MOTOMAN-HC10DT
INSTRUCTIONS

TYPE:
YR-1-06VXHC10-A10

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

YASKAWA

24-hour Telephone Number: (937) 847-3200
Use for urgent or emergency needs for technical support, service and/or replacement parts

Routine Technical Inquiries: techsupport@motoman.com
Allow up to 36 hours for response

Part Number: 184672-1CD
Revision: 2

MANUAL NO. HW1485083 1/75
This instruction manual is intended to explain mainly on the mechanical part of the MOTOMAN-HC10DT 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. Any matter not described in this manual must be regarded as “prohibited” or “improper”.

General information related to safety are described in “Chapter 1. Safety” of the YRC1000/YRC1000micro INSTRUCTIONS. To ensure correct and safe operation, carefully read “Chapter 1. Safety” of the YRC1000/YRC1000micro INSTRUCTIONS.

In some drawings in this manual, protective covers or shields are removed to show details. Make sure that all the covers or shields are installed in place 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 is not responsible for incidents arising from unauthorized modification of its products. Unauthorized modification voids the product warranty.

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.
Notes for Safe Operation

Read this manual carefully before installation, operation, maintenance, or inspection of the MOTOMAN-HC10DT.

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

**DANGER**
Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. Safety Signs identified by the signal word DANGER should be used sparingly and only for those situations presenting the most serious hazards.

**WARNING**
Indicates a potentially hazardous situation which, if not avoided, will result in death or serious injury. Hazards identified by the signal word WARNING present a lesser degree of risk of injury or death than those identified by the signal word DANGER.

**CAUTION**
Indicates a hazardous situation, which if not avoided, could result in minor or moderate injury. It may also be used without the safety alert symbol as an alternative to “NOTICE”.

**NOTICE**
NOTICE is the preferred signal word to address practices not related to personal injury. The safety alert symbol should not be used with this signal word. As an alternative to “NOTICE”, the word “CAUTION” without the safety alert symbol may be used to indicate a message not related to personal injury.

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 “DANGER”, “WARNING” and “CAUTION”.
DANGER

• 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

• 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.
Before operating the manipulator, make sure the servo power is turned OFF by performing the following operations. When the servo power is turned OFF, the SERVO ON LED on the programming pendant is turned OFF.
- Press the emergency stop buttons on the front door of the YRC1000, on the programming pendant, on the external control device, etc.
- Disconnect the safety plug of the safety fence. (when in the play mode or in the remote mode)

If operation of the manipulator cannot be stopped in an emergency, personal injury and/or equipment damage may result.

Before releasing the emergency stop, make sure to remove the obstacle or error caused the emergency stop, if any, and then turn the servo power ON.

Failure to observe this instruction may cause unintended movement of the manipulator, which may result in personal injury.

Observe the following precautions when performing a teaching operation within the manipulator's operating range:
- Be sure to perform lockout by putting a lockout device on the safety fence when going into the area enclosed by the safety fence. In addition, the operator of the teaching operation must display the sign that the operation is being performed so that no other person closes the safety fence.
- View the manipulator from the front whenever possible.
- Always follow the predetermined operating procedure.
- Always keep in mind emergency response measures against the manipulator’s unexpected movement toward a person.
- Ensure a safe place to retreat in case of emergency.

Failure to observe this instruction may cause improper or unintended movement of the manipulator, which may result in personal injury.

Confirm that no person is present in the manipulator's operating range and that the operator is in a safe location before:
- Turning ON the YRC1000 power
- Moving the manipulator by using the programming pendant
- Running the system in the check mode
- Performing automatic operations

Personal injury may result if a person enters the manipulator's operating range during operation. Immediately press an emergency stop button whenever there is a problem. The emergency stop buttons are located on the front panel of the YRC1000 and on the right of the programming pendant.

Read and understand the Explanation of the Warning Labels before operating the manipulator.
• Before operating the manipulator, make sure the servo power is turned OFF by performing the following operations. When the servo power is turned OFF, the SERVO ON LED on the programming pendant is turned OFF.
  – Press the emergency stop button on the programming pendant or on the external control device, etc.
  – Disconnect the safety plug of the safety fence.
When in the play mode or in the remote mode
If operation of the manipulator cannot be stopped in an emergency, personal injury and/or equipment damage may result.

Fig. : Emergency Stop Button

• Before releasing the emergency stop, make sure to remove the obstacle or error caused the emergency stop, if any, and then turn the servo power ON.
Failure to observe this instruction may cause unintended movement of the manipulator, which may result in personal injury.

Fig. : Release of Emergency Stop

• Observe the following precautions when performing a teaching operation within the manipulator's operating range:
  – Be sure to perform lockout by putting a lockout device on the safety fence when going into the area enclosed by the safety fence. In addition, the operator of the teaching operation must display the sign that the operation is being performed so that no other person closes the safety fence.
  – View the manipulator from the front whenever possible.
  – Always follow the predetermined operating procedure.
  – Always keep in mind emergency response measures against the manipulator’s unexpected movement toward a person.
  – Ensure a safe place to retreat in case of emergency.
Failure to observe this instruction may cause improper or unintended movement of the manipulator, which may result in personal injury.

• Confirm that no person is present in the manipulator's operating range and that the operator is in a safe location before:
  – Turning ON the YRC1000micro power
  – Moving the manipulator by using the programming pendant
  – Running the system in the check mode
  – Performing automatic operations
Personal injury may result if a person enters the manipulator's operating range during operation. Immediately press an emergency stop button whenever there is a problem. The emergency stop button is located on the upper right right of the programming pendant.

• Read and understand the Explanation of the Warning Labels before operating the manipulator.
<YRC1000micro only>  

**DANGER**

- 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 4-14 pin and 5-15 pin of the Safety connector (Safety).
- Upon shipment of the YRC1000micro, 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.

<YRC1000/YRC1000micro>  

**WARNING**

- Perform the following inspection procedures prior to conducting manipulator teaching. If there is any problem, immediately take necessary steps to solve it, such as maintenance and repair.
  - Check for a problem in manipulator movement.
  - Check for damage to insulation and sheathing of external wires.
- Always return the programming pendant to the hook on the YRC1000/YRC1000micro cabinet after use. If the programming pendant is left unattended on the manipulator, on a fixture, or on the floor, etc., the Enable Switch may be activated due to surface irregularities of where it is left, and the servo power may be turned ON. In addition, in case the operation of the manipulator starts, the manipulator or the tool may hit the programming pendant left unattended, which may result in personal injury and/or equipment damage.
Definition of Terms Used Often in This Manual <YRC1000>

The MOTOMAN is the YASKAWA industrial robot product. The MOTOMAN usually consists of the manipulator, the controller, the programming pendant, and supply 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>YRC1000 controller</td>
<td>YRC1000</td>
</tr>
<tr>
<td>YRC1000 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>

Definition of Terms Used Often in This Manual <YRC1000micro>

The MOTOMAN is the YASKAWA industrial robot product. The MOTOMAN usually consists of the manipulator, the YRC1000micro controller, manipulator cables, the YRC1000micro programming pendant (optional), and the YRC1000micro 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>YRC1000micro controller</td>
<td>YRC1000micro</td>
</tr>
<tr>
<td>YRC1000micro programming pendant</td>
<td>Programming pendant (optional)</td>
</tr>
<tr>
<td>Cable between the manipulator and the controller</td>
<td>Manipulator cable</td>
</tr>
<tr>
<td>YRC1000micro programming pendant dummy connector</td>
<td>Programming pendant dummy connector (optional)</td>
</tr>
</tbody>
</table>

Registered Trademark <YRC1000/YRC1000micro>

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

Make sure to secure the manipulator base by using the bolts of the specified sizes and by tightening the bolts with the specified tightening torques. If the power is turned ON and the manipulator is operated without securing the manipulator properly, the manipulator may fall down, which may result in personal injury and/or equipment damage.
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1 Product Confirmation

1.1 Contents Confirmation

- **YRC1000**

Confirm the contents of the delivery when the product arrives.

Standard delivery includes the following five items (Information for the content of optional goods is given separately):

YRC1000 Packing contents
- Manipulator (accessories included)
- YRC1000 (spare parts included)
- Programming Pendant
- Three types of manipulator cables (between the manipulator and the YRC1000)
- Manual

**CAUTION**

- Confirm that the manipulator and the YRC1000/YRC1000micro have the same order number. Pay special attention when installing two or more manipulators.

Failure to observe this instruction may cause improper movement of the manipulator, which may result in personal injury and/or equipment damage.

Complete Set of Manuals
(in the CD-ROM which is connected to the USB connector)

Three Types of Manipulator Cables

CD-ROM which is connected to the USB connector
1 Product Confirmation

1.1 Contents Confirmation

- **YRC1000micro**
  - Confirm the contents of the delivery when the product arrives.
  - Standard delivery includes the following four (to six) items (Information for the content of optional goods is given separately):
    - Manipulator (accessories included)
    - YRC1000micro (spare parts included)
    - Three types of manipulator cables (between the manipulator and the YRC1000micro)
    - Complete set of manuals (in the CD-ROM which is connected to the USB connector)
    - Programming pendant (optional)
    - Programming pendant dummy connector (optional)

---

### Accessories of Manipulator

<table>
<thead>
<tr>
<th>Description</th>
<th>Pcs.</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hexagon socket head cap screw M12 (length: 45 mm)</td>
<td>4</td>
<td>For mounting (manipulator)</td>
</tr>
<tr>
<td>Conical spring washer M12</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Washer M12</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Pin HW1407797-5-85</td>
<td>1</td>
<td>For the home position calibrating (S-axis)</td>
</tr>
<tr>
<td>Lifting jig HW1307411-1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Hexagon socket head cap screw M8 (length: 25 mm)</td>
<td>2</td>
<td>For lifting</td>
</tr>
<tr>
<td>Conical spring washer M8</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>
1.2 Order Number Confirmation

Confirm the order number of the manipulator corresponds to the YRC1000/YRC1000micro. The order number is located on a label as shown below.

Fig. 1-1(a): Location of Order Number Labels (YRC1000)

YRC1000 (Front View)  Manipulator (Side View)

Label (Enlarged View)
Fig. 1-1(b): Location of Order Number Labels (YRC1000micro)

THE MANIPULATOR AND THE CONTROLLER SHOULD HAVE SAME ORDER NUMBER.
2 Transporting

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. Be sure to set the manipulator to the posture as shown in fig. 2-1 “Transporting Position”, and remove the casing cover. And then mount the shipping bolts and brackets (colored yellow) to lift the manipulator.

The manipulator should be lifted by a crane with two wire ropes through 40 dia. holes on a transportation bracket.

- The shipping bolts and brackets are fixed with the hexagon socket head cap screw M8 (length: 25 mm, 2 screws).
2 Transporting

2.1 Transporting Method

- Sufficiently ensure that the shipping bolts and bracket are tightened before transportation.
- The weight of the manipulator is approximately 48 kg. Use a wire rope strong enough to withstand the weight.
- The associated shipping bolts and a bracket are designed to support this weight. Do not use them for anything other than transporting the manipulator.
- Mount the shipping bolts and brackets for transporting the manipulator.
- Avoid putting external force on the arm or motor unit when transporting by a crane, forklift, or other equipment. Failure to observe this instruction may result in injury.
- Remove the shipping bolts and brackets after the installation, and then mount the casing cover. The shipping bolts and brackets must be stored for future use, in the event that the manipulator must be moved again.
- If using the servo ON lamp (optional), be careful not to disconnect the wire for the lamp when removing the casing cover.

NOTE

Factory setting for angle and pulse of each axis

<table>
<thead>
<tr>
<th>Axis</th>
<th>Angle</th>
<th>Pulse</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>0°</td>
<td>0</td>
</tr>
<tr>
<td>L</td>
<td>0°</td>
<td>0</td>
</tr>
<tr>
<td>U</td>
<td>0°</td>
<td>0</td>
</tr>
<tr>
<td>R</td>
<td>0°</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>0°</td>
<td>0</td>
</tr>
<tr>
<td>T</td>
<td>0°</td>
<td>0</td>
</tr>
</tbody>
</table>

indicates the position of the center of gravity.
2.1.2 Using a Forklift

When using a forklift, the manipulator should be fixed on a pallet with shipping bolts and brackets as shown in Fig. 2-2 “Using a Forklift”. Insert claws under the pallet and lift it. The pallet must be strong enough to support the manipulator.

Transport the manipulator slowly with due caution in order to avoid overturning or slippage.

Fig. 2-2: Using a Forklift
3 Installation

DANGER

• Perform the risk assessment.
Failure to observe this warning may result in injury or damage.

WARNING

• Do not perform the welding operation for a pedestal or etc. when the power cable is being connected.
Failure to observe this instruction may result in damage to an electric device due to the current of welding.
• Install the manipulator in a location where the tool or the workpiece held by its fully extended arm will not reach the wall, the safety fence, or the YRC1000/YRC1000micro, etc.
Failure to observe this warning may result in injury or damage.
• Make sure to firmly anchor the manipulator before turning ON the power and operating the manipulator.
Failure to observe this instruction may cause overturning of the manipulator, which may result in personal injury and/or equipment damage.
• When mounting the manipulator on the wall, the wall must have sufficient strength and rigidity to support the weight of the manipulator. In addition, take precautionary measures on the manipulator base to prevent the manipulator from falling.
Failure to observe this instruction may result in personal injury and/or equipment damage.
• Do not install or operate a damaged manipulator or a manipulator any of whose components is missing.
Failure to observe this instruction may cause improper movement, etc. of the manipulator, which may result in personal injury and/or equipment damage.

NOTICE

• After completing the installation of the manipulator, make sure to remove the shipping bolts and brackets before turning ON the power.
Failure to observe this instruction may result in damage to the main drive unit.
3 Installation

3.1 Installation of the Safety fence

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

**Responsibility for Safeguarding (ISO10218)**

When designing a robot system in which an operator and a robot collaborate in the environment of no safeguarding, sufficient risk assessment should be carried out to avoid damages to the equipment or unexpected injury to the operator or people around the system during the operation.

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 reaction forces during acceleration and deceleration.

Construct a solid foundation with the appropriate thickness to withstand maximum reaction forces of the manipulator referring to Table 3-1 "Manipulator Reaction Force and Torque".

A baseplate 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. Mount the manipulator base as instructed in chapter 3.2.1 "Mounting Example".

<table>
<thead>
<tr>
<th>Table 3-1: Manipulator Reaction Force and Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Horizontal rotation</strong></td>
</tr>
<tr>
<td>--------------------------</td>
</tr>
<tr>
<td>Emergency stop</td>
</tr>
<tr>
<td>Acceleration/deceleration</td>
</tr>
</tbody>
</table>
Fig. 3-1: Manipulator Reaction Force and Torque
3 Installation

3.2 Mounting Procedures for Manipulator Base

3.2.1 Mounting Example

For the first process, anchor the base plate firmly to the ground. The baseplate should be rugged and durable to prevent shifting of the manipulator or the mounting fixture. It is recommended to prepare a baseplate of 32 mm or more thickness, and anchor bolts of M12 or larger size.

The manipulator base is tapped for four mounting holes. Fix the manipulator base to the baseplate with the four hexagon socket head cap screws M12 (Tensile strength: 1200 N/mm² or more, recommended length: 45 mm) by using the tightening torque 84 N·m.

The hexagon socket head cap screws and the anchor bolts must be tightened firmly so that they will not work loose during the operation. Refer to fig. 3-2 “Mounting Manipulator on Baseplate”.

Fig. 3-2: Mounting Manipulator on Baseplate
3 Installation
3.3 Mounting Method

3.3 Mounting Method

The MOTOMAN-HC10DT are available in four ways: floor-mounted, wall-mounted, tilt-mounted and ceiling-mounted way. For wall-mounted, tilt-mounted and ceiling-mounted ways, the following points listed below are different from the floor-mounted way:

- Fixing of the Manipulator Base
- Precautions to Prevent the Manipulator from Falling

3.3.1 S-Axis Operating Range

For the wall-mounted way, the S-axis operating range is ±60°.

(Optional)

For the tilt-mounted way, the operating range of the S-axis varies as shown in the following table.

<table>
<thead>
<tr>
<th>Installation angle (θ)</th>
<th>Operating range of S-axis</th>
</tr>
</thead>
<tbody>
<tr>
<td>0° ≤ θ ≤ 60°</td>
<td>no limit</td>
</tr>
<tr>
<td>60° &lt; θ</td>
<td>within ±60°</td>
</tr>
</tbody>
</table>

Table 3-2: Installation Angle for Tilt-Mounted Way and Operating Range of S-Axis

Fig. 3-3: Installation Angle for Tilt-Mounted Way
3.3 Mounting Method

3.3.2 Fixing the Manipulator Base

For the wall- and ceiling-mounted ways, be sure to use four hexagon socket head cap screws M12 (tensile strength: 1200 N/mm² or more) when fixing the manipulator base. Use a torque of 84 N·m when tightening the screws.

3.3.3 Precautions to Prevent the Manipulator from Falling

For the wall- or ceiling-mounted ways, take appropriate measures to avoid the falling of the manipulator in case of emergency. Refer to fig. 3-4 "Precaution Against Falling" for details.

Fig. 3-4: Precaution Against Falling

In case of using the wall-/ceiling-/tilt-mounted way, inform YASKAWA of the matter when placing an order. Be sure to contact YASKAWA representative (listed on the back cover of this instruction manual) to execute a wall/ceiling installation on site.
3.4 Location

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

- Ambient Temperature: 0°C to +40°C \(^1\)
- Humidity: 20 to 80%RH (non-condensing)
- Free from water, explosive gas or liquid, or corrosive gas or liquid.
- Free from excessive vibration
  (Vibration acceleration: 4.9 m/s\(^2\) [0.5G] or less)
- Free from large electrical noise (plasma)
- Flatness for installation: 0.5 mm or less
- Free from the strong magnetic field
- Altitude: 1000 m or less

\[\text{NOTE}\]

When the operation is started after the manipulator has been out of operation and left in the low temperature (almost 0°C) for a long period, the alarm may occur since the resistance of the drive unit is large.

If the alarm occurs, perform the break-in for few minutes.

\(^1\) 0 to +35°C when the soft cover for covering the manipulator (optional) is mounted for reducing the contact/collision impact.
4 Wiring

WARNING

- Ground resistance must be 100 Ω or less. Failure to observe this warning may result in fire and/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 electric shock and/or personal injury.
- Wiring must be performed by authorized or certified personnel. Failure to observe this caution may result in fire and/or electric shock.
- When laying the cables from the manipulator to the YRC1000/ YRC1000micro, DO NOT cover the cable with heat insulating material and avoid multiple cabling. Failure to observe this caution may result in burn caused by cable heat emission failure.
4 Wiring
4.1 Grounding

Follow the electrical installation standards and wiring regulations for grounding. A ground wire of 5.5 mm² 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 Wiring

4.2 Cable Connection

Three manipulator cables, 1BC, TQ, and SW are delivered. (Refer to fig. 4-3(a) “Manipulator Cable for YRC1000” and fig. 4-3(b) “Manipulator Cable for YRC1000micro”.)

Connect the both edge of the manipulator cable to the manipulator base connectors and to the YRC1000/YRC1000micro. Before connecting the cable to the manipulator, verify the numbers on the connector as shown in fig. 4-3(a) “Manipulator Cable for YRC1000” and fig. 4-3(b) “Manipulator Cable for YRC1000micro”.

For the connecting position, refer to fig. 4-4 “Manipulator Cable Connection (Manipulator Side)”, fig. 4-5(a) “Manipulator Cable Connection (YRC1000 Side)”, and fig. 4-5(b) “Manipulator Cable Connection (YRC1000micro Side)”.

Refer to table 4-1 “Specifications of Manipulator Cable” for the outside diameter and the minimum bending radius (for fixed part and moving part) of the manipulator cable and the details of the manipulator cable connection on the manipulator side.

- Procedures for inserting the connector (1BC)
  1. Confirm the connector lever of the manipulator cable is at the initial position. Insert the cable straight into the connector on the back side of the YRC1000/YRC1000micro. Insert the manipulator cable to a fixed depth then the lever rotates about 30 degree forward automatically.
  2. Push the lever with hand and turn it (about 30 degree) until the lock is clicked.

- Procedures for removing the connector
  1. Release the lock by pushing the unlock part of the lever to unlock. Turn the lever about 60 degree to return to the initial position.
  2. Pull out the connector straight.

![Fig. 4-2(a): Connection of Manipulator Cable (1BC)](image-url)
4 Wiring
4.2 Cable Connection

- Procedures for inserting the manipulator cable (For TQ and SW)

Do not remove or connect the TQ and SW connectors while the power supply of the YRC1000/YRC1000micro is turned ON. Failure to observe this instruction may result in damage to the sensor.

1. Confirm that the direction of the arrow on the manipulator cable is upward, and insert the cable straight into the manipulator and the connector of the YRC1000/YRC1000micro.
2. Turn the knob with the arrow mark to the direction of the arrow.

- Procedures for removing the manipulator cable (For TQ and SW)
1. Turn the knob with the arrow mark to the opposite direction of the arrow.
2. Pull out the connector straight.

Fig. 4-2(b): Connection of Manipulator Cable (TQ, SW)
4 Wiring

4.2 Cable Connection

Fig. 4-3(a): Manipulator Cable for YRC1000

The YRC1000 side

The Manipulator side

Manipulator cable

Cable for the torque sensor

Cable for the switch/lamp

Fig. 4-3(b): Manipulator Cable for YRC1000micro

The YRC1000micro side

The Manipulator side

1BC encoder/power cable

Cable for the torque sensor

Cable for the switch/lamp
4 Wiring
4.2 Cable Connection

Fig. 4-4: Manipulator Cable Connection (Manipulator Side)

Fig. 4-5(a): Manipulator Cable Connection (YRC1000 Side)

Fig. 4-5(b): Manipulator Cable Connection (YRC1000micro Side)
4.2 Cable Connection

Table 4-1: Specifications of Manipulator Cable

<table>
<thead>
<tr>
<th>Outside diameter (mm)</th>
<th>Minimum bending radius (mm)</th>
<th>Distance between A and B (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25.1</td>
<td>90</td>
<td>260</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fixed part</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moving part</td>
</tr>
<tr>
<td>240 mm or longer</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 4-6: Overhead View of Manipulator Cable Connection (Manipulator Side)
5 Basic Specifications

5.1 Basic Specifications

Table 5-1: Basic Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>Model MOTOMAN-HC10DT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Application</strong></td>
<td>For collaborative operation</td>
</tr>
<tr>
<td><strong>Structure</strong></td>
<td>Vertically Articulated</td>
</tr>
<tr>
<td><strong>Degree of freedom</strong></td>
<td>6</td>
</tr>
<tr>
<td><strong>Payload</strong></td>
<td>10 kg</td>
</tr>
<tr>
<td><strong>Repeatability</strong></td>
<td>±0.1 mm</td>
</tr>
<tr>
<td><strong>Range of Motion</strong></td>
<td></td>
</tr>
<tr>
<td>S-Axis (turning)</td>
<td>-180° ≤ ±180°</td>
</tr>
<tr>
<td>L-Axis (lower arm)</td>
<td>-180° ≤ ±180°</td>
</tr>
<tr>
<td>U-Axis (upper arm)</td>
<td>5° ≤ 355°</td>
</tr>
<tr>
<td>R-Axis (wrist roll)</td>
<td>-180° ≤ ±180°</td>
</tr>
<tr>
<td>B-Axis (wrist pitch/yaw)</td>
<td>-180° ≤ ±180°</td>
</tr>
<tr>
<td>T-Axis (wrist twist)</td>
<td>-180° ≤ ±180°</td>
</tr>
<tr>
<td><strong>Maximum Speed</strong></td>
<td></td>
</tr>
<tr>
<td>S-Axis</td>
<td>2.27 rad/s, 130°/s</td>
</tr>
<tr>
<td>L-Axis</td>
<td>2.27 rad/s, 130°/s</td>
</tr>
<tr>
<td>U-Axis</td>
<td>3.14 rad/s, 180°/s</td>
</tr>
<tr>
<td>R-Axis</td>
<td>3.14 rad/s, 180°/s</td>
</tr>
<tr>
<td>B-Axis</td>
<td>4.36 rad/s, 250°/s</td>
</tr>
<tr>
<td>T-Axis</td>
<td>4.36 rad/s, 250°/s</td>
</tr>
<tr>
<td><strong>Allowable Moment</strong></td>
<td></td>
</tr>
<tr>
<td>R-Axis</td>
<td>27.4 N•m (2.8 kgf•m)</td>
</tr>
<tr>
<td>B-Axis</td>
<td>27.4 N•m (2.8 kgf•m)</td>
</tr>
<tr>
<td>T-Axis</td>
<td>9.8 N•m (1.0 kgf•m)</td>
</tr>
<tr>
<td><strong>Allowable Inertia</strong></td>
<td></td>
</tr>
<tr>
<td>R-Axis</td>
<td>0.78 kg•m²</td>
</tr>
<tr>
<td>B-Axis</td>
<td>0.78 kg•m²</td>
</tr>
<tr>
<td>T-Axis</td>
<td>0.10 kg•m²</td>
</tr>
<tr>
<td><strong>Approx. Mass</strong></td>
<td>48 kg</td>
</tr>
<tr>
<td><strong>Protective enclosure</strong></td>
<td>IP20</td>
</tr>
<tr>
<td><strong>Mounting method</strong></td>
<td>Floor-, wall-, tilt-, ceiling-mounted.</td>
</tr>
<tr>
<td><strong>Ambient Conditions</strong></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>0 to 40°C⁰ (³)</td>
</tr>
<tr>
<td>Humidity</td>
<td>20 to 80% RH (non-condensing)</td>
</tr>
<tr>
<td>Vibration</td>
<td>4.9 m/s² (0.5G) or less</td>
</tr>
<tr>
<td>Altitude</td>
<td>1000 m or less</td>
</tr>
<tr>
<td><strong>Others</strong></td>
<td>Free from corrosive gas or liquid, or explosive gas Free from dust, soot, or water Free from excessive electrical noise (plasma) Free from strong magnetic field</td>
</tr>
<tr>
<td><strong>Power Capacity</strong></td>
<td>1 kVA</td>
</tr>
<tr>
<td><strong>Applicable controller</strong></td>
<td>YRC1000/YRC1000micro</td>
</tr>
<tr>
<td><strong>Noise</strong></td>
<td>70 dB or less</td>
</tr>
</tbody>
</table>

1. SI units are used in this table. However, gravitational unit is used in ( )
2. Conformed to: ISO9283
3. Refer to fig. 6-1 "Moment Arm Rating" for details on the allowable inertia.
4. 0 to +30°C when the soft cover for covering the manipulator (optional) is mounted for reducing the contact/collision impact.
5. Conformed to equivalent continuous A-weighted sound pressure level measured in accordance with ISO11201(EN31201)
   1. Measurement is carried out when the maximum load is mounted to the manipulator and operated in the maximum speed.
   2. Measurement is carried out:
   - between 1.2 m and 1.5 m above the ground.
   - 400 mm away from the P-point maximum envelope.
5.2 Part Names and Working Axes

Fig. 5-1: Part Names and Working Axes

5.3 Baseplate Dimensions

Fig. 5-2: Manipulator Base Dimensions
5.4 Dimensions and P-Point Maximum Envelope

Fig. 5-3: Dimensions and P-Point Maximum Envelope (mm)
5 Basic Specifications
5.5 Stopping Distance and Time for S-, L-, and U-Axes

5.5 Stopping Distance and Time for S-, L-, and U-Axes

5.5.1 General Information

- The stopping distance is an angle traveled by the manipulator from the moment when the stop signal is activated until the manipulator comes to a complete standstill.
- The stopping time is a time elapsed from the moment that the stop signal is activated until the manipulator comes to a complete standstill.
- The data that are given for the main axes S, L and U are the maximum displacement.
- Superposed axes motions may result in longer stopping distance.
- Stopping distance and stopping time are measured in accordance with ISO 10218-1, Annex B
- Stop categories: According to IEC60204-1
  - Stop category 0
  - Stop category 1
- The values specified for Stop category 0 are the reference values that are determined by tests and simulations. The actual stopping distance and stopping time may differ.

5.5.2 Definition of Use

Load : Rated load weight and load on an arm
Speed : Operating speed of the manipulator
Extension : Distance between the rotation center and the P-point of each axis

5.5.3 Stopping Distance and Time for Stop Category 0: S-, L- and U-Axes

Measurement Conditions

- Load: Maximum load
- Speed: Maximum speed
- Posture: Maximum inertia generation posture

<table>
<thead>
<tr>
<th>Axis</th>
<th>Stopping distance (deg)</th>
<th>Stopping Time (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-axis</td>
<td>6.4</td>
<td>0.082</td>
</tr>
<tr>
<td>L-axis</td>
<td>10.2</td>
<td>0.144</td>
</tr>
<tr>
<td>U-axis</td>
<td>16.6</td>
<td>0.140</td>
</tr>
</tbody>
</table>
5.5.4 Stopping Distance and Time for Stop Category 1: S-, L- and U-Axes

5.5.4.1 Extension

Refer to fig. 5-4 “S-Axis Extension”, fig. 5-5 “L-Axis Extension” and fig. 5-6 “U-Axis Extension” for each axis arm extension.

Fig. 5-4: S-Axis Extension

Fig. 5-5: L-Axis Extension

Fig. 5-6: U-Axis Extension
5 Basic Specifications
5.5 Stopping Distance and Time for S-, L-, and U-Axes

Fig. 5-6: U-Axis Extension

100% - 500 mm
5.5.4.2 Stopping Distance and Time for Stop Category 1: S-Axis

![Graphs showing stopping distance and time for S-axis with different extensions and loads.](image-url)
5.5.4.3 Stopping Distance and Time for Stop Category 1: L-Axis

- **Extension 100%**
  - Speed (deg/s) vs. Stopping Angle (deg)
  - Graphs for different loads: 100%, 66%, 33%

- **Extension 66%**
  - Speed (deg/s) vs. Stopping Angle (deg)
  - Graphs for different loads: 100%, 66%, 33%

- **Extension 33%**
  - Speed (deg/s) vs. Stopping Angle (deg)
  - Graphs for different loads: 100%, 66%, 33%
5.5.4.4 Stopping Distance and Time for Stop Category 1: U-Axis

![Graph showing stopping distance and time for U-Axis]
5.6 Alterable Operating Range

The operating range of the S-axis can be altered in accordance with the operating conditions as shown in table 5-2 “S-Axis Operating Range”. If alteration is necessary, contact your YASKAWA representative in advance.

**Table 5-2: S-Axis Operating Range**

<table>
<thead>
<tr>
<th>Item</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-Axis Operating Range</td>
<td>-180° - +180° (standard)</td>
</tr>
<tr>
<td></td>
<td>-165° - +165°</td>
</tr>
<tr>
<td></td>
<td>-150° - +150°</td>
</tr>
<tr>
<td></td>
<td>-135° - +135°</td>
</tr>
<tr>
<td></td>
<td>-120° - +120°</td>
</tr>
<tr>
<td></td>
<td>-105° - +105°</td>
</tr>
<tr>
<td></td>
<td>-90° - +90°</td>
</tr>
<tr>
<td></td>
<td>-75° - +75°</td>
</tr>
<tr>
<td></td>
<td>-60° - +60°</td>
</tr>
<tr>
<td></td>
<td>-45° - +45°</td>
</tr>
<tr>
<td></td>
<td>-30° - +30°</td>
</tr>
<tr>
<td></td>
<td>-15° - +15°</td>
</tr>
<tr>
<td></td>
<td>0° - +0°</td>
</tr>
</tbody>
</table>

5.6.1 Components for Altering Operating Range

Prepare the components listed in fig. 5-7 “The Components of the S-Axis Stopper and Stopper Mounting Position.”, when modifying the angle of S-axis.

1. Ring (HW1306534-1): 2 rings
2. Stopper (HW1306535-1): 1 stopper
3. Stopper (HW1306535-2): 1 stopper
4. Hexagon socket head cap screw M5 "trivalent chromate" (length: 20 mm): 4 screws
   (Tensile strength: 1000 N/mm² or more)
5. Hexagon socket head cap screw M5 "trivalent chromate" (length: 14 mm): 6 screws
   (Tensile strength: 1000 N/mm² or more)
6. Conical spring washer 2H-5 "trivalent chromate": 10 washers
Fig. 5-7: The Components of the S-Axis Stopper and Stopper Mounting Position.

**Fig. 5-7:** The Components of the S-Axis Stopper and Stopper Mounting Position.

- **Hexagon socket head cap screw M5:** trivalent chromate (length: 20 mm) (4 screws)
  - Tensile strength: 1000 N/mm² or more
  - Conical spring washer 2H-5
- **Hexagon socket head cap screw M5:** trivalent chromate (length: 14 mm) (6 screws)
  - Tensile strength: 1000 N/mm² or more
  - Conical spring washer 2H-5

**Section A-A Stopper Mounting Position**

<table>
<thead>
<tr>
<th>S-axis Operating Range</th>
<th>Stopper Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>-165° - +165°</td>
<td></td>
</tr>
<tr>
<td>-150° - +150°</td>
<td></td>
</tr>
<tr>
<td>-120° - +120°</td>
<td></td>
</tr>
<tr>
<td>-105° - +105°</td>
<td></td>
</tr>
<tr>
<td>-90° - +90°</td>
<td></td>
</tr>
<tr>
<td>-75° - +75°</td>
<td></td>
</tr>
<tr>
<td>-60° - +60°</td>
<td></td>
</tr>
<tr>
<td>-45° - +45°</td>
<td></td>
</tr>
<tr>
<td>-30° - +30°</td>
<td></td>
</tr>
<tr>
<td>-15° - +15°</td>
<td></td>
</tr>
<tr>
<td>0°</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HW1306535-2 (Stopper)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>HW1306534-1 (Ring) (two rings)</th>
</tr>
</thead>
</table>

**Table:**

- **HW1485083**

---

5 Basic Specifications

5.6 Alterable Operating Range

| HW1485083 | 43/75 | 5-11 |
5.6 Alterable Operating Range

5.6.2 Notes on the Mechanical Stopper Installation

When mounting the S-axis mechanical stopper, as shown in fig. 5-7 “The Components of the S-Axis Stopper and Stopper Mounting Position.”, mount the HW1366534-1 (two rings) with six hexagon socket head cap screws M5 *trivalent chromate* (length: 14 mm) (two screws) (three places) with using the tightening torque 6 N•m (tensile strength: 1000 N/mm² or more), mount the HW13066535-1 and HW13066535-2 (two stoppers) with four hexagon socket head cap screws M5 *trivalent chromate* (length: 20 mm) (two screws) (two places) with using the tightening torque 6 N•m (tensile strength: 1000 N/mm² or more) to the base.

When the motion range is ±180° (standard), mounting the stopper is not required.

S-axis mechanical stopper can be set at 15° pitch intervals from ± 0° to 165° range.

For the settable angles, refer to table 5-3 “The Settable Angle for S-Axis Stopper”.

1. Use the specified bolts when mounting the S-Axis mechanical stopper.
2. Turn OFF the electric power supply before mounting.

5.6.3 Adjustment to the Pulse Limitation of S-Axis

Apply the Instruction for “8.17 Changing the Parameter Setting” in “YRC1000 INSTRUCTIONS (RE-CTO-A221) / YRC1000micro INSTRUCTIONS (RE-CTO-A222)” as part of reference materials for adjusting the programming pendant when modifying the range of motion of S-Axis.

The limitation to the pulse (Pulse Soft Limit + 1st Axis): SICxG800

The limitation to the pulse (Pulse Soft Limit - 1st Axis): SICxG810

<table>
<thead>
<tr>
<th>Degree</th>
<th>±0°</th>
<th>±15°</th>
<th>±30°</th>
<th>±45°</th>
<th>±60°</th>
<th>±75°</th>
<th>±90°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Pulse</td>
<td>±0</td>
<td>±40070</td>
<td>±8139</td>
<td>±120209</td>
<td>±160279</td>
<td>±200348</td>
<td>±240418</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Degree</th>
<th>±105°</th>
<th>±120°</th>
<th>±135°</th>
<th>±150°</th>
<th>±165°</th>
<th>±180°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Pulse</td>
<td>±280487</td>
<td>±320557</td>
<td>±360627</td>
<td>±400696</td>
<td>±440766</td>
<td>±480835</td>
</tr>
</tbody>
</table>

When modifying the range of motion for machinery, adjust both of the pulse limitation and the angle of S-Axis mechanical stopper.
The settable angles for S-axis stopper are shown in Table 5-3 "The Settable Angle for S-Axis Stopper".

Table 5-3: The Settable Angle for S-Axis Stopper

<table>
<thead>
<tr>
<th>Settable angle</th>
<th>Non-settable angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>180°</td>
<td>-180°</td>
</tr>
<tr>
<td>165°</td>
<td>-165°</td>
</tr>
<tr>
<td>150°</td>
<td>-150°</td>
</tr>
<tr>
<td>135°</td>
<td>-135°</td>
</tr>
<tr>
<td>120°</td>
<td>-120°</td>
</tr>
<tr>
<td>105°</td>
<td>-105°</td>
</tr>
<tr>
<td>90°</td>
<td>-90°</td>
</tr>
<tr>
<td>75°</td>
<td>-75°</td>
</tr>
<tr>
<td>60°</td>
<td>-60°</td>
</tr>
<tr>
<td>45°</td>
<td>-45°</td>
</tr>
<tr>
<td>30°</td>
<td>-30°</td>
</tr>
<tr>
<td>15°</td>
<td>-15°</td>
</tr>
<tr>
<td>0°</td>
<td></td>
</tr>
<tr>
<td>15°</td>
<td></td>
</tr>
<tr>
<td>30°</td>
<td></td>
</tr>
<tr>
<td>45°</td>
<td></td>
</tr>
<tr>
<td>60°</td>
<td></td>
</tr>
<tr>
<td>75°</td>
<td></td>
</tr>
<tr>
<td>90°</td>
<td></td>
</tr>
<tr>
<td>105°</td>
<td></td>
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<tr>
<td>120°</td>
<td></td>
</tr>
<tr>
<td>135°</td>
<td></td>
</tr>
<tr>
<td>150°</td>
<td></td>
</tr>
<tr>
<td>165°</td>
<td></td>
</tr>
<tr>
<td>180°</td>
<td></td>
</tr>
</tbody>
</table>

The Angle of S-Axis Stopper for + Direction

<table>
<thead>
<tr>
<th>Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>180°</td>
</tr>
<tr>
<td>165°</td>
</tr>
<tr>
<td>150°</td>
</tr>
<tr>
<td>135°</td>
</tr>
<tr>
<td>120°</td>
</tr>
<tr>
<td>105°</td>
</tr>
<tr>
<td>90°</td>
</tr>
<tr>
<td>75°</td>
</tr>
<tr>
<td>60°</td>
</tr>
<tr>
<td>45°</td>
</tr>
<tr>
<td>30°</td>
</tr>
<tr>
<td>15°</td>
</tr>
<tr>
<td>0°</td>
</tr>
<tr>
<td>15°</td>
</tr>
<tr>
<td>30°</td>
</tr>
<tr>
<td>45°</td>
</tr>
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<td>60°</td>
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<tr>
<td>75°</td>
</tr>
<tr>
<td>90°</td>
</tr>
<tr>
<td>105°</td>
</tr>
<tr>
<td>120°</td>
</tr>
<tr>
<td>135°</td>
</tr>
<tr>
<td>150°</td>
</tr>
<tr>
<td>165°</td>
</tr>
<tr>
<td>180°</td>
</tr>
</tbody>
</table>

The Angle of S-Axis Stopper for - Direction
5.7 Brake Slippage Check Function

Brake slippage check function is a function to check the braking force of the motor brake of targeted axis and the external brake installed on the same axis as the motor during the playback or when operated manually from the programing pendant.

This function can be changed to Enable or Disable by using the following parameter.

\[
S2C757 \quad 0: \text{Disable} \quad 1: \text{Enable}
\]

This function displays the message and system signal output (#50905) to urge the brake slippage check on the programing pendant 6000 hours after the beginning of the robot use or the last day on which the brake slippage check was performed.

"Perform the brake slippage check."

For MOTOMAN-HC10DT, this function is applied to all axes (S-, L-, U-, R-, B-, and T-axis).

If the braking force is judged to be below the standard value as a result of the check, the specific signal output (#50980) and the following alarms give warning.

\(<\text{For the motor brake}>\)

Alarm 4669: Brake slippage detected [targeted axis displayed]

\(<\text{For the external brake}>\)

Alarm 4669: Brake slippage detected (External brake) [targeted axis displayed]

If the above alarms occur, the motor of the targeted axis displayed needs to be replaced. For the replacement, contact your YASKAWA representative.

Above alarms can be reset on the alarm screen. By resetting them, the operation can be continued. However, make sure to replace the motor of the targeted axis.
5.7 Brake Slippage Check Function

5.7.1 BRAKE CHECK Screen

Selecting {ROBOT} on the Main Menu and then {BRAKE CHECK} will display the following information regarding the brake check.

- **Robot**
  Displays the control group of which the brake slippage check information is displayed.

- **Axis**
  Displays the axis which can be performed the brake slippage check.

- **CHECK TRQ (Check torque) [%]**
  Displays the torque [%] applied to the brake with the brake locked during the brake slippage check.

  The initial value (100%) is already set to the CHECK TRQ. When the security mode is set to "Management" mode, the check torque can be edited. However, it may cause deterioration of the brake depending on the set value. For changing the check torque, contact your YASKAWA representative.

- **SLIP VOL.(PULSE)**
  Displays the amounts of pulse operated in the brake slippage check. The 3 previous pulses are displayed for each axis.

- **MEASURED DATE**
  Displays the dates on which the brake slippage checks were performed. The 3 previous dates are displayed for each axis.
5.7 Brake Slippage Check Function

5.7.2 Brake Slippage Check Function During the Playback Operation

By adding “BRKCHECK” command to JOB, the brake slippage check can be automatically performed during the playback. The command lines and additional items are as follows:

```
BRKCHECK R1 JOINT
```

**Robot**

Specify the robot (R1 to R8) to be performed the brake slippage check. It is displayed when the number of control groups in the command JOB is 2 or more. If any robots are specified, the robot of the slave side is performed the brake slippage check.

**Axis**

Specify the axis to be performed the brake slippage check. The following is a correspondence table of the axes for MOTOMAN-HC10DT.

<table>
<thead>
<tr>
<th>JOINT</th>
<th>Axis Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>S</td>
</tr>
<tr>
<td>2</td>
<td>L</td>
</tr>
<tr>
<td>3</td>
<td>U</td>
</tr>
<tr>
<td>4</td>
<td>R</td>
</tr>
<tr>
<td>5</td>
<td>B</td>
</tr>
<tr>
<td>6</td>
<td>T</td>
</tr>
</tbody>
</table>

When the BRKCHECK command is added to JOB, press [INFORM LIST] to select it in “Others” in the command list dialogue.

Also, when the brake slippage check is performed with the BRKCHECK command, register the move instruction in the above line of it to the position in which the brake slippage check is to be performed.
5.7.3 Manual Brake Slippage Check Function

With displaying the BRAKE CHECK screen, select (UTILITY) of the menu, and select (MANUAL BRAKE CHECK) in it, and then the following screen will be displayed.

(MANUAL BRAKE CHECK screen can be displayed only when the security mode is set to “Management” mode.)

①CONFIRMATION
When “○” is displayed in STATUS column of each axis, “NEED” is displayed.
When “●” is displayed in STATUS column of all axes, “Done” is displayed.
When “NEED” is displayed, the brake slippage check is needed to be performed.

②Robot
Displays the control group to display the information of the brake slippage check.

③Axis
Displays the axes which can be performed the brake slippage check.

④DETECT
Displays the result of the brake slippage check.
When the brake slippage is detected, “NG” is displayed and the alarm occurs.
When the brake slippage is not detected, “OK” is displayed.

⑤POS (Check position)
Set the motor pulse value for the position in which the manual brake slippage check is performed.
Perform the setting with displaying the MANUAL BRAKE CHECK screen.
Selecting “Change POS” in “EDIT” of the menu collectively sets the pulse of each axis of the posture at the time.
Manual brake slippage check is performed after the manipulator is moved to the check position.
5.7 Brake Slippage Check Function

STATUS
Displays whether the brake slippage check is completed or not.
"○" is displayed for the axis which has passed the NEXT DATE. "●" is displayed for the axis which has not passed the date yet.
When "●" is displayed, the brake slippage check is needed to be performed.

NEXT DATE
Displays the date to perform the next brake slippage check.
(6000 [Hr] is set to the interval to perform the check.)

DETECT DATE
Displays the date on which the brake slippage check during the playback or manual brake slippage check is performed.

USE DATE
Displays the date of the first day of the robot use or on which the brake was replaced.

5.7.4 How to Perform the Manual Brake Slippage Check
Perform the brake slippage check according to the following steps.
1. Display the MANUAL BRAKE CHECK screen.
2. Setting of the check position (POS)
   <When the check position is already set:>
   If the manipulator is not in the check position, the following message will be displayed:
   "Manipulator can move to the position to perform the brake slippage check."

   <When the check position is not set:>
   Set the position to perform the manual brake slippage check.

3. Press [Next].
   The manipulator moves to "POS".
   After it moved, the following message will be displayed:
   "Manipulator arrived at POS. Press [Interlock] and [Next] to start the measurement."

4. Move the cursor to the axis to be measured, press [Interlock] and [Next] at the same time to start the measurement.
   When the measurement is completed, the screen is updated and the following message is displayed:
   "The measurement is finished."
6 Allowable Load for Wrist Axis and Wrist Flange

6.1 Allowable Wrist Load

The allowable payload of the wrist axis is 10 kg. However, the requirements listed in table 6-1 “Allowable Wrist Load” must be satisfied regarding the moment and the inertia.

Even if the load is not applied as mass but applied as force, the values in table 6-1 must not be exceeded.

Table 6-1: Allowable Wrist Load

<table>
<thead>
<tr>
<th>Axis</th>
<th>Allowable moment (Nm (kgf•m))</th>
<th>Allowable inertia (GD²/4) kgf•m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-Axis</td>
<td>27.4 (2.8)</td>
<td>0.78</td>
</tr>
<tr>
<td>B-Axis</td>
<td>27.4 (2.8)</td>
<td>0.78</td>
</tr>
<tr>
<td>T-Axis</td>
<td>9.8 (1.0)</td>
<td>0.1</td>
</tr>
</tbody>
</table>

1 (): Gravitational unit

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

Each value of the allowable inertia above is calculated assuming that the moment load is at the maximum. Thus, in the case when only the inertia load is applied, when the moment load is small while the inertia load is large, or when the load is not applied as mass but applied as force, etc., contact your YASKAWA representative in advance.

When a tool is installed, the tool information and the load information must be set. For the setting, refer to “8.3 Tool Data Setting” and “8.4 ARM Control” in “YRC1000INSTRUCTIONS (RE-CTO-A221) / YRC1000micro INSTRUCTIONS (RE-CTO-A222)”.

Fig. 6-1: Moment Arm Rating

Allowable Range of the Wrist Load
6.2 Wrist Flange

The wrist flange dimensions are shown in fig. 6-2 “Wrist Flange”.

It is recommended that the attachment be mounted inside the fitting in order to identify the alignment marks. Fitting depth shall be 13 mm or less.

The attachment which is mounted onto the flange is required to make holes for passing through two internal user I/O wiring harnesses and two air lines. The recommended diameter of the hole is 17 dia. to 25 dia.

Fig. 6-2: Wrist Flange

Recommended range of mounting the attachment
(When the attachment is mounted out of the range, care for the interference.)

Tapped hole M6 (4 places)
(depth: 6 mm) (pitch: 1.0)
When mounting the attachment, use the tightening torque of 13.7 N•m (1.4 kgf•m).
7 System Application

7.1 Internal User I/O Wiring Harness and Air Lines

Internal user I/O wiring harness (8 wires: 0.2 mm², 8 wires: 0.3 mm²) and two air lines are incorporated in the manipulator for the drive of the peripheral devices mounted on the upper arm as shown in fig. 7-1 “Connectors for Internal User I/O Wiring Harness and Air Line (Standard specifications)” and fig. 7-3 “Connectors for Internal User I/O Wiring Harness and Air Line (When From the Bottom of the Manipulator Base)”.

The connector pins 1 to 16 are assigned as shown in fig. 7-2 “Details of the Connector Pin Numbers (Standard Specifications)”.

Wiring must be performed by users. The operating conditions are shown in the following table.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allowable current for I/O wiring</td>
<td>2.5 A or less for each wire (The total current value for pins 1 to 16 must be 40 A or less.)</td>
</tr>
<tr>
<td>Maximum pressure for the air line</td>
<td>490 kPa (5 kgf/cm²) or less (The air hose inside diameter: 2.5 mm)</td>
</tr>
</tbody>
</table>
7 System Application
7.1 Internal User I/O Wiring Harness and Air Lines

**Fig. 7-1: Connectors for Internal User I/O Wiring Harness and Air Line (Standard specifications)**

- Connector for internal user I/O wiring harness: RM21WTR-20P
- Prepare the connector RM21WTP-20S*HIROSE*.

**Fig. 7-2: Details of the Connector Pin Numbers (Standard Specifications)**

- Details of A:
  - Air inlet 1 (tapped hole M5, pitch: 0.8) with pipe plug
  - Air inlet 2 (tapped hole M5, pitch: 0.8) with pipe plug

- Details of B:

The figure shows the state seen from the fitting side (connection side of mating connector) of the manipulator side connector. 

---

The figure shows the state seen from the fitting side (connection side of mating connector) of the manipulator side connector.
7 System Application
7.1 Internal User I/O Wiring Harness and Air Lines

Fig. 7-3: Connectors for Internal User I/O Wiring Harness and Air Line (When From the Bottom of the Manipulator Base)

Details of C
- Connector for internal user I/O wiring harness: RM21WTR-20P
- Prepare the connector RM21WTP-20S*HIROSE*

Tool side
- Air inlet 1
  - Tapped hole M5 (pitch: 0.8) with pipe plug
- Air inlet 2
  - Tapped hole M5 (pitch: 0.8) with pipe plug

Manipulator side
- Connector for internal user I/O wiring harness: 51216-0800 (2 connectors)
- AIR 1 (red)
- AIR 2 (blue)
- Air line (2 air lines, outside dia.: 4)

Details of A

View B

Details of C
7.2 Soft Cover for Covering the Manipulator (Optional)

The soft cover for covering the manipulator is optional.

For the mounting position of the soft cover, refer to fig. 7-4 “Mounting Position of the Soft Cover”.

- **Notes when mounting the soft cover**
  - Mount the soft cover correctly so that the corner deviation may not occur.
  - The soft cover is made of elastic material. Be careful not to strain excessively.
  - Do not cover the entire joint part for preventing interference.

![Fig. 7-4: Mounting Position of the Soft Cover](image_url)

- **Notes when using a soft cover**
  - When the soft cover is mounted, the temperature of the manipulator’s components rises easily. Therefore, the limitation of the ambient temperature for installation is set below the standard temperature for the purpose of protecting the manipulator.

  | Standard | 0 - 40°C |
  | When mounting the soft cover | 0 - 35°C |
Servo ON lamp is an optional. For its location, refer to fig. 8-1 “Servo ON Lamp”.

Fig. 8-1: Servo ON Lamp

NOTE

When removing the casing cover on which the servo ON lamp is installed, be careful not to disconnect the wire for the lamp.
8.2 Internal Connections

Diagrams for internal connections of the manipulator and the YRC1000/YRC1000micro are shown in fig. 8-3(a) "Internal Connection Diagram for YRC1000/YRC1000micro" and fig. 8-3(b) "Internal Connection Diagram for YRC1000/YRC1000micro".
Fig. 8-3(a): Internal Connection Diagram for YRC1000/YRC1000micro
Fig. 8-3(b): Internal Connection Diagram for YRC1000/YRC1000micro
9 Maintenance and Inspection

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 9-1 “Inspection Items”.

In table 9-1, the inspection items are categorized by 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 must be based on the servo power supply on time.
- The following inspection schedule is based on the case where the manipulator is used for the cooperation with the working people. 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 handling, in this case, contact your YASKAWA representative.

**DANGER**

- Do not remove the motor, and do not release the brake.
  Failure to observe this caution may result in death or serious injury from unexpected turning of the manipulator’s arm.

**WARNING**

- 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.
- Before maintenance or inspection, be sure to turn the main power supply OFF, and put up a warning sign. (ex. DO NOT TURN THE POWER ON.)
  Failure to observe this warning may result in electric shock or injury.

**NOTICE**

- 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 must be based on the servo power supply on time.
<table>
<thead>
<tr>
<th>Items$^{1)}$</th>
<th>Schedule</th>
<th>Method</th>
<th>Operation</th>
<th>Inspection Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Daily</td>
<td></td>
<td></td>
<td>Specified Personnel</td>
</tr>
<tr>
<td>1 Alignment mark</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>2 External lead wire</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>3 Working area and manipulator</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>4 Baseplate mounting bolts</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>5 External cover mounting screws</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>6 Connector of manipulator cable</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>7 Connector base unit (including the lead wire for the basic axis) (including the power board)</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>8 Internal wiring harness (Lead wire for the wrist axis)</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>9 Battery pack in manipulator</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
</tbody>
</table>

1. Check alignment mark accordance at the home position. Check for damage. Or check the position deviation at the check point.
2. Check for damage and outside cracks.
3. Replace if necessary.
9 Maintenance and Inspection

9.1 Inspection Schedule

The numbers in the above table correspond to the numbers in table 9-1 “Inspection Items”.

10 S-, L-, U-, R-, B-, T-axes gears

••

11 Overhaul

••

12 Torque sensor

For details, refer to “YRC1000/YRC1000micro Collaborative Operation Instructions (HW1484764)”.

3 Wire harness in manipulator to be replaced at 24000 H inspection.

4 For grease to be used for each part, refer to table 9-2 “Inspection Parts and Grease Used”.

Table 9-2: Inspection Parts and Grease Used

<table>
<thead>
<tr>
<th>No.</th>
<th>Grease Used</th>
<th>Inspected Parts</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Harmonic Grease SK-1A</td>
<td>S, L, U, R, B and T-axes gears</td>
</tr>
</tbody>
</table>

The numbers in the above table correspond to the numbers in table 9-1 “Inspection Items”.
9 Maintenance and Inspection

9.1 Inspection Schedule

Fig. 9-1: Inspection Items

R-axis
L-axis
U-axis
S-axis
B-axis
T-axis
9.2 Notes on Maintenance Procedures

9.2.1 Battery Pack Replacement

Each of the three battery packs are located in the positions shown in fig. 9-2 “Locations of the Battery and Multi-port Connector” with the multi-port connector connectors.

When the battery alarm message is shown on the programming pendant, replace the battery pack in accordance with the following two methods. Perform the replacement by referring to chapter 9.4 “Notes for Maintenance”.

**Fig. 9-2: Locations of the Battery and Multi-port Connector**
9 Maintenance and Inspection
9.2 Notes on Maintenance Procedures

**Normal (The control power supply of the YRC1000/YRC1000micro can be turned ON)**

*Fig. 9-3: Battery connection (the control power supply of the YRC1000/YRC1000micro can be turned ON)*

1. Turn ON the power supply of the YRC1000/YRC1000micro and turn OFF the servo power.

2. Loosen the cover mounting bolt and remove the cover.

3. The old battery pack is fixed with the cable tie. Cut the cable tie to remove the old battery pack.
4. Remove the old battery pack from the multi-port connector and mount the new battery pack.
5. Fix the new battery pack with the cable tie T18L.
6. Tighten the cover mounting bolt by using the tightening torque shown in fig. 9-2 “Locations of the Battery and Multi-port Connector” to reinstall the cover.

**DANGER**

- Make sure to perform the battery replacement with the emergency stop button being pressed.
Failure to observe this instruction may cause improper movement of the manipulator which may result in personal injury and/or equipment damage.

**NOTE**

- When removing the casing cover on which the servo ON lamp is installed, be careful not to disconnect the wire for the lamp.

- When reinstalling the cover, be careful not to get caught the cable.
9 Maintenance and Inspection
9.2 Notes on Maintenance Procedures

- **When the control power supply of the YRC1000/YRC1000micro cannot be turned ON**

![Fig. 9-4: Battery connection (the control power supply of the YRC1000/YRC1000micro cannot be turned ON)](HW1485083)

1. Prepare the lead for battery replacement (HW1471281-A) and the battery pack for backup. (Apart from the new battery pack for replacement, prepare the battery pack for backup)

2. Loosen the cover mounting bolt and remove the cover.

3. Remove the connector from the “IN” port of the multi-port connector. Connect the lead for battery replacement to the “IN” port of the multi-port connector.

4. Connect the battery pack for backup to the lead for battery replacement.

5. The old battery pack is fixed with the cable tie. Cut the cable tie to remove the old battery pack.

6. Remove the old battery pack from the multi-port connector and mount the new battery pack.

7. Fix the new battery pack with the cable tie T18L.

8. Remove the lead for battery replacement and the battery pack for backup from the multi-port connector, connect the connector which has been removed in no.3 of this procedure to the “IN” connector again.

9. Tighten the cover mounting bolt by using the tightening torque shown in fig. 9-2 “Locations of the Battery and Multi-port Connector” to reinstall the cover.

**NOTE**

Before removing the old battery pack, make sure to connect the battery pack for backup to prevent the encoder absolute data from disappearing.

When reinstalling the cover, be careful not to get caught the cable.
9.3 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.

- A injection syringe is one of recommended spare parts for grease replenishment. Do not replenish grease by using the grease pump.
- Soften the grease in a injection syringe by stirring or etc., and fill the necessary amount.
- If the replenishment is performed more than the specified numbers, the internal pressure may rise during the operation and the grease leakage may occur.
- When filling, grease may flow from the inlet. Make sure to prepare a cloth or etc. to wipe off grease and the container which receives grease.
9.3 Notes on Grease Replenishment Procedures

9.3.1 Grease Replenishment for Each Axis Gear

Fig. 9-5: Each Axis Gear Diagram

When removing the casing cover (U- and R-axis) on which the servo ON lamp (optional) is installed, be careful not to disconnect the wire for the lamp.
9.3 Notes on Grease Replenishment Procedures

9.3.1.1 Grease Replenishment

(Refer to fig. 9-5 "Each Axis Gear Diagram".)

Replenish grease in accordance with the following procedure:

1. Adjust the posture of the manipulator to perform grease replenishment smoothly.
2. Remove the two caps from the grease inlet and air exhaust port.
3. Install the injection syringe for replenishment to the grease inlet.
   (The injection syringe is a recommended spare part.)
4. Inject grease through the grease inlet.
   – Grease type: Harmonic Grease SK-1A
   – Amount of grease to inject to the housing (inside of the tube excluded):
     S-, L-axes : 3 g
     U-axis : 2 g
     R-, B- and T-axes : 1 g
5. Remove the injection syringe for replenishment from the grease inlet.
   Install the two caps to the grease inlet and air exhaust port.
9.4 Notes for Maintenance

9.4.1 Multi-Port Connector

Three multi-port connectors (refer to fig. 9-6 "Multi-Port Connector") for the motor signals are mounted on each part of the manipulator. (For the locations, refer to fig. 9-2 "Locations of the Battery and Multi-port Connector")

The multi-port connector has four ports: two for the motor and the other two for the wire harness. (Refer to fig. 9-7 "Wiring of Multi-port Connector Part")

When disconnecting the connector of the multi-port connector during the battery replacement, be careful not to disconnect the connector between the motor and the multi-port connector. If the connector between the motor and the multi-port connector is disconnected, the encoder absolute data disappears.

Fig. 9-6: Multi-Port Connector

Fig. 9-7: Wiring of Multi-port Connector Part
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-HC10DT.

To purchase lead wires of the wire harness or etc., check the order/manufacture no. and contact YASKAWA representative.

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 10-1: Spare Parts for the YR-1-06VXHC10-A10 (Sheet 1 of 3)

<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>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>Grease</td>
<td>Harmonic Grease SK-1A</td>
<td>Harmonic Drive Systems Co., Ltd.</td>
<td>2.5 kg</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>2</td>
<td>Adhesive</td>
<td>LOCTITE 518</td>
<td>Henkel Japan Ltd</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>3</td>
<td>Lead Wire for Battery Replacement</td>
<td>HW1471281-A</td>
<td>YASKAWA Electric Corporation</td>
<td>1</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>4</td>
<td>Battery Pack</td>
<td>HW1483880-A</td>
<td>YASKAWA Electric Corporation</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>5</td>
<td>S- and L-axis unit</td>
<td>HW1172956-A</td>
<td>YASKAWA Electric Corporation</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>6</td>
<td>U- and R-axis unit</td>
<td>HW1172957-A</td>
<td>YASKAWA Electric Corporation</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>7</td>
<td>B- and T-axis unit</td>
<td>HW1172958-A</td>
<td>YASKAWA Electric Corporation</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>8</td>
<td>Connector base unit</td>
<td>HW1373278-A</td>
<td>YASKAWA Electric Corporation</td>
<td>1</td>
<td>1</td>
<td>Including the internal wiring harness for the basic axis</td>
</tr>
<tr>
<td>B</td>
<td>9</td>
<td>Internal wiring harness for the wrist axis</td>
<td>HW1173480-A</td>
<td>YASKAWA Electric Corporation</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>10</td>
<td>S-and L-Axes AC Servomotor</td>
<td>SGM7J-04APK-YR1*</td>
<td>YASKAWA Electric Corporation</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>11</td>
<td>U-Axis AC Servomotor</td>
<td>SGM7J-02APK-YR1*</td>
<td>YASKAWA Electric Corporation</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
### Table 10-1: Spare Parts for the YR-1-06VXHC10-A10 (Sheet 2 of 3)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Parts No.</th>
<th>Name Type</th>
<th>Manufacturer</th>
<th>Qty per Unit</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>12</td>
<td>R-, B- and T-Axes AC Servomotor</td>
<td>YASKAWA Electric Corporation</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>13</td>
<td>Power Cable for S-, L- and U-Axes AC Servomotor</td>
<td>YASKAWA Electric Corporation</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>14</td>
<td>Power Cable for R-, B- and T-Axes AC Servomotor</td>
<td>YASKAWA Electric Corporation</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>15</td>
<td>S-axis torque sensor</td>
<td>YASKAWA Electric Corporation</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>C</td>
<td>16</td>
<td>L-axis torque sensor</td>
<td>YASKAWA Electric Corporation</td>
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### Table 10-1: Spare Parts for the YR-1-06VXHC10-A10 (Sheet 3 of 3)

<table>
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<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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<tbody>
<tr>
<td>B</td>
<td>30</td>
<td>Shield Foam</td>
<td>65TSV10-2 (G)</td>
<td>Zippertubing (Japan), Ltd.</td>
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<td>2</td>
<td>One each for L-axis and T-axis</td>
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<td>A</td>
<td>31</td>
<td>Injector</td>
<td>HW1484274-A</td>
<td>YASKAWA Electric Corporation</td>
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<td>Direct Teach Button</td>
<td>HW1373333-A</td>
<td>YASKAWA Electric Corporation</td>
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</tbody>
</table>
MOTOMAN-HC10DT
INSTRUCTIONS

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