FANUC Robot series

LR Mate 100*i* B

MAINTENANCE MANUAL

B–81595EN/01

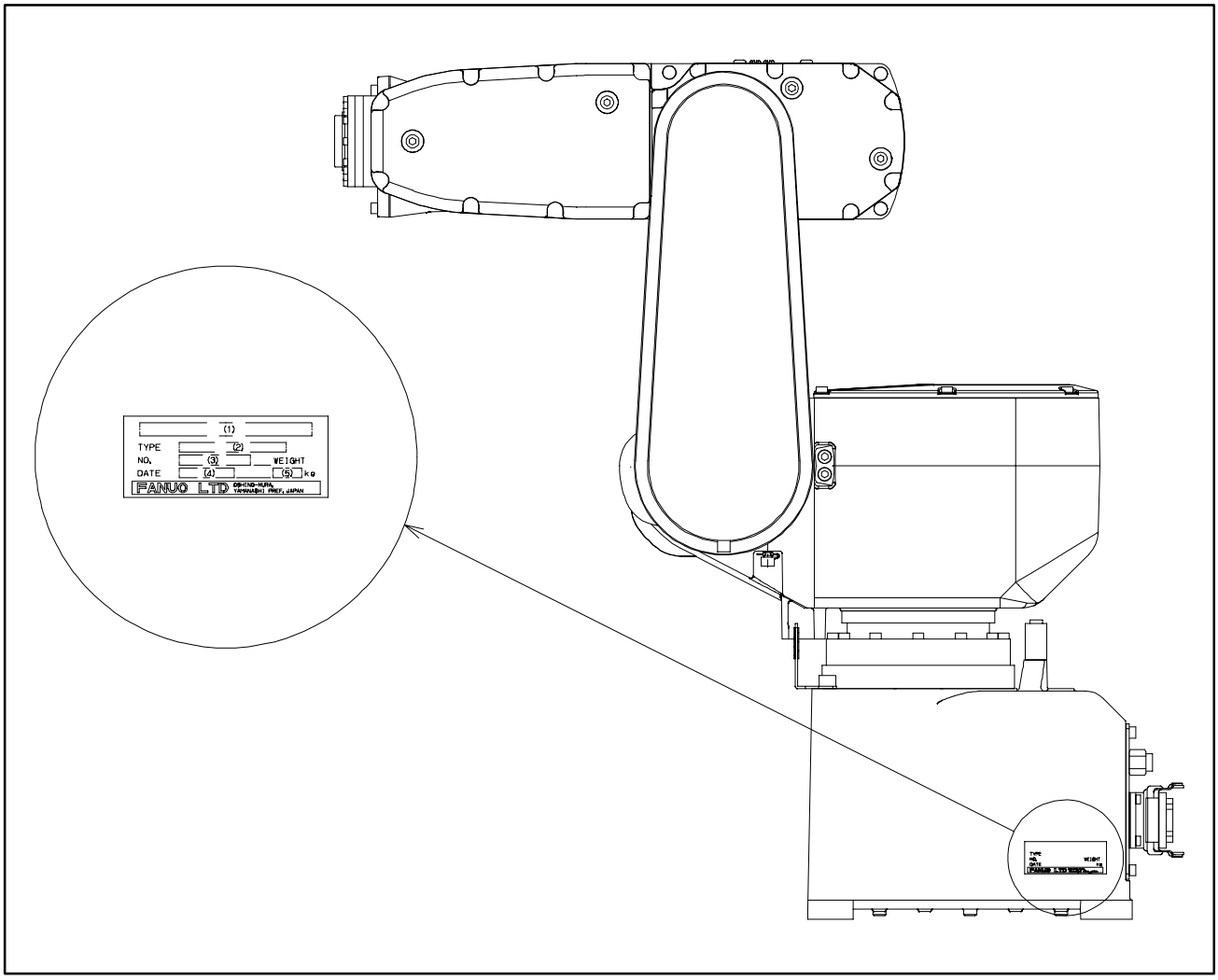
GENERAL

This manual describes the maintenance and connection procedures for the robots listed below.

Model	Abbreviation	Mechanical unit specifications
FANUC Robot LR Mate 100*i* B (J2, J3 axes with brake)	LR Mate 100*i* B	A05B−1137−B201
FANUC Robot LR Mate 100*i* B (All axes with brake)		A05B−1137−B202

Contents of this manual:
I MAINTENANCE
II CONNECTION

Before reading each section, confirm the specification number of the mechanical unit, attached to the robot as shown below.



Position of specification number of mechanical unit

SPECIFICATIONS

Item		Specifications
Type		Articulated type
Controlled axes		5 axes (J1,J2,J3,J4,J5)
Installation		Floor, Upside−down
Load capacity		5 kg **NOTE1**
Motion range **NOTE 2**	J1 AXIS ROTATION	320° (5.59 rad)
	J2 AXIS ROTATION	185° (3.23 rad)
	J3 AXIS ROTATION	365° (6.37 rad)
	J4 AXIS WRIST SWING	240° (4.19 rad)
	J5 AXIS WRIST ROTATION	400° (6.98 rad)
Maximum speed	J1 AXIS ROTATION	240_/sec (4.19 rad/sec)
	J2 AXIS ROTATION	270_/sec (4.71 rad/sec)
	J3 AXIS ROTATION	270_/sec (4.71 rad/sec)
	J4 AXIS WRIST SWING	330_/sec (5.76 rad/sec)
	J5 AXIS WRIST ROTATION	480_/sec (8.38 rad/sec)
Allowable load moment at wrist	J4 axis	7.25 N−m (74.0 kgf−cm)
	J5 axis	5.21 N−m (53.2 kgf−cm)
Allowable load inertia at wrist	J4 axis	0.138 kg−m^2 (1.4 kgf−cm−s^2)
	J5 axis	0.071 kg−m^2 (0.772 kgf−cm−s^2)
Repeatability		±0.04mm
Weight		Mechanical unit : approx. 38kg
Acoustic noise level		70 dB or less
Axes with brake		Standard:J2 and J3 (Option: All axes brake)
Dust−proof and drip−proof mechanism		Conform to IP54 (Option) Conform to IP65 (For undesirable emviroment option)
Incorporated solenoid valve for hand (Option)		Double solenoid ×2
Installation environment		Ambient temperature : 0°C to 45° C (No dew allowed) Ambient humidity : Long term: 75%RH or less Short term: 95%RH or less (within 1 month) Height:Up to 1,000 meters above sea level, no particular provision for altitude is required. Vibration: 0.5G or less

NOTE

1 When a load of 5 kg is imposed, the wrist is oriented only downward in the neighborhood of the top of the operation area (with a reach of 600 mm or more).
2 Mutual angle with J2−axis: 0 to ±138.2°.
3 Definition of IP code
  Definition of IP65
    6= Dust−tight : Dust does not enter the robot.
    5= Protection from water jet : The robot is not seriously affected by direct water jet in any direction.
  Definition of IP54
    5=Dust−protected : It is prevented that dust enters the robot. Normal operation is assured even if some dust enters the robot.
    4=Protection from splashing water : The robot is not seriously affected by a water splash in any direction.
4 Performance of resistant chemicals and resistant solvents

(1) The robot (including severe dust/liquid protection model) cannot be used with the following liquids because there is fear that the rubber parts (packing, oil seal, O ring etc.) will corrode.
  (a) Organic solvents
  (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 must be done. Incomplete draining will make the robot break down.

Table of Contents

SAFETY PRECAUTIONS

1 SAFETY PRECAUTIONS

For the safety of the operator and the system, follow all safety precautions when operating a robot and its peripheral devices installed in a work cell.

1.1 OPERATOR SAFETY

Operator safety is the primary safety consideration. Because it is very dangerous to enter the operating space of the robot during automatic operation, adequate safety precautions must be observed.

The following lists the general safety precautions. Careful consideration must be made to ensure operator safety.

(1) Have the robot system operators attend the training courses held by FANUC.

> FANUC provides various training courses. Contact our sales office for details.

(2) Even when the robot is stationary, it is possible that the robot is still ready to move state and is waiting for a signal. In this state, the robot is regarded as still in motion. To ensure operator safety, provide the system with an alarm to indicate visually or aurally that the robot is in motion.

(3) Install a safety fence with a gate so that no operator can enter the work area without passing through the gate. Equip the gate with an interlock that stops the robot when the gate is opened.

> The controller is designed to receive this interlock signal. When the gate is opened and this signal received, the controller stops the robot in an emergency. For connection, see Fig.1.1.

(4) Provide the peripheral devices with appropriate grounding (Class 1, Class 2, or Class 3).

(5) Try to install the peripheral devices outside the work area.

(6) Draw an outline on the floor, clearly indicating the range of the robot motion, including the tools such as a hand.

(7) Install a mat switch or photoelectric switch on the floor with an interlock to a visual or aural alarm that stops the robot when an operator enters the work area.

(8) If necessary, install a safety lock so that no one except the operator in charge can turn on the power of the robot.

> The circuit breaker installed in the controller is designed to disable anyone from turning it on when it is locked with a padlock.

(9) When adjusting each peripheral device independently, be sure to turn off the power of the robot.

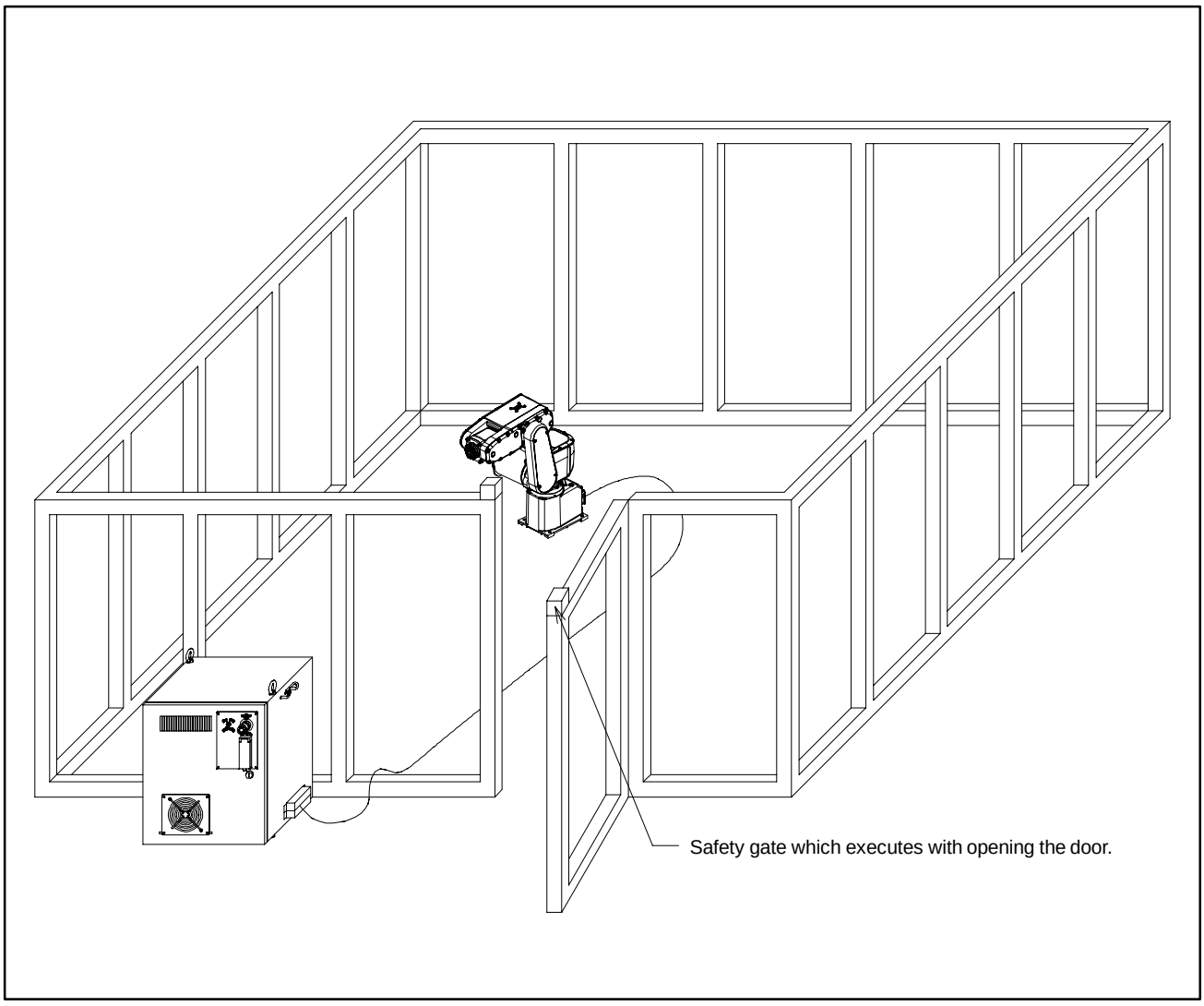


Fig.1.1 Safety Fence and Safety Gate

1.1.1 Operator Safety

The operator is a person who operates the robot system. In this sense, a worker who operates the teach pendant is also an operator. However, this section does not apply to teach pendant operators.

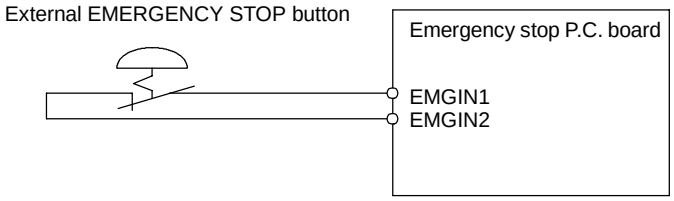
(1) If it is not necessary for the robot to operate, turn off the power of the robot controller or press the EMERGENCY STOP button, and then proceed with necessary work.

(2) Operate the robot system at a location outside the work area.

(3) Install a safety fence with a safety gate to prevent any worker other than the operator from entering the work area unexpectedly and also to prevent the worker from entering a dangerous area.

(4) Install an EMERGENCY STOP button within the operator's reach.

The robot controller is designed to be connected to an external EMERGENCY STOP button. With this connection, the controller stops the robot operation when the external EMERGENCY STOP button is pressed. See the diagram below for connection.



Note) Connect to EMGIN1 and EMGIN2 are on the emergency stop P.C. board

Fig.1.1.1 Connection Diagram for External Emergency Stop Switch

1.1.2 Safety of the Teach Pendant Operator

While teaching the robot, it is necessary for the operator to enter the work area of the robot. It is particularly necessary to ensure the safety of the teach pendant operator.

(1) Unless it is specifically necessary to enter the robot work area, carry out all tasks outside the area.

(2) Before teaching the robot, check that the robot and its peripheral devices are all in the normal operating condition.

(3) When entering the robot work area and teaching the robot, be sure to check the location and condition of the safety devices (such as the EMERGENCY STOP button and the deadman switch on the teach pendant).

FANUC's teach pendant has a switch for enabling or disabling the robot operation from the teach pendant and a deadman switch in addition to the EMERGENCY STOP button. The switches function as follows.

EMERGENCY STOP button	:	Pressing this button always brings the robot to an emergency stop, irrespective of the state of the enable/disable switch.
Deadman switch	:	The function of this switch depends on the state of the enable/disable switch.
In the enable position		− Releasing the deadman switch brings the robot to an emergency stop.
In the disable position		− The deadman switch is disabled.

Note) The deadman switch is provided to bring the robot to an emergency stop when the operator releases the teach pendant in an emergency.

(4) The teach pendant operator should pay careful attention so that no other workers enter the robot work area.

NOTE

In addition to the above, the teach pendant enable switch and the deadman switch also have the following function.

By pressing the deadman switch while the enable switch is on, the emergency stop factor (normally the safety gate) connected to FENCE1 and FENCE2 of the controller is invalidated. In this case, it is possible for an operator to enter the fence during teach operation without making the robot in the emergency stop condition. In other words, the system understands that the combined operations of pressing the teach pendant enable switch and pressing the deadman switch indicates the start of teaching. The teach pendant operator should be well aware that the safety gate is not functional under this condition and bear full responsibility to ensure that no one enters the fence during teaching.

(5) When entering the robot work area, the teach pendant operator should enable the teach pendant whenever he or she enters the robot work area. In particular, while the teach pendant enable switch is off, make certain that no start command is sent to the robot from any operator panel other than the teach pendant.

The teach pendant, operator panel, and peripheral device interface send each robot start signal. However the validity of each signal changes as follows depending on the mode of the teach pendant enable switch and the remote switch on the operator's panel.

Teach pendant enable switch	Remote condition	Teach pendant	Peripheral devices
On	Independent	Allowed to start	Not allowed
Off	Local	Not allowed	Not allowed
Off	Remote	Not allowed	Allowed to start

(6) When a program is completed, be sure to carry out a test run according to the procedure below.

(a) Run the program for at least one operation cycle in the single step mode at low speed.

(b) Run the program for at least one operation cycle in the continuous operation mode at low speed.

(c) Run the program for one operation cycle in the continuous operation mode at the intermediate speed and check that no abnormalities occur due to a delay in timing.

(d) Run the program for one operation cycle in the continuous operation mode at the normal operating speed and check that the system operates automatically without trouble.

(e) After checking the completeness of the program through the test run above, execute it in the automatic operation mode.

(7) While operating the system in the automatic operation mode, the teach pendant operator should leave the robot work area.

1.1.3 Safety During Maintenance

For the safety of maintenance personnel, pay utmost attention to the following.

(1) Except when specifically necessary, turn off the power of the controller while carrying out maintenance. Lock the power switch, if necessary, so that no other person can turn it on.

(2) When disconnecting the pneumatic system, be sure to reduce the supply pressure.

(3) Before the start of teaching, check that the robot and its peripheral devices are all in the normal operating condition.

(4) If it is necessary to enter the robot work area for maintenance when the power is turned on, the worker should indicate that the machine is being serviced and make certain that no one starts the robot unexpectedly.

(5) Do not operate the robot in the automatic mode while anybody is in the robot work area.

(6) When it is necessary to maintain the robot alongside a wall or instrument, or when multiple workers are working nearby, make certain that their escape path is not obstructed.

(7) When a tool is mounted on the robot, or when any moving device other than the robot is installed, such as belt conveyor, pay careful attention to its motion.

(8) If necessary, have a worker who is familiar with the robot system stand beside the operator panel and observe the work being performed. If any danger arises, the worker should be ready to press the EMERGENCY STOP button at any time.

(9) When replacing or reinstalling components, take care to prevent foreign matter from entering the system.

(10) When handling each unit or printed circuit board in the controller during inspection, turn off the power of the controller and also turn off the circuit breaker to protect against electric shock.

(11) When replacing parts, be sure to use those specified by FANUC. In particular, never use fuses or other parts of non-specified ratings. They may cause a fire or result in damage to the components in the controller.

1.2 SAFETY OF THE TOOLS AND PERIPHERAL DEVICES

1.2.1 Precautions in Programming

(1) Use a limit switch or other sensor to detect a dangerous condition and, if necessary, design the program to stop the robot when the sensor signal is received.

(2) Design the program to stop the robot when an abnormal condition occurs in any other robots or peripheral devices, even though the robot itself is normal.

(3) For a system in which the robot and its peripheral devices are in synchronous motion, particular care must be taken in programming so that they do not interfere with each other.

(4) Provide a suitable interface between the robot and its peripheral devices so that the robot can detect the states of all devices in the system and can be stopped according to the states.

1.2.2 Precautions for Mechanism

(1) Keep the component cells of the robot system clean, and operate the robot in an environment free of grease, water, and dust.

(2) Employ a limit switch or mechanical stopper to limit the robot motion so that the robot does not come into contact with its peripheral devices or tools.

1.3 SAFETY OF THE ROBOT MECHANISM

1.3.1 Precautions in Operation

(1) When operating the robot in the jog mode, set it at an appropriate speed so that the operator can manage the robot in any eventuality.

(2) Before pressing the jog key, be sure you know in advance what motion the robot will perform in the jog mode.

1.3.2 Precautions in Programming

(1) When the work areas of robots overlap, make certain that the motions of the robots do not interfere with each other.

(2) Be sure to specify the predetermined work origin in a motion program for the robot and program the motion so that it starts from the origin and terminates at the origin.
Make it possible for the operator to easily distinguish at a glance that the robot motion has terminated.

1.3.3 Precautions for Mechanisms

(1) Keep the work area of the robot clean, and operate the robot in an environment free of grease, water, and dust.

1.4 SAFETY OF THE END EFFECTOR

1.4.1 Precautions in Programming

(1) To control the pneumatic, hydraulic and electric actuators, carefully consider the necessary time delay after issuing each control command up to actual motion and ensure safe control.

(2) Provide the end effector with a limit switch, and control the robot system by monitoring the state of the end effector.

1.5 SAFETY IN MAINTENANCE

(1) Never enter the robot work area while the robot is operating. Turn off the power before entering the robot work area for inspection and maintenance.

(2) If it is necessary to enter the robot work area with the power turned on, first press the EMERGENCY STOP button on the operator panel.

(3) When replacing or reinstalling components, take care to prevent foreign matter from entering the system.
When replacing the parts in the pneumatic system, be sure to reduce the pressure in the piping to zero by turning the pressure control on the air regulator.

(4) When handling each unit or printed circuit board in the controller during inspection, turn off the power of the controller and turn off the circuit breaker to protect against electric shock.

(5) When replacing parts, be sure to use those specified by FANUC.
In particular, never use fuses or other parts of non-specified ratings. They may cause a fire or result in damage to the components in the controller.

(6) Before restarting the robot, be sure to check that no one is in the robot work area and that the robot and its peripheral devices are all in the normal operating state.

1.6 WARNING LABEL

Description

Do not step on or climb the robot or controller as it may adversely affect the robot or controller and you may get hurt if you lose your footing as well.

(1) Step–on prohibitive label

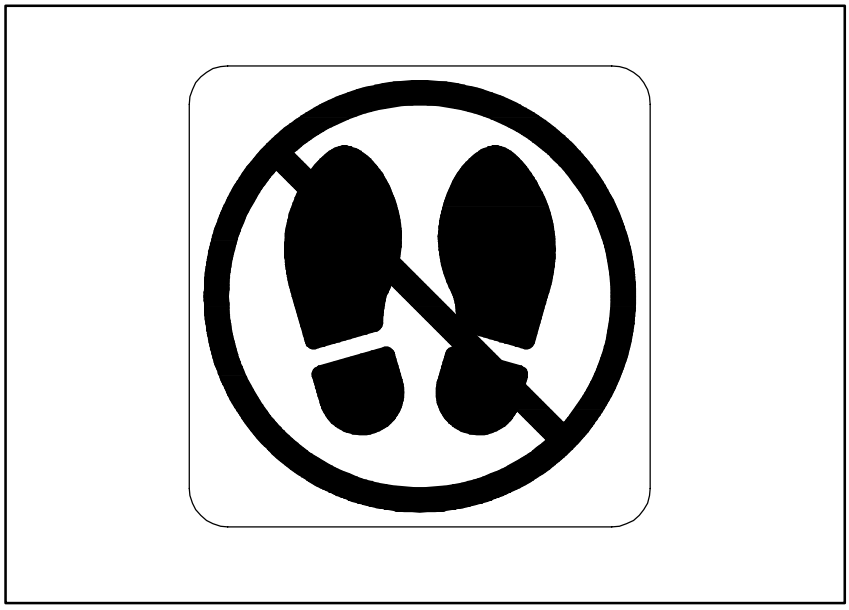


Fig.1.6 (a) Step–on Prohibitive Label

Description

Be cautious about a section where this label is affixed, as the section generates heat. If you have to inevitably touch such a section when it is hot, use a protective provision such as heat–resistant gloves.

(2) High–temperature warning label

Fig.1.6 (b) High–Temperature Warning Label

Description

A high voltage is applied to the places where this label is attached. Before starting maintenance, turn the power to the control unit off, then turn the circuit breaker off to avoid electric shock hazards. Be careful with servo amplifier and other units because high–voltage places in these units may remain in the high–voltage state for a fixed time.

(3) High–voltage warning label

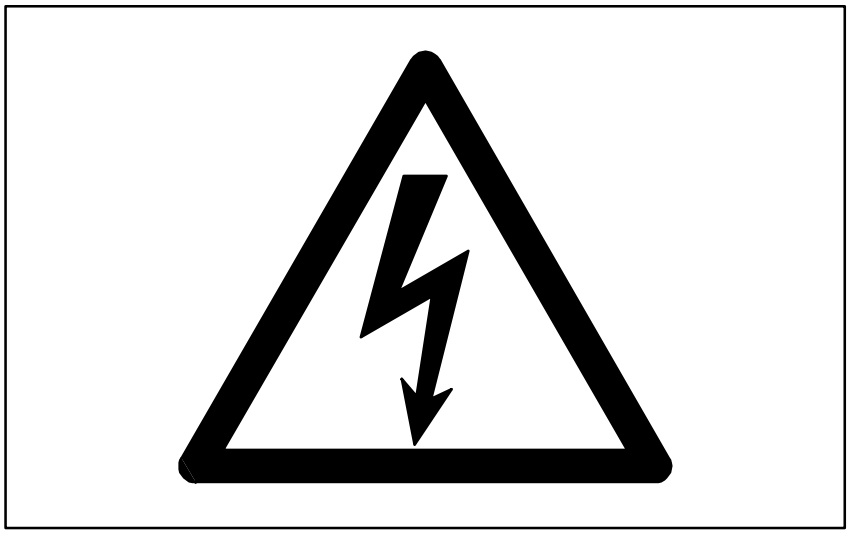


Fig.1.6 (c) High–Voltage Warning Label

Description

There may be a high voltage in a place with this label. Before working on such a portion, turn off the power to the controller and set its circuit breaker to the off position to avoid shock hazards.
In addition, be careful about servo amplifiers and other electric circuits because a high voltage may remain in them for a certain period of time after the power is turned off.

I. MAINTENANCE

1 CONFIGURATION

Fig.1 shows the configuration of the mechanical unit.

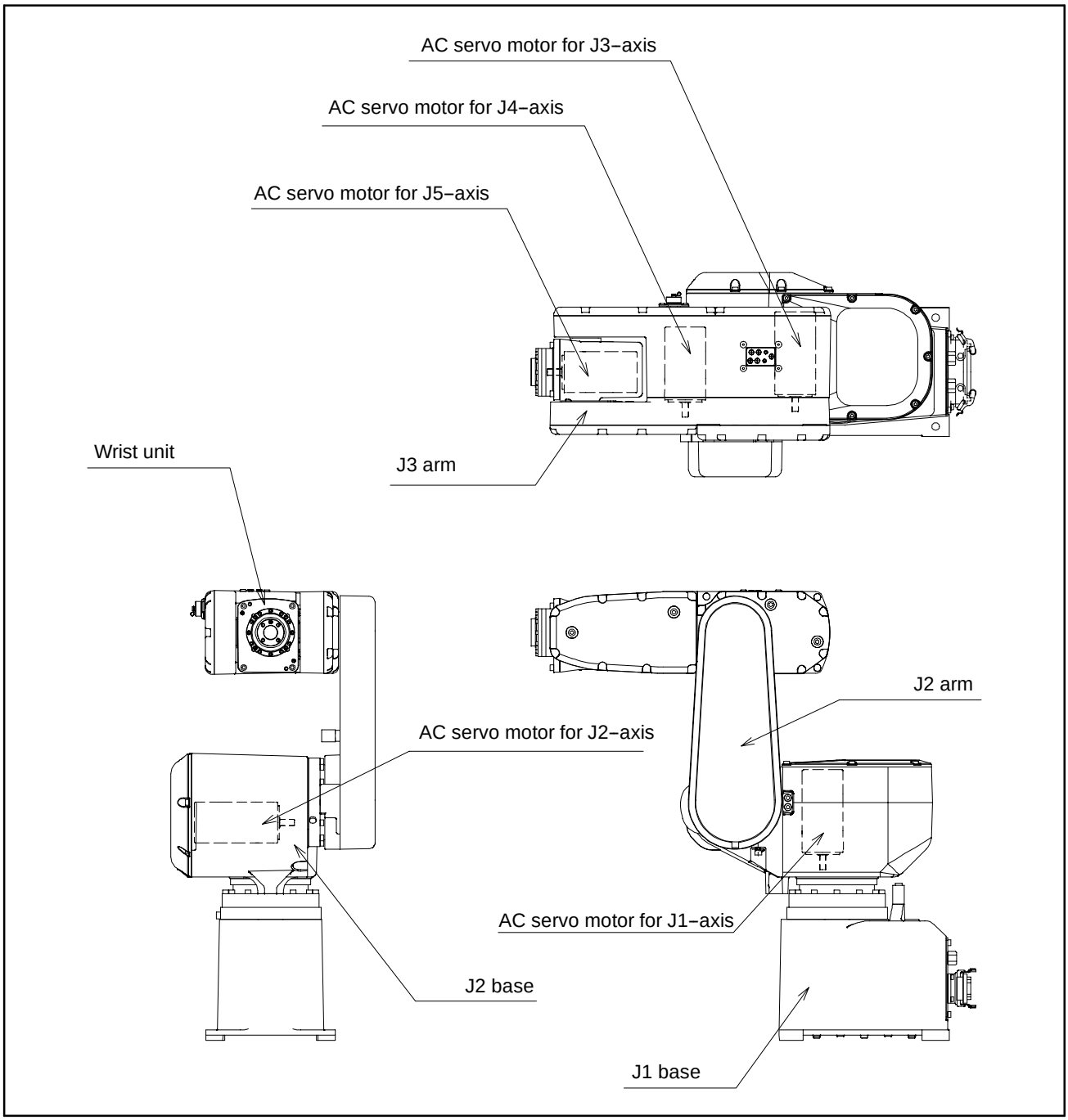


Fig.1 Mechanical unit configuration

1.1 J1–AXIS DRIVE MECHANISM

Fig.1.1 shows the J1–axis drive mechanism.
The rotation of the AC servo motor is decelerated by the reducer via the center gear and the decelerated rotation rotates the J2–axis base. The J2–axis base is supported by the J1–axis base via the J1 axis reducer.

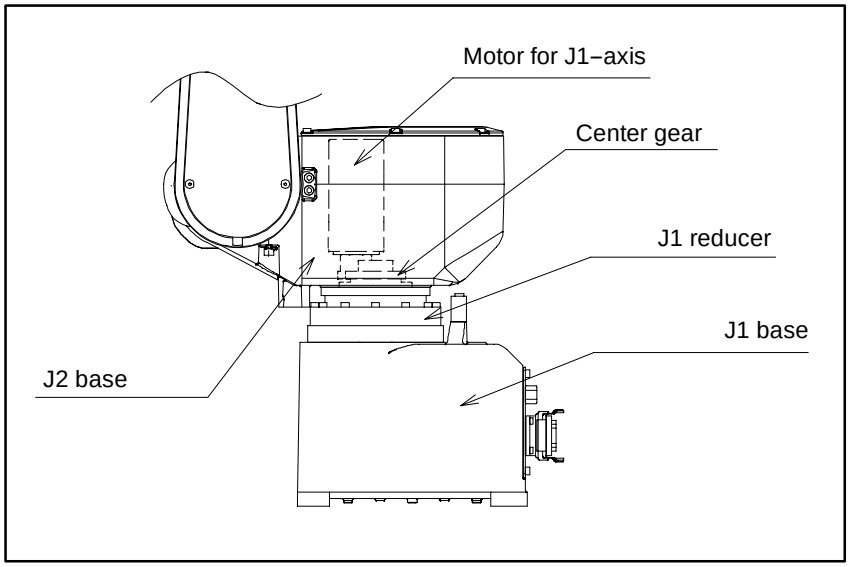


Fig.1.1 J1–axis drive mechanism

1.2 J2–AXIS DRIVE MECHANISM

Fig.1.2 shows J2–axis drive mechanism. The rotation of the AC servo motor is decelerated by the reducer via the center gear and the decelerated rotation rotates the J2–axis arm. The J2–axis arm is supported by the J2–axis base via the reducer.

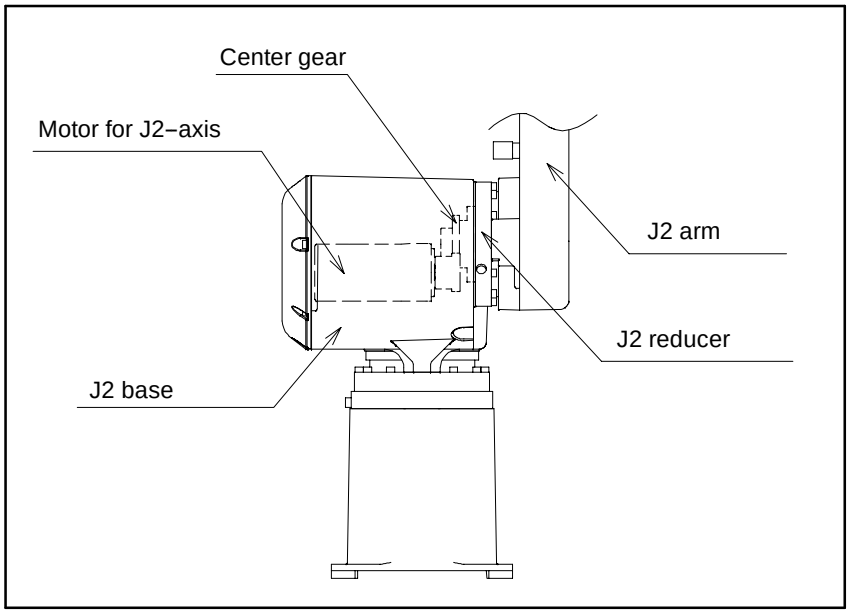


Fig.1.2 J2–axis drive mechanism

1.3 J3−AXIS DRIVE MECHANISM

Fig.1.3 shows the J3−axis drive mechanism. The rotation of the AC servo motor is decelerated by the reducer and rotates the J3−axis arm via the gear. The J3−axis arm is supported by the J2−axis arm via the gear and the bearing.

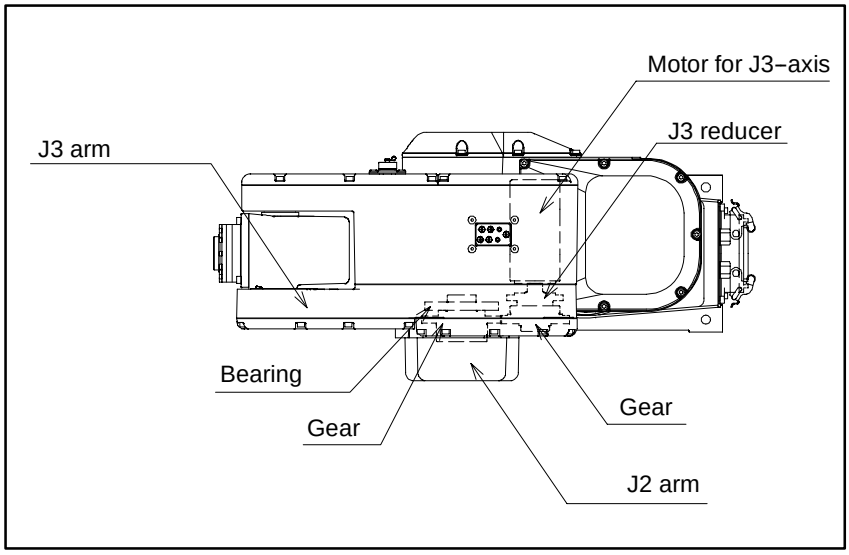


Fig.1.3 J3−axis drive mechanism (LR Mate 100*i*)

1.4 J4−AXIS DRIVE MECHANISM

Fig.1.4 shows the J4−axis drive mechanism. The rotation of the AC servo motor is decelerated by the three steps gear and rotates the wrist unit. The wrist unit is supported by the J3 arm via the gear and bearing.

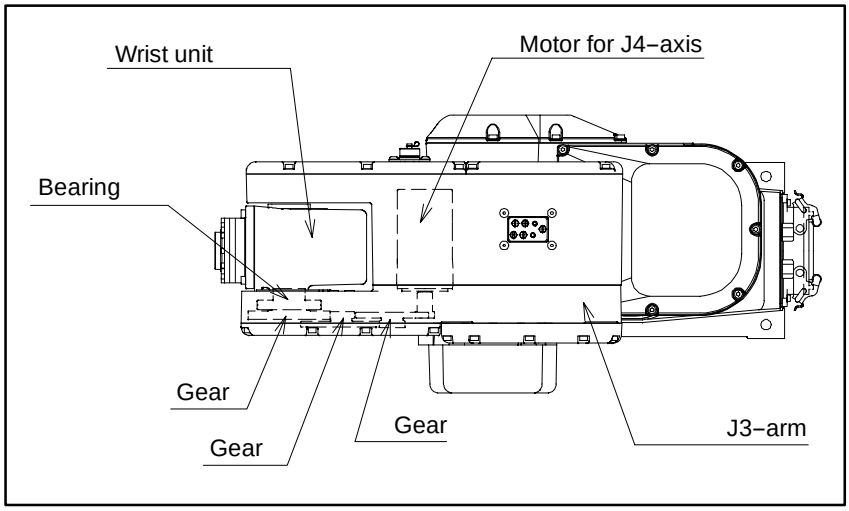


Fig.1.4 J4−axis drive mechanism

1.5 J5–AXIS DRIVE MECHANISM

Fig.1.5 shows the J5–axis drive mechanism. The rotation of the AC servo motor is decelerated by the reducer and rotates the output flange.

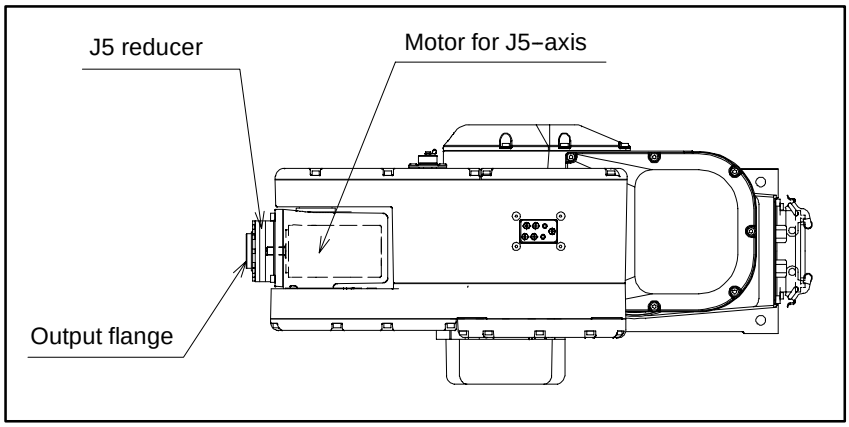


Fig.1.5 J5–axis drive mechanism

1.6 MAJOR COMPONENT SPECIFICATIONS

1) Motor

(a) When 2 axes break type is A05B–1137–B201.

Specifications	Axis	Remarks
A06B–0115–B075#0008	J1	βM0.5/4000
A06B–0115–B275#0008	J2	βM0.5/4000 with brake
A06B–0115–B275#0008	J3	βM0.5/4000 with brake
A06B–0114–B075#0008	J4	βM0.4/4000
A06B–0114–B075#0008	J5	βM0.4/4000

(b) When All axes break type is A05B–1137–B202.

Specifications	Axis	Remarks
A06B–0115–B275#0008	J1	βM0.5/4000 with brake
A06B–0115–B275#0008	J2	βM0.5/4000 with brake
A06B–0115–B275#0008	J3	βM0.5/4000 with brake
A06B–0114–B275#0008	J4	βM0.4/4000 with brake
A06B–0114–B275#0008	J5	βM0.4/4000 with brake

2) Reducer

Specifications	Axis
A97L–0218–0296#80	J1
A97L–0218–0297#80	J2
A97L–0218–0298#100	J3
A97L–0218–0299#50	J5

3) Gear

Specifications	Axis
A290–7137–X211	J1, J2
A290–7137–X212	J1
A290–7137–X312	J2
A290–7137–X411	J3
A290–7137–X412	J3
A290–7137–X413	J4
A290–7137–V401	J4
A290–7137–V402	J4
A290–7137–X416	J4

2 PREVENTIVE MAINTENANCE

Optimum perfomance of the robot can be maintained for a long time by performing the periodic maintenance procedures presented in this chapter.

NOTE
The FANUC robot assumes a yearly run time of 3840 hours. If you use the robot more than 3840 hours a year, maintain the robot according to this chapter in terms of 3840 hours/year.

2.1 DAILY CHECKS

Clean each part, and visually check component parts for damage before daily system operation.
Check the following items as the occasion demands.

a) Before automatic operation

Item	Check items		Check points
1	When air control set is provided.	Air pressure	Check air pressure using the pressure gauge on the air regulator as shown in Fig.2.1. If it does not meet the specified pressure of 0.49MP_a (5 kg/cm^2), adjust it using the regulator pressure setting handle.
2		Leakage from hose	Check the joints, tubes, etc. for leaks. Repair leaks, or replace parts, as required.
3	Cables used in mechanical unit		Refer to section NO TAG.
4	Vibration, abnormal noises and motor heating		Check whether each axis moves smoothly.
5	Changing repeatability		Check whether the stop positions of the robot have not deviated from the previous stop positions.
6	Peripheral devices for proper operation		Check whether the peripheral devices operate properly according to commands from robot.
7	J2,J3−axis brake		Refer to 4.3.

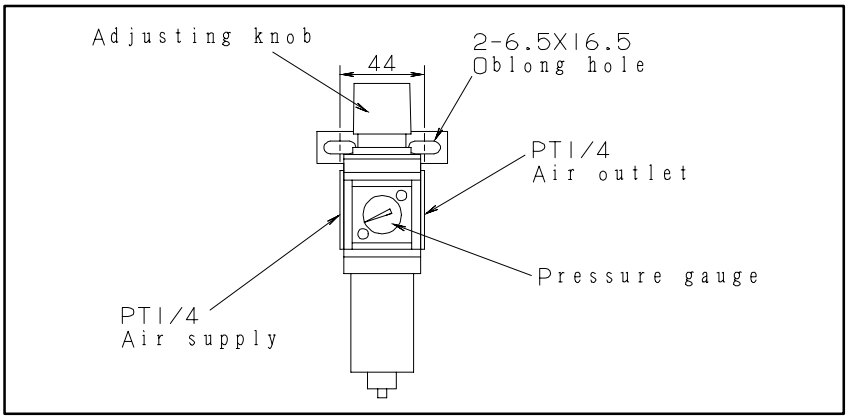


Fig.2.1 Air control set (option)

b) After automatic operation
After automatic operation ends, return the robot to the zero point and turn off the power supply.

Item	Check items	Check points
1	Cleaning and checking each part	Clean each part and check component parts for cracks and flaws.

2.2 3–MONTH CHECKS

Check the following items once every three months. Additional inspection areas and times should be added to the table according to the robot's working conditions, environment, etc.

Item	Check items	Check points
1	Loose bolt	Check if the cover mounting bolts and external mounting bolts are loose.
2	Ventilation portion of control unit	If the ventilation portion of the control unit is dusty, tum off power and clean the unit.
3	Removal of dust, etc.	Remove any spatter, dust, and so forth from the mechanical unit.
4	Connection cable check	Check if the mechanical section connection cable and teach pendant connection cable are broken or bent excessively.

2.3 1–YEAR CHECKS

Check the following items every year.

Item	Check items	Check points
1	Lubrication greasing	Refer to section 3.1

2.4 1.5–YEAR CHECKS

Check the following item once every 1.5 year.

Item	Check items	Check points
1	Battery	Replace battery in the mechanical unit. Refer to Section 3.3.

2.5 MAINTENANCE TOOLS

The following tools and instruments are required for the maintenance procedures contained in this manual.

a) Measuring instruments

Instruments	Accuracy/Tolerance	Applications
Dial gauge	1/100 mm	Measurement of positioning and backlash.
Slide calipers	150 mm	

b) Tools

Torque wrench
Setting: 9.0Nm (92kgfcm) M5
Setting: 5.6Nm (57kgfcm) M5
Setting: 2.5Nm (25kgfcm) M5, M4
Setting: 1.3Nm (13kgfcm) M6, M3

Cross tip (+) screwdrivers:	Large, medium, and small sizes
Flat tip (–) screwdrivers:	Large, medium, and small sizes
Nut drivers:	M3–M6
Hexagonal wrench key sets (metric):	M3–M16
Adjustable wrenches:	Medium and small sizes

Pliers
Needle nose
Diagonal cutters
Metric combination wrenchs
Grease gun
Pliers for C–retaining ring

3 PERIODIC MAINTENANCE

3.1 GREASING

NOTE
Incorrect greasing rapidly increases the pressure in the grease bus. This may cause the seal to be damaged, resulting in a grease leak or operation failure.
When greasing the robot, note the following points:

1 Remove the grease outlet (The plug or the bolt) before greasing the robot.
2 Gradually supply grease with a manual pump.
3 Do not use an air pump driven by compressed air in the factory as much as possible.
If it is unavoidable to use an air pump, make sure that the greasing rate is 15 ml/sec or less and the pressure is 7.35 MPa (75 kgf/cm^2) or less.
4 Use the specified grease. Otherwise, damage to the reducer or other problems may occur.
5 Upon completion of greasing, make sure that grease stops flowing (no pressure is left) before attaching the plug.
6 Completely wipe out grease on the floor and robot, if any, to prevent workers from slipping.

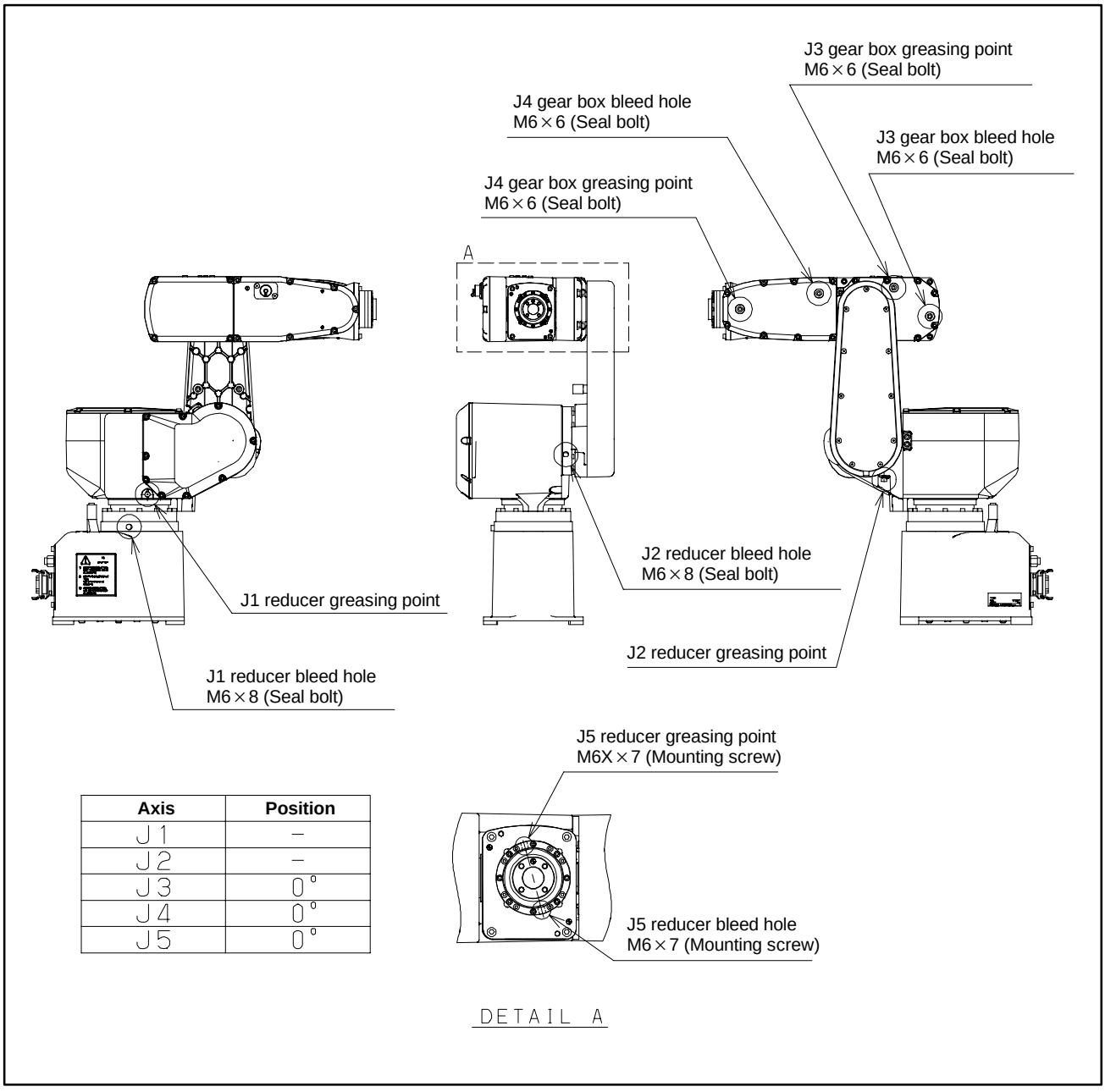
Replace the grease of the reducers of the J1, J2, and J5 axes, and the grease of the gear boxes of the J3 and J4 axes yearly according to the procedure below. See Fig. 3.1 for the greasing points and greasing attitude.

1) Move the robot to the greasing attitude shown in Fig. 3.1.
2) Turn off the power.
3) Remove the seal bolt of each grease outlet.
4) Remove the seal bolt of the grease inlet of the J3, J4, and J5 axes, then attach a grease nipple delivered with the robot.
5) Feed a specified amount of grease through the grease nipple.
For the gear box of the J3 and J4 axes, feed grease until new grease is output from the grease outlet. At this time, ensure that the amount of output grease equals the amount of new fed grease so that the grease path is not fully filled.
6) Attach seal bolts to the grease outlets and grease inlets. When reusing a seal bolt, be sure to seal the bolt with sealing tape.

Table 3.1 (a) Greasing points (LR Mate 100)

Greasing point	Grease	Qty
J1−axis reducer	Harmonic grease SK−3(Note)	30cc
J2−axis reducer		20cc
J3−axis gear box		100cc
J4−axis gear box		380cc
J5−axis reducer		5cc

NOTE
FANUC specification number for SK−3 harmonic grease (2.5−kg can): A98L−0040−0110#2.5KG



Axis	Position
J1	–
J2	–
J3	0°
J4	0°
J5	0°

Fig.3.1 Greasing point

3.2 REPLACING BATTERY

The memory holding the position data of each axis is backed up by batteries.
Replace the backup batteries according to the schedule described in Section NO TAG.
Also, replace the backup batteries when the BLAL alarm is output to indicate that the voltage of the backup batteries has fallen below a preset level.
The BLAL alarm can be released by pressing the alarm release key after replacing the backup batteries.
Replace the backup batteries according to the procedure below.

1 Press the EMERGENCY STOP button to prevent the robot from moving.

NOTE
Be sure to turn on the power beforehand. If the battery is replaced when the power is off, the current position data is lost and mastering becomes necessary.

2 Remove the cover from the top of the J2 base.
3 Remove the case cap of the battery.
4 Replace the old battery from the battery case.
5 Install new batteries. Make sure of the direction.
6 Put the case cap of the battery.
7 Mount the J2 base top cover.

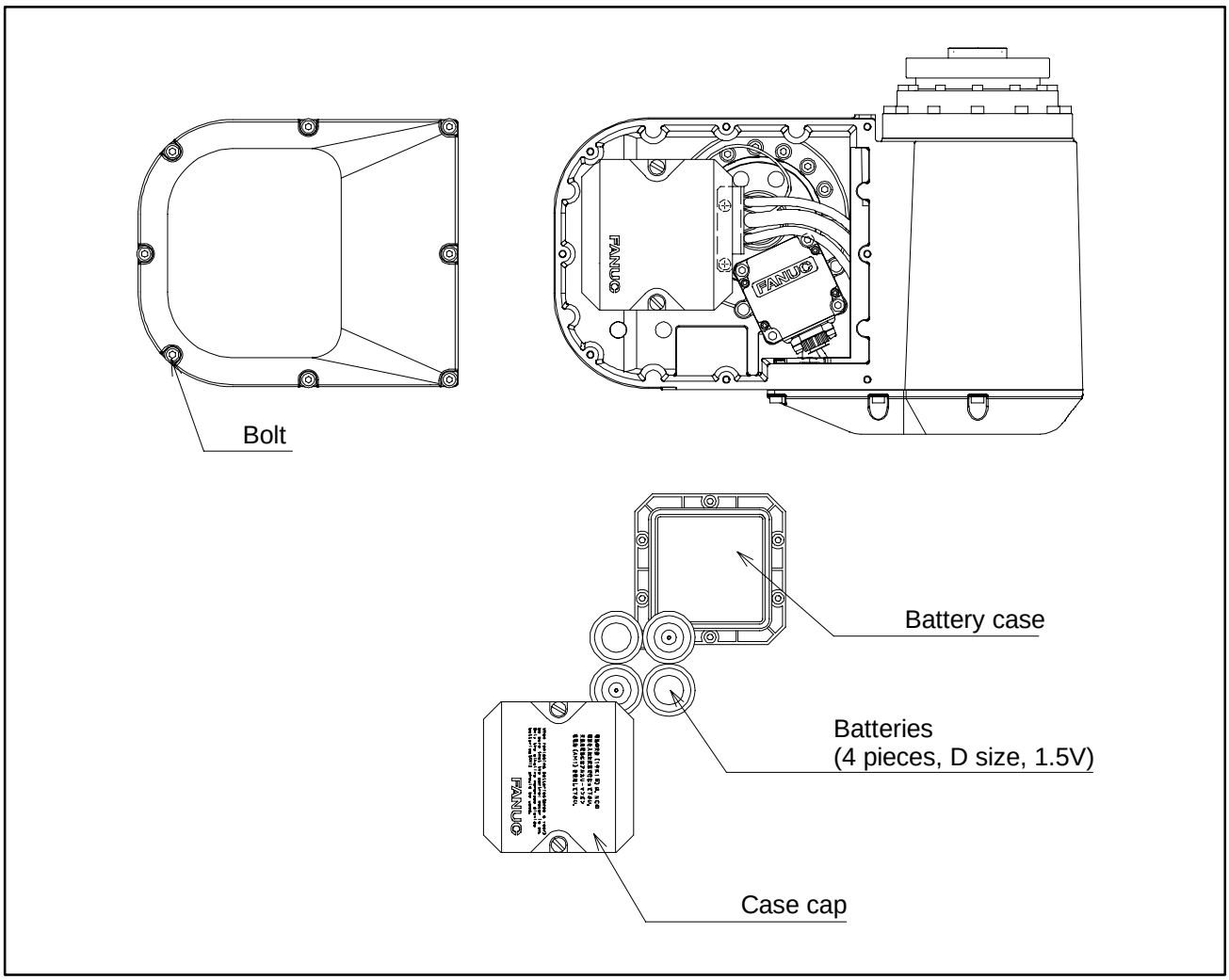


Fig.3.2 Replacing batteries

4 TROUBLESHOOTING

4.1 GENERAL

The source of mechanical unit problems might be difficult to locate because of overlapping causes. Problems might become further complicated if they are not corrected properly. Therefore, it is necessary to keep an accurate record of problems and to take proper corrective actions.

4.2 PROBLEMS AND CAUSES

Major problems in the mechanical unit and their probable causes are listed below:
Contact FANUC, if the cause of a failure or the action to be taken cannot be determined.

Table 4.2 (a) Problems and causes

Symptom	Cause	Action	Remarks
BZAL alarm occurs	The voltage of memory backup batteries dropped.	Perform mastering after battery replacement.	See section 3.2 and sub–section 5.2.5.
	The pulse coder signal cable is broken.	Replace the cable, then perform quick mastering.	See section **. See sub–section 5.2.5.
Deviated position	The robot struck an obstacle.	Modify teaching points.	
	The robot is not firmly mounted.	Secure the robot.	See II. Connection 3.2.
	Peripheral equipment moved out of position.	Fix the peripheral equipment.	
	Overload	Reduce the load. Limit the operation condition.	Wrist load: See section 2.1 in part for Connection.
	The content of the parameters changed.	Correct the parameter.	Operator's manual
	A cable is damaged.	Replace the cable.	Refer to section 8.
	The pulse coder is abnormal.	Replace the motor.	See sections 6.1 through **.
	The mechanical section has backlash. See the item below.		
The robot vibrates	The robot is not bolted securely on the floor.	Secure the robot.	See section 3.2 in part for Connection.
	The floor itself vibrates. (In particular when installed on the second floor or higher.)	Review the location of installation.	
	Overload	Reduce the load. Limit the operation condition.	Wrist load: See section 2.1 in part for Connection.
	Servo adjustment failure	Make a servo adjustment.	Contact FANUC.
	The cable is broken (pulse coder cable)	Replace the cable.	Refer to section 8.
	No connection is made to ground.	Make a connection to ground.	Refer to the control unit maintenance manual.
	Motor is faulty.	Replace the motor.	Refer to section 6.
	The axis board PCB is faulty.	Replace the axis board PCB.	Refer to the control unit maintenance manual.
	Reducer is faulty.	Replace the reducer.	Refer to section 6.
	An incorrect time constant is used.	Correct the time constant.	Operator's manual
	The mechanical section has backlash. See the item below.		
Excessive backlash Note: Backlash less than the amount shown in the table 4.2(b) is not abnormal.	Screws and plus are loose	Tighten the screw. (Apply Loctite to the specified locations.)	
	A reducer is faulty.	Replace the reducer.	See sections 6.2 through 6.1.*.
	Gear adjustment failure	Adjust the gear.	See section 5.1.
	Worn gear	Adjust the gear. Replace the gear.	Contact FANUC.
	Worn bearing	Replace the bearing.	Contact FANUC.
	A part such as a cast is broken.	Replace the broken part.	Contact FANUC.

Symptom	Cause	Action	Remarks
Abnormal sound	Insufficient greasing for a gear or reducer	Feed grease.	See section 3.1.
	Foreign matter caught in a gear or reducer	Clean the gear and reducer then feed grease.	See sections 6.2 through 6.*, and section 3.1.
	Gear adjustment failure	Adjust the gear correctly.	Contact FANUC.
	Worn gear	Adjust the gear. Replace the gear.	Contact FANUC.
	Worn bearing	Replace the bearing.	Contact FANUC.
	Servo adjustment failure	Make a servo adjustment correctly.	Contact FANUC.
Abnormal heat dissipation	Insufficient greasing for a gear or reducer	Feed grease.	See section 3.1.
	A type of grease not specified is used.	Replace the grease.	See section 3.1.
	Overload	Reduce the load. Limit the operation condition.	Wrist load: See section 2.1 in part for Connection.
	Gear adjustment failure	Adjust the gear correctly.	Contact FANUC.
	An incorrect time constant is used.	Correct the time constant.	Refer to the operator's manual.
Falling at power off	The brake gap increased.	Replace motor	Refer to section 6.
	The brake driving relay contact is melted.	Replace relay	Refer to R−J3*i* Mate Maintenance MANUAL
Grease leakage	An O−ring, oil seal, or packing is deteriorated or damaged.	Replace the O−ring, oil seal, or packing.	Contact FANUC.
	A part such as a cast is broken.	Replace the broken part.	Contact FANUC.
	A screw is loose.	Tighten the screw.	

Table 4.2 (b) Permitted (excessive) backlash amount

	J1	J2	J3	J4	J5
Angle conversion (min)	2.0	2.0	6.0	6.0	3.0
Displacement conversion (mm)	0.36	0.15	0.38	0.28	0.13
Distance from measured point to center of axis (mm)	620	250	220	160	150

4.3 REPLACING PARTS AND PERFORMING ADJUSTMENTS

Adjustments are necessary whenever a part is replaced.
The table below shows replacement of parts and the required adjustment items.

Parts to be replaced or functions to be changed	Adjustment
Replacement of cable	(a) Routing of cable (b) Quick Mastering
Replacement of J1/J2/J3/ J5−axis reducer Replacement of J1/J2/J3/ J5−axis motor	(a) Routing of cable (b) Mastering
Replacement of J4−axis motor	(a) Routing of cable (b) Adjustment of the gear backlash (c) Mastering
Replacement of J4−axis gear	(a) Adjustment of the gear backlash (b) Mastering
Replacement of solenoid valve	No adjustment is needed. But the operation must be confirmed.
Replacement of batteries	Replace batteries keeping power on. No adjustment is necessary. When BZAL alarm occurs, quick mastering should be performed.

5 ADJUSTING

Mechanical parts have been adjusted to the optimum condition at the time of shipment. Therefore, adjustment by the customer is normally not needed at the time of delivery.
Adjustment should be made as specified in this section, however, after a long period of use or after replacing a part.

5.1 BACKLASH ADJUSTMENT OF THE J4–AXIS GEAR

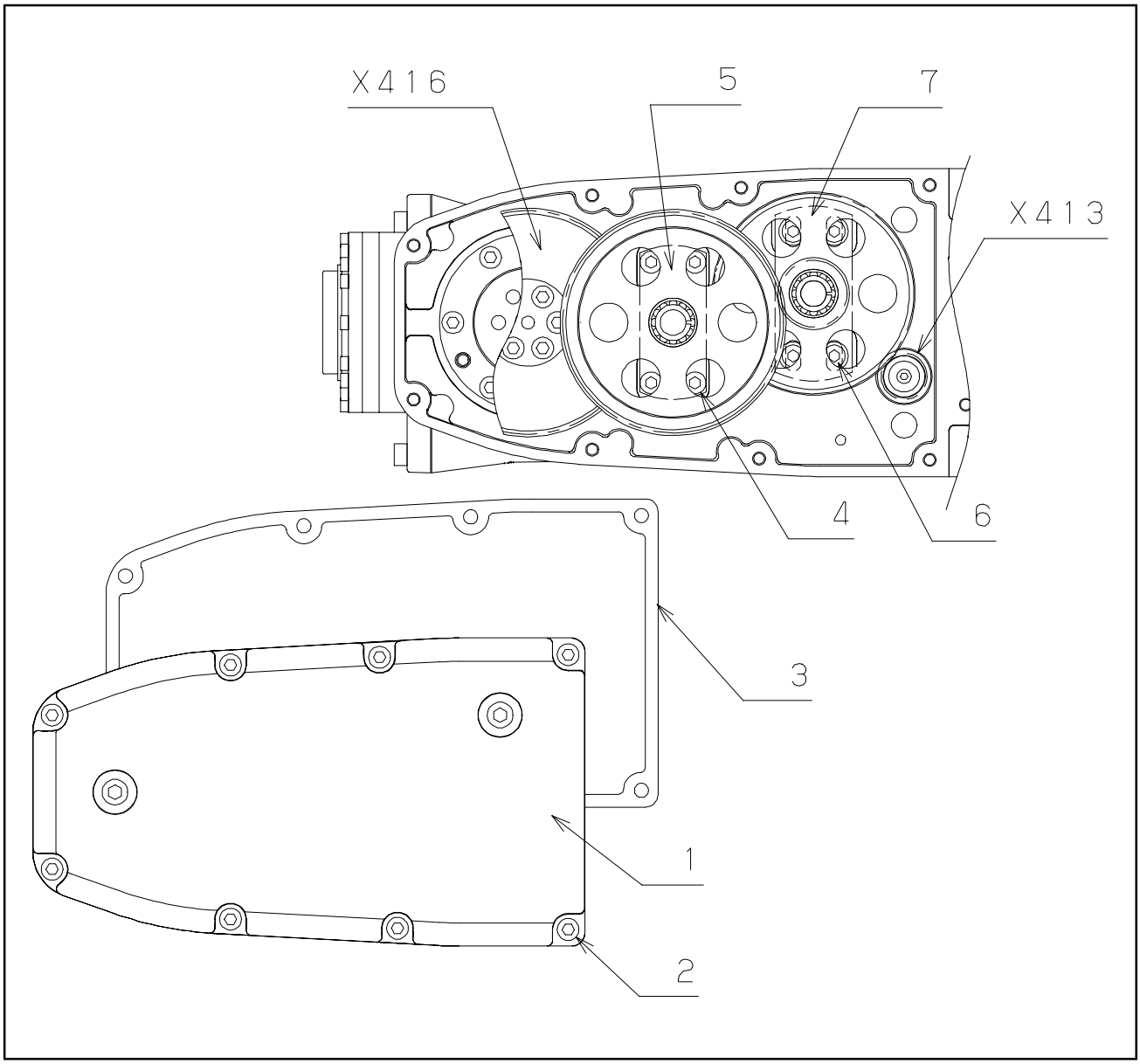
1 Preparation for adjustment
   1) Remove bolt (2), and remove packing (3) and J4 gear box cover (1). At this time, grease can drip. Use care.
   2) Before making a backlash adjustment, clean off grease from the inside of the gear box so that the gear and bolt can be viewed.

2 Flow of adjustment
   1) Remove gear W2 assembly (7).
   2) Adjust the gear W3 assembly (5).
   3) Adjust the gear W2 assembly (7).

3 Backlash adjustment of the gear W3 assembly
   1) Remove bolt (6), then remove gear W2 assembly (7).
   2) Remove bolt (4). When gear W3 assembly (5) is moved right or left, the backlash of gear W3 assembly (5) and J4–axis output gear (X416) changes. Move the position of gear W3 assembly (5) so that the backlash of gear W3 assembly (5) is reduced. Then, secure gear W3 assembly (5) to the J3 arm with bolt (4).
   3) Move the J4 axis within the stroke (–120° to +120°), and repeat step 2) for backlash reduction until the gears do not interfere with each other.

4 Backlash adjustment of the gear W2 assembly
   1) When gear W2 assembly (7) is moved, the backlash of gear W3 assembly (5) and the backlash of J4 motor axis gear (X416) change. Move the position of the gear W2 assembly so that both of the backlashes are reduced. Then, secure the gear W2 assembly to the J3 arm with bolt (6).
   2) Move the J4 axis within the stroke (–120° to +120°), and repeat step 1) for backlash reduction until the gears do not interfere with each other.
   3) Check that the backlash of the J4 axis is reduced to or below the allowable value indicated in Table 4.1(b) (output axis angle of 6 minutes). If the backlash is larger than the allowable value, return to step 1) of 3.

5 Cover attachment and greasing
   1) Secure the J4–axis gear box cover to the J3 arm with bolt (2). At this time, replace packing (3) with a new one to prevent grease leakage.
   3) Feed grease as specified to the J4–axis gear box according to the grease replacing procedure described in Section 3.2.
   4) Perform mastering according to Section 5.4 or Section 5.5.



No.	Name	Specifications	Q'ty	LOCTITE	Torque N-m (kgf-m)
1	G.B. COVER 2	A290-7137-X404	1		
2	BOLT	A97L-0218-0496#M5X12ZN	8		
3	G.B. PACKING 2	A290-7137-X428	1		
4	BOLT	A6-BA-5X10	4	LT262	5.6 (57)
5	GEAR W3 ASS'Y	A290-7137-V402	1		
6	SEAL BOLT	A97L-0218-0495#051010	4		5.6 (57)
7	GEAR W2 ASS'Y	A290-7137-V401	1		

Fig.5.1 Backlash adjustment of the J4−axis gear

5.2 MASTERING

Mastering is an operation performed to associate the angle of each robot axis with the pulse count value supplied from the absolute pulse coder connected to the corresponding axis motor. To be specific, mastering is an operation for obtaining the pulse count value corresponding to the zero position.

5.2.1 General

The current position of the robot is determined according to the pulse count value supplied from the pulse coder on each axis.

Mastering is factory–performed. It is unnecessary to perform mastering in daily operations. However, mastering becomes necessary after:

- Motor replacement.
- Pulse coder replacement.
- Reducer replacement.
- Cable replacement.
- Batteries for pulse count backup in the mechanical unit have gone dead.

NOTE
Robot data (including mastering data) and pulse coder data are backed up by their respective backup batteries. Data will be lost if the batteries go dead. Replace the batteries in the control and mechanical units periodically. An alarm will be issued to warn the user of a low battery voltage.

Mastering method

Table 5.2.1 Types of Mastering

Jig position mastering	This is performed using a mastering jig before the machine is shipped from the factory.
Zero-position mastering (eye mark mastering)	This is performed with all axes set at the 0–degree position. A zero–position mark (eye mark) is attached to each robot axis. This mastering is performed with all axes aligned to their respective eye marks.
Simplified mastering	This is performed at a user–specified position. The corresponding count value is obtained from the rotation speed of the pulse coder connected to the relevant motor and the rotation angle within one rotation. Simplified mastering uses the fact that the absolute value of a rotation angle within one rotation will not be lost.
One-axis mastering	This is performed for one axis at a time. The mastering position for each axis can be specified by the user. This is useful in performing mastering on a specific axis.
Mastering data entry	Mastering data is entered directly.

Once mastering is performed, it is necessary to carry out positioning, or calibration. Positioning is an operation in which the control unit reads the current pulse count value to sense the current position of the robot.

NOTE
If mastering is performed incorrectly, the robot may behave unexpectedly. This is very dangerous. So, the positioning screen is designed to appear only when the $MASTER_ENB system variable is 1 or 2. After performing positioning, press F5 [DONE] on the positioning screen. The $MASTER_ENB system variable is reset to 0 automatically, thus hiding the positioning screen.

5.2.2 Resetting Alarms and Preparing for Mastering

Before performing mastering because a motor is replaced, it is necessary to release the relevant alarm and display the positioning menu.

Alarm displayed

“Servo 062 BZAL” or “Servo 075 Pulse mismatch”

Procedure Preparing the Robot for Mastering

Step

1 To reset the ”Servo 062 BZAL” alarm, follow steps 1 to 7.

1 Press MENUS.
2 Press NEXT and select [SYSTEM].
3 Press F1 [TYPE], and select [Variables] from the menu.
4 Place the cursor on Master/Cal, then press the execution key.
5 Place the cursor on $SPC_RESET, then press F4 [TRUE]. The message “TRUE” appears and disappears immediately.
6 If the message “TRUE” did not appear, retry by repeating the above step several times.
7 Switch the controller power off and on again.

2 To reset the “Servo 075 Pulse mismatch” alarm, follow steps 1 to 3.

1 When the controller power is switched on again, the message “Servo 075 Pulse mismatch” appears again.
2 Rotate the axis for which the message mentioned above has appeared through 10 in either direction.
3 Press [FAULT RESET]. The alarm is reset.

3 Display the positioning menu by following steps 1 to 6.

1 Press MENUS.
2 Press NEXT and select [SYSTEM].
3 Press F1 [TYPE], and select [Variables] from the menu.
4 Place the cursor on $MASTER_ENB, then key in “1” and press [ENTER].
5 Press F1 [TYPE], and select [Master/Cal] from the menu.
6 Select the desired mastering type from the [Master/Cal] menu.

5.2.3 Mastering to a Fixture (Master Position Master)

Jig position mastering is performed using a mastering jig. This mastering is carried out in the predetermined jig position.

Jig position mastering is accurate because a dedicated mastering jig is used. Jig position mastering is factory–performed. It is unnecessary to perform it in daily operations.

When mastering the robot, arrange the robot to meet the following conditions.

- Make the robot mounting base horizontal.
- Remove the hand and other parts from the wrist.
- Set the robot in the condition protected from an external force.

1) Assembling the fixture base

   Assemble the fixture base as shown in Fig.5.2.3 (a).

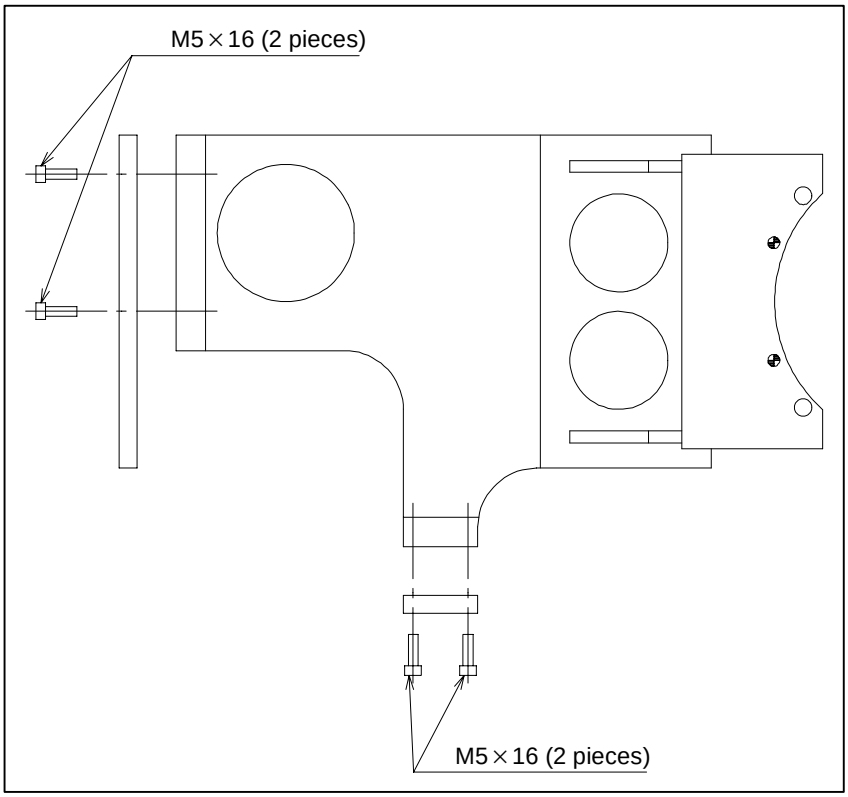


Fig.5.2.3 (a) Assembling fixture base

2) Mount the fixture on the J1–axis base with bolts as shown in Fig.5.2.3(b).

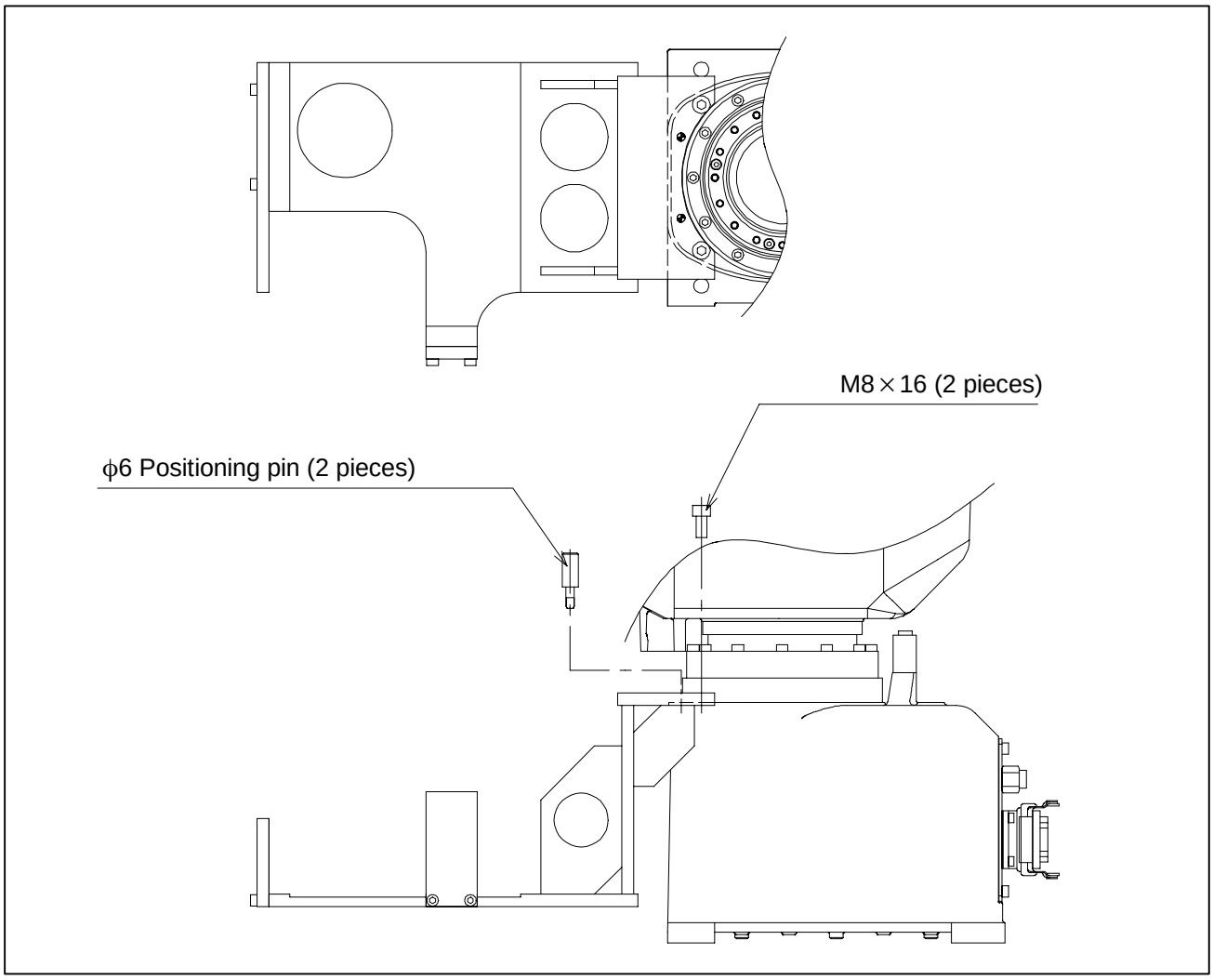


Fig.5.2.3 (b) Mounting fixture base

3) Mount the wrist fixture as shown in Fig.5.2.3 (c).
Adjust the dial gauge to 3.00 mm using the calibration block, and tighten it with M5 bolt as shown in Fig.5.2.3 (c). (Do not tighten the bolt too strongly or the dial indicator will be broken.)

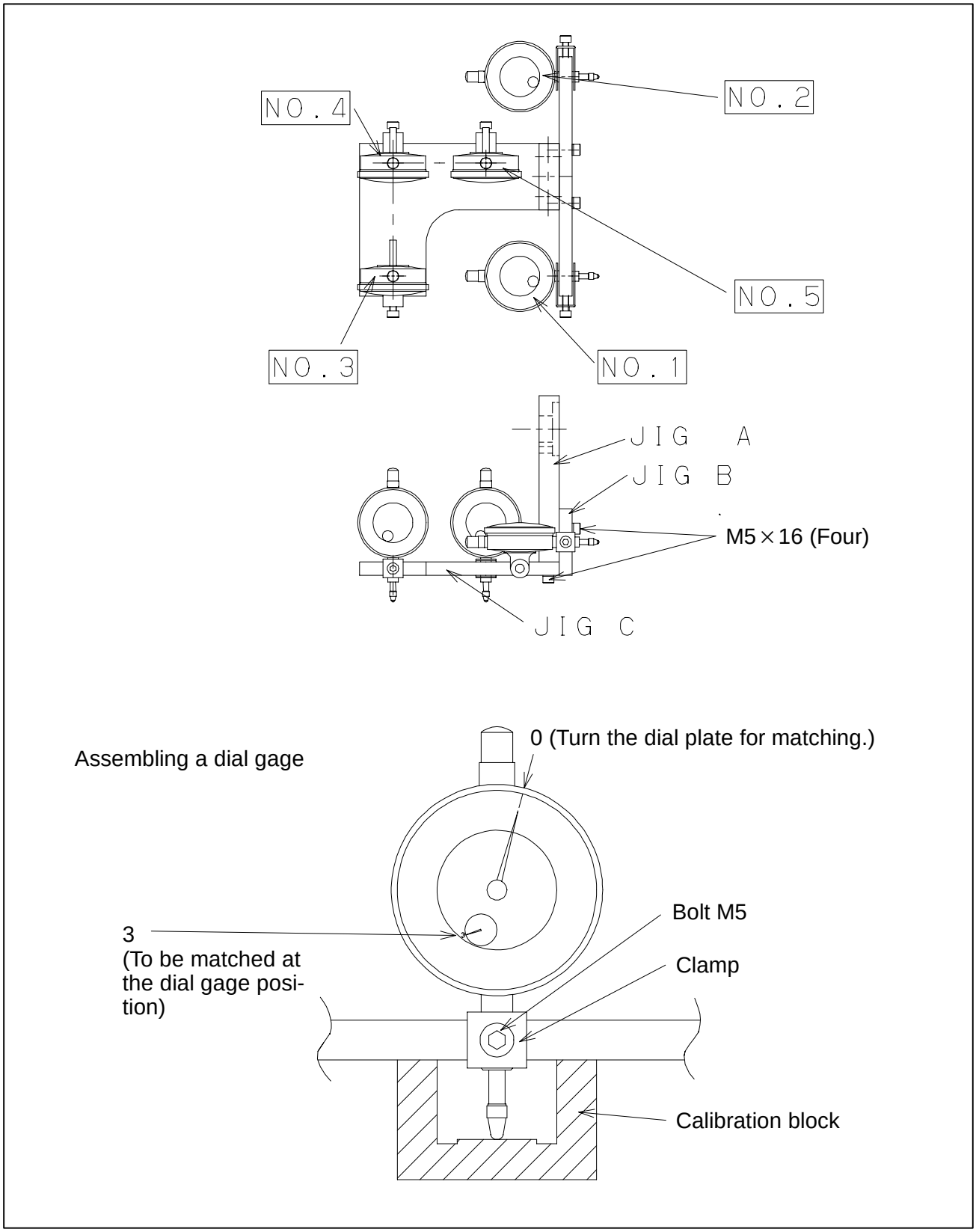


Fig.5.2.3 (c) Mounting the wrist fixture

4) Mounting the fixture to the wrist
Mount the fixture to the wrist flange as shown in Fig.5.2.3 (d).

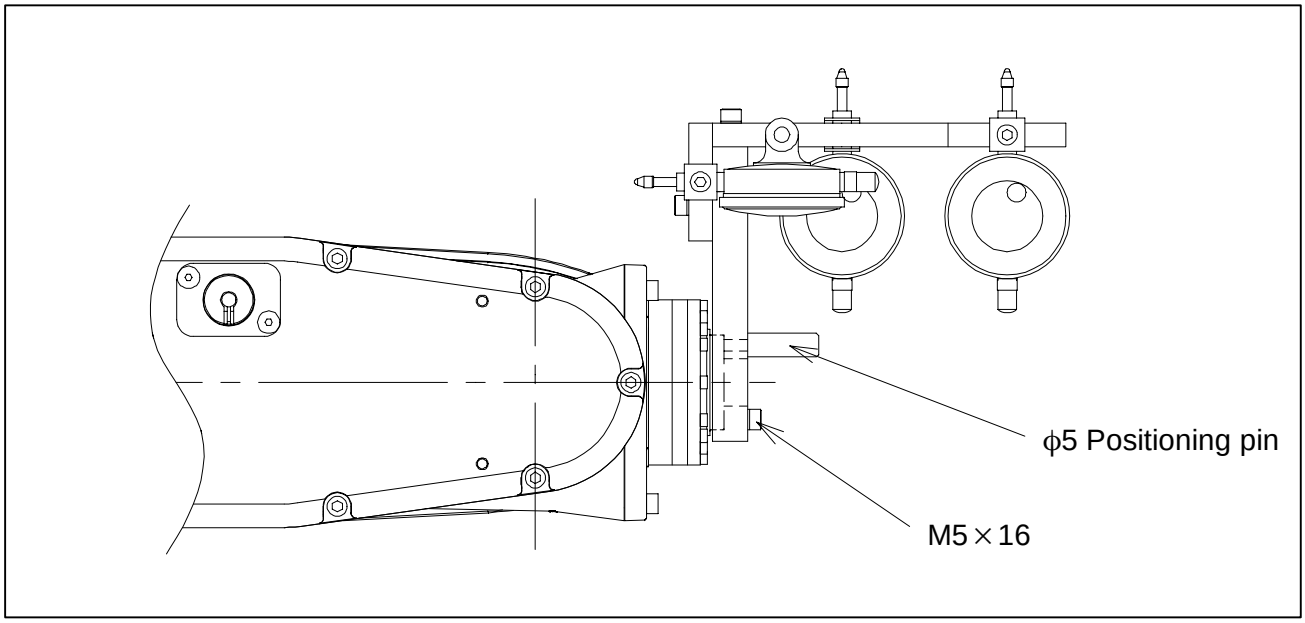


Fig.5.2.3 (d) Mounting fixture to wrist

Mastering

1) Press MENUS.
2) Press NEXT and select SYSTEM.
3) Press F1, [TYPE].
4) Select Master/Cal.

```
SYSTEM Master/Cal                    JOINT 10%

1 FIXTURE POSITION MASTER
2 ZERO POSITION MASTER
3 QUICK MASTER
4 SINGLE AXIS MASTER
5 SET QUICK MASTER REF
6 CALIBRATE

 Press 'ENTER' or number key to select.

[ TYPE ]   LOAD    RES_PCA              DONE
```

5) Release brake control, and jog the robot into a posture for mastering.

NOTE
Brake control can be released by setting the system variables as follows:
$PARAM_GROUP.SSV_OFF_ALL: FALSE
$PARAM GROUP.SSV OFF ENB[*]: FALSE (for all axes)
After changing the system variables, switch the control unit power off and on again.

To prevent an error from occurring due to axis backlash at this time, ensure that the dial gage needle is adjusted to a specified position in the decreasing direction. If the needle is adjusted in the reverse direction, start all over again.

1 Move the robot gradually so that dial gages No. 1 through No. 5 shown in Fig. 5.4.1(c) touch the points indicated by arrows No. 1 through No. 5 shown in Fig. 5.4.1(e).
2 Move the J1 axis so that dial gages No. 1 and No.2 indicate the same value.
3 Move the J5 axis so that dial gages No. 3 and No. 4 indicate the same value.
4 Move the J2, J3, and J4 axes so that dial gages No. 1, No. 4, and No.5 indicate 3.00 mm.
5 After the operations above, check that all dial gages indicate 3.00 mm.

6) Select Fixture Position Master.
7) Press F4, YES. Mastering will be performed automatically. Alternatively, switch the power off and on again. Switching the power on always causes positioning to be performed.
8) After positioning is completed, press F5 [DONE].

NOTE
No check is made on the axis movable range during mastering. Be very careful when running the robot. Continuing axis movement may result in the mechanical stopper being bumped.

Mastering position

Axis	Position
J1	0°
J2	82.571°
J3	−82.925°
J4	−97.075°
J5	0°

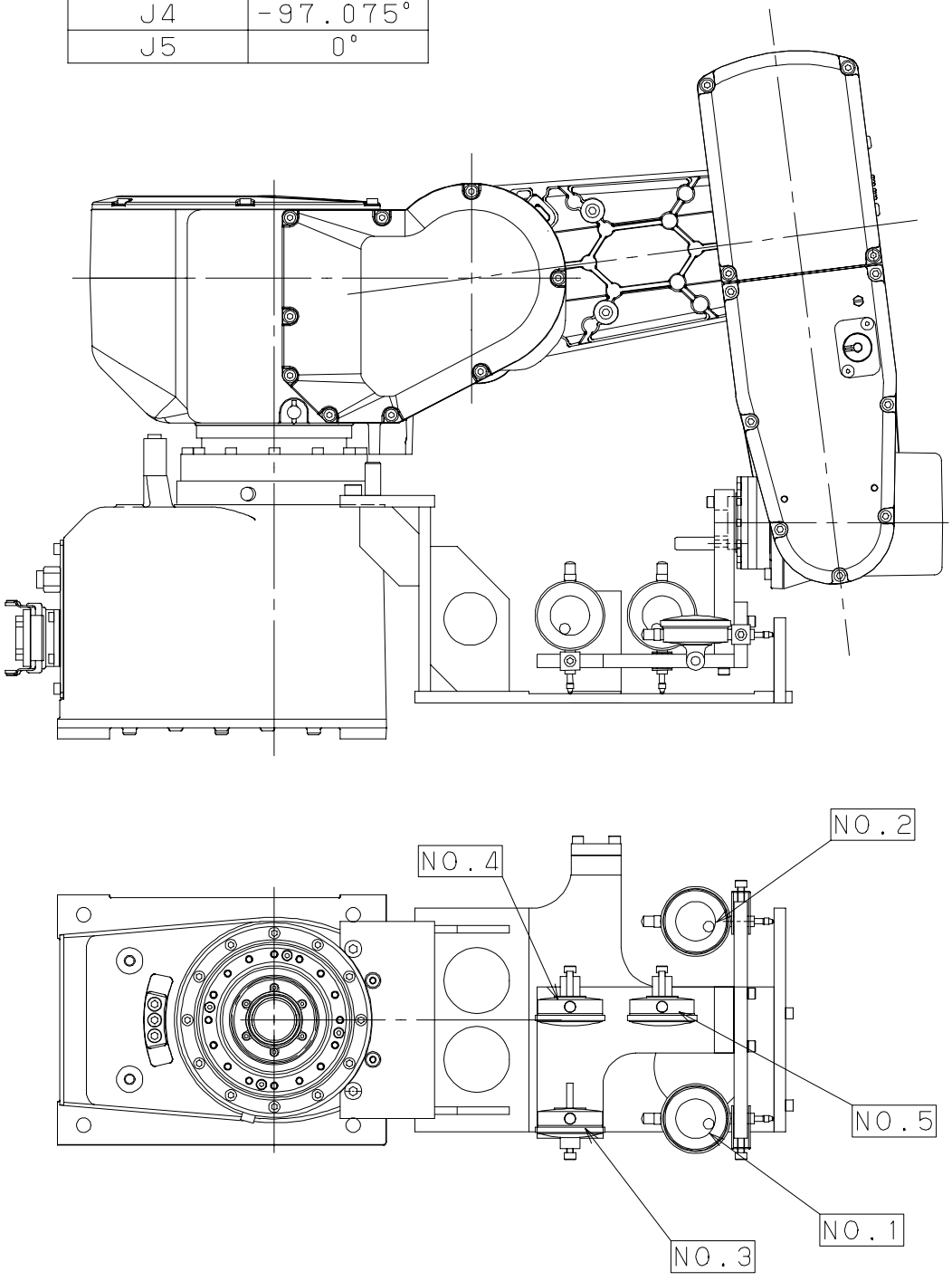


Fig.5.2.3 (e) Mastering attitude

5.2.4 Zero Degree Mastering

Zero–position mastering (eye mark mastering) is performed with all axes set at the 0–degree position. A zero–position mark (eye mark) is attached to each robot axis. This mastering is performed with all axes set at the 0–degree position using their respective eye marks.

Zero–position mastering involves a visual check. It cannot be so accurate. It should be used only as a quick–fix method.

Procedure Mastering to Zero Degrees

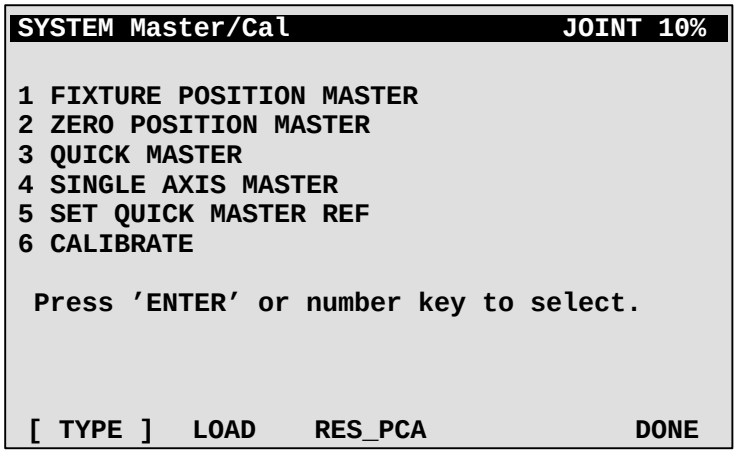
Step

1 Press MENUS.

2 Select NEXT and press SYSTEM.

3 Press F1, [TYPE].

4 Select Master/Cal.



5 Release brake control, and jog the robot into a posture for mastering.

NOTE

Brake control can be released by setting the system variables as follows:

$PARAM_GROUP.SSV_OFF_ALL: FALSE

$PARAM GROUP.SSV OFF ENB[*]: FALSE (for all axes)

After changing the system variables, switch the control unit power off and on again.

6 Select Zero Position Master.

7 Press F4, YES. Mastering will be performed automatically. Alternatively, switch the power off and on again. Switching the power on always causes positioning to be performed.

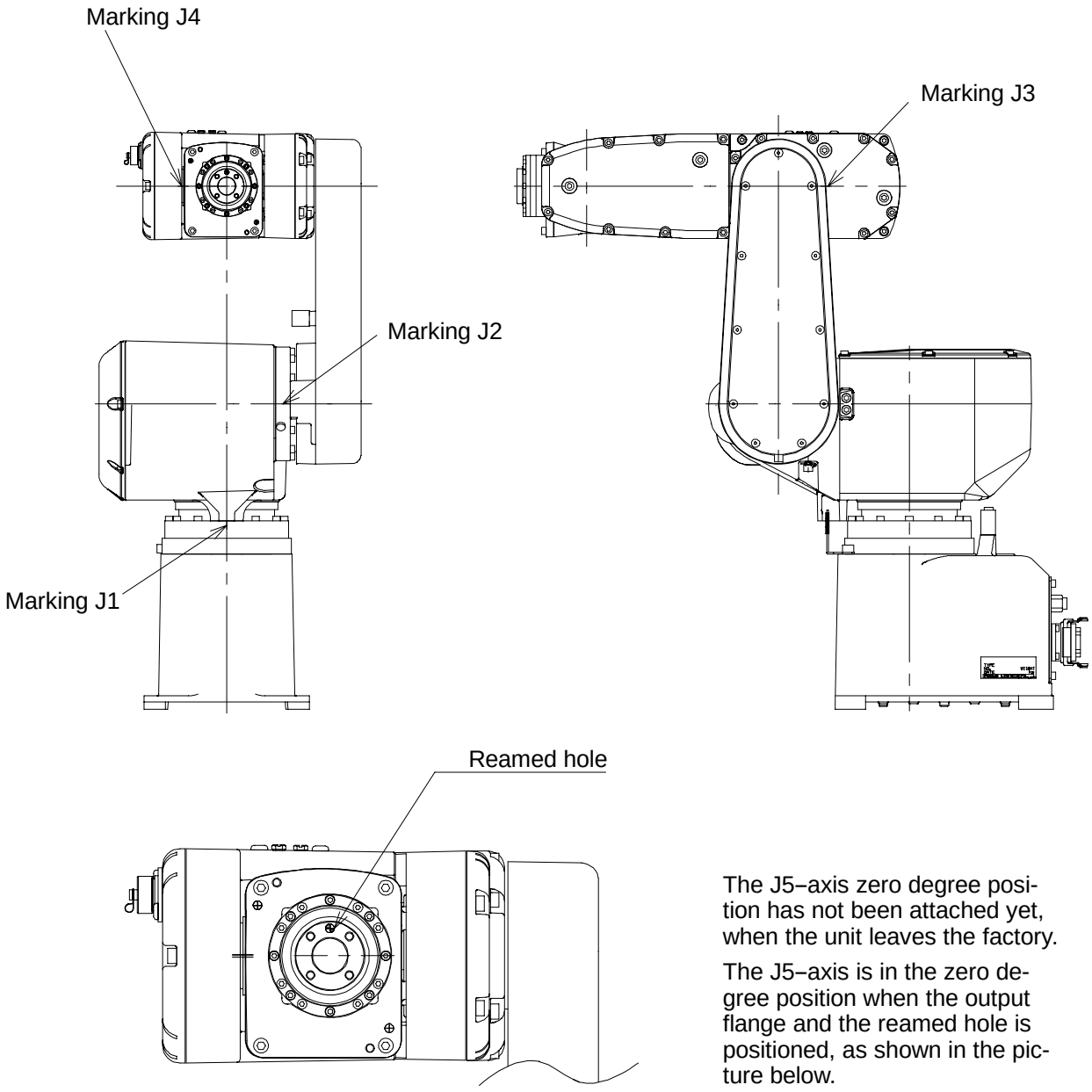


Fig.5.2.4 (a) Zero degree position arrow mark for each axis

5.2.5 Quick Mastering

Simplified mastering is performed at a user–specified position. The corresponding count value is obtained from the rotation speed of the pulse coder connected to the relevant motor and the rotation angle within one rotation. Simplified mastering uses the fact that the absolute value of a rotation angle within one rotation will not be lost.

Simplified mastering is factory–performed at the position indicated in Table 5.2.4. Do not change the setting unless there is any problem.
If it is impossible to set the robot at the position mentioned above, it is necessary to re–set the simplified mastering reference position using the following method. (It would be convenient to set up a marker that can work in place of the eye mark.)

NOTE
1 Simplified mastering can be used, if the pulse count value is lost, for example, because a low voltage has been detected on the backup battery for the pulse counter.

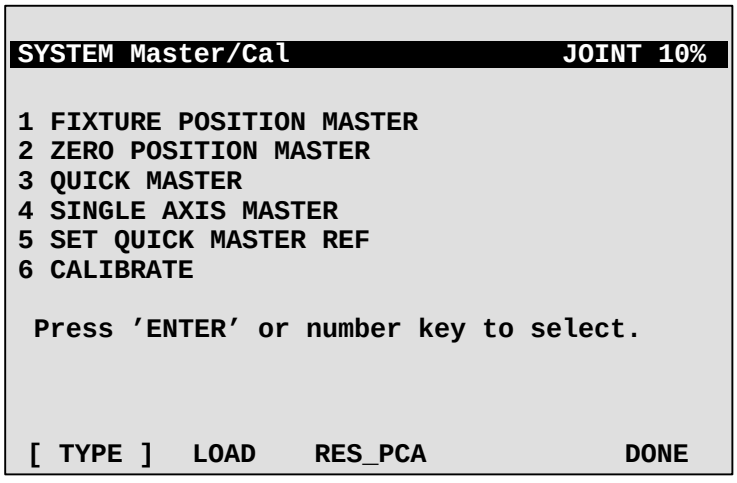
2 Simplified mastering cannot be used, after the pulse coder is replaced or after the mastering data is lost from the robot control unit.

Procedure Recording the Quick Master Reference Position

Step

1 Select SYSTEM.

2 Select Master/Cal.



3 Release brake control, and jog the robot to the simplified mastering reference position.

```
Set quick master ref? [NO]
```

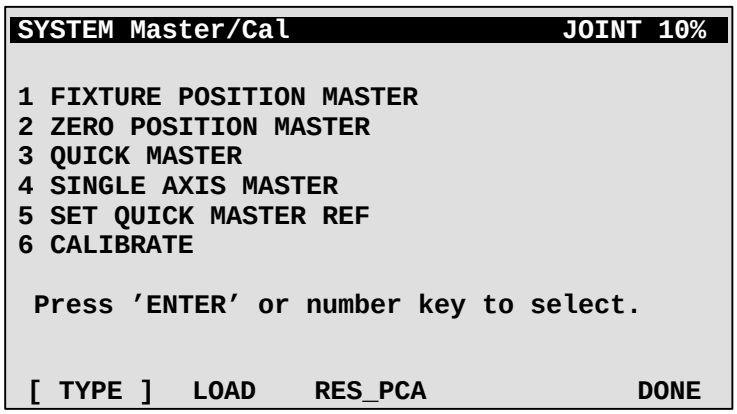
4 Move the cursor to SET QUICK MASTER REF and press ENTER. Press F4, YES.

NOTE
If the robot has lost mastery due to mechanical disassembly or repair, you cannot perform this procedure. In this case, master to a fixture or master to zero degrees to restore robot mastery.

Procedure
Quick Mastering

Step

1 Display the Master/Cal screen.



2 Release brake control, and jog the robot to the simplified mastering reference position.

```
Quick master? [NO]
```

3 Move the cursor to QUICK MASTER and press ENTER. Press F4, YES. Quick mastering data is memorized.

4 Move the cursor to CALIBRATE and press ENTER. Calibration is executed. Calibration is executed by power on again.

5 After completing the calibration, press F5 Done.

5.2.6 Single Axis Mastering

Single axis mastering is performed for one axis at a time. The mastering position for each axis can be specified by the user.

Single axis mastering can be used, if mastering data for a specific axis is lost, for example, because a low voltage has been detected on the pulse counter backup battery or because the pulse coder has been replaced.

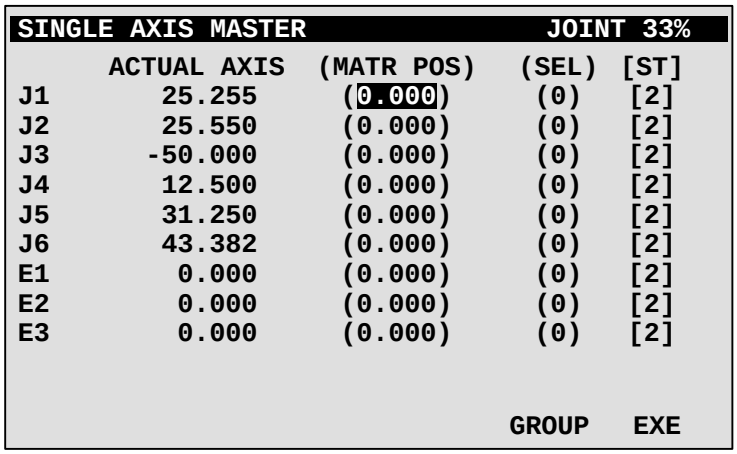


Table 5.2.6 Items Set in Single Axis Mastering

Item	Description
Current position (Actual axis)	The current position of the robot is displayed for each axis in degree units.
Mastering position (Matra pos)	A mastering position is specified for an axis to be subjected to single axis mastering. It would be convenient to set to it to the 0_ position.
SEL	This item is set to 1 for an axis to be subjected to single axis mastering. Usually, it is 0.
ST	This item indicates whether single axis mastering has been completed for the corresponding axis. It cannot be changed directly by the user. The value of the item is reflected in $EACHMST_DON (1 to 9). 0 : Mastering data has been lost. Single axis mastering is necessary. 1 : Mastering data has been lost. (Mastering has been performed only for the other interactive axes.) Single axis mastering is necessary. 2 : Mastering has been completed.

Procedure
Mastering a Single Axis

Step

1 Select SYSTEM.

2 Select Master/Cal.

```
SYSTEM Master/Cal                          JOINT 10%

1 FIXTURE POSITION MASTER
2 ZERO POSITION MASTER
3 QUICK MASTER
4 SINGLE AXIS MASTER
5 SET QUICK MASTER REF
6 CALIBRATE

 Press 'ENTER' or number key to select.



[ TYPE ]   LOAD    RES_PCA
```

3 Select 4, Single Axis Master. You will see a screen similar to the following.

```
SINGLE AXIS MASTER                         JOINT 10%
                                                1/9
 ACTUAL POS       (MSTR POS)    (SEL)  [ST]
 J1   25.255      (   0.000)     (0)    [2]
 J2   25.550      (   0.000)     (0)    [2]
 J3  -50.000      (   0.000)     (0)    [2]
 J4   12.500      (   0.000)     (0)    [2]
 J5   31.250      (   0.000)     (0)    [0]
 J6   43.382      (   0.000)     (0)    [0]
 E1    0.000      (   0.000)     (0)    [2]
 E2    0.000      (   0.000)     (0)    [2]
 E3    0.000      (   0.000)     (0)    [2]

[ TYPE ]                                GROUP   EXEC
```

4 Move the cursor to the SEL column for the unmastered axis and press the numeric key "1." Setting of SEL is available for one or more axes.

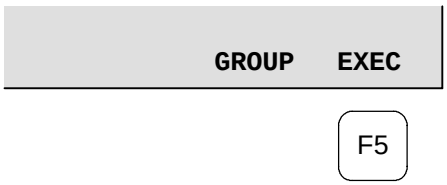
5 Turn off brake control as required, then jog the robot to the mastering position.

6 Enter axis data for the mastering position.

```
                                           JOINT 30%
                                                5/9
(0.000)          (0)           [2]
(0.000)          (0)           [2]
```

```
SINGLE AXIS MASTER                         JOINT 30%
                                                5/9
J5        31.250      (0.000)      (0)     [2]
J6        43.382      (90.000)     (0)     [2]

                                          GROUP   EXEC
```

7 Press F5 [EXEC]. Mastering is performed. So, SEL is reset to 0, and ST is re–set to 2 or 1.



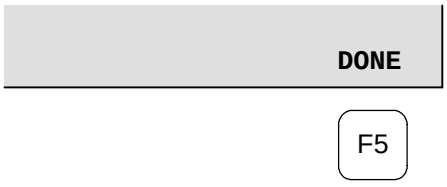

```
SINGLE AXIS MASTER                    JOINT 30%
                                              1/9
      ACTUAL AXIS   (MATR POS)   (SEL)  [ST]
J1       25.255      (0.000)      (0)    [2]
J2       25.550      (0.000)      (0)    [2]
J3      -50.000      (0.000)      (0)    [2]
J4       12.500      (0.000)      (0)    [2]
J5        0.000      (0.000)      (0)    [2]
J6       90.000     (90.000)      (0)    [2]
E1        0.000      (0.000)      (0)    [2]
E2        0.000      (0.000)      (0)    [2]
E3        0.000      (0.000)      (0)    [2]

                                  GROUP   EXEC
```

8 When single axis mastering is completed, press the previous page key to resume the previous screen.


```
SYSTEM Master/Cal                     JOINT 30%

1 FIXTURE POSITION MASTER
2 ZERO POSITION MASTER
3 QUICK MASTER
4 SINGLE AXIS MASTER
5 SET QUICK MASTER REF
6 CALIBRATE

 Press 'ENTER' or number key to select.



[ TYPE ]                                DONE
```

9 Select [6 CALIBRATE], then press F4 [YES]. Positioning is performed.
Alternatively, switch the power off and on again. Positioning is performed.

10 After positioning is completed, press F5 [DONE].



5.2.7 Mastering Data Entry

This function enables mastering data values to be assigned directly to a system variable. It can be used if mastering data has been lost but the pulse count is preserved.

Mastering data entry method

Step

1 Press MENUS, then press NEXT and select SYSTEM.

2 Press F1, [TYPE]. Select [Variables]. The system variable screen appears.

```
SYSTEM Variables                    JOINT 10%
                                    1/98
  1  $AP MAXAX       536870912
  2  $AP PLUGGED     4
  3  $AP TOTALAX     16777216
  4  $AP USENUM      [12] of Byte
  5  $AUTOINIT       2
  6  $BLT            19920216

[ TYPE ]
```

3 Change the mastering data.
The mastering data is saved to the $DMR_GRP.$MASTER_COUN system variable.

```
SYSTEM Variables                    JOINT 10%

  13 $DMR GRP        DMR GRPT
  14 $ENC STAT       [2] of ENC STATT

[ TYPE ]
```

4 Select $DMR_GRP.

```
                                    JOINT 30%
  DMR GRPT
  [2] of ENC STATT
                                      ENTER
```

```
SYSTEM Variables                    JOINT 10%
     $DMR   GRP              1/1
       1    [1]          DMR GRPT
```

```
SYSTEM Variables                    JOINT 10%
     $DMR GRP [1]                       1/8
       1   $MASTER DONE   FALSE
       2   $OT MINUS      [9] of Boolean
       3   $OT PLUS       [9] of Boolean
       4   $MASTER COUN   [9] of Integer
       5   $REF DONE      FALSE
       6   $REF POS       [9] of Real
       7   $REF COUNT     [9] of Integer
       8   $BCKLSH SIGN   [9] of Boolean

[ TYPE ]                      TRUE    FALSE
```

5.2.8 Checking of Mastering

Usually, positioning is performed automatically when the power is turned on. To check if mastering is completed correctly, check that the current position indication matches the actual robot position according to the procedure below.

(a) Replay a particular point in the program to check that the point matches the taught point.

(b) Move the robot by jogging or replay to the position with all axes set to zero degree, then visually check that the position matches the zero−degree position mark shown in Fig. 5.3.

(c) By using a jig, move the robot to the mastering position with the same method as used for mastering. Then, check that the current position indication matches the mastering position.
If these check operations find a position mismatch, two possible causes are considered. That is, the counter value of the pulse coder may have been invalidated by an alarm described in Item (2), or the system variable $DMR_GRP.$MASTER_COUN holding mastering data may have been rewritten by an incorrect operation. Check against the datasheet attached to the delivered robot. Note that the value of the system variable changes after each mastering operation. So, record the value of the system variable on the data sheet after each mastering operation.

6 REPLACING PARTS

- When replacing a part, subsequent adjustment is required.
- Parts requiring replacing and their accompanying adjustment items are listed in item 4.3.
- When tightening a bolt, always observe the tightening torque, if specified.
- Packings and seal bolts cannot be reused. Use new packings and seal bolts.
- When replacing a motor, remove old grease from the reducer.
- Assemble a bolt after applying Loctite to its thread, provided the application of Loctite is specified in the figure.
- When removing or mounting a motor, apply force in the direction of the shaft only. If excessive force is applied in any other direction, the motor and/or reducer may be damaged.
- If a motor and associated parts to be assembled incur a phase mismatch, assembly might prove impossible. Carefully check the state of the parts before removing them.

CAUTION
Those bolts for which no tightening torque is specified must be tightened according to the tightening torque table shown in the appendix.

6.1 REPLACING J1–AXIS MOTOR

1 Change the robot attitude to allow J2 cover U (1) to be removed.
2 Remove bolt (3), then remove J2 cover U (1).
3 Remove bolt (4), then remove J2 cover S (5) (to detach the motor connector).
4 Detach the connector attached to motor (8).
5 Remove bolt (7), then remove motor (8) and O–ring (9). At this time, grease can drip. Use care.
6 Clean off grease from gear (10).
7 Remove bolt (12) and washer (11), then remove gear (10).
8 Using a new motor and packing, assemble the J1–axis motor by reversing the procedure above.
9 Grease the J1–axis reducer according to Section 3.1.

	Name	Specifications	Q'ty	LOCTITE	Torque N-m (kgf-m)
1	J2 COVER U	A290-7137-X303	1		
2	PACKING J2-U	A290-7137-X327 (For undesirable environment)	1		
3	BOLT	A97L-0218-0504#M5×10ZN	8		2.5 (25)
4	BOLT	A97L-0218-0504#M5×10ZN	9		2.5 (25)
5	J2 COVER S	A290-7137-X304	1		
6	PACKING J2-S	A290-7137-X328 (For undesirable environment)	1		
7	BOLT	A6-BA-5×12	3		
8	MOTOR	A06B-0115-B075 (β0.5) A06B-0115-B275 (β0.5B)	1		
9	O-RING	JB-OR1A-G45	1		
10	GEAR J1-J2	A290-7137-X211	1		
11	WASHER	A290-7210-X532	1		
12	BOLT	A6-BA-3×8	1	LT262	1.3 (13)

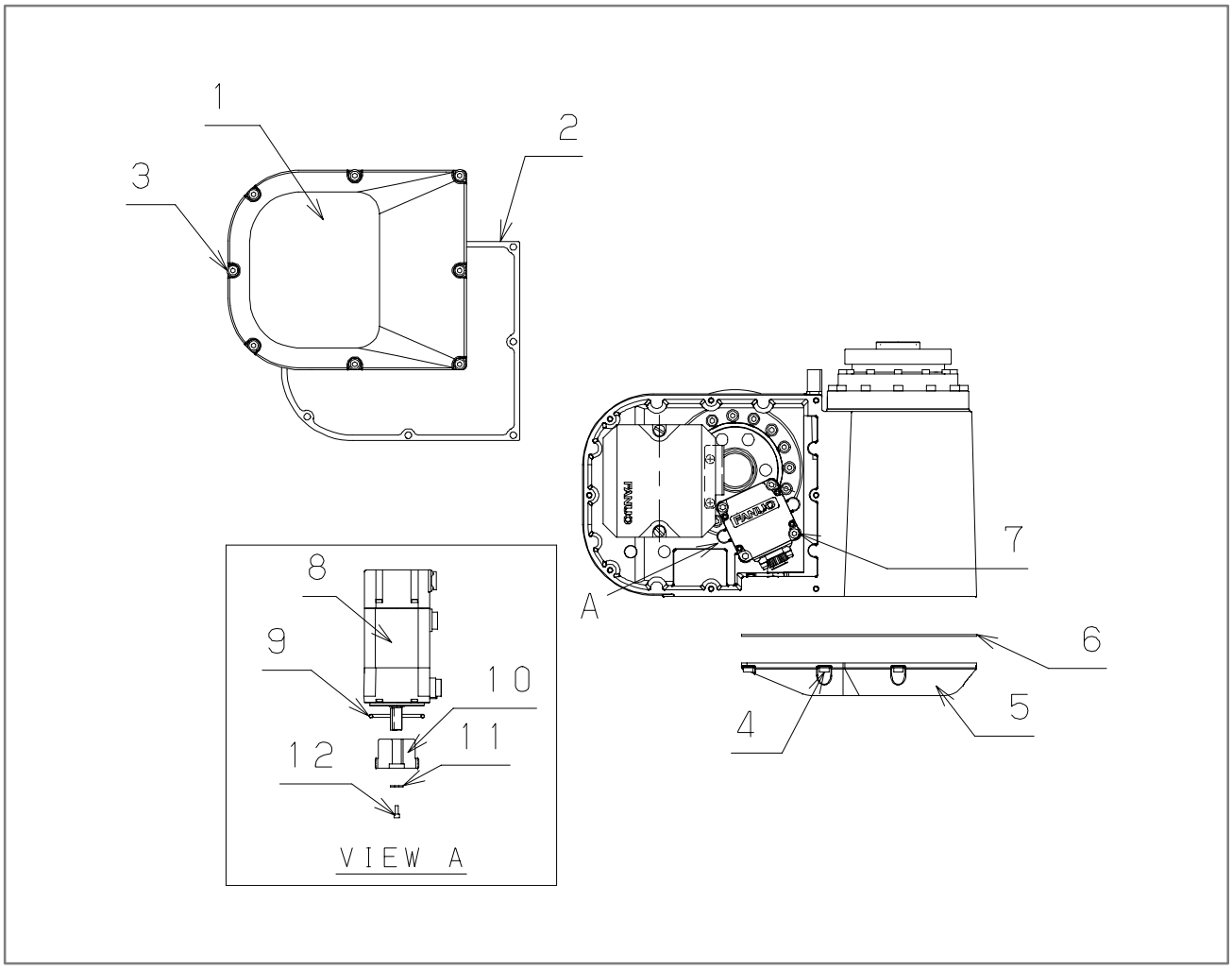


Fig.6.1 Replacing J1−axis motor

6.2 REPLACING J1–AXIS REDUCER

1 Detach the cabling according to Chapter 8.
2 Remove the J1 motor according to Section 6.1. (The gear need not be removed.)
3 Remove bolt (1), then remove the J2 base. At this time, grease can drip. Use care.
4 Clean the grease paths of center gear (3) and J2 base.
5 Remove bolt (4), then remove J1 reducer (7).
6 Remove bolt (2), then remove center gear (3).
7 Pull out collar (9) from the old reducer.
8 Using a new reducer and packing, assemble the J1–axis reducer by reversing the procedure above. Do not fail to install O–rings (5), (6), and (8) delivered with the reducer.

NOTE
1 The reducer has a mounting phase (grease outlet position). So, when assembling the reducer, ensure a match with the mounting phase shown in Fig. 6.2.
2 When assembling the reducer, ensure that the lip of the oil seal pressed into the J2 base is not turned up.

9 Grease the J1–axis reducer according to Section 3.1. Feed grease as much as 68 cc.

	Name	Specifications	Q'ty	LOCTITE	Torque N-m (kgf-m)
1	BOLT	A97L-0218-0504#M5×35	13	LT262	5.6 (57)
2	BOLT	A6-BA-3×10	6	LT262	1.3 (13)
3	GEAR J1-2	A290-7137-X227	1		
4	BOLT	A6-BA-5×45	12	LT262	5.6 (57)
5	O RING	S85 (accessory)	1		
6	O RING	S110 (accessory)	1		
7	J1 REDUCER	A97L-0218-0296#80	1		
8	O RING	117.0×2.0 (accessory)	1		
9	PIPE J1	A290-7137-X227	1		

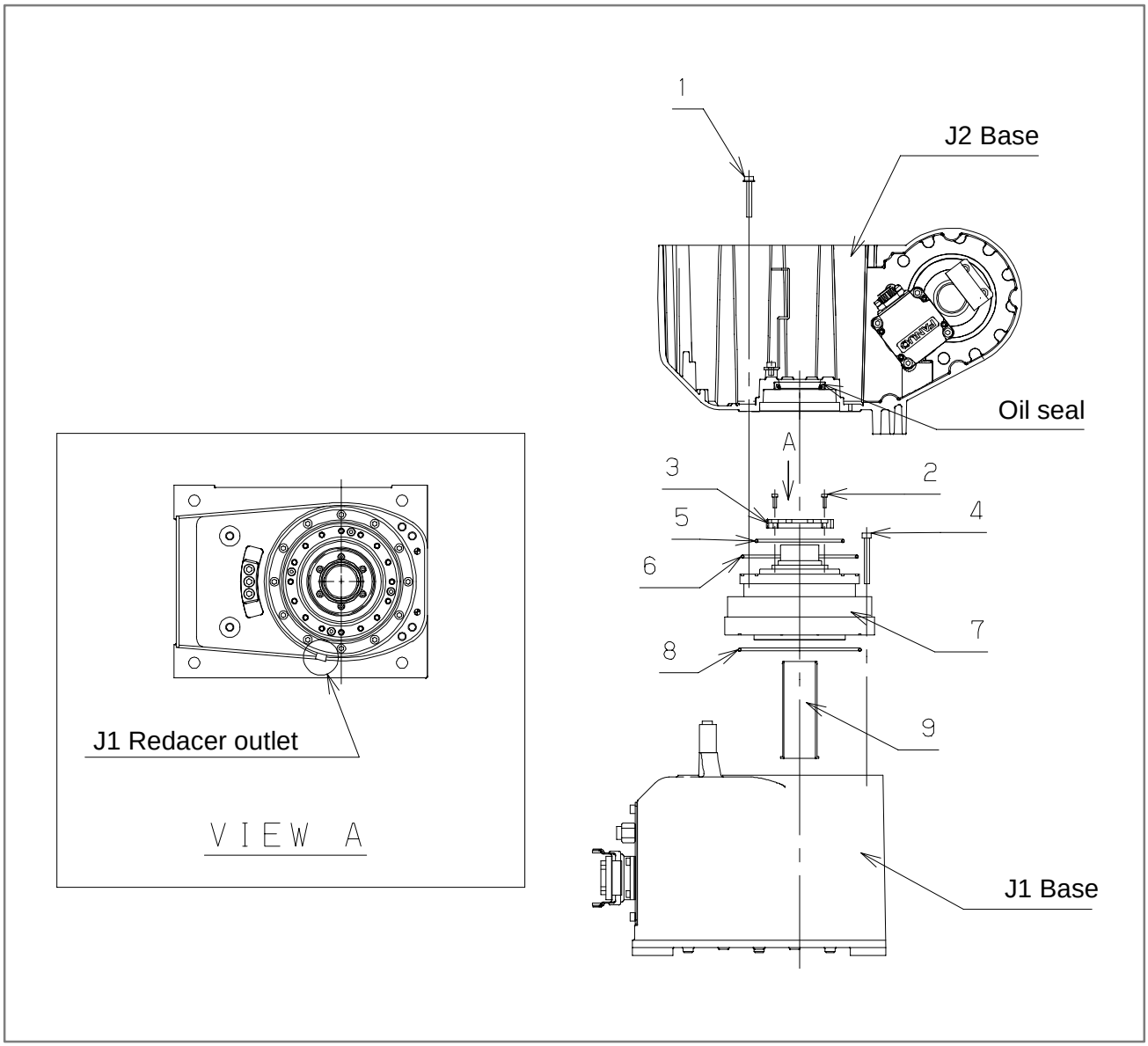


Fig.6.2 Replacing J1−axis reducer

6.3 REPLACING J2–AXIS MOTOR

1 Change the robot attitude to allow J2 cover U (1) to be removed.
2 Remove bolt (2), then remove J2 cover U (1) (to detach the motor connector).
3 Remove bolt (5), then remove J2 cover S (4).
4 Detach the connector attached to motor (8).
5 Remove bolt (7), then remove O–ring (9) and motor (8). At this time, grease can leak from the grease path. Use care.

NOTE
When the motor is removed, the arm moves downward by its weight. Hold the arm so that the arm does not collide with any other objects.

6 Clean gear (10).
7 Remove bolt (12) and washer (11), then remove gear (10).
8 Using a new motor and packing, assemble the J2–axis motor by reversing the procedure above.
9 Grease the J2–axis reducer according to Section 3.1.

	Name	Specifications	Q'ty	LOCTITE	Torque N-m (kgf-m)
1	J2 COVER U	A290-7137-X303	1		
2	BOLT	A97L-0218-0504#M5×10ZN	8		2.5 (25)
3	PACKING J2-U	A290-7137-X327 (For undesirable environment)	1		
4	J2 COVER S	A290-7137-X304	1		
5	BOLT	A97L-0218-0504#M5×10ZN	9		2.5 (25)
6	PACKING J2-S	A290-7137-X328 (For undesirable environment)	1		
7	BOLT	A6-BA-5×12	3		
8	MOTOR	A06B-0115-B275 (β 0.5B)	1		
9	O-RING	JB-OR1A-G45	1		
10	GEAR J1-J2	A290-7137-X211	1		
11	WASHER	A290-7210-X532	1		
12	BOLT	A6-BA-3×8	1	LT262	1.3 (13)

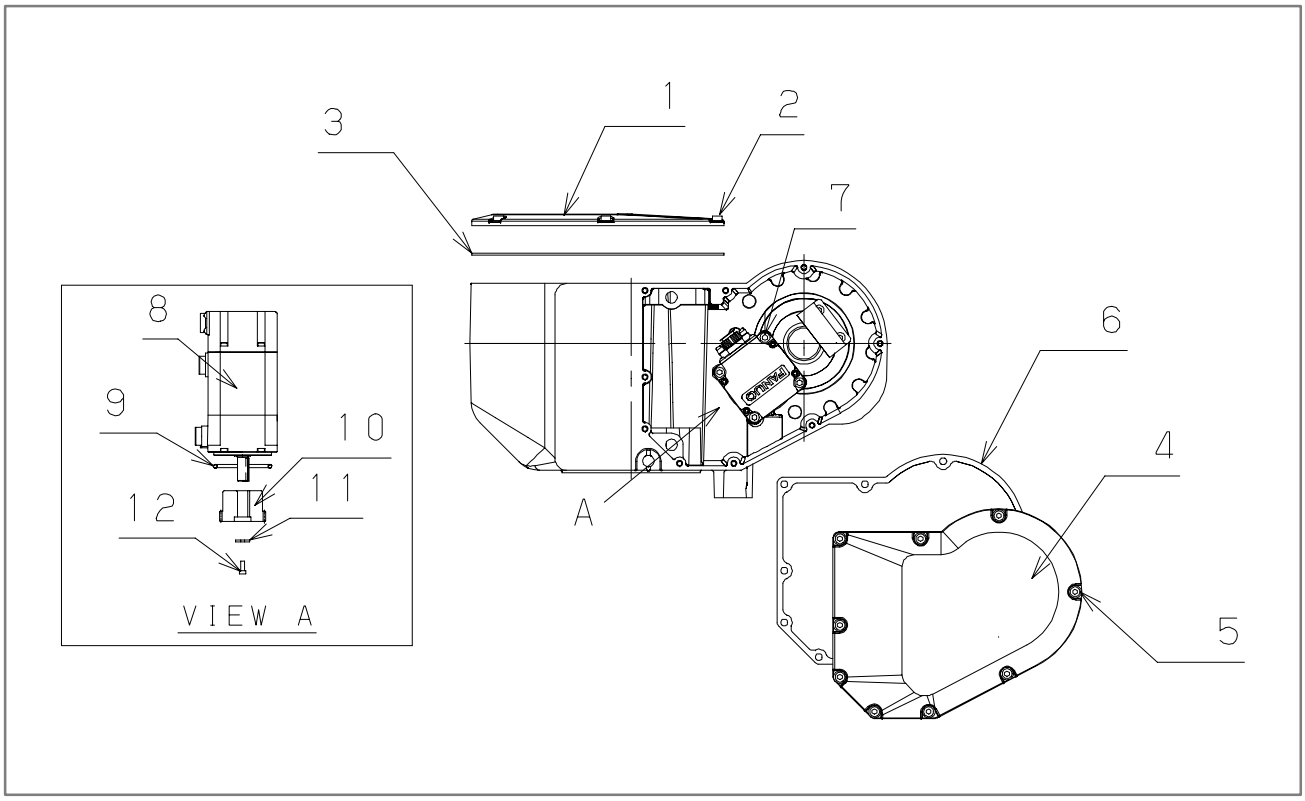


Fig.6.3 Replacing J2−axis motor

6.4 REPLACING J2−AXIS REDUCER

1 Move the robot to an attitude of J2 = 90° and J3 = 0°. The other axes may take arbitrary attitudes.
2 Detach the cabling up to clamp J2−1 according to Chapter 8.
3 Remove bolt (1), then remove washer plate (2) and the J2 arm.
4 Remove bolt (4), then remove J2−axis reducer (6). At this time, grease can drip. Use care.
5 Clean the grease paths of center gear (8) and the J2 base.
6 Remove bolt (9), then remove center gear (8).
7 Pull out collar (3) from the old reducer.
8 Using a new reducer and packing, assemble the J2−axis reducer by reversing the procedure above. Do not fail to install O−rings (5) and (7) delivered with the reducer.

NOTE
1 The reducer has a mounting phase (grease outlet position). So, when assembling the reducer, ensure a match with the mounting phase shown in Fig. 6.4.
2 When assembling the reducer, ensure that the lip of the oil seal pressed into the J2 base is not turned up.
3 The two O−rings delivered with the reducer are similar in size and shape. Use care.
J2 arm side: S90 (thicker one)
J2 base side: 88.62 × 1.78 (thinner one)

9 Grease the J2−axis reducer according to Section 3.1. Feed grease as much as 52 cc.

	Name	Specifications	Q'ty	LOCTITE	Torque N-m (kgf-m)
1	BOLT	A6-BA-5 × 16	12	LT262	5.6 (57)
2	WASHER PLATE J2	A290-7137-X325	1		
3	PIPE J2	A290-7137-X332	1		
4	BOLT	A6-BA-5 × 25	10	LT262	5.6 (57)
5	O RING	S90 (accessory)	1		
6	J2 REDUCER	A97L-0218-0296#80	1		
7	O RING	88.6 × 1.78 (accessory)	1		
8	GEAR J2-2	A290-7137-X312	1		
9	BOLT	A6-BA-3 × 10	6	LT262	1.3 (13)

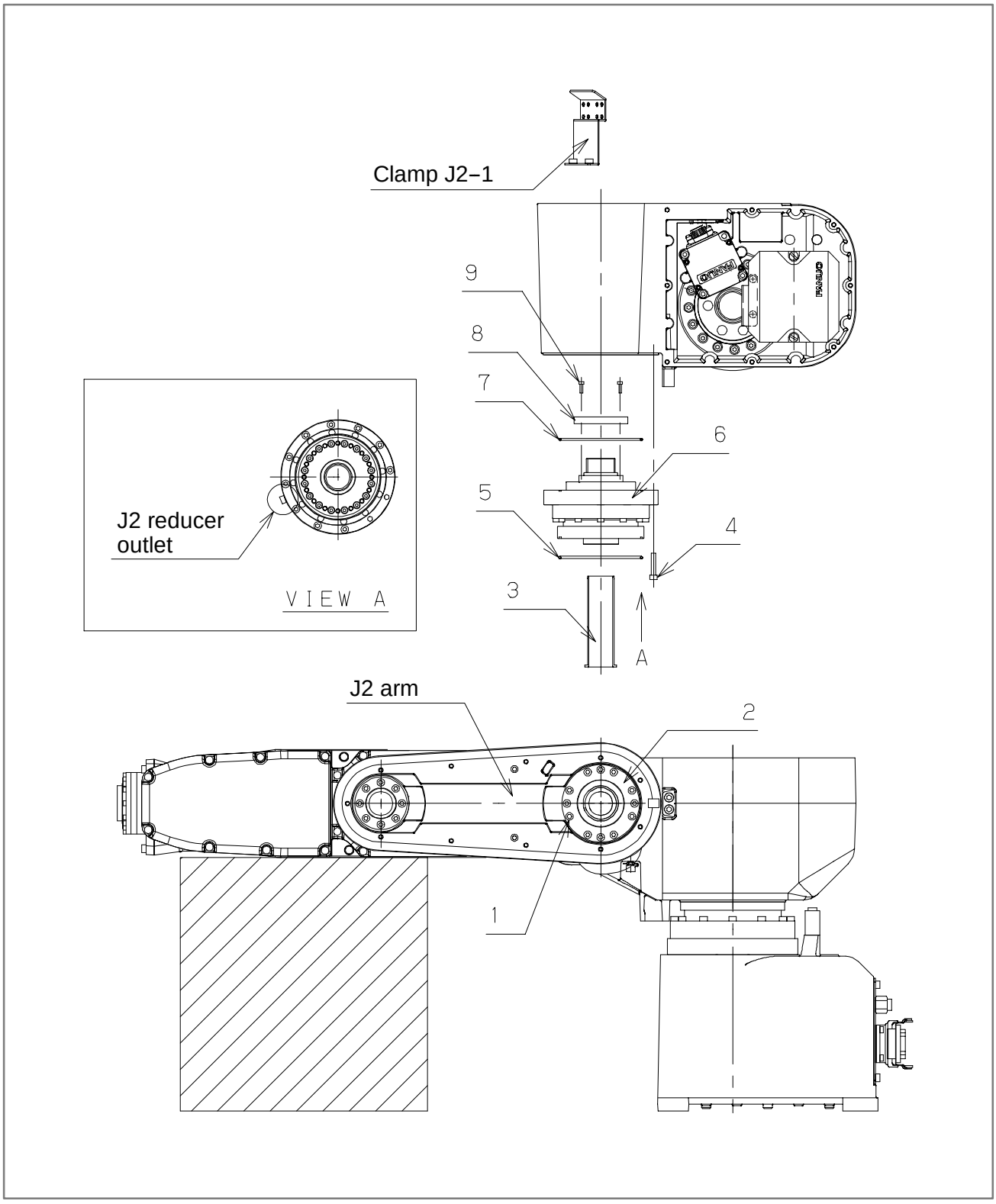


Fig.6.4 Replacing J2−axis reducer

6.5 REPLACING J3–AXIS MOTOR

1 Remove bolt (1), then remove J3 cover R (2).

2 Remove bolt (4), then remove packing (6) and motor (5).

NOTE
When the motor is removed, the arm moves downward by its weight. Hold the arm so that the arm does not collide with any other objects.

3 Detach the connector attached to motor (5).

4 Remove bolt (8), then remove washer (7) and the wave generator.

5 Using a new motor and packing, assemble the J3–axis motor by reversing the procedure above.
Before start of assembly, feed grease sufficiently between the motor and wave generator as shown in Fig. 6.5.

	Name	Specifications	Q'ty	LOCTITE	Torque N-m (kgf-m)
1	BOLT	A97L-0218-0504#M5×12ZN	4		2.5 (25)
2	J3 COVER R	A290-7137-X406	1		
3	J3 COVER PAKING R	A290-7137-X431 (For undesirable environment)	1		
4	BOLT	A6-BA-5×12	4		
5	MOTOR	A06B-0115-B275 (β 0.5B)	1		
6	PACKING	A98L-0040-0042#07	1		
7	WASHER	A290-7210-X532	1		
8	BOLT	A6-BA-3×8	1	LT262	1.3 (13)

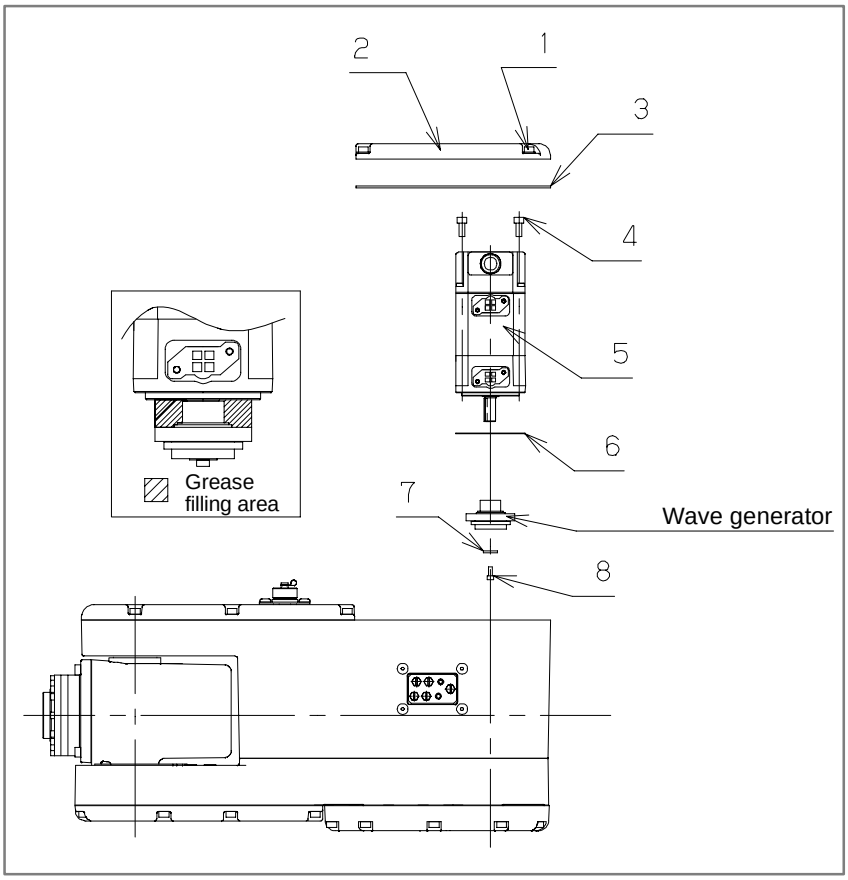


Fig.6.5 Replacing J3−axis motor

6.6 REPLACING J3 GEAR BOX

Disassembly

1 Detach the cabling up to J3 clamp 2 according to Chapter 8.
2 Remove J3 ring (1).
3 Remove bolt (2) and washer plate (3), then remove the J3 arm.
4 Remove bolt (5), then remove packing (6) and gear box cover (4).
5 Clean off grease from the inside of the gear box.
6 Replace the flex–spline of the J3 motor according to Section 6.5.
7 Remove gear (8) and bearing (9).
8 Remove bolt (11) and pin (10), then remove the flex–spline.
9 Remove bolt (12), then remove the circular–spline.
10 Remove bolt (15), then remove cross roller (16) together with gear (14).
11 Remove bolt (13), then remove gear (14).
12 Using a new reducer, gears (8) and (14), cross roller (16), and packing, assemble the J3 gear box according to the procedure below.

Assembly

1 Install cross roller (16) with bolt (15). At this time, pay attention to the cross roller installation direction.
2 Install gear (14) with bolt (13).
3 Install the circular–spline with bolt (12).
4 Attach the flex–spline onto gear (8) with bolt (11) and pin (10).
5 Fill the flex–spline with grease according to Fig. 6.6 (b).
6 Apply grease to the surface of the reducer teeth, then install gear (8) and bearing (9) onto the J3 arm.
7 Assemble the flex–spline with the J3 motor according to Section 6.5.
8 Replace the packing with a new one, and attach gear box cover (4) with bolt (5).
9 Apply sealant to gear (14), then install the J3 arm with bolt (2) and washer plate (3). (See Section 6.13, “APPLYING SEALANT”.)
10 Install J3 ring (1).
11 Return the cabling to the original state according to Chapter 8.
12 Grease the J3 gear box according to Section 3.1.

	Name	Specifications	Q'ty	LOCTITE	Torque N-m (kgf-m)
1	J3 RING	A290-7137-X423	1		
2	BOLT	A6-BA-5×16	8	LT262	5.6 (57)
3	WASHER PLATE J3	A290-7137-X326	1		
4	G.B. COVER 1	A290-7137-X402	1		
5	BOLT	A97L-0218-0496#M5×20ZN	10		5.6 (57)
6	G.B. PAKING 1	A290-7137-X427	1		
7	PIN	JB-PH-H7A-5×12S45C-Q	1		
8	GEAR S1	A290-7137-X411	1		
9	BEARING	A97L0001-0192#120000	1		
10	PIN	JB-PH-H7A-3×8S45C-Q	2	LT242	
11	BOLT	A6-BA-5×12	6	LT262	9.0 (92)
12	BOLT	A6-BA-5×14	8	LT262	5.6 (57)
13	BOLT	A6-BA-5×35	8	LT262	5.6 (57)
14	GEAR S2	A290-7137-X412	1		
15	BOLT	A6-BA-5×16	8	LT262	5.6 (57)
16	C.R. RING	A97L-0218-0493	1		
	J2 REDUCER	A97L-0218-0298#100	1		

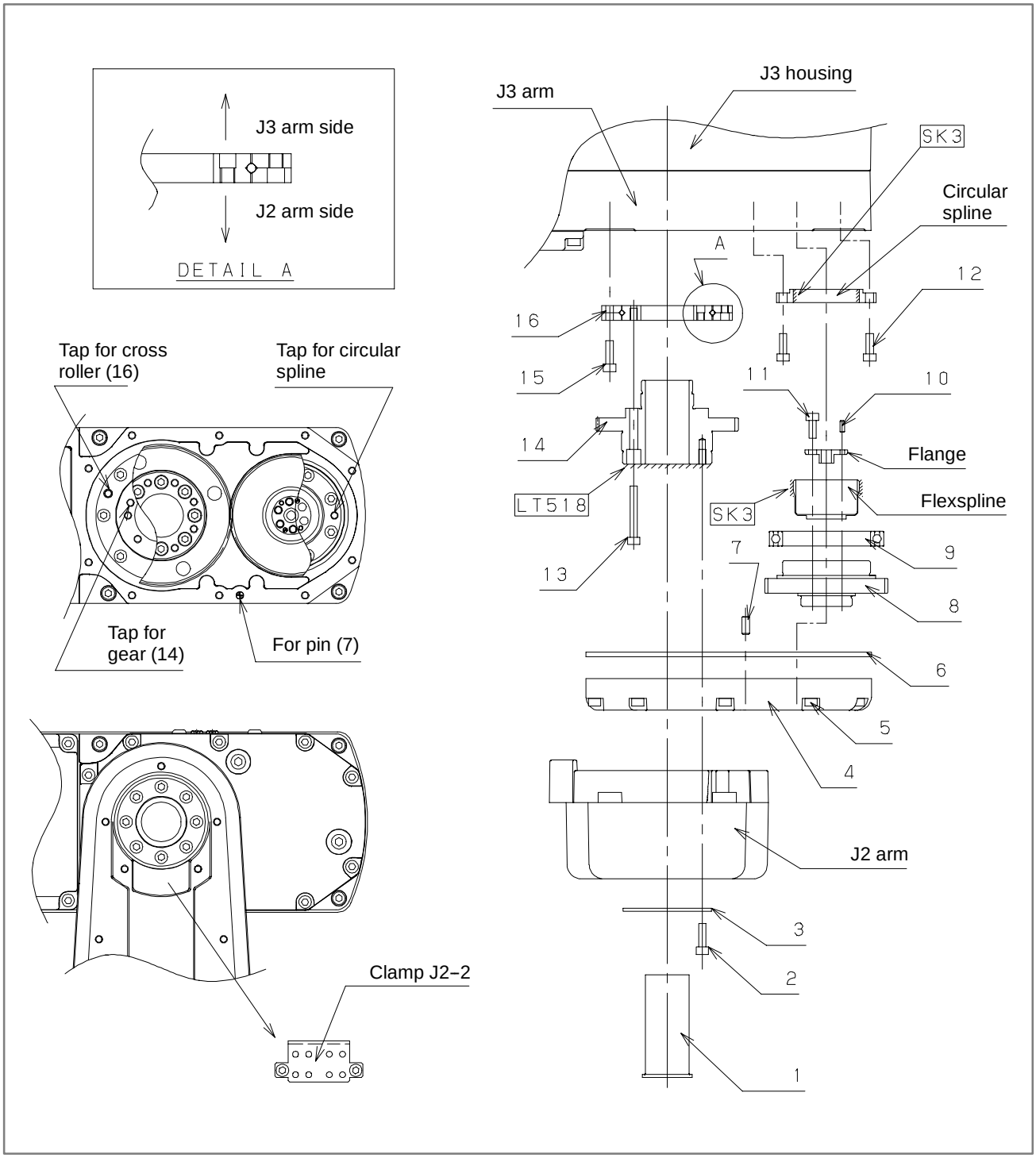


Fig.6.6 (a) Replacing J3 gear box

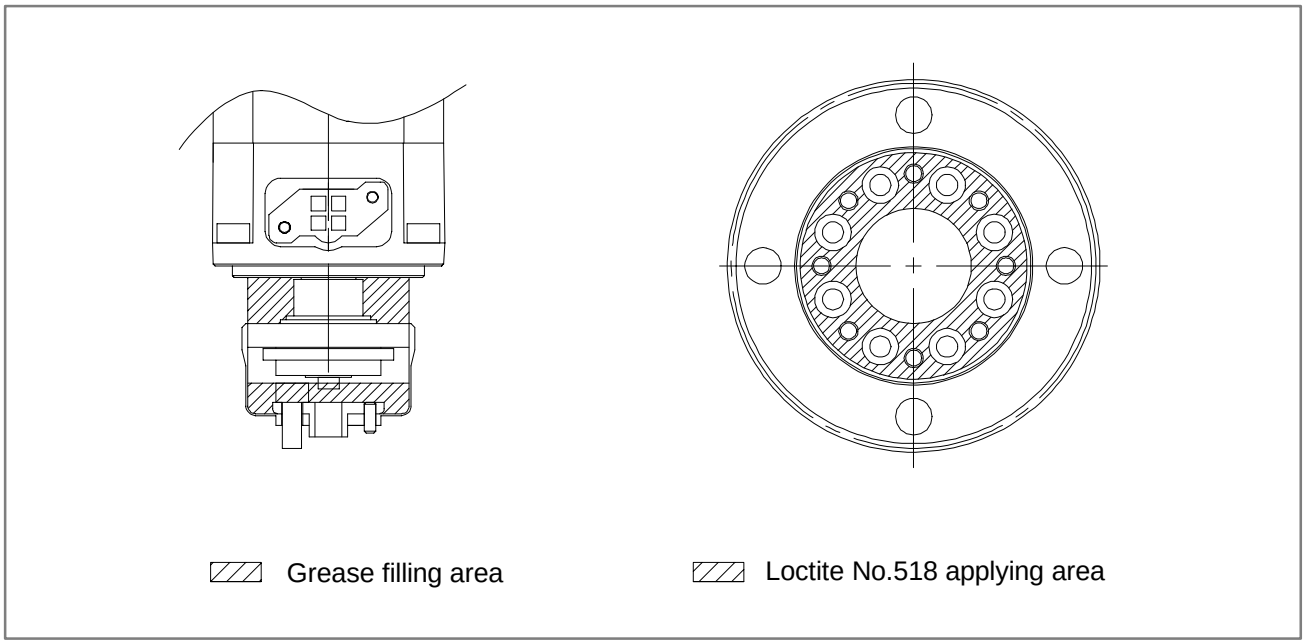


Fig.6.6 (b) Grease filling area and loctite 518 applying area

6.7 REPLACING J4–AXIS MOTOR

1 Remove bolt (2), then remove J3 cover R (1).
2 Remove bolt (4), then remove motor (5) and O–ring (6).

NOTE
When the motor is removed, the arm moves downward by its weight. Hold the arm so that the arm does not collide with any other objects.

3 Remove bolt (9), then remove gear (7) and washer (8).
4 Using a new motor, assemble the J4–axis motor by reversing the procedure above.

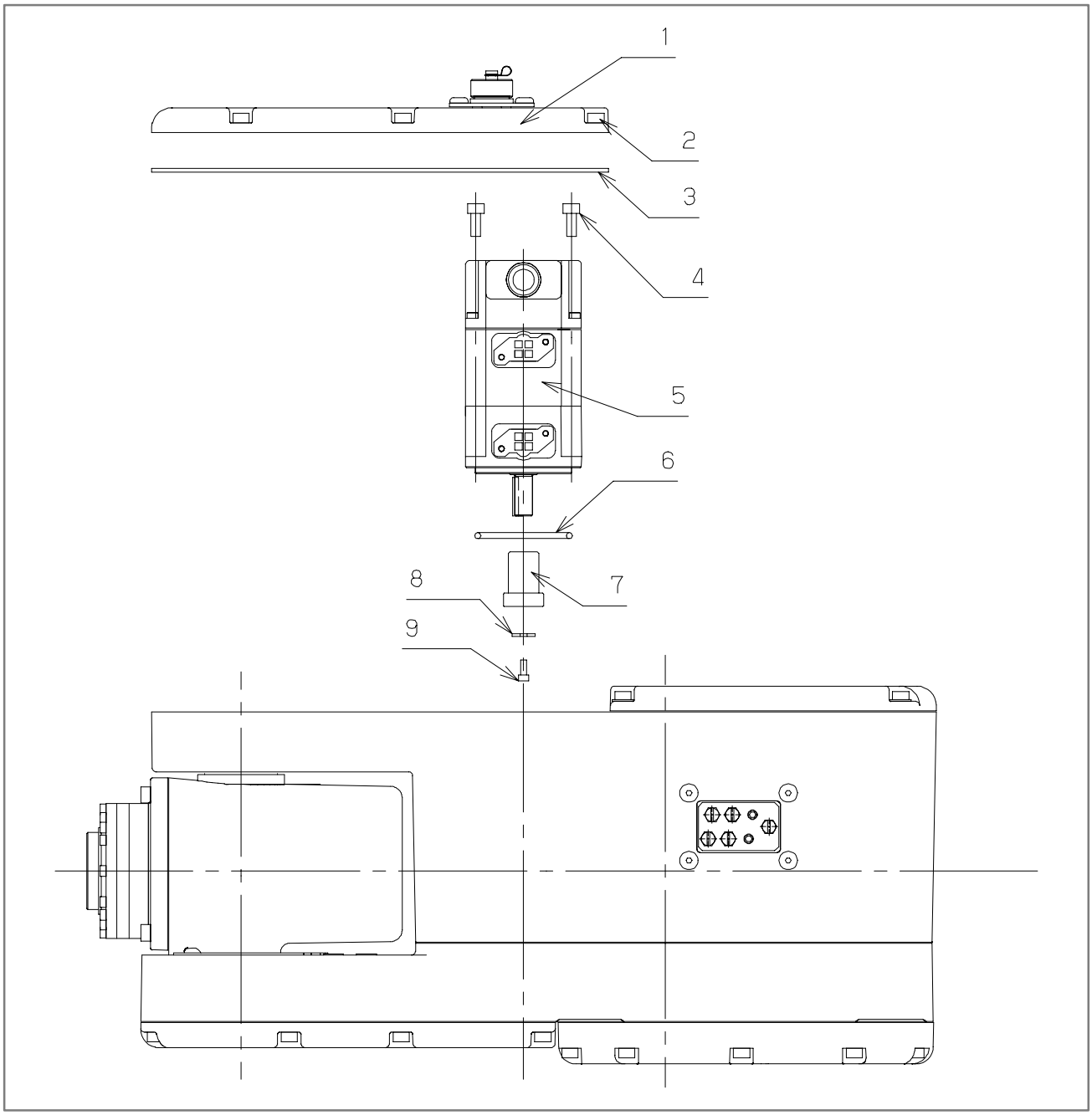


Fig.6.7 Replacing J4−axis motor

6.8 REPLACING J4–AXIS GEAR BOX

1 Remove bolt (2), then remove J4 gear box cover (1). At this time, grease can drip. Use care.
2 Clean off grease from the inside of gear box so that the gear and bolt can be viewed.

NOTE
When the motor is removed, the arm moves downward by its weight. Hold the arm so that the arm does not collide with any other objects.

3 Remove bolt (5), then remove gear W3 assembly (6).
4 Remove bolt (7), then remove gear W2 assembly (8).
5 Remove bolt (10), then remove gear (9).
6 Remove gear (4) according to Section 6.7.
7 Using a new gear, assemble the J4–axis gear box by reversing the procedure above.
8 Secure J4 gear box cover (1) to the J3 arm with bolt (2). At this time, replace packing (3) with a new one to prevent grease leakage.
9 Grease the J4–axis gear box according to Section 3.2.

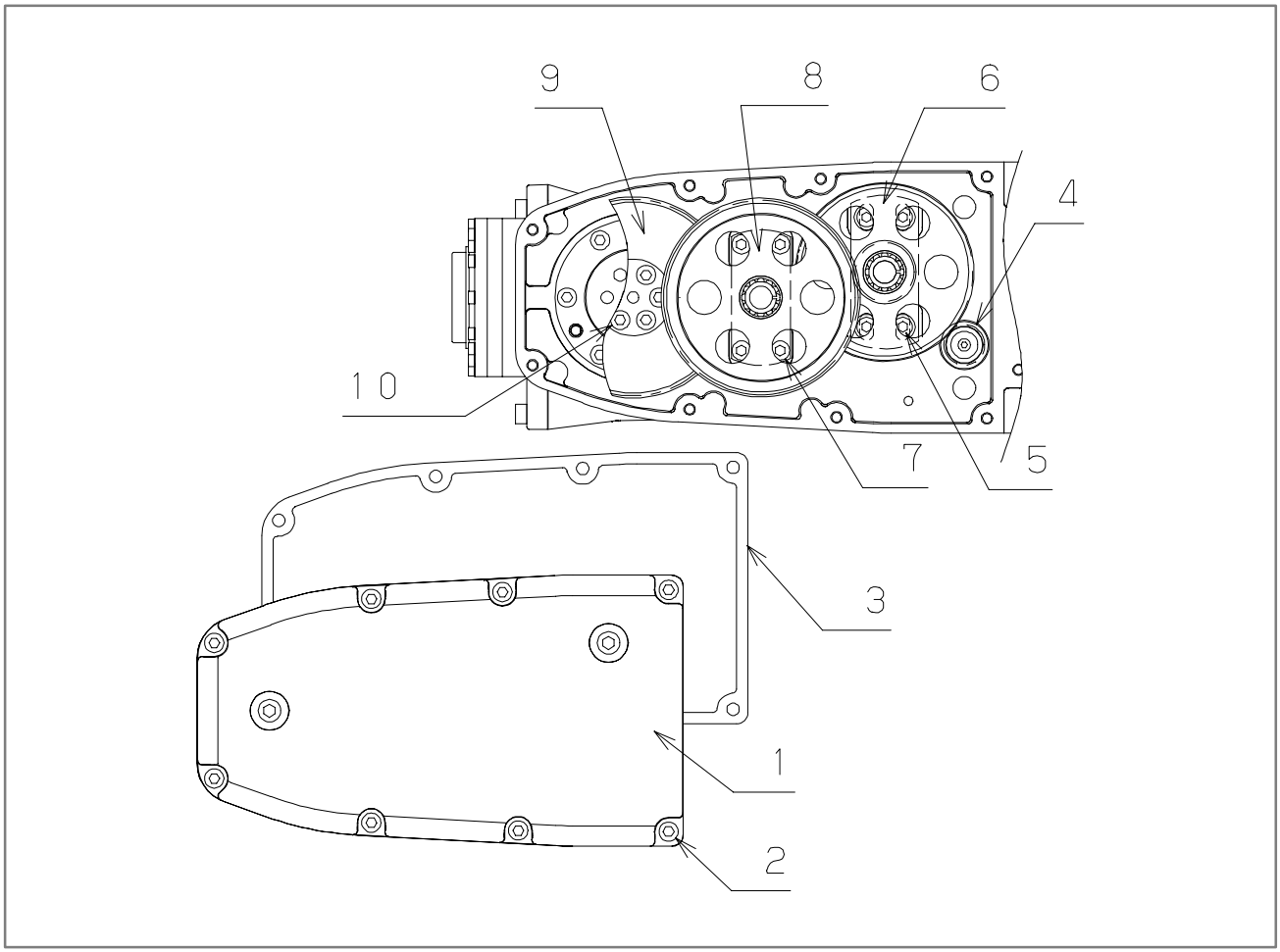


Fig.6.8 Replacing J4–axis gear box

6.9 REPLACING J4–AXIS CROSS ROLLER

1 Detach the cabling up to wrist clamp 1 according to Chapter 8.
2 Remove bolt (1), then remove J3 housing (2) and packing (3).
3 Remove gear (6) according to Section 6.8.
4 Remove the J5 housing.
5 Remove bolt (5), then remove cross roller (4).
6 Install new cross roller (4) with bolt (5).
7 Install gear (6) and the J5 housing with bolt (7). At this time, apply sealant to the J5 housing. (See Section 6.13, ”APPLYING SEALANT”.)
8 Assemble, adjust, and grease the J4 gear box according to Section 6.8.
9 Install J3 housing (2) with bolt (1) by using new packing (3).
10 Install the cable according to Chapter 8.

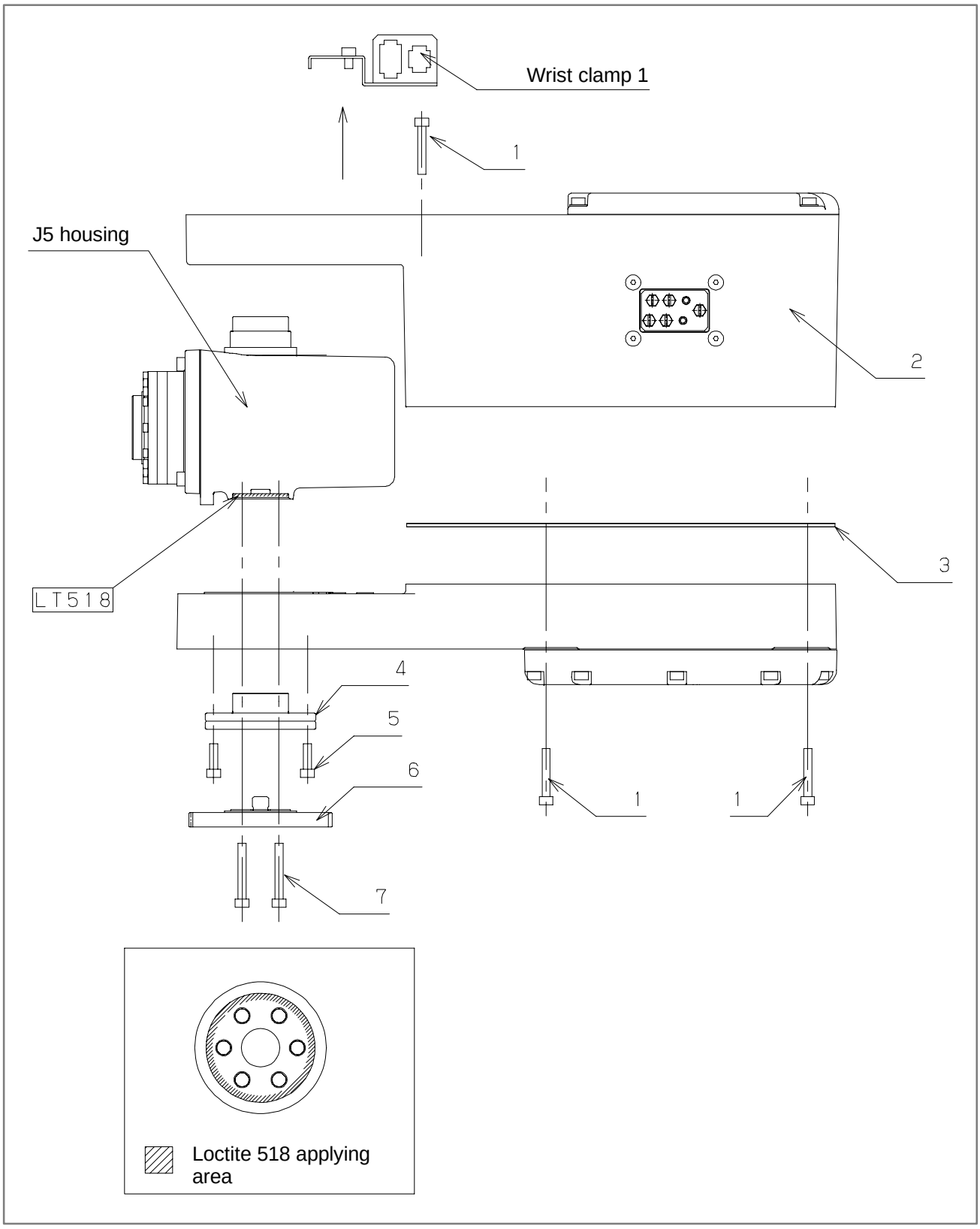


Fig.6.9 Replacing J4–axis cross roller

6.10 REPLACING J5–AXIS MOTOR

1 Remove bolt (1), then remove pin (4), packing (3), and adapter (2).
2 Detach the connector attached to motor (7).
3 Remove bolt (8), then remove packing (6) and motor (7).
4 Remove setscrew (5), then remove the wave generator.
5 Using a new motor and packing, assemble the J5–axis motor by reversing the procedure above. Feed grease sufficiently according to Fig. 6.10.

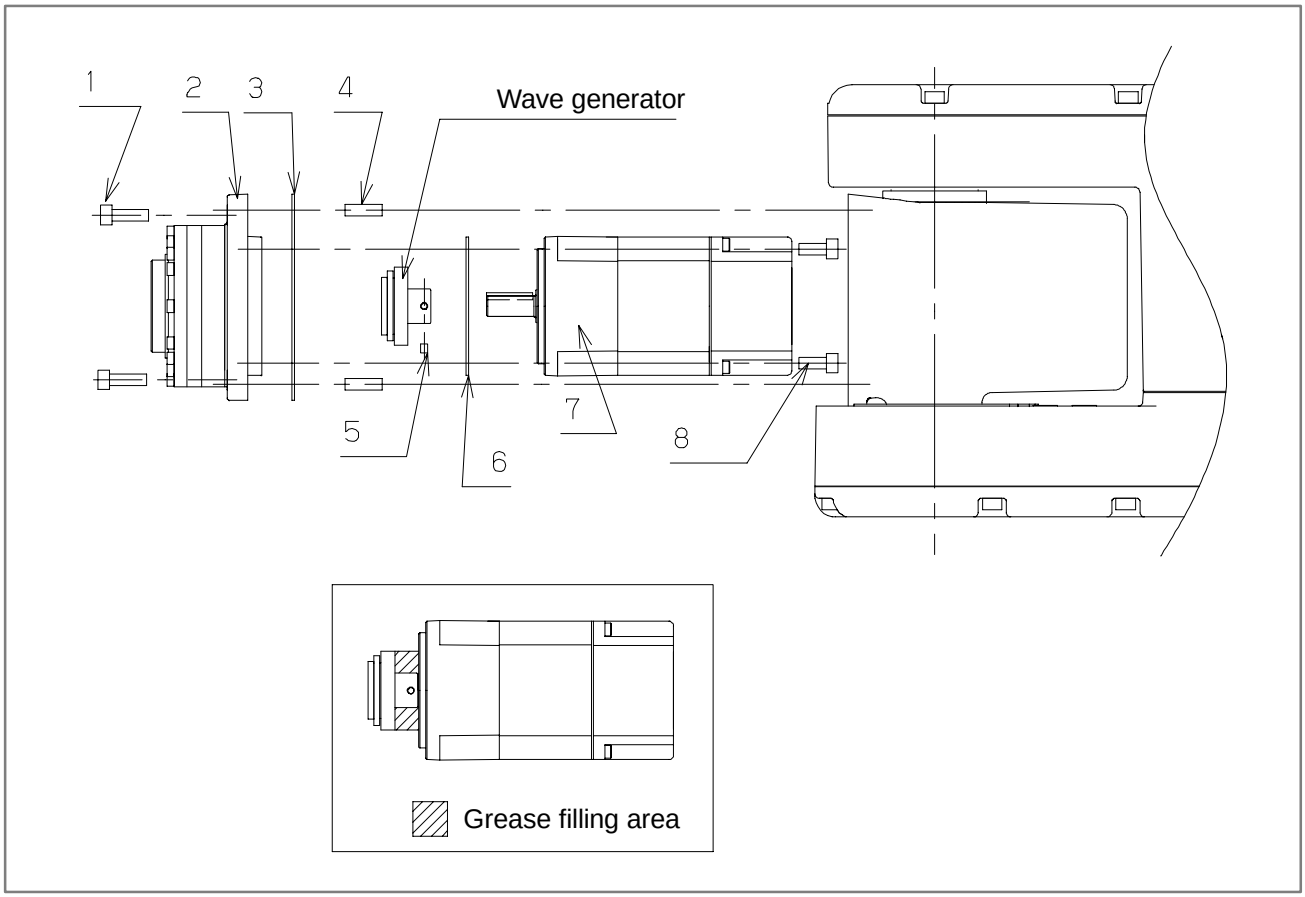


Fig.6.10 Replacing J5–axis motor

6.11 REPLACING J5–AXIS REDUCER

1 Remove bolt (1), then remove pin (6), packing (8), and adapter (4).
2 Detach the connector attached to motor (9).
3 Remove bolt (10), then remove packing (8) and motor (9).
4 Remove setscrew (7), then remove the wave generator.
5 Remove bolt (2), then remove J5 reducer (3).
6 Using a new reducer and packing, assemble the J5–axis reducer by reversing the procedure above. When assembling the J5–axis reducer, feed grease sufficiently to the reducer according to Fig. 6.11.

NOTE
The reducer has a mounting phase (grease input and outlet positions). So, when assembling the reducer, ensure a match with the mounting phase shown in Fig. 6.11.

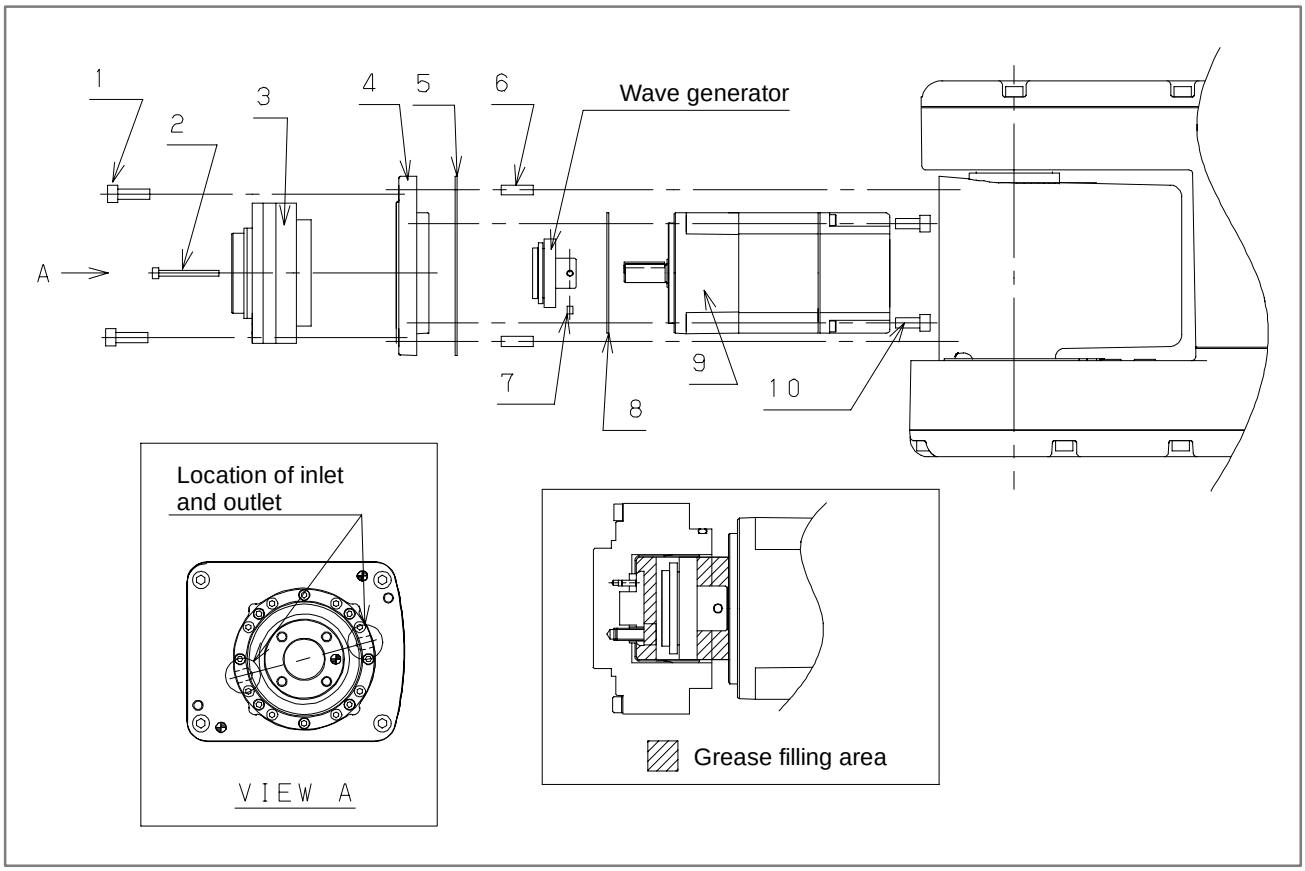


Fig.6.11 Replacing J5–axis reducer

6.12 REPLACING MAGNETIC SOLENOID VALVE

1 Remove bolt (1), then remove J3 cover R (2).
2 Remove the magnetic solenoid valve.
3 Remove bolt (6) and the air tube, then remove magnetic solenoid valve (5).
4 By reversing the procedure above, assemble a new magnetic solenoid valve and packing.

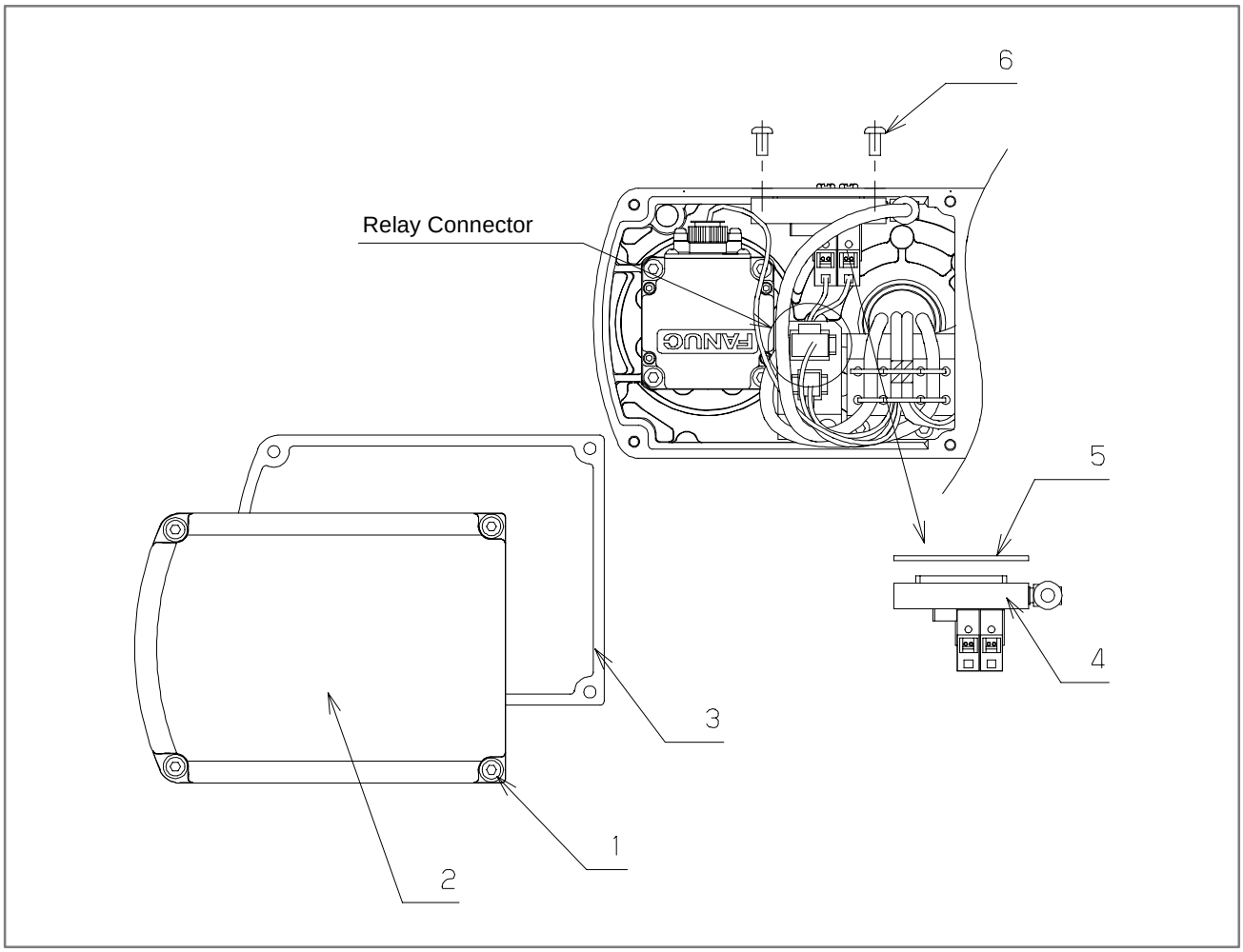


Fig.6.12 Replacing magnetic solenoid valve

6.13 SEALANT APPLICATION

Washing and degreasing the surfaces to be sealed

1 After dismounting the gear or the cross roller, apply releasant (Loctite Gasket Remover) to the arm's surface from which the reducer was dismounted, then wait until the sealant (Loctite 518) becomes softened (for about 10 minutes). Remove the softened sealant from the surface using a spatula.

2 Blow air onto the surface to be sealed to remove dust from the tapped holes.

3 Sufficiently degrease the gear and the cross roller to be sealed and the arm's surface to be sealed, using a cloth dampened with alcohol.

4 Check that there is no flash on the arm's surface to be sealed.

Applying sealant

5 Make sure that the reducer and the arm are dry (with no alcohol remaining). If they are still wet with alcohol, wipe them dry.

6 Apply sealant (Loctite 518) to the surfaces.

NOTE
The portions to which sealant is to be applied vary from one axis to another. See descriptions about reducer replacement for the relevant axes for details.

Assembling

7 To prevent dust from sticking to the portions to which sealant was applied, mount the reducer as quickly as possible after sealant application. Be careful not to touch the applied sealant. If sealant was wiped off, apply again.

8 After mounting the reducer, fasten it with bolts quickly so that the mated surfaces get closer.

NOTE
Do not grease the reducer before the sealant sets, as it may allow grease to leak. Before greasing, wait for about at least one hour after the reducer is mounted.

7 PIPING AND WIRING

7.1 PIPING DIAGRAM

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

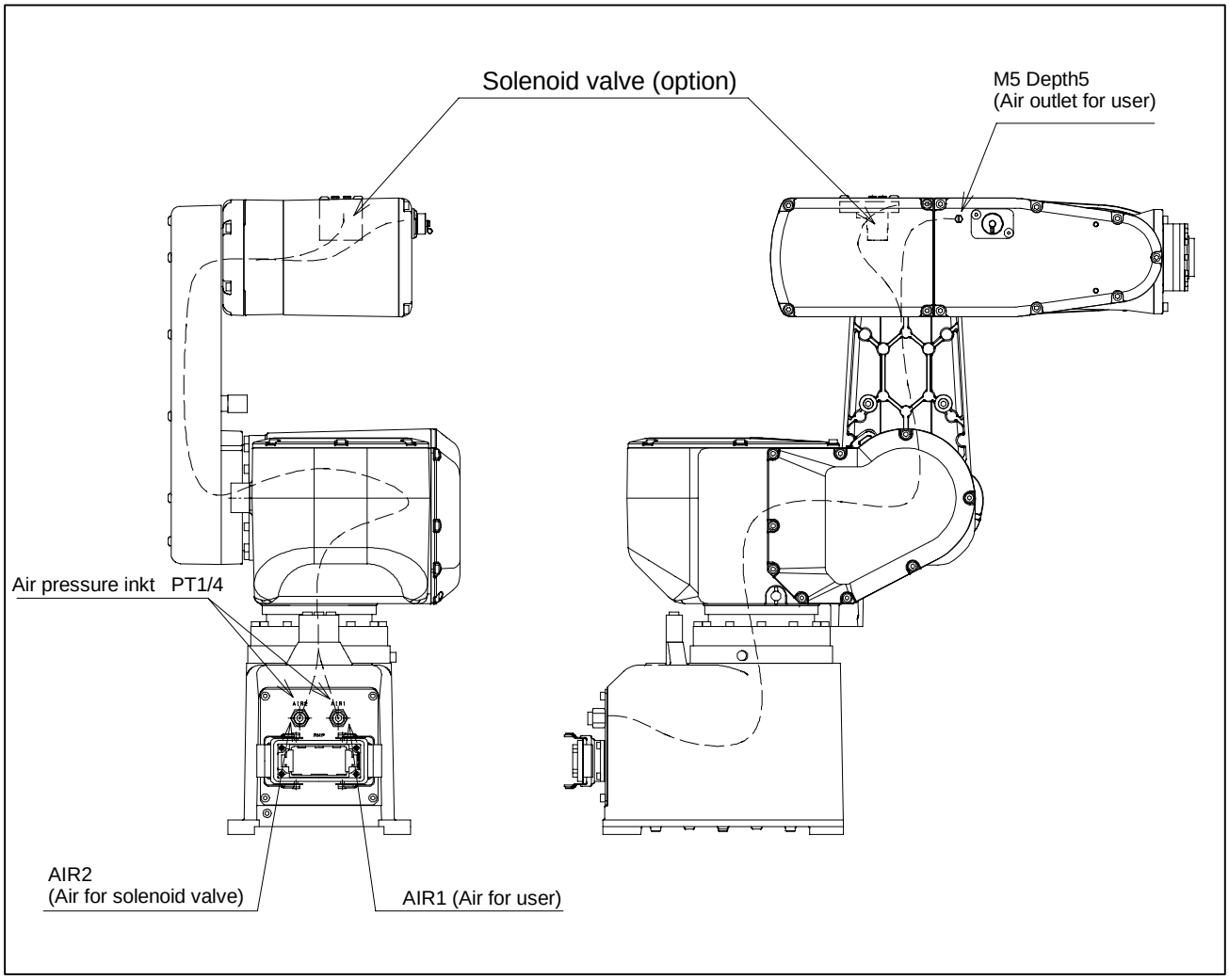


Fig. 7.1 Piping diagram

7.2 WIRING DIAGRAM

Fig.7.2 shows the wiring diagram of the mechanical unit.

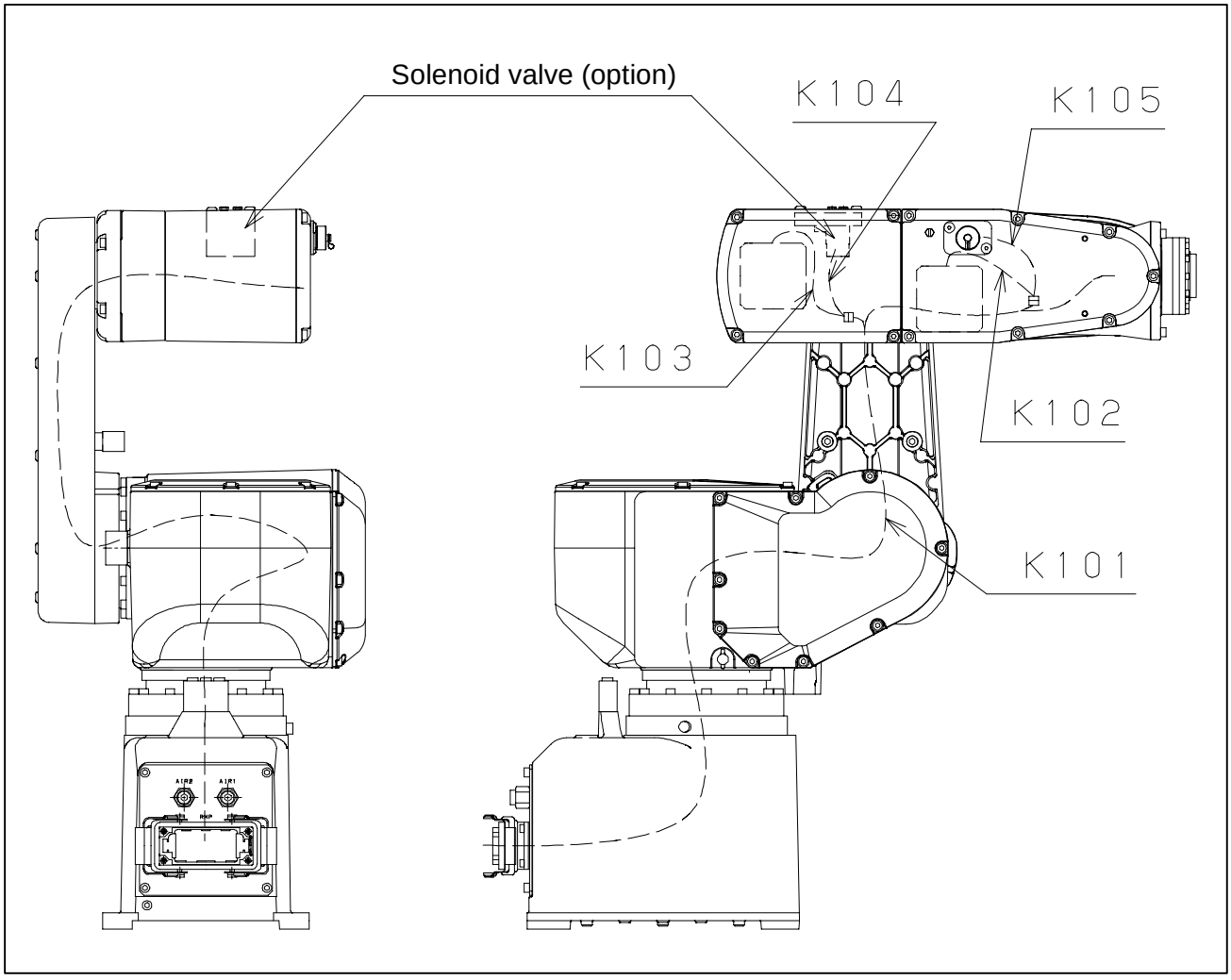
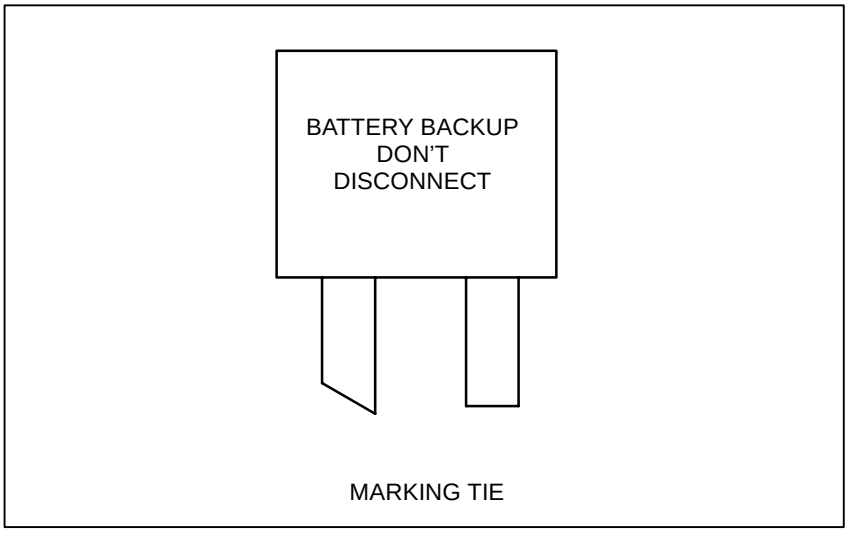


Fig. 7.2 Wiring diagram

8 REPLACING CABLES

Replace the cables every four years. When the cable is broken or damaged, or shows signs of wear, replace it according to this chapter.

Precautions to be observed when handling the pulse coder cable
The pulse coder cable is provided with a marking tie, as shown below, to warn against disconnecting the cable during transportation, installation, or maintenance. If the cable with the marking tie is disconnected, mastering must be performed again. Therefore, do not disconnect the cable except when replacement of the cable is necessary.



8.1 CABLE FORMING

Fig.8.1 shows the cable clamp position.
When replacing cables, clamp the cable at the position specified in Figure 8.1 using a clamp or a nylon band. Otherwise, cables are loosened or forcedly pulled to cause their disconnection. Refer to the figures in section 8.2 for the cable clamp position not listed in the Table.
If a cable is broken or damaged, replace the cable according to this chapter.
When the connector of the cable for the pulse coder is detached, the motor loses absolute position data. So, mastering becomes necessary after cable replacement.

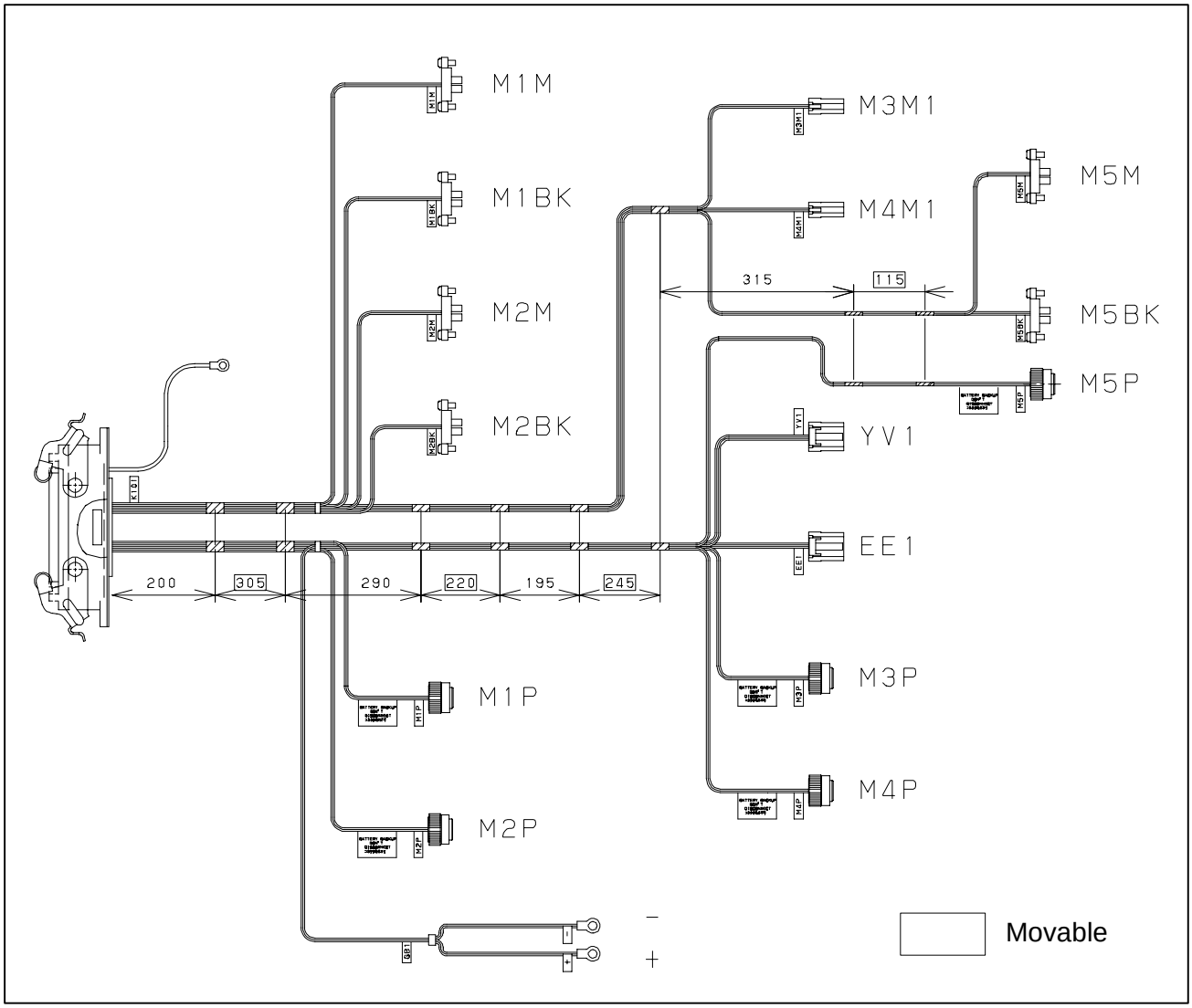


Fig. 8.1 Cable clamp

8.2 REPLACING CABLES AND AIR TUBES

8.2.1 Replacing Cable K101

(1) Detaching the cable in the J3 and J5 housings

1 Move the robot to an attitude of 0° for all axes, then turn off the power to the control unit.
2 Remove bolts (2) and (5), then remove J3 cover R (1), J3 cover F (4).
3 Remove bolt (14), then remove wrist clamp 1 (13). Cut the cable tie.
4 Remove bolt (7), then remove pin (10), packing (9), and adapter (8).
5 Detach the connector attached to J5 motor.
6 Remove bolt (11), then remove wrist clamp 2 (12). Cut the cable tie.
7 Pull out the cable from within the J5 housing.
8 Remove the four relay connectors.
9 Remove bolt (16), then remove J3 clamp 1 (15). Cut the cable tie.
10 Detach the air tube.

	Name	Specifications	Q'ty	LOCTITE	Torque N-m (kgf-m)
1	J3 COVER R	A290−7137−X406	1		
2	BOLT	A97L−0218−0504#M5X12ZN	4		2.5(25)
3	J3 COVER PACKING R	A290−7137−X431	1		
4	BOLT	A97L−0218−0504#M5X12ZN	7		5.6(57)
5	J3 COVER F	A290−7137−X405	1		
6	J3 COVER PACKING F	A290−7137−X430	1		
7	BOLT	A6−BA−5X16	4	LT262	5.6(57)
8	ADAPTER	A290−7137−X502	1		
9	PACKING	A290−7137−X523	1		
10	SPRING PIN	A6−PS−5X16	2		
11	BOLT	A6−BA−5X8	1		
12	WRIST CLAMP 2	A290−7137−X522	1		
13	WRIST CLAMP 1	A290−7137−X426	1		
14	BOLT	A6−BA−5X8	2		
15	J3 CLAMP 1	A290−7137−X424	1		
16	BOLT	A6−BA−5X8	2		

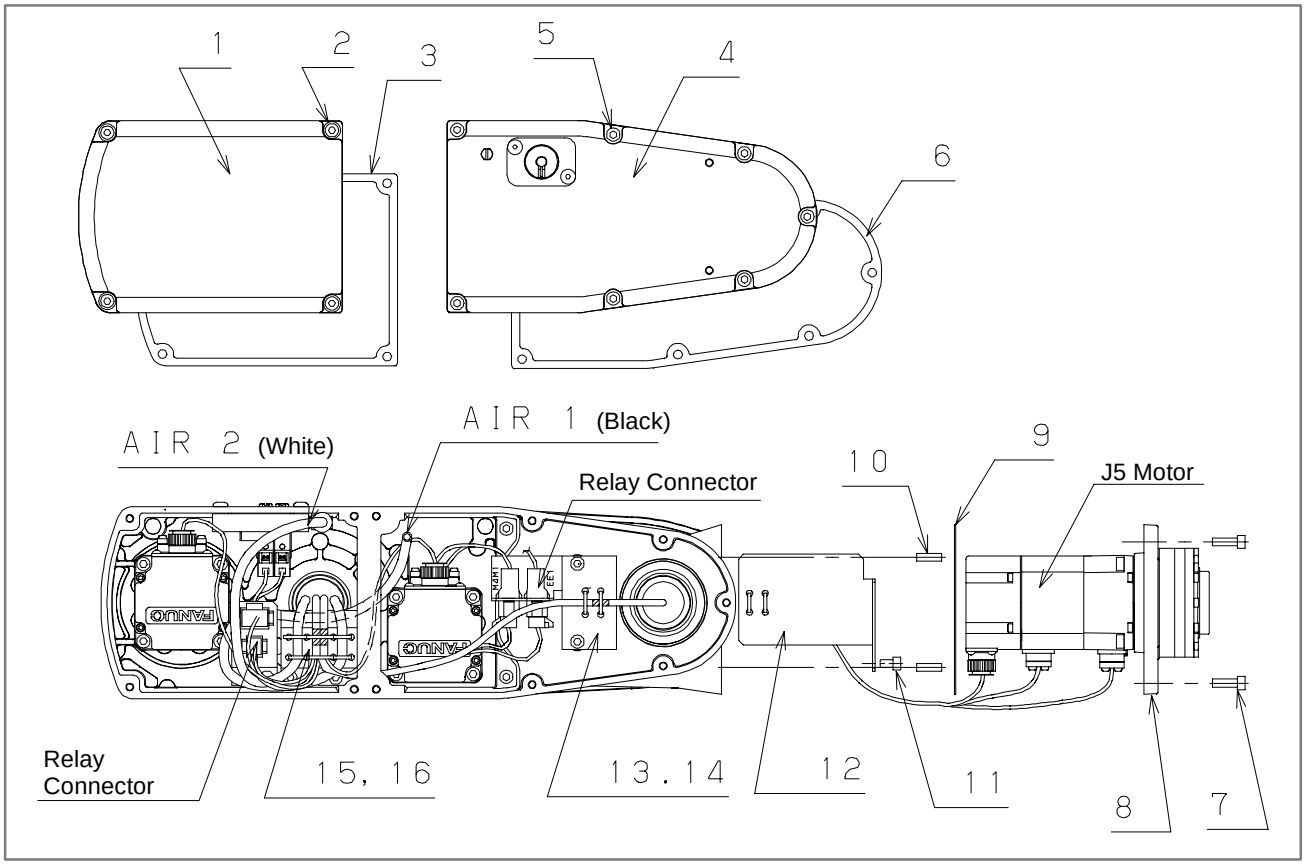


Fig. 8.2.1(a) Replacing cable in J3 and J5 housings

(2) Detaching the cable in the J2 arm

1 Remove bolt (2), then remove J2 arm cover (1).
2 Remove bolt (5), then remove clamp J2−2 (4). Cut the cable tie.
3 Pull out the cable from within the J3 housing.

	Name	Specifications	Q'ty	LOCTITE	Torque N-m (kgf-m)
1	J2 ARM COVER	A290−7137−X333 A290−7137−X324	1		
2	BOLT	A97L−0080−0007#M5X10ZN	4 11		2.5(25)
3	PACKING J2−A	A290−7137−X329	1		
4	CLAMP J2−2	A290−7137−X323	2		
5	BOLT	A6−BA−5X8	4		

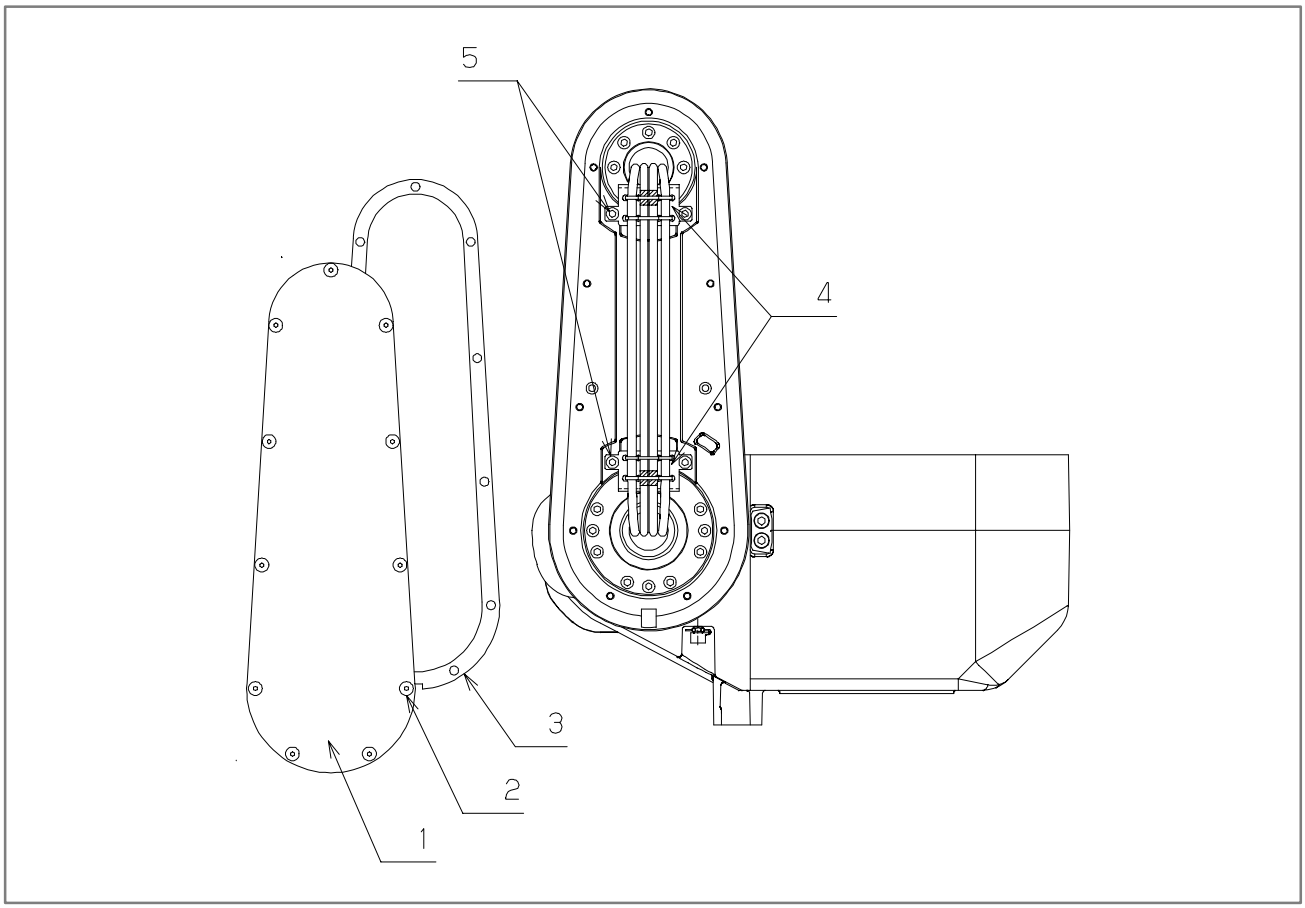


Fig. 8.2.1(b) Replacing cable in J2 arm

(3) Detaching the cable in the J1 and J2 bases

1 Remove bolts (1) and (4), then remove J2 cover S (5) and J2 cover U (2).
2 Remove bolt (7), then remove J2–1 (8). Cut the cable tie.
3 Pull out the cable from the J2 arm.
4 Detach the connector attached to motor (J1, J2).
5 Open the lid of battery box (10), remove screw (9), and remove battery box (10).
6 Detach the cable connected to battery box (10).
7 Remove bolt (17), then move J1 connector panel (16) slightly away from the J1 base. Next, detach the air tube.
8 Remove bolt (13), then remove clamp J1–1 (14).
9 Remove bolt (11), then remove clamp J1–2 (12). Cut the cable tie.
10 Pull out the cable and air tube from the J2 base.
11 Cut the cable tie for clamp J1–1 (14).
12 Remove bolt (17), then remove J1 connector panel (16).
13 Replace the bolt (18) and the connector.

	Name	Specifications	Q'ty	LOCTITE	Torque N-m (kgf-m)
1	BOLT	A97L–0218–0504#M5X10ZN	8		2.5(25)
2	J2 COVER U	A290–7137–X303	1		
3	PACKING J2–U	A290–7137–X327	1		
4	BOLT	A97L–0218–0504#M5X10ZN	9		2.5(25)
5	J2 COVER S	A290–7137–X304	1		
6	PACKING J2–S	A290–7137–X328	1		
7	BOLT	A6–BA–5X8	2		
8	CLAMP J2–1	A290–7137–X322	1		
9	SCREW	A6–SSA–4X10S	2		
10	BATTERY BOX	A98L–0004–0149	1		
11	BOLT	A6–BA–5X8	2		
12	CLAMP J1–2	A290–7137–X321	1		
13	BOLT	A6–BA–5X8	2		
14	CLAMP J1–1	A290–7137–X221	1		
15	PACKING J1–C	A290–7137–X225	1		
16	J1 CON.PLATE	A290–7137–X223	1		
17	BOLT	A97L–0218–0496#M5X10ZN	4		5.6(57)
18	BOLT	A6–BA–4X8	4	LT242	

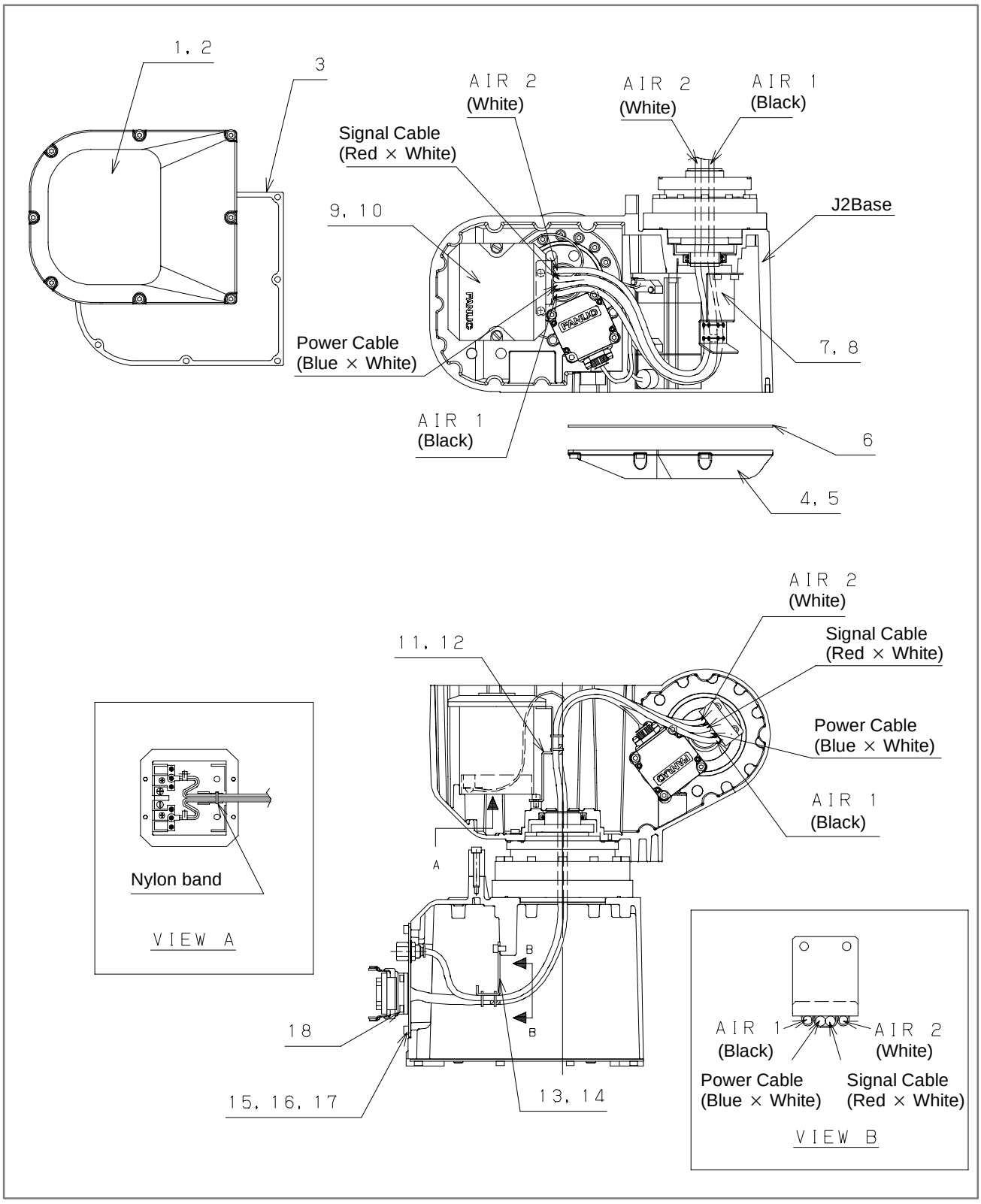


Fig. 8.2.1(c) Replacing cable in J2 base

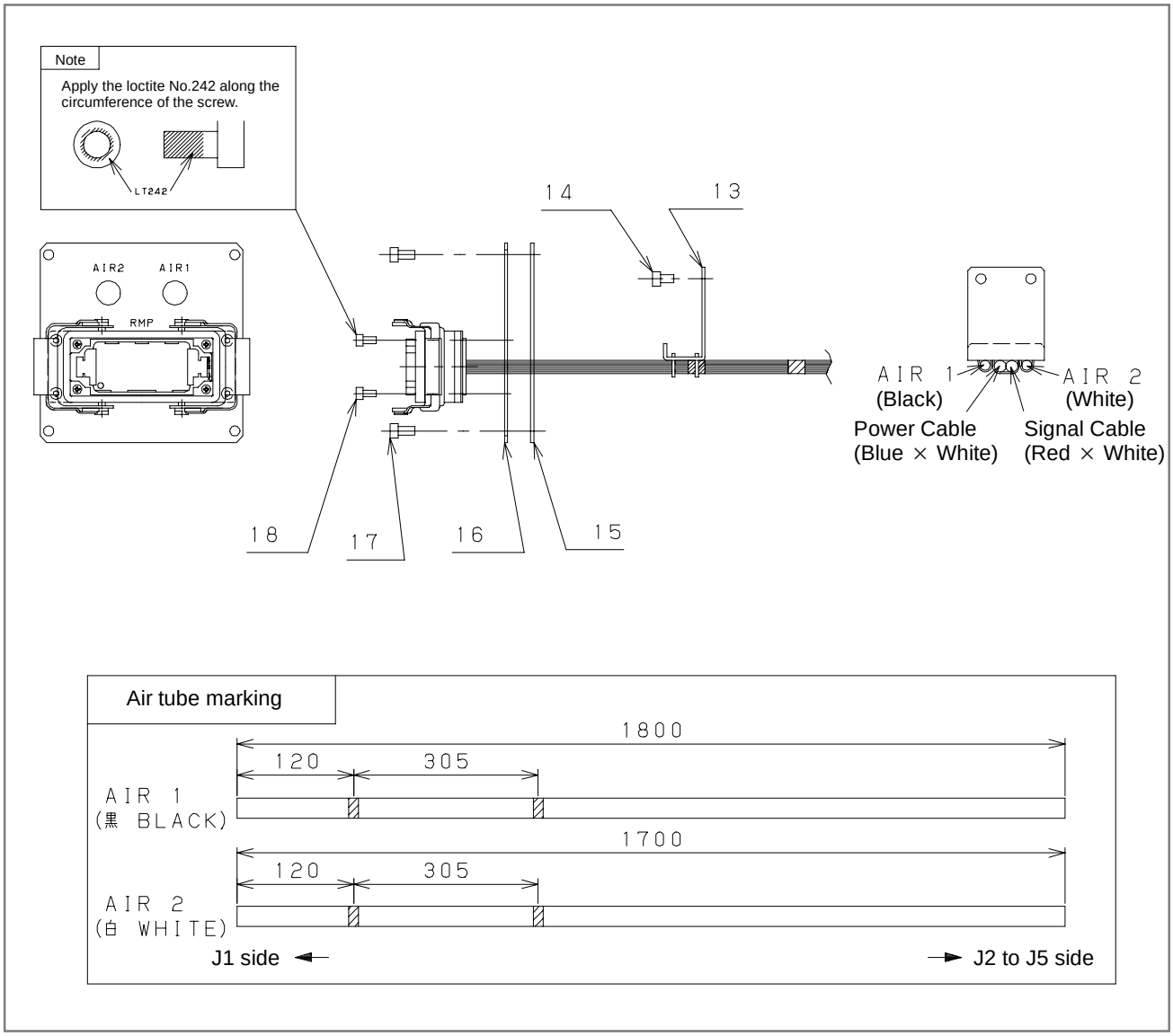


Fig. 8.2.1(d) Replacing cable in J1 base

(4) Installing the cable

1 By reversing the procedure above, install the cable. For the marking position of the air tube, see Fig. 8.2.1(d).

2 Connect the ground terminal to the J1–axis base, then connect the cable for connection with the control unit to the connector panel.

3 Turn on the power. According to Section 5.2, reset an alarm issued at this time.

4 Perform mastering.

8.2.2 Replacing Cables K102 and K103

1 Remove bolt (2), then remove J3 cover F (1) and packing (3).
2 Remove bolt (4), then remove the J3 housing and packing (5).
3 Replace cables K102 and K103.
4 Using a new packing, install the cables by reversing the procedure above.

	Name	Specifications	Q'ty	LOCTITE	Torque N-m (kgf-m)
1	J3 COVER F	A290−7137−X405	1		
2	BOLT	A97L−0218−0504#M5X12ZN	7		5.6(57)
3	J3 COVER PACKING F	A290−7137−X430	1		
4	BOLT	A6−BA−5X30	6	LT262	5.6(57)
5	PACKING	A290−7137−X429	1		

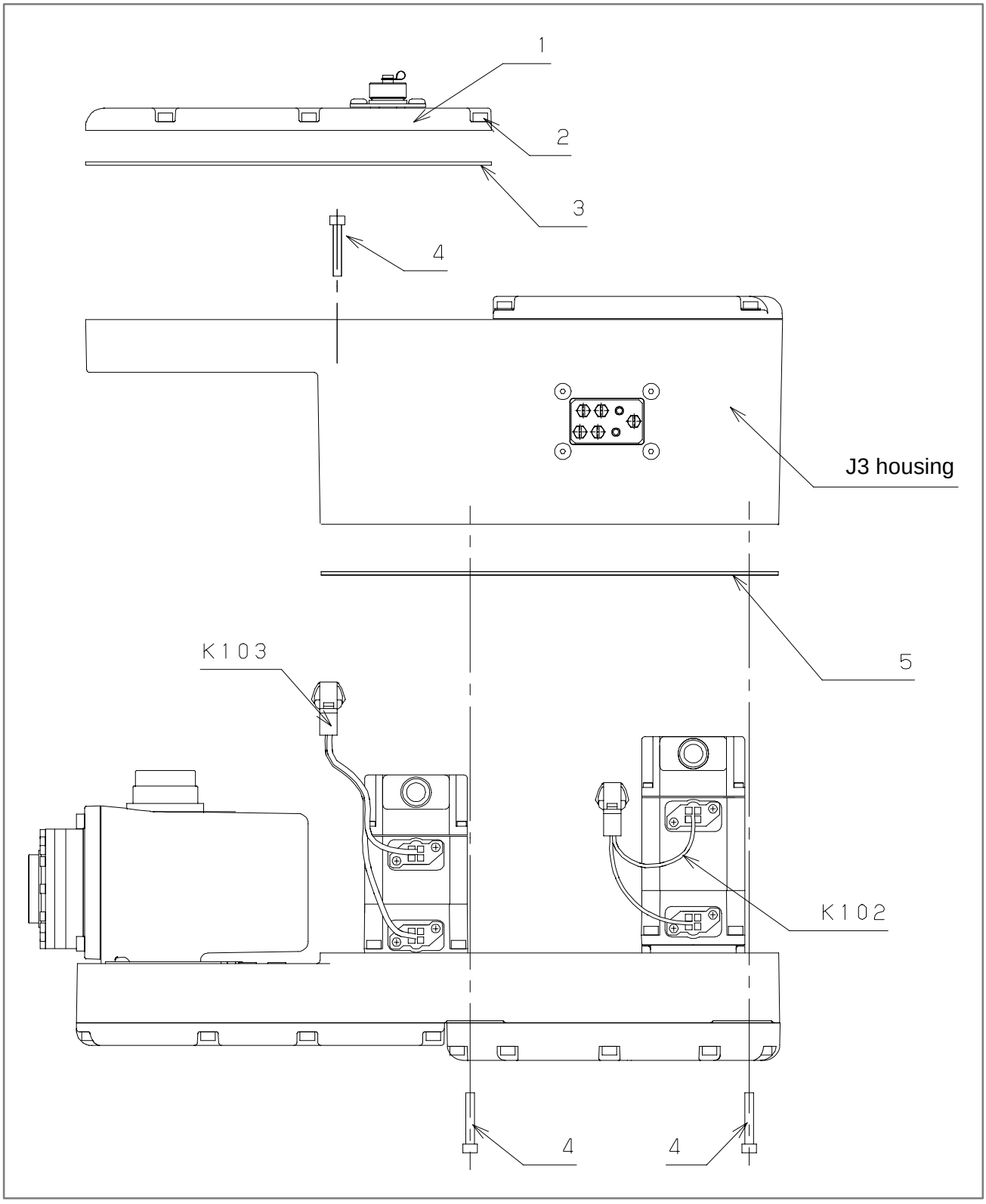


Fig. 8.2.2 Replacing cables K102 and K103

8.2.3 Replacing Cable K104

1 Remove bolt (2), then remove J3 cover F (1) and packing (3).
2 Replace cable K104.
3 Using a new packing, install cable K104 by reversing the procedure above.

	Name	Specifications	Q'ty	LOCTITE	Torque N-m (kgf-m)
1	J3 COVER F	A290−7137−X405	1		
2	BOLT	A97L−0218−0504#M5X12ZN	7		5.6(57)
3	J3 COVER PACKING F	A290−7137−X430	1		
4	BOLT	A97L−0080−0007#M5X8S	2		2.5(25)
5	EE PACKING	A290−7137−X433	1		

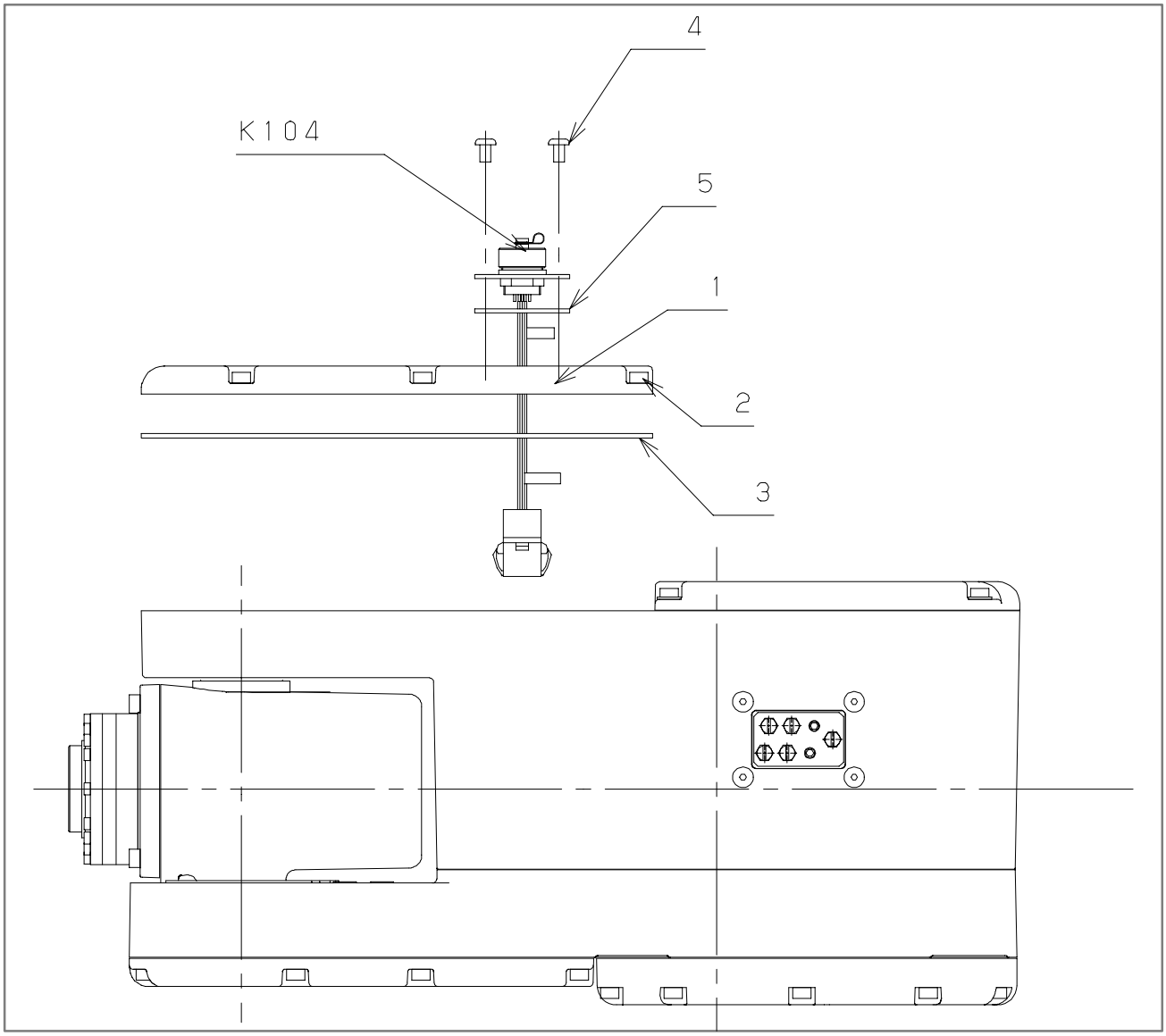


Fig. 8.2.3 Replacing cable K104

8.2.4 Replacing Cable K105

1 Replace cable K105 according to Section 6.12, “REPLACING MAGNETIC SOLENOID VALVE”.

II. CONNECTION

1 OPERATING AREA

1.1 OPERATING AREA AND THE DIMENSIONS OF THE ROBOT

Fig.1.1 shows the operating area and the dimensions of the robot. Care must be taken not to put obstructions in the operating area of a robot when installing peripheral equipment.

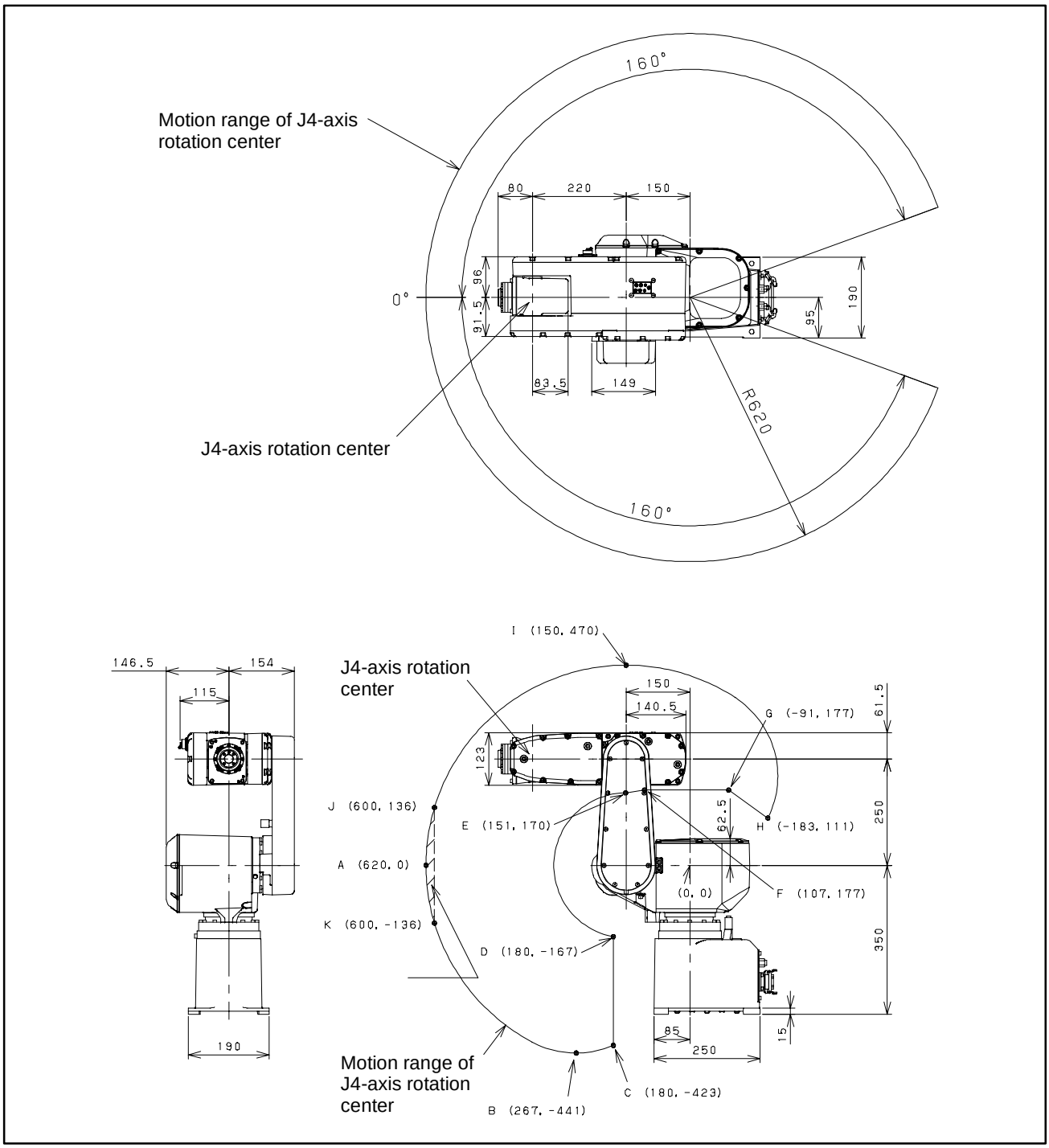


Fig.1.1 Operating area and the dimensions of the mechanical unit

1.2 DETAILS OF THE OPERATING AREA

Fig.1.2 illustrates the details of the operating area of the robot.

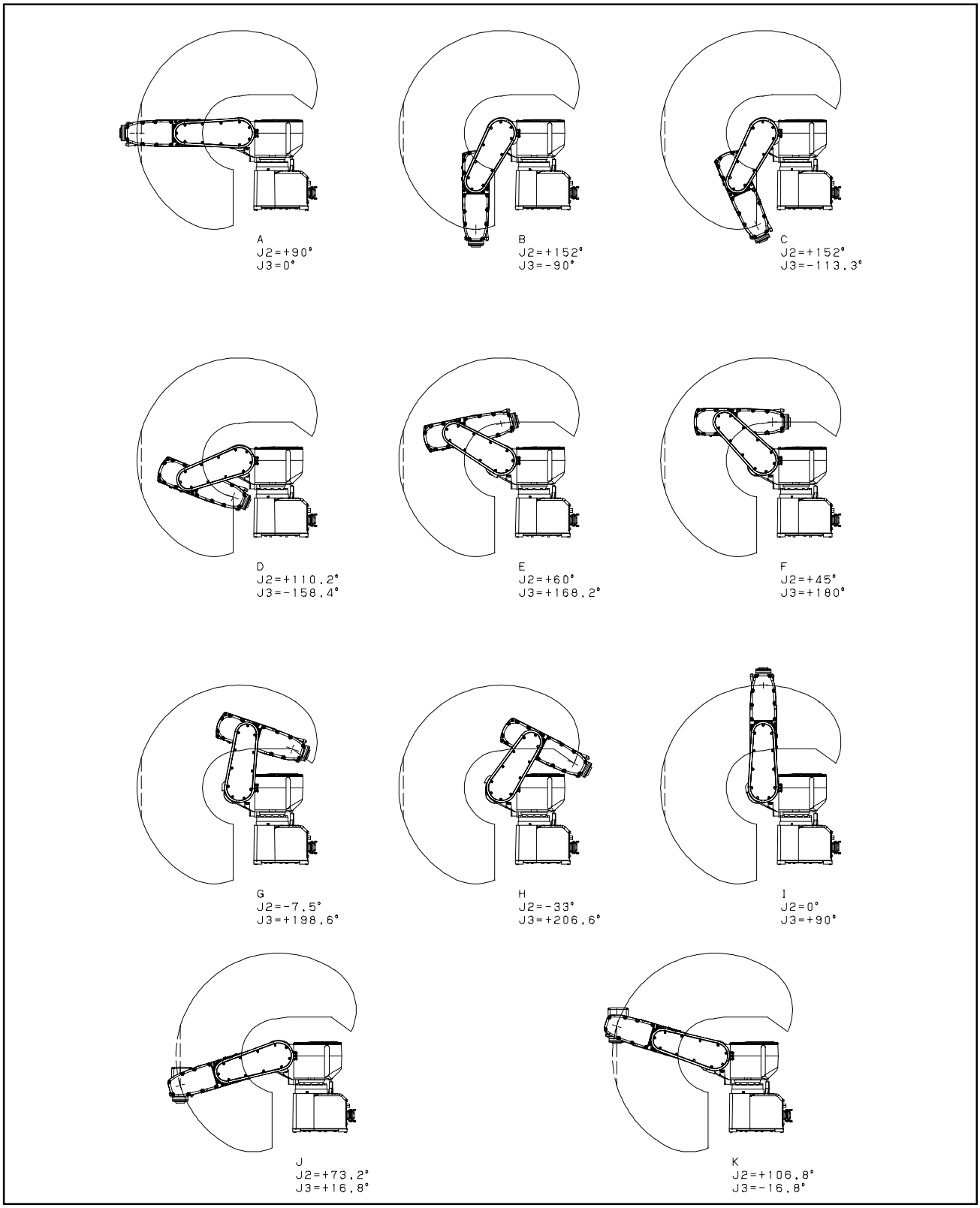


Fig.1.2 Operating area of the robot

2 MECHANICAL COUPLING TO THE ROBOT

2.1 WRIST LOAD CONDITIONS

Fig.2.1 is diagrams to limit loads applied to the wrist. Apply a load within the region indicated in the graph.

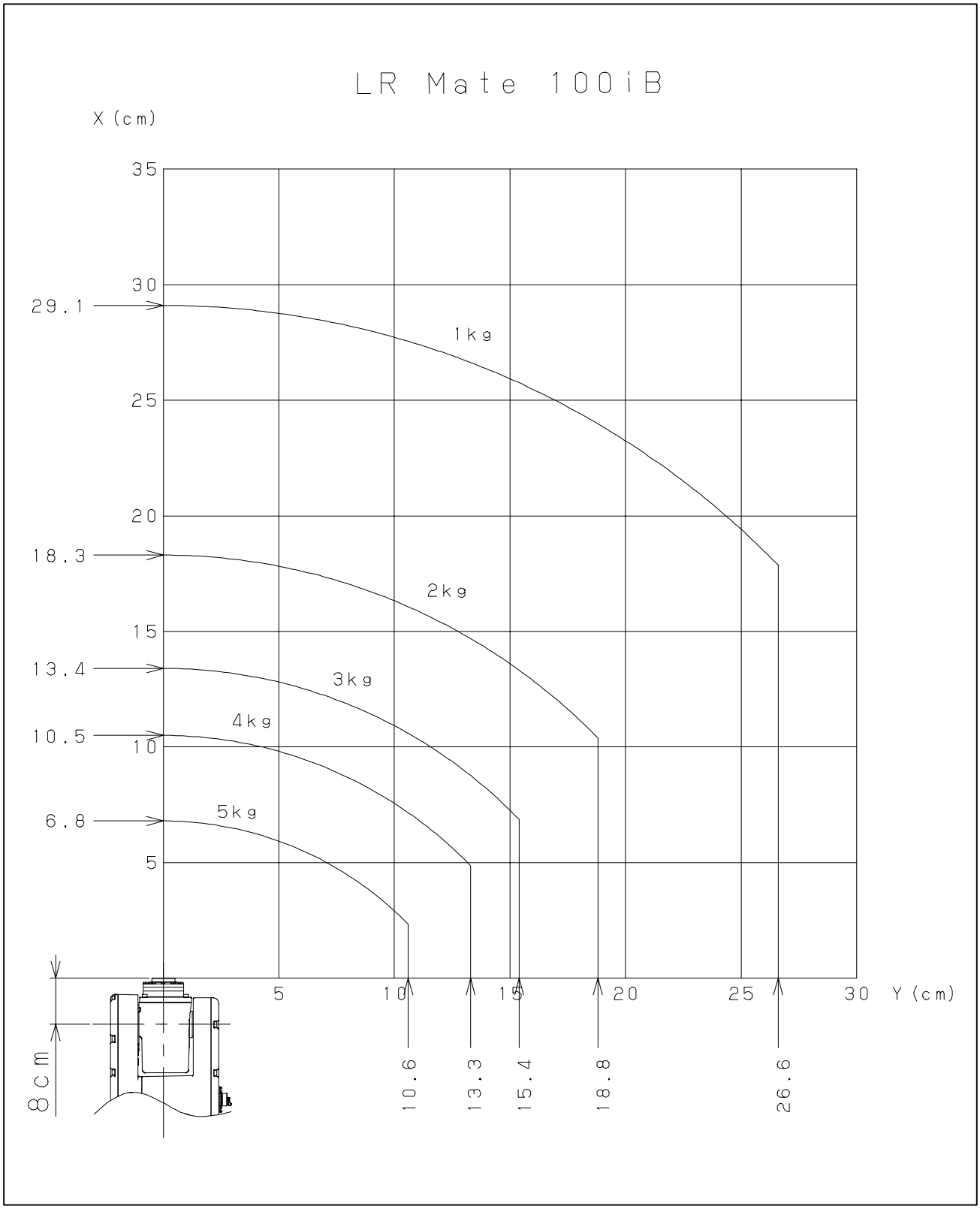


Fig.2.1 Wrist Load Diagram

2.2 INSTALLING THE END EFFECTOR TO THE WRIST

Fig.2.2 shows the end effector mounting face at the tip of the wrist. Fit the end effector to the wrist using a ϕ20H7 or ϕ40h7 engagement, position the effector using a ϕ5H7 reamed hole, and fix the effector to the wrist using 4–M5 tapped holes.
Specify the lengths of the M5 bolts and positioning pin in consideration of the depths of the tapped holes and reamed hole.

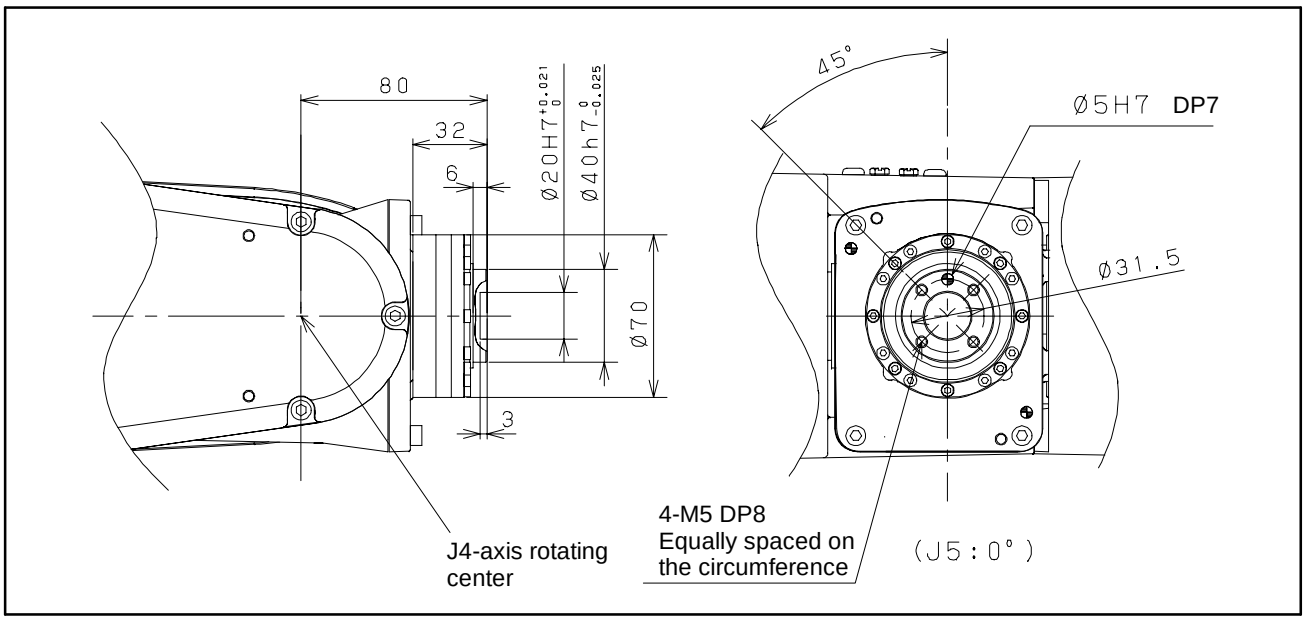


Fig.2.2 Surface for installing the end effector

2.3 HAND CABLE AND AIR TUBE ATTACHMENT PLANE

Fig. 2.3 shows the attachment tap positions for clamping the hand cable and air tube.

NOTE
The clamping parts should be prepared by the customer.

NOTE
The tightening torque of bolts and other fastening parts for the taps must not exceed 5.6 Nm (57 kgfm).

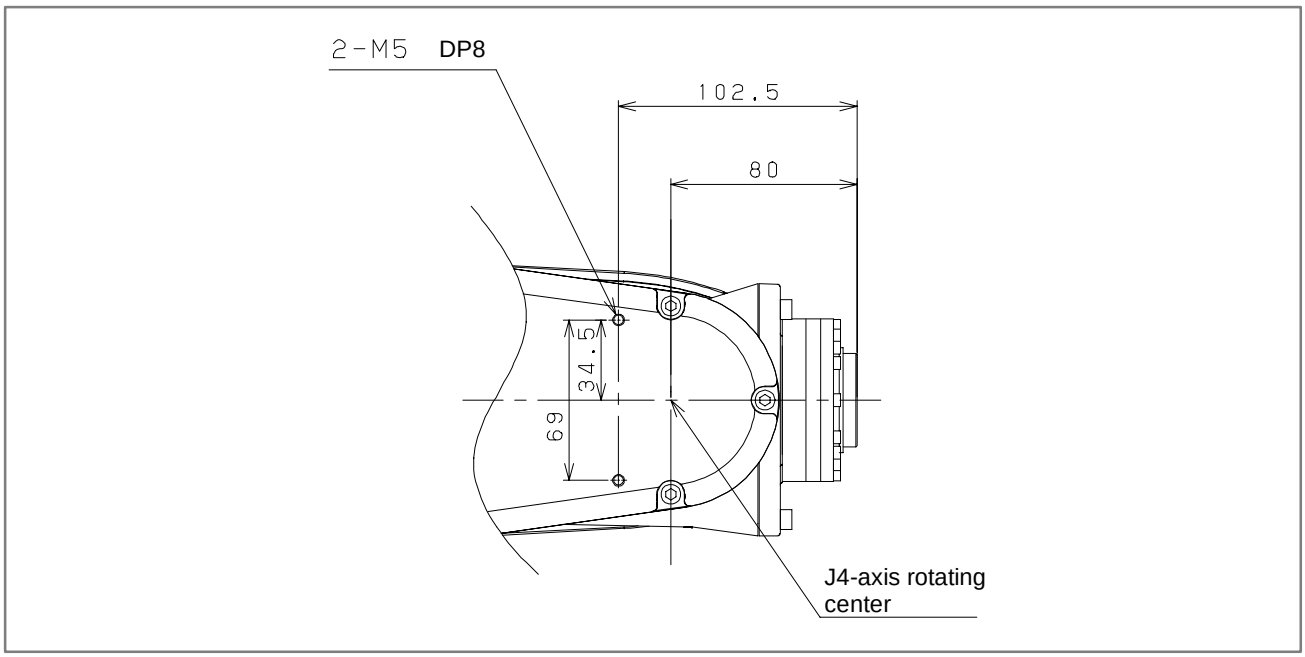


Fig.2.3 Hand cable and air tube attachment plane

2.4 SETTING SYSTEM VARIABLES FOR SHORTEST–TIME CONTROL

It is possible to make an effective use of the robot by setting payload conditions such as the weight, moment, and inertia of the hands and other objects attached to the wrist section of the robot appropriately.

Motion performance screens

The motion performance screens include the MOTION PERFORMANCE screen, MOTION PAYLOAD SET screen, and MOTION ARMLOAD SET screen. These screens are used to specify payload information and equipment information on the robot.

1 Click the [MENUS] key to display the screen menu.
2 Select ”6 SYSTEM” from the next page.
3 Click F1 ([TYPE]).
4 Select ”MOTION.” The MOTION PERFORMANCE screen appears.

```
MOTION PERFORMANCE          JOINT    10%
    Group1
 No.    PAYLOAD[kg]         Comment
  1            4.00   [                ]
  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 = 0
[ TYPE ]  GROUP  DETAIL ARMLOAD SETIND >
```

5 Ten different pieces of payload information can be set using condition Nos. 1 to 10 on this screen. Place the cursor on one of the numbers, and click F3 (DETAIL). The MOTION PAYLOAD SET screen appears.

```
MOTION PAYLOAD SET          JOINT    10%


   Group 1
 1. Schedule No[   1]:[Comment        ]
 2. PAYLOAD           [kg]          4.00
 3. PAYLOAD CENTER X  [cm]        -13.30
 4. PAYLOAD CENTER Y  [cm]          0.00
 5. PAYLOAD CENTER Z  [cm]         48.10
 6. PAYLOAD INERTIA X [kgfcms^2]   46.10
 7. PAYLOAD INERTIA Y [kgfcms^2]   91.30
 8. PAYLOAD INERTIA Z [kgfcms^2]   77.50




[ TYPE ]  GROUP  NUMBER  DEFAULT   HELP
```

6 Set the payload, gravity center position, and inertia around the gravity center on the MOTION PAYLOAD SET screen. The X, Y, and Z directions displayed on this screen correspond to the respective standard tool coordinates (with no tool coordinate system set up). When values are entered, the following message appears: ”Path and Cycletime will change. Set it?” Respond to the message with F4 ([YES]) or F5 ([NO]).
7 Clicking F3 ([NUMBER]) will bring you to the MOTION PAYLOAD SET screen for another condition number. For a multigroup system, clicking F2 ([GROUP]) will bring you to the MOTION PAYLOAD SET screen for another group.
8 Click the previous page key to return to the MOTION PERFORMANCE screen. Click F5 ([SETIND]), and enter the desired payload setting condition number.

Wrist axis payload moment

Assign the following system variables with integers (in kgf–m) × 1000 representing the moment of the wrist section payload.

[Example of setting system variables]

$PARAM_GROUP.$AXISMOMENT[4]:
740 (J4 axis payload moment)
$PARAM_GROUP.$AXISMOMENT[5]:
532 (J5 axis payload moment)

Wrist axis payload inertia

Assign the following system variables with integers (in kgf–cm–s^2) × 1000 representing the inertia of the wrist arm payload.

[Example of setting system variables]

$PARAM_GROUP.$AXISINERTIA[4]:
1400 (J4 axis payload inertia)
$PARAM_GROUP.$AXISINERTIA[5]:
772 (J5 axis payload inertia)

When the above system variables have been set, the power must be turned off then back on for the setting to become effective.

2.5 SUPPLYING AIR

Optional solenoid valves can be mounted as shown in Tables 2.5 (a) and (b). Plugs are inserted in all the ports used for supplying air before the robot is shipped. To use the air circuit, you must remove the plugs and connect the couplings with the ports.
When the solenoid valve is to be replaced, the entire manifold should be replaced.

Table 2.5 (a) Optional solenoid valves

Specification number	Description
A05B–1137–H001	Air joint only (no solenoid valve)
A05B–1137–H002	Double solenoids ¢ 2pcs

Table 2.5 (b) Solenoid valve specifications

RDO number	Manufacturer specifications	Effective cross–spectional area
RDO1 to 4	A67L–0218–0065#D2 manufactured by SMC	1.2mm^2 (CV value)

NOTE
1 When the air circuit is not used, reinstall the plugs as originally installed for the purpose of dust and water protection.
2 Install a silencer and check valve in the air outlet not to allow dust and other foreign particles to enter the inside of the solenoid valves.

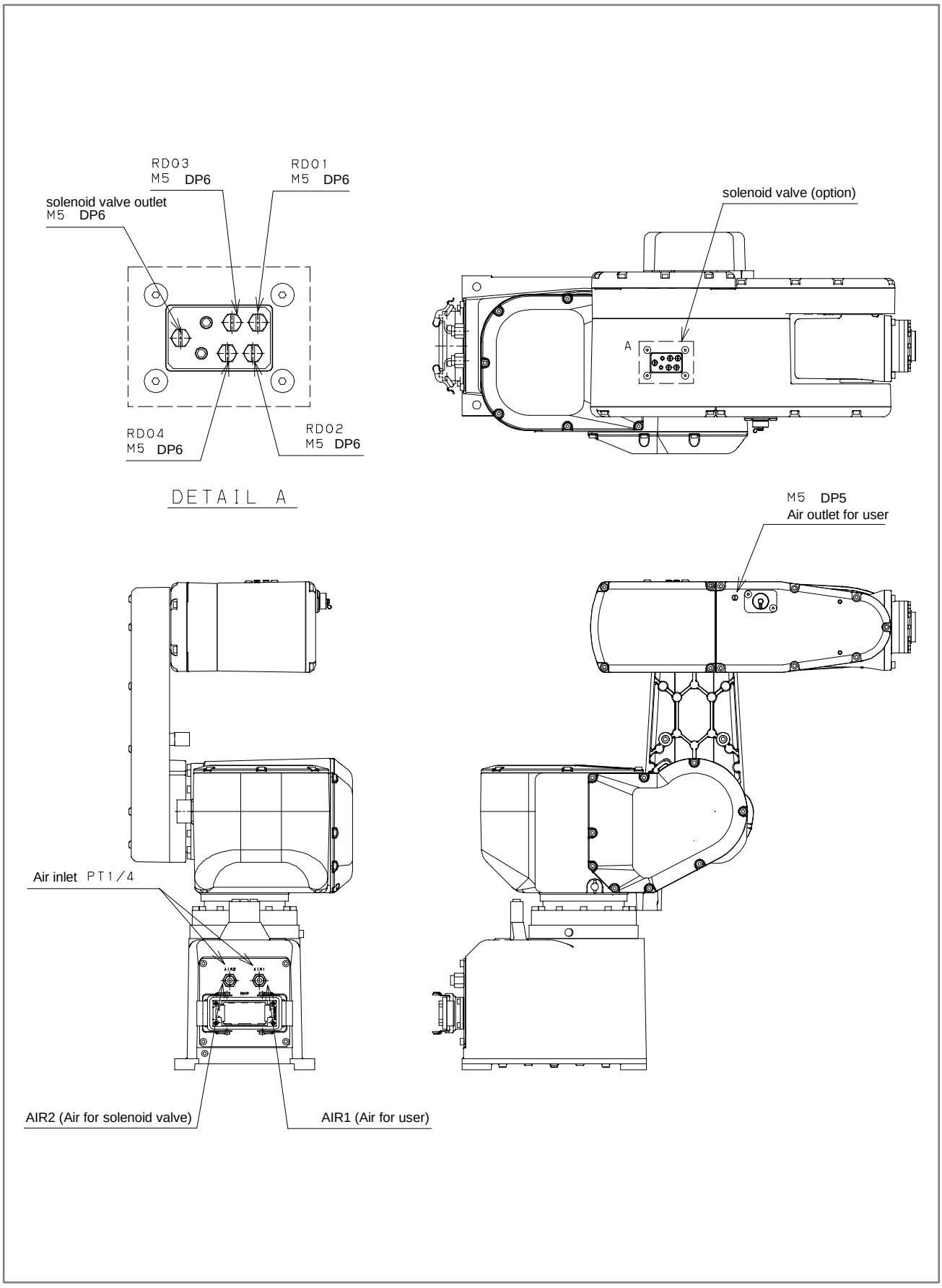


Fig.2.5 Supplying air

2.6 END EFFECTOR SIGNAL INTERFACE

Fig. 2.6 shows the location and pin layout of the signal interface for the end effector.

NOTE
The connector to be plugged into the interface and the cable attached to that connector should be prepared by the customer.

NOTE
When the robot is shipped, a cap is mounted on the end effector interface. When the interface is not used, mount the cap on the interface to ensure that the interface is sealed up.

Supported connector

Table 2.6 (a) shows the connector parts supported by the end effector interface. Some of these parts are available as an option from FANUC. (Table 2.6 (b))

Table 2.6 (a) Supported connector

Manufacturer	Manufacturer specification	Remarks
Hirose Electric Co. Ltd.	Plug : RM15WTP−12P Clamp : RM15WTP−CP (*)	* indicates an applicable cable diameter selected from the following: *: 5, 6, 7, 8, 9, or 10 mm in diameter

Table 2.6 (b) Supported option

Option specification	Manufacturer specification	Remarks
A05B−1137−J057	Plug : RM15WTP−12P Clamp : RM15WTP−CP (8)	Applicable cable diameter: 8 mm

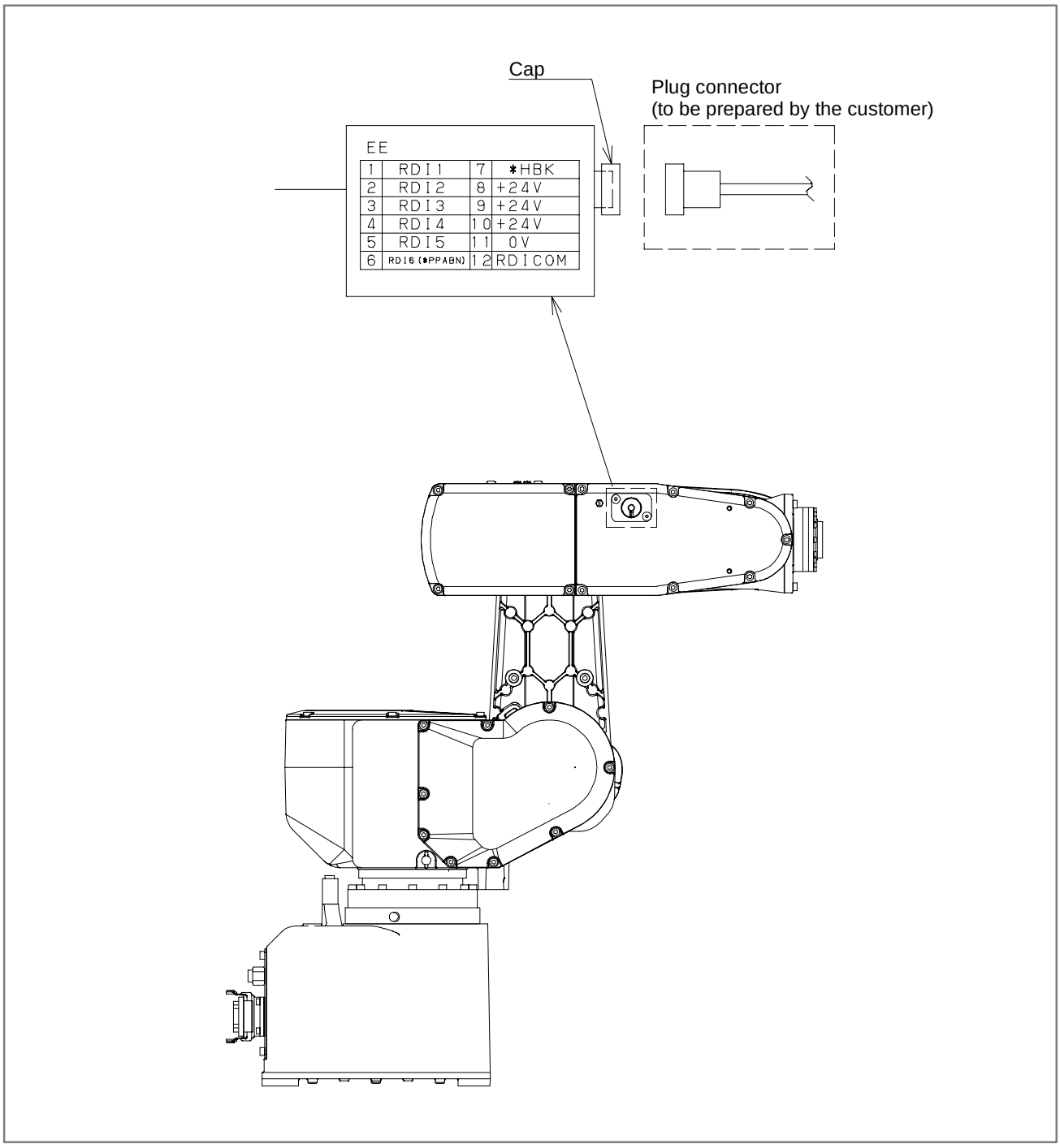


Fig.2.6 Signal interface for end effector

3 TRANSPORTATION AND INSTALLATION

3.1 TRANSPORTATION

While transporting the robot, the robot posture must be set as shown below. To mount and install the robot safely and to prevent rotation, a lifting device is available as an optional unit.

NOTE
When the J1 motor does not have a brake, install a rotation prevention stopper before use.

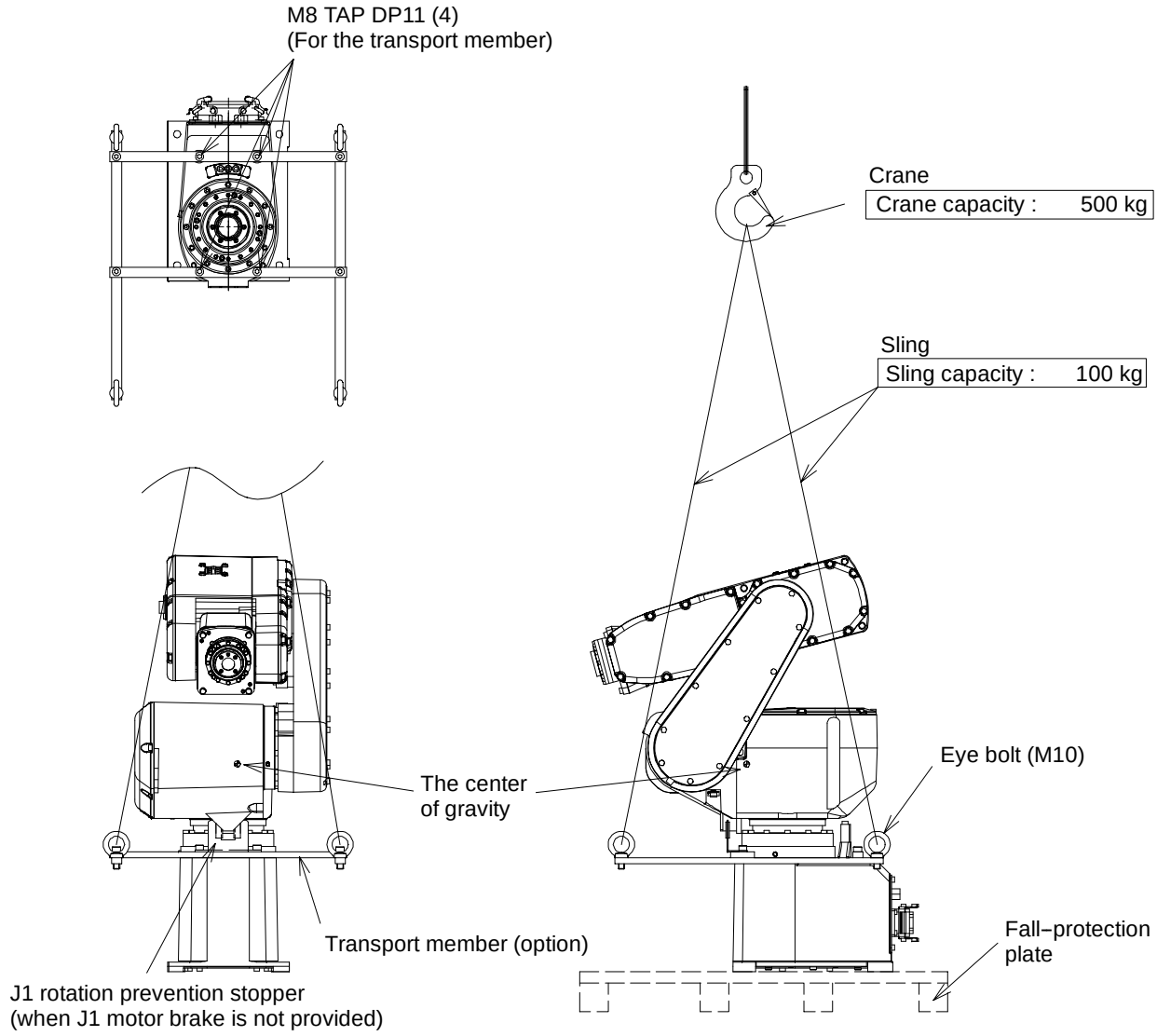


Fig.3.1 Robot posture and transport member while transporting the robot

NOTE
1 After installing the robot, remove the transport members.
2 The robot cannot stand independently. For transportation, the robot is secured to a fall−protection plate. If the fall−protection plate is removed, the robot will fall. So, when removing the fall−protection plate, provide support for the robot.
3 After moving the robot, always secure it as explained in Section 3.2.

3.2 INSTALLATING THE ROBOT

Fig.3.2 (a) shows the base of the robot.
Move the robot on the base until the robot touches three reference surfaces. Then, firmly secure the robot to the base with four M10 bolts.

NOTE
The tightening torque must not exceed 46 Nm (470 kgfm).

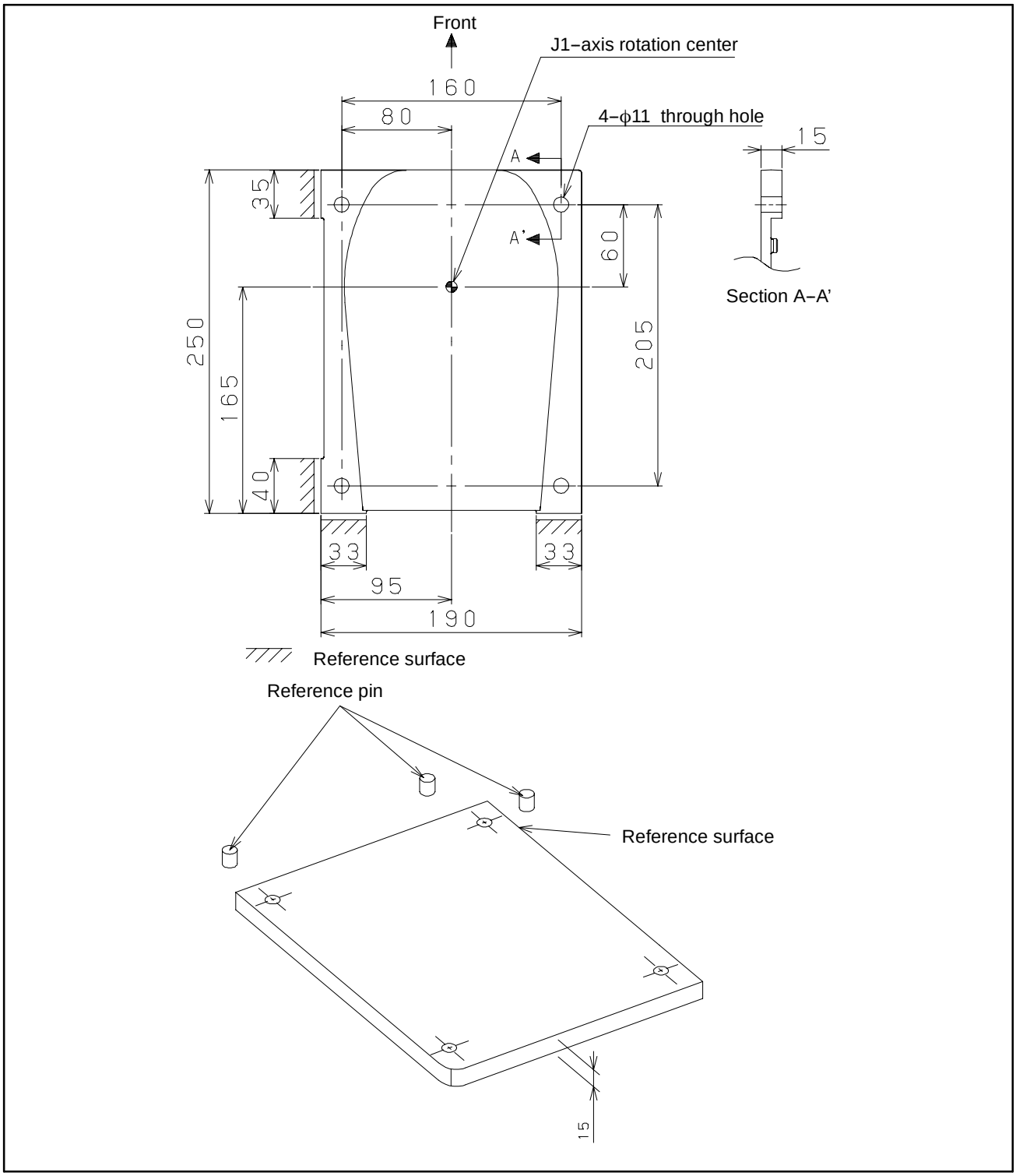


Fig.3.2 (a) Dimensions of the base for the robot

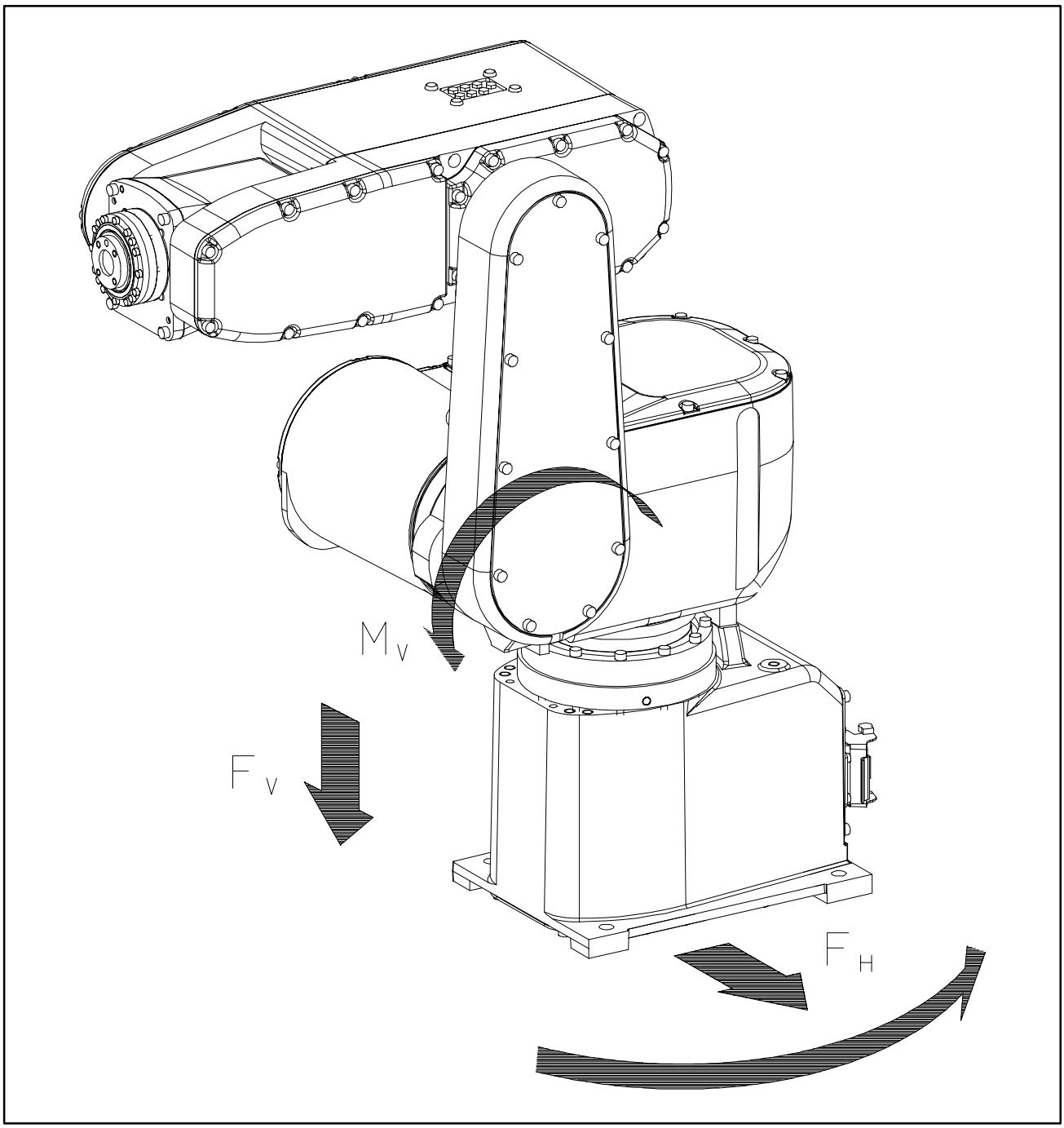


Fig.3.2 (b) Force and moment of J1 base

Table 3.2 Force and moment of J1 base

Condition	Bending moment MV [kgfm] (Nm)	Force in vertical direction FV [kgf] (N)	Twisting moment MH [kgfm] (Nm)	Force in horizontal direction FH [kgf] (N)
During stillness	[13] (128)	[43] (422)	[0] (0)	[0] (0)
During acceleration or deceleration	[44] (426)	[61] (594)	[18] (128)	[47] (459)
During emergency stop	[111] (1083)	[131] (1282)	[65] (633)	[124] (1209)

3.3 INSTALLATION CONDITIONS

Table 3.3 shows the installation conditions of the robot.

Table 3.3 Installation conditions

Item		Description
Air	Supply	0.49MP$_a$ (5kg/cm^2)
	Maximum instanta-neous demand	120N ℓ/min
Weight of mechanical unit		Approx. 38kg
Ambient temperature		0°C to 45°C
Relative humidity		Normally: 75% or less Short term (within a month): 95% or less No condensation
Allowable height		Up to 1000 meters above the sea level
Atmosphere		No corrosive gases (Note)
Vibration		4.9m/S^2 or less (0.5G or less)

NOTE
When the optional built−in solenoid valve is specified, use the robot with an air pressure ranging from 0.2 to 0.49 Mpa (2.0 to 5.0 kgf/cm^2).

NOTE
Chemical resistance and solvent resistance of the mechanical unit of the robot (when the severe environment option is specified)

1 Because the following liquids can deteriorate or corrode the rubber parts (such as a packing, oil seal, and O−ring) used in the robot, these liquids cannot be used:
   (a) Organic solvent
   (b) Chlorine and gasoline−based coolants
   (c) Acid, alkaline, and other corrosive liquids and water solutions, and those liquids and water solutions that can cause rust
   (d) Other liquids and water solutions that nitrile rubber (NBR) cannot resist
2 When using the robot in an environment where liquid such as water is likely to be splashed on the robot, be sure to drain water under the J1 base. Insufficient drainage can keep the J1 base in water all times, resulting in a failure.

3.4 MAINTENANCE AREA

Fig.3.4 shows the layout of maintenance area.

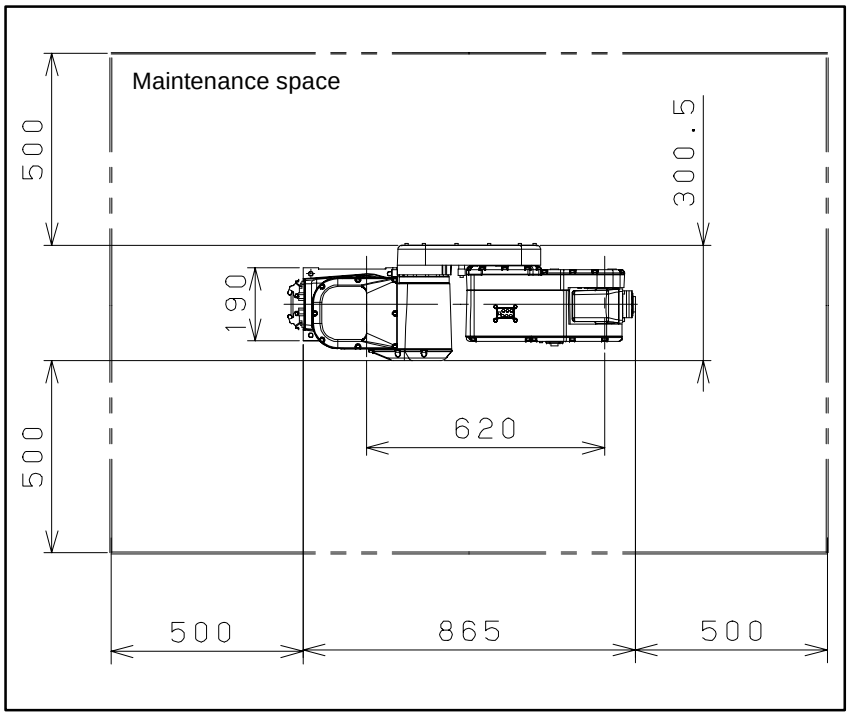


Fig.3.4 Maintenance area

3.5 PNEUMATIC PIPING

Fig.3.5 shows the connection of a pneumatic tube with the robot. In addition, air control set is available as un optional unit.

NOTE
The air control set option is not allailable on a clean type.

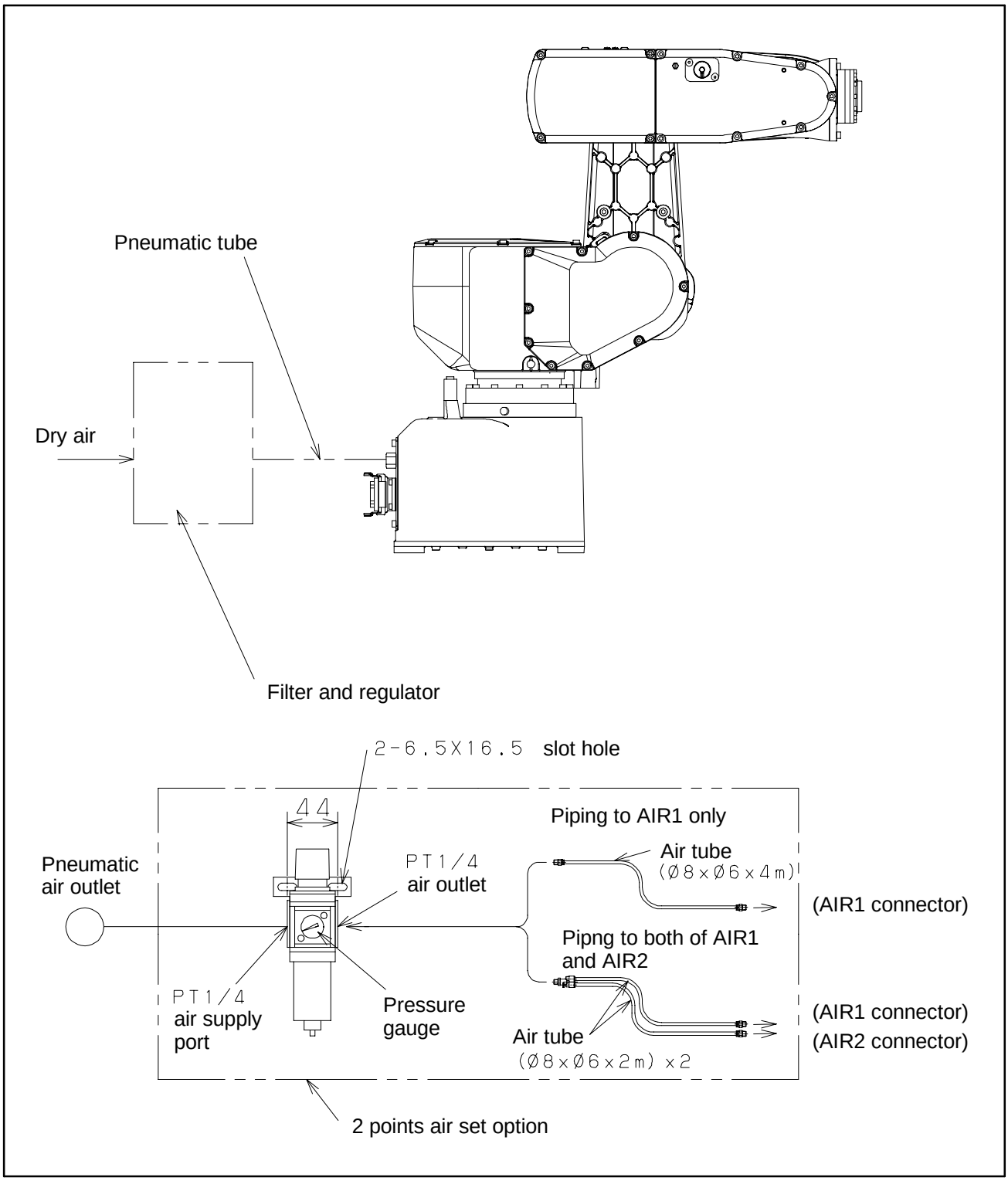


Fig.3.5 Pneumatic piping

3.6 STORAGE

To store the robot, set it to the same attitude as that used for transportation. (See I– 3.1)

APPENDIX

A SPARE PARTS LIST FOR THE MECHANICAL UNIT OF LR Mate 100*i*B

Table A (a) Cable

Name	Specification	Remarks
Cable K101	A660−8014−T355 (2BK) A660−8014−T356 (5BK)	Main cable
Cable K102	A660−4004−T142	J3 Power
Cable K103	A660−2005−T684 (2BK) A660−4004−T143 (5BK)	J4 Power
Cable K104	A660−4004−T144	For solenoid valve
Cable K105	A05B−1137−D002	EE

Table A (b) Motor

For J2−axis brake specifications

Name	Specification	Remarks
βM0.5/4000	A06B−0115−B075#0008	J1axis
βM0.5B/4000	A06B−0115−B275#0008	J2axis
βM0.5B/4000	A06B−0115−B275#0008	J3axis
βM0.4/4000	A06B−0114−B075#0008	J4axis
βM0.4/4000	A06B−0114−B075#0008	J5axis

For all axes brake specifications

Name	Specification	Remarks
βM0.5B/4000	A06B−0115−B275#0008	J1axis
βM0.5B/4000	A06B−0115−B275#0008	J2axis
βM0.5B/4000	A06B−0115−B275#0008	J3axis
βM0.4B/4000	A06B−0114−B275#0008	J4axis
βM0.4B/4000	A06B−0114−B275#0008	J5axis

Table A (c) Reducer

Name	Specification	Remarks
Harmonic drive	A97L–0218–0296#80	J1axis
Harmonic drive	A97L–0218–0297#80	J2axis
Harmonic drive	A97L–0218–0298#100	J3axis
Harmonic drive	A97L–0218–0299#50	J5axis

Table A (d) Bearing

Name	Specification	Remarks
Bearing	A97L–0001–0192#1200000	J3axis
Bearing	A97L–0001–0192#07Z000A	J3 and J4 axes
Cross roller	A97L–0218–0493	J3axis
Cross roller	A97L–0218–0494	J4axis

Table A (e) Gear

Name	Specification	Remarks
Gear J1–J2	A290–7137–X211	J1 and J2 axes
Gear J1–2	A290–7137–X212	J1 axis
Gear J2–2	A290–7137–X312	J2 axis
Gear S1	A290–7137–X411	J3 axis
Gear S2	A290–7137–X412	J3 axis
Gear W1	A290–7137–X413	J4 axis
Gear W2 assembly	A290–7137–V401	J4 axis
Gear W3 assembly	A290–7137–V402	J4 axis
Gear W4	A290–7137–X416	J4 axis

Table A (f) Stopper

Name	Specification	Remarks
J1 sopper	A290–7137–X226	J1 axis (M6×35)
J2 stopper	A290–7137–X330	J2 axis (M6×25)
J3 stopper	A290–7137–X331	J3 axis (M6×25)

Table A (g) Cover

Name	Specification	Remarks
J2 cover U	A290−7137−X303	J2 base upper
J2 cover S	A290−7137−X304	J2 base side
J3 cover R	A290−7137−X406	J3 housing rear cover

Table A (h) Cable protector

Name	Specification	Remarks
Pipe J1	A290−7137−X227	J1 reducer
Pipe J2	A290−7137−X332	J2 reducer
J3 ring	A290−7137−X423	J3 gear

Table A (i) Oil seal / O ring

Name	Specification	Remarks
Oil seal (AD38−50−7)	A98L−0040−0049#03805007	J2 base /J1 axis reducer
Oil seal (UE33−45−8)	A98L−0040−0047#03304508	J2 base /J2 axis reducer
Oil seal (AD35−50−7)	A98L−0040−0049#03505007	J3 arm /J3 gear
Oil seal (UE62−80−9)	A98L−0040−0047#06208009	J3 gear box /J3 gear
Oil seal (UE35−47−7)	A98L−0040−0047#03504707	J3 arm /J4 cross roller
Oil seal (UE38−50−8)	A98L−0040−0047#03805008	J3 housing /J5 housing
O ring (G45)	JB−OR1A−G45	J1, J2, and J4 motor

Table A (j) Packing

Name	Specification	Remarks
Gear box packing 1	A290−7137−X427	J3 gear box
Gear box packing 2	A290−7137−X428	J4 gear box
Packing	A290−7137−X429	J3 housing
Packing	A290−7137−X523	J5 housing
Packing	A98L−0040−0042#07	J3 and J5 motor

Table A (k) Undesirable–environment package

Name	Specification	Remarks
Packing J1–B	A290–7137–X224	J1 back face cover
Packing J1–C	A290–7137–X225	J1 connector panel
Packing J2–U	A290–7137–X327	J2 base upper cover
Packing J2–S	A290–7137–X328	J2 base side cover
Packing J2–A	A290–7137–X329	J2 arm cover
J3 cover packing F	A290–7137–X430	J3 housing front cover
J3 cover packing R	A290–7137–X431	J3 housing rear cover
Valve packing	A290–7137–X432	Solenoid valve
EE packing	A290–7137–X433	End effector
Seal washer	A30L–0001–0048#5M	When an optional air piping A is specified. (H001)
Valve packing	A290–7137–X432	When a solenoid valve is specified. (H002)

Table A (l) Bolt

Name	Specification	Remarks
Seal bolt	A97L–0218–0423#051212	J4 motor
Seal bolt	A97L–0218–0423#051616	J4 cross roller
Seal bolt	A97L–0218–0423#053516	Gear W4
Seal bolt	A97L–0218–0495#051010	Gear W2 assembly
Seal bolt	A97L–0218–0505#060606	J3 and J4 gear box cover (Inlet/Outlet)
Flange socket bolt	A97L–0218–0504#M5X35	J1 reducer / J2 base fixed
Flange socket bolt	A97L–0218–0504#M5X10ZN	J2 base cover
Flange socket bolt	A97L–0218–0504#M5X12ZN	J3 housing rear cover

Table A (m) Solenoid valve

Name	Specification	Remarks
Solenoid valve	A97L–0218–0065#D2	A05B–1137–H002

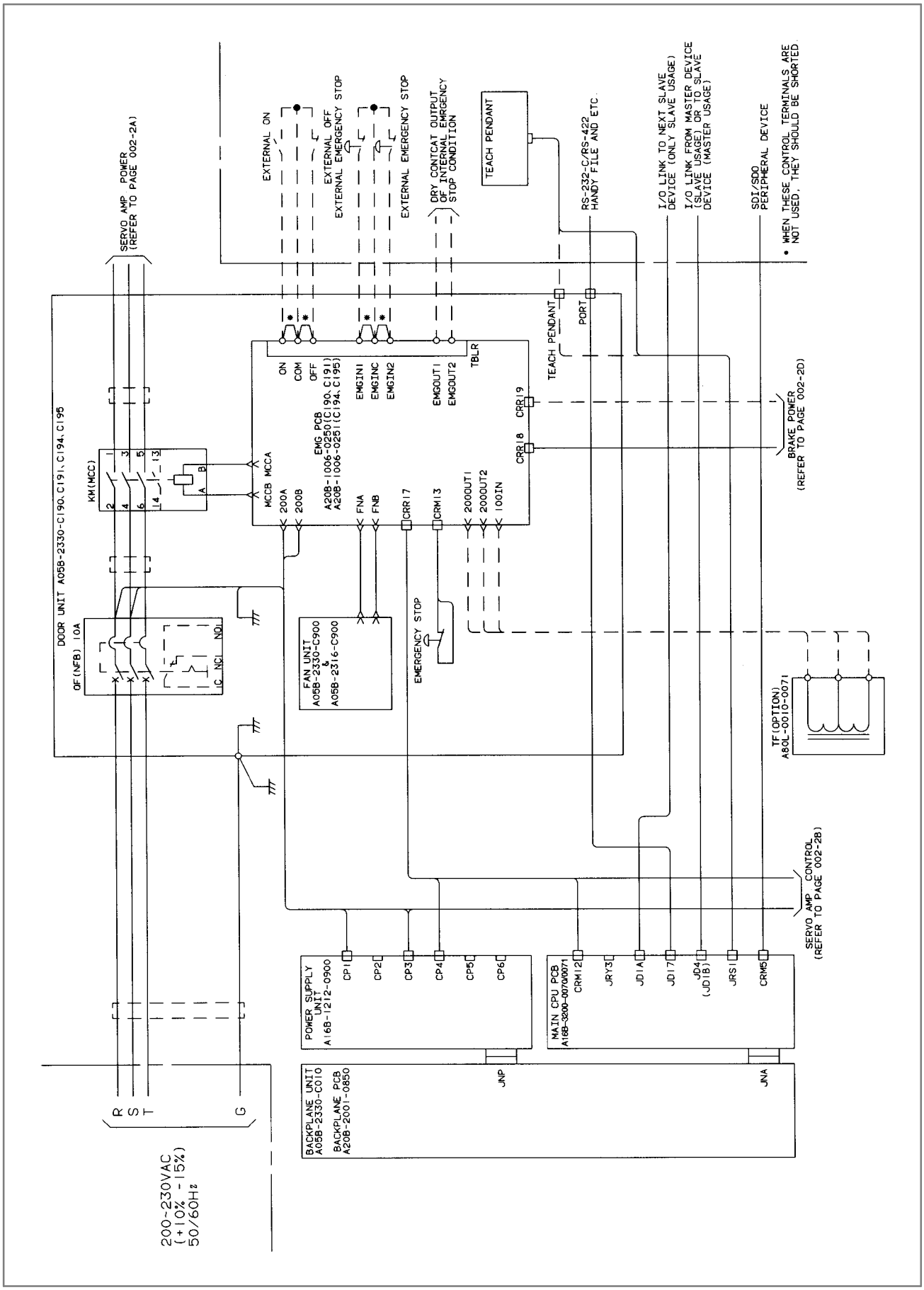
Table A (n) Air tube

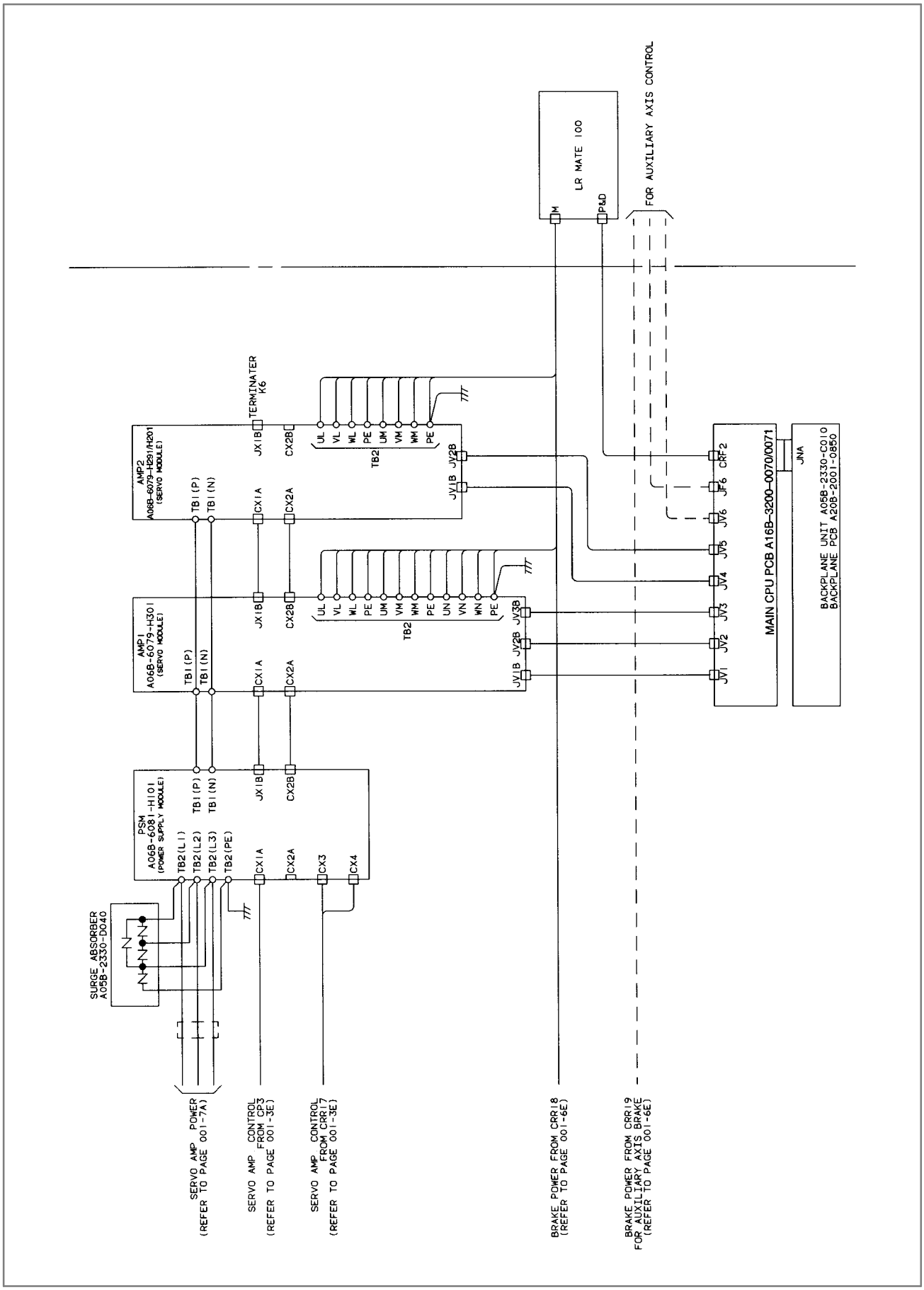
Name	Specification	Remarks
Air tube	A97L–0218–0010#ABL1R803	6mm, Black, 1.8m
Air tube	A97L–0218–0010#BBL1R703	6mm, White, 1.7m

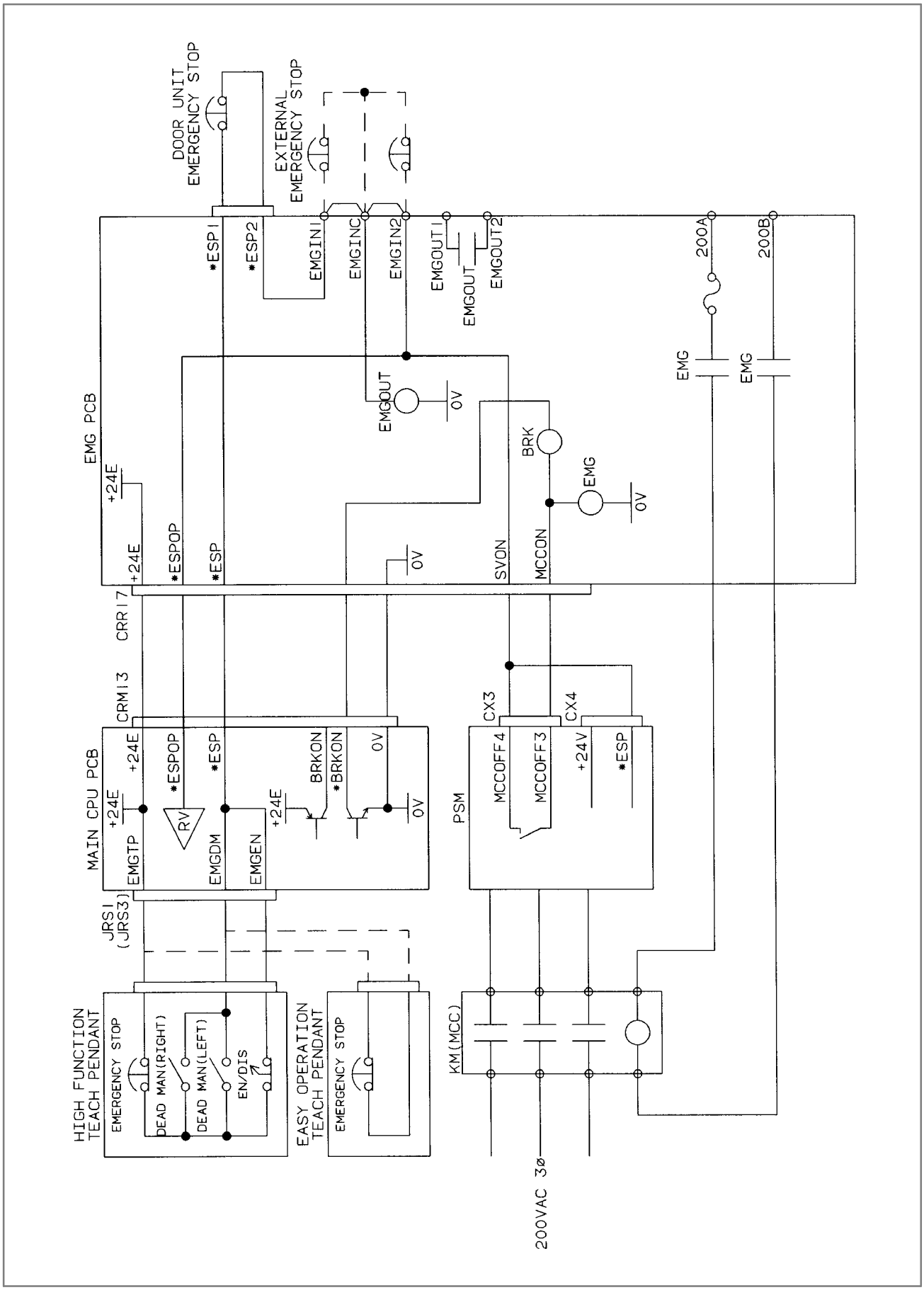
Table A (o) Battery and grease

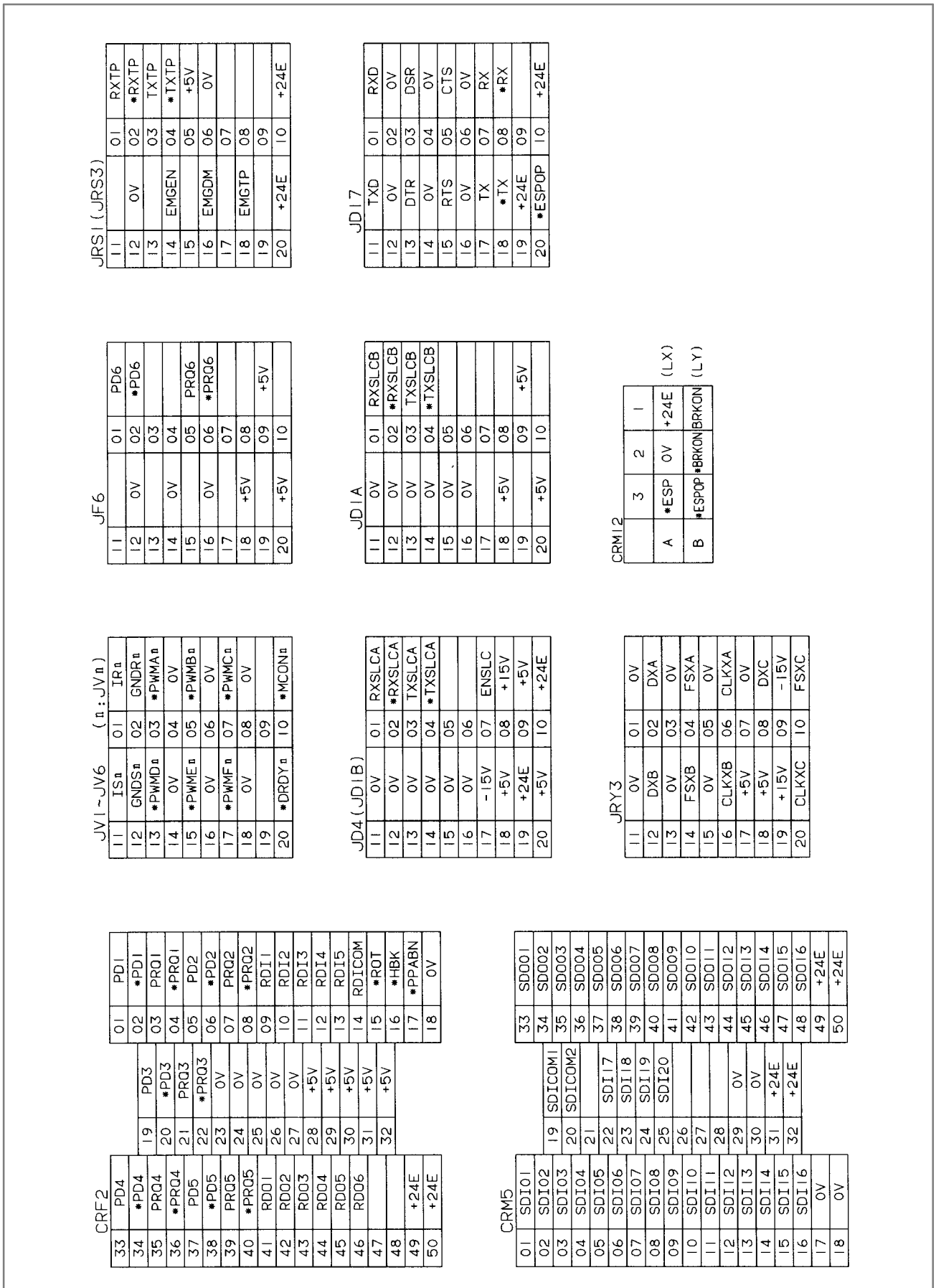
Name	Specification	Remarks
Battery	A98L−0031−0005	Size D 1/1.5V
Grease	A98L−0040−0110#1KG	Harmonic grease SK−3

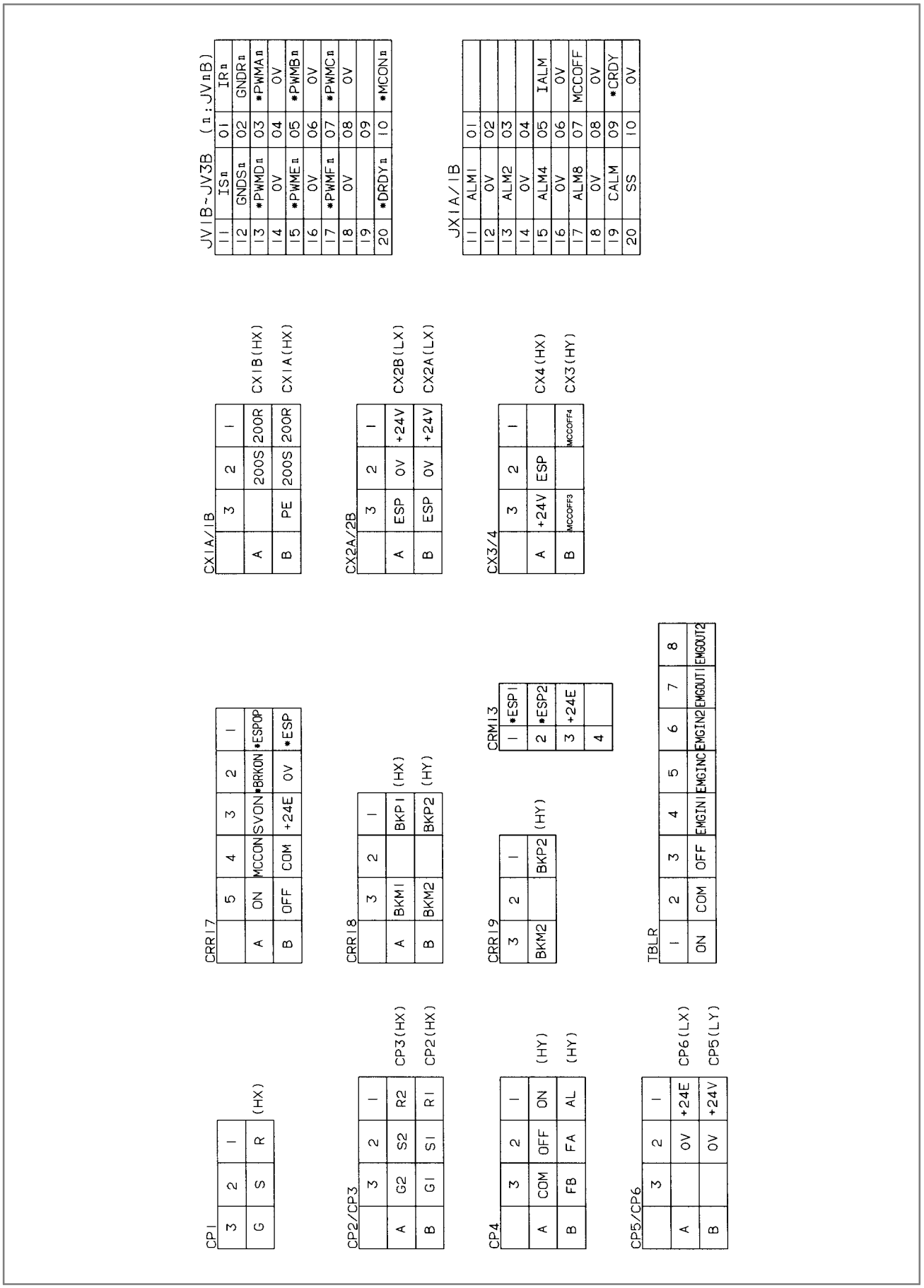
B MECHANICAL UNIT CIRCUIT DIAGRAM


SERVO AMP POWER (REFER TO PAGE 002-2A)
EXTERNAL ON
EXTERNAL OFF
EXTERNAL EMERGENCY STOP
EXTERNAL EMERGENCY STOP
DRY CONTCAT OUTPUT OF INTERNAL EMRGENCY STOP CONDITION
TEACH PENDANT
RS-232-C/RS-422 HANDY FILE AND ETC.
I/O LINK TO NEXT SLAVE DEVICE (ONLY SLAVE USAGE)
I/O LINK FROM MASTER DEVICE (SLAVE USAGE) OR TO SLAVE DEVICE (MASTER USAGE)
SDI/SDO PERIPHERAL DEVICE
• WHEN THESE CONTROL TERMINALS ARE NOT USED, THEY SHOULD BE SHORTED
DOOR UNIT A05B-2330-C190, C191, C194, C195
OF(NFB) 10A
KM(MCC)
MCCB MCCA
EMG PCB A20B-1006-0250(C190, C191) A20B-1006-0251(C194, C195)
ON
COM
OFF
EMGIN1
EMGINC
EMGIN2
EMGOUT1
EMGOUT2
TBLR
TEACH PENDANT
PORT
CRR19
CRR18
BRAKE POWER (REFER TO PAGE 002-2D)
200A
200B
FNA
FNB
CRR17
CRM13
2000UT1
2000UT2
100IN
FAN UNIT A05B-2330-C900 & A05B-2316-C900
EMERGENCY STOP
TF(OPTION) A80L-0010-0071
SERVO AMP CONTROL (REFER TO PAGE 002-2B)
POWER SUPPLY UNIT A16B-1212-0900
CP1
CP2
CP3
CP4
CP5
CP6
MAIN CPU PCB A16B-3200-0070/071
CRM12
JRY3
JD1A
JD17
JD4 (JD1B)
JRS1
CRM5
BACKPLANE UNIT A05B-2330-C010
BACKPLANE PCB A20B-2001-0850
JNP
JNA
R
S
T
G
200~230VAC (+10% -15%) 50/60Hz


LR MATE 100
JM
P&D
FOR AUXILIARY AXIS CONTROL
TERMINATER K6
AMP2 A06B-6079-H291#H201 (SERVO MODULE)
AMP1 A06B-6079-H301 (SERVO MODULE)
PSM A06B-6081-H101 (POWER SUPPLY MODULE)
JX1B
CX2B
CX1A
CX2A
CX3
CX4
TB1(P)
TB1(N)
TB2(L1)
TB2(L2)
TB2(L3)
TB2(PE)
TB2
UL
VL
WL
PE
UM
VM
WM
UN
VN
WN
JV1B JV2B
JV3B
MAIN CPU PCB A16B-3200-0070/0071
BACKPLANE UNIT A05B-2330-C010
BACKPLANE PCB A20B-2001-0850
JNA
JV1
JV2
JV3
JV4
JV5
JV6
CRF2
SURGE ABSORBER A05B-2330-D040
SERVO AMP POWER (REFER TO PAGE 001-7A)
SERVO AMP CONTROL FROM CP3 (REFER TO PAGE 001-3E)
SERVO AMP CONTROL FROM CRR17 (REFER TO PAGE 001-3E)
BRAKE POWER FROM CRR18 (REFER TO PAGE 001-6E)
BRAKE POWER FROM CRR19 FOR AUXILIARY AXIS BRAKE (REFER TO PAGE 001-6E)


DOOR UNIT EMERGENCY STOP
EXTERNAL EMERGENCY STOP
*ESP1
*ESP2
EMGIN1
EMGINC
EMGIN2
EMGOUT1
EMGOUT
EMGOUT2
200A
200B
EMG
EMG
EMG PCB
+24E
*ESPOP
*ESP
EMGOUT
0V
BRK
EMG
0V
SVON
MCCON
CRR17
CRM13
MAIN CPU PCB
+24E
*ESPOP
*ESP
BRKON
*BRKON
0V
RV
EMGTP
EMGDM
EMGEN
CX3
CX4
PSM
MCCOFF4
MCCOFF3
+24V
*ESP
JRS1 (JRS3)
HIGH FUNCTION TEACH PENDANT
EMERGENCY STOP
DEAD MAN(RIGHT)
DEAD MAN(LEFT)
EN/DIS
EASY OPERATION TEACH PENDANT
EMERGENCY STOP
KM(MCC)
200VAC 3ø


JRS1 (JRS3)
01 RXTP
02 *RXTP
03 TXTP
04 *TXTP
05 +5V
06 0V
07
08
09
10 +24E
11
12 0V
13
14 EMGEN
15
16 EMGDM
17
18 EMGTP
19
20 +24E
JD17
01 RXD
02 0V
03 DSR
04 0V
05 CTS
06 0V
07 RX
08 *RX
09
10 +24E
11 TXD
12 0V
13 DTR
14 0V
15 RTS
16 0V
17 TX
18 *TX
19 +24E
20 *ESPOP
JF6
01 PD6
02 *PD6
03
04
05 PRQ6
06 *PRQ6
07
08
09 +5V
10
11
12 0V
13
14 0V
15
16 0V
17
18 +5V
19
20 +5V
JD1A
01 RXSLCB
02 *RXSLCB
03 TXSLCB
04 *TXSLCB
05
06
07
08
09 +5V
10
11 0V
12 0V
13 0V
14 0V
15 0V
16 0V
17
18 +5V
19
20 +5V
CRM12
1
2 0V
3 +24E
A *ESP *BRKON BRKON (LX)
B *ESPOP *BRKON BRKON (LY)
JV1~JV6 (n:JVn)
01 IRn
02 GNDRn
03 *PWMAn
04 0V
05 *PWMBn
06 0V
07 *PWMCn
08 0V
09
10 *MCONn
01 ISn
02 GNDSn
03 *PWMDn
04 0V
05 *PWMEn
06 0V
07 *PWMFn
08 0V
09
10 *DRDYn
11
12 0V
13 0V
14 0V
15 0V
16 0V
17 -15V
18 +5V
19 +24E
20 +5V
JD4 (JD1B)
01 RXSLCA
02 *RXSLCA
03 TXSLCA
04 *TXSLCA
05
06
07 ENSLC
08 +15V
09 +5V
10 +24E
11 0V
12 0V
13 0V
14 0V
15 0V
16 0V
17 -15V
18 +5V
19 +24E
20 +5V
JRY3
01 0V
02 DXA
03 0V
04 FSXA
05 0V
06 CLKXA
07 0V
08 DXC
09 -15V
10 FSXC
11 0V
12 DXB
13 0V
14 FSXB
15 0V
16 CLKXB
17 +5V
18 +5V
19 +15V
20 CLKXC
CRF2
01 PD1
02 *PD1
03 PRQ1
04 *PRQ1
05 PD2
06 *PD2
07 PRQ2
08 *PRQ2
09 RDI1
10 RDI2
11 RDI3
12 RDI4
13 RDI5
14 RDICOM
15 *RDT
16 *HBK
17 *PPABN
18 0V
19 PD3
20 *PD3
21 PRQ3
22 *PRQ3
23 0V
24 0V
25 0V
26 0V
27 0V
28 +5V
29 +5V
30 +5V
31 +5V
32 +5V
33 PD4
34 *PD4
35 PRQ4
36 *PRQ4
37 PD5
38 *PD5
39 PRQ5
40 *PRQ5
41 RDO1
42 RDO2
43 RDO3
44 RDO4
45 RDO5
46 RDO6
47
48
49 +24E
50 +24E
CRM5
01 SDI01
02 SDI02
03 SDI03
04 SDI04
05 SDI05
06 SDI06
07 SDI07
08 SDI08
09 SDI09
10 SDI10
11 SDI11
12 SDI12
13 SDI13
14 SDI14
15 SDI15
16 SDI16
17 0V
18 0V
19 SDICOM1
20 SDICOM2
21
22 SDI17
23 SDI18
24 SDI19
25 SDI20
26
27
28
29 0V
30 0V
31 +24E
32 +24E
33 SD001
34 SD002
35 SD003
36 SD004
37 SD005
38 SD006
39 SD007
40 SD008
41 SD009
42 SD010
43 SD011
44 SD012
45 SD013
46 SD014
47 SD015
48 SD016
49 +24E
50 +24E


JV1B~JV3B (n:JVnB)
IRn
GNDRn
*PWMAn
0V
*PWMBn
0V
*PWMCn
0V
*MCONn
*CRDY
0V
JX1A/1B
ALM1
ALM2
ALM4
IALM
0V
ALM8
MCCOFF
CALM
SS
CX1A/1B
200R
CX1B(HX)
200R
CX1A(HX)
CX2A/2B
+24V
CX2B(LX)
+24V
CX2A(LX)
CX3/4
CX4(HX)
CX3(HY)
CRR17
*ESPOP
*ESP
CRR18
BKP1
(HX)
BKP2
(HY)
CRR19
BKP2
(HY)
CRM13
*ESP1
*ESP2
+24E
TBLR
EMGOUT2
CP1
(HX)
CP2/CP3
CP3(HX)
CP2(HX)
CP4
(HY)
(HY)
CP5/CP6
CP6(LX)
CP5(LY)

C PERIODIC MAINTENANCE TABLE

TYPE4 Periodic Maintenance Table

		Check time	grease amount	First check 320	3 months 960	6 months 1920	9 months 2880	1 year 3840	4800	5760	6720	2 years 7680	8640	9600	10560	3 years 11520	12480	13440	14400
1	Check the mechanical cable	0.2H	−	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f
2	Check the motor connector (loosening)	0.2H	−	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f
3	Tighten the cover and main bolt	2.0H	−	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f
4	Remove spatter and dust etc.	1.0H	−		f	f	f	f	f	f	f	f	f	f	f	f	f	f	f
5	Replacing battery	0.1H	−					F				F				F			
6	Check grease amount on rack gear surface	0.1H	−	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f
7	Greasing to rack gear surface *	0.5H	300 [g/m]		F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
8	Greasing to LM guide block	0.1H	−		F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
9	Replacing grease of reducer	0.5H	340g													F			
10	Replacing cable of mechanical unit	4.0H	−																

* Apply grease every 1 month.

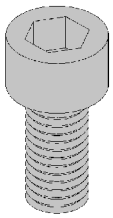
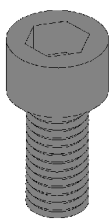
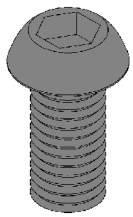
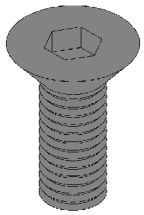
4 years 15360	16320	17280	18240	5 years 19200	20160	21120	22080	6 years 23040	24000	24960	25920	7 years 26880	27840	28800	29760	8 years 30720
f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	Overhaul
f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	
f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	
f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	
F				F				F				F				
f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	f	
F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	
								F								
F																

D BOLT TIGHTENING TORQUE TABLE

Those bolts for which no tightening torque is specified must be tightened according to the following table.

Table D Recommended Bolt Tightening Torques

Unit : Nm (kgf·cm)

Nominal diameter	Hexagon socket head bolt (Steel : strength rating of 12.9)		Hexagon socket head bolt (Stainless)		Hexagon socket head pan bolt Hexagon socket head counter-sunk bolt (Steel : strength rating of 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)	––––––––	––––––––	––––––––	––––––––
					 	

Index

[Numbers]

[A]

[C]

[D]

[G]

[I]

[J]

[M]

[O]

[P]

[Q]

[R]

[S]

[T]

[W]

[Z]

Revision Record

FANUC Robot series LR Mate 100*i* B MAINTENANCE MANUAL (B–81595EN)

Edition	Date	Contents	Edition	Date	Contents
01	Oct., 2001				