Motoman XRC Controller

PMT Function Manual

for UP/SKX-Series Robots

MOTOMAN
a ✦ YASKAWA company

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SECTION 1
INTRODUCTION

1.1   About this Document

This manual provides instructions for PMT 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 – PMT FUNCTION
Provides detailed instructions to utilize the PMT 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)

NOTES

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:

<div align="center">

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

</div>

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.

- 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 the E-STOP button on the teach pendant for proper operation before programming.
- Carry the teach pendant with you when you enter the workcell.
- Be sure that only the person holding the teach pendant enters the workcell.
- Test any new or modified program at low speed for at least one full cycle.

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

PMT 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.

YASKAWA   MANUAL NO. RE-CKI-A425

<table>
<tr><td colspan="1" align="center">🛇 MANDATORY</td></tr>
</table>

- This manual explains the PMT function (position modification function for tool deformation) of YASNAC XRC. 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.

<table>
<tr><td colspan="1" align="center">⚠ CAUTION</td></tr>
</table>

- 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".

⚠ 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.

Emergency Stop Button

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

  Injury may result from unintentional or unexpected manipulator motion.

Release of Emergency Stop   TURN

- 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.

<div style="border: 1px solid black; padding: 1em;">

⚠ 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.

</div>

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.

Equipment	Manual Designation
YASNAC XRC Controller	XRC
YASNAC XRC Playback Panel	Playback Panel
YASNAC XRC Programming Pendant	Programming Pendant

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

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

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.
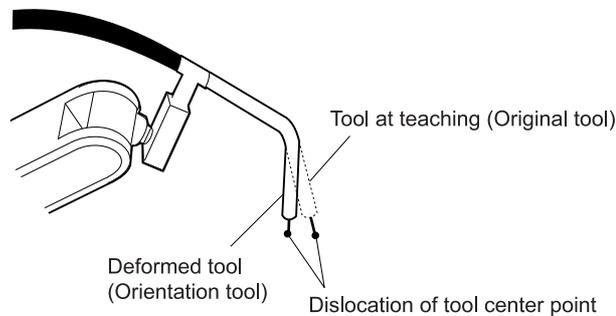
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1 PMT Function

The PMT function corrects the position data when the tool is deformed during operation (PMT : <u>P</u>osition <u>M</u>odification for <u>T</u>ool Deformation). When a tool inadvertently collides with peripheral jigs or walls during operation and is deformed, the tool center point will be dislocated and the taught position of the job which has been set up is shifted: A great deal of time and effort will be needed for the correction. In such a case, the PMT function can be used to correct the position data easily and accurately.

By specifying the desired job, the position data of the taught tool dimensions before deformation are converted automatically to the position data of the tool dimensions after deformation. In the PMT function, the tool before deformation is called the original tool and the tool after deformation is called the orientation tool.

Tool at teaching (Original tool)

Deformed tool
(Orientation tool) Dislocation of tool center point

```
0016 MOVJ          •
0017 WAIT IN#(1)=0
0018 MOVL  V=70      •
```

Position data of the step taught by
the original tool is converted.

NOTE
- For a job in which teaching is performed by using several types of tools, only the position data obtained by the specified original tool is converted.
- The position variables are not converted in the PMT function.

---

2 Operating Methods

> **NOTE** When the PMT function is used, the tool dimensions and the job taught position data are overwritten. In order to secure the data, prepare the backup files beforehand.

Operation

Select {UTILITY} from the top menu in the job contents display in teach mode.[*1] ➡ Select {PMT}[*2] ➡ Select NO. of the tool for conversion[*3] ➡ Register and confirm tool dimensions[*4] ➡ Select the job for conversion[*5] ➡ Select "EXEC"[*6]
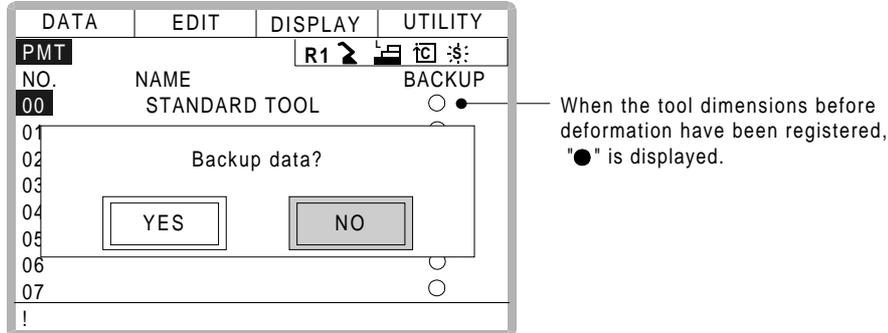
Explanation

1   From the Job Content display, select the PMT function.

```
  JOB       EDIT    DISPLAY   UTILITY
 JOB CONTENT           SETUP SPECIAL RUN
 J:TEST   S:000       PARALLEL SHIFT JOB
 0000 NOP             MIRROR SHIFT
 0001 MOVJ  VJ=12.50  PAM
 0002 MOVJ  VJ=50.00  PMT
 0003 MOVJ  VJ=12.50
 0004 ARCON ASF#(1)
 0005 MOVL  V=50
 0006 MOVL  V=50
 => MOVJ VJ=100.00
 !
```

2   The PMT display is shown.

```
  DATA      EDIT    DISPLAY   UTILITY
 PMT                  R1
 NO.      NAME              BACKUP
 00          STANDARD TOOL     ○
 01                             ○
 02                             ○
 03                             ○
 04                             ○
 05                             ○
 06                             ○
 07                             ○
 !
```
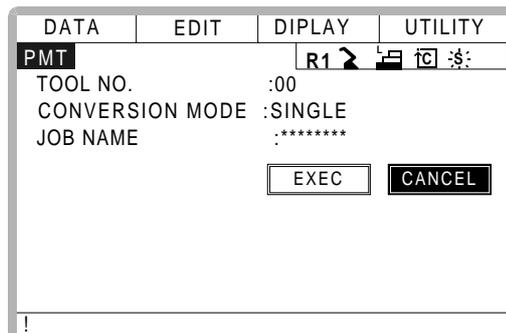
*3   The confirmation dialog to save the tool dimensions before deformation appears.
When the tool dimensions after deformation have been registered, select "NO".
When the tool dimensions after deformation have not been registered, select "YES".
After selecting either "YES" or "NO", the display of *3 appears.

```
  ┌─────────┬─────────┬──────────┬──────────┐
  │  DATA   │  EDIT   │ DISPLAY  │ UTILITY  │
  ├─────────┴─────────┴──────────┴──────────┤
  │ PMT               R1 ↘ 🖳 ⓣ ☼          │
  │ NO.     NAME              BACKUP        │
  │ 00      STANDARD TOOL        ○ ●────────┼──── When the tool dimensions before
  │ 01 ┌────────────────────────────┐       │     deformation have been registered,
  │ 02 │      Backup data?          │       │     "●" is displayed.
  │ 03 │                            │       │
  │ 04 │  ┌────────┐    ┌────────┐  │       │
  │ 05 │  │  YES   │    │   NO   │  │       │
  │ 06 └──┴────────┴────┴────────┴──┘ ○     │
  │ 07                           ○          │
  │ !                                       │
  └──────────────────────────────────────────┘
```

*4   Set the tool dimensions by inputting with the number keys or by selecting{TOOL CALI-BRATION} of {UTILITY}.
For details of methods to set tool dimensions, refer to Section 3.9 "Tool Data Setting" of the YASNAC XRC Instruction manual.
Confirm the tool dimensions before and after the PMT conversion (ORIGINAL TOOL and ORIENTATION TOOL), then select "EXEC".

```
  ┌─────────┬─────────┬──────────┬──────────┐
  │  DATA   │  EDIT   │ DIPLAY   │ UTILITY  │
  ├─────────┴─────────┴──────────┴──────────┤
  │ PMT               R1 ↘ 🖳 ⓣ ☼          │
  │ TOOL NO. :00                            │
  │   ORIENTATION TOOL ← ORIGINAL TOOL      │
  │   X       0.000 mm   X     10.000mm     │
  │   Y       0.000 mm   Y      0.000mm     │
  │   Z     400.000 mm   Z    390.000mm     │
  │   Rx      0.000 deg. Rx     0.000deg.   │
  │   Ry      0.000 deg. Ry     0.000deg.   │
  │   Rz      0.000 deg. Rz     0.000deg.   │
  │                    ┌──────┐ ┌────────┐  │
  │                    │ EXEC │ │ CANCEL │  │
  │                    └──────┘ └────────┘  │
  │ !                                       │
  └──────────────────────────────────────────┘
```
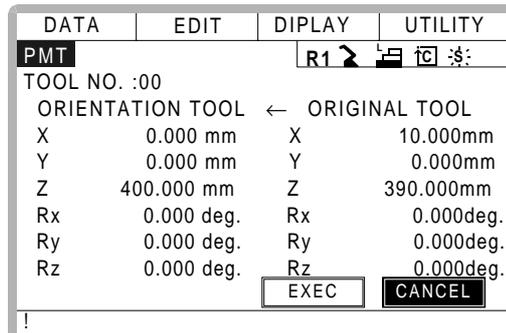
*5   The following three methods are available for selecting a job.

    • Method 1 : SINGLE

    When only the specified job is to be converted, select "SINGLE" from "CONVERSION MODE".
Select "JOB NAME", and then the Job List is displayed. Select the job to be converted.
Selecting "EXEC" converts the selected job.

```
  ┌─────────┬─────────┬──────────┬──────────┐
  │  DATA   │  EDIT   │ DIPLAY   │ UTILITY  │
  ├─────────┴─────────┴──────────┴──────────┤
  │ PMT               R1 ↘ 🖳 ⓣ ☼          │
  │ TOOL NO.           :00                  │
  │ CONVERSION MODE  :SINGLE                │
  │ JOB NAME           :********            │
  │                  ┌──────┐ ┌────────┐    │
  │                  │ EXEC │ │ CANCEL │    │
  │                  └──────┘ └────────┘    │
  │                                         │
  │                                         │
  │ !                                       │
  └──────────────────────────────────────────┘
```

• Method 2 : RELATED

When the jobs related to the specified job are to be converted together, select "RELATED" from "CONVERSION MODE".
Select "JOB NAME", and then the Job List is displayed. Select the job to be converted.
Selecting "EXEC" converts the selected job and the related jobs.

• Method 3 : ALL

When all the jobs registered in XRC are to be converted, select "ALL" from "CONVERSION MODE".
Selecting "EXEC" converts all of the jobs.

*6 After conversion is complete, the display returns to the Job Content display.

NOTE

• For a job after conversion, be sure to confirm the path after conversion by performing NEXT/BACK operations.
• When steps out of the manipulator working envelope are created, "/0V" is displayed in the corresponding step as shown in the following display. "/0V" will disappear by correcting the positions.

```
┌──────────┬──────────┬──────────┬──────────┐
│   JOB    │   EDIT   │  DISPLAY │  UTILITY │
├──────────┴──────────┴──────────┴──────────┤
│ JOB CONTENT          R1 ⟩ ⊡ ⒯ ⓢ           │
│ J:TEST   S:000               TOOL:0        │
│ 0000 NOP                                   │
│ 0001 JOB FOR TYPE A                        │
│ 0002 JUMP JOB:JOB-01                       │
│ 0003 MOVJ  VJ=50.00                        │
│ 0004 MOVJ  /OV VJ=50.00  ●                 │
│ 0005 MOVJ  VJ=50.00                        │
│ 0006 JUMP  JOB:JOB-02                      │
│ 0007 MOVJ  VJ=100.00                       │
│ ! Step exceeding operation range is made   │
└────────────────────────────────────────────┘
```

In the step which is out of the working envelope, "/0V" is displayed for a move instruction.

2-3

YASNAC XRC OPTIONS
INSTRUCTIONS

PMT FUNCTION

YASKAWA ELECTRIC CORPORATION

YASKAWA