FANUC Robot M-900*i*A/600/400L

MECHANICAL UNIT

OPERATOR'S MANUAL

B-82174EN/01

- **Original Instructions**

Thank you very much for purchasing FANUC Robot.
Before using the Robot, be sure to read the "FANUC Robot series SAFETY HANDBOOK (B-80687EN)" and understand the content.

This manual can be used with controllers labeled R-30*i*A or R-J3*i*C. If you have a controller labeled R-J3*i*C, you should read R-30*i*A as R-J3*i*C throughout this manual.

The products in this manual are controlled based on Japan's "Foreign Exchange and Foreign Trade Law". The export from Japan may be subject to an export license by the government of Japan.
Further, re-export to another country may be subject to the license of the government of the country from where the product is re-exported. Furthermore, the product may also be controlled by re-export regulations of the United States government.
Should you wish to export or re-export these products, please contact FANUC for advice.

In this manual, we endeavor to include all pertinent matters. There are, however, a very large number of operations that must not or cannot be performed, and if the manual contained them all, it would be enormous in volume. It is, therefore, requested to assume that any operations that are not explicitly described as being possible are "not possible".

SAFETY PRECAUTIONS

This chapter describes the precautions which must be followed to enable the safe use of the robot. Before using the robot, be sure to read this chapter thoroughly.

For detailed functions of the robot operation, read the relevant operator's manual to understand fully its specification.

For the safety of the operator and the system, follow all safety precautions when operating a robot and its peripheral equipment installed in a work cell.
For safe use of FANUC robots, you must read and follow the instructions in “FANUC Robot series SAFETY HANDBOOK (**B-80687EN)**”.

1 PERSONNEL

Personnel can be classified as follows.

Operator:
- Turns the robot controller power ON/OFF
- Starts the robot program from operator panel

Programmer or Teaching operator:
- Operates the robot
- Teaches the robot inside the safeguarded space

Maintenance technician:
- Operates the robot
- Teaches the robot inside the safeguarded space
- Performs maintenance (repair, adjustment, replacement)

- The operator is not allowed to work in the safeguarded space.
- The programmer or teaching operator and maintenance technician are allowed to work in the safeguarded space. Works carried out in the safeguarded space include transportation, installation, teaching, adjustment, and maintenance.
- To work inside the safeguarded space, the person must be trained on proper robot operation.

Table 1 (a) lists the work outside the safeguarded space. In this table, the symbol “O” means the work allowed to be carried out by the specified personnel.

Table 1 (a) List of work outside the Safeguarded Space

	Operator	Programmer or Teaching operator	Maintenance technician
Turn power ON/OFF to Robot controller	O	O	O
Select operating mode (AUTO/T1/T2)		O	O
Select remote/local mode		O	O
Select robot program with teach pendant		O	O
Select robot program with external device		O	O
Start robot program with operator’s panel	O	O	O
Start robot program with teach pendant		O	O
Reset alarm with operator’s panel		O	O
Reset alarm with teach pendant		O	O
Set data on teach pendant		O	O

	Operator	Programmer or Teaching operator	Maintenance technician
Teaching with teach pendant		○	○
Emergency stop with operator's panel	○	○	○
Emergency stop with teach pendant	○	○	○
Operator's panel maintenance			○
Teach pendant maintenance			○

During robot operation, programming and maintenance, the operator, programmer, teaching operator and maintenance technician take care of their safety using at least the following safety protectors.

- Use clothes, uniform, overall adequate for the work
- Safety shoes
- Helmet

2 DEFINITION OF SAFETY NOTATIONS

To ensure the safety of users and prevent damage to the machine, this manual indicates each precaution on safety with "**WARNING**" or "**CAUTION**" according to its severity. Read the contents of each "**WARNING**", "**CAUTION**" before attempting to use the robot.

Symbol	Definitions
⚠**WARNING**	Used if hazard resulting in the death or serious injury of the user will be expected to occur if he or she fails to follow the approved procedure.
⚠**CAUTION**	Used if a hazard resulting in the minor or moderate injury of the user, or equipment damage may be expected to occur if he or she fails to follow the approved procedure.
NOTE	Used if a supplementary explanation not related to any of WARNING and CAUTION is to be indicated.

3 PROCEDURE TO MOVE ARM WITHOUT DRIVE POWER IN EMERGENCY OR ABNORMAL SITUATIONS

(1) For emergency or abnormal situations (e.g. persons trapped in or pinched by the robot), brake release unit can be used to move the robot axes without drive power.
Please order following unit and cable.

Name	Specification
Brake release unit	A05B-2450-J350 (Input Voltage AC100-115V single-phase) A05B-2450-J351 (Input Voltage AC200-240V single-phase)
Robot connection cable	A05B-2450-J360 (5m) A05B-2450-J361 (10m)
Power cable	A05B-2525-J010 (5m) (AC100-115V Power plug) (*) A05B-2525-J011 (10m) (AC100-115V Power plug) (*) A05B-2450-J364 (5m) (AC100-115V or AC200-240V No power plug) A05B-2450-J365 (10m) (AC100-115V or AC200-240V No power plug)

(*) These do not support CE marking.

(2) Please make sure that adequate numbers of brake release units are available and readily accessible for robot system before installation.
(3) Regarding how to use brake release unit, please refer to Robot controller maintenance manual.

⚠CAUTION
Robot systems installed without adequate number of brake release units or similar means are not in compliance with EN ISO 10218-1 and the Machinery Directive and therefore cannot bear the CE marking.

⚠WARNING
Robot arm would fall down by releasing its brake because of gravity. Especially because spring balancers are used for J2-axis and counter balancer is used for J3-axis, it is hard to predict arm movement by the condition of Robot posture and end effecter. Therefore, it is strongly recommended to take adequate measures such as hanging Robot arm by a crane before releasing a brake.

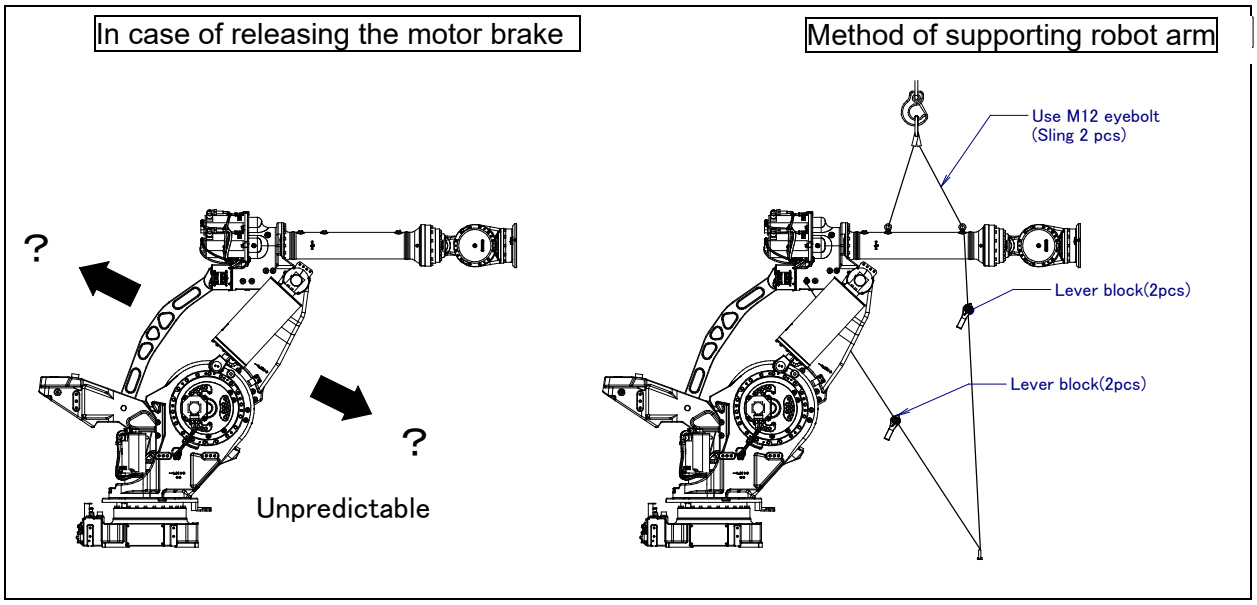


Fig. 3 (a) Releasing J2 motor brake and measures

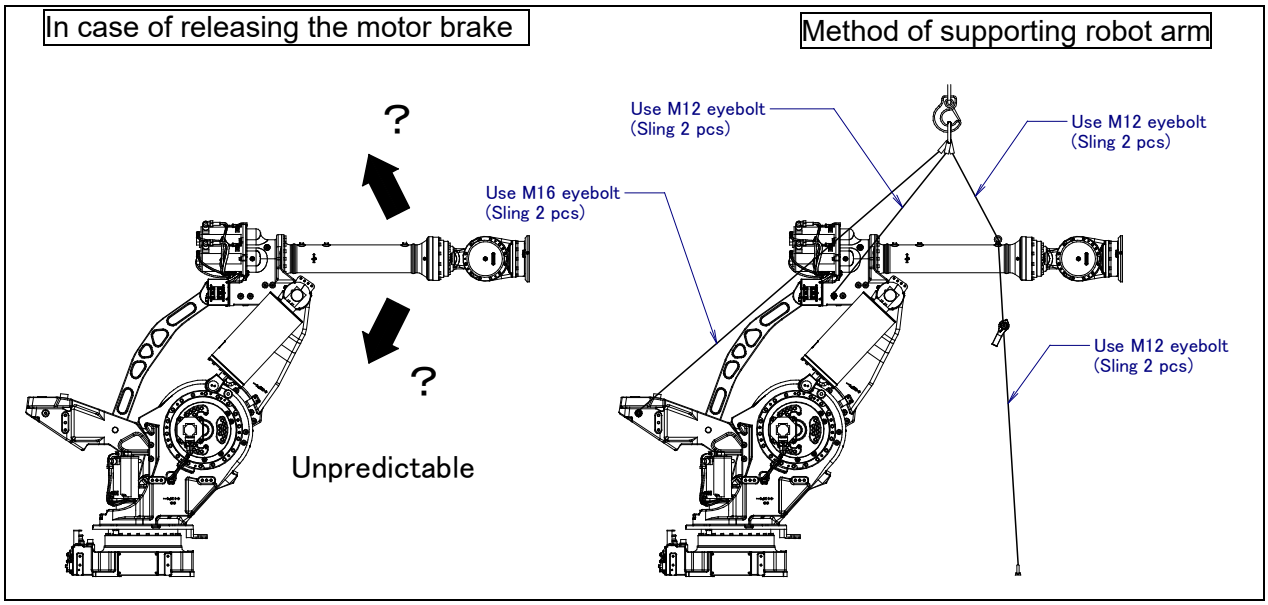


Fig. 3 (b) Releasing J3 motor brake and measures

4 WARNING & CAUTION LABEL

(1) Greasing and degreasing label

Fig. 4 (a) Greasing and degreasing label

Description

When greasing and degreasing, observe the instructions indicated on this label.

1) Open the grease outlet at greasing.
2) Use a hand pump at greasing.
3) Use designated grease at greasing.

> **⚠CAUTION**
> See Section 3.1 REPLACING GREASE OF THE DRIVE MECHANISM for explanations about specified greases, the amount of grease to be supplied, and the locations of grease and degrease outlets for individual models.

(2) Step-on prohibitive label

Fig. 4 (b) Step-on prohibitive 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.

(3) High-temperature warning label

Fig. 4 (c) High-temperature warning 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.

(4) Transportation label

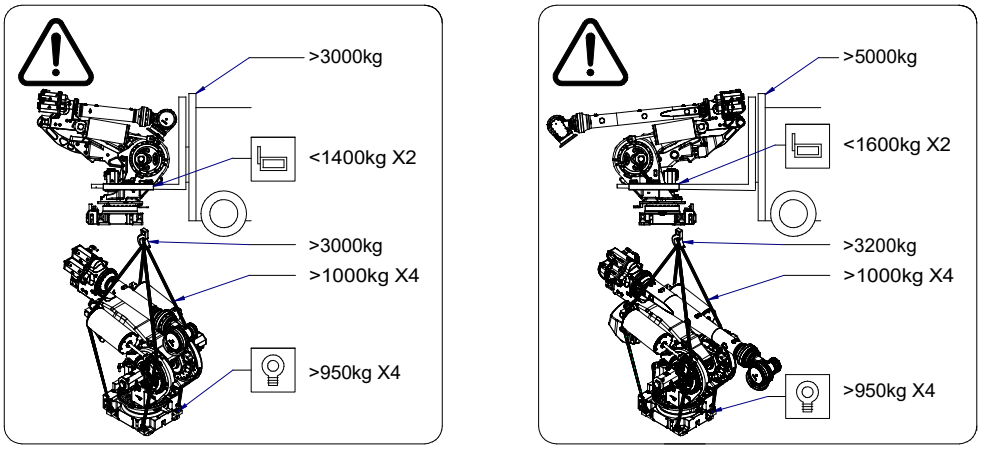


Fig. 4 (d) Transportation label

Description

When transporting the robot, observe the instructions indicated on this label.

1. Using a forklift (M-900*i*A/600)
   - Use a forklift having a load capacity of 3000 kg or greater.
   - Keep the total weight of the robot to be transported to within 2800 kg, because the withstand load of the forklift bracket (option) is 13720 N (1400 kgf)

2. Using a crane (M-900*i*A/600)
   - Use a crane having a load capacity of 3000 kg or greater.
   - Use at least four slings each having a withstand load of 9800 N (1000 kgf) or greater.
   - Use at least four eyebolts each having a withstand load of 9310 N (950 kgf) or greater.

3. Using a forklift (M-900*i*A/400L)
   - Use a forklift having a load capacity of 5000 kg or greater.
   - Keep the total weight of the robot to be transported to within 3200 kg, because the withstand load of the forklift bracket (option) is 15680 N (1600 kgf)

4. Using a crane (M-900*i*A/400L)
   - Use a crane having a load capacity of 3200 kg or greater.
   - Use at least four slings each having a withstand load of 9800 N (1000 kgf) or greater.
   - Use at least four eyebolts each having a withstand load of 9310 N (950 kgf) or greater.

> ⚠ **CAUTION**
> See 10.1 TRANSPORTATION for explanations about the posture a specific model should take when it is transported.

(5) Balancer replacement label

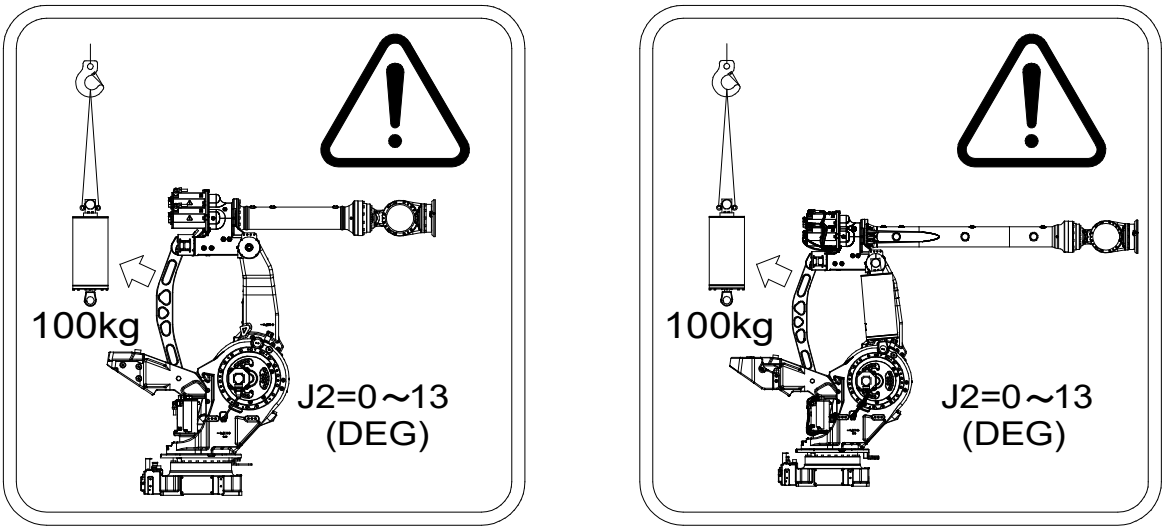


Fig. 4 (e) Balancer replacement label

Description

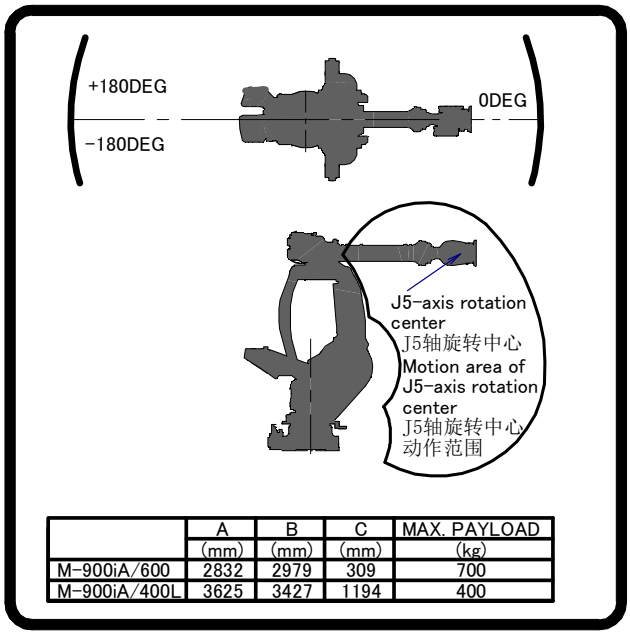
When replacing the balancer, observe the instructions indicated on this label.

- When replacing the balancer, keep the J2 axis from 0 to 13 deg.
- The mass of the balancer is 100 kg.

> ⚠ **CAUTION**
> For information about balancer replacement, contact your local FANUC representatives.

(6) Operating space and payload capacity label

In the case of CE specification, the following label is added:



	A (mm)	B (mm)	C (mm)	MAX. PAYLOAD (kg)
M-900iA/600	2832	2979	309	700
M-900iA/400L	3625	3427	1194	400

Fig. 4 (f) Operating space and payload label

(7) Transportation caution label

(When transportation equipment option is specified)

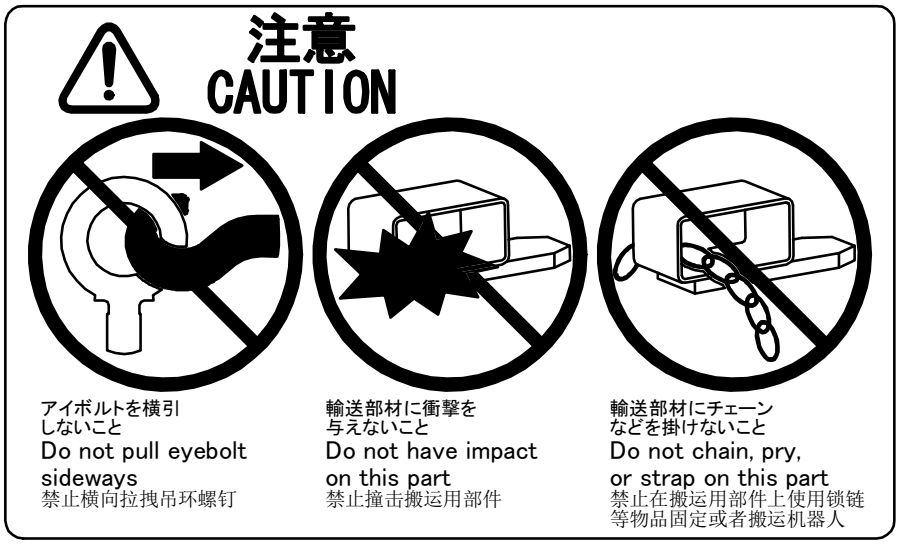


Fig. 4 (g) Transportation caution label

Description

Keep the following in mind when transporting the robot.

1. Do not pull eyebolts sideways.
2. Prevent the forks of the forklift from having impact on a transport equipment.
3. Do not thread a chain or the like through a transport equipment.

PREFACE

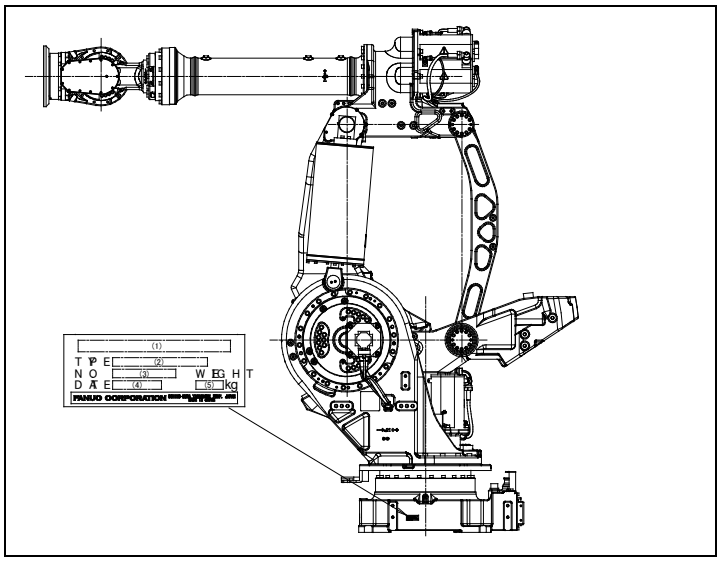
This manual explains the operation procedures for the following robots:

Model Name	Mechanical unit specification No.	Maximum load	Controller
FANUC Robot M-900*i*A/600	A05B-1328-B201	600kg 700kg (Option) (NOTE)	R-J3*i*B
FANUC Robot M-900*i*A/600	A05B-1328-B211	600kg 700kg (Option) (NOTE)	R-30*i*A/R-30*i*B
FANUC Robot M-900*i*A/400L	A05B-1328-B213	400kg	

The label stating the mechanical unit specification number is affixed in the position shown below. Before reading this manual, verify the specification number of the mechanical unit.

NOTE
When the 700kg option of the M-900*i*A/600 is specified.

⚠CAUTION
Note that the models for the R-J3*i*B controller and those for the R-30*i*A/R-30*i*B controller partly differ in the specifications of mechanical unit cables.



Position of label indicating mechanical unit specification number

Table 1)

No.	(1)	(2)	(3)	(4)	(5)
Contents	MODEL	TYPE	No.	DATE	WEIGHT kg (Without controller)
Letters	FANUC Robot M-900*i*A/600 (For R-J3*i*B controller)	A05B-1328-B201	PRINT SERIAL NO.	PRINT PRODUCTION YEAR AND MONTH	2800
	FANUC Robot M-900*i*A/600 (For R-30*i*A/R-30*i*B controller)	A05B-1328-B211			2800
	FANUC Robot M-900*i*A/400L (For R-30*i*A/R-30*i*B controller)	A05B-1328-B213			3150

Specifications

Item			M-900*i*A/600	M-900*i*A/400L
Type			Articulated Type	
Controlled axes			6 axes (J1, J2, J3, J4, J5, J6)	
Installation			Floor mount	
Motion range	J1-axis (Upper limit / Lower limit)		180° (3.14rad) / -180° (-3.14rad)	
	J2-axis (Upper limit / Lower limit)		90° (1.57rad) / -64° (-1.12rad)	
	J3-axis (Upper limit / Lower limit)		30° (0.52rad) / -130° (-2.27rad)	
	J4-axis (Upper limit / Lower limit)		360° (6.28rad) / -360° (-6.28rad)	
	J5-axis (Upper limit / Lower limit)		122° (2.13rad) / -122° (-2.13rad)	
	J6-axis (Upper limit / Lower limit)		360° (6.28rad) / -360° (-6.28rad)	
Max. Motion speed (Note 1)	J1-axis		80°/s (1.40rad/s)	
	J2-axis		80°/s (1.40rad/s)	
	J3-axis		80°/s (1.40rad/s)	
	J4-axis		100°/s (1.75rad/s)	
	J5-axis		100°/s (1.75rad/s)	
	J6-axis		160°/s (2.79rad/s)	
Max. load capacity	At wrist	Standard	600kg	400kg
		Option (Note 2)	700kg	
	At J3 casing		25kg	
	At J2 base		550kg	
Allowable load moment at wrist	J4		3381N·m (345kgf·m)	2744N·m (280kgf·m)
	J5		3381N·m (345kgf·m)	2744N·m (280kgf·m)
	J6		1725N·m (176kgf·m)	1725N·m (176kgf·m)
Allowable load inertia at wrist	J4	Standard	510kg·m^2 (5204kgf·cm·s^2)	
		Option (Note 3)	1098kg·m^2 (11200kgf·cm·s^2)	
	J5	Standard	510kg·m^2 (5204kgf·cm·s^2)	
		Option (Note 3)	1098kg·m^2 (11200kgf·cm·s^2)	
	J6	Standard	320kg·m^2 (3265kgf·cm·s^2)	
		Option (Note 3)	444kg·m^2 (4532kgf·cm·s^2)	
Drive method			Electric servo drive by AC servo motor	
Repeatability			±0.3mm	±0.5mm
Mass			2800kg	3150kg
Acoustic noise level (Note 4)			76.3dB	
Installation environment			Ambient temperature : 0 - 45°C (Note 5) Ambient humidity Normally : 75%RH or less No dew, nor frost allowed. Short time (within one month) : Max 95%RH Height : Up to 1000 meters above the sea level required, no particular provision for attitude Vibration acceleration : 4.9m/s^2 (0.5G) or less Free of corrosive gases (Note 6)	

NOTE 1) During short distance motions, the axis speed may not reach the maximum value stated.

NOTE 2) When the 700kg option of the M-900*i*A/600 is specified.

NOTE 3) When 700kg option is specified for M-900*i*A/600. Please refer to Section 9.6 about 700kg option. When high inertia option is specified for M-900*i*A/400L. Please refer to Section 9.7 about high inertia option.

NOTE 4) This value is equivalent continuous A-weighted sound pressure level that applied with ISO11201 (EN31201). This value is measured with the following conditions.
- Maximum load and speed
- Operating mode is AUTO

NOTE 5) When robot is used in low temperature environment that is near to 0ºC, or robot is not operated for a long time in the environment that is less than 0ºC in a holiday or the night, because viscous resistance of the drive train is so big that may cause occurrence of collision detect alarm (SRVO –050) etc. In this case, we recommend performing the warm up operation for several minutes.

NOTE 6) Contact the service representative, if the robot is to be used in an environment or a place subjected to severe vibrations, heavy dust, cutting oil splash and or other contaminations.

RELATED MANUALS

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

Safety handbook B-80687EN All persons who use the FANUC Robot and system designer must read and understand thoroughly this handbook		Intended readers: Operator, system designer Topics: Safety items for robot system design, operation, maintenance
R-J3*i*B controller	Setup and Operations manual SPOT TOOL **B-81464EN-1** HANDLING TOOL **B-81464EN-2** SEALING TOOL **B-81464EN-4**	Intended readers: Operator, programmer, maintenance technician, system designer Topics: Robot functions, operations, programming, setup, interfaces, alarms Use: Robot operation, teaching, system design
	Maintenance manual **B-81465EN** **B-81465EN-1 (For Europe)**	Intended readers: Maintenance technician, system designer Topics: Installation, start-up, connection, maintenance Use: Installation, start-up, connection, maintenance
R-30*i*A controller	Setup and Operations manual SPOT TOOL+ **B-83124EN-1** HANDLING TOOL **B-83124EN-2** DISPENSE TOOL **B-83124EN-4** ALARM CODE LIST **B-83124EN-6** SERVO GUN FUNCTION **B-82634EN**	Intended readers: Operator, programmer, maintenance technician, system designer Topics: Robot functions, operations, programming, setup, interfaces, alarms Use: Robot operation, teaching, system design
	Maintenance manual **B-82595EN** **B-82595EN-1 (For Europe)** **B-82595EN-2 (For RIA)**	Intended readers: Maintenance technician, system designer Topics: Installation, start-up, connection, maintenance Use: Installation, start-up, connection, maintenance
R-30*i*B controller	OPERATOR'S MANUAL **(**Basic Function**)** **B-83284EN** OPERATOR'S MANUAL **(**Alarm Code List**)** **B-83284EN-1** Optional Function OPERATOR'S MANUAL **B-83284EN-2** Spot Welding Function OPERATOR'S MANUAL **B-83284EN-4** Dispense Function OPERATOR'S MANUAL **B-83284EN-5** Servo Gun Function OPERATOR'S MANUAL **B-83264EN**	Intended readers: Operator, programmer, maintenance technician, system designer Topics: Robot functions, operations, programming, setup, interfaces, alarms Use: Robot operation, teaching, system design
	Maintenance manual **B-83195EN**	Intended readers: Maintenance technician, system designer Topics: Installation, start-up, connection, maintenance Use: Installation, start-up, connection, maintenance

This manual uses following terms.

Name	Terms in this manual
Connection cable between robot and controller	Robot connection cable
Robot mechanical unit	Mechanical unit

TABLE OF CONTENTS

1 CONFIGURATION

The configuration of the mechanical unit is shown in Fig. 1 (a).

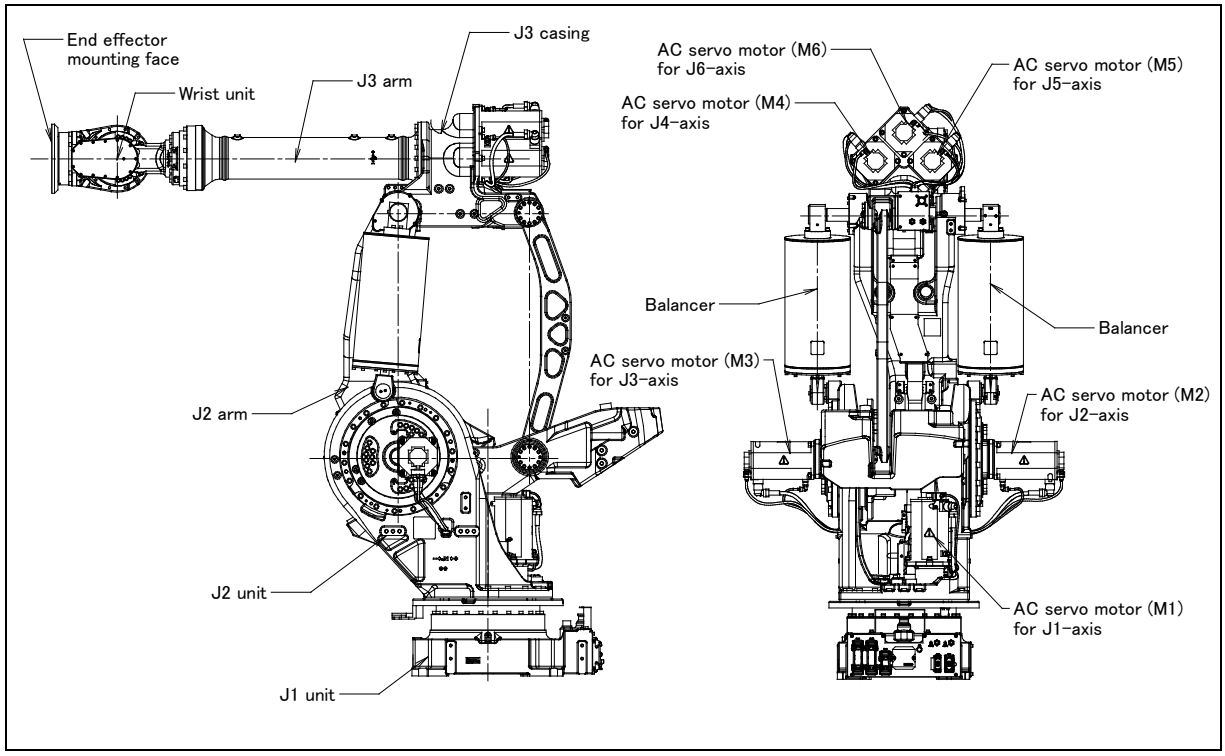


Fig. 1 (a) Mechanical unit configuration

2 CHECKS AND MAINTENANCE

Optimum performance of the robot can be maintained by performing the periodic maintenance procedures presented in this chapter. (See APPENDIX A PERIODIC MAINTENANCE TABLE.)

NOTE
The periodic maintenance procedures described in this chapter assume that the FANUC robot is used for up to 3840 hours a year. In cases where robot use exceeds 3840 hours/year, adjust the given maintenance frequencies accordingly. The ratio of actual operation time/year vs. the 3840 hours/year should be used to calculate the new (higher) frequencies. For example, when using the robot 7680 hours a year with a recommended maintenance interval of 3 years or 11520 hours, use the following calculation to determine the maintenance frequency: 3 years / 2 = perform maintenance every 1.5 years.

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.

(1) Before turning on power

Item	Check items	Check points
1	Oil seepage	Check there is oil exudation on sealed part of each joint. (Note 1)

NOTE
1 Oil seepage may be attached (Slightly a loot oil stick) to outside of lip depend on the movement condition or environment of the circumference. If this oil contents change to a state of dew, it may fail depend on the movement.
You can prevent oil spot from falling down by wiping the oil contents which is accumulated to under part of oil seal before operation referring to Fig.2.1 (a).
2 Also, motors may become the high temperature and the internal pressure of grease bath may rise by frequent repetition movement and use in the high temperature environment.
In these cases, you can return internal pressure by releasing grease out let just after operation of robot. (When opening grease outlet, pay attention grease is not scattered referring to Section 3.1.)

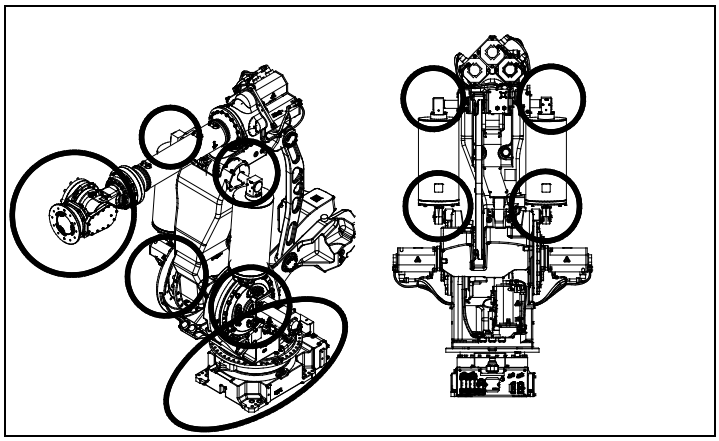


Fig. 2.1 (a) Check parts of oil seepage

Check items

Wipe off the oil contents of each joint part which has oil seal.

Item	Check items	Check points
1	Air pressure	Check the air pressure using the pressure gauge on the air control set as shown in Fig. 2.1 (b). If it does not meet the specified pressure of 0.49 to 0.69 MPa (5-7 kgf/cm^2), adjust it using the regulator pressure-setting handle.
2	Lubricator oil mist quantity	Check the number of oil drops during operation. If it does not meet the specified value (1 drop/10-20 sec), adjust it using the handle for lubricator adjustment. The lubricator becomes empty in about 10 to 20 days under normal operation.
3	Lubricator oil level	Check to see that the air control set oil level is within the specified level.
4	Leakage from hose	Check the joints, tubes, etc. for leaks. Retighten the joints or replace parts, as required.
5	Drain	Check the drain and release it. When quantity of the drain is remarkable, examine the setting of the air dryer to the air supply side.

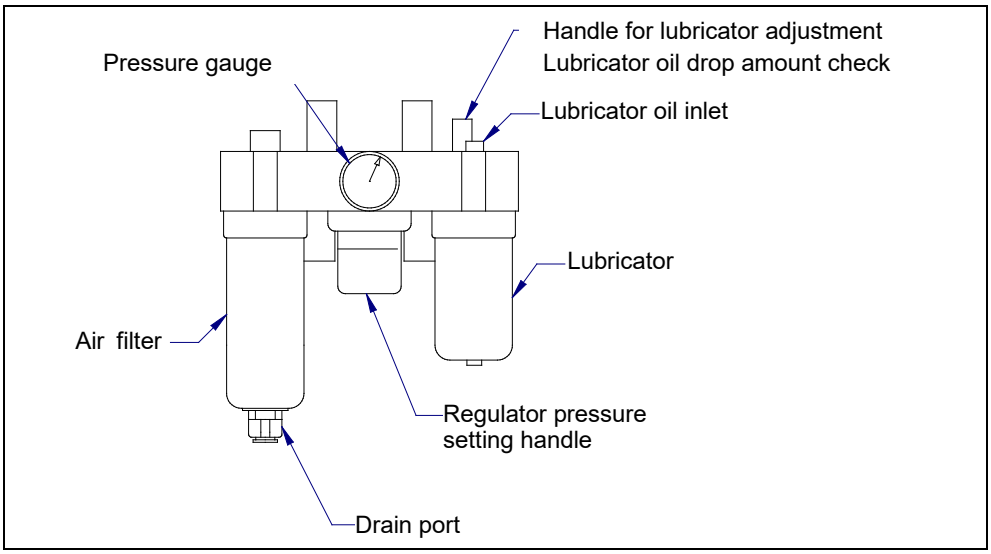


Fig. 2.1 (b) Air control set (option)

(2) After turning on power

Item	Check items	Check points
1	Vibration, abnormal noises, and motor heating	Check whether the robot moves along and about the axes smoothly without unusual vibration or sounds. Also check whether the temperature of the motors are not excessively high.
2	Positioning accuracy	Check to see that the stop positions of the robot have not deviated from the previous stop positions.
3	Peripheral devices for proper operation	Check whether the peripheral devices operate properly according to commands from the robot and the peripheral equipment.
4	Brakes for each axis	Check that the end effector drops within 0.2 mm when the power is cut off.

2.2 FIRST 1-MONTH (320 HOURS) CHECKS

Check the following item once every one-month (320 hours). Additional inspection areas and times should be added to the table according to the robot's working conditions, environment, etc. Then every 3 months thereafter. (See the Section 2.4.)

Item	Check items	Check points
1	Ventilation portion of controller	If the ventilation portion of the controller is dusty, turn off power and clean the unit.

2.3 FIRST 3-MONTH CHECKS (960 HOURS)

Check the following items at the first quarterly inspection, then every year thereafter.(See the Section 2.5.)

Item	Check items	Check points
1	Cables used in mechanical unit	Check whether the jackets of the mechanical unit cables are not damaged. Also check whether the cables are not excessively bent or unevenly twisted. Check that the connectors of the motors and connector panels are securely engaged. (NOTE1)
2	Retightening external main bolts	Retighten the end-effecter mounting bolts and external main bolts.(NOTE2)
3	Check the mechanical stopper and adjustable mechanical stopper	Check the looseness of mounting bolts of mechanical stopper and adjustable mechanical stopper. Particular, check swing stopper of J1-axis rotates smoothly. (NOTE3)
4	Cleaning and checking each part	Clean each part (remove chips, etc.) and check component parts for cracks and flaws. (NOTE4)
5	Check the end effector (hand) cable	Confirm whether there is no damage in the cable.
6	Check the teach pendant cable, operation box connecting cable and robot connecting cable	Check whether the cable connected to the teach pendant, the operation box and the robot is unevenly twisted.

NOTE 1) Inspection points and check items of the mechanical unit cables and connectors

Inspection points of the mechanical unit cables

Fixed part cables likely to interfere with the J1, J2, and J3 movable parts and peripheral equipment.

* For the J1-axis, inspect the cables from above the J2 base and from the side by removing the metal plate on the side of the J1 base.

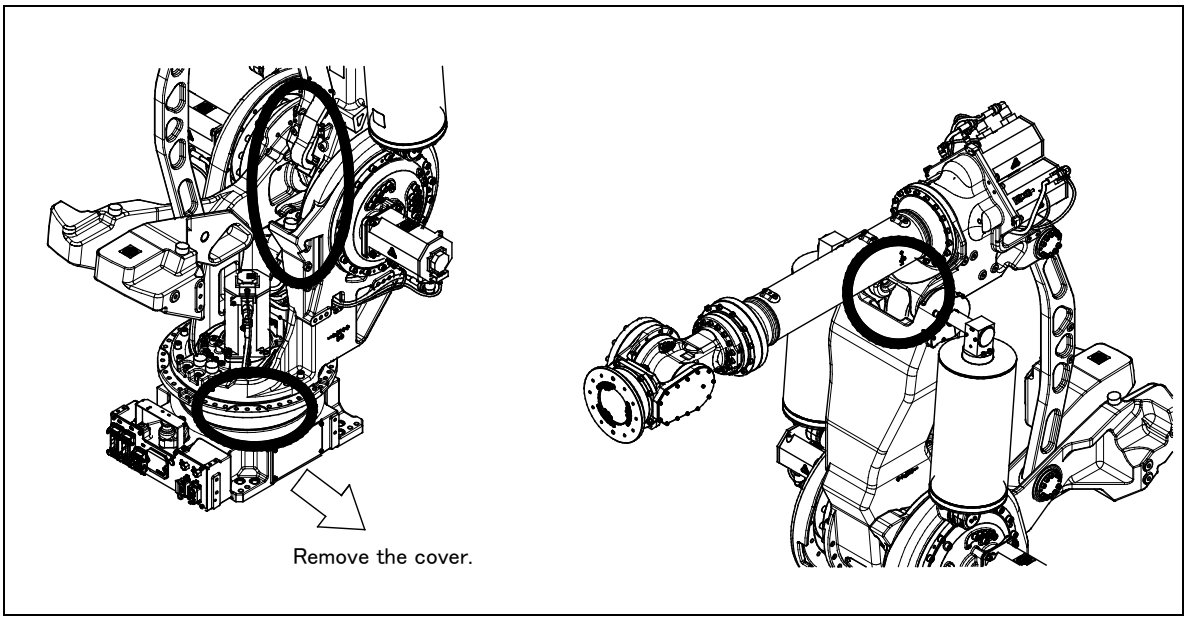


Fig. 2.3 (a) Check items of mechanical unit cable

Check items

For cables with a cable protective sleeve, open the cable protective sleeve before making the check.
Check the cables for a sheath break and wear. If wires of the cable appear, replace it.

Inspection points of the connectors

- Power/brake connectors of the motor exposed externally
- Robot connection cables, earth terminal and user cables

Check items

- Circular connector: Check the connector for tightness by turning it manually.
- Square connector: Check the connector for engagement of its lever.
- Earth terminal: Check the terminal for tightness.

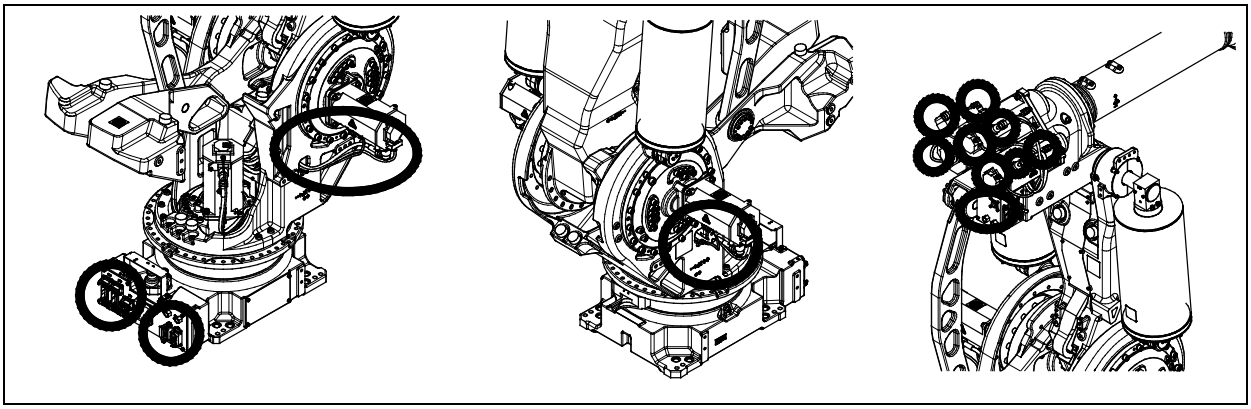


Fig. 2.3 (b) Check items of connector

NOTE 2) Points to be retightened

- The end effecter mounting bolts, robot installation bolts, and bolts to be removed for inspection need to be retightened.
- The bolts exposed to the outside of the robot need to be retightened.
  For the tightening torque, see the recommended bolt tightening torque shown in the Appendix.
  A loose prevention agent (adhesive) is applied to some bolts. If the bolts are tightened with greater than the recommended torque, the loose prevention agent may be removed. So, follow the recommended tightening torque when retightening them.

NOTE 3) Check of mechanical stopper and adjustable mechanical stopper

- Check the tightness of stopper mounting bolts. If they are loose, they are needed to be retightened.
  Especially, check the tightness of mounting bolts of J1-axis swing stopper.
  Check that J1-axis swing stopper rotates smoothly.

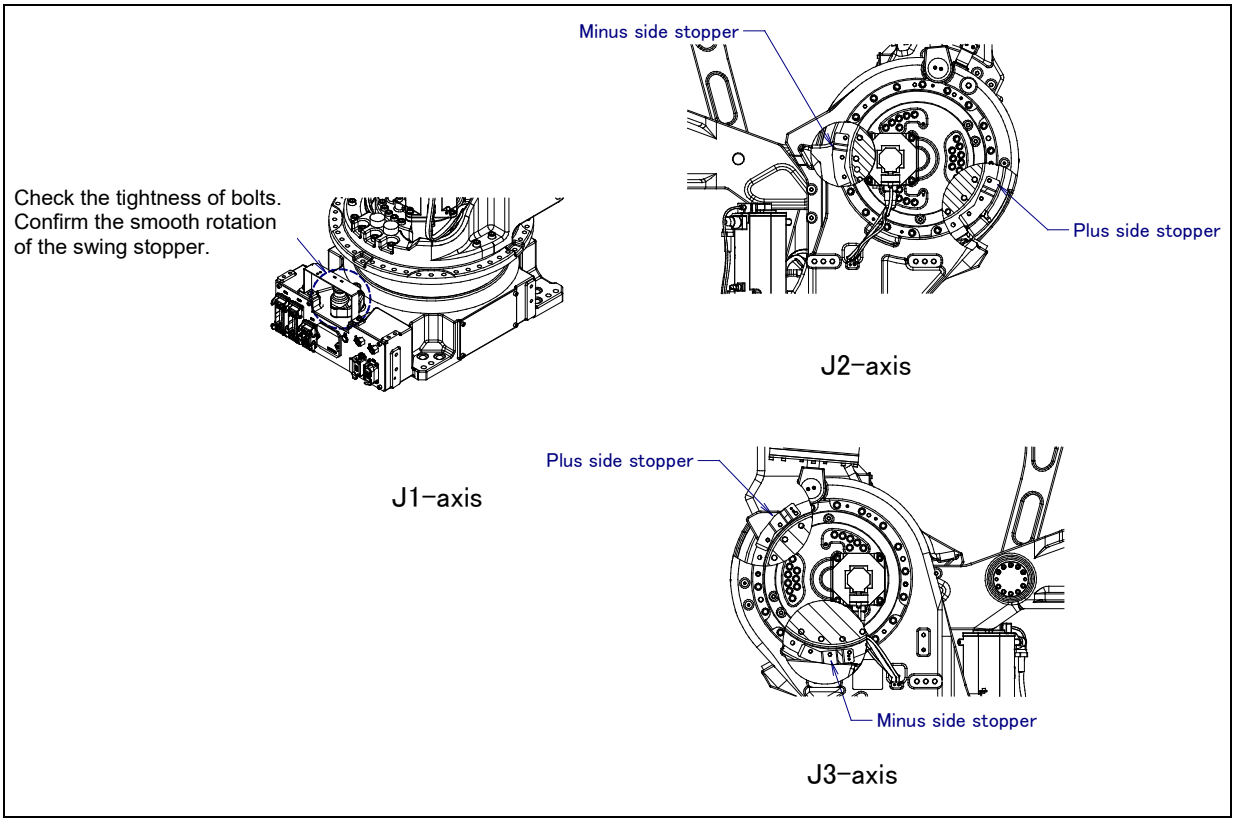


Fig.2.3 (c) Check of mechanical stopper and adjustable mechanical stopper

NOTE 4) Cleaning

- Necessary cleaning points, dust on the flat part, sedimentation of spatters

Clean sediments periodically.
In particular, clean the following points carefully.

1) Vicinity of the balancer rod and shaft
   → If chippings or spatters are attached to the bushing, abnormal wear may be caused.
2) Vicinity of the wrist axis and oil seal
   → If chippings or spatters are attached to the oil seal, an oil leak may be caused.

Check items

- Check if the vicinity of the necessary inspection points, wrist part, and J3 arm significantly wears due to rubbing against the welding cable or hand cable.
- Check if there is a trace of a collision around the gun or hand.

- Check the reducer or grease bath for an oil leak.
  If oil can be found a day after wiping oil, an oil leak may be caused.

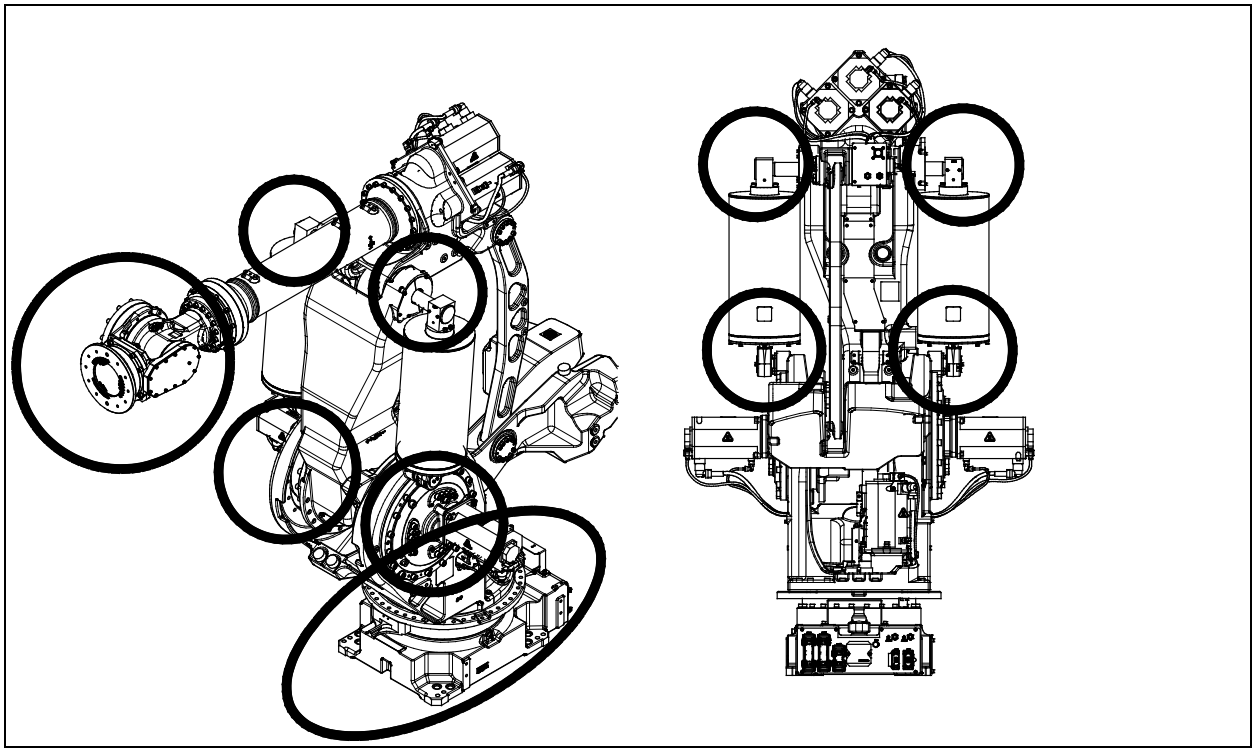


Fig. 2.3 (d) Cleaning part

2.4 3-MONTH (960 HOURS) CHECKS

Check the following item at the intervals based on 3 months or 960 hours, whichever comes first.

Item	Check items	Check points
1	Ventilation portion of controller	(See Section 2.2.)

2.5 1-YEAR (3840 HOURS) CHECKS

Check the following item at the intervals based on 1 year or 3840 hours, whichever comes first.

Item	Check items	Check points
1	Cables used in mechanical unit	(See Section 2.3.)
2	Retightening external main bolts	(See Section 2.3.)
3	Check the mechanical stopper and adjustable mechanical stopper	(See Section 2.3.)
4	Cleaning and checking each part	(See Section 2.3.)
5	Check the end effector (hand) cable	(See Section 2.3.)
6	Check the teach pendant cable, operation box connecting cable and robot connecting cable	(See Section 2.3.)

2.6 1.5-YEAR (5760 HOURS) CHECKS

Check the following item at the intervals based on 1.5 year or 5760 hours, whichever comes first.

Item	Check items	Check points
1	Battery	Replace battery in the mechanical unit. (See Section 3.3)

2.7 3-YEAR (11520 HOURS) CHECKS

Check the following item at the intervals based on 3 years or 11520 hours, whichever comes first.

Item	Check items	Check points
1	Replacing grease of each axis, reducer and gearbox	(See Section 3.1.)
2	Greasing to J2/J3-axis connection part bearing	Supply grease to J2/J3-axis connection part bearing. (See Section 3.2)

2.8 4-YEAR (15360 HOURS) CHECKS

Check the following item at the intervals based on 4 years or 15360 hours, whichever comes first.

Item	Check items	Check points
1	Replace the mechanical unit cable	Replace mechanical unit cable. Contact your local FANUC representative for information regarding replacing the cable.

3 PERIODIC MAINTENANCE

3.1 REPLACING GREASE OF THE DRIVE MECHANISM (3 YEARS CHECK (11520 HOURS) PERIODIC MAINTENANCE)

According to below, replace the grease of the reducers of J1, J2, J3 axes, the J4-axis gearbox, and the wrist at the intervals based on every 3 years or 11520 hours, whichever comes first.

Table 3.1 (a) Grease for 3-year periodical replacement

Models	Supply position	Quantity	Gun tip pressure	Grease name
M-900*i*A/600 M-900*i*A/400L	J1-axis reducer	6100g (7000ml)	0.15MPa or less (NOTE)	Spec.: A98L-0040-0174
	J2-axis reducer	5230g (6000ml)		
	J3-axis reducer	5230g (6000ml)		
	J4-axis gearbox	3660g (4200ml)		
	Wrist 1 (M-900*i*A/600)	2440g (2800ml)		
	Wrist 1 (M-900*i*A/400L)	2790g (3200ml)		
	Wrist 2	2440g (2800ml)		

NOTE
When using a hand pump, apply grease approximately twice per 3 seconds.

⚠ WARNING
Hot grease might eject suddenly when you open the grease outlet. Attach bags for collecting grease, and use appropriate protective equipment such as heat-resistant gloves, protective glasses, a face shield, or a body suit if necessary.

For grease replacement or replenishment, use the postures indicated below.

Table 3.1 (b) Postures for greasing

Supply position	Posture					
	J1	J2	J3	J4	J5	J6
J1-axis reducer	Arbitrary	Arbitrary	Arbitrary	Arbitrary	Arbitrary	Arbitrary
J2-axis reducer		0°				
J3-axis reducer		0°	0°			
J4-axis gearbox		Arbitrary	0°			
Wrist			0°	0°	0°	0°

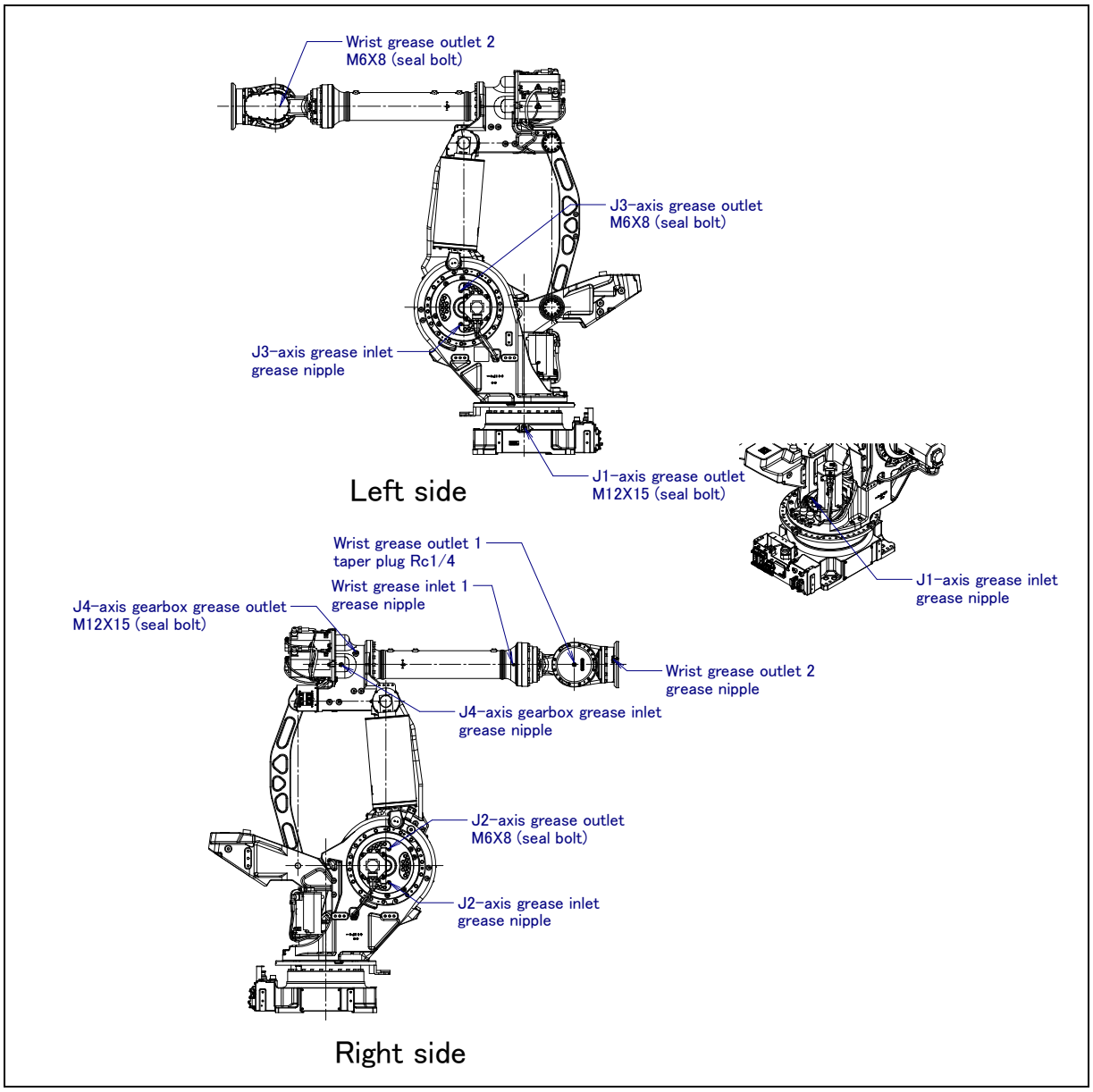


Fig. 3.1 (a) Replacing grease

3.1.1 Grease Replacement Procedure for the J1-axis/J2-axis/J3-axis and J4-axis Gearbox

1 Perform the following steps for each axis.
2 Move the robot to the greasing posture described in Section 3.1.
3 Turn off controller power.
4 Remove the seal bolt from the grease outlet.
5 Supply new grease until new grease is output from the grease outlet.
6 After applying grease, release the remaining pressure within the grease bath as described in the procedure in Subsection 3.1.3.

3.1.2 Grease Replacement Procedure for the Wrist

1 Move the robot to the greasing posture described in Section 3.1.
2 Turn off the controller power.
3 Remove the taper plug from wrist grease outlet 1.
4 Supply new grease through the wrist grease inlet until new grease is output from wrist grease outlet 1.
5 Attach the taper plug onto wrist grease outlet 1. When reusing the taper plug, be sure to seal the taper plug with seal tape.
6 Remove the seal bolt from wrist grease outlet 2.
7 Supply new grease through the wrist grease inlet until new grease is output from wrist grease outlet 2.
8 After applying grease, release the remaining pressure within the grease bath as described in the procedure in Subsection 3.1.3.

⚠ CAUTION
Failure to supply grease correctly may cause an increase of the internal pressure of the grease bath. Such pressure increase will then damage the seal, which in turn leads to grease leakage and abnormal robot operation.
When performing greasing, therefore, observe the following precautions.
1 Before starting to grease, remove the plugs or seal bolts of the grease outlet to allow the grease to come out.
2 Supply grease slowly without applying excessive force, using a manual pump.
3 Whenever possible, avoid using an air pump, which is powered by the factory air supply. If the use of an air pump is unavoidable, supply grease with the pump at a pressure lower than or equal to the gun tip pressure (Table 3.1 (a)).
4 Use grease only of the specified type. Grease of a type other than that specified may damage the reducer or lead to other problems.
5 After applying grease, release the remaining pressure within the grease bath as described in the procedure in Subsection 3.1.3.
6 To prevent slipping accidents and catching fire, completely remove all any excess grease from the floor or robot.

3.1.3 Procedure for Releasing the Grease Remaining Pressure

After applying grease, operate the robot as instructed below to release the remaining pressure within the grease bath. Attach a recovery bag below the grease inlet and outlet to prevent output grease from splattering.

For the J1-axis reducer
Run the program for the time specified below to release the remaining pressure with the grease outlet left open. Perform repetitive operation with an axis angle of at least 80 degrees and OVR50% for 20 minutes or more.

For the J2- or J3-axis reducer
Run the program for the time specified below to release the remaining pressure with the grease outlet left open. Perform repetitive operation with an axis angle of at least 90 degrees for the J2-axis reducer or at least 70 degrees for the J3-axis reducer and OVR50% for 20 minutes or more.

For the J4-axis gearbox
Run the program for the time specified below to release the remaining pressure with the grease outlet left open. Perform repetitive operation with an axis angle of at least 60 degrees for the J4-axis, at least 120 degrees for the J5-axis, or at least 60 degrees for the J6-axis and OVR100% for 20 minutes or more.

For the wrist axis
Run the program for the time specified below to release the remaining pressure with the two grease inlets and two grease outlets left open. Perform repetitive operation with an axis angle of at least 60 degrees for the J4-axis, at least 120 degrees for the J5-axis, or at least 60 degrees for the J6-axis and OVR100% for 20 minutes or more.

When the above operation is impossible due to ambient conditions, adjust the operating time according to the operating angle. (When the maximum allowable axis angle is half the specified angle, run the program for twice the specified time.) Upon completion of the above operation, attach the grease nipple or the seal bolt to each the grease inlet and outlet. When reusing the grease nipple and the seal bolt, be sure to seal it with seal tape.

3.2 GREASING POINTS (3 YEARS CHECK (11520 HOURS) PERIODIC MAINTENANCE)

Fig. 3.2 (a) shows the greasing points of taper roller. Apply grease every three years or 11520 hours. If the robot is installed in a severe environment, apply grease whenever necessary. If water splashes on the robot, apply grease immediately.
Table 3.2 (b) shows the substitute grease.

Table 3.2 (a) Greasing points

Greasing points	Grease	Amount	Method
J2/J3-axis connection taper roller	SHELL ALVANIA GREASE S2 (Spec.: A98L-0004-0602#CTG)	20 ml each (2 locations)	Apply grease from the grease nipple.

Table 3.2 (b) Substitutes for ALVANIA GREASE S2

MOBIL	MOBILACKS EP2
JXTG Nippon Oil & Energy Corporation	MULTINOC 2
JXTG Nippon Oil & Energy Corporation	EPNOC AP-2
IDEMITSU KOHSAN	EPONEX GREASE NO.2
COSMO OIL	DYNAMAX NO.2
Showa Shell Sekiyu K.K.	Shell Gadus S2 V100 2

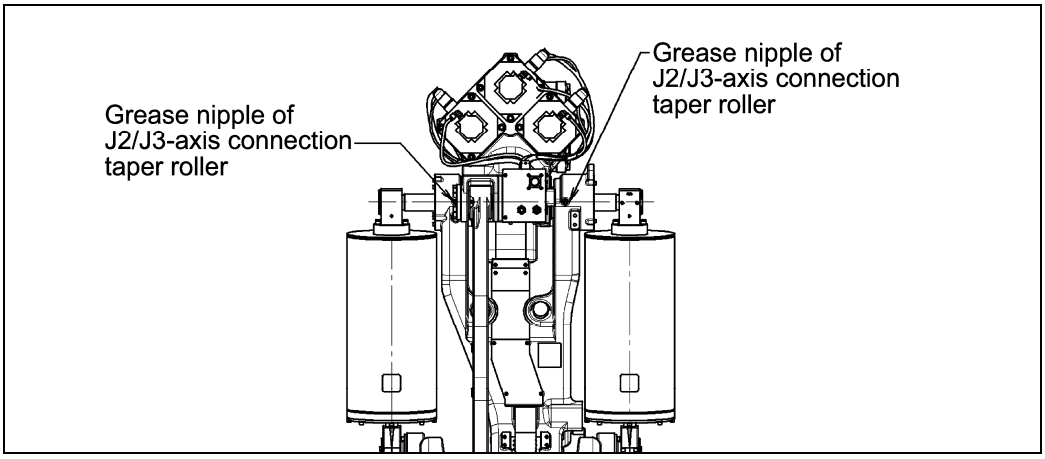


Fig. 3.2 (a) Greasing points

3.3 REPLACING THE BATTERIES (1.5 YEARS PERIODIC MAINTENANCE)

The position data of each axis is preserved by the backup batteries. The batteries need to be replaced every 1.5 year. Also, use the following procedure to replace when the backup battery voltage drop alarm occurs.

Procedure for replacing batteries

1 Press the EMERGENCY STOP button to prohibit the robot motion.

> ⚠ **CAUTION**
> Be sure to keep the power supply turning on. Replacing the batteries with the power supply turned off causes all current position data to be lost. Therefore, mastering will be required again.

2 Remove the battery case cap.
3 Take out the old batteries from the battery case.
4 Insert new batteries into the battery case. Pay attention to the direction of batteries.
5 Close the battery case cap.

> ⚠ **CAUTION**
> When using a robot with the severe dust/liquid protection option, remove the cover from the battery case as shown in Fig.3.3 (b) to replace the battery. After replacing the battery, reinstall the cover. In this time, please be sure to replace the gasket by new one for effects of severe dust/liquid protection.

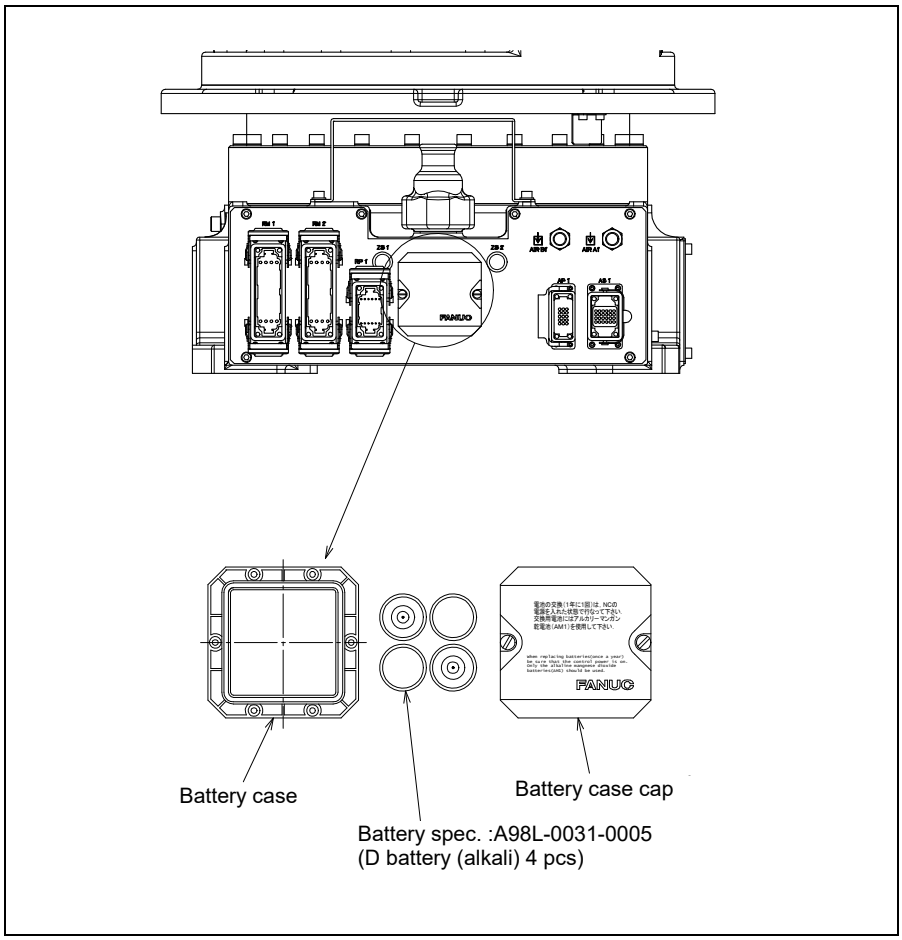


Fig. 3.3 (a) Replacing batteries

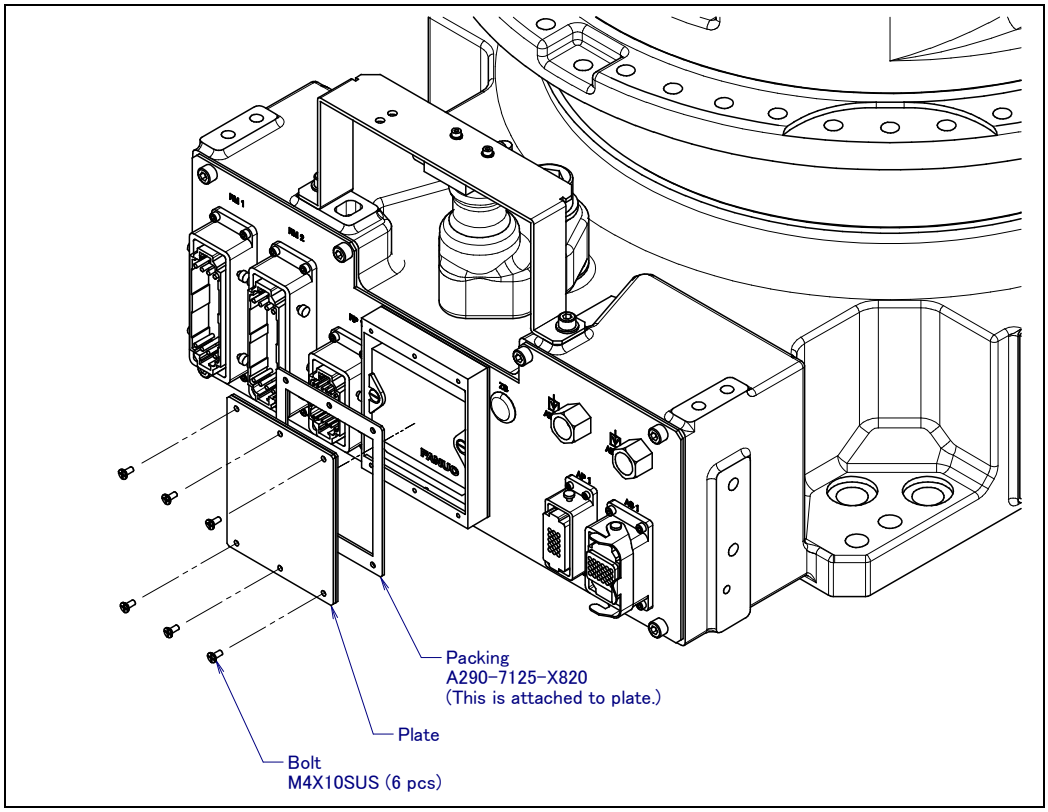


Fig. 3.3 (b) Removing the battery cover plate (When severe dust/liquid protection is specified.)

4 TROUBLESHOOTING

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

4.1 TROUBLESHOOTING

Table 4.1 (a) shows the major troubleshooting that may occur in the mechanical unit and their probable causes. If you cannot pinpoint a failure cause or which measures to take, contact your local FANUC representative.

Table 4.1 (a) Troubleshooting

Symptom	Description	Cause	Measure
Vibration Noise	- As the robot operates, its base plate lifts off the floor plate. - There is a gap between the base plate and the floor plate. - There is a crack in the weld that fastens the base plate to the floor plate.	[Base plate and floor plate fastening] - It is likely that the base plate is not securely fastened to the floor plate because of poor welding. - If the base plate is not securely fastened to the floor plate, it lifts as the robot operates, allowing the base and floor plates to strike each other which, in turn, leads to vibration.	- Re-weld the base plate to the floor plate. - If the weld is not strong enough, increase its width and length.
	- The J1 base lifts off the floor plate as the robot operates. - There is a gap between the J1 base and floor plate. - A J1 base retaining bolt is loose.	[J1 base fastening] - It is likely that the robot J1 base is not securely fastened to the floor plate. - Probable causes are a loose bolt, an insufficient degree of surface flatness, or contamination caught between the J1 base plate and floor plate. - If the robot is not securely fastened to the floor plate, the J1 base lifts the floor plate as the robot operates, allowing the base and floor plates to strike each other. That, in turn, leads to vibration.	- If a bolt is loose, apply LOCTITE and tighten it to the appropriate torque. - Adjust the base plate surface flatness to within the specified tolerance. - If there is any contamination, eliminate them. - Apply adhesive between the J1 base and base plate.
	- The rack or floor plate vibrates during operation of the robot.	[Rack or floor] - It is likely that the rack or floor is not sufficiently rigid. - If the rack or floor is not sufficiently rigid, reaction from the robot deforms the rack or floor, leading to vibration.	- Reinforce the rack or floor to make it more rigid. - If it is impossible to reinforce the rack or floor, modify the robot control program; doing so might reduce the amount of vibration.

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- Vibration becomes more serious when the robot adopts a specific posture. - If the operating speed of the robot is reduced, vibration stops. - Vibration is most noticeable when the robot is accelerating. - Vibration occurs when two or more axes operate at the same time.	[Overload] - It is likely that the load on the robot is greater than the maximum rating. - It is likely that the robot control program is too demanding for the robot hardware. - It is likely that the ACCELERATION value is excessive.	- Check the maximum load that the robot can handle once more. If the robot is found to be overloaded, reduce the load, or modify the robot control program. - Vibration in a specific portion can be reduced by modifying the robot control program while slowing the robot and reducing its acceleration (to minimize the influence on the entire cycle time).
	- Vibration or noise was first noticed after the robot collided with an object or the robot was overloaded for a long period. - The grease of the vibrating or noise occurring axis has not been exchanged for a long period. - Cyclical vibration and noise occur.	[Gear, bearing, or reducer] - It is likely that collision or overload applied an excessive force on the drive mechanism, thus damaging the gear tooth surface or rolling surface of a bearing, or reducer. - Prolonged use with overloaded may cause the fretting fatigue on gear tooth surface or rolling surface of bearing and reducer. - It is likely that contamination caught in a gear, bearing, or within a reducer has caused damage on the gear tooth surface or rolling surface of the bearing, or reducer. - It is likely that contamination caught in a gear, bearing, or within a reducer is causing vibration. - It is likely that, because the grease has not been changed for a long period, fretting occurred on the gear tooth surface or rolling surface of a bearing, or reducer due to metal fatigue by neglect greasing.	- Operate each axis at individually to judge which axis has been vibrating. - Remove the motor, and replace the gear, the bearing, and the reducer. For the specification of parts and the procedure of replacement, contact your local FANUC representative. - Using the robot within its maximum rating prevents problems with the drive mechanism. - Regularly greasing with the specified grease can help prevent problems.

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- The cause of problem cannot be identified from examination of the floor, rack, or mechanical unit.	[Controller, cable, and motor] - If a failure occurs in a controller circuit, preventing control commands from being supplied to the motor normally, or preventing motor information from being sent to the controller normally, vibration might occur. - Pulsecoder defect may be the cause of the vibration as the motor cannot propagate the accurate position to the controller. - If the motor becomes defective, vibration might occur because the motor cannot deliver its rated performance. - If a power line in a movable cable of the mechanical unit has an intermittent break, vibration might occur because the motor cannot accurately respond to commands. - If a Pulsecoder wire in a movable part of the mechanical unit has an intermittent break, vibration might occur because commands cannot be sent to the motor accurately. - If a robot connection cable has an intermittent break, vibration might occur. - If the power supply cable is about to be snapped, vibration might occur. - If the power source voltage drops below the rating, vibration might occur. - It may vibrate when an invalid value parameter was set.	- Refer to the Controller Maintenance Manual for troubleshooting related to the controller and amplifier. - Replace the motor of the axis that is vibrating, and check whether vibration still occurs. For the method of replacement, contact your local FANUC representative. - If vibration occurs only when the robot assumes a specific posture, it is likely that a cable in the mechanical unit is broken. - Shake the movable part cable while the robot is at rest, and check whether an alarm occurs. If an alarm or any other abnormal condition occurs, replace the mechanical unit cable. - Check whether the cable jacket of the robot connection cable is damaged. If so, replace the connection cable, and check whether vibration still occurs. - Check whether the power cable jacket is damaged. If so, replace the power cable, and check whether vibration still occurs. - Check that the robot is supplied with the rated voltage. - Check that the robot control parameter is set to a valid value. If it is set to an invalid value, correct it. Contact your local FANUC representative for further information if necessary.

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- There is some relationship between the vibration of the robot and the operation of a machine near the robot.	[Noise from a nearby machine] - If the robot is not grounded properly, electrical noise is induced on the grounding wire, preventing commands from being transferred accurately, thus leading to vibration. - If the robot is grounded at an unsuitable point, its grounding potential becomes unstable, and noise is likely to be induced on the grounding line, thus leading to vibration.	- Connect the grounding wire firmly to ensure a reliable ground potential and prevent extraneous electrical noise.
	- There is an unusual sound after replacement of grease. - There is an unusual sound after a long period of time. - There is an unusual sound during operation at low speed.	- There may be an abnormal noise when using other than the specified grease. - Even for the specified grease, there may be an abnormal noise during operation at low speed immediately after replacement or after a long time.	- Use the specified grease. - When there is an abnormal noise even when using the specified grease, operate for one or two days as an experiment. Generally, the abnormal noise will disappear.
	- The allophone came out when operating just after the greasing or the component replacement.	- There is a possibility that grease has not been exchanged accurately. The amount of refueling may be insufficient.	- Stop the robot, and confirm the damage situation at once. Replenish grease or oil when they are insufficient.
Rattling	- While the robot is not supplied with power, pushing it with the hand causes part of the mechanical unit to wobble. - There is a gap on the mounting face of the mechanical unit.	[Mechanical section coupling bolt] - It is likely that overloading or a collision has loosened a mounting bolt in the robot mechanical section.	- Check that the following bolts for each axis are tight. If any of these bolts is loose, apply LOCTITE and tighten it to the appropriate torque. - Motor retaining bolt - Reducer retaining bolt - Reducer shaft retaining bolt - Base retaining bolt - Arm retaining bolt - Casting retaining bolt - End effector retaining bolt

Symptom	Description	Cause	Measure
Motor Overheating	- The ambient temperature of the installation location increases, causing the motor to overheat. - After a cover was attached to the motor, the motor overheated. - After the robot control program or the load was changed, the motor overheated.	[Ambient temperature] - It is likely that a rise in the ambient temperature or attaching the motor cover prevented the motor from releasing heat efficiently, thus leading to overheating. [Operating condition] - It is likely that the robot was operated with the maximum average current exceeded.	- The teach pendant can be used to monitor the average current. Check the average current when the robot control program is running. The allowable average current is specified for the robot according to its ambient temperature. Contact FANUC for further information. - Relaxing the robot control program and conditions can reduce the average current, thus preventing overheating. - Reducing the ambient temperature is the most effective means of preventing overheating. - Having the surroundings of the motor well ventilated enables the motor to release heat efficiently, thus preventing overheating. Using a fan to direct air at the motor is also effective. - If there is a source of heat near the motor, it is advisable to install shielding to protect the motor from heat radiation.

Symptom	Description	Cause	Measure
Motor Overheating	- After a control parameter (load setting etc.) was changed, the motor overheated.	[Parameter] - If data input for a work piece is invalid, the robot cannot be accelerated or decelerated normally, so the average current increases, leading to overheating.	- Input an appropriate parameter as described in Section 9.5.
	- Symptom other than stated above	[Mechanical section problems] - It is likely that problems occurred in the mechanical unit drive mechanism, thus placing an excessive load on the motor. [Motor problems] - It is likely that a failure of the motor brake resulted in the motor running with the brake applied, thus placing an excessive load on the motor. - It is likely that a failure of the motor prevented it from delivering its rated performance, thus causing an excessive current to flow through the motor.	- Repair the mechanical unit while referring to the above descriptions of vibration, noise, and rattling. - Check that, when the servo system is energized, the brake is released. If the brake remains applied to the motor all the time, replace the motor. - If the average current falls after the motor is replaced, it indicates that the first motor was faulty.

Grease leakage	- Grease is leaking from the mechanical unit.	[Poor sealing]
		- Probable causes are a crack in the casting, a broken O-ring, a damaged oil seal, or a loose seal bolt or taper plug.
		- A crack in a casting can occur due to excessive force that might be caused in collision.
		- An O-ring can be damaged if it is trapped or cut during disassembling or re-assembling.
		- An oil seal might be damaged if extraneous dust scratches the lip of the oil seal.
		- A loose seal bolt or a taper plug might allow grease to leak along the threads.
		- Problems with the grease nipple or threads.
			- If a crack develops in the casting, sealant can be used as a quick-fix to prevent further grease leakage. However, the component should be replaced as soon as possible, because the crack might extend.
			- O-rings are used in the locations listed below.
			  - Motor coupling section
			  - Reducer (case and shaft) coupling section
			  - Wrist coupling section
			  - J3 arm coupling section
			  - Inside the wrist
			- Oil seals are used in the locations stated below.
			  - Inside the reducer
			  - Inside the wrist
			- Seal bolts and taper plug are used in the locations stated below.
			  - Grease drain outlet
			- Replace the grease nipple.

Symptom	Description	Cause	Measure

Dropping axis	- An axis drops because the brake does not function.
	- An axis drops gradually when it should be at rest.
		[Brake drive relay and motor]
		- It is likely that brake drive relay contacts are stuck to each other and keep the brake current flowing, thus preventing the brake from operating when the motor is reenergized.
		- It is likely that the brake shoe has worn out or the brake main body is damaged, preventing the brake from operating efficiently.
		- It is likely that oil or grease soak through the motor, causing the brake to slip.
			- Check whether the brake drive relays are stuck to each other or not. If they are found to be stuck, replace the relays.
			- Replace the motor after confirming whether the following symptoms have occurred.
			  - Brake shoe is worn out
			  - Brake main body is damaged
			  - Oil soaked through the motor

Displacement	- The robot operates at a point other than the taught position. - The repeatability is not within the tolerance.	[Mechanical section problems] - If the repeatability is unstable, probable causes are a failure in the drive mechanism or a loose bolt. - If the repeatability becomes stable, it is likely that a collision imposed an excessive load, leading to slipping on the base surface or the mating surface of an arm or reducer. - It is likely that the Pulsecoder is abnormal.	- If the repeatability is unstable, repair the mechanical section by referring to the above descriptions of vibration, noise, and rattling. - If the repeatability is stable, correct the taught program. Variation will not occur unless another collision occurs. - If the Pulsecoder is abnormal, replace the motor.
	- Displacement occurs only in a specific peripheral unit.	[Peripheral unit displacement] - It is likely that an external force was applied to the peripheral unit, thus shifting its position relative to the robot.	- Correct the setting of the peripheral unit position. - Correct the taught program.
	- Displacement occurred after a parameter was changed.	[Parameter] - It is likely that the mastering data was rewritten in such a way that the robot origin was shifted.	- Re-enter the previous mastering data, which is known to be correct. - If correct mastering data is unavailable, perform mastering again.
BZAL alarm occurred	- BZAL is displayed on the teach pendant screen.	- It is likely that the voltage of the memory backup battery is low. - It is likely that the Pulsecoder cable is defected.	- Replace the battery. - Replace the cable.

5 ADJUSTMENTS

Each part of the mechanical unit is carefully adjusted at the factory before shipment. Therefore, it is usually unnecessary for the customer to make adjustments at the time of delivery. However, after a long period of use or after parts are replaced, adjustments may be required.

5.1 AXIS LIMITS SETUP

Axis limits define the motion range of the robot. The operating range of the robot axes can be restricted because of:

- Used motion range of the robot is limited.
- There is an area where tool and peripheral equipment interfere with the robot.
- The length of cables and hoses attached for application is limited.

There are three methods used to prevent the robot from going beyond the necessary motion range.
These are
- Axis limit software settings (All axes)
- Adjustable mechanical stopper ((J1, J2, J3-axis) option)
- Axis limit switches ((J1, J2, J3-axis) option)

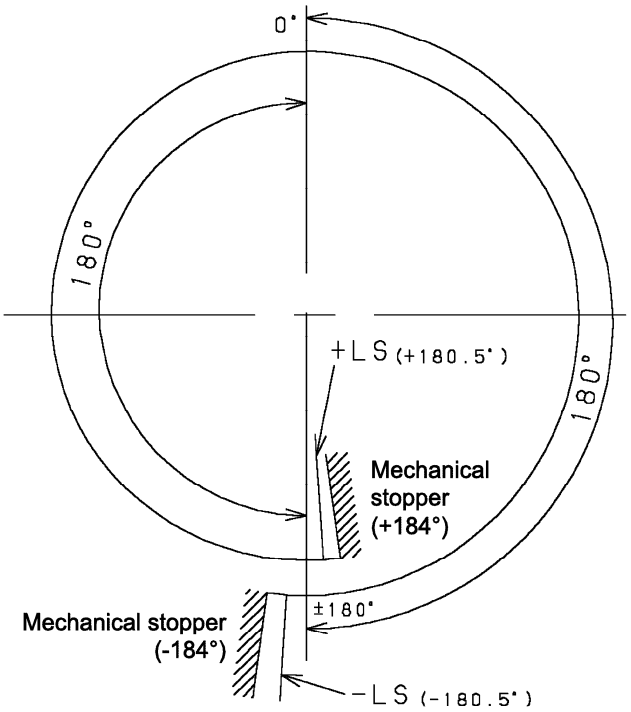
⚠ CAUTION
1. Changing the movable range of any axis affects the operation range of the robot. To avoid trouble, carefully consider a possible effect of the change to the movable range of each axis in advance. Otherwise, it is likely that an unexpected condition occurs; for example, an alarm may occur in a previous taught position.
2. For the J1, J2, and J3 axes, do not count merely on software-based limits to the movable range when changing the movable range of the robot. Use adjustable mechanical stoppers together so that damage to peripheral equipment and injuries to human bodies can be avoided. In this case, make the software-specified limits match the limits based on the adjustable mechanical stoppers.
3. Mechanical stoppers are physical obstacles. The robot cannot move beyond them. For the J1, J2, and J3 axes, it is possible to re-position the mechanical stoppers. For J5-axis, the mechanical stoppers are fixed. For the J4 and J6 axes, only software-specified limits are available.
4. For changing J2 and J3 axes interference angles, only mechanical stoppers are available; a software-specified movable range cannot be used.
5. Adjustable mechanical stoppers (J1, J2, and J3 axes) are deformed in a collision to stop the robot. Once a stopper is subject to a collision, it can no longer assure its original strength and, therefore, may not stop the robot. When this happens, replace it with a new one.

Upper Limits
Displays the upper limits of each axis, or the axis limits in a positive direction.

Lower Limits
Displays the lower limits of each axis, or the axis limits in a negative direction.

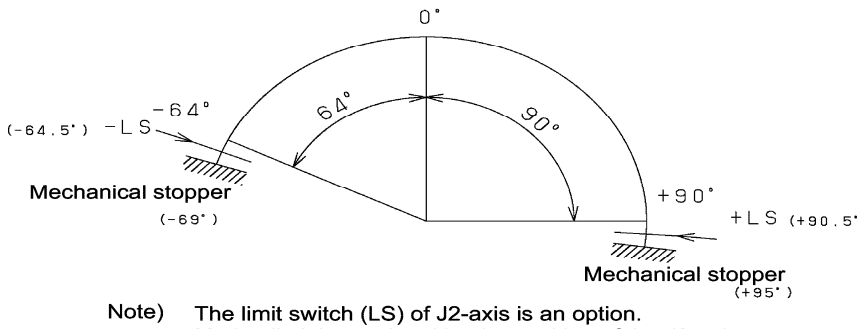
5.1.1 Zero Point Position and Motion Limit

Zero point and software motion limit are provided for each controlled axis. Exceeding the software motion limit of a controlled axis is called overtravel (OT). Overtravel is detected at both ends of the motion limit for each axis. The robot cannot exceed the software motion limit unless there is a failure of the system causing loss of zero point position or there is a system error.
Fig. 5.1.1 (a) to Fig. 5.1.1 (g) show the zero point and motion limit, LS detection position, and mechanical stopper position of each axis.



Note) The limit switch (LS) of J1-axis is an option.

Fig. 5.1.1 (a) J1-axis



Note) The limit switch (LS) of J2-axis is an option.
Motion limit is restricted by the position of the J3-axis.

Fig. 5.1.1 (b) J2-axis

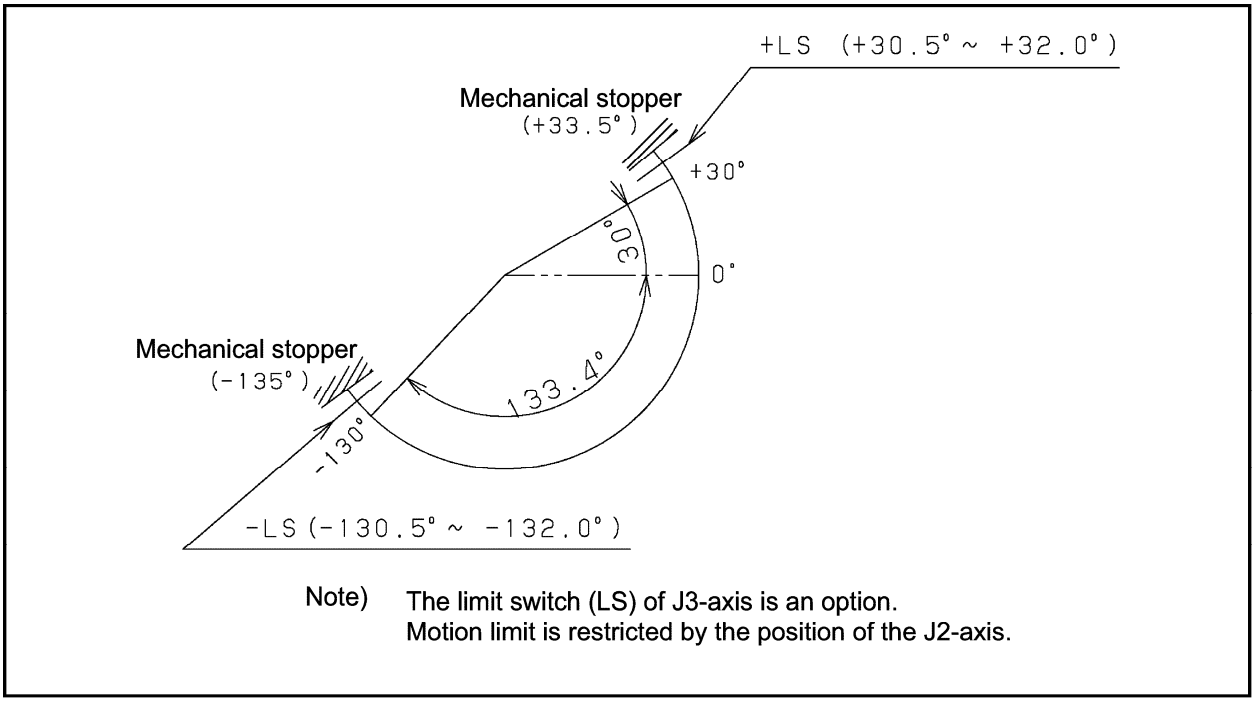


Fig. 5.1.1 (c) J3-axis

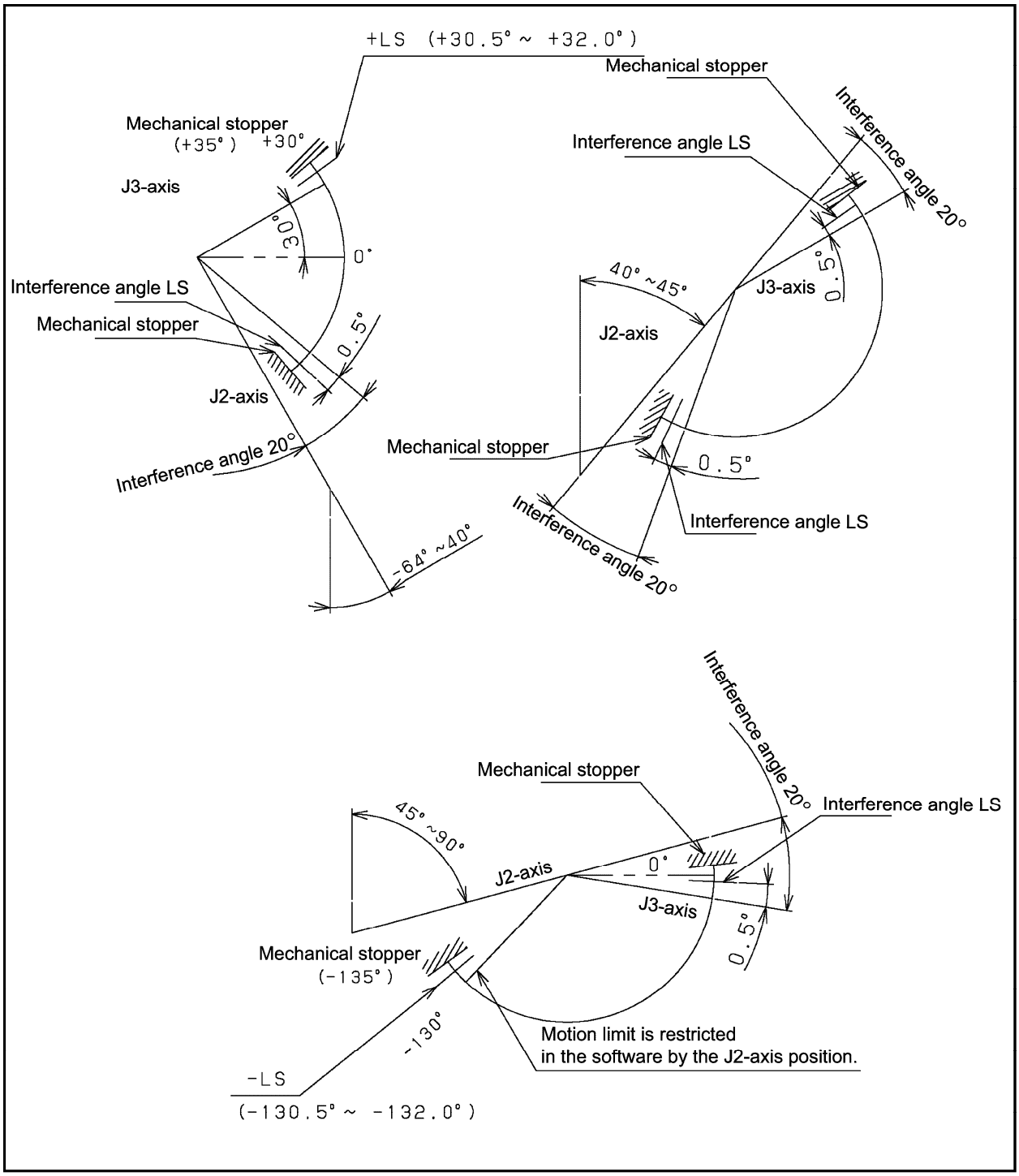
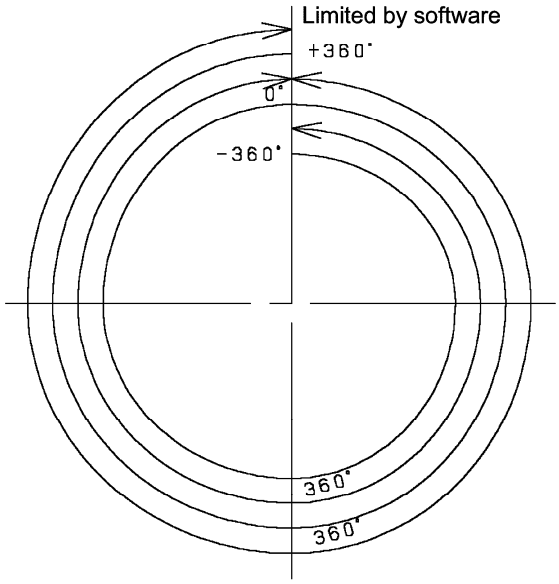
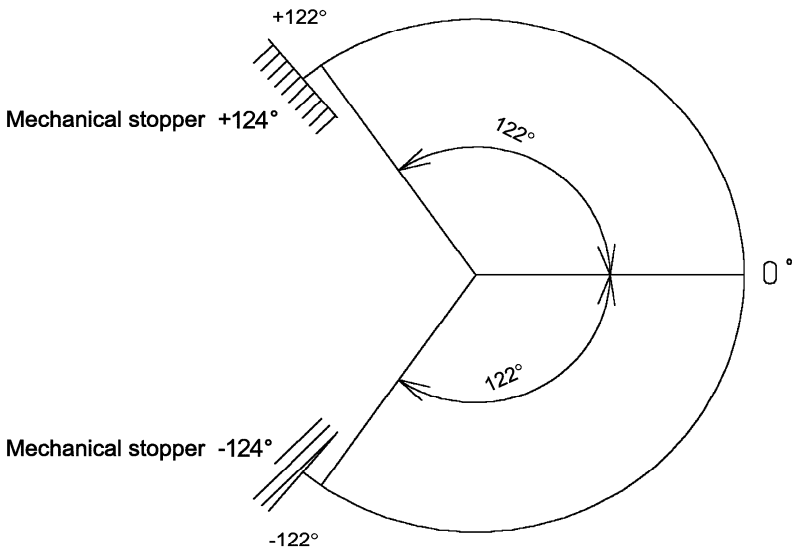


Fig. 5.1.1 (d) J2/J3-axis interference angle



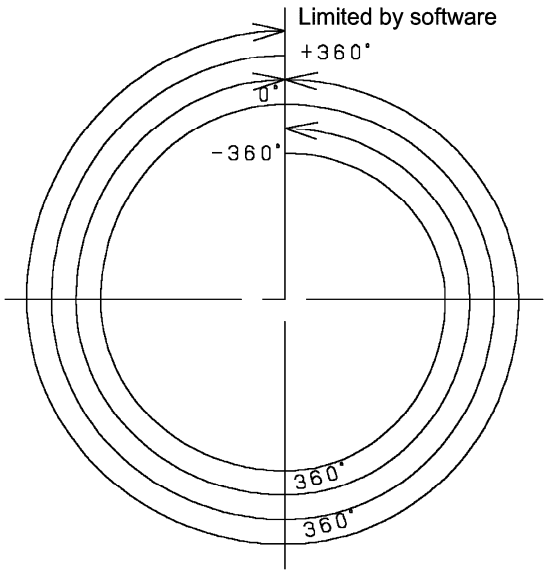
Note) OT and the mechanical stopper are not provided for J4-axis.

Fig. 5.1.1 (e) J4-axis



Note) OT is not provided for J5-axis.

Fig. 5.1.1 (f) J5-axis



Note) OT and the mechanical stopper are not provided for J6-axis.

Fig. 5.1.1 (g) J6-axis

5.1.2 Software Setting

Upper and lower axis limits about motion range can be changed by software settings. The limits can be set for all axes. The robot stops the motion if the robot reaches to the limits.

Setting procedure

1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE].
4 Select [Axis Limits]. The following screen will be displayed.

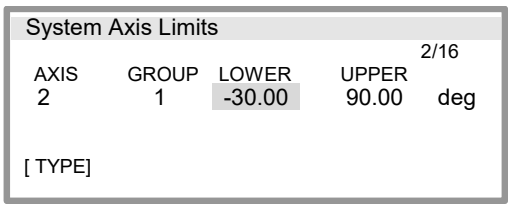
System Axis Limits JOINT 100%
Group1 1/16

AXIS	GROUP	LOWER	UPPER	
1	1	-180.00	180.00	deg
2	1	-64.00	90.00	deg
3	1	-130.00	30.00	deg
4	1	-360.00	360.00	deg
5	1	-122.00	122.00	deg
6	1	-360.00	360.00	deg
7	1	0.00	0.00	mm
8	1	0.00	0.00	mm
9	1	0.00	0.00	mm

[TYPE]

⚠ WARNING
1 The setting value 0.00 indicates that the robot does not have the axis.
2 Do not depend on J1,J2,J3 -axis limit software settings to control the motion range of your robot. Use the axis limit switches or adjustable mechanical stopper also; otherwise injury to personnel or damage to equipment could occur.

5 Move the cursor to the desired axis range and type the new value using the numeric keys on the teach pendant.



6 Perform the setting for all axes.
7 Cycle the power of the controller in the cold start mode so the new settings are enabled.

> ⚠ **WARNING**
> You must turn off the controller and then turn it back on to use the new information; otherwise injury to personnel or damage to equipment could occur.

5.1.3 Adjustable Mechanical Stopper and Limit Switch Setting

For the J1, J2, and J3 axes, Adjustable mechanical stopper (option) can be installed in addition to standard mechanical stopper. It is possible to re-position adjustable mechanical stoppers. Change the position of the adjustable mechanical stoppers according to the desired movable range. The limit switch-based movable range can be changed by changing the dog positions.

Item		
J1-axis adjustable mechanical stopper, limit switch	Upper limit	Settable in steps of 7.5° degrees in a range of –142.5° to +180° degrees.
	Lower limit	Settable in steps of 7.5° degrees in a range of -180° to +142.5° degrees.
	Space between the upper and lower limit	A space of 37.5° degrees or more is required.
J2-axis adjustable mechanical stopper	Upper limit	Settable in steps of 15° degrees in a range of –60° to +75° degrees. A fixed mechanical stopper is also provided at the upper limit +90° degrees of the standard movable range.
	Lower limit	Settable in steps of 15° degrees in a range of –60° to +75° degrees. A fixed mechanical stopper is also provided at the lower limit -64° degrees of the standard movable range.
	Space between the upper and lower limit	A space of 15° degrees or more is required.
J2-axis limit switch	Upper limit	Settable in steps of 15° degrees in a range of –60° to +75° degrees. A fixed mechanical stopper is also provided at the upper limit +90° degrees of the standard movable range.
	Lower limit	Settable in steps of 15° degrees in a range of –60° to +75° degrees. A fixed mechanical stopper is also provided at the lower limit -64° degrees of the standard movable range.
	Space between the upper and lower limit	A space of 15° degrees or more is required.
J3-axis adjustable mechanical stopper	Upper limit	Settable in steps of 15° degrees in a range of –120° to +15° degrees. A mechanical stopper is also provided at the upper limit +30° degrees of the standard movable range.
	Lower limit	Settable in steps of 15° degrees in a range of –120° to +15° degrees. A mechanical stopper is also provided at the lower limit -130° degrees of the standard movable range.
	Space between the upper and lower limit	A space of 15° degrees or more is required.

Item		
J3-axis limit switch	Upper limit	Settable in steps of 15° degrees in a range of –120° to +15° degrees. A mechanical stopper is also provided at the upper limit +30° degrees of the standard movable range.
	Lower limit	Settable in steps of 15° degrees in a range of –120° to +15° degrees. A mechanical stopper is also provided at the lower limit -130° degrees of the standard movable range.
	Space between the upper and lower limit	A space of 15° degrees or more is required.

NOTE
If the newly set operation range does not include 0°, it is necessary to change it by zero degree mastering so that 0° is included.

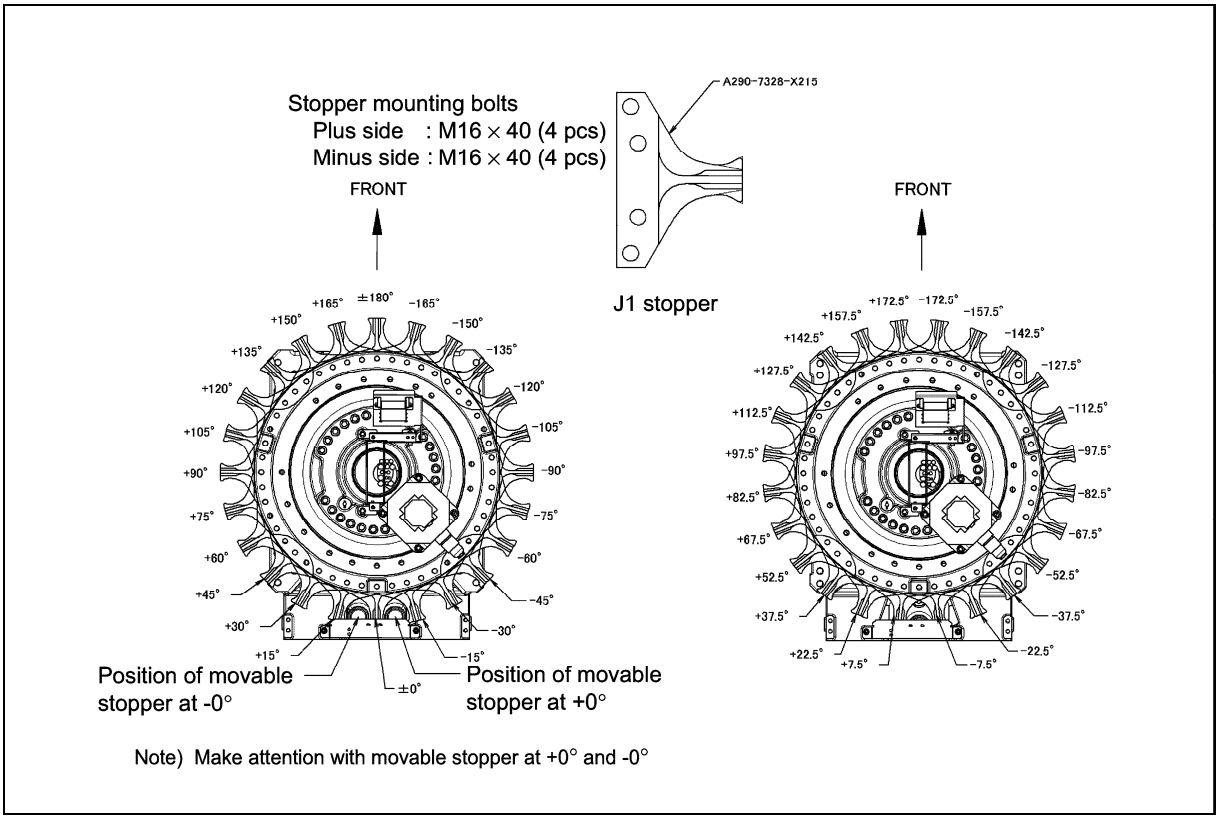


Fig. 5.1.3 (a) Adjustable mechanical stopper change of J1-axis (option)

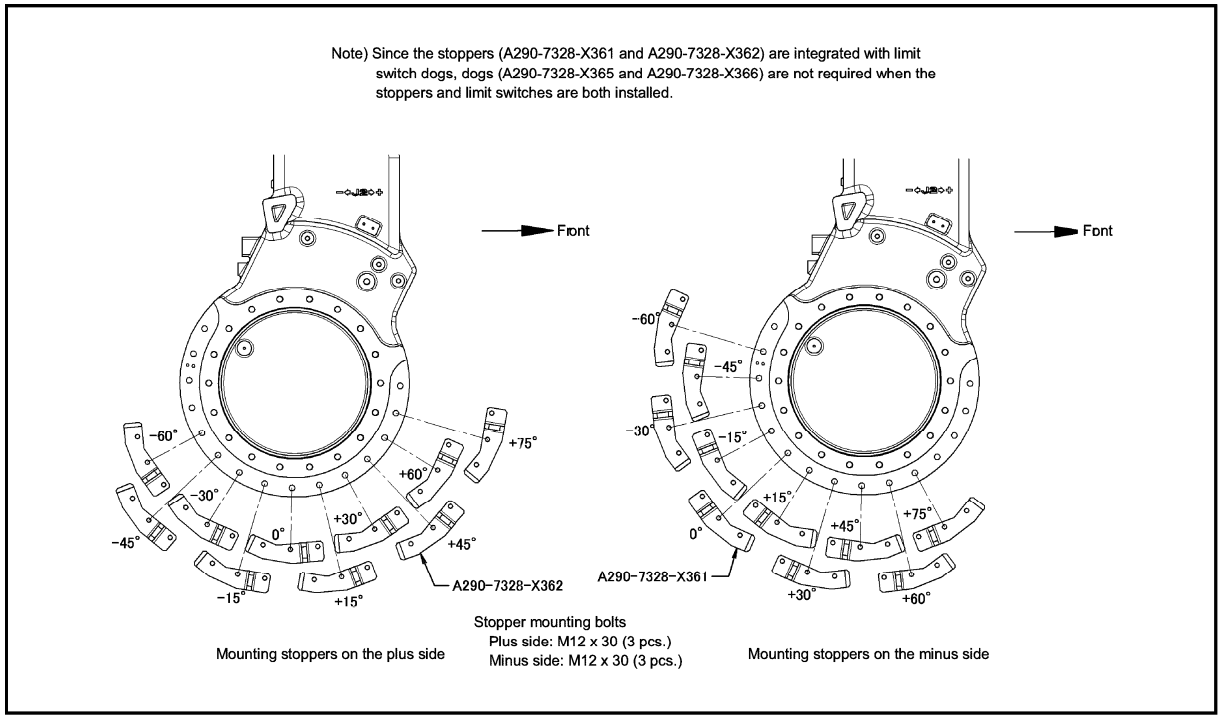


Fig. 5.1.3 (b) Adjustable mechanical stopper change of J2-axis (option)

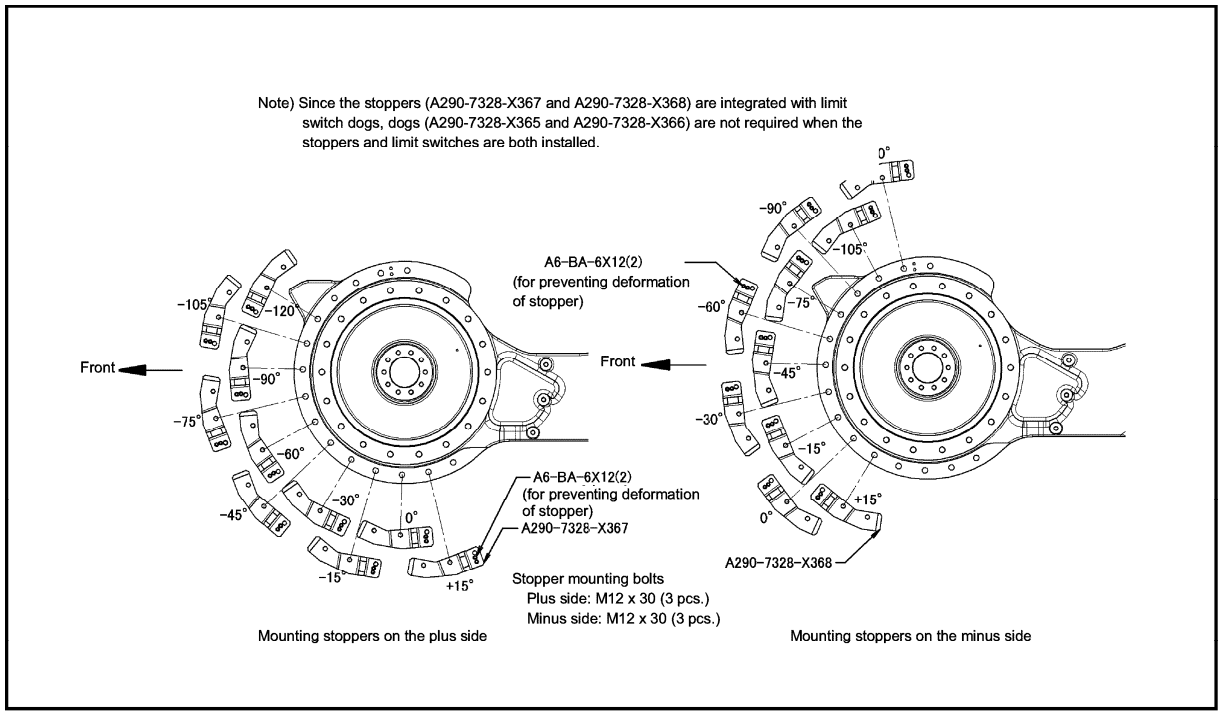


Fig. 5.1.3 (c) Adjustable mechanical stopper change of J3-axis (option)

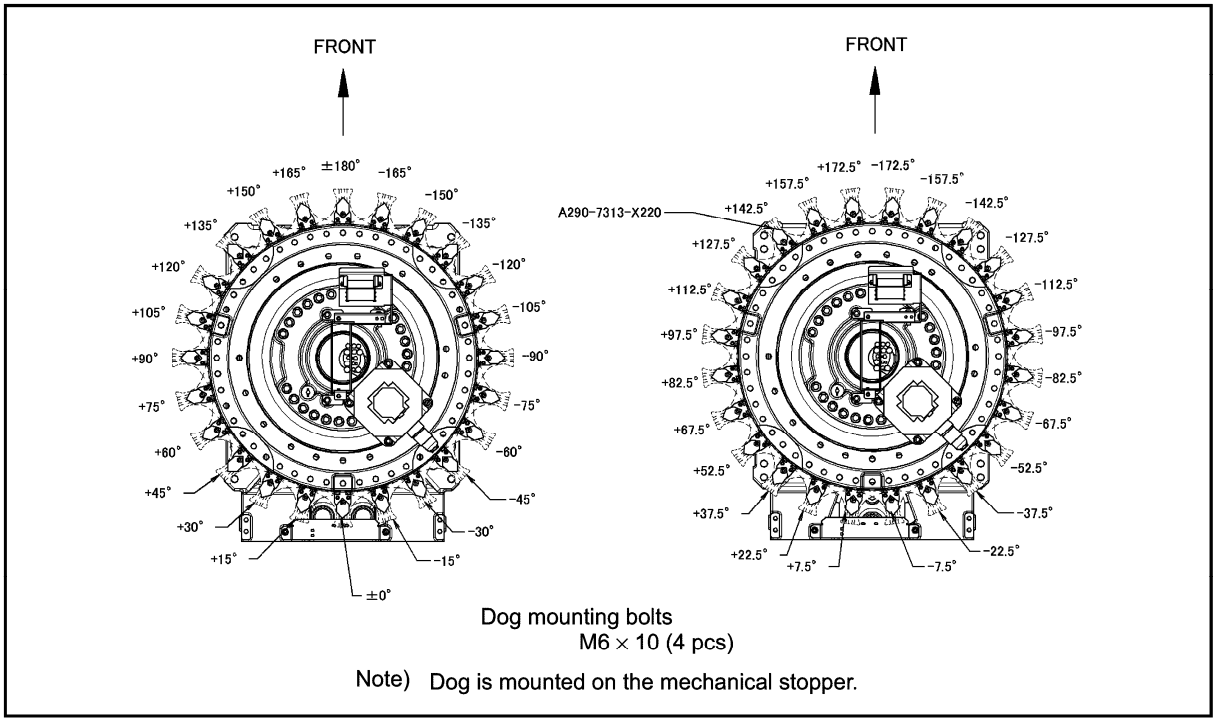


Fig. 5.1.3 (d) J1-axis dog (option) change

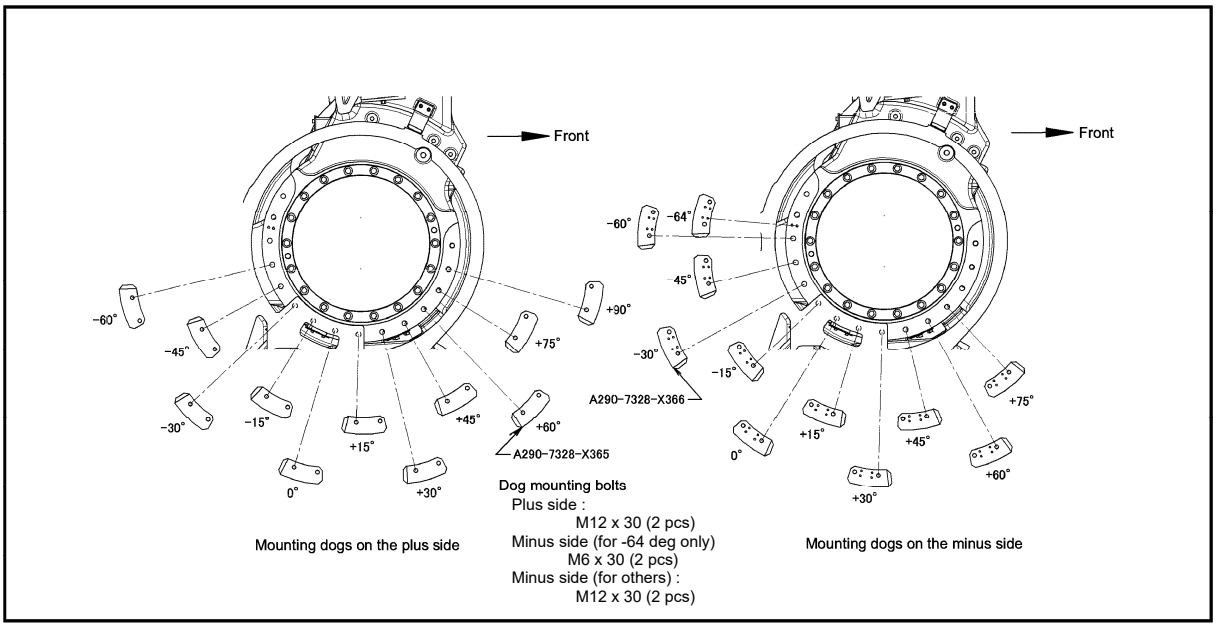


Fig. 5.1.3 (e) J2-axis dog (option) change

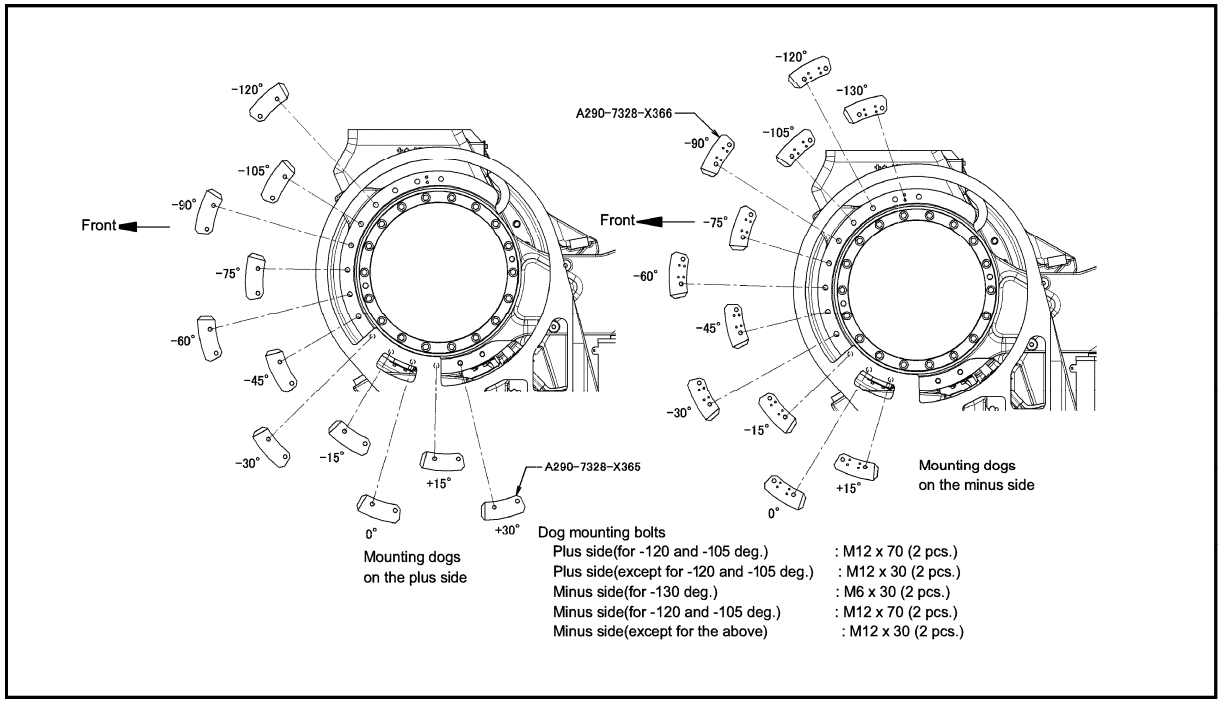


Fig. 5.1.3 (f) J3-axis dog (option) change

5.2 ADJUSTING LIMIT SWITCH (OPTION)

Axis limit switches are overtravel switches that, when tripped, cut power to the servo motors and an operation is stopped. Overtravel switches for J1-axis, J2-axis and J3-axis and J2/J3 interference angle are optional.

ADJUSTING PROCEDURE

1 Set the $MOR_GRP.$CAL_DONE system parameter to FALSE. This disables the motion limit specified by the software. As a result, the operator can rotate the robot by a jog feed which goes beyond the motion limit.

2 Loosen the following bolts that hold the limit switch.
Bolts secure the J1-axis: two M8 x 12 , two M4 x 25
Bolts secure the J2-axis: two M8 x 12 , two M6 x 10
Bolts secure the J3-axis: two M8 x 12 , two M6 x 10
Bolt secure the J2/J3
interference angle: four M4 x 6

3 Move the limit switch so that the robot activates it at about 0.5 degrees before the stroke end. Step on the dog, and position the limit switch in such a place that only one of the step-on allowance indication lines at the tip of the switch is hidden.

4 When the limit switch operates and detects overtravel (OT), the robot stops, and an error message, “OVERTRAVEL”, is displayed. To restart the robot, hold on the SHIFT key and press the RESET key. Then, while holding on the SHIFT key, move the adjusting axis off the OT limit switch by jogging in joint mode.

5 Check that the robot also activates the limit switch when the robot is approx. 0.5 degrees from the opposite stroke end in the same way as above. If the limit switch does not operate at the position, adjust the position of the switch again.

6 Set the $MOR_GRP.$CAL_DONE system parameter to TRUE.

7 Cycle power of the controller.

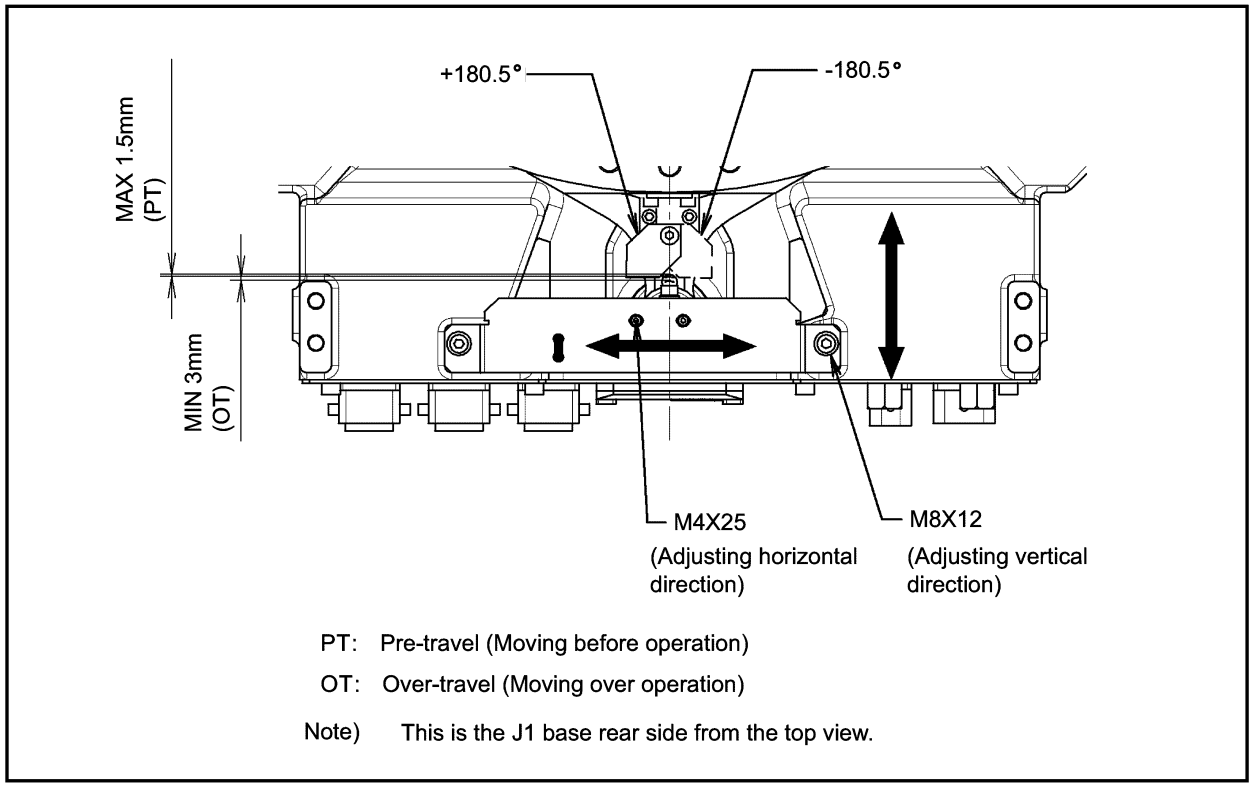


Fig. 5.2 (a) Adjusting J1-axis limit switch (option)

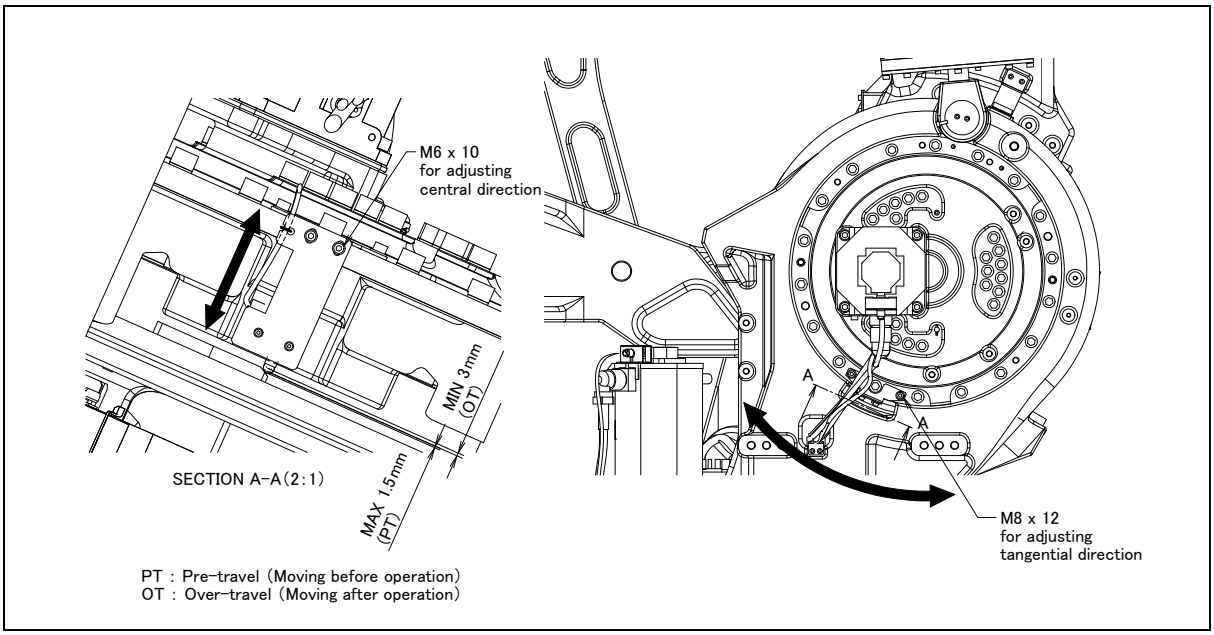


Fig. 5.2 (b) Adjusting J2-axis limit switch (option)

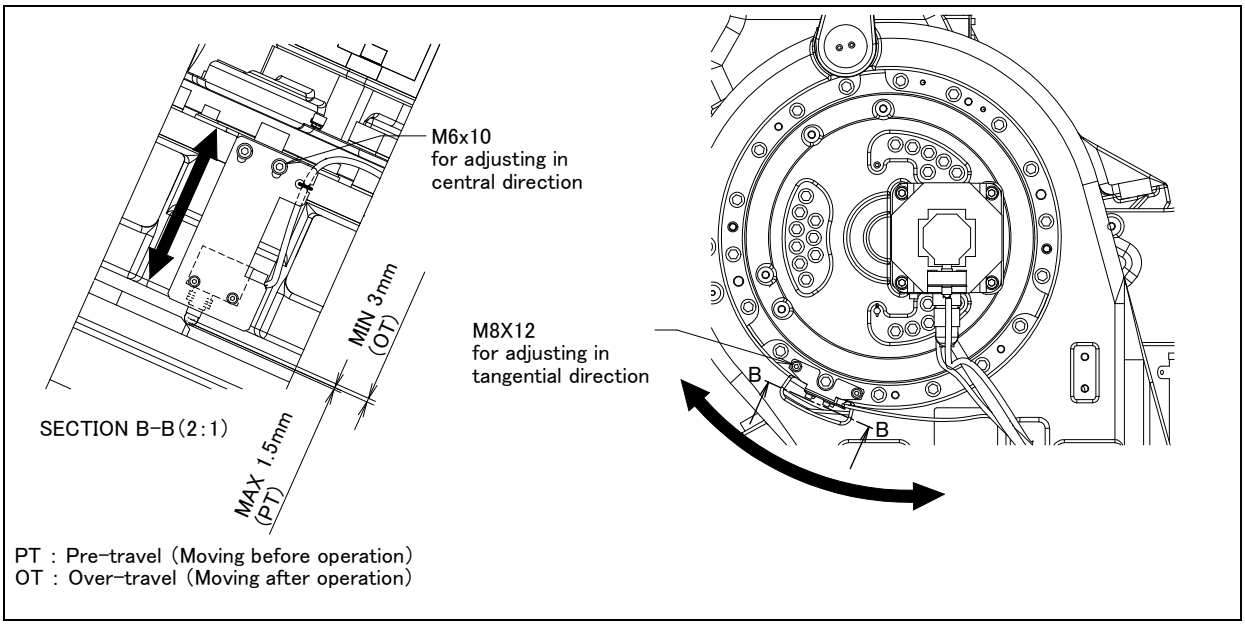


Fig. 5.2 (c) Adjusting J3-axis limit switch (option)

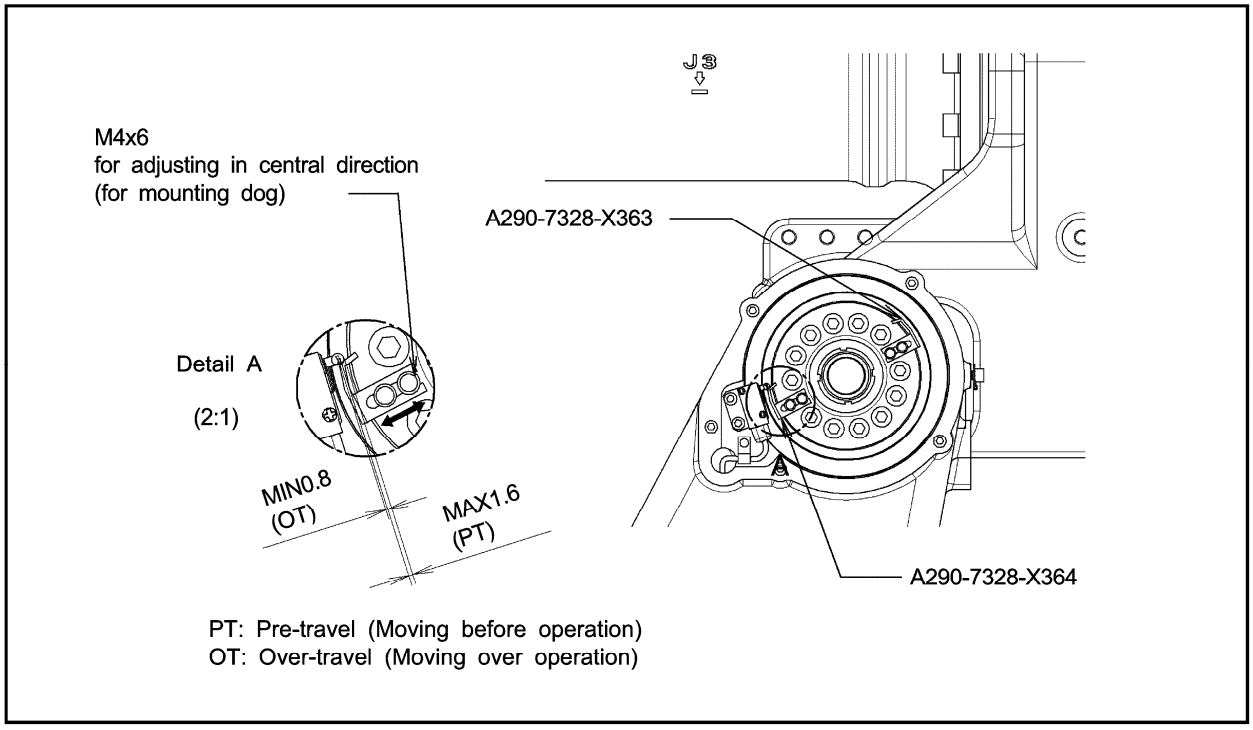


Fig. 5.2 (d) Adjusting J2/J3-axis interference angle limit switch (option)

5.3 MASTERING

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

5.3.1 Overview

The current position of the robot is determined according to the pulse count value supplied from the Pulsecoder on each axis.
Mastering is factory-performed. It is unnecessary to perform mastering in daily operations. However, mastering is required under the following conditions:

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

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

Types of Mastering

There are following mastering methods.

Table 5.3.1 (a) Types of mastering

Fixture position mastering	Mastering performed with the mastering fixture before shipping.
Zero-position mastering (witness mark mastering)	This is performed with all axes set at the 0-degree position. A zero-position mark (witness mark) is attached to each robot axis. This mastering is performed with all axes aligned to their respective witness marks.
Quick mastering	This is performed at a user-specified position. The corresponding count value is obtained from the rotation count of the Pulsecoder connected to the relevant motor and the rotation angle within one rotation. Quick mastering uses the fact that the absolute value of a rotation angle within one rotation will not be lost.
Single-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.
Vision axis mastering (option)	This is performed for one axis at a time with high precision by using vision. 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 controller reads the current pulse count value to sense the current position of the robot.

This section describes zero-position mastering, quick mastering, single-axis mastering, vision axis mastering and mastering data entry. For more detailed mastering, contact your local FANUC representative.

⚠ CAUTION
1 If mastering is performed incorrectly, the robot may behave unexpectedly. This is very dangerous. Therefore, 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.
2 It is recommended that you back up the current mastering data before performing mastering.

5.3.2 Resetting Alarms and Preparing for Mastering

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

Alarm displayed

"SRVO-062 BZAL" or "SRVO-075 Pulse not established"

Procedure

1 Display the positioning menu by following the steps 1 to 6.
   1 Press the [MENU] key.
   2 Press [0 NEXT] and select [6 SYSTEM].
   3 Press F1 ([TYPE]), and select [Variable] from the menu.
   4 Place the cursor on $MASTER_ENB, then key in "1" and press the [ENTER] key.
   5 Press F1 ([TYPE]), and select [Master/Cal] from the menu.
   6 Select the desired mastering type from the [Master/Cal] menu.

2 To reset the "SRVO-062 BZAL" alarm, follow steps 1 to 5.
   1 Press the [MENU] key.
   2 Press [0 NEXT] and select [6 SYSTEM].
   3 Press F1 ([TYPE]), and select [Master/Cal] from the menu.
   4 Press F3 ([RES_PCA]), then press F4 ([YES]).
   5 Cycle power of the controller.

3 To reset the "SRVO-075 Pulse not established" alarm, follow the steps 1 to 2.
   1 After cycling controller power, the message "SRVO-075 Pulse not established" appears again.
   2 Move the axis for which the message mentioned above has appeared in either direction till the alarm disappears when you press the [RESET] key.

5.3.3 Zero Position Mastering

Zero-position mastering (witness mark mastering) is performed with all axes set at the 0-degree position. A zero-position mark (witness mark) is attached to each robot axis (Fig. 5.3.3 (a)). This mastering is performed with all axes set at the 0-degree position using their respective witness marks.

Zero-position mastering involves a visual check, and might not be highly accurate. It should be used only as a quick-fix method.

Zero-position Mastering Procedure

1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE].
4 Select [Master/Cal].

```
SYSTEM Master/Cal          AUTO   JOINT 10 %
                                  TORQUE = [ON ]
 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
```

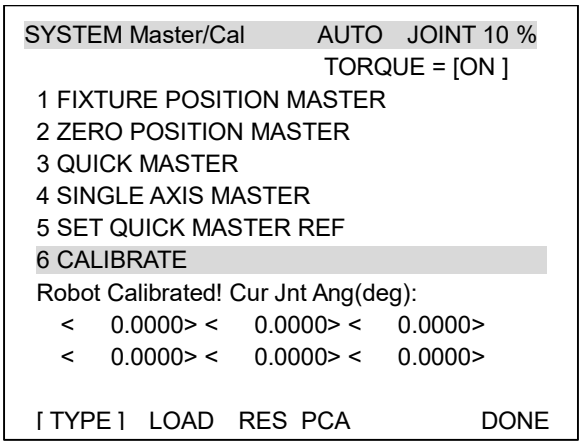
5 Release brake control, and jog the robot into a posture for mastering.

NOTE
Brake control can be released by setting the system variables as follows:
$PARAM_GROUP.SV_OFF_ALL: FALSE
$PARAM_GROUP.SV_OFF_ENB[*]: FALSE (for all axes)
After changing the system variables, turn off the controller power and on again.

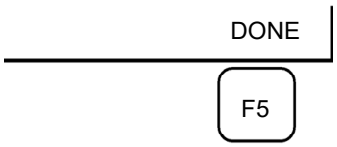
6 Select [2 Zero Position Master]. Press F4 [YES].

```
SYSTEM Master/Cal          AUTO   JOINT 10 %
                                  TORQUE = [ON ]
 1 FIXTURE POSITION MASTER
 2 ZERO POSITION MASTER
 3 QUICK MASTER
 4 SINGLE AXIS MASTER
 5 SET QUICK MASTER REF
 6 CALIBRATE
 Robot Mastered! Mastering Data:
    <0> <11808249> <38767856>
    <9873638> <12200039> <2000319>
[ TYPE ]   LOAD   RES_PCA                DONE
```

7 Select [6 CALIBRATE] and press F4 [YES]. Mastering will be performed automatically. Alternatively, turn off the controller power and on again. Turning on the power always causes positioning to be performed.



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



9 Return brake control to original setting, and cycle power of the controller.

Table 5.3.3 (a) Posture with zero position marks aligned

Axis	Position
J1-axis	0 deg
J2-axis	0 deg
J3-axis	0 deg (NOTE) When J2-axis is 0 deg.
J4-axis	0 deg
J5-axis	0 deg
J6-axis	0 deg

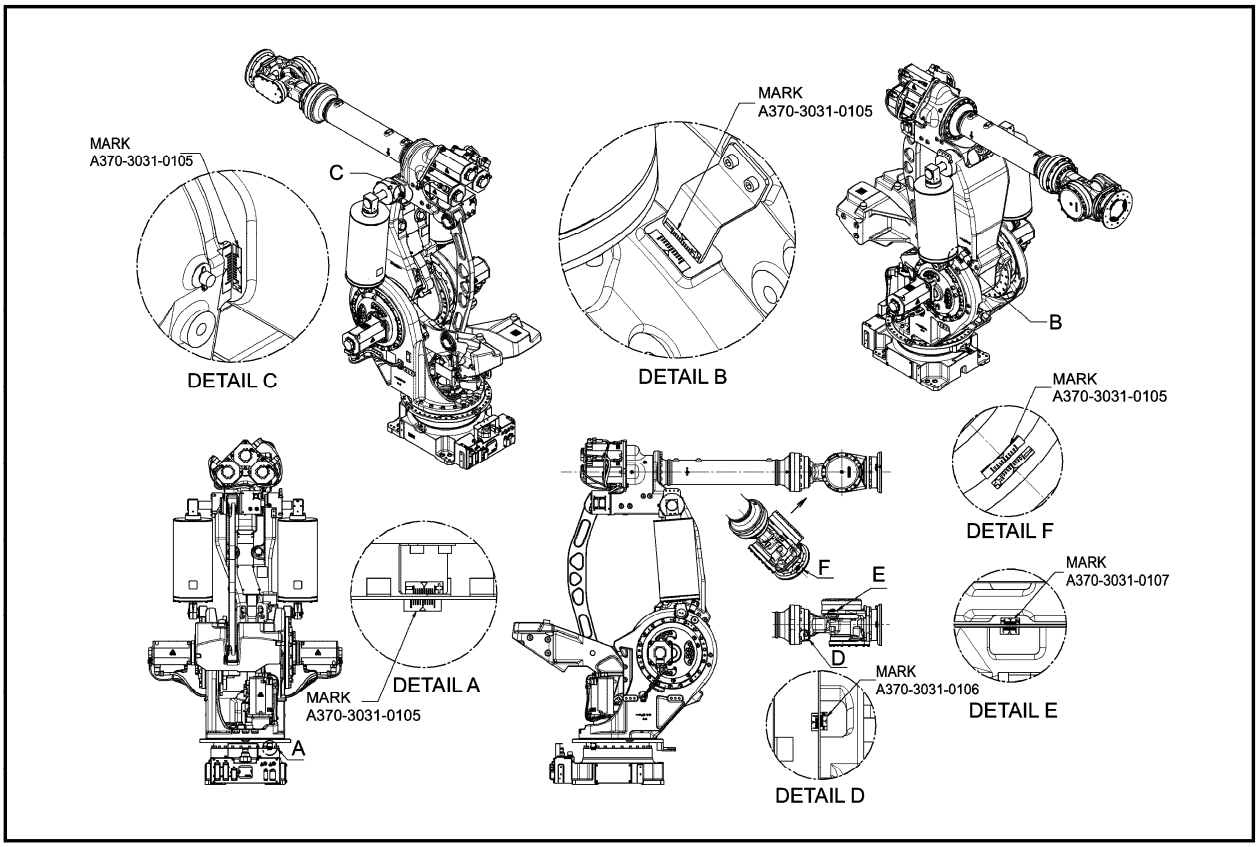


Fig. 5.3.3 (a) Zero position mark for each axis

5.3.4 Quick Mastering

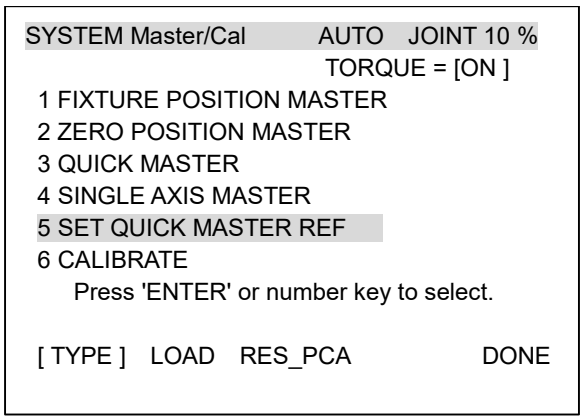
Quick mastering is performed at a user-specified position for one axis. The pulse count value is obtained from the rotation times of the Pulsecoder connected to the relevant motor and the rotation angle within one rotation. Quick mastering uses the character that the absolute value of a rotation angle within one rotation will not be lost.

Quick mastering is factory-performed at the position indicated in Table. 5.3.3 (a). 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 quick mastering reference position using the following method. (It would be convenient to set up a marker that can work in place of the witness mark.)

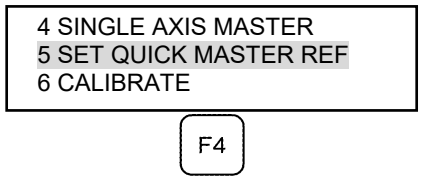
⚠CAUTION
1 Quick mastering can be used, if the pulse count value is lost, for example, because a low voltage has been detected on the backup battery for the pulse counter.
2 Quick mastering cannot be used, after the Pulsecoder is replaced or after the mastering data is lost from the robot controller.

Procedure Recording the Quick Mastering Reference Position

1 Select [6 SYSTEM].
2 Select [Master/Cal]. The positioning screen will be displayed.



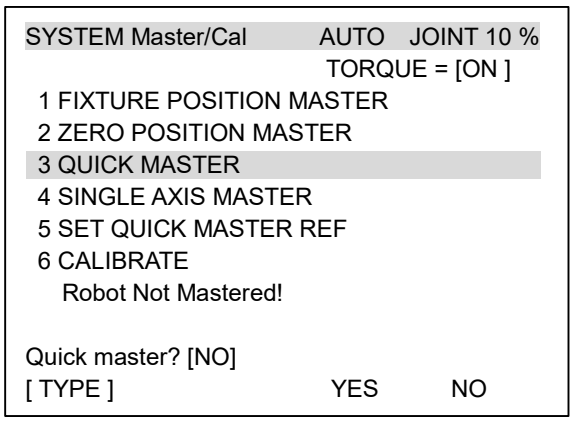
3 Release brake control, and jog the robot to the quick mastering reference position.
4 Select [5 SET QUICK MASTER REF] and press F4 [YES]. Quick mastering reference position will be set.



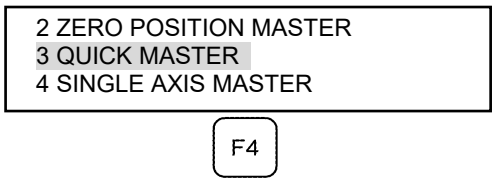
> ⚠ **CAUTION**
> If the robot has lost mastering data due to mechanical disassembly or repair, you cannot perform this procedure. In this case, perform Fixture position mastering or Zero position mastering to restore mastering data.

Procedure of Quick Mastering

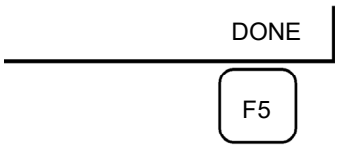
1 Display the Master/Cal screen.



2 Release brake control, and jog the robot to the quick mastering reference position.
3 Select [3 QUICK MASTER]. Press F4 [YES]. Quick mastering reference positon will be set.



4 Select [6 CALIBRATE] and press the [ENTER] key. Calibration is executed. Calibration is executed by power on again.
5 After completing the calibration, press F5 [Done].



6 Return brake control to original setting, and cycle power of the controller.

5.3.5 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 Pulsecoder has been replaced.

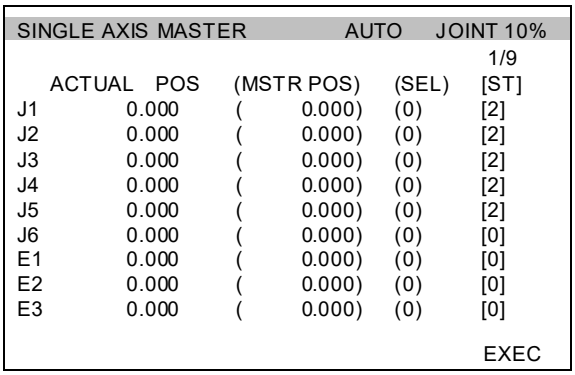


Table 5.3.5 (a) Items set in single axis mastering

Item	Description
Current position (ACTUAL POS)	The current position of the robot is displayed for each axis in degree units.
Mastering position (MSTR POS)	A mastering position is specified for an axis to be subjected to single axis mastering. It would be convenient to set 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 of Single Axis Mastering

1 Select [6 SYSTEM].
2 Select [Master/Cal].

```
SYSTEM Master/Cal          AUTO   JOINT 10 %
                                  TORQUE = [ON ]
 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
```

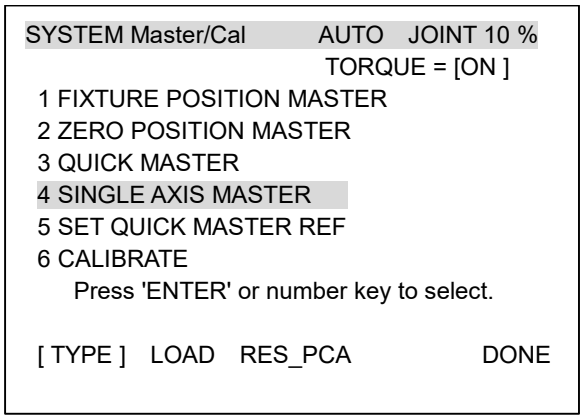
3 Select [4 SINGLE AXIS MASTER]. The following screen will be displayed.

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

                                              EXEC
```

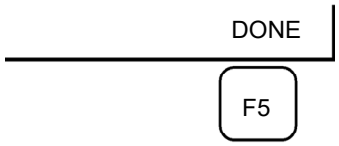
4 For the axis to which to perform single axis mastering, set (SEL) to “1.” Setting of (SEL) is available for one or more axes.
5 Turn off brake control, then jog the robot to the mastering position.
6 Enter axis data for the mastering position.
7 Press F5 [EXEC]. Mastering is performed. So, (SEL) is reset to 0, and [ST] is re-set to 2 or 1.

```
SINGLE AXIS MASTER              AUTO    JOINT 1%
                                                [ON]
    ACTUAL   POS    (MSTR POS)     (SEL)    [ST]
J1        25.255    (     0.000)   (0)      [2]
J2        25.255    (     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)      [0]
E1         0.000    (     0.000)   (0)      [0]
E2         0.000    (     0.000)   (0)      [0]
E3         0.000    (     0.000)   (0)      [0]

                                              EXEC
```

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



9 Select [6 CALIBRATE], then press F4 [YES]. Positioning is performed. Alternatively, turn off the controller power and on again. Positioning is performed.
10 After positioning is completed, press F5 [DONE].



11 Return brake control to the original setting, and cycle power of the controller.

5.3.6 Vision Axis Mastering

Single axis mastering can be performed with high precision by using vision axis master. Target mark have cover plate as Fig.5.3.6 (a), (b). Refer to Fig 5.3.6 (c) about target fixture. Refer to VISION AXIS MASTER chapter of *i*RCalibration operator's manual about vision axis mastering.
Please refer to Table 5.3.6 (a) about measurement position.

Table 5.3.6 (a) Measurement position for vision axis mastering

Measured axis	posture					
	J1-axis	J2-axis	J3-axis	J4-axis	J5-axis	J6-axis
J1-axis	0°	Arbitrary				
J2-axis	Arbitrary	0°				
J3-axis	Arbitrary	0°	-30°	0°		
J4-axis	Arbitrary		0°			
J5-axis	Arbitrary		0°			
J6-axis	Arbitrary		0°			

Reference data setting function is executed in the FANUC robot factory before shipping the robot. There is not tool attached. However, the weight of a tool can cause an error in the reference data. After a tool is attached, the *reference data setting* function should be performed and saved again. (This new reference data needs to be used if the mastering status needs to be recovered.)

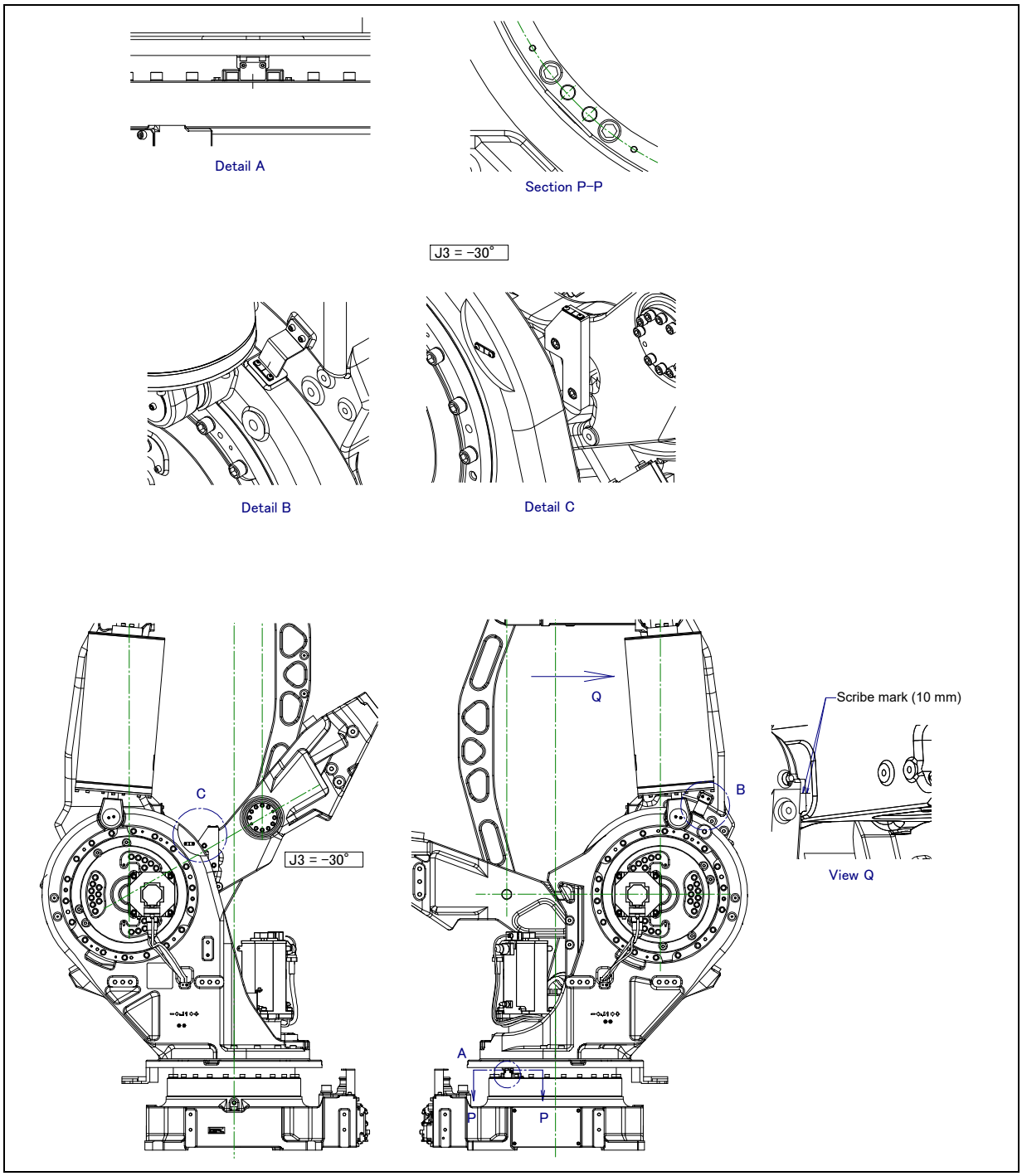


Fig.5.3.6 (a) Target mark cover plate (1/2)

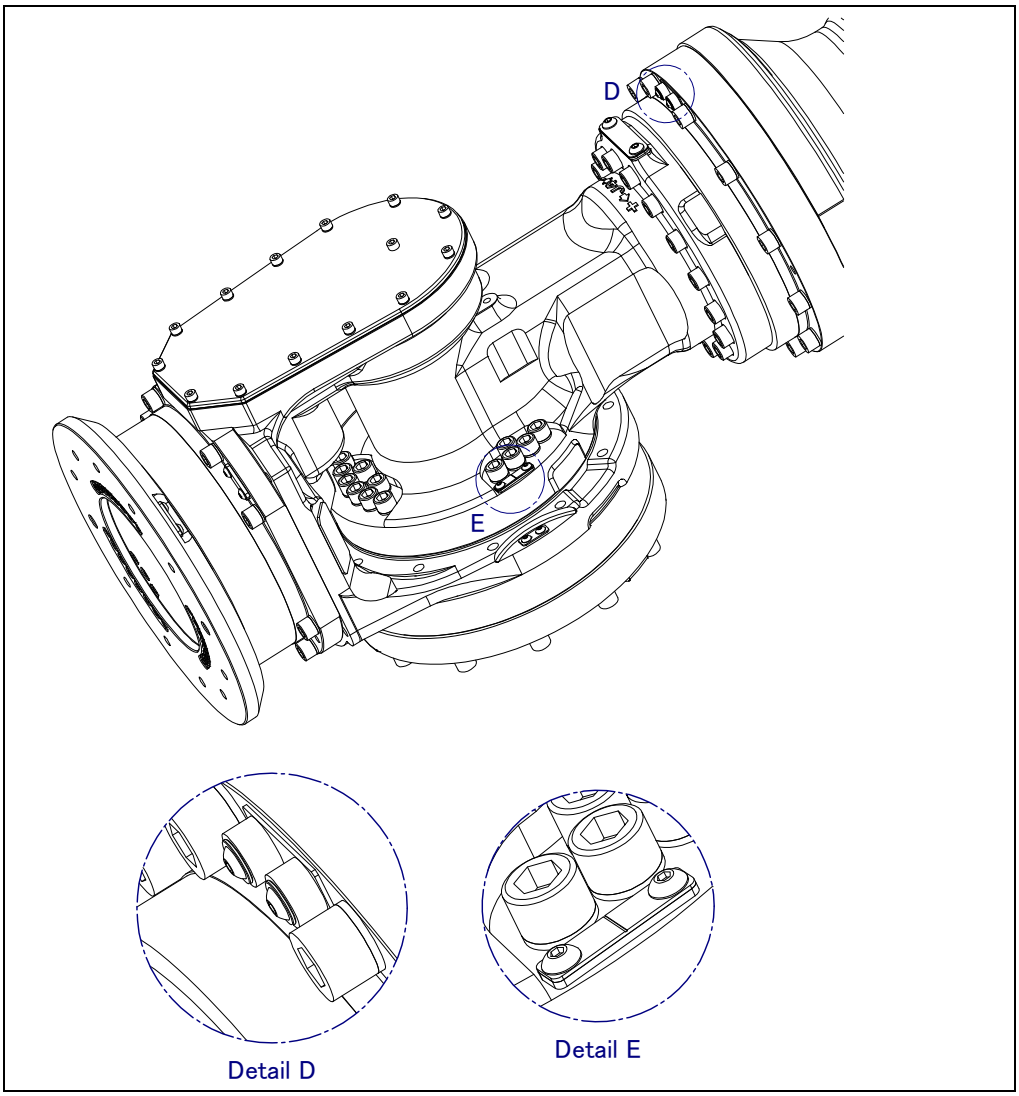


Fig.5.3.6 (b) Target mark cover plate (2/2)

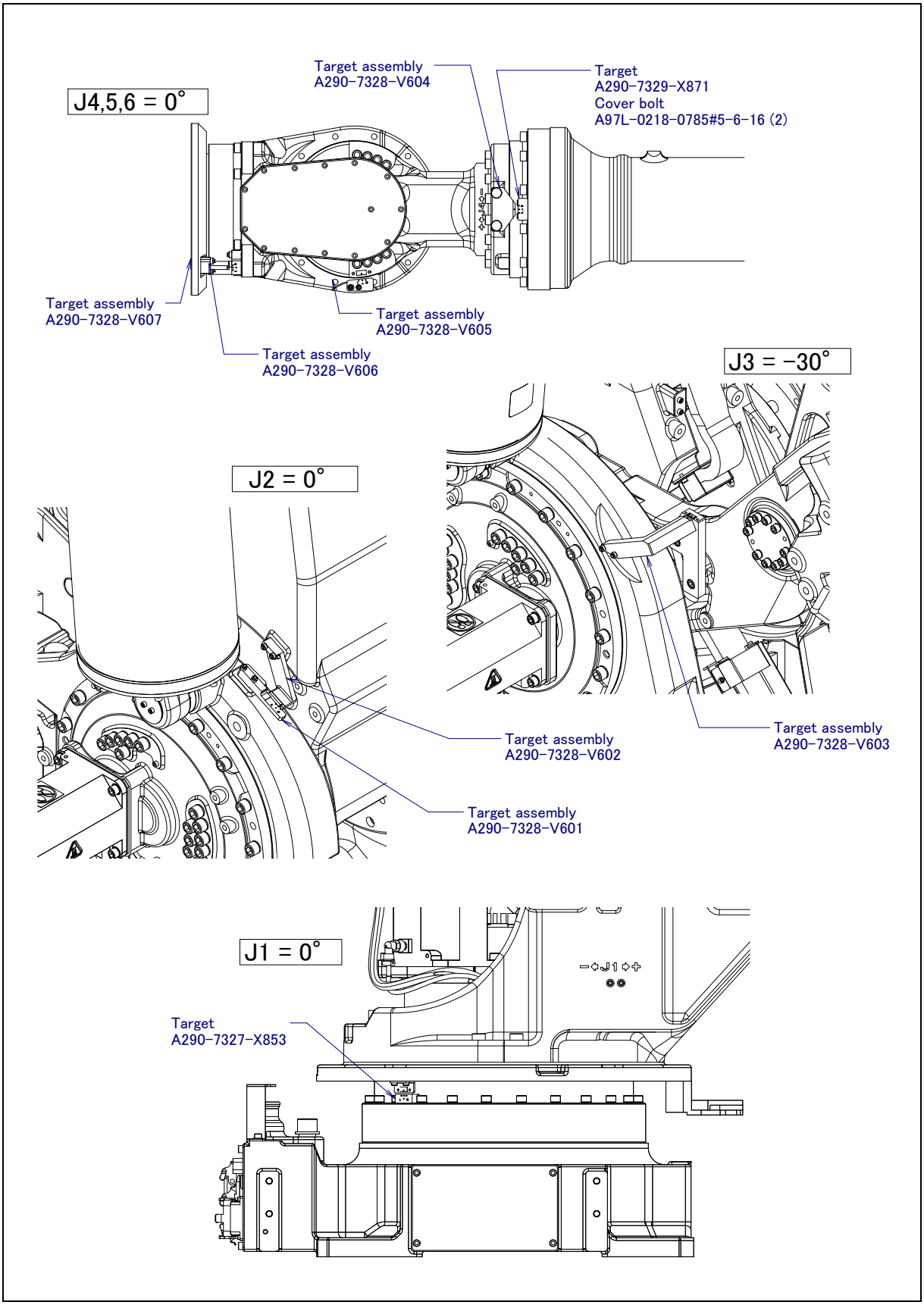


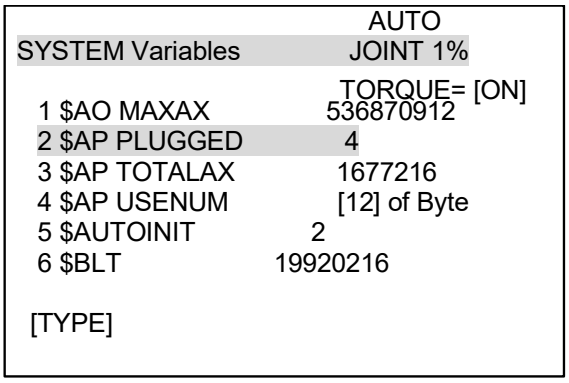
Fig 5.3.6 (c) Target fixture

5.3.7 Mastering Data Entry

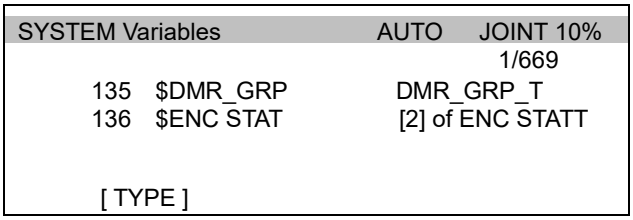
This function enables mastering data values to be assigned directly to a system variable. It can be used if mastering data has been lost but the pulse count is preserved.

Mastering data entry method

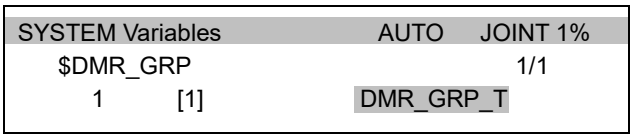
1 Press the [MENU] key, then press [0 NEXT] and select [6 SYSTEM].
2 Press F1 [TYPE]. Select [Variables]. The system variable screen will be displayed.

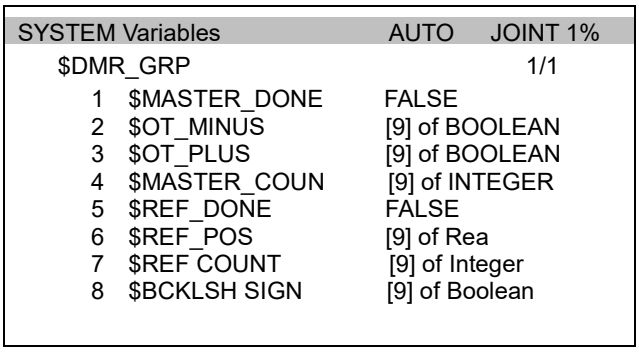


3 Change the mastering data. The mastering data is saved to the $DMR_GRP.$MASTER_COUN system variable.

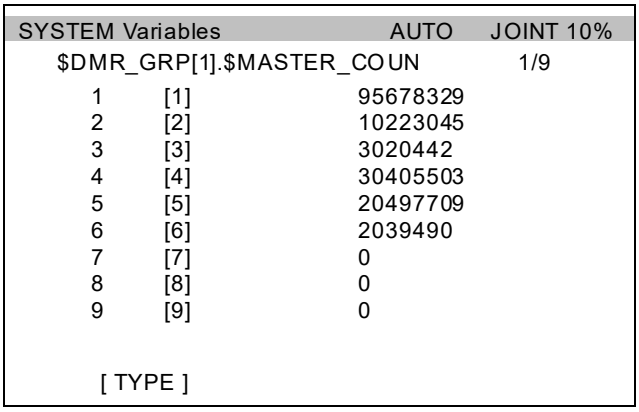


4 Select $DMR_GRP.

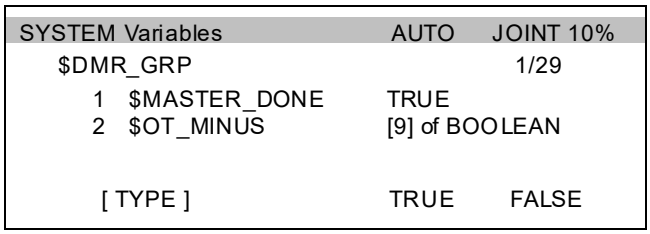




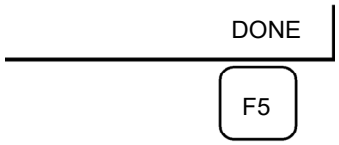
5 Select $MASTER_COUN, and enter the mastering data you have recorded.



6 Press the [PREV] key.
7 Set $MASTER_DONE to TRUE.



8 Display the positioning screen, and select [6 CALIBRATE], then press F4 [YES].
9 After completing positioning, press F5 [DONE].



5.3.8 VERIFYING MASTERING

1 How to verify that the robot is mastered properly:
Usually, positioning is performed automatically when the power is turned on. To check whether mastering has been performed correctly, examine if the current displayed position matches the actual robot position by using one or more of the procedures described below:
(1) Reproduce a particular point in a program. Check whether the point agrees with the specified position.
(2) Set all axes of the robot to their 0-degree (0 rad) positions. Check that the zero-degree position marks indicated in Subsection 5.3.3 of the OPERATOR'S MANUAL are aligned. There is no need to use a visual aid.
If the displayed and actual positions do not match, the counter value for a Pulsecoder may have been invalidated as a result of an alarm described in 2 in this Section. Alternatively, the mastering data in system variable $DMR_GRP.$MASTER_COUN may have been overwritten as a result of an operation error or some other reason.
Compare the data with the values indicated on the supplied data sheet. This system variable is overwritten whenever mastering is performed. Whenever mastering is performed, record the value of the system variable on the data sheet.

2 Alarm types displayed during mastering and their solution method:
(1) BZAL alarm
This alarm is displayed if the Pulsecoder's backup battery voltage decreases to 0 V while the power to the controller is disconnected. Furthermore, if the Pulsecoder connector is removed for cable replacement, etc. this alarm is displayed as the voltage decreases to 0. Check to see if the alarm will disappear by performing a pulse reset (See Subsection 5.3.2.). Then, cycle controller power and check if the alarm disappears or not.
The battery may be drained if the alarm is still displayed. Perform a pulse reset, and turn off and on the controller power after replacing the battery. Note that, if this alarm is displayed, all the original data held by the Pulsecoder will be lost. Mastering is required.
(2) BLAL alarm
This alarm is displayed if the voltage of the Pulsecoder's backup battery has fallen to a level where backup is no longer possible. If this alarm is displayed, replace the battery with a new one immediately while keeping the power turned on. Check whether the current position data is valid, using the procedure described in 1 in this Section.
(3) Alarm notification like CKAL, RCAL, PHAL, CSAL, DTERR, CRCERR, STBERR, and SPHAL may have trouble with Pulsecoder, contact your local FANUC representative.

6 PIPING AND WIRING

6.1 WIRING DIAGRAM

Fig. 6.1 (a), (b) are the routing of the robot cables and the connector wiring.

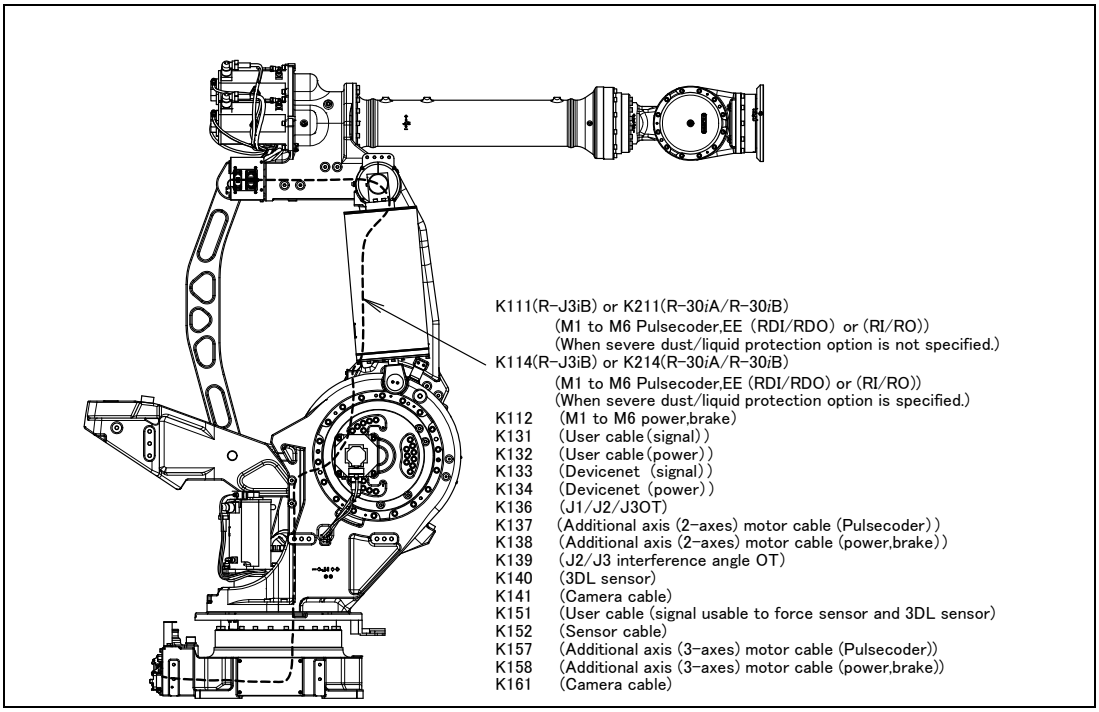


Fig. 6.1 (a) Wiring diagram

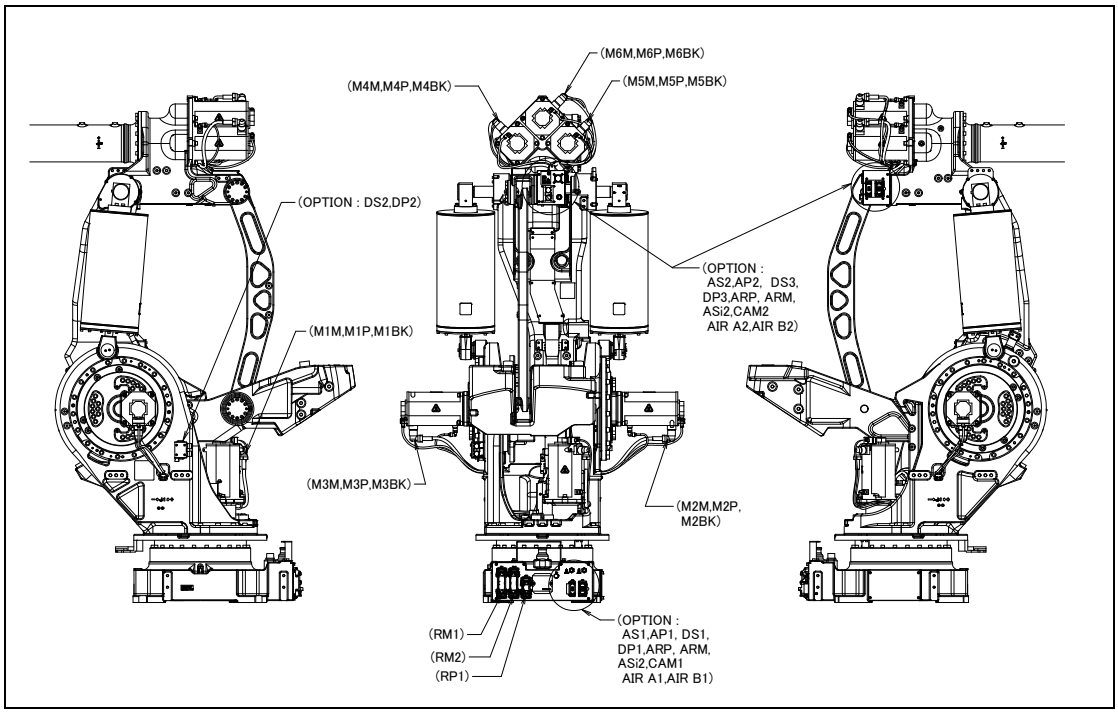


Fig. 6.1 (b) Connector locations

7 SEVERE DUST/LIQUID PROTECTION OPTION

7.1 SEVERE DUST/LIQUID PROTECTION PACKAGE (OPTION)

The package is intended to improve the dustproof and waterproof characteristics of the robot so that it can be used in a severe environment.

NOTE
Contact your FANUC representative for confirmation that the Severe Dust/liquid protection package is suitable for your environment.

Model	Severe dust/liquid protection specification
M-900*i*A/600/400L	A05B-1328-J801

7.2 DUSTPROOF AND WATERPROOF CHARACTERISTICS

The following table lists the IEC60529-based dustproof and waterproof characteristics of the M-900*i*A/600/400L.

	Standard	Severe dust / liquid protection package
J3 arm and wrist section	IP67	IP67
Driving unit of the main body	IP66	IP66
Main body	IP54	IP56

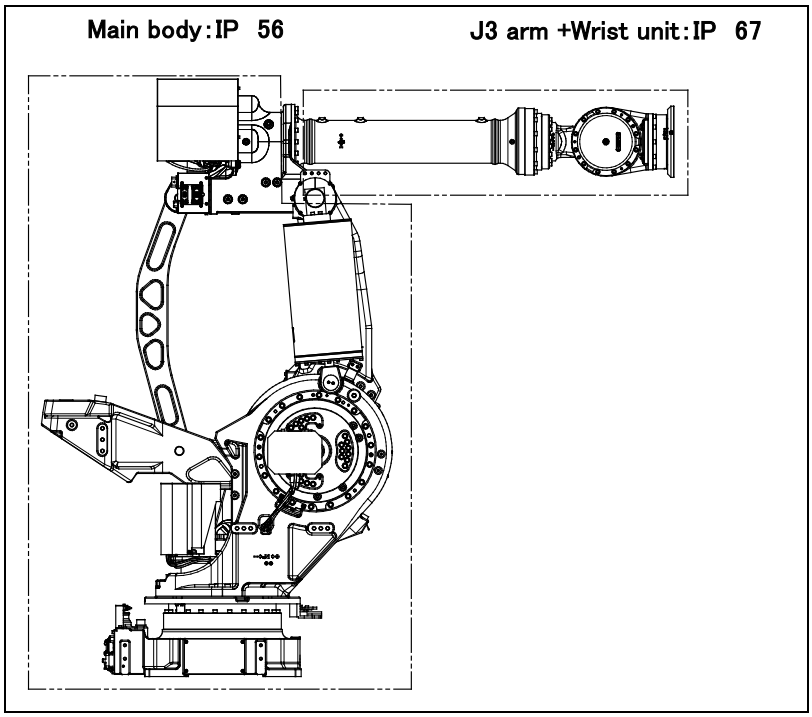


Fig. 7.2 (a) Dustproof and waterproof characteristics of M-900*i*A/600/400L

7.3 CONFIGURATION OF THE SEVERE DUST/LIQUID PROTECTION PACKAGE

The following table lists the major differences between the M-900*i*A/600/400L standard specification and severe dust/liquid protection package.

	Standard specification	Dust-proof/drip-proof enhancement option
Bolts	Black oxide film	FR coating bolt Stainless bolt
Cover		J1 cover J2, J3 cover J4, J5, J6 cover Battery box cover
EE connector	Non-waterproof connector	Waterproof connector

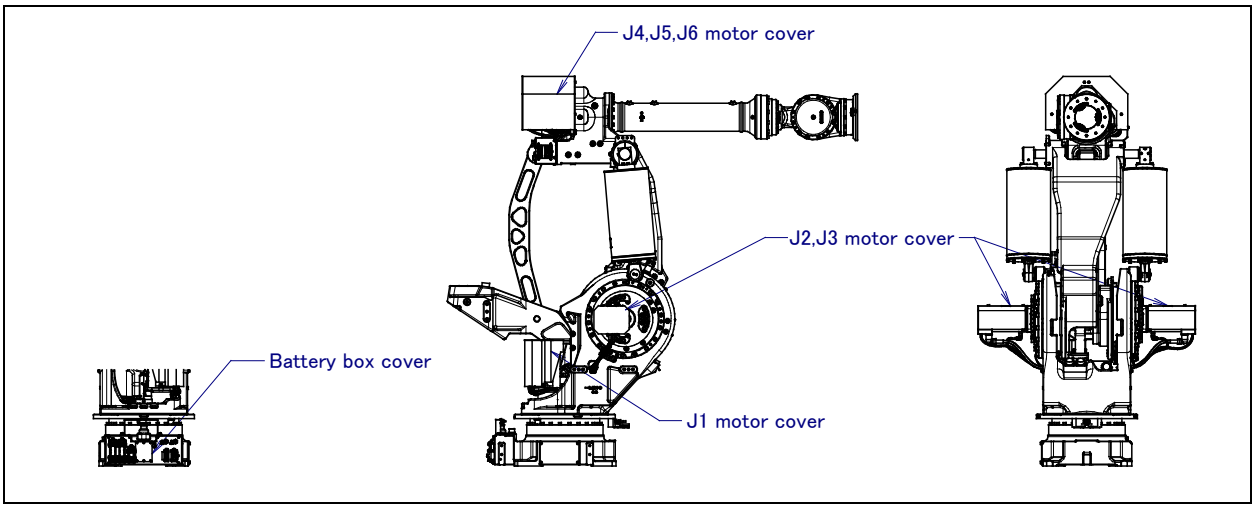


Fig. 7.3 (a) Configuration of the severe dust/liquid protection package of M-900*i*A/600/400L

7.4 NOTES ON SPECIFYING SEVERE DUST/LIQUID PROTECTION PACKAGE

1. The liquids below cannot be applied because they may cause deterioration or corrosion of the rubber parts (such as gaskets, oil seals, and O-rings) used in the robot.
    1. Organic solvent
    2. Chlorine- or gasoline-based cutting fluid
    3. Amine-based cleaning fluid
    4. Liquid or solution that includes a corrosive such as an acid or alkali or causes rust
    5. Some other liquid or solution to which nitrile rubber (NBR) does not have resistance
2. When the robot is used in an environment where a liquid such as water is dashed over the robot, great attention should be given to drainage under the J1 base.
   A failure may be caused if the J1 base is kept immersed in water due to poor drainage.
3. When specifying this option, be sure to specify the mechanical unit cable that supports the severe dust/liquid protection option at the same time.

8 ROBOT OPEARTING SPACE

8.1 MECHANICAL UNIT EXTERNAL DIMENSIONS

Fig. 8.1 (a), (b) show the external dimensions of the robot. When installing peripheral equipment, be careful to clear away any objects that are in the robot's operating space in normal operation.

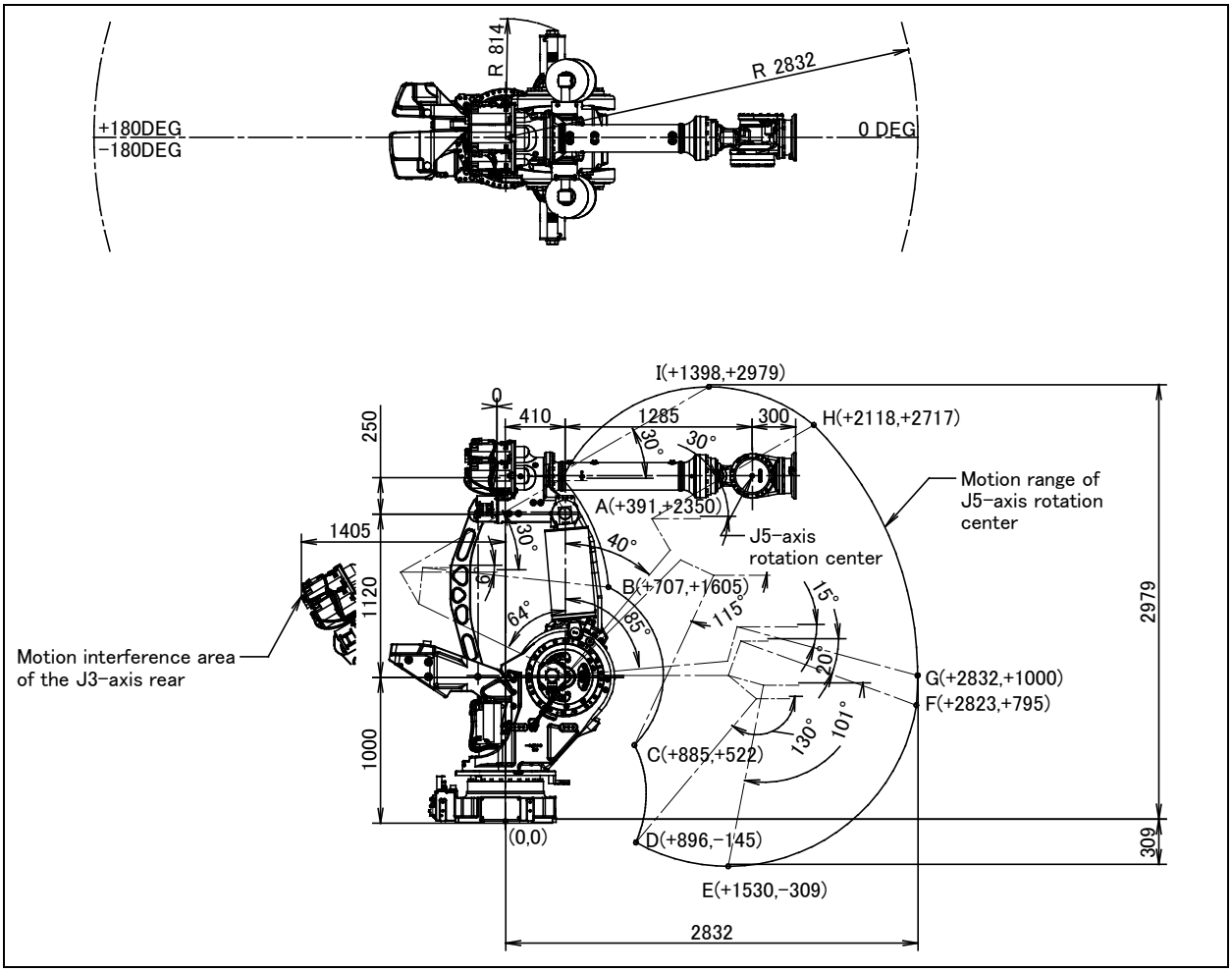


Fig. 8.1 (a) Mechanical unit operating space (M-900*i*A/600)

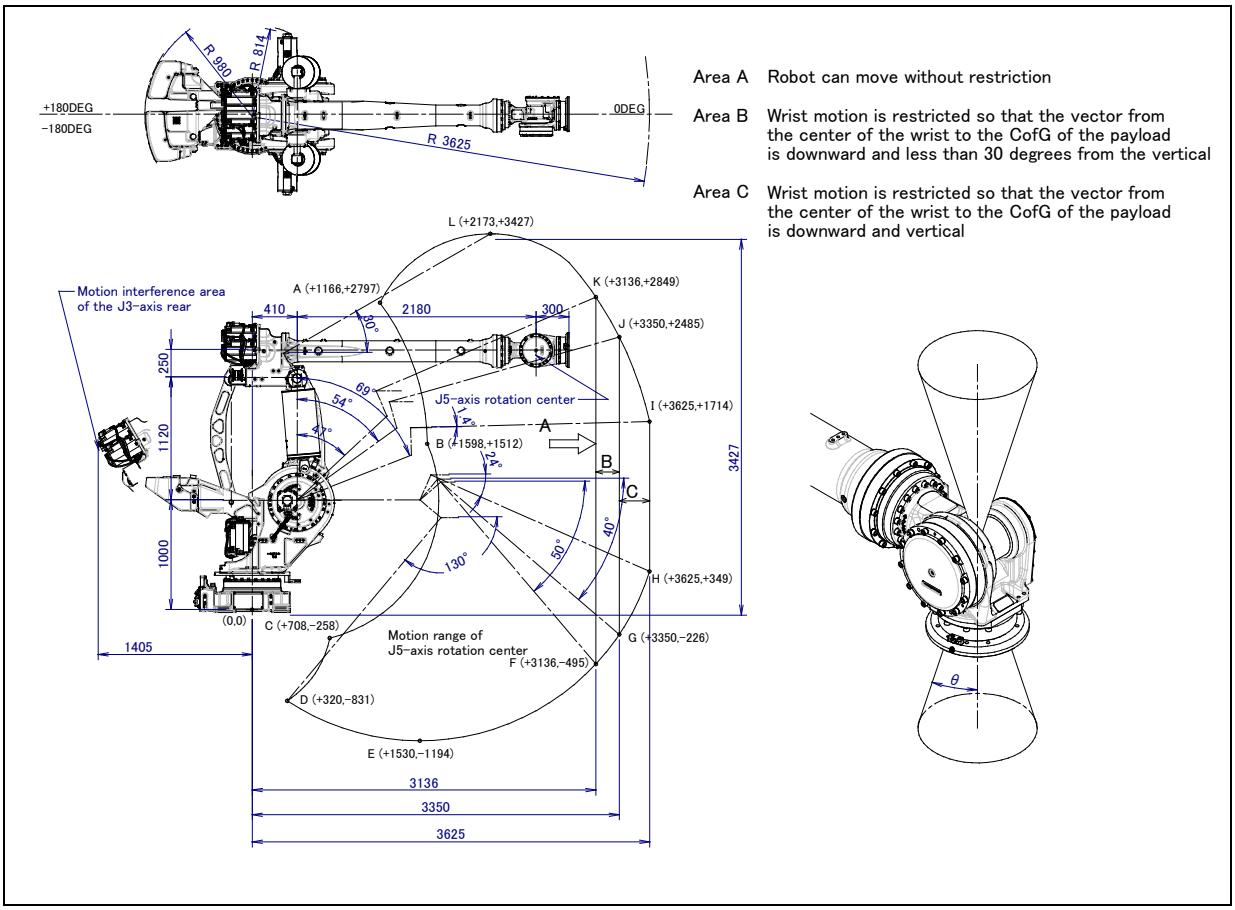


Fig. 8.1 (b) Mechanical unit operating space (M-900*i*A/400L)

9 MECHANICAL EQUIPMENT INSTALLATION TO THE ROBOT

9.1 WRIST LOAD CONDITIONS

Fig. 9.1 (a) to (c) show diagrams that show the wrist load limits. Apply a load within the region indicated in the graph. Apply the conditions of the allowable load moment and the allowable load inertia, too. Refer to specification table of “PREFACE” about allowable inertia and moment.

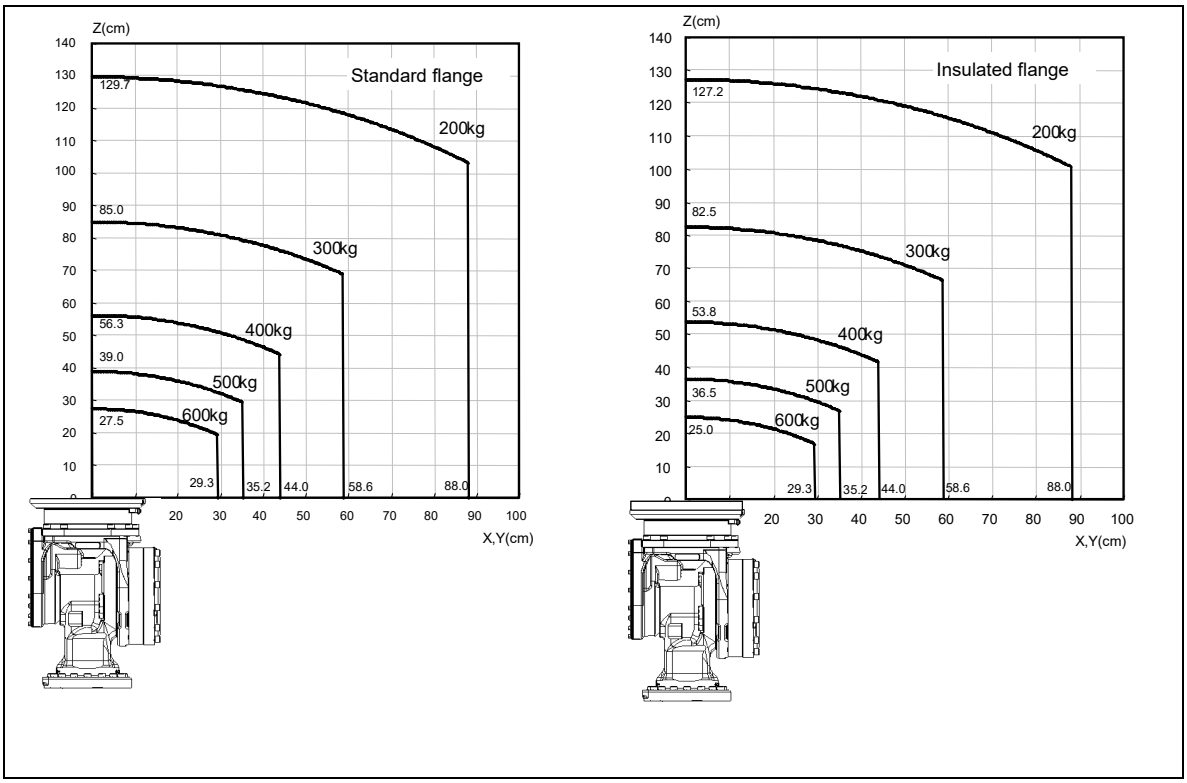


Fig. 9.1 (a) Wrist load diagram (for the standard specifications of M-900*i*A/600)

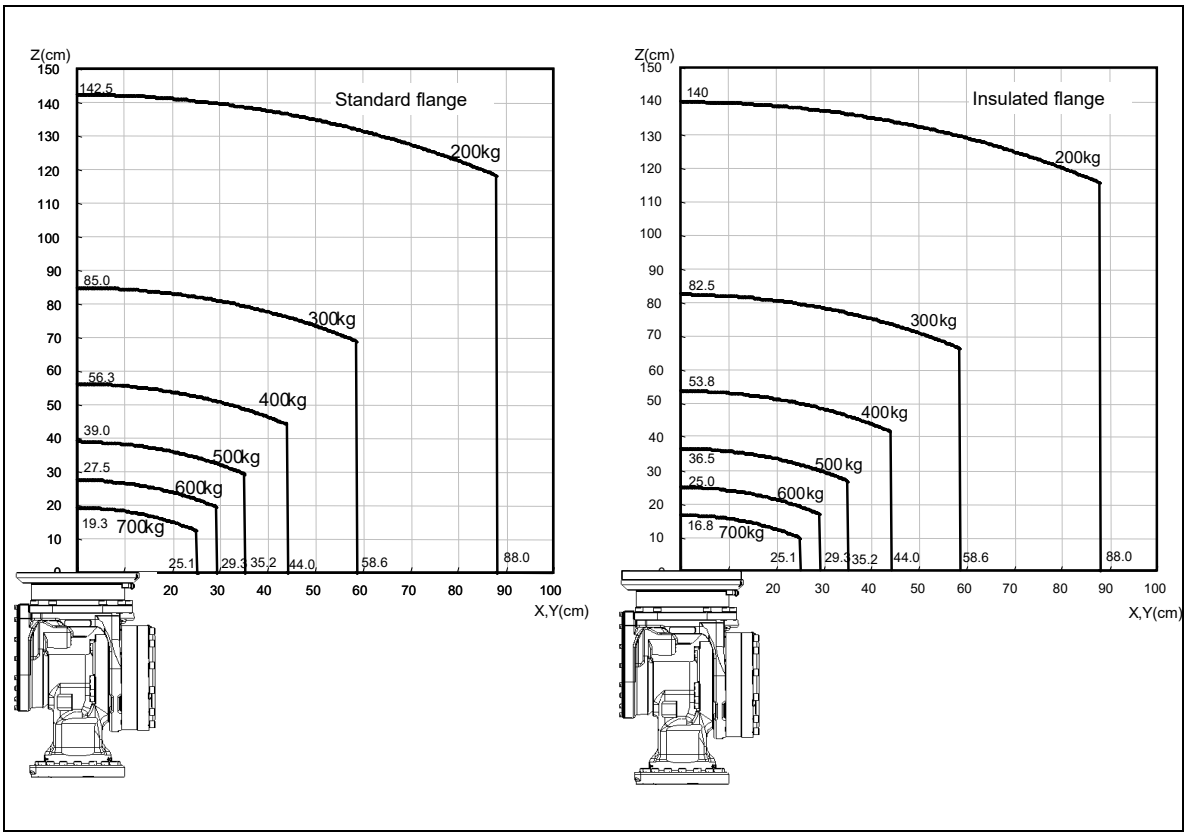


Fig. 9.1 (b) Wrist load diagram (when the 700kg option of M-900*i*A/600 is selected)

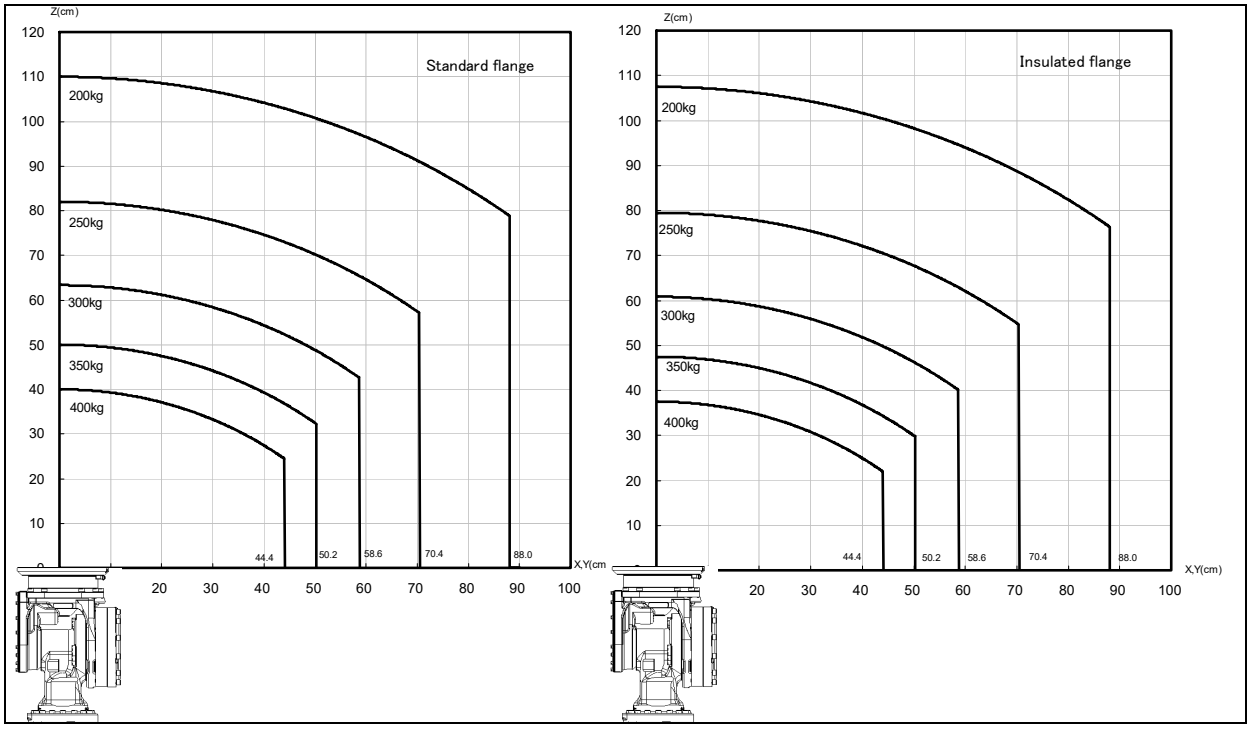


Fig. 9.1 (c) Wrist load diagram (M-900*i*A/400L)

9.2 LOAD CONDITIONS ON J2 BASE AND J3 ARM

Following shows J2 base and J3 arm load conditions.

Table 9.2 (a) Installation conditions of loads to be added

Installation site	Loads	Condition
J2 base	550kg	The center of gravity must lie within a radius of 500 mm from the rotation center of the J1 axis.
J3 arm	25kg	See Fig. 9.2 (a) for the positional condition of the center of gravity.

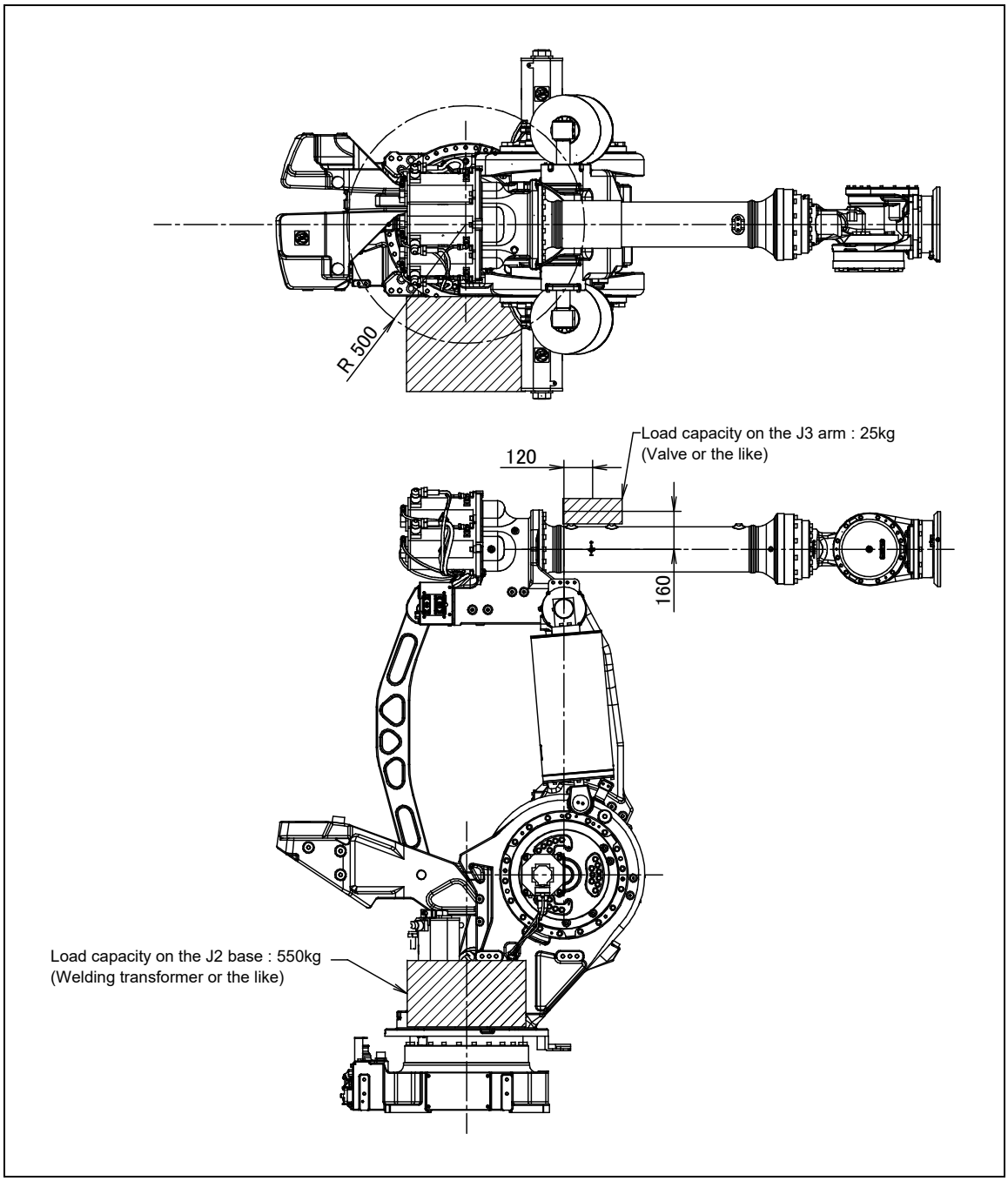


Fig. 9.2 (a) Load conditions on J2 base and J3 arm

9.3 END EFFECTOR INSTALLAITON TO WRIST

Fig. 9.3 (a) and (b) are the diagrams for installing end effectors on the wrist. To fasten the end effector, first position it with two pin holes at [D] using fitting [B] or [C], then lock it using screws at [E]. Select screws and positioning pins of a length that matches the depth of the tapped holes and pin holes. Fasten the bolt for fixing the end effector with following torque:

128.4 ± 6.4 Nm (1310 ± 65kgfcm)

> ⚠ **CAUTION**
> Notice the tooling coupling depth to wrist flange should be shorter than the flange coupling length.

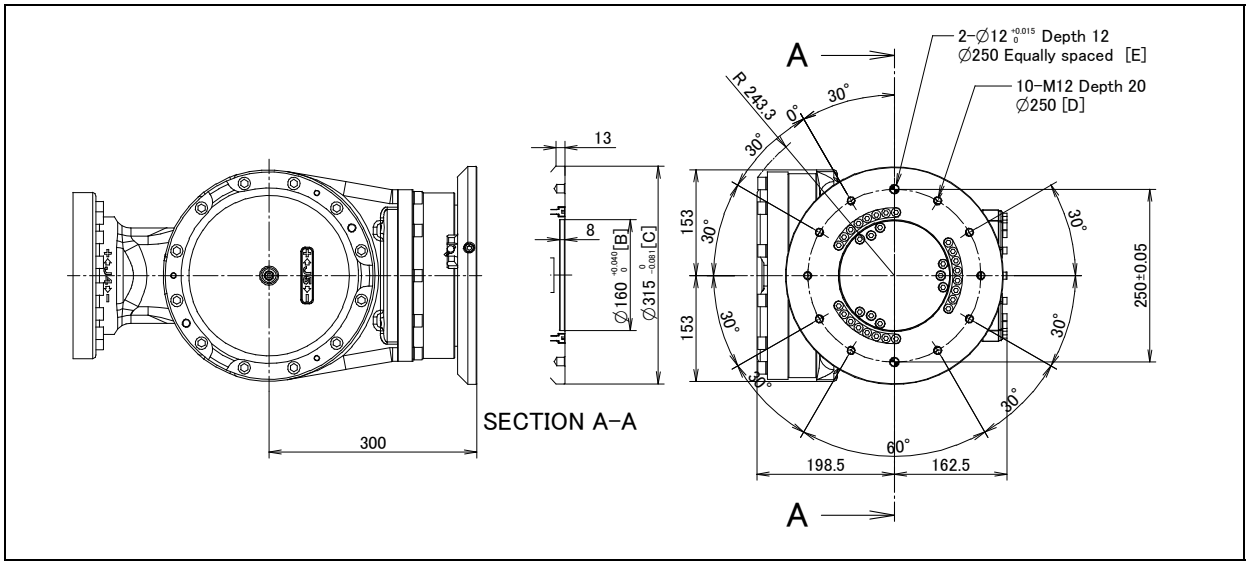


Fig. 9.3 (a) End effector mounting face (ISO flange)

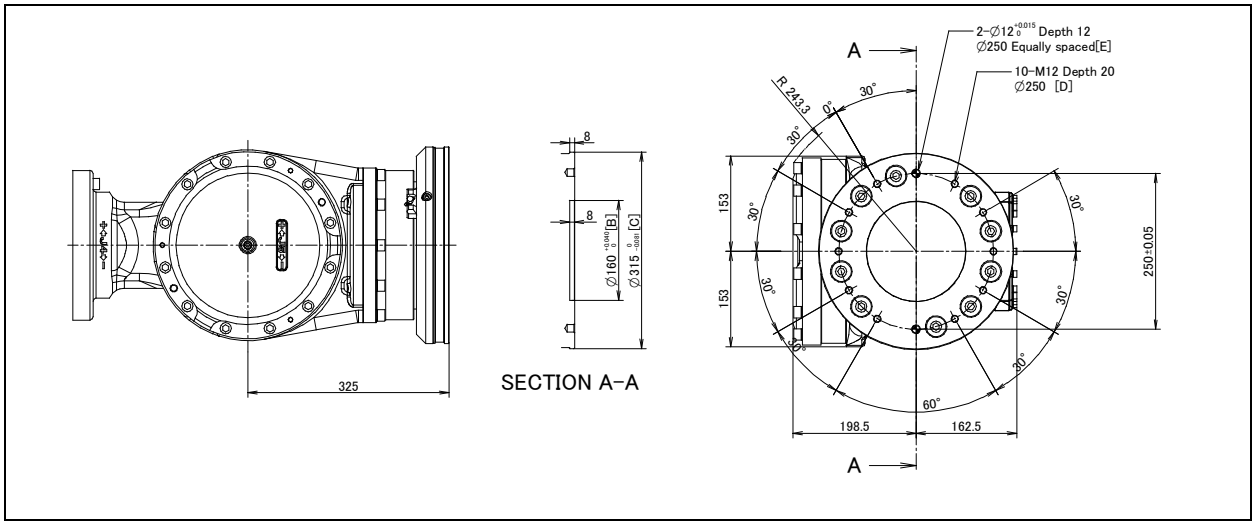


Fig. 9.3 (b) End effector mounting face (Insulated flange)

9.4 EQUIPMENT MOUNTING FACE

As shown in Fig. 9.4 (a), (b), tapped holes are provided to install equipment to the robot.

⚠ CAUTION

1 Never perform additional machining operations such as drilling or tapping on the robot body. This can seriously affect the safety and functions of the robot.
2 Equipment should be installed on robot in a way it does not interfere with the mechanical unit cables. If equipment interferes, the mechanical unit cable might be disconnected, and unexpected troubles might occur.
3 Note that the use of a tapped hole not shown in the following figure is not assured. Please do not tighten both with the tightening bolts used for mechanical unit.

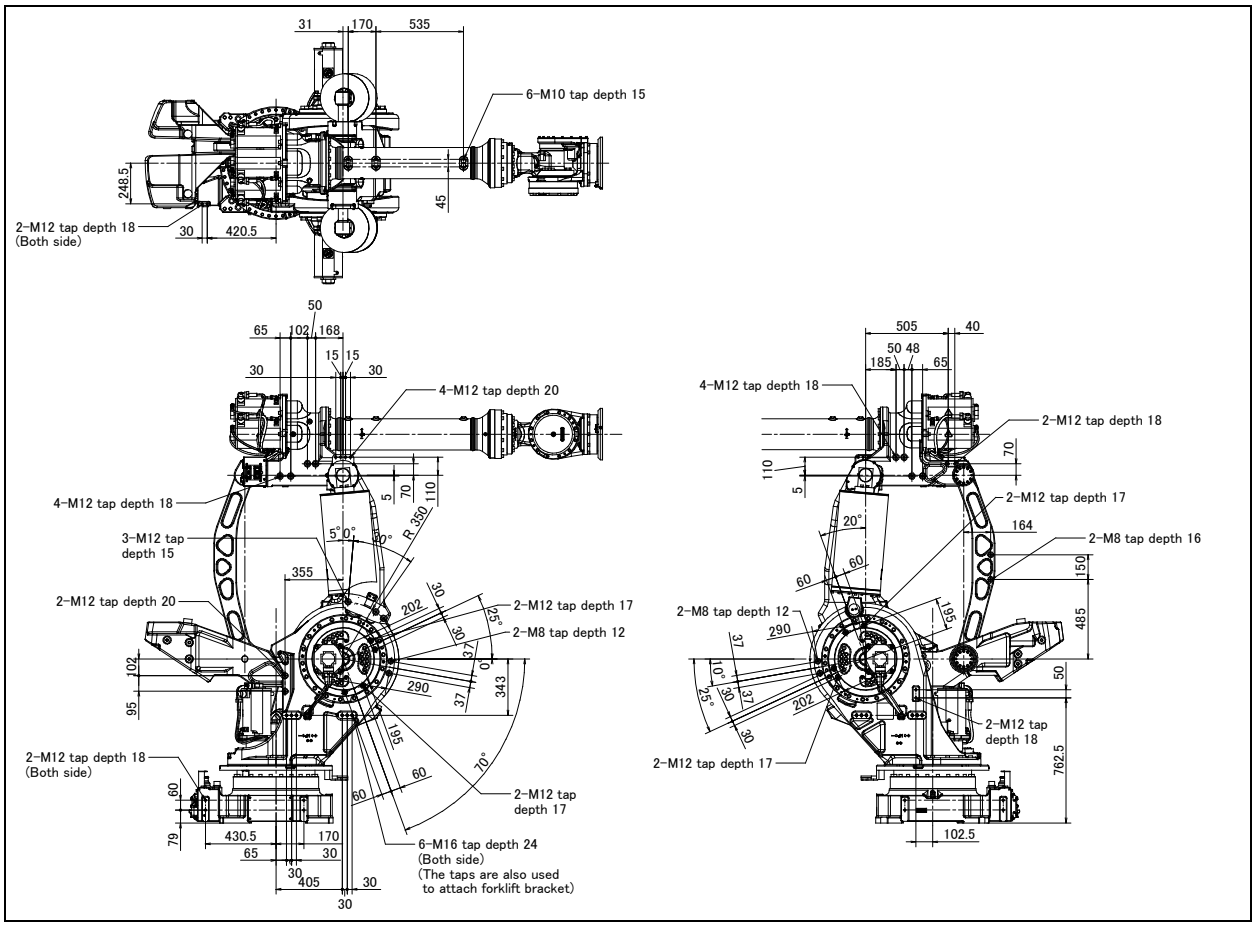


Fig. 9.4 (a) Equipment mounting faces (M-900*i*A/600)

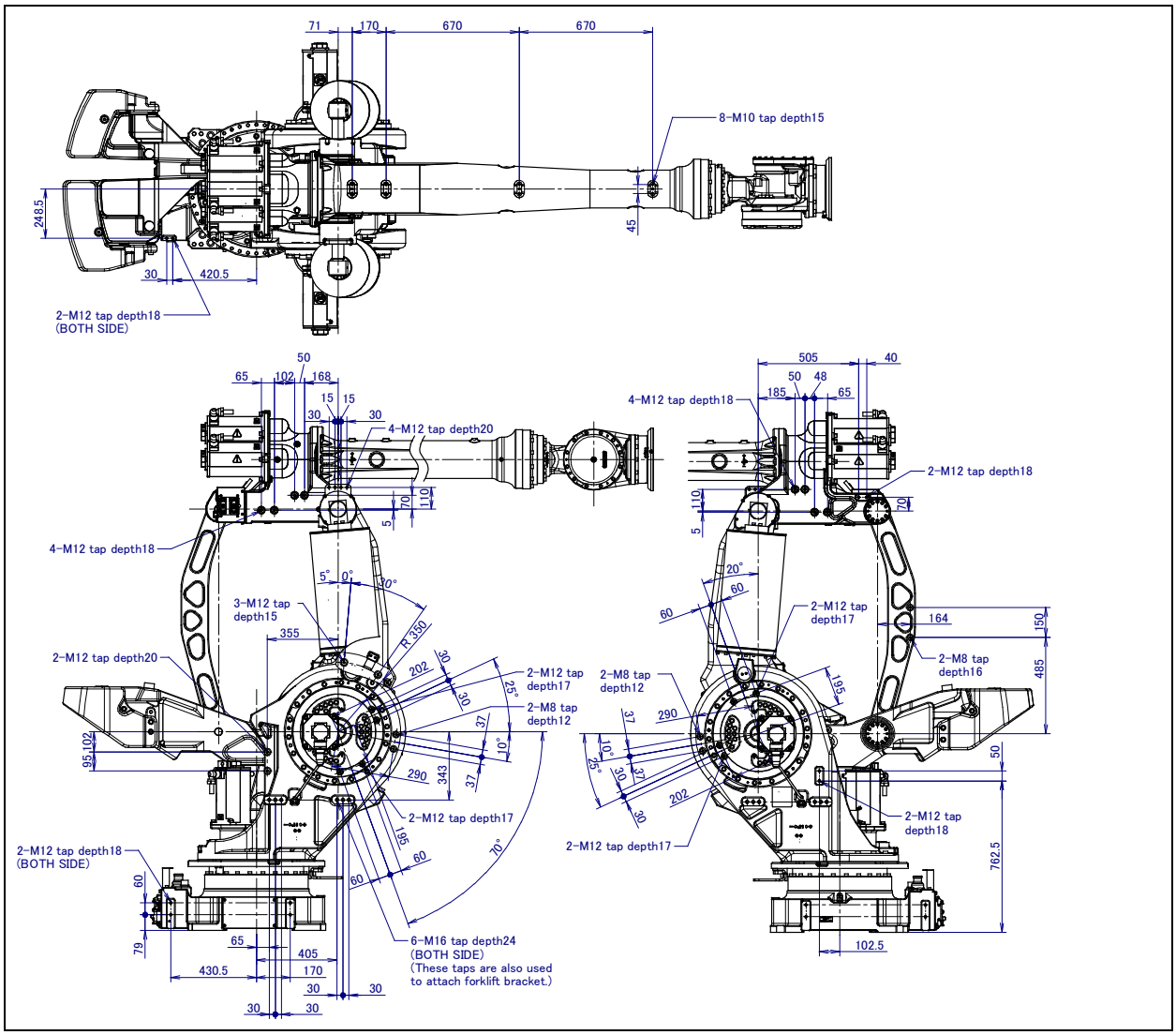


Fig. 9.4 (b) Equipment mounting faces (M-900*i*A/400L)

9.5 LOAD SETTING

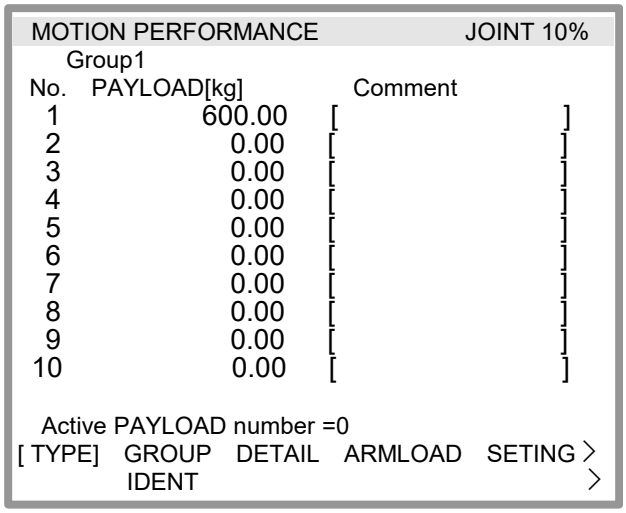
⚠ CAUTION

1 Set load condition parameter before operating the robot. Do not operate the robot in over payload condition. Do not exceed allowable payload including connection cables and its swing. Otherwise troubles such as degradation of reducer life may occur.

2 WHEN PERFORMING LOAD ESTIMATION AFTER PARTS REPLACEMENT
If wrist axis motors (J5/J6-axis) or reducers are replaced, payload estimation accuracy may decrease. Perform calibration of load estimation without the load such as hand before performing load estimation.
Section 9.15 “LOAD ESTIMATION” in R-30*i*A Controller
Spot tool+ OPERATOR’S MANUAL(B-83124EN-1).
Section 9.15 “LOAD ESTIMATION” in R-30*i*A Controller
Handling tool OPERATOR’S MANUAL (B-83124EN-2).
Section 9.15 “LOAD ESTIMATION” in R-30*i*A Controller
Dispense tool OPERATOR’S MANUAL (B-83124EN-3).
Chapter 9 “LOAD ESTIMATION” in
R-30*i*B/R-30*i*B Mate/R-30*i*B Plus/R-30*i*B Mate Plus/R-30*i*B Compact Plus Controller Optional Function OPERATOR’S MANUAL (B-83284EN-2).

The operation motion performance screens include the MOTION PERFORMANCE screen, MOTION PAYLOAD SET screen, and payload information and equipment information on the robot.

1 Press the [MENU] key to display the screen menu.
2 Select [6 SYSTEM] on the next page,
3 Press the F1 [TYPE] key to display the screen switch menu.
4 Select [MOTION]. The MOTION PERFORMANCE screen will be displayed.



5 Ten different pieces of payload information can be set using condition No. 1 to 10 on this screen. Place the cursor on one of the numbers, and press F3 [DETAIL]. The MOTION PAYLOAD SET screen appears.

```
MOTION PAYLOAD SET                JOINT   100%

  Group 1
  Schedule No[   1]:[Comment              ]
1 PAYLOAD              [kg]          600.00
2 PAYLOAD CENTER  X    [cm]          -28.53
3 PAYLOAD CENTER  Y    [cm]            0.00
4 PAYLOAD CENTER  Z    [cm]           27.78
5 PAYLOAD INERTIA X    [kgfcms^2]     56.84
6 PAYLOAD INERTIA Y    [kgfcms^2]     59.39
7 PAYLOAD INERTIA Z    [kgfcms^2]     15.10

 [TYPE]  GROUP  NUMBER  DEFAULT  HELP
```

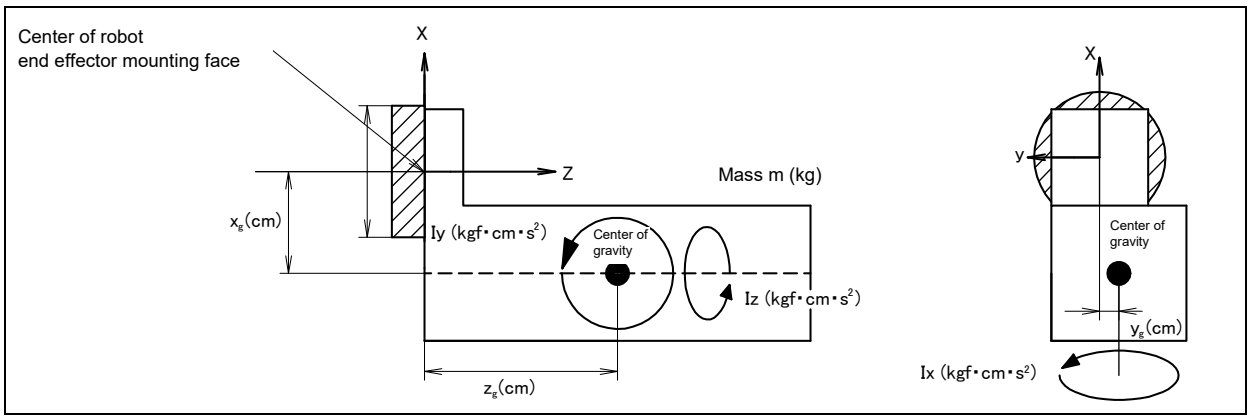


Fig. 9.5 (a) Standard tool coordinate

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 Press F3 [NUMBER] will bring you to the MOTION PAYLOAD SET screen for another condition number. For a multi group system, pressing F2 [GROUP] will bring you to the MOTION PAYLOAD SET screen for another group.

8 Press the [PREV] key to return to the MOTION PERFORMANCE screen. Press F5 [SETIND], and enter the desired payload setting condition number.

9 On the MOTION PERFORMANCE screen, press F4 [ARMLOAD] to display the MOTION ARMLOAD SET screen.

```
MOTION ARMLOAD SET                JOINT   100%

  Group 1
1 ARM LOAD AXIS #1 [kg]                550.00
2 ARM LOAD AXIS #3 [kg]                 25.00

[ TYPE ]    GROUP          DEFAULT  HELP
```

10 Specify the weight of the load on the J2 base and J3 arm as follows:
ARMLOAD AXIS #1[kg]: Weight of the load on the J2 base
ARMLOAD AXIS #3[kg]: Weight of the load on the J3 arm
The following message appears: “Path and Cycle time will change. Set it?” Respond to the message with F4 ([YES]) or F5 ([NO]). Once the arm payload is set up, the settings are completed by switching the power off and on again.

9.6 700kg OPTION

The summary of function

In 700kg option for M-900*i*A/600, you can set the most suitable value for motion parameter of either payload 600kg or 700kg.

Usage

1. Change payload on control start screen (R-30*i*A / R-30*i*B controller only)
   When you select max payload setting, choose 0 for 600kg payload and choose 1 for 700kg payload.

```
-- Select Max Payload Setting --

  0: 600kg Max Payload
  1: 700kg Max Payload

Default value = 0
```

2 Change payload on cold start screen
(In case of R-30*i*A/ R-30*i*B controller)
If you order 700kg option for M-900***i***A/600, two following KAREL programs are loaded.
· CHPAM67C.PC
· CHP67_2C.PC
If you change parameter of M-900***i***A/600 of group 1, execute “CHPAM67C.PC”.
If you change parameter of M-900***i***A/600 of group 2, execute “CHP67_2C.PC”.

(In case of R-J3***i***B controller)
If you order 700kg option for M-900***i***A/600, following KAREL program is loaded.
· CHPAM67.PC
If you change parameter of M-900***i***A/600 of group 1, execute “CHPAM67.PC”.
It does not support for group 2.

(It is common after this)
If you execute KAREL program, a confirmation message as below is displayed on user screen.

```
Now using 600kg payload parameters.
Change 700kg payload parameters?
Yes: 1,  No: Else
```

If you continue executing change KAREL program, select “Yes:1”.
If you stop executing change KAREL program, select “No: Else”.
If you execute change KAREL program, parameter is changed and a screen to notify that execution of KAREL program has been finally completed is displayed on the user screen as follows.

```
***** ROBOT SETUP END *****

Successfully switched
Changed parameter for 700kg payload.
Please cycle power.
```

In this time, turn off and on the controller power to reflect change of parameter.

If you execute change KAREL program in 600kg payload, payload is changed to 700kg.
Adversely, If you execute change KAREL program in 700kg payload, payload is changed to 600kg.

3 Note
- You cannot delete KAREL program “CHPAM67C” and “CHP67_2C”
- If you change payload, motion trace is changed and robot may interfere with outside, so be sure to execute operation check after change payload.

9.7 INERTIA LOAD SETTINGS

For the M-900*i*A/400L, there are two parameter settings depending on the magnitude of load inertia. (By default, the parameter settings for the standard inertia mode are made.)

		Standard inertia mode	High inertia mode
Wrist unit allowable load inertia	J4-axis	510kg·m^2 (5204kgf·cm·s^2)	1098kg·m^2 (11200kgf·cm·s^2)
	J5-axis	510kg·m^2 (5204kgf·cm·s^2)	1098kg·m^2 (11200kgf·cm·s^2)
	J6-axis	510kg·m^2 (5204kgf·cm·s^2)	444kg·m^2 (4532kgf·cm·s^2)

⚠CAUTION
When a workpiece with inertia exceeding the allowable inertia for the standard inertia mode is used in the standard inertia mode, components of the mechanical unit may be degraded earlier.

When high inertia option (A05B-2500-J731) is specified, parameters are set automatically based on the load settings made in Section 9.5.

Except this case, since the high inertia mode is not supported, make use within the allowable range of the standard inertial mode.

⚠ CAUTION
Set the load inertia correctly as described in Section 9.5. When a workpiece with inertia exceeding the allowable inertia for the standard inertia mode is used in the standard inertia mode, components of the mechanical unit may be degraded earlier.

9.8 AIR SUPPLY (OPTION)

There are air inlets and air outlets on the back of the J1 base and the back of J3 casting. The connector is a Rc1/2 female (ISO). As couplings are not supplied, it will be necessary to prepare couplings, which suit to the hose size.

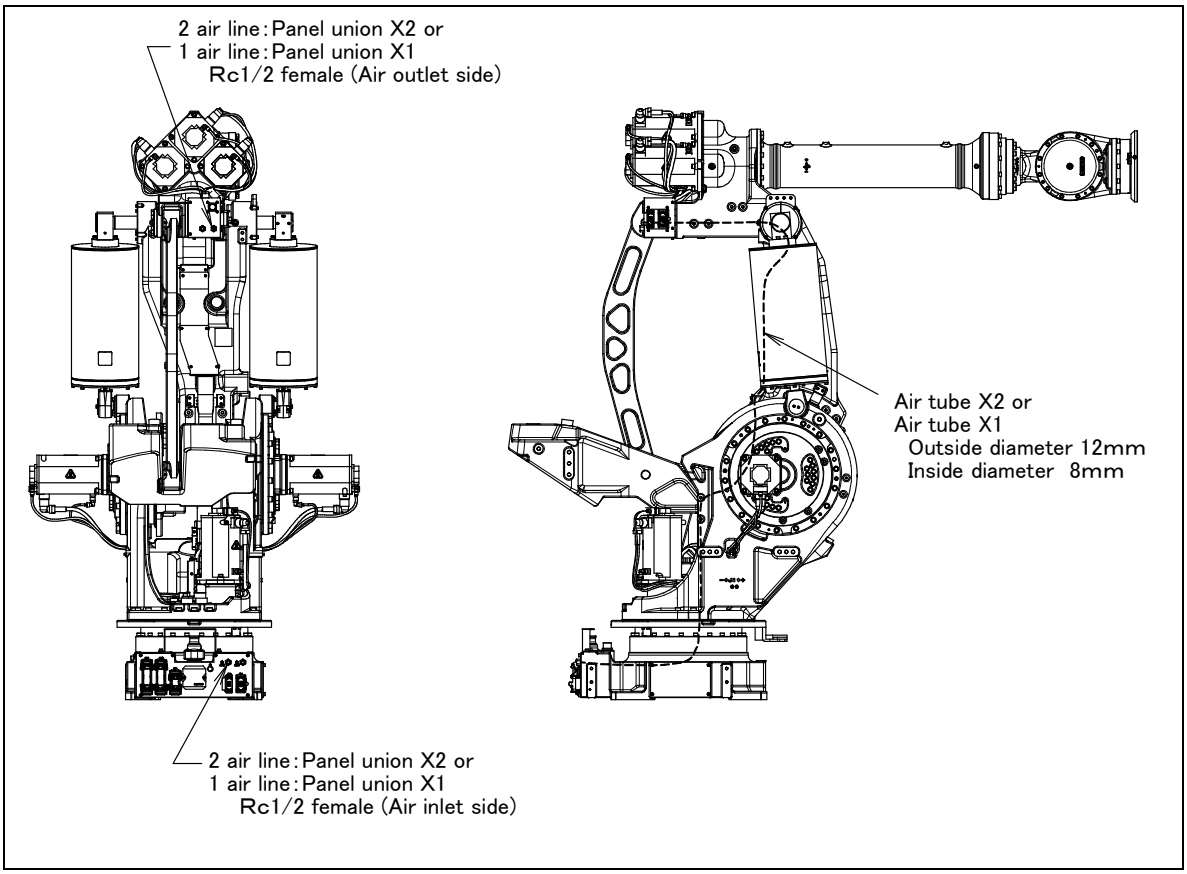


Fig. 9.8 (a) Air-pressure supply connection (option)

9.9 INTERFACE FOR OPTION CABLE (OPTION)

⚠ WARNING

- Only use appropriately-specified mechanical unit cables.
- Do not add user cables or hoses inside of the mechanical unit.
- Please do not obstruct the movement of the mechanical unit cable when cables are added to outside of mechanical unit.
- Please do not perform remodeling (adding a protective cover, or secure an additional outside cable) that obstructs the behavior of the outcrop of the cable.
- When external equipment is installed in the robot, make sure that it does not interfere with other parts of the robot.
- Cut and discard any unnecessary length of wire rod of the end effector (hand) cable. Insulate the cable with seal tape. (See Fig. 9.9 (a))
- If you have end effector wiring and a process that develops static electricity, keep the end effector wiring as far away from the process as possible. If the end effector and process must remain close, be sure to insulate the cable.
- Be sure to seal the connectors of the end effector and robot and terminal parts of all cables to prevent water from entering the mechanical unit. Also, attach the cover to the unused connector.
- Frequently check that connectors are tight and cable jackets are not damaged.
- When precautions are not followed, damage to cables might occur. Cable failure may result in incorrect function of end effector, robot faults, or damage to robot electrical hardware. In addition, electric shock could occur when touching the power cables.

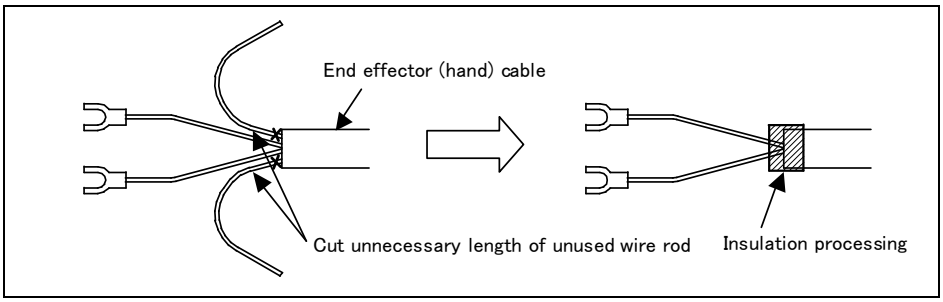


Fig. 9.9 (a) Treatment method of end effector (hand) cable

Fig. 9.9 (b) to (f) show the position of the option cable interface. EE interface (RDI/RDO or RI/RO), user cable (signal lines, signal usable to force sensor , signal usable to force sensor and 3DL sensor, power lines) and device net cable (signal lines, power lines), additional axis motor cable (Pulsecoder/ power, brake), 3DL sensor cable and camera cable are prepared as options.

NOTE

Each option cable is written like below on connector panel.
EE(RI/RO) interface : EE
User cable (signal) : AS
User cable (signal usable to force sensor) : ASH
User cable (signal usable to force sensor and 3DL sensor) : ASi
User cable (power) : AP
DeviceNet cable (signal) : DS
DeviceNet cable (power) : DP
Additional axis motor cable (Pulsecoder) : ARP
Additional axis motor cable (power,brake) : ARM
3DL sensor cable : SEN
Camera cable : CAM

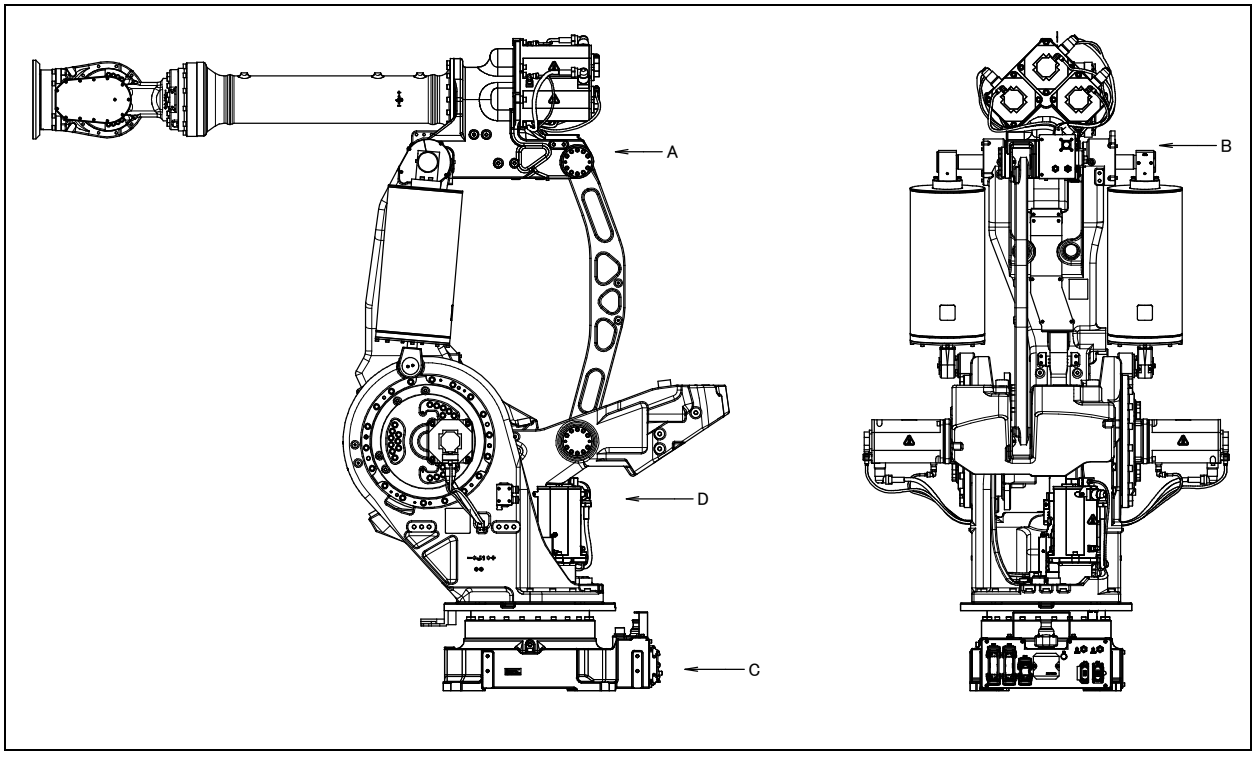
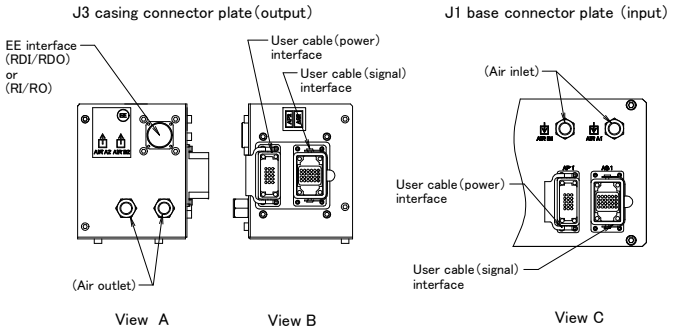
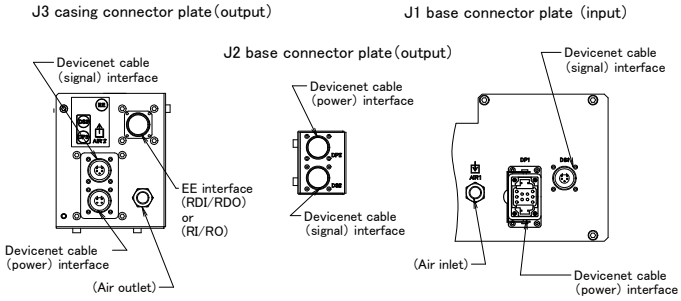


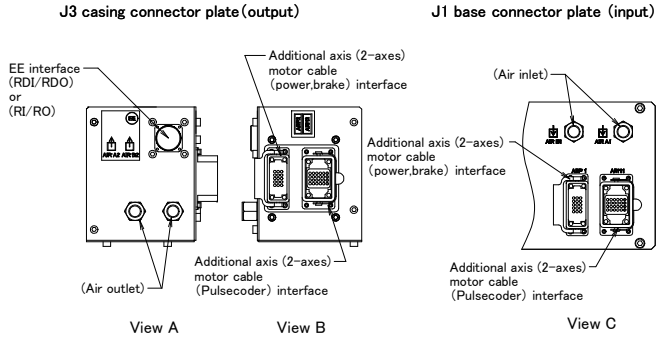
Fig. 9.9 (b) Interface for optional cable (option)



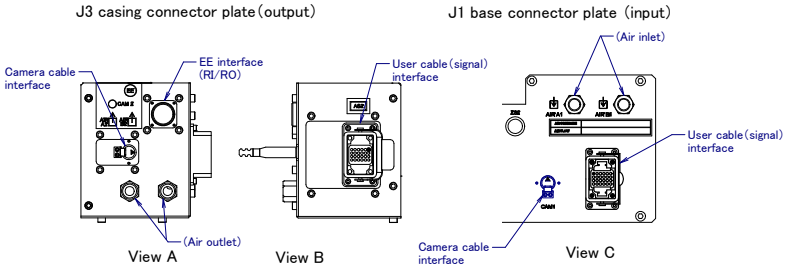
With user cable (signal/power)
Spec. of mechanical unit cable:
A05B-1328-H201 (R-J3*i*B)
A05B-1328-H301 (R-30*i*A/R-30*i*B)



With devicenet cable (signal/power)
Spec. of mechanical unit cable :
A05B-1328-H221 (R-J3*i*B)
A05B-1328-H321 (R-30*i*A/R-30*i*B)

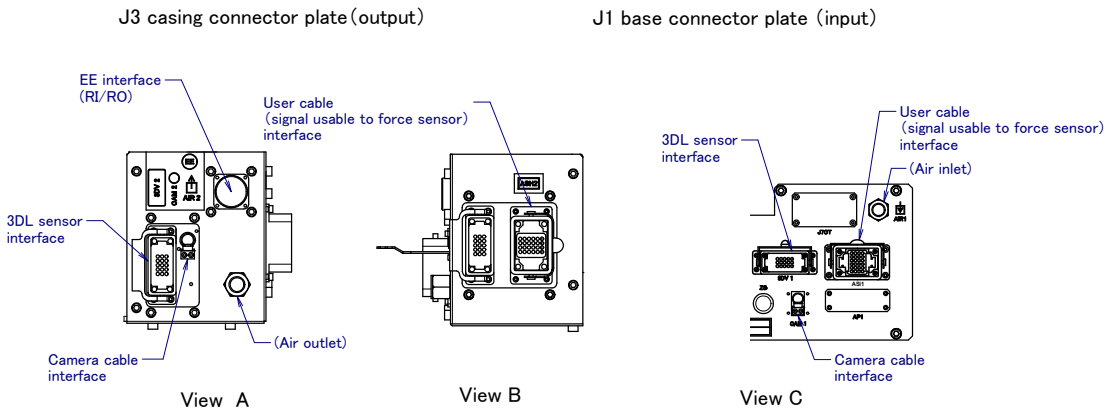


With additional axis (2-axes) motor cable (Pulsecoder/power,brake)
Spec. of mechanical unit cable :
A05B-1328-H204 (R-J3*i*B)
A05B-1328-H304 (R-30*i*A/R-30*i*B)

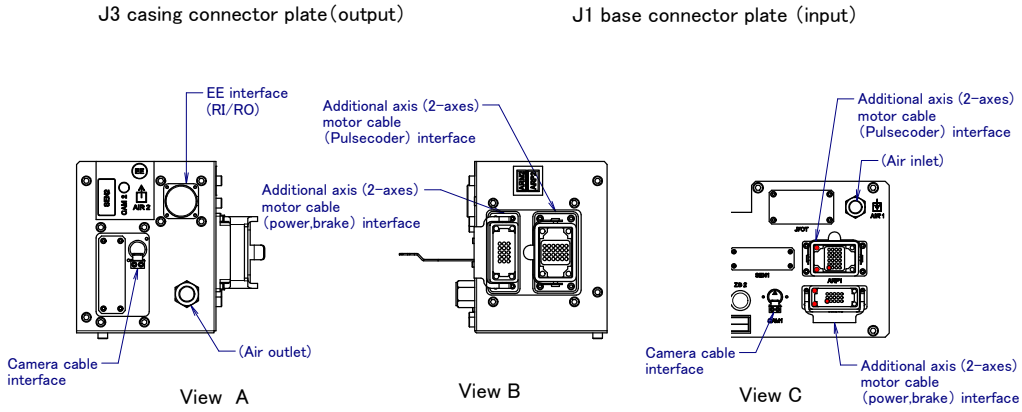


With user cable (signal) and camera cable
Spec. of mechanical unit cable :
A05B-1328-H317 (R-30*i*A/R-30*i*B)

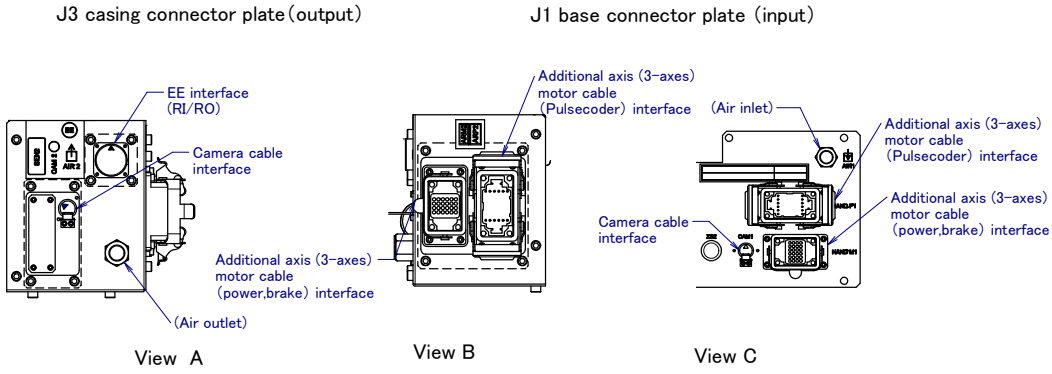
Fig. 9.9 (c) Interface for optional cable (option) 1



With user cable (signal usable to force sensor),camera cable and 3DL sensor
Spec. of mechanical unit cable :
A05B-1328-H965 (R-30*i*A/R-30*i*B)

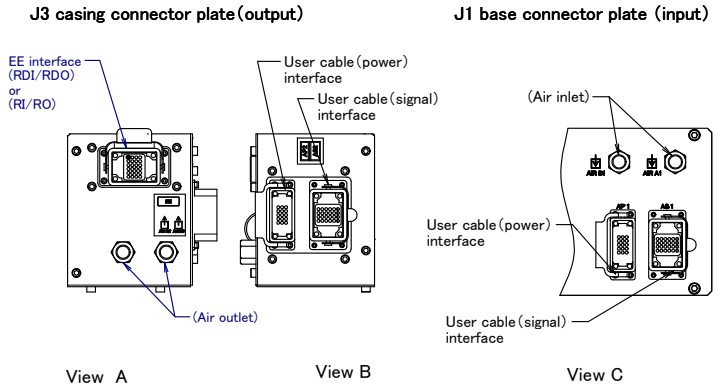


With camera cable and additional axis (2-axes) motor cable (Pulsecoder/power,brake)
Spec. of mechanical unit cable :
A05B-1328-H966 (R-30*i*A/R-30*i*B)

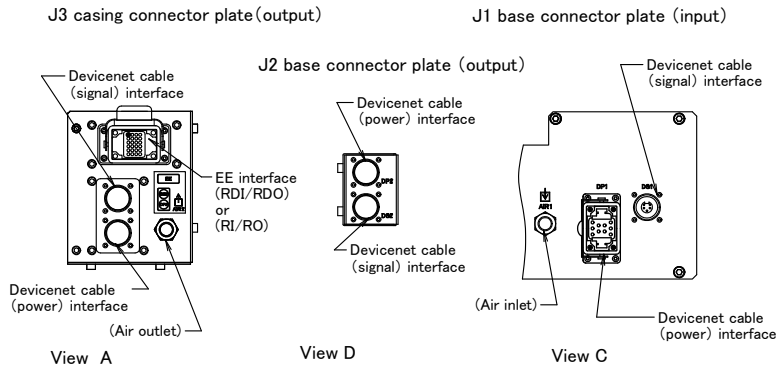


With camera cable and additional axis (3-axes) motor cable (Pulsecoder/power,brake)
Spec. of mechanical unit cable :
A05B-1328-H967 (R-30*i*A/R-30*i*B)

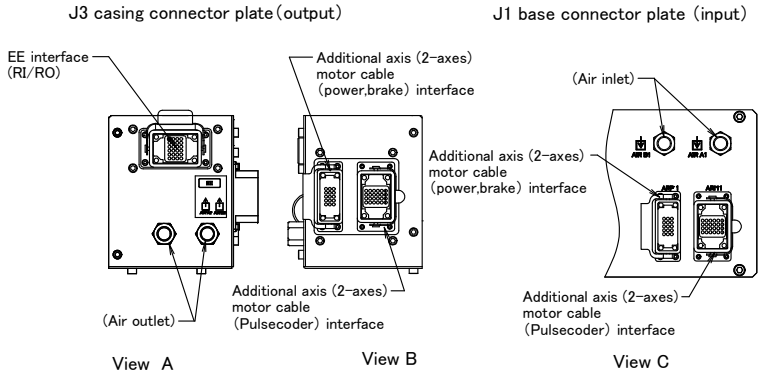
Fig. 9.9 (d) Interface for optional cable (option) 2



With user cable (signal/power)
Spec. of mechanical unit cable:
A05B-1328-H801 (R-J3*i*B)
A05B-1328-H851 (R-30*i*A/R-30*i*B)

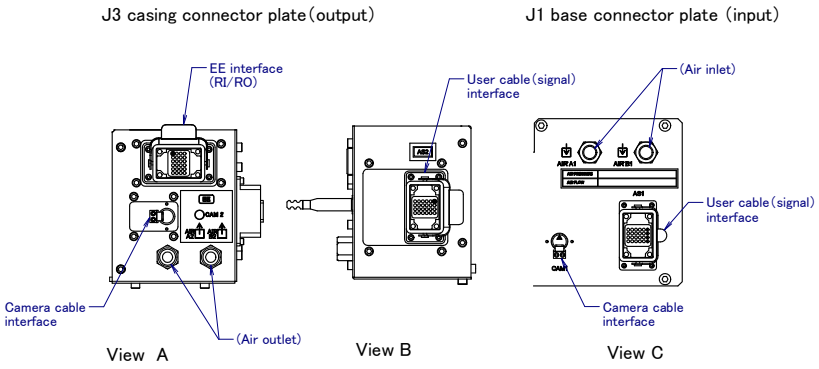


With devicenet cable (signal/power)
Spec. of mechanical unit cable :
A05B-1328-H821 (R-J3*i*B)
A05B-1328-H871 (R-30*i*A/R-30*i*B)

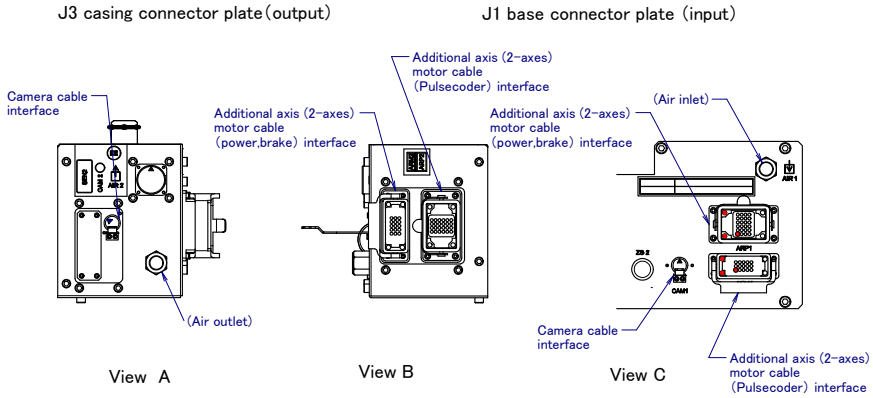


With additional axis (2-axes) motor cable (Pulsecoder/power,brake)
Spec. of mechanical unit cable :
A05B-1328-H854 (R-30*i*A/R-30*i*B)

Fig. 9.9 (e) Interface for optional cable (option) 3



With user cable (signal) and camera cable
Spec. of mechanical unit cable :
A05B-1328-H860 (R-30*i*A/R-30*i*B)



With additional axis (2-axes) motor cable (Pulsecoder/power,brake) and camera cable
Spec. of mechanical unit cable :
A05B-1328-H976 (R-30*i*A/R-30*i*B)

Fig. 9.9 (f) Interface for optional cable (option) 4

1 EE interface (RDI/RDO or RI/RO) (option)

Fig. 9.9 (g), (h), (i), (j) show pin layout for EE interface (RDI/RDO or RI/RO). When severe dust/liquid protection package is specified, the connector has guide pins and bushes for preventing improper insertion. For cables prepared by the user, use these guide pins and bushes.

⚠ WARNING

The RDO signal for the R-J3*i*B controller and the RO signal for the R-30*i*A/ R-30*i*B controller are incompatible with each other because different output formats are used. For details, refer to the Chapter 4 of CONNECTION of controller maintenance manuals.

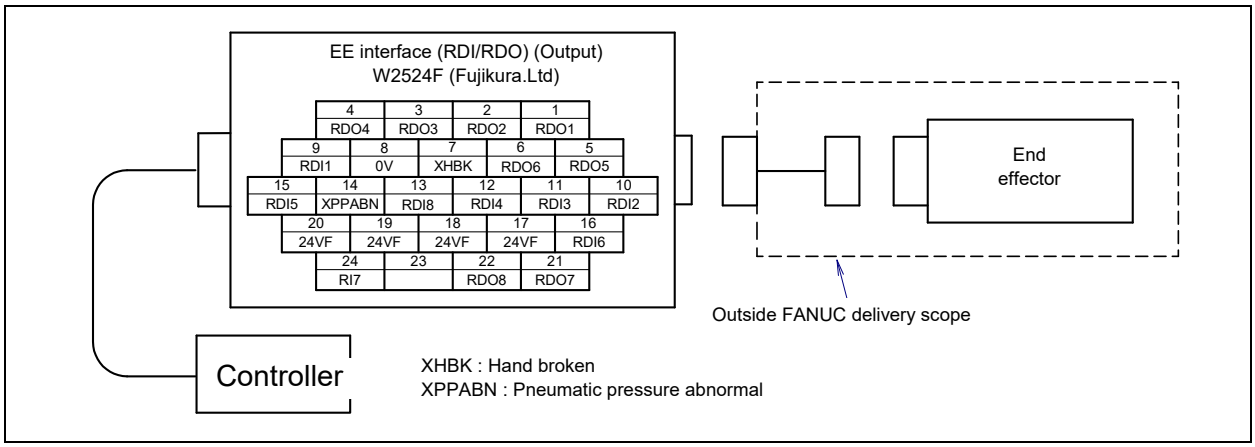


Fig. 9.9 (g) Pin layout for EE interface (RDI/RDO) (option)
(For R-J3*i*B controller)

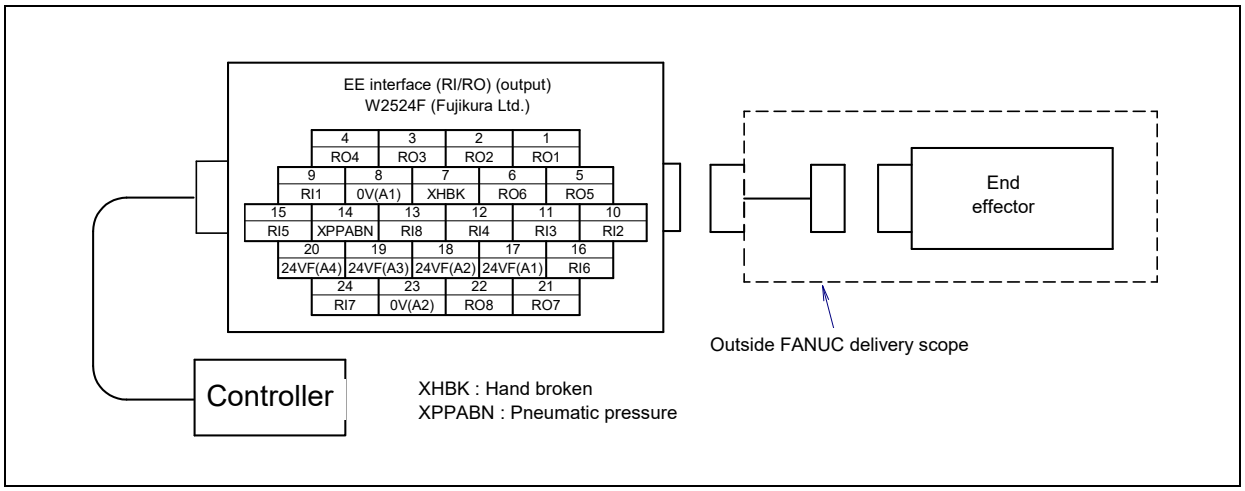


Fig. 9.9 (h) Pin layout for EE interface (RI/RO) (option)
(For R-30*i*A/R-30*i*B controller)

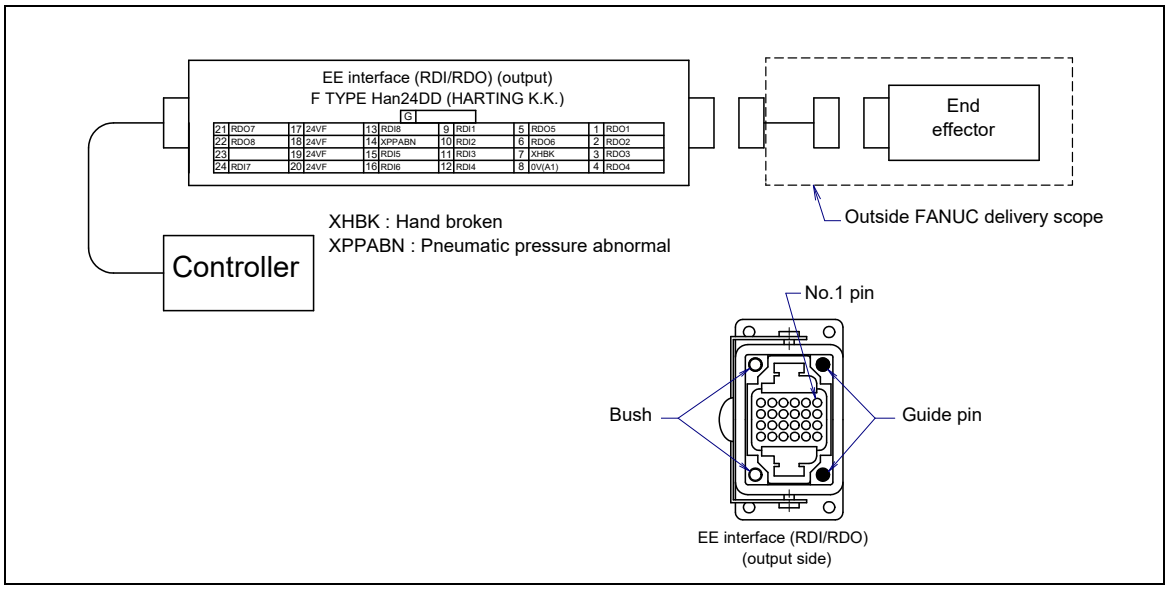


Fig. 9.9 (i) Pin layout for EE interface (RDI/RDO)
(When the severe dust/liquid protection package is specified) (option) (For R-J3*i*B controller)

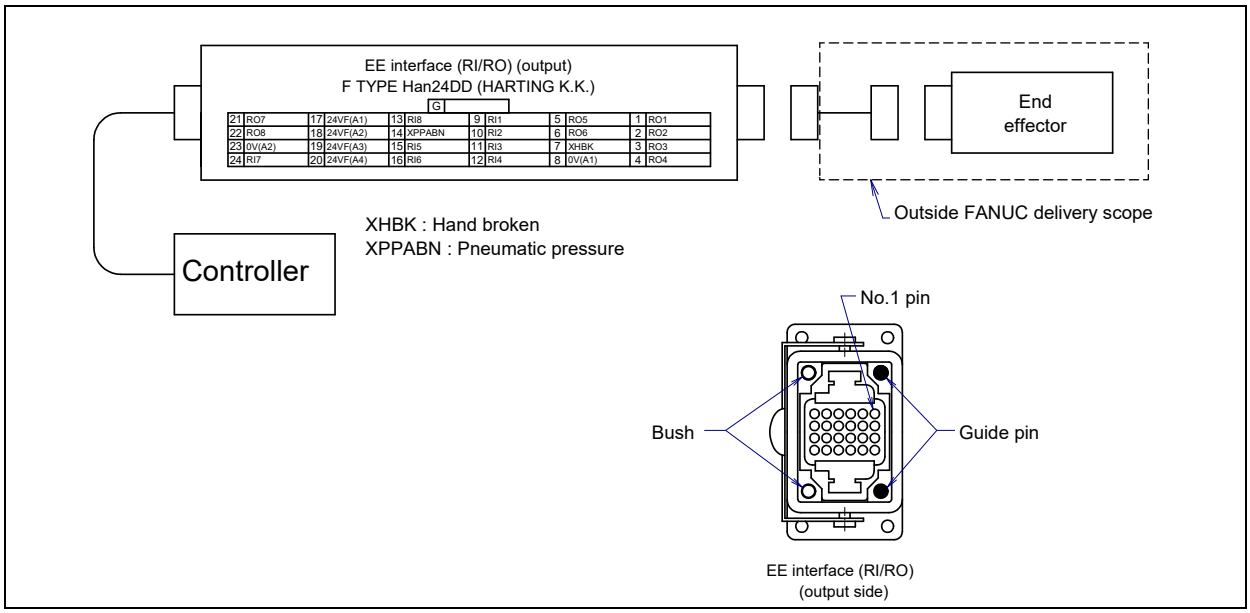


Fig. 9.9 (j) Pin layout for EE interface (RI/RO)
(When severe dust/liquid protection package is specified) (Option) (For R-30*i*A/R-30*i*B controller)

2 User cable (signal line, signal line usable to force sensor ,signal line usable to 3DL sensor and force sensor) Interface (option)

Fig. 9.9 (k) shows pin layout for user cable (signal line, signal line usable to force sensor ,signal line usable to 3DL sensor and force sensor) interface.

The connector has a code pin for preventing improper insertion.

For cables prepared by user, use this code pin.

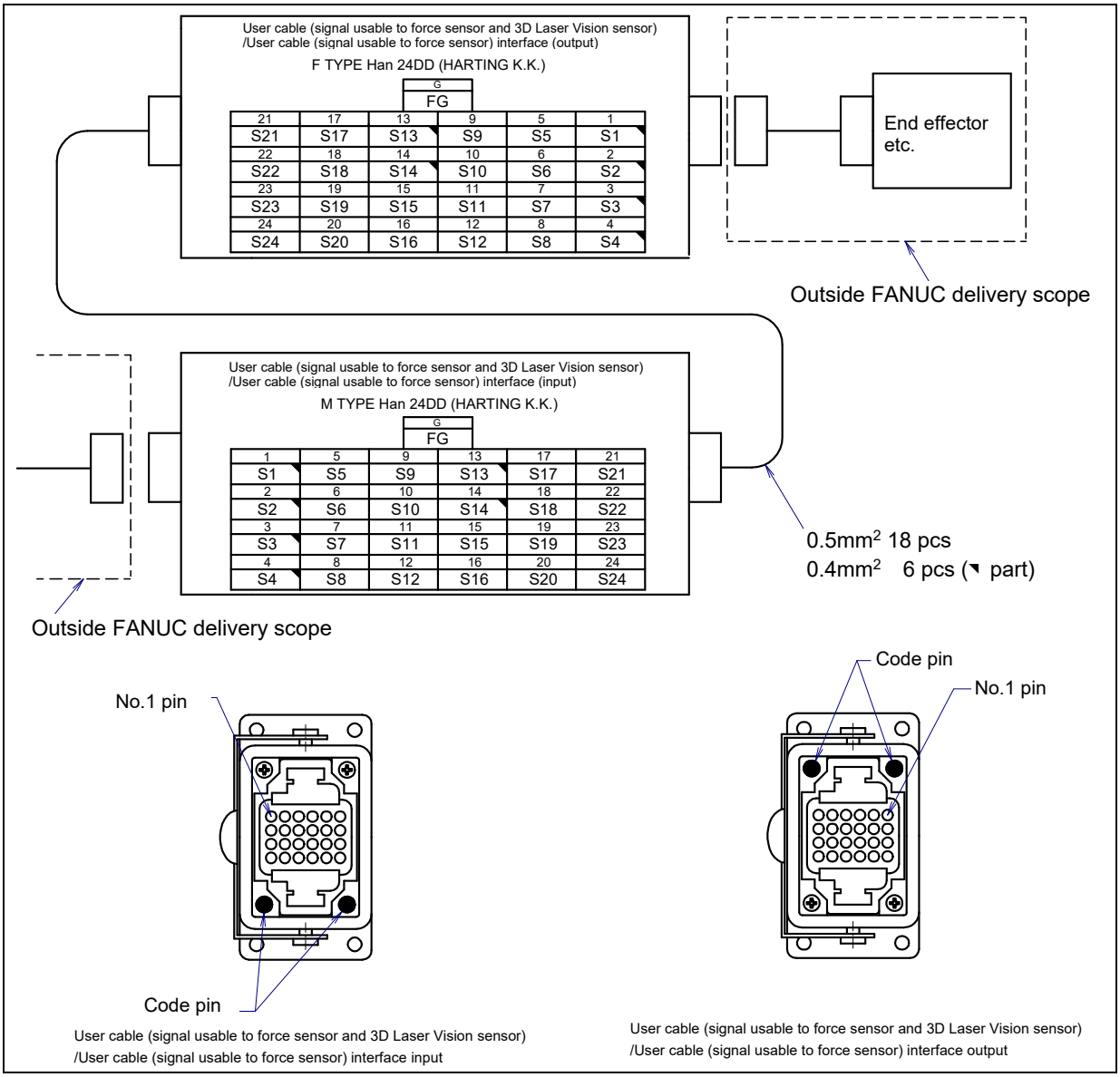


Fig. 9.9 (k) Pin layout for user cable (signal line, signal line usable to force sensor ,signal line usable to 3DL sensor and force sensor) interface and code pin position (option)

3 User cable (power line) interface (option)
Fig. 9.9 (l) shows pin layout for user cable (power line) interface.
The connector has a code pin for preventing improper insertion.
For cables prepared by user, use this code pin.

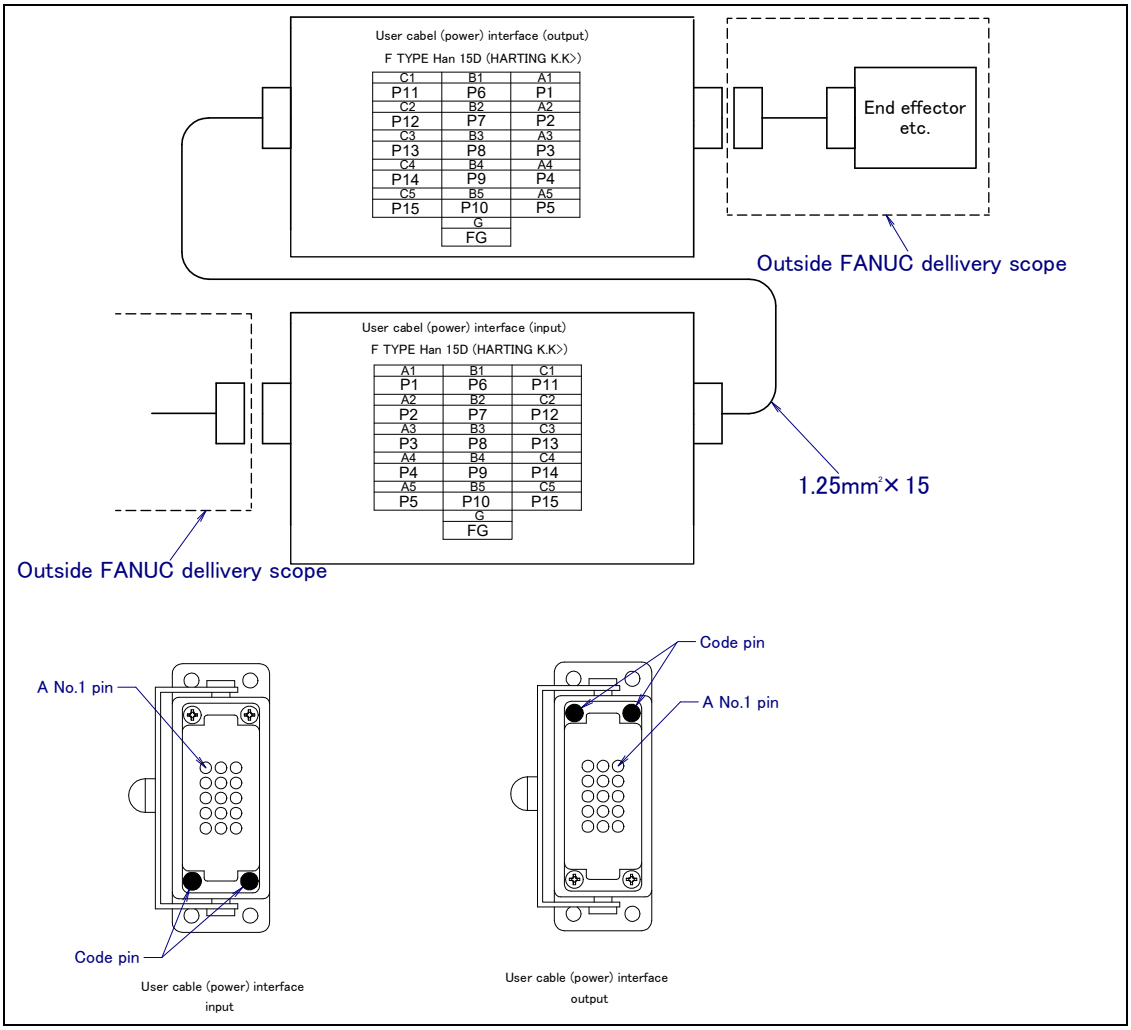


Fig. 9.9 (l) Pin layout for user cable (power line) interface and code pin position (option)

4. DeviceNet cable (signal line) interface (option)
   Fig. 9.9 (m) shows pin layout for DeviceNet cable (signal line) interface.

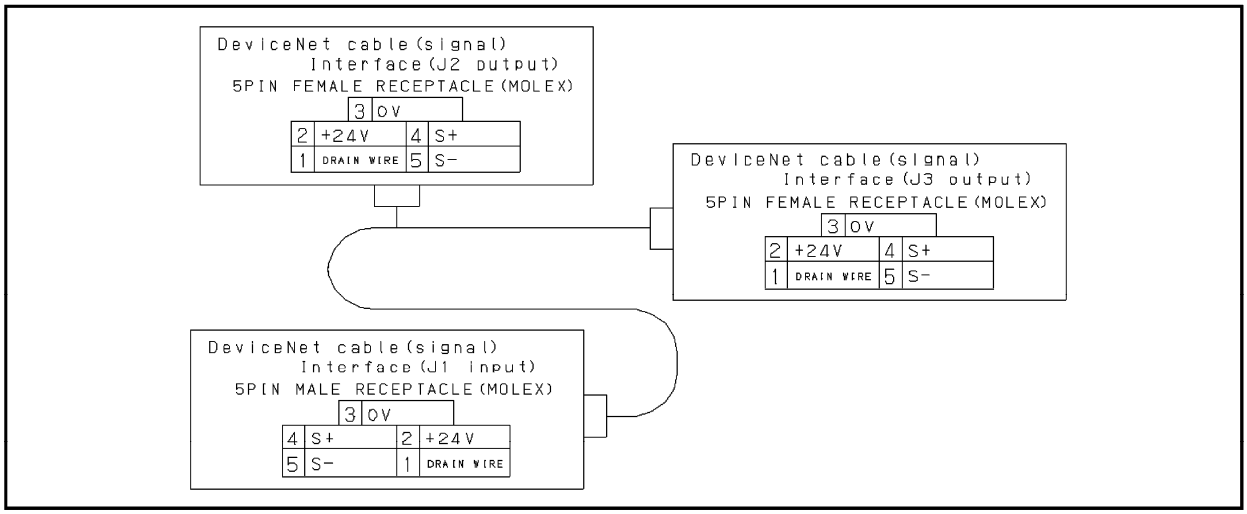


Fig. 9.9 (m) Pin layout for DeviceNet cable (signal line) interface (option)

5. DeviceNet cable (power line) interface (option)
   Fig. 9.9 (n) shows pin layout for DeviceNet cable (power line) interface.

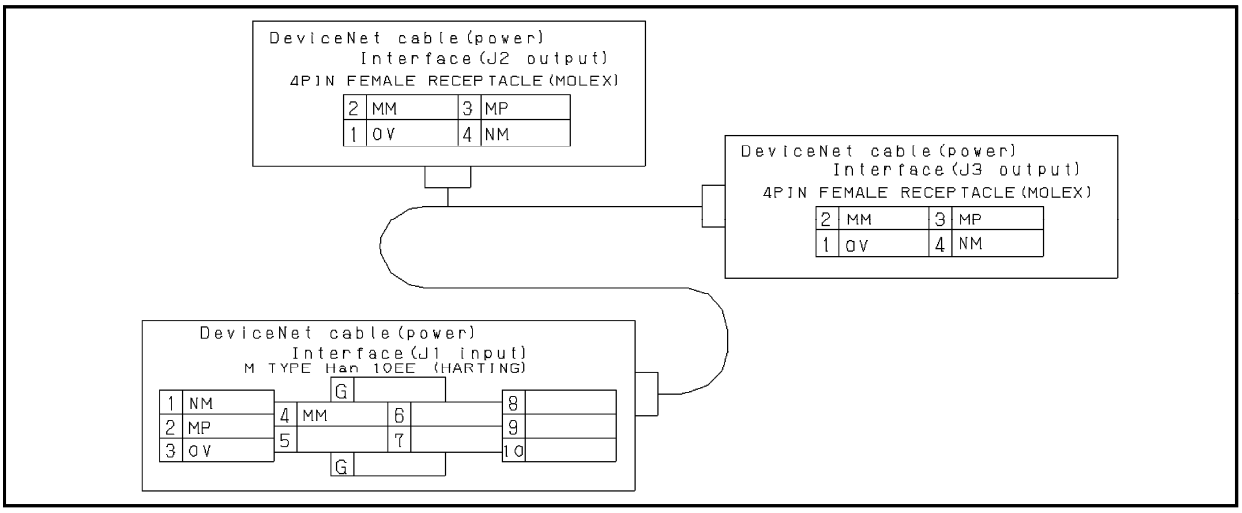


Fig. 9.9 (n) Pin layout for DeviceNet cable (power line) interface (option)

6. Additional axis motor cable (Pulsecoder cable) interface (option)
Fig. 9.9 (o), (p) show the pin layout of the additional axis motor cable (Pulsecoder cable) interface.
The connector has a code pin for preventing improper insertion.

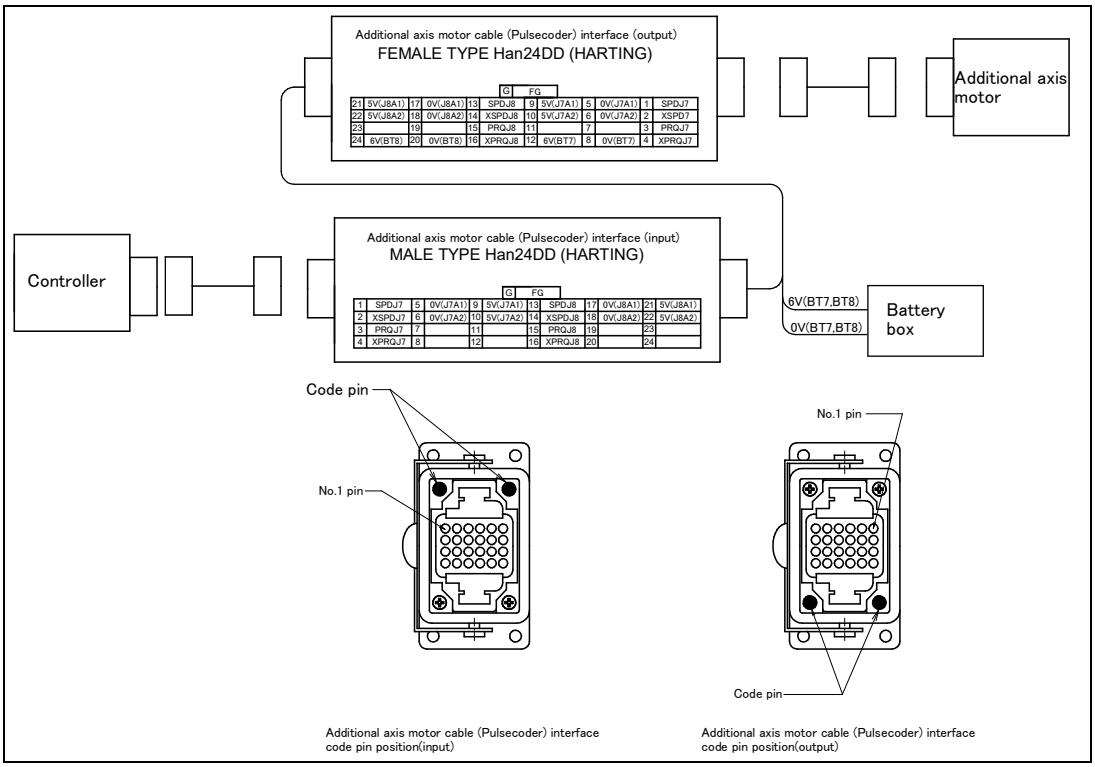


Fig. 9.9 (o) Pin layout of the additional axis (2-axes) motor cable (Pulsecoder cable) Interface and layout position of the code pin (option)

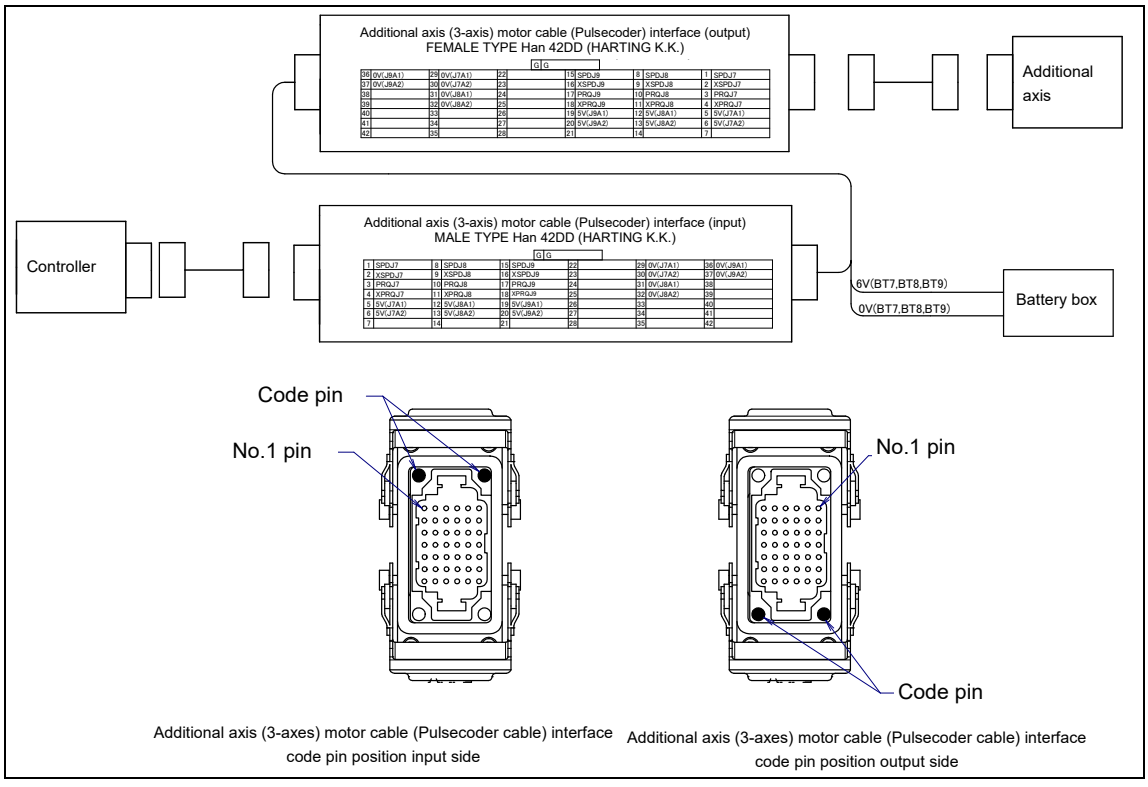


Fig. 9.9 (p) Pin layout of the additional axis (3-axes) motor cable (Pulsecoder cable) interface and layout position of the code pin (option)

7. Additional axis motor cable (power and brake cables) interface (option)
   Fig. 9.9 (q), (r) show the pin layout of the additional axis motor cable (power and brake cables) interface. The connector has a code pin for preventing improper insertion.

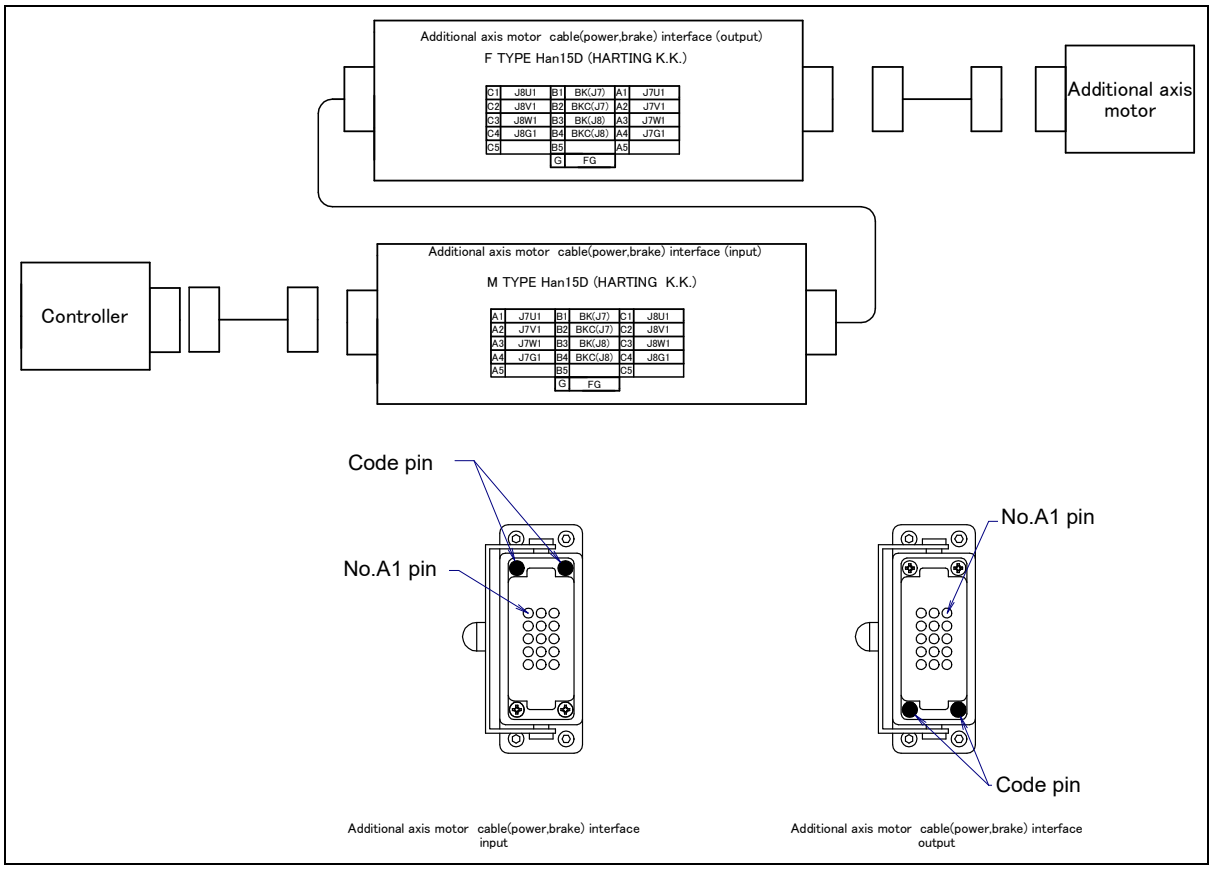


Fig. 9.9 (q) Pin layout of the additional axis motor cable (power and brake cables) Interface and layout position of the code pin (option)

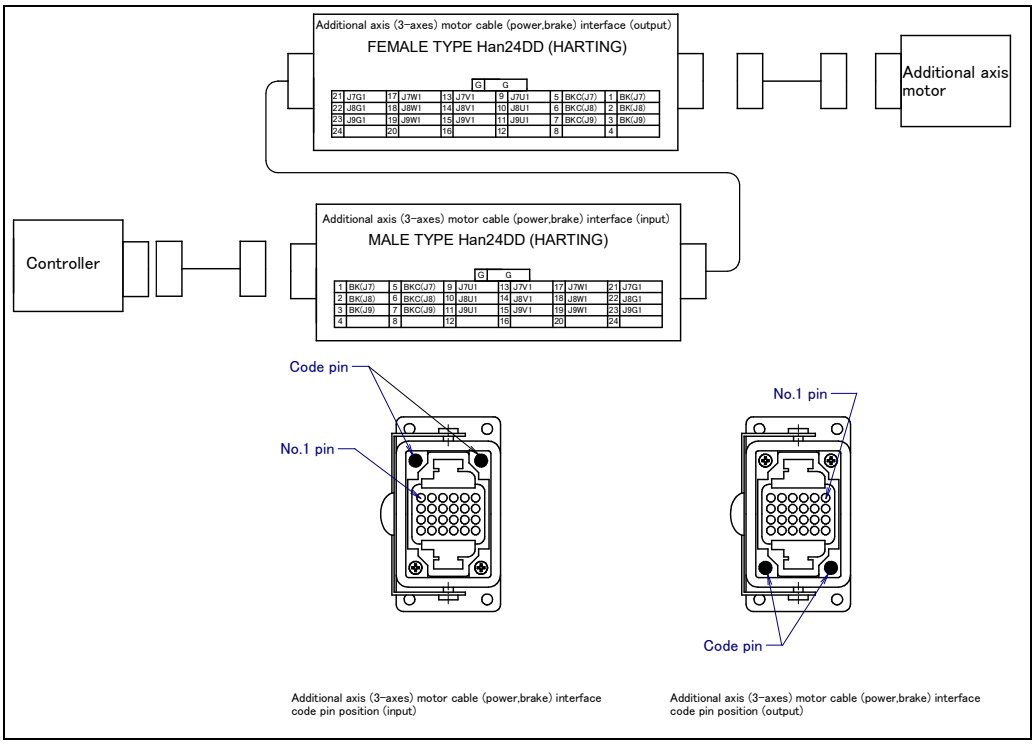


Fig. 9.9 (r) Pin layout of the additional axis (3-axes) motor cable (power and brake cables) interface and layout position of the code pin (option)

Connector Specifications

Table 9.9 (a) Connector specifications (mechanical unit side)

Cable	Input side (J1 base)		Output side (J3 casing)		Maker /Dealer
EE (RDI/RDO or RI/RO)	———		JMWR2524F		Fujikura. Ltd
AS ASH AS	Housing Insert Contact Code pin	09 30 006 0301 09 16 024 3001 09 15 000 6103 09 30 000 9901	Housing Insert Contact Code pin	09 30 006 0301 09 16 024 3101 09 15 000 6203 09 30 000 9901	HARTING K.K.
AP	Housing Insert Contact Code pin	09 20 010 0301 09 21 015 3001 09 15 000 6101 09 30 000 9901	Housing Insert Contact Code pin	09 20 010 0301 09 21 015 3101 09 15 000 6201 09 30 000 9901	
RDI/RDO or RI/RO (Cable corresponds to the severe dust/liquid protection)	Housing Insert Contact Guide pin	———	Housing Insert Contact Guide pin	09 30 006 0301 09 16 024 3101 09 15 000 6204 09 30 000 9908	

Table 9.9 (b) Connector specifications (User side)

Cable	Input side (J1 base)		Output side (J3 casing)		Maker /Dealer
EE (RDI/RDO or RI/RO)	_____		JMSP2524M Straight (Appendix) (FANUC Specification:A63L-0001-0234#S2524M) JMLP2524M Angle		Fujikura. Ltd
AS ASH ASi	Hood (NOTE)	09 30 006 1540 Side entry 1541 0542 0543 1440 Top entry 1441 0442 0443	Hood	←The same	HARTING K.K.
	Insert	09 16 024 3101	Insert	09 16 024 3001	
	Contact (NOTE)	09 15 000 6204 AWG 26-22 6203 AWG 20 6205 AWG 18 6202 AWG 18 6201 AWG 16 6206 AWG 14	Contact (NOTE 2)	09 15 000 6104 AWG 26-22 6103 AWG 20 6105 AWG 18 6102 AWG 18 6101 AWG 16 6106 AWG 14	
	Clamp (NOTE)	09 00 000 5083 5086 5090 5094 etc. Many other types are available	Clamp	←The same	
	Code pin	09 30 000 9901	Code pin	09 30 000 9901	
AP	Hood (NOTE)	09 20 010 1541 Side entry 0540 0541 1440 Top entry 0440 0441	Hood	←The same	
	Insert	09 21 015 3101	Insert	09 21 015 3001	
	Contact (NOTE)	09 15 000 6204 AWG 26-22 6203 AWG 20 6205 AWG 18 6202 AWG 18 6201 AWG 16 6206 AWG 14	Contact (NOTE)	09 15 000 6104 AWG 26-22 6103 AWG 20 6105 AWG 18 6102 AWG 18 6101 AWG 16 6106 AWG 14	
	Clamp (NOTE)	09 00 000 5083 5086 5090 5094 etc. Many other types are available	Clamp	←The same	
	Code pin	09 30 000 9901	Code pin	09 30 000 9901	

Table 9.9 (c) Connector specifications (User side)

Cable	Input side (J1 base)	Output side (J3 casing)		Maker /Dealer
EE (RDI/RDO or RI/RO) (Cable corresponds to the severe dust/liquid protection)	———	Hood	09 30 006 1440 (FANUC Specification: A63L-0001-0453#06B1440)	HARTING K.K.
		Insert	09 16 024 3001 (FANUC Specification: A63L-0001-0453#24DDM)	
		Contact	09 15 000 6104 AWG 26-22 (FANUC Specification: A63L-0001-0453#CA6140) 6103 AWG 20 6105 AWG 18 6102 AWG 18 6101 AWG 16 6106 AWG 14	
		Clamp	09 33 000 9908 (Appendix) (FANUC Specification: A63L-0001-0453#A-9908)	
		Bush	09 33 000 9909 (FANUC Specification: A63L-0001-0453#A-9909)	

Table 9.9 (d) Connector specifications (DeviceNet cable) (mechanical unit side)

Cable	Input side (J1 base)		Maker /Dealer	Output side (J3 casing)	Maker /Dealer
DS	CM03A-R5P-S-2		Fujikura. Ltd	CM03A-PR5S-S-2	Fujikura. Ltd
DP	Housing Insert Contact	09 30 006 0301 09 32 010 3001 09 33 000 6104	HARTING K.K.	CM03A-PR4S-S-2	Fujikura. Ltd

Table 9.9 (d) Connector specifications (DeviceNet cable, on the user side)

Cable	Input side (J1 connector panel)		Maker /dealer	Output side (J3 connector panel)	Maker /dealer
DS	MINI connector for use on the device net 5-pin, FEMALE CM03-P5S		Fujikura Ltd.	MINI connector for use on the device net 5-pin, MALE CM03-J5P	Fujikura Ltd.
DP	Hood (NOTE 2)	09 30 006 1540 Side entry 1541 0542 0543 ↓ 1440 Top entry 1441 ↓ 0442 0443	HARTING K.K.	MINI connector for use on the device net 4-pin, MALE CM03-J4P	Fujikura Ltd.
	Insert	09 32 010 3101			
	Contact (NOTE 2)	09 33 000 6220 AWG20 6214 AWG18 6205 AWG18 6204 AWG16 6202 AWG14 6207 AWG12			
	Clamp (NOTE 2)	09 00 000 5083 5086 5090 5094 Many other types are available.			

Table 9.9 (e) Connector specifications (Additional axis motor cable, Mechanical unit side)

Cable	Input side (J1 base)		Output side (J3 casing)		Maker /Dealer
ARP (2-axes)	Housing	09 30 006 0301	Housing	09 30 006 0301	HARTING K.K.
	Insert	09 16 024 3001	Insert	09 16 024 3101	
	Contact	09 15 000 6103 (8)	Contact	09 15 000 6203 (12)	
	Contact	09 15 000 6104 (8)	Contact	09 15 000 6104 (8)	
	Code pin	09 30 000 9901	Code pin	09 30 000 9901	
ARP (3-axes)	Housing	09 30 010 0301	Housing	09 30 010 0301	
	Insert	09 16 042 3001	Insert	09 16 042 3101	
	Contact	09 15 000 6103	Contact	09 15 000 6203	
	Contact	09 15 000 6104	Contact	09 15 000 6204	
	Guide pin	09 33 000 9908	Guide pin	09 33 000 9908	
	Code bush	09 33 000 9909	Code bush	09 33 000 9909	
ARM (2-axes)	Housing	09 20 010 0301	Housing	09 20 010 0301	
	Insert	09 21 015 3001	Insert	09 21 015 3101	
	Contact	09 15 000 6101	Contact	09 15 000 6201	
	Code pin	09 30 000 9901	Code pin	09 30 000 9901	
ARM (3-axes)	Housing	09 30 006 0301	Housing	09 30 006 0301	
	Insert	09 16 024 3001	Insert	09 16 024 3101	
	Contact	09 15 000 6101	Contact	09 15 000 6201	
	Guide pin	09 33 000 9908	Guide pin	09 33 000 9908	
	Code bush	09 33 000 9909	Code bush	09 33 000 9909	

NOTE

For details, such as the dimensions, of the parts listed above, refer to the related catalogs offered by the respective manufactures, or contact your local FANUC representative.

10 TRANSPORTATION AND INSTALLATION

10.1 TRANSPORTATION

1 Transportation using a crane
The robot can be transported by lifting it. When transporting the robot, be sure to change the posture of the robot to that shown in Fig. 10.1 (a) and (b) and lift by attaching slings to the four M24 eyebolts.

⚠ CAUTION
When lifting the robot, take notice so that the motors, connectors, or cables of the robot are not scratched by slings.

2 Transportation using a forklift
The robots can also be transported using a forklift (refer to Fig. 10.1 (c) and (d)). Transport materials are available as an option.

NOTE
Detach the end effectors and base plate before transporting the robot. If the robot must necessarily be transported with the base plate attached, take the following precautions:

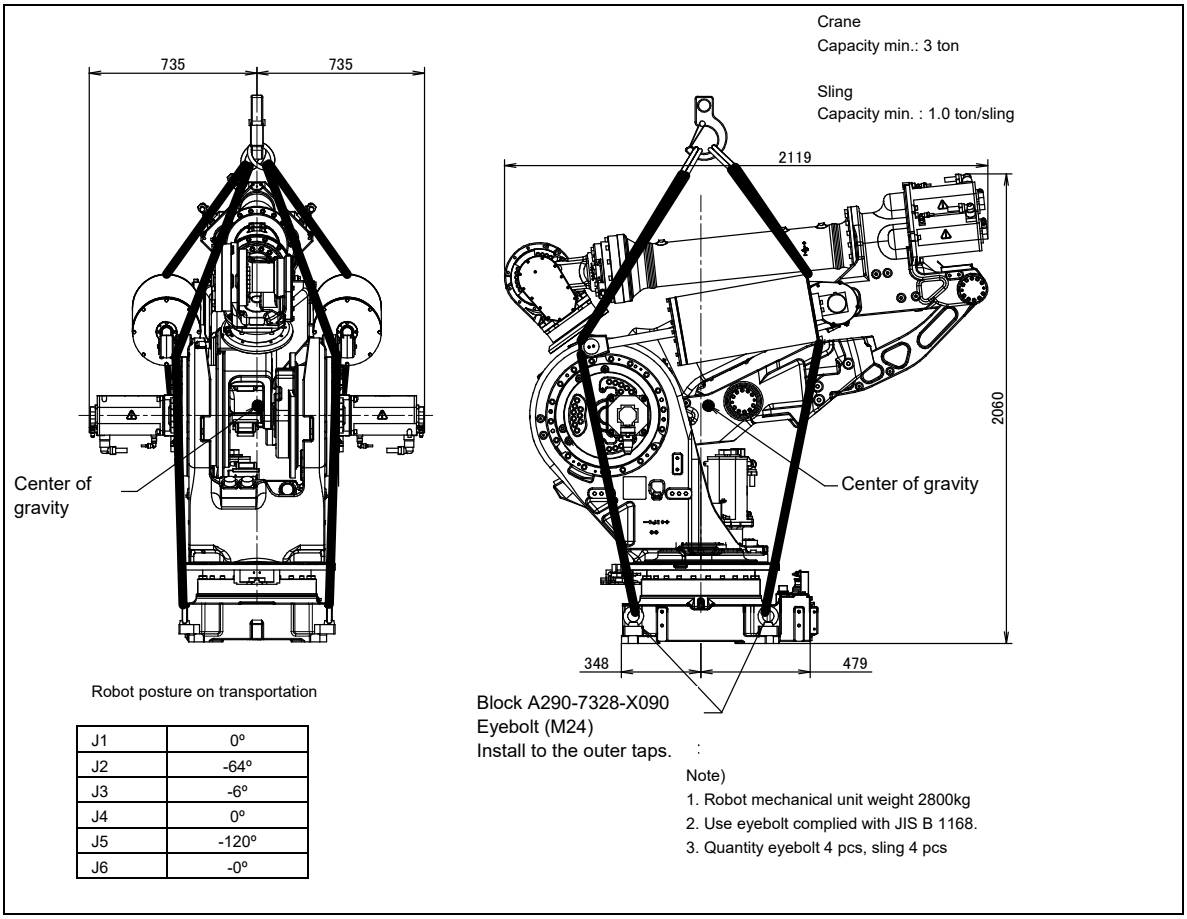
Robot becomes unstable when it is transported with the end effector applied to wrist, and it is dangerous.
Please be sure to remove the end effector when robot is transported. Be extremely careful to keep the robot in balance.

If the base plate is attached, the center of gravity of the entire robot changes. When lifting the robot, be sure to lift the base plate instead of the robot.

If the J2/J3-axis motor covers (option) are installed, be sure to remove them before transporting robot with a crane.

⚠ WARNING
Use the forklift transport bracket only when carrying the robot with a forklift. Do not use the transport bracket for fastening the robot. Before transporting the robot with the transport brackets, check the fastening bolts of the brackets for looseness. Tighten the loose bolts, if any.

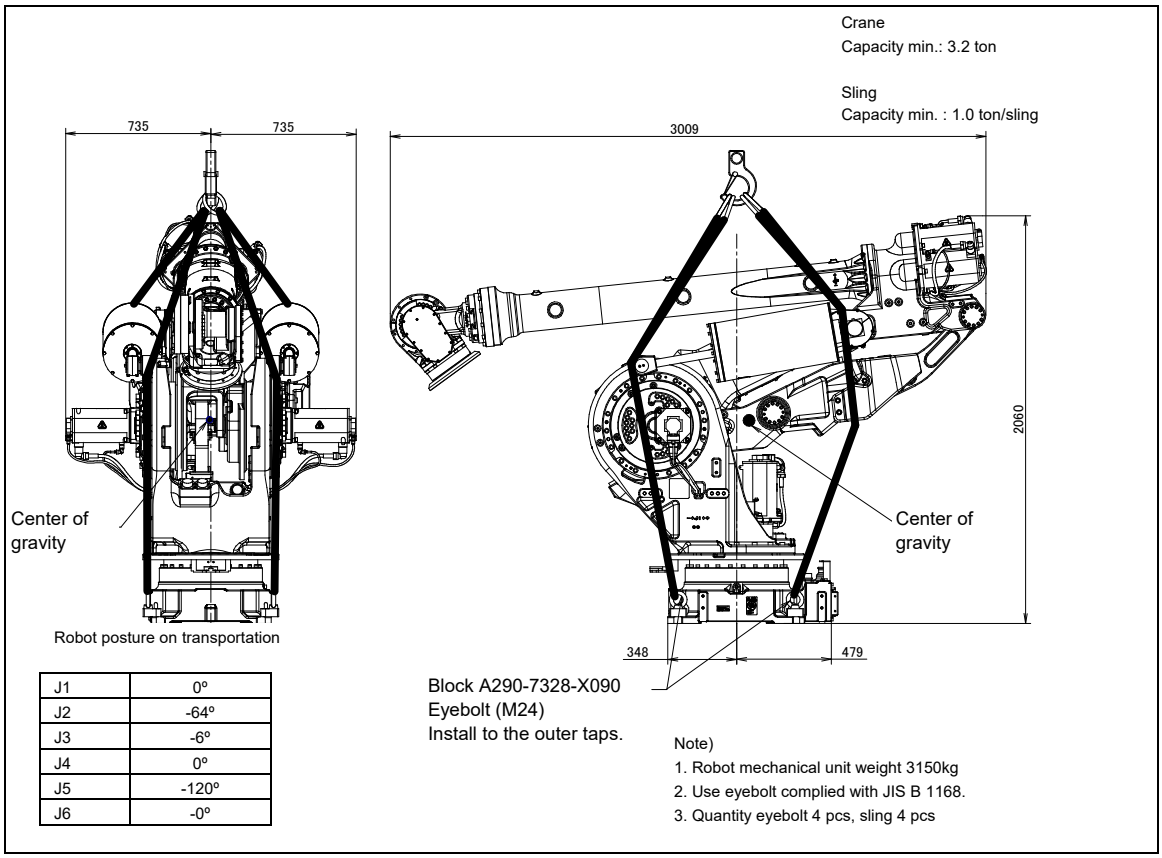
⚠ CAUTION
When hoisting or lowering the robot with a crane or forklift, move it slowly with great care. When placing the robot on the floor, exercise care to prevent the installation surface of the robot from striking the floor strongly.



Robot posture on transportation

J1	0º
J2	-64º
J3	-6º
J4	0º
J5	-120º
J6	-0º

Fig. 10.1 (a) Transportation using a crane (M-900*i*A/600)



Robot posture on transportation

J1	0º
J2	-64º
J3	-6º
J4	0º
J5	-120º
J6	-0º

Fig. 10.1 (b) Transportation using a crane (M-900*i*A/400L)

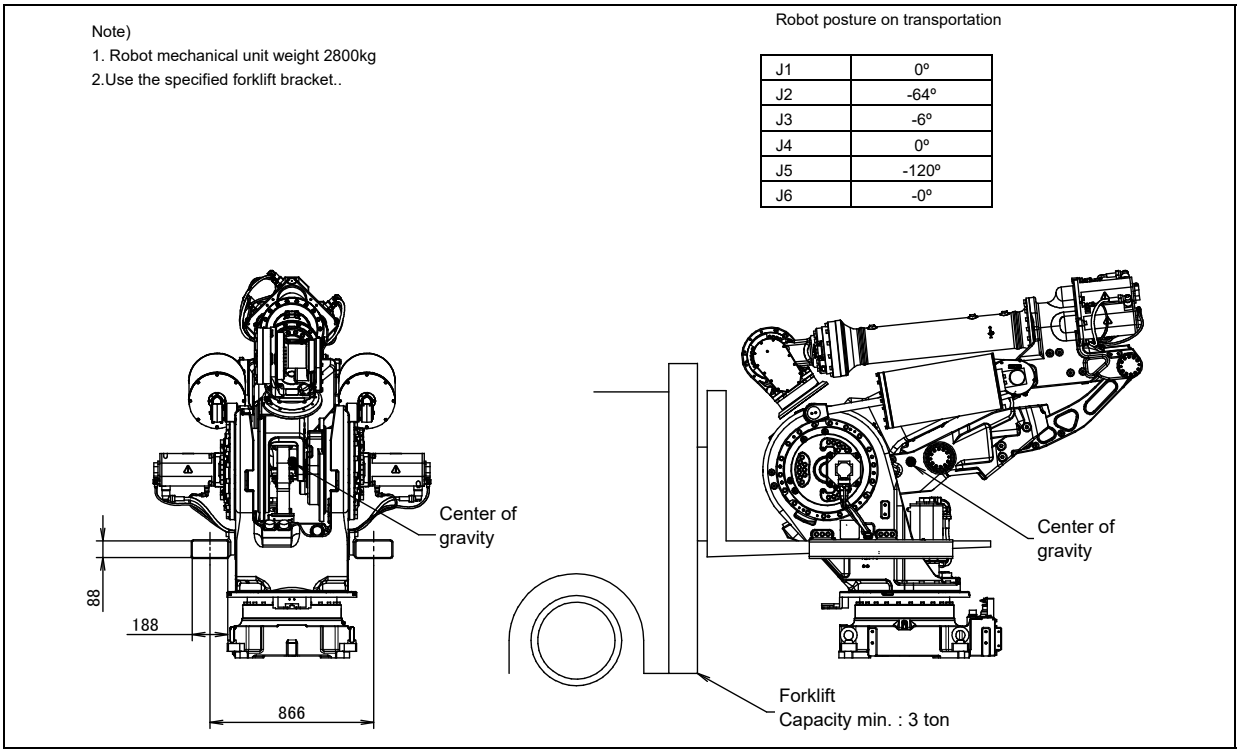


Fig. 10.1 (c) Transportation using a forklift (M-900*i*A/600)

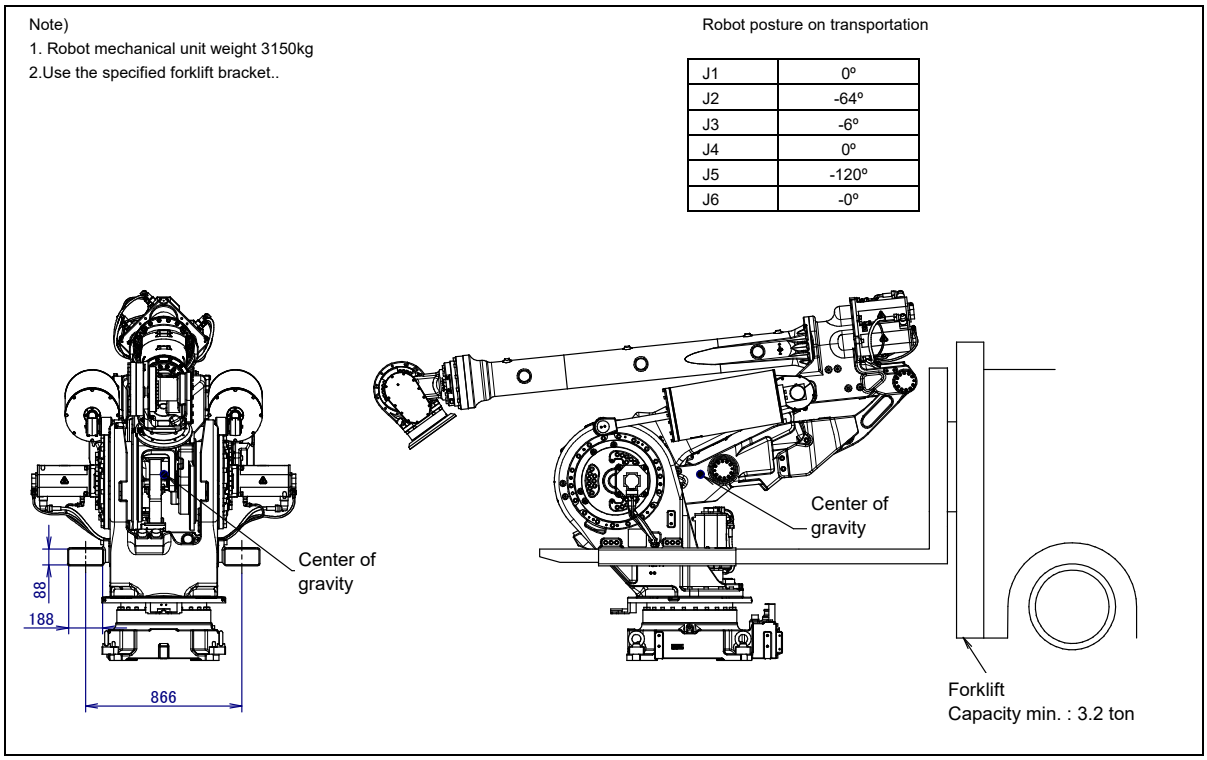


Fig. 10.1 (d) Transportation using a forklift (M-900*i*A/400L)

> ⚠ **CAUTION**
> Be careful not to strike the transport equipment with the forklift forks.

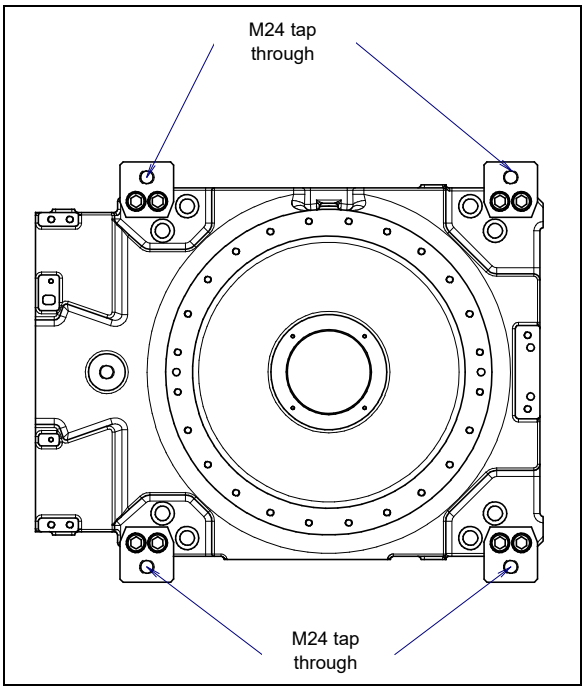


Fig. 10.1 (e) Eyebolt installation location

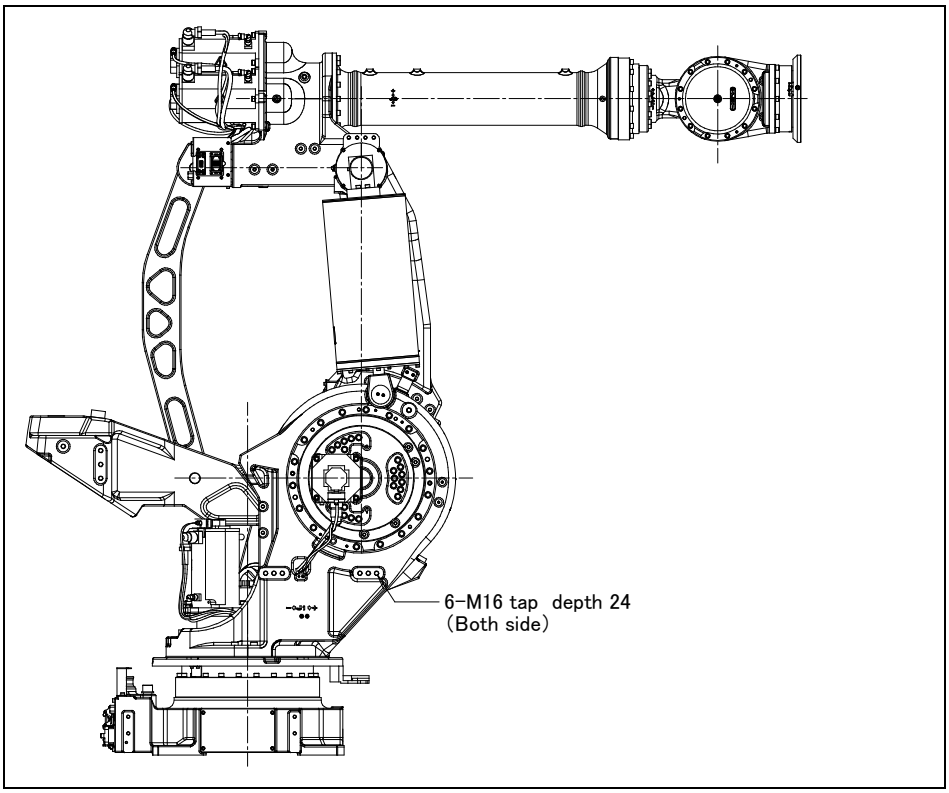


Fig. 10.1 (f) Transport equipment installation location

10.2 INSTALLATION

Fig. 10.2 (a) shows the robot base dimensions. Fig. 10.2 (b) shows actual examples of robot installations. In Fig. 10.2 (b), the floor plate is imbedded in concrete and fastened with twelve M20 (Tensile strength: 400N/mm^2) chemical anchors. Also, fasten the base plate to the robot base using eight M20x60 bolts (Tensile strength: 1200N/mm^2). Next, position the robot, and weld the base plate to the floor plate. (Foot length is 10 to 15mm.) (The base plate is prepared as an option.)
Avoid placing any object in front of the robot on the mounting face to facilitate the installation of the mastering fixture, as shown in Fig. 10.2 (a).

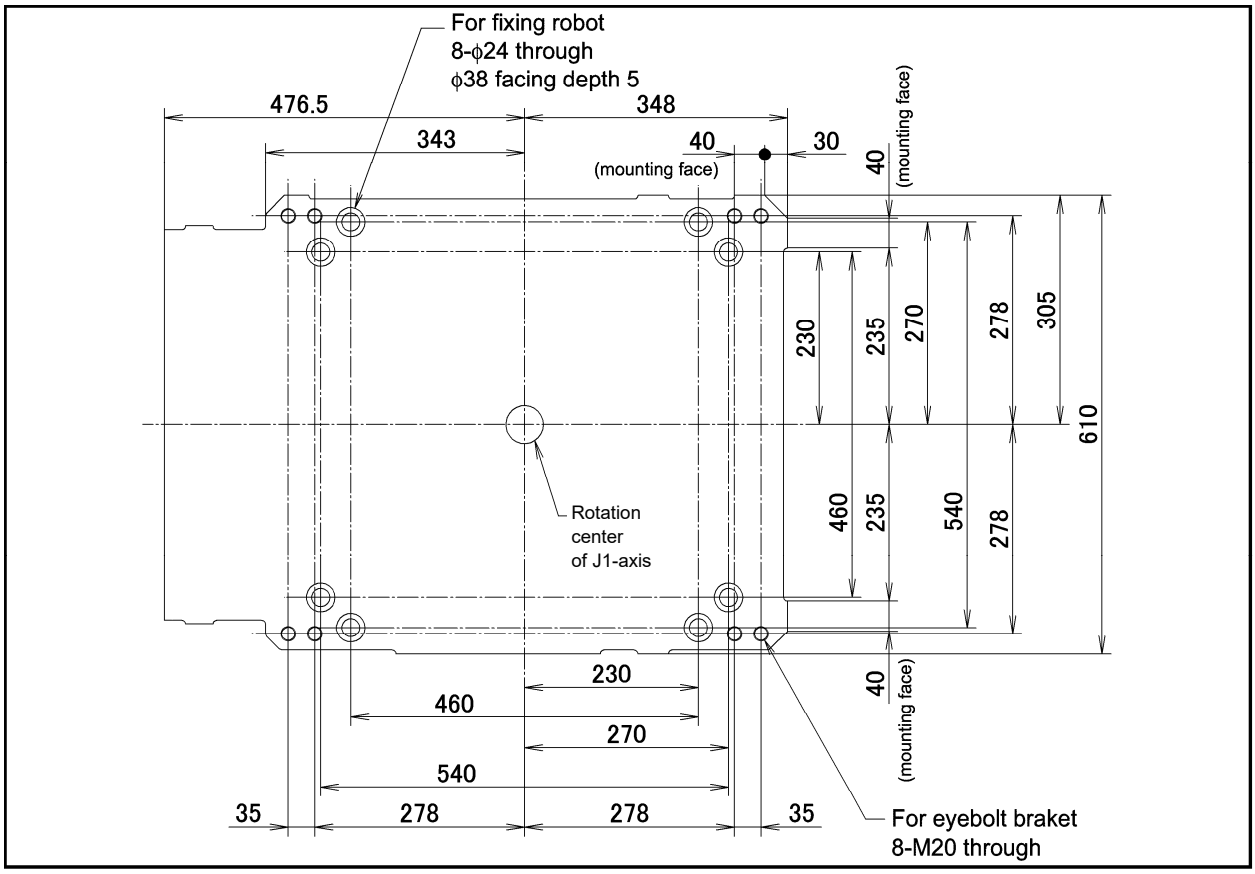


Fig. 10.2 (a) Dimensions of the robot base

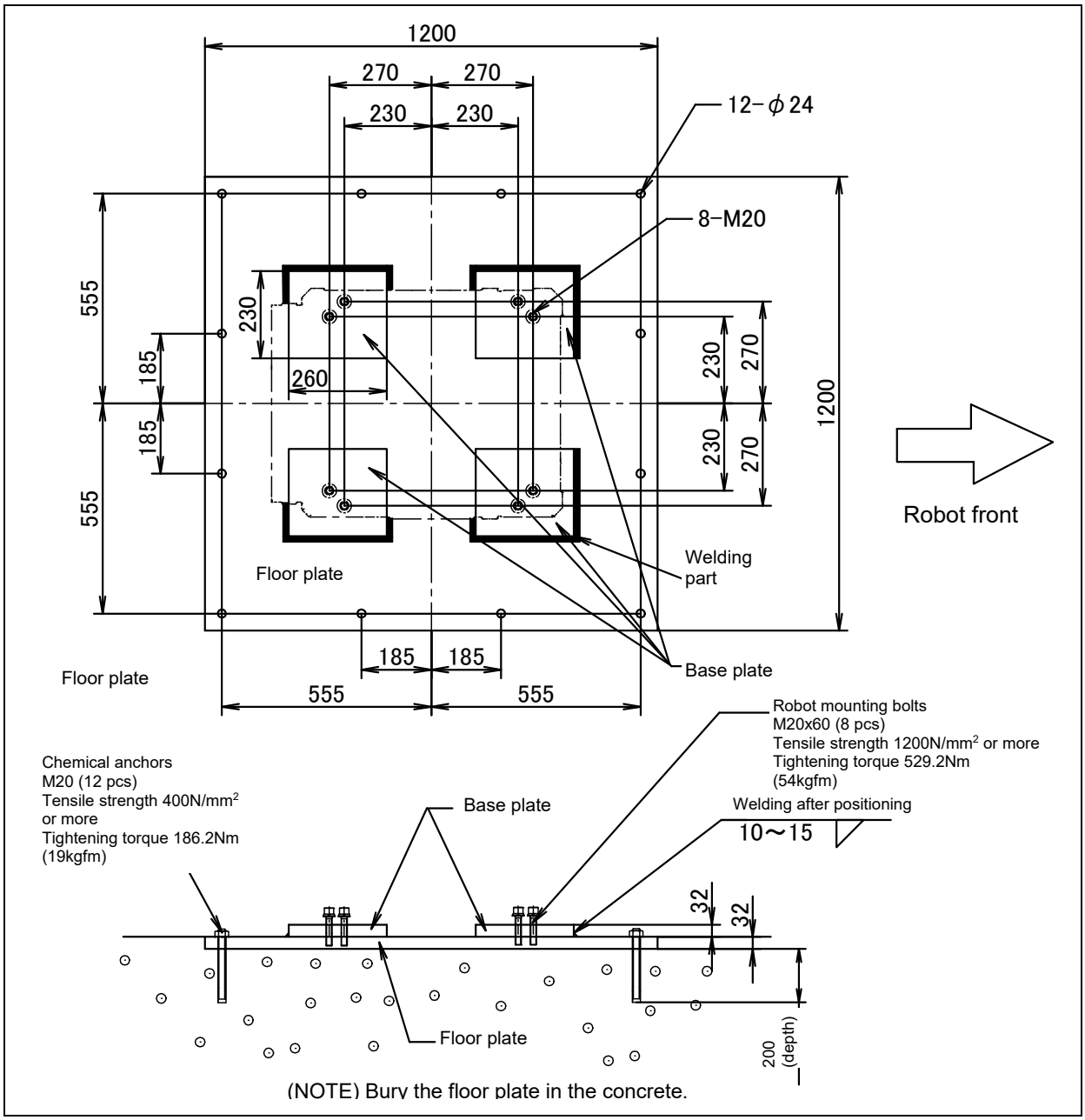


Fig. 10.2 (b) Actual installation example

NOTE

1 The strength of the chemical anchor depends on the concrete strength. See the design guideline of the manufacturer for the execution of the chemical anchor and consider the safety ratio sufficiently before use.

2. Parts to be provided by the customer:
   - Robot mounting bolts : M20 x 60 (Tensile strength 1200N/mm^2 or more 8pcs.
   - Chemical anchors : M20 (Tensile strength 400N/mm^2 or more) 12pcs.
   - Base plates : Thickness 32t 4pcs.
   - Floor plate : Thickness 32t 1pc.

3 Installation work (welding, anchoring, etc.) is prepared by the customer.

4 Flatness of robot installation surface must be less than or equal to 0.5mm. Inclination of robot installation surface must be less than or equal to 0.5º. If robot base is placed on uneven ground, it may result in the base breakage or low performance of the robot.

Fig. 10.2 (c) and Table 10.2 (a) show the force and moment applied to the base plate at the time of Power -Off stop. Table 10.2 (b),(c) indicate the stopping time and distance of the J1 to J3 axis until the robot stopping by Power-Off stop or by Controlled stop after input of the stop signal.
Refer to the data when considering the strength of the installation face.

NOTE
Table 10.2 (b) and (c) are measured reference value complied with ISO10218-1. Values differs depending on each robot individual difference, payload and the program. So confirm the real value by measurement. Values in Table 10.2 (b) is affected by the robot operating status and number of times of the servo-off stop. Periodically measure the real values and confirm those.

Table 10.2(a) Force and moment during Power-Off stop

Model	Vertical moment M_V [kNm (kgfm)]	Force in vertical direction F_V [kN (kgf)]	Horizontal moment M_H [kNm (kgfm)]	Force in horizontal direction F_H [kN (kgf)]
M-900*i*A/600/400L	116.62 (11900)	63.70 (6500)	29.40 (3000)	35.28 (3600)
M-900*i*A/600 When the 700kg option is used	119.56 (12200)	64.68 (6600)	29.40 (3000)	36.26 (3700)

Table 10.2(b) Stopping time and distance until the robot stopping by Power-Off stop after input of stop signal

Model		J1-axis	J2-axis	J3-axis
M-900*i*A/600	Stopping time [ms]	1092	284	340
	Stopping distance [deg] (rad)	40.2 (0.70)	11.5 (0.16)	14.9 (0.22)
M-900*i*A/600 When the 700kg option is used	Stopping time [ms]	1164	292	436
	Stopping distance [deg] (rad)	42.9 (0.75)	11.9 (0.21)	16.3 (0.28)
M-900*i*A/400L	Stopping time [ms]	1068	260	596
	Stopping distance [deg] (rad)	40.4 (0.70)	11.1 (0.19)	24.7 (0.43)

Table 10.2(c) Stopping time and distance until the robot stopping by Controlled stop after input of stop signal

Model		J1-axis	J2-axis	J3-axis
M-900*i*A/600	Stopping time [ms]	1036	1052	1052
	Stopping distance [deg] (rad)	45.7 (0.80)	42.6 (0.74)	42.7 (0.74)
M-900*i*A/600 When the 700kg option is used	Stopping time [ms]	1044	1044	1044
	Stopping distance [deg] (rad)	49.0 (0.85)	45.1 (0.79)	45.1 (0.79)
M-900*i*A/400L	Stopping time [ms]	1036	1052	1044
	Stopping distance [deg] (rad)	44.6 (0.78)	41.5 (0.72)	41.4 (0.72)

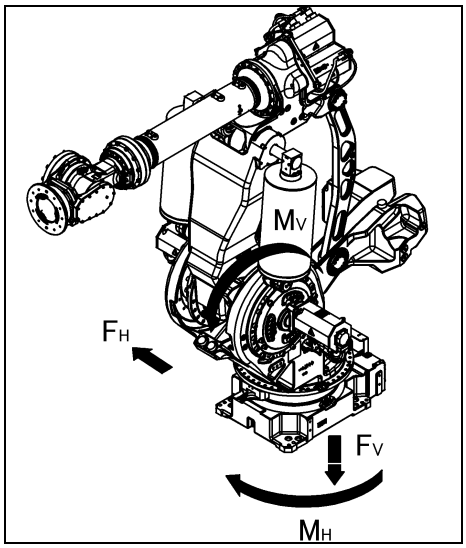


Fig. 10.2 (c) Force and moment that acts during Power-Off Stop

10.3 MAINTENANCE AREA

Fig. 10.3(a), (b) show the maintenance area of the mechanical unit. Be sure to leave enough room for the robot to be mastered.

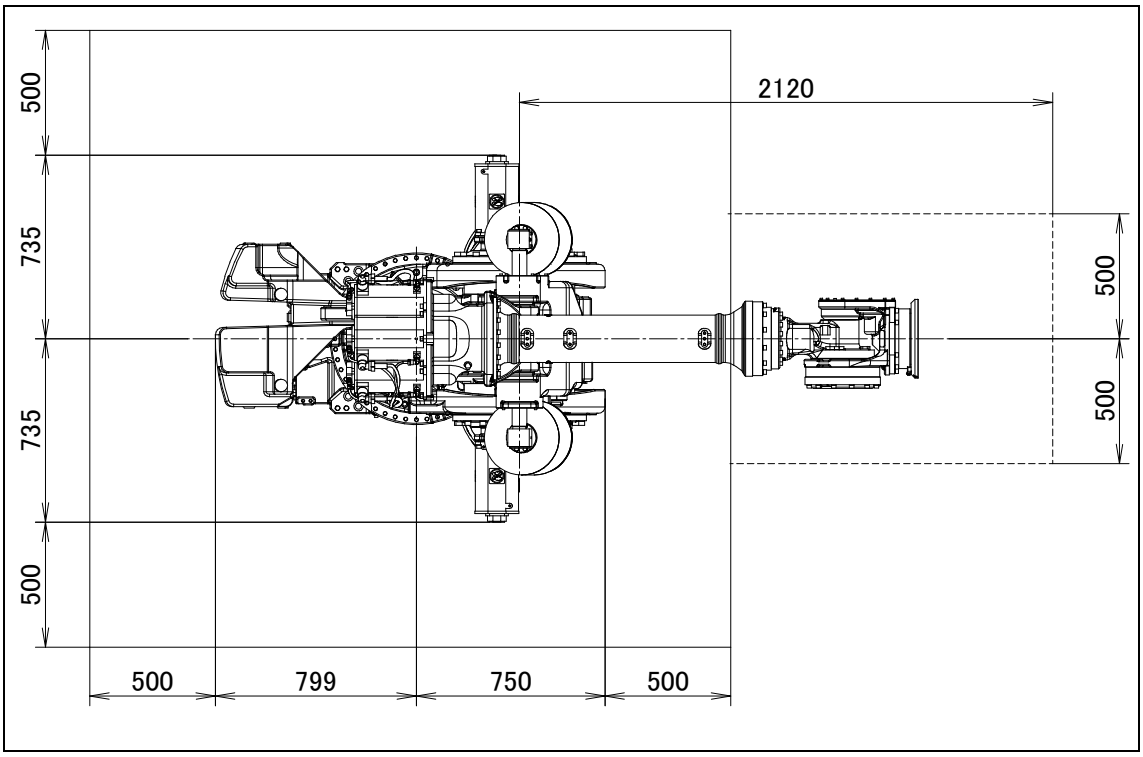


Fig. 10.3 (a) Maintenance area (M-900*i*A/600)

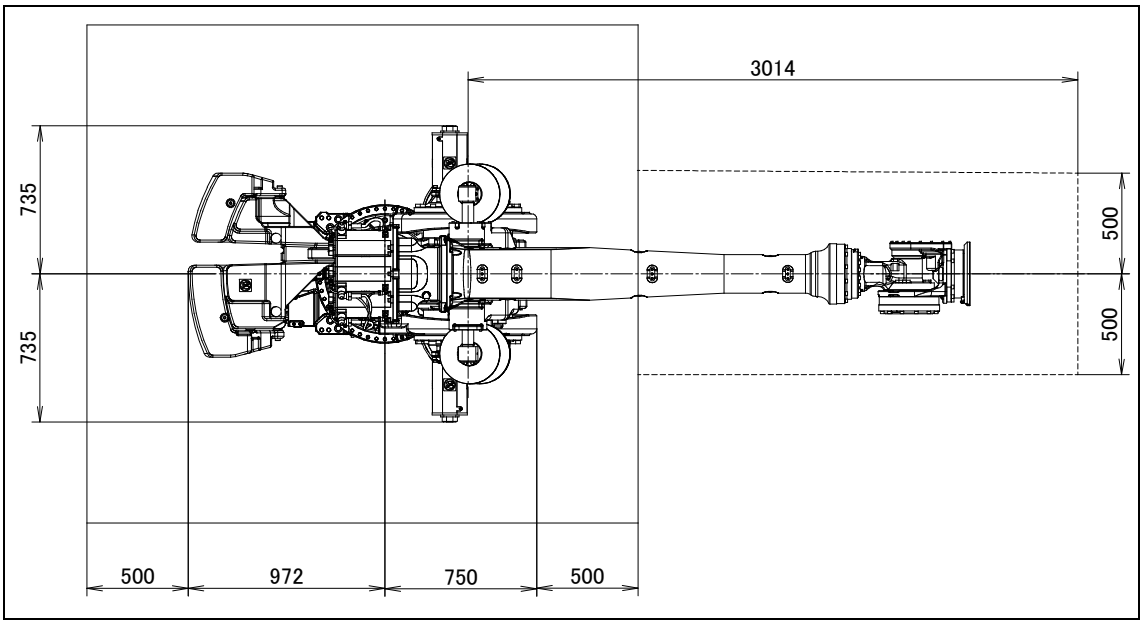


Fig. 10.3 (b) Maintenance area (M-900*i*A/400L)

10.4 AIR PIPING (OPTION)

Fig. 10.4 (a) shows how to connect air hose to the robot. If the air control set is specified as an option, the air hose between the mechanical unit and the air control set is provided. Mount the air control set using the information in Fig. 10.4 (b). This is outside FANUC delivery scope.

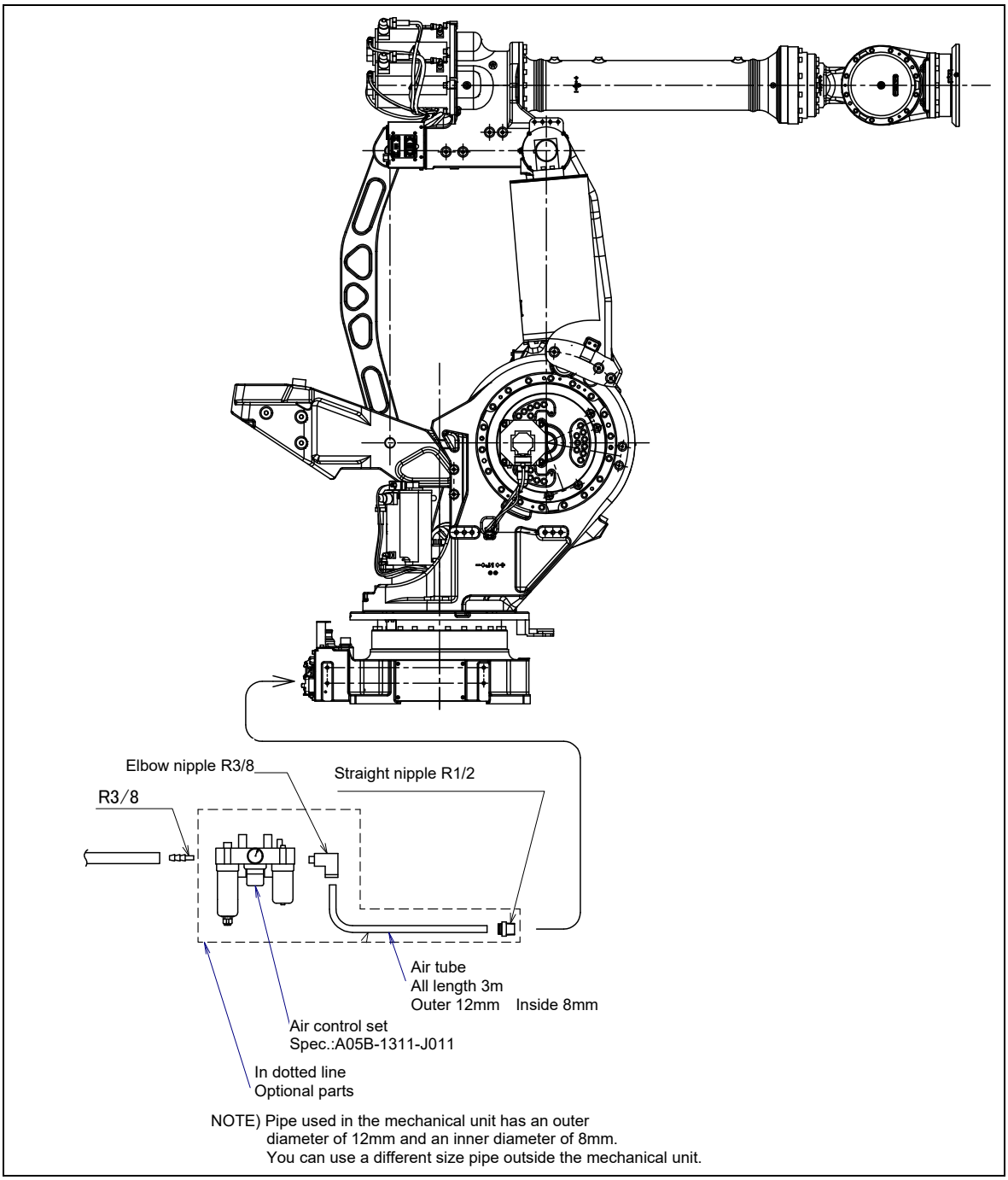


Fig. 10.4 (a) Air piping option (option)

Air control set

Fill the lubricator having three air components to the specified level with turbine oil #90 to #140. The machine tool builder is required to prepare mounting bolts. This is outside FANUC delivery scope.

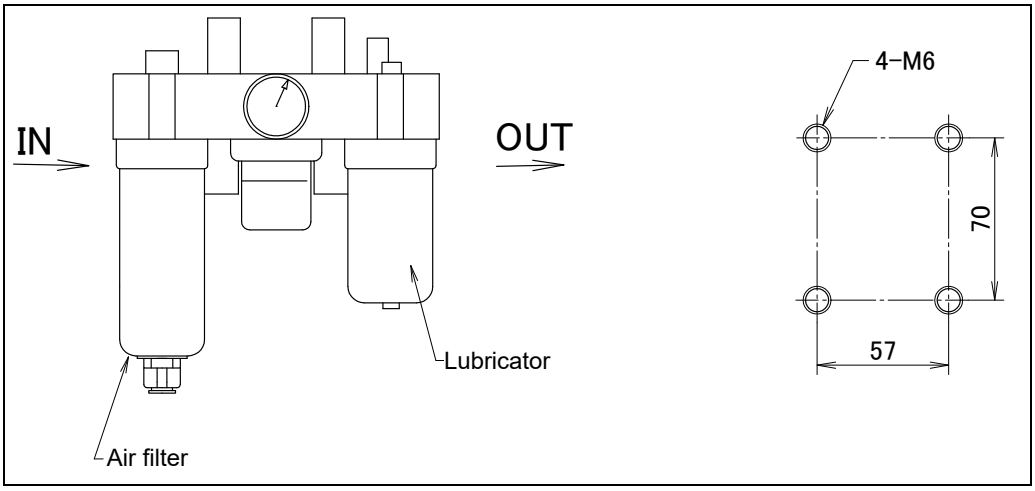


Fig. 10.4 (b) Air control set option (option)

10.5 INSTALLATION CONDITIONS

Refer to specification table of “PREFACE” about installation conditions.

11 CONNECTION WITH THE CONTROLLER

The robot is connected with the controller via the power cable, the signal cable and the earth cable. Connect these cables to the connectors on the back of the robot base. For details on air and option cables, see Chapter 9.

> ⚠ **WARNING**
> Before turning on controller power, be sure to connect the robot and controller with the earth line (ground). Otherwise, there is the risk of electrical shock.

> ⚠ **CAUTION**
> 1 Before connecting the cables, be sure to turn off the controller power.
> 2 Don't use 10m or longer coiled cable without first untying it. The long coiled cable will heat up and become damaged.

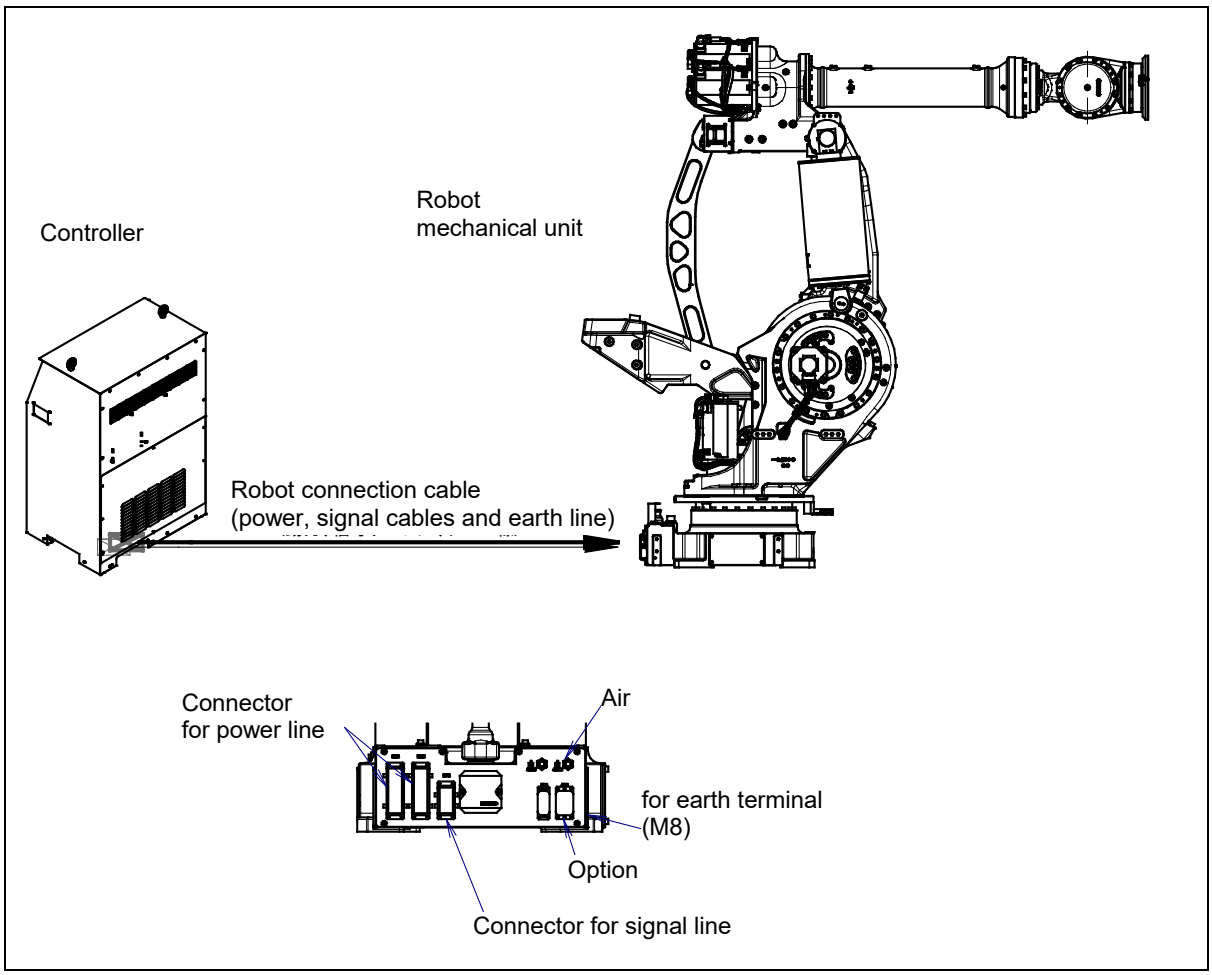


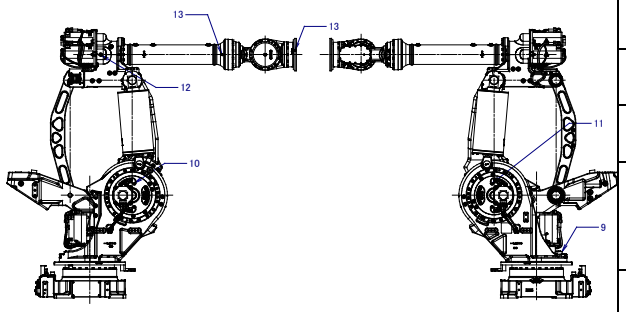
Fig. 11 (a) Cable connection

APPENDIX

A PERIODIC MAINTENANCE TABLE

FANUC Robot M-900*i*A/600/400L **Periodic Maintenance Table**

Items		Accumulated operating time (H)	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
Mechanical unit	1	Check the mechanical cable (damaged or twisted)	0.2H	-		○			○				○				○			
	2	Check the motor connector (loosening)	0.2H	-		○			○				○				○			
	3	Tighten the end effector bolt	0.2H	-		○			○				○				○			
	4	Tighten the cover and main bolt	2.0H	-		○			○				○				○			
	5	Check the mechanical stopper and adjustable mechanical stopper	0.1H	-		○			○				○				○			
	6	Remove spatter and dust etc	1.0H	-		○			○				○				○			
	7	Check the end effector (hand) cable	0.1H	-		○			○				○				○			
	8	Replacing batteries	0.1H	-							●						●			
	9	Replacing grease of J1-axis reducer *	1.0H	7000ml													●			
	10	Replacing grease of J2-axis reducer *	1.0H	6000ml													●			
	11	Replacing grease of J3-axis reducer *	1.0H	6000ml													●			
	12	Replacing grease of J4-axis gearbox *	1.0H	4200ml													●			
	13	Replacing grease of wrist (J5/J6) axis reducer *	1.0H	2800ml + 2800ml or 3200ml													●			
	14																			
	15																			
	16																			
	17	Greasing to J2/J3 bearing *	0.1H	20ml each													●			
	18																			
	19	Replacing cable of mechanical unit	4.0H	-																
Controller	20	Check the robot cable, teach pendant cable and robot connecting cable	0.2H	-		○			○				○				○			
	21	Cleaning the ventilator	0.2H	-	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
	22	Replacing batteries	0.1H	-																



*: Please refer to this manual or Chapter 7 of MAINTENANCE of Controller Maintenance Manual.

●: Requires order of parts

○: Does not require order of parts

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	Item
○				○				○				○					1
○				○				○				○					2
○				○				○				○					3
○				○				○				○					4
○				○				○				○					5
○				○				○				○					6
○				○				○				○					7
		●						●						●			8
								●									9
								●									10
								●									11
								●									12
								●									13
																	14
																	15
																	16
								●									17
																	18
●																	19
○				○				○				○					20
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		21
●																	22

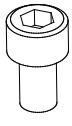
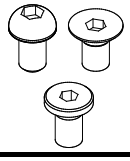
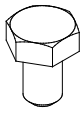
Overhaul

B STRENGTH OF BOLT AND BOLT TORQUE LIST

NOTE
When applying LOCTITE to a part, spread the LOCTITE on the entire length of the engaging part of the female thread. If applied to the male threads, poor adhesion can occur, potentially loosening the bolt. Clean the bolts and the threaded holes and wipe off any oil on the engaging section. Make sure that there is no solvent left in the threaded holes. When finished, remove all the excess LOCTITE when you are finished screwing the bolts into the threaded holes.

Use the following strength bolts. Comply with any bolt specification instructions.
Hexagon socket head bolt made of steel:
Size M22 or less: Tensile strength 1200N/mm^2 or more
Size M24 or more: Tensile strength 1000N/mm^2 or more
All size plating bolt: Tensile strength 1000N/mm^2 or more
Hexagon bolt, stainless bolt, special shape bolt (button bolt, low-head bolt, flush bolt .etc.)
Tensile strength 400N/mm^2 or more
Refer to the following tables if the bolts tightening torque is not specified.

Recommended bolt tightening torques **Unit: Nm**

Nominal diameter	Hexagon socket head bolt (steel)		Hexagon socket head bolt (stainless steel)		Hexagon socket head button bolt Hexagon socket head flush bolt Low-head bolt (steel)		Hexagon bolt (steel)	
	Tightening torque		Tightening torque		Tightening torque		Tightening torque	
	Upper limit	Lower limit	Upper limit	Lower limit	Upper limit	Lower limit	Upper limit	Lower limit
M3	1.8	1.3	0.76	0.53	———	———	———	———
M4	4.0	2.8	1.8	1.3	1.8	1.3	1.7	1.2
M5	7.9	5.6	3.4	2.5	4.0	2.8	3.2	2.3
M6	14	9.6	5.8	4.1	7.9	5.6	5.5	3.8
M8	32	23	14	9.8	14	9.6	13	9.3
M10	66	46	27	19	32	23	26	19
M12	110	78	48	33	———	———	45	31
(M14)	180	130	76	53	———	———	73	51
M16	270	190	120	82	———	———	98	69
(M18)	380	260	160	110	———	———	140	96
M20	530	370	230	160	———	———	190	130
(M22)	730	510	———	———	———	———	———	———
M24	930	650	———	———	———	———	———	———
(M27)	1400	960	———	———	———	———	———	———
M30	1800	1300	———	———	———	———	———	———
M36	3200	2300	———	———	———	———	———	———
								

INDEX

<Z>

REVISION RECORD

Edition	Date	Contents
01	Mar, 2021	

B-82174EN/01