MITSUBISHI ELECTRIC

Mitsubishi Electric Industrial Robot

RV-8CRL INSTRUCTION MANUAL

ROBOT ARM SETUP & MAINTENANCE

MELFA

BFP-A3679-B

⚠ 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

⚠ 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 operation rights of the devices, etc. must be designed by the customer.

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

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

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

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

⚠ 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.

⚠ 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.

⚠ 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.

⚠ 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 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 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.

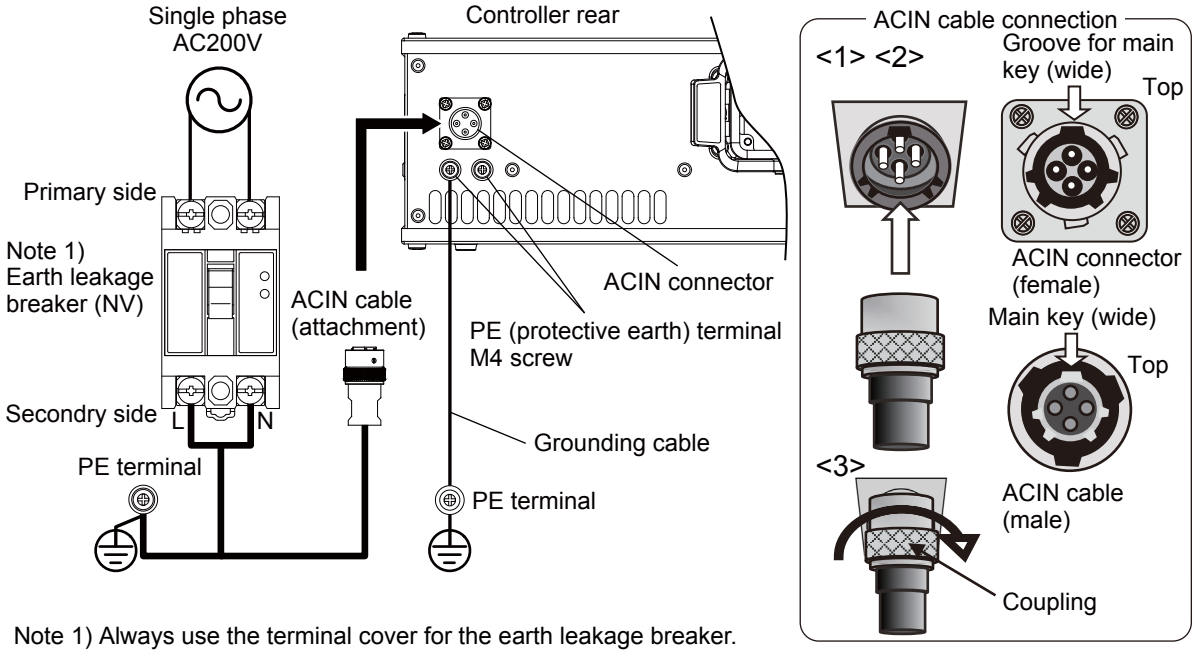
⚠ CAUTION Use the network equipments (personal computer, USB hub, LAN hub, etc) confirmed by manufacturer. The thing unsuitable for the FA environment (related with conformity, temperature or noise) exists in the equipments connected to USB. When using network equipment, measures against the noise, such 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.

⚠ CAUTION To maintain the safety of the robot system against unauthorized access from external devices via the network, take appropriate measures.
To maintain the safety against unauthorized access via the Internet, take measures such as installing a firewall.

*CR800 controller

Notes of the basic component are shown.

⚠CAUTION Please install the earth leakage breaker in the primary side power supply of the controller because of leakage protection.



Note 1) Always use the terminal cover for the earth leakage breaker.

1) Prepare the following items.

Part name	Specifications	Remarks
Earth leakage breaker	The following is recommended product. Single phase: NV30FAU-2P-10A-AC100-240V-30mA (Terminal cover: TCS-05FA2)	Prepared by customer.
Cable for primary power supply	AWG14 ($2mm^2$) or above	Prepared by customer. Tightening torque for terminal fixing screw is 2 to 3 N•m.
Grounding cable	AWG14 ($2mm^2$) or above	Prepared by customer. Tightening torque for terminal fixing screw is 2 to 3 N•m.
ACIN cable	Terminal: M5, cable length: 3m	Supplied with the product.

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 ACIN cable to the breaker.
   Connect the power terminals of the ACIN cable to the secondary side terminals of the earth leakage breaker. Also, ground the FG terminal of the cable.
5) Connect the ACIN cable to the ACIN connector on the rear of the controller.
   <1> Face the main key on the ACIN cable plug upwards. (Refer to the "ACIN cable connection" illustration.)
   <2> Align the main key of the ACIN cable plug with the grooves on the ACIN connector. Push the plug into the connector as far as it will go.
   The plug may be damaged if it is not correctly aligned with the connector.
   <3> Tighten the coupling on the ACIN cable, turning it to the right until it locks.
6) Connect one end of the grounding cable to the PE (protective earth) terminal on the controller and ground the other end (2-point grounding) in order to comply with the requirements of EN 61800-5-1 for the touch current of 3.5 mA AC or more.
7) Connect the primary power cable to the primary side terminal of the earth leakage breaker.

Revision history

Date of Print	Instruction Manual No.	Revision Details
2019-06-24	BFP-A3679	• First print
2019-07-26	BFP-A3679-A	• Deleted the description of the origin data label. • Deleted the description of the origin data input method. • Deleted the description of the origin data record. • Revised "5.6.1 (4) J4 axis origin setting (jig)". • Revised "5.3.2 Installing/removing the covers".
2019-10-31	BFP-A3679-B	• Changed "Grease outlet" to "Pressure release port".

*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."

This document explains for the following robot type.
<Robot type>
• RV-8CRL

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1 Before starting use

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

Manual name	Description
Safety Manual	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 explanations 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	Explains the control function and specifications of conveyor tracking.
GOT Direct Connection Extended Function	Explains the detailed description of data configuration of shared memory, monitoring, and operating procedures about the GOT (standalone type robot).
Ethernet Function	Explains the measures to perform communication with personal computers on Ethernet with the TCP/IP protocol.

1.1.2 Symbols used in instruction manual

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

Table 1-1:Symbols in instruction manual

Terminology	Item/Symbol	Meaning
Item	Standalone type	
	Controller	Indicates the controller which controls the robot arm.
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. Descriptions in this manual are based on R32TB.

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.

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⚠ 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

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2 Unpacking to Installation

2.1 Confirming the product

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

Table 2-1:Standard configuration

No.	Part name	Type	Qty.	Remarks
RV-8CRL				
1	Robot arm	-	1 unit	-
2	Installation bolts	M8 × 40	4 pcs.	For robot arm installation
3	Spring washer for installation bolts	For M8	4 pcs.	
4	Plain washer for installation bolts	For M8	4 pcs.	
5	D-sub connector set	-	2 pcs.	Tool wiring connector
6	Grease nipple	WA-610	1 pc.	-

2.2 Installation

⚠DANGER Install the robot with a safety fence or enclosure around it. Otherwise, operators may be injured due to unintended access to the robot.

2.2.1 Unpacking

The robot is shipped from the factory in cardboard and plywood packing. Always refer to Fig. 2-1 and unpack the robot. For details on transportation of the robot arm, refer to "2.2.2Transportation procedures (Transportation by people)", and "2.2.3Transportation procedures (Transporting with a crane)".

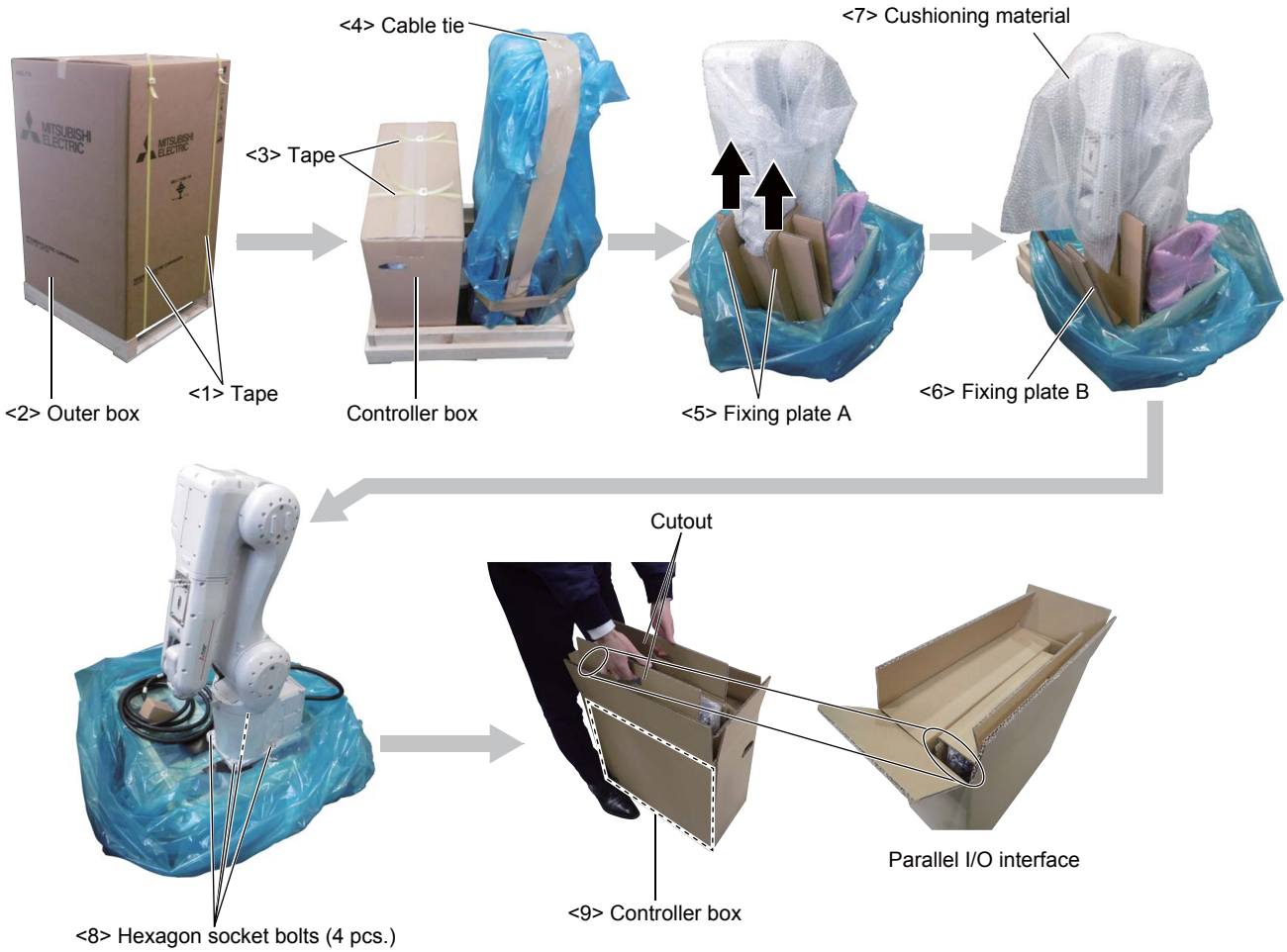


Fig.2-1: Unpacking the robot arm

Note) The packing material is required at re-transportation.
Please keep it with care.

⚠CAUTION Always unpack the robot at a flat place. The robot could tilt over if unpacked at an unstable place.

⚠CAUTION Take the controller box straight up slowly. Be careful not to let the controller slip out of the box.

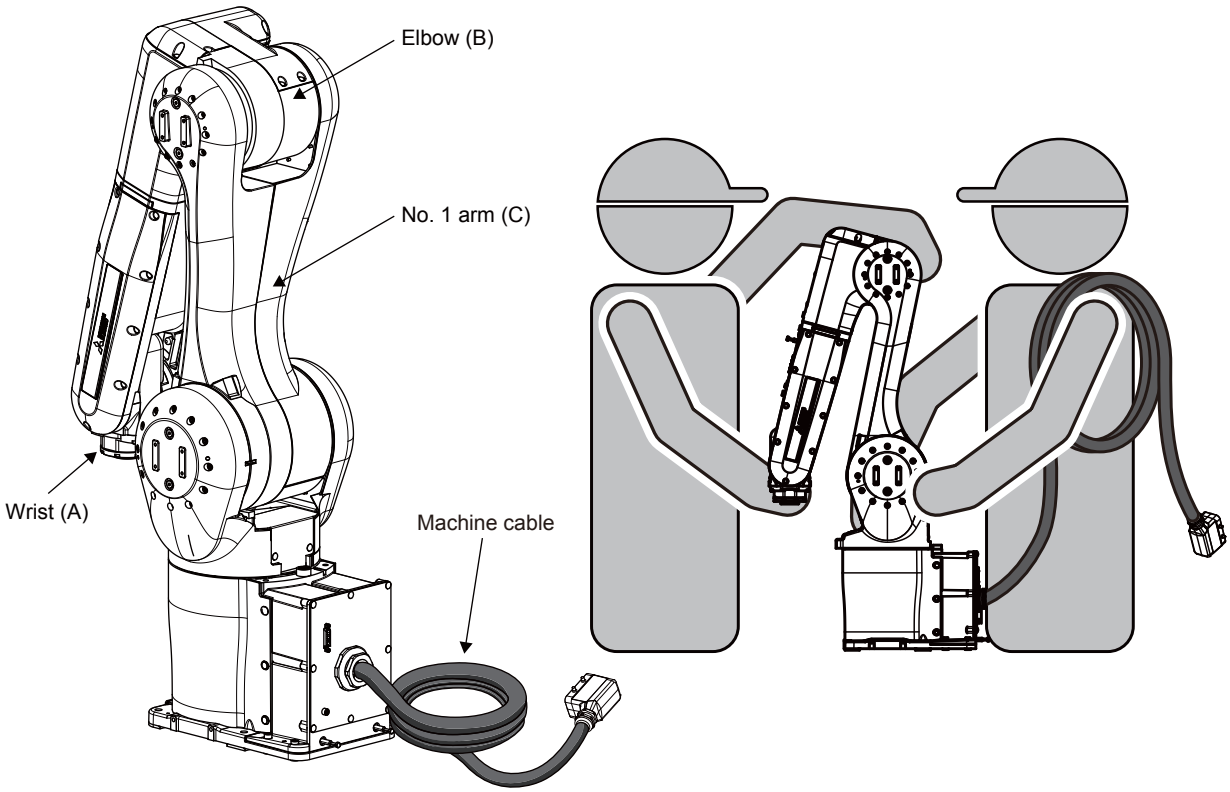
⚠CAUTION The parallel I/O interface is installed on the controller.
Do not hold the parallel I/O interface section when taking out the controller.

The unpacking process is shown below.

1) Cut the tapes <1> around the packing box with scissors or other cutting tool and lift and remove the outer box <2>.
2) Cut the tapes <3> around the controller box with scissors or other cutting tool and take out the controller box.
3) Cut the cable tie <4> with nippers or other cutting tool and open the plastic bag.
4) Lift and remove the two fixing plates A <5> and the fixing plate B <6>. Then remove the cushioning <7> covering the robot arm and cable.
5) Remove the four hexagon socket bolts <8> connecting the robot base and the pallet.
6) Grip the cutout sections of the controller box <9> and take out the controller.

Unpacking is completed.

2.2.2 Transportation procedures (Transportation by people)



Mass: 41kg

Fig.2-2: Transportation of robot arm (Transportation by people)

1) The robot must be transported by two workers. Use a cart or other device for transporting the robot near the installation place. The following instructions for carrying the robot are applicable only when the robot is transferred onto the stand or another cart, or moved for positioning.
2) When carrying the robot, one person should hold the wrist (A) and the elbow (B). The other person should hold arm No.1 (C). Do not hold the cover of the robot when carrying it. Otherwise, the robot may fall down, the cover may be broken or fall, or other accidents may occur. Do not apply force to the cover or avoid strong impact on the robot while carrying the robot. Furthermore, do not interfere with or pull machine cables while carrying the robot.
3) Transfer the robot slowly. Be careful not to get injured with the edge of the robot arm.
4) For secondary transportation such as changing the installation place, fix the robot to its packing box again. If the robot is lifted while it is in the operating posture, its components may be damaged, or the unbalanced robot posture may cause a danger during transportation.

⚠CAUTION Do not hold the cover of the robot for carrying it.

⚠CAUTION For secondary transportation, adjust the posture of each axis of the robot as specified in Table 2-2.

⚠CAUTION If it is difficult to follow the instructions shown in this section, prevent the robot arm joints from moving freely by fixing the robot arm, for example, by using the screw holes for fixing plates. 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.

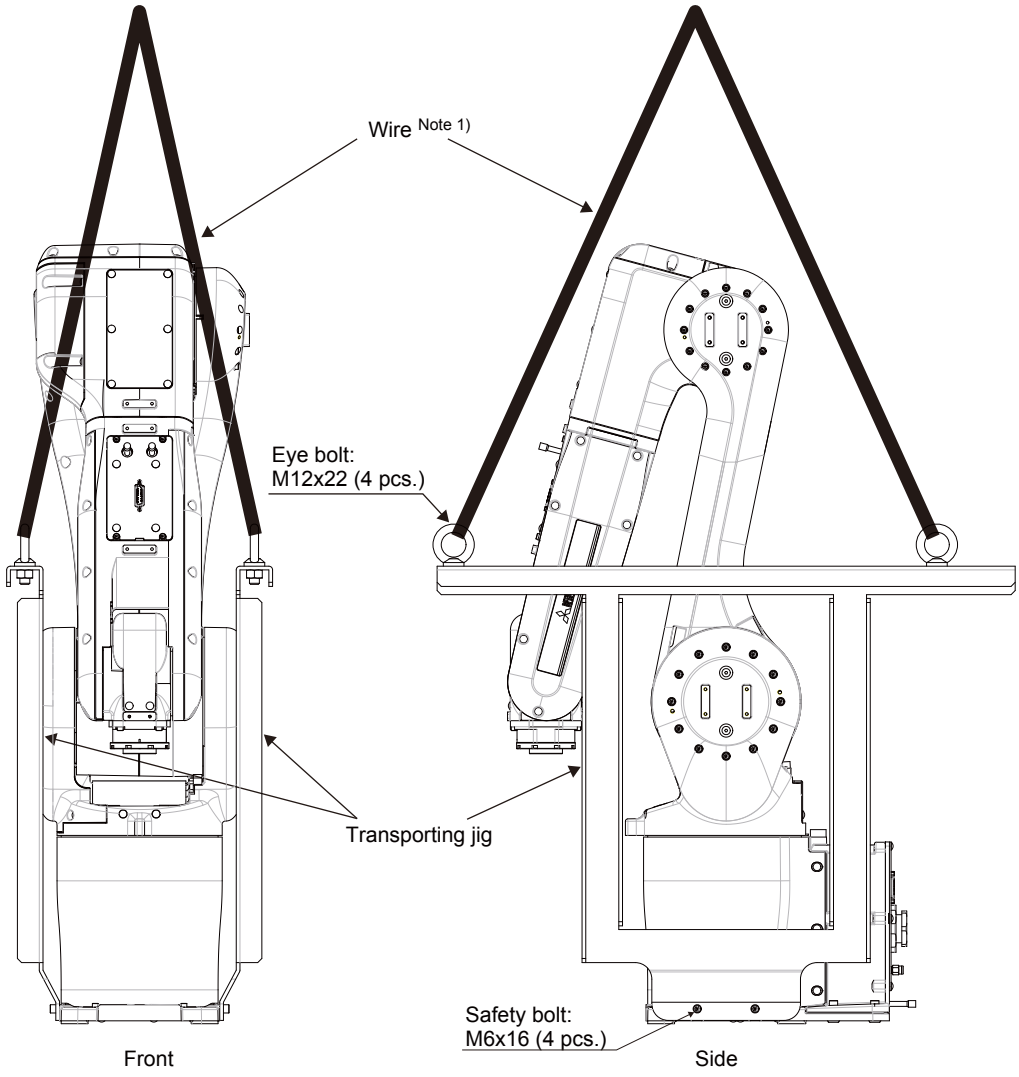
Table 2-2:Transportation posture

Axis	RV-8CRL
J1	0°
J2	0°
J3[Note1)]	167°
J4	0°
J5	13°
J6	0°

Note1)The value is a reference value. Release the brake and move the arm until it contact against the mechanical stopper.

2.2.3 Transportation procedures (Transporting with a crane)

Fig. 2-3 shows the robot posture for transportation with a crane.
Contact the Mitsubishi Electric Service Department to obtain transportation fixtures necessary for transportation with a crane.



Mass: Robot arm: 41 kg
Fixture (2 pcs.): 13 kg
Note 1) Use wires that are 1000 mm or more.
Fig.2-3: Robot posture for crane transportation

⚠CAUTION When the transportation fixtures are reattached, adjust the posture of each axis of the robot as specified in Table 2-3.

⚠CAUTION If the transport frame is difficult to use, use a fixing bracket that screws into available screw holes on the robot, or use another method to secure the joints. If the robot arm is transported unfixed, applying an excessive external force on the joints may cause a malfunction.
Do not apply an excessive load to the robot arm while fixing it. Otherwise, the robot arm may be damaged.

⚠CAUTION Always use a transport frame for secondary transportation. For example, when changing the installation position. If the robot arm is lifted without using the designated fixtures or while it is in the operating posture, its components may be damaged, or the unbalanced robot posture may cause a danger during transportation.

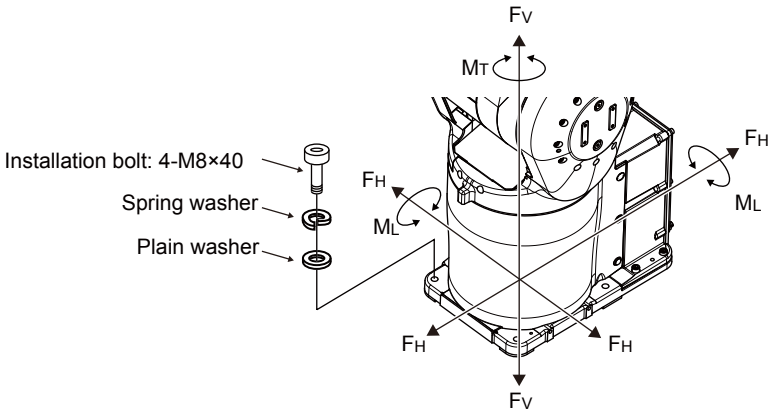
Table 2-3:Transportation posture

Axis	RV-8CRL
J1	0°
J2	0°
J3[Note1)]	167°
J4	0°
J5	13°
J6	0°

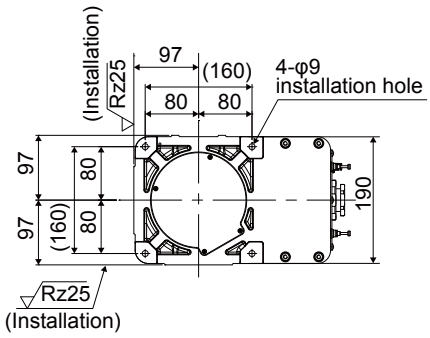
Note1)The value is a reference value. Release the brake and move the arm until it contact against the mechanical stopper.

2.2.4 Installation procedures

The installation procedure of the robot arm is shown below.



<Bottom view>



Bottom view: Installation dimensions

Fig.2-4: Installation dimensions

1) The robot installation surface has been machine finished. Use the installation holes (4-φ9) opened at the four corners of the base, and securely fix the robot with the enclosed installation bolts (M8 hexagon socket bolts). (Recommended tightening torque: 26.5 N•m)
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 6.3a 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) Remove the fixing plates and suspension fittings after installing the robot. The plates and fittings are needed in re-transportation. Please keep it carefully.
7) When the robot is installed by hanging from the ceiling or on the wall, the MEGDIR parameter must be changed. For more information about parameters and how to change the parameters, refer to the separate "Instruction Manual/Detailed Explanation of Functions and Operations".
8) The installation surface must have sufficient strength to withstand the arm reaction during moving the robot at high speed.

Table 2-4:Strength of the installation side (reference)

Item	Unit	Value
RV-8CRL		
Tilt moment: M_L	N•m	900
Torsional moment: M_T	N•m	900
Horizontal direction translation force: F_H	N	1,000
Vertical direction translation force: F_V	N	1,700

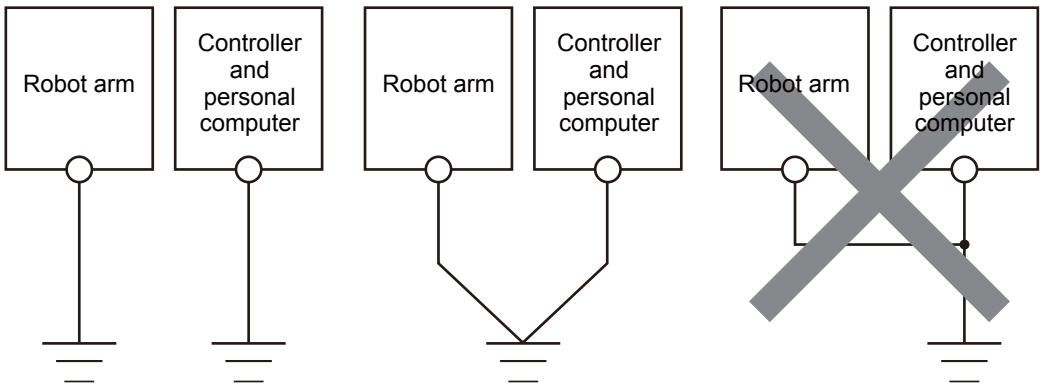
⚠ CAUTION Secure the maintenance space behind the robot for connection of the machine cable. For the dimensions of the maintenance space, refer to "Outside dimensions/Operating range diagram" in the Standard Specifications Manual.

⚠ CAUTION Do not install the robot arm in areas where direct sunlight is present or heat is generated from lighting.
A rise in the temperature of the robot arm surface may cause an error.

2.2.5 Grounding procedures

(1) Grounding methods

1) There are three grounding methods as shown in Fig. 2-5, but the dedicated grounding (Fig. 2-5 (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 100Ω or less). Dedicated grounding separated from the other devices should be used.
3) Use a AWG#11(4.2mm^2) or more stranded wire for the grounding wire. The grounding point should be as close to the robot arm and controller as possible, and the length of the grounding wire should be short.



(a) Dedicated grounding [Optimum]
(b) Shared grounding [Good]
(c) Common grounding [Not allowed]

Fig.2-5: Grounding methods

(2) Grounding procedures

1) Prepare the grounding cable (AWG#11(4.2mm^2) 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.

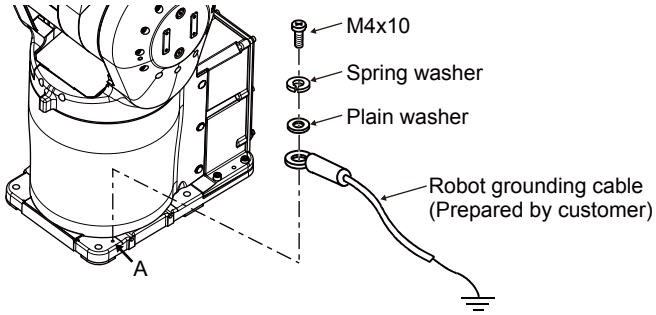


Fig.2-6: Connecting the grounding cable

2.2.6 Connecting with the controller

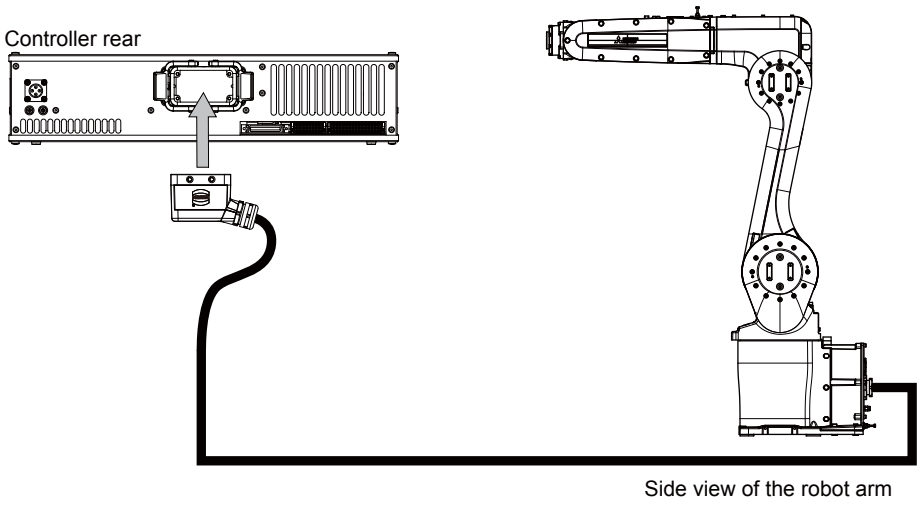


Fig.2-7: Connecting the machine cables

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

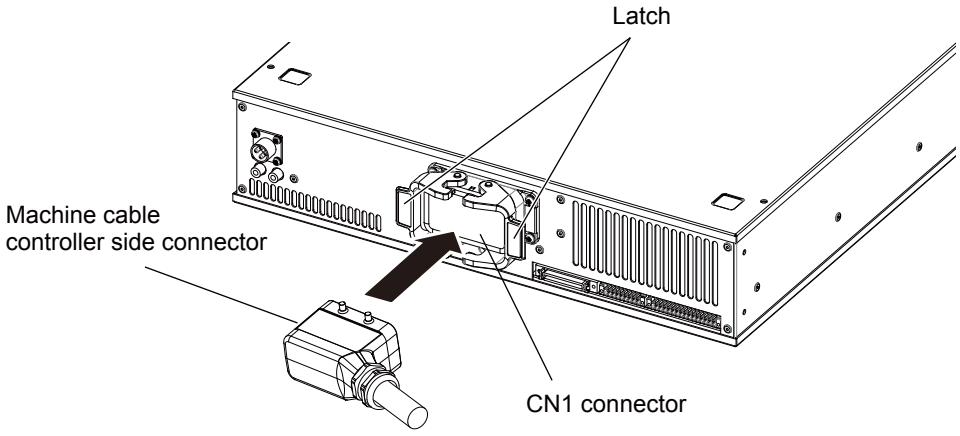


Fig.2-8: Connecting with the controller

1) Make sure that the power of the controller is turned OFF.
2) Connect the controller side connector of the machine cable to CN1 connector on the rear side of the controller.
3) To fix the inserted connector, close the latches of the CN1 connector.
4) The connection method is the same for the optional machine cables (replaceable type). However, refer to the separate "Standard Specifications Manual" for information on how to fix a flexible cable.

Connecting the machine cable is completed.

⚠CAUTION When connecting and disconnecting the connector, be careful not to get your hand pinched.

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

⚠ CAUTION To disconnect the cable, open the latches, hold the connector part, and pull out the cable. Pulling the cable part may cause the cable to come off or break.

⚠ 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.

2.3 Confirming the operation

After the robot is connected to the controller, the origin data is automatically written.
Then, manually move the robot 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, the Work jog that moves along the work 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 range.

⚠ 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 is pressed.

⚠ CAUTION To check whether the origin of the robot deviates, move the robot arm to the position where the keyways align each other, and check the displayed joint coordinates of the position.
For the details of the keyway position and the joint coordinates, refer to Page 61, "5.6 Resetting the origin".

2.3.1 Installing the teaching pendant (T/B)

Installing the T/B, with turning off the controller power.

⚠CAUTION 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 so that stress does not start the cable with the connector itself.

Explain the installation method of T/B below.

1) Check that the controller's power supply is OFF.
2) Refer to Fig. 2-9 and connect T/B connector to the robot controller.
   Use as the upper surface the lock lever, and push in until there is sound.
3) Pressing down the lock lever to lock the connector as shown below.

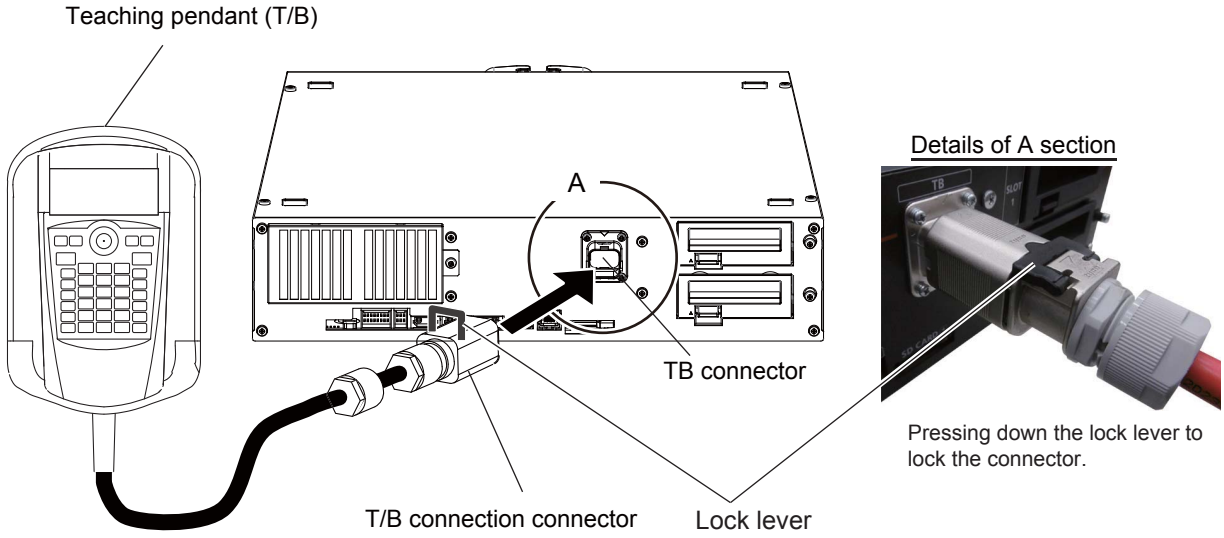


Fig. 2-9: Installing the T/B

The installation of T/B is finished.

2.3.2 Turning ON the control power

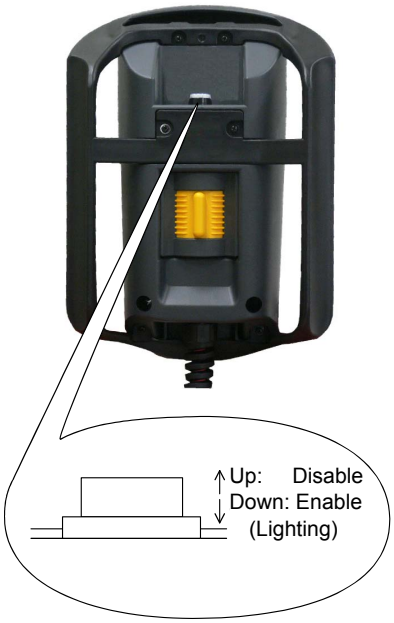
⚠CAUTION Confirm that there are no operators near the robot before turning the power ON.

1) Turn the controller power switch ON.
   Turns ON the switch of the earth leakage breaker of installation outside.

2.3.3 Preparing the T/B

Next, prepare to use the T/B

1) Set the mode of the controller to "MANUAL".



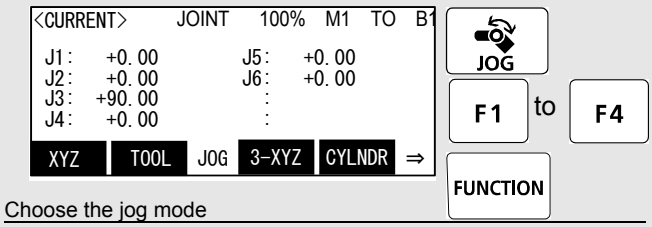
2) Set the T/B [ENABLE] switch to "ENABLE". The menu selection screen will appear.

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

Operating from the T/B

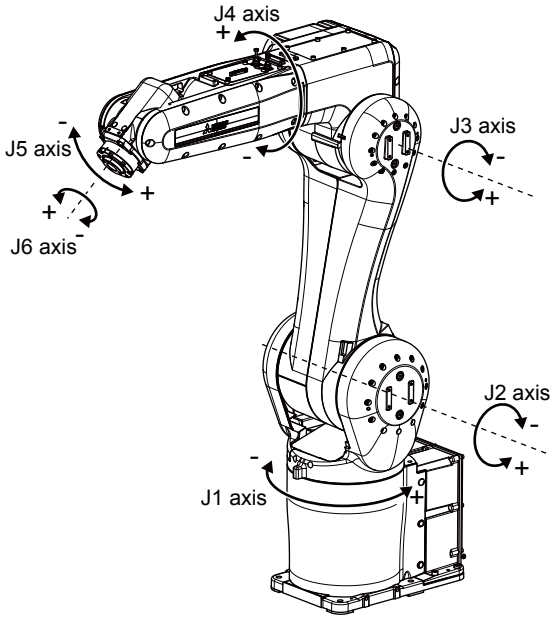
Always set the mode of the controller to "MANUAL", and then set the T/B [ENABLE] switch to "ENABLE". When the T/B is valid, only operations from the T/B are possible. Operations from the external signals will not be accepted. The stop-related operations such as an emergency stop can be performed regardless of the valid/invalid setting.

How to choose the jog mode



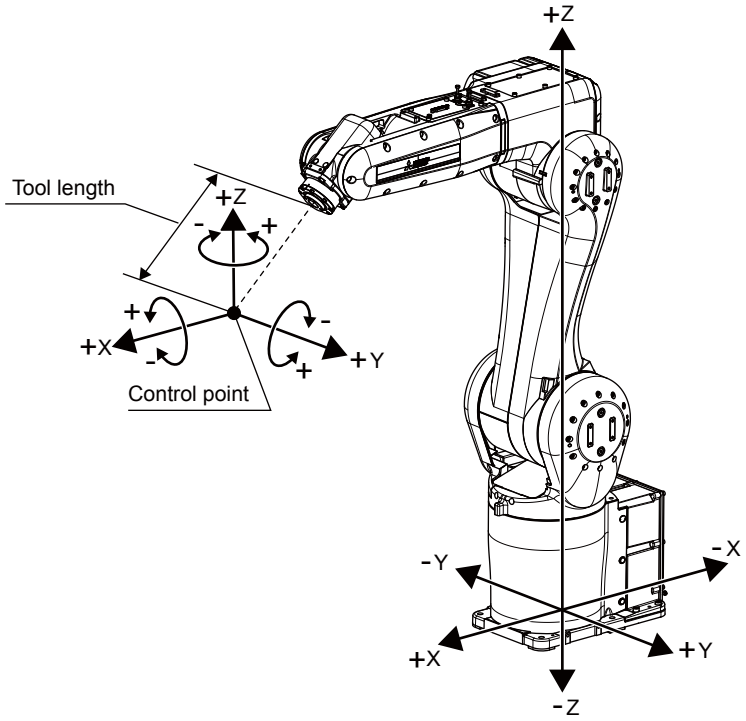
Choose the jog mode

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 (T0), and the base coordinate number (B1) are displayed on the upside of the screen following the present jog mode (JOINT).



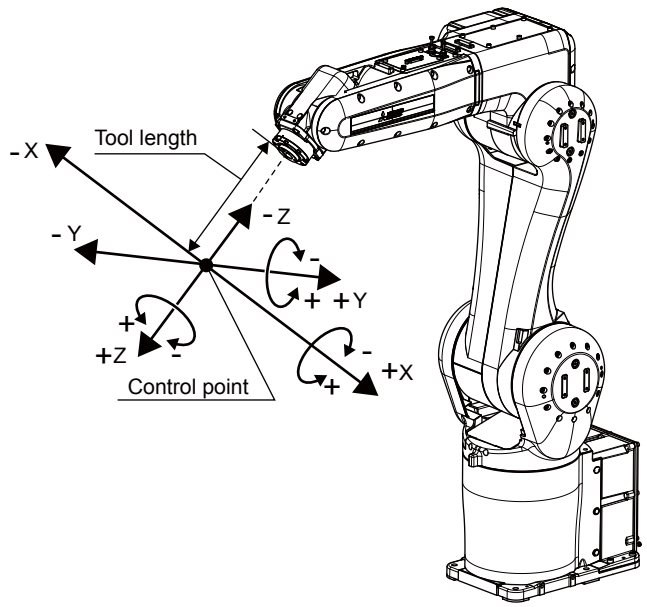
* Each axis moves independently.

Fig. 2-10: JOINT jog operation



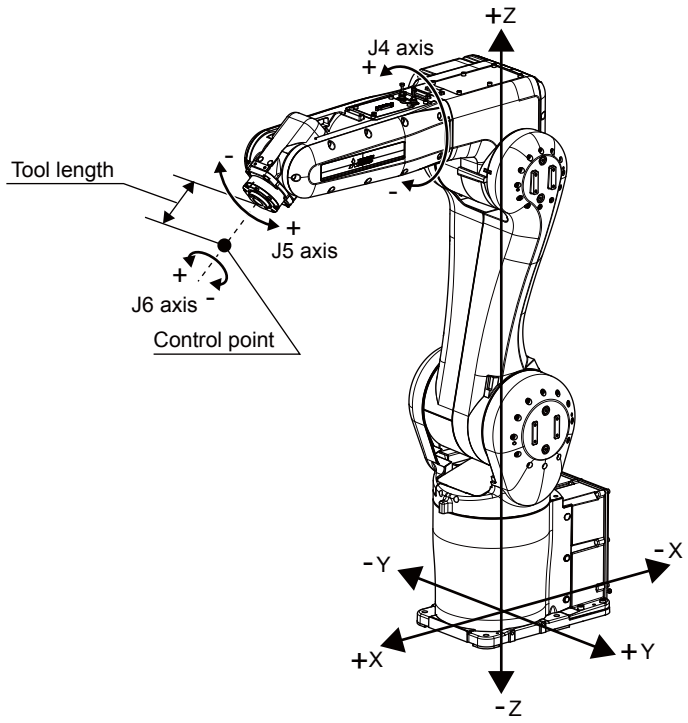
* The axis moves straight along the XYZ coordinate system. The flange surface posture is maintained. Also, while maintaining the flange surface position, the flange surface posture changes.

Fig. 2-11: XYZ jog operation



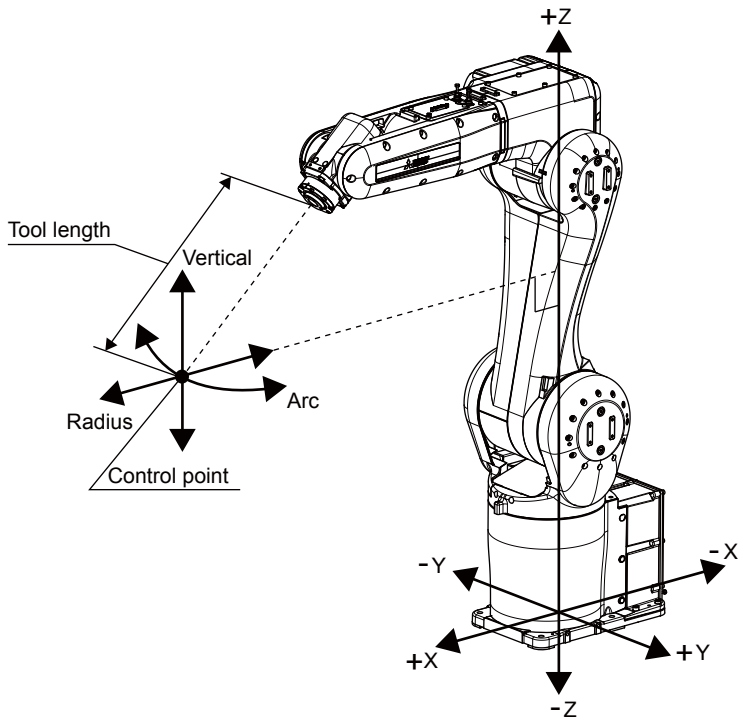
* While maintaining the flange surface posture, the axis moves straight along the tool coordinate system. Also, while maintaining the flange surface position, the flange surface posture changes.

Fig. 2-12: TOOL jog operation



* The axis moves straight along the base coordinate system. At this time, the flange surface posture is not maintained. Also, the flange surface posture changes. The flange surface position does not change at this time.

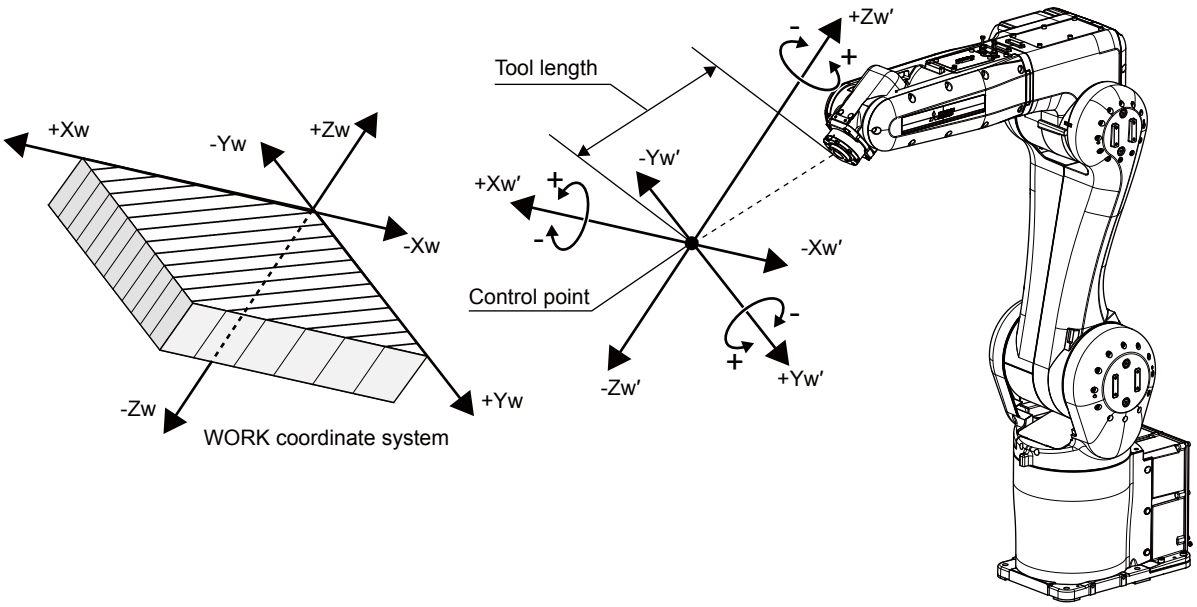
Fig. 2-13: 3-axis XYZ jog operation



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

Fig. 2-14: CYLINDER jog operation

The jog movement based on work coordinates system

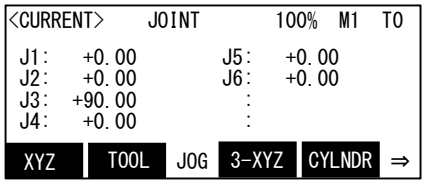


* While maintaining the flange surface posture, the axis moves straight along the work coordinate system.
  Also, while maintaining the flange surface position, the flange surface posture changes.
* Jog operation around the work coordinate system is available (Ex-T jog). In this jog operation, when the jog operation is performed for the posture elements, the posture rotates on the Xw axis, Yw axis, or Zw axis of the work coordinate system while the control point is changed.

Fig. 2-15: WORK jog operation

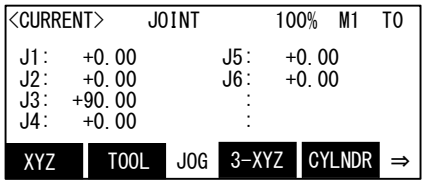
(1) JOINT jog operation

Select joint jog mode



Joint jog mode

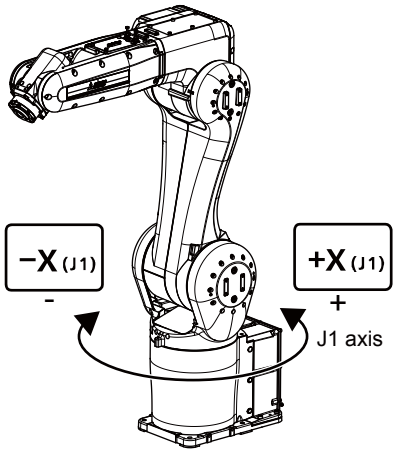
Set jog speed



Setting the speed

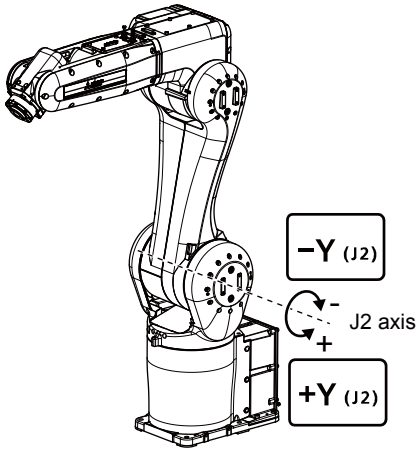
[JOG] Press the key and display the jog screen. ("JOG" is displayed on the screen bottom)
Check that the "joint" in jog mode is displayed on the screen.
If other jog modes are displayed, please press the function key corresponding to the "joint." (If the jog mode which he wishes under the screen is not 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↓] key is pressed, it will go down.
The current setting speed is displayed on screen upper right. Set the override to 10% here for confirmation work.

J1 axis jog operation



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

J2 axis jog operation

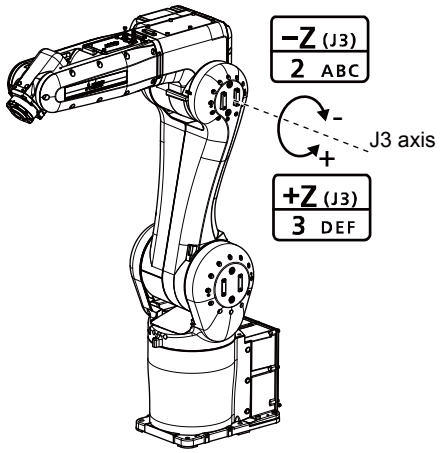


• When the [+Y (J2)] keys is pressed, the J2 axis will rotate in the plus direction.
When the [-Y (J2)] keys is pressed, rotate in the minus direction.

When the robot is in the transportation posture

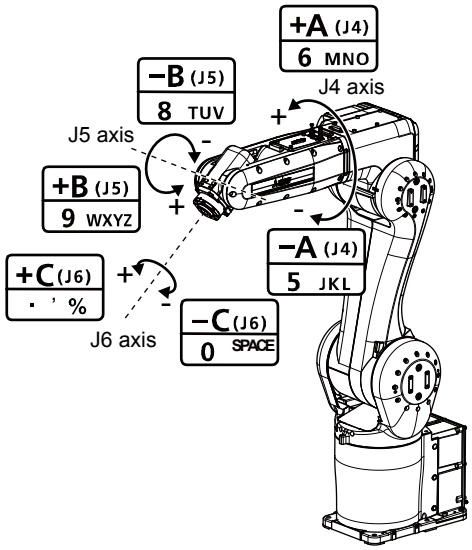
The axes may be outside the movement area. Move these axes toward the inner side of the movement area.

J3 axis jog operation



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

J4, J5 and J6 axis jog operation



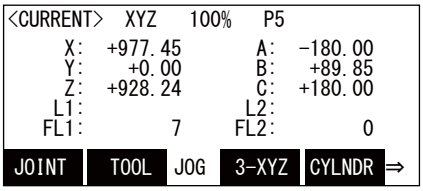
- When the [+A (J4)] key is pressed, the J4 axis will rotate in the plus direction. When the [-A (J4)] keys is pressed, rotate in the minus direction.
- When the [+B (J5)] keys is pressed, the J5 axis will rotate in the plus direction When the [-B (J5)] keys is pressed, rotate in the minus direction.
- When the [+C (J6)] keys is pressed, the J6 axis will rotate in the plus direction When the [-C (J6)] keys is pressed, rotate in the minus direction.

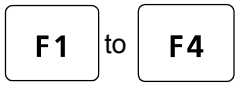
If the buzzer of T/B sounds and the robot does not move

If it is going to move the robot across the operation range, the buzzer of T/B sounds and the robot does not move. In this case, please move to the counter direction.

(2) XYZ jog operation

Select XYZ jog mode

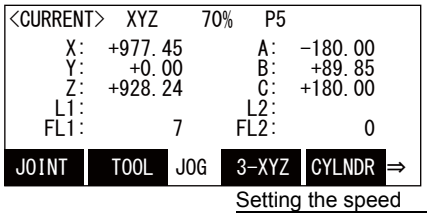


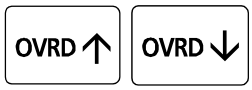


XYZ jog mode

[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."

Set jog speed

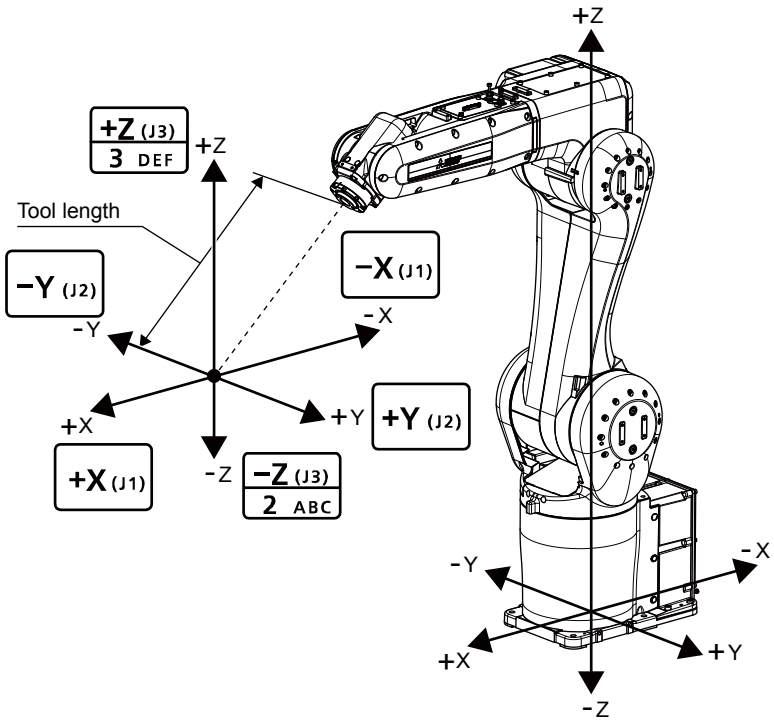




Setting the speed

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. Set the override to 10% here for confirmation work.

Moving along the base coordinate system



* The flange direction does not change.

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

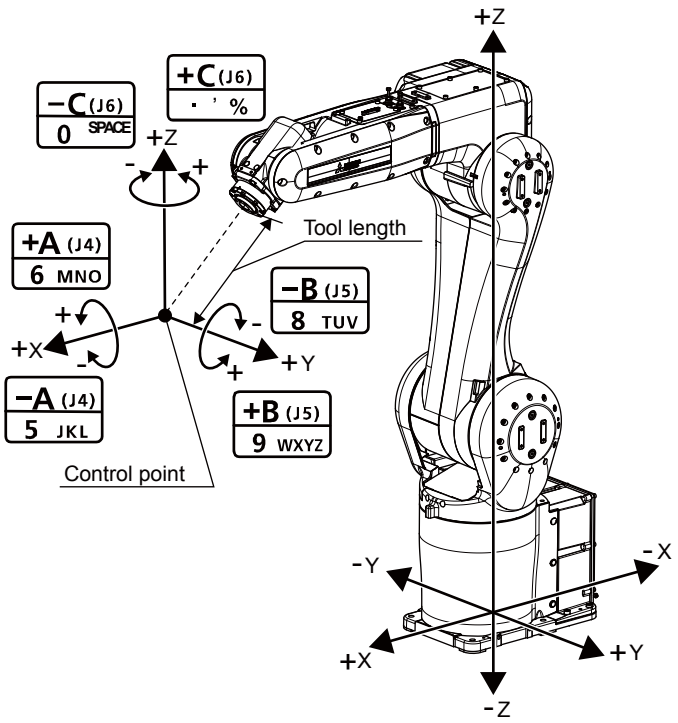
When the robot is in the transportation posture

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

If the buzzer of T/B sounds and the robot does not move

If it is going to move the robot across the operation range, the buzzer of T/B sounds and the robot does not move. In this case, please move to the counter direction.

Changing the flange surface posture



* The control point does not change.

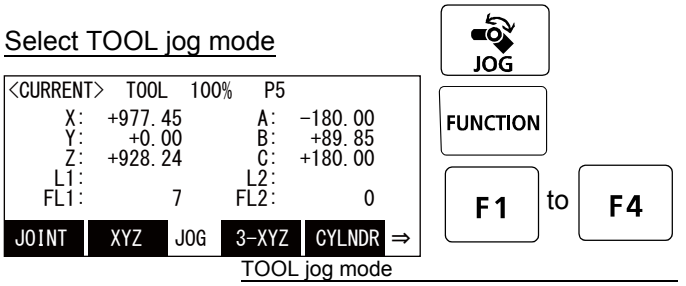
- When the [+A (J4)] key is pressed, the axis will rotate around the X axis in the plus direction. When the [-A (J4)] keys is pressed, rotate in the minus direction.
- When the [+B (J5)] key is pressed, the axis will rotate around the Y axis in the plus direction. When the [-B (J5)] keys is pressed, rotate in the minus direction.
- When the [+C (J6)] key is pressed, the axis will rotate around the Z axis in the plus direction. When the [-C (J6)] keys is pressed, rotate in the minus 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) TOOL jog operation

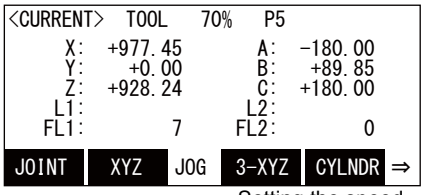
Select TOOL jog mode



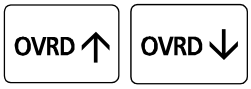
TOOL jog mode

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

Set jog speed

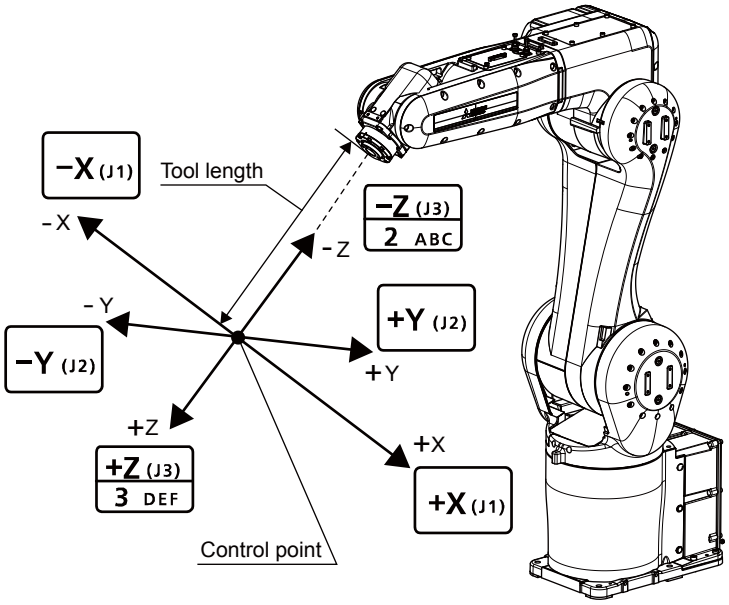


Setting the speed



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. Set the override to 10% here for confirmation work.

Moving along the tool coordinate system



* The direction of the flange will not change

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

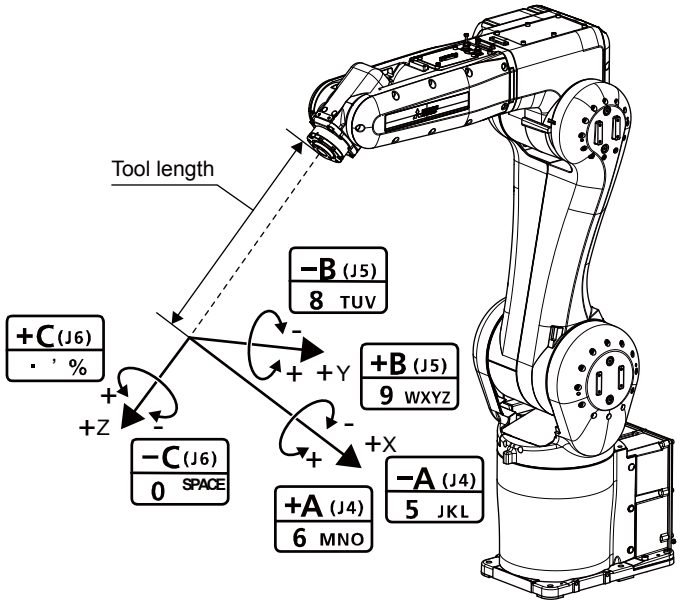
When the robot is in the transportation posture

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

If the buzzer of T/B sounds and the robot does not move

If it is going to move the robot across the operation range, the buzzer of T/B sounds and the robot does not move. In this case, please move to the counter direction.

Changing the flange surface posture



* The control point does not change.

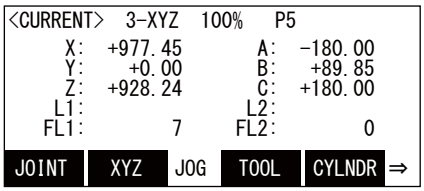
- When the[+A (J4)] keys is pressed, the X axis will rotate in the plus direction of the tool coordinate system.
  When the[-A (J4)] keys is pressed, rotate in the minus direction.
- When the[+B (J5)] keys is pressed, the Y axis will rotate in the plus direction of the tool coordinate system.
  When the[-B (J5)] keys is pressed, rotate in the minus direction.
- When the[+C (J6)] keys is pressed, the Z axis will rotate in the plus direction of the tool coordinate system.
  When the[-C (J6)] keys is pressed, rotate in the minus direction.

Tool length

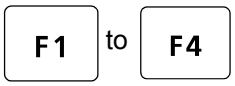
The default tool length is 0mm, and the control point is the center of the end axis.
After installing the hand, set the correct tool length in the parameters. Refer to the separate manual "Detailed Explanation of Functions and Operations" for details.

(4) 3-axis XYZ jog operation

Select 3-axis XYZ jog mode

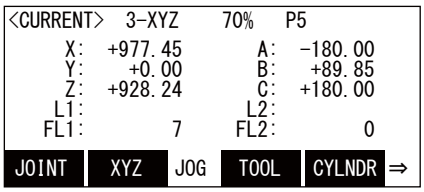


3-axis XYZ jog mode

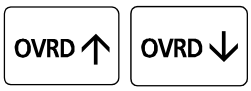


[JOG] Press the key and display the jog screen. ("JOG" is displayed on the screen bottom)
Check that the "3-XYZ" in jog mode is displayed on the screen.
If other jog modes are displayed, please press the function key corresponding to the "3-XYZ" (If the jog mode which he wishes under the screen is not 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."

Set jog speed

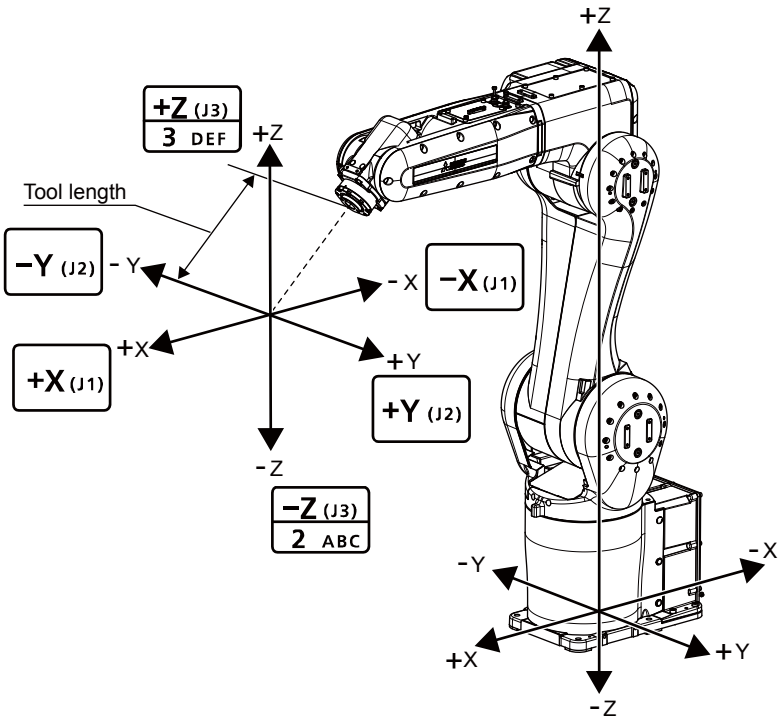


Setting the speed



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. Set the override to 10% here for confirmation work.

Moving along the base coordinate system



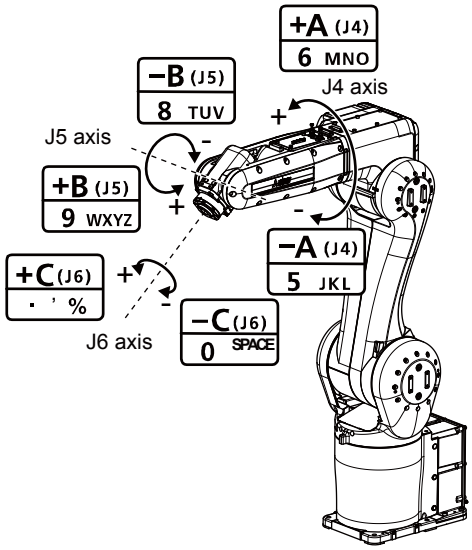
* The direction of the flange will change

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

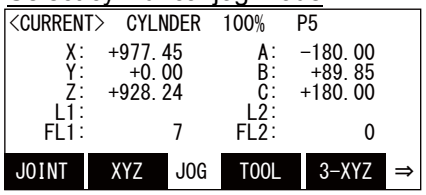


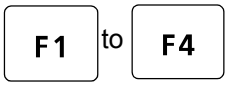
* The wrist pose can be changed maintaining the flange's position.

- When the [+A (J4)] key is pressed, the J4 axis will rotate in the plus direction.
  At this time, to maintain the flange's position, other axes move simultaneously except J5 and J6.
  When the [-A (J4)] key is pressed, the axis will rotate in the minus direction.
- When the[+B (J5)] keys is pressed, the J5 axis will rotate in the plus direction.
  At this time, to maintain the flange's position, other axes move simultaneously except J4 and J6.
  When the[-B (J5)] keys is pressed, the axis will rotate in the minus direction.
- When the[+C (J6)] keys is pressed, the J6 axis will rotate in the plus direction.
  When the[-C (J6)] keys is pressed, the axis will rotate in the minus direction.

(5) CYLNDER jog operation

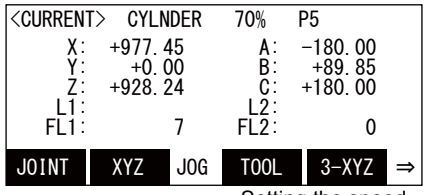
Select cylindrical jog mode

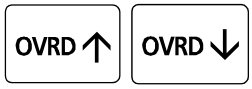




CYLNDER jog mode

Set jog speed

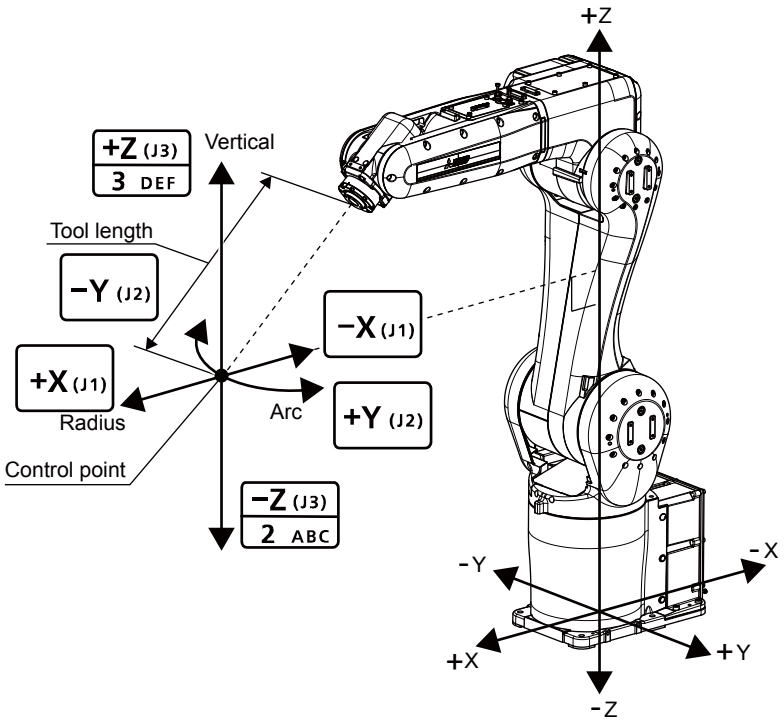




Setting the speed

[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. Set the override to 10% here for confirmation work.

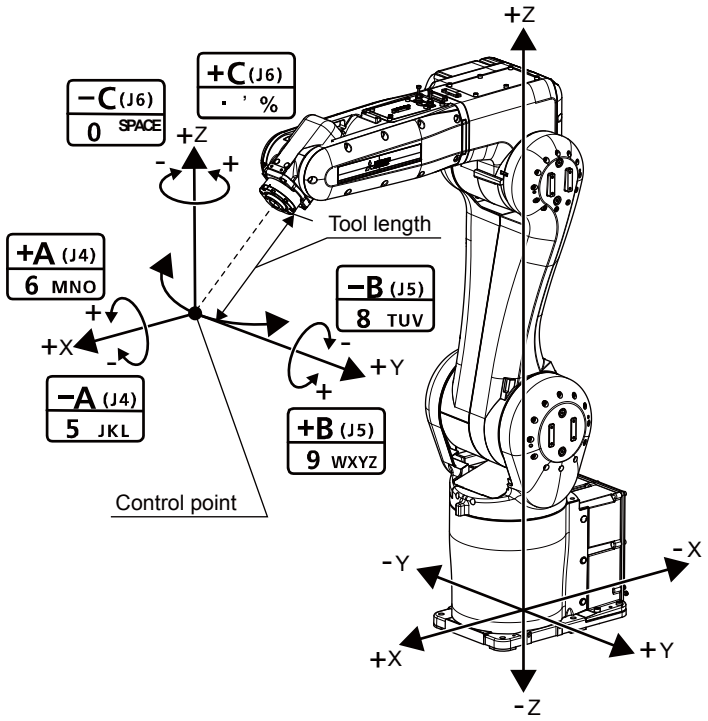
Moving along an arc centering on the Z axis



* The direction of the frange will not change.
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 is pressed, the robot will expand in the radial direction.
  When the[-X (J1)] keys is pressed, contract in the radial direction.
- When the[+Y (J2)] keys is pressed, the robot will move along the arc in the plus direction.
  When the[-Y (J2)] keys is pressed, move in the minus direction.
- When the[+Z (J3)] keys is pressed, the robot will move along the Z axis plus direction.
  When the[-Z (J3)] keys is pressed, move along the minus direction.

Changing the flange surface posture



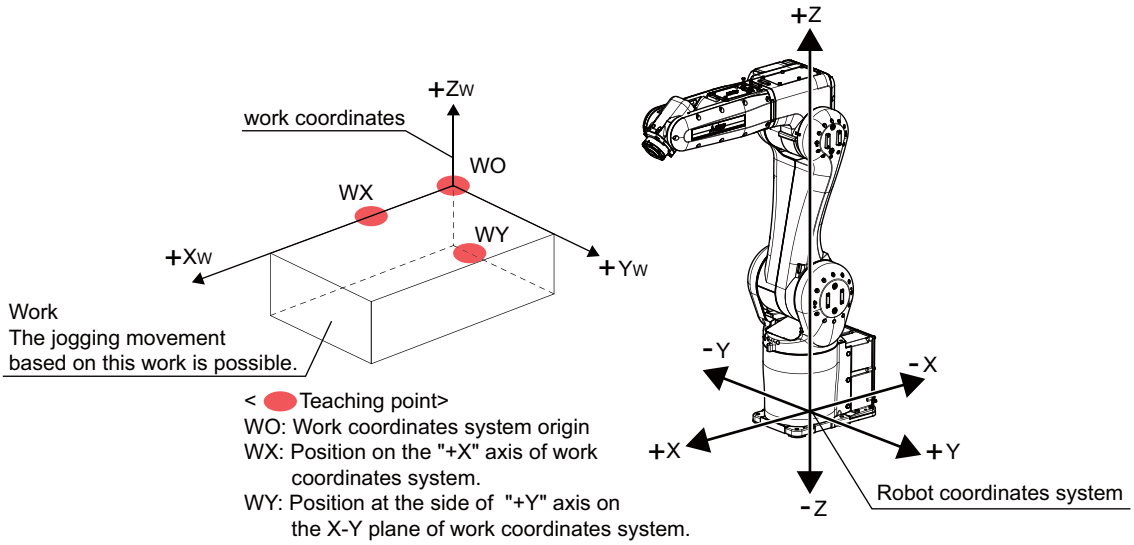
* The flange position does not change.
This is the same as the A, B and C axis XYZ jog operation.

- When the [+A (J4)] key is pressed, the axis will rotate around the X axis in the plus direction. When the [-A (J4)] keys is pressed, rotate in the minus direction.
- When the [+B (J5)] key is pressed, the axis will rotate around the Y axis in the plus direction. When the [-B (J5)] keys is pressed, rotate in the minus direction.
- When the [+C (J6)] key is pressed, the axis will rotate around the Z axis in the plus direction. When the [-C (J6)] keys is pressed, rotate 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).

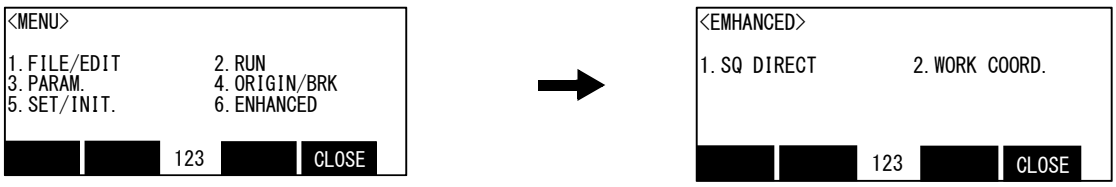


< Teaching point>
WO: Work coordinates system origin
WX: Position on the "+X" axis of work coordinates system.
WY: Position at the side of "+Y" axis on the X-Y plane of work coordinates system.

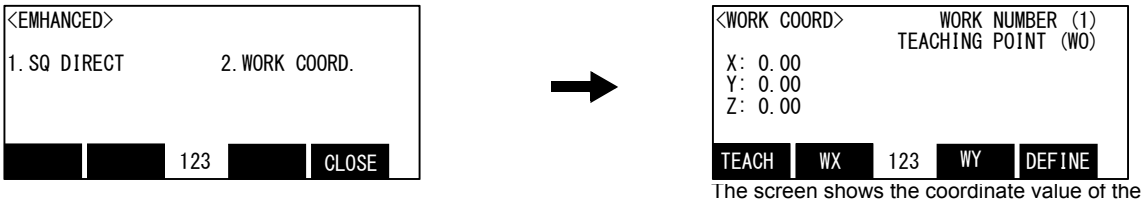
[Supplement] : The coordinate values which use all three teaching points for setting of the work coordinates system are each only X, Y, and the Z-axis. Although the coordinate value of A, B, and C axis is not used, positioning will get easy if the XYZ jog or TOOL jog movement is effected with the same value. (The direction of the hand is the same)
Fig. 2-16: 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.

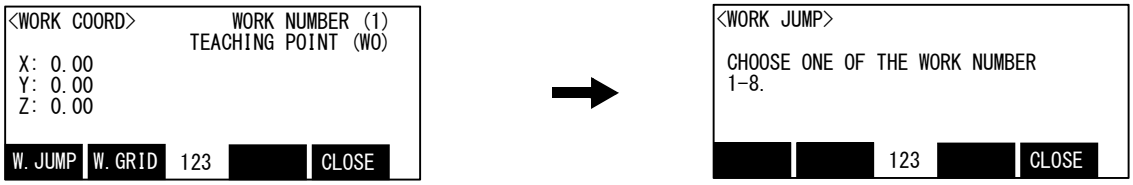


2) Press the [2] keys in the menu screen and select "2. WORK COORD."

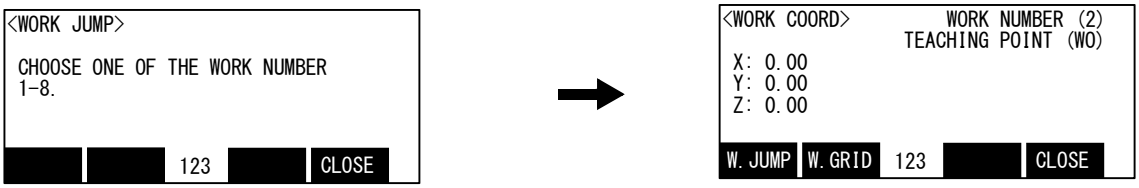


The screen shows the coordinate value of the origin (WO) of the work coordinates number 1.

3) Selection of the work coordinates number
Press the [FUNCTION] keys, and display "W: JUMP" function. Press the function key corresponding to "W: JUMP"



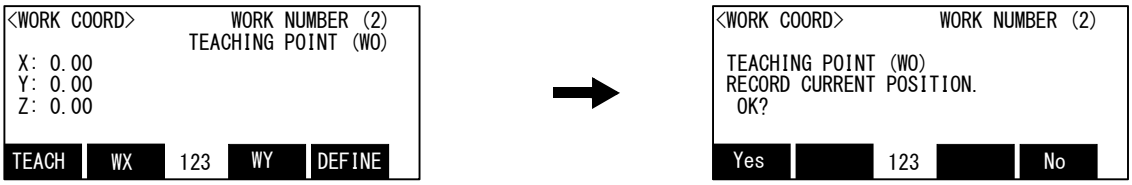
Press numeral key [1] - [8] and specify the work coordinates number. The coordinate value of the specified work coordinates system is displayed.



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

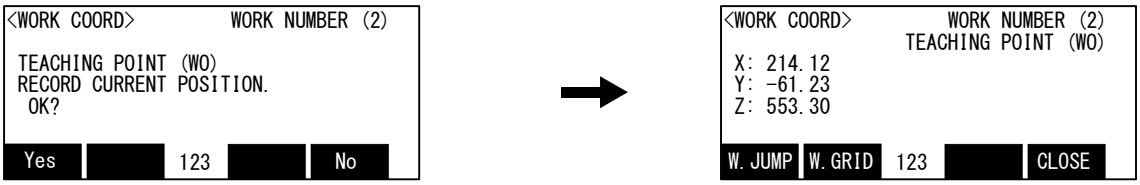
The screen is the example which specified the work coordinates number 2. ("2" at the upper right of the screen)

4) The teaching of the work coordinates system
Teach the three points shown in Fig. 2-16. 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]

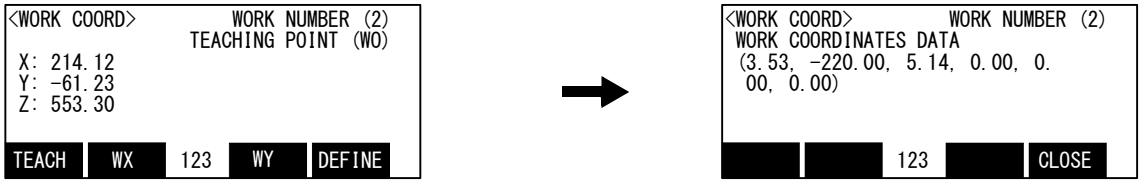
Presses the function key corresponding to"Yes", the robot's current position is registered, and the registered coordinates value is displaye. Operation will be canceled if the [CLOSE] key is pressed.



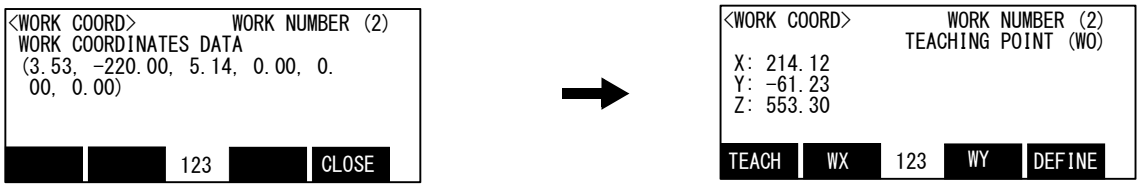
Teach the three points, WO, WX, and WY, by the same operation.
The position data taught here is each registered into the following parameters. ("n" means the work coordinates numbers 1-8)

WO= parameter: WKnWO
WX= parameter: WKnWX
WY= parameter: WKnWY

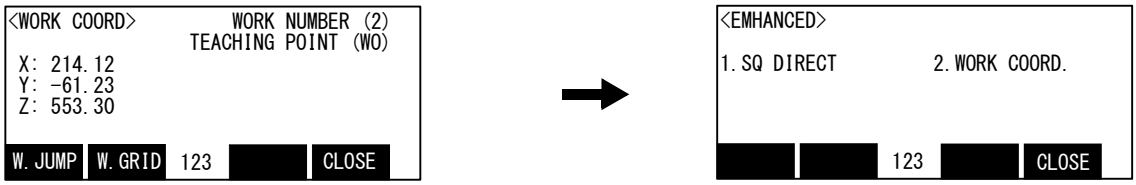
5) Setting of work coordinates (definition)
If the function key corresponding to "DEFINE" ([F1]) is pressed, the work coordinates system will be calculated using the three points, and the result will be displayed.



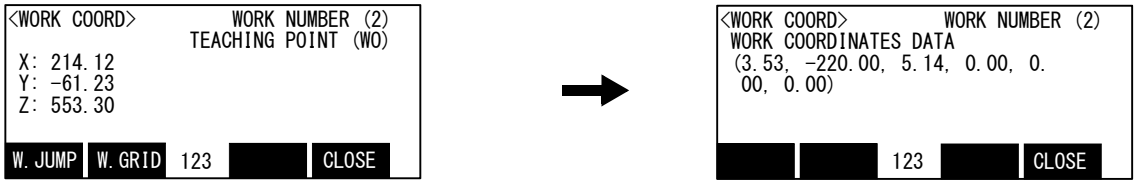
The alarm occurs if the work coordinates system is incalculable. (There are the three points on the straight line, or the two points have overlapped) In this case, reset alarm and re-teach the three points.
This work coordinate data is registered into parameter: WKnCORD. ("n" means the work coordinates 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.



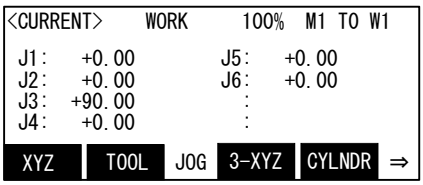
Although setting of work coordinates is finishing above, confirmation of work coordinates can be done by pressing the function key corresponding to "W GRID."([F2])



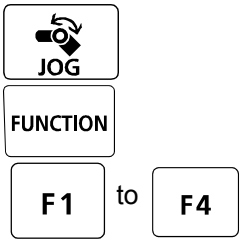
Return to the previous screen by pressing the [CLOSE] ([F4]) key.

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

Select WORK jog mode

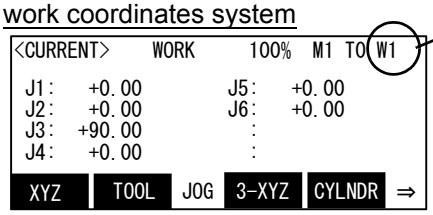


WORK jog mode

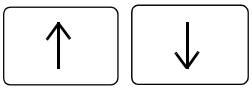


[JOG] Press the key and display the jog screen. ("JOG" is displayed on the screen bottom)
Check that the "WORK" in jog mode is displayed on the screen.
If other jog modes are displayed, please press the function key corresponding to the "WORK." (If the jog mode which he wishes under the screen is not 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 work coordinates system



Target work coordinates system

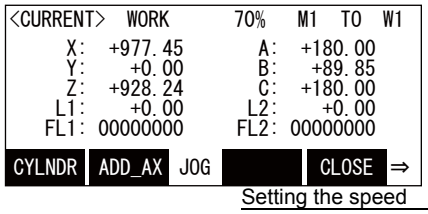


Select the work coordinates system

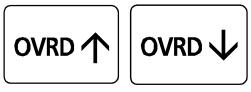
Confirm the target work coordinates system.
The current target number is displayed on the screen upper right. (W1 - W8)
The number of work coordinates can be changed by the arrow key [Upper arrow], [Lower arrow]
Push the key [Upper arrow], the number will increase. (W1, W2, ... W8) Conversely, push the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

⚠ CAUTION 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



Setting the speed

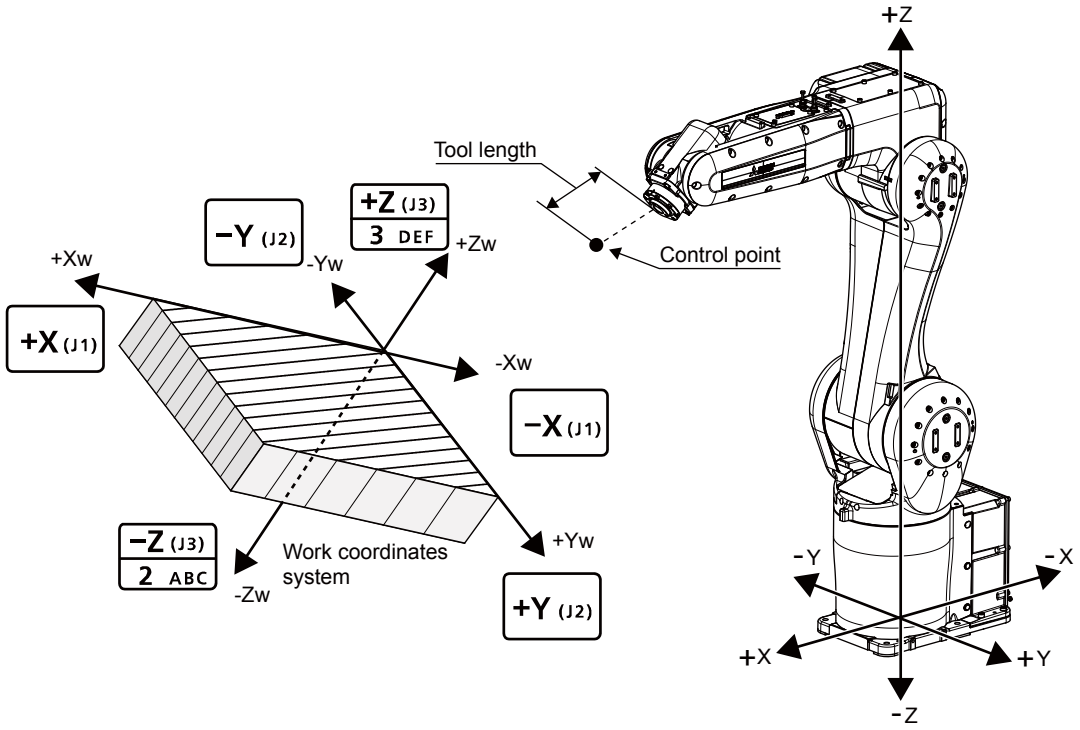


Whenever it presses the key of [OVRD(Upper arrow)], the override goes up. Conversely, if the [OVRD(Lower arrow)] key is pressed, it will go down.
The current setting speed is displayed on screen upper right.
Set the override to 10% here for confirmation work

The WORK jog operation and the Ex-T jog operation can be switched by setting the parameters WK1-JOGMD 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
ABC 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 each axis of the work coordinates system.

The jog movement based on work coordinates system

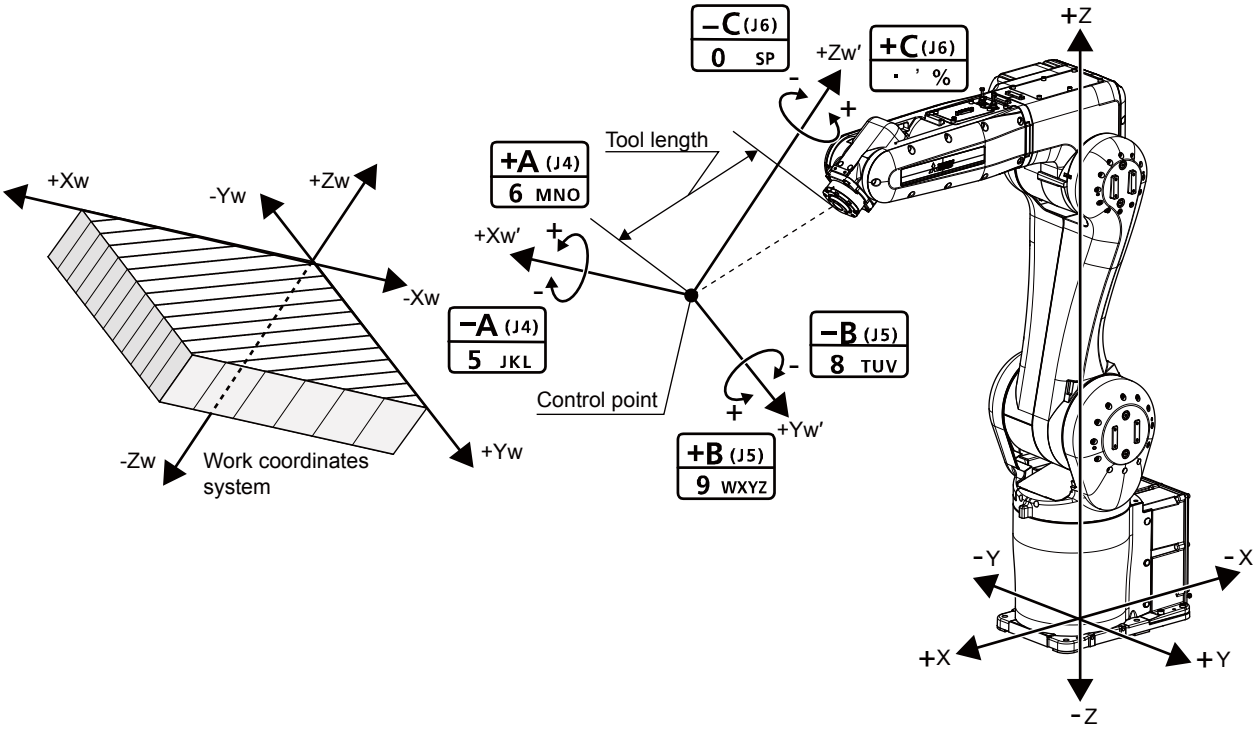


* The direction of the flange will not change.
Move the control point with a straight line in accordance with the work coordinates system

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

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

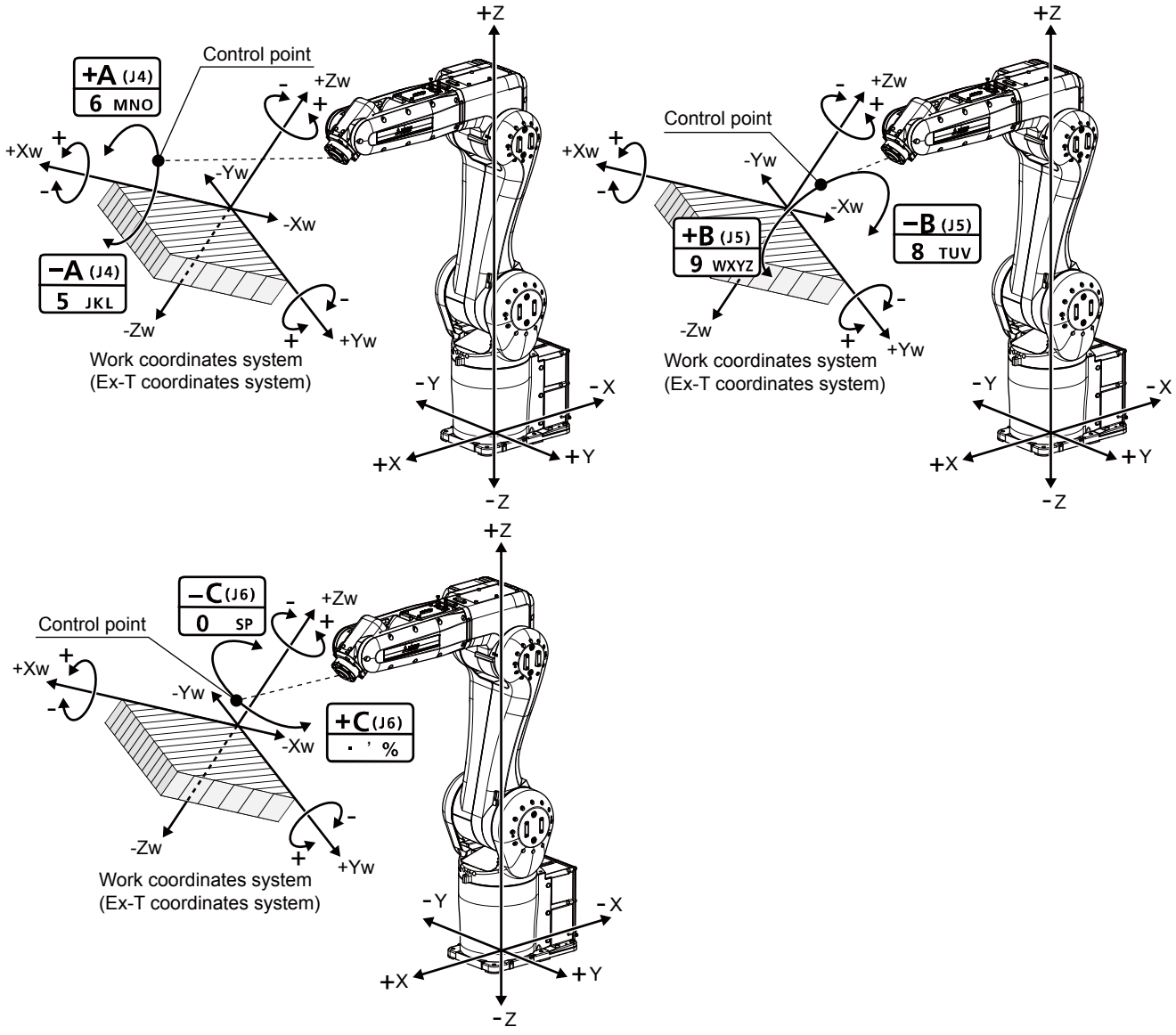
Changing the flange surface posture
<1> Work jog mode



* The position of the control point does not change.
Change the direction of the flange in accordance with the work coordinates system.

- When the [+A (J4)] key is pressed, the axis will rotate around the X axis in the plus direction. When the [-A (J4)] keys is pressed, rotate in the minus direction.
- When the [+B (J5)] key is pressed, the axis will rotate around the Y axis in the plus direction. When the [-B (J5)] keys is pressed, rotate in the minus direction.
- When the [+C (J6)] key is pressed, the axis will rotate around the Z axis in the plus direction. When the [-C (J6)] keys is pressed, rotate in the minus direction.

<2> Ex-T jog mode



* The control point rotates around each axes of work coordinates system (Ex-T coordinates system). When the [+A (J4)] or the [-A (J4)] key is pressed, the control point rotates around the Xw axis. When the [+B (J5)] or the [-B (J5)] key is pressed, the control point rotates around the Yw axis. When the [+C (J6)] or the [-C (J6)] key is pressed, the control point rotates around the Zw axis.

- When the [+A (J4)] keys is pressed, the control point will rotate in the plus direction around the X axis (Xw) of work coordinates system (Ex-T coordinates system).
  When the [-A (J4)] keys is pressed, the control point will rotate in the minus direction.
- When the [+B (J5)] keys is pressed, the control point will rotate in the plus direction around the Y axis (Yw) of work coordinates system. (Ex-T coordinates system).
  When the [-B (J5)] keys is pressed, the control point will rotate in the minus direction.
- When the [+C (J6)] keys is 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 is 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 24, "(1) JOINT jog operation"", and move the robot to a position where linear movement is possible, and then carry out XYZ jog.

If the buzzer of T/B sounds and the robot does not move

If it is going to move the robot across the operation range, the buzzer of T/B sounds and the robot does not move. In this case, please move to the counter direction.

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.

2.3.4 Setting the hand parameters

Set the parameters to set the hand I/O type and the hand condition according to the robot hand to be used. Refer to the separate volume, "Instruction Manual/Detailed Explanations of Functions and Operations" for how to set parameters.

Table 2-5:Hand parameter

Parameter	Parameter name	Details explanation	Factory setting
Hand I/O type	HIOTYPE	Set either the sink type or the source type for the solenoid valve and the logic of the hand input signal. -1: Not set 0: Source type 1: Sink type	-1
Hand condition	HNDDAT* * is 0 to 8	Set the initial condition of the hand. (Specify with the tool coordinate system.) (Weight, size X, size Y, size Z, center of gravity X, center of gravity Y, center of gravity Z) Unit: Kg, mm	The setting varies depending on the model.

3 Installing the option devices

3.1 Installing the operating range change

The operation range of the J1 axis can be limited. Change the mechanical stopper (bolt) positions and the operation range between the stoppers.
When there is possibility of interference with peripheral devices or it is necessary to limit the operation range as a safety precaution, set the range as follows.

(1) Angle setting for changing the operation range

Table 3-1 shows angle settings available for the J1 axis. Refer to the table to determine the mechanical stopper position or parameter setting corresponding to the desired angle.
Refer to Fig. 3-1 to check the stopper installation positions.

Table 3-1:Angle setting available to change the operation range

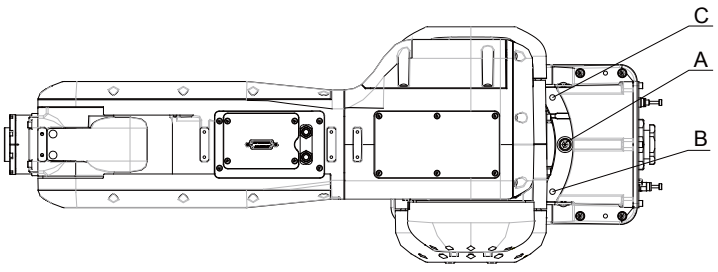
Model	Axis	Direction Note1)	Standard	Angle setting for changing the operation range Note2) Note3)	
					Customer-prepared items
RV-8CRL	J1 axis	Positive	+170°	+141°	—
		Mechanical stopper angle	+172°	+143.5°	Hexagon socket bolt M8 (length: 16) Note4)
		Mechanical stopper position	A	B	
		Negative	-170°	-141°	—
		Mechanical stopper angle	-172°	-143.5°	Hexagon socket bolt M8 (length: 16) Note4)
		Mechanical stopper position	A	C	

Note1) Refer to Fig. 3-1 to check the stopper positions.
Note2) The angles in Table 3-1 show the movable range set by software.
The mechanical stopper angles in the table show the angles limited by the mechanical stoppers.Care should be taken in designing the layout.
Note3) The angles can be set separately for both directions.
Note4) Recommended bolts
Manufacturer: Nissan Screw
Strength class: 10.9
Nickel plated

(2) Installation procedure

Refer to the following to install the stopper(s).
When installing this option, you should move the J1 axis to the 0 degrees by jog operation previously, and do this work.

⚠CAUTION Turn off the controller power before installation to ensure safety.
Each screw should be tightened with 9.5 Nm torque. Please confirm the screws are surely tightened by 9.5 Nm torque before moving the robot.



Top view

Fig.3-1:Installation procedure of optional stoppers

1) Insert the bolt(s) in the hole(s) at the position(s) corresponding to the desired angles shown in Table 3-1.

(3) Setting the parameter

Specify the operating range to parameter MEJAR and the mechanical stopper angle to parameter MORG with appropriate values (variable angles given in Table 3-1) by the following steps.

1) Turn on the power supply.
2) Set up the operating range changed into parameter MEJAR.
   MEJAR: (J1 minus (-) side, J1 plus (+) side, ***, ***, ***, ***, ...).
3) Set up the + side mechanical stopper angle changed into parameter MORG.
   MORG: (J1 plus (+) side mechanical stopper angle, ***, ***, ...).

Note) Refer to the separate "Instruction manual/Detailed Explanation of Functions and Operations" for the details of the setting method.

(4) Check the operating range

After changing the parameter, turn off the controller power and turn on again. And, move the axis changed by joint jog operation to the limit of the operating range. Confirm that the robot stops by limit over at the changed angle.

The operation range changing procedure is complete.

4 Basic operations

The basic operations from creating the program to automatic operation are explained in section "4. Basic operations" in the "Controller setup, basic operation, and 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 Type of inspection and maintenance works

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.
Table 5-1 lists the type of inspection and maintenance works.

Table 5-1: Type of inspection and maintenance works

No.	Type of inspection and maintenance works		Description	Operating time Note1)
1	Daily inspection		Inspection works to be performed every day before starting operation for the safe use of the robot.	-
2	Periodic inspection	Monthly inspection	Inspection and maintenance works to be performed every month.	Every 300hr
3		6-month inspection	Inspection and maintenance works to be performed every 6 months.	Every 1,800hr
4		2-year inspection	Inspection and maintenance works to be performed every 2 years.	Every 7,200hr
5		Lubrication	Lubrication of each axis of the robot. Refer to Page 57, "5.3.4 Lubrication" for the lubrication schedule.	-

Note1) The operating hours assume the robot operation of 15 hours per day for 20 days per month. When the robot operates for 8 hours per day, the operating hours per month become about a half of the one under the above condition. Then, the monthly inspection is required every two months. To check the periodic inspection schedule and calculate the operating hours, refer to Page 48, "(2) 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

Table 5-2 shows the procedure and inspection items. If you notice any abnormal condition, take appropriate measures.

Table 5-2: 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 operation (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

The inspection items and timings for the robot arm are shown below.

(1) Inspection item

Carry out periodic inspection given in Table 5-3.

Table 5-3: Periodic inspection items (details)

Inspection item (details)	Remedies
Monthly inspection	
Are any of the bolts or screws on the robot arm loose?	Securely tighten the bolts.
Are any of the connector fixing screws or terminal block terminal screws loose?	Securely tighten the screws.
2-year inspection[Note1)]	
Is the friction at the timing belt teeth severe?	If the teeth are missing or severe friction is found, replace the timing belt.
Is the timing belt tension value more than the guideline value? Does any position mismatch occur?	When the tension value becomes less than the guideline value, the timing belt must be replaced.
Lubrication	
Check the lubrication schedule for each axis, and perform lubrication.	Lubricate it referring to Page 57, "5.3.4 Lubrication".

Note1) When the robot is operated 24 hours a day or with a heavy load, it is recommended to be inspected every 6 months (1,800hr).

(2) Schedule

The following shows the schedule for the periodic inspection works. Perform the periodic inspection works as appropriate according to the following table.

Operating time Note1)	Inspection schedule		Type of periodic inspection works Note2)			
	15 hours per day	8 hours per day	Monthly inspection	6-month inspection	2-year inspection	Lubrication
300hr	1 month	2 months	○			As appropriate Note3)
600hr	2 months	4 months	○			
900hr	3 months	6 months	○			
1,200hr	4 months	8 months	○			
1,500hr	5 months	10 months	○			
1,800hr	6 months	12 months	○	○		
:	:		:			
3,600hr	12 months	24 months	○	○		
:	:		:			
7,200hr	24 months	48 months	○	○	○	
:	:		:			
10,800hr	36 months	72 months	○	○		

Note1)The following shows examples of calculation of the operating hours.

- Operating hours when the robot operates 15 hours per day for 20 days per month for three months:
  15 hr/day ×20 days/month ×3 months = 900hr
- Operating hours when the robot operates 8 hours per day for 20 days per month for three months:
  8 hr/day× 20 days/month × 3 months = 480hr ... Approx. 500 hr

Note2)The item marked with the circle (○) is to be performed. According to the guideline of the operating hours, perform the inspection to check the items described in Table 5-3.

Note3)Check the lubrication interval described in Page 57, "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 60, "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 below.

Non-excitation magnetic brakes are mounted in all axes's motor.

1) The J1 axis is rotated by the J1 axis motor <1> and the reduction gear <2>.

2) The J2 axis is rotated by the J2 axis motor <3> and the reduction gear <4>.

3) The J3 axis is rotated by the J3 axis motor <5> and the reduction gear <6>.

4) The rotation of the J4 axis motor <8> in the elbow is conveyed to the reduction gear <9> via the timing belt <7> to rotate the J4 axis.

5) The rotation of the J5 axis motor <10> in the No. 2 arm is conveyed to the reduction gear <13> via the timing belt <11> to rotate the J5 axis.

6) The J6 axis is rotated by the J6 axis motor <12> and the reduction gear <14>.

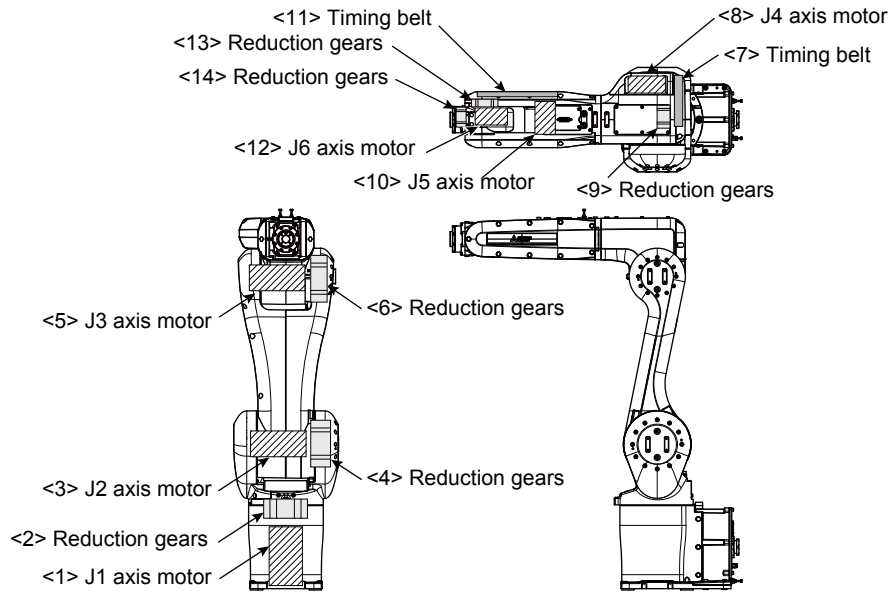


Fig 5-1: Outline structure of robot arm

5.3.2 Installing/removing the covers

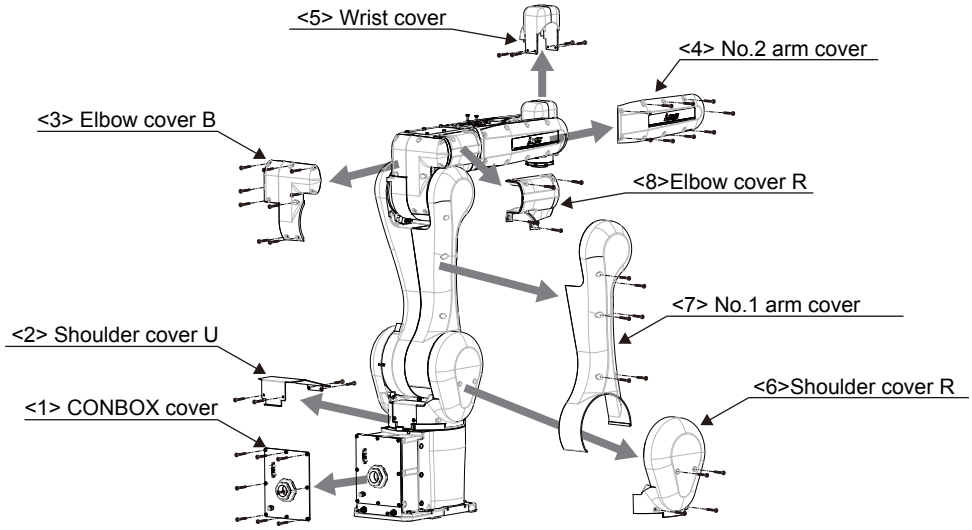


Fig 5-2: Installing/removing the cover

Table 5-4: Cover names and installation screw list

No.	Cover names	Installation screws Note1)	Qty	Remarks
<1>	CONBOX cover	Hexagon socket bolts M4x12	8	-
<2>	Shoulder cover U	Hexagon socket bolts M4x12	4	-
<3>	Elbow cover B	Truss head screw M4x10	9	-
<4>	No.2 arm cover	Truss head screw M4x10	9	-
<5>	Wrist cover	Truss head screw M4x10	4	-
<6>	Shoulder cover R	Truss head screw M4x10	4	-
<7>	No.1 arm cover	Truss head screw M4x10	6	-
<8>	Elbow cover R	Truss head screw M4x10	4	-

Note1) The tightening torque of each installation screw is 1.39 to 1.89 N•m.

(1) Refer to Fig. 5-2, and remove the covers.
(2) The names of the cover and installation screw are given in Table 5-4. The number in Table 5-4 correspond to Fig. 5-2.
(3) 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.
(4) When removing the wrist cover, move the J5 axis to the position of +90 degrees by jog operation.
(5) When reattaching the covers after a maintenance inspection, proceed in the reverse order of their removal. Tightening the screw with the torque shown in Table 5-4.

5.3.3 Inspection replacement of timing belt

This robot uses a timing belt for the drive conveyance system. 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 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.

Please prepare the sound wave type belt tension gauge in inspection of the timing belt. Refer to the Page 56, "(5) Timing belt tension" for the tension of the timing belt.

The recommendation gauge is shown below.
Manufacture: Gates Unitta Asia Company
Type: U-508

Fig.5-3:Tension adjustment method of timing belt

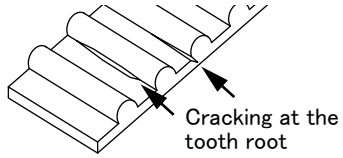
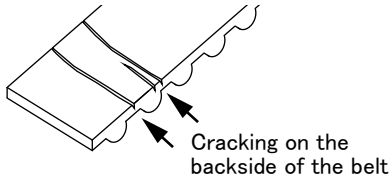
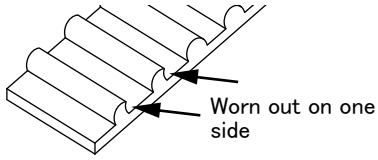
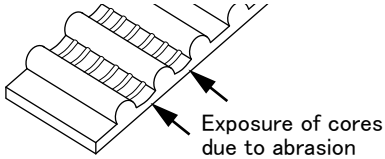
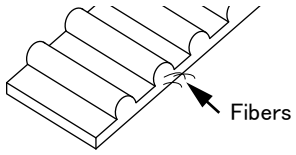
⚠CAUTION When the timing belt has to be removed for repair or some other reason, measure the tension before removing the belt.
When the belt is reinstalled, the tension must be the same as the one measured before removal. Otherwise, the life of the belt and the relevant parts may be shortened.

(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) The belt tension value becomes less than the guideline value.
2) A position mismatch or gear teeth skipping occurs.
3) The belt is damaged as shown in Table 5-5.

Table 5-5:Typical damage conditions of the timing belt

Damage condition	Appearance	Cause
Gear tooth crack		Overload
Backside crack		Deterioration of rubber due heat to or ozone
Worn teeth		Overload Excessive or insufficient tension
Tooth bottom abrasion and exposure of cores		Excessive tension
The following is not a belt damage.		
Fibers coming out of the side face of the belt		Manufacturing related factor. This is not a belt damage.

⚠CAUTION 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.

⚠CAUTION When the belt is replaced, the machine system origin may deviate. After the replacement, ensure to reset the origin.

(2) Timing belt tension measurement

Rotate the timing pulley A to one direction while visually checking its position, and measure the belt tension at every 90 degrees, four times in total. The average of the four measurements is used as the timing belt tension value.

The timing belt must be pulled tight before the tension is measured. For this purpose, rotate the timing pulley A 90 degrees before measurement. Measure the tension of the belt to be pulled by the movement of the timing pulley A.

When the temperature of the robot arm is high, the timing belt tension is increased. To ensure reliability of the measurement, take measurements at least 30 minutes after the robot stops its movement.

Low ambient temperature may make accurate measurements using a tension gauge impossible. In this case, perform the automatic operation or jog operation at measuring target axis for a few minutes, then measure the tension of the belt.

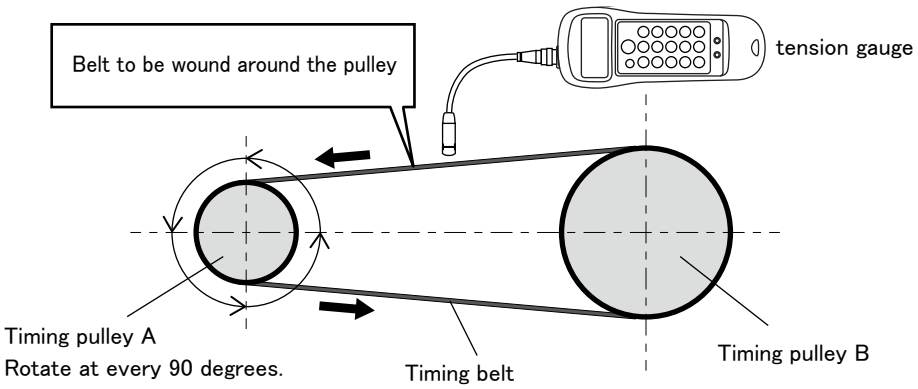


Fig.5-4:Timing belt tension measurement

The procedure is shown below.

1) Turn on the controller's power supply.
2) Rotate the timing pulley A to one direction in jog operation while visually checking its position, and measure the belt tension at every 90 degrees, four times in total (for one turn of the timing pulley A). Refer to Page 56, "(6) Amount of movement of each axis during the timing belt tension measurement" for the standard amount of movement of each axis when timing pulley A is rotated 90°.
3) Take an average of the four measurements to determine the timing belt tension value.
   During inspection of the timing belt, check that the belt tension exceeds the replacement guideline value in Page 56, "(5) Timing belt tension". When the belt tension value becomes less than the guideline value, the belt must be replaced immediately.

(3) Inspection and replacement of the J4 timing belt

The reference figure at inspection of the timing belt is shown in Fig. 5-5.

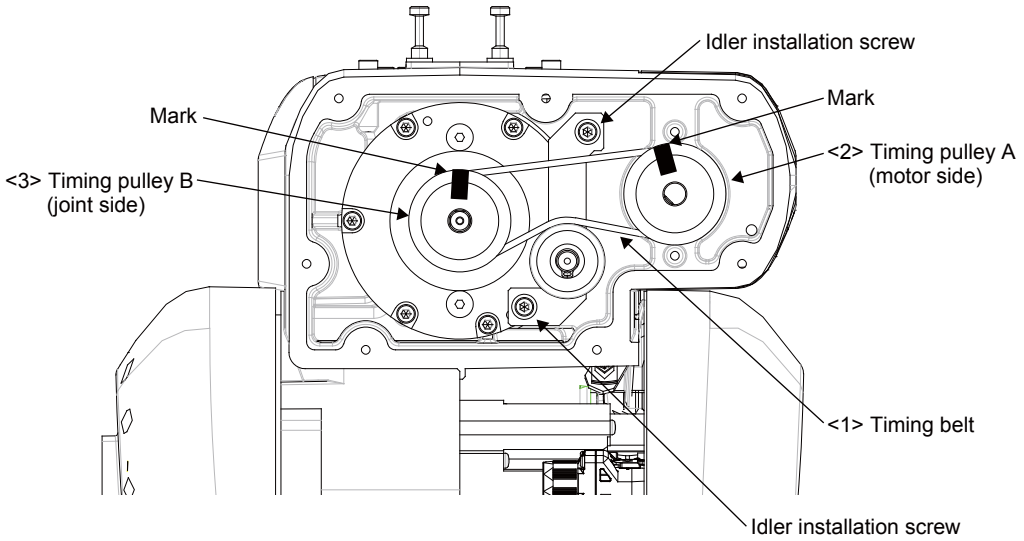


Fig.5-5:Inspection and replacement of J4 axis timing belt

*Inspecting the J4 axis timing belt

1) Refer to Page 50, "5.3.2 Installing/removing the covers" and remove the elbow cover B.
2) Visually confirm that the symptoms indicated in Page 52, "(1) Timing belt replacement period" have not occurred with the timing belt.
3) Refer to Page 53, "(2) Timing belt tension measurement", and confirm the belt tension.
4) Reinstall the elbow cover B securely and finish inspection.

*Replacing the J4 axis timing belt

⚠ CAUTION It is possible for the customer to replace the timing belt, but precise adjustment is needed to prevent malfunction of the relevant parts. To ask for replacement of the timing belt, contact the dealer.

1) Refer to Page 50, "5.3.2 Installing/removing the covers" and remove the elbow cover B.
2) Make sure that the pulleys do not move while replacing the belt. If the timing pulley A <2> and B <3> position relation deviates, the position could deviate.
3) Make marks on the timing belt <1> and timing pulleys <2> and <3> with a felt-tip pen as shown in the figure above, so that the engagement of the timing belt <1> and timing pulleys <2> and <3> does not deviate.
4) Lightly loosen the two idler installation screws. (Do not loosen too much.) Remove the belt.
5) Copy the marks onto the new timing belt. Make sure that both belts are tense when making the marks.
6) Align the new timing belt with the marks on the timing pulleys <2> and <3> and install the belt.
7) Push the timing belt <1> using the idler and adjust the belt tension.
   Adjust the belt tension slack to within the range as shown in Page 56, "(5) Timing belt tension".
   Before the tension measurement, rotate the timing pulley at least three times in each direction so that the timing belt fits in the pulley. Check the tension measurement method in Page 53, "(2) Timing belt tension measurement".
   If the belt is loosened too much when adjusting the tension causing it to come off the timing pulleys <2> and <3>, or if the belt and pulley teeth engagement is deviated, the machine system's origin will deviate.
8) After adjustment, make sure to tighten the idler installation screws (M4 screw tightening torque: 4.51 N•m). Improper tightening can cause the belt to loosen with vibration.
9) Reinstall the elbow cover B securely.
10) Refer to Page 61, "5.6 Resetting the origin", and reset the origin position.
11) When the maintenance forecast function is valid, reset the accumulation data about the belt. Reset by the dedicated screen or parameter MFBRST of RT ToolBox3. Refer to "RT ToolBox3/RT ToolBox3 mini User's Manual" for operation of RT3 and refer to "Instruction Manual/Detailed Explanation of Functions and Operations" for the parameter.

(4) Inspection and replacement of the J5 timing belt

The reference figure at inspection of the timing belt is shown in Fig. 5-6.

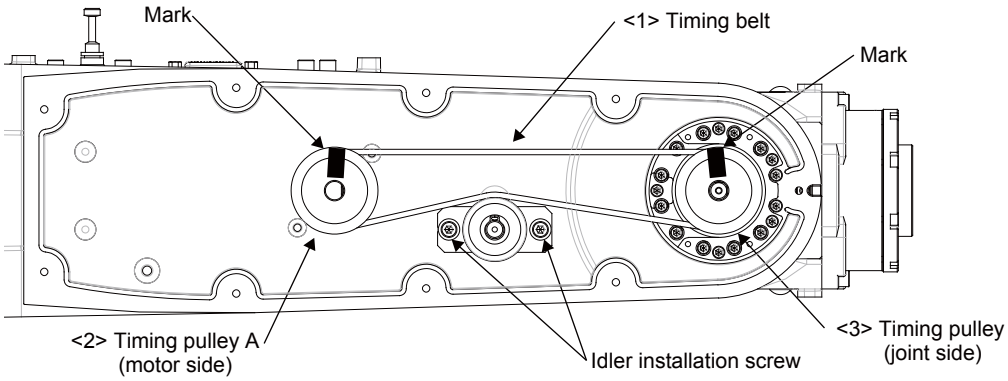


Fig.5-6:Inspection and replacement of J5 axis timing belt

*Inspecting the J5 axis timing belt

1) Refer to Page 50, "5.3.2 Installing/removing the covers", and remove the No. 2 arm cover.
2) Visually confirm that the symptoms indicated in Page 52, "(1) Timing belt replacement period" have not occurred with the timing belt.
3) Refer to Page 53, "(2) Timing belt tension measurement", and confirm the belt tension.
4) Install the No. 2 arm cover securely as before and finish inspection.

*Replacing the J5 axis timing belt

⚠ CAUTION If the timing belt of the J5 axis is removed, the forearm will drop by the self-weight. (faces in the downward) And, if the positional relation between the timing pulley A <2> and B <3> deviated, it will become the cause of the position deviation. For the safety before replacing the timing belt, move the J5 axis so that it may face in the downward by jog operation.

⚠ CAUTION It is possible for the customer to replace the timing belt, but precise adjustment is needed to prevent malfunction of the relevant parts. To ask for replacement of the timing belt, contact the dealer.

1) Refer to Page 50, "5.3.2 Installing/removing the covers", and remove the No. 2 arm cover.
2) Make sure that the pulleys do not move while replacing the belt. If the timing pulley A <2> and B <3> position relation deviates, the position could deviate.
3) Make marks on the timing belt <1> and timing pulleys <2> and <3> with a felt-tip pen as shown in the figure above, so that the engagement of the timing belt <1> and timing pulleys <2> and <3> does not deviate.
4) Lightly loosen the two idler installation screws. (Do not loosen too much.) Remove the belt.
5) Copy the marks onto the new timing belt. Make sure that both belts are tense when making the marks.
6) Align the new timing belt with the marks on the timing pulleys <2> and <3> and install the belt.
7) Push the timing belt <1> using the idler and adjust the belt tension.
   Adjust the belt tension slack to within the range as shown in Page 56, "(5) Timing belt tension".
   Before the tension measurement, rotate the timing pulley at least three times in each direction so that the timing belt fits in the pulley. Check the tension measurement method in Page 53, "(2) Timing belt tension measurement".
   If the belt is loosened too much when adjusting the tension causing it to come off the timing pulleys <2> and <3>, or if the belt and pulley teeth engagement is deviated, the machine system's origin will deviate.
8) After adjustment, make sure to tighten the idler installation screws (M4 screw tightening torque: 4.51 N•m). Improper tightening can cause the belt to loosen with vibration.
9) Install the No. 2 arm cover securely as before.
10) Refer to Page 61, "5.6 Resetting the origin", and reset the origin position.
11) When the maintenance forecast function is valid, reset the accumulation data about the belt. Reset by the dedicated screen or parameter MFBRST of RT ToolBox3. Refer to "RT ToolBox3/RT ToolBox3 mini User's Manual" for operation of RT3 and refer to "Instruction Manual/Detailed Explanation of Functions and Operations" for the parameter.

(5) Timing belt tension

The following table shows the preset values of the sonic belt tension gauge, the tension value for new belt installation, and the tension value as the replacement guideline.

Table 5-6:Belt tension

Axis	Belt type	Preset value			Tension for new belt installation (N)	Replacement guideline tension
		M(g/m)	W(mm/R)	S(mm)		
RV-8CRL						
J4	273-EV3GT-6 RF	2.5	6	81.0	39.2 to 47.9	15
J5	447-EV3GT-6 RF	2.5	6	170.0	39.2 to 47.9	15

(6) Amount of movement of each axis during the timing belt tension measurement

The amount of movement of each axis when the timing pulley A is rotated 90 degrees are shown in Table 5-7.

Table 5-7:Amount of movement of each axis during the tension measurement

Model	Amount of movement	
	J4 axis	J5 axis
RV-8CRL	1.1°	1.1°

5.3.4 Lubrication

*Lubrication position and specifications

The grease nipple position is shown in Fig. 5-7. The lubrication specifications for each place are shown in Table 5-8.

Refer to the Page 50, "5.3.2 Installing/removing the covers" for the method of removing and installing the cover.

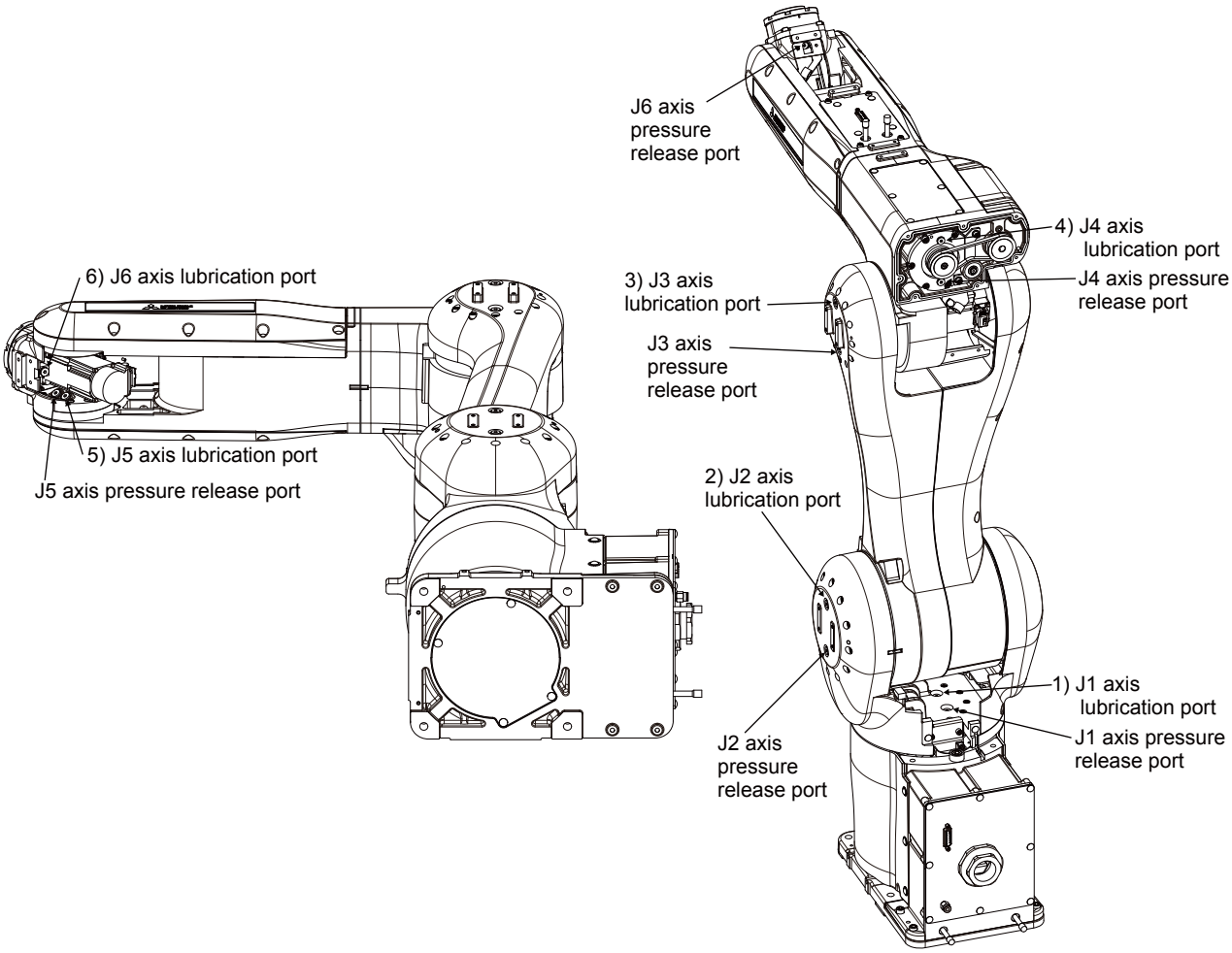


Fig.5-7:Lubrication positions

Table 5-8:Lubrication specifications

No.	Parts to be lubricated Note1)	Oiling method	Lubrication oil (maker)	Lubrication interval	Lubrication amount	Cover to remove
RV-7FR series						
1)	J1 axis reduction gears	Grease nipple WA-610	SK-1A (Harmonic Drive Systems Inc.)	6,000Hr	7g	Shoulder cover U
2)	J2 axis reduction gears				13g	-
3)	J3 axis reduction gears				7g	-
4)	J4 axis reduction gears				4g	Elbow cover B
5)	J5 axis reduction gears				1.5g	-
6)	J6 axis reduction gears				1.5g	Wrist cover

Note1) Screws are inserted into the lubrication ports illustrated in the figure above. Install the supplied grease nipples when greasing the robot.

[Caution]

• The brand name of the grease shown in Table 5-8 is the grease put in at shipping.

- The lubrication interval 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 interval 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 ToolBox3 (option) computes the guide of the lubrication hours put together with the customer's operation status.
- The numbers in the Table 5-8 correspond to the supply positions in Fig. 5-7
- When the specified time limit (24,000 Hr) is due, the overhaul work to replace internal grease is required. If the overhaul cannot be conducted at the specified timing, lubricate them at the lubrication interval in Table 5-8. For the overhaul, contact the dealer.

*Lubrication method

1) Set the robot to the posture shown in Fig. 5-7.
2) Refer to the Page 50, "5.3.2 Installing/removing the covers" and remove the covers.
3) Please protect the timing belt with the cloth etc. so that the grease does not take for the timing belt at the time of oil supply.
4) Remove the screws from the pressure release ports of axes J1 to J6. Wipe off the oil coming out from the screw holes with a rag or the like.
   Remove the screws from the lubrication ports of the 6 axes and install the supplied grease nipples.
   Tighten the grease nipples with a torque of 4.7N•m to 6.3N•m.
5) Insert the grease shown in Table 5-8 using a grease gun from the lubrication grease nipple.
6) Remove the grease nipples installed above and install the original screws.
   Tighten the screws by 4.7N•m to 6.3N•m.
7) Replace the covers with the removal procedure in reverse.
8) If the maintenance forecast function is enable, please reset the accumulated data about grease. Carries out the resetting operation by RT ToolBox3 (option) or parameter MFGRST. Refer to separate "RT ToolBox3/RT ToolBox3 mini User's Manual" for the operation method of RT ToolBox3, and refer to separate "Instruction Manual/Detailed Explanation of Functions and Operations" for details of parameter MFGRST.

⚠ CAUTION 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: KH-120 (amount: 140ml) or KH-32 (amount: 200ml)
(manufacture: Yamada Corporation Inc.,)
The grease guns come 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).

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. 5-8.) 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.

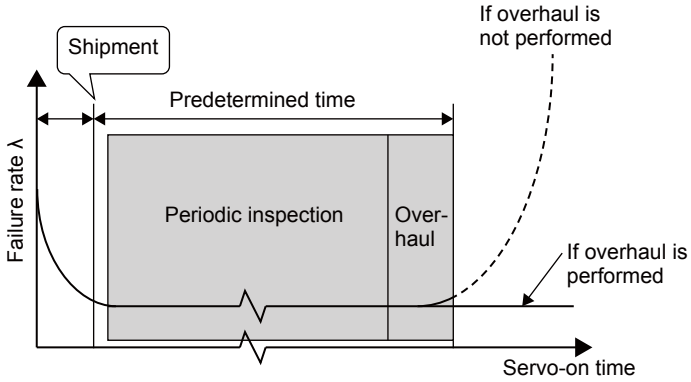


Fig.5-8:Periodic inspection/overhaul periods

5.5 Maintenance parts

The consumable parts that must be replaced periodically are shown in Table 5-9, and spare parts that may be required during repairs are shown in Table 5-10. Purchase these parts from the dealer when required.
[Note] 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 5-9:Consumable part list

No.	Part name	Usage place	Q'ty	Description	Supplier
1	Timing belt	J4 axis	1	"5.3.3Inspection replacement of timing belt"	Mitsubishi Electric
2		J5 axis	1		
3	Grease	Reduction gears of each axis	A small amount	"5.3.4Lubrication"	

Table 5-10:Spare parts list

No.	Names	Usage place	Q'ty	Supplier
1	AC servo motor	J1 axis	1	Mitsubishi Electric
2		J2 axis	1	
3		J3 axis	1	
4		J4, J5 axis	2	
5		J6 axis	1	
6	Reduction gears	J1, J3 axis	2	
7		J2 axis	1	
8		J4 axis	1	
9		J5 axis	1	
10		J6 axis	1	
11	Lithium battery (ER6)	Base section	1	

5.6 Resetting the origin

The origin is set so that the robot can be used with a high accuracy. The origin is set so that the robot can be used with a high accuracy. Setting is required if the motor is replaced or an encoder error occurs.
The origin setting methods and when each origin setting method is required are shown in Table 5-11.

Table 5-11:Origin setting method

No	Method	Explanation	Cases when setting the origin is required	Remarks
1	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 collision.	The setting method is explained in Page 62, "5.6.1 Jig method".
2	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 77, "5.6.2 ABS origin method".
3	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 79, "5.6.3 User origin method".

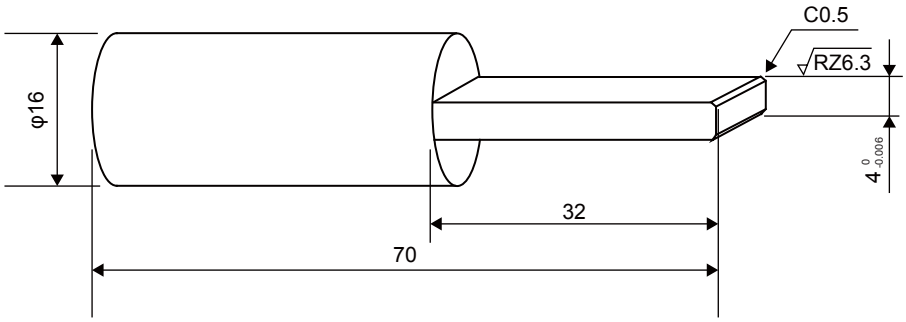
[Remarks]
- The origin data is inherent to the serial number of each robot arm.
- The ABS origin method is used to restore the previous data by aligning the keyways to each other for each axis to set the lost origin data.
  (Although the setting position is confirmed visually, deviations within a half rotation of the motor can be compensated.)

[Caution]
- 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 77, "5.6.2 ABS origin method".

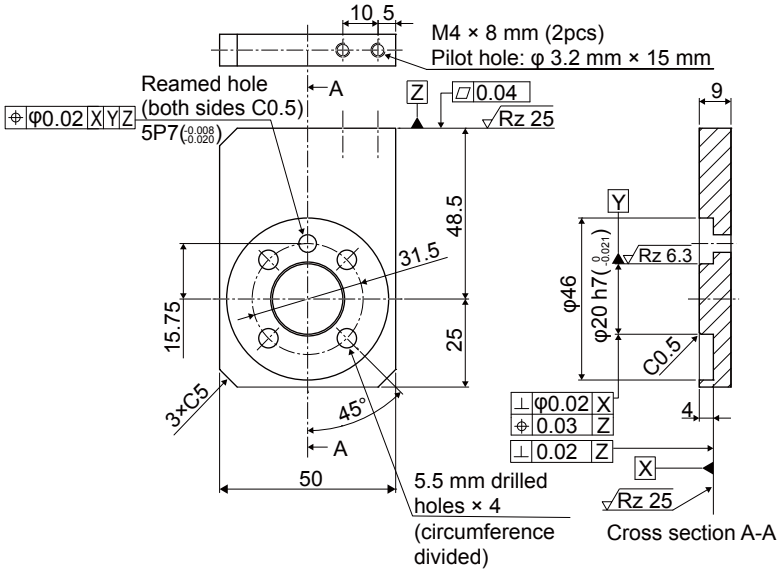
5.6.1 Jig method

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. 5-9.

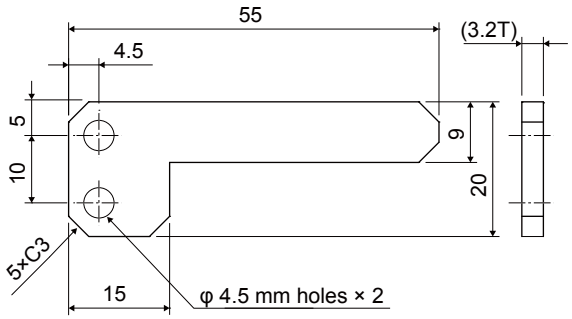
For axes J1 to J5



For axis J6



Jig A



Jig B

Part name	Specifications	Q'ty	Remarks
Hexagon socket bolts	M4x8	2	Screws for securing J6 axis origin setting tools A and B.
Parallel pin	Diameter: 5 mm, length: 8 mm, tolerance: h7	1	A positioning pin used for installing the J6 axis origin setting tool on the mechanical interface.

Fig.5-9:Reference dimension of origin setting tool

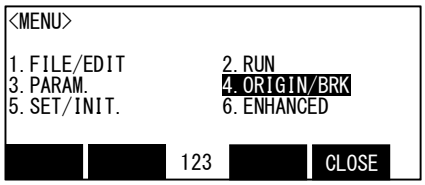
The procedure of setting the origin with the origin setting tool is shown below.

When this method is used, origin setting is performed for each axis.
First, set each axis to the origin position. There are two positioning methods: manual setting by releasing the brake and jog feeding. The following describes the positioning by releasing the brake.
After the positioning, set the origin with the origin setting operation.

⚠CAUTION In the following procedure, the brake is released for the axis with brake to move the arm with both hands.
When the brake is released, the arm may fall by its own weight depending on the posture of the robot.
To ensure safety, take appropriate measures such as supporting the axis to avoid the free fall.

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

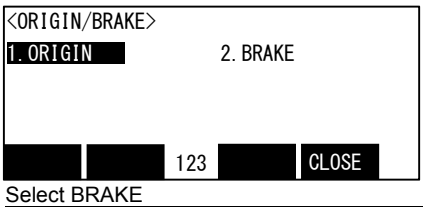
(1) J1 axis origin setting (jig)



Select ORIGIN/BRK

4 GHI

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



Select BRAKE

−Z (J3)
2 ABC

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

select axis

↑ ↓

1 '( )

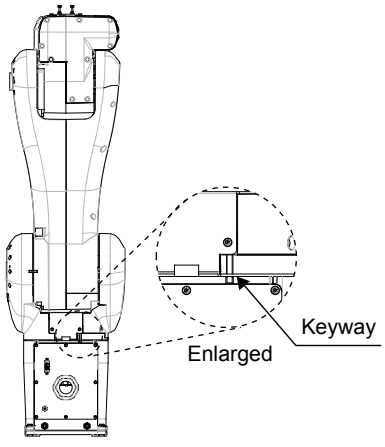
−C (J6)
0 SPACE

3) Release the brake of the J1 axis.
Input "1" into the J1 axis. Set "0" to other axes.

Brake release

F1

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.



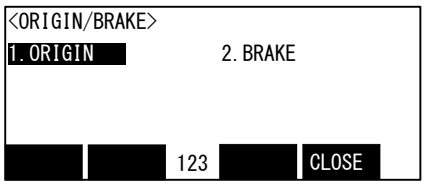
Rear view

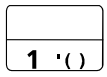
6) Move the J1 axis slowly with both hands to ±0°. Align the keyways of the lower shoulder and base, then insert the J1-axis origin jig into the keyways to fix the axis in place.

Complete brake release

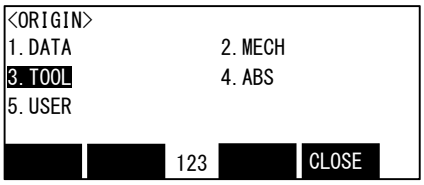
F4

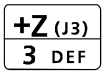
7) Detach the [F1] key and work the brake. Press the [F4] key and return to the origin / brake screen.





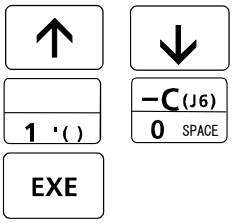
8) Press the [1] key, and display the Origin setting selection screen.





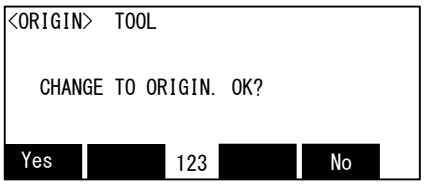
Select TOOL

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



10) Input "1" into the J1 axis. Set "0" to other axes.

11) Press the [EXE] key, and display Confirmation screen.



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

13) Setting of the origin is completed.

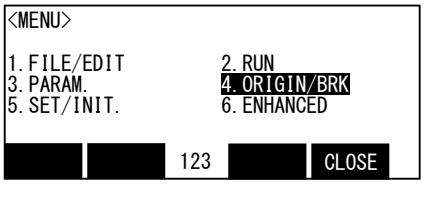
Release the brake

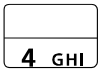
Do cursor movement into the parenthesis of each axis by the arrow key. The brakes can be released only for the axis for which a "1" is displayed on the screen. If the brakes are not to be released, press the [0] key and display a "0". If the [F1] key on the teaching pendant or the enabling switch is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

Select the axis of origin setting

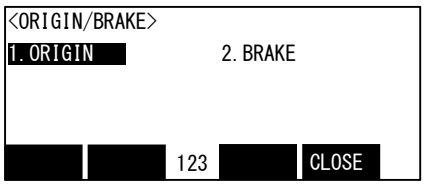
Do cursor movement into the parenthesis of each axis by the arrow key. The origin is set only for the axis for which a "1" is displayed on the screen. If the origin is not to be set, press the [0] key and display a "0".

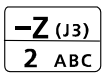
(2) J2 axis origin setting (jig)



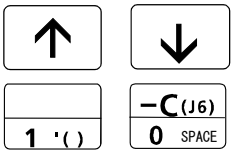


1) Press the [4] key on the menu screen, and display the Origin/Brake selection screen.





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



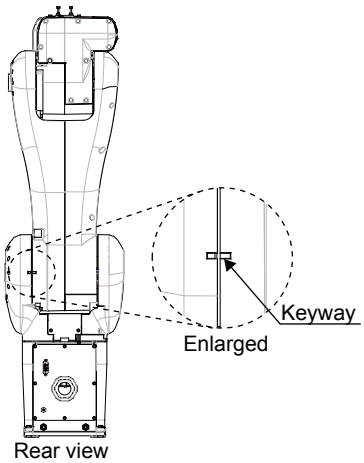
3) Release the brake of the J2 axis.
Input "1" into the J2 axis. Set "0" to other axes.

4) Confirm the axis for which the brakes are to be released.

5) One worker must securely support the upper arm with both hands.

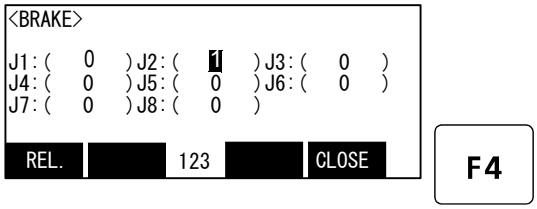
6) Pressing the [F1] key is kept with the enabling switch of T/B pressed down. The brake is released while pressing the key.

7) Move the J2 axis slowly with both hands to ±0°. Align the keyways of arm No.1 and the shoulder, then insert the J2-axis origin jig into the keyways to fix the axis in place.

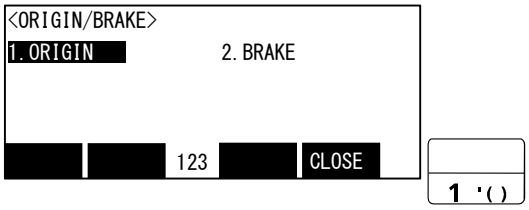


⚠ CAUTION When the brake is released, the arm may fall by its own weight depending on the posture of the robot.
To ensure safety, take appropriate measures such as supporting the axis to avoid the free fall.

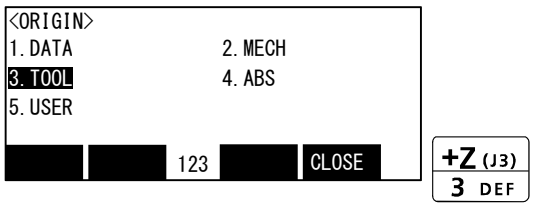
⚠ CAUTION If [F1] key or enable switch of T/B is released, the brakes will be work immediately.



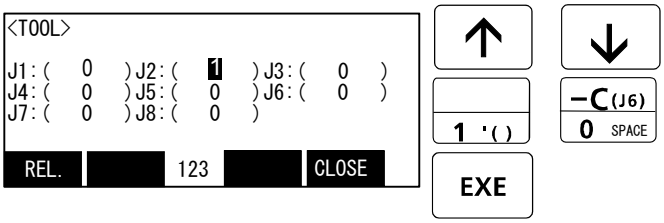
8) Detach the [F1] key and work the brake. Press the [F4] key and return to the origin / brake screen.



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

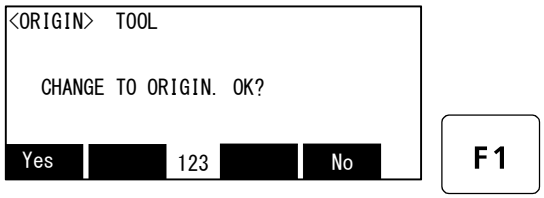


10) Press the [3] key, and display the Tool selection screen.

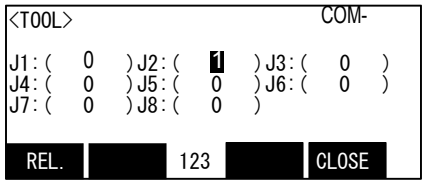


11) Input "1" into the J2 axis. Set "0" to other axes.

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.

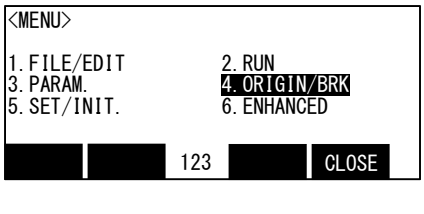
Release the brake

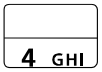
Do cursor movement into the parenthesis of each axis by the arrow key. The brakes can be released only for the axis for which a "1" is displayed on the screen. If the brakes are not to be released, press the [0] key and display a "0". If the [F1] key on the teaching pendant or the enabling switch is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

Select the axis of origin setting

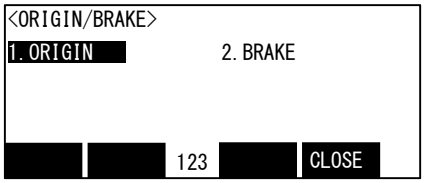
Do cursor movement into the parenthesis of each axis by the arrow key. The origin is set only for the axis for which a "1" is displayed on the screen. If the origin is not to be set, press the [0] key and display a "0".

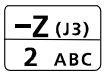
(3) J3 axis origin setting (jig)



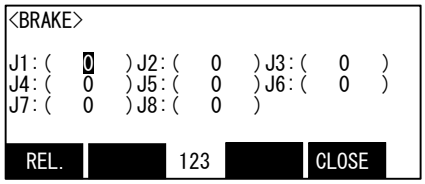


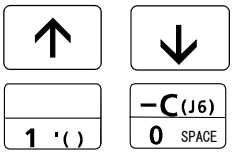
1) Press the [4] key on the menu screen, and display the Origin/Brake selection screen.





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



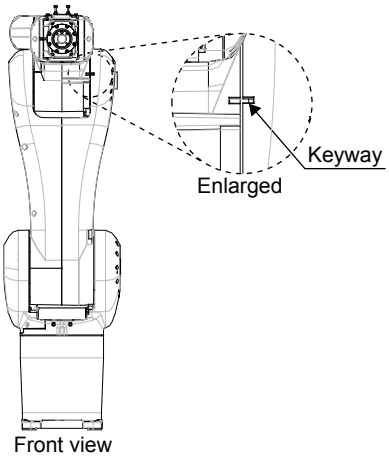


3) Release the brake of the J3 axis. Input "1" into the J3 axis. Set "0" to other axes.

4) Confirm the axis for which the brakes are to be released.

5) One worker must securely support the upper arm with both hands.

6) Pressing the [F1] key is kept with the enabling switch of T/B pressed down. The brake is released while pressing the key.



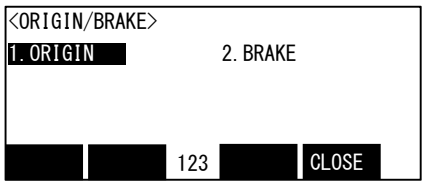
7) Move the J3 axis slowly with both hands to +90°. Align the keyways of arm No. 1 arm and the elbow, then insert the J3-axis origin jig into the keyways to fix the axis in place.

⚠ CAUTION When the brake is released, the arm may fall by its own weight depending on the posture of the robot.
To ensure safety, take appropriate measures such as supporting the axis to avoid the free fall.

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

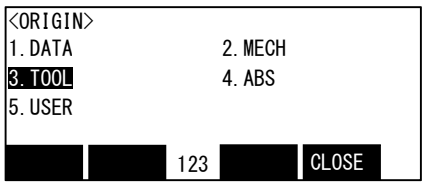
F4

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



1 '()

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



+Z (J3)
3 DEF

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

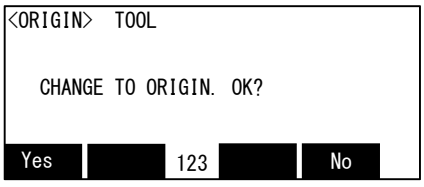
↑ ↓

1 '()

−C (J6)
0 SPACE

EXE

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



F1

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

14) Setting of the origin is completed.

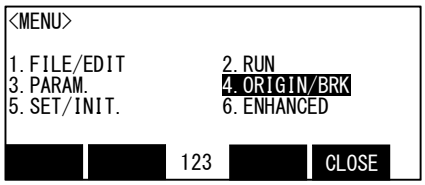
Release the brake

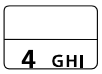
Do cursor movement into the parenthesis of each axis by the arrow key. The brakes can be released only for the axis for which a "1" is displayed on the screen. If the brakes are not to be released, press the [0] key and display a "0". If the [F1] key on the teaching pendant or the enabling switch is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

Select the axis of origin setting

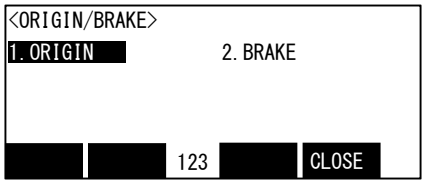
Do cursor movement into the parenthesis of each axis by the arrow key. The origin is set only for the axis for which a "1" is displayed on the screen. If the origin is not to be set, press the [0] key and display a "0".

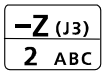
(4) J4 axis origin setting (jig)





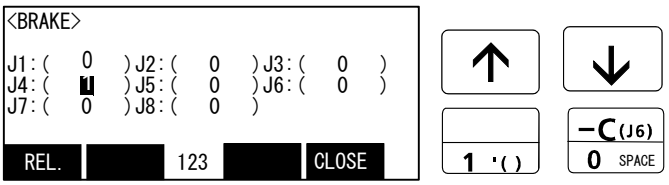
1) Referring to Page 50, "5.3.2 Installing/ removing the covers", in the following order remove the shoulder cover (R), arm cover No.1, and elbow cover (R).
2) Press the [4] key on the menu screen, and display the Origin/Brake selection screen.



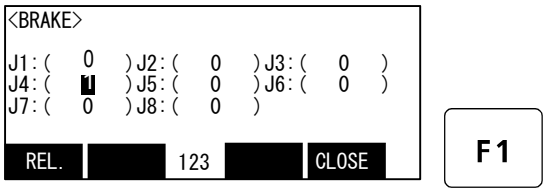


3) Press the [2] key, and display the Brake release selection screen.

4) Release the brake of the J4 axis.
Input "1" into the J4 axis. Set "0" to other axes.

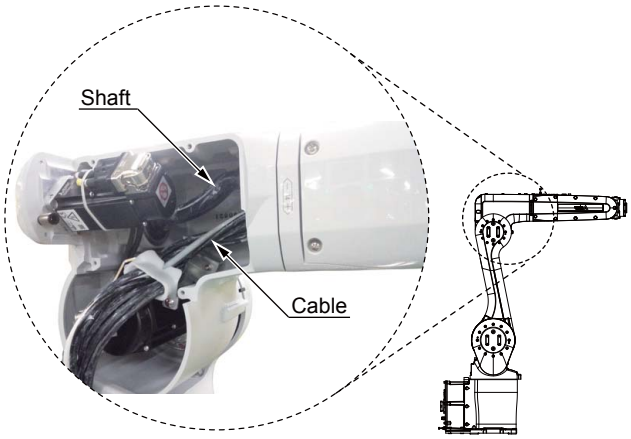


5) Confirm the axis for which the brakes are to be released.
6) One worker must securely support the upper arm with both hands.



7) Pressing the [F1] key is kept with the enabling switch of T/B pressed down. The brake is released while pressing the key.

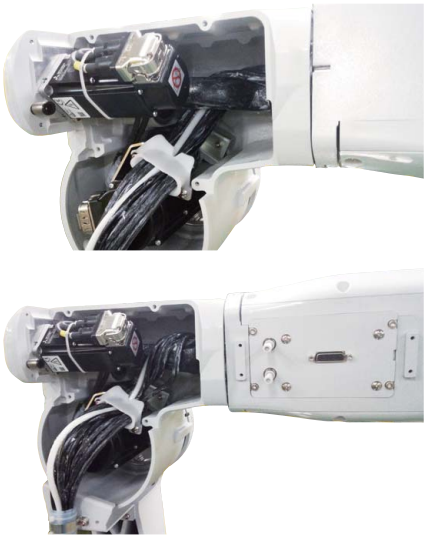
Acceptable: Cables are not wrapped around the shaft.

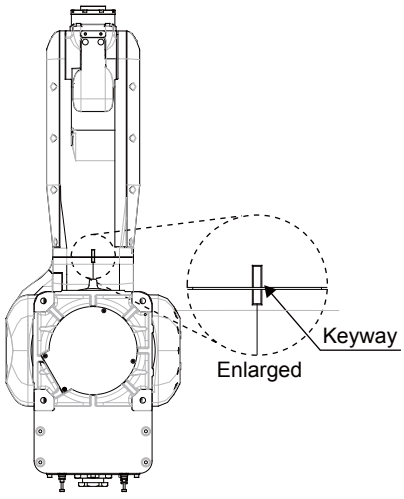


8) Move the J4 axis slowly with both hands to ±0° (keyway position). Check that the cables inside the elbow look like the image on the left and that they have not wrapped around the shaft. For the location of the keyway, refer to step "9)".

⚠ CAUTION The axis does not have a mechanical stopper. Do not rotate the axis manually beyond the operation range (±200°) during the origin setting operation. Otherwise, the internal wiring and piping may be damaged.

Unacceptable: Cables are wrapped around the shaft.

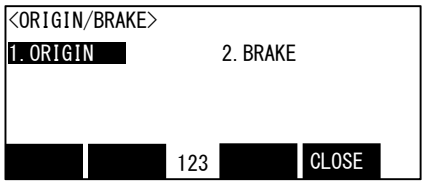




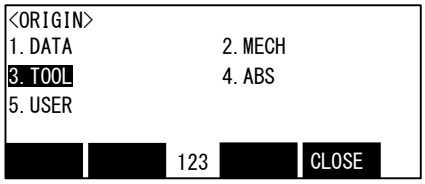
9) Align the keyways of the No.2 arm and the elbow, then insert the J4-axis origin jig into the keyways to fix the axis in place.

F4

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



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



+Z (J3)
3 DEF

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

↑

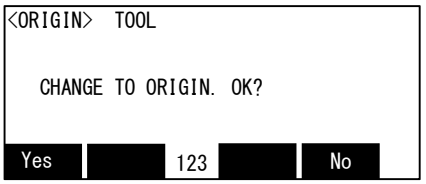
1 '( )

↓

−C (J6)
0 SPACE

EXE

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



F1

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

16) Setting of the origin is completed.

17) Referring to Page 50, "5.3.2 Installing/ removing the covers", in the following order install the elbow cover (R), arm cover No.1, and shoulder cover (R).

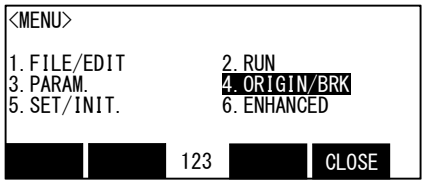
Release the brake

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

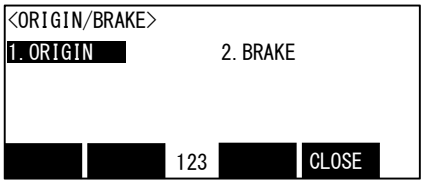
Do cursor movement into the parenthesis of each axis by the arrow key. The origin is set only for the axis for which a "1" is displayed on the screen. If the origin is not to be set, press the [0] key and display a "0".

(5) J5 axis origin setting (jig)



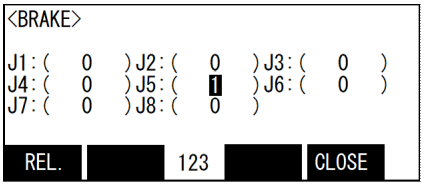
4 GHI

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



−Z (J3)
2 ABC

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

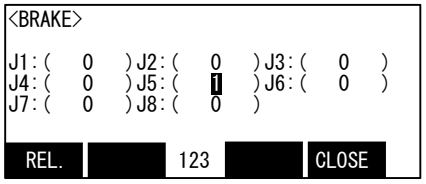


1 '( )

−C (J6)
0 SPACE

3) Brake release of the J5 axis
Press the [Arrow] key, move the cursor to the J5 axis and press the [1] key. Set [0] to other axes.

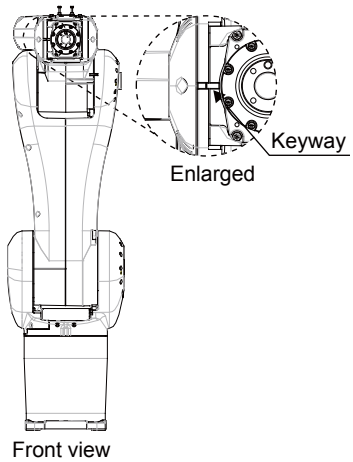
4) Confirm the axis for which the brakes are to be released.



F1

5) The one person needs to support the list part securely with both hands.

6) Pressing the [F1] key is kept with the enabling switch of T/B pressed down. The brake is released while pressing the key.



7) Move the J5 axis slowly with both hands to ±0°. Align the keyways of arm No. 2 and the wrist, then insert the J5-axis origin jig into the keyways to fix the axis in place.

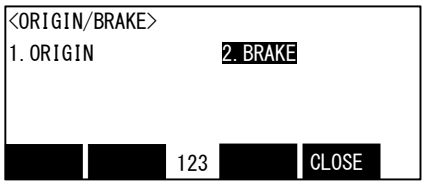
⚠CAUTION When the brake is released, the arm may fall by its own weight depending on the posture of the robot.
To ensure safety, take appropriate measures such as supporting the axis to avoid the free fall.

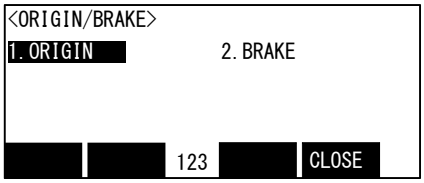
⚠CAUTION If the [F1] key or the enabling switch of T/B is detached, the brake will work immediately.

F4

8) Detach the [F1] key and work the brake.

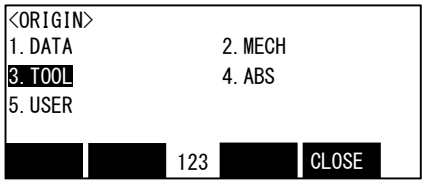
9) Press the [F4] key and return to the origin / brake screen.





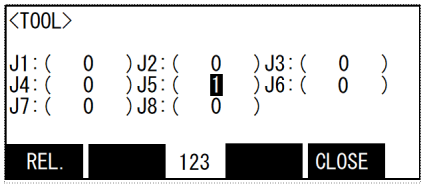
1 '( )

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



+Z (J3)
3 DEF

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



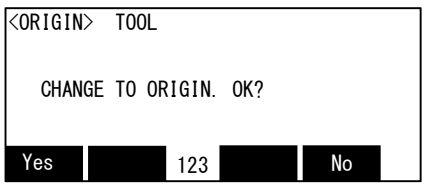
1 '( )

−C (J6)
0 SPACE

12) Press the [Arrow] key, move the cursor, and set "1" to the J5 axis. Set [0] to other axes.

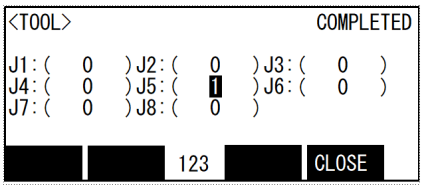
13) Press the [EXE] key , and display Confirmation screen.

EXE



F1

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



15) Setting of the origin is completed.

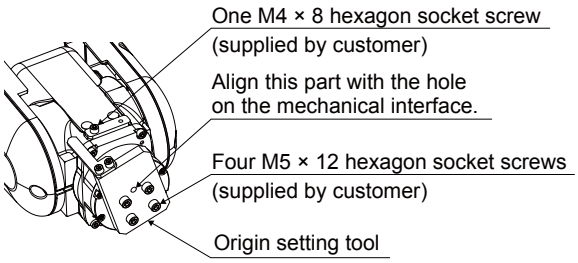
Release the brake

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.

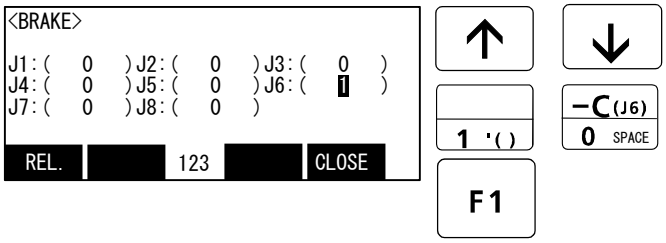
Select the axis of origin setting

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".

(6) J6 axis origin setting (jig)

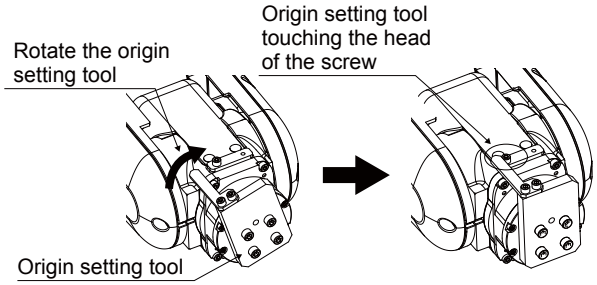


1) Install a M4 × 8 hexagon socket screw (supplied by customer) into the hole on the wrist. Install the J6 axis origin setting tool on the mechanical interface at the same angle shown in the figure using four M5 × 12 hexagon socket screws (supplied by customer).

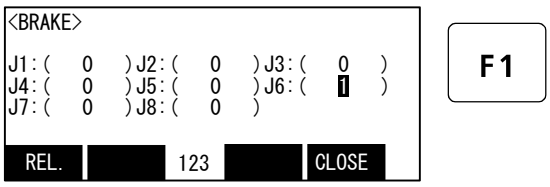


2) Confirm the axis for which the brakes are to be released.

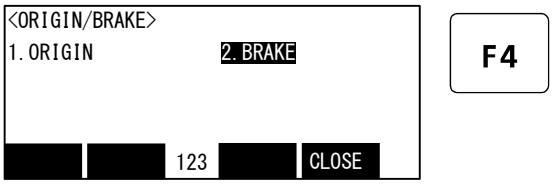
3) Pressing the [F1] key is kept with the enabling switch of T/B pressed down. The brake is released while pressing the key.



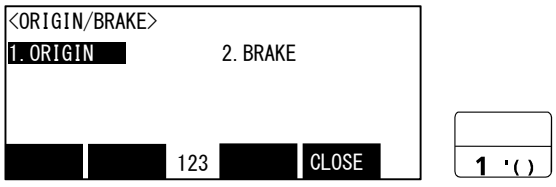
4) Slowly rotate the J6 axis origin setting tool until it touches the M4 × 8 hexagon socket screw on the wrist.



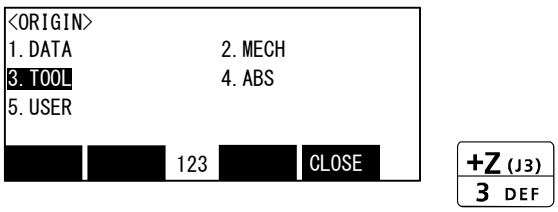
5) Detach the [F1] key and work the brake.



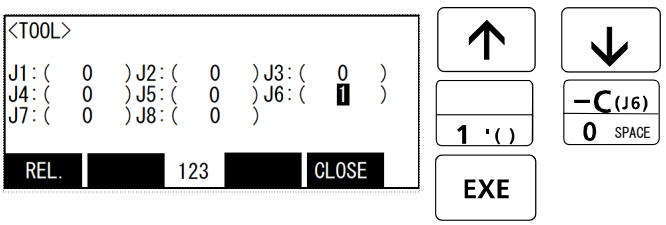
6) Press the [F4] key and return to the origin / brake screen.



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

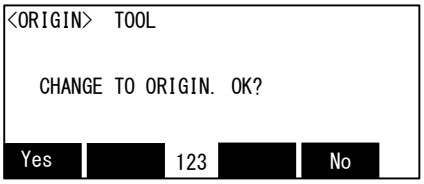


8) Press the [3] key , and display the Tool selection screen.



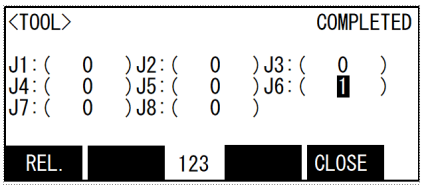
9) Press the [Arrow] key, move the cursor, and set "1" to the J6 axis. Set [0] to other axes.

10) Press the [EXE] key , and display Confirmation screen.



F1

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



12) Setting of the origin is completed.

The origin settings are completed by the jig method.

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.

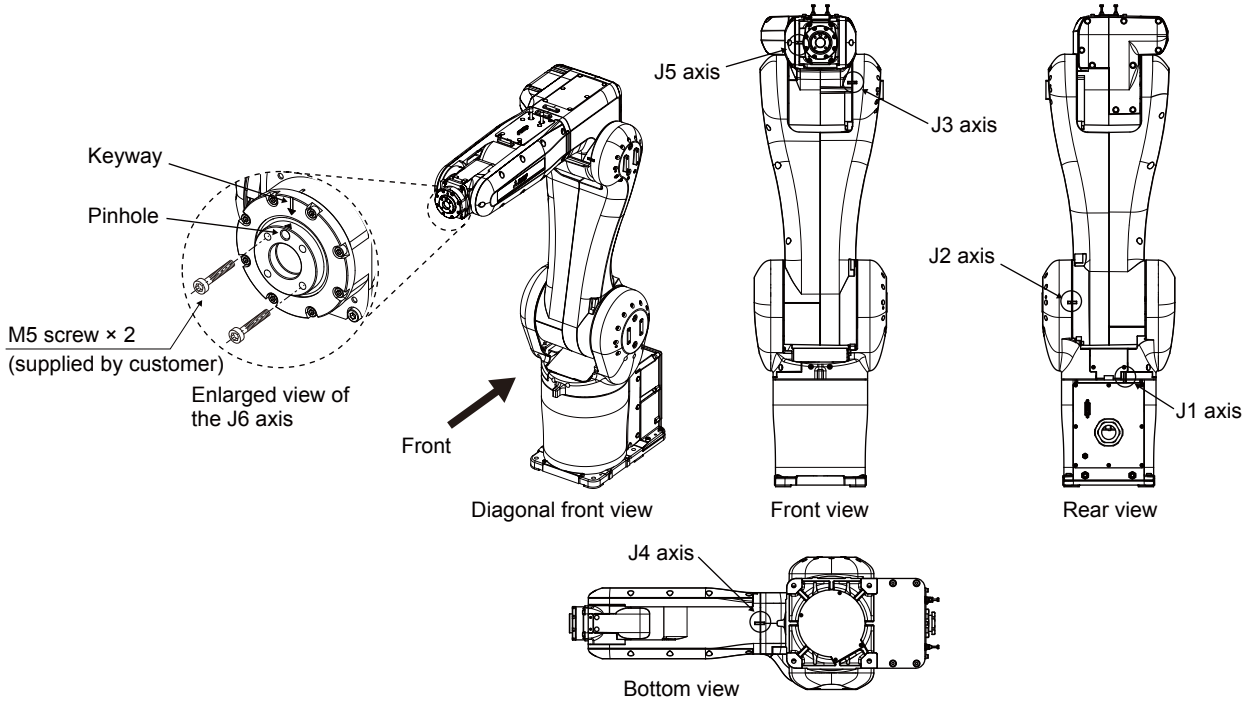
Select the axis of origin setting

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".

5.6.2 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, align the keyways or the pinhole and the keyway of the axes 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 keyways, view the robot from the front. The deviation between the two keyways must be 1 mm or less.
The keyway positions are shown below. Refer to Page 18, "2.3 Confirming the operation" for details on the jog operation.



The angles of each axis which sets up the ABS origin are shown below.

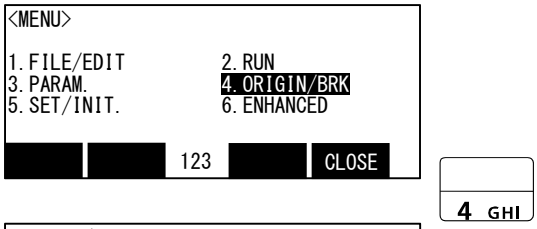
J1 axis	J2 axis	J3 axis	J4 axis	J5 axis	J6 axis
0 degrees	0 degrees	115 degrees	0 degrees	90 degrees	0 degrees

Fig.5-10: Keyway position

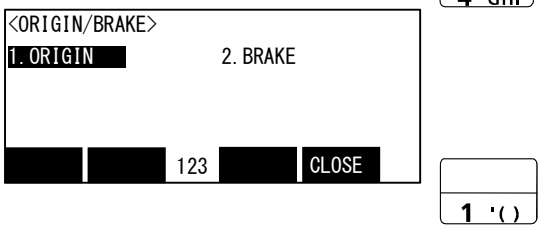
⚠CAUTION When setting the origin of the J6 axis, hold on to the M5 screws and turn the J6 axis slowly. Install the screws diagonally across from each other as shown in the figure above.
The J6 axis does not have a mechanical stopper. Do not rotate the axis manually beyond the operation range (±360°) when setting the origin.
If the pin hole cannot be properly aligned with the keyway, refer to Page 75, "(6) J6 axis origin setting (jig)" and set the origin using that method.

(1) Origin setting procedure

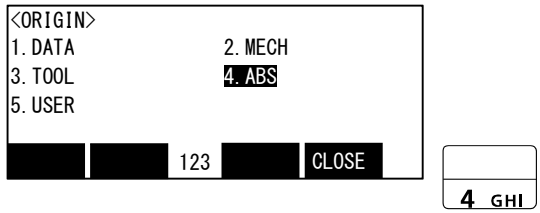
Do the following operations with pressing the enabling switch of T/B lightly.



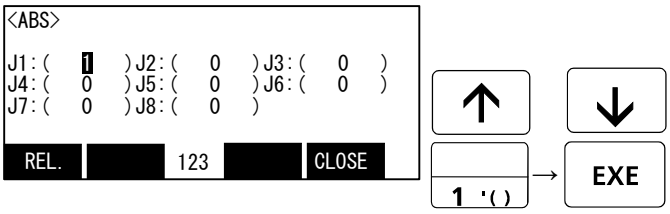
1) Press the [4] key on the menu screen, and display the Origin/Brake selection screen.



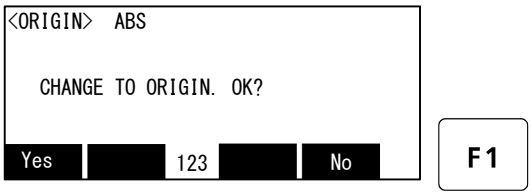
2) Press the [1] key, and display the Origin setting selection screen.



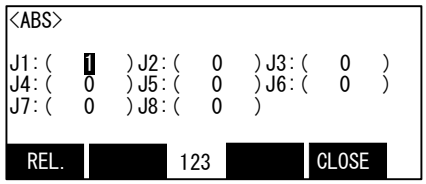
3) Press the [4] key, and display the ABS selection screen.



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.

⚠ 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.

5.6.3 User origin method

⚠CAUTION Before using this method, the origin must be set with the other method.
The setting method is explained in Page 61, "Table 5-11: Origin setting method".

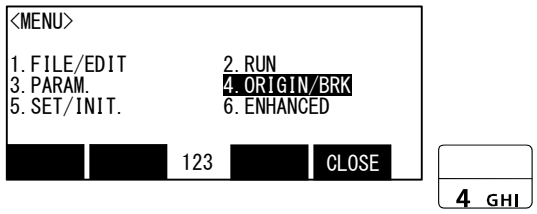
The procedure for setting the origin with the user origin method is explained below.
This operation is carried out with the teaching pendant. Set the [ENABLE] switch on the teaching pendant to "ENABLE" to enable the teaching pendant.
The operation method is shown below.

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

1) Determine the user origin position
Move the robot to the position to be set as the origin with jog operation. Refer to Page 18, "2.3 Confirming the operation" for details on the jog operation.

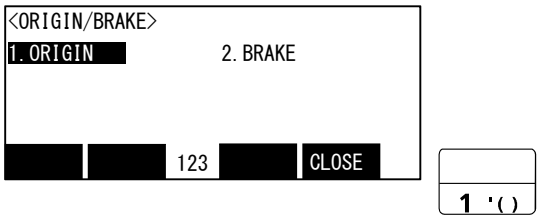
⚠CAUTION Choose the user origin position as the position where it doesn't move by the gravity.
This position is left as a guideline to position all axes with jog operation when setting the origin again with this method.

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.

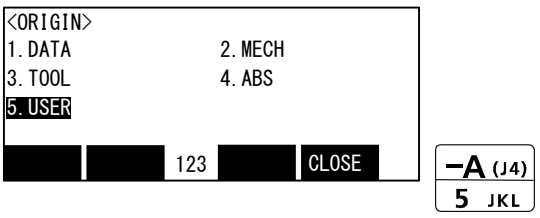


4) Next, set the origin.
Display the menu screen.

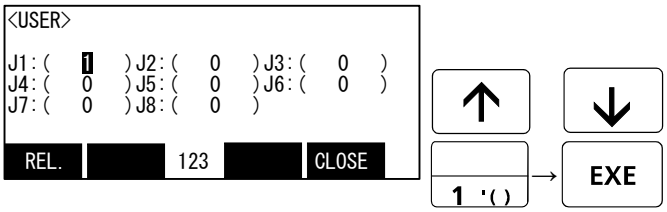
5) Press the [4] key on the menu screen, and display the Origin/Brake selection screen.



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



7) Press the [5] key, and display the User selection screen.



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

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

The origin settings are completed by the user origin method.

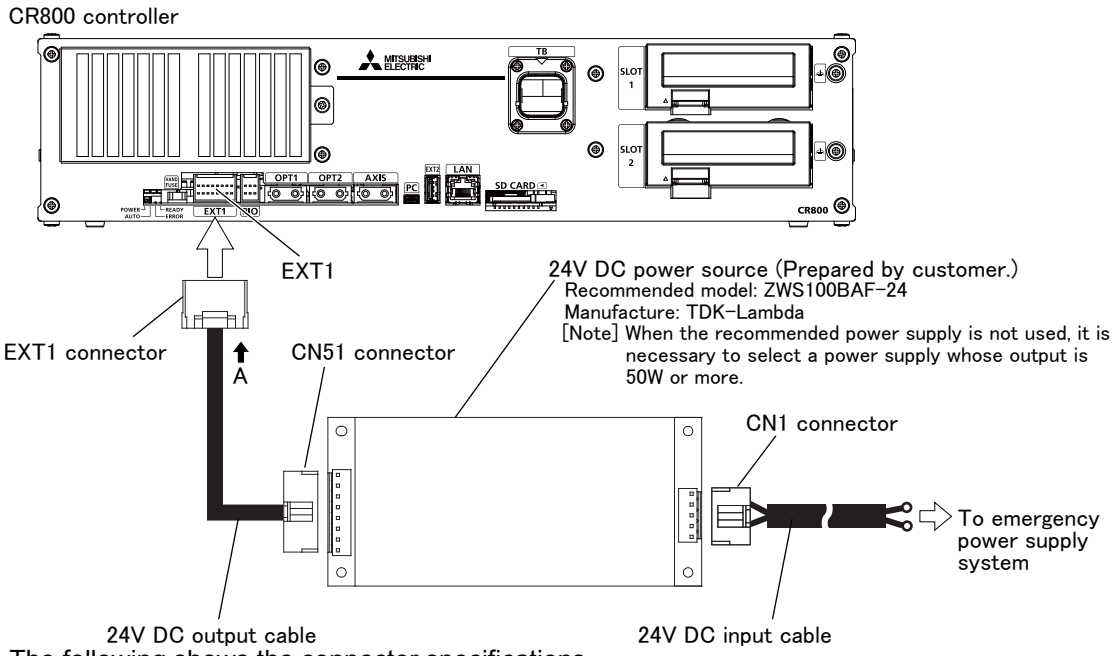
5.7 How to release the brake in an emergency

The following describes how to release the brake using the emergency power supply in an emergency. Using an emergency power supply system separated from the primary power supply of the robot prevents the robot from moving accidentally during the brake release operation, which contributes to enhancing customer safety.

An emergency here means an emergency stop of robot operation, which requires the brake release operation to set the robot in an evacuation posture temporarily.

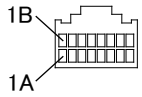
[Note] Do not connect an emergency power supply to multiple robots and release their brakes at the same time.

1) Connect the teaching pendant to the robot controller.
2) Connect the 24V DC power supply to EXT1 of the controller as shown in the figure below.
   To prevent accidental power supply from the primary power supply of the robot, prepare an emergency power supply system separated from the primary power supply of the robot to supply AC power to the 24V DC power supply.



The following shows the connector specifications.

EXT1 connector
Connector: J21DF-16V-KX
Contact: SJ2F-01GF-P1.0
Manufacture: JST



Pin assignment

Pin number	Signal name
8A	24V
8B	
3B	
7A	GND
7B	
3A	

CN51 connector (recommended)
Connector: VHR-8N
Contact: SVH-41T-P1.1
Manufacture: JST

Pin assignment

Pin number	Signal name
1	GND
2	
3	
4	
5	24V
6	
7	
8	

CN1 connector (recommended)
Connector: VHR-5N
Contact: SVH-41T-P1.1
Manufacture: JST

Pin assignment

Pin number	Signal name
1	L
3	N
5	FG

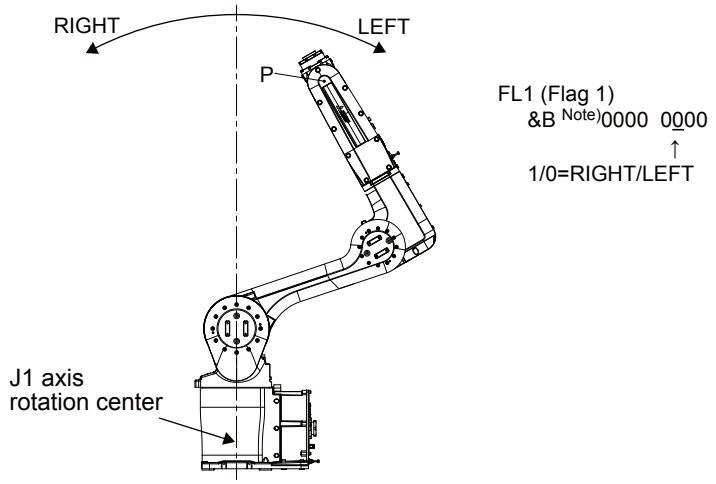
3) When the 24V DC power supply is turned on, the controller starts and then errors (H0712, H0090, H0212) will occur.
4) Release the brake using the teaching pendant.
   For the brake release operation using the teaching pendant, refer to "Explanation of operation methods" in the separate volume, "Instruction Manual/Detailed Explanations of Functions and Operations".

6 Appendix

Appendix 1: Configuration flag

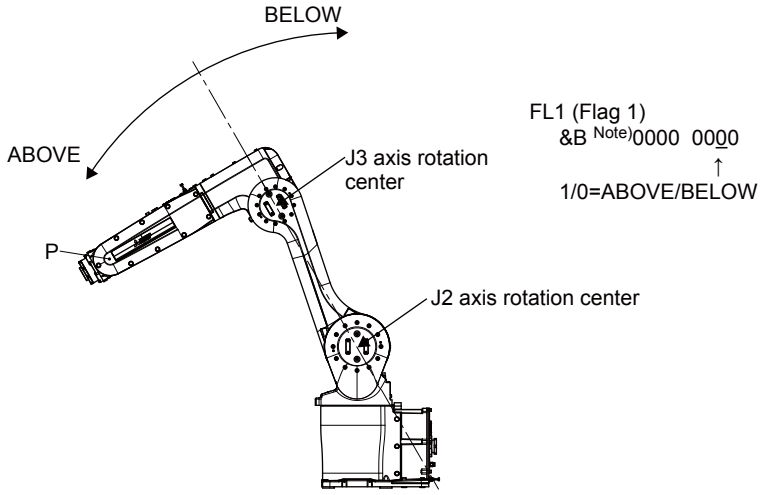
The configuration flag indicates the robot posture.
For the robot, the robot hand end is saved with the position data configured of X, Y, Z, A, B and C. However, even with the same position data, there are several postures that the robot can change to. The posture is expressed by this configuration flag, 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
P is center of J5 axis rotation in comparison with the plane through the J1 axis vertical to the ground.



Note) "&B" is shows the binary
Fig.6-1:Configuration flag (RIGHT/LEFT)

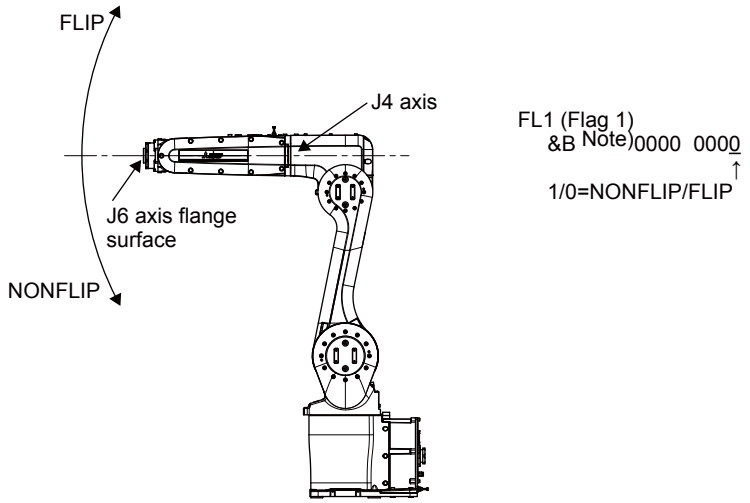
(2) ABOVE/BELOW
P is center of J5 axis rotation in comparison with the plane through both the J3 and the J2 axis.



Note) "&B" is shows the binary
Fig.6-2:Configuration flag (ABOVE/BELOW)

(3) NONFLIP/FLIP

This means in which side the J6 axis is in comparison with the plane through both the J4 and the J5 axis.



Note) "&B" is shows the binary

Fig.6-3:Configuration flag (NONFLIP/FLIP)

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