MITSUBISHI
Mitsubishi Industrial Robot

INSTRUCTION MANUAL ROBOT ARM SETUP \& MAINTENANCE

## \ Safety Precautions

Always read the following precautions and the separate "Safety Manual" before starting use of the robot to learn the required measures to be taken.

All teaching work must be carried out by an operator who has received special training. (This also applies to maintenance work with the power source turned ON.)
Enforcement of safety training

For teaching work, prepare a work plan related to the methods and procedures of operating the robot, and to the measures to be taken when an error occurs or when restarting. Carry out work following this plan. (This also applies to maintenance work with the power source turned ON.) Preparation of work plan

Prepare a device that allows operation to be stopped immediately during teaching work. (This also applies to maintenance work with the power source turned ON.)
Setting of emergency stop switch

Establish a set signaling method to the related operators for starting work, and follow this method.
Signaling of operation start

## . CAUTION

As a principle turn the power OFF during maintenance work. Place a sign indicating that maintenance work is in progress on the start switch, etc. Indication of maintenance work in progress

Before starting work, inspect the robot, emergency stop switch and other related devices, etc., and confirm that there are no errors.
Inspection before starting work

The points of the precautions given in the separate "Safety Manual" are given below. Refer to the actual "Safety Manual" for details.

Use the robot within the environment given in the specifications. Failure to do so could lead to a drop or reliability or faults. (Temperature, humidity, atmosphere, noise environment, etc.)

Transport the robot with the designated transportation posture. Transporting the robot in a non-designated posture could lead to personal injuries or faults from dropping.

Always use the robot installed on a secure table. Use in an instable posture could lead to positional deviation and vibration.

Wire the cable as far away from noise sources as possible. If placed near a noise source, positional deviation or malfunction could occur.

Do not apply excessive force on the connector or excessively bend the cable. Failure to observe this could lead to contact defects or wire breakage.

Make sure that the workpiece weight, including the hand, does not exceed the rated load or tolerable torque. Exceeding these values could lead to alarms or faults.

Securely install the hand and tool, and securely grasp the workpiece. Failure to observe this could lead to personal injuries or damage if the object comes off or flies off during operation.

Securely ground the robot and controller. Failure to observe this could lead to malfunctioning by noise or to electric shock accidents.

Indicate the operation state during robot operation. Failure to indicate the state could lead to operators approaching the robot or to incorrect operation.

When carrying out teaching work in the robot's movement range, always secure the priority right for the robot control. Failure to observe this could lead to personal injuries or damage if the robot is started with external commands.

Keep the jog speed as low as possible, and always watch the robot. Failure to do so could lead to interference with the workpiece or peripheral devices.

CAUTION After editing the program, always confirm the operation with step operation before starting automatic operation. Failure to do so could lead to interference with peripheral devices because of programming mistakes, etc.

Make sure that if the safety fence entrance door is opened during automatic operation, the door is locked or that the robot will automatically stop. Failure to do so could lead to personal injuries.

Never carry out modifications based on personal judgments, or use nondesignated maintenance parts.
Failure to observe this could lead to faults or failures.

When the robot arm has to be moved by hand from an external area, do not place hands or fingers in the openings. Failure to observe this could lead to hands or fingers catching depending on the posture.

Do not stop the robot or apply emergency stop by turning the robot controller's main power OFF. If the robot controller main power is turned OFF during automatic operation, the robot accuracy could be adversely affected. Moreover, it may interfere with the peripheral device by drop or move by inertia of the arm.

Do not turn off the main power to the robot controller while rewriting the internal information of the robot controller such as the program or parameters. If the main power to the robot controller is turned off while in automatic operation or rewriting the program or parameters, the internal information of the robot controller may be damaged.

Use the network equipments (personal computer, USB hub, LAN hub, etc) confirmed by manufacturer. The thing unsuitable for the FA environment (related with conformity, temperature or noise) exists in the equipments connected to USB, RS-232 or LAN. When using network equipment, measures against the noise, such as measures against EMI and the addition of the ferrite core, may be necessary. Please fully confirm the operation by customer. Guarantee and maintenance of the equipment on the market (usual office automation equipment) cannot be performed.

Be careful of interference with peripheral equipment.
Especially don't give a shock to the ball screw shaft (J3 axis). The ball screw shaft may be damaged.

Collision detection function is valid condition for both of automatic and jog operation at shipping in $\mathrm{RH}^{-}$ 3SHR series. However, damage to the ball screw shaft cannot be prevented completely.

Refer to the separate instruction manual "Detailed explanations of functions and operations" for collision detection function.

Take care also of the following items.
(1)The robot's locus of movement may change with specified speed.

Especially as for the corner section, short cut distance may change. Therefore, when beginning automatic operation, moves at low speed at first, and you should gather speed slowly with being careful of interference with peripheral equipment.

(2)It can be confirmed whether the specified position exist in the defined area by using the instruction command "ZONE". It can utilize as one of the methods for collision evasion. Refer to the "detailed description of the instructions manual/function, and operation" of the separate volume for the details of the instruction command.

Don't give a shock to the ball screw shaft at the time of hand installation. Especially don't strike the shaft end by hammer etc. The ball screw shaft may be damaged.

Revision history

| Date of Point | Instruction Manual No. | Revision Details |
| :--- | :--- | :--- |
| 2010-11-19 | BFP-A8839 | - First print |
| 2010-12-02 | BFP-A8839-A | - Error in writing was corrected. (Reference figure number in "3.1 Installing the solenoid <br> valve set") |
| 2011-02-02 | BFP-A8839-B | - The note of installing the hand input cable was added. <br> -The precautions about interference of the ball screw shaft and the movement locus <br> were added. |
| 2011-05-09 | BFP-A8839-C | - The note of the cover installation screw was added. <br> - The caution at installing and removing of the machine cable was added. |
|  |  |  |

Introduction

Thank you for purchasing the Mitsubishi industrial robot.
This instruction manual explains the unpacking methods, installation, basic operation, maintenance and inspection of the robot arm.
Always read through this manual before starting use to ensure correct usage of the robot.
The information contained in this document has been written to be accurate as much as possible. Please interpret that items not described in this document "cannot be performed."

And, when maintenance and inspection of the robot, to access the arm and the base section is necessary. Please prepare the environment which can access the robot with the stepladder etc. in RH-3SDHR.

The contents of this manual correspond to the following robot types.
〈Type〉 - RH-3SDHR3515 : General environment

- RH-3SDHR3512C: Clean specification
- RH-3SDHR3512W: Waterproof specification
- No part of this manual may be reproduced by any means or in any form, without prior consent from Mitsubishi.
- The details of this manual are subject to change without notice.
- The information contained in this document has been written to be accurate as much as possible. Please interpret that items not described in this document "cannot be performed." or "alarm may occur".
Please contact your nearest dealer if you find any doubtful, wrong or skipped point.
- This specifications is original.
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## 1 Before starting use

This chapter explains the details and usage methods of the instruction manuals, the basic terminology and the safety precautions.

### 1.1 Using the instruction manuals

### 1.1.1 The details of each instruction manuals

The contents and purposes of the documents enclosed with this product are shown below. Use these documents according to the application.
For special specifications, a separate instruction manual describing the special section may be enclosed.


Standard
Specifications
or
special
Specifications

## Robot Arm

Setup \&
Maintenance

Controller
Setup, Basic
Operation and
Maintenance

Detailed
Explanation of Functions and Operations


Explains the common precautions and safety measures to be taken for robot handling, system design and manufacture to ensure safety of the operators involved with the robot.

Explains the product's standard specifications, factory-set special specifications, option configuration and maintenance parts, etc. Precautions for safety and technology, when incorporating the robot, are also explained.

Explains the procedures required to operate the robot arm (unpacking, transportation, installation, confirmation of operation), and the maintenance and inspection procedures.

Explains the procedures required to operate the controller (unpacking, transportation, installation, confirmation of operation), basic operation from creating the program to automatic operation, and the maintenance and inspection procedures.

Explains details on the functions and operations such as each function and operation, commands used in the program, connection with the external input/output device, and parameters, etc.

Explains the causes and remedies to be taken when an error occurs. Explanations are given for each error No.

Explains the specifications, functions and operations of the additional axis control.

Explains the control function and specifications of conveyor tracking.

### 1.1.2 Symbols used in instruction manual

The symbols and expressions shown in Table 1-1 are used throughout this instruction manual. Learn the meaning of these symbols before reading this instruction manual.

Table 1-1: Symbols in instruction manual

| Terminology | Item/Symbol | Meaning |
| :--- | :---: | :--- |
| Item | The "Robot controller" or the "Controller" | Indicates the controller which controls the robot arm. <br> Indicates the box which arranged control parts, such as robot CPU, servo <br> amplifier, and the safety circuit. |
| Symbol | Precaution indicating cases where there is a risk of operator fatality or <br> serious injury if handling is mistaken. Always observe these precautions to <br> safely use the robot. |  |

### 1.2 Safety Precautions

Always read the following precautions and the separate "Safety Manual" before starting use of the robot to learn the required measures to be taken.

All teaching work must be carried out by an operator who has received special training. (This also applies to maintenance work with the power source turned ON.) Enforcement of safety training

For teaching work, prepare a work plan related to the methods and procedures of operating the robot, and to the measures to be taken when an error occurs or when restarting. Carry out work following this plan. (This also applies to maintenance work with the power source turned ON.)
Preparation of work plan

Prepare a device that allows operation to be stopped immediately during teaching work. (This also applies to maintenance work with the power source turned ON.) Setting of emergency stop switch

During teaching work, place a sign indicating that teaching work is in progress on the start switch, etc. (This also applies to maintenance work with the power source turned ON.)
Indication of teaching work in progress

Provide a fence or enclosure during operation to prevent contact of the operator and robot.
Installation of safety fence

Establish a set signaling method to the related operators for starting work, and follow this method.
Signaling of operation start

As a principle turn the power OFF during maintenance work. Place a sign indicating that maintenance work is in progress on the start switch, etc. Indication of maintenance work in progress

Before starting work, inspect the robot, emergency stop switch and other related devices, etc., and confirm that there are no errors. Inspection before starting work

### 1.2.1 Precautions given in the separate Safety Manual

The points of the precautions given in the separate "Safety Manual" are given below.
Refer to the actual "Safety Manual" for details.

DANGER
If the automatic operation of the robot is operated by two or more control equipment, design the right management of operation of each equipment of the customer.
CAUTION
Use the robot within the environment given in the specifications. Failure to do so could lead to a drop or reliability or faults. (Temperature, humidity, atmosphere, noise environment, etc.)
CAUTION
Transport the robot with the designated transportation posture. Transporting the robot in a non-designated posture could lead to personal injuries or faults from dropping.

CAUTION
Always use the robot installed on a secure table. Use in an instable posture could lead to positional deviation and vibration.

CAUTION
Wire the cable as far away from noise sources as possible. If placed near a noise source, positional deviation or malfunction could occur.

Do not apply excessive force on the connector or excessively bend the cable. Failure to observe this could lead to contact defects or wire breakage.
CAUTION
Make sure that the workpiece weight, including the hand, does not exceed the rated load or tolerable torque. Exceeding these values could lead to alarms or faults.

Securely install the hand and tool, and securely grasp the workpiece. Failure to observe this could lead to personal injuries or damage if the object comes off or flies off during operation.

Securely ground the robot and controller. Failure to observe this could lead to malfunctioning by noise or to electric shock accidents.

Indicate the operation state during robot operation. Failure to indicate the state could lead to operators approaching the robot or to incorrect operation.

When carrying out teaching work in the robot's movement range, always secure the priority right for the robot control. Failure to observe this could lead to personal injuries or damage if the robot is started with external commands.
CAUTION
Keep the jog speed as low as possible, and always watch the robot. Failure to do so could lead to interference with the workpiece or peripheral devices.

After editing the program, always confirm the operation with step operation before starting automatic operation. Failure to do so could lead to interference with peripheral devices because of programming mistakes, etc.
Make sure that if the safety fence entrance door is opened during automatic operation, the door is locked or that the robot will automatically stop. Failure to do so could lead to personal injuries.

Never carry out modifications based on personal judgments, or use non-designated maintenance parts.
Failure to observe this could lead to faults or failures.
WARNING
When the robot arm has to be moved by hand from an external area, do not place hands or fingers in the openings. Failure to observe this could lead to hands or fingers catching depending on the posture.

CAUTION
Do not stop the robot or apply emergency stop by turning the robot controller's main power OFF.
If the robot controller main power is turned OFF during automatic operation, the robot accuracy could be adversely affected.

Do not turn off the main power to the robot controller while rewriting the internal information of the robot controller such as the program or parameters. If the main power to the robot controller is turned off while in automatic operation or rewriting the program or parameters, the internal information of the robot controller may be damaged.

When the SSCNETIII cable is removed, install the cap in the connector. If the cap is not installed, there is a possibility of malfunctioning by adhesion of the dust etc.

Don't remove the SSCNETIII cable, when the power supply of the robot controller is turned on. Don't face squarely the light emitted from the tip of the SSCNETIII connector or the cable. If light strikes the eyes, there is a possibility of feeling the sense of incongruity for the eyes. (The light source of SSCNETIII is equivalent to the class 1 specified to JISC6802 and IEC60825-1.)

## 2 Unpacking to Installation

### 2.1 Confirming the product

The standard configuration of the robot arm, part of the purchased product, is shown in Table 2-1.
Confirm the parts.
Users who have purchased optional products should refer to the separate "Standard Specifications".
Table 2-1 : Standard configuration

| No. | Part name | Type | Qty. | Remarks |
| :---: | :--- | :--- | :---: | :---: |
| 1 | Robot arm | R | 1 unit |  |
| 2 | Guarantee card |  | 1 copy |  |
| 3 | Installation bolts | M8 $\times 40$ | 4 pcs. | For robot arm installation |
| 4 | Installation bolts (Spare) | M8 | 4 pcs. |  |
| 5 | Installation nut | For M8 | 4 pcs. |  |
| 6 | Spring washer for installation bolts | For M8 | 8 pcs. |  |
| 7 | Plain washer for installation bolts |  | 8 pcs. |  |
| 8 | Hanging tools (Eye bolt) |  | 1 set | To hang the robot arm with the crane. |
| 9 | Fixing plate | M5 | Fixing plates installation bolt: 5 pcs. <br> Nuts: 4 pcs. |  |
| 10 | Nats for T slot | pcs. | For fixing the tool wiring etc. |  |

Note1) The number 3 to 7 is contained in the plastic bag of attachment in the robot arm.
Note2) The numbers 8 and 9 are installed in the robot arm.

### 2.2 Installation

### 2.2.1 Unpacking



Unpacking the robot with hoisting. (Utilize the hanging tools (two places) <4> of the robot arm) Please unpack near the installation place.
$\triangle$ CAUTION
Unpack at the sure flat place. The robot may fall at the unstable place.

## $\triangle$ CAUTION

Don't remove fixing plate <7> till installation is completed. When you pack the robot again, be sure to install the fixing plate $\langle 7\rangle$.

Fig.2-1: Unpacking the robot arm

The unpacking procedure is shown below.

1) Cut with scissors etc. the tape $\langle 1\rangle$ of fixing cardboard.
2) Raise and remove upper cover $\langle 2\rangle$. Remove packing material (cardboard) $\langle 3\rangle$ in the inside.
3) Open the vinyl and confirm the hanging tools (two places) $\langle 4\rangle$. Hang the hook of the crane here. (Two places)
4) Hoist with the crane and separate the robot arm together with packing material from the packing box.
5) Cut with scissors etc. tape $\langle 6\rangle$ which fixed packing material $\langle 5\rangle$, and remove packing material $\langle 4\rangle$.

Unpacking is complete above.

### 2.2.2 Transportation procedures(Transporting with a crane)



Fig.2-2 : Transportation of robot arm

The transportation procedure is shown below. Transport the robot with careful of safety, referring to Fig. 2-2.

## $\triangle$ CAUTION

Transport by using the crane with fixing plate (7) still being installed is necessary. Transport carefully so that the robot may not tilt by using two wires. Take care sufficiently not to give the interference and the shock with the installation stage etc.,

1) Transport the robot by the crane from the condition which unpacking completed to the fixing position of installation stage <8>.
2) Fixing the robot by four installation bolts $\langle 9\rangle$ (attached) certainly to installation stage $\langle 8\rangle$.
3) Remove hanging tools (two places) $\langle 4\rangle$ after installation. Loosen the screw ( $M 5 \times 4, M 4 \times 1$ ) fixing the fixing plate $\langle 7\rangle$, and remove the fixing plate $\langle 7\rangle$. Also remove the nut for $T$ slots. Fixing plate $\langle 7\rangle$, and fixing screws and hanging tools $\langle 4\rangle$ are needed at secondary transportation. Please keep them with care.

Transportation is complete above.
The transportation posture is shown in Table 2-2.
Table 2-2 : Transportation posture

| Axis | RH-3SDHR3515 |
| :---: | :---: |
| J 1 | 0 deg. |
| J 2 | 0 deg. |
| $\mathrm{J} 3^{\text {Note1) }}$ | -569.5 mm (Upper end) |
| J 4 | Not fixed |

Note1) Because if the J3 axis is lowered the shaft juts danger, be sure to specified posture at transport.

### 2.2.3 Installation procedures

The installation procedure of the robot arm is shown below.


Maintenance space

*2) The interference of installation bolt and No. 1 arm may occur depending on the size of installation stage. Take care against interference of installation bolt, such as inserting the installation bolt from the bottom.

Fig.2-3 : Installation dimensions

1) The robot installation surface has been machine finished. Use the installation holes (4- $\phi 9$ ) opened at the four corners of the base, and securely fix the robot with the enclosed installation bolts (hexagon socket bolts).
2) Install the robot on a level surface.
3) It is recommended that the surface roughness of the table onto which the robot is to be installed by Rz25 or more. If the installation surface is rough, the contact with the table will be poor, and positional deviation could occur when the robot moves.
4) When installing, use a common table to prevent the position of the devices and jigs subject to robot work from deviating.
5) The installation surface must have sufficient strength to withstand the arm reaction during operation, and resistance against deformation and vibration caused by the static (dynamic) load of the robot arm and peripheral devices, etc.
6) If you operate the robot at a high speed, reaction forces are applied to the installation stand by the robot's operation. Make sure that the installation stand on which the robot is placed has sufficient strength and rigidity. Table 2-3 shows the maximum reaction force (design values) that may be applied to an installation stand. Please use these values as reference when designing the installation stand.

Table 2-3: Magnitude of each reaction force

|  | Unit | Value |
| :--- | :---: | :---: |
| Tilt moment : $\mathrm{M}_{\mathrm{L}}$ | $\mathrm{N} \cdot \mathrm{m}$ | 380 |
| Torsional moment : $\mathrm{M}_{\mathrm{T}}$ | $\mathrm{N} \cdot \mathrm{m}$ | 410 |
| Horizontal direction translation force $: \mathrm{F}_{\mathrm{H}}$ | N | 920 |
| Vertical direction translation force $: \mathrm{F}_{\mathrm{V}}$ | N | 570 |

$\triangle$ CAUTION
Secure the maintenance space necessary at rear for connection of the machine cable and at side for replacement of the backup battery.
2.2.4 Grounding procedures
(1) Grounding methods


Fig.2-4 : Grounding methods
(2) Grounding procedures


Robot grounding cable (AWG\#11 ( $4.2 \mathrm{~mm}^{2}$ ) or more)
(Prepared by customer)

Fig.2-5 : Connecting the grounding cable

1) There are three grounding methods as shown in Fig. 2-4, but the dedicated grounding (Fig. 2-4 (a)) should be used for the robot arm and controller when possible. (Refer to the separate" Controller Setup, Basic Operation and Maintenance" for details on the controller grounding.)
2) Use Class D grounding (grounding resistance $100 \Omega$ or less).
Dedicated grounding separated from the other devices should be used.
3) Use a AWG\#11(4.2mm ${ }^{2}$ ) or more stranded wire for the grounding wire. The grounding point should be as close to the robot arm and controller as possible, and the length of the grounding wire should be short.
4) Prepare the grounding cable (AWG\#11(4.2 $\mathrm{mm}^{2}$ ) or more) and robot side installation screw and washer.
5) If there is rust or paint on the grounding screw section (A), remove it with a file, etc.
6) Connect the grounding cable to the grounding screw section.

### 2.2.5 Connecting with the controller



Fig.2-6 : Connecting the machine cables

Carry out the following procedure after installing the controller referring to the separate "Controller Setup, Basic Operation and Maintenance" manual.


The procedure of connecting the machine cable is shown below. (Although the figure of the robot arm is the example of RV-12SD, it is the same)

1) Make sure that the power switch on the front of the controller is turned OFF.
2) Connect the machine cable to its corresponding connector on the robot arm side.

3) After connecting the connector, insert the hook attached to the connector on the machine cable side to the rear of the projection of the robot arm connector to fix securely in place.

## . CAUTION Be careful not to get your hand pinched.

4) To remove the cable, insert a minus screwdriver into the hook while padding with a cloth, and remove the cable by lifting the hook.

## $\triangle$ CAUTION

When installing or removing the connector, to the connector of the other party in parallel, install or remove. If load strong against one side is applied, the connector pin may be damaged and it may not be connected securely.

The machine cable connectors are dedicated for the controller side and robot arm side, so take special care when connecting.
If connected incorrectly, the connector pins could bend or break. Thus, even if connected correctly, the robot will not operate correctly, creating a dangerous situation.

Take special care to the leading of the connection cable. If the cable is pulled with force or bent excessively, wires could break or the connector could be damaged.

Connect the machine cable at the place without the effect of the dust or oil mist. Please keep the dust and oil mist from being applied to of the robot-arm connector section, in the condition that the machine cable is removed. Since it becomes the cause of failure.

Please be careful not to catch the hand at installation and removal.

### 2.3 Spare wiring

As spare wiring four pairs of cab tire cables (AWG\#27 ( $0.1 \mathrm{~mm}^{2}$ ), Total is eight cores both) are preinstalled between the base section and the No. 2 arm rear section. Customer can utilize it. The cable clamp (customer preparation) is necessary to use.

### 2.3.1 No. 2 arm section



Fig.2-7 : Pull out spare wiring

1) The spare wiring (ADD) preinstalled in the robot arm has connector. Please prepare the following of the customer.

- The cable (calls the "cable for spare wiring connection" below)
- Connector
- The cable clamp for fixing the cable for spare wiring connection (OA-W1608 : Product by OHM ELECTRIC CO., LTD)
(The cable is AWG\#27 ( $0.1 \mathrm{~mm}^{2}$ ). Refer to the "standard specification document" for detail of the connector.)

2) Remove the low head hexagon socket bolt (four M4 $\times 8$ ) fixing the No. 2 arm cover, and remove the No. 2 arm cover.
3) Confirm spare wiring (ADD).
4) Remove either one grommet on the No. 2 arm cover.
5) Install the connector after letting the cable for spare wiring connection of customer preparation pass to the cable clamp.
6) Fixing the cable clamp securely to the hole which removed the grommet.
7) Connect the cable for spare wiring connection to the spare wiring.
8) Install the No. 2 arm cover as before. Be careful not to catch any the cables.

When pulling out spare wiring, keep big power from being added to the cable, the air hose.

When No. 2 arm cover is installed, please keep too much load from being applied to the cables inside the robot, and the air hoses.
If too much load is added, the breaking of a wire and the air hose break, and the robot cannot operate normally.

Normal condition

abnormal condition


## Air hose

When No. 2 arm cover is installed, catch neither the cable nor the air hose. If the bolt is tightened while it had been caught, the breaking of a wire and the air hose break, and the robot cannot operate normally.

### 2.3.2 Base area

1) Remove the base cover $B(R)$.


Fig.2-8 : Pull out spare wiring(Base area)
2) The spare wiring (ADD: coiled) preinstalled in the robot arm has connector. The spare wiring (ADD) preinstalled in the robot arm has connector. Please prepare the following of the customer.

- The cable (calls the "cable for spare wiring connection" below)
- Connector
- The cable clamp for fixing the cable for spare wiring connection (OA-W1608 : Product by OHM ELECTRIC CO., LTD)
(The cable is AWG\#27 ( $0.1 \mathrm{~mm}^{2}$ ). Refer to the "standard specification document" for detail of the connector.)

3) Remove the base cover $B(L)$.
4) Confirm spare wiring (ADD). Since spare wiring is bundled in the cable tie, if length is necessary, cut the cable tie.
5) Remove the grommet on the base.
6) Install the connector after letting the cable for spare wiring connection of customer preparation pass to the cable clamp.
7) Fixing the cable clamp securely to the hole which removed the grommet.
8) Connect the cable for spare wiring connection to the spare wiring.
9) Install the base cover $B(L)$ as before. Be careful not to catch any the cables.

When pulling out spare wiring, keep big power from being added to the cable, the air hose.

When base cover $B(R)$ is installed, please keep too much load from being applied to the cables inside the robot, and the air hoses.
If too much load is added, the breaking of a wire and the air hose break, and the robot cannot operate normally.

Normal condition

abnormal condition


## Air hose

When base cover $B(R)$ is installed, catch neither the cable nor the air hose. If the bolt is tightened while it had been caught, the breaking of a wire and the air hose break, and the robot cannot operate normally.

### 2.4 Setting the origin

The origin is set so that the robot can be used with a high accuracy. After purchasing the robot, always carry out this step before starting work. This step must also be carried out if the combination of robot and controller being used is changed.
There are several methods for setting the origin, but the origin data input method will be explained here. Refer to Page 81, " 5.6 Resetting the origin" for the other methods.
The teaching pendant is required for this operation.
[Caution] If the origin data at shipment is erased due to out of battery, it is necessary to set the origin again. Refer to Page 81, "5.6 Resetting the origin" and reset the origin using the jig method or ABS method.

### 2.4.1 Installing the teaching pendant (T/B)

When installing and removing the $T / B$, turn off the controller power supply. If $T / B$ is installed or removed in the state of power supply ON, emergency stop alarm will occur.
If you use the robot wherein $T / B$ is removed, please install the attached dummy connector. With the connector, put the dummy connector or draw it out.


Please do not pull the cable of T/B strongly or do not bend it too much.
It becomes the breaking of a wire of the cable and the cause of breakage of the connector. Please installing and removing so that stress does not start the cable with the connector itself.

Explain the installation method of T/B below.

1) Check that the POWER (power supply) switch of the robot controller is OFF.
2) Connects $T / B$ connector to the robot controller. Use as the upper surface the lock lever shown in Fig. 2-9, and push in until there is sound.


Fig.2-9 : Installing and removing the T/B
The installation of $T / B$ is finished.

## $\diamond \diamond \diamond$ If error C0150 occurs $\diamond\rangle \diamond$

At the time of the first power supply injection, error:C0150 (the serial number of the robot arm has not been set up) occur the robot after purchase.
Parameter: Please input the serial number of the robot body into RBSERIAL. Refer to "instructions manual / controller setup, and basic operation \& maintenance" for the operation method.
2.4.2 Setting the origin with the origin data input method
(1) Confirming the origin data

| Date | Default | . . | . . | . . |
| :---: | :---: | :---: | :---: | :---: |
| D | V!\#S29 |  |  |  |
| J 1 | 06DTYY |  |  |  |
| J 2 | 2?HL9X |  |  |  |
| J 3 | 1CP55V |  |  |  |
| Ј 4 | T6!M\$Y |  |  |  |
| J 5 | Z2IJ\%Z |  |  |  |
| 」 6 | A12\%Z0 |  |  |  |
| Method | E | E $\cdot N \cdot S$ P | $\begin{aligned} & E \cdot N \cdot \\ & S P \end{aligned}$ | $E \cdot N \cdot S P$ |

(O: O(Alphabet), 0: Zero)
Note) Meanings of symbols in method column
E: Jig method
N: Not used
SP: Not used
The origin data to be input is noted in the origin data sheet enclosed with the arm, or on the origin data history table attached to the back side of the base cover B(L). (Refer to Fig. 2-10).

Referring to Page 66, " 5.3.2 Installing/ removing the cover", remove the base cover $B(L)$ and confirm the value.

The value given in the default setting column is the origin settings set with the calibration jig before shipment.

Fig.2-10 : Origin data label (an example)

* The origin data to input is found on also the robot examination report sheet.

Always install/remove the cover with the controller control power turned OFF. Failure to do so could lead to physical damage or personal injury should the robot start moving due to incorrect operations.
(2) Turning ON the control power
. CAUTION
Confirm that there are no operators near the robot before turning the power ON.

1) Turn the controller [POWER] switch ON.

The control power will be turned ON, and " 0.100 " will appear on the STATUS NUMBER display on the front of the controller.
(3) Preparing the $T / B$


Next, prepare to use the T/B

1) Set the [MODE] switch on the front of the controller to "MANUAL".
2) Set the T/B [ENABLE] switch to "ENABLE". The menu selection screen will appear.
The following operations are carried out with the T/B.

## Operating from the $T / B \diamond \diamond\rangle$

Always set the [MODE] switch (mode selection key switch) on the front of the controller to "MAMNUAL", and then set the T/B [ENABLE] switch to "ENABLE".
When the $T / B$ is valid, only operations from the $T / B$ are possible. Operations from the controller or external signals will not be accepted.
(4) Selecting the origin setting method


1) Press the [4] key on the menu screen, and display the ORIGIN/BRAKE screen.
2) Press the [1] key on the ORIGIN/BRAKE screen, and display the origin setting method selection screen.
3) Press the [1] key on the origin setting method selection screen, and select the data input method.
4) Display the origin data input screen

## Selecting a menu $\diamond \diamond \diamond$

The menu can be selected with one of the following methods.
A: Press the numeral key for the No. of the item to be selected.
B: Using the [ $\downarrow$ ] and [ $\uparrow$ ] keys, etc., move the cursor to the item to be selected, and then press the [INP] key.

The input method of numeral $\diamond \diamond \diamond$
The number can be inputted if the key displayed on the lower left of each key is pressed. Press the [CHARACTER] key, and in the condition that " 123 " is displayed on the screen lower side, press the number key.
(5) Inputting the origin data

T/B screen Origin data label


Input the value confirmed in section Page 19, "(1) Confirming the origin data".
The correspondence of the origin data label value and axis to be input is shown in Fig. 2-11.

Fig.2-11: Correspondence of origin data label and axis

The method for inputting the origin data is explained below. The value shown in Fig. 2-10 will be input as an example.

2) Input the $D$ value " $V!\% S 29$ ".

Inputting " $V$ "
Press the [CHARACTER] key and set to the character input mode. (Condition that "ABC" was displayed under the screen)
Press the [TUV] key three times. " V " will be set.


Inputting "!"
Press the [, \% ] key five times. "!" will be set.
Press the [ $\rightarrow$ ] key once and advance the cursor.
Press the [, \%] key twice (input "\%"), and press the [PQRS] key four times (input "S").

Press the [CHARACTER] key and set to the numeral input mode. (Condition that "123" was displayed under the screen)
Press the [2] key (input "2"), and press the [9] key (input " 9 ").
" $\mathrm{V}!\%$ S29" will appear at the " D " data on the teaching pendant screen.

3) Press the $[\downarrow]$ key, and move the cursor to the $J 1$ input position.
4) Input the J 1 value in the same manner as above.

Input the $\mathrm{J} 2, \mathrm{~J} 3, \mathrm{~J} 4, \mathrm{~J} 5$ and J 6 values in the same manner.

<ORIGIN> DATA

CHANGE TO ORIGIN. OK?

Yes $\qquad$ 123 No F1
5) After inputting all of the values, press the [EXE] key. The origin setting confirmation screen will appear.

EXE
6) Press $[\mathrm{F} 1]$ (Yes) to end the origin setting

Moving the cursor
Press the [ $\uparrow$ ], [ $\downarrow$ ], $[\leftarrow]$ and $[\rightarrow]$ keys.
Inputting characters $\diamond \diamond \diamond$
Press the [CHARACTER] key and set to the character input mode. (Condition that "ABC" was displayed under the screen). The displayed character is scrolled each time at pressing the key.

## Correcting an input $\diamond \diamond \diamond$

After returning one character by pressing the [CLEAR] key, input the character again.
(6) Installing the base cover $B(L)$.

Return the base cover $B(L)$ removed in section Page 19, "(1) Confirming the origin data" to its original position. This completes the setting of the origin with the origin data input method.

Always remove and install the cover with the controller power turned OFF. Failure to do so could lead to the robot moving because of incorrect operations, or to physical damage or personal injury.
$\diamond \diamond$ If the origin input data is incorrect $\diamond \gg$
If the origin input data is incorrect, the alarm No. 1760 (origin setting data illegal) will occur when origin data input. In this case, reconfirm the value input for the origin data.

### 2.5 Confirming the operation

In this section, the robot will be moved manually using the $T / B$ to confirm that the operation is correct. Moving the robot manually is called "jog operation". This operation includes the JOINT jog that moves each axis, the XYZ jog that moves along the base coordinate system, the TOOL jog that moves along the tool coordinate system, and the CYLNDER jog that moves along the circular arc.
This operation is carried out while pressing the deadman switch on the back of the T/B.
CAUTION
The robot will move during this operation. Make sure that there are no operators near the robot, and that there are no obstacles, such as tools, in the robot operation range.

To immediately stop the robot, release the deadman switch on the back of the T/B. The servo power will turn OFF, and the robot will stop.
The robot will also stop if the [EMG.STOP] switch (emergency stop switch) on the front of the T/B or the [EMG.STOP] switch (emergency stop) on the front of the controller is pressed.

## (1) WARNING

Confirm that the origin has been set. If the origin has not been set, "****" will appear at the current position display on the teaching pendant, the JOINT jog operation will take place in any jog mode selected.
Refer to " 2.4 Setting the origin" on page 18 for details on setting the origin.


Fig.2-12 : JOINT jog operation


* While maintaining the end axis posture, the axis moves straight along the base coordinate system.
Also, while maintaining the end axis position, the end axis posture changes..

Fig.2-13 : XYZ jog operation


Fig.2-14 : TOOL jog operation


Fig.2-15: 3-axis XYZ jog operation


* The current position is set as the arc centering on the $Z$ axis, and the axis moves along that arc, expands and contracts in the radius direction, and moves vertically. At this time, the end axis posture is maintained. Also, while maintaining the axis posture position, the end axis posture changes.

Fig.2-16 : CYLINDER jog operation


Fig.2-17 : WORK jog operation
(1) JOINT jog operation

Select joint jog mode


Set jog speed

[JOG] Press the key and display the jog screen. ("JOG" is displayed on the screen bottom)
Check that the "joint" in jog mode is displayed on the screen.
If other jog modes are displayed, please press the function key corresponding to the "joint." (If the jog mode which he wishes under the screen is not displayed, it is displayed that the [FUNCTION] key is pressed)
If it finishes jog operation, press the [JOG] key again, or function key which correspond to "close."
Whenever it presses the key of [OVRD $\uparrow$ ], the override goes up. Conversely, if the [OVRD $\downarrow$ ]
key is pressed, it will go down.
The current setting speed is displayed on screen upper right, and "STATUS NUMBER" of the controller.
Set the override to $10 \%$ here for confirmation work
$\underline{\mathrm{J} 1 \text { axis jog operation }}$


- When the $[+\mathrm{X}(\mathrm{J} 1)]$ keys are pressed, the J 1 axis will rotate in the plus direction. When the $[-X(J 1)]$ keys are pressed, Rotate in the minus direction.

- When the $[+\mathrm{Y}(\mathrm{J} 2)]$ keys are pressed, the J 2 axis will rotate in the plus direction. When the $[-Y(J 2)]$ keys are pressed, Rotate in the minus direction.

When the robot is in the transportation posture $\rangle\langle\diamond$
The axes may be outside the movement area. Move these axes toward the inner side of the movement area.
$\underline{\text { J3 axis jog operation }}$


- When the $[+Z(\mathrm{~J} 3)]$ keys are pressed, the J 3 axis will rotate in the plus direction. When the $[-Z(J 3)]$ keys are pressed, Rotate in the minus direction.

J4 axis jog


- When the $[+\mathrm{A}(\mathrm{J} 4)]$ keys are pressed, the J 4 axis will rotate in the plus direction. When the [-A (J4)] keys are pressed, Rotate in the minus direction.
$\diamond>$ If the buzzer of T/B sounds and the robot does not move
If it is going to move the robot across the operation range, the buzzer of $T / B$ sounds and the robot does not move. In this case, please move to the counter direction.
(2) XYZ jog operation

Select XYZ jog mode


Set jog speed

[JOG] Press the key and display the jog screen. ("JOG" is displayed on the screen bottom)
Check that the "XYZ" in jog mode is displayed on the screen.
If other jog modes are displayed, please press the function key corresponding to the "XYZ." (If the jog mode which he wishes under the screen is not displayed, it is displayed that the [FUNCTION] key is pressed)
If it finishes jog operation, press the [JOG] key again, or function key which correspond to "close."
Whenever it presses the key of [OVRD $\uparrow$ ], the override goes up. Conversely, if the [OVRD $\downarrow$ ] key is pressed, it will go down.
The current setting speed is displayed on screen upper right, and "STATUS NUMBER" of the controller.
Set the override to $10 \%$ here for confirmation work

Moving along the base coordinate system


- When the $[+X(J 1)]$ keys are pressed, the robot will move along the $X$ axis plus direction. When the $[-X(J 1)]$ keys are pressed, Move along the minus direction.
- When the $[+Y(\mathrm{~J} 2)]$ keys are pressed, the robot will move along the $Y$ axis plus direction. When the $[-Y(J 2)]$ keys are pressed, Move along the minus direction.
- When the $[+Z(\mathrm{~J} 3)]$ keys are pressed, the robot will move along the $Z$ axis plus direction. When the $[-Z(J 3)]$ keys are pressed, Move along the minus direction.
$\diamond>$ When the robot is in the transportation posture
There are directions from which linear movement is not possible from the transportation posture. In this case, the robot will not move. Refer to section "(1)JOINT jog operation" on page 28", and move the robot to a position where linear movement is possible, and then carry out XYZ jog.
$\diamond \gg$ If the buzzer of T/B sounds and the robot does not move $\diamond \gg$
If it is going to move the robot across the operation range, the buzzer of $T / B$ sounds and the robot does not move. In this case, please move to the counter direction.

Changing the end axis posture

-When the [+C (J6)] keys are pressed, The $Z$ axis will rotate in the plus direction. When the $[-\mathrm{C}(\mathrm{J} 6)]$ keys are pressed, Rotate in the minus direction.
$\diamond \diamond \diamond$ When alarm No. 5150 occurs $\diamond \diamond \diamond$
If alarm No. 5150 (ORIGIN NOT SET) occurs, the origin has not been set correctly. Reconfirm the value input for the origin data.

The default tool length is 0 mm , and the control point is the center of the end axis.
After installing the hand, set the correct tool length in the parameters. Refer to the separate manual "Detailed Explanation of Functions and Operations" for details.
(3) TOOL jog operation


Set jog speed

[JOG] Press the key and display the jog screen. ("JOG" is displayed on the screen bottom) Check that the "TOOL" in jog mode is displayed on the screen.
If other jog modes are displayed, please press the function key corresponding to the "TOOL." (If the jog mode which he wishes under the screen is not displayed, it is displayed that the [FUNCTION] key is pressed)
If it finishes jog operation, press the [JOG] key again, or function key which correspond to "close."
Whenever it presses the key of [OVRD $\uparrow$ ], the override goes up. Conversely, if the [OVRD $\downarrow$ ]
key is pressed, it will go down.
The current setting speed is displayed on screen upper right, and "STATUS NUMBER" of the controller.
Set the override to $10 \%$ here for confirmation work

-When the $[+X(J 1)]$ keys are pressed, the robot will move along the $X$ axis plus direction of the tool coordinate system.
When the $[-X(\mathrm{~J} 1)]$ keys are pressed, Move along the minus direction.

- When the $[+Y(J 2)]$ keys are pressed, the robot will move along the $Y$ axis plus direction of the tool coordinate system.
When the $[-Y(J 2)]$ keys are pressed, Move along the minus direction.
-When the $[+Z(J 3)]$ keys are pressed, the robot will move along the $Z$ axis plus direction of the tool coordinate system.
When the $[-Z(J 3)]$ keys are pressed, Move along the minus direction.
$\diamond \gg$ When the robot is in the transportation posture $\rangle \gg$
There are directions from which linear movement is not possible from the transportation posture. In this case, the robot will not move. Refer to section "(1)JOINT jog operation" on page 28 ", and move the robot to a position where linear movement is possible, and then carry out XYZ jog.
$\diamond \diamond$ If the buzzer of T/B sounds and the robot does not move
If it is going to move the robot across the operation range, the buzzer of $T / B$ sounds and the robot does not move. In this case, please move to the counter direction.

Changing the end axis posture


- When the $[+C(J 6)]$ keys are pressed, The $Z$ axis will rotate in the plus direction of the tool coordinate system. When the $[-\mathrm{C}(\mathrm{J} 6)]$ keys are pressed, Rotate in the minus direction.

When alarm No. 5150 occurs $\diamond \diamond\rangle$
If alarm No. 5150 (ORIGIN NOT SET) occurs, the origin has not been set correctly. Reconfirm the value input for the origin data.

## Tool length $\diamond \diamond \diamond$

The default tool length is 0 mm , and the control point is the center of the end axis.
After installing the hand, set the correct tool length in the parameters. Refer to the separate manual "Detailed Explanation of Functions and Operations" for details.
(4) 3-axis XYZ jog operation


Set jog speed

[JOG] Press the key and display the jog screen. ("JOG" is displayed on the screen bottom) Check that the "XYZ456" in jog mode is displayed on the screen.
If other jog modes are displayed, please press the function key corresponding to the "XYZ456." (If the jog mode which he wishes under the screen is not displayed, it is displayed that the [FUNCTION] key is pressed)
If it finishes jog operation, press the [JOG] key again, or function key which correspond to "close."
Whenever it presses the key of [OVRD $\uparrow$ ], the override goes up. Conversely, if the [OVRD $\downarrow$ ] key is pressed, it will go down.
The current setting speed is displayed on screen upper right, and "STATUS NUMBER" of the controller.
Set the override to $10 \%$ here for confirmation work

Moving along the base coordinate system


- When the $[+X(\mathrm{~J} 1)]$ keys are pressed, the robot will move along the $X$ axis plus direction.

When the $[-X(J 1)]$ keys are pressed, Move along the minus direction.

- When the $[+Y$ (J2)] keys are pressed, the robot will move along the $Y$ axis plus direction. When the $[-Y$ (J2)] keys are pressed, Move along the minus direction.
- When the $[+Z(\mathrm{~J} 3)]$ keys are pressed, the robot will move along the $Z$ axis plus direction. When the $[-Z(J 3)]$ keys are pressed, Move along the minus direction.

The flange surface end axis posture cannot be maintained with $3-$ axis XYZ jog.
With 3-axis XYZ jog, the flange surface end axis posture (orientation) is not maintained when moving linearly in the $X, Y$ or $Z$ axis direction.
Use $X Y Z$ jog to maintain the posture.

Changing the end axis posture


- When the $[+\mathrm{C}(\mathrm{J} 6)]$ keys are pressed, the J 4 -axis will rotate in the plus direction.

When the $[-C$ (J6)] keys are pressed, Rotate in the minus direction.
(5) CYLNDER jog operation


Set jog speed

| <CURREN | NT> J0 | JOINT | 10 | 00\% M1 | T0 |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| J1: | $+0.00$ |  | J5: + | +0.00 |  |  |  |
| J2: | +0.00 |  | J6: | +0.00 |  |  |  |
| J3: + | +90.00 |  |  |  |  |  |  |
| J4: | +0.00 |  | . |  |  | OVRD $\uparrow$ | OVRD $\downarrow$ |
| XYZ | T00L | JOG | 3-XYZ | CYLNDR |  |  |  |

[JOG] Press the key and display the jog screen.
("JOG" is displayed on the screen bottom)
Check that the "CYLNDER" in jog mode is displayed on the screen.
If other jog modes are displayed, please press the function key corresponding to the "CYLNDER." (If the jog mode which he wishes under the screen is not displayed, it is displayed that the [FUNCTION] key is pressed)
If it finishes jog operation, press the [JOG] key again, or function key which correspond to "close."
Whenever it presses the key of [OVRD $\uparrow$ ], the override goes up. Conversely, if the [OVRD $\downarrow$ ] key is pressed, it will go down.
The current setting speed is displayed on screen upper right, and "STATUS NUMBER" of the controller.
Set the override to $10 \%$ here for confirmation work

Moving along an arc centering on the Z axis


Assuming that the current position is on an arc centering on the $Z$ axis, the robot moves along that arc.

- When the $[+X(\mathrm{~J} 1)]$ keys are pressed, the robot will expand in the radial direction. When the $[-X(\mathrm{~J} 1)]$ keys are pressed, Contract in the radial direction.
- When the $[+Y$ (J2)] keys are pressed, the robot will move along the arc in the plus direction.

When the $[-Y$ (J2)] keys are pressed, Move in the minus direction.

- When the $[+Z(J 3)]$ keys are pressed, the robot will move along the $Z$ axis plus direction.

When the $[-Z(J 3)]$ keys are pressed, Move along the minus direction.


- When the $[+\mathrm{C}(\mathrm{J} 6)]$ keys are pressed, The $Z$ axis will rotate in the plus direction.

When the $[-\mathrm{C}(\mathrm{J} 6)]$ keys are pressed, Rotates in the minus direction.

## (6) Work jog operation

Setting of the work coordinates system is necessary.
By this jog operation, robot can be move along with the direction of work (or working table etc.), so teaching operations get easier.
When jog operation, select by which work coordinates the robot moves
The setting method of the work coordinates system using T/B (R32TB) is shown in the following.
(Parameter: Setting the coordinate value to WKnCORD (" $n$ " is meaning the number (1-8) of work
coordinates) can also set up the work coordinates system. Refer to the separate manual "Detailed
Explanation of Functions and Operations" for details of parameter.)

In addition, this jog operation is available at the following software versions. The below-mentioned
"6.ENHANCED" menu is not displayed in the other versions.
T/B :Ver.1.3 or later
SQ series: N8 or later
SD series : P8 or later
The work coordinates system teaches and sets up the three points (WO, WX, WY).


Fig.2-18 : Setting of the work coordinates system (teaching point)

The setting (definition) method of the work coordinates system is shown in the following.

1) Select "6.ENHANCED" screen on the <MENU> screen.

2) Press the [2] keys in the menu screen and select "2. WORK COORD."

3) Selection of the work coordinates number

Press the [FUNCTION] keys, and display "W: JUMP" function. Press the function key corresponding to "W: JUMP"


Press numeral key [1] - [8] and specify the work coordinates number. The coordinate value of the specified work coordinates system is displayed.

| LWORK JUMP>CHOOSE ONE OF THE WORK NUMBER$1-8$. |  |  |
| :---: | :---: | :---: |
|  |  |  |
|  | 123 | CLOSE |

Operation will be canceled if the [CLOSE] key is pressed.

| WWORK COORD> | $\begin{array}{l}\text { WORK NUMBER (2) } \\ \text { TEACHING POINT }\end{array}$ |  |
| :--- | :--- | :--- |
| (WO) |  |  |$)$

The screen is the example which specified the work coordinates number 2. ("2" at the upper right of the screen)
4) The teaching of the work coordinates system

Teach the three points shown in Fig. 2-18. Confirm the name currently displayed on the "TEACHING POINT" at the upper right of the screen. If it differs, press the function key corresponding to each point(WO, WX, WY) to teach. Move the robot's arm by jog operation (other jogging movement), and press the function key corresponding to "TEACH."([F1]) The confirmation screen is displayed.

| <WORK COORD> |  | WORK NUMBER (2)TEACHING POINT (WO) |  |  |
| :---: | :---: | :---: | :---: | :---: |
| $X: 0.00$ |  |  |  |  |
| $Y: 0.00$ |  |  |  |  |
| Z: 0.00 |  |  |  |  |
| TEACH | WX | 123 | WY | DEFINE |



Specify the teaching point [WO],[WX],[WY]
teaching the position [TEACH]

Presses the function key corresponding to"Yes", the robot's current position is registered, and the registered coordinates value is displaye. Operation will be canceled if the [CLOSE] key is pressed.


| <WORK COORD> | $\begin{aligned} & \text { WORK NUMBER (2) } \\ & \text { TEACHING POINT (WO) } \end{aligned}$ |  |
| :---: | :---: | :---: |
| X: 214.12 |  |  |
| Y : -61.23 |  |  |
| Z: 553.30 |  |  |
| W. JUMP W. GRID | 123 | CLOSE |

Teach the three points, WO, WX, and WY, by the same operation.
The position data taught here is each registered into the following parameters. ("n" means the work coordinates numbers 1-8)
$\mathrm{WO}=$ parameter: WKnWO
WX= parameter: WKnWX
WY= parameter: WKnWY
5) Setting of work coordinates (definition)

If the function key corresponding to "DEFINE" ([F1]) is pressed, the work coordinates system will be calculated using the three points, and the result will be displayed.

| <WORK COORD>$X: 214.12$$Y:-61.23$$Z: 553.30$ |  | WORK NUMBER (2)TEACHING POINT (WO) |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| TEACH | WX | 123 | WY | DEFINE |


| CWORK COORD> WORK NUMBER (2)  <br> WORK COORDINATES DATA   <br> $(3.53$, $-220.00,5.14$, 0.00, 0. <br> 00, $0.00)$     <br>    <br>   123 |
| :--- |

The alarm occurs if the work coordinates system is incalculable. (There are the three points on the straight line, or the two points have overlapped) In this case, reset alarm and re-teach the three points. This work coordinate data is registered into parameter: WKnCORD. ("n" means the work coordinates numbers 1-8)
If the function key corresponding to "CLOSE" is pressed, it will return to the previous screen.


| <WORK COORD>$X: 214.12$$Y:-61.23$$Z: 553.30$ |  | $\begin{aligned} & \text { WORK NUMBER (2) } \\ & \text { TEACHING POINT (WO) } \end{aligned}$ |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |
|  |  |  |  |  |
| TEACH | WX | 123 | WY | DEFINE |

6) Finishing of setting the work coordinates

Press the [FUNCTION] keys, and display "CLOSE" function. Press the function key corresponding to "CLOSE". Returns to the <MENU> screen.

| 〈WORK COORD> <br> X: 214.12 <br> Y: -61.23 <br> Z: 553.30 |  | $\begin{array}{r} \text { WORK NUMBER (2) } \\ \text { TEACHING POINT (WO) } \end{array}$ |  |
| :---: | :---: | :---: | :---: |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
| W. JUMP | W. GRID | 123 | CLOSE |


| <EMHANCED> |  |  |
| :---: | :---: | :---: |
| 1. SQ DIRECT | 2. WORK COORD. |  |
|  | 123 | CLOSE |

Although setting of work coordinates is finishing above, confirmation of work coordinates can be done by pressing the function key corresponding to "W GRID."([F2])


Return to the previous screen by pressing the [CLOSE] ([F4]) key.

Then, the operation method of the work jog is shown.
Change to the work jog after nearing the work.


Confirmation and selection of the

[JOG] Press the key and display the jog screen. ("JOG" is displayed on the screen bottom)
Check that the "WORK" in jog mode is displayed on the screen.
If other jog modes are displayed, please press the function key corresponding to the "WORK." (If the jog mode which he wishes under the screen is not displayed, it is displayed that the [FUNCTION] key is pressed)
If it finishes jog operation, press the [JOG] key again, or function key which correspond to "close."

Confirm the target work coordinates system. The current target number is displayed on the screen upper right. (W1 - W8)
The number of work coordinates can be changed by the arrow key [Upper arrow], [Lower arrow]
Push the key [Upper arrow], the number will increase. (W1, W2, ..... W8) Conversely, push the key [Lower arrow], the number will decrease

Always confirm that the number of the target work coordinates system is displayed correctly (Display of W1-W8 at the upper right of the screen)
If mistaken, the robot will move in the direction which is not meant and will cause the damage and the personal injuries.

Set jog speed


Whenever it presses the key of [OVRD(Upper arrow)], the override goes up. Conversely, if the [OVRD(Lower arrow)] key is pressed, it will go down.
The current setting speed is displayed on
screen upper right, and "STATUS NUMBER" of the controller.
Set the override to $10 \%$ here for confirmation work


The direction of the end axis will not change. Move the control point with a straight line in accordance with the work coordinates system

- When the $[+X(J 1)]$ keys are pressed, the robot will move along the $X$ axis plus direction on the work coordinates system.
When the $[-X(J 1)]$ keys are pressed, Move along the minus direction.
- When the $[+Y(J 2)]$ keys are pressed, the robot will move along the $Y$ axis plus direction on the work coordinates system.
When the $[-Y$ (J2)] keys are pressed, Move along the minus direction.
- When the $[+Z(J 3)]$ keys are pressed, the robot will move along the $Z$ axis plus direction on the work coordinates system.
When the $[-Z(J 3)]$ keys are pressed, Move along the minus direction.

Changing the end axis posture

-When the $[+C$ (J6)] keys are pressed, The $Z$ axis will rotate in the plus direction of the XYZ coordinate system. When the $[-C(J 6)]$ keys are pressed, Rotate in the minus direction.

## $\diamond$ When the robot is in the transportation posture $\diamond \diamond>$

There are directions from which linear movement is not possible from the transportation posture. In this case, the robot will not move. Refer to section "(1)JOINT jog operation" on page 28 ", and move the robot to a position where linear movement is possible, and then carry out XYZ jog.
$\diamond \gg$ If the buzzer of T/B sounds and the robot does not move $\diamond \gg$
If it is going to move the robot across the operation range, the buzzer of $T / B$ sounds and the robot does not move. In this case, please move to the counter direction.

## $\diamond \diamond$ Tool length

The default tool length is 0 mm , and the control point is the center of the end axis.
After installing the hand, set the correct tool length in the parameters. Refer to the separate manual "Detailed Explanation of Functions and Operations" for details.

## 3 Installing the option devices

### 3.1 Installing the solenoid valve set

Installation outline of the solenoid valve set of general environment specification is shown in Fig. 3-1 and is shown in Fig. 3-2 about clean / waterproof specification.


Fig.3-1: Solenoid valve installation procedures (general environment type)

## 〈Clean/ Waterproof type (RH-3SDHR3512C/3512W) 〉



Fig.3-2 : Solenoid valve installation procedures (clean/ waterproof type)

The installation procedures are as follow. This work must be carried out with the controller power turned OFF.

1) Install the solenoid valve set $\langle 1\rangle$ on the No. 2 arm side. Fixing at the $T$ slot on the No. 2 arm side with two fixing screws and two nuts attached for $T$ slots. Install in the position of 10 mm from the arm end.
2) Connect the hand output cable within No. 2 arm. Makes notch or removes in one of grommet near a solenoid valve. (Following)
a)General environment $\qquad$ : makes notch. (draw in a hand output cable from here)
b)Clean/ Waterproof. $\qquad$ : removes (fixes a hand output cable here by a cable clamp)
3) Loosen the fixing screw and remove the No. 2 arm cover $\langle 3\rangle$ and the arm cover $A(2)\langle 13\rangle$. Since the air tube is connected, No. 2 arm cover $\langle 3\rangle$ is completely inseparable.
4) Pass the hand output cable $\langle 4\rangle$ of the solenoid valve set to No. 2 arm cover.
a) General environment. $\qquad$ pass it to grommet <2> in which the notch was made.
b)Clean/ Waterproof............. : fix fixes it to the hole which removed the grommet by an attached cable clamp. Pass the hand output cable to the attached cable clamp, and pass to the hole of No. 2 arm cover, and pass to the lock nut, and fix it to No. 2 arm cover by lock nut surely.
5) Connect with hand output cable (GR1, GR2) 〈5> of the robot arm side in No. 2 arm. Connect the same connector names.
Note : Please see the hand output cable from the arm cover $A(2)\langle 13\rangle$ side, and store it outside the bracket. If the cable enters within the bracket, it will rub to the timing belt and will become the cause of breaking down.


Fig.3-3 : Storing of the hand output cable
6) Install the No. 2 arm cover $\langle 3\rangle$ and the arm cover $A(2)\langle 13\rangle$ as before. Be careful not to catch any the cables.
7) Connect primary air piping with the two $\phi 6$ air hoses (customer preparation). Connect between the " $R$ " port
(6) of the solenoid valve set and the "RETURN"〈8> on No. 2 arm cover, and between" $P$ " port $\langle 7\rangle$ and "AIROUT" $<9$ >.
8) Connect secondary air piping with the $\phi 4$ air hose (customer preparation).

There are two connection methods as follows.
a) Connect with the tools of customer preparation direct from the solenoid valve set. The fixing place of the air hose which can be used of the customer is shown in Fig. 3-4.
b) Connect via the air hose piped in robot arm previously.

Note: In the robot arm, four $\phi 4$ air hoses are piped to the secondary piping air joint in motor cover J3 <11> from the secondary piping air joint of J 2 axis upper part <10> previously. (If more numbers of piping are necessary, please pipe to the tools directly)
And, please prepare separately the air hose for connection from the secondary piping air joint <11> to the tools. (The conversion coupling is attached ( $\phi 4$ to $\phi 3$ ))
<Reference>: The air hose which can be passed in the shaft is four $\phi 4$ hoses maximum. If you utilize the hand tube optional, it can let the optional hand input cable pass further. Refer to the "standard specifications" for detail.

*1) Fixing the air hose (customer preparation) using the $T$ slot by nylon clamp etc.

Fig.3-4 : Fixing place of the air hose (example)

The connection correspondence after installation is as shown in Table 3-1.

Table 3-1: Solenoid valve ports and hoses: Correspondence of couplings and hand ports

| Hand | Hand port | Solenoid valve port | Solenoid valve used |
| :---: | :---: | :---: | :---: |
| Hand 1 | OPEN | 1 | 1 st row |
|  | CLOSE | 2 |  |
| Hand 2 | OPEN | 3 |  |
|  | CLOSE | 4 | 3 rd row |
| Hand 3 | OPEN | 5 |  |
|  | CLOSE | 6 | 7 |
| Hand 4 | OPEN | 7 | 8 |

### 3.2 Installation of hand tube

The installation procedure of the hand tube is as follows. In use of solenoid valve set and hand input cable optional, please operate with referring to the Page 44, " 3.1 Installing the solenoid valve set" and the Page 53, " 3.3 Installing the hand input cable" together.
And, operate after turning OFF the power supply of the controller.


Fig.3-5 : Installation of the hand tube

The procedure is shown below.

1) To protect the fixing place of the hand tube, roll the attached rubber sheet. If using the hand input cable, roll together.

The hand tube and the hand input cable having the mark at the position which rolls the rubber sheet.
The hand tube is the four places, a), b), c), and d) sequentially from the union side.
The hand input cable is the four places, a), b), c), and d) sequentially from the connector side.


Put together each mark and roll the attached rubber sheet.
Roll at two places between $a$ ) and $b$ ) and between c) and d). And fixing by cable tie (Attachment) each. This position is the fixing position to the piping fixing bracket $\langle 3\rangle$.


Fig.3-6 : Protection of hand tube and hand input cable
2) Remove motor cover $\mathrm{J} 3\langle 1\rangle$ with referring to the Page 66, "5.3.2 Installing/removing the cover".
3) By jog operation, set the J 3 axis to the upper end, and set the J 4 axis to the 0 degree. This position is adjustment basis for fixing hand tube.

4）Install the union（ $\phi 4$ to $\phi 3$ ）side of the tube to secondary piping coupling（ $\phi 4 \times 4$ place）＜2＞on the No． 2 arm inside motor cover $\langle 1\rangle$ ．The number of 1 to 4 is printed to the marking tube of the hand tube．Connect together with the number of coupling on 2 nd arm．


Fig．3－7 ：Connection of hand tube

5）Pass the hand tube（tape attachment side）into the shaft 〈4〉 along piping fixing bracket 〈3＞one by one．
6）Fixing the hand tube to the piping fixing bracket $\langle 3\rangle$ with cable tie．（two places $\langle 5\rangle$ ）
Fixing the tube from top of the rubber sheet that rolled before so that the tube may not slide．
7）Align the top of air tube with the upper end of the piping fixing bracket 〈3〉 by the drawer side at the end of the shaft．
8）At the tool side of customer preparation should roll the rubber sheet（attachments）in the same way，and fix it by cable tie etc（attachments）with maintaining this adjustment position．The example of the fixing method is shown in Fig．3－8．
9）Remove the tape and connect the tool side．Please utilize the attached union（ $\phi 4$ to $\phi 3$ ）for optional if needed．
Note ）The grease is applied to hand tube contact places，such as the inside of the shaft．Please wipe off the grease adhering to the hand tube．
10）Install motor cover $\mathrm{J} 3\langle 1\rangle$ securely as before．
The installation of the hand tube is completion above．

Fixing the hand tube securely．If fixing is not securely，the tube will slide during robot movement and it will become the cause of tube bend．And since the tube change the shape and the air does not flow if fixing not much strongly，take care．


Fig.3-8 : Tool side fixing image of hand tube (example)

## 3．3 Installing the hand input cable

The installation procedure of the hand input cable is as follows．In use of solenoid valve set and hand tube optional，please operate with referring to the Page 44，＂ 3.1 Installing the solenoid valve set＂and the Page 49，＂ 3.2 Installation of hand tube＂together．
And，operate after turning OFF the power supply of the controller．


## $\triangle$ CAUTION

If this cable is connected to the robot，the power supply will be applied to the cable terminal．The end of the cable is free at the time of shipment．
Therefore，if it is not still connecting，the trouble may occur by the short circuit．（The fuse breaks etc．） When you connect to the robot，confirm the cable is disposed properly in the customer in advance．

Fig．3－9：Installation of the hand input cable

1）To protect the fixing place of the hand input cable，roll the attached rubber sheet．Roll the rubber sheet with referring to Page 50，＂Fig．3－6 ：Protection of hand tube and hand input cable＂．If using the hand tube，roll together．
2）Remove motor cover $\mathrm{J} 3\langle 1\rangle$ with referring to the Page 66，＂ 5.3 .2 Installing／removing the cover＂．
3）By jog operation，set the J 3 axis to the upper end，and set the J 4 axis to the 0 degree．This position is adjustment basis for fixing hand input cable．
4）The hand input cable connector $\langle 2\rangle$ is fixed at J 4 motor inside the motor cover $\mathrm{J} 3\langle 1\rangle$ with cable tie．Once cut the cable tie and connect the hand input cable optional connector．Connect the same connector names．
5）Fixing the connector to the J 4 motor by cable tie（attachments）as before．
Note ：Fixing the connector at flat surface on the J 4 motor，to make the connector parallel to the motor cover J3〈1〉．
6）Pass through the hand input cable into the shaft 〈4〉 along the piping fixing bracket＜3＞．
7）Fixing the hand input cable to the piping fixing bracket $\langle 3\rangle$ with cable tie．（two places $\langle 5\rangle$ attachment）．Fixing the cable from top of the rubber sheet that rolled before so that the cable may not slide．
8) Align the top of hand input cable with the upper end of the piping fixing bracket $\langle 3\rangle$ by the drawer side at the end of the shaft.
9) At the tool side of customer preparation should roll the rubber sheet (attachments) in the same way, and fix it by cable tie etc (attachments) with maintaining this adjustment position. Fixing like the fixing method shown in Fig. 3-8.
10) Install motor cover $J 3\langle 1\rangle$ securely as before. The grease is applied to hand input cable contact places, such as the inside of the shaft. Please wipe off the grease adhering to the hand input cable.
The installation of the hand input cable is completion above.
$\triangle$ CAUTION
Fixing the hand input cable securely. If fixing is not securely, the cable will bend during robot movement and it will become the cause of breaking down.

### 3.4 Installing the hand output cable

The installation procedure of the hand output cable is as follows. Please operate with referring to the Page 44,
"3.1 Installing the solenoid valve set" and the Page 55, " 3.4 Installing the hand output cable" together.
And, operate after turning OFF the power supply of the controller.


Fig.3-10 : Installing the hand output cable

The connection summary of the hand output cable is shown in Fig. 3-10. The connection procedure is as follows. Operate after turning OFF the power supply of the controller.

1) Loosen the fixing screw and remove the No. 2 arm cover $\langle 3\rangle$ and the arm cover $A(2)\langle 4\rangle$. Since the air tube is connected, No. 2 arm cover $\langle 3\rangle$ is completely inseparable.
2) Remove one of the three grommets on No. 2 arm cover. (Install the cable clamp here)
3) Remove the lock nut of attachment on the hand output cable and let the connector side of hand output cable (with the cable clamp) pass through the hole of No. 2 arm cover. Fixing securely with the lock nut removed.
4) Connect the connector of hand output cable optional to the hand output cable connector (GR1, GR2) 〈3〉 of robot arm side. Connect the same connector names.

Note : Please see the hand output cable from the arm cover A (2) <4> side, and store it outside the bracket. If the cable enters within the bracket, it will rub to the timing belt and will become the cause of breaking down.


Fig.3-11 : Storing of the hand output cable
5) Install the No. 2 arm cover $\langle 3\rangle$ and arm cover A (2) 〈4〉 as before. Be careful not to catch any the cables.
6) Connect to the solenoid valve of customer preparation the hand output cable taken out from No. 2 arm cover <2>
The installation of the hand output cable is completion above.

### 3.5 Changing the operating range

The operating range change optional installing method is shown below.
The jog operation is necessary for this option installing. Installing this option after installing the robot and completing origin setting. The procedure is shown below.

Note) Be sure to install the operating range change optional according to the procedure. If the procedure is mistaken, changing the operating range will not be correctly made.

### 3.5.1 Operating range change of J 1 axis

## Upper face in base



The hole for operating range change optional insertion (plus side)


The hole for operating range change optional insertion (minus side)


Note) The screw hole for removing
If it is hard to remove, tighten the M4 screw
(customer preparation) for easy removal.
Fig.3-12 : Installation of J 1 axis operating range change optional

1) Turn OFF the power supply of the controller.
2) Remove base cover $B(L)$ and (R) with referring to the Page 66, "5.3.2 Installing/removing the cover".
3) There is the pin cover at back in the base.("A" of Fig. 3-12. Two places)

Loosen the fixing screw and remove the two pin covers both.(Although the removed pin cover is unnecessary, use the screw for fixing this option later)
4) Move the J 1 axis by jog operation. Once turn ON the power supply of the controller. Move the J 1 axis 3 times by joint jog operation, confirming the coordinate value of $\mathrm{T} / \mathrm{B}$ as follows.

Note : This operation is necessary for position adjustment of the mechanism stopper. Although it is not alteration visible especially, performs sure. Because to move correctly, move at $10 \%$ or less speed.
a) First, move to +130 degree or more.

b) Next, move within -110 to -115 degree.

c) Finally stop within -5 to +5 degree.
(Position adjustment of the mechanism stopper is completed now)

5) Turn OFF the power supply of the controller.

6 ) Install operating range change optional (calls as pin henceforth).
Insert the pin in the holes of plus side and minus side each under the two removed pin covers. (Both of the pin are the same.) Fixing the pin with the fixing screw removed before in the original screw hole securely.
7) Confirm whether the mechanism stopper is installed correctly.
turn on the power supply of the controller.
8) With servo off, move the J 1 axis to the mechanism stopper of plus side by hand. (Position at which it stops by the mechanism stopper)
9) Confirm the current coordinate value.

Press the [JOG] key of T/B and display the current coordinate value. (Choose joint jog mode)
If the coordinate value of the J 1 axis is nearly +90 degrees, the mechanism stopper is installed correctly.
10) Confirm the minus side in the same way.

If not installed correctly, please reinstall the pin.
11) Install the base cover $B(L)$ and (R) as before.
12) Setting the operation range parameter. Turn on the power supply of the controller.

Parameter: MEJAR $\qquad$ Set " -90 " and " +90 " as the 1 st element and the 2 nd element each.
Parameter: MORG $\qquad$ Set " +93 " as the 1 st element.
*Refer to the separate manual "Detailed Explanation of Functions and Operations" (Operation of maintenance screen, Movement parameter) for details of operation
13) Confirm movement. Turn off the controller power supply once.
14) Confirm that the J 1 axis does not move the $+/-90$ degree or more with joint jog operation.

The operating range change of J 1 axis is completion above.

### 3.5.2 Operating range change of J 2 axis

Upper face of No. 1 arm


Fig.3-13 : Installation of J2 axis operating range change optional

1) Turn OFF the power supply of the controller.
2) Remove arm cover A (1) with referring to the Page 66, "5.3.2 Installing/removing the cover".
3) There is the pin cover in the No. 1 arm.("A" of Fig. 3-13. Two places)

Loosen the fixing screw and remove the two pin covers both.(Although the removed pin cover is unnecessary, use the screw for fixing this option later)
4) Move the J 2 axis by jog operation. Once turn ON the power supply of the controller. Move the J 2 axis 3 times by joint jog operation, confirming the coordinate value of $\mathrm{T} / \mathrm{B}$ as follows.
Note : This operation is necessary for position adjustment of the mechanism stopper. Although it is not alteration visible especially, performs sure. Because to move correctly, move at $10 \%$ or less speed.
a) First, move to +140 degree or more.

b) Next, move within -125 to -130 degree.

c) Finally stop within -5 to +5 degree.
(Position adjustment of the mechanism stopper is completed now)

5) Turn OFF the power supply of the controller.
6) Install operating range change optional (calls as pin henceforth).

Insert the pin in the holes of plus side and minus side each under the two removed pin covers. (Both of the pin are the same.) Fixing the pin with the fixing screw removed before in the original screw hole securely.
7) Confirm whether the mechanism stopper is installed correctly. turn on the power supply of the controller.
8) With servo off, move the J 2 axis to the mechanism stopper of plus side by hand. (Position at which it stops by the mechanism stopper)
9) Confirm the current coordinate value.

Press the [JOG] key of T/B and display the current coordinate value. (Choose joint jog mode)
If the coordinate value of the J 2 axis is nearly +60 degrees, the mechanism stopper is installed correctly.
10) Confirm the minus side in the same way.

If not installed correctly, please reinstall the pin.
11) Install the arm cover $A$ (1) as before.
12) Setting the operation range parameter. Turn on the power supply of the controller.

Parameter: MEJAR.......... Set " -60 " and " +60 " as the 3rd element and the 4th element each.
Parameter: MORG ............ Set "+63" as the 2nd element.
*Refer to the separate manual "Detailed Explanation of Functions and Operations" (Operation of maintenance screen, Movement parameter) for details of operation
13) Confirm movement. Turn off the controller power supply once.
14) Confirm that the J 2 axis does not move the $+/-60$ degree or more with joint jog operation.

The operating range change of J 2 axis is completion above.

## 4 Basic operations

The basic operations from creating the program to automatic operation are explained in section "4. Basic operations" in the "From Controller Setup to Maintenance" manual. Refer that manual as necessary.

## 5 Maintenance and Inspection

The maintenance and inspection procedures to be carried out to use the robot for a long time without trouble are described in this chapter. The types and replacement methods of consumable parts are also explained.

### 5.1 Maintenance and inspection interval

Maintenance and inspection are divided into the inspections carried out daily, and the periodic inspections carry out at set intervals. Always carry these out to prevent unforeseen trouble, to maintain the product for a long time, and to secure safety.
(1) Inspection schedule

In addition to the monthly inspection, add the following inspection items every three months (estimated at 500 Hr operation hours).


Operating time

〈Guideline for inspection period>
For one shift
$8 \mathrm{Hr} /$ day $\times 20$ days/month $\times 3$ months $=$ approx. 500 Hr
$10 \mathrm{Hr} /$ day $\times 20$ days/month $\times 3$ months $=$ approx. 600 Hr
For two shifts
$15 \mathrm{Hr} /$ day $\times 20$ days/month $\times 3$ months $=$ approx. 1000 Hr
[Caution] When using two lines, the 3-month inspection, 6-month inspection and yearly inspection must be carried out when half the time has passed.

Fig.5-1: Inspection schedule

### 5.2 Inspection items

The inspection items for the robot arm are shown below.
Also refer to section " 5 . Maintenance and inspection" in the "Controller setup, basic operation, and maintenance" manual, and inspect the controller.

### 5.2.1 Daily inspection items

Carry out the daily inspections with the procedures given in Table 5-1.

Table 5-1: Daily inspection items (details)

| Procedure | Inspection item (details) | Remedies |
| :---: | :---: | :---: |
| Before turning power ON (Check the following items before turning the power ON.) |  |  |
| 1 | Are any of the robot installation bolts loose? <br> (Visual) | Securely tighten the bolts. |
| 2 | Are any of the cover tightening screws loose? <br> (Visual) | Securely tighten the screws. |
| 3 | Are any of the hand installation bolts loose? <br> (Visual) | Securely tighten the bolts |
| 4 | Is the power supply cable securely connected? <br> (Visual) | Securely connect. |
| 5 | Is the machine cable between the robot and controller securely connected? <br> (Visual) | Securely connect. |
| 6 | Are there any cracks, foreign contamination or obstacles on the robot and controller cover? | Replace with a new part, or take remedial measures. |
| 7 | Is any grease leaking from the robot arm? (Visual) | After cleaning, replenish the grease. |
| 8 | Is there any abnormality in the pneumatic system? Are there any air leaks, drain clogging or hose damage? Is the air source normal? <br> (Visual) | Drain the drainage, and remedy the air leaks (replace the part). |
| After turning the power ON (Turn the power ON while monitoring the robot.) |  |  |
| 1 | Is there any abnormal motion or abnormal noise when the power is turned ON? | Follow the troubleshooting section. |
| During operation (try running with an original program) |  |  |
| 1 | Check whether the movement points are deviated? <br> Check the following points if there is any deviation. <br> 1. Are any installation bolts loose? <br> 2. Are any hand installation section bolts loose? <br> 3. Are the positions of the jigs other than the robot deviated? <br> 4. If the positional deviation cannot be corrected, refer to "Troubleshooting", check and remedy. | Follow the troubleshooting section. |
| 2 | Is there any abnormal motion or abnormal noise? <br> (Visual) | Follow the troubleshooting section. |

### 5.2.2 Periodic inspection

Carry out periodic inspection with the procedures given in Table 5-2.

Table 5-2 : Periodic inspection items (details)

| Procedure | Inspection item (details) | Remedies |
| :---: | :---: | :---: |
| Monthly inspection items |  |  |
| 1 | Are any of the bolts or screws on the robot arm loose? | Securely tighten the bolts. |
| 2 | Are any of the connector fixing screws or terminal block terminal screws loose? | Securely tighten the screws. |
| 3 | Remove the cover at each section, and check the cables for wear damage and adherence of foreign matter. | Check and eliminate the cause. <br> If the cables are severely damaged, contact the Mitsubishi Service Department. |
| 3-month inspection items |  |  |
| 1 | Is the timing belt tension abnormal? | If the timing belt is loose or too tense, adjust it. |
| 2 | Is there any grease of the shaft section still? | Wipe off the old grease and supply the new grease. |
| 6-month inspection items |  |  |
| 1 | Is the friction the timing belt teeth severe? | If the teeth are missing or severe friction is found, replace the timing belt. |
| 2 | Confirm that there is no rubbing or crack etc at the hand tube and hand input cable. | If there is rubbing or crack etc replace. |
| Yearly inspection items |  |  |
| 1 | Replace the backup battery in the robot arm. | Exchange it referring to Page 77, "5.3.5 Replacing the backup battery". |
| 3-year inspection items |  |  |
| 1 | Lubricate the grease at the harmonic reduction gears to J 1 axis and J2 axis. | Lublicate it referring to Page 75, "5.3.4 Lubrication" |

### 5.3 Maintenance and inspection procedures

The procedures for carrying out the periodic maintenance and inspection are described in this section. Thoroughly read the contents, and follow the instructions. This work can be commissioned to the Mitsubishi Service Department for a fee. (Never disassemble, etc., the parts not described in this manual.)
The maintenance parts, etc., required for the customer to carry out maintenance and inspection are described in Page 80, " 5.5 Maintenance parts" of this manual. Always contact your dealer when parts are needed.

CAUTION
The origin of the machine system could deviate when this work is carried out. "Review of the position data" and "re-teaching" will be required.

### 5.3.1 Robot arm structure

An outline structure drawing is shown in Fig. 5-2. Each part is as shown below.

1) The rotation of the J 1 axis motor $\langle 1\rangle$ arranged in the base is conveyed to the reduction gears $\langle 3\rangle$ via the timing belt <2> to rotate the J 1 axis.
Brakes are not mounted in the J 1 axis motor.
2) The rotation of the J 2 axis motor $\langle 4\rangle$ arranged in the No. 1 arm is conveyed to the reduction gears $\langle 6\rangle$ via the timing belt $\langle 5\rangle$ to rotate the J 2 axis.
Brakes are not mounted in the J 2 axis motor.
3) The rotation of the J 3 axis motor $\langle 7\rangle$ arranged in the No. 2 arm is conveyed to the shaft via the timing belt $\langle 8\rangle$ to move the J 3 axis as up and down.
Non-excitation magnetic brakes are mounted in the J 3 axis motor.
4) The rotation of the J 4 axis motor $\langle 9\rangle$ arranged in the No. 2 arm is conveyed to the shaft via the timing belt (motor side) $\langle 10\rangle$ and the timing belt (shaft side) $\langle 11\rangle$ to rotate the J 4 axis.
Brakes are not mounted in the J4 axis motor.


Fig.5-2 : Outline structure drawing of robot arm

### 5.3.2 Installing/removing the cover

<1> Base cover B (L)
〈3〉 No. 1 Arm cover A


Fig.5-3 : Installing/removing the cover

Table 5-3: Cover fixing screw list

| No. | Cover name |  | Installation screw name: Qty. Note1) |  |
| :--- | :--- | :--- | :--- | :---: |
|  |  | General environment type | Clean/Waterproof type |  |
| $\langle 1\rangle$ | Base cover B (L) | Low head hexagon socket bolt, M4 $\times 8$-eight bolts | SUS hexagon socket bolt, M4 $\times 10$-eight bolts Note2) |  |
| $\langle 2\rangle$ | Base cover B (R) | Low head hexagon socket bolt, M4 $\times 8$-eight bolts | SUS hexagon socket bolt, M4 $\times 10$-eight bolts Note2) |  |
| $\langle 3\rangle$ | No.1 Arm cover A | Low head hexagon socket bolt, M4 $\times 8$-four bolts | SUS hexagon socket bolt, M4 $\times 10$-eight bolts Note2) |  |
| $\langle 4\rangle$ | Arm cover A (1) | Low head hexagon socket bolt, M4 $\times 8$-four bolts | SUS hexagon socket bolt, M4 $\times 8$-eight bolts Note2) |  |
| $\langle 5\rangle$ | No.1 Arm cover B | Low head hexagon socket bolt, M4 $\times 8$-four bolts | SUS hexagon socket bolt, M4 $\times 10$-eight bolts Note2) |  |
| $\langle 6\rangle$ | Motor cover J2 | Low head hexagon socket bolt, M4 $\times 8$-four bolts | SUS hexagon socket bolt, M4 $\times 10$-eight bolts Note2) |  |
| $\langle 7\rangle$ | Motor cover J3 | Low head hexagon socket bolt, M4 $\times 8$-four bolts | SUS hexagon socket bolt, M4 $\times 10$-eight bolts Note2) |  |
| $\langle 8\rangle$ | Arm cover A (2) | Low head hexagon socket bolt, M4 $\times 8$-four bolts | SUS hexagon socket bolt, M4 $\times 8-$ eight bolts |  |
| $\langle 9\rangle$ | Arm cover A (3) | Low head hexagon socket bolt, M4 $\times 8$-four bolts | SUS hexagon socket bolt, M4 $\times 8-$ eight bolts |  |
| $\langle 10\rangle$ | No.2 Arm cover | Low head hexagon socket bolt, M4 $\times 8$-four bolts | SUS hexagon socket bolt, M4 $\times 10-$ eight bolts Note2) |  |
| $\langle 11\rangle$ | Belt pulley cover J4 | Low head hexagon socket bolt, M4 $\times 8$-four bolts | SUS hexagon socket bolt, M4 $\times 10-$ eight bolts Note2) |  |

Note1)Bolting torque of each fixing screw is 1.39 to $1.89 \mathrm{~N} \cdot \mathrm{~m}$.
Note2)With seal washer.
[Caution]
When you remove the cover, don't remove other than the screw shown in Fig. 5-3 and Table 5-3.
(1) Referring to Fig. 5-3, remove the covers.
(2) The names of the covers are given in Table 5-3, and a list of the cover installation screws is given in Table 5-3.
(3) When installing the cover after maintenance and inspection, use the procedure of removal in reverse. Bolt the installation screw with the torque shown in Table 5-3.

Note) Please wipe off the grease which splashed from the ball screw spline at the time of maintenance inspection.

### 5.3.3 Inspection, maintenance and replacement of timing belt

This robot uses a timing belt for the drive conveyance system of the J5 axis. Compared to gears and chains, the timing belt does not require lubrication and has a low noise. However, if the belt usage method and tension adjustment are inadequate, the life could drop and noise could be generated. Sufficient aging to remove the initial elongation of the belt, and adjustment of the belt tension have been carried out before shipment from the factory.
However, depending on the robot working conditions, elongation will occur gradually over a long time. The tension must be confirmed during the periodic inspection. The timing belt must be replaced in the following cases. In addition, it is serviceable if there is the sound wave type belt tension gauge in inspection and adjustment of the timing belt. The recommendation gauge is shown below. Please prepare by customer. Refer to the Page 74, "(6) Timing belt tension" for the tension adjustment value of the timing belt.

Maker:Gates Unitta Asia Company,
Type:U-505
(1) Timing belt replacement period

The timing belt life is greatly affected by the robot working conditions, so a set time cannot be given. However, if the following symptoms occur, replace the belt.

1) When cracks from at the base or back of the belt teeth.
2) When the belt expands due to adherence of oil, etc.
3) When the belt teeth wear (to approx. half of the tooth width).
4) When the belt teeth jump due to belt teeth wear.
5) When the belt snaps.

Due to the manufacturing of the timing belt, initial wear will occur. Wear chips may accumulate in the cover after approx. 300 Hr of operating the robot, but this is not a fault. If the wear chips appear soon after wiping them off, replace the belt.

When the belt is replaced, the machine system origin may deviate. In this case, the position data must be reviewed.
（2）Inspection and maintenance of J 1 axis timing belt
The reference figure at inspection and adjustment of the timing belt is shown in Fig．5－4．


Note）The figure shows the timing belt structure section in the base portion． Remove and confirm both base cover B（L）and（R）．

Fig．5－4 ：Inspection，maintenance and cleaning of J 1 axis timing belt
－Inspecting the J 1 axis timing belt
1）Confirm that the robot controller power is OFF．
2）Refer to Page 66，＂5．3．2 Installing／removing the cover＂，and remove the base cover B（R）and（L）．
3）Visually confirm that the symptoms indicated in＂（1）Timing belt replacement period＂have not occurred with the timing belt．
4）Check the belt tension as shown in＂Fig．5－8 ：Belt tension＂．Lightly press the center of the belt $\langle\mathrm{A}\rangle$ ，and confirm that the value of belt slack is in following．
RH－3SDHR3515 ：Force to press the belt：apprpx．10N • m，Flexure：approx． 1.3 mm
$\square$ Adjusting the J 1 axis timing belt
1）Carry out steps＂1）＂and＂2）＂indicated in＂$\square$ Inspecting the $J 1$ axis timing belt＂above．
2）Lightly loosen the two idler installation bolts $\langle 1\rangle$ ．（Do not loosen too much．）
3）The nut which is fixing tension adjustment screw 〈3＞is loosened，turn tension adjustment screw 〈3〉，and adjust the tension of timing belt $\langle 2\rangle$ ．When the screw is turned to the right，the belt will be stretched，and when turned to the left，will loosen．
Lightly press the center of the belt 〈A〉，and confirm that the value of belt slack is in following． RH－3SDHR3515 ：Force to press the belt：apprpx．10N • m，Flexure：approx． 1.3 mm If the belt is loosened too much when adjusting the tension causing it to come off the timing pulleys $\langle 4\rangle$ and $\langle 5\rangle$ ，or if the belt and pulley teeth engagement is deviated，the machine system＇s origin will deviate
4）After adjustment fastens the fixing nut of tension adjustment screw 〈3〉，and certainly fixes tension adjustment screw $\langle 3\rangle$ ．Moreover，also fasten idler fixing screw $\langle 1\rangle$ certainly．（two pc．）Improper tightening can cause the belt to loosen with vibration．
（3）Inspection and maintenance of J 2 axis timing belt
The reference figure at inspection and adjustment of the timing belt is shown in Fig．5－5．


Note）The figure shows the timing belt structure section in the No． 1 arm portion． Remove and confirm both No． 1 arm cover B．

Fig．5－5 ：Inspection，maintenance and cleaning of J2 axis timing belt
－Inspecting the J2 axis timing belt
1）Confirm that the robot controller power is OFF．
2）Refer to Page 66，＂5．3．2 Installing／removing the cover＂，and remove the No． 1 arm cover B．
3）Visually confirm that the symptoms indicated in＂（1）Timing belt replacement period＂have not occurred with the timing belt＜2＞．
4）Check the belt tension as shown in＂Fig．5－8 ：Belt tension＂．Lightly press the center of the belt $\langle\mathrm{A}\rangle$ ，and confirm that the value of belt slack is in following．
RH－3SDHR3515 ：Force to press the belt：apprpx． $4 \mathrm{~N} \cdot \mathrm{~m}$ ，Flexure：approx． 1.6 mm
－Adjusting the J 2 axis timing belt
1）Carry out steps＂1）＂and＂2）＂indicated in＂$\square$ Inspecting the J 2 axis timing belt＂above．
2）Lightly loosen the two idler installation bolts $\langle 1\rangle$ ．（Do not loosen too much．）
3）The nut which is fixing tension adjustment screw $\langle 3\rangle$ is loosened，turn tension adjustment screw $\langle 3\rangle$ ，and adjust the tension of timing belt $\langle 2\rangle$ ．When the screw is turned to the right，the belt will be stretched，and when turned to the left，will loosen．
Lightly press the center of the belt $\langle A\rangle$ ，and confirm that the value of belt slack is in following．
RH－3SDHR3515 ：Force to press the belt：apprpx． $4 \mathrm{~N} \cdot \mathrm{~m}$ ，Flexure：approx． 1.6 mm
If the belt is loosened too much when adjusting the tension causing it to come off the timing pulleys $\langle 4\rangle$ and $\langle 5\rangle$ ，or if the belt and pulley teeth engagement is deviated，the machine system＇s origin will deviate
4）After adjustment fastens the fixing nut of tension adjustment screw $\langle 3\rangle$ ，and certainly fixes tension adjustment screw 〈3〉．Moreover，also fasten idler fixing screw 〈1〉 certainly．（two pc．）Improper tightening can cause the belt to loosen with vibration．
（4）Inspection and maintenance of J 3 axis timing belt
The reference figure at inspection and adjustment of the timing belt is shown in Fig．5－6．


Note）The figure shows the timing belt structure section inside the No． 2 arm．
Remove and confirm the motor cover J3 and the arm cover $\mathrm{A}(3)$ ．
The belt can be pushed and adjusted from hole for belt maintenance $\langle 6\rangle$ ．
The idler fixing section and the tension adjustment screw section are in the No． 2 arm．
Fig．5－6 ：Inspection，maintenance and cleaning of J 3 axis timing belt
－Inspecting the J3 axis timing belt
1）Confirm that the robot controller power is OFF．
2）Refer to Page 66，＂5．3．2 Installing／removing the cover＂，and remove the motor cover J3 and arm cover $A(3)$ ．
3）Visually confirm that the symptoms indicated in＂（1）Timing belt replacement period＂have not occurred with the timing belt $\langle 2\rangle$ ．
4）Check the belt tension as shown in＂Fig．5－8 ：Belt tension＂．Lightly press the center of the belt $\langle\mathrm{A}\rangle$ ，and confirm that the value of belt slack is in following．
RH－3SDHR3515 ：Force to press the belt：apprpx． $3 \mathrm{~N} \cdot \mathrm{~m}$ ，Flexure：approx． 1.2 mm
$\square$ Adjusting the J 3 axis timing belt
1）Carry out steps＂1）＂and＂2）＂indicated in＂$\square$ Inspecting the J 3 axis timing belt＂above．
2）Lightly loosen the two idler installation bolts $\langle 1\rangle$ ．（Do not loosen too much．）
3）The nut which is fixing tension adjustment screw $\langle 3\rangle$ is loosened，turn tension adjustment screw $\langle 3\rangle$ ，and adjust the tension of timing belt $\langle 2\rangle$ ．When the screw is turned to the right，the belt will be stretched，and when turned to the left，will loosen．
Lightly press the center of the belt 〈A〉，and confirm that the value of belt slack is in following．
RH－3SDHR3515 ：Force to press the belt：apprpx． $3 \mathrm{~N} \cdot \mathrm{~m}$ ，Flexure：approx． 1.2 mm
If the belt is loosened too much when adjusting the tension causing it to come off the timing pulleys $\langle 4\rangle$ and $\langle 5\rangle$ ，or if the belt and pulley teeth engagement is deviated，the machine system＇s origin will deviate
4）After adjustment fastens the fixing nut of tension adjustment screw $\langle 3\rangle$ ，and certainly fixes tension adjustment screw 〈3〉．Moreover，also fasten idler fixing screw 〈1〉 certainly．（two pc．）Improper tightening can cause the belt to loosen with vibration．
(5) Inspection and maintenance of J 4 axis timing belt

The reference figure at inspection and adjustment of the timing belt is shown in Fig. 5-7.
There are the two belts of the motor side and the shaft side, in the J 4 axis. Perform inspection and adjustment of two belts simultaneously.
Motor side (Inside figure of No. 2 arm )


Note) The figure shows the timing belt structure section (motor side) inside the No. 2 arm. Remove and confirm the No. 2 arm cover and the belt pulley cover J4. The belt can be pushed and adjusted by removing the No. 2 arm cover.

Shaft side (Bottom view of No. 2 arm )


Belt pulley cover J4 side

Note) The figure shows the timing belt structure section (shaft side) inside the No. 2 arm. Remove and confirm the No. 2 arm cover and the belt pulley cover J4.

Fig.5-7 : Inspection, maintenance and cleaning of J 4 axis timing belt

Inspecting the J 4 axis timing belt

1) Confirm that the robot controller power is OFF.
2) Refer to Page 66, "5.3.2 Installing/removing the cover", and remove the No. 2 arm cover and the belt pulley cover J4.
3) Visually confirm that the symptoms indicated in "(1)Timing belt replacement period" have not occurred with the timing belt $\langle 2\rangle$.
4) Check the belt tension as shown in "Fig.5-8 : Belt tension" . Lightly press the center of the belt $\langle\mathrm{A}\rangle$, and confirm that the value of belt slack is in following.
RH-3SDHR3515
Motor side: Force to press the belt: apprpx. $2 \mathrm{~N} \cdot \mathrm{~m}$, Flexure: approx. 1.1 mm
Shaft side: Force to press the belt: apprpx.4N • m, Flexure: approx.1.3mm
$\square$ Adjusting the J 4 axis timing belt
5) Carry out steps "1)" and "2)" indicated in " $\square$ Inspecting the J4 axis timing belt" above.
6) Lightly loosen the two idler installation bolts $\langle 1\rangle$. (Do not loosen too much.)
7) The nut which is fixing tension adjustment screw $\langle 3\rangle$ is loosened, turn tension adjustment screw $\langle 3\rangle$, and adjust the tension of timing belt $\langle 2\rangle$. When the screw is turned to the right, the belt will be stretched, and when turned to the left, will loosen.
Lightly press the center of the belt $\langle\mathrm{A}\rangle$, and confirm that the value of belt slack is in following. RH-3SDHR3515

Motor side: Force to press the belt: apprpx.2N • m, Flexure: approx.1.1mm
Shaft side: Force to press the belt: apprpx. 4 N - m, Flexure: approx.1.3mm
If the belt is loosened too much when adjusting the tension causing it to come off the timing pulleys <4> and $\langle 5\rangle$, or if the belt and pulley teeth engagement is deviated, the machine system's origin will deviate
4) After adjustment fastens the fixing nut of tension adjustment screw $\langle 3\rangle$, and certainly fixes tension adjustment screw 〈3>. Moreover, also fasten idler fixing screw 〈1> certainly. (two pc.) Improper tightening can cause the belt to loosen with vibration.
(6) Timing belt tension

f : Pressing force
s : Span
d : Slack
T: Tension

Pressing force

| Axis | Belt type | Sepang : s mm | Slack: d mm | Pressing force : $\mathrm{f}(\mathrm{N})$ |
| :---: | :---: | :---: | :---: | :---: |
| J 1 | $340-5 \mathrm{GT}-20$ | 84 | 1.3 | 10 |
| J 2 | $363-3 \mathrm{GT}-12$ | 103 | 1.6 | 4 |
| J3 | $297-3 G T-9$ | 77 | 1.2 | 3 |
| J4 (Motor side) | $345-3 G T-6$ | 69 | 1.1 | 2 |
| J4 (Shaft side) | $312-3 G T-12$ | 82 | 1.3 | 4 |

The preset value and adjustment value in the sound wave type belt tension gauge

| Axis | Belt type | Preset value |  |  | Standard tension <br> $\mathrm{T}(\mathrm{N})$ |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | $\mathrm{M}(\mathrm{g} / \mathrm{m})$ | $\mathrm{W}(\mathrm{mm} / \mathrm{R})$ | $\mathrm{S}(\mathrm{mm})$ |  |
| J 1 | $340-5 \mathrm{GT}-20$ | 4.0 | 20 | $123 \sim 151$ |  |
| J 2 | $363-3 G T-12$ | 2.5 | 12 | $703 \sim 65$ |  |
| J3 | $297-3 G T-9$ | 2.5 | 9.0 | 77 | $40 \sim 48$ |
| J4 (Motor side) | $345-3 G T-6$ | 2.5 | 6.0 | 69 | $26 \sim 32$ |
| J4 (Shaft side) | $312-3 G T-12$ | 2.5 | 12 | 82 | $53 \sim 65$ |

Fig.5-8 : Belt tension

The timing belt can satisfactorily convey the drive and keep a durable force only when it has an adequate tension. The belt tension should not be too tight or too lose. Instead, it should be adjusted to a degree that elasticity is felt when the belt is pressed with the thumb. If the belt tension is too weak, the belt loosening side will vibrate. On the other hand, if the belt tension is too strong, a sharp sound will be heard and the belt tension side will vibrate.
The detailed adjustment (tension) is shown in Fig. 5-8.
Check and adjust with the belt pressing force $f$ and the slack amount $d$ between span $s$.

### 5.3.4 Lubrication

(1) Lubrication position and specifications


Fig.5-9 : Lubrication positions
Table 5-4: Lubrication specifications

| No. | Parts to be lubricated | Oiling method | Lubrication oil Default charge amount (maker) | Lubrication interval | Lubrication amount guide | Cover to remove |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| <1> | J1 axis reduction gears | Grease nipple WC-610(Only addition) | Grease <br> Harmonic grease SK-1A <br> (Japan Harmonic Systems) | 6,000 Hr | 4.1 g | Base cover B (L) |
| <2> | J2 axis reduction gears |  |  | 6,000 Hr | 1.8 g | - |
| <3> | Shaft | Wipe the old grease, and paint | Marutenpu PS No. 2 (KYODO YUSHI CO.,LTD. ) | Every 2000km movement | 1 g | Motor cover J3 |

The grease nipple position is shown in Fig. 5-9. The lubrication specifications for each place are shown in Table 54. When lubricating, remove the covers that need to be taken off by refer to "Fig.5-3 : Installing/removing the cover".
[Caution]

- The name of each grease of Table 5-4 is the enclosed at shipping.
-The lubrication time is a cumulative value of the operation at the maximum speed. If the operation has been suspended, or if the designated speed is slow, the lubrication time can be lengthened in proportion.
- Depending on the robot operation state, the lubrication time will fluctuate, so determine the time according to the state so that the grease does not run out.
- With the maintenance forecast function of the personal computer support software (option), the guidance of lubrication time is calculated according to the operating environment of the customer.
- The numbers in the Table 5-4 correspond to the supply positions in Fig. 5-9.
- Avoid excessive lubrication since it may lead to grease leak. Also, the number of lubrications is limited to 3 times. The maintenance exceeding 3 times needs the overhaul operations which replace internal grease. Please consult dealer.
(2) Lubrication method

1) The positions of lubrication ports are shown in the Fig. 5-9. Move the robot to the posture in which it can supply the grease easy.
2) Refer to Page 66, "5.3.2 Installing/removing the cover", and remove the covers necessary.
3) Insert the grease shown in Table 5-4 using a grease gun from the lubrication grease nipple.
4) Install the covers with the removal procedure in reverse.

$\triangle$ CAUTION
Use manual grease gun, and inject grease with pressure 0.03 Mpa or less. Do not use the grease gun, which derived by the factory air presser to avoid injecting by too high pressure.
(3) Lubrication method to the $\mathrm{J} 1, \mathrm{~J} 2$ axis

1) Refer to Page 66, "5.3.2 Installing/removing the cover", and remove the covers necessary.
2) Insert the grease shown in Table 5-4 using a grease gun from the lubrication grease nipple. Add only the specified amount of grease. Adding excess grease may cause grease to leak.
3) The J 1 axis has the grease nipple and the timing belt in the near position. Although the timing belt is using the oil-resistant belt, if the grease adheres, please wipe it off.
4) Install the covers with the removal procedure in reverse.
(4) Lubrication method to the shaft
5) Refer to Page 66, "5.3.2 Installing/removing the cover"," remove the motor cover J3.
6) Wipe the old grease off the shaft. At this time, wipe off the grease that has been scattered inside the motor cover J3 and the bracket attached vertically to the shaft fastening area.
7) Apply the specified amount of grease to the shaft. If too much grease is applied, grease may get scattered all over inside of the No. 2 arm. If the grease reaches the timing belt inside the No. 2 arm, the timing belt may deteriorate prematurely.
8) Install the covers with the removal procedure in reverse.

### 5.3.5 Replacing the backup battery

An absolute encoder is used for the position detector, so the position must be saved with the backup battery when the power is turned OFF. The controller also uses a backup battery to save the program, etc. These batteries are installed when the robot is shipped from the factory, but as these are consumable parts, they must be replaced periodically by the customer.
The guideline for replacing the battery is one year, but this will differ according to the robot's usage state.

## Error No. 7520 :Battery consumption time is over

Error No. 133n :Encoder battery voltage low. (n indicates the axis number.)
(The encoder battery voltage of the robot arm is low.)
Error No. 7510 :Battery voltage low (R/C)
(The battery voltage of the controller is low.)
Error No. 7500 :No battery voltage
(The battery of the controller is depleted.)

## © CAUTION

If error No. 7500 occurs, the program data and other data in the controller is lost and it becomes necessary to load the data again.
If any of the battery-related errors above occur and the robot continues to be used, the data integrity of the memory cannot be guaranteed. If an error occurs, replace the batteries of both the robot arm and controller promptly.
It is also recommended to save programs and position data on the personal computer side via the personal computer support software and so forth in advance.
(1) Replacing the robot arm battery

## . CAUTION

Don't disconnect connector, etc. While replacing the battery, the encoder position data is saved by the power supplied from the controller. Thus, if the cable connection is incomplete, the encoder position data will be lost when the controller power is turned OFF. Several batteries are used in the robot arm, but replace all old batteries with new batteries at the same time.


Fig.5-10: Replacing the battery

1) Refer to Page 66, "5.3.2 Installing/removing the cover", and remove the covers necessary.
2) Replacement of the battery should be performed one by one. Extract the old battery from holder and remove the lead connector.
3) Insert the new battery into the holder, and connect the lead connector. Replace all batteries with new ones at the same time.
4) Install the base cover $B(L)$ as before. Be careful not to catch any the cables.
5) Initialize the battery consumption time.

Always carry out this step after replacing the battery, and initialize the battery usage time. Refer to the separate "Instruction Manual/Detailed Explanation of Functions and Operations" for details on the operation methods.

## [Note]

If it is replaced by exhausting the battery, Refer to Page 81, " 5.6 Resetting the origin" and reset the origin using the jig method or mechanical stopper method or ABS origin method.

### 5.4 About Overhaul

Robots which have been in operation for an extended period of time can suffer from wear and other forms of deterioration. In regard to such robots, we define overhaul as an operation to replace parts running out of specified service life or other parts which have been damaged, so that the robots may be put back in shape for continued use. Overhaul interval for robots presumably varies with their operating conditions and thus with the degree of the equipment's wear and loss of performance. As a rule of thumb, however, it is recommended that overhaul be carried out before the total amount of servo-on time reaches the predetermined levels ( 24,000 hours for the robot body and 36,000 hours for the controller). (See Fig. 5-11.) For specific information about parts to be replaced and timing of overhaul, contact your local service representative.


Fig.5-11: Periodic inspection/overhaul periods

### 5.5 Maintenance parts

The consumable parts that must be replaced periodically are shown in Table 5-5, and spare parts that may be required during repairs are shown in Table 5-6. Purchase these parts from the dealer when required. Some Mit-subishi-designated parts differ from the maker's standard parts. Thus, confirm the part name, robot arm and controller serial No. and purchase the parts from the dealer.

Table 5-5 : Consumable part list

| No. | Part name | Type Note1) | Usage place | Q'ty | Supplier |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | Timing belt |  | J1 axis | 1 | Mitsubishi Electric |
|  |  |  | J2 axis | 1 |  |
|  |  |  | J3 axis | 1 |  |
|  |  |  | J4 axis motor side | 1 |  |
|  |  |  | J4 axis shaft side | 1 |  |
| 2 | Grease |  | Reduction gears of each axis | An needed |  |
| 3 | Lithium battery |  | In base cover $\mathrm{B}(\mathrm{L})$ | 4 |  |

Note1)Confirm the robot arm serial No., and contact the dealer or service branch of Mitsubishi Electric Co., for the type.

Table 5-6 : Spare parts list

| No. | Names | Usage place | Q'ty | Supplier |
| :---: | :---: | :---: | :---: | :---: |
| 1 | AC servo motor | J1 axis | 1 | Mitsubishi Electric |
| 2 |  | J2 axis | 1 |  |
| 3 |  | J3 axis | 1 |  |
| 4 |  | J4 axis | 1 |  |
| 5 | Reduction gears | J1 axis | 1 |  |
| 6 |  | J2 axis | 1 |  |
| 7 | Ball screw spline | J3 axis (General environment) | 1 |  |

### 5.6 Resetting the origin

The origin is set so that the robot can be used with a high accuracy. After purchasing the robot, always carry out this step before starting work. The origin must be reset if the combination of robot and controller being used is changed or if the motor is changed causing an encoder area. The types of origin setting methods are shown in Table 5-7.
[Caution] If the old battery is replaced because it has been used up, it is necessary to set the origin again.Reset the origin using the jig method or mechanical stopper method or ABS origin method.

Table 5-7: Origin setting method

| No | Method | Explanation | Remarks |
| :---: | :--- | :--- | :--- |
| 1 | Origin data input <br> method | The origin data set as the default is input from <br> the T/B. | The setting method is explained in Page 18, "2.4 Setting <br> the origin". |
| 2 | Mechanical stopper <br> method | This origin posture is set by contacting each axis <br> against the mechanical stopper. | The setting method is explained in Page 82, " 5.6 .1 <br> Mechanical stopper method". |
| 3 | Jig method | The origin posture is set with the calibration jig <br> installed. | The setting method is explained in Page 90, " 5.6 .2 Jig <br> method". |
| 4 | User origin method | A randomly designated position is set as the <br> origin posture. | The setting method is explained in Page 98, " 5.6 .4 User <br> origin method". |
| 5 | ABS origin method | This method is used when the encoder backup <br> data lost in the cause such as battery cutting. | Before using this method, the origin must be set with the <br> other method with same encoder. The setting method is <br> explained in Page 96, "5.6.3 ABS origin method". |

### 5.6.1 Mechanical stopper method

The method for setting the origin with the transportation jig is explained below.
This operation is carried out with the T/B. Set the [MODE] switch on the front of the controller to "MANUAL", and set the T/B [ENABLE] switch to "ENABLE" to validate the T/B.

The brakes are released here, and the J 3 axis (shaft) is moved with both hands. For safety purposes, the brakes must be released by two workers.
(1) J 1 axis origin setting(mechanical stopper)


1) Press the [4] key on the menu screen, and display the Origin/Break selection screen.

2) With both hands, slowly move the J 1 axis in + (plus) direction, and contact the axis against the mechanical stopper.

3) Press the [1] key, and display the Origin setting selection screen.
4) Press the [2] key, and display the Mechanical stopper selection screen.



EXE

5) Input " 1 " into the J 1 axis. Set " 0 " to other axes.
6) Press the [EXE] key, and display Confirmation screen.
7) Press the [F1] key, and the origin position is set up.
8) Setting of the origin is completed.
9) Refer to Page 100, " 5.6.5 Recording the origin data" in this manual, and record the origin data on the origin data seal.

## Release the brake $\diamond \diamond \diamond$

Do cursor movement into the parenthesis of each axis by the arrow key. The brakes can be released only for the axis for which a " 1 " is displayed on the screen. If the brakes are not to be released, press the [0] key and display a " 0 ". If the [F1] key on the teaching pendant or the enabling switch is detached while the brakes are released, the brakes will be work immediately.

## $\diamond$ Select the axis of origin setting $\diamond \diamond \diamond$

Do cursor movement into the parenthesis of each axis by the arrow key. The origin is set only for the axis for which a " 1 " is displayed on the screen. If the origin is not to be set, press the [0] key and display a " 0 ".
(2) J2 axis origin setting(mechanical stopper)


1) Press the [4] key on the menu screen, and display the Origin/Break selection screen.
2) With both hands, slowly move the J 2 axis in + (plus) direction, and contact the axis against the mechanical stopper. J

3) Press the [1] key, and display the Origin setting selection screen.
4) Press the [2] key, and display the Mechanical stopper selection screen.

5) Input " 1 " into the J2 axis. Set " 0 " to other axes.
6) Press the [EXE] key, and display Confirmation screen.

7) Press the [F1] key, and the origin position is set up.
8) Setting of the origin is completed.
9) Refer to Page 100, " 5.6.5 Recording the origin data" in this manual, and record the origin data on the origin data seal.

## Release the brake

Do cursor movement into the parenthesis of each axis by the arrow key. The brakes can be released only for the axis for which a " 1 " is displayed on the screen. If the brakes are not to be released, press the [0] key and display a " 0 ". If the [F1] key on the teaching pendant or the enabling switch is detached while the brakes are released, the brakes will be work immediately.

Select the axis of origin setting
Do cursor movement into the parenthesis of each axis by the arrow key. The origin is set only for the axis for which a " 1 " is displayed on the screen. If the origin is not to be set, press the [0] key and display a " 0 ".
(3) J3 and J4 axis origin setting (mechanical stopper)

| <MENU> |  |  |
| :---: | :---: | :---: |
| 1. FILE/EDIT | $\begin{aligned} & \text { 2. RUN } \\ & \text { 4. ORIGIN/BRK } \end{aligned}$ |  |
| 3. PARAM. |  |  |
| 5. SET/INIT. | 6. ENHANCED |  |
|  | 123 | CLOSE |


| KORIGIN/BRAKE> <br> I. ORIGIN |  |  |
| :--- | :--- | :--- |


3) Release the brake of the J 3 axis. Input " 1 " into the J3 axis. Set " 0 " to other axes.
4) Confirm the axis for which the brakes are to be released.

5) Pressing the [F1] key is kept with the enabling switch of T/B pressed down. The brake is released while pressing the key.
6) With both hands, slowly move the J 3 axis in + (plus) direction, and contact the axis against the mechanical stopper.
Match the alignment mark of J4 axis in this condition next.

Go to the following procedure continuously.

For safety purposes, the step for releasing the brakes must be carried out by two workers. One worker must operate the T/B, and the other must support the J3 axis (shaft). When the brake is released, the J 3 axis could drops with its own weight.

If [F1] key or enable switch of $T / B$ is released, the brakes will be work immediately.

## General environment type



Clean/Waterproof type

7) Hold the J4 axis with your hand and rotate it slowly to match the alignment marks.
*Move the J4 axis with maintaining the condition that the releasing brake of the J3 axis and the J 3 axis contact to the mechanical stopper.
Note) If the J3 axis has slid, move the J3 axis against the mechanical stopper, and contact again.
8) Detach the [F1] key and work the brake.

Press the [F4] key and return to the origin / brake screen.

9) Press the [1] key, and display the Origin setting selection screen.
10) Press the [2] key, and display the Mechanical stopper selection screen.


| 〈ORIGIN〉 | MECH |  |
| :---: | :---: | :---: |
| CHANGE TO ORIGIN. OK? |  |  |
| Yes |  | 123 |

## F1


14) Setting of the origin is completed.
15) Refer to Page 100, " 5.6 .5 Recording the origin data" in this manual, and record the origin data on the origin data seal.
13) Press the [F1] key, and the origin position is set up.
11) Input " 1 " into the J 3 and J 4 axis. Set " 0 " to other axes.
12) Press the [EXE] key, and display Confirmation screen.

Release the brake
Do cursor movement into the parenthesis of each axis by the arrow key. The brakes can be released only for the axis for which a " 1 " is displayed on the screen. If the brakes are not to be released, press the [0] key and display a " 0 ". If the [F1] key on the teaching pendant or the enabling switch is detached while the brakes are released, the brakes will be work immediately.

## $\diamond$ Select the axis of origin setting $\diamond \gg$

Do cursor movement into the parenthesis of each axis by the arrow key. The origin is set only for the axis for which a " 1 " is displayed on the screen. If the origin is not to be set, press the [0] key and display a " 0 ".
(4) All axis origin setting

1) Refer to the paragraphs from Page 82, "(1) J1 axis origin setting(mechanical stopper)" to Page 86, "(3) J3 and J4 axis origin setting (mechanical stopper)" above for the description of how to adjust the origins of the J 1 to J 4 axes. Line up the ABS marks for the J 4 axis and move the other axes into contact with the mechanical stoppers. At this point, the robot will have the posture shown below

2) Input " 1 " into the J 1 to J 4 axis. Set " 0 " to other axes.
3) Press the [EXE] key, and display Confirmation screen.
4) Press the [F1] key, and the origin position is set up.
5) Setting of the origin is completed.
6) Refer to Page 100, " 5.6.5 Recording the origin data" in this manual, and record the origin data on the origin data seal.

### 5.6.2 Jig method

This method is using the origin setting tool. If the origin setting tool is required, please ask nearby dealer. The reference figure of the origin setting tool is shown in Fig. 5-12.


Fig.5-12 : Reference dimension of origin setting tool

The procedure of setting the origin with the origin setting tool is shown below.

Carry out this method for each axis.
First, set each axis by the origin position. There are the method of releasing the brake and adjusting with the origin position manually and the method of adjusting with the origin position by jog feed. Here, explain operation by brake release.
Then, do origin setting operation and set up the origin.

To ensure safety, the brake-release procedure described below should always be done by two persons.

This operation is carried out with the teaching pendant. Set the [MODE] switch on the front of the controller to "MANUAL", and set the [ENABLE] switch on the teaching pendant to "ENABLE" to enable the teaching pendant. Do the following operations, pressing down the enabling switch of T/B lightly.
(1) J1 axis origin setting




5) Input " 1 " into the J1 axis. Set " 0 " to other axes.
6) Press the [EXE] key, and display Confirmation screen.
7) Press the [F1] key, and the origin position is set up.
8) Setting of the origin is completed.
9) Refer to Page 100, " 5.6 .5 Recording the origin data" in this manual, and record the origin data on the origin data seal.

Release the brake
Do cursor movement into the parenthesis of each axis by the arrow key. The brakes can be released only for the axis for which a " 1 " is displayed on the screen. If the brakes are not to be released, press the [0] key and display a " 0 ". If the [F1] key on the teaching pendant or the enabling switch is detached while the brakes are released, the brakes will be work immediately.
$\diamond$ Select the axis of origin setting $\diamond \diamond \diamond$
Do cursor movement into the parenthesis of each axis by the arrow key. The origin is set only for the axis for which a " 1 " is displayed on the screen. If the origin is not to be set, press the [0] key and display a " 0 ".
(2) J2 axis origin setting

5) Input " 1 " into the J2 axis. Set " 0 " to other axes.
6) Press the [EXE] key, and display Confirmation screen.

7) Press the [F1] key, and the origin position is set up.

8) Setting of the origin is completed.
9) Refer to Page 100, " 5.6 .5 Recording the origin data" in this manual, and record the origin data on the origin data seal.

[^0]Release the brake
Do cursor movement into the parenthesis of each axis by the arrow key. The brakes can be released only for the axis for which a " 1 " is displayed on the screen. If the brakes are not to be released, press the [0] key and display a " 0 ". If the [F1] key on the teaching pendant or the enabling switch is detached while the brakes are released, the brakes will be work immediately.

## $\diamond$ Select the axis of origin setting $\diamond \diamond \diamond$

Do cursor movement into the parenthesis of each axis by the arrow key. The origin is set only for the axis for which a " 1 " is displayed on the screen. If the origin is not to be set, press the [0] key and display a " 0 ".
(3) J3 and J4 axis origin setting

Origin settings for the J 3 and J 4 axes must be performed at the same time.
The method of origin setting is the same as the mechanical stopper method. Refer to Page 86, "(3) J3 and J4 axis origin setting (mechanical stopper)", perform the required origin setting operations.
(4) All axis origin setting

1) Refer to the paragraphs from Page 91, "(1) J 1 axis origin setting" to Page 94 , "(3) J 3 and J 4 axis origin setting" above for the description of how to adjust the origins of the J 1 to J 4 axes. At this point, the robot will have the posture shown below.


2) Press the [1] key, and display the Origin setting selection screen.

| KORIGIN> |  |  |
| :--- | :--- | :--- |
| 1. DATA | 2. MECH |  |
| 3. TOOL | 4. ABS |  |
| 5. USER |  |  |
|  |  | 123 |
|  |  |  |

3) Press the [3] key, and display the Mechanical stopper selection screen.

| <ORIGIN> TOOL |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | [] | J2( | [] | J3( [1) |
|  | []) | J5( | ) | J6( ) |
| J7( | ) | J8( | ) |  |
|  |  | 123 |  | CLOSE |


4) Input " 1 " into the J 1 to J 4 axis. Set " 0 " to other axes.
5) Press the [EXE] key, and display Confirmation screen.
6) Press the [F1] key, and the origin position is set up.
7) Setting of the origin is completed.
8) Refer to Page 100, " 5.6.5 Recording the origin data" in this manual, and record the origin data on the origin data seal.

### 5.6.3 ABS origin method

When the origin setting of the robot is performed for the first time, this product records the angular position of the origin within one rotation of the encoder as the offset value. If the origin setting is performed according to the ABS origin method, this value is used to suppress variations in the origin setting operations and to reproduce the initial origin position accurately.

This operation is carried out with the teaching pendant. Set the [MODE] switch on the front of the controller to "MANUAL", and set the [ENABLE] switch on the teaching pendant to "ENABLE" to enable the teaching pendant. First, set to the ABS mark arrow of the axis for which the origin is to be set with jog operation. This can be set for all axes simultaneously or each axis independently.
When setting the ABS mark, always view the operations from the mark, and set at the end of the triangular mark. The positions where the ABS mark is attached are shown in below. Refer to Page 24, " 2.5 Confirming the operation" for details on the jog operation.

Note that if the ABS marks are peeled off, the positions can be matched using the following alternative methods. $*$ Match the ruling lines of the ABS mark mounting position surfaces.



Alignment mark of J4 axis (View A)


Note) There is no alignment mark of the J3 axis. Contact the J 3 axis against mechanical stopper as the mechanism stopper method.

Fig.5-13: ABS mark attachment positions

The procedures for setting the origin with the ABS method are explained below.
(1) Select the T/B


1) Press the [4] key on the menu screen, and display the Origin/Break selection screen.
2) Press the [1] key, and display the Origin setting selection screen.

3) Press the [4] key, and display the ABS selection screen.

4) Input " 1 " into the axis to origin setting. Press the [EXE] key, and display Confirmation screen.


This completes the setting of the origin with the ABS method.

### 5.6.4 User origin method

. CAUTION
Before using this method, the origin must be set with the other method. The setting method is explained in Page 81, "Table 5-7 : Origin setting method".

The procedure for setting the origin with the user origin method is explained below.
This operation is carried out with the teaching pendant. Set the [MODE] switch on the front of the controller to "AMNUAL", and set the [ENABLE] switch on the teaching pendant to "ENABLE" to enable the teaching pendant. The operation method is shown below.

When setting the origin for the first time using this method, carry out the operations in order from step 1). For the second and following time, move the robot arm to the user origin position with jog operation, and accurately position all axes. Then start the procedure from step 4).

1) Determine the user origin position

Move the robot to the position to be set as the origin with jog operation. Refer to Page 24, " 2.5 Confirming the operation" for details on the jog operation.

Choose the user origin position as the position where it doesn't move by the gravity. This position is left as a guideline to position all axes with jog operation when setting the origin again with this method.
2) Enter the JOINT jog mode, and display the joint coordinates on the teaching pendant screen. Record the value of the axis for which the origin is to be set.
3) Input the value recorded in the "user designated origin parameter (USRORG)".

The parameter details and input methods are described in the separate "Instruction Manual/Detailed Explanation of Functions and Operations". Refer to that manual and input the user designated origin position.

4) Next, set the origin.

Display the menu screen.
5) Press the [4] key on the menu screen, and display the Origin/Break selection screen.
6) Press the [1] key, and display the Origin setting selection screen.
7) Press the [5] key, and display the User selection screen.

8) Input " 1 " into the axis to origin setting. Press the [EXE] key, and display Confirmation screen.
9) Press the [F1] key, and the origin position is set up.

This completes the setting of the origin with the user origin method.

### 5.6.5 Recording the origin data

When the origin has been set with the jig method, record that origin data on the origin data label. With this, the origin can be set with the origin data input method the next time.

Confirm the origin data on the teaching pendant screen (origin data input screen). The origin data label is enclosed with the arm or attached on the back of the .
The teaching pendant operation method and removal method for confirming the origin data is the same as the methods for setting the origin with the origin data input method. Refer to Page 19, "2.4.2 Setting the origin with the origin data input method", and write the origin data displayed on the teaching pendant onto the origin label.
(1) Confirming the origin data label

Remove the .
Refer to Page 66, "5.3.2 Installing/removing the cover", and remove the .
(2) Confirming the origin data

Confirm the value displayed on the teaching pendant's Origin Data Input screen.
Refer to Page 19, "2.4.2 Setting the origin with the origin data input method", "(5)Inputting the origin data" and display the Origin Data Input screen on the teaching pendant display screen.
(3) Recording the origin data

Write the origin data displayed on the teaching pendant to the origin data label attached to the back of the . Refer to Page 19, "Fig.2-10 : Origin data label (an example)", and Page 22, "Fig.2-11: Correspondence of origin data label and axis" for details on the origin data label.
(4) Installing the cover

Install the removed in step "(1)Confirming the origin data label" above.
Refer to Page 66, "5.3.2 Installing/removing the cover", and replace the .

This completes the recording of the origin data.

## 6 Appendix

## Appendix 1 : Configuration flag

The configuration flag indicates the robot posture.
For the 6 -axis type robot, the robot hand end is saved with the position data configured of $\mathrm{X}, \mathrm{Y}, \mathrm{Z}, \mathrm{A}, \mathrm{B}$ and C .
However, even with the same position data, there are several postures that the robot can change to. The posture is expressed by this configuration flag, and the posture is saved with FL1 in the position constant ( $\mathrm{X}, \mathrm{Y}, \mathrm{Z}, \mathrm{A}, \mathrm{B}, \mathrm{C}$ ) (FL1, FL2).
The types of configuration flags are shown below.

## (1) RIGHT/LEFT

Indicates the location of the end axis relative to the line that passes through both the rotational center of the J 1 axis and the rotational center of the J 2 axis.


Fig.6-1: Configuration flag (RIGHT/LEFT)

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[^0]:    *After origin setting should always install the plug in pin hole as before. Roll the seal tape onto the plug and install.

