

Motoman NX100 Controller

Twin Drive Function Manual

Part Number: 152645-1CD
Revision: 0

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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 Twin Drive 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 - TWIN DRIVE INSTRUCTIONS

Provides detailed information for the Twin Drive 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 (EA1400N, HP20, 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 TWIN DRIVE 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.



YASKAWA

MANUAL NO.

HW0482889 

1/18

 **MANDATORY**

- This manual explains the twin drive 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.



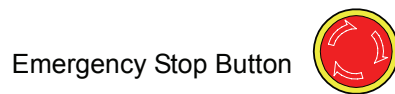
To ensure safe and efficient operation at all times, be sure to follow all instructions, even if not designated as “CAUTION” and “WARNING.”



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 are 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.

1	Outline	
2	Applicable Types	
2.1	Station Axes	2-1
2.2	Base Axes	2-3
2.2.1	Specification of Master and Slave axes	2-5
3	Operation	
3.1	Axis Operation	3-1
3.1.1	Twin Motion Mode	3-2
3.1.2	Single Motion Mode	3-3
3.1.3	Precautions	3-3
4	Setting Parameters	
5	Status Display	
6	Precautions	
6.1	Precautions when selecting Motor	6-1
6.2	Precautions when Setting External Axes	6-1
6.2.1	Setting Mechanical Specifications	6-1
6.2.2	Setting Motor Specifications	6-1
6.2.3	Setting the Rotating Direction	6-2
6.3	Setting the Home Position	6-2
6.4	Precautions upon Application with Coordinated Motion	6-2
6.4.1	Coordinated Motion with TWIN-2	6-2

1 Outline

When configuring the external axes (base or station axes) in the NX100 and using a single motor to control an axis with a heavy load applied during an operation, a large-capacity motor with sufficient capacity and torque is required.

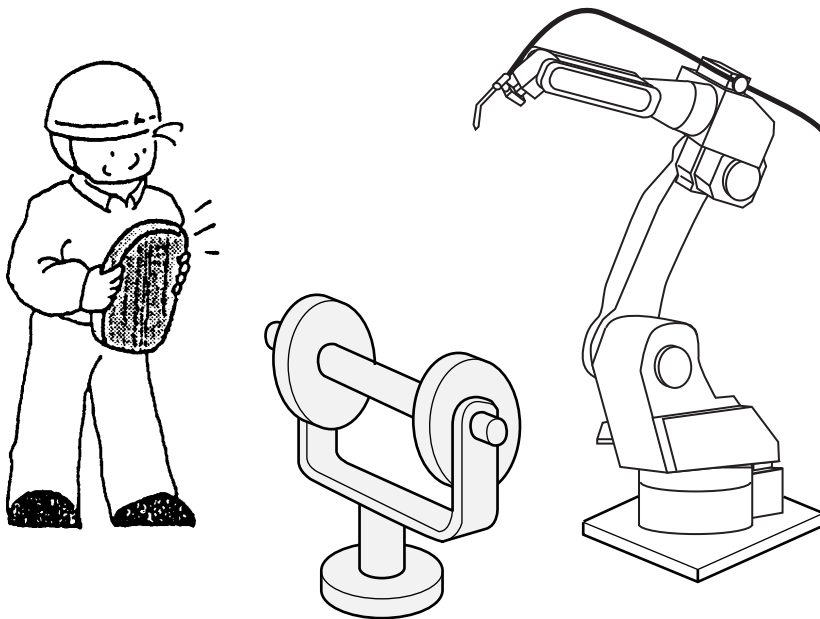
In this case, the external axis becomes very large and requires a wide space for equipment installation.

A system, where a external axis with a heavy load is operated by two motors may be built to provide the necessary motor capacity and torque.

In such a system, the two motors must be operated at the same time, or the system and external axes may be damaged.

Use the twin drive function to operate the motor on the slave axis side at the same time as the external master axis during teaching.

This function economizes on system space and obtains sufficient motor power.



2 Applicable Types

The twin drive function is valid only for the station axes that have been configured for the twin drive.

The following table lists the configurations and the three types of stations where the twin drive can be used.

2.1 Station Axes

Station type	Configuration			Remarks
	Number of station axes	Master axis	Slave axis	
TWIN -3A (TDT3A)	3 axes	Second axis	Third axis	See Fig. A
TWIN -3B (TDT3B)	3 axes	First axis	Third axis	See Fig. B
TWIN -2 (TDT2)	2 axes	First axis	Second axis	See Fig. C

The above three station types can be selected when setting the station axis for the system configuration.

2.1 Station Axes

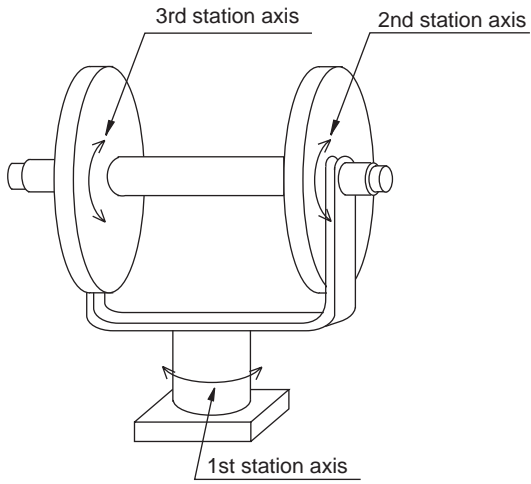


Fig A TWIN-3A

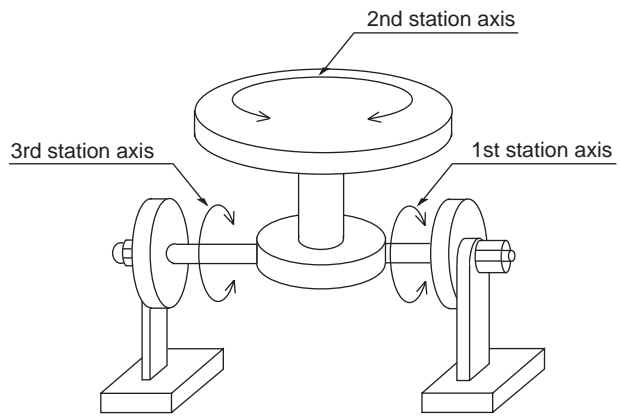


Fig B TWIN-3B

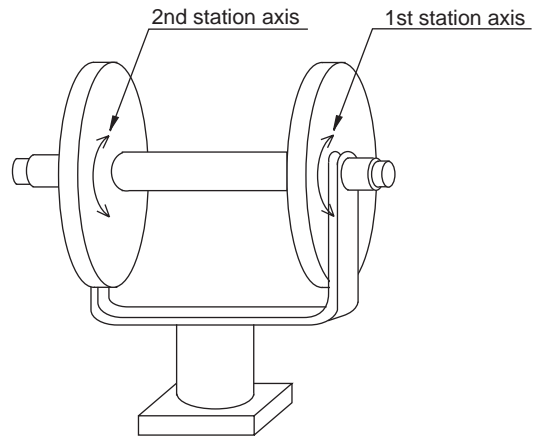


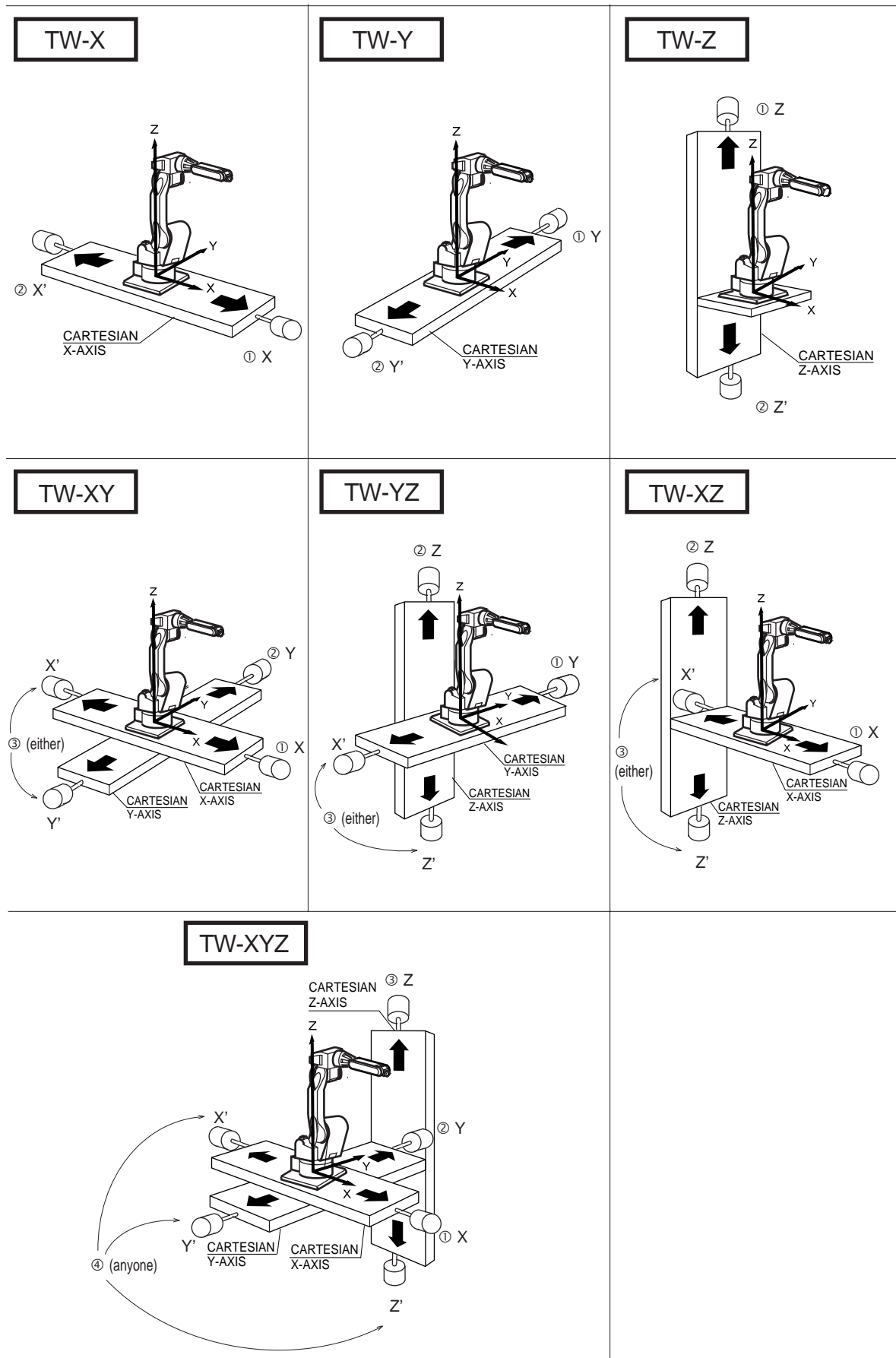
Fig C TWIN-2

2.2 Base Axes

Base type	Configuration		
	Number of base axes	Master axis	Slave axis
TW-X	2 axes	1st axis	2nd axis
TW-Y	2 axes	1st axis	2nd axis
TW-Z	2 axes	1st axis	2nd axis
TW-XY	3 axes	1st or 2nd axis	3rd axis
TW-YZ	3 axes	1st or 2nd axis	3rd axis
TW-XZ	3 axes	1st or 2nd axis	3rd axis
TW-XYZ	4 axes	1st, 2nd or 3rd axis	4th axis

The above base types can be selected when setting the base axis for the system configuration.

2.2 Base Axes



2.2.1 Specification of Master and Slave axes

When selecting TW-XY, TW-YZ, TW-XZ, or TW-XYZ, specify the axes that should be set as twin drive (master and slave).

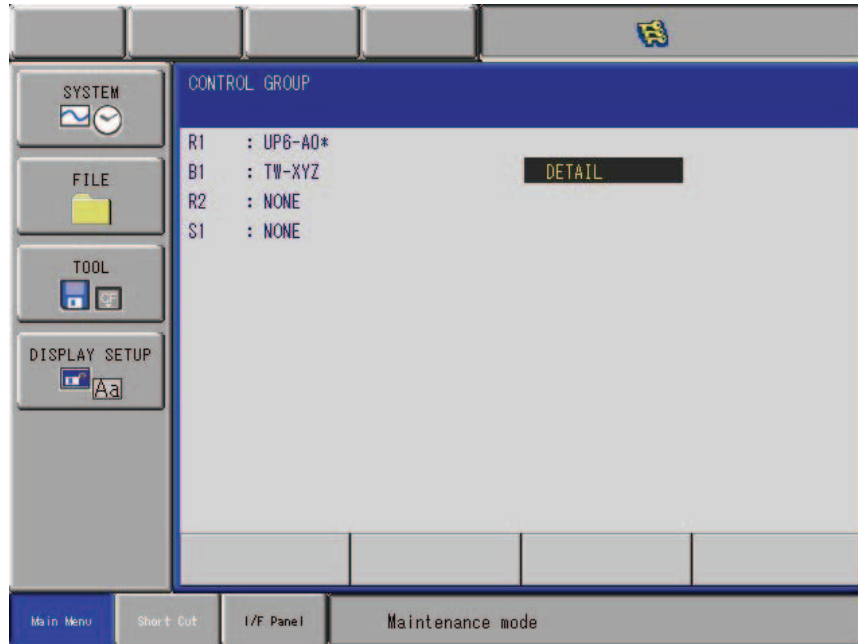
- Slave axis must be specified for the last axis.
- One master and one slave can be set for one control group.

The patterns for setting should be as follows:

Axis No. Base type	1st axis	2nd axis	3rd axis	4th axis
TW-X	X (Master)	X' (Slave)		
TW-Y	Y (Master)	Y' (Slave)		
TW-Z	Z (Master)	Z' (Slave)		
TW-XY	X (Master)	Y	X' (Slave)	
	X	Y (Master)	Y' (Slave)	
TW-YZ	Y (Master)	Z	Y' (Slave)	
	Y	Z (Master)	Z' (Slave)	
TW-XZ	X (Master)	Z	X' (Slave)	
	X	Z (Master)	Z' (Slave)	
TW-XYZ	X (Master)	Y	Z	X' (Slave)
	X	Y (Master)	Z	Y' (Slave)
	X	Y	Z (Master)	Z' (Slave)

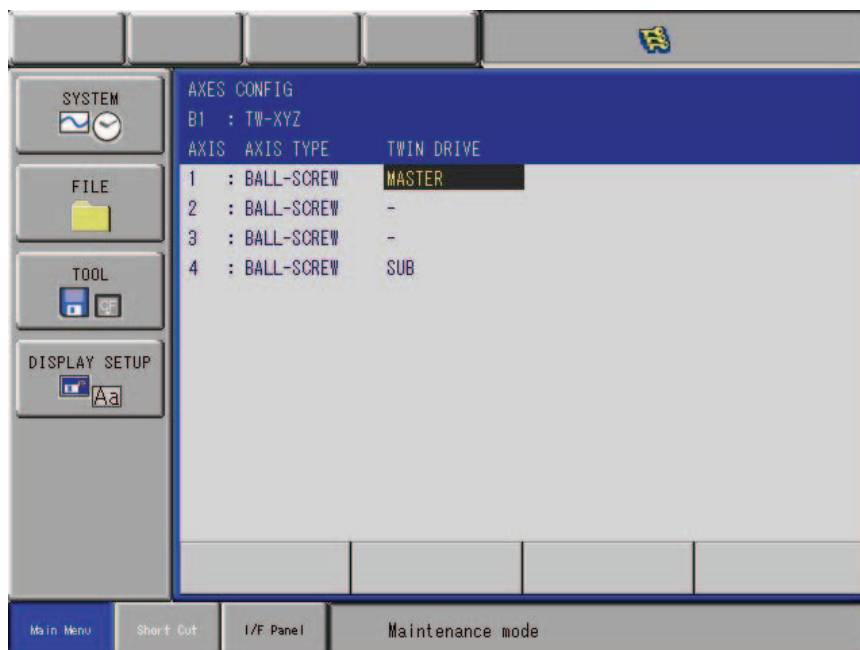
2.2 Base Axes

Master and slave axes specification can be set in the Maintenance mode. The list of each type appears when [SYSTEM], [SETUP], and "CONTROL GROUP" are selected in that order. [DETAIL] tag is to be added to the list when a base axis is available for twin drive function.



When selecting [DETAIL] tag, [AXES CONFIG] window appears on the screen as shown below.

Specify [MASTER] for a master axis and [SUB] for a slave axis. The setting below indicates that the 1st axis is set as MASTER (X) and the 4th axis is set as SLAVE (X').



3 Operation

When the external axis with the twin drive is selected for the axis operation, the twin-driven axes (master axis and slave axis) can be operated at the same time by a single instruction. External axis operation and teaching can be easily performed when teaching. During playback, the axes move according to the taught job data.

3.1 Axis Operation

When the external axis with the twin drive is selected for the axis operation, the following motion is performed.

For the external axis with the twin drive, press the master axis key, and the slave axis and the master axis move at the same time.

However, the external input signal specified by the parameters restricts the axis as outlined in the following table.

External input signal	ON	Single motion mode
	OFF	Twin motion mode

The following describes each mode.

3.1 Axis Operation

3.1.1 Twin Motion Mode

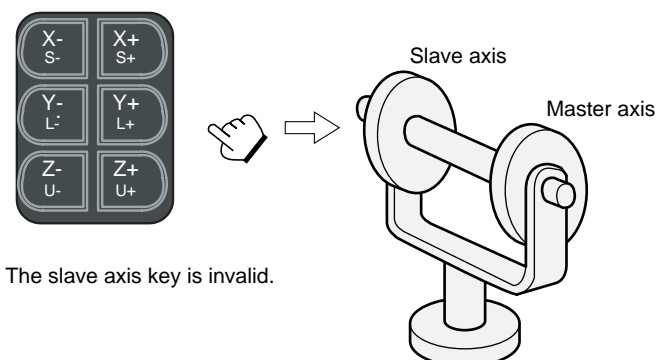
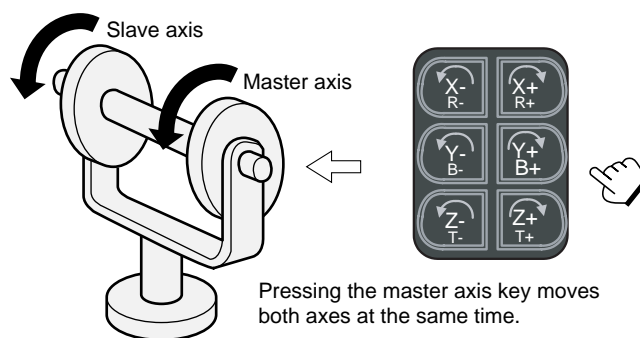
When using the twin drive, the axes can move in twin motion mode.

When the specified external input status is OFF, the axes move in the twin (concurrent) motion mode.

[Example] For TWIN-2

Press the 1st axis key to move the 2nd axis and the 1st axis at the same time.

In this case, no axis moves when the 2nd axis key is pressed.



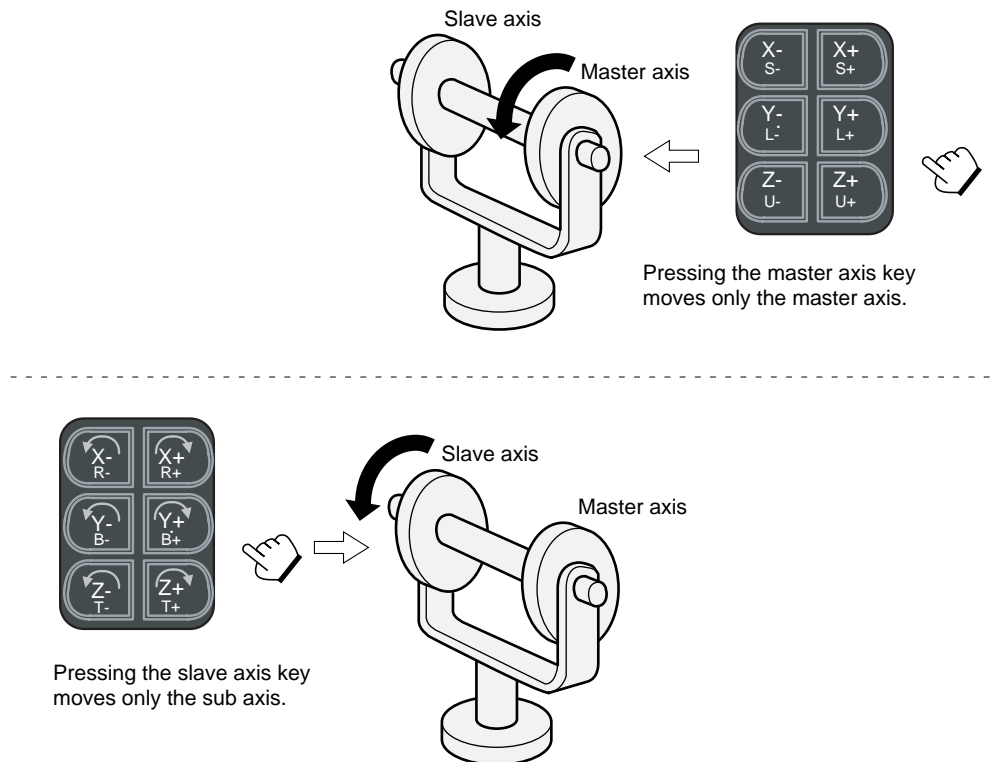
3.1.2 Single Motion Mode

In this mode, the master axis and the slave axis move individually.

When the specified external input status is ON, each axis moves in a single motion.

[Example] For TWIN-2

Press the 1st axis key or the 2nd axis key to move the corresponding axis only.



3.1.3 Precautions

Select either the twin motion mode or the single motion mode by external input before starting the axis operation.

The motion mode does not change when the external input status is changed while an axis key is pressed.

The motion mode is determined according to the external input status that exists when the axis key is pressed, not after.

4 Setting Parameters

In the twin drive, the status of external general-purpose input signal determines the mode as the twin motion or single motion.

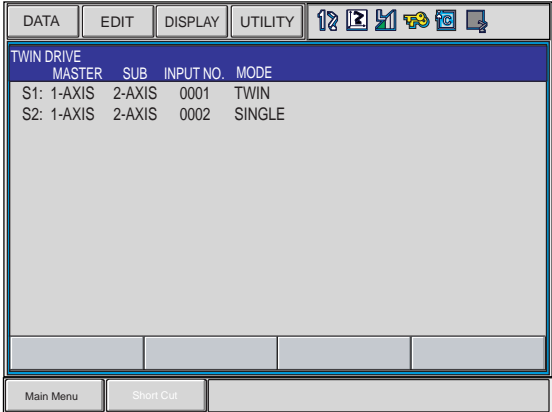
The following parameters specify the general-purpose input numbers.

Parameter	Contents	
S4C140	General-purpose input number specification in the twin drive	Station 1
S4C141		Station 2
S4C142		Station 3
S4C143		Station 4
S4C144		Station 5
S4C145		Station 6
:		:
S4C151		Station 12

When general-purpose input numbers are not set to the above parameters (when “0” is set) for the station axes with twin drive function, the twin motion is the default mode.

5 Status Display

The application status of the twin drive function can be confirmed.

	Operation	Explanation
1	Select {ROBOT} from the menu	
2	Select {TWIN DRIVE}	<p>The twin drive display appears.</p>  <p>MASTER : The number of the master axis appears when the twin drive function is used.</p> <p>SUB : The number of the slave axis appears when the twin drive function is used.</p> <p>INPUT NO. : The general-purpose input number set for the parameter appears. When there is not set general-purpose input number, "[- -]" appears.</p> <p>MODE : The external input signal status appears. "TWIN " : The specified general-purpose input is OFF. The twin (concurrent) motion is possible. "SINGLE": The specified general-purpose input is ON. The single motion is possible.</p>

6 Precautions

Observe the following precautions when using the twin drive.

6.1 Precautions when selecting Motor

When using the twin drive, both twin-driven axes have to move in the same way and the same level for both axis operation and playback. Use the same motors for the twin-driven axes.

6.2 Precautions when Setting External Axes

To use the twin drive function, the external axes must be in maintenance mode. Note the following precautions when setting the external axes.

For operation methods in the maintenance mode, refer to “Instruction Manual” (MANUAL NO.: RE-CTO-A203).

6.2.1 Setting Mechanical Specifications

When setting the station axis, enter the following data for the mechanical specifications.

- MOTION RANGE (+)
- MOTION RANGE (-)
- REDUCTION RATIO (NUMER)
- REDUCTION RATIO (DENOM)

When using the twin drive, both twin-driven axes have to move in the same way and the same level for both axis operation and playback. Set the same condition data for both axes.

6.2.2 Setting Motor Specifications

When setting a station axis, enter the following data for the motor specifications.

- ROTATION DIRECTION (NORMAL/REVERSE)
- MAX. RPM
- ACCELERATION TIME
- INERTIA RATIO

When using the twin drive function, both twin-driven axes have to move in the same way and the same level for both axis operation and playback. Set the same condition data for “MAX. RPM”, “ACCELERATION TIME”, and “INERTIA RATIO” of both axes.

6.2.3 Setting the Rotating Direction

When using the twin drive, specify the same motor rotating direction for both twin-driven axes. Specifying a different direction for each axis may damage a jig and break down the system. Before using the twin drive, confirm the rotating direction of the twin-driven axes to set the correct rotating direction.

6.3 Setting the Home Position

Operate the two station axes configured for the twin drive at the same time and teach the home position so that the two axes have the same “0” position. Because the two axes have the same “0” pulse position, axis operation and playback can be performed with the same pulse value.

6.4 Precautions upon Application with Coordinated Motion

The station coordinated function can be used as an option. The following restrictions apply for the station axes with the twin drive.

6.4.1 Coordinated Motion with TWIN-2

When the robot moves in a coordinated motion using TWIN-2, the coordinated motion is applied to the 1st station axis. The 2nd station axis and the 1st station axis move in twin drive. Calibrate the 1st station axis only.

The coordinated motion is not valid for the 2nd station axis.

NX100 OPTIONS INSTRUCTIONS

FOR TWIN DRIVE FUNCTION

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