | Reset | 24000 | B |
| PA40 | Forward direction soft LS | +99999999 to -99999999 | Command unit | 18-b0 | ○ | Reset | +99999999 | B |
| PA41 | Reverse direction soft LS | +99999999 to -99999999 | Command unit | 18-b0 | ○ | Reset | -99999999 | B |
| PA42 | Backlash compensation | 0-32768 | Pulses | 18-b1 | ○ | Reset | 0 | B |
| PA43 | Brake time | 8-1000 | ms | | ○ | Reset | 8 | B |
| PA44 | Brake-ON motor rotation speed | 1-10000 | r/min | | ○ | Reset | 1 | B |
| PA45 | Reserved | | | | | | | |
| PA46 | Speed limit | 0-240000 | Command units (×1000)/min. | 17-B3 | ○ | Immediately | 24000 | B |
| PA47 | Exponential accel/ decel time constant | 8-1000 | mS | | ○ | Reset | 100 | B |
| PA48 | Exponential accel/ decel bias speed | 0-24000 | Command units (×1000)/min. | | ○ | Reset | 0 | B |

Table 3.1 Parameter List (Individual axis parameters) (Cont'd)

| Parameter No. | Name | Range | Unit | Related parameter no. | Rewrite from the ladder | Effecfive timing of change | Initial value | Parameter type |
|---|---|---|---|---|---|---|---|---|
| PA49 | Zero return mode | 0 : DEC+C<br>1 : ZERO<br>2 : DEC+ZERO<br>3 : C | | 49<br>50<br>51<br>52<br>53<br>54<br>55<br>56 | × | Power-ON | 1 | B |
| PA50 | Zero return direction | 0 : Forward direction;<br>1 : Reverse direction | | | × | Power-ON | 0 | B |
| PA51 | Zero return feed speed | 1-240000 | Command units (×1000) /min. | | ○ | Reset | 1 | B |
| PA52 | Zero return approach speed | 1-240000 | Command units (×1000) /min. | | ○ | Reset | 1 | B |
| PA53 | Zero return creep speed | 1-240000 | Command units (×1000) /min. | | ○ | Reset | 1 | B |
| PA54 | Zero return final traveling distance | 0-99999999 | Command unit | | ○ | Reset | 0 | B |
| PA55 | Zero point position output width | 0-32767 | Pulses | | ○ | Reset | 10 | B |
| PA56 | Zero point pulse polarity selection | 0,1 | 0 : Rising edge ;<br>1 : Falling edge | | × | Power-ON | 0 | C |
| PA57 to PA62 | Reserved | | | | | | | |

Table 3.1 Parameter List (Individual axis parameters) (Cont'd)

| Parameter No. | Name | Range | Unit | Related parameter no. | Rewrite from the ladder | Effecfive timing of change | Initial value | Parameter type |
|---|---|---|---|---|---|---|---|---|
| PA63 | Pulse signal form | Phases-A and-B,<br>0 : multiplied by 1<br>1 : multiplied by 2<br>2 : multiplied by 4 | —— | 18 | × | Power-ON | 2 | B |
| PA64 to PA67 | Reserved | | | | | | | |
| PA68 | Accel/decel type (MOV) | 0 : 1-step linear<br>1 : 2-step linear<br>2 : S-curve | | | × | Reset | 0 | B |
| PA69 | Accel/decel type (JOG) | 0 : 1-step linear<br>1 : 2-step linear<br>2 : S-curve | | | × | Reset | 0 | B |
| PA70 | Accel/decel type (MVA/MVB) | 0 : 1-step linear<br>1 : 2-step linear<br>2 : S-curve | | | × | Reset | 0 | B |
| PA71 | Accel/decel type (ZRN) | 0 : 1-step linear<br>1 : 2-step linear<br>2 : S-curve | | | × | Reset | 0 | B |
| PA72 | Reserved | | | | | | | |
| PA73 to PA75 | Reserved | | | | | | | |
| PA76 | S-curve time constant | 8-128 | ms | 20-b3 | × | Reset | 8 | B |
| | | | | | | | | |
| PA77 to PA99 | Reserved | | | | | | | |

## 3.2 ID CODE

Parameter P000 serves as the MC unit ID code.
The ID code prevents inadvertent loading of motion programs and parameters from one system to other MC units.

If no ID code is set in P000 (containing 0 = ASCII NULL CODE), no ID check is performed that programs and parameters can be loaded and saved to any MC unit. Once parameters including P000 containing an ID code is loaded to MC unit, any attempt to load a program or parameter file lacking that particular ID code is rejected.

| Program and parameter file | | ID check | | MC unit (P000) |
|---|---|---|---|---|
| No ID is set | → | Not performed | → | No ID is set |
| | ← | Not performed | ← | |
| ID is set | → | Not performed | → | No ID is set |
| | ← | Performed | ← | |
| No ID is set | → | Performed | → | ID is set |
| | ← | Performed | ← | |
| ID is set | → | Performed | → | ID is set |
| | ← | Performed | ← | |

Note : The ID of a file is not the value of P000 but an ID set in the header of the file.

## 3.3 FUNDAMENTAL PARAMETERS

This section explains parameters related to peripheral equipment, including mechanical constants, units, and SERVOPACK and SERVOMOTOR specifications.

Parameters explained in this section are as shown below.

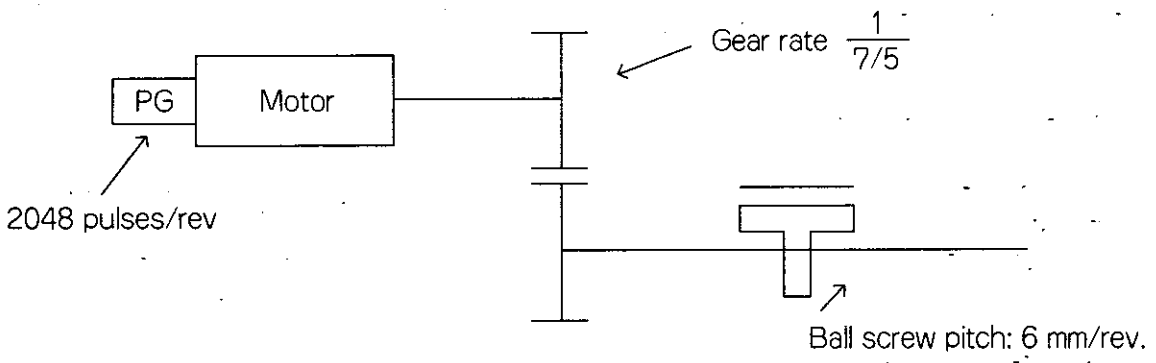
| | | | |
|---|---|---|---|
| PA06 | Positioning completion range | PA14-b0 | Motor rotation direction forward/reverse |
| PA07 | Positioning completion check time | PA14-b1 | Finite length/infinite length |
| PA08 | Number of encoder pulses | PA14-b2 | Linear/rotary |
| PA11 | One load rotation/Command unit | PA63 | Pulse signal selection |
| PA12 | Gear ratio (motor rotation speed) | | |
| PA13 | Gear ratio (load rotation speed) | | |
| PA18-b0 | Software limit switch | PA40 | Forward soft limit |
| | | PA41 | Reverse soft limit |
| PA18-b1 | Use of backlash compensation | PA42 | Amount of backlash compensation |

### 3.3.1 Command Unit (Positioning Command Unit)

The command unit is the minimum positioning unit at load side.
(It can be 0.001 mm, 0.01 mm, or 0.1 degree, etc.)
Command unit must be determined considering mechanical specifications and positioning precision.
A position detection unit (traveling distance per pulse) is determined by the drive system and position detector.
The command unit is used in position and speed commands to the SERVOPACK, which must be determined related to the position detection unit.
For instance, if command unit is set to be 0.001 mm, calculate how many pulses equal that distance.

To convert the command unit to the position detection unit and vice versa, use the following parameters.
Parameter PA08 : Number of encoder pulses
Parameter PA11 : Distance of load per load rotation/command unit
Parameter PA12 : Gear ratio (motor rotation speed)
Parameter PA13 : Gear ratio (load rotation speed)

(Example) PA11, PA12, and PA13 in positioning equipment shown in the figure are determined as follows.




| | |
|---|---|
| Ball screw pitch : | 6 mm/rev. |
| Gear rate : | 1/R = 1/7/5 |
| PG count : | 8192 = 2048×4 |
| Position command unit : | 1/1000 mm |

$$PA11 = \frac{6\ mm}{0.001\ mm} = \boxed{6000}$$

PA12 = [7] (motor rotation speed)
PA13 = [5] (load rotation speed)
} 5 load revolutions for 7 motor revs.

Set the figures in [ ] for the parameters.

To convert the command unit to the number of pulses counted by the detector (encoder), calculate as follows.

$$\frac{B}{A} = \frac{(PA08)\times(\text{multiplier } PA63)\times(PA12)}{(PA11)\times(PA13)}\ \text{(pulse/command unit)}$$

B/A is the number of pulses per command unit from the multiplying equation.

B/A must satisfy the condition on the right. $0.01 \leqq B/A \leqq 100$

This is because of the round-off error in converting the command unit into the detection unit. If the above condition is not met, review mechanical specifications.

Note : Neither A {(parameter PA11)×(parameter PA13)} nor B {(parameter PA8)×(multiplier PA63)×(parameter PA12)} must exceed 2147483647.

Calculation with actual values using the previous example is as follows.

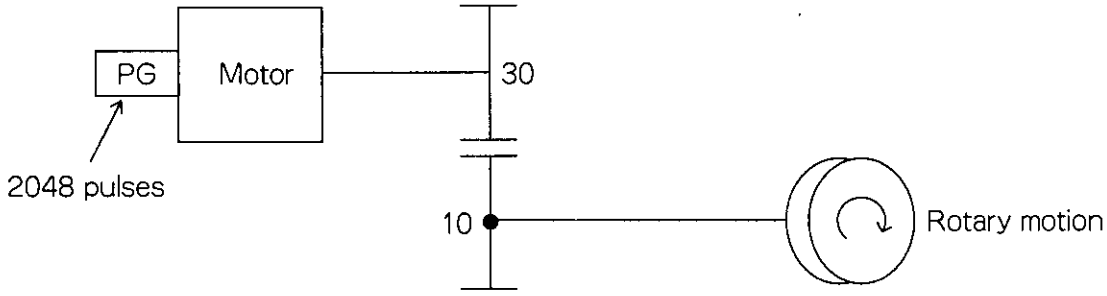
$$\frac{B}{A} = \frac{\boxed{2048} \times \boxed{4} \times \boxed{7}}{\boxed{6000} \times \boxed{5}} \fallingdotseq 1.91 \text{ pulses/0.001 mm}$$

The obtained value (1.91) satisfies the condition.

[Caution with B/A < 1]

When the command unit is less than the encoder pulse resolution, smaller B/A positioning precision becomes less accurate.

(Example) Parameter setting for rotary motion




| | |
|---|---|
| Rotary load : | 360°/rev. |
| Gear rate : | 1/R = 1/10/30 |
| PG count : | 8192 = 2048×4 |
| Position command unit : | 0.1deg |

PA08 = 2048

$$PA11 = \frac{360^\circ}{0.1^\circ} = \boxed{3600}$$

PA12 = [10] (Motor rotation speed)
PA13 = [30] (Load rotation speed)
} 30 load rotations for 10 motor rotations

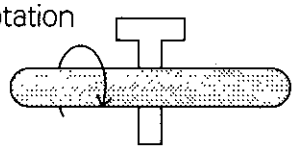
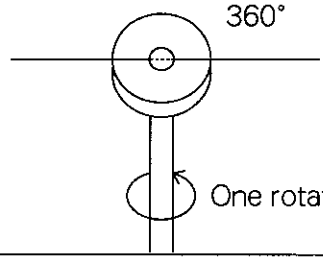
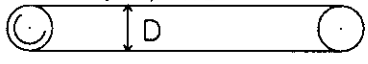
$$\frac{B}{A} = \frac{2048 \times 4 \times 10}{3600 \times 30} \fallingdotseq 0.759 \text{ pulses/command units (0.1 deg.)}$$

The obtained value satisfies the condition. (0.01 < 0.759 < 100)

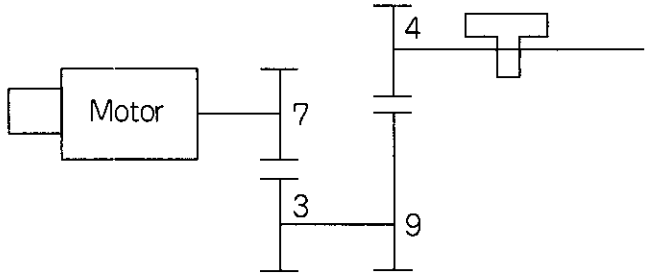
## 3.3.2 Parameters Related to Command Unit

Table 3.2 explains the parameters related to the command unit.

**Table 3.2 Parameters Related to Command Unit**

<table>
<tr><th>Parameter No.</th><th>Name</th><th>Explanation</th><th>Initial value</th></tr>
<tr><td>PA11</td><td>One load rotation/ command unit</td><td>This parameter gives the amount of load movement resulting from one rotation of the load. Set value as distance per load rotation divided by the command unit.<br>PA11 = load movement per load rotation/command unit<br><br>Examples of load movement per axis rotation are given below.<br><table><tr><th>Movement per rotation of the load axis</th><th colspan="2">Load configuration</th></tr><tr><td>P</td><td>Ball screw</td><td>One rotation<br>  <br>P : Ball screw pitch</td></tr><tr><td>360°</td><td>Round table</td><td>360°<br>  <br>One rotation</td></tr><tr><td>π D</td><td>Belt</td><td>One rotation ⟷ π D<br>  <br>D</td></tr></table>Range of PA11: 0 to 1500000<br><br>(Example) Load movement per load axis rotation: 12 mm<br>Command units : 0.001 mm<br><br>PA11 = 12 mm/0.0001 mm = 12000<br>Set [12000] for PA11.</td><td>32768</td></tr>
</table>

**Parameters related to command unit (cont'd)**

| Parameter No. | Name | Explanation | Initial value |
|---|---|---|---|
| PA12 | Gear ratio (motor axis rotation speed) | This parameter sets a gear ratio. Assume that the load axis makes n turns while the motor axis complying with applicable machine specifications turns m times :<br><br>Set m for PA12 and n for PA13. | 100 |
| PA13 | Gear ratio (load axis rotation speed) | Range : 1 to 10000000<br>Unit : Revolutions<br>(Example)<br>  <br><br>Gear ratio 1/R = 3/7 × 4/9 = 4/21<br><br>Set [4] for PA12 and [21] for PA13.<br><br>Note : Even if the ratio is 1 : 1, use larger figures, such as 100 : 100. | 100 |
| PA08 | Number of encoder pulses | Set the number of encoder pulses generated in unit time. (Set the number before being multiplied.) | 2048 |
| PA63 | Encoder pulse signal selection | Select the multiplication factor of encoder pulses.<br>0 : ×1<br>1 : ×2<br>2 : ×4 | |

## 3.4 PARAMETERS DEPENDENT ON MECHANICAL SPECIFICATIONS

Table 3.3 lists the parameters dependent on mechanical specifications.

**Table 3.3 Parameters Dependent on Mechanical Specifications**

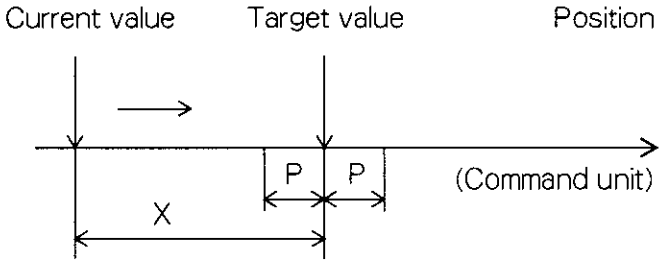
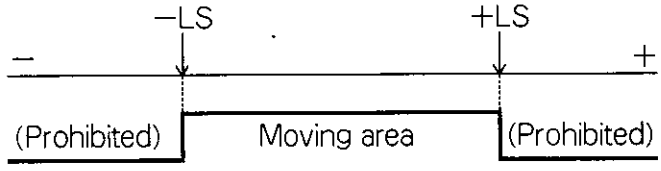
| Parameter No. | Name | Explanation | Initial value |
|---|---|---|---|
| PA06 | Positioning completion range | The in-position status (see Par. 5.2.12) is set to 1 when the distance between the target and current positions (in the command units), that is, the difference between the current and commanded values, reaches the set value or lower.<br>PA06 specifies the allowable range for in-position check used for MOV, ZRN, or PFN function.<br>  <br>P : Positioning completion range (1 to 250 command units)<br>If \| current value - target value \| ≦ P, then in-position status is automatically set to 1.<br>If 0 is set for PA06, in-position check is not performed. | 1 |
| PA07 | Positioning completion check time | If the above positioning completion check is not successful when this time has elapsed, an alarm occurs.<br>If 0 is set for PA07, check time will have no limit. | 0 |

**Table 3.3 Parameters Dependent on Mechanical Specifications (Cont'd)**

<table>
<tr><th colspan="2">Parameter No.</th><th>Name</th><th>Explanation</th><th>Initial value</th></tr>
<tr><td>PA14</td><td>b0</td><td>Motor rotation direction</td><td>Use this parameter for forward rotation command to turn the motor in the reverse direction, or for reverse rotation command to turn the motor in the forward direction.<br><table><tr><th>b1</th><th>Command direction</th><th>Motor rotation direction</th></tr><tr><td rowspan="2">0</td><td>+</td><td>Forward</td></tr><tr><td>−</td><td>Reverse</td></tr><tr><td rowspan="2">1</td><td>+</td><td>Reverse</td></tr><tr><td>−</td><td>Forward</td></tr></table></td><td>0</td></tr>
<tr><td></td><td>b1</td><td>Finite/infinite mode</td><td>This parameter sets a limit on motion.<br><table><tr><th>b1</th><th>Explanation</th></tr><tr><td>0</td><td>Finite mode :<br>Select this mode when there is motion restriction. (Soft LS enabled)</td></tr><tr><td>1</td><td>Infinite mode :<br>Select this mode for endless motion system with no motion restriction, such as round tables and single-direction press feeders. (Soft LS disabled)</td></tr></table></td><td>0</td></tr>
<tr><td></td><td>b2</td><td>Linear/rotary mode</td><td>Set this parameter according to whether the load moves in linear or rotary course.<br><table><tr><th>b2</th><th>Mode</th><th>Explanation</th></tr><tr><td>0</td><td>Linear</td><td>-99999999 to +99999999</td></tr><tr><td>1</td><td>Rotary</td><td>Current position data are given as follows, regardless of the rotation numbers.<br>0 to [set value of PA11 - 1]<br>(anywhere in a single-rotation motion)</td></tr></table></td><td>0</td></tr>
</table>

Table 3.3 Parameters Dependent on Mechanical Specifications (Cont'd)

<table>
<tr><th colspan="2">Parameter No.</th><th>Name</th><th>Explanation</th><th>Initial value</th></tr>
<tr><td>PA18</td><td>b0</td><td>Soft LS<br>Related to parameters: PA40 (forward LS), PA41 (reverse LS)</td><td>(1) Soft LS function takes effect in finite mode.<br>(2)
<table>
<tr><th rowspan="2">b0</th><th colspan="2">Soft LS set position (in command units)</th></tr>
<tr><th>Forward LS</th><th>Reverse LS</th></tr>
<tr><td>0</td><td>+99999999</td><td>−99999999</td></tr>
<tr><td>1</td><td>Set value of parameter PA40</td><td>Set value of parameter PA41</td></tr>
</table>


(3) When soft LS is activated, operation is prohibited and alarm occurs.<br>(4) When the machine reaches to soft LS set position during operation, it slows down at a specified deceleration rate and stops at that position.<br>(5) Use the mechanical coordinate system to set soft LS positions.<br>(6) Soft LS takes effect after zero return.</td><td>0</td></tr>
<tr><td></td><td>b1</td><td>Use of backlash compensation<br>Related to parameter : PA42 (amount of backlash compensation)</td><td>This parameter determines whether backlash compensation function is to be used.
<table>
<tr><th>b1</th><th>Use of backlash compensation</th></tr>
<tr><td>0</td><td>Not performed</td></tr>
<tr><td>1</td><td>Amount of compensation is set in PA42</td></tr>
</table>
Range of a amount of backlash compensation in PA42 : 1 to 32767 ;<br>Unit : pulses (feedback pulse from the encoder)<br>If 1 (μm) of backlash is to be compensated<br><br>Amount of compensation = 1 × B/A pulses<br><br>Compensation direction is determined by PA50 (zero return direction).</td><td>0</td></tr>
</table>

# 3.5 OPERATION PARAMETERS

Speeds and distance are specified in programs or by parameters in each operation mode.
This section explains necessary parameters for operation.

## 3.5.1 Speed Parameters

**Table 3.4 Speed Related Parameters**

| Parameter No. | Name | Description | Initial value |
|---|---|---|---|
| P010 | Interpolation feed maximum speed | Interpolation speed limit in programmed operation | 24000 |
| PA04 | Feed speed 1 | These speeds are feed rates in program and jog operations. Set a desired command speed in units of 1000 command units. | 60 |
| PA31 | Feed speed 2 | | 1 |
| | | | |
| | | | |
| PA39 | Linear accel/decel constant switch speed | This parameter takes effect when 2-step accel/decel mode is selected. | 24000 |
| PA48 | Exponential accel/decel bias speed | This parameter takes effect when exponential accel/decel is selected. | 0 |
| PA51 | Zero return feed speed | These speeds are used zero return operation. (Related parameters : PA49, PA50, PA54) | 1 |
| PA52 | Zero return approach speed | | 1 |
| PA53 | Zero return creep speed | | 1 |
| PA17-b3 | Use of speed limit | Use these parameters to restrict load speed. | 0 |
| PA46 | Speed limit | | 24000 |

## 3.5.2 Feed Speeds (PA04, PA31)

Setting range : 1 to 240000 (× 1000) command units /min.
Feed speed 1 (PA04) is used for MOV operation in program made or JOG operation used in the PLC unit.
Feed speed 2 (PA31) is selected when override #0 is selected in JOG operation.

(Example) To set a feed speed of 15 m/min. with the command unit 0.001 mm,
$(15 \times 10^3)$ mm/0.001 mm = 15,000,000 (command units)
Divide the result by 1000 and set 15000 for the parameter.

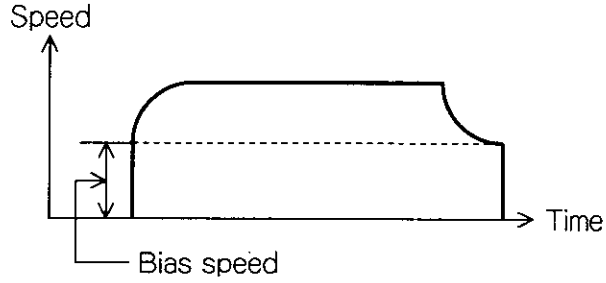
## 3.5.3 Linear Accel/decel Constant Switch Speed (PA39)

Setting range : 1 to 240000 (× 1000) command units /min.
This parameter determines at what speed the second accel/decel rate is applied. See Fig. 3.2.

### 3.5.4 Exponential Accel/decel Bias Speed

Setting range : 1 to 240000 (×1000) command units/min.

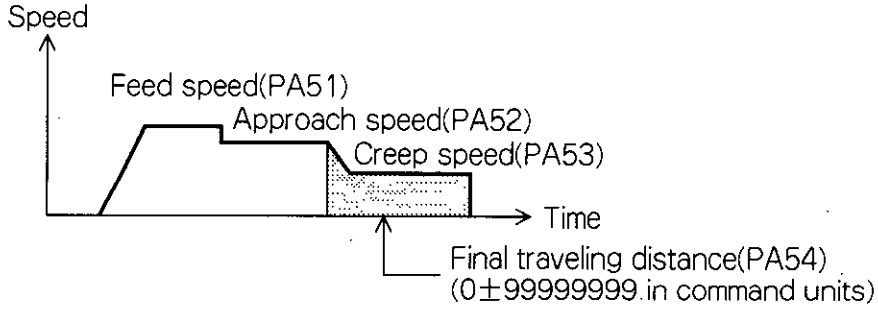
This parameter takes effect when exponential accel/decel is selected, and determines the bias speed.




### 3.5.5 Zero Return Feed Speeds [PA51, PA52, PA53, related parameters : PA49, PA50, PA54]

These parameters determine feed speeds for operation in zero return mode.

These parameters take effect when 1 (Use zero return.) is set in bit 4 of parameter PA18.




There are mode Ⅰ (deceleration LS and phase-C pulse used), mode Ⅱ (ZERO LS signal used), mode Ⅲ (deceleration LS and ZERO LS signal used), and mode Ⅳ (phase-C pulse used) for zero return. These modes are selected by PA49. Refer to PLC unit manual for defail of ZRN command.

### 3.5.6 Speed Limit (PA17-b3, P46)

Speed is limited by the maximum motor speed . Set PA46 (speed limit) for a speed command value at which the motor reaches the maximum rotation speed.

Table 3.5 Speed Restriction

| | Value | Speed limit |
|---|---|---|
| PA17-b3 | 0 | D/A output<br>6V/3000 r/min. |
| | 1 | Parameter PA46 takes effect.<br>PA46<br>Setting range : 1 to 240000<br>Unit : (×1000) command units/min.<br>D/A output 9V/PA46 |

## 3.5.7 Accel/decel Parameters

There are four types of accel/decel : 1-step linear, 2-step linear, S-curve, and exponential. Select optimum type for the machines.

Table 3.6 Accel/decel Parameters

| Parameter No. | Name | Description | Initial value |
|---|---|---|---|
| PA05 | Linear accel/decel constant (1) | Determines accel/decel rate for 1-step accel/decel. | 1000 |
| PA38 | Linear accel/decel constant (2) | Determines 2nd accel/decel rate for 2-step accel/decel. | 1000 |
| PA17-b2 | 2-step accel/decel | Determines mode of 1-step or 2-step linear accel/decel. | 0 |
| PA17-b4 | Accel/decel system selection | Determines mode of linear accel/decel. | 0 |
| PA20-b3 | S-curve accel/decel | Determines whether to use S-curve accel/decel. | 0 |
| PA76 | S-curve time constant | Determines accel/decel rate for S-curve accel/decel. | 8ms |
| PA47 | Exponential accel/decel time constant | Determines accel/decel rate for exponential accel/decel. | 50 |
| PA68 | Accel/decel form selection (MOV) | Determines accel/decel mode for programmed operation. | 0 |
| PA69 | Accel/decel form selection (JOG) | Determines accel/decel mode for JOG operation. | 0 |
| PA71 | Accel/decel form selection (zero return mode) | Determines accel/decel mode for zero-return operation. | 0 |

(Setting range and unit)

PA05, PA38 : 1 to 32767 (15625 command units/$S^2$ )
PA76 : 1 to 127 (×8ms)
PA47 : 1 to 127 (×8ms)

### 3.5.8 Accel/ decel Mode Selection Flowchart

Accel/ decel can be set separately each operation mode. Fig. 3.1 is the flowchart of parameter setting for accel/decel.

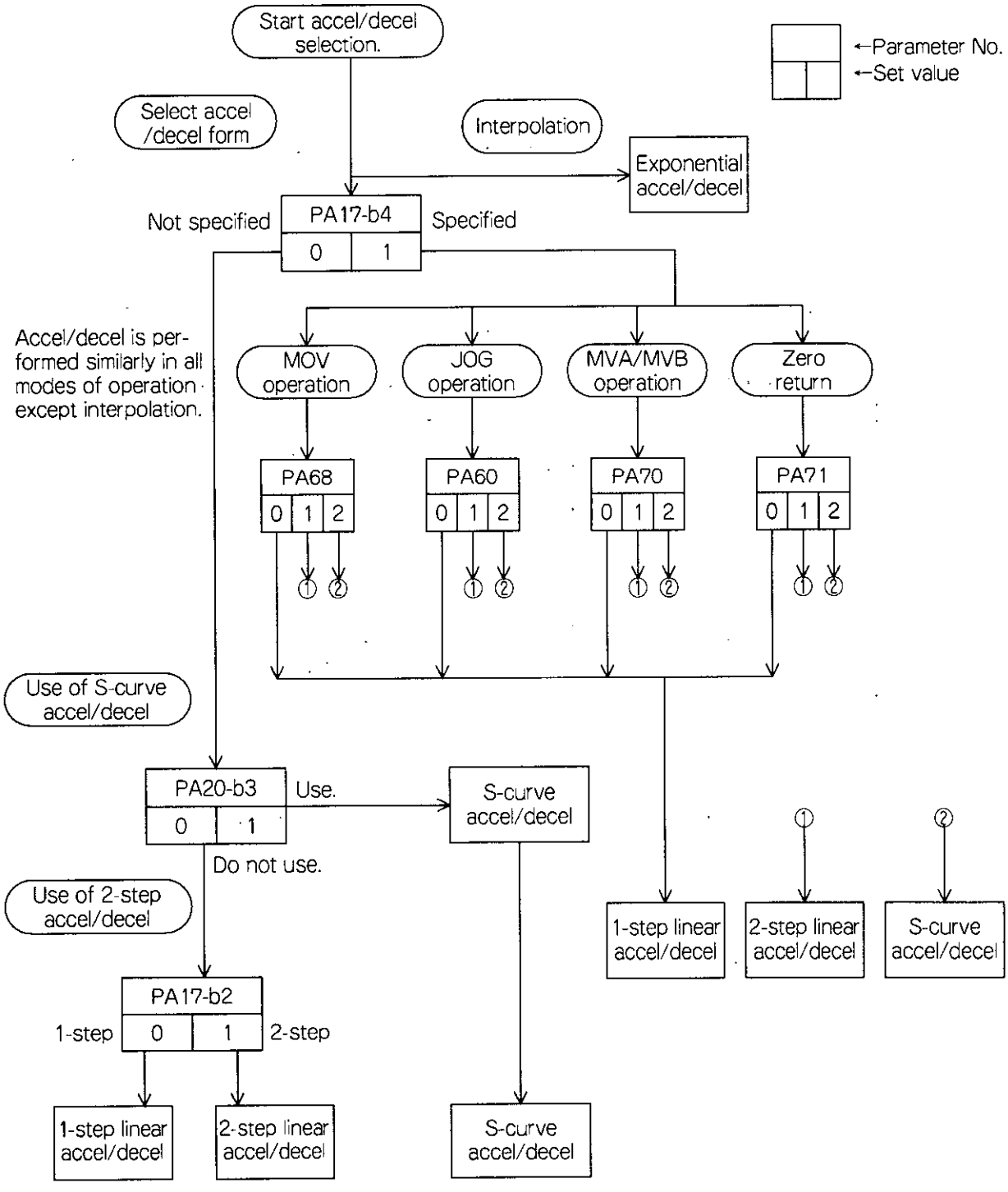



Fig. 3.1 Flowchart to Select

## 3.5.9 Various Accel/decel Parameters

Fig. 3.2 explains available accel/ decel types.

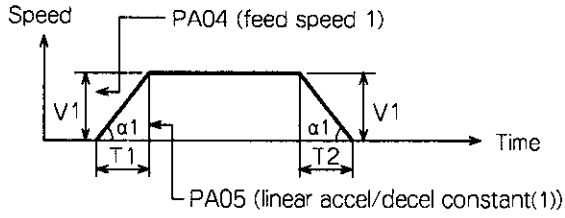
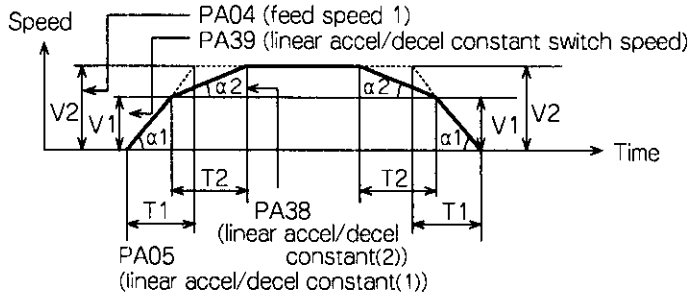
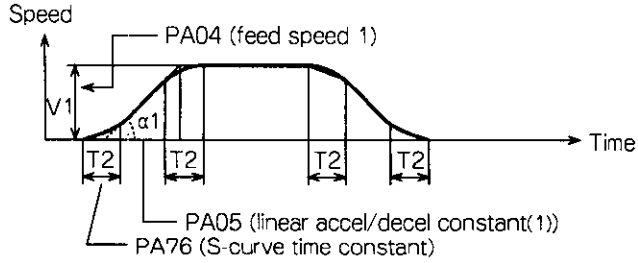
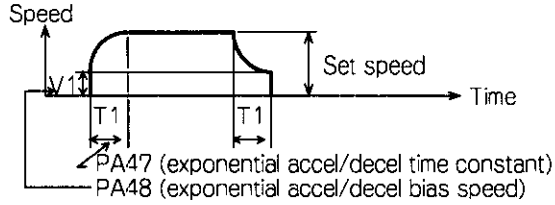
| No. | Accel/decel type | Description |
|---|---|---|
| (1) | 1-step linear accel/decel |  |
| (2) | 2-step linear accel/decel |  |
| (3) | S-curve accel/decel |  |
| (4) | Exponential accel/decel |  <br>Accel/decel varies depending on the exponential speed (feed speed specified by MVS function).<br>  <br>PA47 (exponential accel/decel time constant) |

Fig. 3.2 Accel/decel Types

## 3.5.10 SERVOPACK External I/O Signal Parameters

This section explains parameters listed below.

| Parameter No. | Name | Parameter no. | Name |
|---|---|---|---|
| PA19-b0 | OT signal | | |
| PA19-b2 | Brake release signal | | |

These parameters control external I/O signals of the SERVOPACK. Their functions are listed in Table 3.7.

Table 3.7 External I/O Parameters

<table>
<tr><th colspan="2">Parameter No.</th><th>Name</th><th>Explanation</th><th>Initial value</th></tr>
<tr><td>PA19</td><td>b0</td><td>OT signal</td><td>This parameter can invalidate overtravel LS input signals P-OT (forward overtravel LS) and N-OT (reverse overtravel LS).<br><br><table><tr><th>b0</th><th>P-OT, N-OT</th></tr><tr><td>0</td><td>Do not mask : Set input ON when normal.</td></tr><tr><td>1</td><td>Mask : The input can be OFF.</td></tr></table></td><td>0</td></tr>
<tr><td></td><td>b1</td><td>Reserved</td><td></td><td></td></tr>
<tr><td></td><td>b2</td><td>Brake release signal</td><td>This parameter determines whether to use brake release signal.<br><br><table><tr><th>b2</th><th>P-OT, N-OT</th></tr><tr><td>0</td><td>Do not mask : Brake release signal is output.</td></tr><tr><td>1</td><td>Mask : No brake release signal is output. (The signal is always OFF.)</td></tr></table></td><td>0</td></tr>
</table>

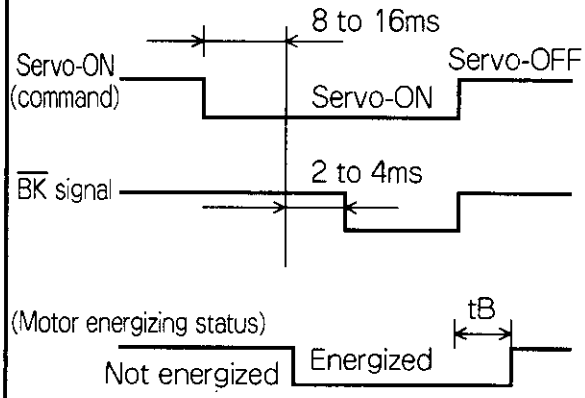
〈Brake release signal [$\overline{BK}$]〉

Brake release signal [$\overline{BK}$] is an output signal that orders brake release interlocked with the open-close status of the motor circuit or the motor rotation speed.

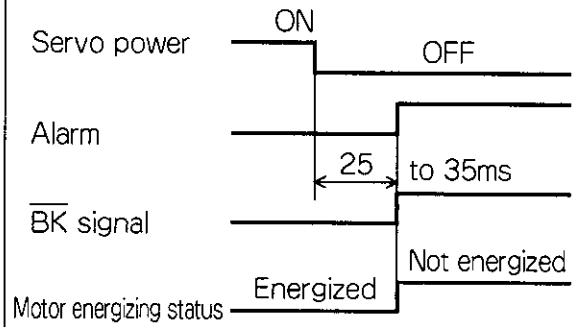
Brake release signal is used when 1 is set for b2 of PA19. To use this signal, set necessany interlock constants in parameters PA43 and PA44.

When the motor stops

Timing with servo-ON signal



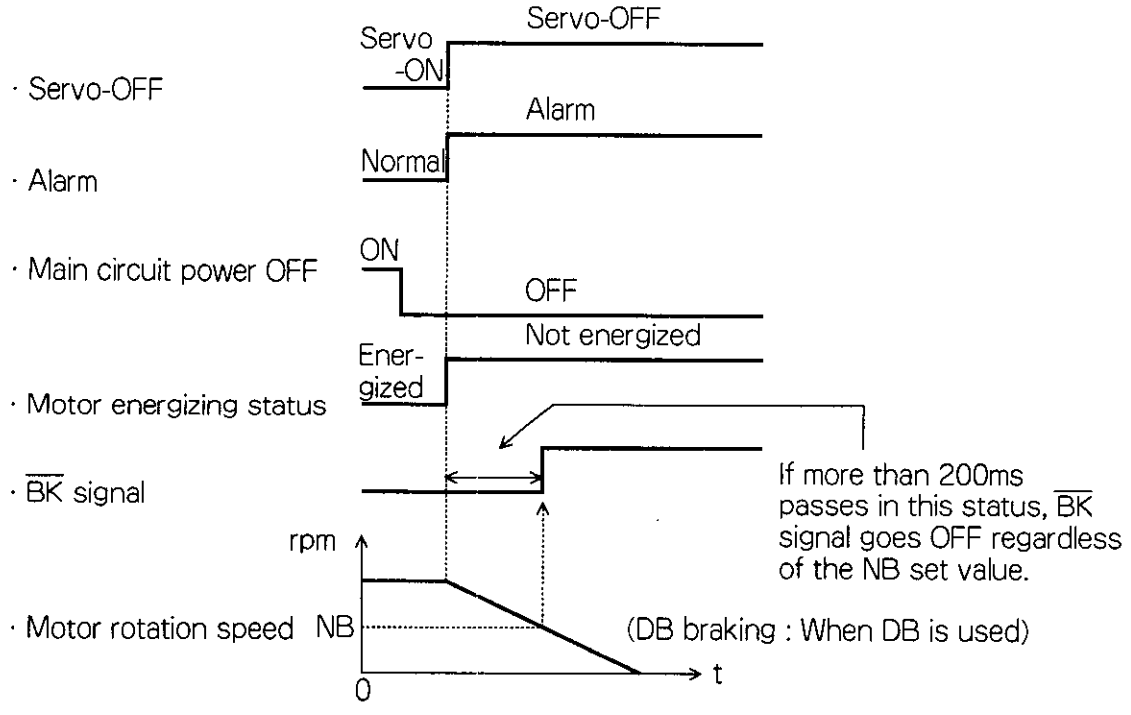

Timing for servo power OFF and alarm




tB : Brake time (set in PA43 : 8ms to 1000ms)

When the motor is running

Timing for servo OFF, main circuit power OFF, and alarm




NB : Rotation speed at which $\overline{BK}$ signal goes OFF (set in PA44 : 1 r/min to 10000 r/min.)

Fig. 3.3 Output Timing for BK Release Signal

### 3.5.11 Servo Characteristics Related Parameters

This section explains parameters listed below.

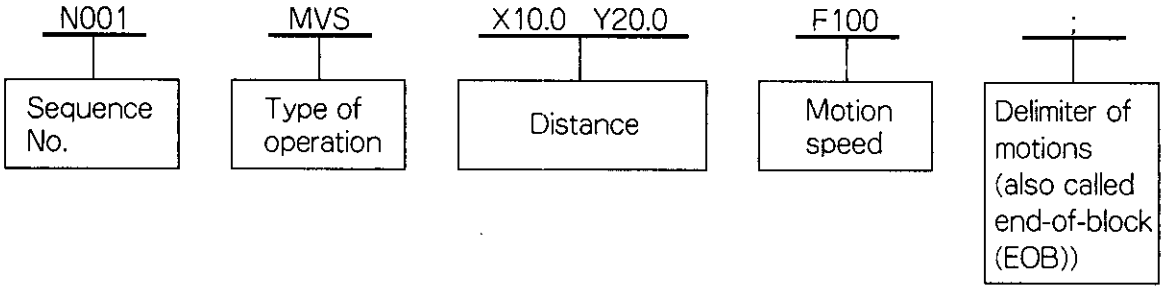
| Parameter No. | Name | Parameter No. | Name |
|---|---|---|---|
| PA01 | Position loop gain ; Kp | | |
| PA06 | Positioning completion range | | |

These parameters determine servo system characteristics. Their functions are listed in Table 3.8.

**Table 3.8 Servo Characteristics Related Parameters**

| Parameter No. | Name | Description | Initial value |
|---|---|---|---|
| PA01 | Position loop gain (Kp) | This parameter contains a set position loop gain, which determines response of the SERVOMOTOR to pulse distribution. Set about 20 $S^{-1}$ to 100 $S^{-1}$, considering the SERVOMOTOR type and mechanical conditions.<br>The response is improved as the position loop gain is increased; however, too high a setting may result in overshooting.<br>Set an optimum value.<br>Setting range : 1 to 0200<br>Unit : $S^{-1}$<br>Position loop gain of the entire system is also varied by modifying speed command gain of the servo amplifier. | 30 |

An example of a program is shown in the following.




As shown in the example, the program is coded with alphabetic character symbols and numeric values. Each line, that is, each block, is ended with ";", indicating the end-of-block. A program consists of these lines.

Sequence number (Nxxx) serves as a label. A program may have no sequence number, or a sequence number can be duplicated. Note that the sequence number is used as the destination label of GOTO command.

To start a motion program from the PLC unit, program number and block number must be specified. To have same sequence number as block number makes it easier to find necessary parts of the program.

Be sure to insert spaces between any two sequence numbers (Nxxx), commands (MVS, for example), and symbols (X, for example).

## 4.1 INPUT FORMAT

### 4.1.1 Input Format List

Table 4.1 lists input formats. Constants in Table 4.1 are maximum allowable number of digits to be input.

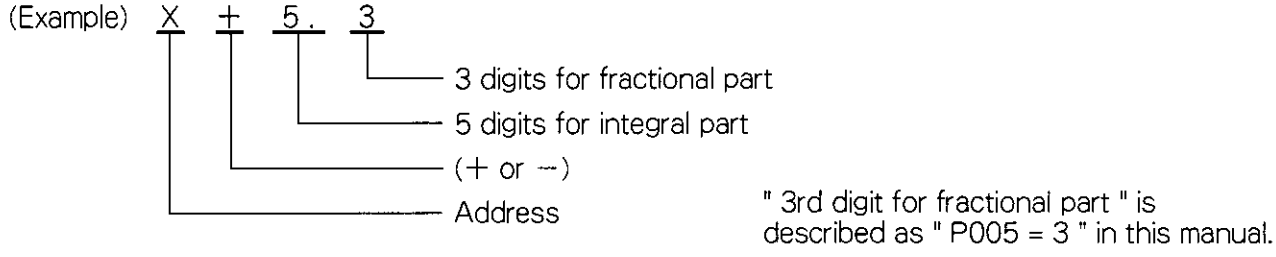



**Table 4.1 Input Formats**

| Item | Input formats | | |
|---|---|---|---|
| | 1st digit for fractional part (P005 = 1) | 2nd digit for fractional part (P005 = 2) | 3nd digit for fractional part (P005 = 3) |
| Program No. | O2 | O2 | O2 |
| Sequence No. | N3 | N3 | N3 |
| Coordinate format | a+7.1 | a+6.2 | a+5.3 |
| Feed per minute | F500.0 | F50.0 | F5.0 |
| M function | M2 | M2 | M2 |
| Variable | H1 | H1 | H1 |
| Dwell time | P3.3 (S) | P3.3 (S) | P3.3 (S) |
| End-of-block | ; | ; | ; |

Note : In coordinate format, "a" stands for any of coordinate address X, Y, Z, S, XF, YF, ZF, or SF.

(1) Leading zeros and plus sign (+) can be omitted in a value following any address or sequence number.

Minus sign (-) must not be omitted.

(Examles) X00123 → X123
X+123 → X123
X-123 → X-123

(2) The end-of-block " ; " terminates a program block. A block cannot span more than one line.

## 4.1.2 Address and Function Characters

Table 4.2 lists address and their meanings.

Table 4.2 Address List

| Address | Meaning | Address | Meaning |
|---|---|---|---|
| F | Interpolation feed speed | XF | X-axis relative coordinate |
| H | Compensation | YF | Y-axis relative coordinate |
| I | X coordinate of the center of an arc | ZF | Z-axis relative coordinate |
| J | Y coordinate of the center of an arc | SF | S-axis relative coordinate |
| K | Z coordinate of the center of an arc | | |
| L | S coordinate of the center of an arc or the number of repetitions | | |
| M | Completion/wait signal output number | | |
| N | Sequence number | | |
| O | Program number | | |
| P | Time or subprogram number | | |
| R | Radius of an arc | | |
| S | S-axis coordinate | | |
| X | X-axis coordinate | | |
| Y | Y-axis coordinate | | |
| Z | Z-axis coordinate | | |

Table 4.3 lists function characters and their meanings.

Table 4.3 Function Character List

| Character | Meaning | Character | Meaning |
|---|---|---|---|
| SP | Space | . | Decimal point |
| LF | Disregard | # | Variable |
| ; CR | End-of-block | * | Multiplication |
| + | Plus sign, addition | = | Equal sign |
| − | Minus sign, subtraction | > | Greater than |
| 0 to 9 | Numerals | < | Less than |
| A to Z | Addresses | " | Comment |
| / | Division operator | | |

### 4.1.3 Decimal Point Input

A numeric value with a decimal point can be used for a command related to coordinate format (distance), time, or speed. Specify decimal point position in P005 (decimal point position).

P005 is set to 3 at the factory. From 1 to 3 can be set. The decimal point is effective in motion programs only. No decimal point can be used in parameter values.

(1) The decimal point can be used with the following symbols.

Coordinates: X, Y, Z, S, I, J, K, L, XF, YF, ZF, and SF
Feed speed: F
Time: P

(2) Decimal point shift

Decimal point shift function is provided for convenience of entry and display. It does not effect to the unit system in MC unit.

In explanations in this manual, standard setting of P005 = 3 (three digits for fractional part), command unit of 0.001 mm (0.001° for rotary axis and 0.1° for S-axis) are used.

Table 2.4 shows examples of input data and values converted by decimal point shift.

Dwell time is fixed at the minimum time unit, 0.001 s.

Table 4.4 Decimal Point Input Data And Converted Values

| Command unit | | 0.01mm | 0.001mm |
|---|---|---|---|
| Input data | | 2 digits in fractional part | 3 digits in fractional part |
| X-axis | X15. | 15.00mm | 15.000mm |
| Y-axis | Y20.5 | 20.50mm | 20.500mm |
| S-axis | S20.5 | 20.5° | 20.5° |
| Dwell time | P1.0 | 1.000S | 1.000S |
| Feed speed | F25. | 25.00mm/min. | 25.000mm/min. |
| | | (F×1000)×0.01 | (F×1000)×0.001 |
| | (If values without a decimal point are input) | | |
| X-axis | X15 | 0.15mm | 0.015mm |
| Y-axis | Y20.5 | 0.20mm | 0.020mm |
| S-axis | S30 | 3.0° | 3.0° |
| Wait time | P1 | 0.001S | 0.001S |
| | (P1= P0.001) | | |
| Feed speed | F25 | 250.00mm/min. | 25.000mm/min. |
| ( Example ) Set value of parameter PA04 Feed speed 1 | 5000 No decimal point can be used. | 5000×1000 ×0.01mm =50m/min. | 5000×1000 ×0.001mm =5m/min. |

## 4.1.4 Buffer Registers

(1) In normal operation (program operation), two blocks of data are read in advance and pre-executed for smooth proceeding. If the read data are commands without axis control, they are executed immediately.

(2) Data of up to 128 characters (bytes) can be contained in a single block.
(All characters including CR and LF are counted.)

### 4.1.5 Program Number

A program number is put at the beginning of the program and used for identifying the program. The program number is effective only when the program is being created. After that, the number is identified as a sort of comment.

(1) The number input at creation of a new program is automatically added to the beginning of the program as an O-number. The O-number is used for the file name extension, and the program is handled using the extender from then on.

(Example)
When a program with O-number 10 is created, the file is named as follows.

FIL.O10

If this program is copied as FILE.O11, the copy program will have program number O11.

(2) A comment can be added only after the program number. A comment must be enclosed by half-character double quotation marks. Comment may include full characters, and must not be longer than 32 half-characters.

### 4.1.6 Sequence Number

(1) A sequence number can be set at the beginning of a program block by address N followed by an integer not greater than 999.

(2) The sequence number is an index number of the block, and has no influence on block execution order. Therefore, sequence numbers may be successive or non-successive, or they can be duplicated, or even do not need to be used. Normally, use of successive sequence numbers may be convenient.

(3) When searching for a sequence number by GOTO command in a block having a sequence number itself, if the target sequence number is less than that in the GOTO command block, a search from that block toward the beginning of the program is conducted, and if not found, it is searched back toward the end. If the target sequence number is greater than that in the GOTO command block, a search is conducted first toward the end of the program and then if not found, it is searched toward the beginning . If the GOTO command block has no sequence number, it is first searched toward the end of the program.

(4) If a sequence number greater than 999 is specified, an error occurs.

## 4.2 COORDINATE WORDS

In general, axis move commands and coordinate system setup commands are called coordinate words. A coordinate word consists of axis selection commands and numeric values that specify the distance and direction. Correspondence between coordinate words and axis numbers are set in parameters.

### 4.2.1 Coordinate Word List

Table 4.5 Coordinate Word List

| Coordinate word commands | | Explanation |
|---|---|---|
| Fundamental axes | X, Y, Z, S | X, Y, Z, and S coordinates and distances |
| Independent axes | A, B, | Used in the PLC unit only, not in motion programs |
| Auxiliary data for circular and helical interpolation | R | Radius of an arc |
| | I, J, K, L | X, Y, Z, and S axes coordinates of the center of an arc |
| | XF, YF, ZF, SF | X, Y, Z, and S axes increments for helical interpolation |

### 4.2.2 Number of Simultaneously Controlled Axes

The maximum number of simultaneously controlled axes are as follows.

Table 4.6 Number of Simultaneously Controlled Axis

| Operation | Number of simultaneously controlled axes |
|---|---|
| Positioning (MOV) | 4 (X, Y, Z, and S) |
| Linear interpolation (MVS) | 3 (Any three of X, Y, Z, or S) |
| Circular interpolation (MCW, MCC) | 2 (Any of XY, YZ, ZX, XS, YS, or ZS) |
| Helical interpolation (MCW, MCC) | 3 (Any of the following)<br>Circle on XY plane + line in parallel with Z-axis<br>Circle on XY plane + line in parallel with S-axis<br>Circle on YZ plane + line in parallel with X-axis<br>Circle on YZ plane + line in parallel with S-axis<br>Circle on ZX plane + line in parallel with Y-axis<br>Circle on ZX plane + line in parallel with S-axis<br>Circle on XS plane + line in parallel with Y-axis<br>Circle on XS plane + line in parallel with Z-zxis<br>Circle on YS plane + line in parallel with X-axis<br>Circle on YS plane + line in parallel with Z-axis<br>Circle on ZS plane + line in parallel with X-axis<br>Circle on ZS plane + line in parallel with Y-axis |

### 4.2.3 Independent Operation Axis Control

Regardless of operation by motion program, up to two axes can be operated independently from the PLC unit. If A or B is selected for the axis name, the axis is assigned as an independent operation axis. Independent operation axes cannot be operated from motion programs.

### 4.2.4 Input Units and Output Units

#### 4.2.4.1 Input Units

(1) Minimum programmable input units are as follows. (3 digits for fractional part)
Linear axis: 0.001 mm
Rotary axis: 0.001° (Fixed at 0.1° for S-axis)

(2) The input unit is set by parameter P005 as shown below. Command unit related parameters PA08, PA11, PA12, and PA13 must be set according to the input unit. (A stands for axis number 1 to 4.)

Table 4.7 Input Unit List

| P005 | Linear axis | Rotary axis | S-axis (rotary axis) |
|---|---|---|---|
| 1 | 0.1mm | 0.1° | 0.1° |
| 2 | 0.01mm | 0.01° | 0.1° |
| 3 | 0.001mm | 0.001° | 0.1° |

For details of the parameters, see Table 3.1, "Parameter List".

#### 4.2.4.2 Output Units

(1) Minimum units of mechanical movement depend on the movement per command unit calculated by parameter PA11.
Movement per command unit, that is, output units are as shown below.
When S-axis is used for rotary axis, only 0.1° is applied per output unit.

Table 4.7 Output Unit List

| Linear axis | Rotary axis | S-axis (rotary axis) |
|---|---|---|
| 0.1mm | 0.1° | 0.1° |
| 0.01mm | 0.01° | 0.1° |
| 0.001mm | 0.001° | 0.1° |

(2) Relationship between the input and output units is shown below.

Table 4.8 Output Unit List

| Input unit | | Output unit | | |
|---|---|---|---|---|
| Value in program | Value of P005 | Command unit | Movement per command unit calculated by PA11 | Actual distance |
| 0.1 | 1 | 1 | 0.1mm<br>0.1° | 0.1mm<br>0.1° |
| 0.1 | 2 | 10 | 0.01mm<br>0.01° | 0.1mm<br>0.1° |
| 0.1 | 3 | 100 | 0.001mm<br>0.001° | 0.1mm<br>0.1° |

Note: Movement per command unit calculated by PA11 must be applied properly with value P005. Otherwise, actual and programmed displacements disagree. (Minimum programmable input unit for S-axis is fixed at 0.1° .)

(3) To convert command units into number of encoder pulses, use parameters PA08, PA11, PA12, or PA13. For details, see Par. 3.3.1

### 4.2.5 Maximum Command Values

(1) Maximum command displacements are as follows, regardless of whether finite or infinite motion is involved.

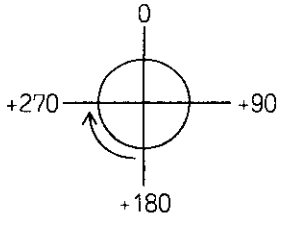
Table 4.10 Maximum Command Value List

| | P005 | Linear axis | Rotary axis | S-axis (rotary axis) |
|---|---|---|---|---|
| Finite length | 1 | ±9999999.9mm | ±9999999.9° | ±9999999.9° |
| | 2 | ±999999.99mm | ±999999.99° | ±9999999.9° |
| | 3 | ±99999.999mm | ±99999.999° | ±999999 .9° |
| Infinite length | 1 | ±(PA11) - 1 | ±(PA11) - 1 | ±(PA11) - 1 |
| | 2 | ±(PA11) - 1 | ±(PA11) - 1 | ±(PA11) - 1 |
| | 3 | ±(PA11) - 1 | ±(PA11) - 1 | ±(PA11) - 1 |

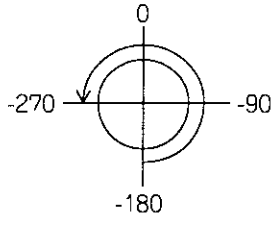
Note: In rotary axis absolute coordinates,
the plus or minus sign indicates the direction of rotation.

(Example) When the current position is at +180° ,

Command for +270.0°




Command for -270.0°




A command for a value not smaller than the absolute value of setting in PA11 results in alarm.
If command exceeds the absolute value setting in PA11, alarm is displayed.

(2) An incremental command must not exceed the maximum allowable command value.

(3) If an absolute command is used, movement must not exceed the maximum allowable movement of the corresponding axis.

(4) A cumulative displacement must not exceed the limits listed below.

Table 4.11 Maximum Cumulative Command Values

| | P005 | Linear axis | Rotary axis | S-axis (rotary axis) |
|---|---|---|---|---|
| Finite length | 1 | ±9999999.9mm | ±9999999.9mm | ±9999999.9mm |
| | 2 | ±999999.99mm | ±999999.99mm | ±999999.99mm |
| | 3 | ±99999.999mm | ±99999.999mm | ±99999.999mm |
| Infinite length | | No restrictions | No restrictions | No restrictions |

# 4.3 FEED SPEED

## 4.3.1 Rapid Traverse Speed

(1) Rapid traverse is used for positioning (MOV) or manual feed (JOG). During rapid traverse, axes move at the rapid traverse speeds set separately for the individual axis.
Since the axis move independently from each other, they do not reach to their target point simultaneously. Therefore, usually the rapid traverse trajectory is not linear.

(2) Overriding factors can be specified for the rapid traverse speed. Use speed numbers shown in the table below.

Table 4.12 Speed Number List

| Speed No. | Speed |
|---|---|
| 0 | Feed speed 2 |
| 1 | Feed speed 1 × 1% |
| 2 | Feed speed 1 × 2% |
| 3 | Feed speed 1 × 4% |
| 4 | Feed speed 1 × 6% |
| 5 | Feed speed 1 × 8% |
| 6 | Feed speed 1 × 10% |
| 7 | Feed speed 1 × 20% |
| 8 | Feed speed 1 × 30% |
| 9 | Feed speed 1 × 40% |
| 10 | Feed speed 1 × 50% |
| 11 | Feed speed 1 × 60% |
| 12 | Feed speed 1 × 70% |
| 13 | Feed speed 1 × 80% |
| 14 | Feed speed 1 × 90% |
| 15 | Feed speed 1 × 100% |

Set speed numbers in the sequence program. For details, refer to the Programming Manual for PLC unit (SIE-C888-1.1).

### 〈Range of Rapid Traverse Speed〉

(1) Rapid speeds (feedspeeds 1 and 2) are set for each axis by the steps below.
Rapid traverse speed step = command unit × 1000/min.

(2) The maximum value to be set for rapid traverse speed is 240000. Therefore, the maximum rapid traverse speed at command unit of 0.1mm is calculated as follows.
Rapid traverse speed = 240000 × 0.1 × 1000 = 24000 m/min.
Set an optimum value considering the machines.

### 4.3.2 Interpolation Feed Speed

(1) Feed speed per minute can be specified by address F followed by five numerals.

(2) The range of address F depends on the position of the decimal point (P005) as follows:

Table 4.13 Address F Range

| P005 | Feed speed range (address F setting) |
|---|---|
| 1 | F100 to F24000000 (100.0 per steps) |
| 2 | F10 to F2400000 (10.0 per steps) |
| 3 | F1 to F240000 (1.0 per steps) |

(3) Servo and mechanical system may impose restrictions on the upper limit of the feed speed shown above. The upper limit is set in parameter P010, and if address F exceeding the value is input, speed is clamped to the set upper limit.

(4) For an address F of linear or circular interpolation, specify the speed in the tangent direction.
For details, see Par. 2.7

(5) Notes
(a) If a rotary axis is included for the axis involved in interpolation, tangent speed of the machine does not equal to the address F.
(b) Command F0 causes a data error (with alarm code 010).
(c) Do not input address F with negative values. In such a case, proper operation is not guaranteed.

# 4.4 COMMANDS

## 4.4.1 Command and Programming Formats

A command consisting of three alphabetic characters specifies the operation of that block.

(1) There are modal and non-modal commands. Some commands can be described together with commands of other types, whereas others cannot.

(2) A modal command is valid until another same kind of command is input.

(3) A non-modal command takes effect only in the block in which it is described.

(4) A space must be placed before and after a command.

〈Example〉 N010 MOV X1000 Y1000 Z1000 PXY ABS SET M50 F200 SNG ;

## 4.4.2 Command List

Table 4.14 Command List

| Command | Function | Programming format | Description |
|---|---|---|---|
| MOV | Positioning | MOV X—Y—Z—S— ; | Move four axes simultaneously by rapid traverse to position (X, Y, Z, or S). |
| MVS | Linear interpolation | MVS X—Y—Z—F— ;<br>MVS X—Z—S—F— ; | Move three axes simultaneously at speed F to position (X, Y, Z, or S). |
| MCW<br>MCC | Circular interpolation | MCW X—Y—R—F— ;<br>MCC X—Y—R—F— ;<br>MCW X—Y—I—J—F— ;<br>MCC X—S—R—F— ; | Move at tangent speed F around center (I or J) at radius R.<br>MCW : Turn clockwise (CW)<br>MCC : Turn couterclockwise (CCW) |
| TIM | Dwell time | TIM P— ; | Wait for specified time P, then proceed to the next block. |
| PXY<br>PYZ<br>PZX<br>PXS<br>PZS<br>PYS | Plane specification for arcs | MCW PXY X—Y—Z—<br>R—F— ;<br>MCC PZY X—Y—Z—<br>R—F— ; | Specify plane for circular interpolation.<br>PXY : XY plane<br>PZX : ZX plane<br>PYZ : YZ plane<br>PXS : XS plane<br>PYS : YS plane<br>PZS : ZS plane |
| ZRN | Automatic zero return | ZRN X—Y—Z—S ; | Move to position (X, Y, Z, or S), then return to zero. For the first time after power-ON, return to zero immediately. |
| ABS | Absolute mode | ABS ; | Change displacement data to absolute mode. |
| INC | Incremental mode | INC ; | Change displacement data to incremental mode. |
| PNT | Notch signal output | PNT X—Y—Z—Mxx ; | Output signal at the specified position range. |
| SET | Wait-for-completion external output | SET M00 ; | Output code M and wait until the PLC unit returns MFIN-ON. |
| STP | Program stop | STP ; | Stop motion program. The program can be restarted by start command. |
| END | Program end | END ; | This is the end of the motion program. |
| GSB | Subprogram call | GSB P10 L2 ; | Call the subprogram and execute for the specified times. |
| RET | Subprogram end | RET ; | End of the subprogram. |

Table 4.14 Command List (Cont'd)

| Command | Function | Programming format | Explanation |
|---|---|---|---|
| PFN | Wait for motion completion (in-position check) | PFN ; | Wait until the axis being positioned enters the in-position range (specified by parameters) |
| SNG | single-block signal disregard | SNG MVS ————— ;<br>SNG #O10=1 ; | Disregard single-block mode signal while executing this block and proceed to the next block. |
| POS | Current position change | POS X—Y—Z—S— ; | Switch current position to the specified (X, Y, Z, or S). After this block, movement specified in ABS mode use the switched coordinate. |
| MVM | Mechanical coordinate mode | MVM MVS X—Y—<br>Z—F— ; | Coordinates after zero return operation are kept in memory as mechanical coordinate. Mechanical coordinates are not affected by coordinate switch by POS. Use the mechanical coordinates for positioning (or move) in this block. |
| INP | Second in-position check range setting | INP X—Y—Z—S— ; | Use the specified in-position range for interpolation commands. This command is canceled by setting 0 for the range. |
| IOW | Wait for input signal | IOW #O—#I—==n#O— | Output the specified signals, wait for the specified input signals and output specified signals. Specification of outputs can be omitted. |

Table 4.15 Command Codal Grouping and Compatibility with Other Commands

| Command | Modal or not | Duplication with commands of other types | Command symbols effective with the command | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | O | N | X | Y | Z | S | XF | YF | ZF | SF | F | M | P | I | J | K | L | R | | | | | |
| MOV | Non-modal | Yes | | ○ | ○ | ○ | ○ | ○ | | | | | | | | | | | | | | | | | |
| MVS | | | | ○ | ○ | ○ | ○ | ○ | | | | | ○ | | | | | | | | | | | | |
| MCW | | | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | | | ○ | ○ | ○ | ○ | ○ | | | | | |
| MCC | | | | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | | | ○ | ○ | ○ | ○ | ○ | | | | | |
| ZRN | Non-modal | No | | ○ | ○ | ○ | ○ | ○ | | | | | | | | | | | | | | | | | |
| MVM | Non-modal | Yes | | ○ | | | | | | | | | | | | | | | | | | | | | |
| PXY | Modal | Yes | | ○ | | | | | | | | | | | | | | | | | | | | | |
| PZX | | | | ○ | | | | | | | | | | | | | | | | | | | | | |
| PYZ | | | | ○ | | | | | | | | | | | | | | | | | | | | | |
| PXS | | | | ○ | | | | | | | | | | | | | | | | | | | | | |
| PYS | | | | ○ | | | | | | | | | | | | | | | | | | | | | |
| PZS | | | | ○ | | | | | | | | | | | | | | | | | | | | | |
| ABS | Modal | Yes | | ○ | | | | | | | | | | | | | | | | | | | | | |
| INC | | | | ○ | | | | | | | | | | | | | | | | | | | | | |
| POS | Non-modal | No | | ○ | ○ | ○ | ○ | ○ | | | | | | | | | | | | | | | | | |
| INP | Modal | No | | ○ | ○ | ○ | ○ | ○ | | | | | | | | | | | | | | | | | |
| IOW | Non-modal | No | | ○ | | | | | | | | | | | | | | | | | | | | | |
| PFN | Non-modal | Yes | | ○ | | | | | | | | | | | | | | | | | | | | | |
| TIM | Non-modal | No | | ○ | | | | | | | | | | | ○ | | | | | | | | | | |
| PNT | Non-modal | Yes | | ○ | ○ | ○ | ○ | ○ | | | | | | ○ | | | | | | | | | | | |
| SNG | Non-modal | Yes | | ○ | | | | | | | | | | | | | | | | | | | | | |
| SET | Non-modal | Yes | | ○ | | | | | | | | | | ○ | | | | | | | | | | | |
| STP | Non-modal | No | | ○ | | | | | | | | | | | | | | | | | | | | | |
| END | Non-modal | No | | ○ | | | | | | | | | | | | | | | | | | | | | |
| GSB | Non-modal | No | | ○ | | | | | | | | | | | ○ | | | | ○ | | | | | | |
| RET | Non-modal | No | | ○ | | | | | | | | | | | | | | | | | | | | | |

Notes : 1. After a command symbol, numbers from 0 to 9, compensation variables from H1 to H8, or common variables from #1 to #199 can be placed.

2. Those marked with ○ in the column of "compatibility with commands of other types" can be described in a block together with those commands on the line marked with ○. Commands in the same box of "compatibility with commands of other types" (such as MOV and MVS) cannot be described together.

## 4.4.3 Positioning (MOV)

(1) MOV (up to four axes of any of X · · · Y · · · Z · · · S · · · ) ;
The above command performs positioning with rapid traverse speed controlling up to four axis simultaneously. Axes not specified in the line are not moved.

(2) Rapid traverse speeds are set in parameters separately for individual axes. The speeds are multiplied by an override rate and used.

Axis 1 : P104 × override or P131
Axis 2 : P204 × override or P231
Axis 3 : P304 × override or P331
Axis 4 : P404 × override or P431

(3) Any of 1-step, 2-step, and S-curve accel/decel can be selected.

Axis 1 : Select by P117, P120, or P168.
Axis 2 : Select by P217, P220, or P268.
Axis 3 : Select by P317, P320, or P368.
Axis 4 : Select by P417, P420, or P468.

(4) The end point can be programmed either by absolute or incremental values according to ABS/INC selection

(5) A program example is shown below. (With a command unit of 0.001㎜)

```
MOV X4000. Y2000. Z2000. ;
Current position : X=Y=Z= 0
Target position : X=4000. (4m) Y=2000. (2m) Z=2000. (2m)
Speed : X=Y=Z=8 m/min. ←Set value of PA04
Decimal point position : parameter P005=3
```

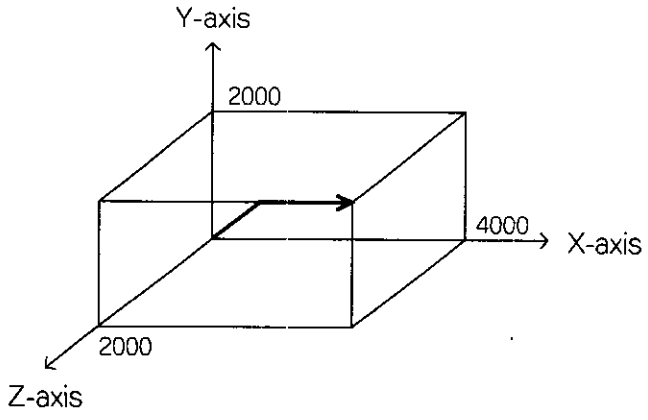



Fig. 4.1

(6) Axis specified by MOV move independently from each other at rapid traverse speed. Therefore, the trajectory may not be linear. Be careful not to contact tools on the workpiece when programming.

(7) The next motion command block is executed only after a specified number of pulses required to reach the programmed target position of MOV command are output and in-position check is performed successfully. If the next command is not a motion command, it is executed while the axes are moved by MOV.
To execute a non-motion command after in-position check, insert PFN command.

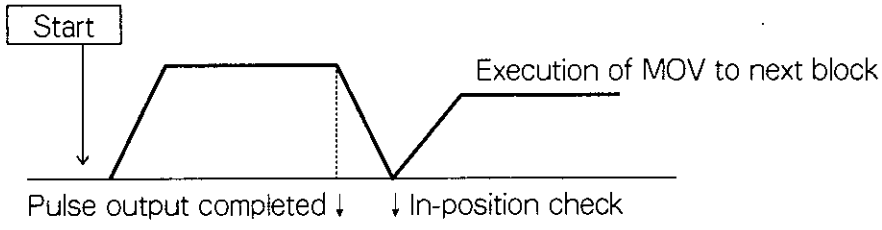



Fig. 4.2

## 4.4.4 Linear Interpolation (MVS)

(1) MVS (up to three axes of any of X・・・Y・・・Z・・・S・・・)[F・・・];
The above command performs linear interpolation controlling up to three axis simultaneously. Axis not specified in the line are not moved.
Select any command in parentheses. Commands in brackets can be omitted if they were described before. If a command is omitted, although there are none preceding, an alarm occurs.

(2) Interpolation feed speed is specified by address F. The axis are controlled so that the synthesized speed of all the specified axis will become the commanded speed.

$$F=\sqrt{F\alpha^2+F\beta^2+F\gamma^2}$$

Where, $\alpha$, $\beta$, and $\gamma$ are the speeds of the selected axis from X, Y, Z, or S.

The maximum value of F is set in parameter P010.

(3) Exponential accel/decel is used. The exponential accel/ decel constant is set in parameters below.

Axis 1 : P147, P148
Axis 2 : P247, P248
Axis 3 : P347, P348
Axis 4 : P447, P448

(4) The end point can be programmed either by absolute or incremental values according to ABS/INC selection.

(5) If address F is not specified either in the current MVS block or previous blocks, an error occurs (with alarm code 010).

(6) A program example is shown below.

MVS X4000. Y2000. Z3000. F1000. ;

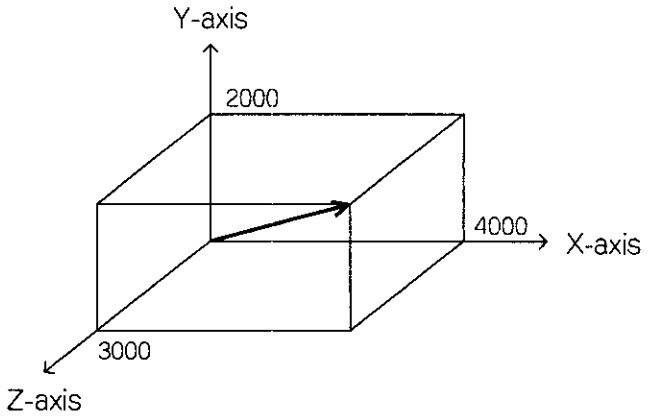



Fig. 4.3

(7) Either a linear or rotary axis can be specified for linear interpolation. Note that interpolation calculation uses the output pulse number only, the interpolation trajectory involved with rotary axis is not linear.

(8) After a number of pulses for the MVS block are output, the next motion command block is executed. To execute the next block after interpolation has been completed, insert in-position wait command (PFN). If the next command is not a motion command, it is executed while the pulses are being output. To execute the next command after interpolation has been completed, insert in-position wait command (PFN).

## 4.4.5 Circular Interpolation (MCW, MCC)

(1) The command shown below makes motion in the plane specified by any two axis of X, Y, Z, or S, toward the end point at the specified coordinates in a circular course to the specified rotary direction of the circular interpolation command. The arc is specified by the coordinates of the center or by a radius. Speed in the tangent direction of the arc is controlled to the speed specified by F.

(MCW / MCC) [ PXY ] X · · Y · · (I · · J · · /R · · ) [ F · · ] ;

| Circular interpolation command | Plane specification | End point coordinates | Center coordinates | Radius | Tangent speed |
|---|---|---|---|---|---|

In the above format, select either a or b for (a/b). The commands in brackets can be omitted if they were described before. If a command is omitted, although there is none preceding, an alarm occurs.

Specify the direction of rotation by the following.
MCW: Turn clockwise. (CW)
MCC: Turn counterclockwise. (CCW)

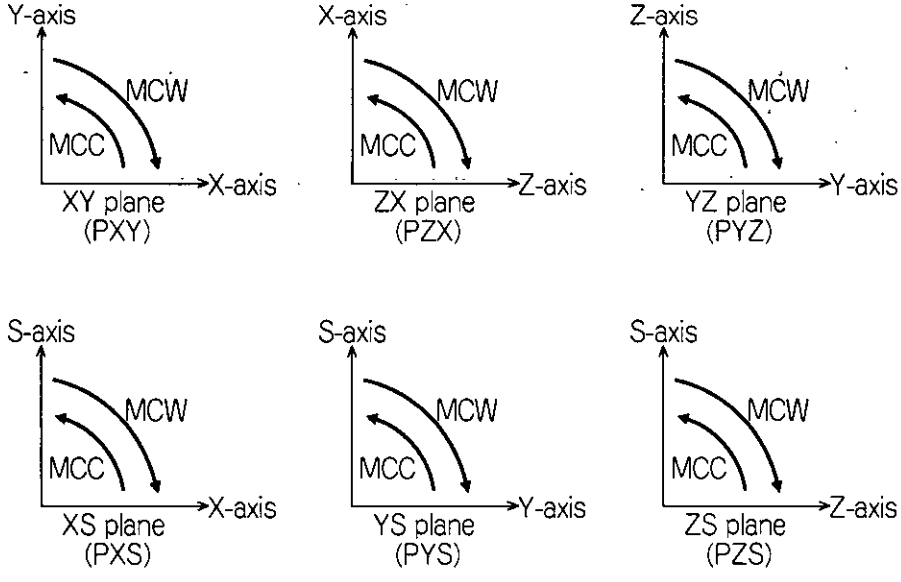



Fig . 4.4

XY plane
(MCW / MCC) [ PXY] X · · Y · · (I · · J · · /R · · ) [F · · ] ;

ZX plane
(MCW / MCC) [ PZX] Z · · X · · (K · · I · · /R · · ) [F · · ] ;

YZ plane
(MCW / MCC) [ PYZ] Y · · Z · · (J · · K · · /R · · ) [F · · ] ;

XS plane
(MCW / MCC) [ PXS] X · · S · · (I · · L · · /R · · ) [F · · ] ;

YS plane
(MCW / MCC) [ PYS ] Y · · S · · (J · · L · · /R · · ) [F · · ] ;

ZS plane
(MCW / MCC) [ PZS ] Z · · S · · (K · · L · · /R · · ) [F · · ] ;

(2) To use circular interpolation (MCW or MCC), as a rule, specify an interpolation plane.

(3) Exponential accel/decel is used. The exponential accel/decel constant is set in the same parameters as for MVS.

(4) The end point and the coordinates of the center of the arc can be programmed either by absolute or incremental values according to ABS/INC selection.

(Program example )
ABS MCC PXY X1500 Y4000 I2500 J1000 F150 ;

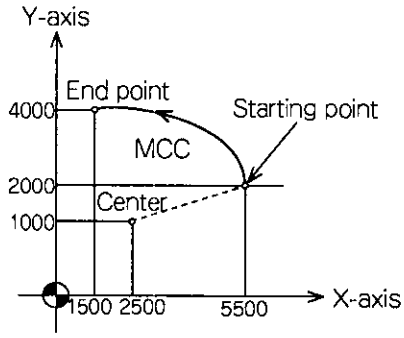



Fig. 4.5 Absolute Command

INC MCC PXY X-4000 Y2000 I-3000 J-1000 ;

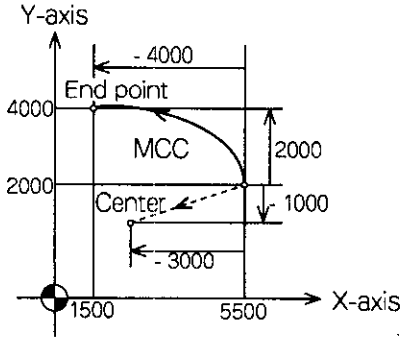



Fig. 4.6 Incremental Command

(5) If radius R is used instead of arc center coordinates (I, J, K, L), interpolation is performed as shown below.

If R > 0, an arc having an arc angle less than 180° is drawn.
If R < 0, an arc having an arc angle greater than 180° is drawn.

(Example) MCW PXY X·····Y·····R ±·····F····· ;

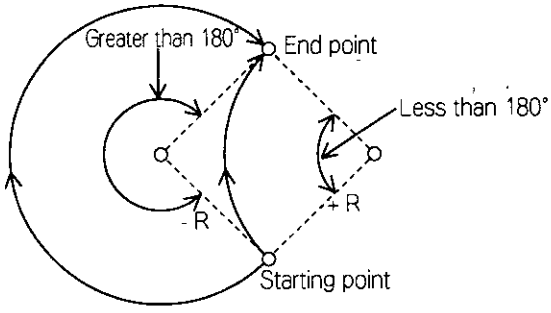



Fig. 4.7

(6) Notes

(a) If the end point is off the circumference because of calculation tolerance, this component moves as shown in Fig.4.8. Initially, it moves to a certain point on the circumreference ( ● in Fig.4.8), and then moves to the specified end point ( ○ in Fig.4.8)

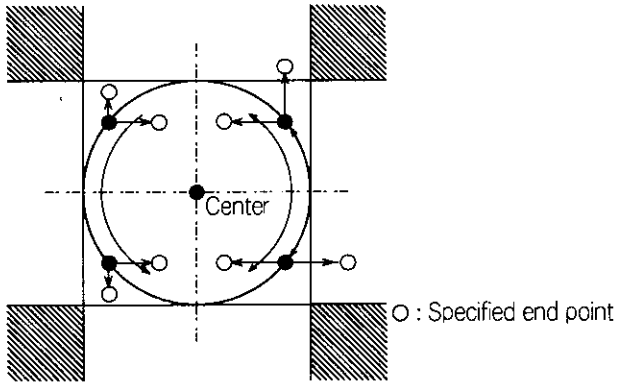



Fig. 4.8

If the end point is specified in the hatched areas, an error occurs (with alarm code 012).

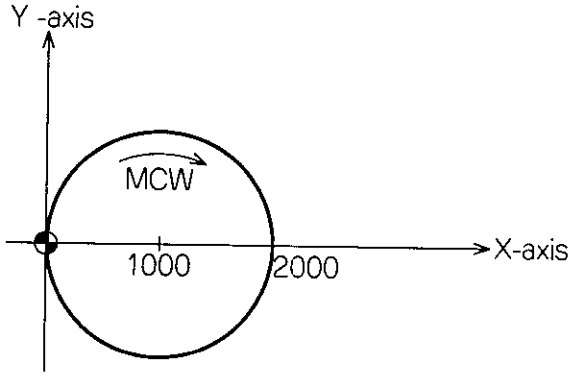
(b) If R=0 (or I=0 and J=0 in XY plane is incremental mode) is specified in circular interpolation command, an error occurs (with alarm code 011).

(7) Complete circle specification

A complete circle trajectory can be commanded in a single block by specifying the same position for the starting and end points.

(Program example)

```
MOV X0 Y0;
MCW PXY X0 Y0 I1000 J0 F100;
```




Fi.g. 4.9

(8) After a number of pulses for the MCW or MCC block are output, the next motion command block is executed.

To execute the next block after interpolation has been completed, insert in-position wait command (PFN).

If the next command is not a motion command, it is executed while the pulses are being output.

To execute the next command after interpolation has been completed, insert in-position wait command (PFN).

## 4.4.6 Helical Interpolation (MCW, MCC)

(1) Helical interpolation is linear interpolation synchronized to circular interpolation using an axis not contained in the arc plane.

(MCW / MCC) [ PXY ] X · · · Y · · · (I · · · J · · · /R · · · ) (Z / ZF) · · · [ F · · · ]

Linear interpolation axis specification

To specify the linear interpolation axis, use coordinate words X, Y, Z, or S as absolute or incremental values according to ABS/INC selection. Otherwise, use coordinate words XF, YF, or SF as incremental values (pitch) regardless of ABS / INC selection.

(2) Format

XY plane + Z-axis
(MCW/MCC) [ PXY ] X · · · Y · · · (I · · · J · · · /R · · · ) (Z/ZF) · · · [ F · · · ];

XY plane + S-axis
(MCW/MCC) [ PXY ] X · · · Y · · · (I · · · J · · · /R · · · ) (S/SF) · · · [ F · · · ];

ZX plane + Y-axis
(MCW/MCC) [ PZX ] Z · · · X · · · (K · · · I · · · /R · · · ) (Y/YF) · · · [ F · · · ];

ZX plane + S-axis
(MCW/MCC) [ PZX ] Z · · · X · · · (K · · · I · · · /R · · · ) (S/SF) · · · [ F · · · ];

YZ plane + X-axis
(MCW/MCC) [ PYZ ] Y · · · Z · · · (J · · · K · · · /R · · · ) (X/XF) · · · [ F · · · ];

YZ plane + S-axis
(MCW/MCC) [ PYZ ] Y · · · Z · · · (J · · · K · · · /R · · · ) (S/SF) · · · [ F · · · ];

XS plane + Y-axis
(MCW/MCC) [ PXS ] Y · · · S · · · (I · · · L · · · /R · · · ) (Y/YF) · · · [ F · · · ];

XS plane + Z-axis
(MCW/MCC) [ PXS ] X · · · S · · · (I · · · L · · · /R · · · ) (Z/ZF) · · · [ F · · · ];

YS plane + X-axis
(MCW/MCC) [ PYS ] Y · · · S · · · (J · · · L · · · /R · · · ) (X/XF) · · · [ F · · · ];

YS plane + Z-axis
(MCW/MCC) [ PYS ] Y · · · S · · · (J · · · L · · · /R · · · ) (Z/ZF) · · · [ F · · · ];

ZS plane + X-axis
(MCW/MCC) [ PZS ] Z · · · S · · · (K · · · L · · · /R · · · ) (X/XF) · · · [ F · · · ];

ZS plane + Y-axis
(MCW/MCC) [ PZS ] Z · · · S · · · (K · · · L · · · /R · · · ) (Y/YF) · · · [ F · · · ];

(Program example)

MCW PXY X0 Y100 I0 J0 Z50 F100

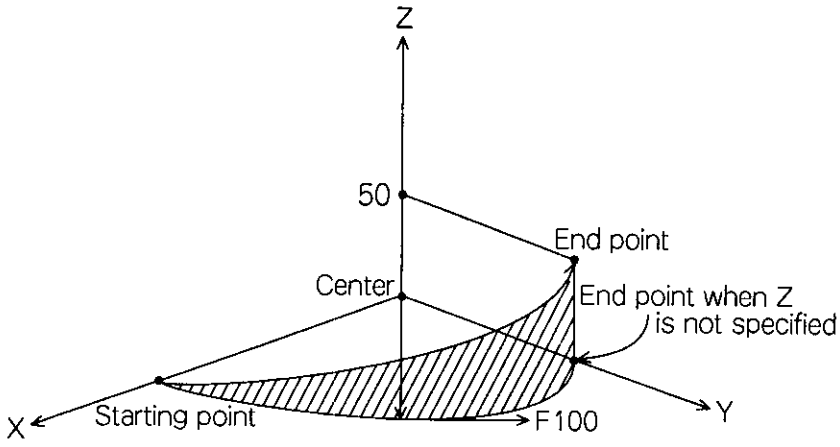



Fig. 4.10

(3) Notes

(a) Arc must not exceed 360°.

(b) Feed speed F is the speed in the tangent direction of the arc in the arc plane. Therefore, speed of the linear axis (F' ) is calculated as follows.

$F' = F \times$ (length of linear axis) / (length of arc)

(c) When using S for one of the plane axis, and S-axis is specified as rotary by the parameter, instruction values for S-axis always have 1 digit for the fractional part.

## 4.4.7 TIME WAIT (TIM)

(1) TIM P · · · ;
The above command dwells progress to the next block for the specified time by address P.

(2) Dwell time is non-modal. This command cannot be described together with other commands.
(Use one block for the command.)

(3) Range of address P is from 0.001 to 99999.999 seconds.

(4) If the preceding motion command is not accompanied by PFN, dwell time is executed even while that motion command is being executed.

( Program example )

```
MOV X100. ;
TIM P2500 ; · · · · · TIM is executed at the same time because the preceding motion block has no PFN.
TIM P2.5 ;
```

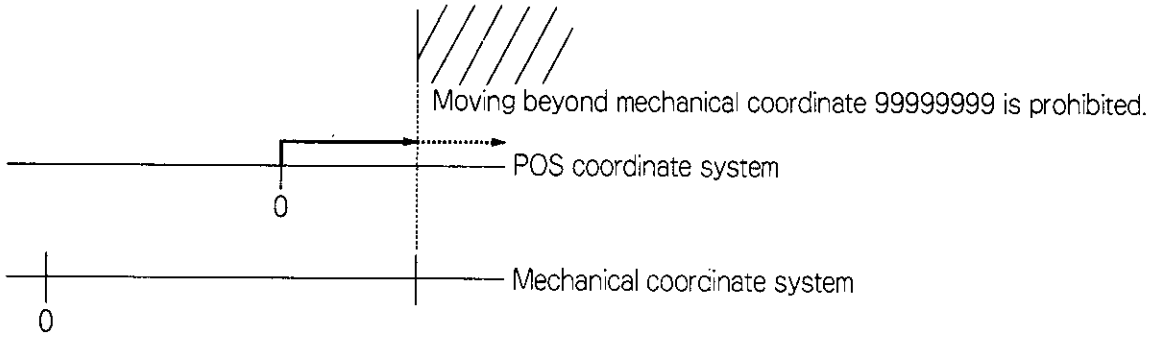
Either description in the above example specifies a wait time of 2.5 seconds.
(This value is independent from the input and output units.)

### 4.4.8 Current Position Switch (POS)

(1) POS ( up to four axes of any of X · · · Y · · · Z · · · S )

(2) POS command switches current position of the axis to the specified values.
Absolute motion commands after POS uses the switched coordinates. Any value specified in motion command provided that the switched coordinate does not exceed ±99999999 (command units) of a mechanical coordinate.

(3) Coordinate can be switched by POS as many as possible. Mechanical coordinates are not affected by this switching.

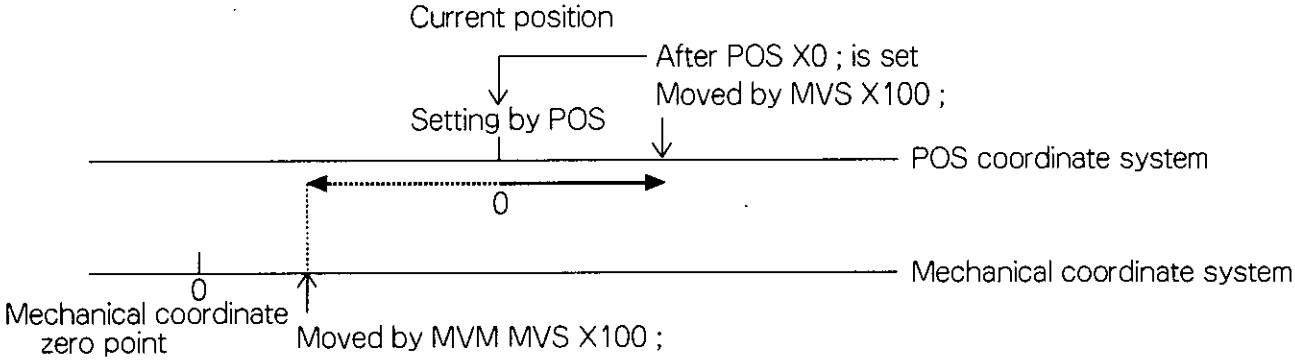


## 4.4.9 Mechanical Coordinate Mode (MVM)

(1) Use this command to return to mechanical coordinates.

(2) Values specified for MVM are processed as absolute values regardless of ABS/INC selection. MVM can be described in the same block only with MOV or MVS.

(3) Mechanical coordinates are used for zero return. Mechanical coordinates are not affected by coordinate setting by POS.




(4) Describe MVM at the beginning of the block where mechanical coordinates are to be used for positioning.

MVM MVS X · · · Y · · · Z · · · F · · · ;

(5) MVM takes effect only in the block where it is described.

## 4.4.10 Zero Return (ZRN)

(1) ZRN first moves axis similarly to MOV, that is, it moves them to a target position at rapid traverse speed (PA04). Then ZRN moves the axis to the zero point in the same way as ZRN used in the PLC unit functions. Note that motion to the target position at rapid traverse speed is omitted for the first ZRN after power-ON.

Direction of zero return is set by parameter PA50 (zero return direction).

(2) ZRN (up to four axis of any of X · · · Y · · · Z · · · S)

The above command moves up to four axes simultaneously. Axis not specified are not moved.

(3) Program example

ZRN X100. Y200.

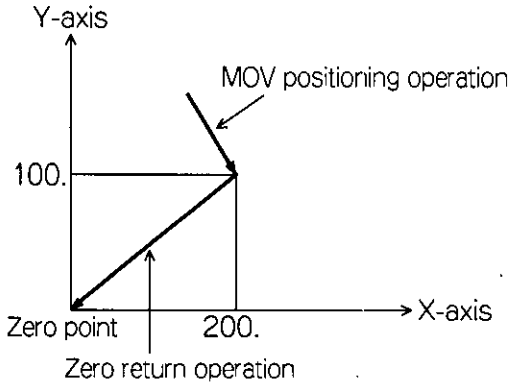



Fig. 4.11

(4) The next block is started when zero return positioning has been completed with all the specified axis.

### 4.4.11 Absolute Mode (ABS)

ABS specifies that the motion data after axis numbers are absolute values.

(1) The blocks after ABS is specified, position data preceded by a coordinate symbol (X, Y) are processed as absolute values. (Absolute positioning mode selection)

(2) ABS is modal command. Absolute mode takes effect until it is switched.
Absolute mode is selected after power-ON.

### 4.4.12 Incremental mode (INC)

(1) The blocks after INC is specified will change position data to incremental values. (Incremental positioning mode selection)

(2) INC is modal command. Incremental mode takes effect until it is switched ON.

(3) Program examples are as shown below. (a) and (b) command same movement.

(a) Use of ABS

```
ABS MOV X10 ;
    MOV X100 ;
    MOV X0 ;
```

(b) Use of INC

```
ABS MOV X10 ;
INC MOV X90 ;
    MOV X -100 ;
```

In the above examples, motion to X coordinates 100 and 0 are coded using ABS and INC. If ABS in example (a) is replaced by INC, the motion is changed as follows.

```
INC MOV X10 ; ·····Move X-axis in X-axis positive direction by 10 from the current X coordinate.
    MOV X100 ;·····Move X-axis by 100 in the same direction.
    MOV X0 ; ·····Do not move anything.
```

### 4.4.13 Notch Signal (PNT)

(1) If PNT command is placed before a positioning block, notch signal is output (address M relay MUXX is turned ON) when the specified notch point is passed by during positioning.
Only a single notch point can be specified for a block.
The address M relay is reset (from ON to OFF) when MFIN is turned ON. If MFIN remains OFF, the machine stops after motion command is completed and waits until it is turned ON and OFF.
(For more information about address M relay and MFIN, see the Programming Manual for PLC unit (SIE-C888-1.1).)
When a notch command is placed after another effective notch command, the latter one takes effect.

(2) Operation examples

(a) N001 PNT Xxp Yyp M10;
N002 MOV Xx1 Yy1;
(address M relay is turned ON after both Xp and Yp are passed by.)

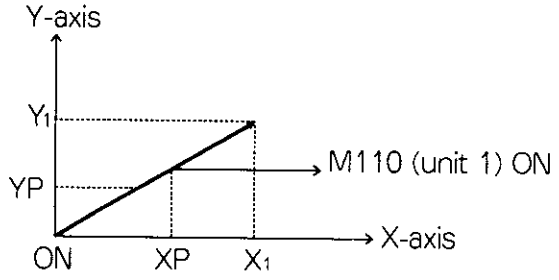



Fig . 4.12

(b) N001 PNT Xxp Yyp M20;
N002 MOV Xx1;

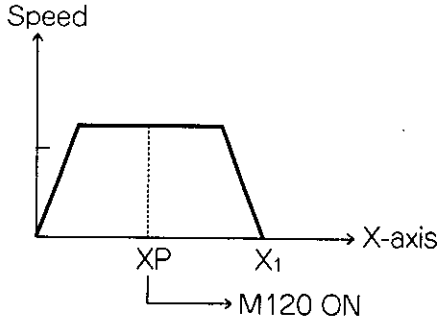



Fig . 4.13

## 4.4.14 Wait for Motion Completion (PFN)

(1) PFN stops command execution until the axis is positioned to the in-position area (specified by positioning completion range PA06).

(2) If the next block to MOV or ZRN is an axis motion block, it is not executed before the axis is in position. Therefore, PFN need not be placed after MOV or ZRN command before another axis motion command. If the next block is not an axis motion block (such as I / 0 processing) and if you want to wait until the axis are in position, PFN must be used before the block.

(3) If the next block to MVS, MCW, or MCC is an axis motion block, it is executed when pulses have been output. If you wish to execute the next block after the axis are in position, use PFN. If the next block is not an axis motion block, it is executed even while the axis are moving, as explained above. If you wish to execute the next block after the axis are in position, place PFN before it.

(4) Specify positions for PFN at the end of that block or in the next block, as shown in the example below.

(5) Program examples

(a)

```
N001 MOV X100. Y100. Z100. ;
N002 PFN ;
N003 MVS X200. Y150. F100 ;
```

PFN on N002 is useless because MOV block on N003 is executed only after MOV block on N001 is completed and the axis are in position.

(b)

```
N001 MOV X100. Y100. Z100. ;
N002 #O10=1 ;
N003 PFN ;
N004 #O10=0 ;
```

The above program turns output 10 ON while executing block N001, and turns OFF when positioning has completed. Since N002 and N004 have nothing to do with axis motion commands, they are executed as MOV command of N001 it is executed unless there is PFN on N003. By use of PFN, output 10 is turned OFF after motion is completed.

(c)

```
N001 MVS X200. Y200. F100. ;
N002 PFN ;
N003 MVS X400. Z200. F200 ;
```

The next block to MVS is executed when pulses have been output. With the use of PFN, the next motion command is executed after the preceding motion is completed. (Axis motion is not completed even when pulses have been output.)

### 4.4.15 Disregard Single-Block Signal (SNG)

(1) The next block after a SNG block is executed regardless of single-block operation mode signal status.

(2) In single-block operation mode, program is executed block-by-block for checking operations.
In program operation, if an axis motion command is followed by a non-axis motion command, the latter is executed while axis are moved according to the former. In single-block operation, however, the next block is always executed after the axis motion is completed.
If you want to execute some blocks continuously in single-block operation for timing events, use SNG.

(3) Program example

①

```
N001 MVS X0 Y0 F1000;----------
N002 SNG MVS X100. Y100. F100; --
N003 SNG #O11=1;          ----------
N004 #O11=1;
N005 #O12=1;
```

These blocks are executed continuously even in single-block operation.

### 4.4.16 Use of Compensation

(1) Position data and speed data can be compensated.

Example : MOV XH1 YH2 ZH3 FH4 ;

(2) Up to four compensations from H1 to H8 are available.

(3) Set compensations by VAR command used in the PLC unit before starting program operation.
If not, previous data is used. (See the Programming Manual for PLC unit.)
All H1 to H8 are preset to 0 at the factory. After any value is set, it is backed up by the battery.

(4) Compensations can be used in programs as many times as you want.

(5) Use of two or more compensations as shown below is prohibited.
MOV XH1 + H2 ;

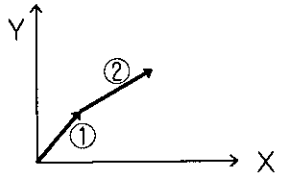
## 4.4.17 Wait-for-completion External Output (SET Mnn)

(1) Use this command to stop program operation at a particular block and restart upon receipt of a signal used in PLC unit.

When SET Mnn (nn : 00 to 89) is executed, address M relay MUXX used in the PLC unit is turned ON and the system waits until MFIN signal used in the PLC unit is turned ON.

The next block is executed when MFIN signal is turned ON and OFF.

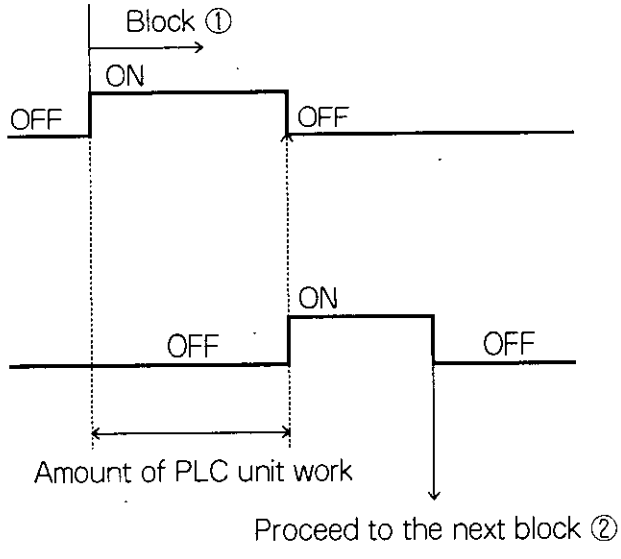
(2) Program example




```
N001 MVS X10.  Y20. ; ————————①
N002 SET M10 ;
N003 MVS X30.  Y30. ; ————————②
```

MC output Address M relay
PLC output (M 1 1 0)
- Address no.
- Motion control unit 1

MC input
PLC output MFIN




The above program executes block ① simultaneously to the next SET block, so that address M relay (M110) is turned ON while block ① is being executed.

If you wish to turn ON the address M relay (M110) after block ① is completed, insert PFN after ①.

## 4.4.18 Subprogram Call (GSB)

(1) Subprograms can be called up from memory by specifying program numbers assigned beforehand, and executed as many times as you wish.

GSB PXX LXX
- LXX: Number of execution of the subprogram
- PXX: Subprogram number to be called up

The subprogram specified by P is executed L times. If L is omitted, the subprogram is executed once. Up to four nestings of subprograms (calling up a subprogram from another) are permitted.

(2) Program exapmle

Program number : O01
```
MOV X0 Y0 Z0;
GSB P02;
MVS X0 Y0 Z0 F1000;
END;
```
Program number : O02
```
INC MVS X10. F500;
GSB P03 L2;
RET
```
Program number : O03
```
INC MVS Y30. F1000;
MVS X20. Y10. F500;
RET;
```

## 4.4.19 Subprogram End (RET)

Specify this command at the end of a subprogram. When RET is executed, control is returned to the block next to the subprogram call up in the main program. If RET is executed in the main program, the main program is restarted from the beginnig.

## 4.4.20 Program Stop (STP)

STP holds execution of a program temporarily. If STP is read during program operation, operation is stopped after that block is executed. To restart operation from the next block, turn ON the motion command (MVL) start signal (input 1).

### 4.4.21 Program End (END)

Specify this command at the end of a program. If END is read during program operation, operation is stopped after that block is executed. If axis are moving, operation is stopped after they are in position. The stopped program is ready to be started from the beginning.

### 4.4.22 Second In-position Check Range for Interpolation Command (INP)

(1) INP (Up to four axes from X · · Y · · Z · · S · · ) ;
The above command performs in-position check for interpolation commands (MVS, MCW, and MCC) without PFN.

(2) The second in-position check width, unlike the in-position width by PFN, can be set up only by INP.

(3) Once a positive number (not 0) is set up for the second in-position check width, it takes effect for all the succeeding interpolation commands.

(4) To cancel, set 0 or turn OFF power.

(5) If PFN is used when the second in-position width is set up, position check by PFN is performed. (PFN takes precedence.)

(6) If more than two axis is to be moved, the next block is executed after all the axis enter the corresponding in-position width check.

(7) If the preceding block has an interpolation command and there is no PFN, the program terminates without waiting for the axis in-position. If this occurs, the current position register on the PLC unit holds at the value when END is executed. (not final position)

## 4.4.23 Wait for I/O Variable (IOW)

(1)

IOW [#O□□□=△] #O□□□==▽
#I□□□==▽ [#O□□□=△;]
A B C

□□□ · · · 1 to 256 (I/O variable number)
△ · · · 0, 1
▽ · · · 0, 1, 2, 3
0 · · · OFF
1 · · · ON
2 · · · Rising edge
3 · · · Falling edge

(2) IOW outputs a value specified by △ to the output variable specified by □□□ of A, waits until the input or output variable specified by □□□ of B changes to the value specified by ▽, then outputs value △ to the output variable specified by □□□ of C.

(3) A and C can be omitted. If not specified, no value is output.

(4) Only == can be described in the formula expression of B.

Example 1 : IOW #I250 ==0 #O251=1;
If input variable #I250 is "0", output "1" to output variable #O251, and proceed to the next block. If input variable #250 is "1", wait until it becomes "0".

Example 2 : IOW #O251=1 #I250==1;
Output "1" to output variable #O251, and proceed to the next block if input variable #I250 is "1". If the input variable is "0", wait until it becomes "1".

Example 3 : IOW #O250==1;
Proceed to the next block if output variable #O250 is "1".

Example 4 : IOW #O250=1 #I251==2 #O250=0;
Output "1" to output variable #O250. Wait until input variable #I251 changes from "0" to "1", then change output variable #O250 to "0" and proceed to the next block. If the input variable is already "1", do not proceed to the next block.

## 4.4.24 Variables

Instead of setting a value directly, a variable can be used. If this variable is called up during operation, the value contained in the variable area is fetched and substituted.
A variable is indicated with # followed by a number. Types of variables are explained below.

### 4.4.24.1 Common Variable (#nnn)

(1) Format
#1 to #199

(2) Common variables can be used in a program. (A common variable is up to 32 bits.) Common variables can be used as temporary memory for calculation. Calculation results are kept in memory until power is turned OFF.

(3) Program example
#10=100 ;
#11=200 ;
#12=300 ;
#13=1000 ;
When the above values are assigned to the variables, the following commands are identical.
MVS X#10 Y#11 Z-#12 F#13 ;

the above block is executed as
MVS X100 Y200 Z-300 F1000 ;

### 4.4.24.2 Input Variable (#Innn)

(1) Format
#I1 to #I256

(2) Description
Input variables are used to read MC unit coil signals and (assigned) external inputs on the PLC unit.
Y1 to Y256 → #I1 to #I256
I1 to I140 (depending on assignment) → #I185 to #I224 (MC unit 1)
Y257 to Y512 → #I1 to #I256
I41 to I80 (depending on assignment) → #I185 to #I224 (MC unit 2)

(3) How to use input variables
#10=#I100 ; State of input 100, either 1 or 0, is substituted for variable #10.
#10=#I100+#I101 ; OR input 100 and input 101 and the result is stored in variable #10.
#10=#I100*#I101 ; AND input 100 and input 101 and the result is stored in variable #10.

(4) Example use of the input variable in IF statement is shown below.

```
        IF #I1==0  GOTO 20 ; If #I1 is OFF (0), jump to N020.
        MOV  X10. ; Execute the next block if #I1 is ON (1).
N020 MVS  Y10. ;
```

(5) Example of use of the input variable in IOW command is shown below.
IOW #O1=0 #I1==1 #O2=1 ; Output 0 to output variable #O1. Wait until input variable #I1 is set ON (1), then change output variable #O2 to 1, and proceed to the next block.

### 4.4.24.3 Output Variable (#Onnn)

(1) Format
#O1 to #O256

(2) Description
Output variables are used to output signals used in PLC unit to MC unit relays and external outputs.
#O1 to #O256 → X1 to X256
#O201 to #O224 → O1 to O40 (depending on assignment) (MC unit 1)
#O1 to #O256 → X257 to X512
#O201 to #O224 → O25 to O48 (depending on assignment) (MC unit 2)

(3) How to use output variables
#O20=1 Output ON.
#O20=0 Output OFF.

## 4.4.25 Calculation

Addition, subtraction, multiplication, and division (by +, −, ＊, and /) is possible using variables and/or constants.

### 4.4.25.1 Set and Replacement of Variables

#i=#j (Constants can be used.)
A variable set in advance can be replaced as follows.
#10=100 ;
#100=#10 ; ・・・・・Replacement
By the above lines, 100 is set to #100.

### 4.4.25.2 Addition-type Operations

#i=#j+#K ・・・Sum
#i=#j−#K ・・・Subtraction
(Constants can be used.)
#11=200 ;
#12=300 ;
With the above definitions, 500 is set to #110 by the following line.
#110=#11+#12 ;
Similarly, −100 is set to #120 by the following line.
#120=#11−#12 ;

### 4.4.25.3 Multiplication-type Operations

#i=#j＊#K ・ ・ ・ Multiplication
#i=#j/#K ・ ・ ・ Division
(Constants can be used instead of #j or K.)
#13=5
#14=3
With the above definitions, 15 is set to #130 by the following line.
#130=#13＊#14 ;
Similarly, 1 is defined for #140 by the following line.
#140=#13/#14 ;
Note : Fractional parts are rounded off.

### 4.4.25.4 Combination of Operations

Variables can also be used in polynomial operations.
#i=#j+#K－#1＊#m/#n
In such a calculation, there is no priority order among operators and calculation proceeds from left to right of the line.
Example : #150=10+5＊4
60 is substituted for #150

### 4.4.25.5 Calculation Precision

Only integers can be used in calculation. Numbers from 0 to ±99999999 (32 bits) can be handled. Fractional parts are rounded off.

## 4.4.26 Control Commands

Branch and repetition commands can be used to change program flow.

### 4.4.26.1 Branch Command

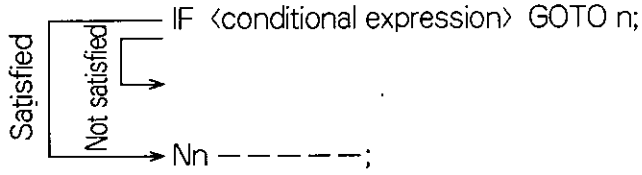
IF 〈conditional expression〉 GOTO n;

With the above line described, if the〈conditional expression〉 is satisfied, operation jumps to the block with sequence number "n" in the same program. The sequence number is searched for from the conditional expression toward the end of the program, and if it is not found, it is searched for again from the beginning of the program.

The destination block of jump can be a variable instead of n.

If the conditional expression is not satisfied, the next block is executed.

If the sequence number is duplicated more than once, the operation jumps to the one that is found first.




A simple jump command is also available by omitting the IF 〈conditional expression〉

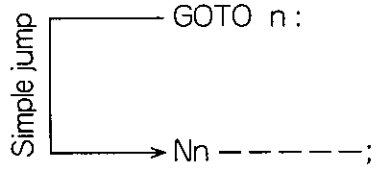



Table 4.16 lists types of conditional expressions.

Table 4.16

| Conditional expression | Meaning |
|---|---|
| #i == #j | (#i = #j) |
| #i <> #j | (#i ≠ #j) |
| #i > #j | (#i > #j) |
| #i < #j | (#i < #j) |
| #i >= #j | (#i ≧ #j) |
| #i <= #j | (#i ≦ #j) |

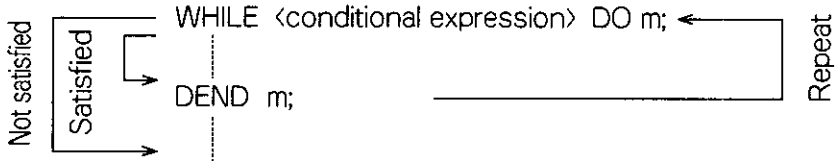
For #i and #j, common variables, input variables, output variables, and constants can be used.

## 4.4.26.2 Repetition Command

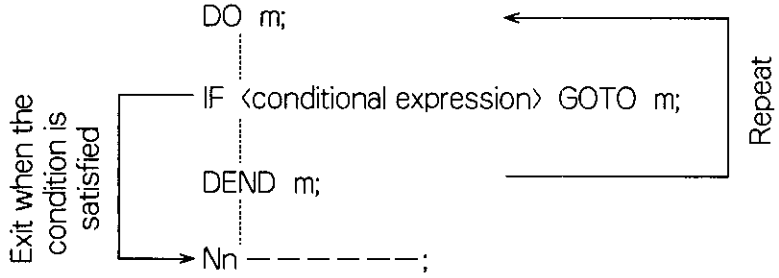
```
WHILE 〈conditional expression〉 DO m ; ( m=1, 2, 3 )
:
DEND m ;
```

With the above lines described, while the 〈conditional expression〉 is satisfied, blocks from DOm to DEND are repeated.

If the conditional expression is not satisfied, operation jumps to the next block to DENDm.




If WHILE 〈conditional expression〉 is omitted, blocks from DOm to DENDm are repeated infinitely. When using an infinite loop, describe IF statements in the middle of the loop so as to exit under specific conditions.




**〈Notes on use of DO,DEND commands〉**

(I) Place DOm prior to DENDm

(II) Specify the same number for m in DOm and DENDm. Only 1, 2, and 3 can be used for m.

(III) The same ID number m can be used as many times as you wish, avoid using more than two same ID numbers at the same range.

(IV) GOTO n can be used to exit from a DO loop, but not to enter.

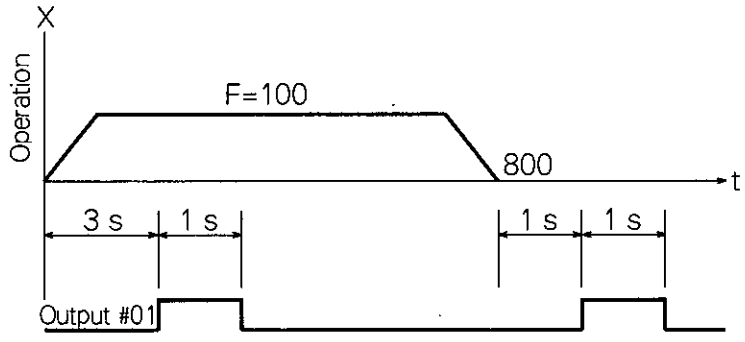
(V) Up to three levels of nesting of DO loops is permitted in a single program.

## 4.5 PROGRAMMING EXAMPLES

During execution of a program, commands read in the read-in-advance buffer are executed immediately if possible.

Be careful when a signal is to be output after servo axis motion is completed. To do so, use in-position completion wait command (PFN). This means that interpolation commands and TIM commands can be executed while servo axis are moving.

· Programming example (1)




The above operation can be implemented by the program below.

```
O01 ;
N001   MVS  X800.  F100.  ;
N002   TIM  P3.  0  ;
N003   #O1=1
N004   TIM  P1.  0  ;
N005   #O1=0
N006   PFN  ;
N007   TIM  P1.  0  ;
N008   #O1=1
N009   TIM  P1.  0 ;
N010   #O1=0
N011   END  ;
```

· Programming example (2)

```
O01 ;
N001 MOV  X500.  Y500.  Z500.  ;
   .
   .
N014  MVS  X505.  ;
N015  MVS  S180.  0  ;
N016  MVS  X500.  ;
N017  MVS  S180.  0  ;
   .
   .
N020  #O10=1 ;
N021  TIM  P0.  5 ;
N022  #O10=0 ;
N023  TIM  P0.  5 ;
N024  #O10=1 ;
N025  TIM  P0.  5 ;
N026  #O10=0 ;
N027  MVS  X500.  0  Y503.  0  Z501.  0 ;
   .
   .
N030  MVS  X400.  0 Y400.  0  F500.  0 ;

N032  #10=0 ;
N033  WHILE  #10  <  100  DO  1 ;
N034  MCW  PXY  X400.  0 Y400. 0  I350.  0  J350.  0  F10.  0 ;

N036  #10=#10+1 ;
N037  END  1 ;
   .
   .
N040  END ;
```

# 5. ALARM CODE LIST

If an error occurs with the MC unit, the corresponding alarm code is selected from the following table and output automatically to the personal computer programmer or to the teach pendent.

## Common alarms

| Code | Explanation | Cause | Corrective action to be taken |
|---|---|---|---|
| 001 | MEMORY OVER | • The program memory is full. | • Delete unnecessary programs. |
| 002 | OVER FLOW (128ch) | • More than 128 characters are input in a single block. | • Correct the program. (Character number) |
| 003 | NO PROGRAM | • The specified program is not found. | • Load or correct the program. |
| 004 | PROG ERROR (NO ADDRESS) | • No data follows the symbol.<br>• No symbol precedes data. | • Correct the program. |
| 005 | PROG ERROR ( "-" , "0" "." ) | • Minus sign (-), zero (0), or decimal point (.) is used incorrectly.<br>• Decimal point is at a wrong position. | • Correct the program.<br>• Check the decimal point position parameter. |
| 006 | PROG ERROR (UNUSABLE CHARACTERS) | • Unusable characters are used in program (except comments) | • Correct the program. |
| 007 | PROG ERROR (DIGITS) | • Input data has a wrong number of digits. | • Correct the program. (Data character number) |
| 008 | PROG ERROR (SYNTAX) | • Incorrect command is used. | • Correct the program. |
| 009 | PROG ERROR (DUPLICATE) | • Non-duplicated commands are used in a single block. | • Correct the program. |
| 0010 | PROG ERROR (F) | • Address F is omitted in an interpolation command. | • Correct the program. |

## Common alarms

| Code | Explanation | Cause | Corrective action to be taken |
|---|---|---|---|
| 011 | PROG ERROR (R=0) | • Radius is set to 0 in a circular interpolation command. | • Correct the program. (R, or I and J) |
| 012 | PROG ERROR (MCW/MCC) | • The specified position is out of the range of circular interpolation command. | • Correct the program. (X and Y, or R) |
| 013 | PROG ERROR (TIM) | • The specified value of P is out of the range. | • Correct the program. (P) |
| 014 | NOTCH ERROR | • Parameters are set up incorrectly. | • Check function setup parameters<br>• Correct the program. |
| 015 | | | |
| 016 | FG ERROR (MVS, MCW, MCC) | • Interpolation command error<br>Plane specification error<br>End point specification error | • Correct the program. |
| 017 | PROG ERROR | • Compensation number specification error | • Correct the program. |
| 018 | PROG ERROR (GSB) | • Address P is omitted in the GSB block. | • Correct the program. (P) |
| 019 | PROG ERROR (GSB) | • The program number called up by GSB is not found. | • Check related programs. |
| 020 | PROG ERROR (GSB) | • RET is omitted at the end of the subprogram. | • Correct the program. |

## Common alarms

| Code | Explanation | Cause | Corrective action to be taken |
|---|---|---|---|
| 021 | PROG ERROR (GSB) | • The nesting level of subprogram call exceed 5. | • Correct the program so as to reduce the nesting level of subprogram call less than 4. |
| 022 | PROG ERROR (END) | • END is omitted at the end of the program. | • Add END. (END) |
| 023 | PROG ERROR (TIM) | • No time is specified in the TIM block. | • Correct the program. |
| 024 | PROG ERROR (NO AXIS) | • The axis to be used is not valid. | • Correct the program.<br>• Correct related parameters. |
| 025 | PROG ERROR (ZERO DIVIDE) | • Division by 0 is attempted. | • Correct the program.<br>• Correct related parameters. |
| 026 | PROG ERROR (OVER FLOW) | • An overflow occurred during calculation. | • Correct the program.<br>• Correct related parameters. |
| 027 | PROG ERROR (IF, GOTO) | • The branch command has no destination. | • Correct the program. |
| 028 | PROG ERROR (WHILE, DO) | • The end command for repetition command (DEND) is omitted.<br>• Ranges of blocks to be repeated overlap. | • Correct the program. |
| 029 | | | |
| 030 | | | |

## Common alarms

| Code | Explanation | Cause | Corrective action to be taken |
|---|---|---|---|
| 071 | RAM ERROR (1) | • MC unit failure | • Contact your YASKAWA representative. |
| 072 | RAM ERROR (2) | • MC unit failure | • Contact your YASKAWA representative. |
| 073 | RAM ERROR (3) | • MC unit failure | • Contact your YASKAWA representative. |
| 074 | RAM ERROR (4) | • MC unit failure | • Contact your YASKAWA representative. |
| 075 | ROM ERROR (1) | • MC unit failure | • Contact your YASKAWA representative. |
| 076 | ROM ERROR (2) | • MC unit failure | • Contact your YASKAWA representative. |
| 077 | ROM ERROR (3) | • MC unit failure | • Contact your YASKAWA representative. |
| 078 | ROM ERROR (4) | • MC unit failure | • Contact your YASKAWA representative. |
| 079 | PARAMETER SUM ERROR | • Backup battery is disconnected.<br>• Power system failure<br>• MC unit failure | • Check the PLC built-in battery.<br>• Check power-related equipment.<br>• Set parameters, program, and offsets again. If the error reoccurs, contact your YASKAWA representative. |
| 080 | PARAMETER DUPLICATE AXIS | • An axis name is duplicated. | • Correct the parameter. |

## Common alarms

| Code | Explanation | Cause | Corrective action to be taken |
|---|---|---|---|
| 081 | EMERGENCY STOP | • Emergency stop | • Clear emergency stop.<br>Check emergency stop input. |
| 082 | | | |
| 083 | | | |
| 084 | | | |
| 085 | | | |
| 086 | | | |
| 087 | | | |
| 088 | | | |
| 089 | | | |
| 090 | | | |

## Individual axis alarm (A: axis number from 1 to 4)

| Code | Explanation | Cause | Corrective action to be taken |
|---|---|---|---|
| A01 | SERVO ERROR | • Servo amplifier error | • Check for servo amplifier error.<br>• If the error recurs after resetting the servo amplifier, contact your YASKAWA representative. |
| A02 | OT-F ERR | • Forward direction overtravel signal is input.<br>• Operation error or program error<br>• Erroneous setting of parameters | • Check the overtravel LS. Reset the LS and return the axis in the reverse direction.<br>• Check parameters related to OT alarm detection.<br>• Check the overtravel input signal. |
| A03 | OT-R ERR | • Reverse direction overtravel signal is input.<br>• Operation error or program error<br>• Erroneous setting of parameters | • Check the overtravel LS. Reset the LS and return the axis in the forward direction.<br>• Check parameters related to OT alarm detection.<br>• Check the overtravel input signal. |
| A04 | SERVO TRACKING ERROR | • Servo system following error is excessive. | • Check connections between the MC unit, servo amplifier, and motor.<br>• Check values parameters related to system setting and servo characteristics.<br>• Check mechanical load. |
| A05 | SOT-F ERR | • Forward direction overtravel signal is input.<br>• Operation error or program error<br>• Erroneous setting of parameters | • Check the program and operation, then reset the error and return the axis in the reverse direction.<br>• Check parameters related to soft limit switch. |
| A06 | SOT-R ERR | • Negative direction overtravel signal is input.<br>• Operation error or program error<br>• Erroneous setting of parameters | • Check the program and operation, then reset the error and return the axis in the forward direction.<br>• Check parameters related to soft limit switch. |
| A07 | RSET-ERR | • Positioning error | • Check parameters related to servo characteristics.<br>• Check connections between the servo amplifier and motor.<br>• Check mechanical load. |
| A08 | | | |
| A09 | | | |
| A10 | PG LINE DISCONNECTION | • Connection error or break in wire with the encoder<br>• Encoder servo amplifier failure<br>• MC unit failure | • Check connections of the encoder. Contact your YASKAWA representative. |

## Individual axis alarm (A: axis number from 1 to 4)

| Code | Explanation | Cause | Corrective action to be taken |
|---|---|---|---|
| A11 | OVER RUN PREVENTION | • Erroneous setting of parameters<br>• Erroneous connection with the motor and encoder<br>• Runaway detected with the MC unit<br>• MC unit failure | • Check system setting parameters.<br>• Check connections of the motor and encoder.<br>• Review the servo system and modify servo characteristic parameters.<br>• Contact your YASKAWA representative. |
| A12 | | | |
| A13 | | | |
| A14 | | | |
| A15 | | | |
| A16 | | | |
| A17 | | | |
| A18 | | | |
| A19 | | | |
| A20 | | | |

# PROGIC-8
# PROGRAMMING MANUAL FOR MC UNIT

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