

# DX200 OPTIONS INSTRUCTIONS

## FOR CONVEYOR SYNCHRONIZED FUNCTION

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

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### MOTOMAN INSTRUCTIONS

MOTOMAN-□□□ INSTRUCTIONS  
DX200 INSTRUCTIONS  
DX200 OPERATOR'S MANUAL (for each purpose)  
DX200 MAINTENANCE MANUAL

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

Part Number: 165637-1CD  
Revision: 1

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## MANDATORY

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



## CAUTION

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

We suggest that you obtain and review a copy of the ANSI/RIA National Safety Standard for Industrial Robots and Robot Systems (ANSI/RIA R15.06-2012). You can obtain this document from the Robotic Industries Association (RIA) at the following address:

Robotic Industries Association

900 Victors Way

P.O. Box 3724

Ann Arbor, Michigan 48106

TEL: (734) 994-6088

FAX: (734) 994-3338

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Ultimately, well-trained personnel are the best safeguard against accidents and damage that can result from improper operation of the equipment. The customer is responsible for providing adequately trained personnel to operate, program, and maintain the equipment. **NEVER ALLOW UNTRAINED PERSONNEL TO OPERATE, PROGRAM, OR REPAIR THE EQUIPMENT!**

We recommend approved Yaskawa training courses for all personnel involved with the operation, programming, or repair of the equipment.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.

## Notes for Safe Operation

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

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



**DANGER**

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



**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 “DANGER”, “WARNING” and “CAUTION”.



## WARNING

- **Before operating the manipulator, check that servo power is turned off when the emergency stop button on the programming pendant is 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.

*Figure 1: Emergency Stop Button*



- In the case of not using the programming pendant, be sure to supply the emergency stop button on the equipment. Then before operating the manipulator, check to be sure that the servo power is turned OFF by pressing the emergency stop button. Connect the external emergency stop button to the 5-6 pin and 16-17 pin of the robot system signal connector (CN2).
- Upon shipment of the FS100, this signal is connected by a jumper cable in the dummy connector. To use the signal, make sure to prepare a new connector, and then input it.

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

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

Injury may result from unintentional or unexpected manipulator motion.

*Figure 2: Release of Emergency Stop Button*



- Observe the following precautions when performing teaching operations within the P-point maximum envelope of the manipulator:
  - Be sure to use a lockout device to the safeguarding when going inside. Also, display the sign that the operation is being performed inside the safeguarding and make sure no one closes the safeguarding.
  - View the manipulator from the front whenever possible.
  - Always follow the predetermined operating procedure.
  - Ensure that you have a safe place to retreat in case of emergency.

Improper or unintended manipulator operation may result in injury.



## CAUTION

- Perform the following inspection procedures prior to conducting manipulator teaching. If problems are found, repair them immediately, and be sure that all other necessary processing has been performed.
  - Check for problems in manipulator movement.
  - Check for damage to insulation and sheathing of external wires.
- Always return the programming pendant to the hook on the cabinet of the FS100 after use.

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

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

## Definition of Terms Used Often in This Manual

The MOTOMAN is the YASKAWA industrial robot product.

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

In this manual, the equipment is designated as follows.

Equipment	Manual Designation
FS100 controller	DX200
FS100 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 /Symbol Keys	The keys which have characters or its symbol printed on them are denoted with [ ]. ex. [ENTER]
	Axis Keys /Numeric Keys	[Axis Key] and [Numeric Key] are generic names for the keys for axis operation and number input.
	Keys pressed simultaneously	When two keys are to be pressed simultaneously, the keys are shown with a "+" sign between them, ex. [SHIFT]+[COORD]
	Displays	The menu displayed in the programming pendant is denoted with { }. ex. {JOB}

## 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.

## Registered Trademark

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



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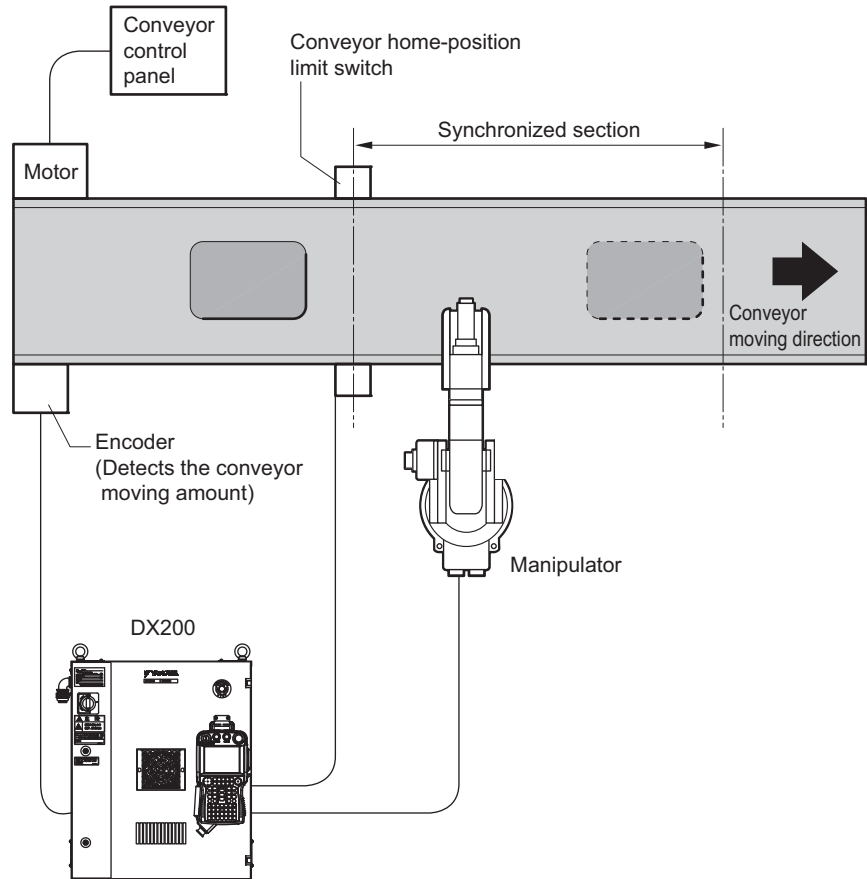
# 1 Conveyor Synchronized Function

## 1.1 System Configuration Example

A basic system configuration example using DX200 conveyor synchronized function is shown below.

The manipulator detects the conveyor moving amount by the encoder mounted on the conveyor.

*Fig. 1-1: System Configuration Example for Conveyor Synchronized Operation*



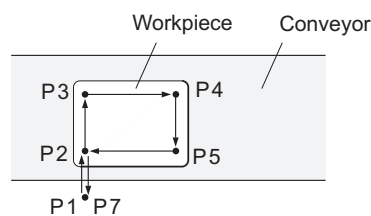
## 1.2 Conveyor Synchronized Operation

The position tracking type conveyor synchronized operation function modifies the taught path in conveyor non-moving state according to the conveyor moving amount so that the manipulator performs follow-up motion in the conveyor moving direction with constant speed relative to the workpiece.

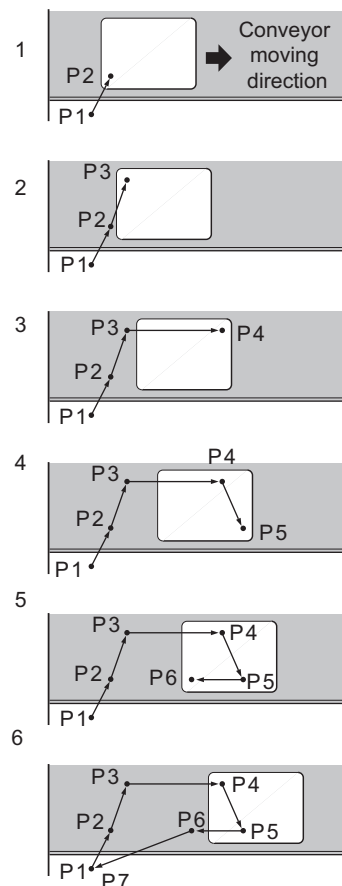
For example, as shown in *Fig. 1-2(a)*, teach P1 to P7 (P2 to P6 are the points in synchronization) with the conveyor stopped. In playback operation, the manipulator follows the conveyor (workpiece) with the motion path modified in the conveyor moving direction as shown in *Fig. 1-2(b)*.

The conveyor synchronized function can use either the manipulator base axis or the traveling axis (external axis) to follow the movement of conveyor. However, the base axis and the traveling axis can not be selected simultaneously.

*Fig. 1-2(a): Teaching*



*Fig. 1-2(b): Synchronized Motion Path in Playback Mode*



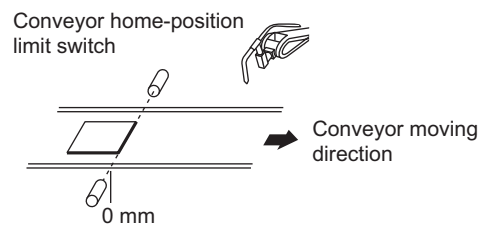
### 1.2.1 Conveyor Home-position Limit Switch

The conveyor home-position limit switch turns ON the conveyor home-position input signal when a workpiece is detected by a sensor.

### 1.2.2 Conveyor Home-position Input Signal

When the conveyor home-position input signal is input, the conveyor current value is automatically reset to 0 mm.

Then, the manipulator can enter synchronized operation status by execution of SYSTART instruction.

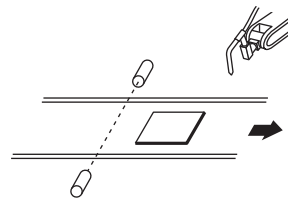


### 1.2.3 SYSTART Instruction and Manipulator Motion

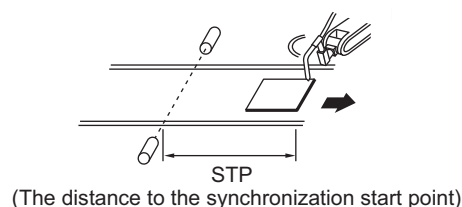
The SYSTART is a conveyor synchronized operation start instruction.

Format: SYSTART CV#(1) <STP= Synchronization start position (units: mm)>

After having executed the SYSTART instruction, when the conveyor reaches the position specified at STP as the synchronization start position, the manipulator enters the synchronized operation status. Up to this moment, the manipulator does not move.



When a workpiece reaches the position set as the synchronization start position, the manipulator starts the synchronized operation.

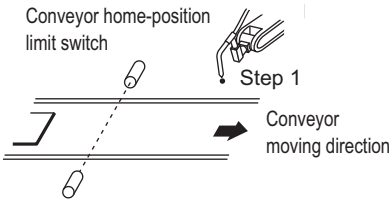
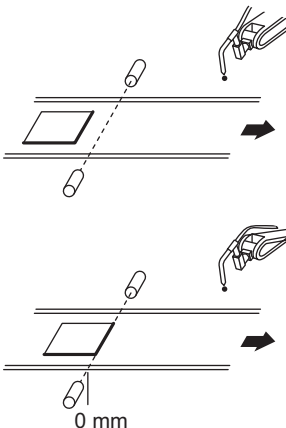
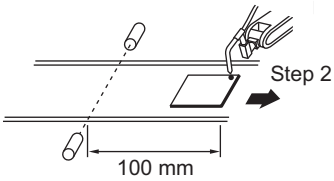


Synchronized Conveyor

1 Conveyor Synchronized Function  
1.2 Conveyor Synchronized Operation

If the SYSTART instruction is executed before the input of conveyor home-position input signal, the manipulator waits until the conveyor home-position input signal is input and the conveyor reaches the synchronization start position, then starts the synchronized operation.

If the conveyor home-position input signal is input before the execution of SYSTART instruction, the manipulator waits until the conveyor reaches the synchronization start position, then enters in synchronized operation status.

Job	Manipulator	Motion
MOVJ	: Moves to Step 1	 <p>Conveyor home-position limit switch Step 1 Conveyor moving direction</p>
SYSTART CV#(1) STP=100.00	: Stops, and waits until the conveyor reaches "STP = 100".	 <p>0 mm</p>
SYMOVL	: Moves to Step 2 in the conveyor synchronized operation after the conveyor position has come to 100 mm.	 <p>Step 2 100 mm</p>



## &lt;Job Example&gt;

A job example of conveyor synchronized operation is shown. Refer to section 5.8 "Job Example" on page 5-18.

```

0000 NOP
0001 SYEND CV#(1)..... Resets the conveyor home-position registration status
0002 MOVJ.....Moves to the stand-by position near the conveyor
0003 SYSTART CV#(1) STP=100.000...Conveyor synchronized operation starts.
0004 GETS B000 $B008
0005 JUMP *END IF B000=0
0006 SYMOVL CV#(1) CTP=50.000
0007 SYMOVL CV#(1) CTP=50.000
0008 SYMOVL CV#(1) CTP=50.000
0009 SYMOVL CV#(1) CTP=50.000
0010 *END
0011 SYEND CV#(1).....Conveyor synchronized operation ends.
0012 MOVJ.....Returns to the stand-by position
0013 END

```

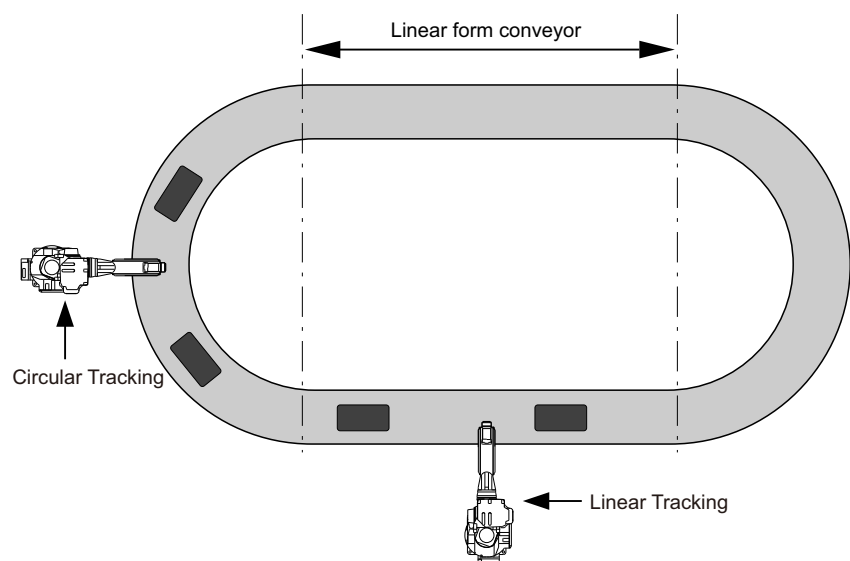
Synchronized operation section

## 1.3 Conveyor

### 1.3.1 Conveyor Form

There are three types of the conveyor tracking motion: robot-axis tracking, base-axis tracking, and circular tracking.

Each type must be set according to its system configuration (tracking motion type).

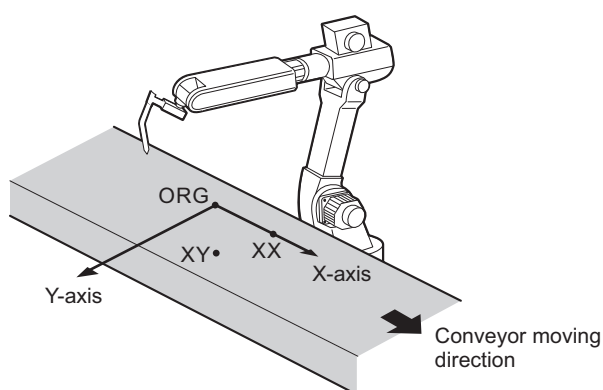


### 1.3.2 Definition of Conveyor Moving Direction

The conveyor moving amount pulses detected by the encoder mounted on the conveyor are scalar. From this number of pulses, the manipulator determines how far to move, but not in which direction. Therefore, the conveyor moving direction must be defined for the manipulator. For the definition of moving direction, a user coordinate is used. (Refer to “⑧ TRACKING (ROBOT-AXIS/BASE-AXIS/CIRCULAR) on page 4-4”.)



For registration of user coordinates, refer to “DX200 INSTRUCTIONS”.



### 1.3.3 Conveyor Distance for Follow-up

With the conveyor synchronized function of DX200, a manipulator can synchronize a conveyor continuously over a maximum distance of 21 m within the manipulator working envelop.

Since the distance more than 21 m can not be processed internally, if the moving distance reaches 21 m during synchronized operation, the alarm 5022 “CONVEYOR POSITION LIMIT” occurs and the manipulator stops disregarding the succeeding synchronization.

### 1.3.4 Measurement of Conveyor Moving Amount

How far the conveyor has moved from the conveyor home-position is measured by the cumulative number of feedback pulses from the encoder mounted on the conveyor. The accumulation starts when the conveyor home-position limit switch is turned ON. At the start, the cumulative amount is zero (0).

## 2 Hardware Specifications

This chapter explains the required equipment and boards to use the conveyor synchronized function, as well as what data are required and how they should be set. Before setting up a system, read carefully this chapter.

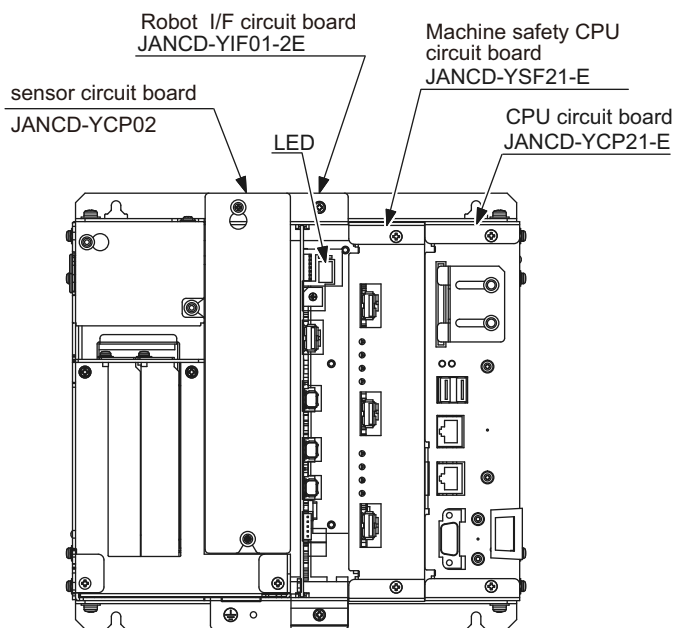
### 2.1 Required Boards and Setup

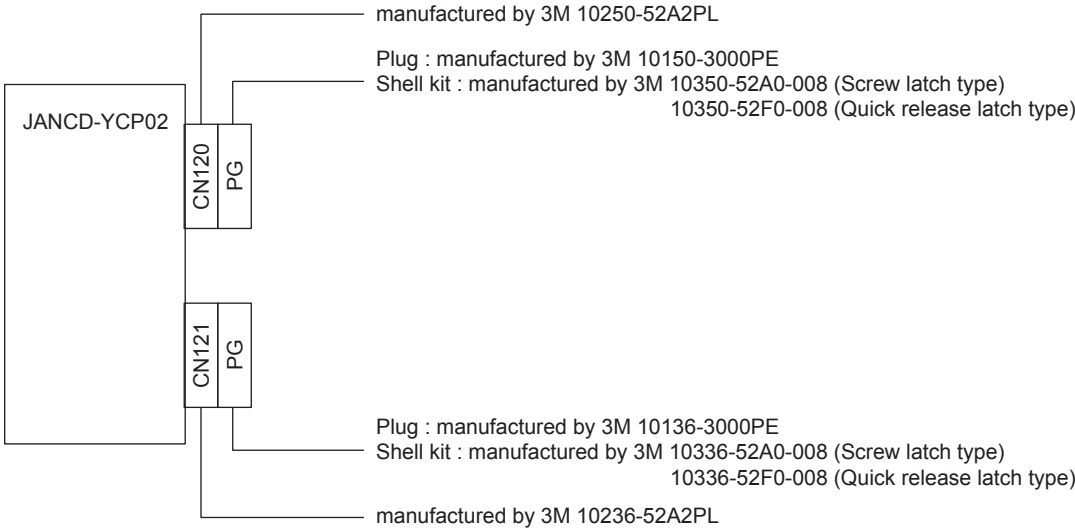
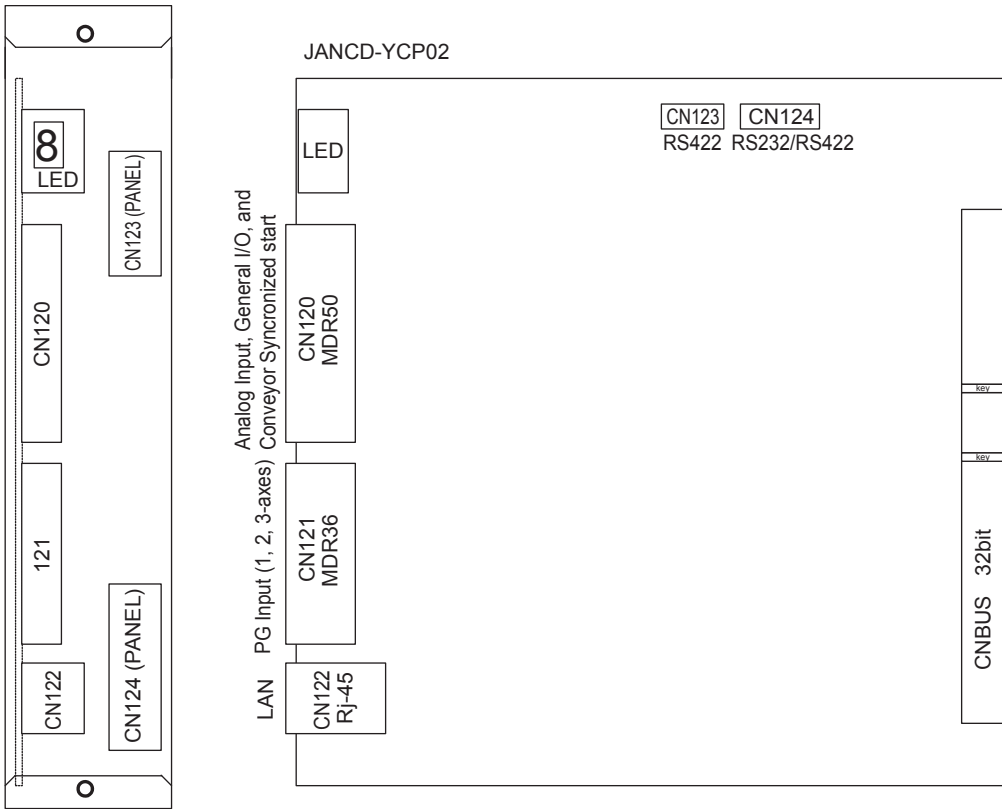
For the conveyor synchronized function, the optional base board JANCD-YCP02 is required besides the standard boards.

Three encoder signal input ports are provided on the YCP02 board. (Note that the connectors are unified in one.)

Up to three conveyor encoders can be connected to a single YCP02 board.

### 2.2 Connecting YCP02 Board to DX200

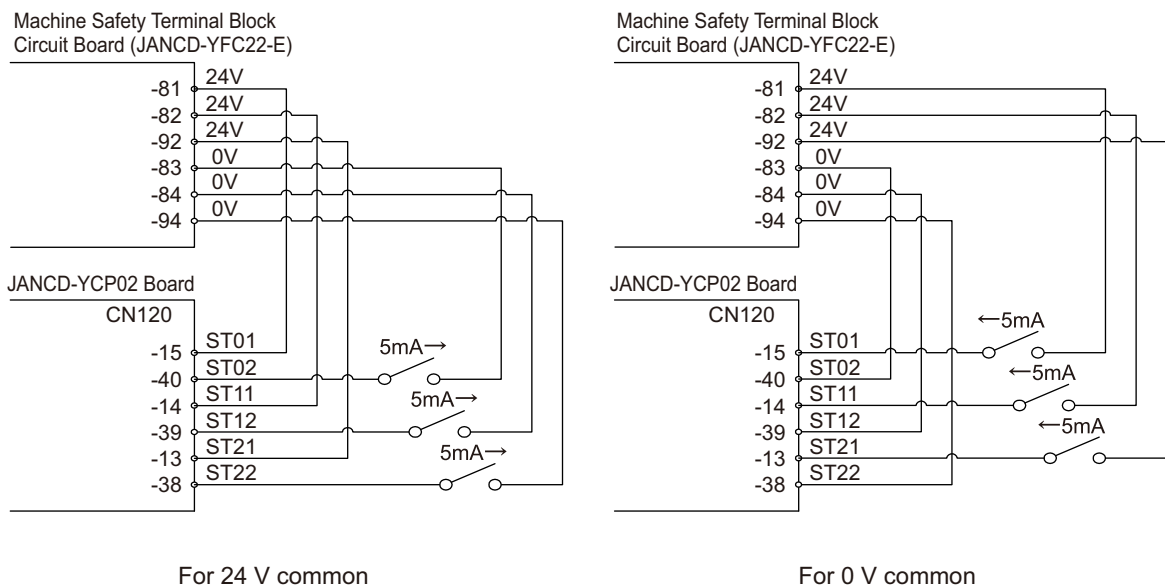




### 2.3 Connecting Conveyor Home-Position Signals to DX200

The conveyor home-position input signals are connected through each encoder input port on the JANCD-YCP02 board. Since the conveyor home-position input signals are used for the reference to the conveyor position, they must be as in phase as possible. It is recommended to connect the conveyor home position signal from the conveyor home-position limit switch directly to the DX200 so as to eliminate dispersion caused by sequencer scan time errors. Input the conveyor home-position limit switch signals to the corresponding conveyor port channels as shown in the figure below so that each signal will not be received while the corresponding channel is executing synchronization.

Check whether the conveyor home-position input signals function correctly on the conveyor condition file window explained later.

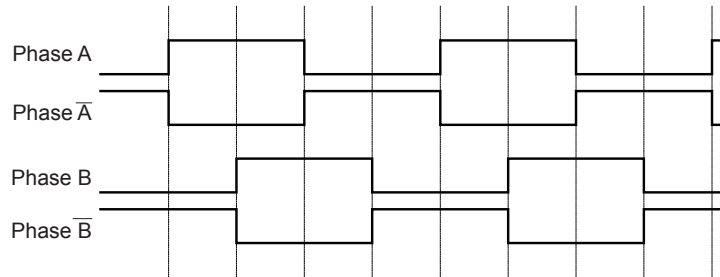


24 V and 0 V wired from the Machine Safety Terminal Block Circuit Board (JANCD-YFC22-E) can be wired to 24 V and 0 V other than Machine Safety Terminal Block Circuit Board (JANCD-YFC22-E).

## 2.4 Applicable Encoder and Connection Specification

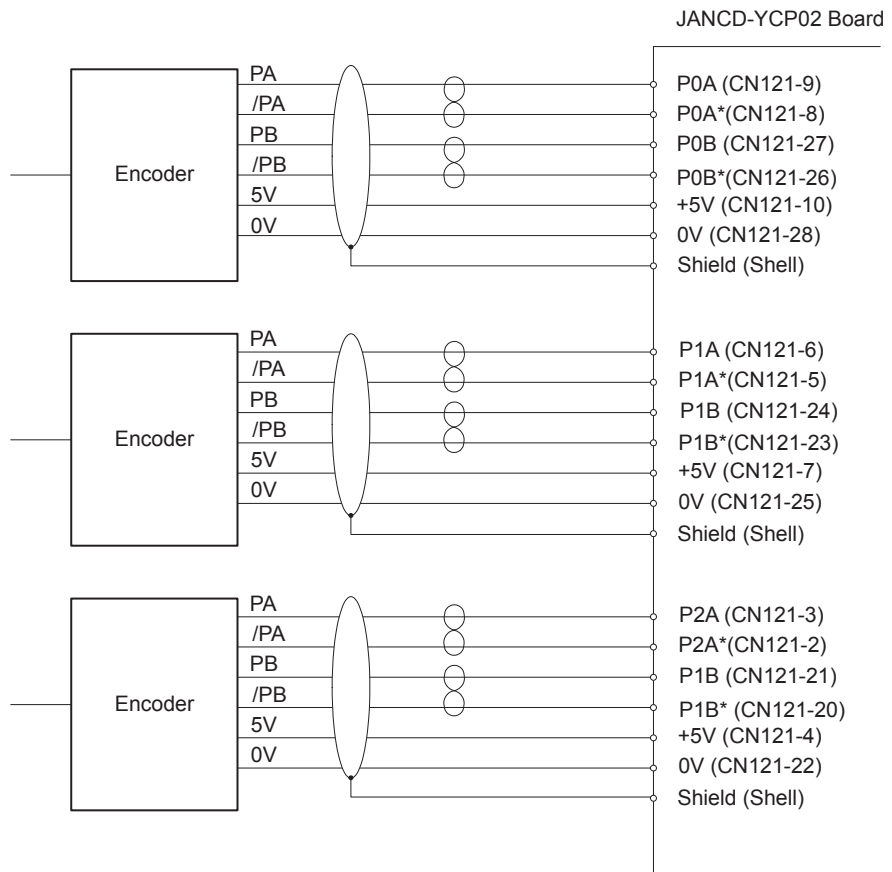
For the conveyor synchronized function, use conveyor encoders with following specifications.

- Incremental type
- Power supply voltage: DC5V
- Line driver output (RS422 or equivalent)
- Two-phase output



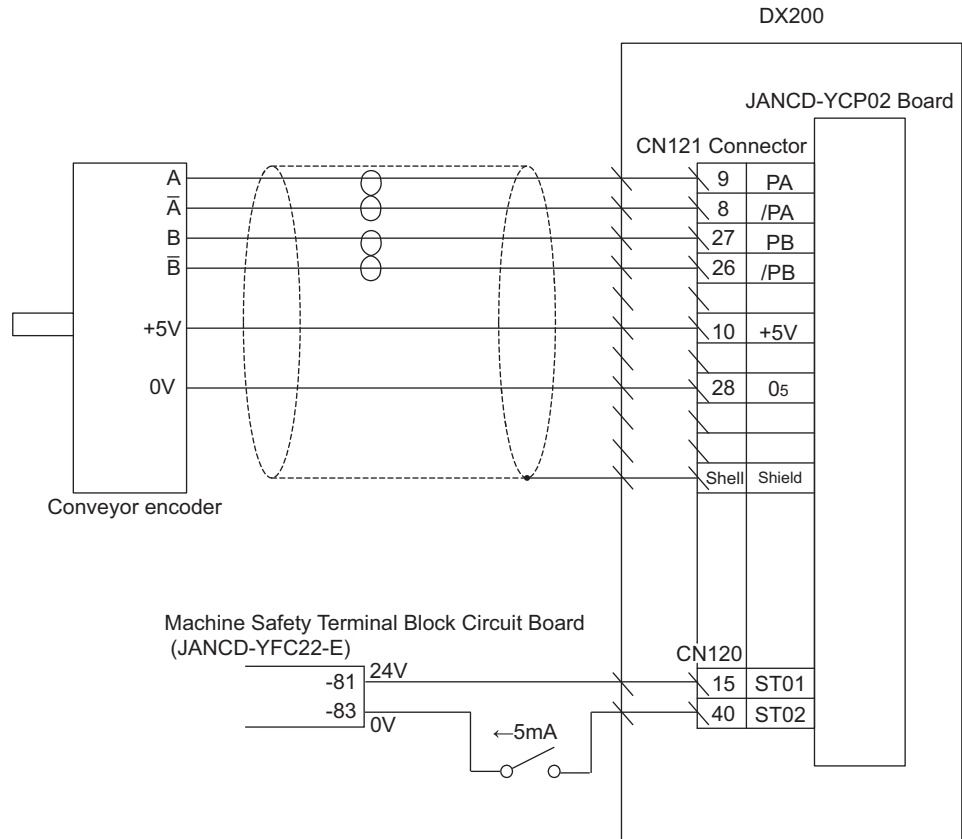
Encoders of open collector output type nor single-phase output type cannot be used.

The connection of encoder to the YCP02 board is as shown below. Check if the encoder operates correctly on the conveyor position window explained later.



## 2.5 Connection Example of One Conveyor

A connection example of one conveyor is shown below. Use a cable of 0.2 pt size.



## 2.6 Detecting Encoder Cable Disconnection

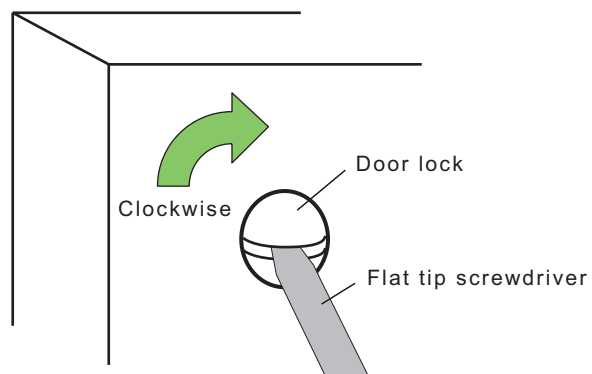
With the conveyor synchronized function, at disconnection of encoder cable, the alarm 1400 “ENCODER ERROR (CONVEYOR)” occurs and the servo power supply is shut down.

### 3 Connector Connection

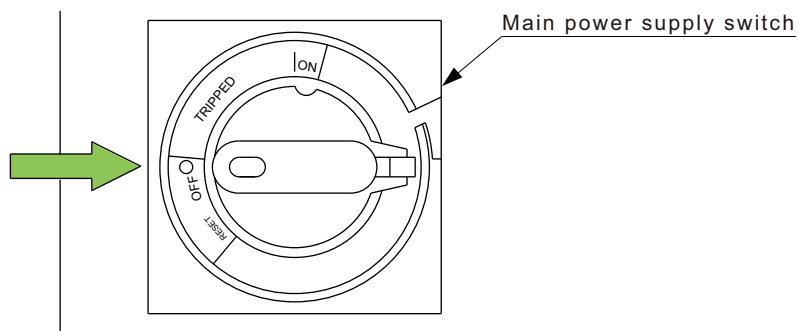
#### 3.1 Opening the Front Door

Open the front door of the DX200.

1. Turn the two door locks on the front face of the DX200 clockwise by 90 ° by using a coin or flat tip screwdriver.



2. With the door locks turned clockwise by 90°, turn the main switch handle to the "OFF" position, and then gently open the door.

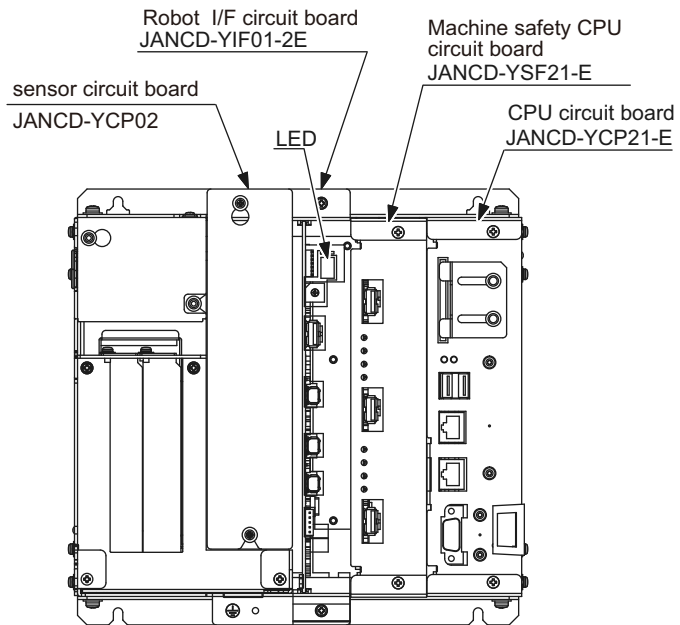




### 3.2 Sensor Cable Connection

Connect the cable from the sensor to the YCP02 board.

*Fig. 3-1: Cable Connection to YCP02 Board*

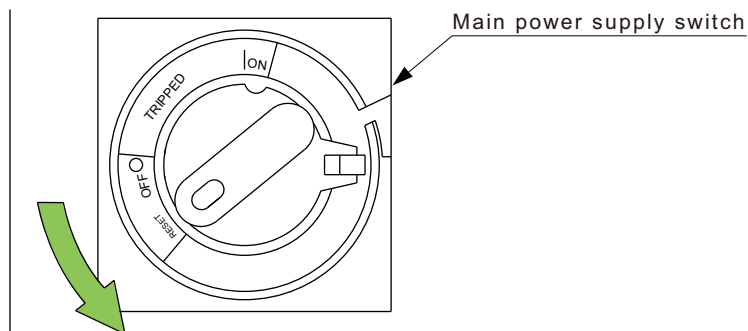


Be sure to securely tighten the connectors with a screwdriver.

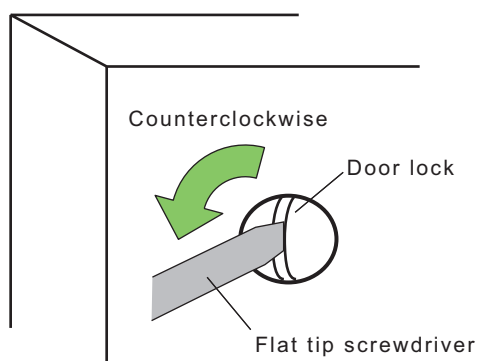
### 3.3 Closing the Front Door

Close the front door of the DX200.

1. Gently close the door of the DX200.



2. Turn the two door locks counterclockwise by 90°.



**NOTE** To ensure the dust resistance, be sure to securely close the door of the DX200.

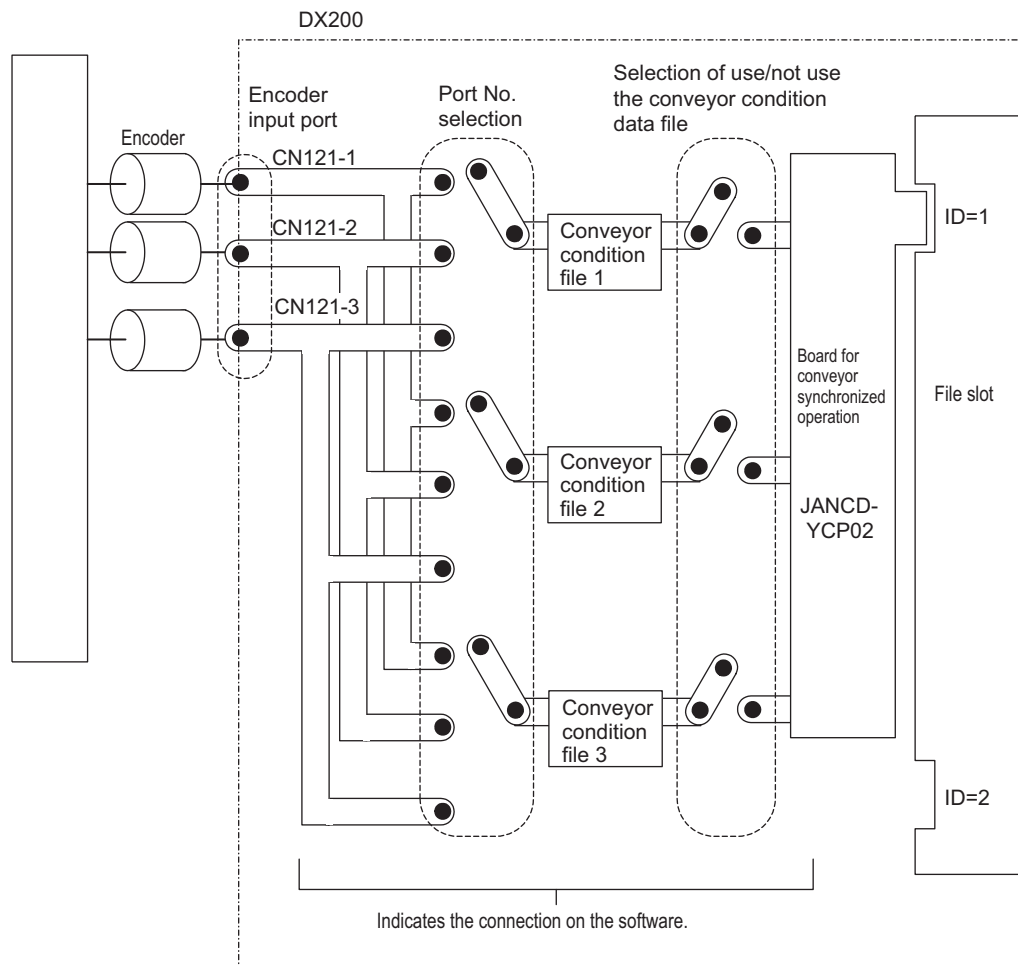
## 4 Settings for Conveyor Condition File

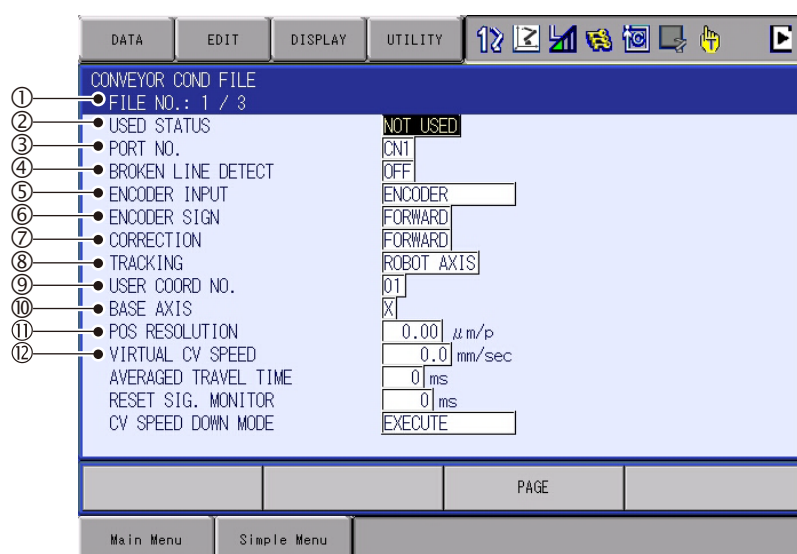
### 4.1 Conveyor Condition File

For proper operation of conveyor synchronized function, the data of conveyor must be provided to the DX200 by setting them in the conveyor condition files.

The conveyor condition files are File No. 1 to 3.

Fig. 4-1: Relevancy of Conveyor Condition Files





① **FILE NO.**

Indicates the conveyor condition file No.

② **STATUS OF USE (USED/NOT USED)**

Select whether to use the conveyor condition file or not.

③ **PORT NO. (CN1/CN2/CN3)**

Specify the port number of which the encoder in use is connected.

④ **BROKEN LINE DETECT (ON/OFF)**

Select whether to use disconnection detection or not.

⑤ **ENCODER INPUT (ENCODER/VIRTUAL ENCDR)**

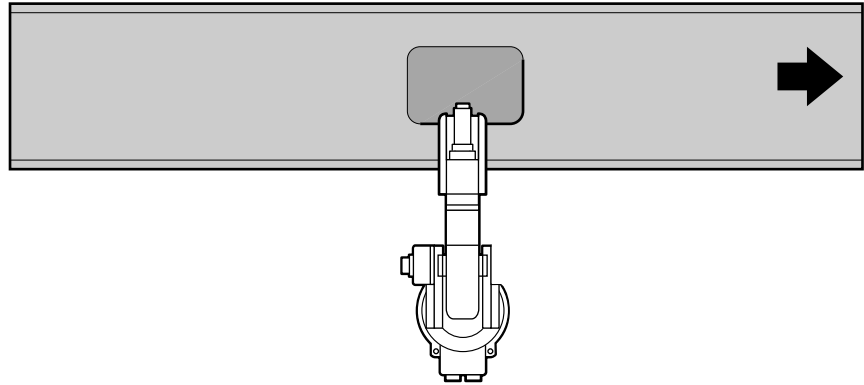
Select whether the synchronization is to be carried out with actual encoder input or virtual pulse encoder.

When "VIRTUAL ENCDR" is selected, the manipulator can perform synchronization even when no encoder is connected or the conveyor is not in operation. This function is convenient for operation check in test run.

**⑥ ENCODER SIGN (FORWARD/REVERSE)**

Select whether to invert the sign of encoder position pulse input from encoder or not.

When "REVERSE" is specified, the signs of data on the windows of conveyor position and conveyor speed are inverted, and the synchronized direction of the manipulator is reversed.



Conveyor Motion (From 1000 pulses to 2000 pulses)

CONVEYOR POSITION	
CURR_POS(PULSE)	CURR_POS
CV#01	0 0.000 mm
CV#02	0 0.000 mm
CV#03	0 0.000 mm

PAGE

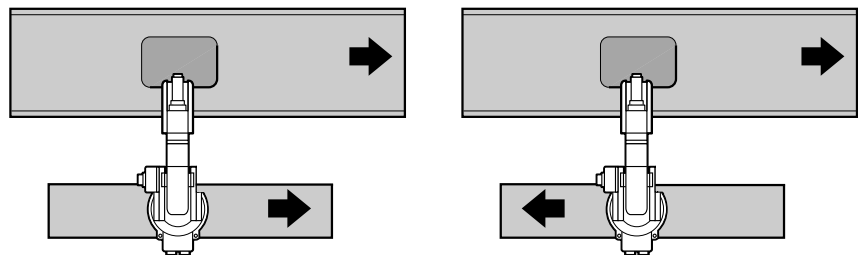
Main Menu Simple Menu

**⑦ CORRECTION (FORWARD/REVERSE)**

Specify whether to reverse the synchronized direction or not.

When "REVERSE" is selected, the sign of correction position on the conveyor speed window is inverted and the manipulator synchronizes in the reverse direction.

When "BASE AXIS" (explained in the item ⑧) is selected for "TRACKING"



"FORWARD"

"REVERSE"

### ⑧ TRACKING (ROBOT-AXIS/BASE-AXIS/CIRCULAR)

Specify whether to carry out the synchronization with the robot-axis or the base-axis (servo track).

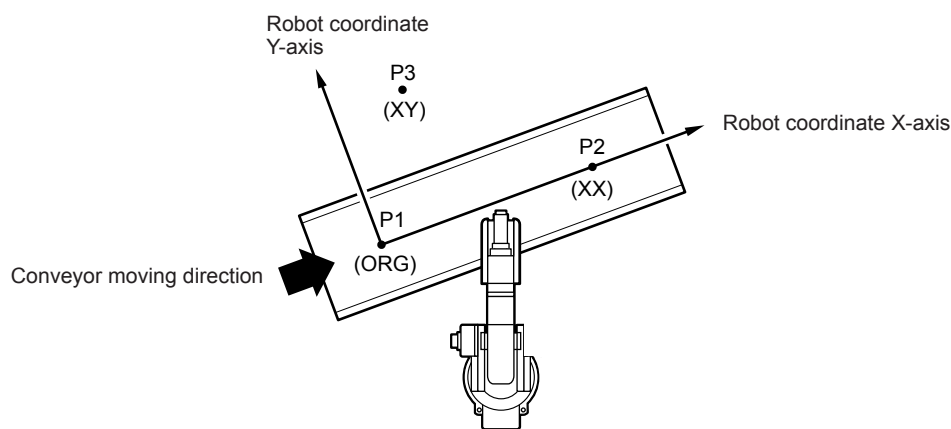
If "BASE AXIS" is selected for the system without base axis, no synchronized motion can be performed.

Robot axis: Teach three points as P1, P2 and P3 on the conveyor as reference points of user coordinate as shown in the figure below. Set the X-axis of user coordinate to the conveyor moving direction.

Register these user coordinates in "USER COORD NO." of the conveyor condition file so that the manipulator synchronizing direction is the conveyor moving direction.



- For registration of user coordinates, refer to "DX200 INSTRUCTIONS".
- For details of circular tacking, refer to *chapter 9 "Turntable Synchronized Function"*.



ORG : User coordinate home position

XX : Point on the X-axis in user coordinates. To define the X-axis.

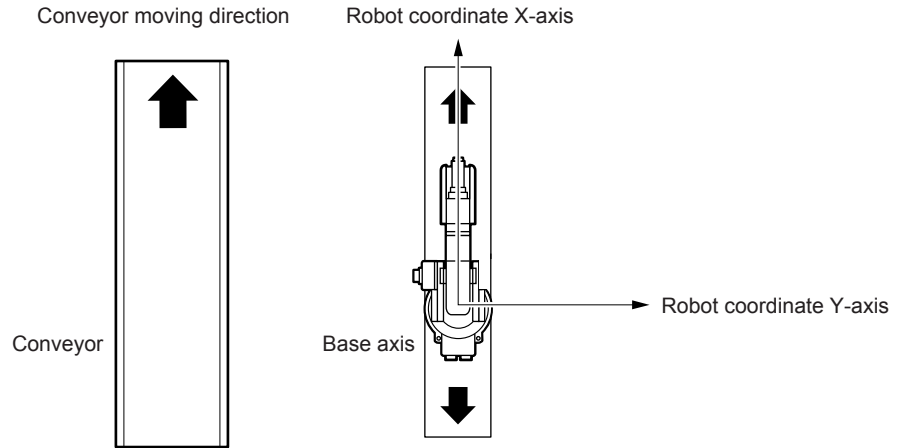
Direction of the X-axis is the conveyor moving direction same direction.

XY : User coordinates Y-axis + side of any one point. To define the Y-axis.

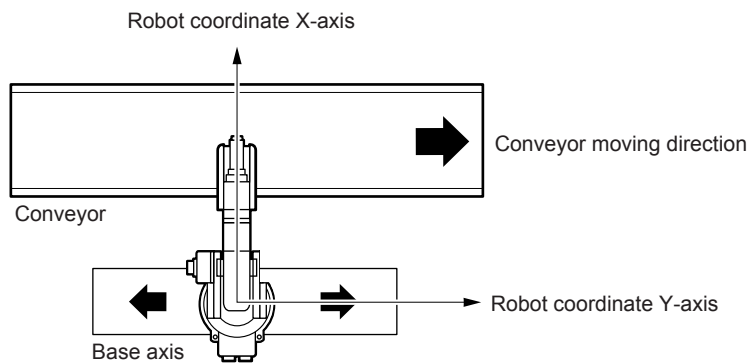
## 4 Settings for Conveyor Condition File

### 4.1 Conveyor Condition File

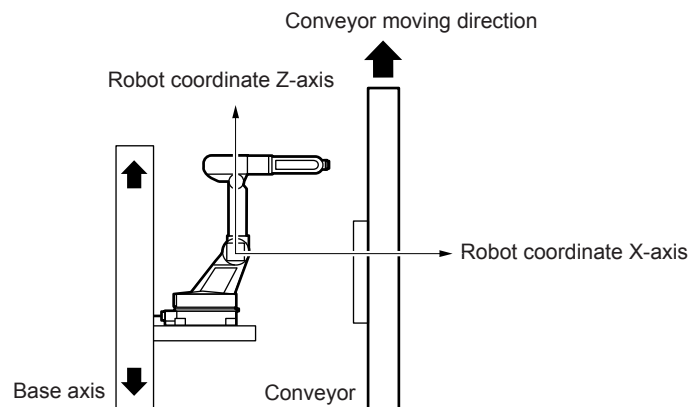
Base axis: Select a base axis (servo track) among X, Y, or Z-axis, which is parallel to the conveyor. In this case, the conveyor moving direction does not need to be defined in a user coordinate. The relations of the base axis, X, Y and Z, the conveyor, and the robot coordinate axis are shown below.



When Synchronized by Servo Track X-axis



When Synchronized by Servo Track Y-axis



When Synchronized by Traveling Axis Z-axis

### ⑨ USER COORD NO. (1 to 63)

When “ROBOT AXIS” is selected in ⑧, specify with which X-axis direction of user coordinate is to be carried out for the synchronization by selecting the user coordinate number.

### ⑩ BASE AXIS (X/Y/Z)

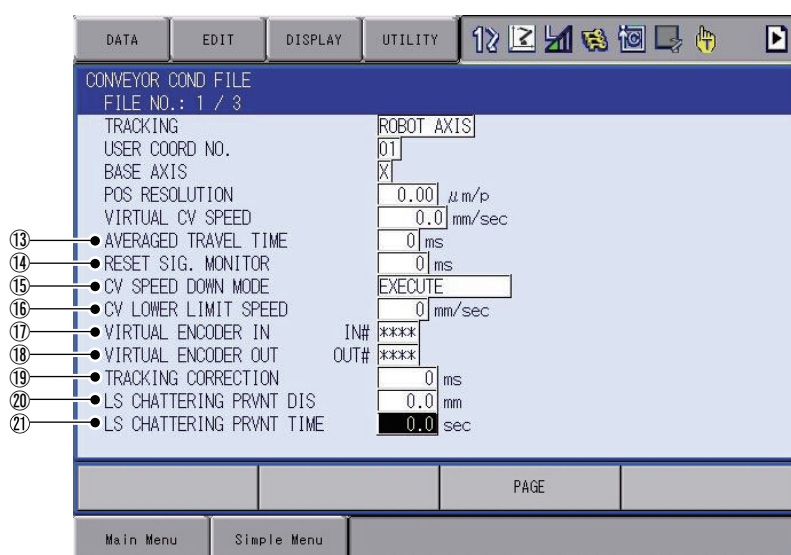
When “BASE AXIS” is selected in ⑧, specify with which base axis the manipulator is to be synchronized among X, Y, or Z-axis.

### ⑪ POSITIONAL RESOLUTION (0.01 to 999.99 $\mu\text{m}$ )

The data for converting 1 pulse from encoder to the conveyor moving amount ( $\mu\text{m}$ ). For details of setting method, refer to *section 4.3 “Setting Conveyor Positional Resolution” on page 4-13.*

### ⑫ VIRTUAL ENCODER SPEED (-3276.8 to +3276.7 mm/sec)

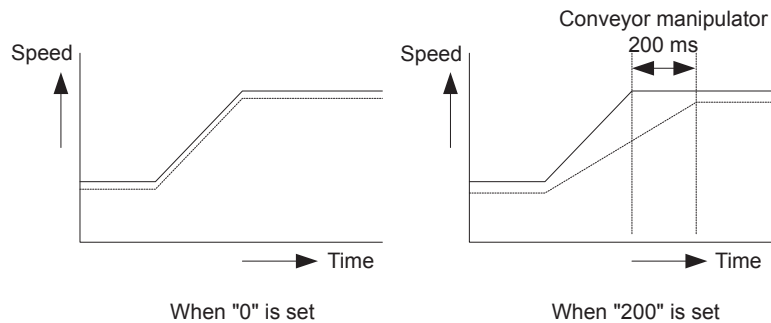
Set the virtual encoder speed when “VIRTUAL ENCODER” is selected in ⑤.





**⑬ AVERAGED TRAVEL TIME (0 to 3000 ms)**

At sudden change in the conveyor moving amount, the moving amounts is automatically averaged so that the manipulator moves smoothly. However, the synchronization responsiveness is lowered in this case. When the conveyor motion is not smooth, set the value to approx. "200". When this function is not used, set at "0".

**⑭ RESET SIGNAL MONITORING (0 to 65535 ms)**

Set a time to wait for the conveyor home-position input signal when no encoder reset signal for a specified conveyor has been input at the execution of SYSTART instruction.

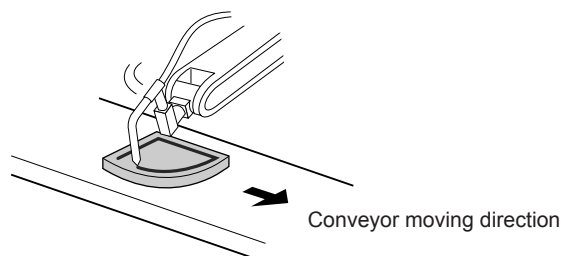
When the waiting time exceeds the set value, the SYSTART instruction is aborted and the next instruction is executed. Therefore, prepare the job so that the manipulator takes retreat motion by internal status.

When "0" is set, the system waits for the conveyor home-position input signal without being interrupted by the time limit for encoder reset signal monitoring.

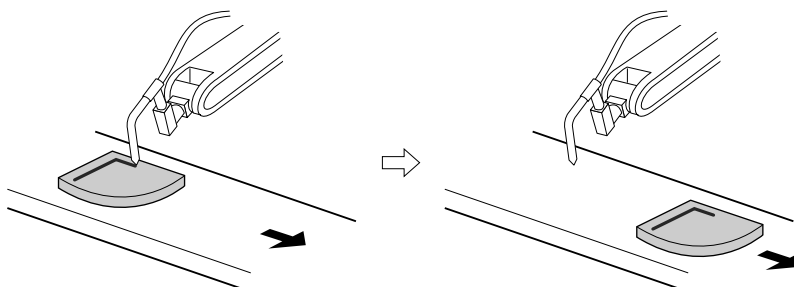
**⑮ CONVEYOR SPEED DOWN MODE (EXECUTE/ALARM/PAUSE JOB)**

Specify the manipulator motion when the conveyor speed is reduced lower than the conveyor lower speed limit specified in ⑯.

**EXECUTE:** The manipulator is operative regardless of the conveyor speed. Accordingly, when the conveyor stops, the manipulator performs the synchronized operation with the conveyor speed 0.



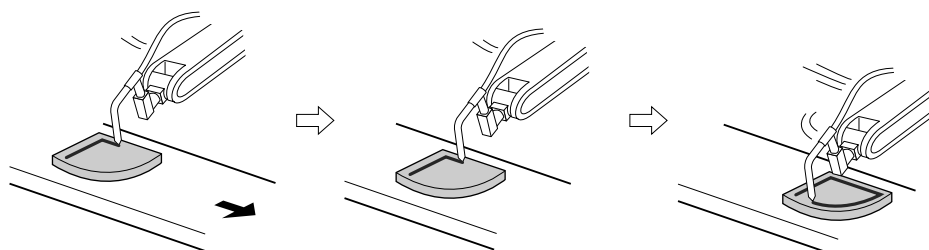
**ALARM:** When the conveyor averaged speed is so lowered that it becomes below the set value in “CONVEYOR LOWER LIMIT SPD” of the conveyor condition file continuously for 0.1 second, an alarm occurs and the manipulator stops. This mode is used where a conveyor stop detection mechanism does not exist in the conveyor control board.



When the conveyor speed is lowered below the conveyor lower limit speed, an alarm occurs and the manipulator stops.

**PAUSE JOB:** When the conveyor speed is so lowered that it becomes below the set value in “CONVEYOR LOWER LIMIT SPD” of the conveyor condition file continuously for 0.1 second, the job motion is interrupted and the manipulator performs only the follow-up motion in the conveyor moving direction.

Then, when the conveyor speed is recovered to the set value in “CONVEYOR LOWER LIMIT SPD” and higher continuously for 0.1 second, the job execution restarts. In this case, only the execution of move instructions in the job are suppressed.



When the conveyor speed is lowered below the conveyor lower limit speed, the execution of move instruction in the job is interrupted and the manipulator performs only the follow-up motion in the conveyor moving direction.

When the conveyor speed is recovered and become higher than the conveyor lower limit speed, the execution of job restarts.

#### ⑩ CONVEYOR LOWER LIMIT SPD (0 to 65535 mm/sec)

This value is used when “ALARM” or “PAUSE JOB” is selected in ⑮. When the conveyor speed becomes lower than this value, the manipulator will be in the “ALARM” mode or “PAUSE JOB” mode.

**⑰ VIRTUAL ENCODER INPUT (0 to 4096)**

When the general purpose input signal of the number which is set in "VIRTUAL ENCODER INPUT" is input, the encoder input enters the virtual encoder mode.

The virtual encoder input signal is used to operate the manipulator with the conveyor stopped in the simulation of conveyor system operation.

0: Not used

1 to 4096: The set general purpose input signal is valid.

**⑱ VIRTUAL ENCODER OUTPUT (0 to 4096)**

If "VIRTUAL ENCDR" is selected in ⑤, the output signal of the number which is set in "VIRTUAL ENCODER OUTPUT" is output.

0: Not used

1 to 4096: The set signal is output.

**⑲ TRACKING CORRECTION (-500 to 1000 msec)**

Set the tracking correction time.

\*Displayed on version DN1.60-000 and later.

**⑳ LS CHATTERING PRVNT DIS (0 to 9999.9 mm)**

Set the limit switch chattering prevention distance.

\*Displayed on version DN1.60-000 and later.

**㉑ LS CHATTERING PRVNT TIME (0 to 999.9 sec)**

Set the limit switch chattering prevention time.

\*Displayed on version DN1.60-000 and later.

## 4.2 Editing Conveyor Condition File

### 4.2.1 Displaying Conveyor Condition File

1. Select {ROBOT} under the top menu.
2. Select {CV CONDITION}.
3. Display a desired conveyor condition file.
  - Press the [PAGE] . The next file No. is called.
  - Press [SHIFT] + [PAGE] . The previous file No. is called.

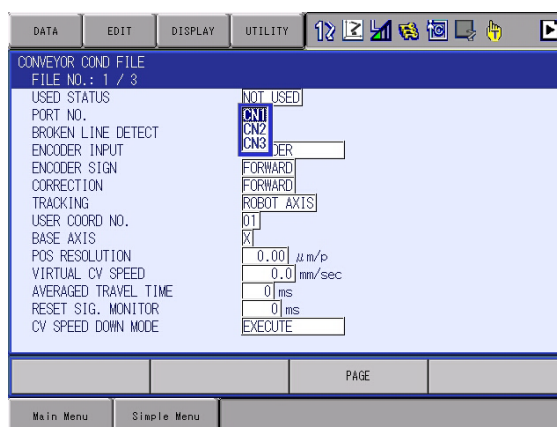
### 4.2.2 Editing Conveyor Condition File

#### 4.2.2.1 Editing "USED STATUS"

1. Select "USED STATUS"
2. "USED" and "NOT USED" switch alternately.

#### 4.2.2.2 Editing "PORT NO."

1. Select "PORT NO.".
2. The selection dialog appears.
3. Select a desired port number.



#### 4.2.2.3 Editing "BROKEN LINE DETECT"

1. Select "BROKEN LINE DETECT".
2. "OFF" and "ON" switch alternately.

#### 4.2.2.4 Editing "ENCODER INPUT"

1. Select "ENCODER INPUT".
2. "ENCODER" and "VIRTUAL ENCDR" switch alternately.

#### 4.2.2.5 Editing "ENCODER SIGN"

1. Select "ENCODER SIGN".
2. "FORWARD" and "REVERSE" switch alternately.

**4.2.2.6 Editing "CORRECTION"**

1. Select "CORRECTION"
2. "FORWARD" and "REVERSE" switch alternately.

**4.2.2.7 Editing "TRACKING"**

1. Select "TRACKING"
2. The selection dialog appears.
3. Select a desired method.

**4.2.2.8 Editing "USER COORD NO."**

1. Select "USER COORD NO."
2. Enter a value using [Numeric Keys].

**4.2.2.9 Editing "BASE AXIS"**

1. Select "BASE AXIS".
  - Editable only if "BASE AXIS" has been selected as a tracking method.
2. The selection dialog appears.
3. Select a desired axis.

**4.2.2.10 Editing "POSITIONAL RESOLUTION"**

1. Select "POSITIONAL RESOLUTION".
2. Enter a value using [Numeric Keys].

**4.2.2.11 Editing "VIRTUAL CONVEYOR SPEED"**

1. Select "VIRTUAL CONVEYOR SPEED".
2. Enter a value using [Numeric Keys].

**4.2.2.12 Editing "AVERAGED TRAVEL TIME"**

1. Select "AVERAGED TRAVEL TIME".
2. Enter a value using [Numeric Keys].

**4.2.2.13 Editing "RESET SIGNAL MONITORING"**

1. Select "RESET SIGNAL MONITORING".
2. Enter a value using [Numeric Keys].

**4.2.2.14 Editing "CONVEYOR SPEED DOWN MODE"**

1. Select "CONVEYOR SPEED DOWN MODE".
2. The selection dialog appears.
3. Select a desired mode.

**4.2.2.15 Editing "CONVEYOR LOWER LIMIT SPD"**

1. Select "CONVEYOR LOWER LIMIT SPD".
2. Enter a value using [Numeric Keys].

---

Synchronized Conveyor	4	Settings for Conveyor Condition File
	4.2	Editing Conveyor Condition File

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#### 4.2.2.16 Editing "VIRTUAL ENCODER INPUT"

1. Select "VIRTUAL ENCODER INPUT".
2. Enter a value using [Numeric Keys].

#### 4.2.2.17 Editing "VIRTUAL ENCODER OUTPUT"

1. Select "VIRTUAL ENCODER OUTPUT".
2. Enter a value using [Numeric Keys].

#### 4.2.2.18 Editing "TRACKING CORRECTION"

1. Select "TRACKING CORRECTION".
2. Enter a value using [Numeric Keys].

#### 4.2.2.19 Editing "LS CHATTERING PRVNT DIS"

1. Select "LS CHATTERING PRVNT DIS".
2. Enter a value using [Numeric Keys].

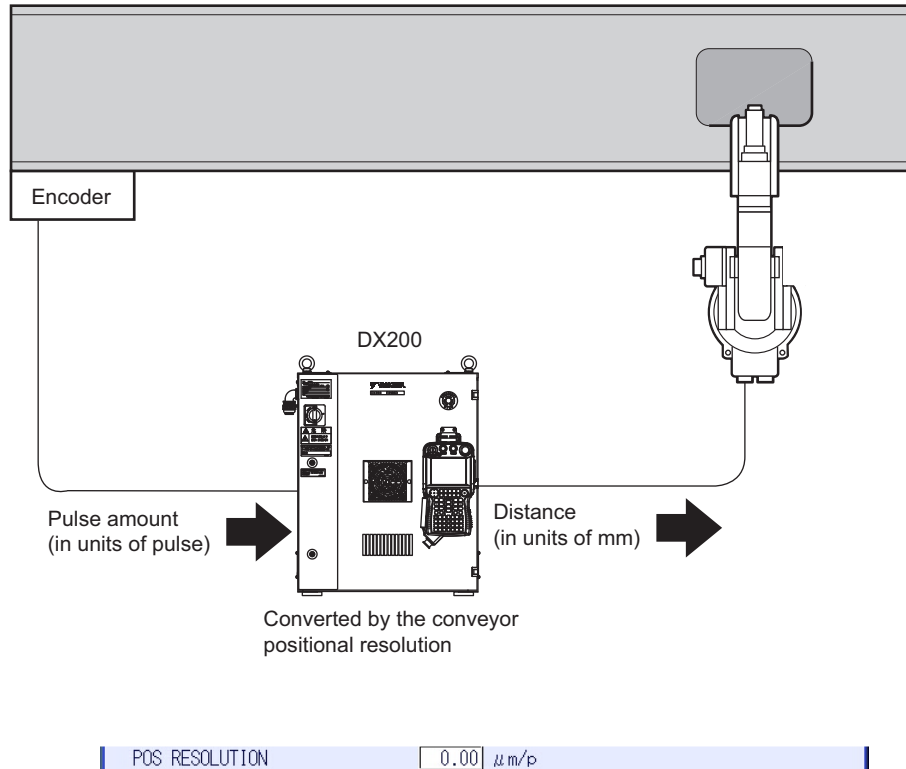
#### 4.2.2.20 Editing "LS CHATTERING PRVNT TIME"

1. Select "LS CHATTERING PRVNT TIME".
2. Enter a value using [Numeric Keys].

### 4.3 Setting Conveyor Positional Resolution

The encoder mounted on the conveyor sends a pulse amount as the conveyor current position. In order that the manipulator recognizes this pulse amount as the conveyor moving amount for its synchronized motion, the pulse amount must be converted into a distance.

The conveyor moving amount ( $\mu\text{m}$ ) per 1 pulse to be used for this conversion is called "POSITIONAL RESOLUTION".



Conveyor Condition File Window

The conveyor positional resolution is set in units of  $\mu$ . For example, when the positional resolution is  $30 \mu/\text{pulse}$ , set "30.00" in POSITIONAL RESOLUTION".

The setting range is from 0 to 999.99  $\mu$ . Since the DX200 internally quadruples every encoder pulse number, the actual conveyor positional resolution for the conveyor encoder is up to 3999.96  $\mu/\text{pulse}$ .

As the resolution error accumulates for the conveyor moving pulse amount, the setting must be made correctly. For example, setting the resolution  $0.01 \mu/\text{pulse}$  bigger causes the follow-up error of 0.1 mm at the point that the conveyor moves for 10000 pulses.

## 4 Settings for Conveyor Condition File

### 4.3 Setting Conveyor Positional Resolution

The conveyor resolution is mentioned in the specification of each conveyor, however, the value cannot be used as it is for the reasons explained below. Measure the actual conveyor resolution in the following manner.



The DX200 internally quadruples the feedback pulse from the conveyor encoder. Accordingly, the conveyor positional resolution set in the conveyor condition file is 1/4 of the conveyor resolution mentioned on your conveyor specification.

#### 4.3.1 Setting Conveyor Positional Resolution

Set the conveyor positional resolution in the following manner.

1. Select {ROBOT} under the top menu, then select {CV MONITOR}.
  - The conveyor position window appears.
2. Take note of the current value (pulses) of the conveyor axis to be used as C1 (pulses).
  - At this moment, the conveyor should be in stop status.

CONVEYOR POSITION			
	CURR_POS(PULSE)	CURR_POS	
CV#01	390	3.900 mm	
CV#02	0	0.000 mm	
CV#03	0	0.000 mm	

PAGE

Main Menu Simple Menu

3. Move the conveyor for 1 m and more to the conveyor moving direction and stop.
  - The conveyor moving amount at this moment is referred as L (m).
4. Take note of the conveyor current value (pulses) at this moment as C2 (pulses).

CONVEYOR POSITION			
	CURR_POS(PULSE)	CURR_POS	
CV#01	1503	15.030 mm	
CV#02	0	0.000 mm	
CV#03	0	0.000 mm	

PAGE

Main Menu Simple Menu



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#### 4 Settings for Conveyor Condition File

##### 4.3 Setting Conveyor Positional Resolution

---

5. The resolution can be obtained by the formula with the measured values C1, C2 and L.

– Formula    Resolution =  $\frac{L \times 1000000}{C2-C1}$  ( $\mu$  /pulse)

Since the conveyor resolution influences largely the follow-up accuracy, set a value as accurate as possible.

**4.3.2 Verifying and Adjusting Conveyor Positional Resolution**

After the setting has been completed, verify and adjust the conveyor positional resolution in the following operations.

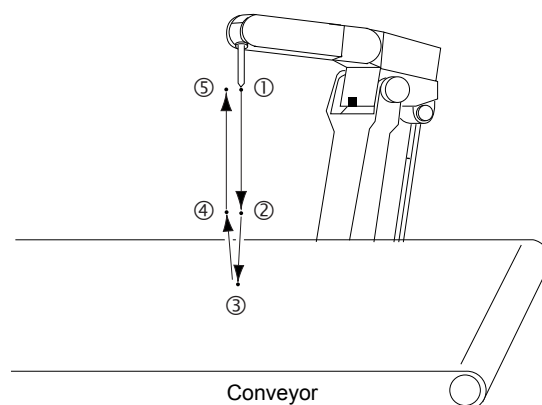
Prepare a job as shown below. This job is to perform a synchronized operation at execution of TIMER at P3 (③ in the below figures) on a conveyor. For teaching methods, refer to *chapter 5 "Teaching"*.

<Job Example>

```

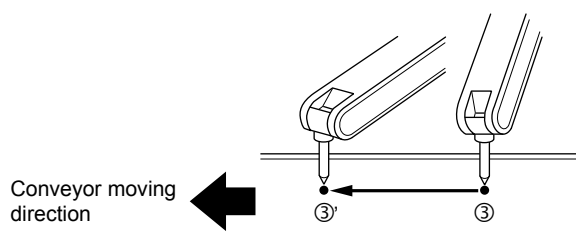
0000 NOP
0001 MOVJ VJ=25.00
0002 MOVL V=300.0
0003 SYSTART CV#(1) ST=10.000
0004 SYMOVL V=200.0 CV#(1) CTP=100.000
0005 TIMER T=10.00
0006 SYMOVL V=200.0 CV#(1) CTP=100.000
0007 SYEND CV#(1)
0008 MOVJ VJ=25.00
0009 END

```



In the execution of this job, when the conveyor resolution value is correct, the tool center point of manipulator synchronizes the conveyor as shown in *Fig. 4-2* and the manipulator moves as if its tool center point is fixed on the point ③.

*Fig. 4-2:*



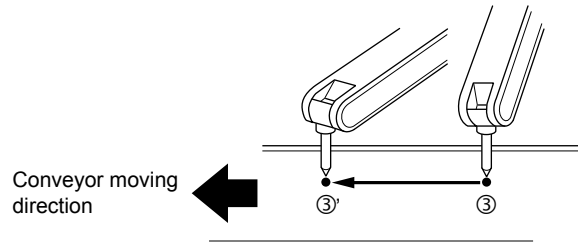
## 4 Settings for Conveyor Condition File

### 4.3 Setting Conveyor Positional Resolution

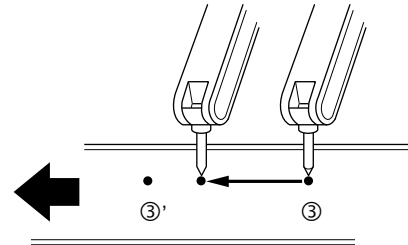
On the contrary, when the conveyor resolution value is not appropriate, the tool center point is dislocated farther from the point ③ as the follow-up time elapses as shown in *Fig. 4-3* and *Fig. 4-4*, the conveyor resolution value is too big. In *Fig. 4-4*, the conveyor resolution value is too small.

According to the resulted follow-up error, adjust the positional resolution value in the conveyor condition file and re-set if necessary.

*Fig. 4-3:*



*Fig. 4-4:*

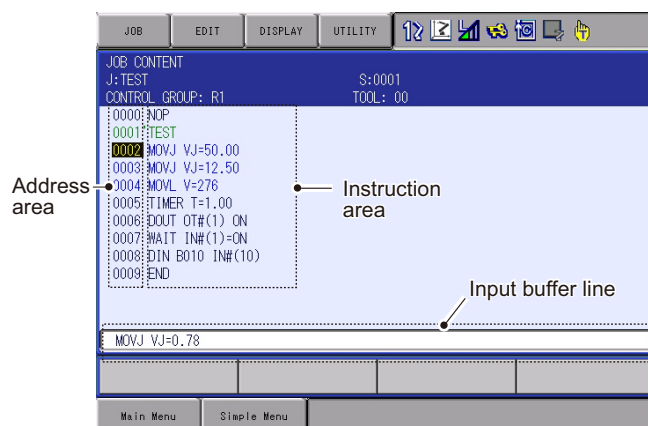


## 5 Teaching

### 5.1 Registering Instructions

The instructions can be registered when the cursor is in the address area on the job content window in teach mode.

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



#### 5.1.1 SYSTART Instruction

##### 5.1.1.1 Function

This instruction indicates the start of a conveyor synchronized operation sequence. The manipulator starts follow-up motion by a move instruction after the SYSTART instruction, or TIMER or WAIT instruction.

When this instruction is executed, the manipulator stops and waits until the conveyor current position value exceeds the synchronization start position value. When it exceeds, the manipulator starts the synchronized motion.

After the instruction is executed, if the encoder reset signal is OFF and remains OFF for the time specified for "Reset signal monitoring" in the conveyor condition file, the execution of instruction is skipped and the succeeding instructions are executed. In this case, no synchronization takes place.

When the SYSTART instruction is executed, if the conveyor current position value already exceeds the synchronization start position value and the difference is within the tolerance (OL), the manipulator starts immediately from the current position the synchronized motion.

However, when the SYSTART instruction is executed, if the conveyor current position value already exceeds the synchronization start position value and the difference is greater than the tolerance (OL), execute the succeeding instructions without synchronized operation resetting the system variable \$B008 to 0. The system variable \$B008 is 1 when the operation has been normally completed.



The system variable \$B008 can not be directly referenced. Copy to the variable Bxxx by GETS instruction and refer.

<Example>

```
GETS B000 $B0008
```

```
JUMP *NG IF B000 <1
```

```

|
|
|

```

### 5.1.1.2 Format

```
SYSTART CV#(1) STP=50.000 OL=10.0
```

①

②

③

#### ① Conveyor Condition File No. (CONVEYOR FILE)

Set the conveyor condition data file No. to be used.

#### ② Synchronization Start Position (SYNC START POS)

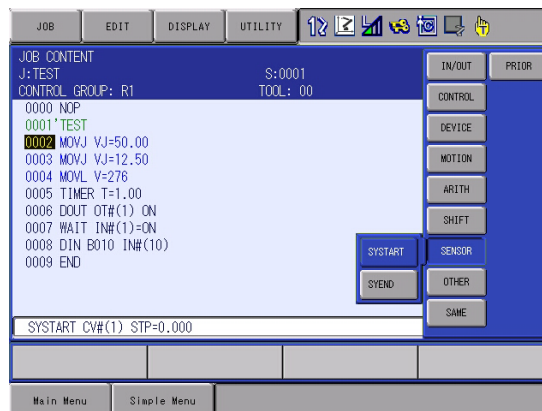
Set the conveyor position where the synchronized operation starts.

#### ③ Tolerance (OVER LIMIT)

Specify the maximum excess to execute the synchronized operation when the conveyor current position value exceeds the synchronization start position value at the execution of SYSTART instruction. Tolerance check will not be executed if setting is omitted or specified at 0.

### 5.1.1.3 Registering SYSTART Instruction

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



## 5 Teaching

### 5.1 Registering Instructions

#### 3. Select "SYSTART".

- An instruction SYSTART is displayed in the input buffer line.



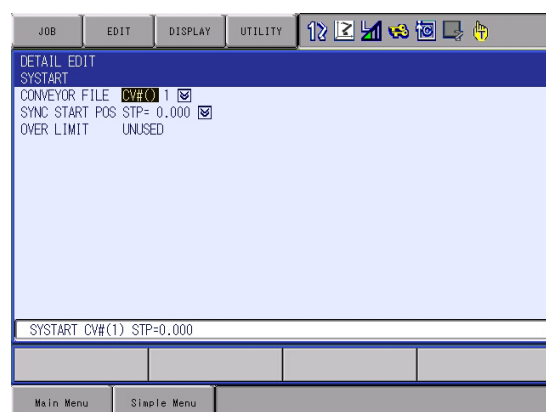
#### 4. Change additional items.

<Register without editing additional items>

- Perform the operation in step 5.

<Edit the additional items>

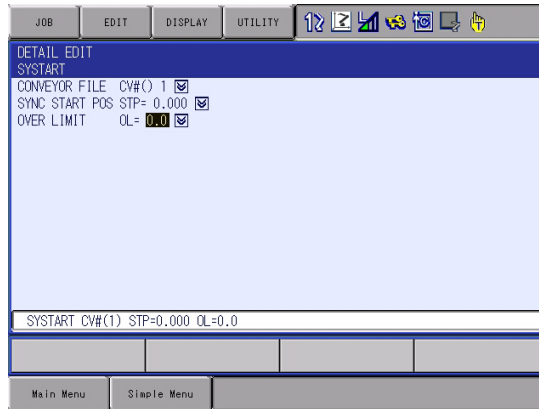
- To change the conveyor condition file No. or/and the synchronization start position
  - Move the cursor to CONVEYOR FILE or SYNC START POS, and press [SELECT]. Enter a desired number or value by using [Numeric Keys], then press [ENTER].
- To add, change or delete the additional item
  - Move the cursor to CONVEYOR FILE or SYNC START POS, and press [SELECT]. Move the cursor to the instruction in the input buffer line, then press [SELECT]. The detail edit window appears.



## 5 Teaching

### 5.1 Registering Instructions

- To add a tolerance, select “UNUSED” in OVER LIMIT. The selection dialog appears. Select “OL =”.



- After having added or changed the additional item, press [ENTER]. 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.

### 5.1.2 SYEND Instruction

#### 5.1.2.1 Function

This instruction indicates the end of a conveyor synchronized operation sequence. The synchronized operation ends at the step where this instruction is registered.

Executing the SYEND instruction clears the conveyor home-position registered status. Then, when the conveyor home-position limit switch is ON, the conveyor home-position is updated.

Register SYEND instruction at the synchronized operation sequence end step and the head of job where the synchronized motion is performed.

#### 5.1.2.2 Format

SYEND CV#(1)

①

① **Conveyor Condition File No. (CONVEYOR FILE)**

Set the conveyor condition file No. to be used.

#### 5.1.2.3 Registering SYEND Instruction

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





## 5 Teaching

### 5.1 Registering Instructions

#### 3. Select "SYEND".

- An instruction SYEND is displayed in the input buffer line.



#### 4. Press [INSERT] and [ENTER].

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

Synchronized Conveyor	5 Teaching
	5.1 Registering Instructions

### 5.1.3 SYMOV□ Instruction

#### 5.1.3.1 Function

These move instructions perform the conveyor synchronized motion. Except that the conveyor position at the time of teaching is registered as CTP (conveyor teaching position), these instructions are the same as ordinary move instructions. Joint motion, linear interpolation, and circular interpolation can be performed in the same way as the ordinary move instructions. However, SYMOVJ (joint motion for conveyor synchronized operation) can be used only when the base axis is selected for synchronization. If SYMOVJ is executed when the robot axis is used for synchronization, the alarm 4583 "CAN NOT USE SMOVJ DURING TRACKING" occurs and the manipulator stops.

SYMOVJ	Joint motion for conveyor synchronized operation (can be used only for synchronization by base axis).
SYMOVL	Linear interpolation for conveyor synchronized operation
SYMOVC	Circular interpolation for conveyor synchronized operation

When these instructions are used, the teaching method is different from that with the ordinary move instructions. Refer to *section 5.1.4 "Interpolation Mode for Conveyor Synchronized Operation"* on page 5-8.

#### 5.1.3.2 Format

SYMOVJ VJ=50.00 CV#(1) CTP=100.000

SYMOVL V=200.0 CV#(1) CTP=100.000

SYMOVC V=200.0 CV#(1) CTP=100.000

①            ②            ③

① **Play speed**

Set the motion speed at playback.

② **Conveyor condition file No.**

Set the conveyor condition data file No. to be used.

③ **Conveyor position at teaching**

Set the conveyor position for teaching.

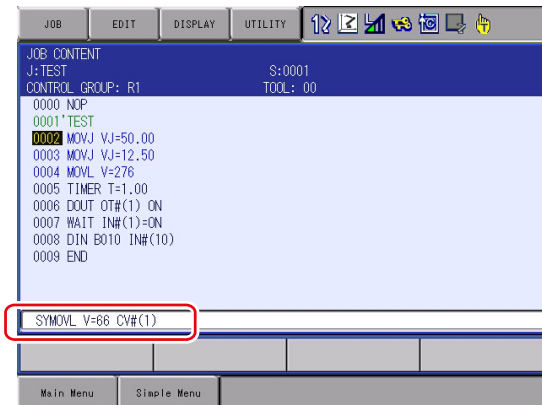
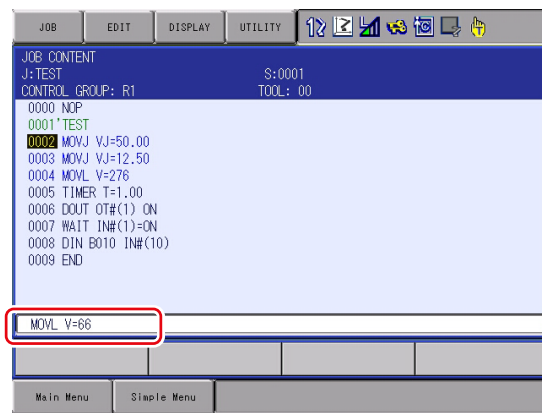
### 5.1.4 Interpolation Mode for Conveyor Synchronized Operation

The interpolation mode of move instructions for conveyor synchronized operation differs from that of ordinary move instructions. Therefore, teaching is performed in “interpolation mode for conveyor synchronized operation”. Switch the interpolation mode in the following manner.

Since the conveyor positions at teaching is registered, they must be properly set up in relation to the conveyor home-position (the position where the conveyor home-position limit switch is ON).

#### 5.1.4.1 Switching the Interpolation Mode

Pressing [SHIFT] + [MOTION TYPE] switches the interpolation mode in the input buffer line between conveyor synchronized interpolation and standard interpolation.



Press [MOTION TYPE].

The interpolation mode switches as: SYMOVJ→SYM OVL→SYM OVC.

## 5.2 Motion Speed

Generally, teaching in the direction opposite to the conveyor moving direction gives such a result as a manipulator can move more easily and slowly in playback operation.

In the conveyor synchronized operation, the manipulator motion speed is the teaching speed added the conveyor motion speed.

However, depending on the relation between the direction of manipulator motion and the conveyor moving direction, the speed is added in the different way as shown below.

Fig. 5-1: When Teaching Direction is the Same as the Conveyor Moving Direction

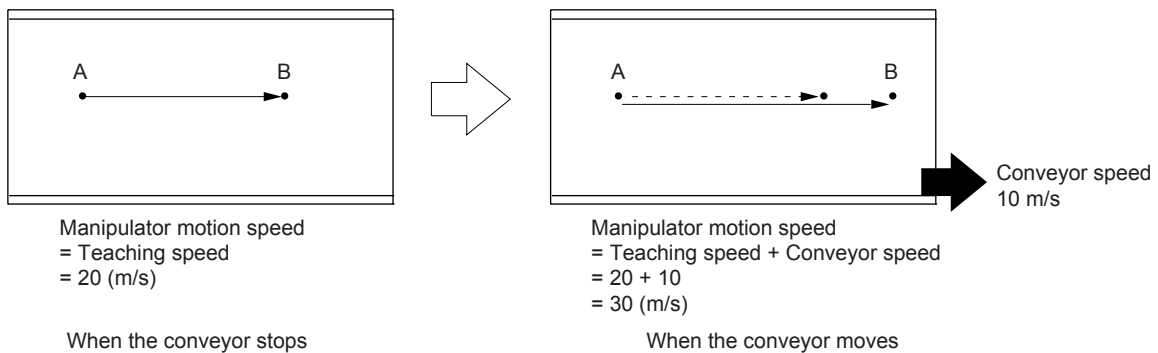


Fig. 5-2: When Teaching Direction is Different from Conveyor Moving Direction by 90°

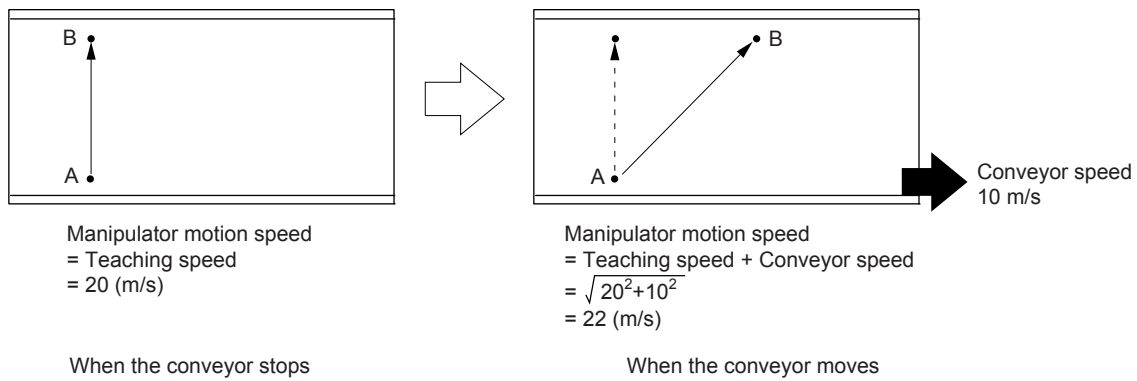
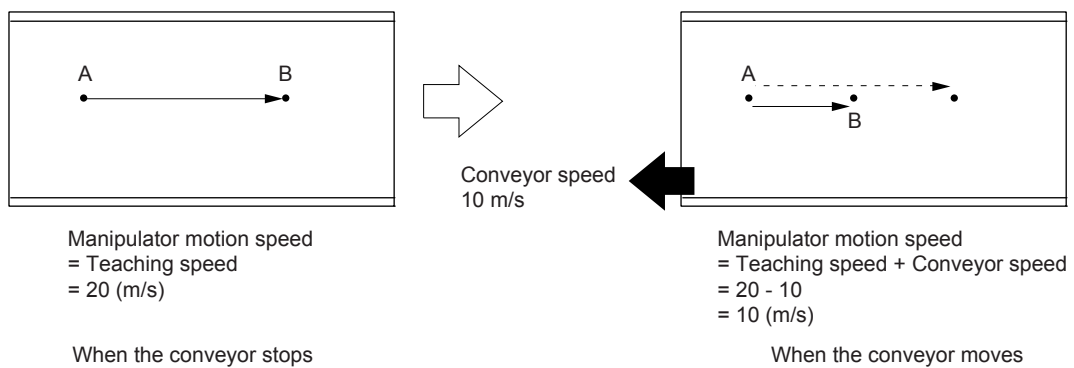
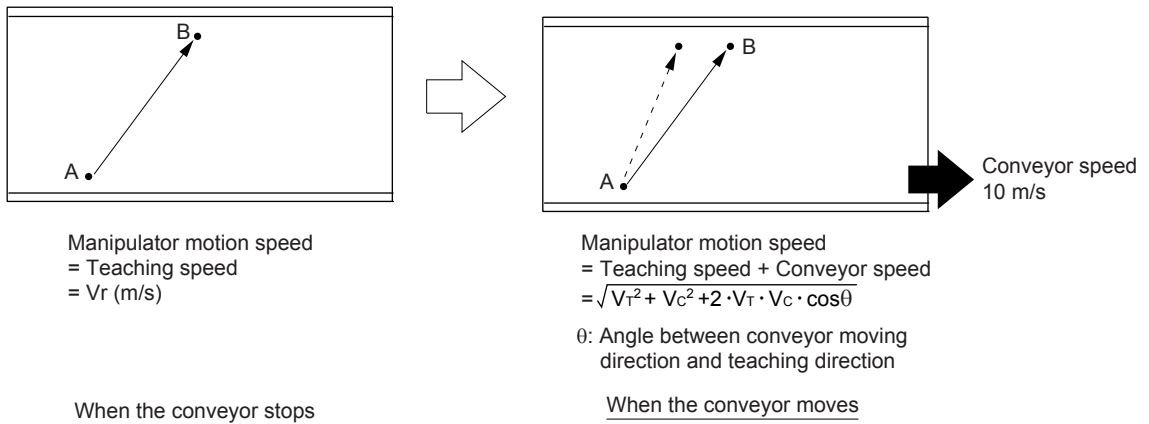


Fig. 5-3: When Teaching Direction is Opposite to Conveyor Moving Direction



*Fig. 5-4: Relation among Manipulator Motion Speed, Teaching Speed, and Conveyor Speed*



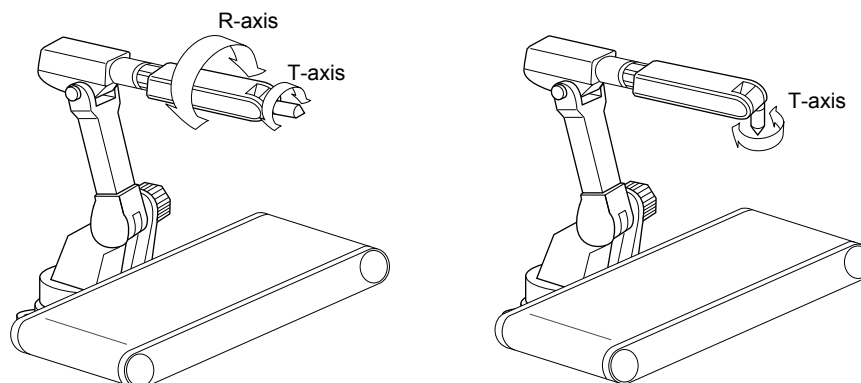
As shown in *Fig. 5-3*, the manipulator motion speed when the conveyor moves is slower than that when the conveyor stops even though the teaching speed remains same. On the contrary, in case of *Fig. 5-1*, the manipulator motion speed when the conveyor moves is faster than that when the conveyor stops.

Therefore, teaching in the direction opposite to the conveyor moving direction is more useful for manipulator.

### 5.3 Wrist Posture in Synchronization

In the synchronization section, the wrist maintains its taught posture while the manipulator is synchronizing the conveyor. Teach a posture so that the wrist can be moved in the conveyor moving direction.

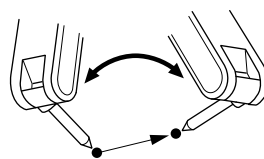
Fig. 5-5: Wrist Posture Not Recommended Fig. 5-6: Wrist Posture Recommended



For example, if the wrist is taught the posture as shown in Fig. 5-5, the structure of the manipulator prevents T-axis control in the conveyor moving direction. Trying to compensate this, R-axis turns sharply, possibly leading to an alarm such as segment over during the synchronized operation, which stops the manipulator.

On the contrary, if the wrist is postured as shown in Fig. 5-6 in teaching, T-axis can turn to adapt to position changes in the conveyor moving direction. In this case, sufficient clearance must be provided around the wrist to allow T-axis to turn for position control.

To check whether the wrist posture is appropriate, move the user coordinate X-axis in the conveyor moving direction with the wrist held in the taught posture to confirm that any axis does not move sharply.



With a move instruction for conveyor synchronized operation, when teaching is performed so that the posture changes largely in short distance, a segment over alarm may occur. To avoid such an alarm, take the following method.

- Set the speed not as “V = …(Tool center point speed)” but as “VR = … (Posture angle speed)”
- Lower the speed of “V = …”

## 5.4 Circular Interpolation Steps

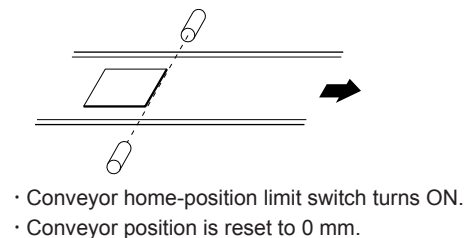
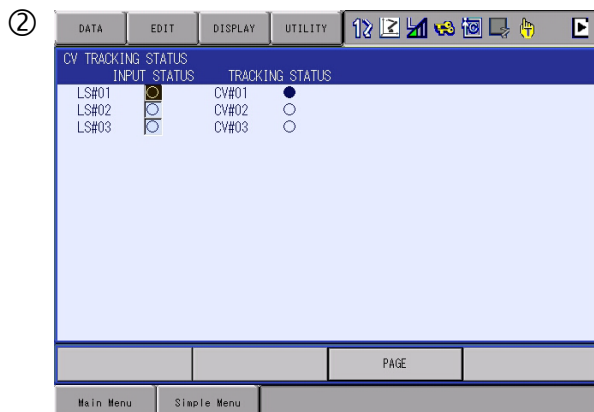
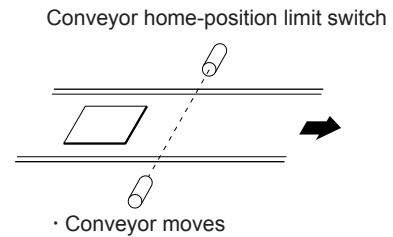
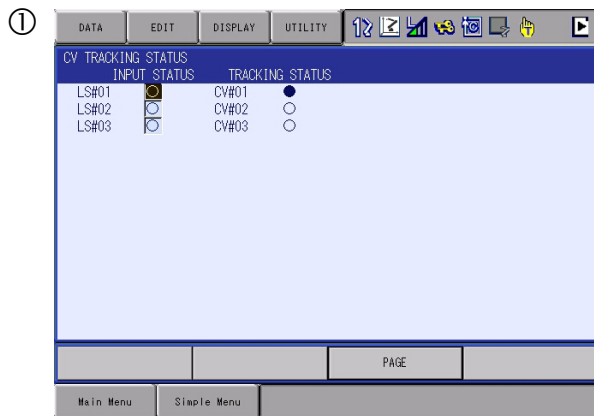
Continuous circular interpolation steps should be performed on the same conveyor position.

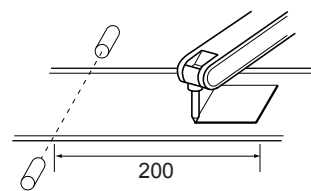
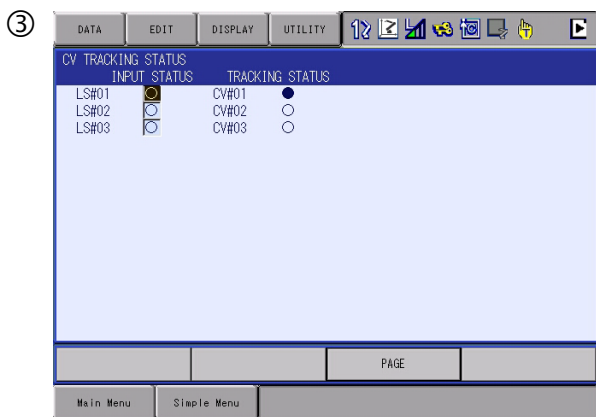
When continuous circular interpolation steps are taught on different conveyor positions, a path different from the taught path may be resulted in the synchronized operation.

## 5.5 Teaching

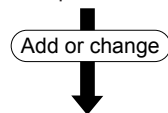
Since the conveyor positions at teaching are registered in a job, they must be properly set up in relation to the conveyor home-position (the position where the conveyor home-position limit switch is ON).

When teaching with a workpiece, move the conveyor and turn ON the conveyor home-position limit switch by the workpiece, then move to a teaching position. When the conveyor home-position limit switch is turned ON, the position where the switch is turned ON is registered automatically as the conveyor home-position.





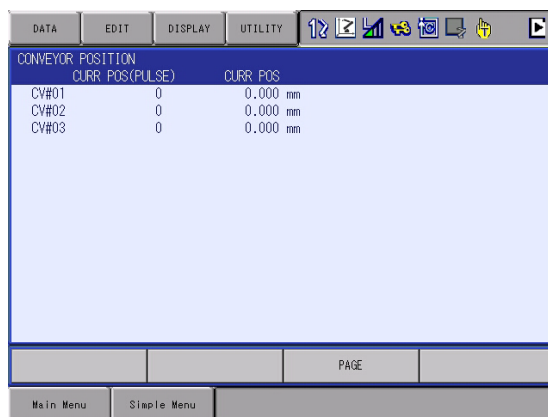
• Confirm by FWD operation, and add or change the step.



SYMOVL V=1000 CV#(1) CTP=200.000

**NOTE** Perform teaching after having confirmed that the conveyor is completely stopped. Teaching while the conveyor moves may cause an error or segment over alarm.

1. Select {ROBOT} under the top menu.
2. Select {CV MONITOR}.
  - The CONVEYOR POSITION window appears.





## 3. Move the conveyor.

- Move the conveyor, and after the conveyor home-position limit switch is ON, stop the workpiece at the teaching position. At the moment the conveyor home-position limit switch is ON, “CURR POS (PULSE)” in the conveyor position window is reset to “0”, which confirms that the counter is reset.

CONVEYOR POSITION		
	CURR POS(PULSE)	CURR POS
CV#01	0	0.000 mm
CV#02	0	0.000 mm
CV#03	0	0.000 mm

The screenshot shows a software interface with a menu bar (DATA, EDIT, DISPLAY, UTILITY) and a toolbar. Below the toolbar is the 'CONVEYOR POSITION' window with a table of data. At the bottom of the window are 'Main Menu' and 'Simple Menu' buttons.

## 4. Display JOB CONTENT window

## 5. Press [SHIFT] + [MOTION TYPE].

- The motion type is set to the conveyor synchronized interpolation mode.

## 6. Select a motion type

- Select a motion type to be used by pressing [MOTION TYPE].

## 7. Press an axis key.

- Move the manipulator to a desired position by using axis keys.

## 8. Press [ENTER].

- The step is registered.

## &lt;Example&gt;

When teaching is performed at the position 1000 mm from the conveyor home-position in linear interpolation, using the conveyor condition file No. 1, it will be registered as follows.

```
0005 SYMOVL V=100 CV#(1) CTP=1000.000
```

The registration after the above is the same as that for an ordinary teaching.

When a move instruction for conveyor synchronized operation is used again after the motion type mode is changed to other than conveyor synchronized interpolation mode in a teaching for air-cut and so on, the conveyor synchronized interpolation mode must be re-selected.

## 5.6 Teaching After Interruption of Playback in Synchronized Operation

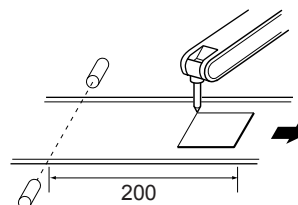
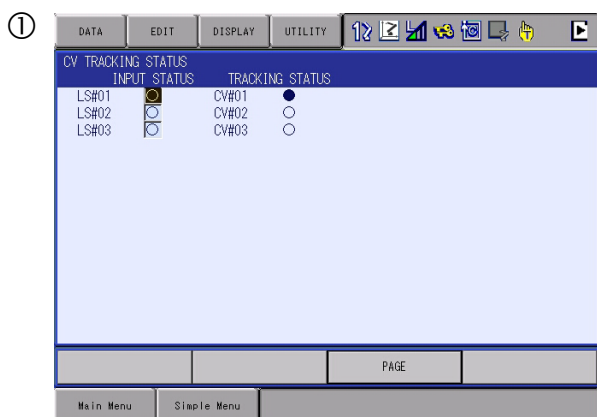
When the synchronized operation is interrupted by hold operation or switching to teach mode and so on during playback in synchronized operation, if another conveyor home-position is attempted to be registered, a conveyor home-position input signal is not accepted. At this moment, the tracking status in the conveyor tracking window is "ON" (marked with ●).

The operations in the following two cases are explained:

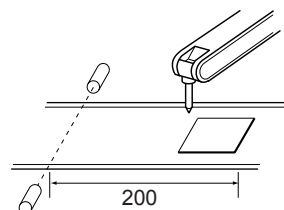
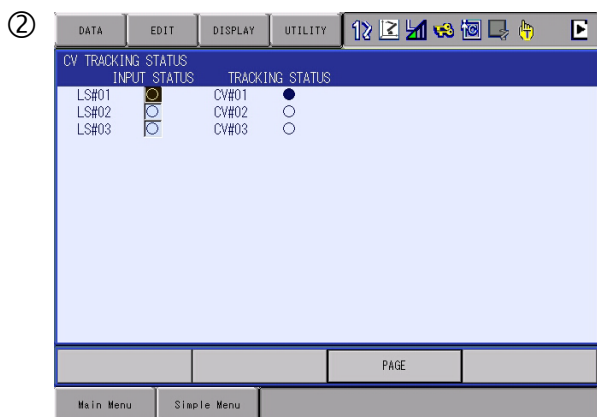
- When adding or changing step after interruption of synchronized operation.
- When performing another teaching (for other workpiece).

### 5.6.1 When Adding or Changing Step After Interruption of Synchronized Operation

In the state that the synchronized operation in play mode is interrupted, a step can be added or changed. Confirm the step position by FWD operation, then add or change.

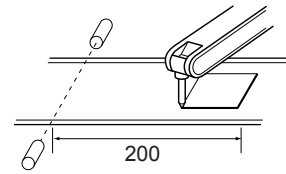
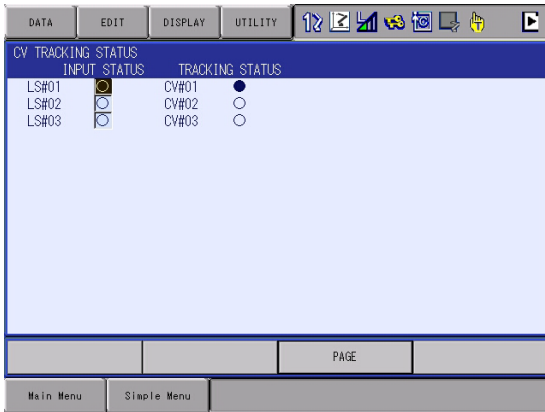


- During conveyor synchronized operation in play mode

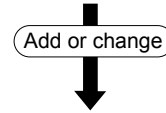


- Synchronized operation interrupted (Switched to teach mode. Manipulator stops; the conveyor also stops.)

③



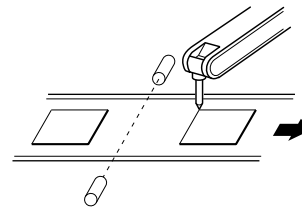
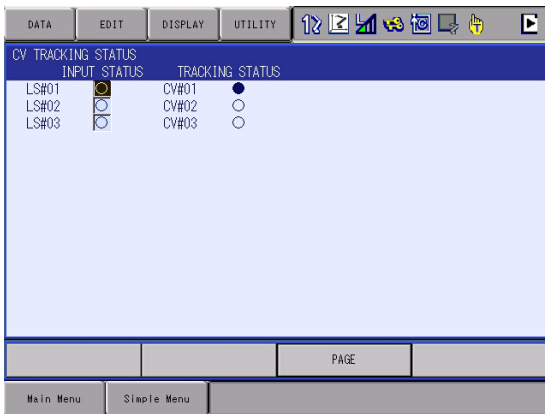
· Confirm by FWD operation, and add or change the step.



SYMOVL V=1000 CV#(1) CTP=200.000

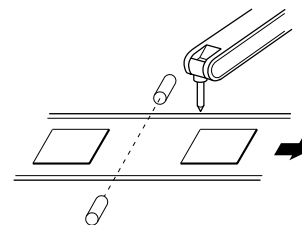
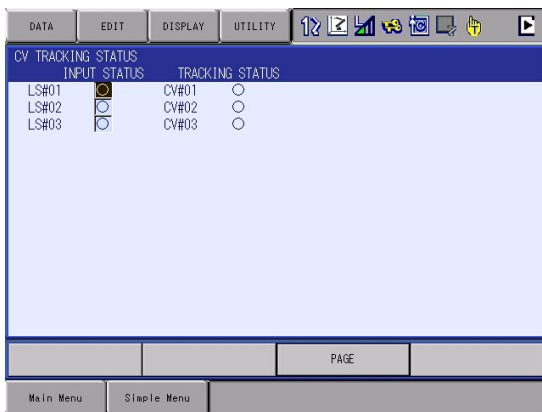
**5.6.2 When Performing Another Teaching (for Other Workpiece)**

1. Reset the synchronized operation status by executing an instruction SYEND or shutting down the control power supply.



· Conveyor synchronized operation interrupted.  
 (Switched to teach mode.  
 Manipulator stops; the conveyor also stops.)

2. Confirm that TRACKING STATUS in the conveyor tracking status window is OFF (marked with O).



· Execute SYEND instruction.

3. Move the conveyor, and turn ON the conveyor home-position limit switch by the workpiece.
4. Move the manipulator to the teaching point and teach.

## 5.7 Notes on Operation

The conveyor synchronized move instructions are special instructions for registering a conveyor position together with a manipulator position. Therefore, different from ordinary move instructions such as MOVJ, these instructions have the following restrictions on operations.

### 5.7.1 Confirming Reach to Step

When the manipulator reaches the target step in FWD/BWD operation or test run (step motion mode) by a conveyor synchronized move instruction, the operation is stopped and the cursor stops blinking. In this way, it can be easily confirmed that the manipulator reaches the target step.



When the manipulator reaches the target step, the cursor stops blinking, however, the cursor restarts blinking when the following operations are performed. In this case, move the cursor to the target step and perform FWD operation again.

- Emergency stop
- The cursor is moved in editing job
- File and job editing operation
- Jog operation

### 5.7.2 Backward (BWD) Operation

Releasing [FWD] and pressing [BWD] in middle of FWD operation does not return the manipulator to the previous step, but the manipulator continues the FWD operation to the next step. Pressing [BWD] after the manipulator reaches the next step, returns the manipulator to the previous step.

### 5.7.3 Changing Tool

The FWD operation of the first SYMOV□ instruction after changing a tool, should be performed on the conveyor position at changing a tool.

Performing the FWD operation after changing a tool and moving the conveyor causes a segment over alarm.

### 5.7.4 Deleting Taught Points

Before deleting a move instruction, the manipulator must be placed at the step position to be deleted. However, this condition can not be satisfied with conveyor synchronized move instructions. This is because a taught position for a conveyor synchronized move instruction is interpreted to different step positions on the conveyor position, as explained before. Therefore, ordinary deleting operation is not possible.

To delete a conveyor synchronized move instruction, press [MODIFY] to change the step position. Then, after the cursor blinks, press [DELETE].

## 5.8 Job Example

A basic job example is shown below.

Instruction	Explanation
NOP	
SYEND CV#(1)	Resets the conveyor home-position registered status. After then, a conveyor home-position limit switch signal is accepted.
MOVJ	After the job is started, the manipulator moves to its stand-by position.
SYSTART CV#(1) STP=100.000	Conveyor synchronization start instruction If the conveyor reaches the specified position (ex.: 100 mm), the conveyor synchronization starts.
GETS B000 \$B008	Converts system variable \$B008, which indicated whether the synchronized operation starts normally or not, to B000. Normal if B000 = 1, abnormal if B000 = 0.
JUMP *END IF B000=0	If B000 is 0 (synchronized operation could not start due to an error), jump to the label “*END”.
SYMOVL CV#(1) CTP=50.000       SYMOVL CV#(1) CTP=50.000	Conveyor synchronized move instruction Moves in conveyor synchronized status.
*END	Jump destination in case of failure in normal starting of conveyor synchronized operation
SYEND CV#(1)	Ends the conveyor synchronized operation.
MOVJ END	The manipulator returns to the stand-by position. End.

## 6 Playback

### 6.1 Conveyor Speed Down

When the conveyor slows down while the manipulator is synchronizing the conveyor, the manipulator will react according to the mode setting in the conveyor condition data file:



Conveyor Condition File Window

- EXECUTE

Regardless of the conveyor speed, the manipulator continues its operation.

- ALARM

An alarm occurs when the conveyor speed slows down.

- PAUSE JOB

The manipulator stops the job operation but only continues follow-up motion when the conveyor speed slows down.

For details of these three modes, refer to “[⑮](#) CONVEYOR SPEED DOWN MODE (EXECUTE/ALARM/PAUSE JOB)” explained in *section 4.1 “Conveyor Condition File” on page 4-1*.

## 6.2 Accuracy

The conveyor synchronized operation function reproduces the path taught with the conveyor in stop status.

Therefore, the accuracy of conveyor synchronized operation function is determined by the amount of difference between the taught path and the synchronized path. Since the object is moving, it is impossible to appreciate the accuracy in the same way as the repetitive positioning accuracy for the still-object.

The amount of difference between the taught path and the synchronized path is resulted from the following factors in interaction. Even if the following factors are adjusted not to cause the difference, the difference shows about ten times the difference from repetitive positioning for still-object.

- Linearity of the conveyor in the synchronization section.
- Conveyor movements that are not indicated in motion pulse data from a conveyor encoder (such as swings with a hanger conveyor).
- Differences between the manipulator actual dimensions and the dimensions registered in DX200.
- Conversion resolution error that occurs when converting the conveyor motion pulse (number of pulses) from the conveyor encoder to the conveyor moving amount (mm). The details of conversion resolution error will be explained in *section 6.3 "Conveyor Resolution Error"*.
- Manipulator mechanical accuracy such as arm bending.
- Follow-up delay for the conveyor speed fluctuation.
- Manipulator system lag time.
- Difference between the conveyor moving direction and the traveling axis moving direction when the synchronization is performed by the traveling axis.

## 6.3 Conveyor Resolution Error

The synchronization error resulted from the conveyor resolution setting error increases as the conveyor position value increases. The farther the conveyor moves, the bigger the synchronization error becomes. The minimum value for conveyor positional resolution setting is 0.01  $\mu\text{m}$ . Therefore, a maximum error of 0.005  $\mu\text{m}$  per pulse may occur.

For example, when the conveyor resolution is 10  $\mu\text{m}$  and the synchronization distance is 2 m, 200000 pulses are output while the conveyor moves for 2 m. Since the maximum error per pulse is 0.005  $\mu\text{m}$ , the synchronization error would be: 200000 pulses \* 0.005  $\mu\text{m}$  = 1 mm.

## 6.4 Restarting Synchronization After Manipulator Stops

When a manipulator stops during the conveyor synchronized operation in the following cases, the synchronized operation is restarted by restarting the manipulator:

- Minor failure alarm (excluding occurrence of alarm related to the conveyor synchronized function)
- Emergency stop or external emergency stop
- Hold or external hold
- Switch of the mode (mode switching between play and teach mode)
- Switch of the operation cycle (switching among auto/ 1 cycle/ step)

## 6.5 Continuance of Conveyor Synchronized Status

The conveyor synchronized status started by execution of SYSTART instruction remains until SYEND instruction is executed or the control power supply is turned OFF. Even if a manipulator stops in the cases explained in the previous section, the conveyor synchronized status remains.

Note that conveyor synchronized status is canceled when a job is executed after the cursor is moved in teach mode, the master job is called or a job selection is made.

## 6.6 Continuance of Parallel Shift Status

The parallel shift status in the conveyor synchronized status continues even after a manipulator stops in the cases explained in the previous section. However, the parallel shift status is cleared in the following cases. Be careful when using the parallel shift function in combination with the conveyor synchronized function.

- Execution of SFTOF instruction
- The cursor is moved in teach mode
- The master job is called
- Job selection
- The main power supply is shut down.

## 6.7 Conveyor Synchronized Operation During Execution of TIMER and WAIT

While the manipulator is in waiting status by execution of TIMER, WAIT, and so forth, the conveyor synchronized operation continues.



## 7 Conveyor Monitoring Windows

There are three windows for conveyor monitoring as follows:

- Conveyor position window.
- Conveyor speed window.
- Conveyor tracking status window.

Call each window in the following manner.

1. Select {ROBOT} under the top menu.
2. Select {CV MONITOR}.
3. Display the conveyor position window.
4. Display a desired window.

– [PAGE] switches from one window to another in the following order:

CONVEYOR POSITION window → CONVEYOR SPEED window → CV TRACKING STATUS window.

Press [SHIFT] + [PAGE] to return to the previous window.

## 7.1 Conveyor Position Window

CONVEYOR POSITION		
	CURR. POS(PULSE)	CURR. POS
CV#01:	0	0.000 mm
CV#02:	0	0.000 mm
CV#03:	0	0.000 mm

The screenshot shows a software window titled 'CONVEYOR POSITION'. It has a menu bar with 'DATA', 'EDIT', 'DISPLAY', and 'UTILITY'. Below the menu bar is a toolbar with various icons. The main area contains a table with three columns: 'CONVEYOR POSITION', 'CURR. POS(PULSE)', and 'CURR. POS'. The table has three rows of data for CV#01, CV#02, and CV#03. All values are 0. Below the table, there are buttons for 'Main Menu' and 'Simple Menu', and a 'PAGE' indicator.

### ① Conveyor Condition File No.

CV#1 to CV#3 are displayed.

### ② CURR POS (PULSE)

The number of feedback pulses from the encoder connected to the conveyor calculated on the base of the position where the conveyor home-position limit switch turns ON as "0". Used for setting of conveyor resolution.

### ③ CURR POS (mm)

The value converted from the number of pulses of current position into the distance from the position where the conveyor home-position limit switch turns ON by using the resolution. When the resolution is not set, "0" is displayed.

## 7.2 Conveyor Speed Window

CONVEYOR	SPEED	CORRECT POS
CV#01	0.0 mm/sec	0.000 mm
CV#02	0.0 mm/sec	0.000 mm
CV#03	0.0 mm/sec	0.000 mm

The screenshot shows a software window titled 'CONVEYOR SPEED'. It contains a table with three columns: 'CONVEYOR', 'SPEED', and 'CORRECT POS'. The table lists three conveyor units (CV#01, CV#02, CV#03) with their respective speeds (0.0 mm/sec) and corrected positions (0.000 mm). Three callouts are present: callout 1 points to the 'CONVEYOR' column, callout 2 points to the 'SPEED' column, and callout 3 points to the 'CORRECT POS' column. The window has a menu bar at the top with 'DATA', 'EDIT', 'DISPLAY', and 'UTILITY' options, and a toolbar with various icons. At the bottom, there are buttons for 'Main Menu' and 'Simple Menu', and a 'PAGE' indicator.

① **Conveyor Condition File No.**

CV#1 to CV#3 are displayed.

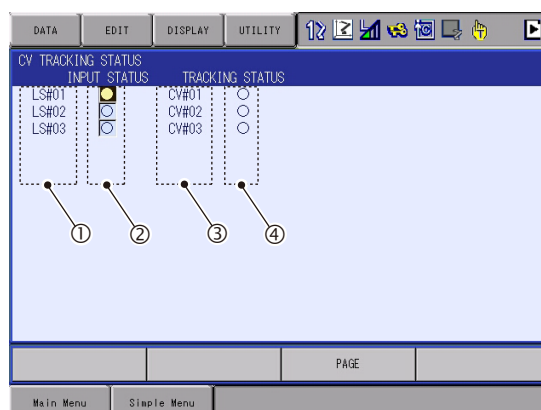
② **SPEED (mm/sec)**

Conveyor averaged speed per 0.1 sec.

③ **CORRECT POS (mm)**

The manipulator follows up the conveyor with a certain delay time to the input conveyor position. Therefore, performing the follow-up motion according to the conveyor current position causes a follow-up error. With the DX200, the follow-up motion is performed according to the conveyor position compensated for the follow-up error. This compensated conveyor position is displayed here.

## 7.3 Conveyor Tracking Status Window



### ① Conveyor Home-Position Input Signal No.

The conveyor home-position input signal Nos. LS#1, LS#2, and LS#3 are the input signals connected to CN1, CN2, and CN3 respectively.

### ② INPUT STATUS

Indicates each conveyor home-position input status.

●: Indicated when the manipulator is not synchronizing the conveyor and the conveyor home-position input signal turns ON.

○: Indicated when the conveyor home-position input signal turns OFF.

### ③ Conveyor Condition File No.

CV#1 to CV#3 are displayed.

### ④ TRACKING STATUS

Indicates the manipulator synchronizing status.

●: Indicated when the manipulator is in synchronized operation status after the synchronized operation starts by execution of SYSTART instruction or after SYMOV□ instruction is executed in FWD operation.

As long as “●” is indicated, the conveyor home-position input signal is not accepted and the synchronized status remains until the execution of SYEND instruction or the control power supply is shut down.

Note that conveyor synchronized status is canceled when a job is executed after the cursor is moved in teach mode, the master job is called or a job selection is made.

○: Indicated when the manipulator synchronizing status is canceled.

## 8 Virtual Encoder Mode

### 8.1 Virtual Encoder Pulse Count

When the manipulator is stopped during operation with a virtual encoder, the virtual encoder pulse counting is stopped as well as the manipulator. Since the virtual encoder continues counting pulses by restarting the manipulator, the manipulator can be restarted from the position where it stopped.

### 8.2 Relation Between Encoder Input and Virtual Encoder Input

There are two types of settings for encoder input:

- Setting by “ENCORDER INPUT” in the conveyor condition file.
- Setting by “VIRTUAL ENCORDER INPUT” in the conveyor condition file.

The relation between “ENCORDER INPUT” setting and the virtual encoder by “general purpose input signal” setting is as follows:

- When the “ENCORDER INPUT” = “VIRTUAL ENCDR”  
Regardless of the status of general purpose input signal, the manipulator operates with the virtual encoder pulse.
- When the “ENCORDER INPUT” = “ENCORDER”  
When the general input signal is ON, the manipulator operates with the virtual encoder pulse.  
When the general input signal is OFF, the manipulator operates with the encoder input.

### 8.3 Precaution on Switching the Encoder Mode

Switching the mode “Encoder/Virtual Encoder” by the general purpose input signal during the conveyor synchronized operation causes the alarm “CANNOT CHANGE CONVEYOR MODE”.

Be sure to switch the encoder mode by the general purpose input signal while the manipulator is not in the conveyor synchronized operation.

## 9 Turntable Synchronized Function

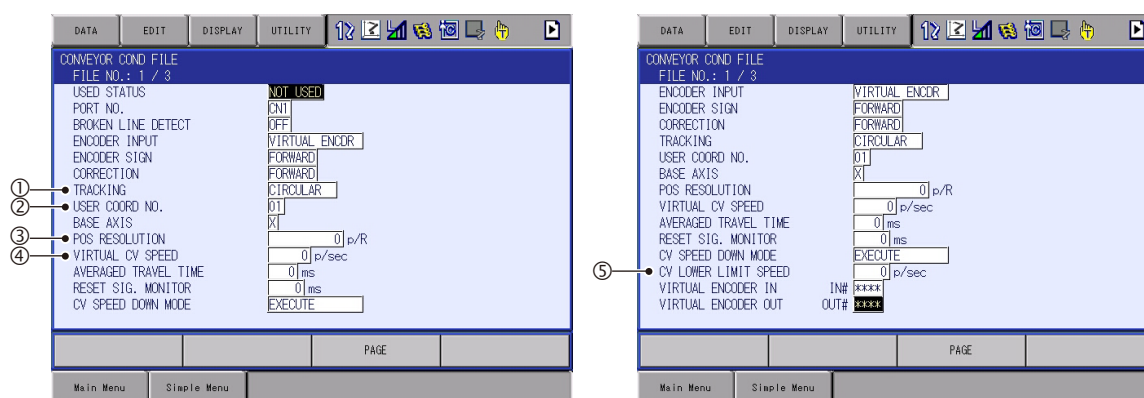
### Functional Overview

This function enables interpolation motion of the manipulator, synchronized with circular conveyor and turntable.

### 9.1 Setting Up the Turntable Synchronized System

#### 9.1.1 Settings for Conveyor Condition File

To use this function, set the TRACKING (①) in CONVEYOR COND FILE window to "CIRCULAR". (Use a cursor key to scroll the window.)



#### ① TRACKING (ROBOT-AXIS/BASE-AXIS/CIRCULAR)

CIRCULAR: specify CIRCULAR for turntable synchronized function. If CIRCULAR is specified, the manipulator performs a circular tracking operation in accordance with a result of calibration executed in section 9.1.2 "Calibration between Manipulator and Turntable" on page 9-2.

#### ② USER COORD NO. (1 to 63)

Specify the user coordinate number to store the result of calibration (relative position of the turntable).

#### ③ POS RESOLUTION (1 to 2147483647 pulse/rev)

Set a pulse count from encoder per turntable revolution. If the turntable positional resolution is unknown, use the data calculated in the calibration.

#### ④ VIRTUAL CV SPEED (-32767 to +32767 pulse/sec)

#### ⑤ CV LOWER LIMIT SPEED (0 to 65535 pulse/sec)

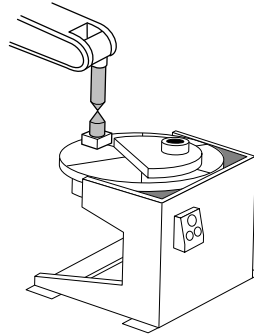
Input unit changes to "mm/sec" to "p/sec" by setting the tracking method (item ①) to CIRCULAR.

### 9.1.2 Calibration between Manipulator and Turntable

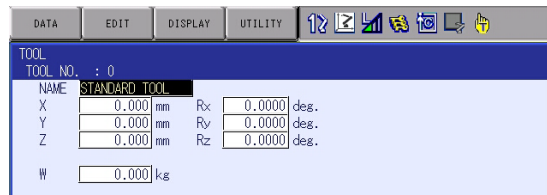
The manipulator-turntable calibration is a setting required before carrying out a synchronized operation of manipulator and turntable. Before the synchronized operation, register their positional correlation following the procedures explained in this section.

#### 9.1.2.1 Setting a Calibration Tool

1. Equip the manipulator with a calibration tool.
  - Use a tool of which accurate dimensions are given.



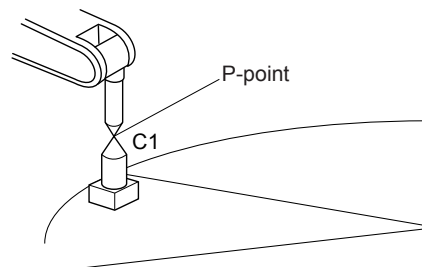
2. Select {ROBOT} under the top menu.
3. Select {TOOL}.
  - The TOOL window appears.



4. Input the tool measurement.
5. Press [ENTER].

#### 9.1.2.2 Teaching Calibration Position

1. Define a desired point (P-point) on turntable.
  - Adjust the manipulator control point to the P-point, and register C1.

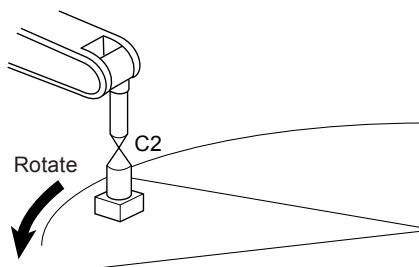


2. Rotate the turntable to desirable extent. (Make sure to rotate it in direction of normal rotation.)

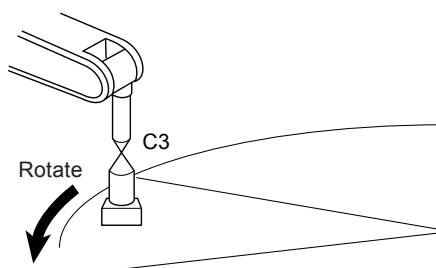
## 9 Turntable Synchronized Function

### 9.1 Setting Up the Turntable Synchronized System

Adjust the manipulator control point to the rotated P-point, and register C2.

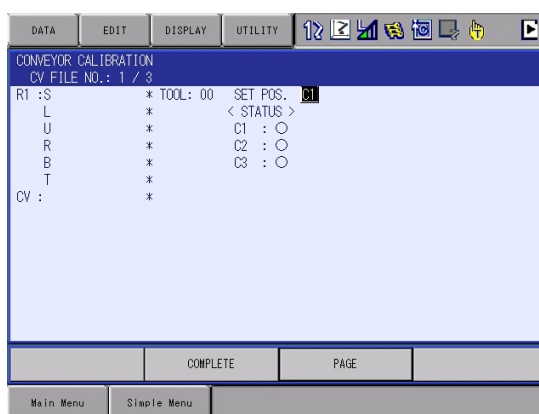


3. Rotate the turntable in the same direction as the previous step. Adjust the manipulator control point to the rotated P-point, and register C3.



#### 9.1.2.3 Operating Calibration

1. Select {ROBOT} under the top menu.
2. Select {CONVEYOR CALIBRATION}.
  - The CONVEYOR CALIBRATION window appears.
  - Conveyor numbers correspond to the conveyor condition file number.
 (Note that this process can be achieved by pressing [PAGE].)



3. Select the number corresponding to the conveyor condition file.
4. Select {ROBOT}.
5. Select {SET POS}.
6. Turn ON the home position limit switch by moving the turntable.
7. Move the manipulator to the calibration position with axis keys.

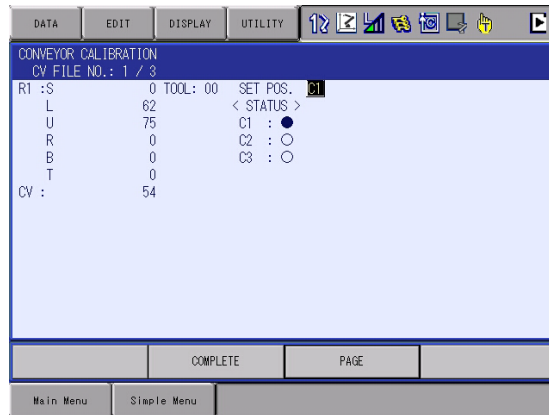


## 9 Turntable Synchronized Function

## 9.1 Setting Up the Turntable Synchronized System

## 8. Press [MODIFY], then [ENTER].

- The taught position will be displayed on the window.



## 9. Select {COMPLETE}.

- The calibration position is registered.
- The taught coordinates are registered in the user coordinate number which is specified in the conveyor condition file. The registered data can be modified by inputting numbers.



- The turntable positional resolution will be calculated when the calibration is carried out.
- If the turntable positional resolution has not been given, set the calculated resolution in the conveyor condition file.

## 9.2 Modifying Instructions

In case of using the turntable synchronized function, the units used for distance and speed are changed from mm ( $\mu$ ) to pulse. The instructions are modified accordingly as follows:

- SYSTART Instruction

[Linear Conveyor Synchronization]

SYSTART CV (#1) STP=50.000 OL=10.0

[Turntable Synchronization]

SYSTART CV (#1) STPP=5000 OLP=100

①                      ②

① Synchronization start position in pulse

Set the conveyor position where the synchronized operation starts in pulse.

② Tolerance

Specify the maximum excess in pulse to execute the synchronized operation when the conveyor current position value exceeds the synchronization start position value at the execution of SYSTART instruction. Tolerance check will not be executed if setting is omitted or specified at 0.

- SYMOV□ Instruction

[Linear Conveyor Synchronization]

SYMOVL V=200.0CV (#1) CTP=100.000

SYMOVC V=200.0CV (#1) CTP=100.000

[Turntable Synchronization]

SYMOVL V=200.0CV (#1) CTPP=100.000

SYMOVL V=200.0CV (#1) CTPP=100.000

①

① Conveyor position at teaching

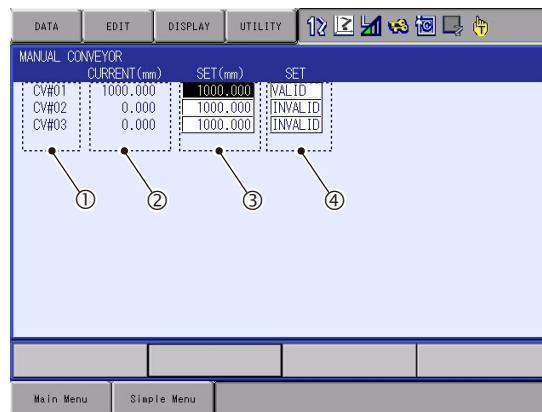
Set the conveyor position for teaching in pulse.

## 10 Manual Conveyor Function

Manual Conveyor Function is a manual setting function for conveyor position. This function enables the conveyor position to be set from the programming pendant without moving the conveyor to modify the taught job.

With this function, instead of moving the conveyor to move the workpiece to the teaching position, by removing a fastening device such as a dog and moving the workpiece to the desired position on the conveyor, the conveyor position can be input to modify the taught job. When the taught job is modified by using the Manual Conveyor Function, the newly set value of the conveyor position is registered to the value of CTP when the registration of the move instruction for the synchronized motion (SYMOV□) is modified.

1. Select {ROBOT} under the top menu.
  2. Select {MANUAL CONVEYOR}.
- The MANUAL CONVEYOR window appears.



### ① Conveyor Condition File No.

CV#1 to CV#3 are displayed.

### ② CURRENT (mm)

Indicates the conveyor's current position (in actual amount of pulses). When the Manual Conveyor Function is used, the position data set is displayed.

### ③ SET (mm) (0 to 21000 mm)

Sets the conveyor position. A value out of the setting range cannot be entered.

### ④ SET

Enables or disables the manual setting mode for the conveyor position.

## 10.1 Settings for Manual Conveyor Function

### 10.1.1 Setting the Conveyor Position

1. Move the cursor to the desired value in the column of the {SET (mm)}

2. Enter a value using [Numeric Keys].

### 10.1.2 Enabling/Disabling the Setting

1. Move the cursor to the desired value in the column of the {SET}.
2. Press [SELECT].
  - “VALID” and “INVALID” switch alternately.

## 10.2 Precautions

### 10.2.1 When the Power is Turned ON

When the power is turned ON, all the setting for the Manual Conveyor Function are disabled regardless of the play or teach mode, and the actual conveyor positions are indicated in {CURRENT (mm)}.

When the MANUAL CONVEYOR window is called up after the power is turned ON, “\*\*\*” appears in the column of {SET (mm)}. The set conveyor positions are retained until the power is turned OFF.

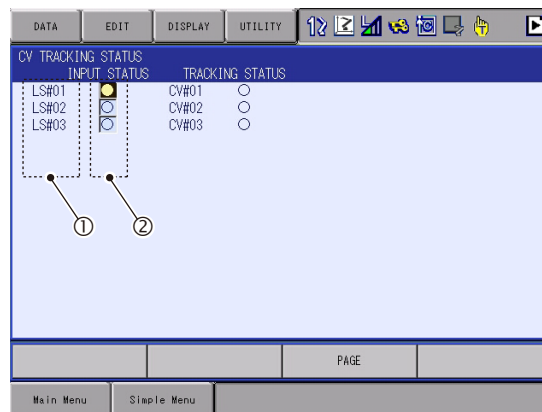


- When the teach mode is switched to the play mode while the Manual Conveyor Function is enabled, the function is automatically disabled.
- The MANUAL CONVEYOR window can be viewed only in the teach mode.
- The Manual Conveyor Function is enabled only when the turntable synchronized function is disabled.

## 11 Manual Setting Function for Conveyor Home-Position Limit Switch

When the conveyor home-position limit switch cannot be turned ON, it can be pseudonymously turned ON in the following manner:

1. Open the CV TRACKING STATUS window.



### ① LS#

Indicates the conveyor home-position input signal number.

### ② INPUT STATUS

Indicates the conveyor home-position input signal status, or inputs the conveyor home-position input signal.

2. Move the cursor to the limit switch number connected to the conveyor home-position input signal that is set in PORT NO. in the conveyor condition file.
3. By pressing [INTERLOCK] and [SELECT] at the same time, select "ON" status to pseudonymously turn the conveyor home-position input signal ON.

The manual setting function for pseudo ON of the conveyor home-position limit switch is valid only in the teach mode. This function is disabled in the play mode.

## 12 Instruction List

“< >” indicates numerical or alphabetical data. If one or more items are shown in one section, select one of them.

SYSTART	Function	Starts the conveyor synchronized operation.	
	Instruction items	CV# (<Conveyor condition file No.>)	1 to 3
		STP= <Synchronization start position (mm)>	
		OL= <Tolerance (mm)>	When omitted or 0 is set, the tolerance check is not performed.
Example	SYSTART CV#(1) STP=100.000		
SYMOVJ <sup>1)</sup>	Function	Moves in joint motion in synchronization with the conveyor.	
	Instruction items	CV# (<Conveyor condition file No.>)	1 to 3
		CTP= <Conveyor position at teaching (mm)>	
		VJ= <Play speed (%)>	VJ: 0.01 to 100.00
Example	SYMOVJ VJ=50.00 CV#(1) CTP=100.000		
SYMOVL	Function	Moves in linear interpolation in synchronization with the conveyor.	
	Instruction items	CV# (<Conveyor condition file No.>)	1 to 3
		CTP= <Conveyor position at teaching (mm)>	
		V= <Play speed>	V: 0.1 to 1500.0 mm/sec. 0.6 to 9000.0 cm/min.
Example	SYMOVL V=200.0 CV#(1) CTP=100.000		
SYMOVC	Function	Moves in circular interpolation in synchronization with the conveyor.	
	Instruction items	CV# (<Conveyor condition file No.>)	1 to 3 Can be omitted.
		CTP= <Conveyor position at teaching (mm)>	
		V= <Play speed>	V: 0.1 to 1500.0 mm/sec. 0.6 to 9000.0 cm/min.
Example	SYMOVC V=200.0 CV#(1) CTP=100.000		
SYEND	Function	Ends the conveyor synchronized operation.	
	Instruction items	CV# (<Conveyor condition file No.>)	1 to 3
	Example	SYEND CV#(1)	

1 SYMOVJ can be used only when synchronizing with a base axis.

## 13 Alarm List

Alarm No.	Message	Causes	Corrective Actions
1003	ROM ERROR (YCP02)		Replace the YCP02 board (ROM).
1109	SYSTEM ERROR (CONVEYOR) [10], Decimal Data: 0 to 255	Internal error.	Replace the YCP02 board.
1400	CONVEYOR ENCODER ERROR [Error occurred conveyor No: 1, 2, 3]	Conveyor encoder error at the error occurred conveyor No.	Replace the encoder cable or the encoder.
1401	CANNOT CHANGE CONVEYOR MODE	The encoder mode "ENCODER/ VIRTUAL ENCDR" has been switched by the general purpose input signal during the conveyor synchronized operation.	Switch the encoder mode by the general purpose input signal while the manipulator is not in the conveyor synchronized operation.
4021	MEMORY ERROR (CONVEYOR CONDITION FILE) [10], Decimal Data: 0 to 255	The conveyor condition file data in the memory has been destroyed.	Initialize the conveyor condition file in customer maintenance mode.
4530	CONVEYOR SYNCHRONIZATION ERROR [10], Decimal Data; 0 to 255	1: The base axis specification in the conveyor condition file is set to other than 0, 1, and 2. 2: The robot axis for tracking robot axis does not exist. 3: The base axis does not exist in the job for tracking the base axis. The error data other than 1, 2, and 3 is an internal error.	Turn the power OFF then back ON. If the alarm occurs again, contact your YASKAWA representative.
4531	UNDEFINED CONVEYOR COND FILE [10], Decimal Data: 0 to 255	The conveyor condition file specified for the job is not set for use.	Set the conveyor condition file to "USED"
4532	CONVEYOR SPEED DOWN [10], Decimal Data: 0 to 255	When the mode for conveyor speed down mode in the conveyor condition file is set to "ALARM", the conveyor speed is lowered to less than its lower limit specified in the conveyor condition file.	Increase the conveyor speed so that it becomes larger than the conveyor speed lower limit specified in the conveyor condition file.
4533	ARITHMETIC ERROR [10], Decimal Data, 0 to 255	Internal error.	Turn the power OFF then back ON. If the alarm occurs again, contact your YASKAWA representative.

<b>Alarm No.</b>	<b>Message</b>	<b>Causes</b>	<b>Corrective Actions</b>
4538	CAN NOT USE SMOVJ DURING TRACKING [10], Decimal Data, 0 to 255	SYMOVJ was executed when a robot axis was used for synchronization.	SYMOVJ can be used only when the base axis is used for synchronization.
5020	SENSOR PARAMETER ERROR [10], Decimal Data: 0 to 255	On the YCP02 board, when parameters were calculated using data in the conveyor condition file, an operation error occurred.	Check whether the data are properly set in the conveyor condition file. Confirm: -that "0" is not set for the user coordinate number. -that "0" is not set for the conveyor positional resolution.
5022	CONVEYOR POSITION LIMIT OVER [Alarm occurred conveyor condition file No: 1, 2, or 3]	The corrected conveyor position value exceeds $\pm 21$ m	Review the synchronized section. After this alarm occurs, the conveyor position is not updated. Therefore, the synchronized operation is not performed after the alarm is reset, and the manipulator continues operation at the position where the alarm occurred.
5023	CONVEYOR COUNTER LIMIT OVER [Alarm occurred conveyor condition file No: 1, 2, or 3]	The conveyor position counter pulse overflowed.	Review the conveyor resolution or the synchronized section. After this alarm occurs, the conveyor position is not updated. Therefore, the synchronized operation is not performed after the alarm is reset, and the manipulator continues operation at the position where the alarm occurred.



## 14 Sensor Parameters (SxE)

Use the sensor parameters with their initial value settings.

No.	Contents	Initial Value
0	Application designation	16
1	Time to recognize the input of start signal	5
2	Reference time to recognize the occurrence of speed down	100
3	Time for averaging the speed variation amount	60
4	Time to recognize the falling edge of start signal	5

# DX200 OPTIONS INSTRUCTIONS

## FOR CONVEYOR SYNCHRONIZED FUNCTION

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