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IM-0043-6

TEACH PENDANT
OPERATION MANUAL



Ver. 2. 4

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Teach Pendant Operation Manual Ver.2.4
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Notations

1 Dangers, Warnings, Cautions, and Notes

There are four levels of special notations are used in this manual.

Table 1 Special Notation List

Notation	Description
DANGER	If the actions indicated by a DANGER are not complied with, sever injury or death could result.
WARINIG	If the actions indicated by a WARNING are not complied with, injury or major equipment damage could result.
CAUTION	If the action specified by the CAUTION is not complied with, damage to your equipment could result.
NOTE	A NOTE provides supplementary information, emphasizes a point or procedure, or gives a tip for easier operation.

2 Message, Menu, LED, and Keys

There are four more types of notations are used in this manual.

Table 2 The Other Types of Notation List

Notation	Description
“Message”	It describes the message on the Teach Pendant inside of “ “.
「Menu」	It describes the menu on the Teach Pendant inside of 「 」.
『LED』	It describes the monitor LED on the Teach Pendant inside of 『 』(e.g., the 『SHIFT』 LED)
END	It describes keys on the Teach Pendant.

3 Key Operation

Following table describes notations for the key operation.

Table 3 Key Operation Notation List

Notation	Description
END	It describes sigle key you need to press. (In this case, press the END key)
FUNC HIGH + spd CAN	It describes 2 keys you need to press simultaneously. (In this case, press the spd CAN key while pressing the FUNC HIGH key.)

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CHAPTER 1 INTRODUCTION

This manual describes the procedure of the preliminary operations for the arm base of the SCARA (horizontal multi-articulated type) robot and the cross base of the rectangular coordinate system robot.

The Hirata robot system is composed of the following units.

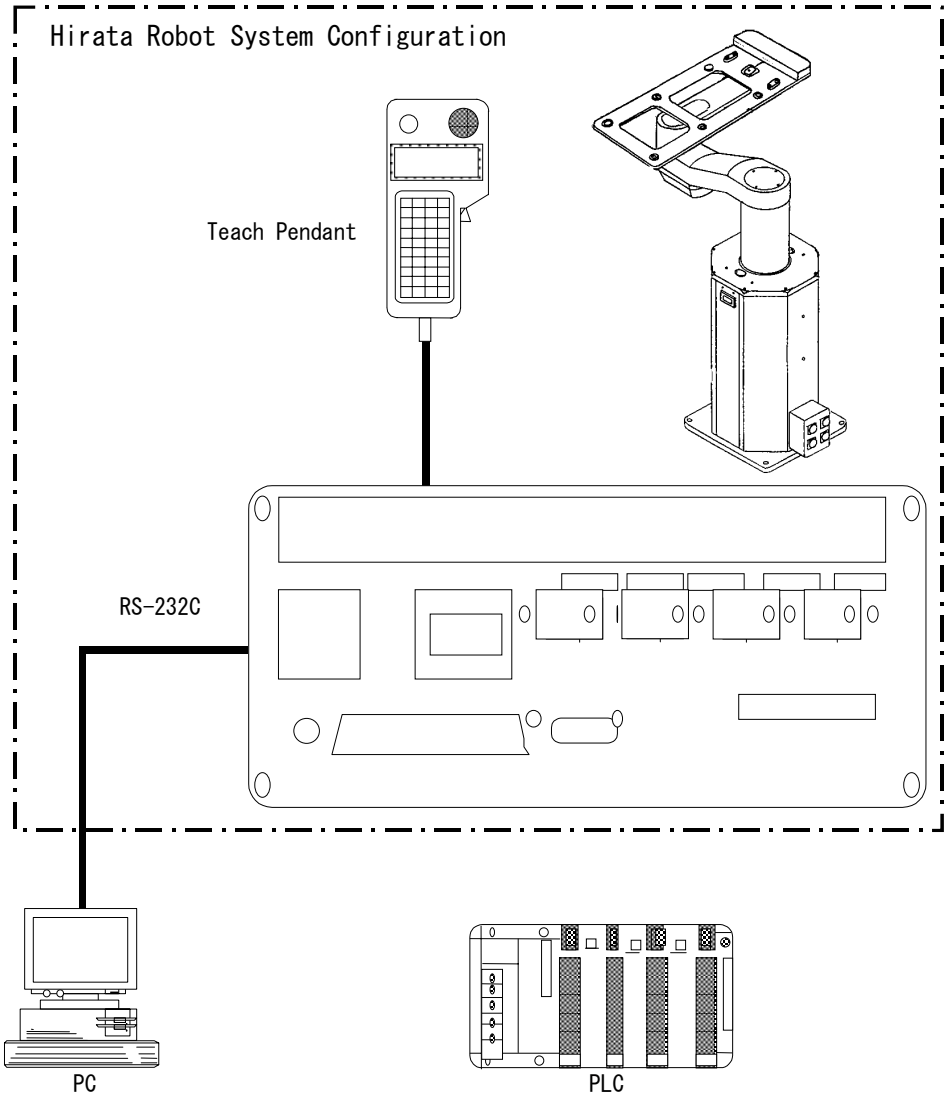


Fig.1. 1 Example of robot system composition

The following shows the outline of a standard procedure for starting up the robot system. Please note that this may not be applicable depending on the type of the robot or controller used.

NOTE

This manual is applicable for the following controller types. In the part of "□," number or blank is applied, and alphabet or blank is applied in the part of "*."

HNC-1□□, HAC-2□□ series
HNC-**3□**□**, HAC-**4□**□**
HNC-544**, HAC-644**

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(1) External wiring

Check the power supply, motor wire, etc.

(2) Deactivation of E.S. (Emergency Stop)

- Check that the Deadman switch is not pressed when the system is used in the TEACH or CHECK mode.
- Check that the E.S. (Emergency stop) button of the Teach Pendant is unlocked.
- Check that the E.S. (Emergency Stop) connector of the controller is not open.
- Check that the 24 V fuse is not burnt-out.

For details, refer to the section describing the "Emergency Stop (E.S.) Function" in your "Robot Controller User's Guide."

(3) A-CAL

Refer to Chapter 3 "A-CAL."

(4) Teaching

Before proceeding with automatic operation, you are required to preset operating positions of the robot. It is possible to set position data by any of the following four methods.

- Input data manually with the numeric keys.
- Teach an operating position by moving the robot to a desired position. (Hereinafter called teaching)
- Transfer data from a memory card.
- Transfer data from the Hr editor[i].

For details, refer to Chapter 5 "TEACH MODE."

(5) Check

- Set the operating conditions in the System Parameter.
  Speed, acceleration, PULL-UP motion, ARCH motion, etc.
  For details, refer to Chapter 19 "DETAILS OF SYSTEM PARAMETER."
- Check the teaching point in the CHECK mode.
  Refer to Chapter 6 "CHECK MODE".

[i] Refer to separate volume, "HR Editor Operation Manual."

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(6) Automatic operation

Check the following to ensure proper operation.

For details, refer to Chapter 7 "ON-LINE MODE."

- AUTO mode
  I/O check
- ON-LINE mode
  Communication speed with the host computer
  Station number of each robot

NOTE

- Operation procedures of the Teach Pendant can differ slightly depending on the type of the robot or controller used. Confirm the type of your robot/controller.
- We have our robot control languages, HARL-U1 and HARL-III. As the instruction manuals for them are provided separately, please purchase them if required.

DANGER

- Before turning ON the power, make sure that all the cables between the robot and the controller are securely connected.
- Before starting the operation of the robot, make sure that there is no person or obstacle in the operating range of the robot.
- The robot can be extremely hazardous if it is used in the wrong way. Never use it in a manner other than the one specified in this manual.
- Do not drop or throw the Teach Pendant.
- Do not use the robot at high ambient temperatures (40ºC or higher) or high humidities. Also, avoid a dusty place and a place where greasy fumes or inflammable/corrosive gas is generated.
- When carrying the Teach Pendant, always grasp it by the body. Never carry it by the cable.
- During robot position teaching or maintenance work, hang the warning sign shown below on the operation panel to prevent a third person from touching the switches on the operation panel.



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CHAPTER 2 OPERATION METHOD OF TEACH PENDANT

2.1 Overview of Teach Pendant

At present there are Teach Pendant two kinds. If controller is CE type, Teach Pendant, H-3333, is used. If controller is other than CE type, Teach Pendant, H-3660, is used.

2.1.1 External View of Teach Pendant

The following figure shows the external view and names of the Teach Pendant.

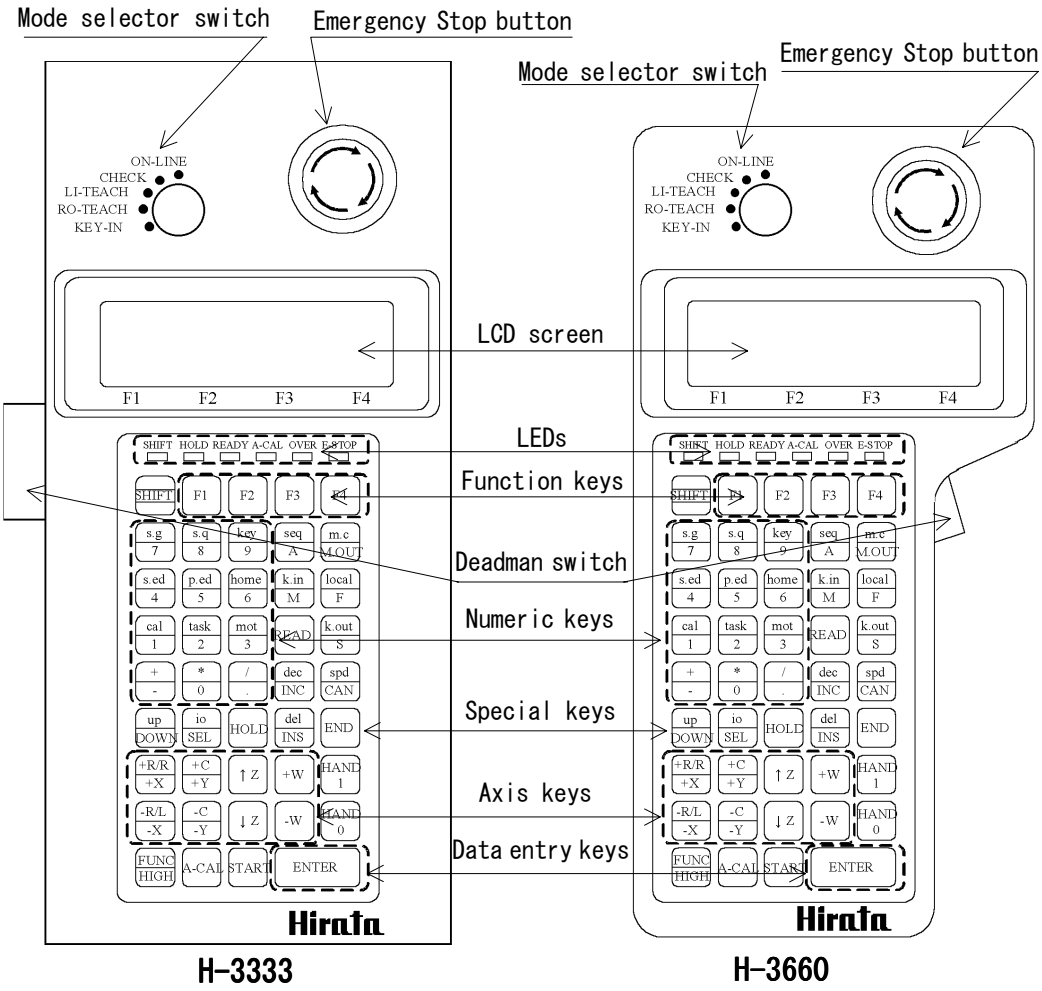


Fig. 2. 1 External view and names of Teach Pendant

(1) Emergency Stop button

Stops the robot immediately in the event of an emergency. When this button is pressed, connection between the servo amplifier/driver and the motor will be interrupted, and the motor of each axis will stop. This button will be locked when pressed, and unlocked when turned clockwise.

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(2) Deadman switch

This switch must be held down when the system is in a mode to operate the robot manually (RO-TEACH, LI-TEACH, or CHECK). Otherwise, Emergency Stop becomes activated and the robot cannot be operated.



Release this switch in the event of a dangerous occurrence during teaching.

(3) Mode selector switch

Select the operation mode of the Teach Pendant. The following five operation modes are available.

① KEY-IN
Enters data using the numeric keys and controls a memory card.

② RO-TEACH (rotary teach)
Performs position teaching by actually moving the robot. Each axis can be operated independently using the axis keys.

③ LI-TEACH (liner teach)
Performs position teaching as well as RO-TEACH. When the axis key is pressed in this mode, the end of the robot will move linearly along the X-Y coordinate axis set by the 「DISPLAY OFFSET」[i] in the System Parameter.

④ CHECK
Checks that taught position data is correct by actually positioning the robot to the specified point.

⑤ ON-LINE
Performs automatic operation according to the signals inputted from outside. The key of the key switch can be pulled out only when this mode is selected.

(4) Special keys

Edit position data.

(5) Numeric keys

Type in numeric values.

(6) Axis keys

Move the robot manually. The robot moves only when this key is held down. When the FUNC HIGH key is pressed simultaneously, the robot moves at a high speed.

(7) Data entry keys

Fixes the data entered in respective modes.

[i] Refer to in the System Parameter, 「OFFSET」 → 「DISPLAY OFFSET1 - 3」 → 「DISP.**」

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(8) FUNC keys

When this key is held down, functions printed on the blue parts of the keys will be active.

(9) SHIFT key

When the 『SHIFT』 LED is lit, functions printed on the pink parts of the keys will be active.

(10) LCD screen

Displays various data and messages. For details, refer to 2.6 "Display (LCD Screen)."

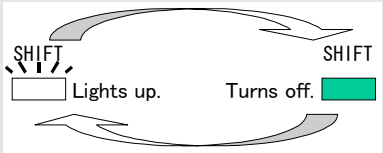
(11) LEDs

① SHIFT

Alternately lights up and turns off each time the SHIFT key is pressed. When this LED is lit, functions printed on the pink parts of the keys of the Teach Pendant will become active.

NOTE

The SHIFT key is of software-locked type. When pressed once, the 『SHIFT』 LED at the upper left will light up; when pressed again, the 『SHIFT』 LED will turn off. When this key operation is required hereafter, such a procedure is indicated with SHIFT in this manual.



② HOLD

Lights up if there is even one axis in the HOLD (servo lock) status. On the LCD screen, the position data of the axis on HOLD is asterisked (*).

Example: When the Z axis is on HOLD

```
 0050  M10  F99  S00  R  0
   X  0500.05  Y  0080.00
 *Z  0020.10  W  0100.00
LI—TEACH
```

In the KEY-IN mode, the HOLD status will be cancelled. When the axis is equipped with a brake, the brake will become activated instead. Therefore, this LED will turn off in this case.

③ READY

Lights up when the controller is ready for operation (when all of the following conditions are satisfied).

- The selector switch of the Teach Pendant is set to "ON-LINE."
- A-CAL is completed.
- No error has occurred.
- "IN0" (SELECT signal) is inputted from the DI.

Under normal conditions, this LED is lit during automatic operation. If this lamp is off during automatic operation, check that the above conditions are satisfied.

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④ A-CAL
Lights up when A-CAL is completed.

⑤ OVER
Lights up when the OVERRUN sensor is ON.
The message “OVERRUN” will appear on the message line of the LCD screen at the same time.

⑥ E-STOP
Lights up when Emergency Stop is activated.
The message “EMERGENCY STOP” will appear on the message line of the LCD screen at the same time.

2.1.2 Specifications of Teach Pendant of CE type Controller

Table 2. 1 Teach Pendant specifications

Item	Specification
Type	H-3333
Size	105 mm(W) 260 mm(D) 44 mm(H)
Cable length	4 m (Option: 8 m)
Weight	1 kg (when 4 m cable is used)
Environment	Operating temperature: 0 to 50℃ Storage temperature: -20 to 60℃
Operation mode	KEY-IN, TEACH, CHECK, ON-LINE
Display	LCD screen (20×4), LEDs
Stopping Device	Lock-type Emergency Stop button, Deadman switch

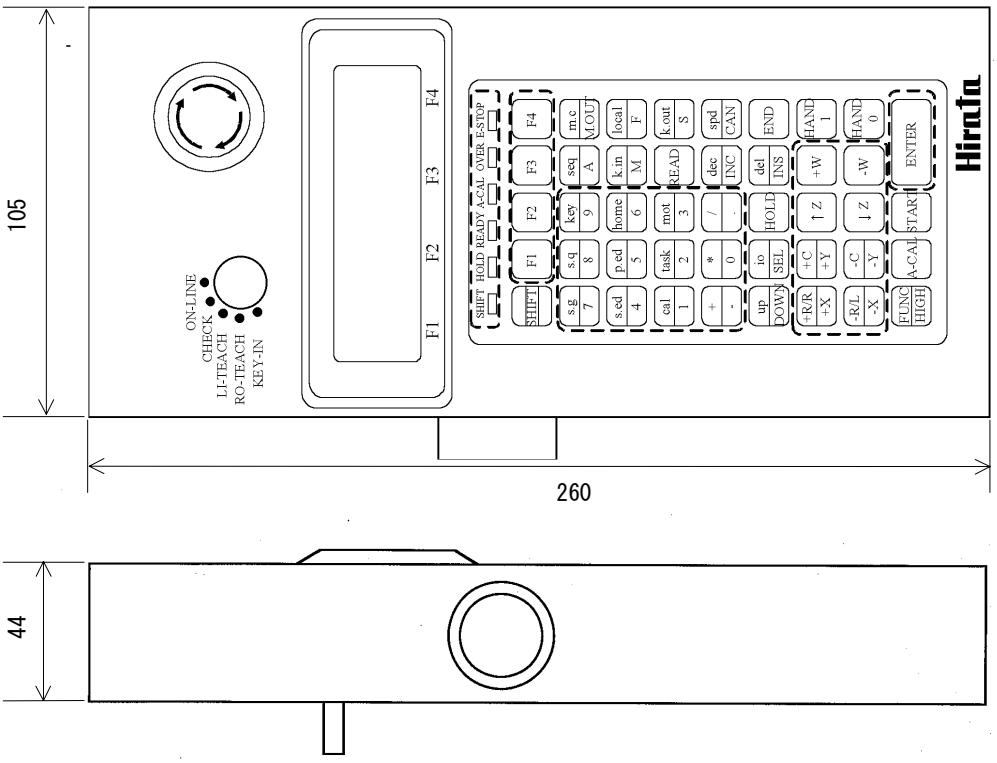


Fig. 2. 2 Outside dimensions of Teach Pendant

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2.1.3 Specifications of Teach Pendant of Other than CE type Controller

Table 2.2 Teach Pendant Specifications

Item	Specification
Type	H-3660
Size	107 mm(W) 238 mm(D) 40 mm(H)
Cable length	4 m (Option: 8 m)
Weight	1kg (when 4 m cable is used)
Environment	Operating temperature: 0 to 50℃ Storage temperature: -20 to 60℃
Operation mode	KEY-IN, TEACH, CHECK, ON-LINE
Display	LCD screen (20×4), LEDs
Stopping Device	Lock-type Emergency Stop button, Deadman switch

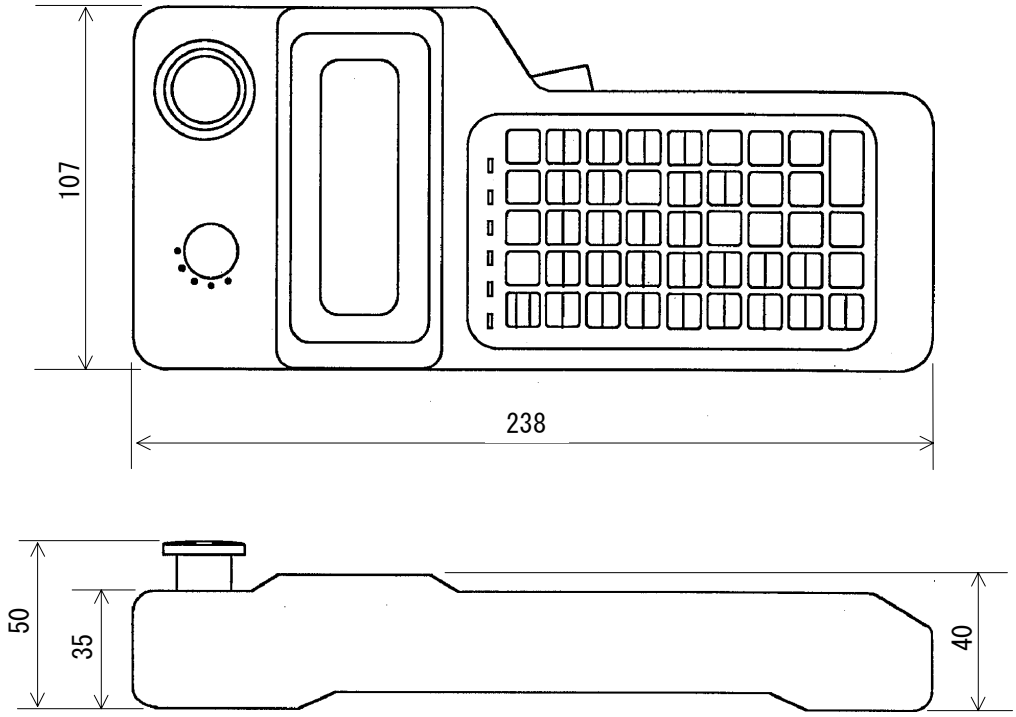


Fig.2. 3 Outside dimensions of Teach Pendant

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2.2 Connecting Teach Pendant

(1) Turn off the power of the controller; then connect the Teach Pendant to the controller.

(2) Lock the connector of the Teach Pendant. (See the figure below.)

Insert the connector in the direction of ①, and move the connector locks in the direction of ② to lock the connector.

(3) Check that the trunk cable between the robot and the controller is securely connected; then turn ON the power of the controller.

(4) After power is turned on, the『E-STOP』LED on the Teach Pendant will light up and a buzzer will sound for about one second. The Teach Pendant is ready for use if the 『E-STOP』 LED turns off and the buzzer stops.

(5) When disconnect the Teach Pendant, turn off the power of the controller beforehand.

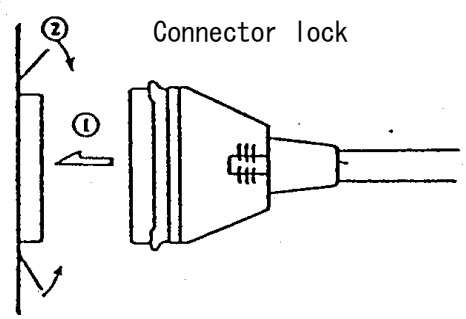


Fig.2. 4 Connector lock

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2.3 Switching Operation Mode

The mode of the robot should be switching according to need. The robot has the following four operation modes.

Table 2. 3 Operation mode

Mode	Function	Reference
KEY-IN	Enters data and controls memory card.	Chapter 4
TEACH	Performs position teaching actually moving the robot.	Chapter 5
CHECK	Checks the validity of position data by actually moving the robot to the taught position.	Chapter 6
ON-LINE	Performs automatic operation.	Chapter 7

In the TEACH mode, either of the following teach modes is selected according to the coordinate system display.

- LI-TEACH (linear teach) mode

  Performs position teaching by actually moving the robot. If the axis key is pressed, the end of the robot will move linearly along the X-Y coordinate axes set by the 「DISPLAY OFFSET」[i] in the System Parameter.

- RO-TEACH (rotary teach) mode

  Performs position teaching by actually moving the robot. Each axis can be operated independently using axis keys.

2.4 Emergency Stop Button





This button is used to stop the robot immediately in the event of an emergency. When this button is pressed, connection between the servo driver and motor will be interrupted, the motor of each axis will stop, and 『E-STOP』 LED light up. This button is locked when pressed, and unlocked when turned clockwise. When this button is unlocked, the 『E-STOP』 LED will turn off.

[i] Refer to in the System Parameter 「OFFSET」 → 「DISPLAY OFFSET1-3」 → 「DISP. * *」

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2.5 Basic Data Entry Procedure

The following explains the basic procedure for entering data with the Teach Pendant.

(1) Item selection

To select an entry item, use the key assigned for each mode or the up/DOWN key, which moves a cursor to the right/left or up/down. When no particular entry procedure is specified, move a cursor with this key and select a desired item.

(2) Numeric value entry

Entry of coordinate values and System Data is in most of case to be made by typing in numeric values. The keys that used in typing in numeric values are the +/−, */0, ／/., cal/1, task/2, mot/3, s.ed/4, p.ed/5, home/6, s.g/7, s.p/8, and key/9 keys. The +/− and ／/. key are accepted only when they are requested. The following is an example of numeric value entry.

① Type in a numeric value.

② When the ENTER key is pressed, the message "ENTER OK ?" will appear on the message line. To fix the entered data, press the ENTER key again. If you wish to cancel the data, press a key other than ENTER key.
The data entered in step ① will be fixed. The entered numeric value will be automatically converted according to the format prescribed for each parameter. The following are the examples of the entry of coordinate values (rectangular coordinates).
When a value exceeding the prescribed number of digits is entered, a completely different value will be displayed.

- +123456.789 → 4569.00

Once entered data is fixed, a plus sign (+) will be omitted. You do not need to enter a plus sign when the numeric value is plus.

- 456.7 → 0456.70
- -12 → -0012.00

(3) ON/OFF entry

When data is displayed as "ON" or "OFF," you can select either of them using the io/SEL key or the */0 or cal/1 key. The io/SEL key switches between "ON" and "OFF." The */0 and cal/1 keys correspond to "OFF": 0 and "ON": 1 respectively. After the selection, press the ENTER key to fix the entered data in the same manner as (2) above.

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(4) YES/NO entry

When data is displayed as “YES” or “NO,” you can select either of them using the [io SEL] key or the [* 0] or [cal 1] key. The [io SEL] key switches between “YES” and “NO.” The [* 0] and [cal 1] keys correspond to “NO” :0 and “YES” :1 respectively. After the selection, press the [ENTER] key to fix the entered data in the same manner as (2) above.

(5) Special data entry

To select the data for the 「TRANSFER RATE」[i] in the System Generation or the mode of position memory operation, use the [io SEL] key or the [* 0] to [key 9] keys. The [io SEL] key switches a selection in sequence.

For example, in the case of the 「TRANSFER RATE」 in the System Generation, the selection switches as follows:

300 → 600 → 1200 → 2400 → 4800 → 9600 → 19200 → 38400

The numeric keys correspond to respective values as follows:

0:300/1:600/…./5:9600/6:19200/7:38400

When the numeric keys are used, you can select a value out of only ten values that are related to the [* 0] to [key 9] keys. After the selection, press the [ENTER] key to fix the entered data in the same manner as (2) above.

[i] Refer to in the System Generation 「ORGIN」 → 「SET-UP SYSTEM」 → 「TRANSFER RATE」

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2.6 Display(LCD Screen)

The LCD screen displays various data and messages in each mode. The screen is capable of displaying 4 lines of 20 characters (80 characters in total). The following figure shows an example of screen layout.

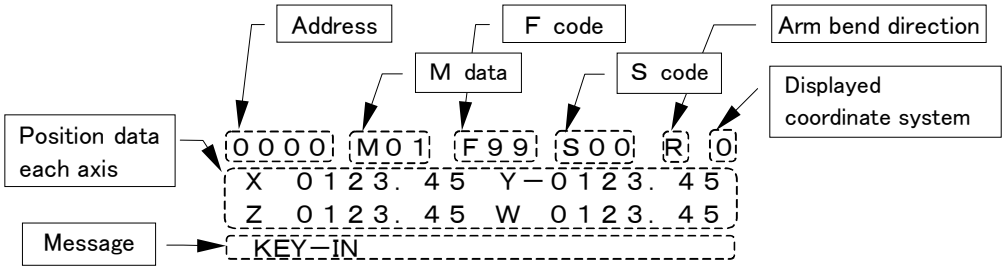


Fig.2. 5 Screen layout

(1) ■: Cursor

the data typed in with the numeric keys will be entered in a position where this cursor.

(2) Address

Shows the address where position data of the robot is stored. The address ranges from 0 to the maximum value specified by the System Generation.

(3) M: M data

Determines the type of output to an external device, and specifies robot motion. For details on the robot motions specified by the M data, refer to 16.5.1 “List of M Data Functions.”

(4) F: F code

Determines the travel speed of the robot. When “F” is set to 99, the speed specified by the system data will be applied. For details, refer to 16.6 “F Code.”

(5) S: S code

Is used for expanded functions. For details on the robot motions specified by the S code, refer to 16.5.2 “List of S Code Functions.”

(6) R or L: Arm bend direction

Specifies the bend direction of the robot arm. In the case of the SCARA (horizontal multi-articulated type) robot (AR), there is a position where the robot can arrive in whichever direction its arm is bent. (See Figures 2.5: Arm right bending (R) and 2.6: Arm left bending (L) [i].) Therefore, the direction of arm bending must be specified when position data is entered with the numeric keys. In the case of the Cartesian type robot (MB), it does not need setting.

[i] These figures show the view from the top.

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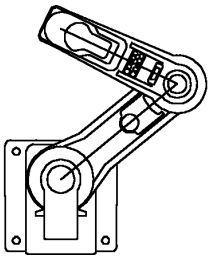


Fig.2. 6 Arm right bending (R)

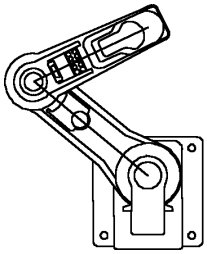


Fig.2. 7 Arm left bending (L)

(7) Displayed coordinate system (Displayed in a number between 0 and 9)

Shows the coordinate system that is currently displayed on the screen of the Teach Pendant.

Table 2. 4 Setting value and description of each coordinate system

Setting value	Description
0	Coordinate system based on DISPLAY OFFSET 1[i]
1	Coordinate system based on DISPLAY OFFSET 2
2	Coordinate system based on DISPLAY OFFSET 3
3	Used when COORDINATE OFFSET is used.
4	Counter display (pulse display) of each axis
5	
6	
7	
8	
9	Used when COUNTER OFFSET is used.

(8) X, Y, Z, W (Position data)

Shows the position data of each axis stored in the displayed address. Under normal conditions, data of up to four axes are displayed simultaneously according to the number of axes that the robot has.

When a special ROM is used, the display of up to six axes including "R" and "C" is possible. However, it becomes impossible to display an error message in that case.

(9) Message

Displays various messages. The messages are classified into two types, i.e. general messages to show information like a currently selected mode and error messages to notify the operator of the error state of the robot. For details, refer to Chapter 23 "MESSAGE."

When a mode other than KEY-IN is selected, you can check the version of the software while you hold the READ key down.

"OLD DATA V2.40"

This message shows that the software version is 2.40.

[i] Refer to in the System Parameter 「OFFSET」→「DISPLAY OFFSET 1 to 3」→「DISPLAY *」

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(10) Function

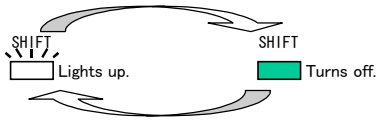
Shows the function mode that is currently displayed on the Teach Pendant. The function mode is a mode that is selected by the FUNC HIGH + cal 1 to key 9, io SEL, m.c M.OUT, k.in M, k.out S, local F or seq A keys. For details, refer to 2.8 “Function Mode.”

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2.7 Special Key

The Teach Pendant has some keys that have special functions besides data entry.

(1) SHIFT key



The 『SHIFT』 LED lights up and turns off alternately each time this key is pressed.

When the 『SHIFT』 LED is lit, functions printed on the pink parts of the keys will be active. For example, if you press the del INS key while the 『SHIFT』 LED is lit, it is regarded that the [del] key is pressed. When the 『SHIFT』 LED is off, it is regarded that the [INS] key is pressed.

NOTE

Besides the SHIFT key, the FUNC HIGH key also selects some functions when used in combination. While you hold the FUNC HIGH key down, functions printed on the blue parts of the keys become active. For details, refer to 2.8 “Function.”

(2) up DOWN key : Cursor move key

The [DOWN] key moves a cursor to the right (or down when there is no further entry item on the right). The [up] key moves a cursor to the left (or up when there is no further entry item on the left).

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2.8 Function Mode

The mode that is selected by the FUNC HIGH + cal 1 to key 9, io SEL, m.c M.OUT, k.in M, k.out S, local F or seq A keys is called a function mode. This mode can be used whatever mode the Teach Pendant is currently in. However, its data is displayed only when the home screen is displayed. (Refer to (2) [task] key.)

Because various function modes can be used independently of the mode of the Teach Pendant, be careful not to mistake them for malfunctions when using these function modes.

The details of each function mode are described below. The terms inside the parentheses are the names of the functions.

When the mode selector switch is set to "ON-LINE," you cannot enter data using a function mode. You can only check data.

(1) FUNC HIGH + cal 1 [cal] key (Calculation)

Automatically calculates the characteristic value of the robot, palletization data, position data offset, servo parameters, etc. (Refer to Chapter 12 "AUTOMATIC CREATION OF POSITION DATA & PARAMETERS.")

(2) FUNC HIGH + task 2 [task] key (task)

Switches the display screen. The screen switches each time the FUNC HIGH + task 2 keys are pressed.

There are three display screens; the first screen is called the home screen.

Table 2. 5 Mode and display screens

Screen No.	Mode	Screen name	Description
1	All modes	Home screen	Normal display
2	KEY-IN TEACH CHECK AUTO	RS232C MONITOR	Displays the communication data sent to/from RS-232C. (Used for maintenance by manufacturer's engineer.)
	ON-LINE		Display should be ignored.
3	KEY-IN TEACH CHECK AUTO	POSITIONING HISTORY	Displays the history of positioning. Data of the last nine addresses will be displayed from the latest one. For details, refer to Chapter 11 "POSITIONING ADDRESS HISTORY."
	ON-LINE	RS232C MONITOR	Displays the communication data sent to/from RS-232C. (Used for maintenance by manufacturer's engineer.)

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NOTE

The data of function modes other than that selected by the [task] key is displayed only on the home screen. When the screen has been switched with the [task] key, press the FUNC HIGH + task 2 keys to return to the home screen.

(3) FUNC HIGH + mot 3 [mot] key (Motion)

Adjusts Servo Offset[i] and performs aging[ii].

(4) FUNC HIGH + s.ed 4 [s.ed] key (Sequence edit)

Has the same function as the [p.ed] key.

(5) FUNC HIGH + p.ed 5 [p.ed] key (Position edit)

Edits position data in block. (Refer to 8.5 "Editing Position Data in Block.")

(6) FUNC HIGH + home 6 [home] key (Home mode)

Switches the display directly to the home screen when a screen other than the home screen is displayed. However, this key cannot bring up the home screen when the display has been switched with the task 2 key.

(7) FUNC HIGH + s.g 7 [s.g] key (System Generation)

Switches the system to the mode to edit the System Generation. (Refer to Chapter 18 "DETAILS OF SYSTEM GENERATION.")

(8) FUNC HIGH + s.p 8 [s.p] key (System Parameter)

Switches the system to the mode to edit the System Parameter. (Refer to Chapter 19 "DETAILS OF SYSTEM PARAMETER.")

(9) FUNC HIGH + key 9 [key] key (KEY-IN)

Switches the system to the KEY-IN mode when pressed in the ON-LINE mode. (Refer to Chapter 4 "KEY-IN MODE.")

[i] For details, refer to your Robot Controller User's Guide.
[ii] For details, refer to 2.9 "Aging Procedure."

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(10) FUNC/HIGH + io/SEL ［io］ key （IO）

Switches the display to the DI/DO monitor. (Refer to 9.1 “DI/DO Monitor.”)

(11) FUNC/HIGH + m.c/M.OUT ［m.c］ key （Memory card）

Switches the system to the mode to use a memory card. (Refer to Chapter 13 “MEMORY CARD.”)

(12) FUNC/HIGH + k.in/M ［k.in］ key （Key macro input）

Starts or stops storing key entries in memory. Key entries made between a press of the K.in/M key and the next press are stored.

(13) FUNC/HIGH + k.out/S ［k.out］ key （Key macro output）

Repeats the key entries stored by the K.in/M key.

The following shows an example of a key entry macro.

Example

When you wish to set the Z-axis data to 10.

① FUNC/HIGH + k.in/M ···Start storing key entries.

② 1Z → cal/1, */0 → ENTER → ENTER ···Sets the Z-axis to 10.

③ FUNC/HIGH + k.in/M ···Stops storing key entries.

④ Read the address where you wish to set the Z-axis data to 10.

⑤ FUNC/HIGH + k.out/S ···Executes the key macro.

⑥ The Z-axis data of the read address will be set to 10. Key entry macros are very useful when you need to repeat the same key entries.

(14) FUNC/HIGH + local/F ［local］ key （Local）

Makes a cursor jump to the section of the displayed coordinate system.

The following is procedure for setting the coordinate system to be display.

① Press the FUNC/HIGH + local/F keys.

② Enter the value for the coordinate system to be displayed, and press the READ key. Selections of setting values are shown in the

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table below. If you change this value, robot motion in the TEACH mode and position data on the display will change.

Table 2. 6 Setting value and description of each coordinate system

Setting value	Description
0	Coordinate system based on DISPLAY OFFSET 1
1	Coordinate system based on DISPLAY OFFSET 2
2	Coordinate system based on DISPLAY OFFSET 3
3	Used when COORDINATE OFFSET is used.
4	Counter display (pulse display) of each axis
5	
6	
7	
8	
9	Used when COUNTER OFFSET is used.

(15) FUNC HIGH + seq A [seq] key (Sequence)

Switches the system to the mode to enter sequence data. This key is also used when special data entry is required.

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2.9 Aging Procedure

Aging means repeated positioning for breaking-in of the robot or for detecting an error. The robot speed at the time of aging is determined by the value set in the System Parameter[i] 「MOTION」→「AXIS SPEED」→「AXIS A,B(X,Y),W」, 「AXIS Z」

(1) Execute A-CAL. This is not necessary when A-CAL has already been executed. For the procedure for A-CAL, refer to 3.4 "A-CAL Procedure."

(2) Set the position data for positioning. Be sure to enter an END point (M data = ??) at the end of the position data. For the procedure for entering an END point, refer to 8.1 "Entering END Point (M data = ??) ."

(3) Set the mode selector switch of the Teach Pendant to "CHECK."

(4) During aging, the robot moves at the same speed as that for automatic operation. Therefore, confirm the operation of the robot in the CHECK mode beforehand. Read the first address of the position data entered in step (2), and try positioning the robot at all the points up to the END point in the set order.

(5) Press the FUNC HIGH + mot 3 keys; then the following screen will appear.

```
Motion Set
Motion = [NORMAL    ]
Motion Address    0000
Aging Count       0000
```

Fig.2.8 Aging screen

(6) Enter data.

To select the data for "Motion," press the io SEL key.

For the other parameters, enter data by the following procedure.

① Type in desired data.

② Check that the entered data is correct, and press the ENTER key. The message
"ENTER OK ?"
will appear on the message line, and a buzzer will sound.

③ Recheck that the data is correct, and press the ENTER key again. Then the data will be set.

The description of each parameter is shown below.

- Motion
  Select a desired operation from the following three options.

[i] You can jump to it with the FUNC HIGH + s.p 8 keys.

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・NORMAL
・AGING
・ADJUST (Servo offset adjustment)

- Motion Address
  Enter the first address of the position data entered in step (2).
- Aging Count
  Enter the number of aging to be performed. When you do not specify the count, enter "0."

(7) Set the mode selector switch of the Teach Pendant to "ON-LINE." The message

"AGING"

will appear on the message line.

(8) Start aging of the robot. After checking the safety of the surroundings and making yourself ready to press the emergency stop button of the Teach Pendant, press the START key.

DANGER

① In the event you observe any abnormal condition such as unusual noise or vibration, press the emergency stop button to stop aging.
② During aging, the robot will be accelerated to the highest speed according to the speed setting in the System Generation.

(9) The robot performs aging operation.

(10) To finish the aging, switch the system to a mode other than ON-LINE.

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CHAPTER 3 A-CAL

3.1 Outline of A-CAL

When you start operating the robot, the 『A-CAL (Automatic origin calibration)』 LED must be lit. Detection of the position of each robot axis is done by the counter in the controller, which counts the pulses generated by the encoder connected to each axis motor. As the encoder and the counter are operated by electricity, the count will not be performed if power is not supplied to the controller. To enable the robot to be positioned to the same position each time and to let the controller detect the position of the robot correctly, it is necessary to match the reference point of the robot to that of the controller.

A-CAL means automatic origin calibration (return to origin) of both the robot and the controller in order to match their reference points.



You do not need to execute A-CAL repeatedly unless the 『A-CAL』 LED turns off.

Once you have executed A-CAL after turning on the power, it is not necessary to execute it repeatedly unless the power is shut off. (You can specify whether A-CAL should be executed after the restoration from emergency stop, by setting the data of the System Parameter[i] 「SET-UP」→「SYSTEM」→「EMERGENCY STOP」.)

[i] You can jump to it with the FUNC HIGH + s.p 8 keys.

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3.2 A-CAL Parameter

The following table shows the data that are referred to when A-CAL is performed.

For details, refer to Chapter 18 “DETAILS OF SYSTEM GENERATION” and Chapter 19 “DETAILS OF SYSTEM PARAMETER.”

Table 3. 1 A-CAL setting data

Parameter	Description	Setting data
System Generation[i]→ 「MAINTE」→ 「MAINTENANCE DATA」→ 「A-CAL CHECK」	Specifies the type of A-CAL operation. 0 : Performs normal A-CAL using sensors and makers. 1 : Gives a warning when the origin point of the robot is outside the prescribed area, but continues processing. 2 : Ignores the error that occurs when the origin point of the robot is outside the prescribed area. 8 : Performs A-CAL on a specified axis. (When both the ABS motor[ii] and the Incre. Motor[iii] are mounted.) 16 : Compares the position with the stored ZERO signal position in the sensor. (Z-axis only) (Available only to a special robot.) 32 : Used for special robot only. 64 : A-CAL without axis operation [iv] 128 : Stores the ZERO signal position in the sensor. (For ZERO signal adjustment, Z-axis only) (Available only to a special robot.) 256 : Used when two turns of W-axis operating range are used. (Available only to a special robot.)	When you wish to select multiple A-CAL operations, add up respective setting values. For example, when you set this parameter to 17, it means 16 + 1; the robot position when the ORIGIN sensor is turned on will be regarded as the origin point, and a warning will be given when the origin point of the robot is outside the prescribed area, but processing will be continued.

---

[i] You can jump to it with the FUNC HIGH + s.g 7 keys.

[ii] ABS motor: Absolute encoder type motor

[iii] Incre. motor: Incremental encoder type motor

[iv] The present position will be the origin point with no operation of an axis.

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Parameter	Description	Setting data
System Generation→ 「ORIGIN」→ 「AXIS DIRECTION」→ 「A-CAL SEQ」	Specifies the sequence of axes in A-CAL. Each digit corresponds to each axis as shown below. O O O O O O O O ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ A B Z W A B Z W When you wish to perform A-CAL on multiple axes simultaneously, specify the same number for them. The shaded area is used in the second[i].	The setting value ranges from 0000: No sequence specification. A-CAL will be performed in a standard sequence. To 6666: A-CAL will be performed simultaneously on all axes. Standard setting is 2212: A-CAL will be performed first on the Z-axis, and then on the remaining axes upon completion of A-CAL of the Z-axis.
System Parameter[ii]→ 「RESPONSE」→ 「RESPONSE」→ 「A-CAL SPEED」	Specifies the speed of the robot during A-CAL. The speed shall be specified as a percentage of the maximum speed.	The setting value ranges from 1 through 999. (0.1%-99.9%) Standard setting value is 250.

[i] For details, refer to (1) A-CAL SEQ in 18.3.2 “AXIS DIRECTION.”

[ii] You can jump to it with the FUNC HIGH + s.p 8 keys.

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3.3 Flow of A-CAL Operation

When the system is in the TEACH or CHECK mode, press the A-CAL key of the Teach Pendant to execute A-CAL. During automatic operation, use a command inputted from an external device (AUTO mode: SELECT signal, ON-LINE mode: A-CAL command).

In a standard A-CAL operation, A-CAL is performed first on the Z-axis (the axis for up-and-down motion) to prevent interference with the other equipment; then the A (X), B (Y), and W axes will move slowly toward their respective ORIGIN sensors. After these ORIGIN sensors for the A (X), B (Y), and W axes have turned ON, these three axes will move inside the operating range and then move toward the ORIGIN sensors again, for the sake of checking the motors and the sensors. When the ORIGIN sensors have turned ON for the second time and an M signal is generated from the encoder, the position counter in the control panel will be reset to "0," and the origin points of the robot and the controller will be matched.

After this, each axis will return inside the operating range, and then move toward the ORIGIN sensor again. The readout of the counter at the time when the sensor turns ON will be checked.

After the checking of the counter readout, each axis will return inside the operating range and stop, otherwise the axes will remain in an overrun state and the robot cannot be operated. Then A-CAL is completed.

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A-CAL of each axis is performed in accordance with the following flow.

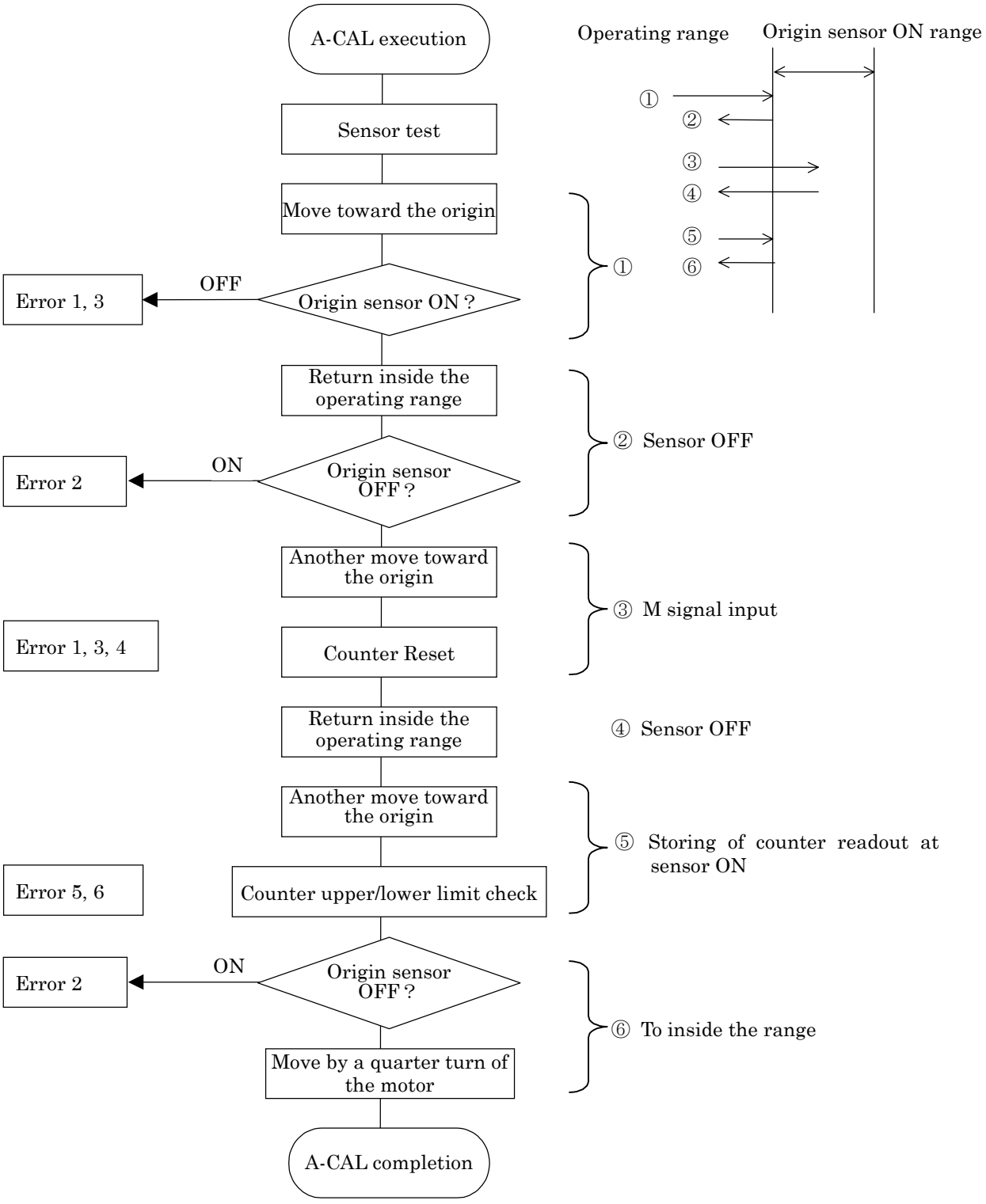


Fig.3. 1 Flow of A-CAL

NOTE

Position of the robot after the completion of A-CAL is not based on precise positioning data.

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3.4 A-CAL Speed

The axis speed for A-CAL is obtained by the following expression.

$$\text{Axis speed} = \text{Maximum axis speed (catalog value)} \times \frac{\text{Output speed value}}{1023}$$

The output speed value varies depending on the A-CAL operation. The following is the list of the output speed values.

Table 3. 2

Operation order	Operation	Output speed value
1	Movement to origin	Can be changed.
2	Movement to operation area side	10
3	Movement to operation at counter reset	8
4	Movement to operation area side at counter reset	8
5	Movement to origin at counter check	8
6	Movement to operation area side at counter check	10

To set the output speed during the movement to the origin in the operation order 1, select the System Parameter 「RESPONSE」→「RESPONSE」→「A-CAL SPEED」 (referred to as A-CAL speed). The output speed is obtained by the following expression.

$$\text{Output speed value} = (\text{Maximum output speed value}^{i} - 10) \times \frac{\text{A-CAL speed}}{999} + 10$$

CAUTION

When the maximum output speed value is smaller than 40, the maximum output speed value shall be 40.

[i] Refer to 26.1 “Robot Speed during Manual Operation.”

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3.5 A-CAL Procedure

When the system is in the TEACH or CHECK mode, press the A-CAL key of the Teach Pendant to execute A-CAL. During automatic operation, use a command inputted from an external device (AUTO mode: SELECT signal, ON-LINE mode: A-CAL command).

The following is the procedure for executing A-CAL manually.

3.5.1 Executing A-CAL on All Axes

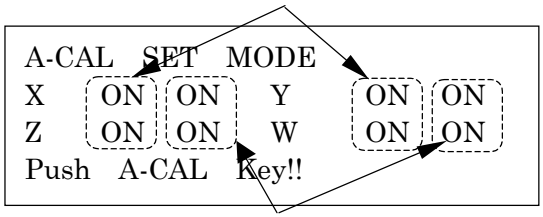
This operation is possible only for the incremental encoder type motor.

(1) Set the mode selector switch of the Teach Pendant to RO-TEACH, LI-TEACH, or CHECK. A-CAL can be executed when any of these modes is selected. The A-CAL procedure is the same in any case.

(2) Hold down the Deadman switch of the Teach Pendant during all the steps described below. If you release the Deadman switch, Emergency Stop will be activated.

(3) Press the A-CAL key. The A-CAL axis selection screen will appear.

Section “a”
ON: A-CAL is selected.
OFF: A-CAL is not selected



Section “b”
ON: A-CAL is completed.
OFF: A-CAL is not completed.

Fig.3. 2 A-CAL axis selection screen

(4) Hold the A-CAL key down until A-CAL is completed.

(5) When A-CAL is completed, the message
“A-CAL COMPLETED”
will appear and a buzzer will sound.



When A-CAL of all the axes is completed, the 『A-CAL』 LED will light up.

CAUTION

If you release the A-CAL key before the completion of A-CAL, A-CAL will be interrupted with a buzzer and the message
“A-CAL INCOMPLETE.”

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As the A-CAL of the selected axes remains incomplete, go back to step (2) and execute A-CAL again.

3.5.2 Executing A-CAL on Specific Axes

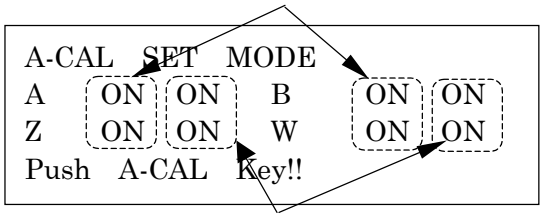
This operation is possible for both the incremental encoder type motor and the absolute encoder type motor. The procedure explained here is the one for the incremental encoder type motor.

(1) Set the mode selector switch of the Teach Pendant to RO-TEACH, LI-TEACH, or CHECK. A-CAL can be executed when any of these modes is selected. The A-CAL procedure is the same in any case.

(2) Hold down the Deadman switch of the Teach Pendant during all the steps described below. If you release the Deadman switch, Emergency Stop will be activated.

(3) Press the A-CAL key. The A-CAL axis selection screen will appear. Then select axes on which you wish to perform A-CAL with the +R/R +X, +C +Y, ↑Z and +W key (or +R/R +X, +C +Y). "ON" will be displayed in the section "a" of the selected axes, and A-CAL will be performed only on these axes. All the axes should be selected in ordinary cases.

Section "a"
ON: A-CAL is selected.
OFF: A-CAL is not selected.



Section "b"
ON: A-CAL is completed.
OFF: A-CAL is not completed.

Fig.3. 3 A-CAL axis selection screen

- +R/R +X key: Selects the A axis.
- +C +Y key: Selects the B axis.
- ↑Z key: Selects the Z axis.
- +W key: Selects the W axis.
- SHIFT, +R/R +X key: Selects the R axis when a special ROM is used.
- SHIFT, +C +Y key: Selects the R axis when a special ROM is used.

(4) When the selection of axes is completed, hold the A-CAL key down until A-CAL is completed.

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(5) When A-CAL is completed, the message
"A-CAL COMPLETED"
will appear and a buzzer will sound.



When A-CAL of all the axes is completed, the 『A-CAL』 LED will light up.

CAUTION

If you release the A-CAL key before the completion of A-CAL, A-CAL will be interrupted with a buzzer and the message
"A-CAL INCOMPLETE."
As the A-CAL of the selected axes remains incomplete, go back to step (2) and execute A-CAL again.

3.5.3 A-CAL of Absolute Encoder Type Motor Manufactured by Sanyo Denki Co., Ltd.

CAUTION

1. When executing A-CAL, be sure to follow the procedure described below.
2. Reset of the absolute encoder required at system start-up and such must be performed after the completion of adjustments such as sensor adjustment following temporary A-CAL. The robot can be operated even if A-CAL is executed without the reset of the absolute encoder. However, this A-CAL will be a temporary one, and displacement of the robot may occur in the case where the power is turned off and on again. For proper A-CAL, execute A-CAL together with the reset of the absolute encoder.
3. In the following cases, displacement of the robot may occur after the power is turned off and on again
   - A-CAL is executed without the reset of the encoder (step (4) below).
   - The encoder is reset, but an axis of the robot is moved before the execution of A-CAL.
   - A-CAL is interrupted halfway through the operation.
   - A-CAL is executed after the power is turned on with no battery connected.
4. When displacement of the robot occurs after the power of the controller is turned off and on even though the 『A-CAL』 LED is lit, execute A-CAL again following the procedure described below.
5. When the system cannot be started up normally, turn on the power while holding down the cal 1 key of the Teach Pendant, and release it when normal display appears.

(1) Set the mode selector switch of the Teach Pendant to KEY-IN.

(2) Turn on the power of the controller.

(3) Select System Generation 「MAINTENANCE」→「MAINTENANCE DATA」→「EMP SELECT」, and set this parameter to 255. When a value other than 255 is given, a servo error will occur during A-CAL.

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CAUTION

Be sure to record the original data. The data must be restored to the original one after the completion of A-CAL.

(4) Reset the encoders of all the axes by the following procedure.

NOTE

The encoder must be reset even when the 7-segment LED of the servo driver displays "U." A-CAL is required after the "U" error is remedied.

① Check that a 2-pin connector exists in the controller.

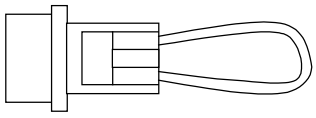


Fig. 3. 4 2-pin connector

② Check that the servo driver that requires encoder reset has a connector with mark tubes bearing inscriptions "**CLR" and "24N." The "**" in the mark tube inscription shows the name of each axis.

③ Connect the 2-pin connector to the connector of the servo driver. Wait for four seconds, and then disconnect the connectors.

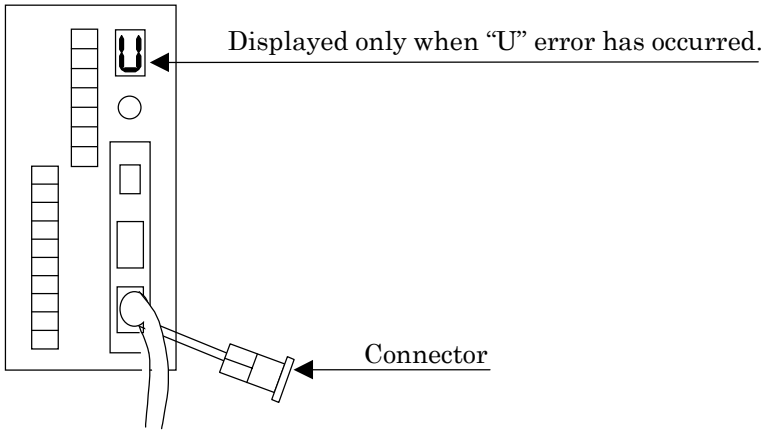


Fig. 3. 5 Connector connection

(5) Turn off the power of the controller.

(6) Turn on the power of the controller again.

(7) Press the FUNC HIGH + cal 1 keys to switch the system to the ROBOT CALCULATE mode (the mode for automatic creation of position data and parameters). Each axis' pulse data at the time when the power is turned on is displayed in "ABS.ENC.A" through "ABS.ENC.W[i]" of the ABS.DATA in the MEMORY mode. (For

[i] "ABS.ENC.R" and "ABS.ENC.C" will be added when a special ROM is used.

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details, refer to 12.3.2 “ABS.DATA SET (Absolute encoder data).”) If the pulse data is within ±8192, reset of the absolute encoder is complete.

(8) Set the mode selector switch of the Teach Pendant to RO-TEACH.

(9) Display pulse data for the position data.

① Press the [FUNC HIGH] + [local F] keys

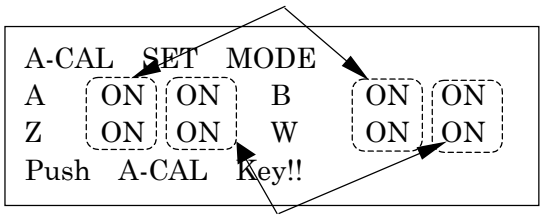
② Press the [s.ed 4] key.

③ Press the [READ] key.

(10) Hold down the Deadman switch of the Teach Pendant during all the steps described below. If you release the Deadman switch, Emergency Stop will be activated.

(11) Press the [A-CAL] keys. The A-CAL axis selection screen will appear. Then select axes on which you wish to perform A-CAL with the [+R/R +X], [+C +Y], [↑Z] and [+W] (or [+R/R +X], [+C +Y]) keys. “ON” will be displayed in the section “a” of the selected axes, and A-CAL will be performed only on these axes. All the axes should be selected in ordinary cases.

Section “a”
ON: A-CAL is selected.
OFF: A-CAL is not selected.



Section “b”
ON: A-CAL is completed.
OFF: A-CAL is not completed.

Fig.3. 6 A-CAL axis selection screen

- [+R/R +X] key: Selects the A axis.
- [+C +Y] key: Selects the B axis.
- [↑Z] key: Selects the Z axis.
- [+W] key: Selects the W axis.
- [SHIFT], [+R/R +X] key: Selects the R axis when a special ROM is used.
- [SHIFT], [+C +Y] key: Selects the R axis when a special ROM is used.

(12) When the selection of axes is completed, hold the [A-CAL] key down until A-CAL is completed.

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(13) When A-CAL is completed, the message

"A-CAL COMPLETED"

will appear and a buzzer will sound.



When A-CAL of all the axes is completed, the 『A-CAL』 LED will light up.

CAUTION

If you release the [A-CAL] key before the completion of A-CAL, A-CAL will be interrupted with a buzzer and the message
"A-CAL INCOMPLETE."
As the A-CAL of the selected axes remains incomplete, go back to step (4) and execute A-CAL again.

(14) Move the axes that have finished A-CAL by approx. 100 mm toward the operating range. Then check and record the current axis position data by means of pulse data.

The following is the procedure for displaying pulse data.

① Press the [FUNC HIGH] + [local F] keys.

② Press the [s.ed 4] key.

③ Press the [READ] key.

(15) Switch the system to the KEY-IN mode.

(16) Turn off the power of the controller.

(17) Turn on the power of the controller again.

(18) Switch the system to the RO-TEACH mode, and let the screen display position data in pulses.

(19) Compare the current position data on the display with the data recorded in step (14) (before the power is turned off). A-CAL can be considered to be successful if the difference between the two data is within 100 pulses. If the difference exceeds 100, go back to step (4) and execute A-CAL again on the axis in question.

(20) If A-CAL has been performed successfully, press the [FUNC HIGH] + [cal 1] keys to switch the system to the ROBOT CALCULATE mode (the mode for automatic creation of position data and parameters). Then record the data in "A-CAL DIS.A" through "A-CAL DIS.W[i]" of the ABS.DATA in the MEMORY mode. This data is used for restoration in case system data is corrupted.

(21) Select System Generation 「MAINTENANCE」→「MAINTENANCE DATA」→「EMP SELECT」and restore the data of this parameter to the original one in step (3).

[i] "A-CAL DIS.R" and "A-CAL DIS.C" will be added when a special ROM is used.

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3.5.4 A-CAL of Absolute Encoder Type Motor Manufactured by Yasukawa Electric Corp.

CAUTION

1. When executing A-CAL, be sure to follow the procedure described below.
2. Reset of the absolute encoder required at system start-up and such must be performed after the completion of adjustments such as sensor adjustment following temporary A-CAL. The robot can be operated even if A-CAL is executed without the reset of the absolute encoder. However, this A-CAL will be a temporary one, and displacement of the robot may occur in the case where the power is turned off and on again. For proper A-CAL, execute A-CAL together with the reset of the absolute encoder.
3. In the following cases, displacement of the robot may occur after the power is turned off and on again
   - A-CAL is executed without the reset of the encoder (step (3) below).
   - The encoder is reset, but an axis of the robot is moved before the execution of A-CAL.
   - A-CAL is interrupted halfway through the operation.
   - A-CAL is executed after the power is turned on with no battery connected.
4. When displacement of the robot occurs after the power of the controller is turned off and on even though the 『A-CAL』 LED is lit, execute A-CAL again following the procedure described below.
5. When the system cannot be started up normally, turn on the power while holding down the cal / 1 key of the Teach Pendant, and release it when normal display appears.

(1) Select System Generation 「MAINTENANCE」→「MAINTENANCE DATA」→「EMP SELECT」and set this parameter to 255. When a value other than 255 is given, a servo error will occur during A-CAL.

CAUTION

Be sure to record the original data. The data must be restored to the original one after the completion of A-CAL.

(2) Turn off the power of the controller.

(3) Disconnect the battery from the encoder of the robot. Then connect the supplied connector for encoder reset to the connector to which the battery has been connected.

Be sure to use the connector for resetting all axes. For the position of the battery, refer to the operation manual for the robot.

(4) Leave the system for a specified time period with the encoder reset connector connected. The counter set in the encoder will then be reset to 0.

The specified time varies depending on the type of the controller used.

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HNC-194 controller (AR-Z651)
Z axis: 5 - 10 minutes
A, B, and W axes: 3 seconds (Σ-series servo driver)

HNC-394 controller (AR-K400CL)
All axes: 3 seconds (Σ-series servo driver)

The specified time for other Yasukawa-made absolute encoders (excl. the Σ-series servo driver) is 10 minutes. Although it causes no harm to the encoder if you leave it for a longer time, we recommend that you follow the specified time period.

(5) Remove the encoder reset connector, and connect the battery.

CAUTION

If you turn on the power with the encoder reset connector connected, the encoder board may be broken. Be extremely careful not to forget to remove the connector.

(6) Turn on the power of the controller.

(7) Press the FUNC HIGH + cal 1 keys to switch the system to the ROBOT CALCULATE mode (the mode for automatic creation of position data and parameters). Each axis' pulse data at the time when the power is turned on is displayed in "ABS.ENC.A" through "ABS.ENC.W[i]" of the ABS.DATA in the MEMORY mode. (For details, refer to 12.3.2 "ABS.DATA SET (Absolute encoder data).") If the pulse data is 0, reset of the absolute encoder is complete.

(8) Set the mode selector switch of the Teach Pendant to "RO-TEACH."

(9) Display pulse data for the position data.

① Press the FUNC HIGH + local F keys

② Press the s.ed 4 key.

③ Press the READ key.

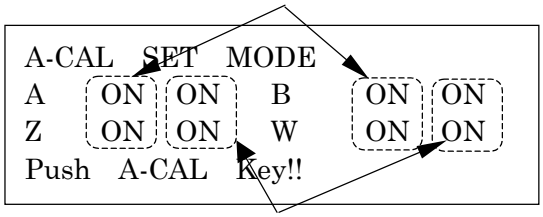
(10) Hold down the Deadman switch of the Teach Pendant during all the steps described below. If you release the Deadman switch, Emergency Stop will be activated.

(11) Press the A-CAL keys. The A-CAL axis selection screen will appear. Then select axes on which you wish to perform A-CAL with the +R/R +X, +C +Y, ↑Z and +W (or +R/R +X, +C +Y) keys. "ON" will be displayed in the section "a" of the selected axes, and A-CAL will be performed only on these axes. All the axes should be selected in ordinary cases.

[i] "ABS.ENC.R" and "ABS.ENC.C" will be added when a special ROM is used.

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Section “a”
ON: A-CAL is selected.
OFF: A-CAL is not selected.



Section “b”
ON: A-CAL is completed.
OFF: A-CAL is not completed.

Fig.3. 7 A-CAL axis selection screen

- [+R/R +X] key: Selects the A axis.
- [+C +Y] key: Selects the B axis.
- [↑Z] key: Selects the Z axis.
- [+W] key: Selects the W axis.
- [SHIFT], [+R/R +X] key: Selects the R axis when a special ROM is used.
- [SHIFT], [+C +Y] key: Selects the R axis when a special ROM is used.

(12) When the selection of axes is completed, hold the [A-CAL] key down until A-CAL is completed.

(13) When A-CAL is completed, the message

“A-CAL COMPLETED”

will appear and a buzzer will sound.



When A-CAL of all the axes is completed, the 『A-CAL』 LED will light up.

CAUTION

If you release the [A-CAL] key before the completion of A-CAL, A-CAL will be interrupted with a buzzer and the message
“A-CAL INCOMPLETE.”
As the A-CAL of the selected axes remains incomplete, go back to step (4) and execute A-CAL again.

(14) Move the axes that have finished A-CAL by approx. 100 mm toward the operating range. Then check and record the current axis position data by means of pulse data.

The following is the procedure for displaying pulse data.

① Press the [FUNC HIGH] + [local F] keys.

② Press the [s.ed 4] key.

③ Press the [READ] key.

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(15) Switch the system to the KEY-IN mode.

(16) Turn off the power of the controller.

(17) Turn on the power of the controller again.

(18) Switch the system to the RO-TEACH mode, and let the screen display position data in pulses.

(19) Compare the current position data on the display with the data recorded in step (14) (before the power is turned off). A-CAL can be considered to be successful if the difference between the two data is within 100 pulses. If the difference exceeds 100, go back to step (4) and execute A-CAL again on the axis in question.

(20) If A-CAL has been performed successfully, press the FUNC HIGH + cal 1 keys to switch the system to the ROBOT CALCULATE mode (the mode for automatic creation of position data and parameters). Then record the data in "A-CAL DIS.A" through "A-CAL DIS.W[i]" of the ABS.DATA in the MEMORY mode. This data is used for restoration in case System Data is corrupted.

(21) Select System Generation 「MAINTENANCE」→「MAINTENANCE DATA」→「EMP SELECT」and restore the data of this parameter to the original one in step (1).

[i] "A-CAL DIS.R" and "A-CAL DIS.C" will be added when a special ROM is used.

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3.6 A-CAL Related Errors

A-CAL is the most basic operation in the robot operations. Because it is possible to check the proper control and functioning of the motor encoders and the sensors through A-CAL, error detection is performed at each step of A-CAL. The following is the list of errors that can be detected during A-CAL.

Table 3. 3 List of A-CAL related errors

Error code	Message	Description
*0	* 0 Not Find	The ORIGIN sensor does not turn on even though the axis has moved to the origin point.
*1	* 1 Not OFF	The ORIGIN sensor does not turn off. The axis does not return to the operating range.
*2	* 2 Other ON	The OVERRUN sensor turned on when the axis moved to the origin point.
*3	* 3 Not Zero	The counter IC is not reset to 0.
*4	* 4 Lower	The counter was reset at a lower point than that specified.
*5	* 5 Upper	The counter was reset at an upper point than that specified.
*6	* 6 Minus	The readout of the pulse counter is minus.
*7	* 7 Error	Same as the following error "*8"
*8	* 8 Abs. Rst	The absolute encoder has not been reset.

NOTE

"*" represents each axis. (A = A (X) axis, B = B (Y) axis, Z = Z axis, W = W axis, R = R axis, C = C axis)

3.6.1 User action for "* 0 Not Find"

(1) Check that the robot has been actuated. If it has not, the coupling might be loosened or the timing belt might have a break.

(2) Move the robot to check that the ORIGIN sensors turn ON.

① Switch the system to the RO-TEACH mode.

② Press the key for moving an axis in a minus direction to move each axis toward the ORIGIN sensor.

- [-R/L / -X] key: Moves the A axis toward the ORIGIN sensor.
- [-C / -Y] key: Moves the B axis toward the ORIGIN sensor.
- [↑Z] key: Moves the Z axis toward the ORIGIN sensor.
- [-W] key: Moves the W axis toward the ORIGIN sensor.
- [SHIFT], [-R/L / -X] keys: Move the R axis toward the ORIGIN sensor when a special ROM is used.
- [SHIFT], [-C / -Y] keys: Move the R axis toward the ORIGIN sensor when a special ROM is used.

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③ Check that the robot operates and the ORIGIN sensors turn ON. Also check that the message

"OVER RUN ****(**)"

will be displayed on the Teach Pendant when the sensors turn ON. In the "****(**)" of this message, the state of respective sensors is shown by means of the four numerals shown below. The data is arranged in the sequence of XYZW(RC).

Table 3. 4 Description of "**(**)"**

Numeral	Description
"0"	No sensor is ON.
"1"	The ORIGIN sensor is ON.
"2"	The OVERRUN sensor is ON.
"3"	Both the ORIGIN sensor and the OVERRUN sensor are ON.

④ Check that "1" is displayed in the part of "****(**)." For example, when the ORIGIN sensor of the X axis has turned ON, the display will be "1000(00)." If this message is not displayed or a wrong number is displayed, there is a possibility that the ORIGIN sensor and the OVERRUN sensor are incorrectly wired, or the sensor is faulty.

3.6.2 User Action for "* 1 Not OFF"

(1) Check that the robot has been actuated. If it has not, the coupling might be loosened or the timing belt might have a break.

(2) Move the robot to check that the ORIGIN sensors turn OFF.

① Switch the system to the RO-TEACH mode.

② As the ORIGIN sensors have been ON, check that the message

"OVER RUN ****(**)"

appears and "1" is displayed in the part of "****(**)." For example, when the ORIGIN sensor of the X axis has turned ON, this display will be "1000(00)."

③ Press the key for moving an axis in a plus direction to move each axis away from the ORIGIN sensor (toward the OVERRUN sensor).

- +R/R +X key: Moves the A axis toward the OVERRUN sensor.
- +C +Y key: Moves the B axis toward the OVERRUN sensor.
- ↓Z key: Moves the Z axis toward the OVERRUN sensor.
- +W key: Moves the W axis toward the OVERRUN sensor.
- SHIFT, +R/R +X keys: Move the R axis toward the OVERRUN sensor when a special ROM is used.
- SHIFT, +C +Y keys: Move the C axis toward the OVERRUN sensor when a special ROM is used.

④ Check that the robot operates and the ORIGIN sensors turn OFF.

⑤ When the ORIGIN sensors turn OFF, the message on the Teach Pendant will disappear.

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3.6.3 User Action for "* 2 Other ON"

(1) Check that the robot has been actuated. If it has not, the coupling might be loosened or the timing belt might have a break.

(2) Press the keys shown below to check the operation of each axis.

① Switch the system to the RO-TEACH mode.

② Check the operation of each axis.

- [+R/R +X] key: Moves the A axis toward the OVERRUN sensor.
- [+C +Y] key: Moves the B axis toward the OVERRUN sensor.
- [↓Z] key: Moves the Z axis toward the OVERRUN sensor.
- [+W] key: Moves the W axis toward the OVERRUN sensor.
- [SHIFT], [+R/R +X] keys: Move the R axis toward the OVERRUN sensor when a special ROM is used.
- [SHIFT], [+C +Y] keys: Move the C axis toward the OVERRUN sensor when a special ROM is used.
- [-R/L -X] key: Moves the A axis toward the ORIGIN sensor.
- [-C -Y] key: Moves the B axis toward the ORIGIN sensor.
- [↑Z] key: Moves the Z axis toward the ORIGIN sensor.
- [-W] key: Moves the W axis toward the ORIGIN sensor.
- [SHIFT], [-R/L -X] keys: Move the R axis toward the ORIGIN sensor when a special ROM is used.
- [SHIFT], [-C -Y] keys: Move the R axis toward the ORIGIN sensor when a special ROM is used.

(3) Check that the ORIGIN sensor and the OVERRUN sensor of each axis turn ON/OFF by the key operations mentioned above. When they turn ON/OFF erroneously, there is a possibility that the ORIGIN sensor and the OVERRUN sensor are incorrectly connected.

3.6.4 User Action for "* 3 Not Zero"

When this error occurs, the ORIGIN sensor(s) might not turn ON or M signals (marker signals or Zero signals) might not be inputted from the motor.

(1) Move the robot to check that the ORIGIN sensors turn ON and the on-state is maintained.

① Switch the system to the RO-TEACH mode.

② Press the key for moving an axis in a minus direction to move each axis toward the ORIGIN sensor.

- [-R/L -X] key: Moves the A axis toward the ORIGIN sensor.

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- [-C / -Y] key: Moves the B axis toward the ORIGIN sensor.
- [↑Z] key: Moves the Z axis toward the ORIGIN sensor.
- [-W] key: Moves the W axis toward the ORIGIN sensor.
- [SHIFT], [-R/L / -X] keys: Move the R axis toward the ORIGIN sensor when a special ROM is used.
- [SHIFT], [-C / -Y] keys: Move the R axis toward the ORIGIN sensor when a special ROM is used.

(2) Otherwise, M signals might be interrupted or the motor might be faulty. In this case, contact HIRATA Corporation Robotics Division.

3.6.5 User Action for "* 4 Lower"

The sensor or the sensor dog is not properly adjusted. The count of pulses from ORIGIN sensor ON to the first M signal is smaller than a quarter of one turn of output pulses.

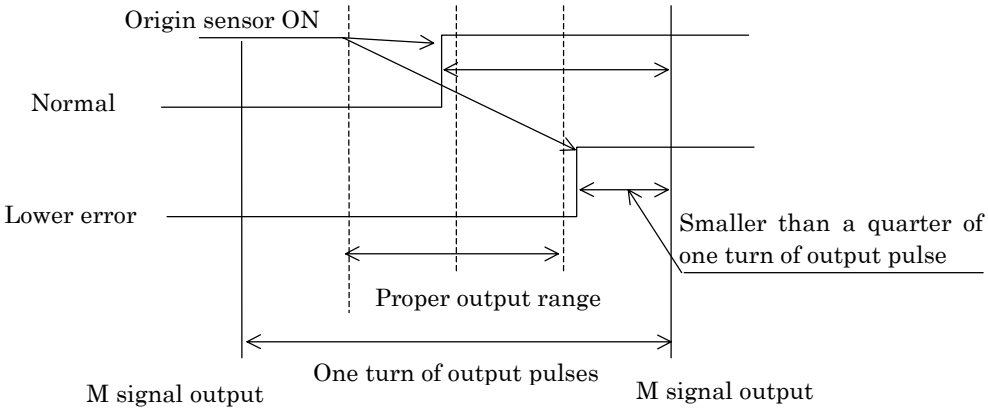


Fig.3. 8 Diagram of lower error

The proper output range for the ORIGIN sensor ON is from one quarter to three quarters of one turn of output pulses. Adjust the sensor or the sensor dog so that the sensor will turn ON within the proper range.

If the [A-CAL] key is held down after the completion of A-CAL, the count of pulses from ORIGIN sensor ON to M signal output is displayed. Adjust the sensor or the sensor dog while checking this data.

3.6.6 User Action for "* 5 Upper"

The sensor or the sensor dog is not properly adjusted. The count of pulses from ORIGIN sensor ON to the first M signal is greater than three quarters of one turn of output pulses.

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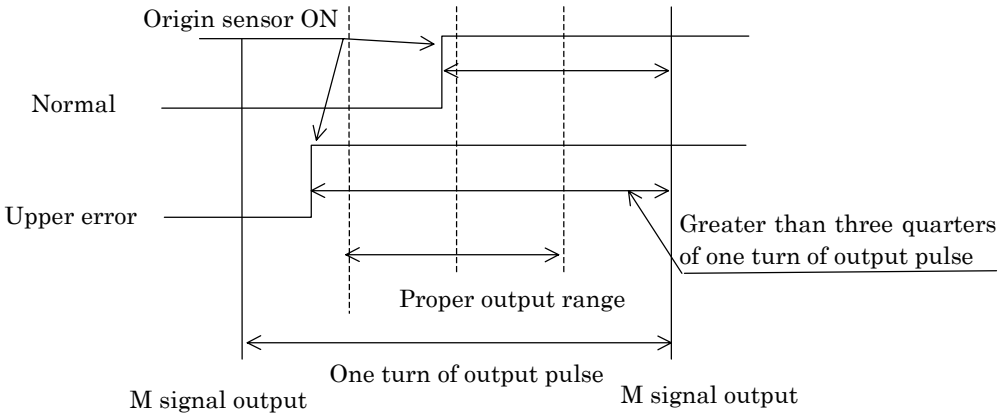


Fig.3. 9 Diagram of upper error

The proper output range for the ORIGIN sensor ON is from one quarter to three quarters of one turn of output pulses. Adjust the sensor or the sensor dog so that the sensor will turn ON within the proper range.

If the A-CAL key is held down after the completion of A-CAL, the count of pulses from ORIGIN sensor ON to M signal output is displayed. Adjust the sensor or the sensor dog while checking this data.

3.6.7 User Action for "* 6 Minus"

(1) The direction of A-CAL might not match the Up/Down switching of the hardware counter. In this case, adjust the direction of A-CAL. (Refer to 3.7 "Setting A-CAL Direction.")

(2) M signals from the motor might be outputted by the negative logic. Check the orientation of the switching jumper, and set it in a proper orientation.

3.6.8 User Action for "* 7 Error"

The error is displayed under the following "* 8 Abs. Rst" error occurrence depending on the software version of the controller.

3.6.9 User Action for "* 8 Abs. Rst"

This error occurs when the absolute encoder type motor is used and the absolute encoder has not been reset properly. Reset the absolute encoder referring to 3.5 "A-CAL Procedure."

If the error persists, there is a possibility that the absolute reset connector wire have a break.

3.6.10 User Action for "OVER RUN ****(**)"

The OVERRUN sensor might have a broken wire. Check the OVERRUN sensor. However, the "OVER RUN ****(**)" error that occurs during the corrective actions for A-CAL related errors (mentioned above) is a normal message.

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3.7 Setting A-CAL Direction

If the direction of A-CAL is not proper, the robot does not operate correctly. This section shows the procedure for setting the direction of A-CAL.

To set the A-CAL direction, first adjust the origin point side (the ORIGIN sensor) and the limit side (the OVERRUN sensor) of each axis. Then set the values of System Data for each axis and the orientation of the jumper switch[i] for hardware counter up/down switching on the CPU board[ii] accordingly.

(1) Set the data of the System Generation 「ORGIN」 → 「AXIS DIRECTION」 → 「A-CAL DIR.A (X) 」 - 「INCH DIR W」 to "PLUS."

(2) Turn off the power of the controller and turn it on again.

(3) Switch the system to the RO-TEACH mode.

(4) Move each axis in a plus direction to check that it moves in a direction to turn on the OVERRUN sensor.

- +R/R / +X key: Moves the A axis toward the OVERRUN sensor.
- +C / +Y key: Moves the B axis toward the OVERRUN sensor.
- ↓Z key: Moves the Z axis toward the OVERRUN sensor.
- +W key: Moves the W axis toward the OVERRUN sensor.
- SHIFT, +R/R / +X keys: Move the R axis toward the OVERRUN sensor when a special ROM is used.
- SHIFT, +C / +Y keys: Move the C axis toward the OVERRUN sensor when a special ROM is used.

① If a servo error occurs before the axis is actuated by the press of the axis key of the Teach Pendant, the Up/Down switching of the hardware counter is improperly set. Turn off the power of the controller, and switch the jumper switch for hardware counter up/down switching on the CPU board. Turn on the power of the controller, and then perform the above check again.

② If the axis moves in a direction to turn ON the ORIGIN sensor, set the data of the System Generation 「ORGIN」 → 「AXIS DIRECTION」 → 「A-CAL DIR. ＊」 to "MINUS." Turn off the controller and on again, and perform the above check again.

(5) Repeat step (4) until all the axes move correctly in a direction to turn on the OVERRUN sensor.

(6) Display pulse data for the position data.

① Press the FUNC / HIGH + local / F keys.

---

[i] It is referred to as "System board" in some controller operation manuals.

[ii] Before proceeding with the setting, refer to the operation manual for your controller and check the position of the jumper switch for hardware counter Up/Down switching (A-CAL direction switch) on the CPU board.

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② Press the [s. ed / 4] key.

③ Press the [READ] key.

(7) Move each axis in a plus direction to check that the count of pulses increases.

- [+R/R / +X] key: Increases the pulse count of the A axis
- [+C / +Y] key: Increases the pulse count of the B axis.
- [↓Z] key: Increases the pulse count of the Z axis.
- [+W] key: Increases the pulse count of the W axis.
- [SHIFT], [+R/R / +X] keys: Increase the pulse count of the R axis when a special ROM is used.
- [SHIFT], [+C / +Y] keys: Increase the pulse count of the R axis when a special ROM is used.

If the pulse count of the specified axis decreases, turn off the power. Switch the jumper switch for hardware counter Up/Down switching on the CPU board of the axis in question. Then turn on the power and perform this check again.

(8) Repeat step (7) until the pulse count of all the axes increases when they are moved in a plus direction.

(9) When all of the above operation is completed, turn off the power and on again.

(10) Setting of A-CAL direction is completed.

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CHAPTER 4 KEY-IN MODE

4.1 General

The KEY-IN mode is used to enter position data using the numeric keys. To select the KEY-IN mode, set the selector switch of the Teach Pendant to "KEY-IN." The KEY-IN mode can be selected by pressing the FUNC/HIGH + key/9 keys even when the system is in the ON-LINE (AUTO or ON-LINE) mode.

CAUTION

1. When you use the KEY-IN mode during the ON-LINE mode operation, try to perform the operation using the KEY-IN mode while the robot is in a standby status wherever possible.
2. Processing of the communication with the external device (DI/DO, serial communication, etc.) may be delayed when the KEY-IN mode is used during the ON-LINE mode operation.

In the KEY-IN mode, the position data stored in the memory is displayed, and the message "KEY-IN" appears on the message line. To enter data, use the numeric keys. The value typed in is applied to the data where a cursor sits. The following figure (4.1 Screen display in KEY-IN mode) shows an example of screen display in the case of a four-axis robot.

```
0000 M01 F90 S00 R 0
X 0123.45 Y-0123.45
Z 0123.45 W 0123.45
KEY-IN
```

Fig.4. 1 Screen display in KEY-IN mode

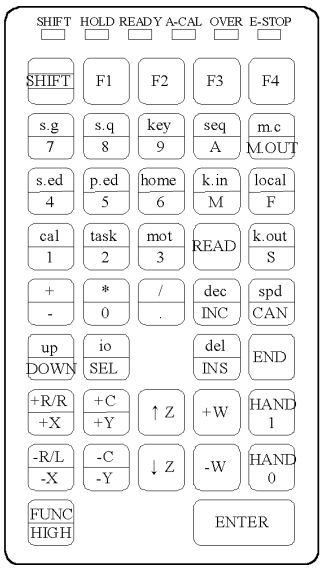


Fig.4. 2 Keys used in KEY-IN mode

The Hold status of all axes is not maintained in the KEY-IN mode. However, when the axis is equipped with a motor brake, it is locked by the brake.

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4.2 Basic Operation in KEY-IN Mode

This section explains how to move a cursor to each parameter and enter data.

(1) Address

Move a cursor to the address data section with the seq/A or up/DOWN key. Then enter data with the numeric keys.

(2) M data

Move a cursor to the M data section with the k.in/M or up/DOWN key. Then enter data with the numeric keys.

(3) F code

Move a cursor to the F code section with the local/F or up/DOWN key. Then enter data with the numeric keys.

(4) S code

Move a cursor to the S code section with the k.out/S or up/DOWN key. Then enter data with the numeric keys.

(5) Arm bend direction

Press the SHIFT key to let the 『SHIFT』 LED light up. Then select "R" or "L" with the +R/R/+X or -R/L/-X key.

(6) Displayed coordinate system

Move a cursor to the displayed coordinate system section with the FUNC/HIGH + local/F keys or the up/DOWN key. Then enter data with the numeric keys.

(7) Position data

Move a cursor to the data of a desired axis by the following means.

① In the case of four-axis robot (X, Y, Z, and W axes)

- X axis: Move a cursor with the +R/R/+X, -R/L/-X or up/DOWN key.
- Y axis: Move a cursor with the +C/+Y, -C/-Y or up/DOWN key.
- Z axis: Move a cursor with the ↑Z, ↓Z or up/DOWN key.
- W axis: Move a cursor with the +W, -W or up/DOWN key.

② In the case of six-axis robot[i] (X, Y, Z, W, R, and C axes)

Move a cursor with the up/DOWN key.

[i] Only when a special ROM is used.

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4.3 Example of Operation in KEY-IN Mode

This section shows an example of data entry where the data, M = 10, F = 99, R/L = L, X = 500.05, Y = -80, Z = 20.1, W = 100, is assigned to address 50.

(1) Set the mode selector switch of the Teach Pendant to "KEY-IN."

(2) The screen display in the KEY-IN mode (Figure 4.1) will appear. The data shown in the figure may be different from those on the actual screen. Enter new data by the following procedure.

① Set the address to "50."

Press the [seq / A] key to move a cursor to the address data section; then press the [p.ed / 5] and [* / 0] keys.

```
0 0 5 0   M 0 1   F 9 0   S 0 0   R   0
```

② Set the M data to "10."

Press the [k.in / M] key to move a cursor to the M data section; then press the [cal / 1] and [* / 0] keys.

```
0 0 5 0   M 1 0   F 9 0   S 0 0   R   0
```

③ Set the F code to "99."

Press the [local / F] key to move a cursor to the F code section; then press the [key / 9] key twice.

```
0 0 5 0   M 1 0   F 9 9   S 0 0   R   0
```

④ Set the arm bend direction.

Press the [SHIFT] key to let the 『SHIFT』 LED light up; then press the [-R/L / -X] key.

```
0 0 5 0   M 1 0   F 9 9   S 0 0   L   0
```

⑤ Set the X-axis data to "500.05."

Press the [SHIFT] key to let the 『SHIFT』 LED light up, and press the [+R/R / +X] or [-R/L / -X] key to move a cursor to the X-axis data section. Then press the [p.ed / 5], [* / 0], [* / 0], [/ / .], [* / 0] and [p.ed / 5] keys in the shown order.

```
X 0 5 0 0 . 0 5   Y 0 1 2 3 . 4 5
```

⑥ Set the Y-axis data to "-80."

Press the [+C / +Y] or [-C / -Y] key to move a cursor to the Y-axis data section. Then press the [+ / −], [s.p / 8] and [* / 0] keys in the shown order.

```
X 0 0 5 0 . 0 5   Y − 0 0 8 0 . 0 0
```

⑦ Set the Z-axis data to "20.1."

Press the [↑Z] or [↓Z] key to move a cursor to the Z-axis data section. Then press the [task / 2], [* / 0], [/ / .] and [cal / 1] keys in the shown order.

```
Z 0 0 2 0 . 1 0   W 0 1 2 3 . 4 5
```

⑧ Set the W-axis data to "100."

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Press the [+W] or [-W] key to move a cursor to the W-axis data section. Then press the [cal 1], [* 0] and [* 0] keys in the shown order.

```
Z 0020. 10 W 0100. 00
```

(3) By the above key entries, the screen display will change as shown below (Figure 4.3: Data setting screen).

```
0050 M10 F99 S00 L 0
 X 0500. 05 Y−0080. 00
 Z 0020. 10 W 0100. 00
KEY−IN
```

Fig.4. 3 Data set screen

CAUTION

If the coordinate system is changed before entered data (ADD, R, M, F, X, Y, Z, W, (R, C)) is set (before the [ENTER] key is pressed), the change of the coordinate system will take precedence, and data entered will be cancelled. When you wish to change the coordinate system, do it after setting the entered data.
(The "coordinate system" means the data that is specified by 「DISPLAY OFFSET 1-3」[i] in the System Parameter.)

(4) Check that the entered data is correct, and press the [ENTER] key. The message

"ENTER OK ?"

will appear on the message line, and a buzzer will sound.

(5) Recheck that the entered data is correct, and press the [ENTER] key again. The data will then be fixed.

(6) When the data is fixed, position data of the next address (address 51 in this example) will be displayed.

(7) When you wish to recheck the data of address 50 set in step (5) above, you can bring up the data setting screen (Figure 4.3) by either of the following means.

SHIFT

① Let the 『SHIFT』 LED light up, and press the [dec INC] key. Then the position data of the previous address (address 50 in this example) will be displayed.

② Press the [seq A] key to move a cursor to the address data section. Press the [p. ed 5] and [* 0] keys in the shown order and then the [READ] key. The data setting screen (Figure 4.3) will then appear.

[i] Refer to in the System Parameter 「OFFSET」 → 「DISPLAY OFFSET1～3」 → 「DISP. * *」

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4.4 Data Correction

This section shows the actions to be taken when you have entered wrong data.

(1) When you have entered wrong data and wish to correct the data, move a cursor to a desired section and reenter data.

(2) When you wish to cancel all of the entered data (when you have not yet set the data), press the READ key. Then the position data stored in the current address will be displayed.

(3) When you wish to abort data setting and return to address 0000, press the spd/CAN key.

(4) When you wish to cancel data setting halfway (when you have pressed the ENTER key once, and the message "ENTER OK ?" is displayed on the message line), press any key other than the ENTER key.

(5) When an error message is displayed, data entry is not accepted. If you press the spd/CAN key, the error message will disappear and stored position data will be displayed. Check the error referring to Chapter 23 "MESSAGE", and then set the position data again.

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CHAPTER 5 TEACH MODE

5.1 General

The TEACH mode is used to perform teaching by moving the robot actually or using keys. The robot moves if the axis key that is related to each axis is pressed.

If the FUNC HIGH key and the axis key are pressed simultaneously, the robot moves at a high speed.

CAUTION

When two mutually contradictory keys (e.g. the +R/R +X key and the -R/L -X key) are pressed simultaneously, the axis will not move.

The Deadman switch must be pressed while the Teach Pendant is operated in the TEACH mode. If you release the Deadman switch, Emergency Stop will be activated.

The TEACH mode has two modes, i.e. the RO-TEACH mode and the LI-TEACH mode. To select either the RO-TEACH mode or the LI-TEACH mode, use the selector switch of the Teach Pendant.

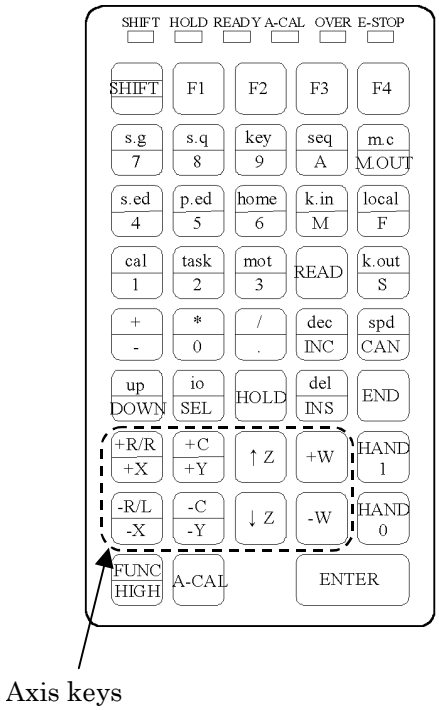


Fig.5. 1 Keys used in TEACH mode

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5.2 Basic Operation in TEACH Mode

5.2.1 Operating X-Y Coordinates in LI-TEACH Mode

In the LI-TEACH mode, the X (A) and Y (B) axes are controlled simultaneously and are moved linearly parallel to the X-Y coordinates set by the 「DISPLAY OFFSET」[i] in the System Parameter.

The [+R/R +X] and [-R/L -X] keys move the robot parallel to the X-axis coordinate; the [+C +Y] and [-C -Y] key move the robot parallel to the Y-axis coordinate.

During this linear motion, the W axis is operated under attitude control (keeps a consistent orientation against the X-Y coordinates set).

CAUTION

A-CAL

When the 『A-CAL』 LED on the Teach Pendant is not lit, the robot cannot be operated in the LI-TEACH mode. The message
"A-CAL INCOMPLETE"
will appear on the screen. In this case, execute A-CAL referring to Chapter 3 “A-CAL.”

5.2.2 Operating X (A) and Y (B) axes in RO-TEACH Mode

In the RO-TEACH mode, the X (A) and Y (B) axes can be operated independently. The [+R/R +X] and [-R/L -X] keys move the X-axis; the [+C +Y] and [-C -Y] keys move the Y-axis.

When the X (A) and Y (B) axes are moved by these axis keys, the W axis rotates asynchronously to the X(A) and Y(B) axes. Under normal conditions, the arm moves away from the origin point when moved in a plus direction. To change the moving direction, select the System Generation 「ORIGIN」→「AXIS DIRECTION」→「INCH DIR」and change the data of this parameter. The details of the moving directions are shown in the figure below.

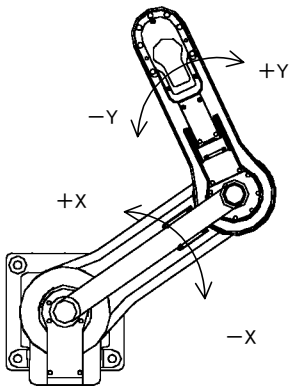


Fig.5. 2 Inching direction

[i] Refer to in the System Parameter 「OFFSET」→「DISPLAY OFFSET1～3」→「DISP.＊＊」

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5.2.3 Operating Z Axis

The Z-axis can be operated in either the RO-TEACH or LI-TEACH mode.

The [↑Z] key moves the Z-axis upward, and the [↓Z] key moves it downward.

5.2.4 Operating W Axis

The W axis can be operated in either the RO-TEACH or LI-TEACH mode, as well as the Z-axis. The [+W] key rotates the W-axis counterclockwise, and the [-W] key rotates it clockwise (when viewed from the top).

When the W-axis is on HOLD in the LI-TEACH mode, the W-axis keeps the same attitude even if the X (A) and Y (B) axes are moved. The attitude will be kept if the robot arm is moved by hand. This brings efficiency to the teaching of the operation to let the robot chuck grasp the works placed in a line.

5.2.5 Operating R Axis (When Special ROM is Used: Six-Axis Robot)



The R-axis can be operated in either the RO-TEACH or LI-TEACH mode, as well as the Z-axis. Press the [SHIFT] key to let the 『SHIFT』 LED light up; then press the [+R/R / +X] key to rotate the R-axis counterclockwise, or the [-R/L / -X] key to rotate it clockwise.

5.2.6 Operating C Axis (When Special ROM is Used: Six-Axis Robot)



The C-axis can be operated in either the RO-TEACH or LI-TEACH mode, as well as the Z-axis. Press the [SHIFT] key to let the 『SHIFT』 LED light up; then press the [+C / +Y] key to rotate the C-axis counterclockwise, or the [-C / -Y] key to rotate it clockwise.

5.2.7 Controlling HOLD Status

Press the [HOLD] key to switch the system to the HOLD setting mode. Then using the axis keys, turn on/off the HOLD for each axis. (Refer to Chapter 10 “HOLD FUNCTION.”)

The axis that is on HOLD is marked with an asterisk (*) on the screen.

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5.2.8 Screen Display in TEACH Mode

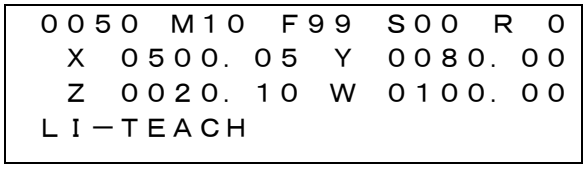


Fig.5. 3 Screen display in LI-TEACH mode

In the TEACH mode, current position of each axis is displayed on the screen. Figure 5.3 shows an example of screen display in the LI-TEACH mode. In the case of RO-TEACH, "RO-TEACH" is displayed on the message line.

Data entry using the numeric keys is accepted only to the address, M data, F code, and displayed coordinate system. The procedure for moving a cursor to each data section and entering data is shown below.

(1) Address

Press the seq / A or up / DOWN key to move a cursor to the address data section. Then enter data with the numeric keys.

(2) M data

Press the k.in / M or up / DOWN key to move a cursor to the M data section. Then enter data with the numeric keys.

(3) F code

Press the local / F or up / DOWN key to move a cursor to the F code section. Then enter data with the numeric keys.

(4) S code

Press the k.out / S or up / DOWN key to move a cursor to the S code section. Then enter data with the numeric keys.

(5) Displayed coordinate system

Press the FUNC / HIGH + local / F keys or the up / DOWN key to move a cursor to the displayed coordinate system section. Then enter data with the numeric keys.

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5.3 Speed in Teach Mode

5.3.1 High-Speed Operation in Teach Mode

When the axis keys of the Teach Pendant are used to move each axis, it moves at a high speed if the FUNC HIGH key is pressed simultaneously.

To set the robot speed for the TEACH mode operation, use the SHIFT + spd CAN keys, or select the System Parameter[i] 「RESPONSE」→「RESPONSE」→「INCHING SPEED」 and change the data of this parameter. When only the axis keys are used, the robot moves at a low speed. When the axis keys are used together with the FUNC HIGH key, the robot moves at a high speed ("INCHING SPEED").

5.3.2 Setting Speed Data in Teach Mode



(1) When the system is in the TEACH mode, let the 『SHIFT』 LED light up and press the spd CAN key. Then the Teach Pendant is ready for setting the value of the System Parameter 「RESPONSE」→「RESPONSE」→「INCHING SPEED」.

(2) Set the speed data.

(3) Press the spd CAN key to return to the TEACH mode.

NOTE

① The speed set here will be applied to all the axes. It is not possible to set a speed for a specific axis.
② The maximum robot speed in the TEACH mode is 250 mm/sec.

5.3.3 Speed in RO-TEACH Mode

The following explains the relation between the value set by selecting the System Parameter 「RESPONSE」→「RESPONSE」→「INCHING SPEED」 (hereinafter referred to as inching speed) in the RO-TEACH mode and the actual axis speed.

(1) During high-speed operation (when the FUNC HIGH key is turned on)

Axis speed＝Maximum axis speed (catalog value) (mm/sec)

$$\times \frac{\text{Output Speed Value}}{1023}$$

[i] You can jump to it with the FUNC HIGH + s.g 7 keys.

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Output speed value ＝ (Maximum output speed value[i]－5)

$$\times \frac{\text{INCHING SPEED}}{999} + 5$$

The following shows the relation between the setting value of inching speed and the axis speed.

Table 5. 1

INCHING SPEED	Axis Speed
999	249 mm/sec
255	69 mm/sec
1	7 mm/sec

(2) During low-speed operation

The speed is a tenth of the speed during the high-speed operation.

5.3.4 Speed in LI-TEACH Mode

The following explains the relation between the value set by selecting the System Parameter 「RESPONSE」→「RESPONSE」→「INCHING SPEED」 (hereinafter referred to as inching speed) in the LI-TEACH mode and the actual axis speed.

(1) During high-speed operation (when the FUNC HIGH key is turned on)

The X/Y axis movement speed is obtained by the following expression.

X/Y axis movement speed (mm/sec) = (250 mm/sec - 25)

$$\times \frac{\text{INCHING SPEED}}{999} + 25$$

The following shows the relation between the setting value of inching speed and the X/Y axis movement speed.

Table 5. 2

INCHING SPEED	X, Y axis speed
999	250 mm/sec
255	82 mm/sec
1	25 mm/sec

[i] For details, refer to 26.1 “Robot Speed during Manual Operation.”

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(2) During low-speed operation

The X/Y axis movement speed is obtained by the following expression.

X/Y axis movement speed (mm/sec)

$$=(250\text{mm/sec}-0.03)\times\frac{\text{INCHING SPEED}}{999}+0.03$$

The following shows the relation between the setting value of inching speed and the X/Y axis movement speed.

Table 5. 3

INCHING SPEED	X, Y Axis speed
999	25 mm/sec
255	6.4 mm/sec
1	0.06 mm/sec

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5.4 Operation Procedure in TEACH Mode

The following is the basic operation procedure in the TEACH mode.

DANGER

In the TEACH mode, the robot moves actually and can hit a person or interfere with the other equipment. Be extremely careful when operating the system in the TEACH mode.

(1) Set the mode selector switch of the Teach Pendant to TEACH.

(2) If the Teach Pendant is equipped with the Deadman switch, it must be pressed and held during the operation in the TEACH mode. If you release this switch, Emergency Stop will be activated.



(3) Execute A-CAL. This is not necessary when A-CAL has already been executed (when the 『A-CAL』 LED is lit).

(4) Set the address in which you wish to store position data.

(5) Press the READ key, and check the F code, M data, S code, and coordinate system that have already been entered.

(6) Set the M data. This is not necessary when the data does not need changing.

(7) Set the F code. This is not necessary when the data does not need changing.

(8) Set the S code. This is not necessary when the data does not need changing.

(9) Set the coordinate system. This is not necessary when the data does not need changing.

(10) Using the axis keys of the Teach Pendant, move the robot to the position to be entered. It is also possible to move the robot by pushing it by hand.

(11) After determining the robot position, press the ENTER key.

The message

"ENTER OK ?"

will appear on the message line, and a buzzer will sound.

(12) Check that the entered data and the robot position are correct, and press the ENTER key again. Then the data will be fixed.

(13) When the data is fixed, the address will be incremented, and the M data and the F code of the new address will be displayed. The position data indicates the current coordinate value of the robot.

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CAUTION

1. When you wish to recheck the position data that has already been entered in the TEACH mode, select a desired address with the numeric keys and then press the READ key. While the READ key is held down, position data of the specified address will be displayed, and, at the same time, the message showing the version of the present software,
   "OLD DATA V2.40,"
   will appear on the message line.

A-CAL



2. In step (10) above, if you press the ENTER key before the completion of A-CAL (when the 『A-CAL』 LED is off), the message
   "A-CAL INCOMPLETE !!"
   will appear and no further data entry will be accepted. In this case, execute A-CAL referring to Chapter 3 “A-CAL.”

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CHAPTER 6 CHECK MODE

6.1 General

The CHECK mode is used to check that the robot is positioned correctly to the position specified in the KEY-IN or TEACH mode.

To select the CHECK mode, use the mode selector switch of the Teach Pendant.

We recommend that you check robot positioning in the CHECK mode before starting automatic operation, as it helps avoid any mistake in programming or unexpected robot motion, and secures safety. **During the CHECK mode operation, the Deadman switch of the Teach Pendant must be held down. If you release the Deadman switch, Emergency Stop will be activated.**

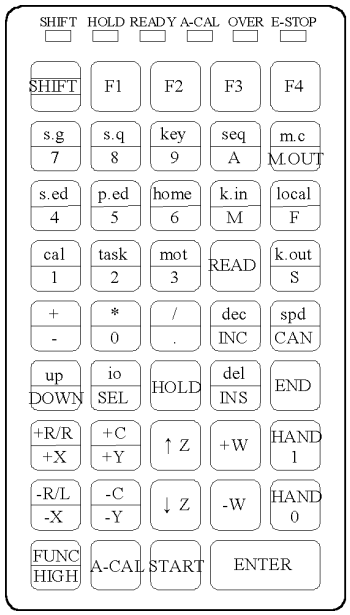


Fig.6. 1 Keys used in CHECK mode

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6.2 Function of CHECK Mode

6.2.1 Selection of Positioning Method

Positioning of the robot is performed by either of two methods, PTP (point to point) or CPC (continuous pass control). The positioning method is selected by specifying the M data in the CHECK mode as follows:

M = 0: Positioning will not be performed.
M = 1 - 79: PTP operation
M = 80 - 89: CPC operation
M = 90 - 99: PTP operation

The function of the S code is also effective. Refer to Chapter 16 "ROBOT OPERATION."

6.2.2 Auto PULL-UP Function

The system compares the Z-axis data specified by the 「PULL-UP」 value in the System Parameters[i], (「MOTION」→「MOTION」→「PULL-UP」) (Refer to 19.1.1 "MOTION.") with the current Z-axis data and the Z-axis data of the target position, moves the Z axis automatically to the position of smaller data, and performs the positioning to the next address.

This is one of the safety systems to prevent the Z-axis from interfering with works or other equipment. The Auto PULL-UP function may not work depending on the setting of the M data and the S code. For details on the M data and the S code, refer to Chapter 16 "ROBOT OPERATION."

6.2.3 Screen Display in Check Mode

In the CHECK mode, current position of the robot is displayed in ordinary cases as well as in the TEACH mode. The following figure shows an example of screen display in the CHECK mode.

```
 0050  M10  F99  S00  R  0
   X  0500.05  Y  0080.00
   Z  0020.10  W  0100.00
CHECK
```

Fig.6. 2 Screen display in CHECK mode

[i] You can jump to it with the FUNC HIGH + s.p 8 keys.

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6.3 Speed in CHECK Mode

6.3.1 Specification of Robot Speed

The robot speed during the CHECK mode operation can be specified on a scale from 0 to 9. "0" represents the minimum speed, and "9" represents the maximum speed. For safety's sake, the maximum speed in the CHECK mode, "9," is set to a speed below 250 mm/sec.

6.3.2 Setting Robot Speed in CHECK Mode



(1) When the system is in the CHECK mode, press the SHIFT key to let the 『SHIFT』 LED light up, and then press the spd/CAN key.

The message

"CHECK SPEED DATA ?> *"

will appear on the message line. ("*" shows the speed from 0 to 9 that is currently selected.)

(2) Set the speed using the numeric key between 0 and 9.

(3) After setting the speed with the numeric key, press the ENTER key. The message

"ENTER OK?"

will appear on the message line. When the data is OK, press the ENTER key again. If you have entered wrong data, press the spd/CAN key and reenter speed data.

WARNING

1. The speed set here will be applied to all the axes. It is not possible to set a speed for a specific axis. In the CHECK mode, the robot operates only at the speed specified for the CHECK mode independently of the speed set in the System Parameter, 「MOTION」→「CPC CONSTANT」→「CPC SPEED」(Refer to Chapter 19 "DETAILS OF SYSTEM PARAMETERS.")
2. Although the robot operates at the specified speed during the CHECK mode operation, the maximum speed during the CPC operation in the CHECK mode is 250 mm/sec. During the other operation, the maximum speed is a quarter of the maximum speed of the robot used.

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6.3.3 PTP Speed in CHECK Mode

The following explains the relation between the PTP operation speed in the CHECK mode and the CHECK mode speed. The expression for the PTP operation speed varies depending on the state of the DIP switch No. 8[i] on the CPU board. The expression for each state is shown below.

(1) When the DIP switch No. 8 is turned off

The movement speed is obtained by the following expression.

PTP movement speed =Maximum axis speed (catalog value) × Ratio

$$\text{Ratio} = \text{Maximum output speed value}^{[ii]} \times \frac{\text{CHECK Mode Speed} + 1}{1024 \times 10}$$

The following shows the relation between the setting value of CHECK mode speed and the movement speed.

Table 6. 1

CHECK Mode Speed	Axis Speed
9	249 mm/sec
5	149 mm/sec
0	24.9 mm/sec

(2) When the DIP switch No. 8 is turned on

The movement speed is obtained by the following expression.

PTP movement speed = Maximum axis speed(catalog value) × Ratio

$$\text{Ratio} = \frac{\text{CHECK MODE SPEED} + 1}{10 \times 6}$$

For the AUTO and ON-LINE modes, refer to 16.1.5 “PTP Operation Speed.”

6.3.4 PASS PTP Speed in CHECK Mode

The following explains the relation between the PASS PTP operation speed in the CHECK mode and the CHECK mode speed. The expression for the PTP operation speed varies depending on the state of the DIP switch No. 8[iii] on the CPU board. The expression for each state is shown below.

(1) When the DIP switch No. 8 is turned off

The movement speed is obtained by the following expression.

PASS PTP movement speed=Maximum axis speed(catalog value) × Ratio

$$\text{Ratio} = \text{Maximum output speed value}^{[iv]} \times \frac{\text{CHECK MODE SPEED} + 1}{1024 \times 10}$$

[i] Refer to the Robot Controller User's Guide.
[ii] Refer to the 26.1 “Speed during Manual Operation.”
[iii] Refer to the Robot Controller User's Guide.
[iv] Refer to the 26.1 “Speed during Manual Operation.”

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The following shows the relation between the setting value of CHECK mode speed and the movement speed.

Table 6. 2

CHECK MODE SPEED	Axis Speed
9	249 mm/sec
5	149 mm/sec
0	24.9 mm/sec

(2) When the DIP switch No. 8 is turned on

The movement speed is obtained by the following expression.

PASS PTP movement speed＝Maximum axis speed(catalog value)×Ratio

$$\text{Ratio}=\frac{\text{CHECK MODE SPEED}+1}{10\times 6}$$

For the AUTO and ON-LINE modes, refer to 16.2.5 “PASS PTP Operation Speed.”

6.3.5 CPC Speed in CHECK Mode

The following explains the relation between the CPC operation speed in the CEHCK mode and the CHECK mode speed. The movement speed is obtained by the following expression.

$$\text{Movement speed}=\text{CPC SPEED}\times\frac{\text{CHECK MODE SPEED}+1}{10}$$

For the CPC speed mentioned above, use the smaller one between the value set by selecting the System Parameter 「MOTION」→「CPC CONSTANT」→「CPC SPEED」and 250 mm/sec.

The following shows the relation between the setting value of CHECK mode speed and the movement speed.

Table 6. 3

CHECK MODE SPEED	Axis speed
9	250 mm/sec
5	150 mm/sec
0	25 mm/sec

For the AUTO and ON-LINE modes, refer to 16.3.5 “CPC Operation Speed.”

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6.4 Operation Procedure in CHECK Mode

The following is the basic operation procedure in the CHECK mode.

DANGER

In the CHECK mode, the robot is operated semiautomatically and can hit a person or interfere with other equipment if operated in a wrong way. Before starting the operation in the CHECK mode, be sure to check that there is no person or equipment in the robot's operating range, and never enter the operating range during the operation.

(1) Set the mode selector switch of the Teach Pendant to CHECK mode.

(2) Hold the Deadman switch down during the entire operation in the CHECK mode.



(3) Execute A-CAL. This is not necessary when A-CAL has already been executed (when the 『A-CAL』 LED is lit).

(4) Set the robot speed in the CHECK mode.

(5) Read the address of which you wish to check position data.

Select a desired address with the numeric keys, and press the READ key.

(6) When the position data of the specified address has been read in, hold the START key down. Positioning of the robot is performed while the START key is held down. If the START key is released or an error occurs halfway, the robot will stop with the message

"INCOMPLETE"

on the message line. When positioning is completed, a buzzer will sound and the message

"COMPLETED"

will appear on the message line. When you wish to check the positioning of the next address continuously, release the START key once and hold it down again.

If the 『SHIFT』 LED is lit during the CPC or PASS PTP operation, positioning will be performed from one teaching point (address) to another. In the case of arch motion, the robot stops when the arch motion is finished.

CAUTION

① In the CHECK mode, the current position data of the robot is displayed in ordinary cases. When you wish to recheck the position data that has already been entered, select a desired address with the numeric keys and then press the READ key. While the READ key is held down, position data of the specified address will be displayed, and, at the same time, the message showing the version of the present software,
"OLD DATA V2.40"
will appear on the message line.

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A-CAL



②If you press the START key before the completion of A-CAL (when the 『A-CAL』 LED is off), the message
"A-CAL INCOMPLETE"
will appear and positioning will not be performed. In this case, execute A-CAL referring to Chapter 3 "A-CAL."
③The method of robot positioning changes depending on the M data and the S code. For details, refer to 16.5.1 "List of M Data Functions" and 16.5.2 "List of S Code Functions."

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CHAPTER 7 ON-LINE MODE

The ON-LINE mode is used to control the robot through the communication with an external device. Automatic operation of the robot is to be performed in this mode.

To select the ON-LINE mode, use the mode selector switch of the controller.

Automatic operation can be performed in either of the following two modes:

- AUTO
- ON-LINE

The AUTO mode is used when the communication is made through the parallel DI/DO with an external device like a sequencer; the ON-LINE mode is used when the communication is made through the serial I/O (RS-232C).

To switch between the AUTO and ON-LINE modes, select the System Generation[i] 「ORIGIN」→「SET-UP SYSTEM」→「AUTO/ON-LINE」 and change the this parameter. When the AUTO mode is selected, "AUTO" is displayed on the message line.

```
 0050  M10  F99  S00  R  0
   X  0500.05  Y  0080.00
   Z  0020.10  W  0100.00
AUTO
```

Fig.7. 1 Screen display in AUTO mode

In the ON-LINE mode, as in the case of the AUTO mode (Figure 7.1), the mode name is displayed on the message line, and the address and position data at the time of positioning are displayed.

```
 0050  M10  F99  S00  R  0
   X  0500.05  Y  0080.00
   Z  0020.10  W  0100.00
ON−LINE
```

Fig.7. 2 Screen display in ON-LINE mode

[i] You can jump to it with the FUNC HIGH + s.g 7 keys.

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7.1 AUTO Mode

The AUTO mode performs automatic operation using an external device like a sequencer and the DI/DO interface. Although 16 signals can be used for input and output respectively, their port allocation has been fixed. For positioning the robot, two positioning methods have been provided, i.e. the sequential access that positions the robot in accordance with the sequence of position addresses and the random access that positions the robot in a random order following the address specification by the operator.

NOTE

The robot speed in the AUTO mode is set by the System Parameter and the F code.

7.1.1 DI Signal

This section shows the DI signal assignment table and description of each signal.

Table 7. 1 Assignment of DI signals (standard)

Signal	Signal name	Description
IN0	SELECT	Operation ready demand signal
IN1	START	Positioning start signal
IN2	NEXT	Next positioning start signal
IN3	HOLD	Servo lock signal
IN4	POS/INCH	Switches IN6 - IN15 signals. When ON, switches them to position address signals; when OFF, to manual operation signals for inching operation.
IN5	STOP	Stop robot motion when ON
IN6	ADDRESS 8 [256]/Axis	Switched by IN4. ・ Perform PTP operation when serving as position address signals. Specification of an address shall be made in binary form (figures in square brackets). ・ Serve as manual operation signals during inching operation. IN8 - IN11 are switched by IN6. When IN6 is ON, the R and C axes are operated; when OFF, the X and Y axes are operated. When IN7 is ON, inching is performed at a high speed.
IN7	ADDRESS 9 [512]/High speed	
IN8	ADDRESS 0 [1] /+X(+R)	
IN9	ADDRESS 1 [2] /-X(-R)	
IN10	ADDRESS 2 [4] /+Y(+C)	
IN11	ADDRESS 3 [8] /-Y(-C)	
IN12	ADDRESS 4 [16] /↑Z	
IN13	ADDRESS 5 [32] /↓Z	
IN14	ADDRESS 6 [64] /+W	
IN15	ADDRESS 7 [128]/-W	

(1) SELECT (IN0) : Operation ready demand signal (‾‾‾‾‾‾‾)

This is a signal from an external device like a sequencer demanding that the controller be ready for operation. If this signal is turned ON when a mode other than AUTO is selected, the controller will not respond.

When the controller has received this signal, it will check the POS/INCH signal (IN4).

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- When the POS/INCH signal is ON (positioning mode)

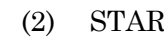
  The controller executes A-CAL if it has not yet been completed. After that, the controller turns the READY and PCA signals ON to notify the sequencer that the system is now ready for operation and is in the positioning mode.

  When a mode other than AUTO is selected, the READY signal will turn OFF. Also, if this signal is turned OFF during positioning operation, the READY signal will turn OFF and the robot will stop.

- When the POS/INCH signal is OFF (inching mode)

  The controller turns the READY signal ON to notify the sequencer that the system is now in the inching mode.

  If A-CAL has been completed, inching operation can be performed in both the LI-TEACH and RO-TEACH modes. If A-CAL has not been completed, inching operation cannot be performed in the LI-TEACH mode, though it is possible in the RO-TEACH mode.

(2) START (IN1) : Positioning start signal ()

This is a signal from a sequencer commanding the controller to start positioning operation. If the POS/INCH signal is not ON (positioning mode), the controller will ignore this signal.

To position the robot to a desired position, let the sequencer output the position address signal(s) (ADDRESS 0 - ADDRESS 9) when both the READY and PCA signals are ON, and then turn this START signal ON. When the M data of the specified address is "0," this address will be skipped, and the robot will be positioned to the next address. When the M data is "??" (end point), positioning will not be performed.

If the controller receives the START signal, it will turn the PCA signal OFF, and start positioning the robot to the specified address.

This type of positioning, in which an address is to be specified each time, is called "Random Access."

(3) NEXT (IN2) : Next position start signal ()

This is a signal commanding the controller to start positioning the robot to the next address (current address + 1). If the POS/INCH signal is not ON (positioning mode), the controller will ignore this signal.

If the M data of the next (+1) address is "0," this address will be ignored, and the robot will be positioned to the subsequent +1 address. If the M data is "??" (end point), positioning will not be performed.

The START signal mentioned in (2) above can also start positioning. However, the NEXT signal eliminates the necessity to specify a position address each time. Once the sequencer has given the first position address to the controller, it will position the robot in sequence incrementing the position address by one by itself, upon turning ON and OFF of the NEXT signal. This type of positioning is called "Sequential Access."

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If Emergency Stop is inputted or the power to the controller is shut off halfway through the sequential access, the position address left half-finished will be stored. As the handling of the NEXT signal given after the restoration, you can select either to continue positioning from the half-finished address or to position the robot to the initial position. To make this setting, select the System Generation 「ORIGIN」→「SET-UP SYSTEM」→「STORE ADDRESS」and change this parameter. In ordinary cases, this parameter is set to 0, i.e. the robot will be positioned to the half-finished address.

(4) HOLD（IN3） : Servo lock signal

This is a servo lock signal. If this signal is turned ON, all axes of the robot will halt upon completion of positioning, and will enter a servo lock state while the PCA signal is outputted. If this signal is turned OFF, all axes of the robot will halt upon completion of positioning, and will be free while the PCA signal is outputted. (When the axis is equipped with a brake, the brake will be activated.)



When you do not use the servo lock function, always turn ON this servo lock signal irrespective of the mode of the robot.

(5) POS/INCH（IN4）: Positioning/inching switching signal

This signal switches between the positioning operation and the inching operation. The positioning operation positions the robot to a specified address by PTP or CPC (random access and sequential access mentioned above), and the inching operation merely moves each axis of the robot. When this signal is ON, positioning is selected, and, when OFF, inching is selected.

(6) STOP（IN5）: Motion stop signal

This is a motion stop signal. If this signal is turned ON during robot positioning operation, the robot will halt, and the controller will turn ON the PCA signal. While this STOP signal is ON, the message

"STOP ON"

will appear on the message line of the Teach Pendant display.

To restore the system from the motion stop, turn OFF the STOP signal and then turn ON the START (IN1) or NEXT (IN2) signal. The controller will restart the operation at the rising edge of the START (IN1) or NEXT (IN2) signal. When the SELECT signal was turned OFF at the time when the STOP signal was turned ON, the SELECT signal must be turned ON after the STOP signal is turned OFF.

This signal can also be used as an interlock (pause) signal. The interlock means to stop the robot temporarily by turning the STOP signal ON halfway through the positioning. Positioning will be

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resumed as soon as the STOP signal is turned OFF. You can select whether to use the STOP signal as an interlock signal by setting the STOP parameter (System Generation 「ORIGIN」→「SET-UP SYSTEM」→「STOP」).

(7) ADDRESS 0 - ADDRESS 9 (IN6 - IN15) : Position address signals

When the POS/INCH signal (IN4) is ON (positioning mode), these signals serve as signals to specify a position address to which the controller should position the robot. When the POS/INCH signal is OFF (inching mode), these signals serve as inching signals that function in the same manner as the axis keys of the Teach Pendant.

Table 7. 2 Position address signals (standard)

No.	Positioning mode(START)	Inching mode
IN6	ADDRESS 8 [256]	
IN7	ADDRESS 9 [512]	High speed
IN8	ADDRESS 0 [1]	+X
IN9	ADDRESS 1 [2]	-X
IN10	ADDRESS 2 [4]	+Y
IN11	ADDRESS 3 [8]	-Y
IN12	ADDRESS 4 [16]	↑Z
IN13	ADDRESS 5 [32]	↓Z
IN14	ADDRESS 6 [64]	+W
IN15	ADDRESS 7 [128]	-W

- Positioning mode

  These signals are used to specify a position address. They are taken into the controller at the rising edge of the START signal (IN1).

  These signals are handled in binary. For example, when you wish to specify address 10, you need to turn ON IN9 and IN11, then turn ON the START signal.

Table 7. 3 Example of position address specification

IN	8	9	10	11	12	13	14	15	6	7
Value	1	2	4	8	16	32	64	128	256	512
Input	O	1	O	1	O	O	O	O	O	O

2+8=10
(Address 10)

Input 1 : ON
0 : OFF

NOTE

Following the address specification method mentioned above, it is possible to specify 1024 addresses (address 0 - 1023) with these 10 DI signals. However, controller's memory capacity is 1000 addresses (address 0 - 999), and a position address error will occur if an address exceeding the capacity is specified.
Additionally, when you have set the ADDRESS MAX value (System Generation 「LIMIT」→「ADDRESS MAX」→「ADDRESS MAX」), a position address error will occur if an address exceeding the address set is specified.

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- Inching mode

  When the inching mode is selected, these signals serve as inching command signals for each axis. As shown in Table 7.2, the position address signals IN8 - IN15 correspond to the [+R/R +X], [-R/L -X], [+C +Y], [-C -Y], [↑Z], [↓Z], [+W], [-W] keys of the Teach Pendant respectively.

  When IN7 is OFF, the robot moves at a low speed specified by the value of the System Parameters 「RESPONSE」→「RESPONSE」→「INCHING SPEED」. When IN7 is ON, the robot moves at a high speed. This speed varies depending on the model of the robot. Nevertheless, the maximum speed in the inching mode is 250 mm/sec.

Table 7. 4 Inching speed setting

IN7	Inching speed
OFF	Low speed
ON	High speed

For example, if IN7 is OFF and the system is switched to the inching mode during the AUTO operation (IN4→OFF), the PCA signal will turn OFF. If IN8 is then turned ON, the X axis will move in the +X direction at a low speed. The relation between the bits (IN8 - IN15) and the robot axes in the inching mode is shown in the table below.

Table 7. 5 Inching axis setting

IN8	IN9	IN10	IN11	IN12	IN13	IN14	IN15
+X	-X	+Y	-Y	+Z	-Z	+W	-W

NOTE

If inching operation is commanded with the servo lock signal OFF, it can take 300 msec at the maximum to start inching operation. (Because processing for releasing brakes will be performed regardless of the presence or absence of the brakes.)

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7.1.2 DO Signals

This section shows the DO signal assignment table and description of each axis.

Table 7. 6 Assignment of DO signals

DO signal	Signal name	Description
OUT0	READY	Operation ready signal
OUT1	ERROR	Error detection signal
OUT2	PCA	Positioning permission signal
OUT3	AUTO	AUTO mode signal
OUT4	BP･AREA	PASS PTP output or area output
OUT5	ZONE	Z axis zone output
OUT6	CPOUT	Output in CPC operation
OUT7	A-CAL	Return to origin completion
OUT8	MOUT0(1) /W	Signals assigned by M data or error codes. Figures in () are BCD.
OUT9	MOUT1(2) /Z	
OUT10	MOUT2(4) /Y	
OUT11	MOUT3(8) /X	
OUT12	MOUT4(10) /	
OUT13	MOUT5(20) /	
OUT14	MOUT6(40) /	
OUT15	MOUT7(80) /	

(1) READY (OUT0) : Operation ready signal

This signal shows that the controller is ready for operation and is able to control the robot upon input of the START or NEXT signal. Therefore, this signal will be OFF when the system is in a mode other than AUTO or the Emergency Stop button is pressed. After the controller has received the SELECT signal, this signal will turn ON following the completion of A-CAL when A-CAL has not yet been completed, or, if it has already been completed, the signal will turn ON immediately.

(2) ERROR (OUT1) : Error detection signal

This signal notifies the external device that the controller has detected some error. When this signal is turned ON, the robot will halt. At the same time, an error message will appear on the Teach Pendant display, and an error code will be outputted to the MOUT signals. Related error messages and their meanings are shown in Table 7.7.

The error detected will be reset by the falling edge of the SELECT signal.

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Table 7. 7 Error code (OUT6 - 15)

Error message	Description	AUTO mode error code
POS. ERROR XXXX	Positioning cannot be completed.	0N
EMERGENCY STOP	Emergency Stop is activated.	10
A-CAL ERROR △△[i]	A-CAL cannot be completed normally.	2N
ADDRESS ERROR	Address exceeding the limit was specified.	30
M DATA ERROR	During free curve interpolation, M data of the moving address is not correct.	31
SENSOR NOT FIND	During W-axis sensor stop, sensor is not found.	32
SPLINE DATA ERROR	Free curve movement data is abnormal.	33
AREA ERROR XXXX	Position data is outside the area limit.	4N
OVERRUN XXXX	Overrun has occurred.	5N
SYSTEM DATA ERROR	System Data is corrupted.	63
POINT DATA ERROR	Position data is corrupted.	64
SERVO ERROR XXXX	Servo error has occurred.	7N
Scene set Error	Vision: Scene setting is outside the setting range.	81
Work not Find	Vision: There is no work for detection.	82
Measurement Error	Vision: Measurement conditions are not satisfied.	83
Out of range	Vision: Measurement data is out of range.	84
Vision not ready	Vision: 'NAK' transmission was repeated.	88
Vision not online	Vision: There is no response from Vision.	89
IMPOSSIBL EERROR	During Pass PTP operation, travel distance is too short.	90
OVERFLOW ERROR	Contact the manufacturer.	91
UNDERFLOW ERROR	Contact the manufacturer.	92
OVER SPEED	Speed is too high.	93
M NUMBER ERROR	During PASS PTP operation, the setting of M data is not correct.	94
XY CONVERT ERROR	Positioning data is improper.	95
POSITIONING ERROR	Positioning cannot be performed.	96
BEZIER ERROR	Contact the manufacturer.	97
START MOTION ERROR	Motor does not rotate.	99
ILLEGAL ERROR	Contact the manufacturer.	9A
DRIVER ERROR	Error has occurred in the servo amplifier/driver.	AN
ENCODER DISCONNECT	Encoder signal is not inputted. (HNC-1**,HAC-2** series only)	B0
ENC ERROR XXXX	Encoder signal is not inputted.	BN

An alphanumeric character out of 1 - F will be assigned to "N" in the AUTO mode error code shown above. For details as to which character will be assigned, see the description on the next page. For description of "XXXX," see the next page as well.

[i] For details, refer to Chapter 3 "A-CAL."

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When identification of axes is possible, the upper half of the error code represents the M-data output, and the lower half represents the status of each axis. When "AREA ERROR 1010" is displayed on the message line, it means that the X (A) and Z axes are outside the area limit, and the following signals will be outputted as an error code.

Table 7. 8 Axis identification in error code

	Error code				Error axis code			
					A	B	Z	W
OUT	15	14	13	12	11	10	9	8
Output	0	1	0	0	1	0	1	0

Area error (0x4*)

O : OFF 1 : ON

The error code shown in Table 7.7 will be outputted to the MOUT signals (OUT6 - OUT15) together with the error detection signal (ERROR: OUT1). The output format is the same as the M data output from the MOUT signals. The error codes not marked with "*" in the table are outputted to OUT8 - OUT15.

If an error other than the errors shown above occurs, no error code will be outputted to the MOUT signals. However, the error detection signal (OUT1) will be outputted.

WARNING

As distinct from other errors, the Emergency Stop error cannot be reset by turning OFF the SELECT signal (IN0). If the Emergency Stop is cancelled, the error will be automatically reset, and the system will return to the initial state of the AUTO mode. Be sure to leave the SELECT signal (IN0) OFF until the Emergency Stop is cancelled.

(3) PCA (OUT2) : Positioning permission signal

This signal notifies the external sequencer that the robot is ready to start positioning upon receipt of the START or NEXT signal. Therefore, if the START or NEXT signal has been OFF at the time when positioning is completed normally, the controller will turn ON the PCA signal, and wait for the next command. If it then receives ON input of the START or NEXT signal, it will turn OFF the PCA signal and start robot positioning.

The PCA signal turns ON at the instant when the READY signal turns ON. If the READY signal turns OFF, the PCA signal turns OFF concurrently. This means that the READY signal must be ON when the PCA signal is turned ON.

(4) AUTO (OUT3) : AUTO mode signal

This signal stays ON at all times during the AUTO mode. If the system is switched to a mode other than AUTO, it will turn OFF.

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(5) BP（OUT4） : Base position signal

Under standard settings, this signal is used for output in PASS PTP operation. (Refer to 16.2 “PASS PTP Operation.”)

This signal can also be used for area output of the A and B (X and Y) axes or base position output. For details, refer to the following sections.

“Base Pos Addr *” in 19.4.1 “EXPANSION A”

“AREA OUT AX” and “AREA OUT BY” in 19.4.2 “EXPANSION B”

(6) ZONE（OUT5） : Z axis zone output

This signal will turn ON if the Z axis moves to a position upper than the preset 「SAFETY ZONE」 value of the System Parameter 「RESPONSE」→「RESPONSE」→「SAFTY ZONE」. If the Z-axis is within the 「SAFETY ZONE」, this signal will turn OFF.

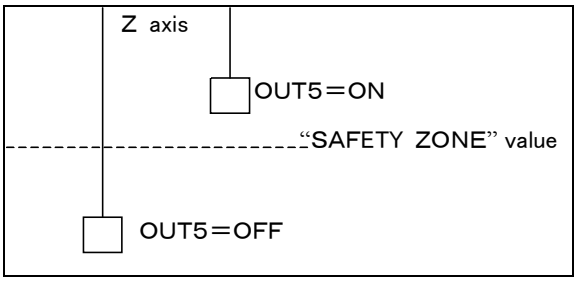


Fig. 7. 3 [SAFETY ZONE]

NOTE

(1) The ZONE signal will not be outputted if A-CAL has not been completed.
(2) The ZONE signal will not turn ON/OFF in the KEY-IN mode.
(3) When the Z-axis auto PULL-UP function is used, the 「SAFETY ZONE」 value in the System Parameter「RESPONSE」→「RESPONSE」→「SAFE. ZONE」 must be greater than the 「PULL-UP」 value in the System Parameter 「MOTION」→「MOTION」→「PULL-UP」.
If the 「SAFETY ZONE」 value is equal to the 「PULL-UP」 value, the ZONE signal can turn ON and OFF repeatedly or cannot turn ON during PULL-UP motion because of vibration generated.

(7) CPOUT（OUT6） : Out put in CPC operation

This signal can be set to turn ON/OFF during CPC operation. For details, refer to 16.3 “CPC Operation.”

(8) A-CAL（OUT7）: Return to origin completion

This signal stays ON at all times while A-CAL of the robot is complete in the same manner as the 『A-CAL』 LED of the Teach Pendant.

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(9) MOUT0 - MOUT7（OUT8 - OUT15） : M data output signal

These signals output M data of position addresses to the external device. The relation between the M data and the OUT signals is shown in the table below.

Table 7. 9 Output patterns

M data	OUT8	OUT9	OUT10	OUT11	OUT12	OUT13	OUT14	OUT15
	MOUT0	MOUT1	MOUT2	MOUT3	MOUT4	MOUT5	MOUT6	MOUT7
0								
1	ON							
2		ON						
3	ON	ON						
4			ON					
5	ON		ON					
6		ON	ON					
7	ON	ON	ON					
8				ON				
9	ON			ON				
10					ON			
20						ON		
30					ON	ON		
40							ON	
50					ON		ON	
60						ON	ON	
70					ON	ON	ON	
80								ON
90					ON			ON

CAUTION

① The M data ranges from 0 to 99, and each data is represented by the combination of signal outputs shown above. (BCD)
When M data is “11” or later, the signal output will be made by the combination as shown below.
For example, when M data is “15,” the signal outputs for M = 10 and M = 5 will be combined. The blank cells in the table mean signal OFF.

② When M data is “0,” neither positioning nor OUT signal output will be performed, but the robot will proceed to the positioning to the next address. (JUMP function)

③ When M data is “??” (end point), output will be made to all the MOUT signals.

④ Output of M data will be made at the start of operation. In the case of PASS PTP or CPC operation, M data will be outputted at each passing point.

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7.1.3 Random Access

The following is the procedure for positioning the robot to a desired address by turning ON/OFF the START signal.

This procedure is based on the signal communication with a sequencer. For the description of each signal, refer to 7.1.1 “DI signals” and 7.1.2 “DO signals.”

(1) Set the Teach Pendant to AUTO mode.

(2) Using the sequencer, turn ON the SELECT signal (IN0) and the POS/INCH signal (IN4). If the 『A-CAL』 LED is not lit, execute A-CAL.

(3) The controller receives the SELECT signal, and turns ON the READY and PCA signals.

(4) If the PCA signal turns ON, output from the sequencer the address position signal(s) (ADDRESS 0 - ADDRESS 9) representing a desired position address and the START signal.

(5) The controller turns OFF the PCA signal, outputs the MOUT signals according to the M data, and then positions the robot to the specified address. If the positioning is completed, the controller will turn ON the PCA signal again.

(6) Repeat steps (4) and (5).

(7) If the M data of the specified address is “??” (end point), the controller will output the PCA signal and all the MOUT signals.

(8) If the position address signal(s) (ADDRESS 0 - ADDRESS 9) and the START signal are newly outputted after the sequencer has received this end point data, steps (4) - (7) will be repeated.

The following figure shows the time chart for signal communication with a sequencer.

- Time chart for normal positioning (random access)

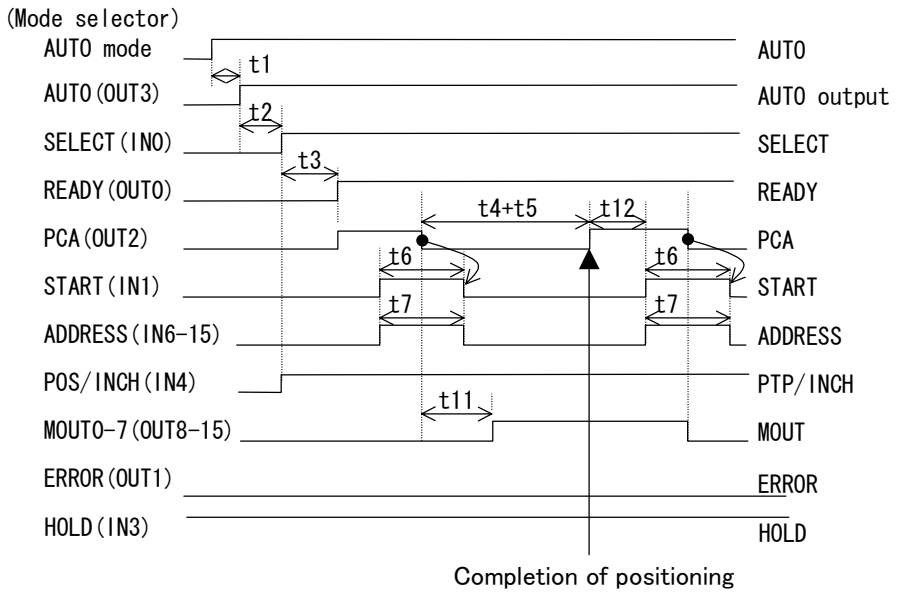


Fig.7. 4 Random access

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- When an error has occurred halfway through the positioning

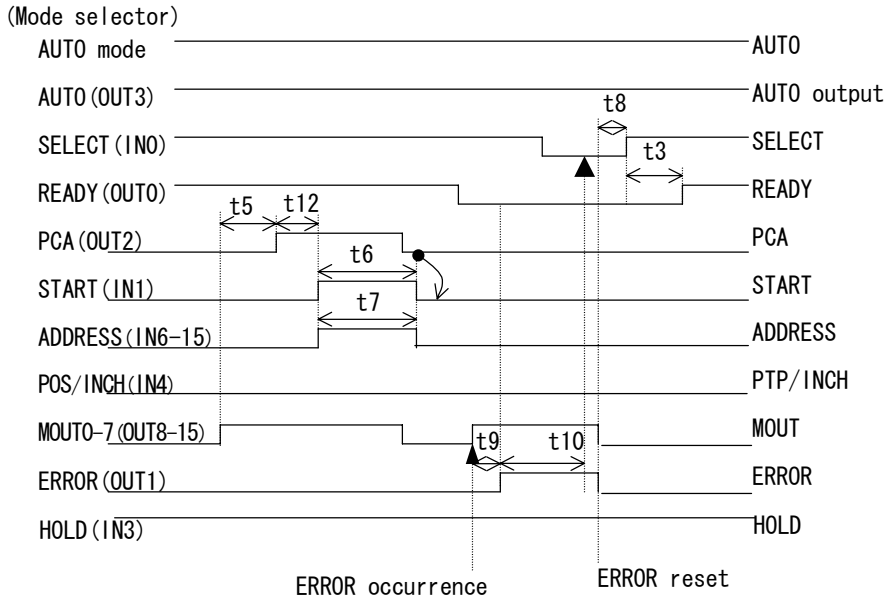
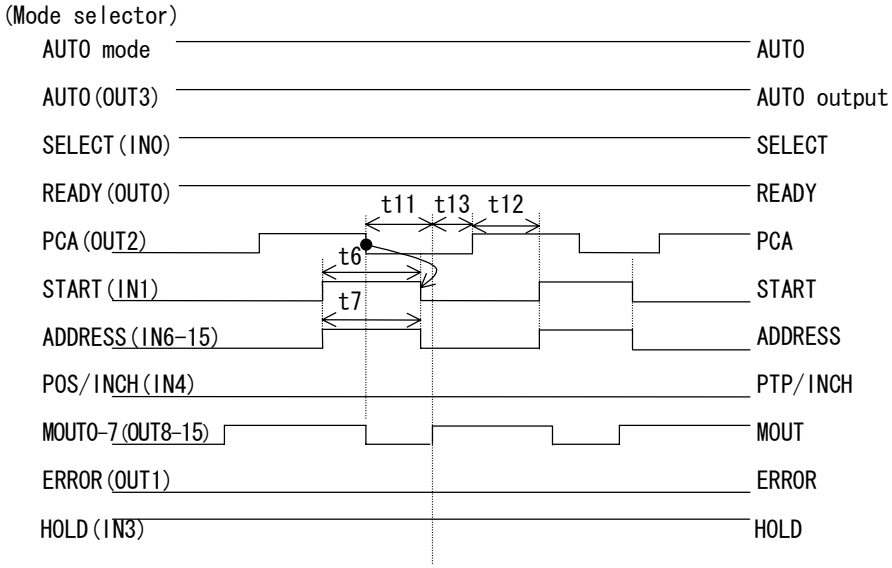


Fig. 7. 5 Error occurrence

- When positioning data contains END



When positioning data contains END, all of MOUT 0 - MOUT 7 will turn ON.

Fig. 7. 6 Positioning data containing END

- t1 : 1.3sec minimum (when power is turned on : .6 sec)
- t2 : 300msec — Time required to be ready to accept the SELECT signal after the AUTO signal output ON
- t3 : 300msec＋α — Time required to output the READY signal from the rising edge of the SELECT signal (α : time required for A-CAL)

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- t4 : Positioning time — Time required to travel from the present point to the next point (If the position of the present point and the next point is the same, t4 is approx. 70 msec.)
- t5 : 64msec — Time required to check positioning, i.e. the time required for the axes to reach the specified position with prescribed precision.
- t6 : PCA→OFF — Time required to accept the START signal (10 msec or more)
- t7 : PCA→OFF — Time required to accept the ADDRESS signal(s) (25 msec or more)
- t8 : 140msec — Time required to accept the SELECT signal after error reset.
- t9 : 10msec — Time required to output ERROR signal ON after the ERROR code output.
- t10 : 45msec — Time required to check SELECT signal OFF after the ERROR output.
- t11 : 40msec — Time required to output the MOUT signals after the PCA signal OFF.
- t12 : 30msec — Time required to be ready to accept the START signal after the PCA signal ON.
- t13 : 10msec — Time from the MOUT signal ON to the PCA signal ON (when positioning is ended)



If positioning using the START/NEXT signal is performed with the servo lock signal OFF, it can take 300 msec at the maximum to start positioning. (Because processing for releasing brakes will be performed regardless of the presence or absence of the brakes.)

7.1.4 Sequential Access

To perform sequential access, set the start address with the START signal, and then let the controller position the robot in sequence with the NEXT signal. If the controller encounters END point data, it will return the robot to the start address. This means you should only set the first address in the sequential access. This positioning method is practicable only when standard DI/DO is used. In the expanded AUTO mode, the NEXT signal has not been assigned.

The operation procedure is almost the same as that for the random access. The difference from the random access is that, in the case of sequential access, address specification is needed only at the start if the sequence of addresses taught in the TEACH or KEY-IN mode is the same as that of actual work.

Upon receipt of the NEXT signal, the controller automatically increments the address by one and performs positioning.

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- Time chart for normal positioning (sequential access)

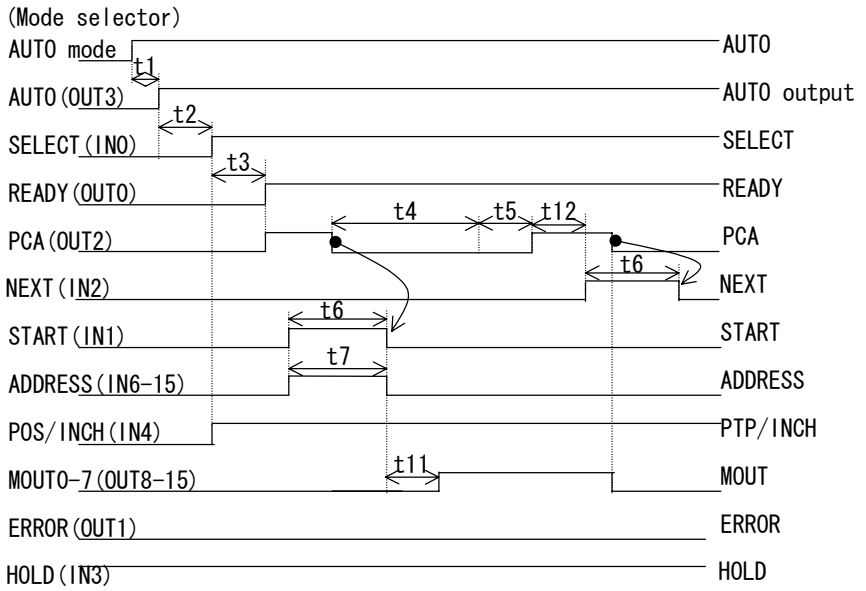


Fig.7. 7 Sequential access

Description of "t" is the same as that for random access.

Timing of signal outputs in the case where an error occurs during positioning or end data is detected is also the same as that in the case of random access.

- When an error has occurred halfway through the positioning

If an error has occurred halfway through the positioning, the ERROR signal will be outputted to the sequencer. When the Teach Pendant is connected, an error message will be displayed on the LCD screen. (Refer to Chapter 23 "MESSAGE.")

To reset the error, follow the procedure shown below.

① Check the type of the error from the error message.

② If the cause of the error has become clear, turn OFF the SELECT signal.
As the ERROR signal from the controller will turn OFF, take actions to remedy the error.

③ After taking necessary actions, turn ON the SELECT signal again to recover from the error.

NOTE

① During PTP operation, the time required to be ready to accept SELECT signal ON after SELECT signal OFF is 0.5 sec.
② At the time when the controller receives SELECT signal ON or outputs the MOUT and PCA signals, both the START and NEXT signals must be OFF.
③ The target address of random access must be fixed while the START signal is ON.
④ If MOUT signal output cannot be accepted normally when the PCA or ERROR signal is ON, delay the timing of acceptance by one scan (in the

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case of a sequencer) from the input of PCA or ERROR signal ON, or set the timer.

⑤ When the ERROR signal is outputted, the controller checks that the SELECT signal is ON. Therefore, when the error is to be reset by SELECT signal OFF, do not turn OFF the SELECT signal during "t10" shown in the time chart.

⑥ As the input/output of signals is designed to make a handshake, do not output signals using a timer. (In particular, the START, NEXT, and ADDRESS signals must be turned OFF after confirming that the PCA signal has turned OFF.)

⑦ The Emergency Stop error cannot be reset by SELECT signal OFF. If the Emergency Stop is cancelled, the error will be automatically reset, and the system will return to the initial state of the AUTO mode. Be sure to leave the SELECT signal OFF until emergency stop is cancelled. Reset the Emergency Stop status after wait three seconds for turning the SELECT signal ON.

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7.1.5 Flow of Automatic Operation in Controller

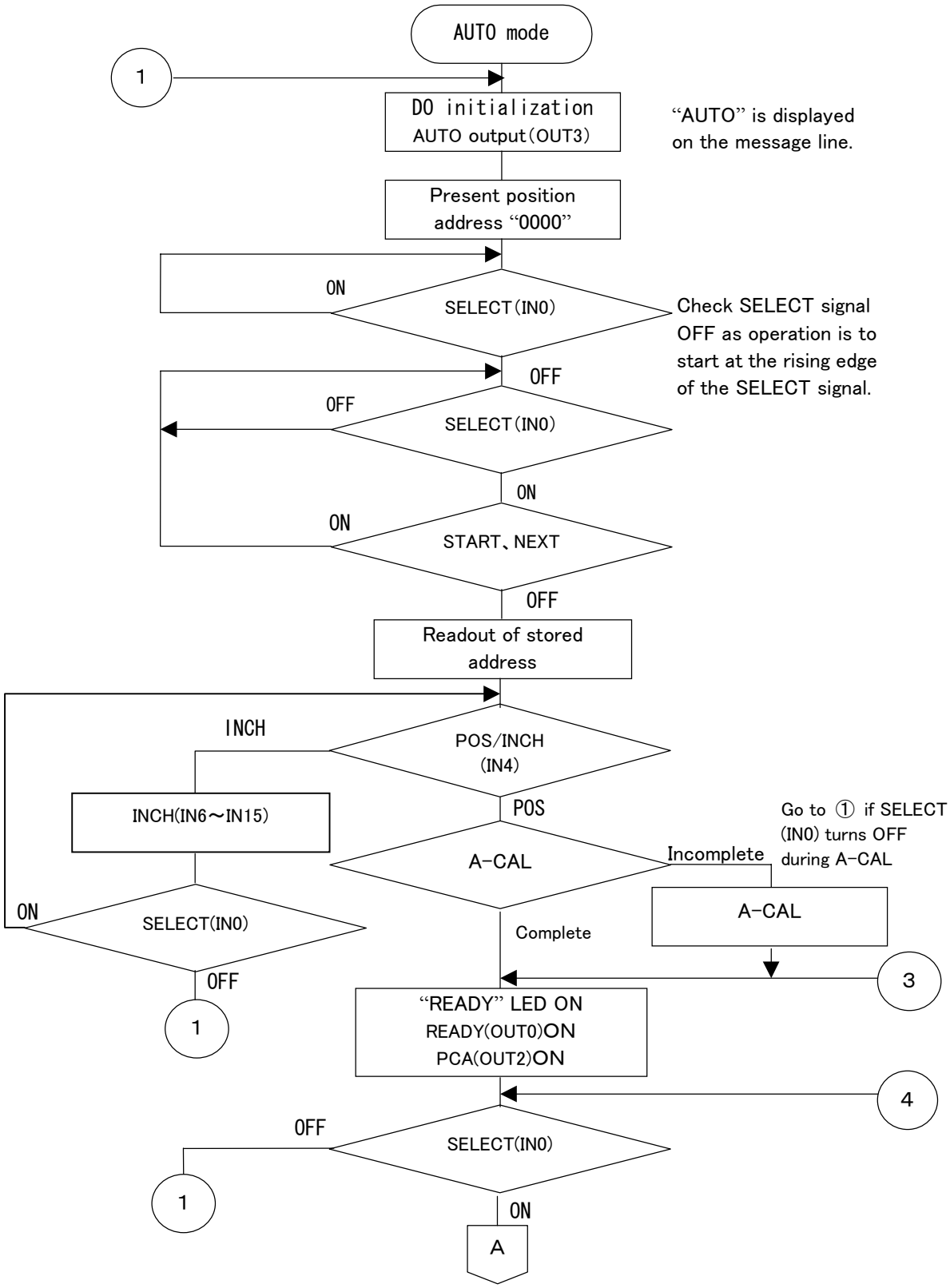


Fig.7. 8 Automatic operation

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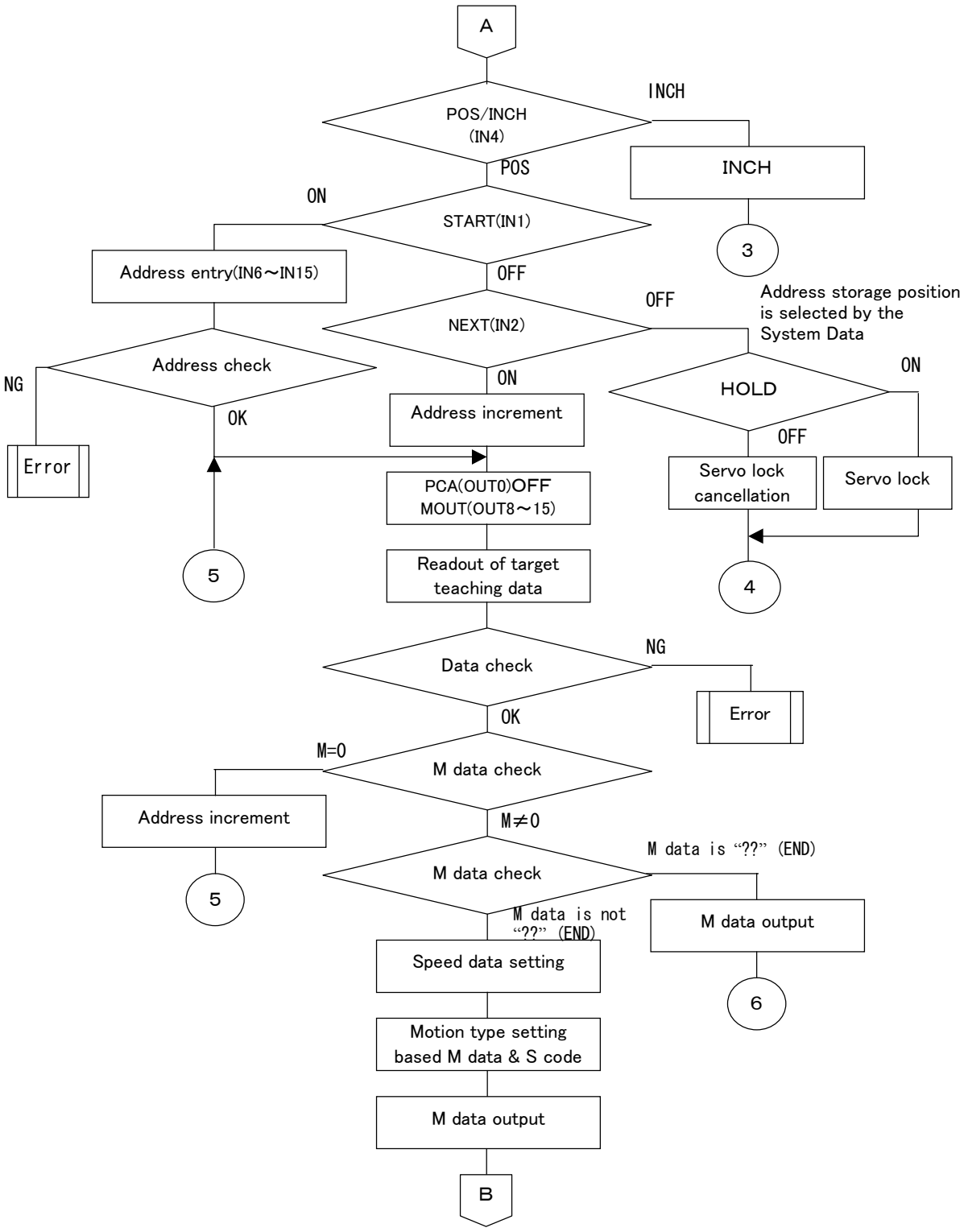


Fig.7. 9 Automatic operation②

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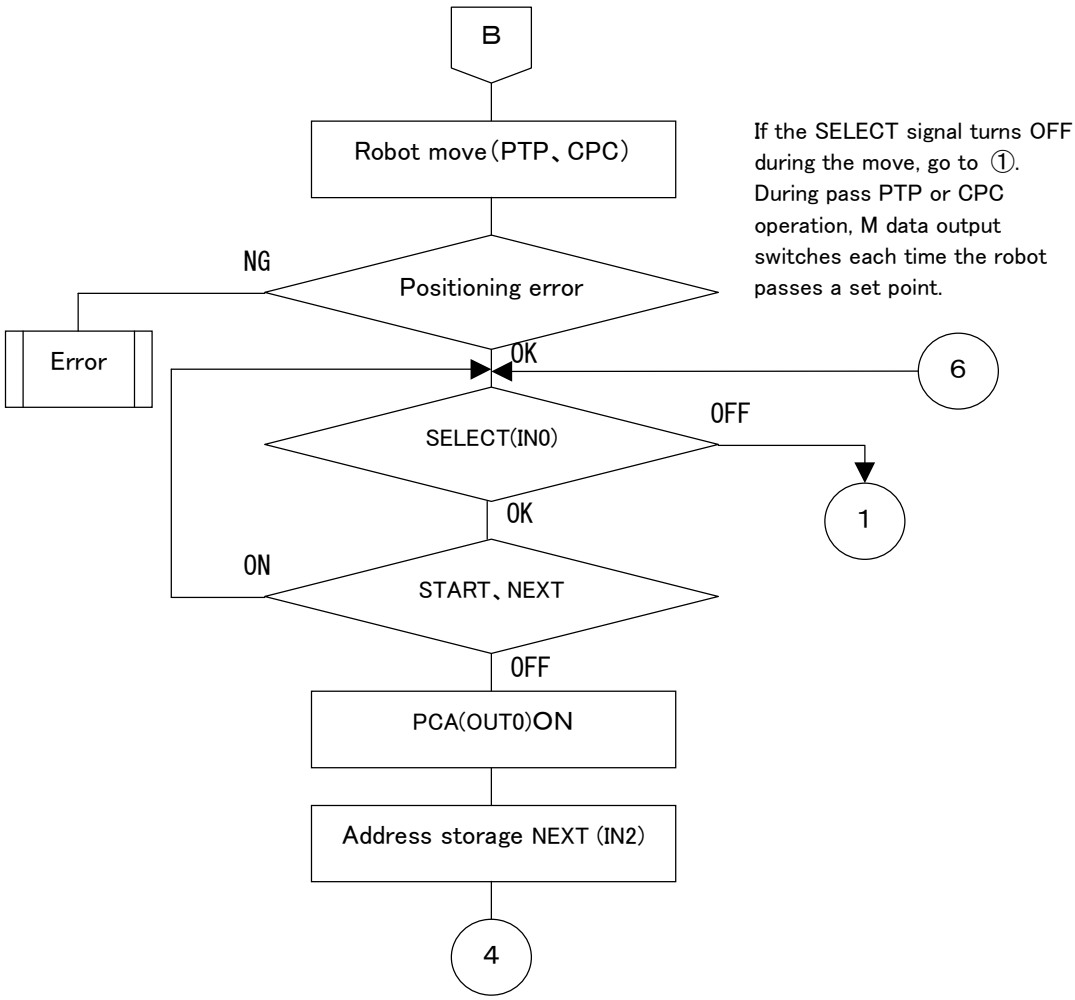


Fig.7. 10 Automatic operation ③

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7.1.6 Position Data Load from Memory Card in AUTO Mode

To cope with the increase in position data brought by model change and others, the system is provided with a function to load position data from a memory card by quoting a file name (file number) with the DI signals in the AUTO mode.

To load position data from a memory card in the AUTO mode, specify a file name using the address bits of the DI signals (IN6 - IN15). Therefore, position data must have been saved under a file name between 0 and 1023.

Position data in a memory card will be automatically loaded to the same position address as that of the time when the data was saved. The data cannot be loaded to a different address. (In the memory card mode, the data can be loaded to a desired address.)

The handshake of the DI/DO signals at the time of data loading from a memory card is shown in Figure 7.11: Signal handshake at data loading from memory card.

The OUT6 signal serves as a signal to indicate the switching to the mode to load data from a memory card, and also as a signal to indicate the completion of data loading when OFF.

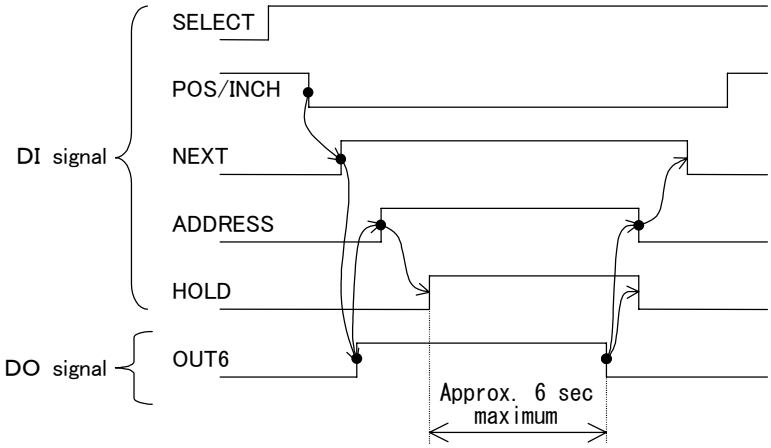


Fig.7. 11 Signal handshake at data loading from memory card

CAUTION

① When you turn OFF the POS/INCH signal (inching mode), be sure to set the address data to "0."
② When you have turned ON the NEXT signal, wait until OUT6 turns ON. Then specify an address (a file name), and turn ON the HOLD signal.
③ When OUT6 has turned OFF, turn OFF the HOLD and ADDRESS signals first, and then turn OFF the NEXT signal.
After that, turn ON the POS/INCH signal to activate the position mode.

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7.2 ON-LINE Mode

The ON-LINE mode is to be used when automatic operation is performed using the HAC (Hirata Assembly cell Controller) or with a host computer via RS-232C interface.

When you use this mode, refer to the HRCS-RⅢ Reference Manual provided separately.

The robot speed in this ON-LINE mode is determined by the System Parameter, F code, and operation commands.

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CHAPTER 8 DATA EDITING

8.1 Entering END Point (M data = ??)

When you prepare position data in the KEY-IN or TEACH mode, enter an END point (M=??) at the end of the data. The END point (M=??) indicates the end of position data, and must be put at the end of position data. In automatic operation or operation in the CHECK mode, positioning to the END point (M=??) will not be performed.

(1) Set the mode selector switch of the Teach Pendant to KEY-IN, RO-TEACH, or LI-TEACH.

(2) Call up the address that should be an END point (M=??).

(3) Press the END key. The message

"END WRITE OK?"

will appear on the message line, and a buzzer will sound.

(4) Check that the address is correct, and press the ENTER key. Then an END point (M=??) is set.

When you have called up a wrong address, press a key other than the ENTER key. Then the END point (M=??) setting will be cancelled.

CAUTION

① The END point explained here means a point where the robot should finish a series of operation. All the addresses after the END point can be used in a normal way.
② The M data of the address assigned as an END point will be displayed as "??." This does not change whichever mode is selected. To cancel the END point setting, enter numeric data into the M data section of the address assigned as an END point. If you set the M data to a numeral, the data of the address will be handled as normal position data.
③ When an END point is set, data of the X, Y, Z, and W axes will be checked simultaneously. If any of the data is improper, an error will arise and the END point setting will abort.

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8.2 Inserting Position Data

Follow the procedure shown below when you wish to insert position data after you have prepared data in the KEY-IN or TEACH mode.

Inserting position data can affect the teaching data that has already been prepared. Be extremely careful when you insert position data.

(1) Set the mode selector switch of the Teach Pendant to the KEY-IN or TEACH.

(2) Call up the address where you wish to insert data. For example, when you wish to insert data between address 50 and address 51, call up address 51.

(3) Create new position data, and then press the del INS key. The 『SHIFT』 LED must be OFF at that time. The message

SHIFT

"INSERT OK?"

will appear on the message line, and a buzzer will sound.

CAUTION

If the TEACH mode is selected and the del INS key is pressed when A-CAL has not been completed, the message
"A-CAL INCOMPLETE"
will appear on the message line, and the data insertion will not be accepted.

(4) Check that the address and data are correct, and press the ENTER key. Then the new data will be inserted.

To cancel the data insertion, press a key other than the ENTER key.

WARNING

①When the sequencer has software for automatic operation, trouble can occur during automatic operation if position data is inserted.
②After position data has been inserted, position data will be shifted as shown in Table 8.1 below. It is therefore required to make a change to the software in the sequencer after position data insertion.

CAUTION

If position data is inserted, the data of the addresses that have exceeded the ADDRESS MAX (System Generation 「LIMIT」→「ADDRESS MAX」→ 「ADDRESS MAX」) will be erased.

Table 8. 1 Data insertion

	Before insertion		After insertion	
	Address	Data	Address	Data
	49	M_0 F_0 X_0 Y_0 Z_0 W_0	49	M_0 F_0 X_0 Y_0 Z_0 W_0
	50	M_1 F_1 X_1 Y_1 Z_1 W_1	50	M_1 F_1 X_1 Y_1 Z_1 W_1
Insert →	51	M_2 F_2 X_2 Y_2 Z_2 W_2	51	Inserted data
	52	M_3 F_3 X_3 Y_3 Z_3 W_3	52	M_2 F_2 X_2 Y_2 Z_2 W_2
	53	M_4 F_4 X_4 Y_4 Z_4 W_4	53	M_3 F_3 X_3 Y_3 Z_3 W_3

S code and Local code data are also included.

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8.3 Deleting Position Data

Follow the procedure shown below when you wish to delete position data after you have prepared data in the KEY-IN or TEACH mode.

Deleting position data can affect the teaching data that has already been prepared. Be extremely careful when deleting position data.

(1) Set the mode selector switch of the Teach Pendant to the "KEY-IN" or "TEACH."

(2) Call up the address of which you wish to delete data.

(3) Press the SHIFT key to let the 『SHIFT』 LED light up, and then press the del INS key. The message



"DELETE OK?"

will appear on the message line, and a buzzer will sound.

(4) Check that the address and data are correct, and press the ENTER key. Then the data will be deleted, and the data of the next address will be displayed.

To cancel the data deletion, press a key other than the ENTER key.

WARNING

When the sequencer has software for automatic operation, trouble can occur during automatic operation if position data is deleted.
After position data has been deleted, position data will be shifted as shown in Table 8.2 below. It is therefore required to make a change to the software in the sequencer after position data deletion.

CAUTION

If position data is deleted, the data of the final address specified by the value of the System Generation 「LIMIT」→「ADDRESS MAX」→ 「ADDRESS MAX」 will be copied onto the previous address. Also, all the addresses after the address deleted will be decremented by one, and the data of the final address will be initialized.

Table 8. 2 Data deletion

Before deletion		After deletion	
Address	Data	Address	Data
4 9	M_0 F_0 X_0 Y_0 Z_0 W_0	4 9	M_0 F_0 X_0 Y_0 Z_0 W_0
5 0	M_1 F_1 X_1 Y_1 Z_1 W_1	5 0	M_1 F_1 X_1 Y_1 Z_1 W_1
5 1 ←Delete	M_2 F_2 X_2 Y_2 Z_2 W_2	5 1	M_3 F_3 X_3 Y_3 Z_3 W_3
5 2	M_3 F_3 X_3 Y_3 Z_3 W_3	5 2	M_4 F_4 X_4 Y_4 Z_4 W_4

S code and LOCAL code data are also included.

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8.4 Copying Position Data

The following is the procedure for copying position data onto another address.

(1) Set the mode selector switch of the Teach Pendant to the KEY-IN.

(2) Enter the address to be a source, and press the READ key.

(3) Enter the address to be a target. Enter data by the following procedure.

① Enter data with the numeric keys such as */0, cal/1, and task/2.

② Press the ENTER key. The message
"ENTER OK?"
will appear on the message line, and a buzzer will sound.

③ Recheck that the entered data is correct, and press the ENTER key again. Then copy is completed

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8.5 Editing Position Data in Block

Press the FUNC HIGH + p.ed 5 keys to switch the system to the position memory block operation mode. The range of addresses that can be edited in block is from address 0 to the address specified by the value of the System Generation 「LIMIT」→「ADDRESS MAX」→「ADDRESS MAX」. For details, refer to the following sections.

8.5.1 Basic Operation

The following figure shows the initial screen in the block operation mode. At the moment just after the mode switching, only the shaded area is displayed. To scroll the screen and display the "MODE COMMAND" and parameters thereafter, press the up DOWN key.

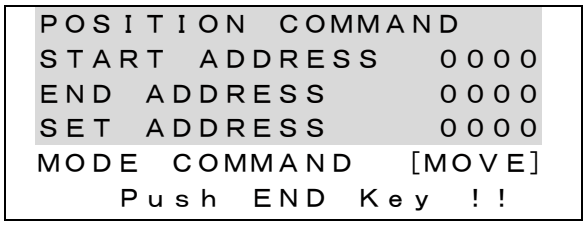


Fig. 8. 1 Block operation screen

(1) Enter desired addresses into "START ADDRESS," "END ADDRESS," and "SET ADDRESS." Enter data by the following procedure.



① Move the cursor to a desired parameter. To move down the cursor, use the up DOWN key. To move up the cursor, press the SHIFT key to let the 『SHIFT』 LED light up, and then press the up DOWN key.

② Enter data with the numeric keys such as * 0, cal 1, and task 2.

③ Press the ENTER key. The message "ENTER OK?" will appear on the message line, and a buzzer will sound.

④ Check that the entered data is correct, and press the ENTER key again. The data will then be fixed.

Description of each parameter is shown below.

Table 8. 3 Description of block operation settings

Parameter	Description
「START ADDRESS」	Specifies the start address.
「END ADDRESS」	Specifies the end address.
「SET ADDRESS」	Specifies the set address.
「MODE COMMAND」	Specifies the type of operation.

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(2) The following five options have been provided for the MODE COMMAND.

① 「MOVE」 Moves data in block.
② 「INS」 Inserts data in block.
③ 「DEL」 Deletes data in block.
④ 「SET」 Sets data in block.
⑤ 「INIT」 Initializes data in block.

To select the mode command, use the numeric key from [*/0] - [s.ed/4].

(3) Press the [END] key. The message

"Position ＊＊＊＊ Ok ?"

will appear.

(4) Press the [ENTER] key to execute the select command. If the execution is completed, the message

"＊＊＊＊ Completed !!"

will appear.

NOTE

"＊＊＊＊"represents a command name.

8.5.2 Moving Position Data (MOVE)

Data of the addresses from the "START ADDRESS" to the "END ADDRESS" will be moved to the addresses starting from the "SET ADDRESS." The difference from the insertion is that the data of target addresses will be overwritten (erased) after the move.

If you move the position data of addresses 10 - 14 to address 30, position data will change as shown in the table below. In this example, the value of the System Generation 「LIMIT」→「ADDRESS MAX」→「ADDRESS MAX」 is set to 100.

Table 8. 4 Data move in block

Before move	
Address	Data
9	Data 9
10	Data 10
11	Data 11
12	Data 12
13	Data 13
14	Data 14
15	Data 15
.	.
.	.
.	.
98	Data 98
99	Data 99
100	Data 100

Move

After move	
Address	Data
29	Data 29
30	Data 10
31	Data 11
32	Data 12
33	Data 13
34	Data 14
35	Data 35
.	.
.	.
.	.
98	Data 98
99	Data 99
100	Data 100

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8.5.3 Inserting Position Data (INS)

Data of the addresses from the "START ADDRESS" to the "END ADDRESS" will be inserted into the "SET ADDRESS." After the insertion, the data of the target address and the addresses thereafter will be shifted by the number of source addresses. The data of the addresses that have exceeded the value of the System Generation 「LIMIT」→「ADDRESS MAX」→「ADDRESS MAX」 after the insertion will be pushed out and erased.

If you insert the position data of addresses 10 - 14 into address 30, position data will change as shown in the table below. In this example, the value of the System Generation 「LIMIT」→「ADDRESS MAX」→「ADDRESS MAX」 is set to 100. The data of addresses 96 - 100 will be pushed out and erased after the insertion.

Table 8. 5 Data insertion in block

Before insertion	
Address	Data
9	Data 9
10	Data 10
11	Data 11
12	Data 12
13	Data 13
14	Data 14
15	Data 15
.	.
96	Data 96
97	Data 97
98	Data 98
99	Data 99
100	Data 100

Insertion

When ADDRESS MAX is 100, these data will be pushed out and erased after the insertion.

After insertion	
Address	Data
29	Data 29
30	Data 10
31	Data 11
32	Data 12
33	Data 13
34	Data 14
35	Data 30
.	.
.	.
.	.
98	Data 93
99	Data 94
100	Data 95

CAUTION

Inserting the data at the back into the forward position can take several seconds if the amount of data to be inserted is great. If you do not require the data of the target addresses, it is recommendable that you use "MOVE" (8.5.2 "Moving position data (MOVE)") to save time. Also, please bear in mind that, after the insertion, the data of the target addresses has been shifted backward by the number of addresses inserted.

8.5.4 Deleting Position Data (DEL)

Data of the addresses from the "START ADDRESS" to the "END ADDRESS" will be deleted.

If you delete the position data of addresses 10 - 14, position data will change as shown in the table below. In this example, the value of the System Generation 「LIMIT」→「ADDRESS MAX」→「ADDRESS MAX」 is set to 100. The data of addresses 96 - 100 will be initialized after the deletion.

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Table 8. 6 Data deletion in block

Before deletion	
Address	Data
9	Data 9
10	Data 10
11	Data 11
12	Data 12
13	Data 13
14	Data 14
15	Data 15
.	.
96	Data 96
97	Data 97
98	Data 98
99	Data 99
100	Data 100

Deletion

After deletion	
Address	Data
9	Data 9
10	Data 15
11	Data 16
12	Data 17
13	Data 18
14	Data 19
15	Data 20
.	.
96	Initial Data
97	Initial Data
98	Initial Data
99	Initial Data
100	Initial Data

8.5.5 Setting Position Data (SET)

Data of the "SET ADDRESS" will be set (copied) onto the addresses from the "START ADDRESS" to the "END ADDRESS."

If you set the position data of address 96 to addresses 10 - 14, position data will change as shown in the table below. In this example, the value of the System Generation 「LIMIT」→「ADDRESS MAX」→「ADDRESS MAX」 is set to 100. The data of addresses 10 - 14 will be overwritten with the data of address 96 after the setting.

Table 8. 7 Data setting in block

Before setting	
Address	Data
9	Data 9
10	Data 10
11	Data 11
12	Data 12
13	Data 13
14	Data 14
15	Data 15
.	.
.	.
.	.
98	Data 98
99	Data 99
100	Data 100

Set the data of address 96.

After setting	
Address	Data
9	Data 9
10	Data 96
11	Data 96
12	Data 96
13	Data 96
14	Data 96
15	Data 15
.	.
.	.
.	.
98	Data 98
99	Data 99
100	Data 100

8.5.6 Initializing Position Data (INIT)

Data of the addresses from the "START ADDRESS" to the "END ADDRESS" will be initialized.

```
0010 M?? F99 S00 L 0
  X 0000.00 Y 0000.00
  Z 0000.00 W 0000.00
KEY IN
```

Fig. 8. 2 Initial data

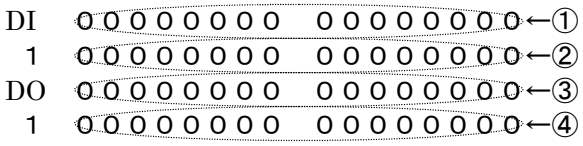
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CHAPTER 9 INPUT/OUTPUT OPERATION

9.1 DI/DO Monitor

9.1.1 DI/DO Monitor Before Ver.2.0

If the FUNC HIGH + io SEL keys are pressed, the system will switch to the DI/DO monitor mode, and the following screen will appear.



Displays the status of each bit from DI0 to DI15. (standard)
Displays the status of each bit from DI16 to DI31. (option)
Displays the status of each bit from DO0 to DO15. (standard)
Displays the status of each bit from DO16 to DO31. (option)

Fig.9. 1 DI/DO monitor

It is possible to turn ON/OFF the DO signal where a cursor sits.

(1) Press the up DOWN key to move a cursor (■).

(2) Turn ON/OFF the DO by either of the following methods.

① Press the io SEL key. The DO signal will turn from 1 to 0, or from 0 to 1.

② Press the * 0 or cal 1 key. The * 0 key will turn the signal to 0; the cal 1 key will turn the signal to 1.

(3) To exit from this mode, press the spd CAN key.

NOTE

Most DO signals can be operated in any operation mode. However, in the AUTO mode, DO signals for BP, ZONE, A-CAL, and AUTO output cannot be operated as they are controlled by the system.

Some models have a controller with 48 signals for DI and DO respectively. In this case, the DI/DO monitor screen is divided into two, i.e. DI/DO 0 - 31 and DI/DO 16 - 47.

SHIFT

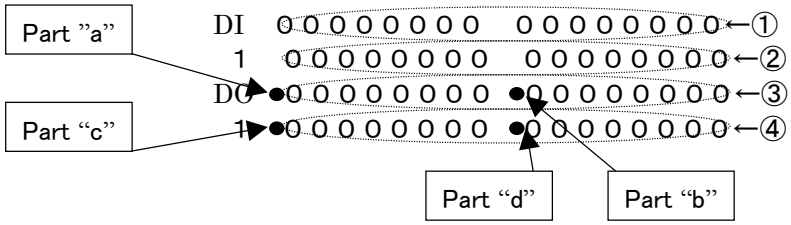
To switch the DI monitor, press the FUNC HIGH + dec INC keys when the 『SHIFT』 LED is OFF. The display switches between DI0 - DI31 and DI16 - DI47. When the data of DI16 - DI47 is displayed, the figure displayed under "DI" will be "2."

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SHIFT To switch the DO monitor, press the FUNC/HIGH + dec/INC keys when the 『SHIFT』 LED is ON. The display switches between DO0 - DO31 and DO16 - DO47. When the data of DO16 - DO47 is displayed, the figure displayed under "DO" will be "2."

9.1.2 DI/DO Monitor in Ver. 2.0 or Later

If the FUNC/HIGH + io/SEL keys are pressed, the system will switch to the DI/DO monitor mode, and the following screen will appear.



Displays the status of each bit from DI0 to DI15. (standard)
Displays the status of each bit from DI16 to DI31. (option)
Displays the status of each bit from DO0 to DO15. (standard)
Displays the status of each bit from DO16 to DO31. (option)

Fig.9. 2 DI/DO monitor

It is possible to turn ON/OFF the DO signals in the line where a cursor sits using the numeric keys.

(1) Press the up/DOWN key to move a cursor (■). The cursor will jump to the part "a," "b," "c," or "d" shown in Figure 9.2: DI/DO monitor.

(2) Turn ON/OFF the DO signal.

The numeric keys from * / 0 - s.g / 7 correspond to the eight bits of the line where the cursor sits, respectively.

If one of these numeric keys is pressed, the corresponding bit will turn from 0 to 1, or from 1 to 0. "0" represents signal OFF, and "1" represents signal ON.

	0 1 2 3 4 5 6 7 ← Numeric keys form 0 to 7
Part "a"	0 0 0 0 0 0 0 0 ← DO0 - DO7
Part "b"	0 0 0 0 0 0 0 0 ← DO8 - DO15
Part "c"	0 0 0 0 0 0 0 0 ← DO16 - DO23 (option)
Part "d"	0 0 0 0 0 0 0 0 ← DO24 - DO31(option)

(3) To exit from this mode, press the spd/CAN key.

NOTE

Most DO signals can be operated in any operation mode. However, in the AUTO mode, DO signals for BP, ZONE, A-CAL, and AUTO output cannot be operated as they are controlled by the system.

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9.2 Manually Outputting M Data Signals

In the KEY-IN, TEACH, or CHECK mode, the controller outputs M data to the output signals in a prescribed form. When you use these output signals from the controller, it becomes possible to check the operation of the other equipment by controlling the output signals during teaching or in the CHECK mode. For details about the M data, refer to 16.5.1 "List of M Data functions."

The following is the procedure for outputting M data manually.

(1) Set the Teach Pendant to the KEY-IN, TEACH, or CHECK mode.

(2) Move a cursor to the M data section.

(3) Press the numeric key(s) representing a desired M data value.
When you wish to set the M data to 10, press the cal/1 and */0 keys.

(4) Press the m.c/M.OUT key. According to the M data displayed at the time when this key is pressed, output will be made to the output signals.

CAUTION

① If you press the ENTER key before pressing the m.c/M.OUT key, the system will proceed with the confirmation of the position data displayed.
If you have pressed the ENTER key by mistake, press a key other than the ENTER key to cancel the data confirmation.
② The output made will be maintained until the next output is carried out. If the mode is switched to ON-LINE or the power is shut off, all the outputs will be turned OFF.

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CHAPTER 10 HOLD FUNCTION

The HOLD function turns ON/OFF the servo lock of each axis.

For example, if the A (X) and B (Y) axes are put on HOLD, their lateral movements will be locked. This helps prevent deflections in a lateral direction at the time when you teach a parts-fitting or screw-tightening position.

This function can be used in the LI-TEACH, RO-TEACH, and CHECK modes. To switch the HOLD status of each axis, follow the procedure described below.

(1) Press the [HOLD] key to bring up the HOLD function screen.

```
HOLD  AXIS  SET
 A  OFF      B  OFF
 Z  OFF      W  OFF
   Push  AXIS Key ! !
```

Fig. 10. 1 HOLD function screen

(2) Using the axis keys, select a desired axis.

Each time the [+R/R +X], [+C +Y], [↑Z] or [+W] key is pressed, the HOLD status of the corresponding axis will turn ON/OFF.

It is also possible to switch the HOLD status by either of the following methods.

- Move a cursor to a desired axis, and press the [io SEL] key. The HOLD status will switch from ON to OFF or from OFF to ON.
- Move a cursor to a desired axis, and press the [* 0] or [cal 1] key. The [* 0] key switches the HOLD status to OFF; the [cal 1] key switches the HOLD status to ON.

(3) Press the [spd CAN] key to exit from the HOLD function screen.

(4) Switching of the HOLD status becomes effective after you exit from the HOLD function screen.



If there is even one axis in the HOLD status, the 『HOLD』 LED lights up, and the head of the position data of the axis on HOLD is asterisked (*).

```
 0050  M10  F99  S00  R  0
   X  0500.05   Y  0080.00
 *Z  0020.10   W  0100.00
LI−TEACH
```

Fig. 10. 2 Display of axis on HOLD

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NOTE

In the KEY-IN mode, the HOLD status will be cancelled. When the axis is equipped with a brake, the brake will become activated instead.

When the robot has an axis equipped with a brake but without a balancer.

When the axis is equipped with a brake but not with a balancer, its HOLD status cannot be turned OFF solely by the above procedure. The following settings must be performed before turning OFF the HOLD status.

① Select System Generation 「MAINTENANCE」→「MAINTENANCE DATA」→「EMP SELECT」and set this parameter to 256, to permit the cancellation of servo lock of the axis with a brake.

② Select System Generation 「ORIGIN」→「AXIS SELECT」→「＊AXIS SEL」and set this parameter to "NOT HOLD" for the axis with a brake but without a balancer.

③ Turn OFF the HOLD status by steps (1) - (4) shown above.

DANGER

If the HOLD status of a gravity axis, in particular, the Z-axis is turned OFF, it can cause a free fall creating safety hazards. Cancellation of the HOLD status must be performed by a person with a thorough knowledge of robot operation and with adequate safety precautions for surroundings.

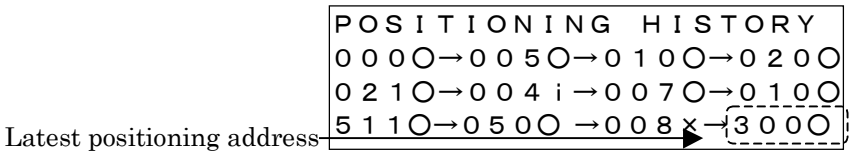
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CHAPTER 11 POSITIONING ADDRESS HISTORY

The controller stores the positioning addresses used during automatic operation. The addresses are to be stored at the rising edge of the START or NEXT signal or at the execution of the MOVE command by the HRCS-R Ⅲ.[i]

The result of positioning whether it was successful or not will also be stored at the same time.

The screen display will switch each time the FUNC/HIGH + task/2 keys are pressed. Press these keys repeatedly until the following screen appears. (Refer to (2) task/2 : [task] key (Task) in 2.8 "Function Mode.")



"__": Aborted.
"×": Error (An alphabet will be displayed in reality. For detail, see Table 11.1:Address history error message List.
"○" : Completed normally.

Fig.11. 1 Address history screen

The above figure shows that the latest address used in positioning is "008," and the oldest address stored is "000." If positioning to another address is performed, the new address will be displayed in a place where "008" is displayed, and all the addresses before it will be shifted accordingly. The controller is capable of storing 12 addresses including the last address. The addresses older than that will be erased.

NOTE

In the case where robot positioning has been interrupted by SELECT signal OFF, the address may be displayed with "○" (completed normally) not with "_" (aborted).

In the part of "×" in Figure 11.1, an alphabet will be displayed in reality. The descriptions of the alphabets are shown in the table below.

[i] HRCS-RⅡ in the case of the version earlier than 2.0

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Table 11. 1 Address history error message list

Display	Display on Teach Pendant	Description
A	POS. ERROR XXXX	Positioning cannot be completed.
B	EMERGENCY STOP	Emergency stop is activated.
C	A-CAL ERROR △△	A-CAL cannot be completed normally.
D	ADDRESS ERROR	Address exceeding the limit was specified.
D	M DATA ERROR	During free curve interpolation, M data of the moving address is not correct.
D	SENSOR NOT FIND	During W-axis sensor stop, sensor is not found.
D	SPLINE DATA ERROR	Free curve movement data is abnormal.
E	AREA ERROR XXXX	Position data is outside the area limit.
F	OVERRUN XXXX	Overrun has occurred.
G	SYSTEM DATA ERROR	System Data is corrupted.
G	POINT DATA ERROR	Position data is corrupted.
H	SERVO ERROR XXXX	Servo error has occurred.
I	Scene set Error	Vision: Scene setting is outside the setting range.
I	Work not Find	Vision: There is no work for detection.
I	Measurement Error	Vision: Measurement conditions are not satisfied.
I	Out of range	Vision: Measurement data is out of range.
I	Vision not ready	Vision: "NAK" transmission was repeated.
I	Vision not online	Vision: There is no response from vision.
J	IMPOSSIBL EERROR	During Pass PTP operation, travel distance is too short.
J	M NUMBER ERROR	During PASS PTP operation, the setting of M data is not correct.
J	XY CONVERT ERROR	Positioning data is improper.
J	POSITIONING ERROR	Positioning cannot be performed.
J	START MOTION ERROR	Motor does not operate even if a speed command is given.
J	OVER SPEED	Speed is too high.
K	DRIVER ERROR	Error has occurred in the servo amplifier/driver.
L	ENCODER DISCONNECT	Encoder has a broker wire. (HNC-1**, HAC-2** series)
L	ENC ERROR XXXX	Encoder has a broker wire.
i	STOP ON	Interlock is inputted. (This is not an error but a message.)

"XXXX" in message shows the status of the axes of the robot.

	Corresponding axes			
	X axis	Y axis	Z axis	R axis
Output	1	0	1	0

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CHAPTER 12 AUTOMATIC CREATION OF POSITION DATA & PARAMETERS

Our robot system is provided with functions to automatically create position data and various parameters. The following are the functions available.

(1) CALCULATE mode

Automatically calculates robot System Data and position data.

① ROBOT mode
Automatically calculates characteristic values of the robot, i.e. initial angle and arm length.

② PALLET mode
Develops position data from three-point data taught on a pallet.

③ PATTERN mode
Develops position data in specified patterns, from a series of operations taught.

(2) OFFSET mode

Compensates robot position data.

① COORDINATE OFFSET
Compensates robot position data using X and Y coordinates in the case where a work object is displaced.

② COUNTER OFFSET
Compensates robot position data using pulse data in the case where an overall robot is displaced.

(3) MEMORY mode

Displays the data area for maintenance.

① A-CAL COMPARE (A-CAL compensation)



This function is not supported at present.

Displays automatically compensated data in the case where A-CAL position has deviated from the robot-specific initial data.

② ABS.DATA SET(Absolute encoder data)
Displays or modifies the motor data of the robot equipped with absolute encoder type motors.



Modifying this data can displace robot position. Modify the data only when the manufacturer instructs you to do so.

(4) DISP mode

Automatically calculates the OFFSET values for the displayed coordinate system.

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(5) OPTION mode

Is available only to a special-spec robot.

(6) UTILITY mode (for INDEX TABLE robot)

① NC CAM PATTERN SET (Selection of speed pattern)
Sets a speed pattern for an INDEX TABLE robot.

② DIVIDE CALCULATION (Creation of divided position data)
Creates divided position data for an INDEX TABLE robot.

(7) OFFSET mode (for INDEX TABLE robot)

NOTE

This function is not supported at present.

(8) MEMORY mode (for INDEX TABLE robot)

NOTE

This function is not supported at present.

To select a desired function, press the FUNC HIGH + cal 1 keys simultaneously.
Then the following screen will appear in the case of a normal robot.

```
ROBOT CALCULATE MODE
1. CALC.      2. OFFSET
3. MEMORY     4. DISP
5. OPTION
```

Fig. 12. 1 ROBOT CALCULATE MODE screen

NOTE

Only in the case of a special-spec robot, a specific function name will be displayed in the place of「5. OPTION.」

In the case of an INDEX TABLE robot, the following screen will appear.

```
ROBOT CALCULATE MODE
1. UTILITY
2. OFFSET
3. MEMORY
```

Fig. 12. 2 ROBOT CALCULATE MODE screen of INDEX TABLE robot

CAUTION

When utilizing one of the functions shown above, select in advance a coordinate system other than “3” (used for COORDINATE OFFSET) or “9” (used for COUNTER OFFSET). [i]

[i] Refer to 2.6 “Display (LCD Screen).”

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12.1 CALCULATE Mode

If the [cal 1] key is pressed to select 「1. CALC.」on the ROBOT CALCULATE MODE screen (Figure 12.1), the following screen will appear.

```
CALCULATE MODE
1. ROBOT     2. PALLET
3. PATTERN
```

Fig.12. 3 CALCULARTE MODE screen

Select a desired menu item with the [cal 1], [task 2], or [mot 3] key.

12.1.1 ROBOT (AR-TYPE)

This function is used to automatically calculate the initial angle and the arm length, which are characteristic values of the SCARA (horizontal multi-articulated type) robot.

In principle, the initial angle and the arm length have been set in the factory. However, in the case where the position of the robot's ORIGIN sensor is changed or the data has disappeared for some reason, reset the data using this function.

CAUTION

① Before executing automatic calculation, save the System Generation data displayed on Figure 12.5: AR TYPE. If abnormal values are obtained through automatic calculation, restore the System Generation data to the original state.
② When teaching operation has already been completed, the taught positions will not be reproduced if you change the characteristic values of the robot.

The following is the procedure of automatic calculation.

(1) Select a coordinate system other than “3” (used for COORDINATE OFFSET) or “9” (used for COUNTER OFFSET).

① Press the [FUNC HIGH] + [local F] keys.

② Select a desired coordinate system with the numeric key such as [cal 1] and [task 2], and then press the [READ] key. The displayed coordinate system will be switched.

(2) Teach the following three points.

P1: Point that produces position A with the arm bent in direction[i] R

P2: Point that produces position A with the arm bent in direction L

[i] Refer to 2.6 “Display (LCD Screen).”

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P3: Point at a precisely determined distance from P1 (Determine the point using a jig.)

CAUTION

Be sure to teach P1, P2, and P3 sequentially in the order presented.

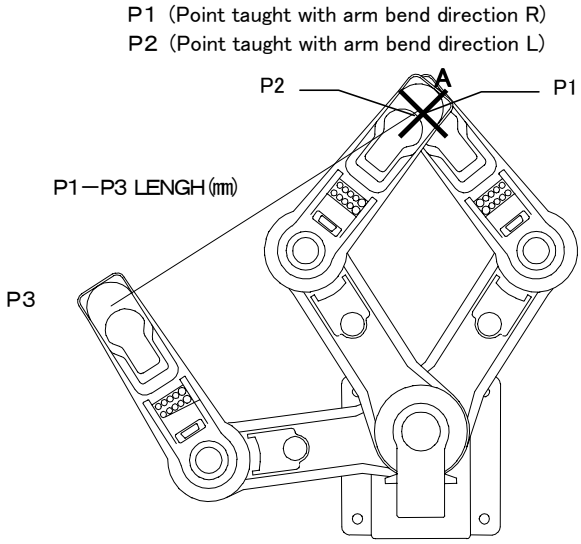


Fig. 12. 4 SCARA (horizontal multi-articulated type) robot

(3) Switch the Teach Pendant to a mode other than "AUTO."

(4) Press the FUNC HIGH + cal 1 keys to call up the ROBOT CALCULATE MODE screen (Figure 12.1). Then press the cal 1 key to select 「1. CALC」.

(5) On the CALCULATE MODE screen (Figure 12.3), select 「1. ROBOT」.

(6) If the cal 1 key 「1. ROBOT」 is pressed, the shaded area in the figure below will be displayed. To scroll the screen and display 「INITIAL B2」 and parameters thereafter, press the up DOWN key.

```
INITIAL CALC.   [ AR ]
TEACH ADDRESS      000
P1−P3 LENGTH   000.00
INITIAL B1   0000.000
INITIAL B2   0000.000
LENGTH A     0000.000
LENGTH B     0000.000
    Push End Key!!
```

Fig. 12. 5 AR TYPE

The following parameters display automatically calculated data or System Generation data.

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CAUTION

Be aware that the System Data will be rewritten if data is modified on this screen. For details, refer to 18.4.1 “AR TYPE “

- INITIAL B1

  Displays the INITIAL B1 value of the System Generation 「ADJUST」→「AR TYPE ADJUST」→「INITIAL B1」. If automatic calculation is executed, the value of the System Generation 「ADJUST」→「AR TYPE ADJUST」→「INITIAL B1」 will be rewritten automatically, and the new value will be displayed.

- INITIAL B2

  Displays the INITIAL B2 value of the System Generation 「ADJUST」→「AR TYPE ADJUST」→「INITIAL B2」. If automatic calculation is executed, the value of the System Generation 「ADJUST」→「AR TYPE ADJUST」→「INITIAL B2」 will be rewritten automatically, and the new value will be displayed.

- LENGTH A

  Displays the LENGTH A value of the System Generation 「ADJUST」→「AR TYPE ADJUST」→「LENGTH A」. If automatic calculation is executed, the value of the System Generation 「ADJUST」→「AR TYPE ADJUST」→「LENGTH A」 will be rewritten automatically, and the new value will be displayed.

- LENGTH B

  Displays the LENGTH B value of the System Generation 「ADJUST」→「AR TYPE ADJUST」→「LENGTH B」. If automatic calculation is executed, the value of the System Generation 「ADJUST」→「AR TYPE ADJUST」→「LENGTH B」 will be rewritten automatically, and the new value will be displayed.

(7) Enter data into the parameters shown below, by the following procedure. The procedure for entering data is common among the parameters.



① Move the cursor to a desired parameter. To move down the cursor, use the up DOWN key. To move up the cursor, press the SHIFT key to let the 『SHIFT』 LED light up, and then press the up DOWN key.

② Enter data with the numeric keys such as * 0, cal 1, and task 2.

③ Press the ENTER key. The message
“ENTER OK?”
will appear on the message line, and a buzzer will sound.

④ Check that the entered data is correct, and press the ENTER key again. The data will then be fixed.

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The following are the descriptions of the parameters to be set.

- TEACH ADDRESS
  Specify the position address in which P1 is taught.
- P1-P3 LENGTH
  Specify the precise distance between P1 and P3.

(8) Press the [END] key. The message

"Calculate Ok?"

will appear.

(9) Press the [ENTER] key to execution calculation.

When calculation is completed, the message

"COMPLETED !!"

will appear.

12.1.2 ROBOT (MB-TYPE)

This function is used to automatically calculate the initial angle and the arm length, which are characteristic values of the rectangular coordinate system robot.

In principle, the initial angle and the arm length have been set in the factory. However, in the case where the position of the robot's ORIGIN sensor is changed or the data has disappeared for some reason, reset the data using this function.

CAUTION

① Before executing automatic calculation, save the System Generation data displayed on Figure 12.7: MB TYPE. If abnormal values are obtained through automatic calculation, restore the System Generation data to the original state.
② When teaching operation has already been completed, the taught positions will not be reproduced if you change the characteristic values of the robot.

The following is the procedure of automatic calculation.

(1) Select a coordinate system other than "3" (used for COORDINATE OFFSET) or "9" (used for COUNTER OFFSET).

① Press the [FUNC HIGH] + [local F] keys.

② Select a desired coordinate system with the numeric key such as [cal 1] and [task 2], and then press the [READ] key. The displayed coordinate system will be switched.

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(2) Teach three points that form a right angle and are at precisely determined distances.

P1－P2: X coordinate

P1－P3: Y coordinate

CAUTION

Be sure to teach P1, P2, and P3 sequentially in the order presented.

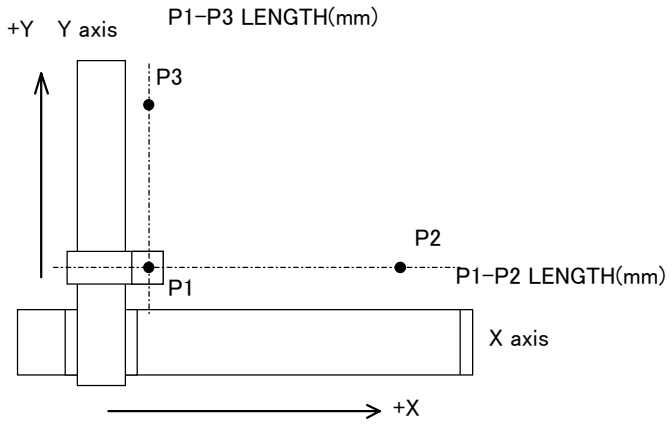


Fig. 12. 6 Rectangular coordinate system robot

(3) Switch the Teach Pendant to mode other than "AUTO."

(4) Press the FUNC HIGH + cal 1 keys to call up the ROBOT CALCULATE MODE screen (Figure 12.1). Then Press the cal 1 key to select 「1.CALC」.

(5) On the CALCULATE MODE screen (Figure 12.3), select「1. ROBOT」.

(6) If the cal 1 key 「1. ROBOT」 is pressed, the shaded area in the figure below will be displayed. To scroll the screen and display 「Y INITIAL」 and parameters thereafter, press the up DOWN key.

```
INITIAL CALC.    [ MB ]
TEACH ADDRESS        000
P1－P2 LENGTH    000. 00
P1－P3 LENGTH    000. 00
Y INITIAL     0000. 000
DISPLAY R1    0000. 000
    Push End Key!!
```

Fig. 12. 7 MB TYPE

The following parameters display the System Generation data or the System Parameter data.

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CAUTION

Be aware that the System Generation data and the System Parameter data will be rewritten if data is modified on this screen.

- Y INITIAL

  Displays the Y INITIAL value of the System Generation 「ADJUST」→「MB TYPE ADJUST」→「Y INITIAL」. If automatic calculation is executed, the value of the System Generation 「ADJUST」→「MB TYPE ADJUST」→「Y INITIAL」 will be rewritten automatically, and the new value will be displayed. For details, refer to 18.4.2 "MB TYPE ADJUST."

- DISPLAY R1

  Displays the DISPLAY R1 value of the System Parameter 「OFFSET」→「DISPLAY OFFSET 1」→「DISPLAY R1」. If automatic calculation is executed, the value of the System Parameter 「OFFSET」→「DISPLAY OFFSET 1」→「DISPLAY R1」 will be rewritten automatically, and the new value will be displayed.
  When P2 and P3 are set as shown in the figure below, this value will be rewritten as the robot-specific World coordinate system switches to the Work coordinate system.

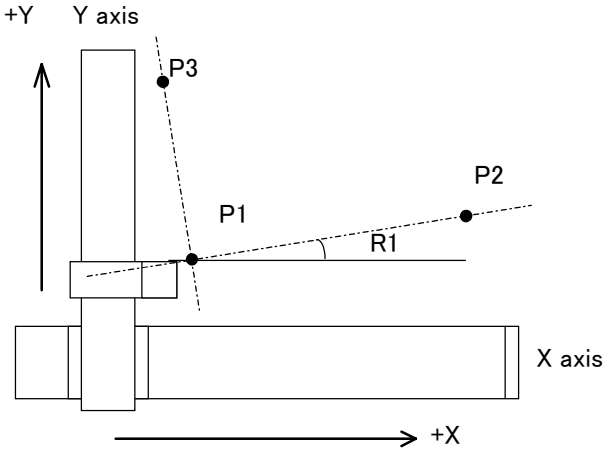


Fig. 12. 8 Coordinate system

(7) Enter data into the parameters shown below, by the following procedure. The procedure for entering data is common among the parameters.

① Move the cursor to a desired parameter. To move down the cursor, use the up DOWN key. To move up the cursor, press the SHIFT key to let the 『SHIFT』 LED light up, and then press the up DOWN key.

② Enter data with the numeric keys such as * 0, cal 1, and task 2.

③ Press the ENTER key. The message "ENTER OK?" will appear on the message line, and a buzzer will sound.

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④ Check that the entered data is correct, and press the ENTER key again. The data will then be fixed.

The following are the descriptions of the parameters to be set.

- TEACH ADDRESS
  Specify the position address in which P1 is taught.
- P1-P2 LENGTH
  Specify the precise distance between P1 and P2.
- P1-P3 LENGTH
  Specify the precise distance between P1 and P3.

(8) Press the END key. The message

"Calculate Ok?"

will appear.

(9) Press the ENTER key to execute calculation. When the calculation is completed, the message

"COMPLETED !!"

will appear.

12.1.3 PALLET

This function is used to create position data through three-point teaching on a pallet. The following is the procedure for creating (palletizing) position data.

(1) Set the coordinate system to "0" (World coordinate system).

① Press the FUNC HIGH + local F keys.

② Select a desired coordinate system with the numeric key * 0, then press the READ key. The displayed coordinate system will be switched.

(2) Teach three points on a tote box, pallet, or anything equivalent.

P1 - P2: X coordinate

P1 - P3: Y coordinate

Better positioning accuracy will be obtained if the W axis takes the same direction on all of P1, P2, and P3. Also, when a large tote box is used for teaching, better accuracy will be obtained if you perform teaching dividing the box and calculate position data by automatic calculation.

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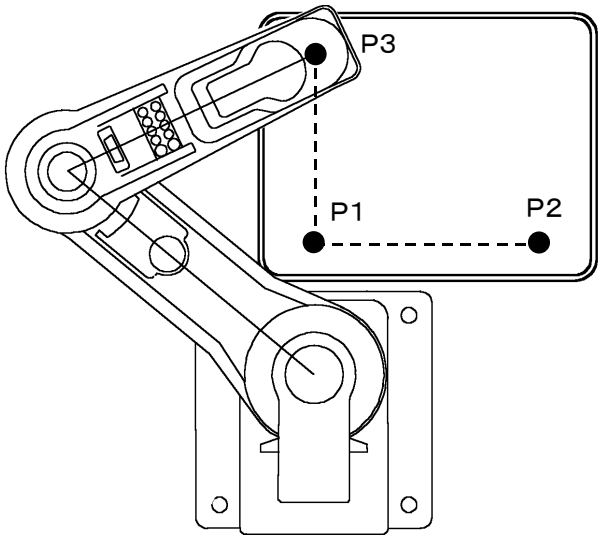


Fig. 12. 9 Example of teaching

(3) Switch the Teach Pendant to a mode other than "AUTO."

(4) Press the FUNC HIGH + cal 1 keys to call up the ROBOT CALCULATE MODE screen (Figure 12.1). Then press the cal 1 key to select 「1.CALC」.

(5) On the CALUCULATE mode screen (Figure 12.3), select 「2.PALLET」.

(6) If the task 2 key「2.PALLET」 is pressed, the shaded area in the figure below will be displayed. To scroll the screen and display 「UPPER M DATA」 and parameters thereafter, press the up DOWN key.

```
PALETIZE CALC MODE
TEACH ADDRESS      0000
OPEN ADDRESS       0000
LOWER M DATA         00
UPPER M DATA         00
Z UPPER DATA    000.00
X WORK NUMBER       000
Y WORK NUMBER       000
WORK STEP 1-2         0
ORDER 0-7             0
PATTERN 0-15         00
ADDR STEP 0-255     000
    Push End Key!!
```

Fig. 12. 10 PALLET screen

(7) Enter data by the following procedure. The procedure for entering data is common among the parameters.

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① Move the cursor to a desired parameter. To move down the cursor, use the up DOWN key. To move up the cursor, press the SHIFT key to let the 『SHIFT』 LED light up, and then press the up DOWN key.

② Enter data with the numeric keys such as * 0, cal 1, and task 2.

③ Press the ENTER key. The message
"ENTER OK?"
will appear on the message line, and a buzzer will sound.

④ Check that the entered data is correct, and press the ENTER key again. The data will then be fixed.

The following are the descriptions of the parameters to be set.

- 「TEACH ADDRESS」
  Specify the position address in which P1 is taught.
- 「OPEN ADDRESS」
  Specify the start address of palletizing position data development.
- 「LOWER M DATA」
  Specify the M data for developed position data.
  When developing position data for upper and lower positions (「Z UPPER POSITION」 is other than 0), specify the M data for the lower position.
  The data must be a value equal to or greater than 1. Refer to Figure 12.11: When Z UPPER DATA is 0 and Figure 12.12: When Z UPPER DATA is not 0.
- 「UPPER M DATA」
  When developing position data for upper and lower positions (「Z UPPER POSITION」 is other than 0), specify the M data for the upper position.
  The data must be a value equal to or greater than 1. When 「Z UPPER POSITION」 is 0, this data will be ignored. Refer to Figure 12.12: When Z UPPER DATA is not 0.
- 「Z UPPER DATA」
  When two different positions are required on one point on the X-Y plane, specify the upper position on the Z axis.
  If the Z axis does not exist or only one position is required on one point, be sure to enter "0."

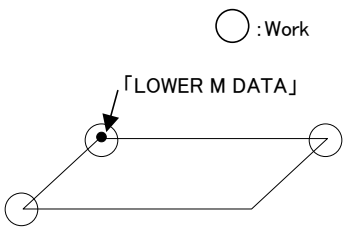


Fig. 12. 11 When Z UPPER DATA is 0

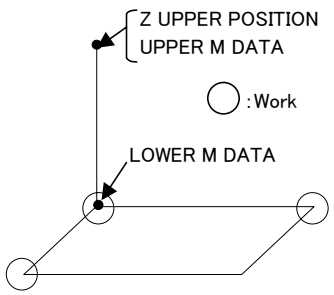


Fig. 12. 12 When Z UPPER DATA is not 0

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- 「X WORK NUMBER」

  Specify the number of rows to be placed between P1 and P2 (X-axis direction). Refer to Figure 12.13: Example ① and Figure 12.14: Example ②.

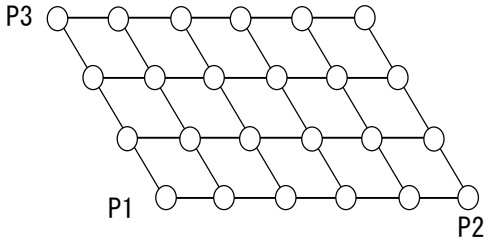
- 「Y WORK NUMBER」

  Specify the number of rows to be placed between P1 and P3 (Y-axis direction). Refer to Figure 12.13: Example ① and Figure 12.14: Example ②.

- 「WORK STEP1-2」

  Specify the method of palletizing data creation. Enter "1" or "2." If a value other than "1" or "2" is entered, it will be regarded as "1."

  When "1" is specified, position data will be created in such a manner as to place position addresses on a matrix, as shown in Figure 12.13: Example ①.

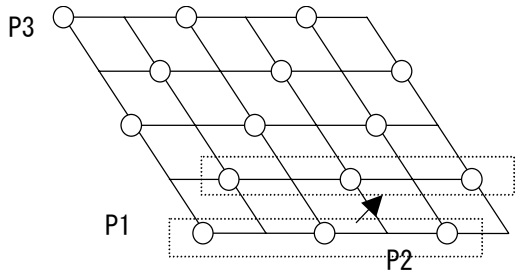


「WORK STEP 1-2」=1
「X WORK NUMBER」=6
「Y WORK NUMBER」=4

Fig. 12. 13 Example ①

When "2" is specified, position data will be created in such a manner as to place position addresses alternately on a shifted matrix, as shown in Figure 12.14: Example ②. (The pattern of matrix shift is determined by「PATTERN 0 - 15.」)

Position data will be created to form a matrix. When the matrix is shifted in the X-axis direction, as in the case of Figure 12.14: Example ②, rows exceeding a normal matrix (「X WORK NUMBER 」= 5: five rows between P1 and P2) will not be counted.



「WORK STEP 1-2」=2
「X WORK NUMBER」=5
「Y WORK NUMBER」=5

Fig. 12. 14 Example ②

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- 「ORDER 0 - 7」

  Specify the sequence of position data development. Select one out of eight patterns shown below.
  P1, P2, and P3 are teaching points. Refer to Figure 12.15: 「ORDER 0 - 7」.

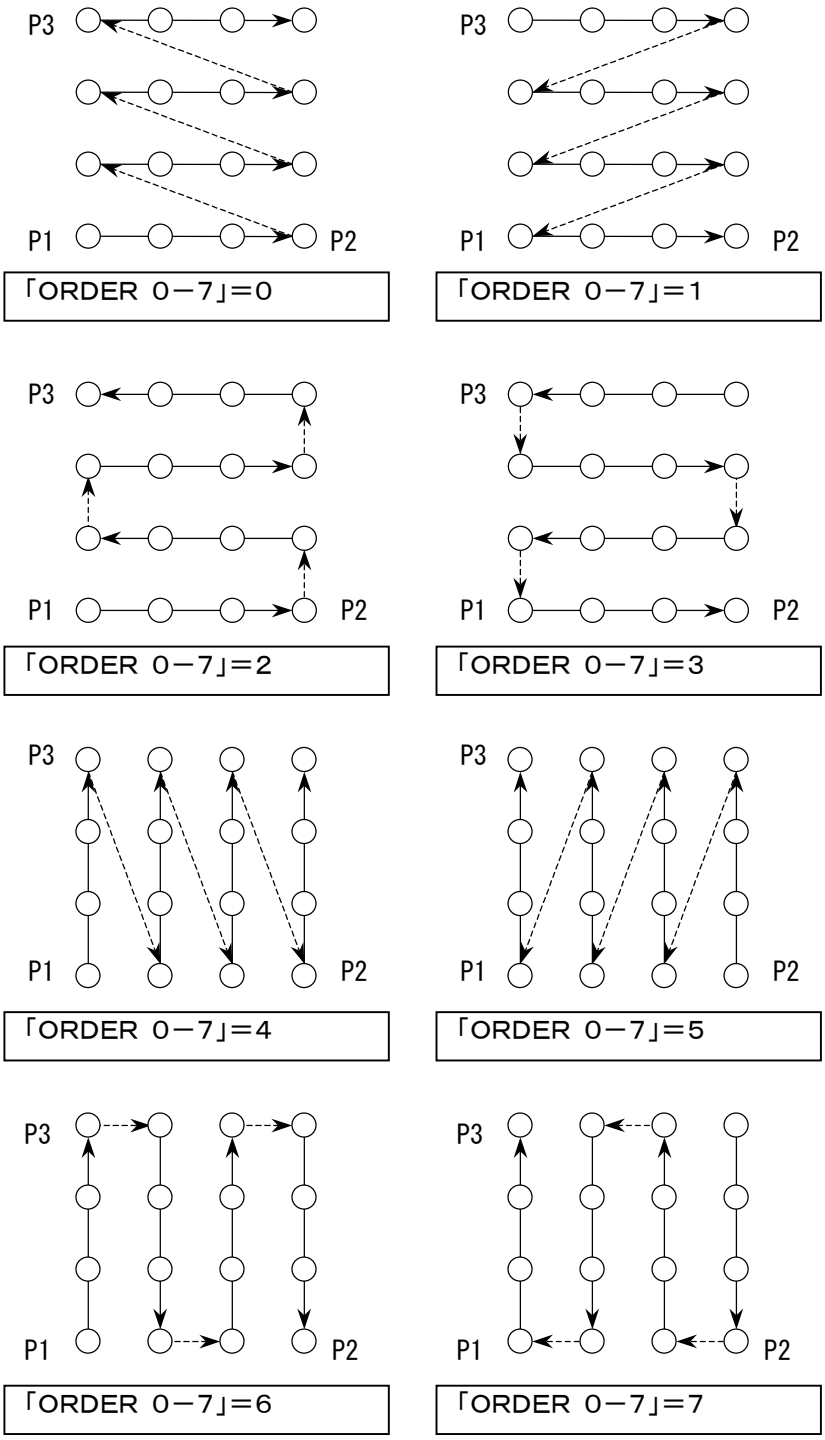


Fig. 12. 15 「ORDER 0 - 7」

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- 「PATTERN 0 - 15」

  Specify the pattern of matrix shift to be used when「WORK STEP1 - 2」is set to "2." This parameter is valid only when「WORK STEP1 - 2」is set to "2." The solid line shows a parallelogram formed by real teaching points, P1, P2, and P3. The dashed line shows a parallelogram formed by points next to the real teaching points.

  Refer to Figures 12.16 and 12.17.

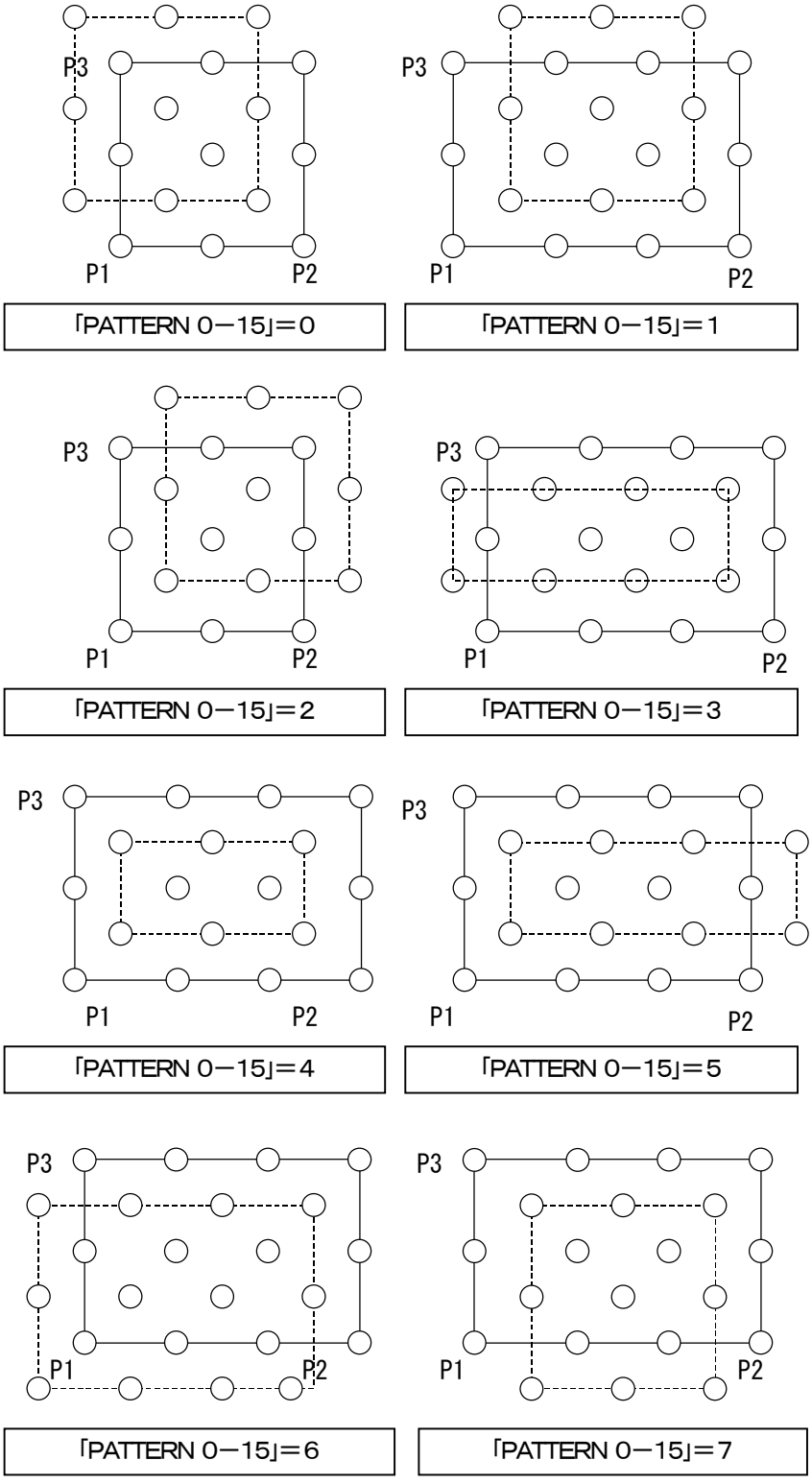


Fig. 12. 16 「PATTERN 0 - 15」①

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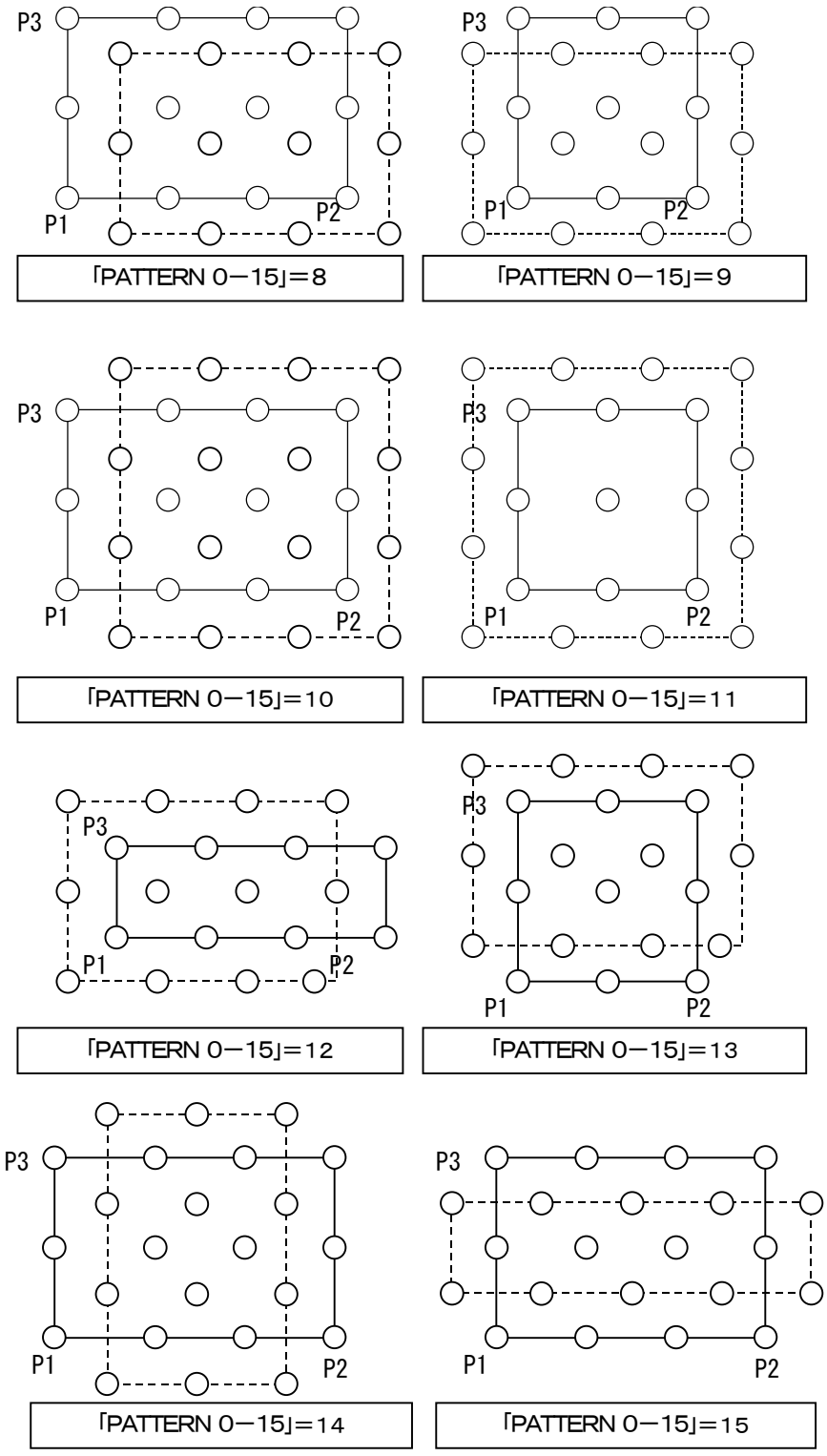


Fig. 12. 17 「PATTERN 0 - 15」②

16 patterns are available as shown above. Select one from among them.

- 「ADDR STEP 0 - 255」

  Specify at intervals of how many addresses position data should be developed. When「Z UPPER DATA」is set to "0," this parameter is automatically set to "1" even if "0" is entered. When「Z UPPER DATA」is not "0," this parameter is automatically set to "2" even if "0" or "1" is entered.

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(8) Press the END key. The message

"Calculate Ok?"

will appear.

(9) Press the ENTER key to execute calculation.

When the calculation is completed, the message

"COMPLETED !!"

will appear.

12.1.4 PATTERN

When position addresses are to be placed following a certain rule, it is possible to teach a series of operations and then develop position data from the block of position data taught.

Example

The following shows an example of pattern development in the case where the Z-axis data should be increased by 20 mm on a block-by-block basis.

Address	X	Y	Z	W	M	F	S
900	100	150	10	60	2	99	0
901	110	160	15	60	3	99	0
902	110	180	15	60	4	99	0
903	120	180	20	80	5	99	0

The above block will be developed into the following blocks starting from address 10 with the addition of 20 mm in the Z-axis direction.

Address	X	Y	Z	W	M	F	S
010	100	150	10	60	2	99	0
011	110	160	15	60	3	99	0
012	110	180	15	60	4	99	0
013	120	180	20	80	5	99	0
014	100	150	30	60	2	99	0
015	110	160	35	60	3	99	0
016	110	180	35	60	4	99	0
017	120	180	40	80	5	99	0
018	100	150	50	60	2	99	0
019	110	160	55	60	3	99	0
020	110	180	55	60	4	99	0
021	120	180	60	80	5	99	0
022	100	150	70	60	2	99	0
023	110	160	75	60	3	99	0
024	110	180	75	60	4	99	0
025	120	180	80	80	5	99	0

The following is the procedure for developing pattern data.

(1) Select a coordinate system "0" (World coordinate system).

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① Press the FUNC HIGH + local F keys.

② Select a desired coordinate system with the numeric key * 0, and then press the READ key. The displayed coordinate system will be switched.

(2) Teach a series of operations that should be a basis. Be sure to teach the starting point, address 900 to 903, for the operations.

(3) Switch the Teach Pendant to a mode other than "AUTO."

(4) Press the FUNC HIGH + cal 1 keys to call up the ROBOT CALCULATE MODE screen. Then press the cal 1 key to select 「1.CALC」.

(5) On the CALCULATE MODE screen (Figure 12.3), select 「3.PATTERN」.

(6) If the mot 3 key 「3.PATTERN」 is pressed, the shaded area in the figure below will be displayed. To scroll the screen and display 「WORK NUMBER」 and parameters thereafter, press the up DOWN key.

```
PATTERN CALC MODE
START ADDRESS      0000
END ADDRESS        0000
OPEN ADDRESS       0000
WORK NUMBER         000
MODE SELECT         000
X OFFSET      0000.000
Y OFFSET      0000.000
Z OFFSET      0000.000
W OFFSET      0000.000
  Push END Key !!
```

Fig. 12. 18 PATTERN screen

(7) Enter data by the following procedure. The procedure for entering data is common among the parameters.



① Move the cursor to a desired parameter. To move down the cursor, use the up DOWN key. To move up the cursor, press the SHIFT key to let the 『SHIFT』 LED light up, and then press the up DOWN key.

② Enter data with the numeric keys such as * 0, cal 1, and task 2.

③ Press the ENTER key. The message "ENTER OK?" will appear on the message line, and a buzzer will sound.

④ Check that the entered data is correct, and press the ENTER key again. The data will then be fixed.

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The following are the descriptions of the parameters to be set.

- 「START ADDRESS」

  Specify the start address of the original pattern block.
  In the example on the previous page, this parameter is set to address 900.

- 「END ADDRESS」

  Specify the end address of the original pattern block.
  In the example on the previous page, this parameter is set to address 903.

- 「OPEN ADDRESS」

  Specify the start address of the pattern blocks to be developed.
  In the example on the previous page, this parameter is set to address 10.

- 「WORK NUMBER」

  Specify the number of developments to be performed.
  In the example on the previous page, this parameter is set to 4 times.

- 「MODE SELECT」

  Specify the System Parameter that should be used for DISPLAY OFFSET.
  This parameter is not used at present. Set this parameter to "0."

- 「X OFFSET」

  This parameter represents the offset (variation) of the X coordinate. Use this parameter when pattern blocks are to be developed in the X-axis direction.
  In the example on the previous page, this parameter is set to "0."

- 「Y OFFSET」

  This parameter represents the offset (variation) of the Y coordinate. Use this parameter when pattern blocks are to be developed in the Y-axis direction.
  In the example on the previous page, this parameter is set to "0."

- 「Z OFFSET」

  This parameter represents the offset (variation) of the Z coordinate. Use this parameter when pattern blocks are to be developed in the Z-axis direction.
  In the example on the previous page, this parameter is set to "20."

- 「W OFFSET」

  This parameter represents the offset (variation) of the W coordinate. Use this parameter when pattern blocks are to be developed in the W-axis direction.
  In the example on the previous page, this parameter is set to "0."

(8) Press the END key. The message

"Calculate Ok?"

will appear.

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(9) Press the ENTER key to execute calculation.

When calculation is completed, the message

“COMPLETED !!”

will appear.

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12.2 Offset Mode (OFFSET)

When the ROBOT CALCULATE MODE (Figure 12.1) screen call up with the FUNC HIGH + cal 1 keys, and then the task 2 key「2.OFFSET」is pressed, the following screen will appear.

```
OFFSET MODE
1. COORDINATE OFFSET
2. COUNTER OFFSET
```

Fig. 12. 19 OFFSET MODE screen

In the case where a work object or an overall robot is displaced for some reason, it is possible to compensate for the displacement using this function.

The following two methods have been provided for the compensation.

- COORDINATE OFFSET
- COUNTER OFFSET

12.2.1 COORDINATE OFFSET

In the case where a work object (not a robot) is displaced, compensate position data using the COORDINATE OFFSET.

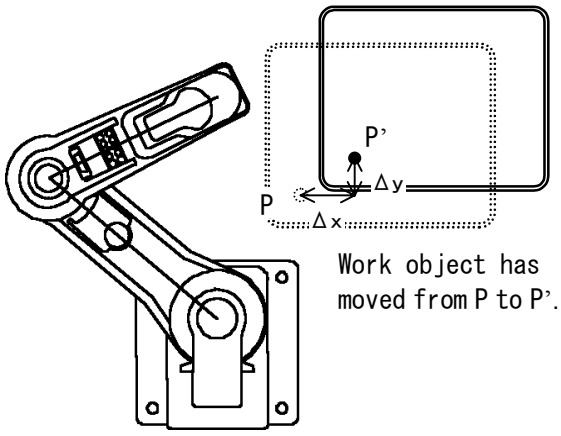


Fig. 12. 20

The COORDINATE OFFSET compensates position data by X and Y coordinate values. (In the above example, they are set to Δx mm and Δy mm.) It is possible to compensate the position data of a specified address or all addresses.

The COORDINATE OFFSET shall be performed by the following procedure.

1. Set initial reference values.
   ↓
2. Obtain the values for coordinate compensation.
   ↓

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3. Enter the coordinate compensation value.
   ↓
4. Check the validity of the compensation values.

If the COORDINATE OFFSET is not performed successfully, perform the offset again from step 1. The operating procedure is described in detail in the following sections.

12.2.1.1 Setting initial reference values

(1) Switch the Teach Pendant to a mode other than AUTO.

Check that the screen show below is displayed.

```
0000 M01 F90 S00 R 0
X 0123.45 Y−0123.45
Z 0123.45 W 0123.45
KEY−IN
```

Fig. 12. 21

(2) Switch the displayed coordinate system (the shaded part in the above figure) to "0" (World coordinate system). This operation is not necessary if "0" is currently displayed.

① Press the FUNC HIGH + local F keys.

② Select a desired coordinate system with the numeric key * 0 then press the READ key. The displayed coordinate system will be switched.

(3) Press the FUNC HIGH + cal 1 keys to call up the ROBOT CALCULATE MODE screen (Figure 12.1), and then press the task 2 key 「2.OFFSET」. The following screen will appear.

```
OFFSET MODE
1. COORDINATE OFFSET
2. COUNTER OFFSET
```

Fig. 12. 22 OFFSET screen

(4) Press the cal 1 key to select 「1.COORDINATE OFFSET」. Then the shaded area in the figure below will be displayed. To scroll the screen and display 「COORD.OFF.Y」 and parameters thereafter, press the up DOWN key.

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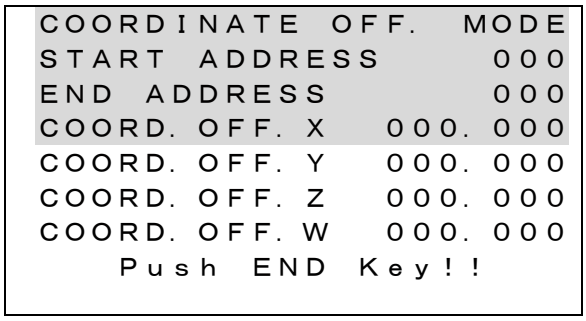


Fig. 12. 23 COORDINATE OFFSET screen

(5) Set all the parameters (form「START ADDRESS」to 「COODR.OFF.W」) to "0" by the following procedure .



① Move the cursor to a desired parameter. To move down the cursor, use the up DOWN key. To move up the cursor, press the SHIFT key to let the 『SHIFT』 LED light up, and then press the up DOWN key.

② Enter data with the numeric keys * 0.

③ Press the ENTER key. The message "ENTER OK?" will appear on the message line, and a buzzer will sound.

④ Check that the entered data is correct, and press the ENTER key again. The data will then be fixed.

(6) Press the END key. The message

"Calculate Ok ?"

will appear.

(7) Press the ENTER key to execute calculation of initial reference values. When calculation is completed, the message

"COMPLETED !!"

will appear.

(8) Switch the mode of the Teach Pendant to call up the original screen.

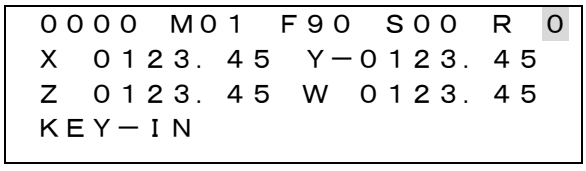


Fig. 12. 24

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12.2.1.2 Obtaining the values for coordinate compensation

(1) Switch the displayed coordinate system (the shaded part in the above figure) to "3" (used for COORDINATE OFFSET). This operation is not necessary if "3" is currently displayed.

① Press the FUNC HIGH + local F keys.

② Select a desired coordinate system with the numeric key mot 3, and then press the READ key. The displayed coordinate system will be switched.

(2) Obtain coordinate compensation values.

① Switch the Teach Pendant to the CHECK mode.

② Select an address of which it is easy to obtain compensation values. (In this example, address 100 is selected.)

③ Press the seq A key. (The cursor blinks beside "A.")

④ Enter the address selected in step ②. (Example: cal 1, * 0, * 0)

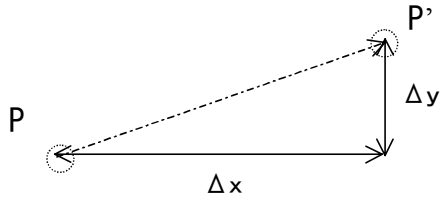
⑤ Press the READ key to load coordinate data.

⑥ Hold down the START key. (The robot starts moving.)
When "COMPLETED" is displayed with a beep, positioning is completed. Release the START key.

⑦ Record the coordinate data of each axis displayed on the Teach Pendant. This position is called point P, i.e. position before compensation.

⑧ Switch the Teach Pendant to the RO-TEACH or LI-TEACH mode, and then move the robot to a desired position. After completing the move, record the coordinate data of each axis displayed on the Teach Pendant. This position is called point P', i.e. position after compensation.

⑨ Calculate coordinate compensation values.



When a work object has moved from P to P'
Variation of X axis : Δx
Variation of Y axis : Δy

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12.2.1.3 Entering coordinate compensation values

(1) Press the FUNC HIGH + cal 1 keys to call up the ROBOT CALCULATE MODE screen (Figure 12.1), and then press the task 2 key 「2.OFFSET」. The following screen will appear.

```
OFFSET MODE
1. COORDINATE OFFSET
2. COUNTER OFFSET
```

Fig. 12. 25 OFFSET MODE screen

(2) Press the cal 1 key to select 「1.COORDINATE OFFSET」. Then the shaded area in the figure below will be displayed. To scroll the screen and display 「COORD.OFF.Y」 and parameters thereafter, press the up DOWN key.

```
COORDINATE OFF.  MODE
START ADDRESS      000
END ADDRESS        000
COORD. OFF. X   000. 000
COORD. OFF. Y   000. 000
COORD. OFF. Z   000. 000
COORD. OFF. W   000. 000
   Push END Key!!
```

Fig. 12. 26 COORDINATE OFFSET screen

(3) Enter data by the following procedure. The procedure is common among the parameters.

SHIFT

① Move the cursor to a desired parameter. To move down the cursor, use the up DOWN key. To move up the cursor, press the SHIFT key to let the 『SHIFT』 LED light up, and then press the up DOWN key.

② Enter data with the numeric keys such as * 0, cal 1, and task 2.

③ Press the ENTER key. The message
"ENTER OK?"
will appear on the message line, and a buzzer will sound.

④ Check that the entered data is correct, and press the ENTER key again. The data will then be fixed.

The following are the descriptions of the parameters to be set.

- 「START ADDRESS」

  Specify the start address of COORDINATE OFFSET. Enter a value between 0 and 999.

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- 「END ADDRESS」

  Specify the end address of COORDINATE OFFSET. Enter a value between 0 and 999.

- 「COORD.OFF.X」

  Enter the X-axis offset value obtained in 12.2.1.2 “Obtaining the values for coordinate compensation.” Enter a value between -999.999 and 999.999 (mm).

- 「COORD.OFF.Y」

  Enter the Y-axis offset value obtained in 12.2.1.2 “Obtaining the values for coordinate compensation.” Enter a value between -999.999 and 999.999 (mm).

- 「COORD.OFF.Z」

  Enter the Z-axis offset value obtained in 12.2.1.2 “Obtaining the values for coordinate compensation.” Enter a value between -999.999 and 999.999 (mm).

- 「COORD.OFF.W」

  Enter the W-axis offset value obtained in 12.2.1.2 “Obtaining the values for coordinate compensation.” Enter a value between -999.999 and 999.999 (mm).

(4) Press the [END] key. The message

“Calculate Ok?”

will appear.

(5) Press the [ENTER] key to execute the calculation of coordinate compensation value. When calculation is completed, the message

“COMPLETED !!”

will appear.

NOTE

The calculation takes 5 - 15 seconds. Do not switch the mode until the calculation is completed.

12.2.1.4 Checking the validity of compensation values

(1) Switch the Teach Pendant to the CHECK mode, and position the robot to the address of which you obtained compensation values. If the robot position (point P) agrees with the compensated position (point P'), offset is correctly set.

① Switch the Teach Pendant to the CHECK mode.

② Select an address of which it is easy to obtain compensation values. (In this example, address 100 is selected.)

③ Press the [seq / A] key. (The cursor blinks beside “A.”)

④ Enter the address selected in step ②. (Example: [cal / 1], [* / 0], [* / 0])

⑤ Press the [READ] key to load coordinate data.

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⑥ Hold down the START key. (The robot starts moving.)
When "COMPLETED" is displayed with a beep, positioning is completed. Release the START key.

(2) Switch the displayed coordinate system (the shaded part in the above figure) to "0" (World coordinate system). This operation is not necessary if "0" is currently displayed.

① Press the FUNC HIGH + local F keys.

② Select a desired coordinate system with the numeric key *0, and then press the READ key. The displayed coordinate system will be switched.

12.2.2 COUNTER OFFSET

The COUNTER OFFSET is to be used in the case where an overall robot is displaced as a result of hitting against the robot, replacement of the motor, the encoder, or the reference point sensor, or change in robot position led by the change of installation location.

The COUNTER OFFSET compensates position data by pulses. It is possible to compensate the position data of a specified address or all addresses.

The COUNTER OFFSET shall be performed by the following procedure.

1. Set initial reference values.
↓
2. Obtain the values for pulse compensation.
↓
3. Enter the pulse compensation values.
↓
4. Check the validity of the compensation values.

If the COUNTER OFFSET is not performed successfully, perform the offset again from step 1. The operating procedure is described in detail in the following sections.

12.2.2.1 Setting initial reference values

(1) Switch the Teach Pendant to a mode other than "AUTO."

Check that the screen shown below is displayed.

```
0000 M01 F90 S00 R 0
X 0123.45 Y-0123.45
Z 0123.45 W 0123.45
KEY-IN
```

Fig. 12. 27

(2) Switch the displayed coordinate system (the shaded part in the above figure) to "0" (World coordinate system). This operation is not necessary if "0" is currently displayed.

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① Press the FUNC HIGH + local F keys.

② Select a desired coordinate system with the numeric key * 0, and then press the READ key. The displayed coordinate system will be switched.

(3) Press the FUNC HIGH + cal 1 keys to call up the ROBOT CALCULATE MODE screen (Figure 12.1), and then press the task 2 key 「2.OFFSET」. The following screen will appear.

```
OFFSET MODE
1. COORDINATE OFFSET
2. COUNTER OFFSET
```

Fig. 12. 28 OFFSET MODE screen

(4) Press the task 2 key to select 「2.COUNTER OFFSET」. Then the shaded area in the figure below will be displayed. To scroll the screen and display 「COUNT.OFF.B」and parameters thereafter, press the up DOWN key.

```
COUNT OFF. MODE
START ADDRESS        000
END ADDRESS          000
COUNT. OFF. A     000000
COUNT. OFF. B     000000
COUNT. OFF. Z     000000
COUNT. OFF. W     000000
   Push END Key!!
```

Fig. 12. 29 COUNTER OFFSET screen

(5) Set all the parameters (from 「START ADDRESS」 to 「COUNT.OFF.W」) to "0" by the following procedure. T

① Move the cursor to a desired parameter. To move down the cursor, use the up DOWN key. To move up the cursor, press the SHIFT key to let the 『SHIFT』 LED light up, and then press the up DOWN key.

SHIFT

② Enter data with the numeric keys such as * 0, cal 1, and task 2.

③ Press the ENTER key. The message "ENTER OK?" will appear on the message line, and a buzzer will sound.

④ Check that the entered data is correct, and press the ENTER key again. The data will then be fixed.

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(6) Press the END key. The message

"Calculate Ok?"

will appear.

(7) Press the ENTER key to execute the calculation of initial reference values.

When calculation is completed, the message

"COMPLETED !!"

will appear.

(8) Switch the mode of the Teach Pendant to call up the origin screen.

```
0000  M01  F90  S00  R  0
X  0123.45  Y−0123.45
Z  0123.45  W  0123.45
KEY−IN
```

Fig. 12. 30

12.2.2.2 Obtaining the values for pulse compensation

(1) Switch the displayed coordinate system (the shaded part in the above figure) to "9" (used for COUNTER OFFSET). This operation is not necessary if "9" is currently displayed.

① Press the FUNC HIGH + local F keys.

② Select a desired coordinate system with the numeric key key 9, and then press the READ key. The displayed coordinate system will be switched.

(2) Obtain pulse compensation values.

① Switch the Teach Pendant to the CHECK mode.

② Select an address of which it is easy to obtain compensation values. (In this example, address 100 is selected.)

③ Press the seq A key. (The cursor blinks beside "A.")

④ Enter the address selected in step ②. (Example: cal 1, * 0, * 0)

⑤ Press the READ key to load coordinate data.

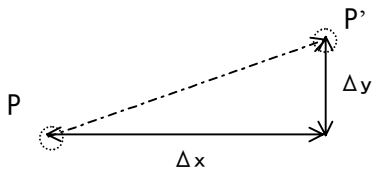
⑥ Hold down the START key. (The robot starts moving.)
When "COMPLETED" is displayed with a beep, positioning is completed. Release the START key.

⑦ Record the pulse data of each axis displayed on the Teach Pendant. This position is called point P, i.e. position before compensation.

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⑧ Switch the Teach Pendant to the RO-TEACH or LI-TEACH mode, and then move the robot to a desired position. After completing the move, record the pulse data of each axis displayed on the Teach Pendant. This position is called point P', i.e. position after compensation.

⑨ Calculate pulse compensation values.



When a work object has moved from P to P'
Variation of X axis : Δx
Variation of Y axis :Δy

12.2.2.3 Entering pulse compensation values

(1) Press the FUNC HIGH + cal 1 keys to call up the ROBOT CALCULATE MODE screen (Figure 12.1), and then press the task 2 key 「2.OFFSET」. The following screen will appear.

```
OFFSET MODE
1. COORDINATE OFFSET
2. COUNTER OFFSET
```

Fig. 12. 31 OFFSET Mode screen

(2) Press the task 2 key to select 「2.COUNTER OFFSET」. Then the shaded area in the figure below will be displayed. To scroll the screen and display 「COUNT.OFF.B」 and parameters thereafter, press the up DOWN key.

```
COUNT OFF. MODE
START ADDRESS      000
END ADDRESS        000
COUNT. OFF. A   000000
COUNT. OFF. B   000000
COUNT. OFF. Z   000000
COUNT. OFF. W   000000
   Push END Key!!
```

Fig. 12. 32 COUNTER OFFSET screen

(3) Enter data by the following procedure. The procedure is common among the parameters.

① Move the cursor to a desired parameter. To move down the cursor, use the up DOWN key. To move up the cursor, press the SHIFT key to let the 『SHIFT』 LED light up, and then press the up DOWN key.



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② Enter data with the numeric keys such as [*/0], [cal/1], and [task/2].

③ Press the [ENTER] key. The message
"ENTER OK?"
will appear on the message line, and a buzzer will sound.

④ Check that the entered data is correct, and press the [ENTER] key again. The data will then be fixed.

The following are the descriptions of the parameters to be set.

- 「START ADDRESS」
  Specify the start address of COUNTER OFFSET. Enter a value between 0 and 999.
- 「END ADDRESS」
  Specify the end address of COUNTER OFFSET. Enter a value between 0 and 999.
- 「COUNT.OFF.A」
  Enter the X-axis offset value obtained in 12.2.2.2 "Obtaining the values for pulse compensation." Enter a value between -999999 and 999999 (pulses).
- 「COUNT.OFF.B」
  Enter the Y-axis offset value obtained in 12.2.2.2 "Obtaining the values for pulse compensation." Enter a value between -999999 and 999999 (pulses).
- 「COUNT.OFF.Z」
  Enter the Z-axis offset value obtained in 12.2.2.2 "Obtaining the values for pulse compensation." Enter a value between -999999 and 999999 (pulses).
- 「COUNT.OFF.W」
  Enter the W-axis offset value obtained in 12.2.2.2 "Obtaining the values for pulse compensation." Enter a value between -999999 and 999999 (pulses).

(4) Press the [END] key. The message

"Calculate Ok?"

will appear.

(5) Press the [ENTER] key to execute the calculation of pulse compensation values.

When calculation is completed, the message

"COMPLETED !!"

will appear.

NOTE

The calculation takes 5 - 15 seconds. Do not switch the mode until the calculation is completed.

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12.2.2.4 Checking the validity of compensation values

(1) Switch the Teach Pendant to the CHECK mode, and position the robot to the address of which you obtained compensation values. If the robot position (point P) agrees with the compensated position (point P'), offset is correctly set.

① Switch the Teach Pendant to the CHECK mode.

② Select an address of which it is easy to obtain compensation values. (In this example, address 100 is selected.)

③ Press the seq / A key. (The cursor blinks beside "A.")

④ Enter the address selected in step ②. (Example: cal / 1, * / 0, * / 0)

⑤ Press the READ key to load coordinate data.

⑥ Hold down the START key. (The robot starts moving.)
When "COMPLETED" is displayed with a beep, positioning is completed. Release the START key.

(2) Switch the displayed coordinate system (the shaded part in the above figure) to "0" (World coordinate system). This operation is not necessary if "0" is currently displayed.

① Press the FUNC / HIGH + local / F keys.

② Select a desired coordinate system with the numeric key * / 0, and then press the READ key. The displayed coordinate system will be switched.

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12.3 Memory Data (MEMORY)

When the ROBOT CALCULATE MODE screen (Figure 12.1) is called up with the FUNC HIGH + cal 1 keys, and then the mot 3 key 「3.MEMORY」is pressed, the following screen will appear.

```
MEMORY  MODE
1. A−CAL  COMPARE
2. ABS.  DATA  SET
```

Fig. 12. 33 MEMORY MODE screen

In this mode, it is possible to check (and edit) the data stored at the time when A-CAL is performed, or when absolute encoder type motors are used.

12.3.1 A-CAL COMPARE (A-CAL Compensation)

This function displays automatically compensated data when A-CAL position has deviated from robot-specific initial data at the time of A-CAL.

NOTE

This function is not supported at present.

If the cal 1 key 「1.A-CAL COMPARE」 is pressed on the above screen (Figure 12.33), the following screen will appear. To scroll the screen and display 「COMP.W」, press the up DOWN key.

```
A−CAL  COMPARE  MODE
COMP. A          000000
COMP. B          000000
COMP. Z          000000
COMP. W          000000
   End  Of  Menu
```

Fig. 12. 34 A-CAL COMPARE screen

Compensated data of each axis is displayed on the screen.

CAUTION

Modifying this data can displace robot position. Modify the data only when the manufacturer instructs you to do so.

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12.3.2 ABS.DATA SET(Absolute Encoder Data)

This function displays the motor data of the robot equipped with absolute encoder type motors. It is possible to modify the data.

CAUTION

Modifying this data can displace robot position. Modify the data only when the manufacturer instructs you to do so.

(1) Switch the Teach Pendant to the KEY-IN mode.

(2) Press the FUNC/HIGH + cal/1 keys to call up the ROBOT CALCULATE MODE screen (Figure 12.1) . Then call up the MEMORY MODE screen (Figure 12.33), and press the task/2 key 「2.ABS.DATA SET」. The following screen will appear.

To scroll the screen and display 「ABS.ENC.W」and parameters thereafter, press the up/DOWN key.

```
ABS. DATA SET MODE
ABS. ENC. A      0000000
ABS. ENC. B      0000000
ABS. ENC. Z      0000000
ABS. ENC. W      0000000
A-CAL DIS. A     0000000
A-CAL DIS. B     0000000
A-CAL DIS. Z     0000000
A-CAL DIS. W     0000000
   End Of Menu
```

Fig.12. 35 ABS.DATA SET screen

- 「ABS.ENC.A」

  Displays the number of motor rotations (in pulses) stored by the absolute encoder type A-axis motor when the power is turned on.

- 「ABS.ENC.B」

  Displays the number of motor rotations (in pulses) stored by the absolute encoder type B-axis motor when the power is turned on.

- 「ABS.ENC.Z」

  Displays the number of motor rotations (in pulses) stored by the absolute encoder type Z-axis motor when the power is turned on.

- 「ABS.ENC.W」

  Displays the number of motor rotations (in pulses) stored by the absolute encoder type W-axis motor when the power is turned on.

(3) Enter data by the following procedure. The procedure is common among the parameters.

① Move the cursor to a desired parameter. To move down the cursor, use the up/DOWN key. To move up the cursor, press the SHIFT

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key to let the 『SHIFT』 LED light up, and then press the up DOWN key.

② Enter data with the numeric keys such as * 0, cal 1, and task 2.

③ Press the ENTER key. The message
"ENTER OK?"
will appear on the message line, and a buzzer will sound.

④ Check that the entered data is correct, and press the ENTER key again. The data will then be fixed.

The following are the descriptions of the parameters to be set.

- 「ABS.ENC.A」

  Enter the distance from the point of A-axis motor encoder reset to the origin point at the time of A-CAL, in pulses.

- 「ABS.ENC.B」

  Enter the distance from the point of B-axis motor encoder reset to the origin point at the time of A-CAL, in pulses.

- 「ABS.ENC.Z」

  Enter the distance from the point of Z-axis motor encoder reset to the origin point at the time of A-CAL, in pulses.

- 「ABS.ENC.W」

  Enter the distance from the point of W-axis motor encoder reset to the origin point at the time of A-CAL, in pulses.

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12.4 DISPLAY OFFSET Automatic Calculation

It is possible to automatically calculate「DISPLAY.X＊」,「DISPLAY.Y＊」,「DISPLAY.W＊」and「DISPLAY.R＊」" of the System Parameter,「OFFSET」→「DISPLAY OFFSET＊」group. The value for 「DISPLAY.Z＊」is not calculated.

(1) Select a coordinate system "0" (World coordinate system).

① Press the FUNC HIGH + local F keys.

② Select a desired coordinate system with the numeric key * 0, and then press the READ key. The displayed coordinate system will be switched.

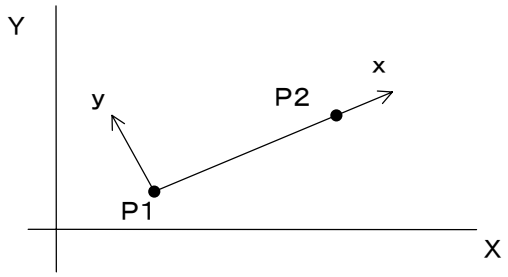
(2) Teach the following two points.

P1: Point to be the origin on the display

P2: Point that makes the X axis on the display together with P1 (P1-P2: X axis)

CAUTION

Be sure to teach P1 and P2 sequentially in the order presented.



X-Y: Basic coordinate of the robot
x-y: Coordinate when P1 is taken as the origin on the display and P1-P2 is taken as the x axis.

Fig. 12. 36 Display coordinate change

(3) Switch the Teach Pendant to a mode other than "AUTO."

(4) Press the FUNC HIGH + cal 1 keys to call up the ROBOT CALCULATE MODE screen (Figure 12.1), and then press the s.ed 4 key「4.DISP」. The following screen will appear.

```
DISP. OFF.   CALC. MODE
1. DISPLAY   1
2. DISPLAY   2
3. DISPLAY   3
```

Fig. 12. 37 DISP MODE screen

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(5) Press the cal / 1 key to select「1.DISPLAY 1」.「2.DISPLAY 2」and「3.DISPLAY 3」are not supported at present.

(6) The shaded area in the figure below will be displayed. To scroll the screen and display「DISPLAY Y1」and parameters thereafter, press the up / DOWN key.

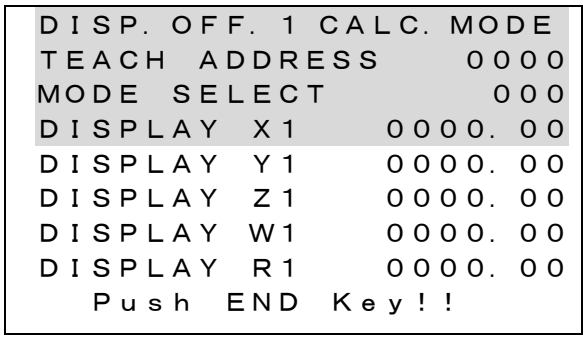


Fig. 12. 38 DISPLAY screen

The following parameters just display System Parameter data. Even if different data is entered on this screen, the entered data will be ignored. For details, refer to 19.3 "OFFSET."

- DISPLAY X1

  Displays the DISPLAY X1 value of the System Parameter「OFFSET」→「DISPLAY OFFSET1」→「DISPLAY X1」. If automatic calculation is executed, the value of the System Parameter「OFFSET」→「DISPLAY OFFSET1」→「DISPLAY X1」will be rewritten automatically, and the new value will be displayed.

- DISPLAY Y1

  Displays the DISPLAY Y1 value of the System Parameter「OFFSET」→「DISPLAY OFFSET1」→「DISPLAY Y1」. If automatic calculation is executed, the value of the System Parameter「OFFSET」→「DISPLAY OFFSET1」→「DISPLAY Y1」will be rewritten automatically, and the new value will be displayed.

- DISPLAY Z1

  Displays the DISPLAY Z1 value of the System Parameter「OFFSET」→「DISPLAY OFFSET1」→「DISPLAY Z1」.

- DISPLAY W1

  Displays the DISPLAY W1 value of the System Parameter「OFFSET」→「DISPLAY OFFSET1」→「DISPLAY W1」. If automatic calculation is executed, the value of the System Parameter「OFFSET」→「DISPLAY OFFSET1」→「DISPLAY W1」will be rewritten automatically, and the new value will be displayed.

- DISPLAY R1

  Displays the DISPLAY R1 value of the System Parameter「OFFSET」→「DISPLAY OFFSET1」→「DISPLAY R1」. If automatic calculation is executed, the value of the System

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Parameter「OFFSET」→「DISPLAY OFFSET1」→「DISPLAY R1」 will be rewritten automatically, and the new value will be displayed.

(7) Enter data by the following procedure. The procedure is common among the parameters.



① Move the cursor to a desired parameter. To move down the cursor, use the up DOWN key. To move up the cursor, press the SHIFT key to let the 『SHIFT』 LED light up, and then press the up DOWN key.

② Enter data with the numeric keys such as * 0, cal 1, and task 2.

③ Press the ENTER key. The message
"ENTER OK?"
will appear on the message line, and a buzzer will sound.

④ Check that the entered data is correct, and press the ENTER key again. The data will then be fixed.

The following are the descriptions of the parameters to be set.

- TEACH ADDRESS
  Specify the position address in which P1 is taught.
- MODE SELECT
  This parameter is not used at present. Set this parameter to "0."

(8) Press the END key. The message

"Calculate Ok?

will appear.

(9) Press the ENTER key to execute calculation.

When calculation is completed, the message

"COMPLETED !!"

will appear.

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12.5 Utilities for Index Table Robot

When the ROBOT CALCULATE MODE screen of the INDEX TABLE robot (Figure 12.2) is called up with the FUNC HIGH + cal 1 keys, and then the cal 1 key (1. INDEX UTILITY) is pressed, the following screen will appear.

```
INDEX UTILITY MODE
1. NC CAM PATTERN SET
2. DIVIDE CALCULATION
```

Fig.12. 39 INDEX UTILITY MODE screen

In this mode, data for the INDEX TABLE robot can be calculated automatically. It is possible to select a speed pattern, and calculate divided position data for indexing.

12.5.1 NC CAM PATTERN SET (Selection of Speed Pattern)

This function is used to set a speed pattern for the INDEX TABLE robot. The following is procedure for setting a speed pattern.

(1) On the INDEX UTILITY MODE screen (Figure 12.39), press the cal 1 key「1. NC CAM PATTERN SET」. Then the following screen appear.

```
CAM_PATTERN SET
CAM_PATTERN =
   [Hirata AR-4      ]
```

Fig.12. 40 NC CAM PATTERN SET screen

(2) The following four speed pattern are available as options. Select one of them with the io SEL key.

- Hirata AR-4
  Optimum speed pattern prepared by the manufacturer. Select this pattern in ordinary cases.
- MODIFIED SINE
  Speed pattern to which the sine function is applied.
- MOD TRAPEZOID
  Speed pattern to which the modified trapezoid function is applied.
- TRAPECLOID
  Speed pattern to which the trapecloid function is applied.

(3) After selecting a desired pattern, press the ENTER key. The speed pattern will be switched.

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12.5.2 DIVIDE CALCULATION(Creation of divided position data)

The function is used to create divided position data for the INDEX ROBOT table.

(1) On the INDEX UTILITY MODE screen (Figure 12.39), press the task 2 key「2. DIVIDE CALCULATION」. Then the shaded area in the figure below will be displayed. To scroll the screen and display「DIVIDE NUMBER」, press the up DOWN key.

```
INDEX CALC MODE
START ADDRESS          000
START DATA         000.000
M DATA                  00
DIVIDE NUMBER           00
   Push End Key!!
```

Fig.12. 41 DIVIDE CALCULATION screen

(2) Enter data by the following procedure. The procedure is common among the parameters.

SHIFT

① Move the cursor to a desired parameter. To move down the cursor, use the up DOWN key. To move up the cursor, press the SHIFT key to let the 『SHIFT』 LED light up, and then press the up DOWN key.

② Enter data with the numeric keys such as * 0, cal 1, and task 2.

③ Press the ENTER key. The message
"ENTER OK?"
will appear on the message line, and a buzzer will sound.

④ Check that the entered data is correct, and press the ENTER key again. The data will then be fixed.

The following are the descriptions of the parameters to be set.

- START ADDRESS
  Specify the start address of the position data development.
- START DATA
  Specify the angle the first position data of the development start address.
- M DATA
  Specify the M data for the developed position data.
- DIVIDE NUMBER
  Specify the number of divisions to be preformed.

(3) Press the END key. The message

"Calculate Ok?"

will appear.

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(4) Press the ENTER key to execute calculation.

When calculation is completed, the message

"COMPLETED !!"

will appear.

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12.6 Automatic Calculation Related Error

Table 12. 1 Automatic calculation related error messages

Error message	Cause	Corrective action
P1-P2 Length Error	Distance between P1 and P2 is too short.	Perform teaching again.
P1-P3 Length Error	Distance between P1 and P3 is too short.	Perform teaching again.
R-Offset Data Error	Rotary offset value is abnormal.	Perform teaching again.
Initial Data Error	Initial data is abnormal.	Perform initialization again.
Teaching Data Error	Teaching data is abnormal.	Perform teaching again.
Address Error	Address is improper.	
Mode Error	A mode other than KEY-IN、TEACH、CHECK is selected.	Select an appropriate mode.
Axis Not Used	The axis subject to calculation is set to "NOT USED."	Reset the data.
Incomplete!!	Calculation cannot be performed normally.	Check setting data and teaching positions, and reset the data or perform teaching again.

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CHAPTER 13 MEMORY CARD

Our robot system is capable of using a memory card as a medium for storing various data in the controller. This chapter describes how to use a memory card and related commands.

13.1 Selecting the Function

If the FUNC HIGH + m.c M.OUT keys are pressed, the memory card function mode is selected, and the following screen will appear.

```
MEMORY CARD
1. ALL-LOAD 3. EDIT
2. ALL-SAVE 4. UTIL
5. VERIFY
```

Fig.13. 1 MEMORY CARD screen

13.2 Basic Operation

(1) To select a menu item, use the numeric keys.

(2) To select an option inside square bracket [ ], use the io SEL key or numeric keys.

(3) A filename shall be set/displayed in a seven-digit number.

(4) An error occurs if you execute a command without setting a memory card into the controller.

NOTE

Files in a memory card are organized in the same manner as those in floppy disk for a personal computer. New memory cards must be formatted before use.

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13.3 Filename List

When saving the data to a memory card, name the data file by number. A number between 0000001 - 9999999 can be used as a filename.

However, numbers 1234560 through 1234564 have been reserved by the system for use in the ALL-LOAD and ALL-SAVE modes.

The assignment of filename numbers is shown in the table below.

Table 13. 1 List of available files

Filename	Contents	
	Area	File description
0000001	User's file area	
:		
1234499		
1234560	System reserved file area	Robot Position data
1234561		Robot System Data (SG,SP)
1234562		Robot servo parameter data
1234563		Robot pallet data
1234564		Option data
1234565	User's file area	
:		
:		
:		
9999999		

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13.4 ALL-LOAD Mode (MEMCARD → ROBOT)

In this mode, it is possible to load all of the System Data, the servo parameter, and position data 0 - 999.

This mode is to be used when you wish to load the data saved in a memory card using the ALL-SAVE mode. (Refer to 13.5 "ALL-SAVE Mode.") Files to be loaded are files 1234500 - 1234504. Be aware that an error will occur if any file in the files saved in the ALL-SAVE mode is missing, or there is a discrepancy in the file type.

(1) On the MEMORY CARD screen (Figure 13.1), press the cal 1 key「1 . ALL-LOAD」. Then the following screen will appear, and buzzer will sound.

```
LOAD MEMORY CARD
MEMCARD >> ROBOT

ALL-LOAD OK ?
```

Fig. 13. 2 ALL-LOAD screen

(2) If the ENTER key is pressed, data loading will start. When loading is completed normally, the message

"COMPLETED !!"

will appear, and the display will return to the MEMORY CARD screen (Figure 13.1.)

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13.5 ALL-SAVE Mode (ROBOT → MEMCARD)

In the mode, it is possible to save all of the System Data, servo parameter data, and position data 0 - 999.

The data stored in the robot controller will be saved to memory card. Each data will be stored in the location shown in the system reserved file area in 13.3 “Filename List.”

(1) On the MEMORY CARD screen (Figure 13.1), press the task/2 key「2. ALL-SAVE」. Then the following screen will appear, and a buzzer will sound.

```
SAVE MEMORY CARD
ROBOT >> MEMCARD

ALL-SAVE OK ?
```

Fig. 13. 3 ALL-SAVE screen

(2) If the ENTER key is pressed, data saving will start.

When saving is completed normally, the message

“COMPLETED !!”

will appear, and the display will return to the MEMORY CARD screen (Figure 13.1).

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13.6 EDIT Mode

In this mode, it is possible to read, write, and delete a file stored in a memory card.

If the mot 3 key「3.EDIT」is pressed on the MEMORY CARD screen (Figure 13.1), the following screen will appear.

```
FILE EDIT
1. FILE  2. LOAD  3. SAVE
4. COPY  5. DEL   6. DUMP
7. FIND
```

Fig.13. 4 EDIT screen

13.6.1 FILE Command

The command displays the files stored in a memory card. If the cal 1 key「1.FILE」is pressed, the following screen will appear.

```
FILES
FILES TYPE
      [Position Data]
 Push END Key !!
```

Fig.13. 5 FILE screen

(1) Select the type of the file to be displayed.

① Select a desired file type with the io SEL key or numeric key.

Numeric key	File type	Numeric key	File type
* 0	Position Data	cal 1	System Data
task 2	Memory Data	mot 3	ALL

② Check that selected file type is correct, and press the ENTER key. Then the message

"ENTER OK? "

will appear on the message line, and a buzzer will sound.

③ Recheck that the selected file type is correct, and press the ENTER key again. This data will then be fixed.

NOTE

Some models have options and/or additional sequence. In that case, additional file types are provided.

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(2) Press the END key. The message

"Files Type Ok ?"

will appear, and a buzzer will sound.

If the ENTER key is pressed, stored files will be displayed.

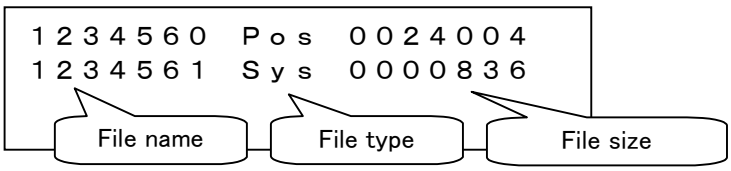


Fig.13. 6 Example of memory card contents display

For descriptions of file types, refer to the following.

Pos: Position data
Sys: System Data (System Generation & System Parameter data)
Mem: Memory data (Available only on the models whose servo parameters can be accessed. In the case of absolute encoder type motors, the values of「A-CAL DIS.＊」are stored.)
Main: Main program *)
Sub: Sub program *)
Hand: Hand program *)
Time: Timer data *)
*) Available when the HARL-U1[i] is used

(3) When there are many files and the display is spread over two or more pages, press any key to display the next page.

(4) When all the files are displayed, the message

"COMPLETED !!"

will appear, and the display will return to the FILE screen (Figure 13.5).

[i] The HARL-U1 is a simplified robot control language developed by Hirata Corporation. For details, refer to the HARL-U1 Instruction Manual.

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13.6.2 LOAD Command

This command loads a specified file into the controller.

If the task 2 key「2.LOAD」is pressed on the EDIT screen (Figure 13.4), the following screen will appear.

```
FILE LOAD
FILE NAME     1234561
START ADDR    0000000
 Push END Key !!
```

Fig.13. 7 FILE LOAD screen

(1) Enter the filename in「FILE NAME」.

① Enter the filename.

② Check that the entered filename is correct, and press the ENTER key. Then the message
"ENTER OK?"
will appear on the message line, and a buzzer will sound.

③ Recheck that the entered filename is correct, and press the ENTER key again. The filename will then be fixed.

(2) Set「START ADRRESS」by the following procedure.

① Enter data.

② Check that the entered the data is correct, and press the ENTER key. Then the message
"ENTER OK?"
will appear on the message line, and a buzzer will sound.

③ Recheck that the entered data is correct, and press the ENTER key again. The data will be fixed.

The method of loading data varies depending on the type of the file to be loaded. The file type is determined at the time when the file is saved.

- Pos: Position data
  Specify an address into which stored position data is to be loaded. When「START ADDR」is set to 999 or lower, position data will be loaded to the specified address. When the amount of position data stored is large and it exceeds the maximum address of the robot when loaded, data will be loaded within the range up to the maximum address of the robot.
  It is possible to see the position addresses stored in a memory card by using the DUMP command. (Refer to 13.6.6 "DUMP command.")

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NOTE

When you wish to load the position data stored in a memory card as is, set 「START ADDR」to 1000 or greater. If the data has been saved with 「START ADDR」0, 「START ADDR」can be set to 0.

- Sys: System Data
  All the System Data stored will be loaded.
  Setting of 「START ADDR」 is not required.
- Mem: Memory data
  Setting of 「START ADDR」 is not required.

(3) Press the [END] key. The message

"File Load Ok ? "

will appear. If the [ENTER] key is then pressed, data will be loaded.

When loading is completed normally, the message

"COMPLETED !!"

will appear, and the display will return to FILE LOAD screen (Figure 13.7).

13.6.3 SAVE Command

This command saves specified data to memory card.

If the [mot 3] key 「3.SAVE」 is pressed on the EDIT screen (Figure 13.4), the shaded area in the figure below will be displayed. To scroll screen and display「STOP ADDR」, press the [up DOWN] key.

```
FILE SAVE
TYPE    [Position Data]
FILE NAME      1234561
START ADDR     0000000
STOP ADDR      0000000
  Push END Key !!
```

Fig.13. 8 FILE SAVE screen

(1) Select the type of the file to be saved.

① Select a desired file type with the [io SEL] key or numeric key.

Numeric key	File type	Numeric key	File type
[* 0]	Position Data	[cal 1]	System Data
[task 2]	Memory Data	[mot 3]	ALL

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② Check the selected file type is correct, and press the [ENTER] key. Then the message
"ENTER OK? "
will appear on the message line, and a buzzer will sound.

③ Recheck that the selected file type is correct, and press the [ENTER] key again. The file type will then be fixed.

NOTE

Some models have options and/or additional sequences. In that case, additional file types are provided.

(2) Enter a filename in「FILE NAME」.

① Enter a filename. Do not use a filename between 1234560 and 1234564 as it is reserved.

② Check that the entered filename is correct, and press the [ENTER] key. Then the message
"ENTER OK? "
will appear on the message line, and a buzzer will sound.

③ Recheck that the entered filename is correct, and press the [ENTER] key again. The filename will then be fixed.

(3) Specify the range of the data to be saved, by the following procedure.

① Enter data.

② Check that the entered data is correct, and press the [ENTER] key. Then the message
"ENTER OK? "
will appear on the message line, and a buzzer will sound.

③ Recheck that the entered data is correct, and press the [ENTER] key again. The data will then be fixed.

The method of saving data varies depending on the type of the file to be saved.

- Pos: Position data

  Enter the start address of the data to be saved in「START ADDR」.

  Enter the end address of the data to be saved in「STOP ADDR」.

  The procedure of entering data is the same as that for「FILE NAME」.

  The start address set will be written in the first four bytes of the position data file, and position data will then follow.

  To save position data, the following free space is required.

$$\text{TOTAL} = \underset{(4\ \text{bytes})}{\text{Start address}} + \underset{(24\ \text{bytes/address})}{\text{Position data}} \times \underset{\text{saved}}{\text{Number of address to be}}$$

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- Sys: System Data
  All the System Data will be saved.
  Setting of the data range is not required.
- Mem: Memory data
  Memory data will be saved. (Available only on the models whose servo parameters can be accessed. In the case of absolute encoder type motors, the values of「A-CAL DIS.＊」are stored.)

(4) Press the END key. The message

"File Save Ok?"

will appear. If the ENTER key is then pressed, data will be saved. When saving is completed normally, the message

"COMPLETED !!"

will appear, and the display will return to the FILE SAVE screen (Figure 13.8).

13.6.4 COPY Command

This command copies a file in memory card onto another file in memory card. If the s. ed 4 key「4. COPY」is pressed on the EDIT screen (Figure 13.4), the following screen will appear.

```
FILE COPY
SOURCE NAME    00000000
DEST. NAME     00000000
 Push END Key !!
```

Fig.13. 9 FILE COPY screen

(1) Enter the name of source file in「SOURCE NAME」.

① Enter a filename.

② Check that the entered filename is correct, and press the ENTER key. Then the message
"ENTER OK? "
will appear on the message line, and a buzzer will sound.

③ Recheck that the entered filename is correct, and press the ENTER key again. The filename will then be fixed.

(2) Enter the name of a target file in「DEST. NAME」. The file type of the target file will be the same as that of the source file.

① Enter a filename.

② Check that the entered filename is correct, and press the ENTER key. The message
"ENTER OK? "
will appear on the message line, and a buzzer will sound.

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③ Recheck that the entered filename is correct, and press the [ENTER] key again. The filename will be fixed.

(3) Press the [END] key, the message

"File Copy Ok?"

will appear. If the [ENTER] key is then pressed, data will be copied. When copying is completed normally, the message

"COMPLETED !!"

will appear, and the display will return to the FILE COPY screen (Figure 13.9).

13.6.5 DELETE Command

This command deletes a specified file. If the [p. ed 5] key「5.DEL」is pressed on the EDIT screen (Figure 13.4), the following screen will appear.

```
FILE DELETE
FILE NAME     0000000

  Push END Key !!
```

Fig. 13. 10 FILE DELETE screen

(1) Enter the filename in「FILE NAME」.

① Enter the filename.

② Check that the entered filename is correct, and press the [ENTER] key. Then the message
"ENTER OK?"
will appear on the message line, and a buzzer will sound.

③ Recheck that the entered filename is correct, and press the [ENTER] key again. The filename will then be fixed.

(2) Press the [END] key, the message

"File Delete Ok?"

will appear. If the [ENTER] key is then pressed, data will be deleted. When deletion is completed normally, the message

"COMPLETED !!"

will appear, and the display will return the FILE EDIT screen (Figure 13.10).

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13.6.6 DUMP Command

This command displays a HEX (hexadecimal) code list of a file stored in a memory card. The first four bytes of each position data file contain start address data. The DUMP command makes it possible to see from what address the file was saved.

If the home 6 key「6.DUMP」is pressed on the EDIT screen (Figure 13.4), the following screen will appear.

```
FILE DUMP
FILE NAME      0000000

  Push END Key !!
```

Fig. 13. 11 FILE DUMP screen

(1) Enter a filename in「FILE NAME」.

① Enter a filename.

② Check that the entered filename is correct, and press the ENTER key. The message
"ENTER OK?"
will appear on the message line, and a buzzer will sound.

③ Recheck that the entered filename is correct, and press the ENTER key again. The filename will then be fixed.

(2) Press the END key, the message

"File Dump OK?"

will appear. If the ENTER key is then pressed, a HEX code list of the specified file will be displayed.

The start address of the specified file is displayed in the shaded part. If the start address is 500 (HEX: 1F4), the display shown below appears.

```
00 00 01 F4 00 00 27
10 00 00 00 00 00 00
00 00 00 00 00 00 01
63 00 00 00 00 28 73
```

Fig. 13. 12 Example of HEX code list

(3) To display the next page, press any key.

(4) When all the codes are displayed, the message

"COMPLETED !!"

will appear, and the display will return to the FILE DUMP screen (Figure 13.11).

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13.6.7 FIND Command

The command searches for a specified file in a memory card. It helps fine a desired file out numerous files.

If the [s.g 7] key「7.FIND」is pressed on the EDIT screen (Figure 13.4), the following screen will appear.

```
FILE FIND
FILE NAME      1234560

 Push END Key !!
```

Fig.13. 13 FILE FIND screen

(1) Enter a filename in「FILE NAME」.

① Enter a filename.

② Check that the entered filename is correct, and press the [ENTER] key. The message
"ENTER OK?"
will appear on the message line, and a buzzer will sound.

③ Recheck that the entered filename is correct, and press the [ENTER] key again. The filename will then be fixed.

(2) Press the [END] key, the message

"File Find Ok?"

will appear. If the [ENTER] key is then pressed, the filename, size, and type of the specified file will be displayed.

```
FILE INFOMATION
1234560 POS 0024004
```

Fig.13. 14 Example of file information display

(3) If any key is pressed, the message

"COMPLETED !!"

will appear, and the display will return to the FILE FIND screen (Figure 13.13).

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13.7 CARD UTILITY Mode (UTIL)

If the s.ed 4 key「4.UTIL」is pressed on the MEMORY CARD screen (Figure 13,1), the following screen will appear.

```
CARD UTILITY
1. INFO      2. CHECK
3. BACKUP    4. SORT
5. FORMAT
```

Fig.13. 15 UTILITY screen

13.7.1 INFO Command

This command displays the current status of the memory card. If the cal 1 key「1.INFO」is pressed on the UTILITY screen (Figure 13.15), the following screen will appear.

```
CARD SIZE   0065536
FREE AREA   0038912
FILE SIZE   0000039
FREE FILE   0000037
```

CARD SIZE : Full capacity of the card (bytes)
FREE AREA : Remaining data area (bytes)
FILE SIZE : Total number of files that can be stored
FREE FILE : Remaining number of files that can be stored

Fig.13. 16 INFO screen

If any key is pressed, the message

“COMPLETED !!”

will appear, and the display will return to the UTILITY screen (Figure 13.15).

13.7.2 CHECK Command

This command checks data in a memory card.

If the task 2 key「2.CHECK」is pressed on the UTILITY screen (Figure 13.15), the message

“MEMCARD CHECK OK ?”

will appear. If the ENTER key is then pressed, the following checks will be preformed.

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- 「FORMAT TEST」

  Checks that “HIRATA-1” is written at the beginning of memory card data.

- 「FAT[i] TEST」

  Checks that the contents of two FAT’s（backup FAT and original FAT）are equal.

- 「BCC[ii] TEST」

  Checks the BCC of each file.

When all the checks are completed normally, the message

“COMPLETED !!”

will appear, and the display will return to the UTILITY screen (Figure 13.15).

If an error occurs, an error message will be displayed, and it will remain until any key is passed.

13.7.3 BACK UP Command

This command is not usable at present.

13.7.4 SORT Command

The command sorts files in a memory card in ascending order.

It makes it easier to find a desired file out of numerous files when the FILE command (13.6.1 “FILE command”) is used.

If the s. ed / 4 key「4.SORT」is pressed on the UTILITY screen (Figure 13.15), the message

“FILE SORT OK ?”

will appear. If the ENTER key is then pressed, files will be sorted.

When sorting is completed normally, the message

“COMPLETED !!”

will appear, and the display will return to the UTILITY screen (Figure 13.15).

[i] FAT is an abbreviation of "file allocation table," which shows in what location of the medium respective files are stored.

[ii] BCC is an abbreviation of "block check character," which is a character provided for checking file data matching.

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13.7.5 FORMAT Command

This command formats a memory card creating files according to its capacity.

Capacity 64 KB: 39 files (2000 point in total)

128 KB: 80 files (4000 point in total)

256 KB: 160 files (8000 point in total)

The figure inside the parentheses shows the maximum number of files that can be saved when only position data is saved. The figure varies depending on the capacity of memory card, and will be smaller when System Data and/or servo parameter data is saved.

If the p. ed / 5 key「5.FORMAT」is pressed on UTILITY screen (Figure 13.15), the following screen will appear.

```
MEM. CARD FORMAT
VOLUME        [ 64KB]

PUSH END KEY !!
```

Fig.13. 17 FORMAT screen

(1) Select applicable data for「VOLUME」with the io / SEL key.

Each time the io / SEL key is pressed, the display will switch between 64 KB, 128 KB, and 256 KB.

(2) Press the END key. The message

"CARD FORMAT OK ?"

will appear. If the ENTER key is then pressed, the memory card will be formatted. Formatting a 256-KB memory card, for example, takes approx. 20 seconds.

(3) When formatting is completed normally, the message

"COMPLETED !! "

will appear, and the display will return to the UTILITY screen (Figure 13.15).

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13.8 VERIFY Mode (VERIFY)

In the mode, it is possible to verify the data stored in a memory card against the data in the robot controller. If the p. ed 5 key「5.VERIFY」is pressed on the MEMORY CARD screen (Figure 13.1), the following screen will appear.

```
MEM. CARD  VERIFY
FILE  NAME      0000000

PUSH  END  KEY  ! !
```

Fig.13. 18 VERIFY screen

(1) Specify a file in a memory card.

① Enter a filename.

② Check that the entered filename is correct, and press the ENTER key. The message
"ENTER OK?"
will appear on the message line, and a buzzer will sound.

③ Recheck that the entered filename is correct, and press the ENTER key again. The filename will then be fixed.

(2) Press the END key. The message

"Card Verify OK ?"

will appear.

(3) If the ENTER key is pressed, verification will be performed.

If the data matches up with that in the controller, the message

"COMPLETED !! "

will appear. If it does not, the message

"VERIFY ERROR !!"

will appear.

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13.9 Error Message

Table 13. 2 Memory card related error message

Message	Cause Corrective action
BCC WRITE ERROR !!	Error occurred while file check character is written. Rewrite the data. If error persists, memory card is corrupted. Use another card.
CARD SUM ERROR	System area of memory card is corrupted. Execute the FORMAT command in utilities. Refer to 13.7.5 “FORMAT command.”
CARD FULL !!	Attempt was made to save data beyond memory card capacity. Delete unnecessary file(s), and save the data again.
CARD NOT READY !!	Memory card is not ready. Insert memory card.
DATA CHECK SUM ERROR !!	File check character or file data is corrupted. Rewrite the data. If error persists, memory card is corrupted. Use another card.
DUPLICATE FILE NAME	Filename of the target file was the same as the one of the source file. Give a different filename to the target file. Refer to 13.6.4 “COPY command.”
FAT WRITE ERROR !!	FAT cannot be written. Rewrite the data. If error persists, memory card is corrupted. Use another card.
FILE BAD ALLOCATION	FAT is corrupted. Execute the FORMAT command in utilities. Refer to 13.7.5 “FORMAT command.”
FILE ID SUM ERROR !!	File check characters do not match up. Delete the file in question using the DELETE command. Refer to 13.6.5 “DELETE command.” Delete unnecessary file(s), and retry the same operation.
FILE ID FULL !!	Attempt was made to save data beyond the prescribed number of files. Refer to 13.7.5 “FORMAT command.” Delete unnecessary file(s), and save the data again.
FILE ID WRITE ERROR	File check character cannot be written. Rewrite the data. If error persists, memory card is corrupted. Use another card.
FILE NOT CLOSE	Attempt was made to use a file control utility when files are open. Close all the files.
FILE NOT FOUND !!	Specified file is not found. Check the filename.
FORMAT ERROR !!	Memory card has not been initialized. Execute the FORMAT command in utilities. Refer to 13.7.5 “FORMAT command.”
NOT ENOUGH MEMORY	This is an error code for extensions. This is not used at present.

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Message	Cause Corrective action
UNDEFINED ERROR !!	Unexpected error occurred. Perform the same operation again. If error persists, contact the manufacturer.
WRITE PROTECT !!	Attempt was made to write data even though write-protect switch of memory card is ON. Check the card and turn OFF the write-protect switch.
VERIFY ERROR !!	File verification failed. Memory card may be broken. Replace memory card.

(Other special errors)	These errors do not occur under normal conditions.
FILE ALREADY OPEN	Attempt was made to open a file that has already been opened.
FILE CAN NOT OPEN	Attempt was made to access a file that has not been opened.
FILE HANDLE FULL	There are too many files opened. More than 10 files should not be opened at a time.

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13.10 Memory Card Specifications

The type of memory card to be used varies depending on the type of controller. Carefully check the type of your controller, and use an appropriate type of card.

CAUTION

Be aware that the memory cards described below have no compatibility with each other.

13.10.1 Memory Card for HNC-1**/HAC-2** Series Controller

Use the following memory card for the HNC-1**/HAC-2** series controller.

NOTE

This memory card is not in production as of 1999.

The useful life of a memory card storing data is 2.5 years in the case of a 128-KB card, and 4 years in the case of a 64-KB card.

Table 13. 3 Memory card specifications

Item	Specifications
Outside dimensions	86×54×2.2mm
Connector	Two-piece type, 1.27 mm, 5000-time connect/disconnect guaranteed
Number of terminals	20 poles
Memory capacity	RAM 64 KB/128 KB/256 KB
Battery life	4 years
Power supply	VCC 5 V +10% -5% GND 0 V
Others	Interface LSI incorporated Replaceable lithium battery Write-protect switch Preventive mechanism against reverse insertion JEIDA Ver. 4 spec.

(1) Environmental conditions

	Temperature range	Humidity range
Operation	0 – 40 ℃	10 - 90%
Standby	-10 - 50 ℃	10 - 90%
Storage	-20 - 40 ℃	10 - 90%

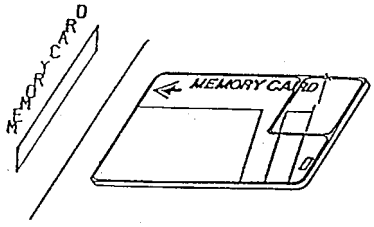
Operation: Conditions required when memory card is operated in equipment.

Standby: Conditions required when memory card is left unpacked but not in operation.
A memory card contains a battery to back up its contents.

Storage: Conditions required when memory card is packed and stored.
The battery in the memory card shall be removed.

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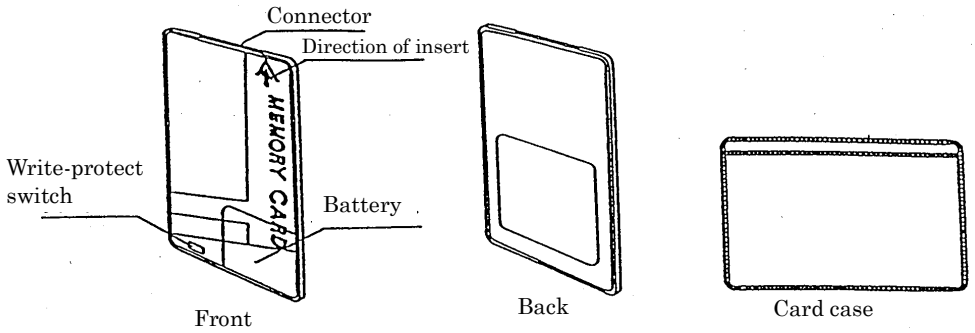
(2) How to insert/extract memory card



CAUTION

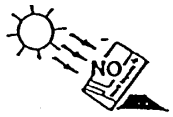
Before inserting/extracting a memory card, be sure to turn OFF the power to the controller

(3) Overview



(4) Precautions for use

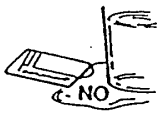
Precautions for use



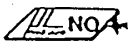
Do not expose the card to high temperatures or direct sunlight.



Do not bend or drop the card. Do not give the card a strong impact.



Protect the card from getting wet, and do not store it in damp places.



Do not disassemble the card without permission, nor touch the connector with a finger or a pin.



To protect the card from static and dust, put the card in the attached card case when it is not in use.



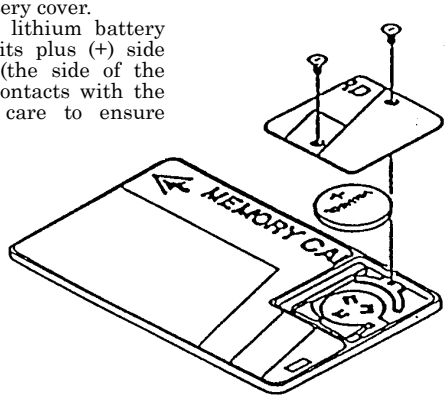
Do not throw the card into a fire.

(5) How to install/replace battery

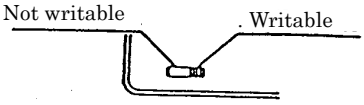
How to install/replace battery

1. Remove two screws with the attached screwdriver. (Be careful not to lose the removed screws.)
2. Remove the battery cover.
3. Push in a new lithium battery (CR2016) with its plus (+) side facing upward (the side of the cover) until it contacts with the end. (Exercise care to ensure correct polarity.)

If the battery is removed, the data stored in the card will be lost.



☐When inserting a memory card into the slot in the equipment, insert it in the direction of the arrow until it contacts with the end.
☐Never insert/extract a card when the power to the equipment is ON.
☐Before writing data into a card, be sure to turn the write-protect switch to the writable position.



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NOTE

If the battery in the memory card is removed, the data stored in the card will be lost.

13.10.2 Memory Card for HNC-3**/HAC-4**/HNC-544**/HAC-644** Series Controller

The useful life of a memory card storing data is 2.5 years in the case of a 128-KB card, and 4 years in the case of a 64-KB card.

Table 13. 4 Memory card specifications

Item	Specification
Outside dimensions	86×54×3.3 mm
Connector	Two-piece type with 68 pins, 5000-time connecting/disconnecting guaranteed
Number of terminals	68 poles
Memory capacity	RAM 64 KB/128 KB/256 KB
Battery life	4 years
Power supply	VCC 5 V±5% GND 0 V
Others	Interface LSI incorporated Replaceable lithium battery Write-protect switch Preventive mechanism against reverse insertion JEIDA Ver. 4 spec.

There are two different types of memory cards, and they use different batteries. The model numbers of memory cards available are shown in the table below.

	Hirata order No.	New memory card model No.	Old memory card model No.
64 KB	H-3724	BN064HSRH2	BN064HMCH2
128 KB	H-3724-1	BN128HSRH2	BN128HMCH2
256 KB	H-3724-2	BN256HSRH2	BN256HMCH2
Battery model No.		CR2025	BR2325

NOTE

At present, only H-3724-2 is available. (In and after December 1999)
When placing an order for a memory card battery, check the model number printed on the back of the card and order an appropriate battery.

(1) Environmental conditions

	Temperature range	Humidity range
Operation	0 - 40 ℃	10 - 90%
Standby	-10 - 50 ℃	10 - 90%
Storage	-20 - 40 ℃	10 - 90%

Operation: Conditions required when memory card is operated in equipment.

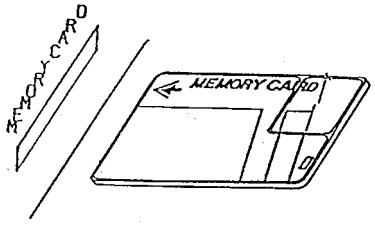
Standby: Conditions required when memory card is left unpacked but not in operation.

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A memory card contains a battery to back up its contents.

Storage: Conditions required when memory card is packed and stored.
The battery in the memory card shall be removed.

(2) How to insert/extract memory card

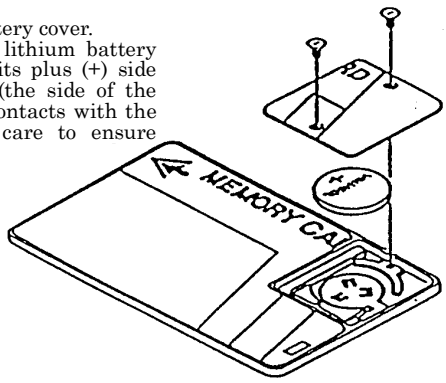


(3) How to install/replace battery

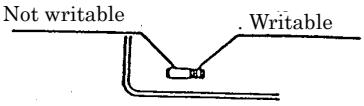
How to install/replace battery

1. Remove two screws with the attached screwdriver. (Be careful not to lose the removed screws.)
2. Remove the battery cover.
3. Push in a new lithium battery (CR2016) with its plus (+) side facing upward (the side of the cover) until it contacts with the end. (Exercise care to ensure

If the battery is removed, the data stored in the card will be lost.



☐When inserting a memory card into the slot in the equipment, insert it in the direction of the arrow until it contacts with the end.
☐Never insert/extract a card when the power to the equipment is ON.
☐Before writing data into a card, be sure to turn the write-protect switch to the writable position.

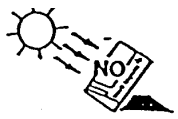


CAUTION

Before inserting/extracting a memory card, be sure to turn OFF the power to the controller.

(4) Precautions for use

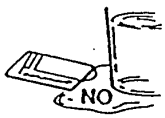
Precautions for use



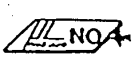
Do not expose the card to high temperatures or direct sunlight.



Do not bend or drop the card. Do not give the card a strong impact.



Protect the card from getting wet, and do not store it in damp places.



Do not disassemble the card without permission, nor touch the connector with a finger or a pin.



To protect the card from static and dust, put the card in the attached card case when it is not in use.



Do not throw the card into a fire.

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(5) Replacing the battery

The battery of an old-type memory card shall be replaced as shown in the figure below.

The battery of a new-type memory card shall be replaced in accordance with the instructions printed on the back of the memory card.

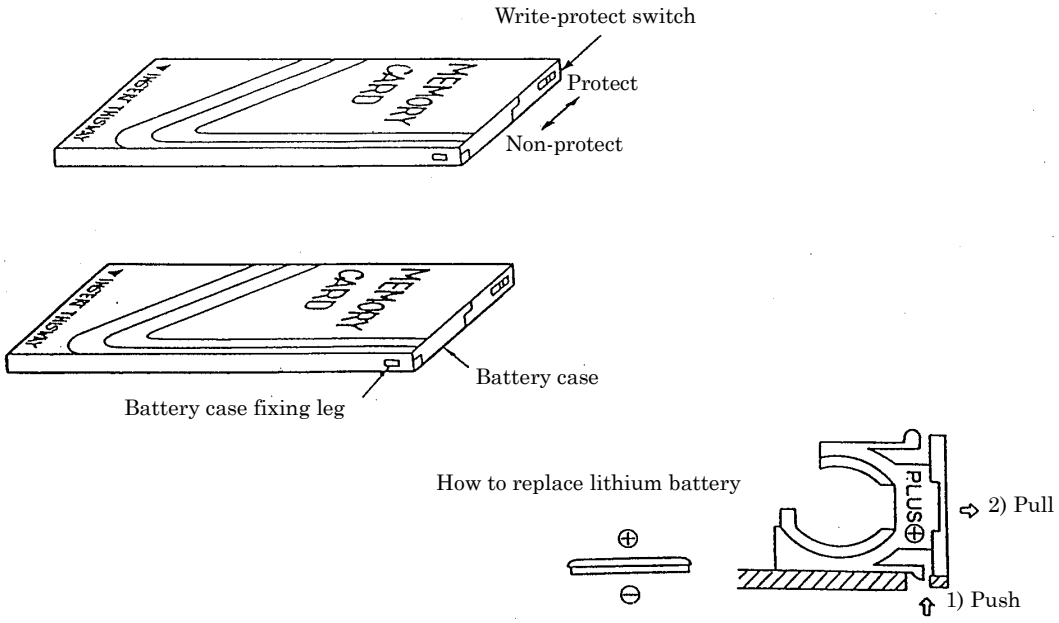


Fig. 13. 19 Replacement of battery in old-type memory card

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CHAPTER 14 W-AXIS SENSOR STOP

This is a function to stop the W axis at a position where a detection signal inputted.

14.1 Specification

(1) Detection accuracy

Within ±0.5 degrees (Responsiveness of the sensor is not considered.)

(2) Detection speed

One second or shorter (when the travel of the W axis is maximum)

(3) Pulse width of detection input signal

ON or OFF state shall be maintained for 4 msec or longer.

(4) When detection error has occurred

The message "SENSOR NOT FIND" shall be displayed on the Teach Pendant.

In the AUTO mode, DO 32 shall be outputted.
In the ON-LINE mode, error code 32 shall be set.

(5) Detection logic

It is possible to switch the logic by modifying the System Parameter.

(6) Offsetting of the W axis is possible after W-axis detection. It is also possible to operate the A, B, and Z axed without moving the W axis.

(7) It is possible to change the detection pulse width. To change the pulse width, modify the System Data.

(8) It is possible to set an area where a detection signal is ignored.

(9) Required hardware (controller and robot)

Special specifications are required. Consult the manufacturer before purchase.

(10) The sensor should be connected to the input of the Z-axis OVERRUN sensor. Be sure to purchase a correct sensor as the power supplied to the sensor differs depending on the model.

HNC-134CL : +12 V (+11 to 13 V)
HNC-114 : +24 V (+20 to +30 V)

Although most controllers supply 24 V, check the power to make sure.

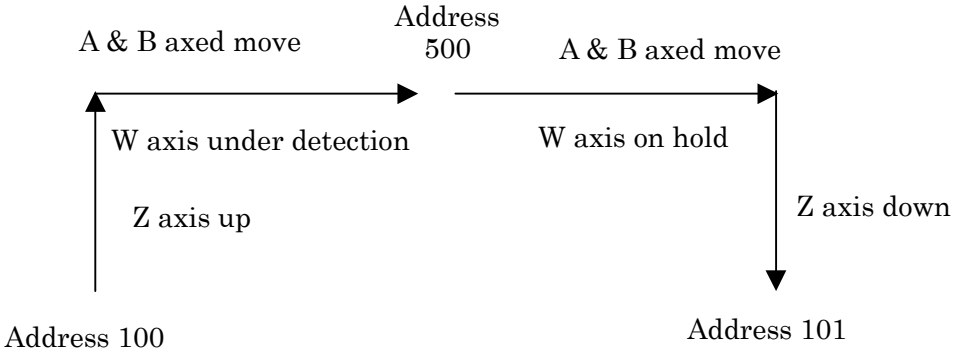
To check signal input, check the Z-axis overrun signal input indicator on the Z/W board in the controller.

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14.2 Usage

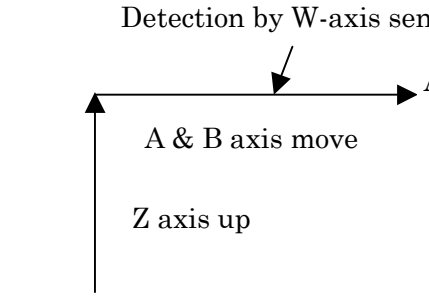
This section describes how to use the W-axis sensor stop function. The W-axis sensor stop shall be used only in the PTP operation[i].

The W-axis sensor stop is performed in two steps, i.e. stopping the W axis upon detection by the W-axis sensor, and moving the robot to a specified position while keeping the same W-axis position. Settings required to use the W-axis Sensor Stop are described below.



(1) Detection by W-axis sensor

To actuate the W-axis sensor, set the S code of the address where the W axis should stop upon detection by the W-axis sensor, to "99."

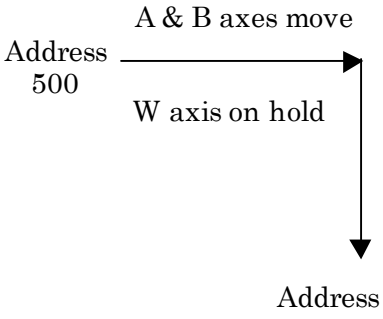


Perform W-axis sensor stop during the move from address 100 to 500.

Address	M	F	S
100	01	99	00
500	04	99	99

(2) Moving the robot while holding W axis

To move the A, B, and Z axes of the robot while holding the W axis at the detecting point, set the S code of the destination address to "98."



Move the robot to the position to place a work, while keeping the W-axis position at the movement of detection.
Move the robot from address 500 to 101.

Address	M	F	S
500	04	99	99
101	02	99	98

[i] Refer to 16.1 "PTP Operation."

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14.3 Timing of Sensor Detection

The W-axis sensor detects W-axis position while the A and B axes are in motion, before the Z axis moves down, or after the Z axis has moved up. The timing of W-axis detection is shown in detail thereunder. (The robot moves from ○ to ●).

(1) When the A and B axes move after the Z axis has moved up

The sensor detects W-axis position while the A and B axes are in motion after the Z axis has moved up.

(2) When the Z axis moves down

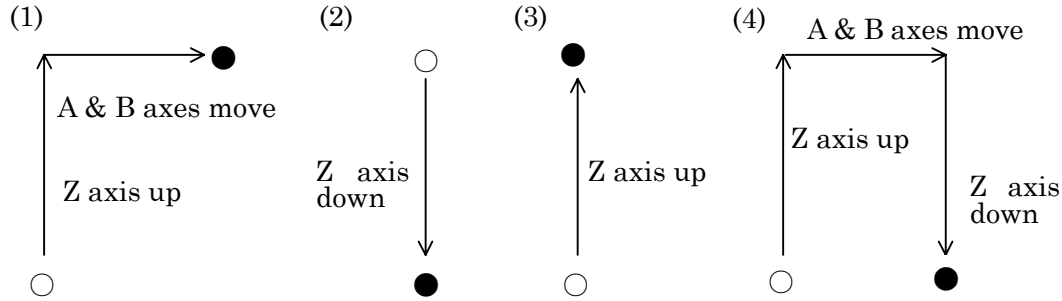
If the sensor is set to detect W-axis position while the Z axis moves down, W-axis detection will occur, but the Z axis will not move down.

(3) When the Z axis moves up

If the sensor is set to detect W-axis position while the Z axis moves up, the sensor detects W-axis position after the Z axis has moved up.

(4) When the Z axis has moved up, the A and B axes move, and then the Z axis moves down

The sensor detects W-axis position while the A and B axes are in motion after the Z axis has moved up. The robot stops upon W-axis detection by the sensor, and the Z axis will not move down.



14.4 Offsetting after W-axis Detection

When the offset value for the W-axis sensor stop has been set, the W axis will be positioned at the detecting point + offset value, and then the W-axis sensor stop will be completed.

When this offset is set to "0," the W axis will stay at the detecting point.

The offset value can be set within the range of ±90.0000 degrees. To set the offset, enter a desired value in the System Parameter 「SET-UP」→「EXPANSION B」→「SENSOR OFFSET」.

A positive value moves the W axis toward the limit, and a negative value moves it toward the origin.

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14.5 Changing Logic of Sensor Input Signal

It is possible to switch the logic of the sensor input signal by modifying the System Generation.

To switch the logic, change the value in the System Generation 「MAINTENANCE」→「MAINTENANCE DATA」→「SENSROR STOP SEL」.

0: Positive logic
1: Negative logic

14.6 Changing Pulse Width of Detection Input Signal

To change the input pulse width, set the System Generation 「MAINTENANCE」→「MAINTENANCE DATA」→「SENSROR COUNT」.

The relationship between the SENSOR COUNT value and the detection pulse width is as shown below.

Detection pulse width = SENSOR COUNT value × 1.5 msec

If this parameter is set to "0" or "1," "2" will be adopted internally as detection accuracy will be degraded when the pulse width is 3 msec or less.

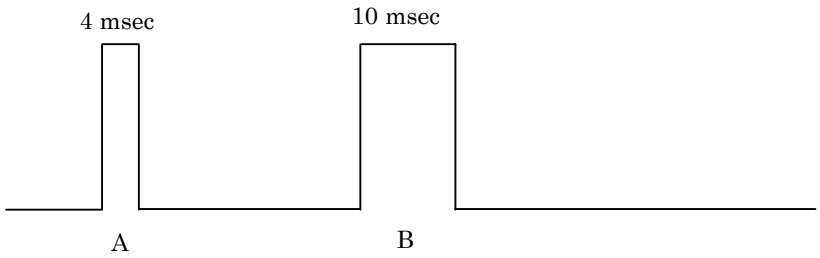


Fig. 14. 1

For example, to set the robot to ignore a 4-msec pulse (A in the above figure) and detect a 10-msec pulse (B), set this parameter to "5."

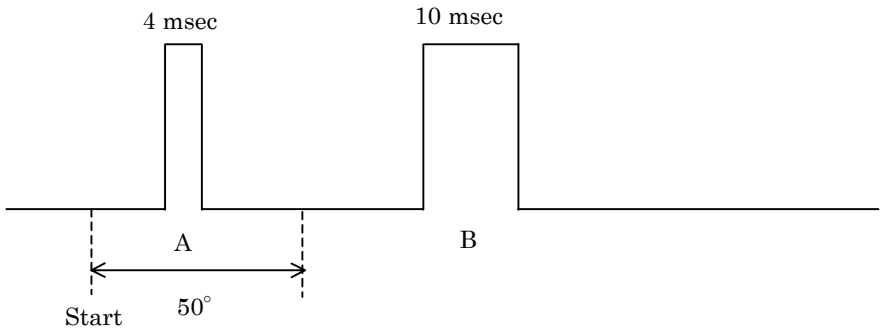
If the pulse width difference between A and B is 2.5 msec or less, false detection may occur. Also, note that this parameter value is approximate.

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14.7 Setting Area Where Detection Is Ignored

It is possible to set the robot to ignore input from the sensor until a specified angle is attained from the start of detection.

To set this area, enter a desired angle in the System Parameter「SET-UP」→「EXPANSION B」→「SENS.SKIP」.



For example, to set the robot to ignore signal A and detect signal B only, set this parameter to “50.”

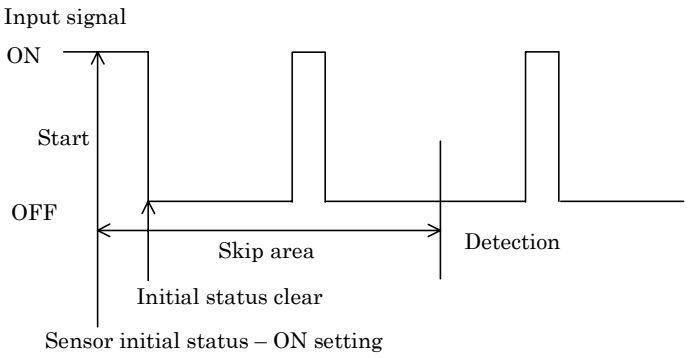
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14.8 Caution

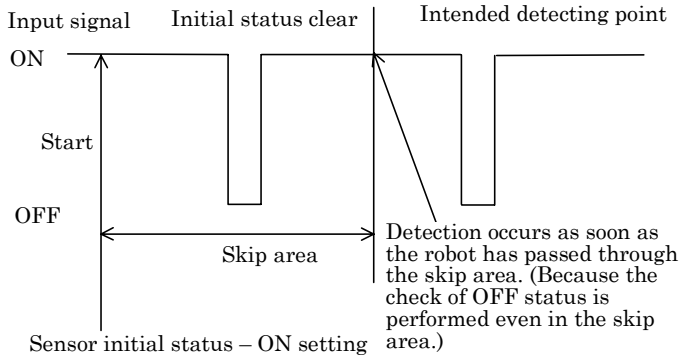
CAUTION

① Be sure to use HOLD so that specified W-axis position can be retained.
② The detection function can be used only in normal PTP operation.
③ It is possible to use the Z-axis Insertion motion and SLOW-UP motion controlled by the M data.
④ When detection is directed (S = 99), the Z axis will not move down.
⑤ When input signal is ON (OFF) at the start of W-axis detection, it must be turned OFF (ON) once to perform a detection stop. Consequently, the W-axis travel range must be set to 360 degrees or greater, for the W-axis detection stop.
⑥ When a detection stop is not performed successfully, decrease the speed of the W axis, by changing the F code or the value in the System Parameter 「MOTION」→「AXIS SPEED」→「SPEED A, B (X, Y) W」.
⑦ Be careful when setting the input signal logic, because the cases like the following are possible.

When input signal logic is proper



When input signal logic is improper (reverse)



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CHAPTER 15 OPERATION METHOD FOR VISION IN AUTO MODE

The vision system can be used only in the AUTO mode.

Prior to the use of the vision, initial setup for the vision must be performed. For the procedure, read the separate Vision Manual thoroughly.

In the ON-LINE mode, the vision shall be connected to the STP-III to perform position correction.

15.1 Utilizing Correction by Vision

Set the value in the System Generation 「ORGIN」→「SET-UP SYSTEM」→「ON-LINE SELECT」to "2."

The following vision commands are processed by specific S codes.

Command name	Vision command	S code
Scene setting command	VS n n	40 – 55 The number obtained by subtracting 40 from the S code (40 – 55) is the scene number.
Measurement command (incl. Correcting move)	VM	56 - 59

15.2 Outline of Correcting Move by Vision

Move to the measurement position (Scene setting) S code 40 – 55

Move to the corrected position (Measurement & correction) S code 56 – 59

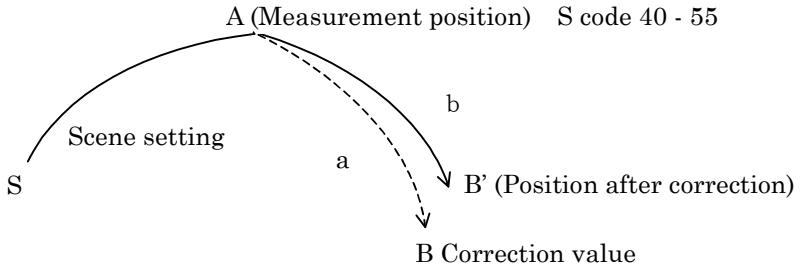


Fig. 15. 1

While the robot moves from S to A (measurement position), the controller sends to the vision the scene number specified by the S code of position A. The scene number is the S code minus 40. If position B (S = 56 - 59) is then specified, correction values will be calculated at position A, and the robot will move to position B' (B + correction values).

The robot will not take route a, but route b.

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15.3 Error Code & Error Message

Error Message	Description	Error code
Vision not online	There is no response from the vision.	89
Vision not ready	'NAK' transmission was repeated.	88
Scene set Error	Scene setting is outside the setting range.	81
Work not Find	There is no work for detection.	82
Measurement Error	Measurement conditions are not satisfied.	83
Out of range	Measurement data is out of range.	84

15.4 Communication Commands for Vision

15.4.1 Scene Setting Command (VS)

Sending side Vision

VS nn

VS nn Normal
VE mm Error

nn: Represents a scene number between 0 and 15
mm: Represents an error code.

If the vision does not respond within three seconds after transmission is finished, data will be retransmitted. If the count of transmission reaches three, the "Vision not online" error will occur.

15.4.2 Measurement Command (VM)

Sending side Vision

VM

VM(xx yy 0 ww) Normal
VE mm Error

xx: Represents a X-coordinate correction value.
yy: Represents a Y-coordinate correction value.
ww: Represents a correction value for the W axis on the edge.

The timeout is set for two seconds. Processing is the same as that of scene setting command (VS) described in 15.4.1.

15.5 Communication Protocol

S_{TX}	Data	E_{TX}	L_{RC}

Compliant to HRCS specifications

In the event of an LRC error, a hardware flaming error, an overflow error, etc., both the sending side and the receiving side transmit "NAK."

If the count of "NAK" receipt reaches five, the system will come to an abnormal end, and the "Vision not ready" error will occur.

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15.6 Format Description

(1) VS nn nn: Represents a scene number between 0 and 15.

Example: VS 0, VS 1, VS 01, VS 15

"VS 015" causes an error/

(2) VM (xx yy 0 ww)

xx: Represents a X-coordinate correction value (mm).
yy: Represents a Y-coordinate correction value (mm).
ww: Represents a W-coordinate correction value (angle).

Each data ranges from -9999.999 to 9999.999. A plus sign is represented by " " (space). Although the integer is of variable length (one-to-four digits), the mantissa is of fixed length (three digits).

Example: _0.001, _12.300, _123.000

-0.001, -12.300

15.7 Error Code

This section describes the "mm" data transmitted from the vision in the form of "VE mm."

mm	Error description
01	Scene setting number is outside the setting range (0 - 15).
02	No object for measurement is detected.
03	Measurement conditions are not satisfied.
04	Measurement data is out of range.

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CHAPTER 16 ROBOT OPERATION

The robot is capable of the following three types of operations.

- PTP operation
- PASS PTP operation
- CPC operation

The type of operation is determined by the M data, the S code, and the F code of each position, and the System Data[i].

This chapter describes details on these operations, how to perform each operation, and the parameters required for them.

16.1 PTP Operation

The PTP operation is an abbreviation of point-to-point operation, in which the robot moves from one specified point to another taking the shortest distance. It is not possible to specify a path for the robot to take. In most cases, this operation is used for pick and place or the like. The following are the variations of PTP operation available on our robot.

16.1.1 GATE Motion

When the robot is moved from point A to point B by GATE motion, the Z axis moves up first and then the other axes move to the target point. To select GATE motion, set the M data of the target point B for PTP operation. The Z axis moves up by the amount specified by the value in the System Parameter[ii] 「MOTION」→「MOTION」→「PULL-UP」.

The following is a detailed description of the gate motion.

- When point A and point B are located lower than the point specified by 「PULL-UP」 (Example 1)

  The Z axis moves up to 「PULL-UP」. → The other axes move horizontally. → The Z axis moves down. In actuality, the robot moves along A→A'→B'→B.

- When target point B is located higher than the point specified by 「PULL-UP」 (Example 2)

  The Z axis moves up to the height of point B. → The other axes move to point B. In actuality, the robot moves along A→A'→B.

- When start point A is located higher than the point specified by 「PULL-UP」 (Example 3)

[i] Refer to Chapter 17 "SYSTEM DATA."

[ii] You can jump to it with the FUNC HIGH + s.p 8 keys.

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The axes other than the Z axis move to just above point B while keeping the height of point A. → The Z axis moves down. In actuality, the robot moves along A→B'→B.

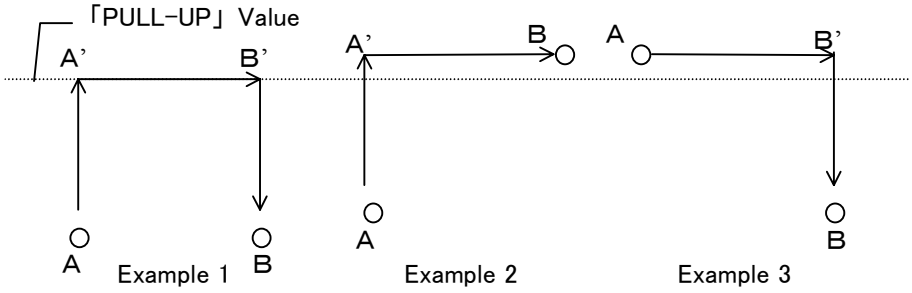


Fig. 16. 1 Examples of GATE motion

16.1.2 ARCH Motion

When the robot is moved from point A to point B by arch motion, the Z axis moves up first in the same manner as the GATE motion. However, in the ARCH motion, the axes other than the Z axis start moving horizontally while the Z axis is still moving upward, and the Z axis starts moving down while the other axes are still moving horizontally.

To select arch motion, set the M data of the target point B for PTP operation. Then set the value in the System Parameter[i] 「MOTION」→「MOTION」→「PULL-UP」, and specify in 「ARCH UP」 in the same group the starting point of the horizontal movement during the Z axis' upward movement, and in 「ARCH DOWN」 the starting point of the Z axis' downward movement during the horizontal movement.

The following is a detailed description of the arch motion.

- When point A and point B are located lower than the point specified by 「PULL-UP」 (Example 1)

  The Z axis moves up to 「ARCH UP」. → The other axes start moving horizontally and the Z axis moves up to 「PULL-UP」. → The other axes continue to move horizontally. → The Z axis starts moving down to 「ARCH DOWN」 while the other axes are moving horizontally. → The Z axis moves down.

- When target point B is located higher than the point specified by 「PULL-UP」 (Example 2)

  The Z axis moves up to 「ARCH UP」. → The other axes start moving horizontally and the Z axis moves up to the height of point B.

- When start point A is located higher than the point specified by 「PULL-UP」 (Example 3)

[i] You can jump to it with the FUNC HIGH + s.p 8 keys.

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The Z axis moves down to「ARCH DOWN」while the other axes are moving horizontally. → The Z axis moves down.

Be aware that there are cases where an intended downward-moving curve is not attained, because the「ARCH DOWN」value is processed in such a manner that horizontal movement does not occur after the Z axis has moved down to its target point.

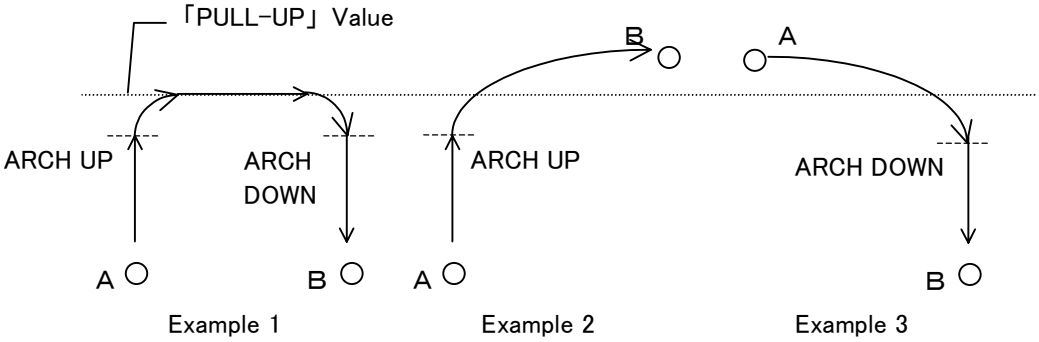


Fig. 16. 2 ARCH motion

16.1.3 INSERTION Motion/SLOW-UP Motion

When only the Z axis is to move in the movement from point A to point B, the speed of the Z axis can be reduced prior to positioning if INSERTION motion is used. This motion, for example, makes it possible to let the robot move gently when it inserts a work. To select INSERTION motion, set the M data of the target point B to a value between 50 and 59, and then specify an INSERTION distance and an INSERTION speed in the value in the System Parameter「MOTION」→「MOTION」→「INS DIS.」and「INS SPEED」.

When only the Z axis moves up in the movement from point A to point B, the Z-axis speed at the start can be reduced if SLOW-UP motion is used. To select SLOW-UP motion, set the M data of the target point B to a value between 40 and 49, and then specify a SLOW-UP distance and a SLOW-UP speed in the value in the System Parameter「MOTION」→「MOTION」→「UP DIS.」and「UP SPEED」.

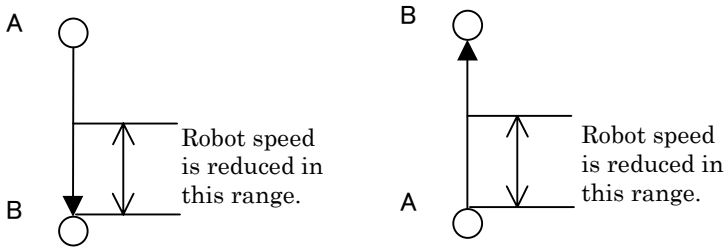


Fig. 16. 3 INSERTION motion & SLOW-UP motion

When you wish to use the INSERTION motion or the SLOW-UP motion together with the GATE motion or the ARCH motion, set the related System Parameter as specified, and then set the M data of the target point for PTP operation and the S code to “93.”

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16.1.4 All-AXIS SIMULTANEOUS PTP Operation

The ALL-AXIS SIMULTANEOUS PTP operation is also called four-axis simultaneous PTP operation, in which all the axes connected to the robot controller start and finish PTP operation simultaneously. The axes operate keeping pace with the slowest axis.

In the ALL-AXIS SIMULTANEOUS PTP operation, special motions, i.e. GATE motion, ARCH motion, INSERTION motion, and SLOW-UP motion, cannot be used.

To select ALL-AXIS SIMULTANEOUS PTP operation, set the value in the System Generation「ORIGIN」→「SET-UP」→「M DATA」 and the M data/S code in combination. For details, refer to 16.5 “Functions of M Data and S Code.”

16.1.5 PTP Operation Speed

Robot speed during PTP operation is determined by the following two parameters.

(1) Speed value for each axis in the System Parameter「MOTION」→「AXIS SPEED」 group

(2) F code of the target point

The travel speed of each axis is obtained by the following formula.

$$\text{Axis travel speed} = \text{Maximum axis speed (catalog value)} \times \frac{\text{X operation speed}}{100} \times \frac{\text{F Code}+1}{100}$$

For details, refer to 19.1.2 “AXIS SPEED.”

Note that the robot takes a different speed in the CHECK mode. For details, refer to 6.3.3 “PTP speed in CHECK mode.”

16.1.6 Acceleration/Deceleration in PTP Operation

One of the following two processing methods can be selected by setting the value in the System Parameter「RESPONSE」→「ACCEL」→「ACCEL SELECT」.

- Auto acceleration. (Acceleration/deceleration time is prepared automatically.)
- Specify acceleration values in System Parameter「RESPONSE」→「ACCEL」→「ACCEL AB(X, Y)W」,「ACCEL Z」

For details, refer to 19.2.1 “ACCEL.”

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16.2 PASS PTP Operation

When the M data of a given position is a value between 30 and 39, the robot moves to the position but proceeds to move to the next position without making a stop. This operation is called PASS PTP operation. This operation is to be used, for example, when there is an obstacle between point A and point C, and you wish to let the robot move from point A to point C by way of point B.

It is possible to let the robot pass though points in a three-dimensional space. It is also possible to operate the robot (horizontal multi-articulated type) while reversing the direction of its arm. In the PASS PTP operation, the four axes start and stop simultaneously.

The GATE motion and the ARCH motion will be ignored even if they are specified. The INSERTION motion and the SLOW-UP motion cannot be used either.

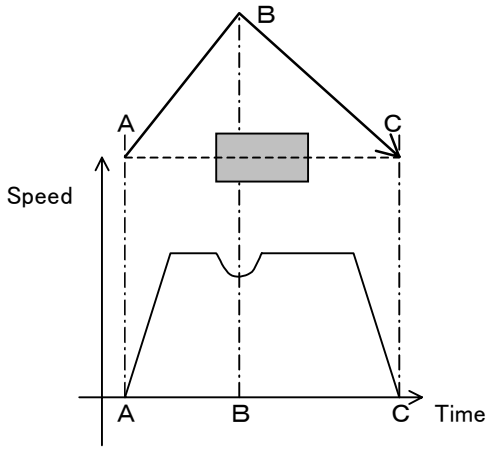


Fig.16. 4 Pass motion

16.2.1 Accuracy of Via-point Passing

The accuracy of via-point passing (with what closeness to the teaching point the robot should pass) is determined by the second half (0 - 9) of the M data (30 - 39). It is also affected by speed specification (F code, speed setting in the System Data, and acceleration setting).

The smaller the second half of the M data, the closer to the teaching point the robot passes. The larger the second half, the farther from the teaching point but the higher the speed at the via point becomes.

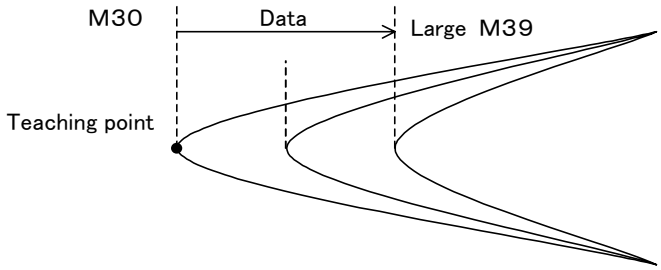


Fig.16. 5 Accuracy of via-point passing

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16.2.2 Speed of PASS PTP Operation

Robot speed during PASS PTP operation varies depending on the distance between the teaching points given for PASS PTP operation.

(1) When the distance between the points given is long

Travel distance is determined by the accuracy of via-point passing (second half of M data 30 - 39), and robot speed is determined accordingly.

Except when the robot passes a via point, robot speed is determined by the F code.

(2) When the distance between the points given is short

There are cases where accuracy of via-point passing and robot speed are determined by travel distance, and speed specification by the F code or other parameters is ignored.

It is possible that the robot speed determined by passing accuracy takes precedence over the speed specified by the F code. In this case, it is not possible to reduce robot speed even if you set the F code to a smaller value.

When it is essential to reduce speed, prolong the distance to the first teaching point.

16.2.3 Output Signals during PASS PTP Operation

Some signals[i] are outputted during PASS PTP operation. The following is a description of the signals to be outputted.

(1) When the value in the System Generation[ii] 「ORIGIN」→「SET-UP SYSTEM」→「I/O ASSIGNMENT」 is set to "0," the OUT4 (BP AREA) signal is used for PASS PTP output.

(2) The M data (30 - 39) is outputted through the OUT8 - OUT15 (MOUT) signals during pass motion.

[i] Refer to 7.1.2 "DO signals."

[ii] You can jump to it with the FUNC HIGH + s.g 7 keys

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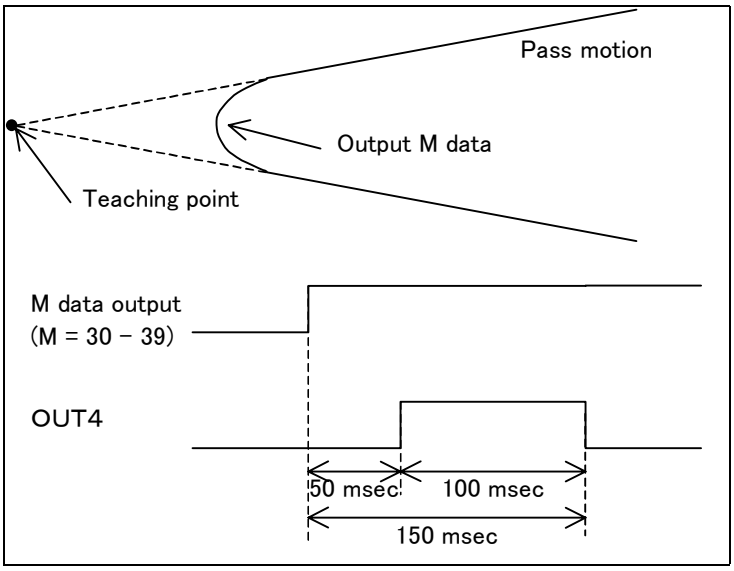


Fig. 16. 6 Signal output timing

16.2.4 Relationship between M Data and Teaching Points

The following figure shows how robot motion changes depending on the M data of the teaching points given for PASS PTP operation.

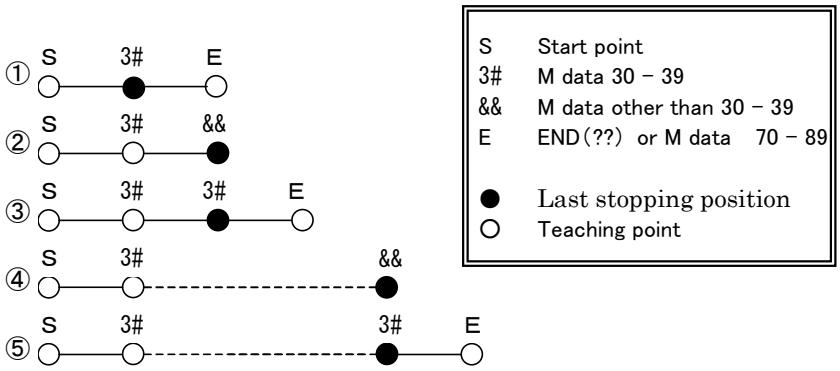


Fig. 16. 7 Relationship between M data and teaching points

In the case of ①, ③, or ⑤, the robot stops at the point just before the END point.

In the case of ② or ④, the robot stops at the point whose M data is not a value between 30 and 39.

The position addresses for PASS PTP operation must be specified as shown below.

Start address < 3# < 3# < ····· <End address

These addresses must be in serial order.

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Additionally, PASS PTP operation from the address in the System Generation[i]「LIMIT」→「ADDRESS MAX」→「ADDRESS MAX」 to address 0 is not possible.

16.2.5 PASS PTP Operation Speed

Robot speed during PASS PTP operation is determined by the following two parameters.

(1) Speed value for each axis in the System Parameter「MOTION」→「AXIS SPEED」 group

(2) F code of the target point

The travel speed of each axis is obtained by the following formula.

$$\text{Axis travel speed} = \text{Maximum axis speed (catalog value)} \times \frac{\text{X operation speed}}{100} \times \frac{\text{F Code}+1}{100}$$

For details, refer to 19.1.2 “AXIS SPEED.”

Note that the robot takes a different speed in the CHECK mode. For details, refer to 6.3.4 “PASS PTP speed in CHECK mode.”

16.2.6 Acceleration/Deceleration in PASS PTP Operation

Although it is apparently possible to select one of two processing methods (AUTO and MANUAL) by setting the value in the System Parameter「RESPONSE」→「ACCEL」→「ACCEL SELECT」, “MANUAL” is automatically selected during PASS PTP operation. To set the acceleration/deceleration, enter desired values in the System Parameter「RESPONSE」→「ACCEL」→「ACCEL AB(X, Y)W（PASS）」,「ACCEL Z（PASS）」.

For details, refer to 19.2.1 “ACCEL.”

[i] You can jump to it with the FUNC HIGH + s.g 7 keys.

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16.3 CPC Operation

The CPC operation is an abbreviation of Continuous Path Control operation, in which the robot moves along a straight line, an arc, or a smooth free curve passing through teaching points given.

The CPC operation has the following three functions.

(1) Linear interpolation: M = 82 - 89

(2) Circular interpolation: Combination of M = 80 and 81

(3) Free curve interpolation: M = 70 - 79

The CPC operation progresses while reading the M data of given teaching points in advance. Therefore, the points for CPC operation must be taught in serial addresses.

When a start point is P0, perform teaching in the order P1, P2 … Pn. The robot continuously moves along interpolated straight lines and/or arcs while the M data is a value between 80 and 89.

The free curve interpolation is a special function. For details, refer to 16.4 “Free-Form Curve Interpolation.”

16.3.1 Notes on CPC Operation

(1) When no acceleration/deceleration is specified in the System Parameter 「MOTION」→「CPC CONSTANT」→「CPC ACCEL/DECEL」, the robot accelerates from the start point to the first teaching point, and decelerates from the point just before the end point.

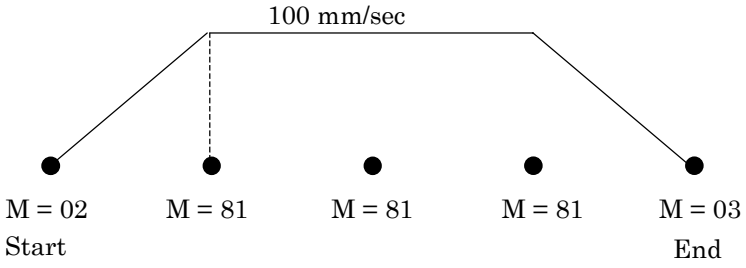


Fig. 16. 8 When “CPC ACCEL/DECEL” is 0.

When acceleration/deceleration is specified in the System Parameter 「MOTION」→「CPC CONSTANT」→「CPC ACCEL/DECEL」, the robot accelerates and decelerates between respective points given for CPC operation.

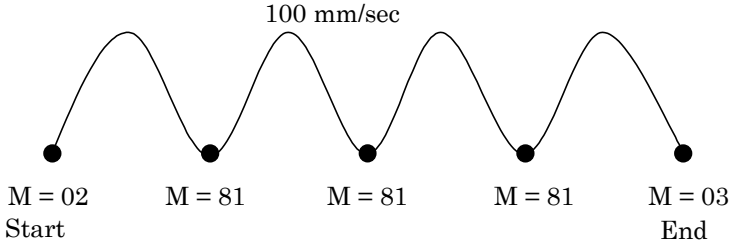


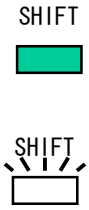
Fig. 16. 9 When “CPC ACCEL/DECEL” is not 0

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(2) While the robot is moving at a constant speed, fluctuations of the edge speed are controlled to within ± 10%.

(3) Continuous CPC operation from the address in the System Generation 「LIMIT」→「ADDRESS MAX」→「ADDRESS MAX」 to address 0 is not possible.

(4) In the CHECK mode, CPC operation shall be performed as shown below.



- When the『SHIFT』LED is OFF

  CPC operation continues as long as M data between 80 and 89 is given continuously.

- When the『SHIFT』LED is ON

  The robot stops each time it comes to the end of an arc or straight line. It helps check the correctness of each teaching point.

(5) When the RS-232C is used for serial communication, specify CPC operation through the communication. CPC operation will be performed only when the M data of the teaching points given is a value between 70 and 89.

(6) The number of teaching points that can be interpolated at a time is 1000 at the maximum. In the ON-LINE mode, it is 40 at the maximum.

(7) When the distance between the start point and the first teaching point is extremely short, specified robot speed may not be attained.

In such a case, robot speed can be improved to some extent if you change the value of the System Parameter 「MOTION」→「CPC CONSTANT」→「CPC CONSTAT」, 「MOTION」→「CPC CONSTANT」→「CPC ACCEL/DECEL」 and the value of the System Generation 「MAINTENANCE」→「MAINTENANCE DATA」→「CPC LOOP TIME」.

Additionally, specified robot speed will not be attained when an extremely small circle or arc is specified for CPC operation.

(8) In the case of the SCARA (horizontal multi-articulated type) robot, positioning accuracy may deteriorate or vibrations may occur when the arm of the A and B axes forms a straight line.

(9) If an identical position is taught repeatedly, the robot axes may vibrate and/or the Z axis may get out of control during CPC operation. In such a case, the “OVER SPEED” error will occur and the robot will stop.

(10) In CPC operation, the robot is controlled so that it will smoothly follow the teaching points given (follow-up motion). However, the robot may be unstable and develop vibrations or jerks depending on operating conditions.

In such cases, robot motion can be smoothed by setting the value in the System Generation 「MAINTENANCE」→「MAINTENACE

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DATA」→「CPC SELECT」[i], which changes the constants used in calculating a robot speed based on the position command generated internally. These constants are set for respective axes by the System Generation shown below[ii].

X axis: 「MAINTENANCE」→「MAINTENANCE DATA」→「CPC SP1」

Y axis: 「MAINTENANCE」→「MAINTENANCE DATA」→「CPC SP2」

Z axis: 「MAINTENANCE」→「EXPANSION A」→「CPC GAIN Z」

W axis: 「MAINTENANCE」→「EXPANSION B」→「CPC GAIN W」

16.3.2 CPC Operation of Robots in Ver. 2.3 or Later

(1) Perfect three-dimensional motion

Robots of conventional models have been controlled in such a manner that the Z axis follows the motion on the X-Y plane (projection type: 2.5 dimensions). Therefore, it was impossible to draw, for example, an interpolated arc in a three-dimensional space. As perfect three-dimensional motion has now become available, it is possible to draw any circle, arc, or straight line in a three-dimensional space as far as the robot can reach.

(2) Adoption of feedforward control

Conventional models have calculated the axis interpolation speed during CPC operation based on feedback control only. Therefore, a speed is outputted only after a gap is detected between the current state and the target state, and hence the robot can sometimes be very slow in performing follow-up motion.

Thanks to the feedforward control adopted, a speed including the value in the System Parameter 「MOTION」→「CPC CONSTANT」→「CPC F F GAIN」 is outputted until an intended robot speed is attained, unless a gap is detected between the current state and the target state.

This resolves the deterioration of accuracy during high-speed follow-up motion.

(3) Speed specification

Speed specification by the F code is supported at each position. This means that accelerations/decelerations in the middle of CPC operation are possible. It is also possible to specify different speeds for a straight line and a circle, respectively, by changing the F code.

(4) Reduction of occurrence of the error mentioned in (9) of 16.3.1 “Notes on CPC Operation”

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[i] For details, refer to (1) CPC SELECT in 18.2.2 “MAINTENANCE DATA.”

[ii] Although they belong to different subgroups, they shall be set in the same manner.

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Robots of conventional models used to stop because of a teaching error when an arc cannot be established from the position data taught for circular interpolation. However, robots in the new version perform linear interpolation in such a case, and thus cause no error.

Even when an identical position is taught repeatedly or interpolation is to be performed only on the Z axis, no error occurs.

(5) Restriction on speed specification 1

When interpolation is to be performed only on the W axis, its angular travel speed is determined by internal calculation, and cannot be specified from the outside.

(6) Restriction on speed specification 2

When CPC operation is to be performed repeatedly, some calculation time is required to prepare for the next motion. The calculation takes 0.07 seconds if the next motion is linear, and 0.19 seconds if circular. When this calculation time is converted into a distance with travel speed 200 mm/s,

- Linear motion: 200 × 0.07 = 14 (mm)
- Circular motion: 200 × 0.19 = 38 (mm)

Because the above distance is required for preparation, robot speed must be reduced accordingly when the distance between the teaching points given is relatively short. For example, when a travel distance before a circular motion is 20 mm,

- 20 (mm)/0.19 (s) = 105.3 (mm/s)

The robot cannot take a speed faster than the above.

16.3.3 Linear Interpolation

The linear interpolation lets the robot move on a straight line between two teaching points given.

16.3.4 Circular Interpolation

The circular interpolation determines a path of the robot from three teaching points given. It draws an arc/circle on a plane formed by the three teaching points.

The combination of M data 80 and 81 determines whether an arc or a circular is drawn. When arcs and/or circulars are to be drawn continuously, M data 80 or 81 shall be repeated in even number. When an odd number of M data 80 or 81 exists in a row, linear interpolation will be performed on the last teaching point.

- Circular interpolation (arc)

  When the M data of adjacent addresses are identical, an arc is drawn.

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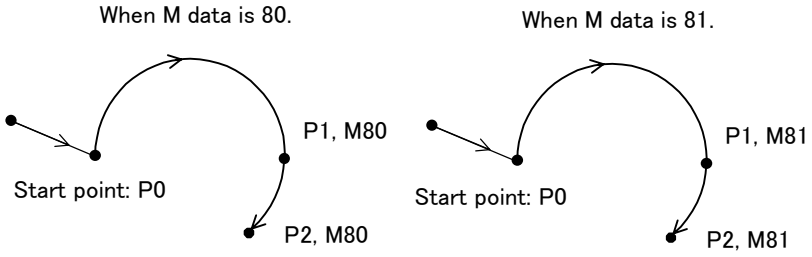


Fig. 16. 10 Circular interpolation (arc)

CAUTION

When you wish to keep a constant W-axis attitude during circular interpolation (arc), specify the same position data for the W axis.

- Circular interpolation (circle)

  When the M data of adjacent addresses are different, a circle is drawn.

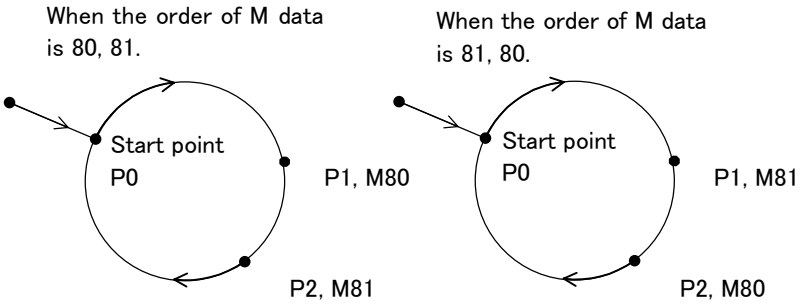


Fig. 16. 11 Circular interpolation (circle)

CAUTION

During circular interpolation (circle), the W axis retains the same attitude (the attitude at the start point).

16.3.5 CPC Operation Speed

Edge speed during CPC operation can be specified in units of mm/sec, by setting the value in the System Parameter 「MOTION」→「CPC CONSTANT」→「CPC SPEED」and the F code of each teaching point.

The maximum speed available varies among models. Even if a speed exceeding the model's maximum speed is specified, the robot operates at its own maximum speed.

$$\text{Edge travel speed (mm/sec)} = \text{「CPC SPEED」} \times \frac{\text{F code}+1}{100}$$

For details, refer to 19.1.3 "CPC CONSTANT."
Note that the robot takes a different speed in the CHECK mode. For details, refer to 6.3.5 "CPC speed in CHECK mode."

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16.3.6 Acceleration/deceleration in CPC Operation

Although it is apparently possible to select one of two processing methods (AUTO or MANUAL) by setting the value in the System Parameter 「RESPONSE」→「ACCEL」→「ACCEL SELECT」, "MANUAL" is automatically selected during CPC operation.

To set the acceleration/deceleration, enter desired values in the System Parameter 「MOTION」→「CPC CONSTANT」→「CPC CONSTANT」, 「CPC ACCEL/DECEL」.
For details, refer to 19.1.3 "CPC CONSTANT."

16.3.7 Output Signals during CPC Operation

Some signals are outputted during CPC operation[i]. The following is a description of the signals to be outputted.

(1) Each time the robot passes a teaching point during CPC operation, the M data (80 - 89) is outputted through the OUT8 - OUT15 (MOUT) signals.

(2) The OUT6 signal can be turned ON/OFF freely by the M data during linear interpolation. This, for example, makes it possible to set the timing of sealant application as desired.

① Turn ON OUT6. ・・・・・・M data = 82, 83, 86, 87
OUT6 turns ON when the robot starts moving to the point with this M data.

② Turn OFF OUT6. ・・・・・M data = 84, 85, 88, 89
OUT6 turns OFF when the robot starts moving to the point with this M data.

CAUTION

When the M data is 80 or 81, current signal output is retained.
If CPC operation is interrupted, the OUT6 signal turns OFF.

16.3.8 DO Specifications for Sealant Application CPC

This section explains how to use the M data in the case where the robot should perform sealant application in the following pattern. (Use the function described in (2) of 16.3.7 "Output signals during CPC operation.")

The robot applies sealant from P1 to P30. Sealant application is switched ON when the robot starts moving from P1 to P2, and switched OFF when the robot starts moving from P29 to P30.

[i] Refer to 7.1.2 "DO signals."

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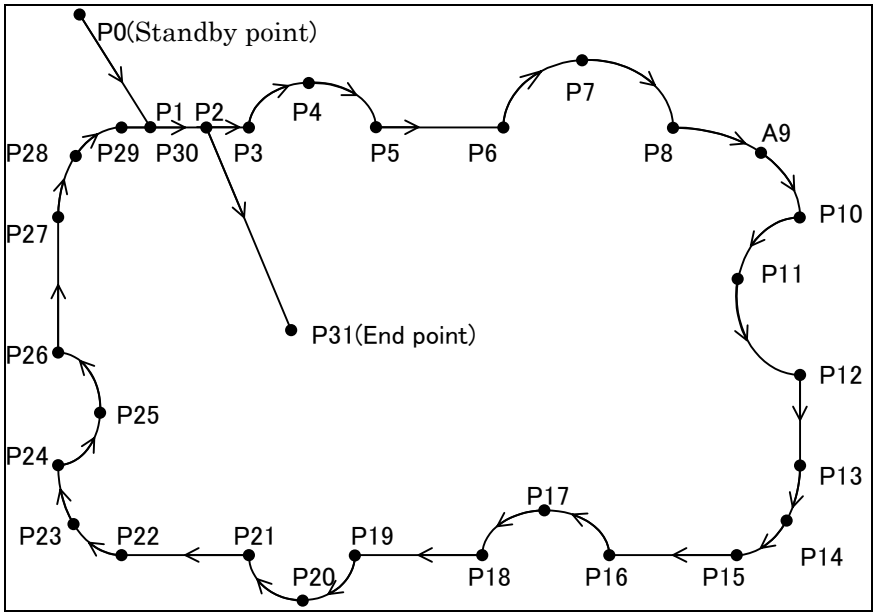


Fig. 16. 12 Example of operation

CAUTION

The same point must be taught for P1 and P30 in the above figure.

Table 16. 1 Position program

Point	Address	M	Motion
P0	0	02	PTP
P1	1	04	Linear
P2	2	82	interpolation
P3	3	86	Linear
P4	4	81	Arc
P5	5	81	interpolation
P6	6	86	Linear
P7	7	81	Arc
P8	8	81	
P9	9	81	Arc
P10	10	81	
P11	11	81	Arc
P12	12	81	
P13	13	86	Linear
P14	14	81	Arc
P15	15	81	
P16	16	86	Linear

Point	Address	M	Motion
P17	17	81	Arc
P18	18	81	
P19	19	86	Linear
P20	20	81	Arc
P21	21	81	
P22	22	86	Linear
P23	23	81	Arc
P24	24	81	
P25	25	81	Arc
P26	26	81	
P27	27	86	Linear
P28	28	81	Arc
P29	29	81	
P30	30	88	Linear
P31	31	08	PTP
P32	END		
P33			

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16.4 Free-Form Curve Interpolation

The free curve interpolation lets the robot move on a smooth free curve passing through multiple teaching points given. It is possible to draw a free curve on a three-dimensional plane.

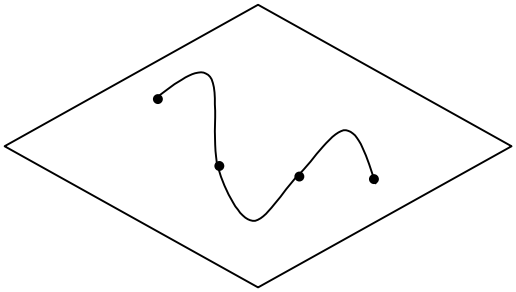


Fig. 16. 13

The free curve interpolation is a three-dimensional four-axis simultaneous CPC operation on a three-dimensional plane. In the free curve interpolation, the Z axis moves so that the edge of the robot follows points on one plane while the other axes move to draw a free curve on the X-Y plane. The W axis retains the same attitude (the attitude before the start of free curve interpolation motion) from the beginning till the end. The W-axis attitude cannot be changed halfway through the motion.

When teaching the points for free curve interpolation, teach them in serial addresses giving M data between 70 and 79. To establish a three-dimensional plane, M data 70 must be given to three addresses in series.

In other words, to perform free curve interpolation, only three points out of all the teaching points except the start point shall have M data 70, and the other points shall have M data between 71 and 79.

When more or less than three points have M data 70, PTP operation will be performed. Conversely, it is possible to check the correctness of position data in the CHECK mode if you give attention to this point.

When free curve interpolation is performed in the CHECK mode, the robot does not stop at each teaching point, and hence it is difficult to check the correctness of position data.

The Z-axis data of the points that have M data between 71 and 79 will be ignored during free curve interpolation. The end of the Z axis may not necessarily exist on the specified three-dimensional plane at the start point. In that case, the Z axis moves independently first and stops on the plane, and then four-axis interpolation operation starts.

The W axis retains the initial attitude during interpolation, and the W-axis data of the points that have M data between 70 and 79 will be ignored.

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16.4.1 Notes on The Use of Free Curve Interpolation

(1) Give M data between 70 and 79 to serial position addresses. M data 70 must be given to three serial addresses out of them.

(2) The number of teaching points that can be interpolated at a time is 4 - 40. If an attempt is made to move the robot to an address other than the serial addresses, the "MISPOSITIONING" error will occur and the robot will stop.

(3) The length of a free curve that can be processed at a time varies depending on the robot speed specified. The following is the data for reference.

When the robot operates at 300 mm/sec: approx. 8000 mm
When the robot operates at 60 mm/sec: approx. 1600 mm

(4) In the free curve interpolation, the robot moves almost linearly around teaching points. When you wish to let the robot draw an arc/circle, use the circular interpolation.

(5) During free curve interpolation, DO signal output is controlled by the M data as shown below.

OUT6 ON: M = 72, 73, 76, 77
OUT6 OFF: M = 71, 74, 75, 78, 79
No switching: M = 70 (OUT6 does not turn ON/OFF.)

16.4.2 Operation Speed during Free Curve Interpolation

Robot speed during free curve interpolation is determined by the value in the System Parameter 「MOTION」→「CPC CONSTANT」→「SPLINE SPEED」and the F code of each teaching point. However, a constant speed is not ensured in the free curve interpolation. Please regard this speed as an index of maximum speed.

$$\text{Edge travel speed (mm/sec)} = \text{「SPLINE SPEED」} \times \frac{\text{F code}+1}{100}$$

For details, refer to 19.1.3 "CPC CONSTANT."

16.4.3 Acceleration/Deceleration in Free Curve Interpolation Operation

The range of acceleration/deceleration varies depending on the teaching points given and robot speed.

(1) When robot speed is 100 mm/sec or lower

The robot operates at almost the same speed from the beginning till the end without acceleration/deceleration

(2) When robot speed is higher than 100 mm/sec

The robot accelerates and decelerates. The range of acceleration is from the start point to the first teaching point; the range of deceleration is from the teaching point just before the end point to the end point.

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16.5 Functions of M Data and S Code

The M data and the S code determine the type of robot motion at each point. In principle, robot motion is determined by the M data, and the S code is used to expand the functions of the robot.

The M data contained in robot position data has the following two functions:

(1) Output the M data of each position address to the outside.[i]

(2) Determine the type of robot motion at each position address.

Although (1) is always executed, (2) is executed only when the value in the System Generation 「ORGIN」→「SET-UP SYSTEM」→「M DATA」 is set to a value between 0 and 7. In this case, the S code is used to expand the robot functions.

When the System Generation 「ORGIN」→「SET-UP SYSTEM」→「M DATA」 is set to a value greater than 7, the M data cannot specify robot motion, but the S code specifies it. The S code can also be used to expand the robot functions.

The M data and S code functions for robot motion setting are described in detail in the following sections.

Table 16. 2 Functions of M data and S code

「M DATA」 in System Generation	M data function	S code function
0 – 7	● Specifies robot motion. ● Outputs M data to the outside.	● Expands robot functions.
8 – 15	● Outputs M data to the outside.	● Specifies robot motion. ● Expands robot functions.

16.5.1 List of M Data Functions

The robot is capable of three types of operations, i.e. PTP operation, PASS PTP operation, and CPC operation. In principle, the type of operation to be performed is determined by the M data as shown below. The following shows the M data functions in the case where 「M DATA」in the System Generation is set to the standard value 0. (System Generation 「ORGIN」→「SET-UP SYSTEM」→「M DATA」)

Table 16. 3 List of M data functions

M data	Function
0	No operation (Jump)
1 – 29	PTP operation
30 – 39	PASS PTP operation
40 – 49	PTP SLOW-UP motion
50 – 59	PTP INSERTION motion
60 – 69	PTP motion
70 – 79	CPC free curve interpolation

[i] For details, refer to 7.2 “DO Signals.”

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80 – 81	CPC circular interpolation
82 – 89	CPC linear interpolation
90 – 99	PTP SLOW-UP motion + PTP INSERTION motion
??[i]	END point

When the M data is 0, the robot does not move to the address in question, but automatically increments the address number until it encounters M data other than 0.

When the M data is a value between 90 and 99, the robot automatically selects and performs PTP SLOW-UP motion when it should move up, and PTP INSERTION motion when it should move down.

16.5.2 List of S Code Functions

In principle, the S code is used to expand the M data functions. Details of the function expansion are shown in the following table.

Table 16. 4 List if S code function

S code	Function	Note
99	Performs W-axis sensor stop.	Refer to Chapter 14 "W-AXIS SENSOR STOP."
98	Moves only the A, B, and Z axis.	Refer to Chapter 14 "W-AXIS SENSOR STOP."
97	Performs no PTP GATE motion	The robot does not make PULL-UP motion.
96	Performs no PTP ARCH motion	
95	Performs INSERTION motion	
94	Performs SLOW-UP motion.	
93	Performs PTP INSERTION motion + PTP SLOW-UP motion.	
92	Performs ALL-AXIS SIMULTANEOUS PTP operation	
91	Performs positioning check once.	
90	Performs continuous PTP operation.	No communication with the outside is performed while PTP operation is performed repeatedly.
29	Moves only the Y axis.	
28	Moves only the Z axis.	
27	Moves the Z axis to the sensor stop position.	
26	Performs data offset move.	Destination = Current position + Position data of the address in question
25	Lets only the Z axis make relative movement.	Z-axis destination = Current Z-axis position +「SET-UP」→「EXPANSION B」→「Z MID OFF」[ii]
24	Lets only the Z axis make relative movement.	Z-axis destination = Current Z-axis position +「SET-UP」→「EXPANSION B」→「Z MID OFF」
23	Lets only the Z axis make relative movement.	Z-axis destination = Current Z-axis position + Z-axis data of the address in question
22	Lets only the Z axis make relative movement.	Z-axis destination = Current Z-axis position - Z-axis data of the address in question
21	Moves only the Z axis.	
20	Moves only the A, B, and W axes.	
1 - 14	Lets only specified axes perform PTP operation.	Refer to 16.5.2.1 "Specification of PTP operation axis by S code."

[i] All of OUT8 - OUT15 will turn ON with no robot motion.

[ii] System Parameter (FUNC HIGH + s.p 8 keys)「SET-UP」→「EXPANSION B」→「Z MID OF.」

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NOTE

① When using S code between 1 and 89, be sure to turn ON "BitNo.2" in the System Generation 「ORIGIN」→「SET-UP SYSTEM」→「INCHING SELECT」. For details, refer to 18.3.1 "SET-UP SYSTEM."
② When the S code is 26, 23, or 33, position data setting may be disabled depending on the values set in 「AREA LIMIT」.[i] Additionally, there may be cases where negative values are not accepted.

16.5.2.1 Specification of PTP operation axis by S code

It is possible to specify the axis/axes to perform PTP operation with the S code.

To specify the axis/axes, use S code between 1 and 14, which selects a combination of the A(X), B(Y), Z, and W axes assigned to bits 0 - 3, respectively.

Table 16. 5

Bit	7 bit	6 bit	5 bit	4 bit	3 bit	2 bit	1 bit	0 bit
Axis to be set	Unused	Unused	Unused	Unused	W axis	Z axis	Y(B) axis	X(A) axis

For example, when you wish to let only the X and Y axes perform PTP operation, bit 3 and bit 2 should be turned ON, and hence an applicable S code is 12. S code 15 is not used as it lets all the axes perform PTP operation (same as normal PTP operation).

Table 16. 6

S code	PTP operation axis			
	W	Z	Y(B)	X(A)
14	○	○	○	
13	○	○		○
12	○	○		
11	○		○	○
10	○		○	
9	○			○
8	○			
7		○	○	○
6		○	○	
5		○		○
4		○		
3			○	○
2			○	
1				○

When one of the above S codes is specified, only the axis/axes selected by the S code perform PTP operation for the teaching point given, while the other axis/axes stay in the same position.

All the axes selected by any of these S codes perform ALL-AXIS SIMULTANEOUS PTP operation[ii].

[i] Refer to System Generation 「LIMIT」→「AREA LIMIT」group).
[ii] Refer to 16.1.4 "ALL-AXIS SIMULTANEOUS PTP operation."

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16.5.3 Changes in M data and S Code Functions Depending on System Generation Setting

The functions of the M data and the S code vary depending on the value set in the System Generation 「ORIGIN」→「SET-UP SYSTEM」→「M DATA」.

(1) When 「M DATA」 is set to a value between 0 and 7

The M data specifies the type of robot motion, and the S code expands robot functions.

(2) When 「M DATA」 is set to a value 8 or greater

The M data is used for the MOUT signals, and does not specify robot motion. The S code succeeds to the M data functions. Only M = 00 (jump) and M = ?? (end) function as ever.

The following table shows the changes in the M data and S code functions according to 「M DATA」 setting.

NOTE

GATE motion and ARCH motion can be utilized in the PTP operation. However, they are disabled in the ALL-AXIS SIMULTANEOUS PTP operation[i].

Table 16. 7 Correspondence between 「M DATA」 and M data

"M DATA" in System Data / M Data	0	1	2	3	4	5	6	7	8 or greater
0	No operation (Jump)	No operation (Jump)	No operation (Jump)	No operation (Jump)	No operation (Jump)	No operation (Jump)	No operation (Jump)	No operation (Jump)	Used only for MOUT signals. Does not specify robot motion.
1 - 9	PTP operation	PTP INSERTION	PTP operation	PTP INSERTION	PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	
10 - 19	PTP operation	PTP INSERTION	PTP operation	PTP INSERTION	PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	
20 - 29	PTP operation	PTP INSERTION	PTP operation	PTP INSERTION	PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	
30 - 39	PASS PTP operation	PASS PTP operation	PASS PTP operation	PASS PTP operation	PASS PTP operation	PASS PTP operation	PASS PTP operation	PASS PTP operation	
40 - 49	PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	
50 - 59	PTP INSERTION	PTP INSERTION PTP SLOW-UP	PTP INSERTION	PTP INSERTION PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	
60 - 69	PTP operation	PTP INSERTION	ALL-AXIS SIMULTANEOUS PTP	ALL-AXIS SIMULTANEOUS PTP	PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	ALL-AXIS SIMULTANEOUS PTP	ALL-AXIS SIMULTANEOUS PTP	
70 - 79	CPC free curve interpolation	CPC free curve interpolation	CPC free curve interpolation	CPC free curve interpolation	CPC free curve interpolation	CPC free curve interpolation	CPC free curve interpolation	CPC free curve interpolation	
80 - 81	CPC circular interpolation	CPC circular interpolation	CPC circular interpolation	CPC circular interpolation	CPC circular interpolation	CPC circular interpolation	CPC circular interpolation	CPC circular interpolation	
82 - 89	CPC linear interpolation	CPC linear interpolation	CPC linear interpolation	CPC linear interpolation	CPC linear interpolation	CPC linear interpolation	CPC linear interpolation	CPC linear interpolation	
90 - 99	PTP INSERTION PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	
END (??)	End position	End position	End position	End position	End position	End position	End position	End position	

[i] Refer to 16.1.4 "ALL-AXIS SIMULTANEOUS PTP operation."

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Table 16. 8 Correspondence between "M DATA" and S code

"M DATA" in System Data / S code	0～7 M function +	8	9	10	11	12	13	14	15
0		PTP operation	PTP INSERTION	PTP operation	PTP INSERTION	PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP SLOW-UP	PTP INSERTION PTP SLOW-UP
1 - 9		PTP operation	PTP INSERTION	PTP operation	PTP INSERTION	PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP SLOW-UP	PTP INSERTION PTP SLOW-UP
10 - 19		PTP operation	PTP INSERTION	PTP operation	PTP INSERTION	PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP SLOW-UP	PTP INSERTION PTP SLOW-UP
20 - 29		PTP operation	PTP INSERTION	PTP operation	PTP INSERTION	PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP SLOW-UP	PTP INSERTION PTP SLOW-UP
30 - 39		PASS PTP operation	PASS PTP operation	PASS PTP operation	PASS PTP operation	PASS PTP operation	PASS PTP operation	PASS PTP operation	PASS PTP operation
40 - 49	Vision	PTP operation	PTP INSERTION	PTP operation	PTP INSERTION	PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP SLOW-UP	PTP INSERTION PTP SLOW-UP
50 - 59	Vision	PTP operation	PTP INSERTION	PTP operation	PTP INSERTION	PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP SLOW-UP	PTP INSERTION PTP SLOW-UP
60 - 69		ALL-AXIS SIMULTANEOUS PTP	ALL-AXIS SIMULTANEOUS PTP	ALL-AXIS SIMULTANEOUS PTP	ALL-AXIS SIMULTANEOUS PTP	ALL-AXIS SIMULTANEOUS PTP	ALL-AXIS SIMULTANEOUS PTP	ALL-AXIS SIMULTANEOUS PTP	ALL-AXIS SIMULTANEOUS PTP
70 - 79		CPC free curve interpolation	CPC free curve interpolation PTP INSERTION	CPC free curve interpolation	CPC free curve interpolation PTP INSERTION	CPC free curve interpolation PTP SLOW-UP	CPC free curve interpolation PTP INSERTION PTP SLOW-UP	CPC free curve interpolation PTP SLOW-UP	CPC free curve interpolation PTP INSERTION PTP SLOW-UP
80 - 81		CPC circular interpolation	CPC circular interpolation	CPC circular interpolation	CPC circular interpolation	CPC circular interpolation	CPC circular interpolation	CPC circular interpolation	CPC circular interpolation
82 - 89		CPC linear interpolation	CPC linear interpolation	CPC linear interpolation	CPC linear interpolation	CPC linear interpolation	CPC linear interpolation	CPC linear interpolation	CPC linear interpolation
90	PASS PTP operation	PASS PTP operation	PASS PTP operation	PASS PTP operation	PASS PTP operation	PASS PTP operation	PASS PTP operation	PASS PTP operation	PASS PTP operation
91	Positioning check to be performed once	Positioning check to be performed once	Positioning check to be performed once	Positioning check to be performed once	Positioning check to be performed once	Positioning check to be performed once	Positioning check to be performed once	Positioning check to be performed once	
92	ALL-AXIS SIMULTANEOUS PTP	ALL-AXIS SIMULTANEOUS PTP	ALL-AXIS SIMULTANEOUS PTP	ALL-AXIS SIMULTANEOUS PTP	ALL-AXIS SIMULTANEOUS PTP	ALL-AXIS SIMULTANEOUS PTP	ALL-AXIS SIMULTANEOUS PTP	ALL-AXIS SIMULTANEOUS PTP	ALL-AXIS SIMULTANEOUS PTP
93	PTP INSERTION PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP INSERTION PTP SLOW-UP
94	PTP SLOW-UP	PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP SLOW-UP	PTP INSERTION PTP SLOW-UP
95	PTP INSERTION	PTP INSERTION	PTP INSERTION	PTP INSERTION	PTP INSERTION	PTP INSERTION PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP INSERTION PTP SLOW-UP	PTP INSERTION PTP SLOW-UP
96	No arch motion	No arch motion	No arch motion PTP INSERTION	No arch motion	No arch motion PTP INSERTION	No arch motion PTP SLOW-UP	No arch motion PTP INSERTION PTP SLOW-UP	No arch motion PTP SLOW-UP	No arch motion PTP INSERTION PTP SLOW-UP
97	No gate motion	No gate motion	No gate motion PTP INSERTION	No gate motion	No gate motion PTP INSERTION	No gate motion PTP SLOW-UP	No gate motion PTP INSERTION PTP SLOW-UP	No gate motion PTP SLOW-UP	No gate motion PTP INSERTION PTP SLOW-UP
98	Only A, B, Z operate.	Only A, B, Z operate.	Only A, B, Z operate. PTP INSERTION	Only A, B, Z operate.	Only A, B, Z operate. PTP INSERTION	Only A, B, Z operate. PTP SLOW-UP	Only A, B, Z operate. PTP INSERTION PTP SLOW-UP	Only A, B, Z operate. PTP SLOW-UP	Only A, B, Z operate. PTP INSERTION PTP SLOW-UP
99	W-axis sensor stop	W-axis sensor stop	W-axis sensor stop PTP INSERTION	W-axis sensor stop	W-axis sensor stop PTP INSERTION	W-axis sensor stop PTP SLOW-UP	W-axis sensor stop PTP INSERTION PTP SLOW-UP	W-axis sensor stop PTP SLOW-UP	W-axis sensor stop PTP INSERTION PTP SLOW-UP

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16.6 F Code

The F code determines the robot speed during each positioning operation. The F code shall be specified as a percentage of the speed value in the System Parameter[i]「MOTION」group.

The F code ranges from 00 to 99, and actual robot speed is obtained by the following formula.

Actual robot speed ＝ System Data value × (F code ＋ 1)/100

The robot speed is based on the following System Parameter values.

- During PTP operation

  「MOTION」→「AXIS SPEED」→「SPEED A,B(X,Y),W」,「SPEED Z」

- During CPC operation

  「MOTION」→「AXIS SPEED」→「CPC SPEED」

To enter the F code, select the KEY-IN or TEACH mode. If the local / F key is pressed in this mode, the cursor will jump to the F code section.

[i] You can jump to it with the FUNC / HIGH ＋ s.p / 8 keys.

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16.7 Conveyor Follow-up Motion (Option)

This is not genuine conveyor follow-up motion, but artificial follow-up motion created by adding upward/downward movement of the Z axis (PTP operation) to CPC operation. It is possible because the robot travels at a constant horizontal-direction speed during CPC operation.

This motion is available only on a special spec robot, as the following modifications are required.

- Addition of DI/DO
- Addition of hardware to exercise control in proportion to conveyor speed
- Specialization of software

For details, contact the manufacturer.

16.7.1 System Parameter Used in Conveyor Follow-up Motion

To use the conveyor follow-up motion, set the following System Parameter.

(1) 「MAINTENANCE」→「MAINTENANCE DATA」

- CPC SELECT（CPC selection）
  Set this parameter to “1” to select conveyor follow-up motion.

(2) 「MOTION」→「CPC CONSTANT」

- CPC ACCEL (CPC acceleration/deceleration)
  Enter an appropriate value.
  For details, refer to 19.1.3 “CPC CONSTANT.”

(3) 「SET-UP」→「EXPANSION B」

NOTE

The following parameters can be set only on a special controller capable of conveyor follow-up motion. They are not available on a normal controller.

- CV Z DIS (Z-axis down standby position)
  Set the standby position where the Z axis should stand by before it moves to Z-axis target position.
- CV Z SPD
  Set the Z-axis speed to be used when the Z axis moves from the above standby position to Z-axis target position.
- CV ESC1 DIS
  Set the distance in which the robot should slow down and stop after the follow-up escape command (IN19) is turned ON.
- CV ESC2 DIS
  Set the distance which the robot should travel in a direction square to the conveyor after the slowing down and stopping by the follow-up escape command.
- CV CV SPEED
  Set the travel speed of the conveyor.

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16.7.2 Type of Conveyor Follow-up Motion

During conveyor follow-up motion, horizontal axes (A, B, and W axes) perform simultaneous CPC operation, while a vertical axis (Z axis) performs PTP operation.

The following two types of conveyor follow-up motions are available.

- Approach follow-up over straight-line conveyor
- Straight-line follow-up over straight-line conveyor

16.7.3 Approach Follow-up Over Straight-line Conveyor

This section describes the approach follow-up motion over a straight-line conveyor.

This motion is to be used, for example, in the case where you wish to let a robot arm stay above the conveyor only while the arm grasps a work.

To perform approach follow-up motion, teach the four points (P0, P1, P2, and P3) shown in the figure below. P0, P1, P2, and P3 must be taught in serial addresses.

P0: Operation start point
P1: Point that includes the height of work grasping point [M = 89]
P2: M = 89
P3: Operation end point [M = 89]
P1-P2 specifies the traveling direction of the conveyor.
Set the M data of the point just after P3 to "??."

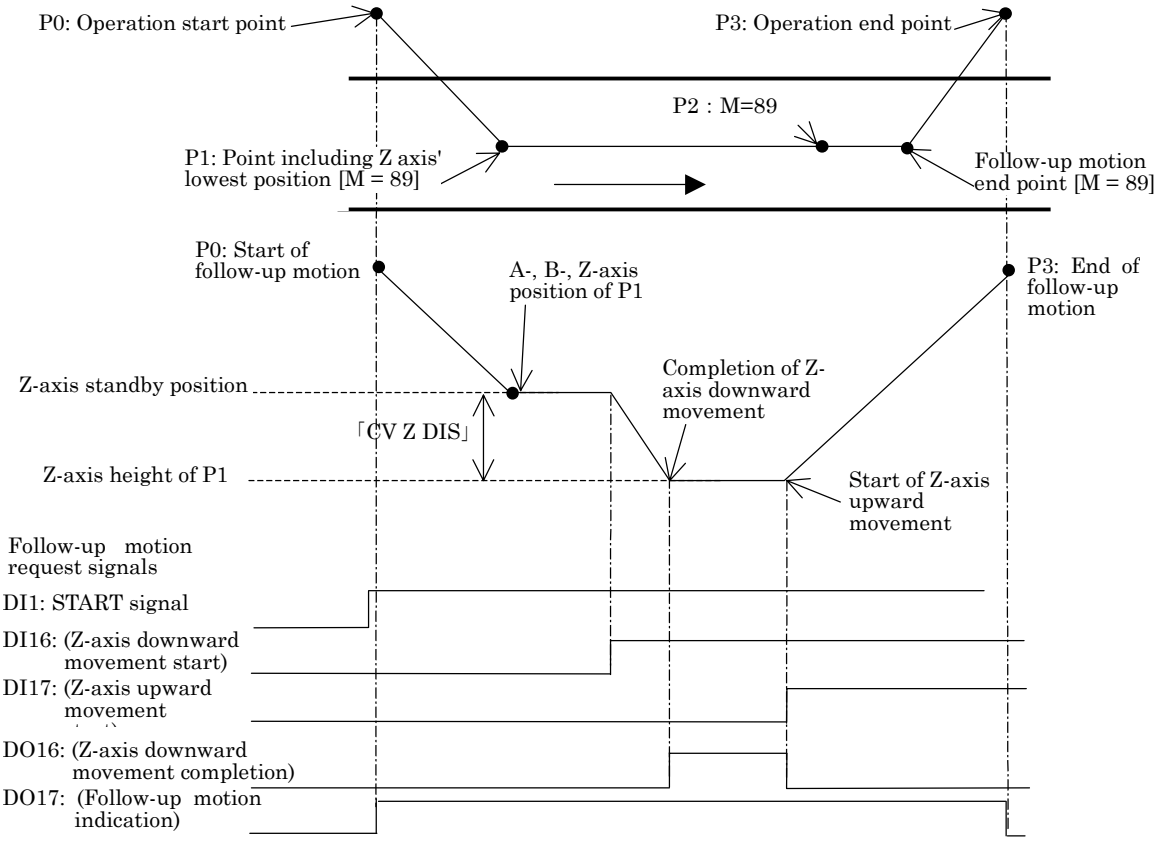


Fig. 16. 14

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The following DI/DO's are added for this conveyor follow-up motion.

- DI :

  IN16: Requests the start of Z-axis downward movement during follow-up motion.

  IN17: Requests the start of Z-axis upward movement during follow-up motion.

  IN18: Reserved.

  IN19: Commands follow-up escape.

- DO :

  OUT16: Indicates the completion of Z-axis downward movement.

  OUT17: Indicates that follow-up motion is in progress.

The following describes each step of conveyor follow-up motion based on the communications with an external control device, centering on Z-axis movements.

(1) The external control device moves the robot to P0.

(2) The external control device outputs to the robot the data of follow-up start point P1, and then turns ON the START signal (IN1).

(3) The robot turns ON the follow-up motion indication signal (OUT17), and, while performing follow-up motion to P1, moves the Z axis down to the standby position (height of P1 minus 「CV Z DIS」[i]).

(4) When the robot has become ready to grasp a work, the external control device turns ON the Z-axis downward movement start request signal (IN16).

(5) While performing follow-up motion, the robot moves down to the height of P1, and turns ON the Z-axis downward movement completion signal (OUT16). At this time, the speed of the Z axis is equal to 「CV Z SPD」[ii].

(6) When the robot has grasped a work, the external control device turns ON the Z-axis upward movement start request signal (IN17).

(7) The robot turns OFF the Z-axis downward movement completion signal (OUT16), and moves to follow-up motion end point P3.

(8) When the robot has reached P3, it turns OFF the follow-up motion indication signal (OUT17) to indicate the completion of follow-up motion. The PCA signal (OUT2) is turned ON at the same time.

NOTE

① If the Z-axis downward movement start request signal (IN16) is not turned ON during follow-up motion, the Z axis will not operate, and only

[i] System Parameter「SET-UP」→「EXPANSION B」→「CV Z DIS」
[ii] System Parameter「SET-UP」→「EXPANSION B」→「CV Z SPD」

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the A, B, and W axes will perform follow-up motion, and finish it upon moving to point C.

② If the Z-axis upward movement start request signal (IN17) is not turned ON after the Z-axis downward movement start request signal (IN16) is turned ON, the robot will move to P3 and then stop with the Z axis left at the lowest position. The follow-up motion indication signal (OUT17) is not turned OFF until the Z-axis upward movement start request signal (IN17) is turned ON. If the Z-axis upward movement start request signal (IN17) is turned ON, the Z axis will move up, and then the follow-up motion indication signal (OUT17) will be turned OFF to indicate the completion of follow-up motion.

16.7.3.1 Follow-up escape processing

When approach follow-up motion is to be terminated halfway for some reason, perform follow-up escape processing. The following is a description of the follow-up escape processing.

(1) When approach follow-up motion is to be terminated, the external control device turns ON the follow-up escape command (IN19).

(2) The robot starts slowing down and stops after traveling the distance set in the System Parameter 「SET-UP」→「EXPANSION B」→「CV ESC1 DIS」.

(3) Then the robot travels in a direction square to the conveyor (toward P0) for the distance set in the System Parameter 「SET-UP」→「EXPANSION B」→「CV ESC2 DIS」. The Z axis moves up to the height of P0.

(4) When the move to the specified position is completed, the robot turns OFF the follow-up motion indication signal (OUT17) to indicate the completion of follow-up motion. The PCA signal (OUT2) is turned ON at the same time.

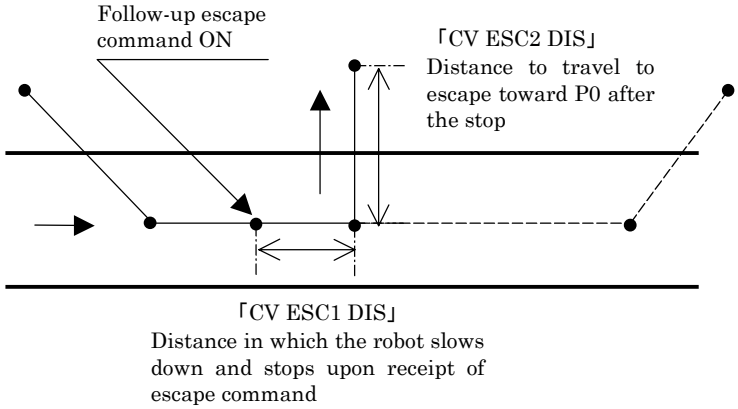


Fig. 16. 15

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16.7.4 Straight-line Follow-up Over Straight-line Conveyor

This section describes the straight-line follow-up motion over a straight-line conveyor.

This motion is to be used when there is no harm if a robot arm stays continuously above the conveyor.

To perform straight-line follow-up motion, teach the two points (P0 and P1) shown in the figure below. P0 and P1 must be taught in serial addresses.

P0: Start point of follow-up motion. The Z axis moves up to the height of this point after the completion of follow-up motion.

P1: Point that includes the height of work grasping point. P0-P1 specifies the traveling direction of the conveyor. [M = 89]

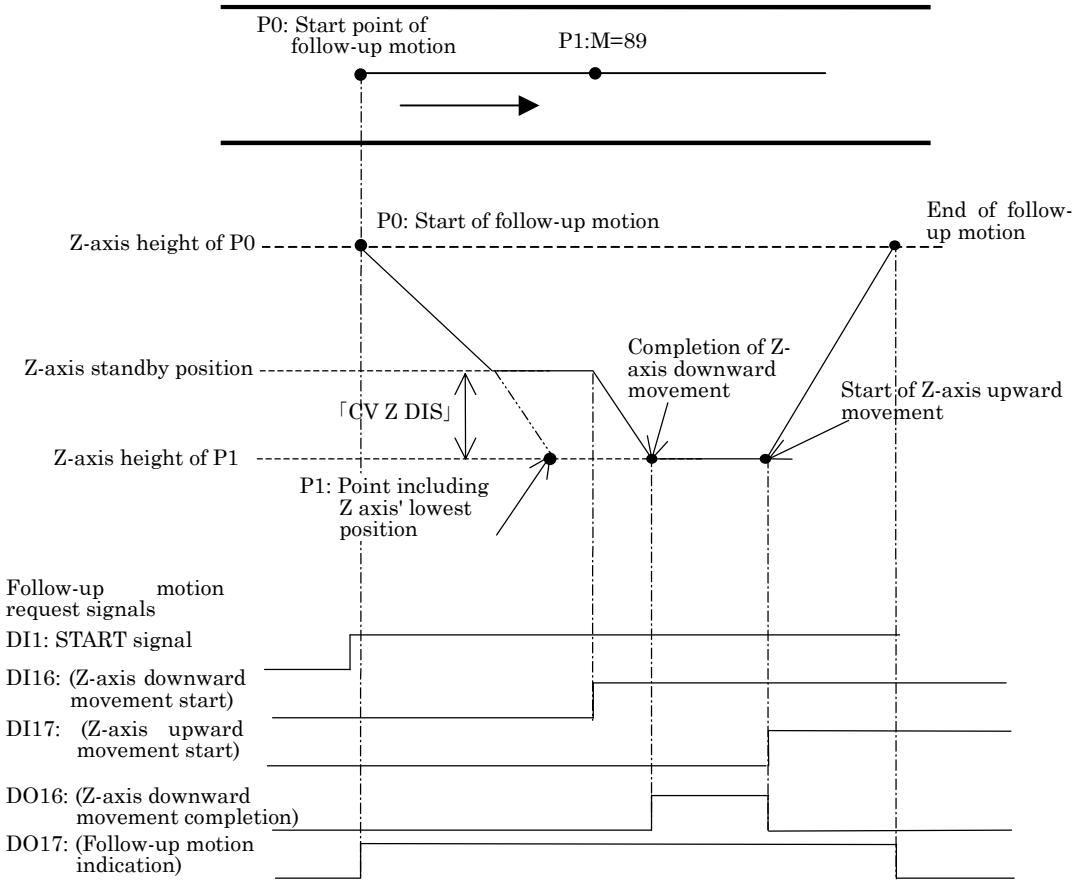


Fig. 16. 16

The following DI/DO's are added for this conveyor follow-up motion.

- DI :

  IN16: Requests the start of Z-axis downward movement during follow-up motion.

  IN17: Requests the start of Z-axis upward movement during follow-up motion.

  IN18: Reserved.

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- DO :

  OUT16: Indicates the completion of Z-axis downward movement.

  OUT17: Indicates that follow-up motion is in progress.

The following describes each step of conveyor follow-up motion based on the communications with an external control device, centering on Z-axis movements.

(1) The external control device moves the robot to P0.

(2) The external control device outputs the data of P1 to the robot, and then turns ON the START signal (IN1).

(3) The robot turns ON the follow-up motion indication signal (OUT17), and while performing follow-up motion above the conveyor, moves the Z axis down to the standby position (height of P1 minus「CV Z DIS」[i]).

(4) When the robot has become ready to grasp a work, the external control device turns ON the Z-axis downward movement start request signal (IN16).

(5) While performing follow-up motion, the robot moves down to the height of P1, and turns ON the Z-axis downward movement completion signal (OUT16). At this time, the speed of the Z axis is equal to「CV Z SPD」[ii].

(6) When the robot has grasped a work, the external control device turns ON the Z-axis upward movement start request signal (IN17).

(7) The robot turns OFF the Z-axis downward movement completion signal (OUT16), and moves up to the height of P0 while performing follow-up motion.

(8) When the robot has reached the height of P0, it turns OFF the follow-up motion indication signal (OUT17) to indicate the completion of follow-up motion. The PCA signal (OUT2) is turned ON at the same time.

NOTE

① If the Z-axis downward movement start request signal (IN16) is not turned ON during follow-up motion, the Z axis will not operate, and only the A, B, and W axes will perform follow-up motion, and finish it upon moving to point C.
② If the Z-axis upward movement start request signal (IN17) is not turned ON after the Z-axis downward movement start request signal (IN16) is turned ON, the robot will continue to move leaving the Z axis at the lowest position. The follow-up motion is not finished and the follow-up motion indication signal (OUT17) is not turned OFF until the Z-axis upward movement start request signal (IN17) is turned ON. The robot continues to move until the “OVERRUN” error occurs.

[i] System Parameter「SET-UP」→「EXPANSION B」→「CV Z DIS」
[ii] System Parameter「SET-UP」→「EXPANSION B」→「CV Z SPD」

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CHAPTER 17 SYSTEM DATA

17.1 Outline

The System Data is semi-fixed data used for operating the robot. It consists of characteristic data of the robot and the data for optimizing the robot for the system. It is not necessary to change the data once the robot is incorporated in the system. Improper data can cause a malfunction or failure of the robot. Be sure to keep a record of data setting and values set before starting the operation of the robot.

The System Data is divided broadly into two groups. One group is called System Generation (SG). Parameters available vary depending on the model of the robot and the type of the controller used. Be sure to check the model/type of your robot/controller to enter proper data.

Another group is called System Parameter (SP). Parameters in this group sometimes require changing even after the robot has been incorporated in the system, e.g. when you wish to change the motion of the robot.

The data is divided into the following groups according to their usage. When setting or checking the System Data, select an applicable group as a first step.

(1) System Generation (SG)

- LIMIT ····· Sets area limits.
- MAINTE ····· Used for maintenance.
- ORIGIN ····· Sets up the system.
- ADJUST ····· Contains robot's characteristic values and data for maintenance.
- CAPABILITY ····· Contains robot's specification data.

(2) System Parameter (SP)

- MOTION ····· Determines robot motion.
- RESPONSE ····· Contains various data on robot axes.
- OFFSET ····· Sets display offset values.
- SET-UP ····· Used for system expansion.
- REMOTE ····· Used in the ON-LINE mode

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17.2 Configuration of System Data

The following figures shoe the configuration of the System Data.

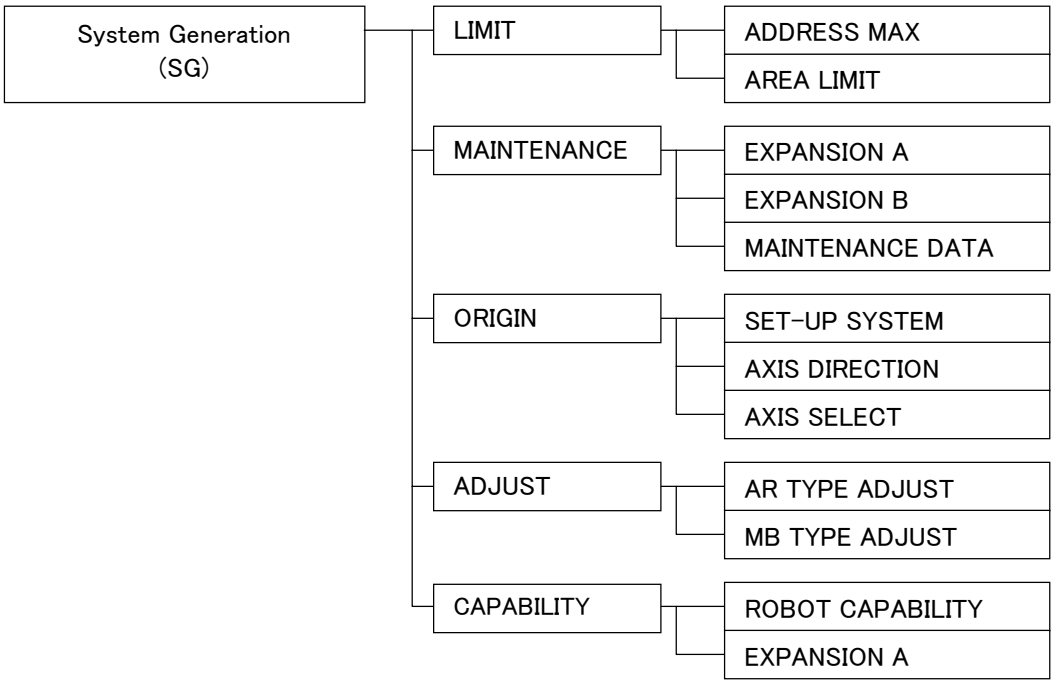


Fig.17 1 Configuration of System Generation

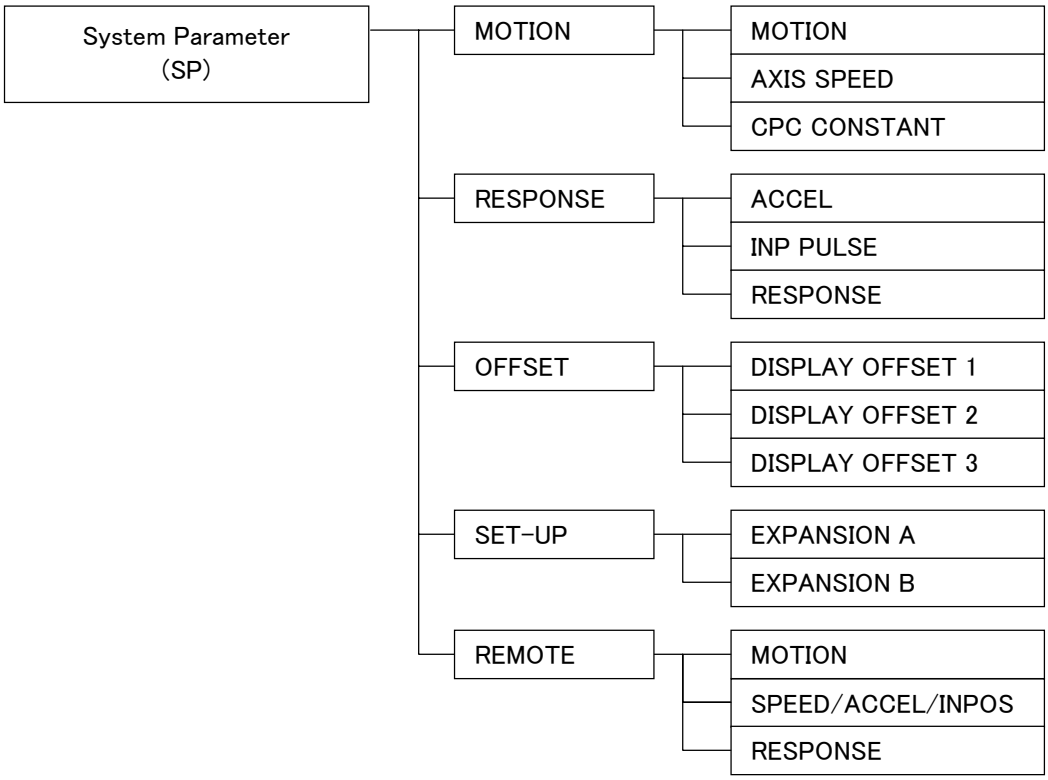


Fig.17 2 Configuration of System Parameter

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17.3 Setting/Changing Data

Before proceeding with data setting, read Chapter 18 “DETAILS OF SYSTEM GENERATION” and Chapter 19 “DETAILS OF SYSTEM PARAMETER” thoroughly.

In the event that a System Data error occurs, be sure to restore the defaults of the System Data, and reenter each data. Then turn the power off and on again.

The following data setting procedures are applicable to any operation mode.

17.3.1 Procedure for System Data Entry

- Select either the System Generation or the System Parameter.

  System Generation : Press the FUNC/HIGH + s.g/7 keys.

  System Parameter : Press the FUNC/HIGH + s.p/8 keys.

```
SYSTEM GENERATION
1. LIMIT      2. MAINTE
3. ORIGIN     4. ADJUST
5. CAPABILITY
```

Fig. 17 3 System Generation menu

- Select an applicable group with a numeric key.

Example

The following explains the data entry procedure taking as an example the case where “Stop” (System Generation 「ORIGIN」→「SET-UP SYSTEM」→「STOP」) is changed to “PAUSE.”

(1) Press the FUNC/HIGH + s.g/7 keys to call up the System Generation menu.

(2) On the System Generation menu screen, press the mot/3 keys. Then the following screen will appear.

```
ORIGIN GROUP
1. SET-UP SYSTEM
2. AXIS DIRECTION
3. AXIS SELECT
```

Fig. 17 4 ORIGIN group menu

(3) Press the cal/1 key 「1. SET-UP SYSTEM」. Then the following screen will appear.

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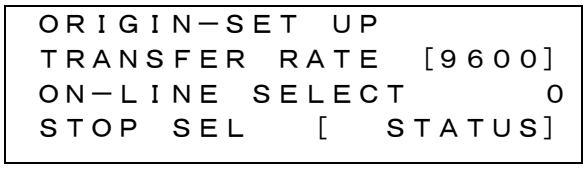


Fig. 17 5 SET-UP data screen ①

(4) A cursor is sitting at the top of the data of「TRANSFER RATE」.
「STOP」 is not displayed at this moment. Press the [up DOWN] key to move the cursor to the data of 「STOP」.

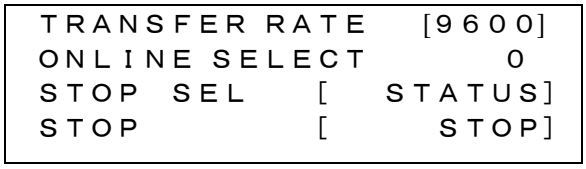


Fig. 17 6 SET-UP data screen ②

(5) Change the data.

Press the [io SEL] key or [cal 1] key to change the data form “STOP” to “PLUSE.”

(6) Fix the data.

① Press the [ENTER] key. The message
“ENTER OK?”
will appear, and a buzzer will sound.

② Check that the data is correct.

③ If it is correct, press the [ENTER] key again.
When you wish to cancel the data, press any key other than the [ENTER] key.

(7) The screen will be scrolled down, and the following screen will appear.

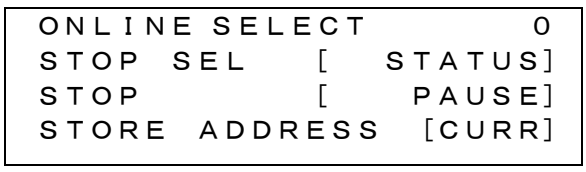


Fig. 17 7「ORIGIN」 screen

(8) Press the [spd CAN] key to return to the ORIGIN group menu.

(9) Press the [spd CAN] key again return to the System Generation menu.

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NOTE

The following are the hints on the operation of the Teach Pendant applicable to System Data change on the data screen.

①If the [A] key is pressed on the data screen, the cursor will move to first data on the data screen.

②If the [up DOWN] key is pressed on the data screen, the cursor will move to the next lower data. If the [SHIFT] key is pressed (『SHIFT』 LED: ON) and then the [up DOWN] key, the cursor will move to the next higher data.

③If the [READ] key is pressed when the data is not yet fixed, the data before change will be displayed.

④If the [spd CAN] key is pressed halfway through the data entry, entry will be cancelled, and a group menu will appear.

17.3.2 Changing Data

Parameter data is changed by either of the following two methods.

- When data is numeric

  Change data using the numeric keys.

- When data is text Select appropriate text

  When data is text like "STOP," the [io SEL] key switches the selection. As selection available are assigned to numeric keys one by one from the [* 0] key, you can also make a selection with numeric key.

17.3.3 Number of Item on Display

The LDC screen can display only four lines at a time. When the number of items to be displayed is more than four, press the [up DOWN] key to scroll the screen and display a hidden part.

The last item is displayed with

"---bottom---"

on the next lower line. This shows the end of the group.

17.3.4 Screen Transition

The System Generation has 5 group menus and 12 data screens; the System Parameter has 5 group menus and 15 data screens.

When a group menu of the System Generation/Parameter is displayed, the [FUNC HIGH] + [dec INC] keys switch the group menu on display in sequence.

When the 『SHIFT』 LED is OFF, the menu switches in ascending order of the menu number. When the 『SHIFT』 LED is ON, the menu switches in descending order of the menu number.

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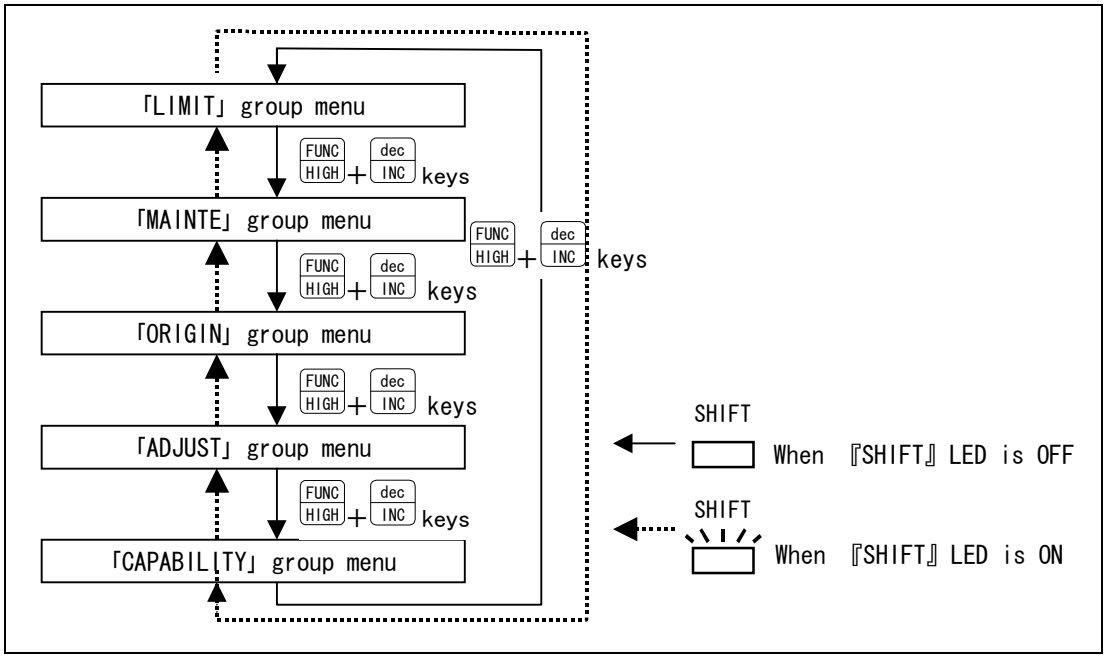


Fig. 17 8 Switching between group menu in System Generation

When a data screen is displayed , the FUNC HIGH + dec INC keys switch the data screen on display in sequence.

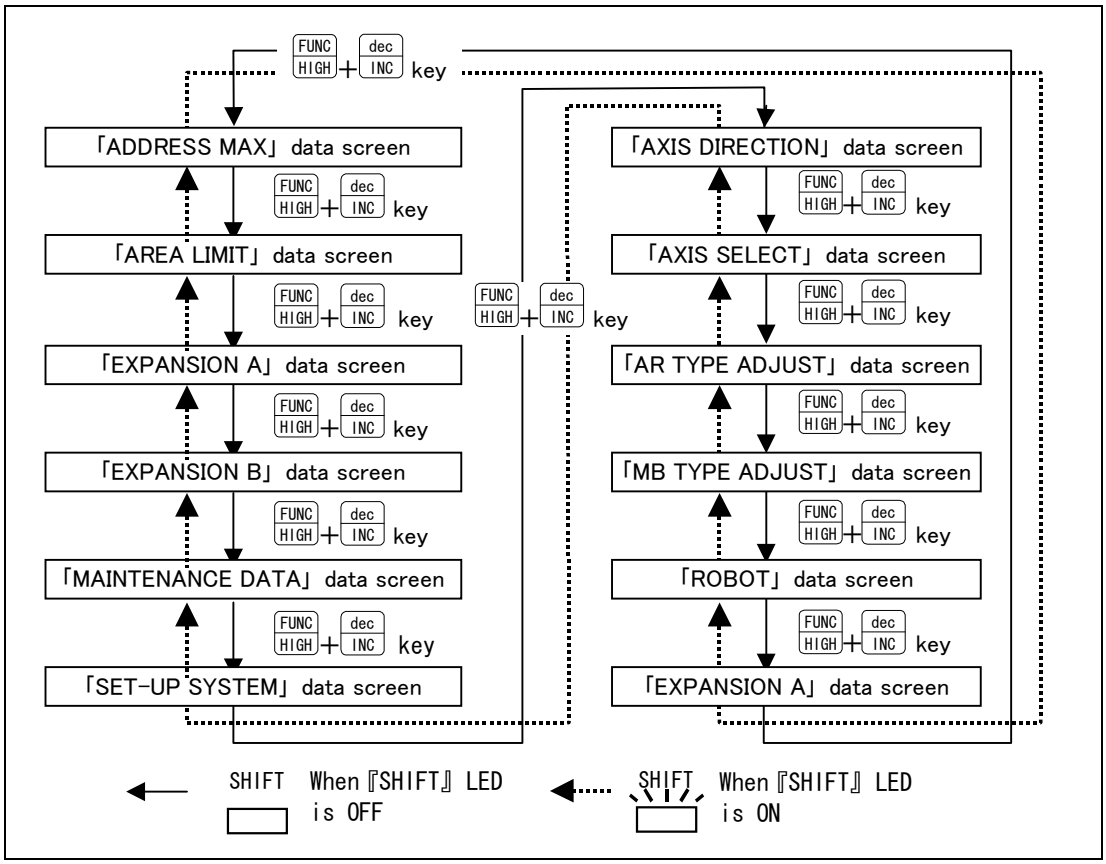


Fig. 17 9 Switching between data screens in System Generation

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17.3.5 Restoring Defaults of System Data

Refer to Chapter 21 “INITIALIZING SYSTEM DATA.”

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CHAPTER 18 DETAILS OF SYSTEM GENERATION

This chapter describes details of the System Generation that is a part of the System Data.

18.1 LIMIT Group

The「LIMIT」group sets limits on position data and robot's operation area on programs, for safety purposes.

18.1.1 ADDRESS MAX

(1) 「ADDRESS MAX」

- Number of digits: 3
- Setting range: 0 to 999
- Minimum unit: 1
- Standard value: 999

This parameter sets the highest number of the position addresses used in programs.

It is possible to set 1000 addresses (address 0 to address 999) at the maximum. When programs require a fewer number of addresses, you can set a limit on the number of addresses using this parameter. When an address number that exceeds the value set is entered or specified from an external device, an error occurs with the message "ADDRESS ERROR."

18.1.2 AREA LIMIT

This data group sets limits on axes' operation areas.

Data shall be specified by angle (degrees) or distance (mm) according to the type of axis.

(1) 「UPPER LMT A」

(2) 「LOWER LMT A」

- Number of digits: 7
- Setting range (UPPER): Minimum operation area to the maximum mechanical operation area
- Setting range (LOWER): 0 to the maximum operation area
- Minimum unit: ±0.001
- Standard value (AR): UPPER LMT A: 300, LOWER LMT A: 0
- Standard value (MB): UPPER LMT A: 1000, LOWER LMT A: 0

These parameters set the maximum and minimum operation areas of the A (X) axis on software, for safety purposes.

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① SCARA (horizontal multi-articulated type) robot

The data of these parameters shall be specified by angle (degrees), with reference to the origin of the A axis at the time of A-CAL. The relationship between respective data is as shown below.

0 ≦ LOWER LMT A < UPPER LMT A ≦ A-axis maximum operation area

Example

The A-axis maximum operation area means the mechanical operating limit of the A axis, and it varies depending on the model of the robot. (Example: A-axis maximum operation area of AR-C270 = 205º)

When the A-axis operation area is limited as follows

「UPPER LMT A」= 200°

「LOWER LMT A」= 130°

and an attempt is made in the KEY-IN or TEACH mode to set A-axis data so as to move the robot into the area other than the shaded area in the figure below, an error occurs with the message "AREA ERROR."

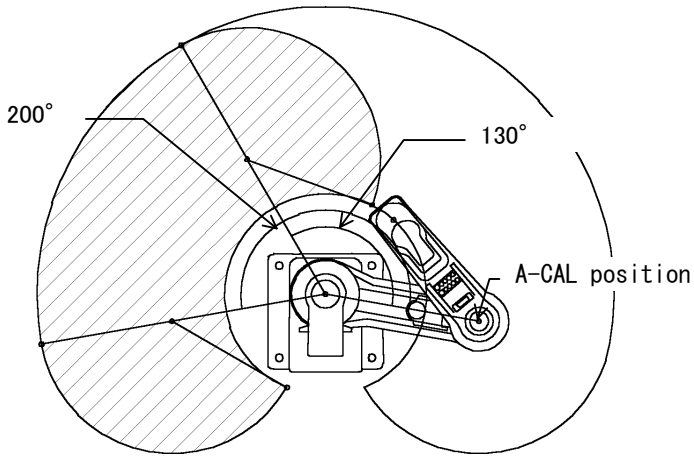


Fig. 18. 1 Area limit (A axis)

When no limit on the operation area is required, set these parameters as shown below.

「UPPER LMT A」= A-axis maximum operation area

「LOWER LMT A」= 0

② Rectangular coordinate system robot

Set 「UPPER LMT A」 to a value for a desired X-axis stroke.

When no limit on the operation area is required, set these parameters as follows.

「UPPER LMT A」= Maximum X-axis stroke

「LOWER LMT A」= 0

(3) 「UPPER LMT B」

(4) 「LOWER LMT B」

- Number of digits: 7
- Setting range (UPPER): Minimum operation area to the maximum mechanical operation area

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- Setting range (LOWER): 0 to the maximum operation area
- Minimum unit: ±0.001
- Standard value (AR): UPPER LMT B: 300, LOWER LMT B: 0
- Standard value (MB): UPPER LMT B: 1000, LOWER LMT B: 0

These parameters set the maximum and minimum operation areas of the B (Y) axis on software, for safety purposes.

① SCARA (horizontal multi-articulated type) robot

These parameters set a limit on the B-axis operation area with reference to the origin of the B axis at the time of A-CAL. Their data shall be specified by angle (degrees). The relationship between respective data is as shown below.

0 ≦ LOWER LMT B < UPPER LMT B ≦B-axis maximum operation area

The B-axis maximum operation area means the mechanical operating limit of the B axis, and it varies depending on the model of the robot. (Example: B-axis maximum operation area of AR-C270 = 285º)

Example

When the A-axis and B-axis operation areas are limited as follows

「UPPER LMT A」 = 200º

「LOWER LMT A」 = 130º

「UPPER LMT B」 = 270º

「LOWER LMT B」 = 20º

and an attempt is made in the KEY-IN or TEACH mode to set B-axis data so as to move the robot into the area other than the shaded area in the figure below, an error occurs with the message "AREA ERROR."

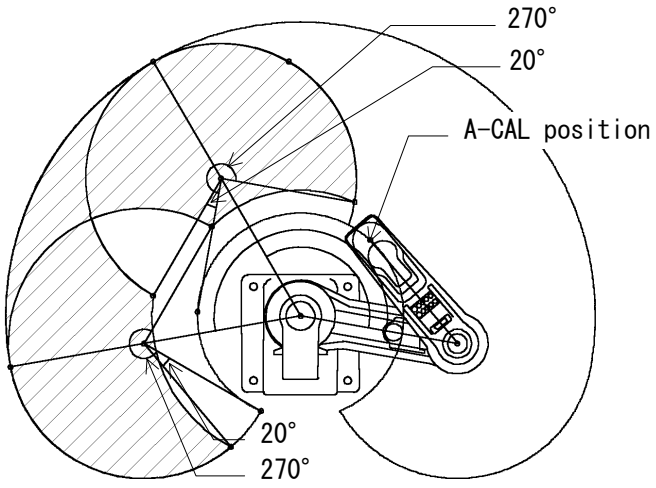


Fig. 18. 2 Area limit (B axis)

When no limit on the operation area is required, set these parameters as shown below.

「UPPER LMT B」 = B-axis maximum operation area

「LOWER LMT B」 = 0

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② Rectangular coordinate system robot

Set「UPPER　LMT B」to a value for a desired Y-axis stroke.

When no limit on the operation area is required, set these parameters as follows.

「UPPER LMT B」= Maximum Y-axis stroke

「LOWER LMT B」= 0

(5) 「UPPER　LMT Z」

(6) 「LOWER LMT Z」

- Number of digits: 7
- Setting range (UPPER): Minimum operation area to the maximum mechanical operation area
- Setting range (LOWER): 0 to the maximum operation area
- Minimum unit: ±0.001
- Standard value: UPPER LMT Z: 150, LOWER LMT Z: 0

These parameters set a limit on the stroke of the Z axis.

When an attempt is made in the KEY-IN or TEACH mode to set Z-axis data exceeding the value set, an error occurs.

For example, when the maximum Z-axis stroke is 150 mm but a stroke of 100 mm is sufficient for the work, set「UPPER LMT Z」to 100 for safety's sake.

When no limit on the operation area is required, set these parameters as follows.

「UPPER LMT Z」= Maximum Z-axis stroke

「LOWER LMT Z」= 0

(7) 「UPPER　LMT W」

(8) 「LOWER LMT W」

- Number of digits: 7
- Setting range (UPPER): Minimum operation area to the maximum mechanical operation area
- Setting range (LOWER): 0 to the maximum operation area
- Minimum unit: ±0.001
- Standard value: UPPER LMT W: 720, LOWER LMT W: 0

These parameters set a limit on the operation area of the W axis.

When an attempt is made in the KEY-IN or TEACH mode to set W-axis data exceeding the value set, an error occurs.

When the W axis is of the rotating type, the data of these parameters shall be specified by angle (degrees).　When it is of the straight type, the data shall be specified by distance (mm).

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18.2 MAINTENANCE

This group contains the data used at the time of maintenance.

CAUTION

Leave the parameters in this group at their defaults "0," unless necessity for a change arises.

18.2.1 EXPANSION A

(1) 「CPC GAIN Z」

- Number of digits: 7
- Setting range: 0 or 50 to 200
- Standard value: 0

This parameter (follow-up gain) determines the smoothness of CPC operation, and works on the Z axis.

Under normal conditions, the robot performs CPC operation while referring to the internal default value. However, when an extreme inertial load is applied to a robot or a special robot is used, there are cases where vibrations occur or follow-up accuracy is deteriorated. In such cases, improve the situation by setting this parameter. When this parameter is used, 「CPC SELECT」 ((1) of 18.2.3 "MAINTENANCE DATA") must be set together.

When this parameter is set to "0," the default value stored in the controller is used.

The internal default value is 100, and set this parameter to a smaller value to reduce vibrations, and a lager value to improve follow-up accuracy.

When a value larger than 0 but smaller than 50 is given, it is regarded as 50. When a value larger than 200 is given, it is regarded as 200.

(2) 「CPC GAIN W」

- Number of digits: 7
- Setting range: 0 or 50 to 200
- Standard value: 0

This parameter (follow-up gain) determines the smoothness of CPC operation, and works on the W axis.

Under normal conditions, the robot performs CPC operation while referring to the internal default value. However, when an extreme inertial load is applied to a robot or a special robot is used, there are cases where vibrations occur or follow-up accuracy is deteriorated. In such cases, improve the situation by setting this parameter. When this parameter is used, 「CPC SELECT」 ((1) of 18.2.3 "MAINTENANCE DATA") must be set together.

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When this parameter is set to "0," the default value stored in the controller is used.

The internal default value is 100, and set this parameter to a smaller value to reduce vibrations, and a lager value to improve follow-up accuracy.

When a value larger than 0 but smaller than 50 is given, it is regarded as 50. When a value larger than 200 is given, it is regarded as 200.

(3) 「DOWN CNT.」

- Number of digits: 7
- Setting range: 0 to 999
- Standard value: 0

When the Z axis is to move down during PTP gate motion, the robot performs a check to confirm that A and B axes' horizontal coordinates are in the area where the Z axis may move down. This parameter sets the count of this check. It is to be set when a high degree of accuracy is required as in the case of a DD robot.

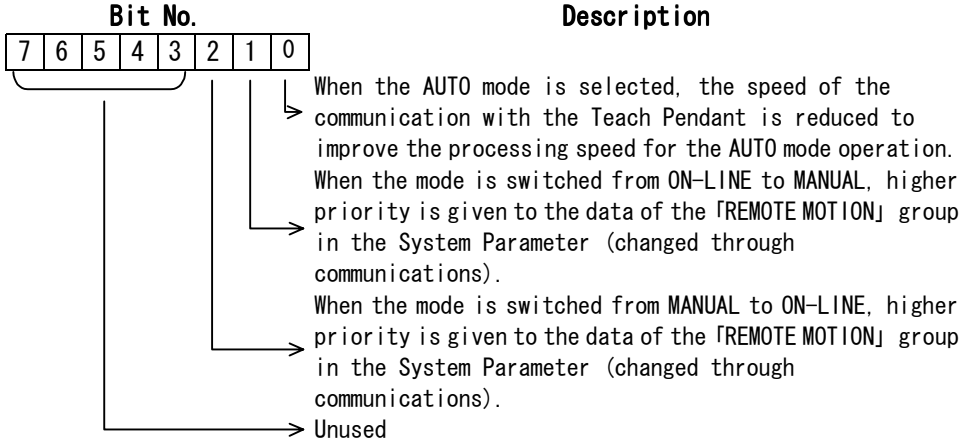
The standard value is 0, and the check is performed only once.

(4) 「PRIV.FLAG」

- Number of digits: 7
- Setting range: 0 to 255
- Standard value: 0

This parameter sets processing speed appropriate to the use of the Teach Pendant, and determines the priority of the data set by the HRCS-RIII protocol.

The function shown below becomes effective if an applicable bit of the data is turned ON.



CAUTION

When bits 1 and 2 are not turned ON, the data set by the Teach Pendant takes precedence over the data of the「REMOTE MOTION」group in the System Parameter upon switching of the mode.

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18.2.2 EXPANSION B

(1) 「INTIAL W」

CAUTION

Set this parameter only when you are instructed to do so.

- Number of digits: 7
- Minimum unit: 0.001
- Standard value: 0

When interpolation operation is to be performed with a robot with an edge tool, this parameter sets the angle of the tool. This data is used to calculate the coordinates of the tool.

(2) 「LENGTH W」

CAUTION

Set this parameter only when you are instructed to do so.

- Number of digits: 7
- Minimum unit: 0.001
- Standard value: 0

When interpolation operation is to be performed with a robot with an edge tool, this parameter sets the length of the tool. This data is used to calculate the coordinates of the tool.

(3) 「AXIS UP/DOWN」

CAUTION

Set this parameter only when you are instructed to do so.

- Number of digits: 3
- Minimum unit: 1
- Standard value: 0

For the loader of the HGL series, the direction to move away from the origin sensor has been set to "+." However, this direction setting (+ or -) can be switched by setting each bit of this data.

Table 18. 1

Bit	7 bit	6 bit	5 bit	4 bit	3 bit	2 bit	1 bit	0 bit
Axis to be set	Unused	Unused	Unused	Unused	W axis	Z axis	Y(B) axis	X(A) axis

If the DISPLAY OFFSET function[i] is used in combination with this parameter, it becomes possible to let the robot regard the Z-axis movement "down→up" is regarded as "-→+."

[i] For details, refer to 12.4 "DISPLAY OFFSET Automatic Calculation."

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(4) 「ANGLE REV.」

CAUTION

Set this parameter only when you are instructed to do so.

- Number of digits: 3
- Minimum unit: 1
- Standard value: 0

This parameter switches the coordinate direction of the W axis.

0: Normal
1: Reverse direction

18.2.3 MAINTENANCE DATA

This group contains the data used at the time of maintenance. Leave the parameters in this group at their defaults "0," unless necessity for a change arises.

(1) 「CPC SELECT」

- Number of digits: 3
- Minimum unit: 1
- Standard value: 0

This parameter determines the type of CPC operation.

Data 0: Performs CPC operation using the internal default value.

1: Performs conveyor follow-up operation.

2: Permits the change of the follow-up gain for each axis during CPC operation. It enables the value in the System Generation 「MAINTENANCE」→「EXPANSION A」→「CPC GAIN Z」, 「CPC GAIN W」 and 「MAINTENANCE」→「MAINTENANCE DATA」→「CPC SP1」, 「CPC SP2」.

3: Enables both data 1 and 2.

128: Sets no acceleration and deceleration.

256: Performs encoder follow-up during simple follow-up motion by M data 40 - 49[i]. (Special robot only)

(2) 「CPC LOOP TIME」

- Number of digits: 3
- Setting range: 0 to 100
- Minimum unit: 1
- Standard value: 0

[i] For details, refer to Chapter 27 "SIMPLE FOLLOW-UP MOTION BY M DATA 40 - 49."

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① Ver.2.3 or later

This parameter is not used at present.

However, in the case of a special robot, this parameter may be used as a low-pass filter for CPC operation. In this case, specify a desired low-pass filter value in %. When a low-pass filter is specified, the robot speed at the next position is created from the speed at the previous position and the current position, by the following formula.

Output speed = (Speed at previous position × Low-pass filter value + Speed at current position × (1−Low-pass filter value)

When the low-pass filter is set to 90%, the following formula is applied.

Output speed = (Speed at previous position × 0.9) + (Speed at current position × (1-0.9))

As the above formula shows, the low-pass filter smoothes steep changes in robot speed between positions. When it is set to 0%, the robot operates as originally specified. When it is given some value, it prevents steep speed changes with reference to the speed at the previous position. The low-pass filter is effective in controlling vibrations when a rapid and acute operation is required as in the case of an application process.

When you use the low-pass filter, set it to 50% to begin with, and then increase or decrease the value so as to reduce vibrations.

② Ver.2.2 or earlier

This parameter sets the count of internal processing loops to be executed.

During CPC operation, 50 internal processing loops are executed before an acceleration is applied for a specified robot speed. However, when a distance to travel is short, it is possible that as much as 50 loops cannot be executed and a specified speed may not be attained. In such a case, reduce the count of internal processing loops so that a specified speed can be attained.

(3) 「CPC SP1」

- Number of digits: 3
- Setting range: 0 or 50 to 200
- Standard value: 0

This parameter (follow-up gain) determines the smoothness of CPC operation, and works on the X axis.

Under normal conditions, the robot performs CPC operation while referring to the internal default value. However, when an extreme inertial load is applied to a robot or a special robot is used, there are cases where vibrations occur or follow-up accuracy is deteriorated. In such cases, improve the situation by setting this parameter. When this parameter is used,「CPC SELECT」((1) of 18.2.3 "MAINTENANCE DATA") must be set together.

When this parameter is set to "0," the default value stored in the controller is used.

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The internal default value is 100, and set this parameter to a smaller value to reduce vibrations, and a lager value to improve follow-up accuracy.

When a value larger than 0 but smaller than 50 is given, it is regarded as 50. When a value larger than 200 is given, it is regarded as 200.

(4) 「CPC SP2」

- Number of digits: 3
- Setting range: 0 or 50 to 200
- Standard value: 0

This parameter (follow-up gain) determines the smoothness of CPC operation, and works on the Y axis.

Under normal conditions, the robot performs CPC operation while referring to the internal default value. However, when an extreme inertial load is applied to a robot or a special robot is used, there are cases where vibrations occur or follow-up accuracy is deteriorated. In such cases, improve the situation by setting this parameter. When this parameter is used,「CPC SELECT」((1) of 18.2.3 "MAINTENANCE DATA") must be set together.

When this parameter is set to "0," the default value stored in the controller is used.

The internal default value is 100, and set this parameter to a smaller value to reduce vibrations, and a lager value to improve follow-up accuracy.

When a value larger than 0 but smaller than 50 is given, it is regarded as 50. When a value larger than 200 is given, it is regarded as 200.

(5) 「A-CAL CHECK」

- Number of digits: 3
- Minimum unit: 1
- Standard value: 0

This parameter determines the type of A-CAL operation.

Data 0: Executes standard A-CAL by the sensors and the markers.

1: Gives a warning (displays "WARNING") when the origin of the robot is outside the prescribed area, but continues processing.

2: Ignores the error that occurs when the origin of the robot is outside the prescribed area.

8: Performs A-CAL on specified axes only. This is usable only when both the special absolute encoder motor and the incremental encoder type motor are mounted.

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16: Compares the position with the ZERO signal position stored in the sensor. (Z axis only, special robot)

32: Used for special robot only.

64: Regards the current position as the origin of the robot without operating any axis.

128: Stores the ZERO signal position in the sensor. (For ZERO signal adjustment, Z axis only, special robot)

256: Used when two turns of W-axis operating range are used. (Special robot)

(6) 「POS ERROR SEL」

- Number of digits: 3
- Minimum unit: 1
- Standard value: 0

This parameter determines whether the positioning error[i] should be detected or only a warning should be given without error detection.

Data 0: Detects positioning errors.

1: Does not detect positioning errors. (Displays "WARNING.")

(7) 「AB SLOWDOWN TIM.」

CAUTION

Set this parameter only when you are instructed to do so.

- Number of digits: 3
- Minimum unit: 1
- Standard value: 0

① Ver.2.3 or later

This parameter sets the slowdown time for the A, B, and W axes. Its setting range is 0 to 999 msec. When "0" is given, the slowdown time is controlled automatically.

The slowdown time cannot be shorter than the shortest acceleration time of the robot even if a shorter slowdown time is given to this parameter.

② Ver.2.2 or earlier

This parameter is used to control the DD axis of a DD robot only by the original counter (not by the internal counter). Under normal conditions, set this parameter to "0.

(8) 「SERVO TYPE」

- Number of digits: 3
- Minimum unit: 1
- Standard value: 0

[i] This error occurs when positioning cannot be completed because of hunting or external pressure.

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This parameter sets the type of servo driver to be used.

Data 0: HPC-346F or later (Servo driver made by HIRATA Corporation)

1: HPC-346 or earlier, or supplies like AC servo

2: HNC-701 (Four-axis servo driver by HIRATA Corporation)

(9) 「EMP SELECT」(Encoder Monitor Program SELECT)

- Number of digits: 3
- Minimum unit: 1
- Standard value: 512

This parameter determines whether the "DRIVER ERROR" and the servo error should be detected or not.

Data 0: Does not perform a test of servo error detection on any axis.

1: Does not perform a test of servo error detection on the A (X) axis.

2: Does not perform a test of servo error detection on the B (Y) axis.

4: Does not perform a test of servo error detection on the Z axis.

8: Does not perform a test of servo error detection on the W axis.

15, 255: Does not detect servo errors. (Does not perform servo error detection on any axis.)

256: Releases the servo lock of the servo lock axis with a brake.

512: Detects "DRIVER ERROR."

When you wish to select "Does not perform a test of servo error detection" on multiple axes, add up the data for the applicable axes.

(10) 「HOLD POWER SAVE」

- Number of digits: 3
- Minimum unit: 1
- Standard value: 0

① Ver2.3 or later

This parameter sets the time interval for switching the HOLD to braking. (Special robot only) The setting range is 0 to 999 msec.

② Ver.2.2 or earlier

「EMP TRAP COUNT」(Encoder Monitor Program TRAP COUNT)

This parameter determines how many errors during PTP/CPC operation should invoke a servo error.

Data 0: 20 errors (Standard value)

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(11) 「Z SLOWDOWN TIM」

CAUTION

Set this parameter only when you are instructed to do so.

- Number of digits: 3
- Minimum unit: 1
- Standard value: 0

① Ver.2.3 or later

With this parameter, the slowdown time for the Z axis is manually set. Its setting range is 0 to 999 msec. When "0" is given, the slowdown time is controlled automatically.

The slowdown time cannot be shorter than the shortest acceleration time of the robot even if a shorter slowdown time is given to this parameter.

② Ver.2.2 or earlier

「EMP TRAP COUNT2」(Encoder Monitor Program TRAP COUNT2)

This parameter determines how many errors in the TEACH mode or during A-CAL should invoke a servo error.

Data 0: 10 errors (Standard value)

(12) 「STATION NO」

① Ver.2.3 or later

CAUTION

Set this parameter only when you are instructed to do so.

- Number of digits: 3
- Setting range: 0 to 999
- Minimum unit: 1
- Standard value: Robot number

This parameter is to be set when station number specification is required for communications. (Special robot only)

② Ver.2.2 or earlier

「EMP DELTA COUNT」

- Number of digits: 3
- Setting range: 0 to 999
- Minimum unit: 1
- Standard value: 0 (1 pulse)

This parameter determines how much pulse change (count of pulses) per unit time of the counter should invoke a servo error.

(13) 「SENSOR STOP SEL」(Sensor stop select)

- Number of digits: 3
- Minimum unit: 1
- Standard value: 0

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This parameter sets the sensor's signal input logic to be applied when W-axis sensor stop[i] is performed.

0: Positive logic

1: Negative logic

(14) 「SENSOR COUNT」

- Number of digits: 6
- Setting range: -90.000 to +90.000
- Minimum unit: 0.001
- Standard value: 0

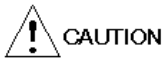
This parameter sets the sensor input detection width to be applied when W-axis sensor stop is performed.

When this offset value is set, the W axis will be positioned at the detecting point + offset value after W-axis detection, and then W-axis sensor stop will be completed.

When the offset is set to "0," the W axis will stay at the detecting point.

A positive offset value moves the W axis toward the limit, and a negative value moves it toward the origin.

(15) 「PTP Z IN DATA」 (PTP Z count)



Set this parameter only when you are instructed to do so.

- Number of digits: 3
- Minimum unit: 1
- Standard value: 0

This parameter determines the processing method of Z-axis acceleration/deceleration.

0: Internally increases the acceleration/deceleration value calculated based on travel distance, so as to shorten travel time.

1: Calculates an acceleration/deceleration value based on travel distance.

2: Calculates an acceleration/deceleration value so as to keep pace with the slowest axis when the A (X), B (X), and W axes are to operate simultaneously. When each axis is to operate independently, the axis' maximum acceleration/deceleration value is referred to, and the acceleration/deceleration value during operation is calculated according to the ACCEL value set by the System Parameter 「RESPONSE」→「ACCEL」group.

[i] Refer to Chapter 14 "W-AXIS SENSOR STOP."

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(16) 「POSITIONING CNT」(Positioning count)

- Number of digits: 3
- Minimum unit: 1
- Standard value: 0 (10 times)

The robot outputs the completion of positioning after it has performed positioning a specified number of times in a row within the range set in the System Parameter「RESPONSE」→「INP PULSE」 group. This parameter sets the number of positionings that the robot should perform in a row.

The robot has been adjusted by our Robotics Division before shipment to complete a positioning check within 0.1 msec. When the positioning check is completed, the robot has completed positioning with the accuracy mentioned on a catalog.

When you wish to let the robot perform positioning with a rougher accuracy, set this parameter to a smaller value. It will shorten the time required for the positioning check, and therefore shorten cycle time.

When the robot is to perform no operation just after the completion of positioning and to start operation after 0.1 msec or more has elapsed, you can set the count of positioning checks to one and shorten cycle time without deteriorating positioning accuracy, only when the HOLD processing is specified (positioning position is retained to increase accuracy). Under normal conditions, set this parameter within the range from 8 to 50.

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18.3 ORIGIN

The「ORIGIN」group sets mechanical characteristics of the robot. This data group must be set precisely, otherwise CPC operation will not be performed correctly, and accuracy of positioning based on coordinate data will be deteriorated.

This group also contains the data that determines the basic combination of robots and robot motion to be selected by a program.

18.3.1 SET-UP SYSTEM

(1) 「TRANSFER RATE」

- Standard value: 9600 [bps]

This parameter sets the data transfer rate of the RS-232C. (Text selection)

After changing this parameter, turn the power to the controller off and on again.

Select an applicable transfer rate out of the following.

・300　・600
・1200　・2400
・4800　・9600
Ver.2.4 or later
・19200　・38400

(2) 「ON-LINE SELECT」

- Number of digits: 1
- Minimum unit: 1
- Standard value: 0

Data　0: Standard
1: Unused
2: To be selected when the vision is used
4: Cancels the step-by-step speeding-up function[i] and let the robot operate at the specified speed from the beginning.

When you wish to use multiple functions at a time, add up the data of applicable functions. For example, to use the speeding-up function together with the vision, set this parameter to “6.” To let the robot operate at the specified speed from the beginning, set this parameter to “4.”

[i] Under standard settings, the robot operates at a lower speed from the start point to the third point. (First point: 20%, second point: 40%, third point: 60%, forth point: 100%)

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(3) 「STOP SELECT」SELECT (Ver 2.2 or earlier:「INTERLOCK SEL」)

- Standard value: STATUS

This parameter sets the signal detection method for the STOP signal (IN5). (Text selection)

Data STATUS: Detects the signal by its status.

RISING: Detects only the rising edge of the signal.

CAUTION

When you select "RISING," be sure to select "STOP" for the 「STOP」 parameter in the following.

(4) 「STOP」(Ver 2.2 or earlier:「INTERLOCK」)

- Standard value: STOP

This parameter determines the function of the STOP signal (IN5). (Text selection)

Data STOP: Stops the robot if the STOP signal turns ON. After STOP signal (IN5) OFF, the robot will restart upon input of the START or NEXT signal.

PAUSE: Stops the robot temporarily while the STOP signal (IN5) is ON.

(5) 「STORE ADDRESS」

- Standard value: NEXT

This parameter determines the restoration address to be selected in the event of power shutdown. (Text selection)

This parameter is enabled in the AUTO mode (automatic operation). In the event that the power is shut down halfway through an operation because of a power failure, this parameter selects either the position at the time of power-down or the next address as a destination address after restoration.

Data NEXT: Selects the next address.

CURR: Selects the address at the time of power-down.

(6) 「I/O ASSIGNMENT」

- Number of digits: 1
- Minimum unit: 1
- Standard value: 0

This parameter determines whether DI/DO's should be used for standard I/O or defined I/O. After changing this parameter, turn the power off and on again.

The functions of data 1, 2, 4, and 8 must be used independently. Also, the functions of data 16 and 32 must be used independently. However, data 16 and any of data 1, 2, 4, and 8, or data 32 and any of data 1, 2, 4, and 8 can be used simultaneously.

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When you wish to use the functions simultaneously, add up the data of applicable functions.

Example

When you use the functions of data 2 and data 16, set this parameter to "18."

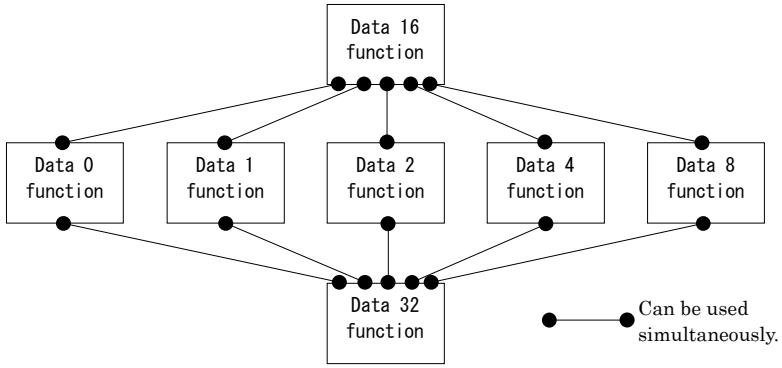


Fig. 18. 3

Data 0: Uses the BP AREA signal (OUT4) for pass PTP output[i].

1: When the ON-LINE mode is selected, uses all of OUT0 - OUT15 in the same manner as in the AUTO mode (for MOUT output).

2: Performs area output on the A (X) and B (Y) axes in any operation mode. The BP AREA signal (OUT4) turns ON[ii] when the A (X) and B (Y) axes satisfy the conditions set in the values in the System Parameter「SET-UP」→「EXPANSION A」→「AREA OUT AX」,「AREA OUT BY」

4: Performs base position output in the AUTO mode. The BP AREA signal (OUT4) turns ON when all of the A (X), B (Y), Z, and W axes are positioned in proximity[iii] to any of addresses in the System Parameter「SET -UP」→「EXPANSION A」→「Base Pos Addr 1」 to「Base Pos Addr 4」

CAUTION

When you do not use all of the four base positions, e.g. when you use only「Base Pos Addr 1」 and「Base Pos Addr 2,」 give the same address number as one of the two base positions' to「Base Pos Addr 3」 and「Base Pos Addr 4」 as well. If an unused base position (Base Pos Addr *) is set to "0," address 0 will be selected as a base position.

[i] Refer to 16.2.3 "Output Signals during Pass PTP Operation."

[ii] For details on the output conditions, refer to (3) AREA OUT AX and (4) AREA OUT BY in 19.4.2 "EXPANSION B."

[iii] For details, refer to (6) Base Pos Pulse in 19.4.1 "EXPANSION A."

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Example

When you wish to let the BP AREA signal (OUT4) turn ON when the robot is positioned in proximity to address 10 or 20

Base Pos Addr1 : 10
Base Pos Addr2 : 20
Base Pos Addr3 : 20
Base Pos Addr4 : 20

Ver.2.36 or later

Data 8: Assigns specified base positions to respective axes. The signal output is performed in any operation mode.
The base positions set in the values in the System Parameter 「SET -UP」→「EXPANSION A」→「Base Pos Addr 1」 to 「Base Pos Addr 4」 are assigned to the A (X), B (Y), Z, and W axes, respectively.
When all of the four axes are positioned in proximity[i] to their respective base positions, the BP AREA signal (OUT4) turns ON. For the axis that requires no base position specification, set an applicable base position (「Base Pos Addr *」) to "999.

Example

When you wish to let the BP AREA signal (OUT4) turn ON when the B (Y) axis is positioned within ±2000 pulses from address 10 (The other axes may be at any position.)

Base Pos Addr1 : 999
Base Pos Addr2 : 10
Base Pos Addr3 : 999
Base Pos Addr4 : 999
「SET-UP」→「EXPANSION A」→「Base Pos Pulse」 : 2000

Ver.2.38 or later

Data 16 : Stores and outputs the M data of the last position in the AUTO mode.
When positioning is completed normally in the AUTO mode, the robot stores the M data of the last address as well as the address number. Please note that the M data is not stored if the robot is stopped by SELECT signal (IN0) OFF or STOP signal (IN5) ON.
When the power is turned off and on again or the operation mode is switched, after the completion of positioning, the stored M data (OUT8 - OUT15) will be outputted if the position data of the robot is in proximity[ii] to that of the last position.
This M-data output function makes it possible to resume an operation even if the power is shut down or the mode is switched for some reason after the completion of positioning.

[i] For details, refer to (6) Base Pos Pulse in 19.4.1 EXPANSION A.
[ii] For details, refer to (6) Base Pos Pulse in 19.4.1 EXPANSION A.

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Data 32: When the AUTO mode is selected and the position of the robot at the time of SELECT signal (IN0) ON is in proximity to one of the specified position addresses, outputs the M data (OUT8 - OUT16) of the applicable address. The BP AREA signal (OUT4) does not turn ON this time.
10 position addresses can be specified for this function, and addresses 980 - 989 have been assigned. Give each position address the M data to be outputted and the S code to be used as a coefficient in the calculation of the pulse count that represents a proximity area.
Give M data 0 to the addresses that are not used.
The pulse count that represents a proximity area is obtained by the following formula.

Pulse count = 200 × (S code + 1)

All the axes used must be in the area established by the above pulse count.

Example

Example)

For example, set this parameter to "32," and specify five position addresses (addresses 980 - 984) for standby points in the event of restoration.
If automatic operation is interrupted by power shutdown or some reason, move the robot to a standby point convenient for restoration.
If you then switch the mode to AUTO and turn ON the SELECT signal (IN0), the M data (MOUT8 - MOUT16) of the current standby position will be outputted, and the external control device will be able to determine the next operation based on this data.
The following is an example of teaching when five position addresses (addresses 980 - 984) are used for standby points in the event of restoration.

Table 18. 2

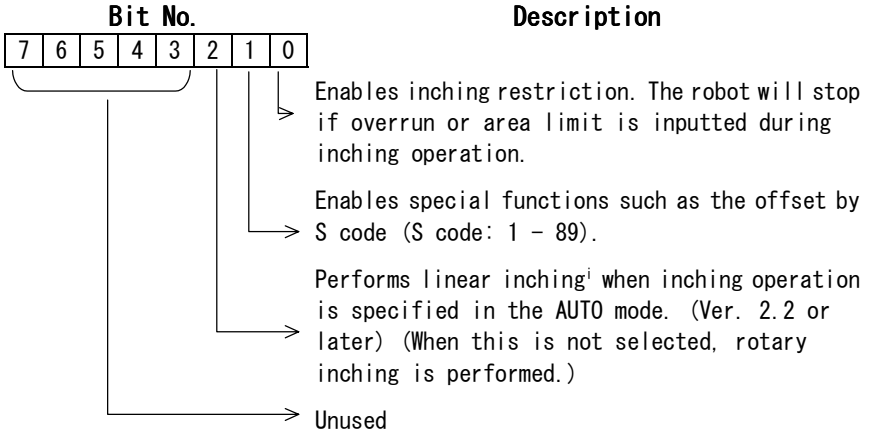
Address	M data	S code	Description
980	90	3	M data 90 will be outputted when all of the four axes are within 800 pulses.
981	91	2	M data 91 will be outputted when all of the four axes are within 600 pulses.
982	92	1	M data 92 will be outputted when all of the four axes are within 400 pulses.
983	93	1	M data 93 will be outputted when all of the four axes are within 400 pulses.
984	94	3	M data 94 will be outputted when all of the four axes are within 800 pulses.
985	0	3	No M data output
986	0	3	No M data output
987	0	3	No M data output
988	0	3	No M data output
989	0	3	No M data output

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(7) 「INCHING SELECT」

- Number of digits: 1
- Minimum unit: 1
- Standard value: 0

This parameter determines the type of inching operation. The function shown below becomes effective if an applicable bit of the data is turned ON.



(8) 「M DATA」

- Number of digits: 2
- Setting range: 0 to 99
- Minimum unit: 1
- Standard value: 0

This parameter determines the usage of the M data contained in robot position data. For details, refer to 16.5.3 "Changes in M data and S code Functions Depending on System Generation setting."

Data 0 - 7: Specifies the type of robot motion by the M data in position data.

8: Specifies the type of robot motion not by the M data, but by the S code only.

(9) 「AUTO/ON-LINE」

- Standard value: ON-LINE

This parameter determines whether the AUTO mode or the ON-LINE mode is selected when the mode is switched to ON-LINE. (Text selection)

Data ON-LINE: Selects the ON-LINE mode.

AUTO: Selects the AUTO mode.

[i] While normal inching is performed independently on each axis, linear inching is performed based on X-Y coordinates. Refer to 5.2.1 "Operating X-Y coordinates in LI-TEACH mode."

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(10) 「EMERGERCY STOP」

- Standard value: KEEP

This parameter determines whether A-CAL is retained or reset in the event of an Emergency Stop. (Text selection)

Data KEEP: Retains A-CAL.
RESET: Resets A-CAL.

18.3.2 AXIS DIRECTION

(1) 「A-CAL SEQ」

① When the CPU board HPC-740 or HPC-747 is used

- Number of digits: 8
- Minimum value: 00001111
- Standard value: 00002212

This parameter specifies the sequence of axes used when A-CAL is performed. Each digit corresponds to an axis as shown below. When A-CAL is to be performed twice, specify the sequence for the second A-CAL in the shaded area.

0 0 0 0 0 0 0 0
↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓
A B Z W A B Z W

When you wish to perform A-CAL on multiple axes simultaneously, specify the same number for them.

② When the CPU board HPC-700 is used

- Number of digits: 4
- Minimum value: 1111
- Standard value: 2212

This parameter specifies the sequence of axes used when A-CAL is performed. Each digit corresponds to an axis as shown below.

0 0 0 0
↓ ↓ ↓ ↓
A B Z W

When you wish to perform A-CAL on multiple axes simultaneously, specify the same number for them.

(2) 「A-CAL DIR.A」 (A-CAL direction A (X))

(3) 「A-CAL DIR.B」 (A-CAL direction B (Y))

(4) 「A-CAL DIR.Z」 (A-CAL direction Z)

(5) 「A-CAL DIR.W」 (A-CAL direction W)

- Standard value: PLUS

These parameters determine the direction of A-CAL. (Text selection)

Data PLUS: Normal direction
MINUS: Reverse direction

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CAUTION

Be sure to keep a record of this data just after the installation of the robot, as this parameter must be reset after the defaults of the System Data are restored. (Refer to Chapter 20 "INITIALIZING SYSTEM DATA.")

(6) 「INCH DIR.A」 (Inching direction A (X))

(7) 「INCH DIR.B」 (Inching direction B (Y))

(8) 「INCH DIR.Z」 (Inching direction Z)

(9) 「INCH DIR.W」 (Inching direction W)

- Standard value: PLUS

These parameters determine the direction of inching operation. (Text selection)

Data PLUS: Normal direction

MINUS: Reverse direction

18.3.3 AXIS SELECT

(1) 「A AXIS TYPE」 (A (X)-axis type)

(2) 「B AXIS TYPE」 (B (Y)-axis type)

(3) 「Z AXIS TYPE」 Z-axis type

(4) 「W AXIS TYPE」 W-axis type

- Standard value: USED

These parameters determine whether the applicable axis is used or not. (Text selection)

Data NOT USED: Disables the applicable axis.

USED: Enables the applicable axis.

CAUTION

Be sure to keep a record of this data just after the installation of the robot, as these parameters must be reset after the defaults of the System Data are restored. (Refer to Chapter 20 "INITIALIZING SYSTEM DATA.")

(5) 「A AXIS SEL」 (A (X)-axis selection)

(6) 「B AXIS SEL」 (B (Y)-axis selection)

(7) 「Z AXIS SEL」 (Z-axis selection)

(8) 「W AXIS SEL」 (Z-axis selection)

- Standard value: NOT HOLD

These parameters determine whether or not the applicable axis should be kept on HOLD all the time. (Text selection)

Data NOT HOLD: Normal

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HOLD: Keeps the applicable axis on HOLD all the time.

In the TEACH or CHECK mode, specification by the HOLD function[i] takes precedence even if "HOLD" is selected here.

CAUTION

Be sure to keep a record of this data just after the installation of the robot, as these parameters must be reset after the defaults of the System Data are restored. (Refer to Chapter 20 "INITIALIZING SYSTEM DATA.")

[i] For details, refer to Chapter 10 "HOLD FUNCTION."

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18.4 ADJUST

This group sets the mechanical data of the robot.

18.4.1 AR TYPE ADJUST

The parameters in this group shall be set only when an SCARA (horizontal multi-articulated type) robot is used.

DANGER

NEVER change these parameters when a rectangular robot is used.
When you have changed them by mistake, be sure to reset them to their original values.

(1) 「INITIAL A」

CAUTION

Set this parameter only when you are instructed to do so.

- Number of digits: 7
- Minimum unit: 0.001
- Standard value: 110º

This parameter sets the A-CAL reference position of the A axis.

When the A axis of the robot is positioned as shown below at the time of A-CAL, the position obtained by rotating the A axis in the direction of ① by the angle set in「INITIAL A」indicates the plus direction of the Y axis. The position obtained by rotating the A axis 90º in the direction of ② indicates the plus direction of the X axis.

The robot's operation area is comprised of the range of「INITIAL A」in the direction of ① and the range of「INITIAL A」in the direction of ③. Therefore, be aware that, if you set「INITIAL A」to a smaller value to reduce the operation area in the +X direction, the operation area in the -X direction will be reduced accordingly.

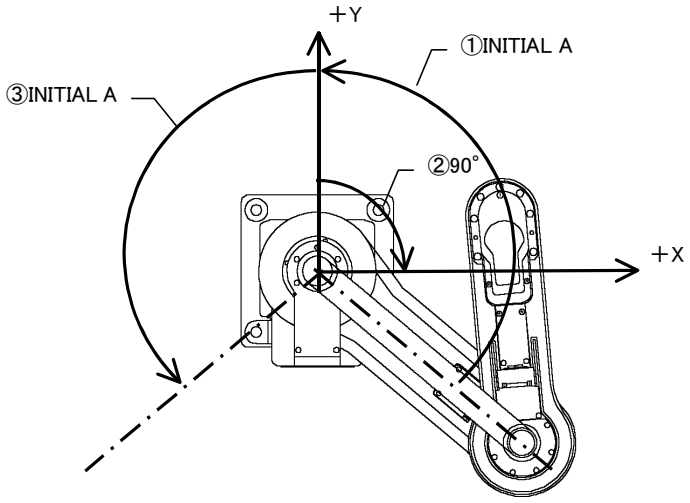


Fig. 18. 4 INITIL A

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(2) 「INITIAL B1」(Initial angle B1)

(3) 「INITIAL B2」(Initial angle B2)

- Number of digits: 7
- Minimum unit: 0.001
- Standard value: 90°

These parameters set the angle that the B axis forms with the A-axis arm at the time of A-CAL. A standard robot has been adjusted by our Robotics Division before shipment to perform A-CAL as shown in Figure 18.6: INITIAL B2. However, as the data for 「INITIAL B1」 has also been provided, you can reverse A-CAL direction[i] without changing the data.

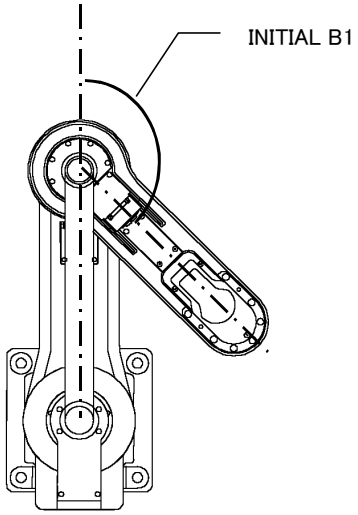


Fig. 18. 5 INITIAL B1

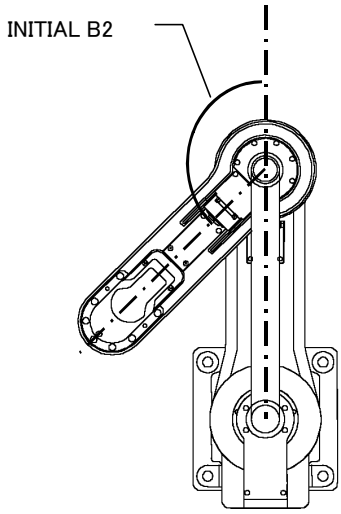


Fig. 18. 6 INITIAL B2

The SCARA (horizontal multi-articulated type) robot internally converts the amount of rotation (encoder pulse counts) of the A and B axes from the A-CAL position (the origin of the machine and control system) into X-Y coordinate data, and use it for display and input.

Therefore, if these parameters are not set precisely, rectangularity of the arms in the X-Y coordinate system (accuracy of coordinate data during arm operation in the LI-TEACH mode and automatic CPC operation) and accuracy of X- and Y-position data will be deteriorated.

The A-CAL position differs depending on the robot as it is set by the signals from the proximity sensors and the encoders.

After you have adjusted or replaced the ORIGIN sensor or encoder of the B axis, or have changed the A-CAL position of the B axis, be sure to correct this initial angle data. The initial angle to be entered can by obtained by automatic calculation (12.1.1 “ROBOT (AR-TYPE)”) or actual measurement.

[i] For details, refer to 3.7 “Setting A-CAL Direction.”

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The following explains the procedure of the actual measurement.

① Switch the Teach Pendant to the TEACH mode.

② Switch the displayed coordinate system to counter data (pulse data).

1. Press the FUNC/HIGH + local/F keys of the Teach Pendant.
2. Press a key between s.ed/4 - key/9 to select counter data display.
3. Press the READ key to switch the displayed coordinate system.

③ Perform A-CAL according to 3.5 “A-CAL Procedure.” The direction of operation at the time of this A-CAL determines whether「INITIAL B1」or「INITIAL B2」is taken as the initial angle. 「INITIAL B2」is taken in the following example.。

④ Select point P1 where the robot can reach in whichever direction (right or left) its arm is bent.

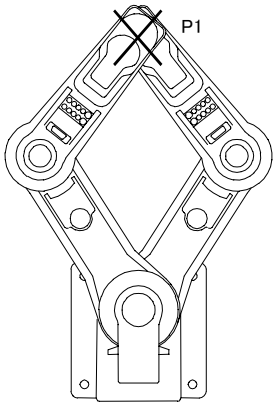


Fig. 18. 7

⑤ Move the end of the arm to P1 bending the arm to the right. Then read the pulse count of the B axis. (81000 is taken in the following example.)

⑥ Move the end of the arm to P1 bending the arm to the left. Then read the pulse count of the B axis. (82153 is taken in the following example.)

⑦ The average of the pulse counts obtained by steps ⑤ and ⑥ is the measured pulse count. Substitute it into the following formula to obtain an initial angle value.
In the following example, the B-axis encoder pulse count is 1000 and the B-axis speed reduction ratio is 50.

Initial angle＝Measured pulse count

$$\times \frac{360}{4 \times \text{B-axis encoder pulse} \times \text{B-axis reduction ratio}}$$

$$= \frac{81000 + 82153}{2} \times \frac{360}{4 \times 1000 \times 50}$$

$$= 146.8377(\text{degree})$$

⑧ Set「INITIAL B2」to “146.84.”

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(4) 「LENGTH A」

(5) 「LENGTH B」

- Number of digits: 7
- Setting range: 0 to 9999.99
- Minimum unit: 0.001
- Standard value: 270º

These parameters set the lengths of the A and B axes.

These parameters are used only by the SCARA (horizontal multi-articulated type) robot.

The SCARA (horizontal multi-articulated type) robot converts the amount of rotation (pulse counts) of the A and B axes into X-Y coordinates, and calculates the coordinates of the robot based on the arm lengths set here. Therefore, if the initial angle and the arm lengths are not set precisely, accuracy of linear arm operations (arm operation in the LI-TEACH mode and automatic CPC operation) will be deteriorated.

Although the primary arm length is fixed according to the model of the robot, the secondary arm length varies depending on the design of each edge tool.

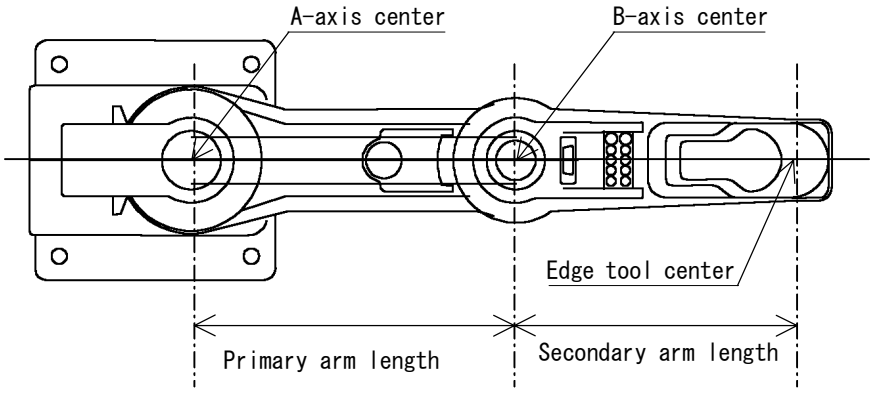


Fig. 18. 8

The arm length can also be obtained by automatic calculation (12.1.1 “ROBOT (AR-TYPE)”).

CAUTION

Be sure to keep a record of this data just after the installation of the robot, as these parameters must be reset after the defaults of the System Data are restored. (Refer to Chapter 20 “INITIALIZING SYSTEM DATA.”)

(6) 「AR COMBINATION」

This parameter is not used.

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18.4.2 MB TYPE ADJUST

The parameters in this group shall be set when a rectangular coordinate system robot is used.

DANGER

NEVER change these parameters when a rectangular robot is used.
When you have changed them by mistake, be sure to reset them to their original values.

(1) 「Y INITIAL ANGLE」

- Number of digits: 7
- Setting range: 0 to 9999.99
- Minimum unit: 0.01

This parameter sets the setting angle (deg) of the Y-axis table against the X axis.

Although the table is set square to the X axis in principle, there may be slight variations in the position, which deteriorate the accuracy of coordinate-based operations and linear operations. This parameter sets a precise setting angle of the Y-axis table to compensate for such variations.

The setting angle of the Y-axis table (Y INITIAL ANGLE) to be entered can by obtained by automatic calculation (12.1.2 “ROBOT (MB-TYPE)”) or actual measurement.

The following explains the procedure of the actual measurement.

① Set reference point P1 in proximity to both the X-axis origin and the Y-axis origin. Its X-Y coordinates are X1 and Y1.

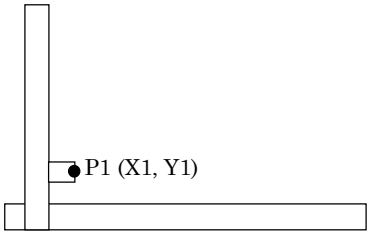


Fig. 18. 9

② Select the RO-TEACH mode, and move only the X axis in a plus direction as far from P1 as possible. This point is P2, and its X-Y coordinates are X2 and Y2.

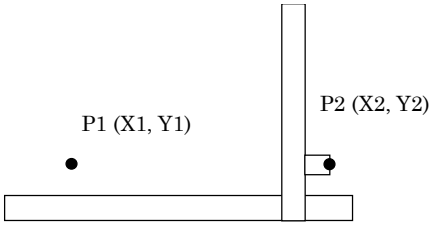


Fig. 18. 10

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③ Return the table to reference point P1. Then move only the Y axis in a plus direction as far as possible. This point is P3, and its X and Y coordinates are X3 and Y3.

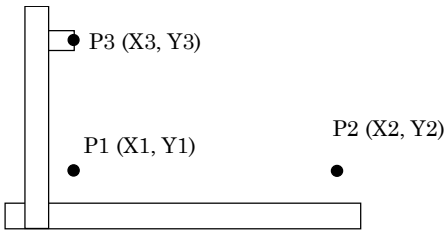


Fig. 18. 11

④ Obtain the distances between these three points.

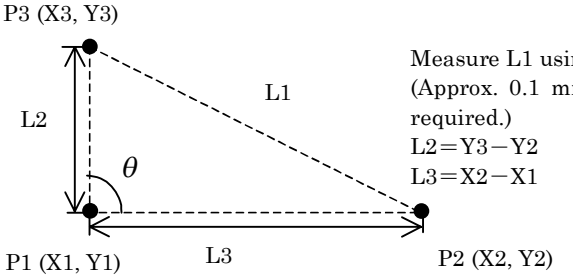


Fig. 18. 12

⑤ Obtain the value of θ by the following formula.

$$\theta = \cos^{-1} \frac{L3^2 + L2^2 - L1^2}{2 \times L3 \times L2}$$

⑥ Enter the obtained value (θ) up to the second decimal place.
The value to be entered should fall within the range of 85.00 - 95.00.
When “90.01(deg)” is entered, 0.017 mm of compensation will be given per 100 mm.

(2) 「MB COMBINATION」

CAUTION

Set these parameters only when you are instructed to do so.

This parameter sets the combination of the axes of the rectangular coordinate system robot.

① Ver.2.38 or later
The CPU board of the controller has ports for four axes.
Assignment of an axis to each port is specified by either a one-digit value or a value of two or more digits. Details of the axis assignment are described below.

- When assignment is specified by a one-digit value
  The value ranges from 0 to 9, and each value selects the combination of axes as shown below.

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Table 18. 3

Value	Primary port	Secondary port	Tertiary port	Quartic port
0	A(X)	B(Y)	Z	W
1	A(X)	None	None	None
2	A(X)	Z	None	None
3	A(X)	W	None	None
4	Z	None	None	None
5	B(Y)	A(X)	Z	W
6	B(Y)	Z	None	None
7	A(X)	B(Y)	W	None
8	A(X)	Z	W	None
9	Z	W	None	None

- When assignment is specified by a value of two or more digits
  When a value of two or more digits is given, it is regarded as a four-digit value. An axis is assigned to each place of the value as shown below.

Thousand's place	Hundred's place	Ten's place	One's place
A(X)	B(Y)	Z	W

The value in each place represents the port to be selected. When an axis is not used, we recommend that you specify "0" or "9" for it for easy recognition.

Table 18. 4

Value	Description	Value	Description
0	Unused axis	5	Unused axis
1	Primary port	6	Unused axis
2	Secondary port	7	Unused axis
3	Tertiary port	8	Unused axis
4	Quartic ort	9	Unused axis

The following table shows examples of setting.

Table 18. 5

Example	Axis	Selected port
When MB COMBINATION is set to 3124	A(X)	Tertiary port
	B(Y)	Primary port
	Z	Secondary port
	W	Quartic port
When MB COMBINATION is set to 1929 (1020) (Equal to MB COMBINATION = 2)	A(X)	Primary port
	B(Y)	Unused axis
	Z	Secondary port
	W	Unused axis
When MB COMBINATION is set to 9991	A(X)	Unused axis
	B(Y)	Unused axis
	Z	Unused axis
	W	Primary port

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② Ver.2.30 or earlier

- Setting range: 1 to 4

The following table shows the combinations of axes available.

Table 18. 6 List of combinations

Value	Combination
1	X and Y axes
2	X axis only
3	X and Z axes
4	X and W axes

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18.5 CAPABILITY

The parameters in this group are used to confirm the specifications of the robot or check the data stored in the robot.

18.5.1 ROBOT CAPABILITY

The following parameters show the settings of the encoders. It is not possible to change their data.

(1) 「ENC.PULSE A」 (Encoder pulse A (X))

(2) 「ENC.PULSE B」 (Encoder pulse B (Y))

(3) 「ENC.PULSE Z」 (Encoder pulse Z)

(4) 「ENC.PULSE W」 (Encoder pulse W)

- Number of digits: 7
- Minimum unit: 1

These parameters show the encoder pulse counts of respective axes.

(5) 「LEAD/GEAR A」 (Lead/gear A (X))

(6) 「LEAD/GEAR B」 (Lead/gear B (Y))

(7) 「LEAD/GEAR Z」 Lead/gear Z

(8) 「LEAD/GEAR W」 Lead/gear W

- Number of digits: 6
- Minimum unit: 0.001

These parameters show the lead or gear ratios of respective axes.

(9) 「MOTOR REV. A」(Maximum motor speed A (X))

(10) 「MOTOR REV. B」(Maximum motor speed B (Y))

(11) 「MOTOR REV. Z」(Maximum motor speed Z)

(12) 「MOTOR REV. W」(Maximum motor speed W)

- Number of digits: 4
- Minimum unit: 1

These parameters show the maximum motor speeds of respective axes.

18.5.2 EXPANSION A

The「EXPANSION A」group contains the System Data for expansion.

All the parameters in this group are used when new functions are added in the future. Set all of them to “0” unless otherwise specified by HIRATA Corporation.

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(1) 「EXPANSION 0」

(2) 「EXPANSION 1」

(3) 「EXPANSION 2」

(4) 「EXPANSION 3」

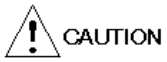
These parameters are not used at present.

(5) 「D/A REF OFFSET 1」(Reference offset for D/A converter of X axis)

(6) 「D/A REF OFFSET 2」(Reference offset for D/A converter of Y axis)

(7) 「D/A REF OFFSET 3」(Reference offset for D/A converter of Z axis)

(8) 「D/A REF OFFSET 4」(Reference offset for D/A converter of W axis)



Set these parameters only when you are instructed to do so.

- Number of digits: 4
- Setting range: -999 to 999
- Minimum unit: 1
- Standard value: 0

These parameters shall be set only when CPU board HPC-747 is used.

The HPC-747 converts speed commands in digital form into analog voltages. Because slight variations in voltage can occur during the conversion, there are cases where the halt condition of the robot (0V) is not correctly set. These parameters are to compensate for such variations.

These parameters are set to "0" under normal conditions. The offset value to be entered is obtained when the motor stops (the counter readout on the Teach Pendant monitor does not change) in the servo offset adjustment mode. For details, refer to Chapter 20 "SERVO OFFSET ADJUSTMENT."

(9) 「CPC INTEG GAIN」

This parameter is not used at present.

(10) 「FV TIME 0」(Sampling time for X (A) and Y (B) axes)

(11) 「FV TIME 1」(Sampling time for Z axis)

(12) 「FV TIME 2」(Sampling time for W axis)



Set these parameters only when you are instructed to do so.

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- Number of digits: 7
- Setting range: 0.50 to 2.00
- Minimum unit: 0.01 (msec)

These parameters set the sampling times for speed feedback.

If a value exceeding the setting range is given, it is regarded as 0.50 msec.

These parameters are used when the servo driver made by our Robotics Division is used.

When an axis of the robot is to be operated, the servo driver operates the motor of the axis according to speed commands given, and it in return receives the feedback on the operating state of the motor (amount of revolution (pulse count) during period of time) all the time. This feedback is speed feedback, and the servo driver uses this information to calculate actual speed and to control motor speed.

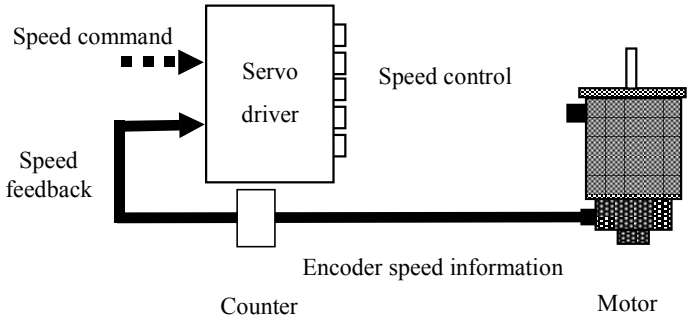


Fig. 18. 13

The above-mentioned parameters set the sampling times for sampling motor speeds of respective axes.

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CHAPTER 19 DETAILS OF SYSTEM PARAMETER

19.1 MOTION

This group sets the operating conditions (motion) of the robot.

19.1.1 MOTION

(1) 「PULL-UP」

- Number of digits: 7
- Setting range: 5 to the maximum operation area of Z axis
- Minimum unit: 0.001
- Standard value: 10

「PULL-UP」 operates the Z axis automatically during PTP operation.

When the robot is to move by PTP between two points that are located lower than the point specified by this parameter, the robot will not move horizontally from the beginning. The Z axis will move up first to the point specified by this parameter (auto PULL-UP function), then the other axes will move horizontally and the Z axis will move down. To set this parameter, specify the distance from the Z-axis origin to the point where the robot should start horizontal movement, in mm.

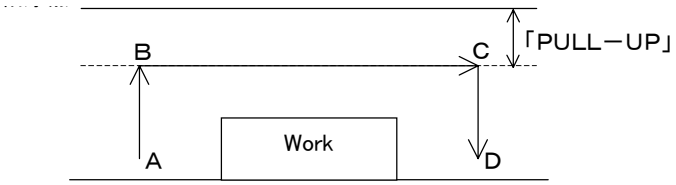


Fig.19. 1 PULL-UP motion

In the above example, the robot will interfere with the work if it moves directly from point A to point D. If「PULL-UP」is set as appropriate, the robot will move from point A to point B by moving up the Z axis, move horizontally to point C, and then stop at D.

If the two points given for PTP operation have the same X-Y coordinates but different Z coordinates, the robot will not make a PULL-UP motion.

CAUTION

If the value for the moving distance to the horizontal direction from point B to C is less than 1mm, PULL-UP motion is not performed

「PULL-UP」must be given a value that will not turn ON the ORIGIN sensor if a PULL-UP motion is made.

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(2) 「ARCH UP」

- Number of digits: 7
- Setting range: 0 to the maximum operation area of Z axis
- Minimum unit: 0.001
- Standard value: 0

When the auto PULL-UP function is selected in the PTP operation, the robot starts horizontal movement after the Z axis has moved up, and the Z axis moves down after the horizontal movement has been completed. This function is provided to prevent the robot from interfering with a work or anything during horizontal movement.

「ARCH UP」 lets the robot start a horizontal movement while the Z axis is still moving up by PULL-UP motion. Although it is effective in shortening cycle time, be very careful in setting this parameter because an improper value can cause the robot to interfere with a work.

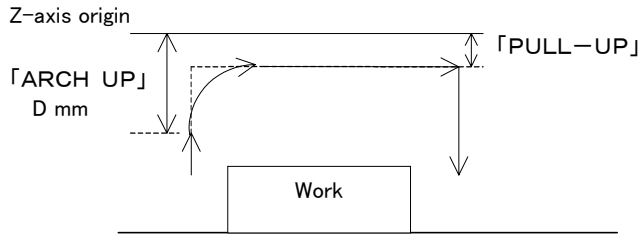


Fig. 19. 2 ARCH UP

To set 「ARCH UP」, specify the distance from the Z-axis origin. When setting 「ARCH UP」, check by how many millimeters the ARCH UP start point is lower than the PULL-UP point. In the above example, because the distance at which the robot will not interfere with the work even if it starts horizontal movement is D, enter distance D (mm) in 「ARCH UP」.

(3) 「ARCH DOWN」

- Number of digits: 7
- Setting range: 0 to the maximum operation area of Z axis
- Minimum unit: 0.001
- Standard value: 0

When the auto PULL-UP function is selected in the PTP operation, the robot starts horizontal movement after the Z axis has moved up, and the Z axis moves down after the horizontal movement has been completed. This function is provided to prevent the robot from interfering with a work or anything during horizontal movement.

「ARCH DOWN」 lets the Z axis starts moving down while the other axes are still moving horizontally by PULL-UP motion. Although it is effective in shortening cycle time, be very careful in setting this parameter because an improper value can cause the robot to interfere with a work.

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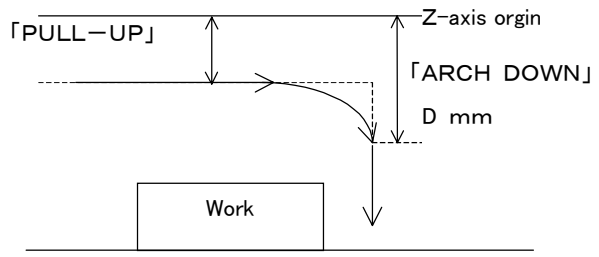


Fig. 19. 3 ARCH DOWN

To set「ARCH DOWN」, specify the distance from the Z-axis origin. When setting「ARCH DOWN」, check by how many millimeters the ARCH DOWN end point is lower than the PULL-UP point. In the above example, because the distance at which the robot will not interfere with the work even if the Z axis starts moving down is D, enter distance D (mm) in「ARCH DOWN」.

(4) 「INS DIS.」

- Number of digits: 7
- Setting range: 0 to the maximum operation area of Z axis
- Minimum unit: 0.001
- Standard value: 20

This parameter determines the area where PTP INSERTION motion is performed.

When the Z axis moves down, the robot slows down from the position obtained by subtracting the set value from the target position.

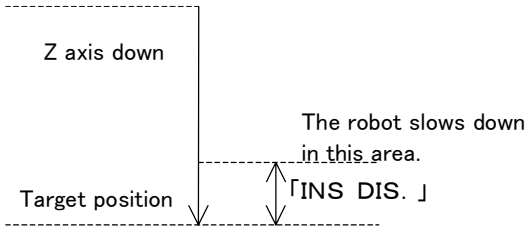


Fig. 19. 4 INS DIS.

(5) 「INS SPEED」(Insertion speed)

- Number of digits: 3
- Setting range: 0 to 99
- Minimum unit: 1
- Standard value: 20

This parameter determines the robot speed during PTP INSERTION motion. The maximum axis speed varies depending on the type of robot. 「INS SPEED」 shall be set on a scale of 0 (minimum speed) to 99 (maximum speed) with reference to the robot's maximum axis speed.

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The robot will travel the distance set in (4) above at the speed specified by this parameter. Area S2 in the figure shows「INS DIS.」(insertion distance).

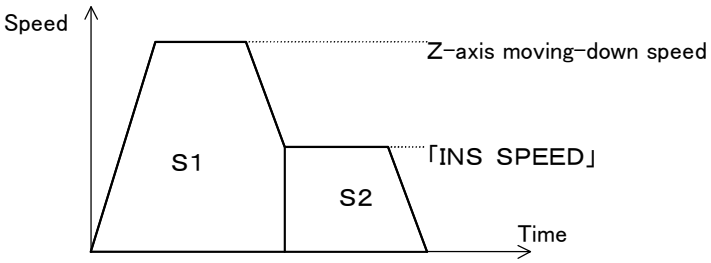


Fig. 19. 5 INS SPEED

NOTE

When the speed specified for the area before「INS DIS.」is smaller than「INS SPEED」, the smaller speed takes precedence over「INS SPEED」. For example, when an original Z-axis moving-down speed is 50 and「INS SPEED」is set to "100," the robot will not take the speed indicated by the dotted line, but the one indicated by the solid line. Area S2 in the figure shows「INS DIS.」(insertion distance).

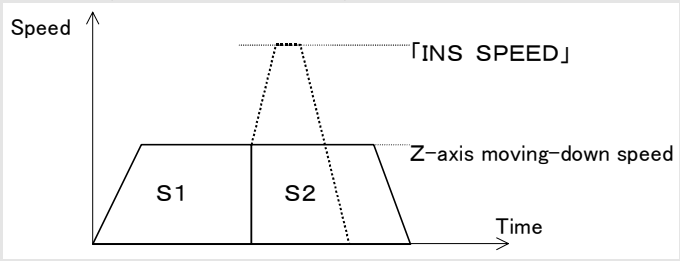


Fig. 19. 6 Note on「INS SPEED」

(6) 「UP DIS.」(Moving-up distance)

- Number of digits: 7
- Setting range: 0 to the maximum operation area of Z axis
- Minimum unit: 0.001
- Standard value: 20

This parameter determines the area where PTP SLOW-UP motion is performed.

To set this parameter, specify the distance for which the robot should travel at a low speed after the start of the Z axis' upward movement.

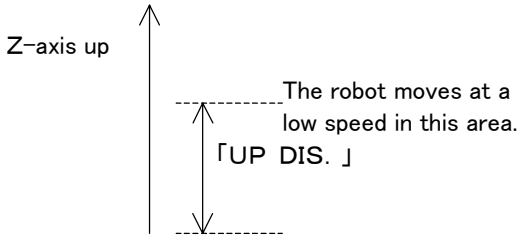


Fig. 19. 7 UP DIS.

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(7) 「UP SPEED」

- Number of digits: 3
- Setting range: 0 to 99
- Minimum unit: 1
- Standard value: 20

This parameter determines the robot speed during PTP SLOW-UP motion.

The robot will travel the distance set in (6) above at the speed specified by this parameter. Area S1 in the figure shows「UP DIS.」(moving-up distance).

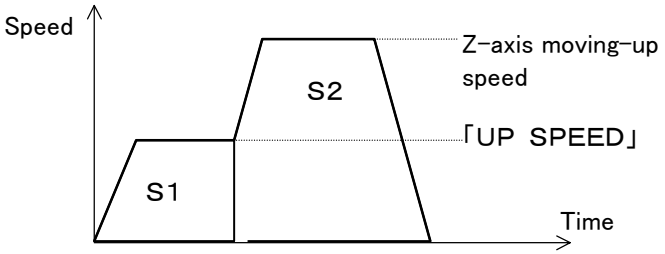


Fig. 19. 8 UP SPEED

NOTE

When the speed specified for the area after「UP DIS.」is smaller than「UP SPEED」, the smaller speed takes precedence over「UP SPEED」. For example, when an original Z-axis moving-up speed is 50 and「UP SPEED」is set to "100," the robot will not take the speed indicated by the dotted line, but the one indicated by the solid line. Area S1 in the figure shows「UP DIS.」(moving-up distance).

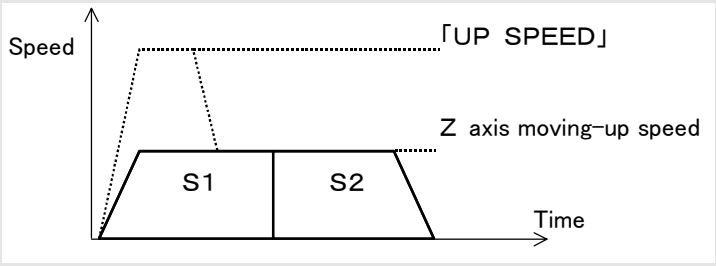


Fig. 19. 9 Note of「UP SPEED」

(8) 「Z NEXT PULL」

This parameter is not used at present.

19.1.2 AXIS SPEED

(1) 「SPEED A,B(X,Y)W」

(2) 「SPEED Z」

- Number of digits: 3
- Setting range: 0 or 1 to 100

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- Minimum unit: 1
- Standard value: 100

These parameters determine the speed of respective axes during automatic operations except CPC operation. The maximum axis speed varies depending on the type of robot. These parameters shall be set on a scale of 1 (minimum speed) to 100 (maximum speed) with reference to the robot's maximum axis speed. The parameter is set to "0", it is regarded as "1." The axis speeds set here will be applied to all positioning operations.

The speed during CPC operation is determined by「CPC SPEED」in the next section.

(3) 「SPEED B」(B-axis speed for expanded function)

(4) 「SPEED W」(W-axis speed for expanded function)

- Number of digits: 3
- Setting range: 0 to 100
- Minimum unit: 1
- Standard value: 100

These parameters are used when the speed is to be specified on an axis basis (expanded function). In this case,「SPEED A,B(X,Y)W」determines the speed of the A (X) axis only.

These parameters determine the speed of respective axes during automatic operations except CPC operation. The maximum axis speed varies depending on the type of robot. These parameters shall be set on a scale of 1 (minimum speed) to 100 (maximum speed) with reference to the robot's maximum axis speed. The parameter is set to "0", it is regarded as "1".

NOTE

When you to not use the expanded function, set these parameters to the same value as that of「SPEED A,B(X,Y)W」. When these parameters are not set, slowing-down distance in stopping by STOP signal ON or SELECT signal OFF may be longer.

19.1.3 CPC CONSTANT

(1) 「CPC SPEED」

- Number of digits: 3
- Setting range: 0 to 999
- Minimum unit: 1
- Standard value: 100

① Ver.2.3 or later

This parameter determines the robot speed during interpolation (CPC operation). The unit used is mm/sec.

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The speed at the robot edge is determined by this「CPC SPEED」and the F code of the start point of CPC operation.

$$\text{Edge speed}=\text{「CPC SPEED」}\frac{\text{F code}+1}{100}\text{(mm/sec)}$$

The maximum speed available varies among models. Even if a speed exceeding the model's maximum speed is specified, the robot operates at its own maximum speed.

② Ver.2.2 or earlier「LINE SPEED」

This parameter determines the robot speed during linear interpolation. The unit used is mm/sec.

The speed at the robot edge is determined by this「LINE SPEED」and the F code of the start point of CPC operation.

$$\text{Edge speed}=\text{「LINE SPEED」}\frac{\text{F code}+1}{100}\text{(mm/sec)}$$

The maximum speed available varies among models. Even if a speed exceeding the model's maximum speed is specified, the robot operates at its own maximum speed.

(2) 「CPC F.F. GAIN」

- Number of digits: 3
- Setting range: 0 to 255
- Minimum unit: 1
- Standard value: 100

① Ver.2.3 or later

This parameter sets the feedforward gain used during CPC operation. By feedforward control, the value of this parameter is added to an output speed until an intended robot speed is attained, unless a gap is detected between the current state and the target state.

If this parameter is set to “200,” a delay in follow-up will be 0 pulse; if the value is too great, an overshoot will occur.

② Ver.2.2 or earlier「ARC/CIRCLE SPEED」

This parameter is not used. 「LINE SPPED」described above is effective.

(3) 「SPLINE SPEED」

- Number of digits: 3
- Setting range: 0 to 999
- Minimum unit: 1
- Standard value: 100

This parameter becomes effective during free curve interpolation. Be aware that this parameter does not necessarily ensure a constant speed during free curve interpolation. Please regard this parameter just as an index of the maximum speed.

$$\text{Edge speed}=\text{「SPLINE SPEED」}\frac{\text{F code}+1}{100}\text{(mm/sec)}$$

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(4) 「CPC CONSTANT」

- Number of digits: 3
- Setting range: Ver. 2.3 or later: 0 to 100 (%)
  Ver. 2.2 or earlier: 0 to 499 (mm)
- - Minimum unit: 1
- - Standard value: 0

① Ver.2.3 or later

This parameter determines the smoothness of robot motion at via points during continuous CPC operation. The setting range is 0 to 100%. Robot motion is gentlest at 0% and steepest at 100%.

When the robot should perform rather short interpolations repeatedly, it may create vibrations when making turns if the value given to this parameter is too great. Conversely, when the robot should perform rather long interpolation at a high speed, specified speed may not be attained if the value is too small.

② Ver.2.2 or earlier

This parameter determines how many millimeters before the robot should start a transition when it moves from one interpolation to another in CPC operation.

This parameter should be set to a value between 0 and 150 in the case of a small-sized robot, and a value between 0 to 300 in the case of a large-sized robot. Please note that the robot may not necessarily perform transition following this value precisely, as the value can be varied internally depending on speed setting.

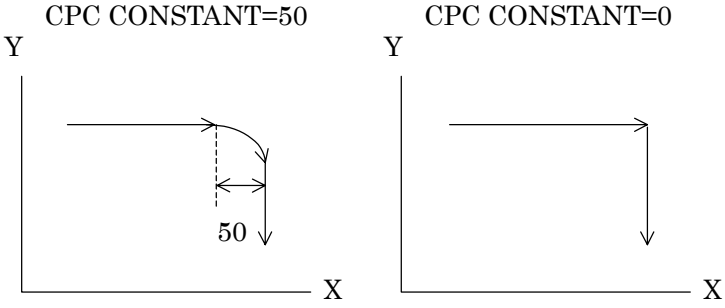


Fig. 19. 10 Operation change by CPC CONSTANT

During CPC operation, the robot moves at a constant speed on the X-Y plane. If an attempt is made to perform CPC operation together with the Z axis, the Z axis may get out of control causing the "OVER SPEED" error. If this parameter is set to "0," all the X, Y, and Z axes can operate at a constant speed, although the X and Y axes will make a right-angled turn as shown in the figure above.

(5) 「CPC ACCEL/DECEL」

- Number of digits: 3
- Setting range: Ver. 2.3 or later: 0 to 499
  Ver. 2.2 or earlier: 0 to 999
- Minimum unit: 1
- Standard value: 0

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① Ver.2.3 or later

This parameter sets the range of acceleration/deceleration during CPC operation, in mm.

When constant speed should take precedence over smoothness of a path as in the case of sealant application, set this parameter to "0." Please note that, even in this case, the robot accelerates/decelerates for the halves of the start and end sections of interpolation in order to avoid vibrations.

② Ver.2.2 or earlier

This parameter sets the range of acceleration/deceleration during linear, circular, or arc interpolation, in mm. The value may be varied by speed specification and load applied. Travel time can be shortened if you specify as small a value within the range that causes no vibration as possible.

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19.2 RESPONSE

19.2.1 ACCEL

Acceleration/deceleration time varies depending on the type of robot. The parameters in this group set acceleration/deceleration time with reference to the robot's shortest acceleration/deceleration time.

(1) 「ACCEL SELECT」

- Standard value: AUTO

This parameter determines whether acceleration/deceleration is set only by the 「ACCEL」 parameters described later or by calculation that creates optimum acceleration/deceleration time from the 「ACCEL」 values and work weight data. (Text selection)

① Ver.2.3 or later

AUTO : Automatically calculates acceleration/deceleration time.
The robot calculates optimum acceleration/deceleration time from (2)「ACCEL AB(X,Y)W」 and (3)「ACCEL Z」 described later and 「PTP WEIGHT」 in the System Parameter (「RESPONSE」→「RESPONSE」→「PTP WEIGHT」). Under normal conditions, (2)「ACCEL AB(X,Y)W」 and (3)「ACCEL Z」 should be set to "100."
Because a higher priority is currently given to short-distance movements, overshoot or vibrations may occur in a movement over a long distance. In such a case, set (2)「ACCEL AB(X,Y)W」 and (3)「ACCEL Z」 to lower values or specify a smaller F code to reduce robot speed.

MANUAL : Sets acceleration/deceleration according to (2)「ACCEL AB(X,Y)W」 and (3)「ACCEL Z」 described later.

NOTE

AUTO is highly effective for the SCARA (horizontal multi-articulated type) robot. However, in the case of the rectangular coordinate system robot, sudden slowing down at acceleration/deceleration may result because motor torque is not taken into consideration when the value in the System Parameter 「RESPONSE」→「RESPONSE」→「PTP WEIGHT」 is used. We recommend that you select MANUAL and set (2)「ACCEL AB(X,Y)W」 and (3)「ACCEL Z」 to shorten cycle time.
During PASS PTP operation, acceleration/deceleration is controlled by (4)「ACCEL ABW (PASS)」 and (5)「ACCEL Z (PASS)」 described later.

② Ver.2.2 or earlier

AUTO : Automatically calculates acceleration/deceleration time.
The robot calculates optimum acceleration/deceleration time from (2)「ACCEL AB(X,Y)W」 and (3)「ACCEL Z」 described later,

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and System Parameter「RESPONSE」→「RESPONSE」→「WORK WEIGHT」and「TOOL WEIGHT」. Under normal conditions, (2)「ACCEL AB(X,Y)W」and (3)「ACCEL Z」should be set to "100."

Because a higher priority is currently given to short-distance movements, overshoot or vibrations may occur in a movement over a long distance. In such a case, set (2)「ACCEL AB(X,Y)W」and (3)「ACCEL Z」to lower values or specify a smaller F code to reduce robot speed.

MANUAL : Sets acceleration/deceleration according to (2)「ACCEL AB(X,Y)W」and (3)「ACCEL Z」described later.

NOTE

AUTO is highly effective for the SCARA (horizontal multi-articulated type) robot. However, in the case of the rectangular coordinate system robot, sudden slowing down at acceleration/deceleration may result because motor torque is not taken into consideration when the value in the System Parameter「RESPONSE」→「RESPONSE」→「WORK WEIGHT」is used. We recommend that you select MANUAL and set (2)「ACCEL AB(X,Y)W」and (3)「ACCEL Z」to shorten cycle time.

(2) 「ACCEL AB(X,Y)W」

(3) 「ACCEL Z」

- Number of digits: 3
- Setting range: 0 to 100
- Minimum unit: 1
- Standard value: 80

These parameters slow down the acceleration/deceleration of axes. Under normal conditions, be sure to set these parameters to a value between 70 and 100. The smaller the value, the slower the acceleration/deceleration becomes.

Table 19. 1 Setting value and acceleration/deceleration time (When the shortest acceleration/deceleration time is 1)

「ACCEL」value	Acceleration/deceleration time	「ACCEL」value	Acceleration/deceleration time
100	1	50	10/5
90	10/9	40	10/4
80	10/8	30	10/3
70	10/7	20	10/2
60	10/6	10	10/1

The following table shows the optimum「ACCEL」value according to robot load.

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Table 19. 2 Robot load and optimum「ACCEL」value

「ACCEL」value	AR-C270	AR-C350	MB
80	2-kg load	2-kg load	Normal load
70			
60		4-kg load	

(4) 「ACCEL ABW （PASS）」

(5) 「ACCEL Z （PASS）」

- Number of digits: 3
- Setting range: 0 to 100
- Minimum unit: 1
- Standard value: 80

(Ver. 2.3 or later only)
These parameters set the acceleration/deceleration during PASS PTP operation. Description on these parameters are the same as that of (2)「ACCEL AB(X,Y)W」and (3)「ACCEL Z」described above.

19.2.2 AXIS INP PULSE

(1) INP PULSE A,B(X, Y)

(2) INP PULSE B

(3) INP PULSE Z

(4) INP PULSE W

- Number of digits: 3
- Setting range: 0 to 999
- Minimum unit: 1 (pulse)
- Standard value: 6

These parameters determine the accuracy of positioning.

The axis controller controls robot position using pulse data. It outputs speed commands to operate each motor, and the motor in return outputs position information from the encoder to the controller. Based on this information, the controller calculates the pulse count of the current position, and operates the motor until the robot is positioned at the target point.

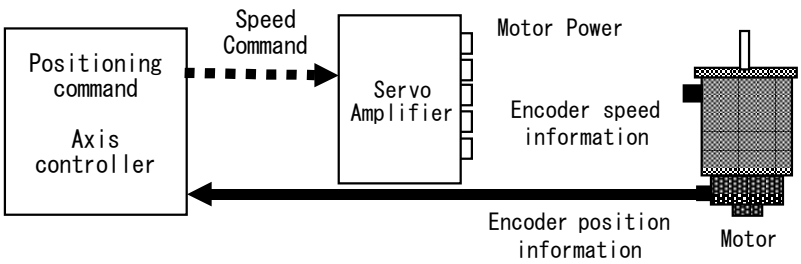


Fig.19. 11 Control method

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Positioning of the robot is performed by the control shown above, and positioning is judged completed when the pulse counts of respective axes have reached the range specified by these parameters.

When these parameters are set to “6,” the positioning completion signal will be outputted when the pulse counts of the current position have reached the range of pulse counts of target position ±6.

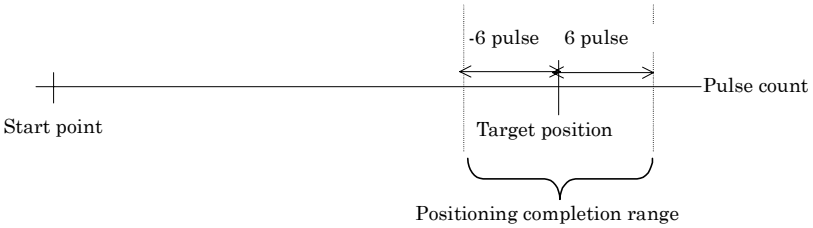


Fig. 19. 12 Example of INP PULSE setting

The values shall be specified in pulses. If a value smaller than 6 is specified, 6 will be assigned automatically.

NOTE

① If the robot does not reach the specified range within three seconds, the “POS ERROR” will occur.
② (2)「INP PULSE B」 is a parameter for expanding B-axis functions. It can be used only when a special robot is used. Under normal conditions, be sure to set this parameter to the same value as 「INP PULSE A」.
③ When the HOLD function is selected, the robot is controlled so that it will continue to approach a target position even after the completion of positioning is confirmed.
④ When high degree of accuracy is not required, you can shorten cycle time by setting these parameters to great values, around 50 as a guide.
⑤ When the “POS ERROR” occurs, set these parameters to greater values.

19.2.3 RESPONSE

(1) 「SAFETY ZONE」

- Number of digits: 7
- Setting range: 0 to the maximum operation area of Z axis
- Minimum unit: 0.001
- Standard value: 10

When the Z axis reaches the point upper (value becomes smaller) than the point specified by this parameter, the ZONE signal (OUT5) will turn ON. This parameter can be used to check the completion of retraction. The unit used is mm.

The ZONE signal (OUT5) turns ON in the following cases.

① When the data in the System Generation 「ORIGIN」→「SET-UP SYSTEM」→「AUTO/ON-LINE」 is set to “AUTO”
This signal is outputted in the TEACH, CHECK, or AUTO mode.

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② When the data in the System Generation 「ORIGIN」→「SET-UP SYSTEM」→「AUTO/ON-LINE」 is set to "ON-LINE"
This signal is outputted during automatic operation only when the value in the System Generation 「ORIGIN」→「SET-UP SYSTEM」→「I/O ASSIGNMENT」is set to "1."

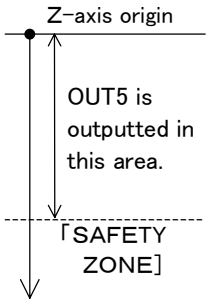


Fig. 19. 13「SAFETY ZONE」

NOTE

① This parameter is invalid when A-CAL is not completed. The ZONE signal (OUT5) stays OFF when A-CAL is not completed.
② The ZONE signal (OUT5) does not turn ON/OFF in the KEY-IN mode.
③ When the Z-axis PULL-UP function is specified, the 「SAFETY ZONE」 value must be greater than the 「PULL-UP」[i] value. If the 「SAFETY ZONE」 value is equal to the 「PULL-UP」 value, the ZONE signal (OUT5) may turn ON and OFF repeatedly, or may not turn ON at all.

(2) 「A-CAL SPEED」

- Number of digits: 3
- Setting range: 1 to 999
- Minimum unit: 1
- Standard value: 255

This parameter determines the robot speed during A-CAL.

The maximum axis speed varies depending on the type of robot. 「A-CAL SPEED」 shall be set on a scale of 1 to 999 (0.1% to 99.9%) with reference to the robot's maximum axis speed. Nevertheless, the robot does not operate at a speed of 250 mm/sec or more for safety reasons.

(3) 「INCHING SPEED」

- Number of digits: 3
- Setting range: 1 to 999
- Minimum unit: 1
- Standard value: 255

This parameter determines the robot speed during inching operation.

[i] System Parameter 「MOTION」 →「MOTION」 →「PULL-UP」

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The maximum axis speed varies depending on the type of robot. 「INCHING SPEED」 shall be set on a scale of 1 to 999 (0.1% to 99.9%) with reference to the robot's maximum axis speed. Nevertheless, the robot does not operate at a speed of 250 mm/sec or more for safety reasons.

(4) 「PTP WEIGHT」 (Ver. 2.2 or earlier: 「WORK WEIGHT」)

- Number of digits: 7
- Setting range: 0 to the load capacity of the robot
- Minimum unit: 0.001
- Standard value: 0

This parameter sets the weight of an edge tool (kg) + a work (kg). The robot calculates optimum acceleration/deceleration during PTP or PASS PTP operation using this data.

During PASS PTP operation, acceleration/deceleration is optimally controlled all the time. During PTP operation, acceleration/deceleration is optimized only when the data in the System Parameter 「RESPONSE」→「ACCEL」→「ACCEL SELECT」 is set to "AUTO."

(5) 「EXPANSION」 (Ver.2.2 or earlier: 「TOOL WEIGHT」)

- Number of digits: 7
- Setting range: 0 to the load capacity of the robot
- Minimum unit: 0.001
- Standard value: 0

① Ver.2.3 or later
This parameter is not used.

② Ver.2.2 or earlier
This parameter becomes effective only when PASS PTP operation is performed. It supplements 「PTP WEIGHT」 described above.
In the PASS PTP operation, acceleration/deceleration must be slower than PTP operation; otherwise, vigorous vibrations may occur during interpolation. If this parameter is set, acceleration/deceleration is automatically optimized based on 「PTP WEIGHT」 described above and this parameter.
In principle, this parameter should be set within the range of 1 to 2 (kg).

(6) 「COMPLIANCE」

This parameter is not used.

(7) 「DD INDEX GAIN」 (Ver.2.2 or earlier: 「RESPONSE A」)

- Number of digits: 3
- Setting range: 0 to 7
- Minimum unit: 1
- Standard value: 7 or 6

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① Ver.2.3 or later (Index robot only)
This parameter sets the gain for DD servo level.

② Ver.2.2 or earlier
This parameter is not used.

NOTE

When it is possible to set speed and acceleration/deceleration on an axis basis (expanded function), this parameter serves as a parameter that sets a short-distance acceleration/deceleration constant for the A axis. For description on this parameter, refer to (8)「PTP CONST AB」- (10)「PTP CONST W」.

(8) 「PTP CONST AB」(Ver.2.2 or earlier:「RESPONSE B」)

(9) 「PTP CONST Z」(Ver.2.2 or earlier:「RESPONSE C」)

(10) 「PTP CONST W」(Ver.2.2 or earlier:「RESPONSE D」)

- Number of digits: 3
- Setting range: 450 to 999
- Minimum unit: 1
- Standard value: 0

① Ver.2.3 or later
These parameters set short-distance acceleration/deceleration constants for respective axes.
Under normal conditions, robot speed changes as shown in (1) of Figure 19.14 below. However, when the distance to travel is short, the speed can change sharply as shown in (2) resulting in vibrations.

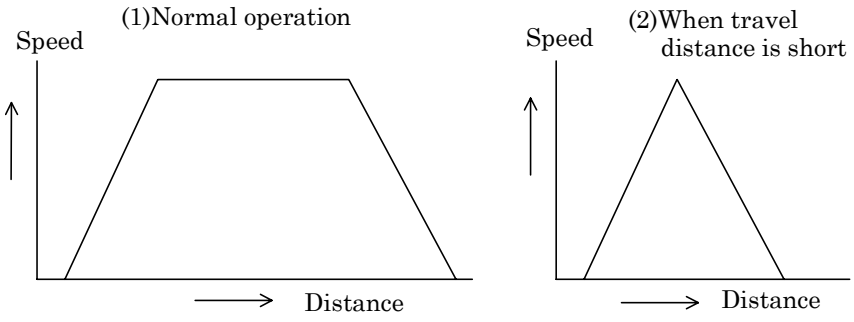


Fig. 19. 14 Speed curve

The constants specified by these parameters let the robot avoid a situation like (2), and take the speed curve indicated by a solid line in the figure below.
The default is 750, and the greater the value, the greater the rate of change in the speed curve becomes.
If a value exceeding the setting range is specified, “750” will be automatically assigned.

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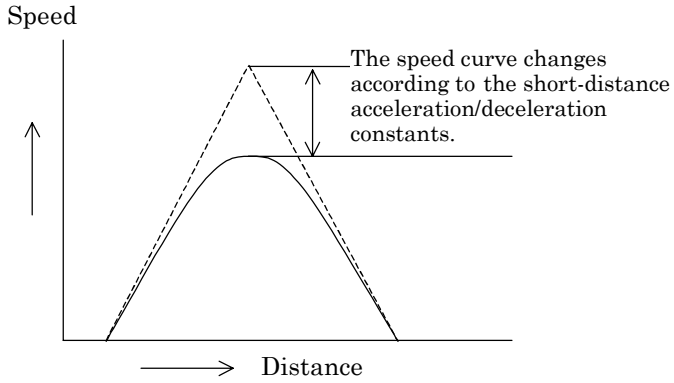


Fig.19. 15 Speed curve corrected by short-distance acceleration/deceleration constant

② Ver.2.2 or earlier
This parameter is not used.

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19.3 OFFSET

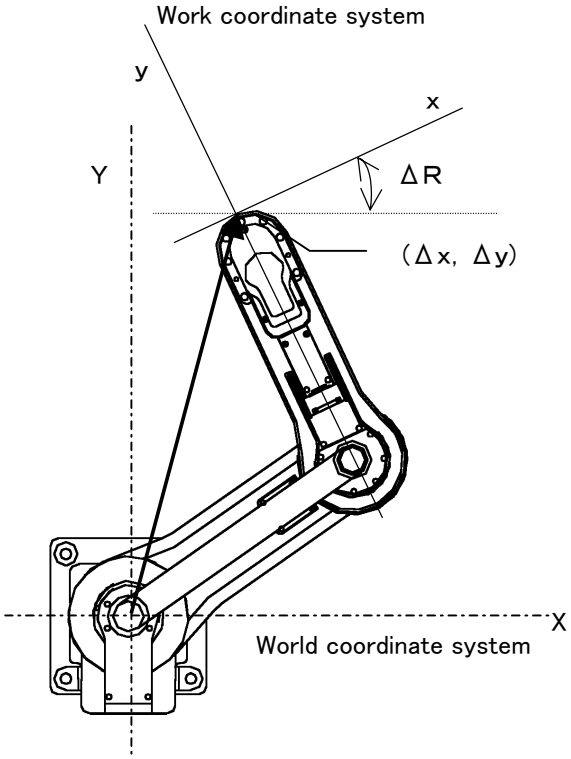
The「OFFSET」→「DISPLAY OFFSET＊」group sets the origin of a coordinate system created display.

Because this is an offset just on the display, actual robot position will not change if you change the offset values.

Using this offset has the following merits

- Entry of position data in the KEY-IN mode becomes easier because the relation between the robot and a work can be set with reference to the created coordinate system.
- Teaching of points in the LI-TEACH mode becomes easier because it is possible to move the robot parallel to the coordinate axis created.
- Setting of「AREA LIMIT」[i] becomes easier.

The coordinate system available is「DISPLAY OFFSET 1」only. (Refer to 2.6 “Display (LCD Screen).”)
To switch displayed data from robot-specific world coordinates to work coordinates (converted data) is called “to perform display offset.”
Conversion from world coordinates to work coordinates is performed as described below.
Set a point that has coordinates (Δx, Δy) on the X-Y plane as the origin of a new coordinate system. (See figure below.) Then rotate the new coordinate system by ΔR. The Z and W axes take the coordinates that are obtained by subtracting Δz and Δw, respectively.



Δx=「DISPLAY X」
Δy=「DISPLAY Y」
ΔR=「DISPLAY R」

Fig. 19. 16「OFFSET」

[i] System Generation「LIMIT」→「AREA LIMIT」group

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The following is a detailed description on each parameter.

(1) 「DISPLAY X1」

(2) 「DISPLAY Y1」

(3) 「DISPLAY R1」

- Number of digits: 7
- Setting range: X axis: -7999.999 to 7999.999
  Y axis: -7999.999 to 7999.999
  R axis: -180.000 to 180.000
- Minimum unit: ±0.001
- Standard value: 0

These parameters set the origin of virtual X and Y coordinate axes for display.

「DISPLAY X1」is a display offset for the X axis, and「DISPLAY Y1」is a display offset for the Y axis. The values shall be specified in mm.「DISPLAY Y1」is a coordinate rotation offset, and shall be specified in degrees. Because this is an offset just on the display, actual robot position will not change if you change the offset values.

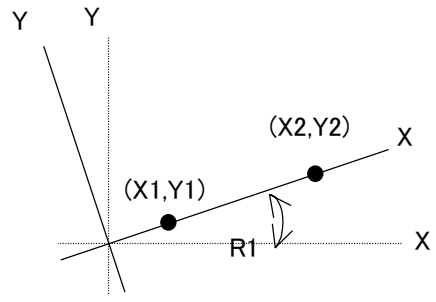
The following explains how to set these parameters taking the 「DISPLAYLAY OFFSET 1」group as an example.

① Enter "0" in「DISPLAY X1」,「DISPLAY Y1」, and「DISPLAY R1」.

② After A-CAL is completed, select the TEACH mode, and move the robot to the origin of a new coordinate system.

③ Read the X and Y coordinates of the origin, and enter the obtained values in「DISPLAY X1」and「DISPLAY Y1」respectively.

④ When you wish to rotate the new coordinate axes, select two points (X1, Y1) and (X2, Y2) on the desired X axis, and calculate the value of「DISPLAY R1」by the following formula.



$$「DISP.\ R1」=\tan^{-1}\frac{Y2-Y1}{X2-X1}$$

Fig. 19. 17 Calculation of「DISPLAY R1」

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(4) 「DISPLAY Z1」

- Number of digits: 7
- Setting range: Z axis: 0 to Z-axis stroke
- Minimum unit: ±0.001
- Standard value: 0

This parameter sets the origin of a virtual Z coordinate axis for display.

「DISPLAY Z1」 is a display offset for the Z axis, and shall be specified in mm. Because this is an offset just on the display, actual robot position will not change if you change the offset value.

(5) 「DISPLAY W1」

- Number of digits: 7
- Setting range: W axis: -540.000 to 540.000
- Minimum unit: ±0.001
- Standard value: 0

This parameter sets a W-axis offset with reference to the X and Y coordinate axes.

The unit used for the W axis is degrees, and, on the display, its position data is expressed as an angle with reference to the X and Y coordinate axes. When new X and Y coordinate axes are set by display offset parameters, W axis' operating direction and position data to be displayed will be those based on the new X and Y coordinate axes.

「DISPLAY W1」 sets the origin of a virtual W axis for display with reference to the X and Y coordinate axes created. Because this is an offset just on the display, actual robot position will not change if you change the offset value.

The following explains how to set this parameter taking the 「DISPLAY OFFSET 1」 group as an example.

① Enter appropriate values in 「DISPLAY X1」, 「DISPLAY Y1」, and 「DISPLAY R1」 to set new X and Y coordinate axes.
② Enter "0" in「DISPLAY W1」.
③ After A-CAL is completed, select the TEACH mode, and rotate the W axis until it reaches the point where W axis' display angle should be "0."
④ Read the data of the W axis, and enter the obtained value in 「DISPLAY W1」.

NOTE

「DISPLAY W＊」 sets an offset just on the display, and does not change the robot's mechanical operation area. Therefore, there are cases where switching to the work coordinate system causes an "AREA ERROR" and disables data entry even if W-axis data is the same.

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(6) 「DISPLAY X2」

(7) 「DISPLAY Y2」

(8) 「DISPLAY R2」

(9) 「DISPLAY X3」

(10) 「DISPLAY Y3」

(11) 「DISPLAY R3」

These parameters are not supported at present.

They set the origin of virtual X and Y coordinate axes for display.

(12) 「DISPLAY Z2」

(13) 「DISPLAY Z3」

These parameters are not supported at present.

They set the origin of a virtual Z coordinate axis for display.

(14) 「DISPLAY W2」

(15) 「DISPLAY W3」

These parameters are not supported at present.

They set the offset of the W axis with reference to the X and Y coordinate axes.

(16) 「TOOL X1」

(17) 「TOOL Y1」

(18) 「TOOL Z1」

(19) 「TOOL X2」

(20) 「TOOL Y2」

(21) 「TOOL Z2」

(22) 「TOOL X3」

(23) 「TOOL Y3」

(24) 「TOOL Z3」

These parameters are not supported at present.

They enable the display of coordinate data of edge tool's work center. As three sets of parameters are provided, they are helpful when three difference types of tools are used. These parameters shall be used in combination with 「DISPLAY.＊＊」 described above.

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19.4 SET-UP

This group contains the data for expansion.

It is divided into「EXPANSION A」and「EXPANSION B」groups.

19.4.1 EXPANSION A

This group contains the data for expansion.

(1) 「Pass Ptp Select」

When M data 30 to 39 is specified, this parameter determines the type of PASS PTP operation to be performed, i.e. PASS PTP operation that does not let the robot stop at via points or PASS PTP operation that is formed by repeated normal PTP operations performed without communications with the outside.

Data 0: Performs PASS PTP operation that does not let the robot stop at via points.

1: Repeats normal PTP operation continuously without communicating with the outside. The robot stops temporarily at each via point.

2: Performs PTP operation if S code 97 is given (even if PASS PTP operation which does not let the robot stop at via points is specified).

(2) 「Base Pos Addr1」

(3) 「Base Pos Addr2」

(4) 「Base Pos Addr3」

(5) 「Base Pos Addr4」

- Number of digits: 3
- Setting range: 0 to 999
- Minimum unit: 1
- Standard value: 0

These parameters set base positions of the robot.

The function of the base position changes depending on the value set in the System Generation「ORIGIN」→「SET-UP SYSTEM」→「I/O ASSIGNMENT」.

① When I/O ASSIGNMENT is set to “4”
The BP AREA signal (OUT4) turns ON when the robot is positioned at one of the base positions specified by these parameters. The number of base positions that can be set is four at the maximum.

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Example

When the BP AREA signal (OUT4) should turn ON when the robot is positioned around address 10 or 20.

Base Pos Addr1 : 10
Base Pos Addr2 : 20
Base Pos Addr3 : 20
Base Pos Addr4 : 20

CAUTION

When you do not use all of the four base positions, e.g. when you use only 「Base Pos Addr1」 and 「Base Pos Addr2」 give the same address number as one of the two base positions' to 「Base Pos Addr3」 and 「Base Pos Addr4」 as well. If an unused base position (Base Pos Addr *) is set to "0," address 0 will be selected as a base position.

② When I/O ASSIGNMENT is set to "8" (Ver. 2.36 or later)

Each parameter sets a base position for a specified axis (the A (X), B (Y), Z, or W axis).

Base Pos Addr1 : A(X)
Base Pos Addr2 : B(Y)
Base Pos Addr3 : Z
Base Pos Addr4 : W

The BP AREA signal (OUT4) turns ON when each axis is positioned at the point specified by the axis data of an applicable base position.

For the axis that requires no base position specification, set an applicable base position to "999."

Example

When you wish to let the BP AREA signal (OUT4) turn ON when the B (Y) axis is around the B (Y)-axis position of address 10 (The other axes may be at any position.)

Base Pos Addr1 : 999
Base Pos Addr2 : 10
Base Pos Addr3 : 999
Base Pos Addr4 : 999

It is possible to utilize the BP AREA signal (OUT4) as an interlock of start permission to an outside control device.

To set the range of stopping position, set 「Base Pos Pulse」 described below.

(6) 「Base Pos Pulse」

- Number of digits: 5
- Setting range: 0 to 99999
- Minimum unit: 1
- Standard value: 0

The function of this parameter changes depending on the value set in the System Generation 「ORIGIN」→「SET-UP SYSTEM」→「I/O ASSIGNMENT」.

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① When I/O ASSIGNMENT is set to “4”

② When I/O ASSIGNMENT is set to “8” (Ver. 2.36 or later)
This parameter sets the range of a base position in the form base position address ±「Base Pos Addr」. The BP AREA signal (OUT4) will turn ON if the robot is positioned within this range. The value shall be specified in pulses.

③ When I/O ASSIGNMENT is set to “16” (Ver. 2.38 or later)
This parameter sets the range of a base position in the form base position address ±「Base Pos Pulse」. Stored M data (OUT8 - OUT15) will be outputted if the robot is finally positioned within this range in the AUTO mode. The value shall be specified in pulses.

(7) 「Safety select」

This parameter changes the reference point for「ARCH UP」[i] or「SAFETY ZONE」[ii]. This parameter is currently fixed at “0.”

Data 0: Sets「ARCH UP」and「SAFETY ZONE」as absolute distance from the Z-axis origin.

1: Turns ON the ZONE signal (OUT5) when the Z axis has moved up by the amount of「SAFETY ZONE」from the current position.

2: Starts the A (X) and B (Y) axes when the Z axis has moved up by the amount of「ARCH UP」from the current position.

19.4.2 EXPANSION B

(1) 「SENSOR OFF」(Sensor offset)

- Number of digits: 7
- Setting range: -99.000 to 99.000
- Minimum unit: 0.001
- Standard value: 0

This parameter sets the offset used when W-axis sensor stop is performed.

When this offset is set, the W axis will be positioned at the detecting point + offset value, and then the W-axis sensor stop will be completed.

When the offset is set to “0,” the W axis will stay at the detecting point. A positive value moves the W axis toward the limit, and a negative value moves it toward the origin.

(2) 「SENSOR SKIP」

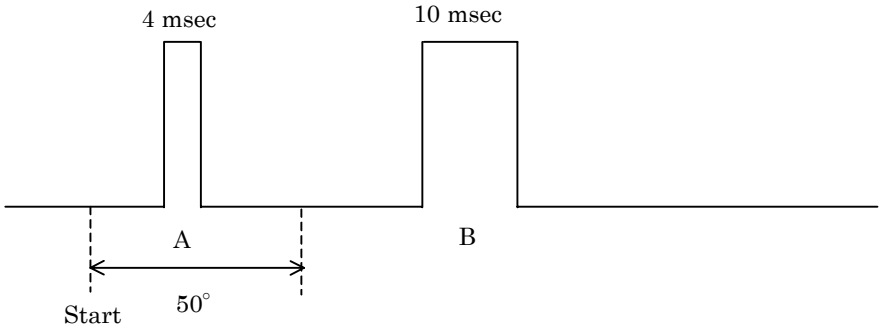
- Number of digits: 7
- Setting range: 0 to 360.000

[i] System Parameter「MOTION」→「MOTION」→「ARCH UP」
[ii] System Parameter「RESPONSE」→「RESPONSE」→「SAFETY ZONE」

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- Minimum unit: 0.001
- Standard value: 0

When W-axis sensor stop is performed, this parameter lets the robot ignore input from the sensor until a specified angle is attained from the start of detection. The value shall be specified by angle.



When the robot should ignore signal A and detect signal B only, set this parameter to "50."

(3) 「AREA OUT AX」(Area output A (X))

(4) 「AREA OUT BY」(Area output B (Y))

- Number of digits: 7
- Setting range:
  SCARA (horizontal multi-articulated type) robot:
  -360.000º to 360.000º
  Rectangular coordinate system robot:
  -7999.999 mm to 7999.999 mm
- Minimum unit: ±0.001
- Standard value: 0

The BP AREA signal (OUT4) stays ON while the axes are within the area set by these parameters.

Because the OUT4 signal is used for PASS PTP output and base position output as well as area output, the value in the System Generation 「ORIGIN」→「SET-UP SYSTEM」→「I/O ASSIGNMENT」 must be set to "2" to use OUT4 for area output.

The plus/minus sign before the value indicates whether the BP AREA signal (OUT4) should turn ON when the position data of the axis is smaller than the value set, or when it is greater.

+ value: Turns ON the signal when the position data of the axis is greater than the value set

- value: Turns ON the signal when the position data of the axis is smaller than the value set

① SCARA (horizontal multi-articulated type) robot
When these parameters are set as shown below, the BP AREA signal (OUT4) will turn ON if the edge of the robot is positioned within the shaded area.

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「AREA OUT AX」= 130º, 「AREA OUT BY」= 0º

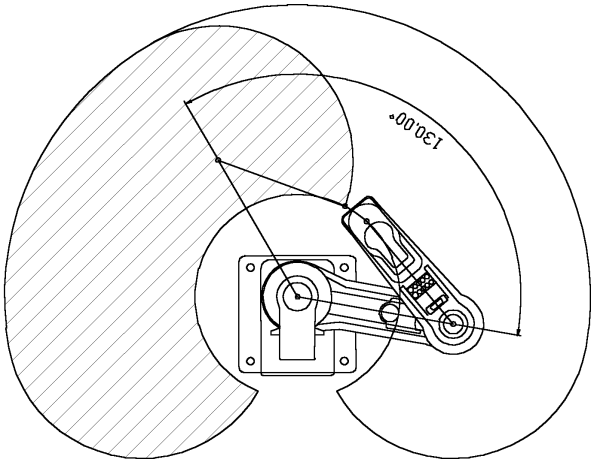


Fig. 19. 18 Example of effective area
SCARA (horizontal multi-articulated type) robot

② Rectangular coordinate system robot

When these parameters are set as shown below, the BP AREA signal (OUT4) will turn ON if the edge of the robot is positioned within the shaded area.

Example 1: 「AREA OUT AX」= 100 mm, 「AREA OUT BY」= 150 mm

Example 2: 「AREA OUT AX」= -100 mm, 「AREA OUT BY」= 150 mm

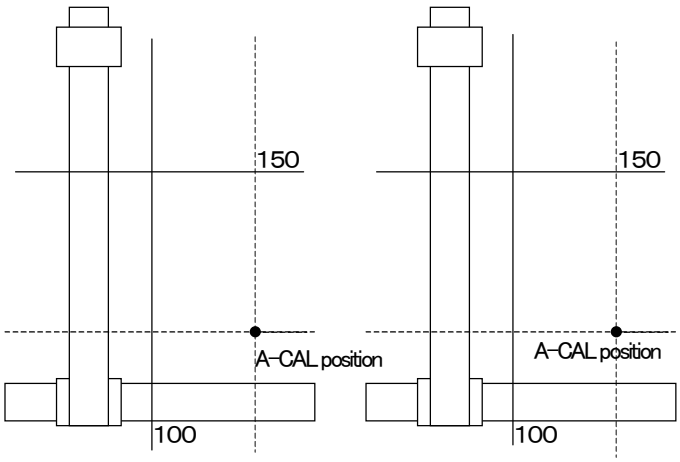


Fig. 19. 19 Example of effective area – Rectangular coordinate system robot

NOTE

①When A-CAL is not completed, the BP AREA signal (OUT4) stays OFF.
②These parameters are effective in any operation mode other than KEY-IN and ON-LINE modes.
③The BP AREA signal (OUT4) turns ON when both 「AREA OUT AX」 and 「AREA OUT BY」 are satisfied.

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(5) 「Z MID OFF」(Z middle offset)

- Number of digits: 7
- Setting range: 450.000 to 999.000
- Minimum unit: 0.001
- Standard value: 0

When S code 24 or 25 is specified, relative positioning of the Z axis is performed based on this parameter.[i]

(6) 「Z2 PULL-UP」(Ver. 2.2 or earlier:「Y ARCH UP」)

NOTE

This parameter is used only when a special robot is used. In other cases, the data is displayed in「EXPANSION」.

① Ver.2.3 or later

- Number of digits: 7
- Setting range: 5.000 to the maximum operation area of Z2 axis
- Minimum unit: 0.001
- Standard value: 10

When the robot has two Z axes, this parameter sets the「PULL-UP」[ii] value for the second Z axis.

② Ver.2.2 or earlier

- Number of digits: 3
- Setting range: 0 to 100
- Minimum unit: 1
- Standard value: 0

This parameter lets the Y axis make arch up motion against the X axis in the same manner as the Z axis.

The Y axis starts moving after the X axis has traveled「Y ARCH UP」(%) of X axis' total travel distance.

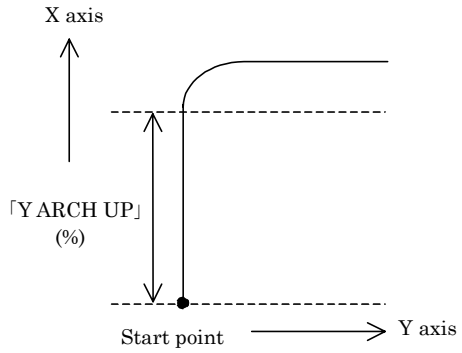


Fig.19. 20 Y ARCH UP

(7) 「EXPANSION」(Ver.2.2 or earlier:「Y ARCH DOWN」)

① Ver.2.3 or later

This parameter is not used at present.

[i] Refer to 16.5.2 "List of S code functions."
[ii] System Parameter「MOTION」→「MOTION」→「PULL-UP」

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② Ver.2.2 まで

- Number of digits: 3
- Setting range: 0 to 100
- Minimum unit: 1
- Standard value: 0

This parameter lets the Y axis make arch down motion against the X axis in the same manner as the Z axis.

The Y axis starts moving after the X axis has traveled「Y ARCH DOWN」(%) of X axis' total travel distance.

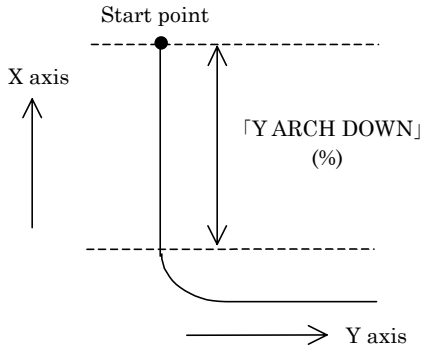


Fig. 19. 21 Y ARCH DOWN

(8) CV Z DIS

NOTE

This parameter is available only when conveyor follow-up motion is supported. For details, refer to 16.7 “Conveyor Follow-up Motion (Option).”

- Number of digits: 7
- Setting range: 0 to 999.999
- Minimum unit: 0.001
- Standard value: 0

This parameter sets the standby position where the Z axis should stand by before it moves to its target position during conveyor follow-up motion, in mm.

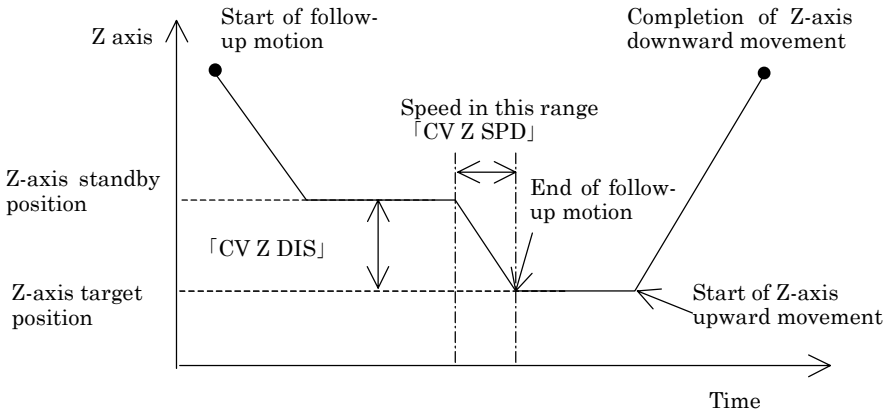


Fig. 19. 22 Conveyor follow-up motion

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(9) CV Z SPD

NOTE

This parameter is available only when conveyor follow-up motion is supported. For details, refer to 16.7 “Conveyor Follow-up Motion (Option).”

- Number of digits: 3
- Setting range: 0 to 999
- Minimum unit: 1
- Standard value: 0

This parameter sets the Z-axis speed that is applied while the Z axis moves from the standby position to the target position during conveyor follow-up motion. (See Figure 19.22: Conveyor follow-up motion.)

(10) CV ESC1 DIS

NOTE

This parameter is available only when conveyor follow-up motion is supported. For details, refer to 16.7 “Conveyor Follow-up Motion (Option).”

- Number of digits: 7
- Setting range: 450.000 to 999.000
- Minimum unit: 0.001
- Standard value: 0

This parameter sets the distance in which the robot should slow down and stop after the follow-up escape command (IN19) has turned ON.

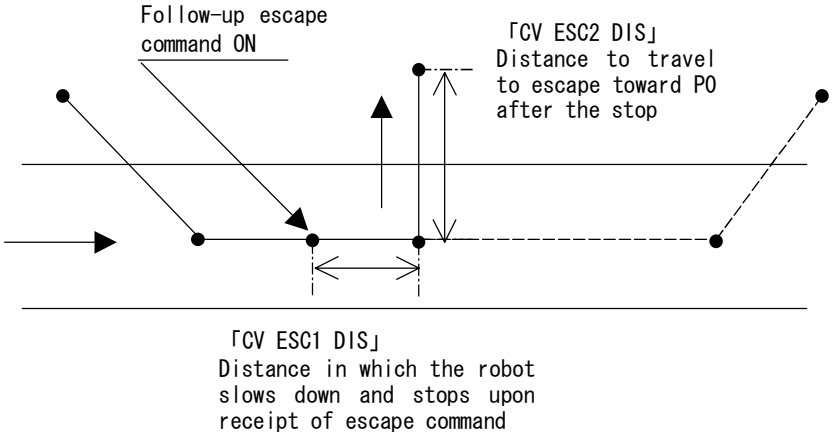


Fig. 19. 23 Follow-up escape processing

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(11) CV ESC2 DIS

NOTE

This parameter is available only when conveyor follow-up motion is supported. For details, refer to 16.7 “Conveyor Follow-up Motion (Option).”

- Number of digits: 7
- Setting range: 450.000 to 999.000
- Minimum unit: 0.001
- Standard value: 0

  This parameter sets the distance which the robot should travel in a direction square to the conveyor after the slowing down & stopping by the follow-up escape command. (See Figure 19.23: Follow-up escape processing.)

(12) CV CV SPD

NOTE

This parameter is available only when conveyor follow-up motion is supported. For details, refer to 16.7 “Conveyor Follow-up Motion (Option).”

- Number of digits: 3
- Setting range: 0 to 999
- Minimum unit: 1
- Standard value: 0

  This parameter sets the travel speed of the conveyor in mm/sec.

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19.5 REMOTE

This group displays the data set by the S (SAVE) command of the HRCS-RIII[i]. It is not possible to change their data.

Applicable data is the data in the「MOTION」and「RESPONSE」groups. For details, refer to the section describing each group.

19.5.1 MOTION

(1) PULL-UP

(2) ARCH UP

(3) ARCH DOWN

(4) INS DIS.

(5) INS SPEED

(6) UP DIS.

(7) UP SPEED

19.5.2 SPEED/ACCEL/INPOS

(1) SPEED A,B(X,Y)W

(2) SPEED B

(3) SPEED Z

(4) SPEED W

(5) ACCEL A,B(X,Y)W

(6) ACCEL ABW(PASS)

(7) ACCEL Z

(8) ACCEL Z(PASS)

(9) INP PULSE A,B

(10) PULSE B

(11) INP PULSE Z

(12) INP PULSE W

19.5.3 REMOTE MOTION

(1) CPC SPEED

(2) CPC F.F.GAIN

(3) SPLINE SPEED

[i] HRCS-RIII is a communication protocol prepared by HIRATA Corporation, which is used to control the robot from a host computer through the RS-232C. For details, refer to HRCS RIII Reference Manual.

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(4) A-CAL SPEED

(5) INCHING SPEED

(6) A-CAL SEQ.

(7) PTP WEIGHT

(8) EXPANSION

For expansion

(9) LOCAL COORDINATE

This parameter is not used at present.

(10) W AXIS ACCEL

(11) W AXIS DECEL

(12) OPTION DATA 1

(13) OPTION DATA 2

(14) OPTION DATA 3

These parameters are used only when a special robot is used.

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CHAPTER 20 SERVO OFFSET ADJUSTMENT

The speed of the servo motor is converted by the CPU board from digital data into analog speed commands (voltages), and outputted to the servo driver/servo amplifier.

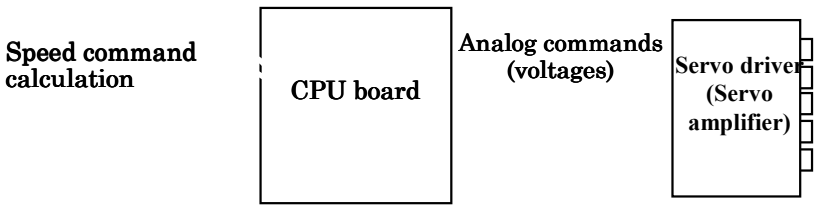


Fig. 20. 1

Because slight variations can occur when digital data is converted into analog speed commands (voltage), it is possible that, even if the CPU board outputs speed command 0 V (robot stop command), the servo driver does not receive it as 0 V. This displacement of 0 V (0 potential difference) is called SERVO OFFSET.

If the 0 potential difference is great, it may deteriorate speed accuracy at positioning leading to positioning errors, may not let the robot start, or may cause the robot to undershoot just before the completion of positioning and respond not at all after stopping.

This section describes the procedure for adjusting this SERVO OFFSET.

To adjust the SERVO OFFSET, adjust the adjusting knob (hardware) of the servo driver. When the servo driver does not have the adjusting knob for SERVO OFFSET adjustment, the adjustment is performed from the CPU board side.

The SERVO OFFSET adjustment is performed in the following steps.

(1) Switch to the SERVO OFFSET adjustment mode.

(2) Adjust the SERVO OFFSET.

The following two adjustment methods are provided.

① Adjusting knob adjustment on the servo driver/servo amplifier
② SERVO OFFSET adjustment by software

Each step is described in detail in the following sections.

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20.1 Switching to SERVO OFFSET Adjustment Mode

(1) Move all the axes of the robot to the center of the operation area.

This is to move the robot in advance to a position where no interference will occur, because the motors operate, though at a low speed, gradually in the SERVO OFFSET adjustment mode.

① Set the selector switch of the Teach Pendant to "RO-TEACH."

② Using the axis keys (+R/R +X, -R/L -X, +C +Y, -C -Y, etc.), move each axis to the center of the operation area.

(2) Press the FUNC HIGH + mot 3 keys of the Teach Pendant. The following screen will appear.

```
Motion Set
Motion = [NORMAL    ]
Motion Address   0000
Aging Count      0000
```

Fig.20. 2 Motion set mode screen

(3) A cursor is blinking on the data of「Motion」. Press the io SEL key to display「SERVO OFF」.

```
Motion Set
Motion = [SERVO OFF ]
Motion Address   0000
Aging Count      0000
```

Fig.20. 3 Selection of SERVO OFFSET adjustment mode

(4) Set the selector switch of the Teach Pendant to "ON-LINE." Switching to the SERVO OFFSET adjustment mode is now complete.

On the screen, present motor positions are displayed in pulse data, which is the pulse count of each motor's position encoder taken by the counter IC.

```
0050 M10 F99 S00 R 0
 X 0000005 Y 0000000
 Z 0000000 W 0000000
```

Fig.20. 4 Pulse counter display

In the SERVO OFFSET adjustment mode, the CPU board continues to output analog speed command 0 V (robot stop command). If SERVO OFFSET is properly adjusted, the motors are at rest and the pulse counter data shows no change. If offset (0 potential difference) exists, the motors are in operation and the pulse counter data changes.

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When offset exists, perform adjustment so that the motors will not operate in the SERVO OFFSET adjustment mode. Because analog signals are used, it is difficult to let the robot stop precisely at 0 V. The adjustment should aim to make the variations smallest.

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20.2 Adjustment of SERVO OFFSET

After switching to the SERVO OFFSET adjustment mode, perform SERVO OFFSET adjustment by either of the following two procedures.

20.2.1 Adjusting Knob Adjustment and Data Adjustment on Servo Driver/Servo Amplifier

(1) To avoid any confusion by misoperation, make a record of the pulse count of each axis displayed on the pulse counter display screen.

(2) Check the adjusting knob on the servo driver/servo amplifier to be adjusted. Refer to the Robot Controller User's Guide for your controller or the instruction manual for the servo driver/servo amplifier.

(3) While checking the pulse data of the axis to be adjusted, turn the adjusting knob slowly clockwise or counterclockwise using a flatblade screwdriver or an adjusting instrument, or change the data for adjustment, until displayed pulse data ceases to change.

(4) Even if the pulse data ceases to change, it can start changing again little while later. Therefore, try to find a position where a certain degree of stability is attained. When it is impossible to find a position where the data ceases to change completely, find a position where the variation is 100 pulses or less per second.

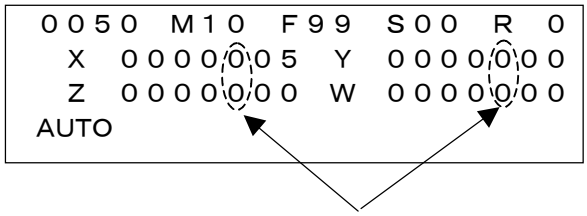


Fig.20. 5 Check of pulse counter

(5) When you have finished the adjustment on all the axes, switch the mode with the selector switch of the controller to exit the SERVO OFFSET adjustment mode.

20.2.2 SERVO OFFSET Adjustment by Software

When CPU board HPC-747 is used for the controller (HNC(HAC)-＊＊D＊ or HNC(HAC)-＊＊E＊ controller), the offset of the HPC-747 (CPU board) can be adjusted through the Teach Pendant. When this adjustment is not successful, perform adjustment according to 20.2.1 “Adjusting knob adjustment and data adjustment on servo driver/servo amplifier.”

(1) To adjust SERVO OFFSET, use the axis keys for the axis to be adjusted, i.e. the +R/R +X and -R/L -X keys in the case of the X axis. Each time one of these keys is pressed, offset will be internally increased/decreased by a trace amount. Adjust the offset until displayed pulse data ceases to change.

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(2) Even if the pulse data ceases to change, it can start changing again little while later. Therefore, try to find a position where a certain degree of stability is attained. When it is impossible to find a position where the data ceases to change completely, find a position where the variation is 100 pulses or less per second.

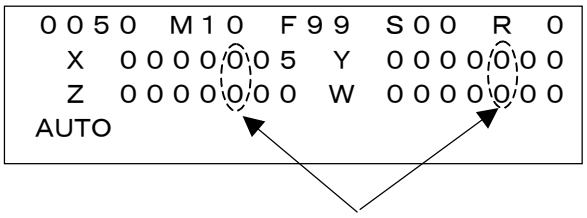


Fig.20. 6 Check of pulse counter

(3) When a point where the motor stops for a certain time is found, press the FUNC/HIGH key and the axis key of the adjusted axis (the +R/R/+X or -R/L/-X key in the case of the X axis) simultaneously. Then appropriate offset will be written in the values in the System Generation 「ORGIN」→「EXPANSION」→「D/A REF OFFSET＊」[i], and the SERVO OFFSET adjustment for the axis will be completed.

(4) Perform the steps (1) to (3) on the remaining axes.

(5) When you have finished the adjustment on all the axes, switch the mode with the selector switch of the controller to exit the SERVO OFFSET adjustment mode.

[i] Refer to 18.5.2 “EXPANSION A.”

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CHAPTER 21 INITIALIZING SYSTEM DATA

21.1 Outline

The System Data is semi-fixed data used for operating the robot. It consists of characteristic data of the robot and the data for optimizing the robot for the system. It is not necessary to change the data once the robot is incorporated in the system. Improper data can cause a malfunction or failure of the robot.

Initialization of the System Data is to be performed in case the System Data is corrupted because of battery exhaustion.

If the System Data is initialized, its default values will be restored.

CAUTION

Before starting the operation of the robot, be sure to set applicable parameters and enter necessary data, and keep a record of the values set. Some types of controllers have servo parameters, which will not be initialized even if the system data is initialized. For details, refer to the Robot Controller User's Guide attached to your controller.

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21.2 Setting Default Values to the System

The following is the procedure for restoring the default values of the System Data.

(1) Switch the Teach Pendant to the KEY-IN mode.



(2) Press the SHIFT key to let the 『SHIFT』 LED light up.

(3) While holding down the FUNC HIGH key, press the READ key.

(4) The message

"DEFAULT COPY OK?"

will appear on the message line. Then press the ENTER key. When you wish to cancel the copying, press any key other than the ENTER key.

CAUTION

After restoring the default values, be sure to reset the System Data to its original state referring to the record made when the system was delivered. If there is a System Data list attached to the controller, perform settings referring to this list.

Position data stored in the robot is X-Y coordinate data. When performing positioning, the robot converts the X-Y coordinate data into pulse data with reference to the initial data (「INITIAL A」, 「INITIAL B1」, and 「INITIAL B2」) and the arm length data (「LENGTH A」 and 「LENGTH B」) in the System Generation「ADJUST」→「AR TYPE ADJUST」 group. For this reason, positions taught cannot be reproduced if the initial data and/or the arm length data is altered after the completion of teaching.

The following parameters in the System Generation will not be affected by the restoration of defaults if their values are within specific ranges. The data of these parameters must be checked after the restoration of defaults.

Table 21. 1 System Generation parameters not affected by restoration of defaults

Parameter	Data location	Data range
Initial data	「ADJUST」→「AR TYPE ADJUST」→「INITIAL A」, 「INITIAL B1」, 「INITIAL B2」	Default ±90° (Varies depending on the model.)
Arm length	「ADJUST」→「AR TYPE ADJUST」→LENGTH A」, 「LENGTH B」	Default ±90° (Varies depending on the model.)
MB COMBINATION	「ADJUST」→「MB TYPE ADJUST」→「MB COMBINATION」	0000 – 9999
A-CAL direction	「ORIGIN」→「AXIS DIRECTION」→「A-CAL DIR. A」 - 「A-CAL DIR. C」	0(PLUS)、or 1(MINUS)
AXIS TYPE	「ORIGIN」→「AXIS SELECT」→「A AXIS TYPE」 - 「C AXIS TYPE」	0(NOT USED)、or 1(USED)
AXIS SELECT	「ORIGIN」→「AXIS SELECT」→「A AXIS SEL」 - 「C AXIS SEL」	0(NOT HOLD)、or 1(HOLD)

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In the event of the "SYSTEM DATA ERROR," be sure to restore the defaults of the System Data, and then edit the data. After completing the data edit, turn the power off and on again without fail.

CAUTION

The data of the above parameters MUST be recorded and stored immediately after the delivery of the system from HIRATA Corporation's robot plant. In case you restore the defaults without storing the above data, contact HIRATA Corporation for data stored at our end.

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21.3 Setting for SCARA (Horizontal Multi-Articulated Type) Robot

The SCARA robot requires the following settings after the initialization of the System Data.

(1) Set the data in the System Generation 「ORIGIN」→「AXIS DIRECTION」→「A-CAL DIR.A」 - 「A-CAL DIR.B」so that counterclockwise rotations of the A, B, and W axes will be sensed as rotations in a plus direction when their position data are displayed in angles.

(2) Set the attitude for A-CAL as shown in the figure below. When the arm may cause interference, perform the setting on an axis basis.

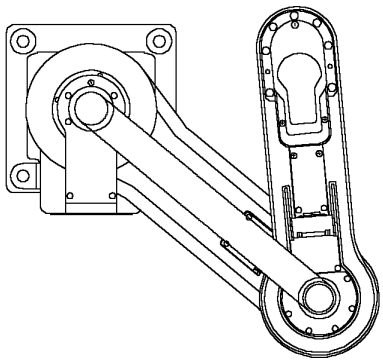


Fig. 21. 1 Attitude for A-CAL

(3) Set the values in the System Generation 「ORIGIN」→「AXIS DIRECTION」→「INITIAL A」 and 「INITIAL B」 so that displayed angle data of the A, B, and W axes will be "0" when the arm is in the attitude shown in the figure below.

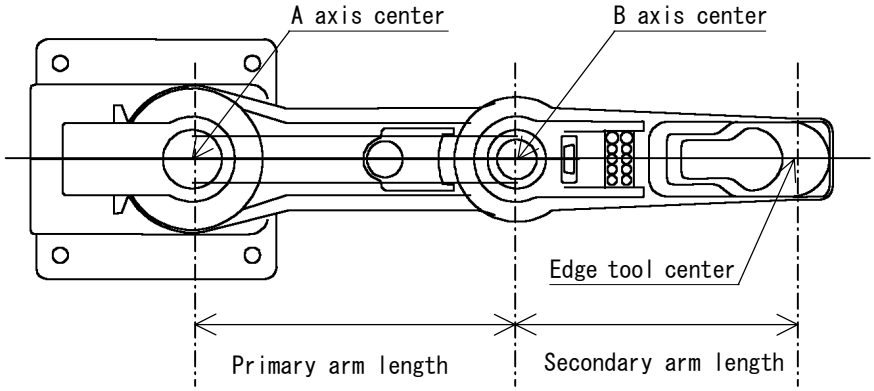


Fig. 21. 2 Attitude for setting「INITIAL A」,「INITIAL B」

Table 21. 2

Type	First arm length 「INITIAL A」	Second arm length 「INITIAL B」
AR-C350-4	350	300
AR-C270-4	270	230

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CHAPTER 22 INITIALIZING POSITION DATA

The position data stored in the robot is to be initialized in case position data is corrupted.

The following is the procedure for initializing the position data in the robot.

(1) Press the FUNC/HIGH + p.ed/5 keys to switch to the position memory block operation mode.

The object of the initialization is address 0 to the address specified by the System Generation「LIMIT」→「ADDRESS MAX」→「ADDRESS MAX」. On the initial screen, only the shaded area in Figure 22.1 is displayed. To scroll the screen and display「MODE COMMAND」, press the up/DOWN key.

```
POSITION COMMAND
START ADDRESS      0000
END ADDRESS        0000
SET ADDRESS        0000
MODE COMMAND    [MOVE]
    Push END Key !!
```

Fig. 22. 1 Block operation mode screen

(2) Enter "0" in「START ADDRESS」, and enter the value in the System Generation「LIMIT」→「ADDRESS MAX」→「ADDRESS MAX」in「END ADDRESS」. It is not necessary to set「SET ADDRESS」. Enter data by the following procedure. The procedure for entering data is common among the parameters.

SHIFT

① Move the cursor to a desired parameter. To move down the cursor, use the up/DOWN key. To move up the cursor, press the SHIFT key to let the 『SHIFT』 LED light up, and then press the up/DOWN key.

② Enter data with the numeric keys such as */0, cal/1, and task/2.

③ Press the ENTER key. The message "ENTER OK?" will appear on the message line, and a buzzer will sound.

④ Check that the entered data is correct, and press the ENTER key again. The data will then be fixed.

(3) Select "INIT" for「MODE COMMAND」.

① Press the io/SEL key repeatedly until "INIT" appears.

② Check that selected data is correct, and press the ENTER key. Then the message

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"ENTER OK? "
will appear on the message line, and a buzzer will sound.

③ Recheck that the selected data is correct, and press the ENTER key again. This data will then be fixed.

(4) Press the END key. The message

"Position INIT Ok ?"
will appear.

(5) Press the ENTER key to execute the INIT command.

(6) Initialization is complete when the message

"INIT Completed !!"
is displayed.

(7) The following is an example of initialized data.

```
0010 M?? F99 S00 L 0
 X 0000.00 Y 0000.00
 Z 0000.00 W 0000.00
 KEY-IN
```

Fig. 22. 2 Initialized data

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CHAPTER 23 MESSAGE

The following tables are the messages displayed on the message line on the Teach Pendant. Also, error messages are displayed. Refer to these messages for trouble-shooting.

23.1 General Message

Table 23. 1 General Message

Message	Mode	Description
A-CAL COMPLETE	TEACH CHECK	A-CAL completed normally. 『A-CAL』 LED light up.
A-CAL INCOMPLETE	TEACH CHECK AGING	A-CAL incomplete. Error is occurred during A-CAL execution. Intend to perform the aging before A-CAL completion.
A-CAL OK?	TEACH CHECK	The A-CAL key is pressed to perform A-CAL.
AXIS SELECT OFF	TEACH CHECK	No axis is selected for A-CAL.
CHECK SPEED DATA >	CHECK	Sets the speed of the robot in CHECK mode.
COMPLETE	CHECK	Positioning complete normally.
COMPLETED!!		Completes memory card transaction.
DEFAULT COPY OK?	KEY-IN	Copies the System Data default value in KEY-IN mode.
DELETE OK?	KEY-IN CHECK	The SHIFT + del INS keys are pressed.
END POINT	CHECK	Intend to perform the positioning to END point in CHECK mode.
END WRITE OK?	KEY-IN TEACH	The END key is pressed.
ENTER OK?	KEY-IN TEACH CHECK	The ENTER key is pressed. Press the ENTER key again for data input.
INCOMPLETE	CHECK	The START key is pressed in the middle of positioning. Error is occurred during positioning.
INSERT OK?	KEY-IN TEACH	The del INS key is pressed.

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23.2 Error Message

Table 23. 2 Error Message

Error Message	Mode	Description	Corrective Action
A-CAL INCOMLETE	TEACH CHECK ON-LINE	A-CAL is not executed normally.	Refer to Chapter 3, "A-CAL (Automatic Calibration)."
A-CAL WARNING!!	TEACH CHECK ON-LINE	When the System Generation 「MAINTENANCE」→「MAINTENANCE DATA」→「A-CAL CHECK」 is set to "1" and A-CAL is not executed normally.	
ACAL ERR *0 Not Find ACAL ERR *1 Not Off ACAL ERR *2 Other On ACAL ERR *3 Not Zero ACAL ERR *4 Lower ACAL ERR *5 Upper ACAL ERR *6 Minus ACAL ERR *7 Error	TEACH CHECK ON-LINE	A-CAL cannot be completed normally. '*' is correspond the each axis. A…X(A)-Axis B…Y(B)-Axis Z…Z-Axis, W…W-Axis	Refer to 3.6 "A-CAL Related Error."
ADDRESS ERROR	KEY-IN TEACH ON-LINE	The value for the input or motion address is out of range in the System Data, 「ADDRESS MAX」[i].	Set the large value for 「ADDRESS MAX」. Correct the designated address.
AGING STOP(Start)	AGING	Aging is completed for the aging count.	
AREA ERROR ****** "******" is designates as X(A), Y(B), Z, W, R,C-Axis status in the sequence.	KEY-IN TEACH CHECK ON-LINE	The designated value is out of the operation area of the robot. "*" is one of the numbers from 0 - 3. 0…Normal, 1…Over the lower limit 2…Over the upper limit 3…Over the both limit	Check the value of the System Generation, 「LIMIT」→「AREA LIMIT」 group and input the value which is inside of the operation area.
AXIS SELECT OFF	TEACH CHECK	Selection of an axis not permitted to use.	Check the Dip Switch of the CPU board and the System Generation 「ORGIN」→「AXIS SELECT」 group. Turn on the power of controller again.
Address Error (Automatic calculation error)	KEY-IN	Address is improper.	
Axis Not Used (Automatic calculation error)	KEY-IN	The axis subject to calculation is set to "NOT USED."	Reset the data.
BCC WRITE ERROR (Memory card abnormal)	KEY-IN TEACH CHECK	Error occurred while file check character is written.	Rewrite the data. If error persists, memory card is corrupted. Use another card.
BEZIER ERROR	CHECK ON-LINE	The value with which PASS PTP operation cannot be performed is set. ・M data is too large. ・Accelerating/decelerating is too large. ・Speed is too large.	Contact Hirata Robotics Division.
CARD FULL!! (Memory card abnormal)	KEY-IN TEACH CHECK	Attempt was made to save data beyond memory card capacity.	Delete unnecessary file(s), and save the data again.
CARD NOT READY!! (Memory card abnormal)	KEY-IN TEACH CHECK	Memory card is not ready.	Insert memory card.
CARD SUM ERROR (Memory card abnormal)	KEY-IN TEACH CHECK	System area of memory card is corrupted.	Execute the FORMAT command in utilities. Refer to 13.7.5 "FORMAT command."
CHECKSUM ERROR	CHECK ON-LINE	The position data is not entered or destroyed.	Enter the position data again.
COMMAND ERROR	ON-LINE	A command is abnormal in HRCS-RⅢ.	Refer to HRCS-RⅢ manual.
CONVERT ERROR	CHECK ON-LINE	X-Y coordinates cannot be exchanged.	Enter the position data.

[i] System Generation, 「LIIMIT」→「ADDRESS MAX」→「ADDRESS MAX」

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Error Message	Mode	Description	Corrective Action
DATA CHECK SUM ERROR!! (Memory card abnormal)	KEY-IN TEACH CHECK	File check character or file data is corrupted.	Rewrite the data. If error persists, memory card is corrupted. Use another card.
DEADMAN SWITCH	TEACH CHECK	Emergency stop status when the Deadman switch is OFF.	
DRIVER ERR.**** '****' is designates as X(A),Y(B),Z,W axis in the sequence.	TEACH CHECK ON-LINE	Error has occurred in the servo amplifier/driver. '****' is one of the numbers 0 and 1. 0···Normal 1···Error occurrence (Press the READ key, check another message on the Teach Pendant.)	Check the servo amplifier/driver.
DUPLICATE COMMAND	ON-LINE	Duplicate command received in ON-LINE mode. (Controlled by HRCS-RⅢ)	
DUPLICATE FILE NAME (Memory card abnormal)	TEACH CHECK	Filename of the target file was the same as the one of the source file.	Give a different filename to the target file. Refer to 13.6.4 "COPY command."
EMERGENCY STOP	TEACH CHECK ON-LINE	Emergency Stop is activated.	Release Emergency stop status.
ENC DISCONNECTION	TEACH CHECK ON-LINE	Encoder signal is not inputted. (HNC-1**, HNC-2** series)	Check the encoder cable.
ENC ERROR **** '****' is designates as X(A),Y(B),Z,W axis in the sequence.	TEACH CHECK ON-LINE	Displayed at encoder line disconnection. '*' is one of the numbers 0 and 1. 0 : Normal 1 : A signal line is disconnected. 2 : B signal line is disconnected. 4 : M signal line is disconnected. 7 : A, B, M signal line are disconnected. (Press the READ key, check another message on the Teach Pendant.)	HNC-P38 * 4, HNC-SR36 * 4 Check the cable (from the CPU board to the motor encoder) for disconnection, the motor encoder, and the CPU board. Although only A signal is used by this controller, disconnection of B or M signal line is also displayed when an error is displayed. The value minus 6 shall be the proper value. Other models Check the cable (from the CPU board to the motor encoder) for disconnection, the motor encoder, and the CPU board.
FAT WRITE ERROR!! (Memory card abnormal)	KEY-IN TEACH CHECK	FAT cannot be written.	Rewrite the data. If error persists, memory card is corrupted. Use another card.
FILE ALREADY OPEN (Memory card abnormal)	KEY-IN TEACH CHECK	Attempt was made to open a file that has already been opened.	
FILE BAD ALLOCATION (Memory card abnormal)	KEY-IN TEACH CHECK	FAT is corrupted.	Execute the FORMAT command in utilities. Refer to 13.7.5 "FORMAT command."
FILE HANDLE FULL!! (Memory card abnormal)	KEY-IN TEACH CHECK	There are too many files opened. More than 10 files should not be opened at a time.	
FILE ID FULL!! (Memory card abnormal)	KEY-IN TEACH CHECK	Attempt was made to save data beyond the prescribed number of files. Refer to 13.7.5 "FORMAT command."	Delete unnecessary file(s), and save the data again.
FILE ID SUM ERROR!! (Memory card abnormal)	KEY-IN TEACH CHECK	File check characters do not match up.	Delete the file in question using the DELETE command. Refer to 13.6.5 "DELETE command." Delete unnecessary file(s), and retry the same operation.
FILE ID WRITE ERROR (Memory card abnormal)	KEY-IN TEACH CHECK	File check character cannot be written.	Rewrite the data. If error persists, memory card is corrupted. Use another card.
FILE NOT CLOSED (Memory card abnormal)	KEY-IN TEACH CHECK	Attempt was made to use a file control utility when files are open.	Close all the files.
FILE NOT FOUND!! (Memory card abnormal)	KEY-IN TEACH CHECK	Specified file is not found.	Check the filename.

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Error Message	Mode	Description	Corrective Action
FILE NOT OPEN (Memory card abnormal)	KEY-IN TEACH CHECK	Attempt was made to access a file that has not been opened.	
FORMAT ERROR	ON-LINE	The command format is not correct in HRCS-RⅢ.	Refer to HRCS-RⅢ manual.
FORMAT ERROR!! (Memory card abnormal)	KEY-IN TEACH CHECK	Memory card has not been initialized.	Execute the FORMAT command in utilities. Refer to 13.7.5 “FORMAT command.”
ILLEGAL ERROR	CHECK ON-LINE		Contact Hirata Robotics Division.
IMPOSSIBLE ERROR	CHECK ON-LINE	During PASS PTP operation, the travel distance is too short.	Perform reteaching while observing the distance carefully.
Incomplete!! (Automatic calculation error)	KEY-IN	Calculation cannot be performed normally.	Check setting data and teaching positions, and reset the data or perform teaching again.
Initial Data Error (Automatic calculation error)	KEY-IN	Initial data is abnormal.	Perform initialization again.
M DATA ERROR	CHECK ON-LINE	During free curve interpolation, the setting of M data for the address where operation is to be made is abnormal.	Refer to 16.4 “Free-Form curve interpolation.”
M NUMBER ERROR	CHECK ON-LINE	During PASS PTP operation, the setting of M data is not correct.	Change the M data.
Mode Error (Automatic calculation error)	KEY-IN	A mode other than KEY-IN, TEACH, CHECK is selected.	Select an appropriate mode.
OVER SPEED ERROR	CHECK ON-LINE	During PASS PTP operation or CPC operation, the speed is not properly for follow-up motion.	Contact Hirata Robotics Division.
OVERFLOW ERROR	CHECK ON-LINE	During PASS PTP operation, the robot changed the motion abruptly.	Contact Hirata Robotics Division.
OVERRUN	CHECK	The START key is pressed when overrunning.	Move the axis to the operation area.
OVERRUN **** ’****’ is designates as X(A),Y(B),Z,W axis in the sequence.	TEACH CHECK ON-LINE	The robot is in overrun area. ’*’ is one of the numbers form 0 – 3. 0･･･Normal 1･･･ORIGIN sensor side 2･･･OVERRUN sensor side 3･･･ORIGIN/OVERRUN sensor Each number describes the sensor is ON.	Move the robot to inside of the operation area, and check the position data.
P1-P2 Length Error (Automatic calculation error)	KEY-IN	Distance between P1 and P2 is too short.	Perform teaching again.
P1-P3 Length Error (Automatic calculation error)	KEY-IN	Distance between P1 and P3 is too short.	Perform teaching again.
POINT DATA ERRPR	ON-LINE	Position data is corrupted.	Perform teaching again.
POS ERROR **** ’****’ is designates as X(A),Y(B),Z,W axis in the sequence.	CHECK ON-LINE	Positioning is not completed even the robot reached at the target position. Excessive load Excessive acceleration/deceleration Improper adjustment for servo amplifier/driver ’*’ is one of the numbers 0 and 1. 0･･･Normal 1･･･Error occurrence	Adjust the servo parameters. Check if any external pressure (Pneumatic hose, cable) is exist.
POSITION DATA ERROR (Memory card abnormal)	ON-LINE	Reading data from memory card is failed during automatic operation.	Check the designated data is stored to the memory card correctly.
POSITIONING ERROR	CHECK ON-LINE	Positioning cannot be performed. Designated speed and acceleration/deceleration at the last position is exceeding. Servo gain is too small.	Adjust the servo parameters. Slow down acceleration/deceleration. Slow down the designated speed (F code) at last position.
POSITIONING WARNING	TEACH CHECK ON-LINE	“POS ERROR ****” error occurrence. System Data 「POS ERROR SELECT」[i] is set to “1.”	

[i] System Generation「MAINTENANCE」→「MAINTENANCE DATA」→「POS. ERROR SEL」

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Error Message	Mode	Description	Corrective Action
R-Offset Data Error (Automatic calculation error)	KEY-IN	Rotary offset value is abnormal.	Perform teaching again.
SENSOR NOT FIND	CHECK ON-LINE	During W-axis sensor stop, sensor is not found.	Check the sensor is connected. Check the data.
SERVO ERROR **** '****' is designates as X(A),Y(B),Z,W axis in the sequence.	TEACH CHECK ON-LINE	Servo error has occurred. '*' is one of the numbers from 0 – 2. 0: Normal 1: The motor revolution is instructed, but there is no feedback signal from encoder. 2: Even in the servo lock status, the encoder counter counts abnormally.	Check encoder cable, motor cable, or servo driver. Also, check the axis for interference with the peripheral devices, etc.
SERVO OVERFLOW!!	TEACH CHECK ON-LINE	Overflow of the counter of servo driver. (Only the robot of DD motor specification) Acceleration/deceleration is too large.	Enter a smaller accel value[i] in the System Data.
SPLINE DATA ERROR	CHECK ON-LINE	Execution error in free curve interpolation.	Refer to 16.4 "Free-Form Curve interpolation."
START MOTION ERROR	CHECK ON-LINE	The motor does not rotate. (This error occurs when a follow-up motion cannot be performed during PASS PTP operation.)	Check in the TEACH mode.
STATUS ERROR	TEACH CHECK ON-LINE	Internal processing error. An error which is not supported by the system occurred.	Press the spd / CAN key to cancel the error. Contact Hirata Robotics Division.
STOP ON(Ver.2.3 or later) INTERLOCK ON(Ver.2.2 or eariler)	TEACH CHECK ON-LINE	IN05 signal (STOP signal) of DI is ON. (Axes operations are prohibited.)	Check the peripheral devices, and turn IN05 signal (STOP signal) OFF.
SYSTEM DATA ERROR	TEACH CHECK ON-LINE	System Data is not correct or not entered.	Copy the default value of the System Data. The enter the required value of the System Data. Refer to 17.3.5 "Setting Default Values for System Data."
SYSTEM ERROR	TEACH CHECK ON-LINE	Internal processing error	Contact Hirata Robotics Division.
Scene set Error Work not Find Measurement Error Out of range Vision not online Vision not ready	CHECK AUTO ON-LINE AGING	Occurs when using the optional vision system.	Refer to Chapter 15 "OPERATION METHOD FOR VISION IN AUTO MODE."
Teaching Data Error (Automatic calculation error)	KEY-IN	Teaching data is abnormal.	Perform teaching again.
UNDERFLOW ERROR	CHECK ON-LINE	During PASS PTP operation, the robot changed the motion abruptly.	Contact Hirata Robotics Division.
UNKNOWN COMMAND	ON-LINE	There is no command in HRCS-RⅢ.	Refer to HRCS-RⅢ manual.
VERIFY ERROR!! (Memory card abnormal)	KEY-IN TEACH CHECK	File verification failed. Memory card may be broken.	Replace memory card.
WRITE PROTECT!! (Memory card abnormal)	KEY-IN TEACH CHECK	Attempt was made to write data even though write-protect switch of memory card is on.	Check the card and turn off the write-protect switch.
XY CONVERT ERROR	CHECK ON-LINE	Position data is improper.	Enter the correct data.

[i] Refer to 16.1.5 "Acceleration/Deceleration in PTP Operation," 16.2.6 "Acceleration/Deceleration in PASS PTP Operation," or 16.3.6 " Acceleration/Deceleration in CPC Operation."

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23.3 System Error Message

These errors will be displayed only on the Teach Pendant. They will not output to DO or RS-232C.

Error message	Mode	Description	Corrective Action
FPC Error	All mode	The floating operation IC in the controller is destroyed.	Contact Hirata Robotics Division.
DD Not Ready		When using DD motor, some abnormality occurs in the DD servo driver.	Check the seven-segment display on the DD servo driver. Refer to the controller manual.
MODE INT. ON STILL		Mode interruption is not released.	Replace the Teach Pendant, then check.
Buss Error		Fault occurs in the controller.	Contact Hirata Robotics Division. The cause could be overheating. Clean the filter.
Address Error			
Illigal Instruction			
Zero Divide			
1010 Emulator			
1111 Emulator			
A Not ON-LINE B Not ON-LINE Z Not ON-LINE W Not ON-LINE	All modes at turn on the power.	The data cannot be read correctly from the absolute encoder.	Check the error code on the servopack.

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CHAPTER 24 LIST OF SYSTEM GENERATION

24.1 LIMIT

24.1.1 ADDRESS MAX

Parameter	Description	Digit	Minimum unit	Standard value	Note	Set Value
ADDRESS MAX	Maximum position address value	3	1	999	0 to 999	

24.1.2 AREA LIMIT

①: SCARA (horizontal multi-articulated type) robot
②: Rectangular coordinate system robot

Parameter	Description	Digit	Minimum unit	Standard value	Note	Set Value
UPPER LMT A	X(A)-axis maximum operation area	7	±0.001 mm	①:300 ②:1000	Minimum operation area to the maximum mechanical operation area	
LOWER LMT A	X(A)-axis minimum operation area	7	±0.001 mm	0	0 to the maximum operation area	
UPPER LMT B	Y(B)-axis maximum operation area	7	±0.001 mm	①:300 ②:1000	Minimum operation area to the maximum mechanical operation area	
LOWER LMT B	Y(B)-axis minimum operation area	7	±0.001 mm	0	0 to the maximum operation area	
UPPER LMT Z	Z-axis maximum operation area	7	±0.001 mm	①:150 ②:150	Minimum operation area to the maximum mechanical operation area	
LOWER LMT Z	Z-axis minimum operation area	7	±0.001 mm	0	0 to the maximum operation area	
UPPER LMT W	W-axis maximum operation area	7	±0.001 mm	①:720 ②:720	Minimum operation area to the maximum mechanical operation area	
LOWER LMT W	W-axis minimum operation area	7	±0.001 mm	0	0 to the maximum operation area	

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24.2 MAINTENANCE

24.2.1 EXPANSION A

Parameter	Description	Digit	Minimum unit	Standard value	Note	Set Value
CPC GAIN Z	Z-axis gain at CPC operation	7	1	0	0 or 50 to200	
CPC GAIN W	W-axis gain at CPC operation	7	1	0	0 or 50 to 200	
DOWN CNT.	Check counter at PTP gate operation	7	1	0	0 to 999	
PRIV. FLAG	PRIV. FLAG	7	1	0	0 to 255	

24.2.2 EXPANSION B

Parameter	Description	Digit	Minimum unit	Standard value	Note	Set Value
INITIAL W	Mounting tool angle	7	0.001	0		
LENGTH W	Mounting tool length	7	0.001	0		
AXIS UP/DOWN	Axis direction (+/-) setting	3	1	0		
ANGLE REV.	W-axis coordinate setting	3	1	0		

24.2.3 MAINTENANCE DATA

①: Ver.2.3 or later ②: Ver.2.2 or earlier

Parameter	Description	Digit	Minimum unit	Standard value	Note	Set Value
CPC SELECT	CPC operation selection	3	1	0		
CPC LOOP TIME	Internal processing loop counter at CPC operation	3	1	0	①0 to 100 % ②0 to 100 count	
CPC SP1	CPC operation smoothness for X axis	3	1	0	0 or 50 to 200	
CPC SP2	CPC operation smoothness for Y axis	3	1	0	0 or 50 to 200	
A-CAL CHECK	A-CAL operation setting	3	1	0		
POS.ERROR SEL	Positioning error detect selection	3	1	0		
AB SLOWDOWN TIM	Slowdown time for A, B, Z axes	3	1	0	0 to 999 msec	
SERVO TYPE	Servo driver type	3	1	0		
EMP SELECT	Encoder monitor program SELECT	3	1	512		
HOLD POWER SAVE ①	Time interval setting from HOLD to breaking	3	1	0	0 to 999 msec	
EMP TRAP COUNT ②	Encoder monitor program TRAP counter					
Z SLOWDOWN TIM ①	Slowdown time for Z axis	3	1	0		
EMP TRAP COUNT2 ②	Encoder monitor program TRAP counter 2					
STATION NO ①	Station number setting (special robot only)	3	1	0	0 to 999	
EMP DELTA COUNT ②	Encoder monitor program DELTA counter					
SENSOR STOP SEL	Logic of the sensor input signal at W-axis sensor stop	3	1	0		
SENSOR COUNT	Input pulse width at W-axis sensor stop	6	0.001	0	-90.000 to +90.000	
PTP Z IN DATA	Processing method of Z-axis acceleration/deceleration	3	1	0		
POSITIONING CNT	Positioning check counter	3	1	0		

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24.3 ORIGIN

24.3.1 SET-UP SYSTEM

①: Ver.2.3 or later ②: Ver.2.2 or earlier

Parameter	Description	Digit	Minimum unit	Standard value	Note	Set Value
TRANSFER RATE	Data transfer rate for RS-232C			9600	Text selection	
ON-LINE SELECT	Function selection	1	1	0		
STOP SELECT ① INTERLOCK SEL ②	Stop signal detect method			STATUS	Text selection	
STOP ① INTERLOCK SEL ②	Stop signal function			STOP	Text selection	
STORE ADDRESS	Address setting at recovery			NEXT	Text selection	
I/O ASSIGNMENT	I/O assignment	1	1	0		
INCHING SELECT	Inching selection	1	1	0		
M DATA	M data of position data usage definition	2	1	0	0 to 99	
AUTO/ON-LINE	AUTO/ON-LINE mode selection			ON-LINE	Text selection	
EMERGENCY STOP	A-CAL selection at E.S.			KEEP	Text selection	

24.3.2 AXIS DIRECTION

Parameter	Description	Digit	Minimum unit	Standard value	Note	Set Value
A-CAL SEQ.	A-CAL sequence	4	1111	2212	8 digit: in case of HPC-740 /HPC-747 is used.	
A-CAL DIR.A	A(X)-axis A-CAL direction			PLUS	Text selection	
A-CAL DIR.B	B(Y)-axis A-CAL direction			PLUS	Text selection	
A-CAL DIR.Z	Z-axis A-CAL direction			PLUS	Text selection	
A-CAL DIR.W	W-axis A-CAL direction			PLUS	Text selection	
INCH DIR.A	A(X)-axis inching direction			PLUS	Text selection	
INCH DIR.B	B(Y)-axis inching direction			PLUS	Text selection	
INCH DIR.Z	Z-axis inching direction			PLUS	Text selection	
INCH DIR.W	W-axis inching direction			PLUS	Text selection	

24.3.3 AXIS SELECT

Parameter	Description	Digit	Minimum unit	Standard value	Note	Set Value
A AXIS TYPE	A-axis used/not used selection			USED	Text selection	
A AXIS SEL	A-axis hold/servo-lock selection			NOT HOLD	Text selection	
B AXIS TYPE	B-axis used/not used selection			USED	Text selection	
B AXIS SEL	B-axis hold/servo-lock selection			NOT HOLD	Text selection	
Z AXIS TYPE	Z-axis used/not used selection			USED	Text selection	
Z AXIS SEL	Z-axis hold/servo-lock selection			NOT HOLD	Text selection	
W AXIS TYPE	W-axis used/not used selection			USED	Text selection	
W AXIS SEL	W-axis hold/servo-lock selection			NOT HOLD	Text selection	

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24.4 ADJUST

24.4.1 AR TYPE ADJUST

Parameter	Description	Digit	Minimum unit	Standard value	Note	Set Value
INITIAL A	A-CAL reference position of A-axis	7	0.001°	110		
INITIAL B1	Initial angle B1	7	0.001°	145		
INITIAL B2	Initial angle B2	7	0.001°	145		
LENGTH A	A-axis arm length	8	0.001 mm	270	0 to 9999.99	
LENGTH B	B-axis arm length	8	0.001 mm	270	0 to 9999.99	
AXIS COMBINATION	Not used	1	1	0	Not used	

24.4.2 MB TYPE ADJUST

Parameter	Description	Digit	Minimum unit	Standard value	Note	Set Value
Y INITIAL	Y-axis initial angle	7	0.01	90	85 to 95	
MB COMBINATION	Axis combination	1	1	0	0000 to 9999	

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24.5 CAPABILITY

24.5.1 ROBOT CAPABILITY

Parameter	Description	Digit	Minimum unit	Standard value	Note	Set Value
ENC.PULSE A	A(X)-axis encoder pulse				Display only	
ENC.PULSE B	B(Y)-axis encoder pulse				Display only	
ENC.PULSE Z	Z-axis encoder pulse				Display only	
ENC.PULSE W	W-axis encoder pulse				Display only	
LEAD/GEAR A	A(X)-axis lead/gear ratio				Display only	
LEAD/GEAR B	B(Y)-axis lead/gear ratio				Display only	
LEAD/GEAR Z	Z-axis lead/gear ratio				Display only	
LEAD/GEAR W	W-axis lead/gear ratio				Display only	
MOTOR REV. A	A(X)-axis maximum motor revolution				Display only	
MOTOR REV. B	B(Y)-axis maximum motor revolution				Display only	
MOTOR REV. Z	Z-axis maximum motor revolution				Display only	
MOTOR REV. W	W-axis maximum motor revolution				Display only	

24.5.2 EXPANSION A

Parameter	Description	Digit	Minimum unit	Standard value	Note	Set Value
EXPANSION 0	Future expansion 0				Not used	
EXPANSION 1	Future expansion 1				Not used	
EXPANSION 2	Future expansion 2				Not used	
EXPANSION 3	Future expansion 3				Not used	
D/A REF OFFSET 1	Reference offset for D/A converter of X axis	4	1	0	-999 to 999	
D/A REF OFFSET 2	Reference offset for D/A converter of Y axis	4	1	0	-999 to 999	
D/A REF OFFSET 3	Reference offset for D/A converter of Z axis	4	1	0	-999 to 999	
D/A REF OFFSET 4	Reference offset for D/A converter of W axis	4	1	0	-999 to 999	
CPC INTEG GAIN	Not used				Not used	
FV TIME 0	Sampling time for X(A) and Y(B) axes	7	0.01	0	0.50 to 2.00	
FV TIME 1	Sampling time for Z axis	7	0.01	0	0.50 to 2.00	
FV TIME 2	Sampling time for W axis	7	0.01	0	0.50 to 2.00	

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CHAPTER 25 LIST OF SYSTEM PARAMETER

25.1 MOTION

25.1.1 MOTION

Parameter	Description	Digit	Minimum unit	Standard value	Note	Set Value
PULL-UP	Z-axis PULL-UP distance at PTP motion	7	0.001	10	5 to Z-axis maximum operation area	
ARCH UP	Z-axis ARCH UP distance at PTP motion	7	0.001	0	0 to Z-axis maximum operation area	
ARCH DOWN	Z-axis ARCH DOWN distance at PTP motion	7	0.001	0	0 to Z-axis maximum operation area	
INS DIS.	Z-axis Insertion distance at PTP motion	7	0.001	20	0 to Z-axis maximum operation area	
INS SPEED	Z-axis Insertion speed at PTP motion	3	1	20	0 to 99	
UP DIS.	Z-axis SLOW-UP distance at PTP motion	7	0.001	20	0 to Z-axis maximum operation area	
UP SPEED	Z-axis SLOW-UP speed at PTP motion	3	1	20	0 to 99	
Z NXT PL	Not used	7	0.001	0	Not used	

25.1.2 AXIS SPEED

Parameter	Description	Digit	Minimum unit	Standard value	Note	Set Value
SPEED A,B(X,Y)W	A,B(X,Y)W-axis speed	3	1	100	0 to 100	
SPEED B	B-axis speed for expansion	3	1	100	0 to 100	
SPEED Z	Z-axis speed	3	1	100	0 to 100	
SPEED W	W-axis speed for expansion	3	1	100	0 to 100	

25.1.3 CPC CONSTANT

①: Ver.2.3 or later ②: Ver.2.2 or earlier

Parameter	Description	Digit	Minimum unit	Standard value	Note	Set Value
CPC SPEED ①	CPC motion speed	3	1	100	0 to 999	
LINE SPEED ②	Linear interpolation speed					
CPC F.F.GAIN ①	Feedforward gain at CPC motion	3	1	100	0 to 255	
ARC/CIRCLE SPEED ②	Not used				Not used	
SPLINE SPEED	Robot speed at free curve interpolation	3	1	100	0 to 999	
CPC CONSTANT	①: Passing operation smoothness at CPC motion ②: Distance of one interpolation to another at CPC motion	3	1	0	①: 0 to 100 % ②: 0 to 499 mm	
CPC ACCEL/DECEL	Range of acceleration/deceleration at CPC motion	3	1	0	①: 0 to 499 ②: 0 to 999	

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25.2 RESPONSE

25.2.1 ACCEL

Parameter	Description	Digit	Minimum unit	Standard value	Note	Set Value
ACCEL SELECT	Acceleration/deceleration selection			AUTO	Text selection	
ACCEL AB(X, Y)W	A,B(X, Y) W-axis Acceleration/deceleration slow down	3	1	80	0 to 100	
ACCEL ABW(PASS)	A,B(X, Y) W-axis Acceleration/deceleration at PASS PTP motion	3	1	80	0 to 100	
ACCEL Z	Z-axis Acceleration/deceleration slow down	3	1	80	0 to 100	
ACCEL Z(PASS)	Z-axis Acceleration/deceleration at PASS PTP motion	3	1	80	0 to 100	

25.2.2 AXIS INP PULSE

Parameter	Description	Digit	Minimum unit	Standard value	Note	Set Value
INP PULSE A,B(X, Y)	A, B(X, Y)-axis accuracy of positioning	3	1 pulse	6	0 to 999	
INP PULSE B	B(Y)-axis accuracy of positioning for expansion	3	1 pulse	6	0 to 999	
INP PULSE Z	Z-axis accuracy of positioning	3	1 pulse	6	0 to 999	
INP PULSE W	W-axis accuracy of positioning	3	1 pulse	6	0 to 999	

25.2.3 RESPONSE

①: Ver.2.3 or later ②: Ver.2.2 or earlier

Parameter	Description	Digit	Minimum unit	Standard value	Note	Set Value
SAFETY ZONE	Safety zone setting	7	0.001	10	0 to Z-axis maximum operation area	
A-CAL SPEED	A-CAL speed	3	1	255	1 to 999	
INCHING SPEED	Inching motion speed	3	1	255	1 to 999	
PTP WEIGHT ① / WORK WEIGHT ②	Edge tool + work weight	7	0.001	0	0 to load capacity of the robot	
EXPANSION ①	Expansion	7	0.001	0	Expansion	
TOOL WEIGHT ②	Supplement for [WORK WEIGHT]				0 to load capacity of the robot	
COMPLIANCE	Not used	3	1	0	Not used	
DD INDEX GAIN ①	Gain of the index robot for DD servo level	3	1	7 or 6	0 to 7	
RESPONSE A ②	Not used				Not used	
PTP CONST AB ①	A,B-axis short distance acceleration/deceleration	3	1	0	450 to 999	
RESPONSE B ②	Not used				Not used	
PTP CONST Z ①	Z-axis short distance acceleration/deceleration	3	1	0	450 to 999	
RESPONSE C ②	Not used				Not used	
PTP CONST W ①	W-axis short distance acceleration/deceleration	3	1	0	450 to 999	
RESPONSE D ②	Not used				Not used	

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25.3 OFFSET

25.3.1 DISPLAY OFFSET1

Parameter	Description	Digit	Minimum unit	Standard value	Note	Set Value
DISPLAY X1	X-axis displayed OFFSET1	7	±0.001	0	-7999.999 to 7999.999	
DISPLAY Y1	Y-axis displayed OFFSET1	7	±0.001	0	-7999.999 to 7999.999	
DISPLAY Z1	Z-axis displayed OFFSET1	7	±0.001	0	0 to Z-axis stroke	
DISPLAY W1	W-axis displayed OFFSET1	7	±0.001	0	-540.000 to 540.000	
DISPLAY R1	R-axis (coordinate rotated) displayed OFFSET1	7	±0.001	0	-180.000 to 180.000	
TOOL X1	X-axis coordinate for edge tool1	7	±0.001	0	Not supported	
TOOL Y1	Y-axis coordinate for edge tool1	7	±0.001	0	Not supported	
TOOL Z1	Z-axis coordinate for edge tool1	7	±0.001	0	Not supported	

25.3.2 DISPLAY OFFSET2 (Not Support at Present)

Parameter	Description	Digit	Minimum unit	Standard value	Note	Set Value
DISPLAY X2	X-axis displayed OFFSET2	7	±0.001	0	-7999.999 to 7999.999	
DISPLAY Y2	Y-axis displayed OFFSET2	7	±0.001	0	-7999.999 to 7999.999	
DISPLAY Z2	Z-axis displayed OFFSET2	7	±0.001	0	0 to Z-axis stroke	
DISPLAY W2	W-axis displayed OFFSET2	7	±0.001	0	-540.000 to 540.000	
DISPLAY R2	R-axis (coordinate rotated) displayed OFFSET2	7	±0.001	0	-180.000 to 180.000	
TOOL X2	X-axis coordinate for edge tool2	7	±0.001	0	Not supported	
TOOL Y2	Y-axis coordinate for edge tool2	7	±0.001	0	Not supported	
TOOL Z2	Z-axis coordinate for edge tool2	7	±0.001	0	Not supported	

25.3.3 DISPLAY OFFSET3 (Not Support at Present)

Parameter	Description	Digit	Minimum unit	Standard value	Note	Set Value
DISPLAY X3	X-axis displayed OFFSET3	7	±0.001	0	-7999.999 to 7999.999	
DISPLAY Y3	Y-axis displayed OFFSET3	7	±0.001	0	-7999.999 to 7999.999	
DISPLAY Z3	Z-axis displayed OFFSET3	7	±0.001	0	0 to Z-axis stroke	
DISPLAY W3	W-axis displayed OFFSET3	7	±0.001	0	-540.000 to 540.000	
DISPLAY R3	R-axis (coordinate rotated) displayed OFFSET3	7	±0.001	0	-180.000 to 180.000	
TOOL X3	X-axis coordinate for edge tool3	7	±0.001	0	Not supported	
TOOL Y3	Y-axis coordinate for edge tool3	7	±0.001	0	Not supported	
TOOL Z3	Z-axis coordinate for edge tool3	7	±0.001	0	Not supported	

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25.4 SET-UP

25.4.1 EXPANSION A

Parameter	Description	Digit	Minimum unit	Standard value	Note	Set Value
PASS PTP Select	PASS PTP selection	3	1	0		
Base Pos Addr1	Base position address 1	3	1	0	0 to 999	
Base Pos Addr2	Base position address 2	3	1	0	0 to 999	
Base Pos Addr3	Base position address 3	3	1	0	0 to 999	
Base Pos Addr4	Base position address 4	3	1	0	0 to 999	
Base Pos Pulse	Base position pulse	5	1	0	0 to 99999	
Safety select	Reference point for 「ARCH UP」 or 「SAFETY ZONE」	3	1	0		

25.4.2 EXPANSION B

①: Ver.2.3 or later ②: Ver.2.2 or earlier

Parameter	Description	Digit	Minimum unit	Standard value	Note	Set Value
SENSOR OFF	W-axis sensor stop OFFSET	7	0.001	0	-99.000 to 99.000	
SENSOR SKIP	W-axis sensor stop OFF area	7	0.001	0	0 to 360	
AREA OUT AX	A(X)-axis area output	7	0.001	0	SCARA robot : -360 to 360 Rectangular coordinate system robot : -7999.999 to 7999.999	
AREA OUT BY	B(Y) -axis area output	7	0.001	0	SCARA robot : -360 to 360 Rectangular coordinate system robot : -7999.999 to 7999.999	
Z MID OFF.	Z axis middle offset	7	0.001	0	450 to 999	
Z2 PULL-UP ①	2nd Z-axis PULL-UP distance at PTP motion	7	0.001	0	5 to 2nd Z-axis maximum operation area	
Y ARCH UP ②	Y-axis ARCH UP distance at PTP motion	7	1	0	0 to 100	
Expansion ①	Not used	7	0.001	0	Not used	
Y ARCH UP ②	Y-axis ARCH DOWN distance at PTP motion	7	1	0	0 to 100	

Option (Conveyor follow-up motion)

Parameter	Description	Digit	Minimum unit	Standard value	Note	Set Value
CV Z DIS	Z-axis standby position	7	0.001	0	0 to 999.999	
CV Z SPD	Z-axis speed from standby position to target position	3	1	0	0 to 999	
CV ESC1 DIS	Distance for slow down and stop at conveyer follow-up motion	7	0.001	0	450.000 to 999.000	
CV ESC12 DIS	Distance for travel in a direction square to the conveyer	7	0.001	0	450.000 to 999.000	
CV CV SPEED	Conveyer travel speed	3	1	0	0 to 999	

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25.5 REMOTE

25.5.1 MOTION

Parameter	Description	Digit	Minimum unit	Standard value	Note	Set Value
PULL-UP	Z-axis PULL-UP distance at PTP motion				Display only	
ARCH UP	Z-axis ARCH UP distance at PTP motion				Display only	
ARCH DOWN	Z-axis ARCH DOWN distance at PTP motion				Display only	
INS DIS.	Z-axis Insertion distance at PTP motion				Display only	
INS SPEED	Z-axis Insertion speed at PTP motion				Display only	
UP DIS.	Z-axis SLOW-UP distance at PTP motion				Display only	
UP SPEED	Z-axis SLOW-UP speed at PTP motion				Display only	

25.5.2 SPEED/ACCEL/INPOS

Parameter	Description	Digit	Minimum unit	Standard value	Note	Set Value
SPEED A,B(X,Y)W	A,B(X,Y)W-axis speed				Display only	
SPEED B	B-axis speed for expansion				Display only	
SPEED Z	Z-axis speed				Display only	
SPEED W	W-axis speed for expansion				Display only	
ACCEL A,B(X,Y)W	Ａ,B(X, Y) W-axis Acceleration/deceleration slow down				Display only	
ACCEL ABW(PASS)	Ａ,B(X, Y) W-axis Acceleration/deceleration at PASS PTP motion				Display only	
ACCEL Z	Z-axis Acceleration/deceleration slow down				Display only	
ACCEL Z(PASS)	Z-axis Acceleration/deceleration at PASS PTP motion				Display only	
INP PULSE A,B	A, B(X, Y)-axis accuracy of positioning				Display only	
INP PULSE B	B(Y)-axis accuracy of positioning for expansion				Display only	
INP PULSE Z	Z-axis accuracy of positioning				Display only	
INP PULSE W	W-axis accuracy of positioning				Display only	

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25.5.3 REMOTE MOTION

①: Ver.2.3 or later ②: Ver.2.2 earlier

Parameter	Description	Digit	Minimum unit	Standard value	Note	Set Value
CPC SPEED ①	CPC motion speed				Display only	
LINE SPEED ②	Linear interpolation speed					
CPC F.F.GAIN ①	Feedforward gain at CPC motion				Display only	
ARC/CIRCLE SPEED ②	Not used				Display only	
SPLINE SPEED	Robot speed at free curve interpolation				Display only	
A-CAL SPEED	A-CAL speed				Display only	
INCHING SPEED	Inching motion speed				Display only	
A-CAL SEQ	A-CAL sequence				Display only	
PTP WEIGHT ①	Edge tool + work weight				Display only	
WORK WEIGHT ②						
EXPANSION ①	For expansion				Display only	
TOOL WEIGHT ②	Supplement for [WORK WEIGHT]				Display only	
LOACL COORDINATE	Not used				Display only	
W AXIS ACCEL	W-axis acceleration for expansion				Special specification	
W AXIS DECEL	W-axis deceleration for expansion				Special specification	
OPTION DATA 1	Option data 1				Special specification	
OPTION DATA 2	Option data 2				Special specification	
OPTION DATA 2	Option data 3				Special specification	

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CHAPTER 26 REFERANCE DATA

26.1 Robot Speed during Manual Operation

This section describes the speed limit that is applied to manual operations (KEY-IN, TEACH, and CHECK modes).

The VDE standards require the travel speed at a robot edge to be 250 mm/sec or lower during manual operation. To comply with these standards, our robots are designed not to exceed the 250 mm/sec according to the following formula.

$$\text{Maximum speed output} = \frac{\text{VDE starndard or lower}}{\text{Maximum axis speed(cata log value)(mm / sec)}} \times 1024$$

(1) Rectangular coordinate system robot (Example: GR1500)

The formula for maximum speed output for the rectangular coordinate system robot is as shown below.

$$\text{Maximum speed output} = \frac{\text{VDE starndard or lower}}{\text{Maximum axis speed(cata log value)(mm / sec)}} \times 1024$$

$$= \frac{\text{250 mm / sec or lower}}{\text{Maximum axis rotation speed} \times \text{Lead value} / \ 60} \times 1024$$

① X and Y axes

$$\text{Maximum speed output} = \frac{250\text{mm / sec}}{1500\text{mm / sec}} \times 1024$$

$$= 170$$

② Z axis

$$\text{Maximum speed output} = \frac{150\text{mm / sec}}{500\text{mm / sec}} \times 1024$$

$$= 204$$

③ W axis

$$\text{Maximum speed output} = \frac{90\text{degree/sec}}{432\,\text{deg ree / sec}} \times 1024$$

$$\fallingdotseq 213$$

(2) SCARA (horizontal multi-articulated type) robot (Example: AR-C270)

The formula for maximum speed output for the SCARA robot is as shown below.

$$\text{Maximum speed output} = \frac{\text{VDE starndard or lower}}{\text{Maximum axis speed(cata log value)(mm / sec)}} \times 1024$$

$$= \frac{\text{250 mm / sec or lower}}{\text{(A - axis edge speed + B – axis edge speed)} \times 3.14}$$

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Maximum speed output=

$$\frac{250\text{mm/sec}}{((270\text{mm}\times 3600\text{r/min}/50\times 60)+(230\text{mm}\times 3600\text{r/min}/50\times 60))\times 3.14}\times 1024$$

=170

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CHAPTER 27 SIMPLE FOLLOW-UP MOTION BY M DATA 40 - 49

Specific robots are capable of performing conveyor follow-up motion between given addresses, where the Y axis travels following up the conveyor while the X and Z axes perform positioning by normal PTP (Point To Point) operation.

This chapter describes a simple conveyor follow-up motion by the use of M data 40 - 49.

This conveyor follow-up motion is possible only to the rectangular robot. For the multi-articulated type robot, the conveyor follow-up motion described in 16.7 “Conveyor Follow-up Motion (Option)“ is available.

To use this conveyor follow-up motion, set the M data of applicable addresses to M40 - M49. The Y axis continues follow-up motion until an address with M data other than M40 - M49 is given.

The conveyor follow-up speed can be specified by either the data measured by the motor encoder or the System Parameter data.

27.1 Specifications

This follow-up motion requires the following special specifications.

- Recommended conveyor encoder specifications

  1000 pulse/revolution (5V) line driver output

- Recommended deceleration ratio

  20 rotation/m (20,000 pulse generation/m)

- Conveyor encoder input connector

  Each controller has a connector for conveyor encoder input. For reference, the connector on the HNC-P38＊4 controller is shown in the following.

  If using a controller other than HNC-P38＊4, consult HIRATA Corporation.

  Controller-side connector: MS3102A-20-7S

  External-side connector: MS3106B-20-7P (Attachment)

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Table 27.1

Pin no.	Signal name
A	A
B	$\overline{A}$
C	B
D	$\overline{B}$
E	Z
F	$\overline{Z}$
G	5V
H	0V

- Specialized software

For details, contact HIRATA Corporation.

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27.2 System Data Setting

To enable the conveyor follow-up motion, set the following System Data.

(1) System Generation「MAINTENANCE」→「MAINTENANCE DATA」group

(2) System Generation「ADJUST」→「MB TYPE ADJUST」group

(3) System Generation「ORIGIN」→「AXIS SELECT」group

(4) System Parameter「SET-UP」→「EXPANSION B」group

Required settings are described in detail in the following sections.

27.2.1 Setting of System Generation

(1) 「MAINTENANCE」→「MAINTENANCE DATA」group

- CPC SELECT
  0 : Performs follow-up motion without using encoder input
  256 : Performs follow-up motion using encoder input
  Select "256" when the encoder is used.

(2) 「ADJUST」→「MB TYPE ADJUST」group

- MB COMBINATION
  0: Normal setting (XYZW)
  5: Used to interchange the X axis and the Y axis (YXZW)
  The conveyor follow-up motion is applicable only to the plus-direction motion of the Y axis. In the case of a one-axis spec robot or when you wish to let the X axis follow up the conveyor for reason of system layout, set「MB COMBINATION」to "5" to interchange the X axis and the Y axis.



Interchange of the X and Y axes may be impossible when they have different specifications. In that case, ROM must be replaced to modify the software.

(3) 「ORIGIN」→「AXIS SELECT」group

- B(Y) AXIS SEL
  Select "HOLD (SERVO LOCK) " for the conveyor follow-up axis.
- W AXIS TYPE
  Select "NOT USE."

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27.2.2 Setting of System Parameters

Set the System Parameter「SET-UP」→「EXPANSION B」 group.

NOTE

The following parameters are available only when the conveyor follow-up motion is supported. Normal controllers cannot set these parameters. They are not described in Chapter 19 "DETAILS OF SYSTEM PARAMETER."

- CV PULSE/m

  Set this parameter when the conveyor to be followed up has an encoder.

  Calculate and enter a pulse count per one meter of the conveyor. If the follow-up is not performed satisfactorily with this value, obtain an actual pulse count by measurement according to the following procedure.

  ① Let the robot perform follow-up motion in the AUTO mode. (M = 40 - 49)

  ② Stop the robot, and record the value stored in 「COMP. W」[i].

  How to read the data in「COMP.W」

  - Press the FUNC/HIGH + cal/1 key to call up the ROBOT CALCULATE MODE screen.

```
ROBOT CALCULATE MODE
1. CALC.      2. OFFSET
3. MEMORY     4. DISP
5. OPTION
```

Fig. 27. 1 ROBOT CALCULATE MODE screen

  - Press the mot/3 key 「3.MEMORY」 to call up the MEMORY screen.

```
MEMORY MODE
1. A-CAL COMPARE
2. ABS. DATA SET
```

Fig. 27. 2 MEMORY screen

  - If the cal/1 key「1.A-CAL COMPARE」 is pressed on the above screen, the following screen will appear. To scroll the screen and display 「COMP.W」, press the up/DOWN key.

[i] Although 「COMP.W」 is not supported under normal conditions, it is used as an exception in this follow-up motion. Refer to 12.3.1 "A-CAL COMPARE (A-CAL compensation)."

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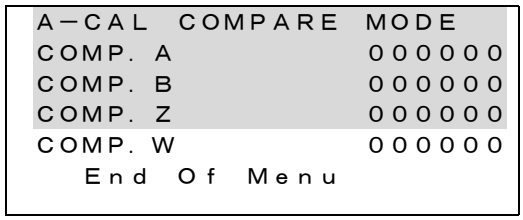


Fig.27. 3 A-CAL COMPARE screen

③ Enter the value of「COMP. W」into「CV PULSE/m」.

- CV RESPONSE

  Set the responsiveness of the conveyor follow-up.

  - Setting range: 0 - 100
  - Standard value: 30 (Response to the conveyor is best at "100," however, motion can be jerky when input from the encoder varies greatly. Adjust this parameter for proper motion according to need.)

- CV CV SPEED
  - Number of digits: 3
  - Setting range: 0 - 999
  - Minimum unit: 1
  - Standard value: 0

  Set the travel speed of the conveyor in mm/sec.

  This parameter is used when follow-up is performed without the use of encoder input.

- CV DIRECTION

  0: Performs conveyor follow-up in +Y direction.

  1: Performs conveyor follow-up in -Y direction.

  Direction of normal conveyor follow-up is the +Y direction only. When you wish a follow-up in a reverse direction, set this parameter to "1."

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27.3 Conveyor Follow-up Motion

Specific robots are capable of performing conveyor follow-up motion between given addresses, where the Y axis travels following up the conveyor while the X and Z axes perform positioning by normal PTP (Point To Point) operation.

To use this conveyor follow-up motion, set the M data of applicable addresses to M40 - M49. The Y axis continues follow-up motion until an address with M data other than M40 - M49 is given.

NOTE

When the robot is moved to an address with M data 40 - 49 by the START or NEXT signal, the Y axis will follow up the conveyor, and then the X and Z axes will perform positioning by PTP (Point To Point) operation.

This section explains the conveyor follow-up motion taking as an example the case where the robot picks up a work waiting on conveyor B1, and places it on conveyor C1 that is moving.

In this example, the axis along conveyor C1 (Y axis) follows up the conveyor.

The robot performs follow-up motion between PM11 and PM12. The flow of operation is as shown below.

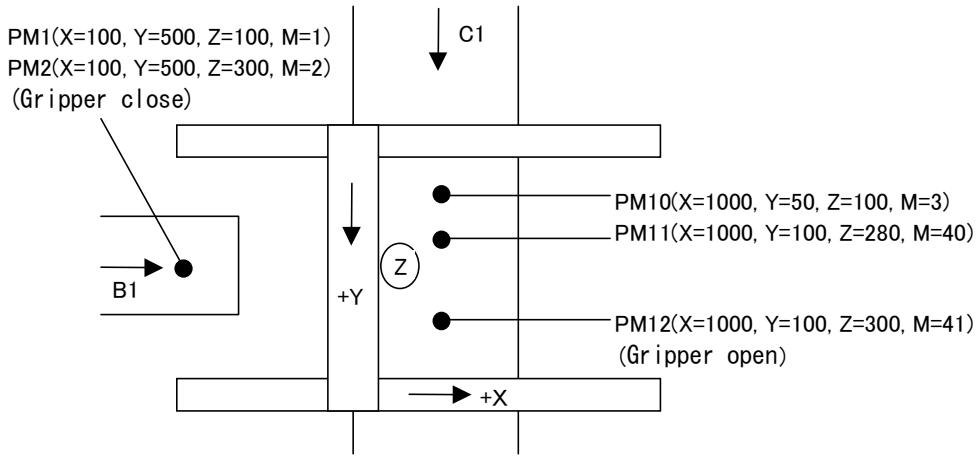


Fig. 27. 4

(1) PLC moves the robot to PM1 (M data = 1), the work waiting position above conveyor B1.

(2) When a work arrives at the stopper position on conveyor B1, PLC moves the robot to PM2 (M data = 2), the work grasping position.

(3) PLC lets the robot grasp the work, and then moves the robot to PM10 (M data = 3) above conveyor C1.

(4) PLC checks that there is no work on conveyor C1, and directs the robot to move to PM11 (M data = 40). The Y axis starts moving at the specified follow-up speed. When the Y axis has passed the Y-axis position of PM11, the X and Z axes start PTP operation.

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(5) When the X and Z axes have completed positioning to PM11 (the Y axis is still continuing follow-up motion), the PCA signal (HNC output port No. 2) and the M40 signal (HNC output port No. 14) are outputted from the controller. Then PLC moves the X and Z axes to PM12 (M data = 41) above conveyor C1.

(6) When the X and Z axes have completed positioning to PM12, PLC opens the hand gripper.

(7) PLC directs the robot to move to PM1, and the follow-up motion of the Y axis is finished.

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27.4 Cautions

(1) Selection of follow-up axis and direction

When the robot system is laid out as shown in the figure below, set the parameters as follows. (Refer to 27.2.1 and 27.2.2.)

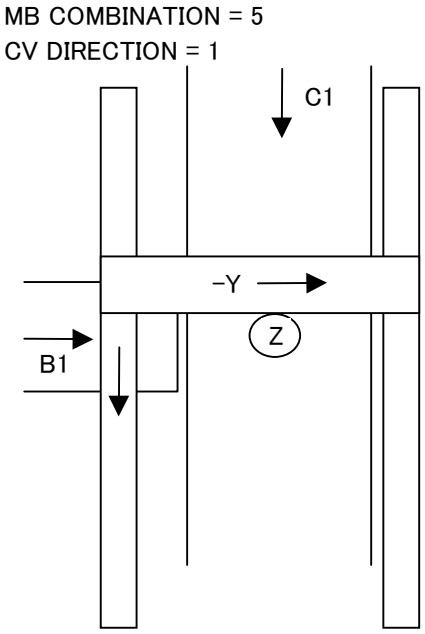


Fig. 27. 5

(2) Resumption from stop by IN5 (STOP signal) ON

The robot stops if IN5 (STOP signal) turns ON during follow-up motion. To resume the operation, turn OFF the IN5 signal, and specify a desired destination address. If IN1 (START signal) is then turned ON, the robot will move to the specified address and resume the operation. The destination address specified here must have M data other than M40 - M49.

(3) Operation in CHECK mode

In the CHECK mode, the robot performs normal PTP operation, not the conveyor follow-up motion.

(4) INSERTION motion / SLOW-UP motion

When M data between M40 and M49 is given, the system judges that the follow-up motion is specified. Therefore, it is not possible to specify the Z axis' INSERTION / SLOW-UP motion in the usual way with M40 - M49. To specify the INSERTION / SLOW-UP motion, use the S code.

- Slow-up motion
  Set the S code of the applicable address to 94.
- Insertion motion
  Set the S code of the applicable address to 95.

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(5) Interlock function

Addresses with M40 - M49 enable an interlock that starts the X and Z axes according to Y-axis position data. The X and Z axes start PTP operation when the follow-up axis (Y axis) has passed a specified position.

(6) Installation of follow-up area limit sensor

The Y axis continues follow-up motion until the robot is directed to move to an address with M data other than M40 - M49. We recommend that you install a follow-up area limit sensor to avoid interference by malfunctions.

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APPENDIX

APPENDIX A I/O Allocation

The following table describes the DI/DO signal allocation and description for each signal during the automatic operation in AUTO mode.

Table A.1 Assignment of DI Signals in AUTO Mode

Signal	Signal name	Description
IN0	SELECT	Operation ready demand signal
IN1	START	Positioning start signal
IN2	NEXT	Next positioning start signal
IN3	HOLD	Servo lock signal
IN4	POS/INCH	Switches IN6 - IN15 signals. When ON, switches them to position address signals; when OFF, to manual operation signals for inching operation.
IN5	STOP	Stop robot motion when ON
IN6	ADDRESS 8 [256]/Axis	Switched by IN4. ・ Perform PTP operation when serving as position address signals. Specification of an address shall be made in binary form (figures in square brackets). ・ Serve as manual operation signals during inching operation. IN8 - IN11 are switched by IN6. When IN6 is ON, the R and C axes are operated; when OFF, the X and Y axes are operated. When IN7 is ON, inching is performed at a high speed.
IN7	ADDRESS 9 [512]/High speed	
IN8	ADDRESS 0 [1] /+X(+R)	
IN9	ADDRESS 1 [2] /-X(-R)	
IN10	ADDRESS 2 [4] /+Y(+C)	
IN11	ADDRESS 3 [8] /-Y(-C)	
IN12	ADDRESS 4 [16] / ↑ Z	
IN13	ADDRESS 5 [32] / ↓ Z	
IN14	ADDRESS 6 [64] /+W	
IN15	ADDRESS 7 [128]/-W	

Table A.2 Assignment of DO Signals in AUTO Mode

DO signal	Signal name	Description
OUT0	READY	Operation ready signal
OUT1	ERROR	Error detection signal
OUT2	PCA	Positioning permission signal
OUT3	AUTO	AUTO mode signal
OUT4	BP・AREA	PASS PTP output or area output
OUT5	ZONE	Z axis zone output
OUT6	CPOUT	Output in CPC operation
OUT7	A-CAL	Return to origin completion
OUT8	MOUT0(1) /W	Signals assigned by M data or error codes. Figures in () are BCD.
OUT9	MOUT1(2) /Z	
OUT10	MOUT2(4) /Y	
OUT11	MOUT3(8) /X	
OUT12	MOUT4(10) /	
OUT13	MOUT5(20) /	
OUT14	MOUT6(40) /	
OUT15	MOUT7(80) /	

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The MOUT signals are related to the M-data, which is the output pattern to the output port of the robot driver. M-data can be set from 0 to 99 and output in the combinations below (BCD [i]). The first digit is described by the MOUT 0-3 signal and the MOUT 4-7 signal for the second digit.

For example, M-data=15 means the combination of M-data=10 and M-data=5 is output. The blanks in the table mean OFF.

At the END POINT (M-data=??), all of the MOUT signals are ON.

Table A.3 M-Data Output

M-data \ MOUT	0	1	2	3	4	5	6	7
0								
1	ON							
2		ON						
3	ON	ON						
4			ON					
5	ON		ON					
6		ON	ON					
7	ON	ON	ON					
8				ON				
9	ON			ON				
10					ON			
20						ON		
30					ON	ON		
40							ON	
50					ON		ON	
60						ON	ON	
70					ON	ON	ON	
80								ON
90					ON			ON
?? (END POINT)		ON	ON	ON	ON	ON	ON	ON

[i] BCD (Binary-Coded Decimal Notation)

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APPENDIX B Error Code

When an error occurs in the controller during automatic operation, error message are displayed on the Teach Pendant (Refer to 23.3, “Error Message.”) and the error codes below are outputs to external devices simultaneously.

Table B. 1 Error code

Error Message	Description	Output code	
		AUTO Mode	ON-LINE Mode
POS. ERROR XXXX	Positioning cannot be completed.	0N	09
EMERGENCY STOP	Emergency Stop is activated.	10	10
A-CAL ERROR △△[i]	A-CAL cannot be completed normally.	2N	20
ADDRESS ERROR	Address exceeding the limit was specified.	30	30
M DATA ERROR	During free curve interpolation, M data of the moving address is not correct.	31	31
SENSOR NOT FIND	During W-axis sensor stop, sensor is not found.	32	32
SPLINE DATA ERROR	Free curve movement data is abnormal.	33	33
AREA ERROR XXXX	Position data is outside the area limit.	4N	40
OVERRUN XXXX	Overrun has occurred.	5N	51
SYSTEM DATA ERROR	System Generation is corrupted.	63	60
POINT DATA ERROR	Position data is corrupted.	64	61
FORMAT ERROR	ON-LINE: The command format is not correct in HRCS-RⅢ.		62
COMMAND ERROR	ON-LINE: A command is abnormal in HRCS-RⅢ.		63
UNKNOWN COMMAND	ON-LINE: There is no command in HRCS-RⅢ.		64
SERVO ERROR XXXX	Servo error has occurred.	7N	70
DUOLICATE COMMAND	ON-LINE: Duplicate command received controlled by HRCS-RⅢ.		80
Scene set Error	Vision: Scene setting is outside the setting range.	81	81
Work not Find	Vision: There is no work for detection.	82	82
Measurement Error	Vision: Measurement conditions are not satisfied.	83	83
Out of range	Vision: Measurement data is out of range.	84	84
Vision not ready	Vision: ‘NAK’ transmission was repeated.	88	88
Vision not online	Vision: There is no response from Vision.	89	89
IMPOSSIBL EERROR	During Pass PTP operation, travel distance is too short.	90	90
OVERFLOW ERROR	Contact the manufacturer.	91	
UNDERFLOW ERROR	Contact the manufacturer.	92	
OVER SPEED	Speed is too high.	93	
M NUMBER ERROR	During PASS PTP operation, the setting of M data is not correct.	94	
XY CONVERT ERROR	Positioning data is improper.	95	
POSITIONING ERROR	Positioning cannot be performed.	96	
BEZIER ERROR	Contact the manufacturer.	97	
START MOTION ERROR	Motor does not rotate.	99	94
ILLEGAL ERROR	Contact the manufacturer.	9A	
DRIVER ERROR	Error has occurred in the servo amplifier/driver.	AN	A0 (A□)
ENCODER DISCONNECT	Encoder signal is not inputted. (HNC-1**,HAC-2** series only)	B0	B0 (b□)
ENC ERROR XXXX	Encoder signal is not inputted.	BN	

An alphanumeric character out of 1 - F will be assigned to "N" in the AUTO mode error code shown above. For details as to which character will be assigned, refer to 7.1.2 “DO Signal.” For description of "XXXX," refer to 7.1.2 “DO Signal” as well.

[i] For details, refer to Chapter 3 “A-CAL.”

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APPENDIX C Data Backup and Data Load

Table A.4 Back Up and Data Load

Data	Stored Location	Backup	Default Value Setting	Data Load
System Data (System Generation, System Parameters)	RAM	Memory card	Refer to Chapter 21, “INITIALIZING SYSTEM DATA.”	Download from the memory card.
Position data	RAM	Memory card	Refer to Chapter 22, “INITIALIZING POSITON DATA.”	Download from the memory card.

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