

Mitsubishi Industrial Robot RH-3FHR3515/3512C/3512W 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

CAUTION

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

⚠ WARNING

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

⚠ CAUTION

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

∕!\ DANGER

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

Installation of safety fence

⚠ CAUTION

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

⚠ CAUTION

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.

♠ DANGER	When automatic operation of the robot is performed using multiple control
	devices (GOT, programmable controller, push-button switch), the interlocking of

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.)

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.

CAUTION

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.

WARNING

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

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

WARNING
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.

CAUTION

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.

CAUTION

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. Moreover, it may interfere with the peripheral device by drop or move by inertia of the arm.

⚠ CAUTION

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.

⚠ DANGER

Do not connect the Handy GOT when using the GOT direct connection function of this product. Failure to observe this may result in property damage or bodily injury because the Handy GOT can automatically operate the robot regardless of whether the operation rights are enabled or not.

⚠ DANGER

Do not remove the SSCNET III cable while power is supplied to the controller. Do not look directly at light emitted from the tip of SSCNET III connectors or SSCNET III cables. Eye discomfort may be felt if exposed to the light. (Reference: SSCNET III employs a Class 1 or equivalent light source as specified in JIS C 6802 and IEC60825-1 (domestic standards in Japan).)

♠ DANGER

Attach the cap to the SSCNET III connector after disconnecting the SSCNET III cable. If the cap is not attached, dirt or dust may adhere to the connector pins, resulting in deterioration connector properties, and leading to malfunction.

A CAUTION

Make sure there are no mistakes in the wiring. Connecting differently to the way specified in the manual can result in errors, such as the emergency stop not being released. In order to prevent errors occurring, please be sure to check that all functions (such as the teaching box emergency stop, customer emergency stop, and door switch) are working properly after the wiring setup is completed.

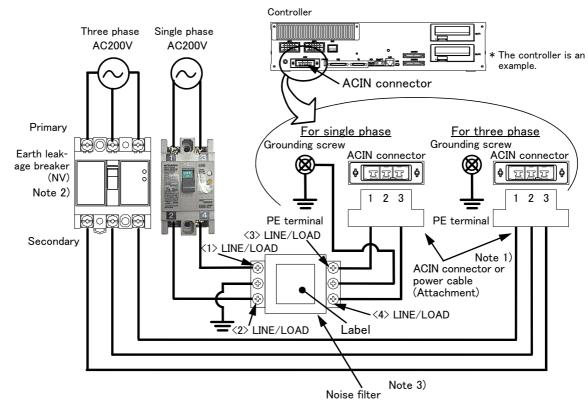
⚠ CAUTION

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. 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.

Notes of the basic component are shown.

A CAUTION

Please install the earth leakage breaker in the primary side supply power supply of the controller of CR751-D or CR751-Q because of leakage protection.



- Note 1) Crimping swage is recommended for connecting the attachment ACIN connector (soldering is also possible)
 Recommendation compression tools: 234171-1(Tyco Electronics)
- Note 2) The earth leakage breaker is the customer preparation. Always use the cover below.

 Recommendation: For single primary power supply NV30FAU-2P-10A-AC100-240V-30mA, (Cover: TCS-05FA2)

 For three primary power supply NV30FAU-3P-10A-AC100-240V-30mA, (Cover: TCS-05FA3)
- Note 3) If necessary, as shown in the figure, connects the noise filter between ACIN terminal blocks and primary power supply.

 (Recommended noise filter: SUP-EL20-ER6 *OKAYA ELECTRIC INDUSTRIES)
 - Please prepare the following: Leakage current breaker (with the terminal cover), cable for connecting the primary power supply (AWG #14 (2mm² or above), cables to ground the primary power supply (AWG #12 (3.5mm² or above).
 - The secondary power cable (with the ACIN connector) for single phase or three phase power is supplied with the product to match the specifications. When you build a cable suitable for your environment using the ACIN connector and the ACIN terminal supplied, prepare a secondary power cable (AWG #14 (2mm²) or above).
 - 2) Confirm that the primary power matches the specifications.
 - 3) Confirm that the primary power is OFF and that the earth leakage breaker power switch is OFF.
 - 4) Connect the secondary power cable.
 - a) When using the supplied power cable with the ACIN connector

Refer to the figure above and connect the cable from the secondary side of the earth leakage breaker.

b) When building a power cable using the ACIN connector and the ACIN terminals supplied

Connect the ACIN terminals with the secondary power cable (prepared by customers), and insert the ACIN terminals to the ACIN connector pins with the following numbers. Crimping caulking is recommended to connect the ACIN terminals.

For single phase: 1 and 3 For three phase: 1, 2, and 3

Refer to the figure above and connect the cable from the secondary side of the earth leakage breaker.

- 5) Connect this ACIN connector to the ACIN connector on the front of the controller.
- 6) Connect the grounding cable to the PE terminal. (M4 screw)
- 7) Connect the primary power cable to the primary side terminal of the earth leakage breaker.



Be careful of interference with peripheral equipment.

Especially don't give a shock to the shaft (J3 axis). When you install the hand, be careful not to knock at the shaft end by the hammer etc. The shaft may be damaged.

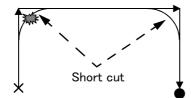
Collision detection function is valid condition for both of automatic and jog operation at shipping in RH-3FHR series. However, damage to the ball screw shaft cannot be prevented completely.

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.



Arch movement (example)

(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.

Revision history

Date of Point	Instruction Manual No.	Revision Details
2013-09-20	BFP-A8993	• First print
2014-01-07	BFP-A8993-A	 Notes about antirust grease were added to "2.2 Installation." T slot cover was added to "Table 2-1: standard configuration". The illustration of the dummy connector was corrected. A description of a location of a pin hole for origin setting by jig method was added. How to choose the origin setting method when an origin resetting is required was added.
2014-03-31	BFP-A8993-B	• Ex-T control function was added.
2014-08-20	BFP-A8993-C	The cover and corporate logo mark of this manual was changed. The explanation of CR751 controller was added. The target model of applying rust preventive grease was changed. (Only for general environment specification robot)
2014-12-19	BFP-A8993-D	 "(1) Replacing the battery (robot arm)" was changed. The explanation of the origin setting method were added. The description of the setting range of ABS origin method was added. The corporate logo mark of illustrations in this manual was changed. In recommended grease gun, CH-400 was deleted and KH-120 was added.
2016-04-06	BFP-A8993-E	· "2.2.2 Transportation procedures (Transporting with a crane)" was supplemented.
2016-10-19	BFP-A8993-F	Timing belt type was changed.
2017-05-23	BFP-A8993-G	 Parameter settings when using a solenoid valve was added. Timing belt type of the J2, J3, and J4 axes was changed. Contact information of the authorised representative was updated.
2017-09-25	BFP-A8993-H	• "5.4 About Overhaul" was modified.

*Introduction

Thank you for purchasing the Mitsubishi industrial robot.

This instruction manual explains the method of unpacking, installation and 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-3FHR.

This document explains for the following robot type.

Robot type · RH-3FHR3515: General environment

· RH-3FHR3512C: Clean specification · RH-3FHR3512W: Waterproof specification

- No part of this manual may be reproduced by any means or in any form, without prior consent from Mitsubishi.
- $\boldsymbol{\cdot}$ 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.
- Company names and production names in this document are the trademarks or registered trademarks of their respective owners.

Copyright(C) 2013-2017 MITSUBISHI ELECTRIC CORPORATION

CONTENTS

	Page
1 Before starting use	1-1
1.1 Using the instruction manuals	1-1
1.1.1 The details of each instruction manuals	
1.1.2 Symbols used in instruction manual	1-2
1.2 Safety Precautions	1-3
1.2.1 Precautions given in the separate Safety Manual	
2 Unpacking to Installation	2-6
2.1 Confirming the product	2-6
2.2 Installation	2-7
2.2.1 Unpacking	
2.2.2 Transportation procedures (Transporting with a crane)	2-8
2.2.3 Installation procedures	2–10
2.2.4 Grounding procedures	2-12
(1) Grounding methods	
(2) Grounding procedures	
2.2.5 Connecting with the controller	
(1) CR750 controller	
(2) CR751 controller	
2.2.6 Ethernet Cables	
2.2.7 No.2 arm section	
2.2.8 Base area	
2.3 Setting the origin	
2.3.1 Installing the teaching pendant (T/B)(1) CR750 controller	
(1) CR750 controller(2) CR751 controller	
2.3.2 Setting the origin with the origin data input method	
(1) Confirming the origin data	
(2) Turning ON the control power	
(3) Preparing the T/B	
(4) Selecting the origin setting method	
(5) Inputting the origin data	
(6) Installing the base cover B (L).	2–27
2.4 Confirming the operation	2–28
(1) JOINT jog operation	2-33
(2) XYZ jog operation	2-36
(3) TOOL jog operation	2–38
(4) 3-axis XYZ jog operation	2-40
(5) CYLNDER jog operation	
(6) Work jog operation	2-44
3 Installing the option devices	
3.1 Installing the solenoid valve set	3–51
3.2 Installation of hand tube	
3.3 Installing the hand input cable	3–60
3.4 Installing the hand output cable	3–62
3.5 Changing the operating range	3-64
3.5.1 Operating range change of J1 axis	
3.5.2 Operating range change of J2 axis	
4 Basic operations	4-68
5 Maintenance and Inspection	5–69
5.1 Maintenance and inspection interval	5–69
5.2 Inspection items	5–70
5.2.1 Daily inspection items	

CONTENTS

	Page
5.2.2 Periodic inspection	5–71
5.3 Maintenance and inspection procedures	5–72
5.3.1 Robot arm structure	5–72
5.3.2 Installing/removing the cover	5–73
5.3.3 Inspection, maintenance and replacement of timing belt	5–75
(1) Timing belt replacement period	5–75
(2) Inspection and maintenance of J1 axis timing belt	5–76
(3) Inspection and maintenance of J2 axis timing belt	5–77
(4) Inspection and maintenance of J3 axis timing belt	5–78
(5) Inspection and maintenance of J4 axis timing belt	5–79
(6) Timing belt tension	5–81
5.3.4 Lubrication	5-82
(1) Lubrication position and specifications	5–82
(2) Lubrication method to the J1, J2 axis	5–83
(3) Lubrication method to the shaft	5–83
5.3.5 Replacing the backup battery	5–84
(1) Replacing the battery (robot arm)	5–85
5.4 About Overhaul	5–86
5.5 Maintenance parts	5–87
5.6 Resetting the origin	5–88
5.6.1 Mechanical stopper method	5–89
(1) J1 axis origin setting (mechanical stopper)	5–89
(2) J2 axis origin setting (mechanical stopper)	
(3) J3 and J4 axis origin setting (mechanical stopper)	5–93
(4) All axis origin setting	5–96
5.6.2 Jig method	5–97
(1) J1 axis origin setting	5–98
(2) J2 axis origin setting	5-100
(3) J3 and J4 axis origin setting	5–101
(4) All axis origin setting	5-102
5.6.3 ABS origin method	5-103
(1) Select the T/B	5–104
5.6.4 User origin method	5-106
5.6.5 Recording the origin data	5–108
(1) Confirming the origin data label	5–108
(2) Confirming the origin data	
(3) Recording the origin data	
(4) Installing the base cover B (L)	5–108
Appendix	Appendix-109
Appendix 1 : Configuration flag	Appendix-109

1 Before starting use

This chapter explains the details and usage methods of the instruction manuals, the basic terminology and the safety precautions. Moreover, handling and operation of a teaching pendant (T/B) are described based on R32TB (R33TB) in instruction manuals. If using other T/B, such as R56TB (R57TB), refer to a supplied instruction manual of the T/B.

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.

Safety	Manua
,	

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.

Standard Specifications

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.

Robot Arm Setup & Maintenance

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

Controller Setup, Basic Operation and Maintenance

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.

Detailed Explanation of Functions and Operations

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.

Troubleshooting

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

Additional axis function

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

Tracking Function Manual

Explains the control function and specifications of conveyor tracking

Extended Function Instruction Manual

Explains the detailed description of data configuration of shared memory, monitoring, and operating procedures, about the PLC(CR750-Q/CR751-Q controller) and the GOT(CR750-D/CR751-D controller).

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		
	iQ Platform			
	Controller	Indicates the controller which controls the robot arm. It consists of the robot CPU system and the drive unit.		
Item	The robot CPU unit or robot CPU	Indicates the CPU unit for the robots which installed to the sequencer base unit (Q3 □ DB) of MELSEC-Q series. It is connected with the drive unit by the dedicated cable.		
	The robot CPU system	Multi-CPU system. It consists of MELSEC units, such as the sequencer base unit, the sequencer CPU unit, and the robot CPU unit, etc.		
	Drive unit	Indicates the box which mounts the servo amplifier for robot, and the safety circuit, etc.		
	Stand-alone type			
Item	Controller	Indicates the box which arranged control parts, such as robot CPU, servo amplifier, and the safety circuit.		
Symbol	⚠ DANGER	Precaution indicating cases where there is a risk of operator fatality or serious injury if handling is mistaken. Always observe these precautions to safely use the robot.		
	⚠WARNING	Precaution indicating cases where the operator could be subject to fatalities or serious injuries if handling is mistaken. Always observe these precautions to safely use the robot.		
	⚠ CAUTION	Precaution indicating cases where operator could be subject to injury or physical damage could occur if handling is mistaken. Always observe these precautions to safely use the robot.		
[JOG]		If a word is enclosed in brackets or a box in the text, this refers to a key on the teaching pendant.		
	[RESET] + [EXE] (A) (B)	This indicates to press the (B) key while holding down the (A) key. In this example, the [RESET] key is pressed while holding down the [EXE] key.		
	T/B	This indicates the teaching pendant.		
	O/P	Indicates the operating panel on the front of controller or drive unit for the controller which installed the operating panel		
	CR751 (Thin type) CR751 (Heavy type)	There are two kinds of CR751 controller; one is "Thin type" (the height is 98mm) and the other is "Heavy type" (the height is 174mm), each of which are different in height. Thin type: CR751-03HD/Q, CR751-06HD/Q, CR751-12HD/Q, CR751-20HD/Q, CR751-03HRD/Q, CR751-02VD/Q, CR751-04VD/Q, CR751-04VD/Q, CR751-07VD/Q. Heavy type: CR751-13VD/Q, CR751-20VD/Q, CR751-07VLD/Q. * Refer to separate Standard Specifications Manual for the outside dimension of CR751 controller.		

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.

⚠ CAUTION

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

⚠CAUTION

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

/NWARNING

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

⚠CAUTION

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

/!\DANGER

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

Installation of safety fence

/!\CAUTION

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

/!\CAUTION

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

When automatic operation of the robot is performed using multiple control devices (GOT, programmable controller, push-button switch), the interlocking of operation rights of the devices, etc. must be designed by the customer.

<u>/!</u>\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.

CAUTION

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.

/i\WARNING

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.

/!\WARNING

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

\CAUTION

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

\WARNING

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.

<u>/!</u>\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.

/!\ 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.

/!\ CAUTION

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.

/!\ CAUTION

Never carry out modifications based on personal judgments, or use non-designated maintenance parts.

Failure to observe this could lead to faults or failures.

∕<u>i</u>∖ 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.

⚠CAUTION

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.

⚠CAUTION

Do not connect the Handy GOT when using the GOT direct connection function of this product. Failure to observe this may result in property damage or bodily injury because the Handy GOT can automatically operate the robot regardless of whether the operation rights are enabled or not.

/!\ DANGER

Do not connect the Handy GOT to a programmable controller when using an iQ Platform compatible product with the CR750-Q/CR751-Q/CR760-Q controller. Failure to observe this may result in property damage or bodily injury because the Handy GOT can automatically operate the robot regardless of whether the operation rights are enabled or not.

/!\DANGER

Do not remove the SSCNET III cable while power is supplied to the multiple CPU system or the servo amplifier. Do not look directly at light emitted from the tip of SSCNET III connectors or SSCNET III cables of the Motion CPU or the servo amplifier. Eye discomfort may be felt if exposed to the light. (Reference: SSCNET III employs a Class 1 or equivalent light source as specified in JIS C 6802 and IEC60825-1 (domestic standards in Japan).)

/!\DANGER

Do not remove the SSCNET III cable while power is supplied to the controller. Do not look directly at light emitted from the tip of SSCNET III connectors or SSCNET III cables. Eye discomfort may be felt if exposed to the light. (Reference: SSCNET III employs a Class 1 or equivalent light source as specified in JIS C 6802 and IEC60825-1 (domestic standards in Japan).)

/!\ DANGER

Attach the cap to the SSCNET III connector after disconnecting the SSCNET III cable. If the cap is not attached, dirt or dust may adhere to the connector pins, resulting in deterioration connector properties, and leading to malfunction.

⚠CAUTION

Make sure there are no mistakes in the wiring. Connecting differently to the way specified in the manual can result in failures, such as the emergency stop not being released. In order to prevent from occurring, please be sure to check that all functions (such as the teaching box emergency stop, customer emergency stop, and door switch) are working properly after the wiring setup is completed

/!\CAUTION

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. 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.

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	Туре	Qty.	Remarks
1	Robot arm	RH-3FHR series	1 unit	
2	Guarantee card		1 сору	
3	Installation bolts	M8 × 90	4 pcs.	For robot arm installation
4	Installation bolts (Spare)	M8 × 40	4 pcs.	
5	Installation nut	M8	4 pcs.	
6	Spring washer for installation bolts	For M8	8 pcs.	
7	Plain washer for installation bolts	For M8	8 pcs.	
8	Hanging tools (Eye bolt)		1 set	To hang the robot arm with the crane.
9	Fixing plate		1 set	Fixing plates installation bolt: 5 pcs. Nuts: 4 pcs.
10	Nats for T slot	M5	4 pcs.	For fixing the tool wiring etc.
11	T slot cover	1.5m	1 pc.	For Clean/Waterproof specification

Note1) Items No. 3 to 7 are contained in the plastic bag of attachment in the robot arm.

Note2) Items No. 8 and 9 are installed in the robot arm.

Note3) Item No. 11 is a dustproof cover for T slots in the sides of No.1 arm and No.2 arm of the robot. Please cut and use the T slot cover to a suitable length.

2.2 Installation

2.2.1 Unpacking

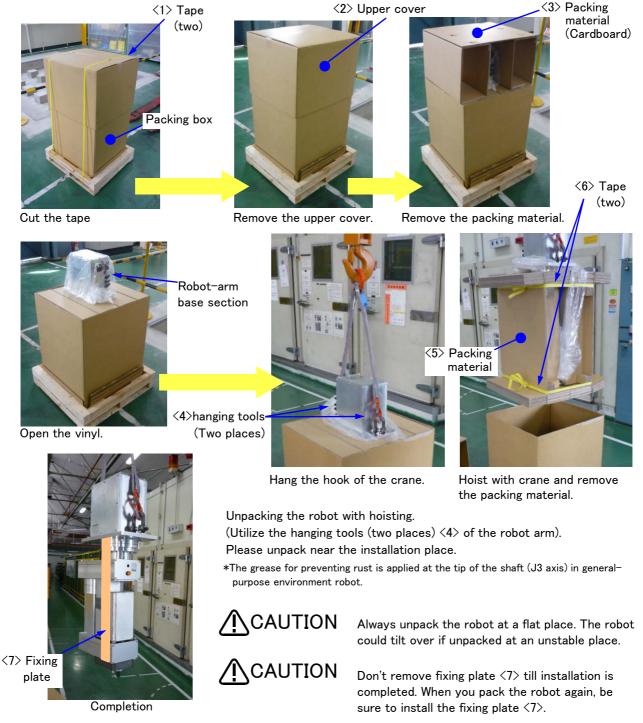


Fig.2-1: Unpacking the robot arm

The unpacking procedure is shown below.

- 1) Cut with scissors etc. the tape <1> of fixing cardboard.
- 2) Raise and remove upper cover <2>. Remove packing material (cardboard) <3> in the inside.
- 3) Open the vinyl and confirm the hanging tools (two places) <4>. 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)

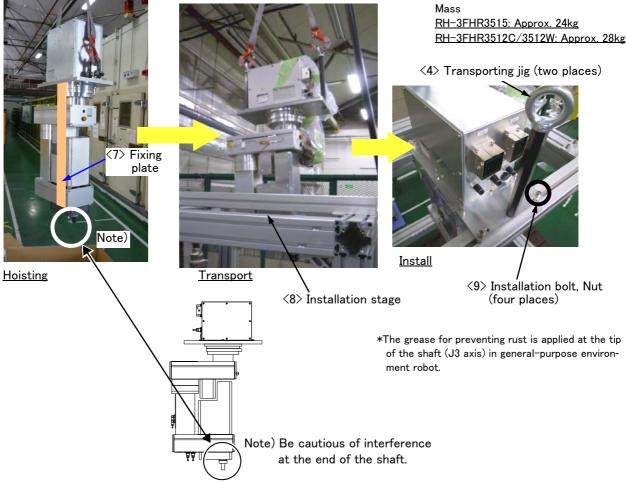


Fig.2-2: Transportation of robot arm

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



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 <9> (attached) certainly to installation stage <8>.
- 3) Remove transporting jigs (two places) <4> after installation. Loosen the screw (M5 x 4, M4x1) fixing the fixing plate <7>, and remove the fixing plate <7>. Also remove the nut for T slots. Fixing plate <7>, and fixing screws and transporting jigs <4> are needed at secondary transportation. Please keep them with care.
- 4) Always attach the fixing plate and transporting jig, and follow the above procedures and methods to transport the robot for secondary transportation, such as when changing the installation position. If the arm is directly suspended without using the specified transporting jig, or if it is suspended in the work posture, the configuration devices could be damaged, and the transportation workers will be subject to risk due to an inadequate center of gravity position.

Transportation is complete above.



To reattach the fixing plate again, set the axes of the robot to the positions according to Table 2-2.



If it is difficult to follow the transportation procedure shown in this section, take countermeasures not to allow the joints of the robot arm freely move by fixing the robot arm in such a way as to take advantage of the screw holes for fixing plates or the like. Otherwise, applying an excessive power on the joints by external forces may cause a malfunction.

Do not apply an excessive load to the robot arm while fixing it. Otherwise, the robot arm may be damaged.

Table 2-2: Transportation posture

Axis	RH-3FHR3515 RH-3FHR3512C/3512W		
J 1	0 deg.		
J 2	0 deg.		
J 3 ^{Note1)}	-569.5mm (Upper end) -599.5mm (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.

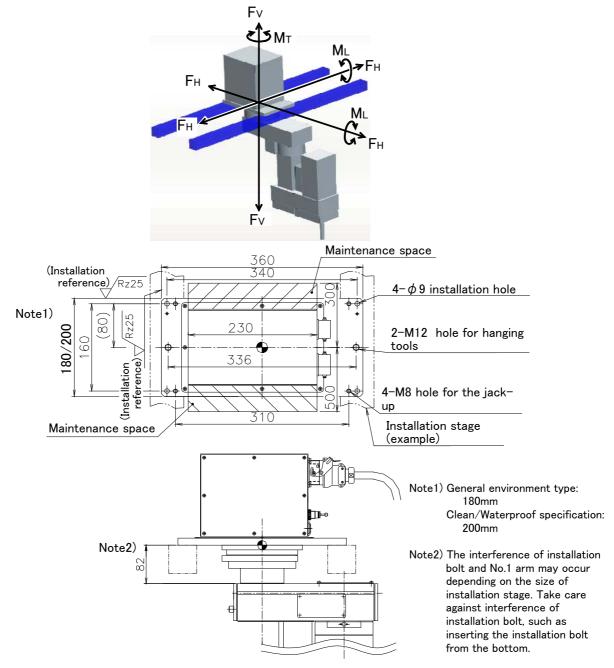


Fig.2-3: Installation dimensions

- 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.
- 7) If you use a clean specification or a water-proof specification robot, always install T-slot cover (attachment) after installing the robot.

Table 2-3: Magnitude of each reaction force

Item	Unit	Value
Tilt moment : M _L	N·m	380
Torsional moment : M _T	N·m	410
Horizontal direction translation force : F _H	N	920
Vertical direction translation force : F _V	N	570



Secure the maintenance space necessary at rear for connection of the machine cable and at side for replacement of the backup battery. And don't install the robot arm in the position where direct rays or the heat of lighting hits. The skin temperature of the robot arm may rise, and the error may occur.

2.2.4 Grounding procedures

(1) Grounding methods

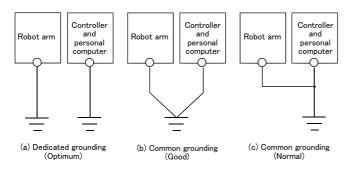


Fig.2-4: Grounding methods

- 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(4.2mm²) 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.

(2) Grounding procedures

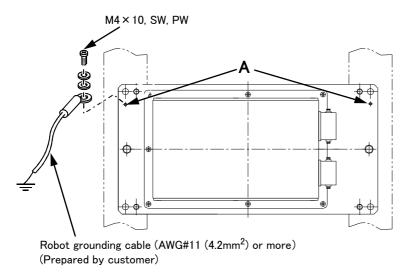


Fig.2-5: Connecting the grounding cable

- 1) Prepare the grounding cable (AWG#11(4.2mm²) or more) and robot side installation screw and washer.
- 2) If there is rust or paint on the grounding screw section (A), remove it with a file, etc.
- 3) Connect the grounding cable to the grounding screw section.

2.2.5 Connecting with the controller

(1) CR750 controller

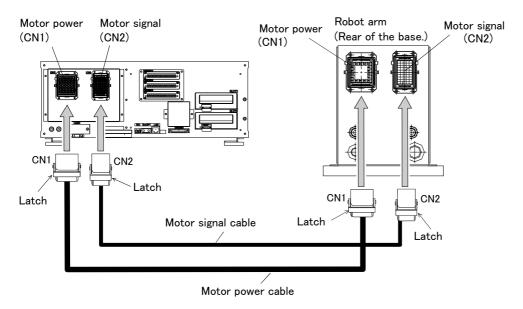
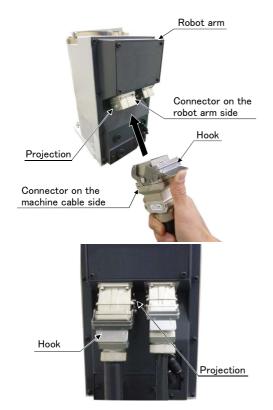
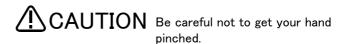


Fig.2-6: Connecting the machine cables

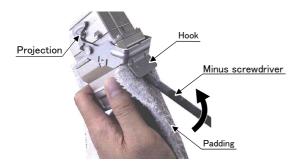
Carry out the following procedure after installing the controller referring to the separate "Controller Setup, Basic Operation and Maintenance" manual. The procedure of connecting the machine cable is shown below.



- Make sure that the power switch on the front of the controller is turned OFF.
 - Note) Although the figure is RH-6FH, also in other robots with same connector type, the connection method is the same.
- 2) Connect the machine cable to its corresponding connector on the robot arm side.
 - Note) Although the figure is RH-6FH, also in other robots with same connector type, the connection method is the same.
- 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.



The connection of machine cables is completed.



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

ACAUTION

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.

CAUTION

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.

CAUTION

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.

♠ CAUTION

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.

CAUTION

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

(2) CR751 controller

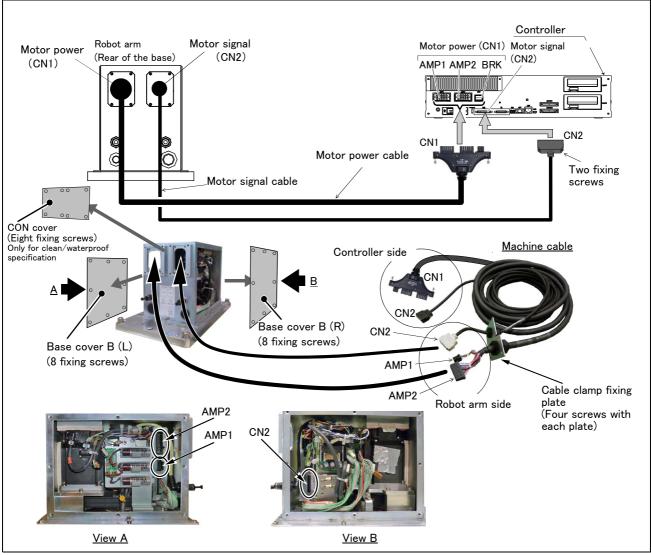


Fig.2-7: Connecting the machine cables (CR751)

Carry out the following procedure after installing the controller and the robot arm referring to the separate "Controller Setup, Basic Operation and Maintenance" and Page 10, "2.2.3 Installation procedures".

And attach a cable fixation plate to the controller referring to the separate "Controller Setup, Basic Operation and Maintenance" manual.

The connection outline is shown in Fig. 2-7.

- 1) Make sure that the power switch on the front of the controller is turned OFF.
- 2) Connect the machine cable connectors to its corresponding connectors on the robot arm side.
 - a) Remove the Base cover B (L) and Base cover B (R). (Refer to Page 73, "5.3.2 Installing/removing the cover" for details.)
 - And, the CON cover is installed to clean/waterproof specification. Removes the eight fixing screws and removes the CON cover. The opening which passes the connector is seen.
 - b) Feed the connectors of robot side to the opening on the back of the robot base.
 - c) Fix the cable clamp fixing plate to the opening. Fix both cables securely with the four screws, respectively.
 - d) Connect the machine cable to its corresponding connector on the robot arm side. Connect the connector (AMP1, AMP2, CN2) securely.
 - e) Install the Base cover B (L) and Base cover B (R) securely as before.
- 3) Connect the machine cable to the corresponding connector of the controller. Connects the connector (CN1(AMP1, AMP2, BRK), CN2) surely. Fix the two fixing screws securely, respectively. Tighten the fixing screw of CN2 by 0.06-0.07 Nm.

The connection of machine cables is completed.



A CAUTION

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.



CAUTION

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.



♠ CAUTION

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.



CAUTION

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

2.2.6 Ethernet Cables

As spare wiring four pairs of cab tire cables (AWG#27(0.1mm²), 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.

2.2.7 No.2 arm section

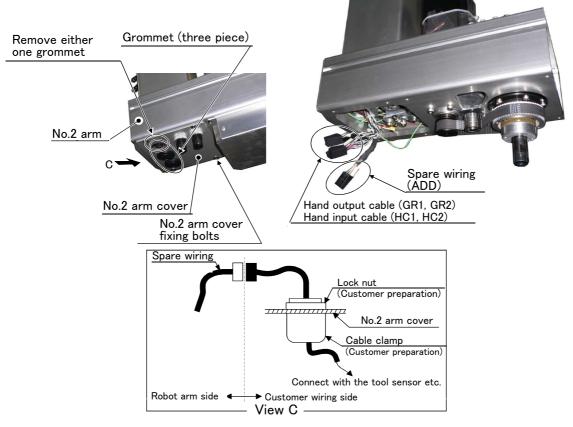


Fig.2-8: Pull out spare wiring

- 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 (0.1mm²). Refer to the "standard specification document" for detail of the connector.)

- 2) Remove the low head hexagon socket bolt (four M4 × 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.

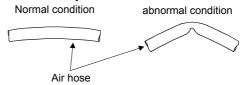


When pulling out spare wiring, keep big power from being added to the cable, the air hose.

ACAUTION

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.





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.

2.2.8 Base area

1) Remove the base cover B (R).

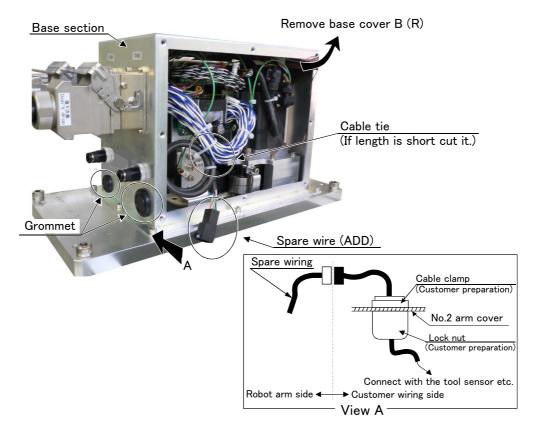


Fig.2-9: Pull out spare wiring(Base area)

- 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 (0.1mm²). 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.

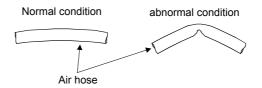


When pulling out spare wiring, keep big power from being added to the cable, the air hose.

ACAUTION

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.





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.

2.3 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 88, "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 88, "5.6 Resetting the origin" and reset the origin using the jig method, mechanical stopper method or ABS method.

2.3.1 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.

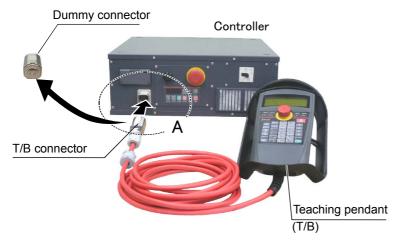


Please do not pull the cable of T/B strongly or do not bend it too much. It becomes the breaking of a wire of the cable and the cause of breakage of the connector. Please installing and removing so that stress does not start the cable with the connector itself.

(1) CR750 controller

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. 2-10, and push in until there is sound.



Details of the A section



When removing the connector for T/B connection, use lock release (state which raised the lock lever to the up side), make the case of the B section slide to the front, and remove and pull up out the latch.

Fig.2-10: Installing and removing the T/B (CR750 controller)

The installation of T/B is finished.

♦♦♦ If error C0150 occurs ♦♦♦

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) CR751 controller

Explain the installation method of T/B below.

- 1) Check that the POWER (power supply) switch of the robot controller is OFF.
- 2) Connect the T/B connector to the controller's T/B connector. Make sure to fix it securely by fastening the hand locks (in 2 places), as shown in Fig. 2-11.

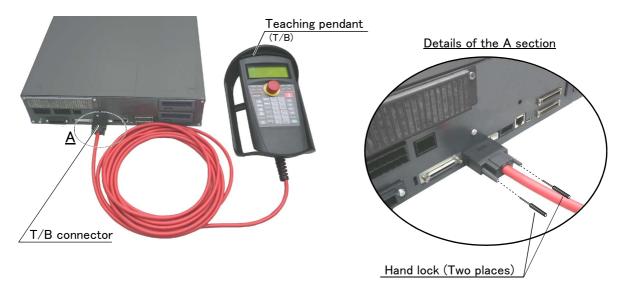


Fig. 2-11: Installing and removing the T/B (CR751controller)

The installation of T/B is finished.

♦♦♦ If error C0150 occurs ♦♦♦

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.

2.3.2 Setting the origin with the origin data input method

(1) Confirming the origin data

Origin data history table (Origin Data History) Serial No.ES804008

Date	Default			
D	V!#S29			
J 1	06DTYY			
J 2	2?HL9X			
J 3	1CP55V			
J 4	T6!M\$Y			
J 5				
J 6				
Method	E	E·N·SP	E·N· SP	E·N·SP

(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. 2-12).

Referring to Page 73, "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.2-12: Origin data label (an example)

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



WARNING 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

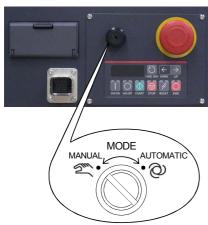
Confirm that there are no operators near the robot before turning the power ON.

1) Turn the controller [POWER] switch ON.

The CR750 controller turns ON the front power switch.

The CR751 controller turns ON the switch of the earth leakage breaker of installation outside.

(3) Preparing the T/B



Next, prepare to use the T/B

1) Set the mode of the controller to "MANUAL". (The figure is example for CR750 controller)



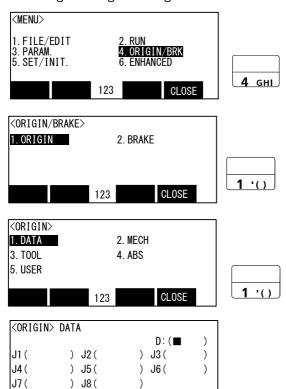
2) Set the T/B [ENABLE] switch to "ENABLE". The menu selection screen will appear.

The following operations are carried out with the T/B.

♦♦♦ Operating from the T/B ♦♦♦

Always set the mode 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

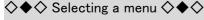


1) Press the [4] key on the menu screen, and display the ORIGIN/BRAKE screen.

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



The menu can be selected with one of the following methods.

CLOSE

- 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 ♦♦♦

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



Input the value confirmed in section Page 23, "(1) Confirming the origin data".

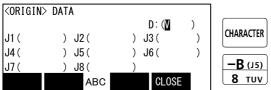
The correspondence of the origin data label value and axis to be input is shown in Fig. 2-13.

Fig.2-13: Correspondence of origin data label and axis

The method for inputting the origin data is explained below. The value shown in Fig. 2-12 will be input as an example.



1) Confirm that the cursor is at the "D" position on the T/B display screen.

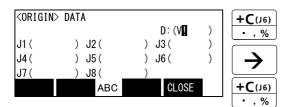


2) Input the D value "V!%S29".

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.

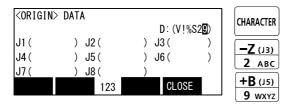




Press the [, %] key five times. "!" will be set.

Press the [ightarrow] key once and advance the cursor.

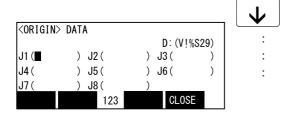
Press the [, %] key twice (input "%"), and press the [PQRS] key four times (input "S").



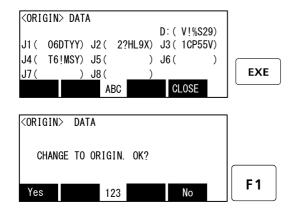
Press the [CHARACTER] key and set to the numeral input mode. (Condition that "123" was displayed under the screen)

Press the [2] key (input "2"), and press the [9] key (input "9").

"V!%S29" will appear at the "D" data on the teaching pendant screen.



- 3) Press the [\downarrow] key, and move the cursor to the J1 input position.
- 4) Input the J1 value in the same manner as above.
- 5) Input the J2, J3 and J4 values in the same manner.



6) After inputting all of the values, press the [EXE] key. The origin setting confirmation screen will appear.

7) Press [F1] (Yes) to end the origin setting

$\diamondsuit \spadesuit \diamondsuit$ Moving the cursor $\diamondsuit \spadesuit \diamondsuit$
Press the $[\uparrow], [\downarrow], [\leftarrow]$ and $[\rightarrow]$ keys

♦♦♦ Inputting characters ♦♦♦

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.

 $\diamondsuit \spadesuit \diamondsuit$ How to input symbols $\diamondsuit \spadesuit \diamondsuit$

The symbol is allocated to ['()], [@=], and [,%] key. Please repress each key until the symbol to wish is displayed.

- a) ['()] key' () " ^ : ; ¥ ?
- b) [@=] key.....@ = + * / <>
- c) [,%] key....., % # \$!&_.
- ♦ ♦ ♦ Correcting an input ♦ ♦ ♦

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 23, "(1) Confirming the origin data" to its original position. This completes the setting of the origin with the origin data input method.



Removing and installing the cover by always turning off the controller power. Failure to do so could lead to the robot moving because of incorrect operations, or to physical damage or personal injury.

♦♦♦ If the origin input data is incorrect ♦♦♦

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.

2.4 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.

Note) The figure of the robot which indicated to the explanation page in each jog mode is an example.



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



CAUTION

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.



To check whether the origin of the robot deviates, move the robot arm to the position where the ABS marks align each other, and check the displayed joint coordinates of the position.

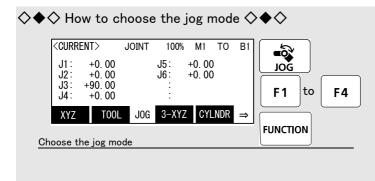
For the details of the ABS mark position and the joint coordinates, refer to ${\sf Page}$ 105, "5.6 Resetting the origin", and Page 120, "5.6.2 ABS origin method".



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.

In such a case, the robot may operate beyond the software-defined operating range, which will cause interference or collisions between the robot mechanical sections. Refer to Page 21, "2.3 Setting the origin" for details on setting the origin.



Press the [JOG] key, the jog screen will be displayed, and display the jog mode which can be chosen at the bottom of the screen. Because these correspond to the function key of [F1] - [F4], press the function key corresponding to the jog mode to wish. And, if the [FUNCTION] key is pressed, selection in jog modes other than the present display is possible. The override (100%), the mechanism number (M1), and the tool number (T1), and the base coordinate number (B1) are displayed on the upside of the screen following the present jog mode (JOINT).

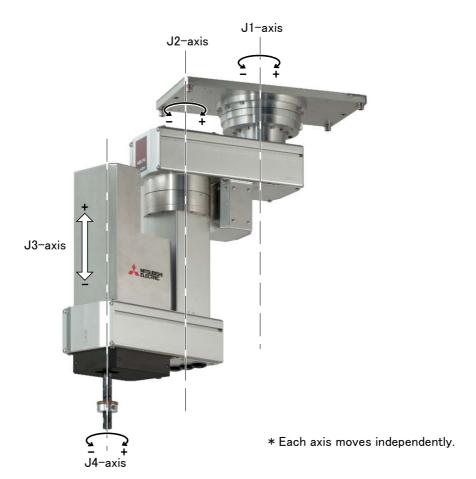


Fig.2-14: JOINT jog operation

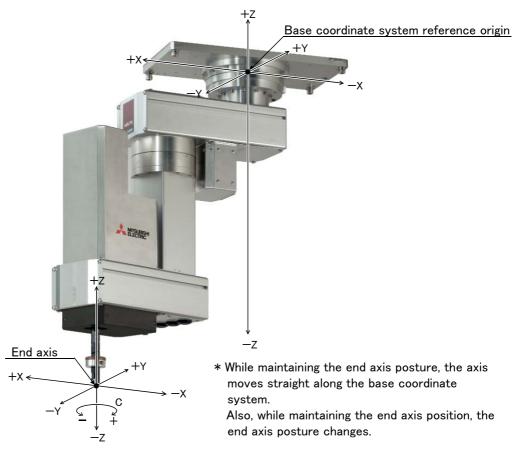


Fig.2-15: XYZ jog operation



Fig.2-16: TOOL jog operation

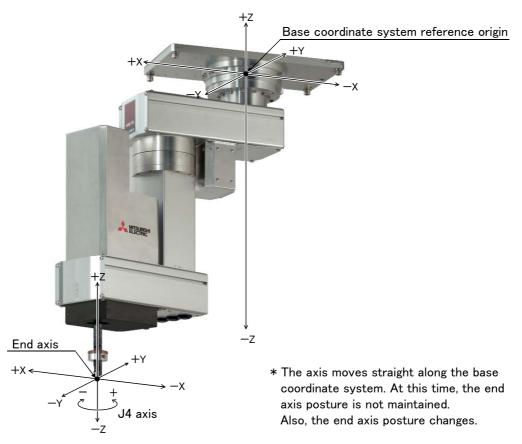


Fig.2-17: 3-axis XYZ jog operation



Fig.2-18: CYLINDER jog operation

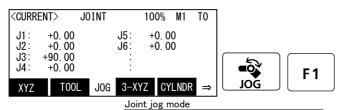


- * While maintaining the end axis posture, the axis moves straight along the work coordinate system. Also, while maintaining the end axis position, the end axis posture changes.
- $*\ When the \ controller \ software \ version \ is \ R5\ (F-Q\ series)/S5\ (F-D\ series) \ or \ later, jog\ operation \ around$ the work coordinates system is available (EX-T jog). In this jog operation, when the jog operation is performed for the posture elements, the posture rotates on the Xw axis, Yw axis, or Zw axis of the work coordinates system while the control point is changed.

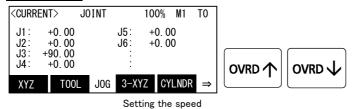
Fig.2-19: WORK jog operation

(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 ↑], 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.

J1 axis jog operation



• When the [+X (J1)] keys are pressed, the J1 axis will rotate in the plus direction. When the [-X (J1)] keys are pressed, rotate in the minus direction.

J2 axis jog operation



• When the [+Y (J2)] keys are pressed, the J2 axis will rotate in the plus direction. When the [-Y (J2)] keys are pressed, rotate in the minus direction.

$\Diamond \blacklozenge \Diamond$ When the robot is in the transportation posture $\Diamond \blacklozenge \Diamond$

The axes may be outside the movement area. Move these axes toward the inner side of the movement area.



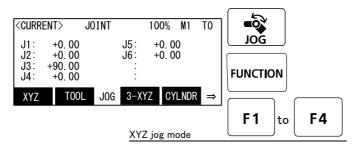
• When the [+Z (J3)] keys are pressed, the J3 axis will rotate in the plus direction. When the [-Z (J3)] keys are pressed, rotate in the minus direction.



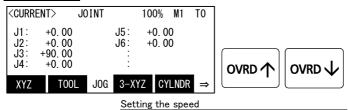
- When the [+A (J4)] keys are pressed, the J4 axis will rotate in the plus direction. When the [-A (J4)] keys are pressed, rotate in the minus direction.
- \diamondsuit \diamondsuit If the buzzer of T/B sounds and the robot does not move \diamondsuit \diamondsuit If it is going to move the robot across 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.

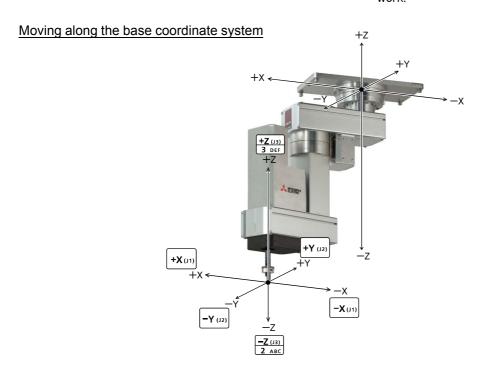
If other jog modes are displayed, please press the function key corresponding to the "XYZ." (If the jog mode which he wishes under the screen is not displayed, it is displayed that the [FUNCTION] key is pressed)

If it finishes jog operation, press the [JOG] key again, or function key which correspond to "close."

Whenever it presses the key of [OVRD ↑], the override goes up. Conversely, if the [OVRD ↓] 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.



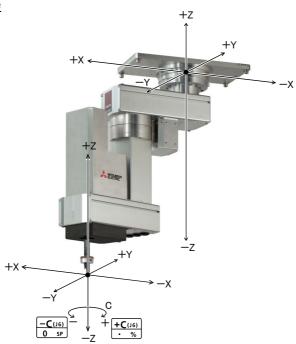
- When the [+X (J1)] keys are pressed, the robot will move along the X axis plus direction. When the [-X (J1)] keys are pressed, move along the minus direction.
- When the [+Y (J2)] keys are pressed, the robot will move along the Y axis plus direction. When the [-Y (J2)] keys are pressed, move along the minus direction.
- When the [+Z (J3)] keys are pressed, the robot will move along the Z axis plus direction. When the [-Z (J3)] keys are pressed, move along the minus direction.

$\Diamond lack \Diamond$ When the robot is in the transportation posture $\Diamond lack \Diamond$

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 Page 33, "(1) JOINT jog operation"", and move the robot to a position where linear movement is possible, and then carry out XYZ jog.

 $\diamondsuit \spadesuit \diamondsuit$ If the buzzer of T/B sounds and the robot does not move $\diamondsuit \spadesuit \diamondsuit$ 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

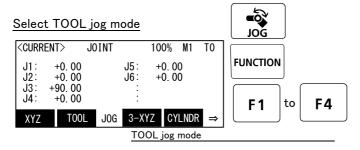


- *The Position of the end axis will not change.
 - When the [+C (J6)] keys are pressed, the Z axis will rotate in the plus direction. When the [-C (J6)] keys are pressed, rotate in the minus direction.
- ♦♦♦ When alarm No. 5150 occurs ♦♦♦ If alarm No. 5150 (ORIGIN NOT SET) occurs, the origin has not been set correctly. Reconfirm the value input for the origin data.
- ♦ Tool length

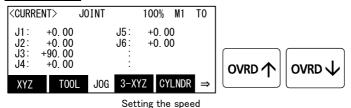
The default tool length is 0mm, and the control point is the center of the end axis.

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 [FUNC-TION] 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 ↑], the override goes up. Conversely, if the [OVRD ↓] key is pressed, it will go down.

The current setting speed is displayed on screen upper right, and "STATUS NUMBER" of the controller.

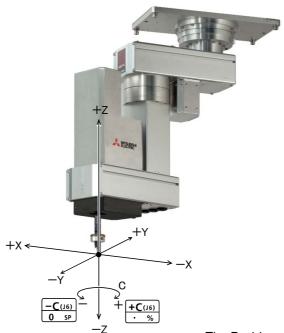
Set the override to 10% here for confirmation work.



- •When the [+X (J1)] keys are pressed, the robot will move along the X axis plus direction of the tool coordinate system.
- When the [-X (J1)] 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 of the tool coordinate system.
- When the [-Y (J2)] keys are pressed, move along the minus direction.
- •When the [+Z (J3)] keys are pressed, the robot will move along the Z axis plus direction of the tool coordinate
- When the [-Z (J3)] keys are pressed, move along the minus direction.

- $\Diamond \blacklozenge \Diamond$ When the robot is in the transportation posture $\Diamond \blacklozenge \Diamond$
 - 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 Page 33, "(1) JOINT jog operation"", and move the robot to a position where linear movement is possible, and then carry out XYZ jog.
- $\Diamond \blacklozenge \Diamond$ If the buzzer of T/B sounds and the robot does not move $\Diamond \blacklozenge \Diamond$ 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



- *The Position of the end axis will not change.
- · When the [+C (J6)] keys are pressed, the Z axis will rotate in the plus direction of the tool coordinate system. When the [-C (J6)] keys are pressed, rotate in the minus direction.
- ♦♦♦ When alarm No. 5150 occurs ♦♦♦

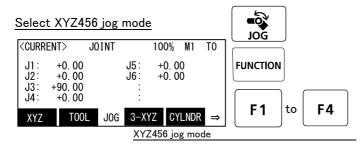
If alarm No. 5150 (ORIGIN NOT SET) occurs, the origin has not been set correctly. Reconfirm the value input for the origin data.

♦ Tool length

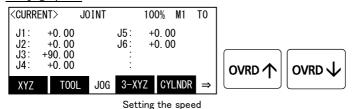
The default tool length is 0mm, and the control point is the center of the end axis.

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 [FUNC-TION] key is pressed)

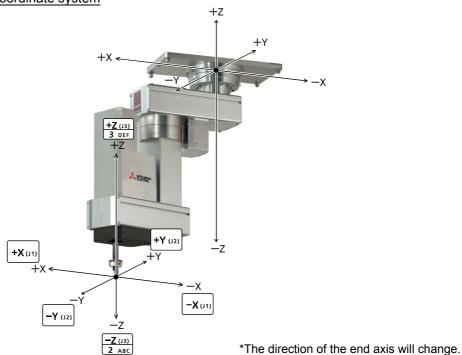
If it finishes jog operation, press the [JOG] key again, or function key which correspond to ″close.′

Whenever it presses the key of [OVRD ↑], the override goes up. Conversely, if the [OVRD ↓] 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.

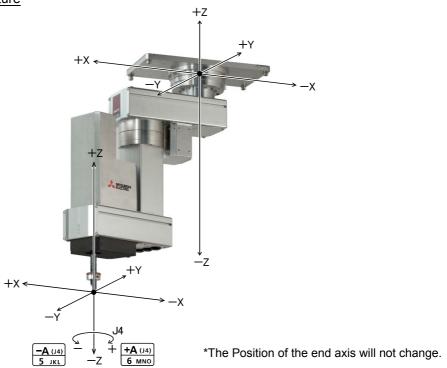
Moving along the base coordinate system



- When the[+X (J1)] keys are pressed, the robot will move along the X axis plus direction. When the [-X (J1)] 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 (J3)] keys are pressed, the robot will move along the Z axis plus direction. When the [-Z (J3)] keys are pressed, move along the minus direction.

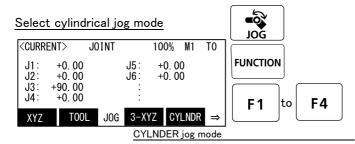
♦♦♦ The flange surface end axis posture cannot be maintained with 3-axis XYZ jog. ♦♦♦ With 3-axis XYZ jog, the flange surface end axis posture (orientation) is not maintained when moving linearly in the X, Y or Z axis direction. Use XYZ jog to maintain the posture.

Changing the end axis posture

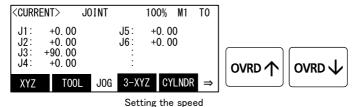


• When the [+C (J6)] keys are pressed, the J4-axis will rotate in the plus direction. When the [-C (J6)] keys are pressed, rotate in the minus direction.

(5) CYLNDER jog operation



Set jog speed



[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)

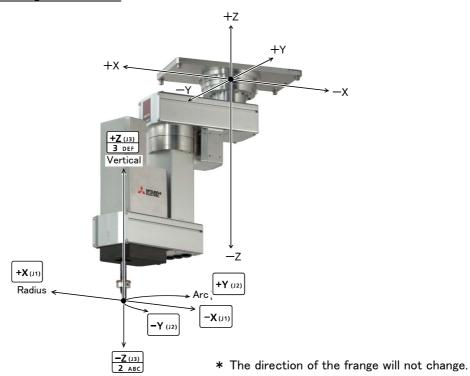
If it finishes jog operation, press the [JOG] key again, or function key which correspond to "close."

Whenever it presses the key of [OVRD ↑], the override goes up. Conversely, if the [OVRD ↓] key is pressed, it will go down.

The current setting speed is displayed on screen upper right, and "STATUS NUMBER" of the controller.

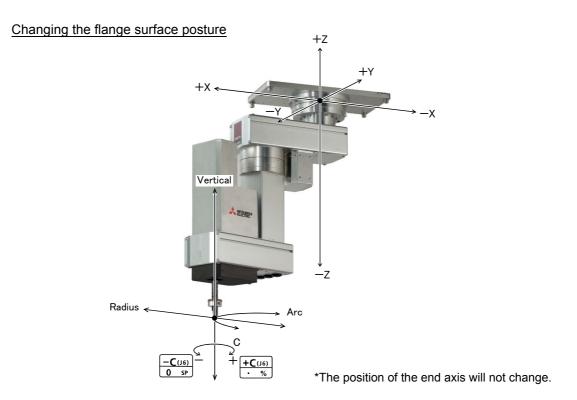
Set the override to 10% here for confirmation work.

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 (J1)] keys are pressed, the robot will expand in the radial direction.
- When the [-X (J1)] 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 (J3)] keys are pressed, the robot will move along the Z axis plus direction. When the [-Z(J3)] keys are pressed, move along the minus direction.



• When the [+C (J6)] keys are pressed, the Z axis will rotate in the plus direction. When the [-C (J6)] keys are pressed, rotates in the minus direction.

(6) Work jog operation

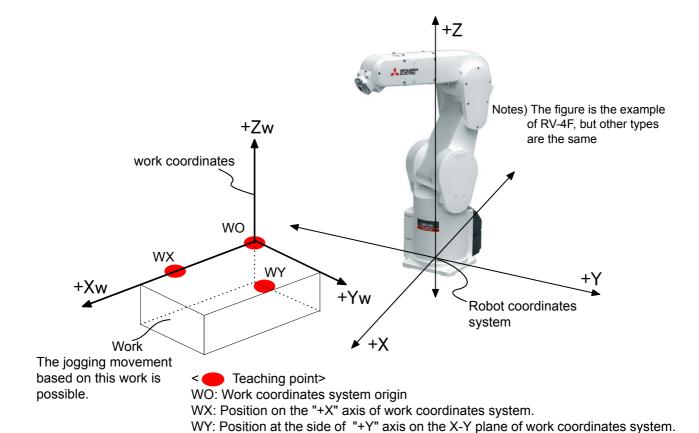
Setting of the work coordinates system is necessary.

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.)

The work coordinates system teaches and sets up the three points (WO, WX, WY).



[Supplement]: The coordinate values which use all three teaching points for setting of the work coordinates system are each only X, Y, and the Z-axis. Although the coordinate value of A, B, and C axis is not used, positioning will get easy if the XYZ jog or TOOL jog movement is effected with the same value. (The direction of the hand is the same)

Fig.2-20: 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.



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

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. 2-20. 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.



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.



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)

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.



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.

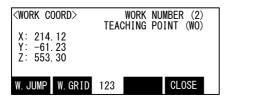


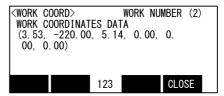
6) Finishing of setting the work coordinates

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



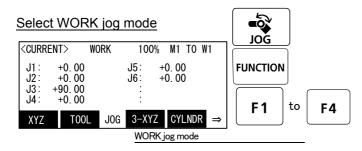
Although setting of work coordinates is finishing above, confirmation of work coordinates can be done by pressing the function key corresponding to "W GRID."([F2])





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.



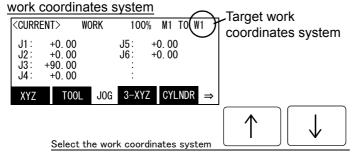
[JOG] Press the key and display the jog screen. ("JOG" is displayed on the screen bottom)

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."

Confirmation and selection of the



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]

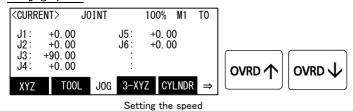
Push the key [Upper arrow], the number will increase. (W1, W2, W8) Conversely, push the key [Lower arrow], the number will decrease



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



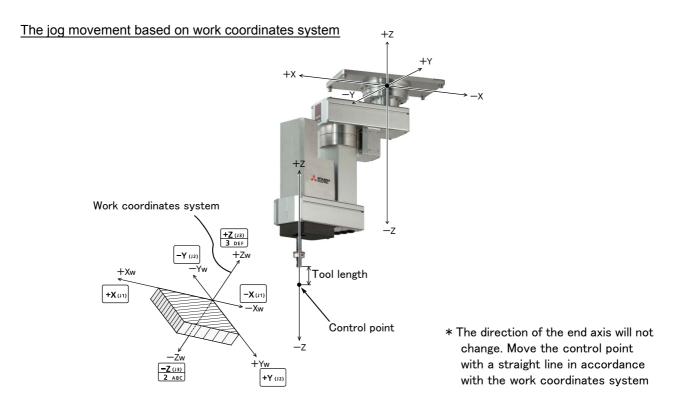
Whenever it presses the key of [OVRD(Upper arrow)], the override goes up. Conversely, if the [OVRD(Lower arrow)] key is pressed, it will go down.

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

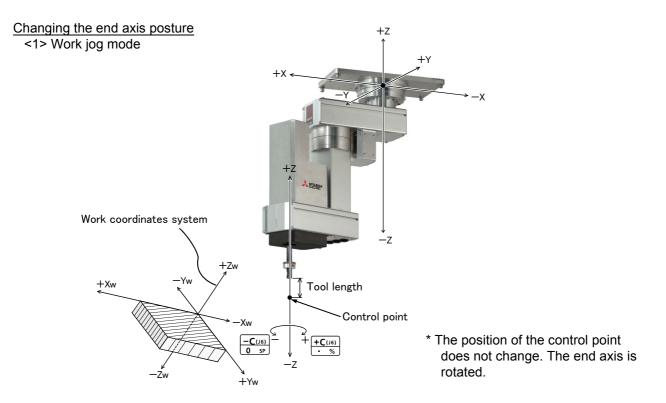
When the software version is R5 (F-Q series)/S5 (F-D series) or later, the additional WORK jog operation, Ex-T jog, is available. The conventional WORK jog operation and the Ex-T jog operation can be switched by setting the parameters WK1JOGMD to WK8JOGMD of each work coordinates system. The respective operations are as follows.

WORK jog operation mode	Conventional WORK jog	Ex-T jog	
Parameters WKnJOGMD (n is 1 to8) setting	0 (initial value)	1	
XYZ key operation	Moves along each axis of the work coordinates system	Same as the conventional WORK jog	
C key operation	With the control point position maintained, the direction changes along the work coordinates system.	While the control point position is changed, the direction changes on the Z axis of the work coordinates system (Zw).	
AB key operation	The robot does not move.	The robot does not move.	

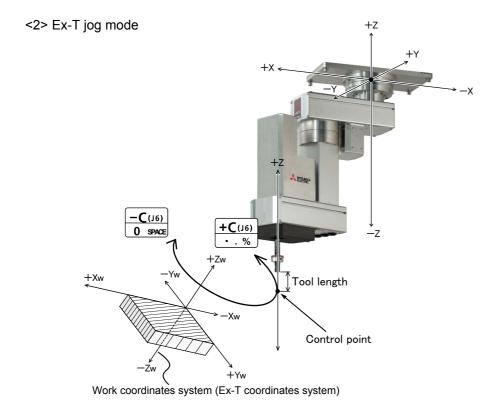


- When the [+X (J1)] keys are pressed, the robot will move along the X axis (Xw) plus direction on the work coordinates system.
- When the [-X (J1)] keys are pressed, Move along the minus direction.
- When the [+Y (J2)] keys are pressed, the robot will move along the Y axis (Yw) plus direction on the work coordinates system.
- When the [-Y (J2)] keys are pressed, Move along the minus direction.
- When the [+Z (J3)] keys are pressed, the robot will move along the Z axis (Zw) plus direction on the work coordinates system.
 - When the [-Z (J3)] keys are pressed, Move along the minus direction.

When the X, Y, or Z keys are used, the operation is the same in the WORK jog and the Ex-T jog modes.



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



• When the [+C (J6)] keys are pressed, the control point will rotate in the plus direction around the Z axis (Zw) of work coordinates system (Ex-T coordinates system).

When the [-C (J6)] keys are pressed, the control point will rotate in the minus direction.

♦♦♦ 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 Page 33, "(1) JOINT jog operation"", and move the robot to a position where linear movement is possible, and then carry out XYZ jog.

- $\diamondsuit \spadesuit \diamondsuit$ If the buzzer of T/B sounds and the robot does not move $\diamondsuit \spadesuit \diamondsuit$ 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.
- ♦♦♦ Tool length

The default tool length is 0mm, 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 summary of the solenoid valve set of general environment specification (RH-3FHR3515) is shown in Fig. 3-1 and is shown in Fig. 3-2 about clean / waterproof specification (RH-3FHR3512C/3512W).

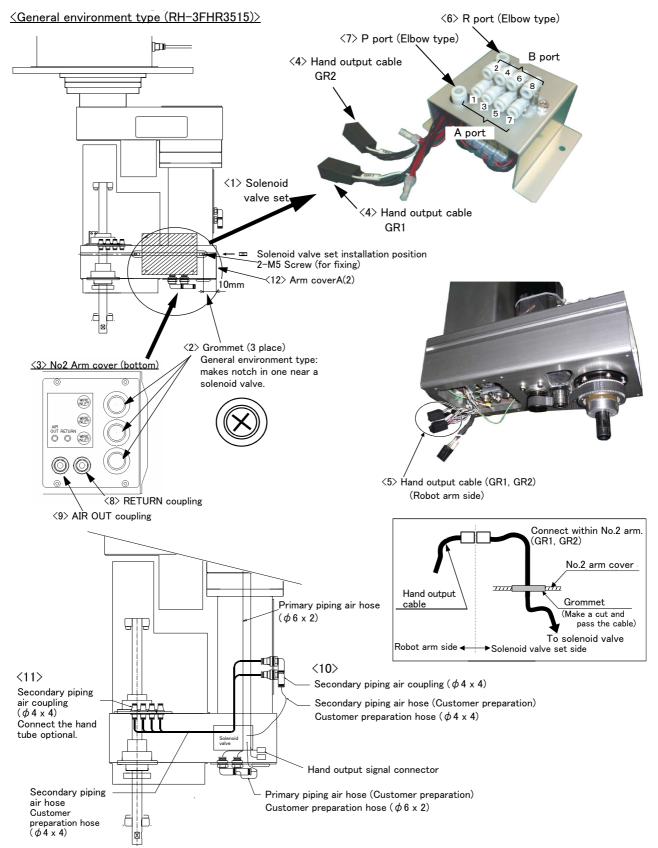


Fig.3-1: Solenoid valve installation procedures (General environment type)

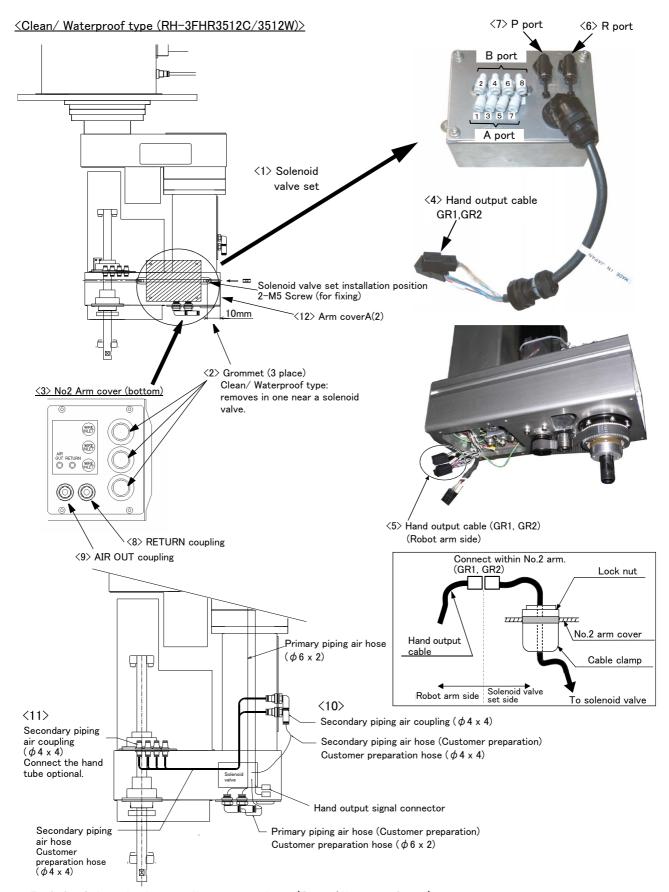


Fig.3-2: Solenoid valve installation procedures (Clean/Waterproof type)

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

It is necessary to set the parameters (HIOTYPE, HANDYPE) in accordance with solenoid valve type (sink type/ source type) and output signal before using the solenoid valve set.

Refer to the separate volume, "Instruction Manual/Detailed Explanations of Functions and Operations" for how to set parameters.

- 1) Install the solenoid valve set <1> 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 10mm 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: makes notch. (draw in a hand output cable from here)
 - b) Clean/ Waterproof:removes (fixes a hand output cable here by a cable clamp)
- 3) Loosen the fixing screw and remove the No.2 arm cover <3> and the arm cover A(2) <12>. Since the air tube is connected, No.2 arm cover <3> is completely inseparable.
- 4) Pass the hand output cable <4> of the solenoid valve set to No.2 arm cover.
 - a) General environment:pass it to grommet <2> in which the notch was made.
 - b) Clean/ Waterproof: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) <12> 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.

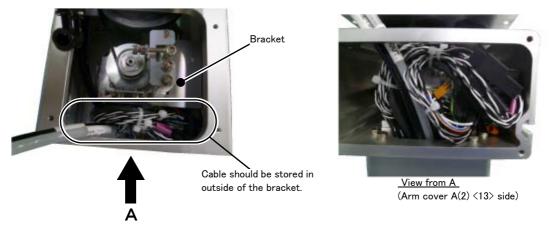


Fig.3-3: Storing of the hand output cable

- 6) Install the No.2 arm cover $\langle 3 \rangle$ and the arm cover A(2) $\langle 12 \rangle$ as before. Be careful not to catch any the cables.
- 7) Connect primary air piping with the two ϕ 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 <7> and "AIROUT"<9>.
- 8) Connect secondary air piping with the ϕ 4 air hose (customer preparation).

There are two connection methods as follows.

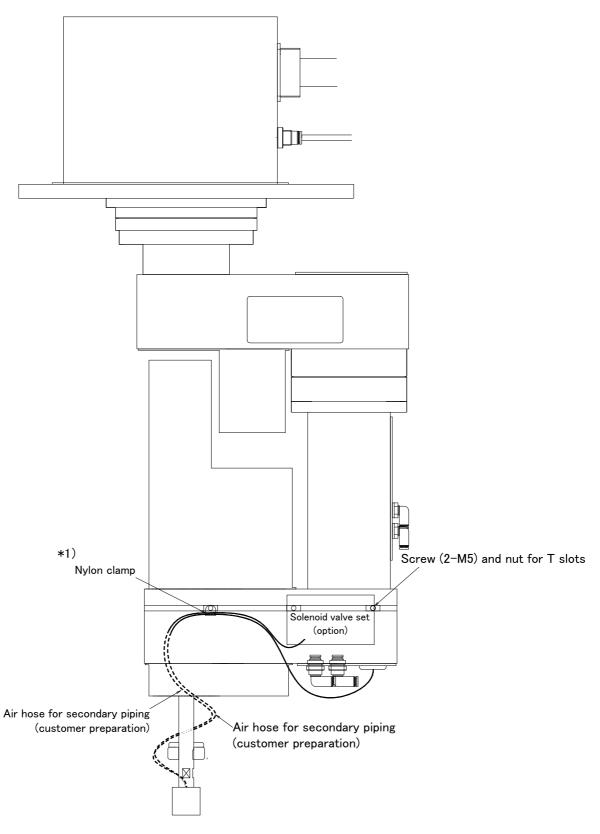
- a) Connect with the tools of customer preparation direct from the solenoid valve set. The fixing place of the air hose which can be used of the customer is shown in Fig. 3-4.
- b) Connect via the air hose piped in robot arm previously.

Note: In the robot arm, four ϕ 4 air hoses are piped to the secondary piping air joint in motor cover J3 $\langle 11 \rangle$ from the secondary piping air joint of J2 axis upper part $\langle 10 \rangle$ 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 $(\phi 4 \text{ to } \phi 3)$)

<Reference>: The air hose which can be passed in the shaft is four ϕ 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
папи і	CLOSE	2	
Hand 2	OPEN	3	2 nd row
Hariu Z	CLOSE	4	
Hand 3	OPEN	5	- 3 rd row
mariu 3	CLOSE	6	
Hand 4	OPEN	7	4 th row
	CLOSE	8	4 tri row

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 51, "3.1 Installing the solenoid valve set" and the Page 60, "3.3 Installing the hand input cable" together.

And, operate after turning OFF the power supply of the controller.

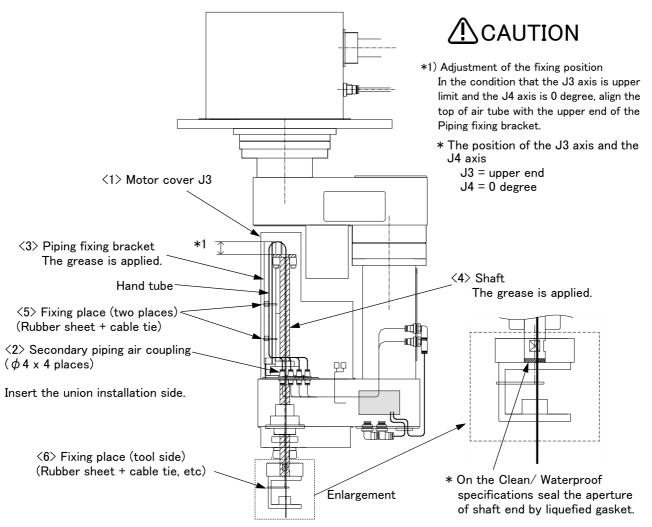
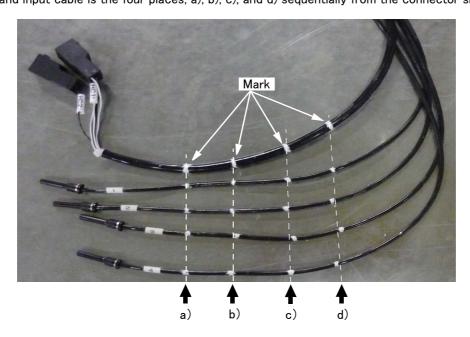


Fig.3-5: Installation of the hand tube

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 $\langle 3 \rangle$.

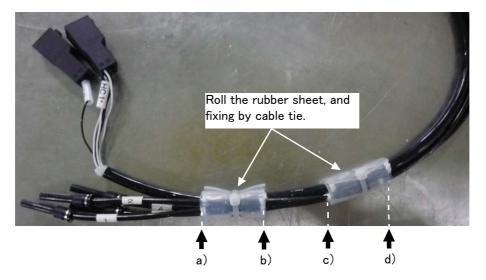


Fig.3-6: Protection of hand tube and hand input cable

- 2) Remove motor cover J3 <1> with referring to the Page 73, "5.3.2 Installing/removing the cover".
- 3) By jog operation, set the J3 axis to the upper end, and set the J4 axis to the 0 degree. This position is adjustment basis for fixing hand tube.

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

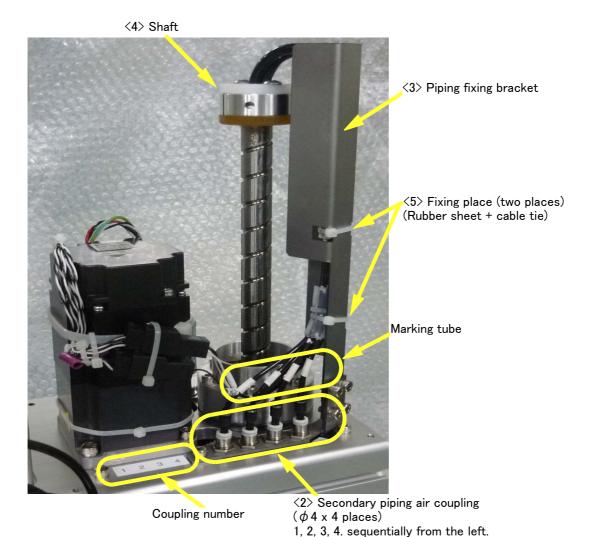


Fig.3-7: Connection of hand tube

- 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 <3> with cable tie. (two places <5>) 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 (ϕ 4 to ϕ 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 J3 <1> 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.

Connect together with same number

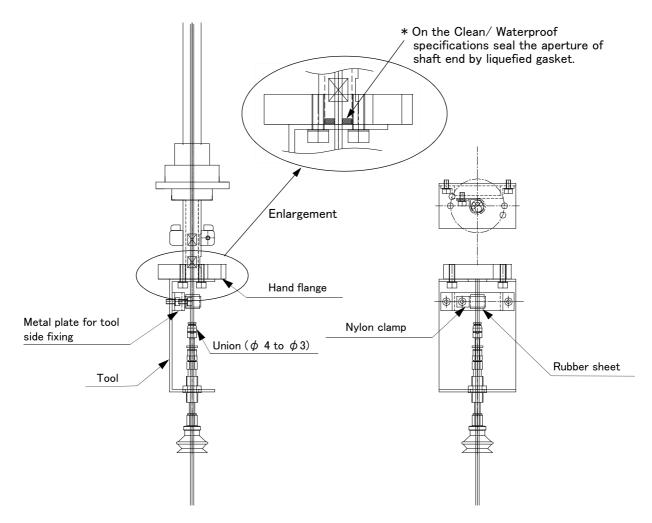
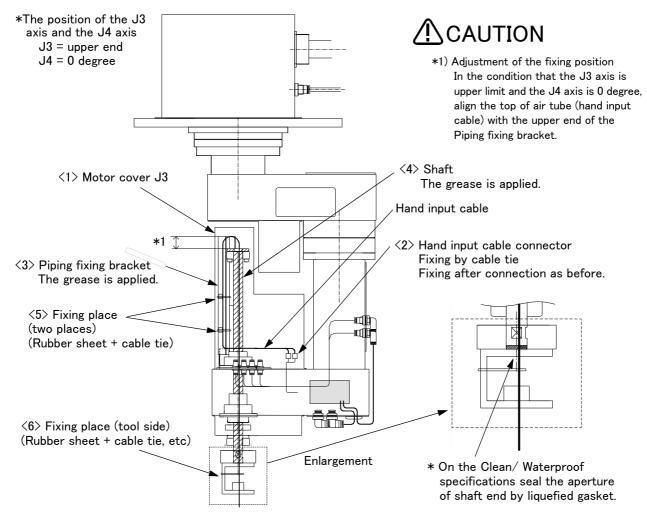


Fig.3-8: Tool side fixing image of hand tube (example)

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 51, "3.1 Installing the solenoid valve set" and the Page 56, "3.2 Installation of hand tube" together.

And, operate after turning OFF the power supply of the controller.



/!\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 57, "Fig.3-6: Protection of hand tube and hand input cable". If using the hand tube, roll together.
- 2) Remove motor cover J3 <1> with referring to the Page 73, "5.3.2 Installing/removing the cover".
- 3) By jog operation, set the J3 axis to the upper end, and set the J4 axis to the 0 degree. This position is adjustment basis for fixing hand input cable.
- 4) The hand input cable connector <2> is fixed at J4 motor inside the motor cover J3 <1> 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 J4 motor by cable tie (attachments) as before. Note: Fixing the connector at flat surface on the J4 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 <3> with cable tie. (two places <5> 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 <3> by the drawer side at the
- 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 J3 <1> 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.



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 51, "3.1 Installing the solenoid valve set" and the Page 62, "3.4 Installing the hand output cable" together.

And, operate after turning OFF the power supply of the controller.

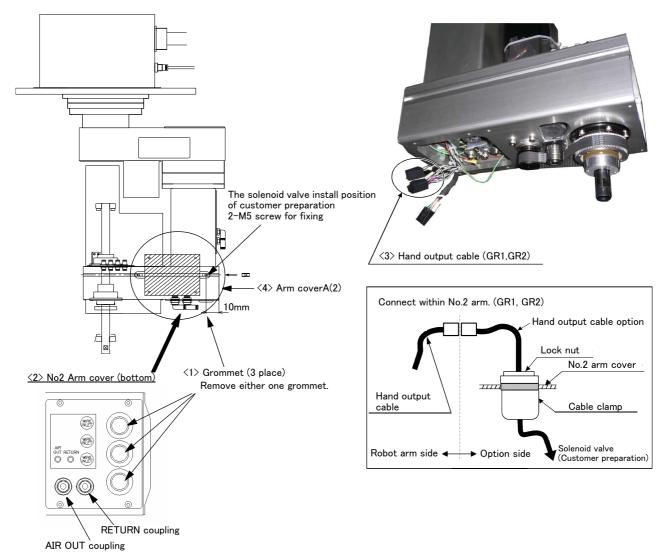


Fig.3-10: Installing the hand output cable

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 <2> and the arm cover A(2) <4>. Since the air tube is connected, No.2 arm cover <2> 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.

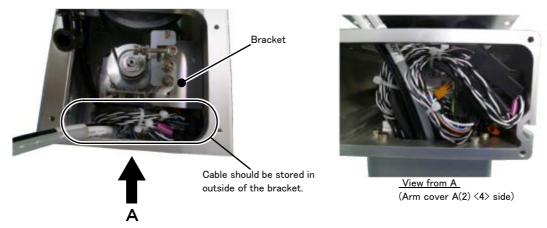


Fig.3-11: Storing of the hand output cable

- 5) Install the No.2 arm cover <2> 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

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 J1 axis

Upper face in base

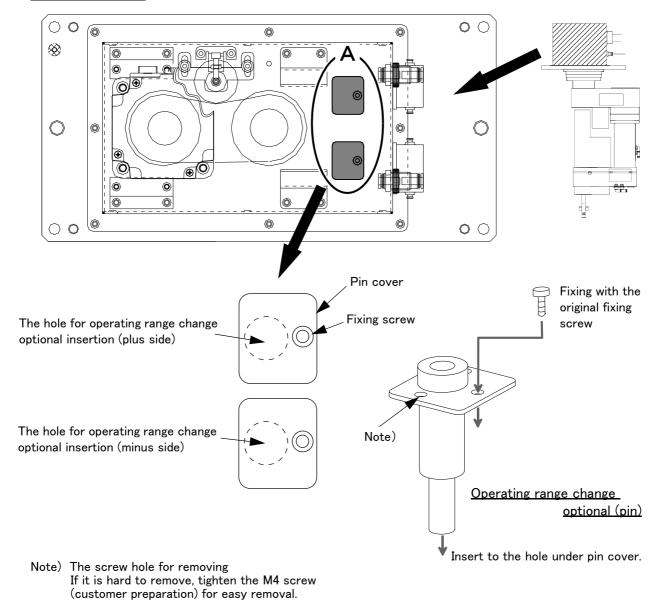
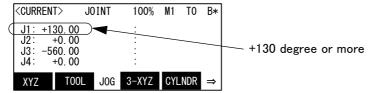


Fig.3-12: Installation of J1 axis operating range change optional

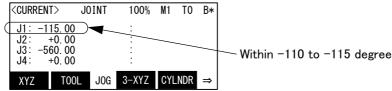
- 1) Turn OFF the power supply of the controller.
- 2) Remove base cover B(L) and (R) with referring to the Page 73, "5.3.2 Installing/removing the cover".
- 3) There is the pin cover at back in the base. ("A" of Fig. 3-12. Two places) Loosen the fixing screw and remove the two pin covers both.(Although the removed pin cover is unnecessary, use the screw for fixing this option later)
- 4) Move the J1 axis by jog operation. Once turn ON the power supply of the controller. Move the J1 axis 3 times by joint jog operation, confirming the coordinate value of T/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.

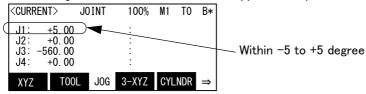


b) Next, move within -110 to -115 degree.



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 J1 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 J1 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 Set "-90" and "+90" as the 1st element and the 2nd element each.

Parameter: MORG...... Set "+93" as the 1st 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 J1 axis does not move the +/-90 degree or more with joint jog operation.

The operating range change of J1 axis is completion above.

3.5.2 Operating range change of J2 axis

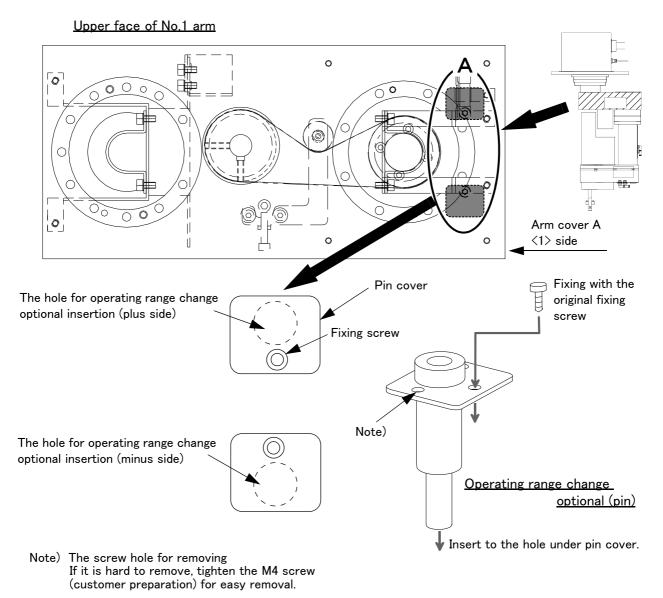
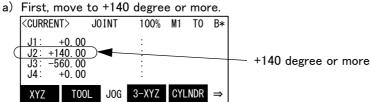


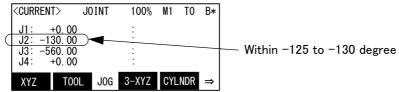
Fig.3-13: Installation of J2 axis operating range change optional

- 1) Turn OFF the power supply of the controller.
- 2) Remove arm cover A (1) with referring to the Page 73, "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 J2 axis by jog operation. Once turn ON the power supply of the controller. Move the J2 axis 3 times by joint jog operation, confirming the coordinate value of T/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.

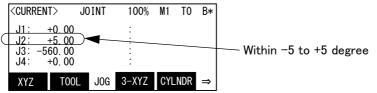


b) Next, move within -125 to -130 degree.



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 J2 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 J2 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 J2 axis does not move the \pm -- 60 degree or more with joint jog operation.

The operating range change of J2 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

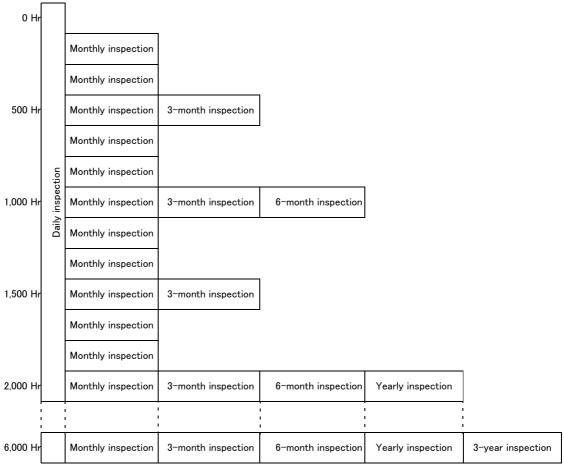
The maintenance and inspection procedures to be carried out to use the robot for a long time without trouble are described in this chapter. The types and replacement methods of consumable parts are also explained.

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 Hr/day × 20 days/month × 3 months = approx. 500 Hr 10 Hr/day × 20 days/month × 3 months = approx. 600 Hr

For two shifts

15 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)

Table J T	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? (Visual)	Securely tighten the bolts.					
2	Are any of the cover tightening screws loose? (Visual)	Securely tighten the screws.					
3	Are any of the hand installation bolts loose? (Visual)	Securely tighten the bolts					
4	Is the power supply cable securely connected? (Visual)	Securely connect.					
5	Is the machine cable between the robot and controller securely connected? (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 there any abnormality in the pneumatic system? Are there any air leaks, drain clogging or hose damage? Is the air source normal? (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 opera	tion (try running with an original program)						
1	Check whether the movement points are deviated? Check the following points if there is any deviation. 1. Are any installation bolts loose? 2. Are any hand installation section bolts loose. 3. Are the positions of the jigs other than the robot deviated? 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? (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-month ins	pection 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 ins	pection items						
1	Is the friction at 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 inspe	ction items						
1	Replace the backup battery in the robot arm.	Exchange it referring to Page 84, "5.3.5 Replacing the backup battery".					
3-year inspe	ection items						
1	Lubricate the grease at the harmonic reduction gears to J1 axis and J2 axis.	Lublicate it referring to Page 82, "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 87, "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 J1 axis motor <1> arranged in the base is conveyed to the reduction gears <3> via the timing belt $\langle 2 \rangle$ to rotate the J1 axis.
 - Brakes are not mounted in the J1 axis motor.
- 2) The rotation of the J2 axis motor <4> arranged in the No.1 arm is conveyed to the reduction gears <6> via the timing belt <5> to rotate the J2 axis.
 - Brakes are not mounted in the J2 axis motor.
- 3) The rotation of the J3 axis motor <7> arranged in the No.2 arm is conveyed to the shaft via the timing belt <8> to move the J3 axis as up and down.
 - Non-excitation magnetic brakes are mounted in the J3 axis motor.
- 4) The rotation of the J4 axis motor <9> arranged in the No.2 arm is conveyed to the shaft via the timing belt (motor side) <10> and the timing belt (shaft side) <11> to rotate the J4 axis. Brakes are not mounted in the J4 axis motor.

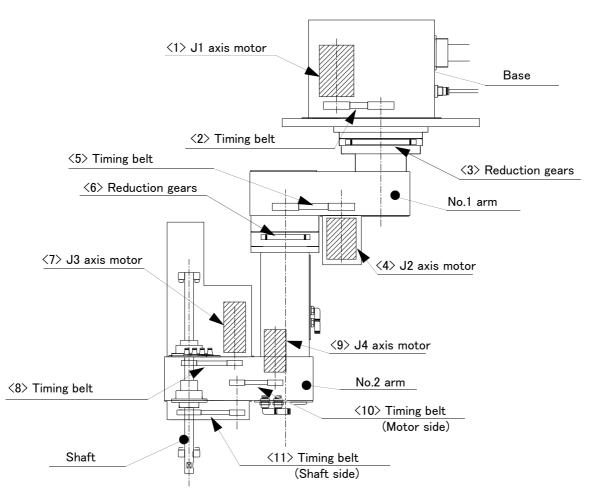


Fig.5-2: Outline structure drawing of robot arm

5.3.2 Installing/removing the cover

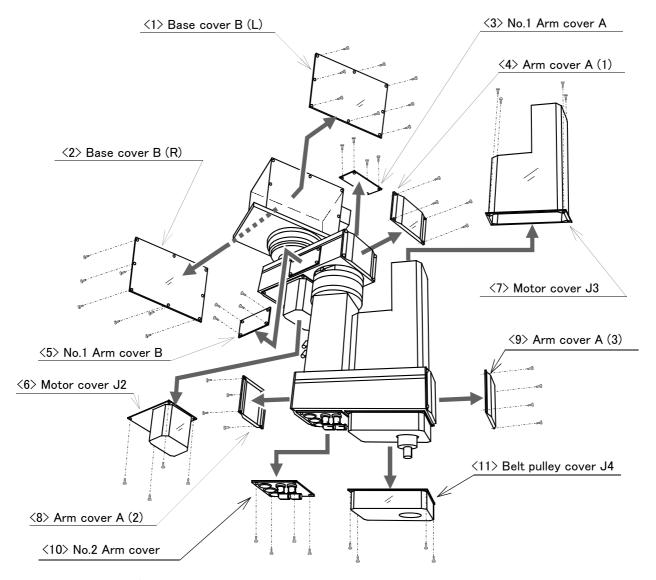


Fig.5-3: Installing/removing the cover

Table 5-3: Cover fixing screw list

No.		Installation screw name: Qty. Note1)			
INO.	Cover name	General environment type	Clean/Waterproof type		
<1>	Base cover B (L)	Low head hexagon socket screw, M4 x 8-eight screws	SUS hexagon socket screw, M4 × 10-eight screws Note2)		
<2>	Base cover B (R)	Low head hexagon socket screw, M4 x 8-eight screws	SUS hexagon socket screw, M4 × 10-eight screws Note2)		
<3>	No.1 Arm cover A	Low head hexagon socket screw, M4 x 8-four screws	SUS hexagon socket screw, M4 × 10-eight screws Note2)		
<4>	Arm cover A (1)	Low head hexagon socket screw, M4 x 8-four screws	SUS hexagon socket screw, M4 × 8-eight screws Note2)		
<5>	No.1 Arm cover B	Low head hexagon socket screw, M4 x 8-four screws	SUS hexagon socket screw, M4 × 10-eight screws Note2)		
<6>	Motor cover J2	Low head hexagon socket screw, M4 x 8-four screws	SUS hexagon socket screw, M4 × 10-eight screws Note2)		
<7>	Motor cover J3	Low head hexagon socket screw, M4 x 8-four screws	SUS hexagon socket screw, M4 × 10-eight screws Note2)		
<8>	Arm cover A (2)	Low head hexagon socket screw, M4 x 8-four screws	SUS hexagon socket screw, M4 × 8-eight screws		
<9>	Arm cover A (3)	Low head hexagon socket screw, M4 x 8-four screws	SUS hexagon socket screw, M4 × 8-eight screws		
<10>	No.2 Arm cover	Low head hexagon socket screw, M4 x 8-four screws	SUS hexagon socket screw, M4 × 10-eight screws Note2)		
<11>	Belt pulley cover J4	Low head hexagon socket screw, M4 x 8-four screws	SUS hexagon socket screw, M4 × 10-eight screws Note2)		

Note1)Bolting torque of each fixing screw is 1.39 to 1.89N \cdot 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) Refer to Fig. 5-3 and remove the covers. The names of the covers and installation screws are given in Table 5-3.
- (2) Depending on the robot's posture, some covers are hard to be removed. In such a case, change the robot's posture by performing jog operation to remove the covers.
- (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 replacement is necessary if the timing belt is in the condition which showed in "(1)Timing belt replacement period". The inspection and adjustment and replacement method of the timing belt of each axis is shown below. Please check, and adjust and replace if necessary.

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 81, "(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.



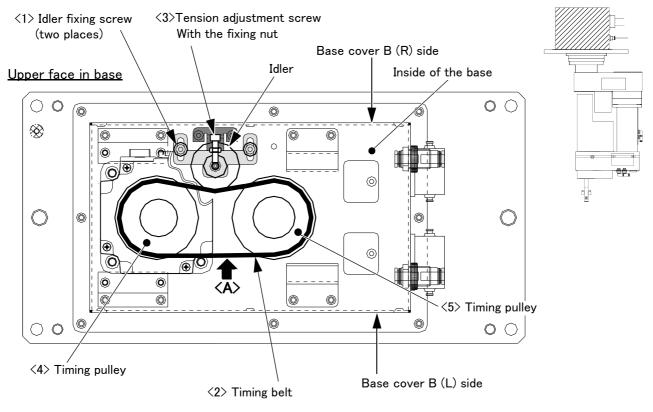
Due to the manufacturing of the timing belt, initial wear will occur. Wear chips may accumulate in the cover after approx. 300 Hr of operating the robot, but this is not a fault. If the wear chips appear soon after wiping them off, replace the belt.



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 J1 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 J1 axis timing belt

- Inspecting the J1 axis timing belt
 - 1) Confirm that the robot controller power is OFF.
 - 2) Refer to Page 73, "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 <A>, and confirm that the value of belt slack is in following.

Force to press the belt: apprpx.10N · m, Flexure: approx.1.3mm

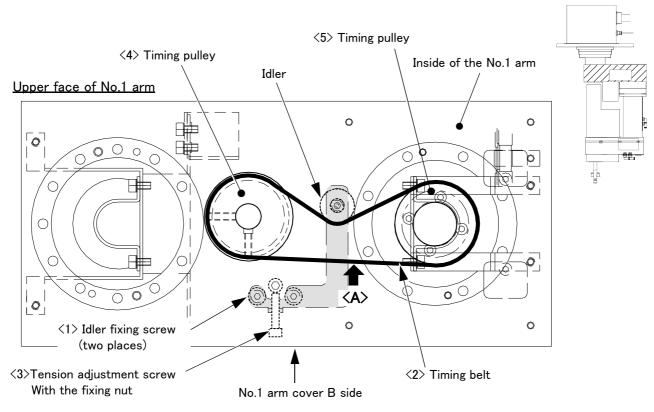
- Adjusting the J1 axis timing belt
 - 1) Carry out steps "1)" and "2)" indicated in " Inspecting the J1 axis timing belt" above.
 - 2) Lightly loosen the two idler installation bolts <1>. (Do not loosen too much.)
 - 3) The nut which is fixing tension adjustment screw <3> is loosened, turn tension adjustment screw <3>, and adjust the tension of timing belt <2>. 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. Force to press the belt: apprpx.10N · 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 <5>, or if the belt and pulley teeth engagement is deviated, the machine system's origin will deviate

(3) Inspection and maintenance of J2 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 73, "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 <A>, and confirm that the value of belt slack is in following.

Force to press the belt: apprpx.4N · m, Flexure: approx.1.6mm

■ Adjusting the J2 axis timing belt

- 1) Carry out steps "1)" and "2)" indicated in " Inspecting the J2 axis timing belt" above.
- 2) Lightly loosen the two idler installation bolts <1>. (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 <2>. When the screw is turned to the right, the belt will be stretched, and when turned to the left, will loosen.

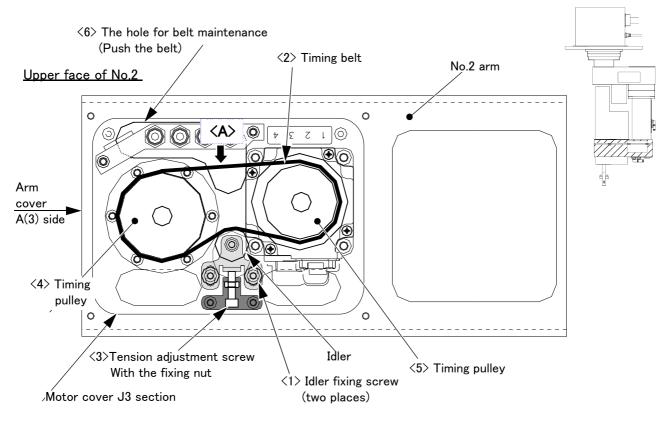
Lightly press the center of the belt <A>, and confirm that the value of belt slack is in following.

Force to press the belt: apprpx.4N · m, Flexure: approx.1.6mm

If the belt is loosened too much when adjusting the tension causing it to come off the timing pulleys <4> and <5>, or if the belt and pulley teeth engagement is deviated, the machine system's origin will deviate

(4) Inspection and maintenance of J3 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 A(3).

The belt can be pushed and adjusted from hole for belt maintenance <6>.

The idler fixing section and the tension adjustment screw section are in the No.2 arm.

Fig.5-6: Inspection, maintenance and cleaning of J3 axis timing belt

■ Inspecting the J3 axis timing belt

- 1) Confirm that the robot controller power is OFF.
- 2) Refer to Page 73, "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 <A>, and confirm that the value of belt slack is in following.

Force to press the belt: apprpx.3N · m, Flexure: approx.1.2mm

■ Adjusting the J3 axis timing belt

- 1) Carry out steps "1)" and "2)" indicated in " Inspecting the J3 axis timing belt" above.
- 2) Lightly loosen the two idler installation bolts <1>. (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.

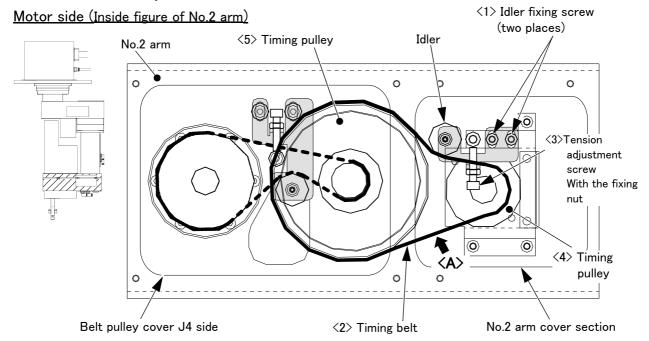
Lightly press the center of the belt <A>, and confirm that the value of belt slack is in following. Force to press the belt: apprpx.3N · m, Flexure: approx.1.2mm

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

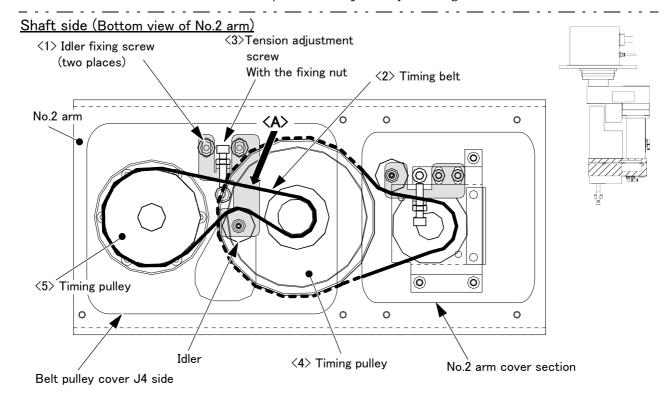
(5) Inspection and maintenance of J4 axis timing belt

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 J4 axis. Perform inspection and adjustment of two belts simultaneously.



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.



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 J4 axis timing belt

- Inspecting the J4 axis timing belt
 - 1) Confirm that the robot controller power is OFF.
 - 2) Refer to Page 73, "5.3.2 Installing/removing the cover", and remove the No.2 arm cover and the belt pulley
 - 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 <A>, and confirm that the value of belt slack is in following.

Motor side: Force to press the belt: apprpx.2N · m, Flexure: approx.1.1mm Shaft side: Force to press the belt: apprpx.4N · m, Flexure: approx.1.3mm

- Adjusting the J4 axis timing belt
 - 1) Carry out steps "1)" and "2)" indicated in " Inspecting the J4 axis timing belt" above.
 - 2) Lightly loosen the two idler installation bolts <1>. (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 <2>. When the screw is turned to the right, the belt will be stretched, and when turned to the left, will loosen.

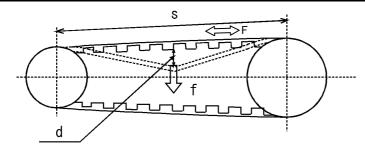
Lightly press the center of the belt <A>, and confirm that the value of belt slack is in following.

Motor side: Force to press the belt: apprpx.2N · m, Flexure: approx.1.1mm

Shaft side: Force to press the belt: apprpx.4N · 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 <5>, or if the belt and pulley teeth engagement is deviated, the machine system's origin will deviate

(6) Timing belt tension



f: Pressing force

s : Span d : Slack T: Tension

Pressing force

			New belt		Used belt	
Axis	Belt type	Sepang : s mm	Slack : d mm	Pressing force : f(N)	Slack : d mm	Pressing force : f(N)
J1	340-5GT-20	84	1.1	16.7	1.1	10
J2	363-3GT-12	103	1.6	6	1.6	4
J3	297-3GT-9	77	1.2	4.5	1.2	3
J4 (Motor side)	345-3GT-6	69	1.1	3	1.1	2
J4 (Shaft side)	312-3GT-12	82	1.3	6	1.3	4

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

		Preset value		Standard tension T(N)		
Axis	Belt type	M (g/m)	W (mm/R)	S(mm)	New belt	Used belt
J1	340-5GT-20	4.0	20	84	171 - 209	103 - 125
J2	363-3GT-12	2.5	12	103	80 - 97	53 - 65
J3	297-3GT-9	2.5	9.0	77	31.1 - 38	16.1 - 23.1
J4 (Motor side)	345-3GT-6	2.5	6.0	69	39.8 - 45.4	19.9 - 28.4
J4 (Shaft side)	312-3GT-12	2.5	12	82	43.6 - 52.8	22.5 - 32.1

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 loose. 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 spans.

5.3.4 Lubrication

(1) Lubrication position and specifications

The grease nipple position is shown in Fig. 5-9. The lubrication specifications for each place are shown in Table 5-4. Refer to the Page 73, "5.3.2 Installing/removing the cover" for the method of removing and installing the cover.

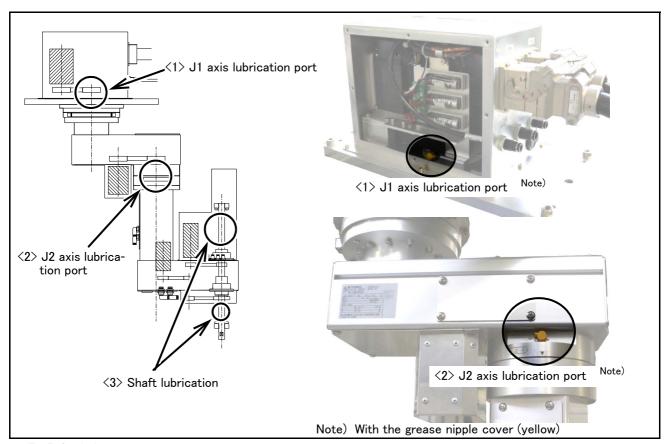


Fig.5-9: Lubrication positions

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 ninnle	Grease	6,000 Hr	4.1 g	Base cover B (L)
<2>		WC-610(Only addition)	Harmonic grease SK-1A (Harmonic Drive Systems Inc.)	6,000 Hr	1.8 g	_
<3>	Shaft (General environment/ Clean type)	Wipe the old grease, and	Marutenpu PS No.2 (KYODO YUSHI CO.,LTD.)	Every 2000km	1 g	Motor cover J3
<4>	Shaft (Waterproof type)	paint	NOK Klubersynth UH1 14-222 (NOK CORPORATION)	movement		

[Caution]

- The brand name of the grease shown in the Table 5-4 is the grease put in 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.
- · By the maintenance forecast function of RT ToolBox2 (option) computes the guide of the lubrication hours put together with the customer's operation status.
- The numbers in the Table 5-4 correspond to the supply positions in Fig. 5-9.
- Because excessive lubrication leads to the grease leak, avoid it. And, the number of times of lubrication limits to 3 times. The maintenance after it needs the overhaul work which replaces internal grease. Please ask dealer.

(2) Lubrication method to the J1, J2 axis

- 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 73, "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.



Use manual grease gun, and inject grease with pressure 0.03Mpa or less. Do not use the grease gun, which derived by the factory air presser to avoid injecting by too high pressure.

A grease gun that fits the grease nipple is required.

Recommended grease gun: CH-400 (manufacture: Yamada Corporation Inc.,)

The CH-400 gun is a cartridge-type grease gun. Contact your dealer and use commercially available grease cartridges.

When a grease can is used, hand grease gun KH-32 (manufacture: Yamada Corporation) is recommended. The KH-32 comes with a short nozzle (HSP-1) as standard. If this short nozzle does not reach the desired areas, depending on the robot model and installation location, it may be useful to use a long nozzle (HSP-2). CH-400 has a long nozzle as standard equipment.

- 4) Install the covers with the removal procedure in reverse.
- 5) If the maintenance forecast function is enable, please reset the accumulated data about grease. Carries out the resetting operation by RT ToolBox or parameter (MFGRST). Refer to separate "RT ToolBox2 / RT ToolBox2 mini User's Manual" for the operation method of RT ToolBox, and refer to separate "Instruction Manual/Detailed Explanation of Functions and Operations" for details of parameter (MFGRST).

The lubricating to J1 and J2 axes is completed.

(3) Lubrication method to the shaft

- 1) Refer to Page 73, "5.3.2 Installing/removing the cover"," remove the motor cover J3.
- 2) 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.
- 3) 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.
- 4) Install the covers with the removal procedure in reverse.

The applying grease to shaft is completed.

5.3.5 Replacing the backup battery

An absolute encoder is used for the position detector, so while power of controller is turned off the position must be saved by the backup battery. The controller also uses a backup battery to save the program, etc. The battery is the lithium battery. 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. There exists the kinds of the errors about the battery shown in Table 5-5. If error 7500 occurs, please exchange the battery of the robot arm and the controller simultaneously.

Table 5-5: The error about the battery

Item	Error number	Description	Measure	
	7520	The battery consumption time was exceeded	Replace the battery	
oller	7510	Battery voltage low	Replace the battery	
Controller	7500	No battery voltage	The backup data cannot be guaranteed if this error occurs.	
	7520	The battery consumption time was exceeded	Replace the battery	
arm	133n ^{Note1)}	Encoder battery voltage low _o		
Robot	112n	Encoder ABS position data lost	The backup data cannot be guaranteed if this error occurs.	

Note1) "n" indicates the axis number

The method of replacing the battery of robot arm is shown below.

refer to the separate "Instruction manual/Controller setup, basic operation, and maintenance" about controller's

About the purchase of the battery, refers to Page 87, "5.5 Maintenance parts".



CAUTION If error 7500 or 112n occurs, the program data and other data in the controller is lost and it becomes necessary to load the data such as program and origin data again.

(1) Replacing the battery (robot arm)



The power supply for the encoder is supplied by cable connected with battery board. The cable must be connected while replacing the battery or operating usually. Thus, if the cable connection is incomplete, the encoder position data will be lost, and resetting the origin is necessary.



Replace the battery one by one . If all batterys are removed the encoder data will be lost, and resetting the origin is necessary.

The battery installation position is shown in Fig. 5-10. Refers to the figure and replaces the batteries in the following procedures.

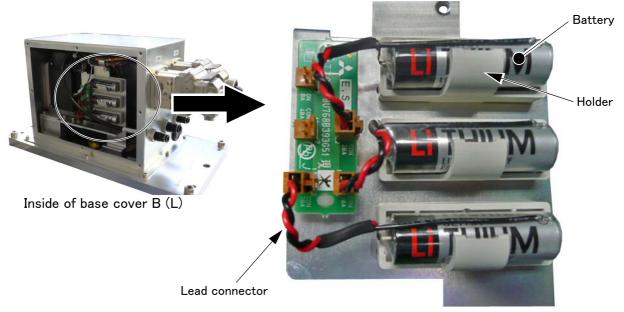


Fig.5-10: Replacing the battery

- 1) Turn the controller control power OFF.
- 2) Refer to Page 73, "5.3.2 Installing/removing the cover", and remove the base cover B (L).
- 3) Replaces the backup battery one by one. The battery holder is located inside the base cover B (L). Remove the old battery from the holder, and disconnect the lead connector.
- 4) Insert the new battery into the holder, and connect the lead connector. Replace all batteries with new ones at the same time.
- 5) All the batteries should be checked that it has been exchanged newly. If the old battery is contained, generating heat and damaging may occur.
- 6) Install the base cover B (L) as before. Be careful so that the cable may not be inserted.
- 7) 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.

[Caution] If the old battery is replaced because it has been used up, it is necessary to set the origin again. Refer to Page 88, "5.6 Resetting the origin" and reset the origin using the 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. As a rule of thumb, it is recommended that overhaul be carried out before the total amount of servo—on time reaches the specified time (24,000 hours for the robot arm and 36,000 hours for the controller) (See Fig. 5—11.). However, the degree of the equipment's wear and deterioration presumably varies depending on their operating conditions. Especially for operation with high load and frequency, the maintenance cycle may be shorter. For details on the part selection for replacement and the timing of overhaul, contact your dealer.

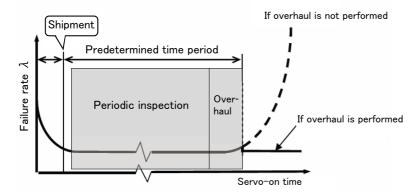


Fig.5-11: Periodic inspection/overhaul periods

5.5 Maintenance parts

The consumable parts that must be replaced periodically are shown in Table 5-6, and spare parts that may be required during repairs are shown in Table 5-7. Purchase these parts from the dealer when required. Some Mitsubishi-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 5-6: Consumable part list

No.	Part name	Туре	Usage place	Q'ty	Supplier	
1	Timing belt		J1 axis	1		
			J2 axis	1		
			J3 axis	1		
			J4 axis motor side	1	Mitsubishi Electric	
			J4 axis shaft side	1		
2	Grease		Reduction gears of each axis	A small amount		
3	Lithium battery	ER6	In base cover B(L)	3		

Table 5-7: Spare parts list

	and of the part of the control of th						
No.	Names	Usage place	Q'ty	Supplier			
1	AC servo motor	J1 axis	1				
2		J2 axis	1				
3		J3 axis	1				
4		J4 axis	1	Mitsubishi Electric			
5	Reduction gears	J1 axis	1				
6		J2 axis	1				
7	Ball screw spline	J3 axis	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 origin setting methods and when each origin setting method is required are shown in Table 5-8.

Table 5-8: Origin setting method

No	Method	Explanation	Cases when setting the origin is required	Remarks
1	Origin data input method	The origin data set as the default is input from the T/B. Use this method at the initial startup.	At the initial startup When the controller is replaced When the data is lost due to flat battery of the robot controller (when C7500 occurs)	The setting method is explained in Page 21, "2.3 Setting the origin".
2	Jig method	The origin posture is set with the calibration jig installed.	When a structural part of the robot (motor, reduction gear, timing belt, etc.) is replaced When deviation occurred by a col- lision.	The setting method is explained in Page 97, "5.6.2 Jig method".
3	Mechanical stopper method	This origin posture is set by contacting each axis against the mechanical stopper.	When a structural part of the robot (motor, reduction gear, timing belt, etc.) is replaced When deviation occurred by a collision.	The accuracy is lower than that of the jig method. The setting method is explained in Page 89, "5.6.1 Mechanical stopper method".
4	ABS origin method	This method is used when the encoder backup data lost in the cause such as battery cutting.	· When the encoder data is lost due to flat battery of the robot arm (when H112n occurs)	Before using this method, the origin must be set with the other method with same encoder. The setting method is explained in Page 103, "5.6.3 ABS origin method".
5	User origin method	A randomly designated position is set as the origin posture.	· When an arbitrary position is set as the origin	Before using this method, the origin must be set with the other method. The setting method is explained in Page 106, "5.6.4 User origin method".

[Caution]

- The origin is set using the jig method (No.2) at factory default.
- The value set with the jig method is encoded and used as the origin data to be input at the initial startup after shipment. When the robot arm does not mechanically deviate (for example caused by replacement of the reduction gear, motor, or timing belt) or does not lose the encoder data, the origin data input method at shipment can be used to set the origin.
- The origin data is inherent to the serial number of each robot arm.
- The ABS origin method is used to restore the previous data by aligning the triangular marks to each other for each axis to set the lost origin data.
 - (Although the setting position is confirmed visually, deviations within a half rotation of the motor can be compensated.)

[Remarks]

- The ABS origin method cannot be used when the robot arm mechanically deviates (for example caused by replacement of the reduction gear, motor, or timing belt).
- *After the origin setting is completed, move the robot arm to the position where the ABS marks align each other, and check that the displayed joint coordinates of the position are correct.

For the details of the ABS mark position and the joint coordinates, refer to Page 103, "5.6.3 ABS origin method".

5.6.1 Mechanical stopper method

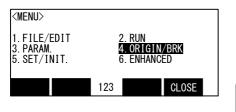
The method for setting the origin with the transportation jig is explained below.

This operation is carried out with the T/B. Set the mode 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 J3 axis (shaft) is moved with both hands. For safety purposes, the brakes must be released by two workers.

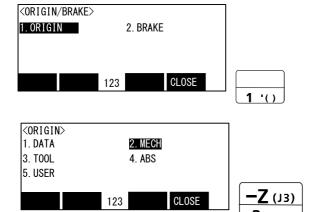
(1) J1 axis origin setting (mechanical stopper)



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

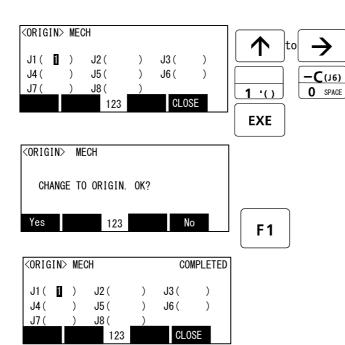


2) With both hands, slowly move the J1 axis in + (plus) direction, and contact the axis against the mechanical stopper.



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

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



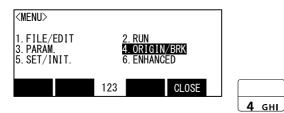
- 5) Input "1" into the J1 axis. Set "0" to other axes.
- 6) Press the [EXE] key, and display Confirmation screen.
- 7) Press the [F1] key, and the origin position is set up.
- 8) Setting of the origin is completed.
- 9) Refer to Page 108, "5.6.5 Recording the origin data" in this manual, and record 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".

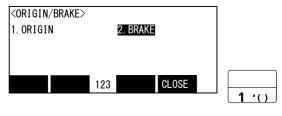
(2) J2 axis origin setting (mechanical stopper)



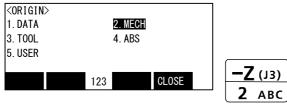
1) Press the [4] key on the menu screen, and display the Origin/Break selection screen.



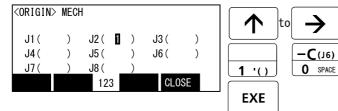
2) With both hands, slowly move the J2 axis in + (plus) direction, and contact the axis against the mechanical stopper.



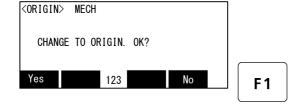
3) Press the [1] key, and display the Origin setting selection screen.



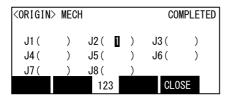
4) Press the [2] key, and display the Mechanical stopper selection screen.



- 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.



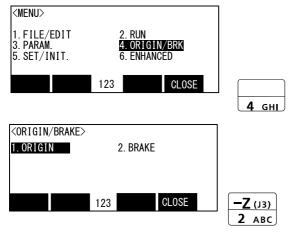
- 8) Setting of the origin is completed.
- 9) Refer to Page 108, "5.6.5 Recording the origin data" in this manual, and record the origin data on the origin data seal.

♦ 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.

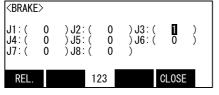
♦♦♦ Select the axis of origin setting ♦♦♦ Do cursor movement into the parenthesis of each axis by the arrow key. The origin is set only for the axis for which a "1" is displayed on the screen. If the origin is not to be set, press the [0] key and display a "0".

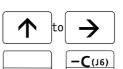
(3) J3 and J4 axis origin setting (mechanical stopper) Always perform origin setting of the J3 axis and the J4 axis simultaneously.



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

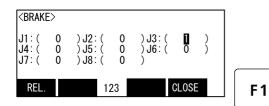
2) Press the [2] key, and display the Break release selection screen.



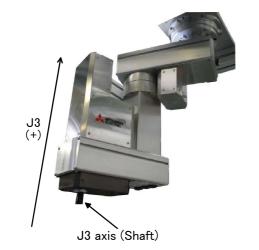


O SPACE

3) Release the brake of the J3 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 J3 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 J3 axis could drops with its own weight.

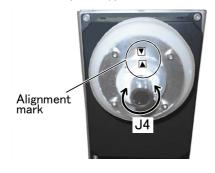


• CAUTION If [F1] key or enable switch of T/B is released, the brakes will be work immediately.

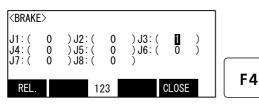
General environment type



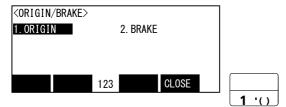
Clean/Waterproof type



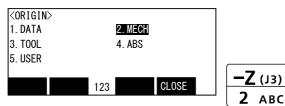
7) Hold the J4 axis with your hand and rotate it slowly to match the alignment marks. *Move the J4 axis with maintaining the condition that the releasing brake of the J3 axis and the J3 axis contact to the mechanical stopper. Note) If the J3 axis has slid, move the J3 axis against the mechanical stopper,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



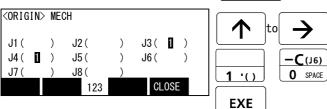
8) Detach the [F1] key and work the brake. Press the [F4] key and return to the origin / brake screen.



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

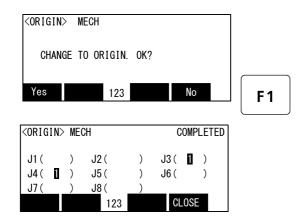


10) Press the [2] key, and display the Mechanical stopper selection screen.



ABC

- 11) Input "1" into the J3 and J4 axis. Set "0" to other axes.
- 12) Press the [EXE] key, and display Confirmation screen.



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

- 14) Setting of the origin is completed.
- 15) Refer to Page 108, "5.6.5 Recording the origin data" in this manual, and record the origin data on the origin data seal.

♦ Release the brake

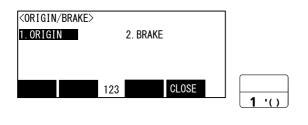
Do cursor movement into the parenthesis of each axis by the arrow key. The brakes can be released only for the axis for which a "1" is displayed on the screen. If the brakes are not to be released, press the [0] key and display a "0". If the [F1] key on the teaching pendant or the enabling switch is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

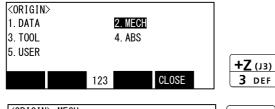
(4) All axis origin setting



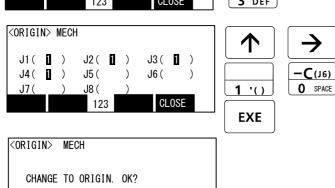
1) Refer to the paragraphs from Page 89, "(1) J1 axis origin setting (mechanical stopper)" to Page 93, "(3) J3 and J4 axis origin setting (mechanical stopper)" above for the description of how to adjust the origins of the J1 to J4 axes. Line up the ABS marks for the J4 axis and move the other axes into contact with the mechanical stoppers. At this point, the robot will have the posture shown below



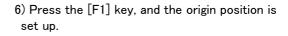
2) Press the [1] key, and display the Origin setting selection screen.

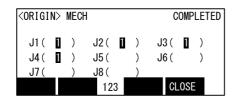


3) Press the [2] key, and display the Mechanical stopper selection screen.



- 4) Input "1" into the J1 to J4 axis. Set "0" to other axes.
- 5) Press the [EXE] key, and display Confirmation screen.





123

- 7) Setting of the origin is completed.
- 8) Refer to Page 108, "5.6.5 Recording the origin data" in this manual, and record the origin data on the origin data seal.

The origin settings are completed by the mechanical stopper method.

F1

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.

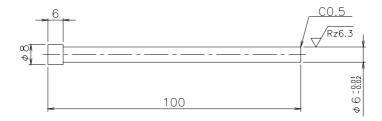


Fig.5-12: Reference dimension of origin setting tool

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

This operation is carried out with the teaching pendant. Set the mode of the controller to "MANUAL", and set the [ENABLE] switch on the teaching pendant to "ENABLE" to enable the teaching pendant.

The origin setting can be performed for the target axis only instead of for all axes. Go to steps for the target axis to set the origin.

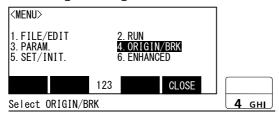
Do the following operations, pressing down the enabling switch of T/B lightly.



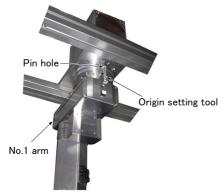
In the following procedure, the J3 axis brake is released to move its shaft with both

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

(1) J1 axis origin setting

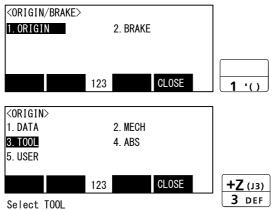


1) Press the [4] key on the menu screen, and display the Origin/Break selection screen.

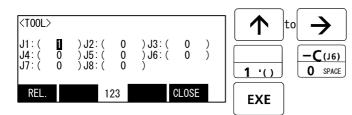


2) Move the J1 axis slowly toward the front using both hands. Align the pinhole of the No.1 arm and the pinhole at the base section, feed through the origin jig into the pinholes and fas-

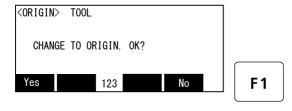
The origin setting tool should be inserted 35mm.



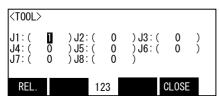
- 3) Press the [1] key, and display the Origin setting selection screen.
- 4) Press the [3] key, and display the Tool selection screen.



- 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.

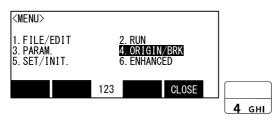


- 8) Setting of the origin is completed.
- 9) Refer to Page 108, "5.6.5 Recording the origin data" in this manual, and record the origin data on the origin data seal.

- ♦♦♦ 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".

(2) J2 axis origin setting



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

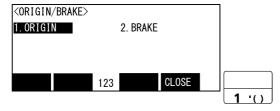


 Slowly rotate the J2 axis 0 degree with both hands. Remove the plug installed in the pin hole by hexagon wrench. Align the pinholes of the No. 1 and No. 2 arms, feed through the origin jig into the pinholes and fasten.

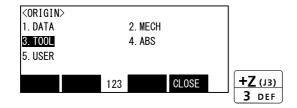
The origin setting tool should be inserted 65mm.

Note) If the stick cannot insert 65mm move the

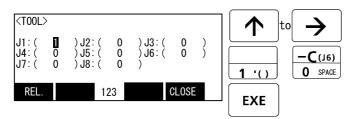
J2 axis to mechanical stopper once.



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

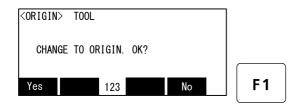


4) Press the [3] key, and display the Tool selection screen.

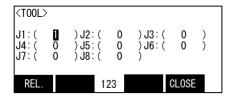


5) Input "1" into the J2 axis. Set "0" to other axes.

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 108, "5.6.5 Recording the origin data" in this manual, and record the origin data on the origin data seal.

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

♦♦♦ 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

Origin settings for the J3 and J4 axes must be performed at the same time.

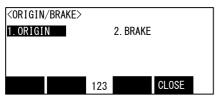
The method of origin setting is the same as the mechanical stopper method. Refer to Page 93, "(3) J3 and J4 axis origin setting (mechanical stopper)", perform the required origin setting operations.

The origin settings are completed by the jig method.

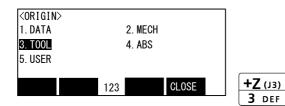
(4) All axis origin setting



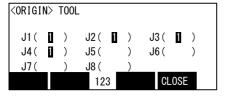
1) Refer to the paragraphs from Page 98, "(1) J1 axis origin setting" to Page 101, "(3) J3 and J4 axis origin setting" above for the description of how to adjust the origins of the J1 to J4 axes. At this point, the robot will have the posture shown below.

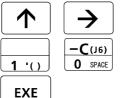


2) Press the [1] key, and display the Origin setting selection screen.



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

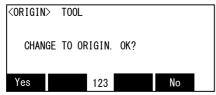




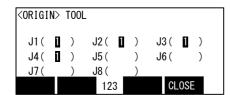
F1

1 ()

4) Input "1" into the J1 to J4 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 108, "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 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.

To align the ABS marks, view the robot from the front. The deviation between the end points of the two triangular marks must be 1 mm or less.

The positions where the ABS mark is attached are shown in below. Refer to Page 28, "2.4 Confirming the operation" for details on the jog operation.

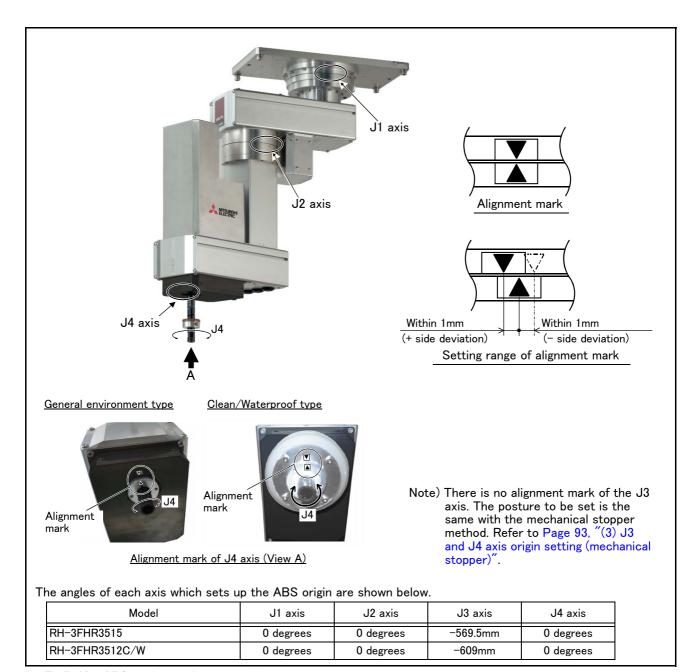
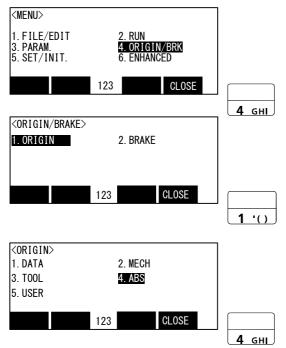


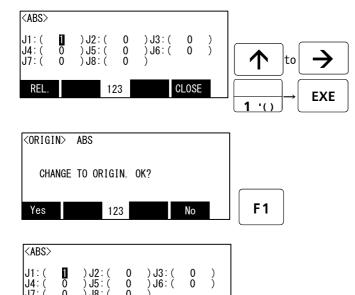
Fig.5-13: ABS mark attachment positions

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

The origin settings are completed by the ABS method.



CAUTION After setting the origin, when the joint coordinates of the ABS mark position deviate from the coordinates of the ABS origin by 1.5° or more, align the end points of the ABS marks and set the origin using the ABS origin method again.



CAUTION When the ABS mark label of the axis other than the J4 axis is peeled off, align the pinholes used to set the origin with the jig method. The joint coordinates are the same between the ABS origin method and the jig method.

5.6.4 User origin method



IN CAUTION Before using this method, the origin must be set with the other method. The setting method is explained in Page 88, "Table 5-8: 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 of the controller to "MAMNUAL", and set the [ENABLE] switch on the teaching pendant to "ENABLE" to enable the teaching pendant. The operation method is shown below.

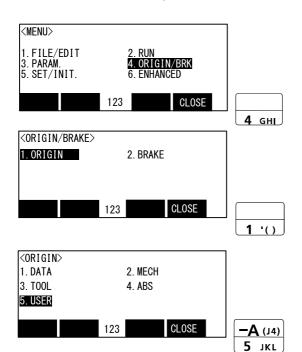
When setting the origin for the first time using this method, carry out the operations in order from step 1). For the second and following time, move the robot arm to the user origin position with jog operation, and accurately position all axis. Then start the procedure from step 4).

1) Determine the user origin position Move the robot to the position to be set as the origin with jog operation. Refer to Page 28, "2.4 Confirming the operation for details on the jog operation.

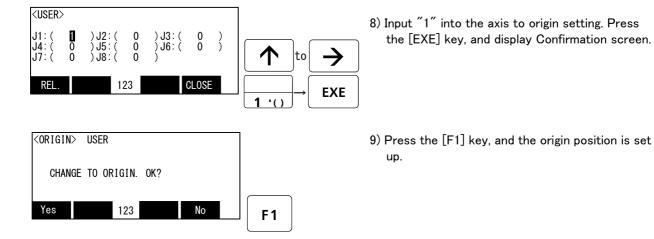


CAUTION Choose the user origin position as the position where it doesn't move by the gravity. This position is left as a guideline to position all axes with jog operation when setting the origin again with this method.

- 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 (USERORG)". 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.



The origin settings are completed by 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 base cover B (L).

The teaching pendant operation method and base cover B (L) 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 23, "2.3.2 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 base cover B (L).

Refer to Page 73, "5.3.2 Installing/removing the cover", and remove the base cover B (L).

(2) Confirming the origin data

Confirm the value displayed on the teaching pendant's Origin Data Input screen.

Refer to Page 23, "2.3.2 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 battery cover. Refer to Page 23, "Fig.2-12: Origin data label (an example)", and Page 26, "Fig.2-13: Correspondence of origin data label and axis" for details on the origin data label.

(4) Installing the base cover B (L)

Install the base cover B (L) removed in step "(1)Confirming the origin data label" above.

Refer to Page 73, "5.3.2 Installing/removing the cover", and replace the battery cover.

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 X, Y, Z, A, 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 (X, Y, Z, A, B, 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 J1 axis and the rotational center of the J2 axis.

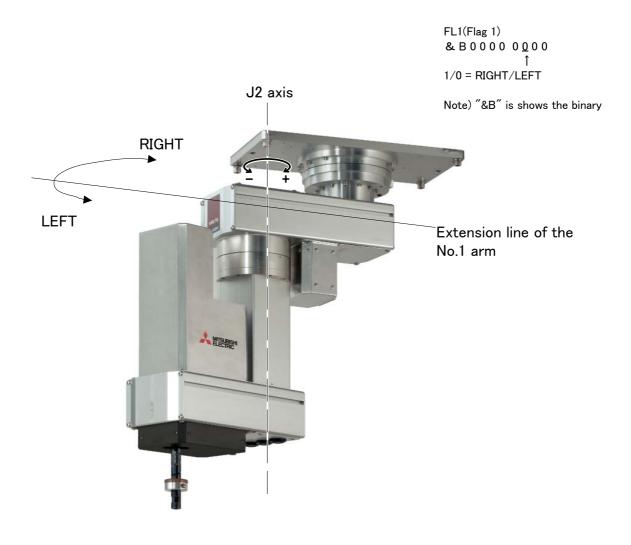


Fig.6-1: Configuration flag (RIGHT/LEFT)

MITSUBISHI ELECTRIC CORPORATION
HEAD OFFICE: TOKYO BUILDING, 2-7-3, MARUNOUCHI, CHIYODA-KU, TOKYO 100-8310, JAPAN
NAGOYA WORKS: 5-1-14, YADA-MINAMI, HIGASHI-KU NAGOYA 461-8670, JAPAN

Authorised representative:

Mitsubishi Electric Europe B.V. FA - European Business Group
Mitsubishi-Electric-Platz 1, D-40882 Ratingen, Germany
Tel: +49(0)2102-4860

Sep., 2017 MEE Printed in Japan on recycled paper.