MOTOMAN-MPP3S INSTRUCTIONS

TYPE:
YR-MPP003S-A00 (STANDARD SPECIFICATIONS)

Upon receipt of the product and prior to initial operation, read these instructions thoroughly, and retain for future reference.

MOTOMAN INSTRUCTIONS

Please have the following information available when contacting Yaskawa Customer Support:

- System
- Primary Application
- Software Version (Located on Programming Pendant by selecting: [Main Menu] - [System Info] - [Version])
- Robot Serial Number (Located on robot data plate)
- Robot Sales Order Number (Located on controller data plate)

Part Number: 167670-1CD
Revision: 5
MANDATORY

• This instruction manual is intended to explain mainly on the mechanical part of the MOTOMAN-MPP3S for the application to the actual operation and for proper maintenance and inspection. It describes on safety and handling, details on specifications, necessary items on maintenance and inspection, to explain operating instructions and maintenance procedures. Be sure to read and understand this instruction manual thoroughly before installing and operating the manipulator.

• General items related to safety are listed in Chapter 1: Safety of the FS100 Instructions. To ensure correct and safe operation, carefully read the FS100 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 MOTOMAN-MPP3S.

In this manual, the Notes for Safe Operation are classified as "DANGER", "WARNING", "CAUTION", "MANDATORY", or "PROHIBITED".

DANGER
Indicates an imminent hazardous situation which, if not avoided, could result in death or serious injury to personnel.

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 "DANGER", "WARNING" and "CAUTION".

DANGER

- 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 these safety precautions may result in death or serious injury from unexpected turning of the manipulator's arm.
WARNING

• Before operating the manipulator, check that servo power is turned OFF when the emergency stop button on the programming pendant is 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.

  *Fig. : Emergency Stop Button*

• In the case of not using the programming pendant, be sure to supply the emergency stop button on the equipment. Then before operating the manipulator, check to be sure that the servo power is turned OFF by pressing the emergency stop button.
  Connect the external emergency stop button to the 5-6 pin and 16-17 pin of the robot system signal connector (CN2).

• Upon shipment of the FS100, this signal is connected by a jumper cable in the dummy connector. To use the signal, make sure to supply a new connector, and then input it.

  If the signal is input with the jumper cable connected, it does not function, which may result in personal injury or equipment damage.

• 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.

  *Fig. : Release of Emergency Stop*

• Observe the following precautions when performing teaching operations within the P-point maximum envelope of the manipulator:
  – Be sure to use a lockout device to the safeguarding when going inside. Also, display the sign that the operation is being performed inside the safeguarding and make sure no one closes the safeguarding.
  – View the manipulator from the front whenever possible.
  – Always follow the predetermined operating procedure.
  – Keep in mind the emergency response measures against the manipulator’s unexpected motion toward you.
  – Ensure that you have a safe place to retreat in case of emergency.

  Improper or unintended manipulator operation may result in injury.
WARNING

- Confirm that no person is present in the P-point maximum envelope of the manipulator and that you are in a safe location before:
  - Turning ON the power for the FS100.
  - Moving the manipulator with the programming pendant.
  - Running the system in the check mode.
  - Performing automatic operations.

Injury may result if anyone enters the P-point maximum envelope of the manipulator during operation. Always press an emergency stop button immediately if there is a problem.

The emergency stop button is located on the right of 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 cabinet of the FS100 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 Warning Labels in the FS100 Instructions before operating the manipulator:
Definition of Terms Used Often in This Manual

The MOTOMAN is the YASKAWA industrial robot product.

The MOTOMAN usually consists of the manipulator, the FS100 controller, manipulator cables, the FS100 programming pendant (optional), and the FS100 programming pendant dummy connector (optional).

In this manual, the equipment is designated as follows:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Manual Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>FS100 controller</td>
<td>FS100</td>
</tr>
<tr>
<td>FS100 programming pendant</td>
<td>Programming pendant</td>
</tr>
<tr>
<td>Cable between the manipulator and the controller</td>
<td>Manipulator cable</td>
</tr>
<tr>
<td>Robot</td>
<td>Manipulator</td>
</tr>
<tr>
<td>FS100 programming pendant dummy connector</td>
<td>Programming pendant dummy connector</td>
</tr>
</tbody>
</table>

Registered Trademark

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

Fig. : Warning Label Locations

WARNING
Do not enter robot work area.

WARNING
Moving parts may cause injury

WARNING
Do not enter robot work area.
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1 Product Confirmation

1.1 Contents Confirmation

Confirm the contents of the delivery when the product arrives.

Standard delivery includes the following three items and accessories (information for the content of optional goods are given separately):

- Manipulator
- FS100
- Manipulator cables (between the FS100 and the Manipulator)
- Accessories
  - HW1404899-1 (Home positioning jig) • • • 1 piece
    (Refer to chapter 10.2.2 "Home Position Calibrating").
  - HW1403777-A (Jig) • • • 1 piece
    (Refer to chapter 10.2.7 "Roller Replacement").
  - HW1483486-A (Bushes) • • • 4 pieces
    (Refer to table 10-1 "Inspection Items").
  - HW1402785-5 (Rollers) • • • 4 pieces
    (Refer to table 10-1 "Inspection Items").
  - HW1404709-A (Spring Units) • • • 4 pieces
    (Refer to table 10-1 "Inspection Items").
  - Hexagon socket head cap screws M16 (length: 70 mm) (stainless) • • • 6 pieces
  - Washer M16 (stainless) • • • 6 pieces
  - Spring washer M16 (stainless) • • • 6 pieces
  - Grease zerk A-MT6 x 1 • • • 1 piece

CAUTION

- Confirm that the manipulator and the FS100 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

The programming pendant and the programming pendant dummy connector are optional.
1.2 Order Number Confirmation

Check that the order number of the manipulator corresponds to the FS100. The order number is located on a label as shown below.

**THE MANIPULATOR AND THE CONTROLLER SHOULD HAVE SAME ORDER NUMBER.**

ORDER No.

---

Fig. 1-1: Location of Order Number Labels

FS100 (Upper View)
2 Transport

2.1 Transport Method

2.1.1 Using a Crane

As a rule, the manipulator should be lifted by a crane when removing it from the package and moving it. Be sure that the manipulator is lifted with three wire ropes as shown in Fig. 2-1 "Hanging Position".

**CAUTION**

- Sling applications and crane or forklift operations must be performed by authorized personnel only.
- Failure to observe this caution may result in injury or damage.
- Avoid excessive vibration or shock during transport.
- The system consists of precision components. Failure to observe this caution may adversely affect performance.

**NOTE**

- The weight of the manipulator is approximately 95kg. Use a wire rope strong enough to withstand the weight.
- Be sure that the eyebolts are removed after unpacking and installation. The eyebolts must be stored for the future use, in the event that the manipulator must be moved again.
2 Transport
2.1 Transport Method

Fig. 2-1: Hanging Position

<table>
<thead>
<tr>
<th>Axis</th>
<th>S-axis</th>
<th>L-axis</th>
<th>U-axis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angle</td>
<td>-42</td>
<td>-42</td>
<td>-42</td>
</tr>
<tr>
<td>Pulse</td>
<td>23000</td>
<td>23000</td>
<td>23000</td>
</tr>
</tbody>
</table>
2.1.2 Shipping Bolts and Brackets

The manipulator is protected from external forces during transportation with the fixture. (fig. 2-2 “Transporting Position”)

- The shipping bolts and brackets are painted yellow.

**NOTE**

Remove the shipping bolts and brackets when unpacking and installing the manipulator. The shipping bolts and brackets then must be stored for future use, in the event that the manipulator must be moved again.

<table>
<thead>
<tr>
<th>Parts for attachment</th>
<th>Pcs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shipping bolts and brackets</td>
<td>6</td>
</tr>
</tbody>
</table>
| • Hexagon socket head cap screw M16 (length: 40mm)  
  (Tensile strength: 1200N/mm²) |      |
| • Conical spring washer 2H-16            |      |
| • Washer M16                              |      |

**Fig. 2-2: Transporting Position**

- Hexagon socket head cap screw
- Conical spring washer 2H-16
- Washer M16
  (Tensile strength: 1200 N/mm²)

Cover the jig with buffer material: 3 places
(two sides and top) to avoid the jig from contacting with the manipulator.

Shipping bolts and brackets
2.1.3 Using a Forklift

When using a forklift, the manipulator should be fixed on a pallet with shipping bolts and brackets as shown in fig. 2-3 “Using a Forklift”. Insert claws under the pallet and lift it. The pallet must be strong enough to support the manipulator. Transporting of the manipulator must be performed slowly in order to avoid overturning or slippage.

Fig. 2-3: Using a Forklift

Avoid putting external force on the arm unit when transporting by a crane, forklift, or other equipment.
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 tool or the workpiece held by its fully extended arm will not reach the wall, safeguarding, or controller. 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.
- When mounting the manipulator on the ceiling or wall, the base section must have sufficient strength and rigidity to support the weight of the manipulator. Failure to observe these warnings may result in injury or damage.

CAUTION

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

To ensure safety, be sure to install safeguarding. It prevents unforeseen accidents with personnel and damage to equipment. Refer to the quoted clause for your information and guidance:

To ensure safety, use a safety fence that consists of acrylic plates with no gaps or netting with a mesh that is 5mm × 5mm or less.

Responsibility for Safeguarding (ISO10218)

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 baseplate or foundation strong enough to support the manipulator and withstand thrust during acceleration and deceleration. Construct a solid foundation with the appropriate thickness to withstand maximum repulsion forces of the manipulator referring to table 3-1 “Maximum Thrust of the Manipulator at Emergency Stop” and table 3-2 “Maximum Thrust During Acceleration/Deceleration”.

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

Mount the manipulator base as instructed in chapter 3.2.2 “Mounting Example”.
3.2 Mounting Procedures for Manipulator Base

3.2.1 Base

A base must be designed and built to withstand the maximum thrusts shown in table 3-1 “Maximum Thrust of the Manipulator at Emergency Stop” and table 3-2 “Maximum Thrust During Acceleration/Deceleration.” The vibration acceleration rate of the manipulator base must be less than 4.9 m/s² (0.5G) when the manipulator alone is in motion.

Table 3-1: Maximum Thrust of the Manipulator at Emergency Stop

| Maximum thrust during horizontal operation | 1470N (150kgf) |

Table 3-2: Maximum Thrust During Acceleration/Deceleration

| Maximum thrust on horizontal operation during acceleration/deceleration | 784N (80kgf) |
3.2 Mounting Procedures for Manipulator Base

3.2.2 Mounting Example

The customer should prepare a base for mounting the manipulator. To ensure sufficient strength, we recommend a baseplate of 30mm or more in thickness, 0.5mm or less in flatness and the use of M16 fixing bolts. Make an opening in the base plate as shown in fig. 3-2 “Base Plate Machining Diagram”.

To extend the manipulator’s capability to the uppermost, install the S-axis (or L or U-axis) parallel to the conveyor’s direction of movement. The T-axis cable may interfere with peripheral devices.

Install the manipulator as shown in fig. 3-1 “Mounting the Manipulator on Baseplate” considering the interference area of the cable.

Fix the manipulator base to the baseplate. The manipulator base has six mounting holes (M16 tap, 32mm in depth). Securely fix the manipulator base to the baseplate with six M16 hexagon socket head cap screws (engagement allowance for the thread part: 28 to 32mm).

Tighten the hexagon socket head cap screws firmly so that they will not work loose during the operation.

NOTE
• Do not remove the eyebolts attached to the manipulator.
• Use the cover fixing bolt for the eyebolts.
• Fixing the Air line refers to chapter 7.1 “Fixing Procedure (Air Line etc.)”.

Refer to fig. 3-1 “Mounting the Manipulator on Baseplate”.

•
3 Installation

3.2 Mounting Procedures for Manipulator Base

Fig. 3-1: Mounting the Manipulator on Baseplate

- Cable Interference Range: 846 mm
- When installing peripheral devices, be sure not to interfere with protruded part of the cable.

- Positioning pin (12 places)
- Lower conveyor (1) installation direction
- Lower conveyor (2) installation direction
- 3-place Nickel-plated Spring washer 6-16 (SUS)
- Hexagon socket head bolt M16 (SUS) (6 screws)
- Spring washer 4H-16 (SUS)
- Washer M16 (SUS)
- Engagement allowance for the thread part: 28-32 mm
- Baseplate
- Manipulator base
- L-axis
- U-axis
- S-axis
- Lower conveyor 2
- Upper conveyor 1
3 Installation
3.2 Mounting Procedures for Manipulator Base

NOTE
The position of the 19 dia. drilled hole for fixing the manipulator is asymmetric to the center-line of the hole in the base-plate.

Fig. 3-2: Base Plate Machining Diagram

Base plate machining dimensions
3.3 Types of Mounting

MOTOMAN-MPP3S is a ceiling-mounted model. Pay careful attention to the following notes when installing the unit.

• Fixing the Manipulator Base

3.3.1 Fixing the Manipulator Base

Be sure to use stainless hexagon socket head cap screws M16 (JIS1054 tensile strength: A2-70 or more) when fixing the manipulator base. Use a torque of 176N•m (6T) when tightening the screws.

NOTE

If changes are made to the installation location on site, be sure to contact one of the indicated service providers (on the back sheet).

3.4 Location

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

• Ambient temperature: 0° to + 40°C
• Humidity: 20 to 80%RH (non-condensing)
• Free from dust or soot
• Free from corrosive gas or liquid, or explosive gas
• Free from excessive vibration
  (Vibration acceleration: 4.9 m/s² [0.5 G] or less)
• Free from large electrical noise (plasma)
• Flatness for installation: 0.5mm or less

NOTE

Sufficiently warm up the machine before use at low temperature (ambient temperature: 10°C or lower).
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 the primary power supply off, and put up a warning sign. (ex. DO NOT TURN THE POWER ON.)
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.
4.1 Grounding

Follow electrical installation standards and wiring regulations for grounding. A ground wire of 5.5mm² or more is recommended. Refer to fig. 4-1 “Grounding Method” to connect the ground line directly to the manipulator.

- Never use this wire 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 electrical installation standards.

Fig. 4-1: Grounding Method
4.2 Cable Connection

Two manipulator cables are delivered with the manipulator: an encoder cable (1BC) and a power cable (2BC). (Refer to fig. 4-2 “Manipulator Cables”.)

Connect these cables to the manipulator base connectors and to the FS100. Refer to fig. 4-3(a) “Manipulator Cable Connectors (Manipulator Side)” and fig. 4-3(b) “Manipulator Cable Connection (FS100 Side)”.

4.2.1 Connection to the Manipulator

Before connecting two cables to the manipulator, verify the numbers on both manipulator cables and the connectors on the connector base of the manipulator. When connecting, adjust the cable connector positions to the main key positions of the manipulator, and insert cables in the order of 2BC, then 1BC. When making connections, insert the connector until you hear a click.

4.2.2 Connection to the FS100

Before connecting cables to the FS100, verify the numbers on both manipulator cables and the connectors on the FS100. When connecting, insert the cables in the order of X21, then X11. When making connections, insert the connector until you hear a click.

Fig. 4-2: Manipulator Cables

![Diagram of Manipulator Cables]

FS100
Connector number

Connector base connector numbers for manipulator

1BC Encoder cable

2BC Power cable
4 Wiring

4.2 Cable Connection

Fig. 4-3(a): Manipulator Cable Connectors (Manipulator Side)

Fig. 4-3(b): Manipulator Cable Connection (FS100 Side)
5 Basic Specifications

5.1 Basic Specifications

Table 5-1: Basic Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>MOTOMAN-MPP3S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structure</td>
<td>Parallel link</td>
</tr>
<tr>
<td>Degree of Freedom</td>
<td>4</td>
</tr>
<tr>
<td>Payload</td>
<td>3kg</td>
</tr>
<tr>
<td>Range of Motion</td>
<td>800mm diameter, 200mm height</td>
</tr>
<tr>
<td>Cycle Time</td>
<td>(25 - 305 - 25)</td>
</tr>
<tr>
<td>1kg</td>
<td>Continuous operation limits in all directions, 250rpm (^1)</td>
</tr>
<tr>
<td></td>
<td>Continuous operation possible in all directions, 185rpm (^2)</td>
</tr>
<tr>
<td>3kg</td>
<td>Continuous operation possible in all directions, 150rpm (^3)</td>
</tr>
<tr>
<td>Repeatability</td>
<td>±0.1mm</td>
</tr>
<tr>
<td>Angle Repeatability Error (T-axis Rotation) (^4)</td>
<td>±0.1 arc-min or less</td>
</tr>
<tr>
<td>Maximum Speed</td>
<td>24.43 rad/s, 1400°/s</td>
</tr>
<tr>
<td>Range of Motion</td>
<td>-360° to +360°</td>
</tr>
<tr>
<td>Allowable Moment (^5)</td>
<td>2.94N•m (0.3kgf•m)</td>
</tr>
<tr>
<td>Allowable Inertia (GD²/4) (^5)</td>
<td>1kg:0.0013kg•m²</td>
</tr>
<tr>
<td></td>
<td>2kg:0.009kg•m²</td>
</tr>
<tr>
<td></td>
<td>3kg:0.017kg•m²</td>
</tr>
<tr>
<td>Approx. Mass</td>
<td>95kg</td>
</tr>
<tr>
<td>Ambient Conditions</td>
<td>IP Grade: IP 67</td>
</tr>
<tr>
<td></td>
<td>Cleanliness Class: ISO class 5 (class 100) equivalency</td>
</tr>
<tr>
<td></td>
<td>Temperature: 0 to 40°C</td>
</tr>
<tr>
<td></td>
<td>Humidity: 20 to 80% RH (non-condensing)</td>
</tr>
<tr>
<td></td>
<td>Vibration: 4.9 m/s² (0.5 G) or less</td>
</tr>
<tr>
<td></td>
<td>Others: Free from corrosive gas, explosive gas, or fluid</td>
</tr>
<tr>
<td></td>
<td>Free from exposure to water, dust, soot, or oil</td>
</tr>
<tr>
<td></td>
<td>Free from excessive electrical noise (plasma)</td>
</tr>
<tr>
<td>Power Requirements</td>
<td>1.5kVA</td>
</tr>
<tr>
<td>Noise (^6)</td>
<td>79 dB</td>
</tr>
</tbody>
</table>

1 SI units are used in this table. However, gravitational unit is used in ( ).
2 No timer condition during suction/release. Long continuous operation may trigger an overload alarm and the machine will stop.
3 Timer at 0.02 s during suction/release
4 Conformed to ISO9283
5 Refer to chapter 6.1 “Allowable T-axis Load” for details on the permissible moment of inertia.
6 Conformed to ISO6926
7 Measurement is carried out when the maximum load is mounted to the manipulator and operated in the maximum speed.
8 Measurement is carried out:
   - between 1.2m and 1.5m above the ground.
   - 400mm away from the P-point maximum envelope.
5.2 Cleanliness Class

This manipulator is conformed to class 5 of ISO14644-1 international standard.

5.3 Part Names and Working Axes

*Fig. 5-1: Part Names and Working Axes*
5.4 Manipulator Base Dimensions

Fig. 5-2: Manipulator Base Dimensions

- Tapped hole M16 (depth: 32 mm) (6 places)
- 12 dia. H7 (depth: 10 mm) (2 places)

5.5 Dimensions and P-Point Maximum Envelope

Fig. 5-3: Dimensions and P-Point Maximum Envelope

- View A
- P-point maximum envelope
5.6 Continuous Operation Conditions

5.6.1 Allowable Values of Motor Duty Cycle

Depending on patterns (timer conditions etc.) of operation, each axis motor duty cycle may become high. The motor duty cycle of one cycle is measured in advance. And when exceeding the value of table 5-2 "Allowable values of motor duty cycle", a speed, timer and other measurements etc. adjust.

Measure and check the motor duty cycle on the programming pendant screen, according to chapter 5.6.2 "Operation for Measuring the Motor Duty Cycle". It is also possible to carry out a prior study of the motor duty cycle by means of a simulation. If necessary, please consult your YASKAWA representative in advance.

**NOTE**

- Before measuring the motor duty cycle in an actual robot, carry out a run-in operation and ensure that the temperature of the motor is sufficiently high.
- If the motor duty cycle exceeds the tolerance limit, consult your YASKAWA representative.

### Table 5-2: Allowable values of motor duty cycle

<table>
<thead>
<tr>
<th>Axis</th>
<th>Motor duty cycle (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-axis</td>
<td>110</td>
</tr>
<tr>
<td>L-axis</td>
<td>110</td>
</tr>
<tr>
<td>U-axis</td>
<td>110</td>
</tr>
<tr>
<td>T-axis</td>
<td>100</td>
</tr>
</tbody>
</table>

This robot is designed for picking and placing operations including the Adept pattern and not for creating jobs with a link motion using the MOVJ instruction.

If you want to create such jobs, use interpolation, such as MOVL.

**NOTE**

The maximum play speed for MOVL interpolation is V=4000mm/s.

**Fig. 5-4: Adept Pattern**

![Adept Pattern Diagram](image-url)
5.6 Continuous Operation Conditions

5.6.2 Operation for Measuring the Motor Duty Cycle

1. Select the job for measuring the motor duty cycle, register [MEASON DUTY] from the [Command list] before the measurement start point, and then register [MEASOF DUTY] after the measurement end point.

2. Execute the job.

3. Select [ROBOT] → [SERVO MONITOR] → [DISPLAY] → (MOTOR DUTY CYCLE) under the Main Menu.

4. The motor duty cycle for each axis of the executed job is displayed.

If the motor duty cycle exceeds the allowable value, perform adjustments, such as inserting a speed, timer and other measurements to reduce the motor duty cycle to below the allowable value.
5.6 Continuous Operation Conditions

5.6.3 Signal Output for Motor Protection

In order to protect the motor of each axis of the manipulator from overheating, if the temperature becomes high the warning message [MOTOR OVERHEAT] will appear on the programming pendant.

If operation is continued while this warning message remains displayed, FS100 and robot components will become damaged and service life will be greatly reduced, possibly leading to a major breakdown.

During high speed continuous operation, the temperature may rise abruptly depending upon the ambient temperature and the operation pattern, so it is necessary to promptly detect a warning.

A warning message is output as a dedicated output signal, so it is recommended that you monitor it on the system side as a warning signal for the sake of safety.

If this warning message is displayed, measure the motor duty cycle of each axe and check that the motor duty cycle is not exceeded.

If this warning message is displayed regardless of the motor duty cycle, it means that there is a motor malfunction or other problems. Accordingly, contact YASKAWA or a service company if these conditions are present.

Refer to “FS100 Concurrent I/O” for details on the signal output.

<table>
<thead>
<tr>
<th>Table 5-3: Dedicated output signal (common)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50726</td>
</tr>
<tr>
<td>SOUT#0576</td>
</tr>
<tr>
<td>Motor temperature rising</td>
</tr>
</tbody>
</table>
5.7 Dislocation Detection Function

5.7.1 Dislocation

The robot minimizes damage to peripheral devices and the robot itself by disconnecting the adjustable joint if excessive force is applied to the seal due to interference of tools or manipulator peripheral devices.

*Fig. 5-5: Dislocation*

Dislocation occurs

Dislocation detection

Refer to chapter 5.7.2 "Dislocation Detection Function"

Immediately stops
5.7.2 Dislocation Detection Function

The dislocation detection function reduces damage to peripheral devices by applying an emergency stop to the manipulator when the L-arm is dislocated due to interference of tools or manipulator peripheral devices. When the dislocation detection function detects that the L-arm is dislocated, an alarm is output and an emergency stop is applied. At this time, the dislocation detection alarm is displayed.

NOTE Specify the tool weight information in the tool file in order to provide more accurate dislocation detection.

NOTE This function does not operate when in teach mode. Dislocation cannot be detected if there is L-arm dislocation during low-speed operation when in play mode.

NOTE If dislocation occurs, refer to chapter 10.2.3 “L-Arm Removal and Installation and Relay Lead Fixing Procedures” and restore the L-arm and the relay lead.

Select "Reset" on the alarm screen to reset the alarm and cancel the dislocation detection status.
This fall off also may occur when the manipulator is operated in the excessive speed or acceleration.

In case the manipulator is about to fall off its arms due to the excessive speed or acceleration, the fall off can be avoided by alarming the following alarm.

Alarm 4732: OVER ACCELERATION

Check the following items when Alarm 4732: OVER ACCELERATION occurred.

1. Check that the mass and load mass position information of the tool file are appropriately set.

   The system is monitoring the acceleration according to the mass and load mass position information of the tool file.
   
   If this information is not appropriately set, the system regards that the maximum load is set and starts monitoring.
   
   As the tool mass is increased, the allowable accelerating speed decreases, and the alarm 4732: OVER ACCELERATION can easily occur.
   
   Also, in case lighter mass than the actual mass is set to the tool file, the arm may fall off because the alarm does not occur even if the manipulator is operated at faster acceleration than the allowable value.

2. If a position level (PL=*) is set to the previous step to the step where the alarm 4732: OVER ACCELERATION occurred, cancel the setting.

   When the PL specification is added, fast acceleration may occur due to the sudden change of the motion direction.
   
   (Please be careful to the motion path because it will change when the PL specification is canceled.)
5 Basic Specifications
5.8 Over Acceleration Alarm

iii) In case an alarm 4732: OVER ACCELERATION occurred at a sharp angle formed by the steps, change the teaching positions to broaden the angle.

When the angle formed by the steps is sharp, the alarm 4732: OVER ACCELERATION is easy to occur.

Please note that the manipulator has its recommended operation range. (Refer to chapter 5.5 "Dimensions and P-Point Maximum Envelope".)

It starts oscillating in case the manipulator is operated out of this range at high speed, as a result, arms may dislocate.

In this consequence, if the manipulator should operate out of the recommended operation range and at the same the alarm 4732: OVER ACCELERATION should occur, set the playing speed to V<2000 mm/s or less in advance to avoid arm dislocation.
5.9 Stopping Angle and Time at the Emergency Stop (S-Axis)

Following data on stopping angle and time at the emergency stop are measured under the standard of ISO10218.

(Stopping angle and time at the emergency stop for U-axis and L-axis are also same as the following data)

5.9.1 Stop Category 0: Emergency Stop

5.9.1.1 Position 100%

Fig. 5-6: Category 0, Position 100% : Stopping Angle and Time at the Emergency Stop

5.9.1.2 Position 66%

Fig. 5-7: Category 0, Position 66% : Stopping Angle and Time at the Emergency Stop
5.9 Stopping Angle and Time at the Emergency Stop (S-Axis)

5.9.1.3 Position 33%

Fig. 5-8: Category 0, Position 33% : Stopping Angle and Time at the Emergency Stop

5.9.2 Stop Category 1: Emergency Stop

The stopping angle and time at the emergency stop in category 1 are not subjected to the load of the manipulator.

Fig. 5-9: Category 1: Stopping Angle and Time the Emergency Stop
6 Allowable Load for T-axis

6.1 Allowable T-axis Load

The allowable T-axis load is 3kg maximum. If force is applied to the wrist instead of the load, force on T-axis should be within the value shown in table 6-1 “Allowable T-axis Load”. Contact your YASKAWA representative for further information or assistance.

Table 6-1: Allowable T-axis Load

<table>
<thead>
<tr>
<th>Axis</th>
<th>Moment N-m (kgf-m)¹</th>
<th>GD²/4 Total Moment of Inertia kg-m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-Axis</td>
<td>2.94(0.3)</td>
<td>1kg:0.0013</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2kg:0.009</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3kg:0.017</td>
</tr>
</tbody>
</table>

¹ (): Gravitational unit

When the volume load is small, refer to the moment arm rating shown in fig. 6-1 “Moment Arm Rating”.

The allowable total moment of inertia is calculated when the moment is at the maximum. Contact your YASKAWA representative when only moment of inertia, or load moment is small and moment of inertia is large. Also, when the load mass is combined with an outside force, contact your YASKAWA representative.
6 Allowable Load for T-axis
6.1 Allowable T-axis Load

Fig. 6-1: Moment Arm Rating

CAUTION

• Be sure to set the mass of the tool.
For more information about setting the mass of the tool, see "8.4 ARM Control" in the FS100 Instructions.
6.2 T-axis Flange

The T-axis flange dimensions are shown in fig. 6-2 “T-axis Flange”. The fitting depth of outside and inside fittings should be 5mm or less.

Fig. 6-2: T-axis Flange

- When mounting an attachment, the bolt thread-mating length should be 9mm or less. Otherwise, the performance of the robot could be affected.

6.3 Acceleration and Deceleration Applied to T-axis Unit

10 G acceleration and deceleration is applied to the T-axis unit when operating at the maximum speed. Select an adsorption pad that can withstand 10 G acceleration and deceleration, and attach it to the tip of the T-axis unit.
Fixing Procedure (Air Line etc.)

Fix the piping bracket with the M16 tapped hole for upper eyebolt (either one of three places).

- Do not remove the eyebolts that are not used for piping.
- Use the cover fixing bolt for the eyebolts.

Locate the air line on the arms of axes other than the S-axis.
The relay lead is fixed on the S-axis.

Put the air line piping through the 80 dia. hole and fix it from the middle to the bottom of the L-arm as shown below. Please make sure not to put it inside of each L-arm.

A recommended procedure is shown in fig. 7-1 "Fixing Procedure (Air Line etc.)".
7 System Application

7.1 Fixing Procedure (Air Line etc.)

Fig. 7-1: Fixing Procedure (Air Line etc.)

- Eyebolt (3 places)
- S-axis
- U-axis
- L-axis
- Inside L-arm
- View A
- Cover

- Allow some space between the air lines and the T-axis to prevent the air line affecting the T-axis operation.
- Cable tie (Recommended type: MCTS200-BLU)
  (HellermannTyton)
8 Cleaning Specification

8.1 Chemical Cleaning

This manipulator can be cleaned by the shower-cleaning and wipe-cleaning methods.

- Only weak acid solution (ph 3 to ph16) and weak alkaline solution (ph 8 to ph11) are available for the manipulator cleaning.
- Completely wipe off the cleaning liquid after cleaning.
- Use soft cloth when wiping off the cleaning liquid.
- Dry the manipulator completely after cleaning.

Please be careful to the following points when cleaning the manipulator to avoid manipulator functions from being damaged by the cleaning.

- Avoid perform cleaning other than above mentioned methods.
- Do not perform cleaning while the power is turned ON.
- Do not perform cleaning while external force is applied to the center of axis rotation.
9 Electrical Equipment Specification

9.1 Internal Connections

Diagrams for internal connections of the manipulator are shown in fig. 9-1 "Internal Connection Diagram".
9 Electrical Equipment Specification
9.1 Internal Connections

Fig. 9-1: Internal Connection Diagram
10 Maintenance and Inspection

10.1 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 several levels as shown in table 10-1 “Inspection Items”. In table 10-1 “Inspection Items”, the inspection items are categorized by three types of operations: operations which can be performed by personnel authorized by the user, operations to be performed by trained personnel, and operations to be performed by service company personnel. Only specified personnel shall perform the inspection work.

- The inspection interval depends on the total servo operation time.
- The following inspection schedule is based on the case where the manipulator is used for picking. If the manipulator is used for other application or if it is used under special conditions, a case-by-case examination is required. The inspection may be conducted at shorter intervals if the manipulator is used very frequently for the application such as picking in this case, contact your YASKAWA representative.

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.
- The battery pack must be connected before removing detection connector when maintenance and inspection.
- Failure to observe this caution may result in the loss of home position data.

NOTE

- The inspection interval depends on the total servo operation time.
- The following inspection schedule is based on the case where the manipulator is used for picking. If the manipulator is used for other application or if it is used under special conditions, a case-by-case examination is required. The inspection may be conducted at shorter intervals if the manipulator is used very frequently for the application such as picking in this case, contact your YASKAWA representative.
Table 10-1: Inspection Items (Sheet 1 of 2)

<table>
<thead>
<tr>
<th>Items</th>
<th>Schedule Method</th>
<th>Operation</th>
<th>Inspection Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Home position</td>
<td>Daily</td>
<td>Home positioning jig</td>
<td>Check that there is no home position deviation.</td>
</tr>
<tr>
<td>2 Working area and manipulator</td>
<td>500 H Cycle, 1000 H Cycle, 2000 H Cycle</td>
<td>Wipe</td>
<td>Clean dirt, dust, grease and other foreign material from the surface of the robot.</td>
</tr>
<tr>
<td>3 Bush</td>
<td>Visual</td>
<td>Flat tip screwdriver</td>
<td>Check for presence of irregularities.</td>
</tr>
<tr>
<td>4 Spring unit</td>
<td>Visual</td>
<td>Flat tip screwdriver</td>
<td>Replace.</td>
</tr>
<tr>
<td>5 Roller</td>
<td>Visual</td>
<td>Spanner, Wrench</td>
<td>Check for presence of irregularities.</td>
</tr>
<tr>
<td>6 Baseplate mounting bolts</td>
<td>Visual</td>
<td>Spanner, Wrench</td>
<td>Replace according to damage conditions.</td>
</tr>
<tr>
<td>7 Cover mounting screws</td>
<td>Visual</td>
<td>Screwdriver, Wrench</td>
<td>Replace if necessary.</td>
</tr>
<tr>
<td>8 Connector base</td>
<td>Manual</td>
<td>Visual</td>
<td>Check for loose connectors.</td>
</tr>
<tr>
<td>9 Relay lead</td>
<td>Visual</td>
<td>Manual</td>
<td>Check that fixing position of lead wire has not deviated and that the lead wire is not worn.</td>
</tr>
<tr>
<td>10 Ball joint</td>
<td>Manual</td>
<td>Wipe</td>
<td>Wipe dust from the ball joint area.</td>
</tr>
</tbody>
</table>
10 Maintenance and Inspection

10.1 Inspection Schedule

12 S-, L-, and U-axes speed reducer
- Grease Gun Injector
Check for malfunction. Supply grease. 

13 T-axis speed reducer
- Grease Gun Injector
Check for malfunction. Supply grease.

14 Battery pack in manipulator
- Replace the battery when the battery alarm occurs or the manipulator drove for 18,000 H.

15 Overhaul 10)
- Check or replace the motor 10), speed reducer, belts, sliding parts, cables, arms and similar parts.

---

Table 10-1: Inspection Items (Sheet 2 of 2)

<table>
<thead>
<tr>
<th>Items</th>
<th>Schedule</th>
<th>Method</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 S-, L-, and U-axes speed reducer</td>
<td>Daily</td>
<td>Grease Gun Injector</td>
<td>Check for malfunction. Supply grease</td>
</tr>
<tr>
<td>13 T-axis speed reducer</td>
<td>1000 H Cycle</td>
<td>Grease Gun Injector</td>
<td>Check for malfunction. Supply grease</td>
</tr>
<tr>
<td>14 Battery pack in manipulator</td>
<td>20000 H Cycle</td>
<td></td>
<td>Replace the battery when the battery alarm occurs or the manipulator drove for 18,000 H</td>
</tr>
<tr>
<td>15 Overhaul 10)</td>
<td></td>
<td></td>
<td>Check or replace the motor, speed reducer, belts, sliding parts, cables, arms and similar parts</td>
</tr>
</tbody>
</table>

---

1. Inspection No. correspond to the numbers in fig. 10-1 “Inspection Items”.
2. Wipe with a mildly acidic or alkaline detergent.
3. Grease bushes whenever there is an arm dislocation, replacing the L-arm or bushes, or cleaning bushes. (chapter 10.2.6 “Bush Replacement”)
4. When dislocation occurs, check for any problem or damage in the springs and the relay lead. Replace them if any defect is found.
5. When checking for relay lead, connect the battery to “BAT” and “OBT” of connectors on the motor side for each axis, and then remove connectors on detector side for each axis from the motor. Otherwise, the home position might be lost.
6. Clean daily for hygienic reasons even if grease protrusion is not irregular.
7. Confirm all ball joints (12 places) and tighten the loose ones. (chapter 10.2.4 “Ball Joint Slack Confirmation”)
8. Belt looseness may trigger vibrations during operation, increase of operation noise and dislocation.
9. Grease used for each part corresponds to table 10-2 “Inspection Parts and Grease Used”.
10. Replace the motor at the time of overhauling. (Grease replacement for the internal bearing of the motor is impossible.)
10 Maintenance and Inspection

10.1 Inspection Schedule

**Fig. 10-1: Inspection Items**

**Table 10-2: Inspection Parts and Grease Used**

<table>
<thead>
<tr>
<th>No.</th>
<th>Grease Used</th>
<th>Inspected Parts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lubriplate Synxtrme FG-0</td>
<td>Speed reducers for S-, L-, U-and T-axes</td>
</tr>
<tr>
<td>2</td>
<td>Lubriplate Synxtrme FG-0</td>
<td>U-arm oil seal lip part</td>
</tr>
</tbody>
</table>
10.2 Notes on Maintenance Procedures

10.2.1 Battery Pack Replacement

The battery packs are installed in the position shown in fig. 10-2 “Battery Location”. If the battery alarm occurs in the FS100, replace the battery in accordance with the following procedure:

Fig. 10-2: Battery Location

- Hexagon socket head cap screw M6 (length: 16 mm) (2 screws)
- Washer M4 (2 washers)
- Tightening torque: 2.8 N • m (0.29 kgf • m)

Removal tap M6 (4 places)

- Hexagon socket head cap screw M6 (length: 16 mm) (stainless) (12 screws)
- Tightening torque: 8.3 N • m (0.85 kgf • m)
1. Turn OFF the FS100 main power supply.
2. Remove the cap and gasket, eyebolt, connector base and gasket, and then unscrew the hexagon socket head cap sems screw (12 screws) to open the cover.
3. Open the cover, and then remove the hexagon socket head cap screws (2) from the battery holder, and then pull the battery holder out.
4. Connect the new battery connector to the unoccupied connector on the board.
5. Remove the old battery connector from the board.
6. Remove the old battery from the battery holder, and then mount the new battery to the holder.
7. Mount the battery holder to its original position with the hexagon socket head cap screws (2).
8. Close the cover, and then, screw the hexagon socket head cap sems screw (12 screws, tightening torque: 5 N•m). Then, mount the eyebolt, the cap and gasket, the connector base and gasket (the hexagon socket head cap sems screw (6 screws, tightening torque: 2.4 N•m) to open the cover.

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

**NOTE**
Do not allow plate to pinch the cables when reinstalling the cover.
10 Maintenance and Inspection
10.2 Notes on Maintenance Procedures

10.2.2 Home Position Calibrating

Home position return methods when exchanging arms are shown below. Use the positioning key (included with the unit). (See table 10-3 "List of Required Parts").

Table 10-3: List of Required Parts

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Manufacturer</th>
<th>Qty</th>
<th>Configuration</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positioning key</td>
<td>HW1404899-1</td>
<td>YASKAWA Electric Corporation</td>
<td>1</td>
<td>9±0.1</td>
<td>Product accessories</td>
</tr>
</tbody>
</table>

10.2.2.1 S-, L-, and U-axes Positioning

- To return the manipulator to the home position, refer to fig. 10-3 "S-, L-, and U-axes Home Position Calibration" while performing the following procedure.

1. Place 9 ± 0.1 part of positioning key (HW1404899-1) to each axis positioning area on the base unit, and then perform a temporary home position registration with the area between the arm. (Repeat for each axis.)

2. Rotate the arm to "+23091 pulse" from the position registered in step (1), and then register the home position again. (Position where the rotational center and ball joint are horizontal)

Fig. 10-3: S-, L-, and U-axes Home Position Calibration
10.2.2 T-axis Positioning

As shown in Fig. 10-4 "T-axis Home Position Calibration", insert the positioning key (HW1404899-1) in the keyways in the base unit and turn the flange to the + side at a low (or inching) speed. Register the position where the positioning key is fixed with the keyways as a home position.

Fig. 10-4: T-axis Home Position Calibration

10.2.3 L-Arm Removal and Installation and Relay Lead Fixing Procedures

- Support the T-axis unit when removing the L-arm so that the T-axis unit (including the band) does not fall.
- When removing the L-arms (2 arms) of the S-axis, remove cable ties (4 places per arm) which are fixing the relay lead in the L-arms. However, the cable ties which are fixing the relay lead in the U-arm of the S-axis does not have to be removed.
When removing the L-arm, remove the L-arm from the T-axis unit side first, then remove it from the U-arm side.
10.2.3.1 L-arm Removal

1. Remove two L-arms at T-axis unit side.
2. Pull the right side L-arm to the direction as shown in the figure below to remove it from the ball joint.

**NOTE**
Please remove L-arm along the ball joint because the spring is strong.
Please do not extend L = 113mm or more to avoid the spring plastic deformation.
10.2 Notes on Maintenance Procedures

3. Remove the spring unit which is attached to the T-axis unit side L-arms (2 arms).

4. Cross right side and left side L-arms to remove them from the U-arm. Crossing them makes easier for the workers to remove the L-arm.
10.2.3.2 L-arm Installation

1. Attach the spring unit only to the U-arm side L-arm. Then, cross right side and left side L-arms to re-install the arms to the U-arm side ball joint. Crossing them makes easier for the workers to re-install the L-arm.

2. Re-install the L-arms to the T-axis unit.

   ![Diagram showing L-arm installation](image1)

   **NOTE**
   
   The T-axis unit should be mounted in the right direction. When mounting the T-axis unit, the outlet of the relay lead should face the S-axis side as shown in the figure below.

3. Re-install the spring unit to the T-axis unit side L-arm.

4. Re-install the left side L-arm to the T-axis unit ball joint. Then, pull the right side L-arm to the direction as shown in the figure below to re-install it to the ball joint.
5. Perform low-speed operation check and check that the L-arm is correctly re-installed to the ball joint before starting normal operation. The relay lead cabling is required in case the L-arm is removed from the S-axis. Please refer to chapter 10.2.3.3 “Relay Lead Fixing” for re-cabling the lead.

**NOTE**

Please attach the L-arm along the ball joint because the spring is strong. Please do not extend L = 113mm or more to avoid the spring plastic deformation.
10.2.3.3 Relay Lead Fixing

- Fix the relay lead to the U and L-arms of the S-axis. This is a standard to distinguish the axes.
- Use the designated cable ties for fixing the relay lead.
- Fix two relay leads to the right side L-arm.

NOTE

- Fix the relay lead to the U and L-arms of the S-axis. This is a standard to distinguish the axes.
- Use the designated cable ties for fixing the relay lead.
- Fix two relay leads to the right side L-arm.

1. Secure the relay lead at the dimensions/positions shown in the figure below.
   - Cable ties used: Metal Content Ties MCTS200-BLU (HellermannTyton)
   - Mark the fixing positions on the relay lead with blue.
   - There are a total of 6 fixing positions.
   - Measure the relay lead fixing positions from reference A shown in fig. 10-5 “Relay Lead Fixing Positions”.

- Secure the relay lead at the dimensions/positions shown in the figure below.
2. Perform low-speed operation check and check that the relay lead do not interfere and there is no excessive tension before starting normal operation.
10.2.4 Ball Joint Slack Confirmation

- Please tighten the ball joints with the specified tightening torque when loosen.
- Continuously use with the ball joints loose causes the damage of them and the arm fall off.

Confiming point (12 points)

Tightening torque: 10N-m

10.2.5 Bush Friction Confirmation

Please replace the bush when the distance between L-arms becomes less than the tolerance level.

Confiming point (8 points)

Please change the bush when the distance between L-arms becomes less than 99 mm.
10 Maintenance and Inspection
10.2 Notes on Maintenance Procedures

10.2.6 Bush Replacement

1. Remove the L-arm from the ball joint.

- Tool used: Flat tip screwdriver

   Be careful not to damage the aluminum part attached to the bush.

2. Insert a flat tip screwdriver to bottom of the bush and lift up to remove the bush.
   - Tool used: Flat tip screwdriver

3. Install new bushes.
   Push in the bush so that the load is evenly distributed on the bush surface, and the bush and aluminum part surfaces are flat.

4. Fix the lead wire and air hose to the L-arm in their original position.
   Perform low-speed operation check and check that the L-arms are properly installed to the ball joint, and that the cables do not interfere and there is no excessive tension before starting normal operation.

• For more information about L-arm removal, see chapter 10.2.3 “L-Arm Removal and Installation and Relay Lead Fixing Procedures”.
• Support the T-axis unit when removing the L-arm so that the T-axis unit (including the band) does not fall.
10.2.7 Roller Replacement

1. Remove the L-arm from the ball joint.

2. As shown in the figure below, hook the roller to the jig, then screw the M3 bolt (length: 25mm or more) into the tapped hole M3 which is tapped on the center of the jig.
   The roller is detached from the L-arm as the screwed M3 bolt presses the pin.
   In the same way, remove another roller at the opposite side.

- For more information about L-arm removal, see chapter 10.2.3 "L-Arm Removal and Installation and Relay Lead Fixing Procedures".
- Support the T-axis unit when removing the L-arm so that the T-axis unit (including the band) does not fall.
10 Maintenance and Inspection
10.2 Notes on Maintenance Procedures

3. Install the new roller.
   Please be careful to the direction of the roller.
   As shown in the figure below, chamfered side should come to the external side.

   ![NOTE]
   At this point, the roller is not completely attached. Execute the following procedures to firmly attach it.

4. Use a water pump pliers to mount the roller.

   ![NOTE]
   The prominence of the pin after the roller attachment is 1.0 mm.
5. Confirm that the roller is firmly attached. Lightly pull the pin and the roller to direction as shown in the following figure to measure the gap between them with the gap gauge. The gap should be 1.65mm or less. Then, try pulling two rollers to the external side so that they would not be pulled out.

6. Re-install the L-arm after the rollers are replaced.

7. Re-install the L-arm by referring to chapter 10.2.3 “L-Arm Removal and Installation and Relay Lead Fixing Procedures”.

8. Relay lead cabling is required in case the S-axis L-arm rollers are replaced. Please refer to chapter 10.2.3 “L-Arm Removal and Installation and Relay Lead Fixing Procedures” for re-cabling the lead.

9. Perform low-speed operation check and check that the rollers are not excessively wearing and that the cables do not interfere and there is no excessive tension before starting normal operation.
10.3 Notes on Grease Replenishment Procedures

Make sure to follow the instructions listed below at grease replenishment. Failure to observe the following notes may result in damage to motor and speed reducer.

- If grease is added without removing the plug from the grease exhaust port, the grease will leak inside a motor or an oil seal of a speed reducer will come off, which may result in damage to the motor. Make sure to remove the plug/screw.
- Do not install a joint, a hose, etc. to the grease exhaust port. Failure to observe this instruction may result in damage to the motor due to coming off of an oil seal.
- Use a hand grease gun or an injector to inject grease.
10.3 Notes on Grease Replenishment Procedures

10.3.1 Grease Replenishment for S-, L-, U- axes Speed Reducer

Fig. 10-6: S-, L-, and U-Axes Grease Inlet
10.3.1 Grease Replenishment

(Refer to fig. 10-6 "S-, L-, and U-Axes Grease Inlet").

Replenish the grease according to the following procedure:

1. Turn OFF the power supply to the FS100.
2. Remove the power cables.
3. Remove the cap and the gasket \( \circ \), eyebolt \( \triangle \), and the hexagon socket head cap sems screws \( \ominus \) and \( \triangleright \). And then, remove the cover and the gasket \( \circ \), the connector base unit and the gasket \( \circ \).
   (Rotate to down the connector base unit \( \circ \) into the connector base fitting hole on the cover \( \circ \), and then remove the cover \( \circ \).)
4. Remove the plug \( \circ \) and \( \circ \) from the exhaust port and from the grease inlet.
5. Install a hand grease gun or an injector to the grease inlet.
6. Inject grease through the grease inlet.
   - Grease type: Synxtreme FG-0
   - Amount of grease: 5 cc (10 cc for 1st supply)
7. Remove the grease gun or the injector from the grease inlet, and then reinstall the plug \( \circ \) and \( \circ \) to the exhaust port and to the grease inlet.
8. Pull up the connector base unit \( \circ \) from the connector base fitting hole on the cover \( \circ \).
9. Reinstall the cover and the gasket \( \circ \) with the hexagon socket head cap sems screws \( \circ \).
   Reinstall the connector base unit and the gasket \( \circ \) with the hexagon socket head cap sems screws \( \circ \).
   Tighten the screws with the tightening torque shown in table 10-4 "S-, L-, and U-axes Motor Parts Checklist".
10. Reinstall the cap and the gasket \( \circ \) and the eyebolt \( \triangle \).
10.3.2 Grease Replenishment for T- axis Speed Reducer

Fig. 10-7: T- axis Speed Reducer Diagram

10.3.2.1 Grease Replenishment

(Refer to fig. 10-7 “T- axis Speed Reducer Diagram”.)

Replenish the grease according to the following procedure:

1. Remove the cover, and then remove the M6 × 6 (one screw) bolts and LP-M5 (one screw) plugs from the grease inlet and from the grease exhaust port.

2. Install a grease zerk A-MT6 x 1 to the grease inlet. (The grease zerk is delivered with the manipulator.)

3. Inject the grease through the grease inlet using a grease gun.
   - Grease type: Synxtrme FG-0
   - Amount of grease: 1cc (2cc for 1st supply)

4. Remove the grease zerk from the grease inlet, and install an Hexagon socket head cap screw M6 × 6 (one screw) in the grease inlet.
   (Tightening torque: 8N•m (0.81kgf•m))
   Before installing the bolt, apply Three Bond 1206C on the thread part of the plug.

5. Before installing the plug in the grease exhaust port, operate the T-axis for 20 or 30 minutes to purge all grease from the exhaust port.

6. Wipe away any grease that was discharged, and then install the LP-M5 (one screw) plug in the grease exhaust port.
   Before installing the plugs, apply Three Bond 1206C on the thread part of each plug.

7. Install the cover.
11 Recommended Spare Parts

It is recommended to keep the parts and components in the following table in stock as spare parts for the MOTOMAN-MPP3S. Product performance cannot be guaranteed when using spare parts from any company other than YASKAWA. 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.

NOTE
For replacing parts in Rank B or Rank C, contact your YASKAWA representative.

Table 11-1: Spare Parts for the MPP3S-A00 (Sheet 1 of 2)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Parts No.</th>
<th>Name</th>
<th>Type</th>
<th>Manufacturer</th>
<th>Qty</th>
<th>Qty per Unit</th>
<th>Remarks</th>
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<td>YASKAWA Electric Corporation</td>
<td>1kg</td>
<td>-</td>
<td>For reducer on each axis oil seal</td>
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<td>Three Bond</td>
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<td>-</td>
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12 Parts List

12.1 Wiring and Piping Assy

Fig. 12-1: Wiring and Piping Assy
### Table 12-1: Wiring and Piping Assy

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12.2 Drive Unit

Fig. 12-2: Drive Unit
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# 12 Parts List

## 12.2 Drive Unit

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12.3 L-Arm and T-Axis Unit

Fig. 12-3: L-Arm and T-Axis Unit
### Table 12-3: L-Arm and T-Axis Unit

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