

Motoman® NX100 Controller

Macro Command Function Manual

Part Number: 149648-17CD
Revision: 1

MOTOMAN
a YASKAWA company

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Chapter 1

Introduction

1.1 About This Document

This manual provides information for the Macro Command function and contains the following sections:

CHAPTER 1 - INTRODUCTION

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

CHAPTER 2 - SAFETY

This section provides information regarding the safe use and operation of Motoman products.

CHAPTER 3 - MACRO COMMAND INSTRUCTIONS

Provides detailed information for the Macro Command function.

1.2 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

1.3 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 (SSA2000, HP50, etc.)
- Application Type (welding, handling, etc.)
- 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 INSTRUCTIONS

FOR MACRO COMMAND 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 manual above corresponds to specific usage.
Be sure to use the appropriate manual.



 **MANDATORY**

- This manual explains the macro command 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 Instructions before reading this manual.

 **CAUTION**

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

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.



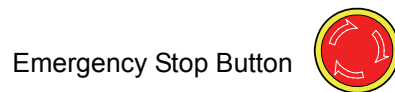
To ensure safe and efficient operation at all times, be sure to follow all instructions, even if not designated as “CAUTION” and “WARNING”.



WARNING

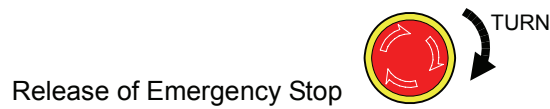
- Before operating the manipulator, check that servo power is turned OFF when the emergency stop buttons on the front door of the NX100 and programming pendant are pressed. When the servo power is turned OFF, the SERVO ON LED on the programming pendant is turned OFF.

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.



- 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 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 problems. 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 NX100	Manipulator Cable

Descriptions of the programming pendant 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 Numeric Keys	“Axis Keys” and “Numeric 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.

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

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1 Outline

The macro command function registers a prepared job as a macro command and then carries out the job by the macro command.

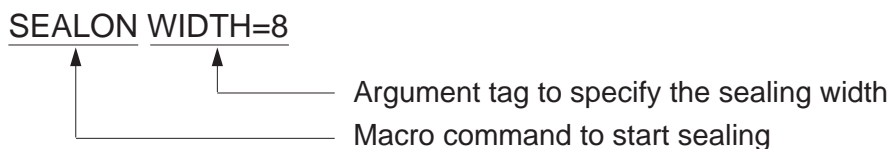
With the macro command function, system integrators who apply various MOTOMAN robot systems can freely create INFORM (a robot programming language used in NX100) that corresponds to each system.

The macro command function enables an easier robot system with use of the key customize function. (Refer to "8.15 Numeric Key Customize Function" in "NX100 INSTRUCTIONS" for details.)

■ Features

- A job prepared with the macro command function by user is registered as a macro command.
- The contents of macro command can be prepared with INFORM, which is the same manner as the normal job data.
- An argument tag can be added to a macro command like a normal instruction. Macro commands and their argument tags can be easily programmed at will in the job data display.

< Example > Macro command for sealing



- The macro commands can be used in the same way as the other instructions. Unlike the CALL instruction, end users do not have to consider the restarting method in case of a job interruption.
- The macro command function enables settings for post-processing of the job interruption, such as the cancellation of current work instruction, etc.
- If a macro command is interrupted during the execution, the interrupted macro command is reexecuted from the beginning when the operation is restarted.



The macro command function is enabled only when the security mode is in the management mode.

2 Preparation of Macro Commands

The execution sequence of a macro command is registered as a macro job.



The macro command function is enabled only when the security mode is in the management mode.

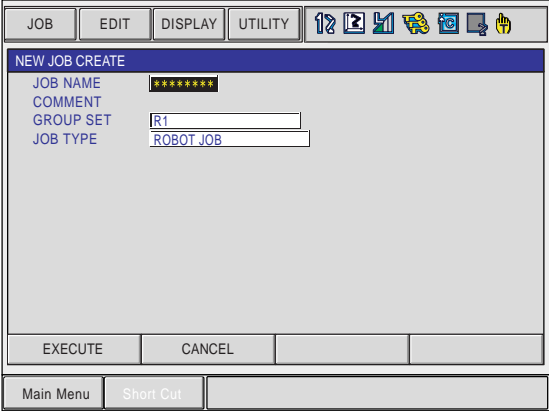
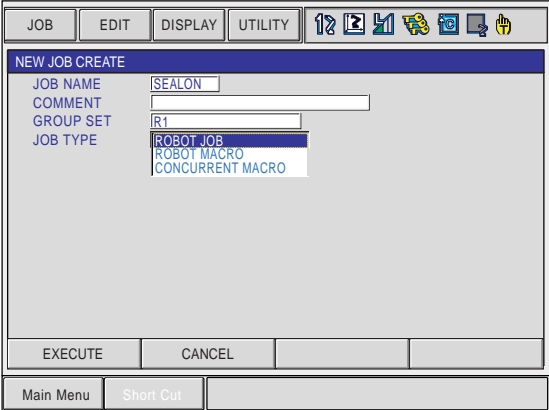
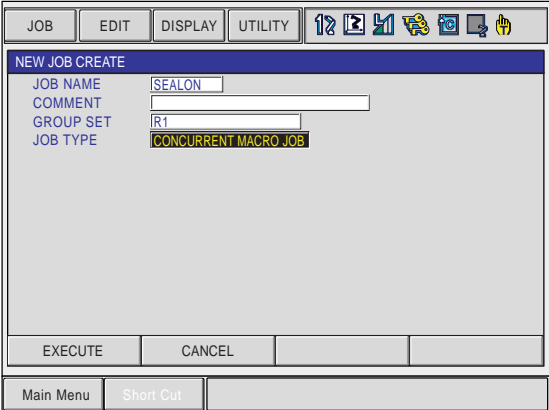
2.1 Preparing a Macro Job

Depending on the applications, there are three types of macro jobs as follows:

- Robot macro job with a designated control group
A move instruction can be registered in a macro command.
A macro command prepared as a robot macro job can be used only in the jobs configured for the same control groups. For example, the macro command prepared as a robot macro job for R1 cannot be used in a job for R2.
- Robot macro job without a control group
Can be used for all robot jobs. Since the control group is not designated, no move instruction can be registered.
- Concurrent macro job
Can be used in a concurrent job. Since the control group is not designated, no move instruction can be registered.

	Operation	Explanation
1	Select "Management Mode" for the security mode.	
2	Select {JOB} from the top menu.	

2.1 Preparing a Macro Job

Operation	Explanation
<p>3 Select {NEW JOB CREATE}</p>	<p>The NEW JOB CREATE window appears.</p> 
<p>4 Enter the job name.</p>	
<p>5 Point the cursor to "JOB TYPE", and press [SELECT].</p>	<p>A selection list appears.</p>  <p>Select "ROBOT MACRO" or "CONCURRENT MACRO".</p> 
<p>6 Select "EXECUTE".</p>	<p>A macro job is prepared, and the JOB CONTENT window appears.</p>

2.2 Teaching a Macro Job

Teach a macro job which is prepared as a macro command in the same manner as normal jobs.

A maximum of sixteen argument tags can be added to a macro command. Since the data of the argument tag is stored in a local variable to be used, the required number of local variables must be set in a "JOB HEADER" before teaching the macro job.



For the setting procedure of the local variables, refer to "4.9.5 Editing Local Variables" described in "NX100 OPERATOR'S MANUAL".



In a macro job, job execution instructions such as JUMP, CALL, and PSTART cannot be registered.

2.2.1 GETARG Instruction

■ Function

The GETARG instruction is an instruction to receive an argument for macro command. When a macro command is executed, the GETARG instruction gets the data of the argument tag which is added to the macro command, and stores it in a local variable to be used in the macro job.

■ Format

GETARG LB000 IARG#(1) Stores the data of the first argument
 ① ② in the local variable LB000.

① Designation of the local variable as the storage destination of the argument data.

The following types of local variables can be used for storage destination:

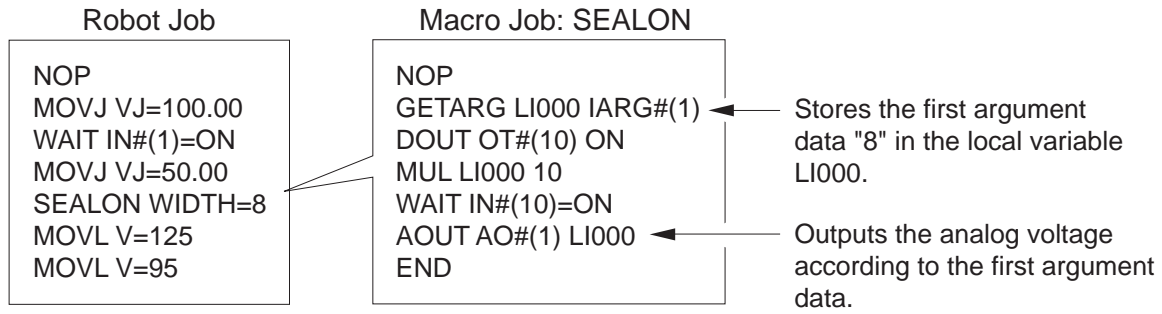
- Byte-type
- Integer-type
- Double-precision integer type
- Real-number type
- Robot-axis-position type
- Base-axis-position type
- Station-axis-position type

② Designation of argument data.

Specifies the number of the argument data to be taken.

2.2 Teaching a Macro Job

■ Job Example




3 Registration of Macro Commands

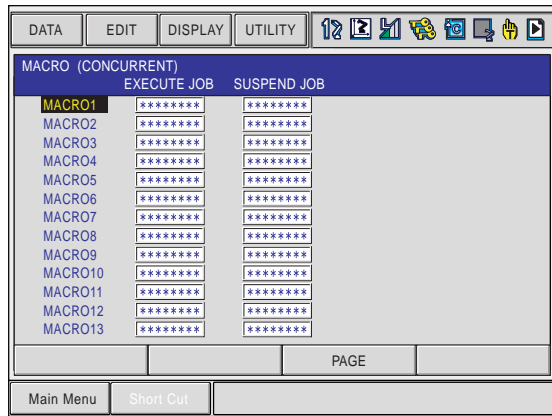
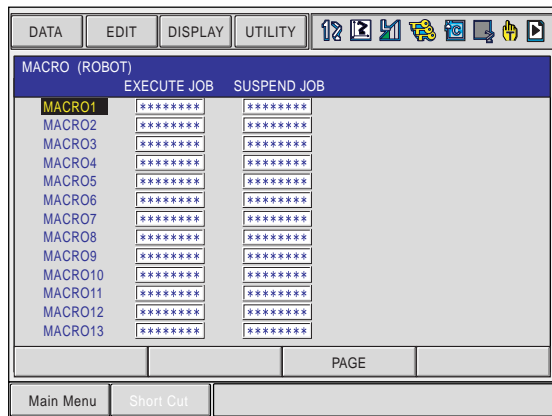
To register the macro job prepared in " 2.1 Preparing a Macro Job " as a macro command, display the MACRO (ROBOT) window or MACRO (CONCURRENT) window following the procedure below.

NOTE The macro command function is enabled only when the security mode is in the management mode.

	Operation	Explanation
1	Select "Management Mode" for the security mode.	
2	Select {SETUP} from the top menu.	

3 Select {MACRO INST.}. The macro command setting window appears.

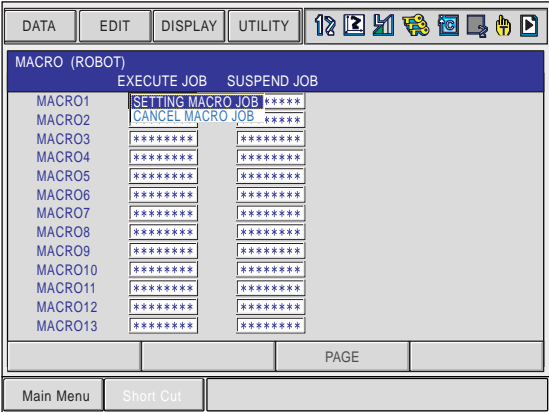
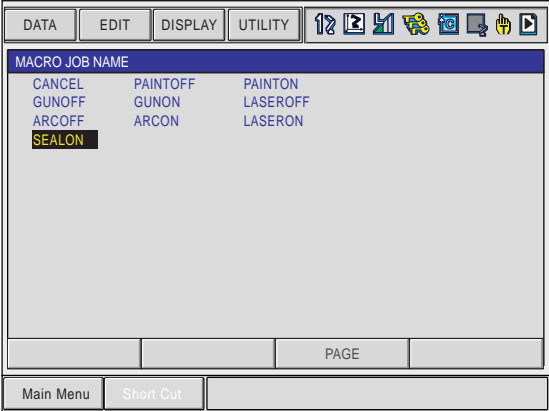
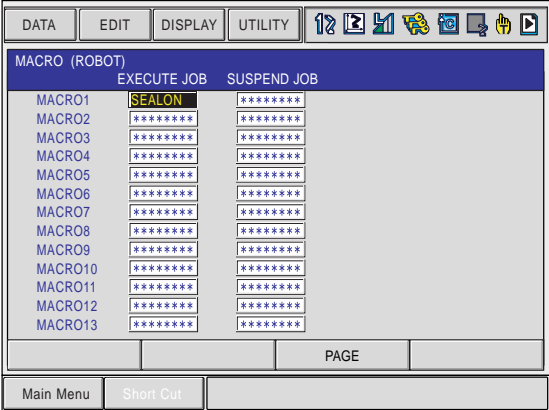
Press the page key  to alternately display the MACRO (ROBOT) window and the MACRO (CONCURRENT) window.



3.1 Setting an Execution Macro Job

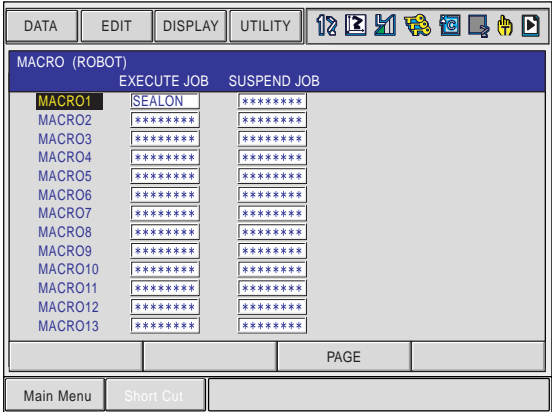

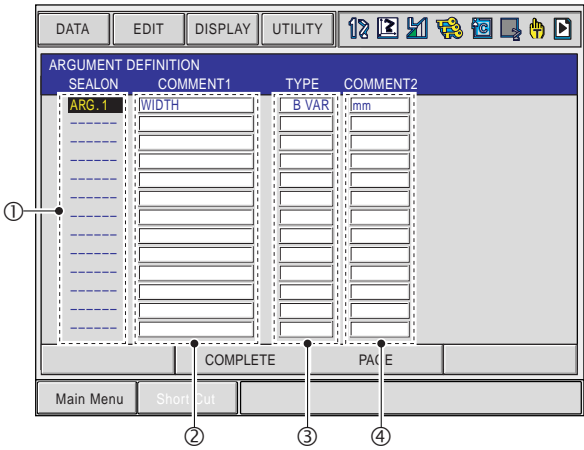
3.1 Setting an Execution Macro Job

The execution macro jobs are macro jobs in which the operations to be carried out by a macro command are programmed. Note that the JOB CONTENT window of a macro command displays the names of the jobs which are specified as execution macro jobs.

	Operation	Explanation
1	Point the cursor to the "EXECUTE JOB" to be set in the macro command setting display, and press [SELECT].	<p>A list box appears.</p> 
2	Select "SETTING MACRO JOB".	<p>The MACRO JOB NAME window appears.</p> 
3	Select the desired macro job.	<p>The selected macro job is registered as an execution macro job.</p> 

3.2 Setting the Contents of Argument Tag Added to the Macro Command

Set the contents of argument tag to be added to the registered macro command. This setting is not necessary for the macro command with no argument.

Operation	Explanation
<p>1 Point the cursor to the macro number to which the argument is to be set.</p>	
<p>2 Press [SELECT]. (Continued on the next page.)</p>	<p>The macro ARGUMENT DEFINITION window appears. There are two windows to define the macro argument. Press the page key  to switch the windows.</p>  <p>① Argument number (ARG. 1 to 16) Point the cursor to the desired argument number, and press [SELECT]. Select "USE" or "NOT USE" from the list box. For the unused argument numbers, the window displays "-----".</p>

3.2 Setting the Contents of Argument Tag Added to the Macro Command

	Operation	Explanation
2	(Continued from the previous page.)	<p>② COMMENT 1 (Up to 16 characters) Point the cursor to COMMENT 1 and press [SELECT]. A character input window appears. Enter the contents of the argument tag added to the macro command in the "COMMENT 1" column. These contents are displayed as the comment for the argument tag in the detail editing window of the macro command.</p> <p>③ TYPE Point the cursor to TYPE and press [SELECT]. A dropdown list appears. Select the data type of the argument tag. The following types of data are available for the setting:</p> <p><Constants or variables> Byte-type Integer-type Double-precision integer type Real-number type</p> <p><Variables or teaching points> Robot-axis-position type Base-axis-position type Station-axis-position type</p> <p>④ COMMENT 2 (Up to 8 characters) Point the cursor to COMMENT 2 and press [SELECT]. A character input window appears. Enter the unit for inputting data in the argument tag to be added to the macro command in "COMMENT 2". The units are displayed as the comment for the argument tag data input units in the detail editing window of the macro command.</p>
	(Continued on the next page.)	<div data-bbox="654 1332 1212 1780" data-label="Image"> <p>The screenshot shows a software window titled 'ARGUMENT DEFINITION'. It has a menu bar with 'DATA', 'EDIT', 'DISPLAY', and 'UTILITY'. Below the menu bar is a table with four columns: 'SEALON', 'COMMENT1', 'DISPLAY', and 'EXPRES'N'. The first row of the table has 'ARG. 1' in the SEALON column, 'WIDTH' in the COMMENT1 column, 'ON' in the DISPLAY column, and 'WIDTH=' in the EXPRES'N column. A dashed rectangular box highlights the 'DISPLAY' and 'EXPRES'N' columns. Below the table are two buttons: 'COMPLETE' and 'PAGE'. At the bottom of the window are 'Main Menu' and 'Short Cut' buttons. Two callout numbers, ⑤ and ⑥, are positioned below the 'COMPLETE' and 'PAGE' buttons respectively, with lines pointing to them.</p> </div> <p>⑤ DISPLAY Select whether to display the expression in the EXPRES'N column. Pressing [SELECT] displays "ON" and "OFF" alternately: "ON" displays the expression; "OFF" hides the expression. When the teaching point for the robot position, base position, or station position is set in "TYPE", the screen does not display the tag set for the teaching point even if "ON" is selected.</p>

3.2 Setting the Contents of Argument Tag Added to the Macro Command

	Operation	Explanation
2	(Continued from the previous page.)	Ⓒ EXPRES'N (Up to 8 characters) Point the cursor to EXPRES'N and press [SELECT]. The character input box appears. Enter the expression for the argument tag.
3	Perform the settings for each item.	

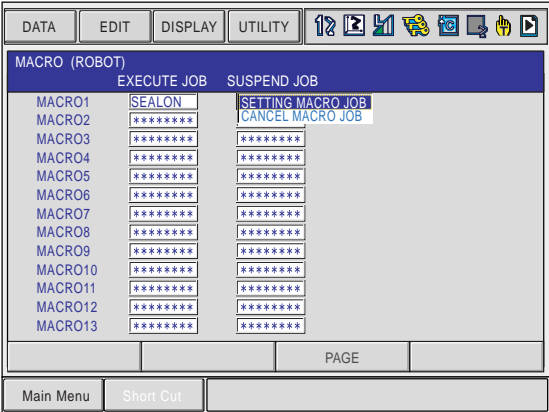
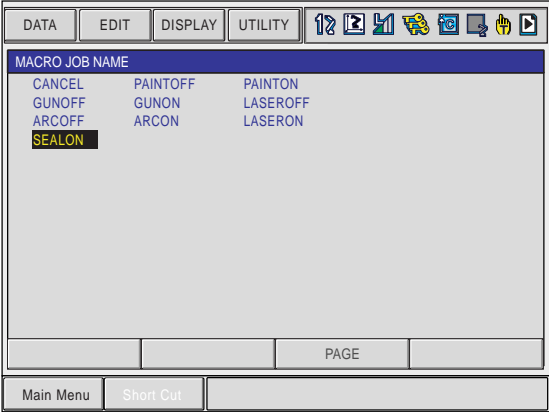
3.3 Setting an Interruption Macro Job

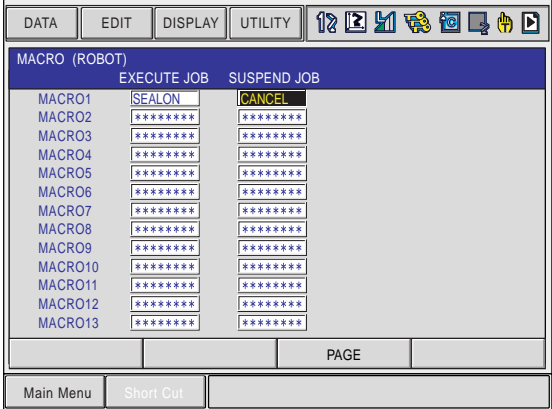
If a post-processing is required when a macro command is interrupted, add an interruption macro job (SUSPEND JOB) to the program.

The interruption macro job is carried out when a macro command that includes an interruption macro job (SUSPEND JOB) is interrupted by being putting on a status such as hold, emergency stop, or mode switching.



Only a robot job without a designated control group can be added to the interruption macro job of the robot macro command.

	Operation	Explanation
1	Point the cursor to the "SUSPEND JOB" column of the macro job for which an interruption macro job is to be added, and press [SELECT].	<p>A list box appears.</p> 
2	Select "SETTING MACRO JOB".	<p>The MACRO JOB NAME window appears.</p> 

	Operation	Explanation
3	Select the desired macro job.	<p>The selected macro job is registered as the interruption macro job.</p>  <p>The screenshot shows a menu titled 'MACRO (ROBOT)' with two columns: 'EXECUTE JOB' and 'SUSPEND JOB'. Under 'EXECUTE JOB', 'MACRO1' is selected with the text 'SEALON'. Under 'SUSPEND JOB', 'CANCEL' is selected. Other macro jobs (MACRO2-MACRO13) are listed with asterisks. The interface includes a menu bar (DATA, EDIT, DISPLAY, UTILITY) and a toolbar with various icons. At the bottom, there are buttons for 'Main Menu' and 'Short Cut', and a 'PAGE' indicator.</p>



If the following infinite loop is programmed in the interruption macro job, the start lamp stays lit but no operation is carried out. Do not add such a job to the program. Also note that the TIMER and WAIT instructions are not carried out in the interruption macro job.

JOB example

```

NOP
*LOOP
DOUT OT#(1) OFF
AOUT AO#(1) 10.00
JUMP *LOOP IF IN#(1)=ON
END
    
```

NX100 OPTIONS INSTRUCTIONS

FOR MACRO COMMAND FUNCTION

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