FANUC Robot M-410*i*B/160/300

MECHANICAL UNIT

OPERATOR'S MANUAL

B-81994EN/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.

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
Teaching with teach pendant		O	O
Emergency stop with operator's panel	O	O	O
Emergency stop with teach pendant	O	O	O
Operator's panel maintenance			O
Teach pendant maintenance			O

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. Supplementary information is indicated by "**NOTE**". Read the contents of each "**WARNING**", "**CAUTION**" and "**NOTE**" before using 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) (except A cabinet integrated type controller) A05B-2450-J361(10m) (except A cabinet controller integrated type controller) A05B-2525-J045 (5m) (A cabinet integrated type controller) A05B-2525-J046(10m) (A cabinet integrated type controller)
Power cable	A05B-2525-J010 (5m) (AC100-150V type Power plug) A05B-2525-J011(10m) (AC100-150V type 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 balancer is used for J2-axis, it is hard to predict J2-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.

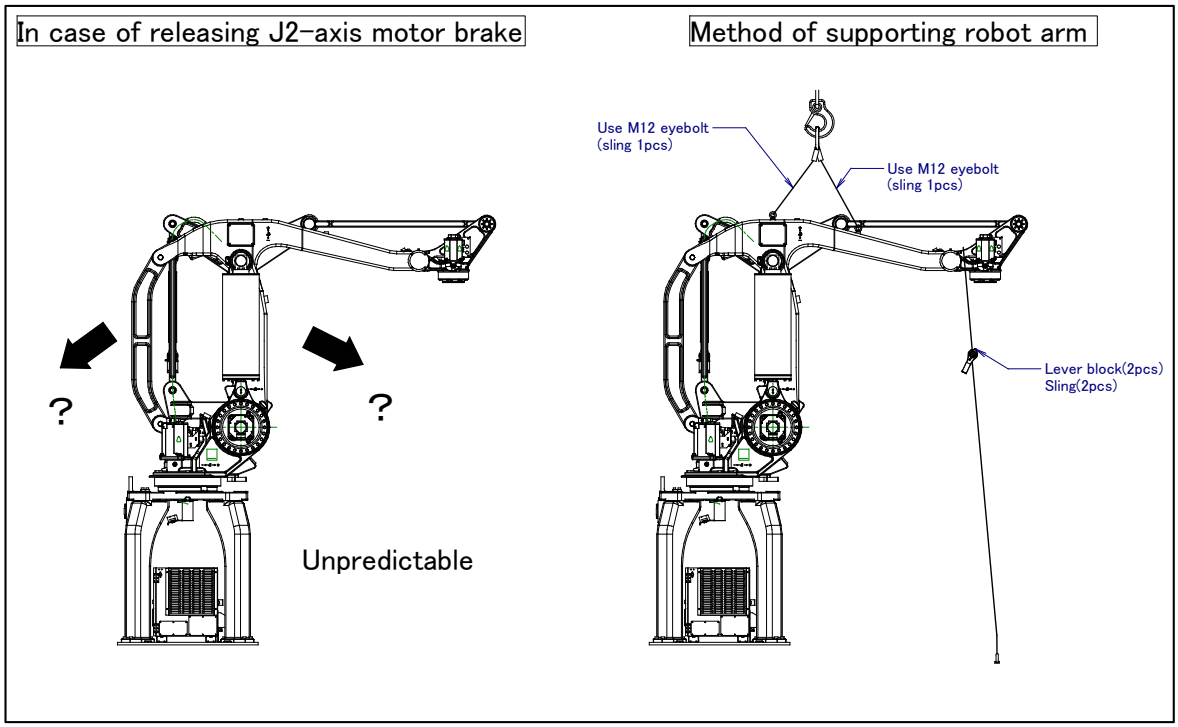


Fig. 3 (a) Arm operation by the release of J2-axis motor brake and measure

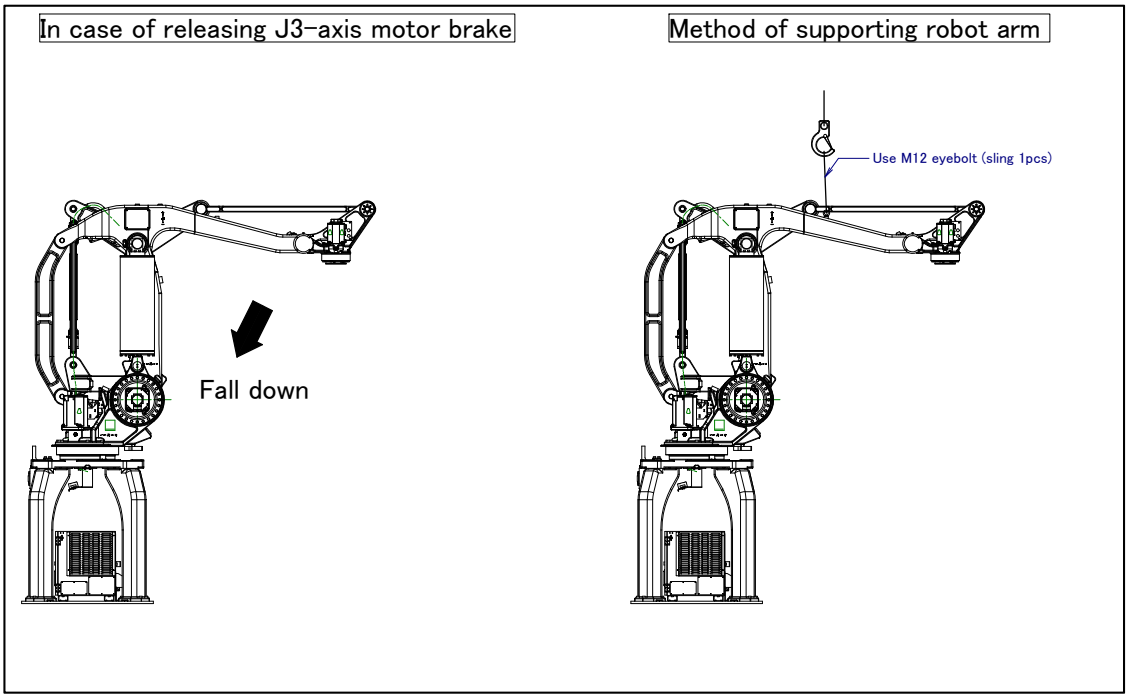


Fig. 3 (b) Arm operation by the release of J3-axis motor brake and measure

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 ″ PERIODIC MAINTENANCE for explanations about specified grease, the grease amount, and the locations of grease and degrease outlets for individual models.

(2) Disassembly prohibitive label

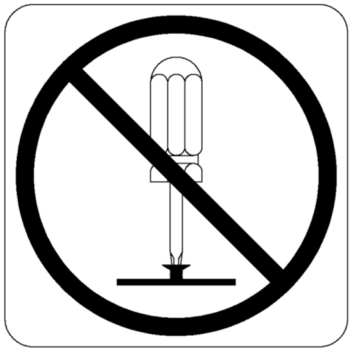


Fig. 4 (b) Disassembly prohibitive label

Description

Do not disassemble the balance unit. It is very dangerous because a spring is loaded in it.

(3) Step-on prohibitive label

Fig. 4 (c) 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.

(4) High-temperature warning label

Fig. 4 (d) 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 tool such as heat-resistant gloves.

(5) Transportation label

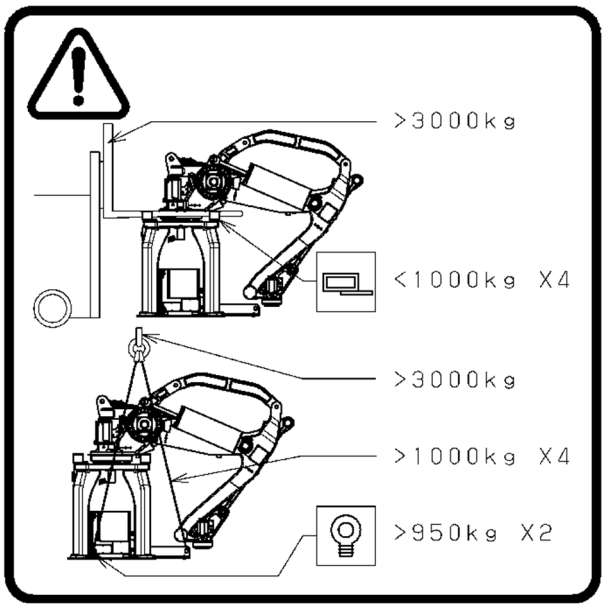


Fig. 4 (e) Transportation label

Description

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

1) Using a forklift
   - Use a forklift having a load capacity of 3000 kg or greater.
   - Keep the total weight of the robot to be transported to within 4000 kg, because the allowable load of the forklift bracket (option) is 9800 N (1000 kgf).

2) Using a crane
   - Use a crane with a load capacity of 3000 kg or greater.
   - Use four slings each with each load capacity of 1000 kg or greater.
   - Use at least four eyebolts with each allowable load of 9310 N (950 kgf) or greater.

> ⚠ **CAUTION**
> See section 9.1 TRANSPORTATION for explanations about the posture a specific model should take when it is transported.

(6) Balancer replacement label

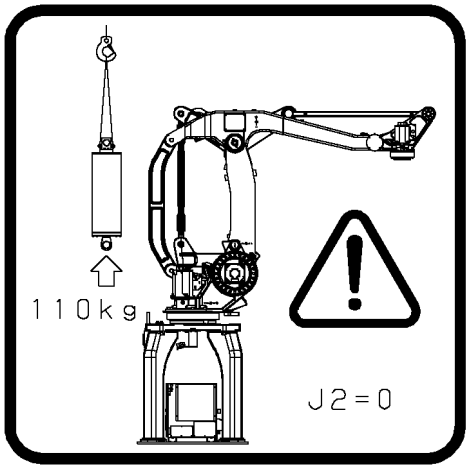


Fig. 4 (f) Balancer replacement label

Description

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

- When replacing the balancer, keep the J2 axis at 0°.
- The mass of the balancer is 110 kg.

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

(7) Transportation caution label

Fig. 4 (g) Transportation caution label

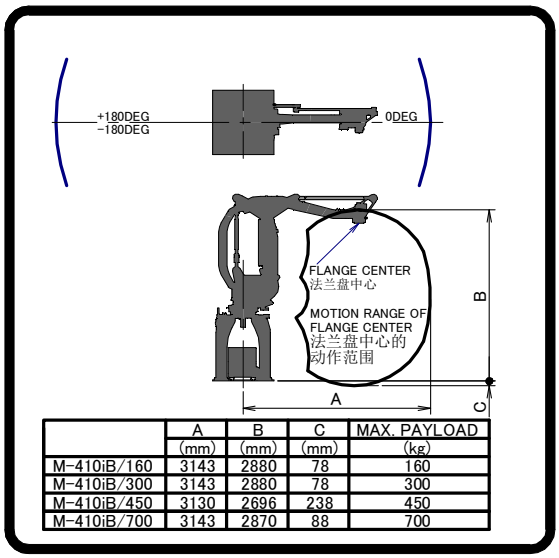
Description

Keep the following in mind when transporting the robot.

- Do not pull eyebolts sideways

(8) Operating space and payload mark label

Below label is added when CE specification is specified.



	A (mm)	B (mm)	C (mm)	MAX. PAYLOAD (kg)
M−410iB/160	3143	2880	78	160
M−410iB/300	3143	2880	78	300
M−410iB/450	3130	2696	238	450
M−410iB/700	3143	2870	88	700

Fig. 4 (h) Operating space and payload mark label

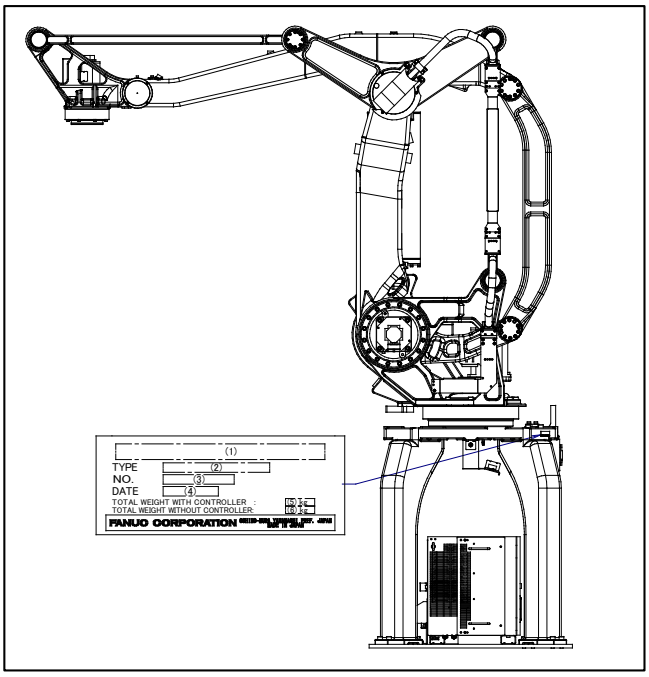
PREFACE

This manual explains the operation procedures for the mechanical units of the following robots:

Model name	Mechanical unit specification No.	Maximum load	Remarks
FANUC Robot M-410*i*B/160	A05B-1041-B201	160kg	R-J3*i*B
FANUC Robot M-410*i*B/300	A05B-1041-B203	300kg	
FANUC Robot M-410*i*B/160	A05B-1041-B211	160kg	R-30*i*A R-30*i*B
FANUC Robot M-410*i*B/300	A05B-1041-B213	300kg	

⚠ 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.

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.



Position of label indicating mechanical unit specification number

Table 1

	(1)	(2)	(3)	(4)	(5)	(6)
CONTENTS	**MODEL**	**TYPE**	**No.**	**DATE**	WEIGHT kg (Including controller)	WEIGHT kg (Not including controller)
LETTERS	FANUC Robot M-410*i*B/160	A05B-1041-B201	SERIAL NO. IS PRINTED	PRODUCTION YEAR AND MONTH ARE PRINTED	1940	1820
	FANUC Robot M-410*i*B/300	A05B-1041-B203				
	FANUC Robot M-410*i*B/160	A05B-1041-B211				
	FANUC Robot M-410*i*B/300	A05B-1041-B213				

Specifications

ITEM		M-410*i*B/160	M-410*i*B/300
Controlled axes		4 axes (J1, J2, J3, J4)	
Installation		Floor mount	
Motion range (Maximum speed) (NOTE 1)	J1-axis	360° (130°/s) 6.28rad (2.27rad/s)	360° (85°/s) 6.28rad (1.48rad/s)
	J2-axis	144° (130°/s) 2.51rad (2.27rad/s)	144° (90°/s) 2.51rad (1.57rad/s)
	J3-axis	136° (135°/s) 2.37rad (2.36rad/s)	136° (100°/s) 2.37rad (1.75rad/s)
	J4-axis	540° (300°/s) 9.42rad (5.24rad/s)	540° (190°/s) 9.42rad (3.32rad/s)
Max. load capacity at wrist (NOTE 2)		160 kg	300 kg
Allowable load inertia at wrist		78kg-m^2 (800kgf-cm-s^2)	137kg-m^2 (1400kgf-cm-s^2)
Drive method		Electric servo drive by AC servo motor	
Repeatability		±0.5 mm	
Weight		1940 kg	
Acoustic noise level		Less than 70dB (NOTE 3)	
Installation requirement		Ambient temperature : 0 to 45℃ (NOTE 4) 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 requires, no particular provision for attitude. Vibration acceleration : 4.9m/s^2 (0.5G) or less Free of corrosive gases (NOTE 5)	

NOTE

1 During short distance motions, the axis speed may not reach the maximum value stated.
2 In case of M-410*i*B, avoid keeping J3 arm horizontally with max payload for a long time to prevent occurrence of the overheat alarm.
3 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

4 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.
5 Contact the service representative, if the robot is to be used in an environment or a place subjected to hot/cold temperatures, severe vibrations, heavy dust, cutting oil splash and or other foreign substances.

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	OPERATOR'S MANUAL HANDLING TOOL **B-81464EN-2**	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)** **B-81505EN (For RIA)**	Intended readers: Maintenance technician, system designer Topics: Installation, start-up, connection, maintenance Use: Installation, start-up, connection, maintenance
R-30*i*A controller	OPERATOR'S MANUAL HANDLING TOOL **B-83124EN-2** ALARM CODE LIST **B-83124EN-6**	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 person, 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**	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).

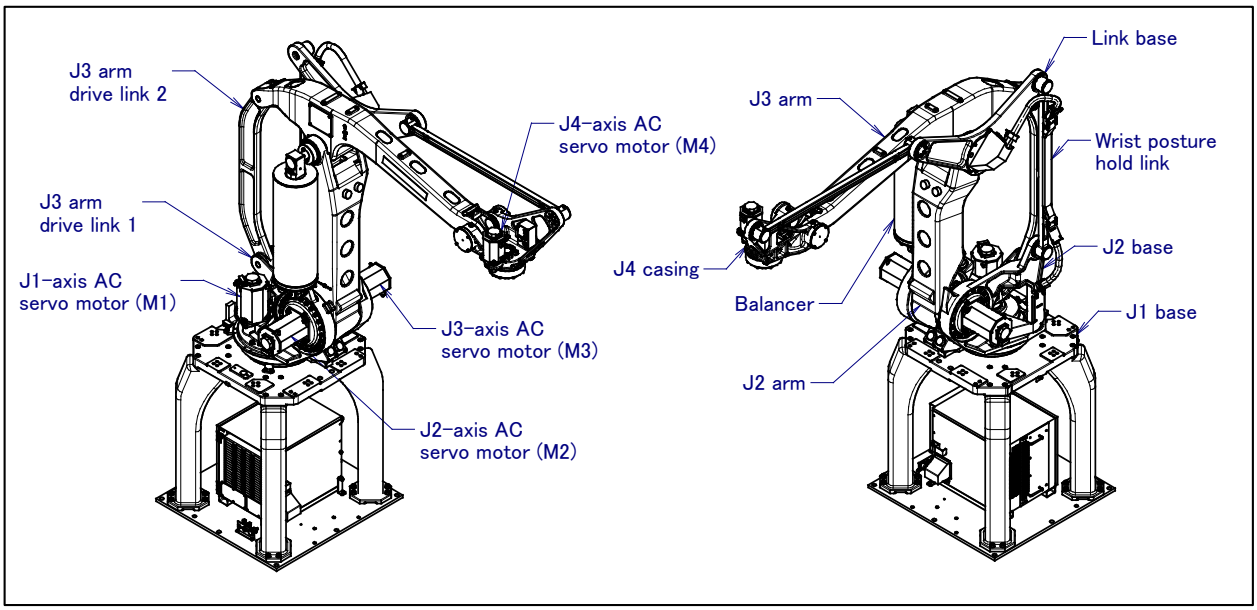


Fig. 1 (a) Mechanical unit configuration

2 CHECKS AND MAINTENANCE

Optimum performance of the robot can be maintained by performing the checks and maintenance procedures presented in this chapter. (See the 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 operating 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, the maintenance frequency should be doubled – i.e. the time interval should be divided by 2.

2.1 CHECKS AND MAINTENANCE

2.1.1 Daily Checks

Check the following items when necessary before daily system operation.

Check items	Check points and management
Oil seepage	Check to see if there is oil on the sealed part of each joint. If there is an oil seepage, clean it. **⇒"2.2.1 Confirmation of Oil Seepage"**
Air control set	(When air control set is used) **⇒"2.2.2 Confirmation of the Air Control Set"**
Vibration, abnormal noises	Check whether vibration or abnormal noises occur. When vibration or abnormal noises occur, perform measures referring to the following section: **⇒"4.1 TROUBLESHOOTING"(symptom : Vibration, Noise)**
Positioning accuracy	Check whether the taught positions of the robot have not deviated from the previous taught positions. When displacement occurs, perform the measures as described in the following section: **⇒"4.1 TROUBLESHOOTING"(Symptom : Displacement)**
Peripheral equipment for proper operation	Check whether the peripheral equipment operate properly according to commands from the robot and the peripheral equipment.
Brakes for each axis	Check that the end effector drops 0.2 mm or less when the servo power is turned off. If the end effector (hand) drops more than the prescribed amount, perform the measures as described in the following section: **⇒"4.1 TROUBLESHOOTING"(symptom : Dropping axis)**
Warnings	Check whether unexpected warnings occur in the alarm screen on the teach pendant. If unexpected warnings occur, perform the measures as described in the following manual: **⇒"R-30*i*B/R-30*i*B Mate/R-30*i*B Plus/R-30*i*B Mate Plus CONTROLLER OPERATOR'S MANUAL (Alarm Code List) (B-83284EN-1) or R-30*i*A/R-30*i*A Mate CONTROLLER OPERATOR'S MANUAL (Alarm Code List) (B-83124EN-6) or R-J3*i*B CONTROLLER HANDLING TOOL OPERATOR'S MANUAL (Alarm Code List) (B-81464EN-2)"**

2.1.2 Periodic Checks and Maintenance

Check the following items at the intervals recommended below based on the period or the accumulated operating time, whichever comes first. (○ : Item needs to be performed.)

Check and maintenance intervals (Period, Accumulated operating time)						Check and maintenance items	Check points, management and maintenance methods	Periodic maintenance table No.
1 month 320h	3 months 960h	1 year 3840h	1.5 years 5760h	3 years 11520h	4 years 15360h			
○ Only 1st check	○					Cleaning the controller ventilation system	Confirm the controller ventilation system is not dusty. If dust has accumulated, remove it.	22
	○					Check the external damage or peeling paint	Check whether the robot has external damage or peeling paint due to the interference with the peripheral equipment. If an interference occurs, eliminate the cause. Also, if the external damage is serious, and causes a problem in which the robot will not operate, replace the damaged parts.	1
	○					Check for damage of the cable protective sleeve	Check the mechanical unit cable protective sleeves for holes or tears. If damage is found, replace the cable protective sleeve. If the cable protective sleeve is damaged due to interference with peripheral equipment, eliminate the cause. **⇒"2.2.3 Check the Mechanical Unit Cables and Connectors"**	2
	○					Check the wear debris of the J1-axis swing stopper	Check whether wear debris has accumulated on the J1-axis swing stopper rotation part. If serious wear is evident on the part that generated the wear debris, replace the part.	3
	○					Check for water	Check whether the robot is subjected to water or cutting oils. If liquid was found, remove the cause, and wipe the liquid off.	4
	○ Only 1st check	○				Check for damages to the teach pendant cable, the operation box connection cable or the robot connection cable	Check whether the cable connected to the teach pendant, operation box and robot are unevenly twisted or damaged. If damage is found, replace the damaged cables.	23
	○ Only 1st check	○				Check for damage to the mechanical unit cable (movable part)	Observe the movable part of the mechanical unit cable, and check for damage. Also, check whether the cables are excessively bent or unevenly twisted. **⇒"2.2.3 Check the Mechanical Unit Cables and Connectors"**	5
	○ Only 1st check	○				Check for damage to the end effector (hand) cable	Check whether the end effector cables are unevenly twisted or damaged. If damage is found, replace the damaged cables.	6

Check and maintenance intervals (Period, Accumulated operating time)						Check and maintenance items	Check points, management and maintenance methods	Periodic maintenance table No.
1 month 320h	3 months 960h	1 year 3840h	1.5 years 5760h	3 years 11520h	4 years 15360h			
	○ Only 1st check	○				Check the connection of each axis motor and other exposed connectors	Check the connection of each axis motor and other exposed connectors. **⇒"2.2.3 Check the Mechanical Unit Cables and Connectors"**	7
	○ Only 1st check	○				Retightening the end effector mounting bolts	Retighten the end effector mounting bolts. Refer to the following section for tightening torque information: **⇒"8.2 END EFFECTOR INSTALLATION TO WRIST"**	8
	○ Only 1st check	○				Retightening the external main bolts	Retighten the bolts which are installed, removed in the inspection, and exposed. Refer to the recommended bolt tightening torque guidelines at the end of the manual. Some bolts are attached with adhesive. If the bolts are tightened with greater than the recommended torque, the adhesive might be removed. Therefore, follow the recommended bolt tightening torque guidelines when retightening the bolts.	9
	○ Only 1st check	○				Check the mechanical stopper and the adjustable mechanical stopper	Check that there is no evidence of a collision on the mechanical stopper, the adjustable mechanical stopper, and check the looseness of the stopper mounting bolts. Check that the J1-axis swing stopper rotates smoothly. **⇒"2.2.4 Check of Fixed Mechanical Stopper and Adjustable Mechanical Stopper"**	10
	○ Only 1st check	○				Clean spatters, sawdust and dust	Check that spatters, sawdust, or dust does not exist on the robot main body. If dust has accumulated, remove it. Especially, clean the robot movable parts well (each joint, and the cable protective sleeve).	11
	○ Only 1st check	○				Check the operation of the cooling fan	(When cooling fans are installed on each axis motor) Check whether the cooling fans are operating correctly. If the cooling fans do not operate, replace them.	12
			○			Replacing the mechanical unit batteries	Replace the mechanical unit batteries **⇒"3.3 REPLACING THE BATTERIES"**	13
				○		Supply grease to J3 arm connection part bearing	Supply grease to the J3 arm connection part bearing **⇒"3.2 SUPPLYING GREASE"**	18

Check and maintenance intervals (Period, Accumulated operating time)						Check and maintenance items	Check points, management and maintenance methods	Periodic maintenance table No.
1 month 320h	3 months 960h	1 year 3840h	1.5 years 5760h	3 years 11520h	4 years 15360h			
				○		Supply grease to J3 base connection part bearing	Supply grease to the J3 base connection part bearing ⇒**"3.2 SUPPLYING GREASE"**	19
				○		Supply grease to wrist connection part bearing	Supply grease to the wrist connection part bearing ⇒**"3.2 SUPPLYING GREASE"**	20
				○		Replacing the grease of drive mechanism	Replace the grease of each axis reducer and gearbox ⇒**"3.1 REPLACING THE GREASE OF THE DRIVE MECHANISM"**	14 to 17
					○	Replacing the mechanical unit cable	Replace the mechanical unit cable. Contact your local FANUC representative for information regarding replacing the cable.	21
					○	Replacing the controller batteries	Replace the controller batteries ⇒**Chapter 7 Replacing batteries of R-J3*i*B CONTROLLER MAINTENANCE MANUAL (B-81465EN) R-30*i*A CONTROLLER MAINTENANCE MANUAL (B-82595EN) R-30*i*A CONTROLLER MAINTENANCE MANUAL (CE specification) (B-82595EN-1) R-30*i*A CONTROLLER MAINTENANCE MANUAL (RIA specification) (B-82595EN-2) R-30*i*B/R-30*i*B Plus CONTROLLER MAINTENANCE MANUAL (RIA specification) (B-83195EN)"**	24

2.2 CHECK POINTS

2.2.1 Confirmation of Oil Seepage

Check items

Confirm whether there is oil seepage on the rotating parts of each joint axis.

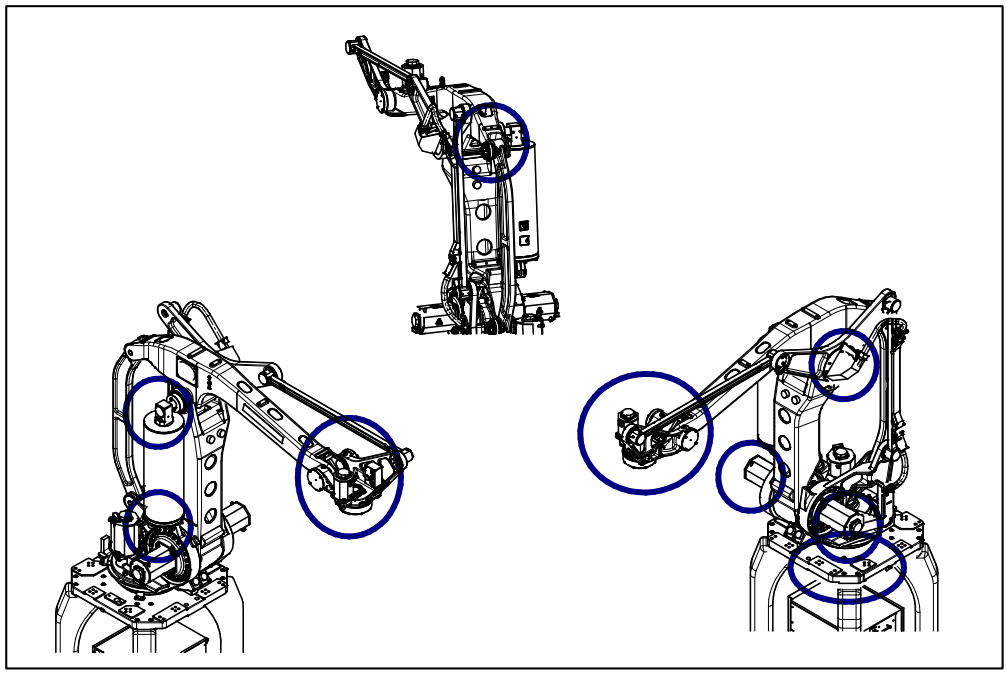


Fig. 2.2.1 (a) Check parts of oil seepage

Management

- Oil might accumulate on the outside of the seal lip depending on the movement condition or environment of the axis. If the oil viscosity changes, the oil might drip depending on the axis movement. To prevent oil spots, be sure to wipe away any accumulated oil under the axis components in Fig. 2.2.1 (a) before you operate the robot.
- Also, drive mechanisms might become hot and the internal pressure of the grease bath might rise by frequent repetitive movement and use in high temperature environments. In these cases, normal internal pressure can be restored by venting the grease outlet. (When opening the grease outlet, refer to Section 3.1 and ensure that grease is not expelled onto the machine or tooling.)

> ⚠ **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.

- If you must wipe oil frequently, and opening the grease outlet does not stop the seepage, perform the measures below.

  ⇒"4.1 TROUBLESHOOTING" (symptom : Grease leakage)

2.2.2 Confirmation of the Air Control Set (option)

When an air control set is used, check the items below.

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. 2.2.2 (a). 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 lubricator control knob. Under normal usage, the lubricator will be empty in about 10 to 20 days.
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. If the quantity of the drained liquid is significant, examine the setting of the air dryer on the air supply side.

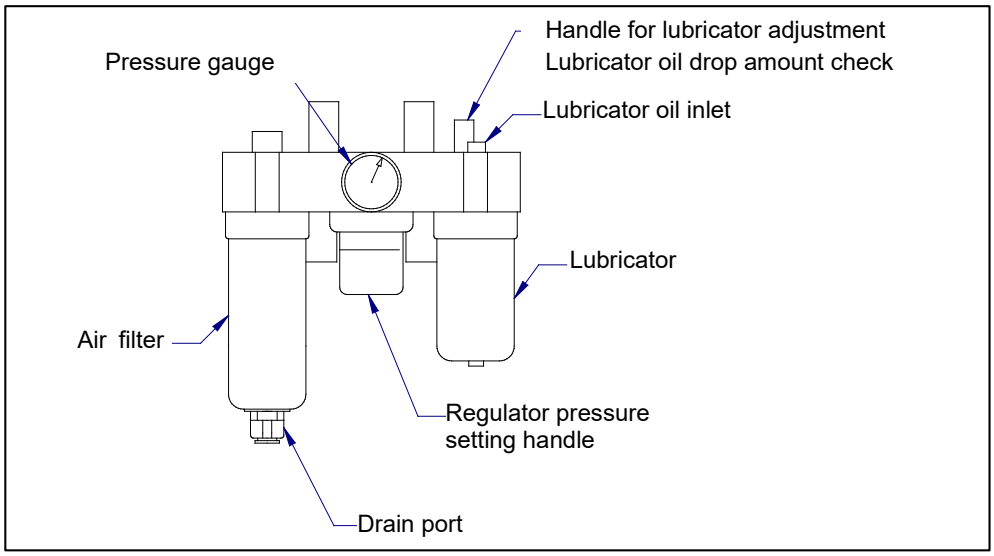


Fig. 2.2.2 (a) Air control set (option)

2.2.3 Check the Mechanical Unit Cables and Connectors

Check points of the mechanical unit cables
Movable parts of J1, the upper side and lower side of link for wrist posture maintenance of rear side of J2 arm, movable part in uniting part of J2 to J3 and J3 to J4 and fixed department cable who interferes easily in peripherals
For J2,J3 connection part, remove the side cover and check them from side.

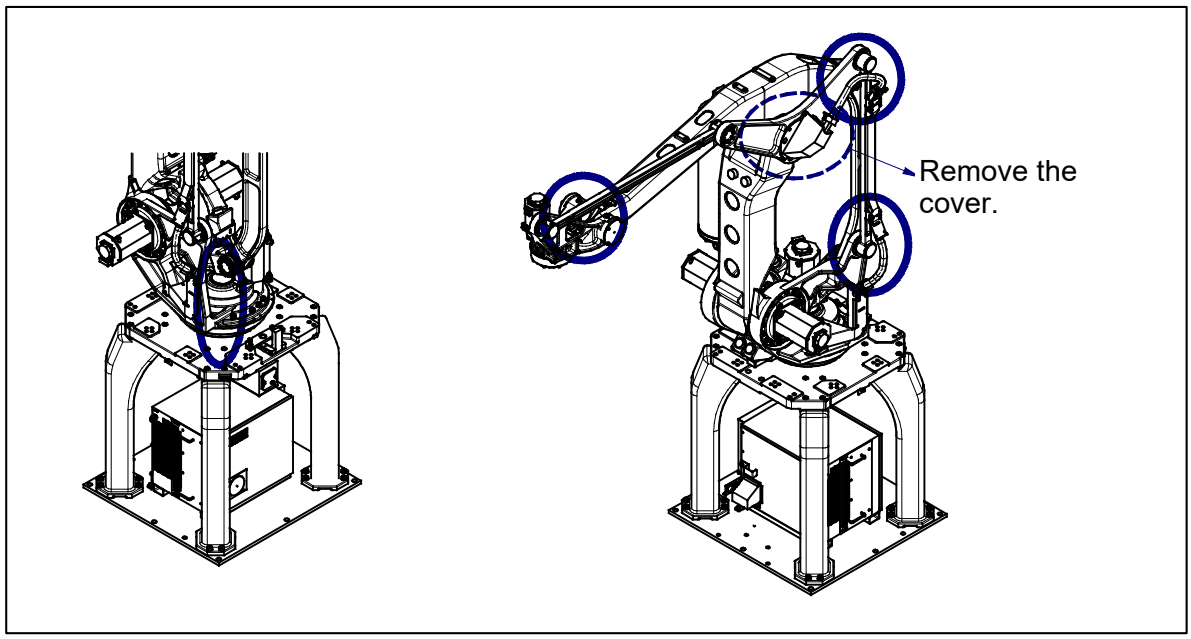


Fig. 2.2.3 (a) Inspection points of the mechanical unit cables

Check items
＜Cable protective sleeve＞
- Check that no holes or tears exist on the cable protective sleeves.
- If there is damage as shown in Fig. 2.2.3 (b), replace the cable protective sleeves.

Fig. 2.2.3 (b) Damage on the cable protective sleeve

＜Cables＞
- Check that there is no wear or damage on the coating.
- If the inside wire strands are exposed due to wear or damage, replace the cables.

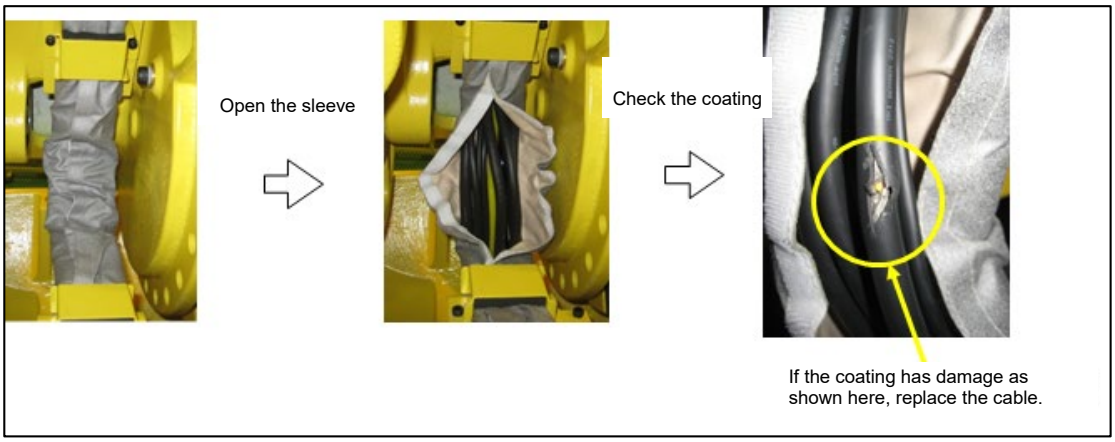


Fig. 2.2.3 (c) Cable check method

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 by hand.
- Square connector : Check the connector for engagement of its lever.
- Earth terminal : Check the terminal for tightness.

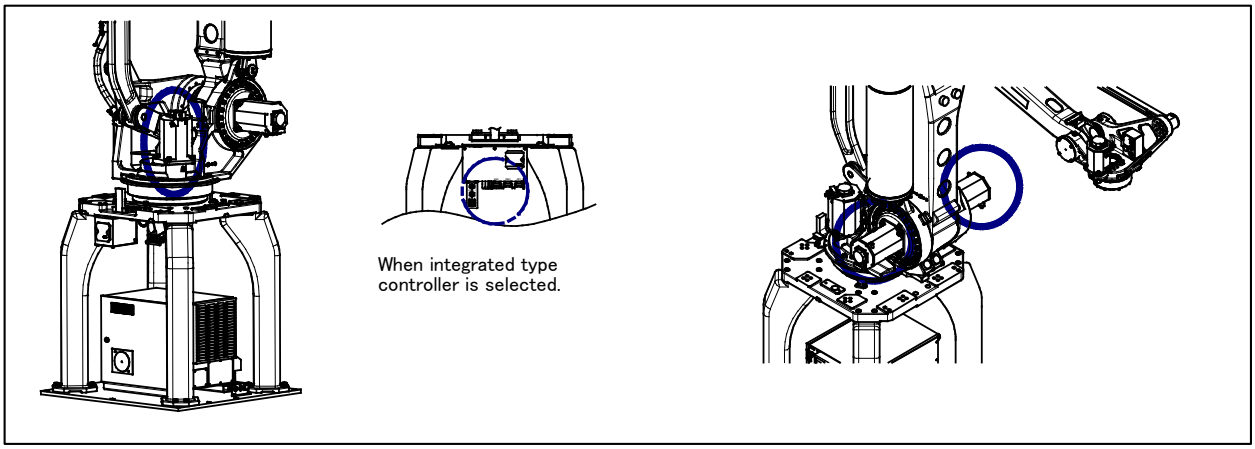


Fig. 2.2.3 (d) Connector Inspection points

2.2.4 Check of Fixed Mechanical Stopper and Adjustable Mechanical Stopper

- Check that there is no evidence of a collision on the mechanical stopper and the adjustable mechanical stopper. If there is evidence of a collision on the stopper, replace the parts.
- Check the tightness of the stopper mounting bolts. If they are loose, retighten them. Be sure to check the tightness of the mounting bolts of the J1-axis swing stopper.
- Check that the J1-axis swing stopper rotates smoothly.
- Refer to Section 5.2 for details regarding the adjustable mechanical stopper.

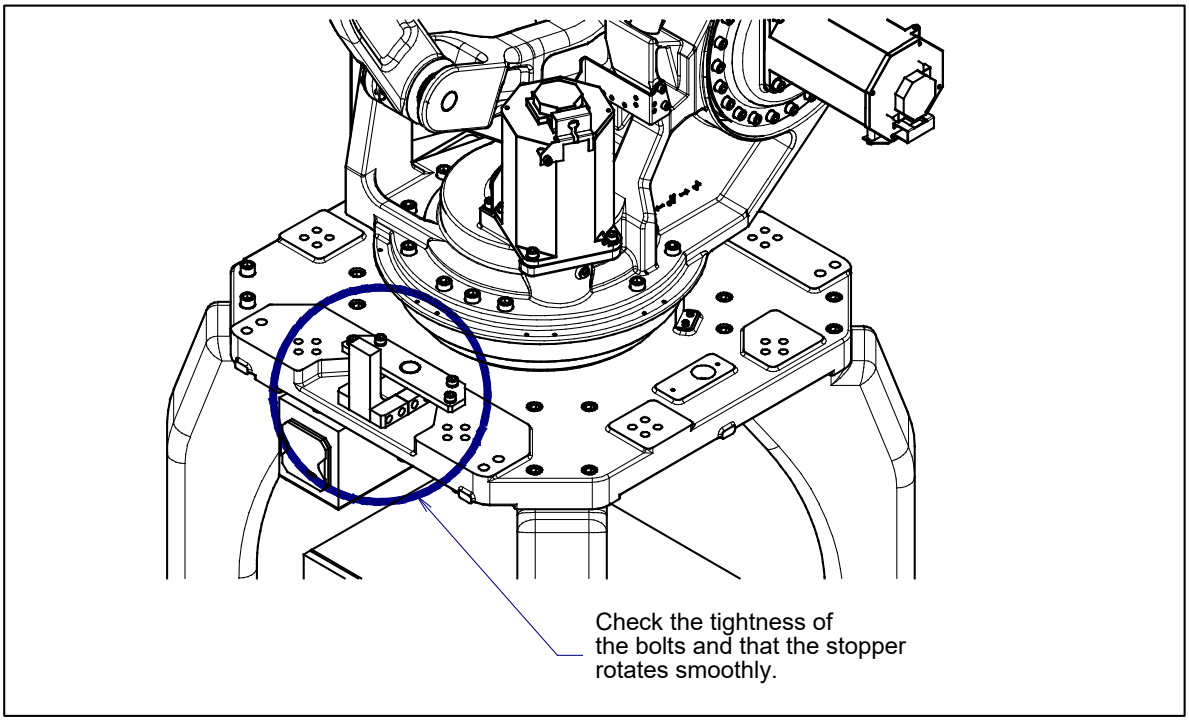


Fig. 2.2.4 (a) Check of fixed mechanical stopper and adjustable mechanical stopper

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 J1, J2, J3, and J4 axes at the intervals based on every 3 years or 11520 hours, whichever comes first.

Table 3.1 (a) Grease for 3-year (11520 hours) periodic replacement

Models	Supply position	Grease name	Quantity	Gun tip pressure
M-410*i*B/160 M-410*i*B/300	J1-axis reducer	Spec.: A98L-0040-0174	6990g (8030ml)	0.15 MPa or less (NOTE)
	J2-axis reducer		1370g (1570ml)	
	J3-axis reducer		1030g (1180ml)	
	J4-axis reducer		1220g (1400ml)	

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

Robot	Supply position	Posture			
		J1	J2	J3	J4
M-410*i*B/160 M-410*i*B/300	J1-axis reducer	-	100°	-125°	0°
	J2-axis reducer				
	J3-axis reducer				
	J4-axis reducer				

NOTE
In a high-duty environment where, for example, a cooling unit (fan) is used, grease must be replaced every half the specified standard period.

⚠ CAUTION

Failure to follow proper lubrication procedures may cause the suddenly increase of the grease bath internal pressure and the damage to the seal, which could lead to grease leakage and abnormal operation. When greasing, observe the following cautions.

1 Before starting to grease, remove the seal bolt or the taper plug to allow the grease to come out.
2 Supply grease slowly, 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 (see Table 3.1 (a)).
4 Use specified grease. Use of non-approved grease may damage the reducer or lead to other problems.
5 After greasing, release remaining pressure from the grease bath using the procedure given in Subsection 3.1.2, and then close the grease outlet.
6 To prevent slipping accidents and catching fire, completely remove any excess grease from the floor or robot.
7 If no old grease is pushed out from the grease outlet soon or if only an extremely small amount of old grease is pushed out when new grease is supplied into the grease inlet, it is likely that grease is leaking because of a damaged seal or a similar break.

3.1.1 Grease Replacement Procedure

Grease replacement procedure for the J1-axis, J2-axis, J3-axis, and J4-axis reducers

> **⚠ CAUTION**
> Be careful not to confuse the grease inlet of the J4-axis reducer with the grease inlet of the wrist link bearing in Fig. 3.2 (c) of Section 3.2 because they are close to each other.

1 Move the robot to the greasing posture described in Section 3.1.
2 Turn off controller power.
3 Remove the seal bolt or the taper plug shown the Fig. 3.1.1 (a) to (d) from the grease outlet.
4 Supply new grease until new grease is output from the grease outlet.
5 After applying grease, release the remaining pressure within the grease bath as described in the procedure in Subsection 3.1.2.

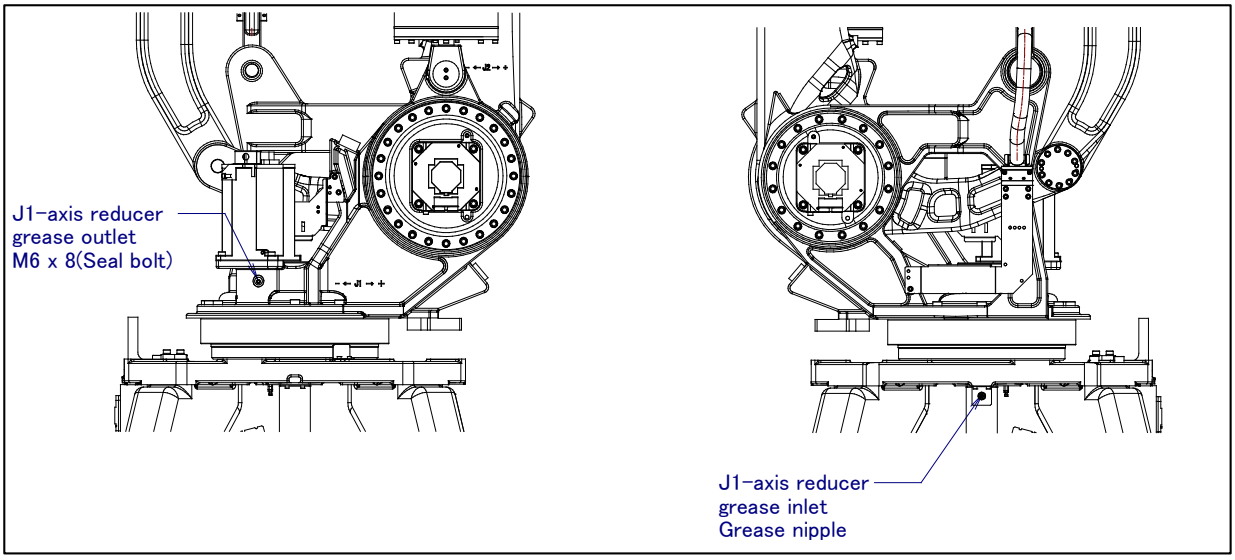


Fig.3.1.1 (a) Replacing grease of J1-axis reducer

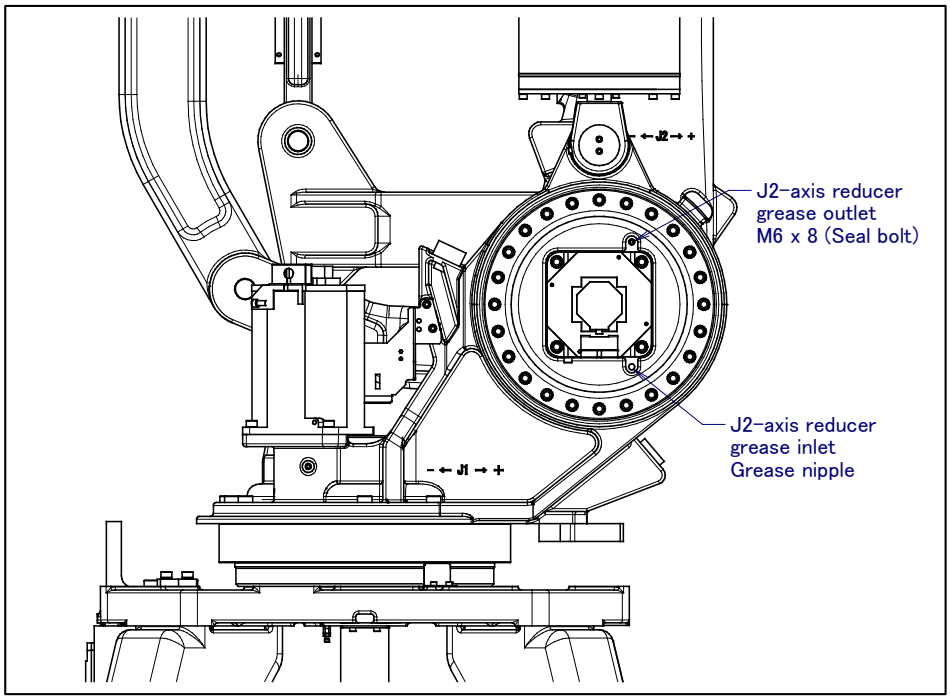


Fig.3.1.1 (b) Replacing grease of J2-axis reducer

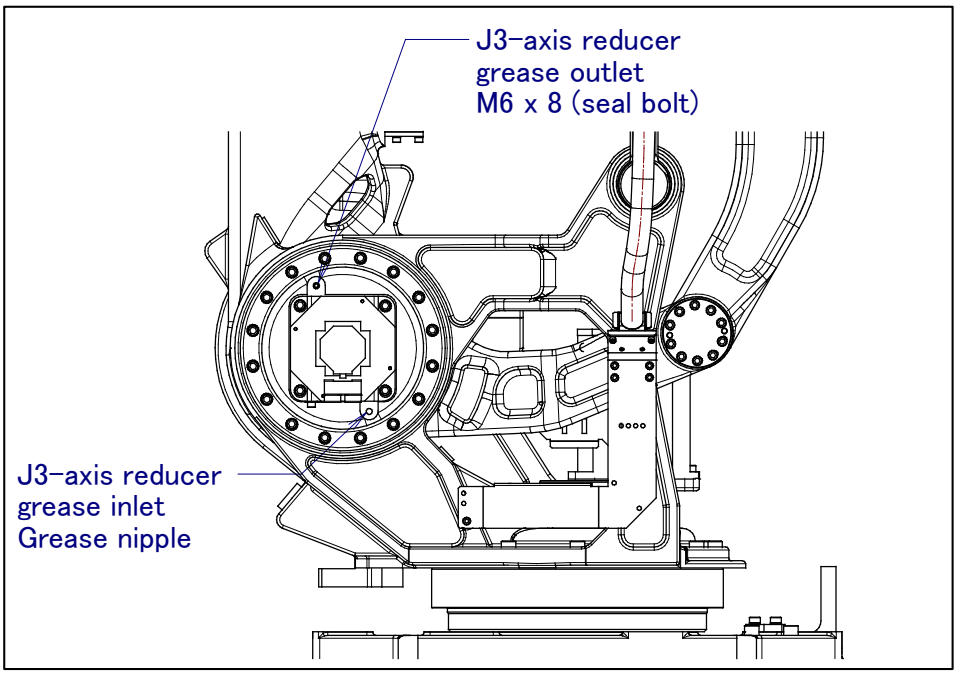


Fig.3.1.1 (c) Replacing grease of J3-axis reducer

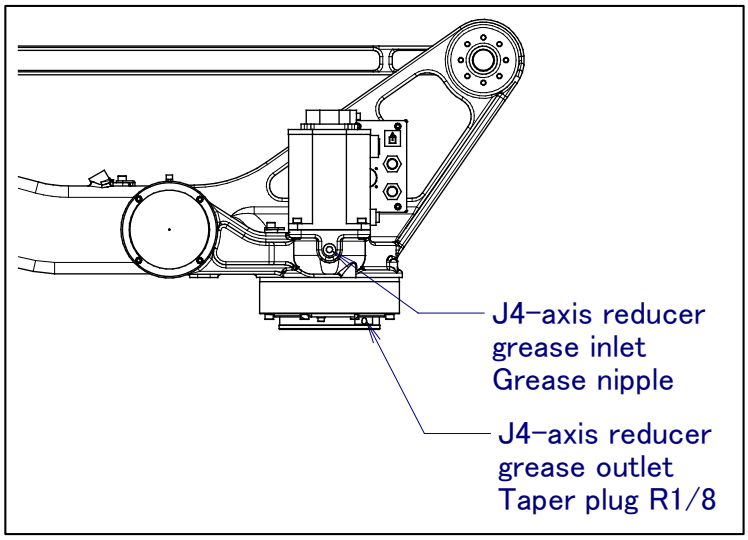


Fig.3.1.1 (d) Replacing grease of J4-axis reducer

Table 3.1.3 (a) Specifications of the seal bolt and the taper plugs

Parts name	Specifications
Seal bolt (M6 x 8)	A97L-0218-0417#060808
Taper plug (R1/8)	A97L-0001-0436#1-1D
Grease nipple	A97L-0218-0013#A110
Grease nipple	A97L-0218-0013#A610

3.1.2 Procedure for Releasing Remaining Pressure within the Grease Bath

To release the remaining pressure in the grease bath after applying grease, operate the robot for 20 minutes or more as described in the table below with the grease nipple of the grease inlet and the seal bolt or the taper plug of the grease outlet left open for the J1-axis reducer and J4-axis reducer, and the seal bolt of the grease outlet left open for the J2-axis reducer and J3-axis reducer.
Attach the reclaim bags under the grease inlet and grease outlet to prevent spilled grease from splattering.

Operating axis / Grease replacement part	J1-axis	J2-axis	J3-axis	J4-axis
J1-axis reducer	Axis angle of 80° or more OVR 50%	Arbitrary		
J2-axis reducer	Arbitrary	Axis angle of 90° or more OVR 50%	Arbitrary	
J3-axis reducer	Arbitrary		Axis angle of 60° or more OVR 50%	Arbitrary
J4-axis reducer	Arbitrary			Axis angle of 60° or more OVR 100%

If the above operation cannot be performed due to the environment, adjust the operating time according to the operating angle. ((For example, when only an axis angle of 30° can be achieved instead of 60°, perform the operation for 40 minutes, which is double the specified time of 20 minutes.) If you grease multiple axes, you can exercise multiple axes at the same time. After the above operation is performed, attach the grease nipple to the grease inlet and the seal bolt or the taper plug to the grease outlet. When the seal bolt, the taper plug or grease nipple is reused, be sure to seal it with seal tape.

3.2 SUPPLYING GREASE (3 YEARS CHECK (11520 HOURS) PERIODIC MAINTENANCE)

Be sure to supply grease to the machine at the timing (cumulative operation time or period whichever earlier) specified in Table 3.2 (a). Adjust the greasing timing if your robot is installed in an adverse environment. Supply grease immediately if water is splashed to the robot. When supplying grease, observe the precautions described in Section 3.1. Table 3.2 (a) and Fig. 3.2 (a) to (c) indicate the parts of the robot to be greased. Table 3.2 (b) lists alternative greases.

NOTE
If the robot is high-duty, requiring a cooling unit (fan), shorten the standard greasing cycle to half.

Table 3.2 (a) Greasing

Robot model	Supply position	Specified grease	Amount of grease	Greasing method
M-410*i*B/160 M-410*i*B/300	J3 arm connecting position bearing greasing point	SHELL ALVANIA GREASE S2 (Spec.: A98L-0004-0602#CTG)	20ml (Two points)	Supply grease through a grease nipple.
	J3-axis base bearing connecting position		20ml	
	Wrist connecting position bearing		10ml (Two points)	

NOTE
After grease is supplied, old grease is pushed out from the bearing's rotating section. Wipe off the old grease immediately after greasing and, as required, after operations of 50 to 100 hours.

Table 3.2 (b) Substitutes for ALVANIA GREASE S2

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

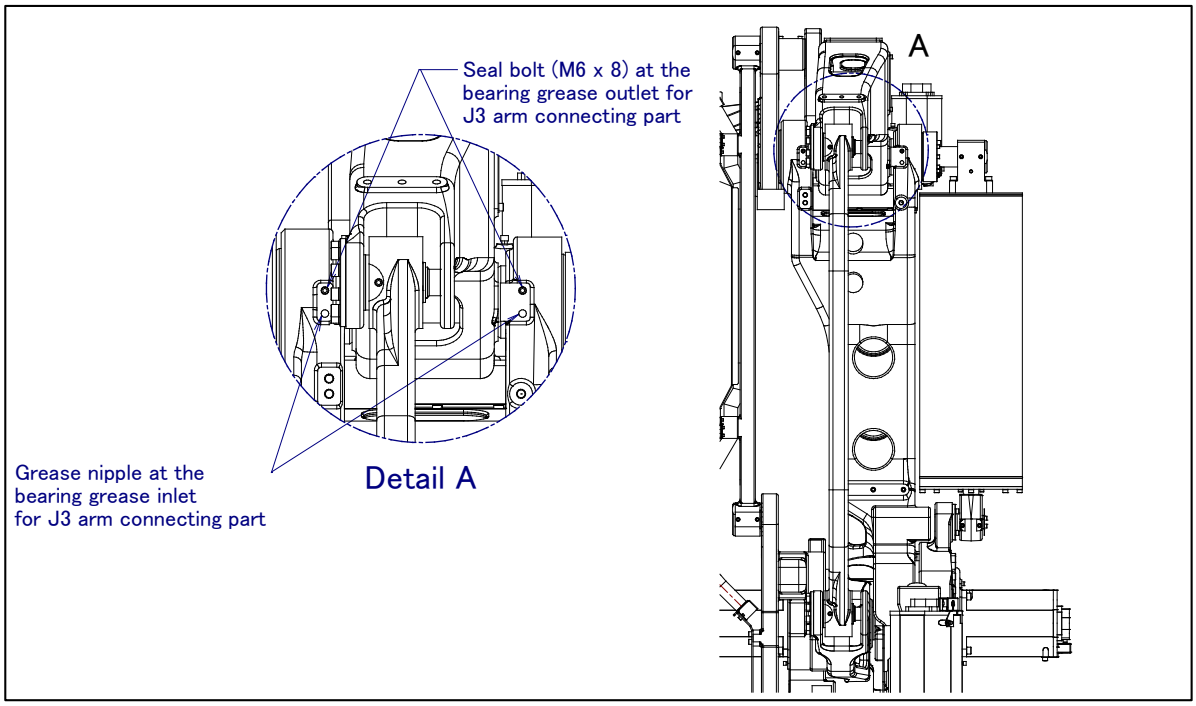


Fig. 3.2 (a) Greasing for bearing J3 arm connection (2 points)

⚠ CAUTION
1 Before greasing, remove the seal bolt at the grease outlet.
2 Apply grease slowly with a manual pump.

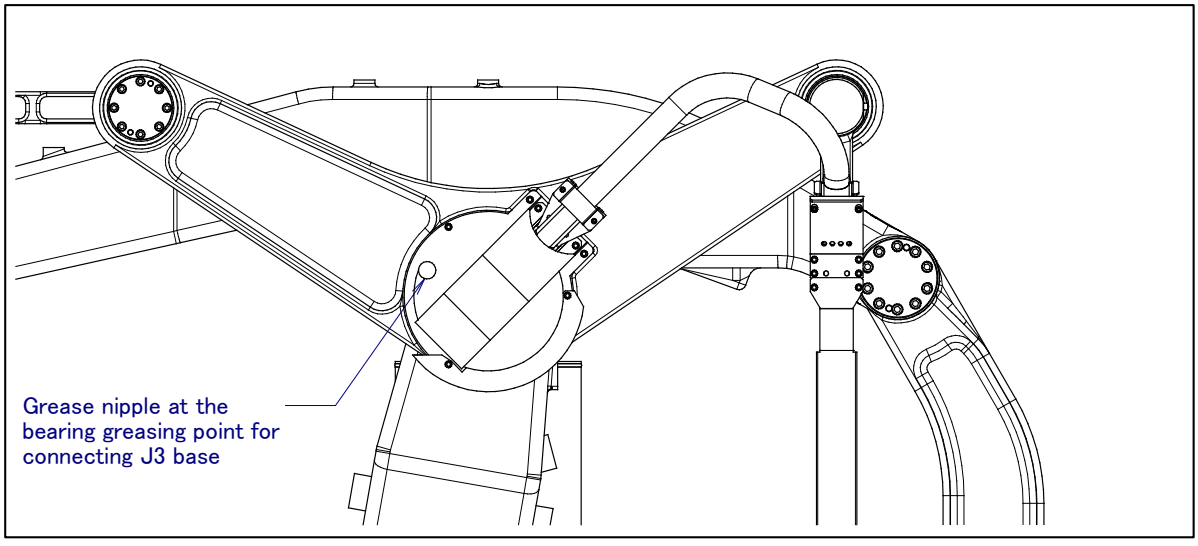


Fig. 3.2 (b) Greasing for bearing of the J3 base

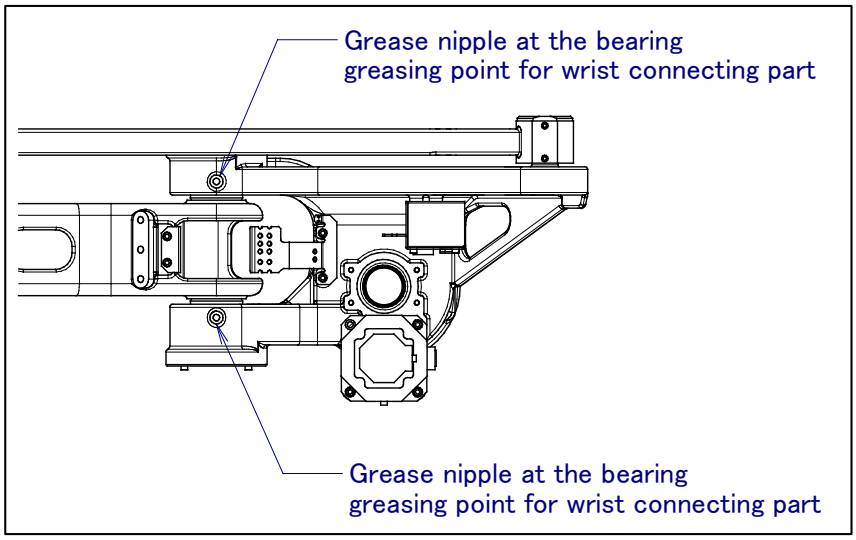


Fig. 3.2 (c) Greasing for bearing wrist connection (2 points)

Table 3.2 (c) Specifications of the seal bolt and the taper plugs

Parts name	Specifications
Seal bolt (M6 x 8)	A97L-0218-0417#060808
Grease nipple	A97L-0218-0013#A110

3.3 REPLACING THE BATTERIES (1.5 YEARS CHECK (5760 HOURS) PERIODIC MAINTENANCE)

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

1 Press the EMERGENCY STOP button to prohibit robot motion.

> **⚠ CAUTION**
> 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.

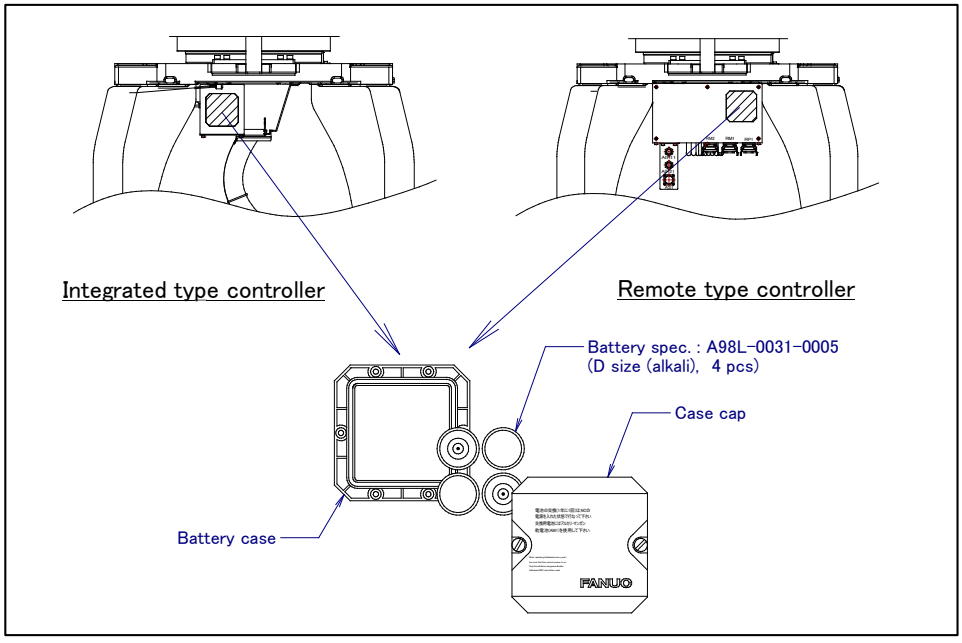


Fig. 3.3 (a) Replacing batteries

4 TROUBLE SHOOTING

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 symptom 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	- The J1 base lifts off the floor plate as the robot operates. - There is a gap between the J1 base and floor plate. - The 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, lead to vibration.	- If a bolt is loose, apply LOCTITE and tighten it to the appropriate torque. - Adjust the floor plate surface flatness to within the specified tolerance. - If there is any contamination between the J1 base and floor plate, remove it.
	- The rack or floor plate vibrates during operation of the robot.	[Rack or floor] - It is likely that the rack or floor is not rigid enough. - If they are not rigid enough, counterforce can deform the rack or floor, and cause 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.
	- 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).

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- 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. - Periodic vibration and noise occur.	[Broken gear, bearing, or reducer] - It is likely that the collision or overload applied an excessive force to the drive mechanism, thus damaging the geartooth surface or rolling surface of a bearing, or reducer. - It is likely that prolonged use of the robot while overloaded caused fretting of the gear tooth surface or rolling surface of a bearing, or reducer due to resulting metal fatigue. - It is likely that contamination caught in a gear, bearing, or within a reducer 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 causes 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.	- Operate one axis at a time to determine which axis is vibrating. - Remove the motor, and replace the gear, the bearing, and the reducer. For the spec. of parts and the method of replacement, contact FANUC. - Using the robot within its maximum rating prevents problems with the drive mechanism. - Regularly greasing with a specified type 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 section.	[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 robot control 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. Contact your local FANUC representative for replacing methods. - If vibration occurs only when the robot assumes a specific posture, it is likely that there is a mechanical problem. - Shake the movable part cable while the robot is at rest, and check whether an alarm occurs. If an alarm or any other abnormality 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. - There is an unusual sound during operation at low speed.	- There may be an unusual sound when using other than the specified grease. - Even for the specified grease, there may be an unusual sound during operation at low speed immediately after replacement or after a long period.	- Use the specified grease. - When there is an unusual sound even for specified grease, perform operation for one or two days on an experiment. Generally, a usual sound will disappear.
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 surface 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 motor overheated due to a rise in temperature in the installation area. - After changing the Robot control program or the load, the motor overheated.	[Ambient temperature] - It is likely that the motor overheated when the ambient temperature rose, and could not dissipate the heat. [Operating condition] - It is likely that the overcurrent is above the specified permissive average current.	- Reducing the ambient temperature is the most effective means of preventing overheat. - Having the surroundings of the motor well ventilated enables the motor to release heat efficiently, thus preventing overheating. - If there is a source of heat near the motor, it is advisable to install shielding to protect the motor from heat radiation. - Relaxing the robot control program and load condition is an effective way to reduce the average current. Thus, prevent overheating. - The teach pendant can monitor the average current. Check the average current when the robot control program launched.
	- After a control parameter (load setting etc.) was changed, the motor overheated.	[Parameter] - If data input for a workpiece is invalid, the robot cannot be accelerated or decelerated normally, so the average current increases, leading to overheating.	- As for load setting, Input an appropriate parameter referring to Section 8.4.
	- 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. - It is likely that cooling fan is broken.	- 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. - If the cooling fan is broken, replace it with a new one.

Symptom	Description	Cause	Measure

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.
		- 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 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
			  - Link 1 coupling section
			- Replace the grease nipple.

Dropping axis	- An axis falls because the brake went out.
	- An axis falls while standing still.
		[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

Symptom	Description	Cause	Measure
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	- The voltage of the memory backup battery may be low. - The Pulsecoder cable may be broken.	- 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 ADJUSTING LIMIT SWITCHES AND DOGS (OPTION)

1) Zero point position and motion limit
Zero point and motion limits are provided for each controlled axis. Reaching the operation limit of controlled axis is called overtravel (OT). Overtravel is detected at J1-axis only (option). Overtravel detection function is not prepared at J2-axis to J4 axis.
The robot cannot exceed the motion range unless there is a failure of the system causing loss of the zero point position, or there is a system error.
Fig. 5.1 (a) shows the zero point, motion limit OT detection point and point of mechanical stopper of J1-axis.

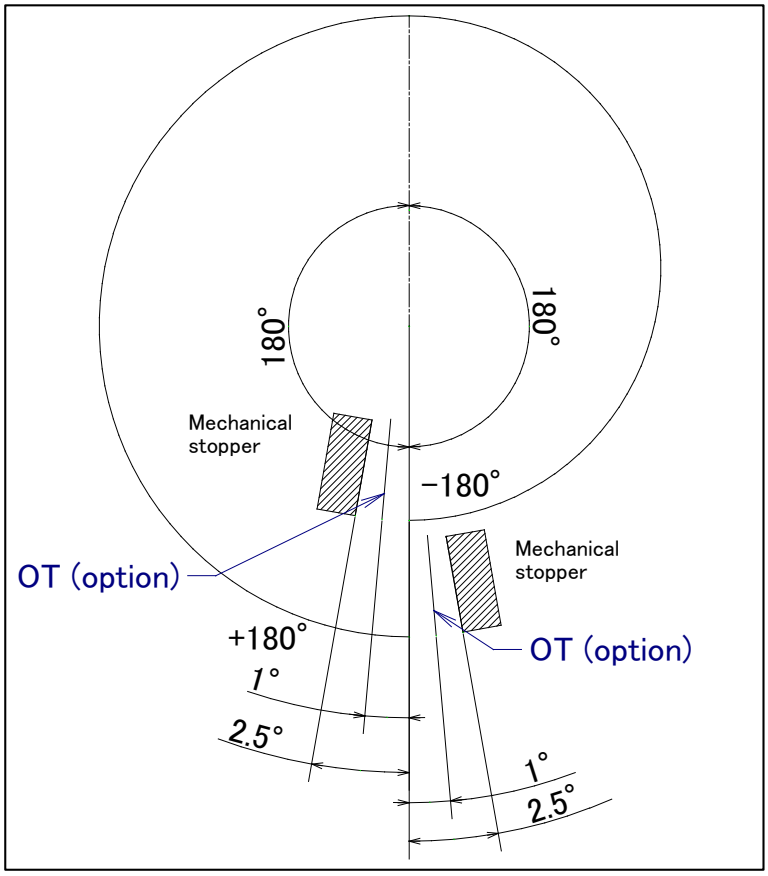


Fig. 5.1 (a) Zero point and motion limit of J1-axis

2) How to adjust the J1-axis limit switch
   1. Set the $MOR_GRP.$CAL_DONE system parameter to FALSE. This disables the stroke end specified by the software. As a result, the operator can rotate the robot around the J1-axis by a jog feed which goes beyond the stroke end.
   2. Loosen the two M6 x 10 bolts and two M4 x 25 bolts that secure the J1-axis limit switch.
   3. Adjust the switch position so that the robot activates the limit switch when approximately 1.0 degree from each stroke end. When the dog is pressed, only one side of the pushing width indication lines on the end of the switch must be 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, release the J1 axis from the limit by JOG feed.
   5. Check that the robot also activates the limit switch when the robot is approx. 1.0 degree 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. Turn off the power, then turn it on again to restart the controller.

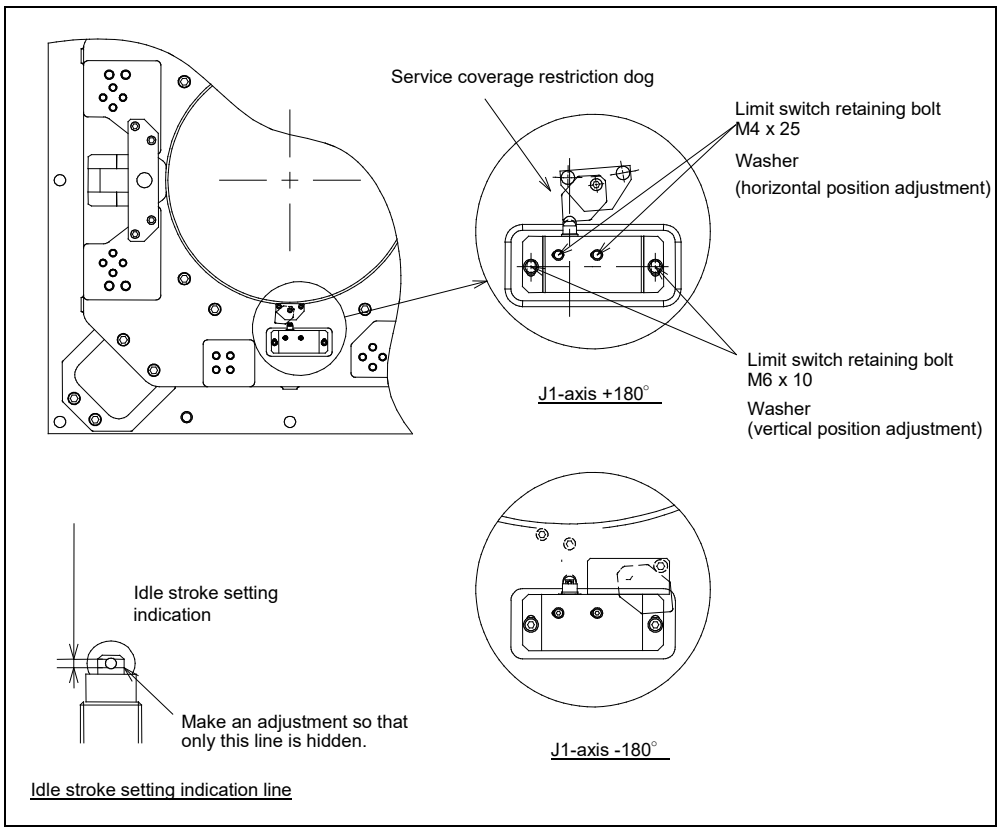


Fig. 5.1 (b) Adjusting J1-axis OT (option)

5.2 ZERO POINT POSITION AND MOTION LIMIT OF J2-AXIS TO J4-AXIS

Fig. 5.2 (a) to (c) show zero point position and motion area and mechanical stopper of each axis.

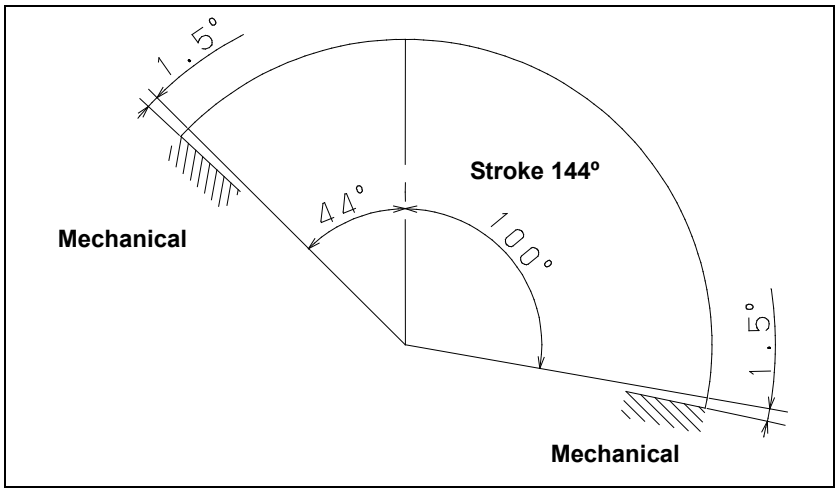


Fig. 5.2 (a) J2-axis

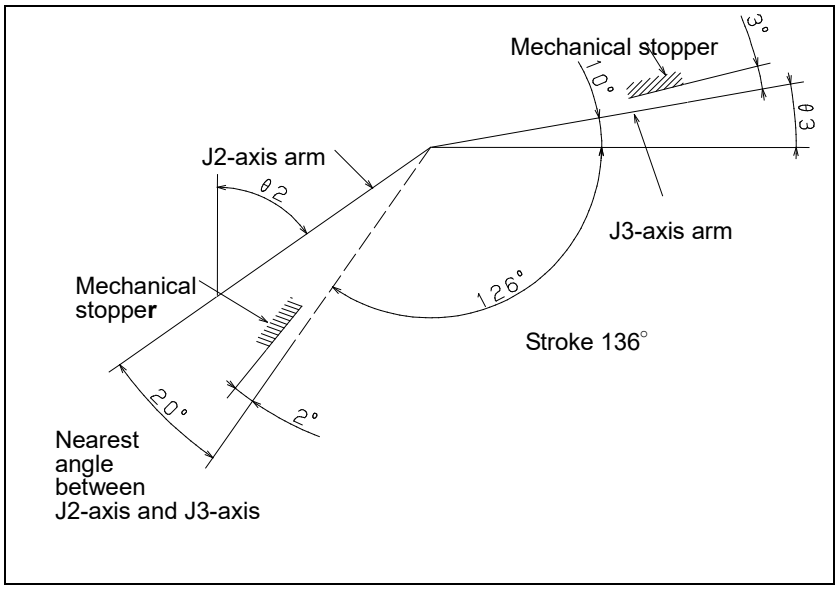
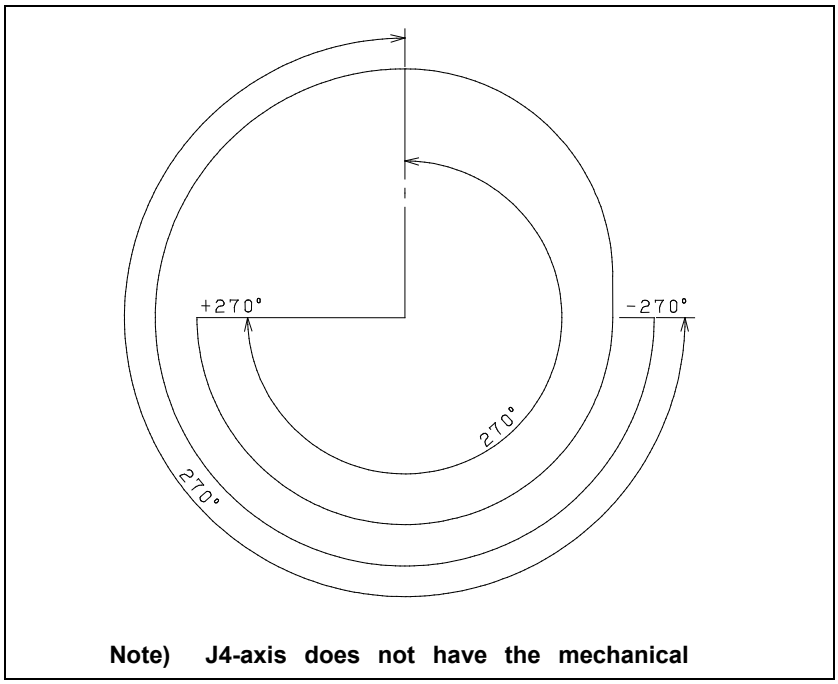


Fig. 5.2 (b) J3-axis



Note) J4-axis does not have the mechanical

Fig. 5.2 (c) J4-axis

Fig.5.2 (d) shows the position of mechanical stopper. Only in case of J1-axis, robot stops by transforming mechanical stopper. Only in case of J1 axis, robot stops by transforming mechanical stopper. Be sure to exchange transformed stopper to new one. Tight the bolts according to Appendix. Replace mechanical stopper of J1- axis referring to Fig.5.2 (d). Don't reconstruct the mechanical stopper. There is a possibility that the robot doesn't stop normally.

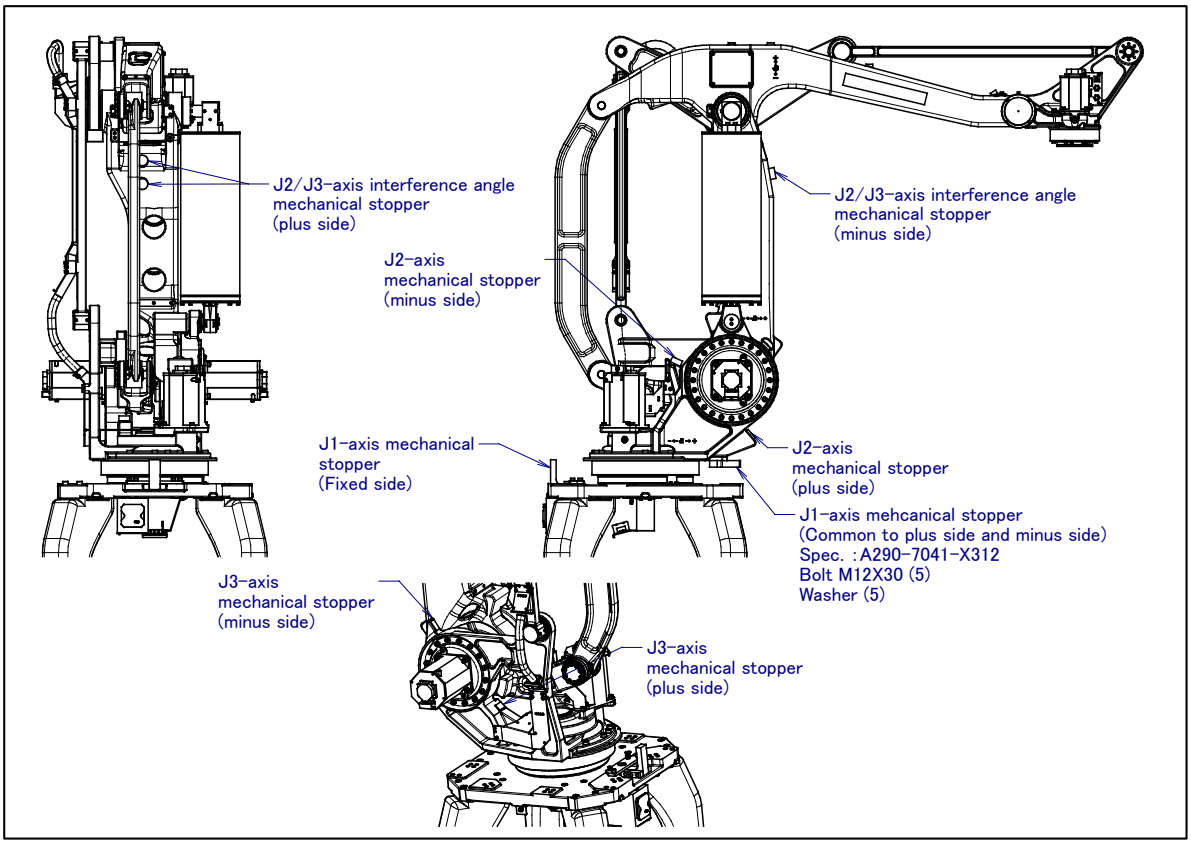


Fig.5.2 (d) Position of mechanical stopper

5.3 J1-AXIS STROKE MODIFICATION (OPTION)

The J1-axis stroke can be limited depending on the operating environment of the robot. The stroke can be changed by changing the locations of the dog and mechanical stopper and the settings of the parameters using the following procedure. (See Fig. 5.3 (a) to (b) and Table 5.3 (a))
The stroke can be changed every 45 degrees in the upper limit of +45 degrees to + 180 degrees and the lower limit of -180 degrees to -45 degrees.

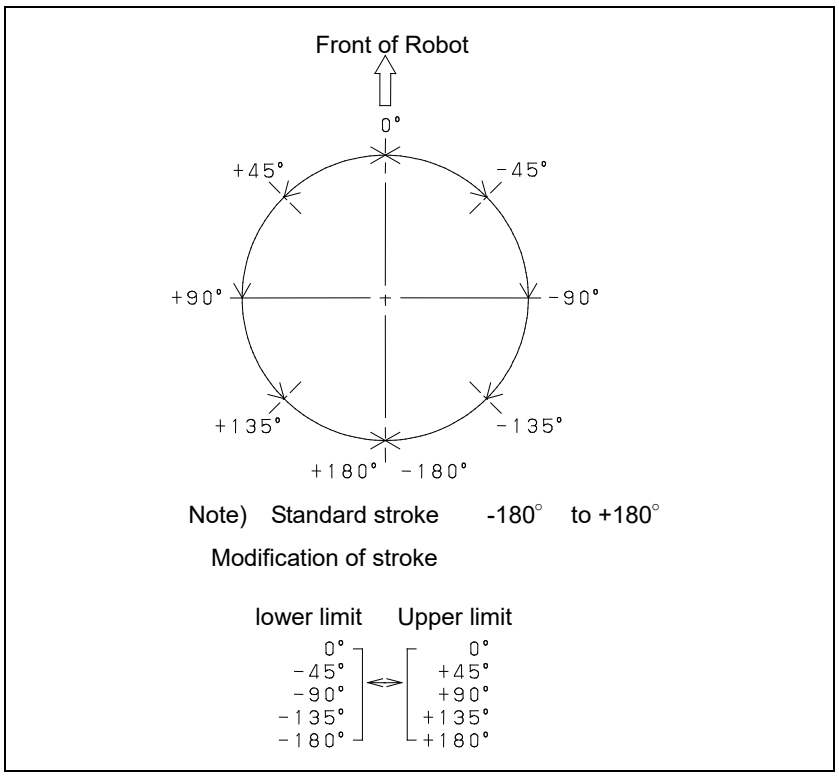
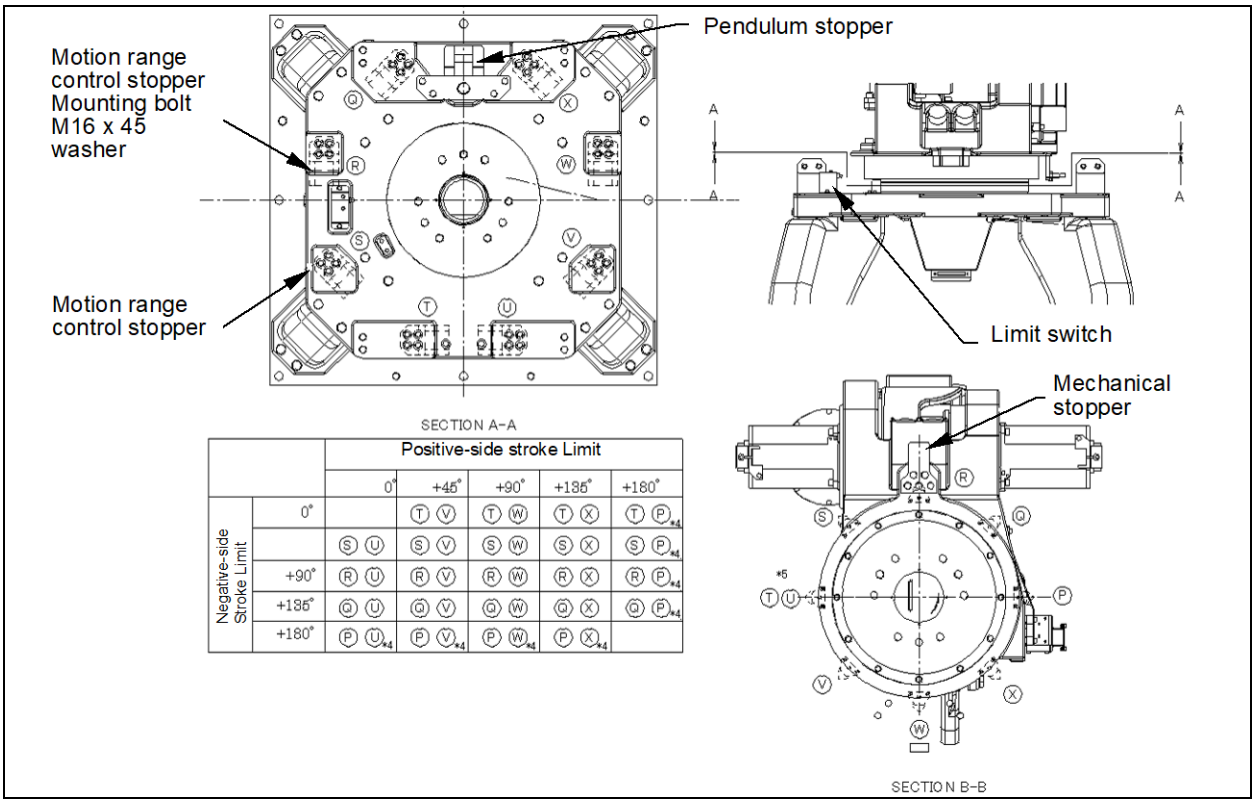


Fig. 5.3 (a) Modifying J1-axis stroke (option)

(a) Changing the mechanical stopper and the dog (option) position.
Change the mechanical position and the dog position as shown in Fig. 5.3 (b).



		Positive-side stroke Limit				
		0°	+45°	+90°	+135°	+180°
Negative-side Stroke Limit	0°		T V	T W	T X	T P *4
		S U	S V	S W	S X	S P *4
	+90°	R U	R V	R W	R X	R P *4
	+135°	Q U	Q V	Q W	Q X	Q P *4
	+180°	P U *4	P V *4	P W *4	P X *4	

Fig. 5.3 (b) Modification of J1-axis stroke (option)

(b) Changing system variables
When changing the dog and mechanical stopper, also be sure to change the following system variables according to the required strokes.
After changing system variables, turn the power off then back on again. (The stroke setting described above can be made also by selecting "SYSTEM" using the "MENU" key, then selecting "Axis limit" menu using F1 (TYPE). Refer to the Controller Operator's Manual for details.

⚠ WARNING
After changing system variables, be sure to run the robot at a low speed and make sure that the robot stops at the ends of the stroke.

Table 5.3 (a) Modification of system variable

Positions	System variable	
	Lower stroke limit $PARAM_GROUP $LOWERLIMS[1]	Upper stroke limit $PARAM_GROUP. $UPPERLIMS[1]
-180°	-180	-
-135°	-135	-
-90°	-90	-
-45°	-45	-
0°	0	0
+45°	-	45
+90°	-	90
+135°	-	135
+180°	-	180

⚠ WARNING
1 If a collision should occur, the J1 axis stopper becomes deformed to absorb energy, so that the robot can stop safely. If the stopper is deformed by mistake, replace it.
2 Do not add threaded holes to the frame, or do not use a self-made stopper to control the J1 stroke at any angle other than the one specified; otherwise, robot operation may be dangerous.

5.4 SOFTWARE SETTING

Upper and lower limits for the motion range of an axis can be changed by software. 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 Press [0 NEXT] and press [6 SYSTEM].
3 Press the 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	-44.00	100.00	deg
3	1	-126.00	10.00	deg
4	1	-270.00	270.00	deg
5	1	0.00	0.00	deg
6	1	0.00	0.00	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-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.

System Axis Limits 2/16

AXIS	GROUP	LOWER	UPPER	
2	1	-44.00	100.00	deg

[TYPE]

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 cycle the power of the controller to enable the new setting. If you fail to do so, the robot does not work normally and it may injure personnel or damage the equipment.

5.5 MASTERING

Mastering is an operation performed to associate 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.

5.5.1 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 becomes necessary after:

- 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.

Mastering method

Table 5.5.1 (a) describes the following mastering methods. Note that "Quick Mastering for Single Axis" is not supported in software version 7DC2 (V8.20P) or earlier.

Table 5.5.1 (a) Type of mastering

Fixture position mastering	This is performed using a mastering fixture before the machine is shipped from the factory.
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. (All axes at the same time)
Quick mastering for single axis	This is performed at a user-specified position for one axis. 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.
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 describeps zero-position mastering, quick mastering, quick mastering for single axis, single-axis mastering, and mastering data entry. For more accurate mastering (fixture position mastering), contact your local FANUC representative.

⚠ CAUTION

1 If mastering is performed incorrectly, the robot may behave unexpectedly. This is very dangerous. For this reason, the Master/Cal screen is designed to appear only when the $MASTER_ENB system variable is 1 or 2. After performing positioning, press F5, ([DONE]) on the Master/Cal screen. The $MASTER_ENB system variable is then reset to 0 automatically, and the Master/Cal screen will disappear.
2 Before performing mastering, it is recommended that you back up the current mastering data.

5.5.2 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.

5.5.3 Zero Degree 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. 5.5.3 (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 QUICK MASTER FOR SINGLE AXIS
 5 SINGLE AXIS MASTER
 6 SET QUICK MASTER REF
 7 CALIBRATE
     Press 'ENTER' or number key to select.

 [ TYPE ]   LOAD   RES_PCA                DONE
```

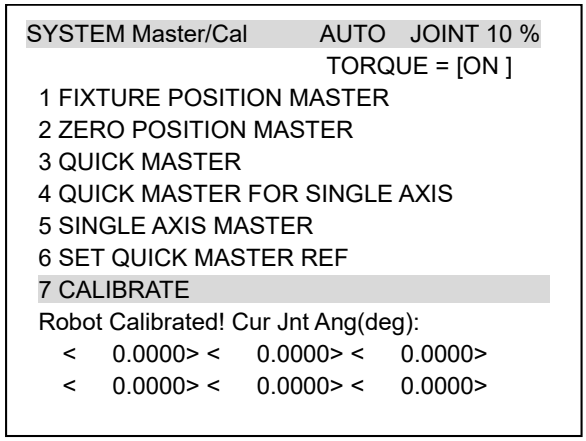
5 Release brake control, and jog the robot into a posture for mastering.

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, cycle power of the controller.

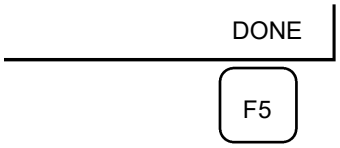
6 Select [2 Zero Position Master]. Press F4 [YES].

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

7 Select [7 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 5.5.3 (a) Posture with position marks aligned

Axis	Position	
	M-410*i*B/160	**M-410*i*B/300**
J1-axis	0 deg	0 deg
J2-axis	0 deg	0 deg
J3-axis	0 deg	0 deg
J4-axis	0 deg	0 deg

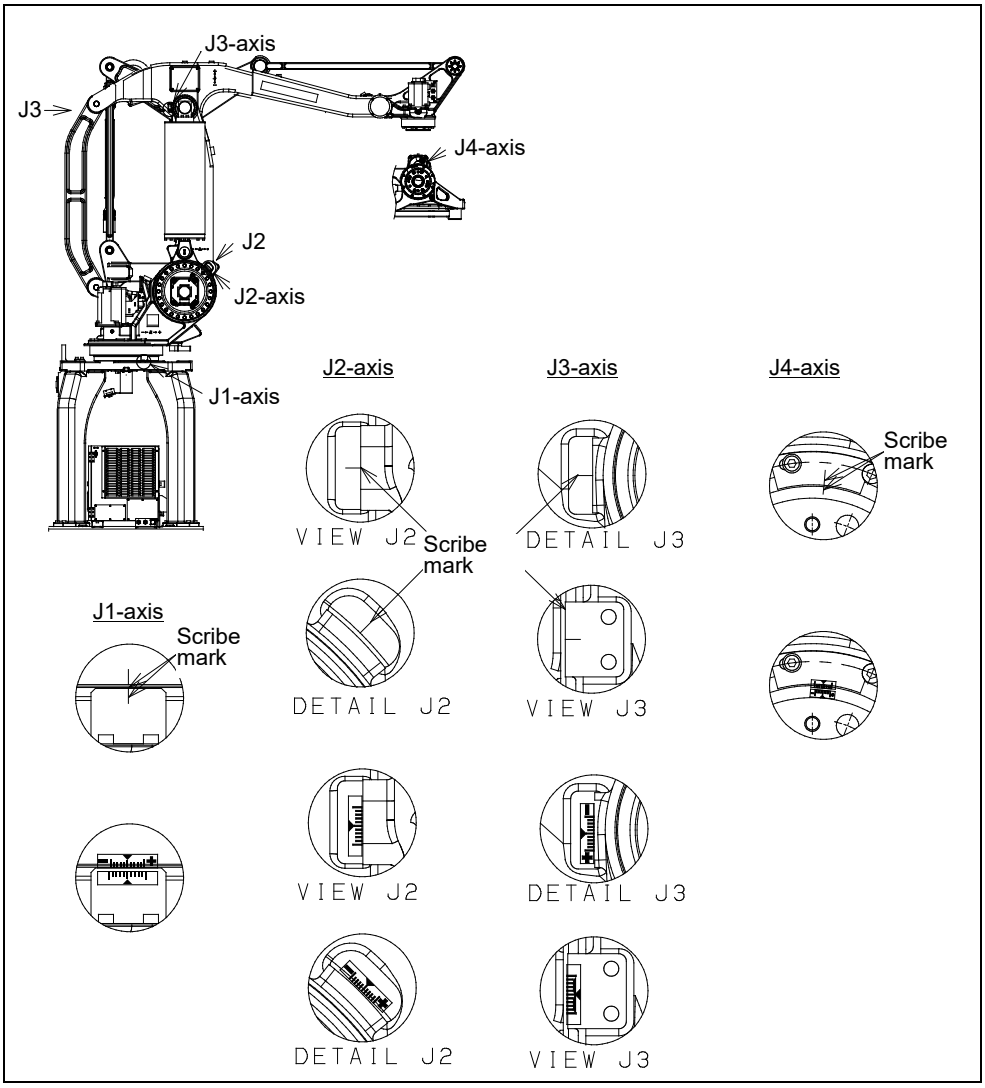


Table 5.5.3 (a) Posture with position marks aligned

5.5.4 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 5.5.3 (a). If possible, do not change the setting.

If setting the robot at the position mentioned above is impossible, you must 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.

```
SYSTEM Master/Cal          AUTO   JOINT 10 %
                                  TORQUE = [ON ]
 1 FIXTURE POSITION MASTER
 2 ZERO POSITION MASTER
 3 QUICK MASTER
 4 QUICK MASTER FOR SINGLE AXIS
 5 SINGLE AXIS MASTER
 6 SET QUICK MASTER REF
 7 CALIBRATE
    Press 'ENTER' or number key to select.

 [ TYPE ]   LOAD   RES_PCA                DONE
```

3 Release brake control, and jog the robot to the quick mastering reference position.
4 Select [6 SET QUICK MASTER REF] and press F4 [YES]. Quick mastering reference position will be set.

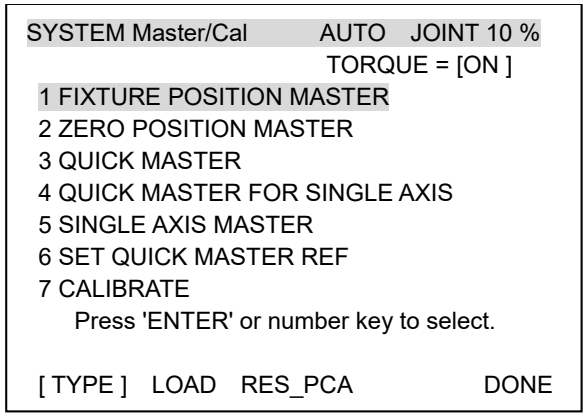
```
 5 SINGLE AXIS MASTER
 6 SET QUICK MASTER REF
 7 CALIBRATE
```

F4

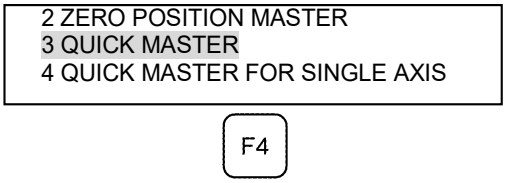
⚠ CAUTION
If the robot has lost mastering data due to mechanical disassembly or repair, you cannot perform this procedure. In this case, perform Fixture position mastering or Zero position mastering to restore mastering data.

Procedure of Quick Mastering

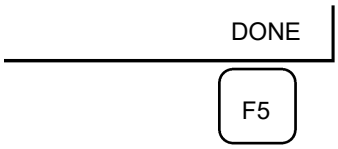
1 Display the Master/Cal screen.



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



4 Select [7 CALIBRATE] and press [ENTER] key. Calibration is executed. Calibration is executed by cycling power.
5 After completing the calibration, press F5 [Done].



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

5.5.5 QUICK MASTERING FOR SINGLE AXIS

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.

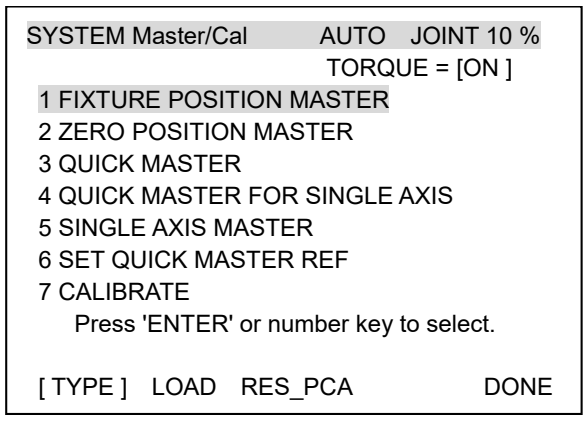
Quick mastering is factory-performed at the position indicated in Table 5.5.3 (a). Do not change the setting unless there is any problem.

If setting the robot at the position mentioned above is impossible, you must 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.)

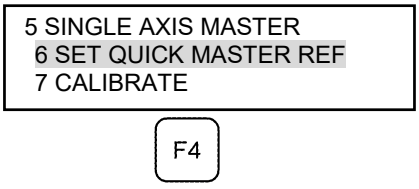
> **⚠ CAUTION**
> 1 Quick mastering can be used, if the pulse count value is lost, for example, because a low voltage has been detected on the backup battery for the pulse counter.
> 2 Quick mastering cannot be used, after the Pulsecoder is replaced or after the mastering data is lost from the robot 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 [6 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 is required to restore mastering data.

Procedure of Quick Mastering for single axis

1 Display the Master/Cal screen.

```
SYSTEM Master/Cal          AUTO   JOINT 10 %
                                  TORQUE = [ON ]
 1 FIXTURE POSITION MASTER
 2 ZERO POSITION MASTER
 3 QUICK MASTER
 4 QUICK MASTER FOR SINGLE AXIS
 5 SINGLE AXIS MASTER
 6 SET QUICK MASTER REF
 7 CALIBRATE
     Press 'ENTER' or number key to select.

 [ TYPE ]   LOAD   RES_PCA                DONE
```

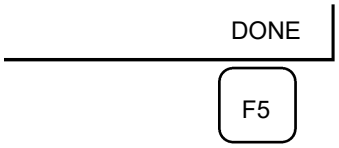
2 Select [4 QUICK MASTER FOR SINGLE AXIS]. You will see the quick master for single axis screen.

```
                                   AUTO JOINT 1%
QUICK MASTER FOR SINGLE AXIS
                                                    1/9
    ACTUAL   POS     (MSTR POS)     (SEL)     [ST]
J1          0.000    (     0.000)   (0)       [2]
J2          0.000    (     0.000)   (0)       [2]
J3          0.000    (     0.000)   (0)       [2]
J4          0.000    (     0.000)   (0)       [2]
J5          0.000    (     0.000)   (0)       [2]
J6          0.000    (     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
```

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

```
                                   AUTO JOIN 1%
QUICK MASTER FOR SINGLE AXIS
                                                    1/9
    ACTUAL   POS     (MSTR POS)     (SEL)     [ST]
J5          0.000    (     0.000)   (1)       [2]
J6          0.000    (     0.000)   (1)       [2]

                                                EXEC
```

4 Turn off brake control, then jog the robot to the quick mastering reference position.
5 Press F5 [EXEC]. Mastering is performed. So, [SEL] is reset to 0, and [ST] is re-set to 2.
6 Select [7 CALIBRATE] and press [ENTER] key. Calibration is executed. Calibration is executed by cycling power.
7 After completing the calibration, press F5 Done.



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

5.5.6 Single Axis Mastering

Single axis mastering is performed for one axis at a time. The mastering position for each axis can be specified by the user.
Single axis mastering can be used, if mastering data for a specific axis is lost, for example, because a low voltage has been detected on the pulse counter backup battery or because the Pulsecoder has been replaced.

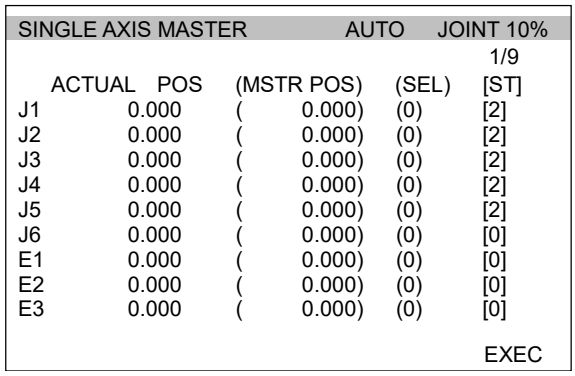


Table 5.5.6 (a) Items set in single axis mastering

Item	Description
Current position (ACTUAL AXIS)	The current position of the robot is displayed for each axis in degree units.
Mastering position (MSTR POS)	A mastering position is specified for an axis to be subjected to single axis mastering. It would be convenient if it is set to 0 degree 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 of Single axis mastering

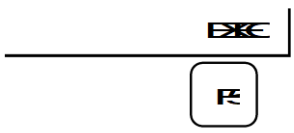
1 Select [6 SYSTEM].
2 Select [Master/Cal]. The positioning screen will be displayed.

```
SYSTEM Master/Cal          AUTO   JOINT 10 %
                                  TORQUE = [ON ]
 1 FIXTURE POSITION MASTER
 2 ZERO POSITION MASTER
 3 QUICK MASTER
 4 QUICK MASTER FOR SINGLE AXIS
 5 SINGLE AXIS MASTER
 6 SET QUICK MASTER REF
 7 CALIBRATE
     Press 'ENTER' or number key to select.

 [ TYPE ]   LOAD   RES_PCA                DONE
```

3 Select [5 SINGLE AXIS MASTER]. The following screen will be displayed.

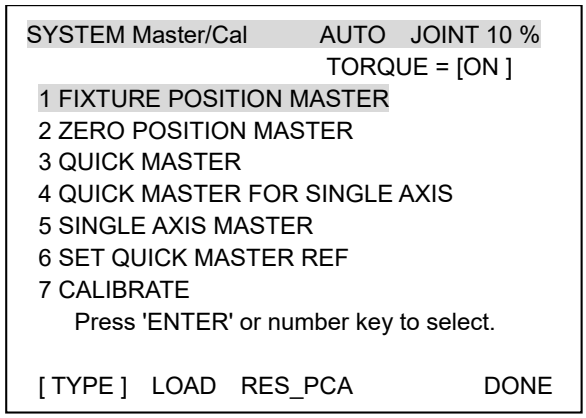
```
SINGLE AXIS MASTER          AUTO    JOINT 10%
                                          1/9
    ACTUAL   POS    (MSTR POS)    (SEL)   [ST]
J1          0.000   (     0.000)  (0)     [2]
J2          0.000   (     0.000)  (0)     [2]
J3          0.000   (     0.000)  (0)     [2]
J4          0.000   (     0.000)  (0)     [2]
J5          0.000   (     0.000)  (0)     [2]
J6          0.000   (     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.



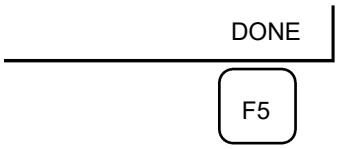

```
SINGLE AXIS MASTER          AUTO    JOINT 10%
                                          6/9
    ACTUAL   POS    (MSTR POS)    (SEL)   [ST]
J1          0.000   (     0.000)  (0)     [2]
J2          0.000   (     0.000)  (0)     [2]
J3          0.000   (     0.000)  (0)     [2]
J4          0.000   (     0.000)  (0)     [2]
J5          0.000   (     0.000)  (0)     [2]
J6         90.000   (     0.000)  (1)     [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 [7 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].



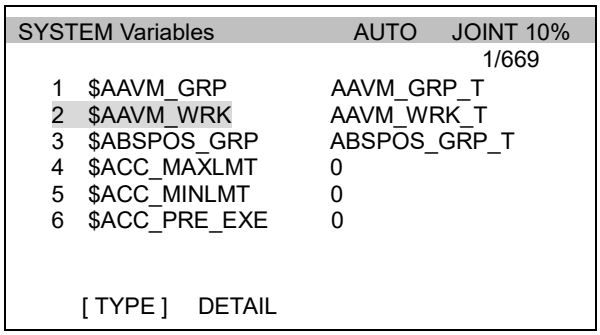
11 Return brake control to original setting, and cycle power of the controller.

5.5.7 Mastering Data Entry

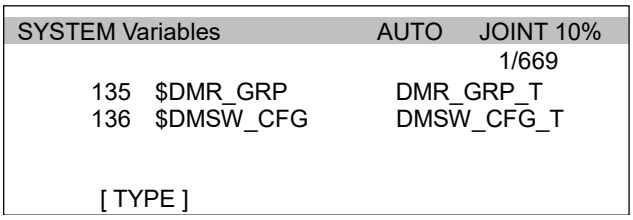
This function enables mastering data values to be assigned directly to a system variable. It can be used if mastering data has been lost but the pulse count is preserved.

Mastering data entry method

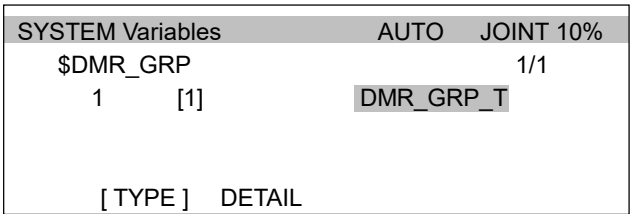
1 Press the [MENU] key, then press [0 NEXT] and select [6 SYSTEM].
2 Press F1 [TYPE]. Select [Variables]. The system variable screen will be displayed.

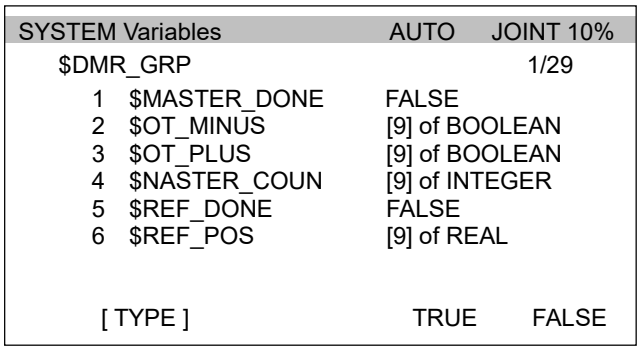


3 Change the mastering data. The mastering data is saved to the $DMR_GRP.$MASTER_COUN system variable.

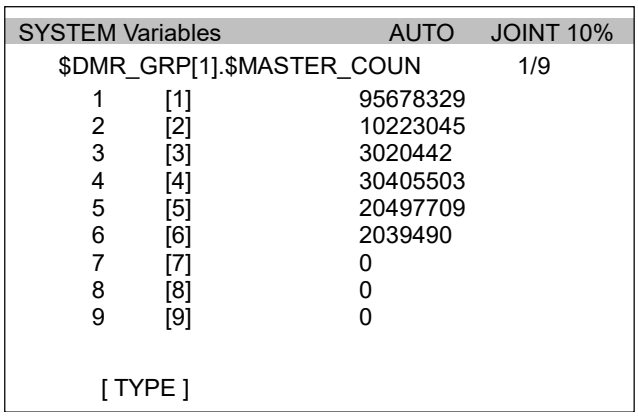


4 Select $DMR_GRP.

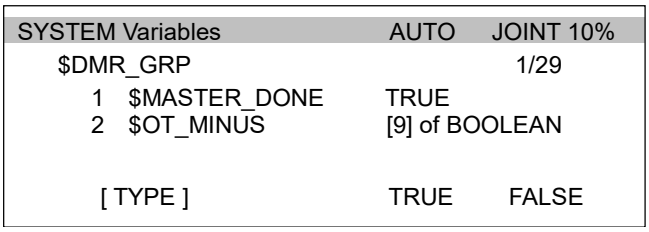




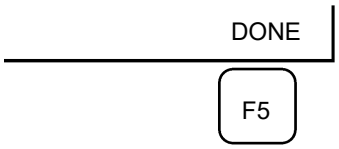
5 Select $MASTER_COUN, and enter the mastering data you have recorded.



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



8 Display the positioning screen, and select [7 CALIBRATE], then press F4 [YES].
9 After completing positioning, press F5 [DONE].



5.6 VERIFYING MASTERING

1 How to verify that the robot is mastered properly:
Usually, positioning is performed automatically at power-on. To check whether mastering has been made correctly, note whether the displayed current position agrees with the actual robot position. Use the procedure 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 5.5.3 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 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 5.5.2.). 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

Fig. 6 (a) and (b) show the piping diagram.

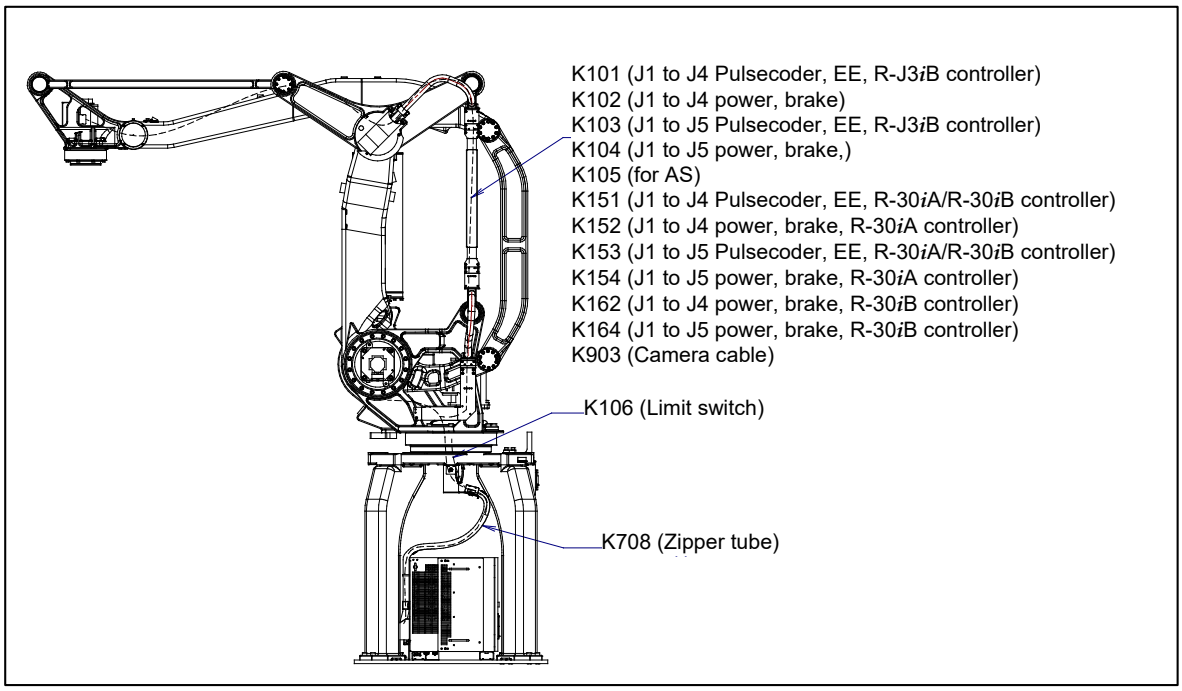


Fig. 6 (a) Piping diagram (Integrated type controller)

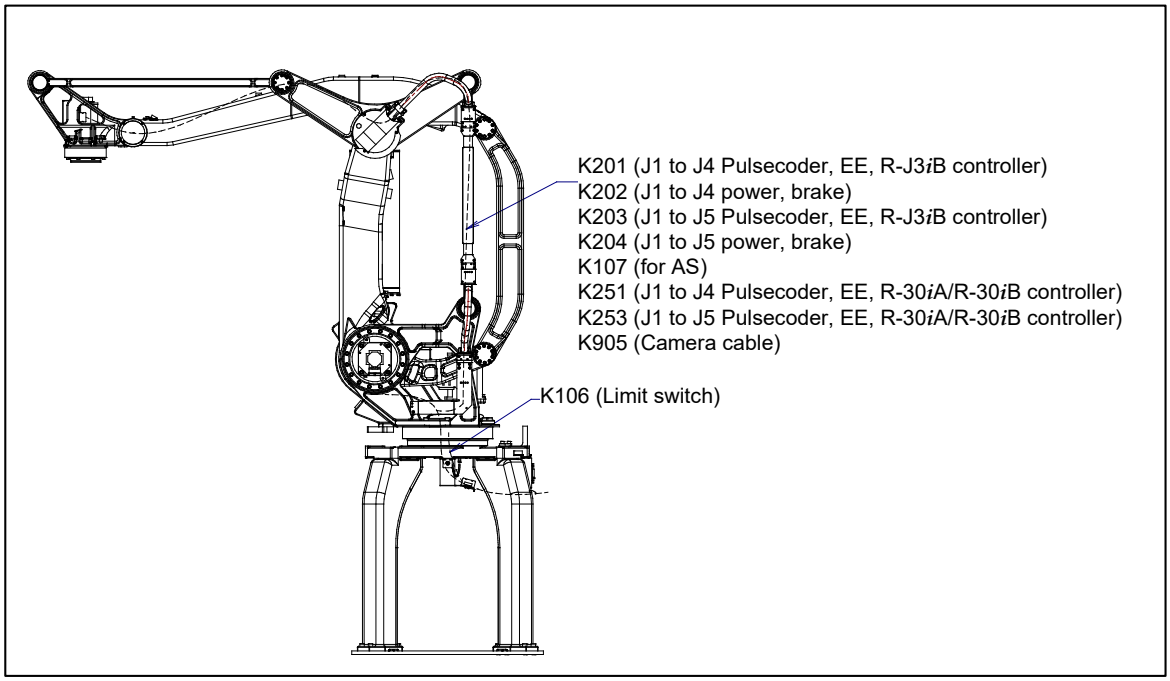


Fig. 6 (b) Piping diagram (Remote type controller)

7 ROBOT OPERATING SPACE

Fig.7 (a) shows the operating space of the robots. When installing peripheral equipment, be careful to clear away any objects that are in the robot's motion path in normal operation.

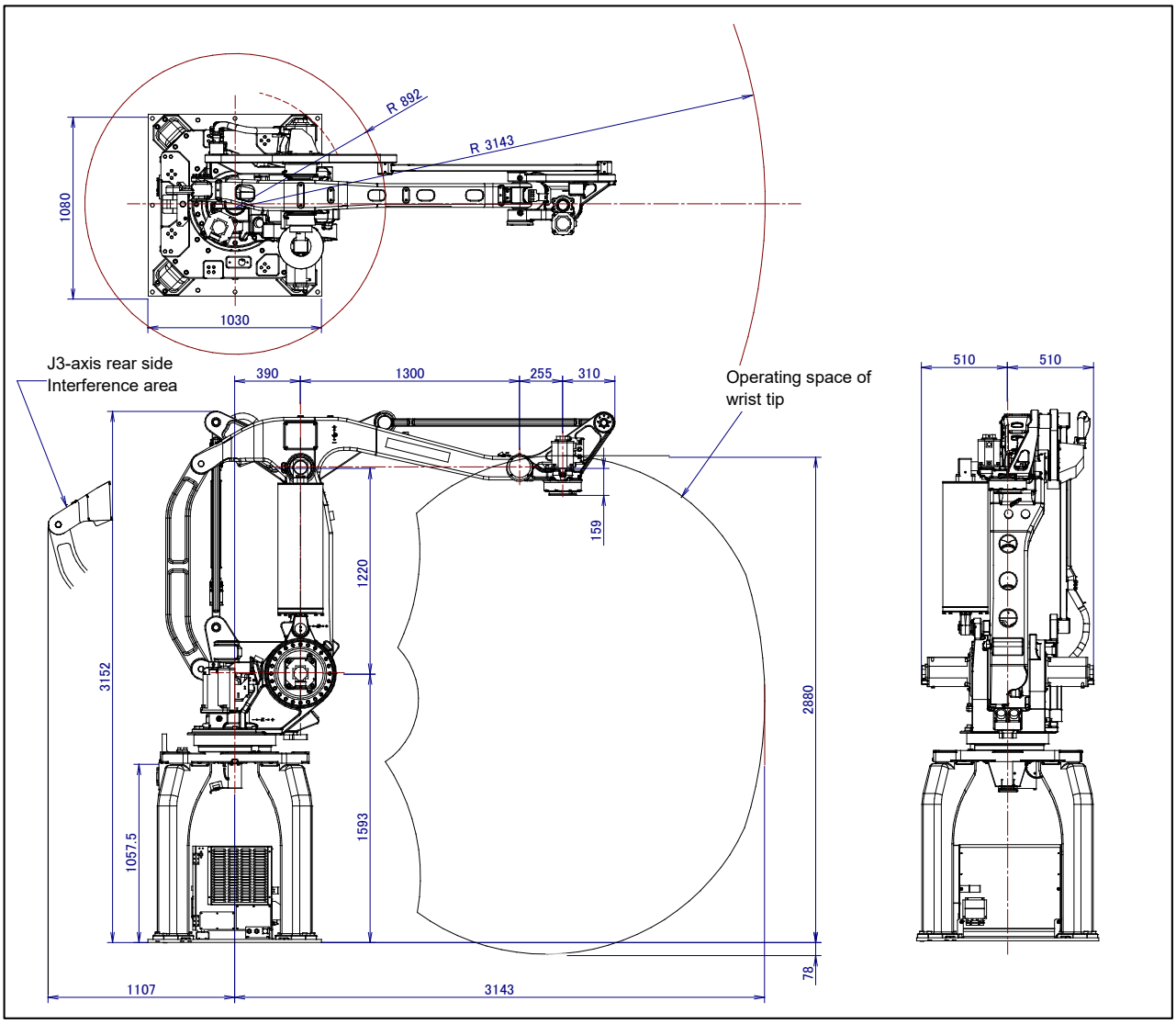


Fig. 7 (a) Operating space

8 EQUIPMENT INSTALLATION TO THE ROBOT

8.1 LOAD CONDITION AT WRIST

Fig. 8.1 (a) and (b) show the relationships between the horizontal offset of the center of gravity of the wrist load and the permissible load inertia. See Fig. 8.1 (c) to check whether the center of gravity of the load is inside or outside of the wrist.
See Fig. 8.1 (d) for explanations about the vertical offset of the center of gravity of the wrist load.
Keep the wrist load within a range graphically shown in Fig. 8.1 (a), (b).
See Fig. 8.1 (e) for explanations about how to calculate the load inertial.

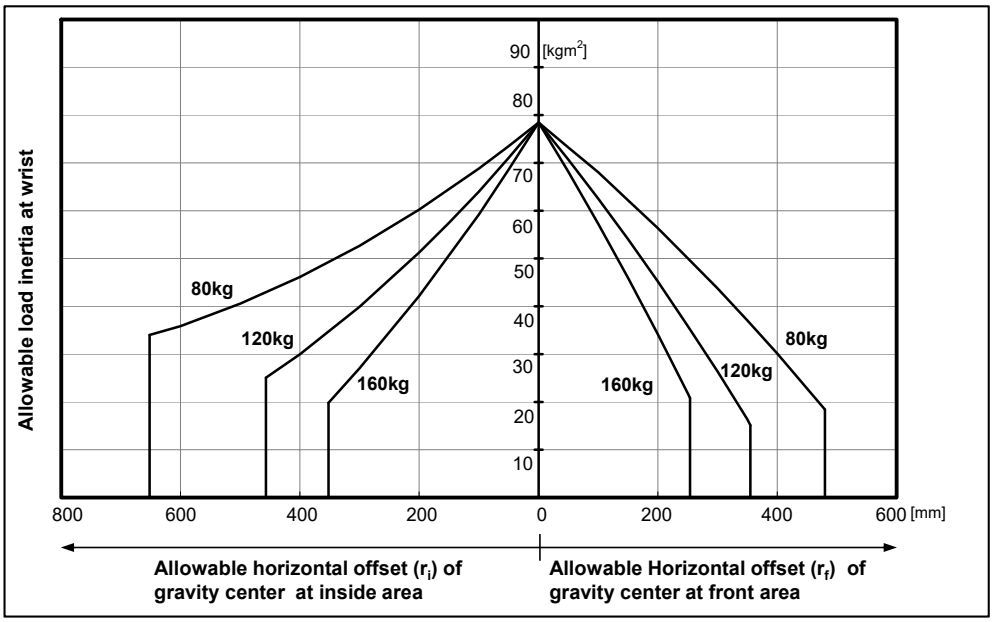


Fig. 8.1 (a) Line chart of the permissible load for the wrist section (horizontal offset) (M-410*i*B/160)

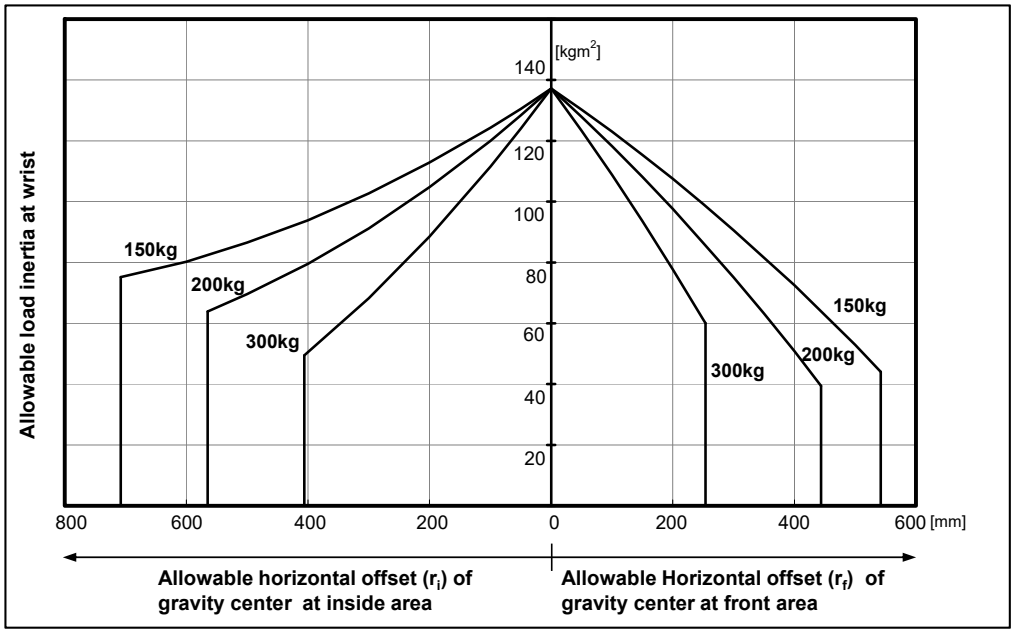


Fig. 8.1 (b) Line chart of the permissible load for the wrist section (horizontal offset) (M-410*i*B/300)

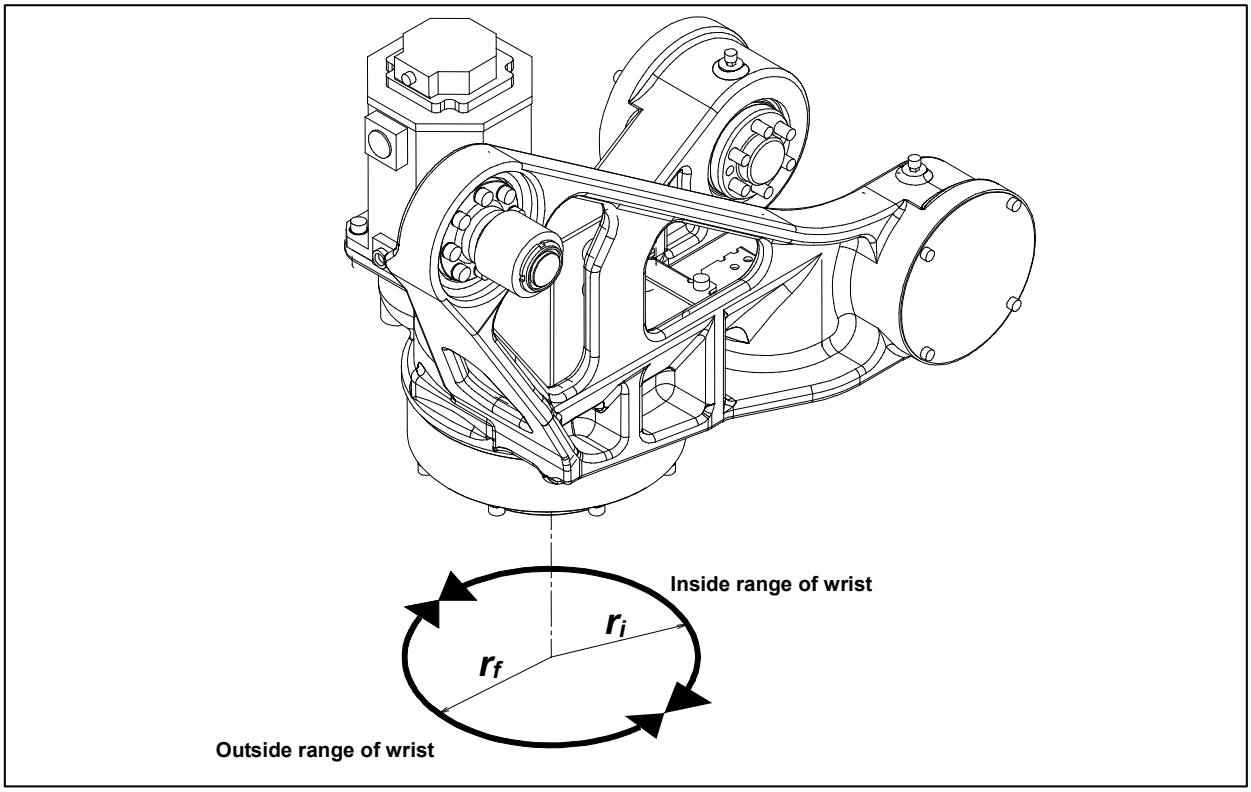


Fig. 8.1 (c) Allowable wrist load condition

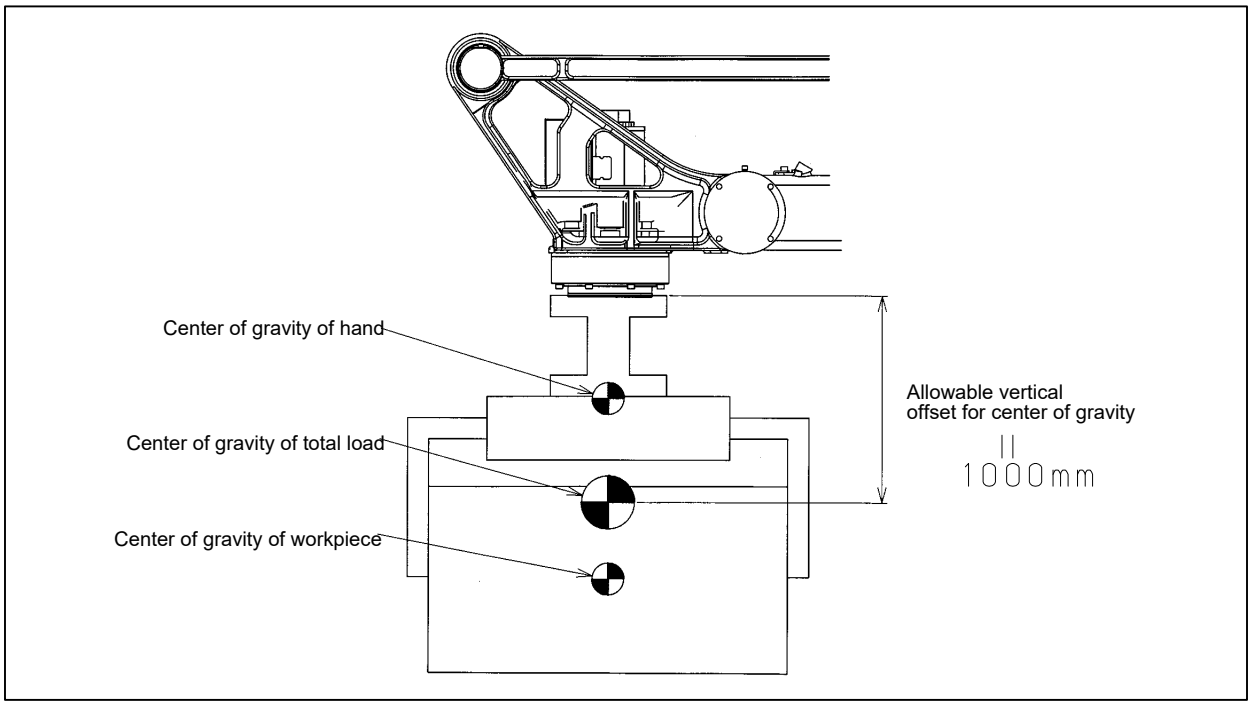


Fig. 8.1 (d) Allowable wrist load condition

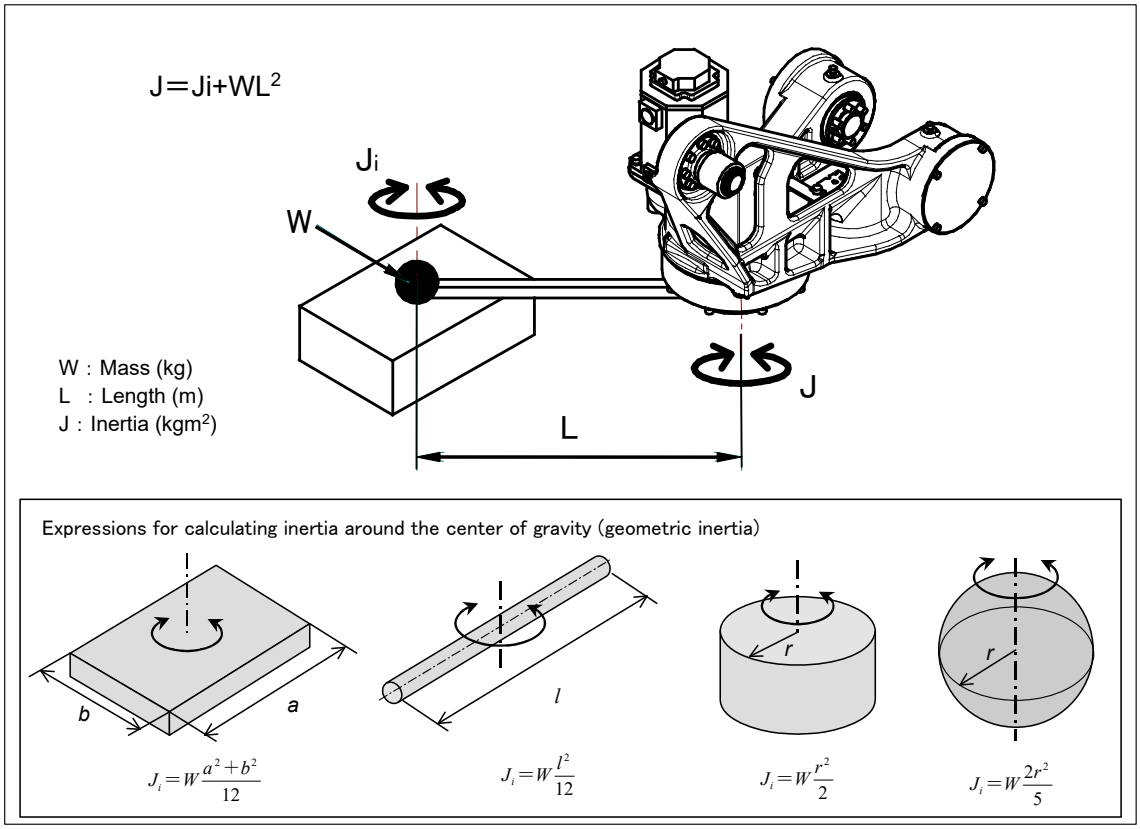


Fig. 8.1 (e) Calculating inertia

The total inertia around the wrist (J4) axis is the sum of the horizontal offset inertia of a workpiece and the geometric inertia around the center of the gravity of the workpiece. It ca be calculated as shown above.

NOTE
If a hand or workpiece has a complicated shape, divide it into simple shapes as shown above. Calculate the geometric inertia and offset inertia of each shape, then obtain their sum.

8.2 END EFFECTOR INSTALLATION TO WRIST

Fig.8.2 (a) is the diagrams for installing end effectors on the wrist. To fasten the end effector, first position it with two pin holes at C using fitting A or B, then lock it using screws at D. Select screws and positioning pins of a length that matches the depth of the tapped and pin holes. Fasten the bolt for fixing the end effector with following torque.

73.5±3.4N-m (750±35kgf-cm)

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

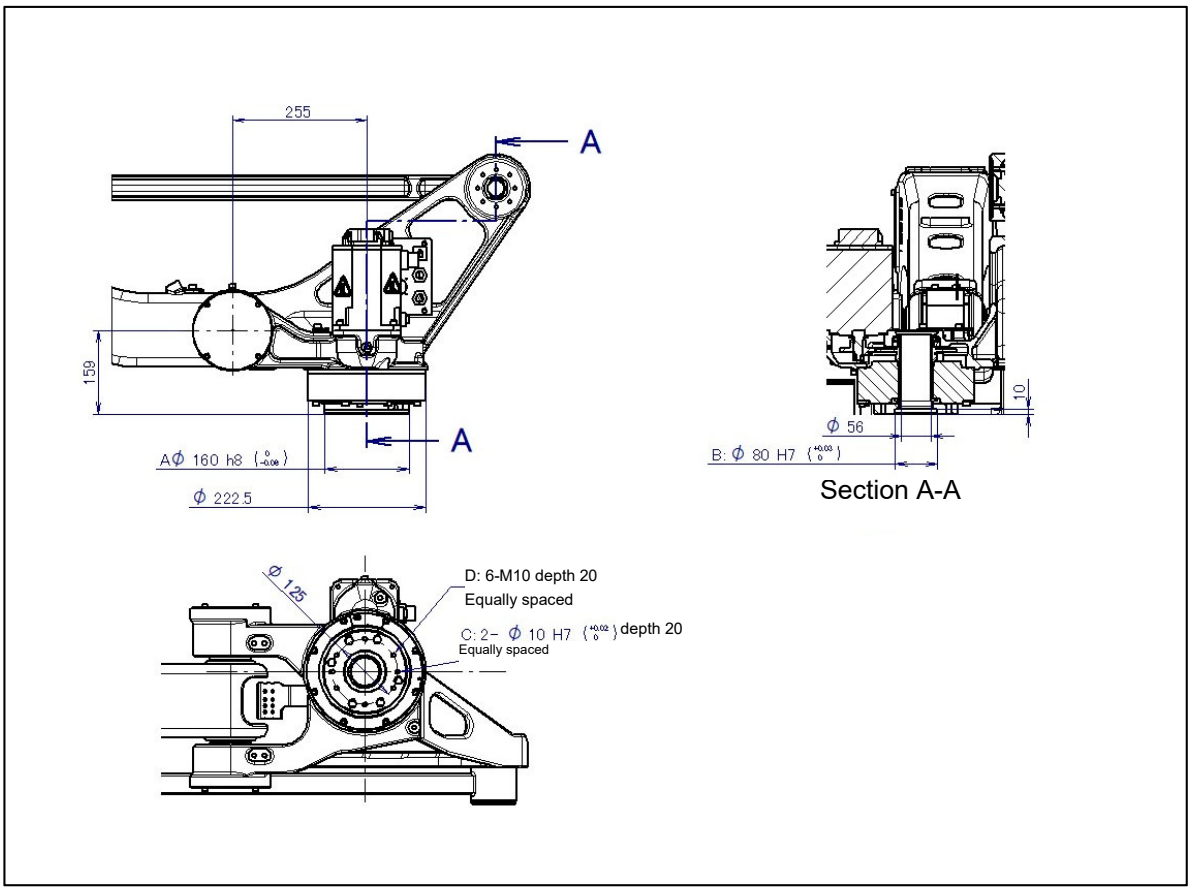


Fig. 8.2 (a) End effector mounting face

8.3 EQUIPMENT MOUNTING FACE

As shown in Fig.8.3 (a), 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 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.
3 Equipment should be installed so that mechanical unit cable does not interfere. If equipment interfere, the mechanical unit cable might be disconnected, and unexpected troubles might occur.

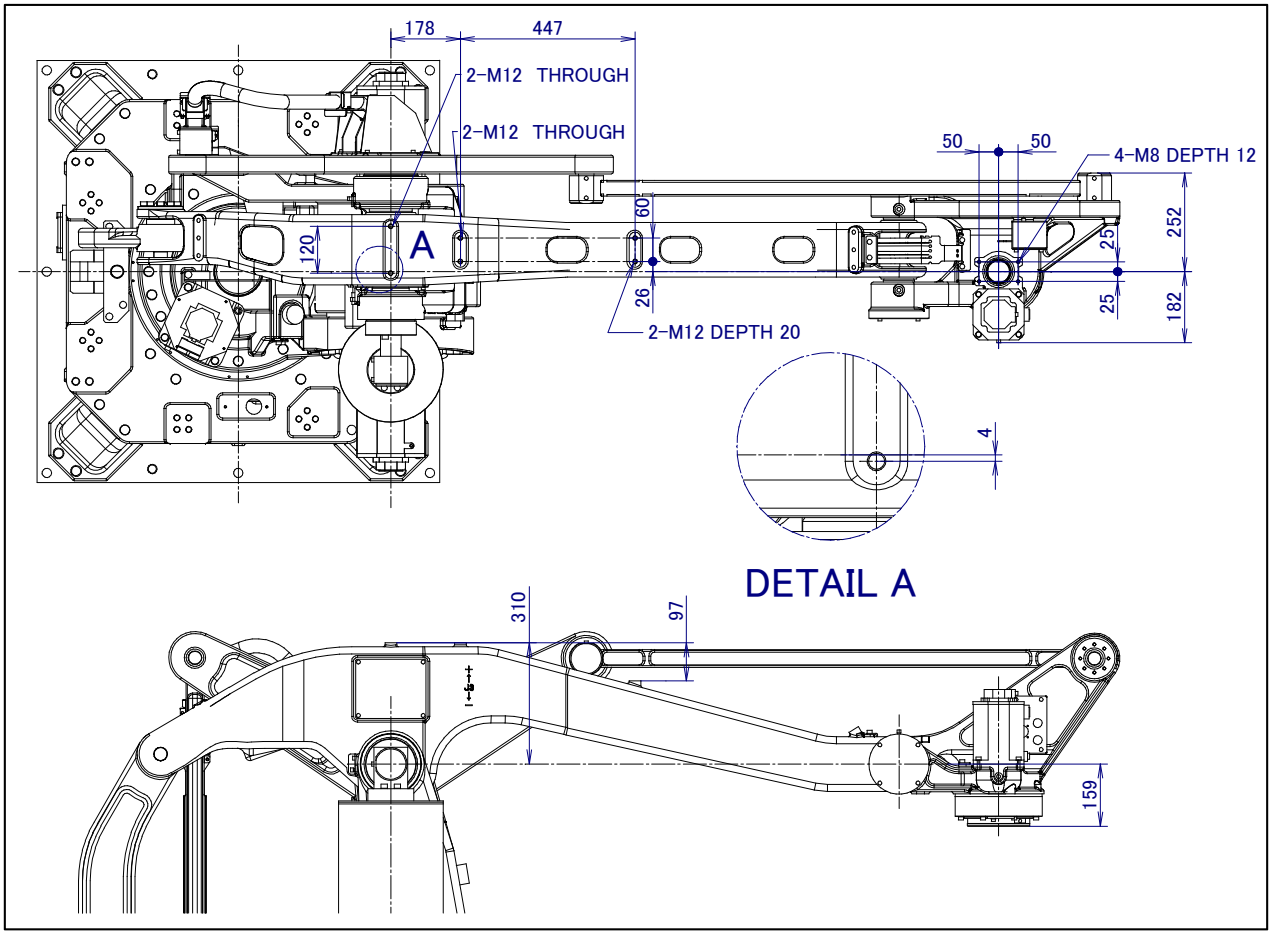


Fig.8.3 (a) Dimension of equipment mounting face

8.4 LOAD SETTING

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

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

1 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.

```
MOTION PERFORMANCE                    JOINT 10%
   Group1
No.   PAYLOAD[kg]          Comment
 1          160.00   [                    ]
 2            0.00   [                    ]
 3            0.00   [                    ]
 4            0.00   [                    ]
 5            0.00   [                    ]
 6            0.00   [                    ]
 7            0.00   [                    ]
 8            0.00   [                    ]
 9            0.00   [                    ]
10            0.00   [                    ]

  Active PAYLOAD number =0
[ TYPE]  GROUP   DETAIL   ARMLOAD   SETING >
         IDENT                             >
```

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

```
MOTION PAYLOAD SET              JOINT   100%

  Group 1
  Schedule No[   1]:[Comment          ]
 1 PAYLOAD              [kg]        160.00
 2 PAYLOAD CENTER  X    [cm]        -25.00
 3 PAYLOAD CENTER  Y    [cm]          0.00
 4 PAYLOAD CENTER  Z    [cm]         15.00
 5 PAYLOAD INERTIA X    [kgfcms^2]    2.79
 6 PAYLOAD INERTIA Y    [kgfcms^2]    4.17
 7 PAYLOAD INERTIA Z    [kgfcms^2]    3.77

 [TYPE]  GROUP  NUMBER  DEFAULT  HELP
```

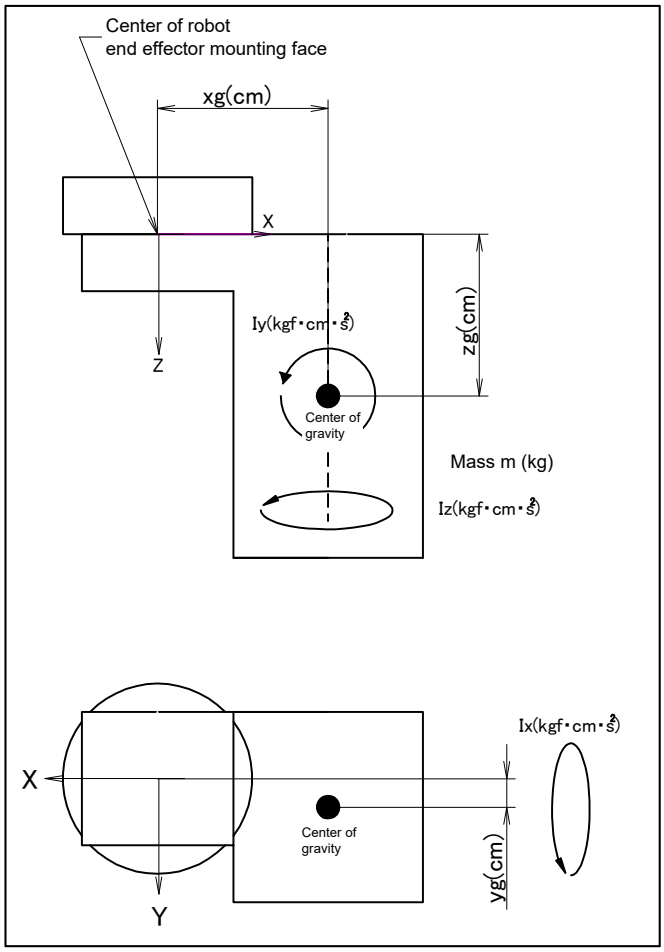


Fig. 8.4 (a) Standard tool coordinate

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 multigroup 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 %

      Group1
1     ARM LOAD AXIS #1 [ kg ]          0.00
2     ARM LOAD AXIS #3 [ kg ]         30.00

 [ 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 (No armload #1 is allowed for the M-410*i*B/160/300.)
ARMLOAD AXIS #3[kg] : Weight of the load on the J3 arm
The following message appears : "Path and Cycletime will change. Set it?" Select F4 ([YES]) or F5 ([NO]). Once the arm payload is set up, the settings are completed by switching the power off and on again.

8.4.1 Switching between Modes

There are two different parameter settings for the M-410*i*B/160 according to the amplitude of the load. (The factory-shipped parameter setting is for standard mode.)

			Standard inertia mode	High inertia mode
Allowable load at wrist	J4-axis	M-410*i*B	160kg	100kg

The parameters are automatically set according to the load settings made in Section 8.4.

Software series	Software version	Mechanical unit
V6.10P (7D80)	95 and later	All models
V6.20P (7D81)	47 and later	
V6.30P (7D82)	45 and later	
V6.33P (7D85)	08 and later	
V7.20P (7DA1) or later	All versions	

⚠ CAUTION
Set the load properly as described in Section 8.4.
If a workpiece heavier than the allowable load in the high speed mode is used in the high speed mode, mechanical parts may degrade earlier.

Set the parameters based on the load, as described later.
(Parameter settings appropriate for the standard inertia mode are made before shipment.)

Software series	Software version	Mechanical unit
V6.10P (7D80)	94 and earlier	All models
V6.20P (7D81)	46 and earlier	
V6.30P (7D82)	44 and earlier	
V6.33P (7D85)	07 and earlier	

⚠ CAUTION
If a workpiece with inertia exceeding the allowable inertia in the standard inertia mode is used in the mode, parts of the mechanical unit may degrade earlier.

To set the parameters, execute the setting program (JDGLOAD.PC) installed before shipment. This program sets the parameters based on the currently-used load inertia of the load settings made in Section 8.4

Setting method (Software version is V6 or before)

The setting program is called in program.
In particular, when load settings are switched with PAYLOAD instruction, execute this program.

[Example of program]
1: PAYLOAD [1]
2: CALL JDGLOAD (i)

For input parameter i of JDGLOAD, specify the group number of the robot. When input parameter i is omitted, the setting of group 1 is done.

Checking the settings (Software version is V6 or before)

Executing the setting program displays the settings made on the user screen. To display the user screen, press MENU key and then select "9 USER."

[Information displayed on the user screen]
For standard settings: Standard payload set. (GP: x, Payload: y)
For high settings: 100kg payload set. (GP: x, Payload: y)

x represents the group number for which the parameter was set. y represents the load setting number used for evaluation.

When checking the current settings only without switching parameters, specify the group number added by 100 for input parameter i of JDGLOAD and then execute the program. This displays the current parameter settings of the group on the user screen.

[Information displayed on the user screen]
For standard inertia load settings: Standard payload type now (GP: x)
For high inertia load settings: 100kg payload type now (GP: x)

x represents the group number whose parameter was checked.

Exception processing (Software version is V6 or before)

In the following cases, exception processing is performed. Parameters are not changed and a message describing the exception processing appears on the user screen.

1 When none of load setting condition numbers (Nos. 1 to 10) is selected

[Information displayed on the user screen]
Payload number 0 is invalid. (GP: x)

When this message appears, select the load setting condition on the motion performance screen or set the load setting condition with the PAYLOAD instruction.

2 When the group specified by input parameter i of JDGLOAD does not exist

[Information displayed on the user screen]
Incorrect group number

When this message appears, specify the correct group number.

3 When the group specified by input parameter i of JDGLOAD is not M-410*i*B/160

[Information displayed on the user screen]
This group is not M-410*i*B/160

When this message appears, specify the correct group number.

8.5 AIR SUPPLY

There is an air-pressure supply opening for supplying air to the end effector. As coupling is not supplied, it will be necessary to prepare couplings that suit to the hose size.

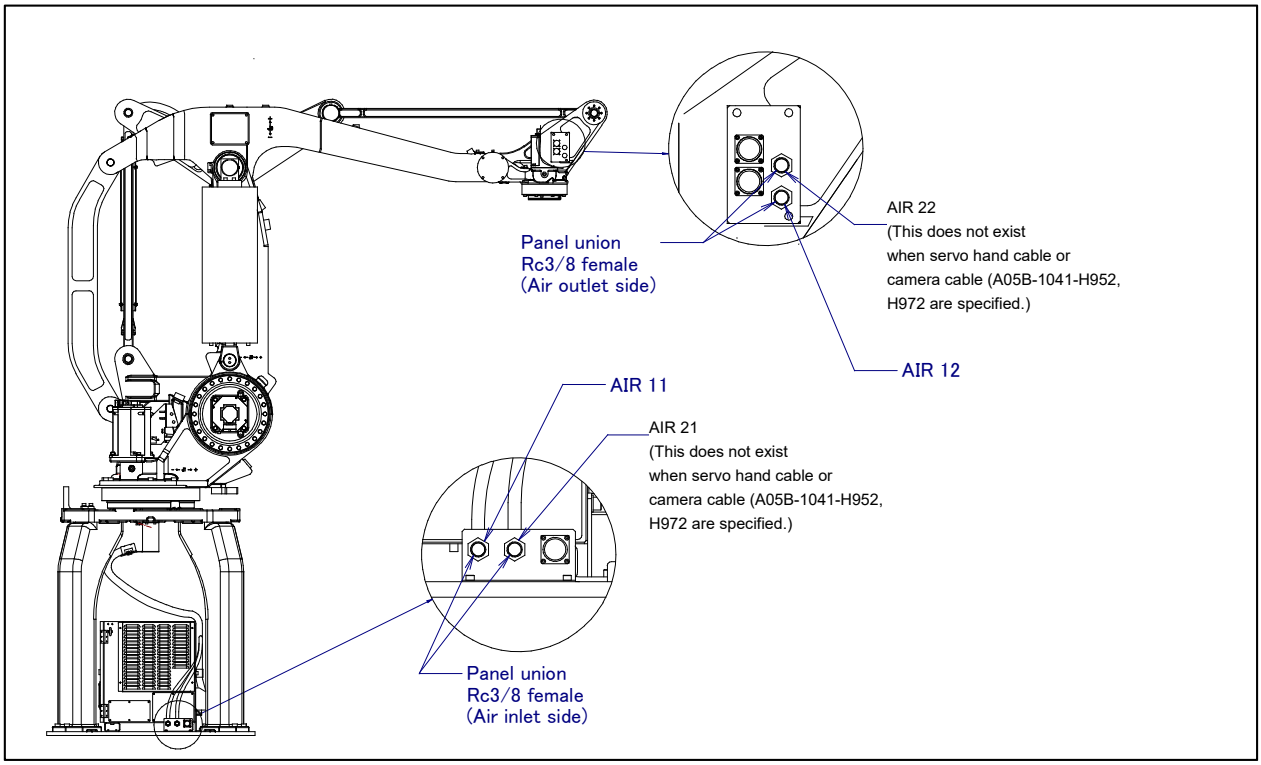


Fig. 8.5 (a) Air-pressure supply connection (Integrated type controller)

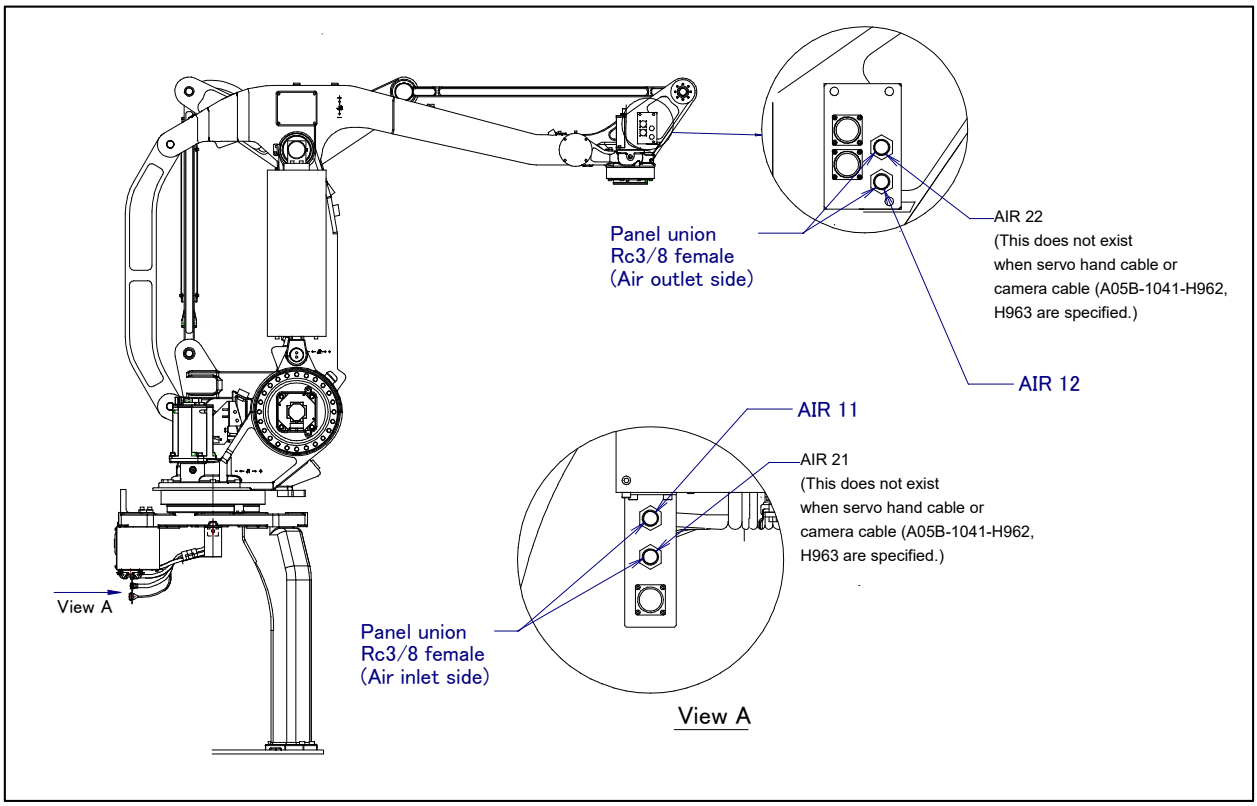


Fig. 8.5 (b) Air-pressure supply connection (Remote type controller)

8.6 OPTION CABLE INTERFACE

⚠ 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. (Refer to Fig. 8.6 (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.

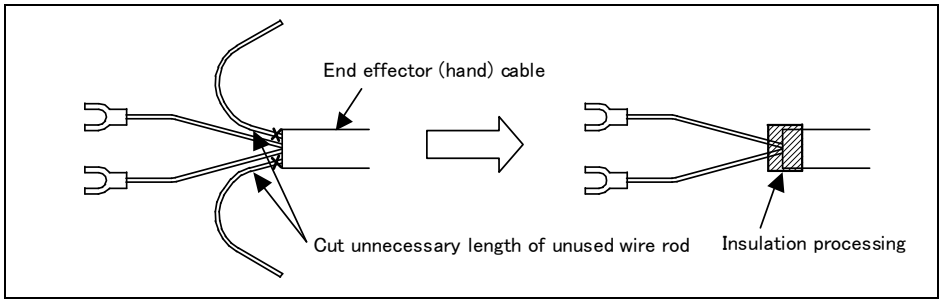


Fig. 8.6 (a) Treatment method of end effector (hand) cable

Fig. 8.6 (b) to (f) show the interface position of the option cable. EE interface (RDI/RDO or RI/RO), user cable (signal line), servo hand cable and camera cable are prepared. The user cable (signal lines option), servo hand cable and camera cable are prepared as an option.

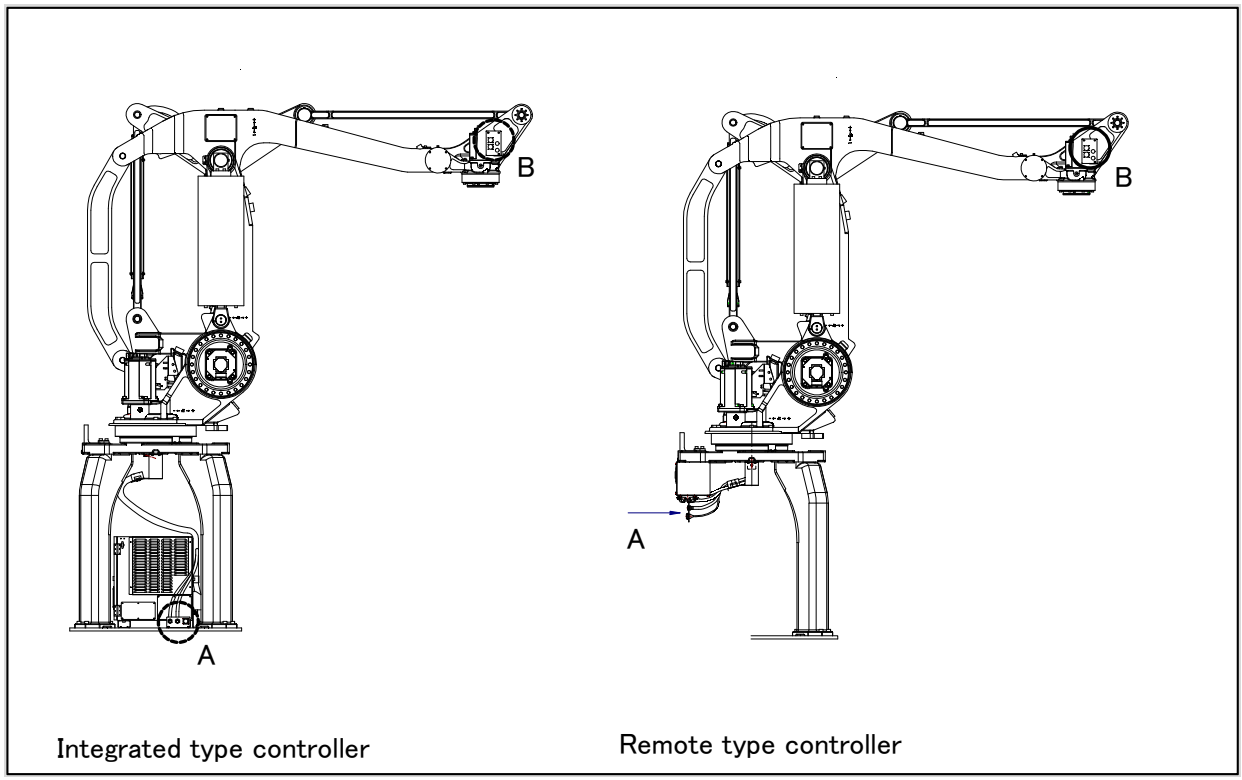


Fig. 8.6 (b) Interface position for option cable

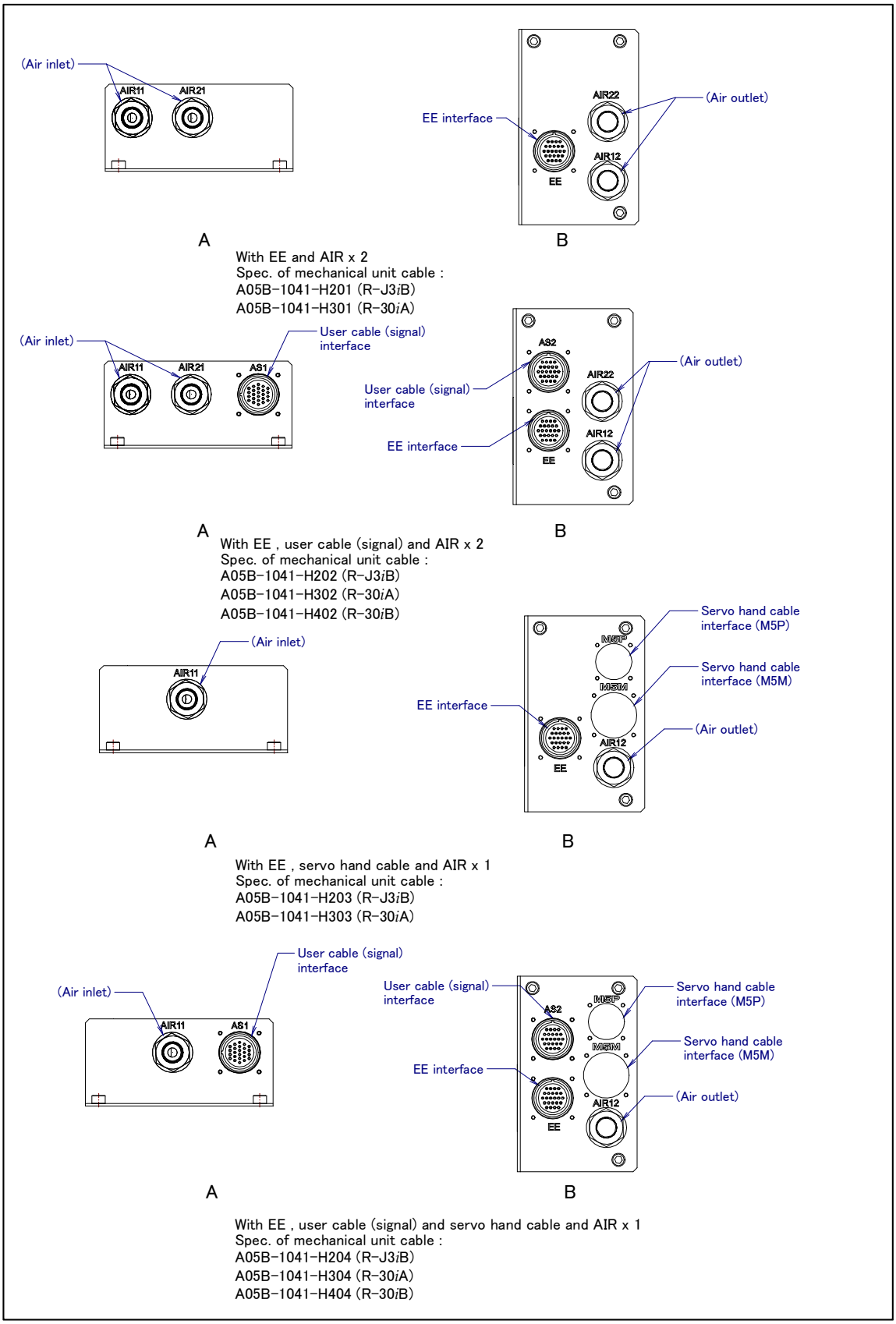


Fig. 8.6 (c) Interface for the option cable (Remote type controller) (1/2)

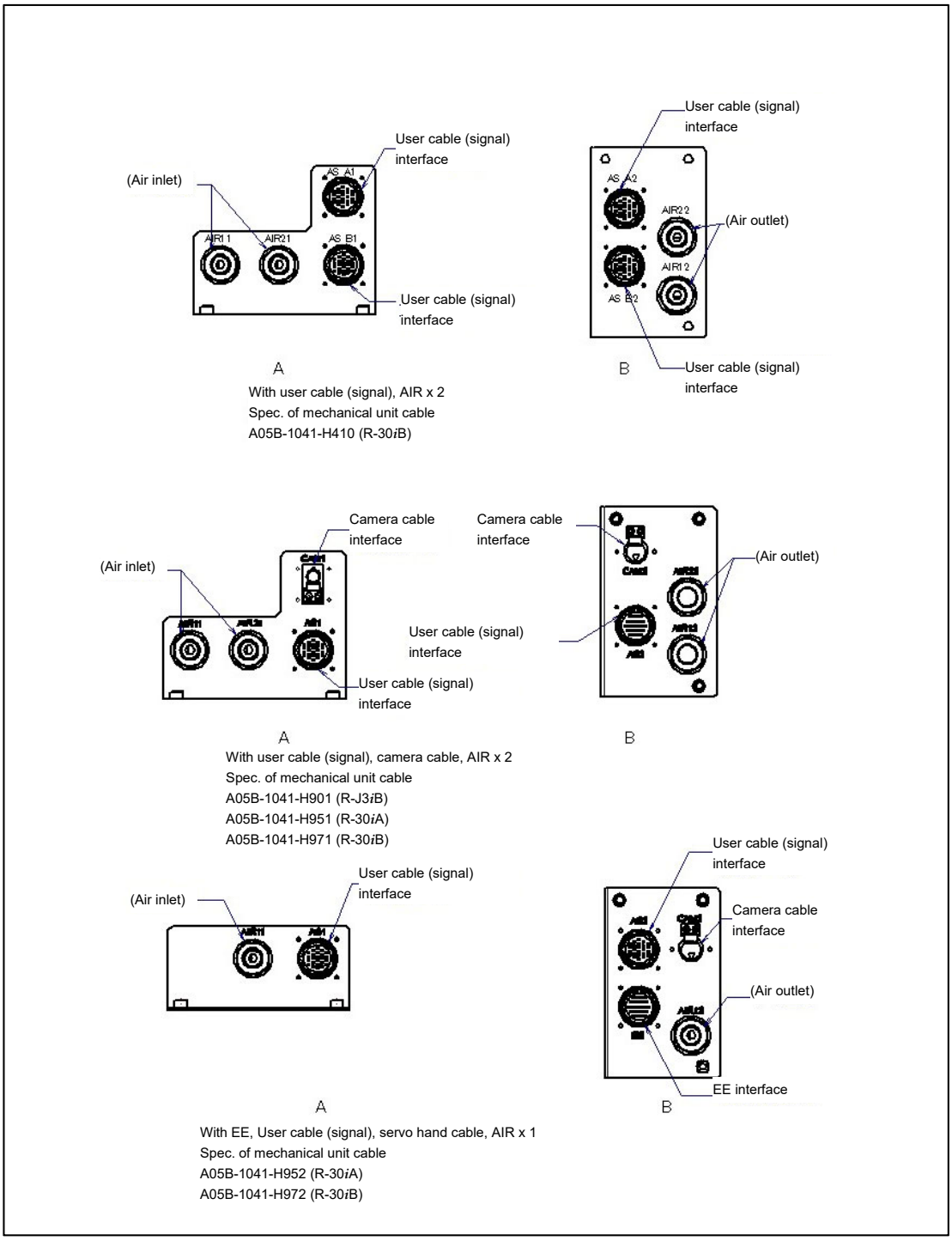


Fig. 8.6 (d) Interface for the option cable (Remote type controller) (2/2)

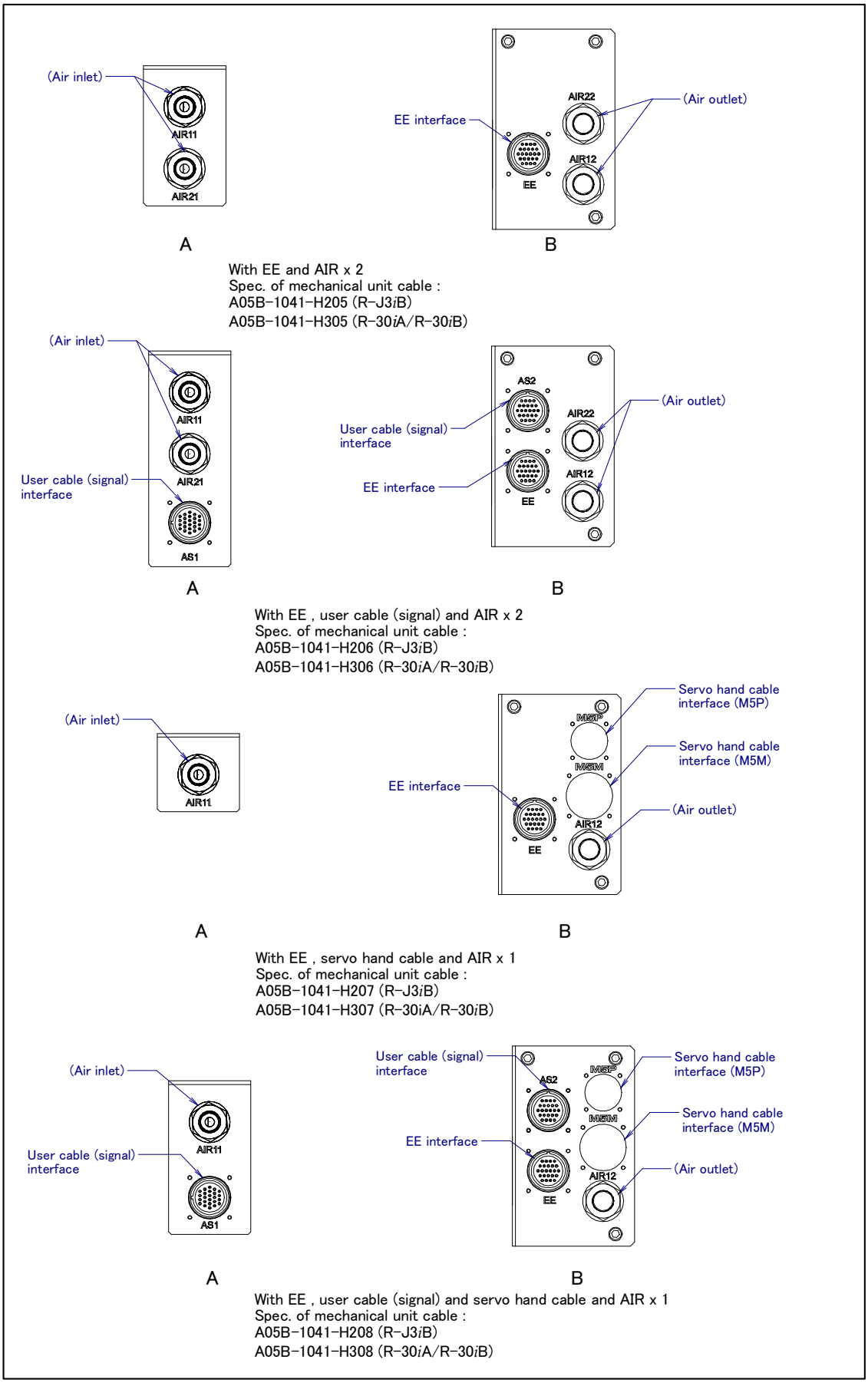


Fig. 8.6 (e) Interface for the option cable (Integrated type controller) (1/2)

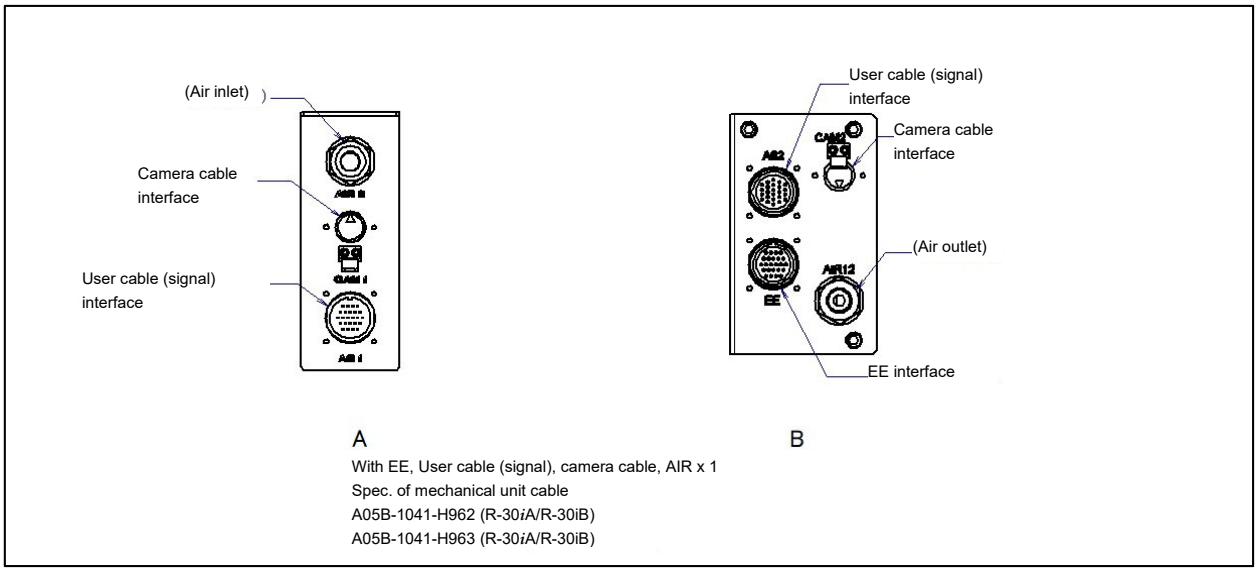


Fig. 8.6 (f) Interface for the option cable (Integrated type controller) (2/2)

(1) EE interface (RDI/RDO or RI/RO)
Fig. 8.6 (g) and (h) shows pin layout for EE interface (RDI/RDO or RI/RO).

> ⚠ **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 maintenance manuals for the controller, too.

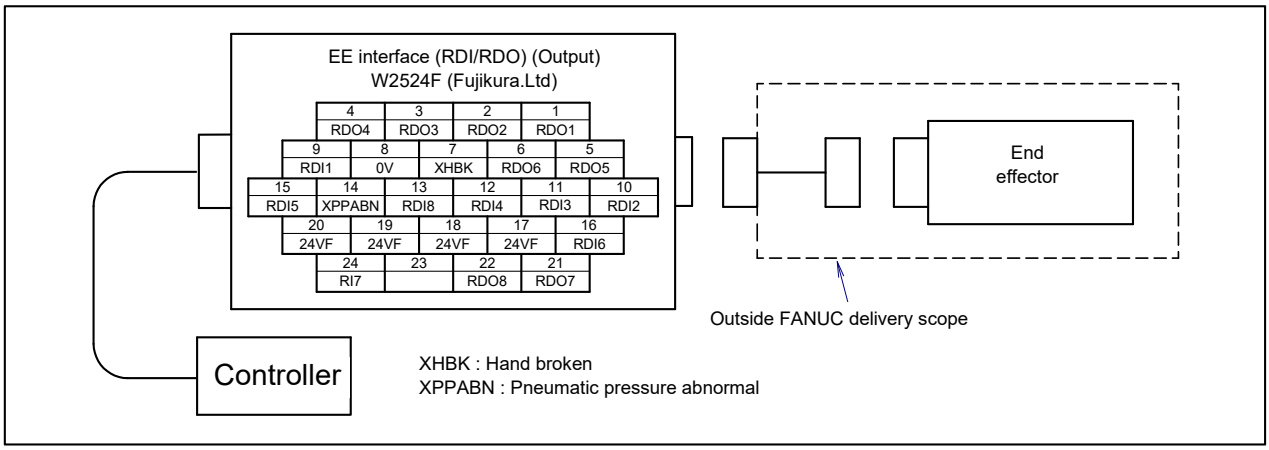


Fig. 8.6 (g) Pin layout for the EE interface (RDI/RDO) (R-J3*i*B controller)

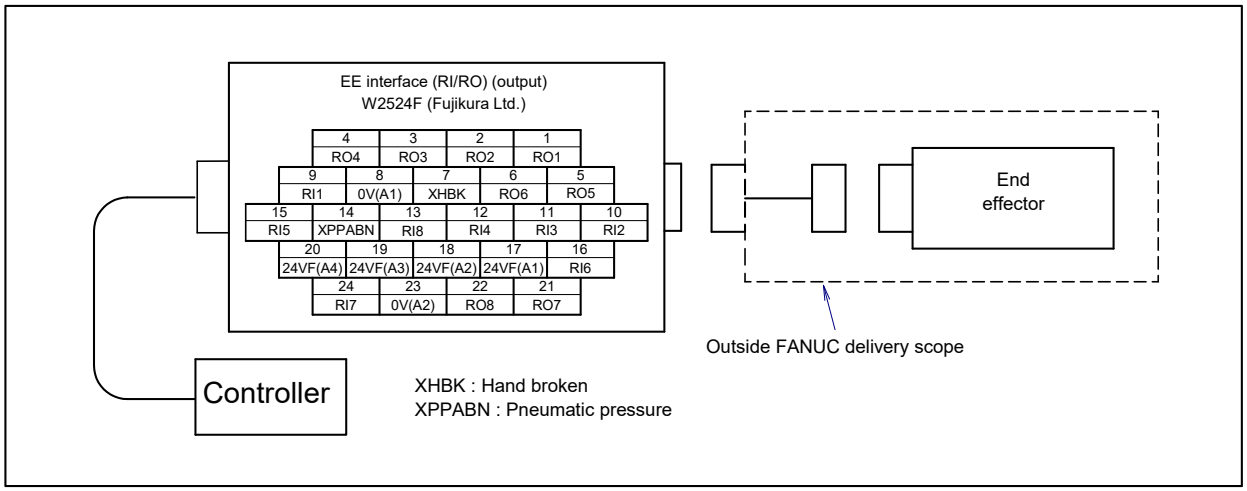


Fig. 8.6 (h) Pin layout for the EE interface (RI/RO) (R-30*i*A/R-30*i*B controller)

(2) User cable (signal line) interface (Option)
Fig. 8.6 (i) shows pin layout for user cable (signal line) interface.

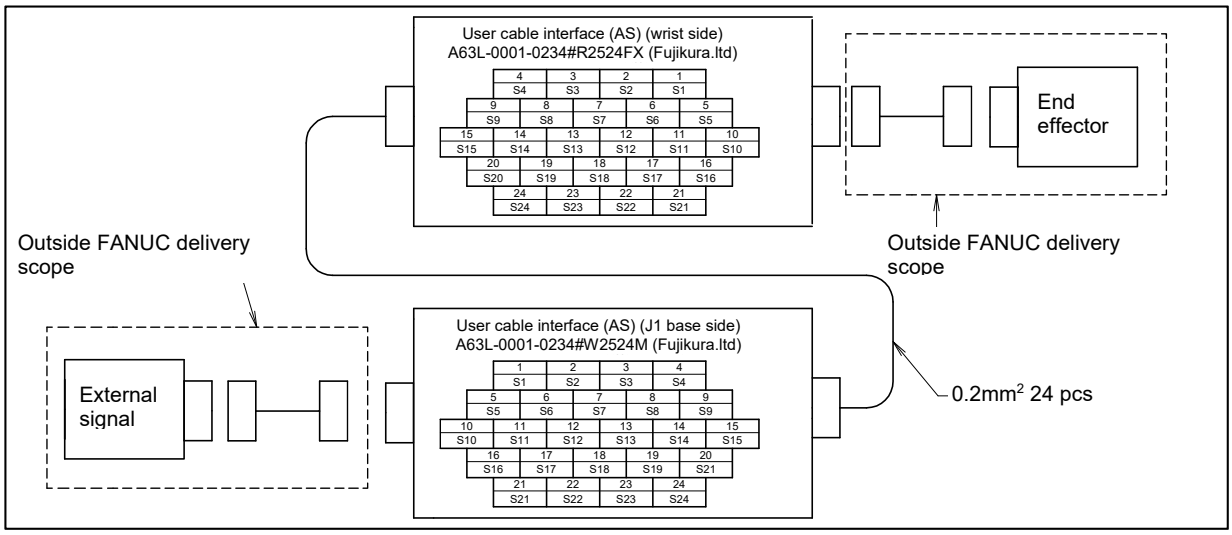


Fig. 8.6 (i) Pin layout for the user cable (signal line) (AS) interface (option)

(3) Servo hand cable interface (option)
Fig. 8.6 (j) show the position for the servo hand cable interface (option) connector.

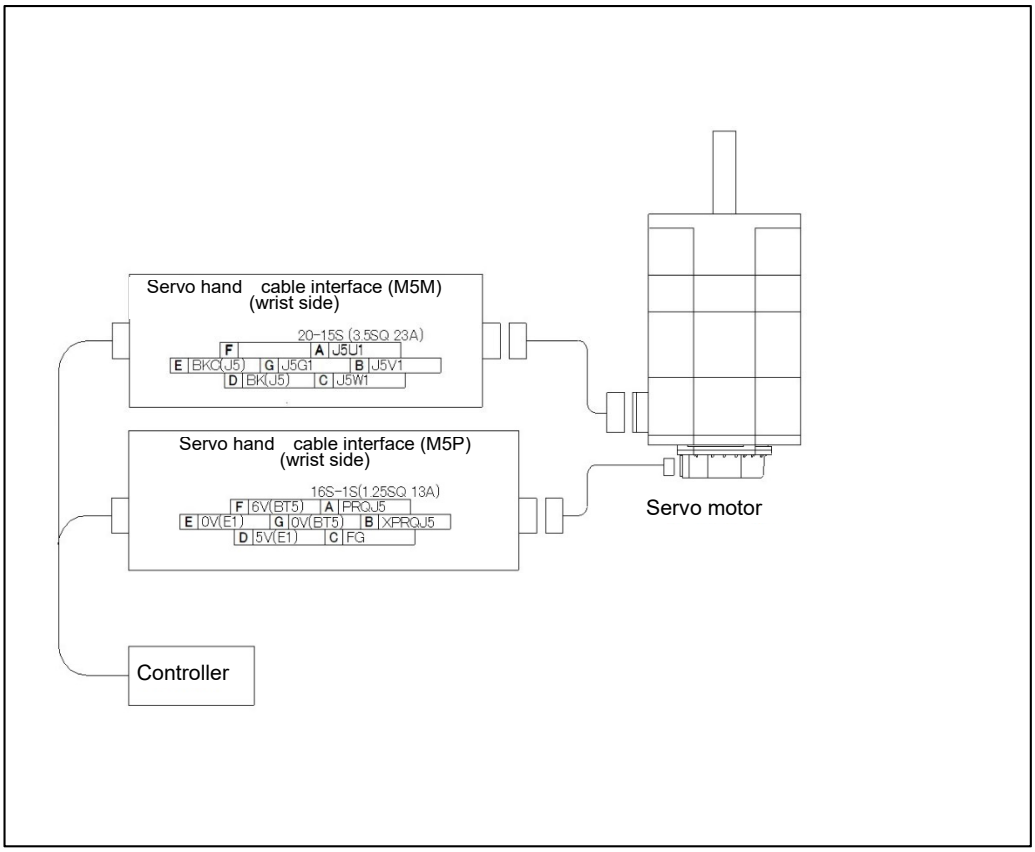


Fig. 8.6 (j) Pin layout for additional axis motor cable (M5M, M5P) interface (option)

Table 8.6 (a) Comparative table of signal name according to the motor

ARP	α motor,β motor	αi, αi –B motor, βi, βi-B motor
SPD	SD	-
XSPD	*SD	-
PRQ	REQ	RD
XPRQ	*REQ	*RD

NOTE
A connector prepared by the customer for the servo cable interface (option) must be a straight type; (an elbow type cannot pass through the hole in the J4 axis.)

Connector specifications

Table 8.6 (b) Connector specifications (Mechanical unit side)

Cable	Input side (J1 base)	Output side (wrist side)	Maker /dealer
EE(RI/RO)	———	FANUC spec.: A63L-0001-0234#R2524F	Fujikura Ltd.
AS	FANUC spec: A63L-0001-0234#W2524M	FANUC spec.: A63L-0001-0234#R2524FX	
M5P	———	MS3102A 16S-1S	Fujikura.Ltd Japan Aviation Electronics Industry, Ltd.
M5M	———	MS3106B 20S-15S	

Table 8.6 (c) Connector specifications (User side)

Cable	Input side (J1 base)	Output side (wrist side)	Maker /dealer
EE(RI/RO)	———	JMSP2524M (*1) Straight JMLP2524M Angle	Fujikura Ltd.
AS	JMSP2524F (*2) Straight plug	JMSP2524MX (*3) Straight plug	

NOTE
1 Below shows spec. to order in our company.
(*1) A63L-0001-0234#S2524M (Appendix)
(*2) A63L-0001-0234#S2524F
(*3) A63L-0001-0234#S2524MX
2 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.

9 TRANSPORTATION AND INSTALLATION

9.1 TRANSPORTATION

Use a crane or a forklift to transport the robot. Fig. 9.1 (a), (b) show transportation posture.

⚠ WARNING

When peripherals are installed on a robot, the center of gravity of the robot changes and the robot might become unstable while being transported.

Robot becomes unstable when it is transported with the end effector applied to wrist, and it is dangerous.
Please be sure to remove end effector when robot is transported.

Use the forklift pockets only to transport the robot with a forklift. Do not use the forklift pockets to secure the robot.

Before moving the robot by using forklift pockets, check and tighten any loose bolts on the forklift pockets.

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

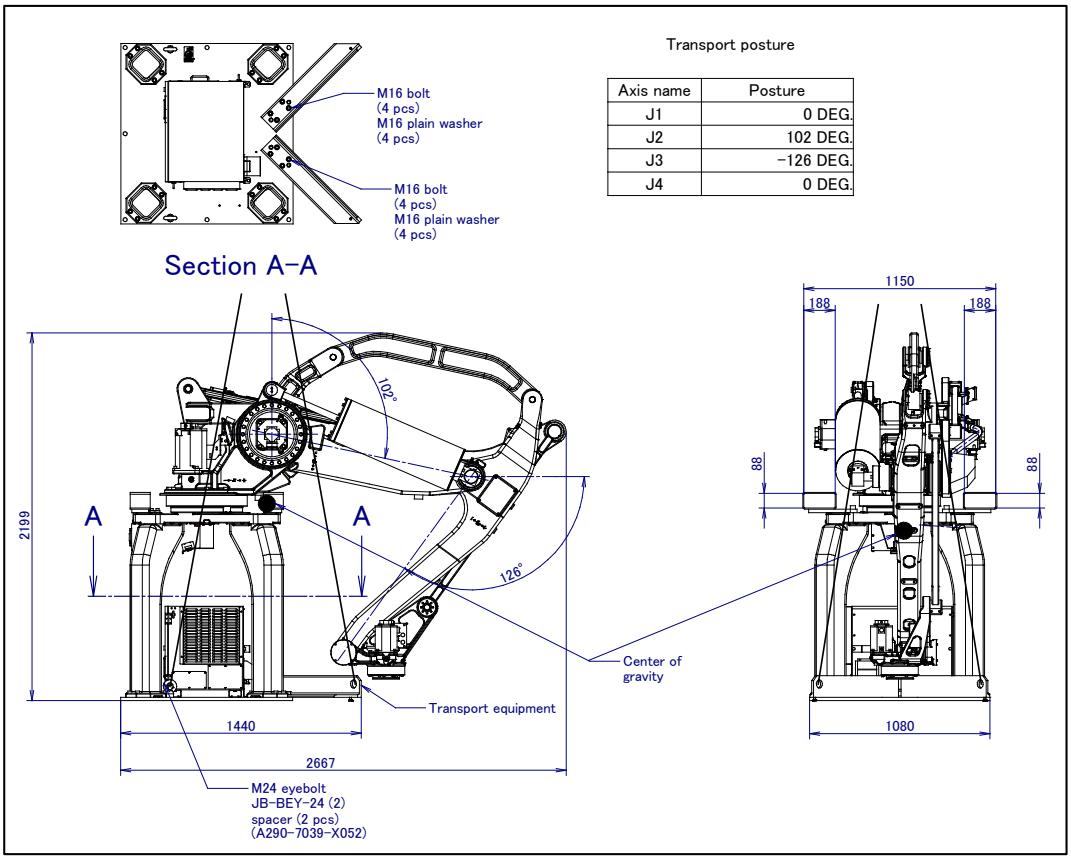


Fig. 9.1 (a) Transportation using a crane

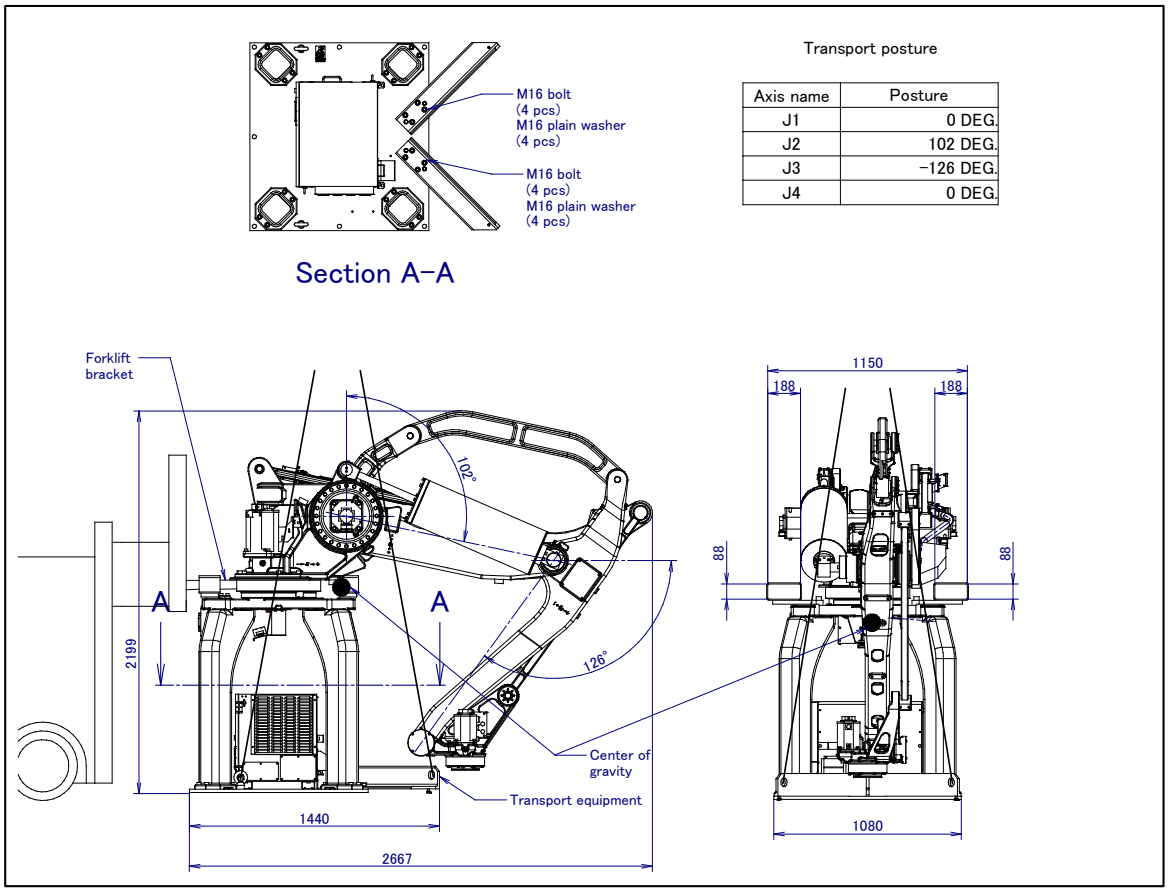


Fig. 9.1 (b) Transportation using a forklift

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

NOTE
Mechanical unit weight : 2.0 tons (including the controller)
Crane permissible load : 3.0 tons or more
Sling permissible load : 1.0 ton or more/1 sling
Number of slings used : Four
Eyebolt permissible load : 950 kg or more/1 eyebolt
Number of eyebolts used : Two
Forklift permissible load : 3.0 ton or more

9.2 INSTALLATION

(1) Installing the robot using the standard pedestal

Described below is how to install the robot using the standard pedestal, which is factory-assembled with the robot.

Fig. 9.2 (a) shows the robot base dimensions. Fig. 9.2 (b) shows an actual example of robot installation. Secure the floor plate (iron plate) to the floor using 16 M20 chemical anchors (Tensile strength 400N/mm^2 or more). Then, secure the robot to the floor plate with eight M20 x 40 bolts (Tensile strength 1200N/mm^2 or more), which are at least 40 mm in length.

- Those bolts for which no tightening torque is specified must be tightened according to the APPENDIX D BOLT TIGHTENING TORQUE TABLE.

⚠ CAUTION

1 If the robot base is secured directly to the floor with chemical anchors, the anchors may fail due to fluctuating load during robot operation.

2 Do not provide leveling (with a wedge, for example) between the robot base and floor plate. Otherwise, any robot vibration may be accentuated due to the robot not being in close contact with the floor plate.

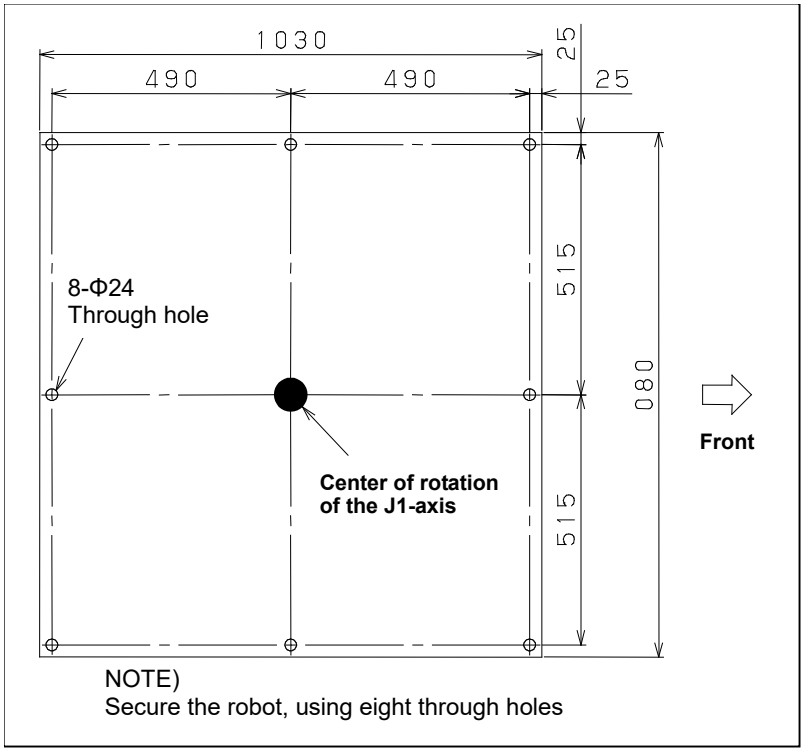


Fig. 9.2 (a) Installation hole dimensions of the robot base

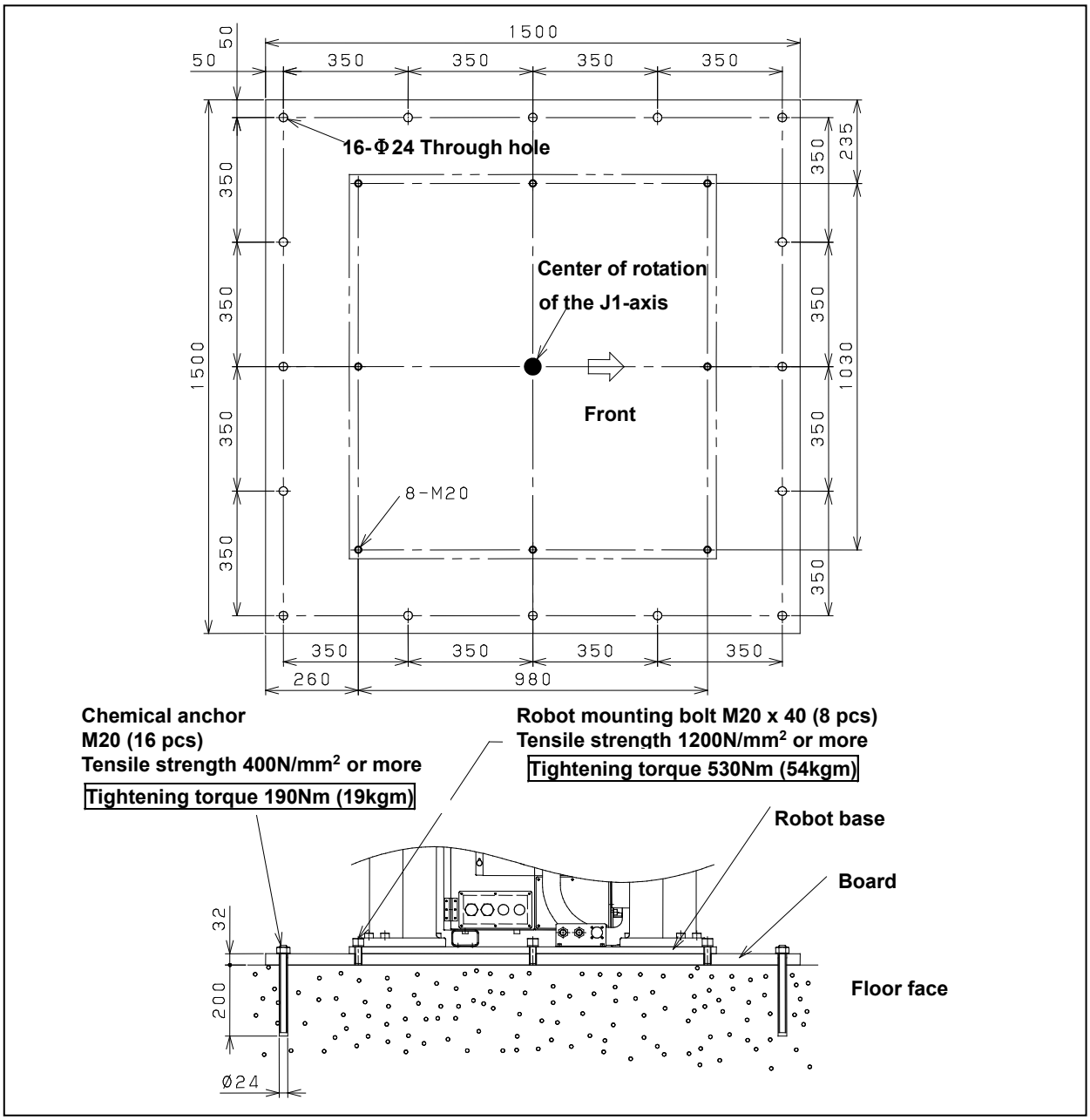


Fig. 9.2 (b) Sample installation

NOTE

1 The customer should prepare the following parts:
   - Eight robot securing bolts : M20 x 40 (Tensile strength 1200N/mm^2 or more)
   - Sixteen chemical anchors : M20 (Tensile strength 400N/mm^2 or more)
   - One floor plate : 32t in thickness
2 The customer is responsible for preparation prior to installation (mounting of anchors, for example)
3 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.

Table 9.2 (a), (b) and Fig. 9.2 (c) indicate the force and moment applied to the base. Table 9.2 (c), (d) indicates the coasting time and distance of the J1 through J3 axes 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 9.2 (c) and (d) 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 9.2 (c) 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 9.2 (a) Force and moment acting to base <M-410*i*B/160>

	At stop	At acceleration/deceleration	At Power-off stop
Vertical moment : M_V	14300 Nm (1460 kgfm)	44800 Nm (4570 kgfm)	53600 Nm (5470 kgfm)
Force in vertical direction : F_V	20600 N (2100 kgf)	31600 N (3230 kgf)	38100 N (3890 kgf)
Horizontal moment : M_H	0 Nm (0 kgfm)	10400 Nm (1060 kgfm)	11600 Nm (1190 kgfm)
Force in horizontal direction : F_H	0 N (0 kgf)	13200 N (1340 kgf)	15700 N (1600 kgf)

Table 9.2 (b) Force and moment acting to base <M-410*i*B/300>

	At stop	At acceleration/deceleration	At Power-off stop
Vertical moment : M_V	19000 Nm (1930 kgfm)	56600 Nm (5780 kgfm)	67100 Nm (6850 kgfm)
Force in vertical direction : F_V	22000 N (2240 kgf)	34800 N (3550 kgf)	41700 N (4260 kgf)
Horizontal moment : M_H	0 Nm (0 kgfm)	14100 Nm (1440 kgfm)	14400 Nm (1470 kgfm)
Force in horizontal direction : F_H	0 N (0 kgf)	9400 N (960 kgf)	10800 N (1100 kgf)

Table 9.2 (c) 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-410*i*B/160	Stopping time [ms]	730	200	168
	Stopping distance [deg] (rad)	47.5 (0.83)	5.0 (0.23)	11.3 (0.20)
M-410*i*B/300	Stopping time [ms]	610	185	135
	Stopping distance [deg] (rad)	25.9 (0.45)	8.3 (0.14)	6.9 (0.12)

Table 9.2 (d) Stopping time and distance until the robot stopping by Controlled stop after input of stop signal

Model		J1-axis	J2-axis	J3-axis
M-410*i*B/160	Stopping time [ms]	1036	1036	1044
	Stopping distance [deg] (rad)	71.4 (1.25)	70.3 (1.23)	74.2 (1.29)
M-410*i*B/300	Stopping time [ms]	788	788	788
	Stopping distance [deg] (rad)	35.7 (0.62)	37.9 (0.66)	42.2 (0.74)

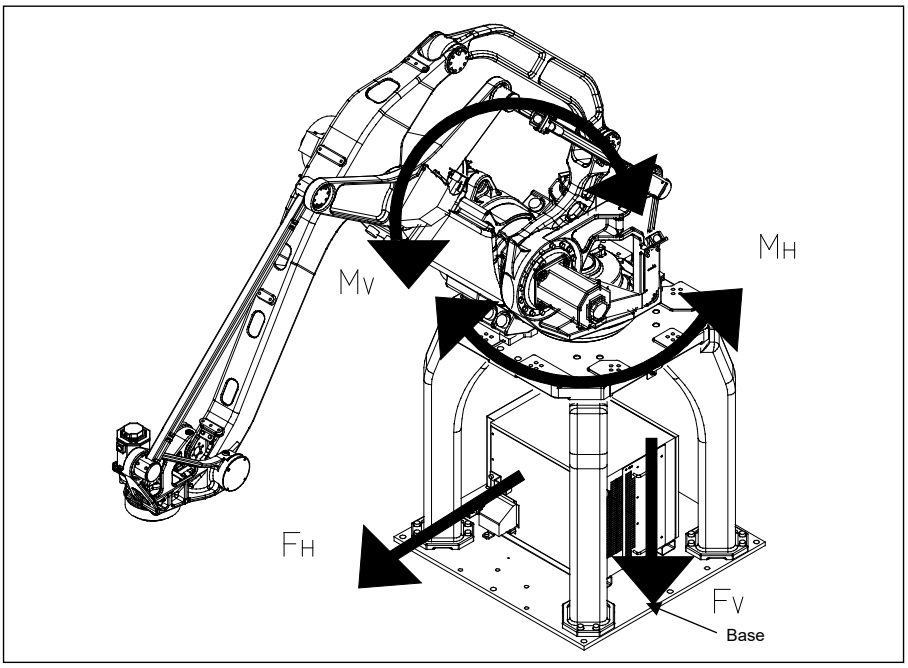


Fig. 9.2 (c) Force and moment acting to the base

(2) Installing the robot without using the standard pedestal

A robot with remote controller can be installed on a customer-prepared pedestal, without using the standard pedestal, which is factory-assembled with the robot.

Fig. 9.2 (d) shows how to remove the standard pedestal from the robot. First put the robot in the posture of J1-axis = 0°, J2-axis = -44°, J3-axis = -25°, and J4-axis = 0°, then prepare to sling up the robot portion above the J1 base with rope. Remove the J1-axis mounting bolts (sixteen M16 x 65 bolts), and separate the J1 base from the pedestal.

Fig. 9.2 (e) shows the installation interface for the robot. Design a pedestal while taking care of the following points:

- Provide space required when replacing the J1-axis motor.
- Provide space required when mounting and dismounting the mastering jig.
- Provide space for periodic maintenance (such as battery exchange and degreasing)
- Avoid interference of the robot with the cables and connector box.
- Make sure that the setup is strong enough to withstand the force and moment listed in Table 9.2 (a) and (b).

To fasten the J1 base to the pedestal, use sixteen bolts having a size of M16 (Tensile strength 1200N/mm^2 or more) and a length of at least 65 mm.

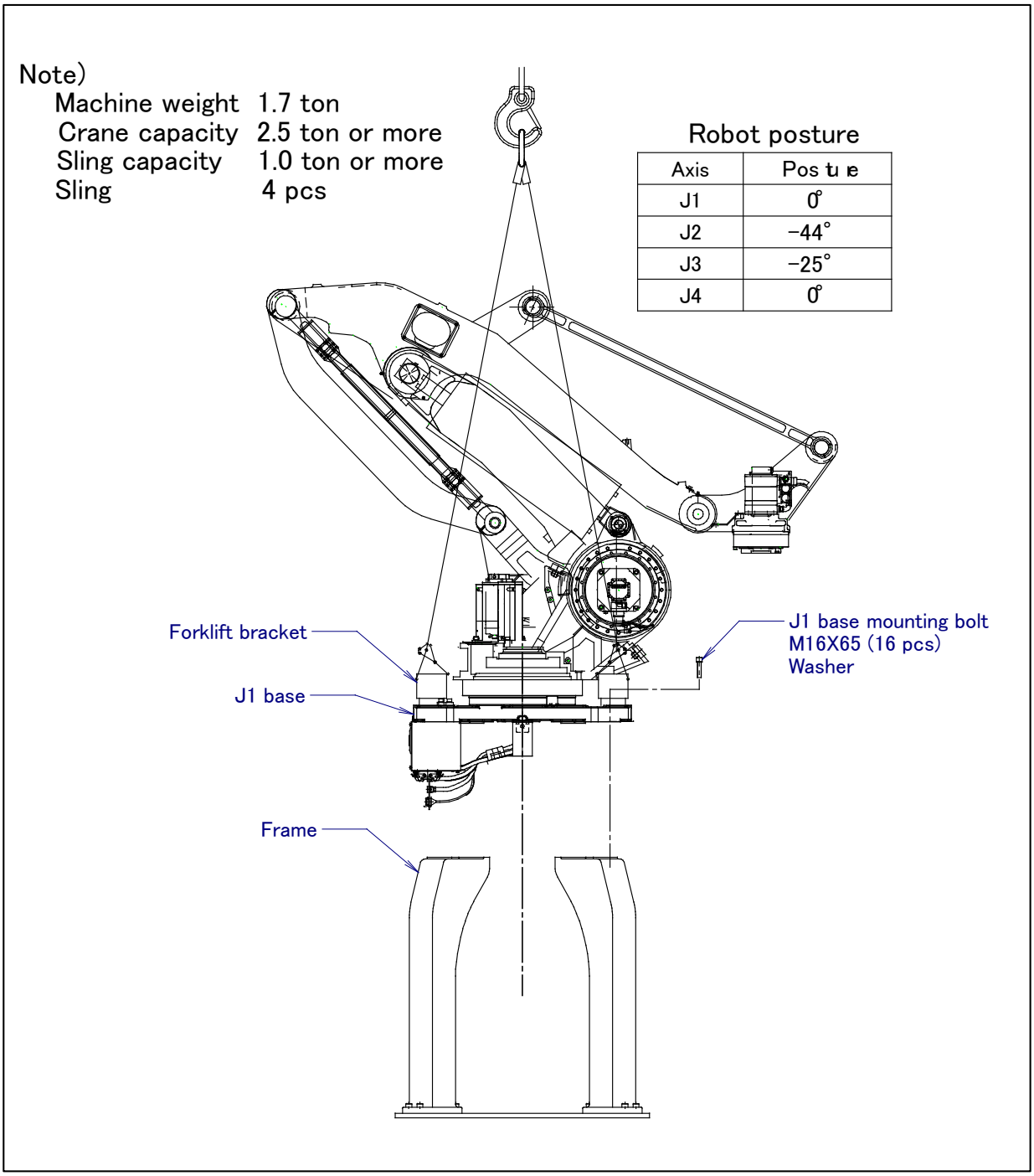


Fig. 9.2 (d) How to remove the pedestal (Remote controller type)

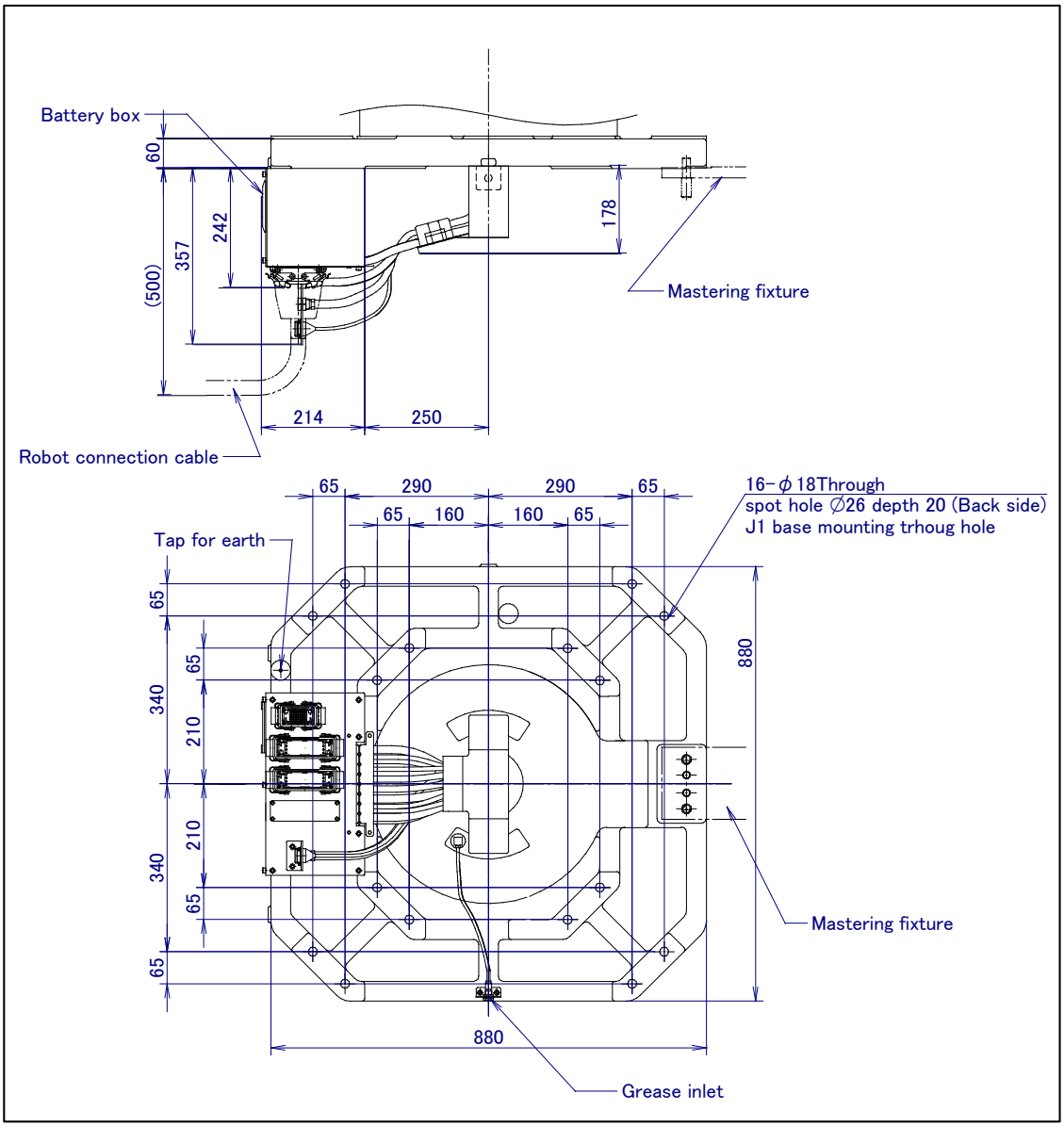


Fig. 9.2 (e) Installation interface for the robot without a standard pedestal (Remote controller type)

9.3 MAINTENANCE AREA

Fig. 9.3 (a) shows the maintenance area of the mechanical unit.

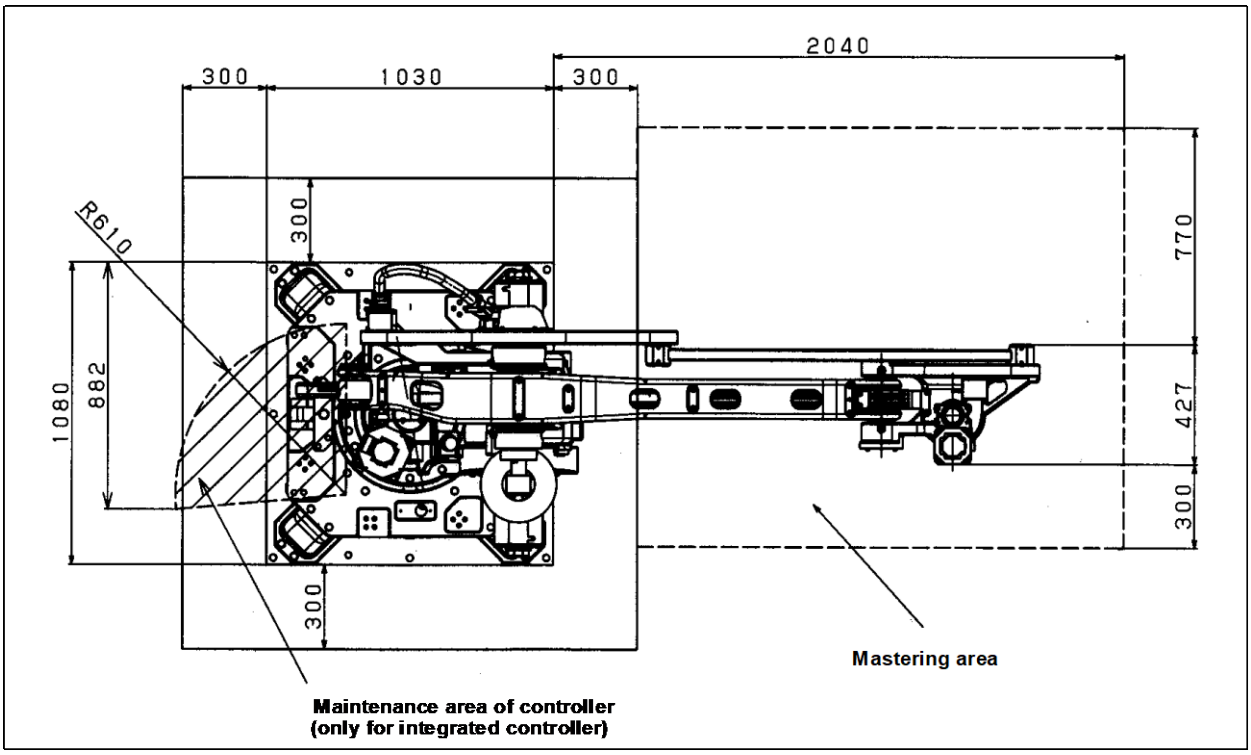


Fig. 9.3 (a) Maintenance area

9.4 INSTALLATION CONDITION

Refer to specification of “PREFACE” about installation specifications.

10 CONNECTION WITH THE CONTROLLER

In case of integrated controller type, cable of controller is connected to motor of robot directly.

In case of remote controller type, the robot is connected with the controller via the power cable, signal cable, and the earth cable. Connect these cables to the connectors on the back of the base.
For details on air and option cables, see Chapter 8.

> ⚠ **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 Do not use 10m or longer coiled cable without first untying it. The long coiled cable could heat up and become damaged.

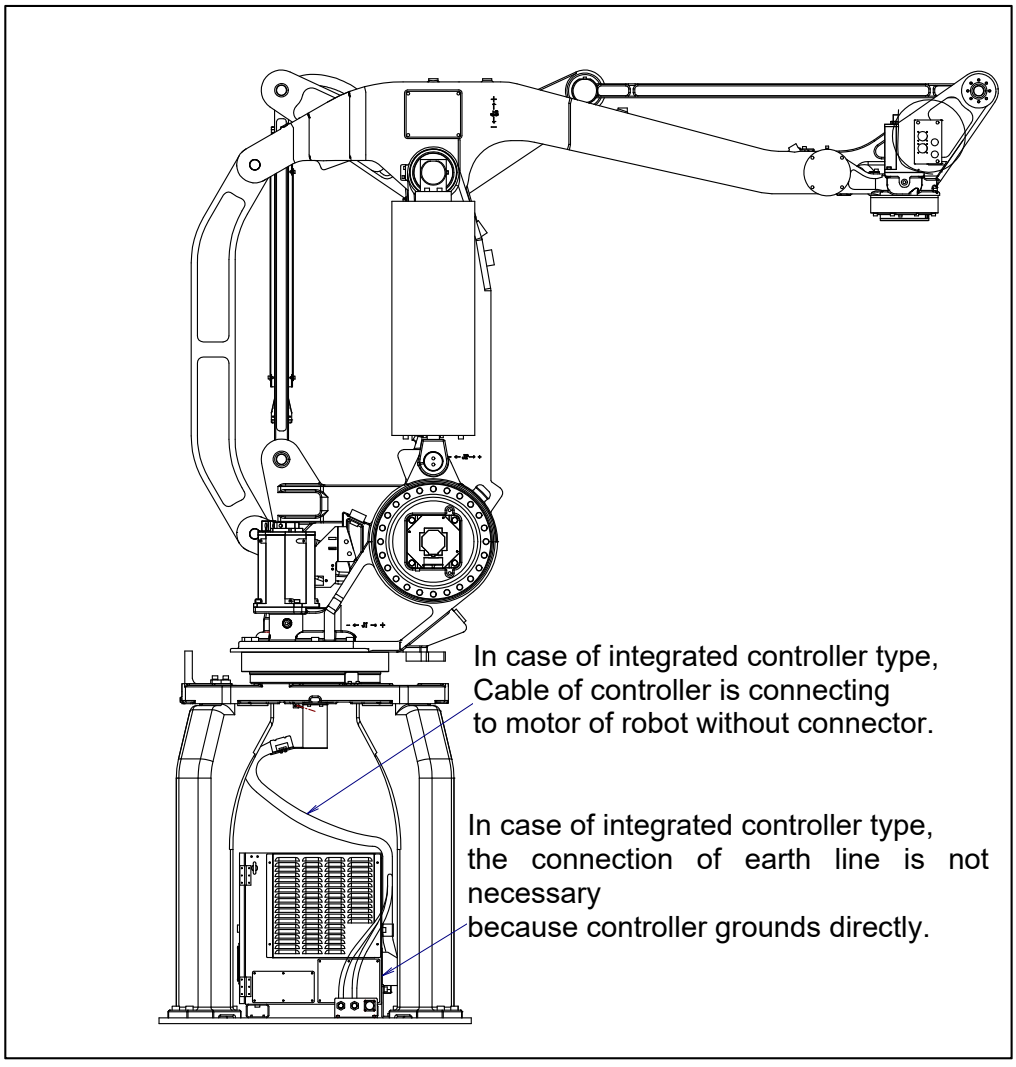


Fig. 10 (a) Cable connection (integrated type controller)

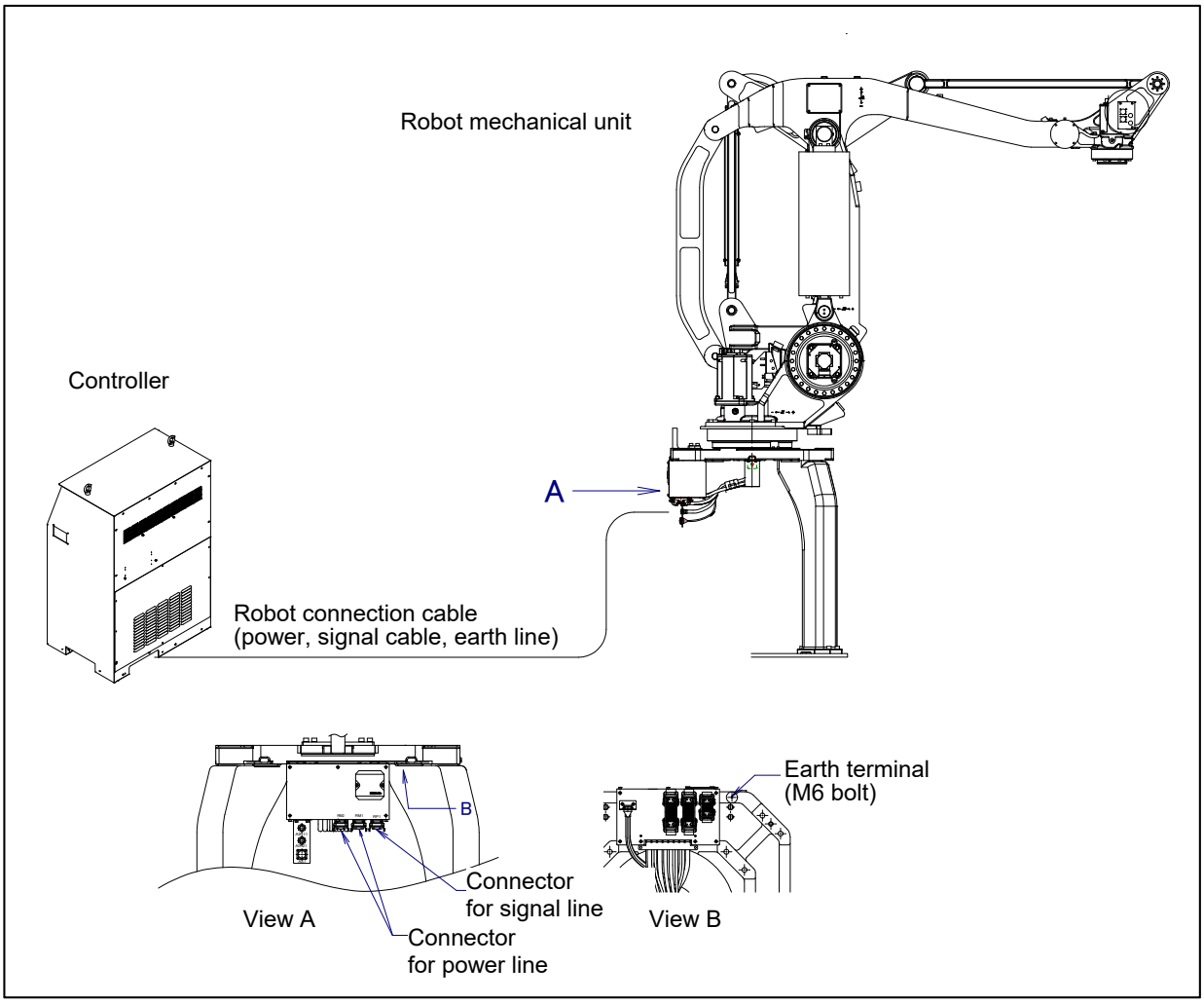


Fig. 10 (b) Cable connection (remote type controller)

APPENDIX

A PERIODIC MAINTENANCE

FANUC Robot M-410*i*B/160/300 **Periodic Maintenance Table**

Items			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
Mechanical unit	1	Check for external damage or peeling paint	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	2	Check damages of the cable protective sleeves	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	3	Check wear debris of J1-axis swing stopper	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	4	Check for water	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	5	Check the mechanical cable. (damaged or twisted)	0.2H	—		○			○				○			
	6	Check the end effector (hand) cable	0.1H	—		○			○				○			
	7	Check the motor connectors and exposed connectors. (loosening)	0.2H	—		○			○				○			
	8	Tighten the end effector bolt.	0.2H	—		○			○				○			
	9	Tighten the cover and main bolt.	2.0H	—		○			○				○			
	10	Check the mechanical stopper and adjustable mechanical stopper	0.1H	—		○			○				○			
	11	Clean spatters, sawdust and dust	1.0H	—		○			○				○			
	12	Check the operation of the cooling fan	0.1H	—		○			○				○			
	13	Replacing battery *4	0.1H	—							●					
	14	Replacing grease of J1 axis reducer *1	1.0H	8030ml												
	15	Replacing grease of J2 axis reducer *1	0.5H	1570ml												
	16	Replacing grease of J3 axis reducer *1	0.5H	1180ml												
	17	Replacing grease of J4 axis gearbox *1	0.5H	1400ml												
	18	Apply greasing to bearing of J3 arm connection*1 (2 location)	0.1H	each 20ml												
	19	Apply greasing to the J3 base bearing *1	0.1H	20ml												
	20	Apply greasing to connection parts of wrist *1 (2 locations)	0.1H	each 10ml												
	21	Replacing mechanical unit cable	4.0H	—												
Controller	22	Cleaning the controller ventilation system	0.2H	—	○	○	○	○	○	○	○	○	○	○	○	○
	23	Check the robot cable, teach pendant cable and robot connecting cable	0.2H	—		○			○				○			
	24	Replacing battery *2 *4	0.1H	—												

*1 Refer to this manual about greasing points.

*2 Refer to "REPLACING UNITS Chapter of MAINTENANCE" of the following manuals.
R-J3*i*B CONTROLLER MAINTENANCE MANUAL (B-81465EN),
R-J3*i*B CONTROLLER MAINTENANCE MANUAL (For Europe) (B-81465EN-1),
R-J3*i*B CONTROLLER MAINTENANCE MANUAL (For RIA) (B-81505EN-),
R-30*i*A CONTROLLER MAINTENANCE MANUAL (Standard) (B-82595EN),
R-30*i*A CONTROLLER MAINTENANCE MANUAL (For Europe) (B-82595EN-1),
R-30*i*A CONTROLLER MAINTENANCE MANUAL (For RIA) (B-82595EN-2),
R-30*i*B/R-30*i*B Plus CONTROLLER MAINTENANCE MANUAL (B-83195EN)

*3 ●: requires order of parts, ○: does not require order of parts

*4 Regardless of the operating time, replace the mechanical unit batteries at 1.5 year, replace controller batteries at 4 years.

3 years 11520	12480	13440	14400	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
○				○				○				○				○					23
				●																	24

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. After you screw the bolts into the threaded holes, remove any excess LOCTITE.

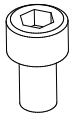
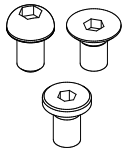
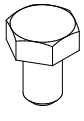
Use the following strength bolts. Comply with any bolt specification instructions.
Hexagon socket head bolt made of steel:

Size M22 or less: Tensile strength 1200N/mm^2 or more
Size M24 or more: Tensile strength 1000N/mm^2 or more
All size plated 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

REVISION RECORD

Edition	Date	Contents
01	Jun. 2021	

B-81994EN/01