WARNING

THE INSTALLATION SHALL BE MADE BY QUALIFIED INSTALLATION PERSONNEL AND SHOULD CONFORM TO ALL NATIONAL AND LOCAL CODES

Hyundai Robot

Hi4aPS071001FMEN3

Hi4a Controller Function Manual

Positioner Synchronization

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Printed in Korea - Oct. 2007. 3rd Edition

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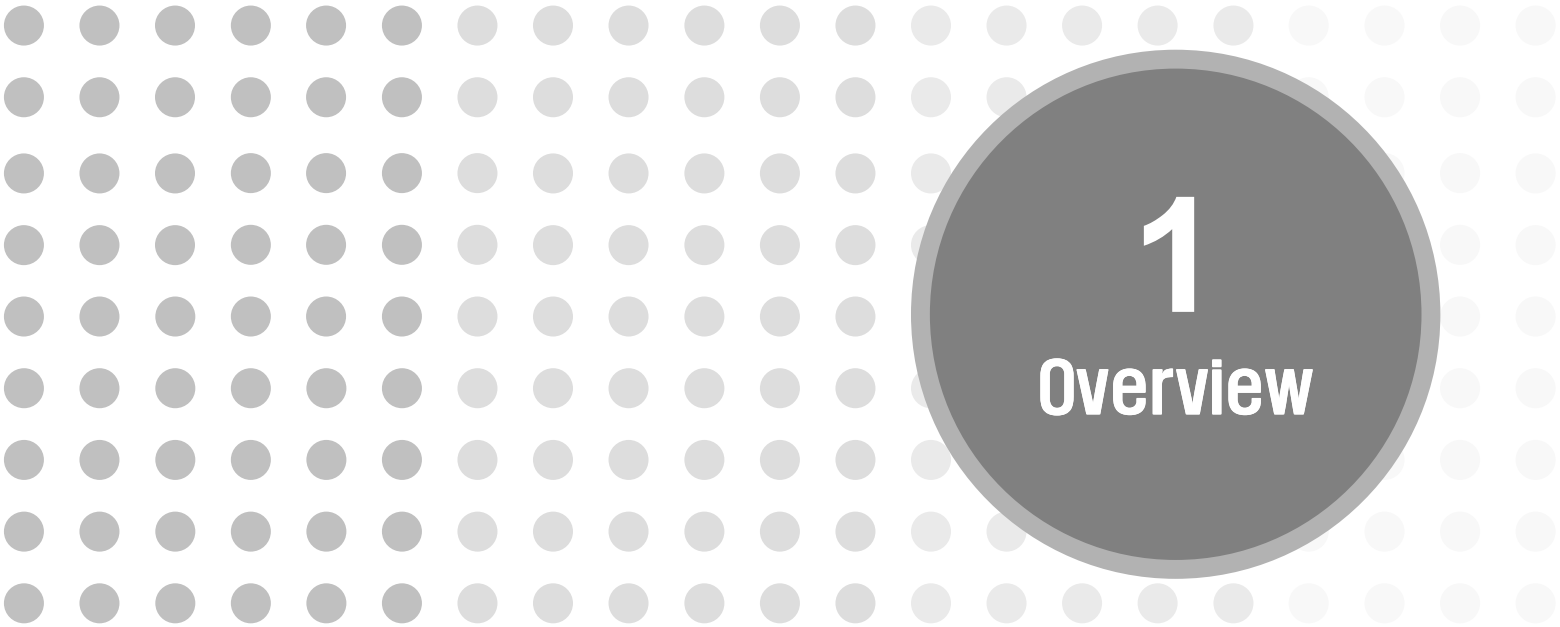

1
Overview

1.1. Overview of Positioner synchronization function

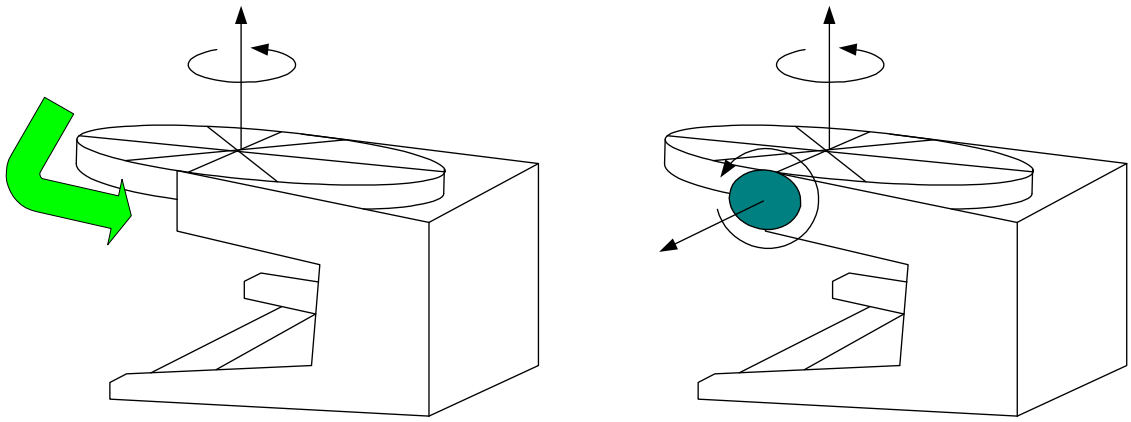
The function of positioner synchronization is to enable the robot's imitation or relative synchronization motion by the motion of manipulator installed outside of robot. In particular, this external manipulator applied to the positioner synchronization is called positioner or station.
With the application of this function, hard p art of working can be done more easily due to the restriction of robot working envelop.

Major functions are as follows.

Specifications of Major Functions	Remarks
Positioner Group	Support the 1~3 Group
Positioner axes	Support the Axis 1, Axis 2 Positioner
Speed Setup	Working Speed Setup
Interpolation Type	Support the Linear, Circular Arc
External Input independent Jog	Support the function of independent operation for the positioner selected in an auto mode, and a playback mode.

1.2. Shape of Positioner

Positioner usually assumes the form of turn table. For the Hi4a controller, axis 1 or axis 2 positioner which has the axis of rotation can be used. Each positioner provides a positioner calibration function that automatically sets up the coordinate system of positioner.



1 Axis Positioner 2 Axes Positioner

Fig. 1.1 Shape of Positioner

1.3. Features of Function

- **Multi-group Positioner**
  It controls the Jig axis that is set as an additional axis by setting to be positioner group. 3 groups of positioners in total can be registered, and each group can be set up to 2 axes positioner.

- **Positioner Calibration**
  For the positioner coordinate system setup, positioner calibration is performed through 3 points of teaching for axis 1, and 5 points for axis 2.

- **Independent Jog Operating Function of Positioner**
  It provides an individual operating function for the axis in which positioner group is registered in an auto mode. With the use of this function, a jog of positioner which is not at work can be operated by an external input signal.

- **Teaching**
  Teaching of independent jog operating function in positioner is designed to use with conversion to robot rectangular coordinate system, positioner synchronization jog, and additional axis operation by selecting the additional axis key. Thus, it is easy to teach positioner synchronization movement instruction(SMOV).

- **Playback**
  Positioner synchronization function is supporting both linear interpolation and circular arc interpolation. Once the synchronization movement instruction(SMOV) is operated, it is playback and perform the interpolation on the positioner.

1.4. Operating Procedure

1. Initialization
It sets up a constant and parameter for additional axis exactly corresponding to the positioner specifications, and sets up positioner group for Jig axis.
It sets up servo parameter for additional axis.

2. Robot Calibration
For the initialized robot, it performs a robot's encoder offset calibration. And then it takes a calibration by using the automatic constant setup function for a constant of axis and a length of tool. Here, a tool with a sharp tip is used for the calibration.

3. Positioner Calibration
It teaches a positioner calibration program, using the tool that is employed to the calibration for a constant or axis and a length of tool.

4. Teaching
If selecting a positioner group by using an additional axis key, you can operate a synchronization jog. If recording the step with positioner group selected, it is recorded as the synchronization operation for the corresponding positioner group. (SMOV S#, #= positioner group number)

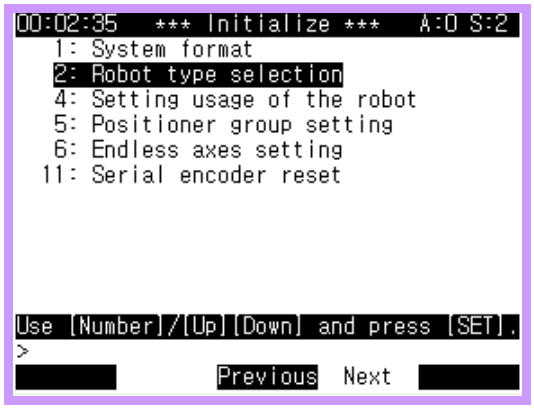
5. Confirmation Test
It may be confirmed by the function of forwarding/backwarding step in a manual mode.

6. Nonstop Operation
It changes to an auto mode. Press the Start button to play. It waits for an individual operating input instead of playing except for the selected positioner if positioner independent operating function(SELSTN S#) is recorded.

2 System Setup

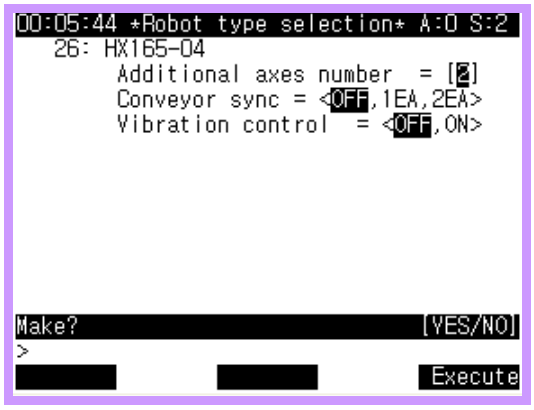
2.1. System Initialization

(1) If the controller and robot is installed for the first time, initialize their system before using.



(2) After the system initialization, select a robot type.

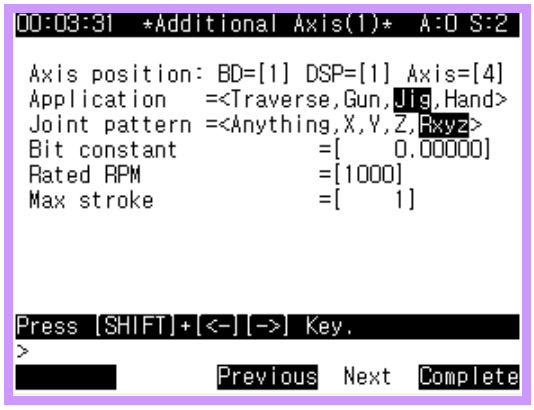
(3) Specify the number of additional axes for the system, and press 『[PF5]: Execute』 key. For the number of additional axes, input total number of additional axes including the number of positioner axes.



(4) For the question of 『Make?』, press [Yes] key.

(5) Set up a constant of additional axis in positioner axis. Be sure to set to be JIG for the specification of additional axis to set as a positioner. And for the formation of axis, Rxyz, the axis of rotation, should be set.

- ✓ For a bit-constant, a precisely calculated value corresponding to the specification of positioner equipment should be input by deg/10000bit.
- ✓ For the rated rotating speed, input the rated rpm of motor.
- ✓ For the maximum stroke, input by the unit of deg.



(6) Apply power again, and adjust the necessary data for tuning the additional axis like servo parameter before using.

2.2. Servo Parameter Setup

(1) After power is re-applied, input R314 code in a teaching mode to set an Engineer_code. Select 『[PF2]: system』 → 『3: Machine parameter』 → 『12: Servo parameter setting』.

(2) Set up 『1: Servo loop gain』 and 『4: Current loop gain』. Please use the values provided by our company for the Gain because it changes depending on the specifications of additional axis.

◆ 【Caution】 ◆

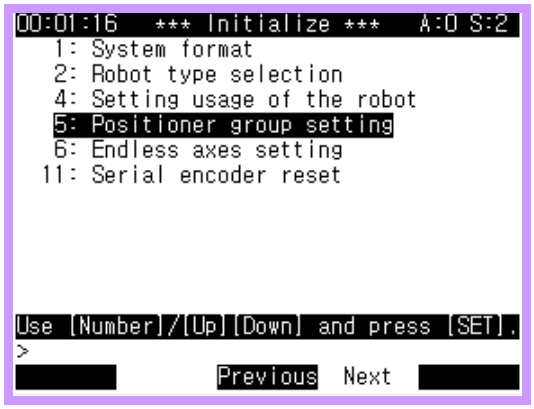
- For the additional axis setup, specify not only axis 1 but all the set additional axes by using [PF4] key.
- For the robot using positioner synchronization function, do not use vibration control function during initialization setup.
- Bit-constant of positioner axis should be correctly set up. Here, the bit-constant means a physical rotating direction and angle of positioner per encoder 1000 bit. In case of the positioner provided by our company, the specified valued provided by our company should be used.
- Set the parameter of servo delay time to be identical with that of positioner in order to improve the performance of synchronization movement between two manipulators. Accordingly, for the positioner axes, F1 and F2 data which is located in servo loop gain of servo parameter should be identical with all the axes, and it is desirable to set up with the highest value among the axes of system.

2.3. Positioner Group Setup

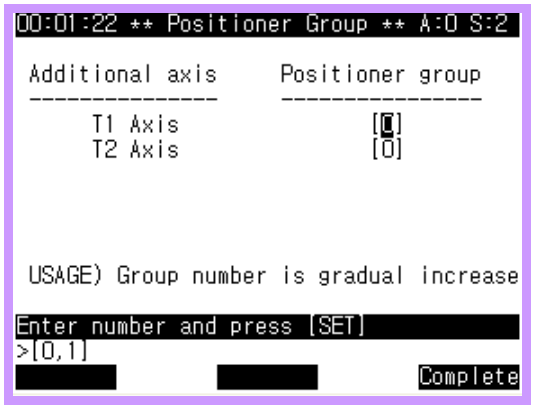
(1) It is possible to set up the positioner synchronization function up to 3 positioner groups, and 2 axes per positioner group is assignable.

(2) Positioner group setup is a way to register a jig axis with a positioner. Thus, for the additional axis set as JIG axis in a initialization menu, it is possible to set as a positioner group.

(3) Select『[PF2]: system』 → 『5: initialize』 → 『5: Positioner group setting』in order.



(4) Set up a positioner group.



◆ 【Caution】 ◆

- Specify the group in order from the lowest axis. And for the group number, select the low number for the low axis.
- Specify [0] for the group that does not synchronization, and it should be set after the synchronization axis setup.
- 3 axes cannot be specified as an identical group of positioner because such group can support up to 2 axes.
- In case of re-definition for group setup, positioner calibration should be executed again because a constsant value of positioner calibration that has been previously set.

▶ **Examples of Positioner Group Setup**

Example 1) 2–axis positioner group 1 & 1-axis positioner group 2 Setups
(in case that all the 3 of additional axes are set to JIG)

Additional Axis		Positioner Group
Axis T1	---------->	[1]
Axis T2	---------->	[1]
Axis T3	---------->	[2]
Axis T4	---------->	[0]

Positioner group 1 is composed of the combination of axis T1 and T2. Axis T3 composes positioner group 2 independently. In case of axis T4, it is set to Jig axis that does not synchronization. Axis that does not synchronization always should be set lastly.

Example 2) 1–axis positioner group 1 & 2-axis positioner group 2 Setups
(in case that all the 3 of additional axes are set to JIG)

Additional Axis		Positioner Group
Axis T1	---------->	[1]
Axis T2	---------->	[2]
Axis T3	---------->	[2]
Axis T4	---------->	[0]

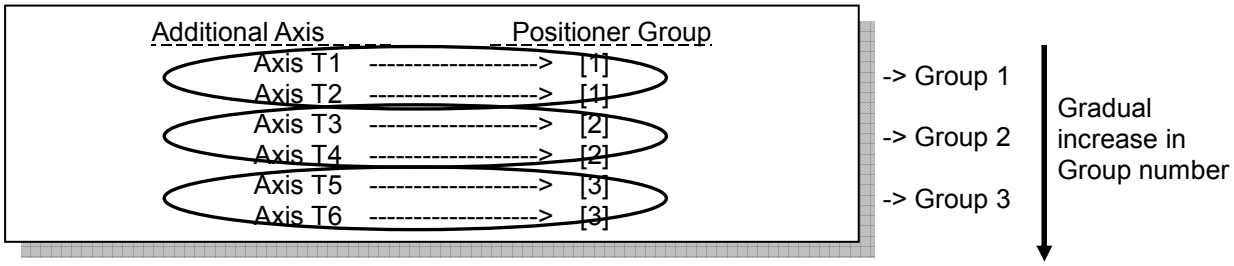
Axis T1 composes positioner group 2 independently. Positioner group 2 is composed of the combination of axis T2 and T3.

Example 3) Three of 1-axis positioners

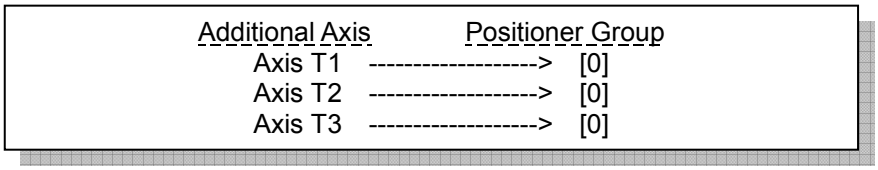
Additional Axis		Positioner Group
Axis T1	---------->	[1]
Axis T2	---------->	[2]
Axis T3	---------->	[3]
Axis T4	---------->	[0]

Axis T1 is an example showing that positioner group 1 is specified, Axis T2 is an example of the specified positioner group 2, and Axis T3 is an example showing that positioner group 3 is specified.

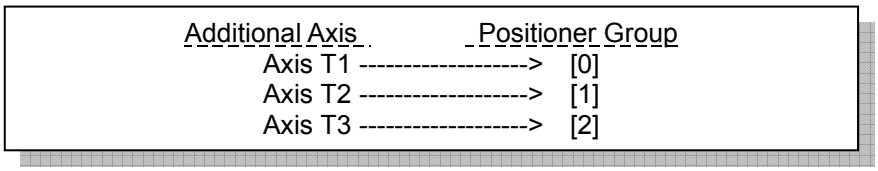
Example 4) Three of 2-axis positioners



Example 5) In case of Jig axis setup that does not synchronization
Use a standard value



Example 6) In case of the use in combination with the axes other than Jig axis
Running Axis(1 axis) + Positioner(1 axis) + Positioner(1 axis)



Set all the axes to 0 other than Jig axis that is to set as a positioner group. Accordingly the running axis is set to 0. It cannot be set by users.

3 Robot Calibration

3.1. Encoder Calibration

(1) After the initialization, perform an encoder offset calibration for the operation of motor ON. Select 『[PF2]: system』 → 『3: Machine parameter』 → 『5: Setting encoder offset』 to calibrate the encoder offset.

(2) After the MOTOR ON, move the robot to the standard position. If the change of initially performed position is needed, perform the encoder offset calibration once again to specify the standard position of robot.

(3) Press [SET] key in the standard position, and record the position with [REC] key.

(4) In case of positioner axis, move the robot to the positioner's standard position to perform an encoder calibration.

(5) After the recording of encoder offset position, end it with 『[PF5]: Complete』 key to exit the menu.

Note) If replacing the motor, the position in which encoder calibration has been performed will be used as the position for encoder re-calibration. Thus, be sure to mark the position in which encoder calibration has been performed.

3.2. Automatic Constant Setup

(1) Attach a arc welding torch or a tool proper to automatic constant setup to the robot's end-effecotr. Use a tool with a sharp tip that is proper to automatic constant setup in order to improve the accuracy of calibration.
Set to 『[PF1]: AutoSETg』 in 『[PF2]: system』 → 『3: Machine parameter』 → 『1: tool data』 to calibrate the posture of tool that is mounted on the robot.

(2) When teaching the robot's automatic constant setup program, it is desirable to record the steps(approximately 6~7 steps), changing the robot's posture a lot.

(3) When executing the automatic constant setup function, setting to 『Setting =<Constant & Tool, Tool >』 and calibrating a constant for axis of robot itself is a way to increase the degree of calibration. It has a significance in that it calibrates an error in the standard position of robot set by encoder calibration mentioned above in 3.1.

◆ 【Caution】 ◆

- To increase the accuracy of automatic constant setup function, teach the robot without an additional load. Besides, when teaching, attach a sharp tip for robot tool, and match it to the standard tip to teach exactly.

- If calibrating 'constant & tool' by using the automatic constant setup, the standard value of axis constant will be newly changed. If calibrating a constant of axis or encoder after the automatic constant setup, the above automatic constant setup must be performed again.

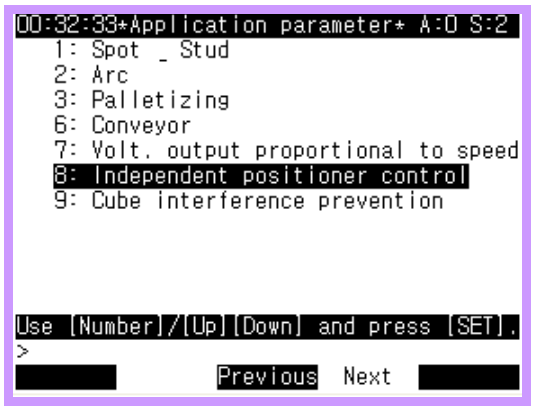
4

Independent Operating Setup of Positioner

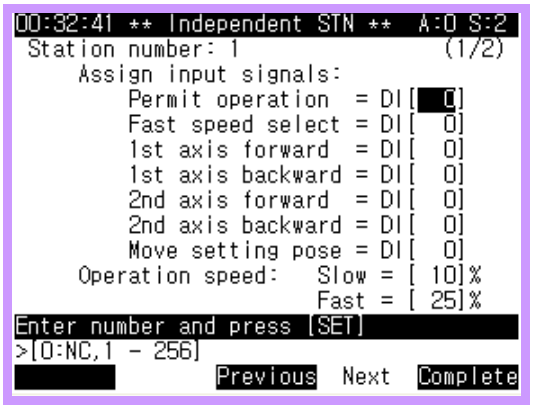
4.1. External Input of Positioner Independent Operation

To enable the positioner axis to be independently operated from outside, set up an external input signal. Here, with the use of assigned signal, the individual operation of positioner would be possible.

(1) Select 『[PF2]: system』 → 『4: application parameter』 → 『8: Independent positioner control』.



(2) Assign an input signal to positioner group(corresponding station number), and set up the operating speed.



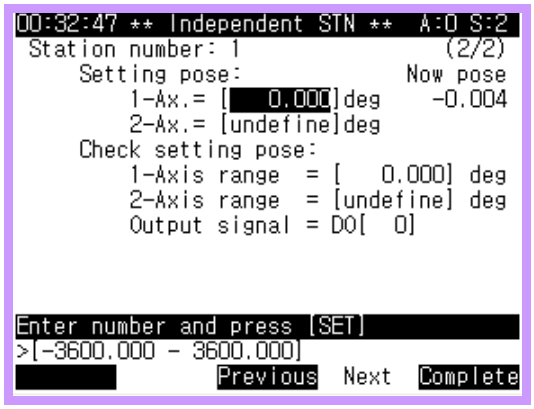


Table 4-1 Signals Assigned to Input/Output Signal

Input/Ouput Signal	Details	Remarks
Allowance of Independent Operation	Independent Operation DSBL(0)/ENBL(1)	Available to operate independently after input the allowance.
High-Speed Selection	Speed Level Selection (0=low-speed, 1=high-speed)	Speed selection in the level set to operating speed. Operating Speed Selection : setup the percentage of maximum high-speed of axis.
1st Axis Positive Rotation	Rotating the 1st axis of positioner in a positive direction(+).	Available to operate 1, 2 axis simultaneously
1st Axis Negative Rotation	Rotating the 1st axis of positioner in a negative direction(-).	Available to operate 1, 2 axis simultaneously
2nd Axis Positive Rotation	Rotating the 2nd axis of positioner in a positive direction(+).	Available to operate 1, 2 axis simultaneously
2nd Axis Negative Rotation	Rotating the 2nd axis of positioner in a negative direction(-).	Available to operate 1, 2 axis simultaneously
Setting Relocation	Move the setting position to the target point.	Move all the 1, 2 axis to the target point. Unavailable to use with axis operating signal.
Matching Output Signal	If all the 1,2 axis reach within the setting location, output a confirmation signal of setting location reach.	Assignment signal output[DO# signal]

◆ 【Caution】 ◆

- The assigned signal in an input signal cannot be assigned repeatedly here.
- For the use of positioner independent operating function, the positioner group should be set first.

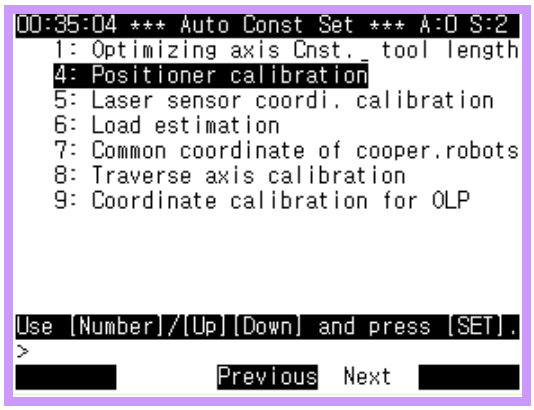
5 Positioner Calibration

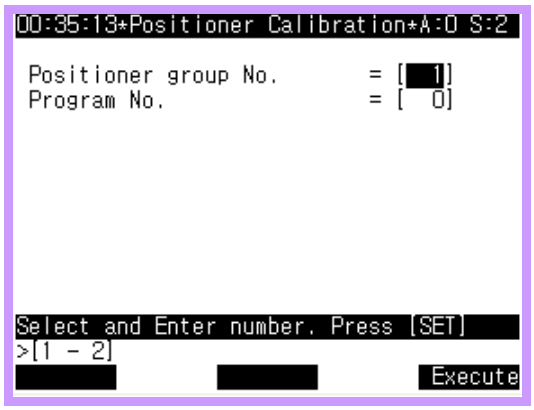
5.1. 1 Axis Positioner Calibration

(1) Select the program number.

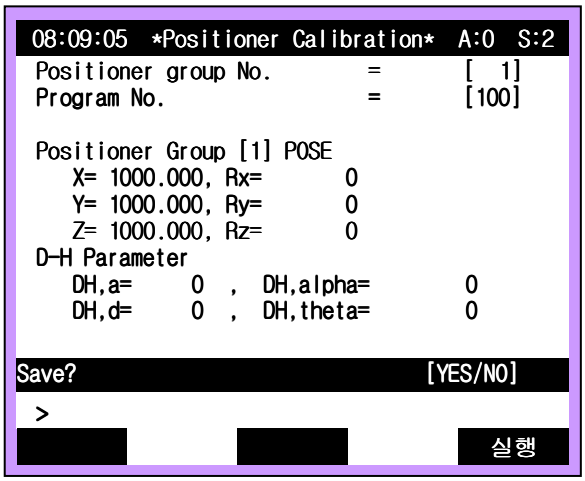
(2) In case of 1 axis positioner, fix the sharp teaching point on the positioner, rotate it by approximately 30, and record it by teaching the 3 points exactly. Teaching method is as shown in below picture.

(3) Select 『[PF2]: System』 → 『6: Automatic constant setting』 → 『4: Positioner calibration』. Here, if a positioner group is not set up, positioner calibration cannot be executed.





(4) Input the program No. corresponding to positioner group, and execute it to see the result.



(5) As the result of execution, automatically generated center position of positioner and posture are displayed. It is possible to check if teaching position is right or not. In case of 1 axis positioner, the D-H Parameter value is not generated.

(6) Check the calculated result, save and end it if there is no error.

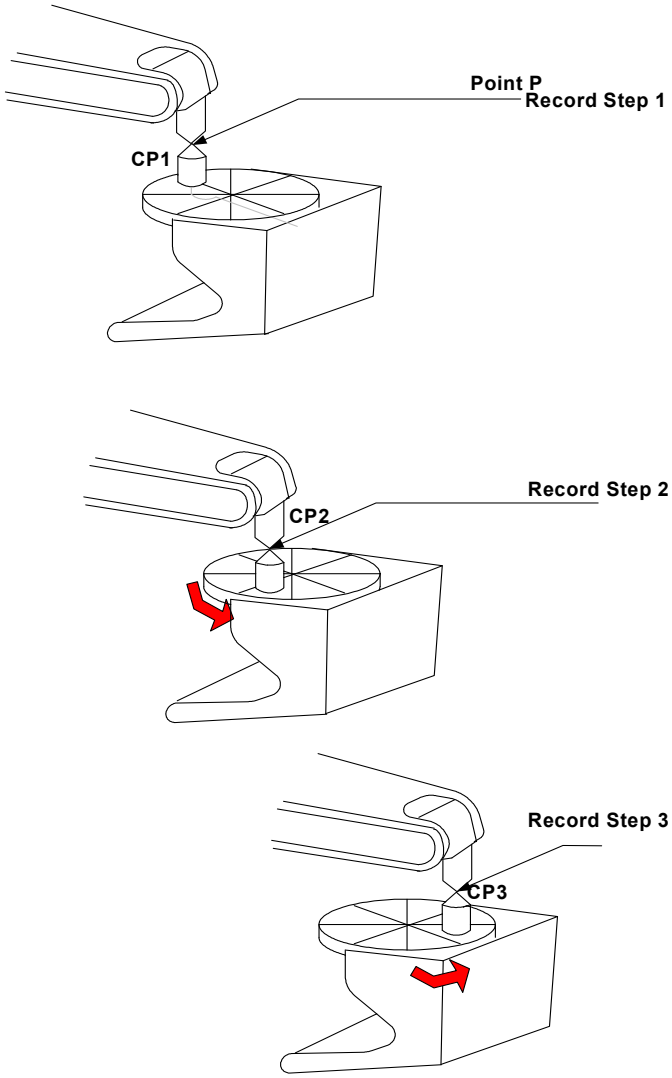


Fig. 5.1 Teaching Procedure of 1 Axis Positioner Calibration

◆ 【Caution】 ◆

- It is necessary to minutely match the tool tip of robot.
- Be sure to use a calibrated tool, and check the tool number before teaching.

5.2. 2-Axis Positioner Calibration

It has the same teaching method as the 1 axis positioner calibration, but it is different in that program is recorded with 5 points teaching to calibrate 2 axes.

(1) Place all the axes of positioner in the standard position, and then record the first teaching point.

(2) Rotate the 2 axes of positioner by approximately 30, and record the same teaching point on the positioner.

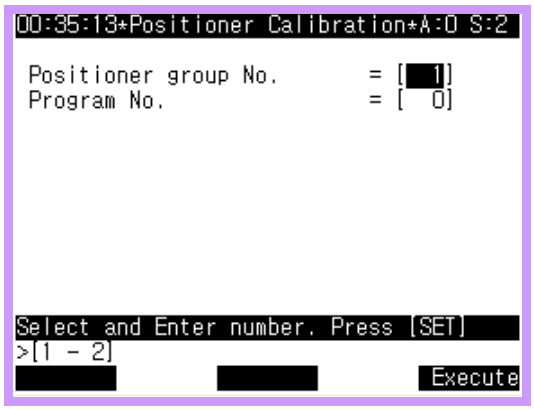
(3) Rotate the 2 axes of positioner again by approximately 30, and record the same teaching point on the positioner.

(4) In the position of above (3), rotate only 1 axis by approximately 30, and record the 4th point.

(5) In the position of above (4), rotate only 1 axis again by approximately 30, and record the 5th point to finish.

(6) Select『[PF2]: system』 → 『6: Automatic constant setting』function.

(7) Input the program number that teaches 5 points and the corresponding positioner group by using 『4: Positioner calibration』, and then press the execution key.



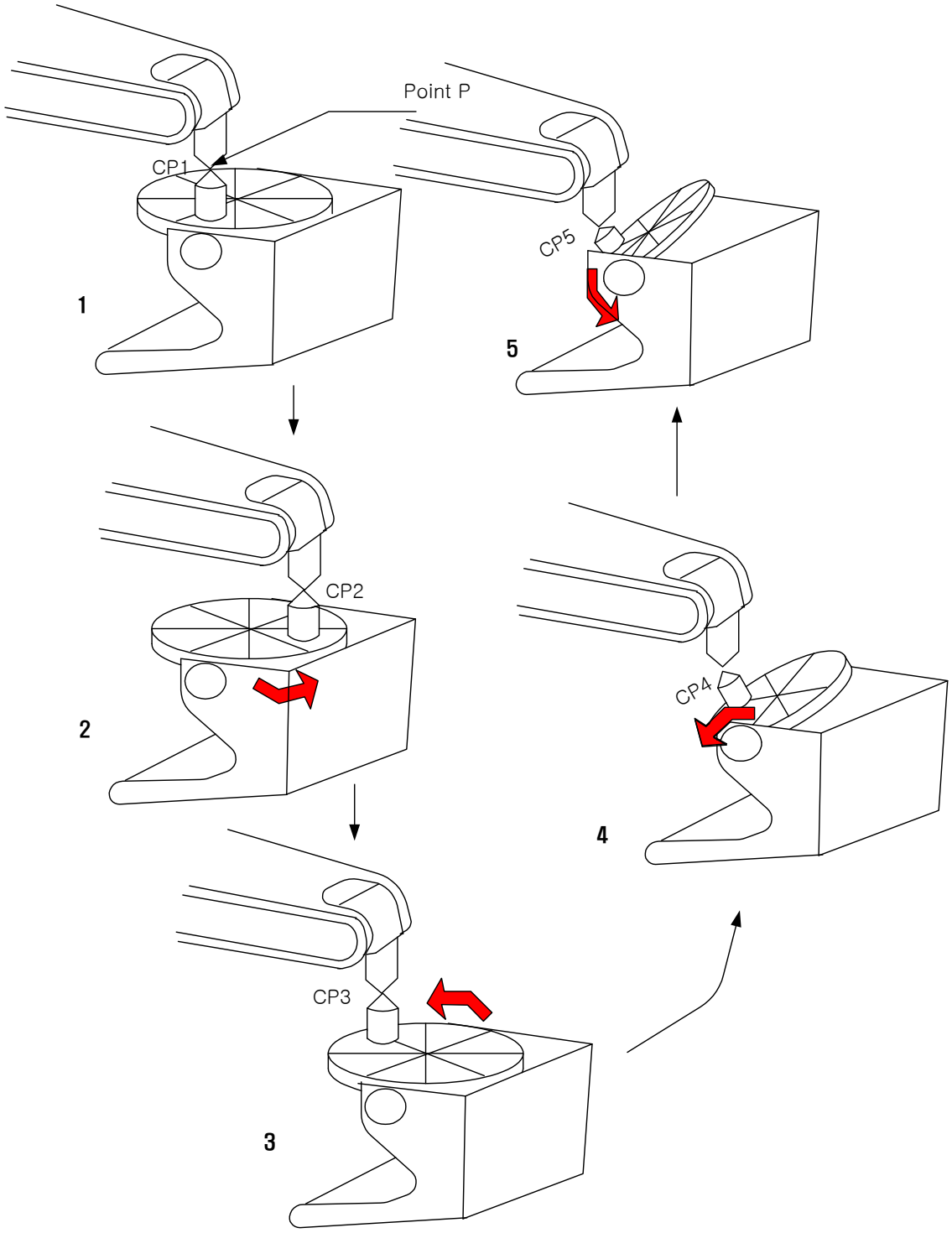
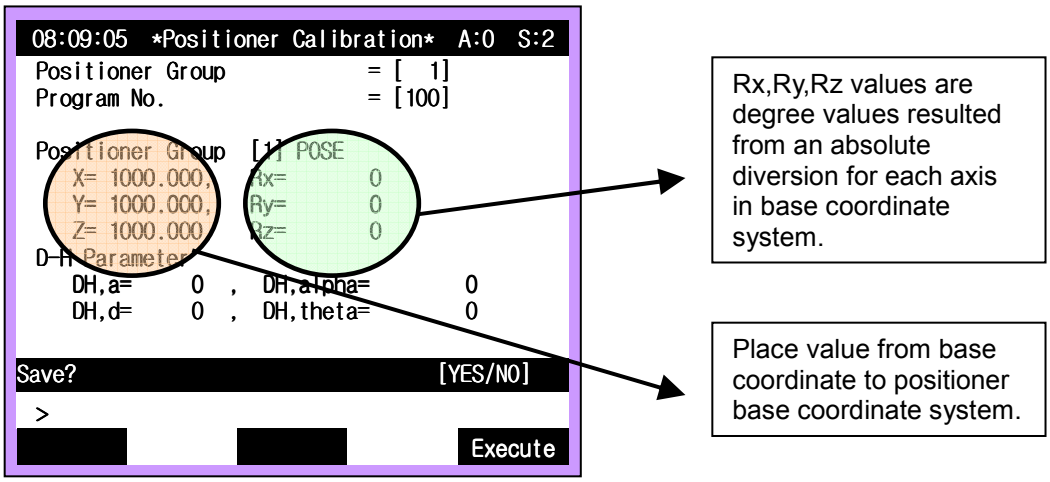


Fig. 5.2 Teaching Procedure of 2-axis Positioner Calibration

(8) When executing [PF5] key, the following result is displayed and 『Make?』 is displayed. Here, if you want to save this value as calibration data, press [Yes].



D-H Parameter value has its significance only for 2-axis positioner.
- DH.a : distance between the 2 rotating axes.
- DH.alpha : the degree of angle between the 2 rotating axes is displayed by [deg].

◆ 【Caution】 ◆

- Robot calibration must be properly done before the positioner calibration.
- Calibration cannot be executed unless positioner group is set. Be sure to set the positioner group first.

6
Jog Function

6.1. Auxiliary Axis LED

The current condition of manipulator being used as jog can be identified by an auxiliary axis LED and through the display screen on teaching pendant. Jog movement according to the condition of auxiliary axis LED is as follows.

Auxiliary Axis LED	Axis Coordinate System	Rectangular Coordinate System	TOOL Coordinate System
○ **(OFF)**	Robot's independent jog for axis coordinate system	Robot's independent jog for rectangular coordinate system	Robot's independent jog for tool coordinate system
• **(ON)**	Additional axis' independent manual jog		
◎ **(flickering)**	Slave synchronization jog of robot that has a positioner as Master <Master=Positioner, Slave=Robot>		

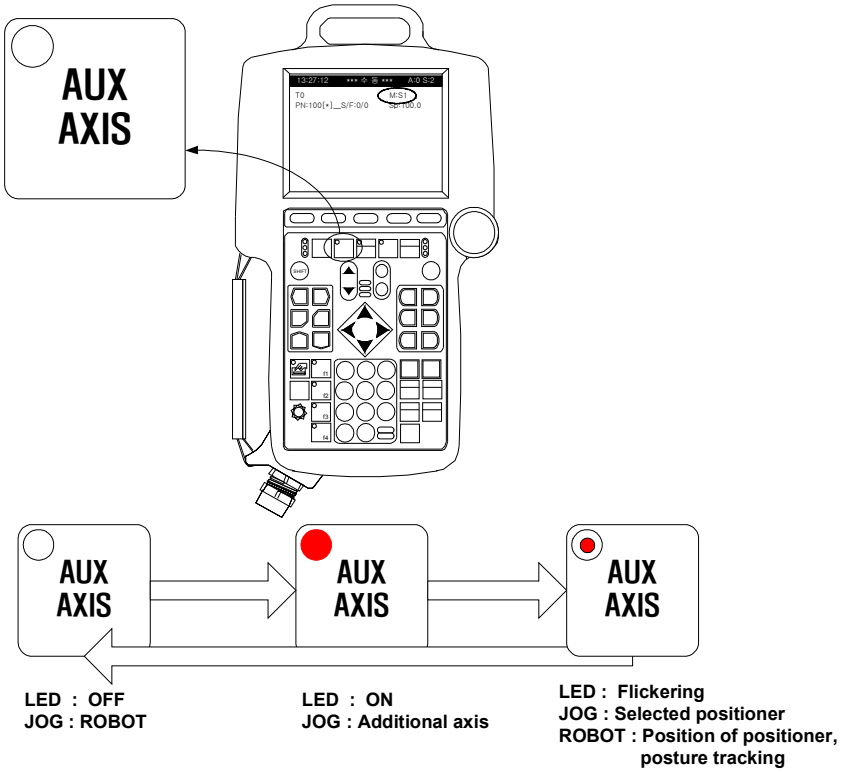
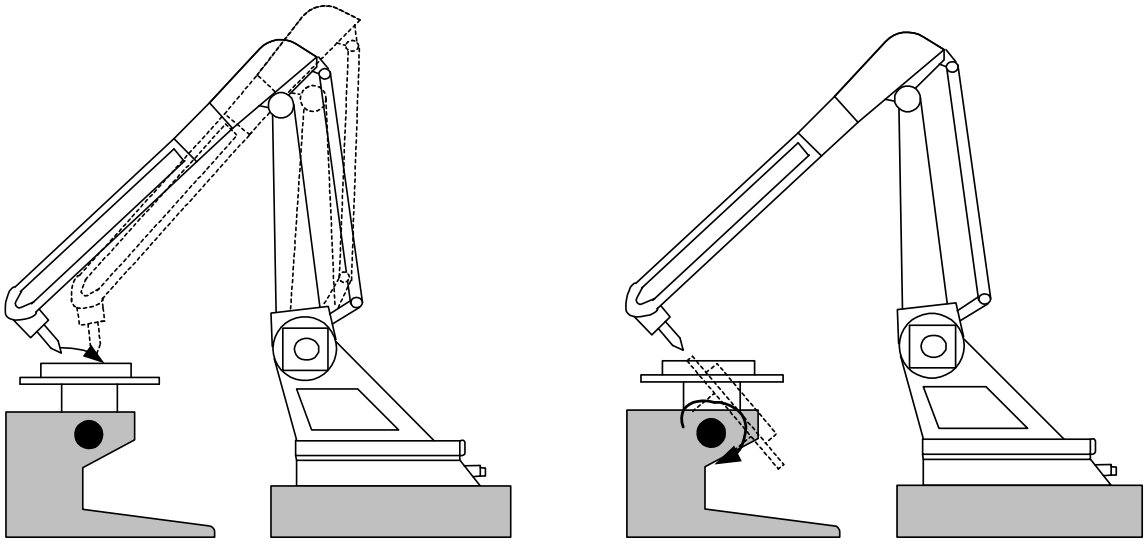


Fig. 6.1 Auxiliary Axis LED

6.2. Independent Jog

When specifying a positioner group, use an auxiliary axis key. If an auxiliary axis LED is OFF on a teaching pendant, the robot is currently in jog. In this condition, robot operation is the same as the other usual robot.

If the auxiliary axis LED is ON(●) by pressing the auxiliary axis key, additional axis is able to start independently. Thus, with the operation of positioner axis, only positioner will be operated.

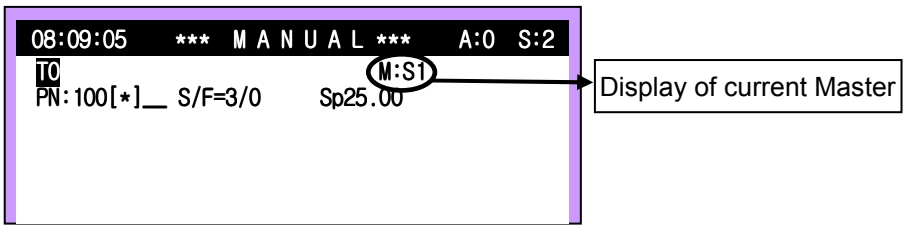


Robot's independent jog movement Additional axis' independent jog movement

Fig. 6.2 Independent Jog Movement

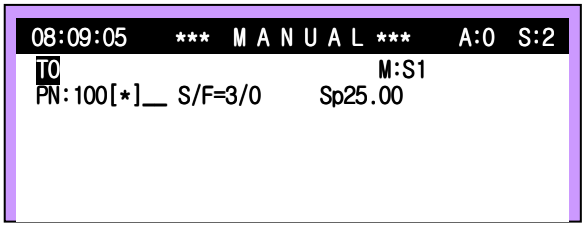
6.3. Synchronization Jog

Positioner group that has completed a positioner calibration is capable of 'synchronization Jog'. Make an auxiliary axis LED flickering (◎) by using an auxiliary axis key. Here, the current information on Master positioner is displayed in the upper part of teaching pendant screen.



※ S1 means a positioner group 1.
S means a Station, and the number means a positioner group number.

Positioner without calibration cannot be selected.



Positioner group without calibration can be selected after the completion of positioner calibration.

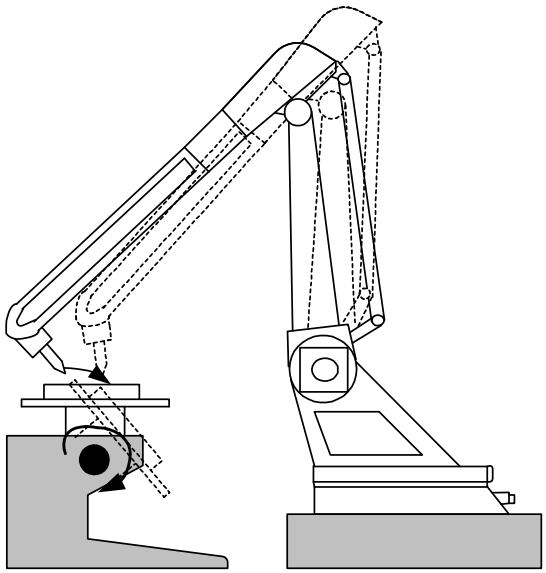


Fig. 6.3 Robot Movement in synchronization Jog

◆【Caution】◆

- Robot and positioner must be calibrated precisely for an accurate synchronization movement.
- In synchronization Jog, axis operation is available only for the selected positioner group. It is a movement that robot follows the position and posture of positioner.

7
Step Record

7.1. Step Record According to Auxiliary Axis LED

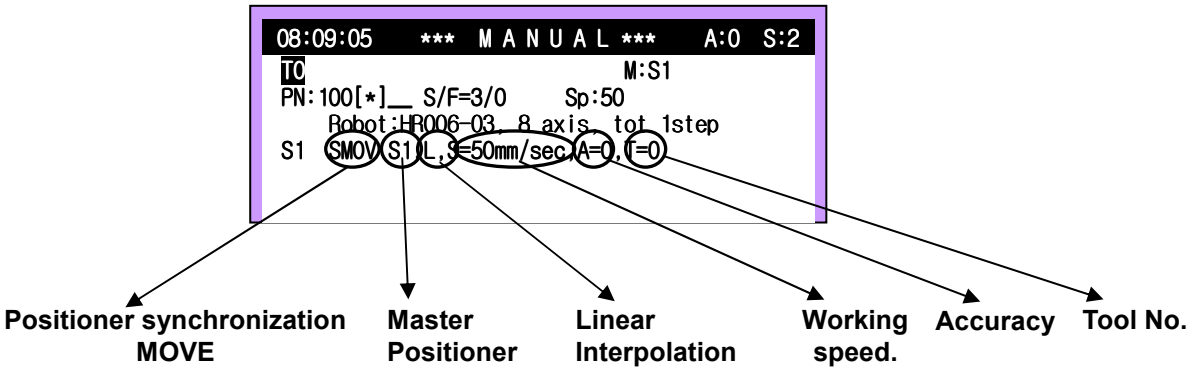
Table 7-1 Step Record According to Auxiliary Axis LED

Auxiliary Axis LED	Master	Interpolation OFF	Linear Interpolation	Circular Arc Interpolation
○ Recording when (OFF)		MOVE P	MOVE L	MOVE C
● Recording when (ON)		MOVE P	MOVE L	MOVE C
◎ Recording when (flickering)	S1	SMOV S1, L	SMOV S1, L	SMOV S1, C
	S2	SMOV S2, L	SMOV S2, L	SMOV S1, C

7.2. SMOV

Record the synchronization step with SMOV, and linear interpolation and circular arc interpolation steps are available to record.
If pressing the record key when the auxiliary axis LED is flickering, it is recorded as SMOV, and each meaning of instructions is as follows.

SMOV {Station No.}, {Interpolation Type}, {Speed}, {Accuracy}, {Tool No.}



7.3. Position Adjustment

- After selecting a step, move the robot, and then press [Posi. MOD] (Shift+REC) key, or press [Quick Open] key and input the value, and then press 『[PF5]: Write』 to adjust.

7.4. Change the Step Recorded With MOVE Instruction to SMOV

(1) In case of MOVE without Pose variable(hidden pose)

- Press [CMD MODIFY] key, move a cursor on MOVE, and then press [AUX. AXIS] key to specify master. And then if pressing [REC] key, the recorded position won't change but instead the instruction will change from MOVE to SMOV. However, other conditions(Interpolation Method, Speed, Accuracy, Tool, ...) except for the position are not changed.

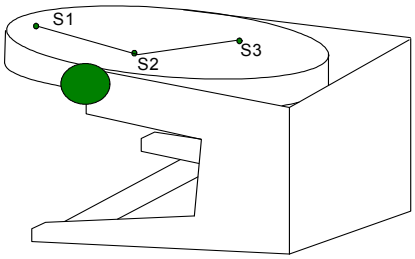
- On the contrary, if pressing [REC] without a speicified master, the step recorded as SMOVE can be changed to MOVE instruction.

(2) In case of MOVE with Pose variable

- It is similar to the above case(1), but it selects MOVE or SMOV in PF menu instead of [REC] key.

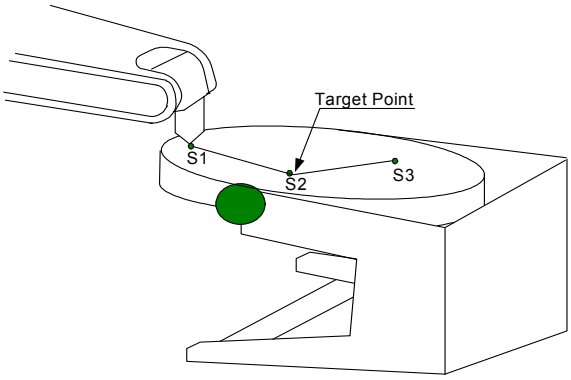
7.5. Example of Linear Interpolation Teaching on Positioner

(1) Set up a starting point and target point on the subject.

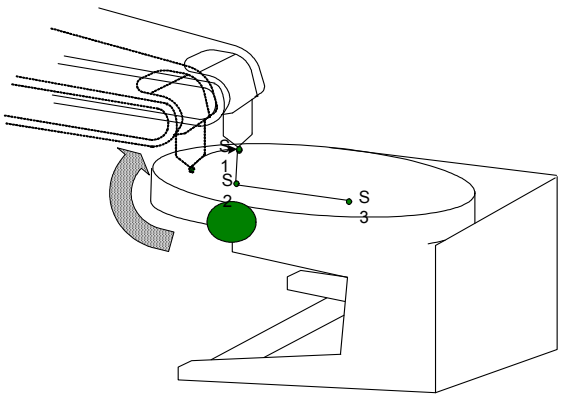


(2) Make it in the condition of “Auxiliary Axis” LED=ON with [AUX. AXIS] key, move the positioner with Jog key, and make the condition of “Auxiliary Axis” LED=OFF with [AUX. AXIS] key, and then match the robot’s tool tip to the working start point with Jog key. Here, press [REC] key to record “MOVE” instruction. (If necessary, it may be recorded as SMOV).

(3) Select a Master(“auxiliary axis” LED=”flickering”) with [AUX. AXIS] key. If the currently working positioner is a group 1, select the Master to be S1.



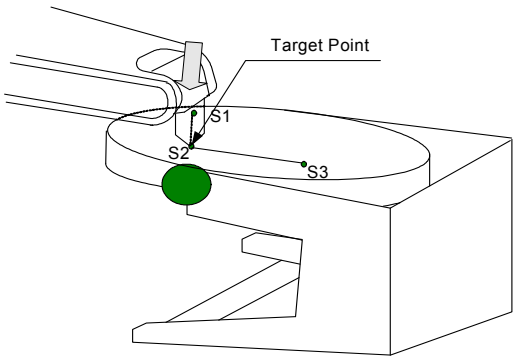
(4) With the Master selected, robot maintains its posture and position along the working start point on positioner as you change the position of positioner to your desired position.



Reference

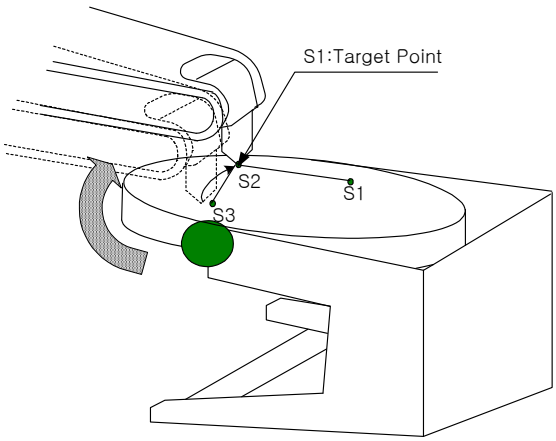
- In the above condition, the error in a point on the positioner and a Tool tip of robot is caused by calibration of robot and positioner, and this error is not displayed as a locus error in a playback. In other words, despite some error, locus position error of step is rarely occurred in a playback if moving the robot again to the target position and recording as “SMOV”.

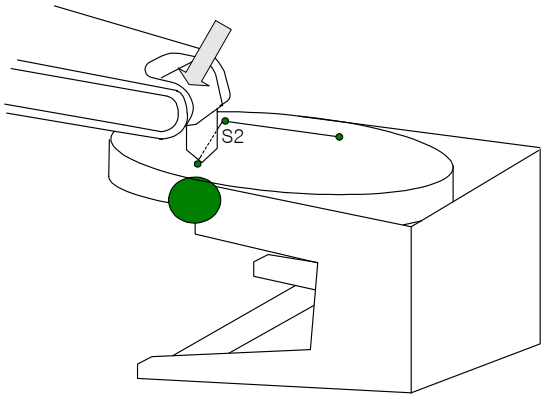
(5) Select “Auxiliary Axis” LED=OFF with [AUX. AXIS] key, and move the robot to the target point(S2) with Jog key to match.



(6) Press [AUX. AXIS] key again to select S1 as a Master in order to record synchronization step(SMOV), and press [REC] key to record “SMOV” step. Here, if an interpolation type is OFF or linear, it is recorded as a linear interpolation, and if circular arc, it is recorded as a circular arc interpolation.

(7) Subsequent steps follow the procedure of (3)→(4)→(5).





(8) If executing the recorded program, positioner is to move, and the robot is to move as a linear interpolation for the workpiece on the positioner.

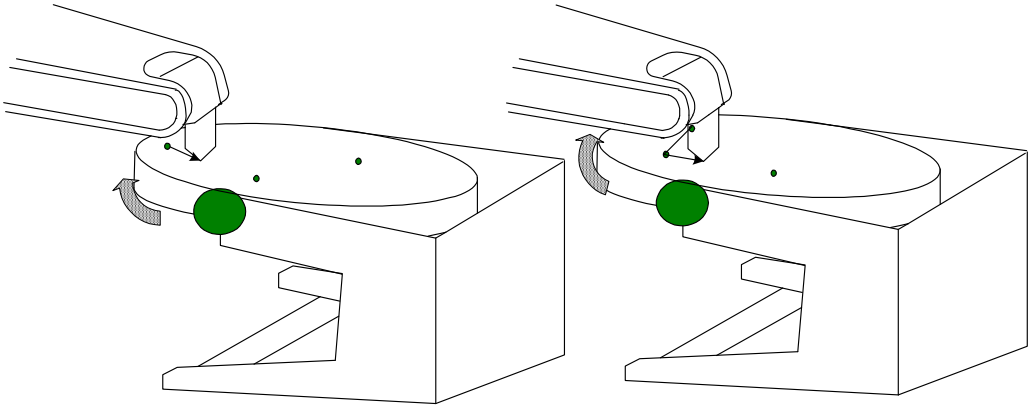


Fig. 7.1 Step Playback of Positioner synchronization Linear Interpolation

◆ 【Caution】 ◆

- Recording the positioner synchronization step (SMOV) is not necessarily to follow the above process in the same way. If recording as SMOV step after determining the position and posture by moving the robot and positioner independently, the robot will move in the mode of interpolation specified in workpiece of positioner.

- If the interpolation types of two steps recorded as SMOV are both “Linear”, it will have a cornering motion like in the case of MOVE.

- The speed of step recorded as SMOV is a working speed. Thus, although the positioner has moved a lot, the usual positional moves at high-speed if the working distance between the recorded steps on working piece is considerably short. Here, if you intend to restrict the speed of positioner, set up the speed unit as “SEC”. This means that although the working distance is 0 between working pieces, steps operate in the specified time. It is because the unit of step move is not set to speed but to time.

7.6. Positioner Independent Operation

Positioner independent operation is a function to select a positioner to start with SELSTN. If this function is not in use, all positioner(SELSTN ALL) are selected in the standard value to start.

Use this function when users intend to start a particular positioner with a program playback, and to operate the unselected positioner independently with external input signal.
This function can change the positioner to start for each section of robot program, so you may classify into the program-operated axis and the independently-operated axis among positioner axes in a playback.

7.6.1. SELSTN

SELSTN , Station No., Standby Time for Independent Operating completion, Shelter position			
Station No.	**ALL**	Seleting all positioners Unavailable to operate all the positioners independently	SELSTN S# released All positioners are playback
	S0	Available to operate all positioners independently	All positioners are not playback
	S1 ~ S3	Selecting the positioner number that is selected in a playback	Only selected positioner is playback
Standby Time	**0 ~ 60**	Standby time until independent operation of selected station is completed	0 = unlimited standby
Shelter position	**Branch Position**	Specifying the step to shelter if independent operation is not completed during standby time	STEP, LABEL, Line No.

◆【Caution】◆

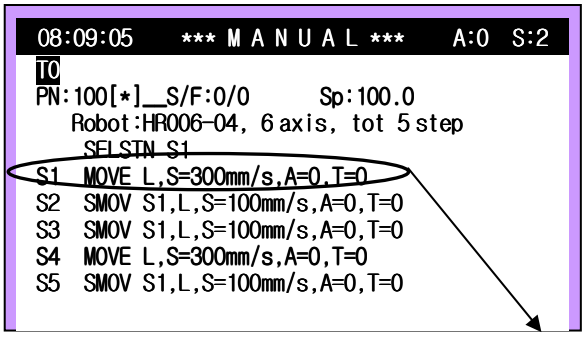
- Positioner independent operation is available only when program is executed in an auto mode.

7.6.2. Selection of Positioner Group

(1) Specify the station number to synchronization with SELSTN S# instruction. Once this instruction is specified, the selected station is operated as recorded in the program in a playback, and other stations are set up to be available for independent operation by external signal.(SELSTN S1)

(2) After the SELSTN instruction, record a synchronization reference step in the position to start positioner synchronization. (S1)

(3) Record the step, while operating the selected positioner.(S2, S3, S4, S5) Here, record the unselected positioner(positioner group 2, positioner group 3, etc.) in the same position without moving it.



Synchronization Reference Step

◆ 【Caution】 ◆

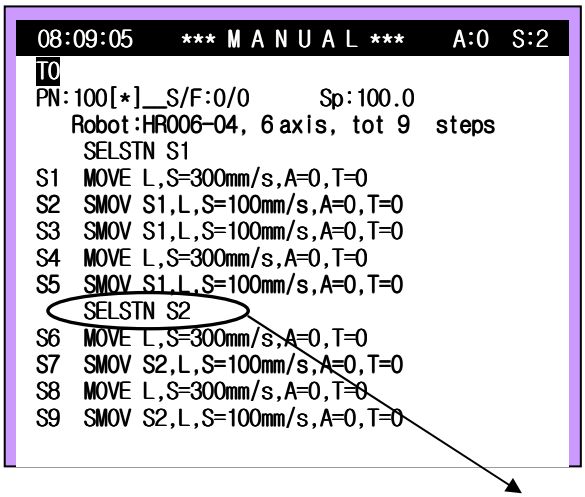
- If the station number specified in SMOV is different from the number in SELSTN, error(E0219) will be occurred during a playback.
- If it is set as SELSTN S0, all stations(S1~S3) will not be operated by a program playback but independently operated.

7.6.3. Change of Positioner Group

If positioner group number changes in a playback, specify a new station number. (SELSTN S2)

Record the reference step to start synchronization for robot and positioner with MOVE instruction. (S6)

Operate the selected positioner to record a step. (S7, S8, S9) Here, record the unselected positioners(station 1, station 3) without changing their position.



Station change, Playback of positioner group 2 from step 6

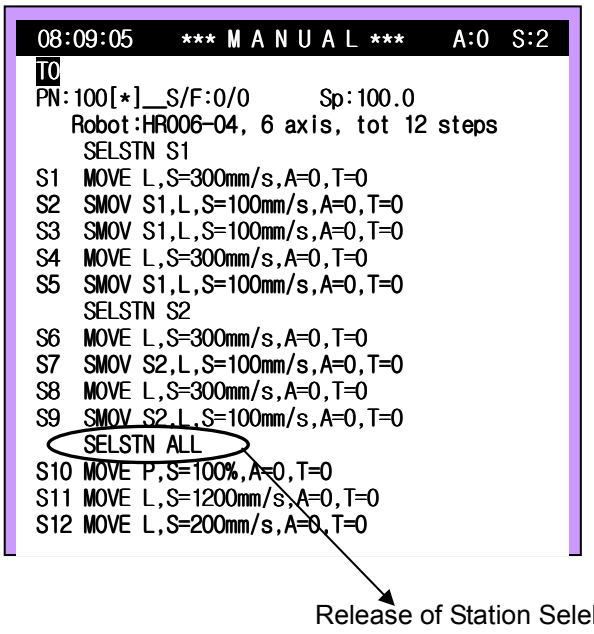
◆ 【Caution】 ◆

- If a station number(S1~S3) is changed by SELSTN instruction, the previously selected positioner groups will be released their selection, and changed to be operated independently.

7.6.4. Release of Positioner Group Selection

(1) If restricting all the independent operation of positioner and placing all the Jig axes to recording position in a step, release the station selection by SELSTN ALL instruction. (SELSTN ALL)

(2) After the SELSTN ALL instruction, all positioners will move to the recorded step position. And even if positioner independent operating input signal is ON, the independent operation cannot be performed.(S10, S11, S12)



◆ 【Caution】 ◆

- If operations such as the change of step, change of program, and external reset are input, the station selection is released(SELSTN ALL), and an independently operating positioner stops.

8

Step Teaching & Playback

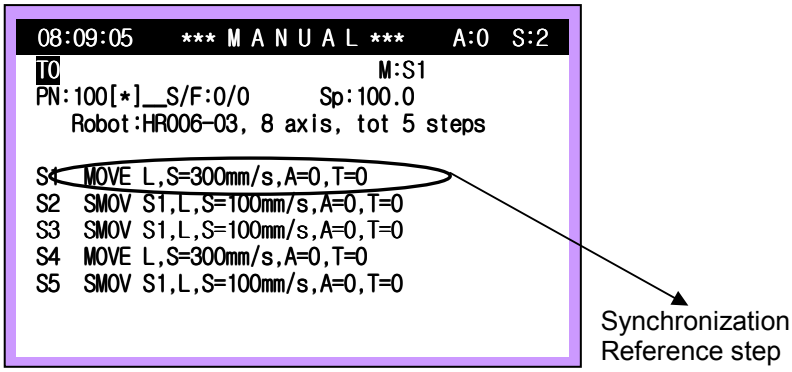
8.1. Linear Interpolation

Record a step on positioner, and then record the next step on the positioner with SMOV(linear interpolation) before playback.

(1) Move the robot and positioner with a separate jog respectively to the reference step position to start positioner synchronization, and record it with MOVE instruction of general movement. (S1)

(2) To perform a linear interpolation on the positioner, users need to move the positioner to their desired position, and record TCP target point on the positioner.(S2)

(3) Repeat recording the linear interpolation step in the same way as above (2). S3)

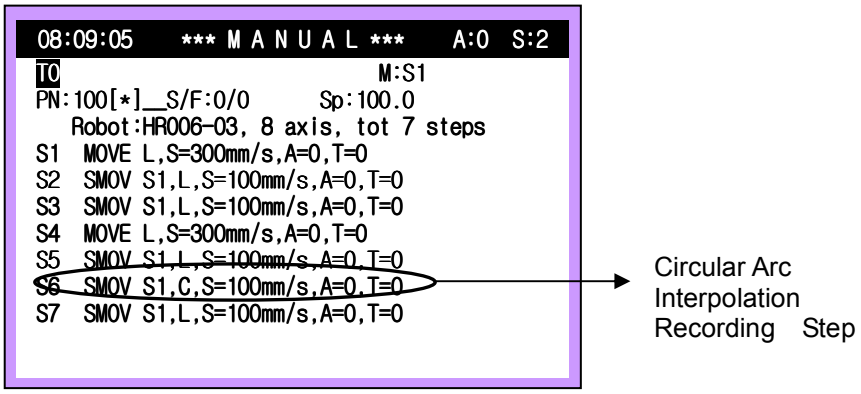


(4) With a step playback, robot TCP will move to step 2, following a positioner and making a linear locus on the positioner workpiece, as the positioner moves to S2 from S1 position.

(5) The movement from step S2 to S3 has a cornering motion because it is a continuous movement.

8.2. Circular Arc Interpolation

Positioner synchronization function supports a circular arc interpolation. However, a reference step for drawing a circular arc is automatically determined and follows the principles as shown in the below table.



Reference Step of Circular Arc
Determinating Principles of Reference Step

(1) If all the previous steps(n-1) and the next steps(n+1) are the positioner synchronization step and the next step is circular arc interpolation, a reference step is the next step(n+1).

(2) If one is a positioner synchronization step among the previous steps(n-1) and the next steps (n+1), the positioner synchronization step is a reference step.

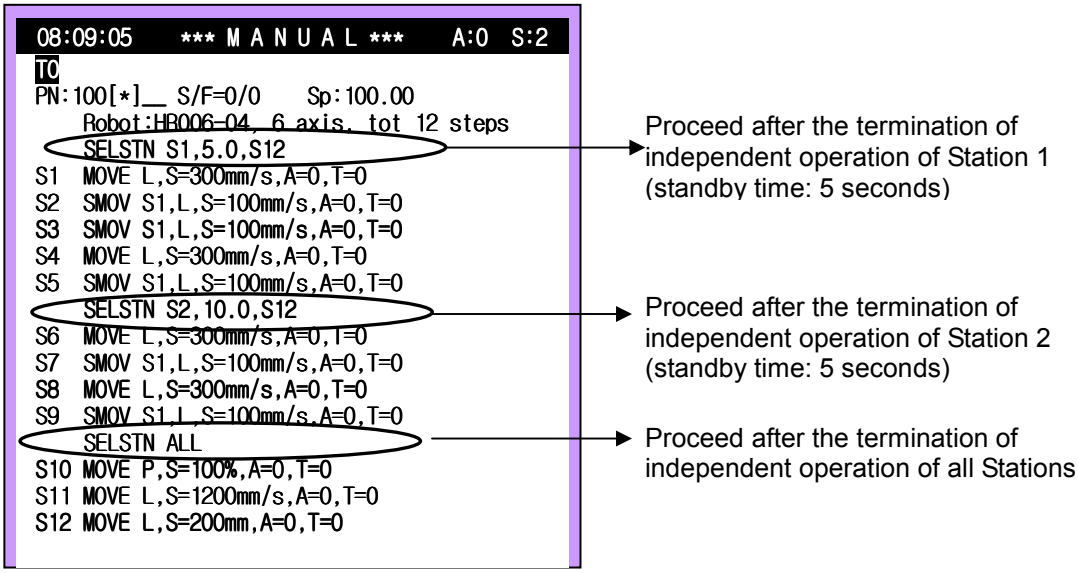
Step	n-1	n	n+1	Reference Step	Reference Position, Posture
Interpolation Type	SMOV L SMOV C	SMOV C	MOVE C, L, P	n-1	Positioner Coordinate System
	MOVE C, L, P	SMOV C	SMOV L, C	n+1	
	SMOV C	SMOV C	SMOV L	n-1	
	SMOV L	SMOV C	SMOV C	n+1	
	SMOV L	SMOV C	SMOV L	n+1	
	MOVE C, L, P	SMOV C	MOVE C, L, P	n+1	Converting to the positioner coordinate system

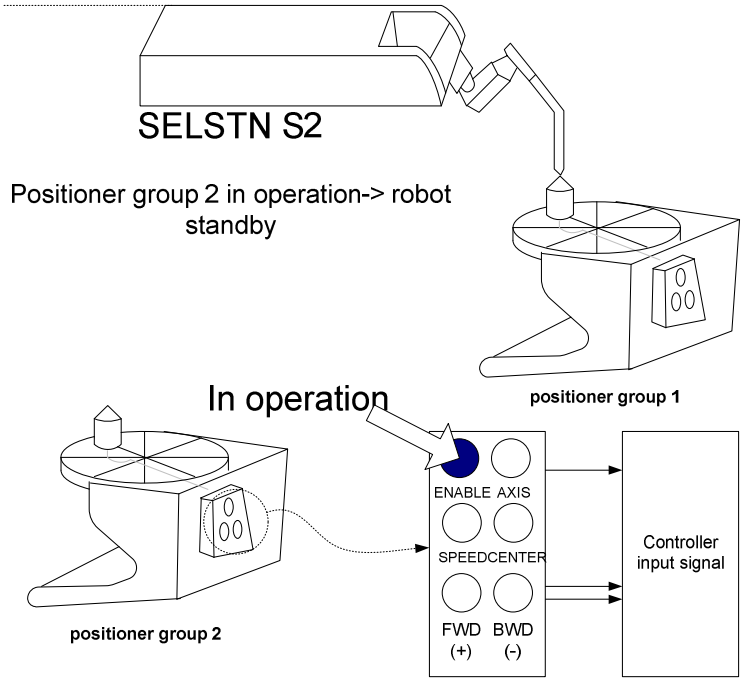
- SMOV L and C are the positioner synchronization linear interpolation step and the circular interpolation step respectively.
- MOVE C, L, P are the general movement interpolation steps other than positioner synchronization.

8.3. Positioner Independent Operating Playback

Playback of program is not available during the execution of positioner independent positioner operation.

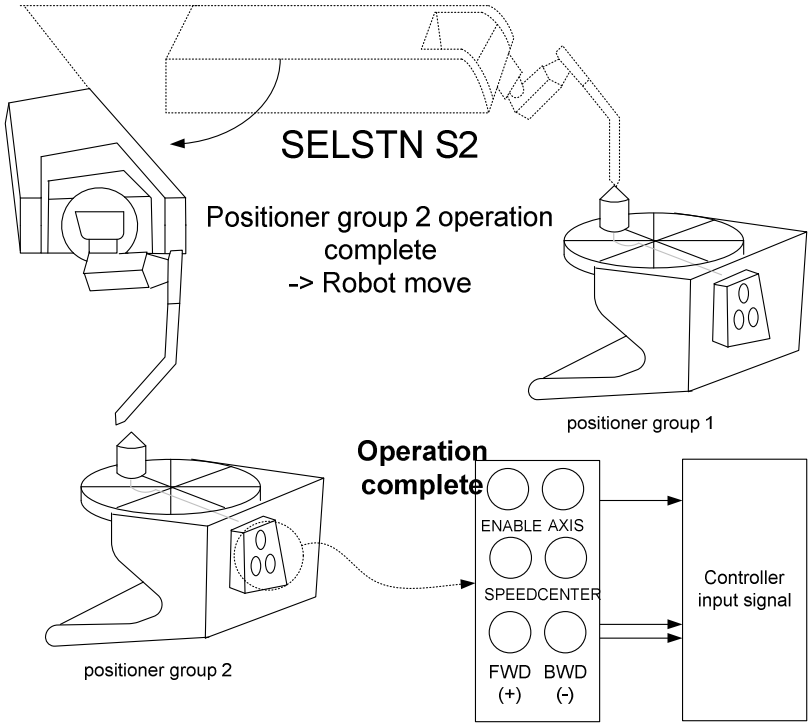
Instructions for changing Stations such as SELSTN S#, SELSTN ALL can be executed only after the selected independent operation of positioner during a playback. Refer to the following program examples.





◆【Caution】◆

- If the <ENBL> signal of selected positioner is in input, robot will wait in the SELSTN position.



- Robot won't move until the selected positioner is completed its independent operation.

◆【Caution】◆

- When the program is initially started, wait until all the independent operation signals are <DSBL>. This action is for the safety of users. If the independent operation signal of positioner is <ENBL>, it is considered that there is a user(operator).

- If operations such as the change of step, change of program, and external reset are input, wait until all the independent operating signals of positioner turn to be <DSBL> during re-start. It is because, in this case, the selection of station is released(SELSTN ALL).

- When teaching the program for arc welding, independent operation of positioner won't be performed if performing the arc exclusive functions such as relevant conditions to voltage & current, weaving, Retry/Restart, and characteristics of welder.
  - -when performing an automatic reset function of endless step
  - -when collaborative control
  - -when performing the ENDLESS RESET, SPOT, GUNSEA functions
  - -when operating Gun change and manually operating a Servo Gun

8.4. Continuity/Discontinuity

Steps with a changeable coordinate system are managed to be discontinuos. (MOVE ↔ SMOV)
Accordingly, if the previous step is MOVE and the next step is SMOV, or the next step is SMOV and the next step is MOVE, playback it discontinuously without cornering motion.

9
Errors & Correction

9.1. Errors & Correction

Code	E0219 Couldn't execute SMOV W/O SELSTN
Cause	Positioner robot instruction(SMOV) may not be executed for the station that is not selected by SELSTN instruction(positioner individual operation instruction)
Action	Select correctly the station to use in SELSTN instruction. Make the station numbers in SMOV instruction identical with the numbers selected in SELST N.

Code	E1041 Axes over at this positioner Group
Cause	The number of axis for positioner group is in excess of 2.
Action	Set the value less than 2 for the corresponding group in system/initialization/positioner group setting.

Code	E1287 Undefined Station(PositionerGroup)
Cause	It occurs when an undefined station is specified for SMOV execution.
Action	Specify the station set in the system/initialization/positioner group setting.

Code	E1288 Not executed Calibration of S(?)
Cause	It occurs when an unexecuted station is specified for SMOV execution.
Action	Execute the system/automatic constant setting/ positioner calibration to the station you intend to use.

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