1311, TFDEN-162-001, 001

NACHI

CFD CONTROLLER INSTRUCTION MANUAL SHIFT FUNCTIONS

1st edition

- Before attempting to operate the robot, please read through this operating manual carefully, and comply with all the safety-related items and instructions in the text.
- The installation, operation and maintenance of this robot should be undertaken only by those individuals who have attended one of our robot course.
- When using this robot, observe the low related with industrial robot and with safety issues in each country.
- This operating manual must be given without fail to the individual who will be actually operating the robot.
- Please direct any queries about parts of this operating manual which may not be completely clear or any inquiries concerning the after-sale service of this robot to any of the service centers listed on the back cover.

NACHI-FUJIKOSHI CORP.

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Chapter 1 Outline

1.1 What the shift functions

1.1.1 Outline

The shift functions serve to move in response to external requests, the positions recorded in the task programs to the positions where the specified shift amounts have been added in real time.

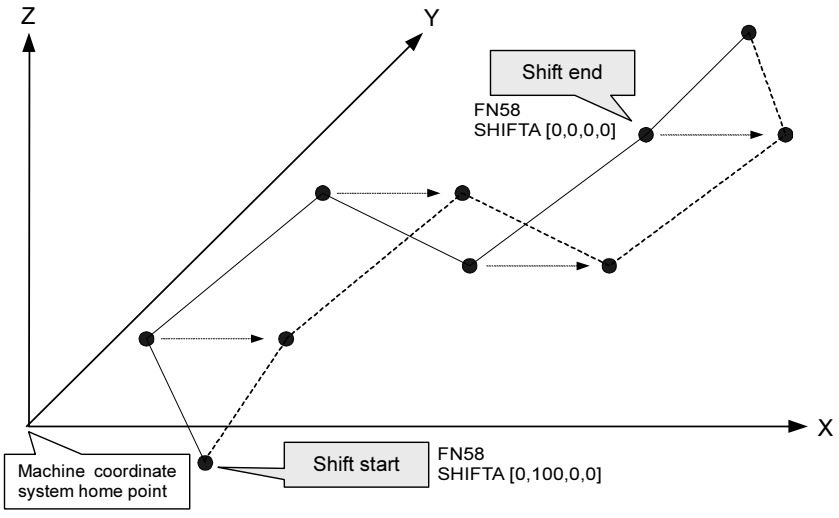
They ensure that the positions are moved temporarily during playback without rewriting the positions (encoder data) recorded in the task programs.

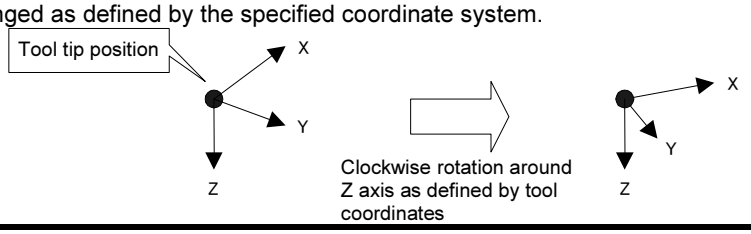
In order for the robot to perform these shift operations, the information on the distances and angles (hereafter referred to as the “shift amount”), for and by which the positions are shifted, must be provided.

In some cases, the shift amount information is provided from visual sensors and other external devices; in other cases, it is recorded in the application command ahead of time.

1.1.2 Frequently used terms

List of terms

Terms	Significance
Shift amounts	The information on the distances and angles by which the robot is shifted to the recorded positions which would otherwise be played back is referred to as the shift amounts.
Shift register	A shift register is a temporary area mainly for storing the shift amounts sent from the visual sensors or other external devices. The shift amounts detected by the search command (SEA: FN59) are also stored in the same shift register. This controller is equipped with 9 shift registers. Although shift registers are temporary areas, their values are retained in cases where, for instance, the power has been cut off and restored when the power comes back on. Furthermore, a shift register is normally initialized (cleared to zero) when step 0 is played back. If the values inside a shift register are not to be cleared when step 0 is played back, they can be retained by setting the “Shift clearance on step 0” to <No Clear> in the “Handling conditions” menu. 
Parallel shift	Parallel shift involves shifting a recorded position in parallel to a specified coordinate system by an amount equivalent to the specified movement distance. The same tool pose as the one established for the recorded position is maintained. 

Terms	Significance
Rotational shift	Rotational shift involves shifting a tool by rotating its direction by an amount equivalent to the rotational amount specified while leaving the tool tip position unchanged as defined by the specified coordinate system. 

1.2 Preparation

When using function command FN59 Search, FN723 Shift value get (signal) and or so, input/output signals must be allocated in advance. For further details, refer to Chapter 2, “Function Command”.

Chapter 2 Function Command

The table below lists the application command which are provided to implement the shift functions of this controller. For further details of each command, refer to the description of the individual command concerned.

Function commands for Shift

Mnemonic	FN No.	FN Name	Outline
RINT	29	Robot interrupt	The robot is adopted so that it will clamp/umclamp the work piece in a position where it comes into contact with the work piece through using the input of a sensor as the robot interrupt input signal.
SHIFTR	52	Shift	This shifts the recorded positions as defined by the specified coordinate system by the shift values which have been set in the specified shift registers.
LOCCVT	53	Coord.trans (shift value)	This offsets by shifting the recorded positions the shift values set in the three specified points serving as the reference and shift registers 1 to 3.
LOCCVT1	54	Coord.trans (posi. value)	This offsets by shifting the recorded positions the coordinate values set in the three specified points serving as the reference and shift registers 1 to 3.
SHIFTA	58	XYZ shift	This shifts the recorded positions in parallel using the specified shift values.
SEA	59	Search	Should the work piece position shift, it is possible to detect the shift value and then store it in the shift register. This function is used in combination with robot interrupt (FN29).
LETR	68	Set shift value	This enables the shift values to be set in the specified shift registers.
ADDR	69	Add shift value	This enables the specified shift values to be added to the specified shift registers.
CHGCOORD	113	Change coord. for shift	This selects the user coordinate numbers which are to be used for performing the shift operations. The user coordinate numbers must be selected using this application command without fail before initiating shifts based on the user coordinate system.
GETSFT	145	V! Set real var.	This stores the contents of the specified shift register in sequence starting with the number specified by the real number variable.
LEFTY	161	Arm config. (left/front)	This enables the left-arm system pose to be forcibly selected for calculating the robot poses.
RIGHTY	162	Arm config. (right/back)	This enables the right-arm system pose to be forcibly selected for calculating the robot poses.
ABOVE	163	Elbow config. (above)	This enables the elbow config. (above) pose to be forcibly selected for calculating the robot poses.
BELOW	164	Elbow config. (below)	This enables the elbow config. (below) pose to be forcibly selected for calculating the robot poses.
FLIP	165	Wrist config. (flip)	This enables the poses of the wrist-flip system (where the J5 axis angle is negative) to be forcibly selected for calculating the robot poses.
NONFLIP	166	Wrist config. (non-flip)	This enables the poses of the wrist-nonflip system (where the J5 axis angle is positive) to be forcibly selected for calculating the robot poses.
FRANGE	202	Flange axis rot. config.	This enables the rotational direction of the J6 axis to be specified for calculating the robot poses.
REGC	224	Shift reg.copy	This enables data to be copied between shift registers.
CLRREGWR	699	Clear register of written sts	This forcibly clears the “setting flag” of designated shift register to 0.
SIGREQ	723	Shift value get (signal)	Obtaining the shit amount through input signals.

2.1 SHIFTR: Shift (FN52)

General description

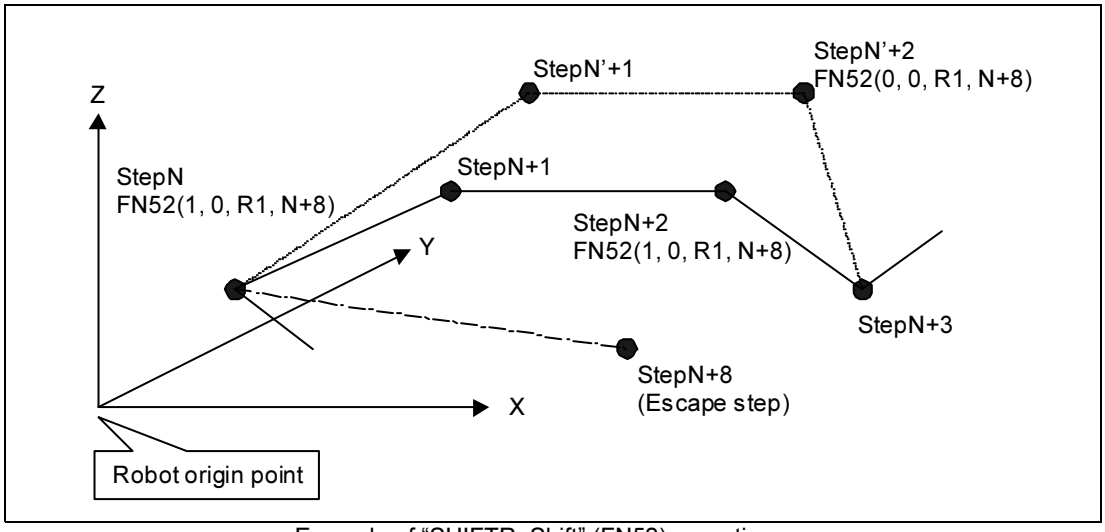
This application command proceeds with playback while shifting the recorded position in the robot program on the basis of the shift value data stored in the specified shift register. One of four options — “Machine coordinates (robot coordinates)”, “Tool coordinates,” “User coordinates” or “Absolute coordinates (world coordinates)” — can be selected for the coordinate system to be moved.

If the shift value data has not been set in the specified shift register, it is possible to jump to the shelter step. Alternatively, the robot can be stopped immediately without escaping.

Example of operation

As shown in the figure, shift start is recorded at the position (step N) where the shift is to start, and shift end is recorded at the position (step N+2) where shift is to end.

When the program is played back, the robot reads the contents of the shift register specified by FN52 after it has reached step N, and it then moves toward the position (step N’+1) established by shifting the next target position (step N+1). The position established by similarly shifting the recorded position as far as the position (step N+2) where shift end has been recorded serves as the target position. (Path of dotted line in figure below)



Example of “SHIFTR: Shift” (FN52) operation

If, when FN52 is executed at step N, the shift data has not been set at the time when the specified shift register is read, the robot moves toward the escape step in the event that an escape step has been set by the FN52 command. (Path of alternate long and short dash line in figure above)

■ **Parameter**

Mnemonic	No.	Command
SHIFTR	FN52	Shift

	Data	Description, setting range
Parameter No. 1	Shift start/end	This is used to specify the start or end of the shift operation. 1: Start / 0: End
Parameter No. 2	Coord	This is used to specify the coordinate system to be shifted. 0: Machine coordinates (robot coordinates) 1: Tool coordinates 2: User coordinate 3: Absolute coordinates (world coordinates) If user coordinates are to be specified, they must first be registered in "10 User coordinate system registration" selected on the Service Utilities menu, and then the number of the user coordinates to be used by the shift must be selected using "FN113 Change coord. for shift" in the application command.

	Data	Description, setting range
Parameter No. 3	Shift registerNo.	This is used to specify the shift register number. (1 to 9) (Caution) In order to shift the register number using the shift value detected with the "SEA: Search" (FN59) command, specify the same shift register number and coordinate system as those used for the "SEA: Search" (FN59) command.
Parameter No. 4	Shelter step	This is used to specify the number of the escape destination step when the shift value data was not set in the specified shift register. (0 to 10000) When 10000 is specified as the shelter step number, an alarm (A2118: “No data has been input in shift register.”) results immediately with no escape operation performed, and the robot can be stopped. When 0 is specified as the shelter step number, the robot waits indefinitely for the reception of the shift value data.

■ **Example of screen display**

```
SHIFTR [0, 0, R1, 10]          FN52; Shift2
```

2.2 LOCCVT: Coord. trans (shift value) (FN53)

General description

When this application command is used, it is possible to proceed with playback while offsetting the skew based on the skew amount (mm) between the recorded position of the three points serving as the reference and the actual position obtained from the vision device or other external device.

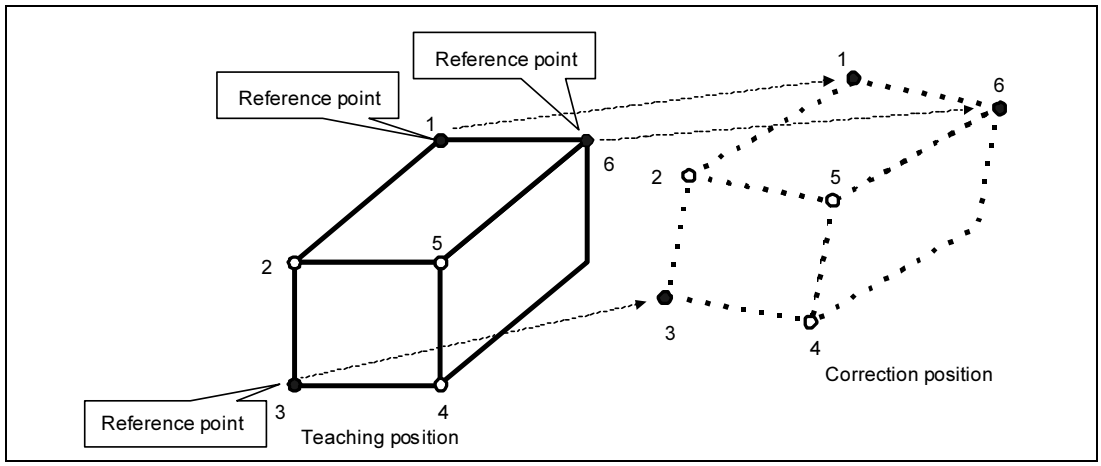
Any already taught three points can be specified as the three points serving as the reference.

The skew amounts are stored in shift registers 1, 2 and 3. These skew amounts are treated as data based on the base coordinate system (machine coordinate system) of the robot.

Before this application command is executed, the shift amount must be fixed.

Example of operation

As shown in the figure, the LOCCVT command is recorded with the three points of steps 1, 3 and 6 which were originally taught serving as the reference points. Before the FN53 command is played back, the skew amount corresponding to the offset position (at the right in the figure below) must first be set in shift registers 1, 2 and 3. When FN53 is now played back, a coordinate transform matrix is generated from the three reference points at taught and the three reference points at offset, and the recorded positions are shifted according to this matrix and played back.



Example of "LOCCVT: Coord. trans (shift value)" (FN53) command operation

When the shift operation ends by FN53, the recorded positions are played back.

- As the three reference points, specify the points in such a way that another recorded position is enclosed.
- Specify the three reference points in such a way that they are not aligned on a single straight line.
- The θ x, θ y and θ z data in the shift registers is not used.

■ Parameter

Mnemonic	No.	Command
LOCCVT	FN53	Coord. trans (shift value)

	Data	Description, setting range
Parameter No. 1	Shift start/end	This is used to specify the start or end of the shift operation. 1: Start / 0: End
Parameter No. 2	Base step No.1	This is used to specify the first step to be used as the reference. (1 to 9999)
Parameter No. 3	Base step No.2	This is used to specify the second step to be used as the reference. (1 to 9999)
Parameter No. 4	Base step No.3	This is used to specify the third step to be used as the reference. (1 to 9999)

■ Example of screen display

```
LOCCVT [1, 1, 2, 3]                FN53; Coord. trans (shift value)
```

2.3 LOCCVT1: Coord. trans (posi. value) (FN54)

General description

When this application command is used, it is possible to obtain the actual coordinates of the three points serving as the reference from the vision device or other external device, and proceed with playback while offsetting the coordinates on the basis of the data obtained.

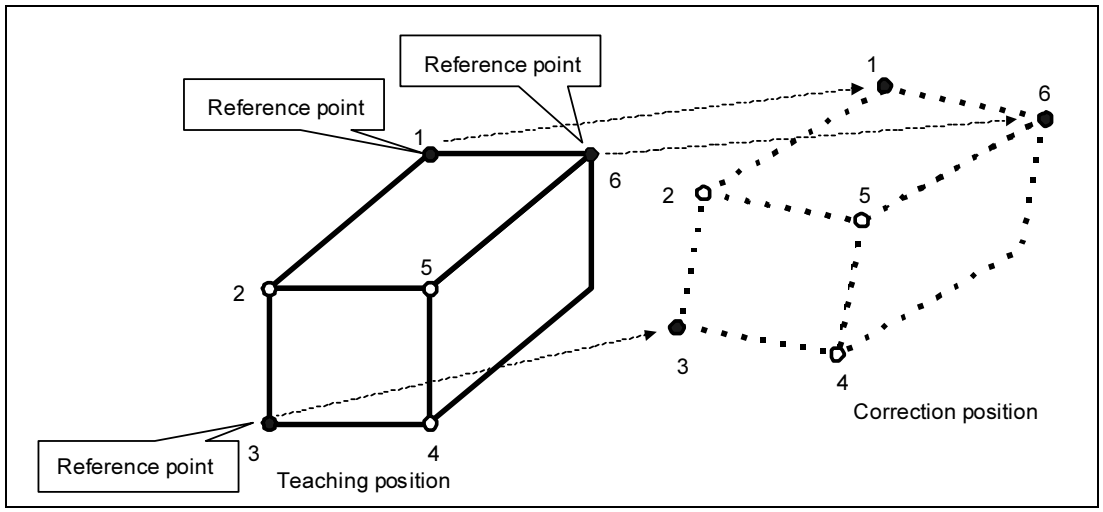
Any already taught three points can be specified as the three points serving a the reference.

The coordinates are stored in shift registers 1, 2 and 3. These coordinates are treated as data based on the robot base coordinate system (machine coordinate system).

Before this application command is executed, the shift amount must be fixed.

Example of operation

As shown in the figure, the LOCCVT1 command is recorded with the three points of steps 1, 3 and 6 which were originally taught serving as the reference points. Before the FN54 command is played back, the coordinates of the offset position (at the right in the figure below) must first be set in shift registers 1, 2 and 3. When FN54 is now played back, a coordinate transform matrix is generated from the three reference points at taught and the three reference points at offset, and the recorded positions are shifted according to this matrix and played back.



Example of "LOCCVT1: Coord. trans (posi. value)" (FN54) command operation

When the shift operation ends by FN54, the recorded positions are played back.

- As the three reference points, specify the points in such a way that another recorded position is enclosed.
- Specify the three reference points in such a way that they are not aligned on a single straight line.
- The θ x, θ y and θ z data in the shift registers is not used.

■ **Parameter**

Mnemonic	No.	Command
LOCCVT1	FN54	Coord. trans (posi. value)

	Data	Description, setting range
Parameter No. 1	Shift start/end	This is used to specify the start or end of the shift operation. 1: Start / 0: End
Parameter No. 2	Base step No. 1	This is used to specify the first step to be used as the reference. (1 to 9999)
Parameter No. 3	Base step No. 2	This is used to specify the second step to be used as the reference. (1 to 9999)
Parameter No. 4	Base step No. 3	This is used to specify the third step to be used as the reference. (1 to 9999)

■ **Example of screen display**

LOCCVT [1, 1, 2, 3]	FN54; Coord. trans (posi. value)

2.4 SHIFTA: XYZ shift (FN58)

General description

The XYZ shift function shifts the position which has already been taught in a parallel direction for each of the 3 dimensions. During the shift operations, the tool poses are maintained. One of four options — “Machine coordinates (robot coordinates)”, “Tool coordinates,” “User coordinates” or “Absolute coordinates (world coordinates)” — can be selected for the coordinate system to be moved.

The shift values are recorded as parameters. In other words, this command is useful when the amounts of the parallel movement by which the robot is to be shifted are already known.

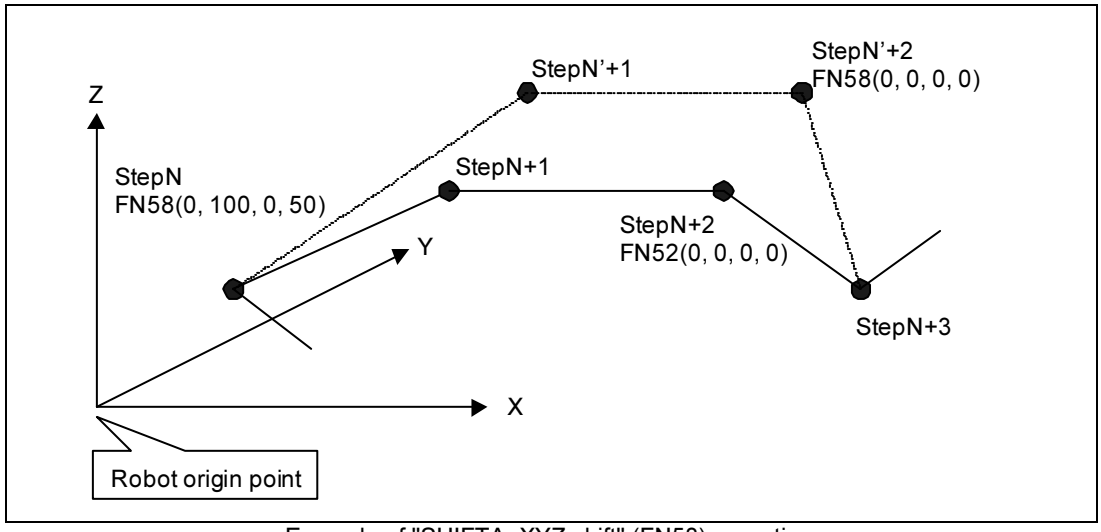
The shift operation is considered to have ended when 0.0 mm is specified for all the shift values recorded in FN58.

Use of this shift function will not update the actual recorded positions in the robot program.

Example of operation

In the example shown in the figure, the XYZ shift (FN58) command with the shift values specified is recorded at step N at which the shift operation is to be started, and the XYZ shift command with zero recorded for all the shift values is recorded at the shift end step.

When the program is played back, the robot, after it has reached step N, plays back toward the target position, step N'+1, which is obtained by adding the shift value in the specified coordinate system recorded in FN58 to the next recorded position (step N+1). After the robot has reached step N+2, the shift operation is ended by executing FN58 with 0 mm set for all the shift values.



Example of "SHIFTA: XYZ shift" (FN58) operation

IMPORTANT

If positions are to be shifted based on the user coordinate system, "User coordinate system registration" must be performed, and the user coordinate numbers must be selected using the "CHGCOORD: Change coord. for shift" (FN113) command beforehand.

IMPORTANT

If a specified shift value exceeds the value specified in "Shift value limit" selected from "Machine constants" under Constant Setting, an error results, and the robot is stopped.

IMPORTANT

This function can be used together with other shift functions. If shift values in the reverse direction from the ones specified by FN58 have been specified by another shift-related command, they will be set to 0.0 mm as a result.

■ **Parameter**

Mnemonic	No.	Command
SHIFTA	FN58	XYZ shift

	Data	Description, setting range
Parameter No. 1	Coord	The parallel movement amounts specified by the second, third and fourth parameters serve as the movement amounts in the coordinate system which is specified here. A setting from 0 to 3 is specified by this parameter for the coordinates. 0: Machine coordinates (robot coordinates) 1: Tool coordinates 2: User coordinate 3: Absolute coordinates (world coordinates) If user coordinates are to be specified, they must first be registered in "10 User coordinate system registration" selected on the Service Utilities menu, and then the number of the user coordinates to be used by the shift must be selected using "FN113: Change coord. for shift" in the application command.
Parameter No. 2	Shift value X	This is used to specify the shift value in the X direction as defined by the coordinate system specified by the parameter No.1. (–3000 mm to 3000 mm)
Parameter No. 3	Shift value Y	This is used to specify the shift value in the Y direction as defined by the coordinate system specified by the parameter No.1. (–3000 mm to 3000 mm)
Parameter No. 4	Shift value Z	This is used to specify the shift value in the Z direction as defined by the coordinate system specified by the parameter No.1. (–3000 mm to 3000mm)

■ **Example of screen display**

```
SHIFTA [0, –10.5, 23.3, 0.0]        FN58; XYZ shift
```

2.5 LETR: Set shift value (FN68)

General description

When this application command is used, the shift value data can be set in the specified shift register.

Even while the specified shift register is being used by the "SHIFTR: Shift" (FN52) or other command, the new values specified by LETR will be set in the shift register without adversely affecting the operation of the other command being executed. The changed shift values become valid when the next "SHIFTR: Shift" (FN52) command is played back.

Example of operation

Shift register values when LETR[R1,100,100,100,10,11,12] has been executed

(1) When the command has been executed while existing values were set in the shift register

	Before LETR is executed	After LETR is executed
Request flag	0	0
Setting flag	1	1
X	110	100
Y	120	100
Z	130	100
θ X	5	10
θ Y	6	11
θ Z	7	12

(2) When the command is executed with the shift registers in the initial status

	Before LETR is executed	After LETR is executed
Request flag	0	0
Setting flag	0	1
X	0	100
Y	0	100
Z	0	100
θ X	0	10
θ Y	0	11
θ Z	0	12

After this command has been executed, the request flag of the shift register is always set to “0,” and the setting flag is always set to “1.” The values specified by the parameters are stored in X through θ z.

■ **Parameter**

Mnemonic	No.	Command
LETR	FN68	Set shift value

	Data	Description, setting range
Parameter No. 1	Shift register No.	This is used to specify the number of the shift register in which the shift value data specified by the parameters No. 2 through No. 7 is to be assigned. (1 to 9)
Parameter No. 2	Shift value X	This is used to specify the value of the shift value in the X direction. (–3000.0 to 3000.0 mm)
Parameter No. 3	Shift value Y	This is used to specify the value of the shift value in the Y direction. (–3000.0 to 3000.0 mm)
Parameter No. 4	Shift value Z	This is used to specify the value of the shift value in the Z direction. (–3000.0 to 3000.0 mm)
Parameter No. 5	Angle shift X	This is used to specify the amount of rotation around the X axis. (–360.0 to 360.0 deg)
Parameter No. 6	Angle shift Y	This is used to specify the amount of rotation around the Y axis. (–360.0 to 360.0 deg)
Parameter No. 7	Angle shift Z	This is used to specify the amount of rotation around the Z axis. (–360.0 to 360.0 deg)

■ **Example of screen display**

```
LETR [R1, 100.0, –100.0, 50.0, 10.0, 0.0, 0.0]          FN68; Set shift value
```

2.6 ADDR: Add shift value (FN69)

General description

When this application command is used, the specified values in the specified shift register can be added up. Even while the specified shift register is being used by the "SHIFTR: Shift" (FN52) or other command, the new values specified by ADDR will be set in the shift register without adversely affecting the operation of the other command being executed. The changed shift values become valid when the next "SHIFTR: Shift" (FN52) command is played back.

Example of operation

Shift register values when ADDR[R1,100,100,100,10,11,12] has been executed

(1) When the command has been executed while existing values were set in the shift register

	Before ADDR is executed	After ADDR is executed
Request flag	0	0
Setting flag	1	1
X	110	210
Y	120	220
Z	130	230
θX	5	15
θY	6	17
θZ	7	19

(2) When the command has been executed with the shift registers in the initial status

	Before ADDR is executed	After ADDR is executed
Request flag	0	0
Setting flag	0	1
X	0	100
Y	0	100
Z	0	100
θX	0	10
θY	0	11
θZ	0	12

After this command has been executed, the request flag of the shift register is always set to “0,” and the setting flag is always set to “1.” The values specified by the parameters are added to the original values and stored in X through θz.

■ **Parameter**

Mnemonic	No.	Command
ADDR	FN69	Add shift value

	Data	Description, setting range
Parameter No. 1	Shift register No.	This is used to specify the number of the shift register in which the shift value data specified by the parameters No. 2 through No. 7 is to be added. (1 to 9)
Parameter No. 2	Shift value X	This is used to specify the value of the shift value in the X direction. (–3000.0 to 3000.0 mm)
Parameter No. 3	Shift value Y	This is used to specify the value of the shift value in the Y direction. (–3000.0 to 3000.0 mm)
Parameter No. 4	Shift value Z	This is used to specify the value of the shift value in the Z direction. (–3000.0 to 3000.0 mm)
Parameter No. 5	Angle shift X	This is used to specify the amount of rotation around the X axis. (–360.0 to 360.0 deg)
Parameter No. 6	Angle shift Y	This is used to specify the amount of rotation around the Y axis. (–360.0 to 360.0 deg)
Parameter No. 7	Angle shift X	This is used to specify the amount of rotation around the Z axis. (–360.0 to 360.0 deg)

■ **Example of screen display**

```
ADDR [R1, 100.0, -100.0, 50.0, 10.0, 0.0, 0.0]          FN69; Add shift value
```

2.7 CHGCOORD: Change coord. for shift (FN113)

General description

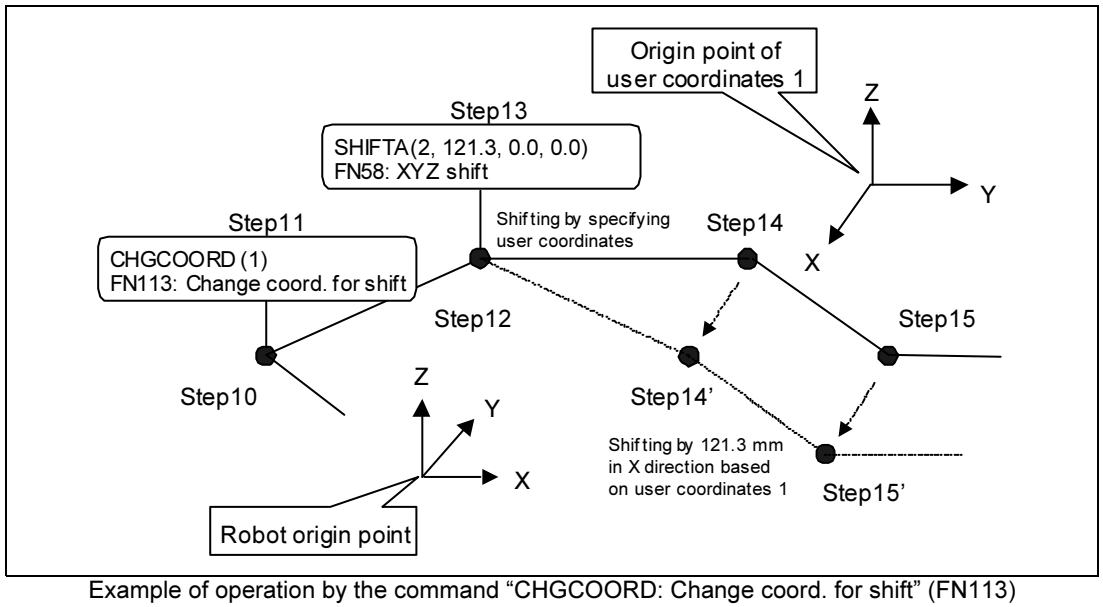
With application command used to implement shift operations such as "SHIFTR: Shift" (FN52) and "SHIFTA: FXYZ shift" (FN58), the user coordinate system can be selected as the system that serves as the reference for shifting. The CHGCOORD command specifies the number of the user coordinate system to be used at this time.

When a shift operation has been executed using a user coordinate system with no user coordinate system number selected by this application command, an alarm results, and the robot is stopped. The user coordinate system must be registered ahead of time using Service Utilities/User coordinates. Up to a hundred coordinates can be registered.

Example of operation

In the figure below, the application command “SHIFTA: XYZ shift” (FN58) has been recorded in step 13, and a user coordinate system has been selected as the coordinate system to be used for this. Therefore, the command “CHGCOORD: Change coord. for shift” (FN113) is recorded in step 11 which is before step 13, and user coordinate system No.1 has been specified.

The movement commands after step 14 operate with the positions (positions of steps 14' and 15' in the figure) shifted by 121.3 mm in the X direction of user coordinate system No.1 serving as the movement target.



Example of operation by the command “CHGCOORD: Change coord. for shift” (FN113)

■ **Parameter**

Mnemonic	No.	Command
CHGCOORD	FN113	Change coord. for shift

	Data	Description, setting range
Parameter No. 1	User coordinate No.	This is used to specify the user coordinate number to be used by the shift-related application commands. (0 to 100) If 0 is specified, this parameter is not selected.

■ **Example of screen display**

CHGCOORD [5]	FN113; Change coord. for shift

2.8 GETSFT: V! Set real var. (shift) (FN145)

General description

When this application command is used, the values (X, Y, Z, θx, θy, θz) recorded in the specified shift register can be assigned in sequence from the number of the specified real variable. Furthermore, the numerical value (1) indicating that the values have been assigned is set in the number of the next specified real variable.

The numerical values at the time concerned are assigned regardless of whether or not the data has been set in the specified shift register.

Example of operation

When the robot reaches the step where the "GETSTF: V! Set real var. (shift)" (FN145) command is recorded, the contents of the shift register are immediately read, copied into the real variables, and set. The robot does not stop.

IMPORTANT

The numerical values are set (written over the existing data) in 7 consecutive real variables regardless of their usage status up to this point.

■ **Parameter**

Mnemonic	No.	Command
GETSFT	FN145	V! Set real var. (shift)

	Data	Description, setting range
Parameter No. 1	Real variable No.	This is used to specify the starting number of the real variables which will store the numerical values inside the shift register. The numerical values are set (or overwritten) in 7 consecutive real variables whose number starts with this. (1 to 94)
Parameter No. 2	Shift register No.	This is used to specify the shift register number. (1 to 9)

■ **Example of screen display**

```
GETSFT [V1!, R1]                FN145; V! Set real var. (shift)
```

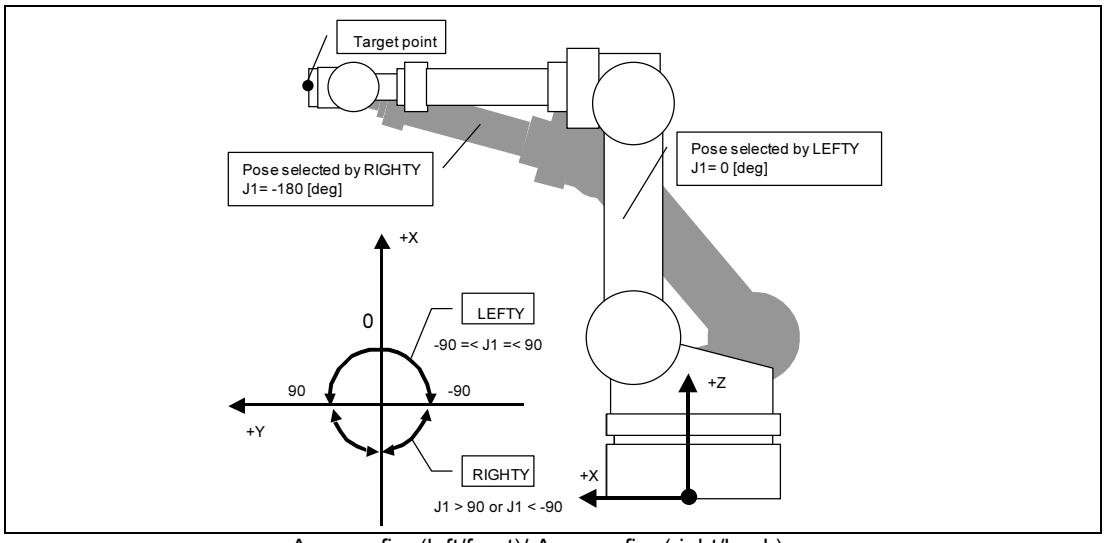
2.9 LEFTY: Arm config. (left/front) (FN161)

General description

This command obtains the angles of the robot axes by calculating them from the head coordinates when shift-type operations are executed. The angles of two patterns capable of expressing the same position are obtained by the calculation. Normally, which angle is to be selected is automatically determined (an angle close to the actual pose is selected). However, the robot may not come to a desired pose. When this application command is used, the poses of the arm config. (left/front) are forcibly selected from among the calculation results in the subsequent steps.

Example of operation

When the "LEFTY: Arm config. (left/front)" (FN161) command is played back, the poses of the arm config. (left/front) are forcibly selected when shift-type operations are executed in the subsequent steps.
The robot does not stop when this command is executed.



Arm config. (left/front)/ Arm config. (right/back)

IMPORTANT

As soon as the first step (step 0) in the program is played back, the forced selection status is released, and the process of automatically determining which angle to select is restored. However, the forced selection status continues at step 0 of a program which has been called.

IMPORTANT

The figure above just shows an example for explanation. Be noted that, depending on the type of robot or the teaching point, the pose shown in the figure above cannot be achieved.

■ **Parameter**

Mnemonic	No.	Command
LEFTY	FN161	Arm config. (left/front)

No parameters

■ **Example of screen display**

LEFTY	FN161; Arm config. (left/front)

2.10 RIGHTY: Arm config. (right/back) (FN162)

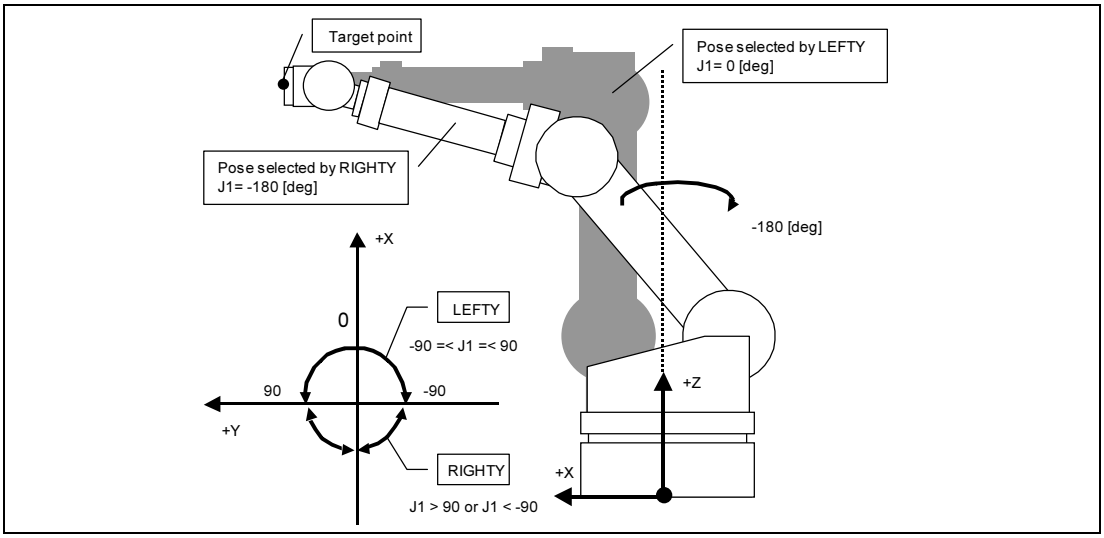
General description

This command obtains the angles of the robot axes by calculating them from the head coordinates when shift-type operations are executed. The angles of two patterns capable of expressing the same position are obtained by the calculation. Normally, which angle is to be selected is automatically determined (an angle close to the actual pose is selected). However, the robot may not come to a desired pose. When this application command is used, the poses of the arm config. (right/back) are forcibly selected from among the calculation results in the subsequent steps.

Example of operation

When the "RIGHTY: Arm config. (right/back)" (FN162) command is played back, the poses of the arm config. (right/back) are forcibly selected when shift-type operations are executed in the subsequent steps.

The robot does not stop when this command is executed.



Arm config. (left/front)/ Arm config. (right/back)

IMPORTANT

As soon as the first step (step 0) in the program is played back, the forced selection status is released, and the process of automatically determining which angle to select is restored. However, the forced selection status continues at step 0 of a program which has been called.

IMPORTANT

The figure above just shows an example for explanation. Be noted that, depending on the type of robot or the teaching point, the pose shown in the figure above cannot be achieved.

■ **Parameter**

Mnemonic	No.	Command
RIGHTY	FN162	Arm config. (right/back)

No parameters

■ **Example of screen display**

RIGHTY	FN162; Arm config. (right/back)

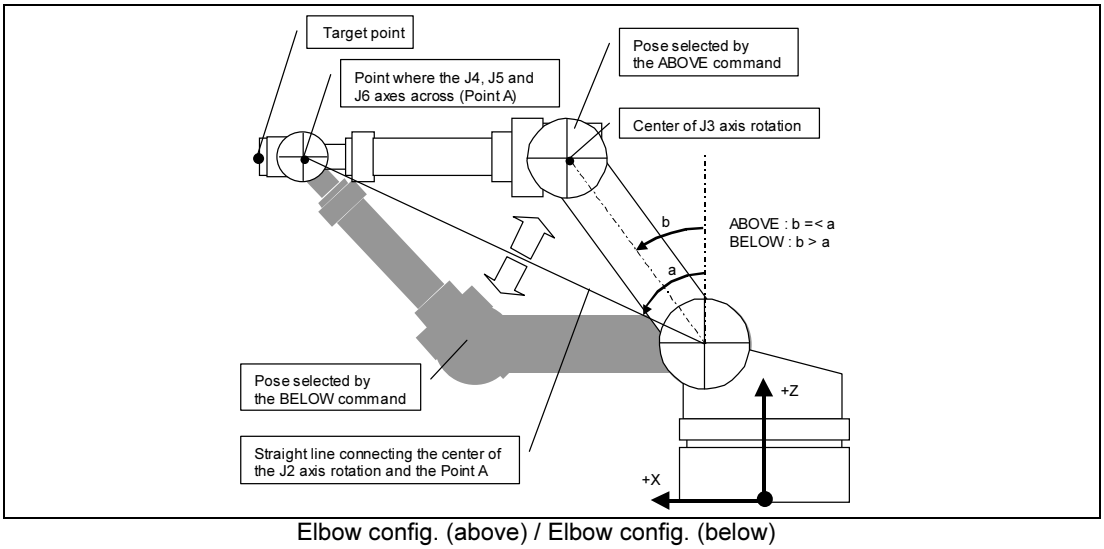
2.11 ABOVE: Elbow config. (above) (FN163)

General description

This command obtains the angles of the robot axes by calculating them from the head coordinates when shift-type operations are executed. The angles of two patterns capable of expressing the same position are obtained by the calculation. Normally, which angle is to be selected is automatically determined (an angle close to the actual pose is selected). However, the robot may not come to a desired pose. When this application command is used, the poses of the arm config. (right/back) are forcibly selected from among the calculation results in the subsequent steps.

Example of operation

When the "RIGHTY: Arm config. (right/back)" (FN162) command is played back, the poses of the arm config. (right/back) are forcibly selected when shift-type operations are executed in the subsequent steps.
The robot does not stop when this command is executed.



Elbow config. (above) / Elbow config. (below)

IMPORTANT

As soon as the first step (step 0) in the program is played back, the forced selection status is released, and the process of automatically determining which angle to select is restored. However, the forced selection status continues at step 0 of a program which has been called.

IMPORTANT

The figure above just shows an example for explanation. Be noted that, depending on the type of robot or the teaching point, the pose shown in the figure above cannot be achieved.

■ Parameter

Mnemonic	No.	Command
ABOVE	FN163	Elbow config. (above)

No parameters

■ Example of screen display

ABOVE	FN163; Elbow config. (above)

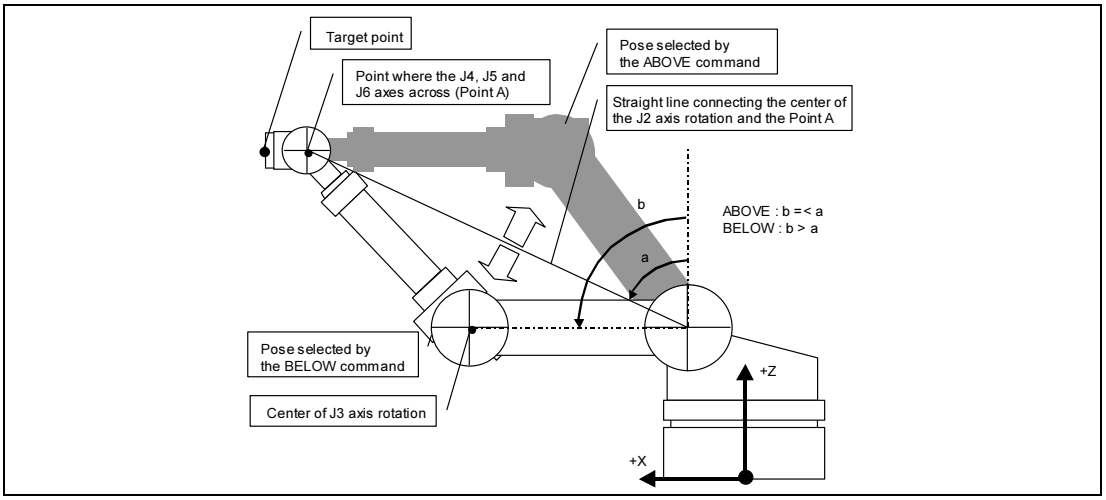
2.12 BELOW: Elbow config. (below) (FN164)

General description

This command obtains the angles of the robot axes by calculating them from the head coordinates when shift-type operations are executed. The angles of two patterns capable of expressing the same position are obtained by the calculation. Normally, which angle is to be selected is automatically determined (an angle close to the actual pose is selected). However, the robot may not come to a desired pose. When this application command is used, the poses of the elbow config. (below) are forcibly selected from among the calculation results in the subsequent steps.

Example of operation

When the "BELOW: Elbow config. (below)" (FN164) command is played back, in order to execute shift-type operations in the subsequent steps, the poses of the elbow config. (below) (i.e., poses in which the center of the J3 axis rotation is located below a straight line connecting the center of the J2 axis rotation and the Point A) are forcibly selected.
The robot does not stop when this command is executed.



Elbow config. (above) / Elbow config. (below)

IMPORTANT

As soon as the first step (step 0) in the program is played back, the forced selection status is released, and the process of automatically determining which angle to select is restored. However, the forced selection status continues at step 0 of a program which has been called.

IMPORTANT

The figure above just shows an example for explanation. Be noted that, depending on the type of robot or the teaching point, the pose shown in the figure above cannot be achieved.

■ Parameter

Mnemonic	No.	Command
BELOW	FN164	Elbow config. (below)

No parameters

■ Example of screen display

BELOW	FN164; Elbow config. (below)

2.13 FLIP: Wrist config. (flip) (FN165)

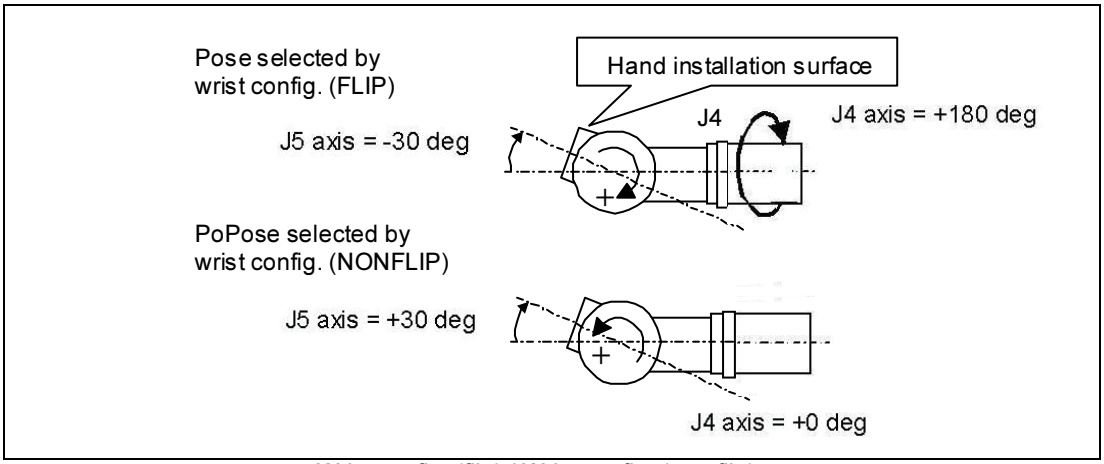
General description

This command obtains the angles of the robot axes by calculating them from the head coordinates when shift-type operations are executed. The angles of two patterns capable of expressing the same position are obtained by the calculation. Normally, which angle is to be selected is automatically determined (an angle close to the actual pose is selected). However, the robot may not come to a desired pose. When this application command is used, the poses at which the angle of the J5 axis is negative are forcibly selected from among the calculation results in the subsequent steps.

Example of operation

When the "FLIP: Wrist config. (flip)" (FN165) command is played back, the poses at which the angle of the J5 axis is negative are forcibly selected when shift-type operations are executed in the subsequent steps.

The robot does not stop when this command is executed.



Wrist config. (flip) / Wrist config. (non-flip)

IMPORTANT

As soon as the first step (step 0) in the program is played back, the forced selection status is released, and the process of automatically determining which angle to select is restored. However, the forced selection status continues at step 0 of a program which has been called.

■ **Parameter**

Mnemonic	No.	Command
FLIP	FN165	Wrist config. (flip)

No parameters

■ **Example of screen display**

FLIP	FN165; Wrist config. (flip)

2.14 NONFIP: Wrist config. (non-flip) (FN166)

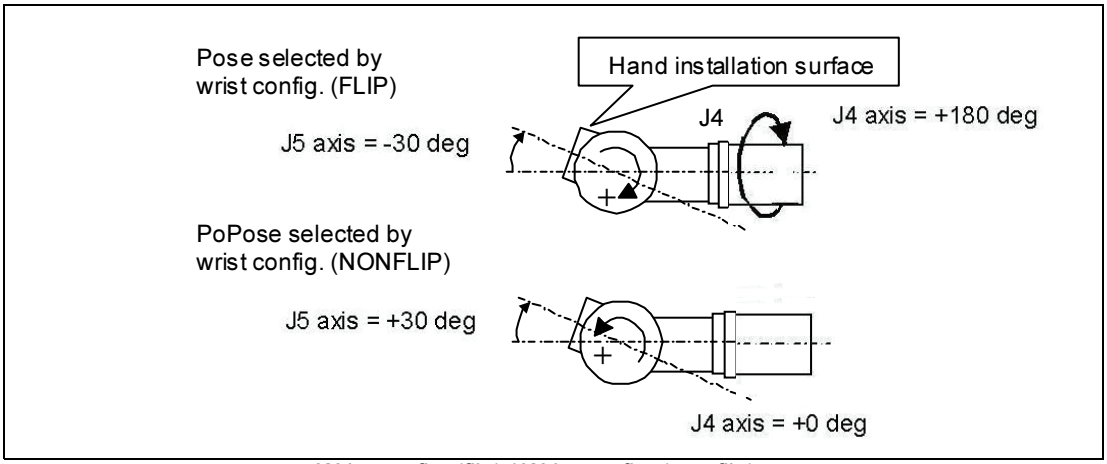
General description

This command obtains the angles of the robot axes by calculating them from the head coordinates when shift-type operations are executed. The angles of two patterns capable of expressing the same position are obtained by the calculation. Normally, which angle is to be selected is automatically determined (an angle close to the actual pose is selected). However, the robot may not come to a desired pose. When this application command is used, the poses at which the angle of the J5 axis is positive are forcibly selected from among the calculation results in the subsequent steps.

Example of operation

When the "NONFLIP: Wrist config. (non-flip)" (FN166) command is played back, the poses at which the angle of the J5 axis is positive are forcibly selected when shift-type operations are executed in the subsequent steps.

The robot does not stop when this command is executed.



Wrist config. (flip) / Wrist config. (non-flip)

IMPORTANT

As soon as the first step (step 0) in the program is played back, the forced selection status is released, and the process of automatically determining which angle to select is restored. However, the forced selection status continues at step 0 of a program which has been called.

■ **Parameter**

Mnemonic	No.	Command
NONFLIP	FN166	Wrist config. (non-flip)

No parameters

■ **Example of screen display**

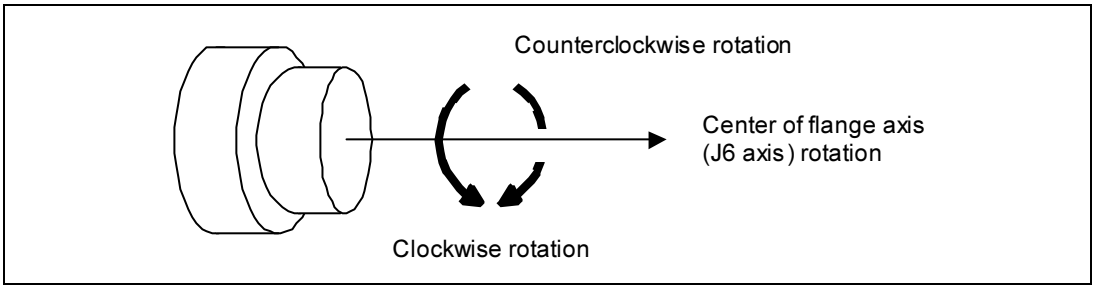
NONFLIP	FN166; Wrist config. (non-flip)

2.15 FRANGE: Flange axis rot. config. (FN202)

General description

Restrictions stemming from the wiring that accompanies the tools and the installation conditions of the robot sometimes make it preferable for the rotational direction of the tools to be fixed. However, during palletizing operations and rotational shifts based on the robot language, etc., the poses that minimize the rotational amount are often selected automatically. This sometimes results in operations which differ from the desired rotational direction.

When this application command is used, the rotational direction of the J6 axis can be forcibly specified.



Flange axis rotational direction

The flange axis rot. config. command is an application command. As with the timer commands or input/output commands, it can be recorded using the [FN] key.

Example of operation

When the "FRANGE: Flange axis rot. config." (FN202) command is played back, the poses are forcibly selected with the rotational direction of the J6 axis specified when shift-type operations are executed in the subsequent steps.

The robot does not stop when this command is executed.

■ **Parameter**

Mnemonic	No.	Command
FRANGE	FRANGE	Flange axis rot. config.

	Data	Description, setting range
Parameter No. 1	ON/OFF	This is used to specify whether to specify the rotational direction or release the specification. (1: ON/2: OFF)
Parameter No. 2	Rotational dir.	This is used to specify the rotational direction of the J6 axis. (1: Clockwise rotation/–1: counterclockwise rotation)

■ **Example of screen display**

```
FRANGE [1, 1]                    FN202; Flange axis rot. config.
```

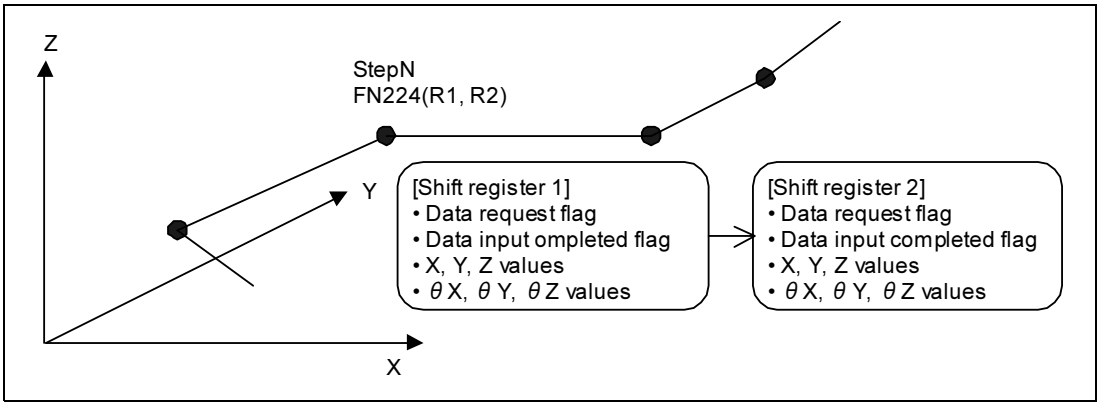
2.16 REGC: Shift reg. copy (FN224)

General description

When this application command is used, data can be copied between shift registers.

Example of operation

The "REGC: Shift reg. copy" (FN224) command is recorded in step N.
When the program is played back, the robot, after reaching step N, copies the contents of the copy source shift register into the copy destination shift register. The "data input completed flag" of the copy destination shift register is always set to "1."



Example of operation by the command "REGC: Shift register copy" (FN224)

■ **Parameter**

Mnemonic	No.	Command
REGC	FN224	Shift reg. copy

	Data	Description, setting range
Parameter No. 1	Copy source shift register No.	This is used to specify the number of the copy source shift register. (1 to 9)
Parameter No. 2	Copy destination shift register No.	This is used to specify the number of the copy destination shift register. (1 to 9)

■ **Example of screen display**

```
REGC [R1, R4]                    FN224; Shift reg. copy
```

2.17 RINT: Robot Interrupt I signal (FN29)

General description

Normal application commands are executed after the robot reaches the recorded position. Consequently, unless the robot reaches the target step, the robot cannot proceed with operations such as "to change the moving path" or "to output the output signal".

When this application command is used, it is possible to proceed with "detection of obstacles to change the moving path" or "output of the output signal" while moving between the MOVE commands.

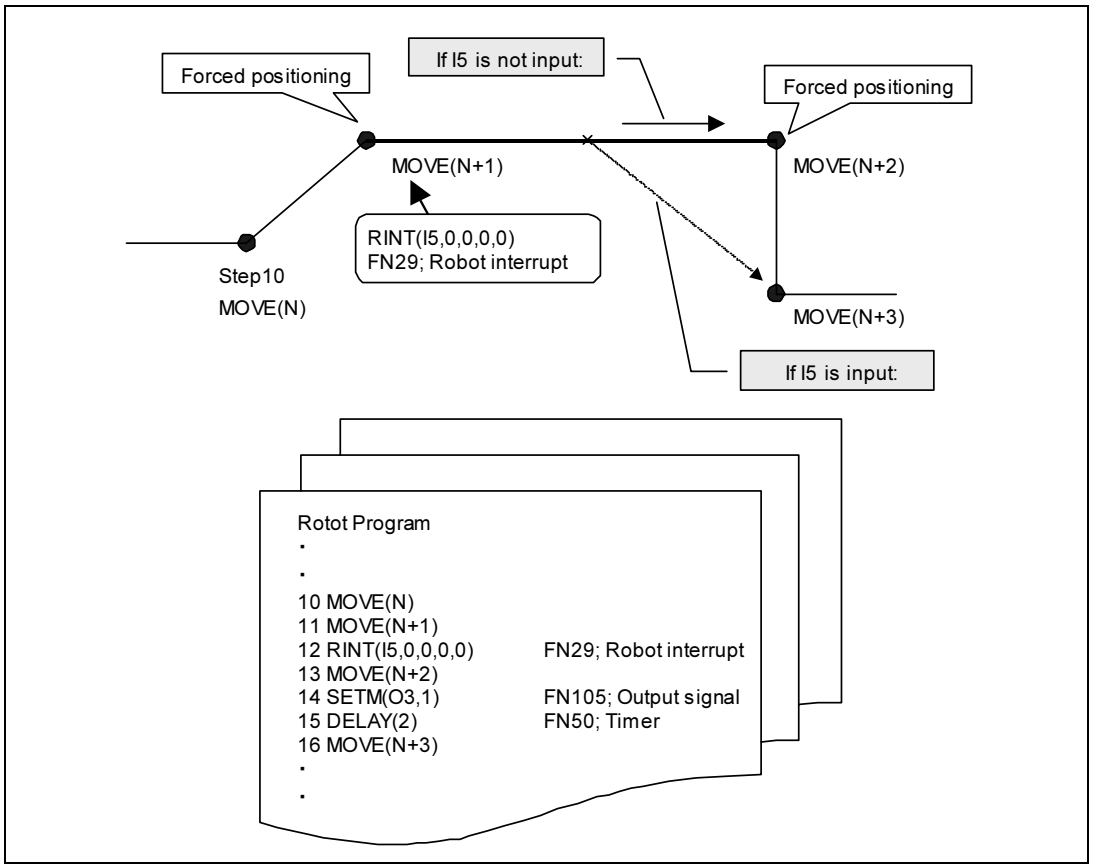
In order to handle a workpiece with poor positioning accuracy, normally adopt the robot so that it will clamp/unclamp the workpiece in a position where it comes into contact with the workpiece through using the input of a sensor as the robot interrupt input signal.

■ **Parameter**

Mnemonic	No.	Command
RINT	FN29	Robot interrupt (I)

	Data	Description, setting range	
Parameter No. 1	Input signal	This is used to specify the input signal number serving as the robot interrupt conditions. (1 to 2048): User input numbers (5101 to 5196): Combination input numbers	
Parameter No. 2	Reference value setting	Used to specify the search basis write status 0: Not set 1: Set	These parameters are used for the "search function". In order to independently use the robot interrupt command, set all these parameters to "0". For the search function, refer to information in **SEA: Search (FN59)**.
Parameter No. 3	Reference X	Used to specify the X coordinate when executing the search basis write (-3000~3000)	
Parameter No. 4	Reference Y	Used to specify the Y coordinate when executing the search basis write (-3000~3000)	
Parameter No. 5	Reference Z	Used to specify the Z coordinate when executing the search basis write (-3000~3000)	

Example of operation



Example of operation of “RINT: robot interrupt I signal” (FN29)

The following section describes the operation taking an example of robot interrupt being recorded after the move command MOVE (N+1) is executed, as shown in the figure above.

• The robot interrupt zone (interrupt processing enable range) covers between the MOVE (N+1) that is a move command immediately before the robot interrupt command RINT step and the MOVE (N+2) that is a move command immediately after the said step.

• Within this robot interrupt zone, if the robot detects the input of input signal I5, it will immediately terminate processing to move to the move command MOVE (N+2) and then go on to the execution of a command recorded next to the move command MOVE (N+2). In the case of example shown above, since the application command SETM is recorded next to the move command MOVE (N+2) and then followed by the application command DELAY, the robot executes these commands in the position where it detects the input signal I5 and then immediately moves toward the position of the move command MOVE (N+3). (Path shown with a dotted line in the figure)

• Steps at both ends of the robot interrupt zone (i.e., the move commands MOVE (N+1) and MOVE (N+2) in the case of the figure) are forcedly put into positioning operation, regardless of contents recorded.

• If the robot does not detect the input of input signal I5 before it reaches the recorded position for the MOVE (N+2), it will move to the recorded position for the MOVE (N+2) as normal and then execute the next command SETM (FN105).

• If the robot detects the input of input signal I5 on the way to the MOVE (N+2) and then moves toward the recorded position for the move command MOVE (N+3), it will move while following the positioning trajectory.

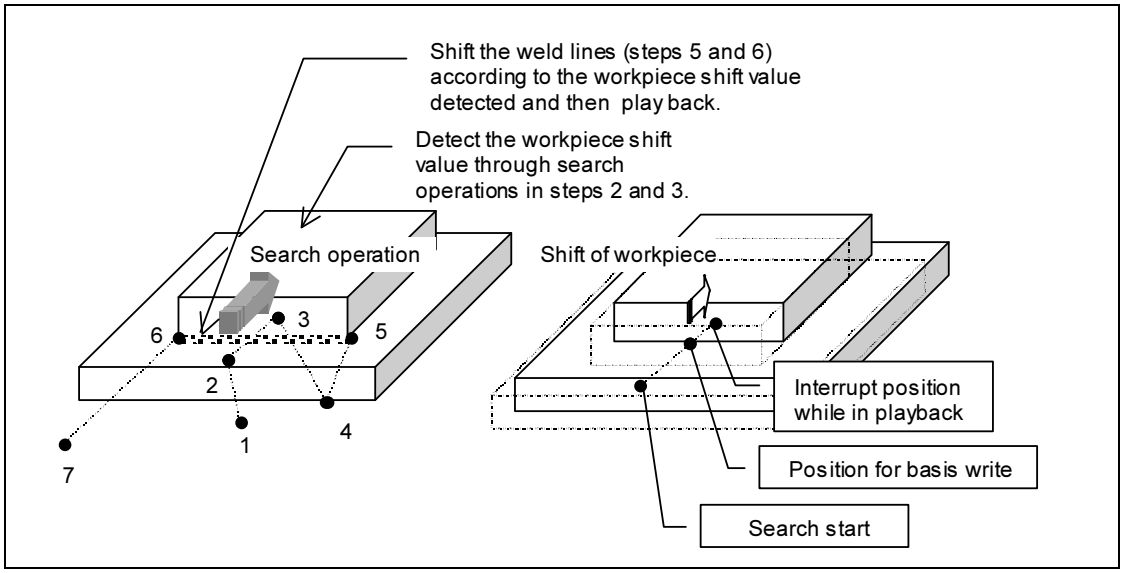
• Record the operation of the move command MOVE (N+2) at a low speed. Operating this command at a high speed may blunt response to interrupt detection.

2.18 SEA: Search (FN59)

General description

When this application command is used, should the workpiece position shift, it is possible to detect the shift value and then store it in the shift register. Using the shift value stored in the shift register makes it possible to shift and move multiple arbitrary steps in a batch with a shift command.

In order to detect the shift value of the workpiece position, the SEA command should be used in combination with the robot interrupt command (FN29). The reason is that contact positions with the workpiece should be loaded.



Overview of search operation

Before computing the shift value, the workpiece position serving as the reference should be known. This is referred to as "**basis write mode**". A difference between the reference position obtained in basis write mode and the actual workpiece position obtained in normal mode is stored in the specified shift register as the shift value. Use the shift value stored in the shift register to shift recorded positions.

For details of the robot interrupt application command, refer to information in "2.17 RINT: Robot Interrupt I signal (FN29)", while for details of the shift application command, refer to information in "2.1 SHIFTR: Shift (FN52)".

■ **Parameter**

Mnemonic	No.	Command
SEA	FN59	Search

	Data	Description, setting range
Parameter No. 1	Start 2/Start/End	This is used to specify the start or end of the search operation. 2 (Start 2): Used to obtain the machine coordinate by which the shift value is not cancelled when detecting the position with the "FN29 Robot interrupt" command. 1 (Start): Used to obtain the machine coordinate by which the shift value was cancelled when detecting the position with the "FN29 Robot interrupt" command. 0 (End): Used to end the search operation.
Parameter No. 2	Coord	This is used to specify the coordinate system serving as the reference for shift value to be set with the shift register. 0 (Machine coordinates): Used to set the shift value as the shift value defined by the machine coordinate system to the shift register. 1 (Tool coordinates): Used to set the shift value as the shift value defined by the tool coordinate system to
Parameter No. 3	Shift register No.	This is used to specify the shift register number to set the shift value. (1~9)

[Signals requiring advance allocation]

The following signals require advance allocation as status signals. Make setting of these signals in the order of <Constant Setting> [6 Signals] [3 Output Signal Assignment] [1 Standard Outputs].

Output signals for search function

Standard output name	Factory set output signal	Function
On searching	0	This is used for the search function (i.e., function to handle the workpiece shifted) and turns ON while in search operation. For details, refer to information in "SEA: Search (FN59)".
Search basis write mode	0	This is used for the search function (i.e., function to handle the workpiece shifted) and turns ON while in search basis write mode. Starting the robot accidentally with the search basis write mode ON disables proper handling of the workpiece. It is recommended to use this signal as robot startup conditions on higher-order controllers. For details, refer to information in "SEA: Search (FN59)".

Example of operation

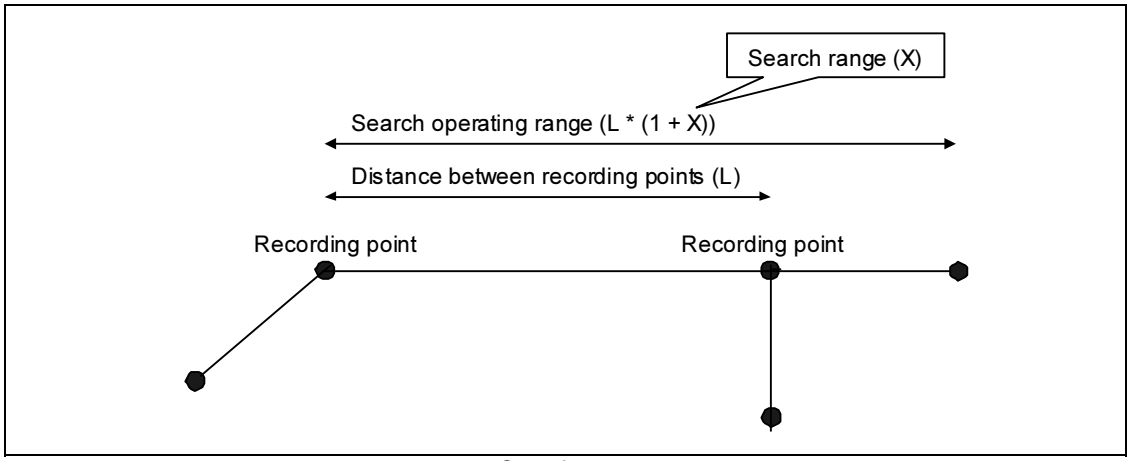
For handling with the use of the search function, follow the procedure shown below.

1. Teaching	Make setting of "search range" and then execute teaching for the search operation.
↓	
2. Search basis write	Obtain a position serving as the reference while in "search basis write" mode.
↓	
3. Execute search operation	Normally, execute the search operation while in playback mode. The shift value obtained is stored in the shift register.
↓	
4. Execute shift operation	According to the contents of shift register, play back while shifting the desired step.

Procedure for search operation

1. Execute teaching for the search operation.

Start with setting of the "search range". The search range means to specify to what extent the search operation (i.e., operation to search the workpiece position) should be executed, as shown in figure below.



Search range

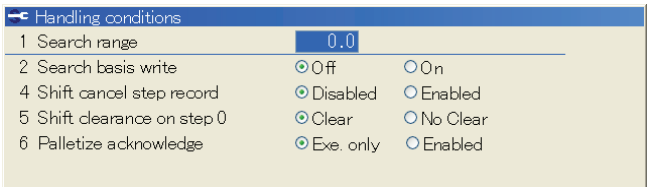
If there is a possibility that the workpiece position shifts farther from the search end point, setting any number other than "0" to the "search range" will have the robot pass over the search end point to the specified position, where it will indefinitely wait for the interrupt condition.

The default value of "search range" is 0.0.

1 **Select the [TEACH] mode or [PLAYBACK] mode.**

2 **Select [Service Utilities] [22 Handling application] [1 Handling conditions].**

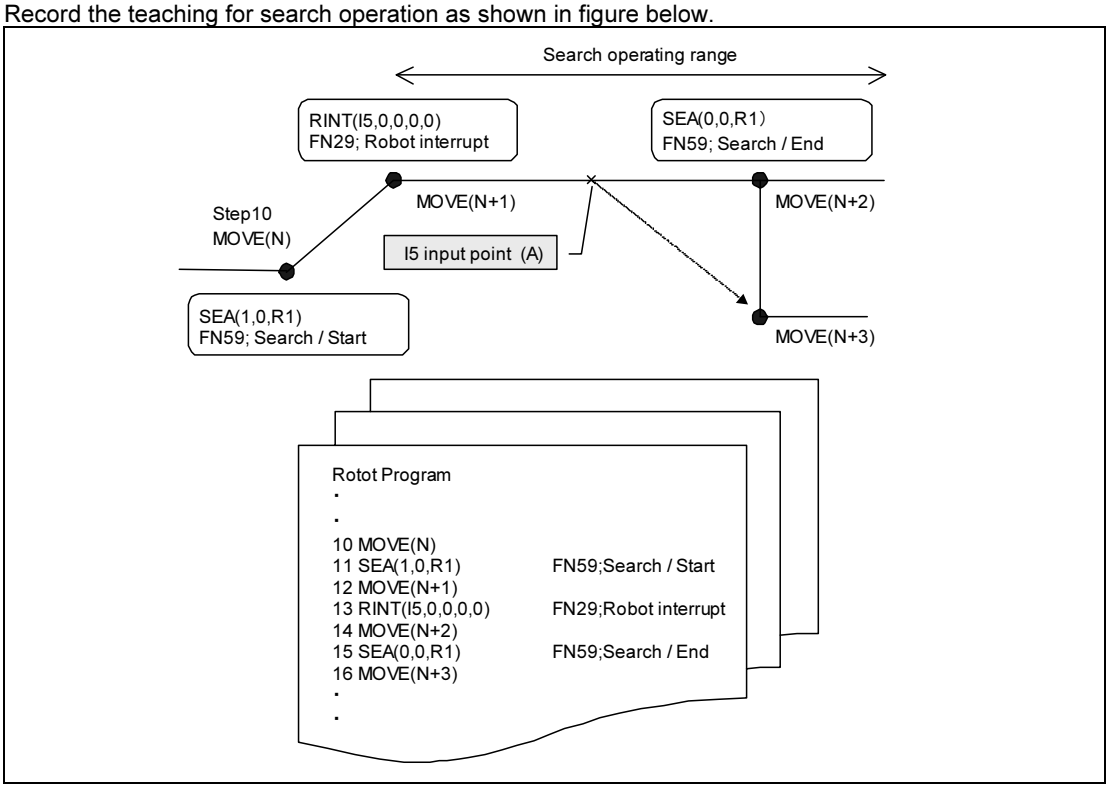
≫ Menu dedicated to handling application shown below should appear on the screen.



3 **Place the cursor on the "Search range" to type desired numeric values, and then press the [ENTER] key.**

4 **After the completion of setting, press the f12 <Complete> key. (In order to stop editing in progress, press the [RESET] key.)**

Record the teaching for search operation as shown in figure below.



Teaching for search operation

• Be sure to record the teaching so as to be in the order of "Search start (SEA: FN59) → Robot interrupt (RINT: FN29) → Search end (SEA: FN59)". The search start command declares "definition of processing as search processing" when executing robot interrupts, which have been recorded subsequently.

• Only a single robot interrupt (RINT: FN29) can be recorded between the search start (SEA: FN59) and the search end (SEA: FN59). Recording two or more interrupts will impair proper function.

• The robot interrupt zone (interrupt processing enable range) covers between the MOVE (N+1) that is a move command immediately before the robot interrupt command RINT step and the MOVE (N+2) that is a move command immediately after the said step and further up to a position specified by the "search range" on an extension of straight line connecting these two points and exceeding the MOVE (N+2).

• The move command MOVE (N+2) is recorded in slow speed and LINEAR. Search operation at a high speed will cause variations in data on the current positions obtained when robot interrupts are detected, thus resulting in degradation in accuracy.

• The detection of a robot interrupt while in search operation means that the robot has reached the MOVE (N+2). In this case, the search end command (SEA: FN59) is executed and then the following step, that is, the move command MOVE (N+3) is executed.

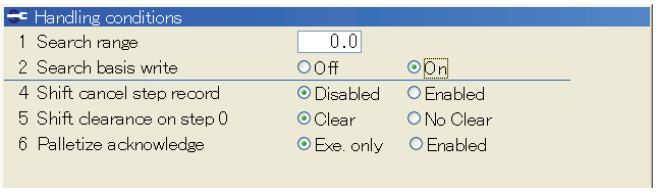
2. Write the search reference position.

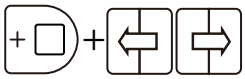
After the completion of teaching, execute "search basis write". The search basis write means to memorize the "reference position". The reference position memorized serves as the reference for subsequent search operations. A difference between this position and a position obtained by normal search operation comes to a shift value.

1 **Select the [TEACH] mode or [PLAYBACK] mode.**

2 **Select [Service Utilities] [22 Handling application] [1 Handling conditions].**

≫ Menu dedicated to handling application shown below should appear on the screen.





3 **Put the cursor on the "Search basis write" and then use the [ENABLE] and [Right] or [Left] cursor" keys to set to "ON".**

4 **After the completion of setting, press the f12 <Complete> key. (In order to stop editing in progress, press the [RESET] key.)**

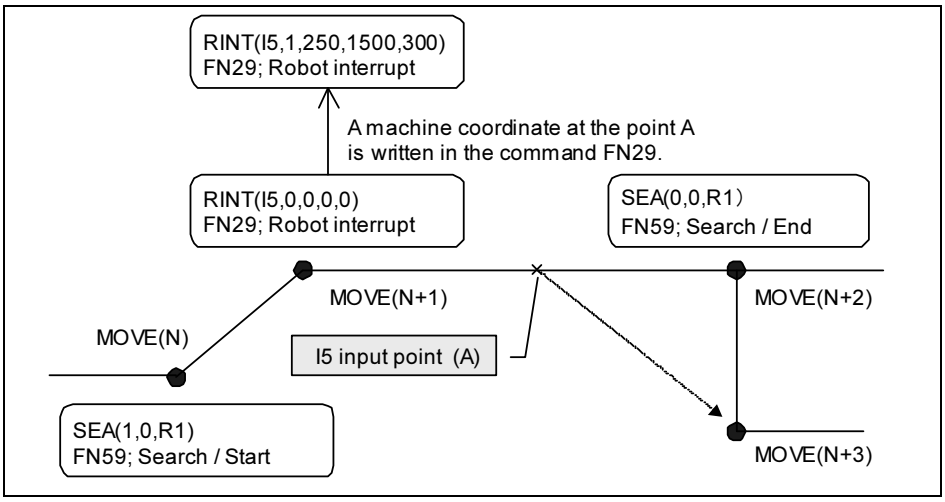
≫ When returning to the top screen, the status display icon should appear on the screen as shown below, thus knowing that the search basis write mode is currently in progress.

Furthermore, defining the "search basis write in progress" signal as the output signal will make it possible to turn ON the output signal while in search basis write mode.

5 **Set the system to playback mode and then play back one cycle of a robot program with teaching executed.**

≫ Be sure to execute the search basis write operation using one-cycle playback mode. If the robot program is played back in any other mode than it, the alarm A2356 will be detected to disable writing of the reference position in the robot interrupt application command.

6 **When the interrupt input signal (e.g. I5 shown in figure on the following page) is input within the search operating range, a machine coordinate at the position concerned (e.g. Position A shown in the said figure) will be automatically written as the reference position in the parameter of the application command RINT: Robot interrupt (FN29).**



If no interrupt signals are detected within the search operating range, the alarm A2357 will be detected to stop the robot. In this case, the reference position is never written

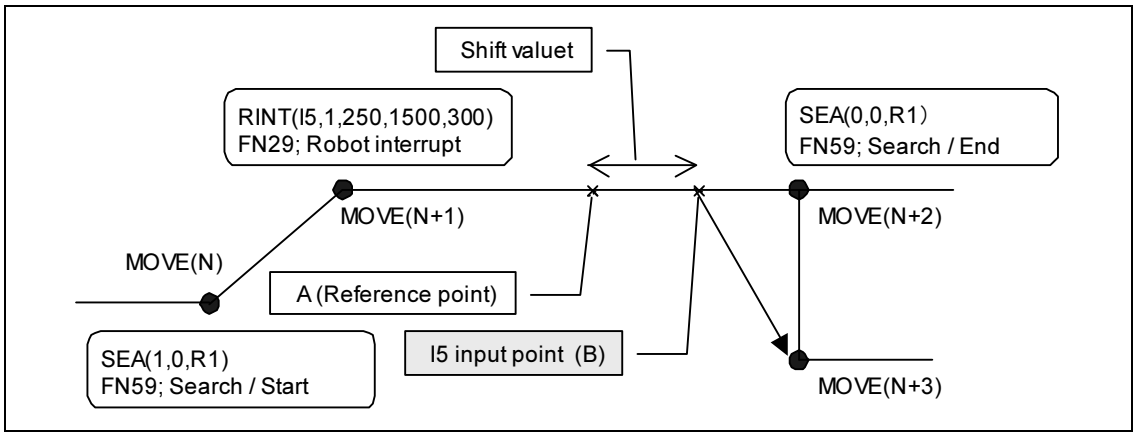
7 **When the search basic write is complete, cancel the search basis write mode. Use the menu under Section 2 to set the search basic write to "OFF".**
>>Starting the robot accidentally with the search basis write mode ON disables proper handling of the workpiece. Be sure to set this mode to "OFF".

POINT

The reference position is automatically written in the program as the parameter of the application command RINT: Robot interrupt (FN29) being recorded in the program used. (The reference value setting is made to 1 and the position is stores in references X, Y, and Z.)
Consequently, do not attempt to apply all protect to the program. (As long as the search basis write is complete, it is okay to apply the protect.)

3. Execute search operation.

If the search basis write ends, subsequent normal playbacks will be enabled.
Before starting normal playbacks, be sure to check the search basis write is set to "OFF".



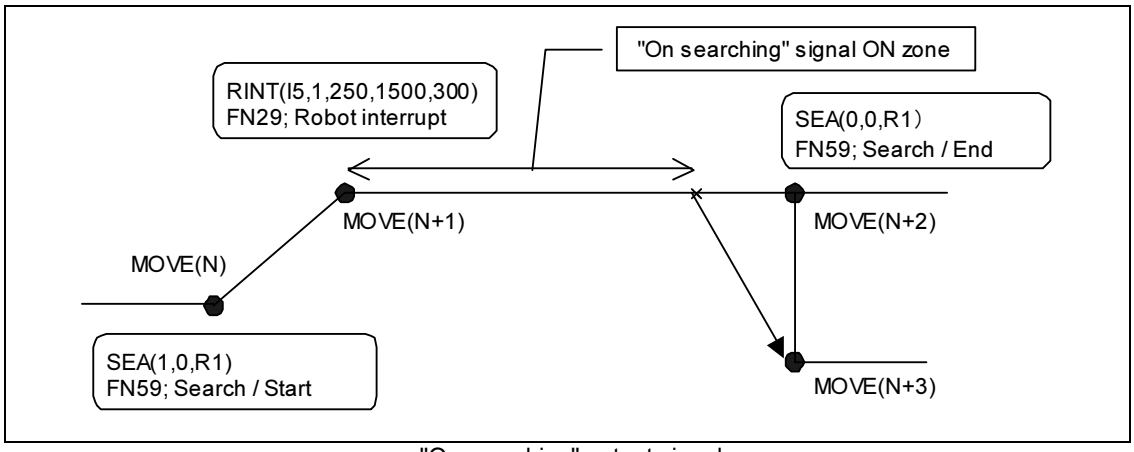
Search operation - Playback with written basis

• The RINT: Robot interrupt command (FN29) has the reference position (coordinate at the Point A) that has been recorded in it.

• If an interrupt is detected at the point B while in normal playback mode, a difference between the reference position (coordinate at the point A) and the coordinate at the point B will be stored as the "shift value" in the shift register.

• To which shift register the difference should be stored can be specified with the search end command. (Shift register 1 in the case of figure)

• If the "On searching" output signal is assigned, the signal output will be enabled while in search operation. This signal output can be also executed while in search basis write operation.



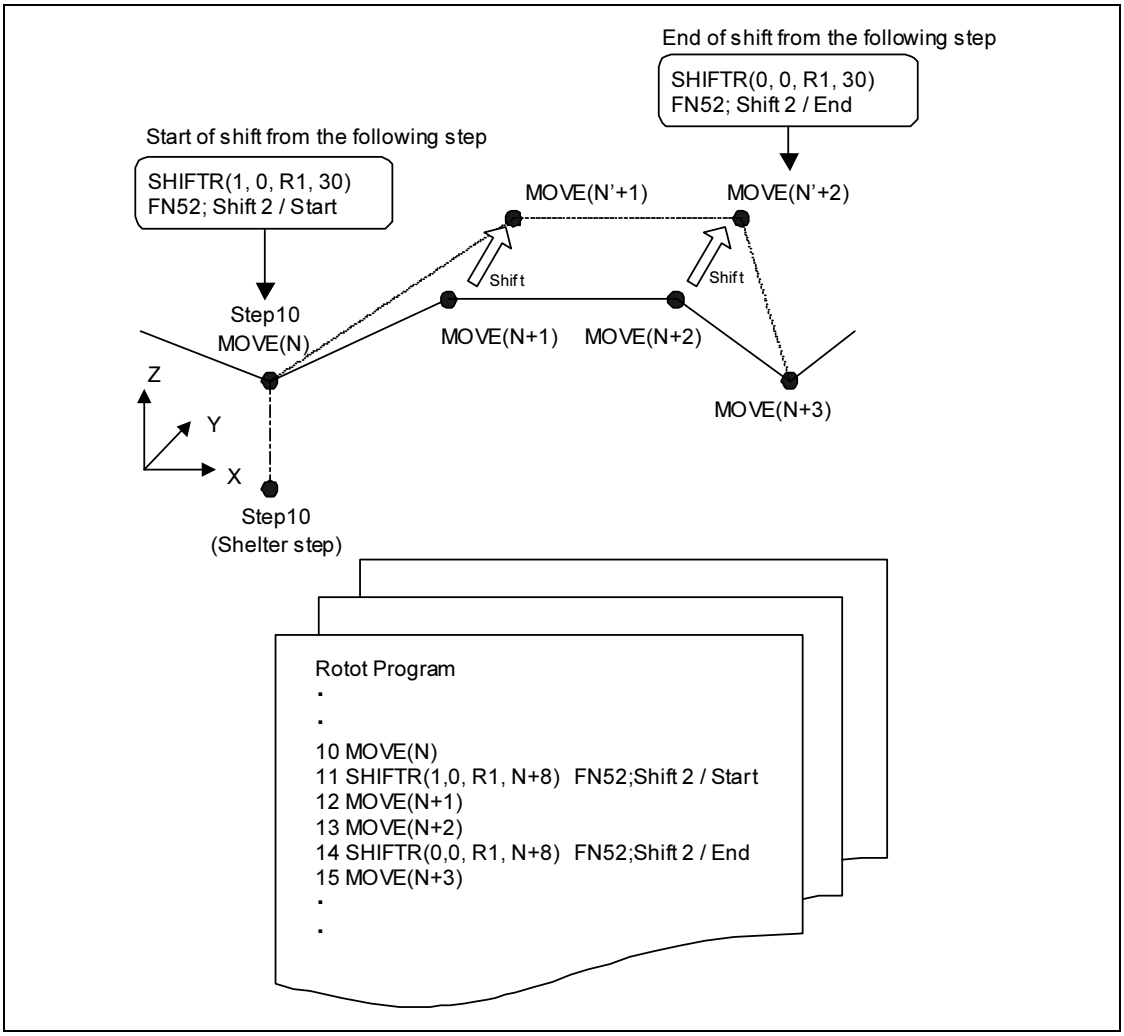
"On searching" output signal

4. Execute shift operation.

According to the shift value stored in the shift register, proceed with handling while shifting to move the desired step. Use the application command shift(SHIFTR: FN52). This command specifies the same shift register number and the coordinate system as those specified with the search start command (SEA: FN59).

For details, refer to information in "2.3 SFIFTR: Shift (FN52)".

Example of operation



Example of operation of SHIFTR: Shift (FN52)

As shown in the figure above, the shift start command is recorded in front of the position where the shift is desired to start, while the shift end command is recorded in front of the position where the shift is desired to end.

When the program is played back, after reaching the move command Move (N), the robot will read the contents of the shift register specified with the SHIFTR: Shift start (FN52) and then move toward the position of Move (N'+1), which is established by shifting the target position of the following move command Move (N+1), thus continuing to shift recorded positions in the same way until the shift end command is issued. (Trajectory shown by dotted lines in the figure) After executing the command SHIFTR: Shift end (FN52) in Step 14, no shift processing is executed.

Consequently, the program is played back in the original recorded position.

If no shift data is set when the shift register specified with the SHIFTR: Shift start (FN52) is read, when the shelter step is set with the SHIFTR: Shift start (FN52), the robot will move toward this shelter step. (Trajectory shown by alternate long and short sash lines in the figure)

2.19 CLRREGWR: Clear register of written sts (FN699)

General description

This command forcibly clears the “setting flag” of the designated shift register.
Even if designated shift register was under usage by SHIFTR : shift (FN52) and or so, this command never influences to these execution.

Example of operation

Shift register value when CLRREGWR[R1] was executed.

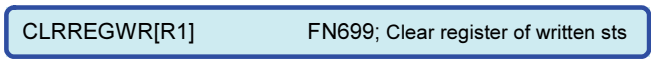
	Before CLRREGWR is executed	After CLRREGWR is executed
Request flag	0	0
Setting flag	1	0
X	110	110
Y	120	120
Z	130	130
θX	5	5
θY	6	6
θZ	7	7

When this command is executed, “setting flag” of shift register is cleared to 0. Another values in this register never changes.

■ **Parameter**

Mnemonic	No.	Command
CLLRREGWR	FN699	Clear register of written sts
Parameter		
	Data	Description, setting range
Parameter No. 1	Shift register No.	This is to specify the shift register No. which “setting flag” is needed to be cleared. If 0 is designated, “setting flag” of all shift register (R1 to R9) is cleared. (0 to 9)

■ **Example of screen display**

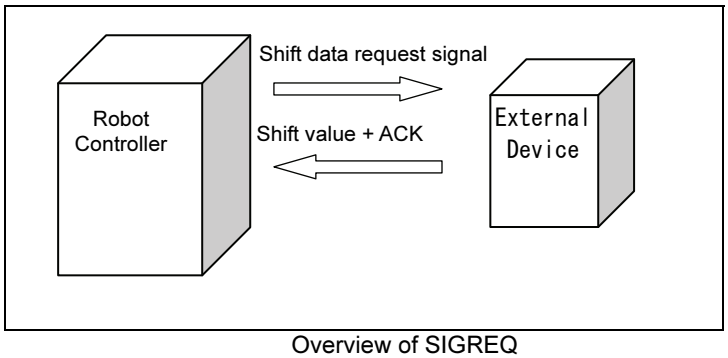


2.20 SIGREQ；Shift value get (signal) (FN723)

General description

This function command can perform the shift data request by sending the external output signal to the external device and signal input the response; the shift value. Then eventually, this command will store the shift value into the specified shift register.

Inside the shift value data are the position data (X,Y,Z) and pose data（θX, θY, θZ）, which can be specified individually.



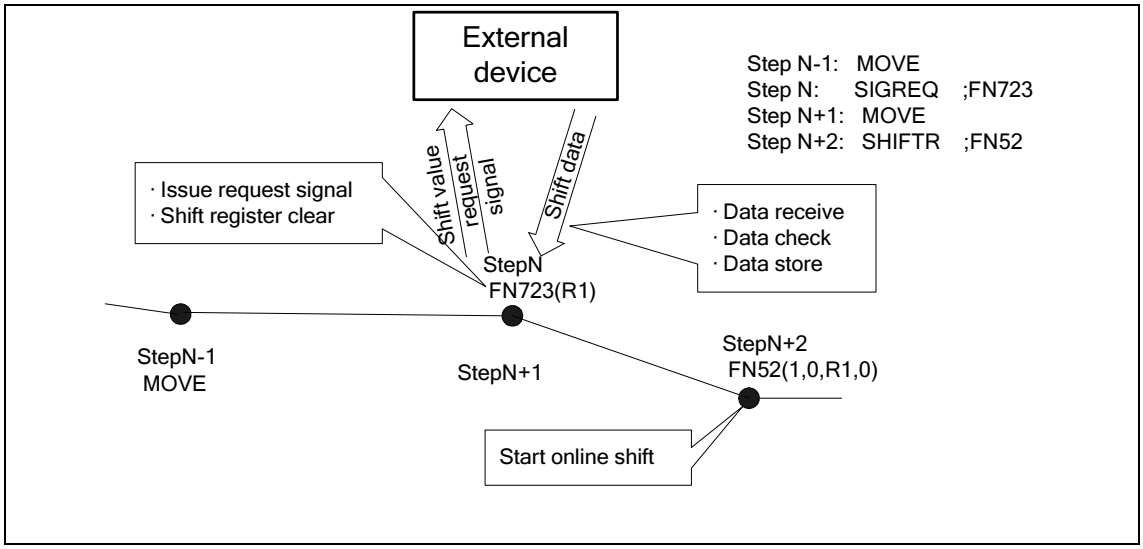
Overview of SIGREQ

When there is no signal input from the external device within the specified time, select one of the following operations; either jump to shelter step or stop the robot by generating failure.

If the robot is stopped during wait shift reg. receive and then restarted, the remaining time in the specified time serves as the waiting time.

Example of operation

As shown in the figure below, when SIGREQ (FN723) is executed at step N, the shift value request is output to the external device and waits for the input of the shift value, until its reception has been completed. When the shift value is received from the external device, the legitimacy of the data is checked, and the data, only when it is found to be legitimate, will be stored in the specified shift register. Then the operation will proceed to the next step. By using the “SHIFTR: Shift” (FN52) or such other commands which is programmed in step N+2, the value of the shift register can perform shift operations.



Example of “SIGREQ; shift value get (signal) (FN723)” operation

■ **Parameter**

Mnemonic	Number	Command
SIGREQ	F N 7 2 3	Shift value get (signal)

Parameter

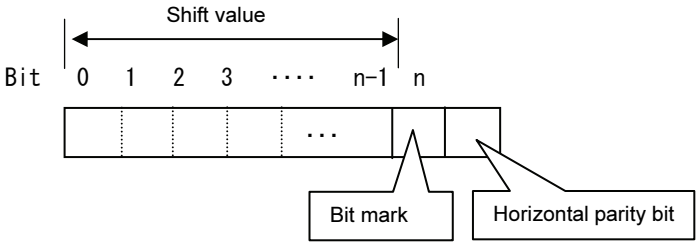
	Data	Description, setting range
Parameter No. 1	Shift register No.	This is used to specify the number of the shift register in which to store the shift value data from the external device. (1-9)
Parameter No. 2	Time (sec)	This is used to specify the wait time. (0.0 to 60.0 sec.) When 0.0 sec. is specified, the wait status is established until the shift value data input.
Parameter No. 3	Shelter step No.	This is used to specify the shelter step when there is no input within the specified time. (0-10000) When 10000 is specified as the shelter step number, an alarm (A2118: “No data has been input in shift register.”) results immediately with no escape operation performed, and the robot can be stopped.

■ **Example of screen display**

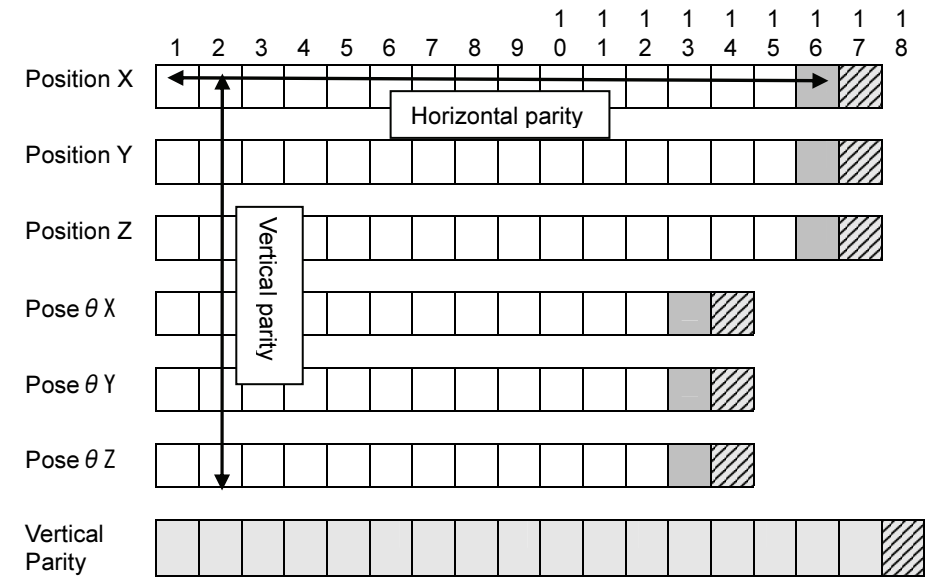
Input/output signal

The following 3 input/output signals, listed in the table below, will be used in this command.

Input/output signals to be used

Name of input signal	Overview
Shift value input signal	This signal is an input signal that informs the shift value to robot controller, and has been prepared the same amount as the shift register (9). Each input signal detects any read out data errors that could have occurred during signal read out, by using the parity mark (vertical, horizontal). **Parity Mark** Within the parity range, each bit with the value of 1 will be totaled. That totaled value, whether even or odd, will determine the bit data. If the sum of the bits with the value of 1 add up to an even number, the parity mark will be 1. If the sum is an odd number, the parity mark will be 0. **Parity Bit** Like the horizontal parity, when there is only 1 bit for the parity mark, here, it will be referred to as the “parity bit”. When there are several bits, they will be referred to as the ”parity data”. The following data are in a single signal; position (X,Y,Z), pose (θX, θY, θZ) and the vertical parity. For each data, a certain amount of bits are used; for the position, 17 bits, for the pose, 14 bits, and for the vertical parity, 18 bits. For the position and pose data, the bits are arranged in the order of, firstly, the shift value data, secondly, the mark bit and lastly, the horizontal parity bit (refer to the figure below). The shift value is inputted in units of; position, 0.1mm and pose, 0.1 degrees, multiplied by 10 and turned into a positive number (the position can only be in units of mm).  Details regarding the parity range is described in another figure.
Shift value input completion notification signal (ACK signal)	This signal notifies the completion of the shift value input signal, mentioned above, to robot controller. The signal will be sent for each shift register. When this signal is turned ON, the shift value input signal, mentioned above must be set at all times. When the shift value input demand signal is turned OFF, this signal needs to be reset in the order of the shift value input signal (the time chart of this signal is shown in another figure).

Name of output signal	Overview
Shift value input request signal	This signal is output in order to urge the shift value input to the external device when enforcing this function command. This signal will be sent for each shift register. After the shift value read out, this signal will be turned OFF.



Horizontal parity bit ・・In the table above, from bit 1 to the bit, second to the last data, will be defined as the parity range.

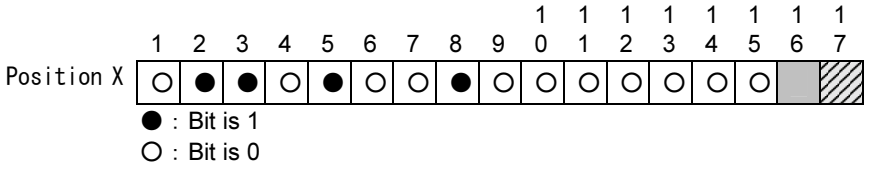
Vertical parity bit ・・From the top (X) to the bottom (X) of the same bit number, in the table above, is the parity range.

Bit mark ・・Arranged next to the shift value data. When the mark is a minus, input 1.

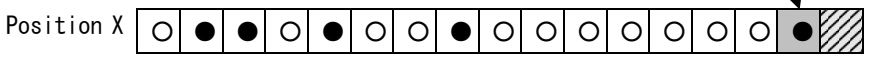
Shift value ・・Input the positive number of the shift value data, 0.1mm, 0.1 degrees, multiplied by 10.

Parity range of the shift value input signal

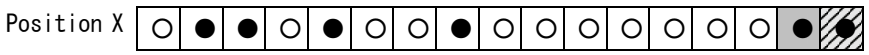
As an example, the signal input of when the X axis is shifted -15mm will be demonstrated below.
When 15 is multiplied by 10, the result will be 150. 150, in the expression of bits, will be “10010110”. When “10010110” is expressed in a table format, it will look like the one shown below.



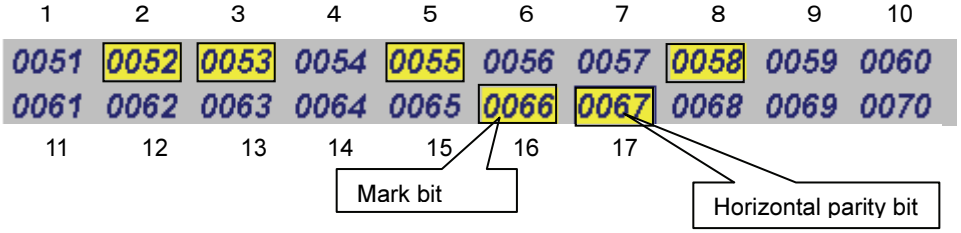
(1) Insert a minus mark to this.



(2) There are 5 ●s and is an odd number. Therefore, the parity will be 1,

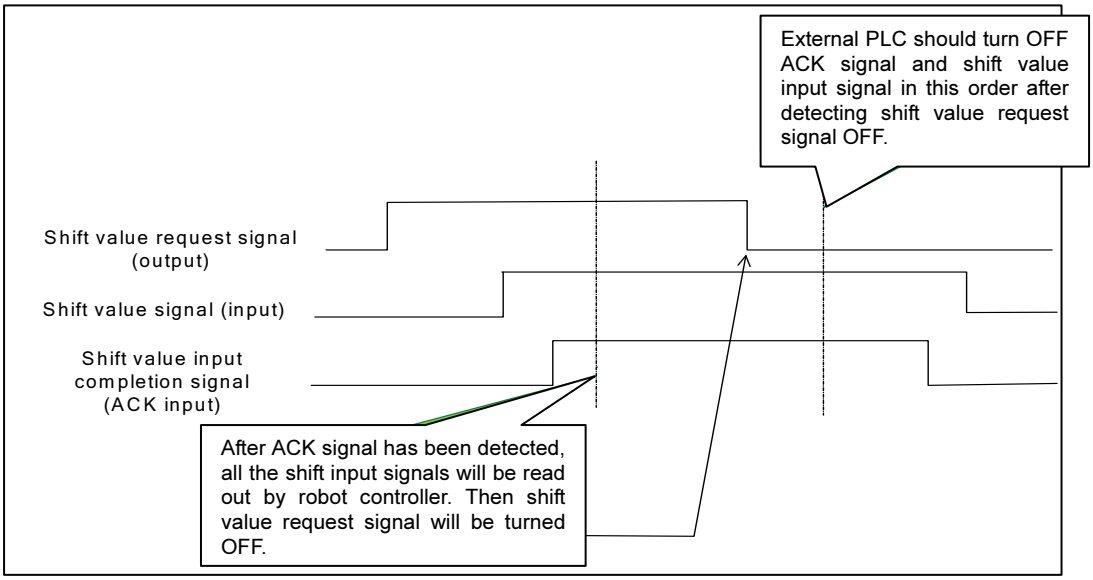


The above is when the shift value is – 15. However, when this is displayed in the general input monitor, it will look like the following (when the X axis of the shift value input signal is allocated from number 51).



■Time chart of the signals

The time chart of the input/output signals is shown below.
Input the signals in this order.



Time chart

Allocating signals

This function uses a number of signals. Therefore, allocation of the signals is performed by a dedicated operation.

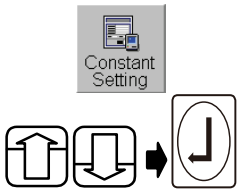
In order to eliminate the task of inputting, the function of allocating signals will specify only the leading signal number of each input/output signal. Then, this function will automatically allocate the signals to its consecutive areas. This means that the signal number, which has the amount of empty consecutive areas, worth the size (number of bits) of the leading signal, must be specified when allocating signals. The sizes of the signals are listed in the table below.

Size of the allocated signals

Type of signals		Size (number of bits)
Shift value input signal	Direction X	17
	Direction Y	17
	Direction Z	17
	θX	14
	θY	14
	θZ	14
	Vertical parity	18
Shift value input completion signal		1
Shift value request output signal		1

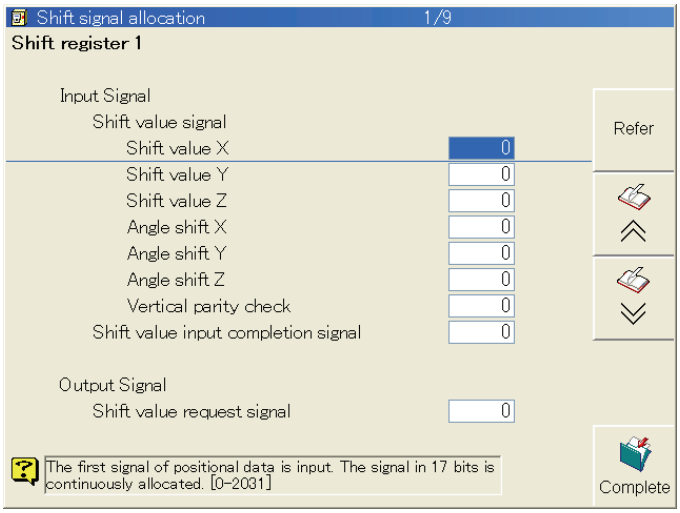
Allocation of the signals

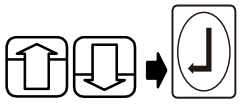
The operation specifications level must be ***EXPERT*** or above when setting.



1 **Press <Constant Setting> - [17 Handling Application] – [3 Shift signal allocation].**

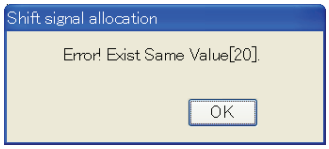
≫ The setting screen of the shift signal allocation will appear.





2 **After transferring to the necessary item, input an unused signal number.**

≫ When the specified signal number is unused, it will be accepted. However, if number was already in use, the following failure notification screen will appear.

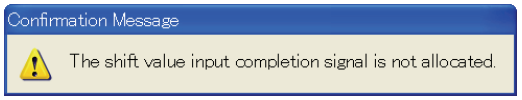


3 **After setting has been completed, press f12 <Complete>.**

≫When the signals that have been inputted do not have any problems, the screen will return to the previous screen after recording the data.

<u>When the shift value input completion signal cannot be allocated.</u>

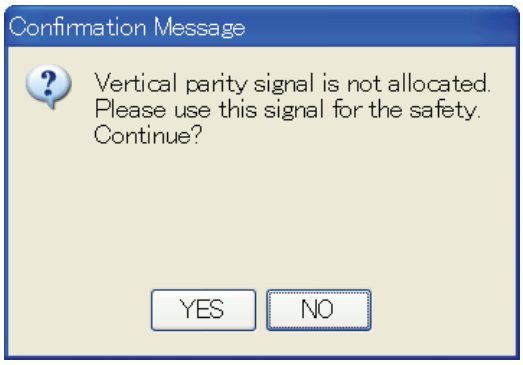
After pressing f12 <Complete>, the following screen will appear.



In order to re-input, press any key to return to the input screen.

<u>When the vertical parity mark cannot be allocated.</u>

After pressing f12 <Complete>, the following screen that urges allocation will appear.



It is recommended that the vertical parity be used for safety. However, operation can also be performed without using the vertical parity. In that case, select “YES” and press [Enter]. Then the screen will return to the screen where the data had been recorded.

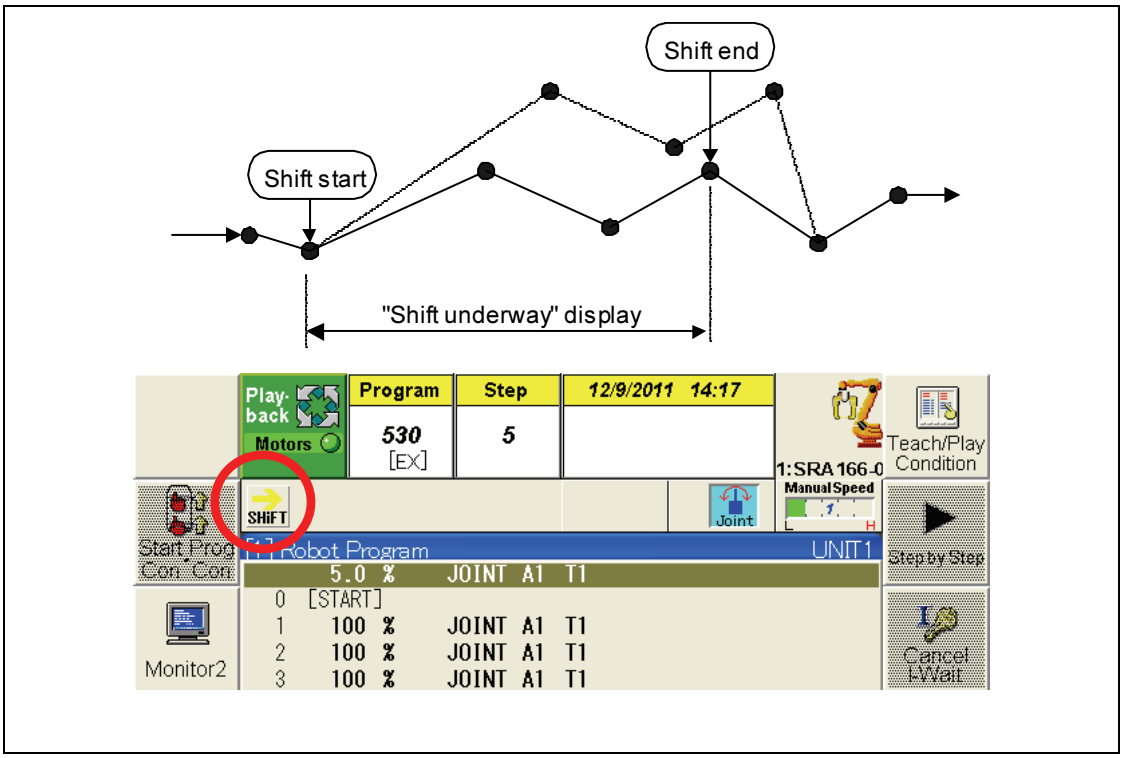
Chapter 3 Useful functions

3.1 Shift monitor

3.1.1 Displays during current shifting

While shifting is underway, an icon indicating that the shift is underway is displayed as shown in the figure below. While this icon is displayed, it means that a shift operation is being performed. It indicates that the robot is not at the position recorded in the program but at the position which has been shifted using the recorded position as the reference.

This point must be borne in mind when the system is to be restarted, etc.



Display of icon indicating shift status

3.1.2 Monitoring the current shift amounts

The current shift amounts can be checked in real time. There are two types of shift operations:

・Shifts based on the "SHIFTR: shift2" (FN52) function command — Shift operations that comply with the contents of shift registers.

・Shifts based on the "SHIFTA: XYZ shift" (FN58) function command — A method that write the shift amounts directly using the parameters of the function command.

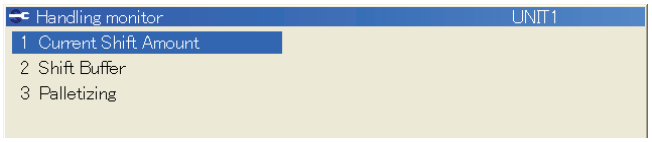
Both types of operations can be executed simultaneously. When they are executed simultaneously, the shift amounts are added for use.

When this monitor is used, each shift amount can be referenced separately.

1 **Select the [TEACH] mode or [PLAYBACK] mode. It does not matter even if a robot playback operation is already underway.**

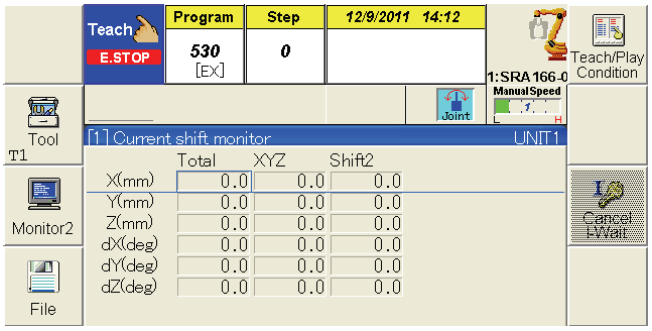
2 **Select [14 Handling monitor] from [Service Utilities] [1/2/3/4 Monitor].**

≫ The list of handling monitor menu items shown below appears.



3 **Select [1 Current Shift Amount.]**

≫ The monitor screen such as the one shown below appears.



It is not possible to edit these data.

Item	Details
Total	This indicates how far the robot has shifted at this moment in the machine coordinate system. When a multiple number of shift functions have been used, it makes it possible to ascertain how far the robot has ultimately shifted in the machine coordinate system.
XYZ	These indicate the shift amounts specified by the function command “SHIFTA: XYZ Shift” (FN58).
Shift2	These indicate the shift amounts specified by the function command “SHIFTR: Shift2” (FN52). Its settings match the contents of one of the shift registers 1 to 9.

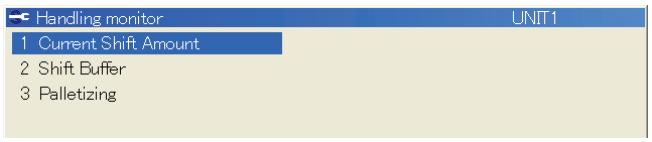
3.1.3 Monitoring the current shift register contents

This monitor screen makes it possible to reference data on nine shift registers. Make use of the monitor screen to reference values written with function commands such as SEA: Search (FN59) or SREQ: Shift data request (FN51). Update to each data is displayed on the monitor screen in real time. However, the monitor screen only displays the contents of each shift register. Since, for the actual robot shift operation, shift data specified with the FN58 command can be added for the shift operation, in order to check the current shift amount of the robot, refer to information in "3.1.2 Monitoring the current shift amounts".

1 **Select the [TEACH] mode or [PLAYBACK] mode. It does not matter even if a robot playback operation is already underway.**

2 **Select [14 Handling monitor] from [Service Utilities] [1/2/3/4 Monitor].**

≫ The list of handling monitor menu items shown below appears.



3 **Select [2 Shift Buffer.]**

≫ The monitor screen such as the one shown below appears.

Item	Details
Requesting	This indicates whether a data request is being made for an external unit using the “SREQ: Shift data request” (FN51) or other command. 0: This indicates a status in which the shift amount data has not been requested. 1: This indicates a status in which the shift amount data has been requested.
Written	This indicates whether the shift amount data has been set. 0: This indicates that shift amount data has not been set. 1: This indicates that shift amount data has been set.
X, Y, Z	These are the parallel shift amounts. They are indicated in millimeters (mm).
dX, dY, dZ	These are the rotational shift amount data. They are used for tool shifting. They are indicated in degrees (deg).

4 **Use the [Up] or [Down] cursor key to move the cursor on the screen and display the contents of the desired shift register.**

3.2 Manually resetting and presetting shift amounts

Shift amounts can be reset or preset manually.
Use these functions at such times as when resuming shift operations which were partially completed or stopping shift operations at a midway point.

CAUTION

Pay extra attention when operating the robot after shift amounts have been changed.
Mistakes made in the process of inputting may give rise to interference with surrounding objects or other such unforeseen trouble.

3.2.1 Direct editing using the shift register monitor

1 **First, stop the robot now in the playback operation. Shift registers cannot be reset or preset during robot operations.**

2 **Select the [TEACH] mode or [PLAYBACK] mode.**

3 **Select [2 Shift Buffer] from [Service Utilities] [1/2/3/4 Monitor] [14 Handling monitor.]**

4 **Press the [EDIT] key.**

≫ The title bar of the shift register monitor screen changes to red, indicating that the edit enable mode is established.

5 **Align the cursor with the desired edit boxes, input the numerical values, and press [ENTER] key.**

6 **Upon completion of the settings, press the f12 <Complete> key.**

≫ The display returns to the shift register monitor screen. The data set has already been reflected.

7 **The operation is resumed.**

3.2.2 Short-cut R162: Shift value change

The shift values used when shifting using the function command “SHIFTR: Shift2” (FN52) can be changed manually. They cannot be used while the robot is operating.

Shortcut	Description
R162	Shift value change

	Data	Description, setting range	
Parameter No. 1	Shift value X	This is used to specify the shift amount in the X direction.	The setting range depends on the “shift amount limit.”
Parameter No. 2	Shift value Y	This is used to specify the shift amount in the Y direction.	
Parameter No. 3	Shift value Z	This is used to specify the shift amount in the Z direction.	
Parameter No. 4	Angle shift X	This is used to specify the tool vector rotational amount around the X axis.	
Parameter No. 5	Angle shift Y	This is used to specify the tool vector rotational amount around the Y axis.	
Parameter No. 6	Angle shift Z	This is used to specify the tool vector rotational amount around the Z axis.	

3.2.3 Short-cuts R163: Cancel shift value

This clears the amounts to be shifted by the application command “SHIFTR: Shift2” (FN52) to zero.
They cannot be used while the robot is operating.

Shortcut	Description
R163	Cancel shift value

	Data	Description, setting range
Parameter No. 1	Shift value canceled/ not canceled	This is used to specify whether or not shift amounts are to be canceled by setting 0 or 1. 0: Shift amount is not canceled. 1: Shift amount is canceled

3.2.4 Short-cuts R350: Shift register clear

This clears the contents of the specified shift register.
If “0” is specified, all the shift registers are cleared.
They cannot be used while the robot is operating.

Shortcut	Description
R350	Shift register clear

	Data	Description, setting range
Parameter No. 1	No. of shift register	Specify the number of the shift register whose shift amounts are to be cleared. If “0” is specified, the contents of all the shift registers are cleared. (0 to 9)

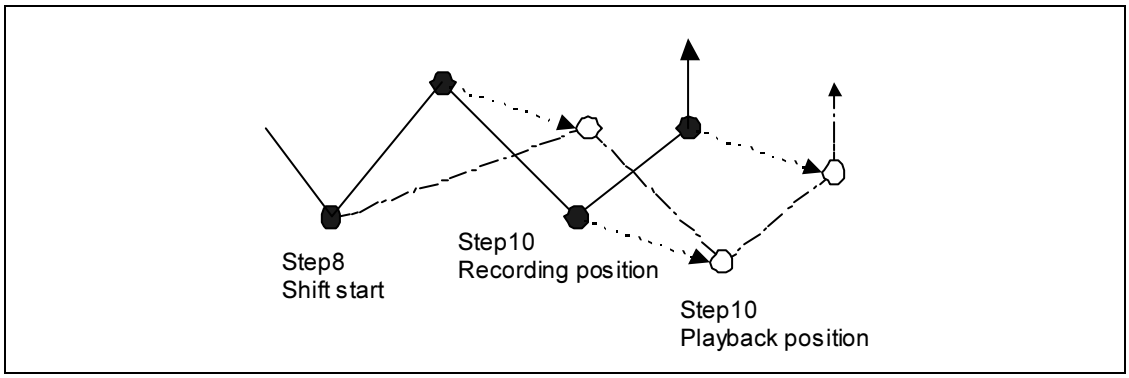
3.3 Recording operations while shifts are executed

3.3.1 Precautions for recording and modifying positions which are in the process of being shifted

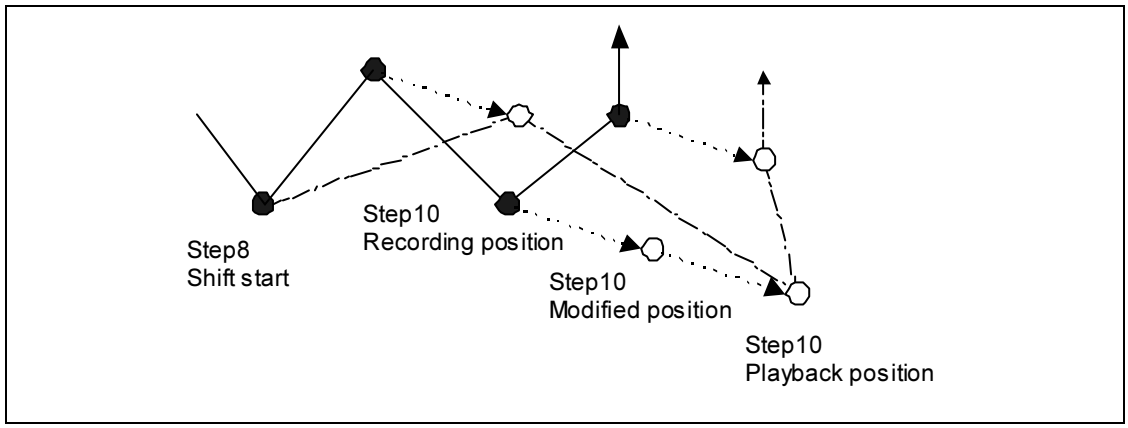
When the robot is stopped during a shift operation and MOVE command [Record], [Add] or [Modify] operations are performed, the current position is recorded. However, if these operations are performed in the process of shifting, the resulting positions will be equivalent to the original taught positions plus the shift amounts. If operators modify the positions while overlooking the fact that the positions were in the process of being shifted, the robot may move to an unforeseen position.

This is explained if figure below.

If the shift was started in step 8, the step 10 recording position will be shifted to the step 10 playback position during playback. If the robot is stopped here and an operation to modify the position is performed, the step 10 playback position will become the new recording position of step 10. In other words, during the next cycle playback, the robot will move to the step 10 playback position which is equivalent to the step 10 modified position plus the shift amount.



Trajectory of shift operations



Trajectory of shift operations after position modification

In order to avoid a situation like this, it has been made possible when recording the steps (movement commands) to obtain the recording position in a state where the current shift amounts have been subtracted. Follow the procedure below to perform the settings.

The current shift amounts can be verified using the “Total” data in “3.1.2 Monitoring the current shift amounts.”

POINT

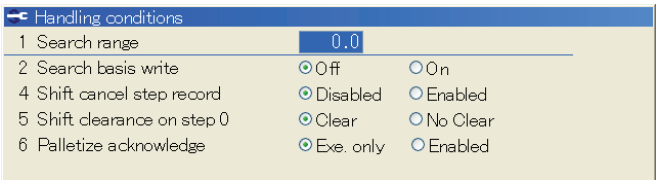
If the robot is stopped during shifting, and a [Record], [Addition] or [Modification] operation is performed, the operator must check without fail using CHECK/GO playback, etc. that the recorded position is in fact the desired position.

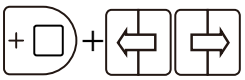
3.3.2 Setting the shift amount cancel step recording

1 **Select the [TEACH] mode or [PLAYBACK] mode.**

2 **Select [Service Utilities] [22 Handling application] [1 Handling conditions].**

≫ The teach/playback condition menu dedicated to handling applications shown below now appears.





3 **Align the cursor with "4 Shift cancel step record," and use the [ENABLE] and [Left] or [Right] cursor key to enable the setting.**

Item	Details
Disabled	At this setting, the current position of the robot is recorded when MOVE command [Record], [Add] or [Modify] operations are performed.
Enabled	At this setting, the position obtained by subtracting the current shift amounts from the current position of the robot is calculated and recorded when MOVE command [Record], [Add] or [Modify] operations are performed.

4 **After the completion of setting, press the f12 <Complete> key. (In order to stop editing in progress, press the [RESET] key.)**

3.4 Clearing shift registers at step 0

3.4.1 Automatic clearing of the shift registers

By intention, the contents of the nine shift registers used to store the shift amounts are automatically cleared when the head (step 0) of the task program is played back. (This does not apply when playing back step 0 of a program which has been called using the program call command.)

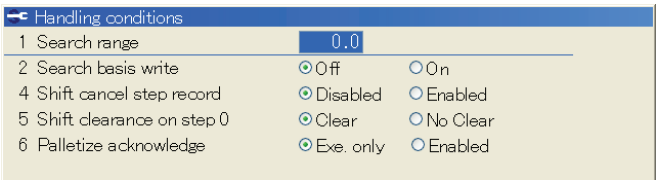
However, it is possible to perform a setting to stop this clearing if it is inconvenient to have the shift registers automatically cleared to zero for the application concerned. Follow the setting procedure below.

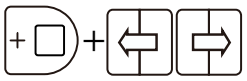
3.4.2 Setting shift register clear at step 0

1 **Select the [TEACH] mode or [PLAYBACK] mode.**

2 **Select [Service Utilities] [22 Handling application] [1 Handling conditions].**

≫ The teach/playback condition menu dedicated to handling applications shown below now appears.





3 **Align the cursor with "5 Shift clearance on step 0," and set it using the [ENABLE] and the [Left] or [Right] cursor keys.**

Item	Details
Clear	The contents of the shift registers are cleared when step 0 is played back.
No Clear	The contents of the shift registers are not cleared even when step 0 is played back.

4 **After the completion of setting, press the f12 <Complete> key. (In order to stop editing in progress, press the [RESET] key.)**

Chapter 4 Troubleshoot

4.1 Troubleshoot

Alarm

A2118: No data has been input to the shift register

[Cause]

This results if no shift amounts are set in the specified shift register when the application command that entails referencing the shift registers is executed. If an escape step, etc. is specified by the application command, this error does not result, and the robot moves instead to the escape step.

[Remedy]

Ensure that the data is set in the shift register before the application command that entails referencing the shift register is executed.

Alarm

A2946: The number of the user coordinate system is not selected

[Cause]

When an attempt has been made to perform a shift operation in which the user coordinate system is used as the reference, this error results if the number of the coordinate system to be used has not been selected.

[Remedy]

Ensure that the number of the coordinate system to be used by the "FN113 Change coord. No. (shift)" command is selected before the shift operation is performed.

Alarm

A2173: Excessive shift amount

[Cause]

This error results when an attempt has been made to perform a shift operation in which the shift will exceed the "shift limit" value.

[Remedy]

Check the setting for the "shift limit" value. Alternatively, check the shift amount to ensure that an unreasonable shift operation will not be performed.

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