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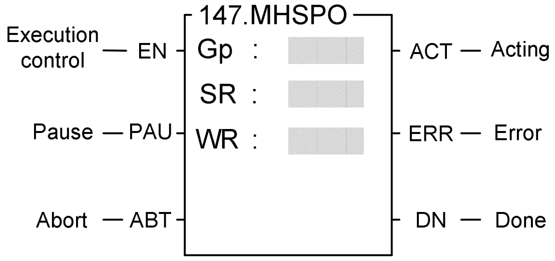
Ladder symbol



Gp : Group number (0～1)

SR : Starting register for positioning program (example explanation)

WR : Starting register for instruction operation (example explanation). It controls 9 registers, which the other program cannot repeat in using.

Range / Ope-rand	HR	DR	ROR	K
	R0 | R3839	D0 | D3999	R5000 | R8071	
Gp				0～1
SR	○	○	○	
WR	○	○	○*	

Instruction Explanation

1. The FUN147 (MHSPO) instruction is used to support the linear interpolation for multi-axis motion control, it consists of the motion program written and edited with text programming. We named every position point as a step (which includes output frequency, traveling distance, and transfer conditions). Every step of positioning point owns 15 registers for coding.

2. The FUN147 (MHSPO) instruction can support up to 4 axes for simultaneous linear interpolation; or 2 sets of 2-axis linear interpolation (i.e. Gp0 = Axes Ps0 & Ps1 **;** Gp1 = Axes Ps2 & Ps3)

3. The best benefit to store the positioning program into the registers is that in the case of association with MMI (Man Machine Interface) to operate settings, it may save and reload the positioning program via MMI when replacing the molds.

4. When execution control “EN”=1, if the other FUN147/FUN140 instructions to control Ps0～3 are not active (corresponding status of Ps0=M1992, Ps1=M1993, Ps2=M1994, and Ps3=M1995 will be ON), it will start to execute from the next step of positioning point (when goes to the last step, it will be restarted from the first step to perform); if Ps0～3 is controlled by other FUN147/FUN140 instruction (corresponding status of Ps0=M1992, Ps1=M1993, Ps2=M1994, and Ps3=M1995 would be OFF), this instruction will acquire the pulse output right of positioning control once the controlling FUN147/FUN140 has released the control right.

5. When execution control input “EN” =0, it stops the pulse output immediately.

6. When output pause “PAU” =1 and execution control “EN” was 1 beforehand, it will pause the pulse output. When output pause “PAU” =0 and execution control is still 1, it will continue the unfinished pulse output.

7. When output abort “ABT”=1, it stops pulse output immediately. (When the execution control input “EN” becomes 1 next time, it will restart from the first step of positioning point to execute.)

8. While the pulse is in output transmitting, the output indication “ACT” is ON.

9. When there is execution error, the output indication “ERR” will be ON.
(The error code is stored in the error code register.)

10. When each step of positioning point is complete, the output indication “DN” will be ON.

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*** The working mode of Pulse Output must be set (without setting, Y0～Y7 will be treated as general output) to be one of U/D, or A/B mode, thus the Pulse Output may have a regular output.

U/D mode : Y0 (Y2, Y4, Y6), it sends out upward counting pulse.
Y1 (Y3, Y5, Y7), it sends out downward counting pulse.

A/B mode : Y0 (Y2, Y4, Y6), it sends out the phase A pulse.
Y1 (Y3, Y5, Y7), it sends out the phase B pulse.

● The output polarity for Pulse Output can select to be Normal ON or Normal OFF.

〔The interfaces for positioning control〕

M1991	ON : Stop or pause FUN147, slow down then stop pulse output OFF : Stop or pause FUN147, stop pulse output immediately
M1992	ON : Ps0 is ready OFF : Ps0 is in action
M1993	ON : Ps1 is ready OFF : Ps1 is in action
M1994	ON : Ps2 is ready OFF : Ps2 is in action
M1995	ON : Ps3 is ready OFF : Ps3 is in action
M1934	ON : Gp0 has finished the last step
M1935	ON : Gp1 has finished the last step

M2000 : ON, multi axes act simultaneously (At the same scan to execute the motion control instructions FUN140/FUN147 for different axes, they will have the pulse output at the same time without any time delay between them)

DR4068	Gp0 vector speed
DR4070	Gp1 vector speed
D4060	Gp0 error code
D4061	Gp1 error code
D4062	The step number (positioning point) which has been completed of Gp0.
D4063	The step number (positioning point) which has been completed of Gp1.

Ps No.	Current output frequency	Current pulse position	The remaining pulse counts to be transmitted
Ps0	DR4080	DR4088	DR4072
Ps1	DR4082	DR4090	DR4074
Ps2	DR4084	DR4092	DR4076
Ps3	DR4086	DR4094	DR4078

※ FUN147 doesn’t support dynamic change for its output frequency during the pulse transmitting.

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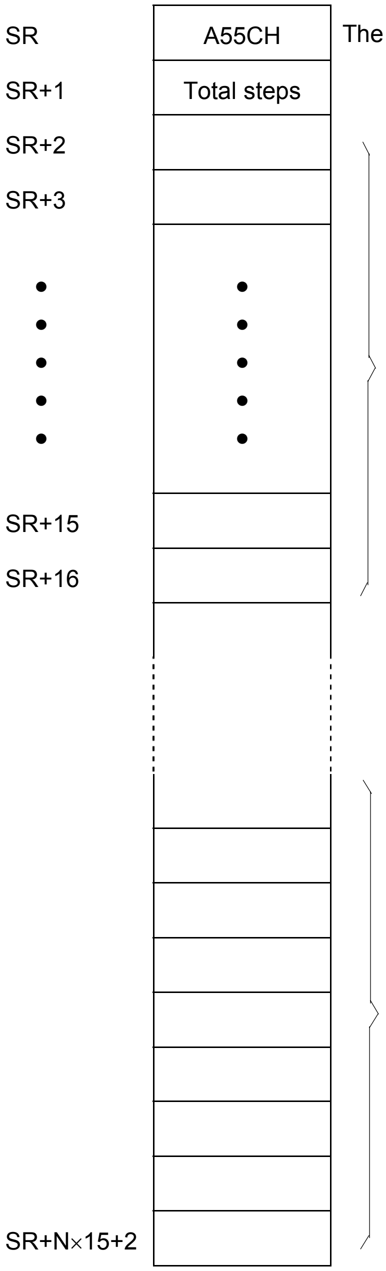
- Format of positioning program with linear interpolation:

SR: Starting register of registers block which reserved to store positioning program, explained as follows:



The effective positioning program; its starting register must be A55CH

The first positioning point (step) of positioning program (every step owns 15 registers for coding).

The Nth step of positioning program.

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- Explanation for working register of instruction operation:

WR is the starting of working registers.

WR+0	Being executed or stopped step
WR+1	Working flag
WR+2	Controlled by system
WR+3	Controlled by system
WR+4	Controlled by system
WR+5	Controlled by system
WR+6	Controlled by system
WR+7	Controlled by system
WR+8	Controlled by system

WR+0 **:** If this instruction is in execution, the content of this register represents the step (1～N) being performed.

If this instruction is not in execution, the content of this register represents the step where it stopped at present

When execution control “EN” =1, it will perform the next step, i.e. the current step plus 1 (if the current step is at the last step, it will restart to perform from the first step).

Before starting the execution control “EN” =1, the user can renew the content of WR+0 to determine starting from which step to perform (when the content of WR+0 =0, and execution control “EN” =1, it represents that the execution starts from the first step).

WR+1 **:** B0～B7, total steps

B8 = ON, output paused

B9 = ON, waiting for transfer condition

B10 = ON, endless output

B12 = ON, pulse output transmitting (the status of output indicator “ACT”)

B13 = ON, instruction execution error (the status of output indicator “ERR”)

B14 = ON, finished being executed step (the status of output indicator “DN”)

*** When step which has been completed, the output indication “DN” will turn ON and keep such status if suspending ; the user may turn OFF the status of “DN” by using the rising edge of output coil controlled by "DN" to clear the content of WR+1 register to be 0, and it can be attained.

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Error indication	Error code	
R4060（Ps0）	0 : Error free	
R4061（Ps1）	1 : Parameter 0 error	
R4062（Ps2）	2 : Parameter 1 error	
R4063（Ps3）	3 : Parameter 2 error	
D4060（Gp0）	4 : Parameter 3 error	
D4061（Gp1）	5 : Parameter 4 error	
	6 Parameter 5 error	The possible error codes for FUN141 execution
	7 : Parameter 6 error	
	8 : Parameter 7 error	
	9 : Parameter 8 error	
	10 : Parameter 9 error	
	13 Parameter 12 error	
	14 Parameter 13 error	
	15 Parameter 14 error	
	30 : Error of variable address for speed setting	
	31 : Error of setting value for speed setting	
	32 : Error of variable address for stroke setting	
	33 : Error of setting value for stroke setting	
	34 : Illegal positioning program	
	35 : Length error of total step	
	36 : Over the maximum step	
	37 : Limited frequency error	
	38 : Initiate/stop frequency error	The possible error codes for FUN140 and FUN147 execution
	39 : Over range of compensation value for movement	
	40 : Over range of moving stroke	
	41 : ABS positioning is not allowed within DRVC commands	
	42 : DRVZ can’t follow DRVC	
	50 : Illegal operation mod of DRVZ	
	51 : Illegal DOG input number	
	52 : Illegal PG0 input number	
	53 : Illegal CLR output number	
	60 : Illegal linear interpolation command	

Note : The content of error indication register will keep the latest error code. Making sure that no more error to happen, you can clear the content of error indication register to be 0, and it still maintains the value at 0.

Editing Servo Program Table with WinProladder

Click the "Servo Program Table" Item which in project windows :

Project name
Table Edit
Servo Program Table → Click right button and select "New Table"

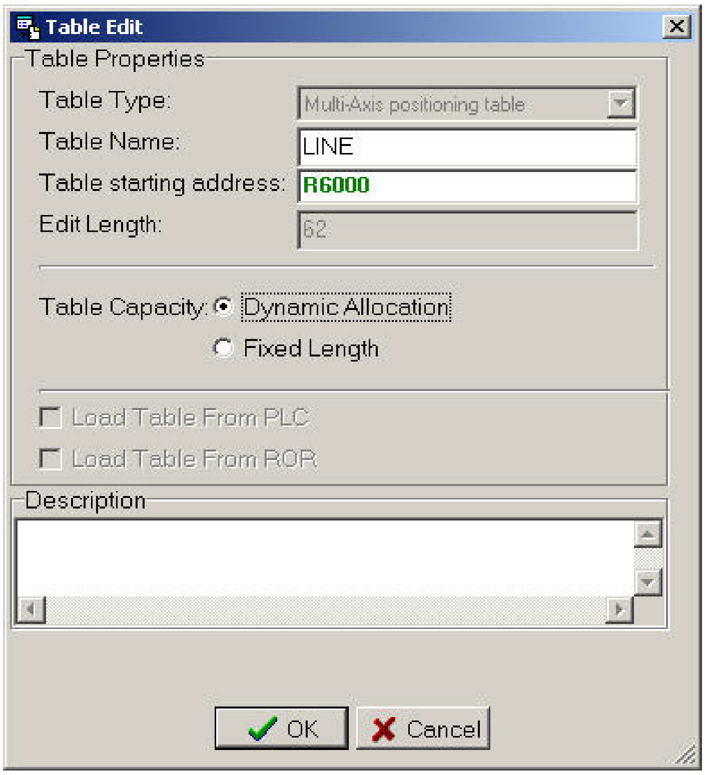


Table Edit

Table Properties

Table Type: Multi-Axis positioning table

Table Name: LINE

Table starting address: R6000

Edit Length: 62

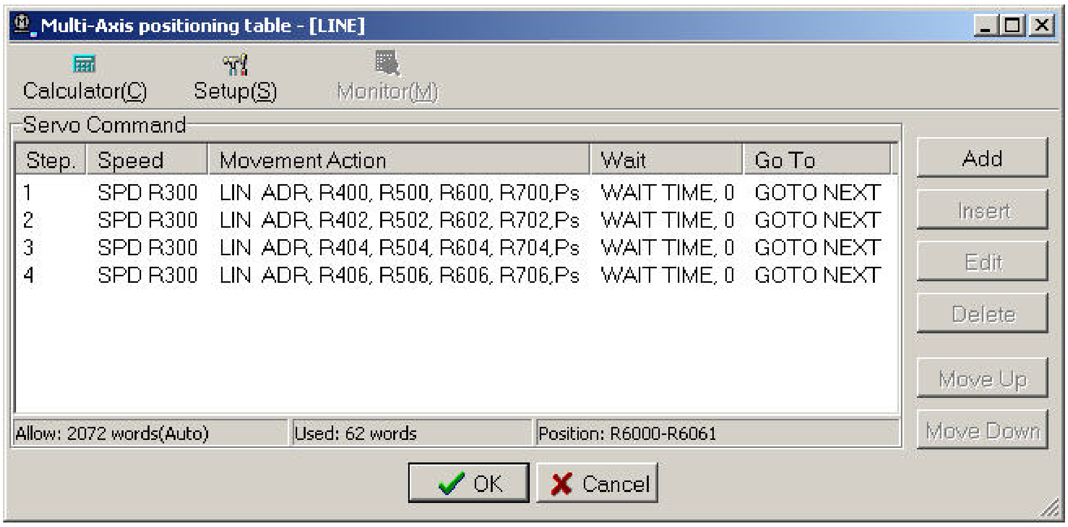
Table Capacity: ● Dynamic Allocation ○ Fixed Length

□ Load Table From PLC

□ Load Table From ROR

Description

- Table Type : Multi-Axis positioning table
- Table Name : For modify or debug, you can give a convenient name.
- Table Starting address : Enter the address which Starting register of …………………



Multi-Axis positioning table - [LINE]

Servo Command

Step.	Speed	Movement Action	Wait	Go To
1	SPD R300	LIN ADR, R400, R500, R600, R700,Ps	WAIT TIME, 0	GOTO NEXT
2	SPD R300	LIN ADR, R402, R502, R602, R702,Ps	WAIT TIME, 0	GOTO NEXT
3	SPD R300	LIN ADR, R404, R504, R604, R704,Ps	WAIT TIME, 0	GOTO NEXT
4	SPD R300	LIN ADR, R406, R506, R606, R706,Ps	WAIT TIME, 0	GOTO NEXT

Allow: 2072 words(Auto) Used: 62 words Position: R6000-R6061

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- For easy programming and trouble shooting, the WinProladder provides the text editing environment to edit the motion program (servo program table) for FUN147 execution.
- Extended positioning instructions for linear interpolation are listed as follows:

Instruction	Operand	Explanation
SPD	XXXXXX or Rxxxx or Dxxxx	• Setting of the vector speed for linear interpolation 1 ≦ setting value ≦ 1840000 • Moving speed in frequency or velocity (FUN141 Parameter_0=0 represents velocity; Parameter_0=1 or 2 for frequency; the system default is frequency). The operand can be input directly with constant or variable (Rxxxx, Dxxxx); when the operand is variable, it needs 2 registers, e.g. D10 represents D10 (Low Word) and D11 (High Word), which is the setting of frequency or velocity. • When selecting to use the velocity setting, the system will automatically convert the velocity setting to corresponding output frequency • The corresponding axis frequency for output will be calculate from the setting of the vector speed • Output frequency range: 1≦output frequency≦921600 Hz.
LIN	ADR，X，Y，Z，W，Ut or or ABS Ps Where, X：Stroke setting of Ps0 Y：Stroke setting of Ps1 Z：Stroke setting of Ps2 W：Stroke setting of Ps3	• Moving stroke setting in Ps or mm,Deg,Inch (When FUN141 Parameter_0=1, the setting stroke in Ut is Ps; Parameter_0=0 or 2, the setting stroke in Ut is mm, Deg, Inch; the system default for Ut is Ps). • When 6_th operand of LIN is Ut (not Ps) , according to the settings of parameter 1, 2, 3 of FUN141, the system will convert the corresponding pulse count to output. • There are 6 operands to construct LIN instruction as follows: 1_st operand: coordinate selection. ADR or ABS: ADR, relative distance movement ABS, absolute position movement 2_nd～5_th operands: moving stroke setting for each axis XXXXXXXX: or −XXXXXXXX or Rxxxx or Dxxxx: It can directly input with constant or variable (Rxxxx, Dxxxx); it needs 2 registers when adopting the variable, e.g. R0 represents R0 (Low Word) and R1 (High Word) as the setting of moving stroke. Positive setting value moves forward Negative setting value moves backward *** When the setting of moving stroke is 0 or in space and 1_st operand is ADR, it means no movement for this axis *** When the setting of moving stroke is in space and 1_st operand is ABS, it means no movement for this axis Maximum setting for one movement must be under ±1999999 Ps 6_th operand: resolution of stroke setting Ut or Ps: for Ut, the resolution is one unit (it is determined by parameter 0, 3 of FUN141); for Ps, the enforced resolution is one pulse.

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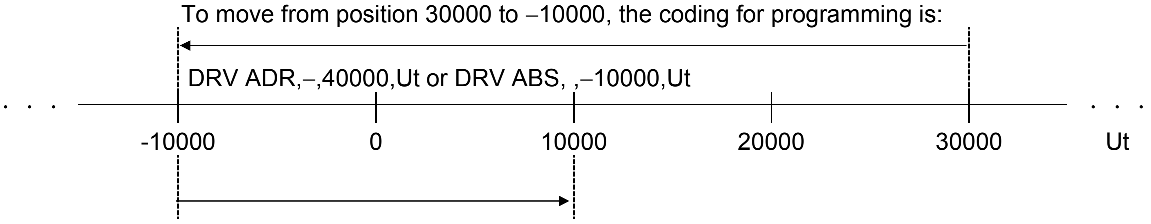
Instruction	Operand	Explanation
LINE	ADR，X，Y，Z，W，Ut or or ABS Ps Where, X：Stroke setting of Ps0 Y：Stroke setting of Ps1 Z：Stroke setting of Ps2 W：Stroke setting of Ps3	• LINE is used for linear interpolation in endless movement • There are 6 operands to construct LINE instruction as LIN's description • The stroke setting for each axis means the output ratio between the active axes, the axis with longest movement is followed by others i.e. In LINE mode, if the stroke settings are 1000、500、300、0(In Ps), it means if Ps0 axis sends 1000Ps, then Ps1 and Ps2 will send 500Ps and 300Ps respectively. (Axis Ps3 doesn't work due to the setting value is 0). It will follow this ratio (1000/500/300/0) for pulse output until the FUN147 instruction is stopped or exists from the LINE mode.

Note: Comparison explanation between the relative coordinate positioning (ADR) and the absolute coordinate positioning (ABS)

To move from position 30000 to −10000, the coding for programming is:



To move from position −10000 to 10000, the coding for programming is:
DRV ADR,+,20000,Ut or DRV ABS, ,10000,Ut

Instruction	Operand	Explanation
WAIT	Time, XXXXX or Rxxxx or Dxxxx or X0～X255 or Y0～Y255 or M0～M1911 or S0～S999	• When pulse output is complete, performing the wait instruction to go to the assigned step. There are 5 kind of operands that explained as follows: Time: The waiting time (the unit is 0.01 second), it can be directly input with constant or variable (Rxxxx or Dxxxx); when it is time up, performs the step that assigned by GOTO. X0～X255: Waiting until the input status is ON, it performs the step that assigned by GOTO. Y0～Y255:Waiting until the output status is ON, it performs the step that assigned by GOTO. M0～M1911: Waiting until the internal relay is ON, it performs the step that assigned by GOTO. S0～S999: Waiting until the step relay is ON, it performs the step that assigned by GOTO.

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EXT	X0～X255 or Y0～Y255 or M0～M1911 or S0～S999	• External trigger instruction; when it is in pulse output (the number of pulses sending is not complete yet), if the status of external trigger is ON, it will perform the step assigned by GOTO immediately. If the status of external trigger is still OFF when the pulse output has been complete, it is the same as WAIT instruction; waiting the trigger signal ON, then perform the step assigned by GOTO.
GOTO	NEXT or 1～N or Rxxxx or Dxxxx	• When matching the transfer condition of WAIT, ACT, EXT instruction, by using GOTO instruction to describe the step to be executed. NEXT: It represents to perform the next step. 1～N : To perform the described number of step Rxxxx: The step to be performed is stored in register Rxxxx Dxxxx: The step to be performed is stored in register Dxxxx
MEND		End of the positioning program.

- The editing for positioning programming with linear interpolation**:**

First, it must complete the FUN147 instruction before the editing of positioning program, and assigned in FUN147 instruction the starting register of registers block to store positioning program. While editing the positioning program, it will store the newly edited positioning program to the assigned registers block; for every one positioning point (called as one step) edited, it owns 15 registers for coding. If there are N positioning points, it will be used by N × 15 + 2 registers in total.

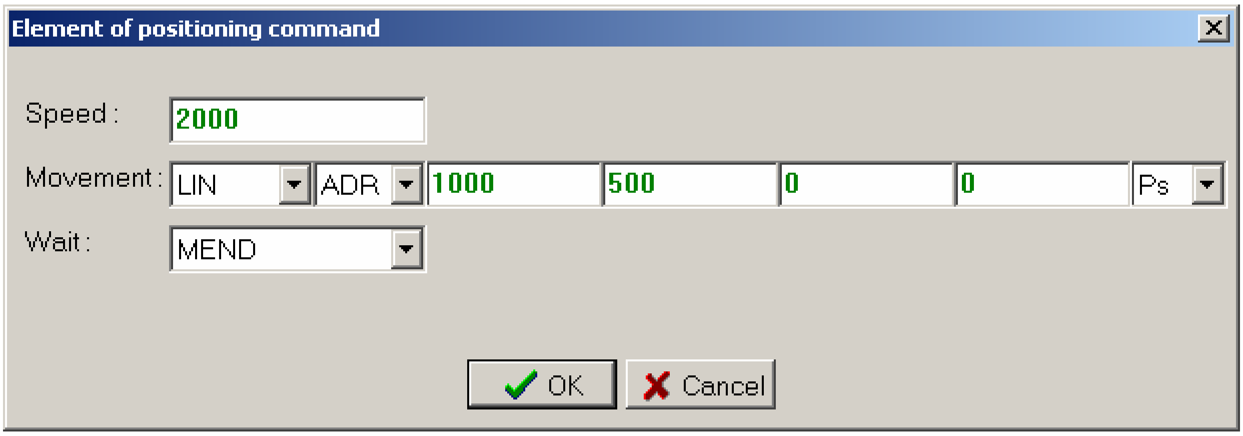
Note: The registers storing the positioning program can not be repeated in using!

- Format and example for the positioning program with linear interpolation:

```
001 SPD 5000                        ; Vector speed is 5K Hz
    LIN    ADR,500,400,300,200 Ut   ; Moving forward 500(Ps0)/400(Ps1)/300(Ps2)/200(Ps3) units
    WAIT   Time,100                 ; Wait for 1 second
    GOTO NEXT                       ; Perform the next step
002 SPD R1000                       ; Vector speed is stored in DR1000 (R1001 and R1000)
    LIN    ADR,D100,D200,  ,  , Ut  ; Moving stroke is stored in DD100(Ps0) & DD200(Ps1)
    WAIT   Time,R500                ; The waiting time is stored in R500
    GOTO NEXT                        ; To perform the next step
003 SPD R1002                        ; Vector speed is stored in DR1002 (R1003 and R1002)
    LIN    ADR,0 ,0,R300,R400, Ps    ; Moving stroke is stored in DR300(Ps2) & DR400(Ps3)
    WAIT  X0                         ; Wait until X0 ON
    GOTO 1                          ; Perform the first step
```

Example and figure for description

The positioning program with linear interpolation instruction as below:



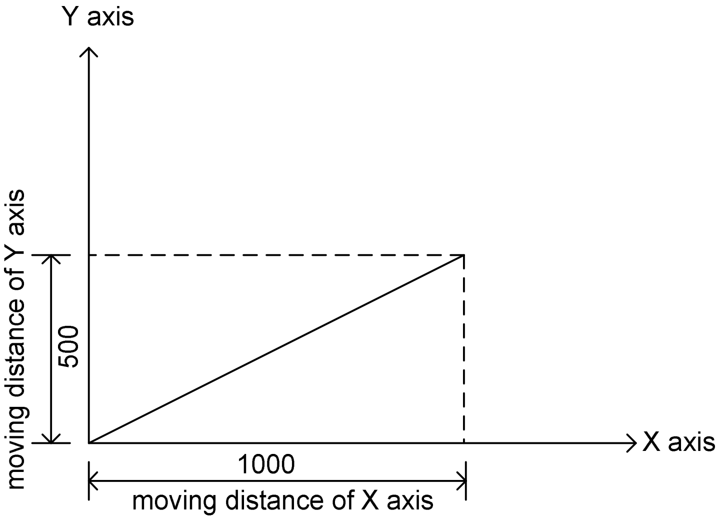
Element of positioning command

Speed : 2000

Movement : LIN ADR 1000 500 0 0 Ps

Wait : MEND

It means the moving stroke setting for axis Ps0(X axis) is 1000 Ps, for axis Ps1(Y axis) is 500 Ps; both axes Ps2 and Ps3 are inactive due to the setting values are 0.



Y axis
moving distance of Y axis
500
X axis
1000
moving distance of X axis