DX100 OPTIONS
INSTRUCTIONS

FOR INDEPENDENT/COORDINATED 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
DX100 INSTRUCTIONS
DX100 OPERATOR'S MANUAL
DX100 MAINTENANCE MANUAL

The DX100 operator's manuals above correspond to specific usage.
Be sure to use the appropriate manual.

Part Number: 156431-1CD
Revision: 0

YASKAWA

MANUAL NO. RE-CKI-A454

MANDATORY

- This manual explains the independent/coordinated control function of the DX100 system and general operations. Read this manual carefully and be sure to understand its contents before handling the DX100.
- General items related to safety are listed in Chapter 1: Safety of the DX100 Instructions. To ensure correct and safe operation, carefully read the DX100 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 DX100.

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

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

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

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

WARNING

- Before operating the manipulator, check that servo power is turned OFF when the emergency stop buttons on the front door of the DX100 and programming pendant are pressed.
  When the servo power is turned OFF, the SERVO ON LED on the programming pendant is turned OFF.

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

Fig. : 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.

Fig. : 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 persons are present in the P-point maximum envelope of the manipulator and that you are in a safe location before:
  - Turning ON the DX100 power
  - Moving the manipulator with the programming pendant
  - Running the system in the check mode
  - Performing automatic operations

Injury may result if anyone enters the P-point maximum envelope of the manipulator during operation. Always press an emergency stop button immediately if there are problems.The emergency stop buttons are located on the right of the front door of the DX100 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 DX100 cabinet after use.

The programming pendant can be damaged if it is left in the P-point maximum envelope of the manipulator, on the floor, or near fixtures.

- Read and understand the Explanation of Warning Labels in the DX100 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
DX100 Controller	DX100
DX100 Programming Pendant	Programming Pendant
Cable between the manipulator and the controller	Manipulator cable

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

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

Description of the Operation Procedure

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

1 Independent/Coordinated Control Function

With the DX100, a system can be configured to control multiple manipulators or stations simultaneously with a single controller.

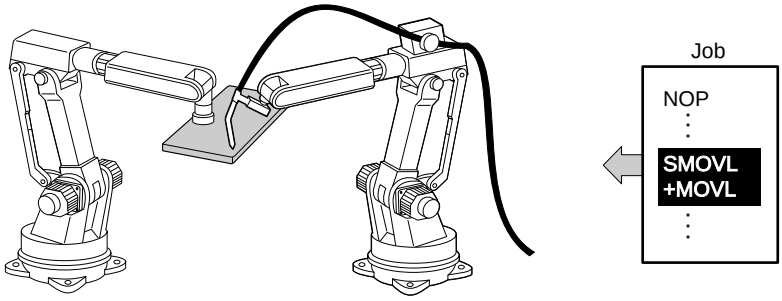
With the independent / coordinated control function, manipulators and/or stations can be operated together or individually. Operation can be optimized for the jobs.

1.1 Coordinated Control

With this function, manipulators or stations execute jobs in a coordinated motion.

<Example>

Using two coordinated manipulators to execute a job.

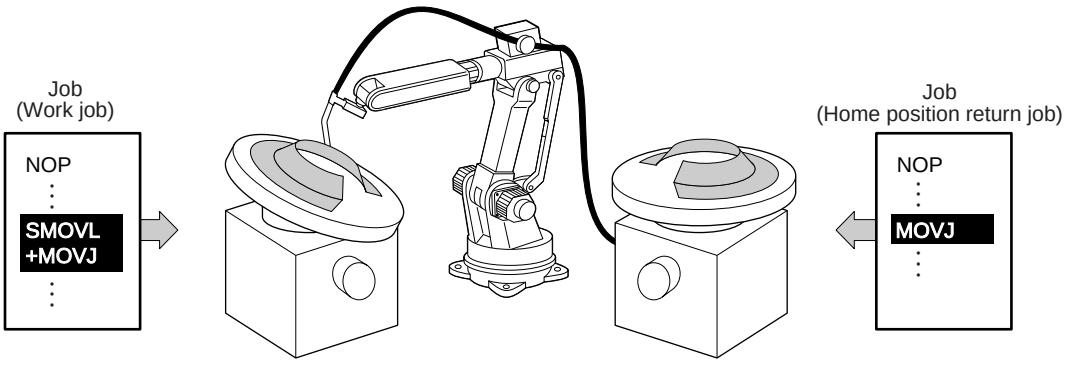


1.2 Independent Control

With this function, manipulators and/or stations execute jobs independently without synchronization.

<Example>

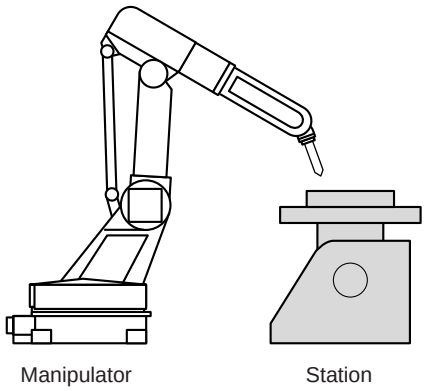
While executing a work job at one station, the other station executes a job to return to the home position for the next job.



2 Coordinated Positioner System

2.1 Outline

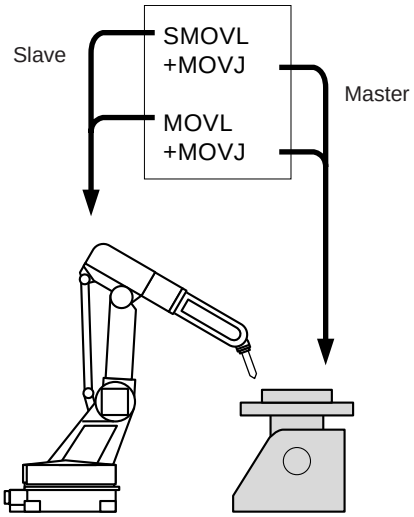
The coordinated positioner system is a system which coordinates a job where a positioner (hereinafter called “station”) holds a workpiece while a manipulator holds a tool.



In order to operate a station and a manipulator simultaneously, a coordinated job is needed.

In the coordinated job, there are two operations: a coordinated interpolation where a station and a manipulator perform a reciprocal movement as master and slave, and an individual interpolation where a station and a manipulator move individually.

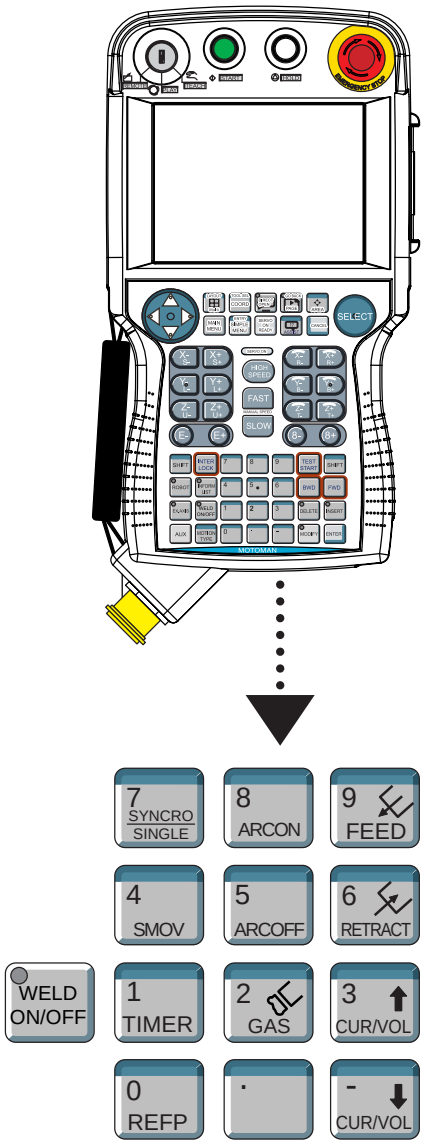
The move instruction in a coordinated job displays two lines: The first line is for the slave side (manipulator), and the second line is for the master side (station).



2.2 Function Keys

The function keys for the coordinated positioner system are assigned to the Numeric keys as shown in the figures below.

2.2.1 Arc Welding Application

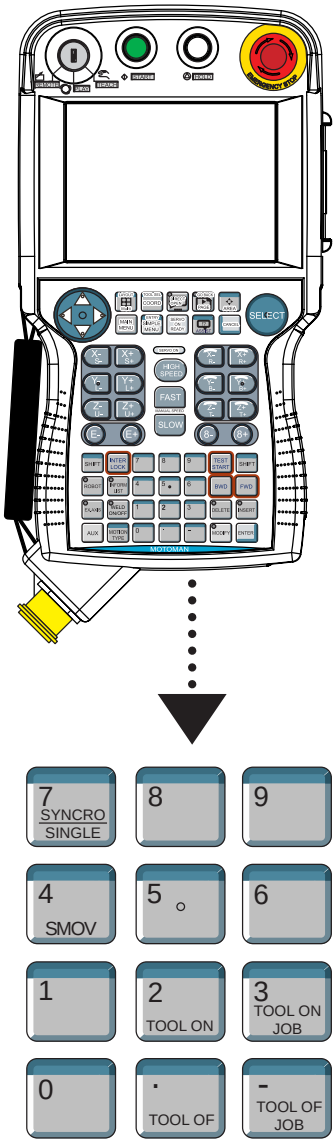


	Registers a timer instruction “TIMER” in a job.
	Registers a reference point “REFP” in a job, or modifies the registered reference point. [REFP] + [FWD] Moves the manipulator to the registered reference point.
	Registers a welding start instruction “ARCON.”
	Registers a welding end instruction “ARCOF.”
	Use when performing a gas check. Gas is fed only while [Gas] is pressed. (Refer to “Chapter 9.3.2 Gas Flow Control Function” at page 9-7 in the Operator’s Manual.)
 	Used for wire inching. Press [FEED] to feed the wire, and press [RETRACT] to retract the wire. While these keys are pressed, the wire feed motor operates. The feed rate can be switched through 3 steps. [FEED] : Low speed [FEED] + [FAST] : Middle speed [FEED] + [HIGH SPEED] : High speed The retract speedfeed rate can be switched through 3 steps. [RETRACT] : Low speed [RETRACT] + [HIGH SPEED] : High speed (Refer to “Chapter 9.3.1 Wire Inching Function” at page 9-7 in the Operator’s Manual.)
 	Modifies the welding current/voltage while welding during the play mode. Press [3/CUR/VOL] to increase the current/voltage value, and press [–/CUR/VOL] to decrease the current/voltage value. (Refer to “Chapter 9.13 Changing Welding Conditions During Playback” at page 9-134 in the Operator’s Manual.)
	Changes the type of movement for the manipulator when teaching a coordinated job. Each time this key is pressed, the movement type changes. SYNCRO: The mark for “synchronized” appears in the status display area. When the master side is moved, the slave side will follow the movement of the master. SINGLE: Only the selected group axis moves.

	Selects either a coordinated or an individual interpolation when teaching a coordinated job. Each time this key is pressed, the operation type changes. Coordinated: All the move instructions that are registered in this mode become coordinated instructions. Individual: The master-slave relationship is cancelled. Each manipulator and station moves independently.

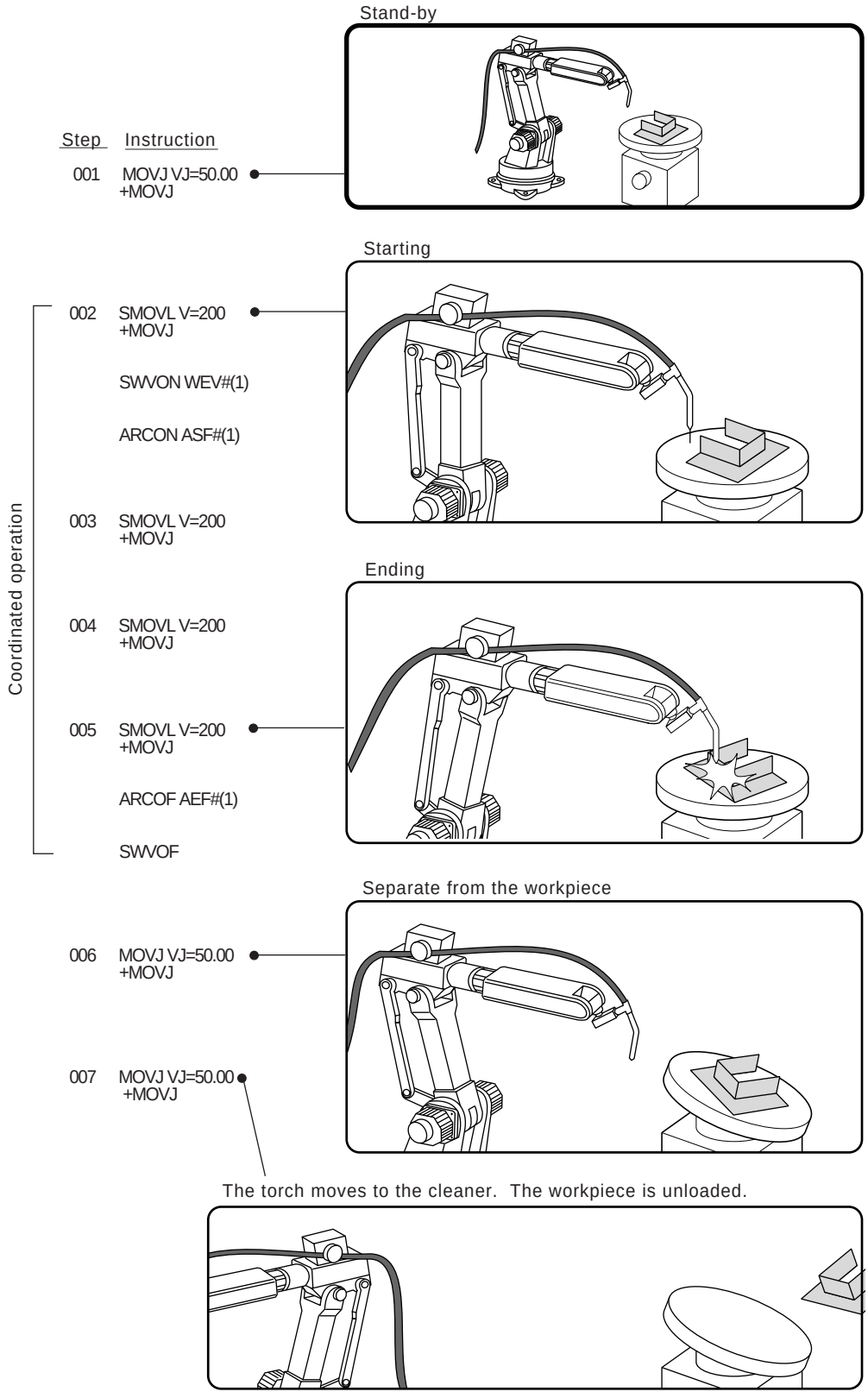
Wire retraction, high-speed inching, or high-speed retraction cannot be performed depending on the Power Source.

2.2.2 General Application



	Registers the TOOLON instruction. If [INTERLOCK] is pressed simultaneously, the TOOLON operation is executed.
	Registers the TOOLOF instruction. If [INTERLOCK] is pressed simultaneously, the TOOLOFF operation is executed.
	Registers the CALL instruction for the reserved job TOOLONxx.
	Registers the CALL instruction for the reserved job TOOLOFxx.
	Changes the type of movement for the manipulator when teaching a coordinated job. Each time this key is pressed, the movement type changes. SYNCRO: The mark for “synchronized” appears in the status display area. When the master side is moved, the slave side will follow the movement of the master. SINGLE: Only the selected group axis moves.
	Selects either a coordinated or an individual interpolation when teaching a coordinated job. Each time this key is pressed, the operation type changes. Coordinated: All the move instructions that are registered in this mode become coordinated instructions. Individual: The master-slave relationship is cancelled. Each manipulator and station moves independently.

2.3 Example of Job Teaching

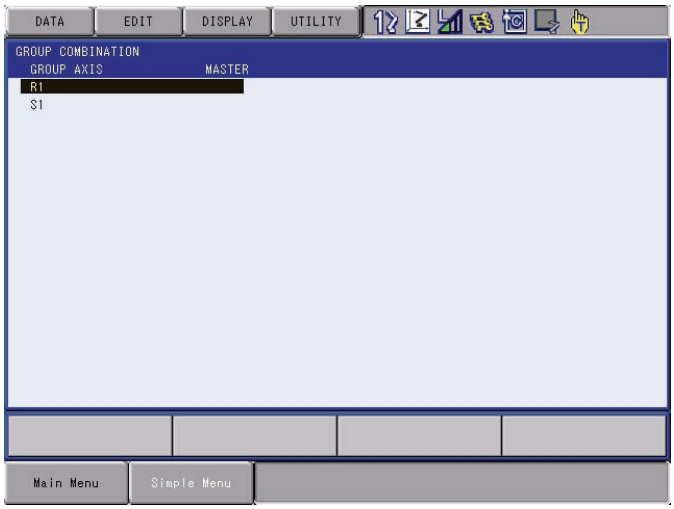


2.4 System Setup

2.4.1 Registering Group Combination

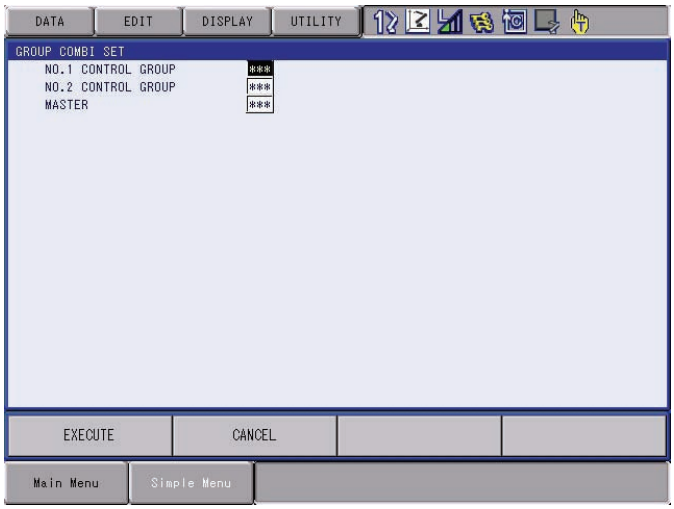
Register a combination of a station and a manipulator.

1. Select {SETUP} under the main menu.
2. Select {GRP COMBINATION}.
   – The GROUP COMBINATION window appears.

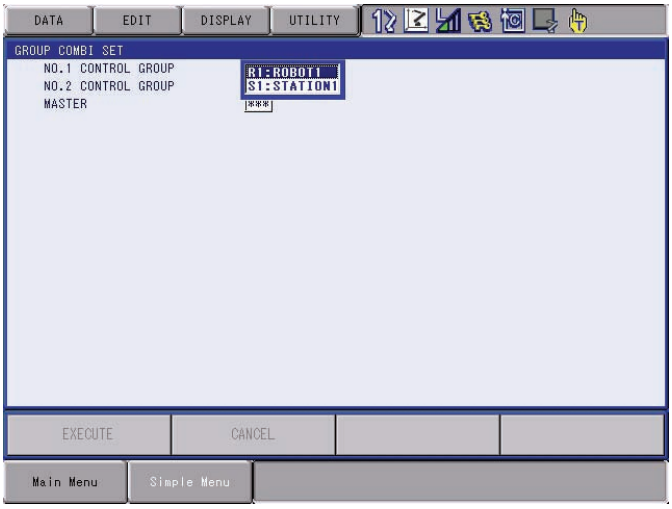


3. Press [SELECT].
   – The selection dialog box appears.

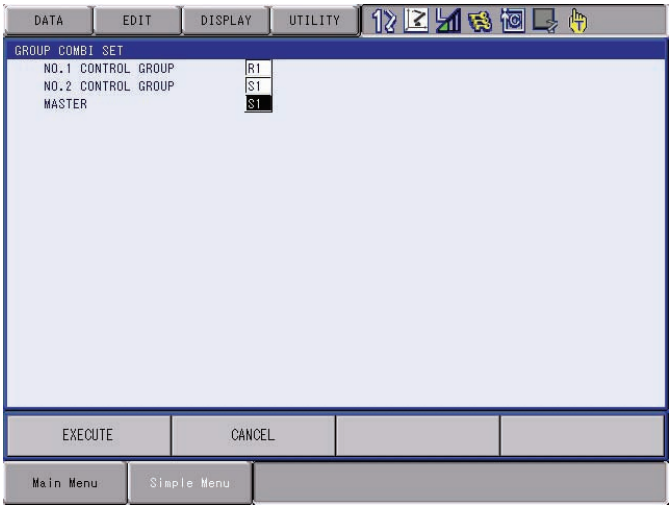
4. Select “ADD GROUP.”
   – The GROUP COMBI SET window appears



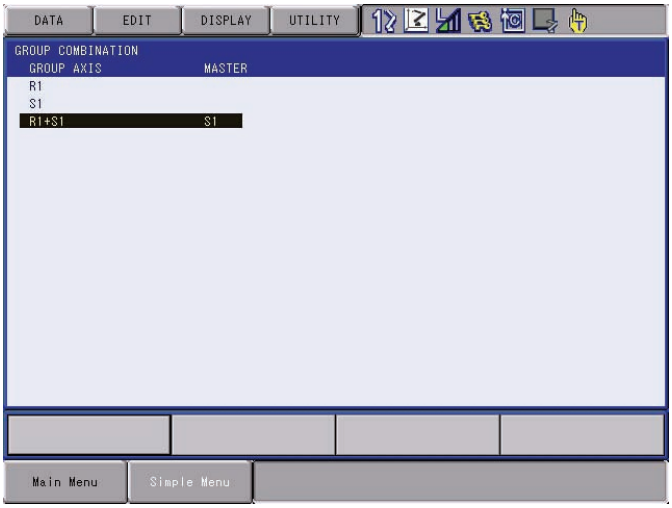
5. Press [SELECT].
   – The selection dialog box appears.



6. Select a group axis to be set.
   – Set a station as “MASTER.”



7. Select “EXECUTE.”
   – The GROUP COMBINATION window reappears.



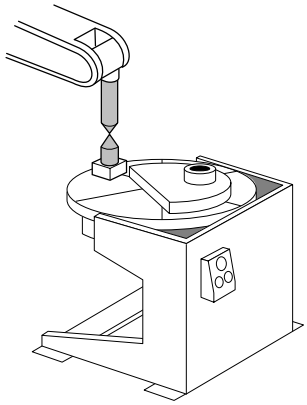
2.4.2 Calibration between Manipulator and Station

For a coordinated motion between a manipulator and a station, prior registration of the settings for mutual positioning is required.

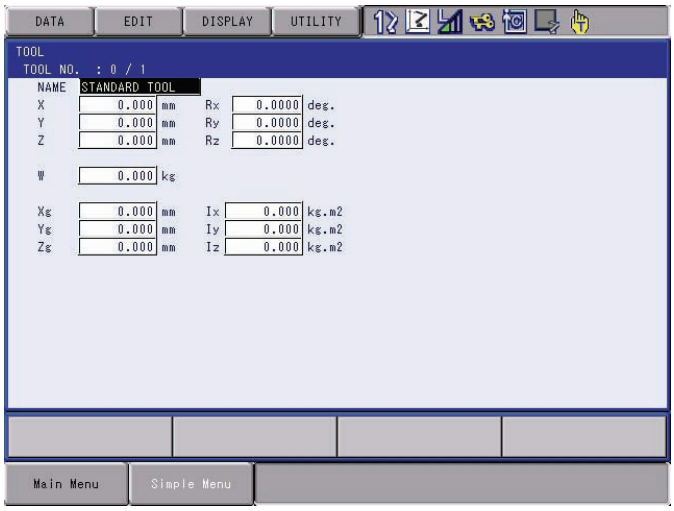
This relationship is set by calibration between the manipulator and the station.

2.4.2.1 Calibration Tool Setting

1. Mount a tool for calibration on the manipulator.
   – Use a tool whose exact dimensions are known.



2. Select {ROBOT} under the main menu.
3. Select {TOOL}.
   – The TOOL window appears.

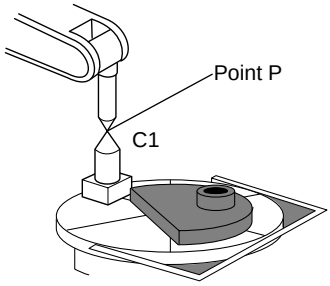


4. Enter the tool dimensions.
5. Press [ENTER].

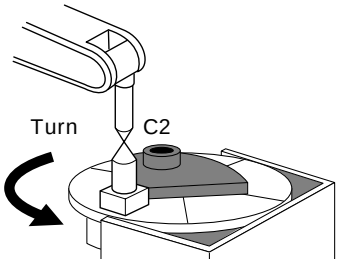
2.4.2.2 Teaching Positions for Calibration

■ **For a station with one rotating axis**

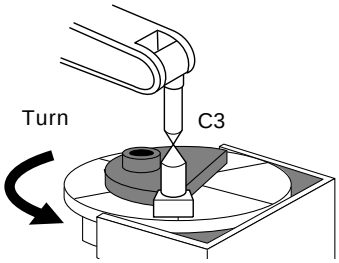
1. Determine an arbitrary point (point P) on the turntable of the station axis. Point P should be as far as possible from the turntable rotation center. Align the TCP of the manipulator with point P, and register it as C1.



2. Turn the station axis. The amount of turning is not limited but should be 30° or more. It does not matter if the rotational direction is positive or negative. Then, align the TCP of the manipulator to point P, and register it as C2.



3. Turn the station axis further in the same direction as in step 2. Then, align the TCP of the manipulator to point P, and register it as C3.

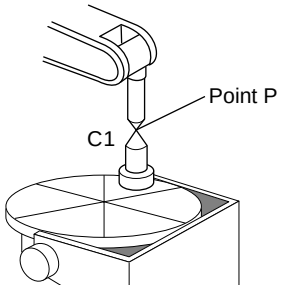


NOTE

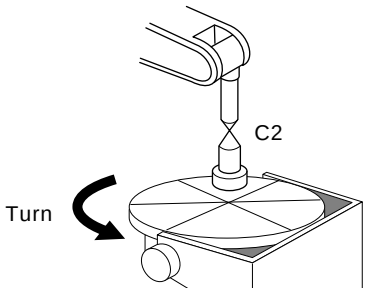
- To minimize teaching error, attach a tool with a pointed end tool on the station axis as shown in the figure above, and use this pointed end as an arbitrary point (point P) when teaching.
- When registering C2 and C3, the manipulator tool should keep as much as possible the same orientation as when C1 was registered.
- The manipulator at teaching should have its L-axis at a 90° angle to the ground and its U-axis parallel to the ground.
- Do not teach with the L-axis and U-axis fully extended or tightly contracted. Otherwise, inaccurate calibration will result.

■ **For a station with two rotating axes**

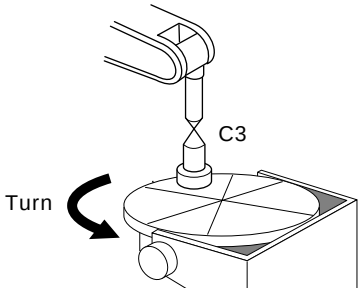
1. Determine an arbitrary point (point P) on the turntable. Point P should be as far as possible from the rotation center of the turntable. With the 1st station axis parallel to the ground, align the TCP of the manipulator to point P, and register it as C1.



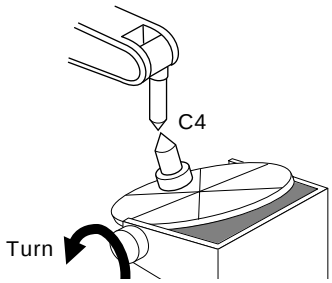
2. Turn the 2nd station axis about 30°. Align the TCP of the manipulator to point P, and register it as C2.



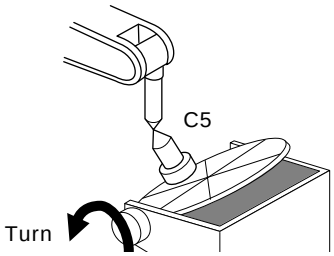
3. Turn the 2nd station axis again for about 30°. Align the TCP of the manipulator to point P, and register it as C3.



4. Turn the 1st station axis about 30°. Align the TCP of the manipulator to point P, and register it as C4.



5. Turn the 1st station axis again for about 30°. Align the TCP of the manipulator to point P, and register it as C5.

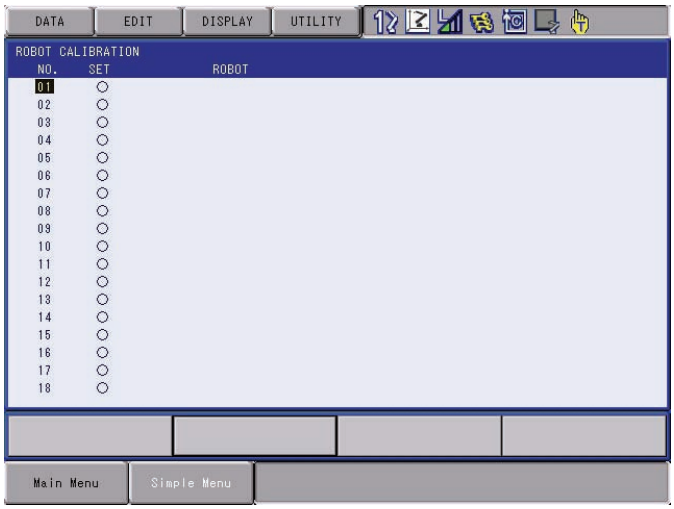


NOTE

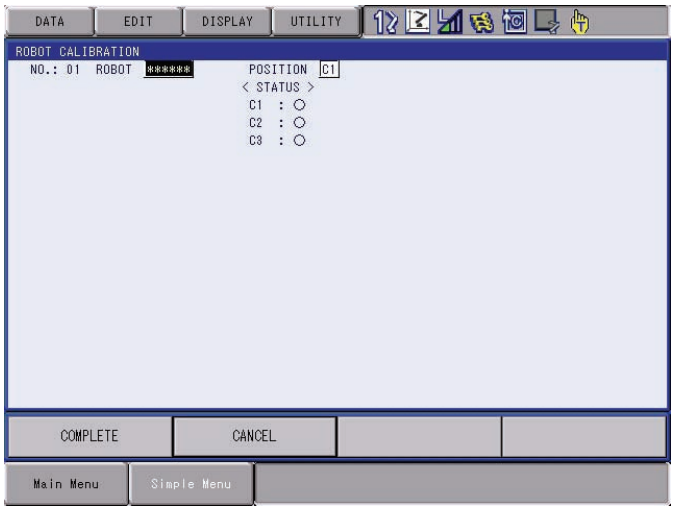
- To minimize teaching error, attach a tool with a pointed end tool on the station axis as shown in the figure above, and use this pointed end as an arbitrary point (point P) when teaching.
- When registering C2 to C5, the manipulator tool should keep as much as possible the same orientation as when C1 was registered.
- The manipulator at teaching should have its L-axis at a 90° angle to the ground and its U-axis parallel to the ground.
- Do not teach with the L-axis and U-axis fully extended or tightly contracted. Otherwise, inaccurate calibration will result.
- For C1, C2, and C3, the position of the 1st station axis must be the same.
- The position of the 2nd station axis for C4 and C5 must be the same as that for C3.

2.4.2.3 Calibration

1. Select {ROBOT} under the main menu.
2. Select {ROBOT CALIB}.
   – The ROBOT CALIBRATION list window appears.



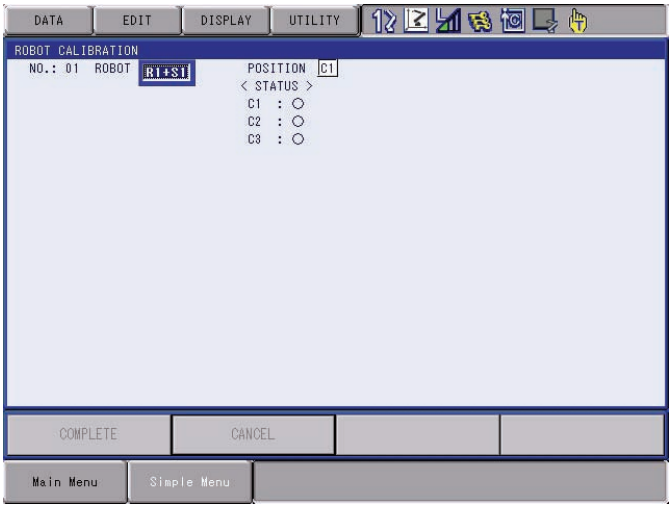
3. Select a robot calibration No.
   – The ROBOT CALIBRATION window for teaching appears.



4. Select “ROBOT.”

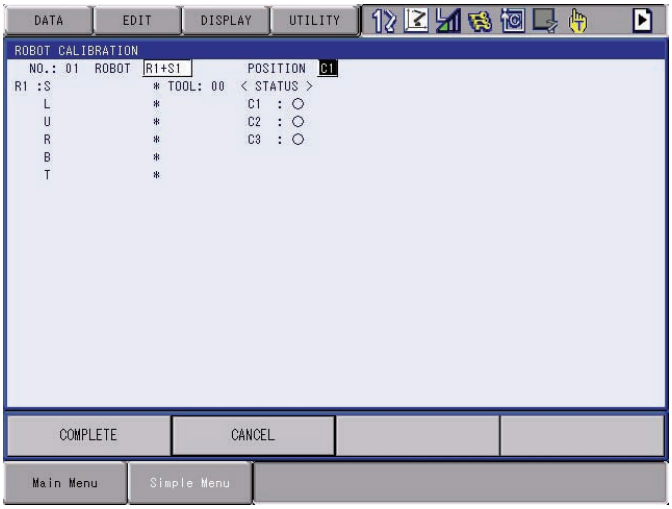
   – The selection dialog box appears.

   (1) Select a control group for calibration.

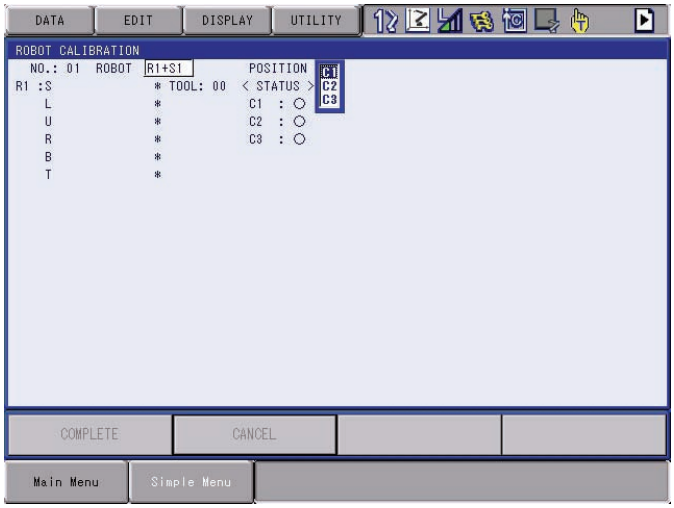


5. Select a group axis combination for calibration.

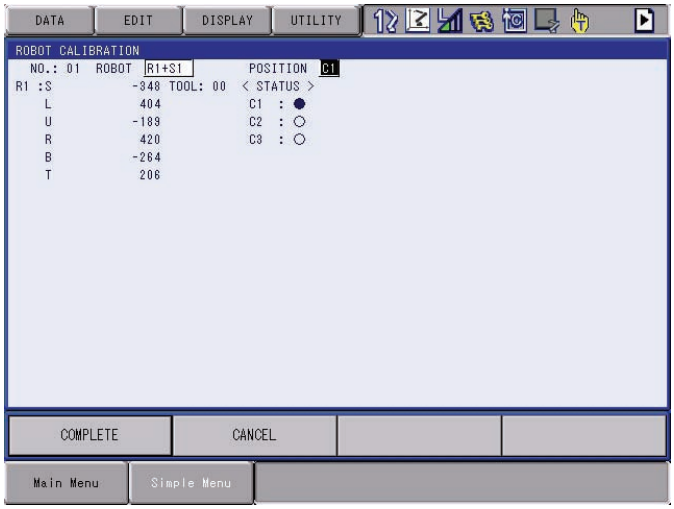
   – The teaching positions are displayed.



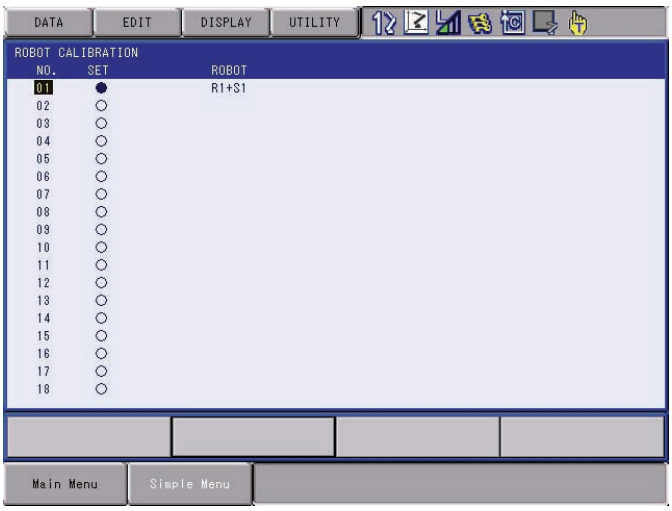
6. Select “POSITION.”
   – The selection dialog box appears.
   (1) Select a position to be taught.



7. Press the axis key to move the manipulator to the desired position.
8. Press [MODIFY] and [ENTER].
   – The positions for calibration are registered.
   – Repeat Operations 6 and 8 to teach set positions C1 to C3.
   – On the window, “●” indicates that the teaching is completed while “○” indicates that the teaching is not completed.
   – The calibration positions appear according to the selected group axis.
   – Press the page key  to change the window.



9. Select “COMPLETE.”
   – The robots are calibrated.
   – When the calibration is completed, the ROBOT CALIBRATION list window reappears.

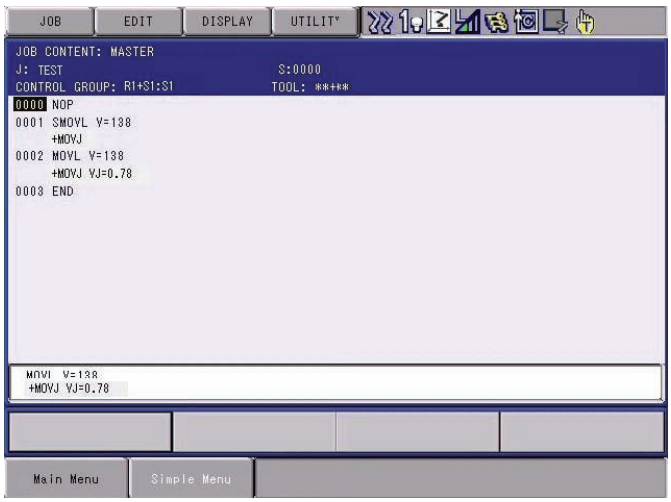


■ **Alarm which is emitted when trouble occurs during calibration teaching**

Alarm Number	Alarm Name	Sub Code	Meanings
4497	DEFECTIVE TAUGHT POINT(CALIB)	1	Some of the teaching points for master-group are on the same point.
		2	Some of the teaching points for slave-group are on the same point.
		3	The 2nd-axis positions of C3, C4, and C5 of station axes are not the same.
		4	The 1st-axis positions of C1, C2, and C3 of station axes are not the same.
		5	The 2nd-axis positions of C1, C2, and C3 of station axes are the same.
		6	The 1st-axis rotation direction of C3, C4, and C5 of station axes are not the same.
		7	The 1st-axis (elevation axis) positions of C1, C2, and C3 of station axes are not the same.
		8	The 1st-axis (elevation axis) positions of C3, C4, and C5 of station axes are not the same.

2.5 JOB CONTENT Window

An example of the contents of a coordinated job is shown below.



① Instructions

For a coordinated job, the move instruction is displayed in two lines: The first line is the instruction to the slave side; the second line is the instruction to the master side.

SMOVL V=138 ←Slave, a manipulator

+MOVJ ←Master, a station

② Synchronized/Single

Synchronized/single are the types of movement available for the manipulator during axis operation.

This mark appears when synchronized movement is selected.

Switch between movements by pressing [SYNCRO/SINGLE].

③ Group axis being handled

Displays the group axis being handled.

Pressing [ROBOT] selects the manipulator.

Pressing [EX. AXIS] selects the station.

④ Coordinated interpolation/Individual interpolation

Switch between coordinated interpolation and individual interpolation by pressing [SMOV].

2.6 Synchronized/Single

There are two ways to handle axes when teaching: “Synchronized” and “Single.”

Switch between movements by pressing [SYNCRO/SINGLE].

Synchronized→ 

Single→ 

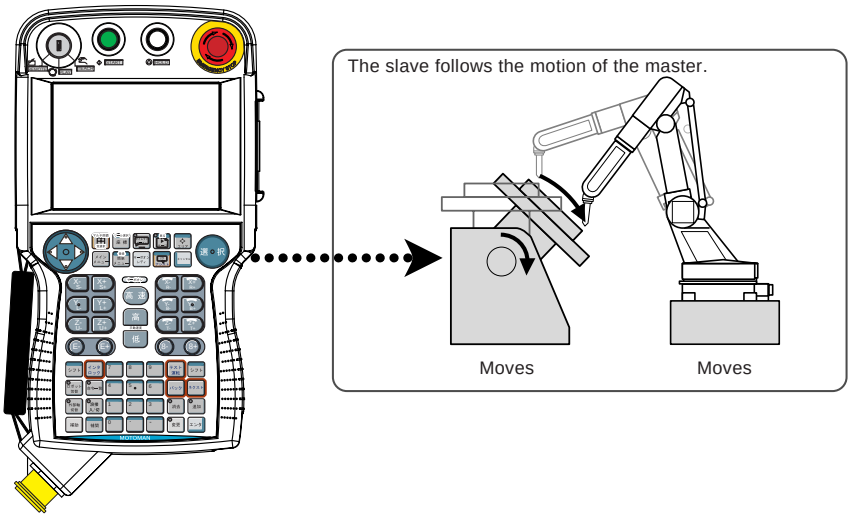
2.6.1 Synchronized

If the axes are handled in the “Synchronized” mode, the slave (manipulator) follows the master (station) when the master moves.

This feature is used to keep the position of the manipulator relative to the station.

However, the master does not move when the slave is moved.

■ **A master axis is moved:**

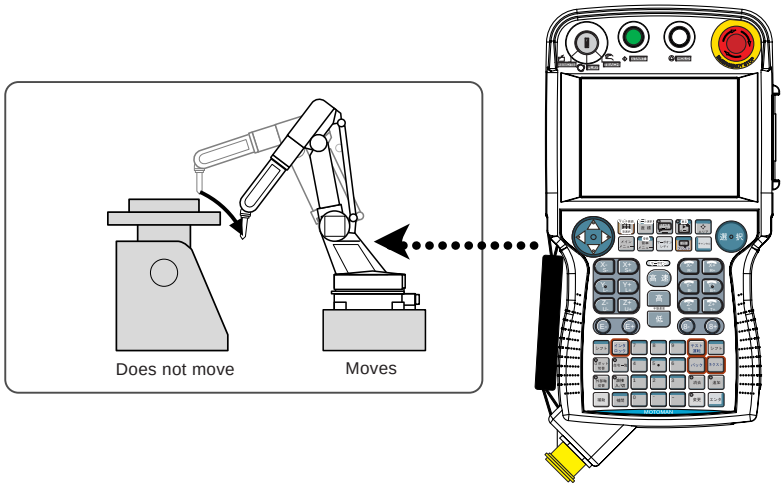


2.6.2 Single

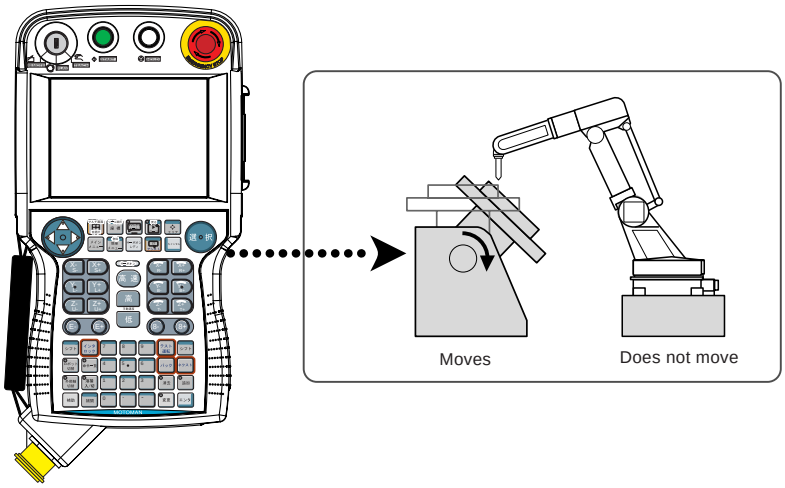
If an axis is handled in “Single” mode, the manipulator or the station whose axis has been handled, moves.

This feature is used where a manipulator and a station each execute an individual job.

■ **A slave axis is moved:**



■ **A master axis is moved:**



NOTE

- The selected mode, Synchronized or Single, is maintained until the next selection is made.
- When an edit job is changed, “Single” is automatically selected.

2.7 Selecting Axis to be Handled

In a coordinated system with multiple numbers of group axes, select a group axis to be handled in the following manner.

2.7.1 When There is an Edit Job

When the edit job is displayed, the group axes registered in the displayed job is the one to be handled.

- Pressing [ROBOT] selects a manipulator for axis handling.

- Pressing [EX. AXIS] selects a station for axis handling.

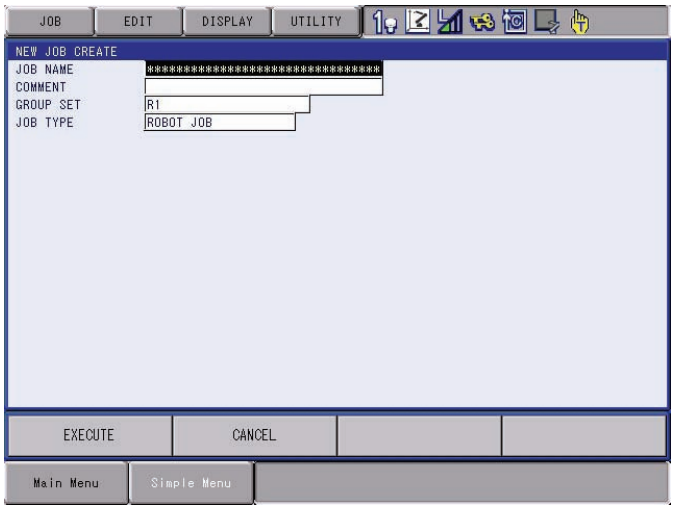
2.7.2 When There is No Edit Job

When there is no edit job, move a manipulator in the following manner.

1. Select the group axes to be moved, and then move it by pressing the axis key.
   - Press [SHIFT]+[ROBOT] to change the manipulator for axis handling.
     The LED of [ROBOT] flashes.
   - Press [SHIFT]+[EX. AXIS] to change the station for axis handling.
     The LED of [EX. AXIS] flashes.
2. Press [ROBOT] or [EX. AXIS] to return to the original window.

2.8 Registering Job

1. Select {JOB} under the main menu.
2. Select {CREATE NEW JOB}.
   – The NEW JOB CREATE window appears.



3. Enter a job name.
   – Select “JOB NAME,” and then enter a job name by entering the characters.
   Refer to “1.2.6 Character Input” of the Operator’s Manual.
4. Press [ENTER].
5. Select “GROUP SET.”
6. Select a group combination.
7. Select “EXECUTE.”
   – The job name is registered in the memory of DX100, and the JOB CONTENT window appears.

2.9 Registering Move Instruction (S)MOV □+MOVJ

Register a move instruction in the following manner.

2.9.1 Operating Master Side (Station)

1. Call the JOB CONTENT window in teach mode.
2. Press [EX. AXIS].
   – The master side (station) is selected for axis handling.

3. Select either “synchronized” or “single.”
   – Press [SYNCRO/SINGLE] to select either “synchronized” or “single.”
   – When “synchronized” is selected, the mark in the window below appears.
   When the slave side is supposed to follow the master side motion, select “synchronized.”

Synchronized→ 

   – When “single” is selected, the mark in the window below appears.

Single→ 

4. Press the axis key to move to the desired position.

2.9.2 Operating Slave Side (Manipulator)

1. Press [ROBOT].
   – The slave side (manipulator) is selected for axis handling.

2. Press the axis key to move to the desired position.
3. Select either a coordinated interpolation or an independent interpolation.
   – Press [SMOV] to select either interpolation.

4. Select an interpolation type.
   – Press [MOTION TYPE] to select an interpolation type.

5. Confirm the speed.
6. Press [ENTER].
   – The registration is completed as follows.

NOTE

- When joint interpolation is set for the slave side (manipulator), teaching cannot be done during a coordinated operation.
- When “JOINT” is selected, the interpolation type will not change to a coordinated interpolation, even if [SMOV] is pressed.
- When “JOINT” is selected during coordinated interpolation, a coordinated move instruction such as “SMOVL” in the input buffer line changes to “MOVJ,” and the interpolation type becomes individual interpolation.

Parameter	Contents and Set Value	Initial Value
S2C213	+MOV INSTRUCTION INTERPOLATION INPUT This parameter specifies which interpolation is permitted for move instructions for the master robot in a coordinated job. (bit specification) D0: +MOVJ D1: +MOVL D2: +MOVC D3: +MOVS	2

2.9.3 (S) MOV □ + MOVJ rate specification

2.9.3.1 Rate specification in a multiple line shift command

The relationship between the rate specification in a shift commnad which causes multiple groups such as “MOV □ + MOVJ” or “SMOV □ + MOVJ” to operate (i.e. to be configured by multiple lines), simultaneously, and the actual operation rate, is as follows.

- Each shift time for the robot (or station) is obtained according to the rate specified for each line.
- The maximum of the respective shift times is obtained, and all groups are operated according to this maximum shift time.

<Example>

MOVL V = 500.0 …The shift time over the shift distance is 2 seconds at V = 500
+MOVJ VJ = 25.00…The shift time for the shift amount is 4 seconds at VJ = 25
*This “MOVL + MOVJ” functions when the shift time is 4 seconds.
Note that for lines in which the rate specification is omitted, the shift time is calculated based on the assumption that the maximum rate has been specified.

<Example>

MOVL V = 500.0 …The shift time over the shift distance is 2 seconds at V = 500
+MOVJ VJ …The shift time for the shift amount is 1 seconds at VJ = 25
*This “MOVL + MOVJ” functions when the shift time is 2 seconds.

2.9.3.2 Rate specification at coordination interpolation (SMOV □)

The rate specification for the manipulator on the slave side at coordination interpolation (SMOV □) is specified as “relative rate” as seem from the master side.

For example, in arc welding, in the case where the slave side manipulator holds the welding torch, this “relative rate” becomes the “welding rate” with respect to the work piece, so it is important to maintain this rate.
In this case, by omitting the rate specification on the master side, the shift rate will be basically determined by the “relative rate.”

<Example>

MOVL V = 100.0 …The shift time at V = 100 over the relative shift distance on the slave side with respect to the master is 5 seconds.
+MOVJ VJ …The shift time at VJ = 100 for the master shift amount is 2 seconds.
*This “SMOVL + MOVJ” functions when the shift time is 5 seconds.

Parameter	Contents and Set Value	Initial Value
S2C212	+MOV INSTRUCTION SPEED INPUT Specifies whether the speed inputting for move instructions of the master side robot in a coordinated job is permitted or not. **<Example> 0: Not Provided** SMOVL V=100 +MOVJ ← Master side Speed specification not provided **1: Provided** SMOVL V=100 +MOVJ VJ=10.00 ← Master side Speed specification provided	0

2.10 Registering Reference Point Instruction (SREFP)

Register a reference point instruction (SPEFP) for a coordinated interpolation in the following manner.

1. Select {JOB} under the main menu.
2. Select {JOB}.
3. Move the cursor.
   – Move the cursor to the line immediately before the line where the reference point instruction is to be registered.

4. Grasp the Enable switch.
   – Turn ON the servo power with the Enable switch.

5. Press the axis key.
   – Move the manipulator to the position which will be a reference point.
6. Press [REF PNT].
   – The reference point instruction appears in the input buffer line.

7. Change the reference point number.
   (1) Move the cursor to the reference point number, and press [SHIFT] + the cursor key to change the reference point number.

   (2) If you use the Numeric keys to change the reference point number, press [SELECT] when the cursor is on the reference point number. Input the number and press [ENTER].

8. Press [INSERT].
   – The [INSERT] key lamp lights up.
   – When registering immediately before the END instruction, pressing [INSERT] is not needed.
9. Press [ENTER].
   – The REFP instruction is registered.

3 Jigless System

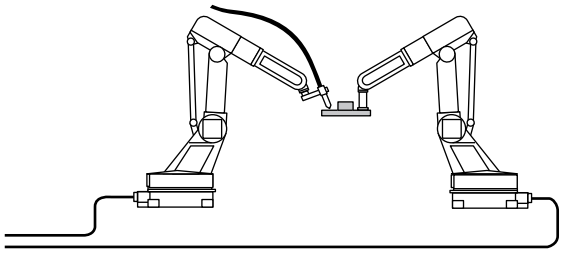
3.1 Outline

A jigless system is a system that welds by coordinating two manipulators; one holding the workpiece while the other holds the torch.

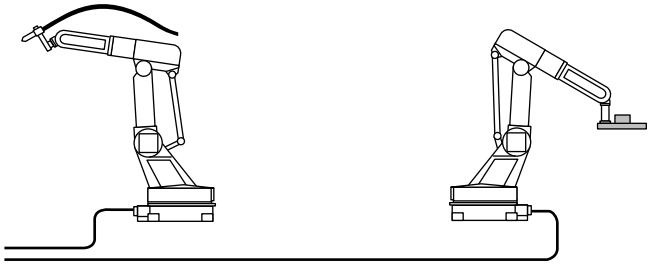
To coordinate the movements of the two manipulators, a coordinated job is needed.

In a coordinated job, there is a coordinated operation where two manipulators, master and slave, perform a reciprocal movement, and an individual operation where each of the two manipulators performs an independent movement.

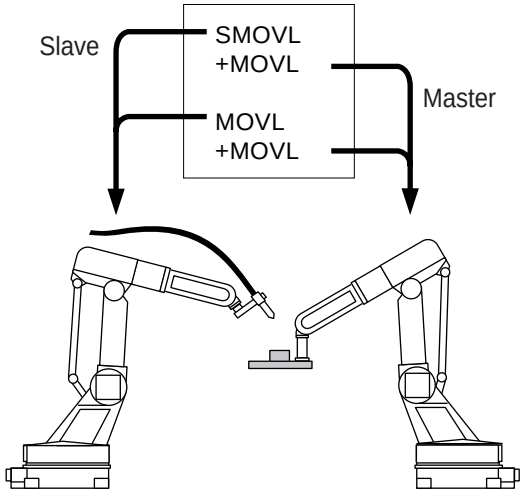
Coordinated operation



Individual operation

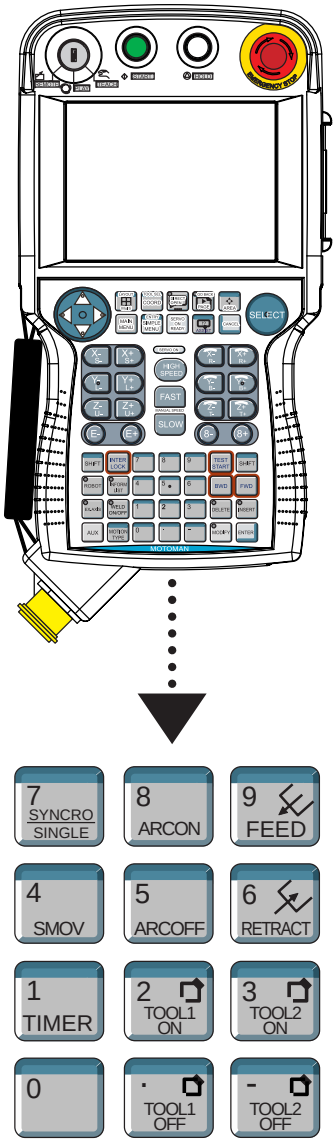


A move instruction in coordinated jobs displays two lines. The first line is for the slave side (torch); the second line is for the master side (workpiece).



3.2 Specific Keys

The specific keys for the jigless system are allocated to the number keys as shown in the figure below.



	Registers a timer instruction “TIMER” in a job.
	Registers a reference point “REFP” in a job, or modifies the registered reference point. [REFP] + [FWD] Moves the manipulator to the registered reference point.
	Registers a welding start instruction “ARCON” in a job.
	Registers a welding end instruction “ARCOF” in a job.
	Use when performing a gas check. Gas is fed only while [Gas] is pressed. (Refer to “Chapter 9.3.2 Gas Flow Control Function” at page 9-7 in the Operator’s Manual.)
 	Used for wire inching. Press [FEED] to feed the wire, and press [RETRACT] to retract the wire. While these keys are pressed, the wire feed motor operates. The feed rate can be switched through 3 steps. [FEED] : Low speed [FEED] + [FAST] : Middle speed [FEED] + [HIGH SPEED] : High speed The retract speedfeed rate can be switched through 3 steps. [RETRACT] : Low speed [RETRACT] + [HIGH SPEED] : High speed (Refer to “Chapter 9.3.1 Wire Inching Function” at page 9-7 in the Operator’s Manual.)
	Changes the type of movement for the manipulator when teaching a coordinated job. Each time this key is pressed, the movement type changes. SYNCRO: The mark for “synchronized” appears in the status display area. When the master side is moved, the slave side will follow the movement of the master. SINGLE: Only the selected group axis moves.

Selects either a coordinated or an individual interpolation when teaching a coordinated job.
Each time this key is pressed, the operation type changes.

Coordinated: All the move instructions that are registered in this mode become coordinated instructions.

Individual: The master-slave relationship is cancelled. Each manipulator and station moves independently.

Wire retraction, high-speed inching, or high-speed retraction cannot be performed depending on the Power Source.

3.3 Opening and Closing Handling Tool

This section explains how to open and close a handling tool by teaching.

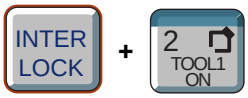
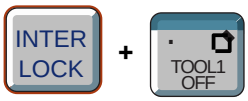
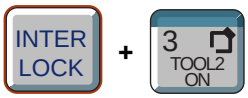
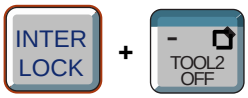
It is unrelated to the content of the job being taught.

To close and open a handling tool by pressing the specific keys, the general output signals #17 to 20 are used.

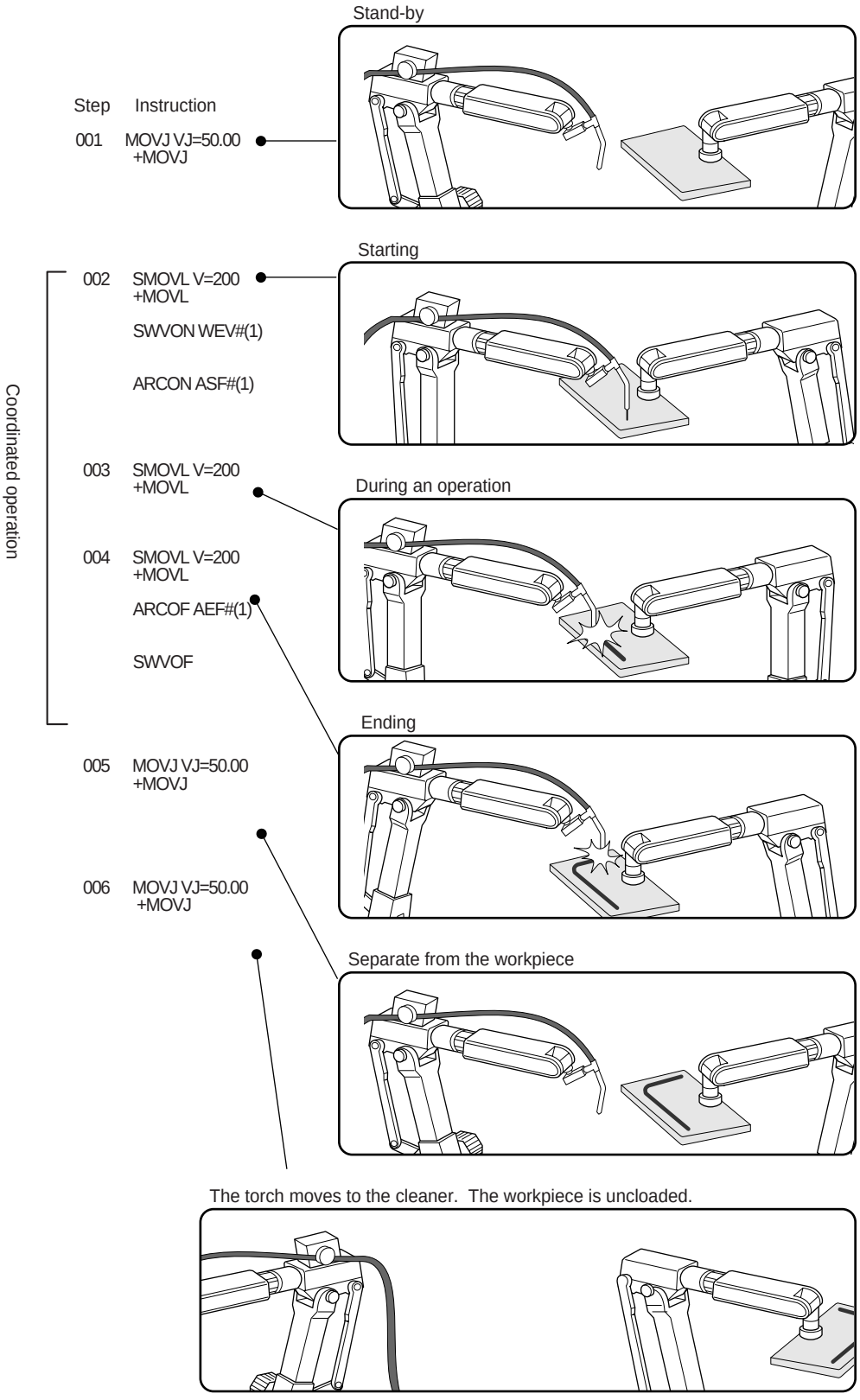
NOTE

The general output signal No. can be changed by the parameter A1P.

A1P026 Tool1 ON general output No. (Initial value: 17)
A1P027 Tool1 OFF general output No. (Initial value: 18)
A1P028 Tool 2 ON general output No. (Initial value: 19)
A1P029 Tool 2 OFF general output No. (Initial value: 20)

	Sends an open instruction to Tool 1. Only while the keys are pressed, general output signal #17 is ON.
	Sends a close instruction to Tool 1. Only while the keys are pressed, general output signal #18 is ON.
	Sends an open instruction to Tool 2. Only while the keys are pressed, general output signal #19 is ON.
	Sends a close instruction to Tool 2. Only while the keys are pressed, general output signal #20 is ON.

3.4 Example of Teaching Job

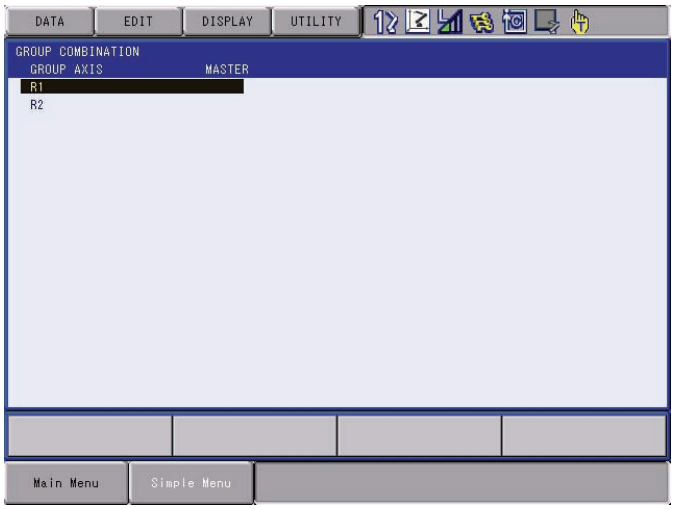


3.5 System Setup

3.5.1 Registering Group Combination

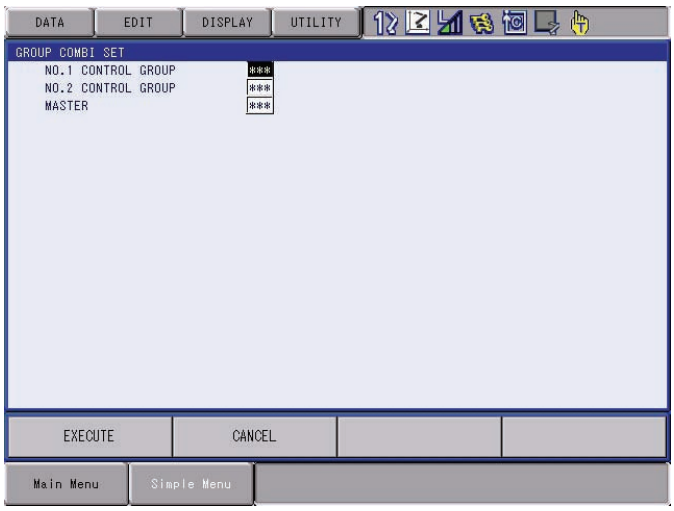
Register a combination of two manipulators.

1. Select {SETUP} under the main menu.
2. Select {GRP COMBINATION}.
   – The GROUP COMBINATION window appears.

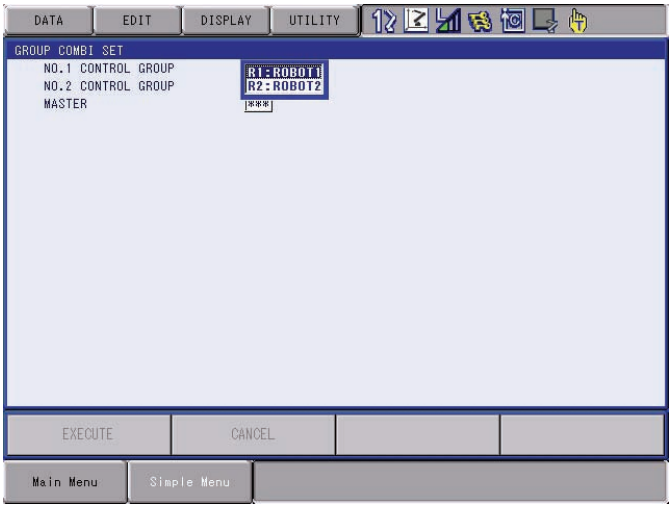


3. Press [SELECT].
   – The selection dialog box appears.

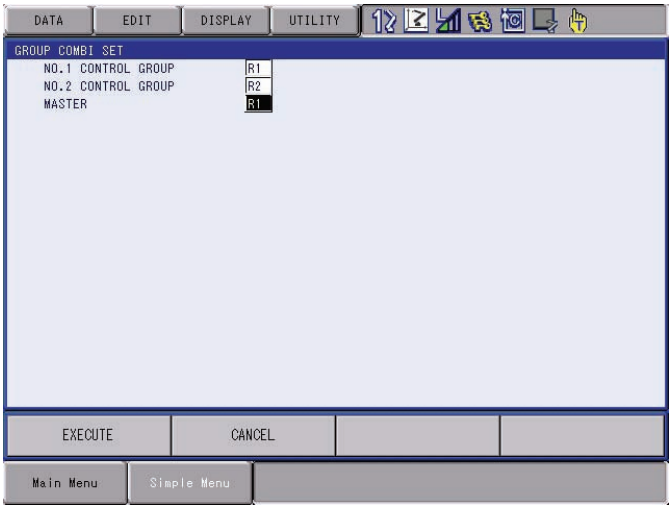
4. Select “ADD GROUP.”
   – The GROUP COMBI SET window appears.



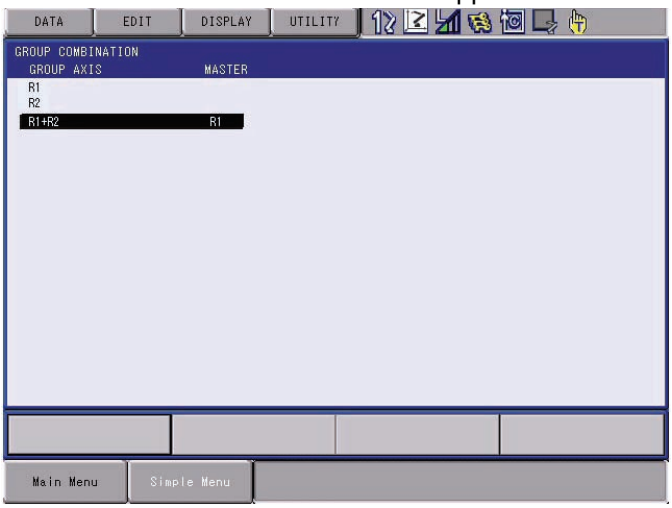
5. Press [SELECT].
   – The selection dialog box appears.



6. Select a group axis to be set.
   – Set R2: ROBOT1 as “MASTER.”



7. Select “EXECUTE.”
   – The GROUP COMBINATION window reappears.



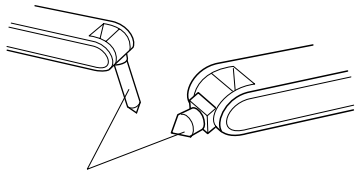
3.5.2 Calibration between Manipulators

For a coordinated operation between manipulators, prior registration of the settings for mutual positioning is required.

This relationship is set by calibration between manipulators.

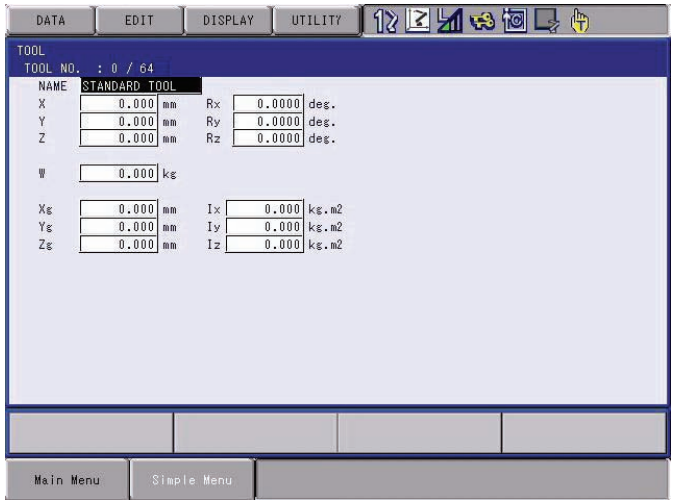
3.5.2.1 Calibration Tool Setting

1. Mount a tool for calibration on the manipulator.
   – Use a tool whose exact dimensions are known.



Tool for calibration

2. Select {ROBOT} under the main menu.
3. Select {TOOL}.
   – The TOOL window appears.

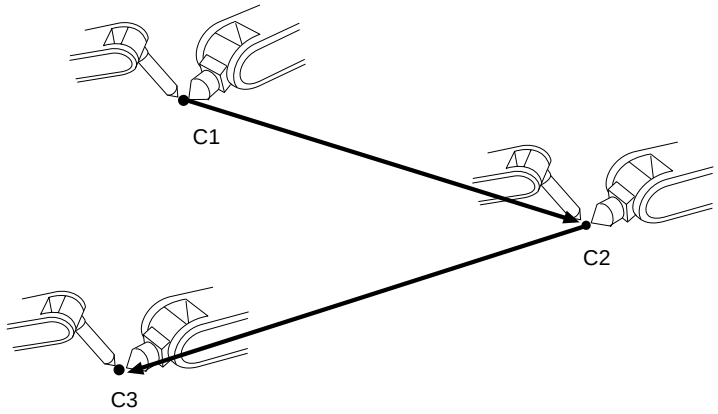


4. Enter the tool dimensions.
5. Press [ENTER].

3.5.2.2 Teaching Position for Calibration

Calibrate the control point for two manipulators at three arbitrary points (C1 to C3) in the space between the manipulators.

1. Move a manipulator to an arbitrary position. Align the tool center point of the other manipulator or to the tool center point of the first manipulator by handling the axis. Register it as C1.
2. Register C2 and C3 in the same manner as C1.

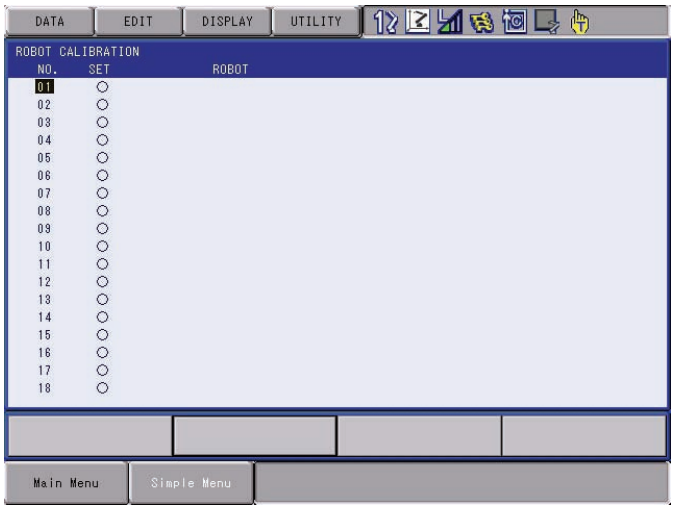


NOTE

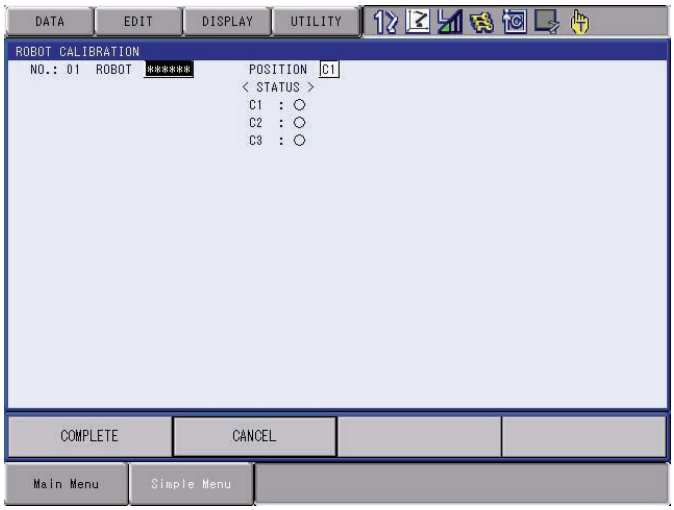
- When registering C2 and C3, the manipulator tool should keep as much as possible the same orientation as when C1 was registered.
- The standard distance between C-1and C-2, C2 and C3, and C3 and C1 should be 1 m or more.
- Teach C1, C2, and C3 so that a triangle, not a straight line, is formed.
- Do not teach with the LU axis fully extended or tightly contracted. Otherwise, inaccurate calibration will result.

3.5.2.3 Calibration

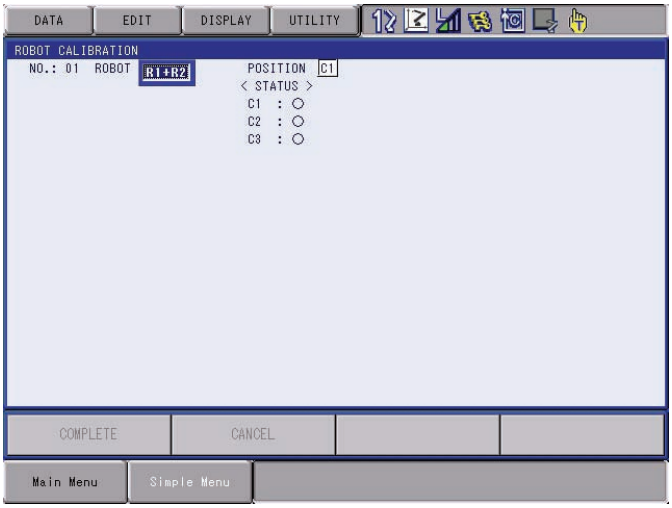
1. Select {ROBOT} under the main menu.
2. Select {ROBOT CALIB}.
   – The ROBOT CALIBRATION list window appears.



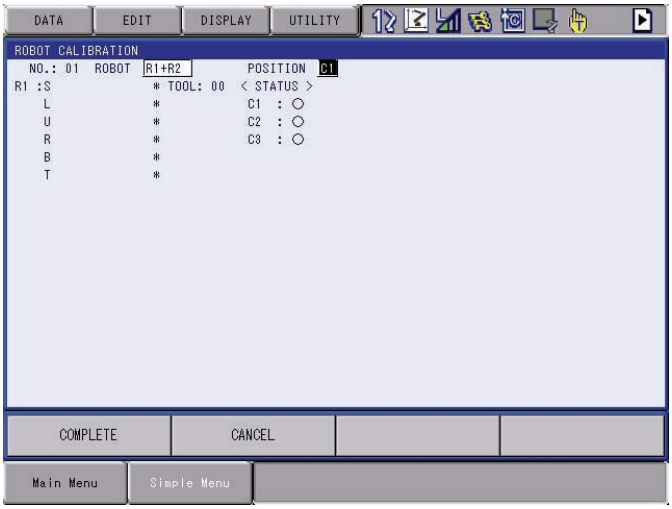
3. Select a robot calibration No.
   – The ROBOT CALIBRATION window for teaching appears.



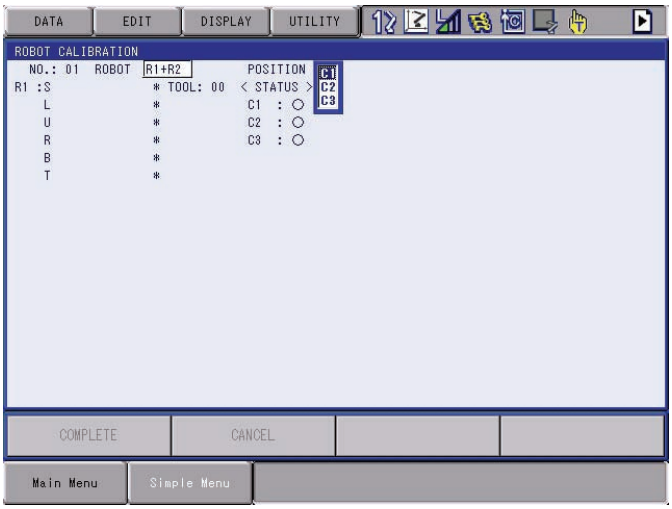
4. Select “ROBOT.”
   – The selection dialog box appears. Select a control group for calibration.



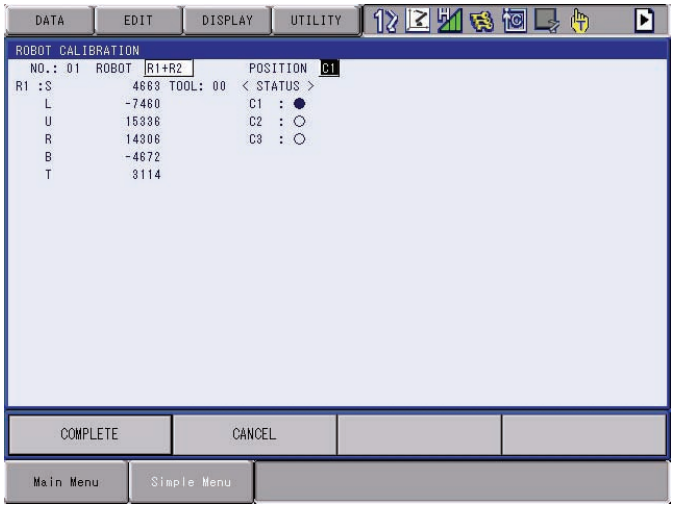
5. Select a group axis combination for calibration.
   – The teaching positions are displayed.



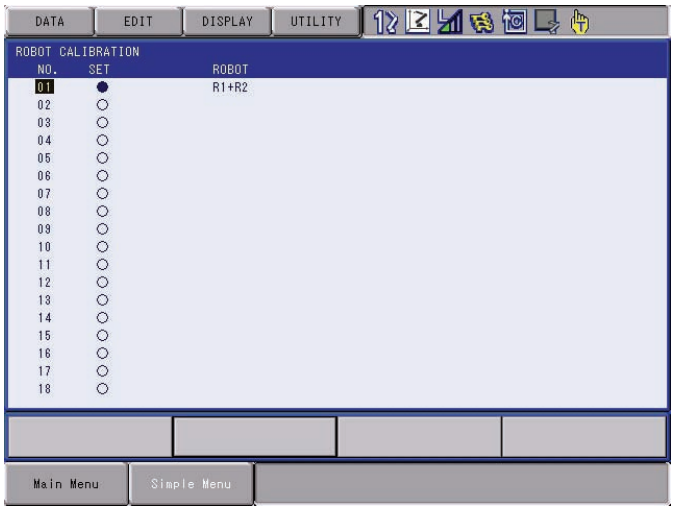
6. Select a group axis combination.
   – The selection dialog box appears. Select a position to be taught.



7. Select “POSITION.”
8. Press the axis key to move the manipulator to the desired position.
9. Press [MODIFY] and [ENTER].
   – The positions for calibration are registered.
   – Repeat Operations 6 to 8 to teach set positions C1 to C3.
   – On the window, “●” indicates that the teaching is completed while “○” indicates that the teaching is not completed.
   – The calibration positions appear according to the selected group axis.
   – Press the page key  to change the window.



10. Select “COMPLETE.”
    – The robots are calibrated.
    – When the calibration is completed, the ROBOT CALIBRATION list window reappears.

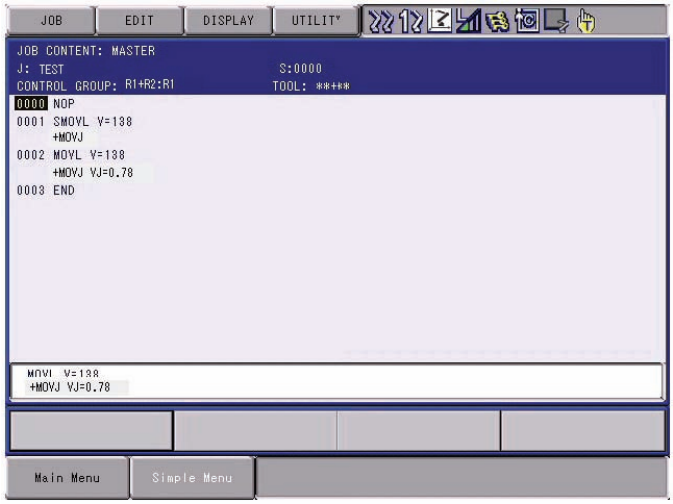


■ Alarm which is emitted when trouble occurs during calibration teaching

Alarm Number	Alarm Name	Sub Code	Meanings
4497	DEFECTIVE TAUGHT POINT(CALIB)	1	Some of the teaching points for master-group are on the same point.
		2	Some of the teaching points for slave-group are on the same point.
		3	The 2nd-axis positions of C3, C4, and C5 of station axes are not the same.
		4	The 1st-axis positions of C1, C2, and C3 of station axes are not the same.
		5	The 2nd-axis positions of C1, C2, and C3 of station axes are the same.
		6	The 1st-axis rotation direction of C3, C4, and C5 of station axes are not the same.
		7	The 1st-axis (elevation axis) positions of C1, C2, and C3 of station axes are not the same.
		8	The 1st-axis (elevation axis) positions of C3, C4, and C5 of station axes are not the same.

3.6 Job Content Display

The contents of a coordinated job are displayed as shown below.



①**Instructions**

For coordinated jobs, the move instruction, the weaving instruction, the shift instruction, and others are displayed in two lines.

The first line is the instruction to the slave side; the second line is the instruction to the master side.

SMOVL V=138 ←Slave, the manipulator holding a torch

+MOVL ←Master, the manipulator holding a workpiece

②**Synchronized/Single**

Synchronized/single are the types of movement available for the manipulator during axis operation.

This mark appears when synchronized movement is selected.

Switch between movements by pressing [SYNCRO/SINGLE].

③**Group axis being handled**

Displays the group axis being handled.

Press [ROBOT] to change the group axis to be handled.

④**Coordinated operation/Individual operation**

Switch between coordinated operation and individual operation by pressing [SMOV].

3.7 Synchronized/Single

There are two ways to handle axes when teaching: “Synchronized” and “Single”.

Switch between movements by pressing [SYNCRO/SINGLE].

Synchronized→ 

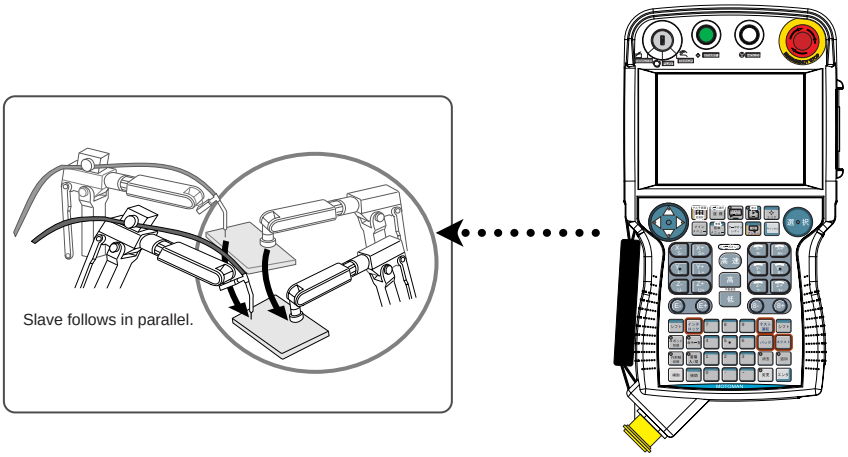
Single→ 

3.7.1 Synchronized

If the axes are handled in the “Synchronized” mode, the slave (torch) follows the master (workpiece) when the master moves.

This feature is used to keep the position of the manipulator relative to the other manipulator.

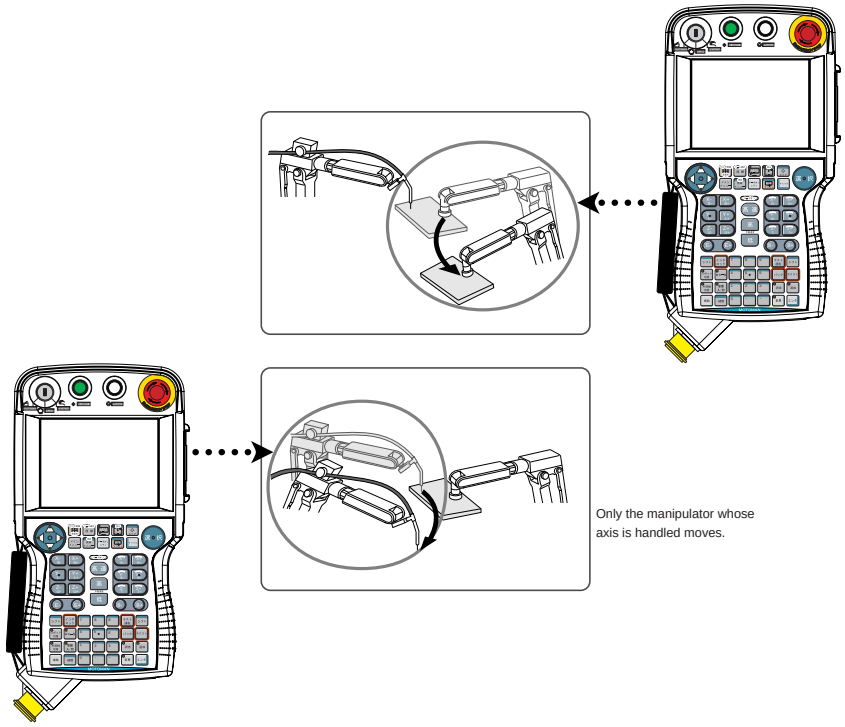
However, the master does not move when the slave is moved.



3.7.2 Single

If an axis is handled in “Single” mode, only the manipulator whose axis is being handled moves.

This feature is used where each of the two manipulators executes an individual job.



NOTE

- The selected mode, Synchronized or Single, is maintained until the next selection is made.
- When an edit job is changed, “Single” is automatically selected.

3.8 Selecting Axis to be Handled

This section explains the methods to select a manipulator to be handled in teach mode.

3.8.1 When There is an Edit Job

Each time [ROBOT] is pressed, a manipulator to be handled changes.

- Pressing [ROBOT] selects a manipulator for axis handling.

- Pressing [EX. AXIS] selects a station for axis handling.

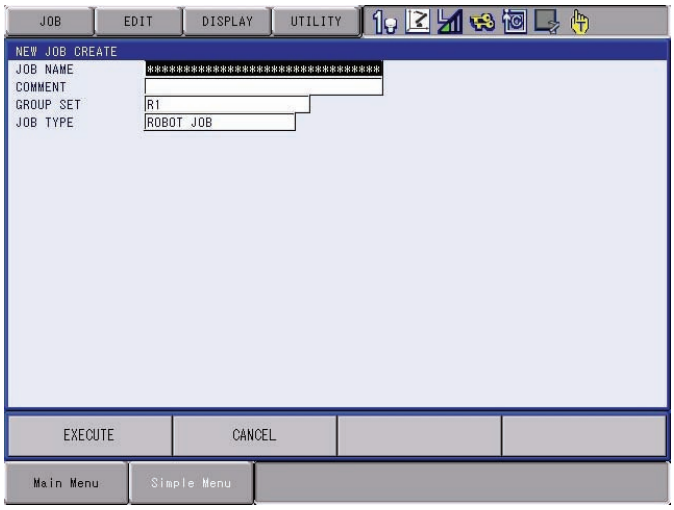
3.8.2 When There is No Edit Job

When there is no edit job, move the manipulator in the following manner.

1. Press [SHIFT]+[ROBOT] to change the manipulator to be handled.
   – The LED of [ROBOT] flashes.
2. Select the group axes to be moved, and then move it by pressing the axis key.
3. Press [ROBOT] to return to the original display.

3.9 Registering Job

1. Select {JOB} under the main menu.
2. Select {CREATE NEW JOB}.
   – The NEW JOB CREATE window appears.



3. Enter a job name.
   – Select “JOB NAME,” and then enter a job name by entering the characters.
   – Refer to “1.2.6 Character Input” of the Operator’s Manual.
4. Press [ENTER].
5. Select “GROUP SET.”
6. Select a group combination.
7. Select “EXECUTE.
   – The job name is registered in the memory of DX100, and the JOB CONTENT window appears.

3.10 Registering Move Instruction (S)MOV □+MOV □

Register a move instruction in the following manner.

3.10.1 Operating Master Side (Workpiece)

1. Call the JOB CONTENT window in teach mode.
2. Press [ROBOT].
   – The master side (manipulator) is selected for axis handling.

3. Select either “synchronized” or “single.”
   – Press [SYNCRO/SINGLE] to select either “synchronized” or “single.”
   – When “synchronized” is selected, the mark in the window below appears.
   When the slave side is supposed to follow the master side motion, select “synchronized.”

Synchronized→ 

   – When “single” is selected, the mark in the window below appears.

Single→ 

4. Press the axis key to move to the desired position.
5. Select an interpolation type.
   – Press [MOTION TYPE] to select an interpolation type.

3.10.2 SMOV □ + MOV □ rate specification

3.10.2.1 Rate specification in a multiple line shift command

The relationship between the rate specification in a shift commnad which causes multiple groups such as “MOV □ + MOVJ” or “SMOV □ + MOVJ” to operate (i.e. to be configured by multiple lines), simultaneously, and the actual operation rate, is as follows.

- Each shift time for the robot (or station) is obtained according to the rate specified for each line.
- The maximum of the respective shift times is obtained, and all groups are operated according to this maximum shift time.

<Example>

MOVL V = 500.0 …The shift time over the shift distance is 2 seconds at V = 500
+MOVJ VJ = 25.00…The shift time for the shift amount is 4 seconds at VJ = 25
*This “MOVL + MOVJ” functions when the shift time is 4 seconds.
Note that for lines in which the rate specification is omitted, the shift time is calculated based on the assumption that the maximum rate has been specified.

<Example>

MOVL V = 500.0 …The shift time over the shift distance is 2 seconds at V = 500
+MOVJ VJ …The shift time for the shift amount is 1 seconds at VJ = 25
*This “MOVL + MOVJ” functions when the shift time is 2 seconds.

3.10.2.2 Rate specification at coordination interpolation (SMOV □)

The rate specification for the manipulator on the slave side at coordination interpolation (SMOV □) is specified as “relative rate” as seem from the master side.

For example, in arc welding, in the case where the slave side manipulator holds the welding torch, this “relative rate” becomes the “welding rate” with respect to the work piece, so it is important to maintain this rate.
In this case, by omitting the rate specification on the master side, the shift rate will be basically determined by the “relative rate.”

<Example>

MOVL V = 100.0 …The shift time at V = 100 over the relative shift distance on the slave side with respect to the master is 5 seconds.
+MOVJ VJ …The shift time at VJ = 100 for the master shift amount is 2 seconds.
*This “SMOVL + MOVJ” functions when the shift time is 5 seconds.

Parameter	Contents and Set Value	Initial Value
S2C212	+MOV INSTRUCTION SPEED INPUT Specifies whether the speed inputting for move instructions of the master side robot in a coordinated job is permitted or not. **<Example> 0: Not Provided** SMOVL V=100 +MOVJ ← Master side Speed specification not provided **1: Provided** SMOVL V=100 +MOVJ VJ=10.00 ← Master side Speed specification provided	0

3.10.3 Operating Slave Side (Torch)

1. Press [ROBOT].
   – The slave side (manipulator) is selected for axis handling.

2. Press the axis key to move to the desired position.
3. Select either a coordinated interpolation or an independent interpolation.
   – Press [SMOV] to select either interpolation.

4. Select an interpolation type.
   – Press [MOTION TYPE] to select an interpolation type.

5. Confirm the speed.
6. Press [ENTER].
   – The registration is completed as follows.

NOTE

- When joint motion is set for the slave side (torch), teaching cannot be done during a coordinated operation.
- When “JOINT” is selected, the interpolation type will not change to a coordinated operation, even if [SMOV] is pressed.
- When “JOINT” is selected during coordinated interpolation, a coordinated move instruction such as “SMOVL” in the input buffer line changes to “MOVJ”, and the interpolation type becomes individual interpolation.

3.11 Registering Reference Point Instruction (SREFP)

Register a reference point instruction (SPEFP) for a coordinated operation in the following manner.

1. Select {JOB} under the main menu.
2. Select {JOB}.
3. Move the cursor.
   – Move the cursor to the line immediately before the line where the reference point instruction is to be registered.

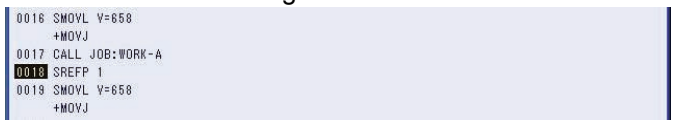
4. Grasp the Enable switch.
   – Turn ON the servo power with the Enable switch.

5. Press the axis key.
   – Move the manipulator to the position which will be a reference point.
6. Select the coordinated interpolation.
   – Press [SMOV] to select either interpolation.
7. Press [REF PNT].
   – The reference point instruction appears in the input buffer line.

8. Change the reference point number.
   – Move the cursor to the reference point number, and press [SHIFT] + the cursor key to change the reference point number.

   – If you use the Numeric keys to change the reference point number, press [SELECT] when the cursor is on the reference point number. Enter the number and press [ENTER].

9. Press [INSERT].
   – The [INSERT] key lamp lights up.
   – When registering immediately before the END instruction, pressing [INSERT] is not needed.
10. Press [ENTER].
   – The REFP instruction is registered.



3.12 Registering Handling Instructions

To register handling instructions, the specific keys [TOOL1 ON], [TOOL1 OFF], [TOOL2 ON], and [TOOL2 OFF] are used.

When these keys are pressed, the instructions shown in the following table are registered.

The general output signals #17 to 20 and the general input signals #17 to 20 are used for handling.

Tool		Specific key	General Output Signal No. (Instruction Output)	General Input Signal No. (Confirmation Input)	Instruction to be Registered
Tool 1	Open		#17	#17	CALL JOB: H1OPEN
	Close		#18	#18	CALL JOB: H1CLOSE
Tool 2	Open		#19	#19	CALL JOB: H2OPEN
	Close		#20	#20	CALL JOB: H2CLOSE

Also by registering a CALL instruction from the instruction list dialog, the instructions in the above table can be registered.

The H1OPEN, H1CLOSE, H2OPEN, and H2CLOSE are reserved jobs. The job contents must have been registered beforehand.
Register a handling instruction according to the application.

An example of H1OPEN registration is shown.

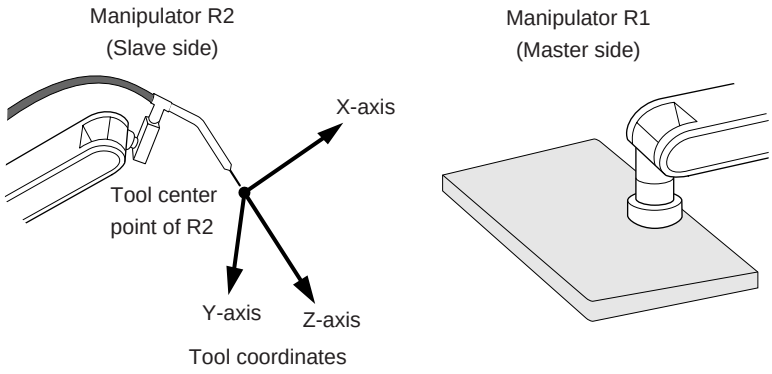
<Example>

The OPEN and CLOSE instructions are of pulse outputs.
After the OPEN or CLOSE instruction, the manipulator waits for a confirmation of the movement.

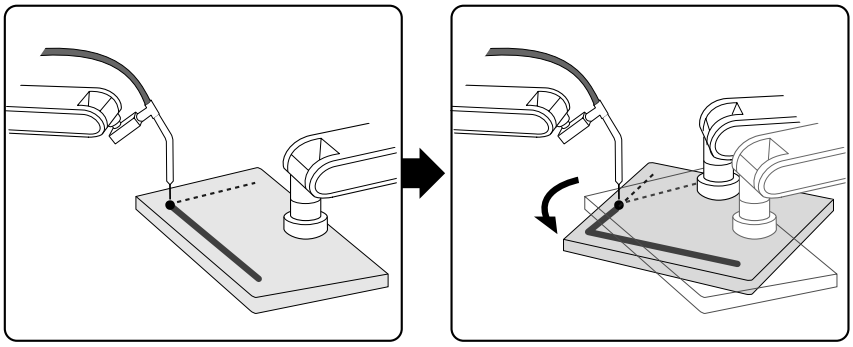
```
NOP
PULSE OT#17…H1OPEN instruction 0.3 second pulse output
WAIT IN#17…Waits for confirmation of H1OPEN
RET
```

3.13 Other Convenient Features

In a jigless system, the control point of slave side manipulator can be set as a reference point so that the master side manipulator can be moved.

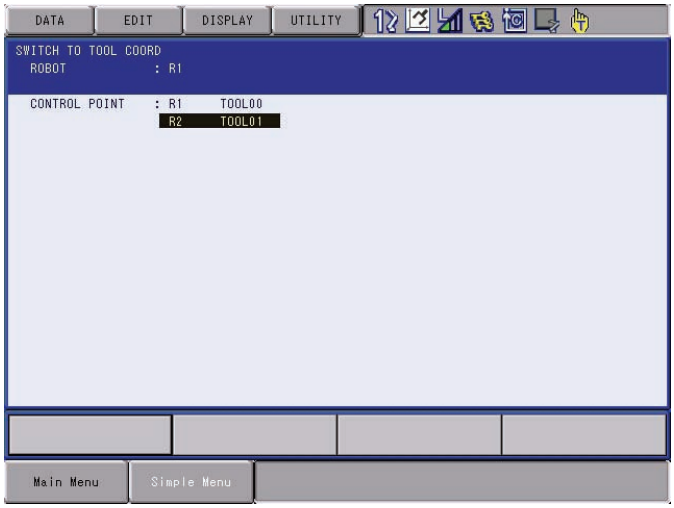


3.13.1 Example of Movement



3.13.2 Operation Method

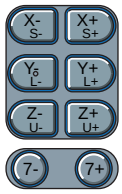
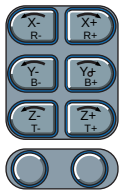
1. Select the tool coordinate system.
   – Press [COORD] and select a tool coordinate system.
2. Press [SHIFT] + [COORD].
   – The switch to tool coordination display is shown.



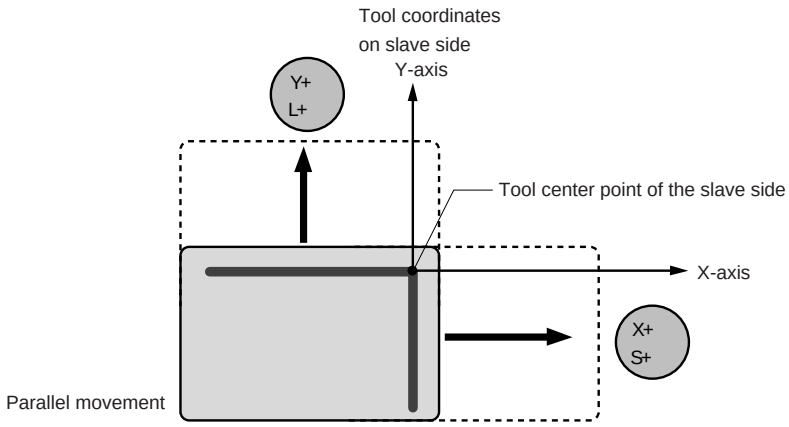
3. Select a operation tool coordinate.
   – Select a manipulator with whose tool center point the manipulator is moved.
   – At turning ON the power supply, the tool center point of the currently selected manipulator is shown.

3.13.3 Manipulator Movement

The operation by the axis keys is the same as that on normal tool coordinate system.

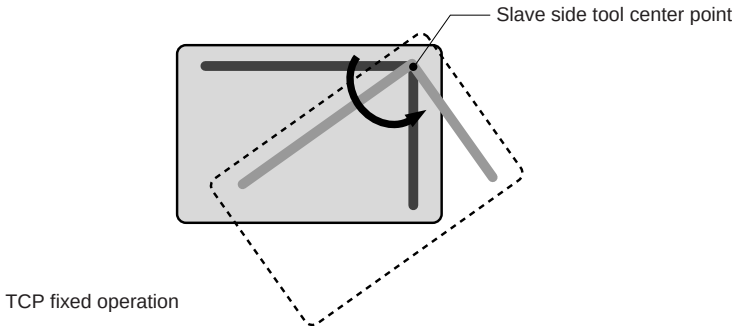
Axis Name	Axis Key	Movement
Basic axes		Moves in parallel to X, Y, and Z-axis of tool coordinates of the selected manipulator.
Wrist axes		With the tool center point of the selected manipulator as a reference point, TCP fixed operation is executed.

3.13.3.1 Basic axes



3.13.3.2 Wrist axes

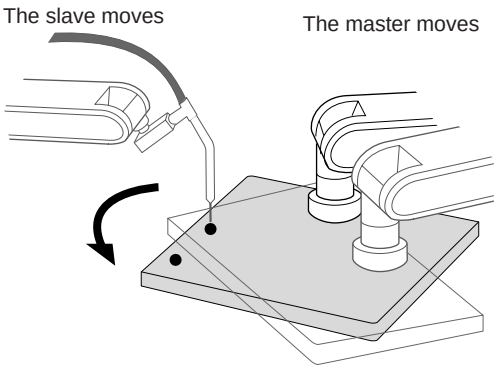
Executing a TCP fixed operation by wrist axes, can change only the wrist orientation without changing its position, with the tool center point of the slave side manipulator as a reference point.



3.13.3.3 Synchronized/Single

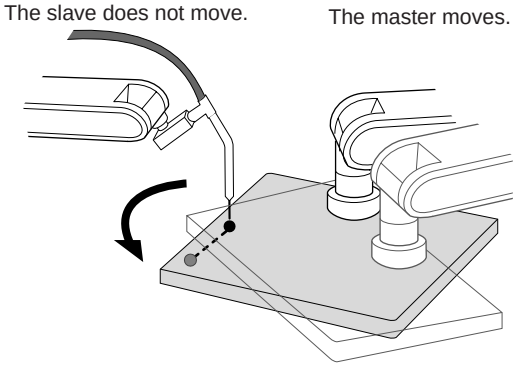
- **When “synchronized” is selected:**
  The master moves with the tool center point of the slave as a reference point.

  The slave follows the master.



- **When “single” is selected:**
  The master moves with the tool center point of the slave as a reference point.

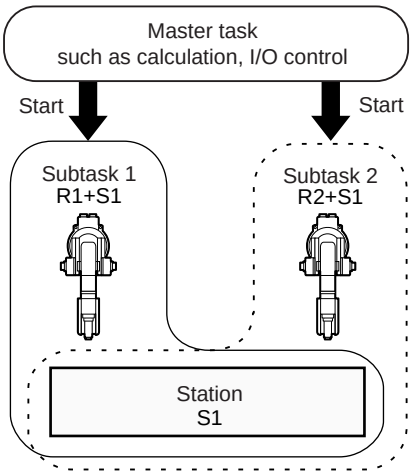
  The slave remains stationary.



4 Twin Synchronous System

4.1 Outline

The twin synchronous system is a system where two manipulators operate in coordination for one station.



In this system, two coordinated jobs are done at the same time.

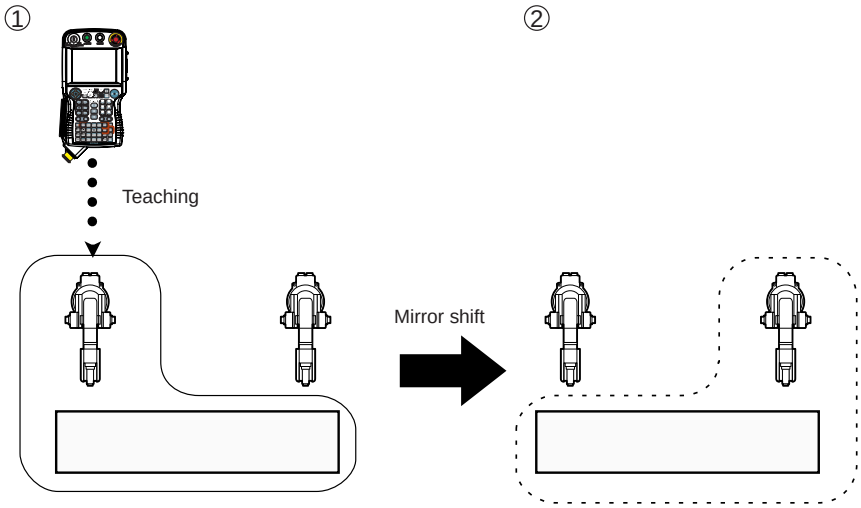
- A coordinated job for one manipulator and the station (R1+S1)
- A coordinated job for the other manipulator and the station (R2+S1)

A concurrent job or a robot job without control groups starts these two jobs and implements
I/O control.

The master task job uses the independent control function to start the robot jobs of subtasks 1 and 2.

Two robot jobs can be created by the following two methods.

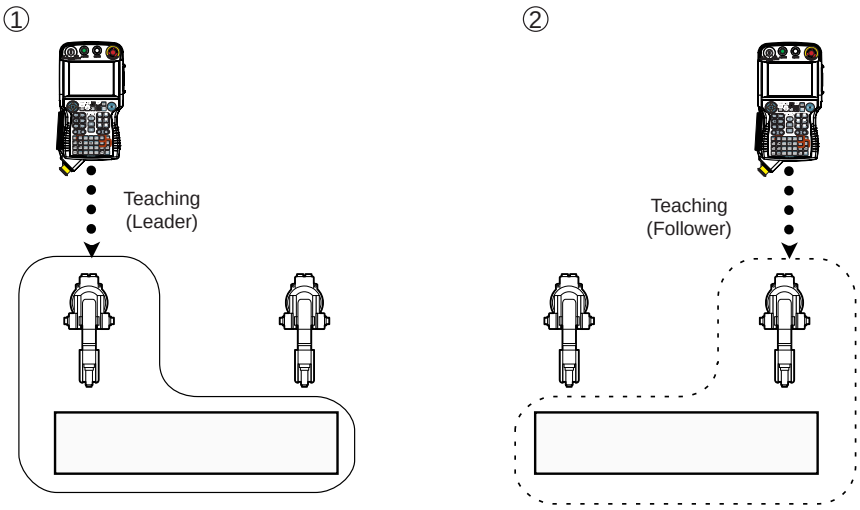
■ **Method 1:**
Copy one subtask job to create another subtask job.



This method is useful when two movement paths are symmetrical.

Use the mirror shift function to convert a job path and copy it. The same teaching operation does not have to be repeated.

■ **Method 2:**
Perform teaching for each manipulator.

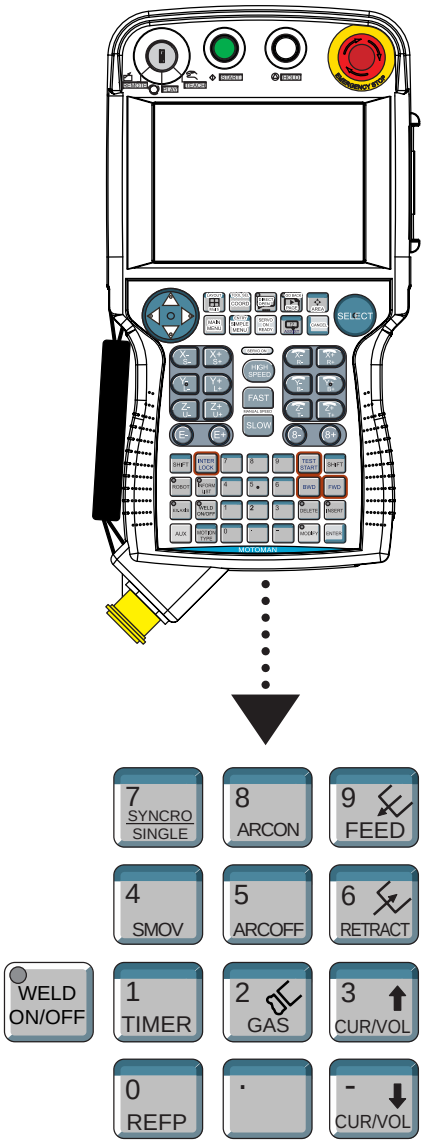


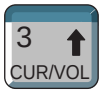
Where there are not many similarities in the paths and movements of the two manipulators, create jobs in Method 2.

4.2 Function Keys

The function keys for the twin synchronous system are assigned to the Numeric keys as shown in the figures below.

4.2.1 Arc Welding Application

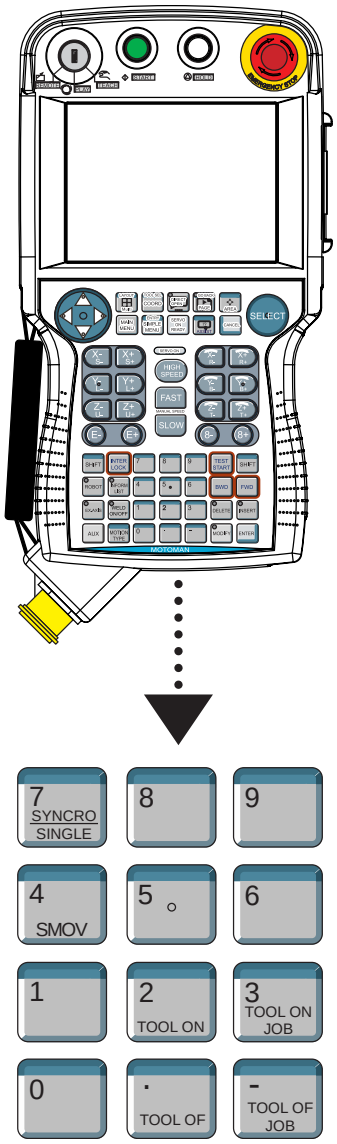


	Registers a timer instruction “TIMER” in a job.
	Registers a reference point “REFP” in a job, or modifies the registered reference point. [REFP]+ [FWD] Moves the manipulator to the registered reference point
	Registers a welding start instruction “ARCON.”
	Registers a welding end instruction “ARCOF.”
	Use when performing a gas check. Gas is fed only while [Gas] is pressed. (Refer to “Chapter 9.3.2 Gas Flow Control Function” at page 9-7 in the Operator’s Manual.)
 	Used for wire inching. Press [FEED] to feed the wire, and press [RETRACT] to retract the wire. While these keys are pressed, the wire feed motor operates. The feed rate can be switched through 3 steps. [FEED] : Low speed [FEED] + [FAST] : Middle speed [FEED] + [HIGH SPEED] : High speed The retract speedfeed rate can be switched through 3 steps. [RETRACT] : Low speed [RETRACT] + [HIGH SPEED] : High speed (Refer to “Chapter 9.3.1 Wire Inching Function” at page 9-7 in the Operator’s Manual.)
 	Modifies the welding current/voltage while welding during the play mode. Press [3/CUR/VOL] to increase the current/voltage value, and press [–/CUR/VOL] to decrease the current/voltage value. (Refer to “Chapter 9.13 Changing Welding Conditions During Playback” at page 9-134 in the Operator’s Manual.)
	Changes the type of movement for the manipulator when teaching a coordinated job. Each time this key is pressed, the movement type changes. SYNCRO: The mark for “synchronized” appears in the status display area. When the master side is moved, the slave side will follow the movement of the master. SINGLE: Only the selected group axis moves.

	Selects either a coordinated or an individual interpolation when teaching a coordinated job. Each time this key is pressed, the operation type changes. Coordinated: All the move instructions that are registered in this mode become coordinated instructions. Individual: The master-slave relationship is cancelled. Each manipulator and station moves independently.

Wire retraction, high-speed inching, or high-speed retraction cannot be performed depending on the Power Source.

4.2.2 General Application



	Registers the TOOLON instruction. If [INTERLOCK] is pressed simultaneously, the TOOLON operation is executed.
	Registers the TOOLOF instruction. If [INTERLOCK] is pressed simultaneously, the TOOLOFF operation is executed.
	Registers the CALL instruction for the reserved job TOOLONxx.
	Registers the CALL instruction for the reserved job TOOLOFxx.
	Changes the type of movement for the manipulator when teaching a coordinated job. Each time this key is pressed, the movement type changes. SYNCRO: The mark for “synchronized” appears in the status display area. When the master side is moved, the slave side will follow the movement of the master. SINGLE: Only the selected group axis moves.
	Selects either a coordinated or an individual interpolation when teaching a coordinated job. Each time this key is pressed, the operation type changes. Coordinated: All the move instructions that are registered in this mode become coordinated instructions. Individual: The master-slave relationship is cancelled. Each manipulator and station moves independently.

4.3 Job Configuration

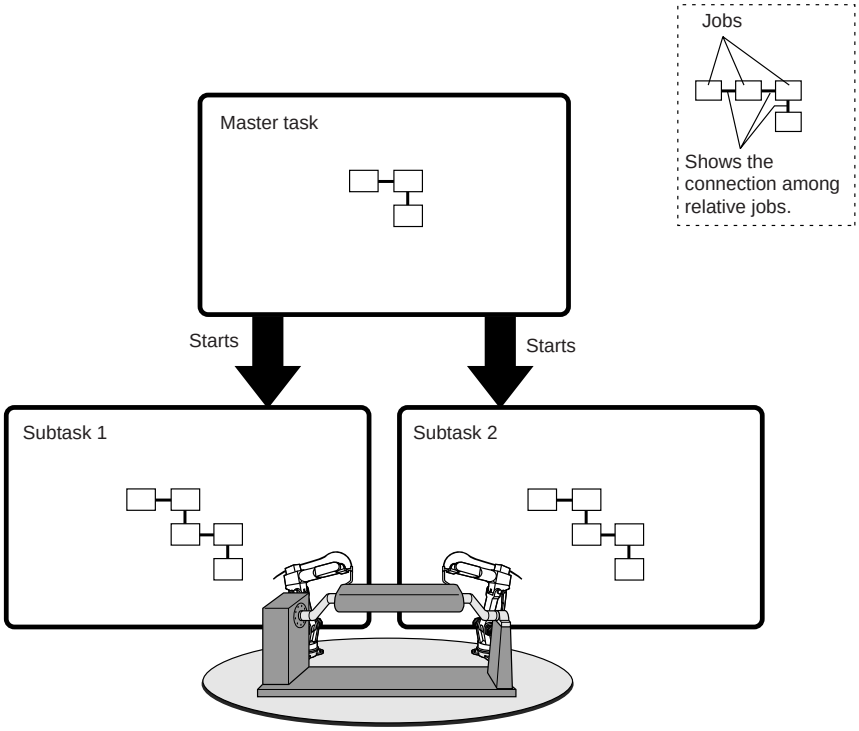
Using the independent control function, configure jobs so that the concurrent job or robot job without control groups of master task operates the robot jobs in subtask 1 and 2.

Master task: Concurrent job (or robot job without control groups)
Starts subtasks 1 and 2, and controls I/Os.

Subtask 1: Robot job
A coordinated job for one manipulator + the station

Subtask 2: Robot job
A coordinated job for the other manipulator + the station

Subtasks 1 and 2 are determined as leader or follower with a tag SYNC in PSTART instruction.



4.4 Leader and Follower

Set either the subtask 1 or the subtask 2 as the follower.

To set a follower, add a tag SYNC and the leader subtask to the PSTART instruction of the master task.

The subtask to which a tag SYNC is added is follower while the subtask without a tag is leader.

The station axis is controlled by the leader job, and the follower job follows the movement of station axis.

NOTE Register a PSTART instruction so that the follower job starts first.

If the PSTART command is not executed correctly, alarm 4103 will be emitted.

When an alarm is emitted, check the sub-code, and correct the job.

<Example>

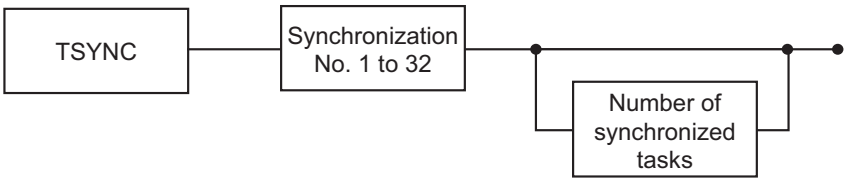
```
PSTART JOB     : R1S1 SUB1
PSTART JOB     : R2   SUB1
      …          AL-4103: [1] Sub task being executed:
                 During execution of SUB1, an attempt is being
                 made to start a different job in the same SUB1.

PSTART JOB     : R1S1 SUB1
                 (R1S1: A job for the robot 1 and the station 1)
PSTART JOB     : R2S1 SUB2
                 (R2S1: A job for the robot 2 and the station 1)
      …          AL-4103 [2] Group axis being used:
                 An attempt is being made to execute a job contain-
                 ing station 1 in SUB2, despite the fact that station 1
                 is being used by SUB1.
PSTART JOB     : R2S1 SUB2 SYNC SUB1
PSTART JOB     : R1S1 SUB1
      …          “Station twin coordination” is being correctly exe-
                 cuted.
```

Alarm Number	Alarm Name	Sub Code	Meanings
4103	PARALLEL START INSTRUCTION ERROR	1	Sub task being executed: Although a job is being executed by instructed sub task, an attempt was made to execute another job by the sub task.
		2	Group axis being used: The job operated by another sub task uses the same group axis.
		3	Multiple start of same job: timing for start command again. The job that was tried to be started was executed by another sub task.
		4	Unregistered master job: Although the master job was not registered, an attempt was made to execute PSTART SUB (job name omitted).
		5	Synchronization instruction error: When restarted by PSTART, synchronization instruction status of the sub task under interruption was different from the status to restart.
		6	Stopped by an alarm: An attempt was made to start the sub task which is stopped by an alarm.
		7	Synchronization task specification of SYNC instruction omit error
		8	The task is specified by synchronization task of SYNC instruction.
		9	I/O jog being executed
		10	Separate group axis being used
		11	The servo power supply is OFF.
		12	Twin synchronous task ID error
		16	PSTART instruction is the old specification.
		17	PWAIT instruction is the old specification.

4.5 Synchronizing with TSYNC

4.5.1 Format



4.5.2 Procedure

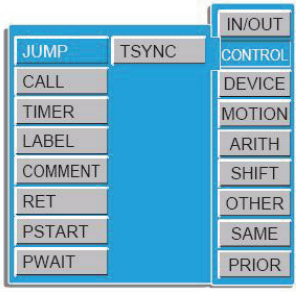
During the execution of the jobs, a deviation between the movements of the two manipulators may occur. In the steps where the movements of the two manipulators should be exactly the same, execute a TSYNC instruction immediately before these steps.

When a TSYNC instruction is executed in one of the robot jobs, the manipulator waits until the same synchronized signal, TSYNC, is executed in the other robot job.

Set the number of synchronized tasks.

When setting “SYNCHRO NUM” to “UNUSED,” the number of tasks is the same as when “SNUM=2.”

1. Move the cursor to the line just above the line where TSYNC instruction is to be registered.
2. Press [INFORM LIST].
   – The instruction list appears.



3. Select “TSYNC.”
   – A TSYNC instruction is displayed in the input buffer line.

4. Change additional items.

– <To register items as displayed in the input buffer line>
Proceed to Operation 5.

– <To change the numerical data>

(1) Move the cursor to the numerical data.

(2) Press [SHIFT] and the cursor key simultaneously to increment or decrement the number.

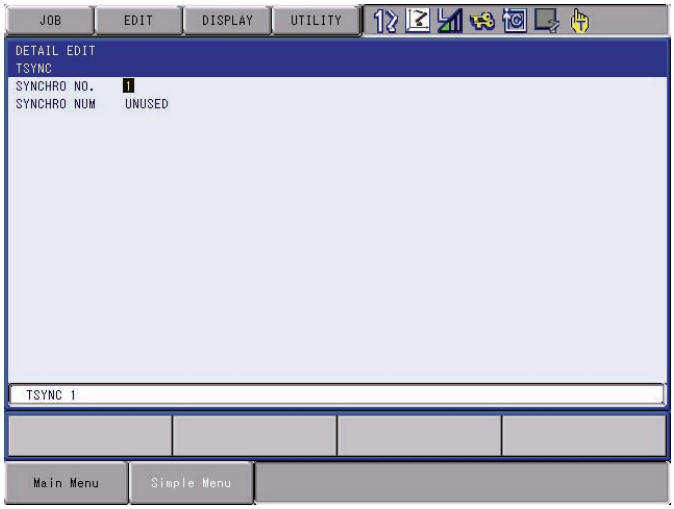
(3) To enter a number by pressing the Numeric keys, press [SELECT] to display the input line.

(4) Enter a number and press [ENTER], then the number in the input buffer line is changed.

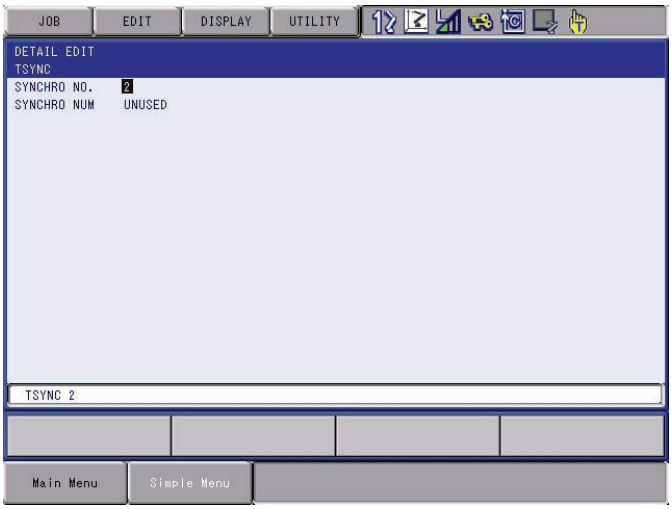
(5) After having changed the numerical data, press [ENTER].
The DETAIL EDIT window is closed and the the JOB CONTENT window reappears.

– <To edit additional items>

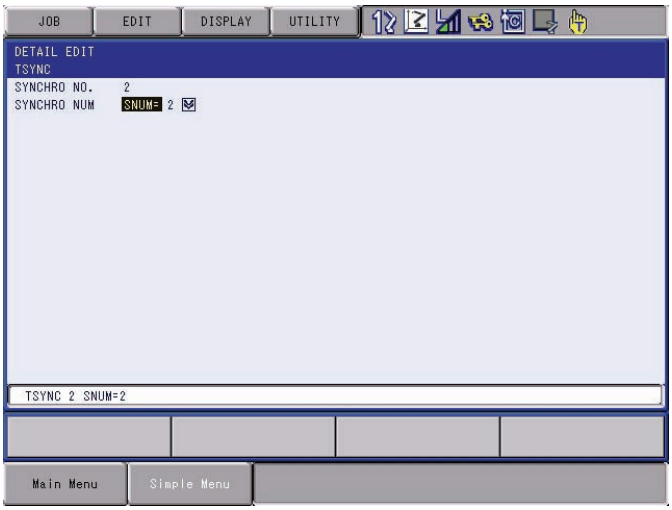
(1) To edit additional items, move the cursor to the instruction in the input buffer line, then press [SELECT]. The DETAIL EDIT window appears.



(2) To change the synchronization number, select “1” of “SYNCHRO NO.”
When the number input status enters, enter the synchronization number, “SYNCHRO NO.” by pressing the Numeric keys, and press [ENTER].



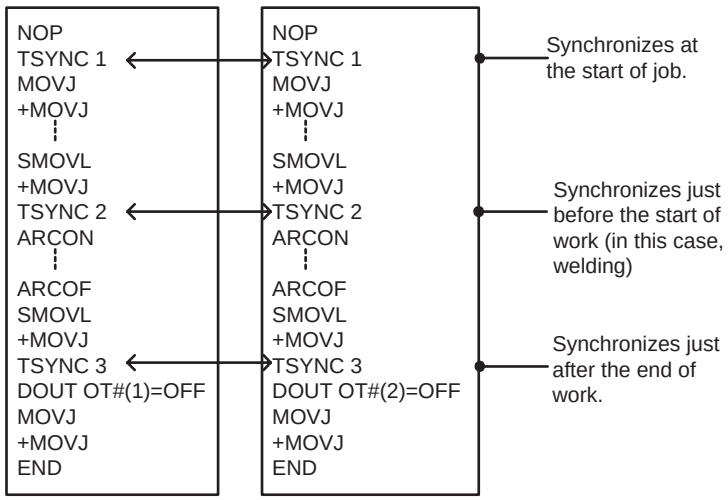
(3) To add the number of synchronized tasks, select “UNUSED” of “SYNCHRO NUM.”
The selection dialog box appears. Select “SNUM=.”



(4) After changed or added the additional items, press [ENTER].

(5) The DETAIL EDIT window is closed, and the JOB CONTENT window appears.

5. Press [INSERT] and [ENTER].
   – The instruction displayed in the input buffer line is registered.

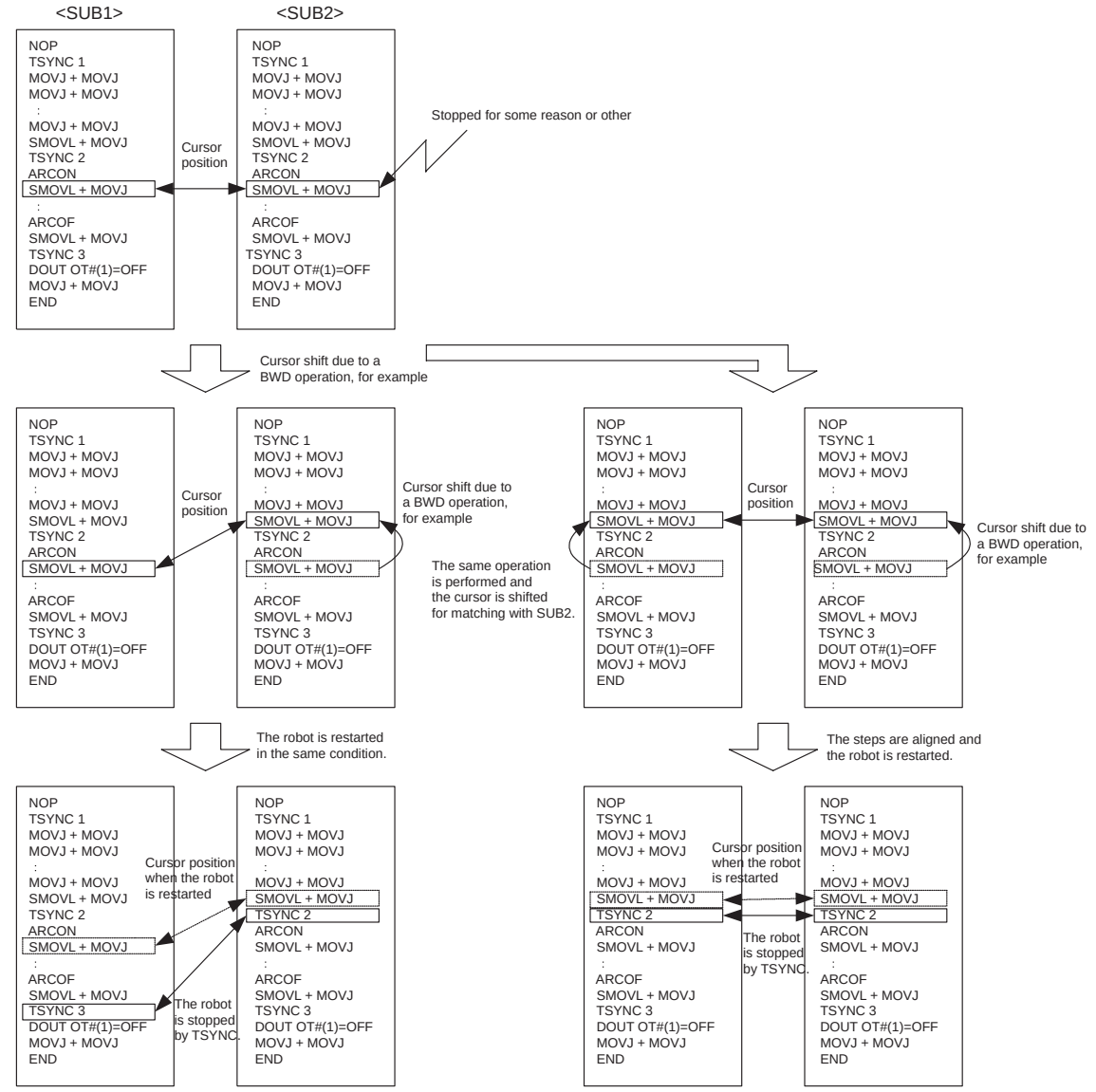


4.5.3 Items to note when using a TSYNC command

Note that even when TSYNC is being used, the steps of two manipulators will fail to match each other if the following operations are performed.

4.5.3.1 When a cursor shift occurs during operation

If the cursor position is shifted to a different step during the execution of a job of one of the two sub-tasks when the robot stops during operation, and the robot is restarted while remaining in this condition, the steps will become misaligned, resulting in the risk of interference from the jig, for example.
Start both jobs from the same position (step).



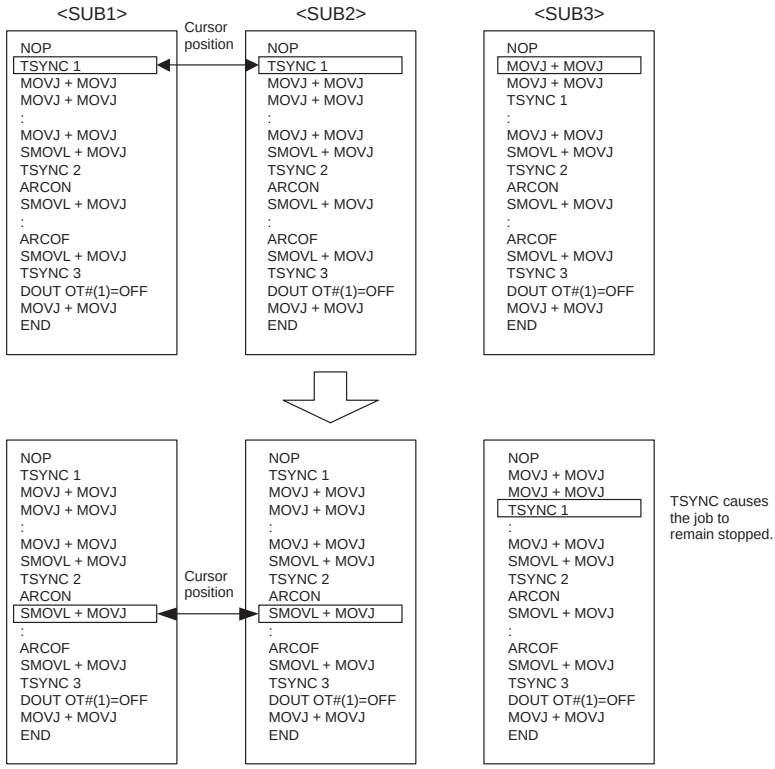
In this case, the steps become misaligned, which may cause the manipulator to interfere with the work piece or the jig.

In this case, the steps do not become misaligned, so normal operation can take place.

If the set number of synchronizations is less than the number of tasks to be synchronized, the robot will be commanded as soon as the TSYNC commands corresponding to the set number of synchronizations are output, and the jobs that cannot be synchronized will remain stopped.

4.5.3.2 If three jobs were set when the number of TSYNC synchronizations was set to “Unused”

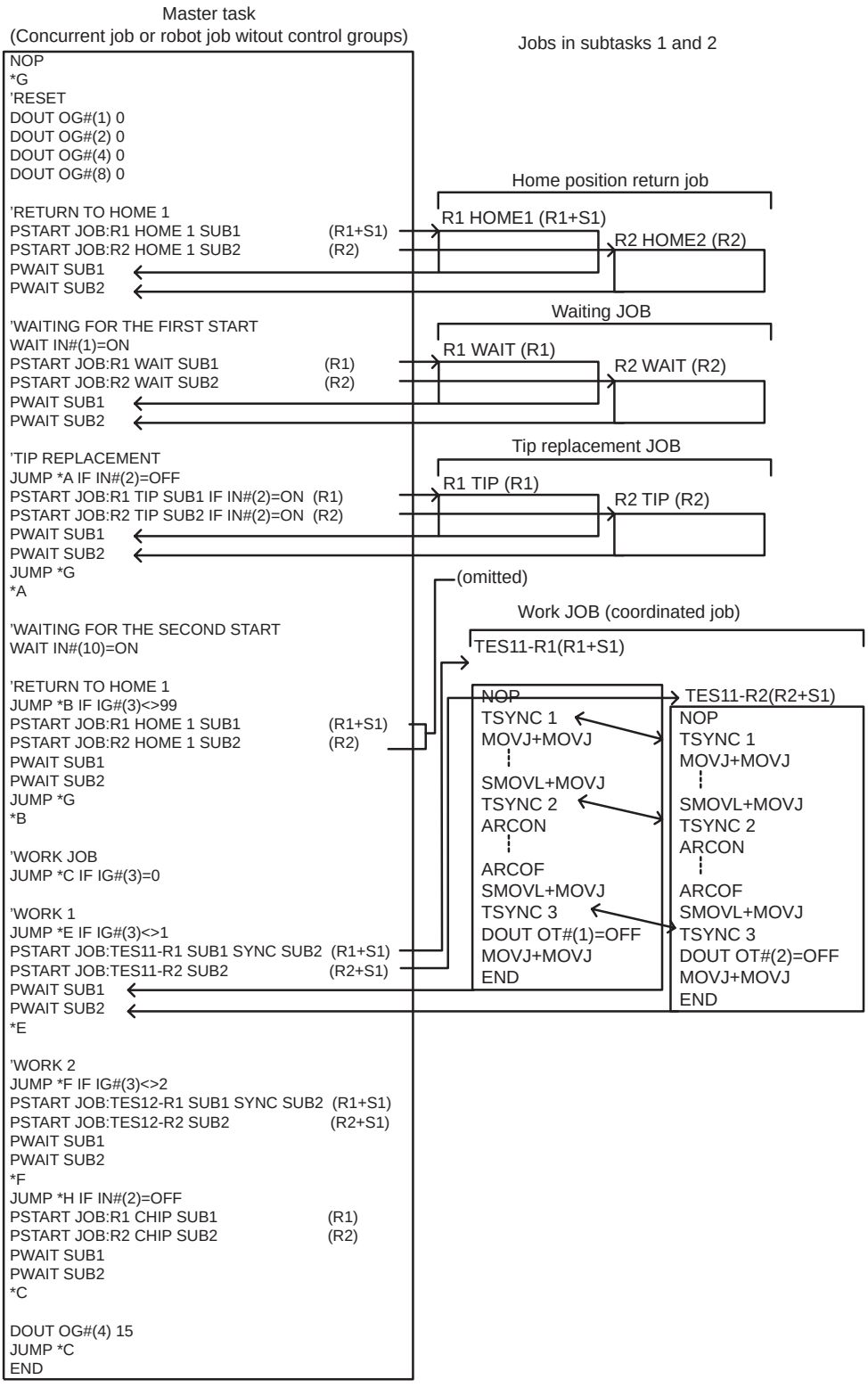
The two jobs that become synchronized first continue to move, and the third job remains stopped.



The two jobs that become synchronized first continue to move.

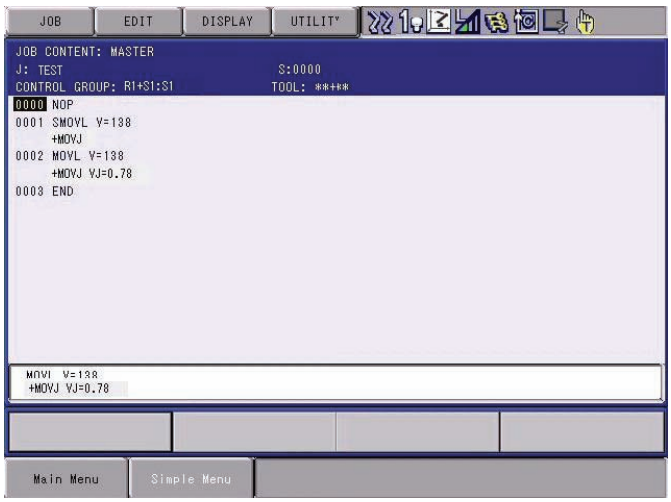
The job cannot be synchronized, and remains stopped.

4.6 Job Example



4.7 JOB CONTENT Window

The contents of coordinated job are displayed as shown below.



① Instructions

For coordinated jobs, the move instruction is displayed in two lines. The first line is the instruction to the slave side; the second line is the instruction to the master side.

SMOVL V=138 ←Slave, a manipulator
+MOVJ ←Master, a station

② Synchronized/Single

Synchronized/single are the types of movement available for the manipulator during axis operation.

This mark appears when synchronized movement is selected.

Switch between movements by pressing [SYNCRO/SINGLE].

③ Group axis being handled

Displays the group axis being handled.

Pressing [ROBOT] selects the manipulator.

Pressing [EX. AXIS] selects the station.

④ Coordinated interpolation/Individual interpolation

Changes between coordinated interpolation and individual interpolation by pressing [SMOV].

4.8 Synchronized/Single

4.8.1 Synchronized/Single Movement Between Station and Manipulator

There are two ways to handle axes when teaching: “Synchronized” and “Single.”

Switch between movements by pressing [SYNCRO/SINGLE].

Synchronized→ 

Single→ 

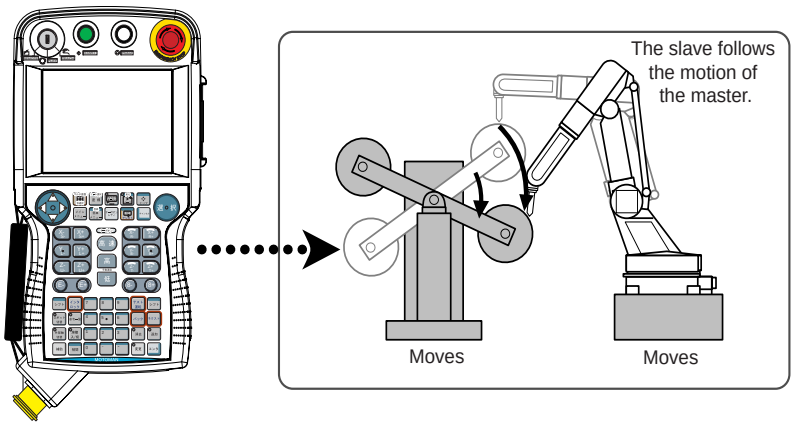
4.8.1.1 Synchronized

If the axes are handled in the “Synchronized” mode, the slave (manipulator) follows the master (station) when the master moves.

This feature is used to keep the position of the manipulator relative to the station.

However, the master does not move when the slave is moved.

■ **A master axis is moved:**

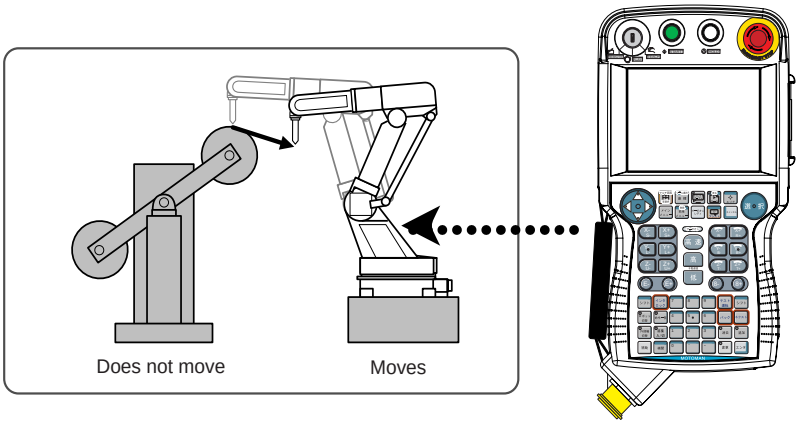


4.8.1.2 Single

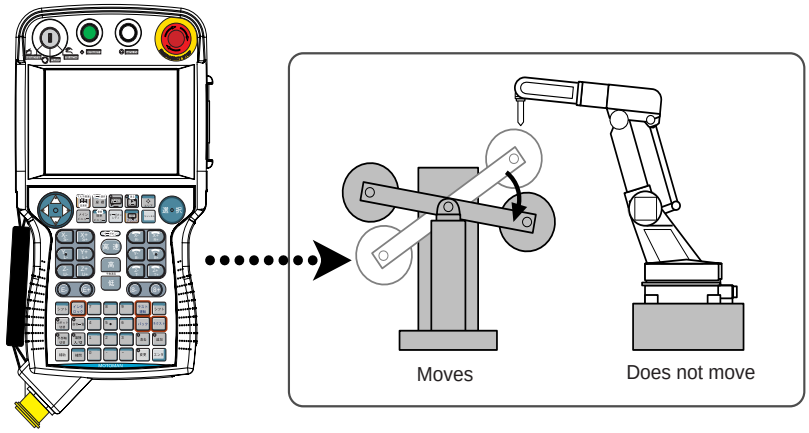
If an axis is handled in “Single” mode, the manipulator or the station whose axis has been handled, moves.

This feature is used where a manipulator and a station each executes an individual job.

■ **A slave axis is moved:**



■ **A master axis is moved:**



NOTE

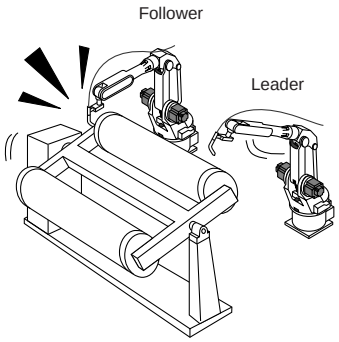
- The selected mode, Synchronized or Single, is maintained until the next selection is made.
- When an edit job is changed, “Single” is automatically selected.

4.8.2 Job Synchronized Mode for Subtask 1 and 2

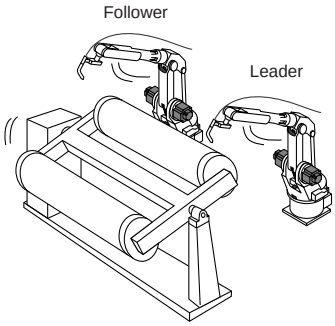
When moving only the leader manipulator in FWD/BWD operation, the follower manipulator in stop status may interfere with a workpiece.

To prevent this, using “job synchronized mode” can move the follower synchronizing the motion of the leader.

The follower manipulator moves, keeping the relative position to the station.

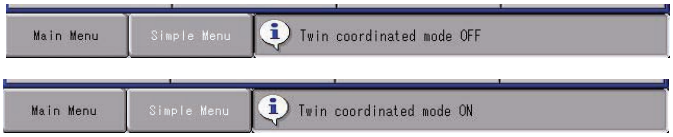


Leader in FWD operation.



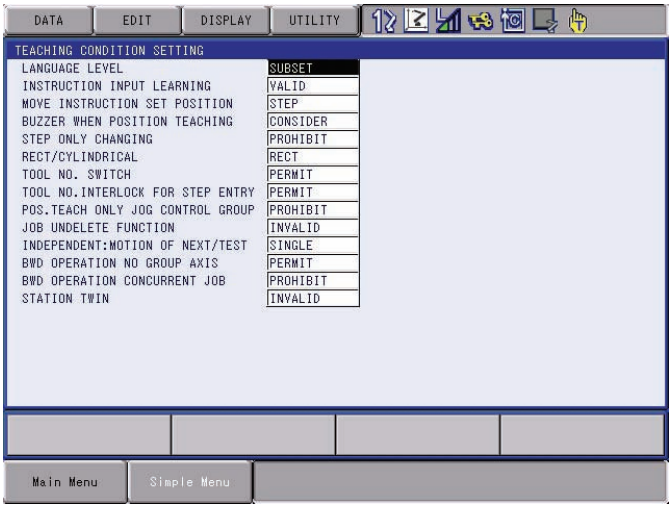
Leader in FWD operation,
using job synchronized mode.

Pressing [SHIFT] + [SYNCRO/SINGLE] changes the job synchronized mode.

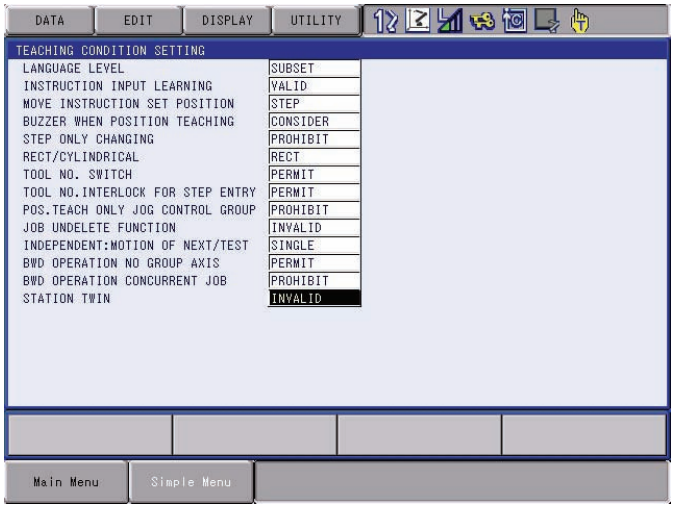


Also in the TEACHING CONDITION window, the job synchronized mode can be set and confirmed.

1. Select {SETUP} under the main menu.
2. Select {TEACHING COND}.
   – The TEACHING CONDITION window appears.



3. Select “TWIN COORDINATED MODE.”
   – Each time [SELECT] is pressed, “VALID” and “INVALID” is selected alternately.



NOTE The job synchronized mode is enabled only when “SINGLE” is selected in “STEP/TEST RUN OPERATION MODE” for the follower manipulator.

4.9 Selecting Axis to be Handled

In a coordinated system with multiple numbers of group axes, select a group axis to be handled in the following manner.

4.9.1 When There is an Edit Job

When the edit job is displayed, the group axes registered in the displayed job is the one to be handled.

- Pressing [ROBOT] selects a manipulator for axis handling.

- Pressing [EX. AXIS] selects a station for axis handling.

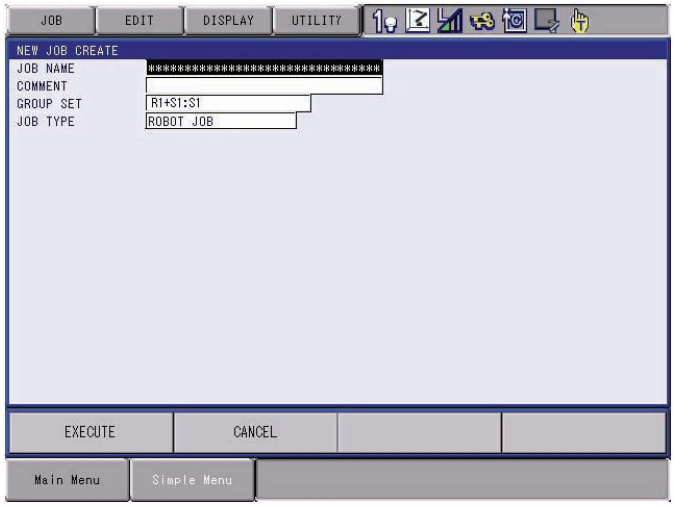
4.9.2 When There is No Edit Job

When there is no edit job, move a manipulator in the following manner.

1. Select the group axes to be moved, and then move it by pressing the axis key.
   – Press [SHIFT] + [ROBOT] to change the manipulator for axis handling.
   The LED of [ROBOT] flashes.
   – Press [SHIFT] + [EX. AXIS] to change the station for axis handling.
   The LED of [EX. AXIS] flashes.
2. Press [ROBOT] or [EX. AXIS] to return to the original window.

4.10 Registering Job

1. Select {JOB} under the main menu.
2. Select {CREATE NEW JOB}.
   – The NEW JOB CREATE window appears.?



3. Enter a job name.
   – Select “JOB NAME,” and then enter a job name by entering the characters.
   – Refer to “1.2.6 Character Input” of the Operator’s Manual.
4. Press [ENTER].
5. Select “GROUP SET.”
6. Select a group combination.
7. Select “EXECUTE.”
   – The job name is registered in the memory of DX100, and the JOB CONTENT window appears.

4.11 Registering Move Instruction (S)MOV □+MOVJ

Register a move instruction in the following manner.

4.11.1 Operating Master Side (Station)

1. Call the JOB CONTENT window in teach mode.
2. Press [EX. AXIS].
   – The master side (station) is selected for axis handling.

3. Select either “synchronized” or “single.”
   – Press [SYNCRO/SINGLE] to select either “synchronized” or “single.”
   – When “synchronized” is selected, the mark in the window below appears.
   When the slave side is supposed to follow the master side motion, select “synchronized.”

Synchronized→ 

   – When “single” is selected, the mark in the window below appears.

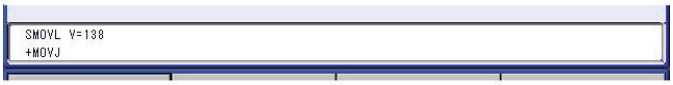
Single→ 

4. Press the axis key to move to the desired position.

4.11.2 Operating Slave Side (Manipulator)

1. Press [EX. AXIS].
   – The slave side (manipulator) is selected for axis handling.

2. Press the axis key to move to the desired position.
   – Select either a coordinated interpolation or an independent interpolation.
   – Press [SMOV] to select either interpolation.



3. Select an interpolation type.
   – Press [MOTION TYPE] to select an interpolation type.

4. Confirm the speed.
5. Press [ENTER].
   – The registration is completed as follows.

NOTE

- When joint motion is set for the slave side (manipulator), teaching cannot be done during a coordinated interpolation.
- When “JOINT” is selected, the interpolation type will not change to a coordinated interpolation, even if [SMOV] is pressed.
- When “JOINT” is selected during coordinated interpolation, a coordinated move instruction such as “SMOVL” in the input buffer line changes to “MOVJ,” and the interpolation type becomes individual interpolation.

Parameter	Contents and Set Value	Initial Value
S2C213	+MOV INSTRUCTION INTERPOLATION INPUT This parameter specifies which interpolation is permitted for move instructions for the master robot in a coordinated job.(bit specification) D0 : +MOVJ D1 : +MOVL D2 : +MOVC D3 : +MOVS	2

4.11.3 (S) MOV □ + MOVJ rate specification

4.11.3.1 Rate specification in a multiple line shift command

The relationship between the rate specification in a shift commnad which causes multiple groups such as “MOV □+ MOVJ” or “SMOV □ + MOVJ” to operate (i.e. to be configured by multiple lines), simultaneously, and the actual operation rate, is as follows.

- Each shift time for the robot (or station) is obtained according to the rate specified for each line.
- The maximum of the respective shift times is obtained, and all groups are operated according to this maximum shift time.

<Example>

MOVL V = 500.0 …The shift time over the shift distance is 2 seconds at V = 500
+MOVJ VJ = 25.00…The shift time for the shift amount is 4 seconds at VJ = 25
*This “MOVL + MOVJ” functions when the shift time is 4 seconds.
Note that for lines in which the rate specification is omitted, the shift time is calculated based on the assumption that the maximum rate has been specified.

<Example>

MOVL V = 500.0 …The shift time over the shift distance is 2 seconds at V = 500
+MOVJ VJ …The shift time for the shift amount is 1 seconds at VJ = 25
*This “MOVL + MOVJ” functions when the shift time is 2 seconds.

4.11.3.2 Rate specification at coordination interpolation (SMOV □)

The rate specification for the manipulator on the slave side at coordination interpolation (SMOV □) is specified as “relative rate” as seem from the master side.

For example, in arc welding, in the case where the slave side manipulator holds the welding torch, this “relative rate” becomes the “welding rate” with respect to the work piece, so it is important to maintain this rate.
In this case, by omitting the rate specification on the master side, the shift rate will be basically determined by the “relative rate.”

<Example>

MOVL V = 100.0 …The shift time at V = 100 over the relative shift distance on the slave side with respect to the master is 5 seconds.
+MOVJ VJ …The shift time at VJ = 100 for the master shift amount is 2 seconds.
*This “SMOVL + MOVJ” functions when the shift time is 5 seconds.

Parameter	Contents and Set Value	Initial Value
S2C212	+MOV INSTRUCTION SPEED INPUT Specifies whether the speed inputting for move instructions of the master side robot in a coordinated job is permitted or not. **<Example> 0: Not Provided** SMOVL V=100 +MOVJ ← Master side Speed specification not provided **1: Provided** SMOVL V=100 +MOVJ VJ=10.00 ← Master side Speed specification provided	0

4.12 Registering Reference Point Instruction (SREFP)

Register a reference point instruction (SPEFP) for a coordinated interpolation in the following manner.

1. Select {JOB} under the main menu.
2. Select {JOB}.
3. Move the cursor.
   – Move the cursor to the line immediately before the line where the reference point instruction is to be registered.

4. Grasp the Enable switch.
   – Turn ON the servo power with the Enable switch.

5. Press the axis key.
   – Turn ON the servo power with the Enable switch. Move the manipulator to the position which will be a reference point.
6. Select the coordinated interpolation.
   – Press [SMOV] to select a coordinated operation.
7. Press [REF PNT].
   – The reference point instruction appears in the input buffer line.

8. Change the reference point number.
   – Move the cursor to the reference point number, and press [SHIFT] + the cursor key to change the reference point number.

   – If you use the Numeric keys to change the reference point number, press [SELECT] when the cursor is on the reference point number. Input the number and press [ENTER].

9. Press [INSERT].
   – The [INSERT] key lamp lights up.
   – When registering immediately before the END instruction, pressing [INSERT] is not needed.
10. Press [ENTER].

– The REFP instruction is registered.

4.13 Switching Tasks

To call the JOB CONTENT window for master task, subtask 1 or subtask 2, proceed the following operation.

1. Select {JOB} under the main menu.
2. Select {JOB}.
3. Press the page key  .

4.14 Creating a Job in a Subtask - Method 1 and 2

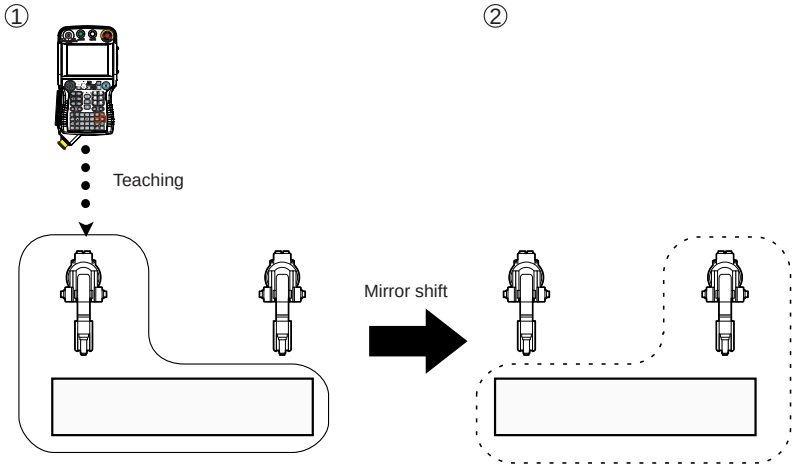
Subtasks 1 and 2 are robot jobs.

Subtask 1: Job of one manipulator + the station

Subtask 2: Job of the other manipulator + the station

There are two methods to create a robot job for a subtask.

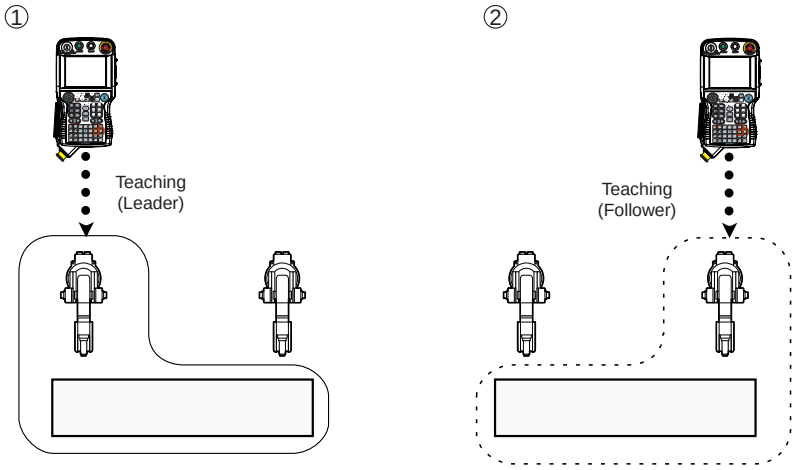
- **Method 1:**
  Copy one subtask job to create another subtask.



This method is useful when two movement paths are symmetrical.

Use the mirror shift function to convert a job path and copy it. The same teaching operation does not have to be repeated.

- **Method 2**
  Perform teaching for each manipulator.

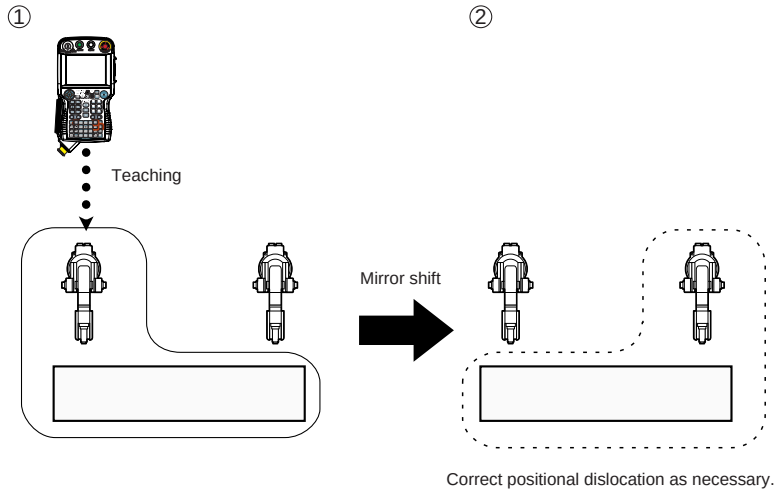


Where there are not many similarities in the paths and movements of the two manipulators, create jobs in Method 2.

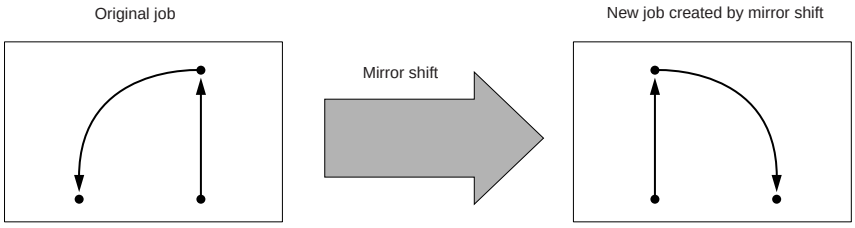
4.14.1 Method 1: Copy One Subtask Job and Create Another Job

When two movement paths are symmetrical, one subtask job can be created by using the job taught by the other manipulator.

1. Perform teaching for either R1 + S1 or R2 + S1.
2. Use the mirror shift to create a job for the other manipulator.

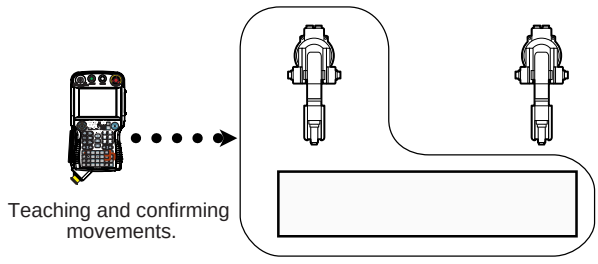


The mirror shift is a function for copying jobs, which creates a job by reversing the signs of the position data for the S-axis, R-axis, and T-axis.



4.14.2 Teaching and Mirror Shift

1. Teach the job for one manipulator + the station, and confirm the movement.
2. After having completed the teaching, perform mirror shift the job.



4.14.2.1 Converting

Call the JOB CONTENT window for the job to be converted.

■ **For the job currently selected**

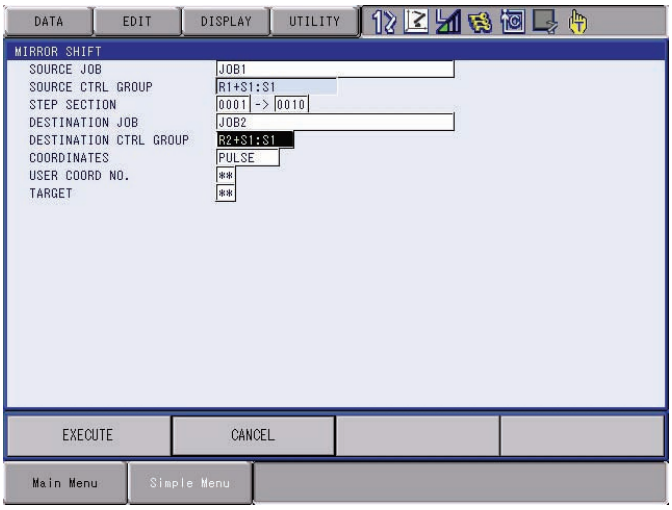
1. Select {JOB} under the main menu.
2. Select {JOB}.

■ **To call another job**

1. Select {JOB} under the main menu.
2. Select {SELECT JOB}.
   – The JOB LIST window appears.
3. Select a job to be displayed.

4.14.2.2 Execute conversion

Fig. 4-1: MIRROR SHIFT window



①SOURCE JOB

Selects the conversion source job.
To select another job to be converted, move the cursor to the name and press [SELECT] to call up the list of jobs. Select the desired job and press [SELECT].

②SOURCE CTRL GROUP

Displays the control group of the conversion source job.

③STEP SELECTION

Specifies the steps to be converted.
From the first step to the last step of the selected job are specified as initial value.

④DESTINATION JOB

Specifies the converted job name.
To enter the name, move the cursor to the name and press [SELECT]. The name of the conversion source job is displayed in the input line as initial value. When "***" is displayed, the name for the converted job is to be the same as that of the conversion source job.

⑤DEST CTRL GROUP

Selects the control group for the converted job.
When the destination job name is entered, the same control group as the conversion source job is automatically set.
To change it, move the cursor to the control group and press [SELECT] to call up the selection dialog box.

⑥COORDINATES

Specifies the coordinates used for conversion.
"PULSE," "ROBOT," or "USER" can be selected. The initial value is "PULSE."

"PULSE": Executes the pulse mirror-shift conversion.
"ROBOT": Executes the mirror-shift conversion on the basis of the cartesian coordinates.
"USER": Executes the mirror-shift conversion on the basis of the specified user coordinates.

⑦USER COORD NO.

Specifies the user coordinates number when "USER" is selected in ⑥.
"01" is automatically set as initial value when the "USER" is selected in ⑥.
This item cannot be set when "PULSE" or "ROBOT" is selected in ⑥.

⑧TARGET

Specifies the coordinate where conversion is to be done when "ROBOT" or "USER" is selected in ⑦.
"XY," "XZ," or "YZ" can be selected.
The "XZ" is automatically set as initial value when "ROBOT" or "USER" is selected in ⑦.
The "XZ" is automatically set as initial value when "ROBOT" or "USER" is selected in ⑦. Always specify "XZ" for "ROBOT."

⑨EXECUTE

Executes the conversion.
When the conversion destination job name is entered, the converted job is created with that name as a new job.
When the conversion destination job name is not entered, the conversion source job is converted and overwritten.

4.14.2.3 Jobs Not to be Converted

The jobs and relative jobs without group axes cannot be converted.

4.14.2.4 Group Axes for Conversion

When the group axes for the SOURCE JOB in the multiple group axes system, the axis configuration, etc. of each group axes for SOURCE JOB and DESTINATION JOB must be the same.

- Robot axis: Same type
- Base axis: Same axis configuration
- Station axis: Same axis configuration

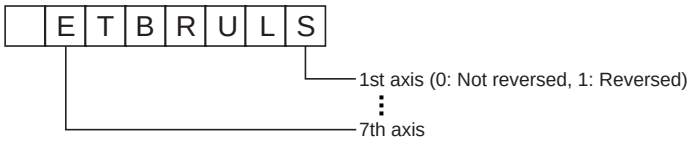
4.14.2.5 Position Type Variables

The position type variables are not for mirror-shift.

4.14.2.6 Parameter

Which axis is to be shifted (reverse the sign) is specified by the following parameter.

S1C×G065: Mirror shift sign reversed axis specification



4.14.3 Correcting Positional Dislocation

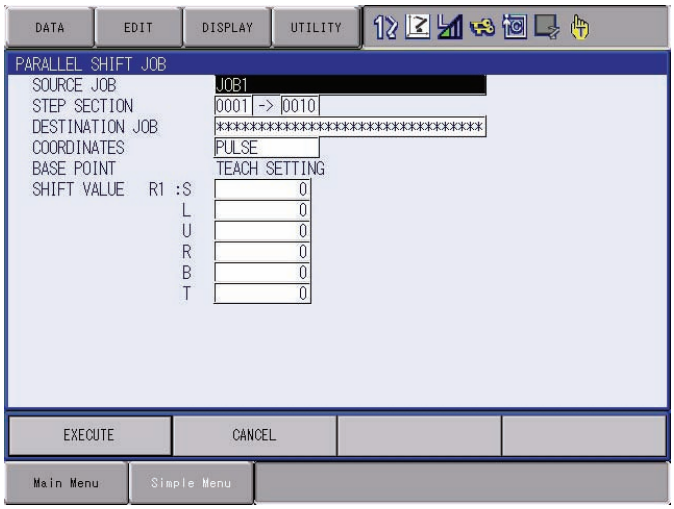
In the job after mirror shift, a position may be dislocated due to the installation error.

In this case, all steps should be corrected by the same shift amount.

For this operation, the parallel shift job conversion function is used.

4.14.3.1 Setting the Items for Conversion

1. Select {JOB} under the main menu.
2. Select {JOB}
   – The JOB CONTENT window appears.
3. Select {UTILITY} under the pull-down menu.
4. Select {PARALLEL SHIFT JOB}.
   – The PARALLEL SHIFT JOB window appears.



5. Specify the conversion items.
   – Specify the following items.

①SOURCE JOB

Selects the job before conversion.
The job which is shown in the JOB CONTENT window is set initially.
To change the job, perform the following procedure.
Move the cursor to the job name and press [SELECT]. The JOB LIST window appears. Select the desired job.

②STEP SECTION (Start Step → End Step)

Specifies the step section of the source job.
All the steps are set initially.
If there is no steps in the source job, "***" is displayed.
To change the section, perform the following procedure.
Move the cursor to the step section indication and press [SELECT]. The input buffer line appears. Input the step number and press [ENTER].

③DESTINATION JOB

Specifies the converted job.
If this is not specified(“********” is displayed), the source job is specified.
If the converted job is specified, the source job is copied and converted.
To change the job, perform the following procedure.
Move the cursor to the converted job name indication and press [SELECT]. The character input line appears. The source job name is displayed in the input line. To enter job name without using the source job name, press [CANCEL] and then input a job name.

④COORDINATES

Selects the conversion coordinates.
Move the cursor to the coordinates name and press [SELECT].
The selection dialog box appears. Select the desired coordinates.
When the user coordinates are selected, the input buffer line appears.
Input the desired user coordinate number and press [ENTER].

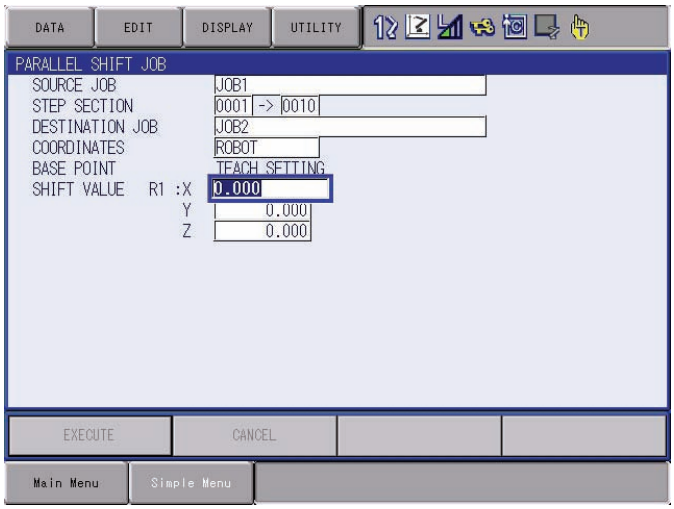
4.14.3.2 Setting the Shift Value

There are two methods for specifying the shift value.

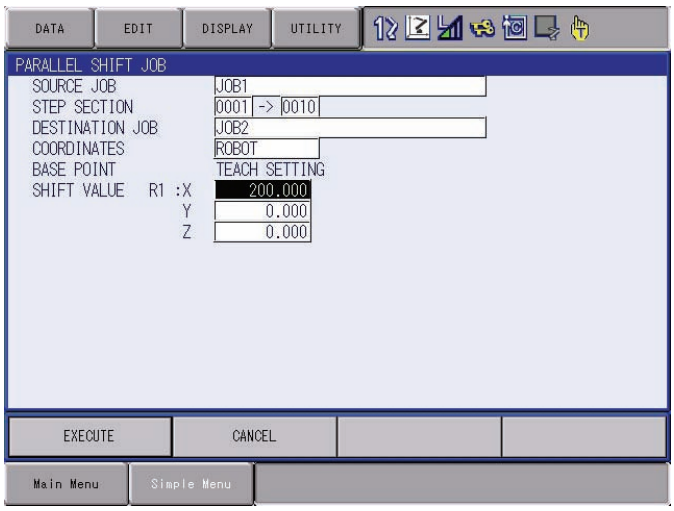
- Directly input the shift value by numerical value.
- Calculate the shift value by teaching the original base point and converted base point.

■ **Numerical Value Input**

1. Display the PARALLEL SHIFT JOB window.
   Select the shift value to be set.
   – The number can now be entered.

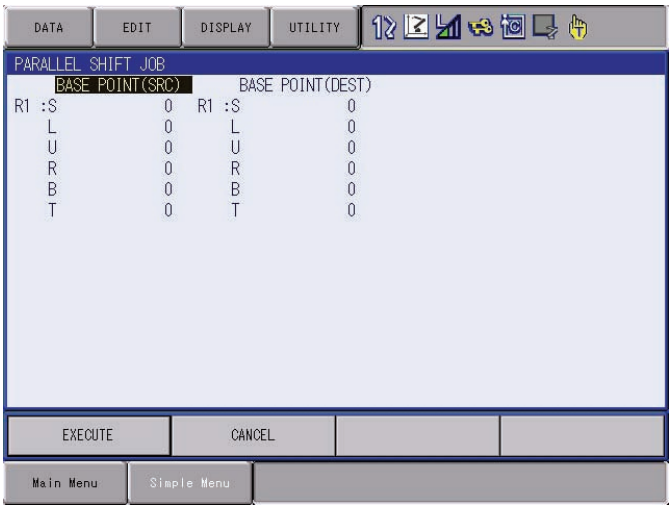


2. Type the shift value using the Numeric keys.
3. Press [ENTER].
   – The shift value is set.

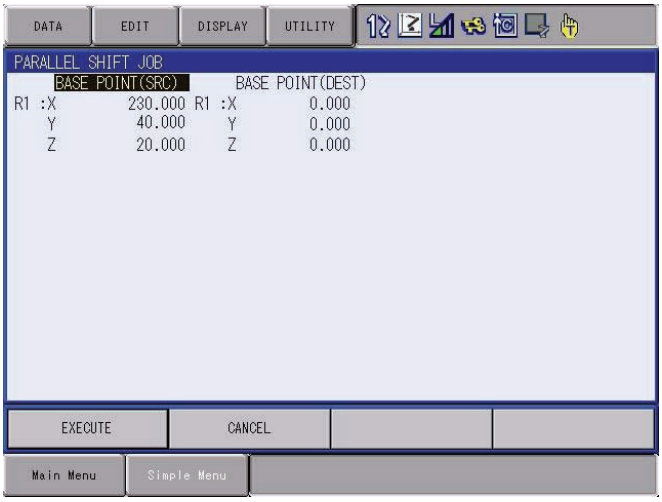


■ **Calculation by Teaching**

1. Display the PARALLEL SHIFT JOB window.
   Select “TEACH SETTING” in the item of “BASE POINT.”
   – The BASE POINT window appears.

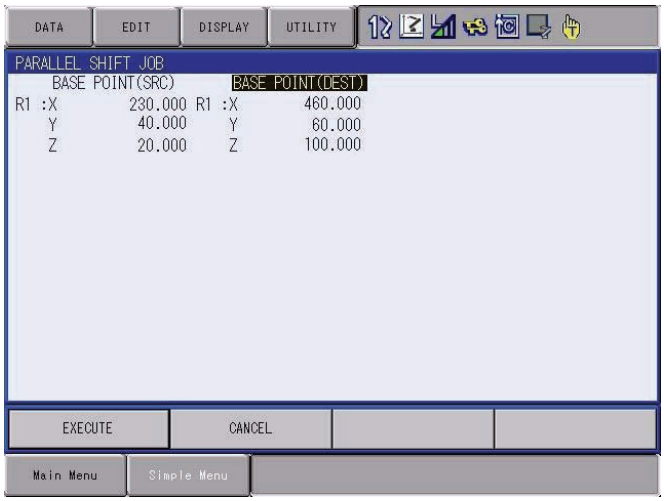


2. Select “BASE POINT(SRC).”
3. Move the manipulator to the original base point by the axis keys.
4. Press [MODIFY] and [ENTER].
   – The original base point is set.

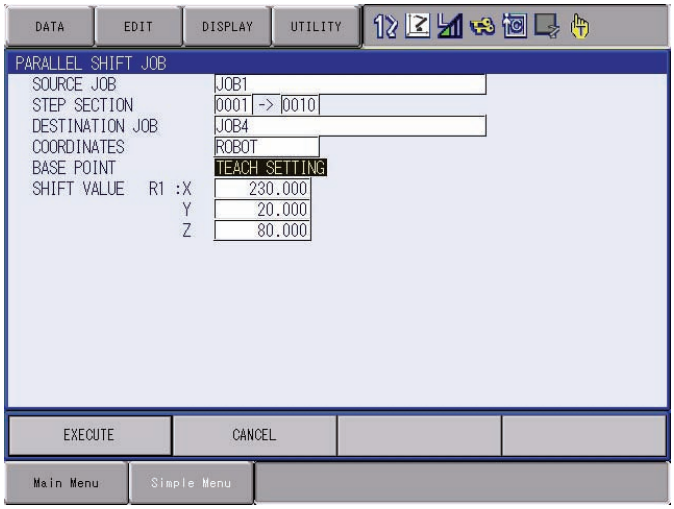


5. Select “BASE POINT(DEST).”
6. Move the manipulator to the converted base point by the axis keys.

7. Press [MODIFY] and [ENTER].
   – The conversion base point is set.



8. Select “EXECUTE.”
   – The difference is calculated by the two teaching points and set as a shift value.

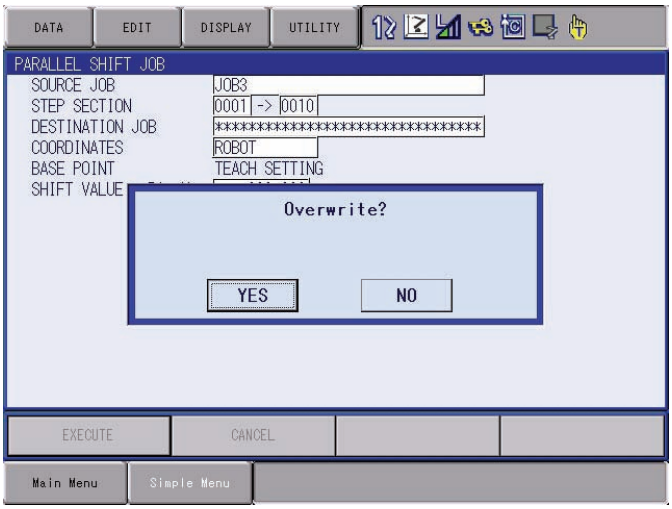


4.14.3.3 Executing Conversion

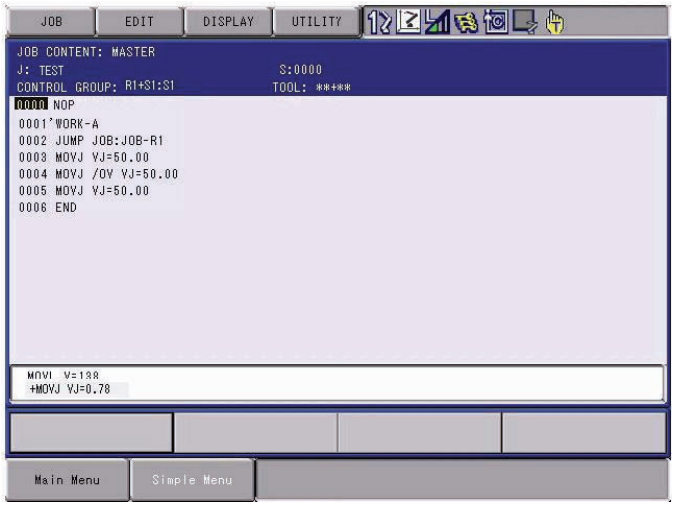
1. Display the PARALLEL SHIFT JOB window.
   Select “EXECUTE.”

   – The confirmation dialog box appears when the converted job is not specified.
   Select “YES” then the conversion is executed.

   – The JOB CONTENT window appears when the conversion is completed.



   – If the converted results are outside the range of motion of the robot, the tag “/OV” will be attached.
   Correct this step manually.

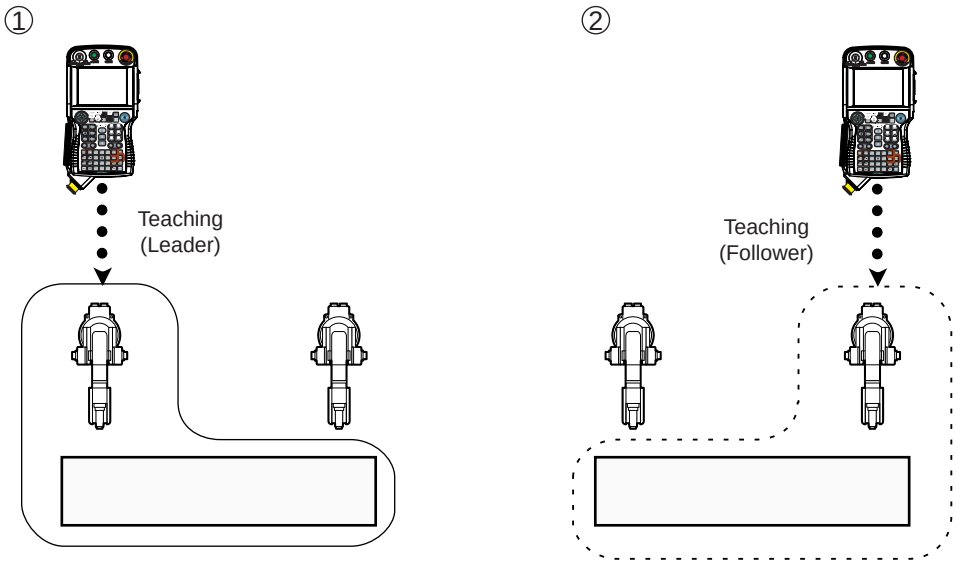


4.14.4 Method 2: Perform Teaching for Each Manipulator

4.14.4.1 Procedure

First, perform teaching a job for the combination of leader manipulator and station.

Next, perform teaching a job for the combination of follower manipulator and station.
For this operation, perform teaching so that the follower manipulator follows the motion of station by FWD operation of the leader job.

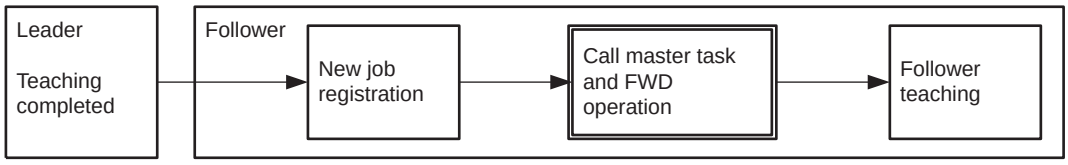


For Method 2, there are two ways of teaching depending on whether the master task is used or not.

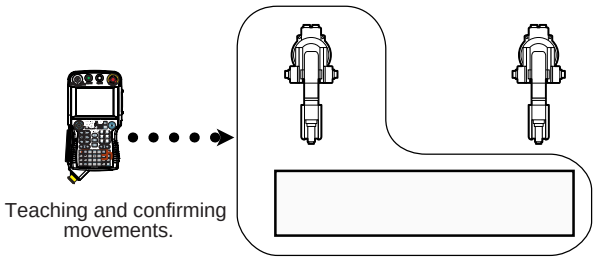
- Teaching using Master Task
- Teaching using SUPERVISORY Window

■ **Teaching using Master Task**

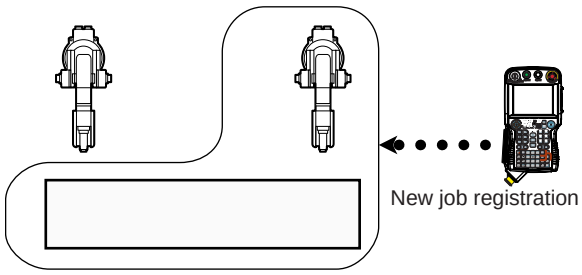
Using the master task can omit the operation to register a job name in the SUPERVISORY window.



1. Teach the coordinated job of leader subtask.
   – Teach all the steps of coordinated job for one manipulator + the station.



2. New job registration for the coordinated job of follower subtask.
   – Register as a new job the coordinated job for the other manipulator + the station.
   For new job registration, refer to " 4.10 Registering Job."

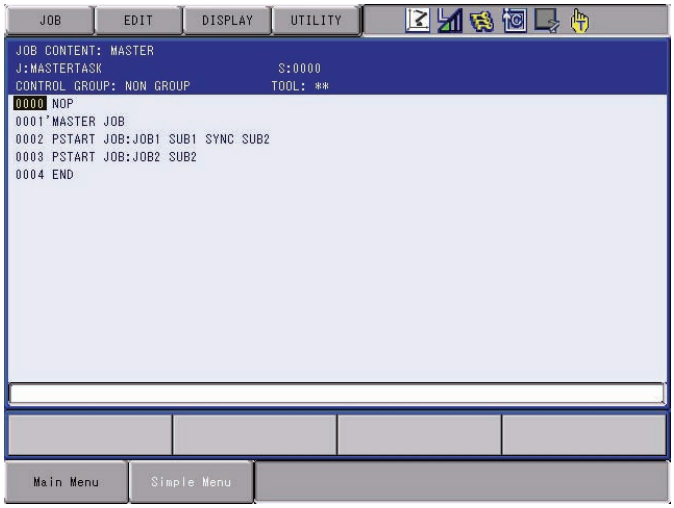


3. New job registration of master task.
   – Newly register the master task as concurrent job.
   For concurent job, refer to " 7.5.2 Concurrent Job. "

4. Register PSTART instruction.

   (1) Register a PSTART instruction to start the job newly registered at Operation 2.
   To specify this subtask as the follower, add a tag SYNC and the leader subtask.

   (2) Then, register a PSTART instcution to start the job taught at Operation 1.



5. Set to “Single job operation mode.”
   – Set the operation mode at FWD operation to “Single job operation mode.”
   – Pressing [SHIFT] + [SMOV] switches the operation mode.
6. Move the cursor to the first PSTART instruction.
7. Press [INTERLOCK] + [FWD].
   – Starts the follower subtask.
8. Move the cursor to the second PSTART instruction.
9. Press [INTERLOCK] + [FWD].
   – Starts the leader subtask.
10. Press the page key to change to the leader subtask.
    – Each time the page key is pressed, the contents of the JOB CONTENT window change in order of master task, subtask 1, and subtask 2.
11. Move the cursor to the step 1.
12. Press [FWD].
13. Press the page key to switch to the follower subtask.
    – Each time the page key is pressed, the contents of the JOB CONTENT window change in order of master task, subtask 1, and subtask 2.

14. Register the step 1 of the follower subtask.

– After the FWD operation of step 1 of leader, switch to the follower and register the position of the follower manipulator relative to the station current position.

15. Register the step 2 and onward of the follower subtask.

(1) Change to the leader's JOB CONTENT window, and perform a FWD operation to the next step.

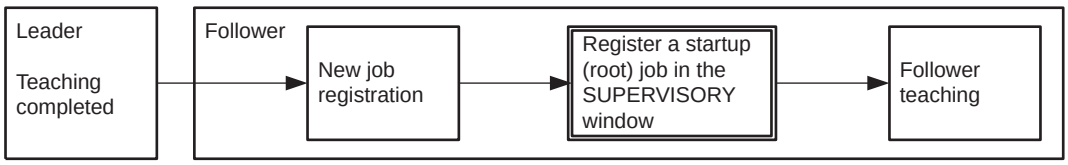
– To maintain the follower manipulator position relative to the station, press [SHIFT] + [SYNCRO/SINGLE] to set the job synchronized mode.

(2) Change to the follower's JOB CONTENT window, and register the follower manipulator position relative to the station current position.

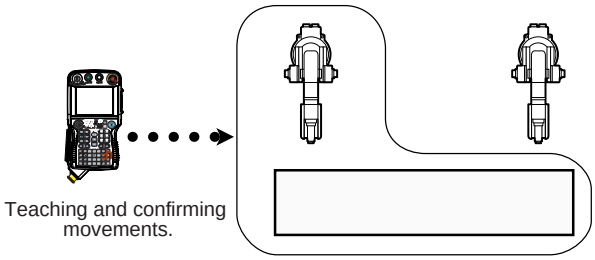
(3) Teach the follower job by repeating the above operations (1) and (2).

■ **Teaching using SUPERVISORY Window**

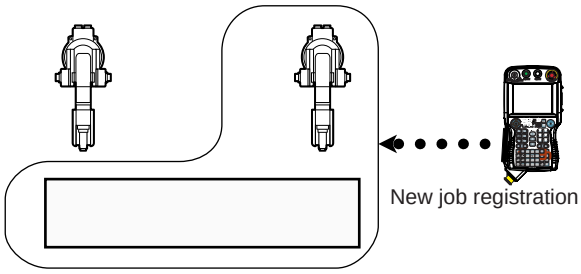
When teaching without master task, it is necessary to register the startup job (ROOT JOB) in the SUPERVISORY window.



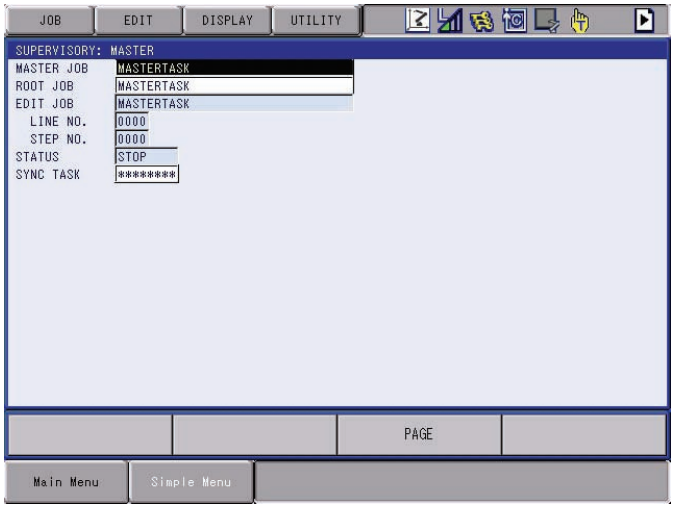
1. Teach a coordinated job of leader subtask.
   – Teach all the steps of the coordinated job of one manipulator + the station.



2. New job registration of a coordinated job of follower subtask.
   – Register as a new job the coordinated job of the other manipulator + the station.
   For new job registration, refer to "4.10 Registering Job."

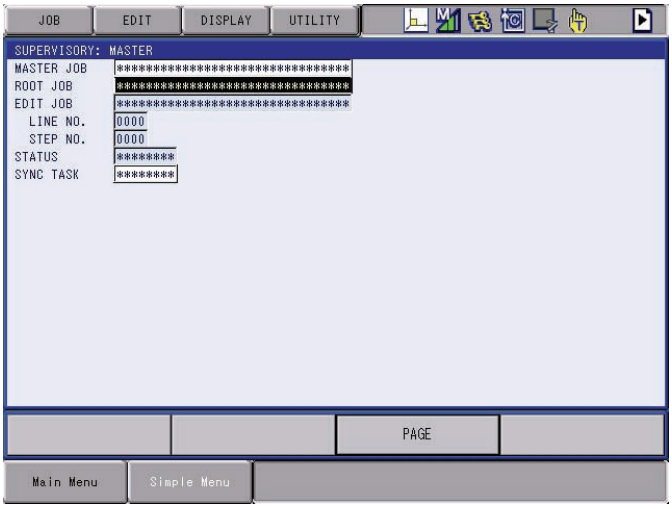


3. Select {JOB} under the main menu.
4. Select {CTRL MASTER}.
   – The SUPERVISORY window appears.

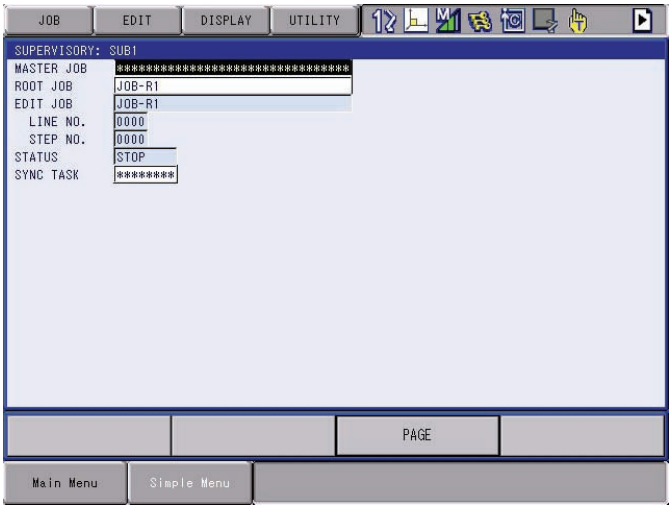


5. Select the root job of master task.

6. Select “CANCEL ROOT JOB.”
   – The root jobs of master task, subtask1, and subtask 2 are cancelled.

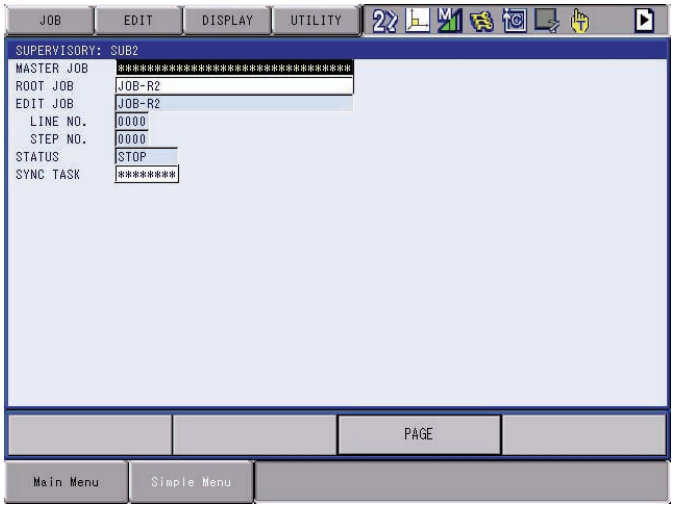


7. Select the root job of subtask 1.
8. Select “REGISTER ROOT JOB.”
   – The root jobs for subtask 1 and subtask 2 are registered.

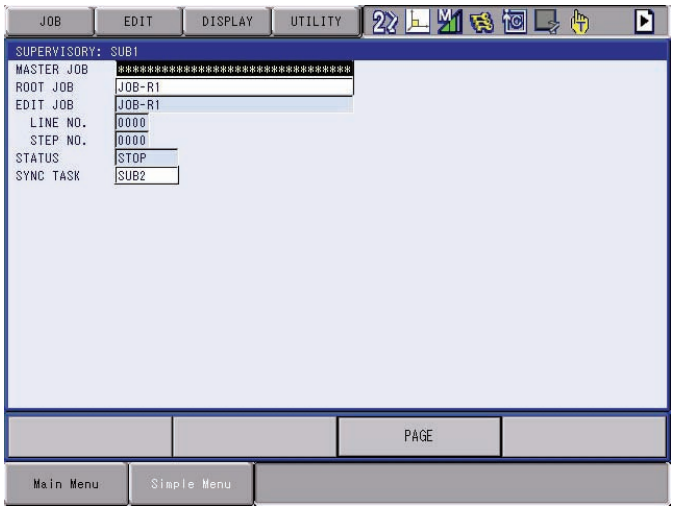


9. Select a job to be registered as root job.
10. Select the root job of subtask 2.
11. Select “REGISTER ROOT JOB.”

12. Select a job to be registered as root job.
    – The root jobs for subtask 1 and subtask 2 are registered.



13. Select the synchronous task of subtask 1.
14. Select “SUB2.”
    – Specify SUB2 of leader task to synchronize the synchronous task of subtask 1.



15. Select “Single job operation mode.”
    – Set “Single job operation mode” for the operation mode at FWD operation.
    – Pressing [SHIFT] + [SMOV] switches the operation mode.
16. Select {JOB} under the main menu.
17. Select {JOB}.
18. Press the page key  to change to leader subtask.
    – Each time the page key  is pressed, the contents of the JOB CONTENT window change in order of master task, subtask 1, and subtask 2.
19. Move the cursor to the step 1.
20. Press [FWD].

21. Press the page key  to change to the leader subtask.
    – Each time the page key  is pressed, the contents of the JOB CONTENT window change in order of master task, subtask 1, and subtask 2.
22. Register the step 1 of follower subtask.
    – to chage to leader subtask.*After the FWD operation of step 1 of leader, switch to follower and register the position of the follower manipulator relative to the station current position.

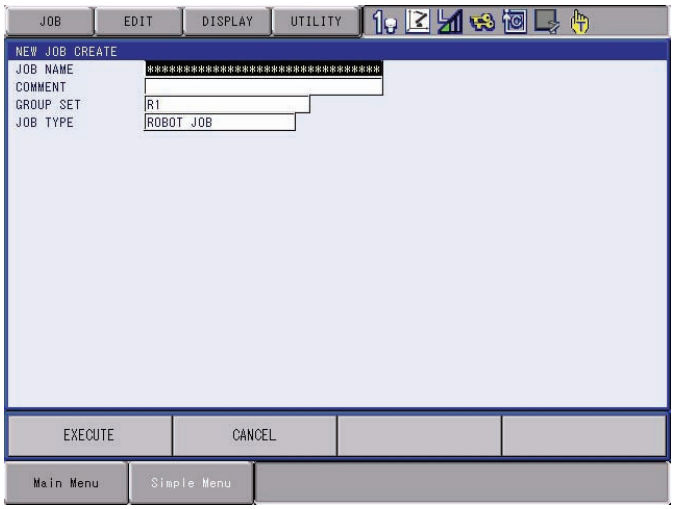
23. Register the step 2 and onward of follower subtask.
    (1) Change to the leader's JOB CONTENT window and perform FWD operation to the next step.
    – To maintain the follower manipulator position relative to the station, press [SHIFT] + [SYNCRO/SINGLE] to set the job synchronized mode.
    (2) Change to the follower's JOB CONTENT window, and register the follower manipulator position relative to the station current position.

    (3) Teach the follower job by repeating the above operations (1) and (2).

4.15 Job in Master Task

The job of master task is a concurrent job or a robot job without control groups.

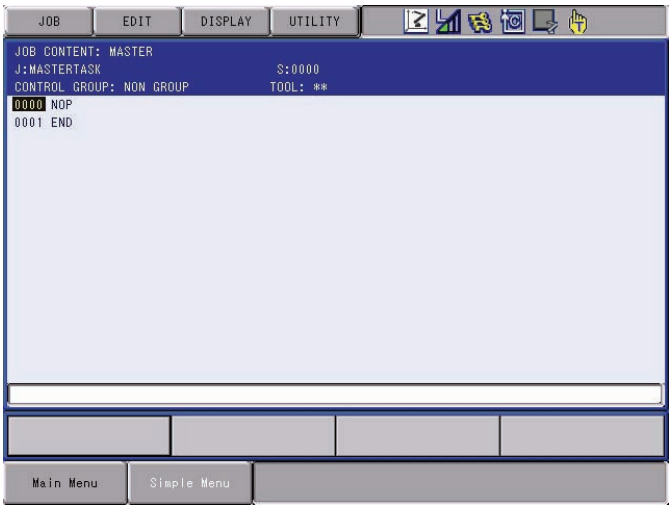
1. Select {JOB} under the main menu.
2. Select {CREATE NEW JOB}.
   – The NEW JOB CREATE window appears.



3. Enter a job name.
   – Move the cursor to JOB NAME and press [SELECT], and enter a job name by entering the characters.
4. Set “GROUP SET.”
   – Selecting “R1” of “GROUP SET” displays the selection dialog box. Select “NON GROUP.”
5. Set “CONCURRENT JOB.”
   – Select “ROBOT JOB” of “JOB TYPE.”
   Each time [SELECT] is pressed, “ROBOT JOB” or “CONCURRENT JOB” is selected alternately.
6. Press [ENTER].

7. Select “EXECUTE.”

– The job is registered in the memory of DX100, and the JOB CONTENT window appears.
NOP and END instructions are registered automatically.



NOTE

- If a tag SYNC is added to neither of PSTARTs, an alarm occurs.
- If the synchronous task is set to “UNUSED,” the follower task, if it is SUB1, performs the same motion as the leader task SUB2, and if it is SUB2, performs the same motion as the leader task SUB1.

4.16 Confirming Operation

4.16.1 Procedure

NOTE

For confirming operation, set to “Multi-job operation mode.”

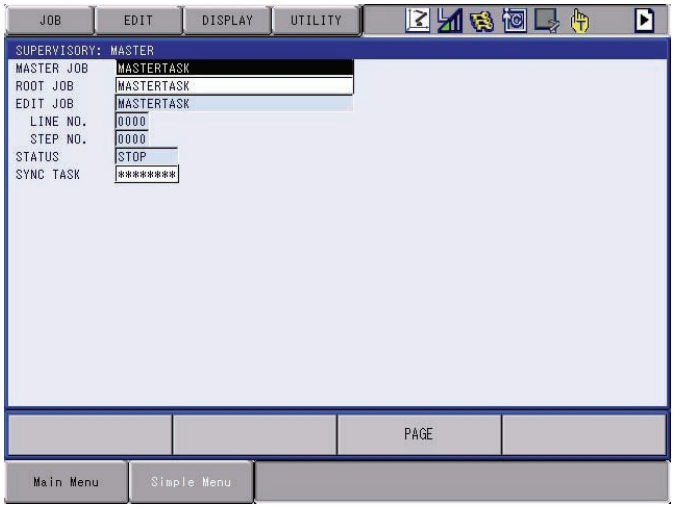
In the multi-job operation mode, the jobs in all the tasks operate. (The operation procedures are explained below.)

If the follower subtask is operated individually, only the follower manipulator moves but not the station.

As the follower manipulator moves following to the station current position, an alarm may occur and the manipulator may interfere the station as a result.

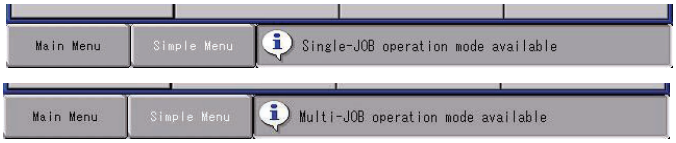
To verify the individual operation of the follower manipulator itself, call the job by job selection operation and confirm the individual operation of the job, but not in the twin synchronization.

1. Create a concurrent job.
   – For procedure, refer to “4.15 Job in Master Task.”
2. Select {JOB} under the main menu.
3. Select {CTRL MASTER}.
   – The SUPERVISORY window appears.



4. Move the cursor to the task where the master job is to be registered.
5. Press [SELECT].
6. Select “SETTING MASTER JOB.”
7. Select a job to be the master job.

8. Press [SHIFT] + [SYNCRO/SINGLE].
   – Set to “Multi-job operation mode.”
   Each time [SHIFT] + [SYNCRO/SINGLE] are pressed, the operation mode changes between “Multi-job operation mode” and “Single job operation mode.”



9. Press [TEST START] or [FWD].
   – When a PSTART instruction is executed, the manipulator and the station move.

Parameter	Contents and Set Value	Initial Value
S4C286	Specifies the user output number to externally output the “Multi-job operation mode” status at teaching. 0: Not output 1 to 1024: User output number	0

4.16.2 Precautions for Confirming Operation

In the following operations, the steps of two manipulators will not coincide.

4.16.2.1 Stops during Operation

<Example>

- When the manipulator stops during operation, move the cursor position to another step of the job in one of the subtasks.
- Call the master job only by one of the subtasks.

When restarting the operation in the states as explained above, an interference with jig, etc. may be caused.

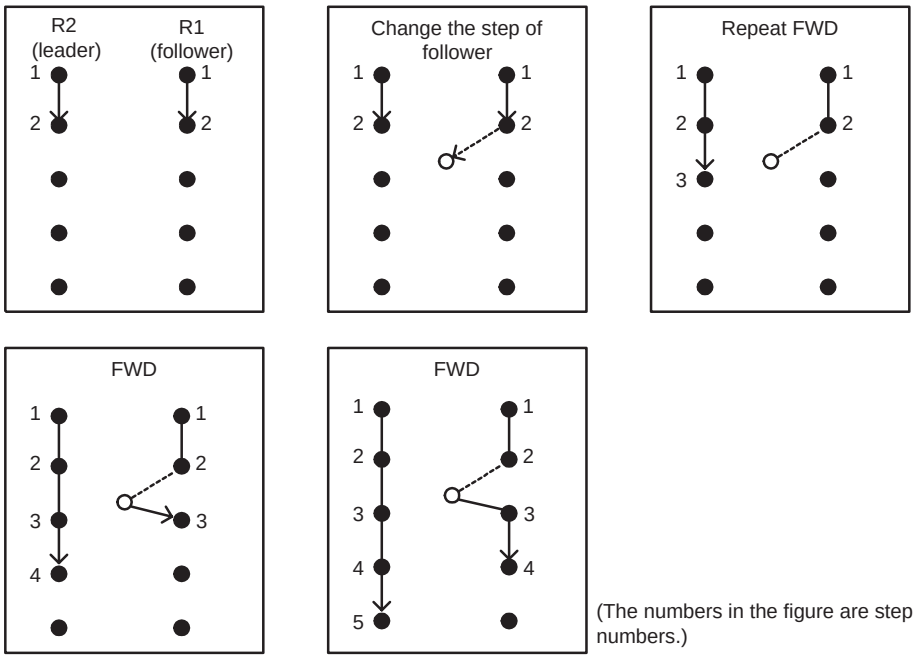
Restart both jobs from the same position (step).

4.16.2.2 When “Multi-job operation mode” is Set in the TEACHING CONDITION Window

<Example>

If the manipulator stops after operating to a certain step, and the step position of the follower R1 is changed and performs FWD operation again, the leader R2 proceeds to the next step but the R1 does not move.

As a result, the R2 goes forward by one step ahead.



(The numbers in the figure are step numbers.)

This is because, in the FWD operation after position change, the step after the change is usually re-executed.

In the above figure, at the FWD operation after the position change, the leader R2, whose step has not been changed, move to the step 3.

However, since position of the follower R1 is changed, the step after the change is executed again. As a result, operation is performed at the same position and it does not proceed to the next step.

In this way, the steps of the leader and follower do not correspond each other.

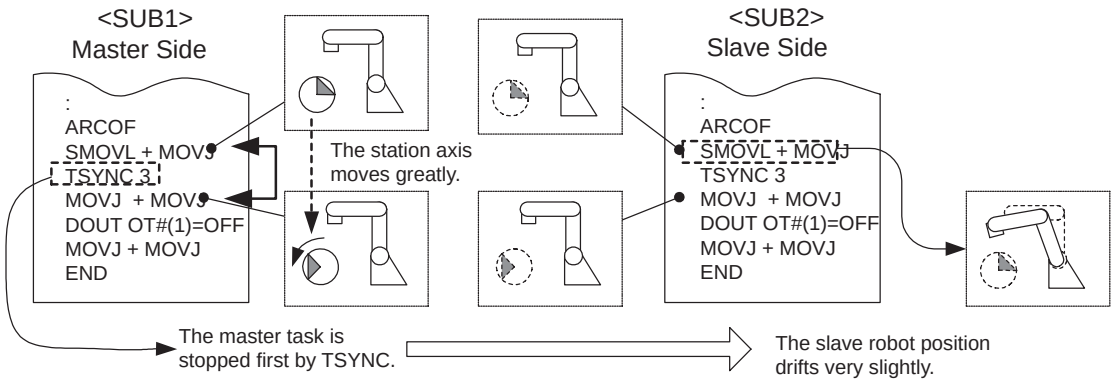
To make the steps of two sides correspond each other at the FWD operation after the position change in the above case, move the cursor to the next step for the job where a change has been made, then perform FWD operation, TEST run, and playback.

4.16.2.3 If the master task is stopped by TSYNC

If teaching that causes the master task station to move violently is carried out during the step following TSYNC, the locus of the slave robot may drift very slightly when the master task is put into a standby status first by TSYNC.

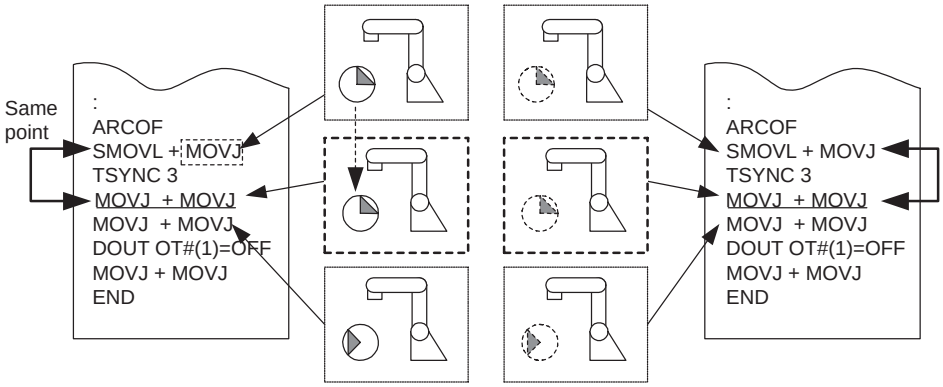
In this case, either carry out teaching in such a way that the station of the master task is not moved by the step following TSYNC, or add an ADVSTOP command after the TSYNC command.

==Phenomenon==



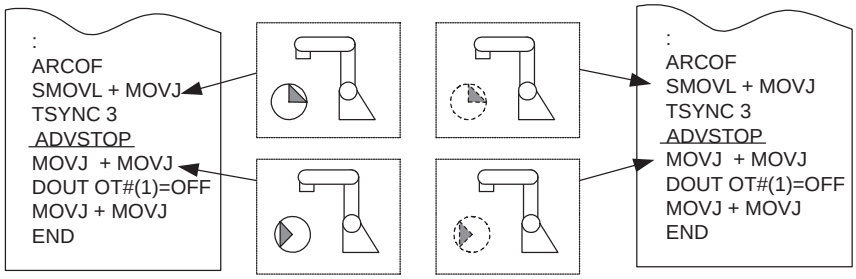
==Measure(1)==

Add the same point immediately after TSYNC.
(The position of the station axis is the same.)



==Measure(2)==

Add ADVSTOP after TSYNC.



4.17 Playback

4.17.1 Start

Call the master job in the following operation and perform a playback.

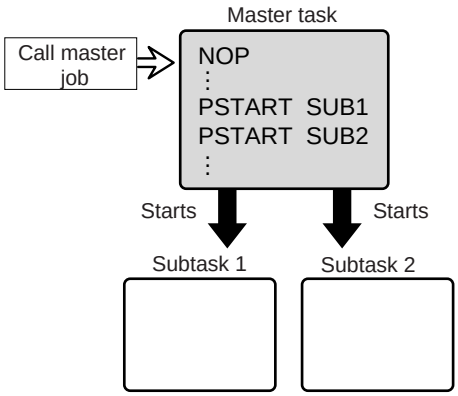
A job in the subtask is started by a PSTART instruction.

1. Select {JOB} under the main menu.
2. Select {CTRL MASTER}.
   – The SUPERVISORY window appears.
3. Move the cursor to MASTER JOB of MASTER.
4. Press [SELECT].
5. Select “CALL MASTER JOB.”
6. Press [START].
   – The called master job is executed from the beginning and the subtask is executed by a PSTART instruction.

NOTE

Performing the Operation 6 clears the job of subtask.

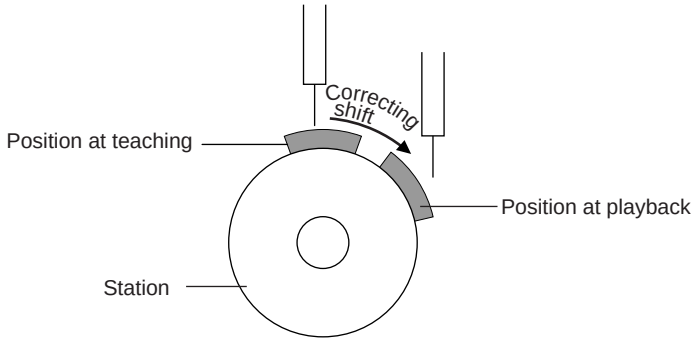
Therefore, if the master task is called while the subtask is interrupted in the middle of its execution, the information relating to the state of subtasks that are halted is lost.



4.17.2 Automatic Correction of Shift Value

During playback operation, as the station is controlled by the leader job, the follower job controls only the follower manipulator.

If there is a shift between the teaching position of the leader job station and the station current position (controlled by the leader job), the follower manipulator moves correcting automatically the shift value in order to keep the position on the station at teaching.

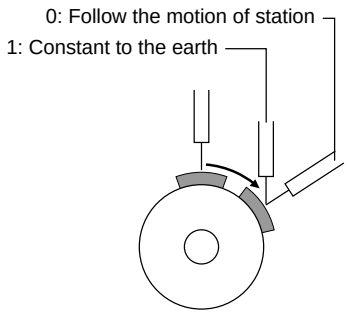


The shift between the teaching position and the station current position is always monitored. If the shift amount exceeds the set value of parameter, the following message is displayed.

Parameter	Contents and Set Value	Initial Value
S3C1101	Maximum shift angle of station axis in twin (triple) synchronous system	Differs depending on system (in units of 0.1°)

The control method of manipulator posture during correction is set by the following parameter.

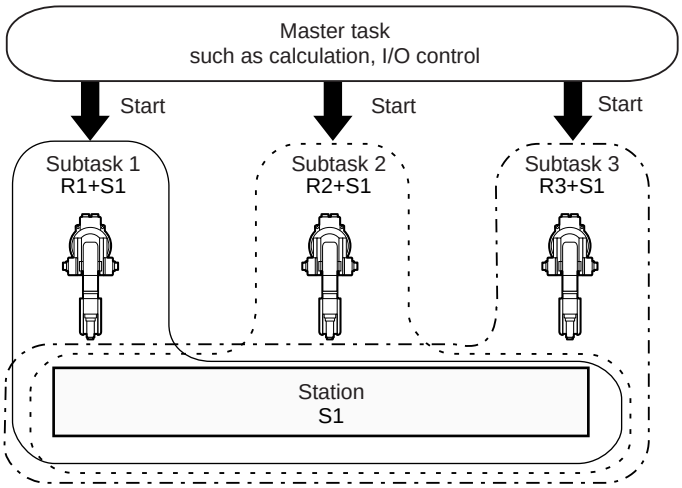
Parameter	Contents and Set Value	Initial Value
S2C420	Control method of follower manipulator posture in twin (triple) synchronous system 0: Follow the motion of station 1: Constant to the earth	0



5 Triple Synchronous System

5.1 Outline

The triple synchronous system is a system where three manipulators operate in coordination for one station.



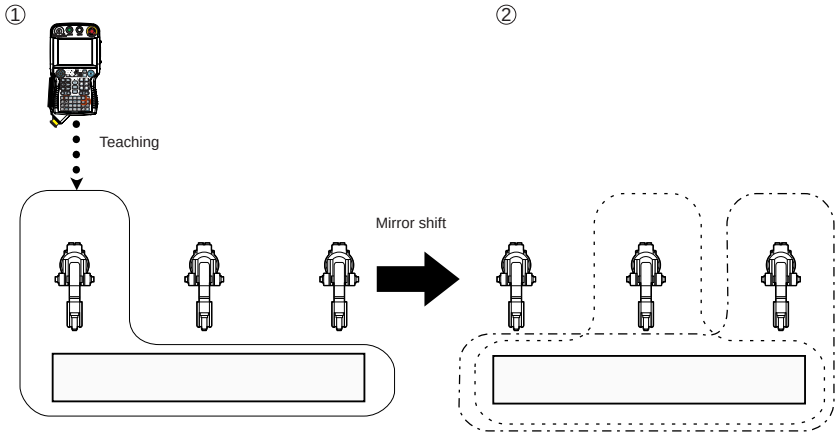
In this system, three coordinated jobs are done at the same time.

- A coordinated job for the first manipulator and the station (R1+S1)
- A coordinated job for the second manipulator and the station (R2+S1)
- A coordinated job for the third manipulator and the station (R3+S1)

A concurrent job or a robot job without control groups starts these three jobs and implements I/O control.
The master task job uses the independent control function to start the robot jobs of subtasks 1, 2, and 3.

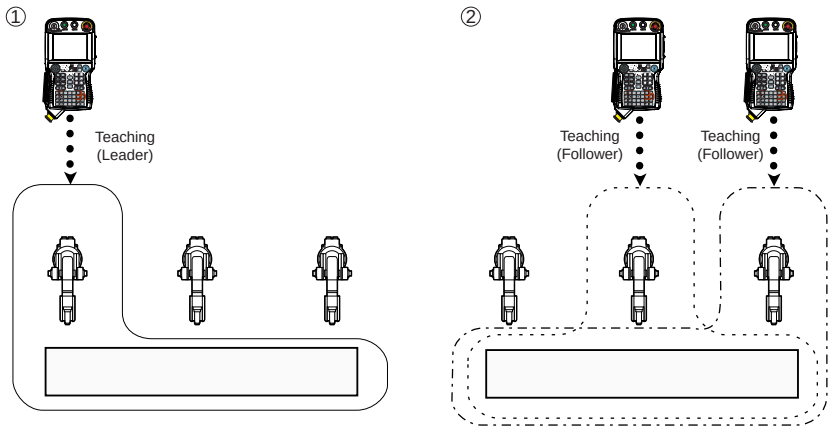
Three robot jobs can be created by the following two methods.

5.1.1 Method 1: Copy one subtask job to create two other subtask jobs.



This method is useful when two movement paths are symmetrical. Use the mirror shift function to convert a job path and copy it. The same teaching operation does not have to be repeated.

5.1.2 Method 2: Perform teaching for each manipulator.

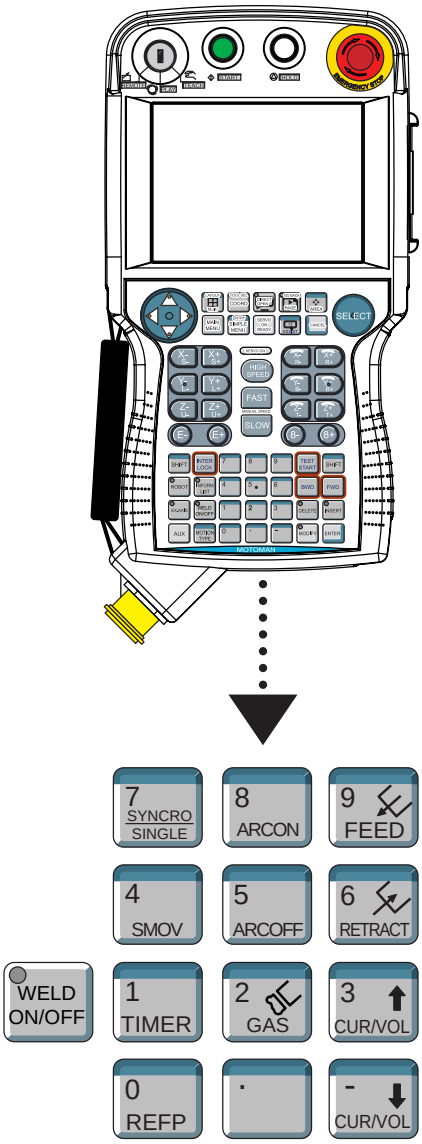


Where there are not many similarities in the paths and movements of the three manipulators, create jobs in Method 2.

5.2 Function Keys

The function keys for the triple synchronous system are assigned to the Numeric keys as shown in the figures below.

5.2.1 Arc Welding Application

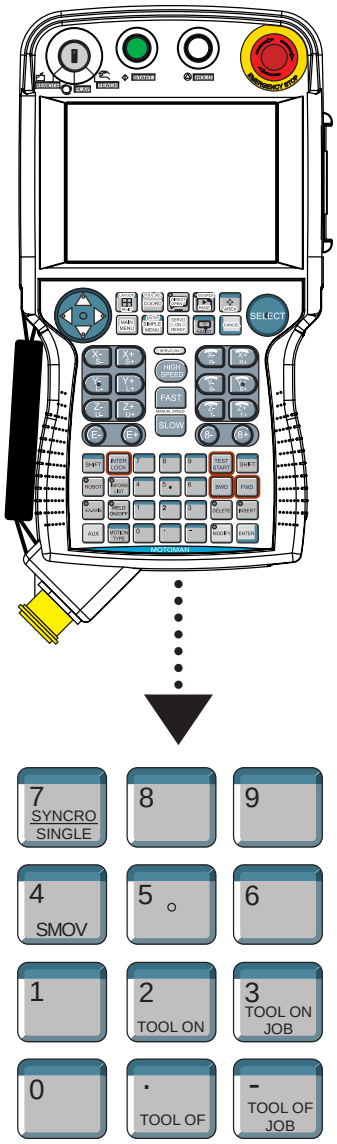


	Registers a timer instruction “TIMER” in a job.
	Registers a reference point “REFP” in a job, or modifies the registered reference point. [REFP] + [FWD] Moves the manipulator to the registered reference point.
	Registers a welding start instruction “ARCON.”
	Registers a welding end instruction “ARCOF.”
	Use when performing a gas check. Gas is fed only while [Gas] is pressed. (Refer to “Chapter 9.3.2 Gas Flow Control Function” at page 9-7 in the Operator’s Manual.)
 	Used for wire inching. Press [FEED] to feed the wire, and press [RETRACT] to retract the wire. While these keys are pressed, the wire feed motor operates. The feed rate can be switched through 3 steps. [FEED] : Low speed [FEED] + [FAST] : Middle speed [FEED] + [HIGH SPEED] : High speed The retract speedfeed rate can be switched through 3 steps. [RETRACT] : Low speed [RETRACT] + [HIGH SPEED] : High speed (Refer to “Chapter 9.3.1 Wire Inching Function” at page 9-7 in the Operator’s Manual.)
 	Modifies the welding current/voltage while welding during the play mode. Press [3/CUR/VOL] to increase the current/voltage value, and press [–/CUR/VOL] to decrease the current/voltage value. (Refer to “Chapter 9.13 Changing Welding Conditions During Playback” at page 9-134 in the Operator’s Manual.)

	Changes the type of movement for the manipulator when teaching a coordinated job. Each time this key is pressed, the movement type changes. SYNCRO: The mark for “synchronized” appears in the status display area. When the master side is moved, the slave side will follow the movement of the master. SINGLE: Only the selected group axis moves.
	Selects either a coordinated or an individual interpolation when teaching a coordinated job. Each time this key is pressed, the operation type changes. Coordinated: All the move instructions that are registered in this mode become coordinated instructions. Individual: The master-slave relationship is cancelled. Each manipulator and station moves independently.

Wire retraction, high-speed inching, or high-speed retraction cannot be performed depending on the Power Source.

5.2.2 General Application



	Registers a timer instruction “TIMER” in a job.
	Registers a reference point “REFP” in a job, or modifies the registered reference point. [REFP] + [FWD] Moves the manipulator to the registered reference point.
	Registers a welding start instruction “ARCON” in a job.
	Registers a welding end instruction “ARCOF” in a job.
	Use when performing a gas check. Gas is fed only while [Gas] is pressed. (Refer to “Chapter 9.3.2 Gas Flow Control Function” at page 9-7 in the Operator’s Manual.)
 	Used for wire inching. Press [FEED] to feed the wire, and press [RETRACT] to retract the wire. While these keys are pressed, the wire feed motor operates. The feed rate can be switched through 3 steps. [FEED] : Low speed [FEED] + [FAST] : Middle speed [FEED] + [HIGH SPEED] : High speed The retract speedfeed rate can be switched through 3 steps. [RETRACT] : Low speed [RETRACT] + [HIGH SPEED] : High speed (Refer to “Chapter 9.3.1 Wire Inching Function” at page 9-7 in the Operator’s Manual.)
 	Modifies the welding current/voltage while welding during the play mode. Press [3/CUR/VOL] to increase the current/voltage value, and press [–/CUR/VOL] to decrease the current/voltage value. (Refer to “Chapter 9.3 Changing Welding Conditions During Playback”at page 9-134 in the Operator’s Manual.)
	Changes the type of movement for the manipulator when teaching a coordinated job. Each time this key is pressed, the movement type changes. SYNCRO: The mark for “synchronized” appears in the status display area. When the master side is moved, the slave side will follow the movement of the master. SINGLE: Only the selected group axis moves.

	Selects either a coordinated or an individual interpolation when teaching a coordinated job. Each time this key is pressed, the operation type changes. Coordinated: All the move instructions that are registered in this mode become coordinated instructions. Individual: The master-slave relationship is cancelled. Each manipulator and station moves independently.

5.3 Job Configuration

Using the independent control function, configure jobs so that the concurrent job or robot job without control groups of master task operates the robot jobs in subtask 1, 2, and 3.

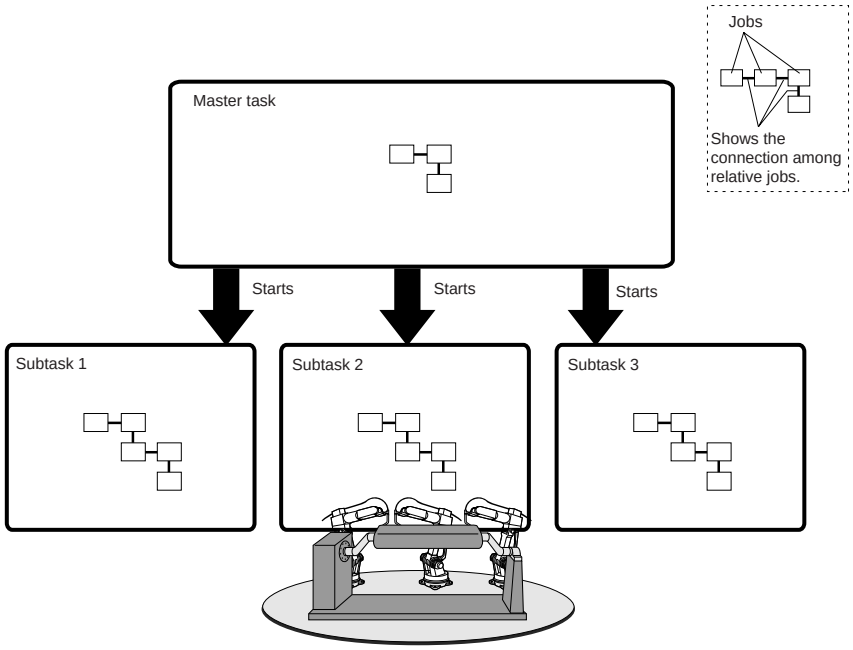
Master task: Concurrent job (or robot job without control groups)
Starts subtasks 1, 2, and 3, and controls I/Os.

Subtask 1: Robot job
A coordinated job for the first manipulator + the station

Subtask 2: Robot job
A coordinated job for the second manipulator + the station

Subtask 3: Robot job
A coordinated job for the third manipulator + the station

Subtasks 1, 2, and 3 are determined as leader or follower with a tag SYNC in PSTART instruction.

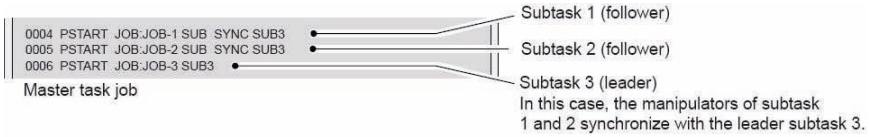


5.4 Leader and Follower

Set the two out of the subtask 1, the subtask 2, and the subtask 3 as the followers. To set a follower, add a tag SYNC and the leader subtask to the PSTART instruction of the master task.

The subtask to which a tag SYNC is added is follower while the subtask without a tag is leader.

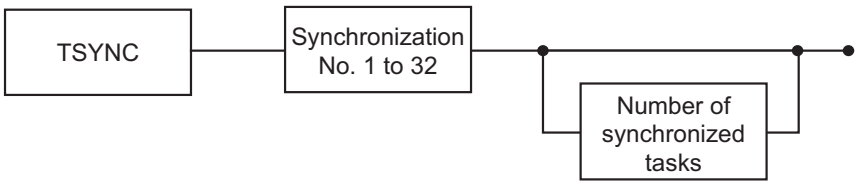
The station axis is controlled by the leader job, and the follower job follows the movement of station axis.



NOTE Register a PSTART instruction so that the follower job starts first.

5.5 Synchronizing with TSYNC

5.5.1 Format



If the PSTART command is not executed correctly, alarm 4103 will be emitted.

When an alarm is emitted, check the sub-code, and correct the job.

<Example>

PSTART JOB : R1S1 SUB1
PSTART JOB : R2 SUB1
… AL-4103: [1] Sub task being executed:
During execution of SUB1, an attempt is being made to start a different job in the same SUB1.

PSTART JOB : R1S1 SUB1 (R1S1: A job for the robot 1 and the station 1)
PSTART JOB : R2S1 SUB2 (R2S1: A job for the robot 2 and the station 1)
… AL-4103 [2] Group axis being used:
An attempt is being made to execute a job containing station 1 in SUB2, despite the fact that station 1 is being used by SUB1.
PSTART JOB : R2S1 SUB2 SYNC SUB1
PSTART JOB : R1S1 SUB1
… “Station twin coordination” is being correctly executed

Alarm Number	Alarm Name	Message	Sub Code	Meanings
4103	PARALLEL START INSTRUCTION ERROR	An error occurred in the independent control startup operation.	1	Sub task being executed: Although a job is being executed by instructed sub task, an attempt was made to execute another job by the sub task.
			2	Group axis being used: The job operated by another sub task uses the same group axis.
			3	Multiple start of same job: timing for start command again. The job that was tried to be started was executed by another sub task.
			4	Unregistered master job: Although the master job was not registered, an attempt was made to execute PSTART SUB (job name omitted).
			5	Synchronization instruction error: When restarted by PSTART, synchronization instruction status of the sub task under interruption was different from the status to restart.
			6	Stopped by an alarm: An attempt was made to start the sub task which is stopped by an alarm.
			7	Synchronization task specification of SYNC instruction omit error
			8	The task is specified by synchronization task of SYNC instruction.
			9	I/O jog being executed
			10	Separate group axis being used
			11	The servo power supply is OFF.
			12	Twin synchronous task ID error
			16	PSTART instruction is the old specification.
			17	PWAIT instruction is the old specification.

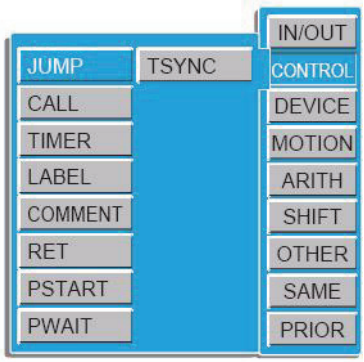
5.5.2 Procedure

During the execution of the jobs, a deviation between the movements of the three manipulators may occur. In the steps where the movements of the three manipulators should be exactly the same, execute a TSYNC instruction immediately before these steps.

When a TSYNC instruction is executed in one of the robot jobs, the manipulator waits until the same synchronized signal, TSYNC, is executed in the other two robot jobs. Set the number of synchronized tasks.

When setting “SYNCHRO NUM” to “UNUSED,” the number of tasks is the same as when “SNUM=2.”

1. Move the cursor to the line just above the line where TSYNC instruction is to be registered.
2. Press [INFORM LIST].
   – The instruction list appears.



3. Select “TSYNC.”
   – A TSYNC instruction is displayed in the input buffer line.

4. Change additional items.
   – <To register items as displayed in the input buffer line>
   Proceed to Operation 5.
   – <To change the numerical data>
   (1) Move the cursor to the numerical data. Press [SHIFT] and the cursor key simultaneously to increment or decrement the number.

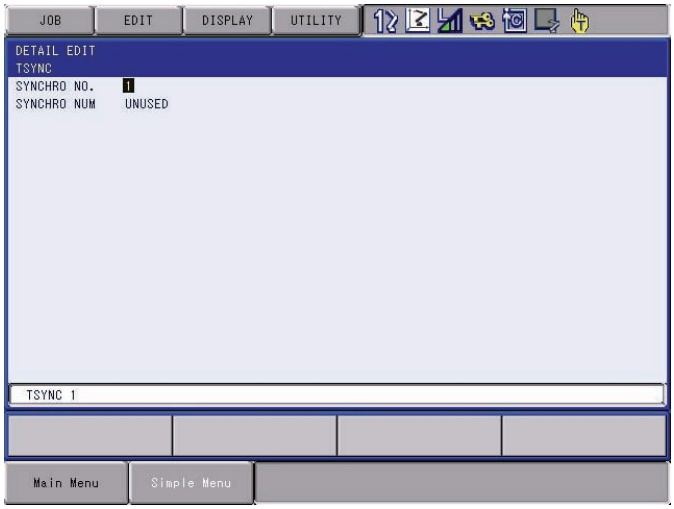
   (2) To enter a number by pressing the Numeric keys, press [SELECT] to display the input line.

   (3) Enter a number and press [ENTER], then the number in the input buffer line is changed.
   (4) After having changed the numerical data, press [ENTER].
   (5) The DETAIL EDIT window is closed and the JOB CONTENT window reappears.

5. Press [INSERT] and [ENTER].

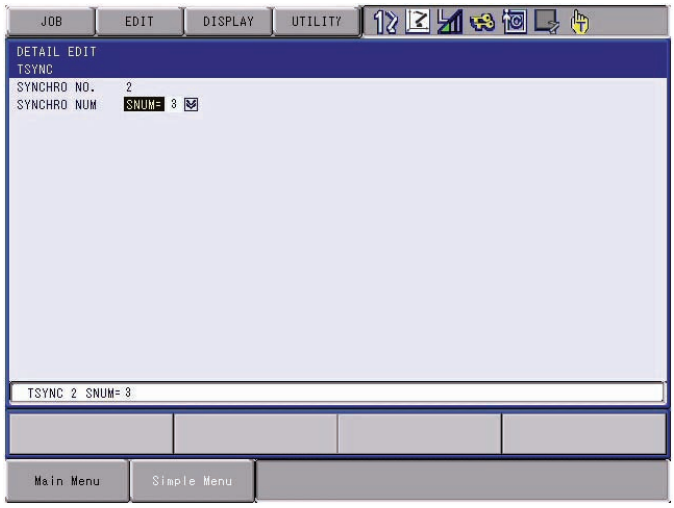
– <To edit additional items>

(1) To edit additional items, move the cursor to the instruction in the input buffer line, then press [SELECT]. The DETAIL EDIT window appears.



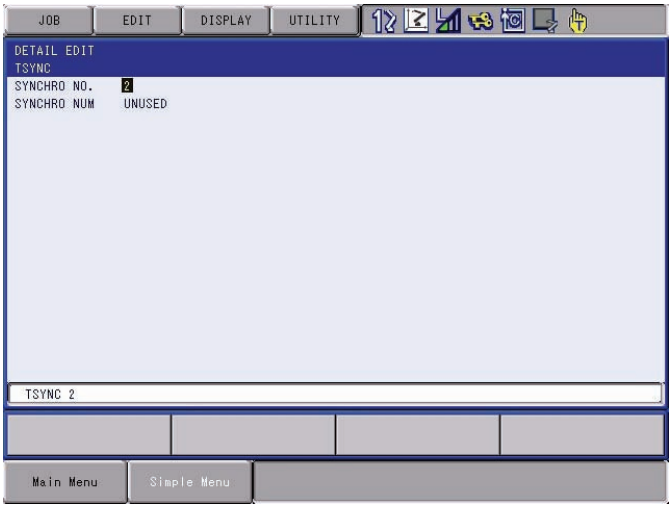
(2) To change the synchronization number, select “1” of “SYNCHRO NO.”
When the number input status enters, enter the synchronization number, “SYNCHRO NO.” by pressing the Numeric keys, and press [ENTER].
To add the number of synchronized tasks, select “UNUSED” of “SYNCHRO NUM.”

(3) The selection dialog box appears. Select “SNUM=.”



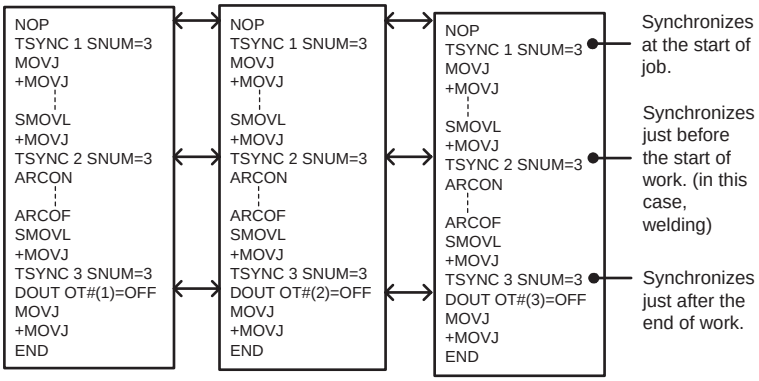
(4) After changed or added the additional items, press [ENTER].
The DETAIL EDIT window is closed, and the JOB CONTENT window appears.

(5) Press [ENTER].



6. The instruction displayed in the input buffer line is registered.

– <Example>

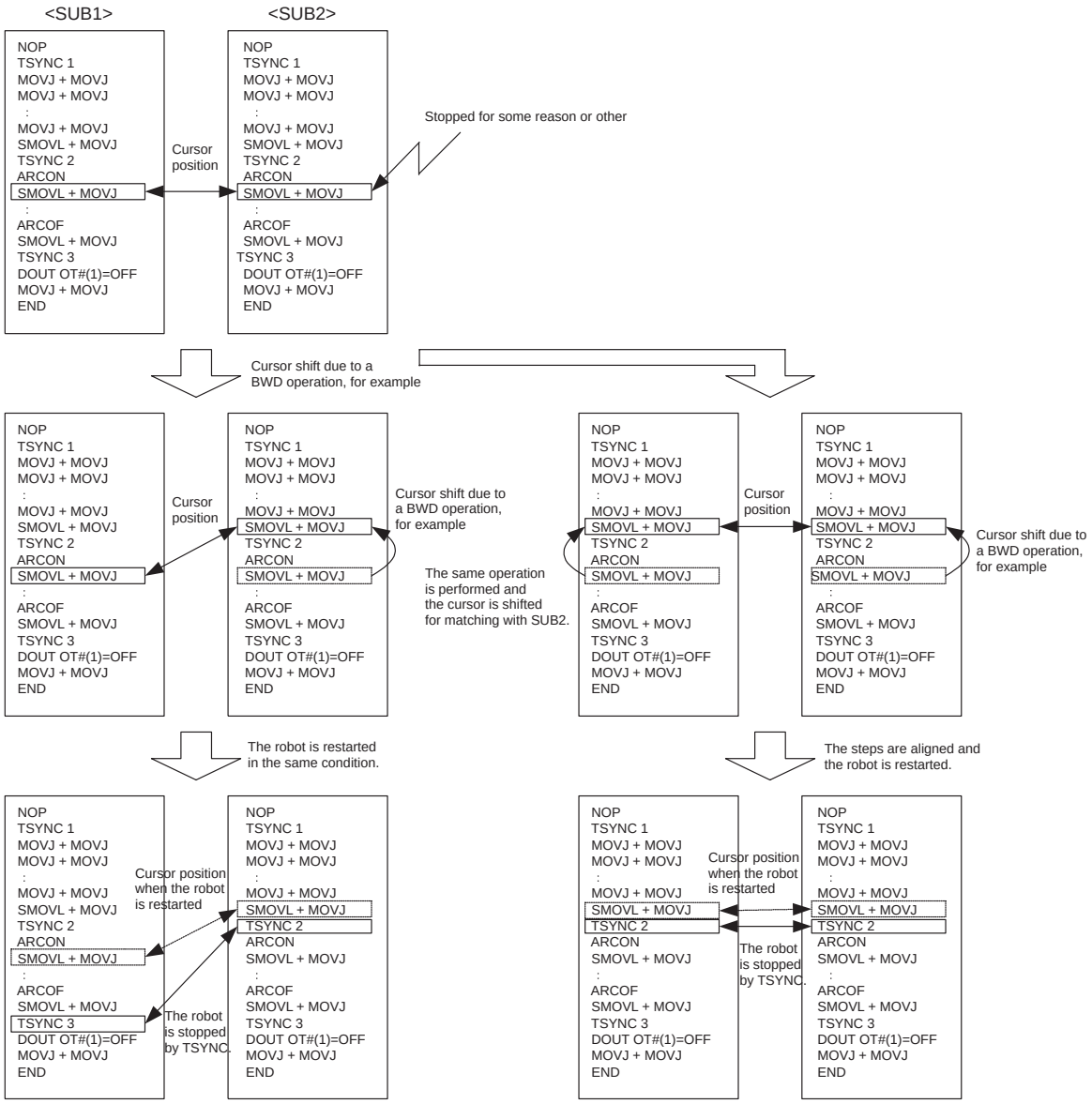


5.5.3 Items to note when using a TSYNC command

Note that even when TSYNC is being used, the steps of two manipulators will fail to match each other if the following operations are performed.

5.5.3.1 When a cursor shift occurs during operation

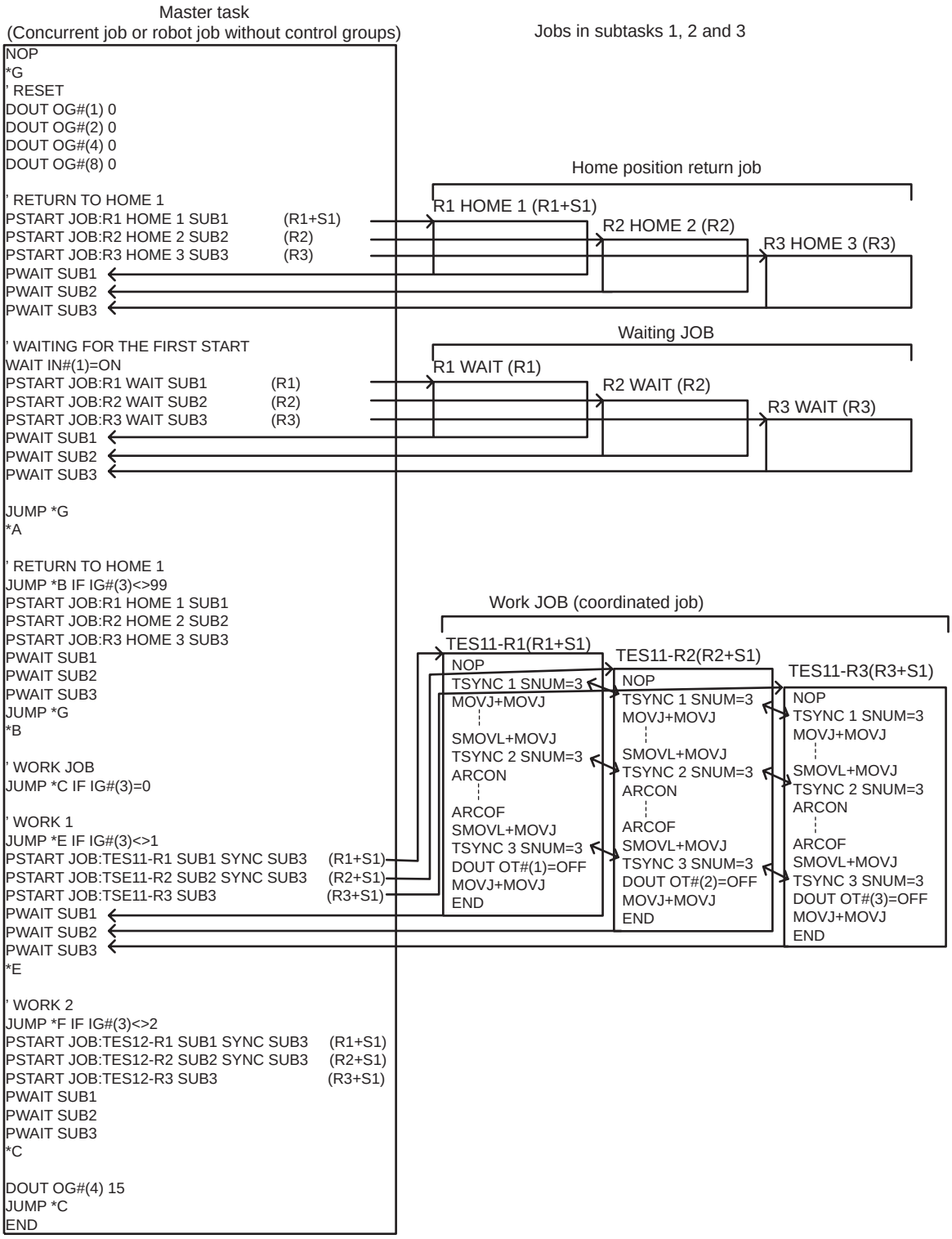
If the cursor position is shifted to a different step during the execution of a job of one of the two sub-tasks when the robot stops during operation, and the robot is restarted while remaining in this condition, the steps will become misaligned, resulting in the risk of interference from the jig, for example.
Start both jobs from the same position (step).



In this case, the steps become misaligned, which may cause the manipulator to interfere with the work piece or the jig.

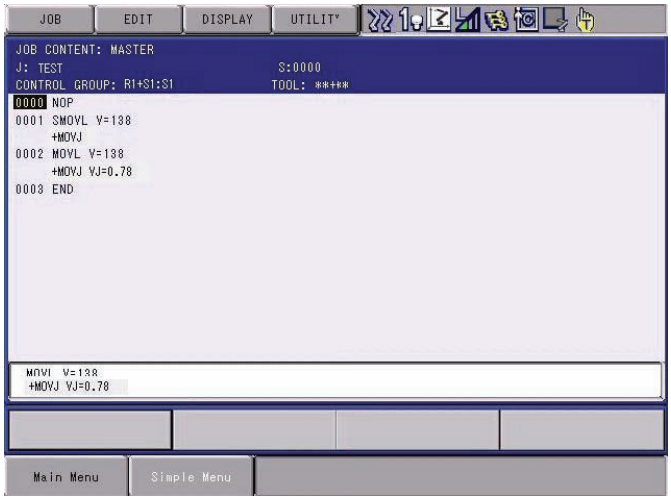
In this case, the steps do not become misaligned, so normal operation can take place.

5.6 Job Example



5.7 JOB CONTENT Window

The contents of coordinated job are displayed as shown below.



①Instructions

For coordinated jobs, the move instruction is displayed in two lines. The first line is the instruction to the slave side; the second line is the instruction to the master side.

SMOVL V=138 ←Slave, a manipulator
+MOVJ ←Master, a station

②Synchronized/Single

Synchronized/single are the types of movement available for the manipulator during axis operation. This mark appears when synchronized movement is selected.

Switch between movements by pressing [SYNCRO/SINGLE].

③ Group axis being handled

Displays the group axis being handled.

Pressing [ROBOT] selects the manipulator.

Pressing [EX. AXIS] selects the station.

④Coordinated interpolation/Individual interpolation

Switch between coordinated interpolation and individual interpolation by pressing [SMOV].

5.8 Synchronized/Single

5.8.1 Synchronized/Single Movement Between Station and Manipulator

There are two ways to handle axes when teaching: “Synchronized” and “Single.”

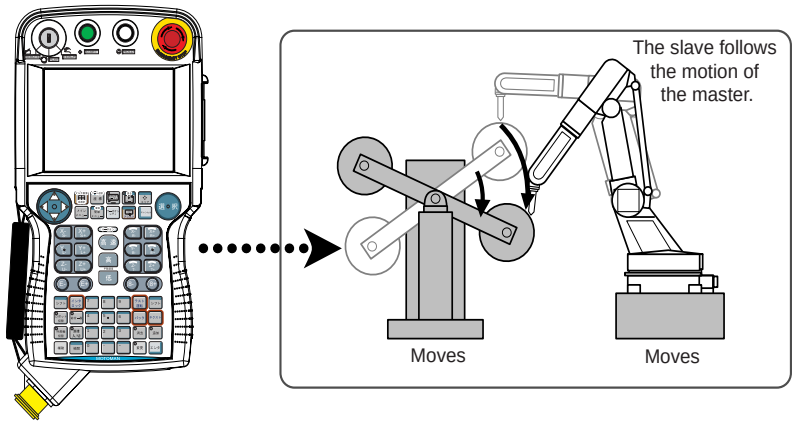
Change between movements by pressing [SYNCRO/SINGLE].

5.8.1.1 Synchronized

If the axes are handled in the “Synchronized” mode, the slave (manipulator) follows the master (station) when the master moves. This feature is used to keep the position of the manipulator relative to the station.

However, the master does not move when the slave is moved.

■ **A master axis is moved:**

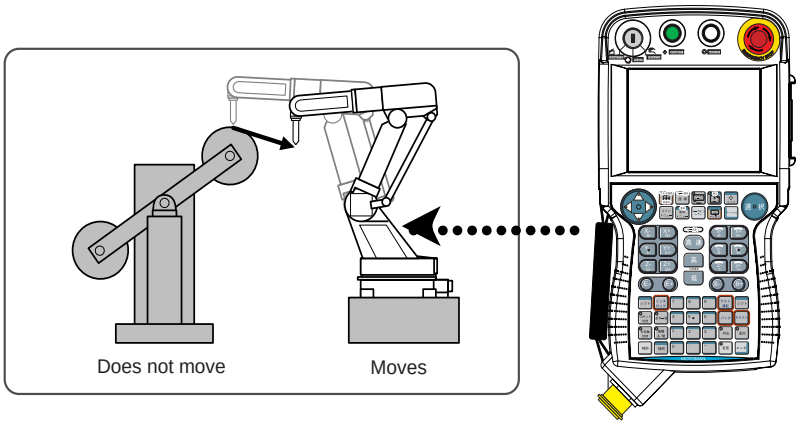


5.8.1.2 Single

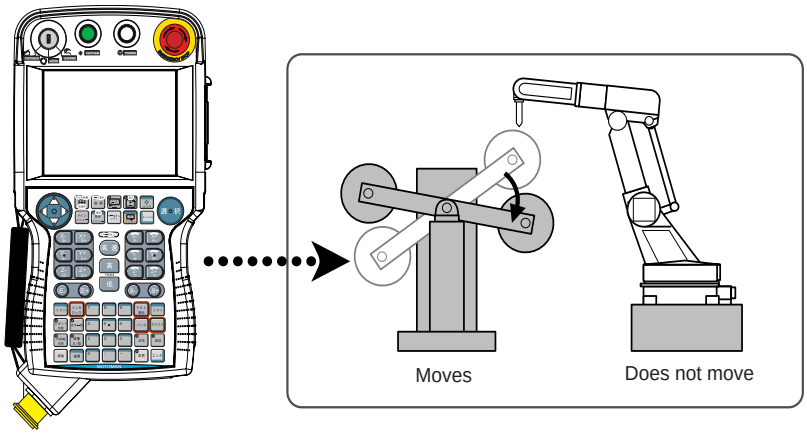
If an axis is handled in “Single” mode, the manipulator or the station whose axis has been handled, moves.

This feature is used where a manipulator and a station each executes an individual job.

■ **A slave side axis is moved**



■ **A master side axis is moved:**



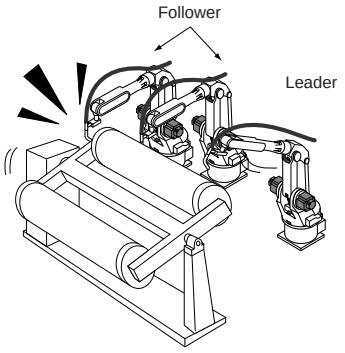
NOTE

- The selected mode, Synchronized or Single, is maintained until the next selection is made.
- When an edit job is changed, “Single” is automatically selected.

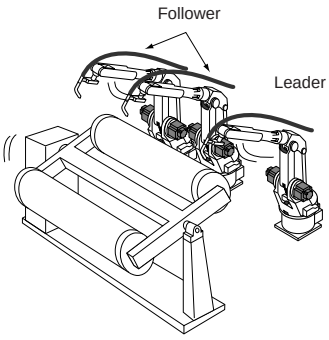
5.8.2 Job Synchronized Mode for Subtask 1, 2, and 3

When moving only the leader manipulator in FWD/BWD operation, the follower manipulator in stop status may interfere with a workpiece.
To prevent this, using “job synchronized mode” can move the follower synchronizing the motion of the leader.

The follower manipulator moves, keeping the relative position to the station.



Leader in FWD operation.

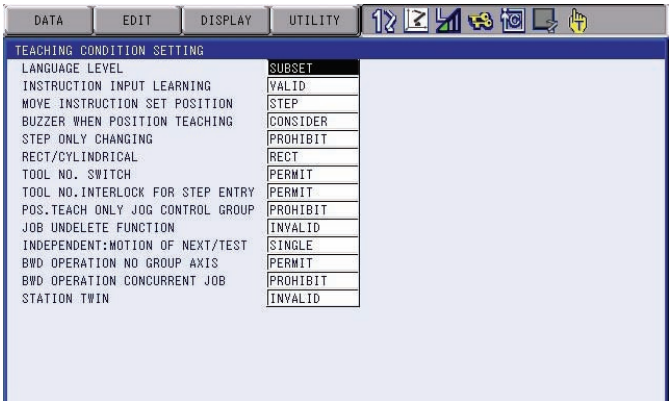


Leader in FWD operation,
using job synchronized mode.

Pressing [SHIFT] + [SYNCRO/SINGLE] changes the job synchronized mode.

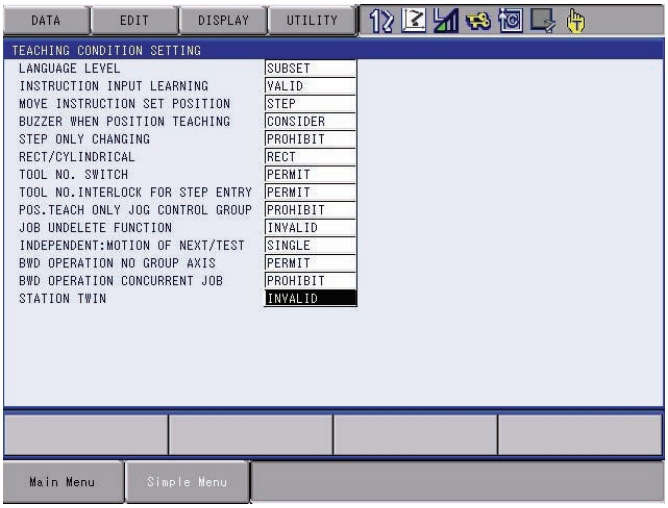
Also in the TEACHING CONDITION window, the job synchronized mode can be set and confirmed.

1. Select {SETUP} under the main menu.
2. Select {TEACHING COND}.
   – The TEACHING CONDITION window appears.



3. Select “TWIN COORDINATED MODE.”

– Each time [SELECT] is pressed, “VALID” and “INVALID” is selected alternately.



NOTE The job synchronized mode is enabled only when “SINGLE” is selected in “STEP/TEST RUN OPERATION MODE” for the follower manipulator.

5.9 Selecting Axis to be Handled

In a coordinated system with multiple numbers of group axes, select a group axis to be handled in the following manner.

5.9.1 When There is an Edit Job

When the edit job is displayed, the group axes registered in the displayed job is the one to be handled.

- Pressing [ROBOT] selects a manipulator for axis handling.

- Pressing [EX. AXIS] selects a station for axis handling.

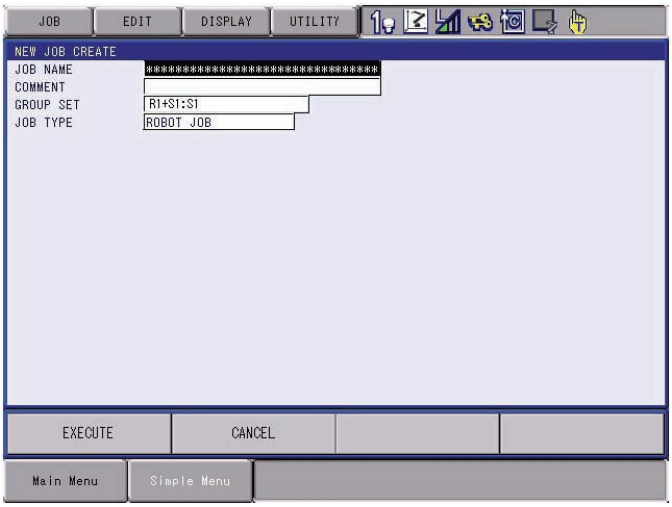
5.9.2 When There is No Edit Job

When there is no edit job, move a manipulator in the following manner.

1. Press [SHIFT] + [ROBOT] to change the manipulator for axis handling.
   – The LED of [ROBOT] flashes.
2. Press [SHIFT] + [EX. AXIS] to change the station for axis handling.
   – The LED of [EX. AXIS] flashes.
3. Select the group axes to be moved, and then move it by pressing the axis key.
4. Press [ROBOT] or [EX. AXIS] to return to the original window.

5.10 Registering Job

1. Select {JOB} under the main menu.
2. Select {CREATE NEW JOB}.
   – The NEW JOB CREATE window appears.



3. Enter a job name.
   – Select “JOB NAME,” and then enter a job name by entering the characters.
   – Refer to “1.2.7 Character Input” of the Operator’s Manual.
4. Press [ENTER].
5. Select “GROUP SET.”
6. Select a group combination.
7. Select “EXECUTE.”
   – The job name is registered in the memory of DX100, and the JOB CONTENT window appears.

5.11 Registering Move Instruction (S)MOV □+MOVJ

Register a move instruction in the following manner.

5.11.1 Operating Master Side (Station)

1. Call the JOB CONTENT window in teach mode.
2. Press [EX. AXIS].
   – The master side (station) is selected for axis handling.

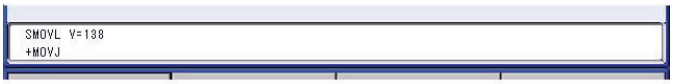
3. Select either “synchronized” or “single.”
   – Press [SYNCRO/SINGLE] to select either “synchronized” or “single.” When “synchronized” is selected, the mark in the window below appears.

   – When the slave side is supposed to follow the master side motion, select “synchronized.”
4. Press the axis key to move to the desired position.

5.11.2 Operating Slave Side (Manipulator)

1. Press [ROBOT].
   – The slave side (manipulator) is selected for axis handling

2. Press the axis key to move to the desired position
3. Select either a coordinated interpolation or an independent interpolation.
   – Press [SMOV] to select either interpolation.



4. Select an interpolation type.
   – Press [MOTION TYPE] to select an interpolation type.

5. Confirm the speed.
6. Press [ENTER].

- The registration is completed as follows.

NOTE

- When joint interpolation is set for the slave side (manipulator), teaching cannot be done during a coordinated interpolation.
- When “JOINT” is selected, the operation will not change to a coordinated interpolation, even if [SMOV] is pressed.
- When “JOINT” is selected during coordinated interpolation, a coordinated move instruction such as “SMOVL” in the input buffer line changes to “MOVJ,” and the operation becomes individual interpolation.

Parameter	Contents and Set Value	Initial Value
S2C213	+MOV INSTRUCTION INTERPOLATION INPUT This parameter specifies which interpolation is permitted for move instructions for the master robot in a coordinated job. (bit specification) D0: +MOVJ, D1: +MOVL D2: +MOVC, D3: +MOVS	2

5.11.3 (S) MOV □ + MOVJ rate specification

5.11.3.1 Rate specification in a multiple line shift command

The relationship between the rate specification in a shift commnad which causes multiple groups such as “MOV □ + MOVJ” or “SMOV □ + MOVJ” to operate (i.e. to be configured by multiple lines), simultaneously, and the actual operation rate, is as follows.

- Each shift time for the robot (or station) is obtained according to the rate specified for each line.
- The maximum of the respective shift times is obtained, and all groups are operated according to this maximum shift time.

<Example>

MOVL V = 500.0 …The shift time over the shift distance is 2 seconds at V = 500
+MOVJ VJ = 25.00…The shift time for the shift amount is 4 seconds at VJ = 25
*This “MOVL + MOVJ” functions when the shift time is 4 seconds.
Note that for lines in which the rate specification is omitted, the shift time is calculated based on the assumption that the maximum rate has been specified.

<Example>

MOVL V = 500.0 …The shift time over the shift distance is 2 seconds at V = 500
+MOVJ VJ …The shift time for the shift amount is 1 seconds at VJ = 25
*This “MOVL + MOVJ” functions when the shift time is 2 seconds.

5.11.3.2 Rate specification at coordination interpolation (SMOV □)

The rate specification for the manipulator on the slave side at coordination interpolation (SMOV □) is specified as “relative rate” as seem from the master side.

For example, in arc welding, in the case where the slave side manipulator holds the welding torch, this “relative rate” becomes the “welding rate” with respect to the work piece, so it is important to maintain this rate.
In this case, by omitting the rate specification on the master side, the shift rate will be basically determined by the “relative rate.”

<Example>

MOVL V = 100.0 …The shift time at V = 100 over the relative shift distance on the slave side with respect to the master is 5 seconds.
+MOVJ VJ …The shift time at VJ = 100 for the master shift amount is 2 seconds.
*This “SMOVL + MOVJ” functions when the shift time is 5 seconds.

Parameter	Contents and Set Value	Initial Value
S2C212	+MOV INSTRUCTION SPEED INPUT Specifies whether the speed inputting for move instructions of the master side robot in a coordinated job is permitted or not. **<Example> 0: Not Provided** SMOVL V=100 +MOVJ ← Master side Speed specification not provided **1: Provided** SMOVL V=100 +MOVJ VJ=10.00 ← Master side Speed specification provided	0

5.12 Registering Reference Point Instruction (SREFP)

Register a reference point instruction (SPEFP) for a coordinated interpolation in the following manner.

1. Select {JOB} under the main menu.
2. Select {JOB}.
3. Move the cursor.
   – Move the cursor to the line immediately before the position where the reference point is to be registered.

4. Grasp the Enable switch.
5. Press the axis key.
   (1) Turn ON the servo power with the Enable switch.
   (2) Move the manipulator to the position which will be a reference point.
6. Select the coordinated interpolation.
   – Press [SMOV] to select a coordinated interpolation.
7. Press [REF PNT].
   – The reference point instruction appears in the input buffer line.

8. Change the reference point number.
   – Move the cursor to the reference point number, and press [SHIFT] + the cursor key to change the reference point number.

   – If you use the Numeric keys to change the reference point number, press [SELECT] when the cursor is on the reference point number. Input the number and press [ENTER].

9. Press [INSERT].
   – The [INSERT] key lamp lights up.
   – When registering immediately before the END instruction, pressing [INSERT] is not needed.
10. Press [ENTER].
   – The REFP instruction is registered.

5.13 Changing Tasks

To call the JOB CONTENT window for master task, subtask 1, subtask 2, and subtask 3, proceed the following operation.

1. Select {JOB} under the main menu.
2. Select {JOB}.
3. Press the page key  .
   – Each time the page key is pressed, the contents of the JOB CONTENT window change in order of master task, subtask 1, subtask 2, and subtask 3.
   – When there is no job in a task, the JOB CONTENT window for this task is not displayed.

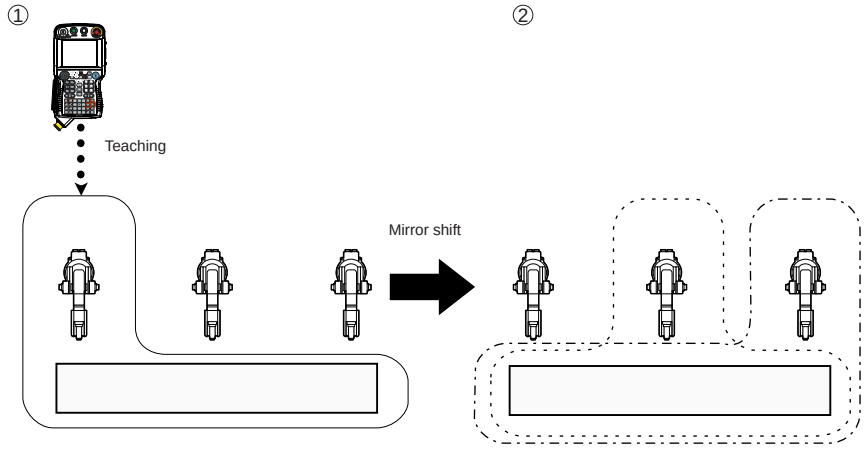
5.14 Creating a Job in a Subtask - Method 1 and 2

Subtasks 1, 2, and 3 are robot jobs.

Subtask 1: Job of the first manipulator + the station
Subtask 2: Job of the second manipulator + the station
Subtask 3: Job of the third manipulator + the station

There are two methods to create a robot job for a subtask.

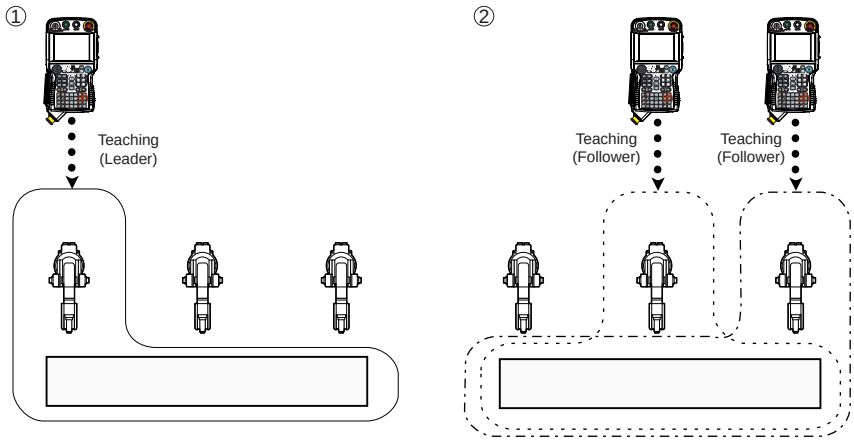
- Method 1: Copy one subtask job to create two other subtasks.



This method is useful when movement paths are symmetrical.

Use the mirror shift function to convert a job path and copy it. The same teaching operation does not have to be repeated.

- Method 2: Perform teaching for each manipulator.



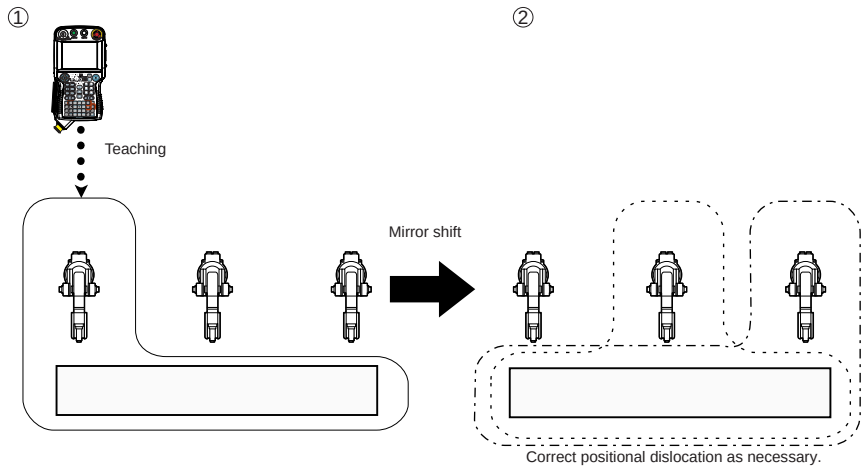
Where there are not many similarities in the paths and movements of the three manipulators, create jobs in Method 2.

5.15 Method 1: Copy One Subtask Job and Create Other Two Jobs

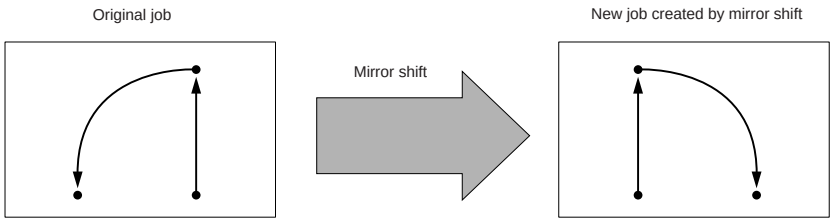
5.15.1 Procedure

When movement paths are symmetrical, two subtask jobs can be created by using the job taught by another manipulator.

Perform teaching for either R1 + S1, R2 + S1, or R3+S1. Use the mirror shift to create a job for the other two manipulators.



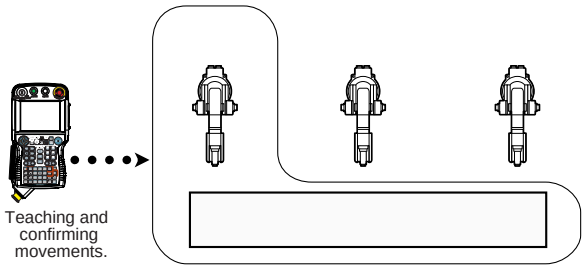
The mirror shift is a function for copying jobs, which creates a job by reversing the signs of the position data for the S-axis, R-axis, and T-axis.



5.15.2 Teaching and Mirror Shift

Teach the job for one manipulator + the station, and confirm the movement.

After having completed the teaching, perform mirror shift the job.



5.15.2.1 Converting

Call the JOB CONTENT window for the job to be converted.

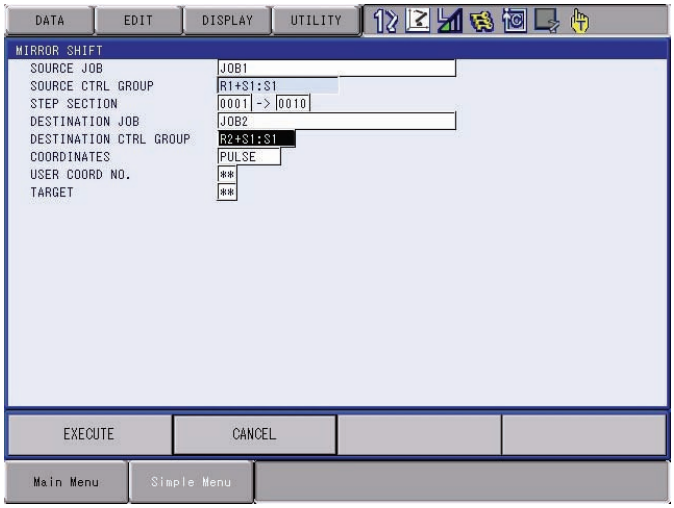
■ **For the job currently selected**

1. Select {JOB} under the main menu.
2. Select {JOB}.

■ **To call another job**

1. Select {JOB} under the main menu.
2. Select {SELECT JOB}.
   – The JOB LIST window appears.
3. Select a job to be displayed.

■ **Execute conversion**



①SOURCE JOB

Selects the conversion source job.

To select another job to be converted, move the cursor to the name and press [SELECT] to call up the list of jobs. Select the desired job and press [SELECT].

②SOURCE CTRL GROUP

Displays the control group of the conversion source job.

③STEP SELECTION

Specifies the steps to be converted.

From the first step to the last step of the selected job are specified as initial value.

④DESTINATION JOB

Specifies the converted job name.

To enter the name, move the cursor to the name and press [SELECT].

The name of the conversion source job is displayed in the input line as initial value.

When "***" is displayed, the name for the converted job is to be the same as that of the conversion source job.

⑤DEST CTRL GROUP

Selects the control group for the converted job.

When the destination job name is entered, the same control group as the conversion source job is automatically set.

To change it, move the cursor to the control group and press [SELECT] to call up the selection dialog box.

⑥COORDINATES

Specifies the coordinates used for conversion.
"PULSE," "ROBOT," or "USER" can be selected.
The initial value is "PULSE."
"PULSE": Executes the pulse mirror-shift conversion.
"ROBOT": Executes the mirror-shift conversion on the basis of the cartesian coordinates.
"USER": Executes the mirror-shift conversion on the basis of the specified user coordinates.

⑦USER COORD NO.

Specifies the user coordinates number when "USER" is selected in ⑥.
"01" is automatically set as initial value when the "USER" is selected in ⑥.
This item cannot be set when "PULSE" or "ROBOT" is selected in ⑥.

⑧TARGET

Specifies the coordinate where conversion is to be done when "ROBOT" or "USER" is selected in ⑥.
"XY," "XZ," or "YZ" can be selected. The "XZ" is automatically set as initial value when "ROBOT" or "USER" is selected in ⑥.
Always specify "XZ" for "ROBOT."

⑨EXECUTE

Executes the conversion.
When the conversion destination job name is entered, the converted job is created with that name as a new job.
When the conversion destination job name is not entered, the conversion source job is converted and overwritten.

5.15.2.2 Jobs Not to be Converted

The jobs and relative jobs without group axes cannot be converted.

5.15.2.3 Group Axes for Conversion

When the group axes for the SOURCE JOB in the multiple group axes system, the axis configuration, etc. of each group axes for SOURCE JOB and DESTINATION JOB must be the same.

- Robot axis: Same type
- Base axis: Same axis configuration
- Station axis: Same axis configuration

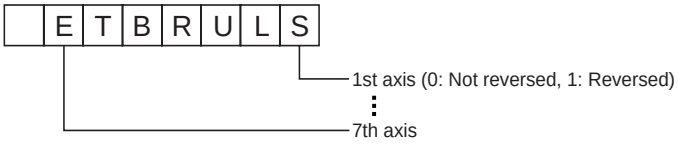
5.15.2.4 Position Type Variables

The position type variables are not for mirror-shift.

5.15.2.5 Parameter

Which axis is to be shifted (reverse the sign) is specified by the following parameter.

S1C×G065: Mirror shift sign reversed axis specification



5.15.3 Correcting Positional Dislocation

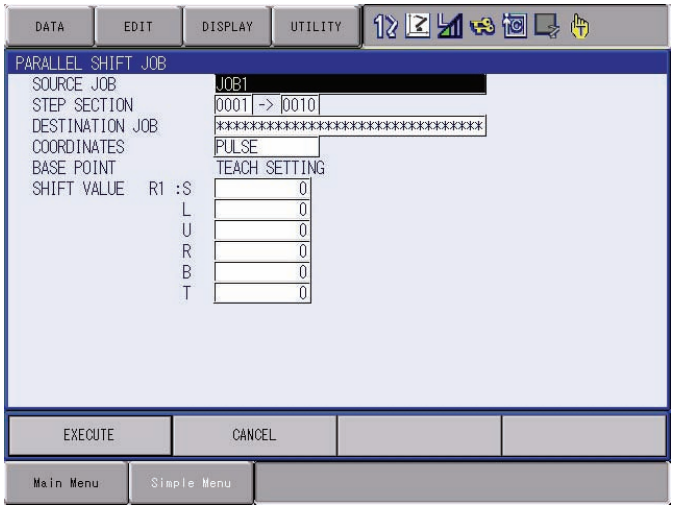
In the job after mirror shift, a position may be dislocated due to the installation error.

In this case, all steps should be corrected by the same shift amount.

For this operation, the parallel shift job conversion function is used.

5.15.3.1 Setting the Items for Conversion

1. Select {JOB} under the main menu.
2. Select {JOB}.
   – The JOB CONTENT window appears.
3. Select {UTILITY} under the pull-down menu.
4. Select {PARALLEL SHIFT JOB}.
   – The PARALLEL SHIFT JOB window appears.



5. Specify the conversion items.

– Specify the following items.

①SOURCE JOB

Selects the job before conversion.
The job which is shown in the JOB CONTENT window is set initially.
To change the job, perform the following procedure.
Move the cursor to the job name and press [SELECT]. The JOB LIST window appears. Select the desired job.

②STEP SECTION (Start Step → End Step)

Specifies the step section of the source job.
All the steps are set initially.
If there is no steps in the source job, "***" is displayed.
To change the section, perform the following procedure.
Move the cursor to the step section indication and press [SELECT]. The input buffer line appears. Input the step number and press [ENTER].

③DESTINATION JOB

Specifies the converted job.
If this is not specified("********" is displayed), the source job is specified.
If the converted job is specified, the source job is copied and converted.
To change the job, perform the following procedure.
Move the cursor to the converted job name indication and press [SELECT]. The character input line appears. The source job name is displayed in the input line. To enter job name without using the source job name, press [CANCEL] and then input a job name.

④COORDINATES

Selects the conversion coordinates.
Move the cursor to the coordinates name and press [SELECT].
The selection dialog box appears. Select the desired coordinates.
When the user coordinates are selected, the input buffer line appears.
Input the desired user coordinate number and press [ENTER].

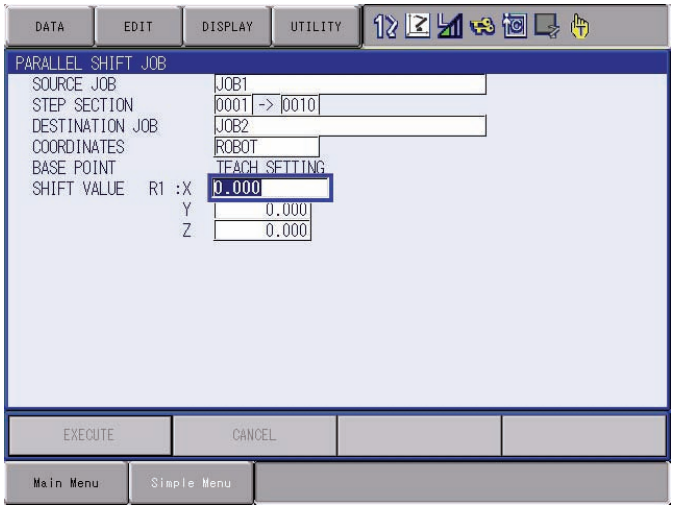
5.15.3.2 Setting the Shift Value

There are two methods for specifying the shift value.

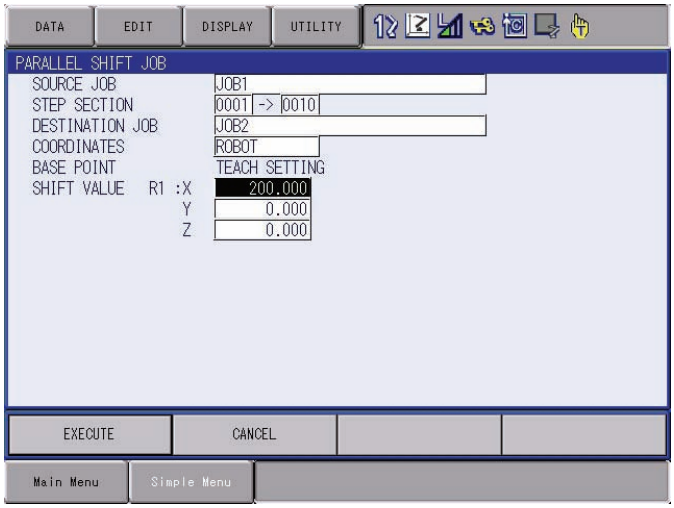
- Directly input the shift value by numerical value.
- Calculate the shift value by teaching the original base point and converted base point.

■ **Numerical Value Input**

1. Display the PARALLEL SHIFT JOB window.
   Select the shift value to be set.
   – The number can now be entered.

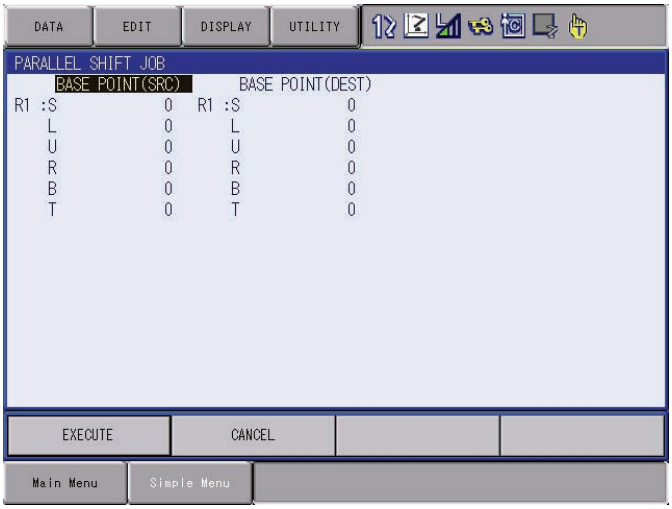


2. Type the shift value using the Numeric keys.
3. Press [ENTER].
   – The shift value is set.

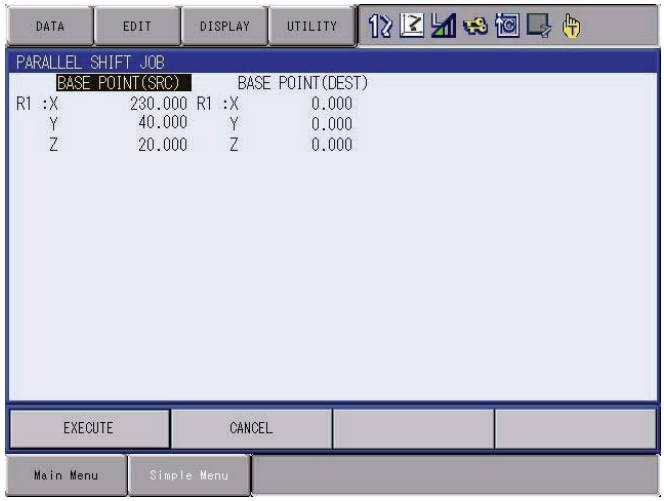


■ **Calculation by Teaching**

1. Display the PARALLEL SHIFT JOB window.
   Select “TEACH SETTING” in the item of “BASE POINT.”
   – The BASE POINT window appears.

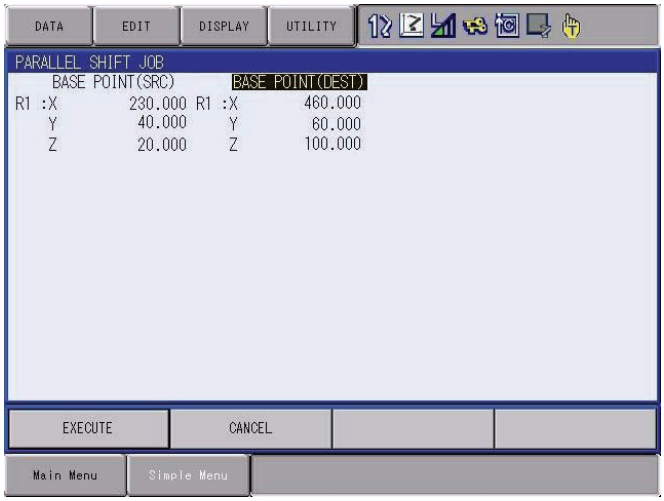


2. Select “BASE POINT(SRC).”
3. Move the manipulator to the original base point by the axis keys.
4. Press [MODIFY] and [ENTER].
   – The original base point is set.

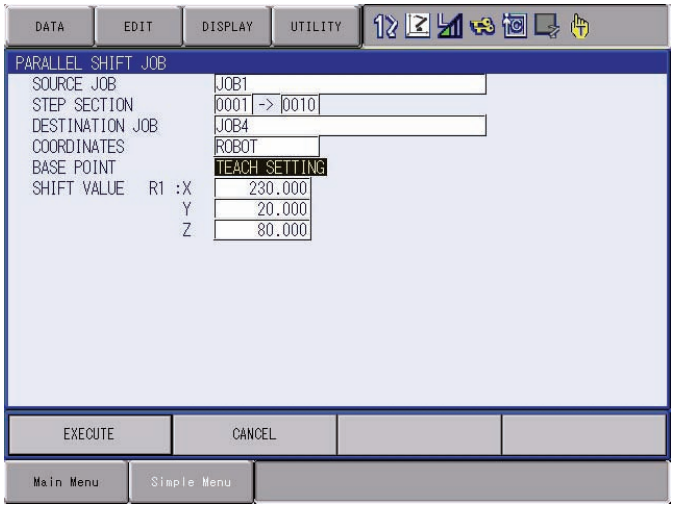


5. Select “BASE POINT(DEST).”
6. Move the manipulator to the converted base point by the axis keys.

7. Press [MODIFY] and [ENTER].
   – The conversion base point is set.



8. Select “EXECUTE.”
   – The difference is calculated by the two teaching points and set as a shift value.

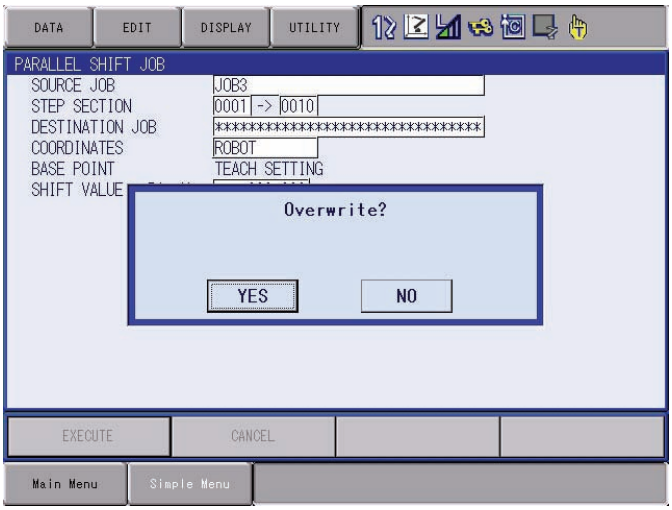


5.15.3.3 Executing Conversion

1. Display the PARALLEL SHIFT JOB window.
   Select “EXECUTE.”

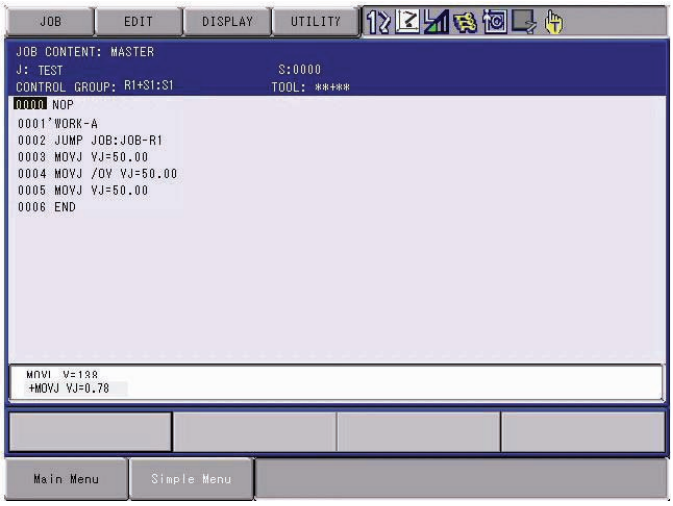
   – The confirmation dialog box appears when the converted job is not specified.
   Select “YES” then the conversion is executed.

   – The JOB CONTENT window appears when the conversion is completed.



SUPPLE-MENT

“/OV” is added to a step whose converted result is outside the movable range of the robot.
At this step, correct the teaching position.



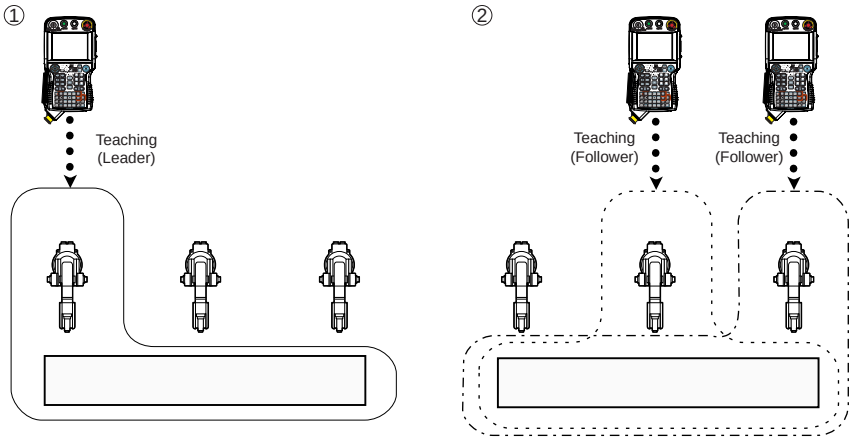
5.16 Method 2: Perform Teaching for Each Manipulator

5.16.1 Procedure

First, perform teaching a job for the combination of leader manipulator and station.

Next, perform teaching a job for the combination of follower manipulator and station.

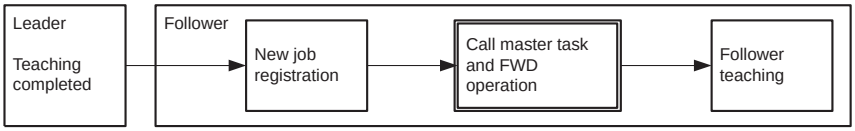
For this operation, perform teaching so that the follower manipulator follows the motion of station by FWD operation of the leader job.



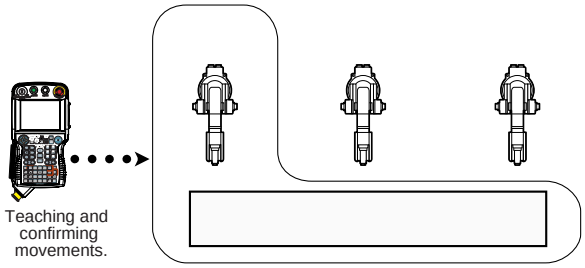
For Method 2, there are two ways of teaching depending on whether the master task is used or not.

5.16.2 Teaching using Master Task

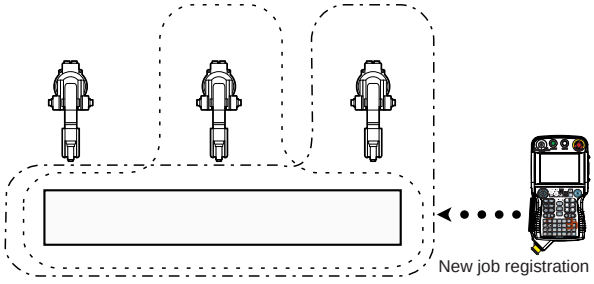
Using the master task can omit the operation to register a job name in the SUPERVISORY window.



1. Teach the coordinated job of leader subtask.
   – Teach all the steps of coordinated job for one manipulator + the station.

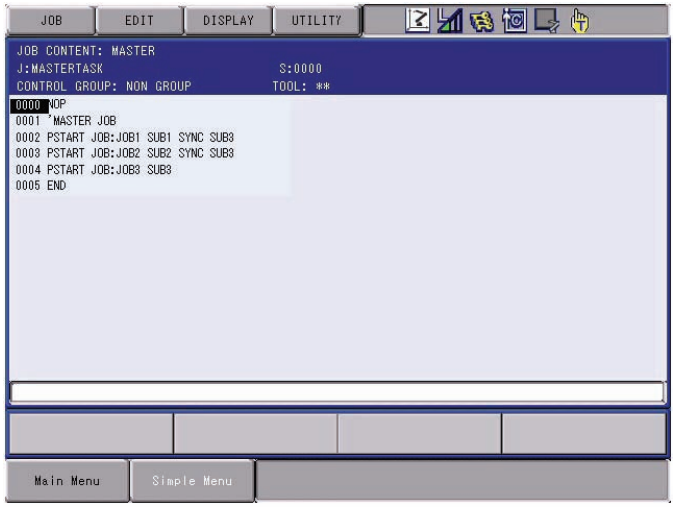


2. New job registration for the coordinated job of follower subtask.
   – Register as a new job the coordinated job for other respective manipulators + the station.
   – For new job registration, refer to *chapter 4.10 “Registering Job” at page 4-24*.



3. New job registration of master task.
   – Register the master task as concurrent job.
   – For concurent job, refer to *chapter 1.7.2 “Concurrent Job” at page 1-25*.

4. Register PSTART instruction.
   – Register a PSTART instruction to start the job that was registered at Operation 2.
   (1) To specify this subtask as the follower, add a tag SYNC and the leader subtask.
   (2) Then, register a PSTART instruction to start the job that was taught at Operation 1.



5. Set to “Single job operation mode.”
   – Set the operation mode at FWD operation to “Single job operation mode.”
   – Pressing [SHIFT] + [SMOV] changes the operation mode.
6. Move the cursor to the first PSTART instruction.
7. Press [INTERLOCK] + [FWD].
   – Starts the follower subtask.
8. Move the cursor to the second PSTART instruction.
9. Press [INTERLOCK] + [FWD].
   – Starts the leader subtask.
10. Press the page key to change to the leader subtask.
   – Each time the page key is pressed, the contents of the JOB CONTENT window change in order of master task, subtask 1, subtask 2, and subtask 3.
11. Move the cursor to the step 1.
12. Press [FWD].
13. Press the page key to change to the follower subtask.
   – Each time the page key is pressed, the contents of the JOB CONTENT window change in order of master task, subtask 1, subtask 2, and subtask 3.

14. Register the step 1 of the follower subtask.

– After the FWD operation of step 1 of leader, change to the follower and register the position of the follower manipulator relative to the station current position.

15. Register the step 2 and onward of the follower subtask.

(1) Change to the leader's JOB CONTENT window, and perform a FWD operation to the next step.

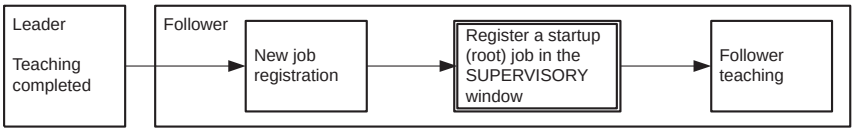
– To maintain the follower manipulator position relative to the station, press [SHIFT] + [SYNCRO/SINGLE] to set the job synchronized mode.

(2) Change to the follower's JOB CONTENT window, and register the follower manipulator position relative to the station current position.

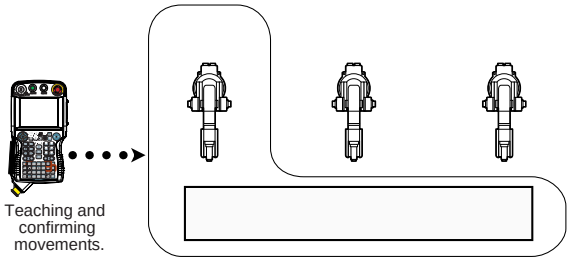
(3) Teach the follower job by repeating the above operations (1) and (2).

5.16.3 Teaching using SUPERVISORY Window

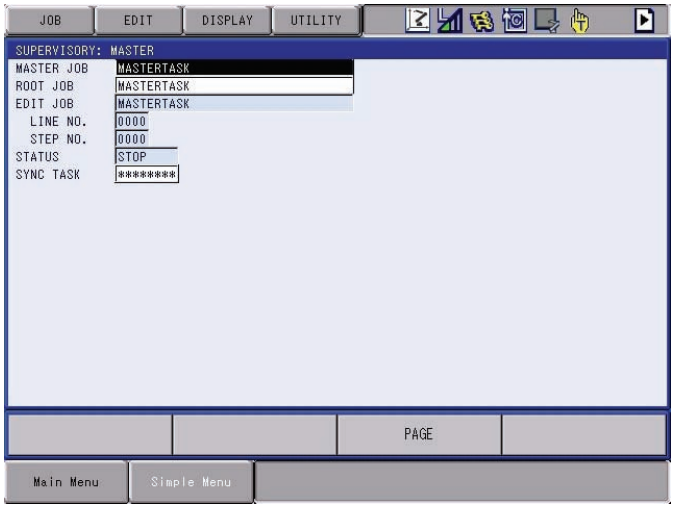
When teaching without master task, it is necessary to register the startup job (ROOT JOB) in the SUPERVISORY window.



1. Teach a coordinated job of leader subtask.
   – Teach all the steps of the coordinated job of one manipulator + the station.

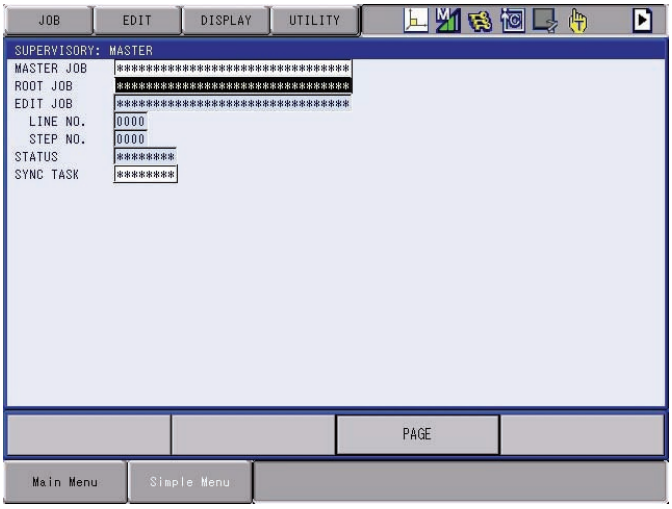


2. New job registration of a coordinated job of follower subtask.
   – Register as a new job the coordinated job of other respective manipulators + the station.
   – For new job registration, refer to *chapter 5.10 “Registering Job” at page 5-24*.
3. Select {JOB} under the main menu.
4. Select {CTRL MASTER}.
   – The SUPERVISORY window appears.

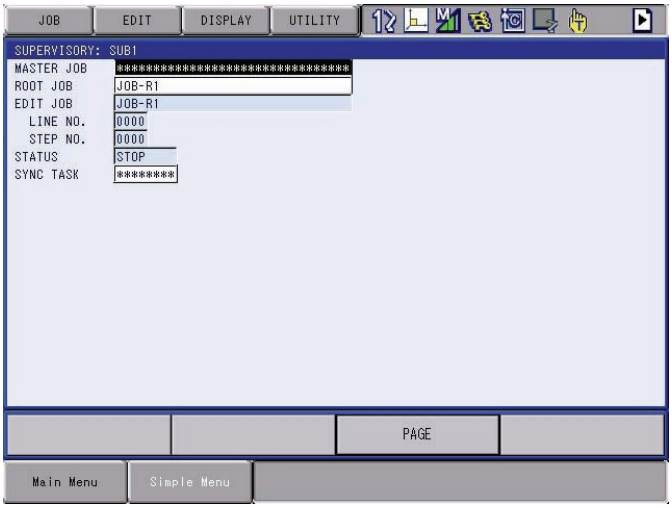


5. Select the root job of master task.

6. Select “CANCEL ROOT JOB.”
   – The root jobs of master task, subtask 1, subtask 2, and subtask 3 are cancelled.

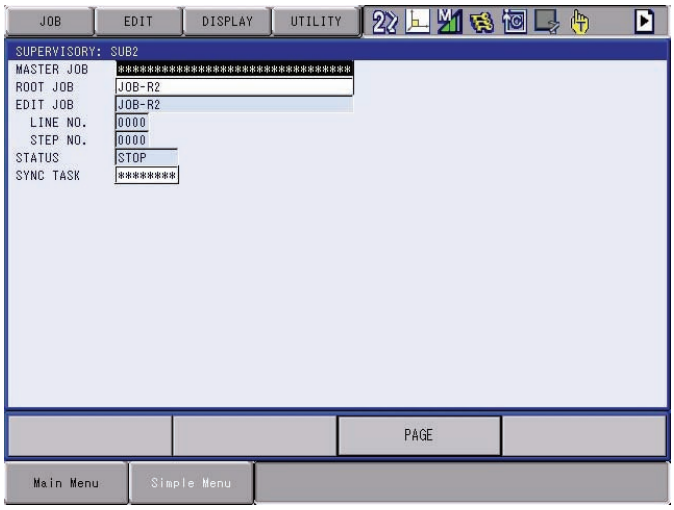


7. Select the root job of subtask 1.
8. Select “REGISTER ROOT JOB.”
   – The root job for subtask 1 is registered.

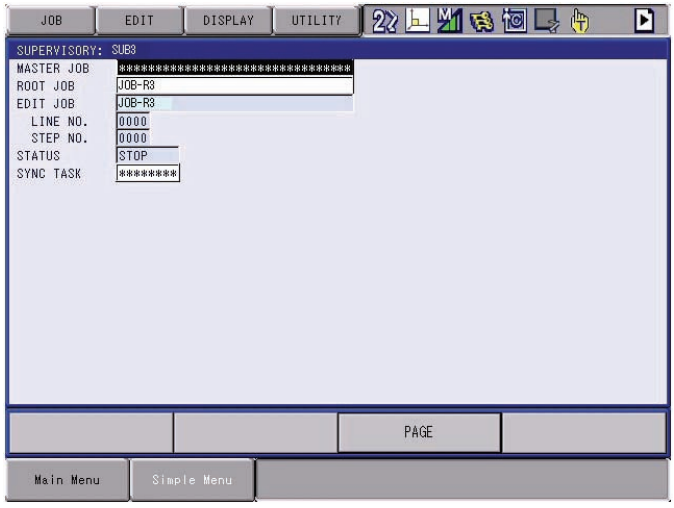


9. Select a job to be registered as root job.
10. Select the root job of subtask 2.

11. Select “REGISTER ROOT JOB.”
    – The root job for subtask 2 is registered.

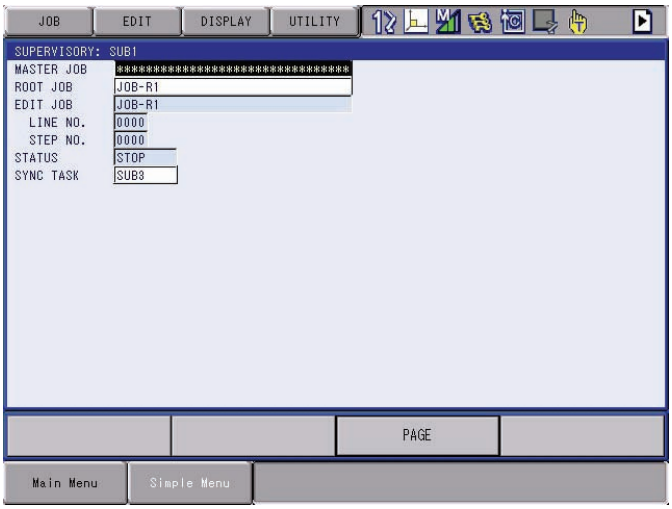


12. Select a job to be registered as root job.
13. Select the root job of subtask 3.
14. Select “REGISTER ROOT JOB.”
15. Select a job to be registered as root job.
    – The root job for subtask 3 is registered.



16. Select the synchronous task of subtask 1 (2).

17. Select “SUB3.”
    – Specify SUB3 of leader task to synchronize the synchronous task of subtask 1 (2).



18. Select “Single job operation mode.”
    – Set “Single job operation mode” for the operation mode at FWD operation.
    – Pressing [SHIFT] + [SMOV] changes the operation mode.
19. Select {JOB} under the main menu.
20. Select {JOB}.
21. Press the page key to change to the leader subtask.
    – Each time the page key is pressed, the contents of the JOB CONTENT window change in order of master task, subtask 1, subtask 2, and subtask 3.
22. Move the cursor to the step 1.
23. Press [FWD].
24. Press the page key to change to the follower subtask.
    – Each time the page key is pressed, the contents of the JOB CONTENT window change in order of master task, subtask 1, subtask 2, and subtask 3.
25. Register the step 1 of the follower subtask.
    – After the FWD operation of step 1 of leader, change to follower and register the position of the follower manipulator relative to the station current position.

26. Register the step 2 and onward of the follower subtask.

(1) Change to the leader's JOB CONTENT window and perform FWD operation to the next step.

– To maintain the follower manipulator position relative to the station, press [SHIFT] + [SYNCRO/SINGLE] to set the job synchronized mode.

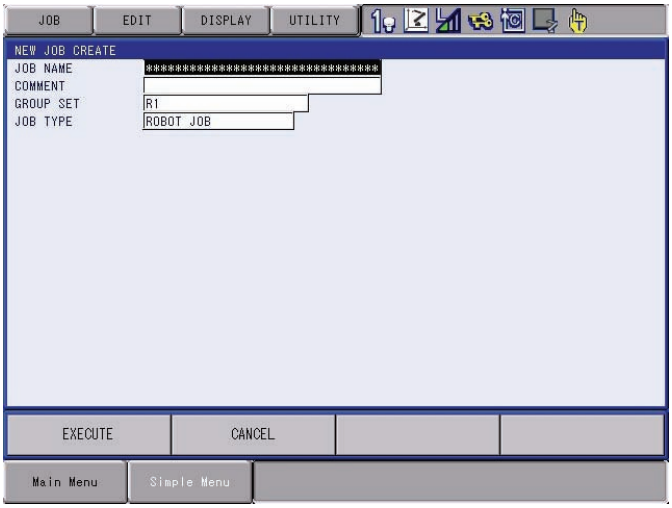
(2) Change to the follower's JOB CONTENT window, and register the follower manipulator position relative to the station current position.

(3) Teach the follower job by repeating the above operations (1) and (2).

5.17 Job in Master Task

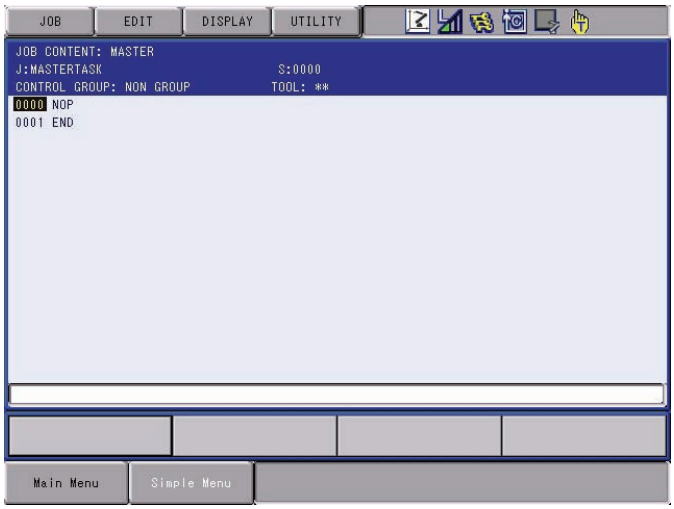
The job of master task is a concurrent job or a robot job without control groups.

1. Select {JOB} under the main menu.
2. Select {CREATE NEW JOB}.
   – The NEW JOB CREATE window appears.

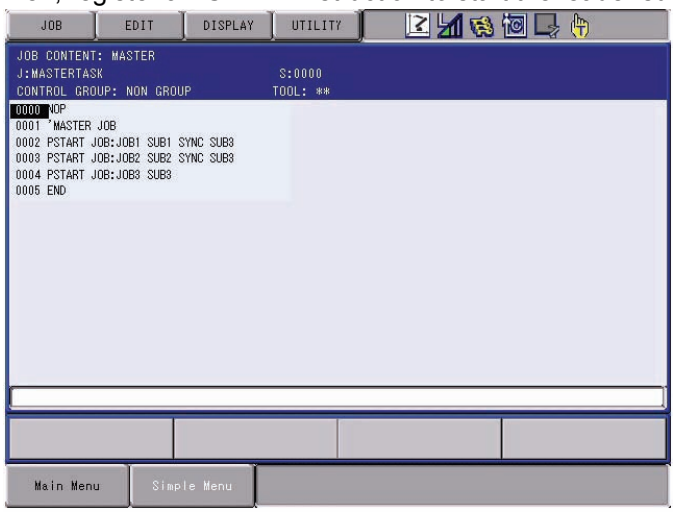


3. Enter a job name.
   – Move the cursor to JOB NAME and press [SELECT], and enter a job name by entering the characters.
4. Set “GROUP SET.”
   – Selecting “R1” of “GROUP SET” displays the selection dialog box. Select “NON GROUP.”
5. Set “CONCURRENT JOB.”
   – Select “ROBOT JOB” of “JOB TYPE.”
   – Each time [SELECT] is pressed, “ROBOT JOB” or “CONCURRENT JOB” is selected alternately.
6. Press [ENTER].

7. Select “EXECUTE.”
   – The job is registered in the memory of DX100, and the JOB CONTENT window appears.
   – NOP and END instructions are registered automatically.



8. Register a PSTART instruction.
   (1) Register PSTART instructions to start the subtask 1, 2, and 3.
   – Since the first PSTART instruction is for starting the follower subtask, add a tag SYNC and the leader subtask.
   (2) Then, register a PSTART instruction to start the leader subtask.



5.18 Confirming Operation

5.18.1 Procedure

NOTE

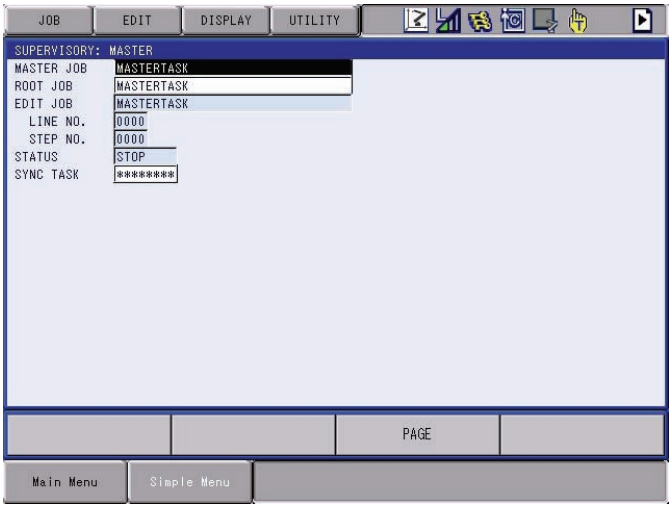
For confirming operation, set to “Multi-job operation mode.”

In the multi-job operation mode, the jobs in all the tasks operate. (The operation procedures are explained below.)

If the follower subtask is operated individually, only the follower manipulator moves but not the station. As the follower manipulator moves following to the station current position, an alarm may occur and the manipulator may interfere the station as a result.

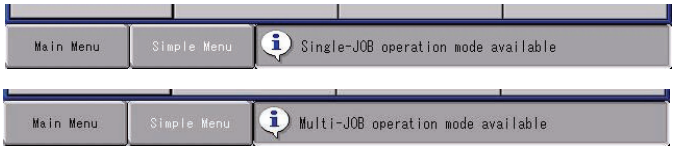
To verify the individual operation of the follower manipulator itself, call the job by job selection operation and confirm the individual operation of the job, but not in the triple synchronization.

1. Create a concurrent job.
   – For procedure, refer to *chapter 5.17 “Job in Master Task” at page 5-51*..
2. Select {JOB} under the main menu.
3. Select {CTRL MASTER}.
   – The SUPERVISORY window appears.
   – Each time the page key is pressed, the contents of the window changes. When the four columns show information for the master task, subtask 1, subtask 2, and subtask 3 press the page key and the information for subtasks 4 to 7 appears instead. Press the page key again, and the information for the master task, subtask 1, subtask 2, and subtask 3 reappears.



4. Move the cursor to the task where the master job is to be registered.
5. Press [SELECT].
6. Select “SETTING MASTER JOB.”
7. Select a job to be the master job.

8. Press [SHIFT] + [SYNCRO/SINGLE].
   – Set to “Multi-job operation mode.”
   – Each time [SHIFT] + [SYNCRO/SINGLE] are pressed, the operation mode changes between “Multi-job operation mode” and “Single job operation mode.”



9. Press [TEST START] or [FWD].
   – When a PSTART instruction is executed, the manipulator and the station move.

Parameter	Contents and Set Value	Initial Value
S4C286	Specifies the user output number to externally output the “Multi-job operation mode” status at teaching. 0: Not output 1 to 1024: User output number	0

5.18.2 Precautions for Confirming Operation

In the following operations, the steps of three manipulators will not coincide.

5.18.2.1 Stops during Operation

<Example>

- When the manipulator stops during operation, move the cursor position to another step of the job in one of the subtasks.
- Call the master job only by one of the subtasks.

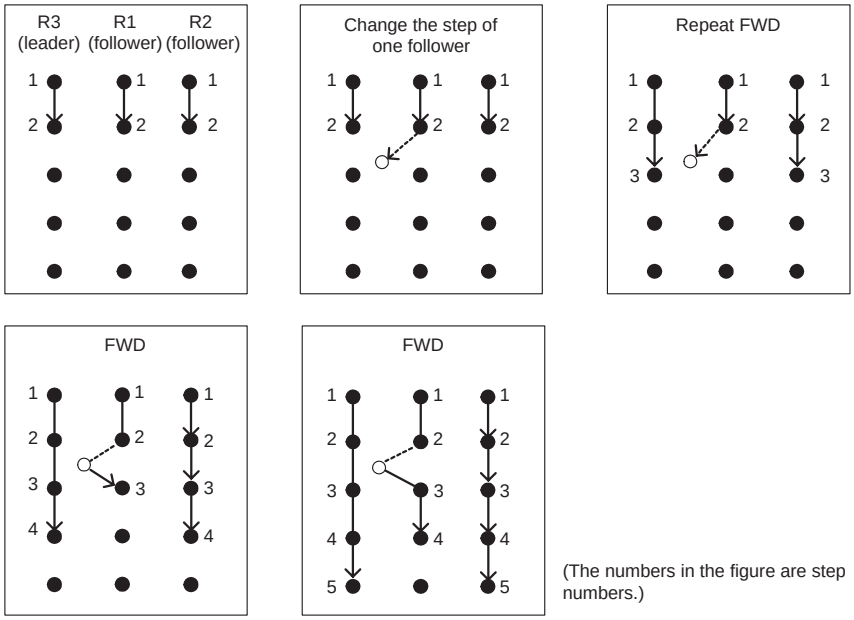
When restarting the operation in the states as explained above, an interference with jig, etc. may be caused.

Restart three subtask jobs from the same position (step).

5.18.2.2 When “Multi-job operation mode” is Set in the TEACHING CONDITION Window

<Example>

If the manipulator stops after operating to a certain step, and the step position of the follower R1 is changed and performs FWD operation again, the leader R3 and the follower R2 proceed to the next step but the R1 does not move.
As a result, the R3 and R2 go forward by one step.



(The numbers in the figure are step numbers.)

This is because, in the FWD operation after position change, the step after the change is usually re-executed.

In the above figure, at the FWD operation after the position change, the leader R3 and the follower R2, whose steps have not been changed, move to step 3.
However, since the position of the follower R1 is changed, the step after the change is executed again. As a result, operation is performed at the same position and does not proceed to the next step. In this way, the steps of the three manipulators do not correspond to each other.
To make the steps of the three manipulators correspond with each other in the FWD operation after the position change in the above case, move the cursor to the next step for the job where a change has been made, then perform the FWD operation, TEST run, and playback.

5.19 Playback

5.19.1 Start

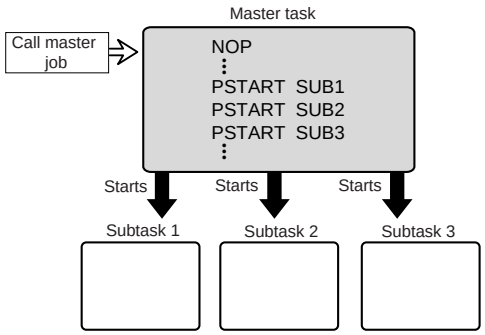
Call the master job in the following operation and perform a playback.

A job in the subtask is started by a PSTART instruction.

1. Select {JOB} under the main menu.
2. Select {CTRL MASTER}.
   – The SUPERVISORY window appears.
3. Move the cursor to MASTER JOB of MASTER.
4. Press [SELECT].
5. Select “CALL MASTER JOB.”
6. Press [START].
   – The called master job is executed from the beginning and the subtask is executed by a PSTART instruction.

NOTE

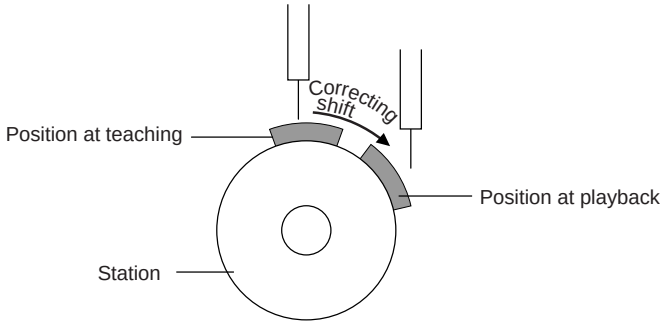
Performing the Operation 6 clears the job of subtask. Therefore, if the master task is called while the subtask is interrupted in the middle of its execution, the information relating to the state of subtasks that are halted is lost.



5.19.2 Automatic Correction of Shift Value

During playback operation, as the station is controlled by the leader job, the follower job controls only the follower manipulator.

If there is a shift between the teaching position of the leader job station and the station current position (controlled by the leader job), the follower manipulator moves correcting automatically the shift value in order to keep the position on the station at teaching.

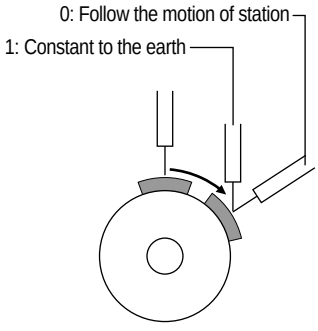


The shift between the teaching position and the station current position is always monitored.
If the shift value exceeds the set value of parameter, the following message is displayed.

Parameter	Contents and Set Value	Initial Value
S3C1101	Maximum shift angle of station axis in twin (triple) synchronous system	Differs depending on system (in units of 0.1°)

The control method of manipulator posture during correction is set by the following parameter.

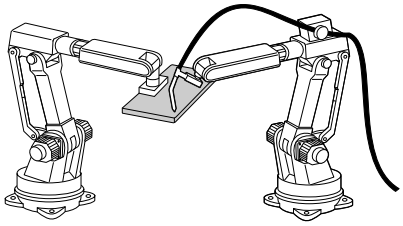
Parameter	Contents and Set Value	Initial Value
S2C420	Control method of follower manipulator posture in twin (triple) synchronous system 0: Follow the motion of station 1: Constant to the earth	0



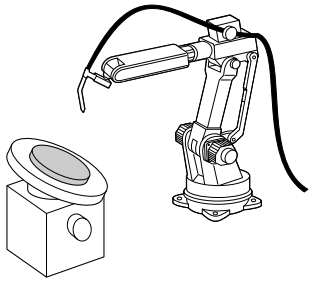
6 Coordinated Control

6.1 Outline

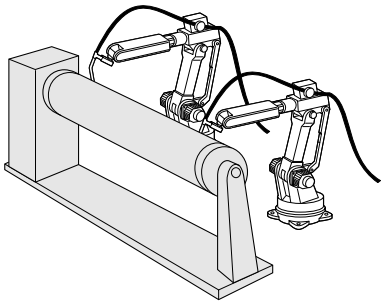
The coordinated control is the function of controlling multiple manipulators and stations at the same time.



Jigless system



Coordinated positioner system



Twin synchronous system

A job to implement the coordinated control is a coordinated job.

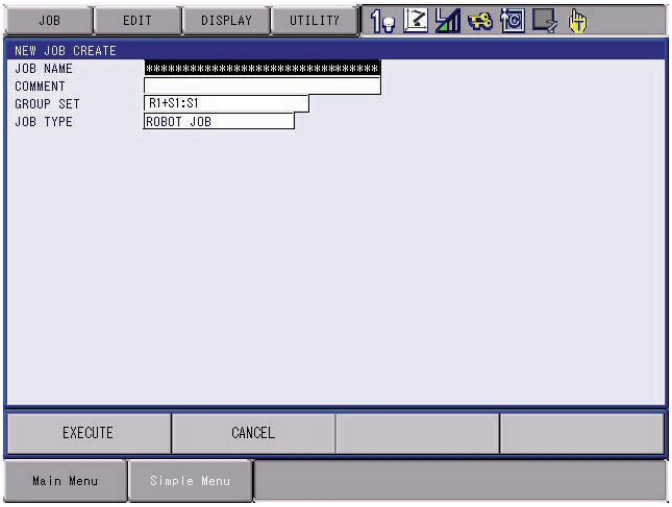
A coordinated job controls two group axes at the same time.

6.2 Group Combination

The group combination in a coordinated job is to specify two group axes to be coordinated.

The master-slave relationship must be assigned between two group axes.

When executing a coordinated instruction, the slave side executes relative interpolation on the tool coordinate system of the master side.
A group combination is set at the registration of new job name.



When a coordinated job is taught, as shown below, a move instruction is normally displayed in two lines: the first line is for slave side, and the second line marked with “+” is for master side.

Step	Instruction	
001	SMOVL	←Slave side
	+MOVL	←Master side
002	MOVL	←Slave side
	+MOVL	←Master side

6.3 Coordinated and Individual Interpolations

Two types of operation are available for a coordinated job.

6.3.1 Coordinated Interpolation

The coordinated interpolation is performed by two group axes in a master-slave relationship.

The slave executes a relative interpolation on the tool coordinate system of the master side.

This feature is used in works that require coordinating to the movement of workpiece.

6.3.2 Individual Interpolation

The individual interpolation is performed with the master-slave relationship cancelled.

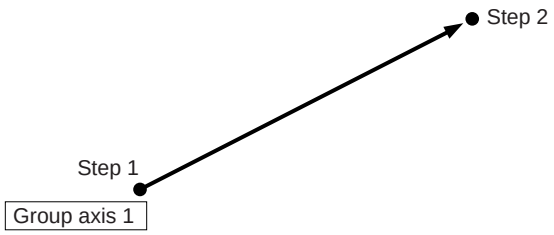
The master side and the slave side both perform their own individual movements, but the starts and the ends of the movements taught to each are the same.

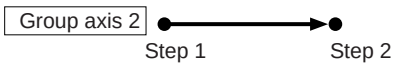
This operation is used when, after the master side and the slave side completed a job of the coordinated operation, each side is to perform its own job.

<Example>

Example of play speed slowed down with individual interpolation

If an identical speed is given to two group axes, in order that they might finish works as far as the step 2 simultaneously, the group axis 2 is given movement slower than V=276.





6.3.3 Changing Interpolation Mode

Each time [SMOV] is pressed, the instruction in the input buffer line changes between coordinated interpolation and individual interpolation.

6.4 Restriction

Only MOVJ instruction can be used as move instructions for the station.

7 Independent Control

7.1 Independent Control

The DX100 is configured to be able to decode and execute four jobs (with option, maximum eight jobs) each independently.

A multitask control performed by this mechanism is called “independent control.”

Four mechanisms which execute jobs are called as follows:

- Master task
- Subtask 1
- Subtask 2
- Subtask 3

The subtask1, subtask 2, and subtask3 are the tasks to execute jobs that are started by the master task.

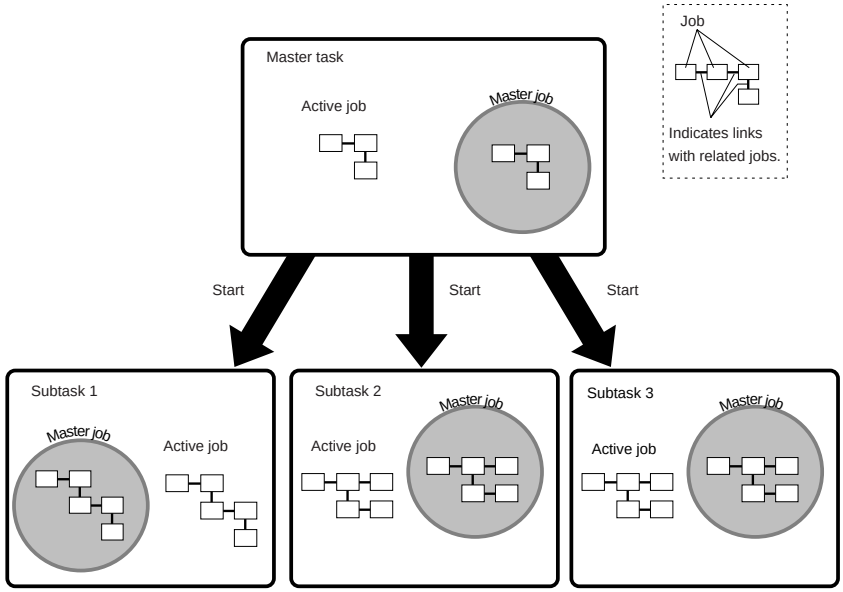
A job which is able to use move instructions is called a robot job. A job which does not use a move instruction is called a concurrent job.

Robot job	A job which moves robot axes or station axes with move instructions.
Concurrent job	This is used as a job to start robot jobs, or as specialized job to control calculations and I/O.

The jobs of subtask 1, subtask 2, and subtask 3 (hereinafter, referred to as “subtask1/2/3”) are started by the PSTART instruction.

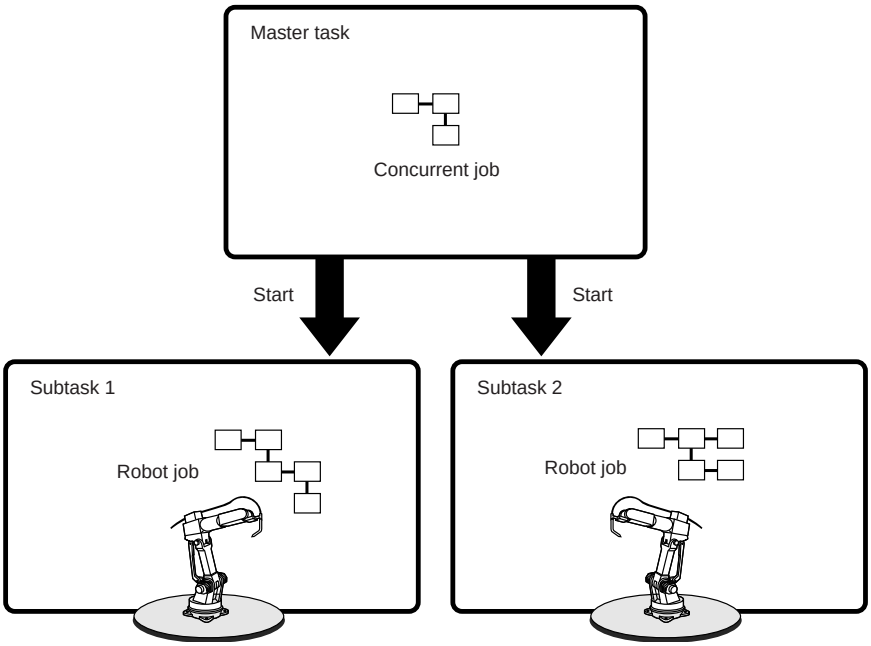
To start a job always fixed, it is convenient to use the master job.

Since a robot job without control groups can start another robot job, it can be used as a master task job.



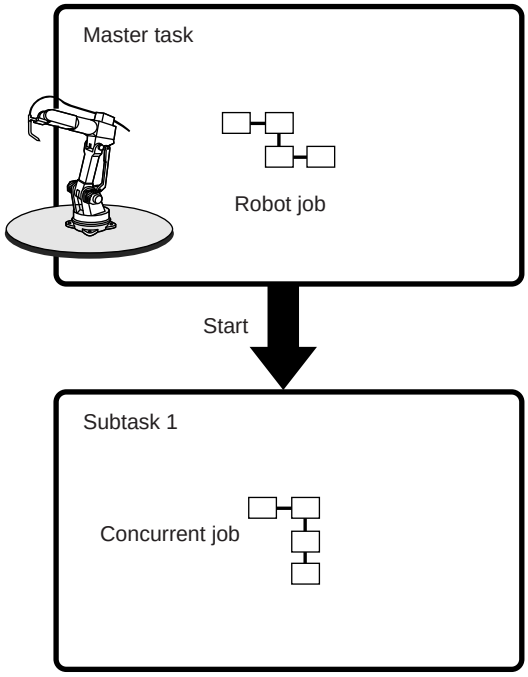
<Example>

When executing two robot jobs, make the master task a concurrent job.



<Example>

When implementing control of calculations or I/O, make the subtask 1 a concurrent job.?



7.2 Startup Method

7.2.1 Starting a Job always Fixed (Master Job)

To execute a job always fixed in each task, it is convenient to use a master job.

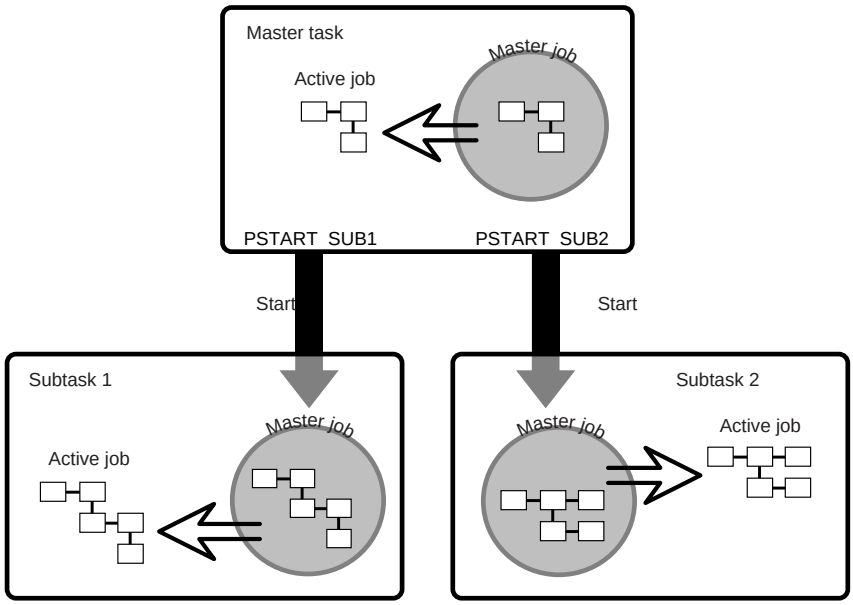
One master job (a series of jobs including related jobs) can be registered for each task.

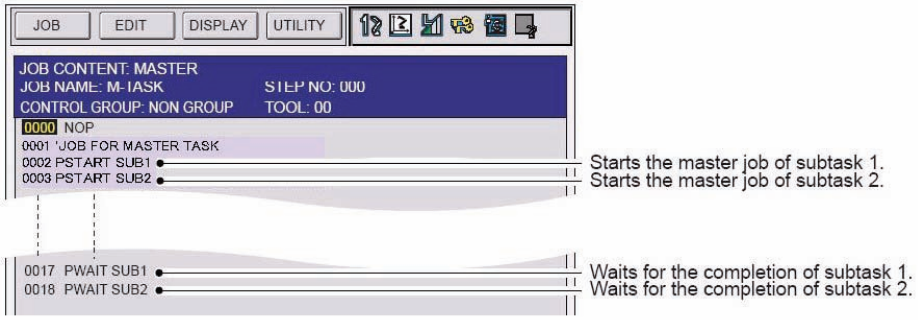
Always register a master job for master tasks.

If there is no master job registered, it cannot function as a master task.

For subtasks, if a master job is registered, the job name which starts with a PSTART instruction can be omitted.

PSTART SUB1 ···The master job of subtask 1 starts automatically.
PSTART SUB2 ···The master job of subtask 2 starts automatically.





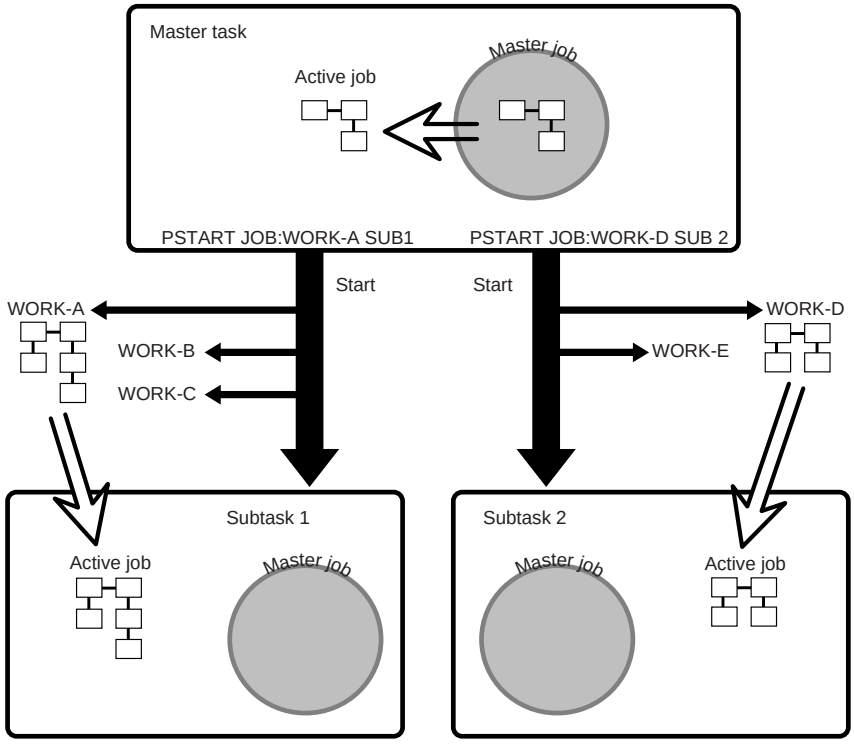
Even if a master job is registered, another unrelated job can be started.

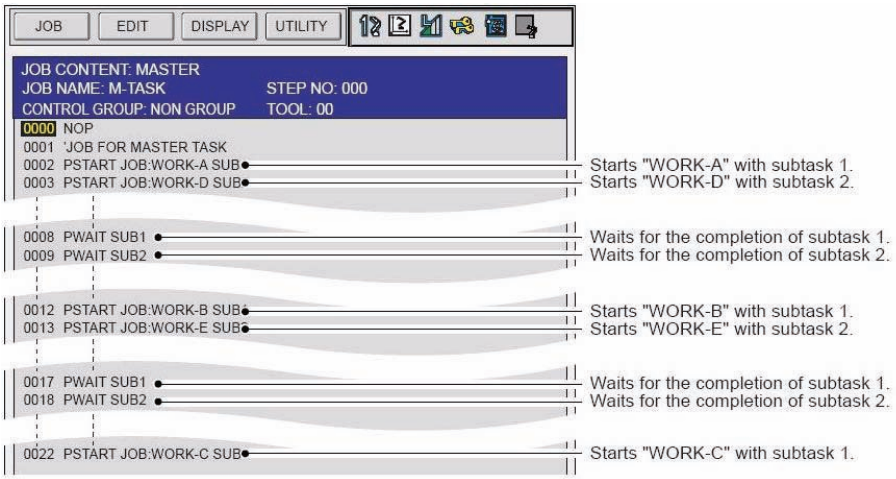
Refer to *chapter 7.2.2 “Starting Various Jobs” at page 7-6*.

7.2.2 Starting Various Jobs

When a job executed in each task is not fixed, set each job name to be started with a PSTART instruction.

PSTART JOB: job name SUB □…A specified job is started in a specified task.





If the PSTART command is not executed correctly, alarm 4103 will be emitted.

When an alarm is emitted, check the sub-code, and correct the job.

<Example>

PSTART JOB : R1S1 SUB1
PSTART JOB : R2 SUB1
… AL-4103: [1] Sub task being executed:
During execution of SUB1, an attempt is being made to start a different job in the same SUB1.

PSTART JOB : R1S1 SUB1 (R1S1: A job for the robot 1 and the station 1)
PSTART JOB : R2S1 SUB2 (R2S1: A job for the robot 2 and the station 1)
… AL-4103 [2] Group axis being used:
An attempt is being made to execute a job containing station 1 in SUB2, despite the fact that station 1 is being used by SUB1.

Alarm Number	Alarm Name	Sub Code	Meanings
4103	PARALLEL START INSTRUCTION ERROR	1	Sub task being executed: Although a job is being executed by instructed sub task, an attempt was made to execute another job by the sub task.
		2	Group axis being used: The job operated by another sub task uses the same group axis.
		3	Multiple start of same job: timing for start command again. The job that was tried to be started was executed by another sub task.
		4	Unregistered master job: Although the master job was not registered, an attempt was made to execute PSTART SUB (job name omitted).
		5	Synchronization instruction error: When restarted by PSTART, synchronization instruction status of the sub task under interruption was different from the status to restart.
		6	Stopped by an alarm: An attempt was made to start the sub task which is stopped by an alarm.
		7	Synchronization task specification of SYNC instruction omit error
		8	The task is specified by synchronization task of SYNC instruction.
		9	I/O jog being executed
		10	Separate group axis being used
		11	The servo power supply is OFF.
		12	Twin synchronous task ID error
		16	PSTART instruction is the old specification.
		17	PWAIT instruction is the old specification.

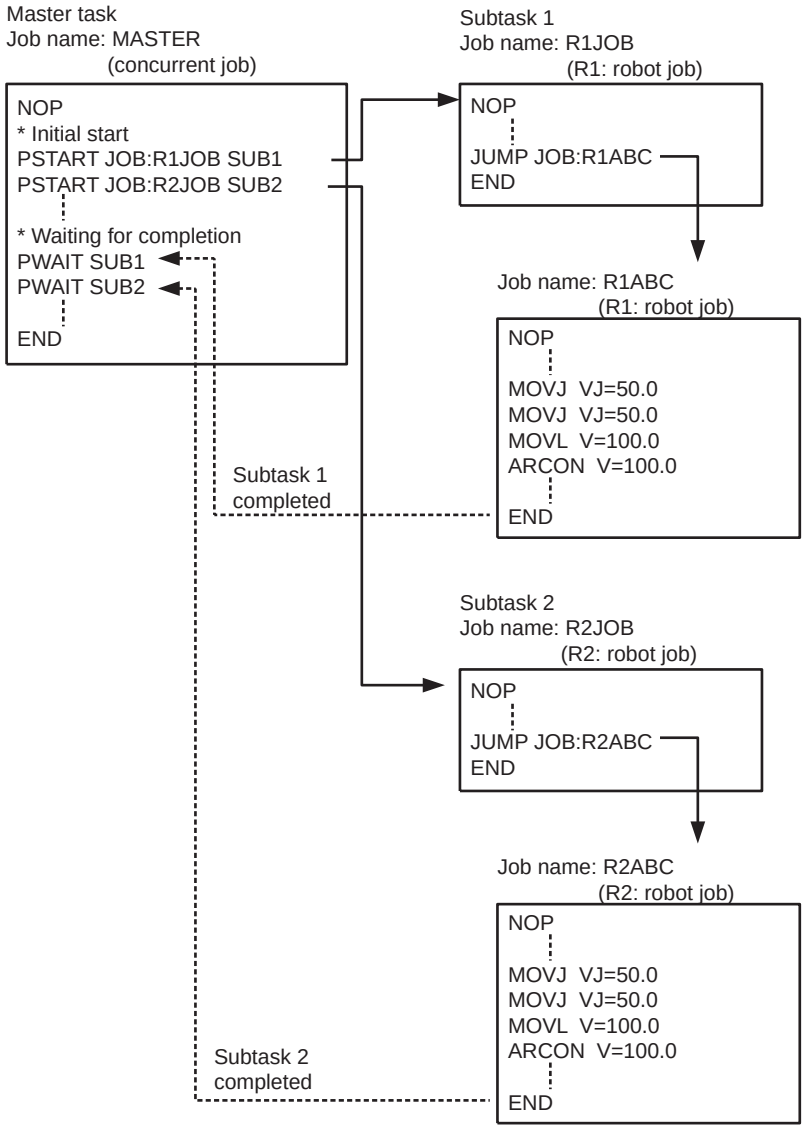
7.3 Job Examples

7.3.1 Non-Synchronous Operation

The example below is a job configuration for the manipulators 1 and 2 to perform entirely separate operations in non-synchronous mode.

Set a concurrent job as the master task, and start the R1 job in subtask 1, and the R2 job in subtask 2 from the master task.

Whether each subtask has completed or not can be confirmed in the master task.



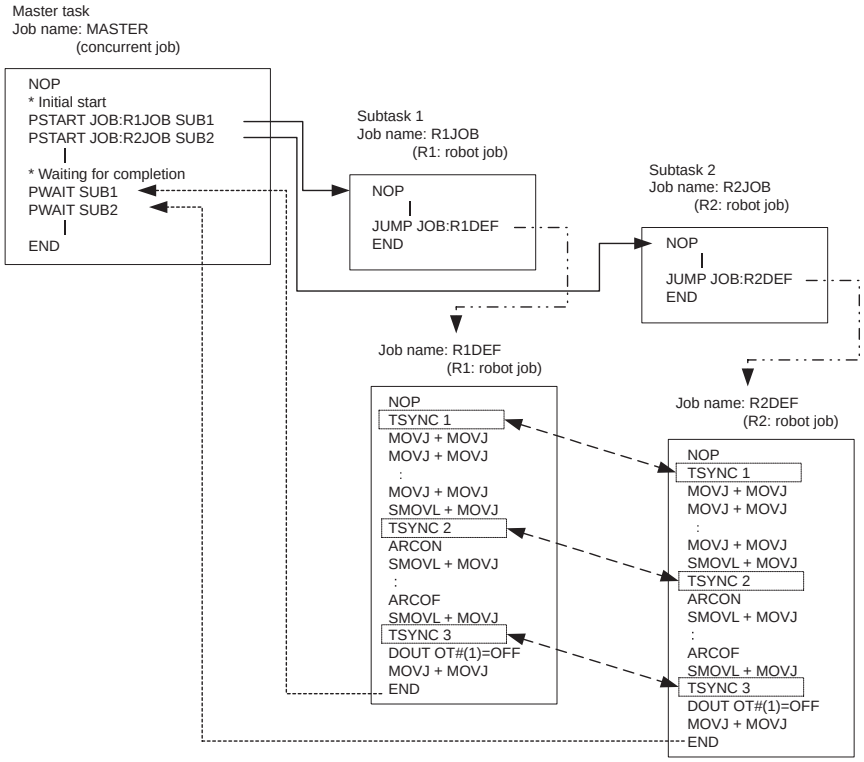
7.3.2 Synchronous Operation

The example below is a job configuration for the manipulators 1 and 2 to achieve detailed synchronization mode.

This is used when an interference area exists between manipulators.

Set a concurrent job as the master task, and start the R1 job in subtask 1, and the R2 job in subtask 2.

The synchronization of each subtask is executed by TSYNC instruction.



7.4 Switching Task Window

To call the JOB CONTENT window of the master task and subtask 1/2/3, take the following procedure.

1. Select {JOB} under the main menu.
2. Select {JOB}
3. Press the page key.
   - Each time the page key is pressed, the contents of the JOB CONTENT window change in order of Master task, Subtask 1, Subtask 2, and Subtask 3.
   - The JOB CONTENT window of the task where no job is registered, is not shown.

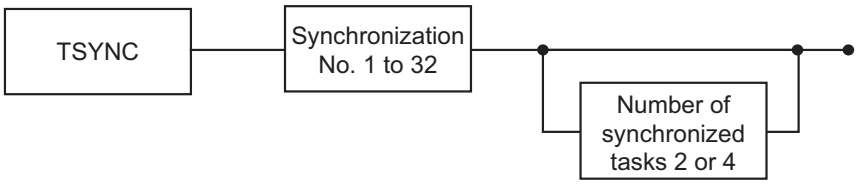
7.5 Synchronizing with TSYNC

During the execution of the jobs, a deviation between the movements of the two manipulators may occur. In the steps where the movements of the two manipulators should be exactly the same, execute a TSYNC instruction immediately before these steps.

When a TSYNC instruction is executed in one of the robot jobs, the manipulator waits until the same synchronized signal, TSYNC, is executed in the other robot job.

Set the number of synchronized tasks. When setting “SYNCHRO NUM” to “UNUSED,” the number of tasks is the same as when “SNUM=2.”

■ **Format**

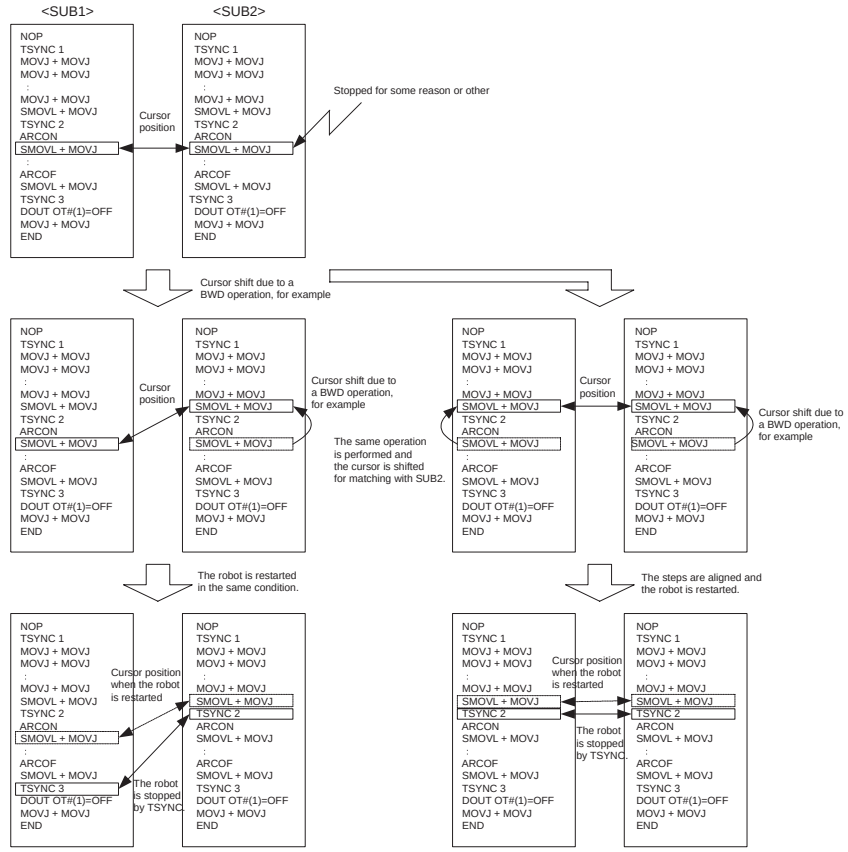


7.5.1 TItems to note when using a TSYNC command

Note that even when TSYNC is being used, the steps of two manipulators will fail to match each other if the following operations are performed.

7.5.1.1 When a cursor shift occurs during operation

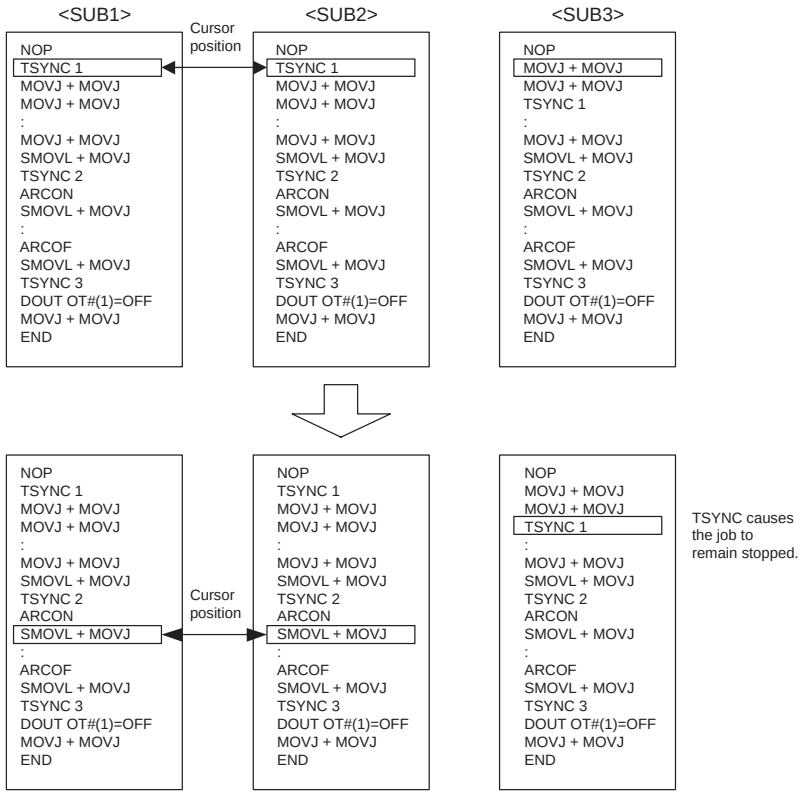
If the cursor position is shifted to a different step during the execution of a job of one of the two sub-tasks when the robot stops during operation, and the robot is restarted while remaining in this condition, the steps will become misaligned, resulting in the risk of interference from the jig, for example.
Start both jobs from the same position (step).



If the set number of synchronizations is less than the number of tasks to be synchronized, the robot will be commanded as soon as the TSYNC commands corresponding to the set number of synchronizations are output, and the jobs that cannot be synchronized will remain stopped.

7.5.1.2 If three jobs were set when the number of TSYNC synchronizations was set to “Unused”

The two jobs that become synchronized first continue to move, and the third job remains stopped.



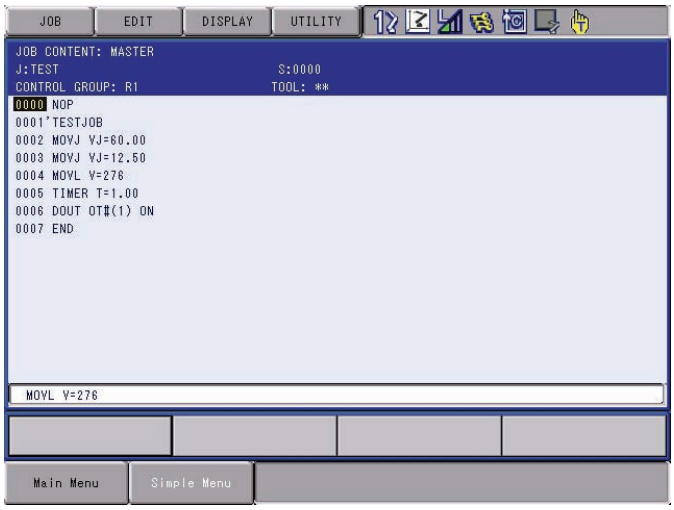
The two jobs that become synchronized first continue to move.

The job cannot be synchronized, and remains stopped.

7.6 Registering Instructions

Register an instruction when the cursor is in the address area in the JOB CONTENT window in teach mode.

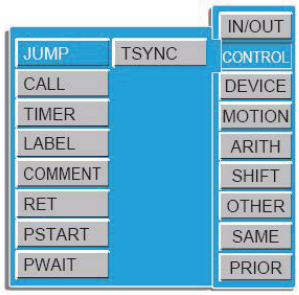
1. Select {JOB} under the main menu.
2. Select {JOB}
3. Move the cursor to the address area.



7.6.1 PSTART Instruction

1. Move the cursor to the line just above the place where PSTART instruction is to be registered.

1. Press [INFORM LIST].
   – The instruction list appears.



2. Select “PSTART.”
   – A PSTART instruction is displayed in the input buffer line.

3. Change additional items.

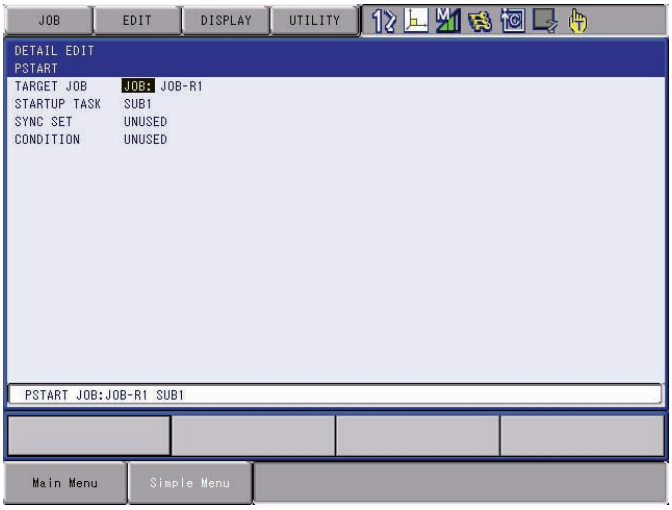
– <To register items as displayed in the input buffer line>
Proceed to Operation 5.

– <To edit additional items>

(1) When the job name is to be changed, move the cursor to the job name, then press [SELECT].

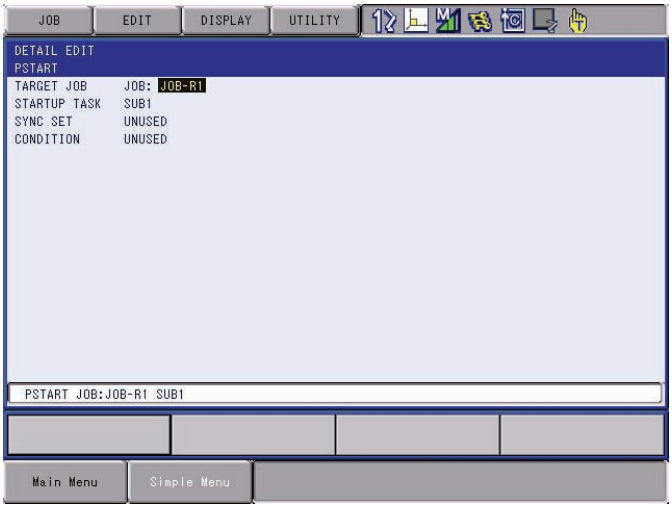
– The window for job name selection appears. Select a job to be changed.

(2) To edit additional items, move the cursor to the instruction in the input buffer line, then press [SELECT]. The DETAIL EDIT window appears.



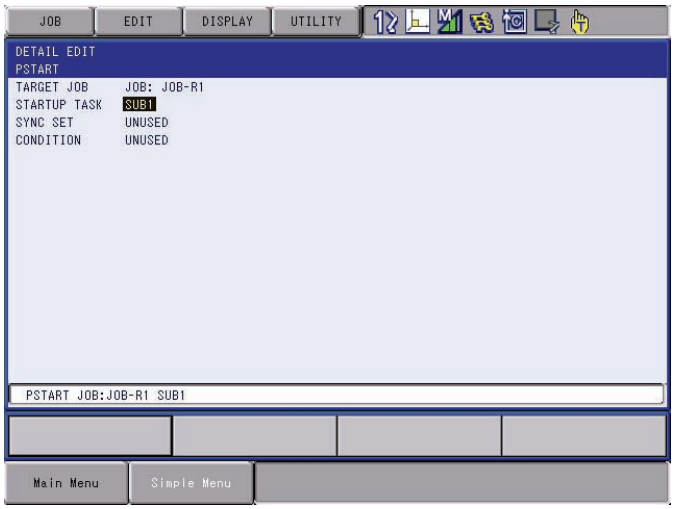
(3) To change the target task, move the cursor to “JOB:,” then press [SELECT].

– The selection dialog box appears. Select a target job to be changed with.



(4) To change the startup task, select “SUB1” of “STARTUP TASK.”

– The selection dialog box appears. Select the startup task to be changed with.



(5) After changed or added the additional items, press [ENTER].

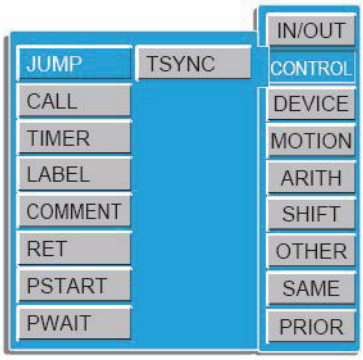
(6) The DETAIL EDIT window is closed and the JOB CONTENT window appears.

4. Press [INSERT] and [ENTER].

– The instruction displayed in the input buffer line is registered.

7.6.2 PWAIT Instruction

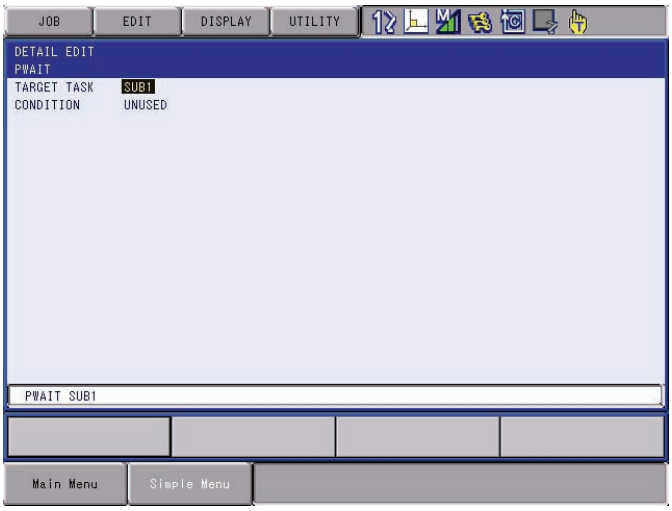
1. Move the cursor to the line just above the place where PWAIT instruction is to be registered.
2. Press [INFORM LIST].
   – The instruction list appears.



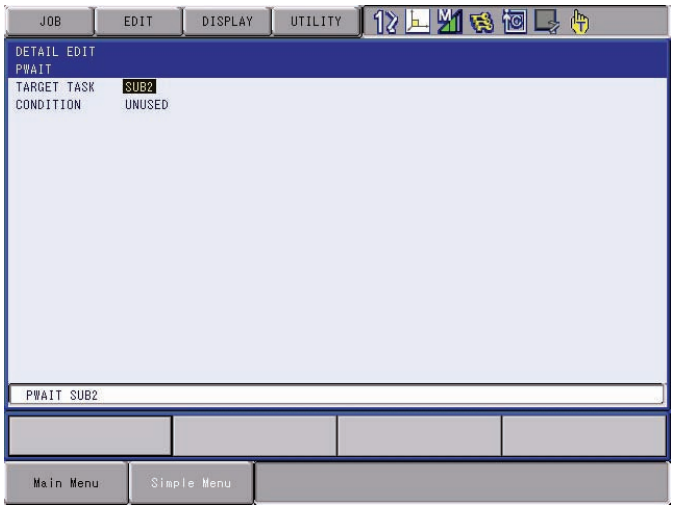
3. Select “PWAIT.”
   – A PWAIT instruction is displayed in the input buffer line.

4. Change additional items.
   – <To register items as displayed in the input buffer line>
   Proceed to Operation 5.
   – <To edit additional items>

   (1) To edit additional items, move the cursor to the instruction in the input buffer line, then press [SELECT]. The DETAIL EDIT window appears.



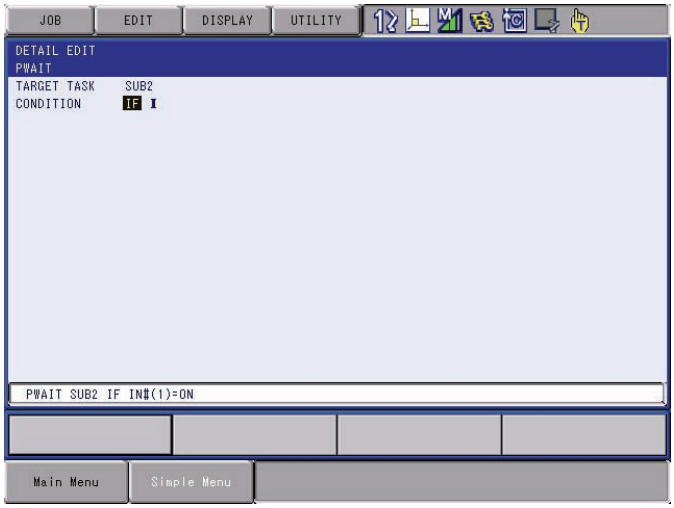
   (2) To change the target task, select “SUB1” of “TARGET TASK.”
   – The selection dialog box appears. Select a target task to be changed with.



(3) To add a condition, select “UNUSED” of “CONDITION.”

(4) The selection dialog box appears. Select “IF.”

– “IF” is shown in the DETAIL EDIT window.



(5) Press [ENTER] to add “IF.”

(6) After changed or added the additional items, press [ENTER].

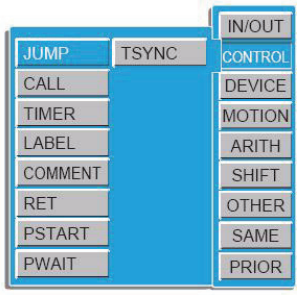
(7) The DETAIL EDIT window is closed, and the JOB CONTENT window appears.

5. Press [INSERT] and [ENTER].

– The instruction displayed in the input buffer line is registered.

7.6.3 TSYNC Instruction

1. Move the cursor to the line just above the place where TSYNC instruction is to be registered.
2. Press [INFORM LIST].
   – The instruction list appears.



3. Select “TSYNC.”
   – A TSYNC instruction is displayed in the input buffer line.

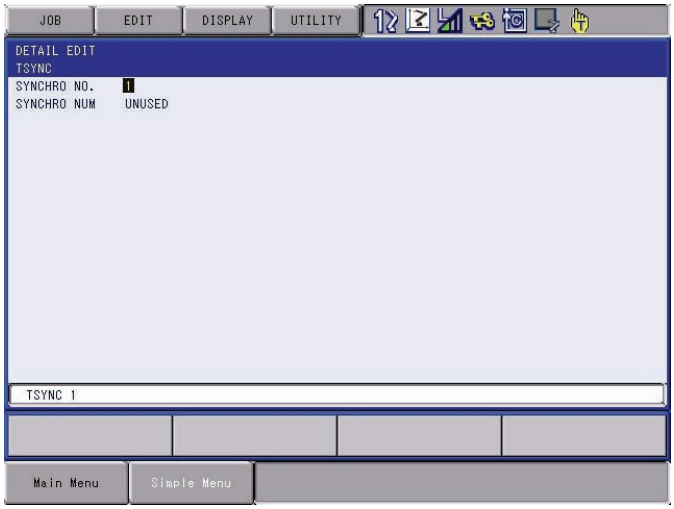
4. Change the numerical data.
   – <To register items as displayed in the input buffer line>
   Proceed to Operation 5.
   – <To change the numerical data>
   (1) Move the cursor to the numerical data.
   (2) Press [SHIFT] and the cursor key simultaneously to increment or decrement the number.

   – To enter a number by pressing the Numeric keys, press [SELECT] to display the input buffer line.

   (3) Enter a number, then press [ENTER]. The number displayed in the input buffer line is changed.
   (4) After changed the numerical data, press [ENTER].
   – The DETAIL EDIT window is closed, and the JOB CONTENT window appears.

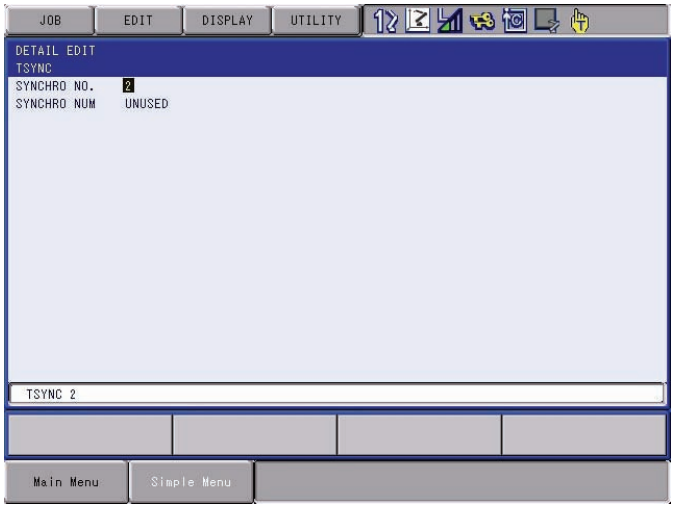
<To edit additional items>

(1) Enter a number, then press [ENTER]. The number displayed in the input buffer line is changed.To edit additional items, move the cursor to the instruction in the input buffer line, then press [SELECT]. The DETAIL EDIT window appears.



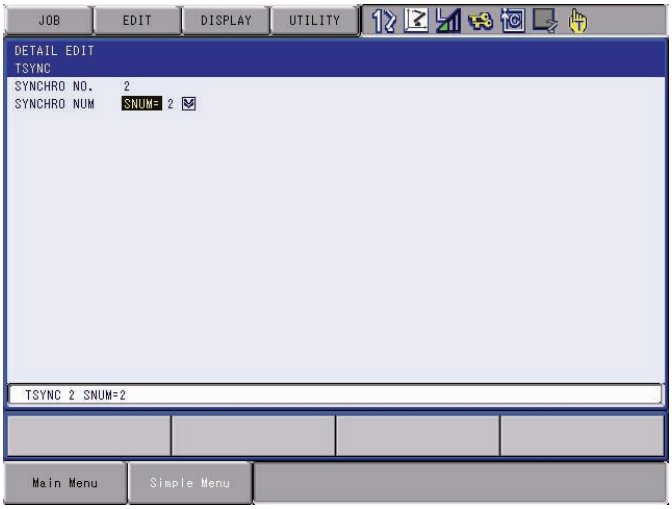
(2) To change the synchronization number, select “1” of “SYNCHRO NO.”

– When the number input status enters, enter the synchronization number, “SYNCHRO NO.” by pressing the Numeric keys, and press [ENTER].



(3) To add the number of synchronized tasks, select “UNUSED” of “SYNCHRO NUM.”

– f synchronized tasks, select “UNUSED” of “SYNCHRO NUM.” The selection dialog box appears. Select “SNUM=.”



(4) After changed or added the additional items, press [ENTER].

(5) The DETAIL EDIT window is closed, and the JOB CONTENT window appears.

5. Press [INSERT] and [ENTER].

– The instruction displayed in the input buffer line is registered.

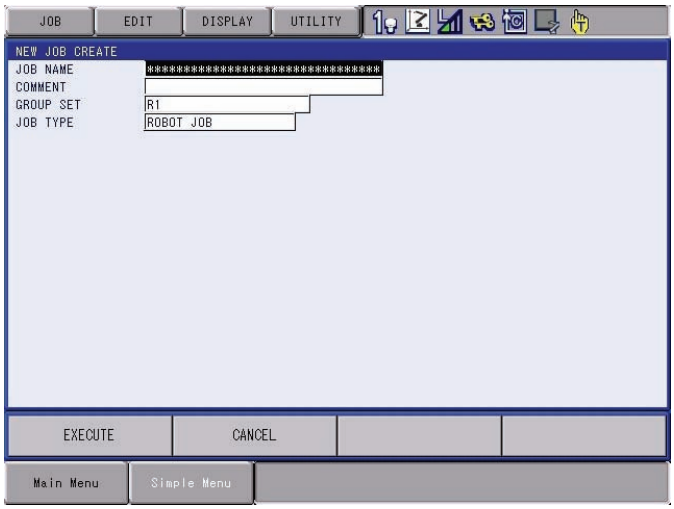
7.7 Registering Job

7.7.1 Robot Job

Register a job in the subtasks.

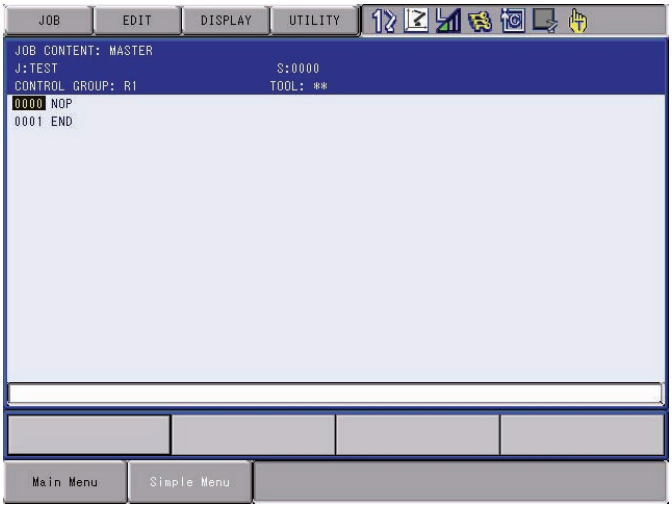
The robot jobs in subtasks are registered task by task.

1. Select {JOB} under the main menu.
2. Select {CREATE NEW JOB}.
   – The NEW JOB CREATE window appears.



3. Enter a job name.
   – Move the cursor to the job name, then press [SELECT]. Enter a job name by character input operation.
4. Set “GROUP SET.”
   – Select “R1” of “GROUP SET.” The selection dialog box appears. Select a group combination or “NON GROUP.”
5. Set “ROBOT JOB.”
   – Set “ROBOT JOB” for “JOB TYPE.”
6. Press [ENTER].
7. Select “EXECUTE.”
   – The job name is registered in the memory of DX100, then the JOB CONTENT window appears.

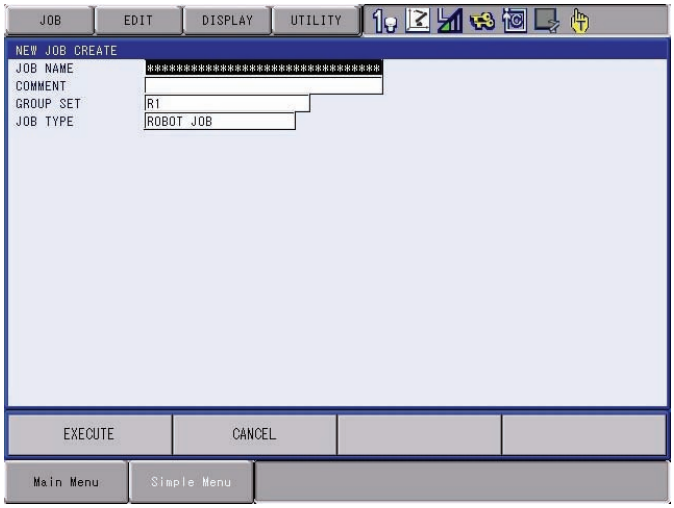
– NOP and END instructions are automatically registered.



7.7.2 Concurrent Job

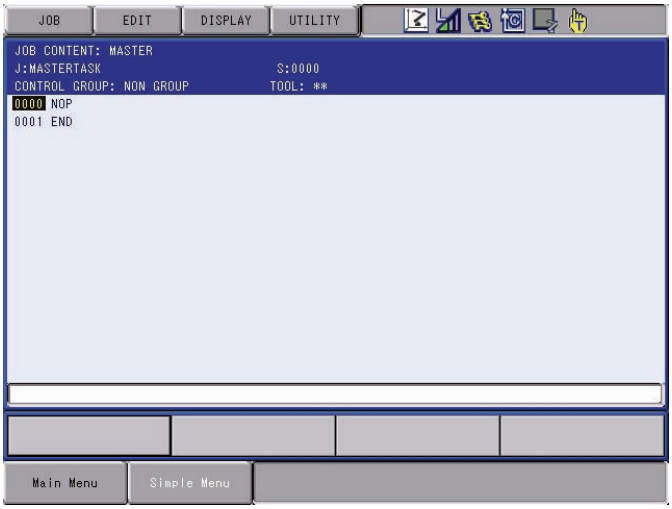
Register a job in the master task.

1. Select {JOB} under the main menu.
2. Select {CREATE NEW JOB}.
   – The NEW JOB CREATE window appears.



3. Enter a job name.
   – Move the cursor to the job name, then press [SELECT]. Enter a job name by character input operation.
4. Set “GROUP SET.”
   – Select “R1” of “GROUP SET.” The selection dialog box appears. Select “NON GROUP.”
5. Set “CONCURRENT JOB.”
   – Move the cursor to “ROBOT JOB” of “JOB TYPE,” then press [SELECT]. Each time [SELECT] is pressed, “ROBOT JOB” and “CONCURRENT JOB” is shown alternately.
6. Press [ENTER].

7. Select “EXECUTE.”
   – The job name is registered in the memory of DX100, and the JOB CONTENT window appears.
   – NOP and END instructions are automatically registered



7.8 Confirming Operation

7.8.1 FWD/BWD Operation and Test Run

7.8.1.1 Confirming the Operation of the Task being Displayed

When confirming operation in FWD/BWD operation or a test run, usually only the job of the task currently being displayed is targeted.

Operation can be confirmed with [FWD], [BWD], and [TEST START].

7.8.1.2 Confirming the Operation of All Tasks

To operate all tasks at the same time, perform the following operations 1 to 4.

1. Set the operation mode at independent control to “Multi-job operation mode.”
2. Register a concurrent job as the master job.
3. Perform FWD operation on the concurrent job, and execute PSTART instruction.
4. Continue performing FWD operation so that all the tasks simultaneously perfome FWD operation.

NOTE

Sometimes operation is performed at a different speed from the playback speed.

Exercise full caution to any interference between manipulators.

7.8.2 Switching Operating Method

There are two operating methods during FWD/BWD operation and a test run:

- Operate only the task currently being displayed …“Single job operation mode”
- Operate all tasks …“Multi-job operation mode”

These two operating methods can be switched on the TEACHING CONDITION window.

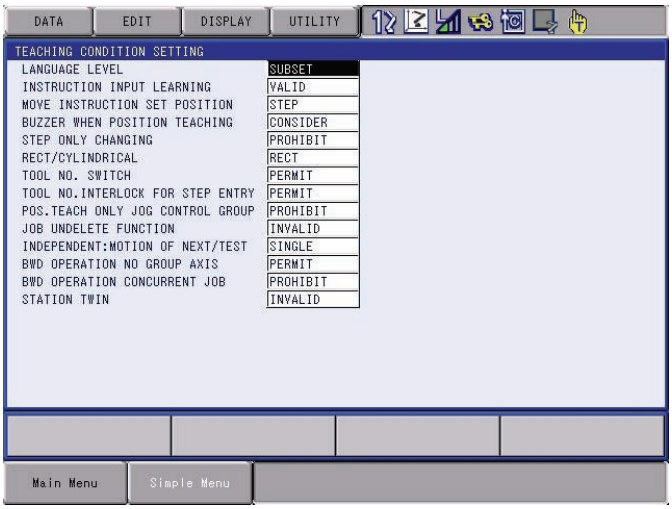
For arc coordinated system and jigless system, simply pressing [SHIFT]+[SMOV] can switch the operating method.

7.8.2.1 Switching by [SHIFT]+[SMOV]

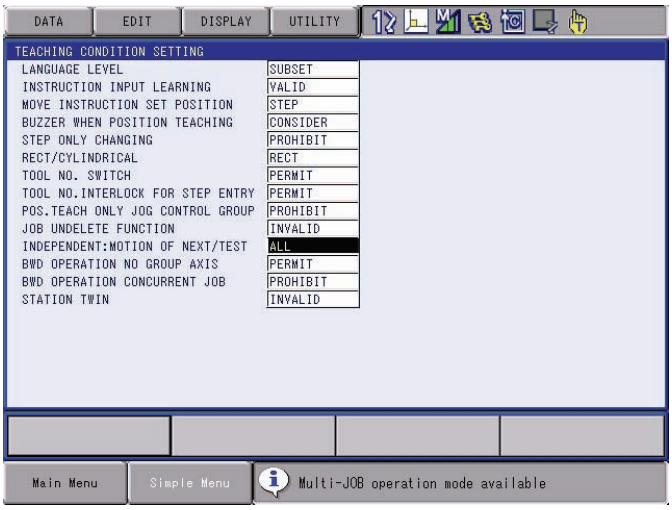
For arc coordinated system and jigless system, simply pressing [SHIFT]+[SMOV] can switch the operating method.

7.8.2.2 Switching on TEACHING CONDITION Window

1. Select {SETUP} under the main menu.
2. Select {TEACHING COND}.
   – The TEACHING CONDITION window appears.



3. Select “STEP/TEST RUN OPERATION MODE.”
   – Each time [SELECT] is pressed, the setting changes between “ALL” and “SINGLE.”



Parameter	Contents and Set Value	Initial Value
S4C286	Specifies the user output number to externally output the “Multi-job operation mode” status at teaching. 0: Not output 1 to 1024: User output number	0

7.8.3 BWD Operation of Concurrent Job

During BWD operation, a concurrent job and a job without control groups can be set so that they do not back, on the TEACHING CONDITION window. For the operation procedures, refer to *chapter 7.8.2 "Switching Operating Method" at page 7-27*.

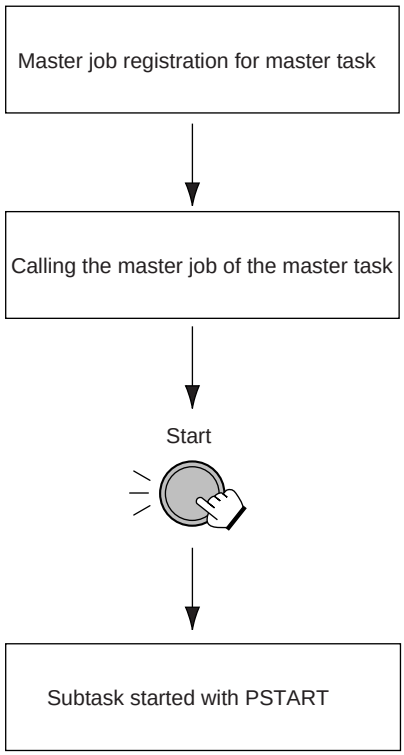
7.9 Playback

7.9.1 Procedure

A playback is performed in the manner described in the following diagram.

Executing PSTART instruction in master task, starts the job in subtasks.

The operation status of each task can be checked on the SUPERVISORY window.



SUPPLE -MENT

For information about playback, refer to the DX100 Operator's Manual.

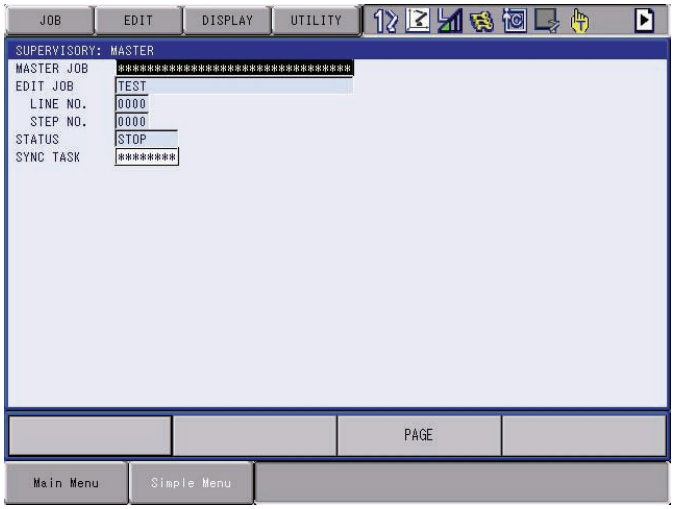
This manual explains the independent control characteristic operations.

7.9.2 Registering Master Job

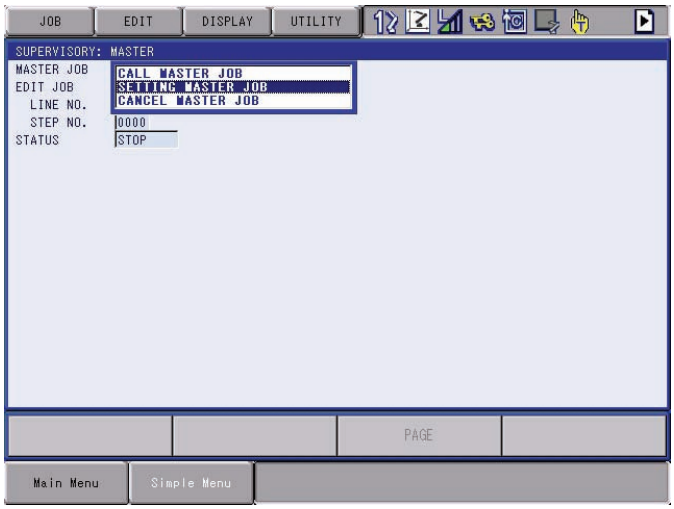
7.9.2.1 Registering

Register a master job in teach mode.

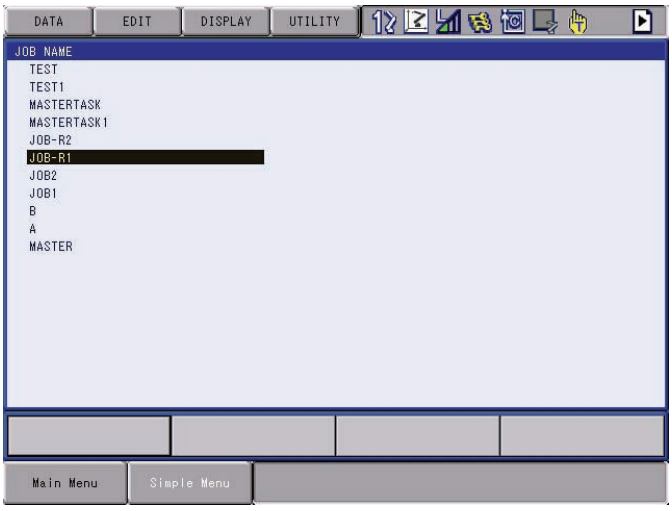
1. Select {JOB} under the main menu.
2. Select {CTRL MASTER}.
   – The SUPERVISORY window appears.



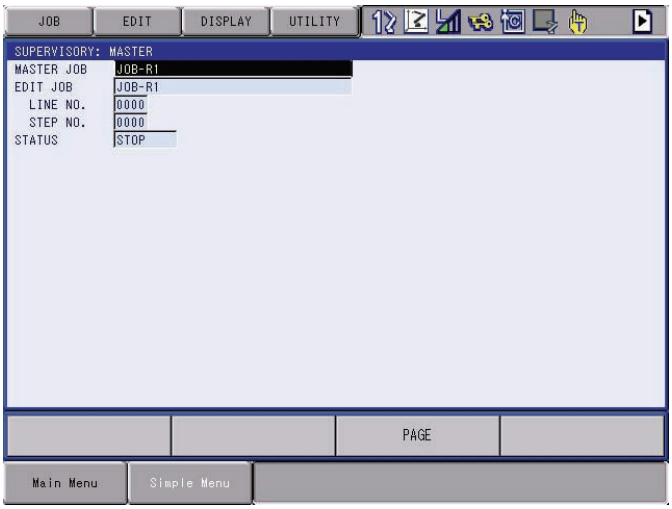
3. Move the cursor to the task where a master job is to be registered.
4. Press [SELECT].
   – The selection dialog box appears.



5. Select “SETTING MASTER JOB.”
   – The JOB NAME window appears.

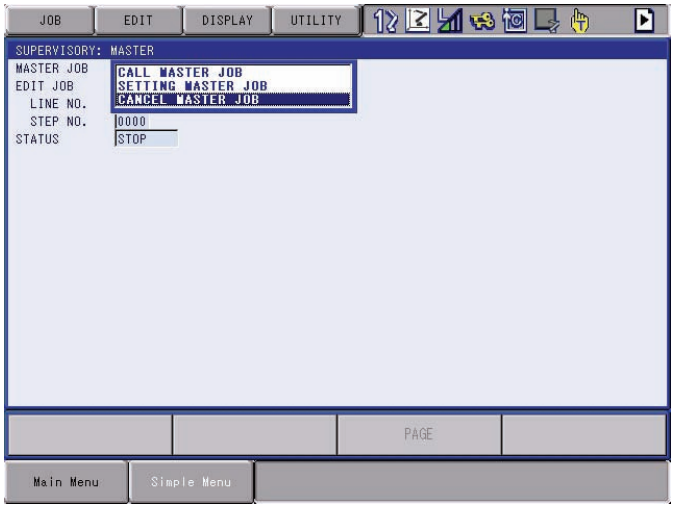


6. Select a job to be registered as a master job.
   – The selected job is registered as a master job.



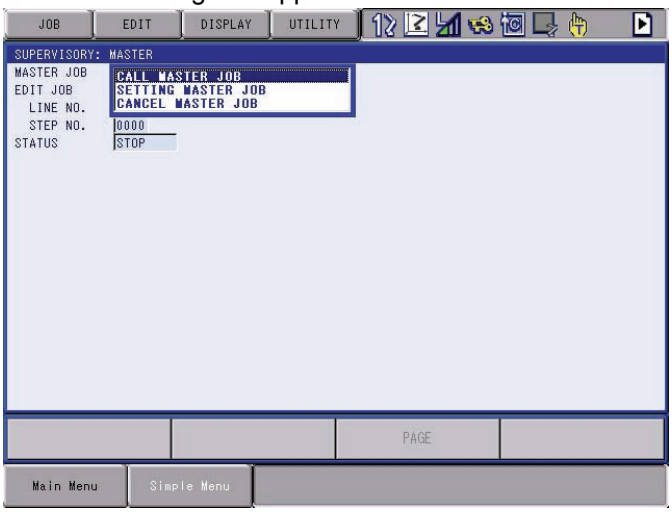
7.9.2.2 Cancelling Registration

1. Move the cursor to the task whose registration is to be cancelled.
2. Press [SELECT].
3. Select “CANCEL MASTER JOB.”
   – The selection dialog box appears.

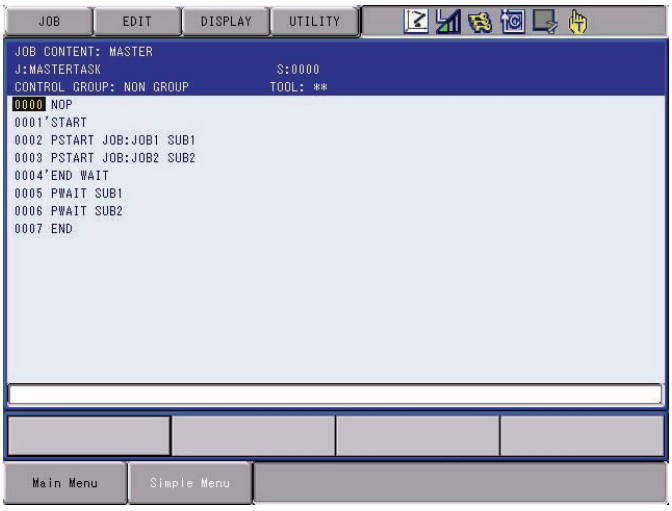


7.9.3 Calling Master Job

1. Move the cursor to the master job whose task is to be called.
2. Press [SELECT].
   – The selection dialog box appears.

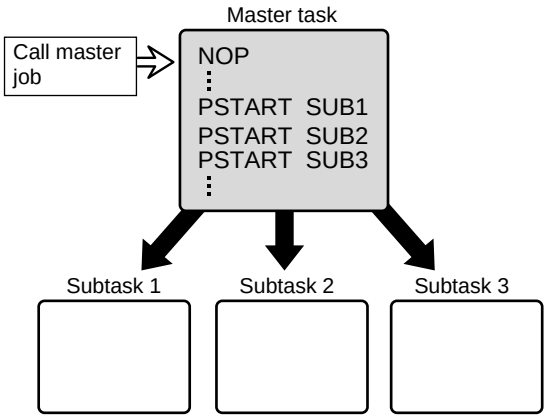


3. Select “CALL MASTER JOB.”
   – The master job is called.



7.9.3.1 When the Master Job in the Master Task is Called

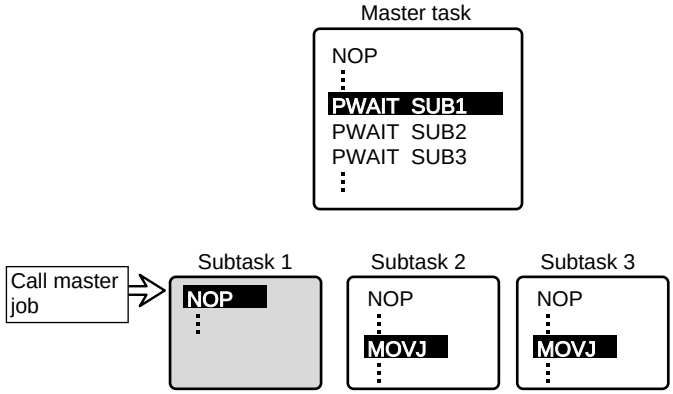
The master job of the master task is called, and the jobs of the subtasks are cleared.



7.9.3.2 When the Master Job in a Subtask 1/2/3 is Called

Only the master job in a specified subtask is called.

The jobs in other tasks are as they were before calling.



NOTE For the subtask 1/2/3, it can be selected whether the master job is to be called or the root job (job started by PSTART) is to be called.

Parameter	Contents and Set Value	Initial Value
S2C232	Call the master job: 0 Call the root job: 1	0

7.9.4 Registration of Root (startup) Job

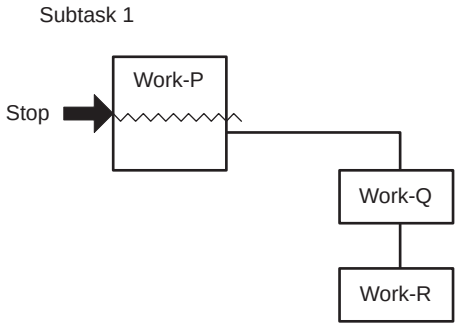
The root job is a job executed at starting up each task.

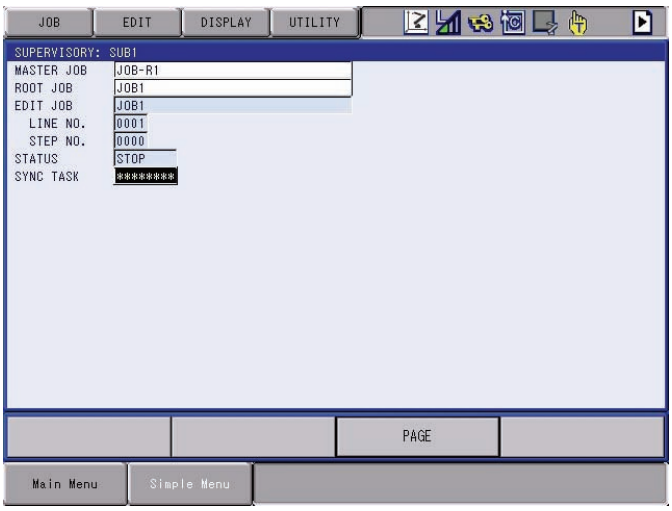
As the root job is determined automatically according to the job configuration, normally it is not necessary to be registered.

However, when the currently active job is to be changed forcibly, register a desired root job to start the task.
The task is executed from the registered root job.

<Example>

During execution of a series of jobs in the subtask 1 as shown in the figure below, the task is stopped in the middle of “Work-P.”
To restart the task from “Work-Q” without executing the remaining of “Work-P,” register “Work-Q” for “ROOT JOB” in the SUPERVISORY window.

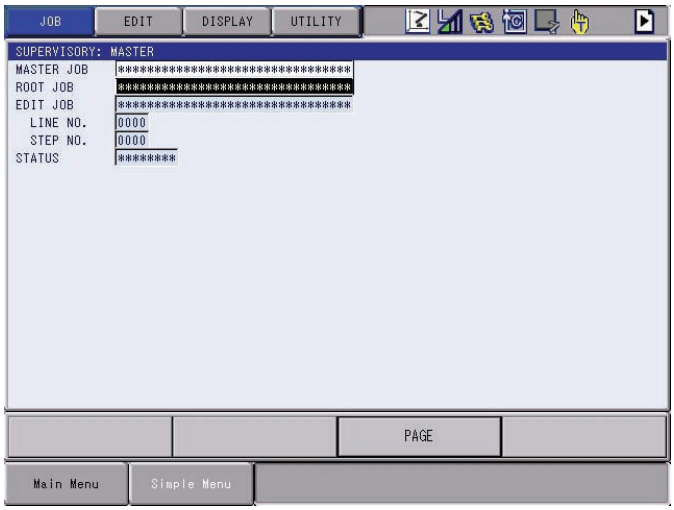




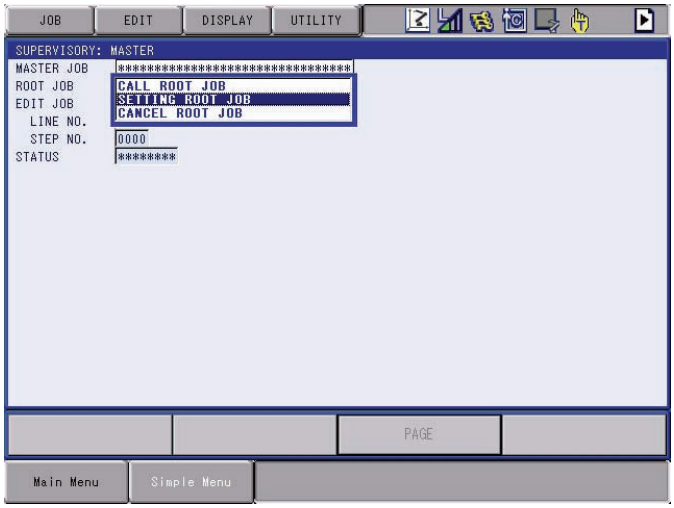
7.9.4.1 Registrering

Register a root job in teach mode.

1. Select {JOB} under the main menu.
2. Select {CTRL MASTER}.
   – The SUPERVISORY window appears.

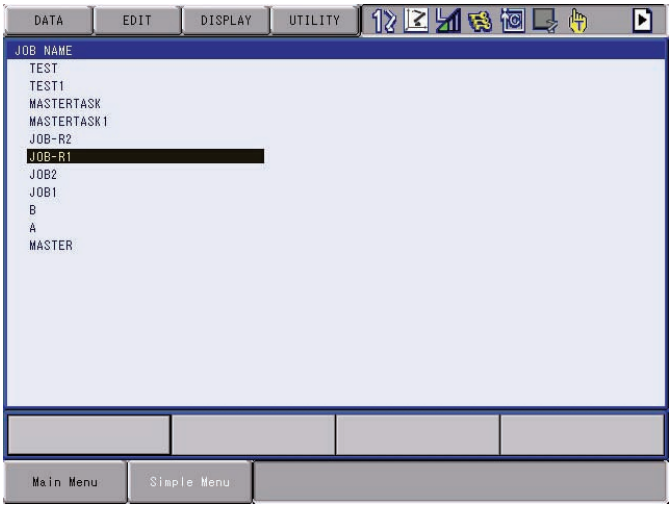


3. Move the cursor to the task where a root job is to be registered.
4. Press [SELECT].
   – The selection dialog box appears



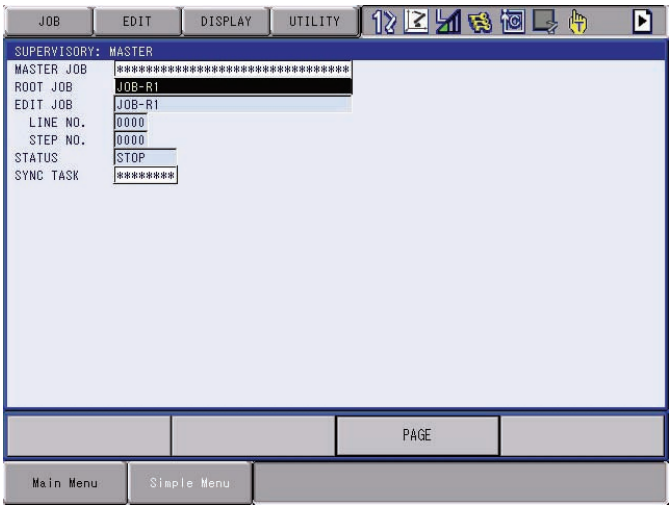
5. Select “REGISTER ROOT JOB.”

– The JOB NAME window appears.



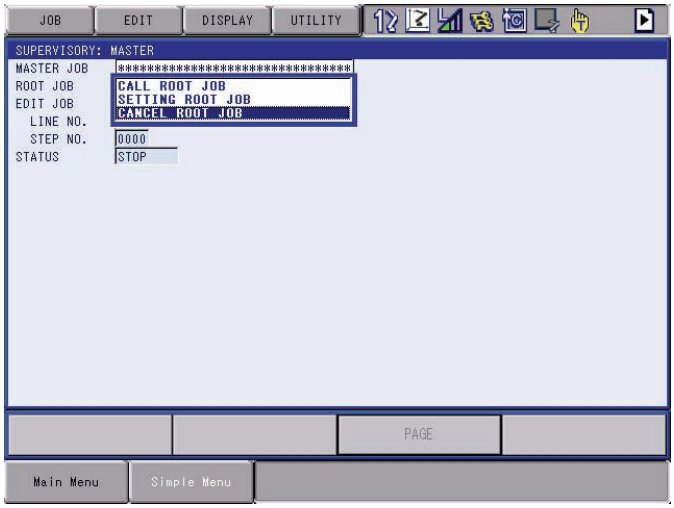
6. Select a job to be registered as a root job.

– The selected job is registered as a root job.

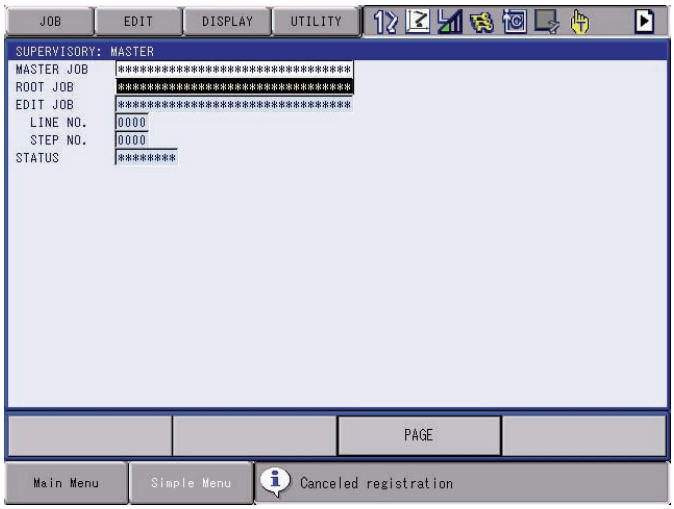


7.9.4.2 Cancelling Registration

1. Move the cursor to the task whose registration is to be cancelled.
2. Press [SELECT].
   – The selection dialog box appears.



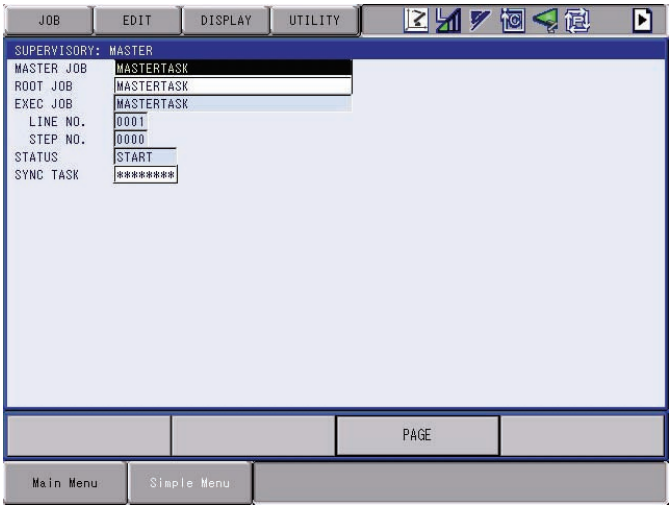
3. Select “CANCEL ROOT JOB.”
   – The root job registration is cancelled

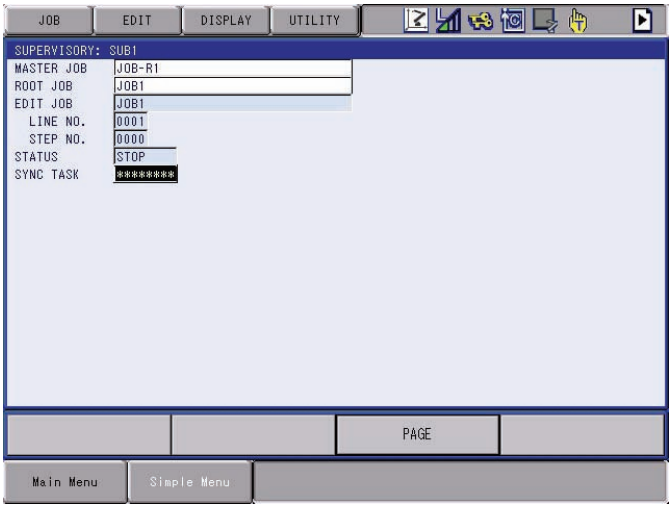


7.9.5 Confirming Operating Status (SUPERVISORY Window)

The operating status of each task can be confirmed on the SUPERVISORY window.

1. Select {JOB} under the main menu.
2. Select {CTRL MASTER}.
   – The SUPERVISORY window appears.





① MASTER JOB

Displays the master job of each task.

② ROOT JOB

Displays a job at starting each task.
It is displayed when “1” (call a root job) is set to the parameter S2C232.

③ EXEC JOB/EDIT JOB

In play mode, displays the currently active job.
In teach mode, displays the currently editing job.
The line number and step number of the current cursor position of the EXEC JOB/EDIT JOB are displayed in “LINE NO.” and “STEP NO.” respectively.

④ STATUS

Displays the status of execution of the task.
START: Displays during playback or during a test run.
RUN: Displays while executing FWD/BWD operation.
STOP: Displays while stopped.
ALARM: Displays while an alarm is occurring.
HOLD: Displays while holding.
E.STOP: Displays during emergency stop.
PWAIT1: Displays while waiting completion of subtask 1.
PWAIT2: Displays while waiting completion of subtask 2.
PWAIT3: Displays while waiting completion of subtask 3.

7.9.6 Precautions

7.9.6.1 Stopping

If a hold or an emergency stop procedure is performed, all currently executing jobs are stopped.

7.9.6.2 Restarting

The following methods are available for restarting after a hold or an emergency stop.

- **To continue operation**
  If operation is restarted from the stopped position, the master task and subtasks1/2/3/4/5/6/7 all continue their execution from the line (step) number at the time of the stop.

  However, if a job selection is made and the message “SUB task restart impossible” is displayed, subtasks 1/2/3/4/5/6/7 cannot continue their execution. Only the master task is restarted.

- **To execute only one of the subtasks from the beginning**
  Before conducting start procedures, first turn ON the system input signal “Sub □ Master job call” (40071 to 40077 of the subtask to be executed from the beginning, and press the start button.

  The job of the subtask for which this signal is ON, is executed from the beginning.
  The jobs of other tasks continue execution from the line (step) number at the time of the stop.

- **To execute jobs of both subtasks from the beginning**
  First turn ON the system input signal “Master job call” (40070), then press the start button.

  When the master job of the master task is called, subtasks 1/2/3/4/5/6/7 which were stopped in the middle are canceled.
  When PSTART instruction is executed in the job of the master task, the jobs of both subtasks start and are executed from the beginning.

7.9.6.3 Stopping and Restarting a Subtask Alone

During operation of subtasks 1/2/3/4/5/6/7, with an I/O alarm or a PAUSE instruction, only a specified subtask can be stopped. Refer to the system inputs 40021 to 40027, and the system outputs 50621 to 50627, for I/O alarm.

When subtask 1/2/3/4/5/6/7 is halted, the system output signal 50601 to 50607 “HELD” is output.
The system output signal 50070 “RUN” stays ON, but the start lamp on the programming pendant flashes when a subtask is halted.

To restart the halted subtask 1/2/3/4/5/6/7, reset the alarm and press the external start or the start botton on the programming pendant.

8 Servo Power Supply Individual Control Function

8.1 Outline

The servo power supply individual control function is to turn ON/OFF the servo power supply in units of specified control group freely in the robot system with multiple control group configuration.

Using this function, without stopping whole the system operation, the servo power supply only for the control group selected by an operator can be turned OFF. Therefore, the safe operation for removing a workpice with the system running and maintenance for robot tool, is secured, moreover, the operating effeciency is increased.

NOTE

The servo power supply individual control function is to control the servo power supply in units of contactor unit. To use this function, use the contactor unit originally designed for separation in units of control group.

8.2 Connection of Signals for Servo Power Supply Individual Control

The servo power supply individual control function turns ON/OFF the servo power supply in units of contactor unit. “ON_EN” signal of power supply contactor unit is used.

“ON_EN” signals of each power supply contactor unit is connected to the following terminals.

- power supply contactor unit (JZNC-YSU01-□E): 1 to 8 of CN211
- The ON/OFF of the servo power supply for the first system (robot) of the contactor unit is controlled by the “ON-EN” signals of CN211-1 & -2 and -3 & -4.
- The ON/OFF of the servo power supply for the second system (external axes) of the contactor unit is controlled by the “ON-EN” signals of CN211-5 & -6 and -7 & -8.

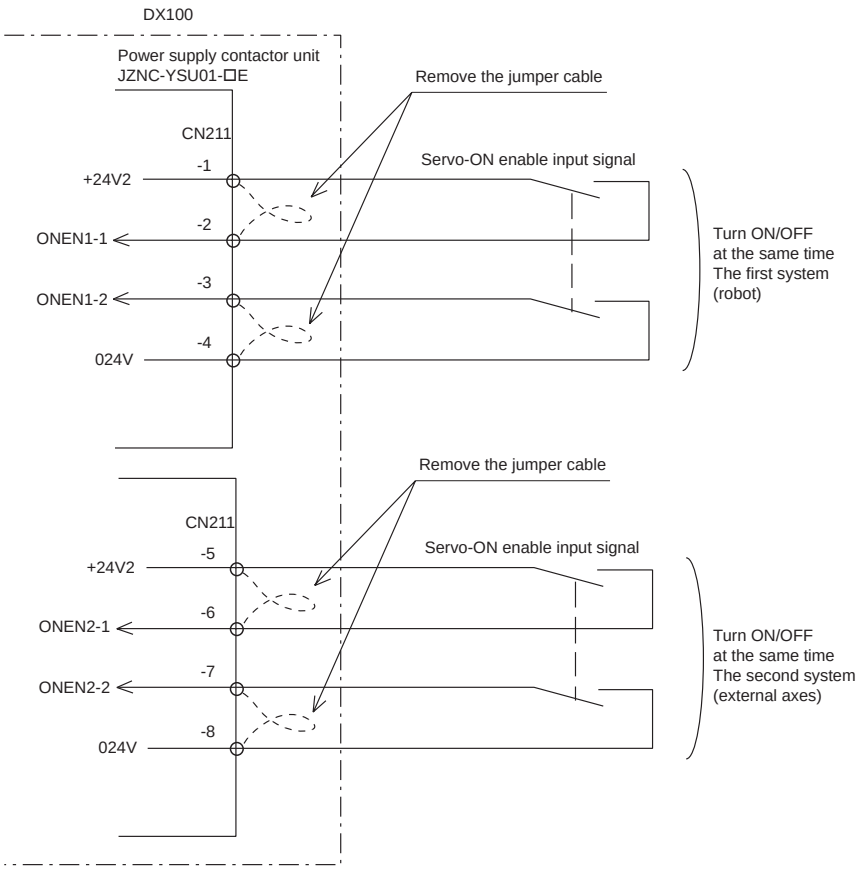
NOTE

For safety reasons, dual circuits are used for the Servo-ON Enable input signals. Connect the signal so that both input signals are turned ON or OFF at the same time.

If only one signal is turned ON, an alarm occurs.

Connect the servo power supply individual control signals in the following manner.

1. Remove the jumpers connected to the above mentioned contactor unit terminals.
2. Connect an output contact such as area sensor to “ON_EN” terminal as shown in the figure below.



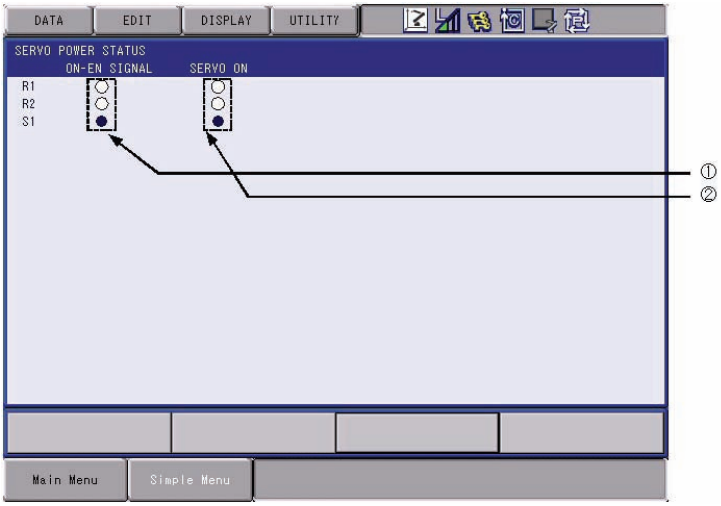
For the wiring termination and connecting method, refer to “WAGO Connector” in “12.3.2 Units and Circuit Boards in the CPU Unit” of DX100 Instructions.

Short-circuited between the above terminals as a standard.

8.3 Confirming Connection

The status of “ON_EN” signals connected to each contactor unit and the servo power supply status can be confirmed on the SERVO POWER STATUS window.

1. Select {IN/OUT} under the main menu.
2. Select {SV POWER STATUS}.
   – The SERVO POWER STATUS window appears.



① ON_EN SIGNAL

Displays the status of “ON_EN” signal of contactor unit connected to each control group.

○: Open (OFF) status
Turns OFF the servo power supply.

●: Closed (ON) status
Turns ON the servo power supply when the servo ON lamp is lit.

② SERVO ON

Displays the status of servo power supplied to each control group.

○: Servo power OFF status

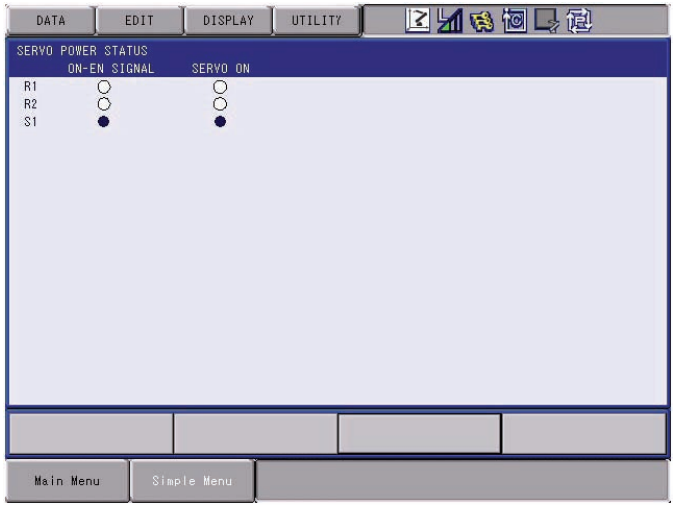
●: Servo power supply ON completed status

8.4 Application Examples

8.4.1 Turning ON Only the Servo Power Supply for the Selected Control Group at Teaching

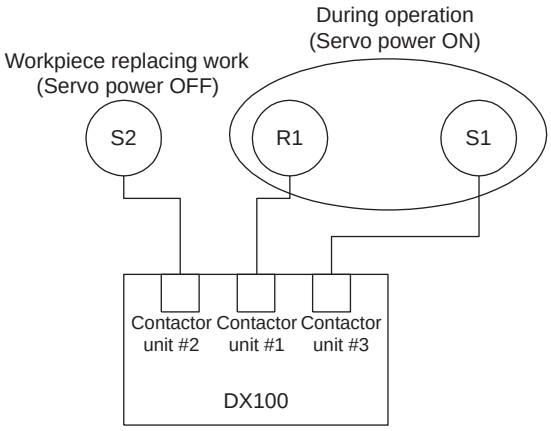
At turning the servo ON, only the servo power supply for the selected control group can be turned ON.

As shown below, when the servo power supply is turned ON with only the “ON_EN” signal of contactor unit connected to S2 set to “ON,” the servo power is supplied only to S2.

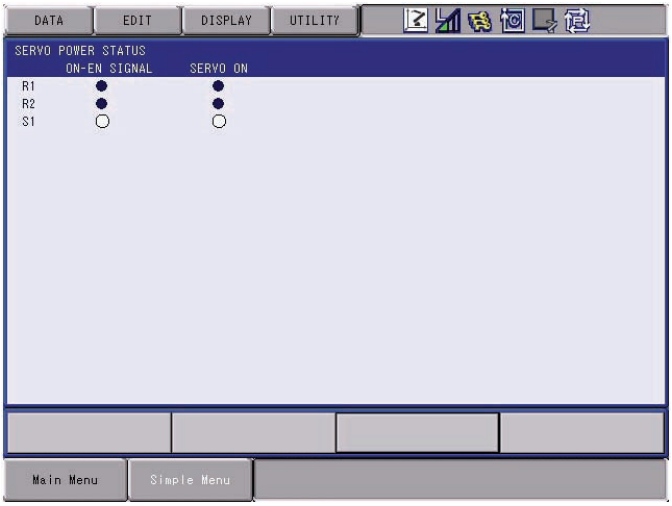


8.4.2 Turning OFF Only the Servo Power Supply for the Selected Control Group at Playback

When an operator touches the positioner in such a case as replacement of workpiece, only the servo power supply for the positioner to be touched can be turned OFF for security.



As shown below, with the “ON_EN” signal of contactor unit connected to S2 set to “OFF,” only the servo power supply to S2 can be turned OFF even during playback operation.



While the servo ON lamp is lit, if “ON_EN” signal is turned ON, the servo power supply for the corresponding control group is turned ON.

NOTE To control individually the servo power supply for a selected control group without stopping whole the system during playback, it is necessary to prepare an application job, using the independent control function.

8.5 System Output Signals

8.5.1 Servo Power ON Status Signal for Each Control Group

The servo power ON status of each control group is output to the following system output signal.

In the standard concurrent I/O ladder, these system output signals are not output externally. When installing an interlock operated by PLC, etc., modify the concurrent I/O ladder so that the system output signals are output externally.

50327	50326	50325	50324	50323	50322	50321	50320
SOUT#256	SOUT#255	SOUT#254	SOUT#253	SOUT#252	SOUT#251	SOUT#250	SOUT#249
Servo power ON status Robot 8	Servo power ON status Robot 7	Servo power ON status Robot 6	Servo power ON status Robot 5	Servo power ON status Robot 4	Servo power ON status Robot 3	Servo power ON status Robot 2	Servo power ON status Robot 1

50337	50336	50335	50334	50333	50332	50331	50330
SOUT#264	SOUT#263	SOUT#262	SOUT#261	SOUT#260	SOUT#259	SOUT#258	SOUT#257
Servo power ON status Station 8	Servo power ON status Station 7	Servo power ON status Station 6	Servo power ON status Station 5	Servo power ON status Station 4	Servo power ON status Station 3	Servo power ON status Station 2	Servo power ON status Station 1

50347	50346	50345	50344	50343	50342	50341	50340
SOUT#272	SOUT#271	SOUT#270	SOUT#269	SOUT#268	SOUT#267	SOUT#266	SOUT#265
Servo power ON status Station 16	Servo power ON status Station 15	Servo power ON status Station 14	Servo power ON status Station 13	Servo power ON status Station 12	Servo power ON status Station 11	Servo power ON status Station 10	Servo power ON status Station 9

50357	50356	50355	50354	50353	50352	50351	50350
SOUT#280	SOUT#279	SOUT#278	SOUT#277	SOUT#276	SOUT#275	SOUT#274	SOUT#273
Servo power ON status Station 24	Servo power ON status Station 23	Servo power ON status Station 22	Servo power ON status Station 21	Servo power ON status Station 20	Servo power ON status Station 19	Servo power ON status Station 18	Servo power ON status Station 17

8.5.2 “During Servo ON” Signal

The system output signal 50073 (during servo ON) is output in connection with the servo ON lamp on the programming pendant.

After the servo power supply is turned ON, even if all the “ON_EN” signals connected to contactor unit are set to “OFF,” the servo ON lamp remains lit and the system output signal “During Servo ON” does not turn “OFF.”

8.6 Operation of Job Without Control Group Specification

When the servo power supply is individually turned OFF where jobs in multiple number of tasks are operated using the independent control function, the job execution of the control group whose servo power supply is turned OFF is interrupted.

The jobs of other control groups continue their execution.

For the jobs without control group specification such as master job, the conditions for execution can be set by the parameter.

Parameter	Contents and Set Value	Initial Value
S2C687 (Condition of execution of job without control group specification)	0: Execution possible only when servo power supply to all the axes have been turned ON 1: Execution possible when servo power supply to any axis is turned ON.	1

9 Robot Language (INFORM III) Instructions

9.1 Coordinated Motion Instructions

< > indicates numerical or alphabetical data. If multiple items are shown in one section, select one of the items.

SMOVL	Function	While coordinating the slave side with the master side, moves to teaching position with linear interpolation. (Coordinated move instruction to the slave side manipulator)	
	Additional Item	Position data, base axis position data	These data do not appear on the screen.
		V=<play speed> VR=<play speed for posture>	V: 0.1 to 1500.0 mm/s 0.6 to 9000.0 cm/min VR: 0.1 to 180.0°/s
		PL=<position level>	PL: 0 to 8
		UNTIL statement	
		NWAIT	
		+MOVJ instruction, +MOVL instruction	
	Example	SMOVL V=150 +MOVL	
SMOVC	Function	While coordinating the slave side with the master side, moves to teaching position with circular interpolation. (Coordinated move instruction to the slave side manipulator)	
	Additional Item	Position data, base axis position data	These data do not appear on the screen.
		V=<play speed> VR=<play speed for posture>	V: 0.1 to 1500.0 mm/s 0.6 to 9000.0 cm/min VR: 0.1 to 180.0°/s
		PL=<position level>	PL: 0 to 8
		NWAIT	
		+MOVJ instruction, +MOVL instruction	
	Example	SMOVL V=150 NWAIT +MOVL	

SIMOV	Function	While coordinating the slave side with the master side, moves by only the specified increments with linear interpolation.	
	Additional Item	P <variable No.>, BP <variable No.>	
		V=<play speed>, VR=<play speed for posture>, VS=<speed at reach point>	V: 0.1 to 1500.0 mm/s 0.6 to 9000.0 cm/min VR: 0.1 to 180.0°/s VS: 0.1 to 1500.0 mm/s 0.6 to 9000.0 cm/min
		PL = <position level>	PL: 0 to 8
		UNTIL statement	
		NWAIT	
		+IMOV instruction	
	Example	SIMOV P000 V=138 PL=1 +IMOV P001 SIMOV P001 BP002 +IMOV P000	
SREFP	Function	During coordinated movement, specifies a reference point such as wall point for weaving. (Reference point instruction to the slave side manipulator)	
	Additional Item	Position data, base axis position data	These data do not appear on the screen.
		<Reference point No.>	Wall point 1 for weaving: 1 Wall point 2 for weaving: 2
	Example	SREFP1	
+MOVJ	Function	The master side moves to the teach position with joint interpolation. This instruction should always be placed after a coordinated move instruction (individual interpolation). (Coordinated move instruction to the master side manipulator)	
	Additional Item	Position data, base axis position data, station axis position data	These data do not appear on the screen.
		VJ=<play speed (%)>	Effective in parameter setting
	Example	MOVL=138 PL=0 +MOVJ	
+MOVL	Function	The master side moves to the teach position with linear interpolation. This instruction should always be placed after a coordinated move instruction (coordinated interpolation, individual interpolation). (Coordinated move instruction to the master side manipulator)	
	Additional Item	Position data, base axis position data, station axis position data	
		V=<play speed>	Effective in parameter setting
	Example	SMOVL V=276 +MOVL MOVL V=276 +MOVL	

+IMOV	Function	The master side moves by only the specified increment with linear interpolation.	
	Additional Item	P <variable No.>, BP <variable No.>	
		V=<play speed>, VR=<play speed for posture>, VE=<play speed of external axes>, VS=<speed at reach point>	V: 0.1 to 1500.0 mm/s 0.6 to 9000.0 cm/min VR: 0.1 to 180.0°/s VE: 0.01 to 100.00 % VS: 0.1 to 1500.0 mm/s 0.6 to 9000.0 cm/min
		BR, RF, TF, UF# (<User coordinate No.>)	BF: Base coordinate RF: Robot coordinate TF: Tool coordinate UF: User coorcinate
	Example	IMOV P000 V=138 PL=1 RF +IMOV P001 SIMOV P001 BP002 +IMOV P000	
SSFTON	Function	Starts coordinated shift movement.	
	Additional Item	<Robot axis position variable>	
	Example	SSFTON P000	
SSFTOF	Function	Stops coordinated shift movement.	
	Additional Item	None	
	Example	SSFTOF	
SWVON	Function	Starts coordinated weaving.	
	Additional Item	WEV# (<weaving condition file No.>)	1 to 16
	Example	SWVON WEV#(3)	
SWVOF	Function	Stops coordinated weaving.	
	Additional Item	None	
	Example	SWVOF	

9.2 Independent Control Instructions

< > indicates numerical or alphabetical data. If multiple items are shown in one section, select one of the items.

PSTART	Function	Starts a job.	
	Additional Item	JOB: <Job name>	
		SUB1, SUB2, SUB3 (SUB4, SUB5, SUB6, SUB7)	Subtask that is started
		SYNC	Added to follower task
		SUB1, SUB2, SUB3 (SUB4, SUB5, SUB6, SUB7)	Leader subtask to be synchronized
		IF statement	
	Example	PSTART SUB1 PSTART JOB:TEST-1 SUB1 PSTART JOB: TEST-1 SUB1 SYNC SUB2	
	Remarks	If the job name is omitted, the master job registered in the selected subtask is started.	
PWAIT	Function	Waits for completion of subtask.	
	Additional Item	SUB1, SUB2, SUB3 (SUB4, SUB5, SUB6, SUB7)	Subtask waiting for completion
	Example	PWAIT SUB1	
TSYNC	Function	Synchronizes tasks.	
	Additional Item	<synchronization No.>	1 to 32
		SNUM=<the number of synchronized tasks>	2 to 4 (8)
	Example	TSYNC 1 TSYNC 1 SNUM=3	

DX100 OPTIONS
INSTRUCTIONS

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