Motoman NX100 Controller

TCP Multiple Tool Function Manual

Part Number: 149648-20CD
Revision 1

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a YASKAWA company

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Chapter 1
Introduction

1.1 About This Document

This manual provides information for the TCP Multiple Tool 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 - TCP MULTIPLE TOOL INSTRUCTIONS
Provides detailed instructions for the TCP Multiple Tool function.

1.2 Reference to Other Documentation

For additional information refer to the following:

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

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 (HP200)
- Application Type (handling)
- Robot Serial Number (located on back side of robot arm)
- Robot Sales Order Number (located on back of controller)

Notes

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 Victors 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

NX100 OPTIONS
IINSTRUCTIONS

FOR TCP FUNCTION

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 corresponds to specific usage.
Be sure to use the appropriate manual.

YASKAWA

MANUAL NO.
HW0482422

MANDATORY

- **This manual explains the TCP function of the NX100 system and general operations. 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 Instruction before reading this manual.**

CAUTION

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

Notes for Safe Operation

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

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

WARNING

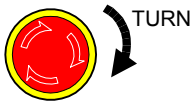
- **Before operating the manipulator, check that servo power is turned OFF when the emergency stop buttons on the front door of the NX100 and programming pendant are pressed.**
  When the servo power is turned OFF, the SERVO ON LED on the programming pendant is turned OFF.

  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.

  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 

- **Observe the following precautions when performing teaching operations within the P-point maximum envelope of the manipulator:**

  - View the manipulator from the front whenever possible.
  - Always follow the predetermined operating procedure.
  - Ensure that you have a safe place to retreat in case of emergency.

  Improper or unintended manipulator operation may result in injury.

- **Confirm that no persons are present in the P-point maximum envelope of the manipulator and that you are in a safe location before:**

  - Turning ON the 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.

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 NX100 cabinet after use.**

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

- **Read and understand the Explanation of Warning Labels in the NX100 Instructions 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 programming pendant, and supply cables.
In this manual, the equipment is designated as follows:

Equipment	Manual Designation
NX100 controller	NX100
NX100 programming pendant	Programming pendant
Cable between the manipulator and the controller	Manipulator cable

The programming pendant and playback panel keys, buttons, and displays are designated 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}

Description of the Operation Procedure

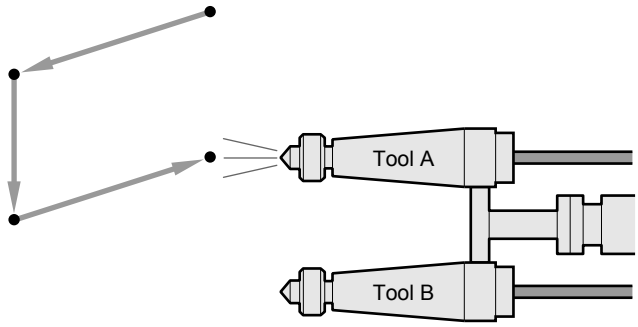
In the explanation of the operation procedure, the expression "Select • • • " means that the cursor is moved to the object item and the SELECT key is pressed, or that the item is directly selected by touching the screen.

1 TCP Function

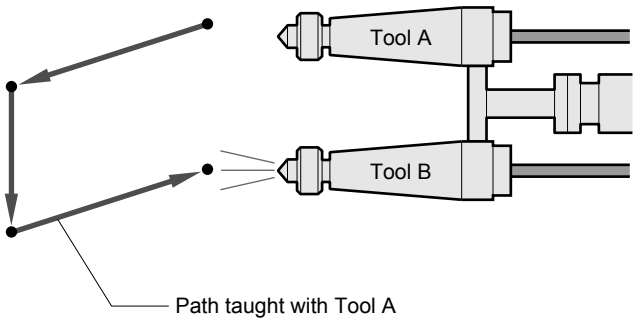
The TCP (Tool Center Point) function is to use a tool on the path taught with another tool. Several tools can be used for the same path with this function.

For example, the following figure shows a painting system with two tools. One tool is used for undercoat paint operation; the other is used for the top coat paint operation. To put the top coat after the undercoat, teach a path to either one of the two tools, then the teaching for the other tool is not necessary.

1. After teaching with Tool A, put the undercoat using Tool A.

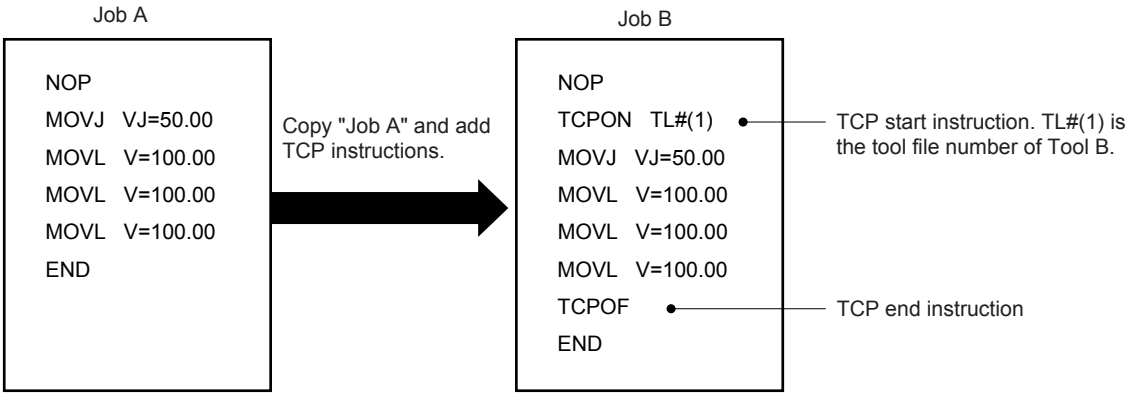


2. With the TCP function, put the top coat using Tool B.



1.1 Job Preparation

The job copied from the job taught with Tool A, defined as "Job A", can be defined as "Job B". Add the TCP instructions before and after the sections where Tool B is to be used in Job B. Set a tool file number for Tool B in the TCPON instruction.

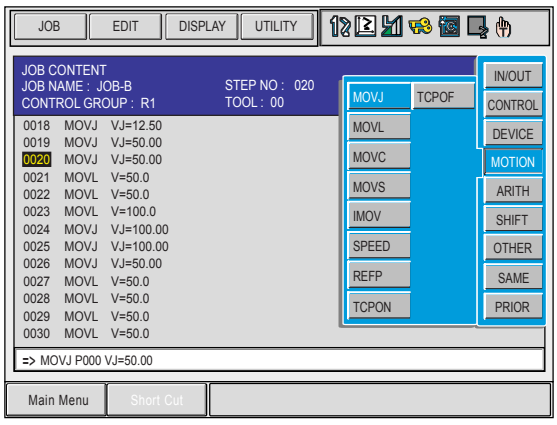


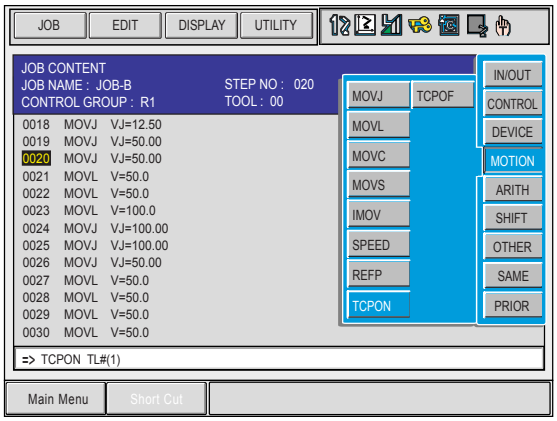
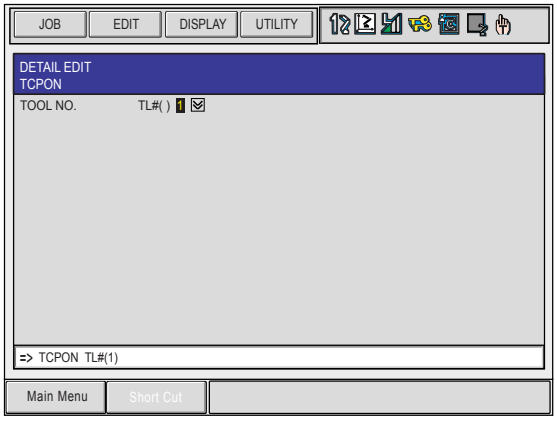
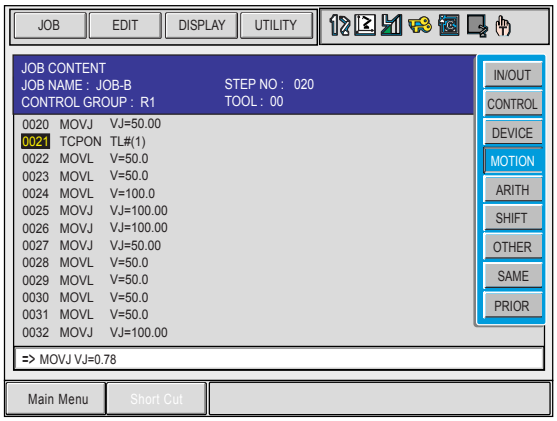
2 Registration of Instructions

2.1 TCPON Instruction

TCPON is an instruction to start the TCP function in which the tool with the specified tool number starts operating the taught path.

NOTE If a manipulator designation (RB1/RB2/RB3/RB4) is omitted in the coordinated system, the TCP function of a manipulator on the slave side will be executed.

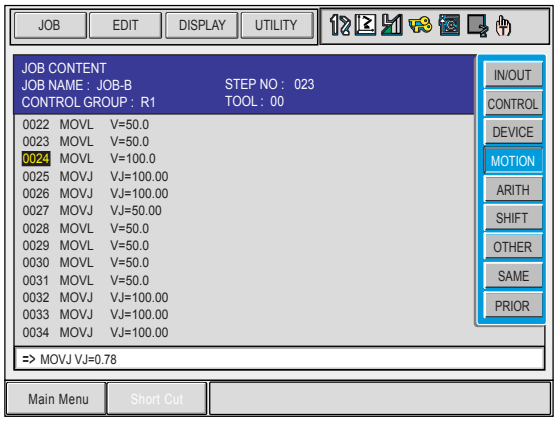
	Operation	Explanation
1	Move the cursor to address area.	
2	Move the cursor to the line where the TCPON instruction is to be registered.	
3	Press [INFORM LIST].	The instruction list dialog appears. The cursor moves to the instruction list dialog while the cursor in the address area changes to an underbar. 

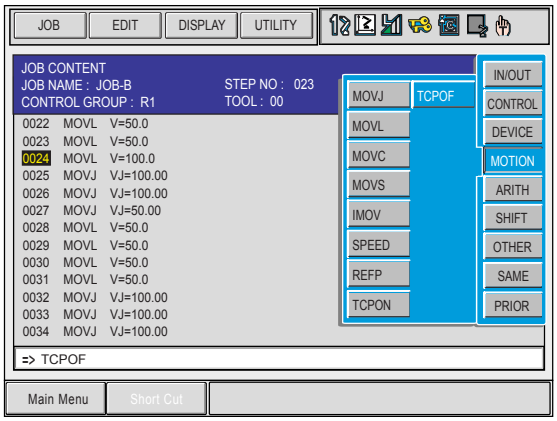
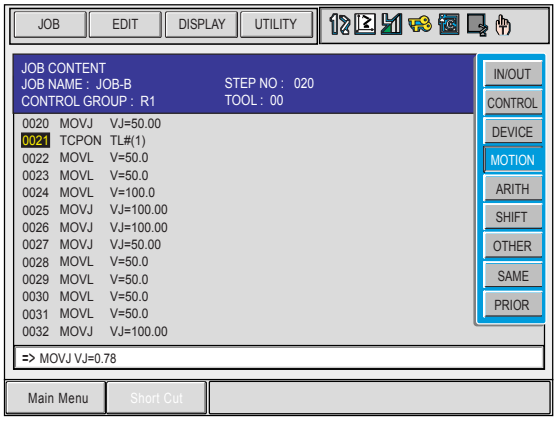
	Operation	Explanation
4	Select {TCPON}.	The TCPON instruction appears with the previously registered additional items in the input buffer line. 
5	Press [SELECT] again.	
6	Enter a tool file number in the detail edit display.	Specify a tool file number from 0 to 23. Move the cursor over to the file number, and press [SELECT]. Enter the tool file number with number keys, and press [ENTER]. 
7	Press [ENTER].	The input buffer line shows the data set for the operation. Press [ENTER] again to register the data. 

2.2 TCPOF Instruction

TCPOF is an instruction to end the TCP function and change the operation tool back to a taught tool.

NOTE If a manipulator designation (RB1/RB2/RB3/RB4) is omitted in the coordinated system, the TCP function of a manipulator on the slave side will be terminated.

	Operation	Explanation
1	Move the cursor to address area.	
2	Move the cursor to the line where the TCPOF instruction is to be registered.	
3	Press [INFORM LIST].	The instruction list dialog appears. The cursor moves to the instruction list dialog while the cursor in the address area changes to an underbar. 

	Operation	Explanation
4	Select {TCPOF}.	The TCPOF instruction appears with the previously registered additional items in the input buffer line. 
5	Press [ENTER].	The contents displayed in the input buffer line are registered. 

3 Examples of the TCP Function

3.1 System with Two Manipulators

3.1.1 Independent Operation (MOVx + MOVx)

1. Prepare two jobs taught with Tool 0 and Tool 1 as shown in Fig. A.
2. Operate the tools with the TCP instruction, respectively changing the Tool 0 and Tool 1 to Tool 2 and Tool 3. The tool 2 and tool 3 move exactly the same as the tool 0 and tool 1, as shown in Fig. B.

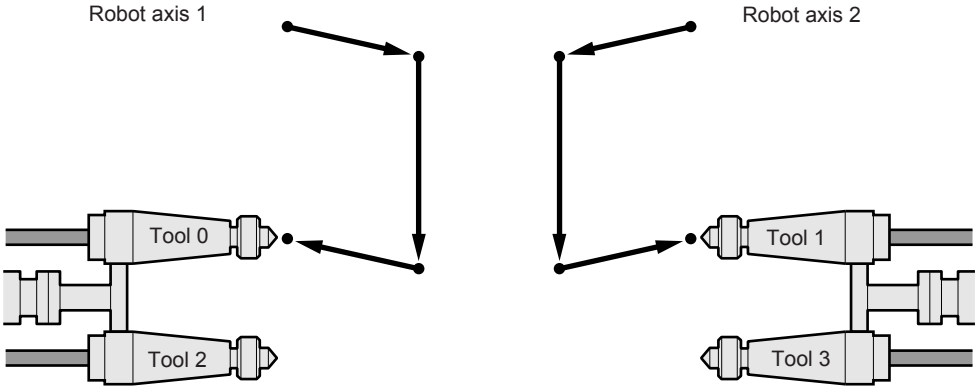


Fig. A

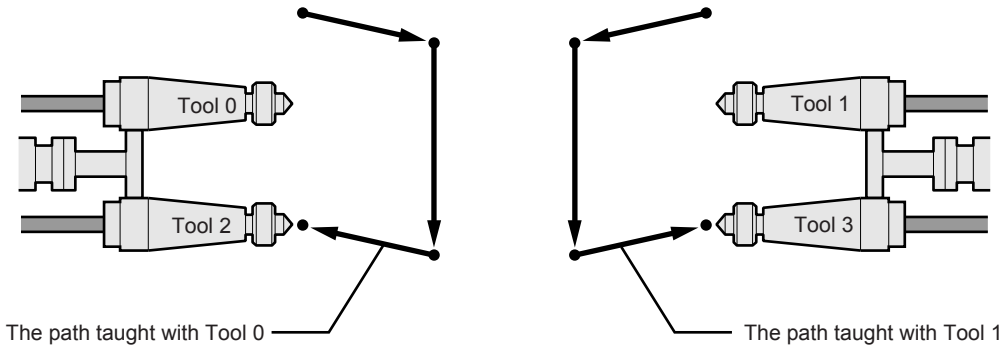


Fig. B

■ Job

• The following is the job taught with the Tool 0 and Tool 1.

```
0000  NOP
0001  MOVL
      +MOVL
0002  MOVL
      +MOVL
0003  MOVL
      +MOVL
0004  MOVL
      +MOVL
0005  END
```

• The following is the job with the TCP instruction for the Tool 2 and Tool 3.

```
0000  NOP
0001  TCPON   RB1   TL#(2)
0002  TCPON   RB2   TL#(3)
0003  MOVL
      +MOVL
0004  MOVL
      +MOVL
0005  MOVL
      +MOVL
0006  MOVL
      +MOVL
0007  TCPOF   RB1
0008  TCPOF   RB2
0009  END
```

3.1.2 Coordinated Operation (SMOVx + MOVx)

1. Prepare a job taught with Tool 1 on the master side as shown in Fig. A.
2. Operate the tools on the master side with the TCP instruction, changing the Tool 1 to Tool 2. The tool 2 moves exactly the same as the tool 1, as shown in Fig. B.

Note that there is no change in robot axis 1 on the slave side. The position of the Tool 2 on the master side is changed to the position taught with the Tool 1.

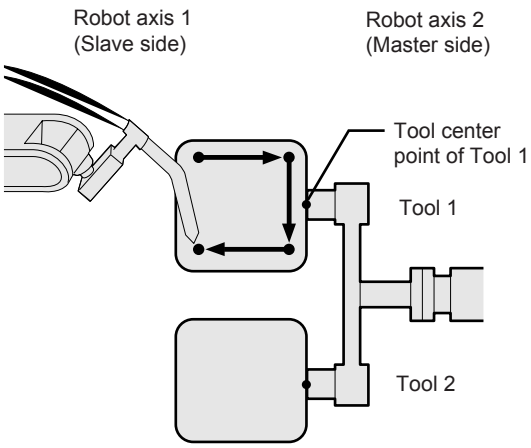


Fig. A

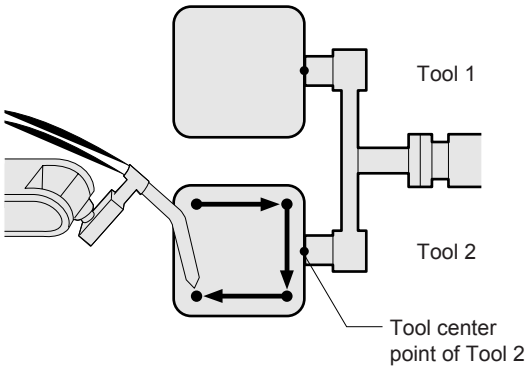


Fig. B

■ Job

• The following is the job taught with the Tool 1.

```
0000  NOP
0001  SMOVL
      +MOVL
0002  SMOVL
      +MOVL
0003  SMOVL
      +MOVL
0004  SMOVL
      +MOVL
0005  END
```

• The following is the job with the TCP instruction for the Tool 2.

```
0000 NOP
0001 TCPON   RB2   TL#(2)
0002 SMOVL
     +MOVL
0003 SMOVL
     +MOVL
0004 SMOVL
     +MOVL
0005 SMOVL
     +MOVL
0006 TCPOF   RB2
0007 END
```

4 Instruction List

Numeric or alphabetical data is indicated in the parenthesis "<>". If there is more than one item in a format column, select one of the items.

TCPON	Function	Starts the TCP function.	
	Format	TL# (<Tool File Number>)	
		RB1, RB2, RB3, RB4	The slave side starts the TCP function if designation is omitted.
	Example	TCPON RB1 TL#(1)	
TCPOF	Function	Ends the TCP function.	
	Format	RB1, RB2, RB3, RB4	The slave side terminates the TCP function in case of omitting designation.
	Example	TCPOF TCPOF RB1	

NX100 OPTIONS
INSTRUCTIONS
FOR TCP FUNCTION

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