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http://www.motoman.com/forms/techpubs.asp
Chapter 1
Introduction

This manual provides system information for the Relative Job Function and contains the following sections:

SECTION 1 - INTRODUCTION
Provides general information about the structure of this manual, a list of reference documents, and customer service information.

SECTION 2 - SAFETY
This section provides information regarding the safe use and operation of Motoman products.

SECTION 3 - RELATIVE JOB INSTRUCTIONS
Provides detailed information about the Relative Job Function.

1.1 Reference to Other Documentation

For additional information refer to the following:

- NX100 Controller Manual (P/N 149201-1)
- Concurrent I/O Manual (P/N 149230-1)
- Operator’s Manual for your application
- Vendor manuals for system components not manufactured by Motoman

1.2 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 (EA1400, HP20, etc.)
- Application Type (arcwelding, spot welding, handling)
- Robot Serial Number (located on back side of robot arm)
- Robot Sales Order Number (located on back of controller)
Chapter 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 R15.06-1999. The address is as follows:

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

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, Operation, and Maintenance Safety (Section 2.6)

### 2.2 Standard Conventions

This manual includes the following alerts – in descending order of severity – that are essential to the safety of personnel and equipment. As you read this manual, pay close attention to these alerts to insure safety when installing, operating, programming, and maintaining this equipment.

**DANGER!**

Information appearing in a DANGER 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 in a WARNING 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 in a CAUTION 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 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 R15.06-1999, section 4.2.5, Sources of Energy, 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 R15.06-1999 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 equipment is provided as standard:

- Safety fences and barriers
- Light curtains and/or safety mats
- Door interlocks
- Emergency stop palm buttons located on operator station, robot controller, and programming pendant

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 R15.06-1999 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, Operation, and 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. 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 program, operate, and maintain the system. All personnel involved with the operation of the equipment must understand potential dangers of operation.

- Inspect the robot and work envelope to be sure no potentially hazardous conditions exist. Be sure the area is clean and free of water, oil, debris, etc.
- Be sure that all safeguards are in place. Check all safety equipment for proper operation. Repair or replace any non-functioning safety equipment immediately.
- Do not enter the robot cell while it is in automatic operation. Be sure that only the person holding the programming pendant enters the workcell.
- Check the E-STOP button on the programming pendant for proper operation before programming. The robot must be placed in Emergency Stop (E-STOP) mode whenever it is not in use.
- Back up all programs and jobs onto suitable media before 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.
• Any modifications to PART 1, System Section, of the robot controller concurrent I/O program can cause severe personal injury or death, as well as damage to the robot! Do not make any modifications to PART 1, System Section. 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.

• The robot controller allows modifications of PART 2, User Section, of the concurrent I/O program and modifications to controller parameters for maximum robot performance. Great care must be taken when making these modifications. 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 and other parts of the system. Double-check all modifications under every mode of robot operation to ensure that you have not created hazards or dangerous situations.

• Check and test any new or modified program at low speed for at least one full cycle.

• This equipment has multiple sources of electrical supply. Electrical interconnections are made between the controller and other equipment. Disconnect and lockout/tagout all electrical circuits before making any modifications or connections.

• Do not perform any maintenance procedures before reading and understanding the proper procedures in the appropriate manual.

• Use proper replacement parts.

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

MOTOMAN INSTRUCTIONS
MOTOMAN-□□□ INSTRUCTIONS
NX100 INSTRUCTIONS
NX100 OPERATOR’S MANUAL
NX100 MAINTENANCE MANUAL

The NX100 operator’s manuals above correspond to specific usage. Be sure to use the appropriate manual.
This manual explains the relative job function of the NX100. Read this manual carefully and be sure to understand its contents before handling the NX100.

General items related to safety are listed in Section 1: Safety of the NX100 Instructions. To ensure correct and safe operation, carefully read the NX100 Instructions 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 NX100.

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 front door of the NX100 and programming pendant are pressed. When the servo power is turned OFF, the SERVO ON LED on the programming pendant is turned OFF

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

• 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.

• 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 person is present in the P-point maximum envelope of the manipulator and that you are in a safe location before:
  - Turning ON the NX100 power.
  - Moving the manipulator with the programming pendant.
  - Running the system in the check mode.
  - Performing automatic operations.

Injury may result if anyone enters the P-point maximum envelope of the manipulator during operation. Always press an emergency stop button immediately if there is a problem. The emergency stop buttons are located on the right of the front door of the NX100 and the programming pendant.
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 programming pendant, and supply cables.

In this manual, the equipment is designated as follows.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Manual Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>NX100 Controller</td>
<td>NX100</td>
</tr>
<tr>
<td>NX100 Programming Pendant</td>
<td>Programming Pendant</td>
</tr>
<tr>
<td>Cable between the manipulator and the controller</td>
<td>Manipulator cable</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><strong>Character Keys</strong> The keys which have characters printed on them are denoted with [ ]. ex. [ENTER]</td>
</tr>
<tr>
<td></td>
<td><strong>Symbol Keys</strong> The keys which have a symbol printed on them are not denoted with [ ] but depicted with a small picture. ex. page key The cursor key is an exception, and a picture is not shown.</td>
</tr>
<tr>
<td></td>
<td><strong>Axis Keys</strong> and <strong>Numeric Keys</strong> are generic names for the keys for axis operation and number input.</td>
</tr>
<tr>
<td></td>
<td><strong>Keys pressed simultaneously</strong> When two keys are to be pressed simultaneously, the keys are shown with a “+” sign between them, ex. [SHIFT]+[COORD]</td>
</tr>
<tr>
<td></td>
<td><strong>Displays</strong> The menu displayed in the programming pendant is denoted with { }. ex. {JOB}</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, or that the item is directly selected by touching the screen.
# Relative Job

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6  Instruction List
1 Relative Job

In a standard job, each position is defined by a set of pulse numbers, which represent the amount of revolutions of the S, L, U, R, B, and T axes. In a relative job, however, each position is represented with a set of three values (X, Y, Z) in a specified coordinate system.

1.1 Coordinate Systems

In a relative job, any of the following three types of coordinate systems can be used:

- Base coordinate system
- Robot coordinate system
- User coordinate system (24 systems available)

1.2 Relative Job Shift Functions

In a relative job that uses a user coordinate system, changing the definition points to re-determine the coordinate system also changes the coordinates used for the robot operations accordingly. Also when the operating coordinate system number is changed, the coordinates used for operations are also changed accordingly.
1.2 Relative Job Shift Functions

Movement in User Coordinate System No. 1

Relative Job Shifting Operation when Definition Point is Changed

- Changing definition points of the user coordinate system or varying the coordinate system number without due consideration may cause the manipulator to move in an unexpected direction when the job is executed. Be careful when changing the coordinate system.
- Shifting the steps that have been taught by the MOVJ instruction may distort the path. Be careful and avoid interference with jigs and other machinery.
2 Examples of Use of Relative Jobs

2.1 Shift Function to Offset Workpiece Position Error

After teaching a standard job for a workpiece placed at a reference point, the job is converted into a relative job in a user coordinate system. With a shift function and sensors, possible differences of workpiece positions between teaching and playback can be offset.

1. Place a workpiece at a reference point and teach as usual. Name the job as “STANDARD-1”.
2. Create a user coordinate system for the workpiece. Execute a job that creates a user coordinate system based on the position data of three definition points detected on the workpiece by sensors.

3. Create a relative job. Convert “STANDARD-1” created in step 1 into a relative job called “RELATIVE-1” using user coordinate system No. 1 created in step 2.

```
NOP
LOADV P000 ← a
LOADV P001 ← b
LOADV P002 ← c
    Position data of points detected by external sensors is received and stored as position variables.
MFRAME UF##(1)  P000  P001  P002 ← User coordinate system created.
END
```
4. Play back the job.
   Use the following job to perform the relative job.

   NOP
   LOADV P000
   LOADV P001
   LOADV P002  \{ Position data of points detected by external sensors is received and stored as position variables. \}
   MFRAME UF#(1) P000 P001 P002  \leftarrow User coordinate system created
   MOVJ VJ=50.0  \leftarrow Moving to waiting position
   CALL JOB:RELATIVE-1  \leftarrow "RELATIVE-1" of user coordinate system No.1 executed
   END

   User Coordinate System before Modification

   User Coordinate System after Modification

   Playback: Sensors detect a workpiece position error.
   This error is corrected by changing the original coordinate system to create a new user coordinate system.
   The workpiece is processed using this new user coordinate system.
2.2 A Single Manipulator to Work on the Same Type of Workpiece in Different Locations

With the relative job function, a single manipulator can easily work on the same type of workpiece in different locations in the following two ways.

### 2.2.1 By Modifying the Teaching Coordinate

Create a job for a single workpiece, and then shift the job to another location to create another job. In this way, create a job at each location, fine adjustment at each position is possible.

1. Create a job for a single workpiece.
2. Teach a user coordinate system (for instance, UF#1) for the workpiece in that location.
3. Convert the job created in step 1 into a relative job in the user coordinate system taught in step 2.
4. Move the workpiece to another location and teach another user coordinate system (for instance, UF#2) for the workpiece in that location.
5. Call up the job header display of the relative job created in step 3 and change the coordinate system to the user coordinate system (UF#2) taught in step 4.
6. Create a new standard job by converting the relative job of the modified coordinate system. This new standard job is to be executed at the location of step 4.
7. To create more jobs for other locations, repeat steps 4 to 6 using other user coordinate system numbers.
2.2 A Single Manipulator to Work on the Same Type of Workpiece in Different Locations

### 2.2.2 By Converting the User Coordinate when Operating

A single relative job can be executed at more than one position. In this way, the memory can be used effectively.

1. Create job “ABCDEF” for a single workpiece.

2. Teach a user coordinate system (for instance, UF#1) for the workpiece in that location.

3. Convert the job created in step 1 into a relative job using the user coordinate system taught in step 2.

4. Move the workpiece to another location and teach another user coordinate system (for instance, UF#2) for the workpiece in that location.

5. Specify the operating coordinate system when calling the work job from a control job.

   ```
   NOP
   |
   CALL JOB:ABCDEF UF#2
   |
   END
   ```

   When the CALL instruction is executed, relative job “ABCDEF” that was taught using UF#1 is performed using UF#2.

6. To create more jobs to execute at other locations, repeat steps 4 and 5 using other user coordinate system numbers.

**NOTE**: The manipulator is not always capable of carrying out the operation depending on the operating position. Do not force the manipulator to make excessive position changes.
2.3 Using One Job on Multiple Manipulators

A job taught to one manipulator can be used for other manipulators on the line.

1. On manipulator No.1, create a job for a single workpiece.

2. Teach a user coordinate system (for instance, UF#1) for the workpiece in that location.

3. Convert the job created in step 1 into a relative job using the user coordinate system taught in step 2.

4. Save the created relative job in an external memory device, such as a compact flash card or a floppy disk. (In case of saving data in a floppy disk, YASNAC FC1 or YASNAC FC2 is required.)

5. Set workpieces to manipulators No. 2 and No. 3 to which the job will be shifted. Teach the user coordinate system (UF#1) to the manipulators.

6. Load the relative job saved in step 4 and convert it to standard jobs for manipulators No. 2 and No. 3.

**NOTE**
The manipulator is not always capable of carrying out the operation depending on the operating position. Check the positions by FWD and BWD operations.
3 Operations Related to Relative Jobs

3.1 Converting into a Related Job

To create a relative job, convert a standard job into a relative job. The conversion of a relative job into a standard job is also possible.

![Diagram showing conversion between Standard Job and Relative Job]

<table>
<thead>
<tr>
<th>Operation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Select {JOB} under the main menu.</td>
</tr>
<tr>
<td>2</td>
<td>Select {JOB CONTENT}.</td>
</tr>
<tr>
<td>3</td>
<td>Select {UTILITY} under the menu. Relative job conversion window appears.</td>
</tr>
</tbody>
</table>

**SOURCE JOB**
Selects the job to be converted. Select {SOURCE JOB} and the job list display is shown. Select the job to be converted.

**CONVERSION METHOD**
Displays the conversion method.
- STANDARD → RELATIVE: Converts a standard job into a relative job
- RELATIVE → STANDARD: Converts a relative job into a standard job
3.1 Converting into a Related Job

<table>
<thead>
<tr>
<th>Operation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>(Cont’d) Select {RELATIVE JOB}.</td>
</tr>
</tbody>
</table>

1. **COORDINATE**
   - Selects a coordinate system where a standard job is converted into a relative job.
   - Select {COORDINATE}, and the selection dialog is displayed.
   - Sets a job name for the conversion destination.
   - Enter a job name for the conversion destination. When a job name for the conversion destination has been set, a new job is created when converting. When a job name has not been set, the job at the conversion source itself is used.

2. **EXECUTE**
   - Executes job conversion.
   - Select {EXEC} to execute the conversion.

### Operation Explanation

- During conversion, all key operations are unavailable.
- Any alarm during the conversion interrupts the operation.
- When the conversion is completed, the job contents window appears.

The following diagram shows that when a relative job has been converted into a standard job, “/OV” appears in the programming steps when the new position is beyond the P-point maximum envelope of the manipulator. The “/OV” indication disappears after modifying the position.

<table>
<thead>
<tr>
<th>JOB CONTENT</th>
<th>STEP NO. : 0003</th>
</tr>
</thead>
<tbody>
<tr>
<td>J : JOB-A</td>
<td></td>
</tr>
<tr>
<td>S : 000</td>
<td></td>
</tr>
<tr>
<td>0000  NOP</td>
<td></td>
</tr>
<tr>
<td>0001  &quot;JOB FOR CARMODEL-A&quot;</td>
<td></td>
</tr>
<tr>
<td>0002  JUMP JOB:JOB-01</td>
<td></td>
</tr>
<tr>
<td>0003  MOVJ VJ=50.00</td>
<td></td>
</tr>
<tr>
<td>0004  MOVJ /OV VJ=50.00</td>
<td></td>
</tr>
<tr>
<td>0005  MOVJ VJ=50.00</td>
<td></td>
</tr>
<tr>
<td>0006  JUMP JOB:JOB-02</td>
<td></td>
</tr>
</tbody>
</table>

* "/OV" appears after the move instruction when the position is beyond the P-point maximum envelope of the manipulator.*
### 3.2 Verification of Information Related to Relative Job

#### 3.2.1 Verifying Coordinate System

The coordinate system used for teaching can be verified in the job header window.

<table>
<thead>
<tr>
<th>Operation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Select {JOB} under the main menu.</td>
</tr>
<tr>
<td>2</td>
<td>Select {JOB CONTENT}.</td>
</tr>
<tr>
<td>3</td>
<td>Select {DISPLAY} under the menu.</td>
</tr>
<tr>
<td>4</td>
<td>Select {JOB HEADER}. The job header window appears. The window is scrolled with the cursor.</td>
</tr>
</tbody>
</table>

When the coordinate system used for teaching is a user coordinate system, the user coordinate numbers can be changed in this window.

<table>
<thead>
<tr>
<th>Operation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Select {TEACH COORD}.</td>
</tr>
<tr>
<td>2</td>
<td>Enter the user coordinate number and press [ENTER].</td>
</tr>
</tbody>
</table>
### 3.2.2 Verifying Command Positions

The command position of XYZ-type can be verified by calling up the command position window for the relative job.

<table>
<thead>
<tr>
<th>Operation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Select {ROBOT} under the main menu.</td>
</tr>
<tr>
<td>2</td>
<td>Select {COMMAND POSITION}. The command position window appears.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Menu Options</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ShortCutMain</td>
<td>Main Menu</td>
</tr>
<tr>
<td>Main Menu</td>
<td>ShortcutMain Menu</td>
</tr>
</tbody>
</table>

### 3.3 Instructions Related to Relative Job

#### 3.3.1 CALL/JUMP

CALL or JUMP are the instructions used to call and execute a relative job. If no coordinate system number is specified for the job, the job is carried out with the coordinate system used for teaching.

```
CALL JOB: JOB-1
JUMP JOB: JOB-1 IF IN#(1)=OFF
```

If the job was taught using a user coordinate system, the job can be carried out using another user coordinate system when called by CALL or JUMP.
A relative job “JOB-1”, which was taught using the user coordinate system No. 1, is changed to the coordinate system to No. 2 when it is executed. The coordinates of the steps in JOB-1 are converted into the coordinates of coordinate system No. 2.

CALL JOB: JOB-1 UF#(2)

### 3.3.2 MFRAME

The MFRAME instruction creates a user coordinate system from position data detected by sensors.

<Example>

Position data of sensor-detected definition points of the user coordinate system is stored as position variables. A user coordinate system is created using the position variables.

```
MFRAME UF#(1)       P000  P001  P002
  ORG    XX     XY
```

Position variables and position data of user coordinate system definition points are stored.
### 3.3.3 Registering an Instruction

<table>
<thead>
<tr>
<th>Operation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  Move the cursor to the address area.</td>
<td>In the job content window, move the cursor to the line immediately above the place where an instruction is to be registered.</td>
</tr>
<tr>
<td>2  In the job content window, move the cursor to the line immediately above the place where an instruction is to be registered.</td>
<td>In the job content window in the teach mode, move the cursor to the line immediately above the place where an instruction is to be registered.</td>
</tr>
<tr>
<td>3  Press [INFORM LIST].</td>
<td>The instruction list dialog appears. The cursor moves to the instruction list dialog while the cursor in the address area changes to an underbar.</td>
</tr>
<tr>
<td>4  Select an instruction to be registered.</td>
<td>Synchronizing with the cursor, instructions appear in the input buffer line the same way as the additional items are registered last time.</td>
</tr>
</tbody>
</table>
3.3 Instructions Related to Relative Job

<table>
<thead>
<tr>
<th>Operation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Change the additional items and variable data.</td>
<td>&lt;To register items as they appear in the input buffer&gt; Perform operation 6.&lt;br&gt;&lt;br&gt;&lt;To edit any additional items&gt; Move the cursor to the additional item to be changed, and then press [SELECT] to display an input line. &lt;br&gt;&lt;br&gt;Move the cursor to the job to additionally register as a CALL instruction, then press [SELECT].</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 Press [ADD] and [ENTER].</td>
<td></td>
</tr>
</tbody>
</table>
3.4 Editing Relative Jobs

Relative jobs, like standard jobs, can be edited with the programming pendant to add, modify, and delete positions. The differences in editing relative jobs and editing standard jobs are explained in this section.

3.4.1 Blink Indication of Move Instruction on Job Content Window

XYZ type current positions are updated by the FWD operation, and are not updated by just calling the job. Therefore, the move instructions merely blink right after calling the job and do nothing else even if the current and the commanded manipulator positions match.

3.4.2 Addition and Modification of Steps

<table>
<thead>
<tr>
<th>Coordinate system of teaching</th>
<th>Taught coordinate system of a relative job is used. If the taught coordinate system is a user coordinate system and another user coordinate system has been specified for the operating coordinate system, the operating coordinate system is used.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching tool</td>
<td>Coordinates of operation positions are registered by the tool used when the axis is operated.</td>
</tr>
</tbody>
</table>

3.4.3 Cut & Paste Function

Cutting and pasting from a standard job to a relative job is impossible, and vice versa. Cutting and pasting between relative jobs in different coordinate systems is also impossible.
3.5 Relative Job Operation Method

When a relative job is performed, there are several ways to move to the step position. The following three methods can be used to designate the motion.

- **Previous Step Regarded (Constant B-axis sign)**
  
  Effective for a job of which the B-axis does not pass the point 0°. (i.e. in case of an operation performed with the B-axis pointed downward.)

- **Previous Step Regarded (Minimum R-axis movement)**

  Effective for a job of which the B-axis passes the point 0°.

- **Type Regarded**

  Effective for a job created in offline teaching is to be performed.

The operation method can be specified by the following parameter. When converting a relative job into a standard job, the method specified by this parameter is also used.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Settings</th>
<th>Initial value</th>
</tr>
</thead>
<tbody>
<tr>
<td>S2C332</td>
<td>0: Previous step regarded (constant B-axis sign)</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>1: Type regarded</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2: Previous step regarded (Minimum R-axis movement)</td>
<td></td>
</tr>
</tbody>
</table>

3.5.1 Previous Step Regarded (Constant B-axis Sign)

This method allows movement to the specified step in relation to the B-axis angle of the previous step. During operation, movement is made keeping the B-axis angle sign (+/-) constant so that it does not change. Therefore, it is used for a job of which the B-axis does not pass the point 0°.
If a job of which the B-axis passes the point $0^\circ$ is executed, the angle of the B-axis stays unchanged even when it should be changed, resulting in the R-axis turning to the position opposite by $180^\circ$.

- When converting a standard job into a relative job, teach a standard job where the B-axis does not pass $0^\circ$.
- When converting a relative job into a standard job, the manipulator’s current posture is referred. To perform a conversion, posture the manipulator in a similar posture in the first step of the relative job to be converted.
3.5.2 Previous Step Regarded (Minimum R-axis Movement)

This method keeps the R-axis movement to a minimum when the manipulator moves from the previous step to the next step. Therefore, it can be used for jobs of which the B-axis passes the point 0°.

Since this method minimizes R-axis movement, add some steps to the prescribed path if it is desired to move the R-axis in a wider range.

If a parallel shift is executed in a relative job, the R-axis may have to rotate greatly when the shift amount is large. This method can not be applied to such cases: use the method "3.5.1 Previous Step Regarded (Constant B-axis Sign)".

- When converting a standard job into a relative job, a standard job should be taught so that the R-axis movement between steps does not exceed 90°. To move the R-axis in an angle measuring more than 90°, add some steps to divide the large angle into smaller ones.
- When converting a relative job into a standard job, the manipulator's current posture is referred. To perform a conversion, posture the manipulator in a similar posture in the first step of the relative job to be converted.
3.5.3 Type Regarded

When a relative job is converted from a standard job, position data of each step is classified into XYZ type position data and type data. In the type operation method, a movement is operated so that the type is added to the position data.

Since a movement is made for the specified type in any case, this method is effective when performing a job taught offline.

However, in case where a relative job is used as the shifting function for workpiece dislocation, special attention must be paid. If the teaching position is near the pole changing point, the movement may not be made for the specified type when the position is shifted according to the workpiece dislocation.

For example, if the angle of the R-axis of the teaching position for a standard job is close to but less than 90° and this position is changed, the angle of the R-axis may change to exceed 90°. The movement is made in “flip” before shifting and “no-flip” after shifting. Since a movement is made for a specified type even when using the type regarded method, the angle of the R-axis is near -90° when reversing 180°. Therefore, moving 180° in the opposite direction to the position taught by the R-axis may cause interference with the workpiece. The final tool position and stance are not changed before and after shifting.
4 Interface with an Easy Offline Teaching System

A relative job can be used as an interface with an easy offline teaching system. This chapter describes the necessary information to create a relative job on the easy offline teaching system.

4.1 Job Data Format

When a relative job is output via the YASNAC FC1 or FC2 or by data transmission, the output file contents are as follows.

FILE NAME .JBI

/JOB
//NAME <JOB NAME>
//POS
///NPOS  <C>,<BC>,<EC>,<P>,<BP>,<EX>
///USER <N>
///TOOL <N>
///POSTYPE <T>
///RECTAN
///RCONF <l>,<m>,<n>,<o>,<p>,<q>
Cxxxx =X,Y,Z,Rx,Ry,Rz
BCxxxx=X0,Y0,Z0
ECxxxx=1,2

/INST
///DATE <YYYY>/<MM>/<DD> <HH>:<TT>
///COMM  <COMMENT CHARACTER LINE>
///ATTR  <ATTRIBUTE 1>,<ATTRIBUTE 2>,….,<ATTRIBUTE 16>
///FRAME <C>
///GROUP1 <m1>,<m2>,<m3>
///GROUP2 <m1>,<m2>,<m3>
NOP
MOVJ  Cxxx BCxxx ECxxx VJ=xxx.x

END
A pseudo instruction is distinguished by a single slash (/) at its beginning. Each level of individual instructions are marked with a double slash (///), a triple slash (///), and a fourfold slash (/////).

A pseudo instruction related to the job is made as follows.
4.1 Job Data Format

4.1.1 JOB
Function: Shows that it is a job.
Format: /JOB

4.1.2 NAME
Function: Represents the job name.
Format: //NAME <Name>

<Name>: up to 8 characters

4.1.3 POS
Function: Represents the position data.
Format: ///POS

NPOS
Function: Represents the number of position data items.
Format: ///NPOS <C>,<BC>,<EC>,<P>,<BP>,<EX>
<C>: Number of robot axis teaching positions
<BC>: Number of base axis teaching positions
<EC>: Number of external (station) axis teaching positions
<P>: Number of robot axis position variables
<BP>: Number of base axis position variables
<EX>: Number of external (station) axis position variables

USER
Function: Represents the currently selected user coordinate system No.
Format: ///USER <N>

<N>: User coordinate system No.(0 to 23)

TOOL
Function: Represents the currently selected tool No.
Format: ///TOOL <N>

<N>: Tool No.(0 to 23)

POSTYPE
Function: Represents the position data type.
Format: ///POSTYPE<T>

<T>: |PULSE||BASE||ROBOT||TOOL||USER||MTOOL|
PULSE: Pulse data
<BASE>: Cartesian data, base coordinate system
<ROBOT>: Cartesian data, robot coordinate system
4.1 Job Data Format

<TOOL> : Cartesian data, tool coordinate system
<USER> : Cartesian data, user coordinate system
<MTOOL> : Cartesian data, master tool coordinate system

PULSE
Function : Represents that pulse data is defined during and after this pseudo instruction.
Format : ///PULSE

<C>:<Cxxxx>=<S>,<L>,<U>,<R>,<B>,<T>,<E1>,<E2>
<BC>:<BCxxxx>=<1>,<2>,<3>,<4>,<5>,<6>,<E1>,<E2>
<EC>:<ECxxxx>=<1>,<2>,<3>,<4>,<5>,<6>,<E1>,<E2>
<P>:<Pxxxx>=<S>,<L>,<U>,<R>,<B>,<T>,<E1>,<E2>
<BP>:<BPxxxx>=<1>,<2>,<3>,<4>,<5>,<6>,<E1>,<E2>
<EX>:<EXxxxx>=<1>,<2>,<3>,<4>,<5>,<6>,<E1>,<E2>

<Cxxxx>: Robot axis teaching position
<BCxxxx>: Base axis teaching position
<ECxxxx>: External (station) axis teaching position
<Pxxxx>: Robot axis position variables
<BPxxxx>: Base axis position variables
<EXxxxx>: External (station) axis position variables

xxxx := A number from 0 to 999

RECTAN
Function : Represents that Cartesian data is defined during and after this pseudo instruction.
Format : ///RECTAN

<C>:<Cxxxx>=<X>,<Y>,<Z>,<Rx>,<Ry>,<Rz>
<BC>:<BCxxxx>=<1>,<2>,<3>,<4>,<5>,<6>
<P>:<Pxxxx>=<X>,<Y>,<Z>,<Rx>,<Ry>,<Rz>
<BP>:<BPxxxx>=<1>,<2>,<3>,<4>,<5>,<6>

<X> : X-axis Cartesian data
<Y> : Y-axis Cartesian data
4.1 Job Data Format

<Z> : Z-axis Cartesian data
<Rx> : Rx-axis Cartesian data
<Ry> : Ry-axis Cartesian data
<Rz> : Rz-axis Cartesian data

**RCONF**
Function: Represents the manipulator type of the Cartesian data defined during and after this pseudo instruction.
Format: ///RCONF<l>,<m>,<n>,<o>,<p>,<q>

<i>: 0: Flip, 1: No-flip
<m>: 0: Upper arm, 1: Lower arm
<n>: 0: Front, 1: Rear
<o>: 0: R < 180, 1: R >= 180
<p>: 0: T < 180, 1: T >= 180
<q>: 0: S < 180, 1: S >= 180

For manipulator type, refer to Section 4.4 “Manipulator Type”.

4.1.4 INST

Function: Represents that it is an instruction.
Format: ///INST

**DATE**

Function: Represents the date.
Format: ///DATE <YYYY>/<MM>/<DD> <HH>:<TT>

<YYYY>: Year
<MM>: Month
<DD>: Day
<HH>: Hour
<TT>: Minute

**COMM**

Function: Represents that it is a job comment.
Format: ///COMM <Comment character line>

<Comment character line>: Up to 32 characters

**ATTR**

Function: Represents the job attribute.
Format: ///ATTR <Attribute 1>,<Attribute 2>,⋯,<Attribute16>

<Attribute>: JD|DD|SC|(RO|WO|RW)|RJ
<JD>: Job Destroy
<DD>: Directory Destroy
<SC>: Save Complete
4.1 Job Data Format

{RO|WO|RW}
<RO>: Writing disabled “Edit-lock”(Read Only)
<WO>: Reading disabled(Write Only)
<RW>: Reading/Writing capable(Read/Write)
<RJ>: Relative job

FRAME
Function : Represents relative job teaching coordinate system.
Format : ///FRAME <C>

<C>: BASE|ROBOT|N|
<N>: User coordinate system No.(1 to 24)
<Base>: Base coordinate system(Cartesian)
<ROBOT>: Robot coordinate system(Cartesian)
<USER>: User coordinate system(Cartesian)

GROUP1
Function : Represents 1st MOVE control group.
Format : ///GROUP1 <m1>,<m2>,<m3>

Add any of the following to<m1>,<m2>, and<m3>.
RE1(robot 1)
RE2(robot 2)
RE3(robot 3)
RE4(robot 4)
BS1(base 1)
BS2(base 2)
BS3(base 3)
BS4(base 4)
ST1(station 1)
ST2(station 2)
ST3(station 3)
ST4(station 4)
ST5(station 5)
ST6(station 6)
ST7(station 7)
ST8(station 8)
ST9(station 9)
ST10(station 10)
ST11(station 11)
ST12(station 12)
4.1  Job Data Format

GROUP2
Function : Represents 2nd MOVE control group.
Format : ///GROUP2 <m1>,<m2>,<m3>

Add any of the following to <m1>,<m2>, and <m3>.
RE1(robot 1)
RE2(robot 2)
RE3(robot 3)
RE4(robot 4)
BS1(base 1)
BS2(base 2)
BS3(base 3)
BS4(base 4)
ST1(station 1)
ST2(station 2)
ST3(station 3)
ST4(station 4)
ST5(station 5)
ST6(station 6)
ST7(station 7)
ST8(station 8)
ST9(station 9)
ST10(station 10)
ST11(station 11)
ST12(station 12)

GROUP3
Function : Represents 3rd MOVE control group.
Format : ///GROUP3 <m1>,<m2>,<m3>

Add any of the following to <m1>,<m2>, and <m3>.
RE1(robot 1)
RE2(robot 2)
RE3(robot 3)
RE4(robot 4)
BS1(base 1)
BS2(base 2)
BS3(base 3)
BS4(base 4)
ST1(station 1)
ST2(station 2)
ST3(station 3)
ST4(station 4)
ST5(station 5)
ST6(station 6)
ST7(station 7)
ST8(station 8)
4.1 Job Data Format

ST9(station 9)
ST10(station 10)
ST11(station 11)
ST12(station 12)

GROUP4
Function : Represents 4th MOVE control group.
Format : ///GROUP4 <m1>,<m2>,<m3>

Add any of the following to<m1>,<m2>, and<m3>.
RE1(robot 1)
RE2(robot 2)
RE3(robot 3)
RE4(robot 4)
BS1(base 1)
BS2(base 2)
BS3(base 3)
BS4(base 4)
ST1(station 1)
ST2(station 2)
ST3(station 3)
ST4(station 4)
ST5(station 5)
ST6(station 6)
ST7(station 7)
ST8(station 8)
ST9(station 9)
ST10(station 10)
ST11(station 11)
ST12(station 12)

LVARS
Function : Represents the number of local variables.
Format : ///LVARS <LB>,<LI>,<LD>,<LR>,<LS>,<LP>,<LBP>,<LEX>

<LB>: Number of byte type local variables
<LI>: Number of integer type local variables
<LD>: Number of double-precision type local variables
<LR>: Number of real number type local variables
<LS>: Number of character type local variables
<LP>: Number of robot axis position type local variables
<LBP>: Number of base axis position type local variables
<LEX>: Number of external (station) axis position type local variables
4.2 Relative Job Data Examples

4.2.1 Job for User Coordinate System No. 3, Only for Robot Axis

File Name : SAMPLE1.JBI

/JOB
//NAME SAMPLE1
//POS
///NPOS 5,0,0,0,0,0
///USER 3
///TOOL 0
///POSTYPE USER
///RECTAN
///RCONF 0,0,0,0,0
C0000=171.314,36.037,36.032,179.99,-1.52,85.23
C0001=39.290,36.037,36.014,179.99,-1.51,85.23
C0002=39.292,-65.965,36.016,179.99,-1.51,85.23
C0003=39.288,-65.949,-75.987,179.99,-1.52,85.24
C0004=171.314,36.037,36.032,179.99,-1.52,85.23
///INST
///DATE 1993/07/23 16:34
///ATTR SC,RW,RJ
///FRAME 3
///GROUP1 RB1
NOP
MOVJ C0000 VJ=50.00
MOVL C0001 V=46.0
MOVL C0002 V=46.0
MOVL C0003 V=46.0
MOVJ C0004 VJ=50.00
END
4.2.2 Job for Robot Axis + Base axis (Base Coordinate System)

File Name: SAMPLE2.JBI

/JOB
/NAME SAMPLE2
/POS
///NPOS 3,3,0,0,0,0
///TOOL 0
///POSTYPE BASE
///RECTAN
///RCONF 0,0,0,0,0
C0000=-415.000,0.000,770.000,180,00,-90.00,0.00
C0001=874.552,-626.159,1031.906,64.76,-37.91,95.22
C0002=1344.117,582.515,1090.264,52,72,-37.72,18.41
BC0000=0.000,0.000
BC0001=1343.952,-531.981
BC0002=1838.601,830.637
//INST
///DATE 1993/07/23 17:36
///ATTR SC,RW,RJ
///FRAME BASE
///GROUP1 RB1,BS1
NOP
MOVJ C0000 BC0000 VJ=25.00
MOVJ C0001 BC0001 VJ=25.00
MOVJ C0002 BC0002 VJ=25.00
END
4.2.3  Job for Robot Axis + Base Axis + Station Axis (Base Coordinate System, Single Job)

File Name: SAMPLE3.JBI

/JOB
//NAME SAMPLE3
//POS
///NPOS 2,2,2,0,0,0
///TOOL 0
///POSTYPE BASE
///RECTAN
///RCONF 0,0,0,0,0
C0000=-494.484,-248.122,1090.264,52.72,-37.2,118.41
C0001=-157.216,-187.240,1079.290,84.07,-35.63,118.76
BC0000=0.000,0.000
BC0001=550.647,485.316
///POSTYPE PULSE
///PULSE
EC0000=7103,27536
EC0001=7230,27577
///INST
///DATE 1993/07/23 18:11
///ATTR SC,RW,RJ
///FRAME BASE
///GROUP1 RB1,BS1,ST1
NOP
MOVJ C0000 BC0000 EC0000 VJ=25.00
MOVJ C0001 BC0001 EC0001 VJ=25.00
END
4.2.4  Job for Robot Axis + Base Axis + Station Axis (Base Coordinate System, Coordinate Job)

File Name:SAMPLE4.JBI

/JOB
/NAME SAMPLE3
/POS
///NPOS 2,2,2,0,0,0
///TOOL 0
///POSTYPE BASE
///RECTAN
///RCONF 0,0,0,0,0
C0000=-494.484,-248.122,1090.264,52.72,-37.2,118.41
C0001=-157.216,-187.240,1079.290,84.07,-35.63,118.76
BC0000=0.000,0,000
BC0001=550.647,485.316
///POSTYPE PULSE
///PULSE
EC0000=7103,27536
EC0001=7230,27577
///INST
///DATE 1993/07/23 18:11
///ATTR SC,RW,RJ
///FRAME BASE
///GROUP1 RB1,BS1,ST1
NOP
MOVJ C000 BC000 VJ=25.00 +MOVJ EC000 VJ=25.00
MOVJ C001 BC001 VJ=25.00 +MOVJ EC001 VJ=25.00
END
4.2.5 Job for Robot Axis + Robot Axis (Base Coordinate System, Coordinate Job)

File Name: SAMPLE5.JBI

/JOB
//NAME SAMPLE5
//POS
//NPOS 10,0,0,0,0,0
//TOOL 0
//POSTYPE BASE
//RECTAN
//RCONF 0,0,0,0,0
C0000=-765.337,202.936,1118.673,0.00,1.59,160.42
//TOOL 1
C0001=-856.025,-93.532,1134.850,1.43,-25.69,172.39
//TOOL 0
C0002=-831.637,122.110,1130.506,-0.36,6.81,167.30
//TOOL 1
C0003=-812.058,-39.516,1162.852,1.42,-25.68,172.39
//TOOL 0
C0004=-767.908,249.592,1071.301,0.00,1.59,157.08
//TOOL 1
C0005=-882.057,-101.531,1070.875,1.42,-25.68,172.40
//TOOL 0
C0006=-557.794,402.473,1033.164,0.63,-7.68,137.99
//TOOL 1
C0007=-920.071,-149.510,1042.893,1.41,-25.67,172.41
//TOOL 0
C0008=-765.337,202.936,1118.673,0.00,1.59,160.42
//TOOL 1
C0009=-856.025,-93.532,1134.850,1.43,-25.69,172.39
//INST
//DATE 1993/07/23 16:41
///ATTR SC,RW,RJ
///FRAME BASE
///GROUP1 RB1
///GROUP2 RB2
NOP
MOVJ C0000 VJ=50.00 +MOVJ C0001 VJ=50.00
SMOVL C0002 V=46.0 +MOVL C0003
SMOVL C0004 V=46.0 +MOVL C0005
MOVL C0006 V=46.0 +MOVL C0007 V=11.0
MOVJ C0008 VJ=50.00 +MOVJ C0009 VJ=50.00
END
4.3 Configuration of Position Data

The configuration of the position data for each axis in each coordinate system is as follows.

4.3.1 Position Data of Each Axis

■ Robot Axis

R1 = X, Y, Z, RX, RY, RZ + type
The position of a robot axis is represented in a specified coordinate system.

■ Station Axis

S1 = W1, W2
The position of a station axis is represented by a pulse number.

■ Base Axis

B1 = X0, Y0, Z0
The position of a base axis is represented as the distance of the axis from the origin of the coordinate system of teaching. (For the used axes only)

• For the base coordinate system, the distance from the origin of the base coordinate system.
• For the robot coordinate system, the distance from the origin of the base coordinate system.
• For the user coordinate system, the distance from the origin of the user coordinate system.
4.3.2 Position Data of Each Coordinate System

The position data of a robot axis, base axis, and station axis in each coordinate system is as follows.

- **Base Coordinate System**

- **Robot Coordinate System**
4.4 Manipulator Type

To describe robot axis position data in the XYZ type, several solutions can be obtained due to the manipulator mechanism when the manipulator is moved to the described position. In order to select one solution, it is necessary to specify the manipulator type. This manipulator type is called “TYPE”.

The NX100 has up to six types. The number of types differs depending on the manipulator models.

Six types are explained in this section.

4.4.1 Flip/No-flip (R-axis position)

The following diagram shows that “flip” is when the R-axis position is at position A and “no-flip” is when the R-axis is at position B. However, with a manipulator whose R-axis moves more than ±180° even at position A, it is necessary to specify whether the R-axis is between -90° to 90°, 270° to 360°, or -360° to -270°. This also applies to position B. For specifying R-axis, refer to the manipulator type explained in section 4.4.2. “R-axis Angle” for more details.
## 4.4 Manipulator Type

<table>
<thead>
<tr>
<th>Flip</th>
<th>No-flip</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Diagram" /></td>
<td><img src="image2.png" alt="Diagram" /></td>
</tr>
</tbody>
</table>

Note: $\theta_R$ is the angle when the R-axis zero-point position is assumed to be at $0^\circ$.

This specification is required for EA, ES, and HP model manipulators.

### 4.4.2 R-axis Angle

Specify whether the R-axis angle is within $\pm 180^\circ$ or exceeds $\pm 180^\circ$.

<table>
<thead>
<tr>
<th>$R&lt;180^\circ$</th>
<th>$R\geq 180^\circ$</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image3.png" alt="Diagram" /></td>
<td><img src="image4.png" alt="Diagram" /></td>
</tr>
</tbody>
</table>

Note: $\theta_R$ is the angle when the R-axis zero-point position is assumed to be at $0^\circ$.

This specification is required for EA, ES, and HP model manipulators.
4.4.3 T-axis Angle

Specify whether the T-axis angle is within $\pm 180^\circ$ or exceeds $\pm 180^\circ$ in a manipulator with a three-axis wrist, paying attention to the T-axis angle.

Note : $\theta_T$ is the angle when the T-axis zero-point position is assumed to be at $0^\circ$.

This specification is required for EA, ES, and HP model manipulators.

The specifications in the sections 4.4.1, 4.4.2, and 4.4.3 determine the positions of the R, B, and T-axes respectively.
4.4.4 Front/Back (Relation between S-axis and Control Point)

Viewing the L-axis and U-axis from the right side, specify the side of the S-axis rotation center where the B-axis rotation center will be located. The right side of the S-axis rotation center is the front and left side is back.

The above diagrams show the S-axis angle at 0° and 180°. Specification must be performed by always viewing the L-axis and U-axis from the right side. This specification is required for EA, ES, and HP model manipulators.
4.4.5 Upper/Lower Arm (Type Comprised of an L-axis and U-axis)

Specify the type comprised of the L-axis and the U-axis when the L-axis and the U-axis are viewed from the right side.

<table>
<thead>
<tr>
<th>Upper arm</th>
<th>Lower arm</th>
</tr>
</thead>
</table>

This specification is required for the EA, ES, and HP model manipulators.
4.4.6 S-axis Angle

Specify whether the S-axis angle is within $\pm 180^\circ$ or exceeds $\pm 180^\circ$.

<table>
<thead>
<tr>
<th></th>
<th>$S &lt; 180^\circ$</th>
<th>$S \geq 180^\circ$</th>
</tr>
</thead>
<tbody>
<tr>
<td>-180$^\circ$&lt; $\theta_s$&lt;=$180^\circ$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: $\theta_s$ is the angle when the S-axis zero-point position is assumed to be at $0^\circ$.

This specification is required for the manipulators of which S-axis operating range is greater than $\pm 180^\circ$. 
# 5 Alarm and Error Message List

## 5.1 Alarm Messages

<table>
<thead>
<tr>
<th>Alarm Number</th>
<th>Message</th>
<th>Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>4500</td>
<td>UNDEFINED USER FRAME</td>
<td>Undefined user coordinates were used.</td>
<td>Define the user coordinate.</td>
</tr>
<tr>
<td></td>
<td>[Decimal Data]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4509</td>
<td>MFRAME ERROR</td>
<td>Impossible to create user coordinates. 8: No position file registered</td>
<td>Register the position file (variables).</td>
</tr>
<tr>
<td></td>
<td>[Decimal Data]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4512</td>
<td>THREE STEPS SAME LINE</td>
<td>The three points for creating the user coordinates lie on the same line.</td>
<td>Teach again so that the three points do not lie on the same line.</td>
</tr>
<tr>
<td></td>
<td>[No data display]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## 5.2 Error Messages

<table>
<thead>
<tr>
<th>Error Number</th>
<th>Message</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>300</td>
<td>Undefined user frame</td>
<td>The user coordinate system to be used at conversion is not registered.</td>
</tr>
<tr>
<td>2470</td>
<td>Wrong JOB type</td>
<td>Setting of coordinate system for a standard job is not possible.</td>
</tr>
<tr>
<td>2480</td>
<td>Wrong JOB coordinates setting</td>
<td>Coordinate systems other than the user coordinate system can not be changed.</td>
</tr>
<tr>
<td>2500</td>
<td>Cannot convert the JOB.</td>
<td>A job with only a station axis and without group axis can not be converted into a relative job.</td>
</tr>
</tbody>
</table>
# 6 Instruction List

< > shows number or character data. When there are more than one additional items in one section, choose one.

<table>
<thead>
<tr>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MFRAME</strong></td>
</tr>
<tr>
<td><strong>Function</strong></td>
</tr>
<tr>
<td><strong>Additional items</strong></td>
</tr>
<tr>
<td>UFO&lt;User coordinate system No.&gt;</td>
</tr>
<tr>
<td>Data 1</td>
</tr>
<tr>
<td>Data 2</td>
</tr>
<tr>
<td>Data 3</td>
</tr>
<tr>
<td>IF statement</td>
</tr>
<tr>
<td><strong>Example</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CALL</strong></td>
</tr>
<tr>
<td><strong>Function</strong></td>
</tr>
<tr>
<td><strong>Additional items</strong></td>
</tr>
<tr>
<td>JOB&lt;Job name&gt;</td>
</tr>
<tr>
<td>IG&lt;Input group No.&gt;</td>
</tr>
<tr>
<td>B&lt;Variable No.&gt;</td>
</tr>
<tr>
<td>UF&lt;User coordinate system No.&gt;</td>
</tr>
<tr>
<td>IF statement</td>
</tr>
<tr>
<td><strong>Example</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>JUMP</strong></td>
</tr>
<tr>
<td><strong>Function</strong></td>
</tr>
<tr>
<td><strong>Additional items</strong></td>
</tr>
<tr>
<td>JOB&lt;Job name&gt;</td>
</tr>
<tr>
<td>IG&lt;Input group No.&gt;</td>
</tr>
<tr>
<td>B&lt;Variable No.&gt;</td>
</tr>
<tr>
<td>&lt;Label No.&gt;</td>
</tr>
<tr>
<td>UF&lt;User coordinate system No.&gt;</td>
</tr>
<tr>
<td>IF statement</td>
</tr>
<tr>
<td><strong>Example</strong></td>
</tr>
</tbody>
</table>
NX100

INSTRUCTIONS FOR RELATIVE JOB FUNCTION

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