

DX200 OPTIONS INSTRUCTIONS

FOR EXTERNAL REFERENCE POINT CONTROL FUNCTION

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

MOTOMAN INSTRUCTIONS

MOTOMAN-□□□ INSTRUCTIONS
DX200 INSTRUCTIONS
DX200 OPERATOR'S MANUAL
DX200 MAINTENANCE MANUAL

The DX200 operator's manuals above correspond to specific usage.
Be sure to use the appropriate manual.

Part Number: 166579-1CD
Revision: 0



MANDATORY

- This manual explains the functions of the DX200 external reference point control. Read this manual carefully and be sure to understand its contents before handling the DX200.
- General items related to safety are listed in Chapter 1: Safety of the DX200 Instructions. To ensure correct and safe operation, carefully read the DX200 Instructions before reading this manual.



CAUTION

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

Notes for Safe Operation

Read this manual carefully before installation, operation, maintenance, or inspection of the DX200.

In this manual, the Notes for Safe Operation are classified as "WARNING", "CAUTION", "MANDATORY", or "PROHIBITED".



WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury to personnel.



CAUTION

Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury to personnel and damage to equipment. It may also be used to alert against unsafe practices.



MANDATORY

Always be sure to follow explicitly the items listed under this heading.



PROHIBITED

Must never be performed.

Even items described as "CAUTION" may result in a serious accident in some situations.

At any rate, be sure to follow these important items



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



WARNING

- Before operating the manipulator, check that servo power is turned OFF pressing the emergency stop buttons on the front door of the DX200 and the programming pendant. When the servo power is turned OFF, the SERVO ON LED on the programming pendant is turned OFF.

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

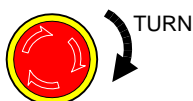
Figure 1: Emergency Stop Button



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

Injury may result from unintentional or unexpected manipulator motion.

Figure 2: Release of Emergency Stop



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

Improper or unintended manipulator operation may result in injury.

- Confirm that no person is present in the P-point maximum envelope of the manipulator and that you are in a safe location before:
 - Turning ON the power for the DX200.
 - Moving the manipulator with the programming pendant.
 - Running the system in the check mode.
 - Performing automatic operations.

Injury may result if anyone enters the P-point maximum envelope of the manipulator during operation. Always press an emergency stop button immediately if there is a problem.

The emergency stop buttons are located on the right of front door of the DX200 and the programming pendant.



CAUTION

- Perform the following inspection procedures prior to conducting manipulator teaching. If problems are found, repair them immediately, and be sure that all other necessary processing has been performed.
 - Check for problems in manipulator movement.
 - Check for damage to insulation and sheathing of external wires.
- Always return the programming pendant to the hook on the cabinet of the DX200 after use.

The programming pendant can be damaged if it is left in the manipulator's work area, on the floor, or near fixtures.

- Read and understand the Explanation of Warning Labels in the DX200 Instructions before operating the manipulator:

Definition of Terms Used Often in This Manual

The MOTOMAN is the YASKAWA industrial robot product.

The MOTOMAN usually consists of the manipulator, the controller, the programming pendant, and supply cables.

In this manual, the equipment is designated as follows:

Equipment	Manual Designation
DX200 controller	DX200
DX200 programming pendant	Programming pendant
Cable between the manipulator and the controller	Manipulator cable

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

Equipment	Manual Designation	
Programming Pendant	Character Keys /Symbol Keys	The keys which have characters or its symbol printed on them are denoted with []. ex. [ENTER]
	Axis Keys /Numeric Keys	[Axis Key] and [Numeric Key] are generic names for the keys for axis operation and number input.
	Keys pressed simultaneously	When two keys are to be pressed simultaneously, the keys are shown with a "+" sign between them, ex. [SHIFT]+[COORD]
	Displays	The menu displayed in the programming pendant is denoted with { }. ex. {JOB}

External Reference Point
Control

Description of the Operation Procedure

In the explanation of the operation procedure, the expression "Select ●●●" means that the cursor is moved to the object item and the SELECT key is pressed.

Registered Trademark

In this manual, names of companies, corporations, or products are trademarks, registered trademarks, or brand names for each company or corporation. The indications of (R) and TM are omitted.

1	External Reference Point Control Function.....	1-1
1.1	Operation at Teaching	1-2
1.1.1	Major Axes	1-3
1.1.2	Wrist Axes	1-3
1.2	Operation at Playback	1-4
1.3	Preparations for External Reference Point Control.....	1-5
1.3.1	Registration of User Coordinates	1-5
1.4	Move Instructions.....	1-5
1.4.1	Type	1-5
1.4.2	Play Speed	1-5
1.4.3	User Coordinate No.....	1-5
1.5	Teaching and Modification.....	1-7
1.5.1	Teaching.....	1-7
1.5.2	Checking Paths	1-8
1.5.3	Modifying Paths	1-8
2	External Reference Point Control Function For Coordinated Operation of Two Robots.....	2-1
2.1	Functional Overview	2-1
2.2	Preparations for Using the External Reference Point Control Function for Coordinated Operation (of Two Robots).....	2-2
2.2.1	Registration of User Coordinates	2-2
2.2.2	Setting up the Coordinated Operation Function	2-2
2.3	Instructions of the External Reference Point Control Function for Coordinated Operation (of Two Robots).....	2-2
2.3.1	Move Instructions	2-2
2.3.2	Play Speed	2-2
2.3.3	User Coordinates Number.....	2-2
2.3.4	Examples.....	2-2
2.4	Operation During Teaching.....	2-3
2.5	Teaching.....	2-3
2.5.1	Teaching.....	2-3
2.5.2	Checking Paths	2-5
2.5.3	Rate Specification	2-5

2.6	Editing Move Instructions.....	2-6
2.6.1	Interpolation Switching.....	2-6
2.6.2	Input Line Editing.....	2-7
2.6.3	Detail Editing.....	2-8
2.6.4	Precautions When Editing Move Instructions	2-9

1 External Reference Point Control Function

The external reference point function makes it possible to use a point in space as a control point of the manipulator for teaching and playback. This point in space is called the external reference point.

During sealing or spot-welding where the workpiece is held by the manipulator, by defining the tip of a nozzle or the gun as a reference point, the orientation of the workpiece, etc. can be changed.

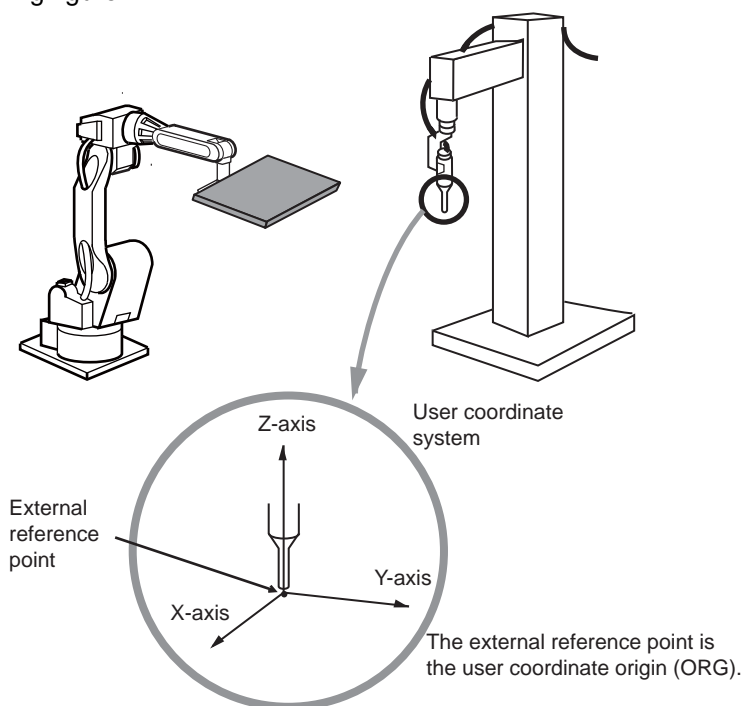
For interpolation during playback, the speed of an external reference point is controlled in relation to the speed of the workpiece.

The external reference point function saves teaching time and makes it easier to control relative speeds of the nozzle and the workpiece.

An external reference point is defined to the user coordinate origin (ORG). Therefore, external reference point control is possible only when user coordinates are registered.

Since up to 63 user coordinates can be stored in memory, up to 63 external reference points can be set up.

An example of sealing by a workpiece-holding manipulator is shown in the following figure.



For the user coordinate system, refer to "2.3.5 User Coordinates" in the DX200 operator's manual.



NOTE The external reference point control is not available with the coordinated job.

1.1 Operation at Teaching

Teaching must be performed in the user coordinate system. For operations to change to the user coordinate system, refer to *Section 1.5.1 “Teaching” on page 1-7*

The “Axis Key” operations are the same as that in a user coordinate system, as explained in the following table.

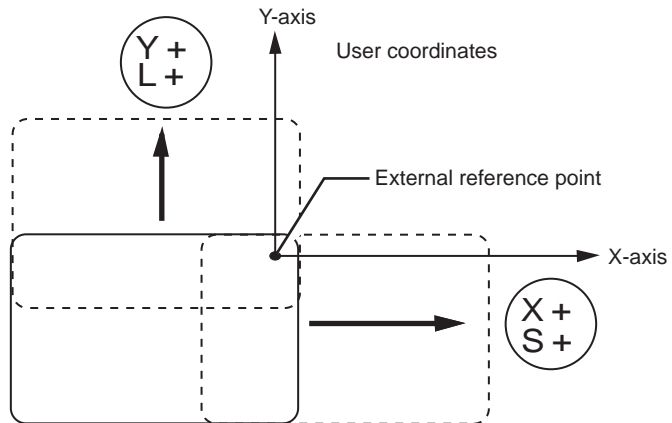
Axis	Axis Keys	Motion
Major Axes		Moves parallel to the X-, Y-, and/or Z-axis of the selected user coordinate.
Wrist Axes		Executes the motion about TCP. (The external reference point is set as the TCP.)



For details, refer to Section 2.3.5 “User Coordinates” and Section 2.3.7 “Control Point Operation” in the DX200 operator’s manual.

1.1.1 Major Axes

Fig. 1-1: Parallel Movement



1.1.2 Wrist Axes

With a motion about TCP by the wrist axes, the manipulator's posture can be changed without changing the position of the TCP (the external reference point).

Motion about TCP

Fig. 1-2(a): Without the External Reference Point Control Function

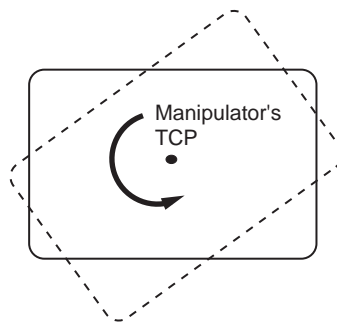
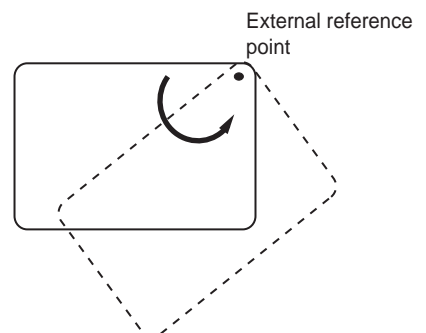
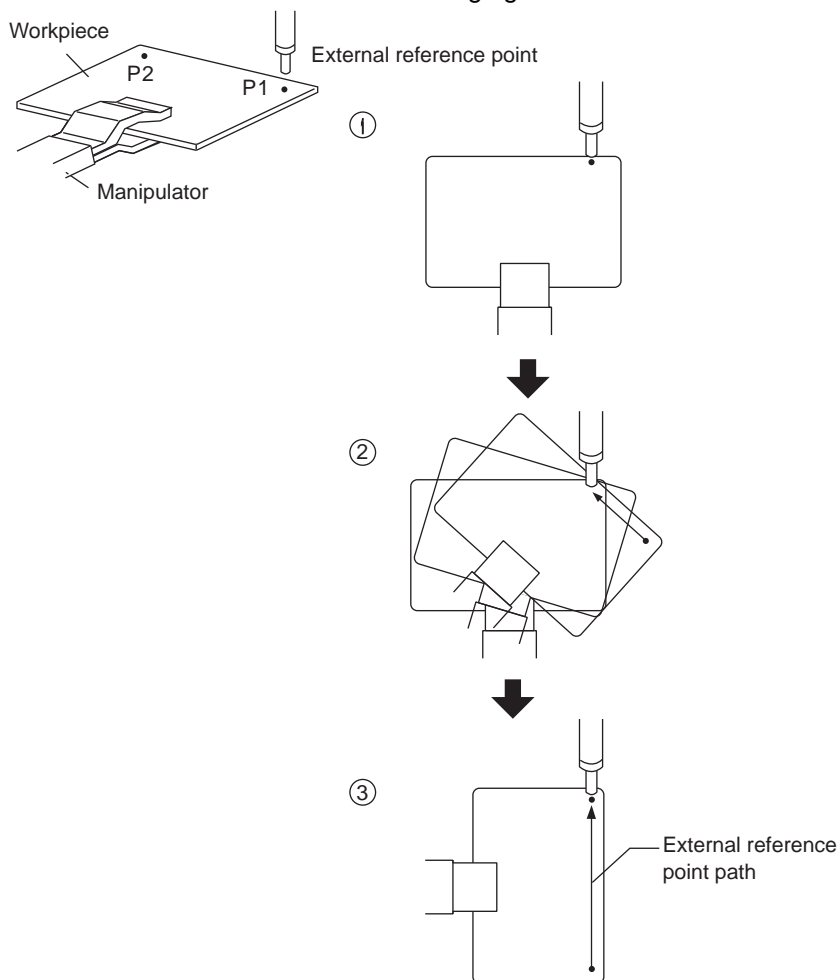


Fig. 1-2(b): With the External Reference Point Control Function



1.2 Operation at Playback

External reference point control with linear interpolation between teaching points P1 and P2 is shown in the following figure.



1.3 Preparations for External Reference Point Control

To perform the external reference point control for teaching, user coordinates must be registered.

1.3.1 Registration of User Coordinates

For registration of user coordinates, refer to Section 2.3.5 "User Coordinates" in the DX200 operator's manual.

1.4 Move Instructions

1.4.1 Type

There are two move instructions for external reference point control.

EIMOVL : Used for external linear interpolation.

EIMOVC : Used for external circular interpolation.

1.4.2 Play Speed

The setting procedure is the same as that for linear or circular motions.

1.4.3 User Coordinate No.

When a move instruction for the external reference point control is registered, the user coordinate number of the external reference point selected at the time is automatically registered.

EIMOVL V=100 UF#(1)

<Examples of instruction registration and movement>

- An example of instruction registration for EIMOVL

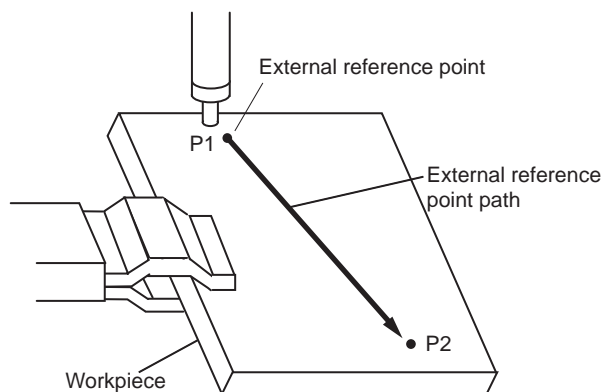
```

0000 NOP
0001 MOVJ VJ=50.00
0002 EIMOVL UF#(5) V=138
0003 EIMOVL UF#(5) V=88
0004 MOVJ VJ=50.00
0005 END

```

Move instruction for manipulator's TCP
P1
P2

Fig. 1-3(a): EIMOVL (Linear interpolation)



- An example of instruction registration for EIMOVC

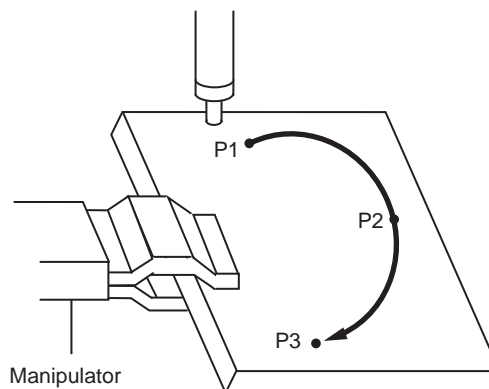
```

0000 NOP
0001 MOVJ VJ=50.00
0002 TIMER T=1.00
0003 EIMOVC UF#(4) V=138
0004 EIMOVC UF#(4) V=88
0005 EIMOVC UF#(4) V=66
0006 MOVJ VJ=50.00
0007 END

```

P1
P2
P3

Fig. 1-3(b): EIMOVC (Circular interpolation)



1.5 Teaching and Modification

After registering user coordinates, move instructions for external reference point control can be taught or modified.

1.5.1 Teaching

1. Call the JOB CONTENT window.

- (1) Select {JOB} from {JOB} under the main menu.
- (2) Move the cursor to the line above where the move instruction is to be inserted.

```
0000 NOP
0001 MOVJ VJ=0.78
0002 MOVJ VJ=0.78
0003 END
```

2. Press [COORD] to set the external reference points'



coordinates.

```
JOB: CONTENT
J: TEST
CONTROL_GROUP: R1
0000 NOP
S:0000
TOOL: **
```

3. When the desired user coordinate file is not shown, press [SHIFT] + [COORD].

```
USER COORD SELECT
1 : JIG1
2 : PAL1
3 :
4 :
5 : PAL2
```

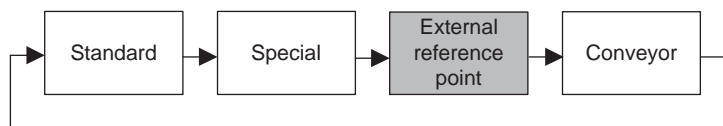
4. Move the cursor to the desired user coordinate file No., and then press [SELECT]

```
USER COORD SELECT
1 : JIG1
2 : PAL1
3 :
4 :
5 : PAL2
6 :
```

5. By pressing the axis key, set the external reference point to the desired position.

6. Press [SHIFT] + [MOTION TYPE] to select the external reference point interpolation mode.

– The interpolation mode is switched in the following order. (When the special interpolation mode and the conveyor interpolation mode are invalid, the mode is switched between the standard interpolation mode and the external reference point interpolation mode.)



7. Press [MOTION TYPE] to select either EIMOV L (external linear interpolation) or EIMOV C (external circular interpolation).

EIMOV L UF#(5) V=86

8. With the cursor on the line No., press [SELECT].

EIMOV L UF#(5) V=86

9. Press the right cursor key to move the cursor on the speed indication “V=**.”

EIMOV L UF#(5) V=88

– Then hold down [SHIFT] and press the top or bottom of the cursor key to change the play speed.

10. Press [ENTER] to register the move instruction.

1.5.2 Checking Paths

To check whether the taught step positions are correct, use [FWD] and [BWD] on the programming pendant.

For details, refer to Section 3.3 “Checking Steps” in the DX200 operator’s manual.

1.5.3 Modifying Paths

If the paths need to be modified, refer to the following sections in the DX200 operator’s manual.

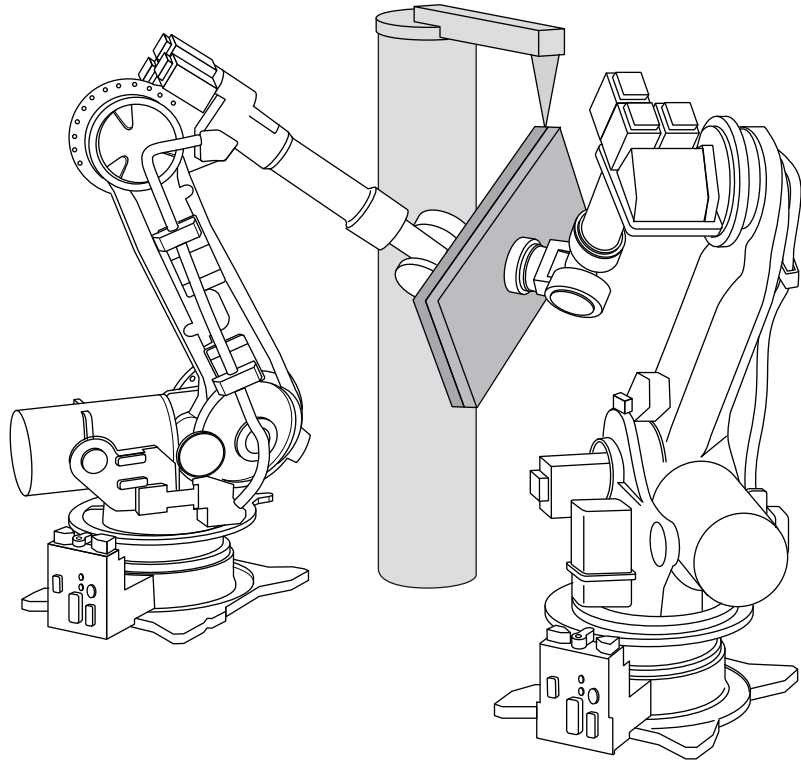
- 3.4.2 “Inserting Move Instructions”
- 3.4.3 “Deleting Move Instructions”
- 3.4.4 “Modifying Move Instructions”

2 External Reference Point Control Function For Coordinated Operation of Two Robots

2.1 Functional Overview

The external reference point control function for coordinated operation of two robots was developed to weld two workpieces with coordinated operation of two robots.

This function can be applied to sealing or arc-welding operations where the workpiece is held by two robots, by defining the tip of a torch or the gun as an external reference point.



External Reference Point Control	2 External Reference Point Control Function For Coordinated Operation of Two Robots 2.2 Preparations for Using the External Reference Point Control Function
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2.2 Preparations for Using the External Reference Point Control Function for Coordinated Operation (of Two Robots)

2.2.1 Registration of User Coordinates

By using the master robot, register the user coordinates to the tip of the nozzle or the torch.

For the method of registering the user coordinates, refer to Section 2.3.5 “User Coordinate Setting” in the “DX200 Operator’s Manual” (165300-1CD).

2.2.2 Setting up the Coordinated Operation Function

Set up the coordinated operation function of two robots.

For the method of performing calibration between the robots, refer to Section 3.5 “System Setup” in the “DX200 Options Instructions for the Independent/Coordinated Control Function” (165836-1CD).

2.3 Instructions of the External Reference Point Control Function for Coordinated Operation (of Two Robots)

2.3.1 Move Instructions

- Move instructions for the slave robot
 - SMOVL: Coordinated linear interpolation instruction
Normally, set this SMOVL instruction when performing an operation synchronized with the master robot.
 - SMOVC: Coordinated circular interpolation instruction
- The external reference point instructions for the master robot are as follows:
 - + EIMOVL: Linear interpolation
 - + EIMOVC: Circular interpolation

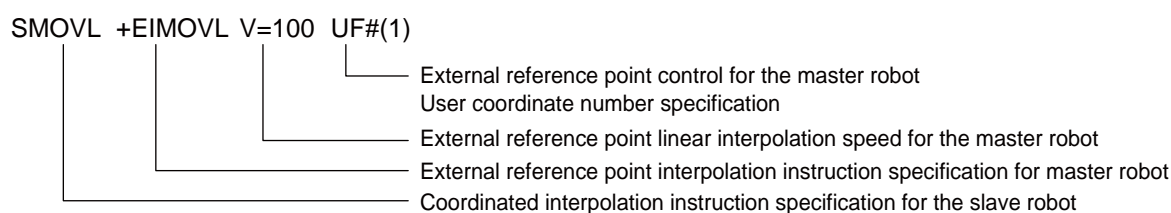
2.3.2 Play Speed

It is the speed of linear interpolation and circular interpolation during external reference point control.

2.3.3 User Coordinates Number

Set the user coordinate No. on which the external reference point is registered.

2.3.4 Examples



2.4 Operation During Teaching

For the motion path of external reference point control, refer to *Section 1.1 "Operation at Teaching"* on page 1-2.

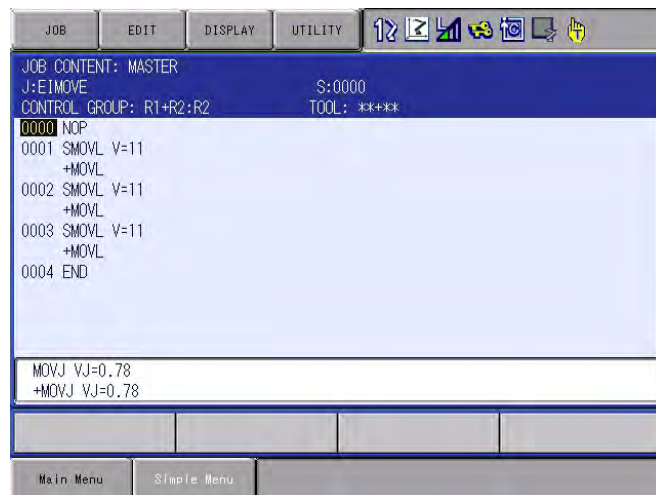
When the system is set to the synchronized operation mode, the slave robot maintains the synchronized operation with the master robot while keeping a relative position to the master robot.

2.5 Teaching

2.5.1 Teaching

Here, a mode setting method which the master robot performs an external reference point jog operation while the slave robot performs a synchronized operation is explained.

1. Call JOB CONTENT window.



- (1) Select {JOB} from {JOB CONTENT} under the main menu.
 - (2) Move the cursor to the adjacent line where the move instruction is to be inserted.
2. Press [7] numeric key to switch the mode to the synchronized operation mode.
 - The control group for the JOG operation target switches to the master robot, and the mode switches to the synchronized operation mode.



3. Press [COORD] to set the external reference points' coordinates.

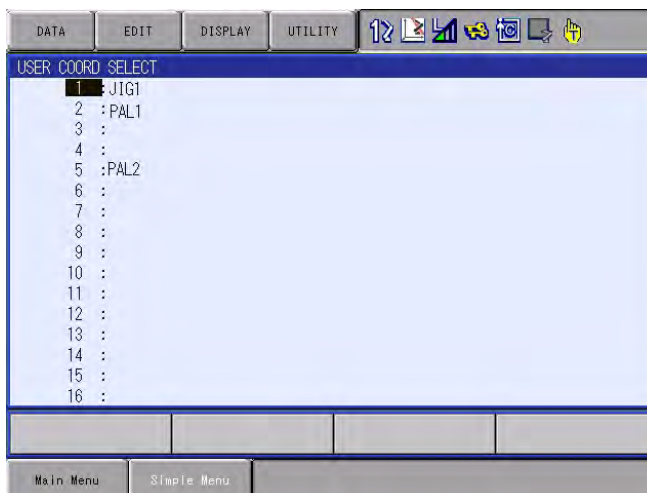


2 External Reference Point Control Function For Coordinated Operation of Two Robots

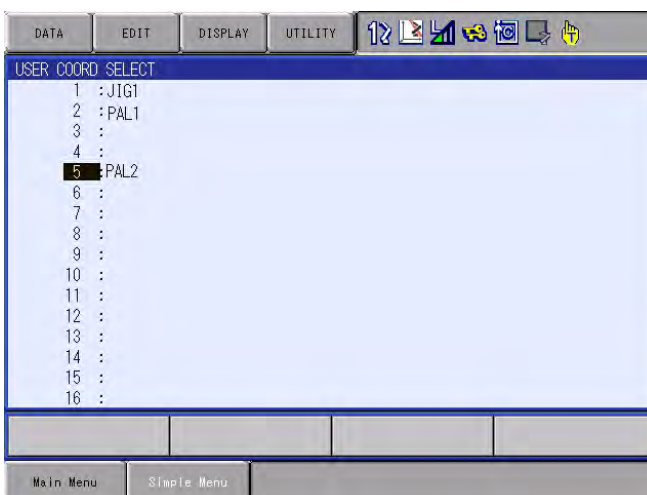
2.5 Teaching

- When the desired user coordinate file is not shown, press [SHIFT] + [COORD].

– USER COORD SELECT window appears.

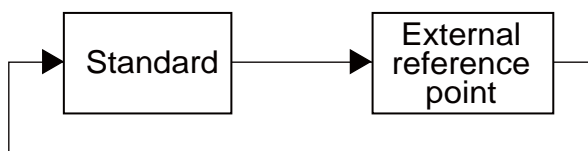


- Move the cursor to the desired user coordinate file No., then press [SHIFT] + [COORD] to return to the original window.

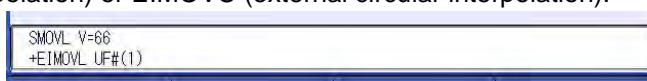


- Press the axis key to set the external reference point to the desired position.
- Press [SHIFT] + [MOTION TYPE] to select the external reference point interpolation mode.

– The interpolation mode alternates in the following order.



- Press [MOTION TYPE] to select either EIMOV L (external linear interpolation) or EIMOV C (external circular interpolation).



- Press [ENTER] to register the move instruction.

2.5.2 Checking Paths

To check whether the taught step positions are correct, use [FWD] and [BWD] on the programming pendant.

2.5.3 Rate Specification

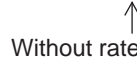
Under this function, the master and the slave robots are controlled to perform operations with an external point as a reference point while grasping a same workpiece.

In this case, the slave robot maintains the coordinated operation while keeping a relative position to the master robot.

In other words, the amount of movements of the slave robot with respect to the workpiece is "0."

At this time, if the following rate specification is made, the robot will operate at the maximum speed.

SMOVL V=100.0 +EIMOV L UF#(1)



With specified rate specification
However, the relative motion is 0.

Without rate specification: The speed is determined based
on the maximum speed of each robot.

In the case where the slave robot simply moves in unison with the master robot, specify the speed on the master side.

SMOVL +EIMOV L UF#(1) V=100.0



Without rate
specification

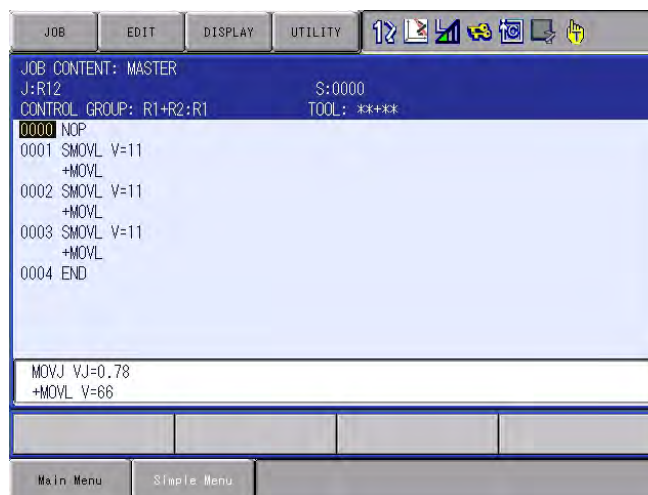
The operation speed is determined
by the speed specified here.

2.6 Editing Move Instructions

2.6.1 Interpolation Switching

1. Job reading

- Read and display the target job.



2. Mode switching

- Press [4] numeric key to switch from the individual mode to the coordinated mode.
- “+EIMOV*” can only be set in the coordinated mode.

3. Robot selection

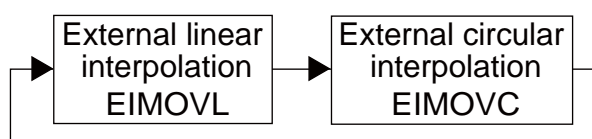
- Press [ROBOT] to select the master robot.
- “+EIMOV*” can be set only to the master robot.

4. Switching the interpolation instructions

- Press [SHIFT] + [MOTION TYPE] to select the external reference point interpolation mode.
 - “+EIMOVL” and “+EIMOVC” can be set only when the 2nd control interpolation instruction semivowel.”
 - Likewise, in the case where “+EIMOVL” and “+EIMOVC” are set to the master side, if the 2nd control interpolation instruction is changed, the 1st control interpolation instruction will be set to “+MOVL” and “+MOVC.”

5. Switching the type of interpolation

- Press [MOTION TYPE] to select either EIMOVL (external linear interpolation) or EIMOVC (external circular interpolation).

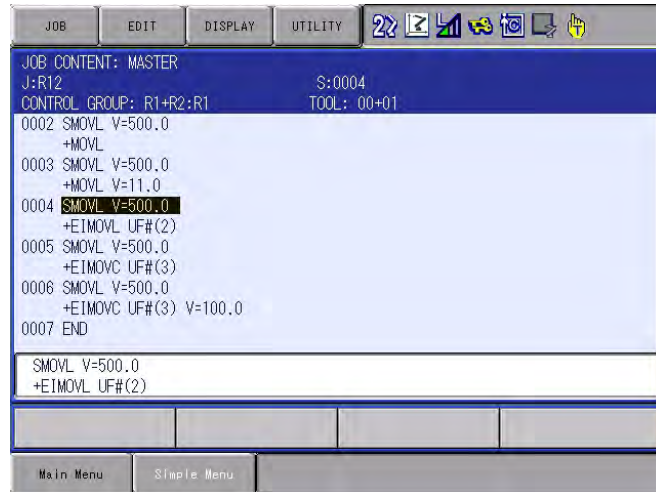


- 6. When interpolation is switched once again, the instruction will return to “+MOVL.”

2.6.2 Input Line Editing

1. Input line selection

- Move the cursor to the code part of the step to be edited, and select the step.



- When [SELECT] is pressed in this state, it will be in the line editing state and the instruction on the input line is highlighted.

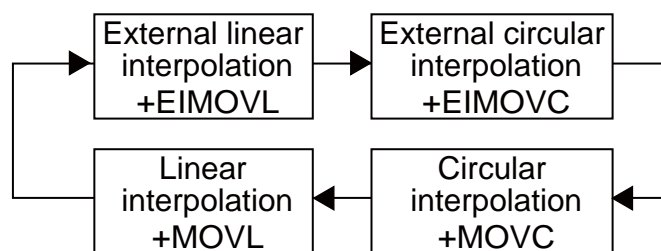
2. Edit

- When [SELECT] is pressed again on the item to be input it will be in the editable state.



3. Switching interpolation instruction

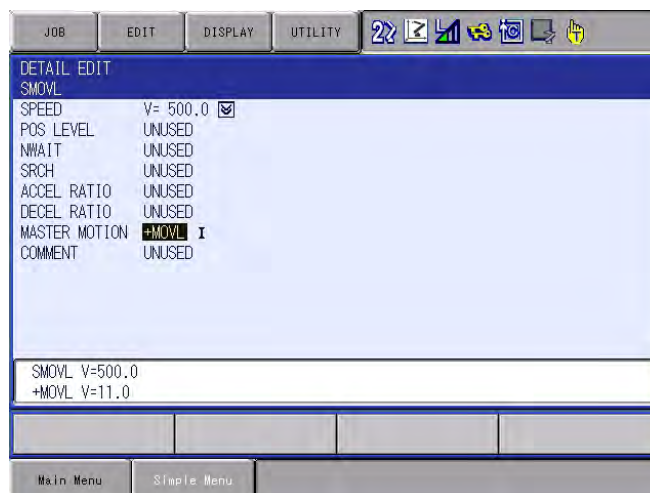
- You can switch the interpolation instructions by pressing [SHIFT] + UP or DOWN cursor keys.
- Interpolation rotates.



2.6.3 Detail Editing

1. Select

- Like input line editing, press [SELECT] on the editing target step code, and then press [SELECT] on the target instruction to display the DETAIL EDIT window.



2. Edit

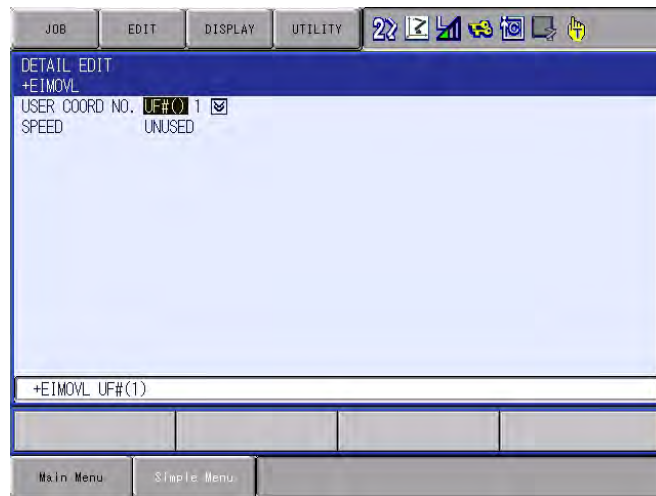
- (1) Move the cursor to the interpolation instruction, and press [SELECT]. A dialog box consisting of a list of selectable interpolation instructions will be displayed.



- (2) Move the cursor to the interpolation instruction to be set and press [SELECT] to determine the selection.

3. Switching interpolation

- After the selection has been made, the DETAIL EDIT window for the changed interpolation instruction appears.



4. Editing items

- The “User coordinate No.” can be edited.
- “+EIMOV*” is used only in the coordinated mode, so it cannot be used to set the speed.

5. Finalizing the edited contents

- Upon completion of all editing work, press [ENTER]. The system will return to the input line editing condition in which the edited contents have been incorporated.

2.6.4 Precautions When Editing Move Instructions

- When “+EIMOV*” is selected at the master robot, if the coordinated mode is switched to the individual mode, the instruction for the robot concerned will switch to “+MOVJ.”
Note, however, that “+EIMOVL” will not be displayed on the master robot even if the system is returned from this condition to the coordinated mode.
To return the system to “+EIMOVL”, change the interpolation instruction once again.
- Like mode switching, the interpolation instruction of the robot in which “+EIMOV*” is set will switch to “+MOVJ” when the job is switched as well.

DX200 OPTIONS INSTRUCTIONS

FOR EXTERNAL REFERENCE POINT CONTROL FUNCTION

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