

YRC1000micro 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

YRC1000micro INSTRUCTIONS

YRC1000micro OPERATOR'S MANUAL

YRC1000micro MAINTENANCE MANUAL

YRC1000micro ALARM CODES (MAJOR ALARMS) (MINOR ALARMS)

The YRC1000micro alarm codes above consists of "MAJOR ALARMS" and "MINOR ALARMS".

THIS MATERIAL IS FOR STUDY PURPOSE ONLY.
YOU MUST READ THE MANUAL WHICH ENCLOSED
WITH A ROBOT.



DANGER

- This manual explains the external reference point control function of the YRC1000micro system. Read this manual carefully and be sure to understand its contents before handling the YRC1000micro. Any matter not described in this manual must be regarded as "prohibited" or "improper".
- General information related to safety are described in "Chapter 1. Safety" of the YRC1000micro INSTRUCTIONS. To ensure correct and safe operation, carefully read "Chapter 1. Safety" of the YRC1000micro INSTRUCTIONS.



CAUTION

- In some drawings in this manual, protective covers or shields are removed to show details. Make sure that all the covers or shields are installed in place before operating this product.
- YASKAWA is not responsible for incidents arising from unauthorized modification of its products. Unauthorized modification voids the product warranty.

NOTICE

- 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.

Notes for Safe Operation

Read this manual carefully before installation, operation, maintenance, or inspection of the YRC1000micro.

In this manual, the Notes for Safe Operation are classified as “DANGER”, “WARNING”, “CAUTION”, or “NOTICE”.



DANGER

Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. Safety Signs identified by the signal word DANGER should be used sparingly and only for those situations presenting the most serious hazards.



WARNING

Indicates a potentially hazardous situation which, if not avoided, will result in death or serious injury. Hazards identified by the signal word WARNING present a lesser degree of risk of injury or death than those identified by the signal word DANGER.



CAUTION

Indicates a hazardous situation, which if not avoided, could result in minor or moderate injury. It may also be used without the safety alert symbol as an alternative to “NOTICE”.

NOTICE

NOTICE is the preferred signal word to address practices not related to personal injury. The safety alert symbol should not be used with this signal word. As an alternative to “NOTICE”, the word “CAUTION” without the safety alert symbol may be used to indicate a message not related to personal injury.

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 “DANGER”, “WARNING” and “CAUTION”.



DANGER

- Before operating the manipulator, make sure the servo power is turned OFF by performing the following operations. When the servo power is turned OFF, the SERVO ON LED on the programming pendant is turned OFF.
 - Press the emergency stop button on the programming pendant or on the external control device, etc.
 - Disconnect the safety plug of the safety fence. (when in the play mode or in the remote mode)

If operation of the manipulator cannot be stopped in an emergency, personal injury and/or equipment damage may result.

Fig. : Emergency Stop Button



- Before releasing the emergency stop, make sure to remove the obstacle or error caused the emergency stop, if any, and then turn the servo power ON.

Failure to observe this instruction may cause unintended movement of the manipulator, which may result in personal injury.

Fig. : Release of Emergency Stop



- Observe the following precautions when performing a teaching operation within the manipulator's operating range:
 - Be sure to perform lockout by putting a lockout device on the safety fence when going into the area enclosed by the safety fence. In addition, the operator of the teaching operation must display the sign that the operation is being performed so that no other person closes the safety fence.
 - View the manipulator from the front whenever possible.
 - Always follow the predetermined operating procedure.
 - Always keep in mind emergency response measures against the manipulator's unexpected movement toward a person.
 - Ensure a safe place to retreat in case of emergency.

Failure to observe this instruction may cause improper or unintended movement of the manipulator, which may result in personal injury.

- Confirm that no person is present in the manipulator's operating range and that the operator is in a safe location before:
 - Turning ON the YRC1000micro power
 - Moving the manipulator by using the programming pendant
 - Running the system in the check mode
 - Performing automatic operations

Personal injury may result if a person enters the manipulator's operating range during operation. Immediately press an emergency stop button whenever there is a problem. The emergency stop button is located on the right of the programming pendant.

- Read and understand the Explanation of the Warning Labels before operating the manipulator.

**DANGER**

- In the case of not using the programming pendant, be sure to supply the emergency stop button on the equipment. Then before operating the manipulator, check to be sure that the servo power is turned OFF by pressing the emergency stop button. Connect the external emergency stop button to the 4-14 pin and 5-15 pin of the Safety connector (Safety).
- Upon shipment of the YRC1000micro, this signal is connected by a jumper cable in the dummy connector. To use the signal, make sure to supply a new connector, and then input it.

If the signal is input with the jumper cable connected, it does not function, which may result in personal injury or equipment damage.

**WARNING**

- Perform the following inspection procedures prior to conducting manipulator teaching. If there is any problem, immediately take necessary steps to solve it, such as maintenance and repair.
 - Check for a problem in manipulator movement.
 - Check for damage to insulation and sheathing of external wires.
- Return the programming pendant to a safe place after use.

If the programming pendant is left unattended on the manipulator, on a fixture, or on the floor, etc., the Enable Switch may be activated due to surface irregularities of where it is left, and the servo power may be turned ON. In addition, in case the operation of the manipulator starts, the manipulator or the tool may hit the programming pendant left unattended, which may result in personal injury and/or equipment damage.

Definition of Terms Used Often in This Manual

The MOTOMAN is the YASKAWA industrial robot product.

The MOTOMAN usually consists of the manipulator, the YRC1000micro controller, manipulator cables, the YRC1000micro programming pendant (optional), and the YRC1000micro programming pendant dummy connector (optional).

In this manual, the equipment is designated as follows:

Equipment	Manual Designation
YRC1000micro controller	YRC1000micro
YRC1000micro programming pendant	Programming pendant (optional)
Cable between the manipulator and the controller	Manipulator cable
YRC1000micro programming pendant dummy connector	Programming pendant dummy connector (optional)

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

Equipment	Manual Designation
Programming Pendant	Character Keys /Symbol Keys
	The keys which have characters or symbols printed on them are denoted with []. ex. [ENTER]
	Axis Keys /Number 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]
PC Keyboard	Mode Key
	Three kinds of modes that can be selected by the mode key are denoted as follows: REMOTE, PLAY, or TEACH
	Button
	Three buttons on the upper side of the programming pendant are denoted as follows: HOLD button START button EMERGENCY STOP button
PC Keyboard	Displays
	The menu displayed in the programming pendant is denoted with { }. e.g. {JOB}
PC Keyboard	
The name of the key is denoted. e.g. Ctrl key on the keyboard	

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 [SELECT] is pressed, or that the item is directly selected by touching the screen.

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.

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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.

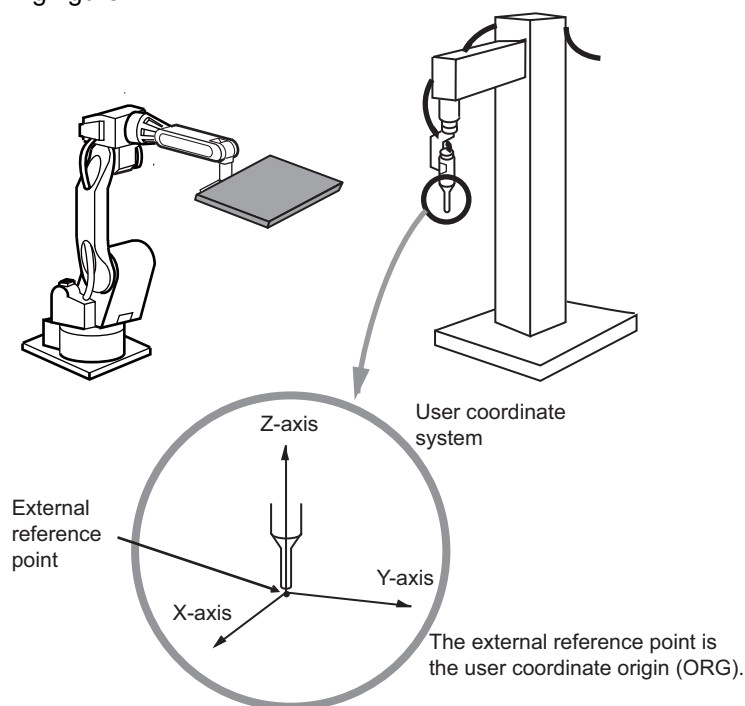
For interpolation during playback, the speed of an external reference point is controlled in relation to the speed of the workpiece.

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 "YRC1000micro OPERATOR'S MANUAL(RE-CSO-A058)".

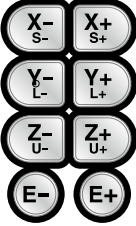
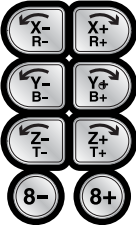


The external reference point control is not available with the coordinated job.

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 *chapter 1.5.1 “Teaching”*

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.)



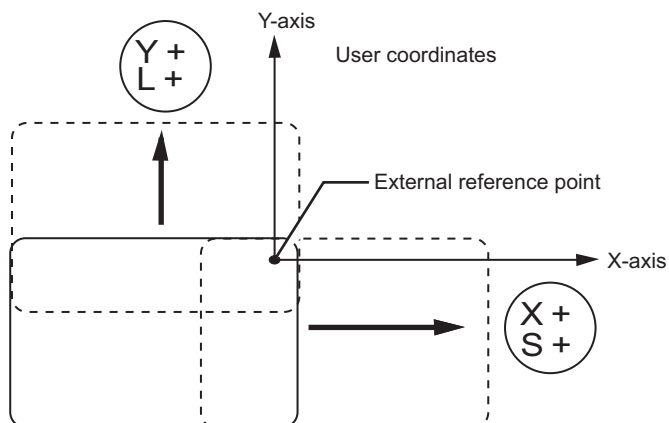
For details, refer to “2.3.5 User Coordinates” and “2.3.7 Control Point Operation” in “YRC1000micro OPERATOR'S MANUAL(RE-CSO-A058)”.

1 External Reference Point Control Function

1.1 Operation at Teaching

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

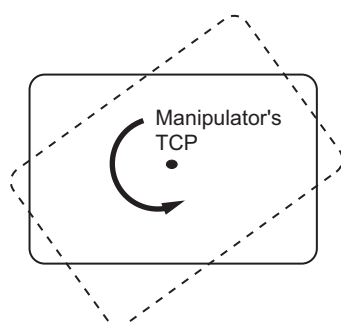
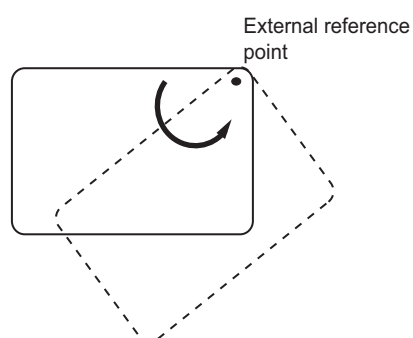


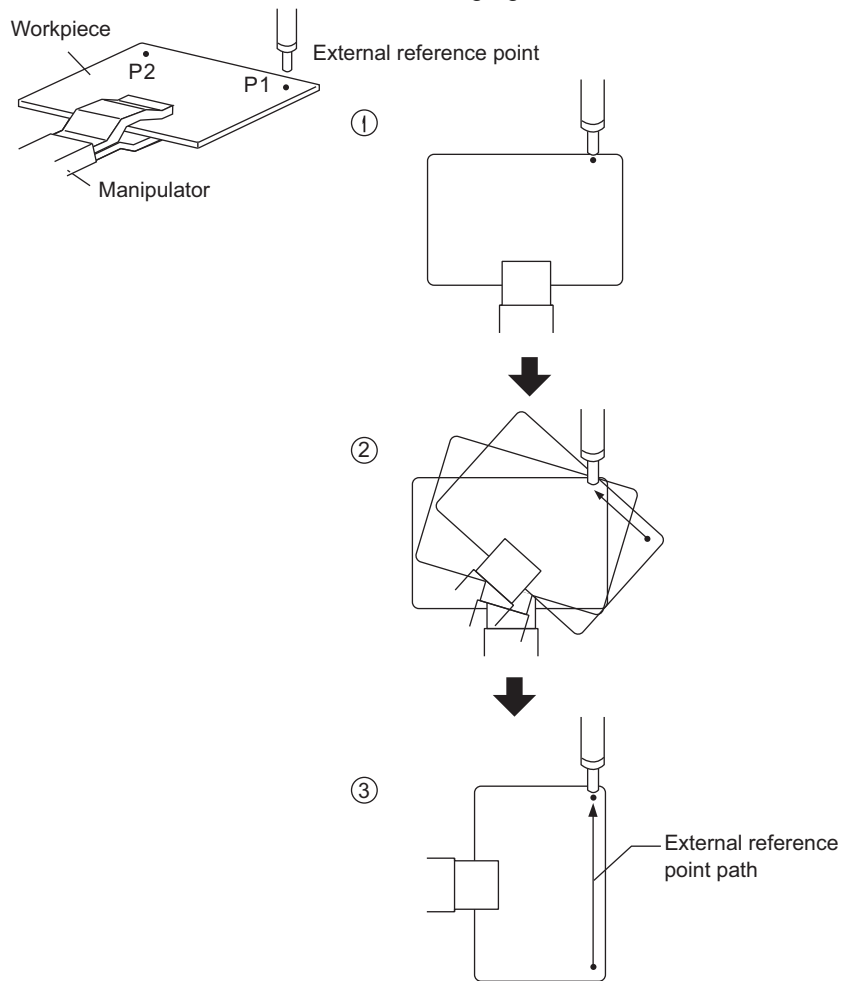
Fig. 1-2(b): With the External Reference Point Control Function



1 External Reference Point Control Function
1.2 Operation at Playback

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 External Reference Point Control Function
 - 1.3 Preparations for External Reference Point Control
-

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 “2.3.5 User Coordinates” in “YRC1000micro OPERATOR'S MANUAL(RE-CSO-A058)”.

1.4 Move Instructions

1.4.1 Type

There are two move instructions for external reference point control.

EIMOV L : Used for external linear interpolation.

EIMOV C : 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.

EIMOV L V=100 UF#(1)
 └───┘ └───┘
 Play speed User coordinate No.

1 External Reference Point Control Function

1.4 Move Instructions

<Examples of instruction registration and movement>

- An example of instruction registration for EIMOVL

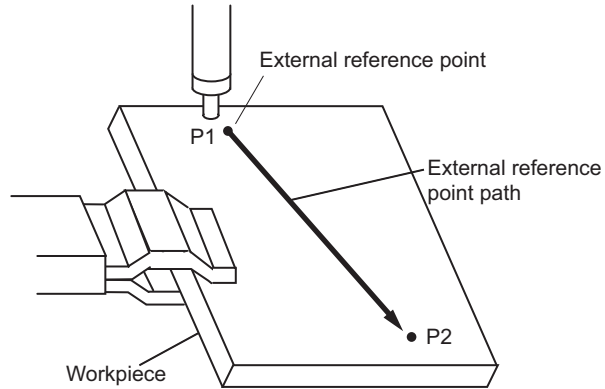
```

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

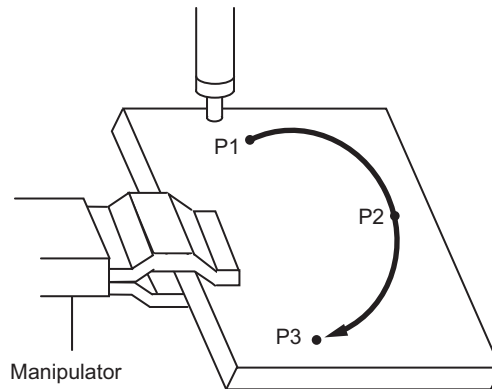
```

0000 NOP
0001 MOVJ VJ=50.00
0002 TIMER T=1.000
0003 EIMOVC UF#(4) V=138
0004 EIMOVC UF#(4) V=66
0005 EIMOVC UF#(4) V=66
0006 MOVJ VJ=50.00
0007 END

```

P1
P2
P3

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



- 1 External Reference Point Control Function
- 1.5 Teaching and Modification

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	EDIT	DISPLAY	UTILITY	12	13	14	15	16	17	18	19	20
JOB CONTENT												
J:TEST S:0000												
CONTROL GROUP: R1 TOOL: **												
0000 NOP												

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

DATA	EDIT	DISPLAY	UTILITY	12	13	14	15	16	17	18	19	20
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]

DATA	EDIT	DISPLAY	UTILITY	12	13	14	15	16	17	18	19	20
USER COORD. SELECT												
1 : JIG1												
2 : PAL1												
3 :												
4 :												
5 : PAL2												
6 :												

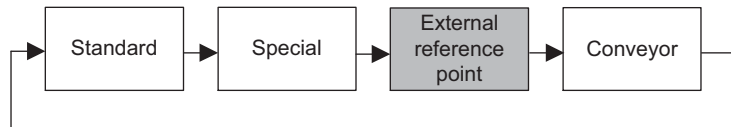
5. By pressing the axis key, set the external reference point to the desired position.

1 External Reference Point Control Function

1.5 Teaching and Modification

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=66

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

EIMOV L UF#(5) V=66

9. Press the right cursor to move the cursor on the speed indication "V=**."

EIMOV L UF#(5) V=86

- Then hold down [SHIFT] and press the top or bottom of the cursor 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 "3.3 Checking Steps" in "YRC1000micro OPERATOR'S MANUAL(RE-CSO-A058)".

1.5.3 Modifying Paths

If the paths need to be modified, refer to the following sections in the YRC1000micro OPERATOR'S MANUAL.

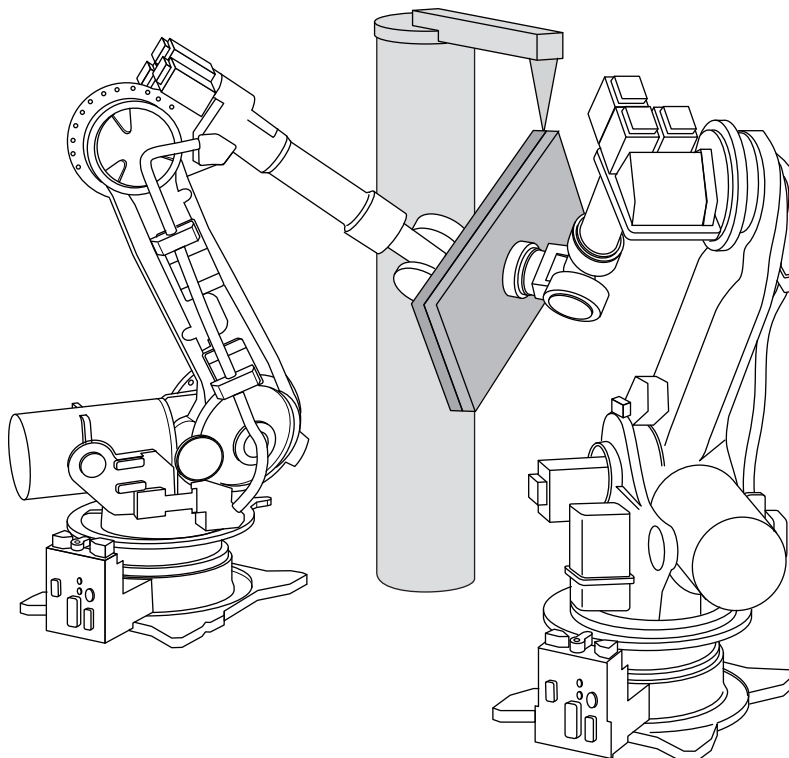
- "3.4.2 Inserting Move Instructions"
- "3.4.3 Deleting Move Instructions"
- "3.4.4 Modifying Move Instructions"

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 by using the synchronized operation of the coordinated operation.



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

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 tool.

For the method of registering the user coordinates, refer to “2.3.5 User Coordinates” in “YRC1000micro OPERATOR'S MANUAL(RE-CSO-A058)”.

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 “3.3 System Setup” in “YRC1000micro OPTIONS INSTRUCTIONS FOR INDEPENDENT/COORDINATED CONTROL FUNCTION (HW1484481)”.

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

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: Liner interpolation
 - + EIMOVC: Circular interpolation

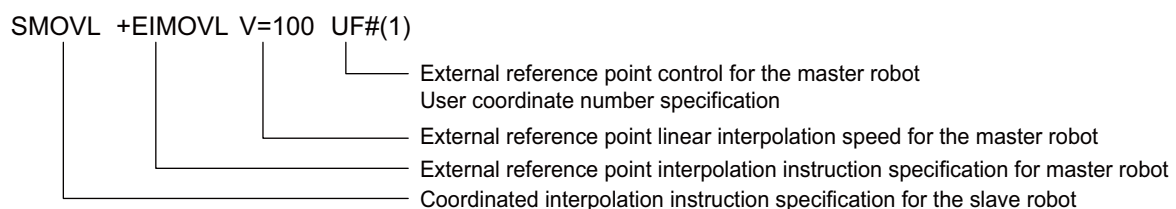
2.3.2 Play Speed

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 *chapter 1.1 "Operation at Teaching"*.

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.

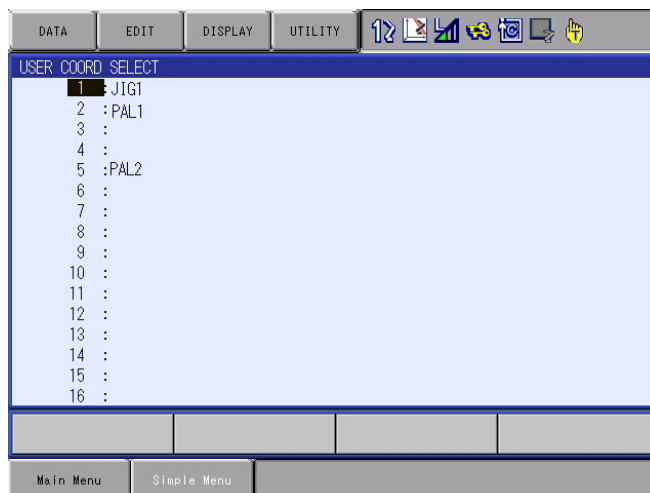


2 External Reference Point Control Function For Coordinated Operation of Two Robots

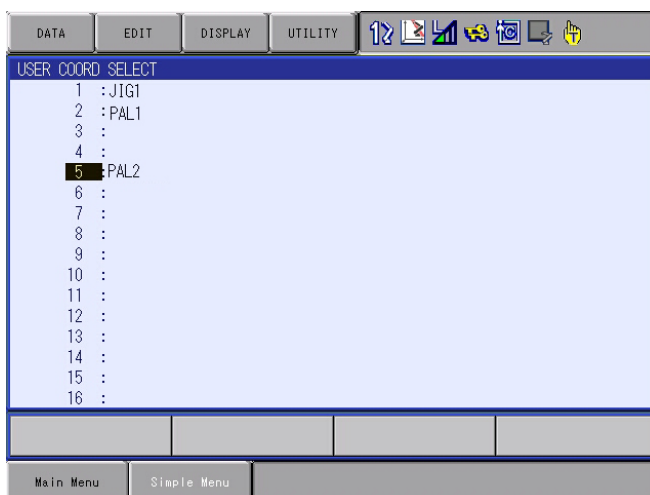
2.5 Teaching

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

– USER COORD SELECT window appears.

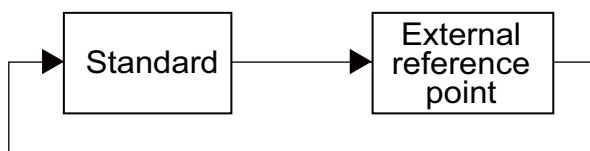


5. Move the cursor to the desired user coordinate file No., then press [SHIFT] + [COORD] to return to the original window.

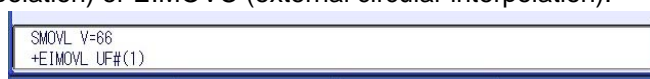


6. Press the axis key to set the external reference point to the desired position.
7. Press [SHIFT] + [MOTION TYPE] to select the external reference point interpolation mode.

– The interpolation mode alternates in the following order.



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



9. 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)

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

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

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

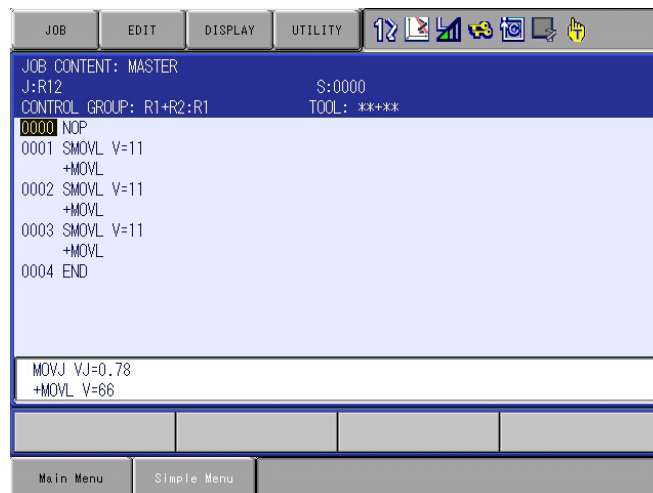
The operation speed is determined by the speed specified here.

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

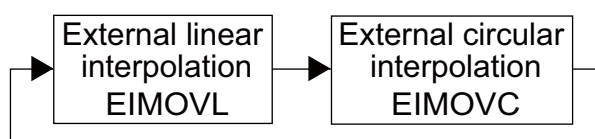
- Press [ROBOT] to select the master robot.
- “+EIMOV*” can be set only to the master robot.

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).

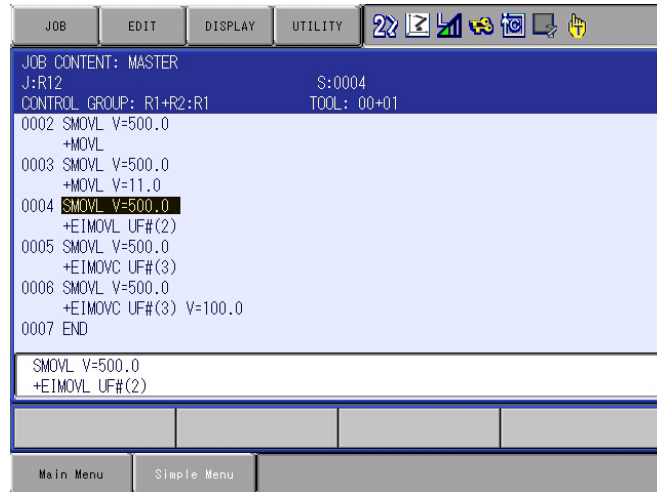


- #### 6. When interpolation is switched once again, the instruction will return to “+MOVL.”

2.6.2 Input Line Editing

1. Input line selection

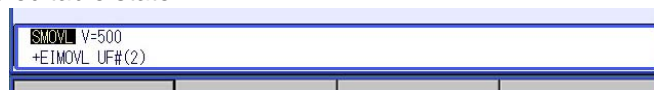
- Move the cursor to the code part of the step to be edited, and select the step.



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

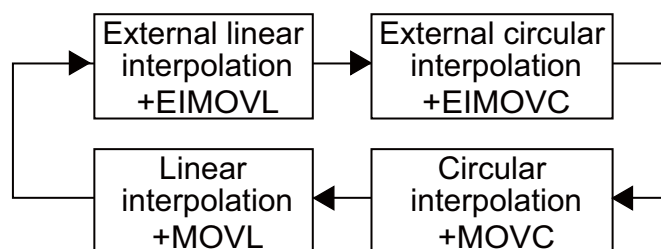
2. Edit

- 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.



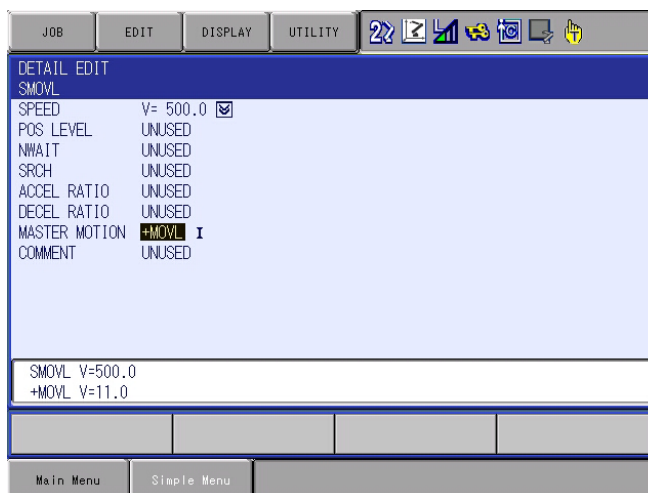
2 External Reference Point Control Function For Coordinated Operation of Two Robots

2.6 Editing Move Instructions

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

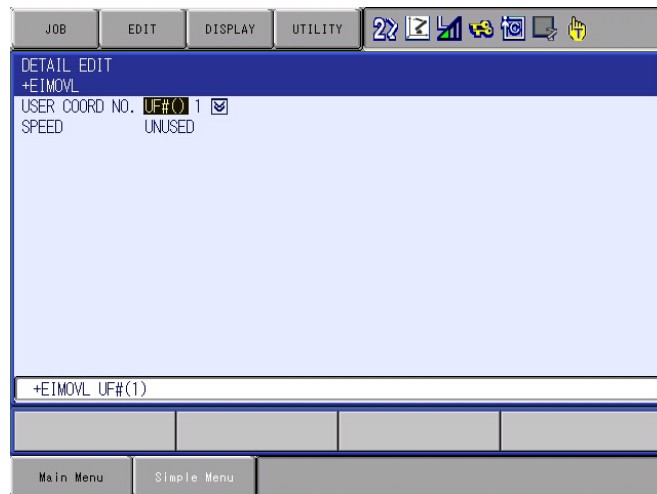
- (1) Move the cursor to the interpolation instruction, and press [SELECT]. A dialog box consisting of a list of selectable interpolation instructions will be displayed.



- (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 “+EIMOV” 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 “+EIMOV”, 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.

YRC1000micro OPTIONS INSTRUCTIONS

FOR EXTERNAL REFERENCE POINT CONTROL FUNCTION

HEAD OFFICE

2-1 Kurosakishiroishi, Yahatanishi-ku, Kitakyushu 806-0004, Japan
Phone +81-93-645-7703 Fax +81-93-645-7802

YASKAWA America Inc. (Motoman Robotics Division)
100 Automation Way, Miamisburg, OH 45342, U.S.A.
Phone +1-937-847-6200 Fax +1-937-847-6277

YASKAWA Europe GmbH (Robotics Division)
Yaskawastrasse 1, 85391 Allershausen, Germany
Phone +49-8166-90-100 Fax +49-8166-90-103

YASKAWA Nordic AB
Verkstadsgatan 2, Box 504, SE-385 25 Torsås, Sweden
Phone +46-480-417-800 Fax +46-486-414-10

YASKAWA Electric (China) Co., Ltd.
22F, One Corporate Avenue, No.222, Hubin Road, Huangpu District, Shanghai 200021, China
Phone +86-21-5385-2200 Fax +86-21-5385-3299

YASKAWA SHOUGANG ROBOT Co. Ltd.
No7 Yongchang North Road, Beijing E&T Development Area, China 100176
Phone +86-10-6788-2858 Fax +86-10-6788-2878

YASKAWA India Private Ltd. (Robotics Division)
#426, Udyog Vihar, Phase- IV, Gurgaon, Haryana, India
Phone +91-124-475-8500 Fax +91-124-475-8542

YASKAWA Electric Korea Corporation
35F, Three IFC, 10 Gukjegeumyung-ro, Yeongdeungpo-gu, Seoul, Korea 07326
Phone +82-2-784-7844 Fax +82-2-784-8495

YASKAWA Electric Taiwan Corporation
12F, No.207, Sec. 3, Beishin Rd., Shindian District, New Taipei City 23143, Taiwan
Phone +886-2-8913-1333 Fax +886-2-8913-1513

YASKAWA Electric (Singapore) PTE Ltd.
151 Lorong Chuan, #04-02A, New Tech Park, Singapore 556741
Phone +65-6282-3003 Fax +65-6289-3003

YASKAWA Electric (Thailand) Co., Ltd.
59,1st-5th Floor, Flourish Building, Soi Ratchadapisek 18, Ratchadapisek Road,
Huaykwang, Bangkok 10310, THAILAND
Phone +66-2-017-0099 Fax +66-2-017-0199

PT. YASKAWA Electric Indonesia
Secure Building-Gedung B Lantai Dasar & Lantai 1 Jl. Raya Protokol Halim Perdanakusuma,
Jakarta 13610, Indonesia
Phone +62-21-2982-6470 Fax +62-21-2982-6741

Specifications are subject to change without notice
for ongoing product modifications and improvements.

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YASKAWA ELECTRIC CORPORATION

© Printed in Japan July 2017 17-07

MANUAL NO.

HW1484508