Motoman NX100 Controller

EP4000N
Manipulator Manual

Part Number: 151530-1CD
Revision: 0
Chapter 1

Introduction

1.1 About This Document

This manual provides information for the EP4000N manipulator 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 - EP4000N INSTRUCTIONS
Provides detailed instructions for the EP4000N.

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 (EP4000N, HP50, etc.)
• Application Type (handling, welding, 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:

RoboticIndustriesAssociation
900VictorsWay
P.O.Box3724
AnnArbor,Michigan48106
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).
MOTOMAN-EP4000N
INSTRUCTIONS
FOR INTER-PRESS HANDLING
TYPE: YR-EP4000N-*0* (PARALLEL LINK HAND SPECIFICATION)
    YR-EP4000N-*1*
    YR-EP4000N-*3* (PARALLEL LINK HAND SPECIFICATION, ALUMINUM LINK PART MOUNTED ON THE RIGHT SIDE)
    YR-EP4000N-*4* (DIAGONAL-MOUNT PARALLEL LINK HAND SPEC: +45 DEGREE ANGLE)
    YR-EP4000N-*5* (DIAGONAL-MOUNT PARALLEL LINK HAND SPEC: -45 DEGREE ANGLE)

Upon receipt of the product and prior to initial operation, read these instructions thoroughly, and retain for future reference.
This instruction manual explains operating instructions and maintenance procedures primarily for the MOTOMAN-EP4000N.

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

Some drawings in this manual are shown with the protective covers or shields removed for clarity. Be sure all covers and shields are replaced before operating this product.

The drawings and photos in this manual are representative examples and differences may exist between them and the delivered product.

YASKAWA may modify this model without notice when necessary due to product improvements, modifications, or changes in specifications. If such modification is made, the manual number will also be revised.

If your copy of the manual is damaged or lost, contact a YASKAWA representative to order a new copy. The representatives are listed on the back cover. Be sure to tell the representative the manual number listed on the front cover.

YASKAWA is not responsible for incidents arising from unauthorized modification of its products. Unauthorized modification voids your product's warranty.
Notes for Safe Operation

Read this manual carefully before installation, operation, maintenance, or inspection of the NX100.

In this manual, the notes for safe operation are classified as “WARNING”, “CAUTION”, “MANDATORY”, or “PROHIBITED”.

- **WARNING**: Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury to personnel.

- **CAUTION**: Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury to personnel and damage to equipment. It may also be used to alert against unsafe practices.

- **MANDATORY**: Always be sure to follow explicitly the items listed under this heading.

- **PROHIBITED**: Must never be performed.

Even items described as "CAUTION" may result in a serious accident in some situations. At any rate, be sure to follow these important items.

**NOTE**: To ensure safe and efficient operation at all times, be sure to follow all instructions, even if not designated as "CAUTION" and "WARNING".
• Before operating the manipulator, check that servo power is turned off when the emergency stop buttons on the front door of the NX100 and programming pendant are pressed. When the servo power is turned off, the SERVO ON LED on the programming pendant is turned off.

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

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 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 NX100 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 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 manipulator’s work area, on the floor, or near fixtures.

- Read and understand the Explanation of the 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 manipulator cables. In this manual, the equipment is designated as follows:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Manual Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>NX100 Controller</td>
<td>NX100</td>
</tr>
<tr>
<td>NX100 Programming Pendant</td>
<td>Programming pendant</td>
</tr>
<tr>
<td>Cable between the manipulator and the controller</td>
<td>Manipulator cable</td>
</tr>
</tbody>
</table>
**Explanation of Warning Labels**

The following warning labels are attached to the manipulator. Always follow the warnings on the labels. Also, an identification label with important information is placed on the body of the manipulator. Prior to operating the manipulator, confirm the contents.

Warning Label A

![Warning Label A]

**WARNING**

Moving parts may cause injury

Warning Label B

![Warning Label B]

**WARNING**

Do not enter robot work area

Nameplate

![Nameplate]

**WARNING**

Do not enter robot work area.

**WARNING**

Moving parts may cause injury.
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10  Recommended Spare Parts
1 Product Confirmation

1.1 Contents Confirmation

Confirm the contents of the delivery when the product arrives. Standard delivery includes the following four items (Information for the content of optional goods is given separately):

- Manipulator
- NX100
- Programming pendant
- Manipulator cables (six cables, between manipulator and NX100)

**CAUTION**

- Confirm that the manipulator and the NX100 have the same order number. Special care must be taken when more than one manipulator is to be installed.

If the numbers do not match, manipulators may not perform as expected and cause injury or damage.

**NOTE**

Connectors for manipulator cables are located on different positions depending on manipulator types.

1.2 Order Number Confirmation

Check that the order number of the manipulator corresponds to the NX100. The order number is located on a label as shown below.

![Label (Enlarged View)](image)

(a) NX100 (Front View)  (b) Manipulator (Top View)

Fig. 1 Location of Order Number Labels
2.1 Transporting Method

2.1.1 Using a Crane

As a rule, when removing the manipulator from the package and moving it, a crane should be used. The manipulator should be lifted using wire ropes threaded through shipping bolts and brackets. Be sure the manipulator is fixed with the shipping bolts and brackets before transportation, and lift it in the posture as shown in "Fig. 2 Transporting Position".
2.1 Transporting Method

Fig. 2 Transporting Position
2.2 Shipping Bolts and Brackets

The manipulator is equipped with shipping bolts and brackets at points A, B, and C ("Fig. 2 Transporting Position").

- The shipping bolts and brackets are painted yellow.

<table>
<thead>
<tr>
<th>Position</th>
<th>Bolt Type</th>
<th>Pcs</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Hexagon socket head cap screw: M12 (length: 30 mm) (Tensile strength: 1200 N/mm² or more)</td>
<td>3</td>
</tr>
<tr>
<td>B</td>
<td>Hexagon nut: M12</td>
<td>2</td>
</tr>
<tr>
<td>C</td>
<td>Hexagon nut: M12</td>
<td>2</td>
</tr>
</tbody>
</table>

Before turning ON the power, check to be sure that the shipping bolts and brackets have been removed. The shipping bolts and brackets then must be stored for future use, in the event that the robot must be moved again.
3 Installation

**WARNING**

- Install the safeguarding.
  
  Failure to observe this warning may result in injury or damage.

- Install the manipulator in a location where the manipulator's tool or the workpiece held by the manipulator will not reach the wall, safeguarding, or NX100 when the arm is fully extended.
  
  Failure to observe this warning may result in injury or damage.

- Do not start the manipulator or even turn on the power before it is firmly anchored.
  
  The manipulator may overturn and cause injury or damage.

**CAUTION**

- Do not install or operate the manipulator which is damaged or lacks parts.
  
  Failure to observe this caution may cause injury or damage.

- Before turning on the power, check to be sure that the shipping bolts and brackets explained in “2.2 Shipping Bolts and Brackets” are removed.
  
  Failure to observe this caution may result in damage to the driving parts.
3.1 Safeguarding Installation

To insure safety, be sure to install safeguarding. They prevent unforeseen accidents with personnel and damage to equipment. The following term is quoted for your information and guidance.

**Responsibility for Safeguarding [ISO 10218]**

The user of a manipulator or robot system shall ensure that safeguards are provided and used in accordance with Sections 6, 7, and 8 of this standard. The means and degree of safeguarding, including any redundancies, shall correspond directly to the type and level of hazard presented by the robot system consistent with the robot application. Safeguarding may include but not be limited to safeguarding devices, barriers, interlock barriers, perimeter guarding, awareness barriers, and awareness signals.

3.2 Mounting Procedures for Manipulator Base

The manipulator should be firmly mounted on a manipulator base mount strong enough to support the robot and withstand repulsion forces during acceleration and deceleration. Construct a solid foundation with the appropriate thickness to withstand maximum repulsion forces of the manipulator, referring to "Table 1 Maximum repulsion forces of the manipulator base mount".

A base mount flatness must be kept at 0.5 mm or less: insufficient flatness of installation surface may deform the manipulator shape and affect its functional abilities.

**Note**: Connectors for manipulator cables are located on different positions depending on manipulator types. Confirm the correct position of the manipulator cable before installing the manipulator.
3.2 Mounting Procedures for Manipulator Base

3.2.1 Manipulator Base Mount

Design and construct the manipulator base mount so that it can bear the torque shown in the table below. The vibration in the manipulator base must be 4.9 m/s² (0.5G) or less when the manipulator is individually operated. The manipulator base mount has 12 mounting holes. Mount the manipulator base firmly using the hexagon socket head cap screws M24 (tensile strength: 1000 N/mm² or more, recommended length: 90 mm).

<table>
<thead>
<tr>
<th>Torque</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum torque in horizontal rotation (JT1-axis moving direction)</td>
<td>88200 N·m or more (9000 kgf·m)</td>
</tr>
<tr>
<td>Maximum torque in vertical rotation (JT2-, JT3-axis moving directions)</td>
<td>68600 N·m or more (7000 kgf·m)</td>
</tr>
</tbody>
</table>

![Fig. 3 Installation Base](image-url)
3.3 Location

When the manipulator is installed, it is necessary to satisfy the following environmental conditions:

- Ambient temperature: 0 to 45°C.
- Humidity: 20 to 80%RH at constant temperature.
- Free from exposure to water, oil, or dust.
- Free from corrosive gas or liquid, or explosive gas.
- Free from large electrical noise (plasma).
- Shock or vibration from the press must be 9.8 m/s^2 (1.0 G) or less.
- Free from excessive shock or vibration: 4.9 m/s^2 (0.5G) or less when the manipulator is operated individually (with no vibration from other equipment such as the press). (Excessive vibration affects the mechanism.)
- Flatness for installation: 0.5 mm or less.
4.1 Grounding

4 Wiring

**WARNING**

- **Ground resistance must be 100 Ω or less.**
  Failure to observe this warning may result in fire or electric shock.

- **Before wiring, make sure to turn OFF the primary power supply, and put up a warning sign such as: “DO NOT TURN ON THE POWER.”**
  Failure to observe this warning may result in fire or electric shock.

**CAUTION**

- **Wiring must be performed by authorized or certified personnel.**
  Failure to observe this caution may result in fire or electric shock.

- **Do not cover the cable with heat insulating material, and avoid multiple cabling when laying manipulator cables from the manipulator to the NX100.**
  Failure to observe this caution may result in burn caused by cable heat emission failure.

Follow local regulations for grounding line size. A line of 8.0 mm² or more is recommended. Refer to "Fig. 4 Grounding Method" to connect the ground line directly to the manipulator.

**NOTE**

- Never use this line sharing with other ground lines or grounding electrodes for other electric power, motor power, welding devices, etc.
- Where metal ducts, metallic conduits, or distributing racks are used for cable laying, ground in accordance with Electric Equipment Technical Standards.
4.2 Manipulator Cable Connection

As shown in "Fig. 5 Manipulator Cables", there are six cables for the power supply. Connect these cables to the connectors on the manipulator base and the NX100, referring to "Fig. 5 Manipulator Cables".

4.2.1 Connection to the Manipulator

Before connecting the cables to the manipulator, verify the numbers: there are 1BC, 2BC, 3BC, 4BC, 5BC, and 6BC on both manipulator cables and the manipulator base connectors. When connecting the cables, adjust the cable connector positions to the main key positions of the manipulator, and insert the cables in the order of 2BC, 3BC, 4BC, 5BC, 6BC, and 1BC, then set each lever downward until it clicks.

4.2.2 Connection to the NX100

Before connecting the cables to the NX100, verify the numbers: there are X11, X21, X22, X23, X24, and X25 on both manipulator cables and the connectors on the NX100. When connecting the cables, adjust the cable connector positions to the main key positions of the NX100, and insert the cables in the order of X21, X22, X23, X24, X25, and X11, then set each lever downward until it clicks.

![Diagram illustration of grounding method with labels and caution note]

**CAUTION**

- Do not cover the cable with heat insulating material, and avoid multiple cabling when laying manipulator cables from the manipulator to the NX100.

Failure to observe this caution may result in burn caused by cable heat emission failure.
4.2 Manipulator Cable Connection

Fig. 5 Manipulator Cables
4.2 Manipulator Cable Connection

Fig. 6 (a) Manipulator Cable Connectors (Manipulator Side)
4.2 Manipulator Cable Connection

Fig. 6 (b) Manipulator Cable Connectors (NX100 Side)
## Basic Specifications

### 5.1 Basic Specifications

<table>
<thead>
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<td>Configuration</td>
<td>Vertically Articulated</td>
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<td>Degree of Freedom</td>
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<td><strong>Motion Range</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JT1-Axis (turning)</td>
<td>±150°</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JT2-Axis (lower arm)</td>
<td>+25°, -122°</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JT3-Axis (upper arm)</td>
<td>+53°, -70°</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JT4-Axis (wrist roll)</td>
<td>±360°</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JT5-Axis (wrist pitch/yaw)</td>
<td>+85°, -120°</td>
<td>±120°</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JT6-Axis (wrist twist)</td>
<td>±70°</td>
<td>±360°</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Maximum Speed</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JT1-Axis</td>
<td>1.57 rad/s, 90°/s</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JT2-Axis</td>
<td>1.57 rad/s, 90°/s</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JT3-Axis</td>
<td>1.57 rad/s, 90°/s</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JT4-Axis</td>
<td>1.40 rad/s, 80°/s</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JT5-Axis</td>
<td>1.40 rad/s, 80°/s</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JT6-Axis</td>
<td>2.79 rad/s, 160°/s</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mass</strong></td>
<td>3100 kg</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ambient Conditions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>0 to 45°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Humidity</td>
<td>20 to 80% RH (non-condensing)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vibration</td>
<td>9.8 m/s² (1.0 G) or less</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>• Free from corrosive gasses or liquids, or explosive gasses.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Free from exposure to water, oil, or dust.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Free from excessive electrical noise (plasma).</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Power Requirements</strong></td>
<td>22 kVA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*1 SI units are used in this table. However, gravitational unit is used in ( ).

*2 Conformed to ISO9283.
5.2 Part Names and Working Axes

Fig. 7 Part Names and Working Axes

5.3 Manipulator Base Dimensions

Fig. 8 Baseplate Dimensions (mm)
5.4 Dimensions and P-Point Maximum Envelope

Fig. 9 Dimensions and P-Point Maximum Envelope

Units: mm
5.5 JT5-Axis Operating Range

The JT5-axis operates keeping the constant angle to the center of U-arm as shown in "Fig. 10 JT5-Axis Operating Range".

![Fig. 10 JT5-Axis Operating Range](image)

5.6 Alterable Operating Range

The operating range of the JT1-axis can be altered according to the operating conditions as shown in "Table 3 JT1-Axis Operating Range". If alteration is necessary, contact your Yaskawa representative in advance.

<table>
<thead>
<tr>
<th>Item</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>JT1-Axis Operating Range</td>
<td>±150° (standard)</td>
</tr>
<tr>
<td></td>
<td>±120°</td>
</tr>
<tr>
<td></td>
<td>±90°</td>
</tr>
<tr>
<td></td>
<td>±60°</td>
</tr>
<tr>
<td></td>
<td>±30°</td>
</tr>
</tbody>
</table>
6 Allowable Load for Wrist Axis and Wrist Flange

6.1 Allowable Wrist Load

The allowable wrist load including the mass of the gripper is 200 kg. This section explains the allowable values and conditions.

As shown in "Table 4 Allowable Inertia and Moment of Inertia" below, there are limitations in moment and moment of inertia: fulfill the requirement in the table in operating the manipulator.

Table 4  Allowable Inertia and Moment of Inertia

<table>
<thead>
<tr>
<th></th>
<th>Allowable Moment N-m (^{(1)} )</th>
<th>Allowable Moment of Inertia ( (GD^{2/4}) ) kg m^2</th>
</tr>
</thead>
<tbody>
<tr>
<td>JT4-axis</td>
<td>1274 (130)</td>
<td>84.5</td>
</tr>
<tr>
<td>JT5-axis</td>
<td>2156 (220)</td>
<td>330</td>
</tr>
<tr>
<td>JT6-axis</td>
<td>0 (0)</td>
<td>80</td>
</tr>
</tbody>
</table>

\(^{(1)} \): Gravitational unit

- Allowable wrist load is based on an assumption that the robot is handling a workpiece horizontally by keeping its wrist flange downwards.
6.2 Wrist Flange

It is recommended that the attachment be mounted inside the fitting to identify the alignment marks. Fitting depth of inside and outside fittings must be 8 mm or less.

Wash off anti-corrosive paint (yellow) on the wrist flange surface with thinner or light oil before mounting the tools.

Units: mm

Fig. 11 Wrist Flange
7 System Application

7.1 Peripheral Equipment Mounts

The peripheral equipment mounts and tapped holes are provided on the upper arm of the manipulator as shown in "Fig. 12 Tapped Holes for Peripheral Equipment Mounts", for easier installation of the user's system applications. Make efficient use of these mounts following the conditions in "Table 5 Condition for Attachment".

![Fig. 12 Tapped Holes for Peripheral Equipment Mounts](image)

<table>
<thead>
<tr>
<th>Application</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Cabling</td>
<td>Allowable load mass is 200 kg including wrist load.</td>
</tr>
<tr>
<td>B Cabling</td>
<td>10 kg or less. 25 N·m (2.5 kgf·m) or less for increased moment amount of upper arm</td>
</tr>
</tbody>
</table>

Table 5 Condition for Attachment
7.2 Internal User I/O Wiring Harness and Air Line

34 wires (0.5 mm²) and 2 air lines are used in the manipulator for the drives of the peripheral devices mounted on the upper arm as described in "Fig. 13 Internal User I/O Wiring Harness and Air Line". The connector pins 1 to 34 are assigned as shown in the close-up drawing in Fig. 13. Wiring must be performed by user.

- The allowable current for wires: 6.6 A or less for each wire.
  (The total current value for pins 1 to 34 must be 60 A or less.)
- The maximum pressure for the air lines: 490 kPa (5 kgf/cm²) or less for each line.
  (The inside diameter: 8 mm.)

Fig. 13 Internal User I/O Wiring Harness and Air Line

The same pin number (1-34) of two connectors is connected in the lead line of single 0.5mm².
8 Electrical Equipment Specifications

8.1 Locations of Limit Switches

(1) “YR-EP4000N-**0”
   Equipped with an overrun limit switch for the JT1-axis.
   Refer to “Fig. 14 Locations of Limit Switches” for the location.

(2) “YR-EP4000N-**1”
   Equipped with overrun limit switches for the JT1- and JT2-axes, and an interference
   limit switch for the JT2- and JT3-axes.
   Refer to “Fig. 14 Locations of Limit Switches” for the locations.

(3) The JT2-axis overrun limit switch and the JT2-JT3-axis interference limit switch
    electrically restrict the ranges of each subject axis motion by adjusting the dog posi-
    tion. The mechanical stopper is effective at the P-point maximum envelope, and its
    position cannot be changed.

(4) The power supply to the manipulator will be cut off once the limit switch is activated,
    resulting in an emergency stop of the manipulator.
    Refer to “9.6 Overrun / Tool Shock Sensor Releasing” in “NX100 INSTRUCTIONS”
    to release the manipulator from the overrun status.

(5) The limit switches are set at the P-point maximum envelope before the shipment.

NOTE
In case of re-adjusting the operating range of each subject axis, it is also required to
change the dog location and limit values in software. Contact your Yaskawa representative
if re-adjustment is required.

(6) Adjustable range of the JT2-axis overrun limit switch
   As shown in “Fig. 15 JT2-axis Overrun Limit Switch Adjustable Range”, JT2-axis is
   adjustable within the range between 26° to the plus (+) direction and 123° to the
   minus (-) direction. However, the least adjustable range of motion is 16°. The JT2-
   axis can be set at any degrees within the above mentioned range as long as it is set
   at 16° or more.
8.1 Locations of Limit Switches

(7) Adjustable range of the JT2-JT3-axis interference limit switch
The limit switch for the JT2- and JT3-axis interference is structured to check the interference angle between the JT2- and JT3-axes. Set the interference angle between the JT2- and JT3-axes within the range from 19° to 161° as shown in "Fig. 16 JT2-JT3-axes Interference Limit Switch Adjustable Range".

Fig. 15 JT2-axis Overrun Limit Switch Adjustable Range

Fig. 16 JT2-JT3-axis Interference Limit Switch Adjustable Range
8.2 Internal Connections

High reliability connectors which can be easily put on and removed are used with each connector part.

For the numbers, types, and locations of the connectors, see "Fig. 17 Location and Numbers of Connectors" and "Table 6 List of Connector Types". As to the internal connections between the manipulator and the NX100, see connection diagrams in "Fig. 18 (a)" and "Fig. 18 (b)" on the following pages.

Table 6 List of Connector Types

<table>
<thead>
<tr>
<th>Name</th>
<th>Type of Connector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connector base:</td>
<td>Connector for internal user I/O wiring harness</td>
</tr>
<tr>
<td></td>
<td>JL05-2A28-21PC (JL05-6A28-21S: Optional)</td>
</tr>
<tr>
<td>U-arm:</td>
<td>Connector for internal user I/O wiring harness</td>
</tr>
<tr>
<td></td>
<td>JL05-2A28-21SC (JL05-6A28-21P: Optional)</td>
</tr>
</tbody>
</table>

Fig. 17 Location and Numbers of Connectors
8.2 Internal Connections

Note:

For the limit switch specification of the JT2- and JT3-axes, the connection of the section (B) is changed as follows:

Fig. 18 (a) Internal Connection Diagram
Fig. 18 (b) Internal Connection Diagram
9 Maintenance and Inspection

**WARNING**

- Before maintenance or inspection, be sure to turn OFF the main power supply, and put up a warning sign. (ex. DO NOT TURN ON THE POWER.)

Failure to observe this warning may result in electric shock or injury.

**CAUTION**

- Maintenance and inspection must be performed by specified personnel.

Failure to observe this caution may result in electric shock or injury.

- For disassembly or repair, contact your Yaskawa representative.

- Do not remove the motor, and do not release the brake.

Failure to observe this caution may result in injury from unexpected turning of the manipulator’s arm.

- The battery pack must be connected before removing encoder connector when maintenance and inspection.

Failure to observe this caution may result in the loss of home position data.

9.1 Inspection Schedule

Proper inspections are essential not only to assure that the mechanism will be able to function for a long period, but also to prevent malfunctions and assure safe operation.

Inspection intervals are classified into six levels as shown in "Table 7 Inspection Items". Conduct periodical inspections according to the inspection schedule in this table.

In the table, the inspection items are categorized by three types of operations: operations which can be performed by personnel authorized by the user, operations which can be performed by personnel being trained, and operations which can be performed by service company personnel.

Only specified personnel are to do inspection work.
The inspection interval depends on the total servo operation time. For axes which are used very frequently (in handling applications, etc.), it is recommended that inspections be conducted at shorter intervals. Contact your Yaskawa representative.

The speed reducers for the JT1-, JT2-, and JT3-axes are recommended to be replaced in the secondary inspection (which is to be done in 18000-hour cycle) as a preventive maintenance. The replacement should be made in less than 18000-hour cycle, depending upon the operation pattern.

### Table 7 Inspection Items

<table>
<thead>
<tr>
<th>Items</th>
<th>Schedule</th>
<th>Method</th>
<th>Operation</th>
<th>Inspection Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Daily</td>
<td>500H Cycle</td>
<td>3000H Cycle</td>
<td>9000H Cycle</td>
</tr>
<tr>
<td>1</td>
<td>Alignment mark</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>2</td>
<td>External leads</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>3</td>
<td>Manipulator (whole exterior)</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>4</td>
<td>JT2, JT3-axis motors</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>5</td>
<td>Manipulator base mounting screws</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>6</td>
<td>Cover mounting screws</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>7</td>
<td>JT1, JT2, JT3, JT4, JT5, JT6-axis motor connectors</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>8</td>
<td>Connector base</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>9</td>
<td>Internal wiring harness in JT1-axis</td>
<td>○</td>
<td>○</td>
<td>Visual</td>
</tr>
<tr>
<td>10</td>
<td>Internal wiring harness protective spring</td>
<td>○</td>
<td>○</td>
<td>Visual</td>
</tr>
<tr>
<td>11</td>
<td>JT2-axis balancer</td>
<td>○</td>
<td>○</td>
<td>Visual, Grease Gun</td>
</tr>
</tbody>
</table>
## 9.1 Inspection Schedule

### Table 7 Inspection Items

<table>
<thead>
<tr>
<th>Schedule</th>
<th>Method</th>
<th>Operation</th>
<th>Inspection Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily</td>
<td>500H Cycle</td>
<td>3000H Cycle</td>
<td>9000H Cycle</td>
</tr>
<tr>
<td><strong>Internal wiring harness</strong></td>
<td>Multimeter</td>
<td>Check for conduction between the main connector of base and each connector with manually shaking the wiring harness. Check for wear of protective spring. Replace the wire (3000H cycle).</td>
<td></td>
</tr>
<tr>
<td><strong>Limit switch dog (JT1-axis)</strong></td>
<td>Driver, Wrench, Multimeter</td>
<td>Check for dirt, damage, looseness. Tighten if necessary. Check the operation.</td>
<td></td>
</tr>
<tr>
<td><strong>Limit switch (JT2-axis)</strong></td>
<td>Driver, Wrench, Multimeter</td>
<td>Check for dirt, damage, looseness. Tighten if necessary. Check the operation.</td>
<td></td>
</tr>
<tr>
<td><strong>JT2, JT3-axis interference limit switch</strong></td>
<td>Driver, Wrench, Multimeter</td>
<td>Check for dirt, damage, looseness. Tighten if necessary. Check the operation.</td>
<td></td>
</tr>
<tr>
<td><strong>JT2, JT3-axis arm connection parts</strong></td>
<td>Visual, Manual</td>
<td>Check for backlash of bearings by moving the JT2, JT3-axes back and forth, and up and down. Supply grease.</td>
<td></td>
</tr>
<tr>
<td><strong>Battery pack in manipulator</strong></td>
<td>Multimeter</td>
<td>Replace if the result of voltage check is 2.8 V or less.</td>
<td></td>
</tr>
<tr>
<td><strong>JT1-axis speed reducer</strong></td>
<td>Grease Gun</td>
<td>Check for malfunction. (Replace if necessary.) Replenish grease. (3000H cycle). See Par. 9.2.2. Exchange grease. (9000H cycle). See Par. 9.2.3 and 9.2.4.</td>
<td></td>
</tr>
<tr>
<td><strong>JT2, JT3-axis speed reducers</strong></td>
<td>Grease Gun</td>
<td>Check for malfunction. (Replace if necessary.) Replenish grease. (3000H cycle). See Par. 9.2.2. Exchange grease. (9000H cycle). See Par. 9.2.3 and 9.2.4.</td>
<td></td>
</tr>
<tr>
<td><strong>JT4, JT5, JT6-axis gears</strong></td>
<td>Grease Gun</td>
<td>Check for malfunction. (Replace if necessary.) Replenish grease. (3000H cycle). See Par. 9.2.2. Exchange grease. (9000H cycle). See Par. 9.2.3 and 9.2.4.</td>
<td></td>
</tr>
</tbody>
</table>
9.1 Inspection Schedule

**Table 7 Inspection Items**

<table>
<thead>
<tr>
<th>Items</th>
<th>Schedule</th>
<th>Method</th>
<th>Operation</th>
<th>Inspection Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Daily 500H Cycle</td>
<td>3000H Cycle</td>
<td>9000H Cycle</td>
<td>18000H Cycle</td>
</tr>
<tr>
<td>JT4-axis speed reducer</td>
<td>○</td>
<td>○</td>
<td>Grease Gun</td>
<td>Check for malfunction. (Replace if necessary)</td>
</tr>
<tr>
<td>JT5, JT6-axis speed reducers, JT5, JT6-axis gears</td>
<td>○</td>
<td>○</td>
<td>Grease Gun</td>
<td>Check for malfunction. (Replace if necessary)</td>
</tr>
<tr>
<td>JT2-axis cross roller bearing</td>
<td>○</td>
<td>○</td>
<td>Grease Gun</td>
<td>Check for malfunction. (Replace if necessary)</td>
</tr>
<tr>
<td>Overhaul</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*1 When checking for conduction with a multimeter, remove connectors on encoder side for each axis from the motor.
*2 The internal wiring harness is to be replaced at 18000H inspection (at overhaul).
*3 For the grease, refer to “Table 8 Inspection Parts and Grease Used”.
*4 Inspection numbers correspond to the numbers in “Fig. 19 Inspection Parts and Inspection Numbers”.

**Table 8 Inspection Parts and Grease Used**

<table>
<thead>
<tr>
<th>No.</th>
<th>Grease Used</th>
<th>Inspected Parts</th>
</tr>
</thead>
<tbody>
<tr>
<td>18, 19, 20, 21, 22</td>
<td>Molywhite RE No. 00</td>
<td>Speed reducers for all axes JT5- and JT6-axis gears</td>
</tr>
<tr>
<td>11, 16, 23</td>
<td>Alvania EP Grease 2</td>
<td>JT2-axis cross roller bearing JT2-axis balancer</td>
</tr>
</tbody>
</table>

The numbers in the above table correspond to the numbers in “Table 7 Inspection Items”.
Fig. 19 Inspection Parts and Inspection Numbers (Manipulator in Home Position)

Note: The manipulator is in the home position.
9.2 Notes on Maintenance Procedures

9.2.1 Battery Pack Replacement

Two battery packs are installed in the position described in "Fig. 20 Battery Location". If a battery alarm shows up on the NX100, replace the battery according to the following procedure:

![Fig. 20 Battery Location](image)

![Fig. 21 (a) Battery Connection for JT1-, JT2-, JT3-Axes](image)

- a: Crimped contact-pin (pin)
- b: Crimped contact-pin (socket)
9.2 Notes on Maintenance Procedures

1. Turn OFF the NX100 main power supply.
2. Remove the plate from the connector base and pull out the battery pack to replace it with a new battery pack.
3. Unscrew the battery pack mounting screws on the battery holder, and remove the battery pack.
4. Remove the electrical tape (insulation tape) protecting the connection part of the battery pack in the manipulator.
5. Connect the new battery pack.
6. Remove the old battery pack.
7. Protect the connection part of the battery pack in the manipulator with electrical tape (insulation tape).
8. Fix the battery pack with screws, and put the connector base back on the manipulator.

**NOTE**: Remove the old battery pack after connecting the new one so that the encoder absolute data does not disappear.

**NOTE**: Pay attention not to pinch the cable when the plate is being installed.

Fig. 21 (b) Battery Connection for JT4-, JT5-, JT6-Axes
9.2.2 Grease Replenishment/Exchange for JT1-Axis Speed Reducer and Gear

![Diagram of JT1-Axis Speed Reducer and Gear](image)

**Grease Replenishment (Refer to "Fig. 22 JT1-Axis Speed Reducer and Gear Diagram").**

1. Remove the plug from the JT1o grease exhaust port.

   **NOTE**
   If grease is added with the plug on, the grease will go inside the motor and may damage it. Never fail to remove the plug before the grease injection.

2. Inject the grease into the JT1i grease inlet using a grease gun.

<table>
<thead>
<tr>
<th>Grease type: Molywhite RE No. 00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount of grease: 2340 cc</td>
</tr>
<tr>
<td>(4680 cc for the initial supply)</td>
</tr>
</tbody>
</table>

3. Before putting the plug back on the JT1o grease exhaust port, move the JT1-axis for a few minutes to discharge the excess grease.

4. Wipe the discharged grease with a cloth and reinstall the plug on the JT1o grease exhaust port. Tighten the plug with a tightening torque of 5 N·m (0.51 kgf·m). (Apply Three Bond 1206C on the thread part of the plug.)
9.2 Notes on Maintenance Procedures

Grease Exchange (Refer to “Fig. 22  JT1-Axis Speed Reducer and Gear Diagram”.)

1. Remove the plug from the JT1o grease exhaust port.

2. Inject the grease into the JT1i grease inlet using a grease gun.

   Grease type: Molywhite RE No. 00
   Amount of grease: 11700 cc

3. The grease exchange is completed when new grease appears in the JT1o grease exhaust port. The new grease can be distinguished from the old grease by its color.
4. Before putting the plug back on the JT1o grease exhaust port, move the JT1-axis for a few minutes to discharge the excess grease.
5. Wipe the discharged grease with a cloth and reinstall the plug on the JT1o grease exhaust port. Tighten the plug with a tightening torque of 5 N·m (0.51 kgf·m). (Apply Three Bond 1206C on the thread part of the plug.)

   If grease is added with the plug on, the grease will go inside the motor and may damage it. Never fail to remove the plug before the grease injection.

   NOTE

   Grease type: Molywhite RE No. 00
   Amount of grease: 11700 cc
9.2.3 Grease Replenishment/Exchange for JT2-Axis Speed Reducer

Grease exhaust port JT2o
(Hexagon socket head plug PT1/8)

Grease inlet JT2i
(Grease zerk A-PT1/8)

Fig. 23 JT2-Axis Speed Reducer Diagram

- Grease Replenishment (Refer to "Fig. 23 JT2-Axis Speed Reducer Diagram").
  1. Make the L-arm posture as shown in "Fig. 23 L-Axis Speed Reducer Diagram".
  2. Remove the plug from the JT2o grease exhaust port.

**NOTE**
If grease is added with the plug on, the grease will go inside the motor and may damage it. Never fail to remove the plug before the grease injection.

3. Inject the grease into the JT2i grease inlet using a grease gun.

Grease type: Molywhite RE No. 00
Amount of grease: 520 cc
(1040 cc for the initial supply)
4. Before putting the plug back on the JT2o grease exhaust port, move the JT2-axis for a few minutes to discharge the excess grease.

5. Wipe the discharged grease with a cloth and reinstall the plug on the JT2o grease exhaust port. Tighten the plug with a tightening torque of 5 N·m (0.51 kgf·m). (Apply Three Bond 1206C on the thread part of the plug.)

**Grease Exchange (Refer to "Fig. 23  JT2-Axis Speed Reducer Diagram").**

1. Make the L-arm posture as shown in "Fig. 23 L-Axis Speed Reducer Diagram".
2. Remove the plug from the JT2o grease exhaust port.

3. Inject the grease into the JT2i grease inlet using a grease gun.

   | Grease type: Molywhite RE No. 00 |
   | Amount of grease: approx. 2600 cc |

4. The grease exchange is completed when new grease appears in the JT2o grease exhaust port. The new grease can be distinguished from the old grease by its color.

5. Before putting the plug back on the JT2o grease exhaust port, move the JT2-axis for a few minutes to discharge the excess grease.

6. Wipe the discharged grease with a cloth and reinstall the plug on the JT2o grease exhaust port. Tighten the plug with a tightening torque of 5 N·m (0.51 kgf·m). (Apply Three Bond 1206C on the thread part of the plug.)
### 9.2.4 Grease Replenishment/Exchange for JT3-Axis Speed Reducer

![Diagram of JT3-Axis Speed Reducer](Image)

**Fig. 24 JT3-Axis Speed Reducer Diagram**

- **Grease Replenishment** (Refer to "Fig. 24 JT3-Axis Speed Reducer Diagram").
  1. Make the L-arm posture as shown in "Fig. 23 U-Axis Speed Reducer Diagram".
  2. Remove the plug from the JT3o grease exhaust port.
  3. Inject the grease into the JT3i grease inlet using a grease gun.

**NOTE**

If grease is added with the plug on, the grease will go inside the motor and may damage it. Never fail to remove the plug before the grease injection.

- Grease type: Molywhite RE No. 00
- Amount of grease: 698 cc
  (1396 cc for the initial supply)
4. Before putting the plug back on the JT3o grease exhaust port, move the JT3-axis for a few minutes to discharge the excess grease.

5. Wipe the discharged grease with a cloth and reinstall the plug on the JT3o grease exhaust port. Tighten the plug with a tightening torque of 5 N·m (0.51 kgf·m). (Apply Three Bond 1206C on the thread part of the plug.)

Grease Exchange (Refer to "Fig. 24 JT3-Axis Speed Reducer Diagram").

1. Make the L-arm posture as shown in "Fig. 24 U-Axis Speed Reducer Diagram".

2. Remove the plug from the JT3o grease exhaust port.

3. Inject the grease into the JT3i grease inlet using a grease gun.

   Grease type: Molywhite RE No. 00
   Amount of grease: approx. 3490 cc

4. The grease exchange is completed when new grease appears in the JT3o grease exhaust port. The new grease can be distinguished from the old grease by its color.

5. Before putting the plug back on the JT3o grease exhaust port, move the JT3-axis for a few minutes to discharge the excess grease.

6. Wipe the discharged grease with a cloth and reinstall the plug on the JT3o grease exhaust port. Tighten the plug with a tightening torque of 5 N·m (0.51 kgf·m). (Apply Three Bond 1206C on the thread part of the plug.)
9.2.5 Grease Replenishment/Exchange for JT4, JT5-, JT6-Axis Gears

1. Remove the plug from the Go grease exhaust port.
2. Inject the grease into the Gi grease inlet using a grease gun.

**NOTE:** If grease is injected with the plug on, the grease will go outside the grease box and may cause a damage. Never fail to remove the plug before the grease injection.

3. Before putting the plug back on the Go grease exhaust port, move the JT4-, JT5-, JT6-axes for a few minutes to discharge the excess grease.
4. Wipe the discharged grease with a cloth and reinstall the plug on the Go grease exhaust port. Tighten the plug with a tightening torque of 5 N·m (0.51 kgf·m). (Apply Three Bond 1206C on the thread part of the plug.)

Grease type: Molywhite RE No. 00
Amount of grease: 1040 cc
(2080 cc for the initial supply)
9.2 Notes on Maintenance Procedures

**Grease Exchange (Refer to “Fig. 25  JT4-, JT5-, JT6-Axis Gear Diagram.”)**

1. Remove the plug from the Go grease exhaust port.

   **NOTE** If grease is injected with the plug on, the grease will go outside the grease box and may cause a damage. Never fail to remove the plug before the grease injection.

2. Inject the grease into the Gi grease inlet using a grease gun.

   - Grease type: Molywhite RE No. 00
   - Amount of grease: approx. 5200 cc

3. The grease exchange is completed when new grease appears in the Go grease exhaust port. The new grease can be distinguished from the old grease by its color.

4. Before putting the plug back on the Go grease exhaust port, move the JT4-, JT5-, JT6-axis for a few minutes to discharge the excess grease.

5. Wipe the discharged grease with a cloth and reinstall the plug on the Go grease exhaust port. Tighten the plug with a tightening torque of 5 N·m (0.51 kgf·m). (Apply Three Bond 1206C on the thread part of the plug.)
9.2.6 Grease Replenishment/Exchange for JT4-Axis Speed Reducer

Grease Replenishment (Refer to "Fig. 26 JT4-Axis Speed Reducer Diagram").

1. Remove the plug from the JT4o grease exhaust port.

   **NOTE**
   
   If grease is injected with the plug on, the grease will go outside the grease box and may cause a damage. Never fail to remove the plug before the grease injection.

2. Inject the grease into the JT4i grease inlet using a grease gun.

   - Grease type: Molywhite RE No. 00
   - Amount of grease: 466 cc
     (932 cc for the initial supply)

3. Before putting the plug back on the JT4o grease exhaust port, move the JT4-axis for a few minutes to discharge the excess grease.

4. Wipe the discharged grease with a cloth and reinstall the plug on the JT4o grease exhaust port. Tighten the plug with a tightening torque of 5 N·m (0.51 kgf·m). (Apply Three Bond 1206C on the thread part of the plug.)
Grease Exchange (Refer to "Fig. 26  JT4-Axis Speed Reducer Diagram").

1. Remove the plug from the JT4o grease exhaust port.

2. Inject the grease into the JT4i grease inlet using a grease gun.

If grease is injected with the plug on, the grease will go outside the grease box and may cause a damage. Never fail to remove the plug before the grease injection.

3. The grease exchange is completed when new grease appears in the JT4o grease exhaust port. The new grease can be distinguished from the old grease by its color.

4. Before putting the plug back on the JT4o grease exhaust port, move the JT4-axis for a few minutes to discharge the excess grease.

5. Wipe the discharged grease with a cloth and reinstall the plug on the JT4o grease exhaust port. Tighten the plug with a tightening torque of 5 N·m (0.51 kgf·m). (Apply Three Bond 1206C on the thread part of the plug.)

Grease type: Molywhite RE No. 00
Amount of grease: approx. 2330 cc
9.2.7 Grease Replenishment/Exchange for JT5-Axis Speed Reducer and Gear

Grease Replenishment (Refer to "Fig. 27 JT5-Axis Speed Reducer and Gear Diagram").

1. Remove the plug from the JT5o grease exhaust port.

**NOTE**
If grease is injected with the plug on, the grease will go outside the grease box and may cause a damage. Never fail to remove the plug before the grease injection.

2. Inject the grease into the JT5i grease inlet using a grease gun.

   Grease type: Molywhite RE No. 00
   Amount of grease: 260 cc
   (520 cc for the initial supply)

3. Before putting the plug back on the JT5o grease exhaust port, move the JT5-axis for a few minutes to discharge the excess grease.

4. Wipe the discharged grease with a cloth and reinstall the plug on the JT5o grease exhaust port. Tighten the plug with a tightening torque of 5 N·m (0.51 kgf·m). (Apply Three Bond 1206C on the thread part of the plug.)
9.2 Notes on Maintenance Procedures

- Grease Exchange (Refer to “Fig. 27  JT5-Axis Speed Reducer and Gear Diagram”.)

1. Remove the plug from the JT5o grease exhaust port.

   **NOTE**
   If grease is injected with the plug on, the grease will go outside the grease box and may cause a damage. Never fail to remove the plug before the grease injection.

2. Inject the grease into the JT5i grease inlet using a grease gun.

   | Grease type: Molywhite RE No. 00 |
   | Amount of grease: approx. 1300 cc |

3. The grease exchange is completed when new grease appears from the JT5o grease exhaust port. The new grease is distinguished from the old grease by its color.

4. Before putting the plug back on the JT5o grease exhaust port, move the JT5-axis for a few minutes to discharge the excess grease.

5. Wipe the discharged grease with a cloth and reinstall the plug on the JT5o grease exhaust port. Tighten the plug with a tightening torque of 5 N·m (0.51 kgf·m). (Apply Three Bond 1206C on the thread part of the plug.)
9.2.8 Grease Replenishment/Exchange for JT6-Axis Speed Reducer and Gear

Grease Replenishment (Refer to "Fig. 28 JT6-Axis Speed Reducer and Gear Diagram").

1. Remove the plug from the JT6o grease exhaust port.

   **NOTE:** If grease is injected with the plug on, the grease will go outside the grease box and may cause a damage. Never fail to remove the plug before the grease injection.

2. Inject the grease into the JT6i grease inlet using a grease gun.

   Grease type: Molywhite RE No. 00
   Amount of grease: 220 cc (440 cc for the initial supply)

3. Before putting the plug back on the JT6o grease exhaust port, move the JT6-axis for a few minutes to discharge the excess grease.

4. Wipe the discharged grease with a cloth and reinstall the plug on the JT6o grease exhaust port. (Apply Three Bond 1206C on the thread part of the plug.)
9.2 Notes on Maintenance Procedures

Grease Exchange (Refer to “Fig. 28  JT6-Axis Speed Reducer and Gear Diagram”.)

1. Remove the plug from the JT6o grease exhaust port.

   *NOTE* If grease is injected with the plug on, the grease will go outside the grease box and may cause a damage. Never fail to remove the plug before the grease injection.

2. Inject the grease into the JT6i grease inlet using a grease gun.

   Grease type: Molywhite RE No. 00  
   Amount of grease: approx. 1100 cc

3. The grease exchange is completed when new grease appears from the JT6o grease exhaust port. The new grease is distinguished from the old grease by its color.
4. Before putting the plug back on the JT6o grease exhaust port, move the JT6-axis for a few minutes to discharge the excess grease.
5. Wipe the discharged grease with a cloth and reinstall the plug on the JT6o grease exhaust port. (Apply Three Bond 1206C on the thread part of the plug.)
9.2.9 Grease Replenishment for JT2-Axis Cross Roller Bearing

1. Remove the plug from the exhaust port. (Refer to "Fig. 29 L-Axis Cross Roller Bearing Diagram").
2. Inject the grease into the JT2c grease inlet using a grease gun.

Grease type: Alvania EP Grease 2
Amount of grease: 64 cc

The exhaust port is for AIR exhaust: the grease is not exhausted from the exhaust port. Do not inject excessive grease into the grease inlet.

3. Reinstall the plug on the exhaust port. Tighten the plug with a tightening torque of 5 N·m (0.51 kgf·m). (Apply Three Bond 1206C on the thread part of the plug.)
9.2.10 Grease Replenishment for Tapered Roller Bearing in the Link Part

Fig. 30  Link Part

1. Remove the plugs from the exhaust ports on link parts (6 exhaust ports). (Refer to "Fig. 30  Link Part").
2. Inject the grease into each Hc grease inlet on link part using a grease gun (6 inlets).
3. Reinstall the plug on each exhaust port. Tighten the plug with a tightening torque of 5 N·m (0.51 kgf·m). (Apply Three Bond 1206C on the thread part of the plug.)

- Grease type: Alvania EP Grease 2
  - Amount of grease: 9 cc
  - (18 cc for the initial supply)

The exhaust port is for AIR exhaust: the grease is not exhausted from the exhaust port. Do not inject excessive grease into the grease inlet.
9.2.11 Grease Replenishment for Balancer Link Part

1. Remove the plugs from the Vo exhaust ports on link parts (4 exhaust ports). (Refer to "Fig. 31 Balancer Link Part").
2. Inject the grease into each Vi grease inlet on link part using a grease gun (3 inlets).

   Grease type: Alvania EP Grease 2
   Amount of grease: 10 cc

3. Reinstall the plug on each exhaust port. Tighten the plug with a tightening torque of 5 N·m (0.51 kgf·m). (Apply Three Bond 1206C on the thread part of the plug.)
9.2 Notes on Maintenance Procedures

9.2.12 Notes for Maintenance

Connecting the new battery pack before removing the old one so that the encoder absolute data will not disappear.

- Motors for JT1-, JT2-, JT3-, JT4-, JT5-, JT6-Axes

The connectors for the battery pack connection of each motor are attached to the main body of respective motor. Connect the battery pack according to "Fig. 32 Backup Battery Pack Connection for Motor".

1. Remove a cap attached to the battery backup connector of the motor encoder by removing the cover mounting screws.
2. Connect the battery pack (HW9470932-A or HW9470932-B) to the battery backup connector (crimped contact-pin).
3. After the maintenance check, confirm all the connectors are connected properly, then remove the battery pack.

**NOTE** Do not remove the battery pack in the connector base.

![Diagram of backup battery pack connection for motor](image)

**Fig. 32 Backup Battery Pack Connection for Motor**
9.2 Notes on Maintenance Procedures

**Fig. 33** Battery Pack Connection

**CAUTION**
Connect battery to encoder to save the data BEFORE removing connector.

**Fig. 34** Caution Label
10 Recommended Spare Parts

It is recommended to keep the parts and components in the following table in stock as spare parts for the MOTOMAN-EP4000N.
Product performance cannot be guaranteed in case of using the spare parts other than the recommended parts listed below.

The spare parts are ranked as follows:
- Rank A: Expendable and frequently replaced parts
- Rank B: Parts for which replacement may be necessary as a result of frequent operation
- Rank C: Drive Unit

To replace parts in Rank B or Rank C, contact your Yaskawa representative.

Table 9  Spare Parts for the Motoman-EP4000N

<table>
<thead>
<tr>
<th>Rank</th>
<th>Parts No.</th>
<th>Name</th>
<th>Type</th>
<th>Manufacturer</th>
<th>Qty per Unit</th>
<th>Remarks</th>
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<tbody>
<tr>
<td>A 1</td>
<td>Battery Pack</td>
<td>HW9470932-A</td>
<td>Yaskawa Electric Corporation</td>
<td>1</td>
<td>1</td>
<td>For JT1, JT2, JT3-axes</td>
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<tr>
<td>A 2</td>
<td>Battery Pack</td>
<td>HW9470932-B</td>
<td>Yaskawa Electric Corporation</td>
<td>1</td>
<td>1</td>
<td>For JT4, JT5, JT6-axes</td>
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<td>A 3</td>
<td>Grease</td>
<td>Molywhite RE No. 00</td>
<td>Yaskawa Electric Corporation</td>
<td>16kg</td>
<td>-</td>
<td>For all axes' speed reducers and wrist unit</td>
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<tr>
<td>A 4</td>
<td>Grease</td>
<td>Alvania EP Grease 2</td>
<td>Showa Shell Sekiyu K.K.</td>
<td>16kg</td>
<td>-</td>
<td>For tapered roller bearings</td>
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<tr>
<td>B 5</td>
<td>JT1-Axis Speed Reducer</td>
<td>HW0280730-A</td>
<td>Yaskawa Electric Corporation</td>
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<td>B 6</td>
<td>JT2-, JT3-Axis Speed Reducers</td>
<td>HW0280731-A</td>
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<td>Manufacturer</td>
<td>Qty</td>
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<td>B</td>
<td>10</td>
<td>Wrist Unit</td>
<td>HW0170875-A</td>
<td>Yaskawa Electric Corporation</td>
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<td>C</td>
<td>11</td>
<td>AC Servomotor for JT1-Axis</td>
<td>HW0381330-A (SGMGH-1AA2A-YR3*)</td>
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<td>1</td>
<td>3</td>
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<td>C</td>
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<td>AC Servomotor for L- and U-Axes</td>
<td>HW0381527-A (SGMGH-75A2A-YR9*)</td>
<td>Yaskawa Electric Corporation</td>
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<td>AC Servomotor for JT4- and JT6-Axes</td>
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<td>HW0381261-A (SGMGH-44A2A-YR8*)</td>
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<td>Cooling Fan</td>
<td>HW0370631-E</td>
<td>Yaskawa Electric Corporation</td>
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