Motoman NX100 Controller

Sensor Function Instructions Manual

Part Number: 151496-1CD
Revision 0

MOTOMAN
a YASKAWA company

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Chapter 1
Introduction

1.1 About This Document

This manual provides information for the Sensor Function and contains the following sections:

SECTION 1 - INTRODUCTION
Provides general information about the structure of this manual, a list of reference documents, and customer service information.

SECTION 2 - SAFETY
This section provides information regarding the safe use and operation of Motoman products.

SECTION 3 - SENSOR FUNCTION INSTRUCTIONS
Provides detailed instructions for the Sensor Function.

1.2 Reference to Other Documentation

For additional information refer to the following:

- NX100 Controller Manual (P/N 149201-1)
- Concurrent I/O Manual (P/N 149230-1)
- Operator's Manual for your application
- Vendor manuals for system components not manufactured by Motoman

1.3 Customer Service Information

If you are in need of technical assistance, contact the Motoman service staff at (937) 847-3200. Please have the following information ready before you call:

- Robot Type (EA1400, HP50, etc.)
- Application Type (handling, welding, etc.)
- Robot Serial Number (located on back side of robot arm)
- Robot Sales Order Number (located on back of controller)

Notes

Chapter 2
Safety

2.1 Introduction

It is the purchaser's responsibility to ensure that all local, county, state, and national codes, regulations, rules, or laws relating to safety and safe operating conditions for each installation are met and followed.

We suggest that you obtain and review a copy of the ANSI/RIA National Safety Standard for Industrial Robots and Robot Systems. This information can be obtained from the Robotic Industries Association by requesting ANSI/RIA R15.06-1999. The address is as follows:

Robotic Industries Association
900 Victors Way
P.O. Box 3724
Ann Arbor, Michigan 48106
TEL: (734) 994-6088
FAX: (734) 994-3338
INTERNET: www.roboticsonline.com

Ultimately, the best safeguard is trained personnel. The user is responsible for providing personnel who are adequately trained to operate, program, and maintain the robot cell. **The robot must not be operated by personnel who have not been trained!**

We recommend that all personnel who intend to operate, program, repair, or use the robot system be trained in an approved Motoman training course and become familiar with the proper operation of the system.

This safety section addresses the following:

- Standard Conventions (Section 2.2)
- General Safeguarding Tips (Section 2.3)
- Mechanical Safety Devices (Section 2.4)
- Installation Safety (Section 2.5)
- Programming, Operation, and Maintenance Safety (Section 2.6)

2.2 Standard Conventions

This manual includes the following alerts – in descending order of severity – that are essential to the safety of personnel and equipment. As you read this manual, pay close attention to these alerts to insure safety when installing, operating, programming, and maintaining this equipment.

DANGER!
Information appearing in a DANGER concerns the protection of personnel from the immediate and imminent hazards that, if not avoided, will result in immediate, serious personal injury or loss of life in addition to equipment damage.

WARNING!
Information appearing in a WARNING concerns the protection of personnel and equipment from potential hazards that can result in personal injury or loss of life in addition to equipment damage.

CAUTION!
Information appearing in a CAUTION concerns the protection of personnel and equipment, software, and data from hazards that can result in minor personal injury or equipment damage.

Note: Information appearing in a Note provides additional information which is helpful in understanding the item being explained.

2.3 General Safeguarding Tips

All operators, programmers, plant and tooling engineers, maintenance personnel, supervisors, and anyone working near the robot must become familiar with the operation of this equipment. All personnel involved with the operation of the equipment must understand potential dangers of operation. General safeguarding tips are as follows:

- Improper operation can result in personal injury and/or damage to the equipment. Only trained personnel familiar with the operation of this robot, the operator's manuals, the system equipment, and options and accessories should be permitted to operate this robot system.
- Do not enter the robot cell while it is in automatic operation. Programmers must have the teach pendant when they enter the robot cell.
- Improper connections can damage the robot. All connections must be made within the standard voltage and current ratings of the robot I/O (Inputs and Outputs).
- The robot must be placed in Emergency Stop (E-STOP) mode whenever it is not in use.
- In accordance with ANSI/RIA R15.06-1999, section 4.2.5, Sources of Energy, use lockout/tagout procedures during equipment maintenance. Refer also to Section 1910.147 (29CFR, Part 1910), Occupational Safety and Health Standards for General Industry (OSHA).

2.4 Mechanical Safety Devices

The safe operation of the robot, positioner, auxiliary equipment, and system is ultimately the user's responsibility. The conditions under which the equipment will be operated safely should be reviewed by the user. The user must be aware of the various national codes, ANSI/RIA R15.06-1999 safety standards, and other local codes that may pertain to the installation and use of industrial equipment. Additional safety measures for personnel and equipment may be required depending on system installation, operation, and/or location. The following safety equipment is provided as standard:

- Safety fences and barriers
- Light curtains and/or safety mats
- Door interlocks
- Emergency stop palm buttons located on operator station, robot controller, and programming pendant

Check all safety equipment frequently for proper operation. Repair or replace any non-functioning safety equipment immediately.

2.5 Installation Safety

Safe installation is essential for protection of people and equipment. The following suggestions are intended to supplement, but not replace, existing federal, local, and state laws and regulations. Additional safety measures for personnel and equipment may be required depending on system installation, operation, and/or location. Installation tips are as follows:

- Be sure that only qualified personnel familiar with national codes, local codes, and ANSI/RIA R15.06-1999 safety standards are permitted to install the equipment.
- Identify the work envelope of each robot with floor markings, signs, and barriers.
- Position all controllers outside the robot work envelope.
- Whenever possible, install safety fences to protect against unauthorized entry into the work envelope.
- Eliminate areas where personnel might get trapped between a moving robot and other equipment (pinch points).
- Provide sufficient room inside the workcell to permit safe teaching and maintenance procedures.

2.6 Programming, Operation, and Maintenance Safety

All operators, programmers, plant and tooling engineers, maintenance personnel, supervisors, and anyone working near the robot must become familiar with the operation of this equipment. Improper operation can result in personal injury and/or damage to the equipment. Only trained personnel familiar with the operation, manuals, electrical design, and equipment interconnections of this robot should be permitted to program, operate, and maintain the system. All personnel involved with the operation of the equipment must understand potential dangers of operation.

- Inspect the robot and work envelope to be sure no potentially hazardous conditions exist. Be sure the area is clean and free of water, oil, debris, etc.
- Be sure that all safeguards are in place. Check all safety equipment for proper operation. Repair or replace any non-functioning safety equipment immediately.
- Do not enter the robot cell while it is in automatic operation. Be sure that only the person holding the programming pendant enters the workcell.
- Check the E-STOP button on the programming pendant for proper operation before programming. The robot must be placed in Emergency Stop (E-STOP) mode whenever it is not in use.
- Back up all programs and jobs onto suitable media before program changes are made. To avoid loss of information, programs, or jobs, a backup must always be made before any service procedures are done and before any changes are made to options, accessories, or equipment.

- Any modifications to PART 1, System Section, of the robot controller concurrent I/O program can cause severe personal injury or death, as well as damage to the robot! Do not make any modifications to PART 1, System Section. Making any changes without the written permission of Motoman will VOID YOUR WARRANTY!
- Some operations require standard passwords and some require special passwords. Special passwords are for Motoman use only. YOUR WARRANTY WILL BE VOID if you use these special passwords.
- The robot controller allows modifications of PART 2, User Section, of the concurrent I/O program and modifications to controller parameters for maximum robot performance. Great care must be taken when making these modifications. All modifications made to the controller will change the way the robot operates and can cause severe personal injury or death, as well as damage the robot and other parts of the system. Double-check all modifications under every mode of robot operation to ensure that you have not created hazards or dangerous situations.
- Check and test any new or modified program at low speed for at least one full cycle.
- This equipment has multiple sources of electrical supply. Electrical interconnections are made between the controller and other equipment. Disconnect and lockout/tagout all electrical circuits before making any modifications or connections.
- Do not perform any maintenance procedures before reading and understanding the proper procedures in the appropriate manual.
- Use proper replacement parts.
- Improper connections can damage the robot. All connections must be made within the standard voltage and current ratings of the robot I/O (Inputs and Outputs).

Notes

NX100 OPTIONS
INSTRUCTIONS

FOR SENSOR FUNCTION

Upon receipt of the product and prior to initial operation, read these instructions thoroughly, and retain for future reference.

MOTOMAN INSTRUCTIONS

MOTOMAN-□□□ INSTRUCTIONS
NX100 INSTRUCTIONS
NX100 OPERATOR'S MANUAL
NX100 MAINTENANCE MANUAL

The NX100 operator's manual above corresponds to specific usage.
Be sure to use the appropriate manual.

YASKAWA

MANUAL NO.
HW0483000

MANDATORY

- This manual explains the sensor function of the NX100. Read this manual carefully and be sure to understand its contents before handling the NX100.
- General items related to safety are listed in Section 1: Safety of the NX100 Instructions. To ensure correct and safe operation, carefully read the NX100 Instructions before reading this manual.

CAUTION

- Some drawings in this manual are shown with the protective covers or shields removed for clarity. Be sure all covers and shields are replaced before operating this product.
- The drawings and photos in this manual are representative examples and differences may exist between them and the delivered product.
- YASKAWA may modify this model without notice when necessary due to product improvements, modifications, or changes in specifications. If such modification is made, the manual number will also be revised.
- If your copy of the manual is damaged or lost, contact a YASKAWA representative to order a new copy. The representatives are listed on the back cover. Be sure to tell the representative the manual number listed on the front cover.
- YASKAWA is not responsible for incidents arising from unauthorized modification of its products. Unauthorized modification voids your product's warranty.

NOTES FOR SAFE OPERATION

Read this manual carefully before installation, operation, maintenance, or inspection of the NX100.
In this manual, the Notes for Safe Operation are classified as “WARNING”, “CAUTION”, “MANDATORY”, or ”PROHIBITED”.

 WARNING	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury to personnel.
 CAUTION	Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury to personnel and damage to equipment. It may also be used to alert against unsafe practices.
 MANDATORY	Always be sure to follow explicitly the items listed under this heading.
 PROHIBITED	Must never be performed.

Even items described as “CAUTION” may result in a serious accident in some situations. At any rate, be sure to follow these important items.

To ensure safe and efficient operation at all times, be sure to follow all instructions, even if not designated as “CAUTION” and “WARNING”.

WARNING

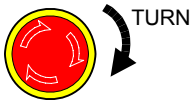
- Before operating the manipulator, check that servo power is turned OFF when the emergency stop buttons on the front door of the NX100 and programming pendant are pressed.
  When the servo power is turned OFF, the SERVO ON LED on the programming pendant is turned OFF

  Injury or damage to machinery may result if the emergency stop circuit cannot stop the manipulator during an emergency. The manipulator should not be used if the emergency stop buttons do not function.

Emergency Stop Button 

- Once the emergency stop button is released, clear the cell of all items which could interfere with the operation of the manipulator. Then turn the servo power ON

  Injury may result from unintentional or unexpected manipulator motion.

Release of Emergency Stop 

- Observe the following precautions when performing teaching operations within the P-point maximum envelope of the manipulator :
  - View the manipulator from the front whenever possible.
  - Always follow the predetermined operating procedure.
  - Ensure that you have a safe place to retreat in case of emergency.

  Improper or unintended manipulator operation may result in injury.

- Confirm that no person is present in the P-point maximum envelope of the manipulator and that you are in a safe location before:
  - Turning ON the NX100 power.
  - Moving the manipulator with the programming pendant.
  - Running the system in the check mode.
  - Performing automatic operations.

  Injury may result if anyone enters the P-point maximum envelope of the manipulator during operation. Always press an emergency stop button immediately if there is a problem. The emergency stop buttons are located on the right of the front door of the NX100 and the programming pendant.

CAUTION

- Perform the following inspection procedures prior to conducting manipulator teaching. If problems are found, repair them immediately, and be sure that all other necessary processing has been performed.
  -Check for problems in manipulator movement.
  -Check for damage to insulation and sheathing of external wires.
- Always return the programming pendant to the hook on the NX100 cabinet after use.

  The programming pendant can be damaged if it is left in the manipulator's work area, on the floor, or near fixtures.
- Read and understand the Explanation of the Warning Labels in the NX100 Instructions before operating the manipulator.

Definition of Terms Used Often in This Manual

The MOTOMAN manipulator is the YASKAWA industrial robot product.
The manipulator usually consists of the controller, the programming pendant, and supply cables.
In this manual, the equipment is designated as follows.

Equipment	Manual Designation
NX100 Controller	NX100
NX100 Programming Pendant	Programming Pendant
Cable between the manipulator and the controller	Manipulator cable

Descriptions of the programming pendant keys, buttons, and displays are shown as follows:

Equipment		Manual Designation
Programming Pendant	Character Keys	The keys which have characters printed on them are denoted with [ ]. ex. [ENTER]
	Symbol Keys	The keys which have a symbol printed on them are not denoted with [ ] but depicted with a small picture. ex. page key  The cursor key is an exception, and a picture is not shown.
	Axis Keys Number Keys	“Axis Keys” and “Numeric Keys” are generic names for the keys for axis operation and number input.
	Keys pressed simultaneously	When two keys are to be pressed simultaneously, the keys are shown with a “+” sign between them, ex. [SHIFT]+[COORD]
	Displays	The menu displayed in the programming pendant is denoted with { }. ex. {JOB}

Description of the Operation Procedure

In the explanation of the operation procedure, the expression "Select • • • " means that the cursor is moved to the object item and the SELECT key is pressed, or that the item is directly selected by touching the screen.

1 Sensor Function

2 Wiring

3 Real-time Path Correction Function

4 Real-time Speed Correction Function

1 Sensor Function

The sensor function corrects the manipulator path and speed, measures distance, and detects position using a sensor such as the distance sensor or the torque sensor.
The analog input signals from a sensor are connected to the NX100, and various controls are performed according to the input voltage. The signals from a sensor directly connect to the NX100, and therefore an external sequencer is not required. This allows easy and simple system construction, and minimizes the delay of response to the signals.
The sensor function has the following various control functions to be used depending on the application.

- Real-time path correction function
- Real-time speed correction function
- Shift amount creation function
- Search function

1.1 Real-time Path Correction Function

The real-time path correction function corrects the motion path of the manipulator according to the input signals from a sensor.
Normally, a manipulator moves along the taught path. However, when the manipulator cannot move along the taught path due to distortion or displacement of the workpiece, the sensor function detects the distortion or displacement in real-time and corrects the manipulator path accordingly to do the job.

1.2 Real-time Speed Correction Function

The real-time speed correction function corrects the motion speed of the manipulator according to the input signals from a sensor.
Normally, a manipulator moves at the set speed in a job. However, when the work time for each workpiece differs, the sensor function detects the progress of work and moves the manipulator at its optimum speed.

1.3 Shift Amount Creation Function

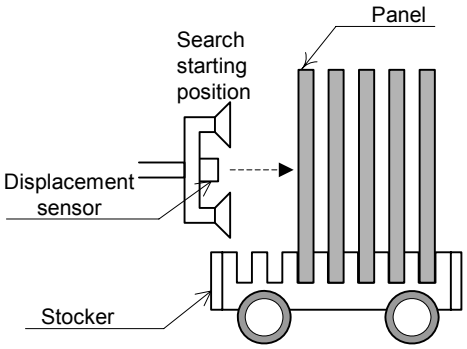
The shift amount creation function computes the distance to a selected workpiece according to the input signals from a displacement sensor. The measurement of more than one position enables a three-dimensional shift when using the relative job conversion function.

1.4 Search Function

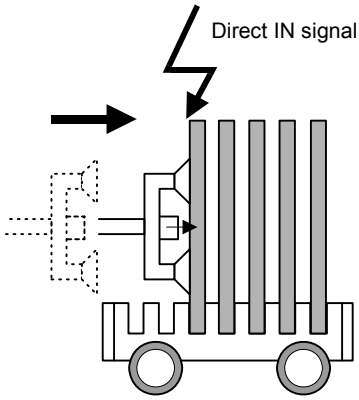
The search function moves a manipulator according to the input signal from a sensor, and stops the manipulator when the input signal reaches a designated level.
The sensor monitors the manipulator operation, and stops the manipulator at the moment of completing the operation.

<Application Example> A manipulator performs a handling operation of panels.

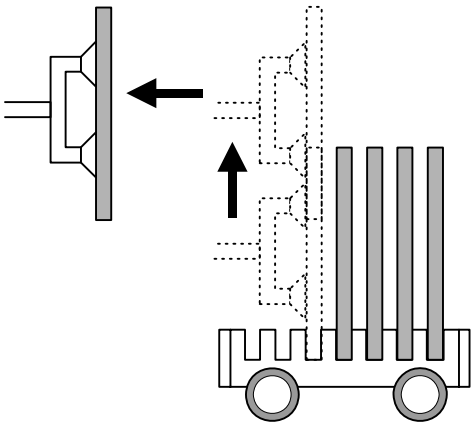
1. The manipulator moves to the search starting position.



2. The manipulator moves to the goal position in the search operation at low-speed. When the manipulator comes to the position to take the panel, an input signal (Direct-IN signal) from the sensor turns ON, then the manipulator stops. At this moment, the difference between the search starting position and the detected position is calculated.



3. According to the calculated difference, the program is modified to proceed the operation.



2 Wiring

2.1 Analog Input Signal Connection

Connect analog input signals from each sensor to the analog input terminals on the optional base board. Connect the signals from the sensors in the following manner.

1. Provide an analog input cable between the sensor and the NX100. For the connection specification, see " Analog Input Signal Connection Diagram " to be described.
2. Turn OFF the main power supply by turning the NX100 to the OFF position.
3. Connect the sensor with an analog input cable to the analog input terminal: CN05 on the option base board: JANCD-NCP02.
4. Set the connected channel No. to the parameter: SxE020 to SxE027 (sensor input channel specification, see " 9 Sensor Parameters (SxE) ").

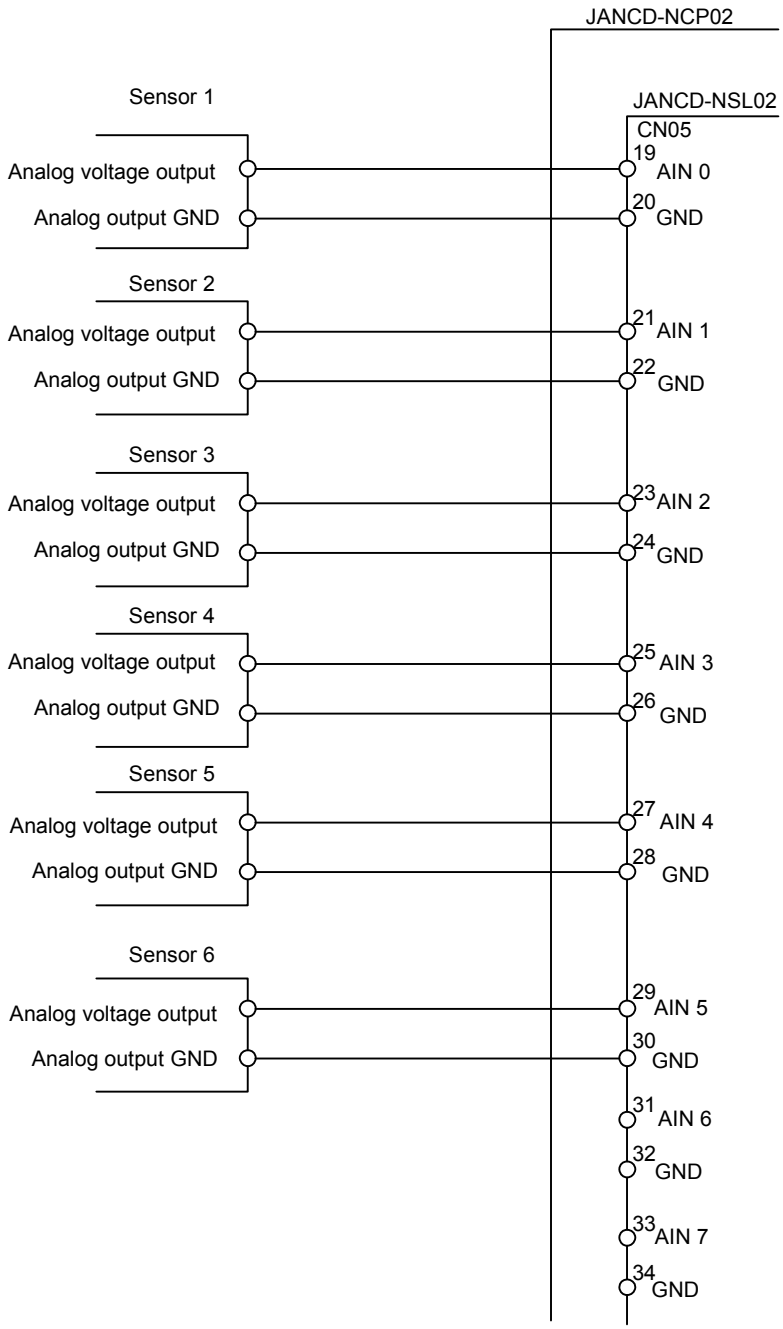
■ Analog Input Signal Specification

Channel number : 8 channel

Voltage range : ±10 V

■ Connector Specification for Input Cable

Name	Maker	Type
MDR connectors, solder plug connector	3 M	10136-3000VE
MDR connector, plastic solder plug junction shell, non-shielded	3 M	10336-52A0-008



Analog Input Signal Connection Diagram

2.2 Direct-in Signal Connection

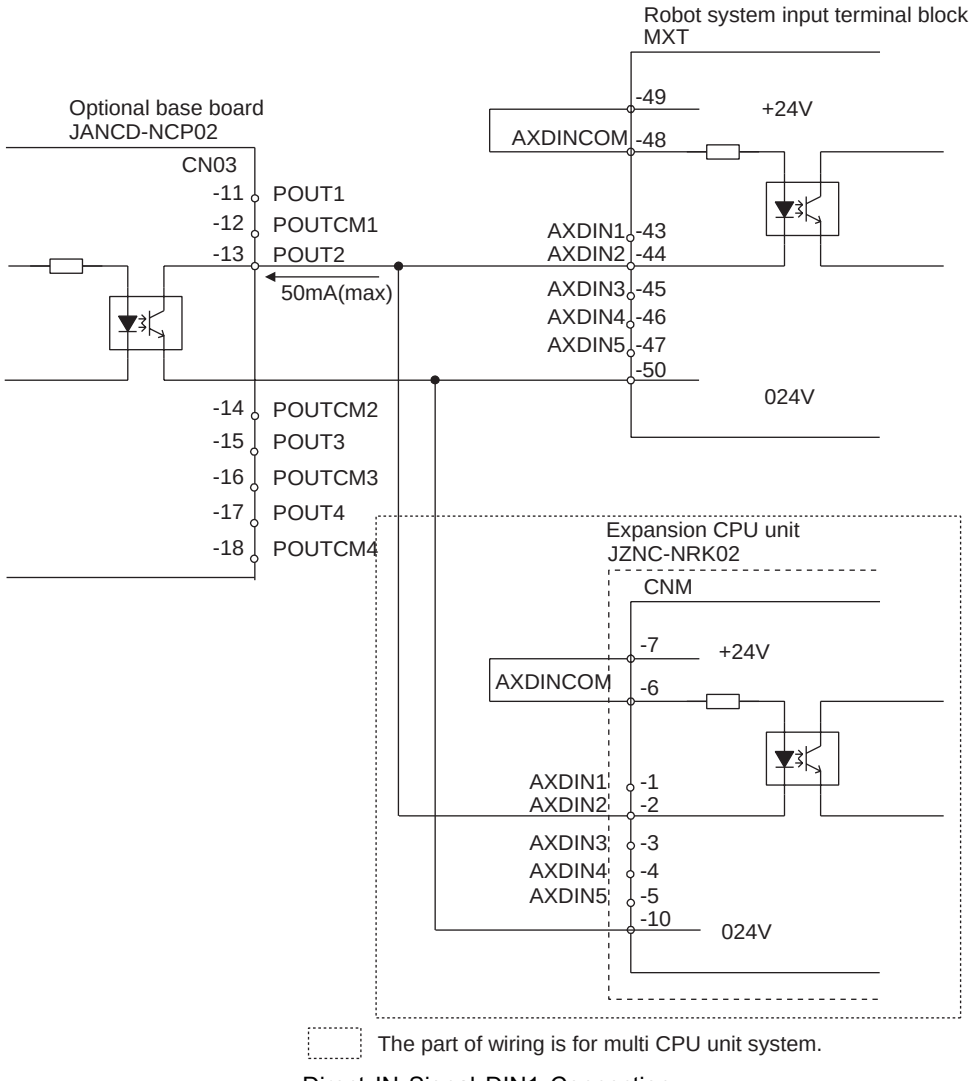
For the search function, the direct-in signal needs to be connected between the optional base board and the terminal for transmission between the sensor section and the servo section. When the search function is not used, this wiring is not necessary.

Wire according to the instructions described in the section " ■ Direct-in (Servo)1 to 5" of "12.3.2 Units and Circuit Boards in the CPU Unit" in the NX100 INSTRUCTIONS (manual No. RE-CTO-A211).

Then, set the channel No. to which the direct-in signal and the general output signal of the NCP02 board are connected, to the parameters as follows.

SxE057 General output signal No. of NCP02 board for the search function.
(The set value is "2" for the following connection diagram.)

SxE058 Direct-in signal No. for the search function.
(The set value is "2" for the following connection diagram.)

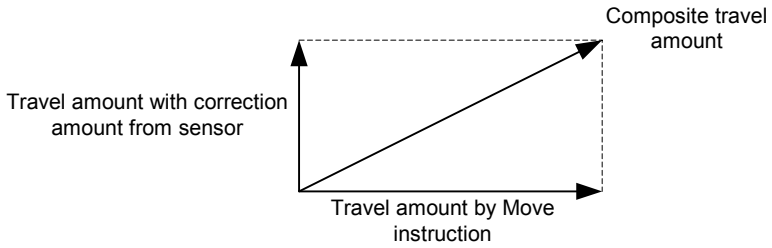


Direct IN Signal DIN1 Connection

3 Real-time Path Correction Function

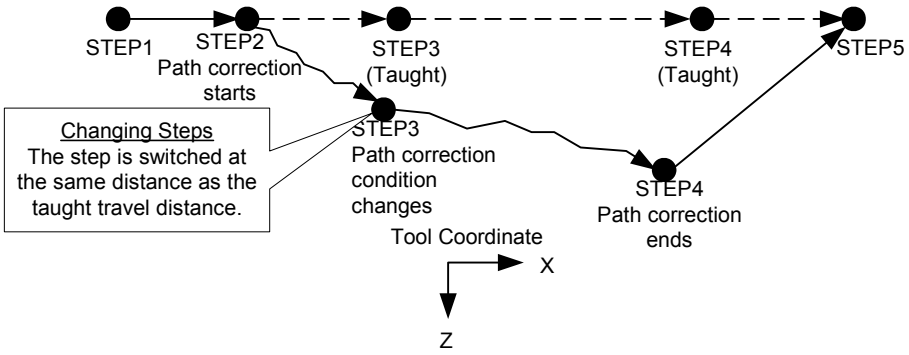
The real-time path correction function corrects the motion path of the manipulator according to the input signal from a sensor.
To start path correction, execute a real-time path correction start instruction (ACORON). To end it, execute a real-rime path correction end instruction (ACOROF).
During path correction, the manipulator moves in the motion instructed by a move instruction with the correction amount output from the sensor section. The averaging process*1 in the servo control section is not performed during path correction.

1 To obtain a smooth travelling motion, processes such as averaging the travel amount of the manipulator are executed in the servo control section.



<Job Example>

```
001 NOP
002 MOVJ VJ=25.00
003 MOVL V=100
004 SCALIB TCH#(3)
005 ACORON TF TCH#(3) TV=0.000
006 MOVL V=100
007 ACORCH TCH#(3) TV=1.000
008 MOVL V=100
009 ACOROF
010 MOVL V=100
011 MOVJ VJ=25.00
012 END
```



3.1 Correction Amount

For the deviation of the analog input, the correction amount is calculated in the following formula.

i) $V_{in} > V_{thresh} + V_{offset} + V_{nosens}$

$C_{out} = R \times (V_{in} - (V_{thresh} + V_{offset} + V_{nosens}))$

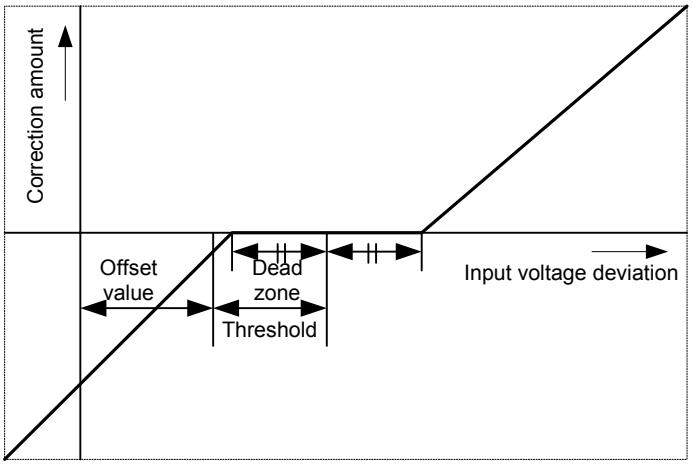
ii) $V_{thresh} + V_{offset} - V_{nosens} < V_{in} < V_{thresh} + V_{offset} + V_{nosens}$

$C_{out} = 0$

iii) $V_{in} < V_{thresh} + V_{offset} - V_{nosens}$

$C_{out} = R \times (V - (V_{thresh} + V_{offset} - V_{nosens}))$

C_{out}	:Correction amount
R	:Resolution
V_{in}	:Input voltage
V_{thresh}	:Threshold
V_{offset}	:Offset value
V_{nosens}	:Dead zone



3.2 Correction Direction

The direction in which the path is to be corrected can be determined in the following three ways.

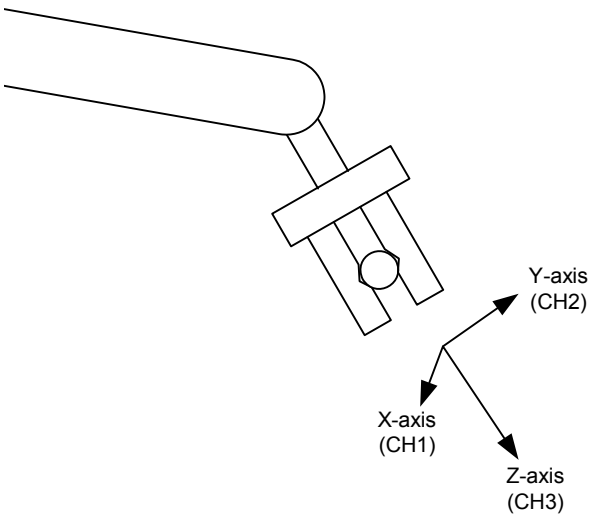
- Tool coordinate
- Forward direction
- Optional direction

The correction from the sensor is executed on the coordinates specified by ACORON and SACORON instructions (real-time path correction start instructions).

3.2.1 Tool Coordinate

The correction is performed using a tool mounted on the wrist flange of the manipulator as a reference point. Select one of the following three directions; the X-axis direction, the Y-axis direction, or the Z-axis direction.

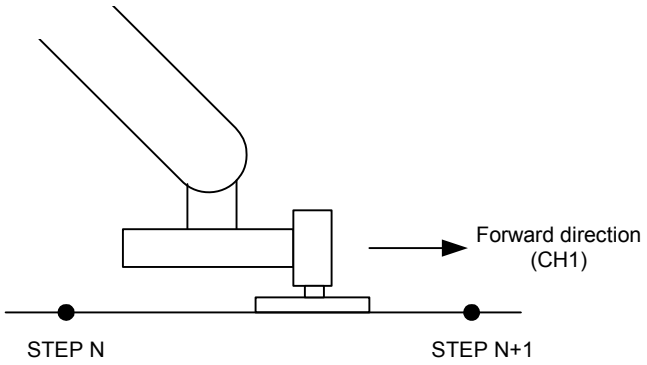
Correction Direction	Sensor Input Channel (specify at registration of instruction)
X-axis direction	CH1
Y-axis direction	CH2
Z-axis direction	CH3



3.2.2 Forward Direction

The correction is executed toward the forward direction of move instruction in execution.

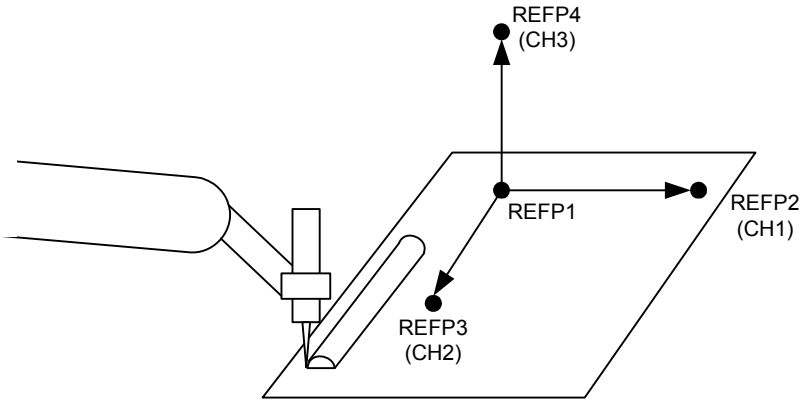
Correction Direction	Sensor Input Channel (specify at registration of instruction)
Forward direction	CH1



3.2.3 Optional Direction

The motion path is corrected in the direction determined by two reference points. (Not limited to the orthogonal coordinate system.)

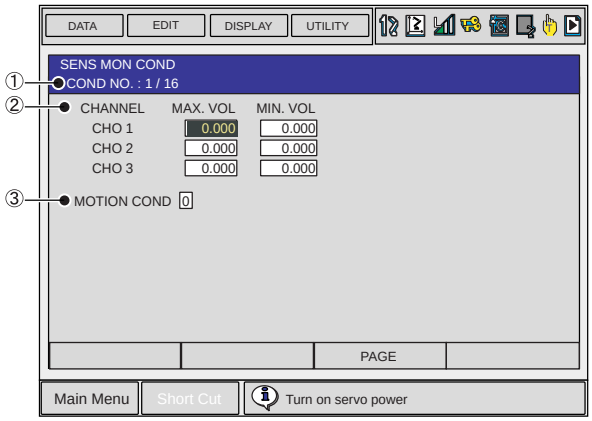
Correction Direction	Sensor Input Channel (specify at registration of instruction)
Direction from REFP1 to REFP2 (Direction from SREFP1 to SREFP2)	CH1
Direction from REFP1 to REFP3 (Direction from SREFP1 to SREFP3)	CH2
Direction from REFP1 TO REFP4 (Direction from SREFP1 to SREFP4)	CH3



3.3 Monitoring of Sensor Input Voltage

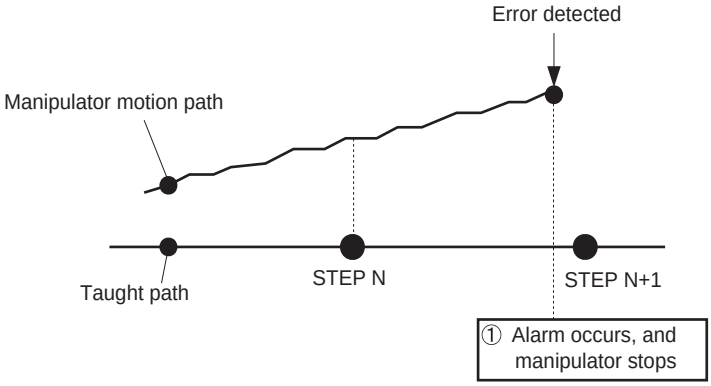
To prevent the manipulator from deviating excessively from its path, the analog signals are monitored during the path correction.
When the path correction starts, the signals are monitored according to a specified sensor monitor condition file. When an error occurs, the manipulator moves according to the motion condition of the aforementioned file.
In the sensor monitor condition file, the maximum voltage value and the minimum voltage value of each channel can be set. When the input voltage of an analog signal exceeds these values, an error occurs.

3.3.1 Sensor Monitor Condition File

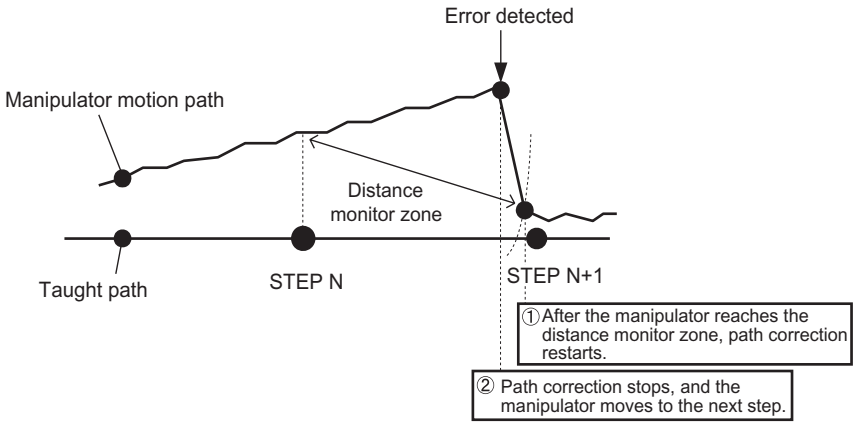


①COND NO. (1 to 16)
Displays the file number.
②MAX. VOL, MIN.VOL (-10.000 to 10.000 [V])
The monitor conditions of analog input signal. Set for each sensor input channel.
No monitoring for the channels whose maximum and minimum voltages are set to 0.
③MOTION COND (0 to 2)
Specifies the motion condition when an error is detected.

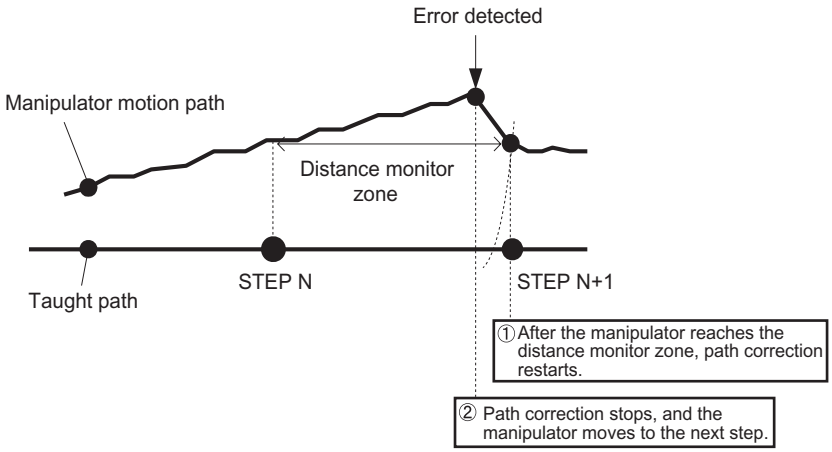
0: Generates an alarm to stop the manipulator.



1: Stops the path correction and moves the manipulator toward the taught steps.
After the end of a step is detected by distance monitoring, the path correction restarts.



2: Stops the path correction, and moves the manipulator toward the taught steps keeping the amount of correction up to the previous step. When the end of the step is detected in the distance monitoring, the path correction restarts.



3.3.2 Display of Sensor Monitor Condition File

	Operation	Explanation
1	Select [ROBOT] under the main menu.	
2	Select [SENS MON COND].	

3.3.3 Editing of Sensor Monitor Condition File

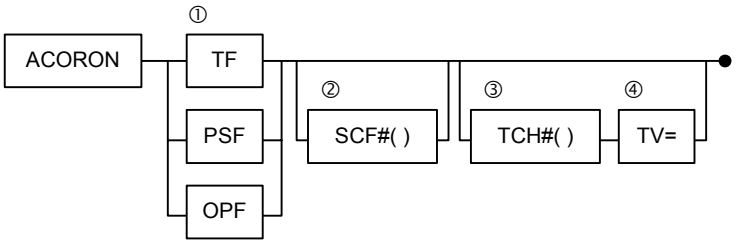
	Operation	Explanation
1	Select an item to be changed.	
2	Enter a value using the number keys.	
3	Press [ENTER].	

3.4 Instructions for the Real-time Path Correction Function

3.4.1 ACORON and SACORON Instructions

The ACORON and the SACORON are instructions to start the real-time path correction. Use the SACORON in a coordinated job.

<Format>



①Correction coordinates

Specifies the coordinate system where the path correction is performed. For details on each coordinate system, refer to Section 3.2 “Correction Direction”. The following coordinate systems can be selected.

TF : Tool frame (Tool coordinate)

PSF: Pass frame (Forward direction)

OPF: Optional frame (Optional direction)

②Sensor monitor condition file

Sets a condition file when the input voltage from the sensor is monitored. When this setting is omitted, monitoring is not performed. For details on the file, refer to Section 3.3.1 “Sensor Monitor Condition File”.

③Threshold channel No.

Specifies a sensor input channel for path correction. For details on the input channels, refer to Section 3.2 “Correction Direction”.

1 to 3: CH1 to CH3

0 or No specification: The correction amounts of all the channels (directions) on the specified coordinate system are averaged to correct the path.

④Threshold

Sets a threshold for executing path correction.

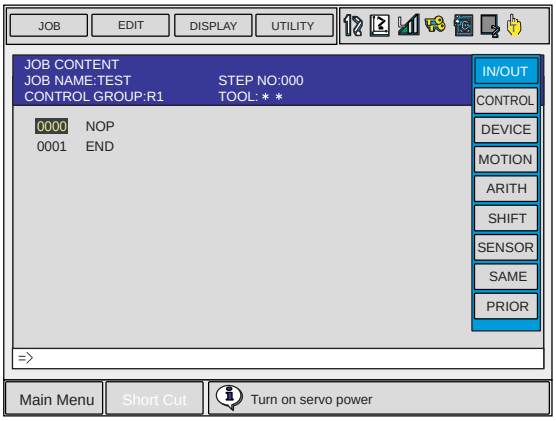
When this setting and the sensor input number are both omitted, the threshold is set to 0.000 [V]. When “0” is set for THRESHOLD CH, the threshold is set for all the channels.

Unit: V

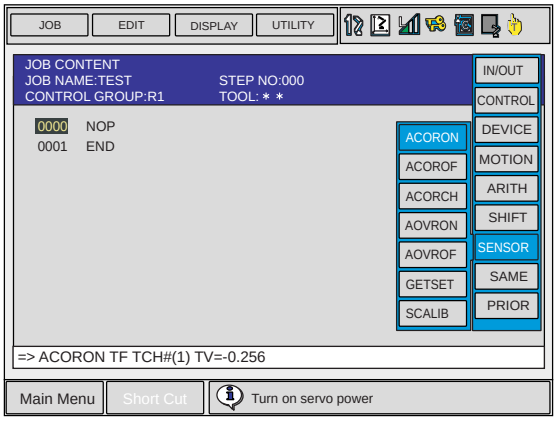
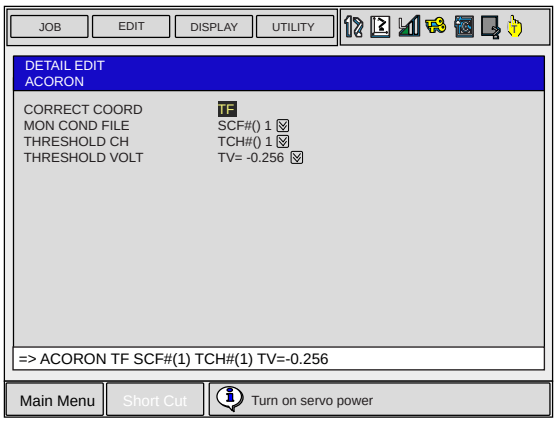
Setting Range: -10.000 to 10.000

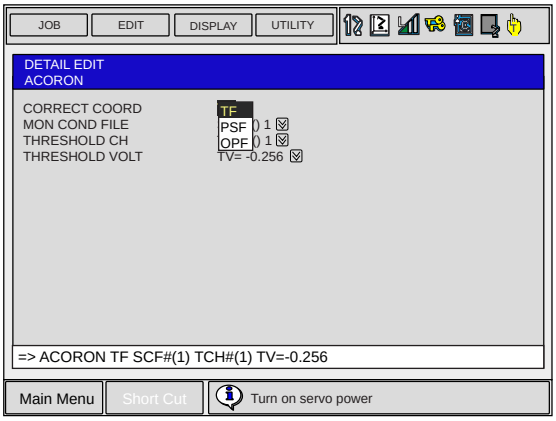
■ Registration of the ACORON Instruction

	Operation	Explanation
1	Move the cursor to the address area.	
2	Press [INFORM LIST].	The instruction list dialog box appears.



Instruction List Dialog Box

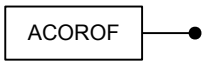
	Operation	Explanation
3	Select {SENSOR}.	The sensor instruction list dialog box appears.  Sensor Instruction List Dialog Box
4	Select {ACORON}.	An ACORON instruction appears in the input buffer line.
5	Press [SELECT].	The DETAIL EDIT display appears. 

	Operation	Explanation
6	Set the conditions in the DETAIL EDIT display.	**Set the correction conditions.** • **Editing in “CORRECT COORD”** Move the cursor to the “CORRECT COORD”, and press [SELECT]. The following selection dialog box appears.  Select a coordinate system for the correction. • **Editing other items** Select an item to be edited, and enter a value using the number keys.
7	Press [ENTER] two times.	

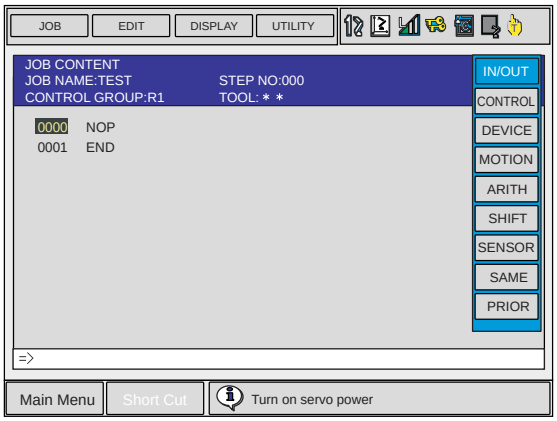
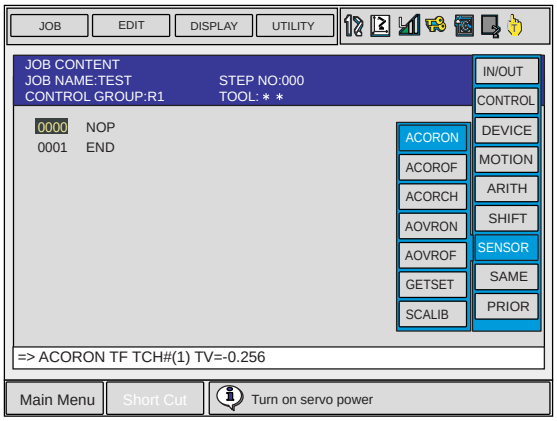
3.4.2 ACOROF and SACOROF Instructions

The ACOROF and the SACOROF are instructions to end the real-time path correction. Use the SACOROF in a coordinated job.

<Format>



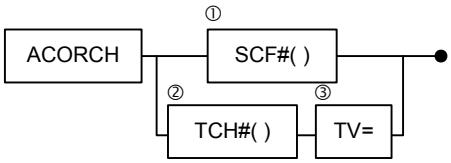
■ Registration of the ACOROF Instruction

	Operation	Explanation
1	Move the cursor to the address area.	
2	Press [INFORM LIST].	The instruction list dialog box appears.  Instruction List Dialog Box
3	Select {SENSOR}.	The sensor instruction list dialog box appears.  Sensor Instruction List Dialog Box
4	Select {ACOROF}.	An ACOROF instruction appears in the input buffer line.
5	Press [ENTER].	

3.4.3 ACORCH and SACORCH Instructions

The ACORCH and the SACORCH are instructions to change the real-time path correction conditions.

<Format>



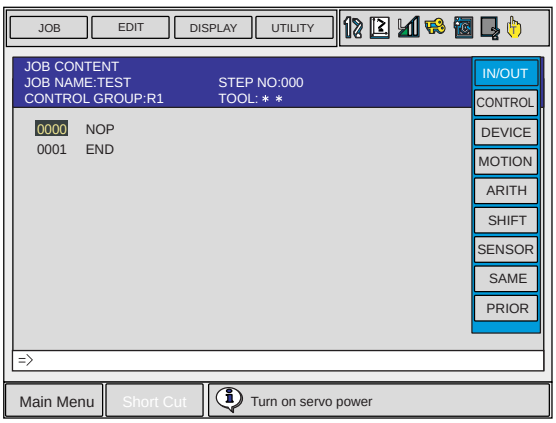
①Sensor monitor condition file
Sets a condition file when the input voltage from the sensor is monitored.

②Threshold channel No.
Specifies a sensor input channel for path correction. For details on the input channels, refer to Section 3.2 “Correction Direction”.
1 to 3: CH1 to CH3
0 : The correction amounts of all the channels (directions) on the specified coordinate system are averaged to correct the path. The threshold is the same for all the channels.

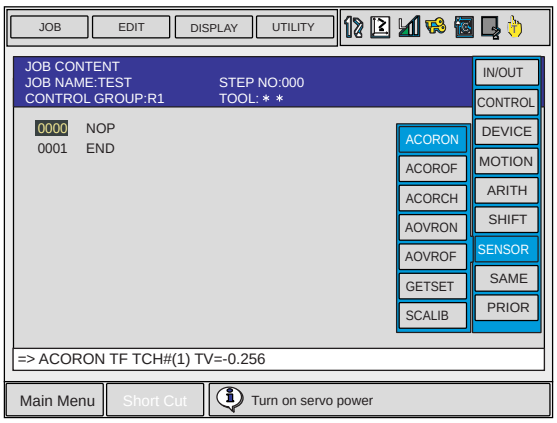
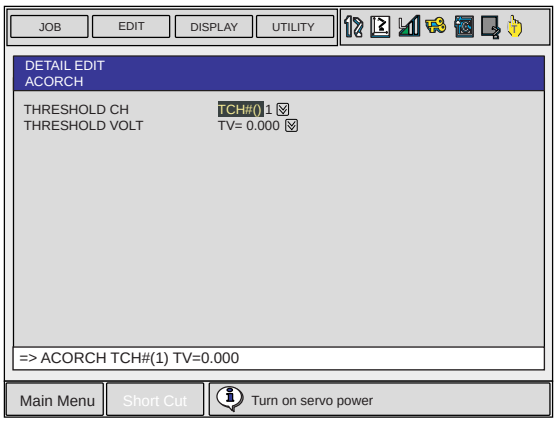
③Threshold
Sets a threshold for executing path correction.
Unit: V
Setting Range: -10.000 to 10.000

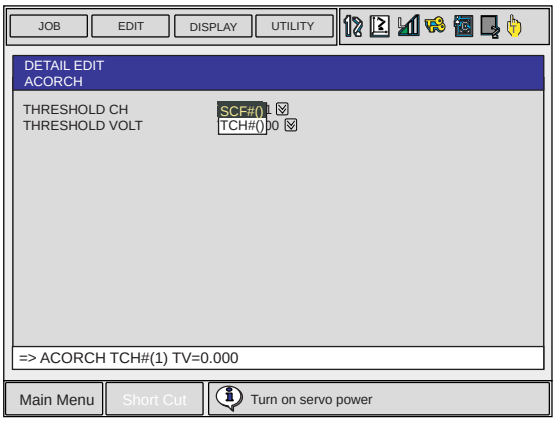
■ Registration of the ACORCH Instruction

	Operation	Explanation
1	Move the cursor to the address area.	
2	Press [INFORM LIST].	The instruction list dialog box appears.



Instruction List Dialog Box

	Operation	Explanation
3	Select {SENSOR}.	The sensor instruction list dialog box appears.  Sensor Instruction List Dialog Box
4	Select {ACORCH}.	An ACORCH instruction appears in the input buffer line.
5	Press [SELECT].	The DETAIL EDIT display appears. 

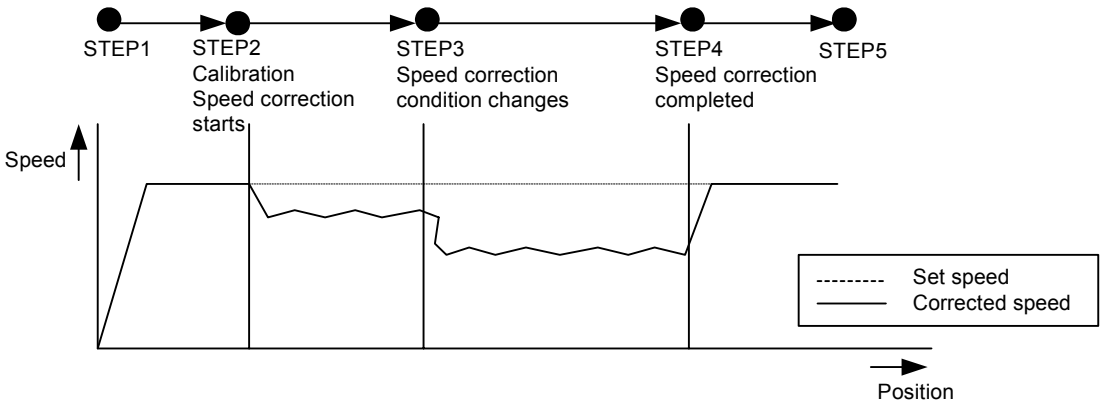
	Operation	Explanation
6	Set the conditions in the DETAIL EDIT display.	**Set a condition to be changed.** • **Selecting a condition to be changed** Move the cursor to either the “THRESHOLD CH” or “THRESHOLD VOLT”. The following selection dialog box appears.  Select a condition to be changed. • **Editing other items** Select an item to be edited, and enter a value using the number keys.
7	Press [ENTER] two times.	

4 Real-time Speed Correction Function

During playback of the manipulator, the real-time speed correction function corrects the speed according to the signals from a sensor. To start speed correction, execute a real-time speed correction start instruction (AOVRON). To end it, execute a real-time speed correction end instruction (AOVROF). To execute speed correction, correct the override ratio. This function only decreases the speed for the correction.

<Job Example>

```
001  NOP
002  MOVJ  VJ=25.00
003  MOVL  V=100
004  SCALIB  TCH#(1)
005  AOVRON  TCH#(1)  TV=1.000
006  MOVL  V=100
007  MOVL  V=100
008  AOVROF
009  MOVL  V=100
010  MOVJ  VJ=25.00
011  END
```



4.1 Override Ratio

The override ratio is calculated as follows.

i) $V_{in} > V_{thresh} + V_{offset} - V_{nosens}$

$O_{out} = 100$

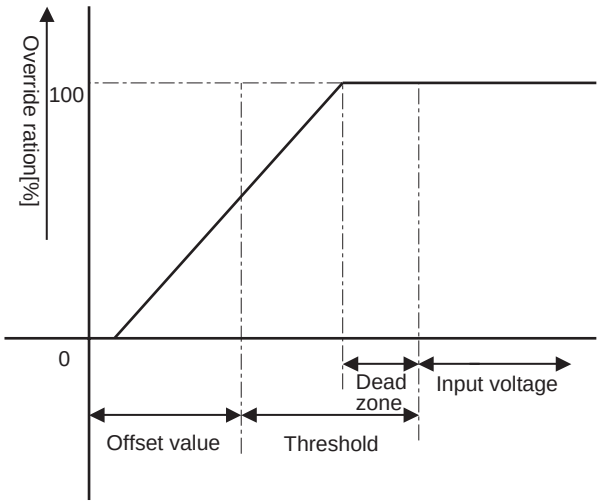
ii) $V_{thresh} + V_{offset} - V_{nosens} - 100 / R < V_{in} < V_{thresh} + V_{offset} - V_{nosens}$

$O_{out} = R \times (V_{in} - (V_{thresh} + V_{offset} - V_{nosens})) + 100$

iii) $V_{in} < V_{thresh} + V_{offset} - V_{nosens} - 100 / R$

$O_{out} = 0$

O_{out}	:Override ratio
R	:Resolution
V_{in}	:Input voltage
V_{thresh}	:Threshold
V_{offset}	:Offset volue
V_{nosens}	Dead zone

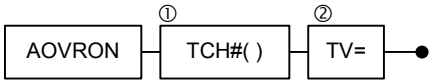


4.2 Instructions for the Real-time Speed Correction Function

4.2.1 AOVRON Instruction

The AOVRON is an instruction to start the real-time speed correction.

<Format>

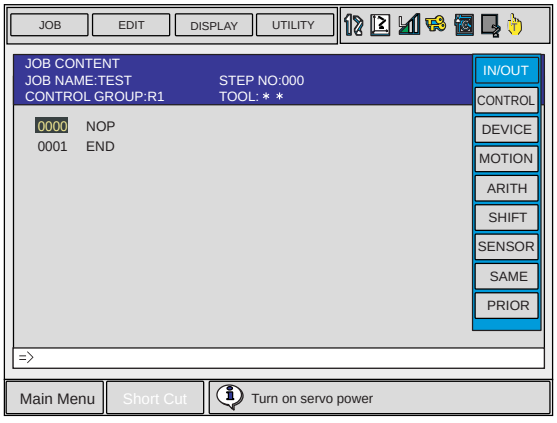


①Threshold channel No.
Specifies the input channel for the sensor for speed correction.
1 to 6: CH1 to CH6

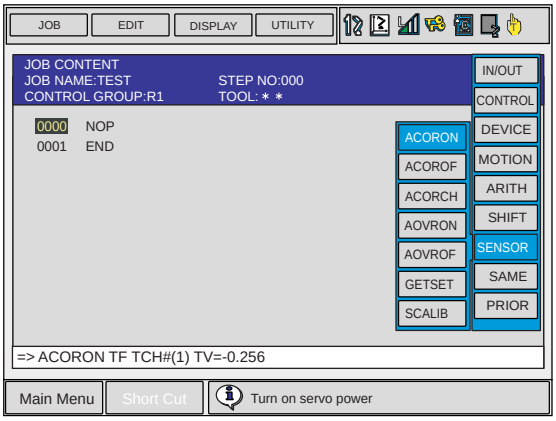
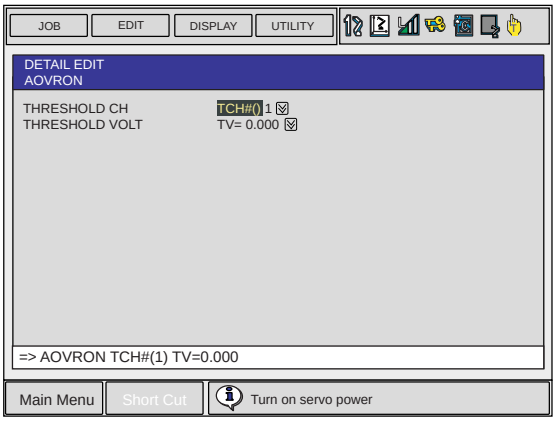
②Threshold
Sets a threshold for executing speed correction.
Unit: V
Setting Range: -10.000 to 10.000

■ Registration of the AOVRON Instruction

	Operation	Explanation
1	Move the cursor to the address area.	
2	Press [INFORM LIST].	The instruction list dialog box appears.



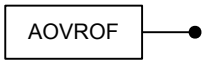
Instruction List Dialog Box

	Operation	Explanation
3	Select {SENSOR}.	The sensor instruction list dialog box appears.  Sensor Instruction List Dialog Box
4	Select {AOVRON}.	An AOVRON instruction appears in the input buffer line.
5	Press [SELECT].	The DETAIL EDIT display appears. 
6	Set the conditions in the DETAIL EDIT display.	**Editing other items** Select an item to be edited, and enter a value using the number keys.
7	Press [ENTER] two times.	

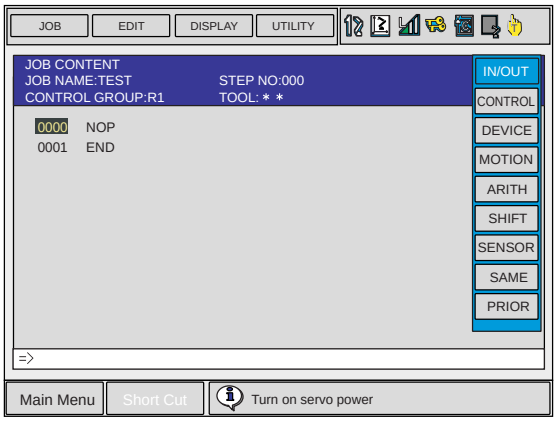
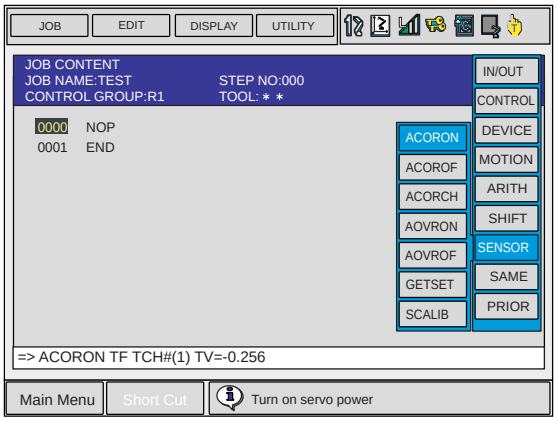
4.2.2 AOVROF Instruction

The AOVROF is an instruction to end the real-time speed correction.

<Format>



■ Registration of the AOVROF Instruction

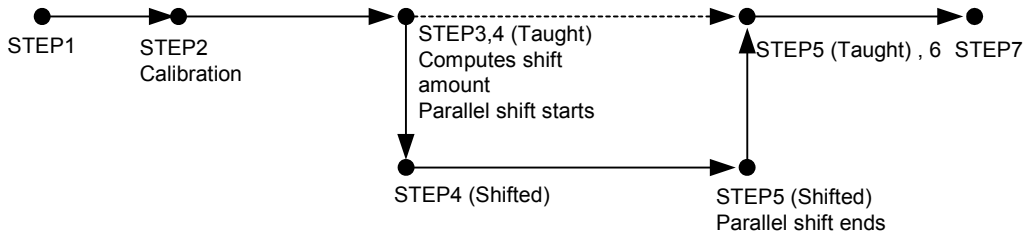
	Operation	Explanation
1	Move the cursor to the address area.	
2	Press [INFORM LIST].	The instruction list dialog box appears.  Instruction List Dialog Box
3	Select {SENSOR}.	The sensor instruction list dialog box appears.  Sensor Instruction List Dialog Box
4	Select {AOVROF}.	An AOVROF instruction appears in the input buffer line.
5	Press [ENTER].	

5 Shift Amount Creation Function

The shift amount creation function detects a distance between a manipulator and a workpiece using a displacement sensor to calculate the shift amount on the base coordinate system.

<Job Example>

```
001  NOP
002  MOVJ  VJ=25.00
003  MOVL  V=100
004  SCALIB  TCH#(1)
005  MOVL  V=100
006  GETSFT  TCH#(1)  TV=0.000  P000
007  SFTON  P000  TF
008  MOVL  V=100
009  SFTOF
010  MOVL  V=100
011  MOVJ  VJ=25.00
012  END
```



5.1 Shift Amount

Calculate the shift amount with the same formula as for the correction amount of the real-time path correction function. Refer to Section 3.1 “Correction Amount”.

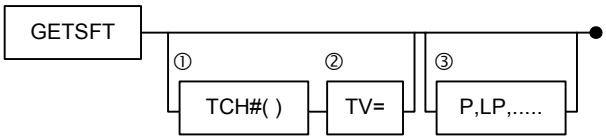
5.2 Coordinate System and Sensor Input Channel for Shift Amount Creation

Select a coordinate system and a sensor input channel for the shift amount creation in the same manner as for the correction amount of the real-time path correction function. Refer to Section 3.2 “Correction Direction”.

5.3 GETSFT Instruction

The GETSFT is an instruction to create the shift amount.

<Format>



①Threshold channel No.

Specifies the sensor input channel to be used for the creation of the shift amount.

1 to 3: CH1 to CH3

0 or No specification: The shift amounts of all the channels (directions) on the specified coordinate system are averaged to calculate a shift amount.

②Threshold

Sets a threshold for executing the creation of the shift amount.

When this setting and the threshold channel No. are both omitted, the threshold is set to 0.000 [V]. When “0” is set for the sensor input No., the threshold is set for all the channels.

Unit: V

Setting Range: -10.000 to 10.000

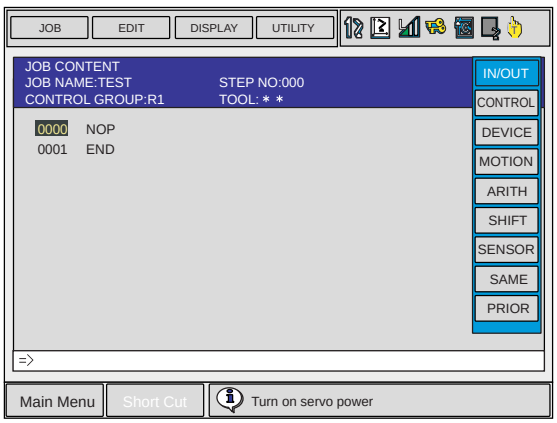
③Position variable

Sets a position variable to save a created shift amount.

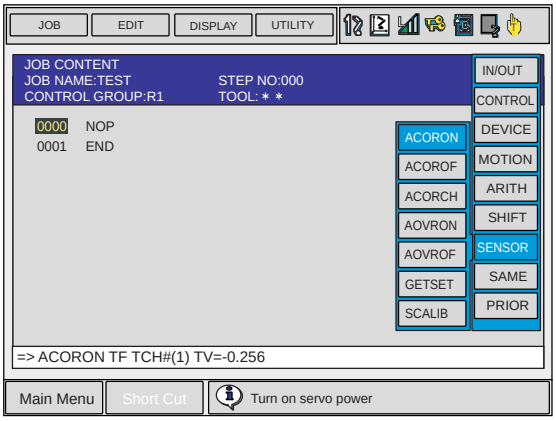
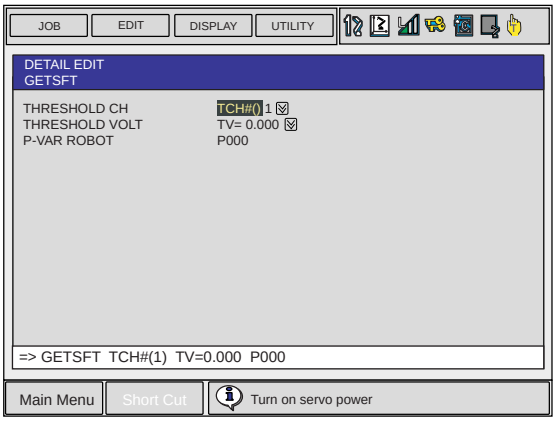
The coordinate for the shift amount is a base coordinate.

5.3.1 Registration of the GETSFT Instruction

	Operation	Explanation
1	Move the cursor to the address area.	
2	Press [INFORM LIST].	The instruction list dialog box appears.



Instruction List Dialog Box

	Operation	Explanation
3	Select {SENSOR}.	The sensor instruction list dialog box appears.  Sensor Instruction List Dialog Box
4	Select {GETSFT}.	A GETSFT instruction appears in the input buffer line.
5	Press [SELECT].	The DETAIL EDIT display appears. 
6	Set the conditions in the DETAIL EDIT display.	**Editing other items** Select an item to be edited, and enter a value using the number keys.
7	Press [ENTER] two times.	

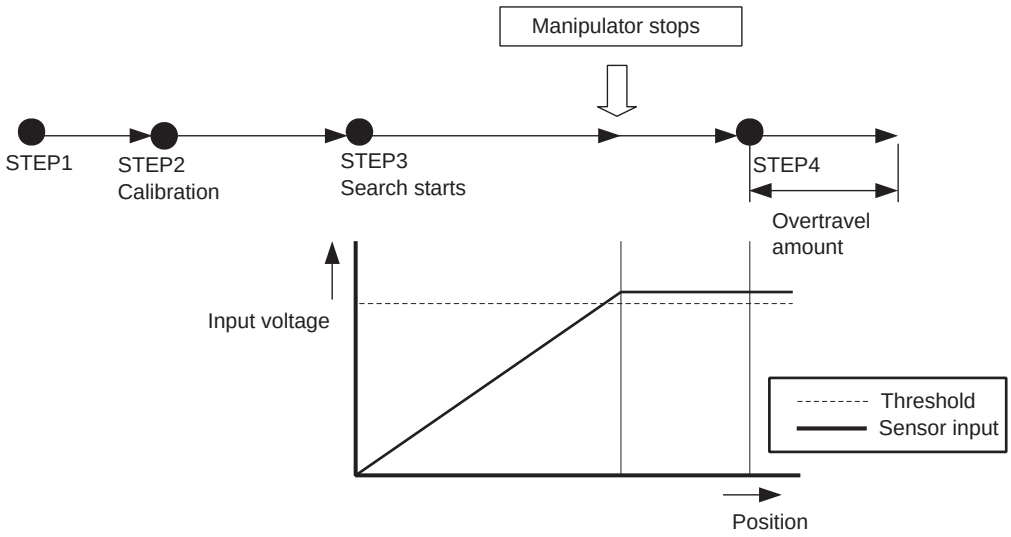
6 Search Function

When the analog signal changes according to the position of manipulator, the serch function monitors the analog signal while the manipulator moves in linear interpolation. When the detected value exceeds the set value, the detection result and the detected position are saved and the manipulator is stopped.
The search operation is executed with a move instruction that has a specified search operation tag (ASRCH). The following move instructions start the search operation.

- MOVL
- SMOVL

<Job Example>

```
001 NOP
002 MOVJ VJ=25.00
003 MOVL V=100
004 SCALIB TCH#(1)
005 MOVL V=100
006 MOVL V=100 ASRCH SCH#(1) TV=0.000 RISE
DIS=0.00
007 GETS B000 $B002
008 JUMP *NG IF B002=0
009 GETS PX000 PX002
010 CNVRT PX001 PX000 BF
011 SFTON P000 BF
012 MOVL V=100
013 SFTOF
014 END
```



6.1 Detection Results

After the search operation, the detection results are registered in the system variables.

System Variable	Contents
$B02	Detection 0: Not detected 1: Detected
$PX002	Detected position (pulse)
$PX003	Detected position (base axis orthogonal value)

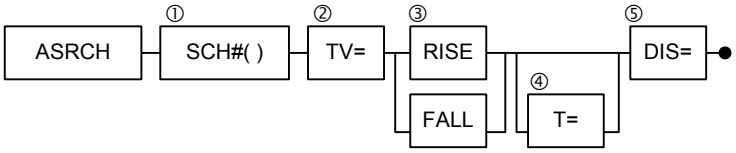
6.2 Search Operation with Multiple Channels

Normally in the search operation, one search detection channel is monitored. But, monitoring more than one channel at the same time is also possible. In this case, a detection is executed when a channel exceeds the threshold. Set the channels to be monitored in the parameter (SxE059).

6.3 ASRCH Instruction

The ASRCH is an instruction to start the search operation with a move instruction.

<Format>



①Search detection channel No.
Specifies the sensor input channel to be monitored in the search operation.
1 to 6: CH1 to CH6
0: Search with multiple channels

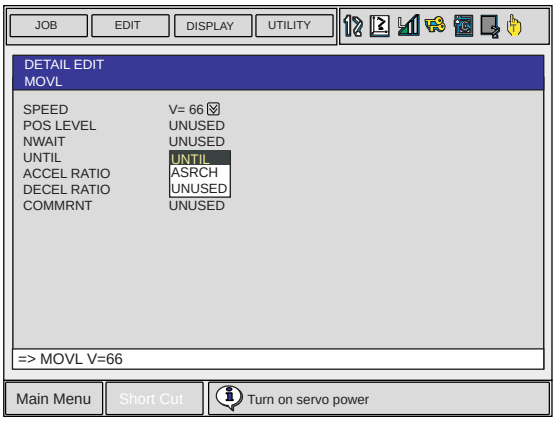
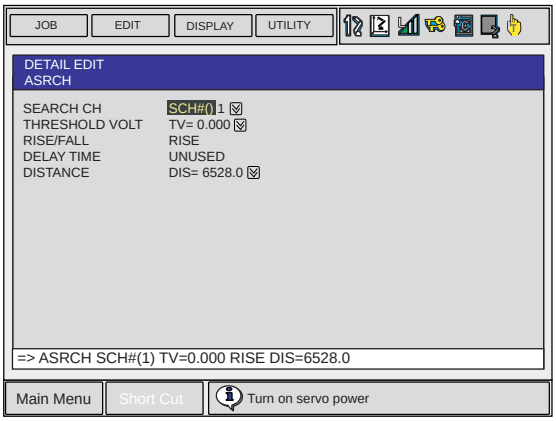
②Threshold
Sets a threshold at detection
Unit: V
Setting Range: -10.000 to 10.000

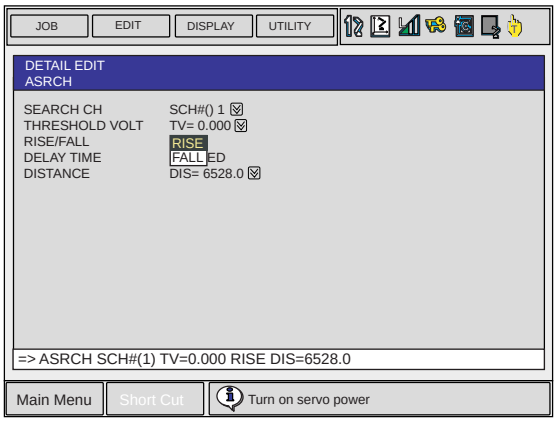
③Rising/Falling
Sets the direction in which the analog input signal passes the threshold.
RISE: Rising detection (Direction that the input voltage absolute value increases)
FALL: Falling detection (Direction that the input voltage absolute value decreases)

④Time
The delay time to start checking the analog input signal
Unit: sec.
Setting Range: 0 to 99.99

⑤Distance
The overtravel distance from the target position in the search operation
Unit: mm
Setting Range: 0 to 999.99

6.3.1 Registration of the ASRCH Instruction

	Operation	Explanation
1	Move the cursor to the instruction area.	
2	Move the cursor to a move instruction where a search instruction is to be registered.	
3	Press [SELECT] two times.	
4	Select {UNTIL}.	The instruction list dialog box appears.  Instruction List Dialog Box
5	Select {ASRCH}.	The DETAIL EDIT display appears. 

	Operation	Explanation
6	Set the conditions in the DETAIL EDIT display.	**Editing other items** • **Editing in RISE/FALL** Move the cursor to the “RISE/FALL”, and then press [SELECT]. Select either “RISE” or “FALL”. The following dialog box appears.  • **Editing other items** Select an item to be edited, and enter a value using the number keys.
7	Press [ENTER] two times.	

7 Calibration

Some sensors have a characteristic that changes the analog output according to an external factor such as temperature change. With this function, the amount that an analog signal changes is set in the offset value for compensation, so each function can be used appropiately.
In each function, the effective value is the value that results when the offset value is subtracted from the analog input voltage value.

Effective value = Analog input voltage value – Offset value

When calibrating, set the analog input voltage value to the offset value.

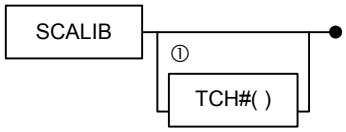
Offset value = Analog input voltage value

Set the offset value in the following manner.
- Execute a calibration instruction (SCALIB) in the job.
- In the sensor output status display, enter and register a value.
- In the sensor output status display, calibrate all channels.

7.1 SCALIB Instruction

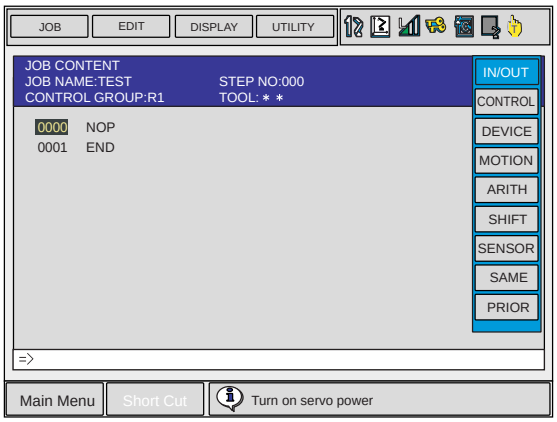
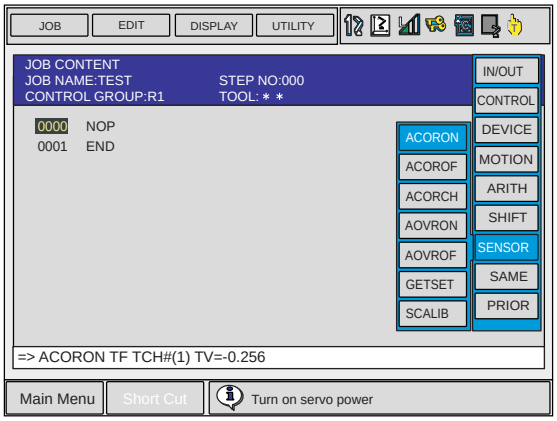
The SCALIB is an instruction to calibrate the threshold channel.

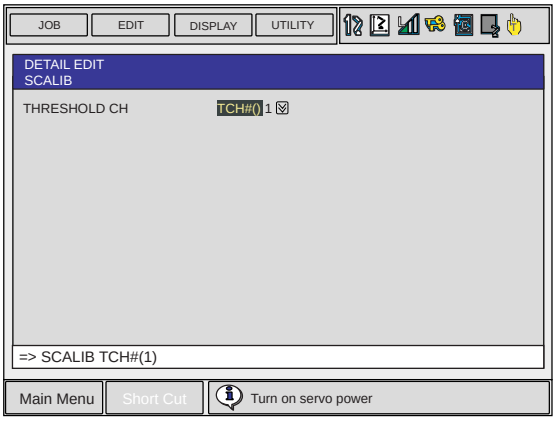
<Format>



①Threshold channel No.
Specifies a sensor input channel for calibration.
1 to 6: CH1 to CH6
0 or No specification: All the connected sensor input channels

7.1.1 Registration of the SCALIB Instruction

	Operation	Explanation
1	Move the cursor to the address area.	
2	Press [INFORM LIST].	The instruction list dialog box appears.  Instruction List Dialog Box
3	Select {SENSOR}.	The sensor instruction list dialog box appears.  Sensor Instruction List Dialog Box
4	Select {SCALIB}.	A SCALIB instruction appears in the input buffer line.

	Operation	Explanation
5	Press [SELECT].	The DETAIL EDIT display appears. 
6	Set the conditions in the DETAIL EDIT display.	**Editing other items** • **Editing in THRESHOLD CH** Select “THRESHOLD CH”, and enter a value using the number keys.
7	Press [ENTER] two times.	

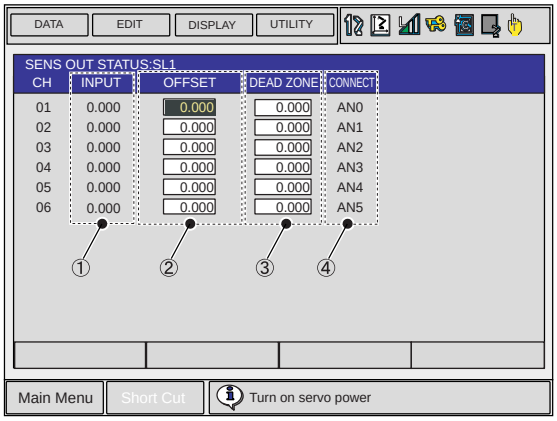
7.2 Entering an Offset Value

Follow the explanation in the section " 8.2 Editing in Sensor Output Status Display ".

7.3 All Channels Calibration

Follow the explanation in the section " 8.3 Calibration of All Sensor Input Channels ".

8 Sensor Output Status Display



①INPUT (-10.000 to 10.000 V)
Displays the input voltage of the sensor input channel.
②OFFSET (-10.000 to 10.000 V)
Displays the offset value of the sensor input channel.
③DEAD ZONE (0.000 to 10.000 V)
Displays the dead zone of the sensor input channel.
④CONNECT
Displays the analog input port for the sensor input channel.

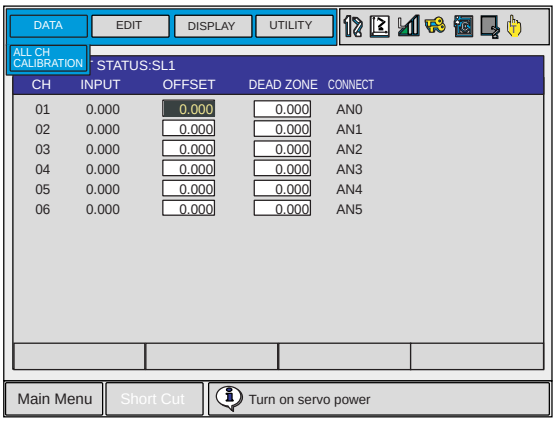
8.1 Calling Sensor Output Status Display

	Operation	Explanation
1	Select {ROBOT} under the main menu.	
2	Select {SENS OUT STATUS}.	

8.2 Editing in Sensor Output Status Display

	Operation	Explanation
1	Select an item to be changed.	
2	Enter a value using the number keys.	
3	Press [ENTER].	

8.3 Calibration of All Sensor Input Channels

	Operation	Explanation
1	Select {DATA} under the main menu.	The calibration menu appears. 
2	Select {ALL CH CALIBRATION}.	All sensor input channels are calibrated, and the offset voltages for all the sensor input channels are set.

9 Sensor Parameters (SxE)

No.	Contents		Initial Value	Setting Range
0	Application specification			
20	Sensor input channel specification 0 : No specification 1: AN0 5: AN4 2: AN1 6: AN5 3: AN2 7: AN6 4: AN3 8: AN7	CH1	0	
21		CH2	0	
22		CH3	0	
23		CH4	0	
24		CH5	0	
25		CH6	0	
26	Resolution For real-time path correction, [0.01 mm/V] For real-time speed correction, [0.1 %/V]	CH1	0	
27		CH2	0	
28		CH3	0	
29		CH4	0	
30		CH5	0	
31		CH6	0	
32	Dead zone [mV]	CH1	0	
33		CH2	0	
34		CH3	0	
35		CH4	0	
36		CH5	0	
37		CH6	0	

No.	Contents		Initial Value	Setting Range
38	Function for analog input signal and real-time path correction D0: Low-pass filter D1: Fuzzy control (valid only for path correction) D2: Compensation control for the delay of real-time path correction	CH1	5	
39		CH2	5	
40		CH3	5	
41		CH4	5	
42		CH5	5	
43		CH6	5	
56	Sampling interval [msec]		2	1 to 10
57	General output signal No. of NCP02 board for the search function		2	
58	Direct-in signal No. for the search function		2	
59	Combination at execution of search operation by multiple sensors D0 : CH1 D3: CH4 D1 : CH2 D4: CH5 D2 : CH3 D5: CH6		0	
60	Low-pass filter cut-off frequency [0.1 Hz]		340	
61	Scaling factor 1		20	
62	Scaling factor 2		10	
63	Scaling factor 3		15	
64	Scaling factor 4		6	
70	Resolution mode for "Common" or "Individual" between path correction and the other functions 0: Common 1: Individual		0	0-1
71	Resolution for path control under individual resolution mode [0.01 mm/V]	CH1	0	
72		CH2	0	
73		CH3	0	
74		CH4	0	
75		CH5	0	
76		CH6	0	

No.	Contents		Initial Value	Setting Range
77	Path correction delay compensation, 1st frequency for 4 dimension delay filter		1000	
78	Path correction delay compensation, 2nd frequency for 4 dimension delay filter		1000	
79	Path correction delay compensation, delay compensation time [segment clock]		4	
80	Path correction delay compensation, delay compensation gain [0.01 mm/V]	CH1	50	
81		CH2	50	
82		CH3	50	
83		CH4	50	
84		CH5	50	
85		CH6	50	
86	Path correction delay compensation, maximum correction speed [0.1 mm/s]		1000	

10 Alarm List

Alarm No.	Message	Cause	Remedy
1003	ROM ERROR (XCP02)	Check error in ROM (memory) for sensor program	Replace the XCP02 board.
5010	ANALOG INPUT FAULT (XCP02) [Decimal Data]	Cannot read the analog input value on the NCP02 board correctly. The decimal data indicates the channel where the input fault occurs.	Check the cable. Replace the XCP02 board.
5030	SYSTEM ERROR (SENSOR) [Decimal Data]	An error occurs in the sensor system of the sensor function. The decimal data indicates the type of error.	Needs investigation. Contact your Yaskawa representative. State any observations, the alarm No. and data displayed.
5031	SENSOR PROCESS ERROR [Decimal Data]	An error occurs in the sensor when processing using the sensor function. The decimal data indicates the type of error. 3: The sensor input channels which are instructed to set in " 2.1 Analog Input Signal Connection " are not set to the parameters: SxE020 to 025. For the sensor input channel specification, see " 9 Sensor Parameters (SxE) ". 4: Real time path correction (ACORON) is started under wrong condition. The real time path correction should be started after the MOVE instruction.	Needs investigation. Contact your Yaskawa representative. State any observations, the alarm No. and data displayed.

NX100 OPTIONS
INSTRUCTIONS

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