FANUC Robot ARC Mate 100*i* MODEL B
FANUC Robot M-6*i* MODEL B

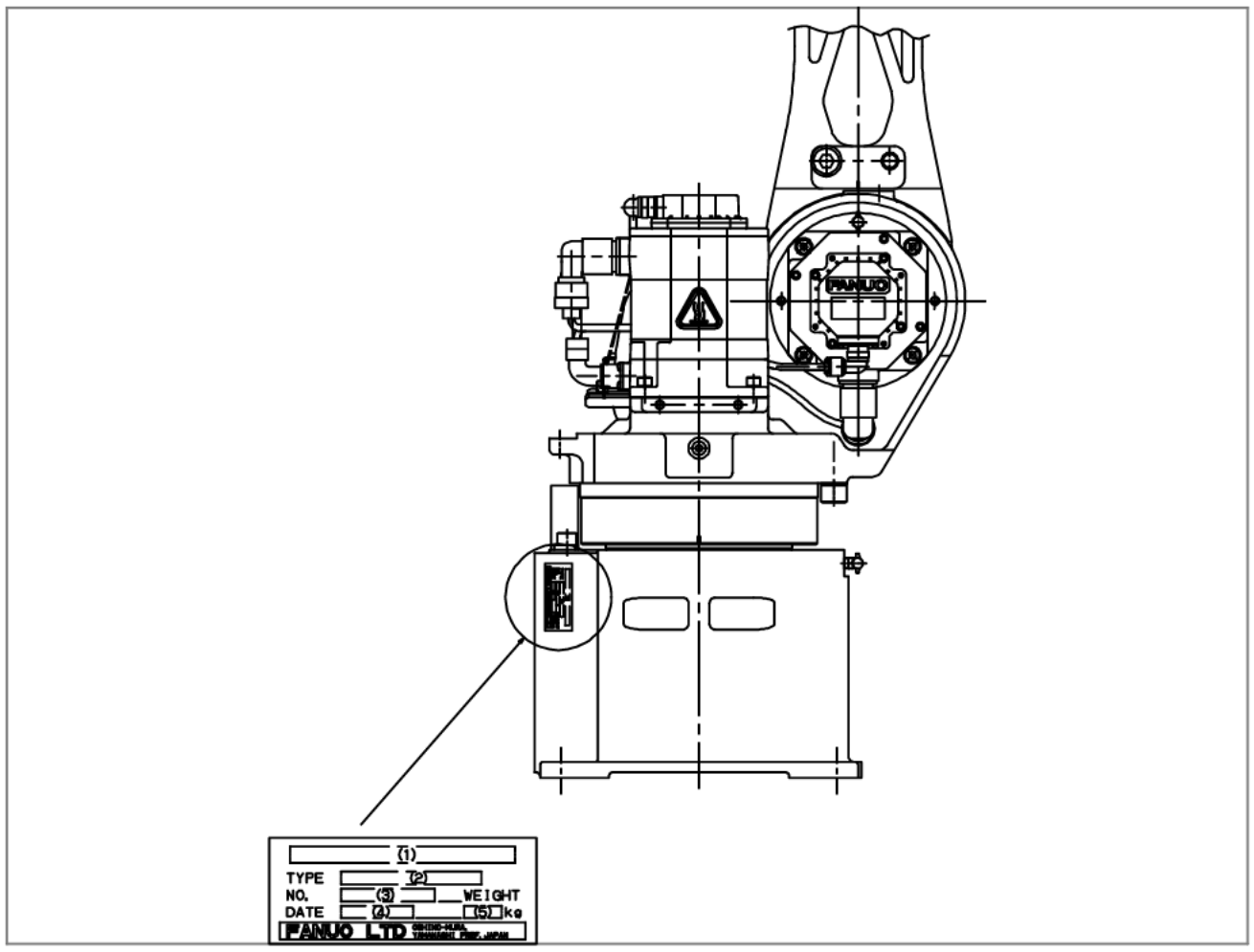
MAINTENANCE MANUAL

B–81545EN/01

PREFACE

This manual explains the maintenance and connection procedures for the mechanical units (R–J3*i* controller) of the following robots. Before replacing the purts, determine the specification number of the mechanical unit.:

Model name	Abbreviation	Mechanical unit specification No.
FANUC Robot ARC Mate 100*i* MODEL B (With J2 and J3–axis brake)	ARC Mate 100*i* MODEL B	A05B–1215–B201
FANUC Robot ARC Mate 100*i* MODEL B (With all axes brake)		A05B–1215–B601
FANUC Robot M–6*i* MODEL B (With J2 and J3–axis brake)	M–6*i* MODEL B	A05B–1215–B202
FANUC Robot M–6*i* MODEL B (With all axes brake)		A05B–1215–B602



No.	(1)	(2)	(3)	(4)	(5)
CONTENTS	MODEL	TYPE	No.	DATE	WEIGHT (Without controller)
LETTERS	FANUC Robot ARC Mate 100*i* MODEL B (2–axis brake)	A05B–1215–B201	PRINT SERIAL NO.	PRINT PRODUCTION YEAR AND MONTH	184 kg
	FANUC Robot ARC Mate 100*i* MODEL B (6–axis brake)	A05B–1215–B601			138 kg
	FANUC Robot M–6*i* MODEL B (2–axis brake)	A05B–1215–B201			184 kg
	FANUC Robot M–6*i* MODEL B (6–axis brake)	A05B–1215–B601			138 kg

Specification

Item		R–2000*i*/165F
Type		Articulated type
Controlled axes		6 axes (J1, J2, J3, J4, J5, J6)
Installation		Floor, Upside–dowm (Wall & Angle mount) (Note 1)
Motion range (Maximum speed)	J1 axis rotation	340° (5.93rad)
	J2 axis rotation	250° (4.36rad)
	J3 axis rotation	315° (5.60rad)
	J4 axis wrist rotation	380° (6.63rad)
	J5 axis wrist swing	280° (4.89rad)
	J6 axis wrist rotation	720° (12.57rad)
Maximum speed	J1 axis	150°/s (2.62rad/s)
	J2 axis	160°/s (2.79rad/s)
	J3 axis	170°/s (2.97rad/s)
	J4 axis	400°/s (6.98rad/s)
	J5 axis	400°/s (6.98rad/s)
	J6 axis	500°/s (8.73rad/s)
Max. load capacity at wrist		6kg
Max. load capacity on J3 catting		12kg
Allowable load moment at wrist	J4 axis	15.7N·m (1.8kgf·m)
	J5 axis	9.8N·m (1.0kgf·m)
	J6 axis	5.9N·m (0.5kgf·m)
Allowable load inertia at wrist	J4 axis	0.63kg·m^2 (6.4kgf·cm·s^2)
	J5 axis	0.22kg·m^2 (2.2kgf·cm·s^2)
	J6 axis	0.061kg·m^2 (0.62kgf·cm·s^2)
Drive method		Electric servo drive by AC servo motor
Repeatability		±0.06mm
Weight of mechanical unit		134kg (2–axis brake type) 138kg (6–axis brake type)
Installation environment		Ambient temperature : 0 – 45°C Ambient humidity : Normally :75%RH or less : Short time 95%RH or less (within 1 month) (No dew or frost allowed) Vibration : 0.5G (4.9m/s^2) or less

NOTE
1 Under the installation condition within ( ), the J1 and J2 axis motion range will be limited.

Dust–proof/waterproof performance of M–6*i* B

	Normal specification
Wrist+J3 arm	IP67
Other part	IP54

NOTE
Definition of IP code
Definition of IP 67
6=Dust–tight
7=Protection from water immersion
Definition of IP 54
5=Dust–protected
4=Protection from splashing water

Performance of resistant chemicals and resistant solvents

(1)(1) The robot (including severe dust/liquid protection model) cannot be used with the following liquids because there is feat that rubber parts (packing, oil seal, O ring etc.) will corrode.
(a) Organic solvcnts
(b) Coolant including chlorine / gasoline
(c) Acid, alkali and liquid causing rust
(d) Other liquids or solutions, that will harm NBR

(2) When the robots work in the environment, using water or liquid, complete draining of J1 base must be done. Incomplete draining of J1 base will make the robot break down.

RELATED MANUALS

For the FANUC Robot series, the following manuals are available:

Safety handbook B–80687EN All persons who use the FANUC Robot and system designer must read and understand thoroughly this handbook		Intended readers : All persons who use FANUC Robot, system designer Topics : Safety items for robot system design, operation, maintenance
R–J3*i* MODEL B controller	Setup and Operations manual SPOT TOOL B–81464EN–1 HANDLING TOOL B–81464EN–2 ARC TOOL B–81464EN–3 SEALING TOOL B–81464EN–4	Intended readers : Operator, programmer, maintenance person, system designer Topics : Robot functions, operations, programming, setup, interfaces, alarms Use : Robot operation, teaching, system design
	Maintenance manual B–81465EN B–81465EN–1 (European specification)	Intended readers : Maintenance person, system designer Topics : Installation, connection to peripheral equipment, maintenance Use : Installation, start–up, connection, maintenance
Mechanical unit	Maintenance manual FANUC Robot ARC Mate 100*i* B M–6*i* B B–81545EN	Intended readers : Maintenance person, system designer Topics : Installation, connection to the controller, maintenance Use : installation, start–up, connection, maintenance

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I. MAINTENANCE

1 CONFIGURATION

Fig. 1 shows the configuration of the mechanical unit.

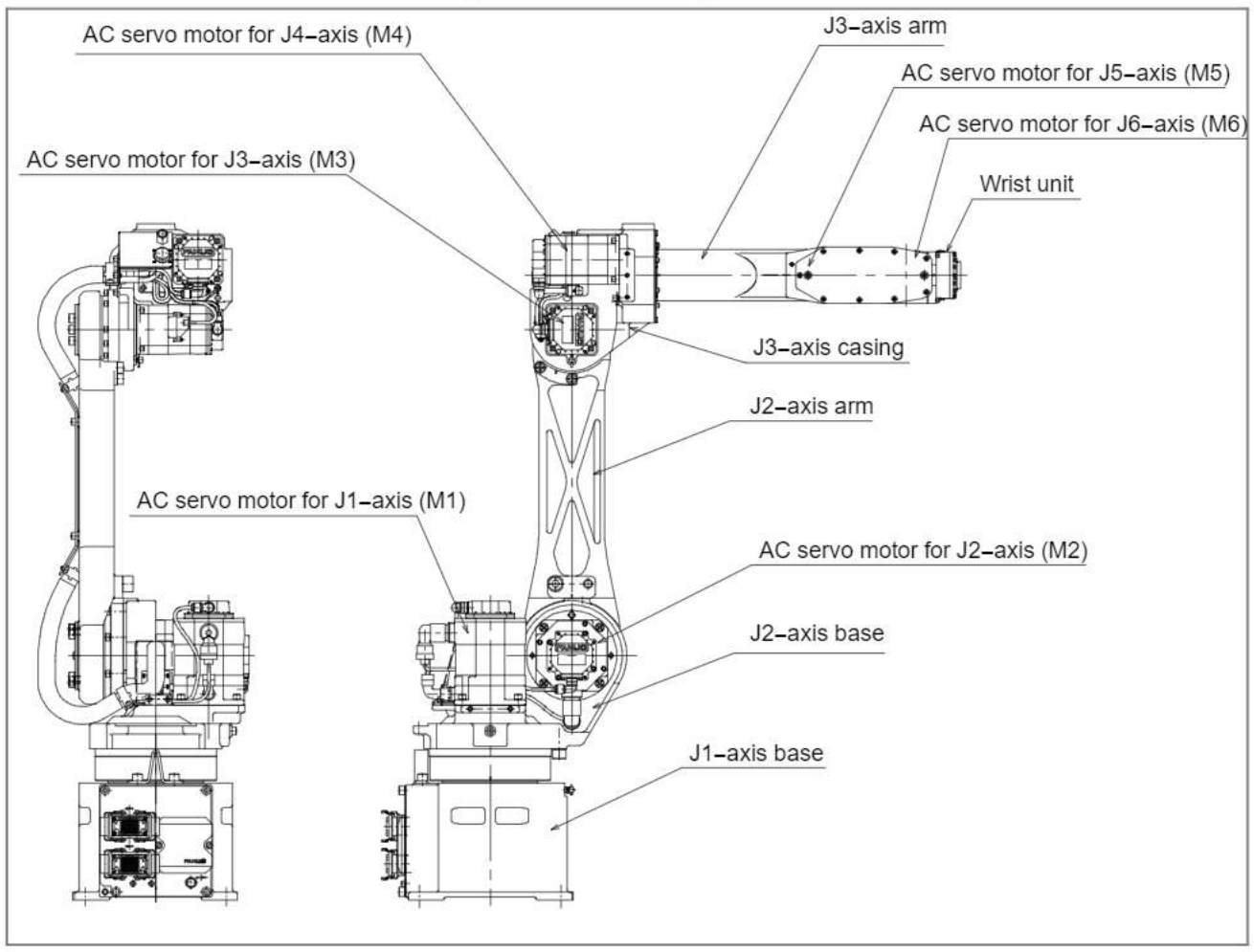


Fig 1 Mechanical unit configuration

1.1 J1–AXIS DRIVE MECHANISM

Fig. 1.1 shows the J1–axis drive mechanism.
The J1–axis drive mechanism is configured in such a way that the J2–axis base is rotated by reducing the rotation speed of an AC servo motor with a reducer.
The J2–axis base is supported on the J1–axis base through the reducer.

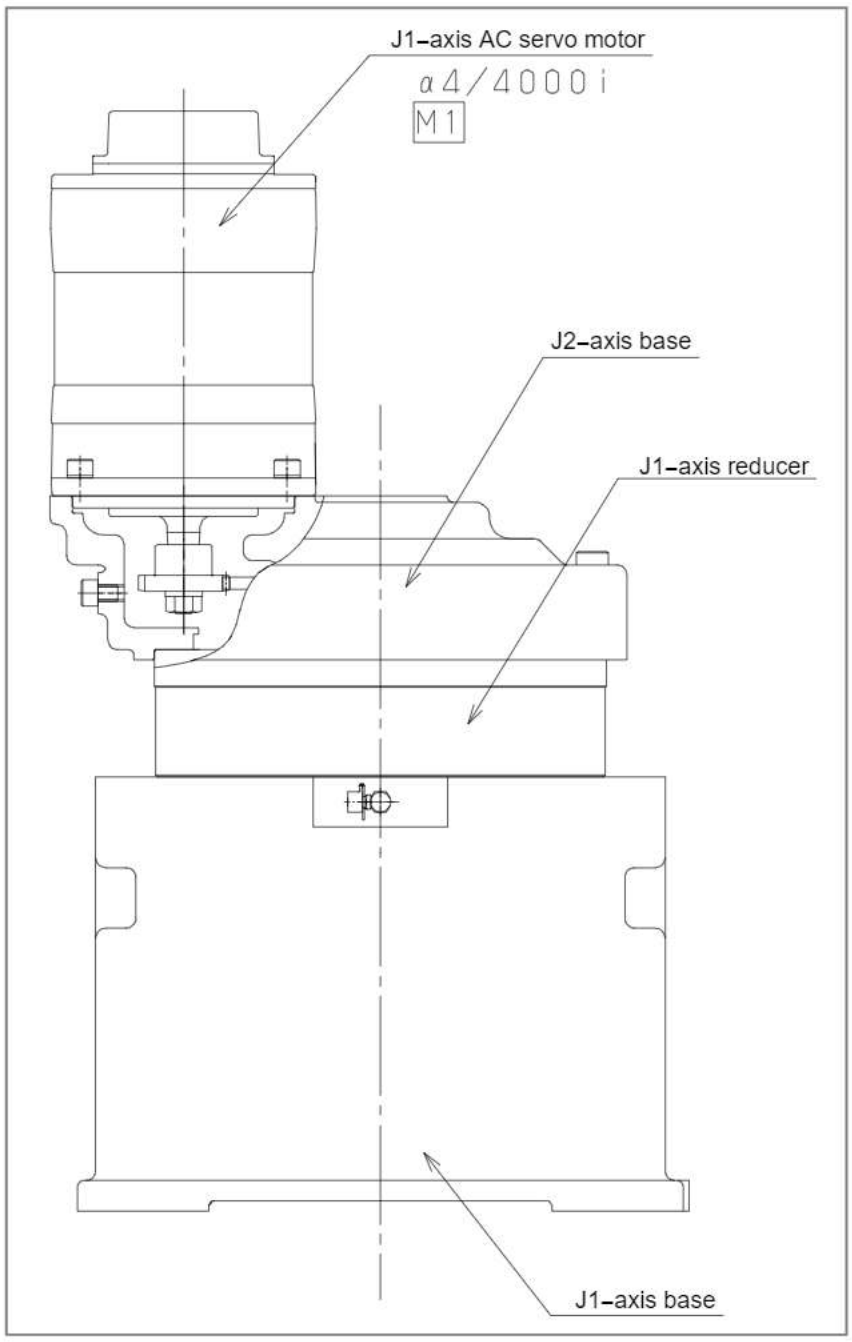


Fig 1.1 J1–axis drive mechanism

1.2 J2–AXIS DRIVE MECHANISM

Fig. 1.2 shows the J2–axis drive mechanism. The J2–axis drive mechanism is configured in such a way that the J2–axis arm is rotated by reducing the rotation speed of an AC servo motor with a reducer.
The J2–axis arm is supported on the J2–axis base through the reducer.

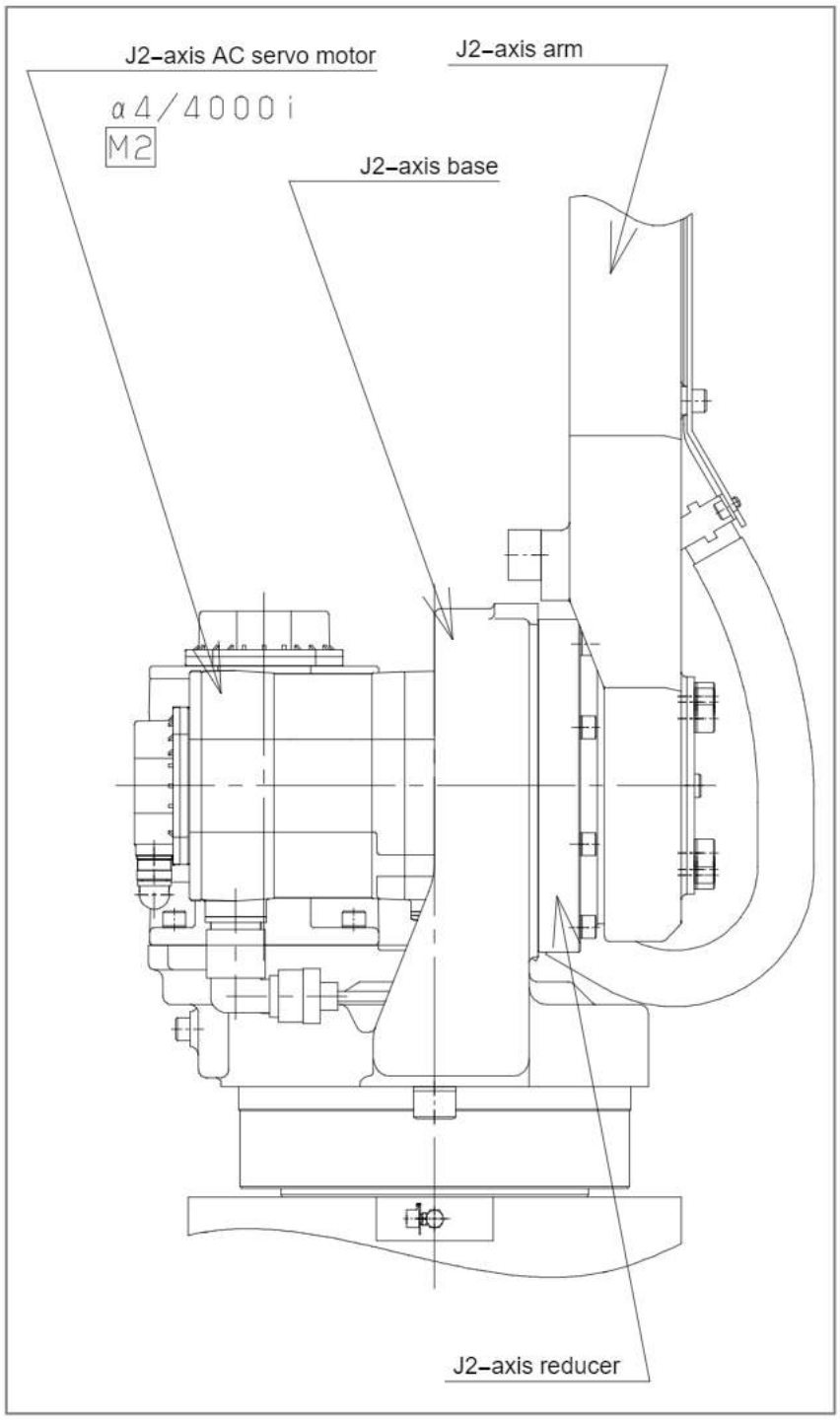


Fig 1.2 J2–axis drive mechanism

1.3 J3–AXIS DRIVE MECHANISM

Fig. 1.3 shows the J3–axis drive mechanism. The J3–axis drive mechanism is configured in such a way that the J3–axis casing is rotated by reducing the rotation speed of an AC servo motor with a reducer. The J3–axis casing is supported on the J2–axis arm through the reducer.

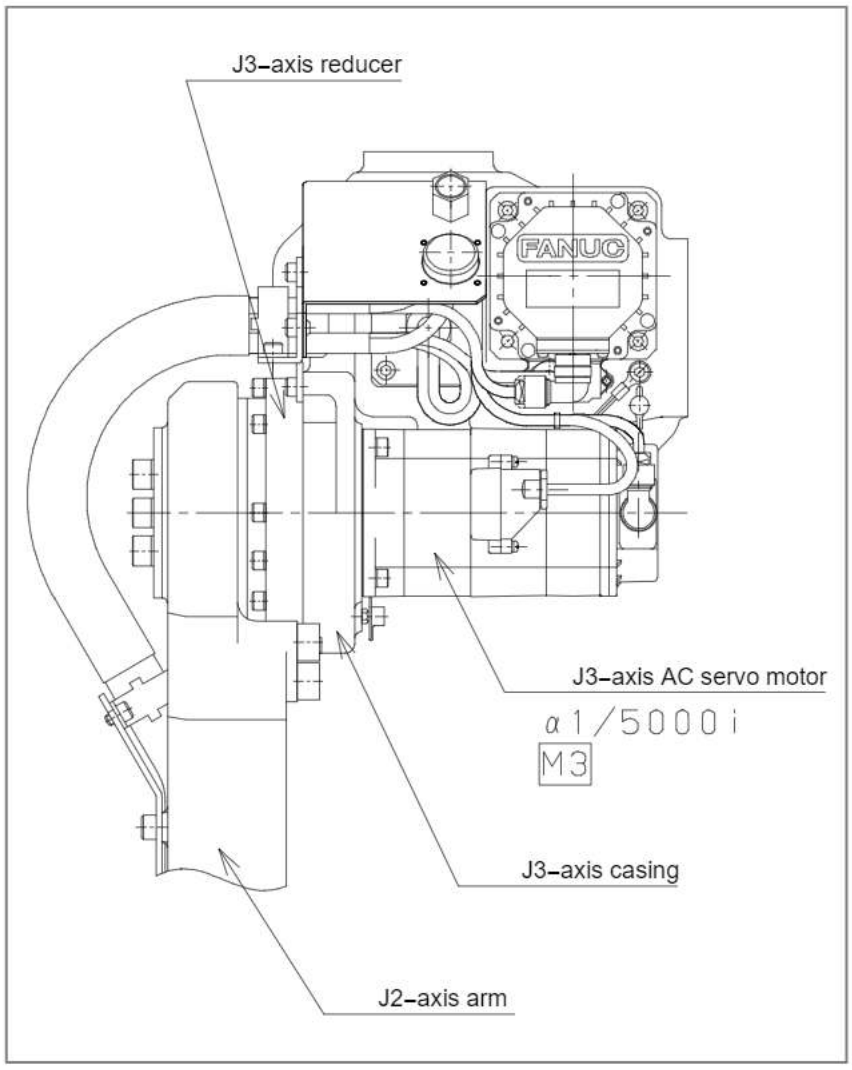


Fig 1.3 J3–axis drive mechanism

1.4 J4–AXIS DRIVE MECHANISM

Fig. 1.4 shows the J4–axis drive mechanism. The J4–axis drive mechanism is configured in such a way that the J3–axis arm is rotated by reducing the rotation speed of an AC servo motor with a two–stage gear.

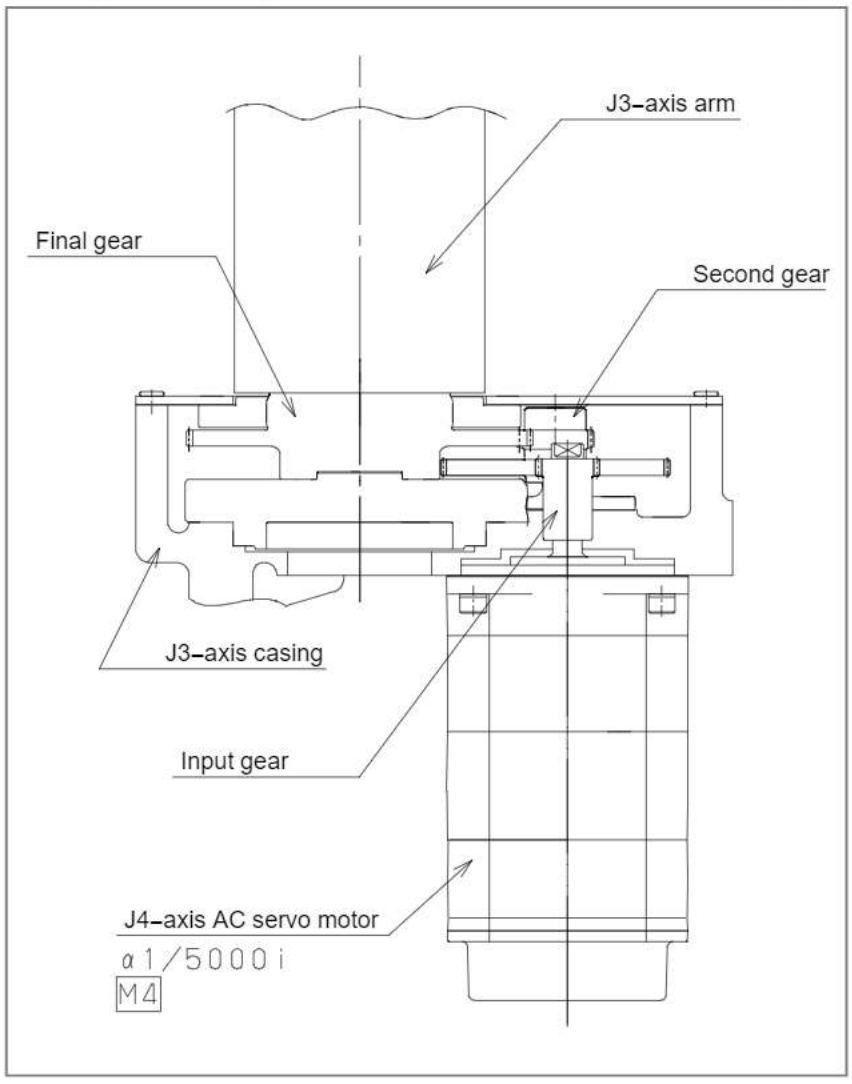


Fig 1.4 J4–axis drive mechanism

1.5 J5– AND J6–AXIS DRIVE MECHANISMS

Fig. 1.5 shows the J5– and J6–axis drive mechanisms. The J5–axis drive mechanism is configured in such a way that the J6–axis unit is rotated by reducing the rotation speed of an AC servo motor with a three–stage gear. The J6–axis drive mechanism is configured in such a way that the output flange is rotated by reducing the rotation speed of an AC servo motor with a reducer.

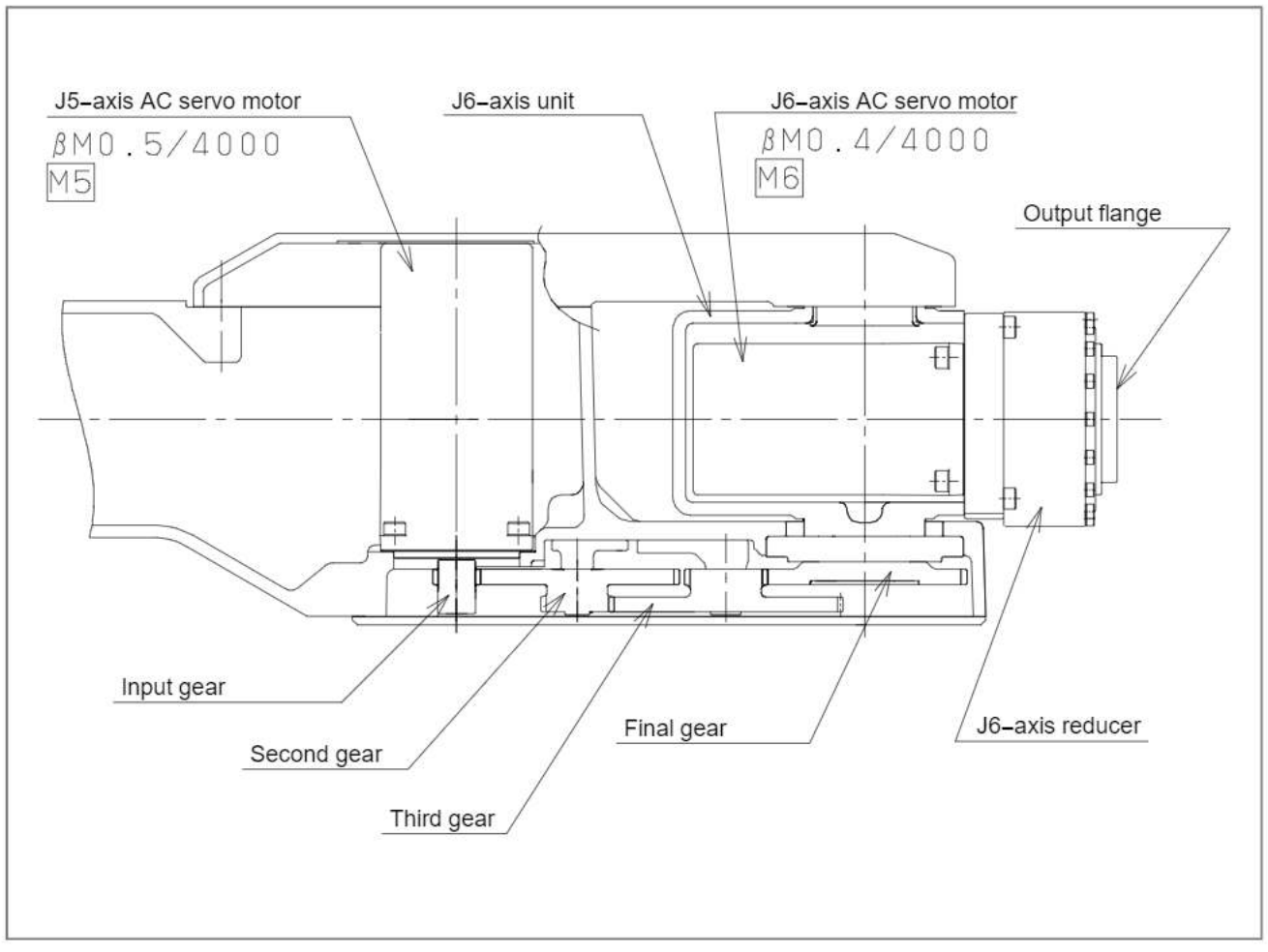


Fig 1.5 J5– and J6–axis drive mechanisms

1.6 SPECIFICATIONS OF THE MAJOR MECHANICAL UNIT COMPONENTS

1) Motors

ARC Mate 100*i* MODEL B
(two–axis, equipped with a brake): A05B–1215–B201
M–6*i* MODEL B
(two–axis, equipped with a brake): A05B–1215–B202

Specification	Axis	Remark
A06B-0223-B005	J1	α 4/4000*i*
A06B-0223-B605	J2	α 4/4000*i* Equipped with a brake
A06B-0202-B605	J3	α 1/5000*i* Equipped with a brake
A06B-0202-B005	J4	α 1/5000*i*
A06B-0115-B075#0008	J5	β M0.5/4000
A06B-0114-B075#0008	J6	β M0.4/4000

ARC Mate 100*i* MODEL B
(six–axis, equipped with a brake): A05B–1215–B601
M–6*i* MODEL B
(six–axis, equipped with a brake): A05B–1215–B602

Specification	Axis	Remark
A06B-0223-B605	J1	α 4/4000*i* Equipped with a brake
A06B-0223-B605	J2	α 4/4000*i* Equipped with a brake
A06B-0202-B605	J3	α 1/5000*i* Equipped with a brake
A06B-0202-B605	J4	α 1/5000*i* Equipped with a brake
A06B-0115-B275#0008	J5	β M0.5/4000 Equipped with a brake
A06B-0114-B275#0008	J6	β M0.4/4000 Equipped with a brake

2) Reducers

Specification	Axis
A97L-0218-0288#33	J1
A97L-0218-0289#153	J2
A97L-0218-0295#161	J3
A97L-0218-0224	J6

3) J4–axis gearbox

Specification	Axis
A05B-1215-K401	J4

4) Gears

Specification	Axis
A290-7215-X511	J5
A290-7215-V501	J5
A290-7215-V502	J5
A290-7215-X514	J5

5) Stoppers

Specification	Axis
A290-7215-X241	J1
A290-7215-X323	J2
A290-7215-X324	J3

Note) 330° stopper

2 PREVENTIVE MAINTENANCE

Performing daily inspection, periodic inspection, and maintenance can keep the performance of robots in a stable state for a long period.

2.1 DAILY INSPECTION

Clean and maintain each component of robots during everyday system operations. At the same time, check the components to see if there is a crack or break in them. Also check and maintain the following items as required.

a) Before automatic operation

No.	Inspection item		Inspection procedure
1	For machines with a three–piece pneumatic option	Pneumatic pressure check	Make a pneumatic pressure check, using the three–piece pneumatic option shown in Fig. 2.1. If the measured pneumatic pressure does not fall in the range between 0.5 and 0.7 MPa (5 and 7 kg/cm^2), make adjustments, using the regulator pressure setting handle.
2		Check on the amount of oil mist	Put the pneumatic pressure system in operation and check the amount of oil dripping. If the measured amount of oil dripping does not meet the rating (one drop/10 to 20 seconds), make adjustments, using the oil adjustment knob. The oiler becomes empty after 10 to 20 days of normal operation.
3		Check on the amount of oil	Check to see if the amount of oil in the three–piece option is within the rated level shown in Fig. 2.1.
4		Check for leakage from the piping	Check to see if a joint or hose leaks. If you find a problem, tighten the joint or replace any defective component.
5	Whether cables are abnormal Mechanical unit		See Chapter 8.
6	Battery voltage check		Make sure that when the power is turned on, the BLAL alarm has not been raised. If the BLAL alarm has been raised, replace the battery as directed in Section 3.3.
7	Whether there is any abnormal vibration, noise, or heat generation in motors		Check that each axis is running smoothly.
8	Whether there is a change to positioning precision		Check to see if there is any displacement from the previous position and there are variations in the stop position.

No.	Inspection item	Inspection procedure
9	Reliable operation of peripheral equipment	Check to see if the machine operates exactly according to directions from the robot and peripheral equipment.
10	Check on the operation of the J2– and J3–axis brakes.	See Section 4.2.

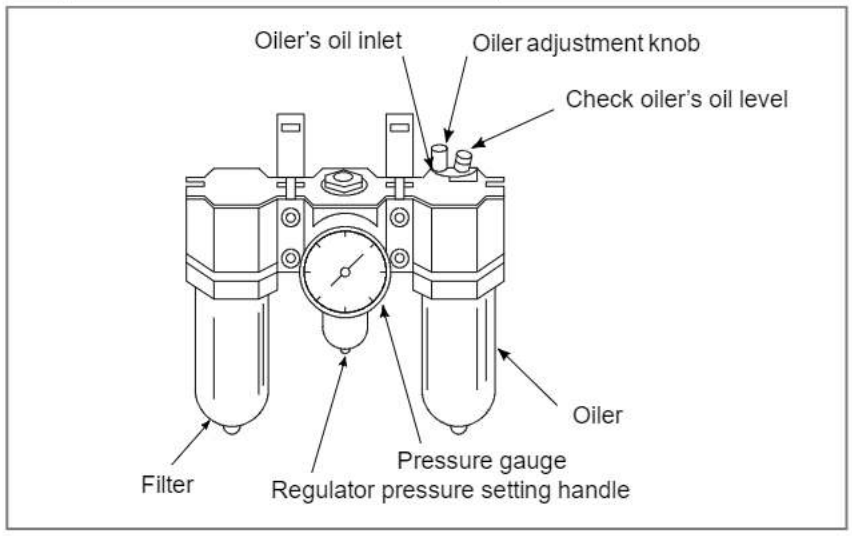


Fig 2.1 Three–piece pneumatic option

b) After automatic operation

Once you are finished with automatic operation, bring the robot to its reference position, and turn it off.

No.	Inspection item	Inspection procedure
1	Component cleaning and inspection	Clean and maintain each component. At the same time, check the components to see if there is a crack or break in them.

2.2 QUARTERLY INSPECTION

Inspect the following items at regular intervals of three months. Increase the locations and the frequency of inspection if the conditions under which the robot is used and the environment in which it runs require so.

No.	Inspection item	Inspection procedure
1	Loose connector	Check that the motor connectors or other connectors are not loose.
2	Loose bolt	Check that the cover retaining bolts or external bolts are not loose.
3	Debris removal	Remove any spatter, debris, and dust from the mechanical unit.

2.3 YEARLY INSPECTION

Inspect the following item at regular intervals of one year.

No.	Inspection item	Inspection procedure
1	Greasing	See Section 3.1.

2.4 ONE– AND HALF–YEAR PERIODIC INSPECTION

Perform the following inspection/maintenance item at regular intervals of one year and half.

No.	Inspection item	Inspection procedure
1	Battery replacement	Replace the battery in the mechanical unit. (See Section 3.3.)

2.5 THREE–YEAR PERIODIC INSPECTION

No.	Inspection item	Inspection procedure
1	Grease replacement	See Section 3.2.

2.6 MAINTENANCE TOOLS

You should have the following instruments and tools ready for maintenance.

a) Measuring instruments

Instrument	Condition	Use
Dial gauge	1/100mm	For positioning precision and backlash measurement
Calipers	150mm	

b) Tools

Phillips screwdrivers (large, medium, and small sizes)
Flat–blade screwdrivers (large, medium, and small sizes)
Box wrenches (M3 to M6)
Allen wrenches (M3 to M16)
Torque wrench
Long T wrenches (M5 and M6)
Adjustable wrenches (medium and small sizes)
Pliers
Long–nose pliers
Cutting pliers
Both–ended wrench
Grease gun
C–ring pliers
Flashlight

3 PERIODIC MAINTENANCE

3.1 GREASING

When greasing the robot, keep its power turned off.

i) Roughly speaking, replenish the robot with grease once a year.

ii) See Fig. 3.1 and Table 3.1 for greasing points and the method.

Table. 3.1 Greasing points

No.	Greasing point	Specified grease	Amount of grease	Greasing method
1	J6–axis reducer	Mori White RE No.00 (Specification: A97L-0040-0119)	40cc	J6–axis grease inlet and outlet, and attach the supplied grease nipple to the grease inlet. After greasing, remove the grease nipple, and attach the flat–head bolts and sealing washers to the grease inlet and outlet.

CAUTION

If you grease incorrectly, the pressure in the grease bath may increase steeply, leading to a broken seal, which will eventually cause grease leakage or malfunction.

When greasing, be sure to follow the cautions stated in Section 3.2.

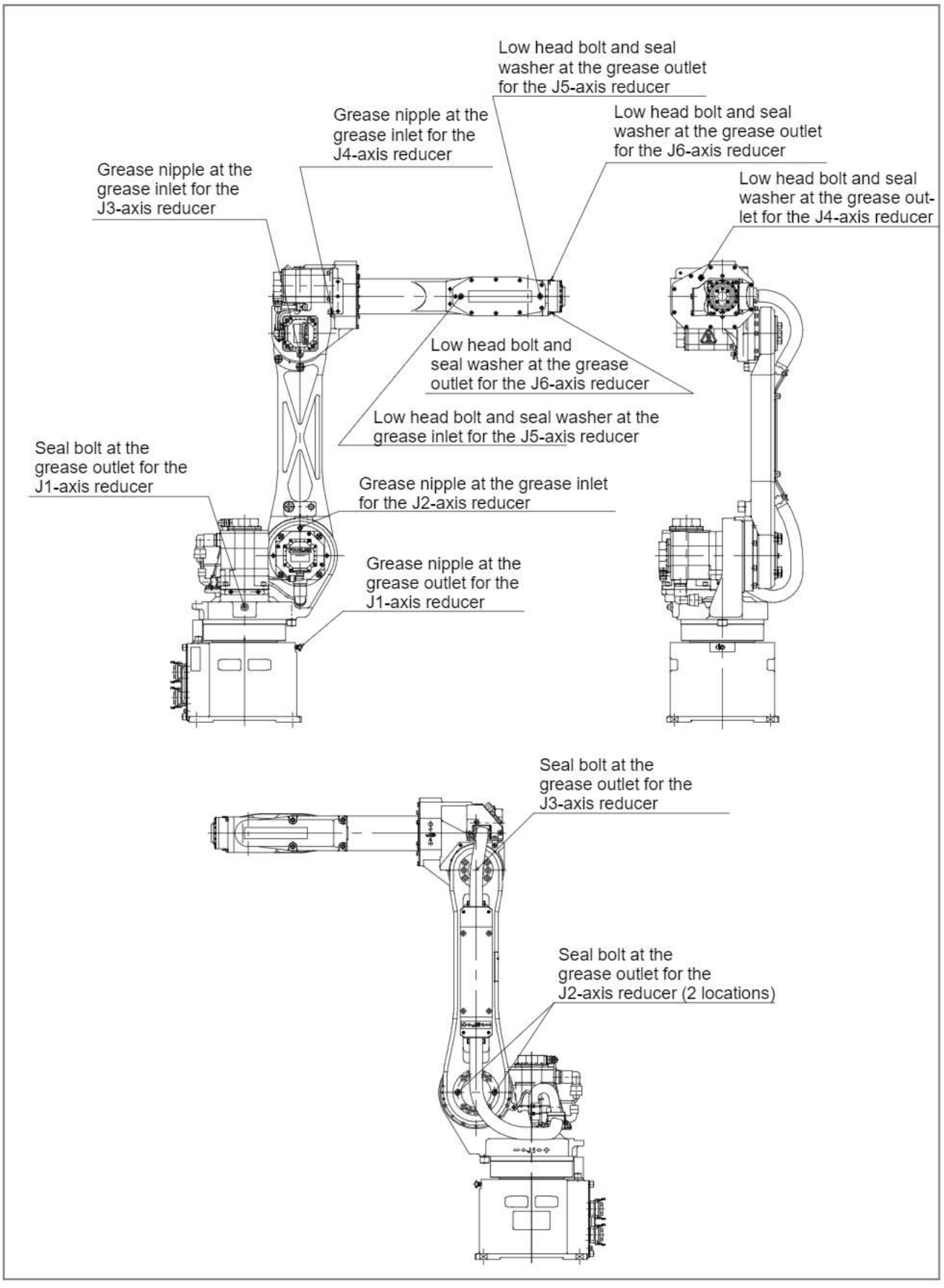


Fig 3.1 Greasing points

3.2 GREASE REPLACEMENT

Follow the procedure stated below to replace the grease in the J1–, J2–, and J3–axis reducers and the J4– and J5–axis gearboxes once every three years or after 11,520 hours of operation. See Fig. 3.1 for greasing points.

1) Remove the seal bolts from the J1–, J2–, and J3–axis grease outlets shown in Fig. 3.1. Also remove the flat–bolts and sealing washers from the J4– and J5–axis grease outlets.
2) Uncap the grease nipples at the J1–, J2–, J3–, and J4–axis grease inlets. Remove the flat–head bolt from the J5–axis grease inlet and attach the supplied grease nipple to the J5–axis grease inlet.
3) Supply the grease specified in Table 3.2 to the J1–, J2–, and J3–axis reducers, and J4– and J5–axis gearboxes through their respective grease nipples. Keep greasing until the new grease pushes out the old grease and comes out from each grease outlet. Ensure that the amount of the newly supplied grease equals the amount of the drained grease so that the grease bath will not become full.
4) Wind sealing tape around the J1–, J2–, and J3–axis seal bolts you removed, and attach them to the respective grease outlets.
5) Attach the J4– and J5–axis flat–head bolts and the J4– and J5–axis sealing washers to the respective grease inlets and outlets.

Table. 3.2 Grease to be replaced at regular intervals of three years

	Specified grease	Amount of grease to be applied (cc)	Robot posture when greased
	Kyodo Yushi		
J1–axis reducer	Mori White RE No.00 (Specification: A98L-0040-0119#2.4KG)	About 1100	–
J2–axis reducer		About 570	–
J3–axis reducer		About 300	–
J4–axis gearbox		About 700	–
J5–axis gearbox		About 400	J4=+90°

CAUTION

If you grease incorrectly, the pressure in the grease bath may increase steeply, leading to a broken seal, which will eventually cause grease leakage or malfunction.

When greasing, be sure to follow the cautions stated below.

1 Before starting greasing, open the grease outlets (remove bolts and the like from the grease outlets).
2 Using a manual greasing pump, grease gently and slowly.
3 Avoid using a pneumatic pump driven from a factory pneumatic line as much as possible.
  If you cannot avoid using it, observe a greasing speed of 15 cc/s or lower and a pressure of 75 kgf/cm^2 or lower.
4 Be sure to use the specified grease. Otherwise, damage to reducers or a similar abnormality may occur.
5 Before capping the grease outlets, make sure that a grease flow from the grease outlet has stopped (the remaining pressure has been released).
6 Wipe off any grease from the floor and robot completely, so no one will slip on it.

When replacing or supplying grease, keep the robot in the posture shown in Fig. 3.2.

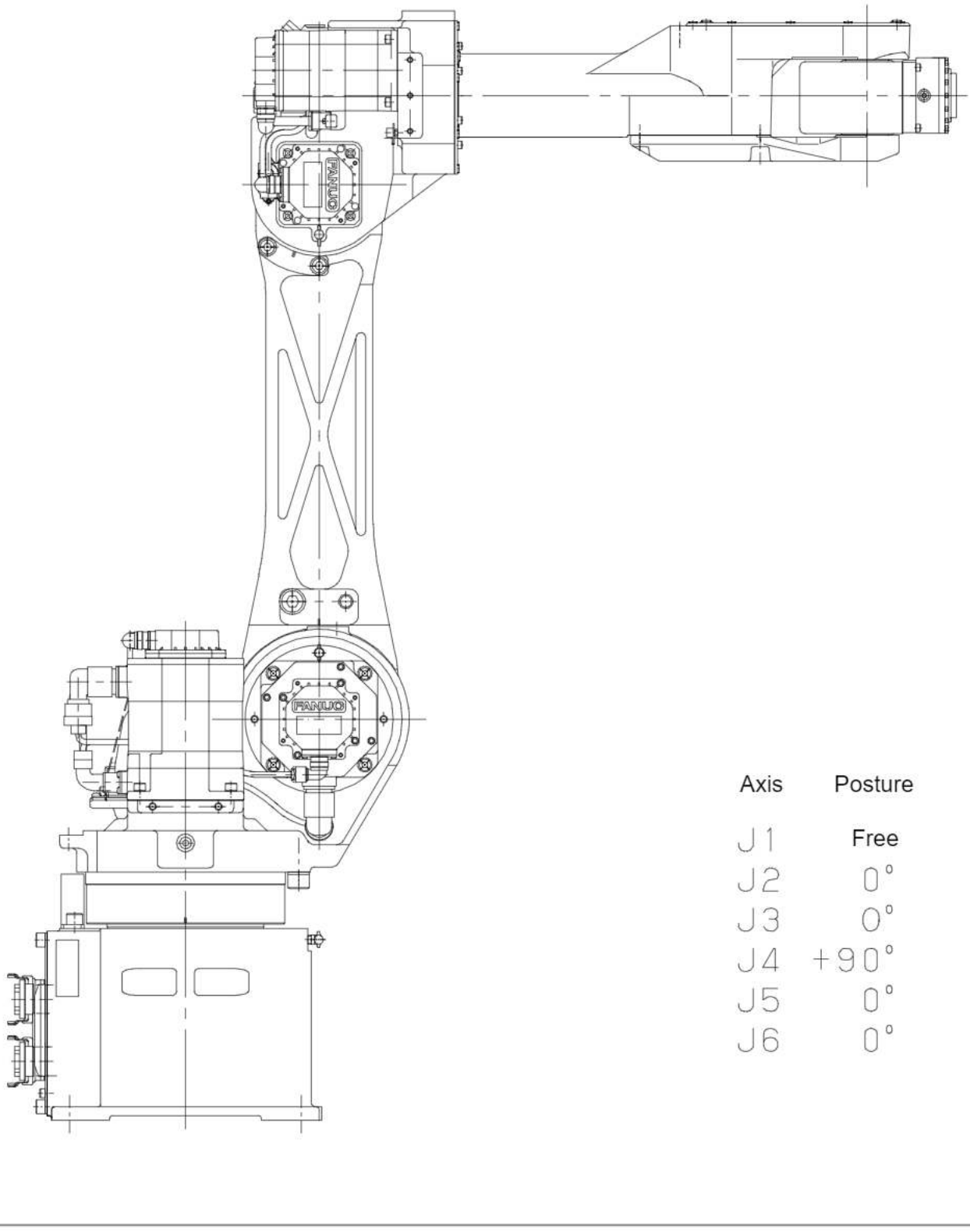


Fig 3.2 Robot posture for greasing

3.3 BATTERY REPLACEMENT

A backup battery is used to keep the reference–position data for each axis of the robot.
The battery needs to be replaced at regular intervals of one year and half.
Follow this procedure for battery replacement.

1) Keep the power turned on.
   Press the EMERGENCY STOP button of the robot to keep it from moving.
2) Uncap the battery case.
3) Take out the battery from the battery case.
4) Insert a new battery into the battery case while paying attention to the polarity of the battery.
5) Cap the battery case.

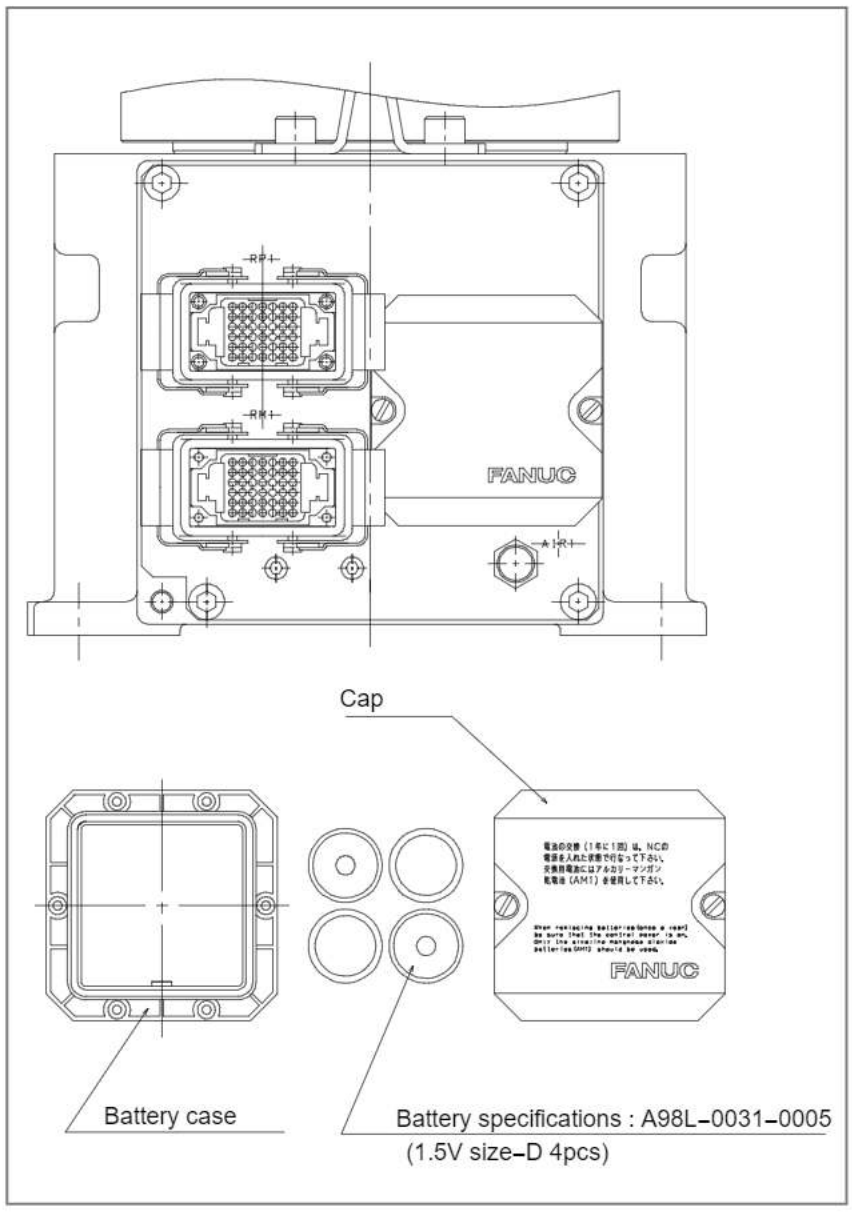


Fig 3.3 Battery replacement

4 TROUBLESHOOTING

4.1 OVERVIEW

A trouble with a mechanical unit may occur due to a combination of multiple causes. It is difficult to find out the true cause, and an incorrect measure may make the trouble worse. When troubleshooting, it is important to get hold of the situation of any error accurately and take a correct measure.

4.2 TROUBLES AND CAUSES

Table 4.2 (a) lists the major troubles in the mechanical unit and their causes. If you cannot find a cause accurately or do not know what measure to take, please contact FANUC.
Note, however, that the backlash and drop levels listed, respectively, in Table 4.2 (b) and Table 4.2 (c) and lower are not abnormal.

Table 4.2 (a) Major troubles and causes (1/3)

Symptom	Cause	Measure	Remark
BZAL alarm issued (battery zero)	The voltage of the memory backup battery has dropped.	Replace the battery, and perform simplified mastering.	See Section 3.3. See Section 5.3.
	Broken pulse coder signal cable	Replace the cable, and perform simplified mastering.	See Section 8.2. See Section 5.3.
Incorrect positioning	Something hit the robot.	Correct the taught point.	
	The robot is not firmly fixed.	Fix it.	See Section 3.2 of Part II, “Connection”.
	Peripheral equipment has shifted.	Fix it.	
	Load too heavy	Reduce the load. Limit the operating condition.	Load on the wrist: Refer to “Descriptions”. Peripheral equipment: See Section 2.2 of Part II, “Connection”.
	Incorrect parameter setting	Correct it.	Refer to “Operator’s Manual”.
	Broken cable	Replace the cable.	See Section 8.2.
	Pulse coder error	Replace the motor.	See Sections 6.1 to 6.11.
	Backlash in the mechanical unit –– see the next section.		

Table 4.2 (a) Major troubles and causes (2/3)

Symptom	Cause	Measure	Remark
Vibration	The robot is not firmly fixed.	Fix it.	See Section 3.2 of Part II, “Connection”.
	The floor is vibrating (especially when the robot is installed on the second floor or above).	Re–examine the location of installation.	
	Load too heavy	Reduce the load. Limit the operating condition	Load on the wrist: Refer to “Descriptions”. Peripheral equipment: See Section 2.2 of Part II, “Connection”.
	Servo maladjustment	Adjust the servo section.	Contact FANUC.
	Broken cable	Replace the cable.	See Section 8.2.
	Robot not grounded	Ground the robot.	Refer to “Maintenance Manual for the Controller”.
	Defective motor	Replace the motor.	See Sections 6.1 to 6.11.
	Defective axis printed–circuit board	Replace the axis printed–circuit board.	Refer to “Maintenance Manual for the Controller”.
	Defective reducer	Replace the reducer.	See Sections 6.2 to 6.11.
	Invalid time constant setting	Change the time constant.	Refer to “Operator’s Manual”.
	Backlash in the mechanical unit –– see the next section.		
Backlash or wobbling	Loose screw or pin	Tighten it (and apply Loctite to it if specified so)	
	Defective reducer	Replace the reducer.	See Sections 6.2 to 6.11.
	Gear maladjustment	Adjust the gear.	See Section 5.7.
	Worn gear	Adjust or replace the gear.	Contact FANUC.
	Worn bearing	Replace the bearing.	Contact FANUC.
	Broken casting or other part	Replace the broken component.	Contact FANUC.
Abnormal sound	Insufficient grease for gear or reducer	Apply grease.	See Sections 3.1 and 3.2.
	Foreign matter in gear or reducer	Wash the gear or reducer and apply grease.	See Sections 6.2 to 6.11, 3.1, and 3.2.
	Gear maladjustment	Adjust the gear.	Contact FANUC.
	Worn gear	Adjust or replace the gear.	Contact FANUC.
	Worn bearing	Replace the bearing.	Contact FANUC.
	Servo section maladjustment	Adjust the servo section.	Contact FANUC.

Table 4.2 (a) Major troubles and causes (3/3)

Symptom	Cause	Measure	Remark
Abnormal heat generation	Insufficient grease for gear or reducer	Apply grease.	See Sections 3.1 and 3.2.
	Non–specified grease used	Replace the grease.	See Sections 3.1 and 3.2.
	Load too heavy	Reduce the load. Limit the operating condition.	Load on the wrist: Refer to “Descriptions”. Peripheral equipment: See Section 2.2 of Part II, “Connection.”
	Gear maladjustment	Adjust the gear.	Contact FANUC.
	Invalid time constant setting	Change the time constant setting.	Refer to “Operator’s Manual”.
Arm drop at power turn–off	Too large a brake gap	Replace the motor.	See Sections 6.1 to 6.11.
	Brake drive relay contact deposition	Replace the relay	Refer to “Maintenance Manual for the Controller”.
Grease leakage	Deteriorated or broken O–ring, oil seal, or gasket	Replace the O–ring, oil seal, or gasket.	Contact FANUC.
	Broken casting or other part	Replace the broken component.	Contact FANUC.
	Loose screw	Tighten it.	

Table 4.2 (b) Allowable backlash level for each axis

	J1	J2	J3	J4	J5	J6
Backlash in term of angle (min)	2.5	2.5	2.5	3.0	4.5	3.0
Backlash in term of displacement (mm)	0.95 (1300)	0.44 (600)	0.44 (600)	0.17 (200)	0.2 (200)	0.17 (200)

NOTE
The backlash in term of displacement (mm) is measured in the direction of rotation at a distance represented with a value enclosed in parentheses.

Table 4.2 (C) Allowable arm drop

At power turn–off time	5mm
At emergency stop time	5mm

4.3 COMPONENT REPLACEMENT AND ADJUSTMENT ITEMS

Adjustments are needed after a component is replaced.
The following table lists components and the adjustment items that must be made after their replacement. After replacing a component, make necessary adjustments according to this table.

Component replacement or function change	Adjustment item
Cable replacement	(a) Cable dressing (b) Simplified mastering
Change to J1–axis stroke	(a) Change to stopper position (b) Change to parameter
Battery replacement (The battery should be replaced once a year.)	Replace the battery with the power kept on. No adjustment is needed.

5 ADJUSTMENTS

Each part of the mechanical units of a robot is set to the best condition before the robot is shipped to the customer. The customer does not need to make adjustments on the robot when it is delivered.
If a mechanical unit of the robot has a large backlash because of a long–term use or component replacement, make adjustments according to this section.

5.1 REFERENCE POSITION AND MOVING RANGE

1) Reference position and operation limit

Each controlled axis is provided with a reference position and operation limit.
A state in which a controlled axis has reached its operation limit is known as overtravel (OT). For each axis, an overtravel condition can be detected at the both ends of it. As long as the robot does not encounter a servo section error or system error that causes a reference position to be lost, the robot is controlled in such a way that it will not go out of its operation area.
Fig. 5.1 (a) to Fig. 5.1 (g) show the reference position and operation area (stroke) of each axis and their mechanical stopper positions.
Fig. 5.1 (h) shows the operation directions (+/– directions) of each axis.

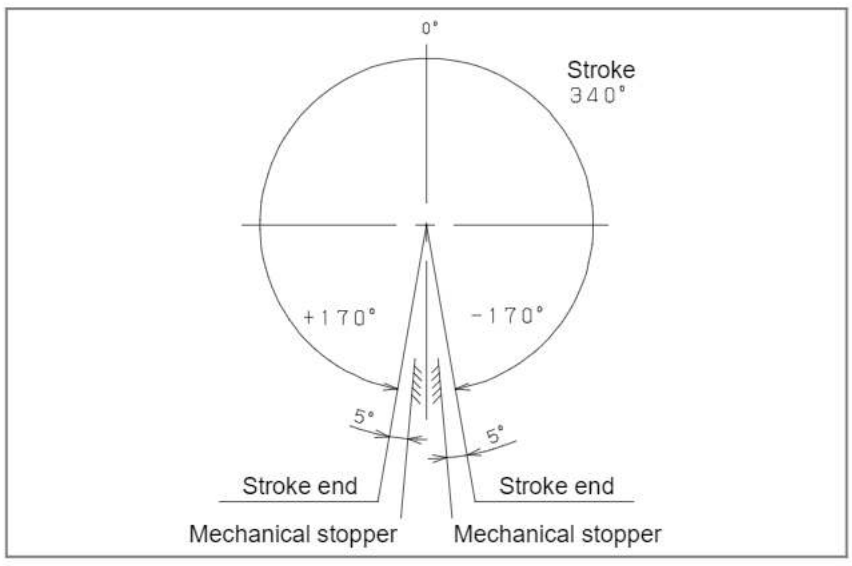


Fig 5.1 (a) J1–axis swiveling (typically 340°)

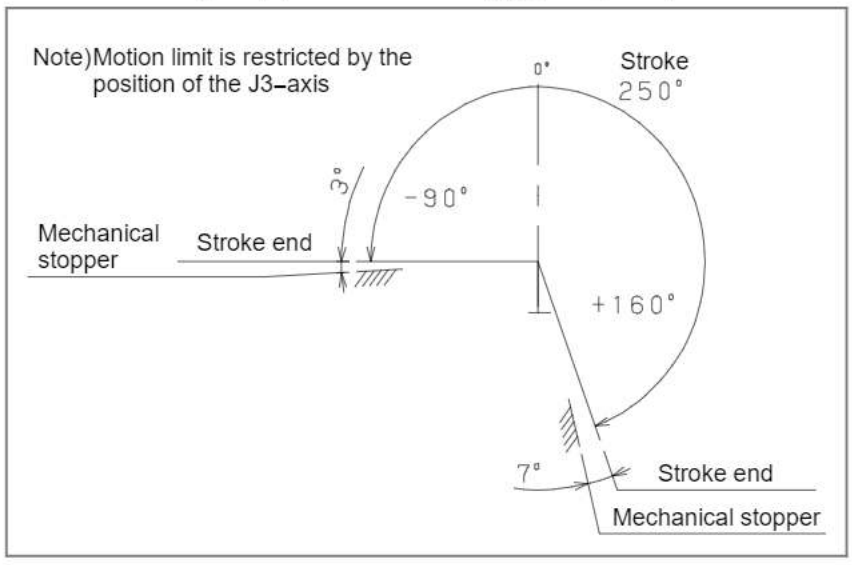


Fig 5.1 (b) J2–axis rotation

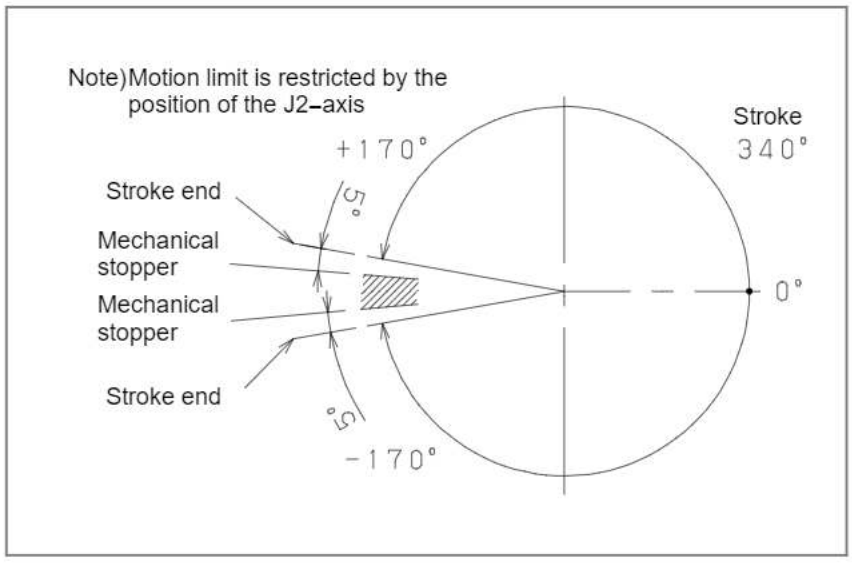


Fig 5.1 (c) J3–axis rotation

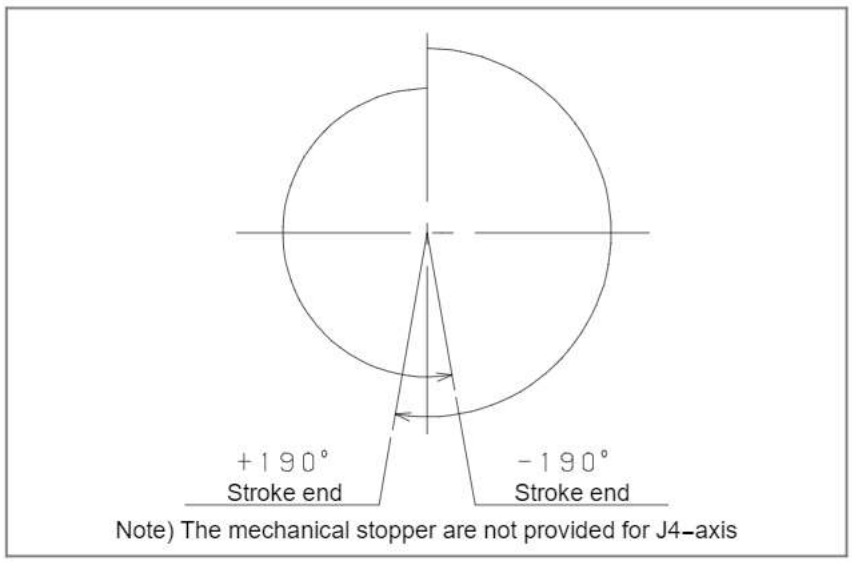


Fig 5.1 (d) J4–axis rotation

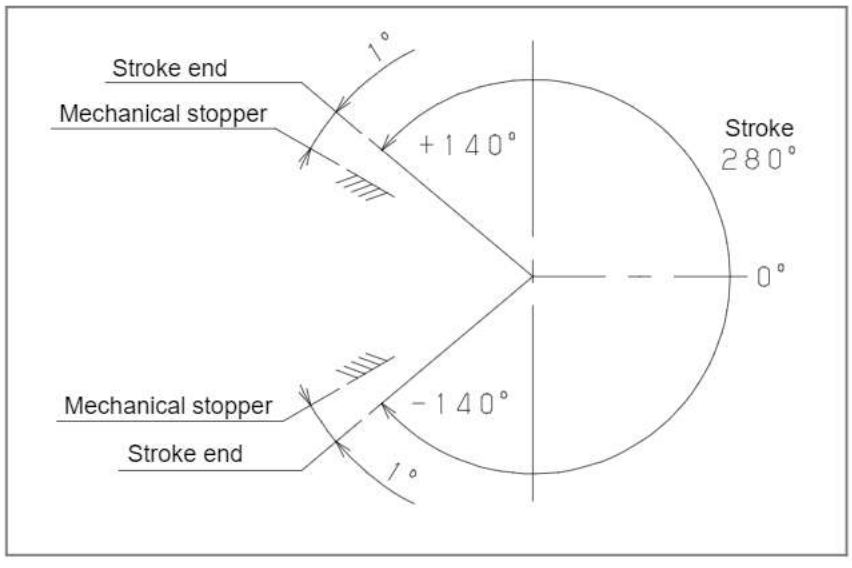


Fig 5.1 (e) J5–axis wrist rotation

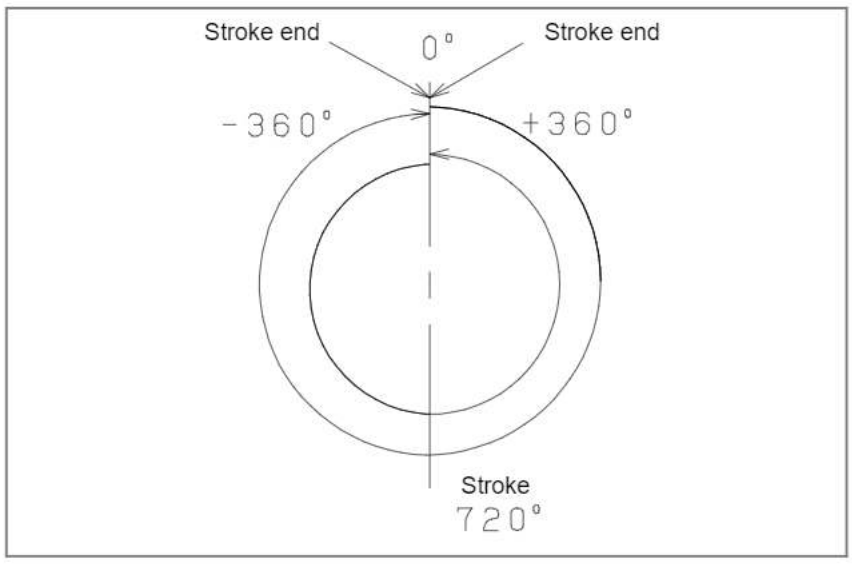


Fig 5.1 (f) J6–axis wrist rotation

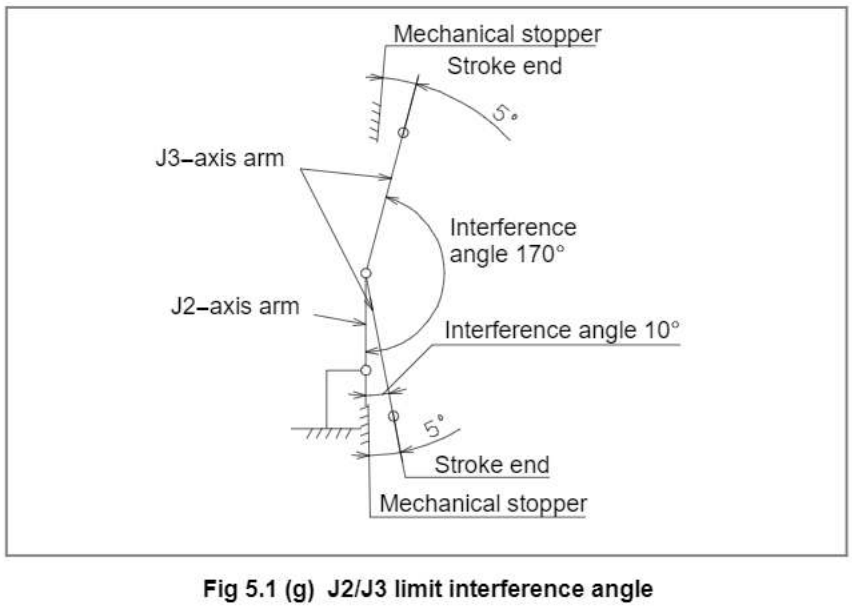


Fig 5.1 (g) J2/J3 limit interference angle

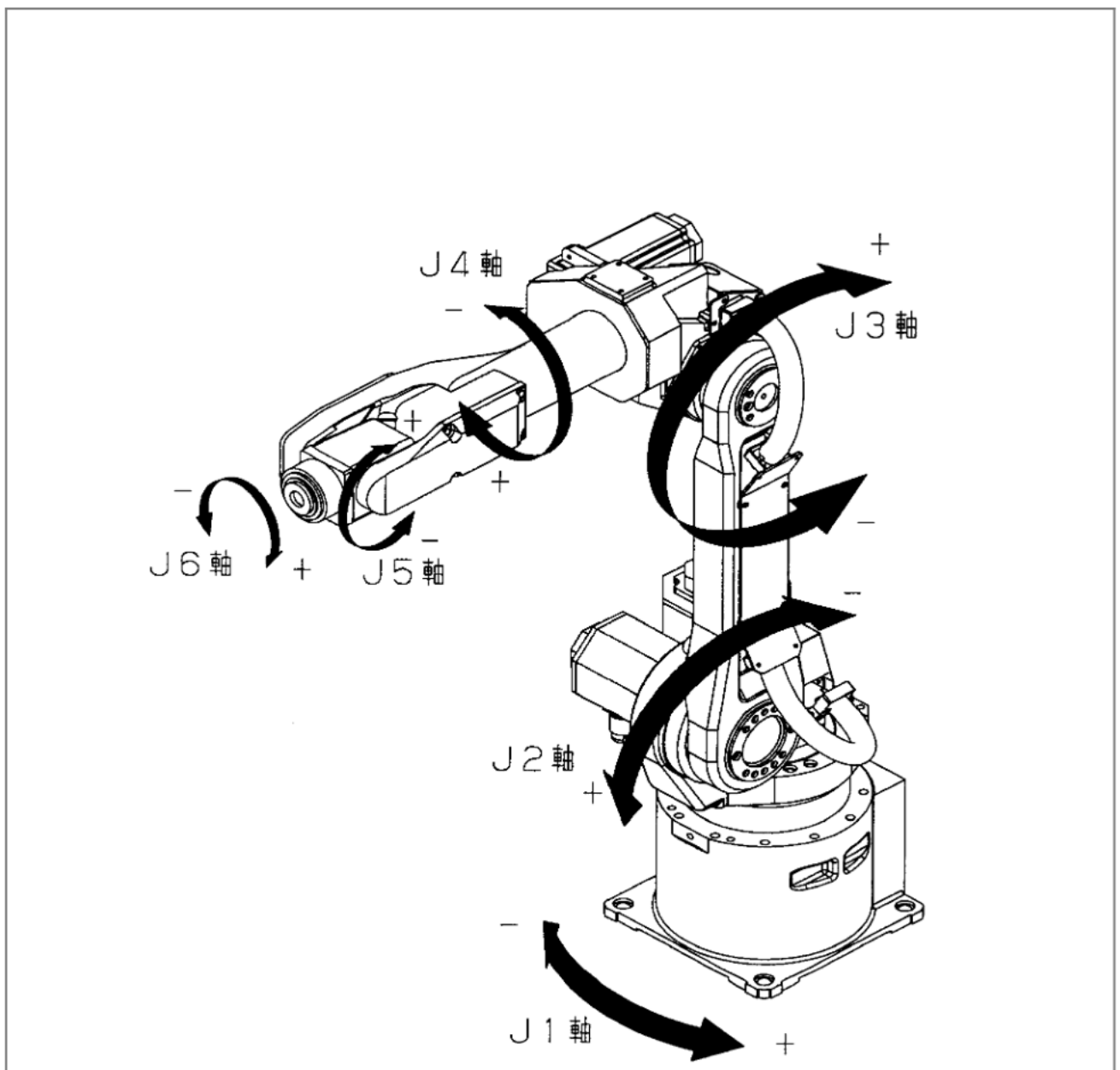


Fig 5.1 (h) Operation directions of each axis

5.2 SIMPLIFIED MASTERING

The term simplified mastering refers to a procedure for resuming the previous position completely after a pulse coder battery backup is disconnected because of cable replacement.
Simplified mastering cannot be used if the pulse coder phase has changed mechanically because of a motor or reducer having been replaced. To calibrate the robot position accurately, perform the jig–based mastering described in Section 5.4.

1) Procedure

Described below is the simplified mastering to be performed with a posture of zero degrees for all axes after cable replacement.

1 Before replacing the cable, be sure to take note of the system variable $DMR_GROUP.$MASTER_COUN[1] to [6] (previous mastering data).
2 Replace the cable according to the cable replacement procedure described in Section 8.2.
3 If you want to release brake control, set the system variable $PARAM_GROUP.$SV_OFF_ENB to FALSE for all axes, turn off the power, and then perform a cold start.
4 After the power is turned on, the alarm message BZAL alarm is displayed. Select “TRUE” for the system variable $MCR.SPC_RESET, turn off the power, and then perform a cold start.
5 After the power is turned on again, the message Pulse not established is displayed. Rotate each axis through 20° or so in either (+ or –) direction, using an individual–axis feed command, and then press the alarm reset key to reset this message.
6 By performing an individual–axis feed command for each axis, set the zero–degree mark within +/–1 mm from the scribed line. (See Fig. 5.2.) If no reference position has been set up at zero degrees for all axes, using simplified mastering, go to 7. Otherwise, go to 8.
7 Assign the mastering data in $DMR_GROUP.$MASTER_COUN[1] to [6] that was taken note of at 1 to the system variable $DMR_GROUP.$REF_CONUT[1] to [6] (simplified mastering data). Load the system variable $DMR_GROUP.$REF_POS[1] to [6] (simplified mastering reference positions) with “0”. Select “TRUE” for the $DMR_GROUP.$REF_DONE (simplified mastering completion flag). Now the simplified mastering reference position has been set up at zero degrees for all axes.
8 Press the screen selection key to select “0” NEXT, and select SYSTEM from the menu.
9 Press the F1 key TYPE, select the system variable, and set $MASTER_ENB value in the list to 1. Press the F1 key TYPE and select MASTER / CAL.
10 Select The system calibration menu from the system positioning menu, and press the FA key YES to perform simplified mastering. Now the mastering data obtained from the pulse coder counter value is set in the system variable $DMR_GRP.MASTER_COUN, and the system variable $DMR_GRP.MASTER_DONE (mastering completion flag) is set to “TRUE”.

11 Select CALIBRATE from the system positioning menu, and press the F4 key YES Now positioning is carried out, and teaching and replaying are enabled.
12 After you are finished with mastering, reset the system variable $MASTER_ENB to 0.
13 If you released brake control before, re–set the system variable $PARAM_GROUP.$SV_OFF_ENB for each axis to the previous value, turn off the power, and then perform a cold start.

Once mastering is completed, update the data sheet supplied together with the robot with the new mastering data ($DMR_GROUP.$MASTER_COUN[1] to [6]).

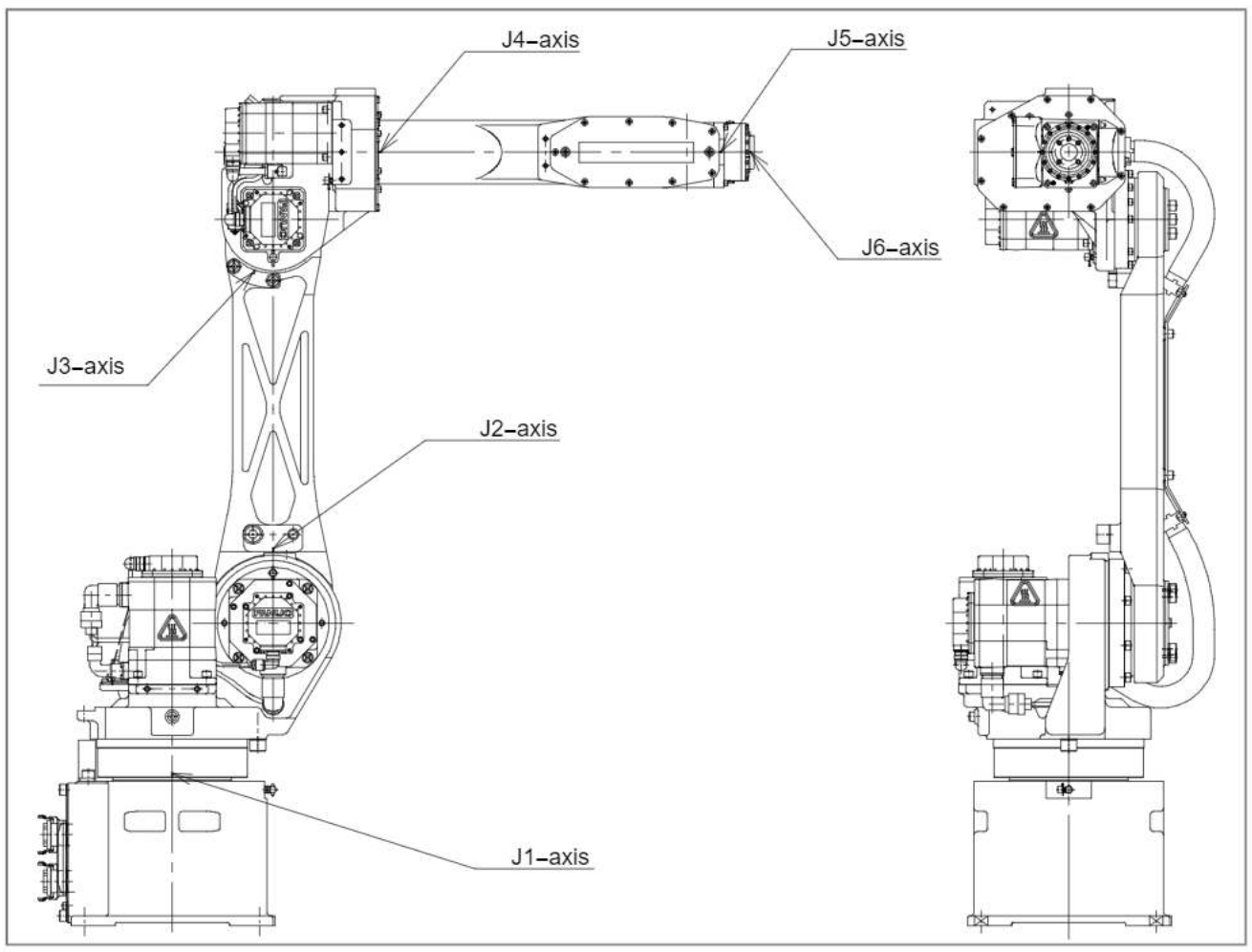


Fig 5.2 Marking of the zero–degree position for each axis

5.3 MASTERING BY ZERO POSITION MARK ALIGNMENT

Each robot axis is provided with the scribed lines shown in Fig. 5.2 for positioning. When these markings are aligned to each other, each axis is at the zero–degree position. If the markings get misaligned because of motor or reducer replacement, the following procedure can be used for rough positional calibration. This is a simplified method. To perform accurate positional calibration, use the jig–based mastering described in Section 5.4.

1) Procedure (zero–position mastering)
   1 If you want to release brake control, set the system variable $PARAM_GROUP.$SV_OFF_ENB to “FALSE” for all axes, turn off the power, and then perform a cold start.
   2 After the power is turned on, if the alarm message BZAL alarm is displayed, select “TRUE” for the system variable $MCR.SPC_ RESET, turn off the power, and then perform a cold start.
   3 After the power is turned on again, if the message Pulse not established is displayed, rotate each axis through 20° or so in either (+ or –) direction, using an individual–axis feed command, and then press the alarm reset key to reset this message.
   4 By performing an individual–axis feed command for each axis, set each axis to the zero–degree mark. (See Fig. 5.2.)
   5 Press the screen selection key to select “0” NEXT, and select SYSTEM from the menu.
   6 Press the F1 key TYPE, select the system variable, and set $MASTER_ENB value in the list to 1. Press the F1 key TYPE and select MASTER/CAL.
   7 Select ZERO POSITION MASTER from the system positioning menu, and press the F4 key YES to perform zero–position mastering. Now the system variable $DMR_GRP.MASTER_ COUN is set with the mastering data obtained from the pulse coder counter value, and the system variable $DMR_GRP.MASTER_ DONE (mastering completion flag) is set to “TRUE”.
   8 Select MASTER/CAL from the system positioning menu, and press the F4 key YES. Now positioning is carried out, and teaching and replaying are enabled.
   9 After you are finished with mastering, reset the system variable $MASTER_ENB to 0.
   10 If you released brake control before, re–set the system variable $PARAM_GROUP.$SV_OFF_ENB to the previous value for all axes, turn off the power, and then perform a cold start.

Once mastering is completed, update the data sheet supplied together with the robot with the new mastering data ($DMR_GROUP.$MASTER_ COUN[1] to [6]).

If you want to perform mastering for a specific axis, use the following single–axis mastering procedure. New position information for that axis is stored, and position information for the other axes is preserved.
As for the J2– and J3–axes, each of which is accompanied by the other, perform mastering for them simultaneously.

2) Procedure (single–axis mastering)

1 If you want to release brake control, set the system variable $PARAM_GROUP.$SV_OFF_ENB to “FALSE” for all axes, turn off the power, and then perform a cold start.

2 After the power is turned on, if the alarm message BZAL alarm is displayed, select “TRUE” for the system variable $MCR.SPC_ RESET, turn off the power, and then perform a cold start.

3 After the power is turned on again, if the message Pulse not established is displayed, rotate each axis through 20° or so in either (+ or –) direction, using an individual–axis feed command, and then press the alarm reset key to reset this message.

4 By performing an individual–axis feed command for a desired axis, set the axis to the zero–degree mark. (See Fig. 5.2.)

5 Press the screen selection key, select “0” NEXT, and select SYSTEM from the menu.

6 Press the F1 key TYPE, select the system variable, and set $MASTER_ENB value in the list to 1. Press the F1 key TYPE, and select MASTER/CAL.

7 Select SINGLE AXIS MASTER from the system positioning menu. A setting menu for each axis appears. Enter “1” in the (SEL) column for the axis for which you want to perform mastering. Enter “0” for the other axes. Enter “0” (zero degrees) in the MASTERING POSITION column, and press the F5 key EXEC to perform zero–degree position mastering for the selected axis.

8 Select MASTER/CAL from the system positioning menu, and press the F4 key YES. Now positioning is carried out, and teaching and replaying are enabled.

9 After you are finished with mastering, reset the system variable $MASTER_ENB to 0.

10 If you released brake control before, re–set the system variable $PARAM_GROUP.$SV_OFF_ENB to the previous value for all axes, turn off the power, and then perform a cold start.

Once mastering is completed, update the data sheet supplied together with the robot with the new mastering data ($DMR_GROUP.$MASTER_ COUN[1] to [6]).

5.4 JIG–BASED MASTERING

If the current–position value stored through the pulse coder becomes different from the actual position of each axis because a major component of the mechanical unit of the robot is replaced, mastering is performed by specifying the geometric position of the robot. (Mastering is performed at a position of J1 = 0(.) For all robots, mastering is performed at the factory.

When calibrating the robot, have it satisfy the following conditions.

- Δ Level out the installation base for the robot (1 mm/base).
- Δ Remove the hand and all other components from the wrist.
- Δ Keep the robot from any external force.

NOTE
When the robot is being subjected to mastering, it does not make a stroke check. Pay sufficient attention to the operation of the robot axes.

1) Mastering procedure
   a) Assembling mastering jigs
      i) Assembling the jig base
      As shown in Fig. 5.4 (a), attach mastering jig B to mastering jig C.

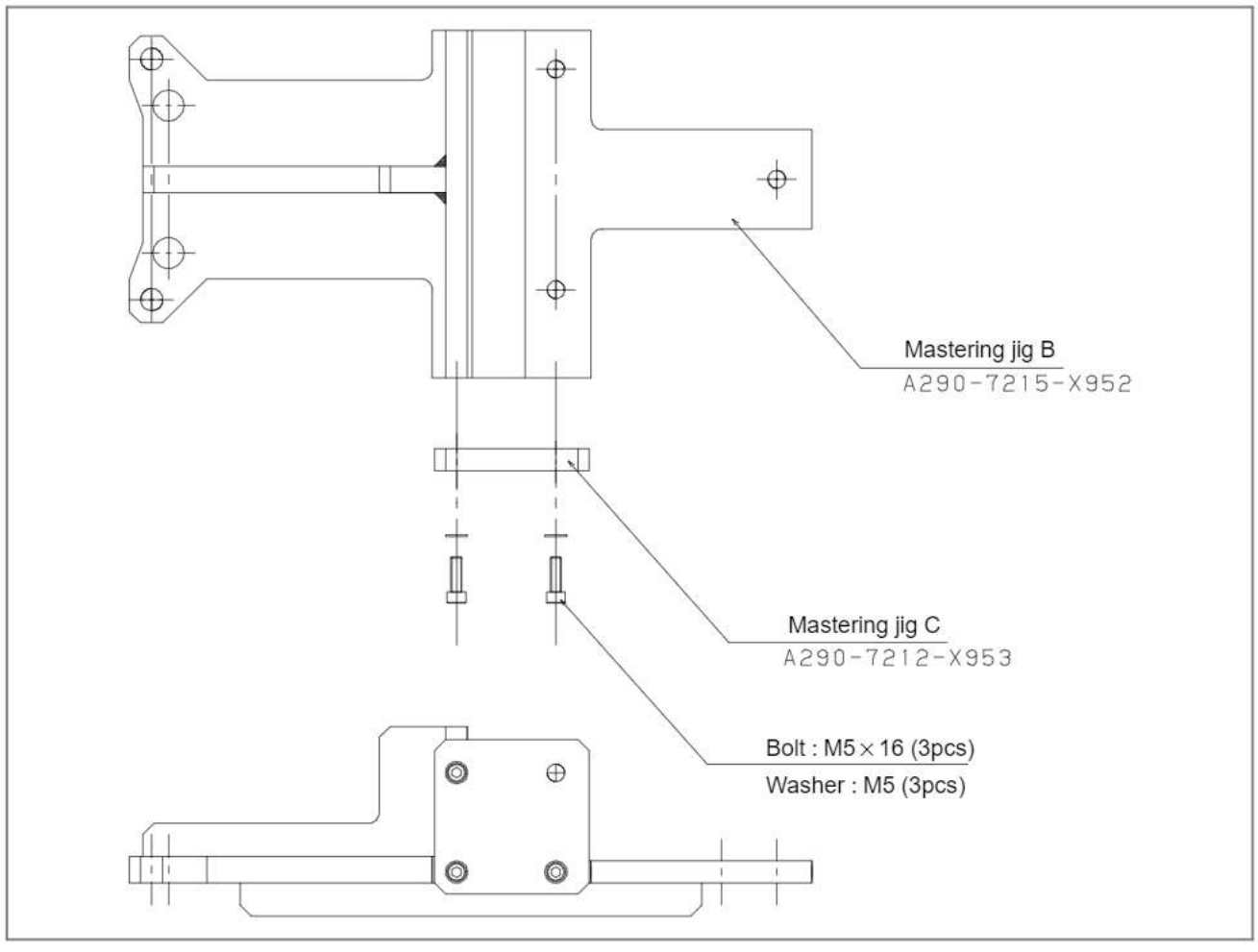


Fig 5.4 (a) Assembling the jib base

ii) Attaching to the robot main body
As shown in Fig. 5.4 (b), mount dial gauges to the jig base. Using a calibration block, set the pointer of each dial gauge to 3.0 mm, and fix the dial gauges with M5 bolts. (Be careful when tightening the bolts. Tightening them too firmly can break the dial gauges.)

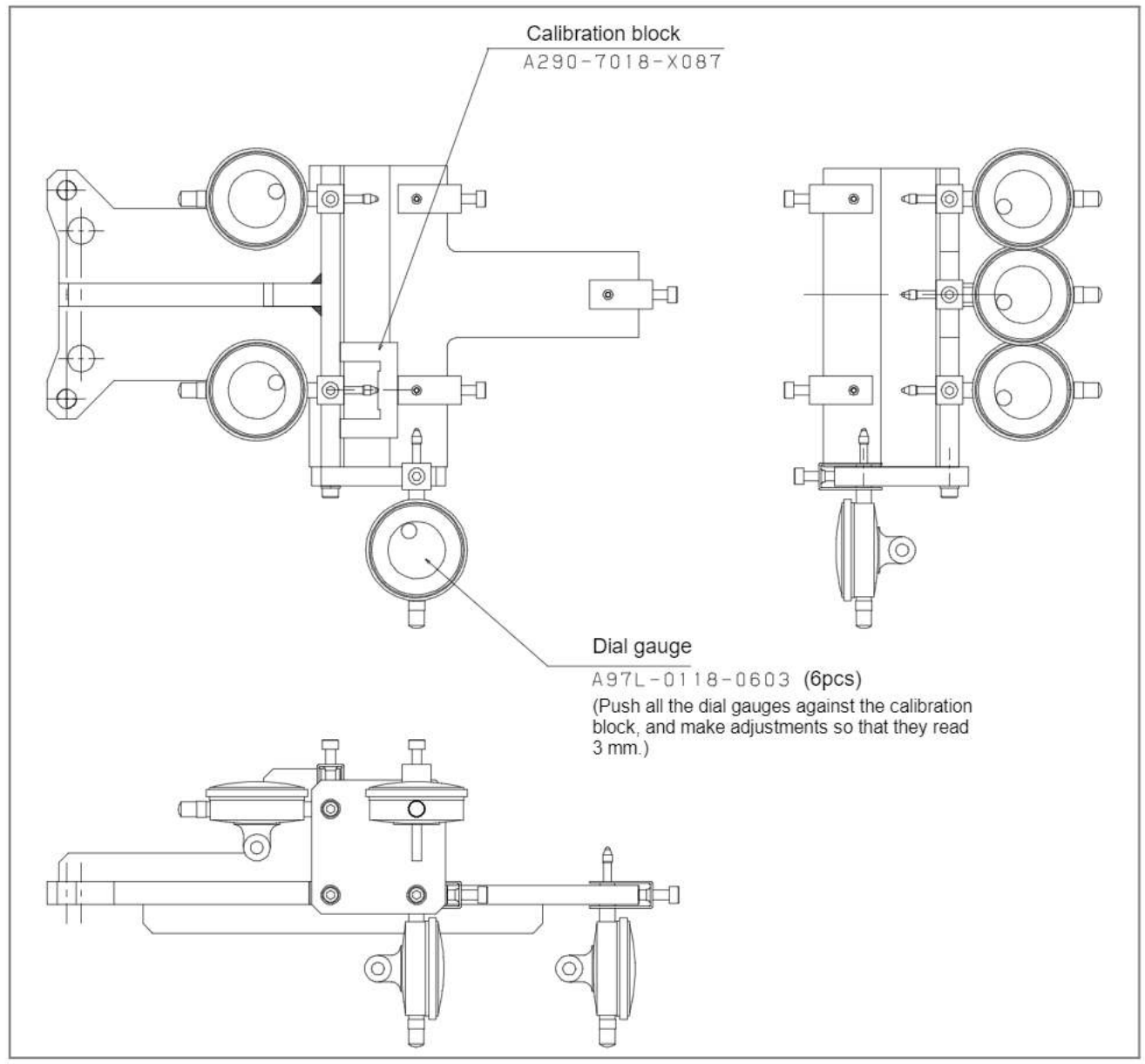


Fig 5.4 (b) Attaching the dial gauge

iii) Attaching to the robot main body
As shown in Fig. 5.4 (c), attach the jig base to the J1 base with bolts and pins.

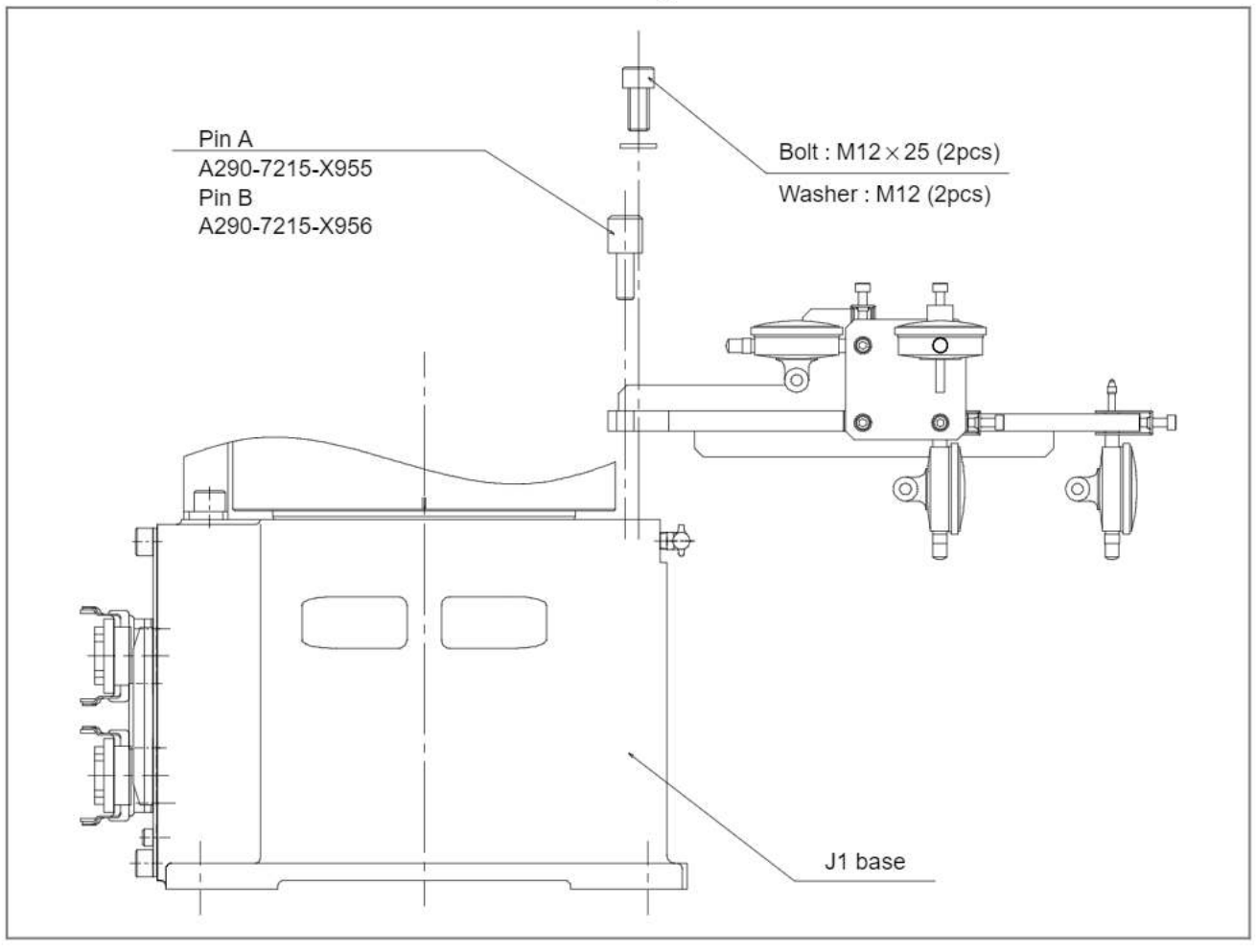


Fig 5.4 (c) Attaching to the robot main body

iv) Attaching the jig to the wrist
Manually move the wrist axis to a position of J4 = J5 = J6 = 0°.
Attach mastering jig A to the J6–axis in the orientation shown in Fig. 5.4 (d).

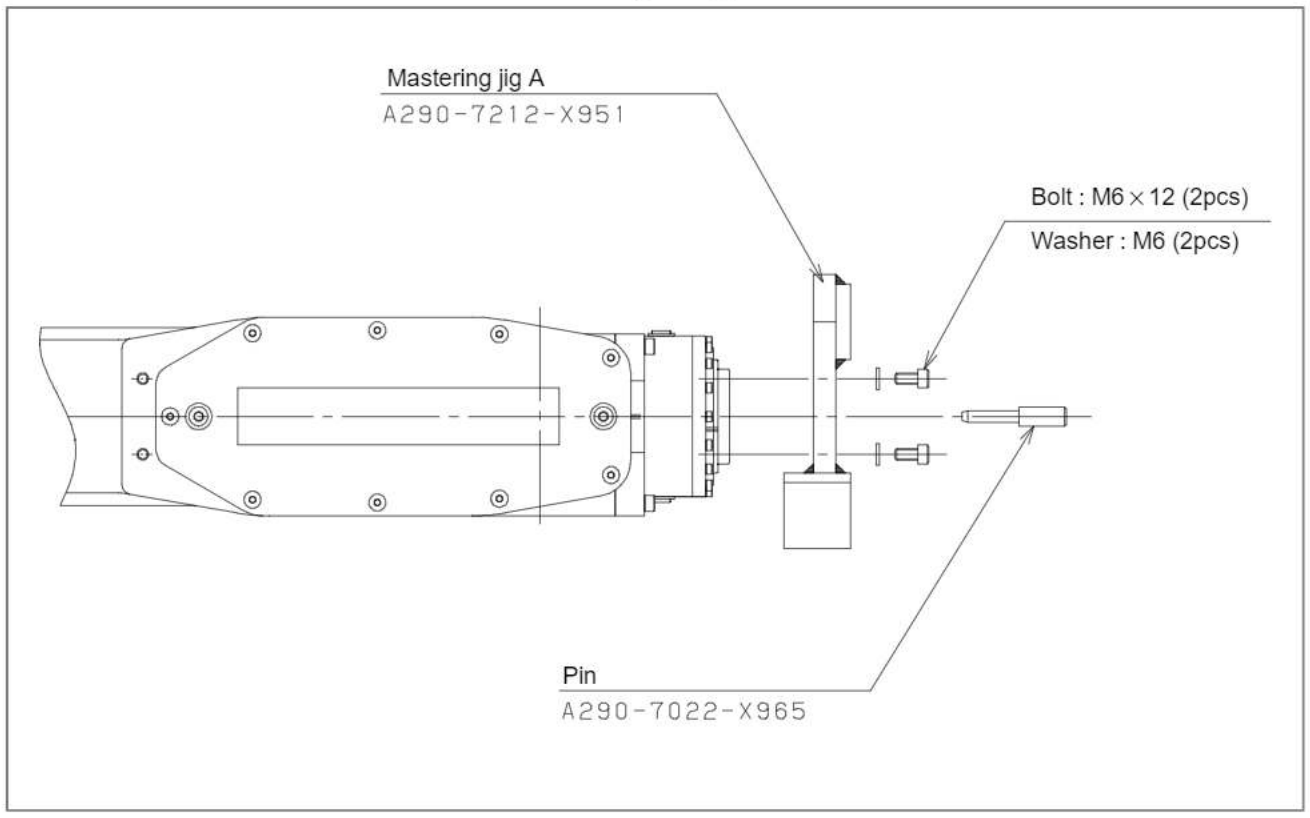


Fig 5.4 (d) Attaching the jig to the wrist

b) Performing mastering

1 First perform the mastering by zero–degree positioning described in Section 5.3.
This procedure will set an approximate, temporary coordinate origin in the robot.

2 To disable brake control, set the system variable $PARAM_GROUP_SV_OFF_ENB to FALSE for all axes, turn the power off, and perform a cold start.

3 Press the screen selection key, select "0" NEXT, and then select SYSTEM from the menu. Press the F1 key TYPE, and select the system variable. For $DMR_GROUP.$MASTER_DONE (simplified mastering completion flag), select "FALSE" so that each axis can move out of the stroke range. When operating the robot, keep its taught override speed low.

4 Using a single–axis feed command, place the robot in the mastering posture shown in Fig. 5.4 (e).

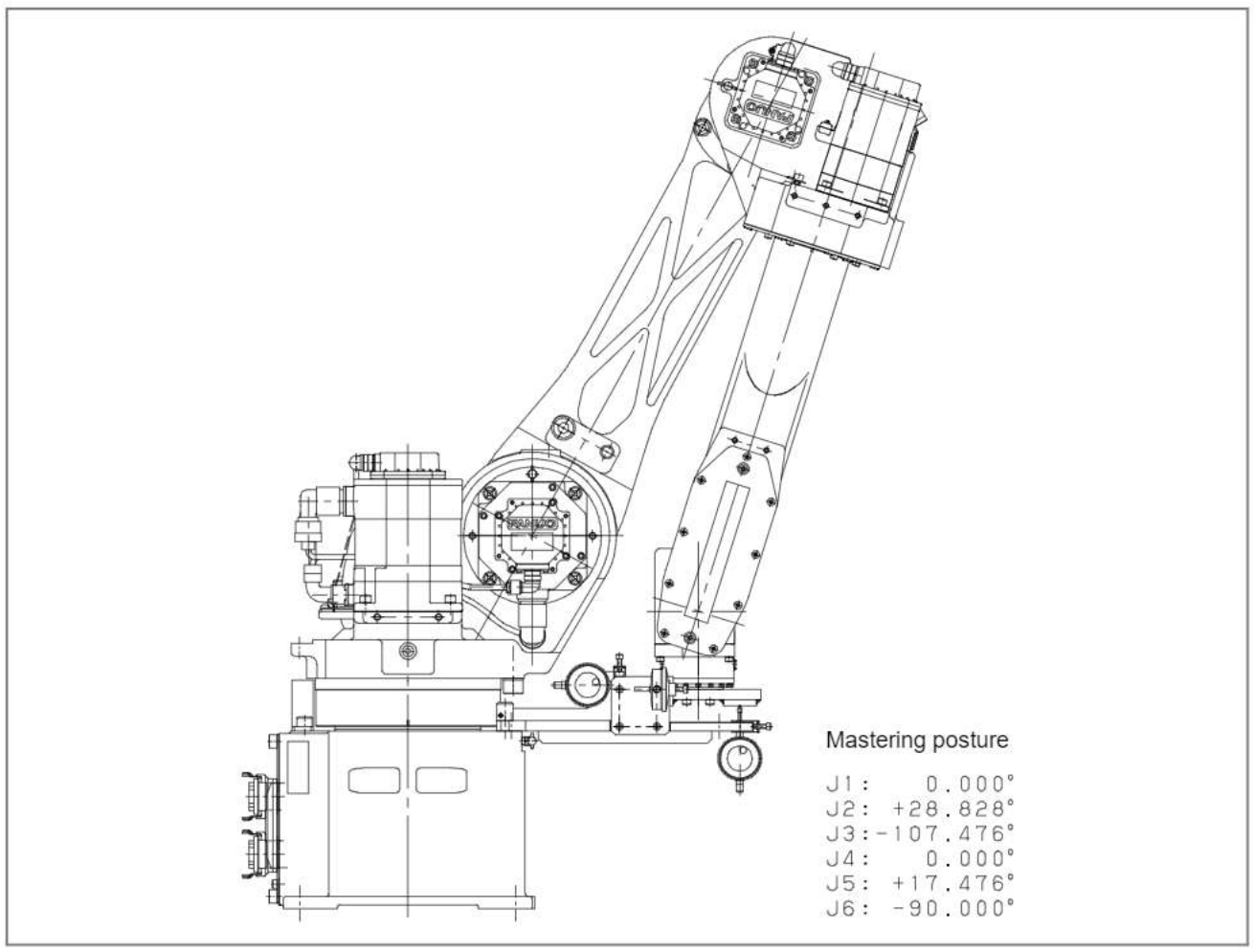


Fig 5.4 (e) Mastering posture

5 Press the screen selection key, select "0" NEXT, and select SYSTEM from the menu. Press the F1 key TYPE, and select the system variable. In the list, set $MASTER_ENB to 1. Then press the F1 key TYPE, and select MASTER/CAL.

6 Select FIXTURE POSITION MASTER from the system positioning menu, and press the F4 function key YES. Mastering is performed. Now, the system variable $DMR_GRP.MASTER_COUN is set with the mastering data obtained from the pulse coder counter value, and the system variable $DMR_GRP.MASTER_DONE (mastering completion flag) is set to "TRUE".

7 Select MASTER/VOL from the system positioning menu, and press the F4 key YES. Positioning is performed, and teaching and replaying become enabled.

8 Once you are finished with mastering, reset the system variable $MASTER_ENB value to 0.

9 To enable brake control, re–set the $PARARM_GROUP.$SV_OFF_ENB to the previous value for all axes, turn off the power, and perform a cold start.

Once mastering is completed, update the data sheet supplied together with the robot with the new mastering data ($DMR_GROUP.$MASTER_COUN[1] to [6]).

If you want to perform mastering for a specific axis, take note of the value of the mastering data (system variable $DMR_GROUP.$MASTER_COUN), and then perform mastering for all axes. Once you are finished with mastering, re–enter the mastering data of the axes other than that specific axis. New position information for that axis is stored, and position information for the other axes is preserved.

5.5 CONFIRMING MASTERING

1) Confirming that mastering was performed normally

Usually, positioning is performed automatically when the power is turned on. To confirm that mastering was performed normally, check that the current–position display matches the actual position of the robot, using this procedure.

a) Replay the taught operation of the robot to set each axis to zero degrees, and visually check that the zero–degree position marks shown in Fig. 5.2 are aligned.

b) Replay a specific portion of the program, and check that the robot has moved to the taught position.

2) Possible alarms in positioning

The following paragraphs describe alarms that may occur in positioning and explain how to handle them.

a) BZAL alarm
This alarm is raised if the voltage of the pulse coder backup battery becomes 0V when the controller power is off. Mastering must be performed again because the counter has already lost data.

b) BLAL alarm
This alarm indicates that the voltage of the pulse coder backup battery is too low to run the pulse coder. If this alarm is issued, replace the backup battery soon while keeping the power on, and check whether the current–position data is correct, using a method described in item (1).

c) CKAL, RCAL, PHAL, CSAL, DTERR, CRCERR, STBERR, and SPHAL alarms
If any of these alarms is issued, contact your FANUC service representative. A motor may have to be replaced.

5.6 J5–AXIS GEAR BACKLASH ADJUSTMENTS

If the backlash in the J5–axis is harder than the allowable value (output axis angle of 4.5 minutes) listed in Table 4.2 (b), make backlash adjustments, using this procedure. (See Fig. 5.6.)

1 Place the robot in a posture of J4 = +90° and J5 = J6 = 0°.

2 Remove the nine M5 × 10 flat–head bolts, and dismount the J5–axis gearbox cover (A290–7215–X524) from the J3 arm (A290–7215–X402).

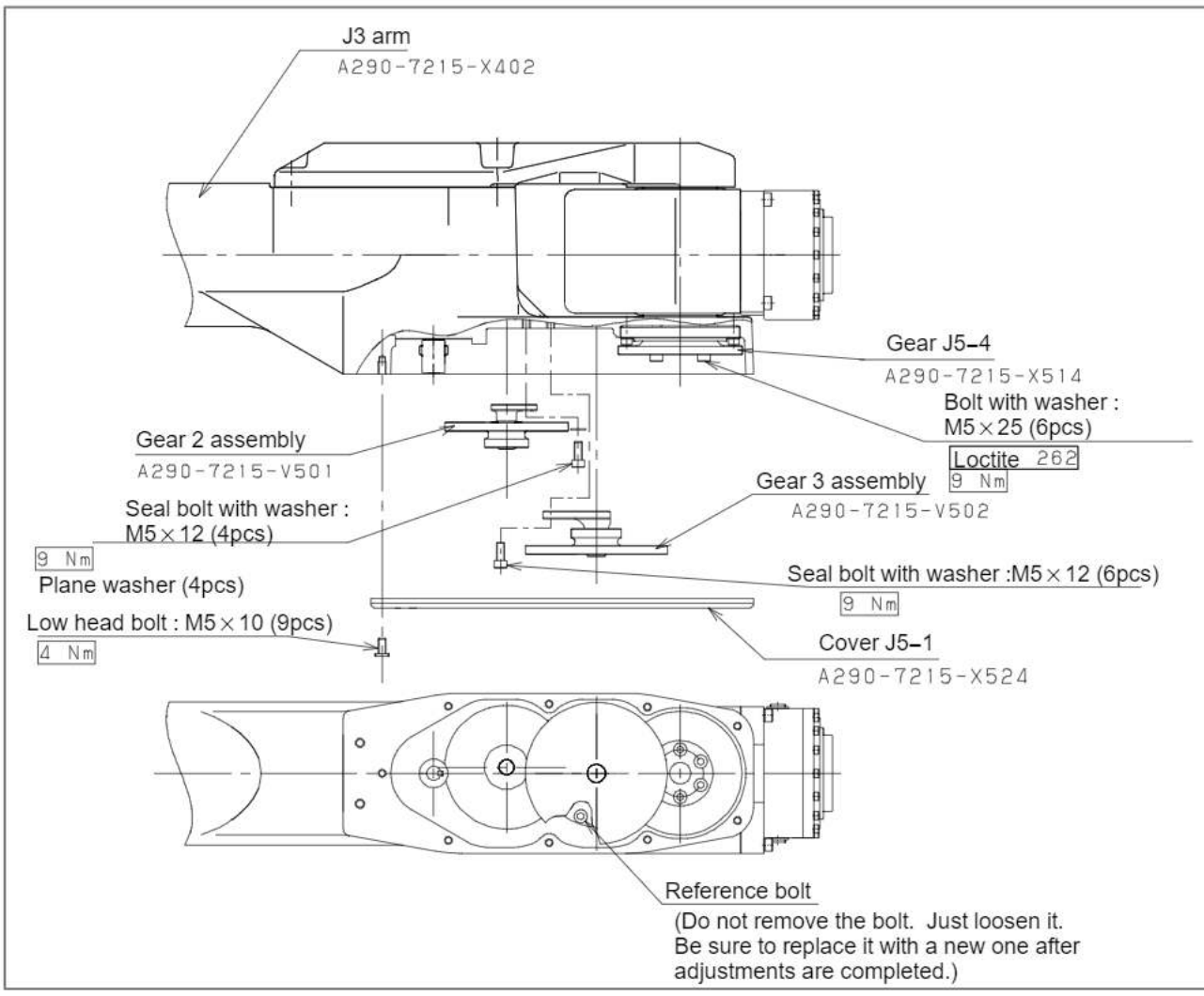


Fig 5.6 J5–axis gear backlash adjustments

1) Gear 3 assembly and gear J5–4 backlash adjustments

1 Remove the four M5 × 12 seal bolts with a washer, and retract the gear 2 assembly (A290–7215–V501) to such a point that it will not be engaged with the gear 3 assembly (A290–7215–V502).

2 Remove the five M5 × 12 seal bolts with a washer. These bolts work not only for mounting but also sealing the gear unit grease bath. Once you have removed them, replace them with new ones. In reference to the bolt (Do not remove this bolt; just loosen it. However, loosening it impairs its ability to seal. Once adjustments are completed, after the other seal bolts are tightened, replace this bolt with a new one. Otherwise, grease may leak.) shown in Fig. 5.6, push the gear 3 assembly against the output gear (A290–7215–X514), and fix the gear 3 assembly temporarily. After you have fixed the gear 3 assembly temporarily, rotate the J6 housing (output gear) in both positive and negative directions, and check whether their rotation is abnormally heavy and any portion has a serious backlash. Repeat the above procedure until any backlash becomes lower than the maximum allowable value and the engagement and rotation torque becomes moderate.

3 Once you have completed adjustments, fix the J3 arm with new six M5 × 12 seal bolts.

2) Gear 2 assembly and gear 3 assembly backlash adjustments

1 Shift the gear 2 assembly in a direction vertical to the gear 3 assembly and input gear (A290–7215–X511) so that the backlash is reduced, and fix the gear 2 assembly to the J3 arm with four M5 × 12 seal bolts with a washer.

2 Rotate the gear 2 assembly, and check the operation of the J5–axis by operating it within its stroke (–140° to +140°). Repeat step 1 for reducing the backlash until the gears will not interfere with each other.
Fix the gear 2 assembly temporarily in the same manner as stated in (1). Once you have completed adjustments, mount the assembly with new M5 × 12 seal bolts with a washer.

3 Make sure that the total backlash in the J5–axis unit is lower than the maximum allowable value (output axis angle of 4.5 minutes) listed in Table 4.2 (b). If the requirement is not satisfied, go back to 1 of procedure (1).

4 Fix the J5–axis gearbox cover to the J3 arm with nine M5 × 10 flat–head bolts.

5 Apply the specified grease to the J5–axis gearbox by following the grease replacement procedure stated in Section 3.2.

6 Perform mastering as stated in Sections 5.3 and 5.4.

5.7 BRAKE RELEASE

When the robot power is off, the brakes of the robot can be released using the brake release unit (option). In this case, the robot can be put in a different posture. Observe Notes 1 to 4 given below.

NOTE
1 When releasing the brakes of the J2–axis or J3–axis motor (M2 or M3), suspend the robot with a crane as shown in Fig. 5.7.
2 When releasing the brakes of the J4–axis to J6–axis motor (M4 to M6), suspend the end effector with a crane so that it will not fall.
3 When releasing the brakes of motors, use slings having a sufficient tensile strength.
4 Do not release the brakes of more than one motor simultaneously.

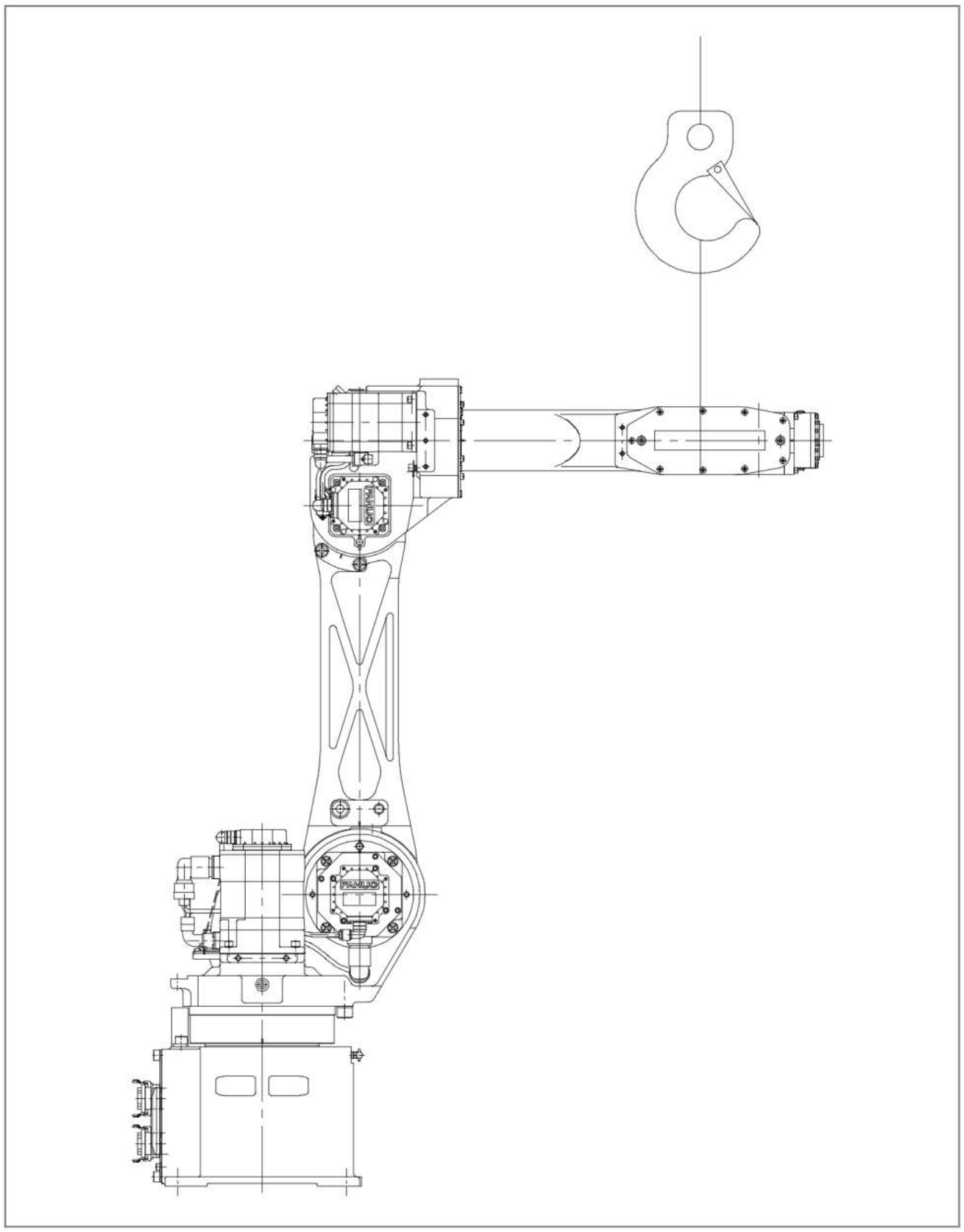


Fig 5.7 Releasing the brakes of the J2–axis motor

6 COMPONENT REPLACEMENT AND ADJUSTMENTS

Adjustments are needed after a component is replaced.
The following table lists components and the adjustment items that must be made after the components are replaced. After replacing a component, make necessary adjustments according to this table.

Replacement component	Adjustment item
Motor	(a) Mastering
J1–, J2–, and J3–axis reducers	(a) Mastering
J4–axis gearbox	(a) Mastering
J5–axis gearbox	(a) Mastering
J6–axis reducer	(a) Mastering

NOTE
Be very careful when dismounting and mounting the heavy components that are listed below.

Component	Weight
J3–axis arm (See Fig. 6.8.)	10.4kg
All components from J3–axis reducer to wrist unit (See Fig. 6.6.)	31kg
All components from J2–axis arm to wrist unit (See Fig. 6.4. (a).)	38.7kg
All components from J2–axis base to wrist unit (See Fig. 6.2 (a) and (b).)	69.4kg

6.1 REPLACING THE J1–AXIS MOTOR M1

1 Turn off the controller power.
2 Remove the J1–axis motor connector.
3 Remove the four M8 × 20 motor mounting bolts. Dismount the motor from the J1–axis unit. When dismounting the motor, be careful of the grease that may drop from the motor if the robot is suspended from a ceiling or mounted on a wall.
4 Remove the M10 hexagonal nut from the motor shaft, and pull out the gear (A290–7215–X211).
5 Attach the gear to a new motor (with two axes equipped with a brake (A06B–0223–B005) or six axes equipped with a brake (A06B–0223–B605)).
6 Attach an M10 spring washer, apply Loctite 242 to the M10 threaded portion of the motor, and tighten the M10 nut with a specified torque of [16.7 Nm].
7 Make sure that the O–ring (G105) is correctly attached to the J2 base (A290–7215–X301) portion where the J1–axis motor is to be mounted, and fasten them with four M8 × 20 bolts.
8 Attach the cable connector to the J1–axis motor.
9 According to Section 3.2, supply the J1–axis grease bath with the specified grease.
10 While referencing Chapter 5, perform mastering.

NOTE
If there is a danger that the J1–axis section may swivel, for example, because the robot is installed on a tilted surface, fix the J1–axis section during replacement work, for example, by pushing the J1–axis mechanical stopper against to the J1–axis section.

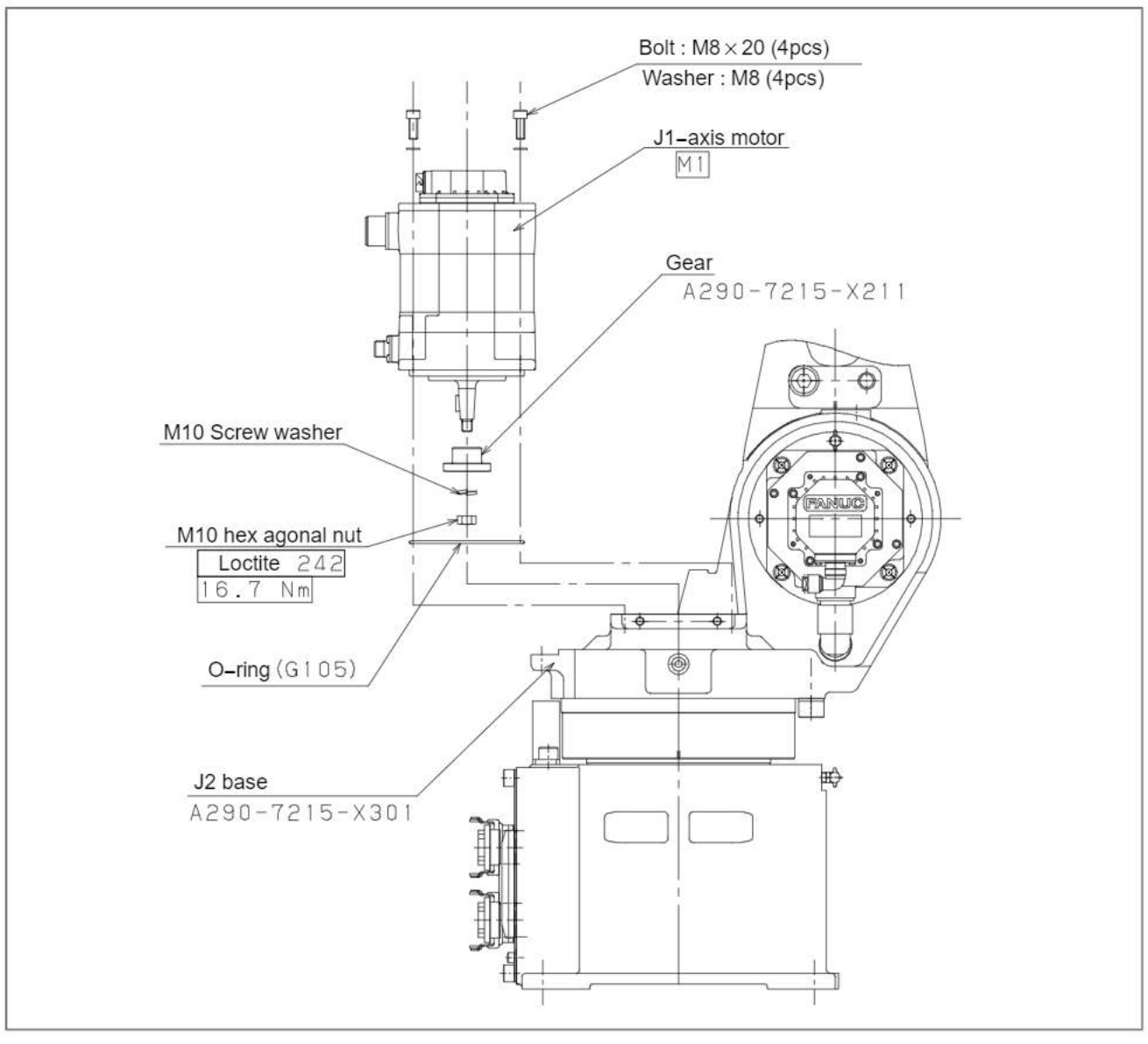


Fig 6.1 Replacing the J1–axis motor

6.2 REPLACING THE J1–AXIS REDUCER

1 Put the robot in such a posture that the J2 base and the portions above it can be suspended with a crane or the like (hereafter abbreviated as a crane), and then turn off the controller power.
2 While referencing Section 8.2, pull out the cables below the J2 base (A290–7215–X301) from the J1–axis hollow pipe section toward the upper portion of the J2 base.
3 While referencing Section 6.1, remove the J1–axis motor from the J2 base.
4 As shown in Fig. 6.2 (a), remove the eight M10 × 50 bolts that fasten the J2 base to the J1–axis reducer.
5 While referencing Section 3.1 of Part II, “Connection,” hoist the J2 base and portions above it slowly.
6 As shown in Fig. 6.2 (a), remove the O–ring (A290–7207–X342), bearing, and center gear (A290–7215–X212).
7 Remove the six M12 × 80 bolts that fasten the J1–axis reducer to the J1 base (A290–7215–X201), and dismount the reducer.
8 As shown in Fig. 6.2 (b), remove the four M4 × 10 bolts that fasten the pipe (A290–7215–X213) to the reducer, and dismount the pipe.
9 Make sure that the pipe is fitted with the O–ring (G60) correctly, and attach the pipe to a new reducer (A97L–0218–0288#33) with four M4 × 10 bolts.
10 Attach the O–rings (SO100 and SO150) to the reducer, and fasten the reducer to a new J1 base with six M12 × 80 bolts (by applying Loctite 262 and tightening with a torque of [129 Nm]).
11 Mount the center gear, bearing (with Loctite 675 applied to its outer ring), and O–ring (A290–7207–X342) to the reducer.
12 Fasten the J2 base to the reducer with eight M10 × 50 bolts (by applying Loctite 262 and tightening with a torque of [73.5 Nm]). Be careful not to let the pipe damage the oil seal.
13 According to Section 6.1, mount the J1–axis motor on the J2 base.
14 According to Section 3.2, supply the J1–axis grease bath with the specified grease.
15 While referencing Chapter 5, perform mastering.

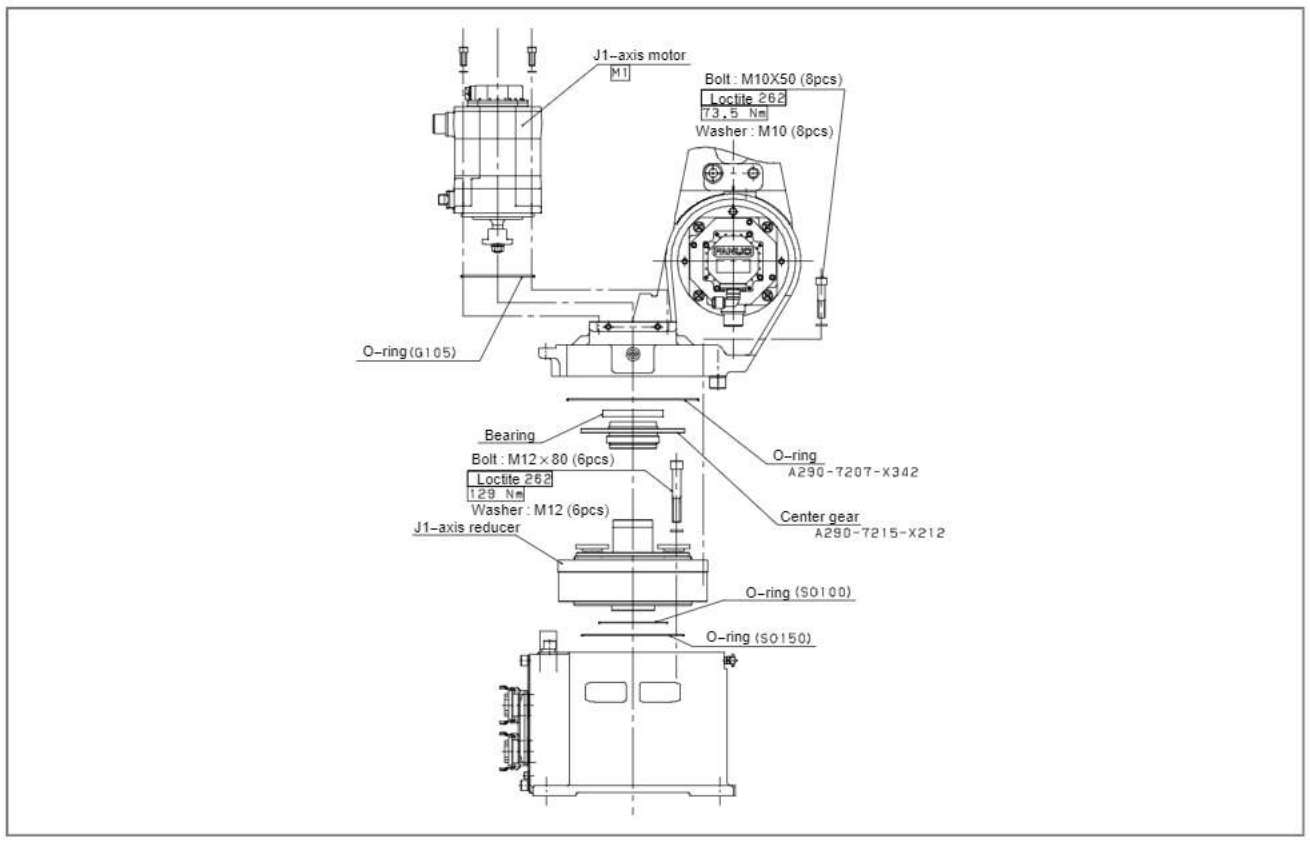


Fig 6.2 (a) Replacing the J1–axis reducer

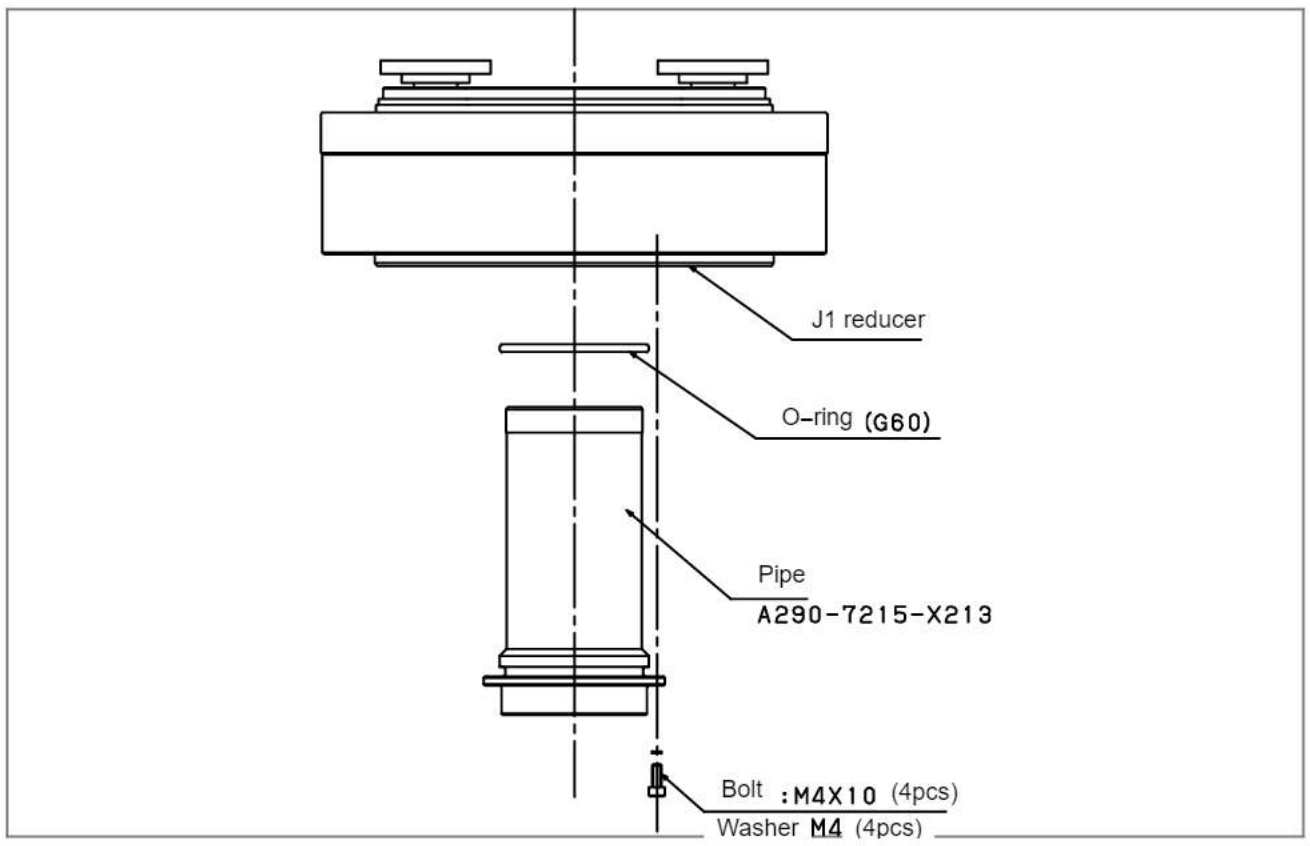


Fig 6.2 (b) Replacing the J1–axis reducer

6.3 REPLACING THE J2–AXIS MOTOR M2

1 Push the J2–axis section against the mechanical stopper, or fix it in such a way that it will not swivel when the motor is dismounted, for example, by placing it in the direction of gravity.

NOTE
If the J2–axis section is not pushed against the stopper correctly, or it is not placed in the direction of gravity, there is a danger that the J2–axis section will swivel when the J2–axis motor is removed.

2 Turn off the controller power.
3 Remove the J2–axis motor connector.
4 Remove the four M8 × 20 motor mounting bolts, and dismount the motor from the J2 base.
5 Remove the M6 hexagonal nut that fastens the input spline, and dismount the input spline. Also remove the draw bolt from the motor shaft.
6 Apply Loctite 242 to the threaded portion of a new motor (A06B–0223–B605), and tighten the draw bolt with a torque of [16.7 Nm].
7 Put the input gear over the draw bolt, attach an M6 spring washer, apply Loctite 242 to the M6 threaded portion of the draw bolt, and tighten the M6 nut with a torque of [5.5 Nm].
8 Make sure that the O–ring (G115) is correctly attached to the J2 base (A290–7215–X301) portion where the motor is to be mounted, and fasten the motor to the J2 base with four M8 × 20 bolts. Do not force in the motor. Otherwise, the input spline may not settle in the correct place, possibly causing vibration (if the spline is engaged correctly, the motor will be mounted smoothly).
9 Attach the cable connector to the J2–axis motor.
10 According to Section 3.2, supply the J2–axis grease bath with the specified grease.
11 While referencing Chapter 5, perform mastering.

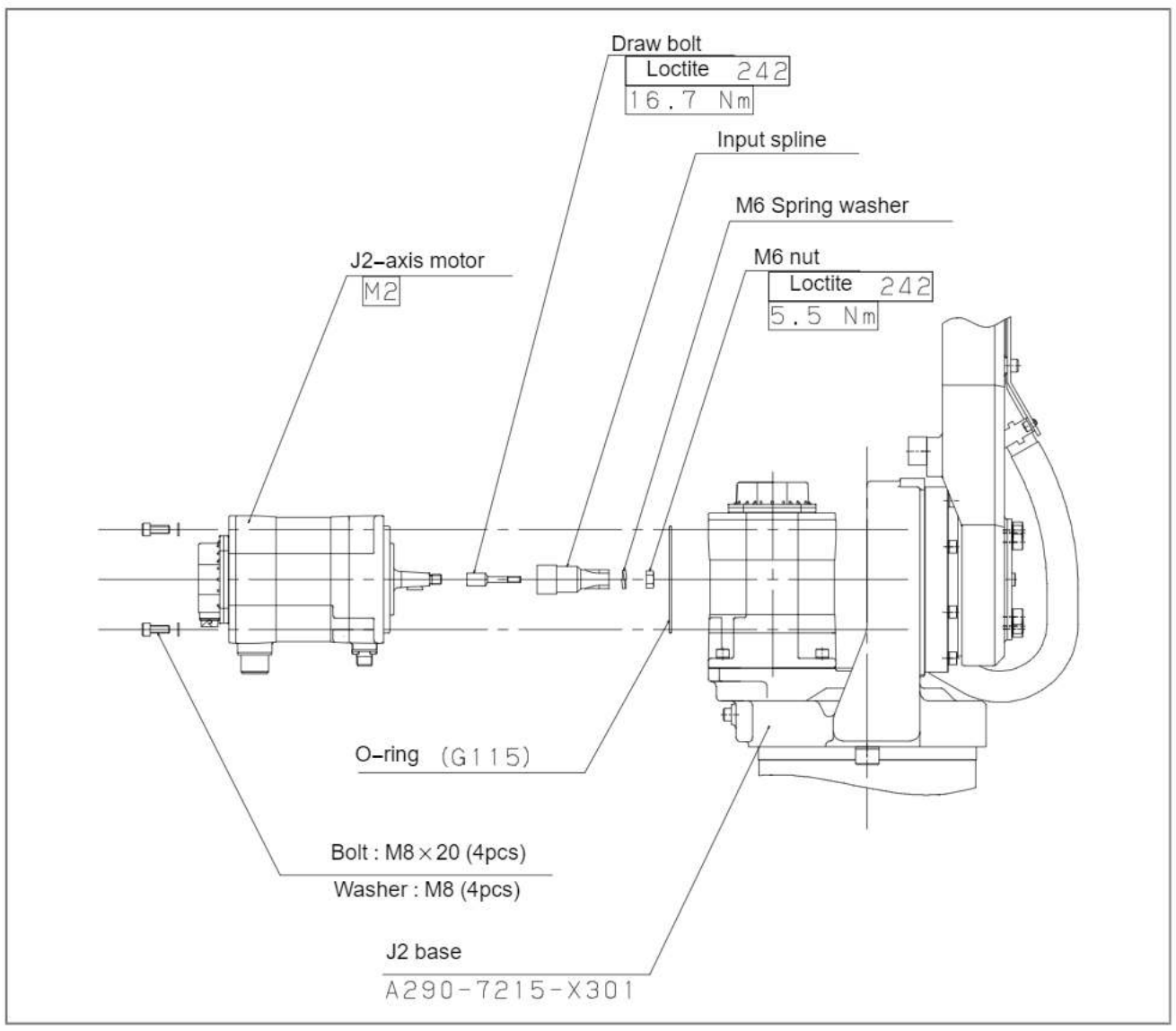


Fig 6.3 Replacing the J2–axis motor

6.4 REPLACING THE J2–AXIS REDUCER

1 Put the robot in such a posture that the J2 arm (A290–7215–X302) and the components on it can be suspended with a crane, and then turn off the controller power.
2 Suspend the J2 arm and the components on it with a crane so that they will not drop when the J2 arm is dismounted.
3 As shown in Fig. 6.4 (a), remove the ten M10 × 50 bolts that fasten the J2 arm, dismount the J2 arm and plate (A290–7215–X321) from the J2–axis reducer, and then dismount adapter 1 (A290–7210–X321). Be careful not to allow an excessive load to be put on the cables (because the cables are left attached when the reducer is dismounted).
4 Remove the eight M8 × 35 bolts that fasten the J2–axis reducer to the J2 base, and dismount the J2–axis reducer from the J2 base.
5 Attach the O–ring (AS258) to a new reducer (A97L–0218–0289#153), insert it into the J2 base, and fasten them with eight M8 × 35 bolts (by applying Loctite 262 and tightening with a torque of [37.2 Nm]).
6 Degrease both the J2 arm and the J2–axis reducer surfaces that are to meet each other, and as shown in Fig. 6.4 (b), apply sealant (Loctite No. 518) to the J2 arm surface on which the J2 reducer is to be mounted.
7 After attaching adapter 1 (A290–7210–X321) to the J2–axis reducer, mount the J2 arm on the J2 reducer, insert the plate (A290–7215–X321), and fasten the J2 arm with ten M10 × 50 bolts (by applying Loctite 262 and tightening with a torque of [73.5 Nm]).
8 According to the grease replacement procedure described in Section 3.2, supply the J2–axis grease bath with the specified grease.
9 While referencing Chapter 5, perform mastering.

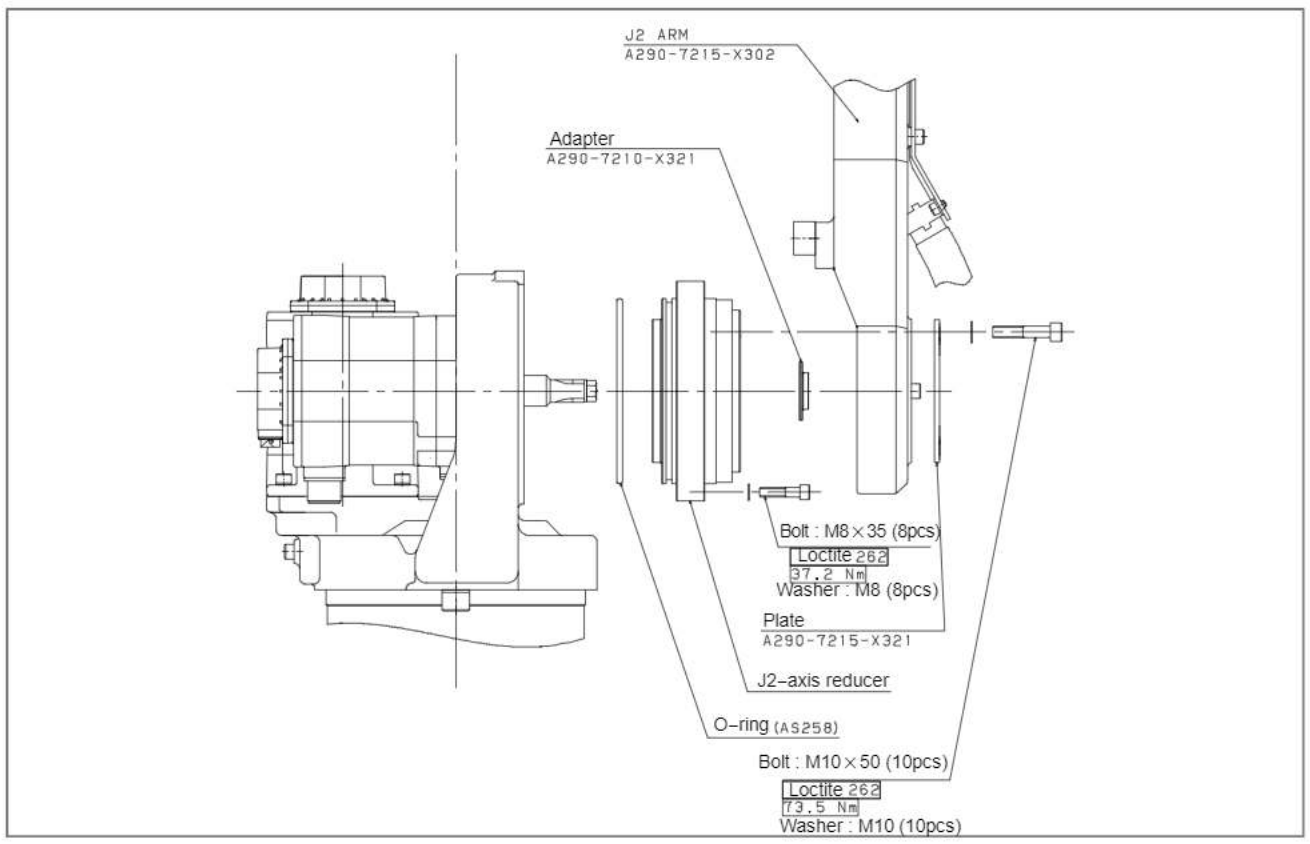


Fig 6.4 (a) Replacing the J2–axis reducer

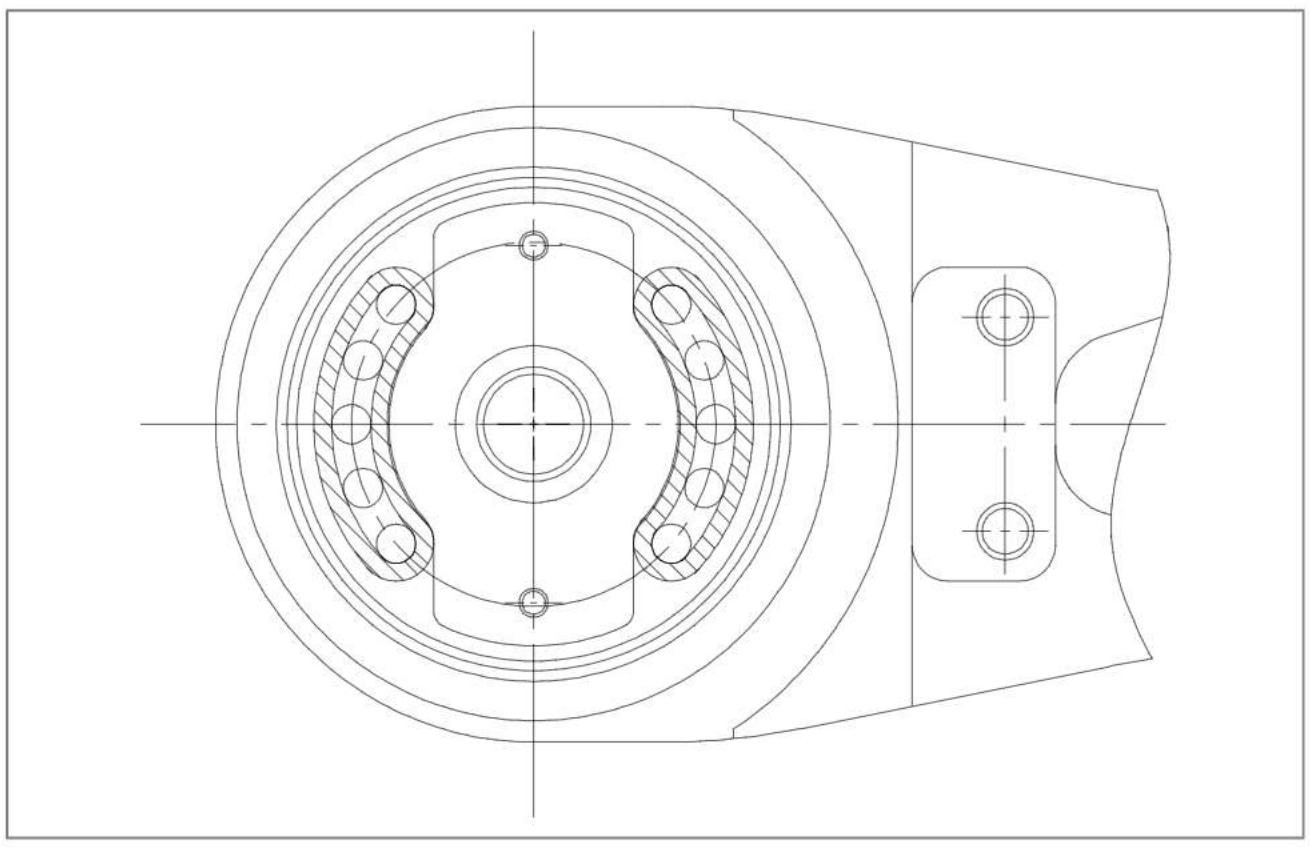


Fig 6.4 (b) Applying sealant to the J2–axis reducer

NOTE

Observe the following cautions when applying sealant (Loctite No. 518).

1 Greasing the surface where sealant is to be applied
   1) Remove dust from the surface and the inside of the tap, for example, by blowing it off.
   2) Degrease the surface completely with a cloth dampened with solvent. Do not spray solvent directly onto the surface.
   3) Wipe off any solvent from the surface with a dry cloth. Make sure that no solvent is left in the tap or on any other portion.
   4) Always use a new surface of a cloth so that the grease once wiped up with the cloth will not get on the degreased surface.
2 Allowing time during which the sealant can cure
   To let the applied sealant cure, avoid running the robot and applying grease for at least four hours after the sealant is applied.
3 Wiping off excessive sealant
   After attaching the cover, wipe off any excessive sealant that comes out from the sealed section with a cloth or spatula. Do not use solvent.

6.5 REPLACING THE J3–AXIS MOTOR M3

1 Push the J3–axis section to the mechanical stopper, or fix it in such a way that it will not swivel when the motor is dismounted, for example, by placing it in the direction of gravity.

NOTE
If the J3–axis section is not pushed against the stopper correctly, or it is not placed in the direction of gravity, there is a danger that J3–axis section will swivel when the J3–axis motor is removed.

2 Turn off the controller power.
3 Remove the connector of a cable leading to the J3–axis motor.
4 Remove the four M6 × 14 bolts that fasten the J3–axis motor to the J3 casing (A290–7215–X401), and dismount the motor and gasket.
5 Remove the M5 nut from the motor shaft, and dismount the input spline and draw bolt.
6 Apply Loctite 242 to the threaded portion of a new motor (A06B–0202–B605), and tighten the draw bolt with a torque of [3.2 Nm].
7 Put the input gear over the draw bolt, attach an M5 spring washer, apply Loctite 242 to the M5 threaded portion of the draw bolt, and tighten the M5 nut with a torque of [3.2 Nm].
8 Attach a new gasket (A98L–0040–0042#03), and insert the motor into the reducer. Keep the J3–axis degrease outlet on the J2 arm side open (see Fig. 3.1), and look into the outlet to make sure that the input spline has settled in the correct place. Even one teeth of a shift in engagement can cause vibration. (If the input spline is engaged correctly, the motor can get in the reducer smoothly.)
9 Fasten the motor to the J3–axis reducer with four M6 × 14 bolts. Be sure to use a new gasket so as to prevent grease leakage.
10 Attach the cable connector to the J3–axis motor.
11 According to Section 3.2, supply the J3–axis grease bath with the specified grease.
12 While referencing Chapter 5, perform mastering.

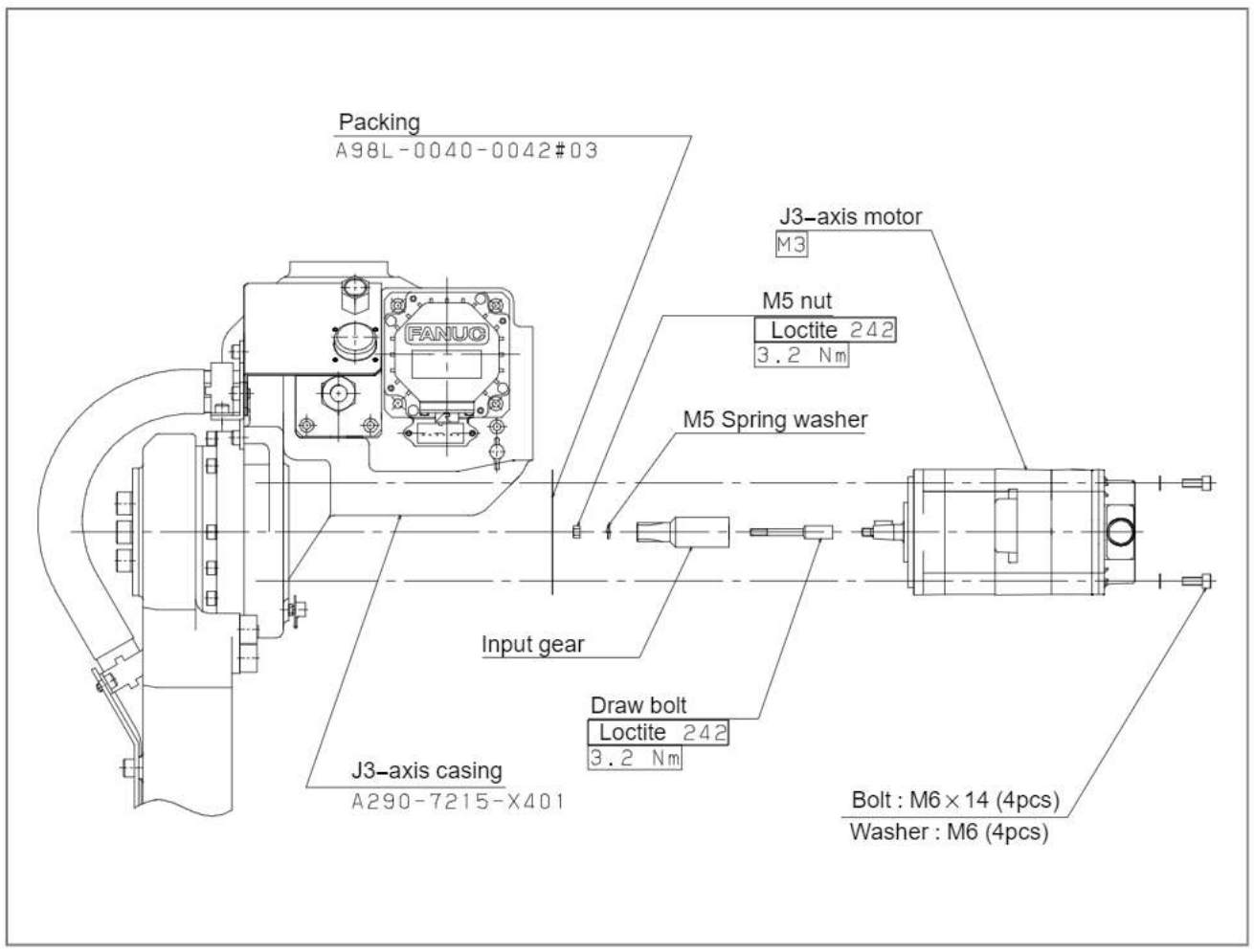


Fig 6.5 Replacing the J3–axis motor

6.6 REPLACING THE J3–AXIS REDUCER

1 Put the robot in such a posture that the J3–axis section and the components on it can be suspended with a crane, and then turn off the controller power.
2 While referencing Section 8.2, remove the cable from the J2 arm section.
Suspend the J3–axis section and the components on it with a crane so that they will not drop when the reducer is dismounted from the J2 arm. Be careful not to allow an excessive load to be put on the cable (because the cables are left attached when the reducer is dismounted).
3 As shown in Fig. 6.6, remove the six M10 × 45 bolts that fasten the J3–axis reducer to the J2 arm, and dismount the J3 arm unit from the J2 arm.
4 While referencing Section 6.5, dismount the J3–axis motor from the J3 arm unit.
5 Remove ten M6 × 30 bolts that fasten the J3–axis reducer to the J3 casing (A290–7215–X401), dismount the J3–axis reducer from the J3 casing, and remove the O–ring from the J3–axis reducer.
6 Attach an O–ring (SO120) to a new reducer (A97L–0218–0295#161), mount the reducer on the J3 casing, and fasten them with ten M6 × 30 bolts (by applying Loctite 262 and tightening with a torque of [15.7 Nm]).
7 While referencing Section 6.5, mount the J3–axis motor on the J3 arm unit.
8 Remove the O–ring from the J2 arm, degrease both the J2 arm and the J3–axis reducer surfaces that are to meet each other, and as shown in Fig. 6.6 (b), apply sealant (Loctite No. 518) to the J2 arm surface on which the J3 reducer is to be mounted.
9 Attach adapter 2 (A290–7210–X322) and the O–ring (SO100) to the J2 arm surface on which the J3–axis reducer is to be mounted.
10 Suspend the J3–axis section and the components on it with a crane, and fasten the J2 arm and J3–axis reducer with six M10 × 45 bolts (by applying Loctite 262 and tightening with a torque of [73.5 Nm]).
11 While referencing Section 8.2, dress the cable into the previous form.
12 According to Section 3.2, supply the J3–axis grease bath with the specified grease.
13 While referencing Chapter 5, perform mastering.

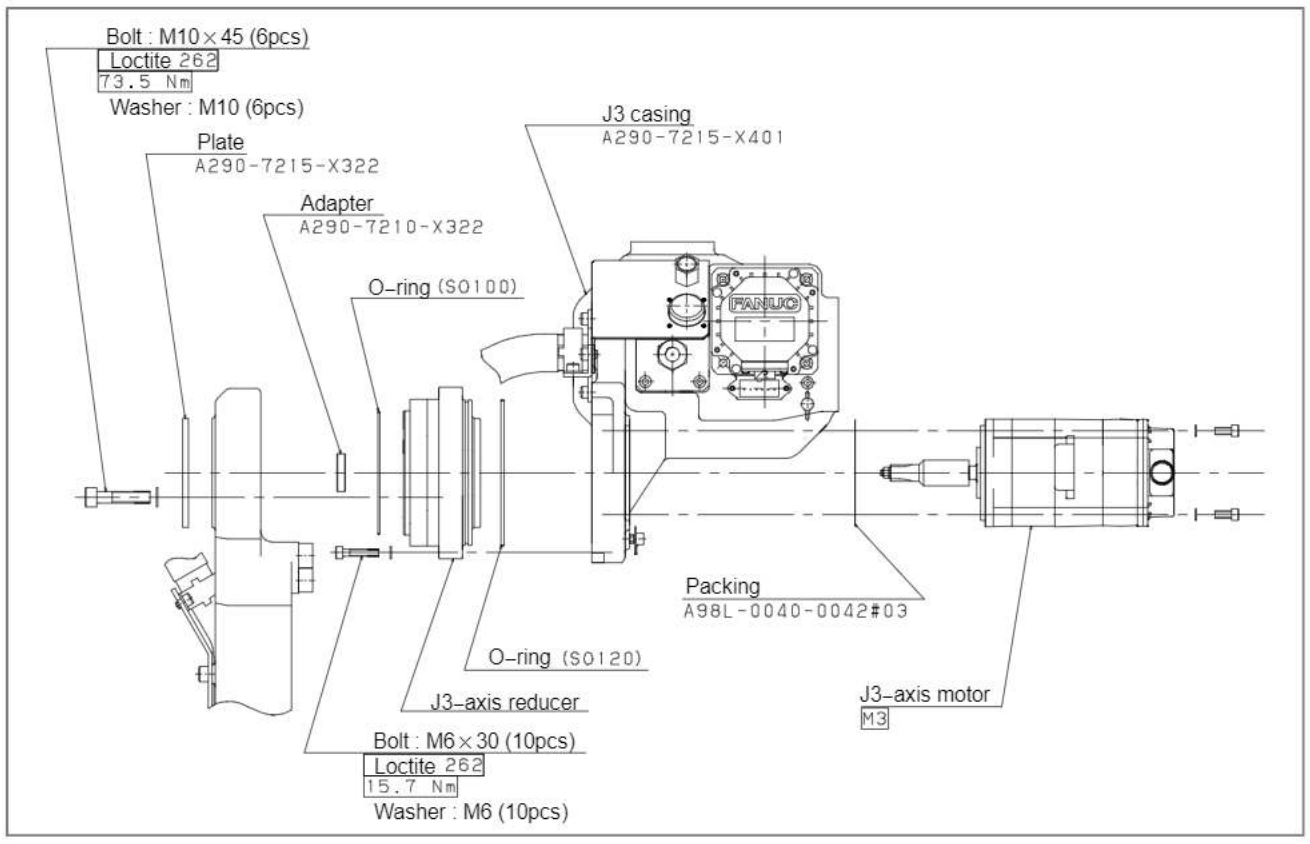


Fig 6.6 (a) Replacing the J3–axis reducer

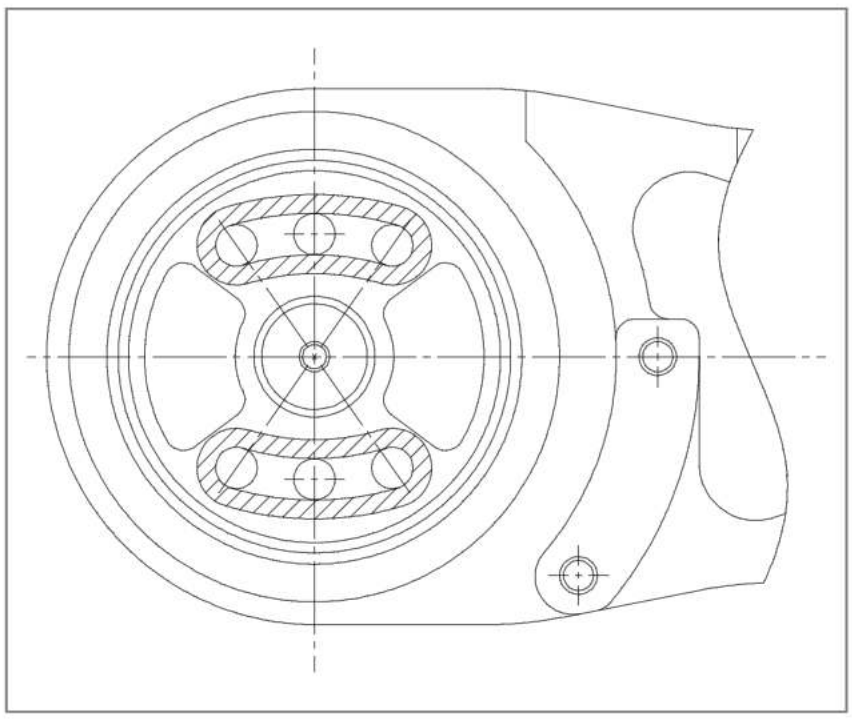


Fig 6.6 (b) Applying sealant to the J3–axis reducer

6.7 REPLACING THE J4–AXIS MOTOR M4

1 Place the robot in a posture of J4 = –90°. Keep this condition until step <10> (mastering). Note that if the operation for setting the zero–degree position is performed incorrectly, the cable may be twisted more than allowed, leading to a broken cable. If the robot is in a posture of J3 = –90°, grease will not drop when the motor is dismounted.
2 Turn off the controller power.
3 Remove the connector of a cable leading to the J4–axis motor.
4 As shown in Fig. 6.7, remove the three M6 × 14 bolts that fasten the J4–axis motor to the J3 casing (A290–7215–X401), and dismount the motor.
5 Remove the nut (A290–7215–X412) that fastens the J4–1 gear (A290–7215–X411) to the motor shaft, and dismount the J4–1 gear and M5 spring washer.
6 Mount the J4–1 gear to a new motor (with two axes equipped with a brake (A06B–0202–B005) or six axes equipped with a brake (A06B–0202–B605)), apply Loctite 242 to the threaded portion of the motor shaft, and fasten them with a nut (A290–7215–X412) by tightening with a torque of [9 Nm]. (Be very careful when tightening the nut because if you do not tighten with the specified torque, the J4–axis may get out of place.)
7 Make sure that the O–ring (G75) is put accurately in the J3 casing portion where the motor is to be mounted, and fasten the motor to the J3 casing with three M6 × 14 bolts.
8 Attach the cable connector to the J4–axis motor.
9 According to Section 3.2, supply the J4–axis grease bath with the specified grease.
10 While referencing Chapter 5, perform mastering.

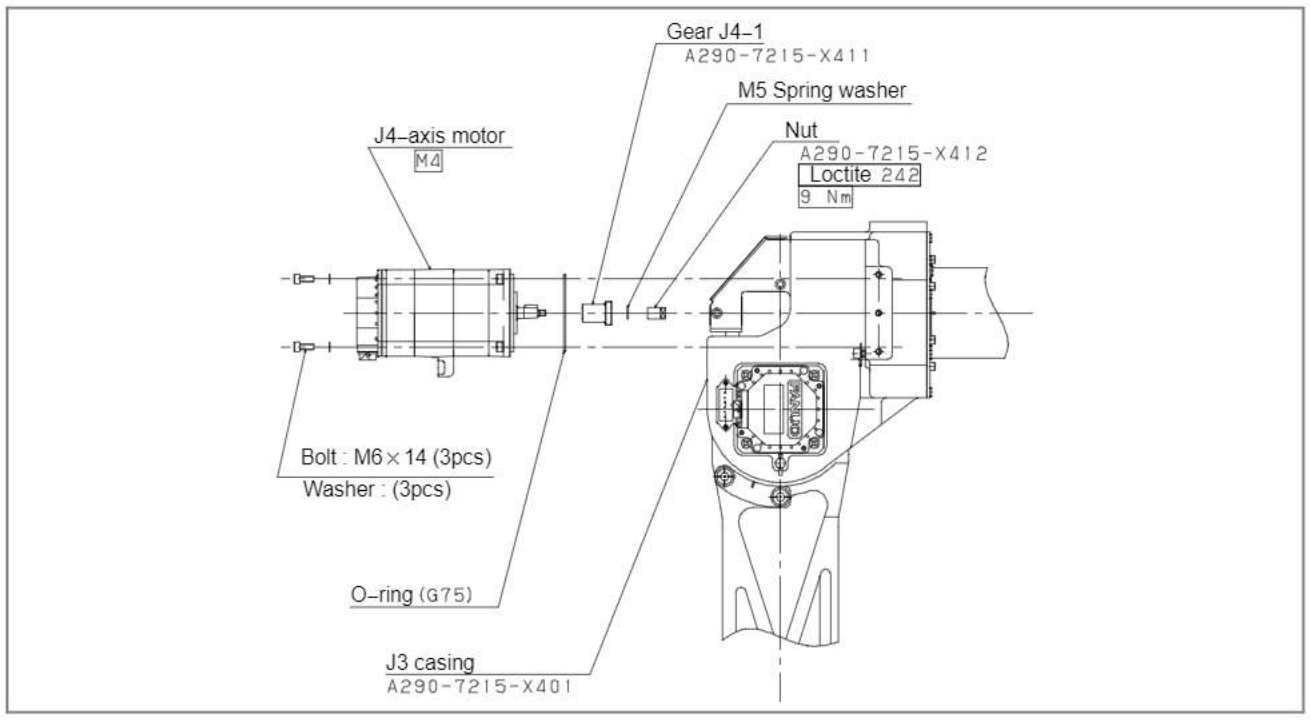


Fig 6.7 Replacing the J4–axis motor

6.8 REPLACING THE J4–AXIS GEARBOX

1 Turn off the controller power.
2 According to Section 8.2, remove the cables that run from the J3–/J4–axis motor connectors through the clamps on the J3 casing and in the J3 arm to the J6–axis motor in the J6 housing, and take them out from the J3 arm unit.
3 Suspend the J3 arm through an M6 eye bolt with a crane. Remove the six M6 × 70 bolts that fasten the J3 arm to the J4 gearbox unit, and dismount the J3 arm from the J4–axis gearbox unit. (See Fig. 6.8.)
4 Suspend the J4–axis gearbox unit above the J3 casing (A290–7215–X401) through an M6 eyebolt with a crane. Remove the six M10 × 45 bolts that fasten the J4 gearbox unit to the J2 arm, and dismount the J4 gearbox unit from the J2 arm.
5 According to the procedures described in Sections 6.5, 6.6, and 6.7, dismount the J3– and J4–axis motors and J3–axis reducer.
6 According to the procedures described in Sections 6.6 and 6.7, mount the J4–axis motor and J3–axis reducer on a new J4–axis gearbox (A05B–1215–K401).
Do not forget to insert an O–ring and gasket.
7 Fasten the J4–axis gearbox unit mentioned in <6> with ten M10 × 45 bolts (by applying Loctite 262 and tightening with a torque of [73.5 Nm]).
8 According to the procedure described in Section 6.5, mount the J3–axis motor.
9 Suspend the J3 arm with a crane, fasten the J4–axis box with six M6 × 70 bolts (by applying Loctite 262 and tightening with a torque of [15.7 Nm]).
10 According to Section 8.2, dress the cables that run from the clamp on the J3 casing to the J6–axis motor in the J6 housing through the clamp in the J3 arm into the previous form. Attach the J3 and J4–axis motor connectors.
11 According to Section 3.2, supply the J3– and J4–axis grease baths with the specified grease.
12 While referencing Chapter 5, perform mastering.

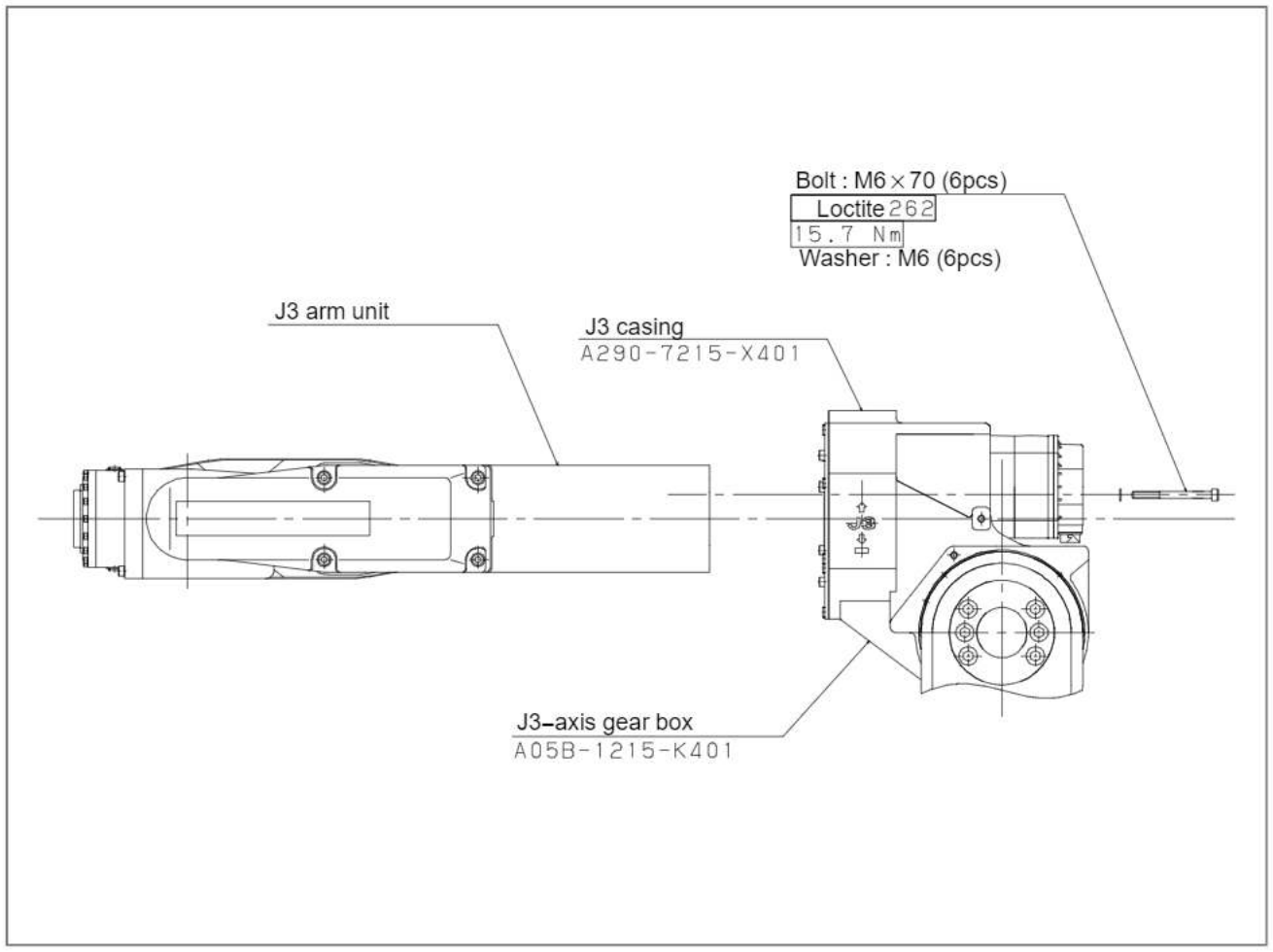


Fig 6.8 Replacing the J4–axis gearbox unit

6.9 REPLACING THE J5–AXIS MOTOR M5

1 Place the robot in a posture of J4 = –90°.
2 Turn off the controller power.
3 As shown in Fig. 6.9, remove the four M6 × 16 bolts, rotate the J5–2 cover (A290–7215–X502) around the J5–axis to such a point that the J5 motor can be taken out, and fasten it to the J3 arm (A290–7215–X402) temporarily.
4 While referencing Section 8.2, detach the clamp (A290–7215–X525) from the inside of the J3 arm, and take out inline cable connectors M5M1 and M5P1.
5 Remove the four M5 × 12 bolts with a washer that fasten the J5–axis motor to the J3 arm, and dismount the motor from the J3 arm.
6 Remove the two M3 × 4 setscrews that fasten the J5–1 gear (A290–7215–X511) to the motor shaft, and pull out the gear. Also detach the leads from the motor.
7 Bond a new key (JB–HKY–3 × 3 × 8A) to a new motor (with two axes equipped with a brake (A06B–0115–B075#0008) or six axes equipped with a brake (A06B–0115–B275#0008)) with Loctite 675, mount the J5–1 gear, and fasten them with setscrews M3 × 4 (by applying Loctite 242). Be careful not to allow the key to stick out from the gear when bonding it.
8 Attach the leads that were detached at <6> to the motor.
9 Attach a new gasket (A98L–0040–0042#07) to the motor flange with Alvania grease, fasten the motor to the J3 arm with four new M5 × 12 seal bolts with a washer. Be sure to use new seal bolts. Otherwise, grease may leak.
10 While referencing Section 8.2, attach the inline cable connectors, attach the clamp to the inside of the J3 arm, and dress the cables into the previous form.
11 While being careful not to allow the gasket (A290–7215–X527) to stick out or to be twisted and not to have non–bound cable portions caught between the gasket and motor flange, fasten the J5–2 cover with four M6 × 16 bolts (by applying Loctite 242 and tightening with a torque of [15.7 Nm]).
12 According to Section 3.2, supply the J5–axis grease bath with the specified grease.
13 While referencing Chapter 5, perform mastering.

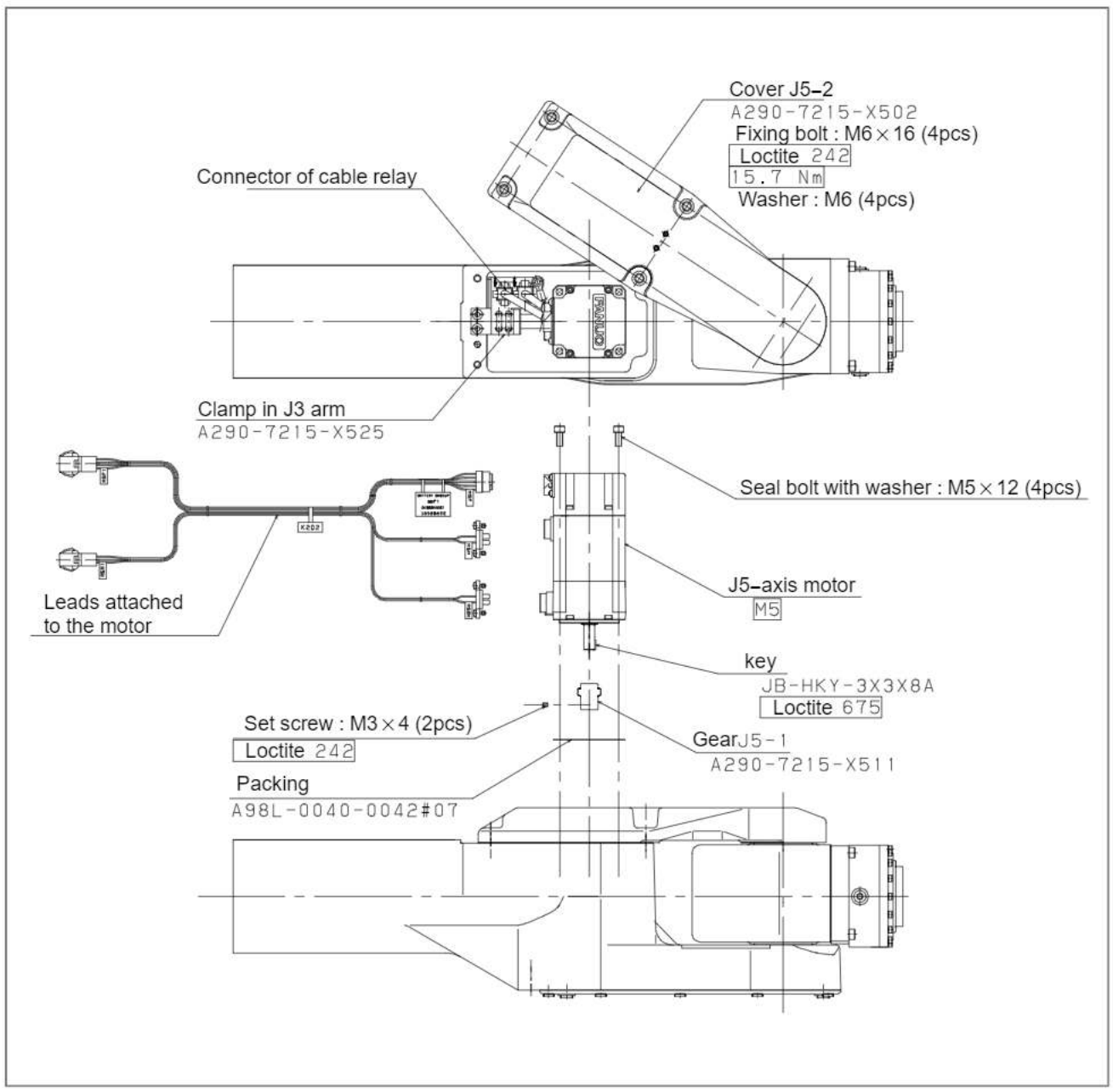


Fig 6.9 Replacing the J5–axis motor

6.10 REPLACING THE J5–AXIS GEAR

1 To replace the J5–1 gear, follow the motor replacement procedure stated in Section 6.9.
2 Place the robot in a posture of J4 = +90° and J5 = 0°.
3 Turn off the controller power.
4 According to Section 6.9, dismount the J5–axis motor.
5 As shown in Fig. 6.10, remove the nine M5 × 10 flat–head bolts, and dismount the J5–1 cover (A290–7215–X524).
6 Remove the four M5 × 12 seal bolts with a washer that fasten the gear 2 assembly (A290–7215–V501), and dismount the gear 2 assembly from the J3 arm.
7 Remove the six M5 × 12 seal bolts with a washer that fasten the gear 3 assembly (A290–7215–V502), and dismount the gear 3 assembly from the J3 arm.
8 Remove the six M5 × 25 bolts that fasten the J5–4 gear (A290–7215–X514), and dismount the J5–4 gear from the J3 arm.
9 Fasten a new J5–4 gear to the J3 arm with six M5 × 25 bolts (by applying Loctite 262 and tightening with a torque of [9 Nm]).
10 According to the backlash adjustment procedure described in Section 5.7, make backlash adjustments on a new gear 3 assembly, and fasten it to the J3 arm.
11 According to the backlash adjustment procedure described in Section 5.7, make backlash adjustments on a new gear 2 assembly, and fasten it to the J3 arm.
12 Once the backlash adjustments described in Section 5.7 are completed, fasten the J5–1 cover to the J3 arm with nine M5 × 10 flat–head bolts by tightening them with a torque of [4 Nm].
13 According to Section 3.2, supply the J5–axis grease bath with the specified grease.
14 While referencing Chapter 5, perform mastering.

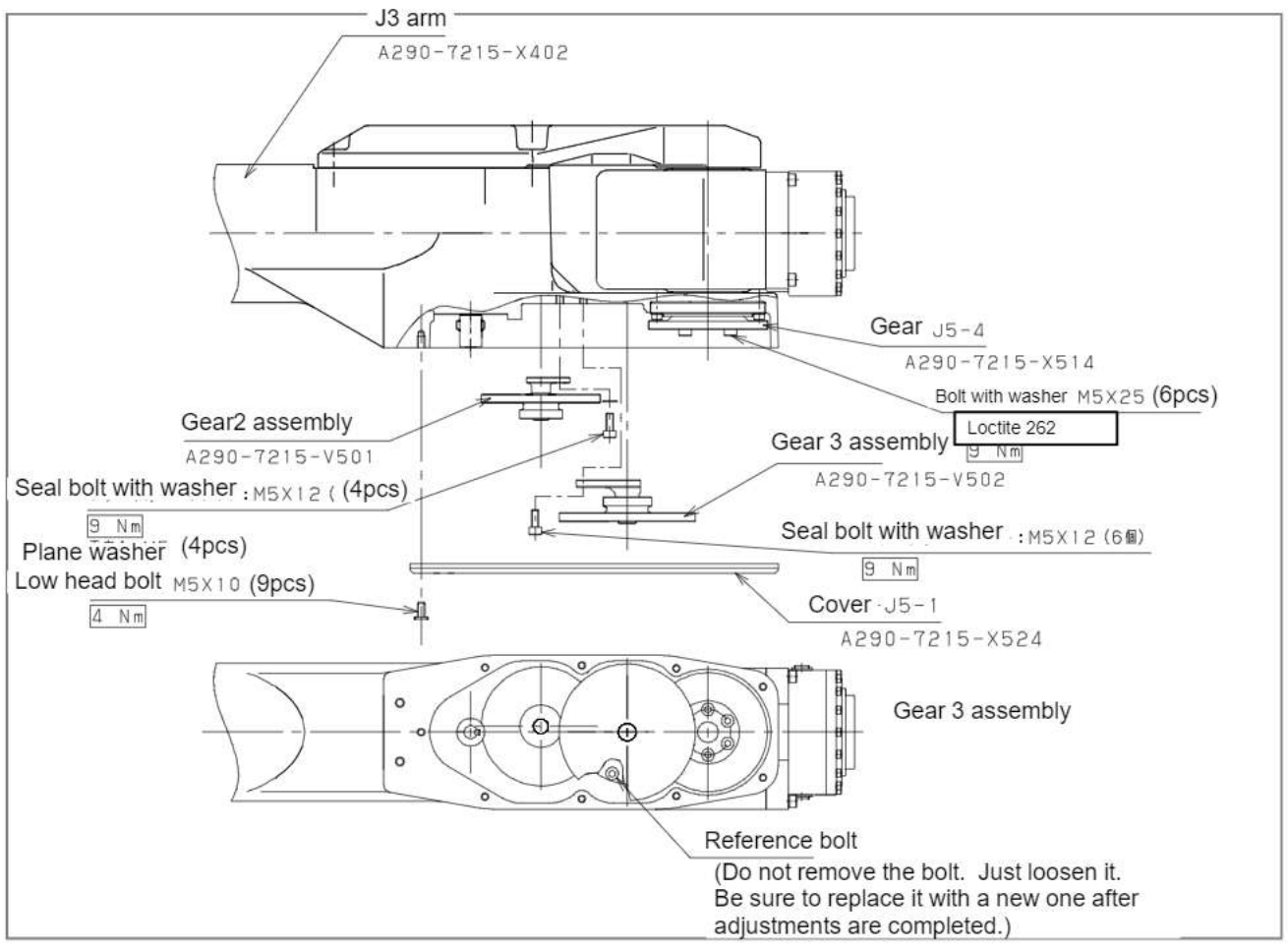


Fig 6.10 Replacing the J5–axis gear

6.11 REPLACING THE J6–AXIS MOTOR M6 AND REDUCER

1) Replacing the J6–axis motor M6

1 Place the robot in a posture of J4 = –90° and J5 = 0°.
2 Turn off the controller power.
3 While referencing Section 8.2, dismount the J5–2 cover, remove the two M4 × 6 seal bolts that fasten the J5–2 clamp (A290–7215–X531) in the cover, and release the J5–2 clamp. Now it is easy to take out the wrist flange. (The J5–2 clamp can move through the J5 hollow section.)
4 As shown in Fig. 6.11 (a), remove the four M5 × 25 bolts, and dismount the wrist flange from the J6 housing (A290–7215–X501).
5 While referencing Section 8.2, remove the two M3 × 6 bolts that fasten the J6 motor connector to the J6 clamp (A290–7215–X534), and dismount the clamp from the wrist flange.
6 Remove the four M5 × 12 bolts with a washer that fasten the motor to the wrist flange, and dismount the motor from the wrist flange.
7 Remove the M3 × 8 bolts and washers (A290–7215–X532), and dismount the reducer wave generator from the motor.
8 Fasten the wave generator to the shaft of a new motor (with two axes equipped with a brake (A06B–0114–B075#0008) or six axes equipped with a brake (A06B–0114–B275#0008)) with M3 × 8 bolts by applying Loctite 242 and tightening with a torque of [2 Nm]. (Do not forget to insert washers [A290–7215–X532].) Also apply a plenty of grease (Mori White RE No. 00) around the wave generator.
9 Attach a new gasket (A97L–0040–0042#07) to the motor flange with Alvania grease, and fasten the motor to the wrist flange with four M5 × 12 bolts with a washer (by applying Loctite 262). Be sure to use a new gasket so as to prevent grease leakage.
10 Pass a new gasket (A290–7215–X533) over the cable, and attach the J6 clamp (A290–7215–X534) to the wrist flange with two M3 × 6 bolts. Attach the motor cable connector. It will be convenient that you hook the gasket on the parallel pins on the J6 housing.
11 After making sure that the gasket (A290–7215–X533) is placed properly between the J6 housing and wrist flange, fasten the wrist flange equipped with the motor to the J6 housing with four M5 × 25 bolts by (applying Loctite 262 and) tightening with a torque of [9 Nm]. At this point, while referencing Section 8.2, be careful to keep non–bound movable cable portions in the J5–axis hollow section from being caught in the J6 housing. If the robot is assembled and put in operation with the cables caught, it is likely that the service life of the cables may be badly shortened.

12 While referencing Section 8.2, being careful to keep the non–bound movable cable portions in the J5–axis hollow section from being twisted, fasten the J5–2 clamp (A290–7215–X531) to the J5–2 cover (A290–7215–X502) with two new M4 × 6 seal bolts. Be sure to use new bolts. Otherwise, the seal–ability of the wrist section may get lower. Then, while referencing Section 6.9, mount the J5–2 cover to the J3 arm (A290–7215–X402).

13 As described in Section 3.2, supply the J6–axis grease bath with the specified grease.

14 While referencing Chapter 5, perform mastering.

2) Replacing the J6–axis reducer

1 Turn off the controller power.

2 Following procedure (1) on the previous page, remove the J5–2 cover, and dismount the wrist flange from the J6 housing (A290–7215–X501). Also dismount the motor from the wrist flange, then wave generator from the motor.

3 While referencing Section 8.2, remove the two M3 × 6 bolts that fasten the J6 motor connector and J6 clamp (A290–7215–X534), and dismount the J6 clamp from the wrist flange.

4 Remove the four M5 × 12 bolts with a washer that fasten the motor to the wrist flange, and dismount the motor from the wrist flange.

5 Remove M3 × 8 bolts and washers (A290–7215–X532), and dismount the reducer wave generator from the motor.

6 By following procedure (1) on the previous page, mount a new reducer wave generator to the motor, and apply a plenty of grease around the wave generator.

7 As shown in Fig. 6.11 (b), remove the eight M3 × 40 bolts with a washer that fasten the adapter (A290–7215–X543) to the cross–roller ring, and dismount the adapter (A290–7215–X543) from the cross–roller ring.

8 Remove the twelve M3 × 15 bolts with a washer that fasten the circular spline, adapter B (A290–7215–X544), and the ring (A290–7215–X545) to the adapter (A290–7215–X543), and dismount the adapter from the circular spline. Mount and fasten a new circular spline together with adapter B (A290–7215–X543) and the ring to the adapter (A290–7215–X543) with twelve M3 × 15 bolts with a washer (by applying Loctite 262 and tightening with a torque of [2 Nm]).

9 Remove the six M5 × 12 bolts that fasten the flex spline, and dismount the flex spline from the cross–roller ring. Position a new flex spline with the flange (A290–7210–X524) and f3 × 8 parallel pins, and fasten it with six M5 × 12 bolts with a washer (by applying Loctite 262 and tightening with a torque of [9 Nm]).

10 After making sure that the O–ring (S71) is set properly in the adapter (A290–7215–X543), mount the cross–roller ring on the (A290–7215–X543), and fasten them with eight M3 × 40 bolts with a washer (by applying Loctite 262 and tightening a torque of [2 Nm]).

11 While referencing (1) in Section 6.11, mount the motor, and also mount the wrist flange to the J6 housing. Then attach the J5–2 cover.

12 According to Section 3.2, supply the J6–axis grease bath with the specified grease.

13 While referencing Chapter 5, perform mastering.

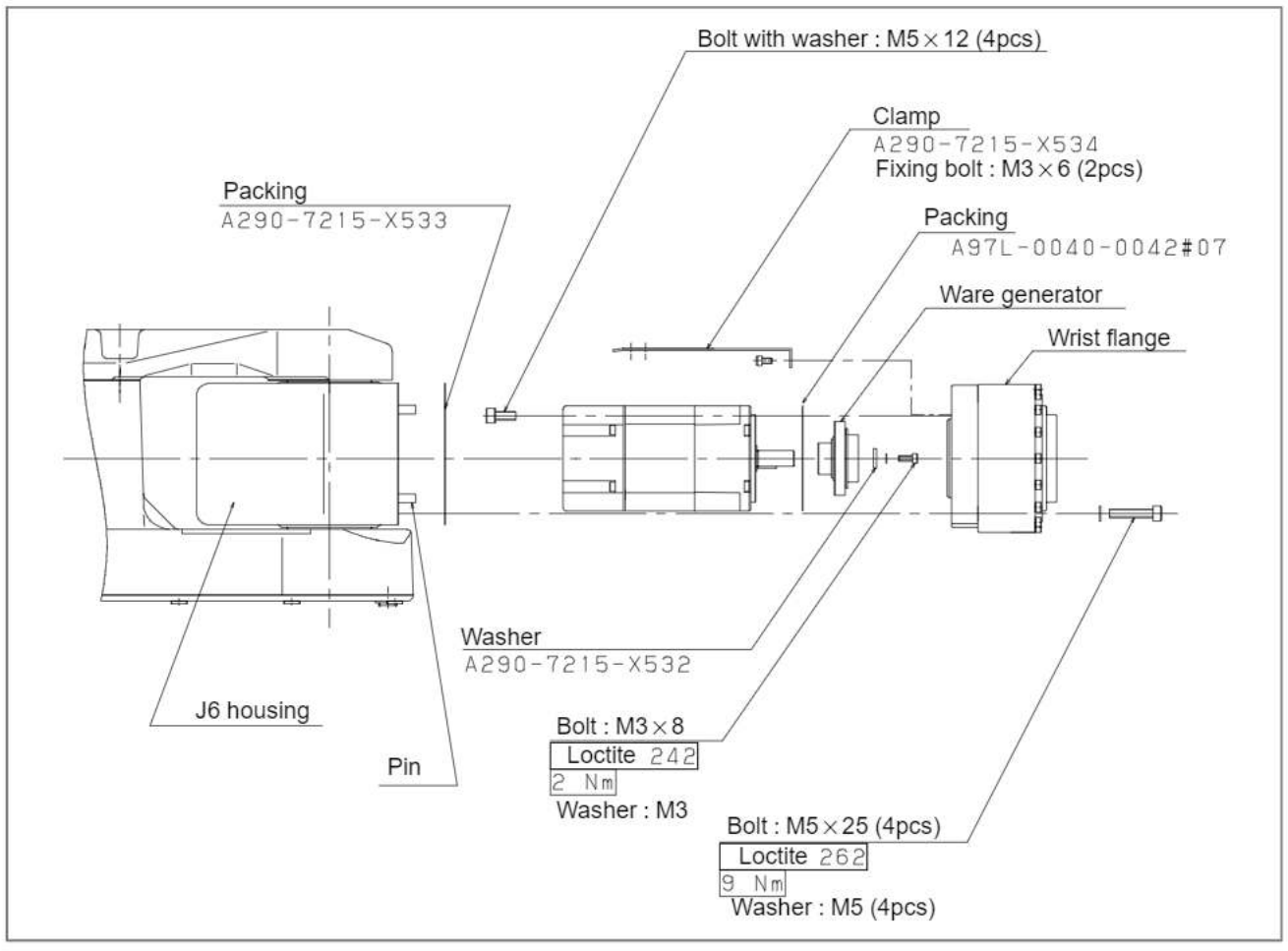


Fig 6.11 (a) Replacing the J6–axis motor and reducer

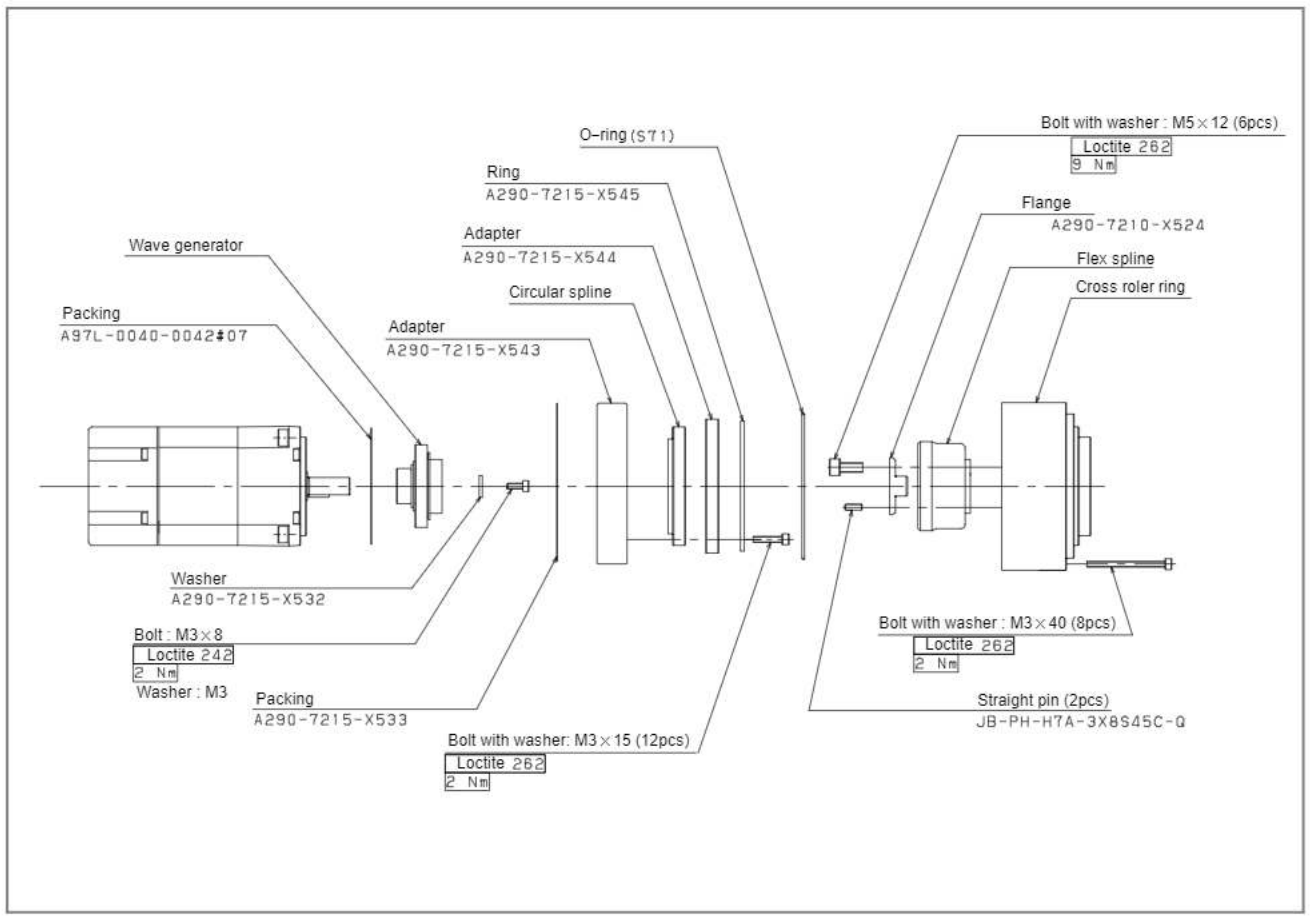


Fig 6.11 (b) Replacing the J6–axis reducer

7 PIPING AND WIRING

7.1 PIPING DRAWING

Fig. 7.1 shows the diagram of piping in the mechanical unit.

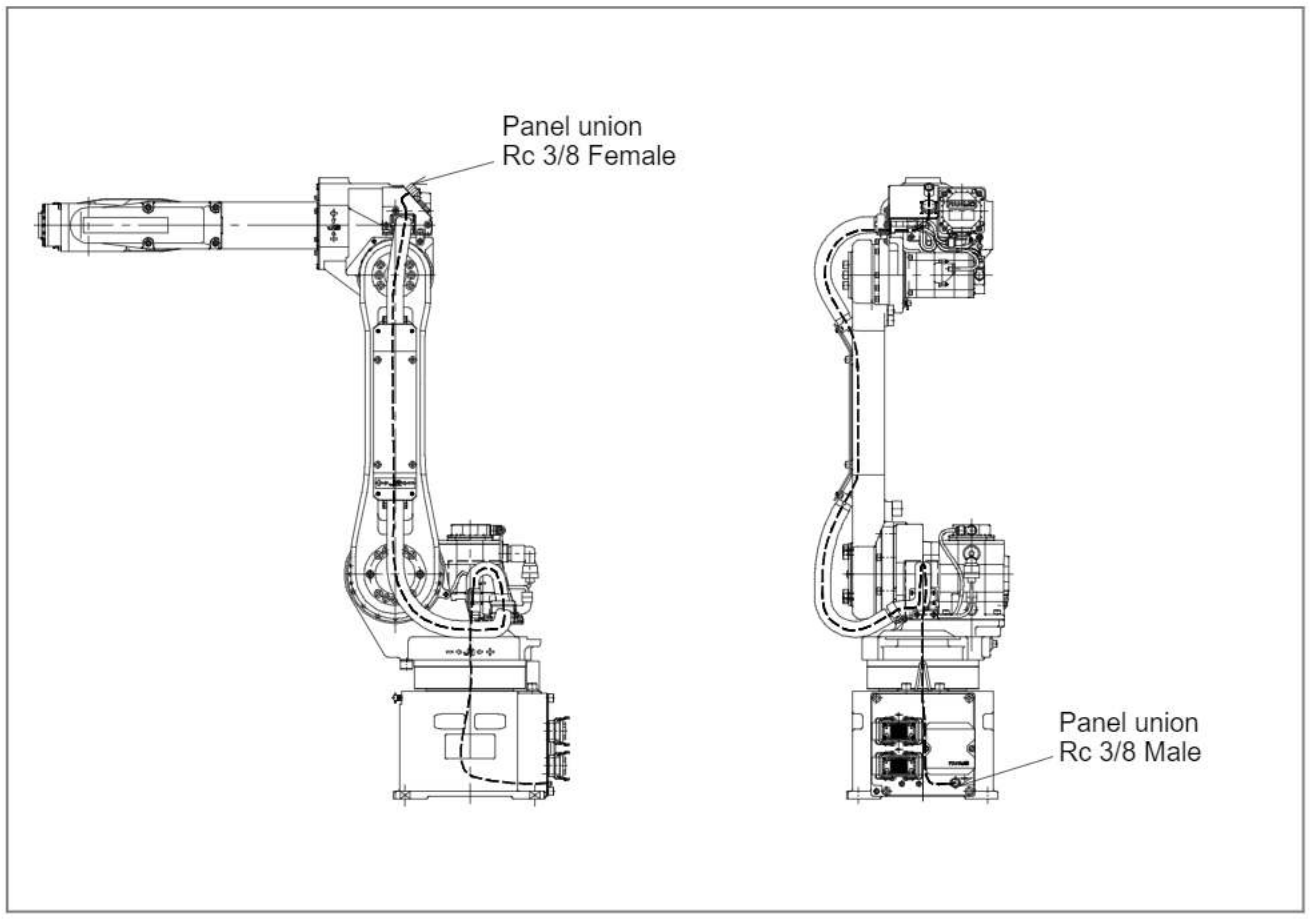


Fig 7.1 Piping diagram

7.2 WIRING DIAGRAMS

Fig. 7.2 (a) and Fig. 7.2 (b) show the diagrams of wiring in the mechanical unit.

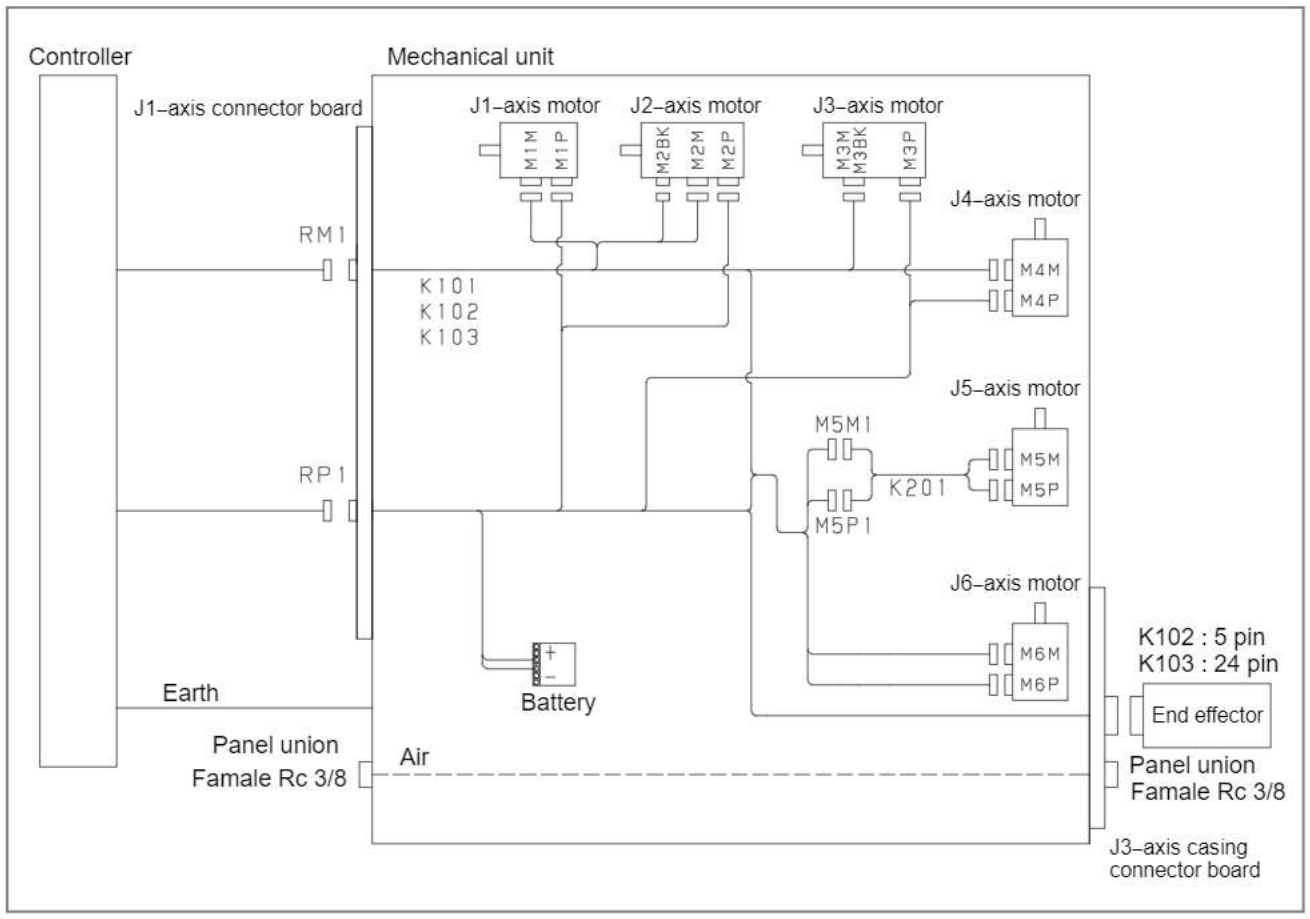


Fig 7.2 (a) Wiring in the mechanical unit with two axes equipped with a brake

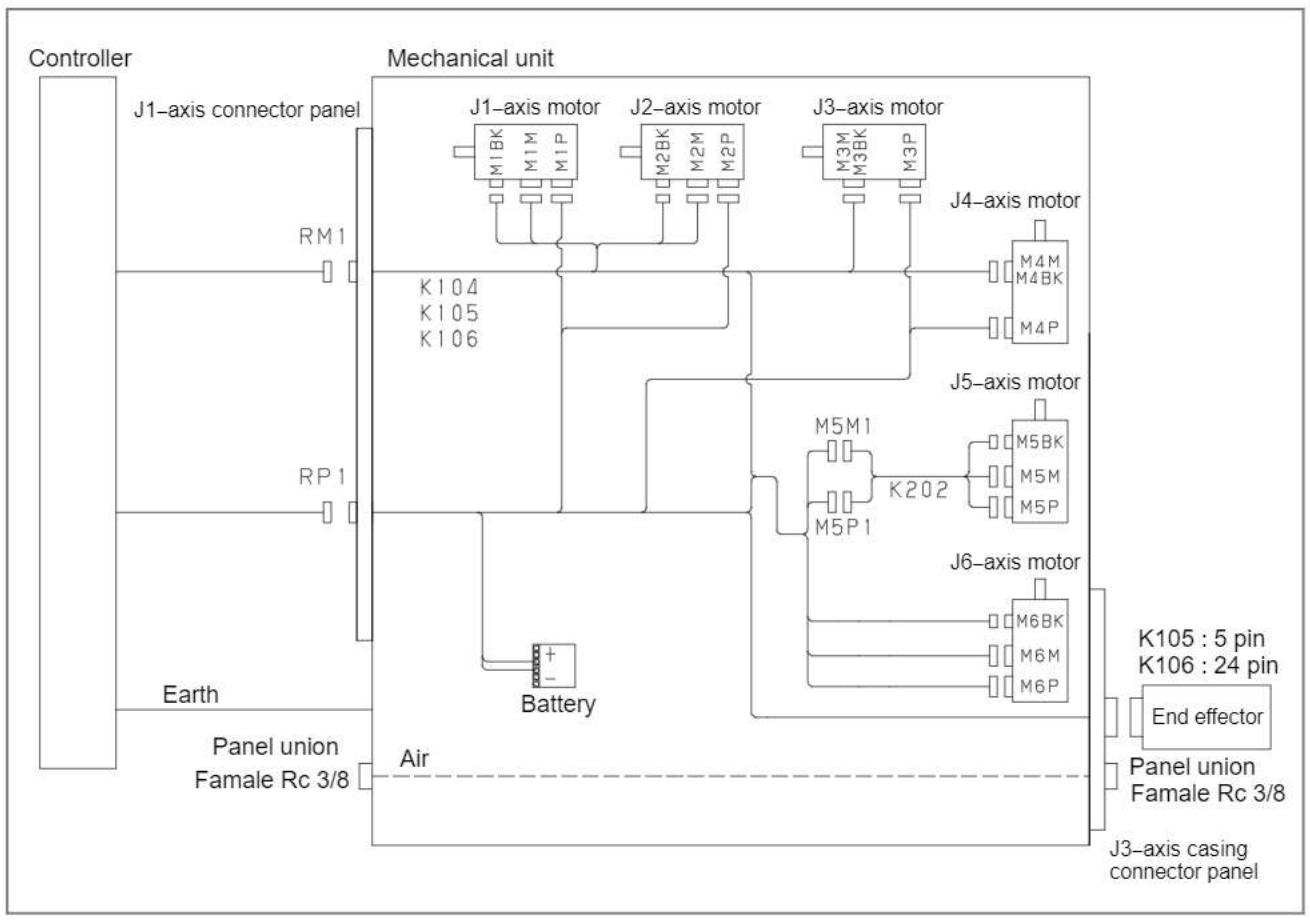


Fig 7.2 (b) Wiring in the mechanical unit with all axes equipped with a brake

7.3 CABLE MOUNTING DIAGRAM

Make the following visual checks to see if there is any abnormal cable.

1) Whether the swiveling motion of the robot has caused any local torsion or bending in the swiveling section.
2) Whether the cables leading to the J2– or J3–axis sections have worn each other during operation.
3) Whether the route of cables leading to the end effector is appropriate for the operation of the wrist and the service operation of the robot.

Fig. 7.3 is the mounting diagram of cables in the mechanical unit.

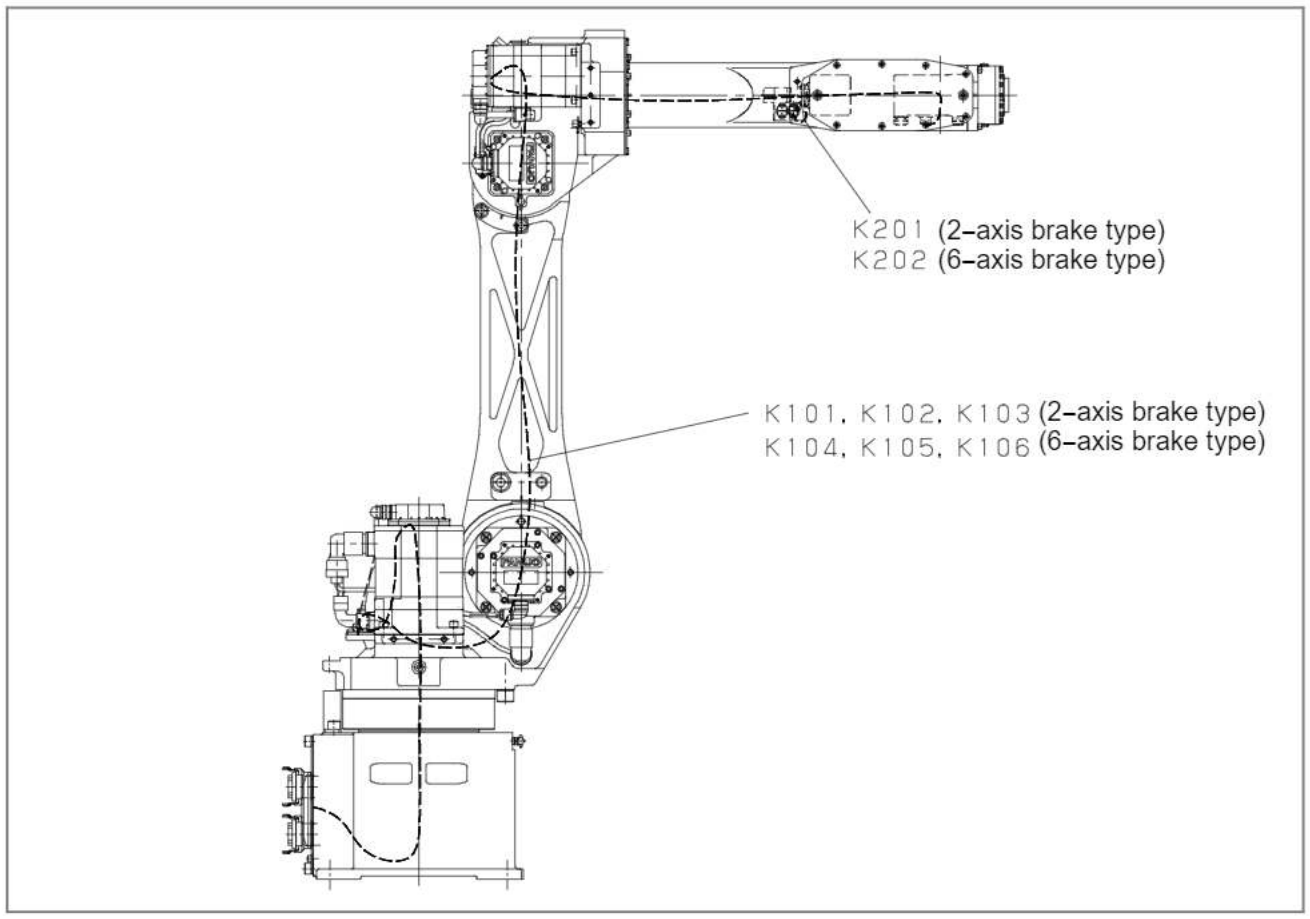


Fig 7.3 Cables in the mechanical unit

8 CABLE REPLACEMENT

Replace the cables of the robot once every four years. If a cable is broken or damaged, replace it according to the procedure described in this chapter.

Cautions in handling the pulse coder cable

When transporting, installing, or maintaining the robot, do not detach the pulse coder cables carelessly. The cables are provided with the marking tie shown below. If you detached any cable with the marking tie, you need to perform mastering for the robot.

Do not detach any connector unless you replace a motor, pulse coder, reducer, or cable.

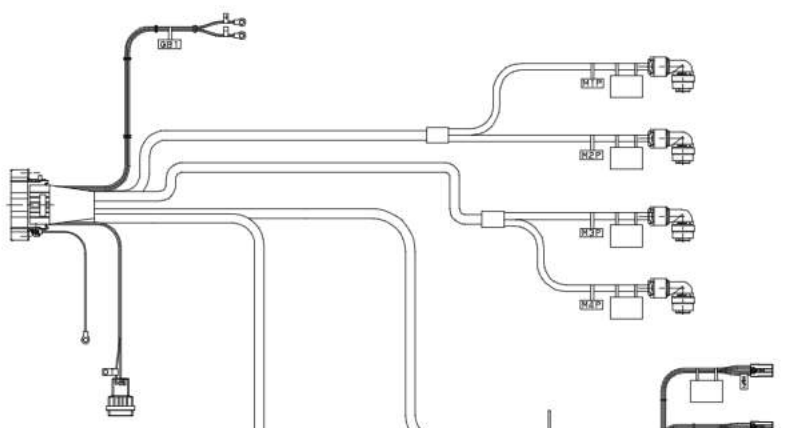
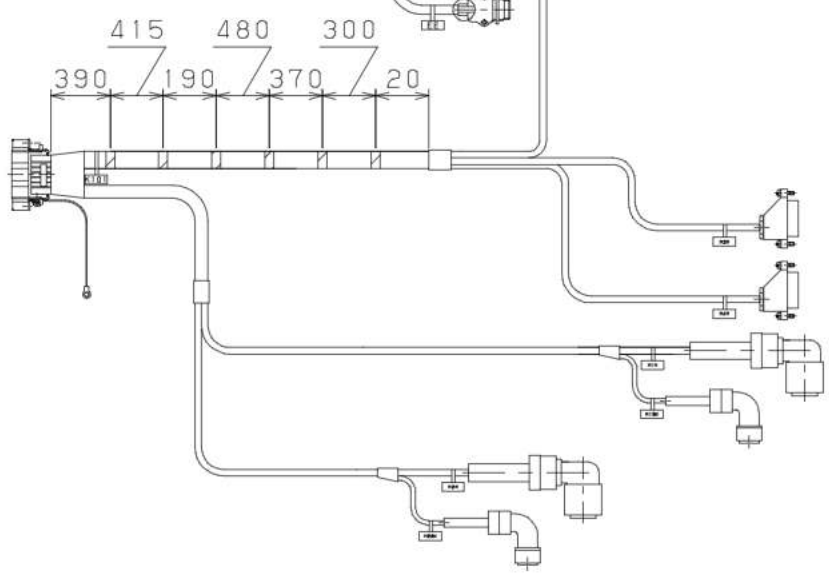
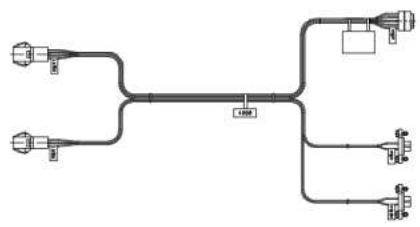
Fig 8 Marking tie

If there is a break in or any other damage to a cable, replace the cable according to the procedure described in this chapter. If the connector of a pulse coder cable (K101, K102, K103, K104, K105, K106, K201, or K202) is detached, the data about the absolute position of the robot is lost. Once any of these cables is replaced, perform simplified mastering while referencing Section 5.3. If the data is lost because of a break in a cable, also perform simplified mastering to calibrate the robot into the previous absolute position.

8.1 CABLE DRESSING

After a cable is replaced individually rather than in kit, clamp it with rubber bushings and nylon ties (cable ties) at the specified positions listed in Table 8.1. Otherwise, the cable may sag or become too tight, leading to a break in the cable.

Table 8.1 Cable clamp positions

Mark	Cable clamping position	Mark	No.
RP1		+6V 0V M1P M2P M3P M4P M5P1 M5P1 M6P M6M (M6BK) EE	K101 K102 K103 K104 K105 K106
RM1		M3M M3BK M4M (M4BK) M1M (M1BK) M2M M2BK	
M5P1 M5M1		M5P M5M (M5BK)	K202

8.2 REPLACING CABLES

First, place the robot in a posture of the J4–axis being at –90° and all other axes being at 0°. Before starting cable replacement, put the controller apart from the robot main body.

1) Replacing the cable kit
   1 Cut the nylon ties (cable ties) for the J2–/J3–axis Cornex cover, and take out the cover from the cable kit.
   2 Dismount the J1 connector board from the J1 base. (See Fig. 8.2 (a).)
   3 Cut the nylon tie that bounds the rubber boot, and detach the rubber boot from the cable. Separate the RM1 and RP1 connector inserts from the connector housing on the J1 connector board. (Dismount the connector housing from the J1 connector board because otherwise the rubber boot will get caught on the housing and their removal will be hindered.)
   Dismount the terminals from the battery box.
   4 Remove the M1M, M1BK (with six axes equipped with a brake), M2M, M2BK, M1P, and M2P connectors from the J1–/J2–axis motor.
   5 While referencing Fig. 8.2 (a), remove the two M6 × 6 bolts that fasten the plate (A290–7215–X222) in the J1 base, and pull out the cable from the inside of the J1 base toward the upper section of the J1 hollow pipe section. The connector inserts mentioned in <3> tend to get caught inside the pipe. Do not force it out from the pipe. Otherwise, a break may occur in the cable.
   6 While referencing Fig. 8.2 (b), remove the two M6 × 10 bolts that fasten the cable cover above the J2 base (A290–7215–X301), and dismount the cable cover.
   7 While referencing Fig. 8.2 (b), remove the two M8 × 10 bolts that fasten the plate (A290–7215–X331), and dismount the plate.
   8 While referencing Fig. 8.2 (b), remove the four M8 × 10 cable kit mounting bolts from the J2 arm, and dismount the cable kit from the J2 arm.
   9 While referencing Section 6.11, dismount the J5–2 cover and wrist flange unit, and then remove the J6–axis motor connector. Then, as shown in Fig. 8.2 (c), cut nylon ties (cable ties) for the J6 clamp (A290–7215–X534) and the J5–2 clamp (A290–7215–X531) [and also for the support (A290–7215–X529)] to separate the non–bound cables portions.
   10 While referencing Fig. 8.2 (b), remove the four M6 × 10 bolts that fasten the plate (A290–7215–X430) on the rear of the J3 casing. Loosen the nut for the resin bushing that fastens the plate, and slide the bushing in such a direction that the cable will become loose.
   11 As shown in Fig. 8.2 (c), remove the two M5 × 10 bolts that fasten the J5–1 clamp (A290–7215–X525), and dismount the J5–1 clamp from the J3 arm, and pull it out. Then, cut the nylon ties (cable ties), and pull out the cable from the inside of the wrist toward the rear of the J3 casing.
   12 While referencing Fig. 8.2 (b), remove the two M6 × 10 bolt that fasten the plate (A290–7215–X426) on the J3 casing, and dismount the cable kit completely from the robot main body.

13 Mount a new cable kit by reversing the above steps. In this case, however, do not tighten the nut for the resin bushing on the plate (A290–7215–X430) behind the J3 casing. After passing the cables through the J3 arm, pass them through the J5–2 cover (A290–7215–X502) and gasket (A290–7215–X527), and then insert them into the J6 housing.

14 After going back to 8 on the previous page, fasten the J5–2 clamp (A290–7215–X531) together with the support (A290–7215–X529) to the non–bound cable portions. After fixing the nylon ties, do not fasten the J5–2 clamp to the J5–2 cover immediately; keep it loose.

15 While referencing Fig. 8.2 (c), attach the J6 clamp (A290–7215–X534) to the non–bound cable portions. Be careful to keep non–bound twisted pairs from being twisted. Also carefully observe a rated clamp distance of 160 mm shown in Fig. 8.2 (c).

16 After making sure that the non–bound twisted pairs are not twisted in the J5–axis hollow section or not caught in the J6 housing, fasten the J6 clamp (A290–7215–X534) to the J5–2 cover with two new M4 × 6 seal bolts. Then make sure that J5–1 clamp (A290–7215–X525) is fastened to the inside of the J3 arm securely, and mount the J5–2 cover. At this point, make sure that the non–bound cable portions are not worn against any sheet metal edge inside the J3 arm and that they are not caught under the J5–2 cover when it is attached. (If it is likely that a non–bound cable portion may be worn against any sheet metal edge, confine it with a nylon tie (cable tie) or take a similar measure.)

17 With the nut for the resin bushing on the plate (A290–7215–X430) behind the J3 casing kept loose, twist the cables passing the J4 hollow section through 90° clockwise as viewed from behind the J3 casing (to prevent the cables from twisting when the J4–axis is at 0°) so that the cables will not be too tight or not sag behind the J3 casing. Then tighten the resin nut by hand.

18 Mount the cable kit by going back from 7 to 2.

19 Attach the rubber boot to the previous place.
Before mounting the J1 connector board to the J1 base, push the OT jumper connector into the rubber boot, and bind the opening of the rubber boot for both RM1 and RP1 with a nylon tie. While being careful not to pinch non–bound cable portions, mount the J1 connector board on the J1 base.

20 Mount the J2–/J3–axis Cornex cover on the cable kit again, and fasten them with a nylon tie (cable tie). (Do not fasten the nylon tie too tightly.)

2) Replacing the cables separately

1 While referencing item (1) of Section 8.2, dismount the cable kit from the robot main body, and remove the J2–/J3–axis Cornex cover.

2 While referencing Fig. 8.2 (d), dismount the clamp and grommet from the cable kit, and replace the cables. After cable replacement, mount the clamp and grommet, but do not tighten the mounting bolts.

3 Mount the cable kit on the robot main body as before. (See (1) of Section 8.2.) Arrange the cables inside and outside the J2–/J3–axis movable section by shifting the wires so that they are at regular intervals and look natural. After their length is adjusted, tighten the mounting bolts for the grommet retaining clamp.

4 Mount the Cornex cover as before. (Tight the nylon tie but not firmly.)

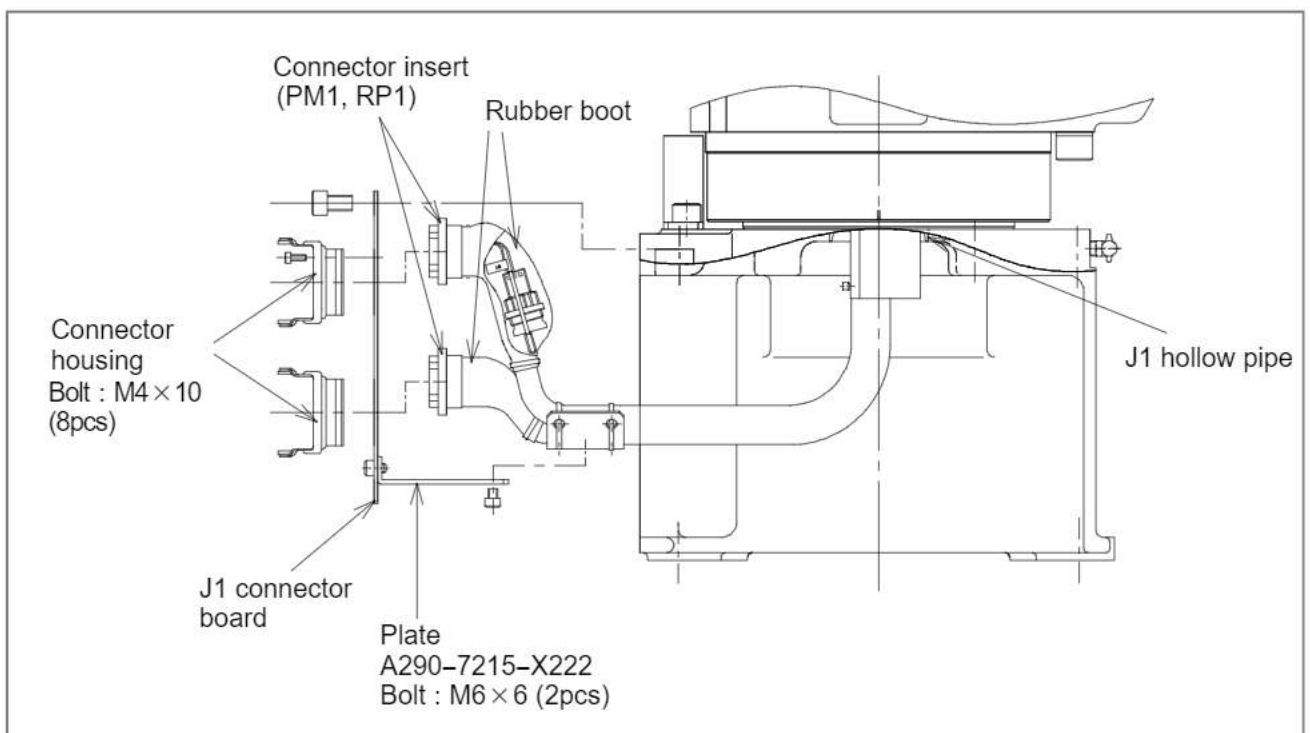


Fig 8.2 (a) Replacing the cable kit

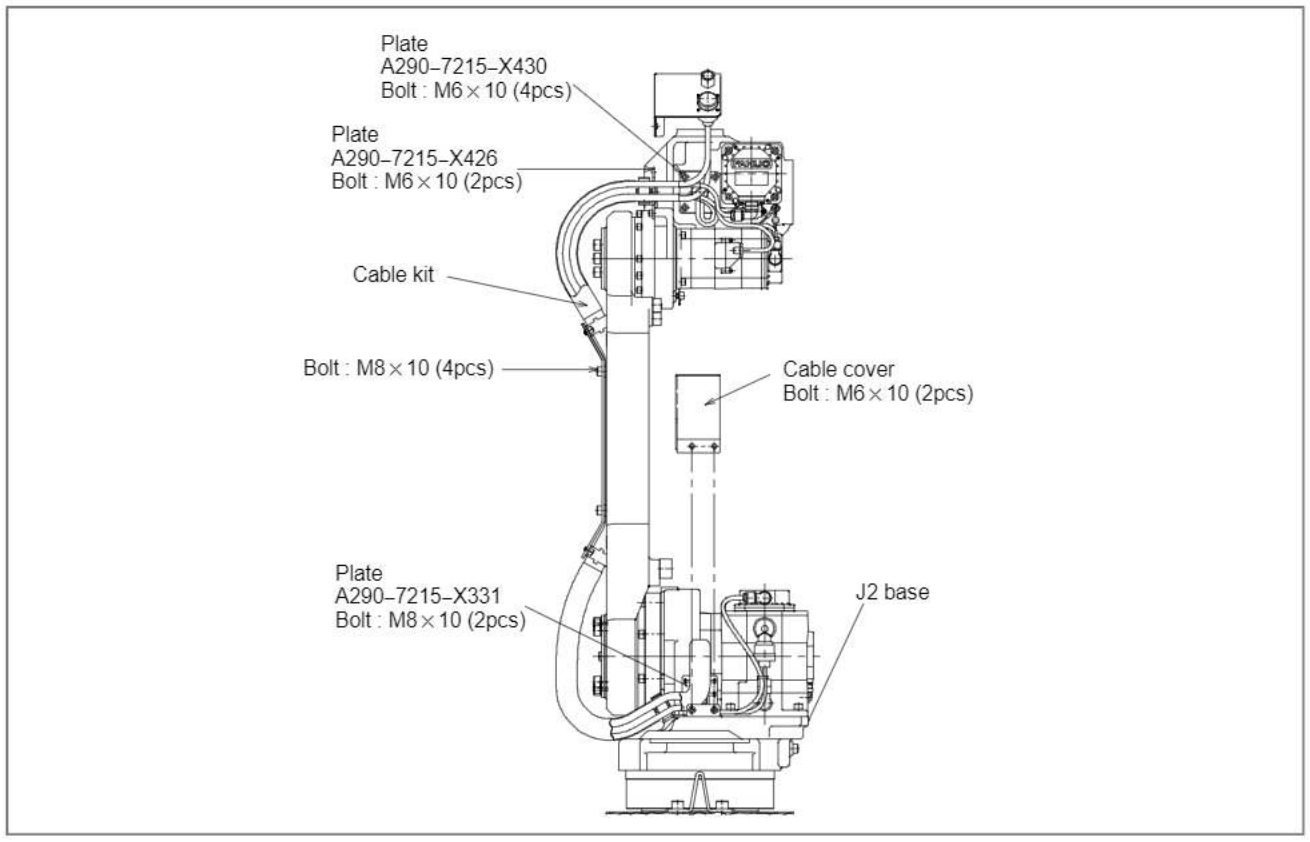


Fig 8.2 (b) Replacing the cable kit

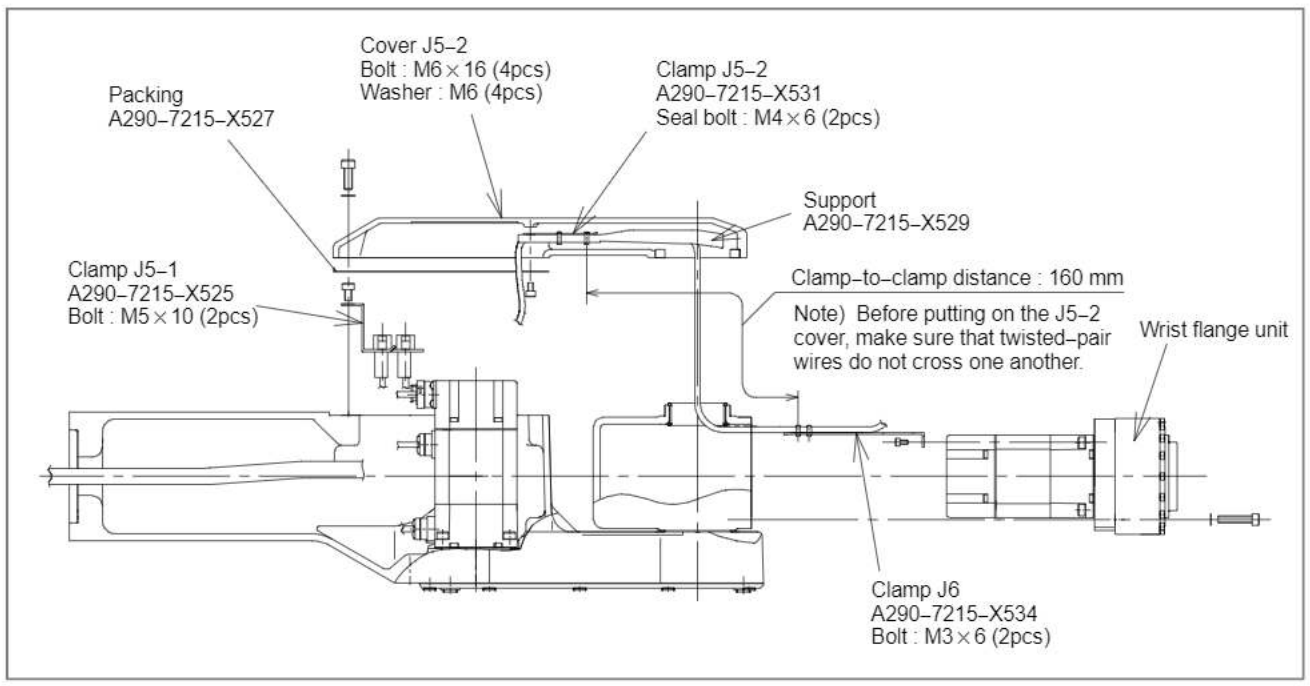


Fig 8.2 (c) Replacing the cable kit (wrist section)

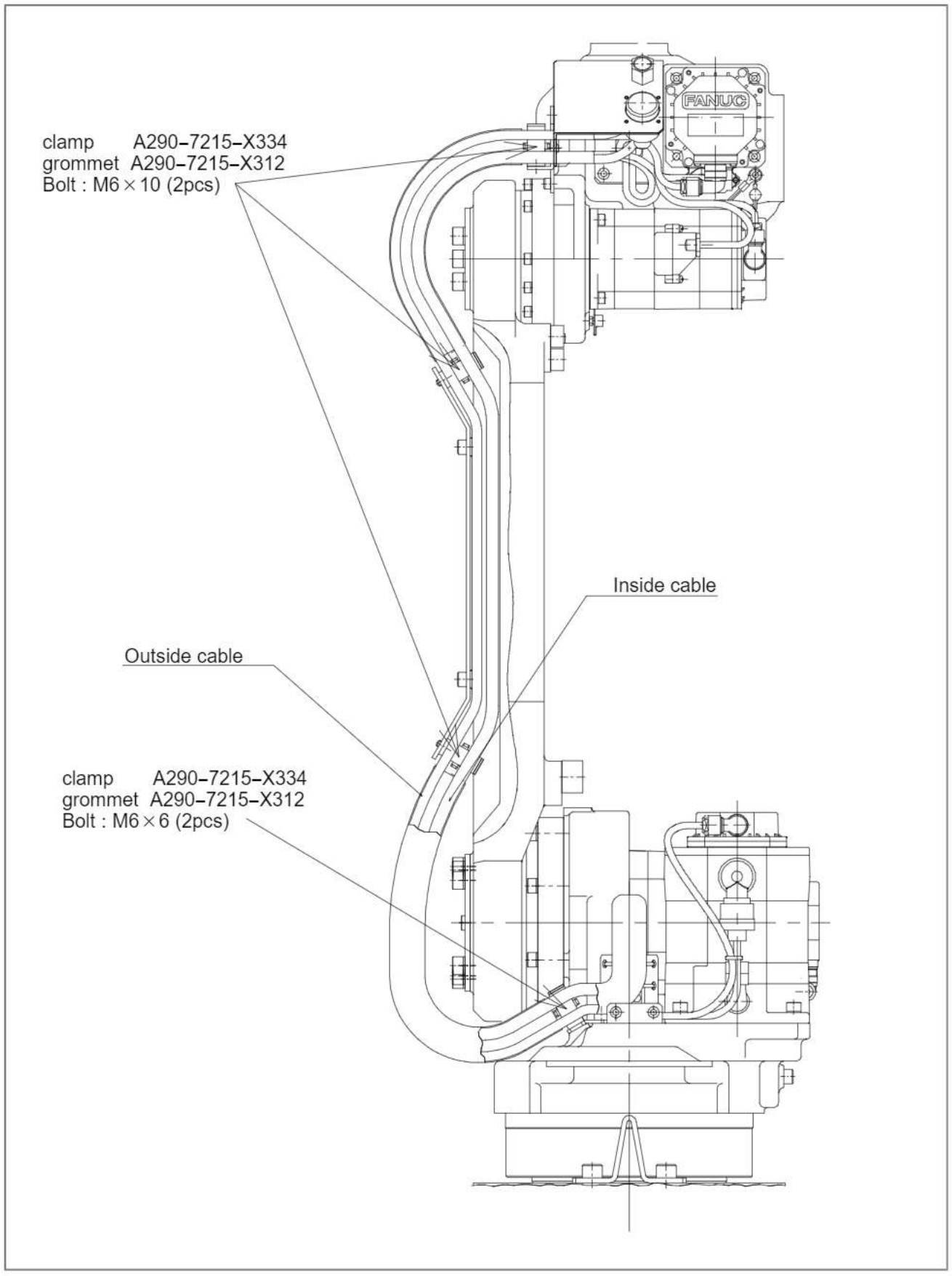


Fig 8.2 (d) Adjusting cable length

9 COVER OPTION REPLACEMENT

9.1 REPLACING THE J2 COVER OPTION (A05B–1210–J401)

Fig. 9.1 shows a method for replacing the J2 cover option.

(Replacement procedure)

1 Remove the three M6 × 8 button bolts that fasten the J2 cover (A290–7210–X371), and dismount the J2 cover from the supports.
2 Remove the two M8 × 16 bolts that fasten the clamp (A290–7210–X333) and supports (A290–7210–X372 and A290–7210–X373) to the clamp (A290–7210–X333), and dismount the supports (A290–7210–X372 and A290–7210–X373).
3 Remove the M8 × 10 seal bolt that fastens the support (A290–7210–X374) to the J2 base (A290–7210–X301), and dismount the support (A290–7210–X374).
4 Mount the supports and J2 cover by reversing the procedure. To reuse the seal bolt that was removed, wind seal tape around it.

Fig 9.1 Replacing the J2 cover option (ARC Mate 100*i*/M–6*i*)

9.2 REPLACING THE J4 COVER OPTION (A05B–1210–J402)

Fig. 9.2 shows a method for replacing the J4 cover option.

(Replacement procedure)

1 Remove the six M5 × 8 button bolts that fasten the J4 cover (A290–7210–X435), and dismount the J4 cover.
2 Remove the M6 × 10 bolt that fastens the support (A290–7210–X437) to the J3 plate, and dismount the support (A290–7210–X437).
3 Remove the M6 × 10 bolt and the two M5 × 8 button bolts that fasten the support (A290–7210–X436), and dismount the support (A290–7210–X436).
4 Mount the supports and J4 cover by reversing the procedure.

Fig 9.2 Replacing the J4 cover option (ARC Mate 100*i*/M–6*i*)

10 M–6*i* PACKAGES WITH REINFORCED DUST–PROOF AND DRIP–PROOF CHARACTERISTICS

The M–6*i* packages with reinforced dust–proof and drip–proof characteristics have been reinforced for dust–proof and drip–proof characteristics so that they enable the robot to withstand harsh environments. They are also rust–proof so that the robot can be used for a long period.

Specifications

M–6*i* mechanical unit
(with two axes equipped with a brake): A05B–1210–B202
M–6*i* mechanical unit
(with six axes equipped with a brake): A05B–1210–B602

NOTE
The packages with reinforced dust–proof and drip–proof characteristics are available only for the M–6*i*; they are unavailable for the ARC Mate 100*i*.

10.1 DUST–PROOF AND DRIP–PROOF PERFORMANCE OF THE PACKAGES WITH REINFORCED DUST–PROOF AND DRIP–PROOF CHARACTERISTICS

The following table lists the dust–proof and drip–proof performance of the M–6*i* packages with reinforced dust–proof and drip–proof characteristics according to JIS C0920.

	Packages with reinforced dust–proof and drip–proof characteristics
Wrist section and J3 arm section	IP67
Main body	IP55

Fig 10.1 Dust–proof and drip–proof performance of the M–6*i* packages with reinforced dust–proof and drip–proof characteristics

10.2 CONFIGURATION OF THE PACKAGES WITH REINFORCED DUST–PROOF AND DRIP–PROOF CHARACTERISTICS

The following table lists the major differences between the M–6*i* standard specification and the M–6*i* packages with reinforced dust–proof and drip–proof characteristics.

	Standard specification	Package with reinforced dust–proof and drip–proof characteristics
Coating	Polyurethane enamel coating or melamine enamel coating	Polyurethane enamel coating
Bolt and washer	Blackened steel bolt Blackened washer	FR–coated bolt Stainless bolt Black chromated washer
Cover		J1 cover J2 cover J4 cover Battery box cover
EE connector	Non–waterproof connector	Waterproof connector
Others		Sealing gasket for the connector box Sealed tap Rust–proof grease coating

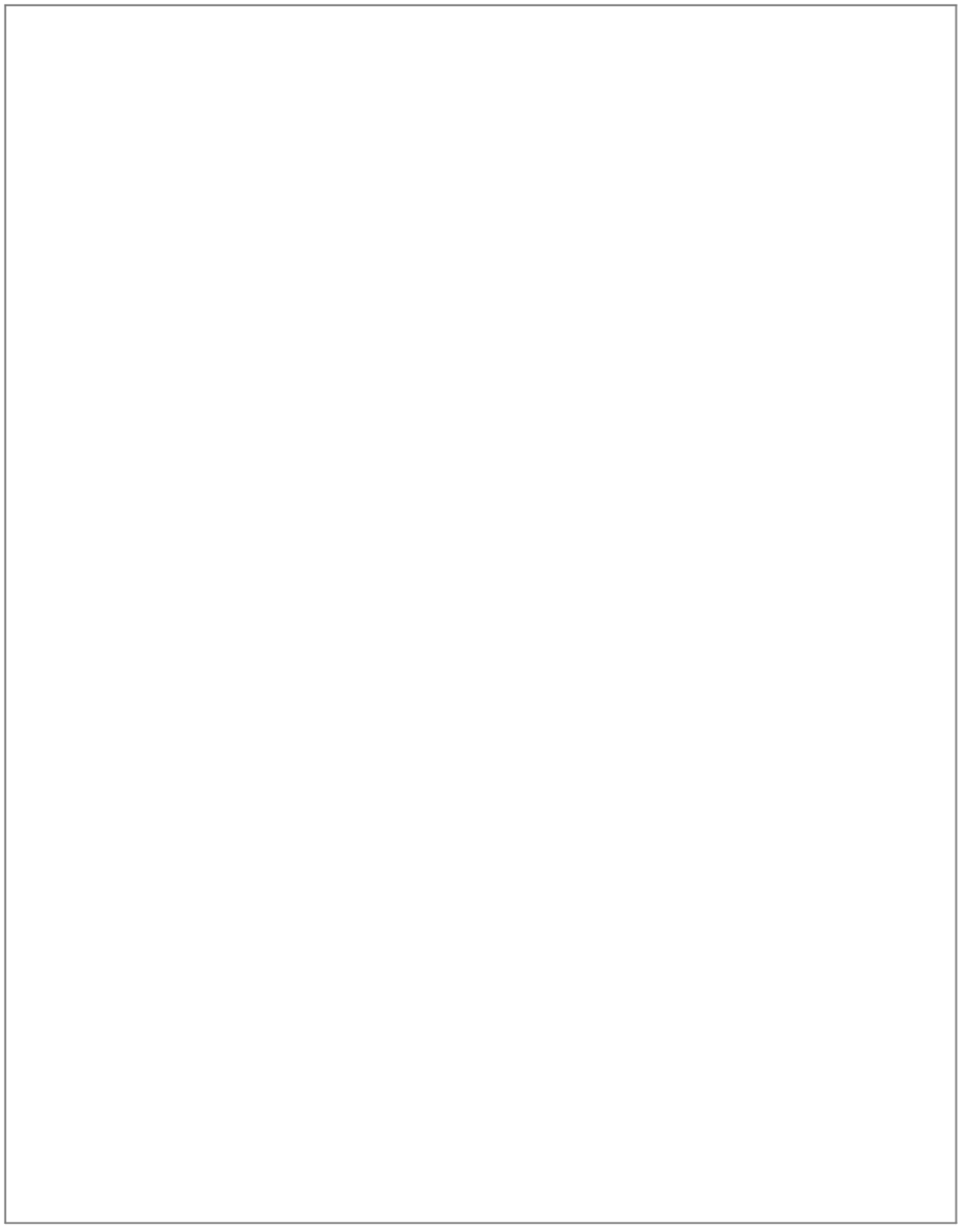


Fig 10.2 Configuration of the package with reinforced dust–proof and drip–proof characteristics

10.3 CAUTIONS IN SELECTING THE PACKAGES WITH REINFORCED DUST–PROOF AND DRIP–PROOF CHARACTERISTICS

1) The following fluids can deteriorate or corrode the rubber components (such as gaskets, oil–seals, and O–rings) of the robot. So the packages with reinforced dust–proof and drip–proof characteristics cannot be used in environments with these fluids.
   a) Organic solvent
   b) Chlorine or gasoline coolant
   c) Corrosive fluids (such as acid and alkaline), and fluids or solutions that can cause rust
   d) Any other fluid or solution to which nitrile rubber (NBR) is not resistant
2) When the robot is used in an environment where water or any other fluid splashes onto the robot, be sure to drain under the J1 base. A trouble can occur if the J1 base is kept in fluid constantly.

10.4 REPLACING THE COMPONENTS OF THE PACKAGES WITH REINFORCED DUST-PROOF AND DRIP-PROOF CHARACTERISTICS

1) Replacing the J1 cover
   1 Cut the nylon tie that fastens Cornex motor cover 6 (A290-7210-X288), and dismount motor cover 6.
   2 Remove the ten M6×10SUS bolts that fasten motor cover 3 (A290-7210-X285), and dismount motor cover 3.
   3 Dismount the connector box from the J1 base.
   4 Remove the M6×10SUS bolt that fastens motor cover 4 (A290-7210-X286) and motor cover 5 (A290-7210-X287), and the one that fastens motor cover 1 (A290-7210-X283) and motor cover 5 (A290-7210-X287).
   5 Dismount motor covers 4 and 5 from motor cover 2 (A290-7210-X284).
   6 By reversing the procedure, mount motor covers 1 to 6 and the connector box.

Fig 10.4 (a) Replacing the J1 cover

2) Replacing the J2 cover
   Replace the J2 cover according to Section 9.1.
3) Replacing the J4 cover
   Replace the J4 cover according to Section 9.2.
4) Replacing the battery
   1 Turn off the robot power by pressing the EMERGENCY STOP button to disable the robot from moving.
   2 Remove the five M8×12SUS bolts that fasten cover 1 (A290-7210-X280/A290-7210-X282).
   3 Uncap the battery case, and take out the battery.
   4 Insert a new battery into the battery case while pay attention to the polarity of the battery.
   5 By reversing the procedure, cap the battery case, and attach cover 1.

Fig 10.4 (b) Replacing the battery

5) Replacing the K101 cable
   1 Remove all connectors from the connector box.
   2 Remove the J2 cover according to Section 9.1.
   3 Remove the J4 cover according to Section 9.2.
   4 While referencing Fig. 10.4 (c), remove the five M8 × 12SUS bolts that fasten cover 1 (A290–7210–X280/A290–7210–X282) and cover 2 (A290–7210–X281).
   5 Uncap the battery case, and remove the two screws (A6–SSA–4X10S) that fasten the battery case to cover 2.
   6 Remove the GB1 crimp terminals of the K101 cable (A660–8012–T043/A660–8012–T044) from the battery case.
   7 Remove the uniseal of the K101 cable from cover 2, and pull out the K101 cable from cover 2.
   8 According to 3 and below in Section 8.2, replace the K101 cable. The J1 cover need not be removed.

Fig 10.4 (c) Replacing the K101 cable (M–6*i* package with reinforced dust–proof and drip–proof characteristics)

II. CONNECTION

1 ROBOT OUTLINE DRAWING AND OPERATION AREA DIAGRAM

1.1 OUTLINE DRAWING AND OPERATION AREA DIAGRAM

Fig. 1.1 (a) shows the outline drawing and operation area diagram of a robot with a separate controller.
When installing a peripheral device, be careful not to let it interfere with the robot main body. While referencing Section 3.2, use 4–ϕ18 through holes in the base to install the peripheral device.
Fig. 1.1 (b) and (c) show the operation diagrams of the robot.

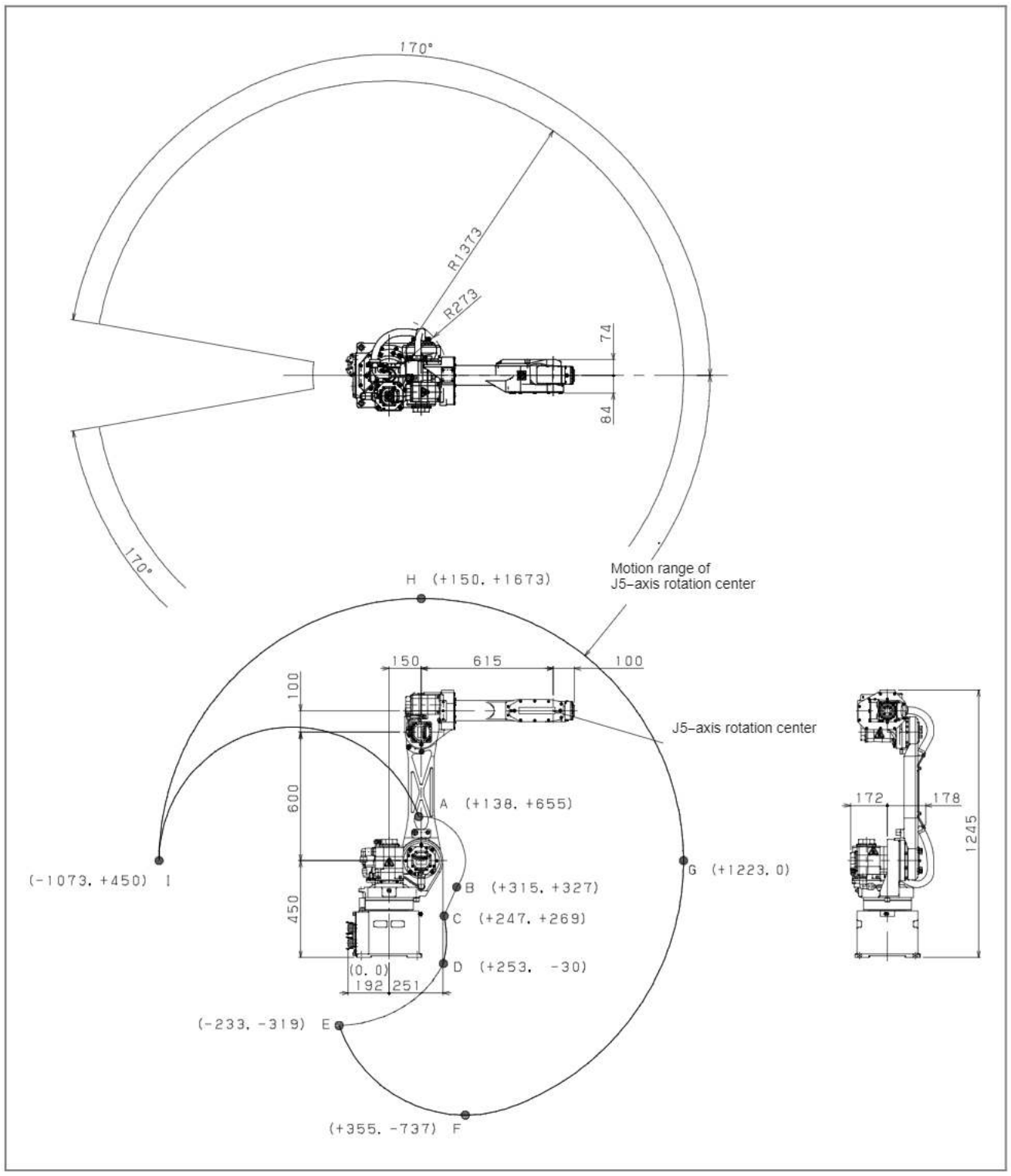


Fig 1.1 (a) Outline drawing and operation area diagram of a robot with a separate controller

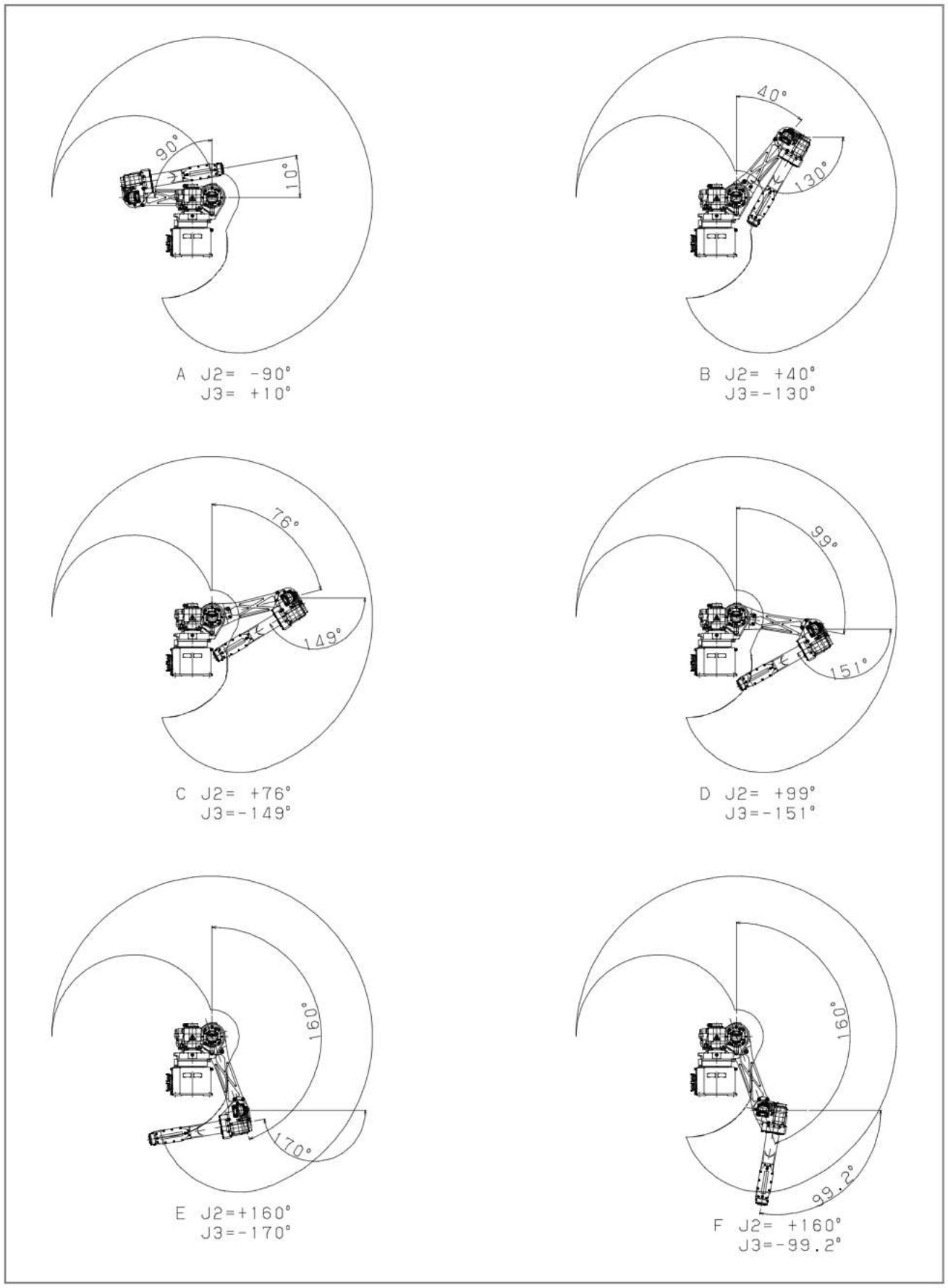


Fig 1.1 (b) Operation diagram of a robot with a separate controller (No. 1)

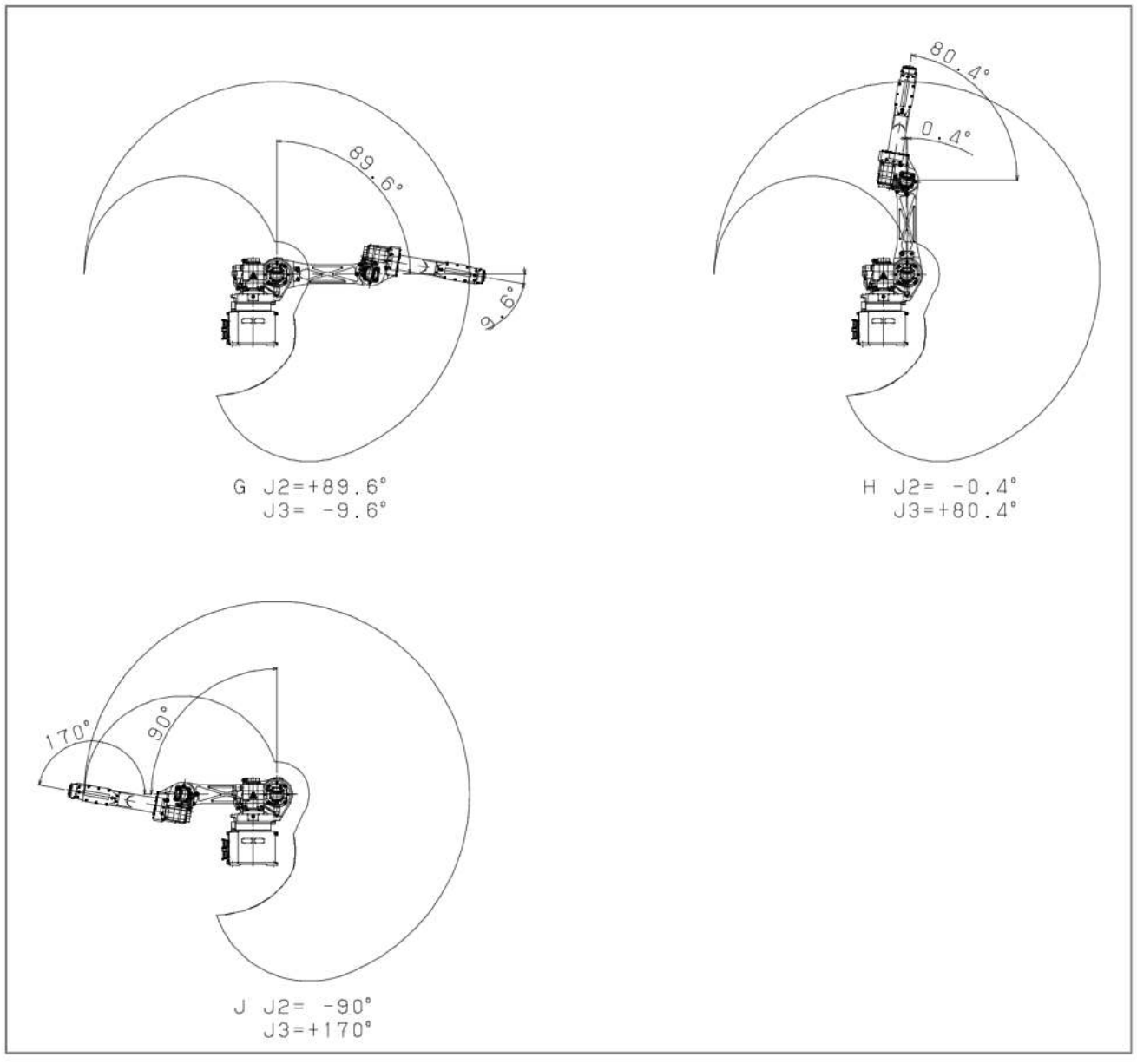


Fig 1.1 (c) Operation diagram of a robot with a separate controller (No. 2)

2 MOUNTING DEVICES ON THE ROBOT

2.1 WRIST SECTION END EFFECTOR MOUNTING SURFACE

1) Mounting surface for an ISO flange-type end effector (standard)

Fig. 2.1 (a) sows the end effector mounting surface at the tip of the wrist. The end effector is engaged using a ϕ50h7 spigot or ϕ25H7 socket, positioned using a 1-ϕ6H8 reamed hole, and fastened using four M6 self-tapping screws. As for the M6 self-tapping screws, select those not longer than the tapping depth (10 mm).

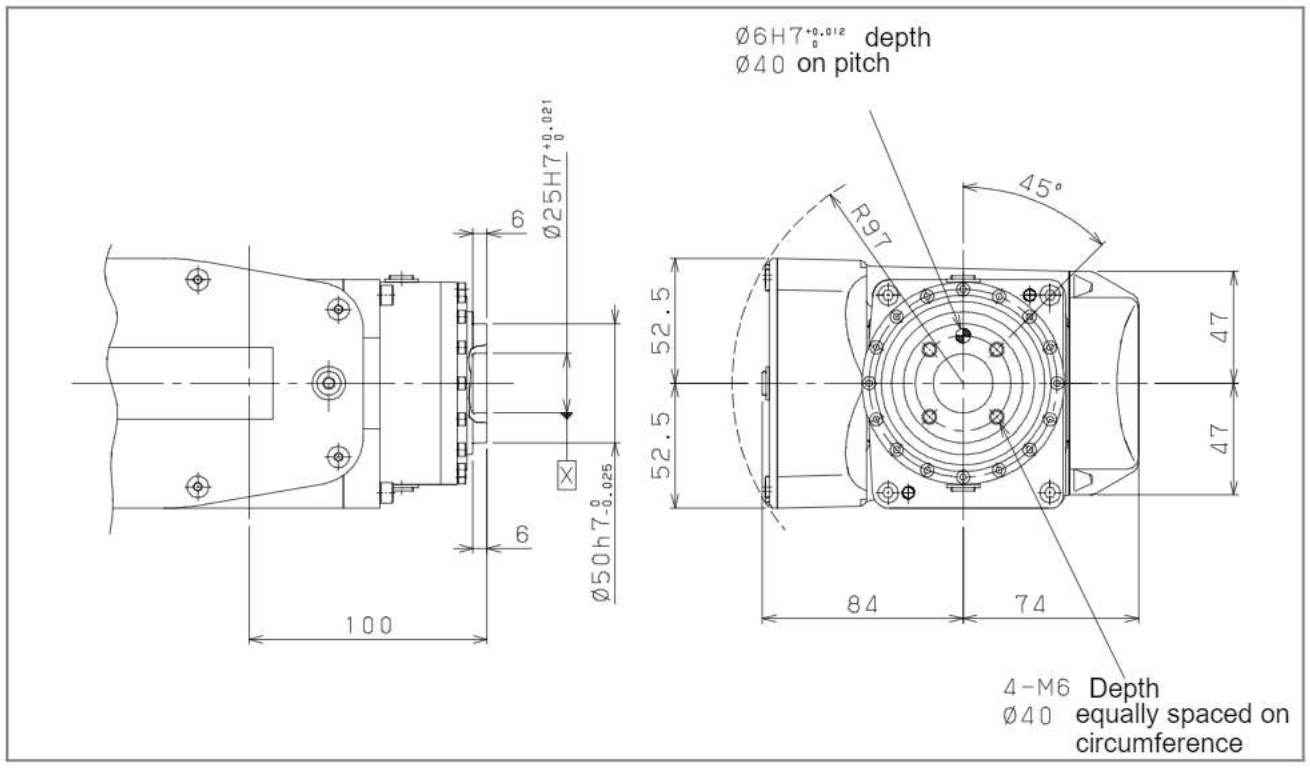


Fig 2.1 Mounting surface for the ISO flange type end effector

2.2 DEVICE MOUNTING SURFACES

As shown in Fig. 2.2 (a), there are two device mounting surfaces.

NOTE
1 Keep the gravity center of devices mounted on device mounting surfaces A and B within the area shown by hatching in Fig. 2.2 (b).
2 The mass of each device mounted on a device mounting surface shall satisfy the following condition:
1) $W + A + B \leqq 18$ (kg)
where W : Mass (kg) of the device on the end effector mounting surface
A : Mass (kg) of the device on device mounting surface A
B : Mass (kg) of the device on device mounting surface B

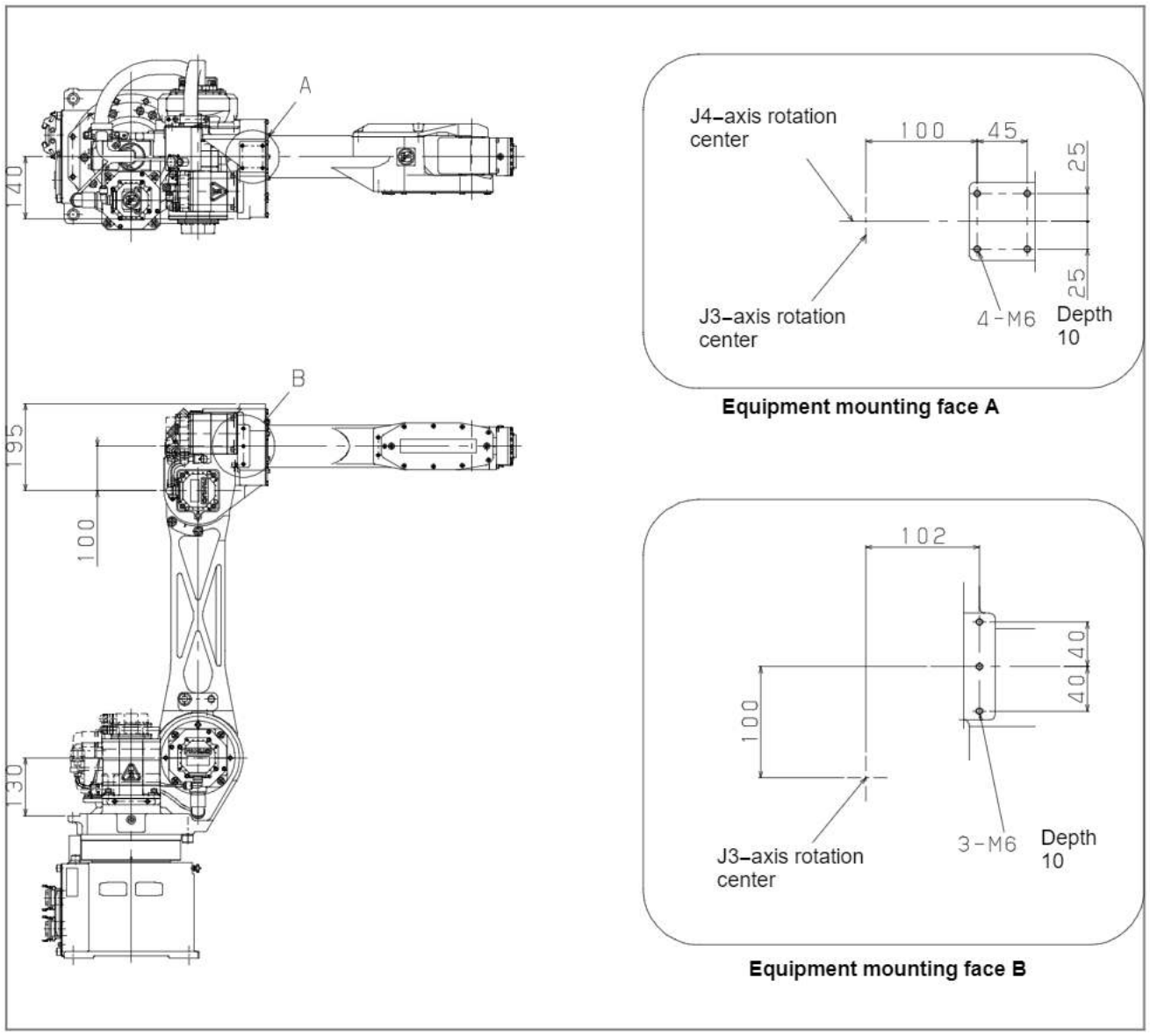


Fig 2.2 (a) Device mounting surface dimensions

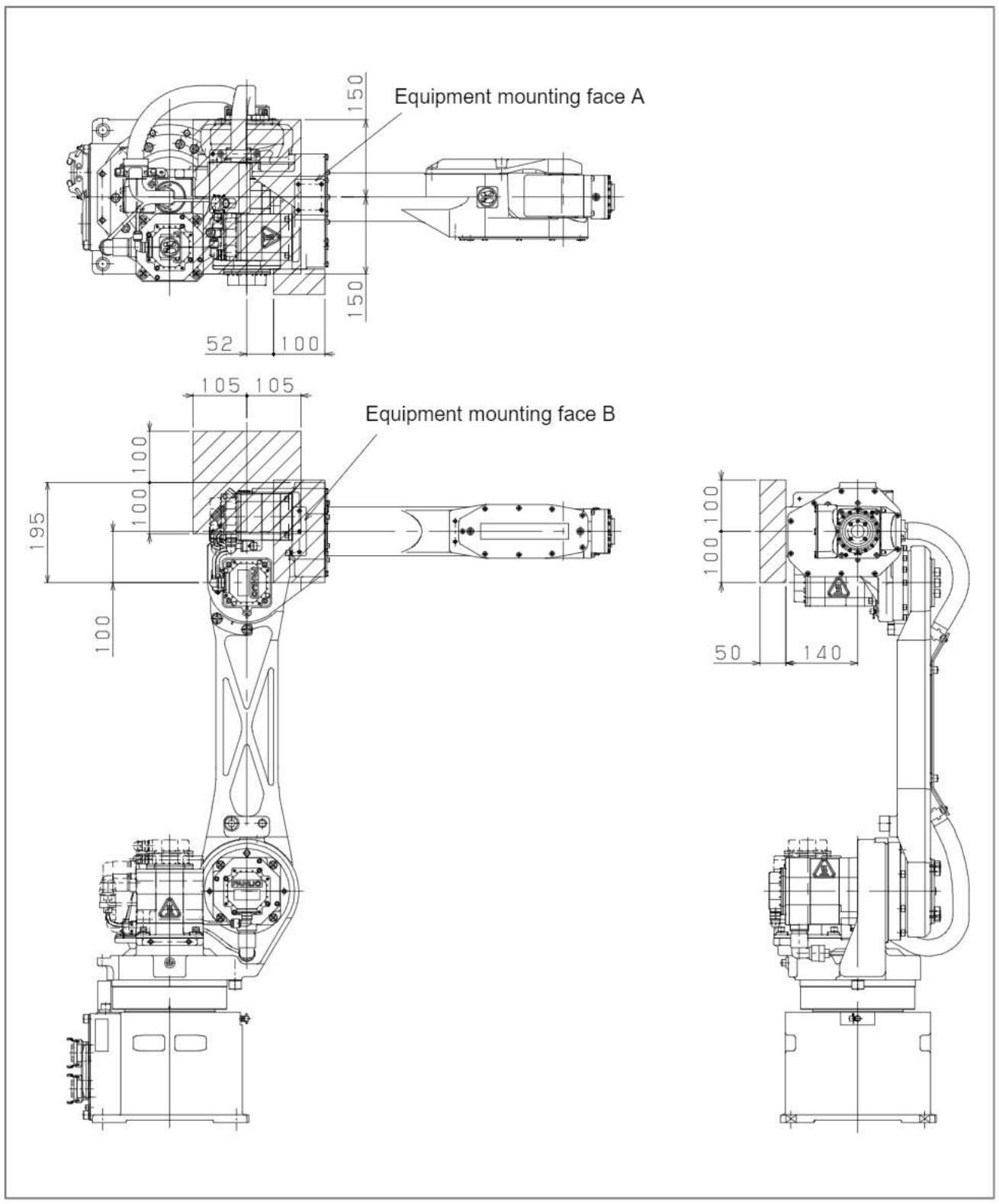


Fig 2.2 (b) Dimensions of the gravity center position of the device on the device mounting surfaces

2.3 SETTING THE SYSTEM VARIABLES FOR SHORTEST–TIME CONTROL

Setting up appropriately the load conditions, such as mass, moment, and inertia, of the wrist section and hand mounted on the J3–axis arm of a robot enables effective use of the robot.

Wrist axis load moment

Load the following system variables with the wrist section load moment represented using an integer (kgf–m).
[Input examples]
$PARAM_GROUP.$AXISMOMENT[4]: 160 (J4–axis load moment)
$PARAM_GROUP.$AXISMOMENT[5]: 100 (J5–axis load moment)
$PARAM_GROUP.$AXISMOMENT[6]: 60 (J6–axis load moment)

Wrist axis load inertia

Load the following system variables with the wrist section load inertia represented using an integer (kgf–cm–s2).
[Input examples]
$PARAM_GROUP.$AXISINERTIA[4]: 640 (J4–axis load inertia)
$PARAM_GROUP.$AXISINERTIA[5]: 220 (J5–axis load inertia)
$PARAM_GROUP.$AXISINERTIA[6]: 62 (J6–axis load inertia)

Mass of the loads mounted on the J3–axis arm and J2–axis base

Load the following system variable with the mass of the loads mounted on the J3–axis arm and J2–axis base represented using an integer (kg)
[Input examples]
$PARAM_GROUP.$ARM_LOAD[1] : 12.25 (mass of the load on the J3–axis arm)
$PARAM_GROUP.$ARM_LOAD[2] : 0 (mass of the load on the J2–axis base)

Operation performance screens

The operation performance screens include the list screen, load setting screen, and device setting screen. These screens are used to set up information about loads and that about devices on the robot.

1 Press the screen selection key to display the screen menu.
2 Select SYSTEM on the next page.
3 Press F1 TYPE. The screen switching menu appears.
4 Press F1 Motion Performance. The list screen appears.

```
MOTION PERFORMANCE                          10%
    Group1
 No.    PAYLOAD[kg]          Comment
  1            6.34   [                  ]
  2            0.00   [                  ]
  3            0.00   [                  ]
  4            0.00   [                  ]
  5            0.00   [                  ]
  6            0.00   [                  ]
  7            0.00   [                  ]
  8            0.00   [                  ]
  9            0.00   [                  ]
 10            0.00   [                  ]

Active PAYLOAD number = 1
[ TYPE ]  GROUP  DETAIL ARMLOAD SETIND >
                                        >
```

5 On this screen, you can set up ten different types of load information (condition No. 1 to No. 10). Place the cursor on the line of a desired condition number, and press F3 DETAIL. The load setting screen appears.

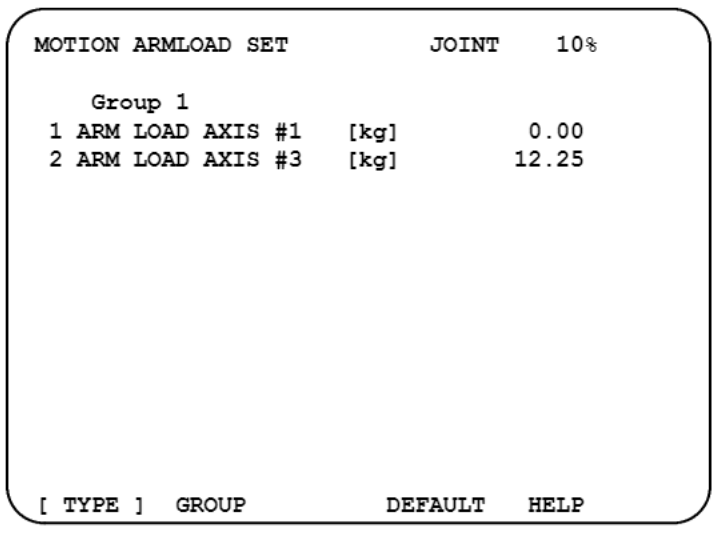
```
MOTION PAYLOAD SET          JOINT    10%


   Group 1
   Schedule No[   1]:[Comment         ]
 1. PAYLOAD           [kg]          6.34
 2. PAYLOAD CENTER X  [cm]         -7.99
 3. PAYLOAD CENTER Y  [cm]          0.00
 4. PAYLOAD CENTER Z  [cm]          6.44
 5. PAYLOAD INERTIA X [kgfcms^2]    0.13
 6. PAYLOAD INERTIA Y [kgfcms^2]    0.14
 7. PAYLOAD INERTIA Z [kgfcms^2]    0.07




[ TYPE ]  GROUP  NUMBER  DEFAULT   HELP
```

6 On this screen, specify the mass and gravity center position of the load and the inertia around the gravity center. The X, Y, and Z directions displayed on the screen correspond to the standard tool coordinates (with no tool coordinate system set up). When you enter values, the confirmation message “Path and Cycletime will change. Set it?” appears. Select F4 YES or F5 NO.

7 Pressing F3 NUMBER brings you to the load setting screen for another condition number. In a multigroup system, pressing F2 GROUP brings you to the setting screen for another group.

8 Press the previous page key to return to the list screen. Press F5 SETIND, and enter a desired load setting condition number.

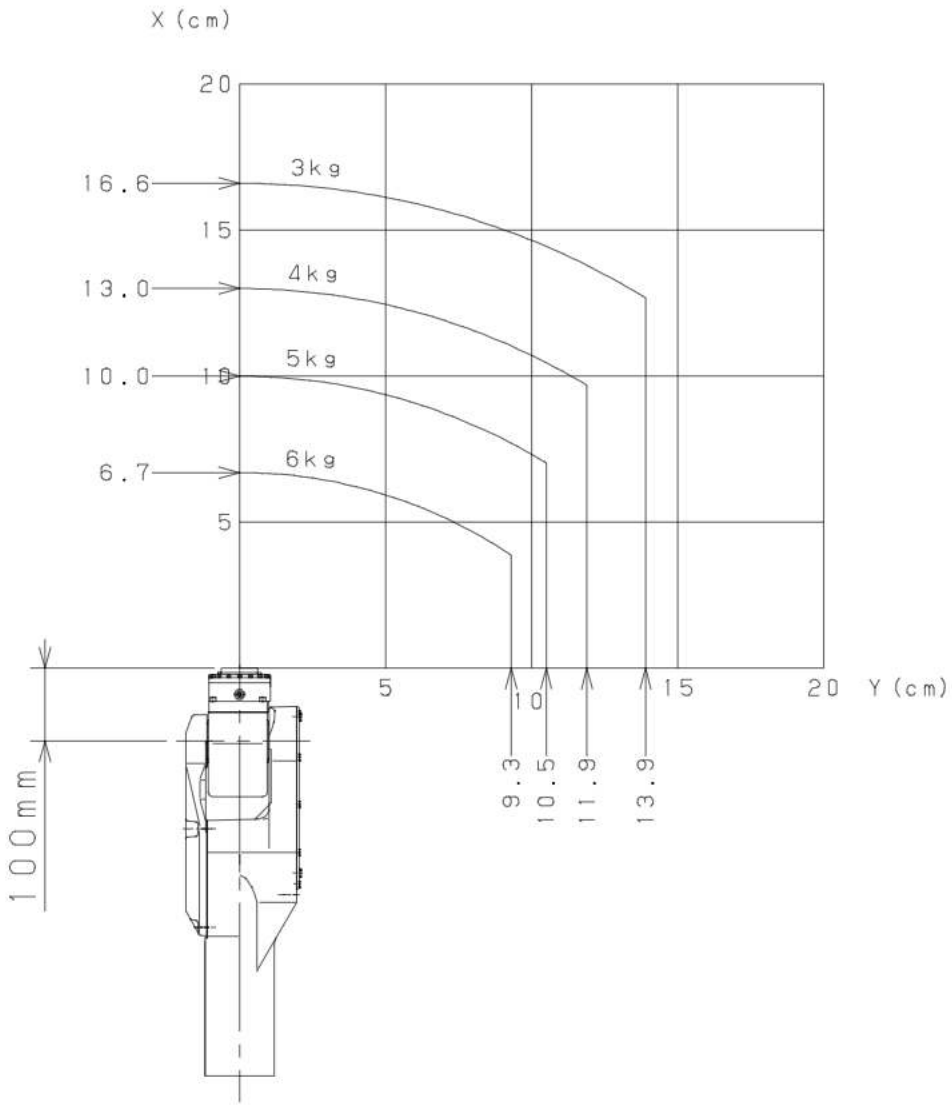
9 On the list screen, pressing F4 ARMLOAD brings you to the device setting screen.



10 Specify the mass of the loads on the J2–axis base and J3–axis arm.
When you enter
ARMLOAD AXIS #1[kg] : Mass of the load on the J2–axis base and
ARMLOAD AXIS #3[kg] : Mass of the load on the J3–axis arm,
the confirmation message “Path and Cycletime will change. Set it?” appears. Select F4 YES or F5 NO.
Once the mass of a device is entered, it is put in effect by turning the power off and on again.

2.4 WRIST LOAD CONDITIONS

Fig. 2.4 is the allowable load curves of the wrist of the robot.
Use the robot with the load conditions kept within the range shown on the graph.



The load inertia is the sum of the offset inertia from the center of each axis section to the gravity center of the workpiece and the shape inertia around the gravity center of the workpiece.
Keep the total load inertia including the shape inertia at or below the values listed below.

J_x (kg・m²)	J_y (kg・m²)
0.22	0.061

(*) J_x: Inertia around the X-axis
J_y: Inertia around the Y-axis

Fig 2.4 Wrist section allowable load conditions

2.5 END EFFECTOR AIR PIPING

If you select cables (A05B–1215–H203, –H204, –H603, and –H604) in the mechanical unit with a pneumatic option, an air pipe whose inlet is on the J1–axis connector panel and outlet is behind the J3 casing is provided. See Fig. 7.1 of Part I, “Maintenance,” for explanations about the piping routes. The joint diameter for the air pipe inlet and outlet is RC3/8 female. No joint is supplied together with the option. The customer shall arrange for the joints that match the tubes to be used.

2.6 END EFFECTOR INPUT SIGNALS (RDI/RDO)

There are end effector connectors for connecting peripheral devices behind the J3 casing. Fig. 2.6 (a) and Fig. 2.6 (b) show the pin arrangement of end effector connectors. Refer to "R-J3*i* MODEL B Controller Maintenance Manual" for details of input-common settings.

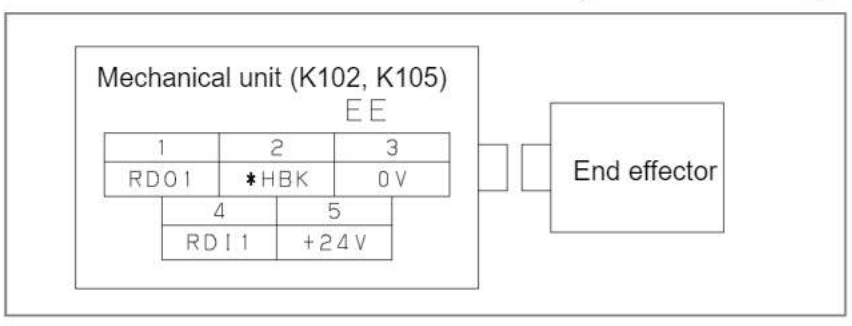


Fig 2.6 (a) End effector signal arrangement (one RDI signal and one RDO signal)

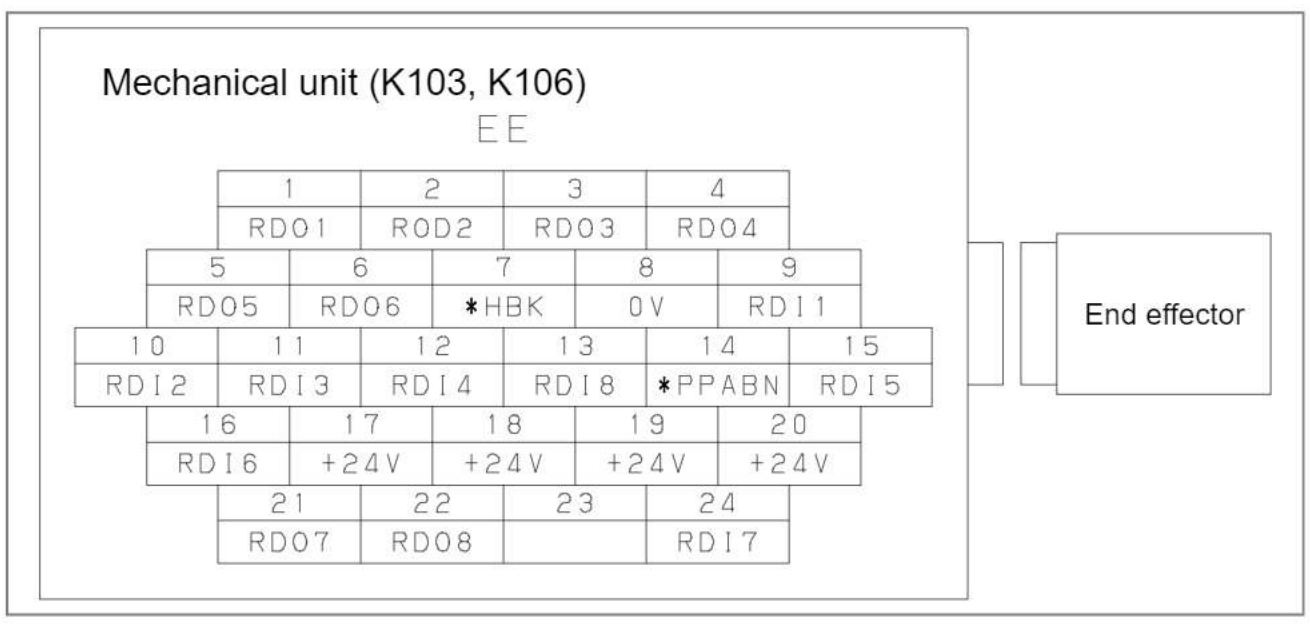


Fig 2.6 (b) End effector signal arrangement (eight RDI signals and eight RDO signals)

2.7 CONNECTOR SPECIFICATIONS

Table 2.7 (a) lists the makers and models of the connectors used on the robot mechanical unit. Table 2.7 (b) lists the makers and models of the connectors to be used on user–prepared devices.

Table 2.7 (a) Connector specifications (on the mechanical unit side)

Cable name	Output side (J3–axis casing)	Maker
RDI/O × 1	JMWR1305F	Daiichi Denshi Kogyo K.K.
RDI/O × 8	JMWR2524F	Daiichi Denshi Kogyo K.K.

Table 2.7 (b) Connector specifications (on the user side)

Cable name	Output side (J3–axis casing)	Maker
RDI/O × 1	JMSP1305M	Daiichi Denshi Kogyo K.K.
RDI/O × 8	JMSP2524M	Daiichi Denshi Kogyo K.K.

NOTE
For detailed descriptions of the dimensions of the connectors, contact FANUC or refer to the respective catalogs available from the maker.

3 TRANSPORTATION AND INSTALLATION

3.1 TRANSPORTATION

1) Installation procedure
   1 Release the transportation stopper (red).
   2 Using JOINT, feed the J2– and J3–axis sections in the positive direction to such a position that the J2– and J3–axis transportation stoppers can be released.
   3 Remove the J2– and J3–axis transportation stoppers(red).
   4 Remove the two M10 eyebolts from the J2 base. Now you are ready to install the robot.

NOTE
If an overtravel alarm is issued at 2, hold down the shift key and press the alarm reset key. Then, while holding down the shift key, feed the J2– and J3–axis sections to such a position, using JOINT, that the overtravel condition is released.

2) Carrying the robot with a crane

The robot can be carried by suspending it with a crane. To hoist the robot, hook rope on the two M10 eyebolts. Once the robot is installed, release the transportation stoppers. (See Fig. 3.1.)
These stoppers are bolts for preventing the swiveling axes of the robot from moving during its transportation. The stoppers are pained or plated in red. Before starting to operate the robot, be sure to remove these stoppers.
Be careful not to let the suspending sling get caught on the connectors of the motors; the connectors may be damaged if the sling get caught on it.

NOTE
When transporting a robot having two axes that are equipped with a brake while leaving an end effector mounted on its wrist, be sure to place soft material such as sponge rubber between the J2 and J3 arms previously so that the J4–axis section will not swing. Otherwise, the end effector or the robot main body may be damaged if the J4–axis section swings to let the end effector hit the robot main body during transportation. If the J4–axis section is caused to rotate beyond its operation range, a break may occur in the cable.

Position during shipment

J1–axis	0°
J2–axis	–45°
J3–axis	–15°
J4–axis	–90°
J5–axis	0°
J6–axis	0°

Note)
1. Machine weight : 138 kg
2. Eyebolts complied with JIS B1168.
   [Load capacity : 150 kg/1]
3. Quantity Eyebolt : 2
   Sling : 2

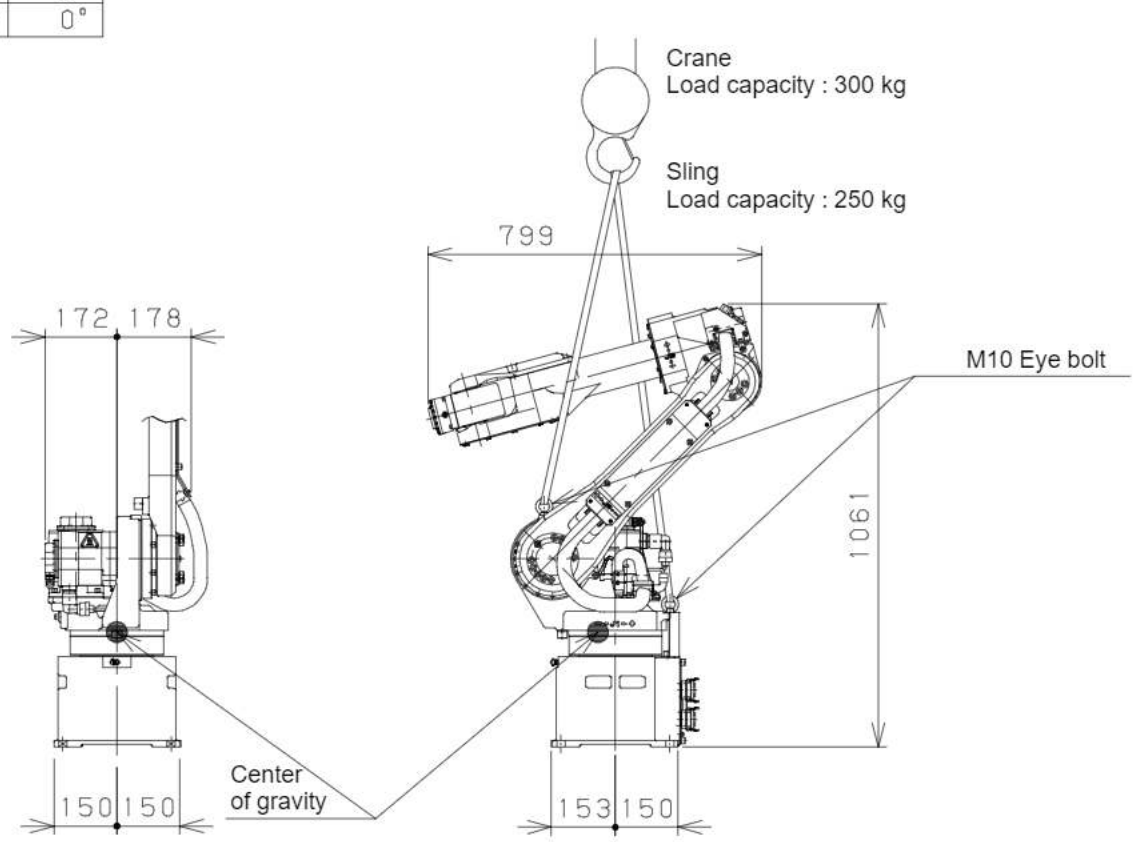


Fig 3.1 Carrying the robot with a crane

3.2 STORING THE ROBOT

When storing the robot, keep it in the posture shown in Fig. 3.1.
Be very careful when the robot is in any other posture, because it can fall down.

3.3 INSTALLATION

Fig. 3.3 (a) shows the dimensions of the base of the robot main body.

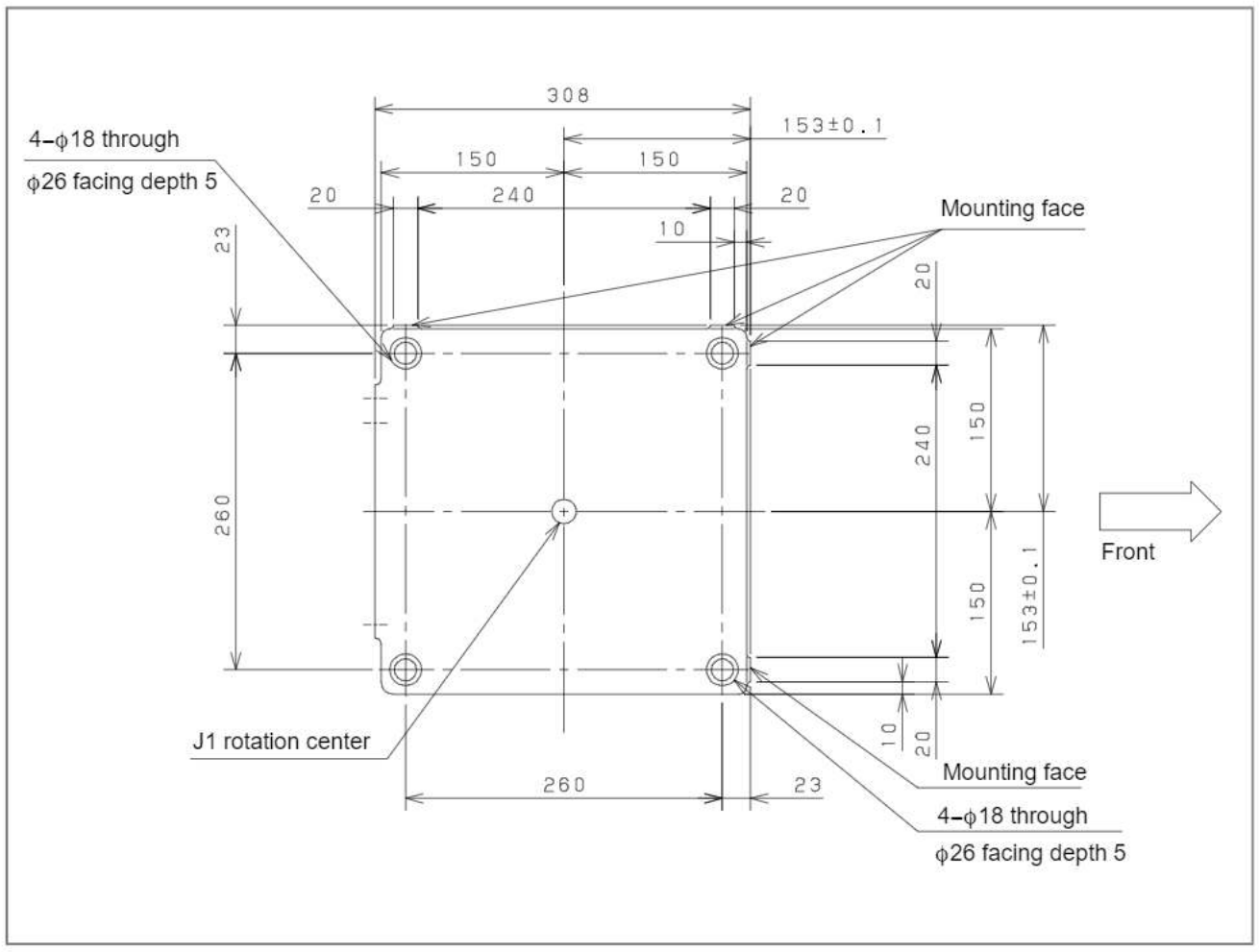


Fig 3.3 (a) Dimensions of the base of the robot main body

Fig. 3.3 (b) shows an example of installing the robot. In this example, the sole plate is fixed with four M20 chemical anchors (in strength category 4.8), and the robot base is fastened to the sole plate with four M16 × 35 bolts (in strength category 12.9). If compatibility must be maintained in teaching the robot after the robot mechanical unit is replaced, use the butt surface.

NOTE
The customer shall arrange for the positioning pin, anchor bolts, and sole plate.

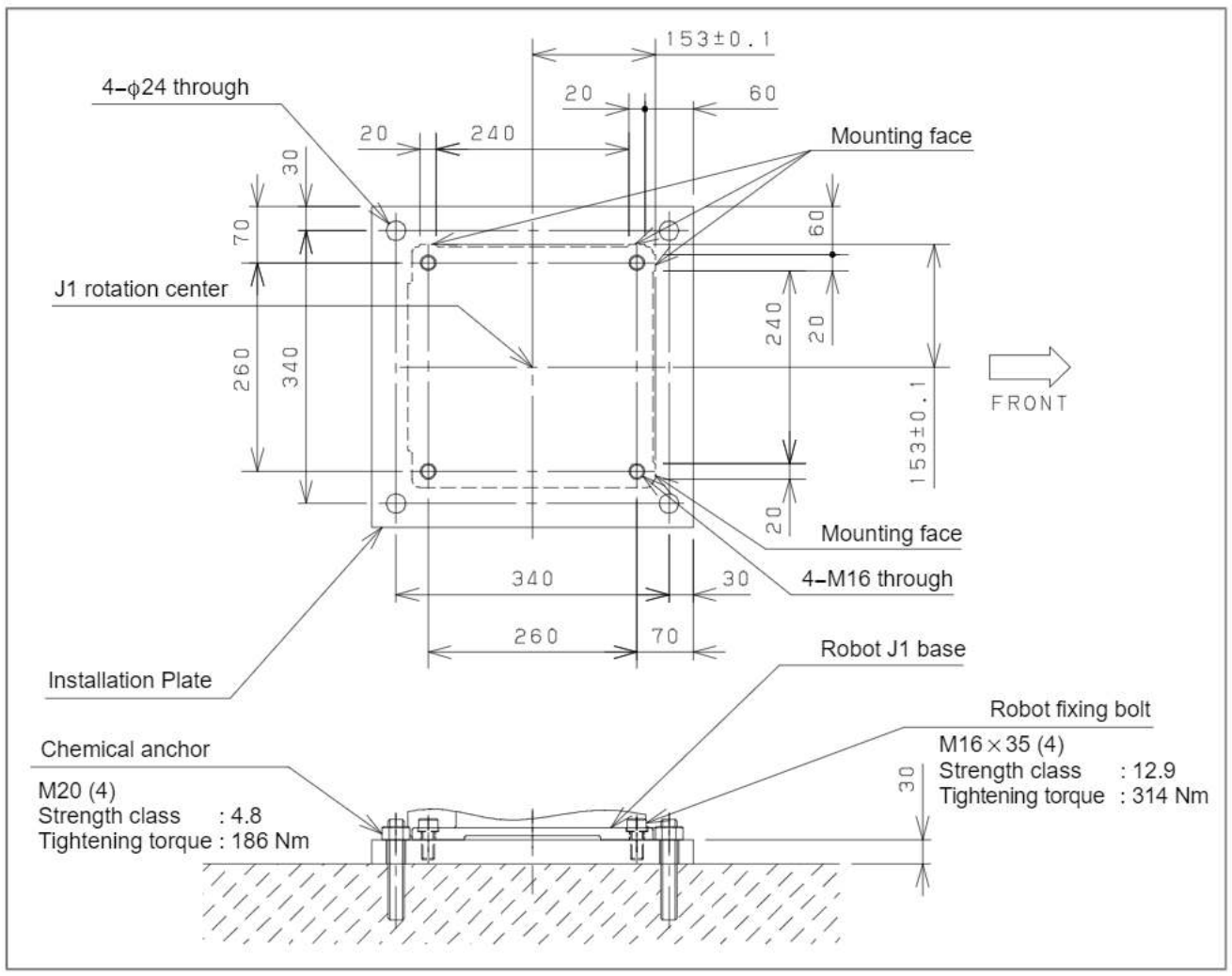


Fig 3.3 (b) Example of installing the robot

Fig. 3.3 (c) and Table 3.3 explain what load is put on the J1 base when the robot is at a rest, accelerating or decelerating, and at an emergency stop.

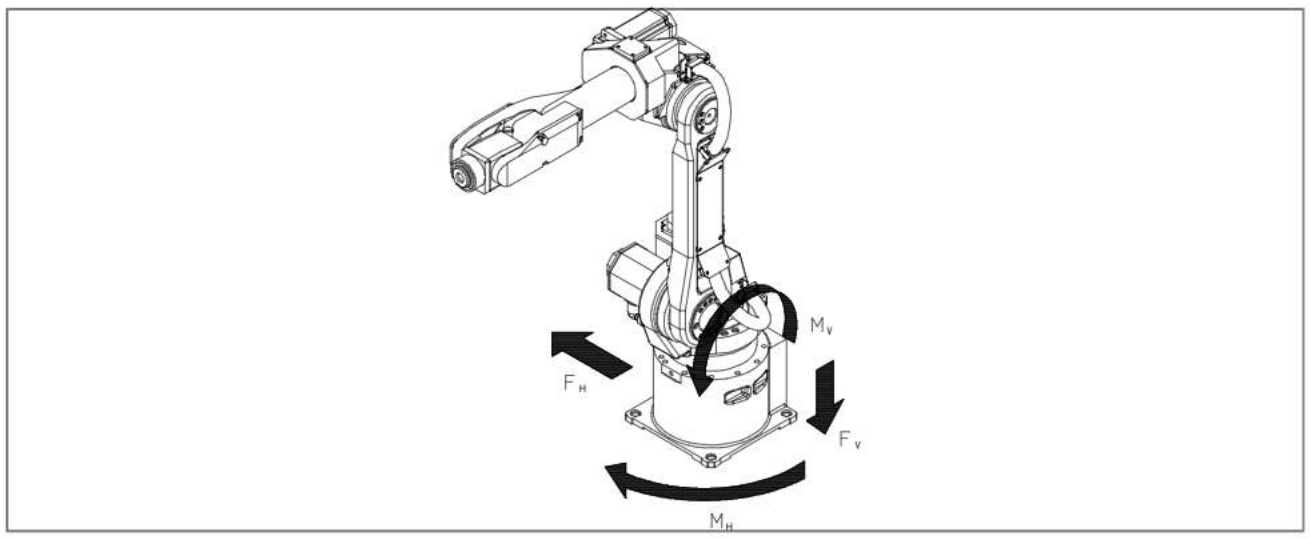


Fig 3.3 (c) Load and moment applied to the J1 base

Table 3.3 Load and moment applied to the J1 base

State	Bending moment MV[kgfm](Nm)	Vertical load FV[kgf](N)	Torsion moment MH[kgfm](Nm)	Horizontal load FH[kgf](N)
At a rest	[56](549)	[230](2254)	[0](0)	[0](0)
Accelerating or decelerating	[189](1852)	[297](2911)	[61](598)	[105](1029)
At an emergency stop	[724](7095)	[677](6635)	[231](2264)	[252](2470)

3.4 MAINTENANCE CLEARANCE

Fig. 3.4 (a) shows the clearance required in maintaining the robot.

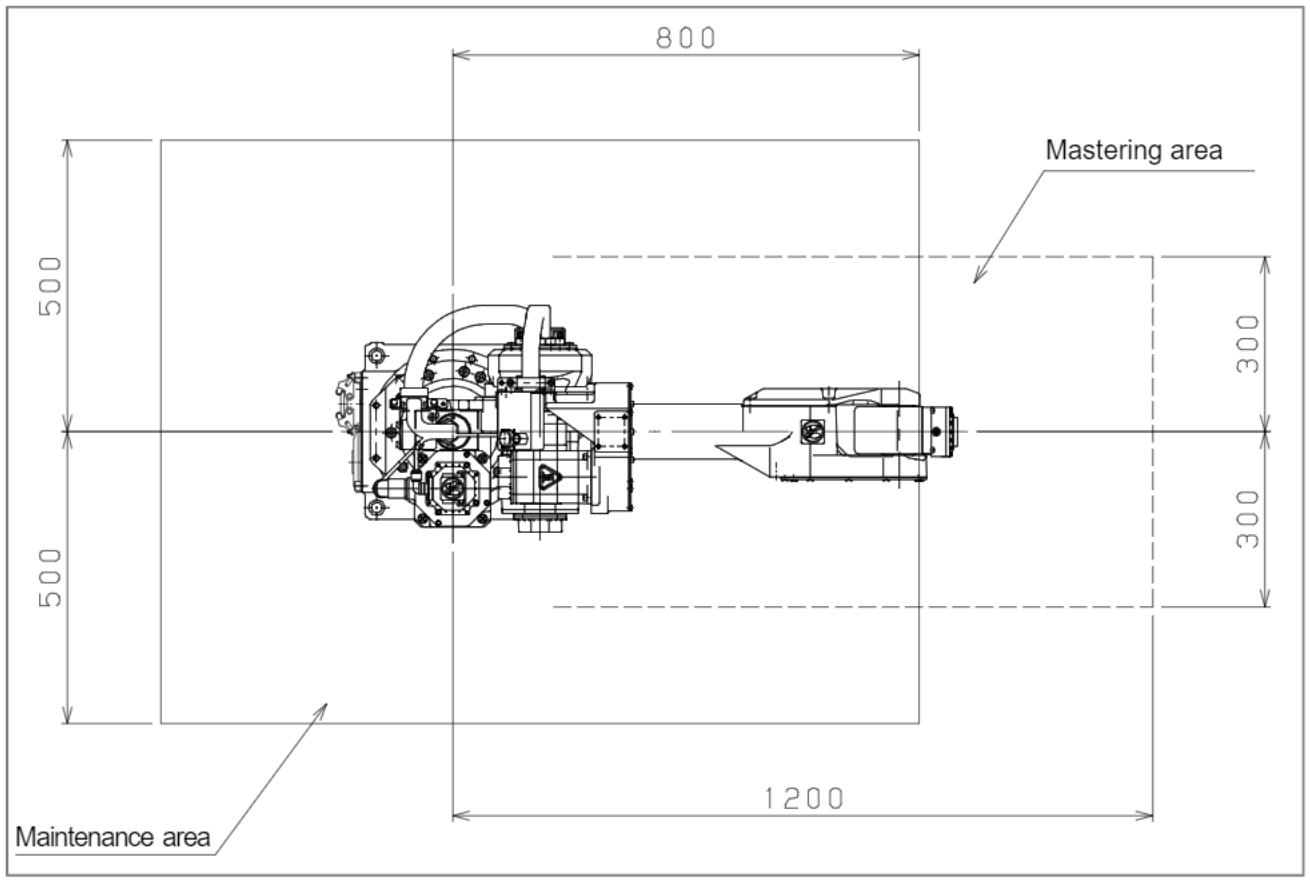


Fig 3.4 (a) Maintenance clearance layout

The robot must be kept in the posture shown in Fig. 3.4 (b) during mastering. Provide such a clearance around the robot that the robot can take a posture of J1 = 0°.

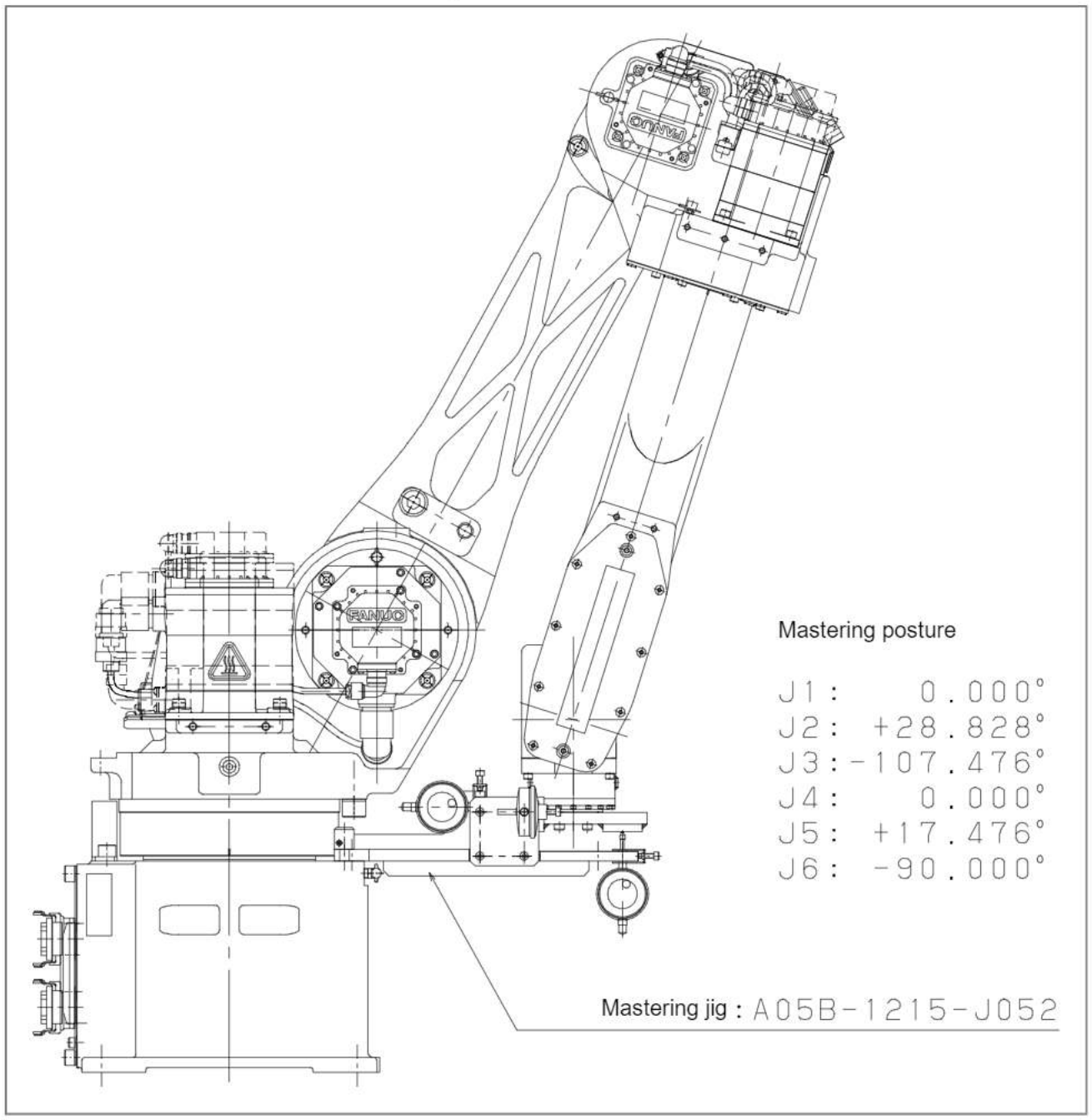


Fig 3.4 (b) Robot posture for mastering

3.5 ASSEMBLING THE ROBOT FOR INSTALLATION

If a separate controller is selected for the robot, the robot connection cables are detached from the connector board of the mechanical unit (they are left connected to the controller) when the robot is shipped. When installing the robot, attach the cables to the connector board of the mechanical unit shown in Fig. 3.5.
When attaching the connectors, be careful not to pull the cables that have HARTING connectors.
The customer shall arrange for installation of cable ducts between the robot main body and its controller.

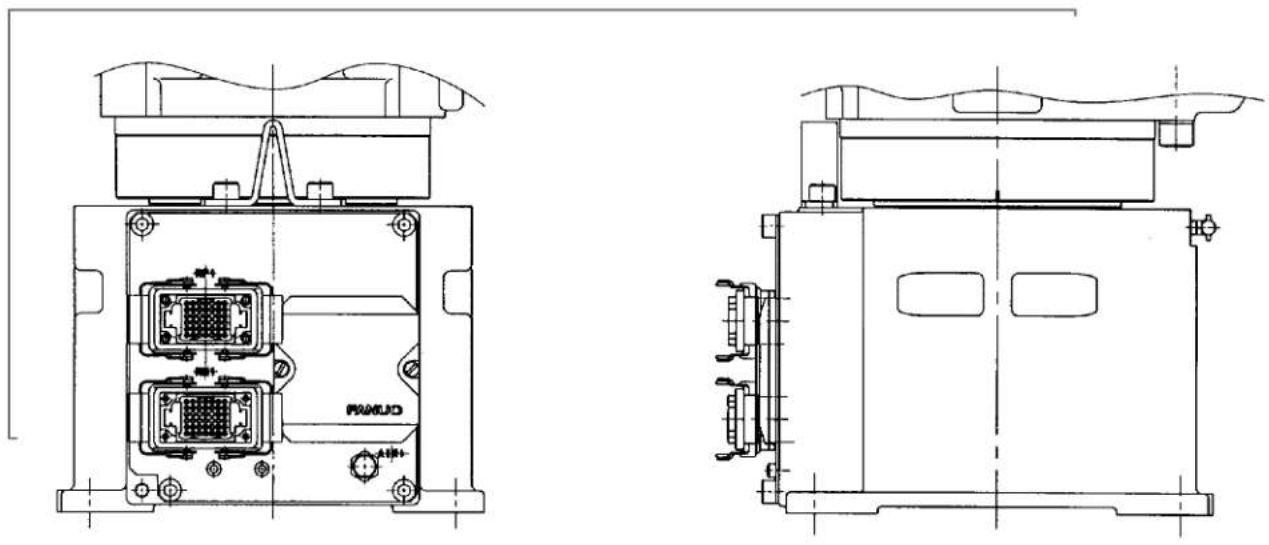
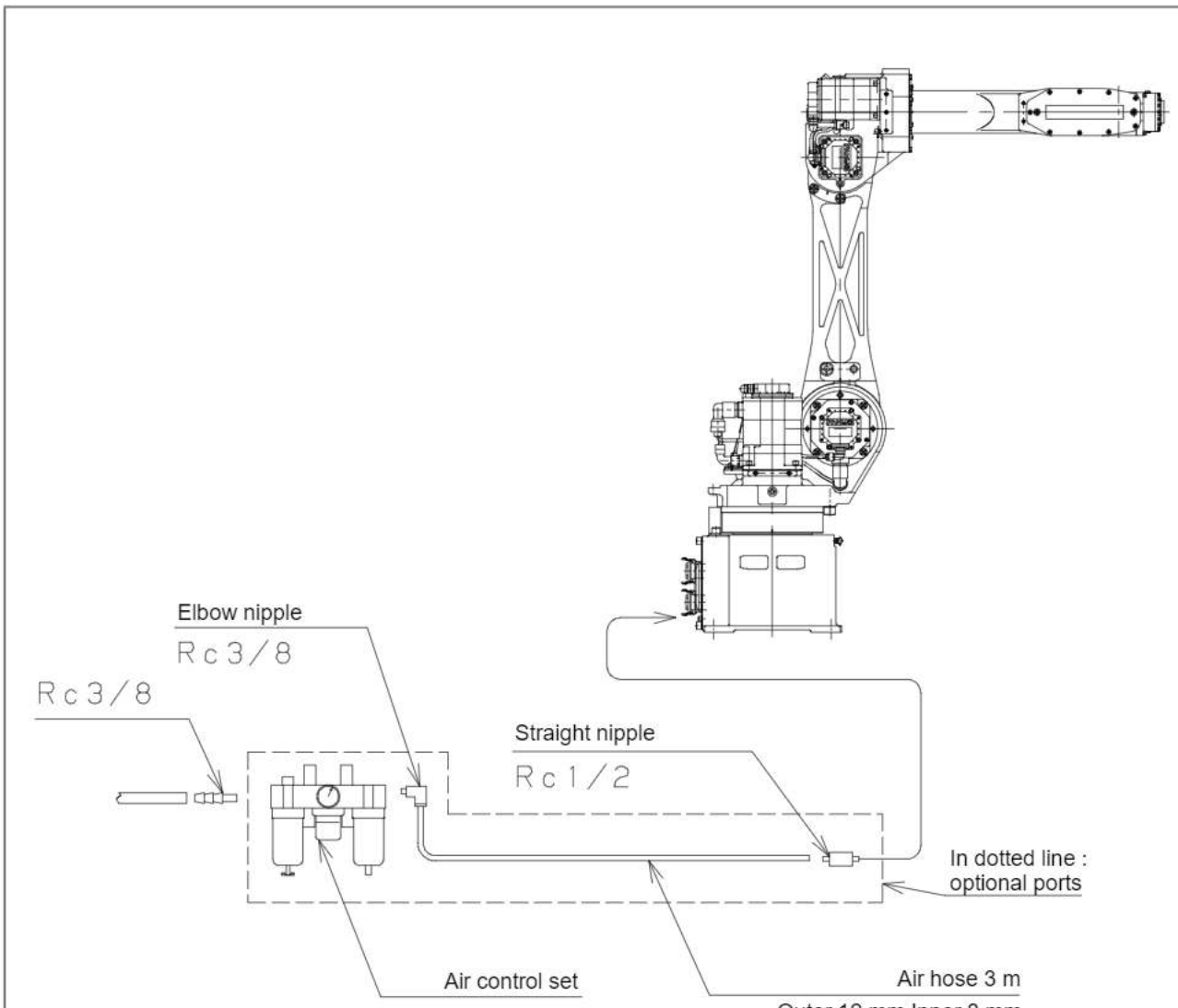


Fig 3.5 Cable connection panel for the robot mechanical unit

3.6 AIR PIPING

Fig. 3.6 (a) shows the air piping of the robot.
If the three–piece pneumatic option is selected, it comes with the air pipe to be installed between it and the mechanical unit. To use the option, the customer shall arrange for a three–piece pneumatic option mounting section that has the self–tapping screw holes whose dimensions and layout are specified in Fig. 3.6 (b) and for its installation.



Note
Hose used in the mechanical unit has an outer diameter of 12 mm and an inner diameter of 8 mm.
You can use a different size hose outside the mechanical unit.

Fig 3.6 (a) Air piping

Fill the oiler in the three–piece pneumatic option with any turbine oil between #90 and #140 to the specified level.
The customer shall arrange for mounting bolts.

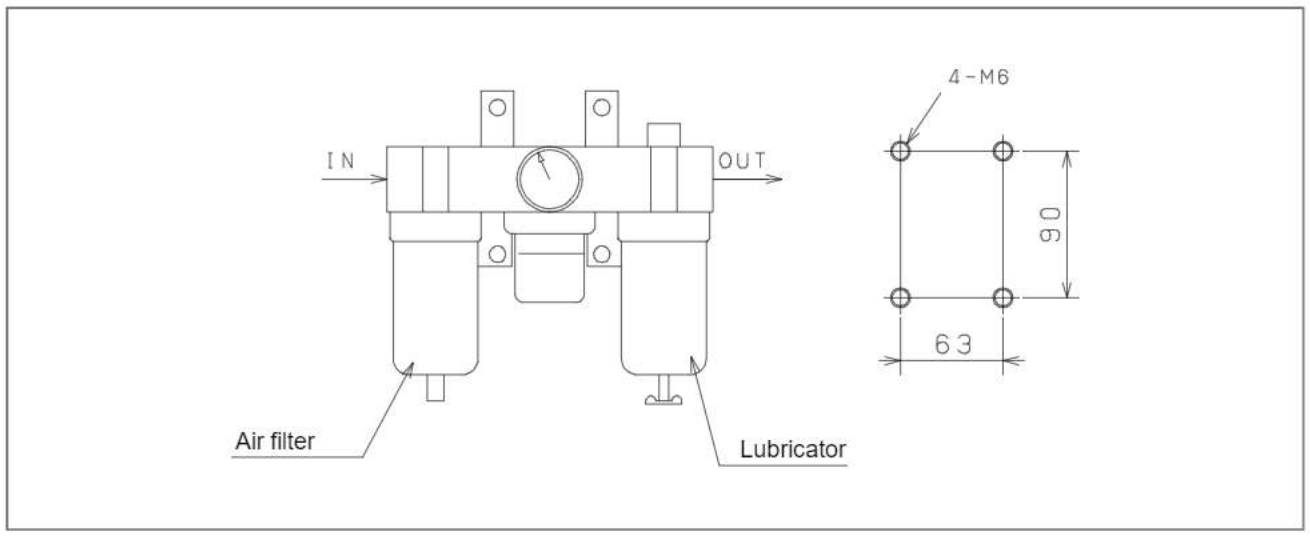


Fig 3.6 (b) Three–piece pneumatic option

3.7 INSTALLATION CONDITIONS

Table 3.7 lists the installation conditions for the robot.

Table 3.7 Installation conditions

Item		Specification
Pneumatic pressure	Supply air pressure	0.5 to 0.7 MPa (5 to 7 kg/cm^2) (set at 0.5 MPa (5 kg/cm^2))
	Consumption	Maximum instantaneous amount: 150 Nl/min (Note 1)
Mechanical unit mass		About 134 kg: Type having two axes equipped with a brake About 138 kg: Type having six axes equipped with a brake
Allowable ambient temperature		0 to 45°C
Allowable ambient humidity		Regularly: 75%RH or below Short period (within one month): 95%RH (maximum) or below No condensation is allowed.
Atmosphere		There shall be no corrosive gas (Note 2).
Vibration		0.5 G or less

NOTE
1 This is the capacity of the three–piece pneumatic option. Use the robot at or below this value.
2 If you cannot avoid using the robot in an adverse environment with respect to vibration, dust, or coolant, contact FANUC.

APPENDIX

A SPARE PARTS LISTS

Table A (a) Cables

A) Two axes equipped with a brake (with no RDI/O signal and without pneumatic option)
A05B-1215-H201

Cable	Specification	Remark
K101	A05B-1215-D001	J1, J2, J3, J4, J5, and J6 power cables J1, J2, J3, J4, J5, and J6 pulse coder cables
K201	A660-4004-T115	J5 power and pulse coder inline connector cable
	A660-2005-T088	OT jumper connector

B) Two axes equipped with a brake (with one RDI/O signal and without pneumatic option)
A05B-1215-H202

Cable	Specification	Remark
K102	A05B-1215-D002	J1, J2, J3, J4, J5, and J6 power cables J1, J2, J3, J4, J5, and J6 pulse coder cables
K201	A660-4004-T115	J5 power and pulse coder inline connector cable
	A660-2005-T088	OT jumper connector

C) Two axes equipped with a brake (with one RDI/O signal and with pneumatic option)
A05B-1215-H203

Cable	Specification	Remark
K102	A05B-1215-D002	J1, J2, J3, J4, J5, and J6 power cables J1, J2, J3, J4, J5, and J6 pulse coder cables
K201	A660-4004-T115	J5 power and pulse coder inline connector cable
	A660-2005-T088	OT jumper connector

D) Two axes equipped with a brake (with eight RDI/O signals and pneumatic option)
A05B-1215-H204

Cable	Specification	Remark
K103	A05B-1215-D003	J1, J2, J3, J4, J5, and J6 power cables J1, J2, J3, J4, J5, and J6 pulse coder cables
K201	A660-4004-T115	J5 power and pulse coder inline connector cable
	A660-2005-T088	OT jumper connector

E) Six axes equipped with a brake (with no RDI/O signal and without pneumatic option)

A05B-1215-H601

Cable	Specification	Remark
K104	A05B-1215-D004	J1, J2, J3, J4, J5, and J6 power cables J1, J2, J3, J4, J5, and J6 pulse coder cables
K202	A660-4004-T116	J5 power and pulse coder inline connector cable
	A660-2005-T088	OT jumper connector

F) Six axes equipped with a brake (with one RDI/O signal and without pneumatic option)

A05B-1215-H602

Cable	Specification	Remark
K105	A05B-1215-D005	J1, J2, J3, J4, J5, and J6 power cables J1, J2, J3, J4, J5, and J6 pulse coder cables
K202	A660-4004-T116	J5 power and pulse coder inline connector cable
	A660-2005-T088	OT jumper connector

G) Six axes equipped with a brake (with one RDI/O signal and with pneumatic option)

A05B-1215-H603

Cable	Specification	Remark
K105	A05B-1215-D005	J1, J2, J3, J4, J5, and J6 power cables J1, J2, J3, J4, J5, and J6 pulse coder cables
K202	A660-4004-T116	J5 power and pulse coder inline connector cable
	A660-2005-T088	OT jumper connector

H) Six axes equipped with a brake (with eight RDI/O signals and pneumatic option)

A05B-1215-H604

Cable	Specification	Remark
K106	A05B-1215-D006	J1, J2, J3, J4, J5, and J6 power cables J1, J2, J3, J4, J5, and J6 pulse coder cables
K202	A660-4004-T116	J5 power and pulse coder inline connector cable
	A660-2005-T088	OT jumper connector

Table A (b) Motors

ARC Mate 100*i* MODEL B
(two axes equipped with a brake) A05B-1215-B201

M–6*i* MODEL B
(two axes equipped with a brake) A05B-1215-B202

Specification	Axis	Remark
A06B-0223-B005	J1	α4/4000*i*
A06B-0223-B605	J2	α4/4000*i* with a brake
A06B-0202-B605	J3	α1/5000*i* with a brake
A06B-0202-B005	J4	α1/5000*i*
A06B-0115-B075#0008	J5	βM0.5/4000
A06B-0114-B075#0008	J6	βM0.4/4000

ARC Mate 100*i* MODEL B
(six axes equipped with a brake) A05B-1215-B601

M–6*i* MODEL B
(six axes equipped with a brake) A05B-1215-B602

Specification	Axis	Remark
A06B-0223-B605	J1	α4/4000*i* with a brake
A06B-0223-B605	J2	α4/4000*i* with a brake
A06B-0202-B605	J3	α1/5000*i* with a brake
A06B-0202-B605	J4	α1/5000*i* with a brake
A06B-0115-B275#0008	J5	βM0.5/4000 with a brake
A06B-0114-B275#0008	J6	βM0.4/4000 with a brake

Table A (c) Reducers

Specification	Axis
A97L-0218-0288#33	J1
A97L-0218-0289#153	J2
A97L-0218-0295#161	J3
A97L-0218-0224	J6

Table A (d) Motor auxiliary seals

Specification	Axis
A98L-0004-0771#A03TP	J1/J2
A98L-0004-0771#A01TP	J3/J4

Table A (e) J4–axis gearbox

Specification	Axis
A05B-1215-K401	J4

Table A (f) Gears

Specification	Axis
A290-7215-X511	J5
A290-7215-V501	J5
A290-7215-V502	J5
A290-7215-X514	J5

Table A (g) Cover

Specification	Remark
A05B-1215-H351	J2–axis cable protect cover

Table A (h) Battery

Specification	Remark	Quantity
A98L-0031-0005	R20 (1.5 V)	4

Table A (i) Grease

Name	Specification
Mori White RE No. 00	A98L-0040-0119#2.4KG

Table A (j) Grease nipples

Name	Specification	Axis
Grease nipple (1/8)	A97L-0218-0013#A110	J2/J3
Grease nipple [elbow type] (1/8)	A97L-0218-0013#C110	J1
Grease nipple (M6)	A97L-0218-0013#A610	J4/J5/J6

Table A (k) O–ring

Specification	Location of use
A98L–0001–0347#S150	J1RV output
A98L–0001–0347#S100	J1RV output
A290–7207–X342	J1RV input
JB–OR1A–G60	J1 pipe
JB–OR1A–G105	J1 motor
JB–OR1A–G115	J2 motor
A98L–0001–0347#S135	J2RV output
A98L–0040–0041#258	J2RV input
A98L–0001–0347#S135	J2RV output
A98L–0001–0347#S100	J3RV output
A98L–0001–0347#S120	J3RV input
JB–OR1A–G75	J4 motor
A98L–0001–0347#S65	J3 arm mounting section
A98L–0001–0347#S71	J6 cross roller mounting section

Table A (l) Gaskets

Specification	Location of use
A98L–0040–0042#03	J4 motor
A98L–0040–0042#07	J5/J6 motor
A290–7215–X527	J5–2 (X502) cover mounting section
A290–7215–X533	Wrist flange mounting section

Table A (m) Stoppers

Specification	Axis
A290–7215–X241	J4
A290–7215–X323	J4
A290–7215–X324	J4

Note) 330° stopper

Table A (n) Seal bolts

Specification	Remark
A97L–0218–0417#081010	J1/J2/J3 grease outlet
A97L–0218–0621#051212	J5–axis motor and J5 gear unit mounting (with a washer)

B INTRA–MECHANICAL UNIT CONNECTION DIAGRAMS

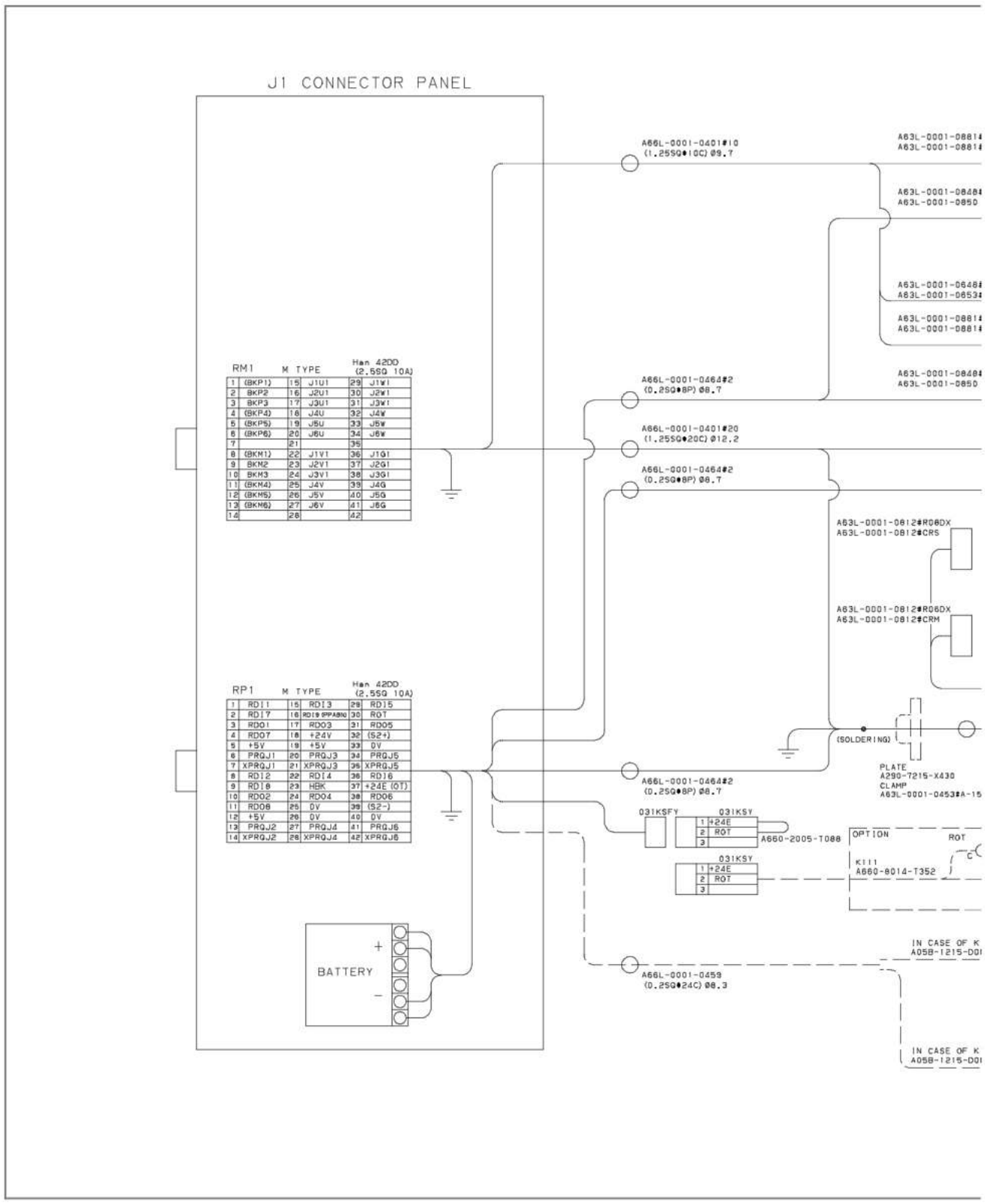
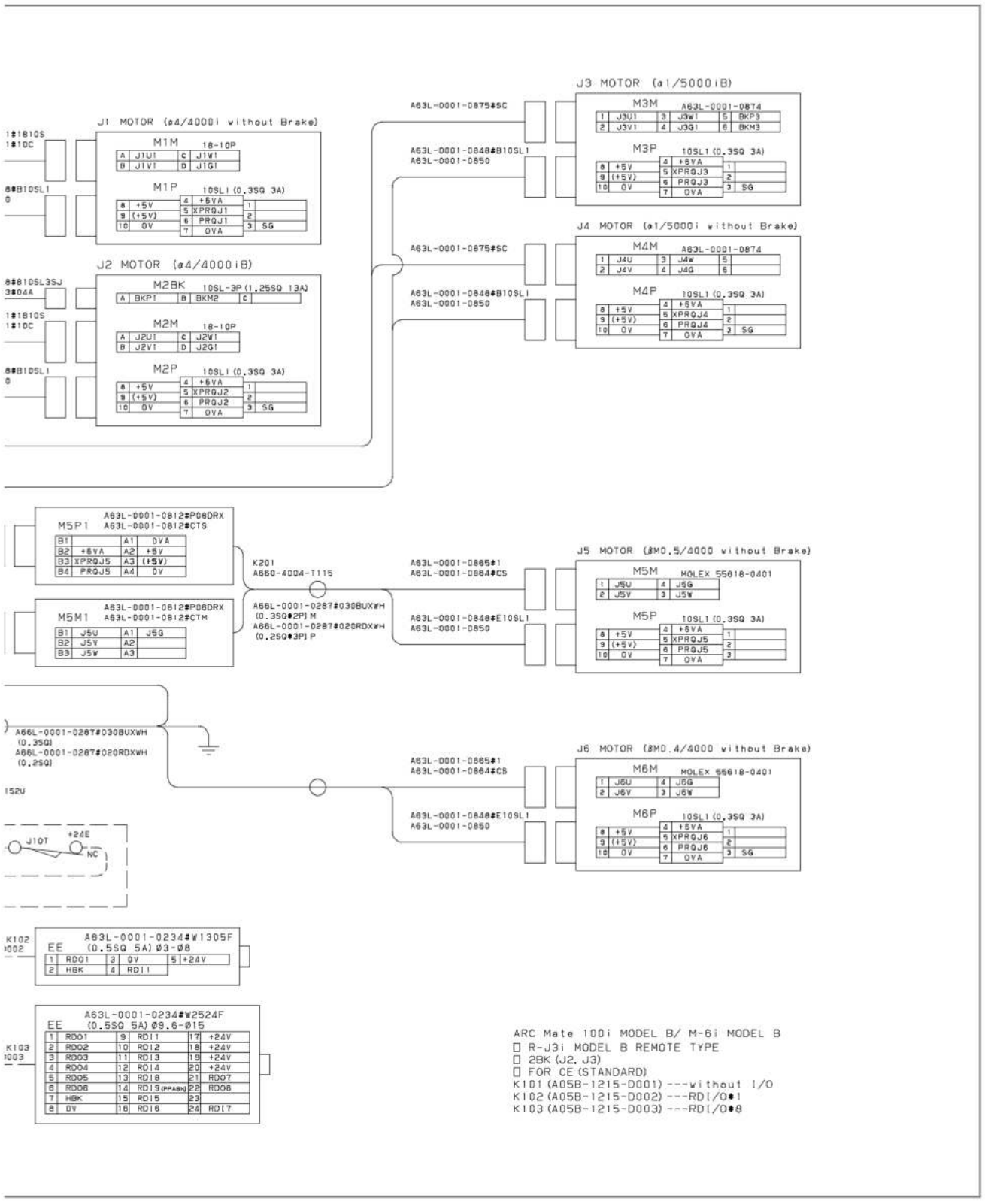


Fig B (a) Intra–mechanical unit circuit diagram (two axes with a brake, separate controller)


J1 MOTOR (α4/4000i without Brake)
M1M 18-10P
M1P 10SLI (0.3SQ 3A)
J2 MOTOR (α4/4000iB)
M2BK 10SL-3P (1.25SQ 13A)
M2M 18-10P
M2P 10SLI (0.3SQ 3A)
J3 MOTOR (α1/5000iB)
M3M A63L-0001-0874
M3P 10SLI (0.3SQ 3A)
J4 MOTOR (α1/5000i without Brake)
M4M A63L-0001-0874
M4P 10SLI (0.3SQ 3A)
M5P1 A63L-0001-0812#P08DRX A63L-0001-0812#CTS
M5M1 A63L-0001-0812#P08DRX A63L-0001-0812#CTM
K201 A660-4004-T115
A66L-0001-0287#030BUXWH (0.3SQ•2P) M
A66L-0001-0287#020RDXWH (0.2SQ•3P) P
J5 MOTOR (βM0.5/4000 without Brake)
M5M MOLEX 55618-0401
M5P 10SLI (0.3SQ 3A)
A66L-0001-0287#030BUXWH (0.3SQ)
A66L-0001-0287#020RDXWH (0.2SQ)
J6 MOTOR (βM0.4/4000 without Brake)
M6M MOLEX 55618-0401
M6P 10SLI (0.3SQ 3A)
J10T +24E NC
A63L-0001-0234#W1305F EE (0.5SQ 5A) Ø3-Ø8
A63L-0001-0234#W2524F EE (0.5SQ 5A) Ø9.6-Ø15
ARC Mate 100i MODEL B/ M-6i MODEL B
□ R-J3i MODEL B REMOTE TYPE
□ 2BK (J2, J3)
□ FOR CE (STANDARD)
K101 (A05B-1215-D001) ---without I/O
K102 (A05B-1215-D002) ---RDI/O•1
K103 (A05B-1215-D003) ---RDI/O•8

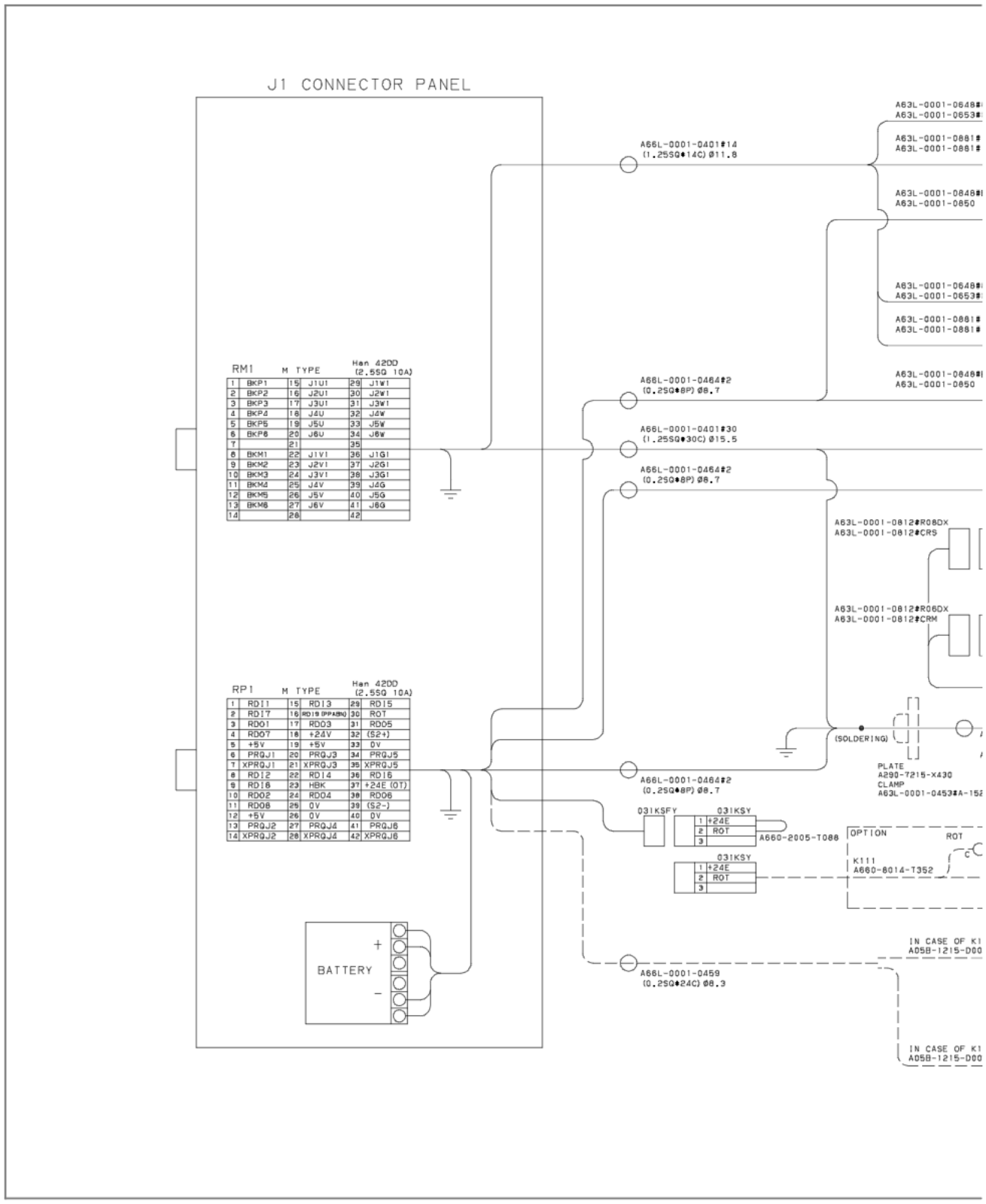
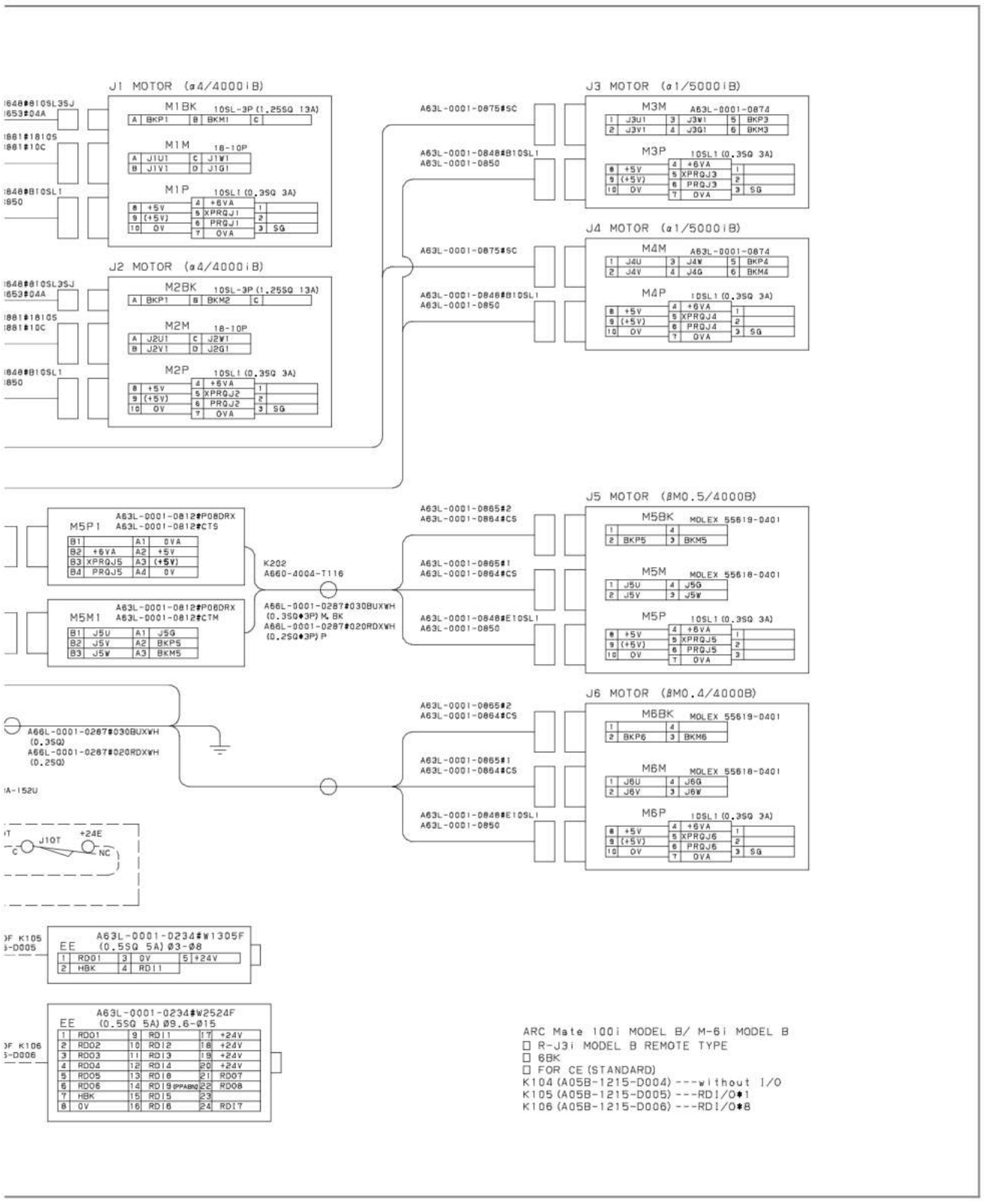


Fig B (b) Intra–mechanical unit circuit diagram (six axes with a brake, separate controller)


J1 MOTOR (α4/4000iB)
M1BK 10SL-3P(1.25SQ 13A)
M1M 18-10P
M1P 10SL!(0.3SQ 3A)
J2 MOTOR (α4/4000iB)
M2BK 10SL-3P(1.25SQ 13A)
M2M 18-10P
M2P 10SL!(0.3SQ 3A)
J3 MOTOR (α1/5000iB)
M3M A63L-0001-0874
M3P 10SL!(0.3SQ 3A)
J4 MOTOR (α1/5000iB)
M4M A63L-0001-0874
M4P 10SL!(0.3SQ 3A)
J5 MOTOR (βM0.5/4000B)
M5BK MOLEX 55619-0401
M5M MOLEX 55618-0401
M5P 10SL!(0.3SQ 3A)
J6 MOTOR (βM0.4/4000B)
M6BK MOLEX 55619-0401
M6M MOLEX 55618-0401
M6P 10SL!(0.3SQ 3A)
M5P1 A63L-0001-0812#P08DRX A63L-0001-0812#CTS
M5M1 A63L-0001-0812#P08DRX A63L-0001-0812#CTM
K202 A660-4004-T116
A66L-0001-0287#030BUXWH (0.3SQ*3P) M, BK
A66L-0001-0287#020RDXWH (0.2SQ*3P) P
A66L-0001-0287#030BUXWH (0.3SQ)
A66L-0001-0287#020RDXWH (0.2SQ)
J10T +24E
A63L-0001-0234#W1305F EE (0.5SQ 5A) Ø3-Ø8
A63L-0001-0234#W2524F EE (0.5SQ 5A) Ø9.6-Ø15
ARC Mate 100i MODEL B/ M-6i MODEL B
☐ R-J3i MODEL B REMOTE TYPE
☐ 6BK
☐ FOR CE (STANDARD)
K104 (A05B-1215-D004) ---without I/O
K105 (A05B-1215-D005) ---RDI/O*1
K106 (A05B-1215-D006) ---RDI/O*8

C PERIODIC INSPECTION TABLE

FANUC Robot ARC Mate 100i MODEL B/M-6i MODEL B Periodic maintenance table

	Items	Working time (H)	Check time	Grease amount	Period/ month	1 year 360	2 years 720	3 years 1080	4000	5760	6720	7 years 2520	8640	9600	10560	9 years 3240	12480	13440	14400	11 years 3960	15360	16320	17280	18240	5 years 1800	21600	22560	6 years 2160	24480	25920	7 years 2520	27840	28800	29760	8 years 2880	Overhaul 3025
Mechanical unit	1 Check the mechanical cable. (damaged or twisted)		0.2 H	—		○																														
	2 Check the motor connector (tightness).		0.2 H	—			○																														
	3 Tighten the end effector bolt.		0.2 H	—		○		○																													
	4 Tighten the cover and main bolt.		0.5 H	—			○																														
	5 Remove spatter and dust etc.		0.5 H	—		○		○																													
	6 Replacing battery.	NOTE 1)	0.1 H	—																																
	7 Replacing grease of J6 axis reducer.	NOTE 2)	0.2 H	50cc																																
	8 Replacing grease of J5 axis gear box.	NOTE 2)	0.3 H	400cc																																
	9 Replacing grease of J4 axis gear box.	NOTE 2)	0.3 H	600cc																																
	10 Replacing grease of J3 axis reducer.	NOTE 2)	0.2 H	300cc																																
	11 Replacing grease of J2 axis reducer.	NOTE 2)	0.3 H	500cc																																
	12 Replacing grease of J1 axis reducer.	NOTE 2)	0.3 H	1100cc																																
	13 Replacing cable of mechanical unit.	NOTE 3)	3.0 H	—																																
Controller unit	14 Check the robot cable and teach pendant cable.		0.2 H	—		○	○	○																												
	15 Cleaning the ventilator. (Include air filter)	NOTE 4)	0.2 H	—		○	○	○																												
	16 Check the source voltage.	NOTE 5)	0.2 H	—		○																														
	17 Replacing battery.	NOTE 1)	0.1 H	—																																

○ : Item for checking
● : Item for replacing

NOTE 1) Refer to the manual "MAINTENANCE 2.4".
NOTE 2) Refer to Fig.3.1 in "MAINTENANCE 3.1" according to Greasing point.
NOTE 3) The cycle of replacing is be able to extended.
Refer to "MAINTENANCE 8." In replacing the cable.
NOTE 4) Clean the robot properly In case of using the robot under much dust existing.
NOTE 5) Refer to the manual of R-J3i controller.

Fig C Periodic inspection table

D BOLT MOUNTING TORQUE LIST

If no tightening torque is specified for a bolt, tighten it according to this table.

Recommended bolt tightening torque **Unit: Nm (kgf–cm)**

Nominal diameter	Hexagon socket head bolt (steel in strength category 12.9)		Hexagon socket head bolt (stainless)		Hexagon socket head boss bolt Hexagon socket head flush bolt (steel in strength category 12.9)	
	Tightening torque		Tightening torque		Tightening torque	
	Upper limit	Lower limit	Upper limit	Lower limit	Upper limit	Lower limit
M3	1.8(18)	1.3(13)	0.76(7.7)	0.53(5.4)	—	—
M4	4.0(41)	2.8(29)	1.8(18)	1.3(13)	1.8(18)	1.3(13)
M5	7.9(81)	5.6(57)	3.4(35)	2.5(25)	4.0(41)	2.8(29)
M6	14(140)	9.6(98)	5.8(60)	4.1(42)	7.9(81)	5.6(57)
M8	32(330)	23(230)	14(145)	9.8(100)	14(140)	9.6(98)
M10	66(670)	46(470)	27(280)	19(195)	32(330)	23(230)
M12	110(1150)	78(800)	48(490)	33(340)	—	—
(M14)	180(1850)	130(1300)	76(780)	53(545)	—	—
M16	270(2800)	190(1900)	120(1200)	82(840)	—	—
(M18)	380(3900)	260(2700)	160(1650)	110(1150)	—	—
M20	530(5400)	370(3800)	230(2300)	160(1600)	—	—
(M22)	730(7450)	510(5200)	—	—	—	—
M24	930(9500)	650(6600)	—	—	—	—
(M27)	1400(14000)	940(9800)	—	—	—	—
M30	1800(18500)	1300(13000)	—	—	—	—
M36	3200(33000)	2300(23000)	—	—	—	—

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Revision Record

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