XRC and XRC 2001 Controller

Conveyor Tracking Function Manual
for UP/SKX-Series Robots

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## TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 INTRODUCTION</td>
<td></td>
</tr>
<tr>
<td>1.1 About this Document</td>
<td>1-1</td>
</tr>
<tr>
<td>1.2 Reference to Other Documentation</td>
<td>1-1</td>
</tr>
<tr>
<td>1.3 Customer Service Information</td>
<td>1-1</td>
</tr>
<tr>
<td>2 SAFETY</td>
<td></td>
</tr>
<tr>
<td>2.1 Introduction</td>
<td>2-1</td>
</tr>
<tr>
<td>2.2 Standard Conventions</td>
<td>2-2</td>
</tr>
<tr>
<td>2.3 General Safeguarding Tips</td>
<td>2-4</td>
</tr>
<tr>
<td>2.4 Mechanical Safety Devices</td>
<td>2-4</td>
</tr>
<tr>
<td>2.5 Installation Safety</td>
<td>2-5</td>
</tr>
<tr>
<td>2.6 Programming Safety</td>
<td>2-5</td>
</tr>
<tr>
<td>2.7 Operation Safety</td>
<td>2-6</td>
</tr>
<tr>
<td>2.8 Maintenance Safety</td>
<td>2-7</td>
</tr>
<tr>
<td>3 CONVEYOR TRACKING (SYNCHRONIZED) FUNCTION</td>
<td></td>
</tr>
<tr>
<td>1 Conveyor Synchronized Function</td>
<td>1-1</td>
</tr>
<tr>
<td>2 Hardware Specifications</td>
<td>2-1</td>
</tr>
<tr>
<td>3 Connector Connection</td>
<td>3-1</td>
</tr>
<tr>
<td>4 Settings for Conveyor Condition File</td>
<td>4-1</td>
</tr>
<tr>
<td>5 Teaching</td>
<td>5-1</td>
</tr>
<tr>
<td>6 Playback</td>
<td>6-1</td>
</tr>
<tr>
<td>7 Conveyor Monitoring Displays</td>
<td>7-1</td>
</tr>
<tr>
<td>8 Virtual Encoder Mode</td>
<td>8-1</td>
</tr>
<tr>
<td>9 Instruction List</td>
<td>9-1</td>
</tr>
<tr>
<td>10 Alarm List</td>
<td>10-1</td>
</tr>
<tr>
<td>11 Sensor Parameters (SxE)</td>
<td>11-1</td>
</tr>
<tr>
<td>12 Turntable Synchronized Function</td>
<td>12-1</td>
</tr>
</tbody>
</table>
SECTION 1
INTRODUCTION

1.1 About this Document
This manual provides instructions for Conveyor Tracking Function and contains the following sections:

SECTION 1 – INTRODUCTION
General information about this manual, a list of reference documents, and customer service information.

SECTION 2 – SAFETY
Provides information for the safe use and operation of Motoman products.

SECTION 3 – CONVEYOR TRACKING FUNCTION
Provides detailed instructions to utilize the Conveyor Tracking Function.

1.2 Reference to Other Documentation
For additional information refer to the following:
• Concurrent I/O & Parameters Manual (P/N 142102-1)
• Operator’s Manual for General Purpose (P/N 142099-1)
• Operator’s Manual for Handling (P/N 142100-1)
• Operator’s Manual for Spot Welding (P/N 142101-1)
• Operator’s Manual for Arc Welding (P/N 142098-1)
• Motoman UP6, XRC Manipulator Manual (P/N 142104-1)
• Motoman SK16X, XRC Manipulator Manual (P/N 142105-1)
• Motoman SK45X, XRC Manipulator Manual (P/N 142106-1)
• Motoman UP130, XRC Manipulator Manual (P/N 142107-1)

1.3 Customer Service Information
If you are in need of technical assistance, contact the Motoman service staff at (937) 847-3200. Please have the following information ready before you call:
• Robot Type (UP6, SK16X, etc.)
• Application Type (welding, handling, etc.)
• Robot Serial Number (located on the back side of the robot arm)
• Robot Sales Order Number (located on back side of XRC controller)
SECTION 2
SAFETY

2.1 Introduction

It is the purchaser’s responsibility to ensure that all local, county, state, and national codes, regulations, rules, or laws relating to safety and safe operating conditions for each installation are met and followed.

We suggest that you obtain and review a copy of the ANSI/RIA National Safety Standard for Industrial Robots and Robot Systems. This information can be obtained from the Robotic Industries Association by requesting ANSI/RIA R15.06. The address is as follows:

Robotic Industries Association
900 Victors Way
P.O. Box 3724
Ann Arbor, Michigan 48106
TEL: (734) 994-6088
FAX: (734) 994-3338

Ultimately, the best safeguard is trained personnel. The user is responsible for providing personnel who are adequately trained to operate, program, and maintain the robot cell. **The robot must not be operated by personnel who have not been trained!**

We recommend that all personnel who intend to operate, program, repair, or use the robot system be trained in an approved Motoman training course and become familiar with the proper operation of the system.

This safety section addresses the following:

- Standard Conventions (Section 2.2)
- General Safeguarding Tips (Section 2.3)
- Mechanical Safety Devices (Section 2.4)
- Installation Safety (Section 2.5)
- Programming Safety (Section 2.6)
- Operation Safety (Section 2.7)
- Maintenance Safety (Section 2.8)
2.2 **Standard Conventions**

This manual includes information essential to the safety of personnel and equipment. As you read through this manual, be alert to the four signal words:

- **DANGER**
- **WARNING**
- **CAUTION**
- **NOTE**

Pay particular attention to the information provided under these headings which are defined below (in descending order of severity).

### DANGER!

Information appearing under the **DANGER** caption concerns the protection of personnel from the immediate and imminent hazards that, if not avoided, will result in immediate, serious personal injury or loss of life in addition to equipment damage.

### WARNING!

Information appearing under the **WARNING** caption concerns the protection of personnel and equipment from potential hazards that can result in personal injury or loss of life in addition to equipment damage.

### CAUTION!

Information appearing under the **CAUTION** caption concerns the protection of personnel and equipment, software, and data from hazards that can result in minor personal injury or equipment damage.

**NOTE:** Information appearing in a **NOTE** caption provides additional information which is helpful in understanding the item being explained.
2.3 General Safeguarding Tips

All operators, programmers, plant and tooling engineers, maintenance personnel, supervisors, and anyone working near the robot must become familiar with the operation of this equipment. All personnel involved with the operation of the equipment must understand potential dangers of operation. General safeguarding tips are as follows:

- Improper operation can result in personal injury and/or damage to the equipment. Only trained personnel familiar with the operation of this robot, the operator's manuals, the system equipment, and options and accessories should be permitted to operate this robot system.
- Do not enter the robot cell while it is in automatic operation. Programmers must have the teach pendant when they enter the robot cell.
- Improper connections can damage the robot. All connections must be made within the standard voltage and current ratings of the robot I/O (Inputs and Outputs).
- The robot must be placed in Emergency Stop (E-STOP) mode whenever it is not in use.
- In accordance with ANSI/RIA R15.06, section 6.13.4 and 6.13.5, use lockout/tagout procedures during equipment maintenance. Refer also to Section 1910.147 (29CFR, Part 1910), Occupational Safety and Health Standards for General Industry (OSHA).

2.4 Mechanical Safety Devices

The safe operation of the robot, positioner, auxiliary equipment, and system is ultimately the user's responsibility. The conditions under which the equipment will be operated safely should be reviewed by the user. The user must be aware of the various national codes, ANSI/RIA R15.06 safety standards, and other local codes that may pertain to the installation and use of industrial equipment. Additional safety measures for personnel and equipment may be required depending on system installation, operation, and/or location. The following safety measures are available:

- Safety fences and barriers
- Light curtains
- Door interlocks
- Safety mats
- Floor markings
- Warning lights

Check all safety equipment frequently for proper operation. Repair or replace any non-functioning safety equipment immediately.
2.5 Installation Safety

Safe installation is essential for protection of people and equipment. The following suggestions are intended to supplement, but not replace, existing federal, local, and state laws and regulations. Additional safety measures for personnel and equipment may be required depending on system installation, operation, and/or location. Installation tips are as follows:

- Be sure that only qualified personnel familiar with national codes, local codes, and ANSI/RIA R15.06 safety standards are permitted to install the equipment.
- Identify the work envelope of each robot with floor markings, signs, and barriers.
- Position all controllers outside the robot work envelope.
- Whenever possible, install safety fences to protect against unauthorized entry into the work envelope.
- Eliminate areas where personnel might get trapped between a moving robot and other equipment (pinch points).
- Provide sufficient room inside the workcell to permit safe teaching and maintenance procedures.

2.6 Programming Safety

All operators, programmers, plant and tooling engineers, maintenance personnel, supervisors, and anyone working near the robot must become familiar with the operation of this equipment. All personnel involved with the operation of the equipment must understand potential dangers of operation. Programming tips are as follows:

- Any modifications to PART 1 of the MRC controller PLC can cause severe personal injury or death, as well as damage to the robot! Do not make any modifications to PART 1. Making any changes without the written permission of Motoman will VOID YOUR WARRANTY!
- Some operations require standard passwords and some require special passwords. Special passwords are for Motoman use only. YOUR WARRANTY WILL BE VOID if you use these special passwords.
- Back up all programs and jobs onto a floppy disk whenever program changes are made. To avoid loss of information, programs, or jobs, a backup must always be made before any service procedures are done and before any changes are made to options, accessories, or equipment.
- The concurrent I/O (Input and Output) function allows the customer to modify the internal ladder inputs and outputs for maximum robot performance. Great care must be taken when making these modifications. Double-check all modifications under every mode of robot operation to ensure that you have not created hazards or dangerous situations that may damage the robot or other parts of the system.
- Improper operation can result in personal injury and/or damage to the equipment. Only trained personnel familiar with the operation, manuals, electrical design, and equipment interconnections of this robot should be permitted to operate the system.
2.7 **Operation Safety**

All operators, programmers, plant and tooling engineers, maintenance personnel, supervisors, and anyone working near the robot must become familiar with the operation of this equipment. All personnel involved with the operation of the equipment must understand potential dangers of operation. Operation tips are as follows:

- Be sure that only trained personnel familiar with the operation of this robot, the operator's manuals, the system equipment, and options and accessories are permitted to operate this robot system.
- Check all safety equipment for proper operation. Repair or replace any non-functioning safety equipment immediately.
- Inspect the robot and work envelope to ensure no potentially hazardous conditions exist. Be sure the area is clean and free of water, oil, debris, etc.
- Ensure that all safeguards are in place.
- Improper operation can result in personal injury and/or damage to the equipment. Only trained personnel familiar with the operation, manuals, electrical design, and equipment interconnections of this robot should be permitted to operate the system.
- Do not enter the robot cell while it is in automatic operation. Programmers must have the teach pendant when they enter the cell.
- The robot must be placed in Emergency Stop (E-STOP) mode whenever it is not in use.
- This equipment has multiple sources of electrical supply. Electrical interconnections are made between the controller, external servo box, and other equipment. Disconnect and lockout/tagout all electrical circuits before making any modifications or connections.
- All modifications made to the controller will change the way the robot operates and can cause severe personal injury or death, as well as damage the robot. This includes controller parameters, ladder parts 1 and 2, and I/O (Input and Output) modifications. Check and test all changes at slow speed.
2.8 **Maintenance Safety**

All operators, programmers, plant and tooling engineers, maintenance personnel, supervisors, and anyone working near the robot must become familiar with the operation of this equipment. All personnel involved with the operation of the equipment must understand potential dangers of operation. Maintenance tips are as follows:

- Do not perform any maintenance procedures before reading and understanding the proper procedures in the appropriate manual.
- Check all safety equipment for proper operation. Repair or replace any non-functioning safety equipment immediately.
- Improper operation can result in personal injury and/or damage to the equipment. Only trained personnel familiar with the operation, manuals, electrical design, and equipment interconnections of this robot should be permitted to operate the system.
- Back up all your programs and jobs onto a floppy disk whenever program changes are made. A backup must always be made before any servicing or changes are made to options, accessories, or equipment to avoid loss of information, programs, or jobs.
- Do not enter the robot cell while it is in automatic operation. Programmers must have the teach pendant when they enter the cell.
- The robot must be placed in Emergency Stop (E-STOP) mode whenever it is not in use.
- Be sure all safeguards are in place.
- Use proper replacement parts.
- This equipment has multiple sources of electrical supply. Electrical interconnections are made between the controller, external servo box, and other equipment. Disconnect and lockout/tagout all electrical circuits before making any modifications or connections.
- All modifications made to the controller will change the way the robot operates and can cause severe personal injury or death, as well as damage the robot. This includes controller parameters, ladder parts 1 and 2, and I/O (Input and Output) modifications. Check and test all changes at slow speed.
- Improper connections can damage the robot. All connections must be made within the standard voltage and current ratings of the robot I/O (Inputs and Outputs).
YASNAC XRC OPTIONS
INSTRUCTIONS
FOR CONVEYOR SYNCHRONIZED FUNCTION

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

MOTOMAN INSTRUCTIONS
MOTOMAN SETUP MANUAL
MOTOMAN-□□□ INSTRUCTIONS
YASNAC XRC INSTRUCTIONS
YASNAC XRC OPERATOR’S MANUAL
YASNAC XRC OPERATOR’S MANUAL for BEGINNERS

The YASNAC XRC operator’s manuals above correspond to specific usage. Be sure to use the appropriate manual.
This manual explains the conveyor synchronized function of the YASNAC XRC system and general operations. Read this manual carefully and be sure to understand its contents before handling the YASNAC XRC.

General items related to safety are listed in Section 1: Safety of the Setup Manual. To ensure correct and safe operation, carefully read the Setup Manual before reading this manual.

Some drawings in this manual are shown with the protective covers or shields removed for clarity. Be sure all covers and shields are replaced before operating this product.

The drawings and photos in this manual are representative examples and differences may exist between them and the delivered product.

YASKAWA may modify this model without notice when necessary due to product improvements, modifications, or changes in specifications. If such modification is made, the manual number will also be revised.

If your copy of the manual is damaged or lost, contact a YASKAWA representative to order a new copy. The representatives are listed on the back cover. Be sure to tell the representative the manual number listed on the front cover.

YASKAWA is not responsible for incidents arising from unauthorized modification of its products. Unauthorized modification voids your product's warranty.
NOTES FOR SAFE OPERATION

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

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

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

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

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

- **PROHIBITED**
  Must never be performed.

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

**NOTE**
To ensure safe and efficient operation at all times, be sure to follow all instructions, even if not designated as “CAUTION” and “WARNING”.
Before operating the manipulator, check that servo power is turned off when the emergency stop buttons on the playback panel or programming pendant are pressed. When the servo power is turned off, the SERVO ON READY lamp on the playback panel and the SERVO ON LED on the programming pendant are 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.

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.

Always set the Teach Lock before entering the robot work envelope to teach a job.

Operator injury can occur if the Teach Lock is not set and the manipulator is started from the playback panel.

Observe the following precautions when performing teaching operations within the working envelope of the manipulator:
- 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.

Confirm that no persons are present in the manipulator's work envelope and that you are in a safe location before:
- Turning on the YASNAC XRC power
- Moving the manipulator with the programming pendant
- Running check operations
- Performing automatic operations

Injury may result if anyone enters the working envelope of the manipulator during operation. Always press an emergency stop button immediately if there are problems. The emergency stop button is located on the right side of both the YASNAC XRC playback panel and programming pendant.
CAUTION

• Perform the following inspection procedures prior to conducting manipulator teaching. If problems are found, repair them immediately, and be sure that all other necessary processing has been performed.
  - Check for problems in manipulator movement.
  - Check for damage to insulation and sheathing of external wires.

• Always return the programming pendant to the hook on the XRC cabinet 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 the Alarm Display in the setup manual before operating the manipulator.

Definition of Terms Used Often in This Manual

The MOTOMAN manipulator is the YASKAWA industrial robot product. The manipulator usually consists of the controller, the playback panel, the programming pendant, and supply cables. The MOTOMAN manipulator is the YASKAWA industrial robot product. In this manual, the equipment is designated as follows.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Manual Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>YASNAC XRC Controller</td>
<td>XRC</td>
</tr>
<tr>
<td>YASNAC XRC Playback Panel</td>
<td>Playback Panel</td>
</tr>
<tr>
<td>YASNAC XRC Programming Pendant</td>
<td>Programming Pendant</td>
</tr>
</tbody>
</table>
Descriptions of the programming pendant and playback panel keys, buttons, and displays are shown as follows:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Manual Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programming Pendant</td>
<td></td>
</tr>
<tr>
<td>Character Keys</td>
<td>The keys which have characters printed on them are denoted with [ ]. ex. [ENTER]</td>
</tr>
<tr>
<td>Symbol Keys</td>
<td>The keys which have a symbol printed on them are not denoted with [ ] but depicted with a small picture. ex. page key</td>
</tr>
<tr>
<td></td>
<td>The cursor key is an exception, and a picture is not shown.</td>
</tr>
<tr>
<td>Axis Keys</td>
<td>“Axis Keys” and “Number Keys” are generic names for the keys for axis operation and number input.</td>
</tr>
<tr>
<td>Number Keys</td>
<td></td>
</tr>
<tr>
<td>Keys pressed simultaneously</td>
<td>When two keys are to be pressed simultaneously, the keys are shown with a “+” sign between them, ex. [SHIFT]+[COORD]</td>
</tr>
<tr>
<td>Displays</td>
<td>The menu displayed in the programming pendant is denoted with { }. ex. {JOB}</td>
</tr>
<tr>
<td>Playback Panel</td>
<td></td>
</tr>
<tr>
<td>Buttons</td>
<td>Playback panel buttons are enclosed in brackets. ex. [TEACH] on the playback panel</td>
</tr>
</tbody>
</table>

**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.
1 Conveyor Synchronized Function

1.1 System Configuration Example .............. 1-1
1.2 Conveyor Synchronized Operation .......... 1-2
  1.2.1 Conveyor Home-position Limit Switch ....... 1-2
  1.2.2 Conveyor Home-position Input Signal ....... 1-3
  1.2.3 SYSTART Instruction and Manipulator Motion .... 1-3
1.3 Conveyor .................................... 1-5
  1.3.1 Conveyor Form ................................ 1-5
  1.3.2 Definition of Conveyor Moving Direction .... 1-6
  1.3.3 Conveyor Distance for Follow-up ......... 1-6
  1.3.4 Measurement of Conveyor Moving Amount .... 1-6

2 Hardware Specifications

2.1 Required Boards and Setup .................... 2-1
2.2 Connecting XCP02 and XSL02 Boards to XRC .... 2-2
2.3 Connecting Conveyor Home-position Signals to XRC. ........................................ 2-4
2.4 Applicable Encoder and Connection Specification 2-5
2.5 Connection Example with One Conveyor .......... 2-6
2.6 Detecting Encoder Cable Disconnection .......... 2-6

3 Connector Connection

3.1 Opening the Front Door ......................... 3-1
3.2 Sensor Cable Connection ....................... 3-2
3.3 Closing the Front Door of the XRC ............ 3-3

4 Settings for Conveyor Condition File

4.1 Conveyor Condition File ........................ 4-1
4.2 Editing Conveyor Condition File ............... 4-8
  4.2.1 Displaying Conveyor Condition File .......... 4-8
  4.2.2 Editing Conveyor Condition File .............. 4-8
    ■ Editing “USED STATUS” ..................... 4-8
    ■ Editing “PORT NO.” ...................... 4-8
    ■ Editing “BROKEN LINE DETECT” ............ 4-9
    ■ Editing “ENCODER INPUT” ................. 4-9
    ■ Editing “ENCODER SIGN” ................... 4-9
    ■ Editing “CORRECTION” .................... 4-9
4.3 Setting Conveyor Positional Resolution .......................... 4-11
 4.3.1 Setting Conveyor Positional Resolution ......................... 4-12
 4.3.2 Verifying and Adjusting of Conveyor Positional Resolution .. 4-12

5 Teaching

5.1 Registering Instructions ........................................... 5-1
 5.1.1 SYSTART Instruction ............................................ 5-1
    ■ Function ................................................... 5-1
    ■ Format .................................................... 5-2
    ■ Registering .............................................. 5-2
 5.1.2 SYEND Instruction ............................................. 5-4
    ■ Function ................................................... 5-4
    ■ Format .................................................... 5-4
    ■ Registering .............................................. 5-4
 5.1.3 SYMOV* Instruction ........................................... 5-5
    ■ Function ................................................... 5-5
    ■ Format .................................................... 5-5
 5.1.4 Interpolation Mode for Conveyor Synchronized Operation .... 5-5
    ■ Switching the interpolation mode .......................... 5-6

5.2 Motion Speed ...................................................... 5-6

5.3 Wrist Posture in Synchronization .................................. 5-8

5.4 Circular Interpolation Steps ...................................... 5-9

5.5 Teaching ............................................................ 5-9

5.6 Teaching After Interruption of Playback in Synchronized Operation ........................................... 5-11
  5.6.1 When Adding or Changing Step After Interruption of Synchronized Operation .................................. 5-12
  5.6.2 When Performing Another Teaching (for other workpiece) .... 5-13

5.7 Notes on Operation .................................................. 5-13
  5.7.1 Confirming Reach to Step ................................... 5-13
  5.7.2 Backward (BWD) Operation .................................. 5-14
  5.7.3 Changing Tool ............................................. 5-14
  5.7.4 Deleting Taught Points ..................................... 5-14
5.8 Job Example ................................................. 5-15

6  Playback

6.1 Conveyor Speed Down ................................. 6-1
6.2 Accuracy ................................................. 6-2
6.3 Conveyor Resolution Error ......................... 6-2
6.4 Restarting Synchronization After Manipulator Stops.6-3
6.5 Continuance of Conveyor Synchronized Status .... 6-3
6.6 Continuance of Parallel Shift Status ............... 6-3
6.7 Conveyor Synchronized Operation During Execution of
    TIMER and WAIT ....................................... 6-4

7  Conveyor Monitoring Displays

7.1 Conveyor Position Display ........................... 7-2
7.2 Conveyor Speed Display ............................... 7-3
7.3 Conveyor Tracking Status Display .................. 7-4

8  Virtual Encoder Mode

8.1 Virtual Encoder Pulse Count .......................... 8-1
8.2 Relation Between Encoder Input and Virtual Encoder Input
       ......................................................... 8-1
8.3 Precaution on Switching the Encoder Mode ......... 8-1

9  Instruction List

10  Alarm List

11  Sensor Parameters (SxE)
12 Turntable Synchronized Function

12.1 Setting Turntable Synchronized System ........ 12-1
   12.1.1 Conveyor Condition File ...................... 12-1
   12.1.2 Calibration between Manipulator and Turntable .... 12-2
      ■ Calibration Tool Setting ....................... 12-2
      ■ Teaching Positions for Calibration .............. 12-3
      ■ Calibration ...................................... 12-4

12.2 Notes on Instructions ............................. 12-5
1 Conveyor Synchronized Function

1.1 System Configuration Example

A basic system configuration example using XRC conveyor synchronized function is shown below.
The manipulator detects the moving amount of conveyor by the encoder mounted on the conveyor.
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, 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 the Fig. 2. 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 cannot be selected simultaneously.

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 Conveyor Synchronized Operation

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.
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.

<table>
<thead>
<tr>
<th>Job</th>
<th>Manipulator</th>
<th>Motion</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOVJ</td>
<td>: Moves to Step 1</td>
<td>①</td>
</tr>
<tr>
<td>SYSTART CV#(1) STP=100.00</td>
<td>: Stops, and waits until the conveyor reaches “STP = 100”.</td>
<td>②, ③</td>
</tr>
<tr>
<td>SYMOVL</td>
<td>: Moves to Step 2 in the conveyor synchronized operation.</td>
<td>④</td>
</tr>
</tbody>
</table>

![Diagram of conveyor synchronized operation]

① Conveyor home-position limit switch

② Step 1

③ Conveyor moving direction

④ 0 mm

⑤ Step 2

100 mm
A job example of conveyor synchronized operation is shown. Refer to Section 5.11 "Job Example".

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 Conveyor synchronized motion
0007 SYMOVL CV#(1) CTP=50.000 (Linear interpolation)
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

1.3 Conveyor

1.3.1 Conveyor Form

There are two types of the conveyor tracking motion:
- Linear Tracking (Tracking method is specified to "ROBOT AXIS" or "BASE AXIS.")
- Circular Tracking (Tracking method is specified to "CIRCULAR.")

Either of these types must be set according to the conveyor forms.
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.

For registration of user coordinates, refer to the YASNAC XRC Instruction manual.

![Diagram of conveyor moving direction]

1.3.3 Conveyor Distance for Follow-up

With the conveyor synchronized function of XRC, 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).
This chapter explains the required equipments 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 option base board JANCD-XCP02 and the board JANCD-XSL02 for conveyor synchronized operation are required besides the standard boards.

For the XSL02 board, the types for 1 axis, 2 axes, and 3 axes are available according to the number of encoders (number of conveyor axes) to be used and they are provided with 1, 2, and 3 ports to receive signal from encoder respectively. Up to three conveyor encoders can be connected to a single XSL02 board.
2.2 Connecting XCP02 and XSL02 Boards to XRC

- **PC card**
- **Battery alarm**
- **RS232C connector**
- **Battery**
- **System control board JANCD-XCP01**
- **Control power supply unit CPS-150F**

**Connections and Outputs**:
- **200 VAC input** (from power supply unit)
- **Connection to control power supply ON/OFF**
- **24 VDC output** (To programming pendant)
- **Monitor alarm display**
- **24 VDC and 5 VDC outputs** (To XIU)

**Supplementary Information**:
- **PC card**
- **Battery alarm**
- **RS232C connector**
- **Battery**
- **System control board JANCD-XCP01**
- **Control power supply unit CPS-150F**

**Notes**:
- **CN01 to CN09**
- **CNS1 to CNSL**
The JANCD-XSL02 board is connected to the CNSL of JANCD-XCP02 board.

Plug: 10114-3000VE made by 3M
Shell kid: 10314-52A0-008 made by 3M
10214-52A2JL made by 3M
The conveyor home-position input signals are connected through each encoder input port on the JANCD-XSL02 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 XRC 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 display explained later.
2.4 Applicable Encoder and Connection Specification

For XRC conveyor synchronized function, use a conveyor encoder with two-phase line driver outputs (equivalent to RS422). Encoders with open-collector output or signal-phase output are not applicable.

The connection of encoder to the XSL02 board is as shown below. Check if the encoder operates correctly on the conveyor position display explained later.

For 5 V encoder with line driver, PREA-3C30/□□ made by Yaskawa Control is recommended.
2.5 Connection Example with One Conveyor

A connection example with 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

1. Turn the two door locks on the front face of the XRC clockwise for 90 ° by using a coin or flat tipped driver.

2. With the door locks turned clockwise for 90 °, turn the main switch handle to the "OPEN RESET" position, and then slowly open the door.
3.2 Sensor Cable Connection

Connect the cable from the sensor to the XSL02 board.

Be sure to connect the connector with the screws securely tightened with screwdriver.
3.3 Closing the Front Door of the XRC

1. Turn the main switch handle, which is now in the OFF position, to the “OPEN RESET” position, and then slowly close the door.

2. Turn the two door locks counterclockwise for 90°.
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 XRC by setting them in the conveyor condition files. There are six conveyor condition files from File No. 1 to 6. Up to three files can be used for each JANCD-XSL02 board for conveyor synchronized operation. In the system with one JANCD-XSL02 board, up to three files from File No. 1 to 3 can be set.
4.1 Conveyor Condition File

<table>
<thead>
<tr>
<th>DATA</th>
<th>EDIT</th>
<th>DISPLAY</th>
<th>UTILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONVEYOR COND FILE</td>
<td>R1</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
</tbody>
</table>

- **FILE NO.**
  Displays the conveyor condition file No.

<table>
<thead>
<tr>
<th>Board for conveyor synchronized operation</th>
<th>File No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>JANCD-XSL02</td>
<td></td>
</tr>
<tr>
<td>With one board</td>
<td>1 to 3</td>
</tr>
<tr>
<td>With two boards</td>
<td>1 to 6</td>
</tr>
</tbody>
</table>

- **USED STATUS (USED/NOT USED)**
  Specify whether the conveyor condition file is used or not.

- **PORT NO. (CN1/CN2/CN3)**
  Specify the port No. to which the encoder in use is connected.

- **BROKEN LINE DETECT (ON/OFF)**
  Selects whether disconnection detection is to be used or not.

- **ENCODER INPUT (ENCODER/VIRTUAL ENCDR)**
  Specify whether actual or virtual input from the encoder is to be used for synchronization. When “VIRTUAL ENCDR” is specified, even when no encoder is connected or the conveyor is not operating, the manipulator can perform synchronization. This function is convenient for checking operations in test run.
**ENCODER SIGN (FORWARD/REVERSE)**
Specify whether the sign of encoder position pulse input from encoder is to be inverted or not.
When “REVERSE” is specified, the signs of data on the conveyor position and conveyor speed display are inverted, and the synchronized direction of the manipulator is reversed.

When the conveyor moves from 1000 pulses to 2000 pulses

<table>
<thead>
<tr>
<th>CONVEYOR POSITION</th>
<th>CURR POS (PULSE)</th>
<th>CURR POS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CV#01</td>
<td>2000</td>
<td>20.000 mm</td>
</tr>
</tbody>
</table>

When “FORWARD” is selected: 1000 pulses → 2000 pulses

<table>
<thead>
<tr>
<th>CONVEYOR POSITION</th>
<th>CURR POS (PULSE)</th>
<th>CURR POS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CV#01</td>
<td>-2000</td>
<td>-20.000 mm</td>
</tr>
</tbody>
</table>

When “REVERSE” is selected: -1000 pulses → -2000 pulses

**CORRECTION (FORWARD/REVERSE)**
Specify whether the synchronized direction is to be reversed or not.
When “REVERSE” is specified, the sign of correction position on the conveyor speed display is inverted and the manipulator synchronizes in the reversed direction.

When “BASE AXIS” is selected for “TRACKING”

**TRACKING (ROBOT AXIS/BASE AXIS)**
Specify whether the manipulator synchronizes with the robot axis or the base axis (traveling axis).
If “BASE AXIS” is specified 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.

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

For registration of user coordinates, refer to the YASNAC XRC Instruction manual.
4.1 Conveyor Condition File

When synchronized by traveling axis Y-axis

When synchronized by traveling axis Z-axis

**USER COORD NO.**
When “ROBOT AXIS” is selected at ⑤, specify a user coordinate in whose X-axis direction the manipulator synchronizes by selecting the user coordinate number.

**BASE AXIS (X/Y/Z)**
When “BASE AXIS” is selected at ⑤, specify with which base axis the manipulator synchronizes, X, Y, or Z-axis.

**POSITIONAL RESOLUTION (0 to 999.99 μm)**
The data for converting 1 pulse from encoder to the conveyor moving amount (μm). For details of setting method, refer to 4.3 “Setting of Conveyor Positional Resolution”

**VIRTUAL CONVEYOR SPEED (-32767 to +32767 mm/sec)**
When “VIRTUAL ENCODER” is selected at ⑤, set the virtual encoder speed.
**4.1 Conveyor Condition File**

**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 follow-up responsibility is lowered in this case. When the conveyor motion is not smooth, set a value approx. “200”. When this function is not used, set “0”.

![Graph showing conveyor and manipulator speed over time](image)

**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.

**CONVEYOR SPEED DOWN MODE (EXECUTE/ALARM/PAUSE JOB)**
Specify the motion of manipulator when the conveyor speed is lowered below the conveyor lower speed limit specified at 4.6.

EXECUTE: Regardless of the conveyor speed, the manipulator operates. Accordingly, when the conveyor is stopped, the manipulator performs the synchronized operation with the conveyor speed 0.

![Conveyor moving direction](image)
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 is stopped. This mode is used where a conveyor stop detection mechanism does not exist in the conveyor control board.

![Image showing conveyor speed decrease and alarm]

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 is restarted. In this case, only the execution of move instructions in the job are suppressed.

![Image showing conveyor speed decrease, job interruption, and job restart]

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

This value is used when “ALARM” or “PAUSE JOB” is selected at 🚨. When the conveyor speed is lowered below this value, the “ALARM” mode or “PAUSE JOB” mode enters.

**VIRTUAL ENCODER INPUT (IN#000 to IN#256)**

When the general purpose input signal of the number that 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.

- IN#000: Not used
- IN#001 to IN#256: The set general purpose input signal is valid.
4.2 Editing Conveyor Condition File

4.2.1 Displaying Conveyor Condition File

**Operation**

Select {ROBOT} under the top menu ➔ Select {CV CONDITION} ➔ Display a desired conveyor condition file.*1

**Explanation**

*1 Press the page key . The next file No. is called.

Press [SHIFT] + the page key . The previous file No. is called.

4.2.2 Editing Conveyor Condition File

**Editing “USED STATUS”**

**Operation**

Select “USED STATUS” ➔ “USED” and “NOT USED” appears alternately.

**Editing “PORT NO.”**

**Operation**

Select “PORT NO.” ➔ The selection dialog appears ➔ Select a desired port number.

---

**VIRTUAL ENCODER OUTPUT (OUT#000 to OUT#256)**

When “VIRTUAL ENCODR” is selected at ⑥, the output signal of the number that is set in “VIRTUAL ENCODER OUTPUT” is output.

OUT#000: Not used

OUT#001 to OUT#256: The set signal is output.
4.2 Editing Conveyor Condition File

- **Editing “BROKEN LINE DETECT”**
  
  **Operation**
  Select “BROKEN LINE DETECT” ➔ “OFF” and “ON” appears alternately

- **Editing “ENCODER INPUT”**
  
  **Operation**
  Select “ENCODER INPUT” ➔ “ENCODER” and “VIRTUAL ENCDR” appears alternately

- **Editing “ENCODER SIGN”**
  
  **Operation**
  Select “ENCODER SIGN” ➔ “FORWARD” and “REVERSE” appears alternately

- **Editing “CORRECTION”**
  
  **Operation**
  Select “CORRECTION” ➔ “FORWARD” and “RESERVE” appears alternately

- **Editing “TRACKING”**
  
  **Operation**
  Select “TRACKING” ➔ “ROBOT AX IS” and “BASE AXIS” appears alternately

- **Editing “USER COORD NO.”**
  
  **Operation**
  Select “USER COORD NO.” ➔ Enter a number by using the number keys

- **Editing “BASE AXIS”**
  
  **Operation**
  Select “BASE AXIS” ➔ The selection dialog appears ➔ Select a desired axis

- **Editing “POSITIONAL RESOLUTION”**
  
  **Operation**
  Select “POSITIONAL RESOLUTION” ➔ Enter a number by using the number keys
4.2 Editing Conveyor Condition File

- Editing “VIRTUAL CONVEYOR SPEED”
  
  **Operation**
  
  Select “VIRTUAL CONVEYOR SPEED” ➔ Enter a number by using the number keys

- Editing “AVERAGED TRAVEL TIME”
  
  **Operation**
  
  Select “AVERAGED TRAVEL TIME” ➔ Enter a number by using the number keys

- Editing “RESET SIGNAL MONITORING”
  
  **Operation**
  
  Select “RESET SIGNAL MONITORING” ➔ Enter a number by using the number keys

- Editing “CONVEYOR SPEED DOWN MODE”
  
  **Operation**
  
  Select “CONVEYOR SPEED DOWN MODE” ➔ The selection dialog appears ➔ Select a desired mode

- Editing “CONVEYOR LOWER LIMIT SPD”
  
  **Operation**
  
  Editing “CONVEYOR LOWER LIMIT SPD” ➔ Enter a number by using the number keys

- Editing “VIRTUAL ENCODER INPUT”
  
  **Operation**
  
  Select “VIRTUAL ENCODER INPUT” ➔ Enter a number by using the number keys

- Editing “VIRTUAL ENCODER OUTPUT”
  
  **Operation**
  
  Select “VIRTUAL ENCODER OUTPUT” ➔ Enter a number by using the number 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 follow-up motion, a pulse amount must be converted into a distance. The conveyor moving amount (μm) per 1 pulse to be used for this conversion is called "POSITIONAL RESOLUTION".

The conveyor positional resolution (μm) per 1 pulse is called "POSITIONAL RESOLUTION". It is set in units of μm. For example, when the positional resolution is 30 μm/pulse, set "30.00" in the "POSITIONAL RESOLUTION".

The setting range is from 0 to 999.99 μm. Since the XRC internally quadruples every encoder pulse number, the conveyor positional resolution for the conveyor encoder is 3999.96 μm/pulse. As the resolution error accumulates for the conveyor moving pulse amount, the setting must be correct. For example, setting the resolution 0.01 μm/pulse bigger causes the follow-up error of 0.1 mm at the point that the conveyor moves for 10000 pulses.

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

**NOTE**

The XRC 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 Setting Conveyor Positional Resolution

### 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 display 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.

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).

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

\[
\text{Resolution} = \frac{L \times 1000000}{C2 - C1} \text{ (μ/pulse)}
\]

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

### 4.3.2 Verifying and Adjusting of 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) on a conveyor. For teaching methods, refer to Section 5 “Teaching”.
4.3 Setting Conveyor Positional Resolution

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. 3 and the manipulator moves as if its tool center point is fixed on the point ③.
On the contrary, when the conveyor resolution value is not appropriate, the tool center point is dislocated farther from the point ① as the follow-up time elapses as shown in Figs. 4 and 5. In Fig. 4, the conveyor resolution value is too big. In Fig. 5, 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.
5 Teaching

5.1 Registering Instructions

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

**Operation**

Select {JOB} under the top menu ➔ Select {JOB CONTENT} ➔ Move the cursor to the address area

![Address area and Instruction area]

### 5.1.1 SYSTART Instruction

**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), the system variable $B008 is reset to 0. And the succeeding instructions are executed without synchronized operation. The system variable $B008 is 1 when the operation has been normally completed.

**Note**
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

**Format**

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

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)**
   - 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. When omitted or 0 is set, tolerance check is not executed.

**Registering**

**Operation**

Move the cursor to the line just above the place where a SYSTART instruction is to be registered ➔ Press [INFORM LIST]*1 ➔ Select “SYSTART”*2 ➔ Change additional items*3 ➔ Press [INSERT] and [ENTER] *4

**Explanation**

*1 The instruction list dialog appears.
*2 A SYSTART instruction is displayed in the input buffer line.

\[ \Rightarrow \text{SYSTART CV#(1) STP=0.000} \]

*3 <Register without editing additional items>

Perform the operation *4.

<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 the number keys, then press [ENTER].
- To add, change or delete the additional item
  Move the cursor to the instruction in the input buffer line, then press [SELECT]. The detail edit display appears.

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 display is closed and the job content display appears.

*4 The instruction displayed in the input buffer line is registered.
5.1.2 SYEND Instruction

**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.

**Format**

SYEND CV#(1)

**Conveyor condition file No. (CONVEYOR FILE)**

Set the conveyor condition file No. to be used.

**Registering**

**Operation**

Move the cursor to the line just above the place where a SYEND instruction is to be registered ➔ Press [INFORM LIST]*1 ➔ Select “SYEND”*2 ➔ Press [INSERT] and [ENTER] *3

**Explanation**

*1 The instruction list dialog appears.

*2 A SYEND instruction is displayed in the input buffer line.

*3 The instruction displayed in the input buffer line is registered.
5.1.3 SYMOV□ Instruction

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.

Format

<table>
<thead>
<tr>
<th>Instruction</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYMOVJ</td>
<td>Joint motion for conveyor synchronized operation (can be used only for synchronization by base axis).</td>
</tr>
<tr>
<td>SYMOVL</td>
<td>Linear interpolation for conveyor synchronized operation</td>
</tr>
<tr>
<td>SYMOVC</td>
<td>Circular interpolation for conveyor synchronized operation</td>
</tr>
</tbody>
</table>

When these instructions are used, the teaching method is different from that with the ordinary move instructions. Refer to 5.1.4 “Interpolation Mode for Conveyor Synchronized Operation”.

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 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).
5.2 Motion Speed

- Switching the interpolation mode

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

- MOVL V=66 => MOVL (standard interpolation)
- SYMOV V=66 CV#(1) => SYMOVL (conveyor synchronized interpolation)

Press [MOTION TYPE]. The interpolation mode changes as:
SYMOVJ⇒SYMOVL⇒SYMOVC

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. 6 When the teaching direction is the same as the conveyor moving direction**

- Manipulator motion speed = Teaching speed
- = 20 (m/s)

  - When the conveyor stops

  - Conveyor speed 10 m/s

  - When the conveyor moves

**Fig. 7 When teaching direction is different from conveyor moving direction for 90°**

- Manipulator motion speed = Teaching speed
- = 20 (m/s)

  - When the conveyor stops

  - Conveyor speed 10 m/s

  - When the conveyor moves

  - Manipulator motion speed = Teaching speed + Conveyor speed
- = 20 + 10
- = 30 (m/s)
### 5.2 Motion Speed

As shown in Fig. 8, 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. 6, 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.

For example, if the wrist is taught the posture as shown in Fig. 10, 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. 11 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 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.

1

<table>
<thead>
<tr>
<th>DATA EDIT DISPLAY UTILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>CV TRACKING STATUS</td>
</tr>
<tr>
<td>INPUT STATUS TRACKING STATUS</td>
</tr>
<tr>
<td>LS#01 CV#01 ○ ○ ○ ○</td>
</tr>
<tr>
<td>LS#02 CV#02 ○ ○ ○ ○</td>
</tr>
<tr>
<td>LS#03 CV#03 ○ ○ ○ ○</td>
</tr>
<tr>
<td>LS#04 CV#04 ○ ○ ○ ○</td>
</tr>
<tr>
<td>LS#05 CV#05 ○ ○ ○ ○</td>
</tr>
<tr>
<td>LS#06 CV#06 ○ ○ ○ ○</td>
</tr>
</tbody>
</table>

Conveyor moves

2

<table>
<thead>
<tr>
<th>DATA EDIT DISPLAY UTILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>CV TRACKING STATUS</td>
</tr>
<tr>
<td>INPUT STATUS TRACKING STATUS</td>
</tr>
<tr>
<td>LS#01 CV#01 ○ ○ ○ ○</td>
</tr>
<tr>
<td>LS#02 CV#02 ○ ○ ○ ○</td>
</tr>
<tr>
<td>LS#03 CV#03 ○ ○ ○ ○</td>
</tr>
<tr>
<td>LS#04 CV#04 ○ ○ ○ ○</td>
</tr>
<tr>
<td>LS#05 CV#05 ○ ○ ○ ○</td>
</tr>
<tr>
<td>LS#06 CV#06 ○ ○ ○ ○</td>
</tr>
</tbody>
</table>

Conveyor home-position limit switch turns ON.

Conveyor position is reset to 0 mm.
The conveyor position display appears.

Move the conveyor. After the conveyor home-position limit switch is ON, stop the work-piece at the teaching position. At the moment the conveyor home-position limit switch is ON, "CURR POS (PULSE)" in the conveyor position display is reset to "0", which confirms that the counter is reset.

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

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

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

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

Operation

Select {ROBOT} under the top menu ➔ Select {CV MONITOR} ➔ Move the conveyor ➔ Press [SHIFT] + [MOTION TYPE] ➔ Select a motion type ➔ Press an axis key ➔ Press [ENTER]

Explanation

*1 The conveyor position display appears.

*2 Move the conveyor. After the conveyor home-position limit switch is ON, stop the work-piece at the teaching position. At the moment the conveyor home-position limit switch is ON, "CURR POS (PULSE)" in the conveyor position display is reset to "0", which confirms that the counter is reset.

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

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

*5 Move the manipulator to a desired position by using axis keys.
The step is registered.

*Example>
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=100.0 CV#(1) CTP=1000.0

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.

---

As long as the conveyor synchronized operation is not performed, the conveyor home-position input signal is accepted and the conveyor home-position is updated. Therefore, even though teaching is made on the same conveyor position, if the conveyor home-position limit switch inadvertently turns ON, the conveyor home-position is changed.
If there is risk that an operation to be taught will turn ON the conveyor home-position limit switch, perform a FWD operation for that step after programming the first conveyor synchronized move instruction (SYMOVL, SYMOVC). This starts the conveyor synchronized function so that the conveyor home-position will not be changed even if the conveyor home-position limit switch turns ON.
In this case, execute a SYEND instruction after completion of teaching to clear the synchronization operating status.

---

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 display 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.

1. During conveyor synchronized operation in play mode

2. Synchronized operation interrupted
   (Switched to teach mode. Manipulator stops and the conveyor stops also.)

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

<table>
<thead>
<tr>
<th>DATA</th>
<th>EDIT</th>
<th>DISPLAY</th>
<th>UTILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>CV TRACKING STATUS</td>
<td>INPUT STATUS</td>
<td>TRACKING STATUS</td>
<td></td>
</tr>
<tr>
<td>LS#01</td>
<td>○</td>
<td>CV#01</td>
<td>●</td>
</tr>
<tr>
<td>LS#02</td>
<td>○</td>
<td>CV#02</td>
<td>○</td>
</tr>
<tr>
<td>LS#03</td>
<td>○</td>
<td>CV#03</td>
<td>○</td>
</tr>
<tr>
<td>LS#04</td>
<td>○</td>
<td>CV#04</td>
<td>○</td>
</tr>
<tr>
<td>LS#05</td>
<td>○</td>
<td>CV#05</td>
<td>○</td>
</tr>
<tr>
<td>LS#06</td>
<td>○</td>
<td>CV#06</td>
<td>○</td>
</tr>
</tbody>
</table>

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 a SYEND instruction or shutting down the control power supply.

<table>
<thead>
<tr>
<th>DATA</th>
<th>EDIT</th>
<th>DISPLAY</th>
<th>UTILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>CV TRACKING STATUS</td>
<td>INPUT STATUS</td>
<td>TRACKING STATUS</td>
<td></td>
</tr>
<tr>
<td>LS#01</td>
<td>○</td>
<td>CV#01</td>
<td>●</td>
</tr>
<tr>
<td>LS#02</td>
<td>○</td>
<td>CV#02</td>
<td>○</td>
</tr>
<tr>
<td>LS#03</td>
<td>○</td>
<td>CV#03</td>
<td>○</td>
</tr>
<tr>
<td>LS#04</td>
<td>○</td>
<td>CV#04</td>
<td>○</td>
</tr>
<tr>
<td>LS#05</td>
<td>○</td>
<td>CV#05</td>
<td>○</td>
</tr>
<tr>
<td>LS#06</td>
<td>○</td>
<td>CV#06</td>
<td>○</td>
</tr>
</tbody>
</table>

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

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.
5.7 Notes on 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.

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

- **EXECUTE**
  Regardless of the conveyor speed, the manipulator continues its operation.

- **ALARM**
  When the conveyor speed is slowed down, an alarm occurs.

- **PAUSE JOB**
  When the conveyor speed is slowed down, the manipulator stops the job operation but only continues follow-up motion.

For details of these three modes, refer to "CONVEYOR SPEED DOWN MODE" of 4.1 "Conveyor Condition File".
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 XRC
- 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 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 µm. Therefore, a maximum error of 0.005 µm per pulse may occur. For example, when the conveyor resolution is 10 µm 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 µm, the following synchronization error may occur: 200000 pulses × 0.005 µm = 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.

• At occurrence of minor failure alarm (excluding occurrence of alarm related to the conveyor synchronized function)
• At emergency stop or external emergency stop
• By hold or external hold
• By switching the mode (mode switching between play and teach mode)
• By switching 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 the synchronized operation is performed by execution of SYMOV□ instruction even if 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, etc. the conveyor synchronized operation continues.
7 Conveyor Monitoring Displays

The following three displays are available for monitoring conveyor.

- Conveyor position display
- Conveyor speed display
- Conveyor tracking status display

Call each display in the following manner.

**Operation**

Select {ROBOT} under the top menu ➤ Select {CV MONITOR} ➤ Display the conveyor position display ➤ Display a desired display

**Explanation**

*1 Pressing the page key 📺 switches the display in order of CONVEYOR POSITION display → CONVEYOR SPEED display → CV TRACKING STATUS display

Pressing [SHIFT] + the page key 📺 returns to the previous display.
## 7.1 Conveyor Position Display

<table>
<thead>
<tr>
<th>CONVEYOR POSITION</th>
<th>CURR POS(PULSE)</th>
<th>CURR POS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CV#01</td>
<td>390</td>
<td>3.900 mm</td>
</tr>
<tr>
<td>CV#02</td>
<td>0</td>
<td>0.000 mm</td>
</tr>
<tr>
<td>CV#03</td>
<td>0</td>
<td>0.000 mm</td>
</tr>
<tr>
<td>CV#04</td>
<td>0</td>
<td>0.000 mm</td>
</tr>
<tr>
<td>CV#05</td>
<td>0</td>
<td>0.000 mm</td>
</tr>
<tr>
<td>CV#06</td>
<td>0</td>
<td>0.000 mm</td>
</tr>
</tbody>
</table>

1. **Conveyor condition file No.**
   With one conveyor board, CV#1 to CV#3 are displayed. With two conveyor boards, CV#1 to CV#6 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**
   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 Display

1. **Conveyor condition file No.**
   With one conveyor board, CV#1 to CV#3 are displayed. With two conveyor boards, CV#1 to CV#6 are displayed.

2. **SPEED**
   Conveyor averaged speed per 0.1 sec.

3. **CORRECT POS**
   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 XRC, the follow-up motion is performed according to the conveyor position compensated for the follow-up error. This compensated conveyor position is displayed here.

#### Table: Conveyor Speed Display

<table>
<thead>
<tr>
<th>Conveyor</th>
<th>SPEED</th>
<th>CORRECT POS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CV#01</td>
<td>100.0 mm/sec</td>
<td>4.000 mm</td>
</tr>
<tr>
<td>CV#02</td>
<td>0.0 mm/sec</td>
<td>0.000 mm</td>
</tr>
<tr>
<td>CV#03</td>
<td>0.0 mm/sec</td>
<td>0.000 mm</td>
</tr>
<tr>
<td>CV#04</td>
<td>0.0 mm/sec</td>
<td>0.000 mm</td>
</tr>
<tr>
<td>CV#05</td>
<td>0.0 mm/sec</td>
<td>0.000 mm</td>
</tr>
<tr>
<td>CV#06</td>
<td>0.0 mm/sec</td>
<td>0.000 mm</td>
</tr>
</tbody>
</table>
7.3 Conveyor Tracking Status Display

**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. LS#4, LS#5, and LS#6 are the input signals connected to CN1, CN2, and CN3 of the 2nd conveyor board respectively.

**INPUT STATUS**
Displays each conveyor home-position input status.

- ●: Displayed when the manipulator is not synchronizing the conveyor and the conveyor homeposition input signal turns ON.
- ○: Displayed when the conveyor home-position input signal turns OFF.

**Conveyor condition file No.**
With one conveyor board, CV#1 to CV#3 are displayed. With two conveyor boards, CV#1 to CV#6 are displayed.

**TRACKING STATUS**
Displays the manipulator synchronizing status.

- ●: Displayed 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 displayed, 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.

- ○: Displayed when the manipulator synchronizing status is cancelled.

<table>
<thead>
<tr>
<th>DATA</th>
<th>EDIT</th>
<th>DISPLAY</th>
<th>UTILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>CV TRACKING STATUS</td>
<td>INPUT STATUS</td>
<td>TRACING STATUS</td>
<td>DATA EDIT DISPLAY UTILITY</td>
</tr>
<tr>
<td>LS#01</td>
<td>○</td>
<td>CV#01</td>
<td>●</td>
</tr>
<tr>
<td>LS#02</td>
<td>○</td>
<td>CV#02</td>
<td>○</td>
</tr>
<tr>
<td>LS#03</td>
<td>○</td>
<td>CV#03</td>
<td>○</td>
</tr>
<tr>
<td>LS#04</td>
<td>○</td>
<td>CV#04</td>
<td>○</td>
</tr>
<tr>
<td>LS#05</td>
<td>○</td>
<td>CV#05</td>
<td>○</td>
</tr>
<tr>
<td>LS#06</td>
<td>○</td>
<td>CV#06</td>
<td>○</td>
</tr>
</tbody>
</table>
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 “ENCODER INPUT” in the conveyor condition file
- Setting by “VIRTUAL ENCODER 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” = “ENCODER”
  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 Instruction List

< > indicates numerical or alphabetical data. If multiple items are shown in one section, select one of the items.

<table>
<thead>
<tr>
<th>SYSTART</th>
<th>Function</th>
<th>Starts the conveyor synchronized operation.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Instruction items</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CV# (&lt;Conveyor condition file No.&gt;)</td>
<td>1 to 6</td>
</tr>
<tr>
<td></td>
<td>STP= &lt;Synchronization start position (mm)&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>OL= &lt;Tolerance (mm)&gt;</td>
<td>When omitted or 0 is set, the tolerance check is not performed.</td>
</tr>
<tr>
<td>Example</td>
<td>SYSTART CV#(1) STP=100.000</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SYMOVJ*</th>
<th>Function</th>
<th>Moves in joint motion in synchronization with the conveyor.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Instruction items</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CV# (&lt;Conveyor condition file No.&gt;)</td>
<td>1 to 6</td>
</tr>
<tr>
<td></td>
<td>CTP= &lt;Conveyor position at teaching (mm)&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>VJ= &lt;Play speed (%)&gt;</td>
<td>VJ: 0.01 to 100.00</td>
</tr>
<tr>
<td>Example</td>
<td>SYMOVJ VJ=50.00 CV#(1) CTP=100.000</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SYMOVL</th>
<th>Function</th>
<th>Moves in linear interpolation in synchronization with the conveyor.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Instruction items</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CV# (&lt;Conveyor condition file No.&gt;)</td>
<td>1 to 6</td>
</tr>
<tr>
<td></td>
<td>CTP= &lt;Conveyor position at teaching (mm)&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>V= &lt;Play speed&gt;</td>
<td>V: 0.1 to 1500.0 mm/sec. 0.6 to 9000.0 cm/min.</td>
</tr>
<tr>
<td>Example</td>
<td>SYMOVL V=200.0 CV#(1) CTP=100.000</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SYMOVC</th>
<th>Function</th>
<th>Moves in circular interpolation in synchronization with the conveyor.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Instruction items</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CV# (&lt;Conveyor condition file No.&gt;)</td>
<td>1 to 6 Can be omitted.</td>
</tr>
<tr>
<td></td>
<td>CTP= &lt;Conveyor position at teaching (mm)&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>V= &lt;Play speed&gt;</td>
<td>V: 0.1 to 1500.0 mm/sec. 0.6 to 9000.0 cm/min.</td>
</tr>
<tr>
<td>Example</td>
<td>SYMOVC V=200.0 CV#(1) CTP=100.000</td>
<td></td>
</tr>
</tbody>
</table>
**SYEND**

<table>
<thead>
<tr>
<th>Function</th>
<th>Ends the conveyor synchronized operation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instruction items</td>
<td>CV# (&lt;Conveyor condition file No.&gt;)</td>
</tr>
<tr>
<td>Example</td>
<td>SYEND CV#(1)</td>
</tr>
</tbody>
</table>

*1 SYMOVJ can be used only when synchronizing with a base axis.
## 10 Alarm List

<table>
<thead>
<tr>
<th>Alarm No.</th>
<th>Message</th>
<th>Causes</th>
<th>Corrective Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1003</td>
<td>ROM ERROR (XCP02)</td>
<td>Internal error.</td>
<td>Replace the XCP02 board (ROM).</td>
</tr>
<tr>
<td>1109</td>
<td>SYSTEM ERROR (CONVEYOR) [10], Decimal Data: 0 to 255</td>
<td></td>
<td>Replace the XSL02 board.</td>
</tr>
<tr>
<td>1400</td>
<td>CONVEYOR ENCODER ERROR [Error occurred conveyor No.: 1, 2, 3]</td>
<td>Conveyor encoder error at the error occurred conveyor No.</td>
<td>Replace the encoder cable or the encoder.</td>
</tr>
<tr>
<td>1401</td>
<td>CANNOT CHANGE CONVEYOR MODE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4021</td>
<td>MEMORY ERROR (CONVEYOR CONDITION FILE) [10], Decimal Data: 0 to 255</td>
<td>The conveyor condition file data in the memory has been destroyed.</td>
<td>Initialize the conveyor condition file in customer maintenance mode.</td>
</tr>
<tr>
<td>4530</td>
<td>CONVEYOR SYNCHRONIZATION ERROR [10], Decimal Data: 0 to 255</td>
<td>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.</td>
<td>Turn the power OFF then back ON. If the alarm occurs again, contact your YASKAWA representative.</td>
</tr>
<tr>
<td>4531</td>
<td>UNDEFINED CONVEYOR COND FILE [10], Decimal Data: 0 to 255</td>
<td>The conveyor condition file specified for the job is not set for use.</td>
<td>Set the conveyor condition file to “USED”</td>
</tr>
<tr>
<td>Alarm No.</td>
<td>Message</td>
<td>Causes</td>
<td>Corrective Actions</td>
</tr>
<tr>
<td>----------</td>
<td>----------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>4532</td>
<td>CONVEYOR SPEED DOWN [10], Decimal Data: 0 to 255</td>
<td>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.</td>
<td>Increase the conveyor speed so that it becomes larger than the conveyor speed lower limit specified in the conveyor condition file.</td>
</tr>
<tr>
<td>4533</td>
<td>ARITHMETIC ERROR [10], Decimal Data, 0 to 255</td>
<td>Internal error.</td>
<td>Turn the power OFF then back ON. If the alarm occurs again, contact your YASKAWA representative.</td>
</tr>
<tr>
<td>4583</td>
<td>CAN NOT USE SMOVJ DURING TRACKING [10], Decimal Data, 0 to 255</td>
<td>SYMOVJ was executed when a robot axis was used for synchronization.</td>
<td>SYMOVJ can be used only when the base axis is used for synchronization.</td>
</tr>
<tr>
<td>5020</td>
<td>SENSOR PARAMETER ERROR [10], Decimal Data: 0 to 255</td>
<td>On the XSL02 board, when parameters were calculated using data in the conveyor condition file, an operation error occurred.</td>
<td>Check whether the data are properly set in the conveyor condition file. Confirm that “0” is not set for the user coordinate number.</td>
</tr>
<tr>
<td>5022</td>
<td>CONVEYOR POSITION LIMIT OVER [Alarm occurred conveyor condition file No.: 1, 2, or 3]</td>
<td>The corrected conveyor position value exceeds ±21 m</td>
<td>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.</td>
</tr>
<tr>
<td>5023</td>
<td>CONVEYOR COUNTER LIMIT OVER [Alarm occurred conveyor condition file No: 1, 2, or 3]</td>
<td>The conveyor position counter pulse overflowed.</td>
<td>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.</td>
</tr>
</tbody>
</table>
# Sensor Parameters (SxE)

Use the sensor parameters with their initial value settings.

<table>
<thead>
<tr>
<th>No.</th>
<th>Contents</th>
<th>Initial Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Application designation</td>
<td>16</td>
</tr>
<tr>
<td>1</td>
<td>Time to recognize the input of start signal</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>Reference time to recognize the occurrence of speed down</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>Time for averaging the speed variation amount</td>
<td>60</td>
</tr>
<tr>
<td>4</td>
<td>Time to recognize the falling edge of start signal</td>
<td>5</td>
</tr>
</tbody>
</table>
12 Turntable Synchronized Function

This function enables a manipulator to move in interpolation, synchronizing with circular conveyor or turntable.

12.1 Setting Turntable Synchronized System

12.1.1 Conveyor Condition File

To use turntable synchronized function, set "CIRCULAR" to "TRACKING" in the conveyor condition file.

<table>
<thead>
<tr>
<th>DATA</th>
<th>EDIT</th>
<th>DISPLAY</th>
<th>UTILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>FILE NO.</td>
<td>:1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USED STATUS</td>
<td>:NOT USED</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PORT NO.</td>
<td>:CN1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BROKEN LINE DETECT</td>
<td>:OFF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENCODER INPUT</td>
<td>:ENCODER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENCODER SIGN</td>
<td>:FORWARD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CORRECTION</td>
<td>:FORWARD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRACKING</td>
<td>:ROBOT AXIS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USER COORD NO.</td>
<td>:01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BASE AXIS</td>
<td>:X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>POS RESOLUTION</td>
<td>:7000000 p/R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VIRTUAL CV SPEED</td>
<td>:3500 p/sec</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AVERAGED TRAVEL TIME</td>
<td>:1000 ms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RESET SIG. MONITOR</td>
<td>:10000 ms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CV SPEED DOWN MODE</td>
<td>:EXECUTE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CV LOWER LIMIT SPEED</td>
<td>:100 p/sec</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VIRTUAL ENCODER IN</td>
<td>:IN#000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VIRTUAL ENCODER OUT</td>
<td>:OUT#000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1️⃣ TRACKING (ROBOT AXIS/BASE AXIS/CIRCULAR)
Circular: Turntable synchronized operation
When "CIRCULAR" is specified, circular tracking is performed according to the calibration results executed in 12.1.2 "Calibration between Manipulator and Turntable."

2️⃣ USER COORD NO. (1 to 24)
Specify user coordinate No. in which calibration results (related position of turntable) are stored.

3️⃣ POS RESOLUTION (1 to 2147483647 pulse/rev)
Set a pulse number from an encoder per rotation of turntable. If a positional resolution of turntable is unknown, set the value calculated at calibration.

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

5️⃣ CV LOWER LIMIT SPEED (0 to 65535 pulse/sec)
When "CIRCULAR" is selected at 1️⃣, input unit is changed to "pulse/sec" from "mm/sec."
### 12.1.2 Calibration between Manipulator and Turntable

For a synchronized operation between a manipulator and a turntable, prior registration of the settings for mutual positioning is required. This relationship is set by calibration between the manipulator and the turntable.

#### Calibration Tool Setting

<table>
<thead>
<tr>
<th>Operation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mount a tool for calibration on the manipulator</td>
<td>*1 Use a tool whose exact dimensions are known.</td>
</tr>
<tr>
<td>Select (ROBOT) under the top menu</td>
<td></td>
</tr>
<tr>
<td>Select (TOOL)</td>
<td>Enter the tool dimensions Press [ENTER]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TOOL</th>
<th>R1</th>
<th>R2</th>
<th>R3</th>
<th>R4</th>
<th>R5</th>
<th>R6</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOOL NO.: 00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NAME: CALIBRATION TOOL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>0.000 mm</td>
<td>Rx</td>
<td>0.00 deg.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Y</td>
<td>0.000 mm</td>
<td>Ry</td>
<td>0.00 deg.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z</td>
<td>0.000 mm</td>
<td>Rz</td>
<td>0.00 deg.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Teaching Positions for Calibration

1. Determine an arbitrary point (point P) on the turntable. Align the tool center point of the manipulator with point P, and register it as C1.

2. Turn the turntable in positive direction. Then, align the tool center point of the manipulator to point P, and register it as C2.

3. Turn the turntable further in the same direction as in step 2. Then, align the tool center point of the manipulator to point P, and register it as C3.
12.1 Setting Turntable Synchronized System

Calibration

Operation

Select {ROBOT} under the top menu ➔ Select {CONVEYOR CALIB}[^1] ➔ Select a conveyor calibration No. ➔ Select “ROBOT” ➔ Select “SET POS” ➔ Move the turntable to turn ON the home-position limit switch ➔ Press the axis key to move the manipulator to the desired position ➔ Press [MODIFY] and [ENTER]^[2] ➔ Select “COMPLETE”[^3]

Explanation

*1 The conveyor calibration display is shown. The CV FILE NO. corresponds to the conveyor condition file No.

Pressing the page key P switches CV FILE NO.

*2 The teaching positions are displayed.

*3 The positions for calibration are registered. The taught coordinate is registered in the user coordinate No. specified in the conveyor condition file. The registered data can be changed by using the number keys.

The positional resolution of turntable is calculated at calibration. If the resolution is unknown, set the calculated value to conveyor condition file.
12.2 Notes on Instructions

When using turntable synchronized function, the instructions are changed as follows since the unit of distance/speed is changed from mm (µ) to pulse.

• SYSTART instruction

  [Linear conveyor synchronized operation]
  SYSTART CV (#1) STP=50.000 OL=10.0

  [Turntable synchronized operation]
  SYSTART CV (#1) STPP=5000 OLP=100

  ① Synchronization start pulse
  Set the conveyor position in unit of pulse where synchronized operation starts.

  ② Tolerance
  Set the maximum excess in unit of pulse to execute the synchronized operation when the conveyor current position value exceeds the synchronization start position value at the execution of SYSTART instruction. When omitted or 0 is set, tolerance check is not executed.

• SYMOVL instruction

  [Linear conveyor synchronized operation]
  SYMOVL V=200.0CV (#1) CTP=100.000
  SYMOVC V=200.0CV (#1) CTP=100.000

  [Turntable synchronized operation]
  SYMOVL V=200.0CV (#1) CTPP=100.000
  SYMOVC V=200.0CV (#1) CTPP=100.000

  ① Conveyor position at teaching
  Set the conveyor position for teaching in unit of pulse.
YASNAC XRC OPTIONS

INSTRUCTIONS

FOR CONVEYOR SYNCHRONIZED FUNCTION

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