FANUC Robot ARC Mate 120*i*C
FANUC Robot M-20*i*A

MECHANICAL UNIT
OPERATOR'S MANUAL

B-82874EN/14

- **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 the “FANUC Robot series SAFETY HANDBOOK (**B-80687EN)**”.

1 PERSONNELR

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. Work 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-2525-J047	(5m)	
	A05B-2525-J048	(10m)	
Power cable	A05B-2525-J010	(5m)	(AC100-115V Power plug) (*)
	A05B-2525-J011	(10m)	(AC100-115V Power plug) (*)
	A05B-2450-J364	(5m)	(AC100-115V or AC200-240V No power plug)
	A05B-2450-J365	(10m)	(AC100-115V or AC200-240V No power plug)

(*) These do not support CE marking.

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

> ⚠ **CAUTION**
> Robot systems installed without adequate number of brake release units or similar means are neither in compliance with EN ISO 10218-1 nor with the Machinery Directive and therefore cannot bear the CE marking.

> ⚠ **WARNING**
> Robot arm would fall down by releasing its brake because of gravity. Therefore, it is strongly recommended to take adequate measures such as hanging Robot arm by a crane before releasing a brake.

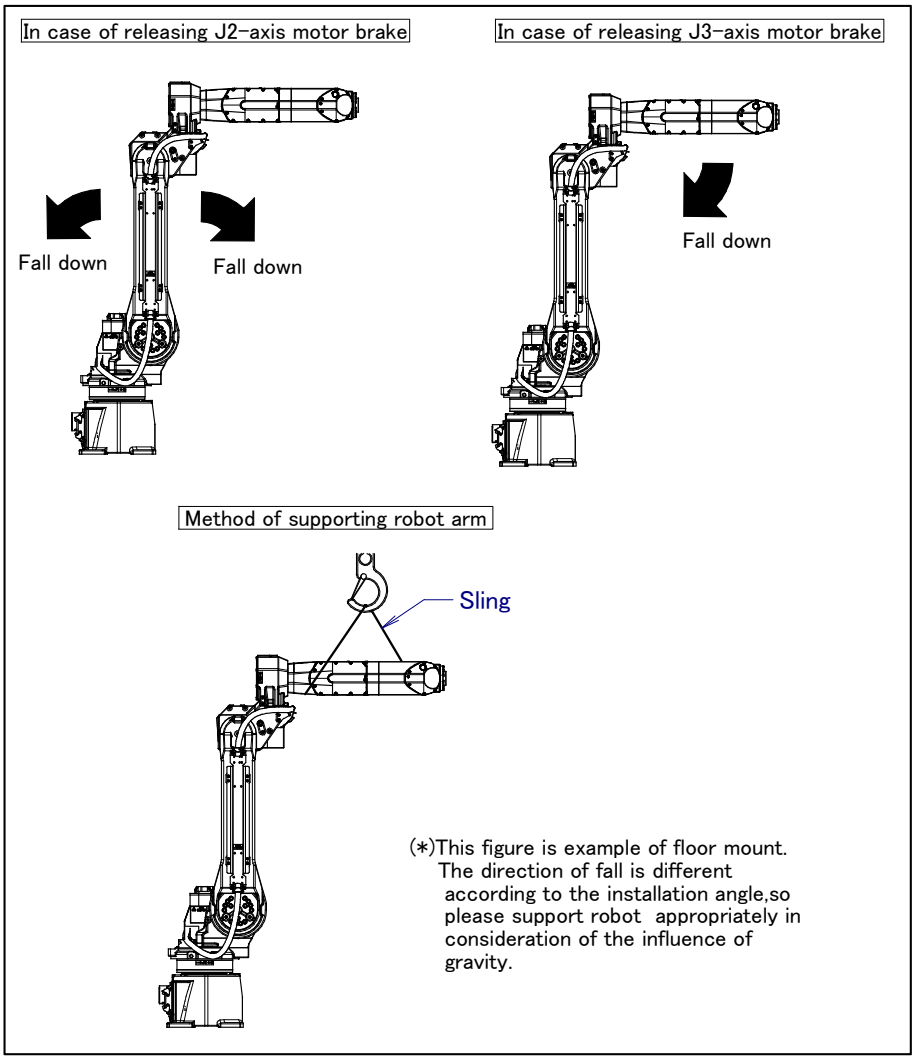


Fig. 3 (a) Arm operation by the release of J2/J3-axis motor brake and measures

4 WARNING & CAUTION LABEL

(1) Greasing and degreasing label

Fig. 4 (a) Greasing and degreasing label

Description

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

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

> ⚠ **CAUTION**
> See Subsection 7.3.2, 8.3.2 and 8.3.3 for explanations about specified grease, the grease amount, and the locations of grease and degrease outlets for individual models.

(2) Step-on prohibitive label

Fig. 4 (b) Step-on prohibitive label

Description

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

(3) High-temperature warning label

Fig. 4 (c) High-temperature warning label

Description

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

(4) Transportation label

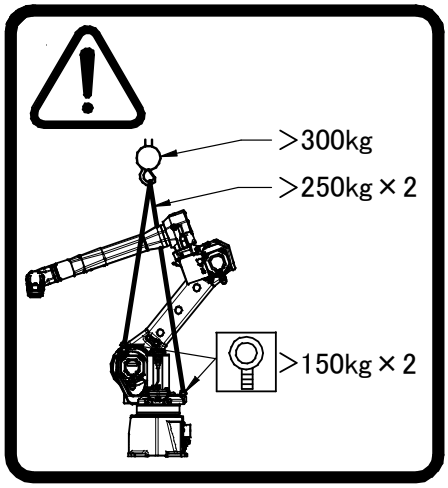


Fig. 4 (d) Transportation label

Description

When transporting the robot, observe the instructions indicated on this label. The above label indicates the following:

Using a crane

- Use a crane with a load capacity of 2940 N (300kgf) or greater.
- Use two slings with each load capacity of 2450 N (250 kgf) or greater, sling the robot as shown Chapter 1 of operator's manual.
- Use two M10 eyebolts with each load capacity of 1470 N (150 kgf) or greater.

> ⚠ **CAUTION**
> See Section 1.1 TRANSPORTATION of operator's manual for explanations about the posture a specific model should take when it is transported.

(5) Transportation prohibitive label (When transport equipment option A05B-1222-H072 is specified.)

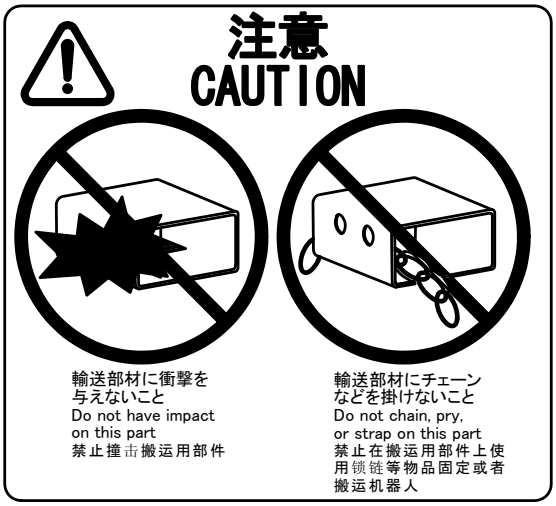


Fig. 4 (e) Transportation prohibitive label

Description

Keep the following in mind when transporting the robot.

(1) Do not have impact on this part.
(2) Do not chain, pry, or strap on this part.

(6) High current attention label

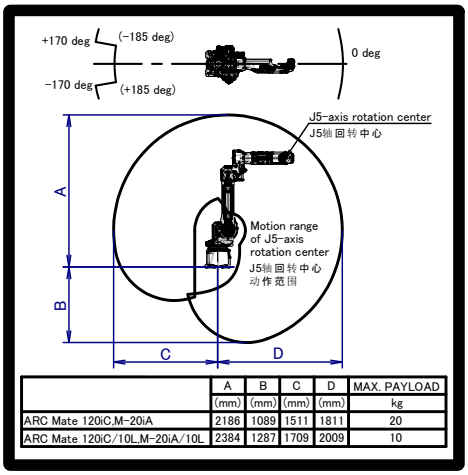
Fig. 4 (f) High current attention Label

Description

Do not access during welding due to the energized high current inside.

(7) Operating space and payload label

Below label is added when CE specification is specified.



	A	B	C	D	MAX. PAYLOAD
	(mm)	(mm)	(mm)	(mm)	kg
ARC Mate 120iC,M-20iA	2186	1089	1511	1811	20
ARC Mate 120iC/10L,M-20iA/10L	2384	1287	1709	2009	10

Fig. 4 (g) Operating space and payload label
(Example of ARC Mate 120*i*C, M-20*i*A, ARC Mate 120*i*C/10L, M-20*i*A/10L)

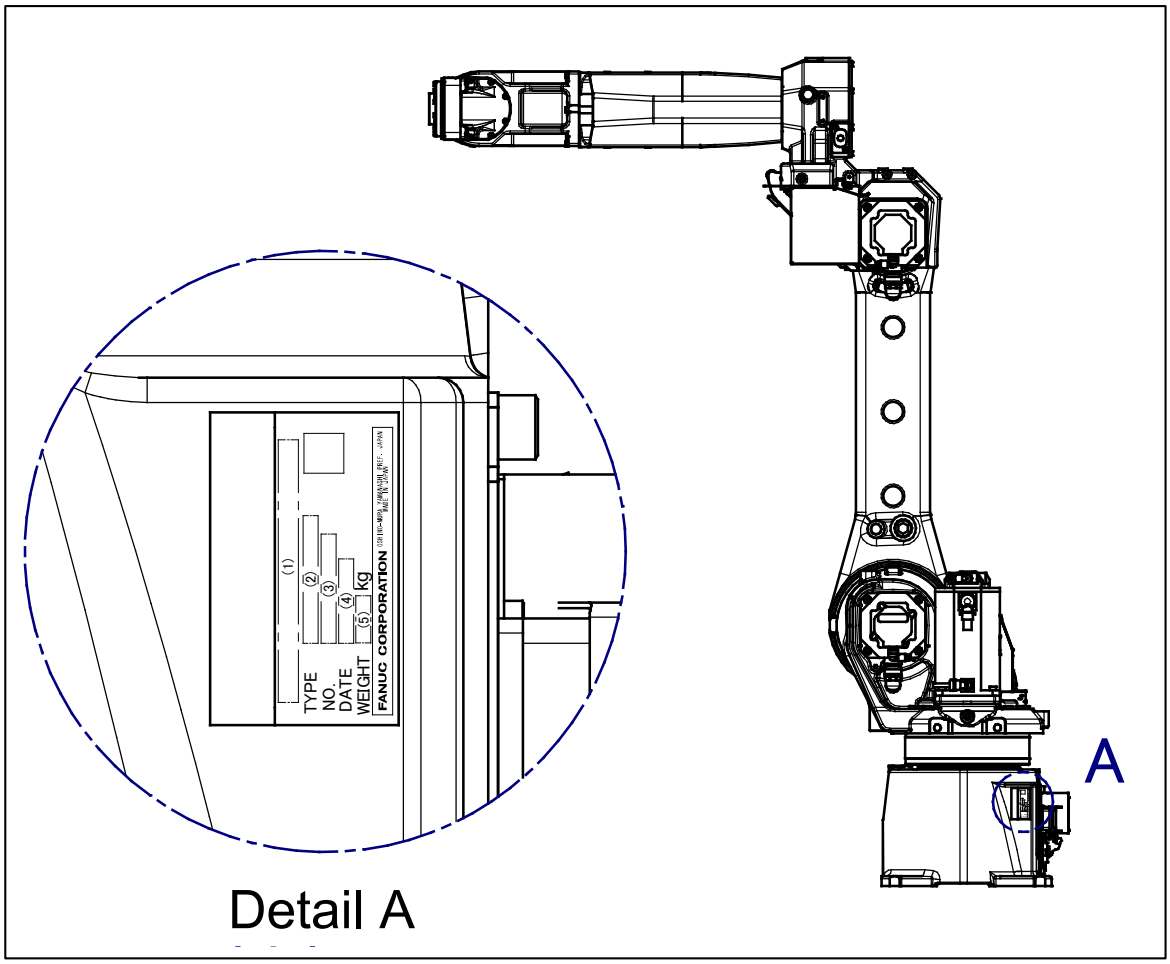
PREFACE

This manual explains maintenance procedures for the following mechanical units:

Model name	Mechanical unit specification No.	Maximum load
FANUC Robot ARC Mate 120*i*C	A05B-1222-B201 (*1) (*3)	3kg or 20kg
	A05B-1225-B201 (*2) (*3)	
	A05B-1225-B251 (*2) (*4)	
FANUC Robot M-20*i*A	A05B-1222-B202 (*1) (*3)	3kg or 20kg
	A05B-1225-B202 (*2) (*3)	
	A05B-1225-B252 (*2) (*4)	
FANUC Robot ARC Mate 120*i*C/10L	A05B-1222-B301	3kg or 10kg
FANUC Robot M-20*i*A/10L	A05B-1222-B302	3kg or 10kg
FANUC Robot M-20*i*A/20M	A05B-1222-B702 (*1)	20kg
	A05B-1225-B702 (*2)	
FANUC Robot ARC Mate 120*i*C/12L	A05B-1225-B301 (*3)	3kg or 12kg
	A05B-1225-B351 (*4)	
FANUC Robot M-20*i*A/12L	A05B-1225-B302 (*3)	3kg or 12kg
	A05B-1225-B352 (*4)	
FANUC Robot M-20*i*A/35M	A05B-1225-B705	35kg

NOTE
Motor specifications of (*1) differs from (*2).
Wrist unit specifications of (*3) differs from (*4).

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)

CONTENTS	(1)	(2)	(3)	(4)	(5)
	Model name	**TYPE**	**No.**	**DATE**	**WEIGHT kg (Without controller)**
LETTERS	FANUC Robot ARC Mate 120*i*C	A05B-1222-B201	SERIAL NO. IS PRINTED	PRODUCTION YEAR AND MONTH ARE PRINTED	250
		A05B-1225-B201			
		A05B-1225-B251			
	FANUC Robot M-20*i*A	A05B-1222-B202			250
		A05B-1225-B202			
		A05B-1225-B252			
	FANUC Robot ARC Mate 120*i*C/10L	A05B-1222-B301			250
	FANUC Robot M-20*i*A/10L	A05B-1222-B302			250
	FANUC Robot M-20*i*A/20M	A05B-1222-B702			250
		A05B-1225-B702			
	FANUC Robot ARC Mate 120*i*C/12L	A05B-1225-B301			250
		A05B-1225-B351			
	FANUC Robot M-20*i*A/12L	A05B-1225-B302			250
		A05B-1225-B352			
	FANUC Robot M-20*i*A/35M	A05B-1225-B705			252

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-30*i*A controller	OPERATOR'S MANUAL HANDLING TOOL **B-83124EN-2** ARC TOOL **B-83124EN-3** DISPENCE TOOL **B-83124EN-4** ALARM CODE LIST **B-83124EN-6**	Intended readers : Operator, Programmer, Maintenance technician, System designer Topics : Robot functions, Operations, Programming, Start-up, Interfaces, Alarms Use : Robot operation, Teaching, System design
	MAINTENANCE MANUAL **B-82595EN** **B-82595EN-1** (For Europe) **B-82595EN-2** (For RIA)	Intended readers : Maintenance technician, System designer Topics : Installation, Start-up, Connection, Maintenance Use : Installation, Start-up, Connection, Maintenance
R-30*i*A Mate controller	OPERATOR'S MANUAL LR HANDLING TOOL **B-83134EN-1** LR ARC TOOL **B-83134EN-2** ALARM CODE LIST **B-83124EN-6**	Intended readers : Operator, Programmer, Maintenance technician, System designer Topics : Robot functions, Operations, Programming, Start-up, Interfaces, Alarms Use : Robot operation, Teaching, System design
	MAINTENANCE MANUAL **B-82725EN** **B-82725EN-1** (For Europe) **B-82725EN-2** (For RIA)	Intended readers : Maintenance technician, System designer Topics : Installation, Start-up, Connection, Maintenance Use : Installation, Start-up, Connection, Maintenance

R-30*i*B **R-30*i*B Mate** **R-30*i*B Plus,** **R-30*i*B Mate Plus** **controller**	OPERATOR'S MANUAL (Basic Operation) **B-83284EN** OPERATOR'S MANUAL (Alarm Code List) **B-83284EN-1** OPERATOR'S MANUAL (Optional Function) **B-83284EN-2** ARC Welding Function OPERATOR'S MANUAL **B-83284EN-3** Spot Welding Function OPERATOR'S MANUAL **B-83284EN-4** Dispense Function OPERATOR'S MANUAL **B-83284EN-5**	Intended readers : Operator, programmer, Teaching operator, Maintenance technician, System designer Topics : Robot functions, Operations, Programming, Setup, Interfaces, Alarms Use : Robot operation, Teaching, System design
	MAINTENANCE MANUAL **R-30*i*B, R-30*i*B Plus :** **B-83195EN** **R-30*i*B Mate, R-30*i*B Mate Plus:** **B-83525EN**	Intended readers : Maintenance technician, System designer Topics : Installation, Connection to the controller, Maintenance Use : Installation, Start-up, Connection, Maintenance

Following words is used in this manual.

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

TABLE OF CONTENTS

1 TRANSPORTATION AND INSTALLATION

1.1 TRANSPORTATION

Use a crane or a forklift to transport the robot. When transporting the robot, be sure to change the posture of the robot to that shown below and lift by using the eyebolts and the transport equipment at their points.

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

> ⚠ **WARNING**
> 1 The robot becomes unstable when it is transported with the end effector or equipment is installed. Make sure to remove the end effector when the robot is transported. (Except light cargo such as welding torch or wire feeder).
> 2 Use the transport equipment only for transportation. Do not use the forklift pockets to secure the robot.
> 3 Before moving the robot by using crane, check and tighten any loose bolts on the transport equipment.
> 4 Do not pull eyebolts sideways.

> ⚠ **CAUTION**
> Before moving the J2-axis section, be sure to remove the eyebolt from the J2 base so that the J2-axis stopper does not interfere with the eyebolt.

(2) Transportation using a crane (Fig. 1.1 (a) to (c))
Fasten the M10 eyebolts to the two points of the robot base and lift the robot by the two slings. In this case, please intersect and hang two Slings as shown in figure.

> ⚠ **CAUTION**
> When lifting the robot, be careful not to damage motors, connectors, or cables of the robot by slings.

(3) Transporting the robot with a forklift (Fig. 1.1 (d) to (f))
When transporting a robot with a forklift, use special transport equipment. Transport equipment is prepared as the option.

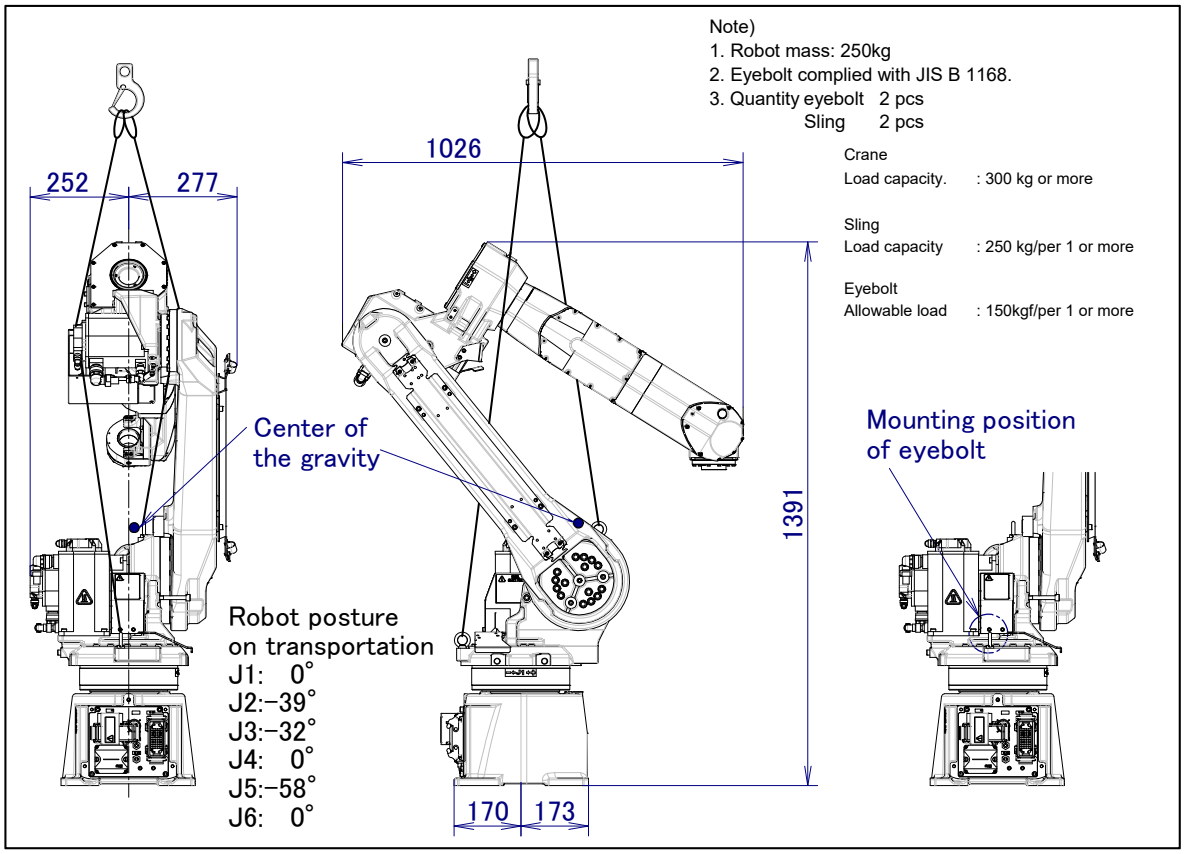


Fig. 1.1 (a) Transportation using a crane (ARC Mate 120*i*C, M-20*i*A)

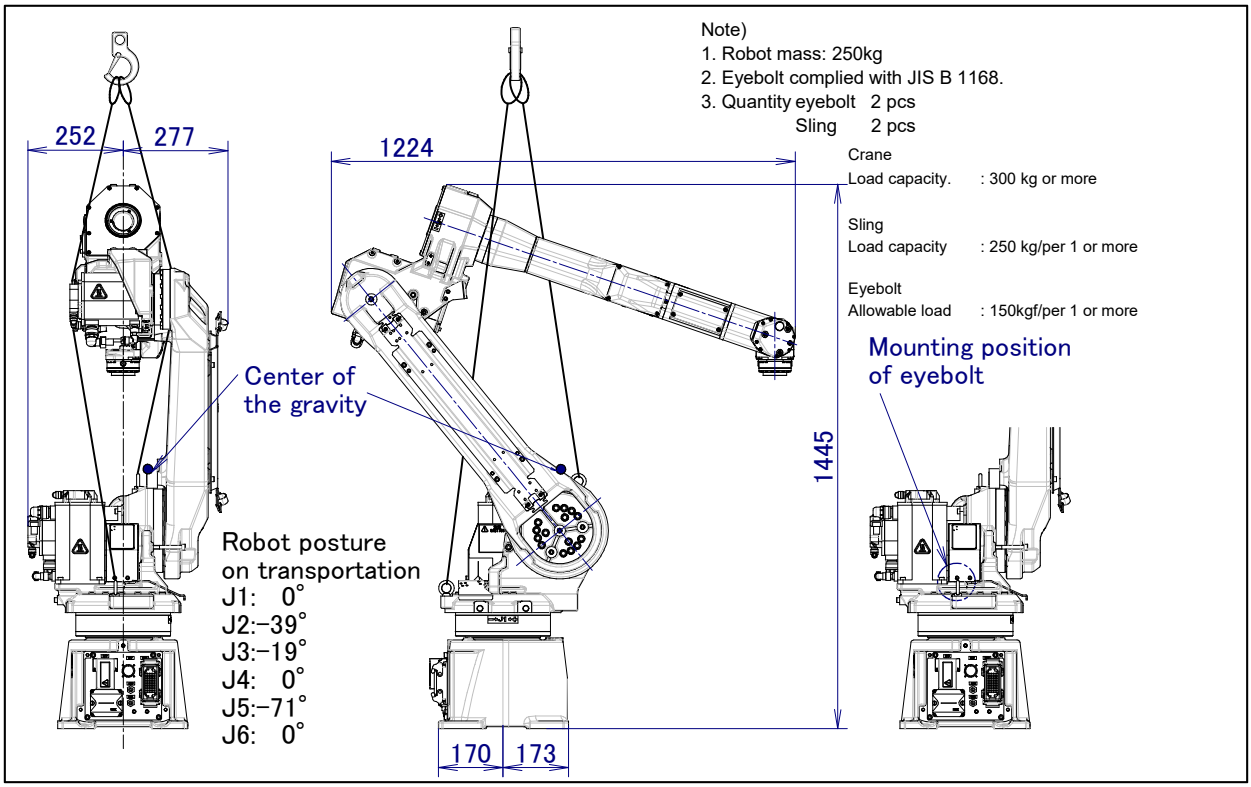


Fig. 1.1 (b) Transportation using a crane (ARC Mate 120*i*C/10L/12L, M-20*i*A/10L/12L)

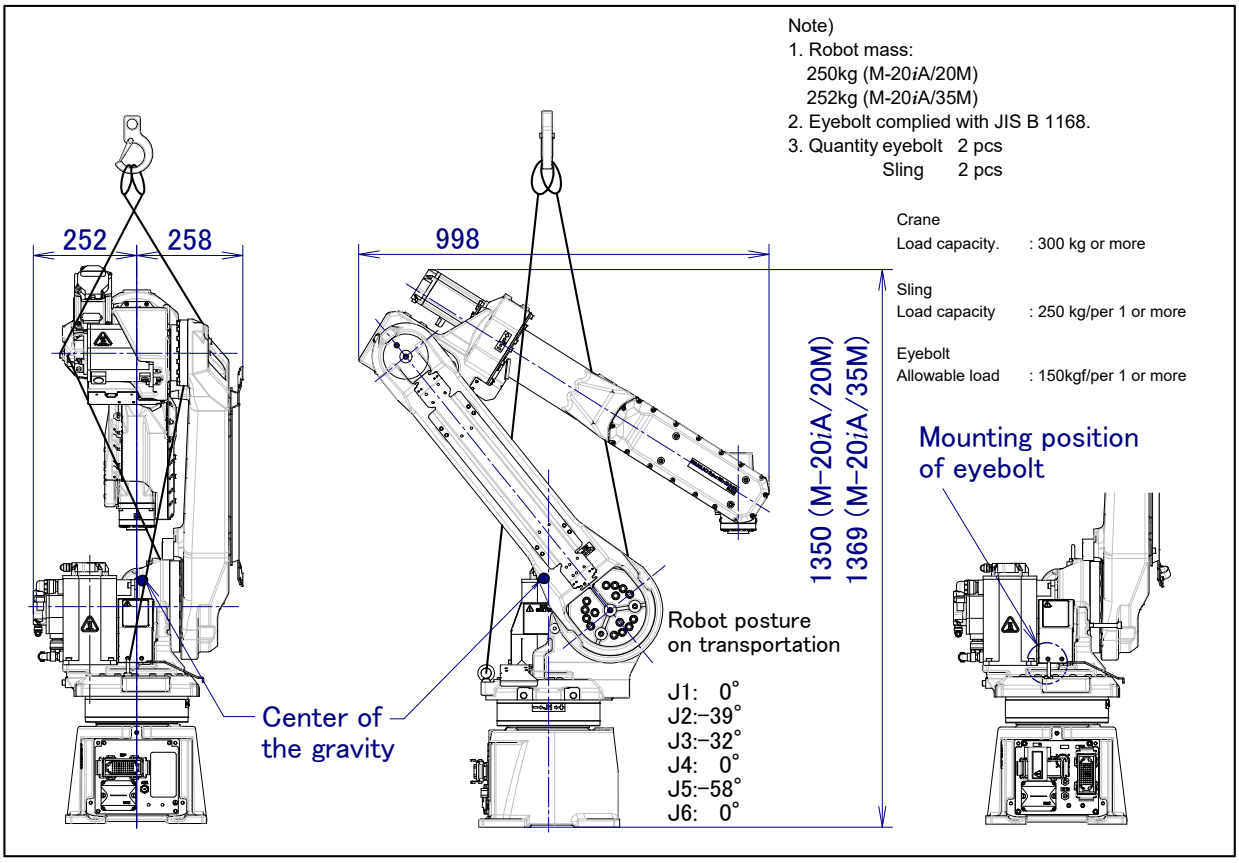


Fig. 1.1 (c) Transportation using a crane (M-20*i*A/20M/35M)

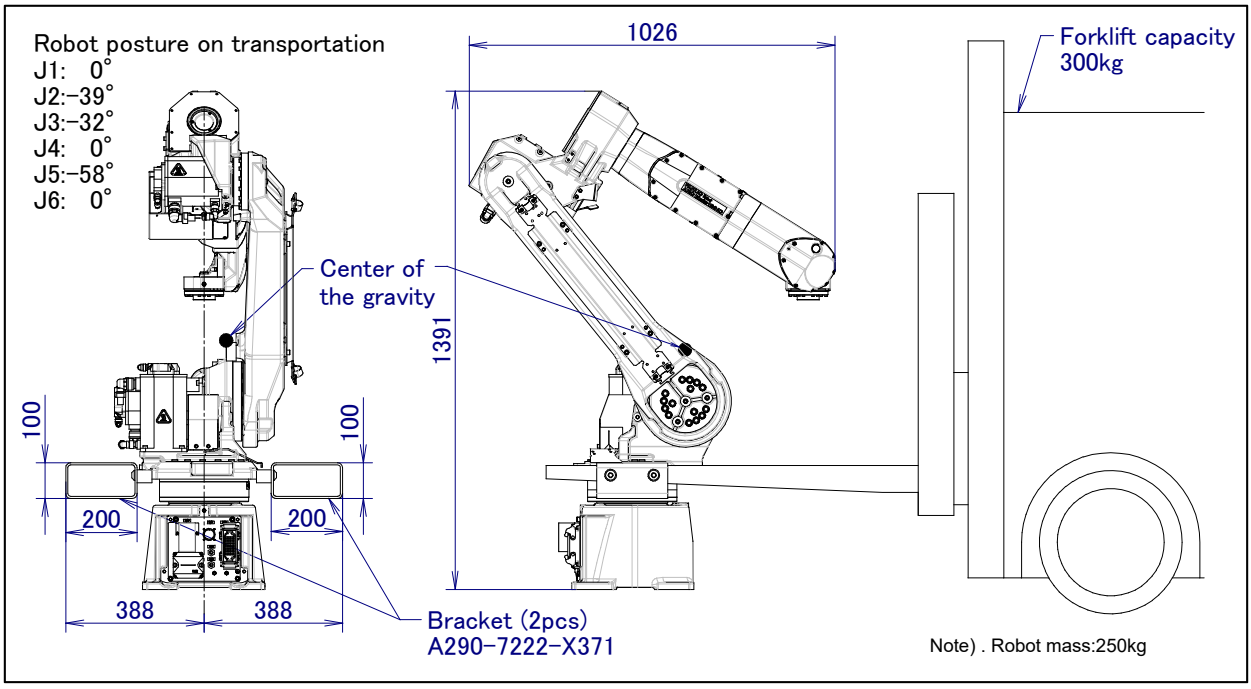


Fig. 1.1 (d) Transportation using a forklift (ARC Mate 120*i*C, M-20*i*A)

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

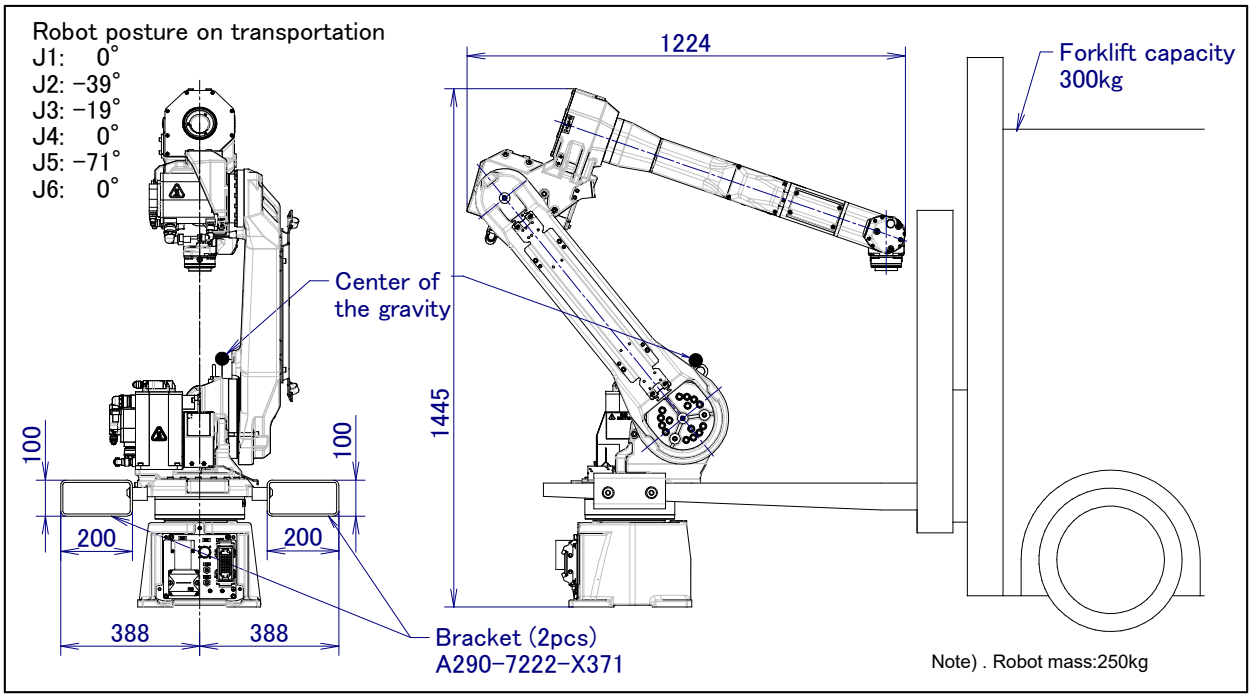


Fig. 1.1 (e) Transportation using a forklift
(ARC Mate 120*i*C/10L/12L, M-20*i*A/10L/12L)

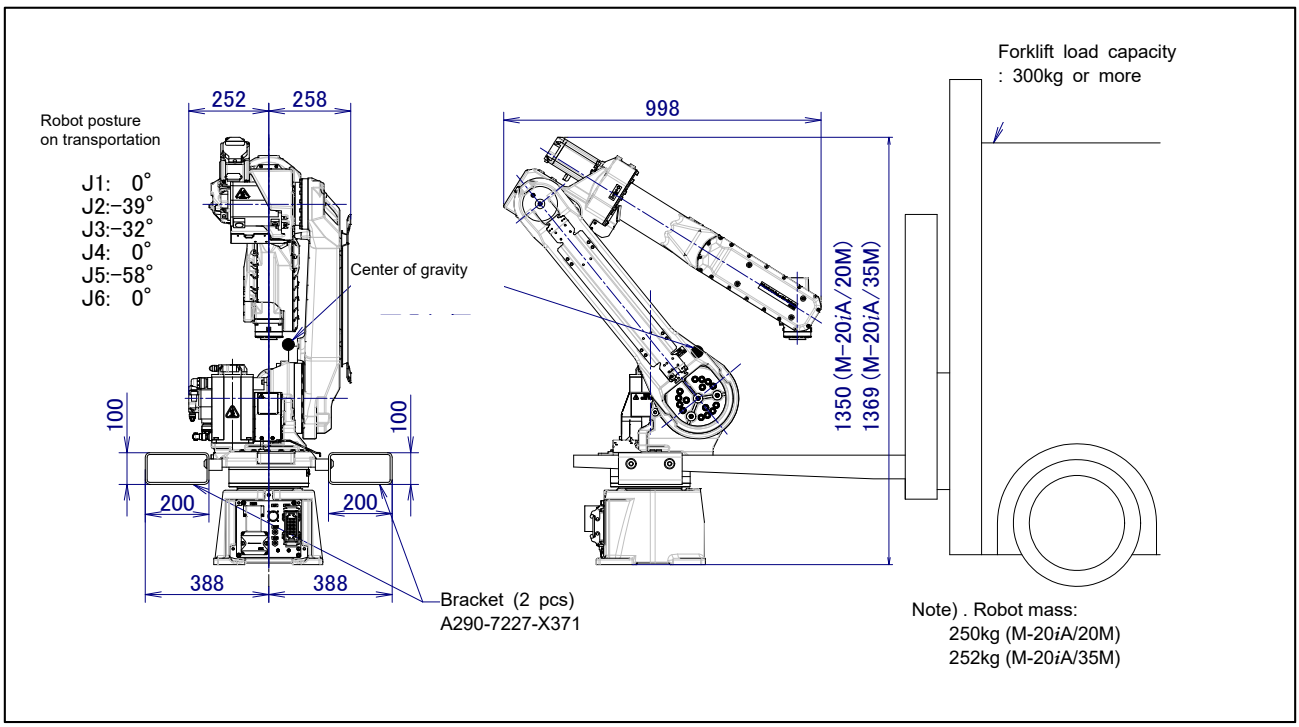


Fig. 1.1 (f) Transportation using a forklift (M-20*i*A/20M/35M)

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

1.2 INSTALLATION

Fig. 1.2 (a) shows the robot base dimensions. Avoid placing any object in front of the robot on the mounting face to facilitate the installation of the mastering fixture.

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

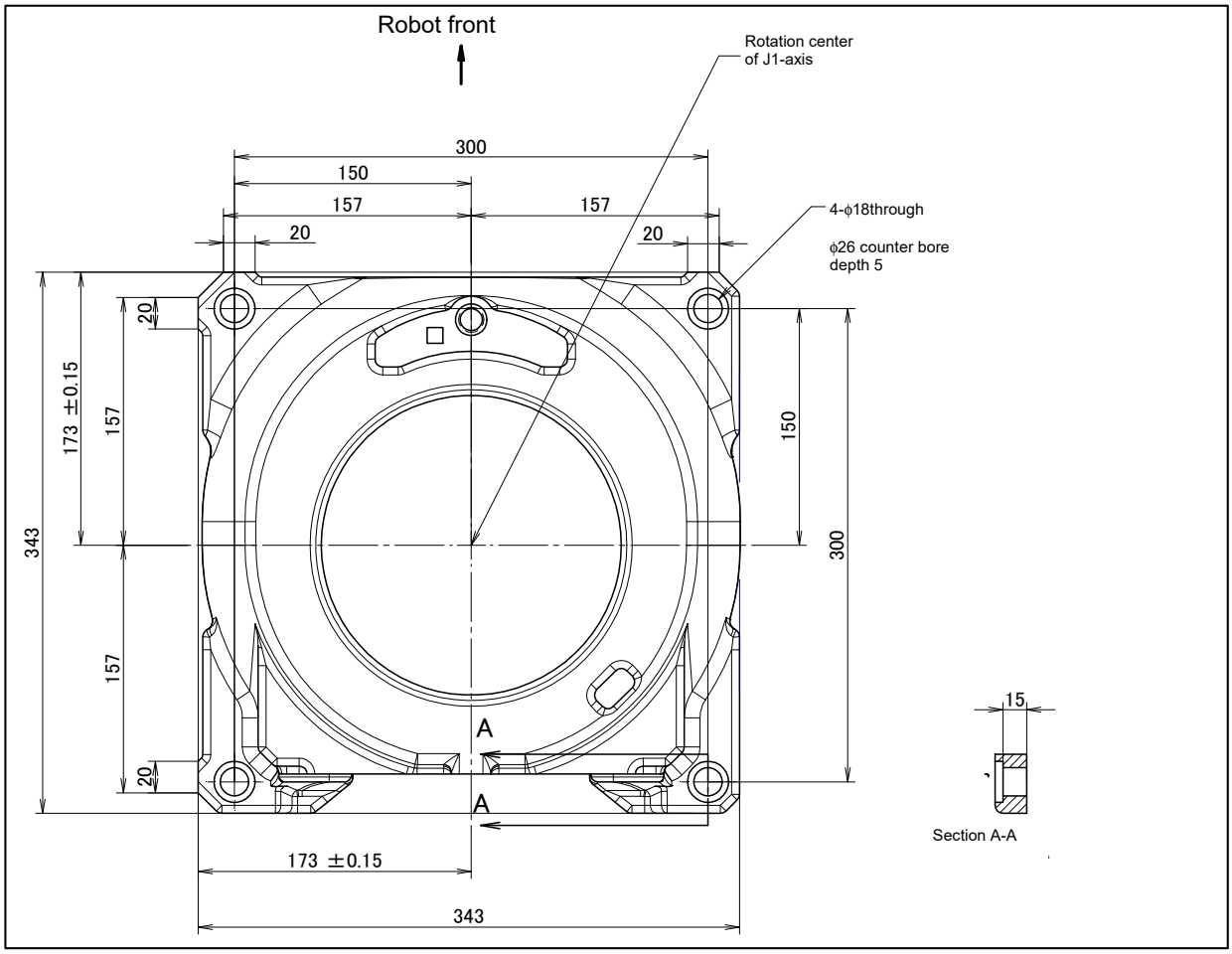


Fig. 1.2 (a) Dimensions of the robot base

1.2.1 Installation Example

Fig. 1.2.1 (a) shows an example of installing the robot. In this example, the floor plate is fixed with four M20 chemical anchors (tensile strength 400N/mm^2 or more), and the robot base is fastened to the floor plate with four M16 x 40 bolts (tensile strength 1200N/mm^2 or more). If compatibility must be maintained in teaching the robot after the robot mechanical unit is replaced, use the locating surface.

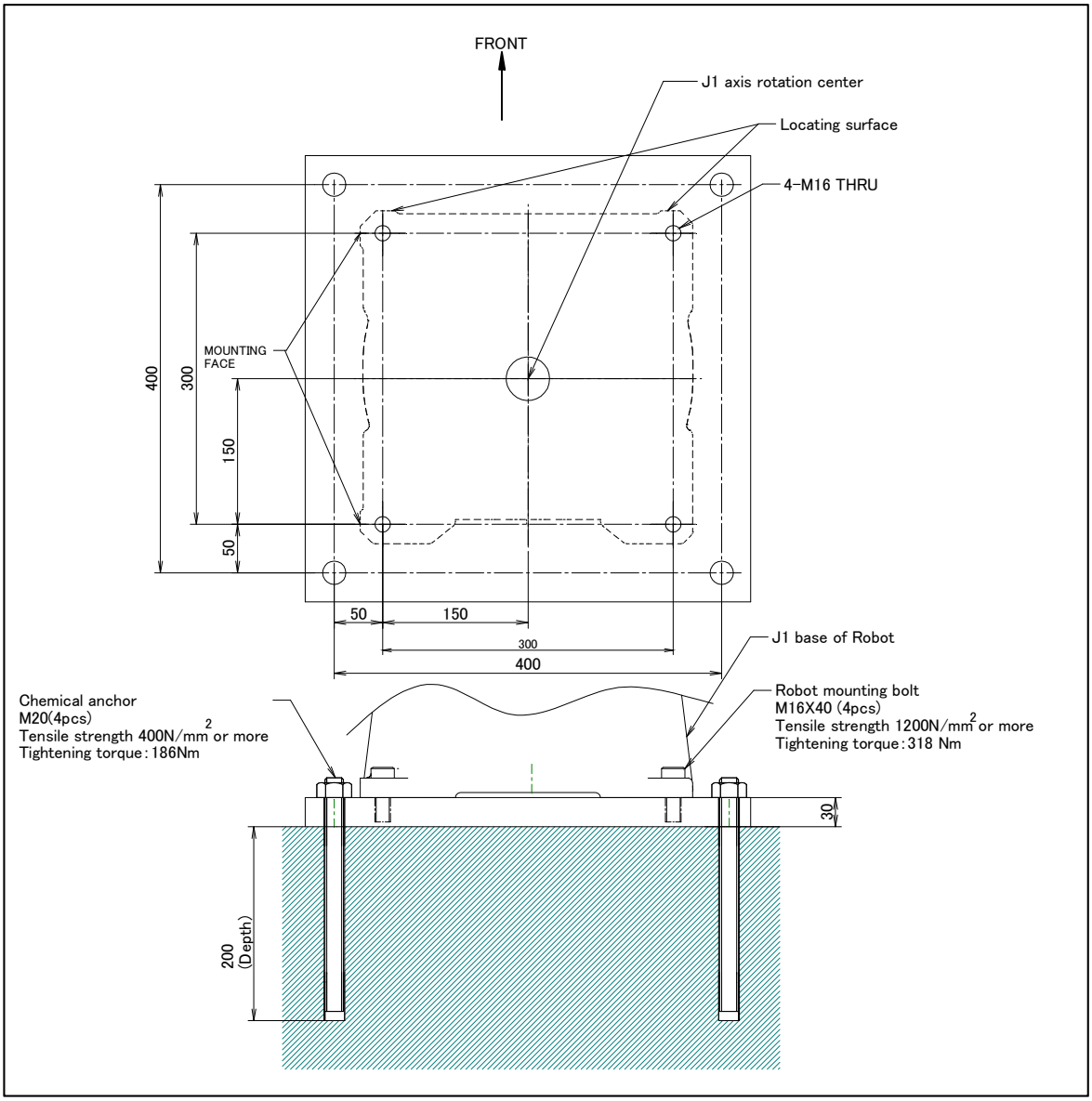


Fig. 1.2.1 (a) Example of installing the robot

NOTE

- The customer shall arrange for the positioning pin, anchor bolts, and floor plate. Don't perform leveling at the robot base directly using a push bolt or a wedge. To secure the robot base, use four hexagon socket head bolt M16 x 40 (tensile strength 1200N/mm^2 or more) and tighten them with regulated tightening torque 318Nm.
  Flatness of robot installation surface must be less than or equal to 0.5mm.
  Inclination of robot installation surface must be less than or equal to 0.5º.If robot base is placed on uneven ground, it may result in the base breakage or low performance of the robot.

Fig. 1.2.1 (b), Table 1.2.1 (a) to Table 1.2.1 (c) indicate the force and moment applied to the robot base. Table 1.2.1 (d) and (e) indicate the stopping distance and time of the J1 to J3 axes until the robot stops 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

Stopping times and distances in Table 1.2.1 (d) and (e) are reference values measured in accordance with ISO 10218-1. Please measure and check the actual values, since it varies depending on robot individual, load condition and operation program. Stopping times and distances in Table 1.2.1 (d) are affected by the robot's operating status and the number of Servo-off stops. Please measure and check the actual values periodically.

Table 1.2.1 (a) Force and moment that act on J1 base (ARC Mate 120*i*C, M-20*i*A, ARC Mate 120*i*C/10L/12L, M-20*i*A/10L/12L)

	Vertical moment M_V [Nm](kgfm)	Force in vertical direction F_V [N] (kgf)	Horizontal moment M_H [Nm] (kgfm)	Force in horizontal direction F_H [N] (kgf)
During stillness	1537 (157)	2732 (279)	0(0)	0(0)
During acceleration or deceleration	6233 (636)	4425 (451)	2020(206)	3912 (399)
During Power-Off stop	12802 (1306)	7979 (814)	8315 (848)	7239 (739)

Table 1.2.1 (b) Force and moment that act on J1 base (M-20*i*A/20M)

	Vertical moment M_V [Nm](kgfm)	Force in vertical direction F_V [N] (kgf)	Horizontal moment M_H [Nm] (kgfm)	Force in horizontal direction F_H [N] (kgf)
During stillness	1554 (159)	2751 (281)	0 (0)	0 (0)
During acceleration or deceleration	6302 (643)	4457 (455)	2045 (209)	3953 (403)
During Power-Off stop	12944 (1321)	8038 (820)	8415 (859)	7318 (747)

Table 1.2.1 (c) Force and moment that act on J1 base (M-20*i*A/35M)

	Vertical moment M_V [Nm](kgfm)	Force in vertical direction F_V [N] (kgf)	Horizontal moment M_H [Nm] (kgfm)	Force in horizontal direction F_H [N] (kgf)
During stillness	1817 (185)	2818 (288)	0 (0)	0 (0)
During acceleration or deceleration	5662 (578)	3567 (364)	1146 (117)	4425 (452)
During Power-Off stop	12618 (1288)	6069 (619)	7095 (724)	6409 (654)

Table 1.2.1 (d) Stopping time and distance until the robot stopping by Power-off stop after input of stop signal

Model		J1-axis	J2-axis	J3-axis
ARC Mate 120*i*C, M-20*i*A	Stopping time [ms]	246	246	125
	Stopping angle [deg] (rad)	25.7 (0.45)	21.2 (0.37)	11.5 (0.20)
ARC Mate 120*i*C/10L, M-20*i*A/10L	Stopping time [ms]	199	192	104
	Stopping angle [deg] (rad)	20.8 (0.36)	15.3 (0.27)	10.7 (0.19)
M-20*i*A/20M	Stopping time [ms]	292	252	132
	Stopping angle [deg] (rad)	30.3 (0.53)	21.2 (0.37)	11.7 (0.20)
M-20*i*A/35M	Stopping time [ms]	204	188	124
	Stopping angle [deg] (rad)	6.5 (0.11)	5.7 (0.10)	7.2(0.13)
ARC Mate 120*i*C/12L, M-20*i*A/12L	Stopping time [ms]	132	124	92
	Stopping angle [deg] (rad)	12.4 (0.22)	10.1 (0.18)	5.1 (0.09)

Table1.2.1 (e) Stopping time and distance until the robot stopping by Controlled stop after input of stop signal

Model		J1-axis	J2-axis	J3-axis
ARC Mate 120*i*C, M-20*i*A	Stopping time [ms]	428	429	444
	Stopping angle [deg] (rad)	45.3 (0.79)	44.3 (0.77)	47.3 (0.83)
ARC Mate 120*i*C/10L, M-20*i*A/10L	Stopping time [ms]	437	442	442
	Stopping angle [deg] (rad)	47.6 (0.83)	44.6(0.78)	45.2(0.79)
M-20*i*A/20M	Stopping time [ms]	476	468	468
	Stopping angle [deg] (rad)	50.1 (0.87)	44.3 (0.77)	47.3 (0.83)
M-20*i*A/35M	Stopping time [ms]	588	596	596
	Stopping angle [deg] (rad)	19.3(0.34)	21.0(0.37)	35.9(0.63)
ARC Mate 120*i*C/12L, M-20*i*A/12L	Stopping time [ms]	476	468	468
	Stopping angle [deg] (rad)	51.0 (0.89)	38.1 (0.66)	28.6 (0.50)

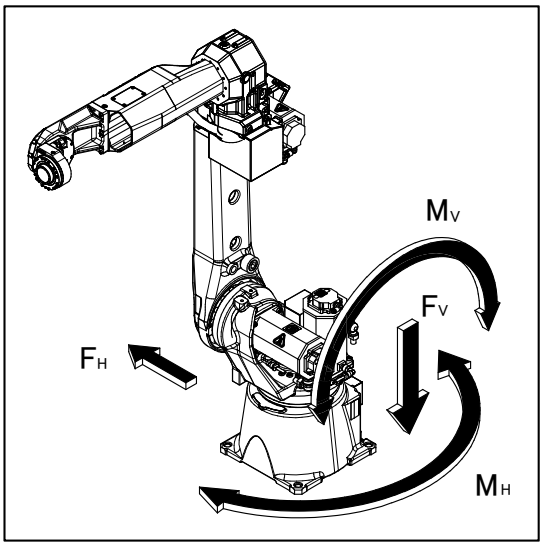
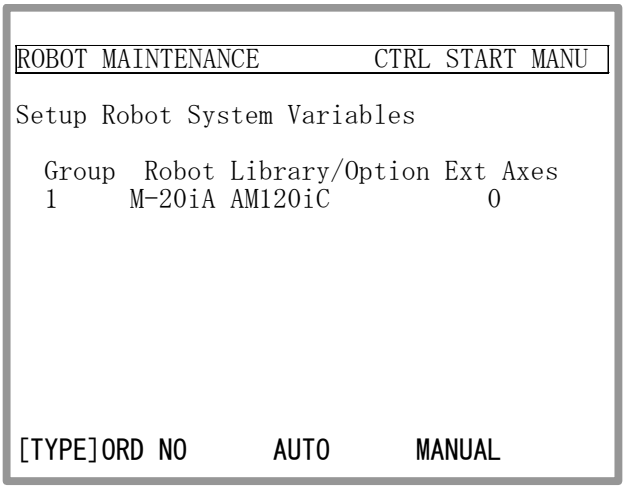


Fig. 1.2.1 (b) Force and moment that acts on the robot base

1.2.2 Angle of Mounting Surface Setting

For all robot mounts except floor mount, be sure to set the mounting angle referring to the procedure below. Refer to Section 3.1 for installation specifications.

1 Turn on the controller with [PREV] and [NEXT] key pressed. Then select [3 Controlled start].
2 Press [MENU] key and select [9 MAINTENANCE].
3 Select the robot for which you want to set the mount angle, and press the [ENTER] key.



4 Press the [F4] key.
5 Press the [ENTER] key until screen below is displayed.

```
*******Group 1 Initialization***********
*************ARC Mate 120iC*************


--- MOUNT ANGLE SETTING ---

  0 [deg] : floor mount type
 90 [deg] : wall mount type
180 [deg] : upside-down mount type

Set mount_angle (-180 - 180[deg])->
Default value = 0
```

6 Input the angle of mounting surface referring to Fig.1.2.2 (a).

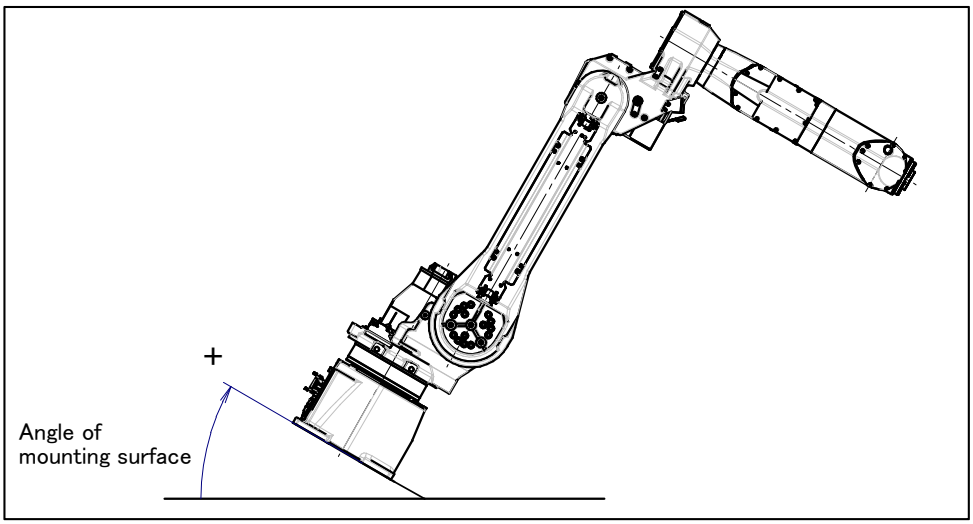


Fig. 1.2.2 (a) Mounting angle

7 Press the [ENTER] key until screen below is displayed again.

```
ROBOT MAINTENANCE          CTRL START MANU

Setup Robot System Variables

  Group  Robot Library/Option Ext Axes
  1      M-20iA AM120iC            0




[TYPE]ORD NO       AUTO       MANUAL
```

8 Press the [FCTN] key and select [1 START (COLD)].

1.3 MAINTENANCE AREA

Fig. 1.3 (a) to (c) shows the maintenance area of the mechanical unit. Be sure to leave enough room for the robot to be mastered. See Chapter 9 for mastering information.

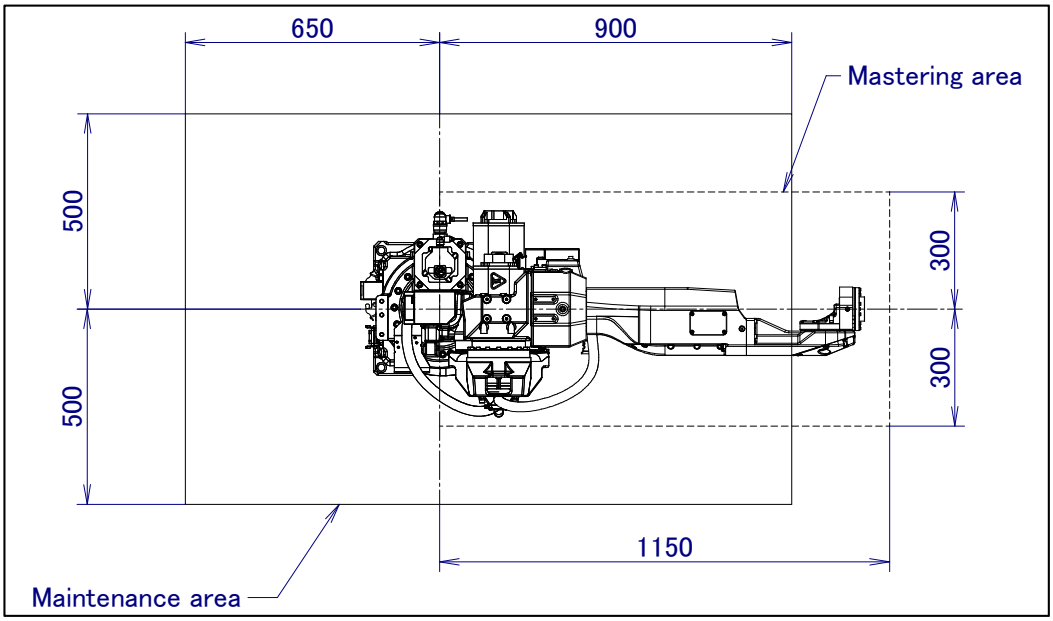


Fig. 1.3 (a) Maintenance area (ARC Mate 120*i*C, M-20*i*A)

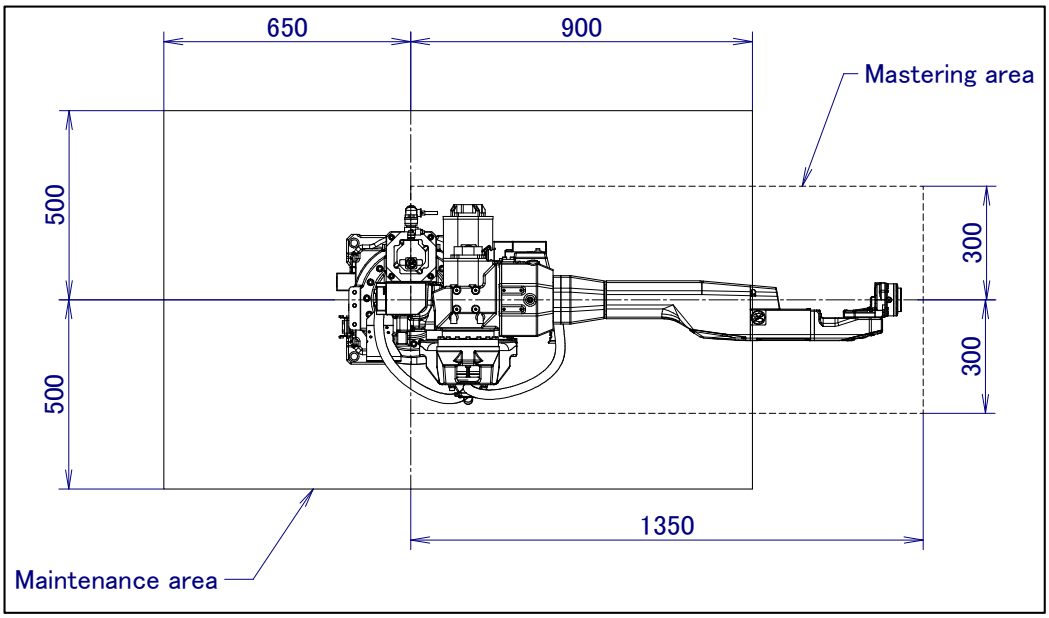


Fig. 1.3 (b) Maintenance area (ARC Mate 120*i*C/10L/12L, M-20*i*A/10L/12L)

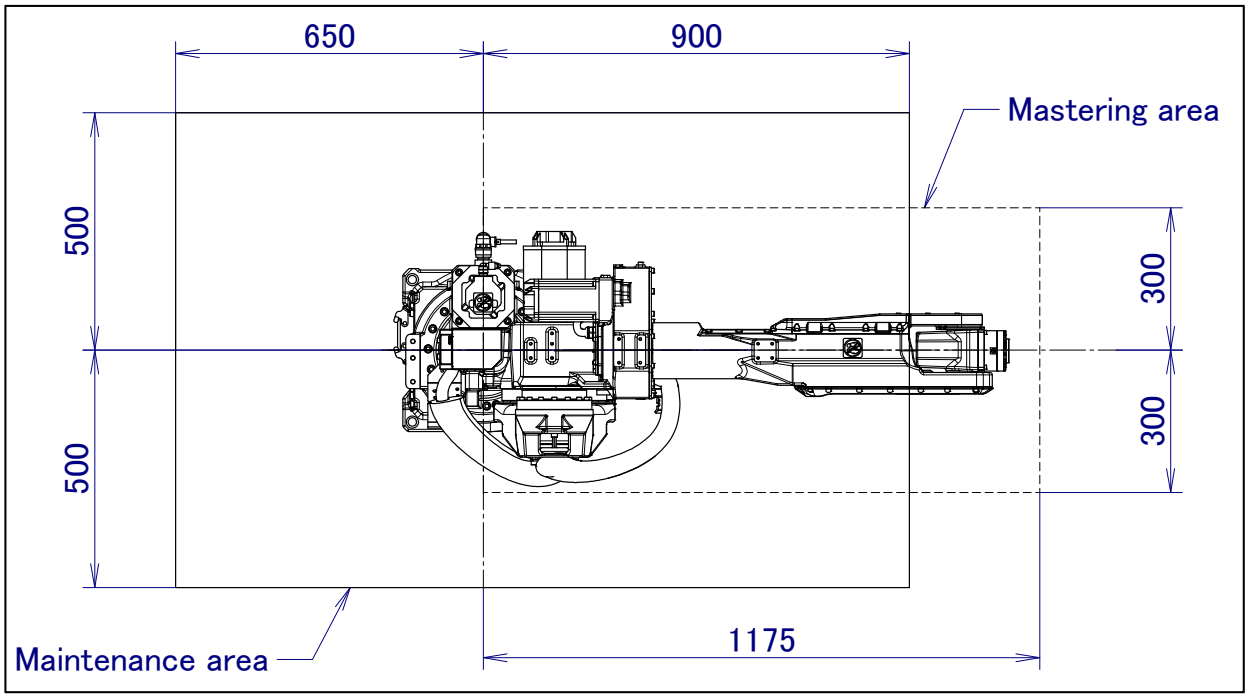


Fig. 1.3 (c) Maintenance area (M-20*i*A/20M/35M)

1.4 INSTALLATION CONDITIONS

Refer to specification of Section 3.1 about installation conditions.

2 CONNECTION WITH THE CONTROLLER

The robot is connected with the controller via the power and signal cable and earth cable. Connect these cables to the connectors on the back of the base. For details on air and option cables, see Chapter 5.

⚠ 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.

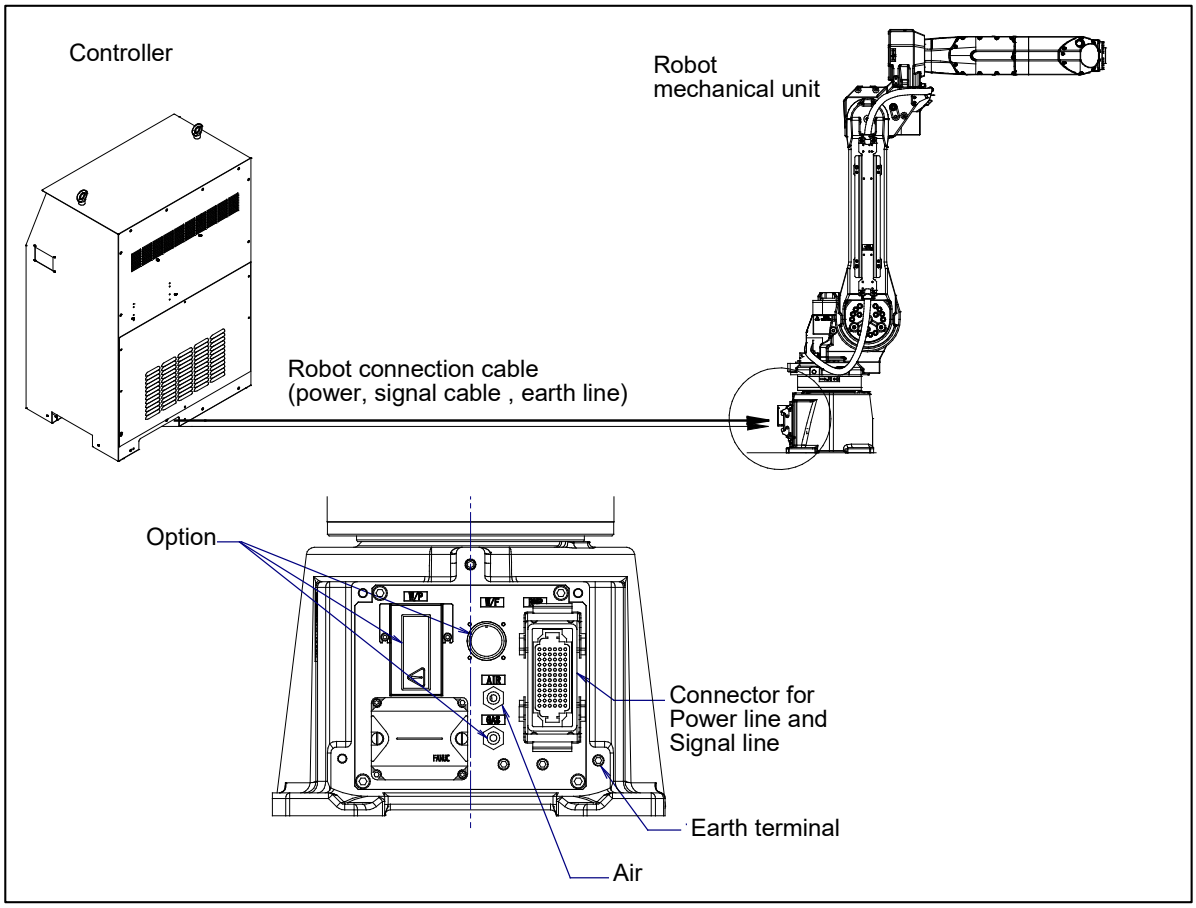


Fig. 2 (a) Cable connection

3 BASIC SPECIFICATIONS

3.1 ROBOT CONFIGURATION

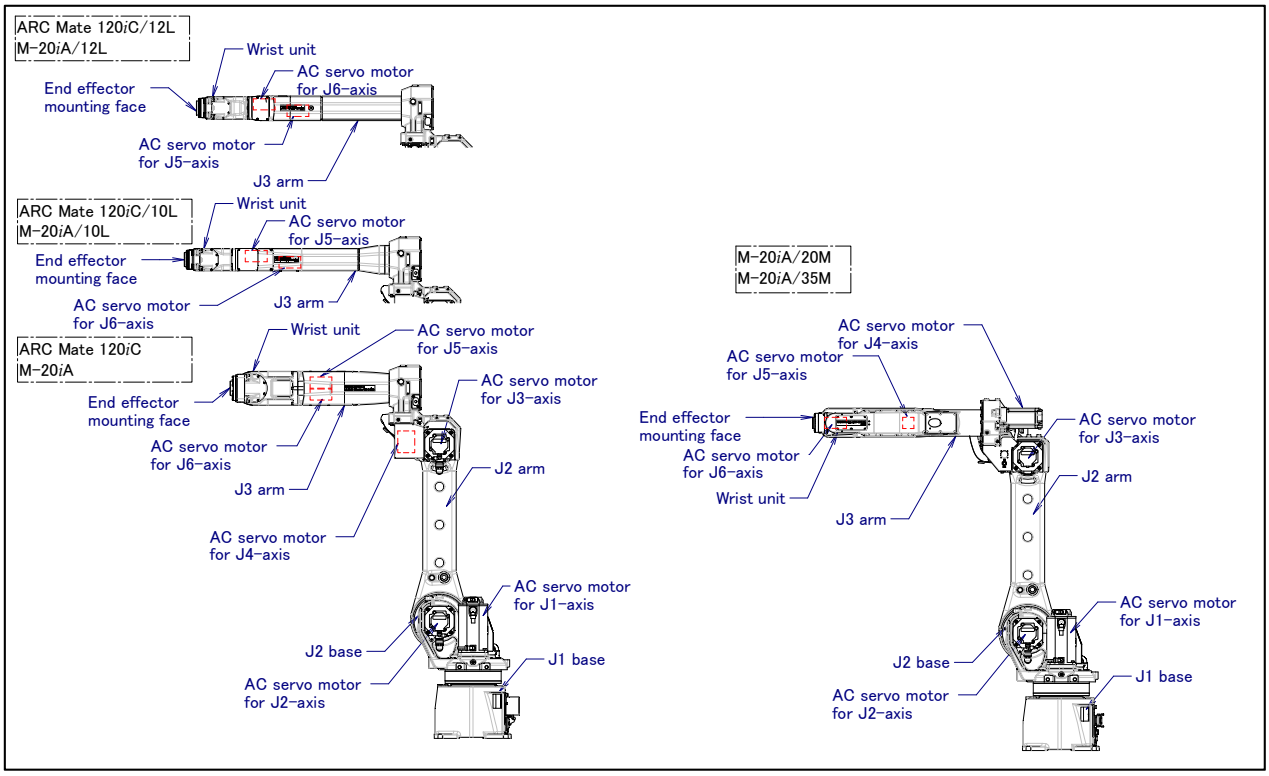


Fig. 3.1 (a) Mechanical unit configuration

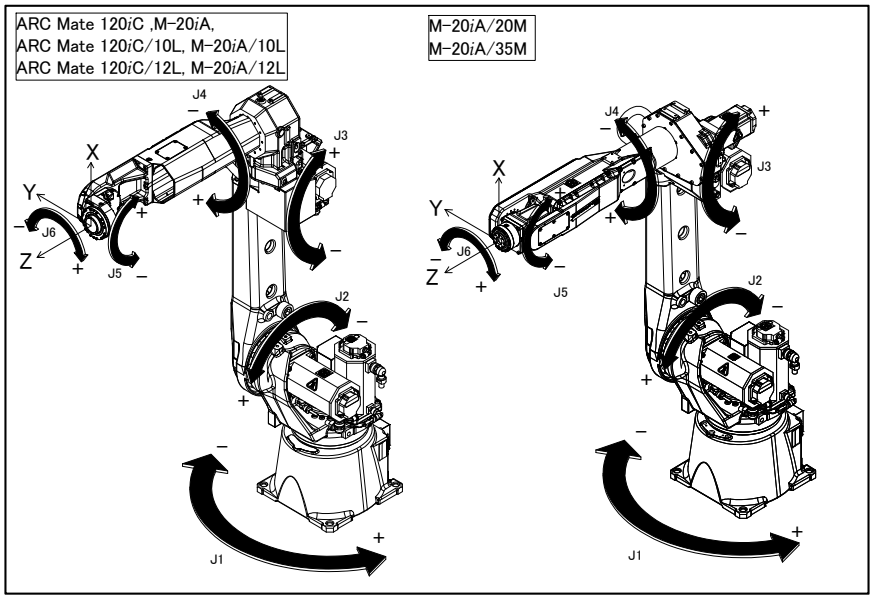


Fig. 3.1 (b) Each axes coordinates and mechanical interface coordinates

NOTE

The end effector mounting face center is 0, 0, 0 of the mechanical interface coordinates.

Specifications (NOTE 1) (1/4)

Item			Specification	
Model			ARC Mate 120*i*C, M-20*i*A	
Type			Articulated type	
Controlled axes			6axes(J1, J2, J3, J4, J5, J6)	
Installation			Floor, (Upside-down, Wall & Angle mount) (NOTE 2)	
Load setting			3 kg mode (Standard welding torch mode)	20 kg mode (High inertia mode)
Motion range Upper limit /Lower limit	J1-axis		185° (3.23rad) / -185° (-3.23rad)	
	J2-axis		160° (2.79rad) / -100° (-1.75rad)	
	J3-axis		273° (4.77rad) / -185° (-3.23rad)	
	J4-axis		200° (3.49rad) / -200° (-3.49rad)	
	J5-axis	(NOTE 3)	140° (2.44rad) / -140° (-2.44rad)	
		(NOTE 4)	180° (3.14rad) / -180° (-3.14rad)	
	J6-axis	(NOTE 3)	270° (4.71rad) / -270° (-4.71rad)	
		(NOTE 4)	450° (7.85rad) / -450° (-7.85rad)	
Maximum speed (NOTE 5)	J1-axis		195°/s(3.40rad/s)	
	J2-axis		175°/s(3.05rad/s)	
	J3-axis		180°/s(3.14rad/s)	
	J4-axis		360°/s(6.28rad/s)	
	J5-axis		360°/s(6.28rad/s)	
	J6-axis		550°/s(9.60rad/s)	
Maximum load	At wrist		3kg	20kg
	On J3 arm (NOTE 6)		12kg	
Allowable load moment at wrist	J4-axis		7.7N·m (0.79kgf·m)	44N·m (4.5kgf·m)
	J5-axis		7.7N·m (0.79kgf·m)	44N·m (4.5kgf·m)
	J6-axis		0.22N·m (0.022kgf·m)	22N·m (2.2kgf·m)
Allowable load inertia at wrist	J4-axis		0.24kg·m^2 (2.5kgf·cm·s^2)	1.04kg·m^2 (10.6kgf·cm·s^2)
	J5-axis		0.24kg·m^2 (2.5kgf·cm·s^2)	1.04kg·m^2 (10.6kgf·cm·s^2)
	J6-axis		0.0027kg·m^2 (0.028kgf·cm·s^2)	0.28kg·m^2 (2.9kgf·cm·s^2)
Repeatability			±0.03 mm	
Robot mass			250kg	
Acoustic noise level			Less than 70dB (NOTE 7)	
Installation environment			Ambient temperature: 0 to 45℃ (NOTE 8) Ambient humidity: Normally 75%RH or less (No dew or frost allowed) Short time 95%RH or less (Within 1 month) Permissible altitude: Above the sea 1000m or less Vibration acceleration : 4.9m/s^2 (0.5G) or less Free of corrosive gases (NOTE 9)	

NOTE

1 Even if the robot is used according to the defined specifications, motion programs might shorten reducer life or cause the robot to overheat. Use ROBOGUIDE (system design support tool by FANUC) for further evaluation before running production.
2 Under the installation condition within ( ), motion range will be limited only when high inertia mode. See Section 3.6.
3 The specification of “Cable integrated J3 Arm”.
4 The specification of "Conventional dress-out".
5 During short distance motions, the axis speed may not reach the maximum value stated.
6 Maximum load on J3 arm depends on load of wrist. See Section 4.2 in detail.
7 This value is equivalent continuous A-weighted sound pressure level, which applied with ISO11201 (EN31201). This value is measured with the following conditions.
-Maximum load and speed
-Operating mode is AUTO
8 When the robot is used in a low temperature environment that is near to 0ºC, or not operated for a long time in the environment that is less than 0ºC (during a holiday or during the night), a collision detection alarm (SRVO-050) etc. may occur since the resistance of the drive mechanism could be high immediately after starting the operation. In this case, we recommend performing the warm up operation for several minutes.
9 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, water, water vapor, cutting oil, cleaning fluid splash and or other foreign materials.

Specifications (NOTE 1) (2/4)

Item			Specification	
Model			ARC Mate 120*i*C/10L, M-20*i*A/10L	
Type			Articulated type	
Controlled axes			6axes(J1, J2, J3, J4, J5, J6)	
Installation			Floor, (Upside-down, Wall & Angle mount) (NOTE 2)	
Load setting			3 kg mode (Standard welding torch mode)	10 kg mode (High inertia mode)
Motion range Upper limit /Lower limit	J1-axis		185° (3.23rad) / -185° (-3.23rad)	
	J2-axis		160° (2.79rad) / -100° (-1.75rad)	
	J3-axis		275.6° (4.81rad) / -185° (-3.23rad)	
	J4-axis		200° (3.49rad) / -200° (-3.49rad)	
	J5-axis	(NOTE 3)	140° (2.44rad) / -140° (-2.44rad)	
		(NOTE 4)	180° (3.14rad) / -180° (-3.14rad)	
	J6-axis	(NOTE 3)	270° (4.71rad) / -270° (-4.71rad)	
		(NOTE 4)	450° (7.85rad) / -450° (-7.85rad)	
Maximum speed (Note 5)	J1-axis		195°/s (3.40rad/s)	
	J2-axis		175°/s (3.05rad/s)	
	J3-axis		180°/s (3.14rad/s)	
	J4-axis		400°/s (6.98rad/s)	
	J5-axis		400°/s (6.98rad/s)	
	J6-axis		600°/s(10.47rad/s)	
Maximum load	At wrist		3kg	10kg
	On J3 arm (NOTE 6)		12kg	
Allowable load moment at wrist	J4-axis		7.7N·m (0.79kgf·m)	22N·m (2.2kgf·m)
	J5-axis		7.7N·m (0.79kgf·m)	22N·m (2.2kgf·m)
	J6-axis		0.22N·m (0.022kgf·m)	9.8N·m (1.0kgf·m)
Allowable load inertia at wrist	J4-axis		0.24kg·m^2 (2.5kgf·cm·s^2)	0.63kg·m^2 (6.4kgf·cm·s^2)
	J5-axis		0.24kg·m^2 (2.5kgf·cm·s^2)	0.63kg·m^2 (6.4kgf·cm·s^2)
	J6-axis		0.0027kg·m^2 (0.028kgf·cm·s^2)	0.15kg·m^2 (1.5kgf·cm·s^2)
Repeatability			±0.03 mm	
Robot mass			250kg	
Acoustic noise level			Less than 70dB (NOTE 7)	
Installation environment			Ambient temperature: 0 to 45°C (NOTE 8) Ambient humidity: Normally 75%RH or less (No dew or frost allowed) Short time 95%RH or less (Within 1 month) Permissible altitude: Above the sea 1000m or less Vibration acceleration: 4.9m/s^2 (0.5G) or less Free of corrosive gases (NOTE 9)	

NOTE

1 Even if the robot is used according to the defined specifications, motion programs might shorten reducer life or cause the robot to overheat. Use ROBOGUIDE (system design support tool by FANUC) for further evaluation before running production.
2 Under the installation condition within ( ), motion range will be limited only when high inertia mode. See Section 3.6.
3 The specification of “Cable integrated J3 Arm”.
4 The specification of "Conventional dress-out".
5 During short distance motions, the axis speed may not reach the maximum value stated.
6 Maximum load on J3 arm depends on load of wrist. See Section 4.2 in detail.
7 This value is equivalent continuous A-weighted sound pressure level, which applied with ISO11201 (EN31201). This value is measured with the following conditions.
-Maximum load and speed
-Operating mode is AUTO
8 When the robot is used in a low temperature environment that is near to 0ºC, or not operated for a long time in the environment that is less than 0ºC (during a holiday or during the night), a collision detection alarm (SRVO-050) etc. may occur since the resistance of the drive mechanism could be high immediately after starting the operation. In this case, we recommend performing the warm up operation for several minutes.
9 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, water, water vapor, cutting oil, cleaning fluid splash and or other foreign materials.

Specifications (NOTE 1) (3/4)

Item		Specification	
Model		M-20*i*A/20M	M-20*i*A/35M
Type		Articulated type	
Controlled axes		6-axis(J1, J2, J3, J4, J5, J6)	
Installation		Floor (Upside-down, Wall & Angle mount) (NOTE 2)	
Load setting		20kg mode	35kg mode
Motion range Upper limit /Lower limit	J1-axis	185° (3.23rad) / -185° (-3.23rad)	
	J2-axis	160° (2.79rad) / -100° (-1.75rad)	
	J3-axis	275.6° (4.81rad) / -185° (-3.23rad)	
	J4-axis	200° (3.49rad) / -200° (-3.49rad)	
	J5-axis	140° (2.44rad) / -140° (-2.44rad)	
	J6-axis	450° (7.85rad) / -450° (-7.85rad)	
Maximum speed (Note 3)	J1-axis	195°/s (3.40rad/s)	180°/s (3.14rad/s)
	J2-axis	175°/s (3.05rad/s)	180°/s (3.14rad/s)
	J3-axis	180°/s (3.14rad/s)	200°/s (3.49rad/s)
	J4-axis	405°/s (7.07rad/s)	350°/s (6.11rad/s)
	J5-axis	405°/s (7.07rad/s)	350°/s (6.11rad/s)
	J6-axis	615°/s(10.73rad/s)	400°/s (6.98rad/s)
Maximum load	At wrist	20kg	35kg
	On J3 arm (NOTE 4)	12kg	
Allowable load moment at wrist	J4-axis	45.1Nm (4.6kgf·m)	110.0Nm (11.2kgf·m)
	J5-axis	45.1Nm (4.6kgf·m)	110.0Nm (11.2kgf·m)
	J6-axis	30.0Nm (3.1kgf·m)	60.0Nm (6.12kgf·m)
Allowable load inertia at wrist	J4-axis	2.01kg.m^2 (20.42 kgf·cm·s^2)	4.00kg.m^2 (40.82 kgf·cm·s^2)
	J5-axis	2.01kg.m^2 (20.42 kgf·cm·s^2)	4.00kg.m^2 (40.82 kgf·cm·s^2)
	J6-axis	1.01kg.m^2 (10.26 kgf·cm·s^2)	1.50kg.m^2 (15.31 kgf·cm·s^2)
Repeatability		±0.03mm	
Robot mass		250kg	252kg
Acoustic noise level		Less than 70dB (NOTE 5)	
Installation environment		Ambient temperature: 0 to 45℃ (NOTE 6) Ambient humidity: Normally 75%RH or less (No dew or frost allowed) Short time 95%Rhor less (Within 1 month) Permissible altitude: Above the sea 1000m or less Vibration acceleration : 4.9m/s^2 (0.5G) or less Free of corrosive gases (NOTE 7)	

NOTE

1 Even if the robot is used according to the defined specifications, motion programs might shorten reducer life or cause the robot to overheat. Use ROBOGUIDE (system design support tool by FANUC) for further evaluation before running production.
2 Under the installation condition within ( ), motion range will be limited. See Section 3.6.
3 During short distance motions, the axis speed may not reach the maximum value stated.
4 Maximum load on J3 arm depends on load of wrist. See Section 4.2 in detail.
5 This value is equivalent continuous A-weighted sound pressure level, which applied with ISO11201 (EN31201). This value is measured with the following conditions.
-Maximum load and speed
-Operating mode is AUTO
6 When the robot is used in a low temperature environment that is near to 0ºC, or not operated for a long time in the environment that is less than 0ºC (during a holiday or during the night), a collision detection alarm (SRVO-050) etc. may occur since the resistance of the drive mechanism could be high immediately after starting the operation. In this case, we recommend performing the warm up operation for several minutes.
7 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, water, water vapor, cutting oil, cleaning fluid splash and or other foreign materials.

Specifications (NOTE 1) (4/4)

Item			Specification	
Model			ARC Mate 120*i*C/12L, M-20*i*A/12L	
Type			Articulated type	
Controlled axes			6axes(J1, J2, J3, J4, J5, J6)	
Installation			Floor, (Upside-down, Wall & Angle mount) (NOTE 2)	
Load setting			3 kg mode (Standard welding torch mode)	12 kg mode (High inertia mode)
Motion range Upper limit /Lower limit	J1-axis		185° (3.23rad) / -185° (-3.23rad)	
	J2-axis		160° (2.79rad) / -100° (-1.75rad)	
	J3-axis		275.6° (4.81rad) / -185° (-3.23rad)	
	J4-axis		200° (3.49rad) / -200° (-3.49rad)	
	J5-axis	(NOTE 3)	140° (2.44rad) / -140° (-2.44rad)	
		(NOTE 4)	180° (3.14rad) / -180° (-3.14rad)	
	J6-axis	(NOTE 3)	270° (4.71rad) / -270° (-4.71rad)	
		(NOTE 4)	450° (7.85rad) / -450° (-7.85rad)	
Maximum speed (NOTE 5)	J1-axis		200°/s (3.49rad/s)	
	J2-axis		175°/s (3.05rad/s)	
	J3-axis		190°/s (3.32rad/s)	
	J4-axis		430°/s (7.50rad/s)	
	J5-axis		430°/s (7.50rad/s)	
	J6-axis		630°/s(11.00rad/s)	
Maximum load	At wrist		3kg	12kg
	On J3 arm (NOTE 6)		12kg	
Allowable load moment at wrist	J4-axis		7.7N·m (0.79kgf·m)	22N·m (2.2kgf·m)
	J5-axis		7.7N·m (0.79kgf·m)	22N·m (2.2kgf·m)
	J6-axis		0.22N·m (0.022kgf·m)	9.8N·m (1.0kgf·m)
Allowable load inertia at wrist	J4-axis		0.24kg·m^2 (2.5kgf·cm·s^2)	0.65kg·m^2 (6.6kgf·cm·s^2)
	J5-axis		0.24kg·m^2 (2.5kgf·cm·s^2)	0.65kg·m^2 (6.6kgf·cm·s^2)
	J6-axis		0.0027kg·m^2 (0.028kgf·cm·s^2)	0.17kg·m^2 (1.7kgf·cm·s^2)
Repeatability			±0.03 mm	
Robot mass			250kg	
Acoustic noise level			Less than 70dB (NOTE 7)	
Installation environment			Ambient temperature: 0 to 45°C (NOTE 8) Ambient humidity: Normally 75%RH or less (No dew or frost allowed) Short time 95%Rhor less (Within 1 month) Permissible altitude: Above the sea 1000m or less Vibration acceleration : 4.9m/s^2 (0.5G) or less Free of corrosive gases (NOTE 9)	

NOTE

1 Even if the robot is used according to the defined specifications, motion programs might shorten reducer life or cause the robot to overheat. Use ROBOGUIDE (system design support tool by FANUC) for further evaluation before running production.
2 Under the installation condition within ( ), motion range will be limited only when high inertia mode. See Section 3.6.
3 The specification of “Cable integrated J3 Arm”.
4 The specification of "Conventional dress-out".
5 During short distance motions, the axis speed may not reach the maximum value stated.
6 Maximum load on J3 arm depends on load of wrist. See Section 4.2 in detail.
7 This value is equivalent continuous A-weighted sound pressure level, which applied with ISO11201 (EN31201). This value is measured with the following conditions.
-Maximum load and speed
-Operating mode is AUTO
8 When the robot is used in a low temperature environment that is near to 0ºC, or not operated for a long time in the environment that is less than 0ºC (during a holiday or during the night), a collision detection alarm (SRVO-050) etc. may occur since the resistance of the drive mechanism could be high immediately after starting the operation. In this case, we recommend performing the warm up operation for several minutes.
9 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, water, water vapor, cutting oil, cleaning fluid splash and or other contaminations.

The following table lists the IEC60529-based Severe dust/liquid protection characteristics of the ARC Mate 120*i*C, M-20*i*A.

Table 3.1 (a) The dustproof and waterproof characteristics of ARC Mate 120*i*C, ARC Mate 120*i*C/10L/12L

	Normal specification
Wrist (*) + J3 arm	IP54
Other part	IP54

Table 3.1 (b) The dustproof and waterproof characteristics of M-20*i*A, M-20*i*A/10L/12L, M-20*i*A/20M/35M

	Normal specification	Severe dust/liquid protection option
Wrist (*) + J3 arm	IP67	IP67
Other part	IP54	IP55

(*) It does not include conduit part. M/H (Material Handling) conduit and No dust M/H (Material Handling) conduit do not have dustproof and waterproof characteristic. IP level of NO DUST M/H conduit is 65. Refer to Chapter 11 and 12 for details.

NOTE
Definition of IP code
Definition of IP 67
6 = Dust-tight
7 = Protection from water immersion
Definition of IP 55
5 = Dust-protected
5 = Protection from water jet
Definition of IP 54
5 = Dust-protected
4 = Protection from splashing water

Performance of resistant chemicals and resistant solvents

(1) The robot (including severe dust/liquid protection model) cannot be used with the following liquids. Potentially these liquids will cause irreversible damage to the rubber parts (such as: gaskets, oil seals, O-rings etc.). (As exception to this only liquids tested and approved by FANUC can be used with the robot.)
   (a) Organic solvents
   (b) Cutting fluid or cleaning fluid including chlorine / gasoline
   (c) Amine type cutting fluid or cleaning fluid
   (d) Acid, alkali and liquid causing rust
   (e) Other liquids or solutions, that will harm NBR or CR rubber
(2) When the robots work in the environment, using water or liquid, complete draining of J1 base must be done. Incomplete draining of J1 base will make the robot break down.
(3) Do not use unconfirmed cutting fluid and cleaning fluid.
(4) Do not use the robot immersed in water, neither temporary nor permanent. Robot must not be wet permanently.
   * Example : in case motor surface is exposed to water for a long time, liquid may invade inside the motor and cause failure.

3.2 MECHANICAL UNIT EXTERNAL DIMENSIONS AND OPERATING SPACE

Fig. 3.2 (a) to (d) show the robot operating space. When installing peripheral devices, be careful not to interfere with the robot and its operating space.

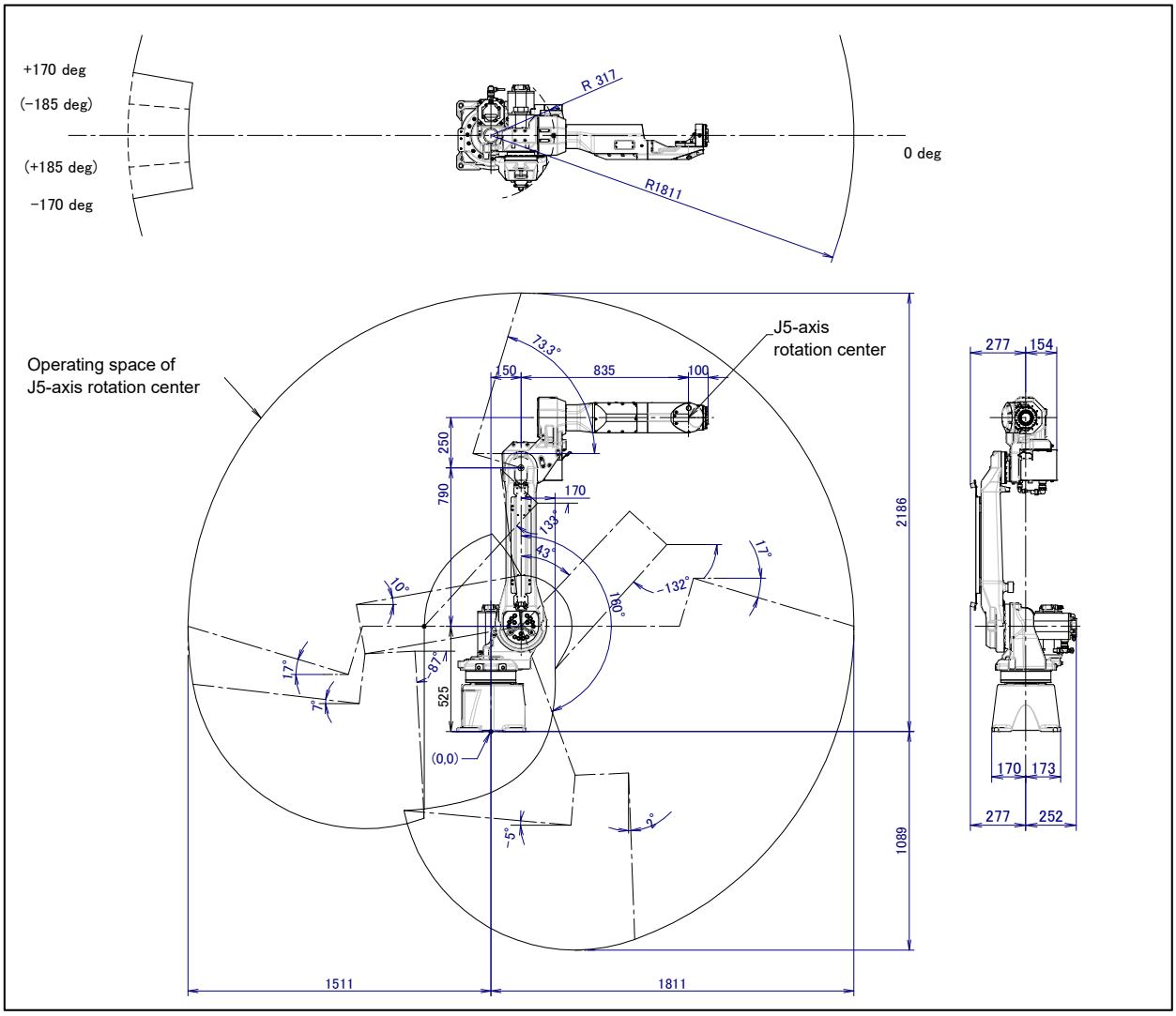


Fig. 3.2 (a) Operating space (ARC Mate 120*i*C, M-20*i*A)

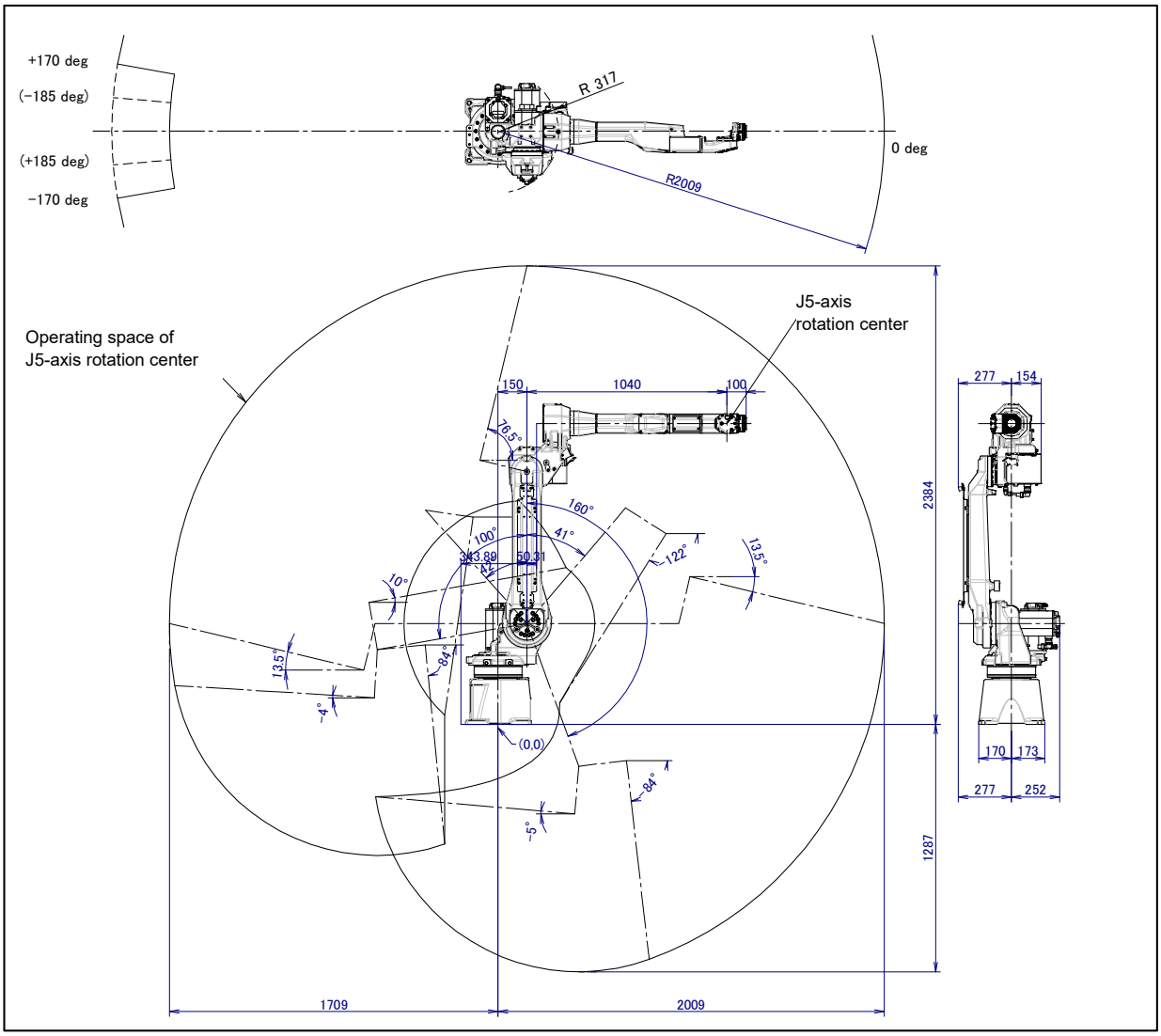


Fig. 3.2 (b) Operating space (ARC Mate 120*i*C/10L, M-20*i*A/10L)

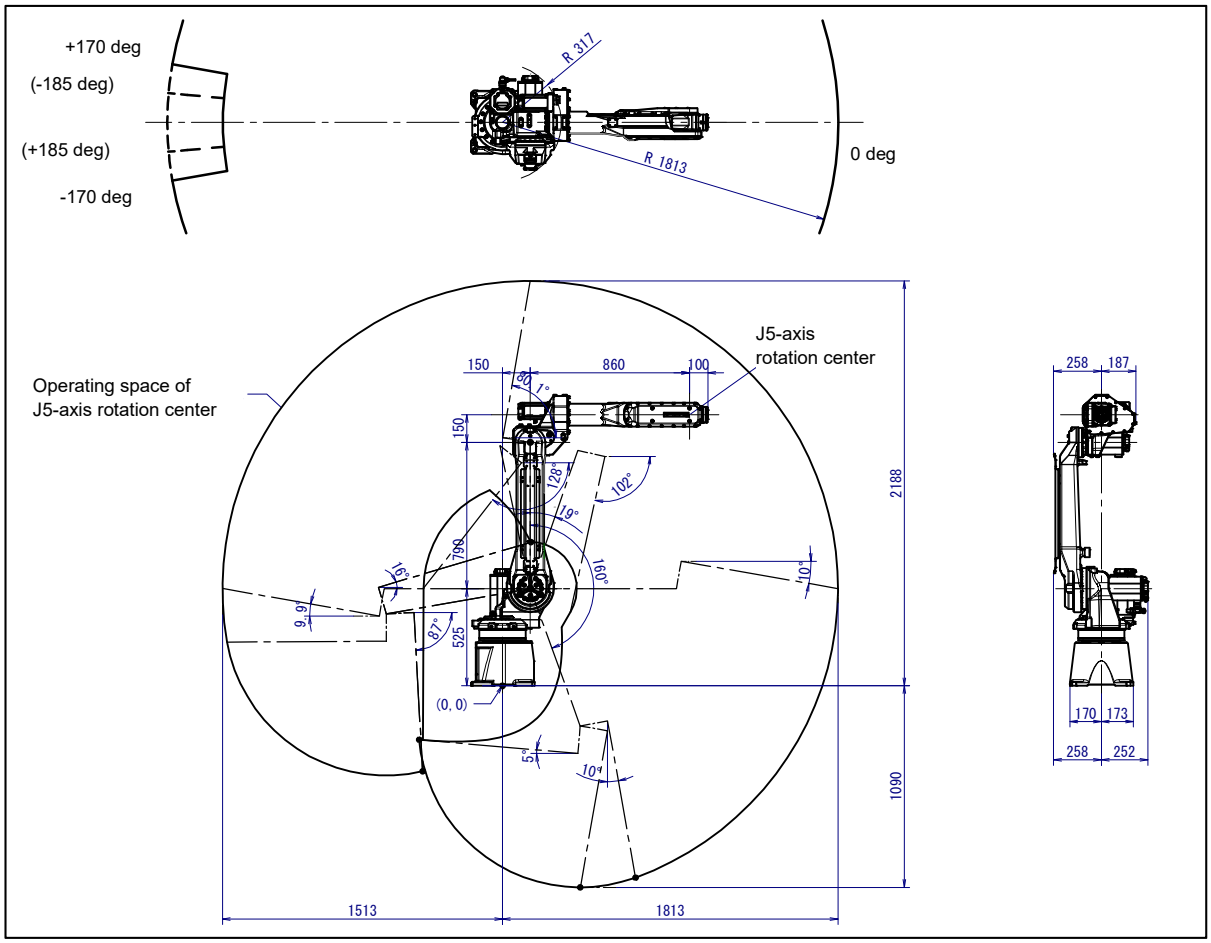


Fig. 3.2 (c) Operating space (M-20*i*A/20M, M-20*i*A/35M)

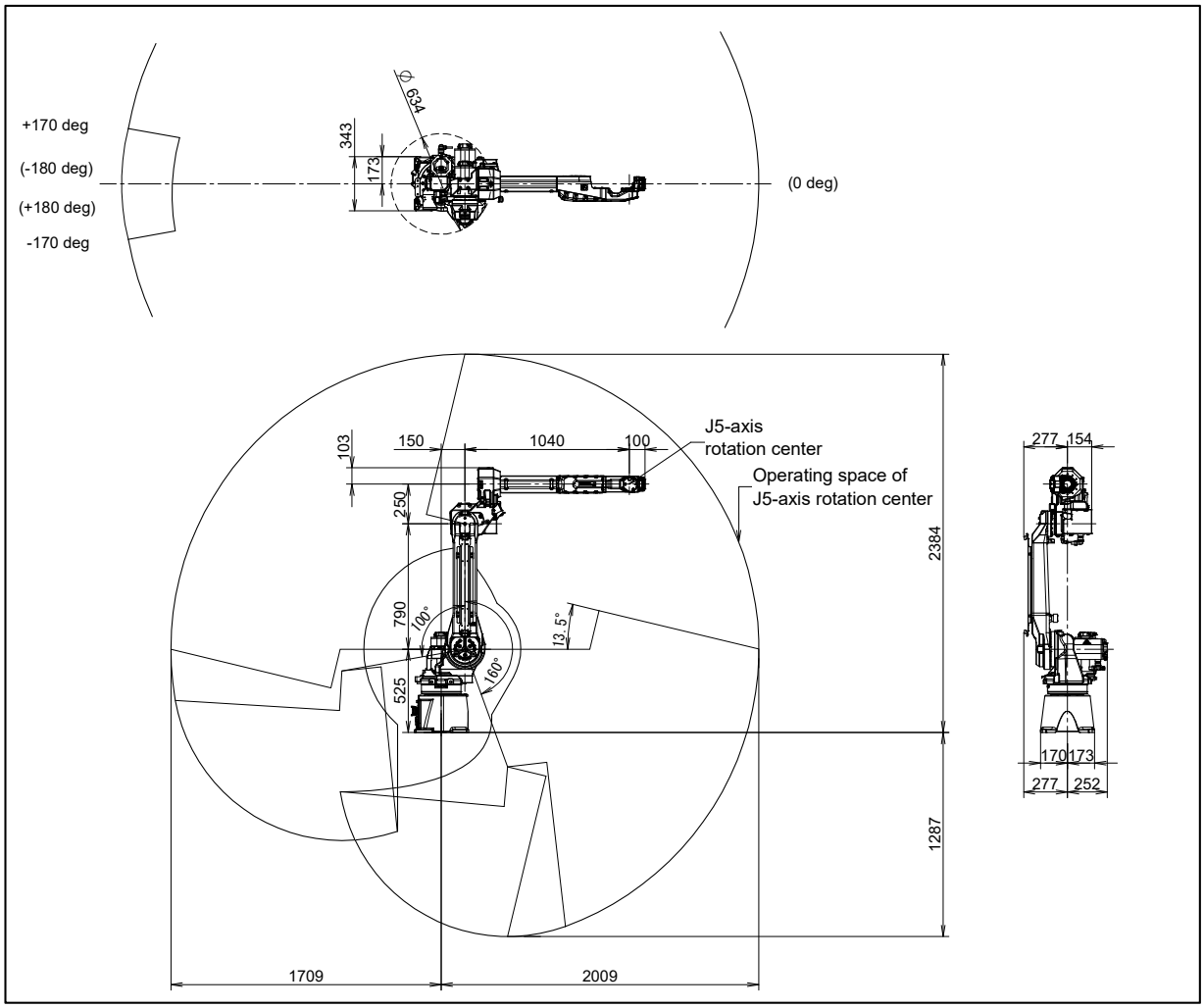


Fig. 3.2 (d) Operating space (ARC Mate 120*i*C/12L, M-20*i*A/12L)

3.3 ZERO POINT POSITION AND MOTION LIMIT

Zero point and motion range are provided for each controlled axis. Exceeding the software motion limit of a controlled axis is called overtravel (OT). Overtravel is detected at both ends of the motion limit for each axis. The robot cannot exceed the motion range unless there is a loss of zero point position due to abnormalities in servo system or system error. In addition, the motion range limit by a mechanical stopper is also prepared to improve safety.

Fig. 3.3 (a) shows the position of the mechanical stopper. For the J1 to J3-axis, stopping by overtravel damages the mechanical stopper. If this occurs, replace the stopper with a new one. Don't reconstruct the mechanical stopper. There is a possibility that the robot doesn't stop normally.

Fig.3.3 (b) to (k) show the zero point, and mechanical stopper position of each axis.

* The motion range can be changed. For information on how to change the motion range, see Chapter 6, "AXIS LIMIT SETUP".

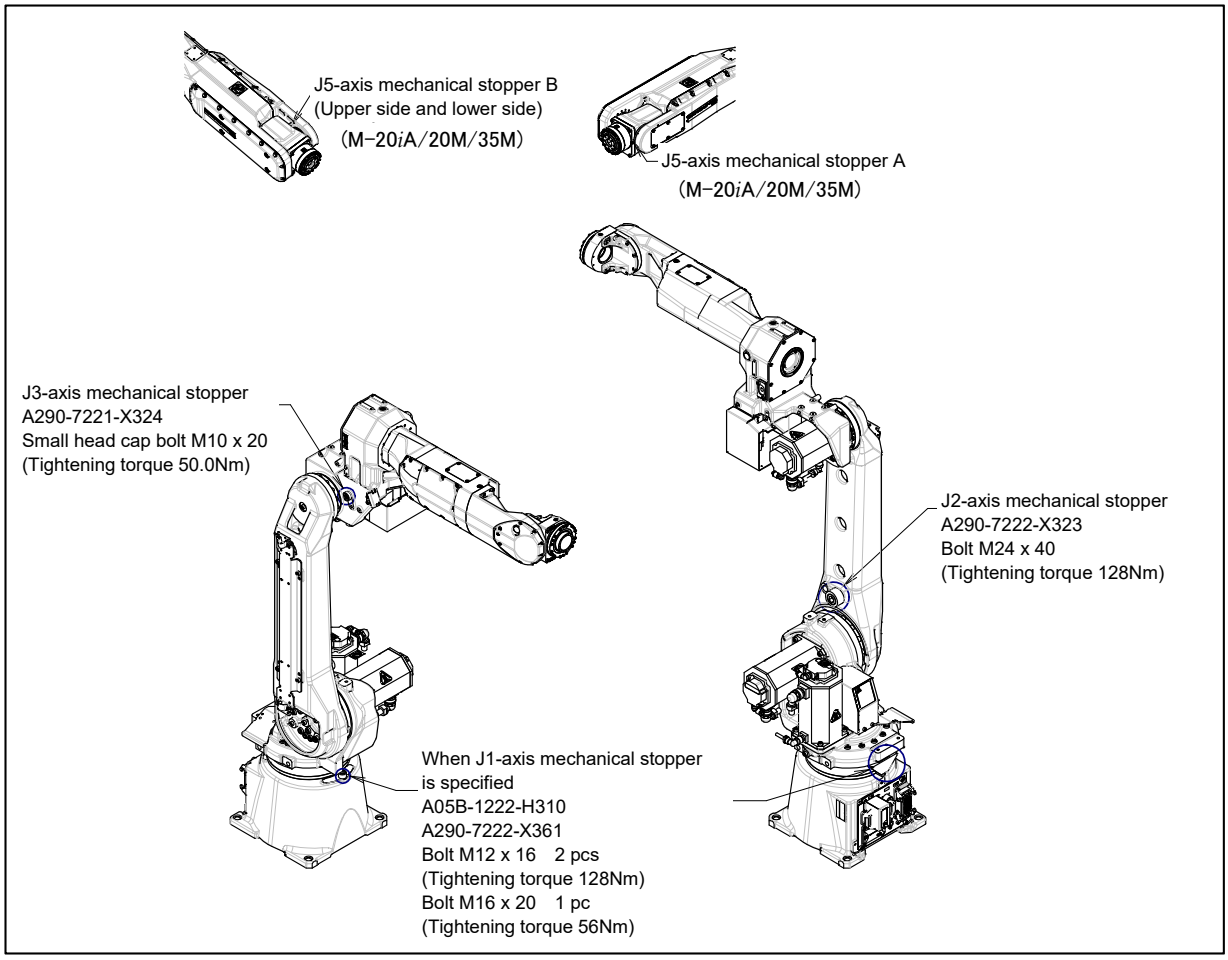


Fig. 3.3 (a) Position of mechanical stopper

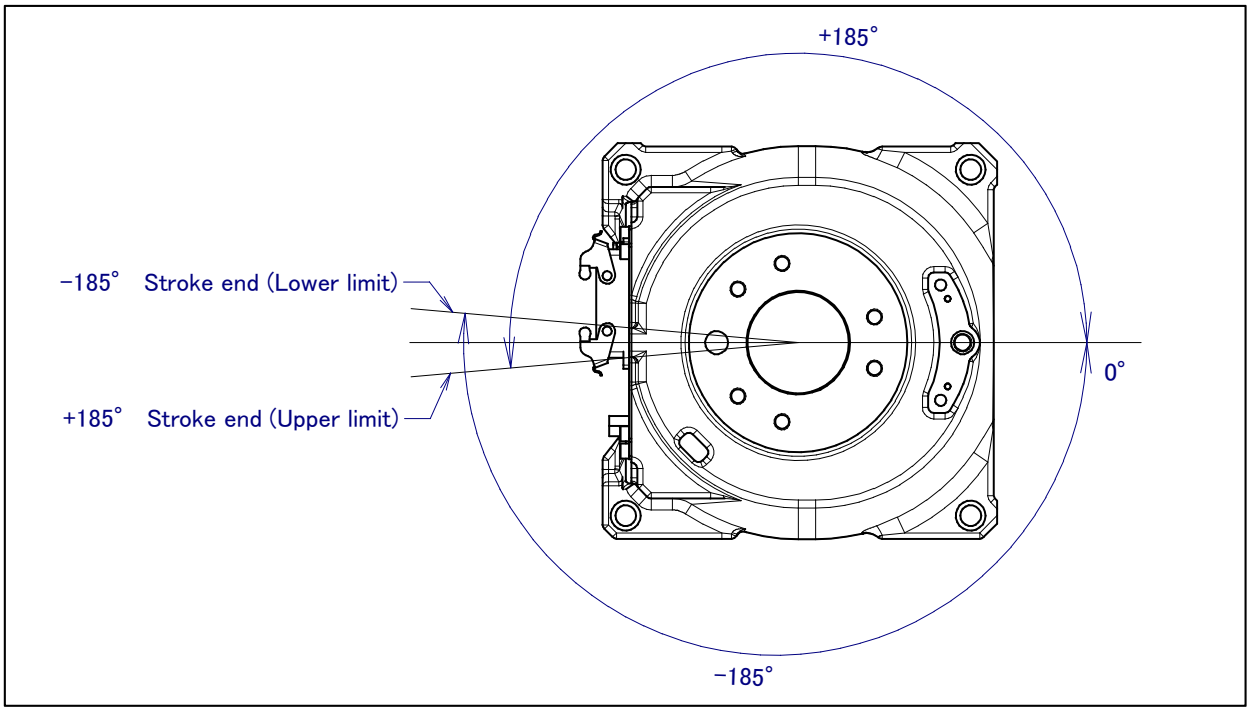


Fig. 3.3 (b) J1-axis motion limit (When mechanical stopper is not selected)

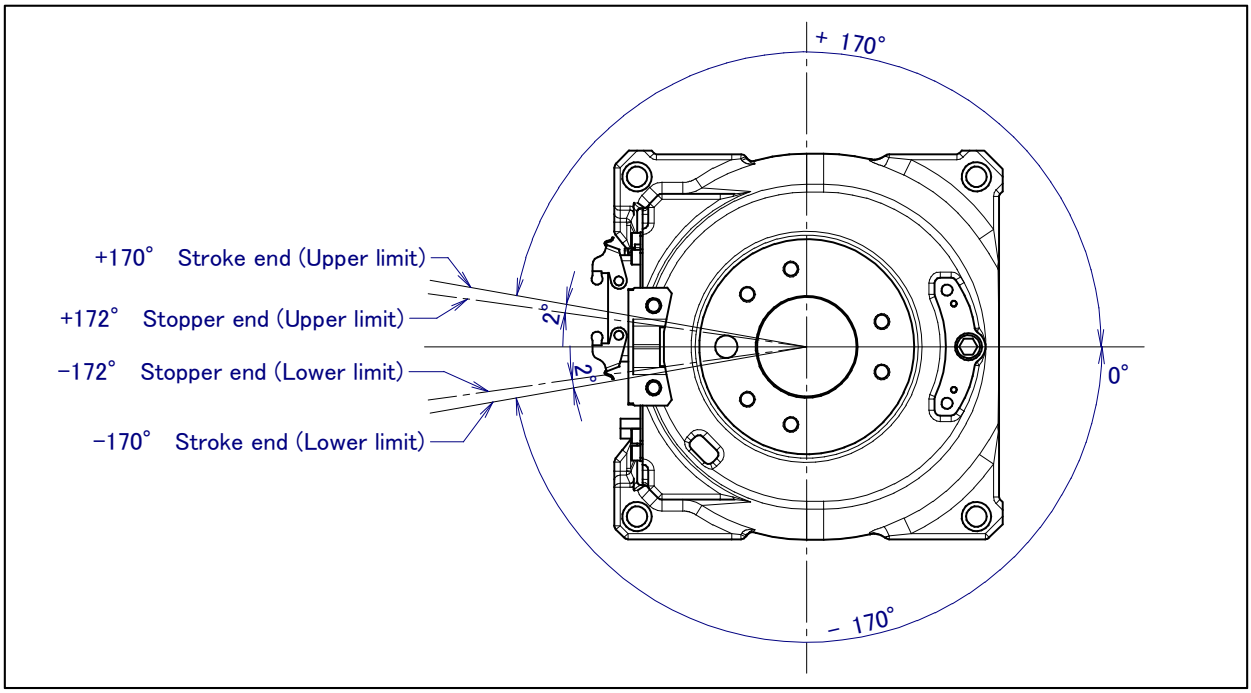


Fig. 3.3 (c) J1-axis motion limit (When mechanical stopper is selected)

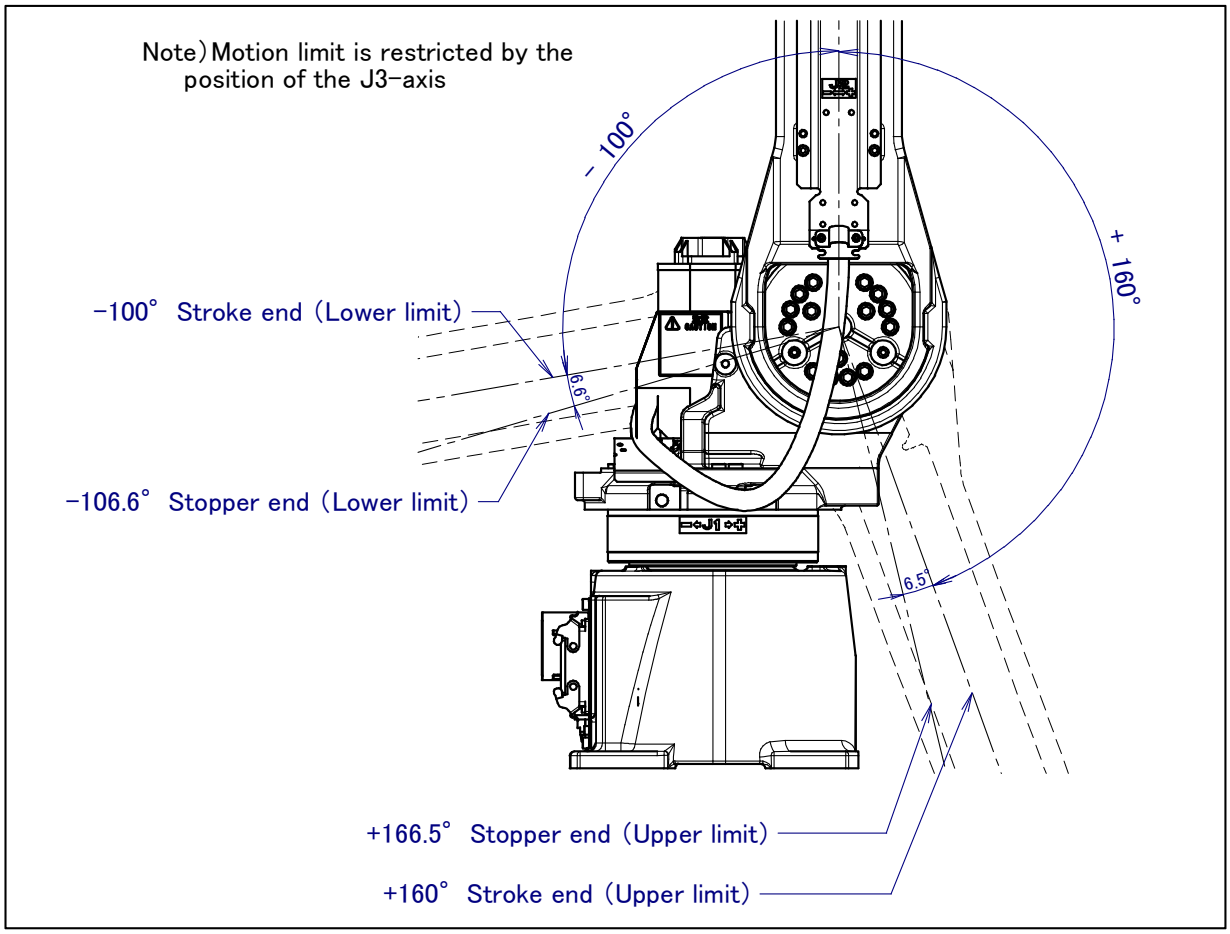


Fig. 3.3 (d) J2-axis motion limit

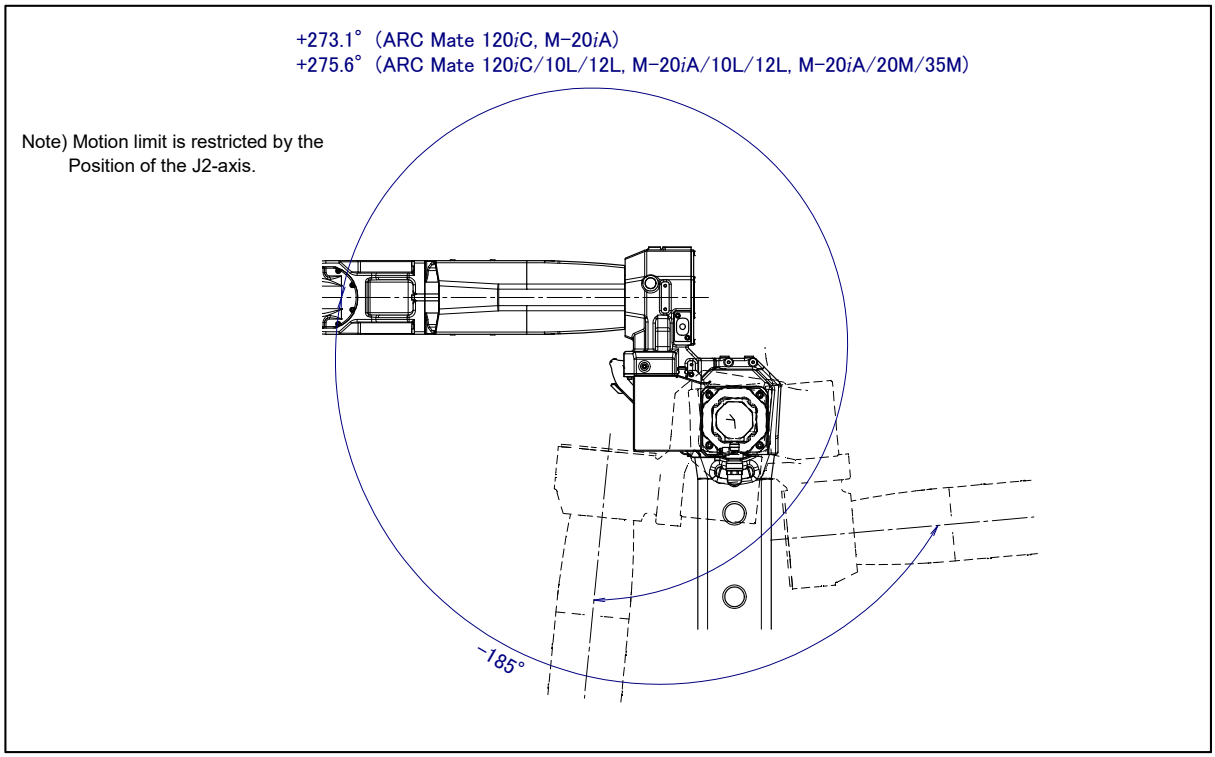


Fig. 3.3 (e) J3-axis motion limit

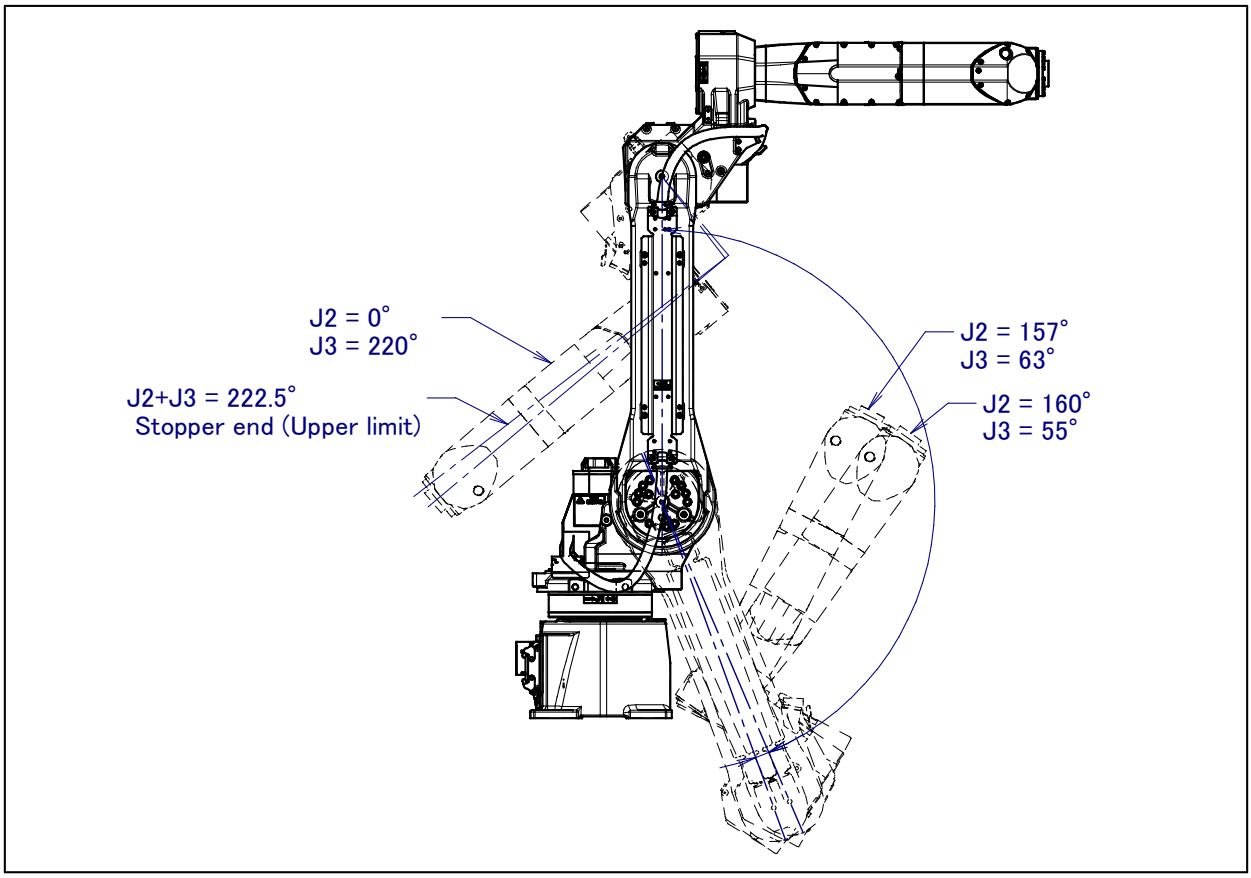


Fig. 3.3 (f) J2/J3-axis motion limit (Upper limit)

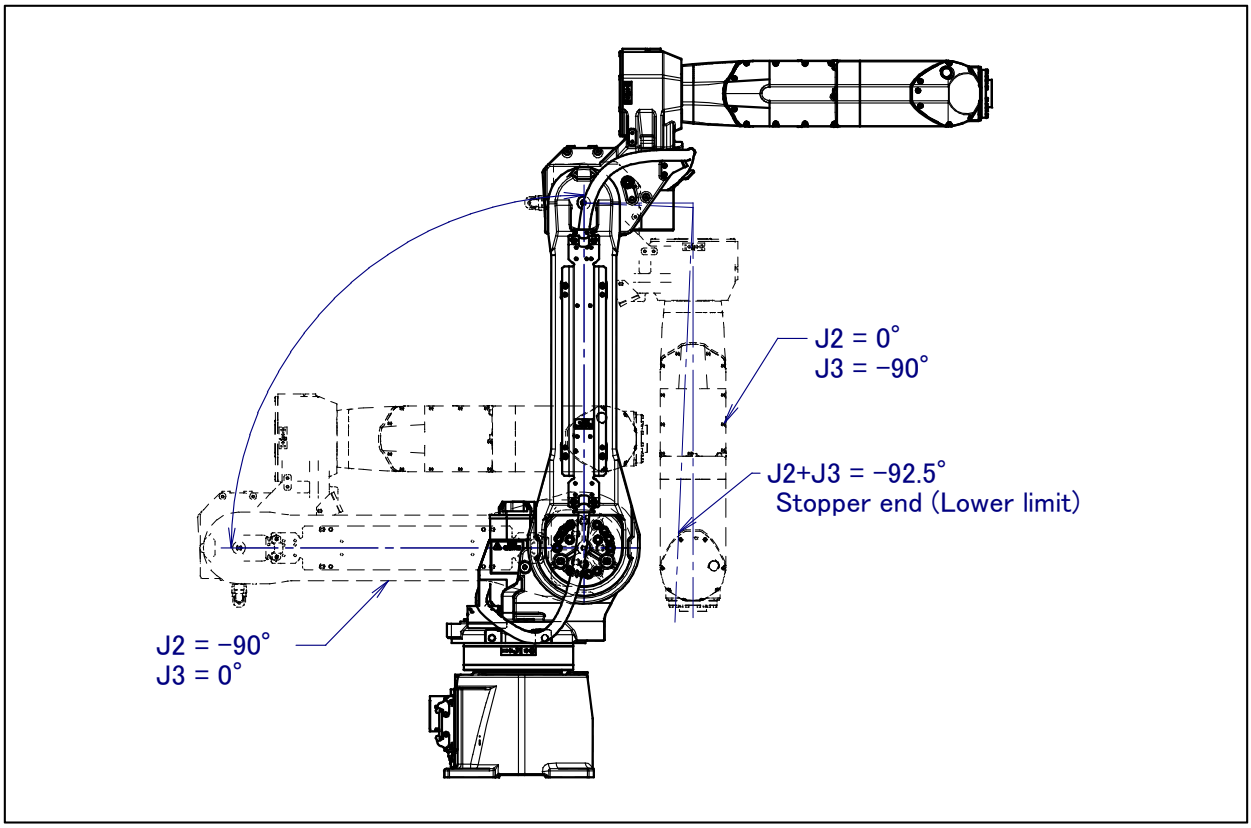


Fig. 3.3 (g) J2/J3-axis motion limit (Lower limit)

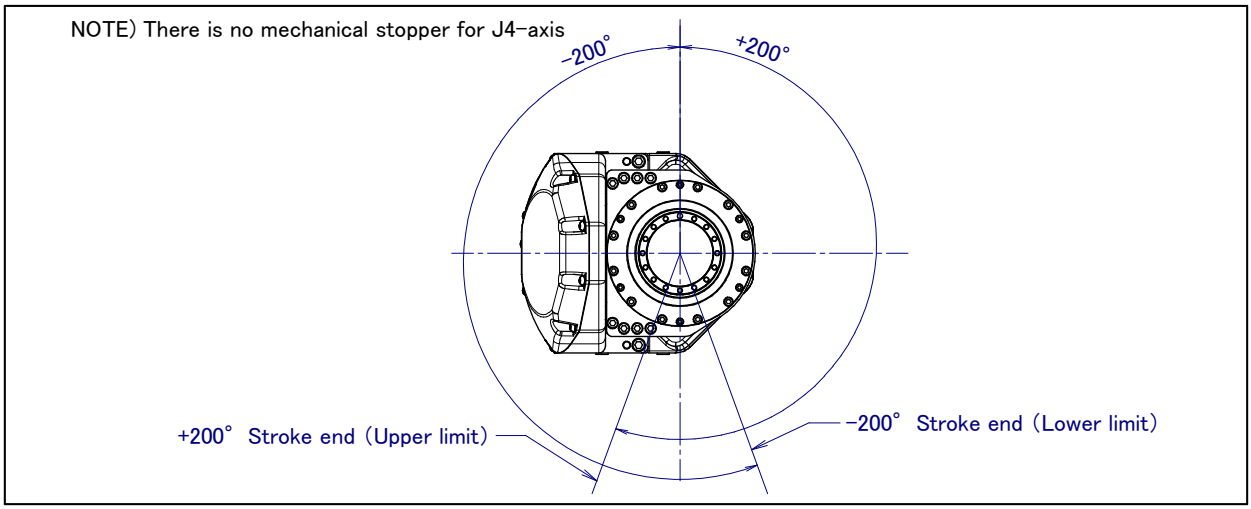


Fig. 3.3 (h) J4-axis motion limit

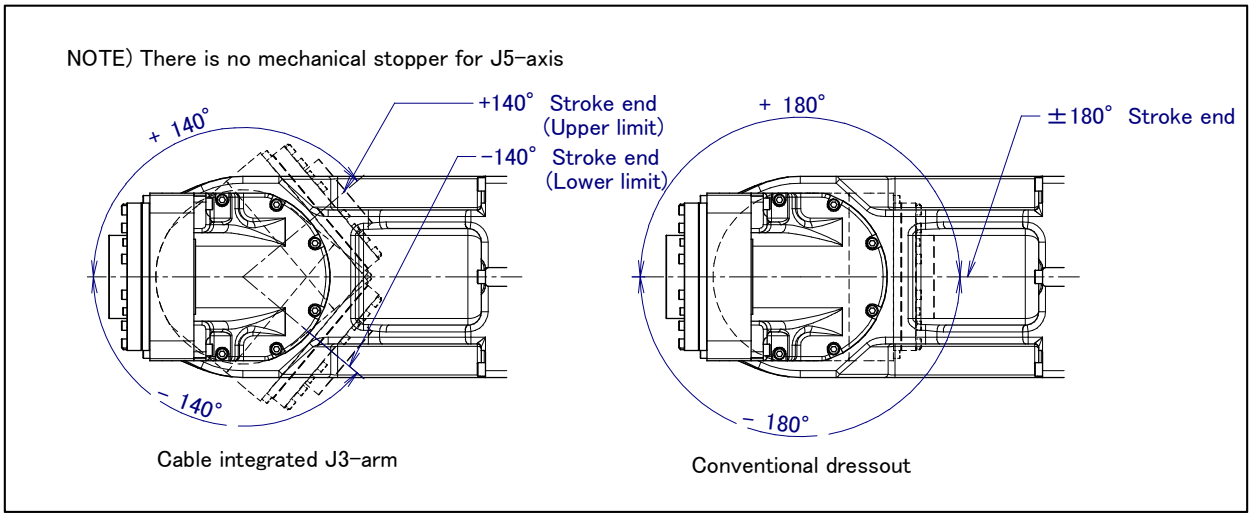


Fig. 3.3 (i) J5-axis motion limit
(ARC Mate 120*i*C, M-20*i*A, ARC Mate 120*i*C/10L/12L, M-20*i*A/10L/12L)

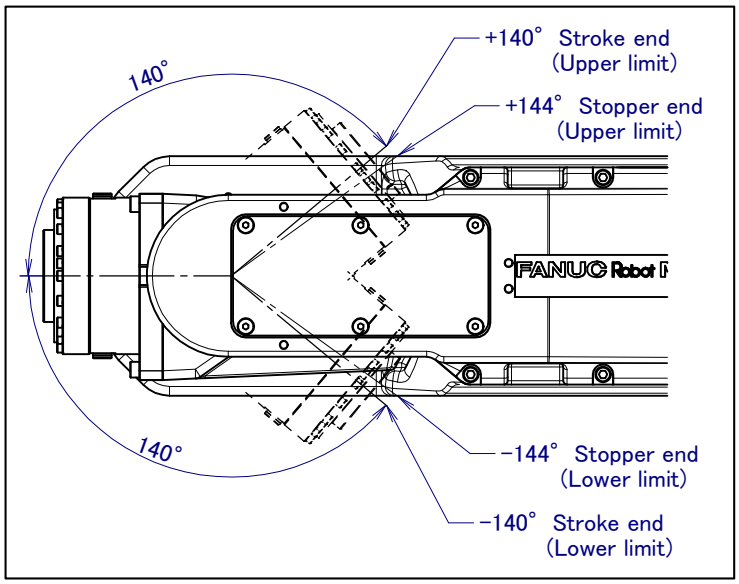


Fig. 3.3 (j) J5-axis motion limit (M-20*i*A/20M/35M)

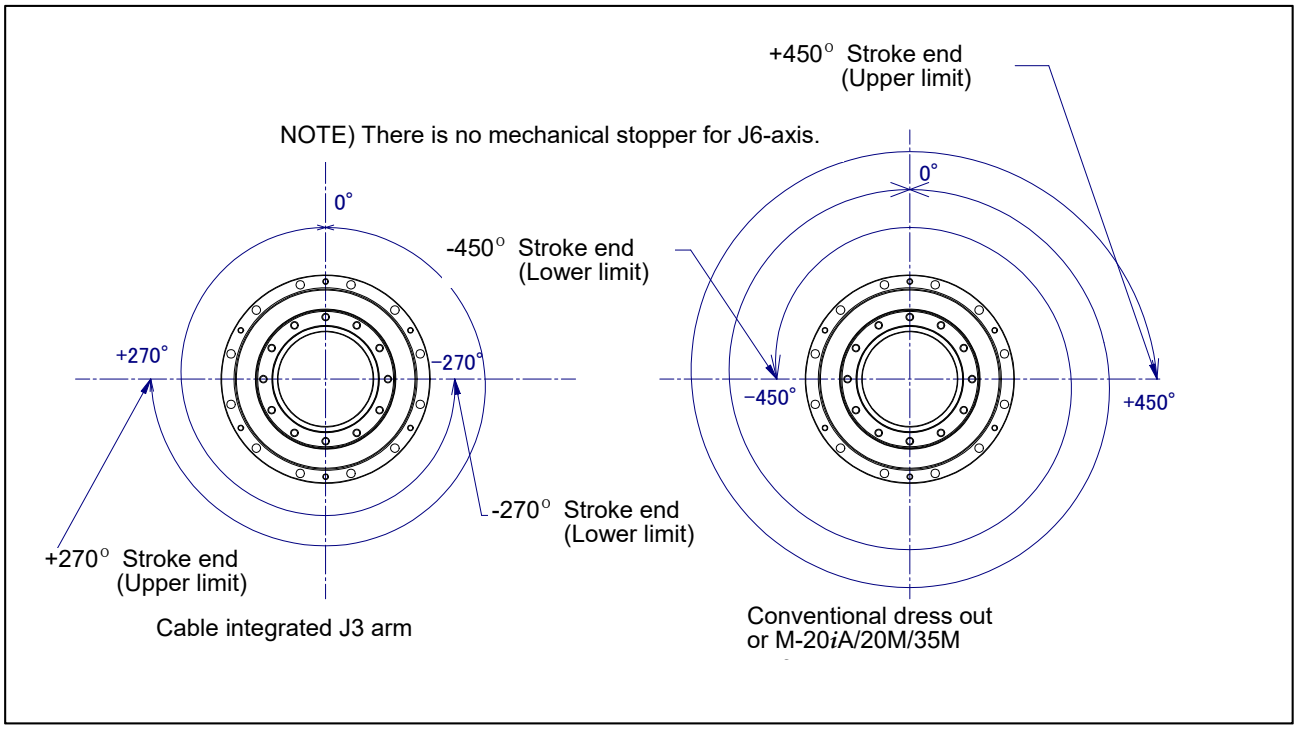


Fig. 3.3 (k) J6-axis motion limit

3.4 ABOUT THE SETTING OF THE MOTION RANGE OF THE ROBOT

In ARC Mate 120*i*C(M-20*i*A), Cable is integrated hollow part of J3 arm is standard. (It is “Cable integrated J3 Arm type” in the following). When the robot is shipped, is set to the range of motion of “Cable integrated J3 arm type”.
The case where conduit is inserted in the J3 arm hollow part, and the cable is passed as shown in Fig. 3.4 is defined as "Cable integrated J3 arm".
Other than the above-mentioned, the case where the cable is passed outside of the J3 arm is defined as "Conventional dress-out” and the case of where the option of no dust M/H conduit is defined as "No dust M/H conduit”.

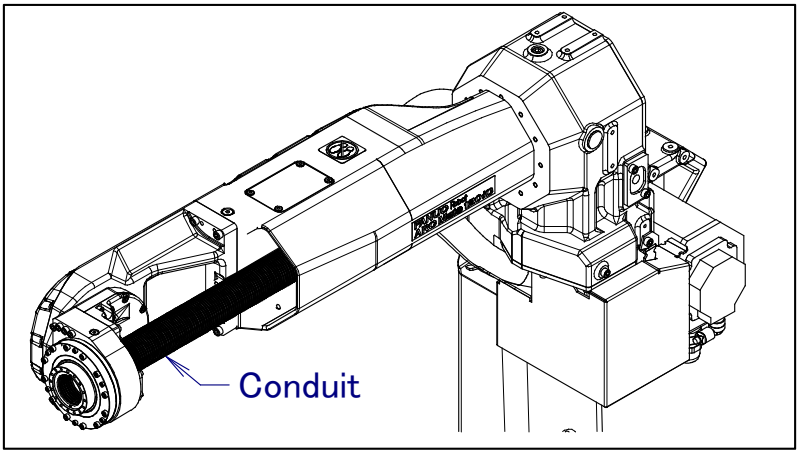


Fig. 3.4 (a) Example of “Cable integrated J3 arm”

When robot is used with “Conventional dress-out” or "No dust M/H conduit”, its motion range needs to be reset. Set the motion range by the following methods.

1 Perform a Controlled Start.
2 Set “Conventional dress-out” or "No dust M/H conduit” on the robot initialization screen
3 Perform a Cold Start.

```
1: Cable integrated J3 arm
   (J5:-140 .. 140, J6:-270 .. 270[deg])
2: Conventional dress-out
   (J5:-180 .. 180, J6:-360 .. 360[deg])
3: No dust M/H conduit
   (J5:-120 .. 120, J6:-270 .. 270[deg])

Select cable dress-out type (1 or 2 or 3) ->
```

1) Note about “Cable integrate J3 arm” type
   The range of motion of “1” is a set value when the hand (torch and tool) cable which FANUC recommends is integrated in J3 arm. (Handling specification. M/H conduit option [A05B-1222-J701, J702, A05B-1225-J701] is needed. Refer to Section 11.3 about exchange cycle.) For other cases, set motion range and the regular replacement cycle of the wrist axis according to the specification of installed hand (torch and tool) cable, just like with conventional dress out type.
2) Note about “Conventional dress out” type
   The range of motion of “2” is the one of the dress out type. Set the motion range and the regular exchange cycle of the wrist axis according to installing hand (torch and tool) cable as usual.
3) Note about “No dust M/H conduit” type
   The range of motion of “3” is the motion range when the no dust M/H conduit option [A05B-1222-J721, A05B-1225-J721] is specified. Set the motion range and the regular exchange cycle of the wrist axis according to the installing hand (tool) cable. (Refer to Chapter 11 about exchange cycle.)

3.5 WRIST LOAD CONDITIONS

Fig. 3.5 (a) to (g) are diagrams showing the allowable load that can be applied to the wrist section.

- Apply a load within the region indicated in the graph.
- Please use it to meet the requirement of the allowable load moment and inertia at wrist. See the 3.1 about allowable load moment and inertia at wrist.
- See Section 4.1 about mounting of end effector.

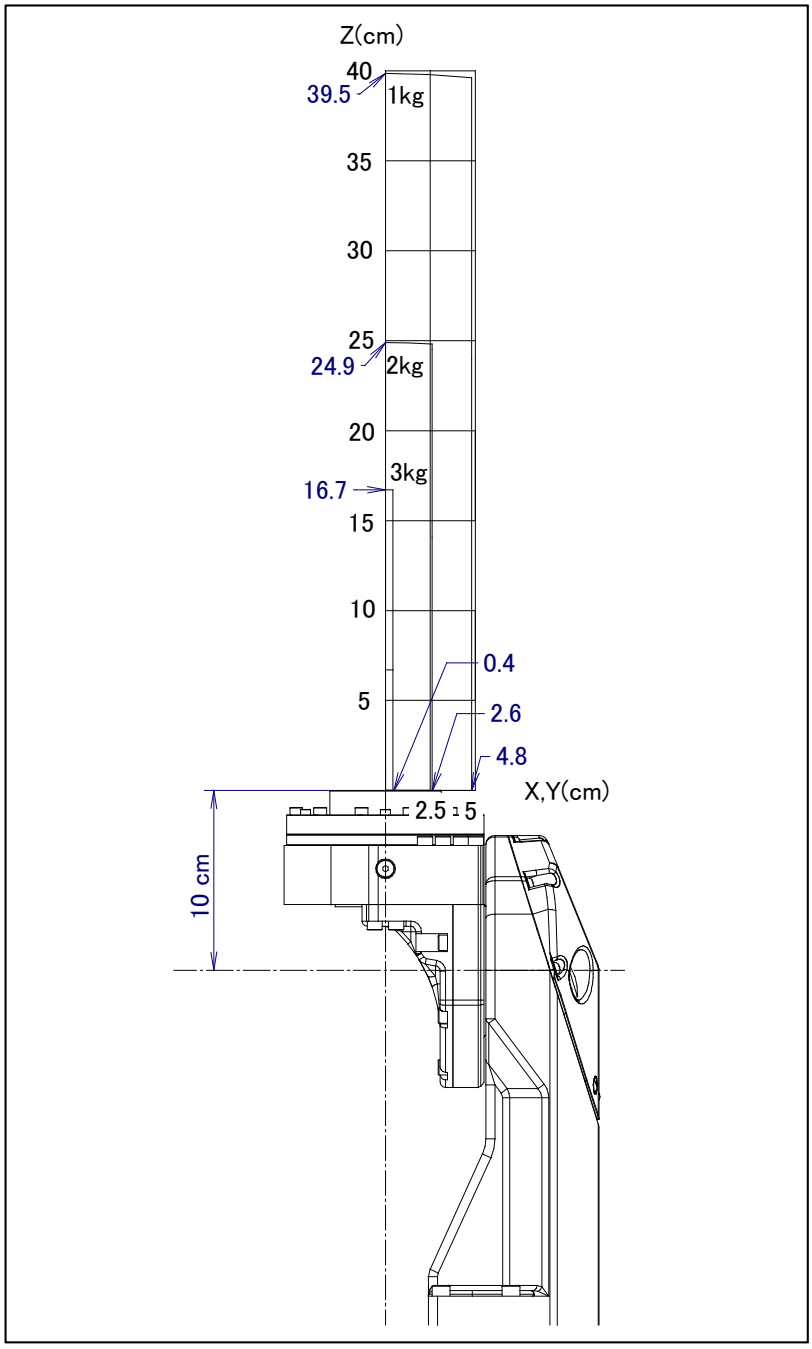


Fig. 3.5 (a) Wrist load diagram
(ARC Mate 120*i*C, M-20*i*A 3kg wrist payload specification)

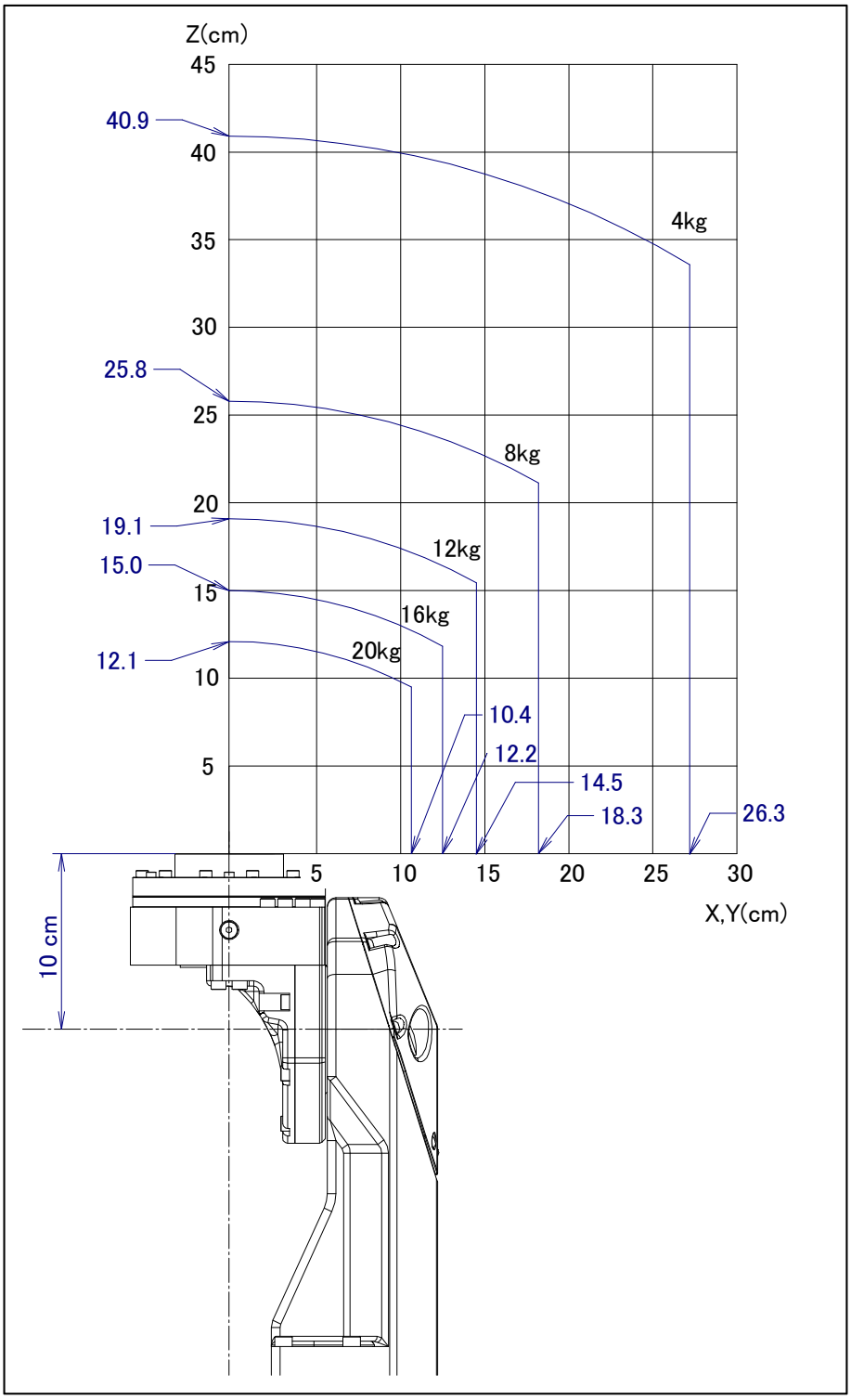


Fig. 3.5 (b) Wrist load diagram
(ARC Mate 120*i*C, M-20*i*A 20kg wrist payload specification)

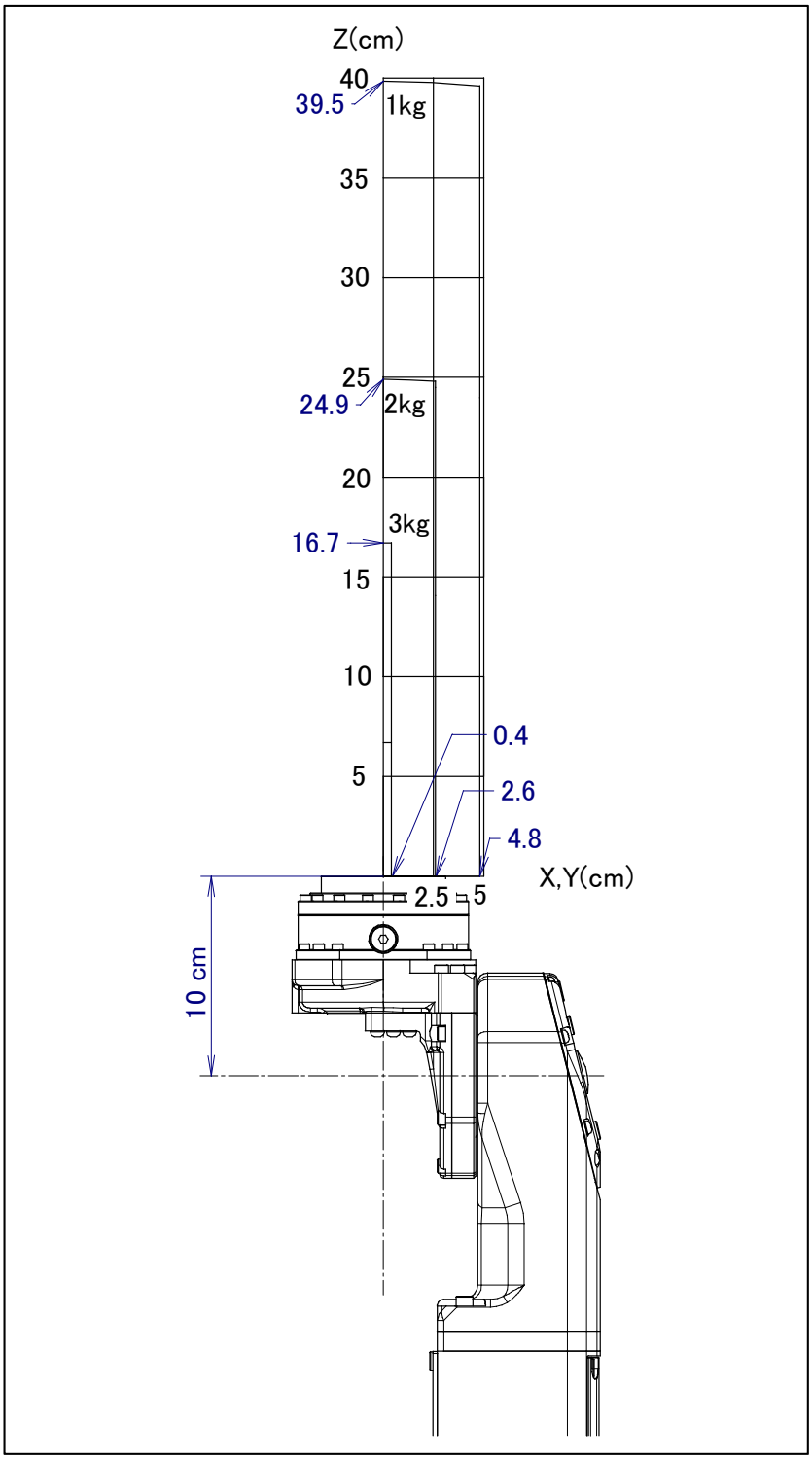


Fig. 3.5 (c) Wrist load diagram
(ARC Mate 120*i*C/10L, M-20*i*A/10L, ARC Mate 120*i*C/12L, M-20*i*A/12L 3kg wrist payload specification)

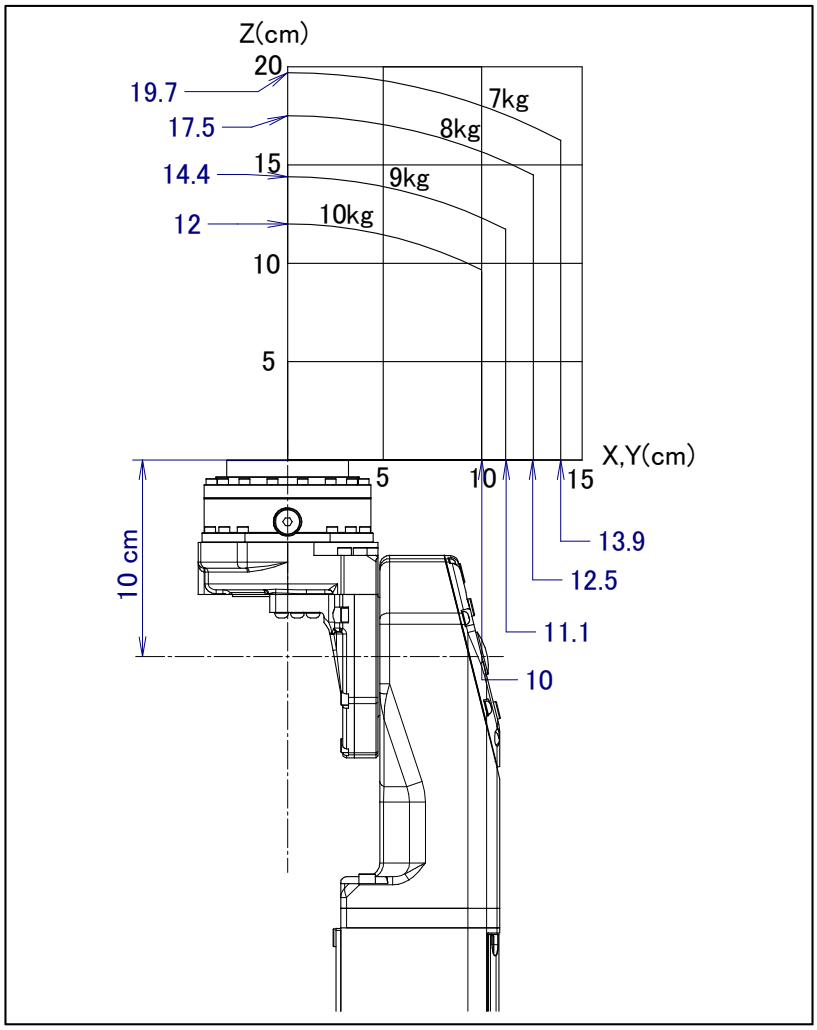


Fig. 3.5 (d) Wrist load diagram
(ARC Mate 120*i*C/10L, M-20*i*A/10L 10kg wrist payload specification)

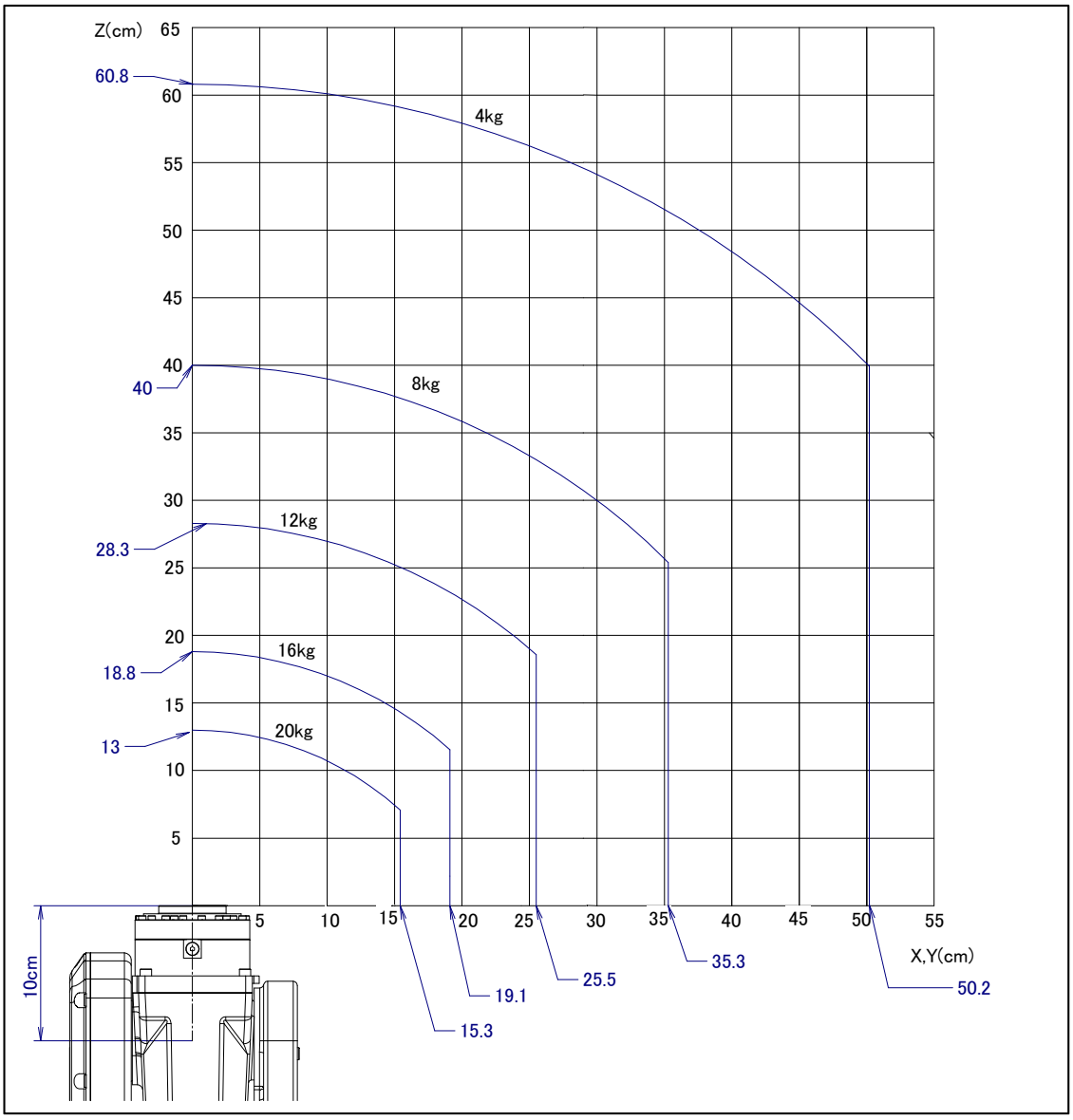


Fig. 3.5 (e) Wrist load diagram
(M-20*i*A/20M)

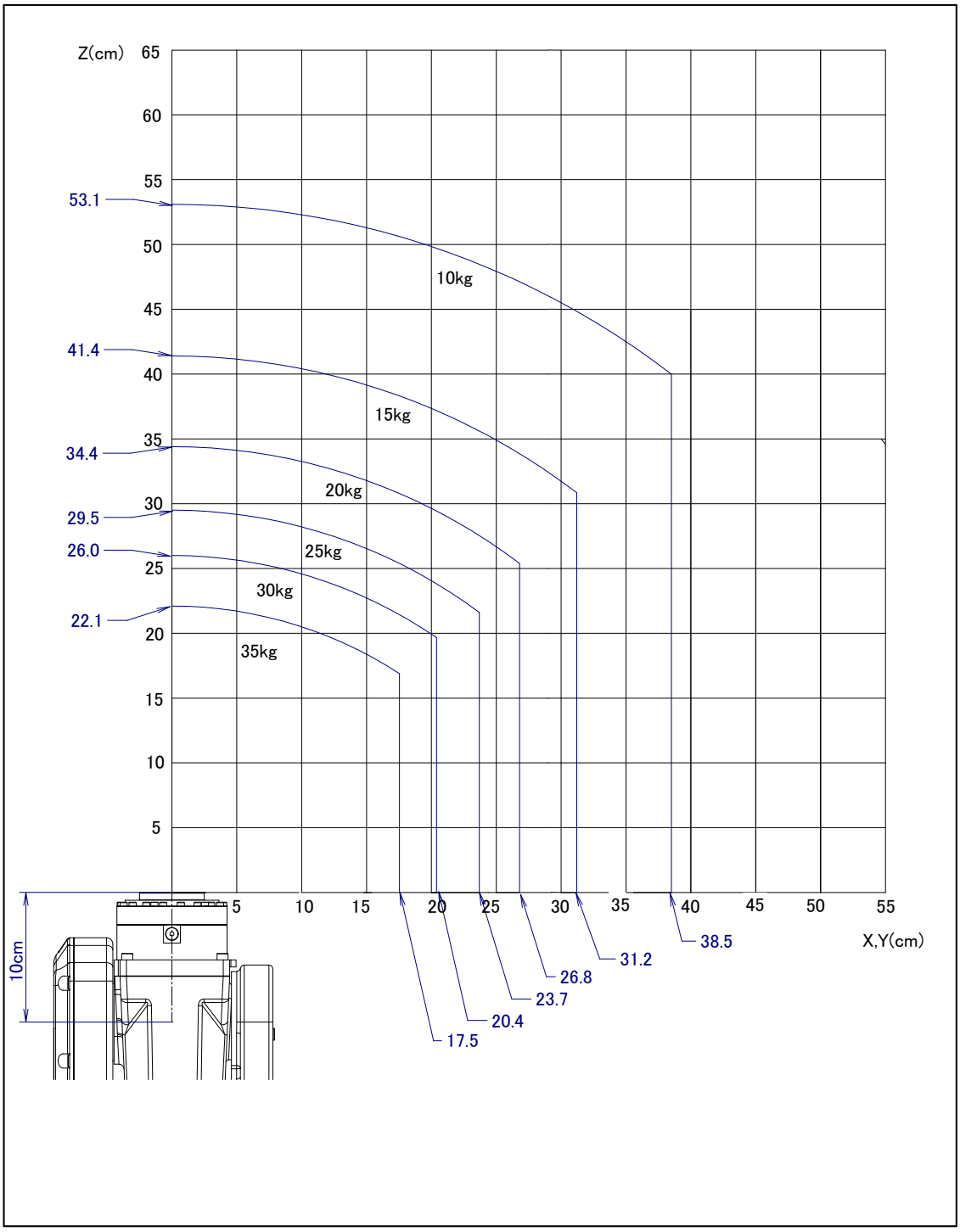


Fig. 3.5 (f) Wrist load diagram
(M-20*i*A/35M)

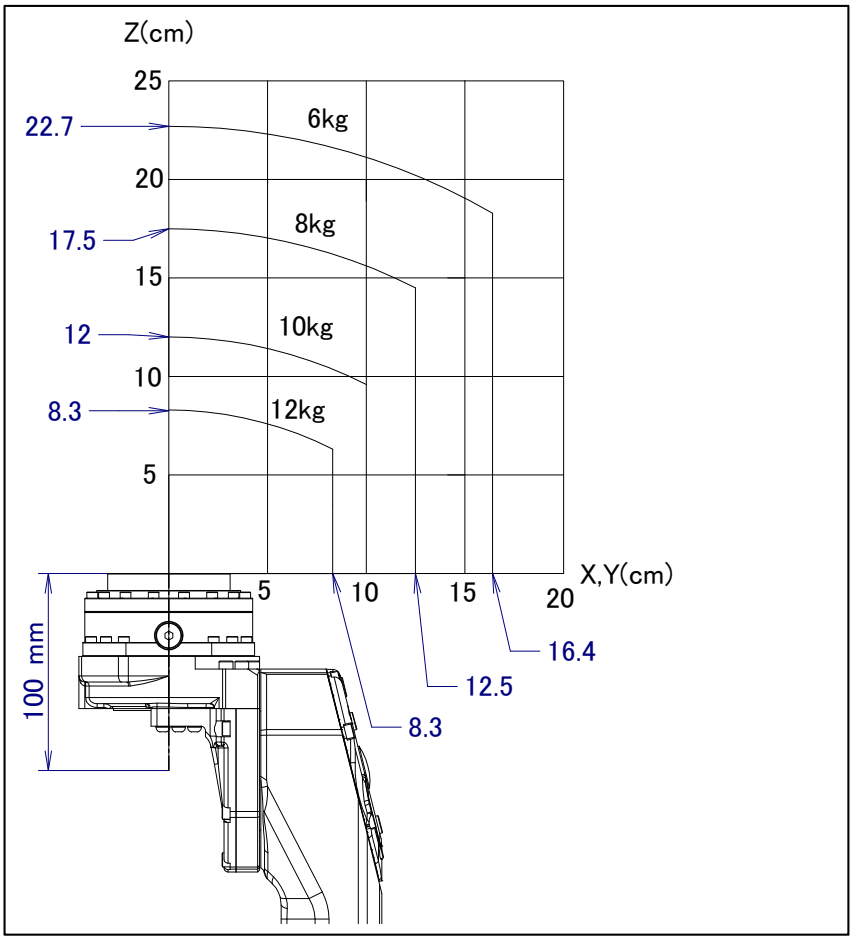


Fig. 3.5 (g) Wrist load diagram
(ARC Mate 120*i*C/12L, M-20*i*A/12L 12kg wrist payload specification)

3.6 OPERATING SPACE FOR INCLINATION INSTALLATION

In case of High inertia mode (20 kg payload specification in case of ARC Mate 120*i*C, M-20*i*A, 10 kg payload specification in case of ARC Mate 120*i*C/10L, M-20*i*A/10L, 12 kg payload specification in case of ARC Mate 120*i*C/12L, M-20*i*A/12L) or M-20***i***A/20M, M-20***i***A/35M, when the robot is installed on an angle, the operating space is limited as the angle.
Wall mount and inclination installation is enable against only the front direction and the back direction. Against side direction is impossible.

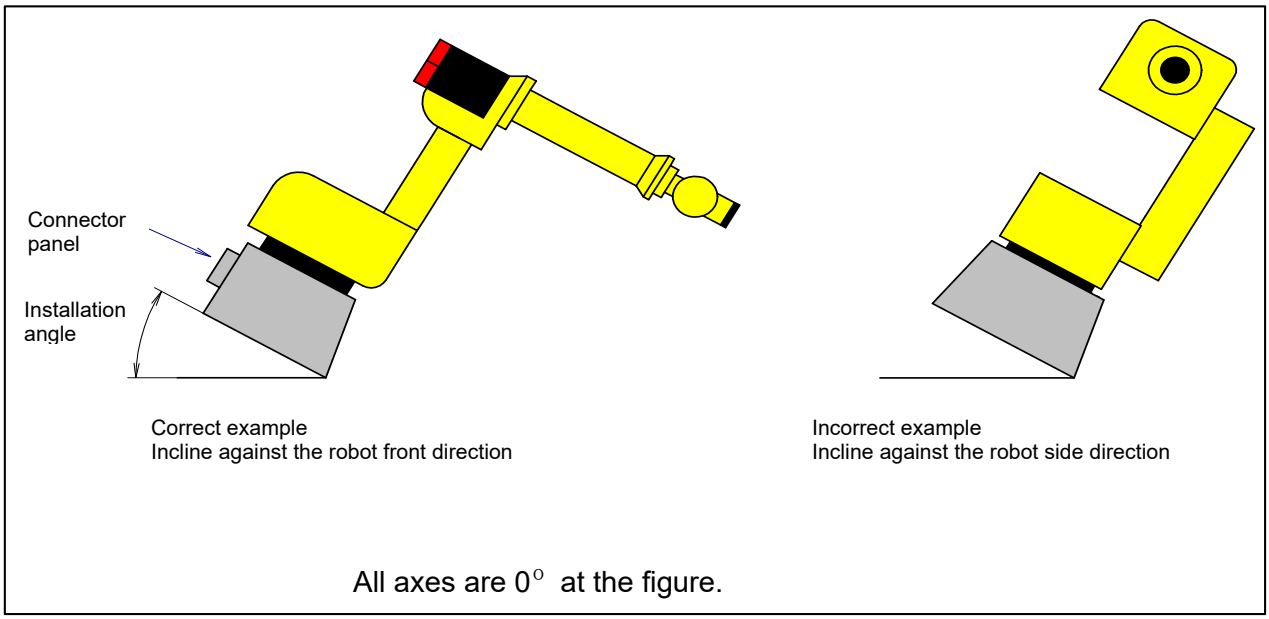


Fig.3.6 (a) Direction of robot wall mount and inclination installation

The robot can't rest except for the ranges that are shown in the Fig. 3.6 (b) to (n).
In case of standard welding mode (3kg payload specification), there is no restriction for operating area.

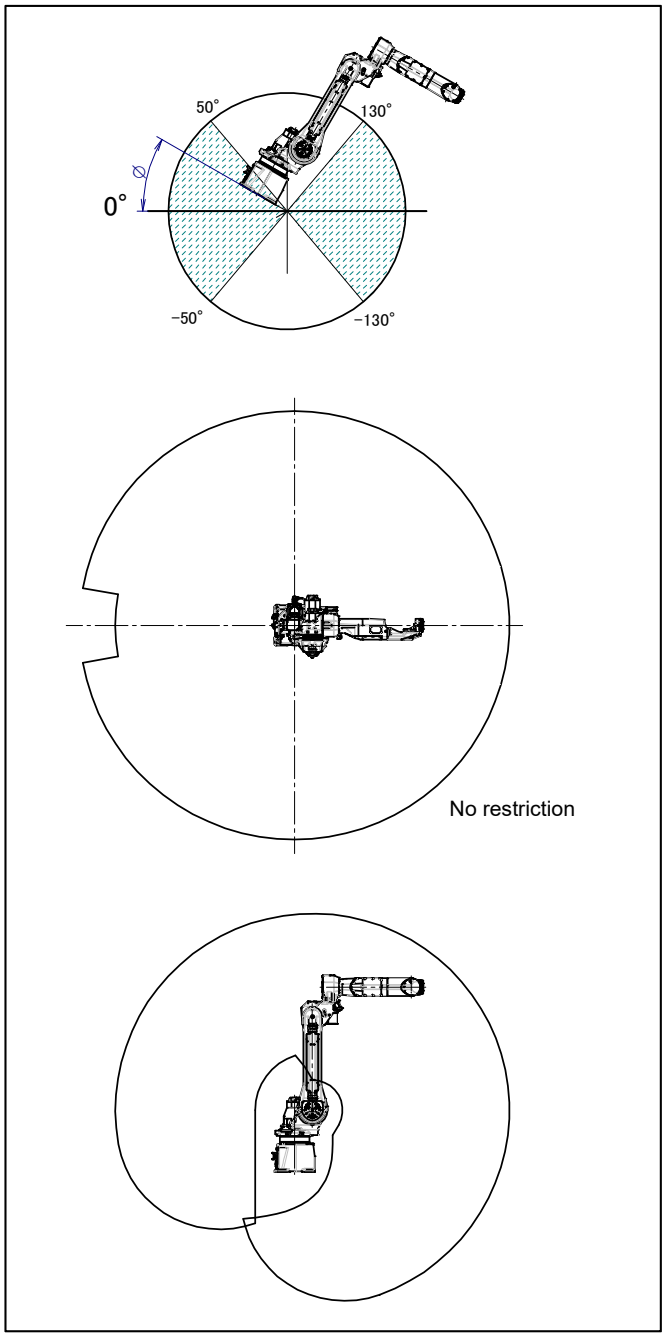


Fig. 3.6 (b) Installation area (1) operating space (ARC Mate 120*i*C, M-20*i*A)
(-180°≦ϕ≦−130°, -50°≦ϕ≦50°, 130°≦ϕ≦180°)

NOTE
In case of mounted angle (1), there is no operating area restriction.

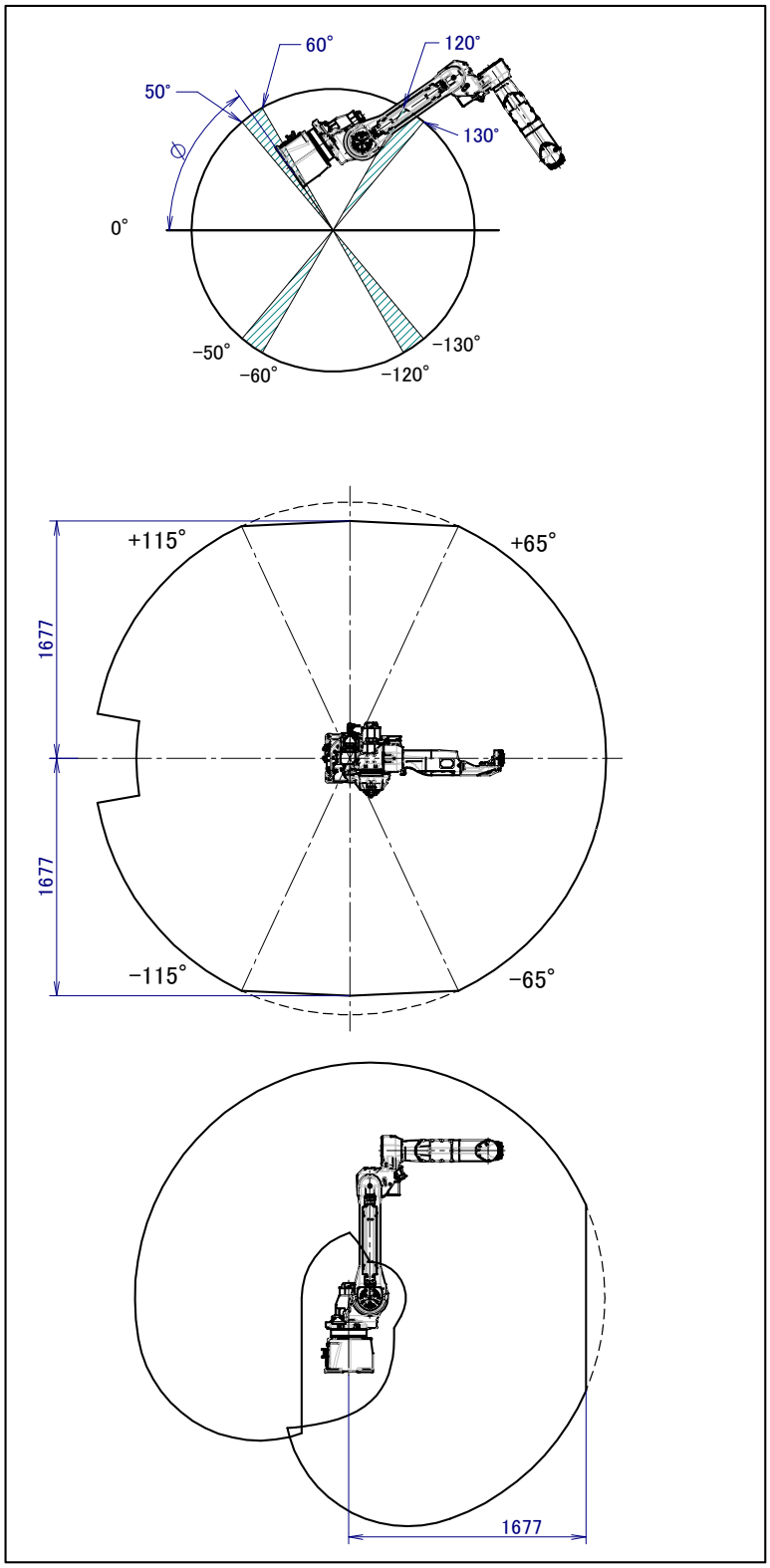


Fig. 3.6 (c) Installation area (2) operating space (ARC Mate 120*i*C, M-20*i*A)
(-130°<ϕ≦−120°, -60°≦ϕ<-50°, 50°<ϕ≦60°, 120°≦ϕ<130°)

NOTE
Robot can rest in a solid line range. The operation to a dotted line range becomes possible when not resting.

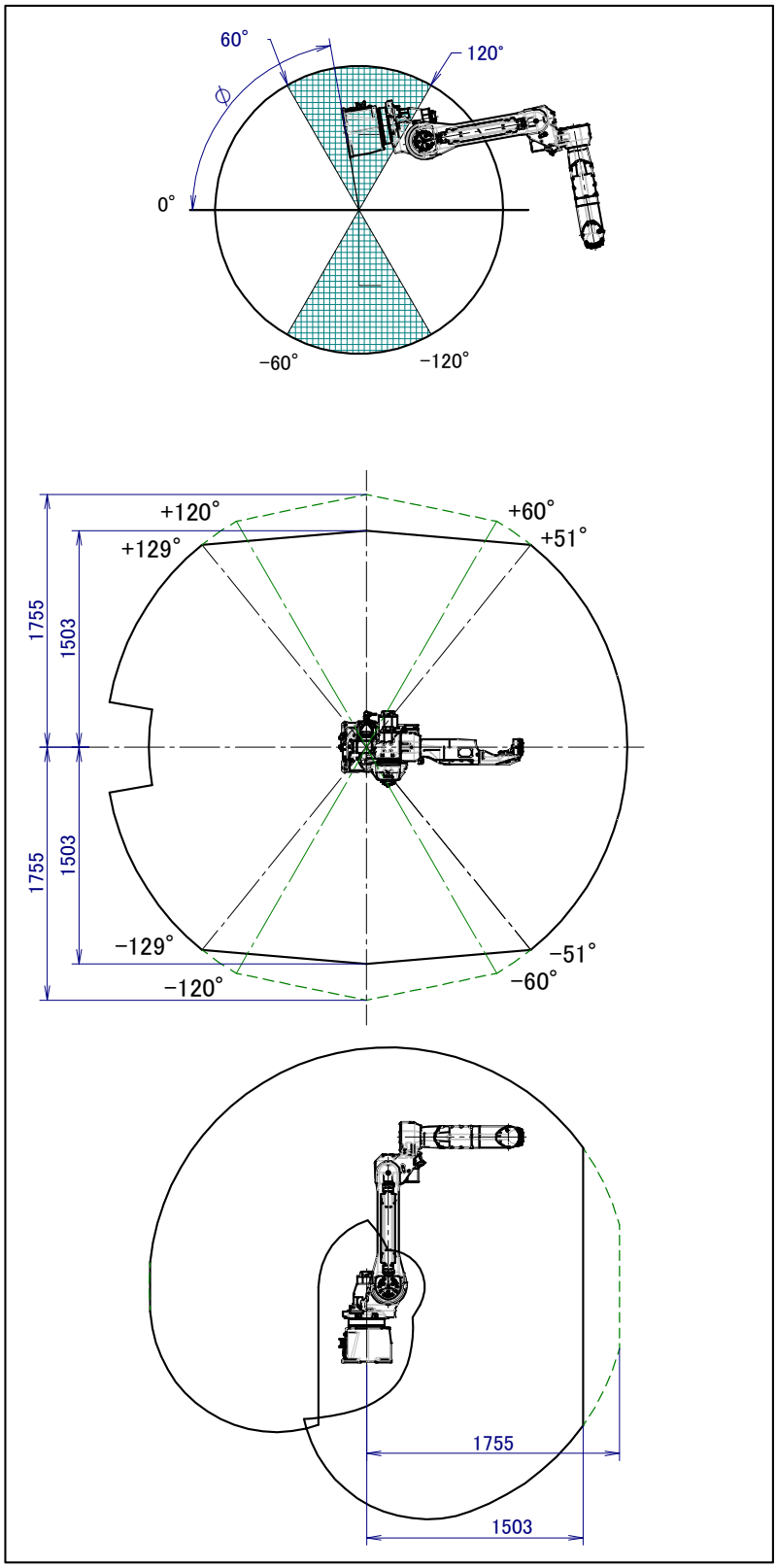


Fig. 3.6 (d) Installation area (3) operating space (ARC Mate 120*i*C, M-20*i*A)
(-120°<ϕ<-60°, 60°<ϕ<120°)

NOTE
Robot can rest in a solid line range. The operation to a dotted line range becomes possible when not resting.

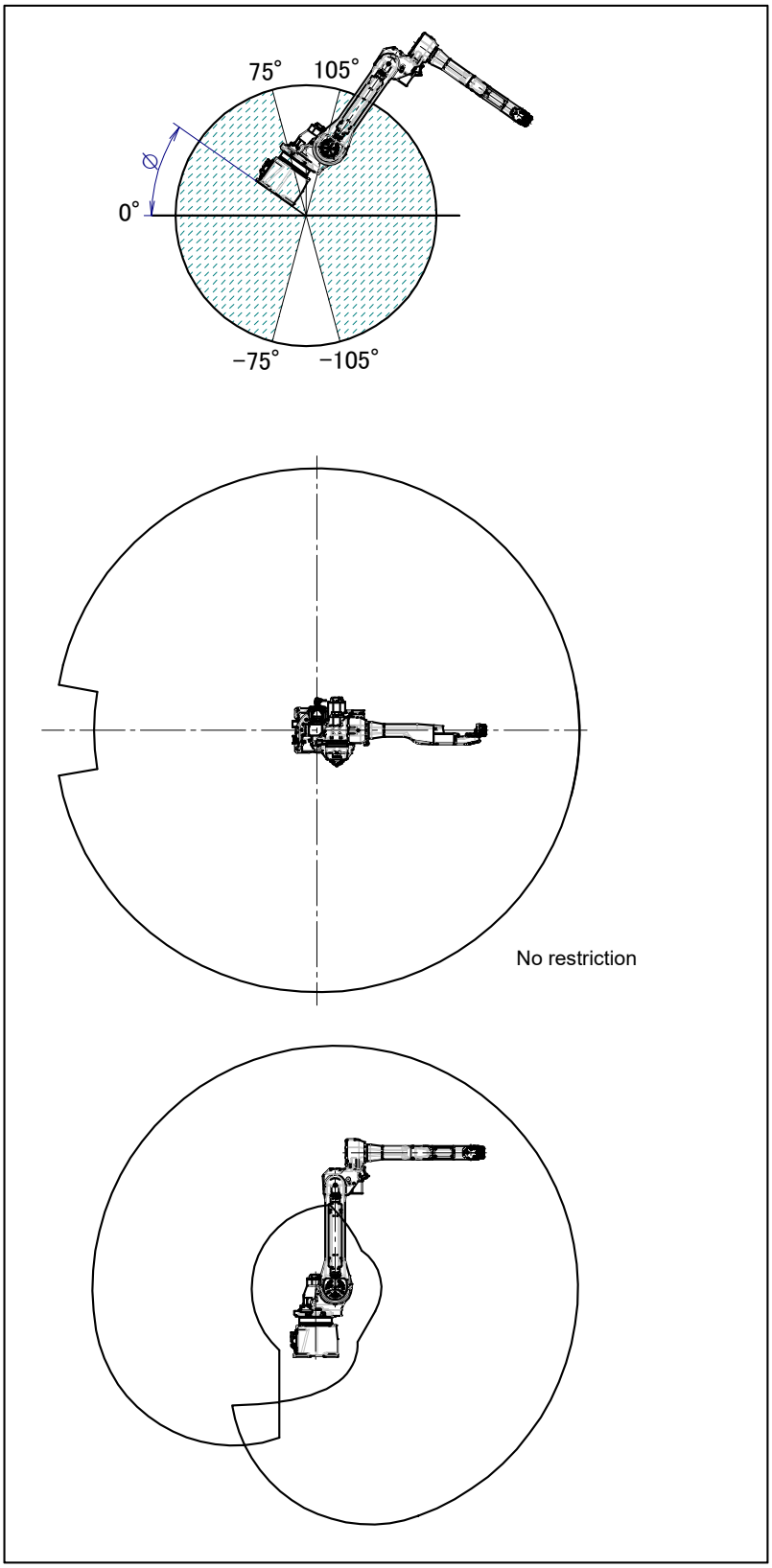


Fig. 3.6 (e) Installation area (1) operating space (ARC Mate 120*i*C/10L, M-20*i*A/10L)
(-180°≦ϕ≦105°, -75°≦ϕ≦75°, 105°≦ϕ≦180°)

NOTE
In case of mounted angle (1), there is no operating area restriction.

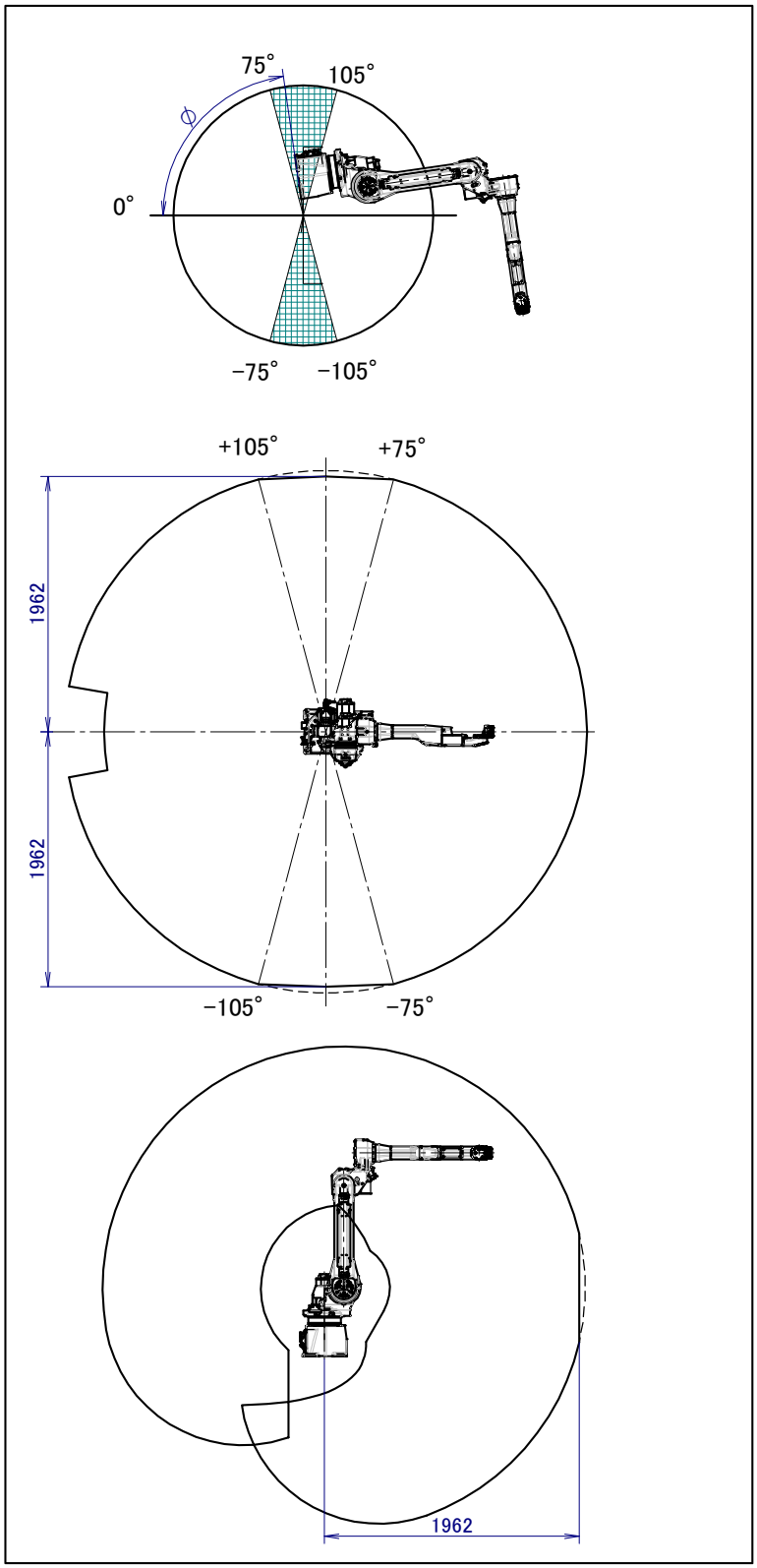


Fig. 3.6 (f) Installation area (2) operating space (ARC Mate 120*i*C/10L, M-20*i*A/10L)
(-105°<ϕ<-75°, 75°<ϕ<105°)

NOTE
Robot can rest in a solid line range. The operation to a dotted line range becomes possible when not resting.

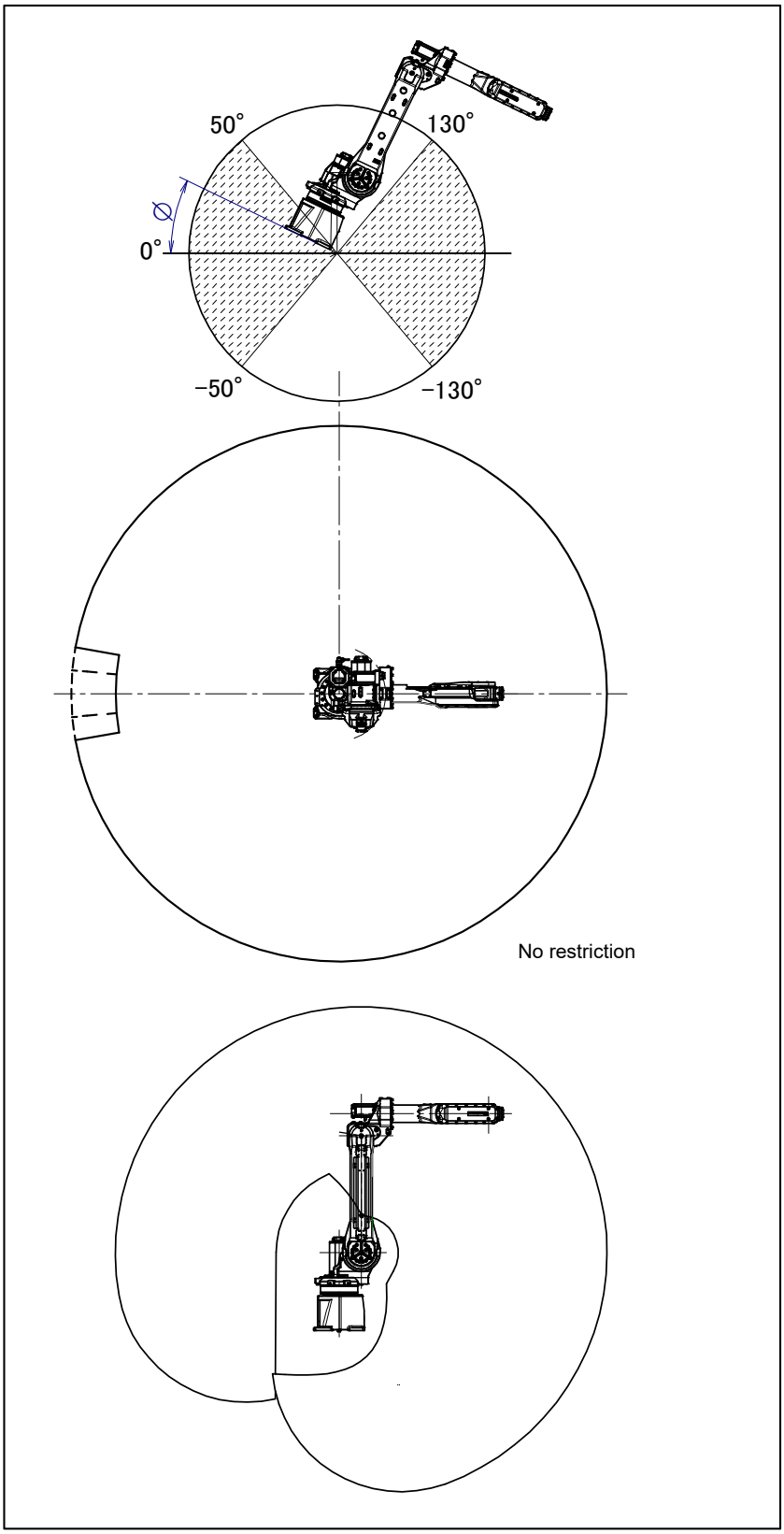


Fig. 3.6 (g) Installation area (1) operating space (M-20*i*A/20M)
(-180°≦φ≦−130° -50°≦φ≦50°, 130°≦φ≦180°)

NOTE
In case of mounted angle (1), there is no operating area restriction.

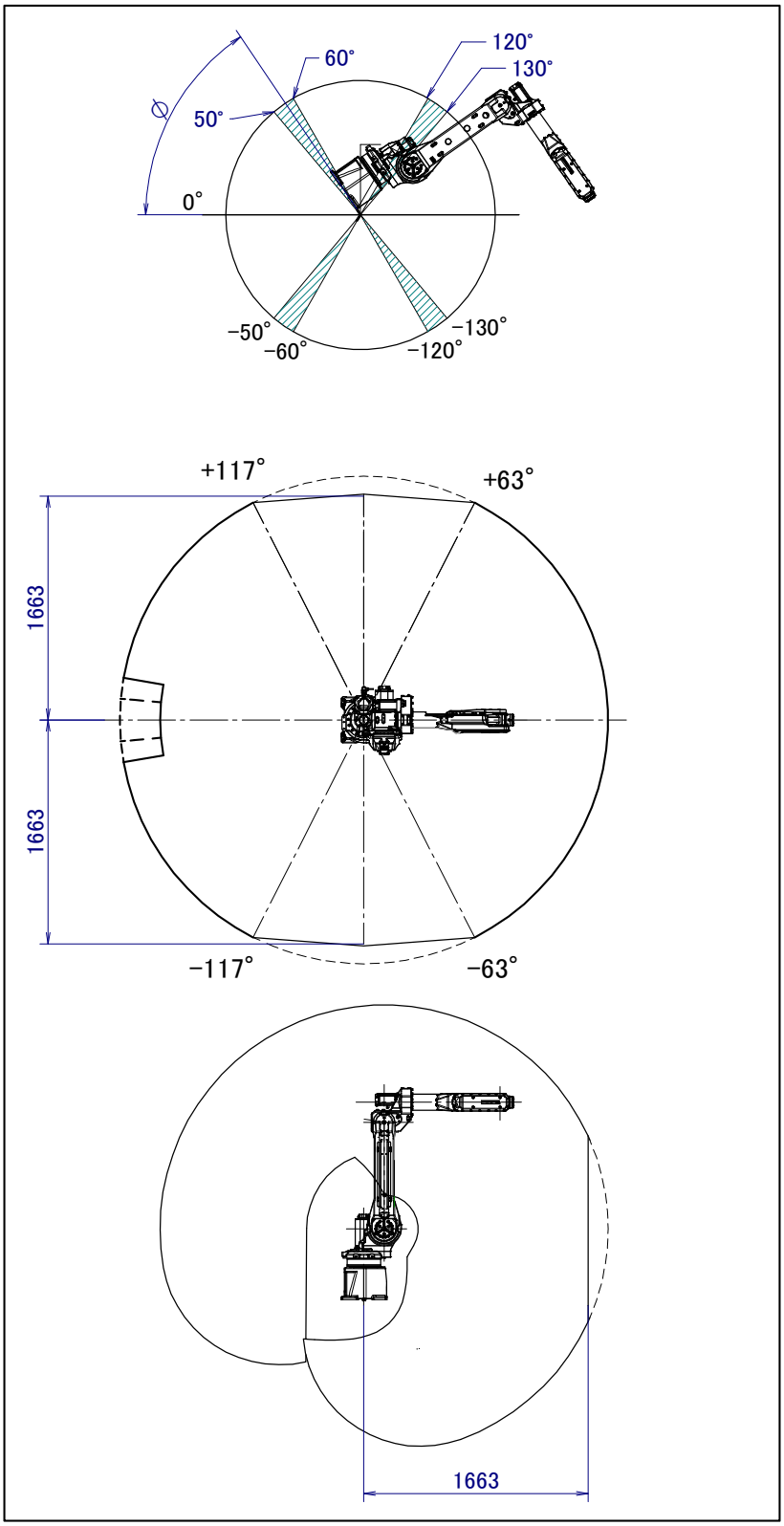


Fig. 3.6 (h) Installation area (2) operating space (M-20*i*A/20M)
(-130°<φ≦-120° -60°≦φ<-50° 50°<φ≦60°, 120°≦φ<130°)

NOTE
Robot can rest in a solid line range. The operation to a dotted line range becomes possible when not resting.

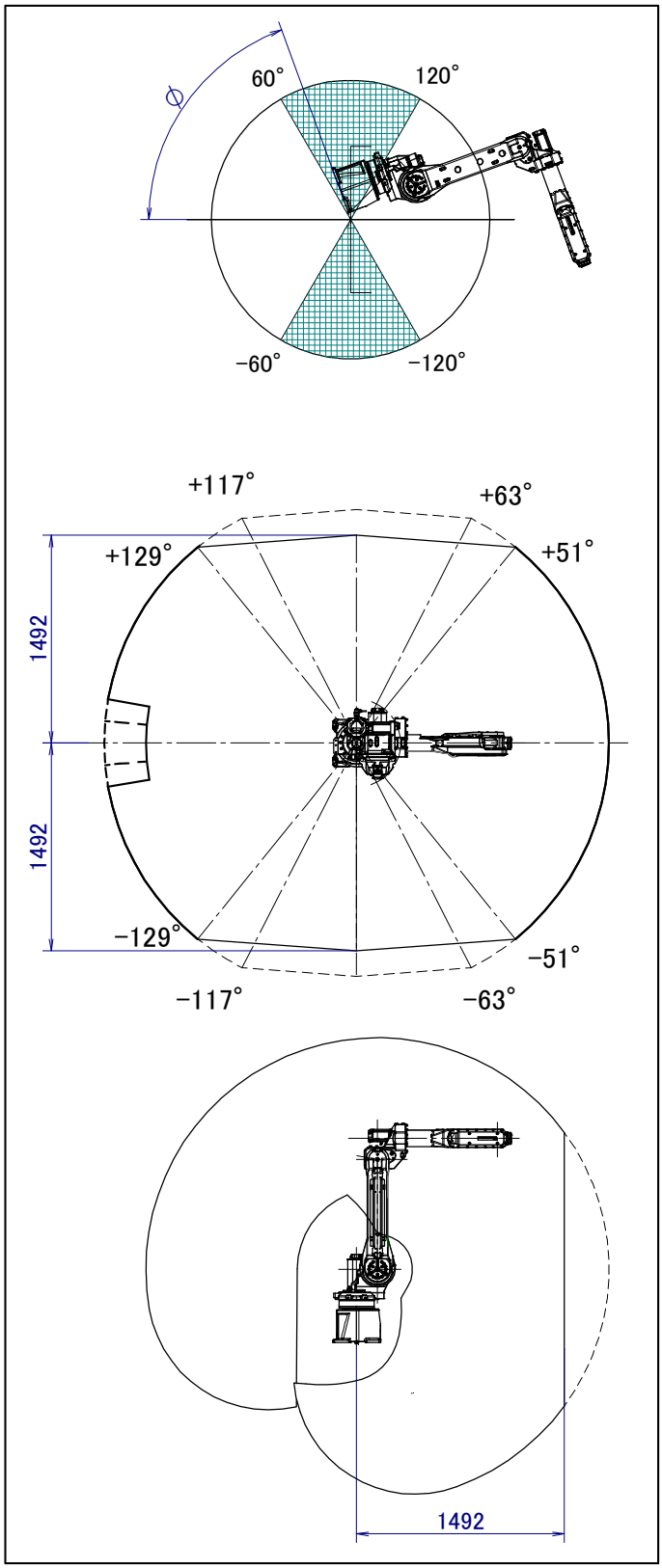


Fig. 3.6 (i) Installation area (3) operating space (M-20*i*A/20M)
(-120°<ϕ<-60°, 60°<ϕ<120°)

NOTE
Robot can rest in a solid line range. The operation to a dotted line range becomes possible when not resting.

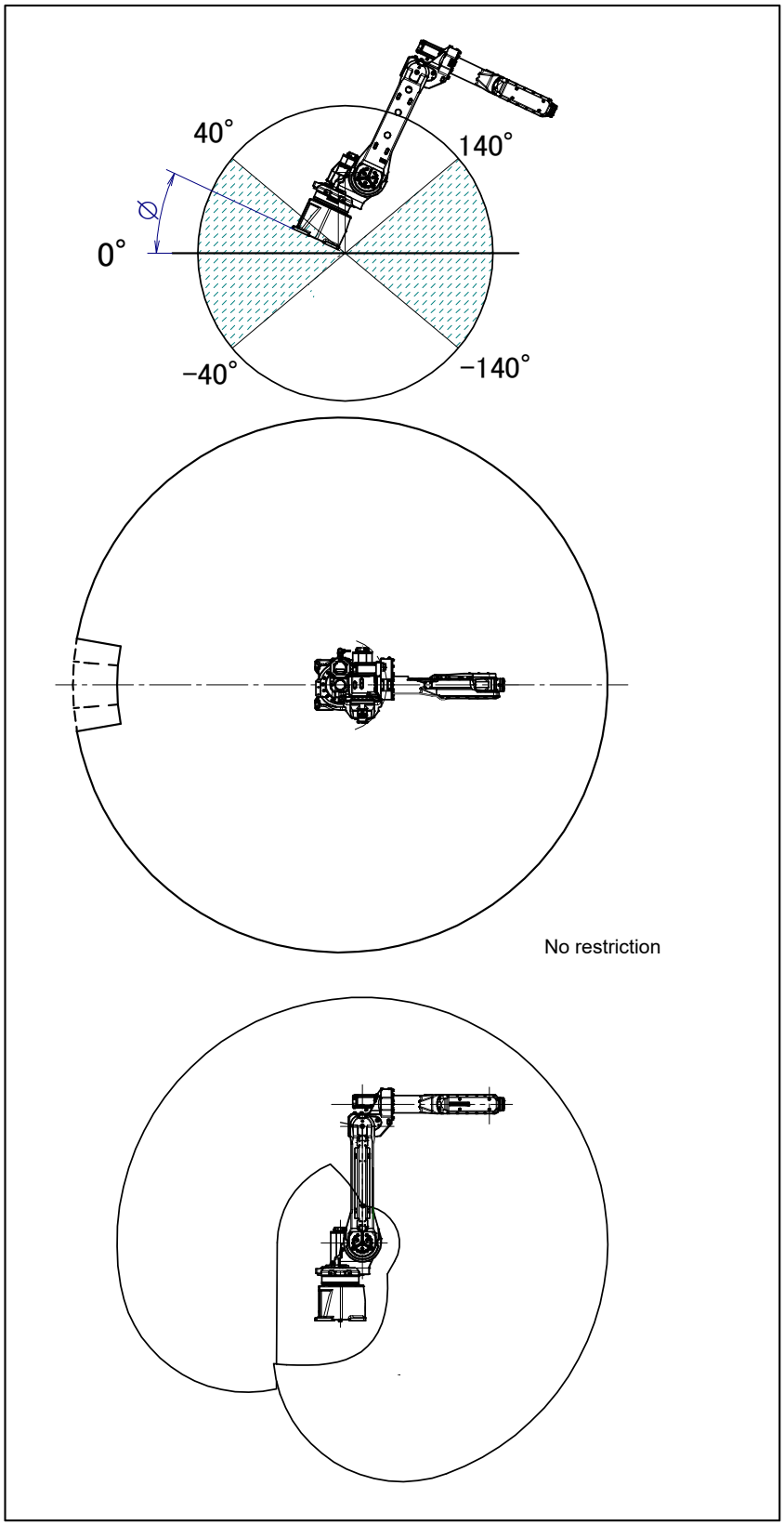


Fig. 3.6 (j) Installation area (1) operating space (M-20*i*A/35M)
(-180°≦ϕ≦−140°, -40°≦ϕ≦40°, 140°≦ϕ≦180°)

NOTE
In case of mounted angle (1), there is no operating area restriction.

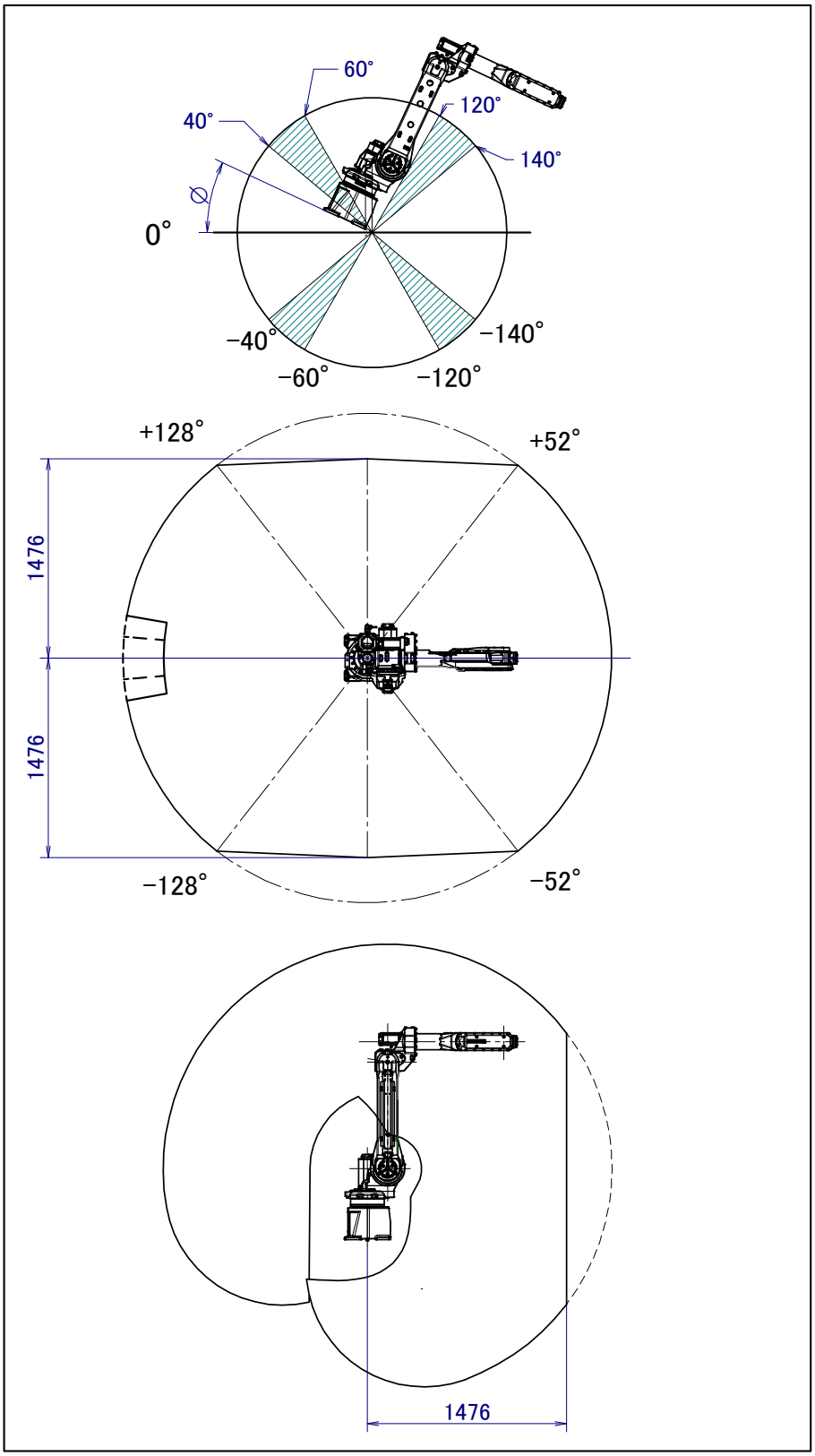


Fig. 3.6 (k) Installation area (2) operating space (M-20*i*A/35M)
(-140°<ϕ≦−120°, -60°≦ϕ<-40°, 40°<ϕ≦60°, 120°≦ϕ<140°)

NOTE
Robot can rest in a solid line range. The operation to a dotted line range becomes possible when not resting.

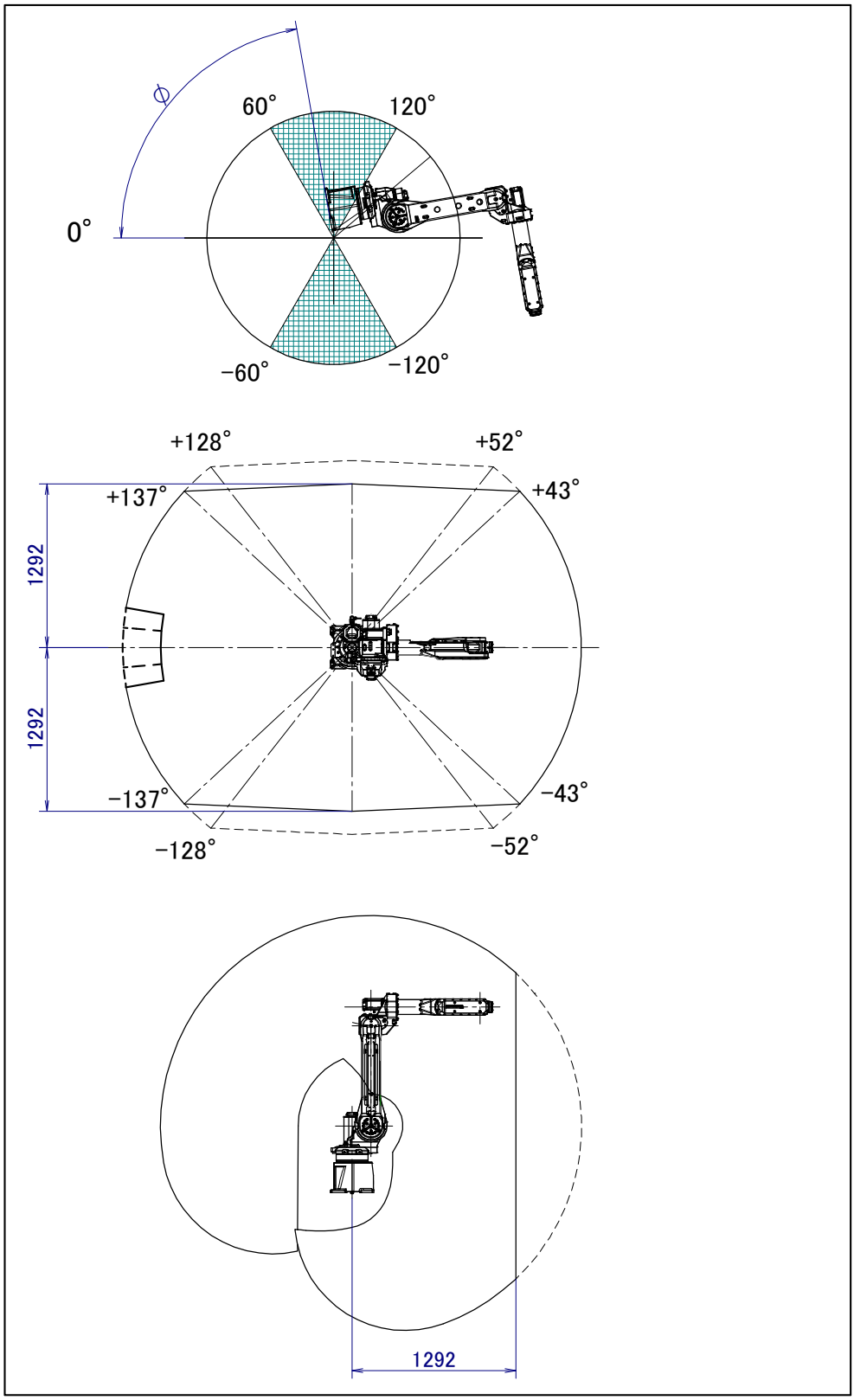


Fig. 3.6 (l) Installation area (3) operating space (M-20*i*A/35M)
(-120°<ϕ<−60°, 60°<ϕ<120°)

NOTE
Robot can rest in a solid line range. The operation to a dotted line range becomes possible when not resting.

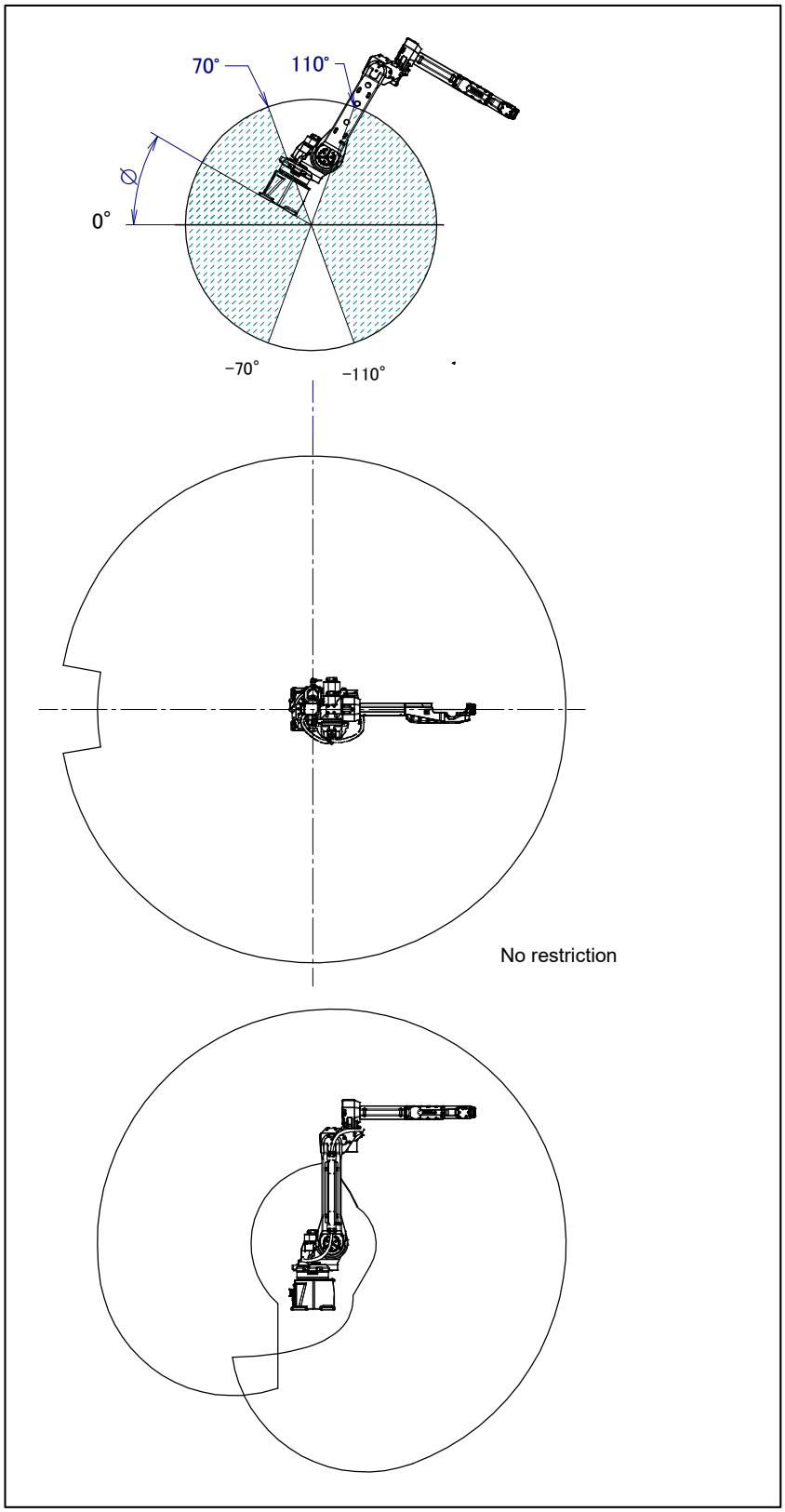


Fig. 3.6 (m) Installation area (1) operating space (ARC Mate 120*i*C/12L, M-20*i*A/12L)
(-180°≦ϕ≦−110° -70°≦ϕ≦70°, 110°≦ϕ≦180°)

NOTE
In case of mounted angle (1), there is no operating area restriction.

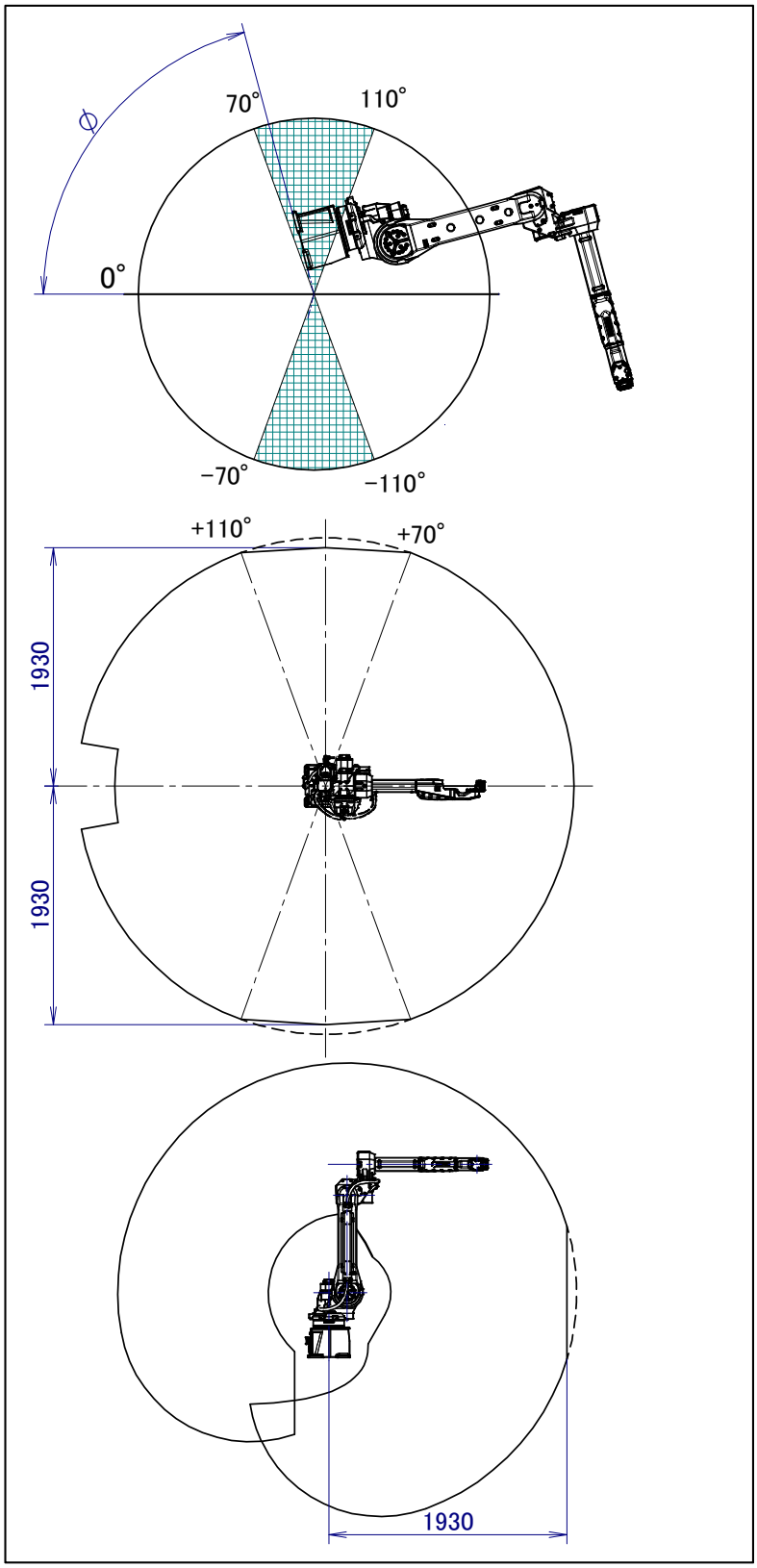


Fig. 3.6 (n) Installation area (2) operating space (ARC Mate 120*i*C/12L, M-20*i*A/12L)
(-110°<ϕ<−70°, 70°<ϕ<110°)

NOTE
Robot can rest in a solid line range. The operation to a dotted line range becomes possible when not resting.

4 EQUIPMENT INSTALLATION TO THE ROBOT

⚠ CAUTION
Antirust oil is applied on the wrist end effector mounting surface when robot is shipped. If necessary, remove this oil.

4.1 END EFFECTOR INSTALLATION TO WRIST

Fig. 4.1 (a) to (f) show the figures for installing end effectors on the wrist. Select screws and positioning pins of a length that matches the depth of the tapped holes and pin holes. See Appendix B "STRENGTH OF BOLT AND BOLT TORQUE LIST" for tightening torque specifications.

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

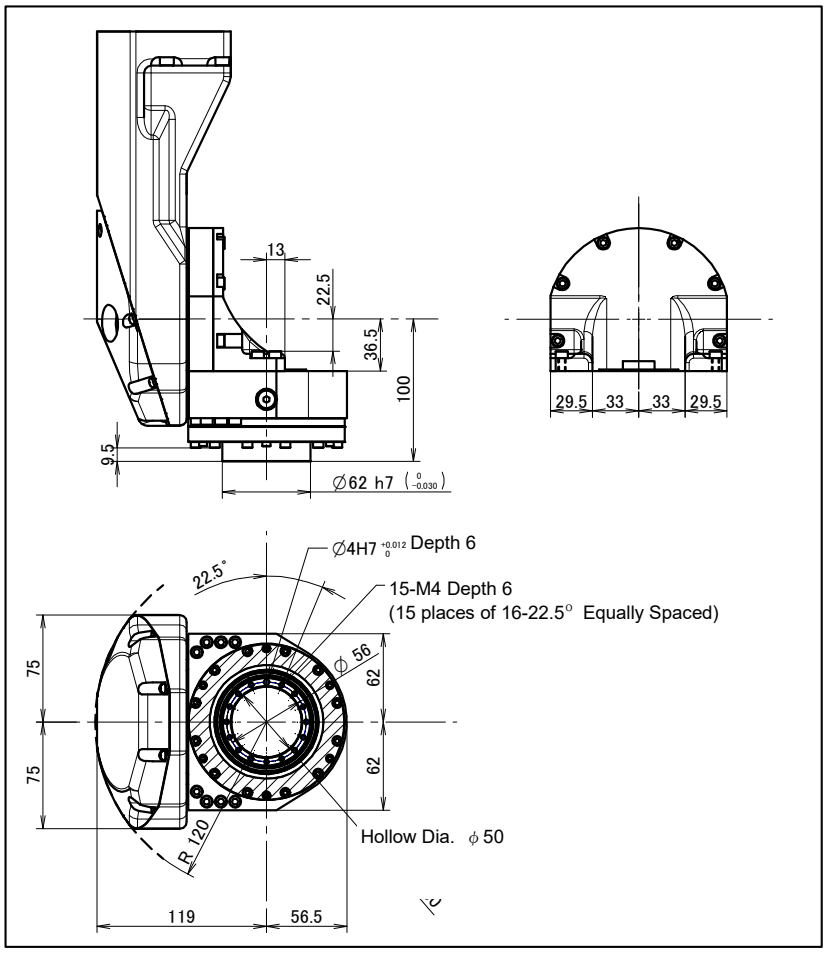


Fig. 4.1 (a) End effector interface (ARC Mate 120*i*C, M-20*i*A)
(A05B-1222-B201, B202, A05B-1225-B201, B202)

⚠ CAUTION
Do not remove the M3, M4 bolts of shaped area. If they are removed, work of re-assembling robot becomes difficult.

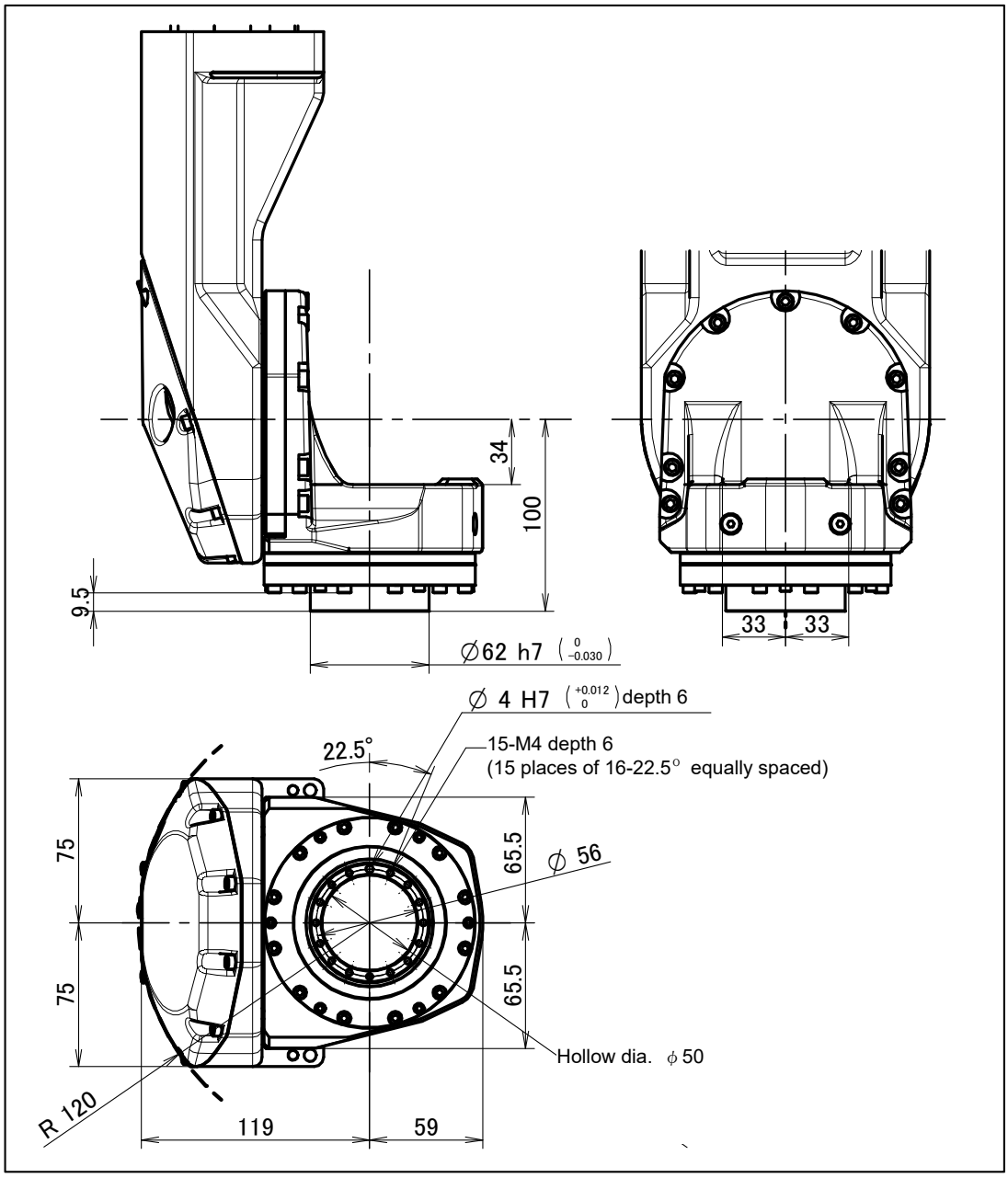


Fig. 4.1 (b) End effector interface (ARC Mate 120*i*C, M-20*i*A)
(A05B-1225-B251, B252)

> ⚠ **CAUTION**
> Do not remove the M3, M4 bolts of shaped area. If they are removed, work of re-assembling robot becomes difficult.

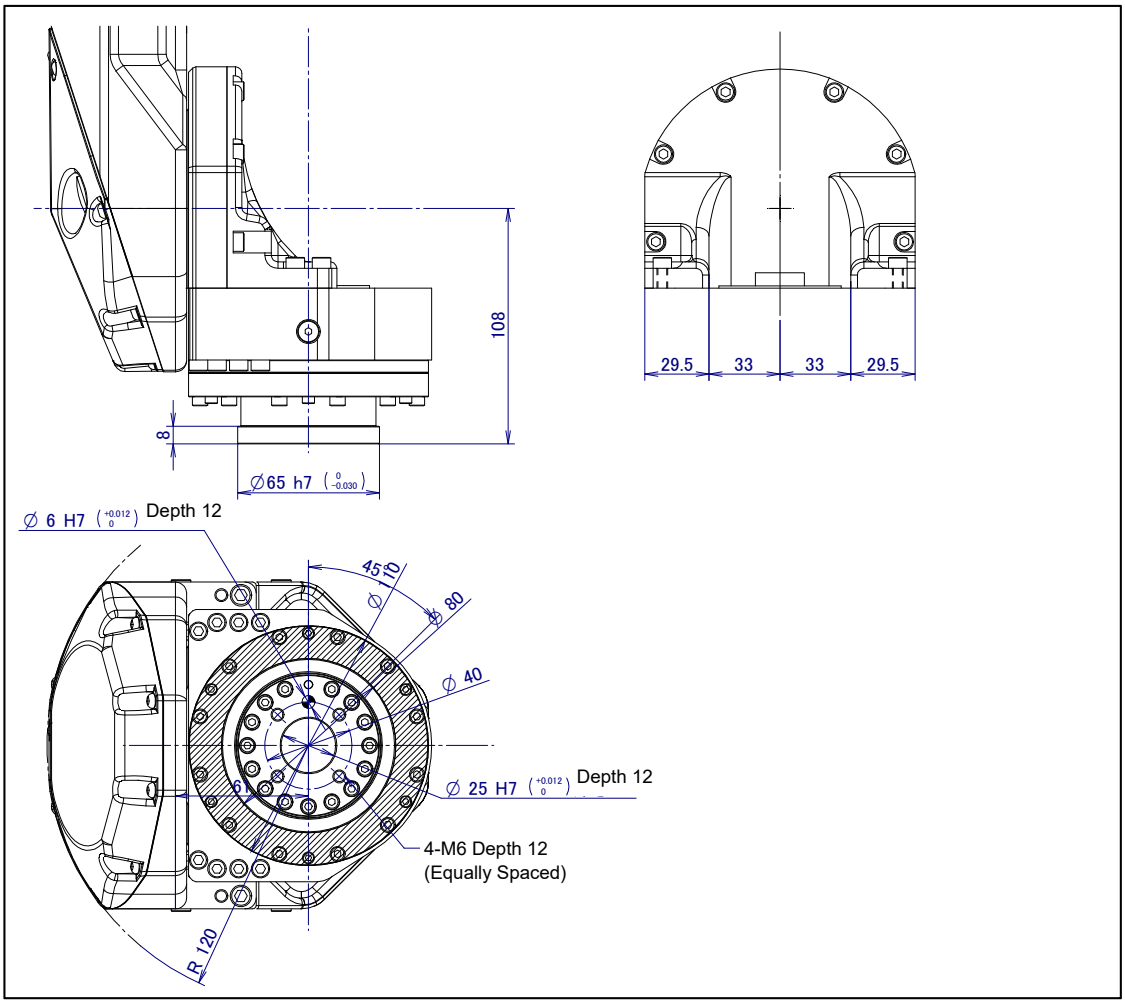


Fig. 4.1 (c) End effector interface (When ISO flange adapter is installed) (ARC Mate 120*i*C, M-20*i*A)

> ⚠ **CAUTION**
> Do not remove the M3, M4 bolts of shaped area. If they are removed, work of re-assembling robot becomes difficult.

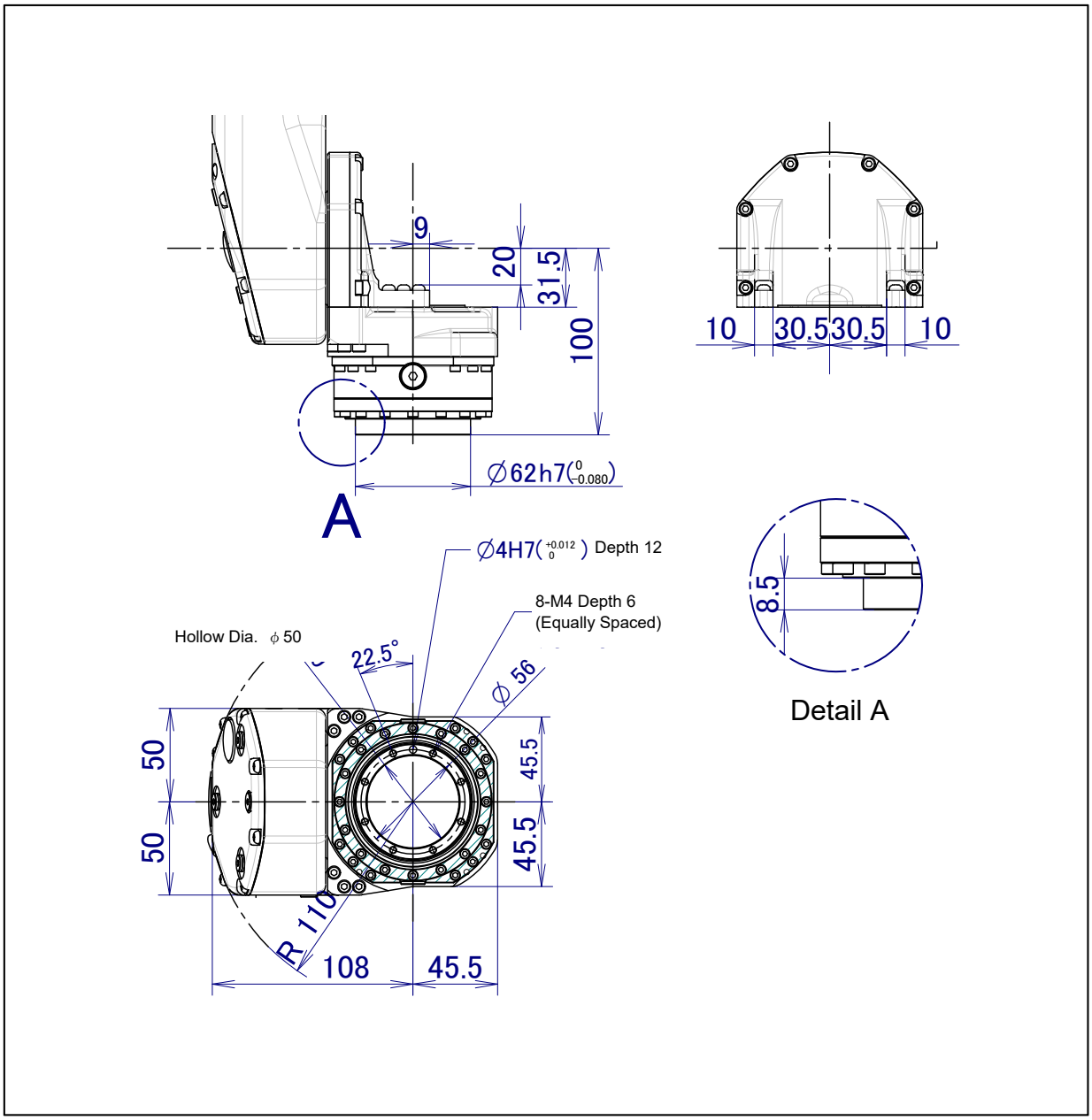


Fig. 4.1 (d) End effector interface
(ARC Mate 120*i*C/10L/12L, M-20*i*A/10L/12L)

> ⚠ **CAUTION**
> Do not remove the M3 bolts of shaped area. If they are removed, work of re-assembling robot becomes difficult.

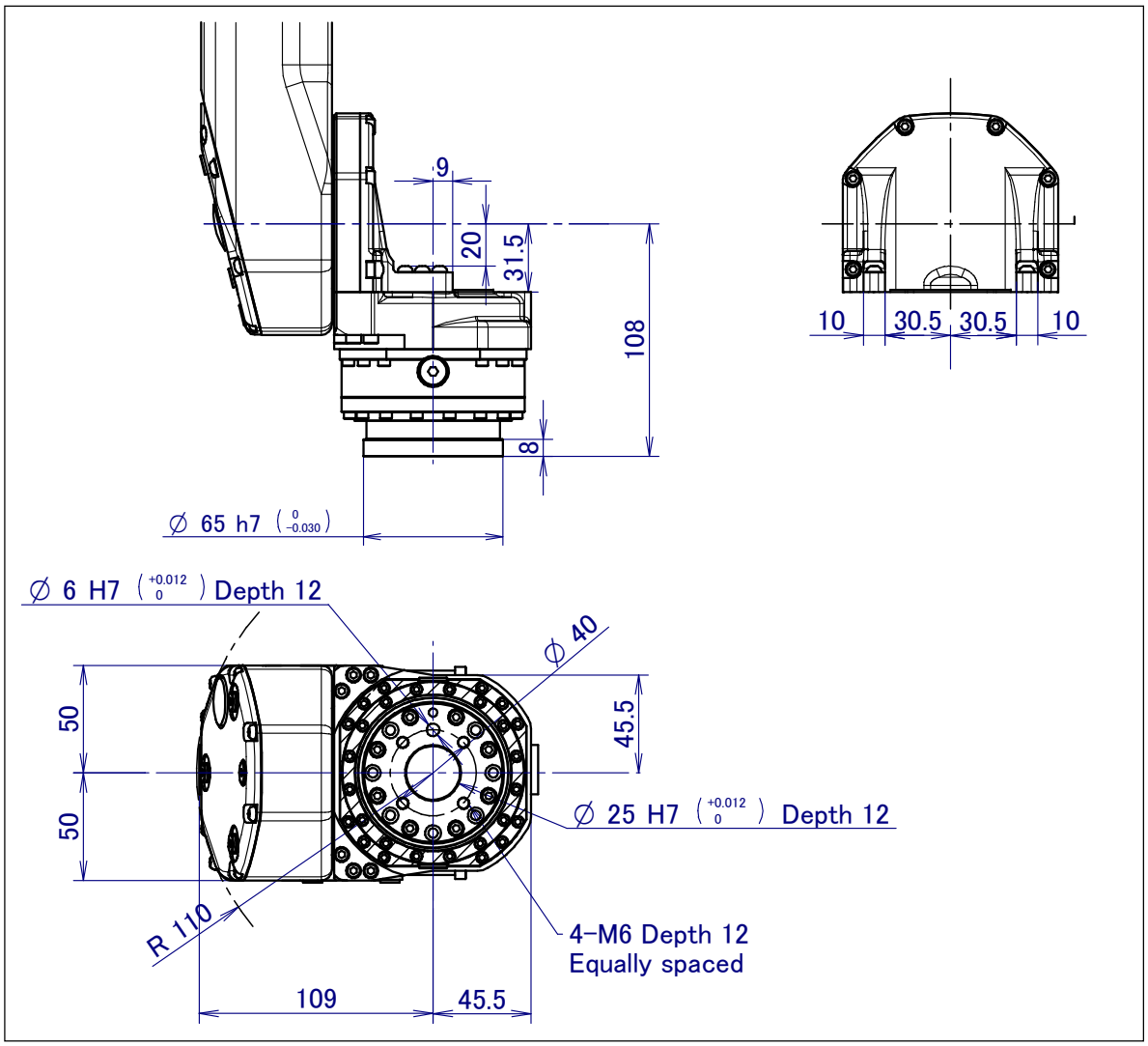


Fig. 4.1 (e) End effector interface (When ISO flange adapter is installed)
(ARC Mate 120*i*C/10L/12L, M-20*i*A/10L/12L)

> ⚠ **CAUTION**
> Do not remove the M3 bolts of shaped area. If they are removed, work of re-assembling robot becomes difficult.

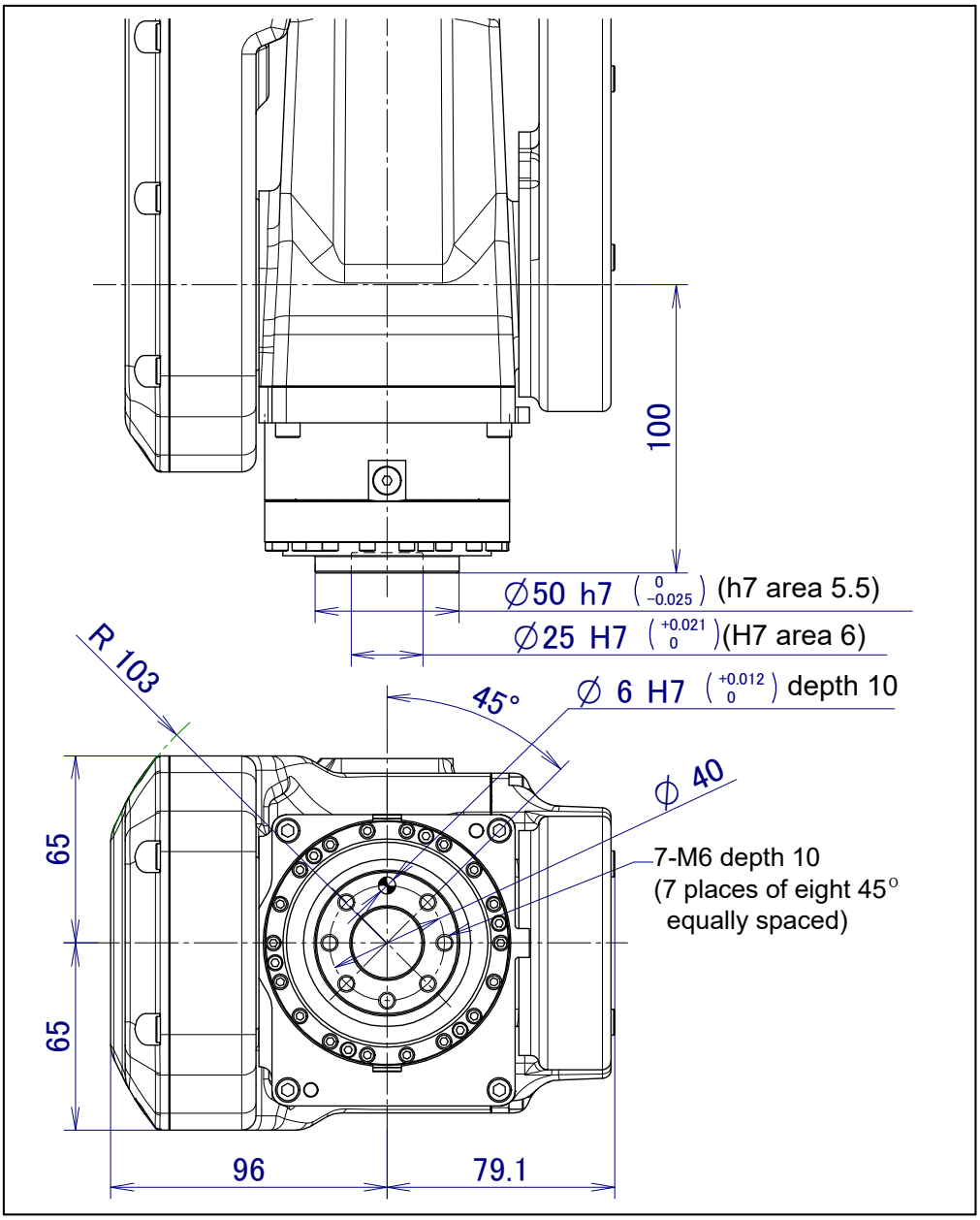


Fig. 4.1 (f) End effector interface (M-20*i*A/20M/35M)

4.2 EQUIPMENT MOUNTING FACE

Fig. 4.2 (a), (b) and (c) show position of tapped and load condition install equipment to the robot.

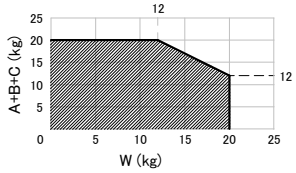
> ⚠ **CAUTION**
> 1 Never perform additional machining operations such as drilling or tapping on the robot body. This can seriously affect the safety and functions of the robot.
> 2 Equipment should be installed on robot in a way it does not interfere with the mechanical unit cables. If equipment interfere, the mechanical unit cable might be disconnected, and unexpected troubles might occur.

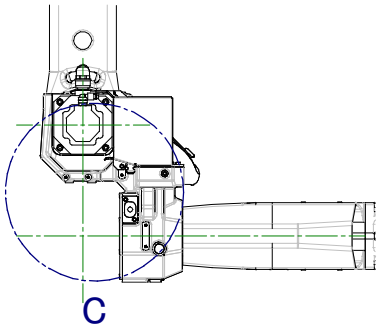
NOTE
Note that the use of a tapped hole not shown in the following figure is not assured. Please do not tighten both with the tightening bolts used for mechanical unit.

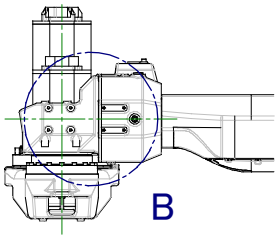
W: Mass of the end effector mounting face
A,B,C: Mass of devices on the J3 casing

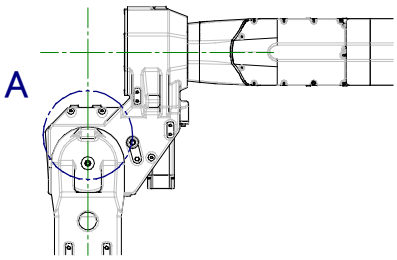
ARC Mate 120*i*C, M-20*i*A

Make W, A, B and C meet the following requirements.



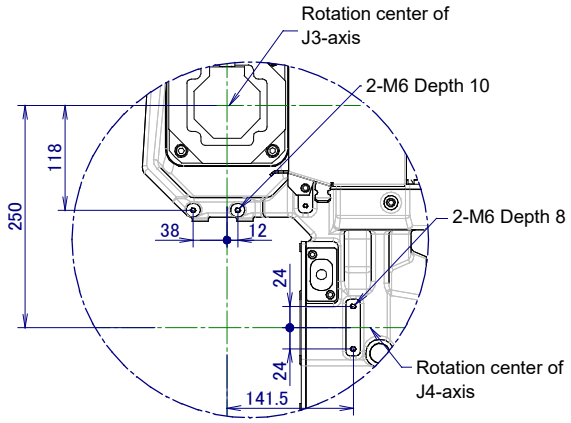




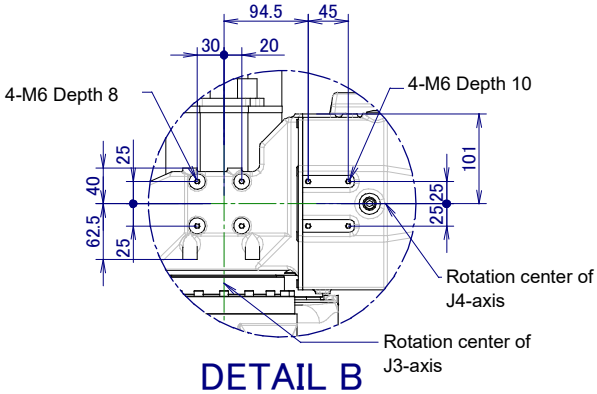


ARC Mate 120*i*C/10L, M-20*i*A/10L

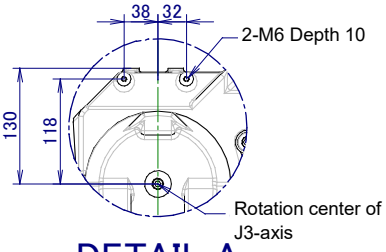
Make the load that hangs to A, B, and C become to 12kg of less.



DETAIL C



DETAIL B



DETAIL A

Fig. 4.2 (a) Equipment mounting faces and load limitation (ARC Mate 120*i*C, ARC Mate 120*i*C/10L, M-20*i*A, M-20*i*A/10L)

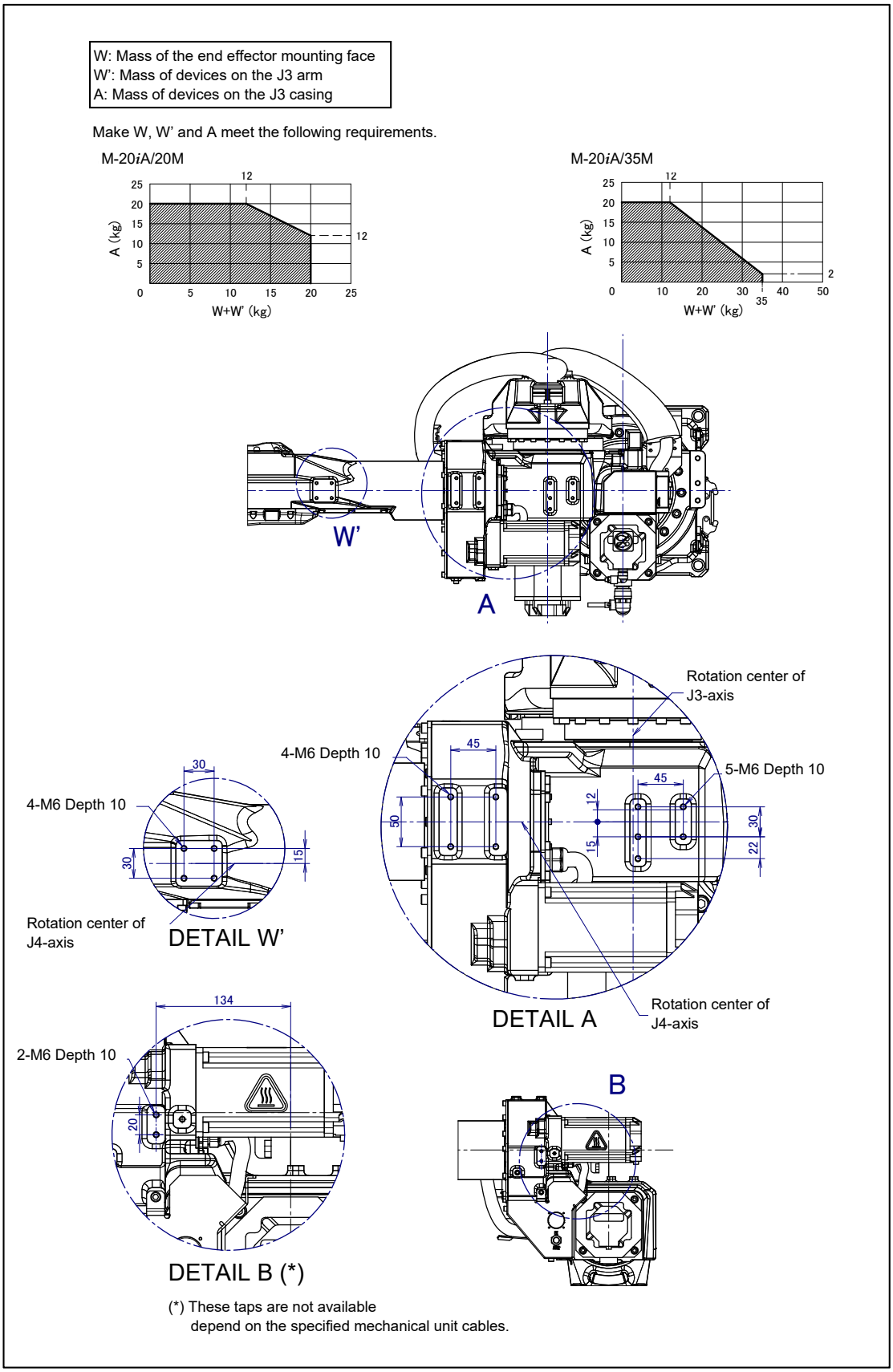


Fig. 4.2 (b) Equipment mounting faces and load limitation (M-20*i*A/20M/35M)

W: Mass of the end effector mounting face
W': Mass of devices on the J3 arm
A,**B,C**: Mass of devices on the J3 casing

Make W, W',A, B and C meet the following requirements.

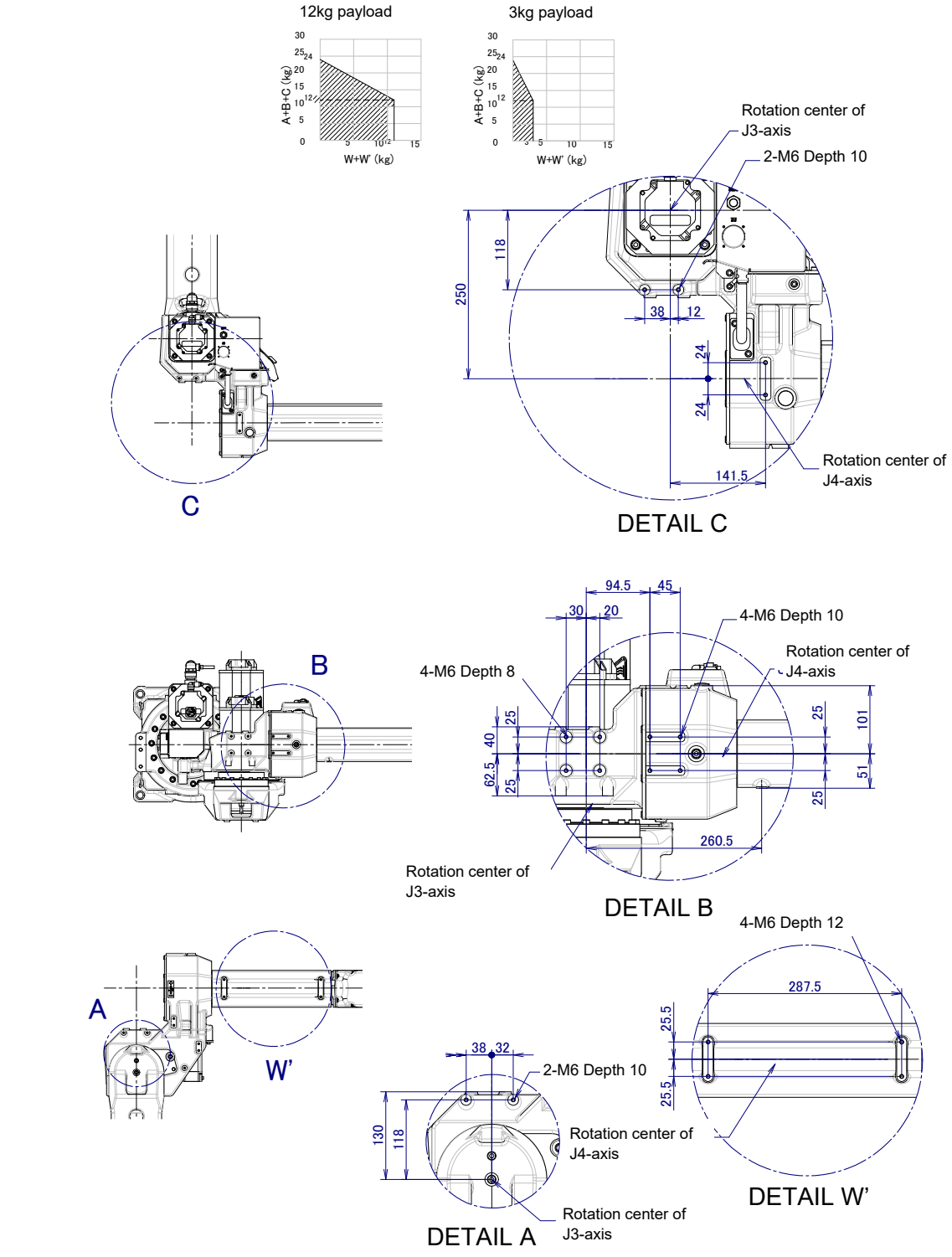


Fig. 4.2 (c) Equipment mounting faces and load limitation (ARC Mate 120*i*C/12L, M-20*i*A/12L)

Fig. 4.2 (d) shows taps for the cable clamp of M-20*i*A/20M/35M.

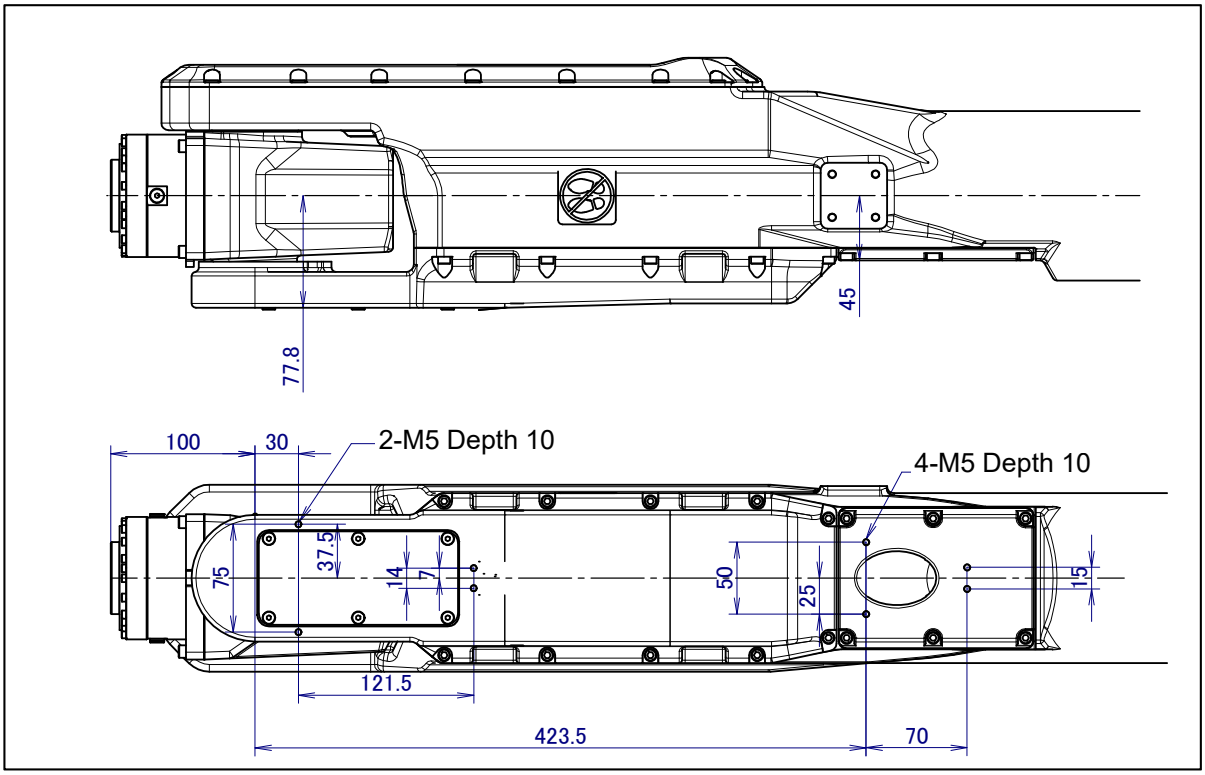


Fig. 4.2 (d) Equipment mounting faces (for the cable clamp) (M-20*i*A/20M/35M)

NOTE
When the clamp option is specified, the taps of Fig.4.2 (d) cannot be used.

Fig. 4.2 (e) shows tap positions for the cable clamp option of M-20*i*A/20M/35M.

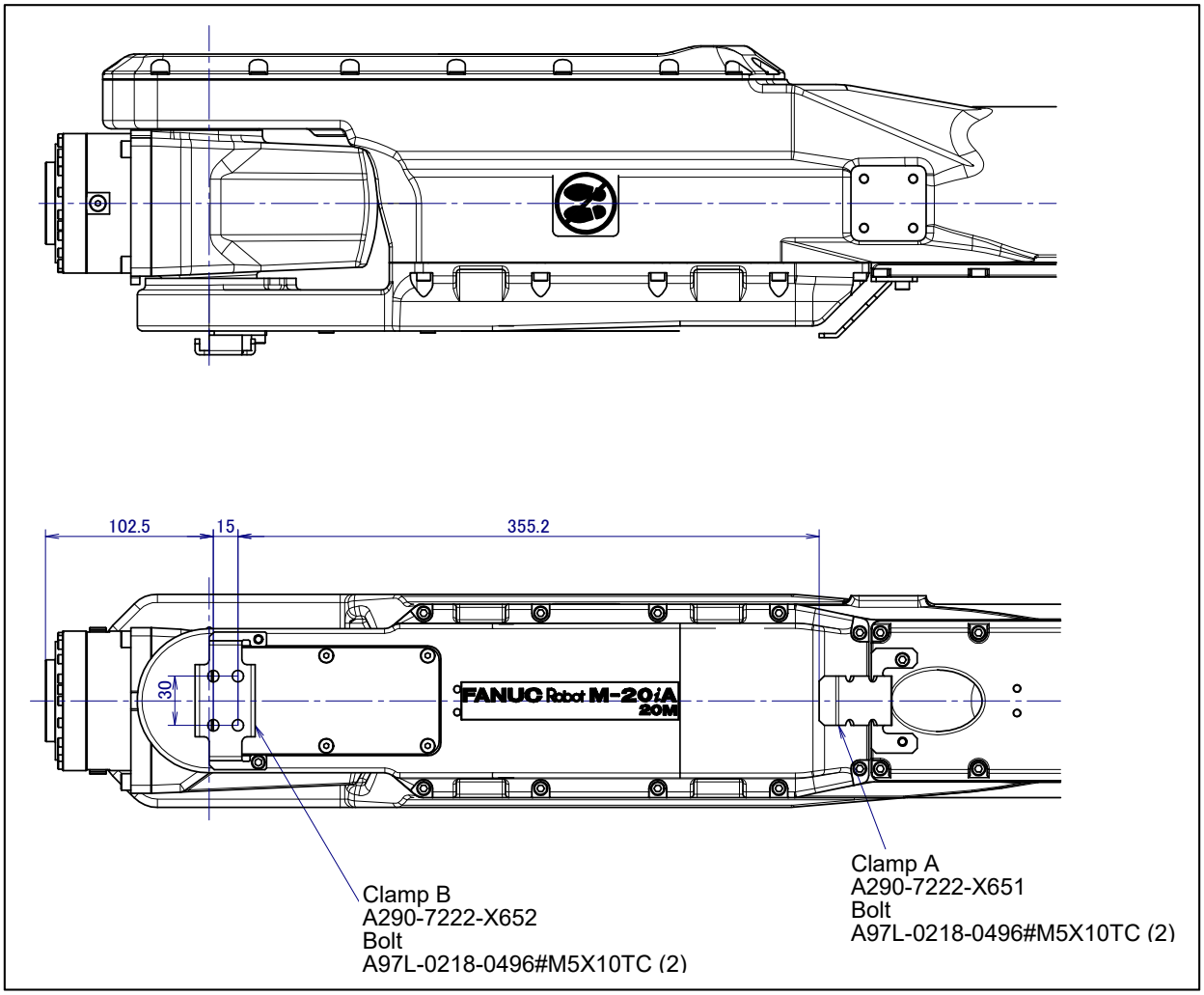


Fig. 4.2 (e) Cable clamp (option) (M-20*i*A/20M/35M)

4.3 LOAD SETTING

NOTE
1 Set load condition parameter before operating the robot. Do not operate the robot in over payload reduction. Do not exceed allowable payload including connection cables. Otherwise troubles such as degradation of reducer life may occur.
2 Except for ARC Mate120*i*C/12L, M-20*i*A/12L, wrist payload specification cannot be changed with the setting described in this section. Refer to Section 4.4.

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

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

```
MOTION PERFORMANCE                    JOINT 10%
   Group1
No.  PAYLOAD[kg]          Comment
 1          20.00   [                    ]
 2           0.00   [                    ]
 3           0.00   [                    ]
 4           0.00   [                    ]
 5           0.00   [                    ]
 6           0.00   [                    ]
 7           0.00   [                    ]
 8           0.00   [                    ]
 9           0.00   [                    ]
10           0.00   [                    ]

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

5 Ten different pieces of payload information can be set using condition No.1 to No.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]          20.00
2 PAYLOAD CENTER  X  [cm]          -7.99
3 PAYLOAD CENTER  Y  [cm]           0.00
4 PAYLOAD CENTER  Z  [cm]           6.44
5 PAYLOAD INERTIA X  [kgfcms^2]     0.13
6 PAYLOAD INERTIA Y  [kgfcms^2]     0.14
7 PAYLOAD INERTIA Z  [kgfcms^2]     0.07

 [TYPE]  GROUP  NUMBER  DEFAULT  HELP
```

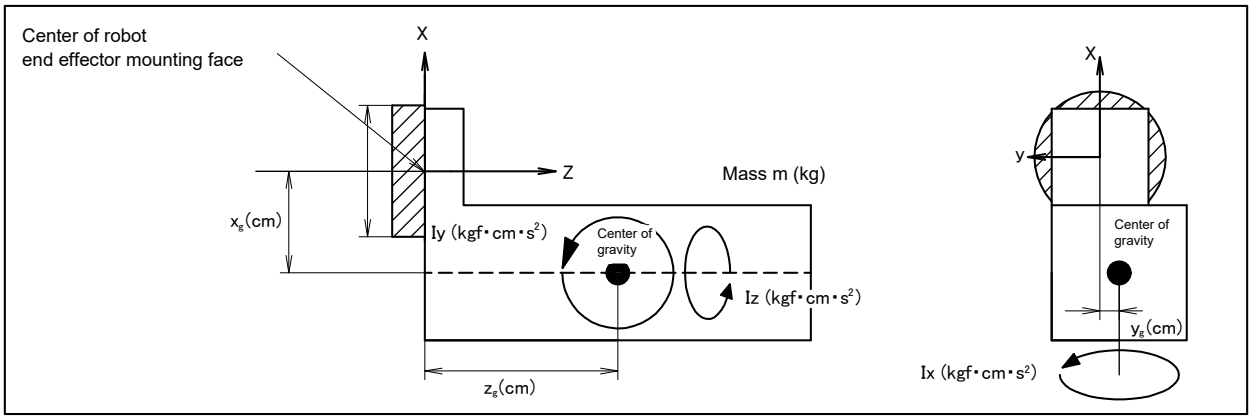


Fig. 4.3 Standard tool coordinate

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 will be displayed: “Path and Cycle time will change. Set it?” Respond to the message with F4 ([YES]) or F5 ([NO]).

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

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

```
MOTION ARMLOAD SET              JOINT   100%

   Group 1
 1 ARM LOAD AXIS #1 [kg]              0.00
 2 ARM LOAD AXIS #3 [kg]             12.00

[ TYPE  ]    GROUP          DEFAULT   HELP
```

10 Specify the mass of the loads on the J2 base and J3 casing. When you enter following parameter,
ARMLOAD AXIS #1[kg]: Mass of the load on the J2 base
(Contact FANUC if you install equipments on J2 base.)
ARMLOAD AXIS #3[kg]: Mass of the load on the J3 casing
the confirmation message “Path and Cycle time will change. Set it?” appears. Select F4 YES or F5 NO. Once the mass of a device is entered, it is put in effect by turning the power off and on again.

4.4 MAX PAYLOAD SHIFT FUNCTION (EXCEPT ARC Mate120*i*C/12L, M-20*i*A/20M/35M/12L)

About Max payload shift function

In ARC Mate120*i*C/M-20*i*A, the best two servo motion parameters are prepared respectively when the wrist payload specification is 3kg and 20kg. (3kg and 10kg for ARC Mate120*i*C/10L, M-20*i*A/10L.)
The best acceleration and deceleration operation can be achieved by setting the parameter matched to the wrist payload specification. The parameter is changed by executing the following KAREL programs (It is abbreviated as KAREL for Changing method of wrist payload specification thereafter.)

ARCMate120*i*C, M-20*i*A

- M20SET03.PC: 3kg wrist payload specification
- M20SET20.PC: 20kg wrist payload specification

ARCMate120*i*C/10L, M-20*i*A/10L

- M2LSET03.PC: 3kg wrist payload specification
- M2LSET10.PC: 10kg wrist payload specification

The following procedure is based on an example of ARC Mate 120*i*C, M-20*i*A.

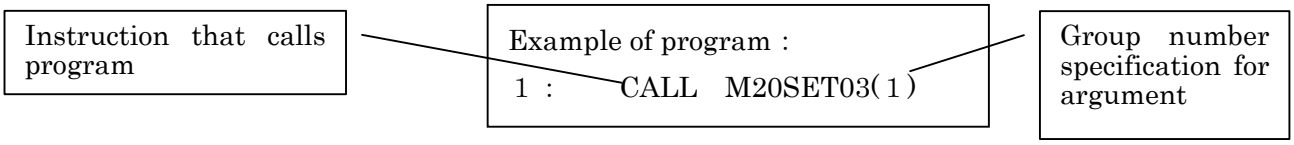
M-20*i*A is set in 20kg wrist payload specification, M-20*i*A/10L is set in 10kg wrist payload specification and ARC Mate 120*i*C and ARC Mate 120*i*C/10L is set to an acceptable 3kg wrist payload specification when robot is shipped.
But when the robot is specified Servo Torch, ARC Mate 120*i*C is set in 20kg wrist payload specification, ARC Mate 120*i*C/10L is set in 10kg wrist payload specification

> ⚠ **CAUTION**
> When the robot over the payload in 3kg wrist payload specification (Refer to specification table in Section 3.1 and Section 3.5.), set in 20kg wrist payload specification. (In case of ARC Mate 120*i*C/10L or M-20*i*A/10L, set in 10kg wrist payload specification.) If the robot is operated with wrong setting, the function and the lifetime of the robot would deteriorate.
> In case of M-20*i*A/20M and 35M, it is impossible to change payload.
> In case of ARC Mate120*i*C/12L, M-20*i*A/12L, payload specification is automatically set according to the set load

Method of shifting

There are the following two in the method of executing KAREL for changing method of wrist payload specification. Please use it properly according to the purpose.

1) Method of executing KAREL program by using "Call program" → Refer to Subsection 4.4.1.
   - The KAREL program is set in the program call instruction of the TP program and the parameter is set by specifying with the argument that shows the group number, and executing it. The parameter of M-20*i*A of a specific group can be switched in this method.



2) Method of executing KAREL program directly → Refer to Subsection 4.4.2
   - Select and execute the KAREL program in program select screen.
   - To set same load parameter to multiple M-20*i*A in the multi group system, use this method to switch the parameter at once.

> ⚠ **CAUTION**
> Execute KAREL for Changing method of wrist payload specification in the state of cold start mode. Be careful that the paths and the cycle time of an existing teach program change if KAREL for changing method of wrist payload specification is executed.

Below section explains the method of executing KAREL for changing wrist payload specification.

4.4.1 Method of Executing KAREL Program by Using "Call program"

* The following procedures assume the thing of changing M-20*i*A of the first group to the 3kg wrist payload specification.

Execution procedure

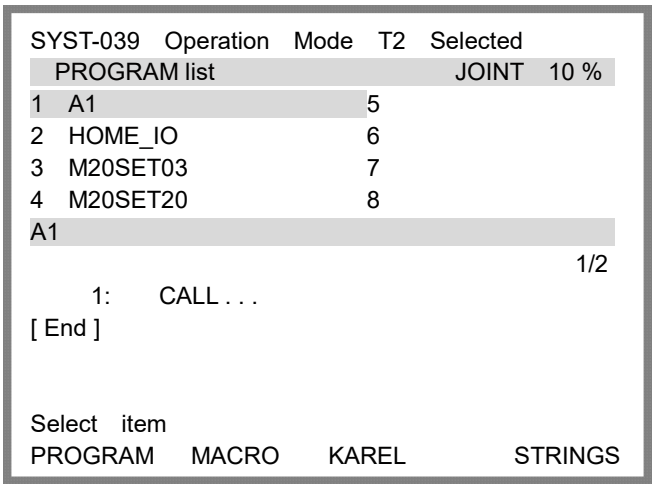
1 Call the system variable screen.

[MENU] key → Select "SYSTEM" and press F1 key(screen) → Select "Variables"

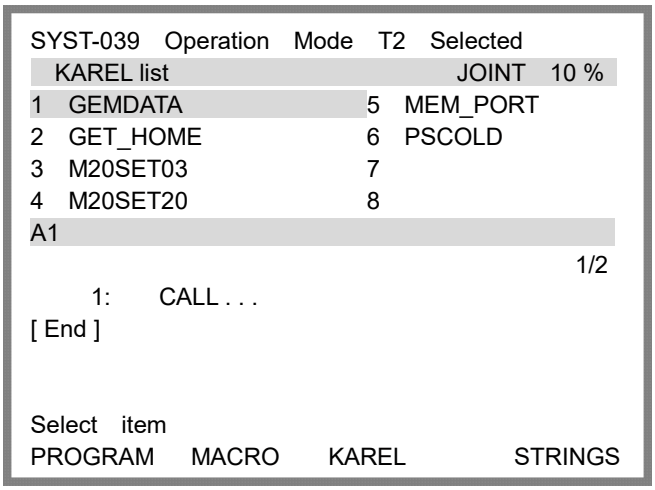
2 Set system variables $KAREL_ENB to 1.
3 Open TP program edit screen.
4 Select "call program" from among the program instruction

F1 key (INST) → Select "CALL" → Select "CALL program"

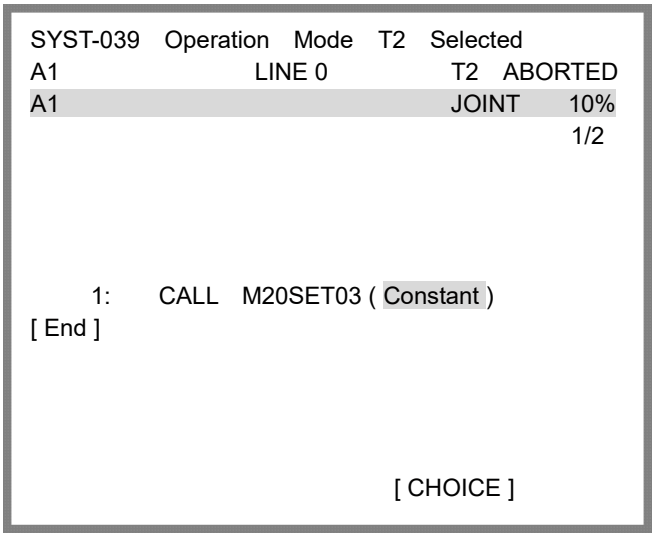
Then, the following screens will be displayed.



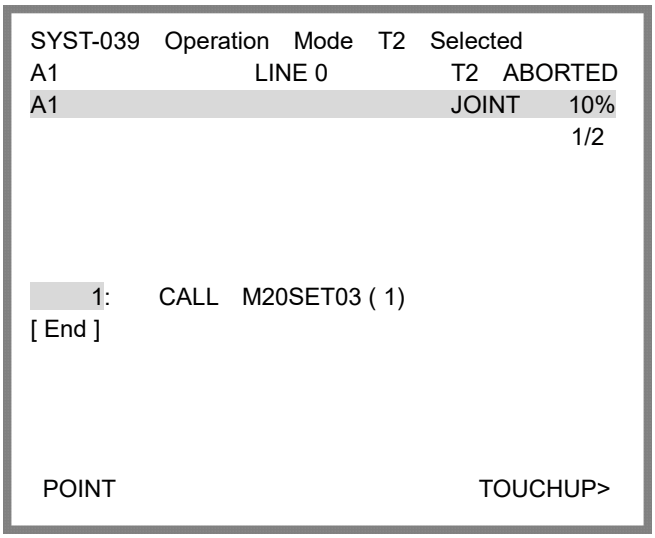
5 Press F3 key (KAREL). Then, select KAREL. The following screen will be displayed. Then select M20SET03 of 3kg wrist payload specification from among that.



6 Press F4 key (select). Choose “CONSTANT” from there. Then, it becomes the following screens.



7 Enter group number (1 in this case) while the cursor is at “Constant”.



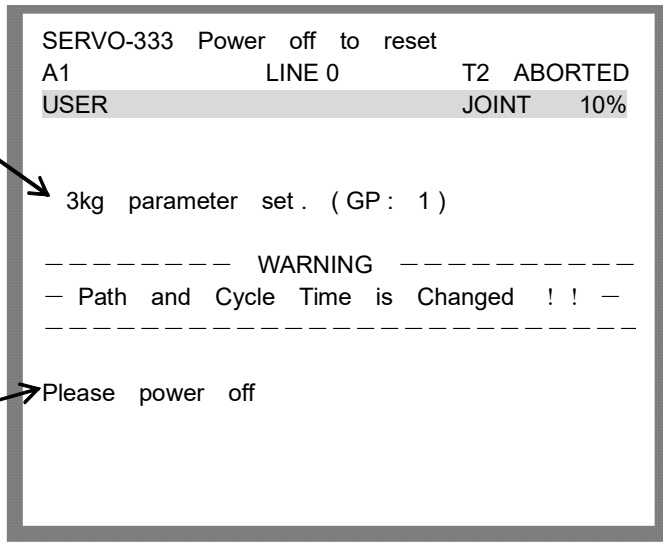
8 Execute this program.

Press the [FWD] key while pressing the [SHIFT] key.

Then, the following screens are displayed. This indicates that KAREL M20SET03.PC of 3kg wrist payload specification is executed.

This means specification is changed to wrist payload 3kg specification.

Please cycle power of the controller.



9 Cycle power of the controller.

This completes the parameter switching.

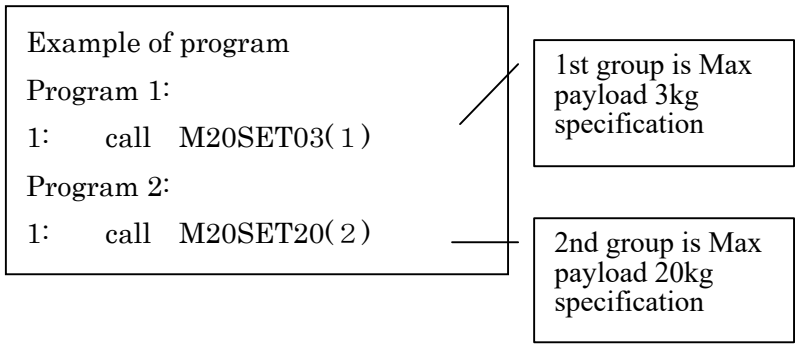
4.4.2 Method of Executing KAREL Program Directly

Use scene

For instance, it is assumed that the following multi group systems exist.
1st group: M-20*i*A
2nd group: M-20*i*A
3rd group: Positioner A
To set M-20***i***A in 1st and 2nd group to 3kg wrist payload specification, the method explained below will allow you to do it at once.

NOTE

If you want to set M-20*i*A of 1st group to 3kg wrist payload specification and M-20*i*A of 2nd group to 20kg wrist payload specification, method of this chapter cannot be used.
In that case, please make two programs as follows, and do the parameter change by the method of Chapter 1.
1 Turn on the controller power again after executing the program 1.
2 Turn on the controller power again after executing the program 2.



Execution procedure

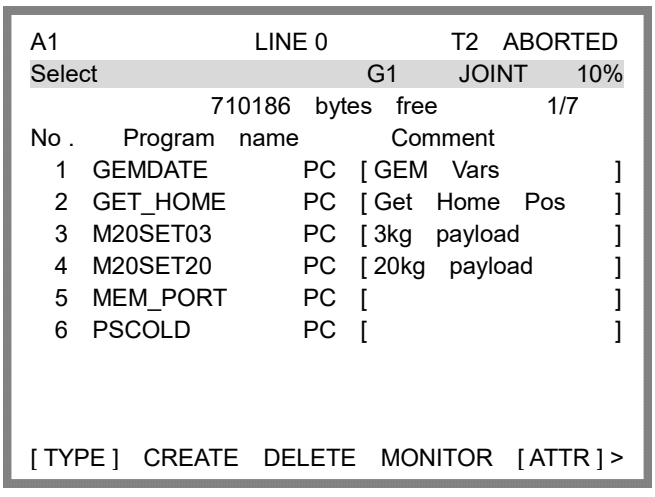
1 Call the system variable screen.

[MENU] key → Press F1 key (screen) after selecting “SYSTEM” → Select system variables

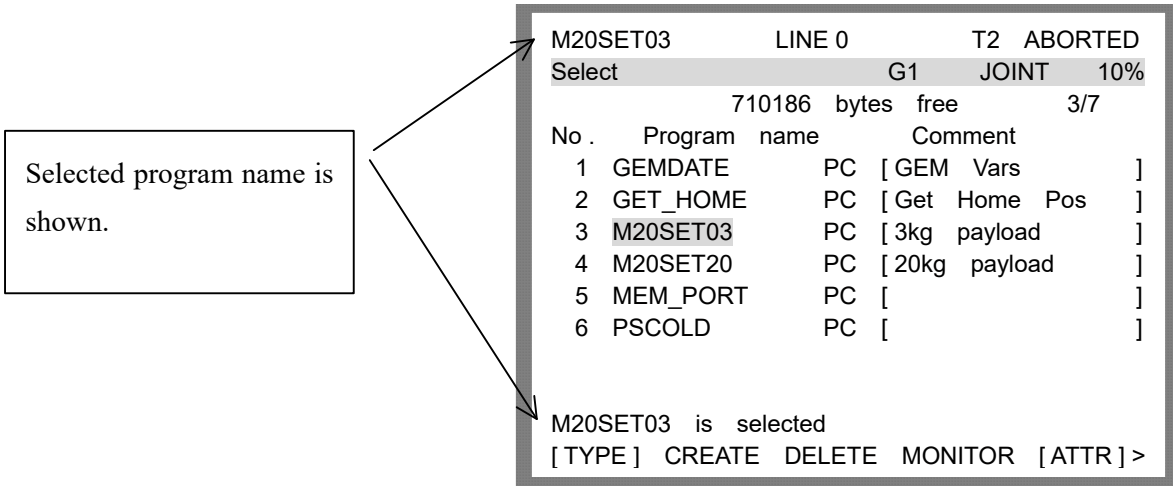
2 Set system variables $KAREL_ENB to 1.
3 Call program select screen and select “

program select key → select KAREL by F1 key（type）

Then, three KAREL programs are displayed as follows.



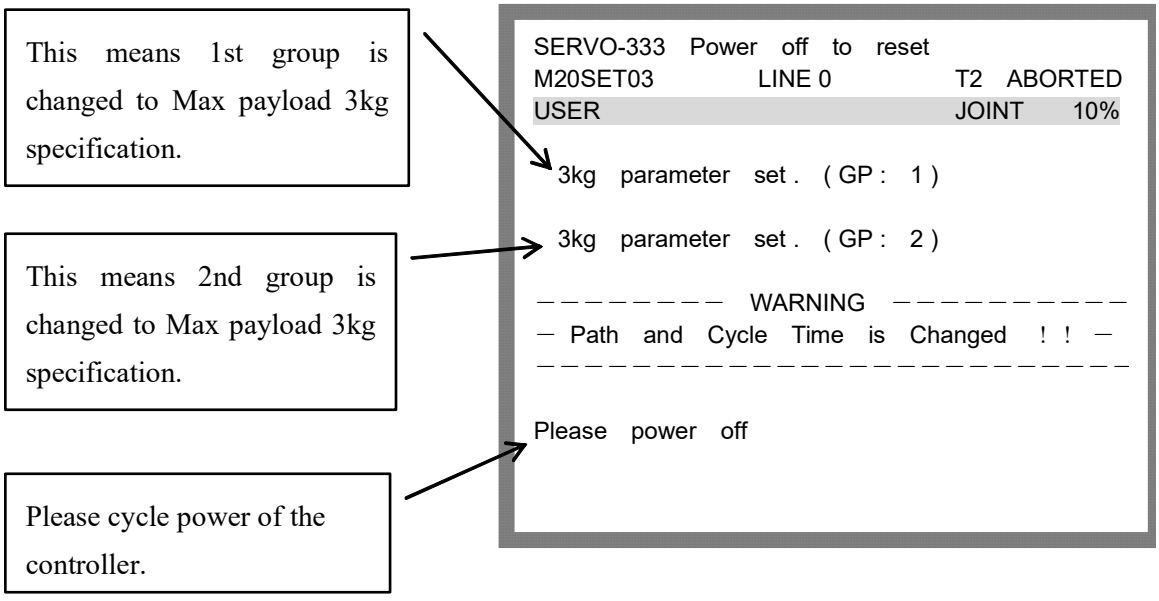
4 Place the cursor to the KAREL program of the load to be set, and press [ENTER] key. M20SET03.PC KAREL of 3kg wrist payload specification is selected in below screen. The selected program name is displayed to two places as follows.



5 Execute the program.

Press the [FWD] key while pressing the [SHIFT] key.

Then, the following screens are displayed. This is case of executing KAREL M20SET03.PC of Max payload 3kg specification.



6 Cycle power of the controller.

This completes the parameter switching.

5 PIPING AND WIRING TO THE END EFFECTOR

⚠ WARNING

- Only use appropriately-specified mechanical unit cables.
- Do not add user cable or hose to inside of the mechanical unit.
- Please do not obstruct the movement of the mechanical unit 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 strand of the end effector (hand) cable. Insulate the cable with seal tape. (See Fig. 5 (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 user cable 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.

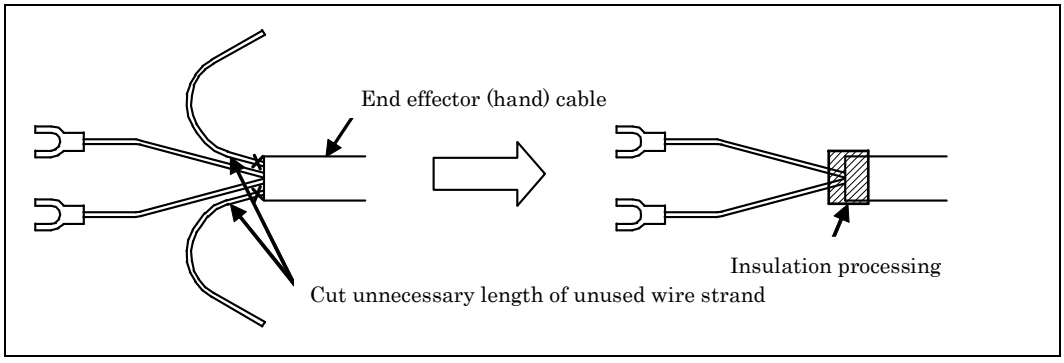


Fig. 5 (a) Treatment method of end effector (hand) cable

5.1 AIR SUPPLY (OPTION)

Robot has air inlet and air outlet openings on the J1 base and the J3 casing used to supply air pressure to the end effector. As couplings are not supplied, it will be necessary to prepare couplings, which suit to the hose size. Please refer to the table below about panel union and inside and outer diameter of air tube.

Spec. of Mechanical unit cable	Panel union (Input side)	Panel union (Output side)	Outer, inner and number of air tube
A05B-1222-H201 A05B-1222-H601 A05B-1222-H221 A05B-1222-H605 A05B-1222-H231 A05B-1222-H621 A05B-1222-H251 A05B-1222-H625 A05B-1222-H505 A05B-1222-H861 A05B-1222-H507 A05B-1225-H231 A05B-1222-H525 A05B-1225-H235 A05B-1222-H535 A05B-1225-H251 A05B-1222-H537 A05B-1225-H255	Rc3/8 FemaleX1	Rc3/8 FemaleX1	Outer diameter 8mm Inside diameter 5mmX1 pc
A05B-1222-H202 A05B-1222-H512 A05B-1222-H203 A05B-1222-H513 A05B-1222-H206 A05B-1225-H232 A05B-1222-H232 A05B-1225-H532 A05B-1222-H233 A05B-1225-H533 A05B-1222-H236	1/4NPT FemaleX2 (*)	None	Outer diameter 6.35mm Inside diameter 4.23mmX2 pcs (*)
A05B-1222-H214	Rc3/8 FemaleX2	Rc3/8 FemaleX2	Outer diameter 10mm Inside diameter 6.5mmX2 pcs
A05B-1222-H224	Rc3/8 FemaleX2	Rc3/8 FemaleX2	Outside diameter 8mm Inside diameter 5mmX2 pcs

(*) There is two hose. One is for the welding gas.

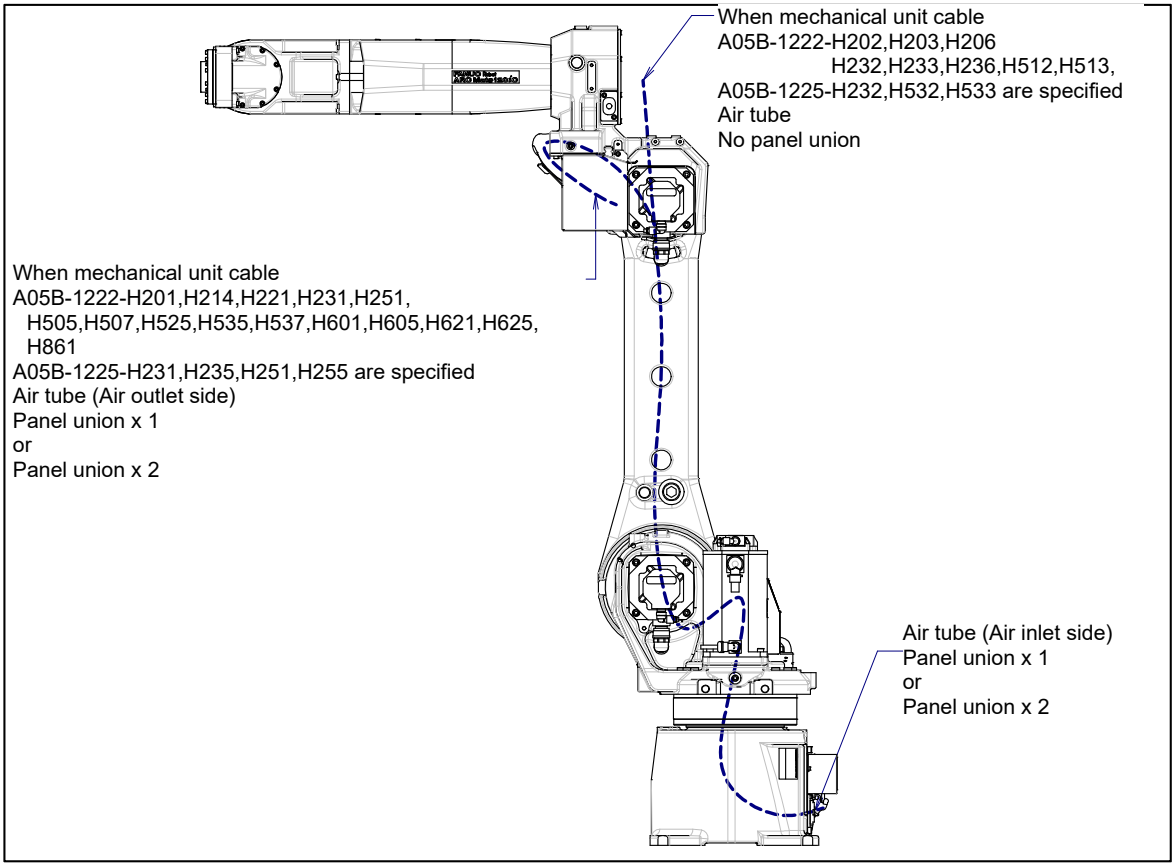


Fig. 5.1 (a) Air supply (option)

5.2 AIR PIPING (OPTION)

Fig. 5.2 (a) shows how to connect air hose to the robot. If the air control set is specified as an option, the air hose between the mechanical unit and the air control set is provided. Mount the air control set using the information in Fig. 5.2 (b). This is outside FANUC delivery scope.

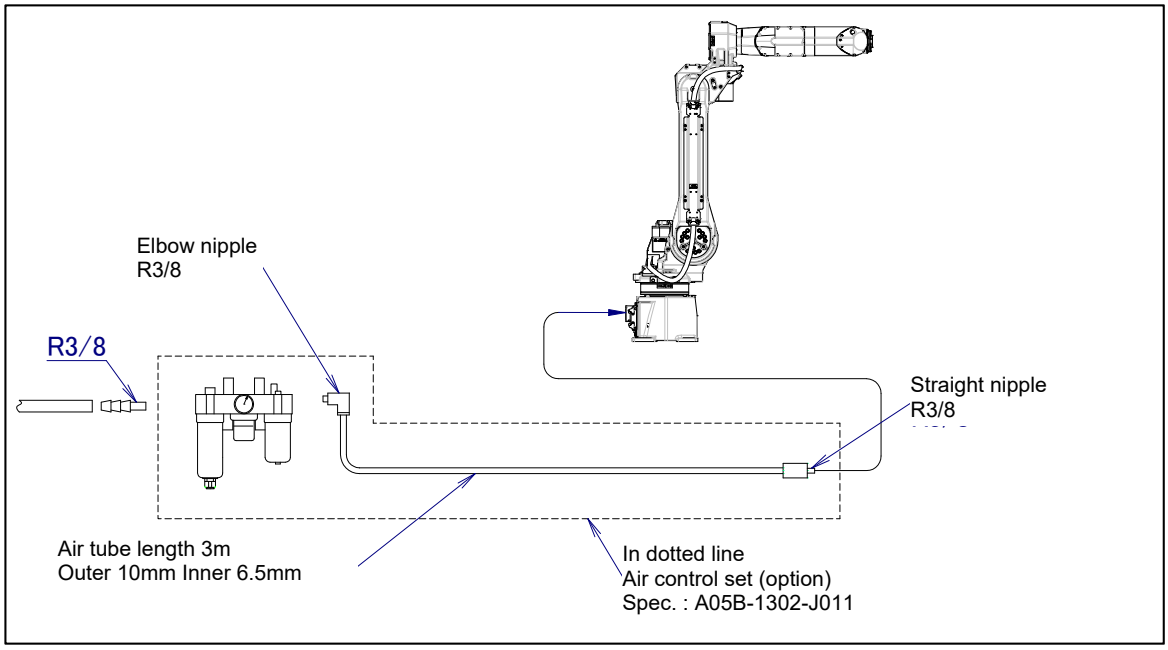


Fig. 5.2 (a) Air piping (Option)

Air control set

For the lubricator of air control set, fill in turbine oil #90 to #140 to the specified level. The machine tool builder is required to prepare mounting bolts.

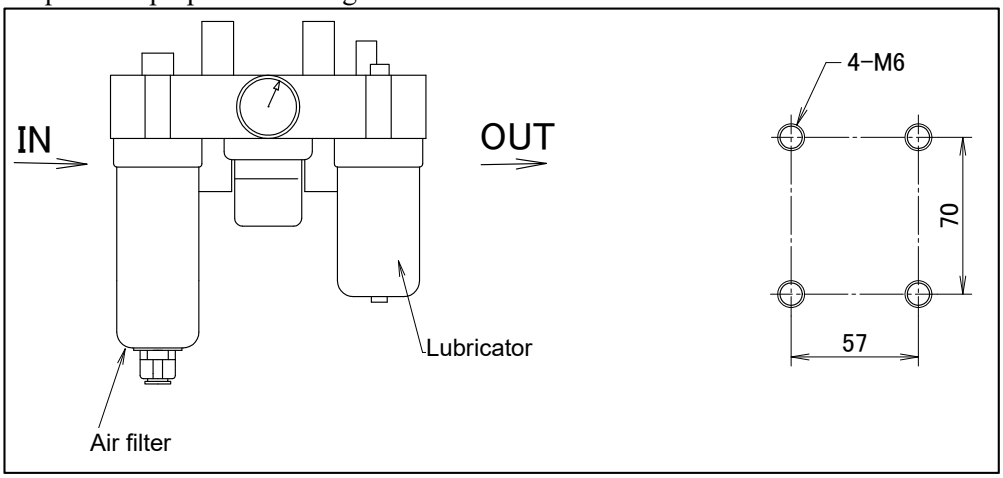


Fig. 5.2 (b) Air control set option (option)

NOTE
The capacity of the air control set is as follows.
These values must not be exceeded.

Air pressure	Supply air pressure	0.49 to 0.69MPa(5 to 7kgf/cm^2) Setting: 0.49MPa(5kgf/cm^2)
	Amount of consumption	Maximum instantaneous amount 150Nl/min (0.15Nm^3/min)

5.3 INTERFACE FOR OPTION CABLE (OPTION)

Fig. 5.3 (b) to (n) show the position of the option cable interface. EE (RI/RO), user cable (signal line, signal line usable to 3D Laser Vision Sensor and Force Sensor), user cable (power line), wire feeder cable, welding power cable, camera cable, 3D Laser Vision Sensor cable and Ethernet cable (signal) are prepared as options.

NOTE

Each option cable is written as shown below on the connector panel.

EE(RI/RO)	: EE
User cable (signal)	: AS
User cable (power)	: AP
Wire feeder cable	: W/F
Welding power cable	: W/P
User cable usable to 3D Laser Vision Sensor and Force Sensor	: ASi
Camera cable	: CAM
3D Laser Vision Sensor cable	: SEN
Ethernet cable (signal)	: ES

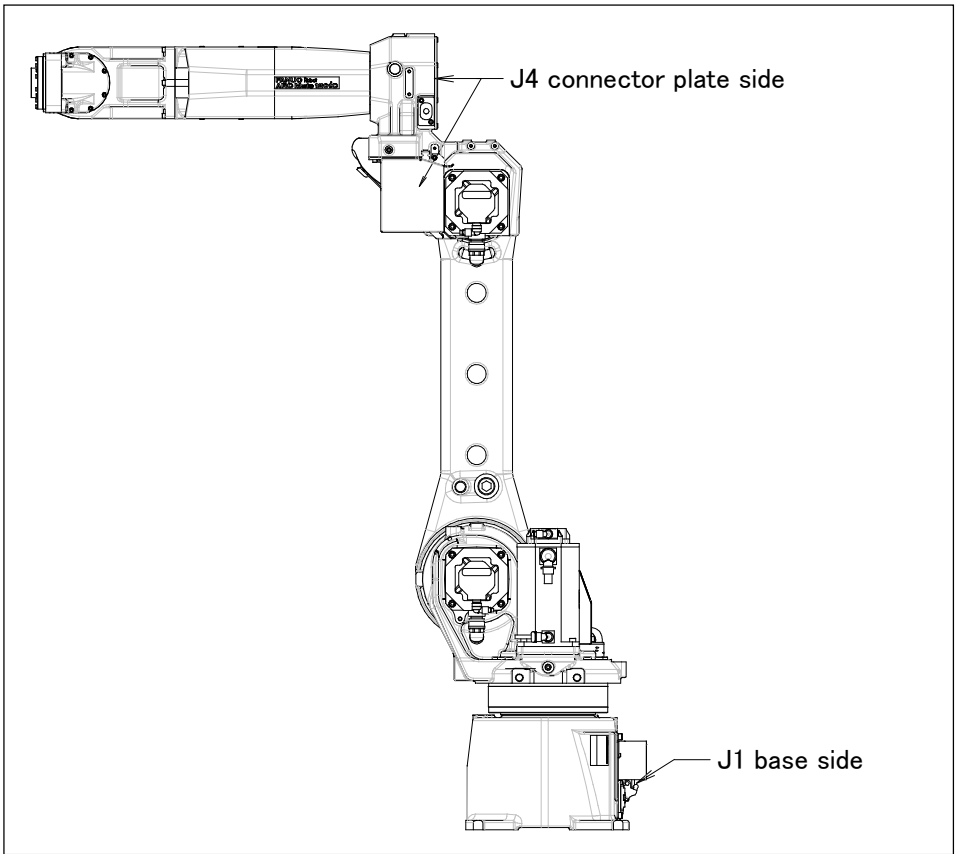


Fig. 5.3 (a) Interface for option cable (Option)

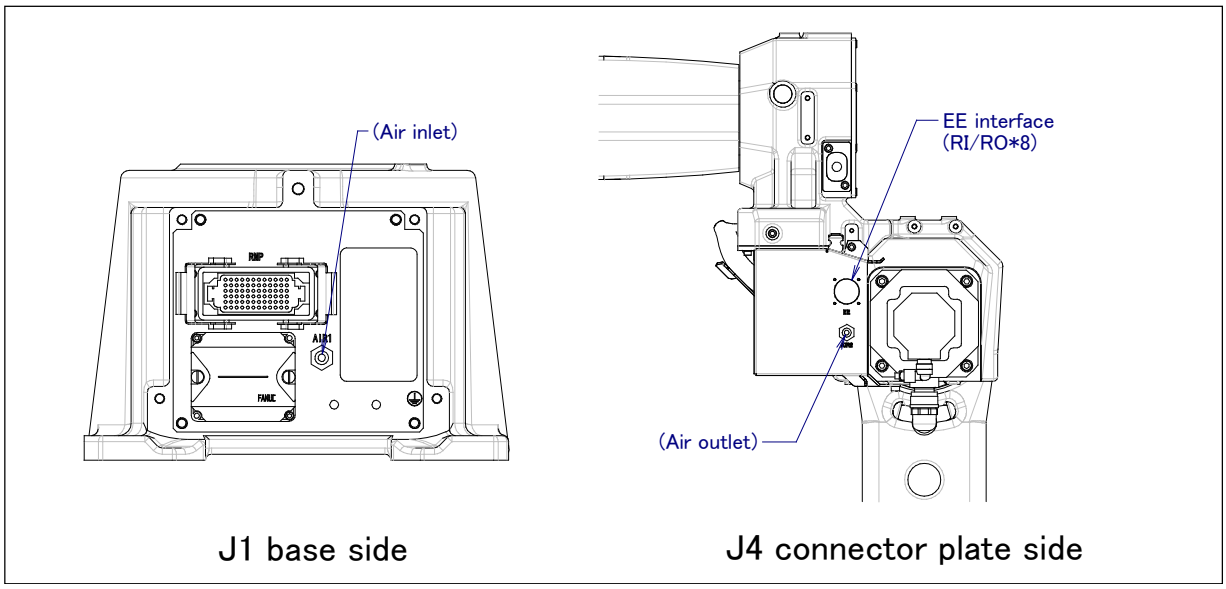


Fig. 5.3 (b) Interface for option cable (A05B-1222-H201, H231, A05B-1225-H231 are specified)

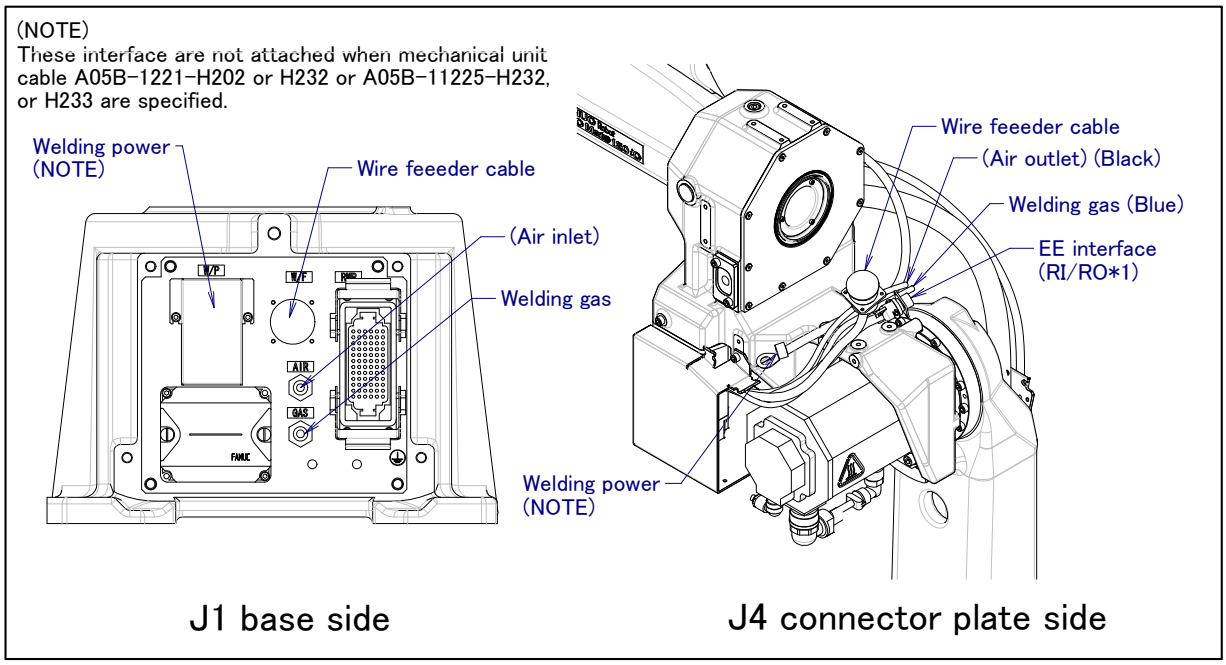


Fig. 5.3 (c) Interface for option cable
(A05B-1222-H202, H203, H206, H232, H233, H236, H512, H513, A05B-1225-H232, H233, H236, H532, H533 are specified)

NOTE
A05B-1222-H202, H203, H206, H232, H233, H236, A05B-1225-H232, H233, H236 are for LINCOLN wire feeder.
A05B-1222-H512, H513, A05B-1225-H532, H533 are for DAIHEN wire feeder.

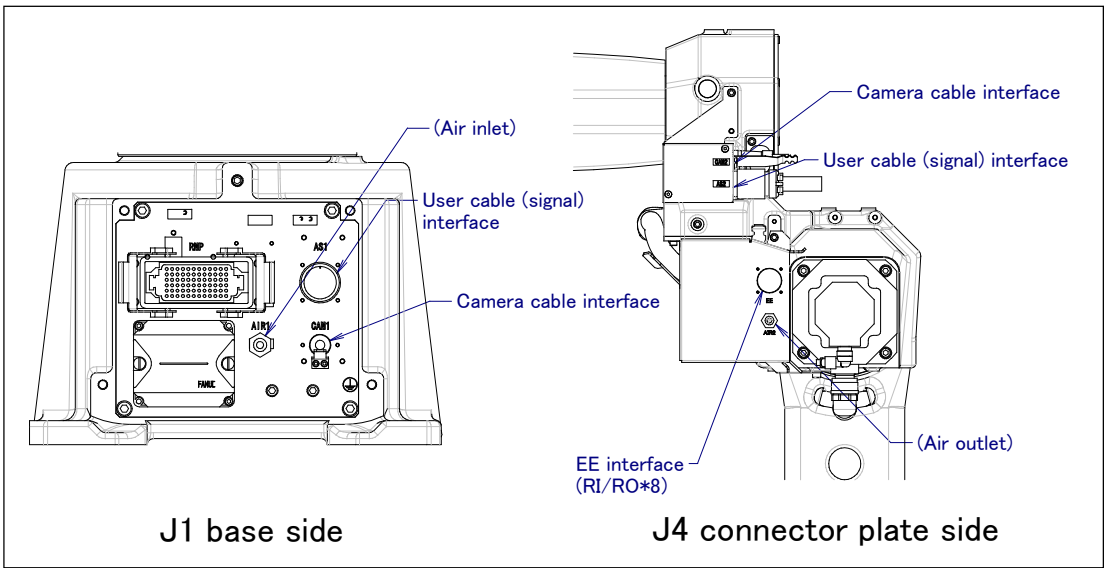


Fig. 5.3 (d) Interface for option cable (A05B-1222-H505, H535, A05B-1225-H235 are specified)

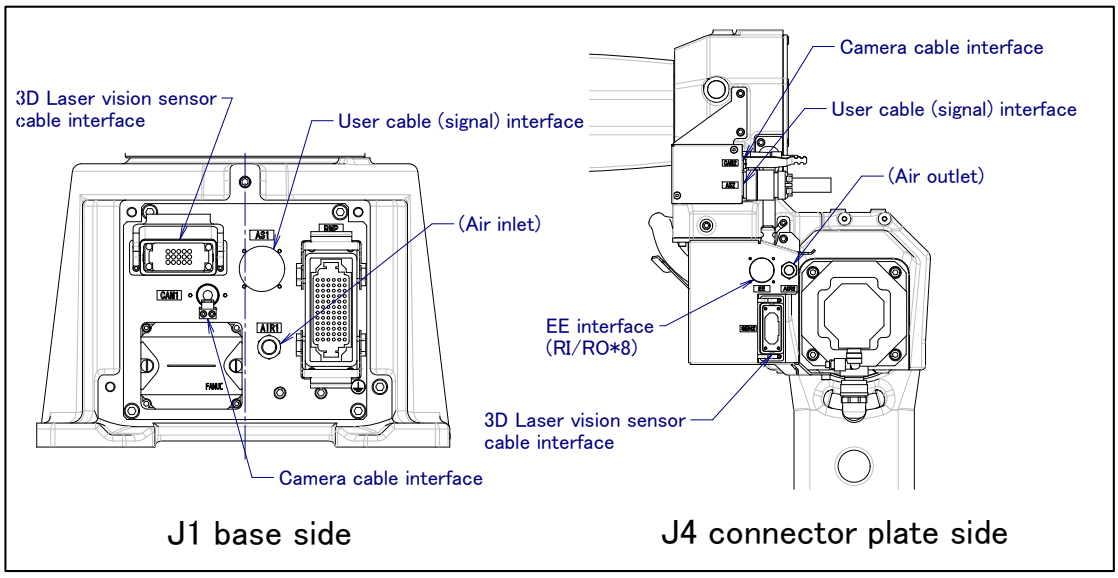


Fig. 5.3 (e) Interface for option cable (A05B-1222-H507, H537 is specified)

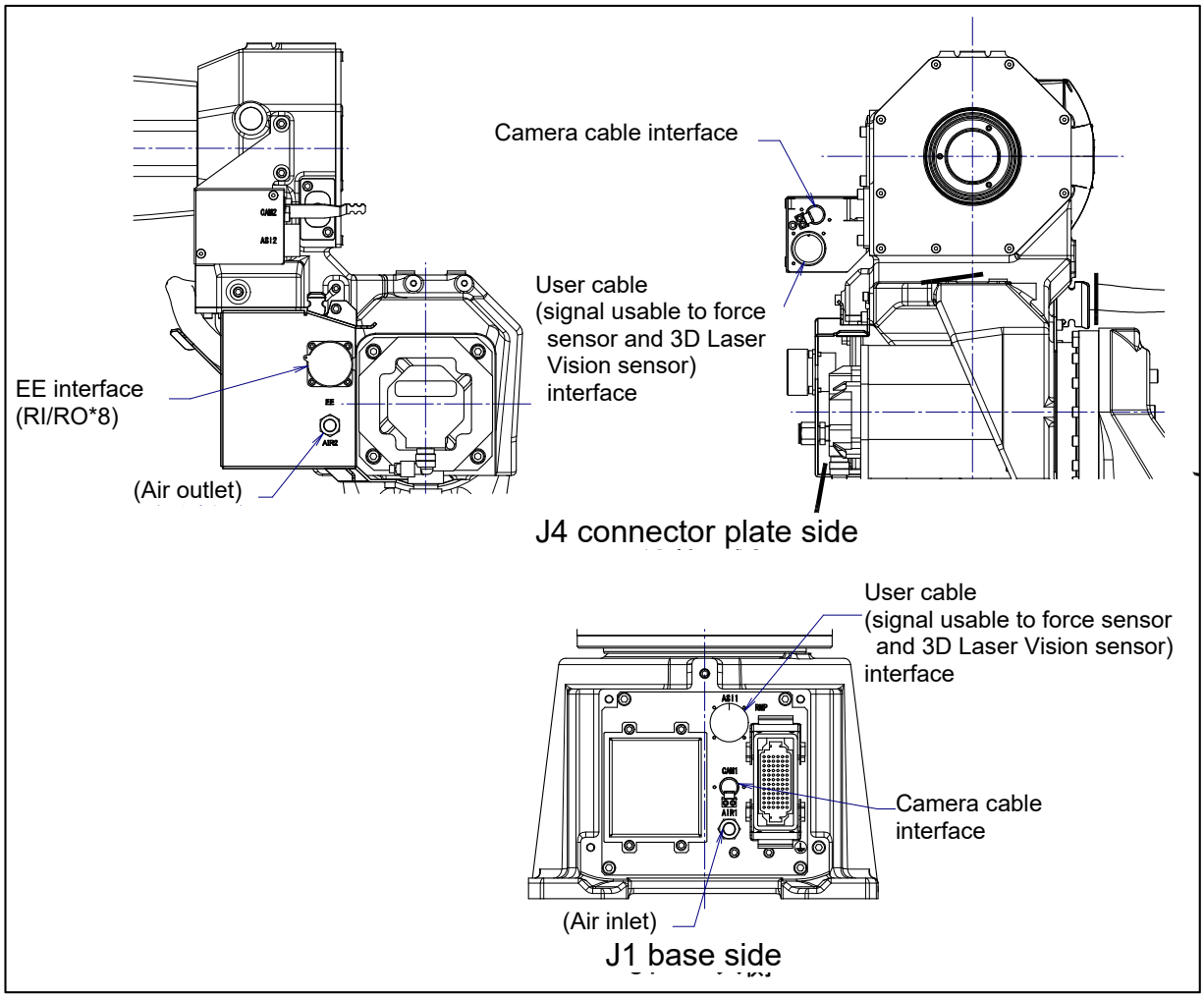


Fig. 5.3 (f) Interface for option cable (A05B-1222-H525, A05B-1225-H255 are specified)

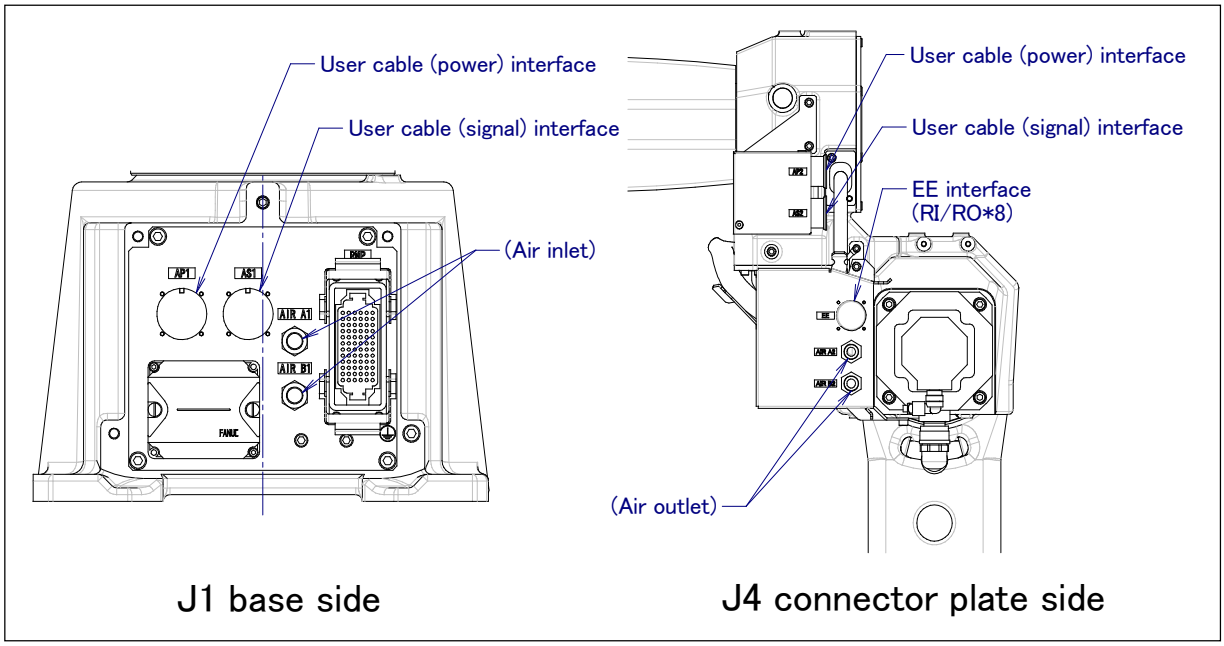


Fig. 5.3 (g) Interface for option cable (A05B-1222-H214 is specified)

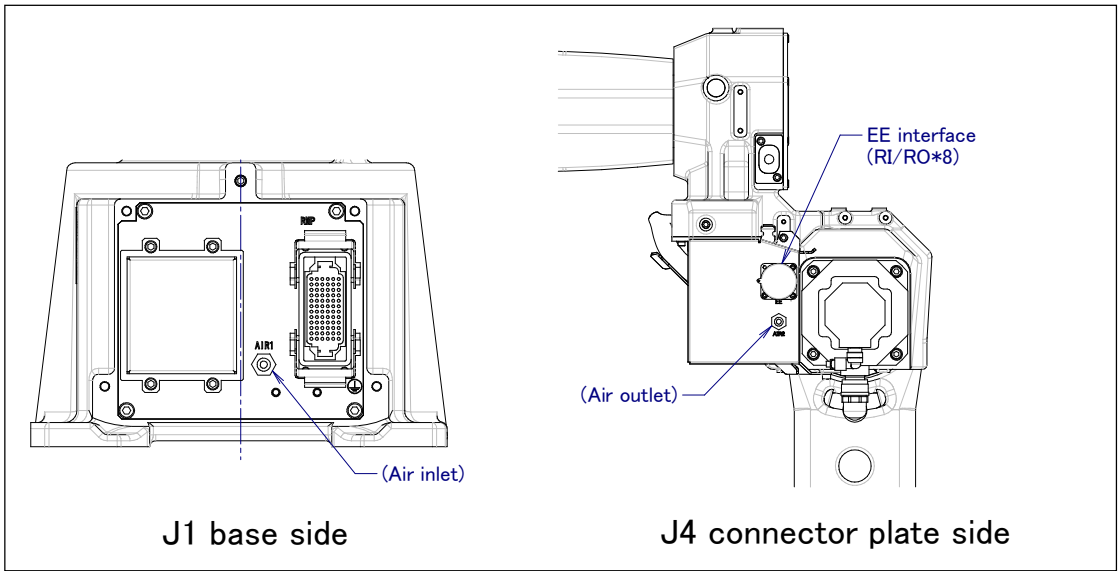


Fig. 5.3 (h) Interface for option cable (A05B-1222-H221, H251, A05B-1225-H251 is specified)

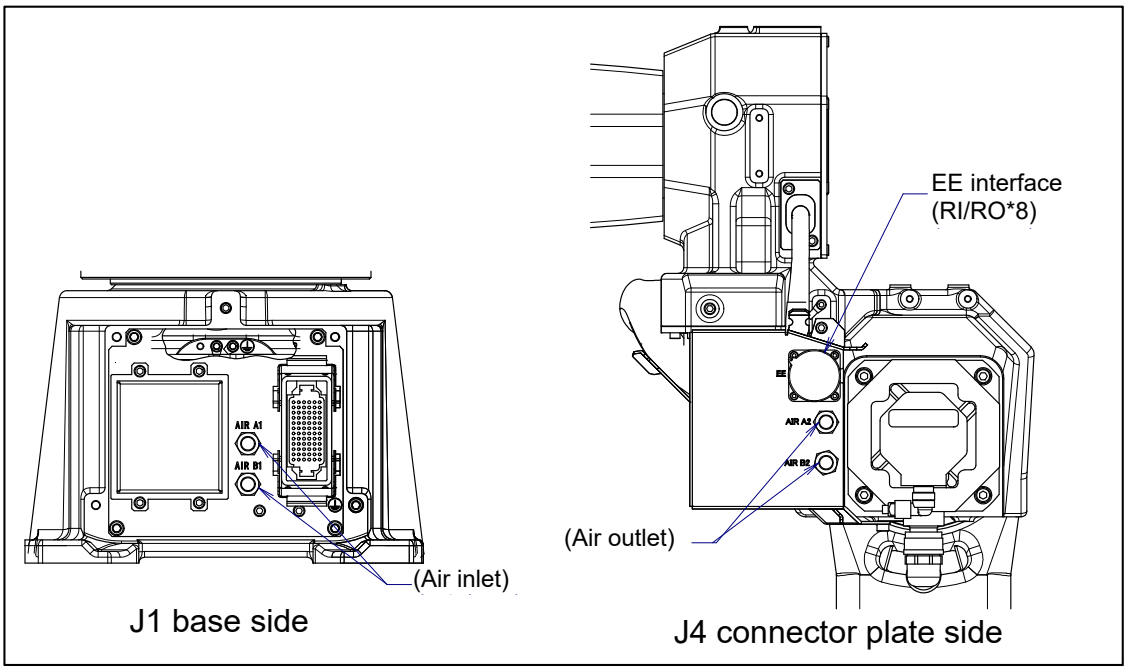


Fig. 5.3 (i) Interface for option cable (A05B-1222-H224 is specified)

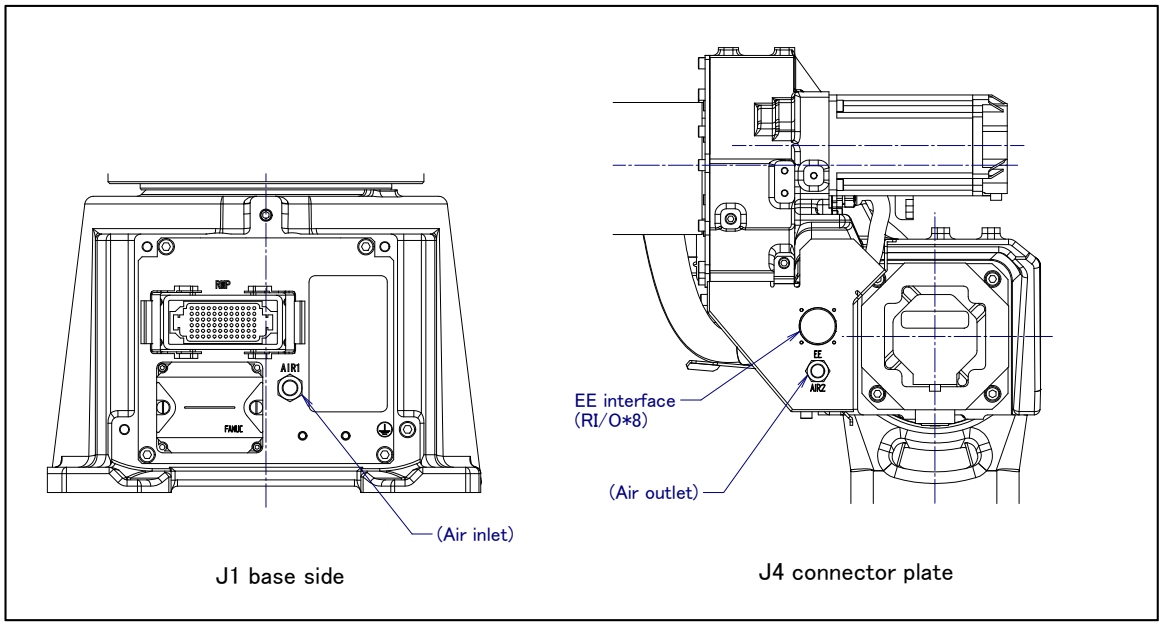


Fig. 5.3 (j) Interface for option cable (A05B-1222-H601 is specified)

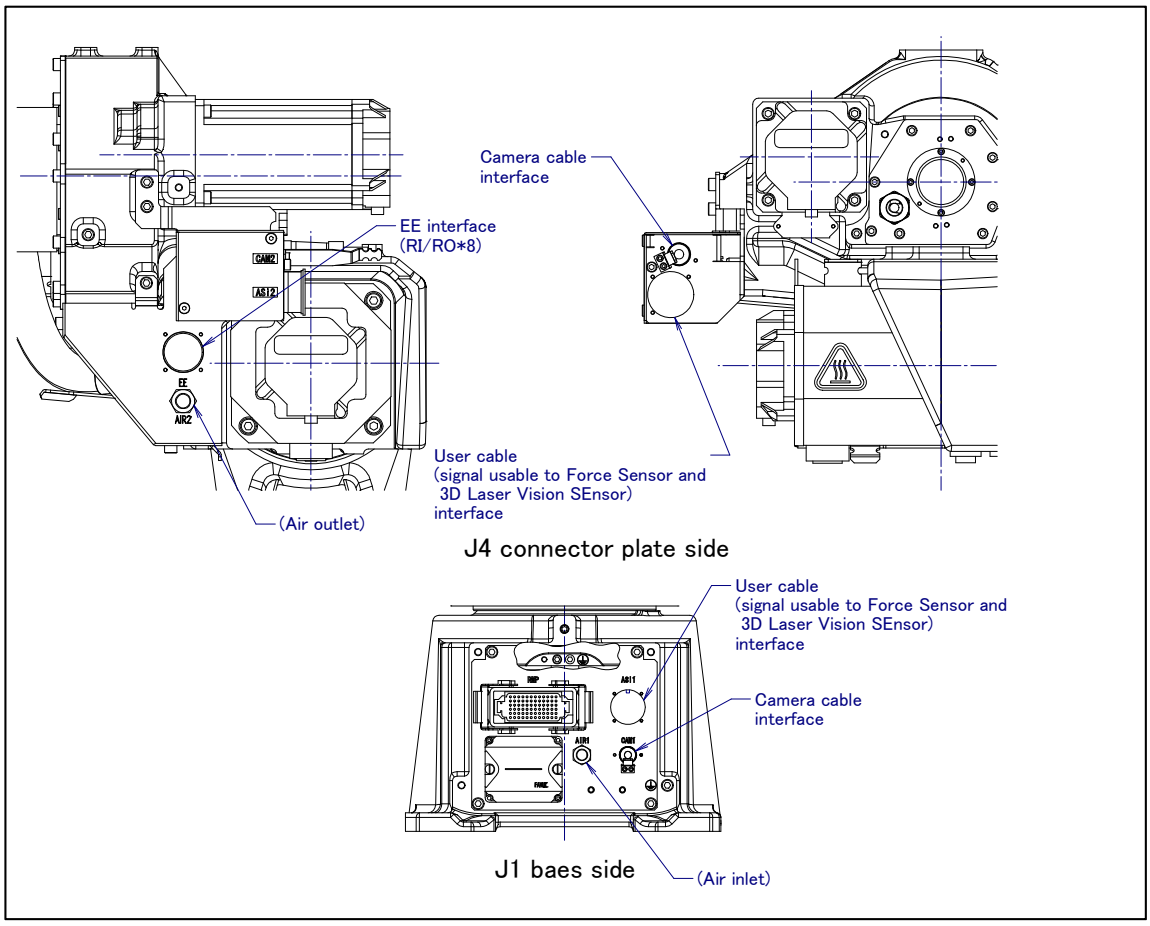


Fig. 5.3 (k) Interface for option cable (A05B-1222-H605 is specified)

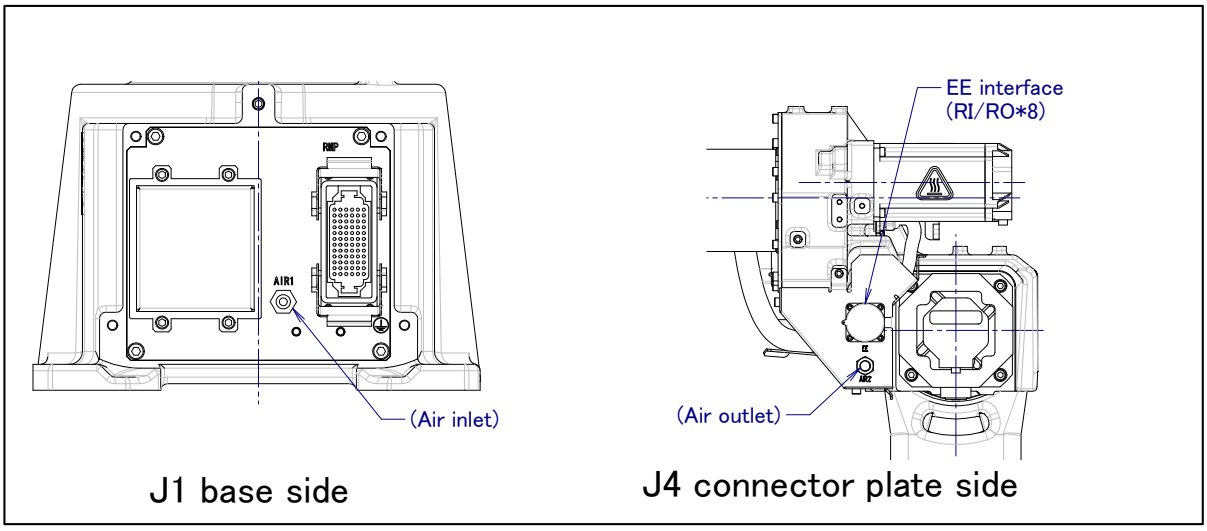


Fig. 5.3 (l) Interface for option cable (A05B-1222-H621 is specified)

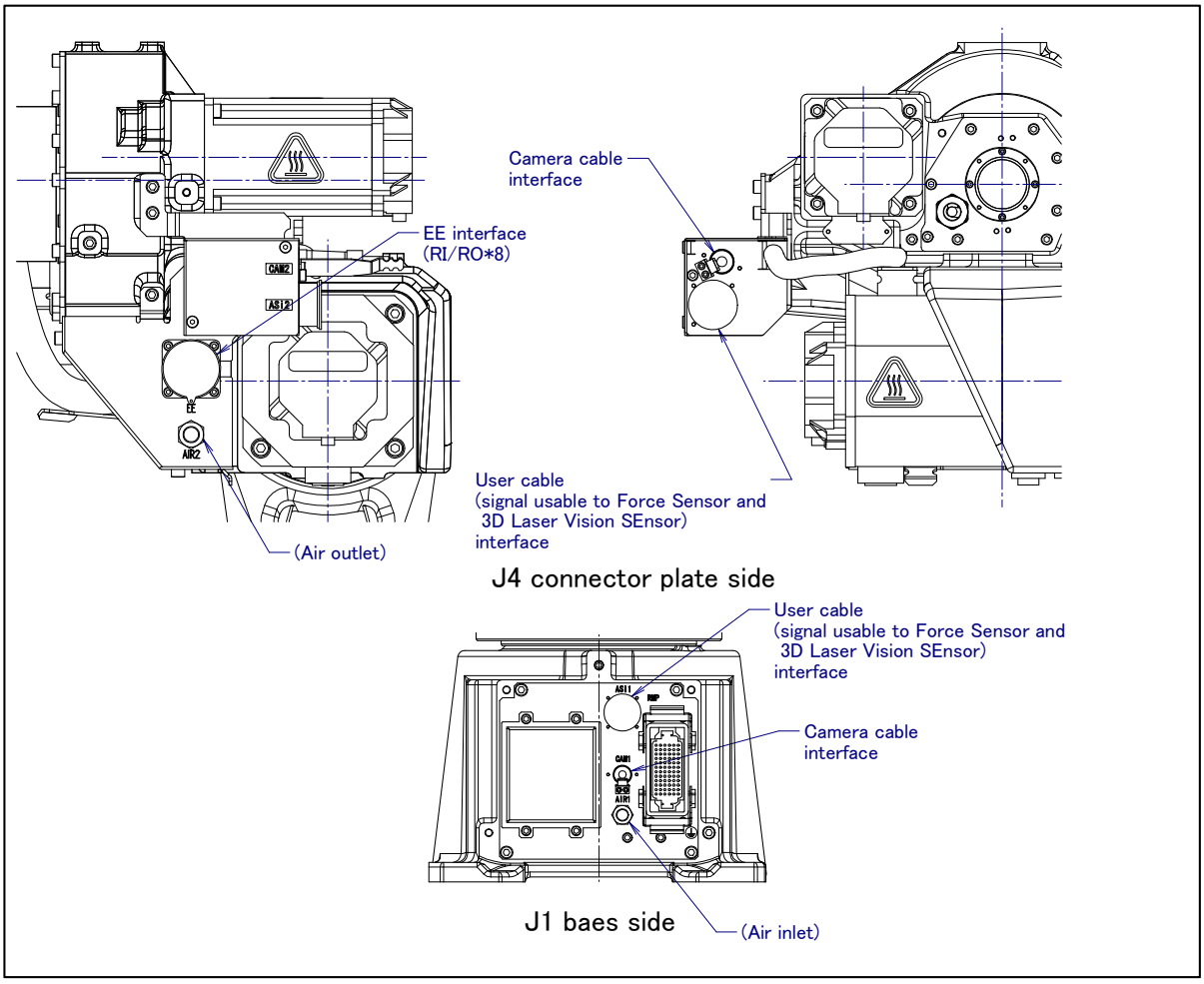


Fig. 5.3 (m) Interface for option cable (A05B-1222-H625 is specified)

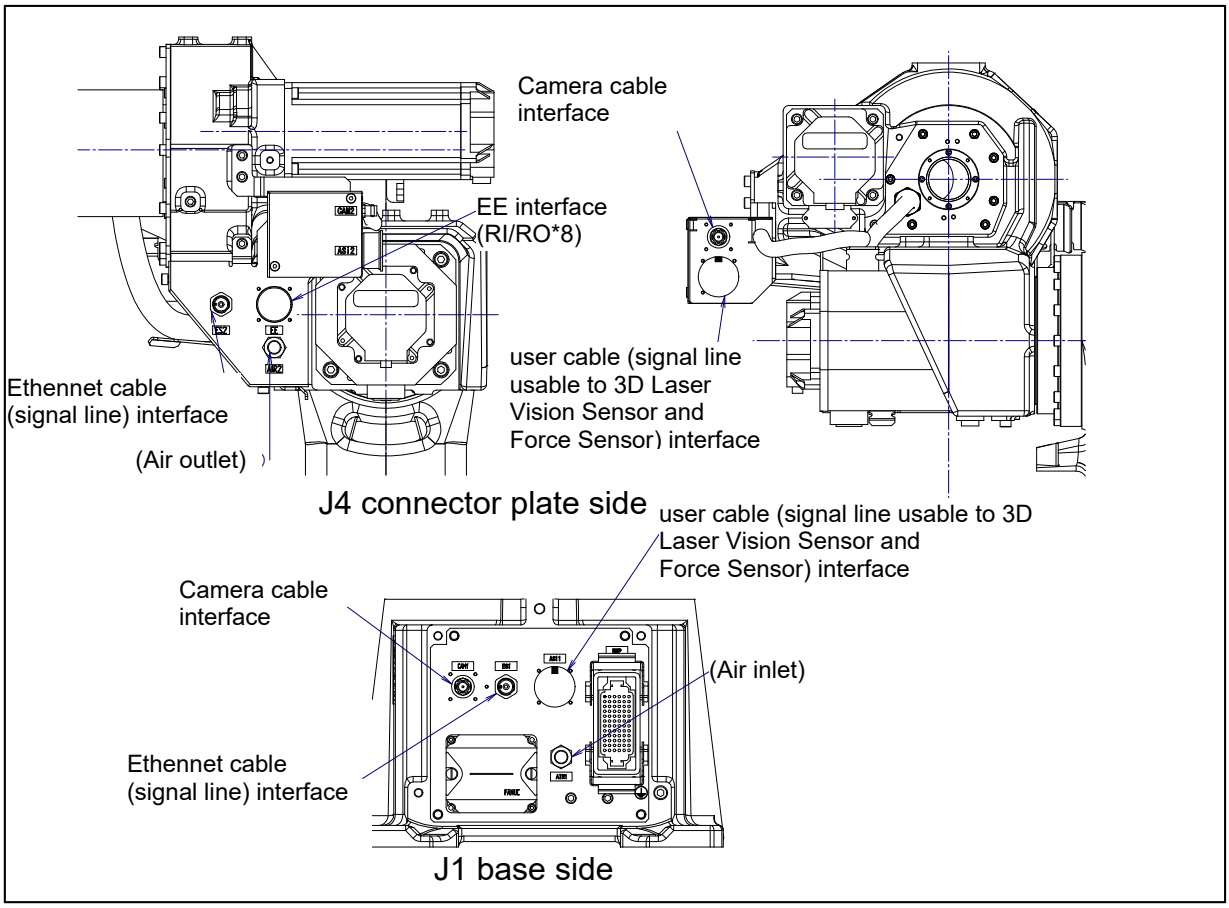


Fig. 5.3 (n) Interface for option cable (A05B-1222-H861 is specified)

1 EE interface (RI/RO) (option)
Fig. 5.3 (o) to (q) show pin layout for EE interface (RI/RO).

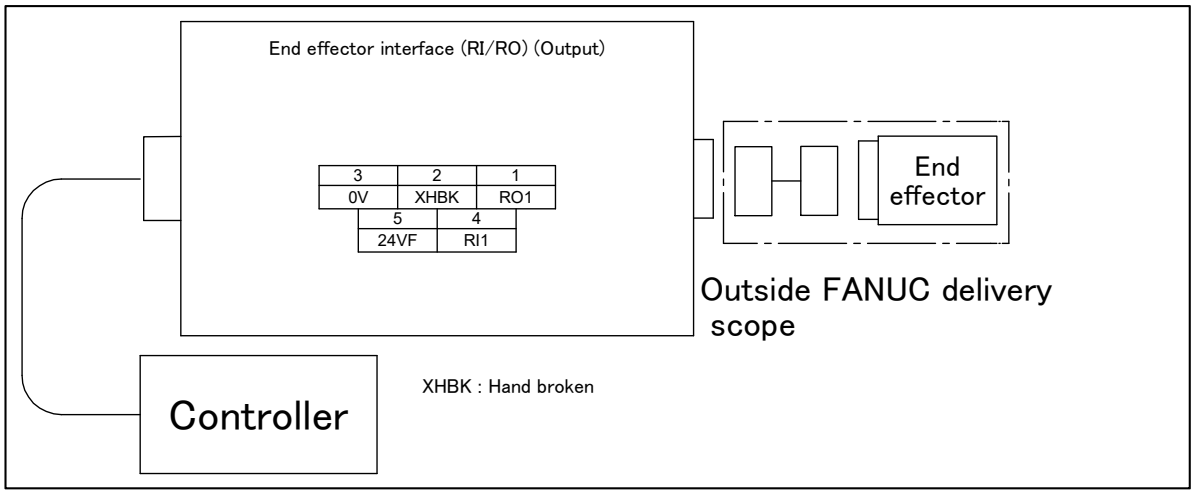


Fig. 5.3 (o) Pin layout for EE interface (RI/RO) RI/RO x 1 (option)

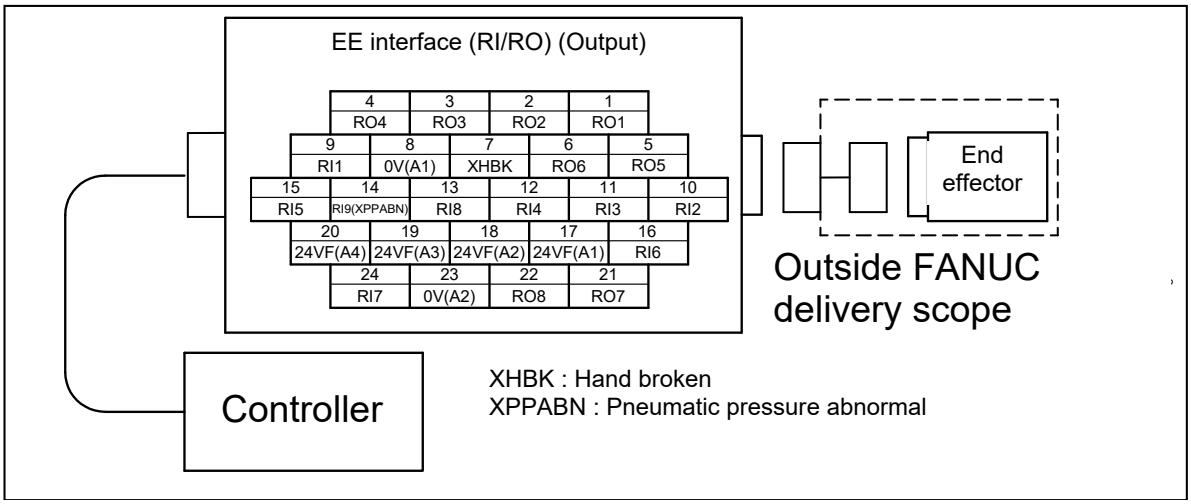


Fig. 5.3 (p) Pin layout for EE interface (RI/RO) RI/RO x 8 (option)

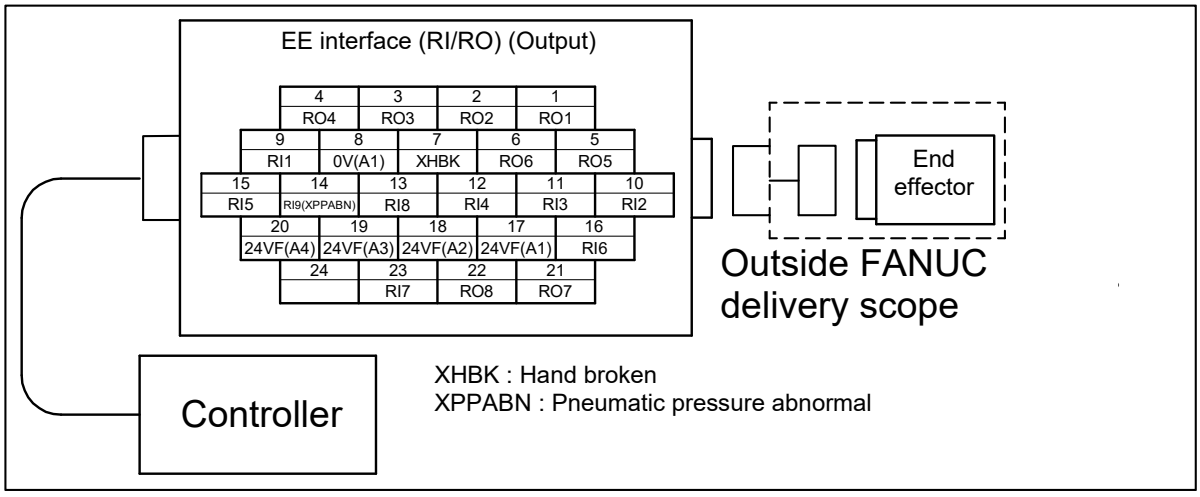


Fig. 5.3 (q) Pin layout for EE interface
(When M-20*i*A, M-20*i*A/10L/12L/20M/35M severe dust/liquid protection option is specified) RI/RO x 8 (option)

> ⚠ **CAUTION**
> To wire the peripheral device to the EE interface, refer to the ELECTRICAL CONNECTIONS Chapter of the CONTROLLER MAINTENANCE MANUAL.

2 Wire feeder (W/F) power supply Interface (option)
Fig. 5.3 (r), (s) show pin layout for wire feeder power supply interface.

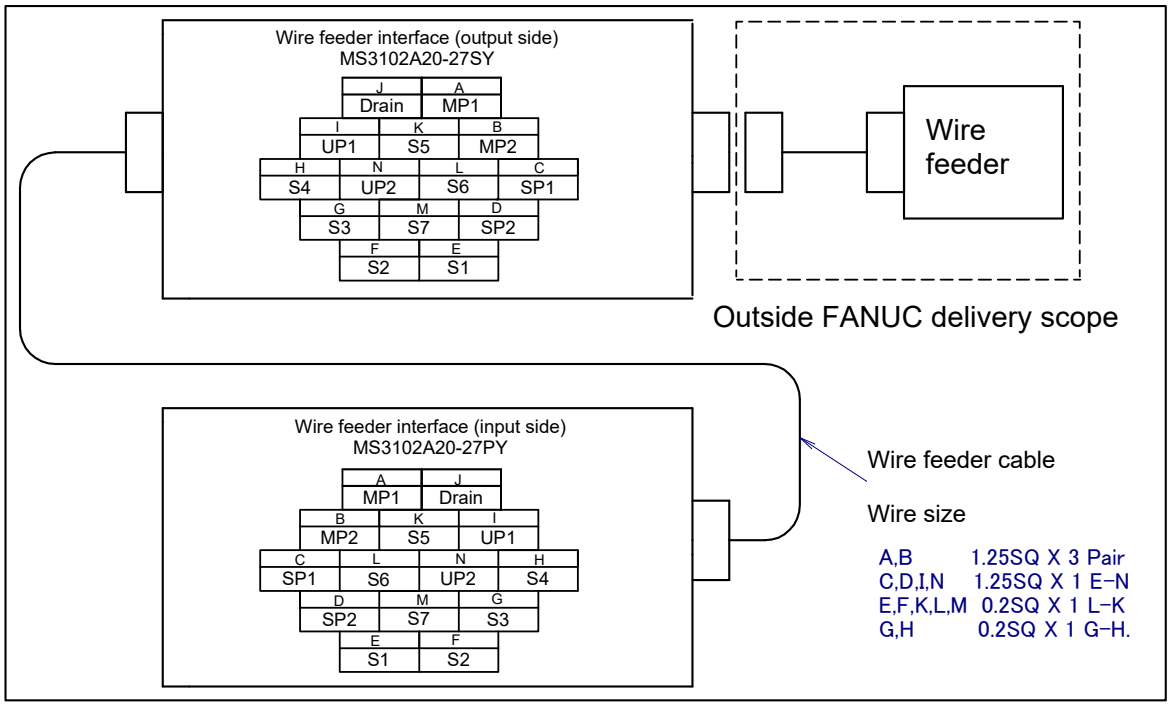


Fig. 5.3 (r) Pin layout for LINCOLN wire feeder (W/F) power supply interface (option)

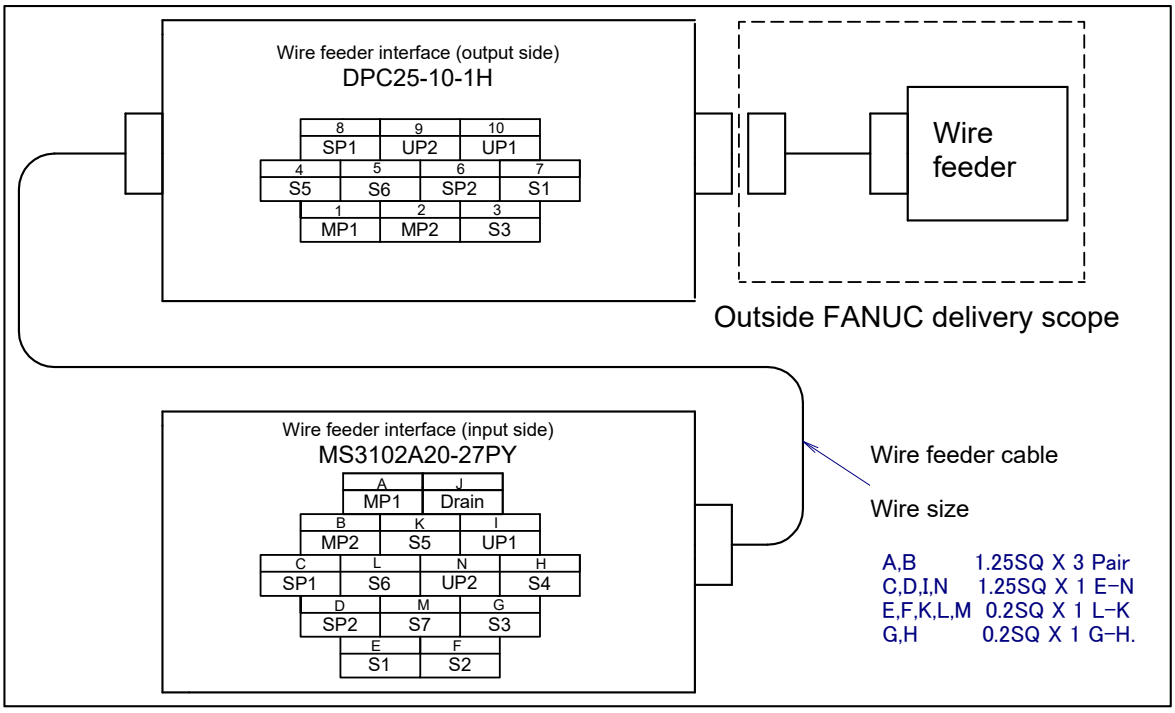


Fig. 5.3 (s) Pin layout for DAIHEN wire feeder (W/F) power supply interface (option)

3 User cable (signal line/signal usable to 3D Laser Vision Sensor and Force Sensor) (AS)(ASi) Interface (option)
Fig. 5.3 (t) shows pin layout for user cable (signal line/signal usable to 3D Laser Vision Sensor and Force Sensor) interface.

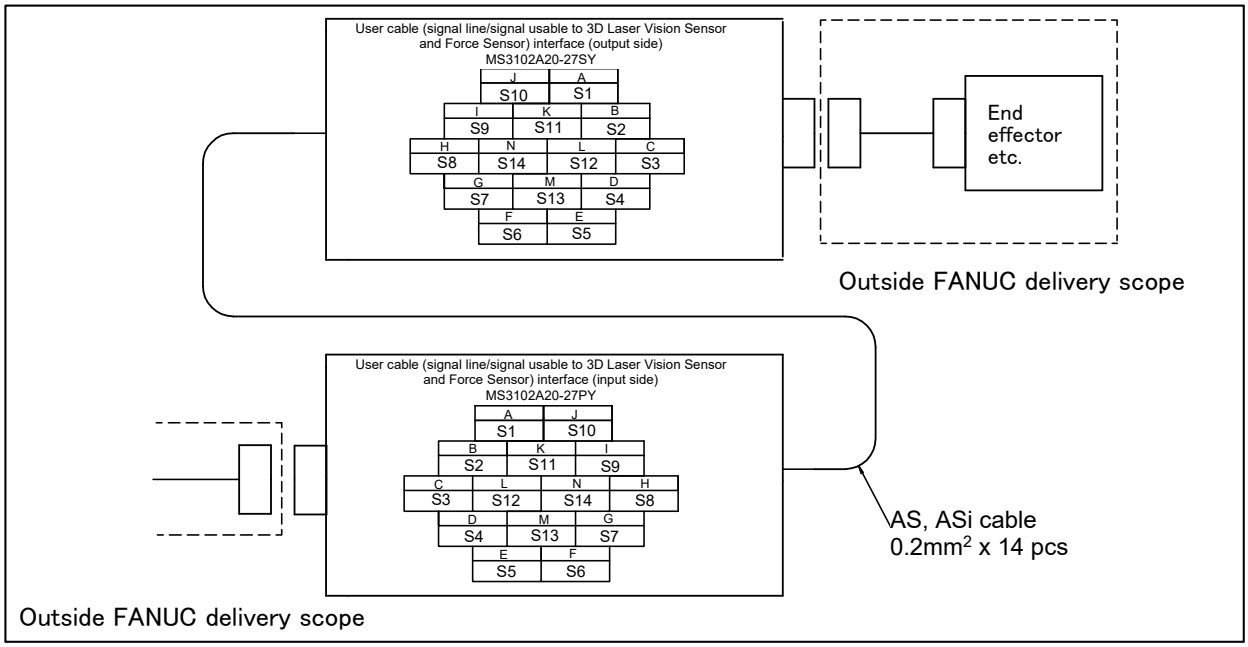


Fig. 5.3 (t) Pin layout for user cable
(signal line/signal usable to 3D Laser Vision Sensor and Force Sensor) (AS) (ASi) interface (option)

4 User cable (power line) (AP) Interface (option)
Fig. 5.3 (u) shows pin layout for user cable (power line) interface.

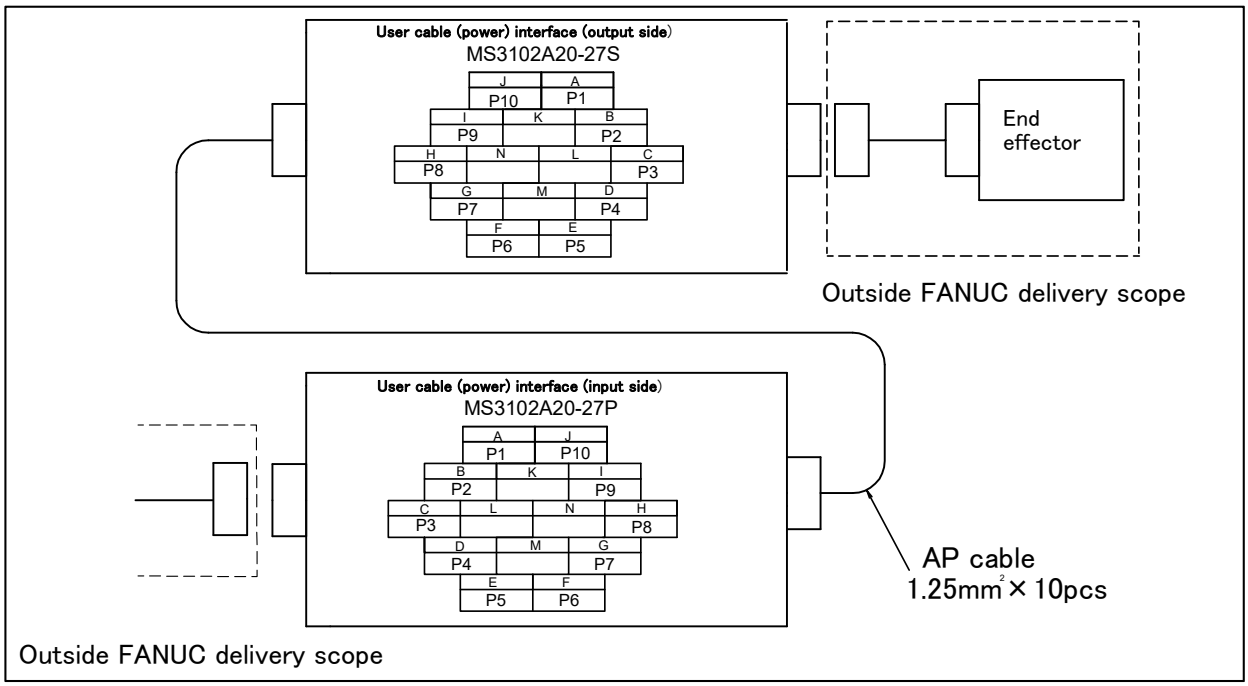


Fig. 5.3 (u) Pin layout for user cable (power line) (AP) interface (option)

5 Ethernet cable Interface (ES)(option)
Fig. 5.3 (v) shows the pin layout for the Ethernet cable interface.

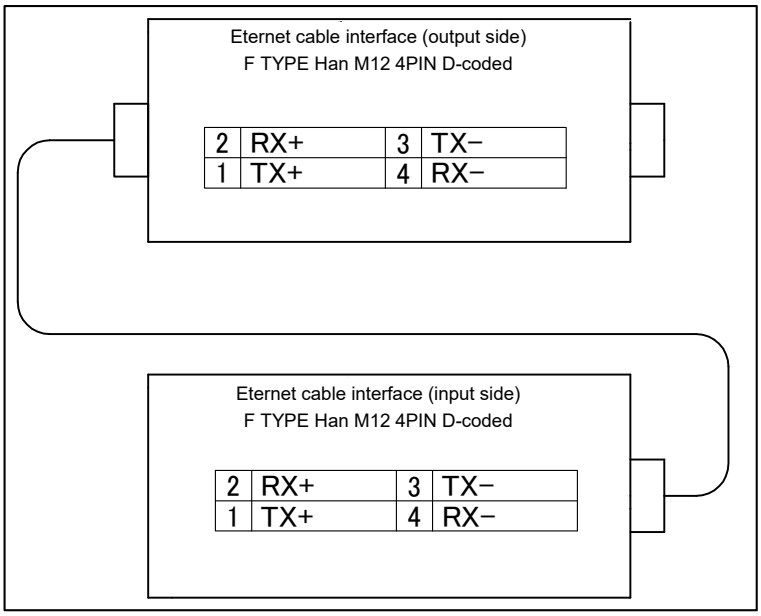


Fig. 5.3 (v) Pin layout for Ethernet (ES) cable interface (option)
(When A05B-1222-H861 is specified)

Connector specifications

Table 5.3 (a) Connector specifications (User side)

Cable name	Input side (J1 base)	Output side (J3 casing)	Maker/dealer
EE (RI/RO x 1)	————	JMSP1305M Straight plug (FANUC Spec : A05B-1221-K845) JMLP1305M Angle plug	Fujikura.Ltd
EE (RI/RO x 8)	————	JMSP2524M Straight plug (Attached) (FANUC Spec : A63L-0001-0234#S2524M) JMLP2524M Angle plug	
EE (RI/RO x 8) For severe dust/liquid protection package	————	Plug : JL05-6A24-28PC-F0-R (FANUC spec.: A63L-0001-0463#P2424P) End bell (elbow) : JL04-24EBH-R (FANUC spec.: A63L-0001-0463#24EBL) Clamp : JL04-2428CK(20)-R (FANUC spec.: A63L-0001-0463#2428CK20) Pin contact : ST-JL05-16P-C3-100 (FANUC spec.: A63L-0001-0463#16PC3)	Japan Aviation Electronics Industry, Ltd.
W/F(*1), AS ASi	Straight plug : MS3106B20-27SY (*3) Elbow plug : MS3108B20-27SY or a compatible product Clamp : MS3057-12A (*3) (FANUC spec.: A05B-1221-K843 Straight plug (*3) and clamp (*3) are included)	Straight plug : MS3106B20-27PY (*4) Elbow plug : MS3108B20-27PY or a compatible produce Clamp : MS3057-12A (*4) (FANUC spec.: A05B-1221-K841 Straight plug (*4) and clamp (*4) are included)	Fujikura.Ltd Japan Aviation Electronics Industry, Ltd.
W/F(*1), ASi For severe dust/liquid protection package	Plug : D/MS3106A20-27SY(D190)(R1) Back shell (straight) : CE02-20BS-S-D(R1) Back shell (elbow) : CE-20BA-S-D(R1) Cable clamp (cable diameter) ϕ12.5 - 16 : CE3057-12A-1-D(R1) ϕ9.5 - 13 : CE3057-12A-2-D(R1) ϕ6.8 - 10 : CE3057-12A-3-D(R1) ϕ14.5 - 17 : CE3057-12A-7-D(R1)	Plug : D/MS3106A20-27PY(D190)(R1) Back shell (straight) : CE02-20BS-S-D(R1) Back shell (elbow) : CE-20BA-S-D(R1) Cable clamp (cable diameter) ϕ12.5 - 16 : CE3057-12A-1-D(R1) ϕ9.5 - 13 : CE3057-12A-2-D(R1) ϕ6.8 - 10 : CE3057-12A-3-D(R1) ϕ14.5 -17 : CE3057-12A-7-D(R1)	Fujikura.Ltd
W/F(*2)	Connector Straight plug : MS3106B20-27SY (*3) Elbow plug : MS3108B20-27SY or a compatible product Clamp MS3057-12A (*3) (FANUC spec.: A05B-1221-K843 Straight plug (*3) and clamp (*3) are included)	DPC25-10A-1H0 (FANUC spec.: A63L-0101-0074#S)	Input side Fujikura.Ltd Japan Aviation Electronics Industry, Ltd. Output side TOUA WIRELESS CO.
AP	Maker specification Connector Straight plug : MS3106B20-27S (*5) Elbow plug : MS3108B20-27S or a compatible mode Clamp MS3057-12A (*5) FANUC specification A05B-1221-K844 (Straight plug (*5) and clamp (*5) are included)	Maker specification Connector Straight plug : MS3106B20-27P (*6) Elbow plug : MS3108B20-27P Or a compatible mode Clamp MS3057-12A (*6) FANUC specification A05B-1221-K842 (Straight plug (*6) and clamp (*6) are included)	Fujikura.Ltd Japan Aviation Electronics Industry, Ltd.

Cable name	Input side (J1 base)	Output side (J3 casing)	Maker/dealer
ES	Connector 2103 881 1405 2103 882 3405 Contact 0967 000 7576 0967 000 5576 0967 000 8576 0967 000 3576	Connector 2103 881 1405 2103 882 3405 Contact 0967 000 7576 0967 000 5576 0967 000 8576 0967 000 3576	HARTING K.K.

(Note) The voltage to which the wire feeder connector can be input is direct current 40V.
(*1) for LINCOLN wire feeder
(*2) for DAIHEN wire feeder

Table 5.3 (b) Connector specifications (Mechanical unit side・reference)

Cable name	Input side (J1 base)	Output side (J3 casing)	Maker/dealer
EE (RI/RO x 1)	―――	JMWR1305F	Fujikura.Ltd
EE (RI/RO x 8)	―――	JMWR2524F	
W/F(*1), AS, ASi	MS3102A20-27PY	MS3102A20-27SY	Fujikura.Ltd, Japan Aviation Electronics Industry, Ltd. etc
ASi For severe dust/liquid protection package	MS3102R20-27PY	MS3102R20-27SY	Fujikura.Ltd, Japan Aviation Electronics Industry, Ltd. etc
W/F (*2)	MS3102A20-27PY	DPC25-10C-1H	Input side Fujikura.Ltd Japan Aviation Electronics Industry, Ltd. Output side TOUA WIRELESS CO.
ES	Connector 21 03 882 2425 Contact 09 67 000 7476	Connector 21 03 882 2425 Contact 09 67 000 7476	HARTING K.K

(*1) for LINCOLN wire feeder
(*2) for DAIHEN wire feeder

Table 5.3 (c) Connector specifications (on the Mechanical unit side when the M-20*i*A, M-20*i*A/10L/12L/20M/35M severe dust/liquid protection option is specified reference)

Component name	Model	Maker/dealer
Receptacle	JL05-2A24-28SC-F0-R	Japan Aviation Electronics Industry, Ltd.
Socket contact	ST-JL05-16S-C3-100	

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

6 AXIS LIMIT SETUP

By setting the motion range of each axes, you can change the robot's motion range from the standard values. Changing the motion range of the robot is effective under following circumstances:

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

The two methods used to prevent the robot from going beyond the necessary motion range.

- Axis limit by DCS (All axes)
- Axis limit adjustable mechanical stopper ((J1-axis) option)

⚠ WARNING

1 Changing the motion range of any axis affects the operating range of the robot. To avoid trouble, carefully consider the possible effect of the change to the movable range of each axis in advance. Otherwise, it is likely that an unexpected condition will occur; for example, an alarm may occur when the robot tries to reach a previously taught position.
2 For J1-axis, use adjustable mechanical stoppers, for J2/J3-axis, use the DCS function so that damage to peripheral equipment and injuries to human bodies can be avoided.
3 Mechanical stoppers are physical obstacles. For J1-axis, it is possible to re-position the adjustable mechanical stoppers. But the robot cannot move beyond them. For J2, J3-axis, the mechanical stoppers are fixed. For the J4, J5 and J6-axis, only DCS-specified limits are available.
4 Adjustable mechanical stoppers (J1-axis) are damaged in any collision to stop the robot. Once a stopper is subjected to a collision, it can no longer assure its original strength and, therefore, might not stop the robot. When this happens, replace the mechanical stopper with a new one.
5 When the mechanical stopper (J1-axis) is not used, attach the label and protect the mounting face. If spatter etc. attached to the mounting face or the tap, the stopper cannot be installed correctly, and there is a possibility that the robot does not stop.

6.1 CHANGE AXIS LIMIT BY DCS (OPTION)

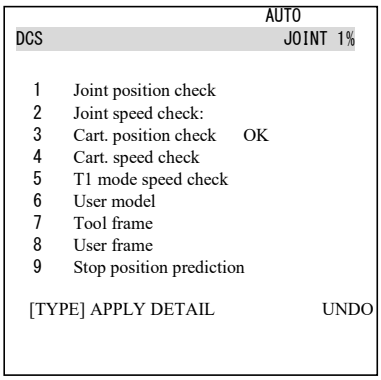
The robot motion can be restricted with DCS (Dual check safety) function by using the following software. For J2/J3-axis, the same effect as J1-axis adjustable mechanical stopper describe in Section 6.2 can be obtained. The robot motion can be restricted at any angle and position if it is in robot motion area. DCS functions are certified to meet the requirements of International Standard ISO13849-1 and IEC61508 approved by certificate authority. If only the operating space is set using Joint Position Check, the robot stops after it goes beyond the workspace. When the motor power is shut down, the robot's momentum causes it to move some distance before it completely stops. The actual "Robot Stop Position" will be beyond the workspace. To stop the robot within the robot workspace, use the DCS Stop Position Prediction function. The stop position prediction is disabled by default.

- DCS position/speed check function (J567)

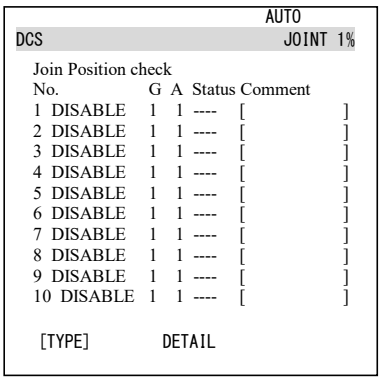
As an example, we shows the procedure to set ±30° for J2-axis in here. Refer to R-30*i*B/R-30*i*B Mate /R-30*i*B Plus Controller Dual check safety function Operator's Manual (B-83184EN) or R-30*i*A/R-30*i*A Mate Controller Dual check safety function Operator's Manual (B-83104EN) for details of other setting, function and DCS stop position prediction.

Setting procedure

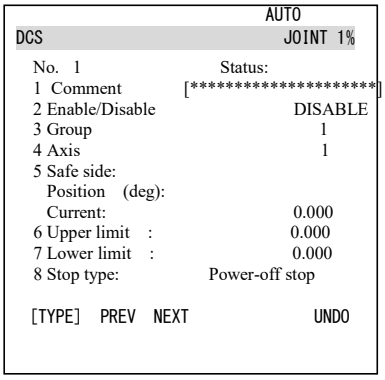
1 Press the [MENU] key to display the screen menu.
2 Press [0 NEXT] and press [6 SYSTEM].
3 Press the F1 ([TYPE]).
4 Select [DCS]. The following screen will be displayed.



5 Move the cursor to [1 Joint position check], then press the [DETAIL].



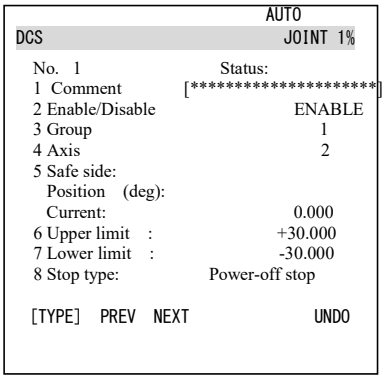
6 Move the cursor to [1], then press the [DETAIL].



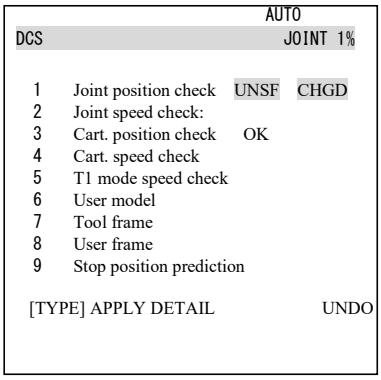
7 Move the cursor to [DISABLE], then press [CHOICE], set the status to [ENABLE].
8 Move the cursor to [Group], then input the robot group number, then press the [ENTER] key.
9 Move the cursor to [Axis], then input "2", then press the [ENTER] key.

10 Move the cursor to [Upper limit] right side, then input “30”, then press the [ENTER] key.
11 Move the cursor to [Lower limit] right side, then input “-30”, then press the [ENTER] key.

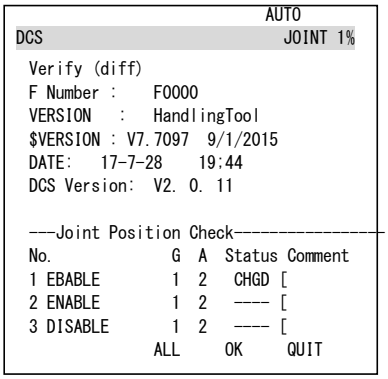
> ⚠ **WARNING**
> If only the operating space is set using Joint Position Check, the robot stops after it goes beyond the workspace. When the motor power is shut down, the robot’s momentum causes it to move some distance before it completely stops. The actual "Robot Stop Position" will be beyond the workspace. To stop the robot within the robot workspace, use the DCS Stop Position Prediction function. The stop position prediction is disabled by default.



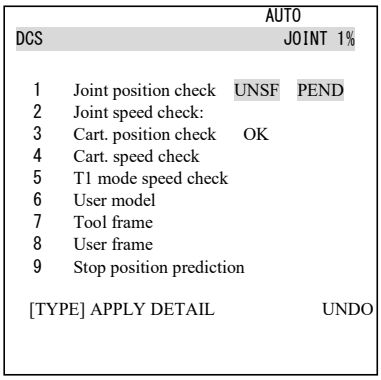
12 Press the [PREV] key two times, back to the first screen.



13 Press the [APPLY].
14 Input 4-digit password, then press the [ENTER] key. (Password default setting is “1111”.)
15 The following screen will be displayed, then press the [OK].



[CHGD] on the right side of [1 Joint position check] will change to [PEND].



16 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.

6.2 ADJUSTABLE MECHANICAL STOPPER SETTING (OPTION)

For the J1-axis, it is possible to re-position mechanical stoppers. Change the position of the mechanical stoppers according to the desired movable range. Be sure to exchange transformed stopper by new one. Replacing method and parts are common to the J1-axis mechanical stopper. Please refer to Section 3.3.

Item		Movable range
J1-axis adjustable mechanical stopper	Upper limit	Settable in steps of 30° degrees in a range of +20° to +170° degrees
	Lower limit	Settable in steps of 30° degrees in the range of -170° to -20° degrees
	Space between the upper and lower limits.	A space of 60° or more is required.

> **NOTE**
> 1 If the newly set operation range does not include 0°, you must change it by zero degree mastering so that 0° is included.
> 2 When adjustable mechanical stopper is ordered, mounting bolt is attached.
> 3 When motion range is changed by adjustable mechanical stopper, be sure to set the motion range of soft same refer to Subsection 6.2.2.

6.2.1 Installing the Adjustable Mechanical Stopper

J1-AXIS STROKE MODIFICATION

Install the adjustable mechanical stopper referring to Fig. 6.2.1 (a).

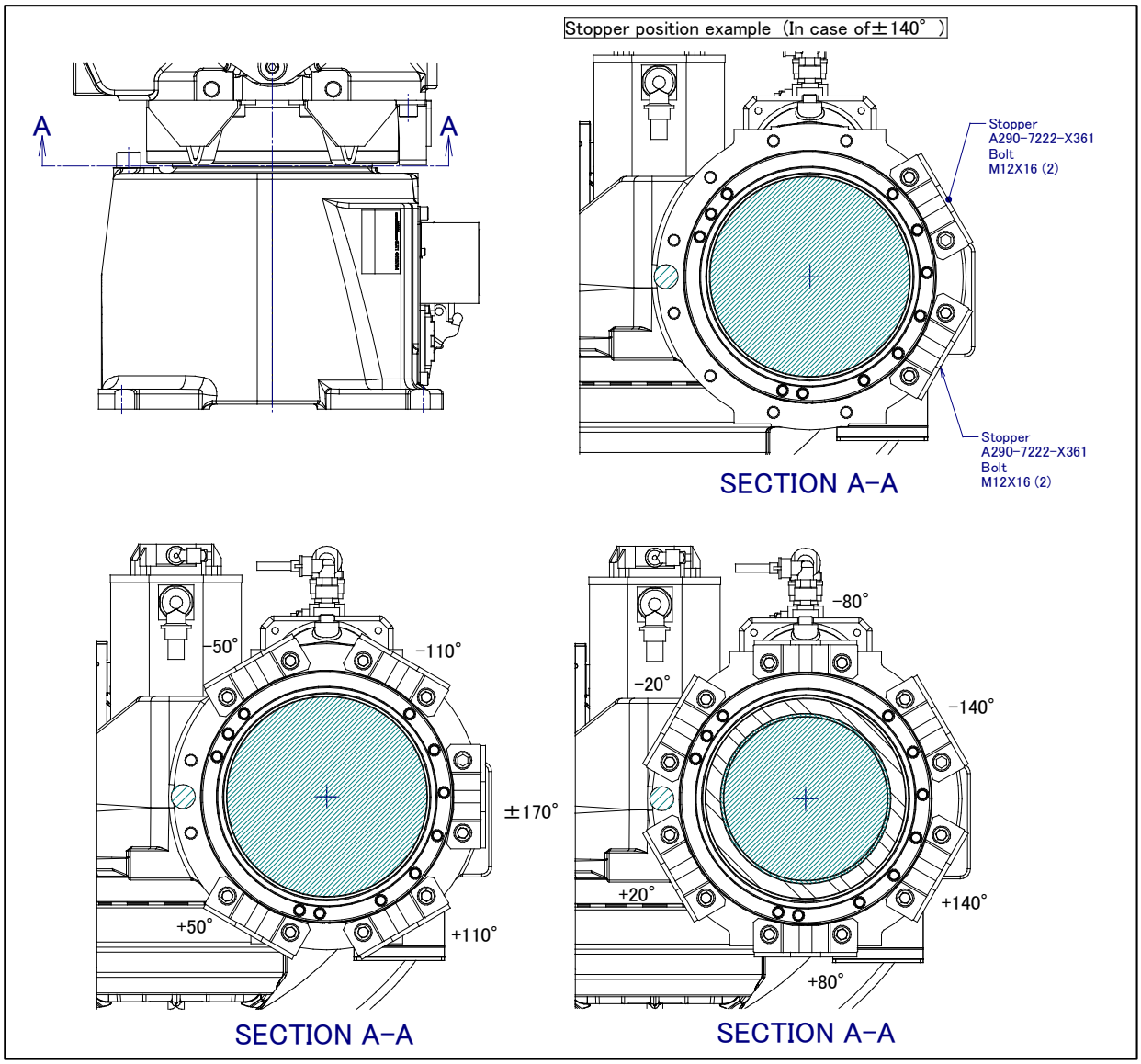


Fig. 6.2 (b) Installing of J1-axis adjustable stopper

6.2.2 Changing the Parameter Setting

Setting procedure

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

```
SYSTEM Axis limits                    JOINT
  AXIS   GROUP  LOWER    UPPER         1/16
  1        1    -180.00  180.00        deg
  2        1    -100.00  160.00        deg
  3        1    -185.00  273.00        deg
  4        1    -200.00  200.00        deg
  5        1    -140.00  140.00        deg
  6        1    -270.00  270.00        deg
  7        1       0.000    0.00        mm
  8        1       0.000    0.00        mm
  9        1       0.000    0.00        mm

   [TYPE]
```

NOTE
0.00 indicates the robot does not have these axes.

5 Move the cursor to J1-axis. Type the new value using the numeric keys on the teach pendant. In this time, set the axial upper limit and the lower limit at the position same as adjustable mechanical stoppers are attached.

```
System Axis Limits                    JOINT 100%
   Group1                                  1/16
  AXIS     GROUP     LOWER     UPPER
  2          1       -100.0     160.00    deg

[ TYPE]
```

6 Turn off the controller and then turn it back on again in the cold start mode so the new information can be used.

⚠ WARNING
1 You must turn off the controller and then turn it back on to use the new information; otherwise, the old settings remain valid and could cause personnel injury or equipment damage.
2 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.
3 If a collision should occur, the J1-axis adjustable mechanical stopper becomes deformed to absorb energy, so that the robot can stop safely. If the stopper is deformed by mistake, replace it. The replacing method and ordering parts are common to J1-axis mechanical stopper. Refer to Section 3.3.
4 Do not depend on parameter settings to control the motion range of your robot.

7 CHECKS AND MAINTENANCE (EXCEPT FOR M-20*i*A/20M/35M)

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 operation time/year vs. the 3840 hours/year should be used to calculate the new (higher) frequencies. For example, when using the robot 7680 hours a year with a recommended maintenance interval of 3 years or 11520 hours, use the following calculation to determine the maintenance frequency: 3 years / 2 = perform maintenance every 1.5 years.

7.1 CHECKS AND MAINTENANCE

7.1.1 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. **⇒"7.2.1 Confirmation of Oil Seepage"**
Air control set	(When air control set is used) **⇒"7.2.2 Confirmation of the Air Control Set"**
Vibration, Abnormal noises	Check whether the taught positions of the robot have not deviated from the previous taught positions. When the displacement occurs, perform the measures as described in the following section: **⇒"10.1 TROUBLESHOOTING"(symptom : Vibration, Noise)**
Positioning accuracy	Check that the taught positions of the robot have not deviated from the previously taught positions. If displacement occurs, perform the measures as described in the following section: **⇒"10.1 TROUBLESHOOTING"(Symptom : Displacement)**
Peripheral equipment for proper operation	Check whether the peripheral equipment operates properly according to commands from the robot and the peripheral equipment.
Brakes for each axis	Check that the droppage of the end effector mounting face is within 5 mm when the servo power is turned off. If the end effector (hand) drops, perform the measures as described in the following section: **⇒"10.1 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/R-30*i*B Compact Plus/R-30*i*B Mini 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)"**

7.1.2 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 item	Check points, management and maintenance method	Periodic maintenance table No.
1 month 320h	3 months 960h	1 year 3840h	2 years 7680h	3 years 11520h	4 years 15360h			
○ Only 1st check	○					Check the oil sight glasses of J4/J5/J6-axes gearboxes	Please confirm whether the amount of oil of the oil sight glass of J4/J5/J6-axes gearboxes has come above the 3/4 (1/4 for ARC Mate 120*i*C/12L, M-20*i*A/12L J5/J6-axis) of total height. **⇒"7.2.3 Check the Oil Sight Glasses"**	11
○ Only 1st check	○					Check the failure of the wrist part fluoric resin ring	Check to see whether there is failure on the wrist part fluoric resin ring. If it is broken, replace it with a new one. **⇒"7.2.4 Check the Failure of the Wrist Part Fluoric Resin Ring"**	21
○ Only 1st check	○					Cleaning the controller ventilation system	Confirm the controller ventilation system is not dusty. If dust has accumulated, remove it.	23
	○					Check the external damage or peeling paint	Check whether the robot has external damage or peeling paint due to the interference with the peripheral devices. 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. **⇒"7.2.5 Check the Mechanical unit Cables and Connectors"**	2
	○					Check for water	Check whether the robot is subjected to water or cutting oils. If liquid is found, remove the cause, and wipe the liquid off.	3
	○ 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.	22

Check and maintenance intervals (Period, Accumulated operating time)						Check and maintenance item	Check points, management and maintenance method	Periodic maintenance table No.
1 month 320h	3 months 960h	1 year 3840h	2 years 7680h	3 years 11520h	4 years 15360h			
	○ Only 1st check	○				Check for damage to the mechanical unit cable (movable part) and welding cable	Observe the movable part of the mechanical unit cable and welding cable, and check for damage. Also, check whether the cables are excessively bent or unevenly twisted. **⇒"7.2.5 Check the Mechanical Unit Cables and Connectors"**	4
	○ Only 1st check	○				Check for damage to the end effector (hand) connection cable	Check whether the end effector connection cables are unevenly twisted or damaged. If damage is found, replace the damaged cables.	5
	○ 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. **⇒"7.2.5 Check the Mechanical Unit Cables and Connectors"**	6
	○ Only 1st check	○				Retightening the end effector mounting bolts	Retighten the end effector mounting bolts. Refer to the following section for tightening torque information: **⇒"4.1 END EFFECTOR INSTALLATION TO WRIST"**	7
	○ Only 1st check	○				Retightening the external main bolts	Retighten the bolts which were installed, removed, or exposed during inspection. Refer to the recommended bolt tightening torque guidelines at the end of the manual. Some bolts are attached with adhesive. Tightening the bolts with a torque greater than what is recommended might damage the adhesive. Therefore, follow the recommended bolt tightening torque guidelines when retightening the bolts.	8
	○ 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 that the stopper mounting bolts are loose. **⇒"7.2.6 Check of Fixed Mechanical Stopper and Adjustable Mechanical Stopper"**	9
	○ 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, around the welding torch, conduit part, wrist axis hollow part and the cable protective sleeve). Insulation failure might occurs when spatter has collected around the wrist flange or welding torch, and there is a possibility of damaging the robot mechanical unit by the welding current. (See Appendix C)	10

Check and maintenance intervals (Period, Accumulated operating time)						Check and maintenance item	Check points, management and maintenance method	Periodic maintenance table No.
1 month 320h	3 months 960h	1 year 3840h	2 years 7680h	3 years 11520h	4 years 15360h			
		○				Replacing the mechanical unit batteries	Replace the mechanical unit batteries. Regardless of operating time, replace batteries at 1 year. **⇒"7.3.1 Replacing the Batteries"**	12
			○			Replace the wrist part fluoric resin ring	Replace the wrist part fluoric resin ring. Contact your local FANUC representative for information regarding replacing the fluoric resin ring. **⇒"7.2.4 Check the Failure of the Wrist Part Fluoric Resin Ring"**	21
			○			Replacing cable of Mechanical unit welding power	Replace the cable of Mechanical unit welding Contact your local FANUC representative for information regarding replacing the cable.	19
			○			Replacing the Material handling (M/H) conduit or No dust material handling conduit	Replace the Material handling (M/H) conduit Contact your local FANUC representative for information regarding replacing the Material handling (M/H) conduit or No dust material handling conduit	20
				○		Replacing the grease and oil of J1 to J3-axis reducer and J4 to J6-axis gearbox	Replace the grease and oil of each axis reducer and gearbox **⇒"7.3.2 Replacing the Grease and Oil of the Drive Mechanism"**	13 to 17
					○	Replacing the mechanical unit cable	Replace the mechanical unit cable Contact your local FANUC representative for information regarding replacing the cable.	18
					○	Replacing the controller batteries	Replace the controller batteries. Regardless of operating time, replace batteries at 4 years. **⇒Chapter 7 Replacing batteries of R-30*i*B/R-30*i*B Plus CONTROLLER MAINTENANCE MANUAL (B-83195EN) or R-30*i*B Mate CONTROLLER MAINTENANCE MANUAL (B-83525EN) or R-30*i*A CONTROLLER MAINTENANCE MANUAL (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*A Mate CONTROLLER MAINTENANCE MANUAL (B-82725EN) R-30*i*A Mate CONTROLLER MAINTENANCE MANUAL(For Europe) (B-82725EN-1) R-30*i*A Mate CONTROLLER MAINTENANCE MANUAL(For RIA) (B-82725EN-2)"**	24

7.2 CHECK POINTS

7.2.1 Confirmation of Oil Seepage

Check items

Check there is oil on sealed part of each joint parts. If there is oil seepage, clean them.

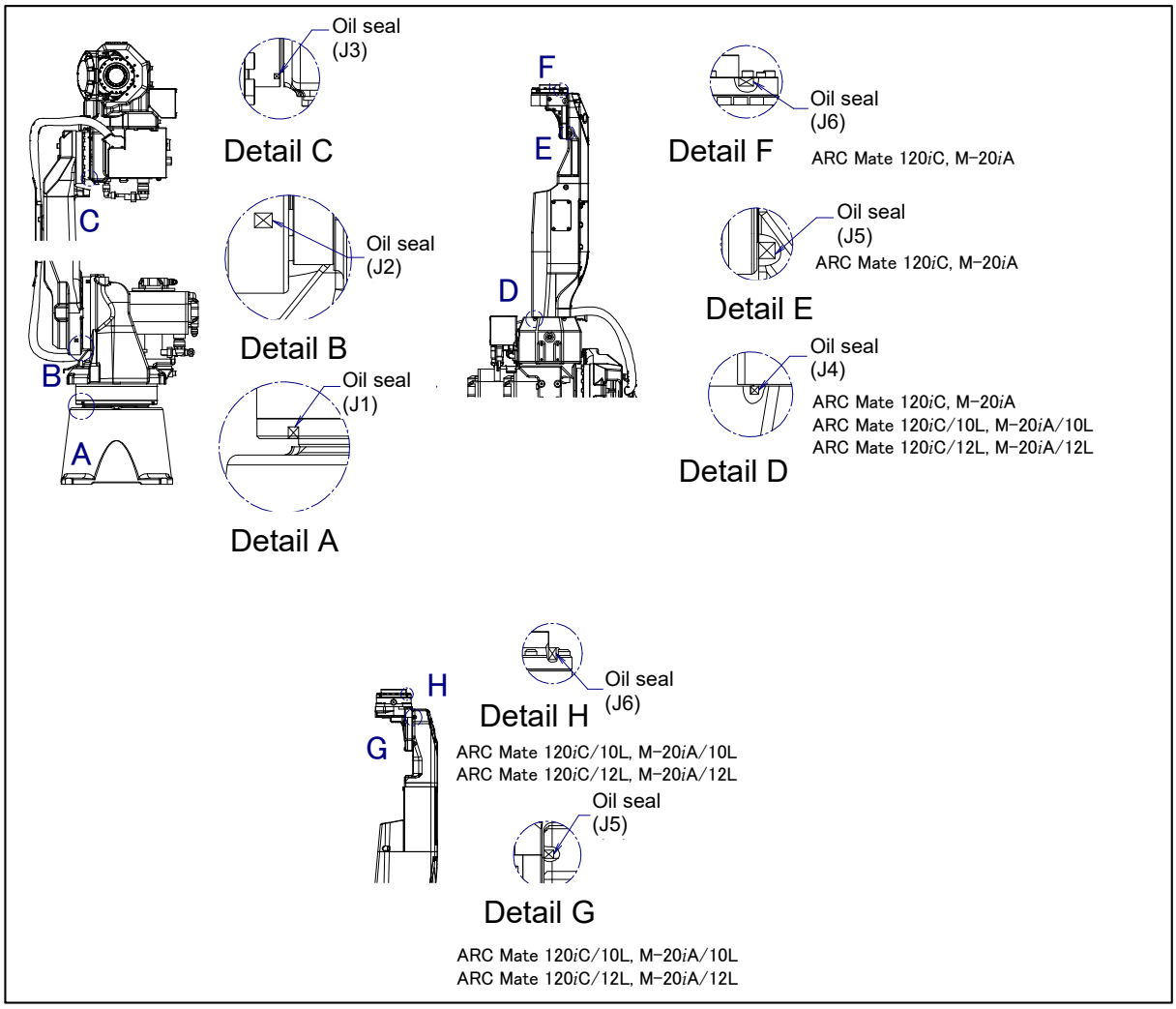


Fig. 7.2.1 (a) Check parts of oil seal

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. 7.2.1(a) before you operate the robot.
- In case of oil seepage, please consider replacing the grease and the oil altogether. This replacement potentially can help improve the seepage situation.
- Also, motors might become hot and the internal pressure of the grease bath or oil bath may increase 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 Subsection 7.3.2 and ensure that grease is not expelled onto the machine or tooling. When opening the oil outlet, refer to Subsection 7.3.2, put an oil tray under the oil outlet or place the oil outlet at the upper side.)

> ⚠ **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.
⇒"10.1 TROUBLESHOOTING"(symptom : Grease leakage , Oil leakage)

7.2.2 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. 7.2.2 (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 handle for lubricator adjustment. The lubricator becomes empty in about 10 to 20 days under normal operation.
3	Lubricator oil level	Check to see that the air control set oil level is within the specified level.
4	Leakage from hose	Check the joints, tubes, etc. for leaks. Retighten the joints or replace parts, as required.
5	Drain	Check the drain and release it. When quantity of the drain is remarkable, examine the setting of the air dryer to the air supply side.

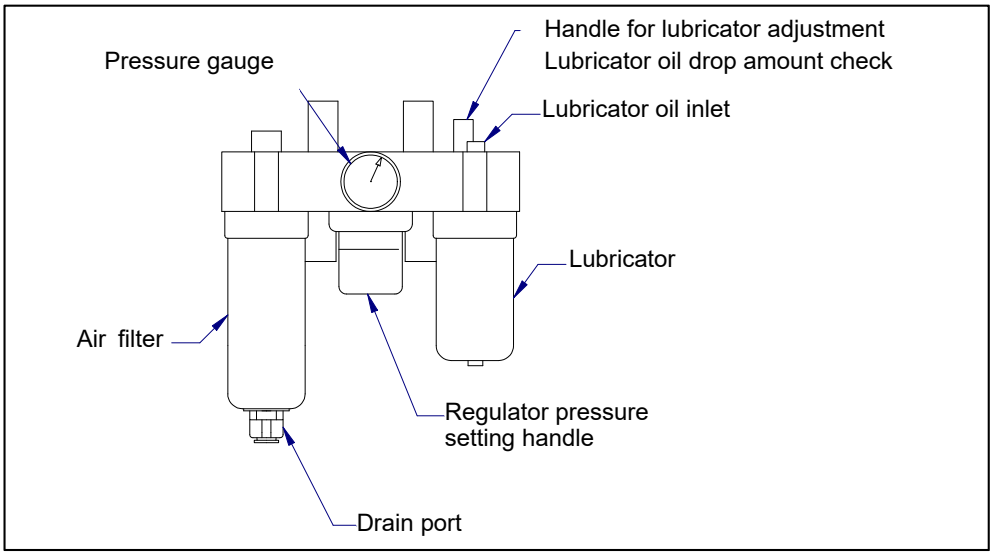


Fig. 7.2.2 (a) Air control set (option)

7.2.3 Check the Oil Sight Glasses

Please confirm whether the amount of oil of the oil sight glass of J4/J5/J6-axes gearboxes has come above the 3/4 (1/4 for ARC Mate 120iC/12L, M-20iA/12L J5/J6-axis) of total height. Please replenish it in case of the shortage. Through the oil sight glass might not have air part, but this is not trouble. When oil does not fill enough, the red index of the oil sight glass shows the reflected heat of the light, and the outline of the index is seen clearly. When oil fills enough, it does not show this reflected heat, and the outline of the index is not clear. When the oil sight glass cannot be read at all because of the oil discoloration due to deterioration, like a right edge of Fig.7.2.3(a), exchange oil referring to Section 7.3.2.

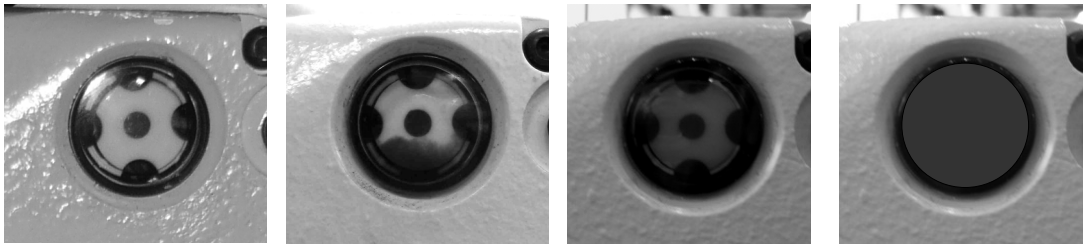


Fig. 7.2.3 (a) The extent of oil deterioration

> ⚠ **CAUTION**
> If you continue using the oil in the dirty state, it reduce the seal performance of oil seal and cause the sludge outbreak, and cause vibration of robot.
> If operation condition is severe, oil is stained early, in that case we recommend early oil exchange.

7.2.4 Check the Failure of the Wrist Part Fluoric Resin Ring

Check to see whether there is failure on the wrist part fluoric resin ring. If is broken, replace it by new one. Two years are aims in an exchange period. If you operate robot with the state that hard mine dust is attached to rotated part, exchange period may shorten.
(Spec. of fluoric resin ring for ARC Mate 120*i*C, M-20*i*A: A290-7222-X571,
for ARC Mate 120*i*C/10L/12L, M-20*i*A/10L/12L: A290-7221-X571)

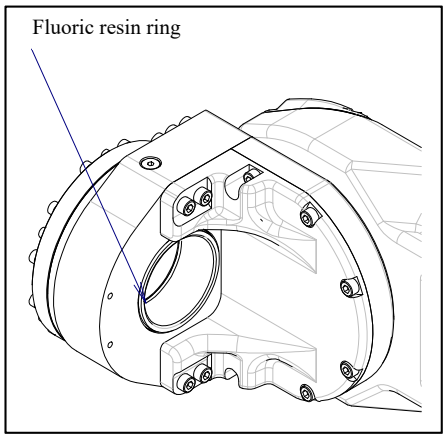


Fig. 7.2.4 (a) Fluoric resin ring

If the fluoric resin rig is broken as shown in Fig.7.2.4 (b), replace it.

Fig .7.2.4 (b) Failure of the fluoric resin ring

7.2.5 Check the Mechanical Unit Cables and Connectors

Inspection points of the mechanical unit cables and welding cables

Check the cable for damage that has been exposed. Take special care for movable parts.
Clean it when the spatter adheres.

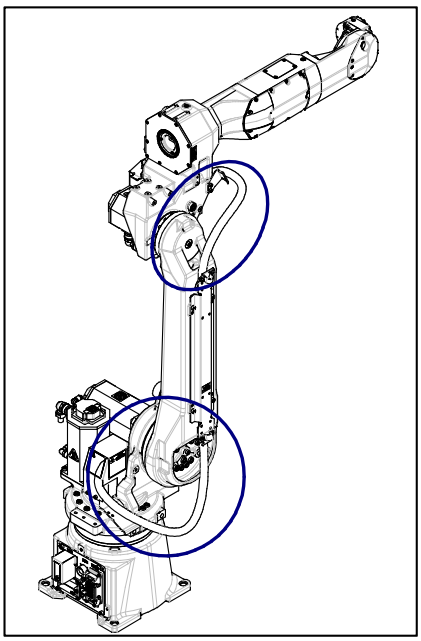


Fig. 7.2.5 (a) Inspection points of the mechanical unit cables

Check points

＜Cable protective sleeve＞

- Check that no holes or tears exist on the cable protective sleeves.
- If there is damage as shown in Fig. 7.2.5 (b), replace the cable protective sleeves.

Fig. 7.2.5 (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.

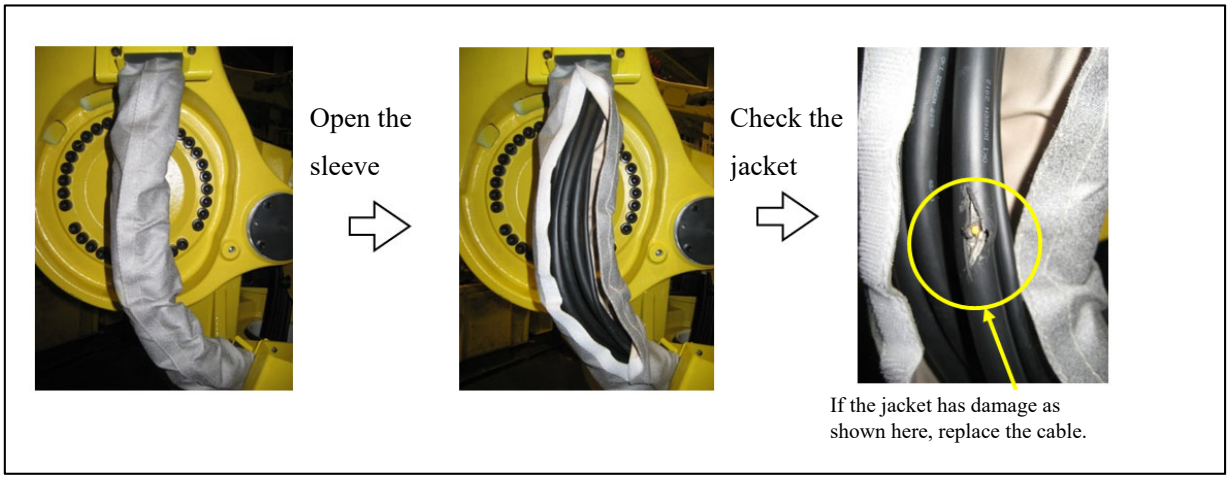


Fig. 7.2.5 (c) Cable check method

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

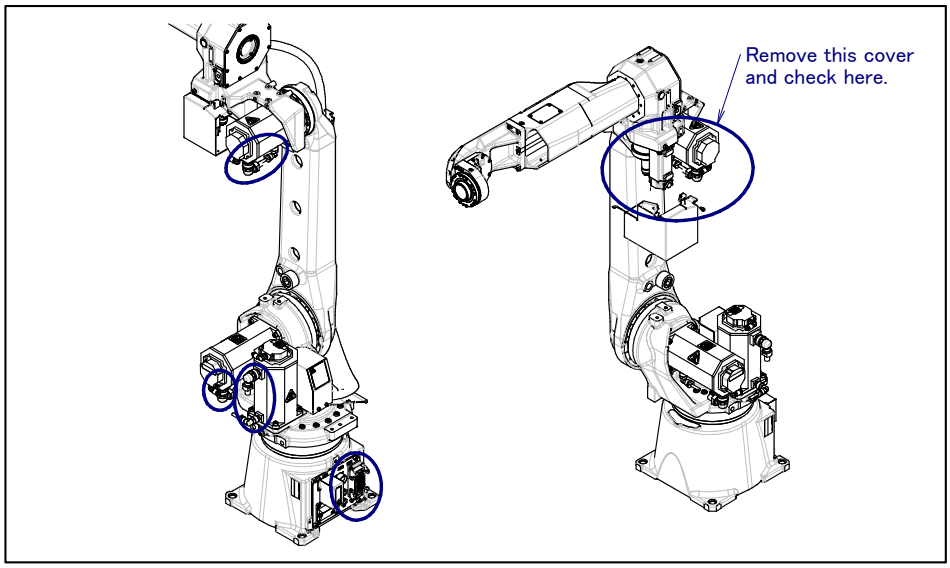


Fig. 7.2.5 (d) Connector Inspection points

7.2.6 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.
- Refer to Section 6.2 of the operator's manual for details regarding the adjustable mechanical stopper.

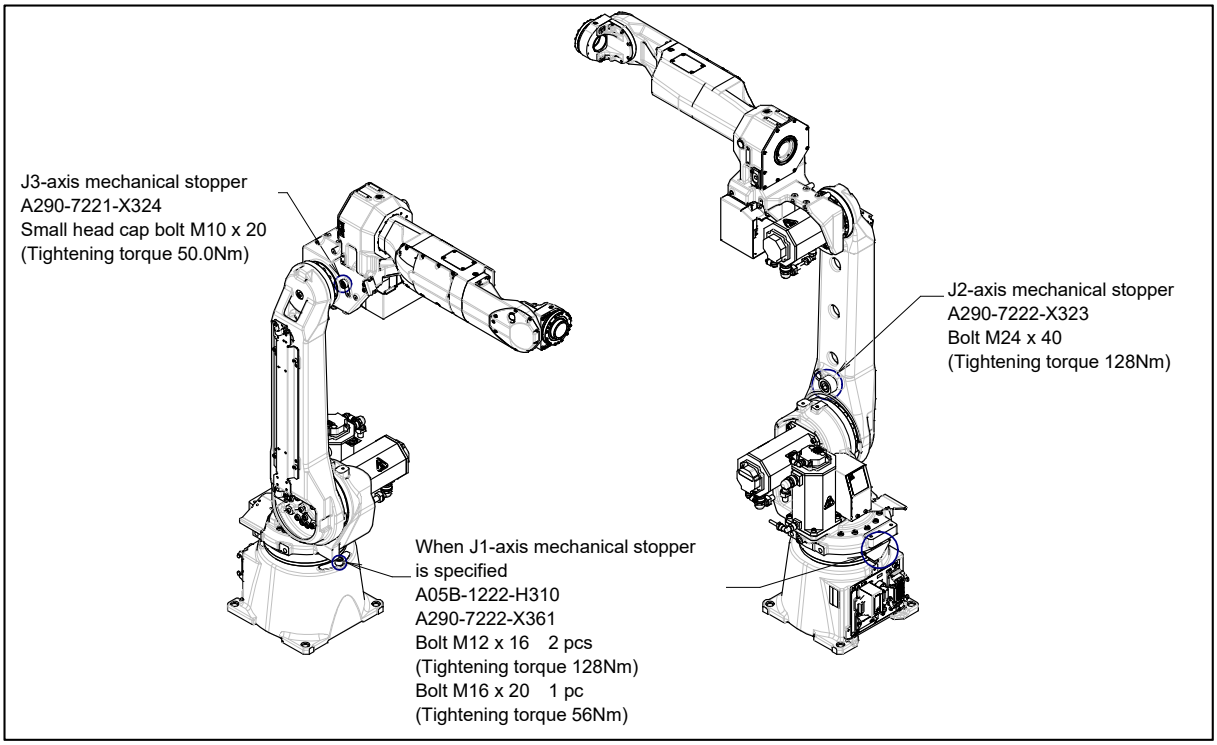


Fig. 7.2.6 (a) Check of mechanical stopper and adjustable mechanical stopper

7.3 MAINTENANCE

7.3.1 Replacing the Batteries (1-year checks)

The position data of each axis is preserved by the backup batteries. The batteries need to be replaced every 1 year. Also, use the following procedure to replace when the backup battery voltage drop alarm occurs.

Procedure of replacing the battery

1 Press the EMERGENCY STOP button to stop robot motion.

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

2 Remove the battery case cap. (Fig. 7.3.1 (a), (b)) If it cannot be removed, tap it to side direction with a plastic hammer.
3 Take out the old batteries from the battery case. In this time, battery can be taken out by pulling the stick of the center of the battery box.
4 Insert new batteries into the battery case. Pay attention to the direction of batteries.
5 Close the battery case cap.

> **⚠ CAUTION**
> When using a robot with the severe dust/liquid protection option, remove the cover from the battery case as shown in Fig. 7.3.1 (b) to replace the battery. After replacing the battery, reinstall the cover. At this time, please be sure to replace gasket with new one for severe dust/liquid protection. When placing a gasket on a battery cover, please be sure no gaps exist.

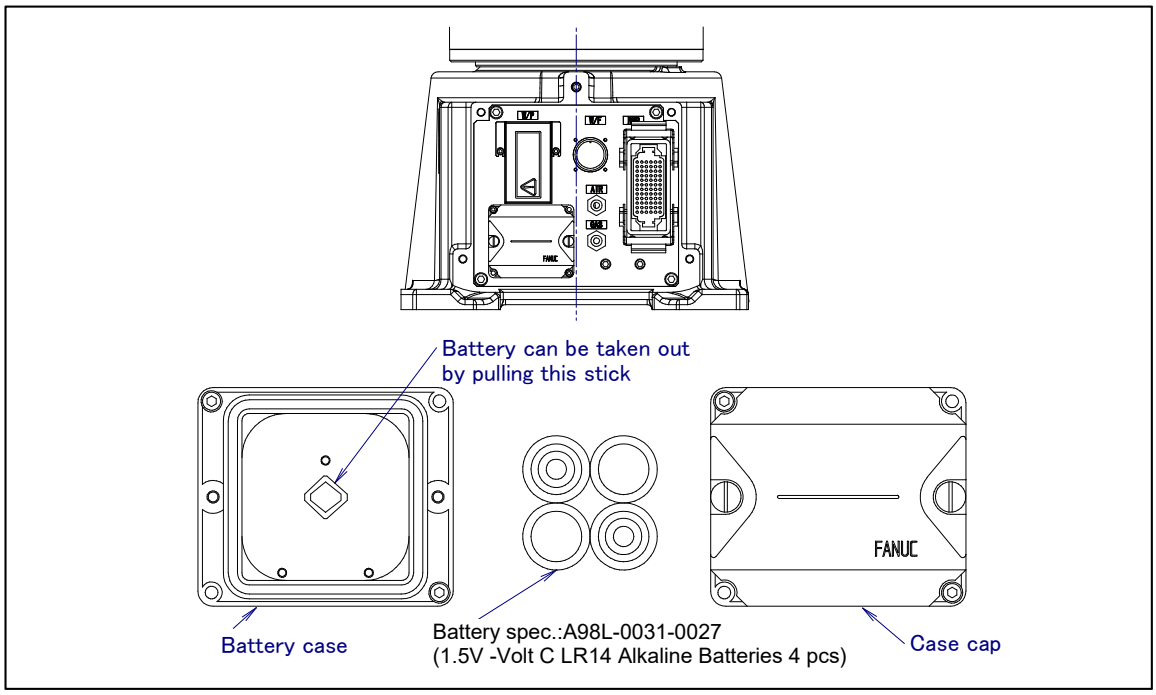


Fig. 7.3.1 (a) Replacing the battery

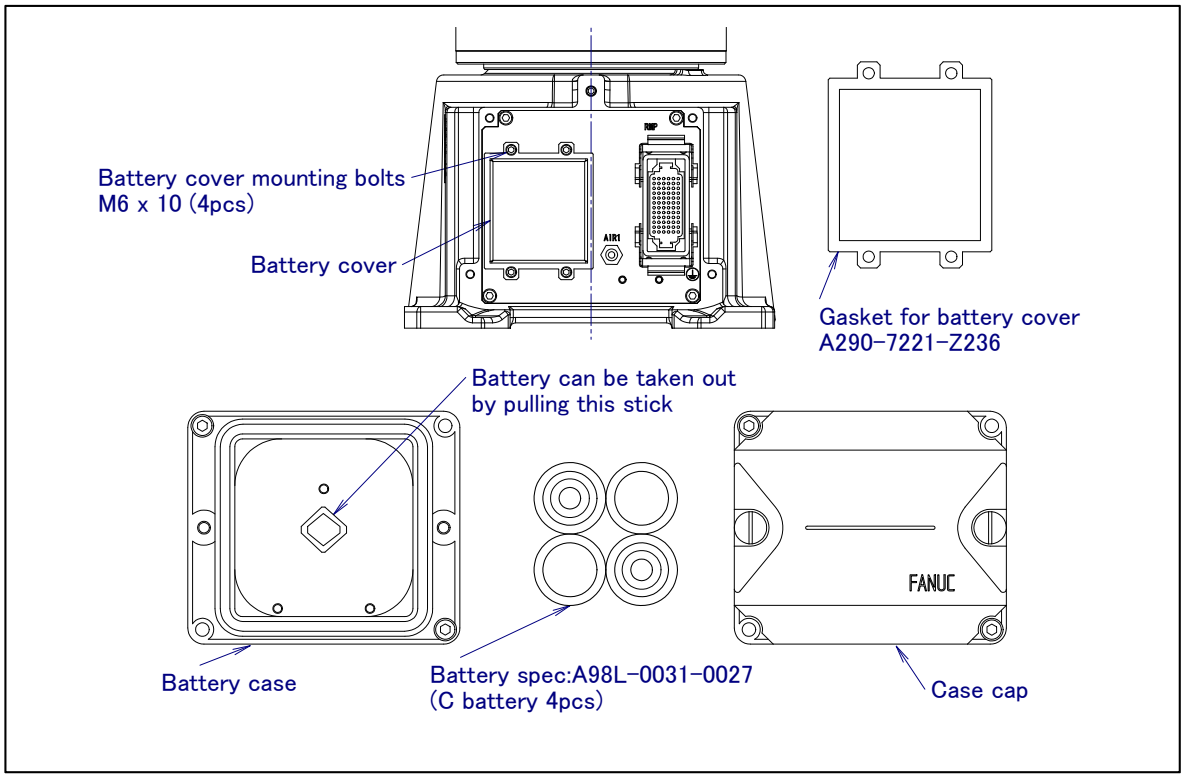


Fig. 7.3.1 (b) Replacing the battery (When severe dust/liquid protection option is specified)

7.3.2 Replacing the Grease and Oil of the Drive Mechanism (3-year (11520 hours) checks)

According to the procedures below, replace the grease or the oil of the reducers of J1,J2, and J3 axes and J4/J5/J6-axis gearbox every 3 years or 11520 hours, whichever comes first.

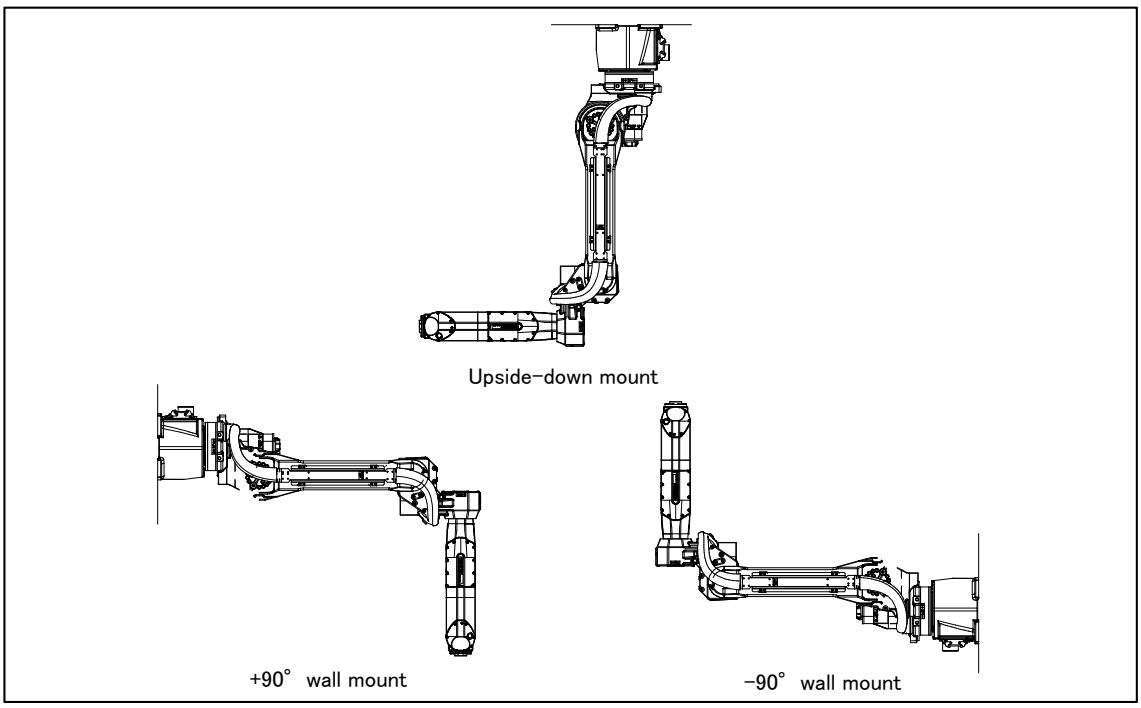


Fig. 7.3.2 (a) Installation method

7.3.2.1 Grease replacement procedure for J1 to J3-axis reducer

⚠ CAUTION

Failure to follow proper greasing procedures may cause a sudden increase of the grease bath internal pressure and damage to the seal. This 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 of the grease outlet to allow the grease to come out.
2 Supply grease slowly, using a manual pump. (once per two seconds)
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 7.3.2.1 (a)).
4 Use grease only of the specified type. Grease of a type other than that specified may damage the reducer or lead to other problems.
5 After greasing, release remaining pressure from the grease bath using the procedure given in Subsection 7.3.2.2, and then close the grease outlet.
6 To prevent an accident such as a fall or fire, remove all the excess grease from the floor and robot.

Table 7.3.2.1 (a) Grease name and amount (J1/J2/J3-axis reducer)

Grease supplying position	Amount of grease to be applied	Gun tip pressure	Specified grease
J1-axis reducer	1000g(1110ml)	0.1MPa or less (NOTE)	(Specification: A98L-0040-0174)
J2-axis reducer	850g(940ml)		
J3-axis reducer	340g(380ml)		

NOTE

When using a hand pump, apply grease approximately once per two 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. Consider relative angle of from posture of floor mount when robot is angle mount.

Table 7.3.2.1 (b) Postures for greasing (J1/J2/J3-axis reducer)

Grease supplying position		Posture					
		J1	J2	J3	J4	J5	J6
J1-axis reducer grease supplying posture	Floor mount	Arbitrary	Arbitrary	Arbitrary	Arbitrary	Arbitrary	Arbitrary
	Upside-down mount						
	Wall mount -90°						
	Wall mount +90°						
J2-axis reducer grease supplying posture	Floor mount)		0°	Arbitrary			
	Upside-down mount		0°				
	Wall mount -90°		90°				
	Wall mount +90°		-90°				
J3-axis reducer grease supplying posture	Floor mount		0°	0°			
	Upside-down mount		0°	180°			
	Wall mount -90°		90°	-90°			
	Wall mount +90°		-90°	90°			

1 Move the robot to the greasing posture described in Table 7.3.2.1 (b).
2 Turn off the controller power.
3 Remove the seal bolt or taper plug from grease outlet. (Fig. 7.3.2.1(a))
  J1-axis : 1 location (seal bolt M8 x 10)
  J2-axis : 3 locations (seal bolt M8 x 10)
  J3-axis : 1 locations (J3-axis reducer first grease outlet, seal bolt M8 x 10)
  *When robot is shipped after June, 2011, robot has 2 grease outlet. Remove only first grease outlet.
4 Remove the seal bolt or taper plug from grease inlet and attach grease nipple.
5 Keep greasing until the new grease pushes out the old grease and comes out from each grease outlet.
6 Release the remaining pressure using the procedure given in Subsection 7.3.2.2. In case of upside-down mount, pull out about 130ml grease of the J1-axis to make space of grease bath.

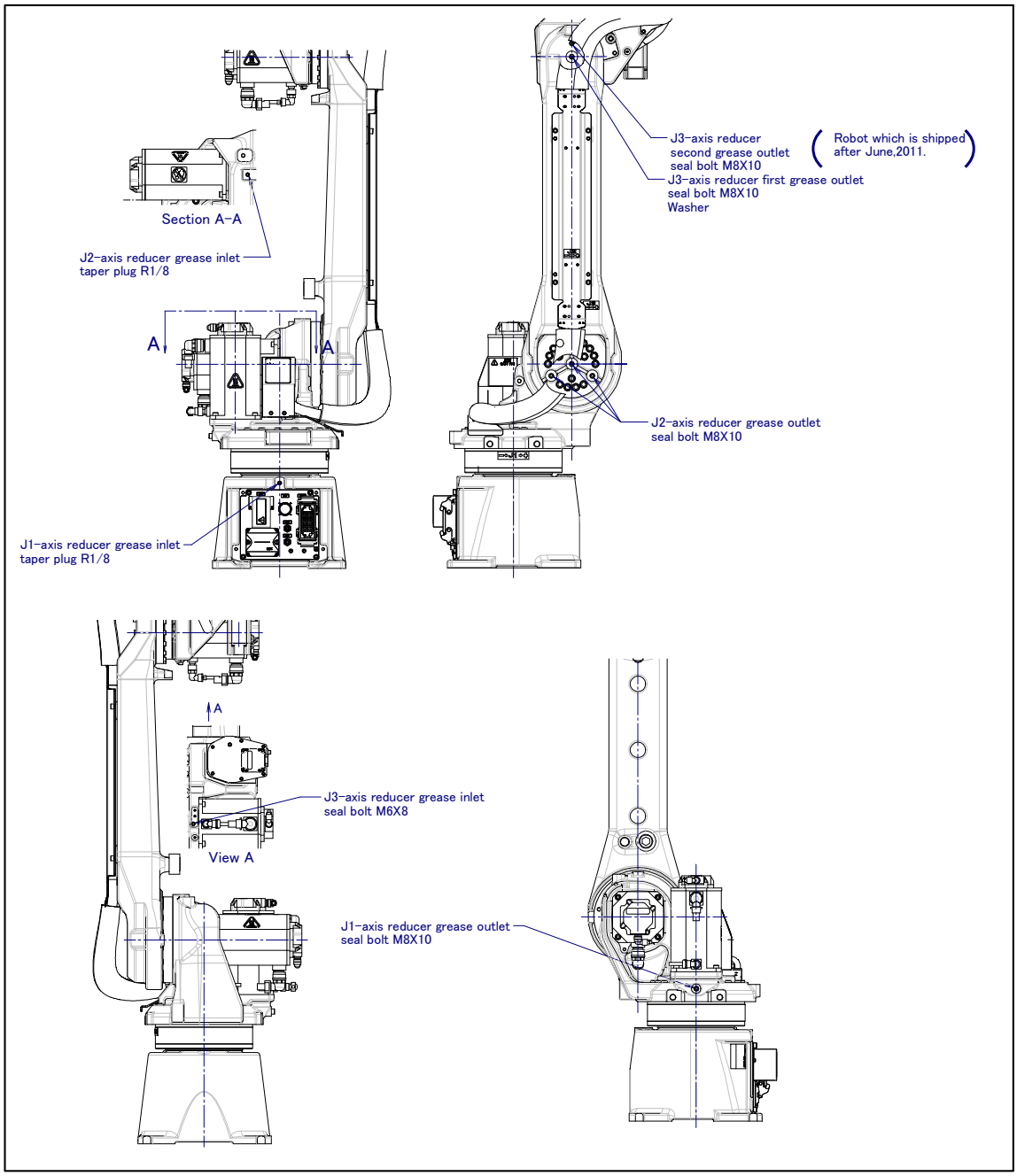


Fig. 7.3.2.1 (a) Greasing point of J1 to J3-axis reducer

Table 7.3.2.1 (c) Specification of the seal bolts and the taper plug

Parts name	Specification
Seal bolt (M6 x 8)	A97L-0218-0417#060808
Seal bolt (M8 x 10)	A97L-0218-0417#081010
taper plug (R1/8)	A97L-0001-0436#1-1D

7.3.2.2 Procedure for releasing remaining pressure from the grease bath (J1 to J3-axis)

After applying grease, operate the robot as instructed below with the plug and seal bolt of the grease inlet and outlet uncapped to release the remaining pressure within the grease bath. In case of J2-axis, there are three seal bolts for grease outlet. In case of J3-axis, robot which shipped before May, 2011 has one grease outlet, robot which shipped June, 2011 has two grease outlet. So uncap all of them.
Attach a recovery bag below the grease inlet and outlet to prevent output grease from splattering.

<table>
<tr><th>Operating axis
Grease replacement part</th><th>J1-axis</th><th>J2-axis</th><th>J3-axis</th><th>J4-axis</th><th>J5-axis</th><th>J6-axis</th></tr>
<tr><td>J1-axis reducer</td><td>Axis angle of 60° or more OVR 100%</td><td colspan="5">Arbitrary</td></tr>
<tr><td>J2-axis reducer</td><td>Arbitrary</td><td>Axis angle of 60° or more OVR 100%</td><td colspan="4">Arbitrary</td></tr>
<tr><td>J3-axis reducer</td><td colspan="2">Arbitrary</td><td>Axis angle of 60° or more OVR 100%</td><td colspan="3">Arbitrary</td></tr>
</table>

If the above operation cannot be performed due to the environment of the robot, adjust the operating time according to the operating angle. (When the maximum allowable axis angle is 30°, perform the twice operation for 20 minutes or more.) After completion of the operation, attach the plug and seal bolts to the grease inlets and outlets. When reusing the seal bolts or grease nipples, be sure to seal them with seal tape. If you grease or oil multiple axes, you can exercise multiple axes at the same time.

After replacing grease or oil, the internal pressure of the grease bath or oil bath may rise if the robot is operated again under frequent inversion movement or a high temperature environment. In these cases, you can return to normal internal pressure by releasing the grease outlet or oil outlet just after robot operation. (When opening grease outlet or oil outlet, be sure that grease or oil is not spattered.)

7.3.2.3 Oil replacement procedure for J4-axis gearbox (ARC Mate 120*i*C, ARC Mate 120*i*C/10L/12L, M-20*i*A, M-20*i*A/10L/12L)

⚠ CAUTION

1 There is severe risk of gear damage in case robot is operated with oil shortage. Please make sure the gearbox is always filled with correct amount of oil.
2 Failure to supply oil correctly may cause damage to the seal, which would in turn lead to oil leakage and abnormal operation. When performing oiling, therefore, observe the following cautions.
   1 Use specified oil. Use of non-approved oil may damage the reducer or lead to other problems.
   2 After oiling, release remaining pressure from the grease bath using the procedure given in Subsection 7.3.2.6, and then close the grease outlet.
   3 To prevent an accident such as a fall or fire, remove all the excess oil from the floor and robot.

Table 7.3.2.3 (a) Oil name and amount (J4-axis gearbox)

Oiling points	Amount of oil to be applied (NOTE 1)	Gun tip pressure	Specified oil
J4-axis gearbox	700g(822ml)	0.1MPa or less	(Specification: A98L-0040-0233)

NOTE 1) It is not a regulated amount injection. Please confirm height of oil sight glass oil surface is 3/4 or more of all heights. Refer to Fig.7.3.2.3 (e).

Table 7.3.2.3 (b) Postures for oiling (J4-axis gearbox)

Supply position		Posture					
		J1	J2	J3	J4	J5	J6
J4-axis gearbox	Floor mount	Arbitrary	Arbitrary	0°	Arbitrary	Arbitrary	Arbitrary
	Upside-down mount			180°			
	-90° wall mount			-90°			
	+90° wall mount			90°			

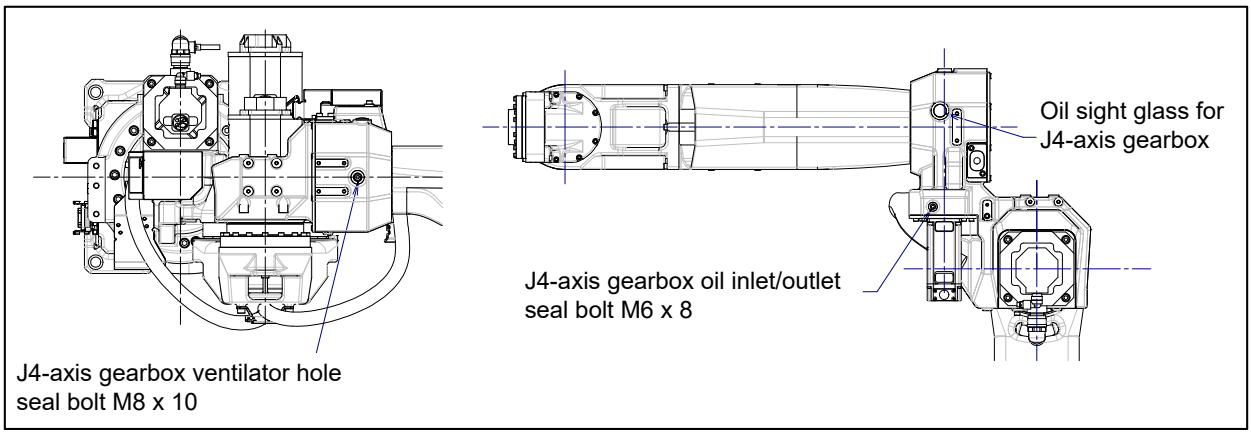


Fig. 7.3.2.3 (a) Greasing point of J4-axis gearbox
(ARC Mate 120*i*C, ARC Mate 120*i*C/10L/12L, M-20*i*A, M-20*i*A/10L/12L)

Table 7.3.2.3 (c) Specification of the seal bolts and the taper plug

Parts name	Specification
Seal bolt (M6 x 8)	A97L-0218-0417#060808
Seal bolt (M8 x 10)	A97L-0218-0417#081010

Exhausting oil method

1 Move the robot to the greasing posture described in Table 7.3.2.3 (b).
2 Turn off the controller power.
3 Remove any peripheral equipment, if it was mounted at the ventilator hole.

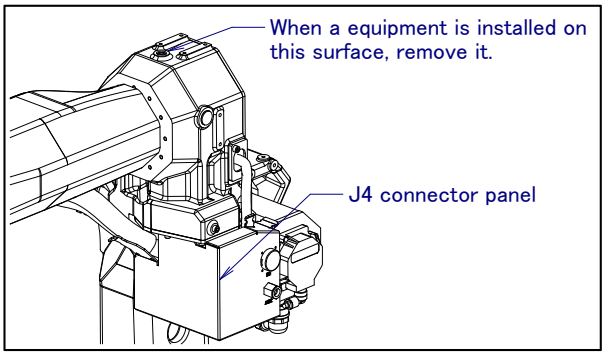


Fig. 7.3.2.3 (b) Removing equipment of the ventilator hole

4 Put the oil tray under the oil outlet.
5 Block the gap using tape etc. to prevent oil from oil outlet intruding into the J4 connector panel. If robot is shipped before April 2009, remove the J4 connector panel mounting bolts and make plug of oil inlet/outlet can be seen. When moving the connector panel, remove user side or air joint if it is necessary. Then Remove taper plug or seal bolt or oil outlet and ventilator hole and exhaust oil.
6 When all oil is discharged, attach the taper plug. Replace the taper plug by new one. When reusing it, wind it with a seal tape.

Injecting oil method

7 According to description below, inject oil.
(1) Install the oil injection nipple with valve (A05B-1221-K006) to the oil inlet.
(2) Confirm the valve is open. Perform oiling using the oil gun (A05B-1221-K005). If the oil sight glass is filled with oil, push the oil gun about 4cm (about 80ml).

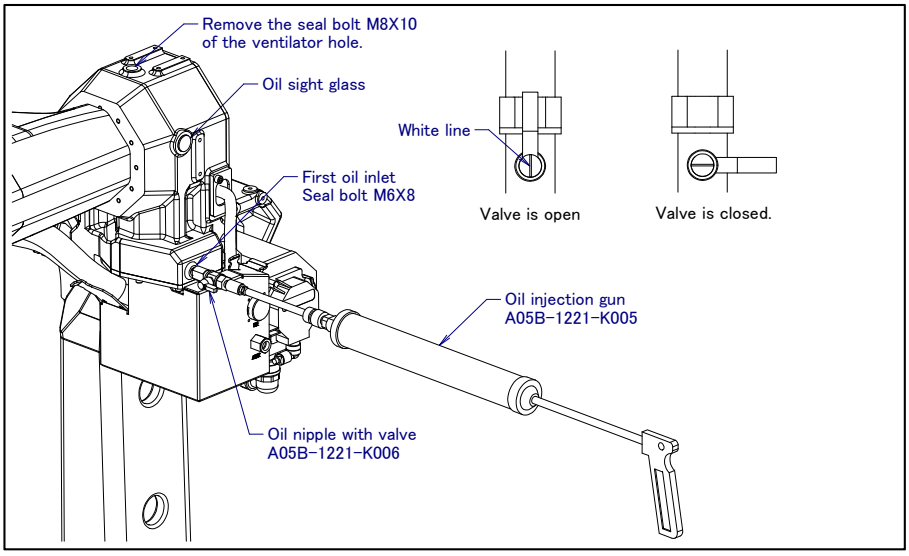


Fig. 7.3.2.3 (c) Oiling by oil gun

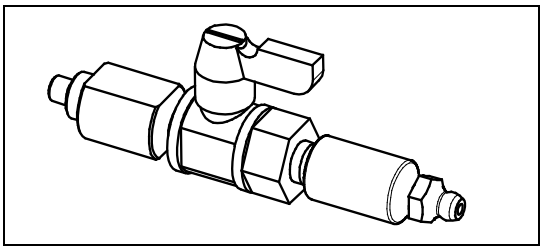


Fig. 7.3.2.3 (d) Oil injection nipple with valve (A05B-1221-K006)

(3) Close the valve of oil injection nipple, then remove the oil gun.
(4) Attach the seal bolt to the ventilator hole. Replace the seal bolt by new one. When reusing it, be sure to wind it with a seal tape.
(5) Remove oil injection nipple, and attach seal bolt to oil inlet. Replace seal bolt by new one. When reusing it, be sure to wind it with seal tape.
(6) Release remaining pressure of oil bath referring to Subsection 7.3.2.6 and confirm oil quantity with oil sight glass.

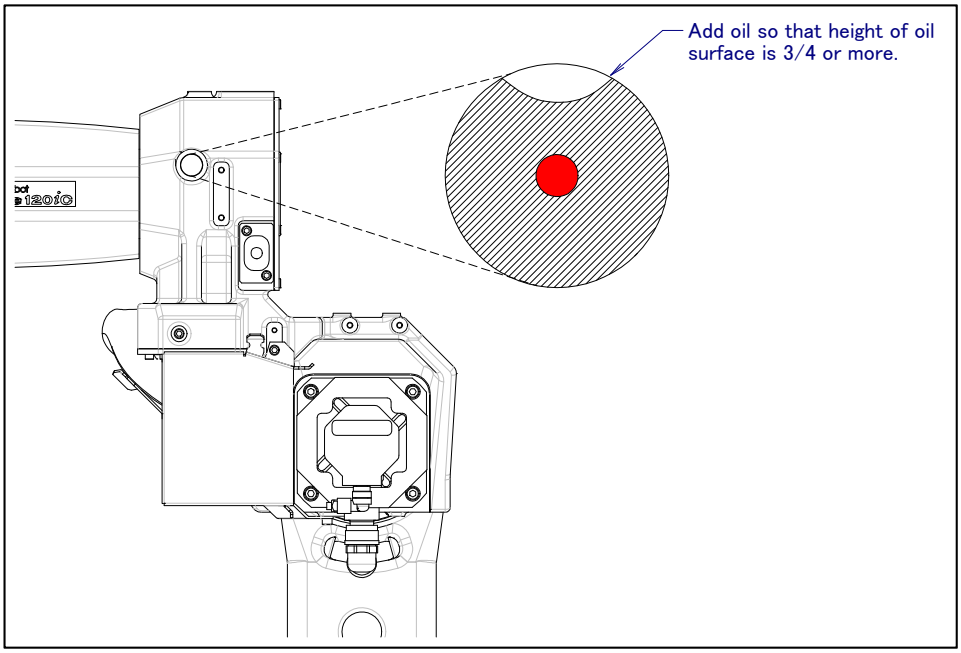


Fig. 7.3.2.3 (e) Aim of oil sight glass (Oiling of J4-axis gearbox)

7.3.2.4 Oil replacement procedure for J5/J6-axis gearbox (ARC Mate 120*i*C, M-20*i*A)

⚠ CAUTION

1 There is severe risk of gear damage in case robot is operated with oil shortage. Please make sure the gearbox is always filled with correct amount of oil.
2 Failure to supply oil correctly may cause damage to the seal, which would in turn lead to oil leakage and abnormal operation. When performing oiling, therefore, observe the following cautions.
   1 Use specified oil. Use of non-approved oil may damage the reducer or lead to other problems.
   2 After oiling, release remaining pressure from the grease bath using the procedure given in Subsection 7.3.2.6, and then close the grease outlet.
   3 To prevent an accident such as a fall or fire, remove all the excess oil from the floor and robot.

Table 7.3.2.4 (a) Oil name and amount (J5/J6-axis gearbox)

Oiling points	Amount of oil to be applied (NOTE 1)	Gun tip pressure	Specified oil
J5/J6-axis gearbox	700g(822ml)	0.1MPa or less	(Specification: A98L-0040-0233)

NOTE 1) It is not a regulated amount injection. Be sure to confirm the amount of oil with the oil sight glass.

Table 7.3.2.4 (b) Postures for oiling (J5/J6-axis gearbox) (A05B-1222-B201, B202, A05B-1225-B201, B202)

Supply position		Posture					
		J1	J2	J3	J4	J5	J6
J5/J6-axis gearbox (Supplying posture) (Discharging posture)	Floor mount	Arbitrary	Arbitrary	-50°	0°	50°	Arbitrary
	Upside-down mount			50°	180°		
	-90°wall mount			140°	180°		
	+90°wall mount			40°	0°		
J5/J6-axis gearbox (Confirm oiling posture)	Floor mount			-35°	0°	0°	
	Upside-down mount			35°	180°		
	-90°wall mount			125°	180°		
	+90°wall mount			55°	0°		

Table 7.3.2.4 (c) Postures for oiling (J5/J6-axis gearbox)
(A05B-1225-B251, B252)

Supply position		Posture					
		J1	J2	J3	J4	J5	J6
J5/J6-axis gearbox (Supplying posture) (Discharging posture)	Floor mount	Arbitrary	Arbitrary	0°	0°	0°	Arbitrary
	Upside-down mount			180°	0°		
	-90°wall mount			-90°	0°		
	+90°wall mount			90°	0°		
J5/J6-axis gearbox (Confirm oiling posture)	Floor mount			-30°	-45°	0°	
	Upside-down mount			150°	-45°		
	-90°wall mount			120°	-135°		
	+90°wall mount			60°	-45°		

NOTE) Choose the one of the posture taken easily when there is two or more posture.

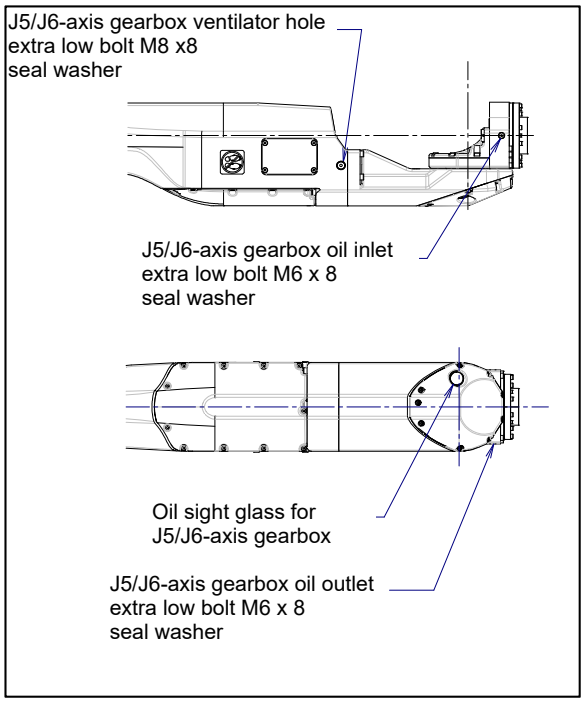


Fig. 7.3.2.4 (a) Greasing point of J5/J6-axis gearbox (ARC Mate 120*i*C, M-20*i*A)
(A05B-1222-B201, B202, A05B-1225-B201, B202)

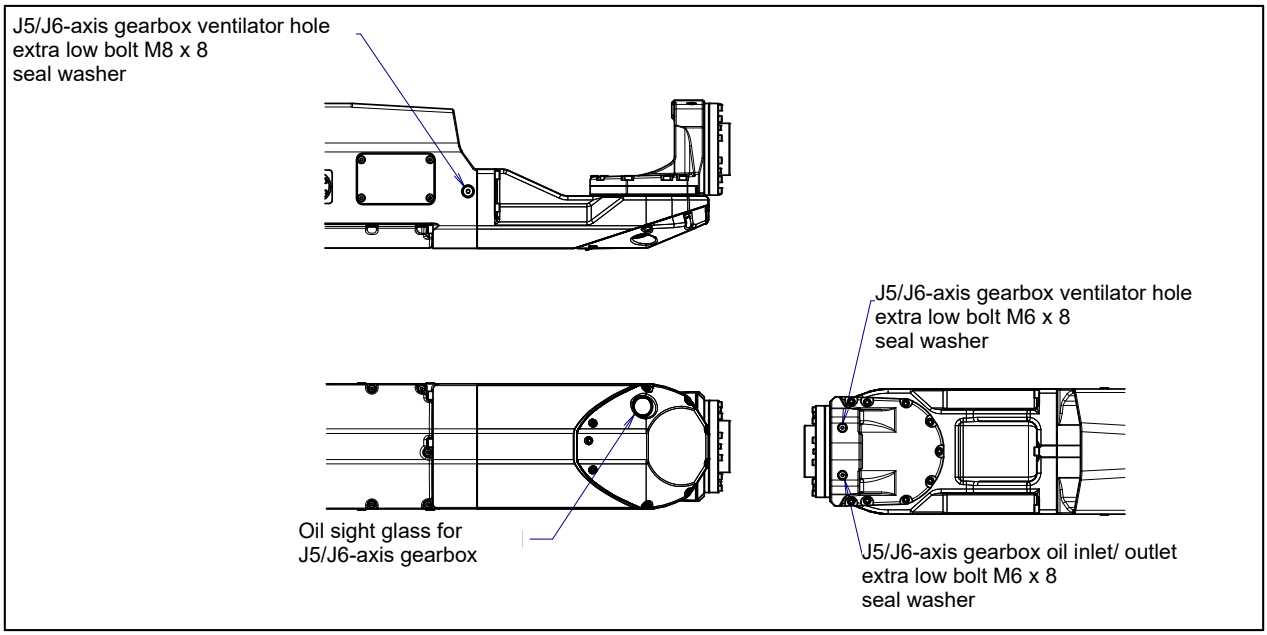


Fig. 7.3.2.4 (b) Greasing point of J5/J6-axis gearbox (ARC Mate 120*i*C, M-20*i*A)
(A05B-1225-B251, B252)

Table 7.3.2.4 (d) Spec. of the seal washer

Part name	Specification
Seal washer (M6)	A30L-0001-0048#6M
Seal washer (M8)	A30L-0001-0048#8M

Exhausting oil method

1 Move the robot to the posture for oiling and discharging oil described in Table 7.3.2.4 (b), (c).
2 Turn off the controller power.
3 Put the oil tray under the oil outlet. Remove extra low bolt and seal washer of oil outlet, then remove oil inlet and ventilator hole. (See Fig.7.3.2.4 (a), (b)) (In this time, if you remove bolt of oil outlet firstly, you can prevent spilling oil on surroundings.)

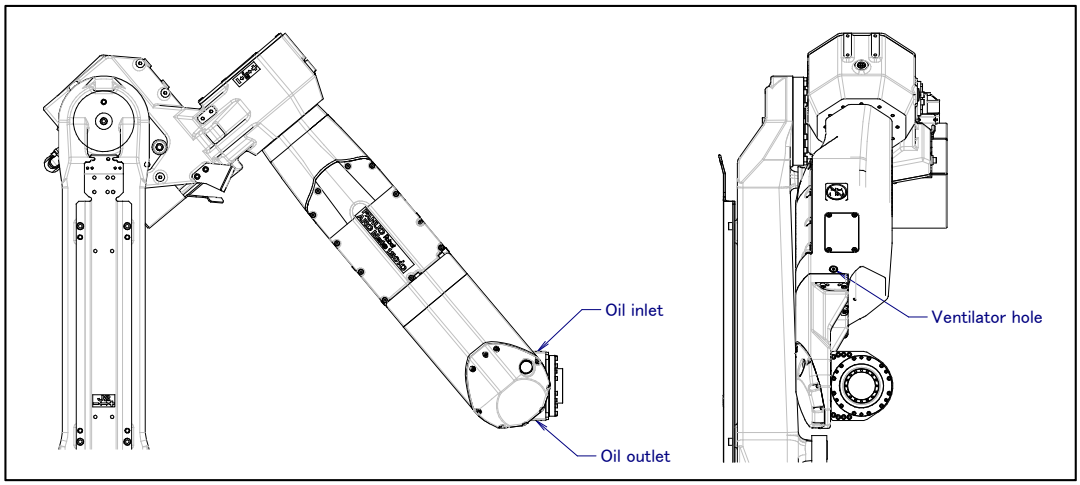


Fig. 7.3.2.4 (c) Oil inlet/outlet and ventilator hole ARC Mate 120*i*C, M-20*i*A)
(A05B-1222-B201, B202, A05B-1225-B201, B202)

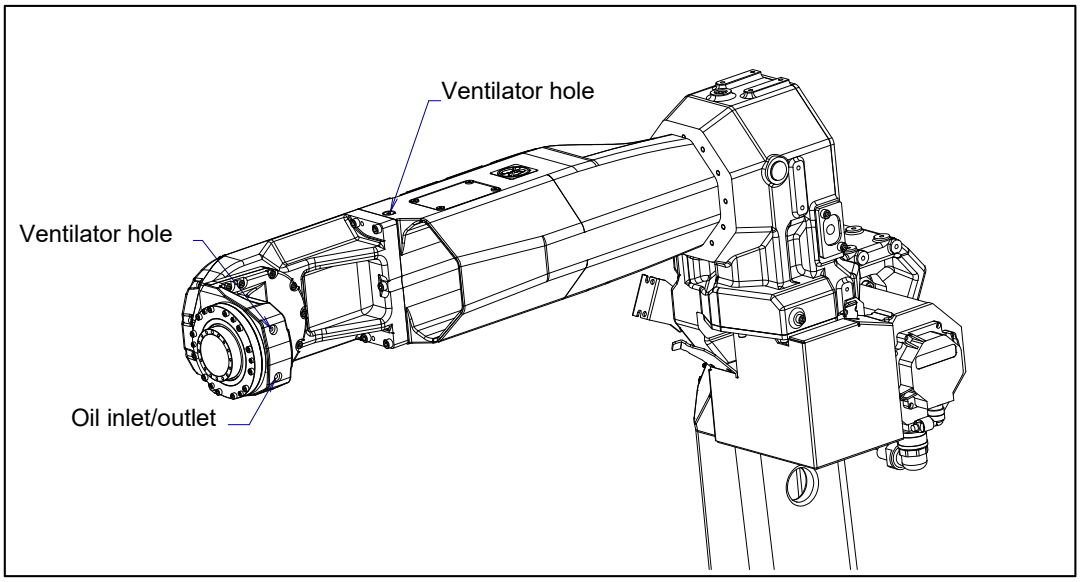


Fig. 7.3.2.4 (d) Oil inlet/outlet and ventilator hole ARC Mate 120*i*C, M-20*i*A)
(A05B-1225-B251, B252)

4 When all oil is discharged, attach extra low bolt and seal washer to oil outlet.

Injecting oil method

5 Confirm robot posture is J5/J6-axis gearbox (posture for oiling and discharging oil) in Table 7.3.2.4 (b), (c), and oil outlet is closed, then supply oil according to description below.

A When oil gun is used

(1) Attach oil injection nipple with valve (A05B-1221-K006) to oil inlet referring to Fig. 7.3.2.4 (e), (f).

(2) Attach oil tray with valve (A05B-1221-K007) to ventilator hole.

(3) Confirm valve of oil inlet and oil outlet are open. Supply oil to J5/J6-axis gearbox by oil injection gun (A05B-1221-K005). If oil comes out in oil tray from oil outlet, Stop supplying oil, close the valve oil injection nipple, and remove oil gun.

(4) Close the valve of oil tray, remove tray and close the oil outlet.

(5) Remove the oil injection nipple, then attach extra low bolt and seal washer to first oil inlet.

(6) Turn on the controller power, move the robot to the posture (J5/J6-axis gearbox (confirm oiling)) as shown in Table 7.3.2.4 (b), (c).
Confirm the amount of oil. (See Fig. 7.3.2.4 (g).) If oil is insufficient, add oil using syringe etc. from ventilator hole. If oil is added, stir the oil in oil bath by releasing remaining pressure of Subsection 7.3.2.6, then confirm the amount of oil.

(7) According to Subsection 7.3.2.6, release the remaining pressure of oil bath and confirm the oil sight glass again.

> ⚠ **CAUTION**
> If supplying oil forcibly when valve is closed, internal pressure of oil bath rise abnormally and cause oil leak from seal part or oil seal falling out. Be careful.

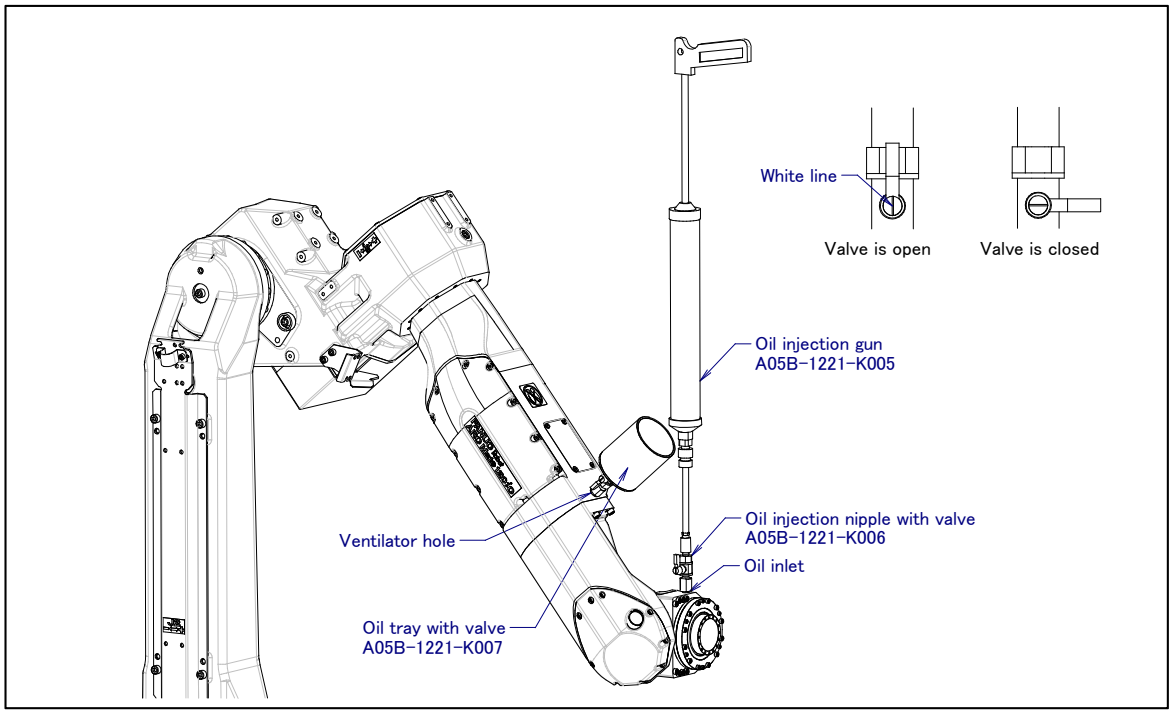


Fig. 7.3.2.4 (e) Oiling by oil gun (ARC Mate 120*i*C, M-20*i*A)
(A05B-1222-B201, B202, A05B-1225-B201, B202)

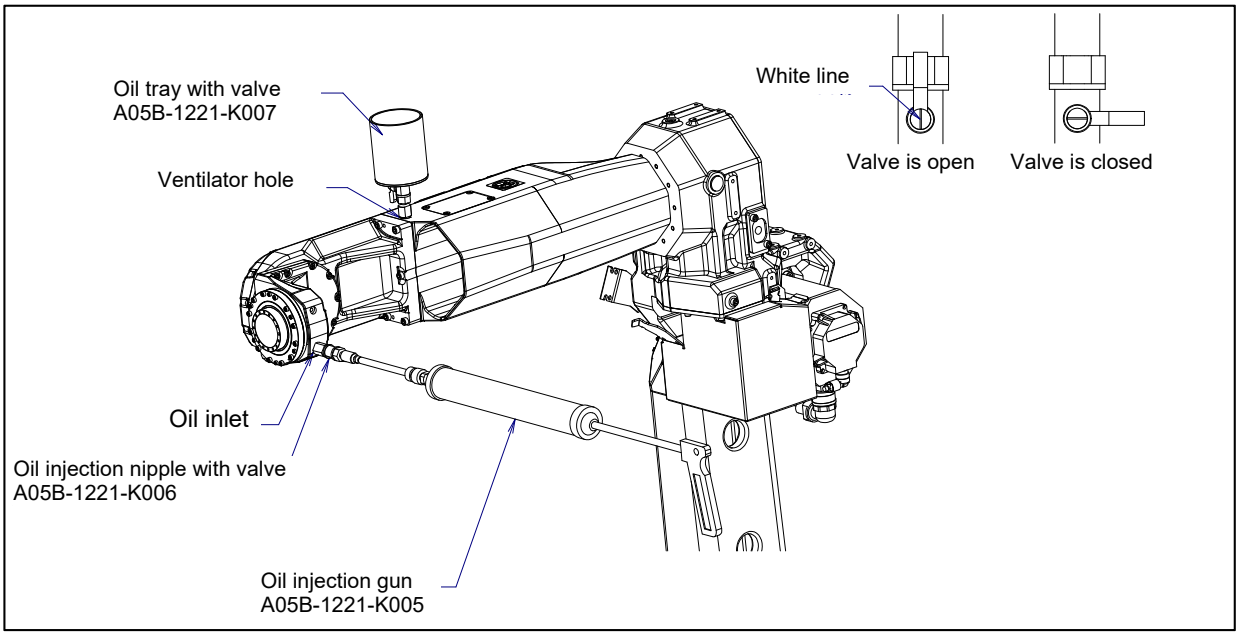


Fig. 7.3.2.4 (f) Oiling by oil gun (ARC Mate 120*i*C, M-20*i*A)
(A05B-1225-B251, B252)

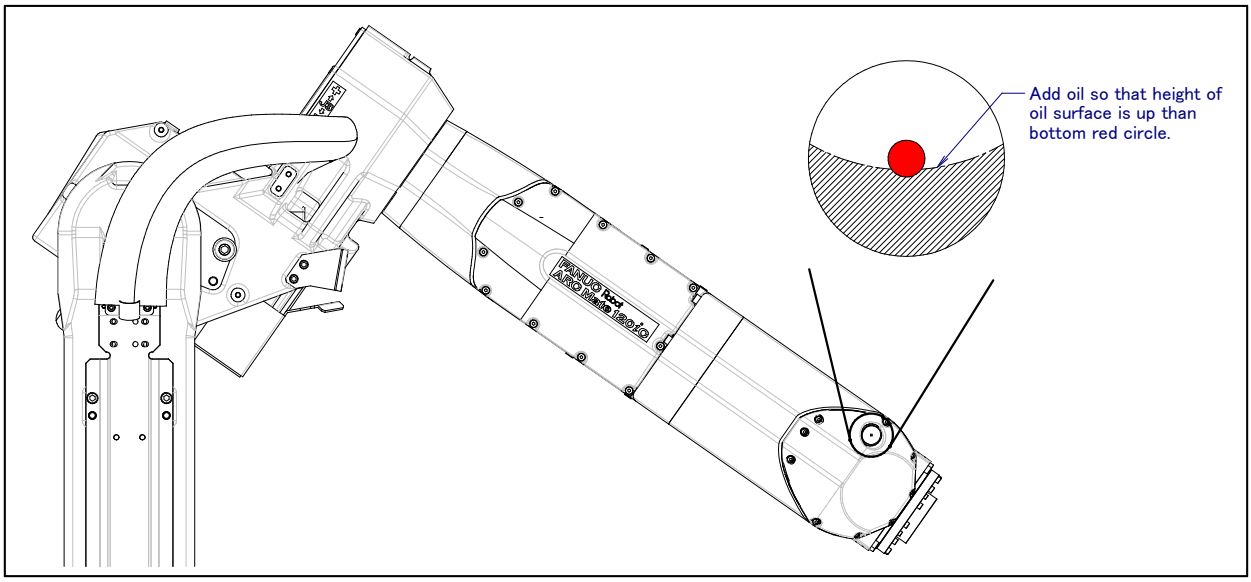


Fig. 7.3.2.4 (g) Standard of oil sight glass (supply oil J5/J6-axis gearbox) (ARC Mate 120*i*C, M-20*i*A)

B When oil gun is not used

(1) Supply oil from oil inlet. If oil overflowed form ventilator hole, stop supplying oil and close the ventilator hole. When oil adapter (A290-7222-X591) is used, attach it referring to example of Fig. 7.3.2.4 (h). The amounts of oiling are about as many as 0.6 adapters. It takes about 25 minutes. Oil adaptor cannot be used for A05B-1225-B251, B252.

(2) Attach extra low bolt and seal washer to oil inlet.

(3) Turn on the controller power, Move the robot to the posture (J5/J6-axis gearbox (confirm oiling)) as shown in Table 7.3.2.4 (b), (c), then confirm the amount of oil sight glass. (See Fig. 7.3.2.4 (g)). If oil is insufficient, add oil using syringe etc. from ventilator hole. If oil is added, stir the oil in oil bath by releasing remaining pressure of Subsection 7.3.2.6, then confirm the amount of oil.

(4) According to Subsection 7.3.2.6, release remaining pressure of oil bath and confirm the oil sight glass again.

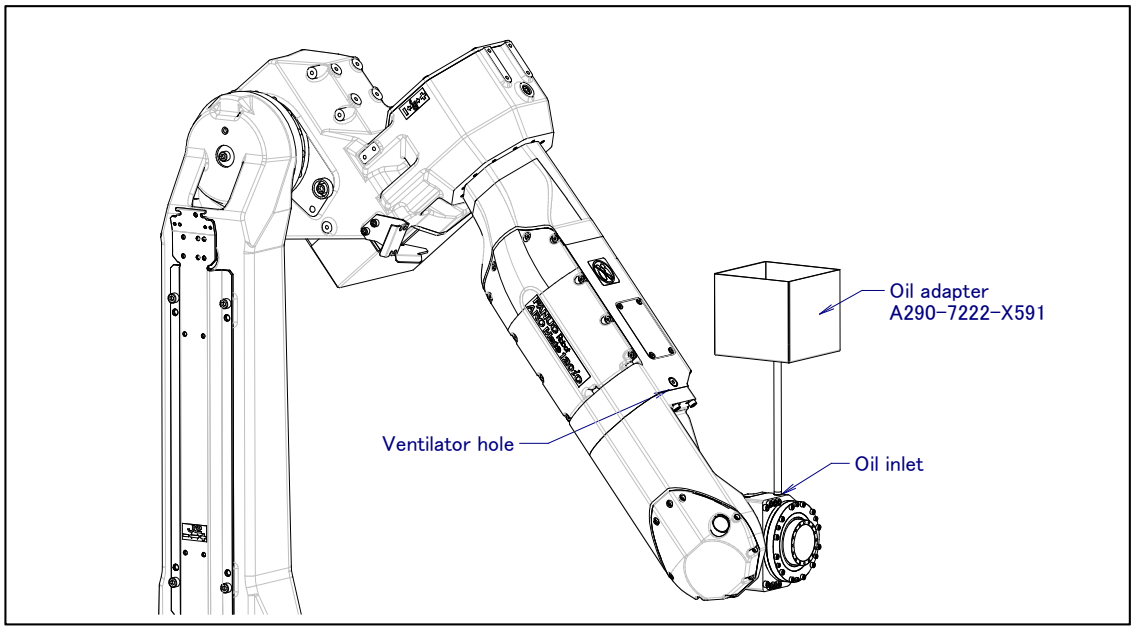


**Fig. 7.3.2.4 (h) Oil adapter (for J5/J6-axis gearbox oil inlet) (ARC Mate 120*i*C, M-20*i*A)
(A05B-1222-B201, B202, A5B-1225-B201, B202)**

7.3.2.5 Oil replacement procedure for J5/J6-axis gearbox (ARC Mate 120*i*C/10L/12L, M-20*i*A/10L/12L)

⚠ CAUTION

1 There is severe risk of gear damage in case robot is operated with oil shortage. Please make sure the gearbox is always filled with correct amount of oil.
2 Failure to supply oil correctly may cause damage to the seal, which would in turn lead to oil leakage and abnormal operation. When performing oiling, therefore, observe the following cautions.
  1 Use specified oil. Use of non-approved oil may damage the reducer or lead to other problems.
  2 After oiling, release remaining pressure from the grease bath using the procedure given in Subsection 7.3.2.6, and then close the grease outlet.
  3 To prevent slipping accidents and catching fire, completely remove any excess oil from the floor or robot.

Table 7.3.2.5 (a) Oil name and amount (J5/J6-axis gearbox)

Oiling points	Amount of oil to be applied (NOTE 1)	Gun tip pressure	Specified oil
J5/J6-axis gearbox (NOTE 2)	340g(400ml)	0.1MPa or less	(Specification: A98L-0040-0233)
J5/J6-axis gearbox (NOTE 3)	330g(390ml)		

NOTE 1) : It is not a regulated amount injection. Be sure to confirm the amount of oil with the oil sight glass.
NOTE 2) : ARC Mate 120*i*C/10L, M-20*i*A/10L
NOTE 3) : ARC Mate 120*i*C/12L, M-20*i*A/12L

Table 7.3.2.5 (b) Postures for oiling (J5/J6-axis gearbox)

Supply position		Posture					
		J1	J2	J3	J4	J5	J6
J5/J6-axis gearbox (Oiling posture) (When oil gun is used)	Floor mount	Arbitrary	Arbitrary	18°	-40°	0°	Arbitrary
	Upside-down mount			-18°	140°		
	-90°wall mount	0°		-72°	-40°		
	+90°wall mount			108°	-40°		
J5/J6-axis gearbox (Oiling posture) (When oil gun is not used)	Floor mount	Arbitrary		18°	90°		
	Upside-down mount			-18°	-90°		
	-90°wall mount	0°		-72°	90°		
	+90°wall mount			108°	90°		
J5/J6-axis gearbox (replenishing oil)	Floor mount	Arbitrary		90°	0°		
	Upside-down mount			-90°	0°		
	-90°wall mount	0°		0°	0°		
	+90°wall mount			180°	0°		
J5/J6-axis gearbox (discharging oil)	Floor mount	Arbitrary		-30°	-70°		
	Upside-down mount			30°	110°		
	-90°wall mount	0°		-210°	-70°		
	+90°wall mount			150°	-70°		
J5/J6-axis gearbox (confirm oiling)	Floor mount	Arbitrary		0°	0°		
	Upside-down mount			180°	0°		
	-90°wall mount	0°		-90°	0°		
	+90°wall mount			90°	0°		
J5/J6-axis gearbox (release remaining pressure)	Floor mount	Arbitrary		20° to 90°	90°	Arbitrary	
	Upside-down mount			-20° to -90°	-90°		
	-90°wall mount	0°		0° to 70°	-90°		
	+90°wall mount			110° to 180°	90°		

NOTE) Choose the one of the posture taken easily when there is two or more posture.

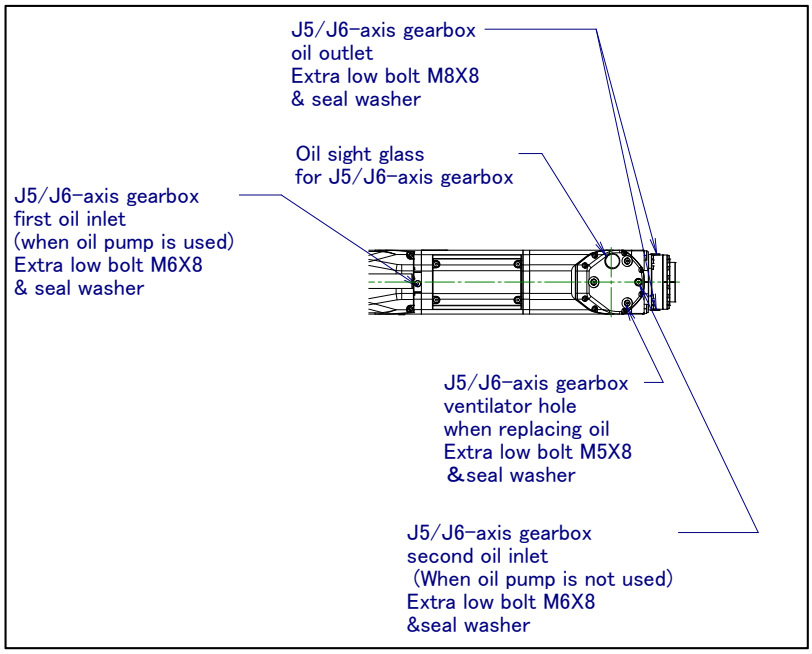


Fig. 7.3.2.5 (a) Oil inlet and outlet (ARC Mate 120*i*C/10L, M-20*i*A/10L)

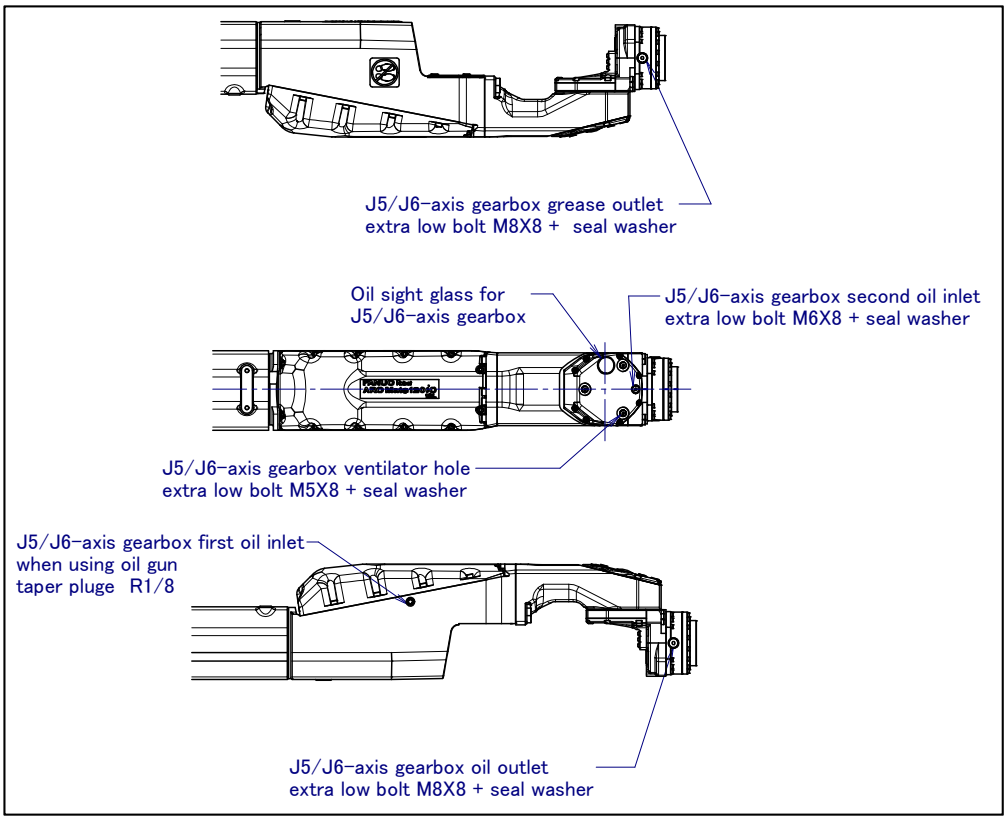


Fig. 7.3.2.5 (b) Oil inlet and outlet (ARC Mate 120*i*C/12L, M-20*i*A/12L)

Table 7.3.2.5 (c) Spec. of the extra low bolts, the taper plug and the seal washers

Parts name	Specification
Extra low bolt (M5)	A97L-0218-0502#M5X8
Extra low bolt (M6)	A97L-0218-0502#M6X8
Extra low bolt (M8)	A97L-0218-0502#M8X8
Taper plug (R1/8)	A97L-0001-0436#1-1D
Seal washer (M5)	A30L-0001-0048#5M
Seal washer (M6)	A30L-0001-0048#6M
Seal washer (M8)	A30L-0001-0048#8M

Exhausting oil method

1 Move the robot to the posture of J5/J6-axis (oil discharge) described in Table 7.3.2.5 (b).
2 Turn off the controller power.
3 Put the oil tray under the oil outlet.
Remove the extra low bolt and seal washer of first oil inlet and seal washer. See Fig. 7.3.2.5 (a) and (b). (In this time, if you remove bolt of oil outlet firstly, you can prevent spilling oil on surroundings.)
4 Install the taper plug or extra low bolt and seal washer to the first oil outlet and oil outlet after all oil is exhausted.
5 Turn on the controller power.

Injecting oil method

6 Move the robot to the J5/J6-axis gearbox oil supplying posture as shown in Table 7.3.2.5 (b) (posture when using oil gun differs from posture when not using oil gun. Please be careful)
7 Turn off the controller power.

Supply oil according to the procedure below.

A When oil gun is used
(1) Install oil injection nipple with valve to J5/J6-axis gearbox first oil inlet (A05B-1221-K006 or A05B-1224-K006) referring to Fig. 7.3.2.5 (c), (d).
(2) Attach oil tray with valve (A05B-1221-K007) to J5/J6-axis gearbox oil outlet (J6-axis cross roller part).
(3) Confirm valve of oil inlet and oil outlet are open referring to Fig. 7.3.2.5 (c) and (d). Supply oil to J5/J6-axis gearbox by oil injection gun (A05B-1221-K005). If starts coming out in oil tray from oil outlet, Stop supplying oil, close the valve oil injection nipple, and remove oil gun
(4) Close the valve of oil tray, remove tray and close the oil outlet.
(5) Remove the oil injection nipple, then attach extra low bolt and seal washer to first oil inlet.
(6) Move robot to the posture for J5/J6-axis gearbox (replenishment) of Table 7.3.2.5 (b) and add oil from second oil inlet (M5) by a syringe fountain pen filler. If about 15ml of oil is added, oil starts coming out from oil inlet. Then close the oil inlet.
(7) Move robot to the posture for J5/J6-axis gearbox (confirm oiling) of Table 7.3.2.5 (b) and confirm the quantity of oil. (See Fig. 7.3.2.5 (e) and (f).)
(8) Turn J4-axis 90 degree by each axis jog, back to the original posture, confirm oil amount height is 3/4 or more. If oil is insufficient, add oil by a syringe fountain pen filler.
(9) Release remaining pressure using the procedure given in Subsection 7.3.2.6 and confirm the oil sight glass again.

> ⚠ **CAUTION**
> If supplying oil forcibly when valve is closed, internal pressure of oil bath rise abnormally and cause oil leak from seal part or oil seal falling out. Be careful

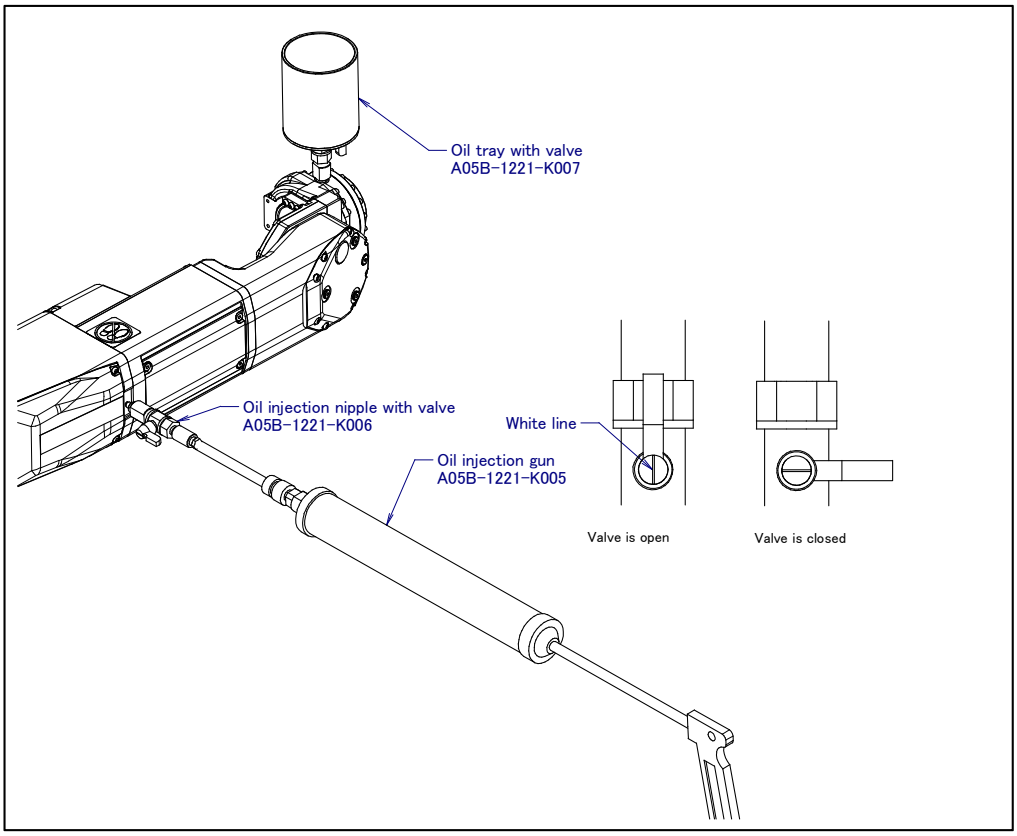


Fig. 7.3.2.5 (c) Oil injection with an oil gun (ARC Mate 120*i*C/10L, M-20*i*A/10L)

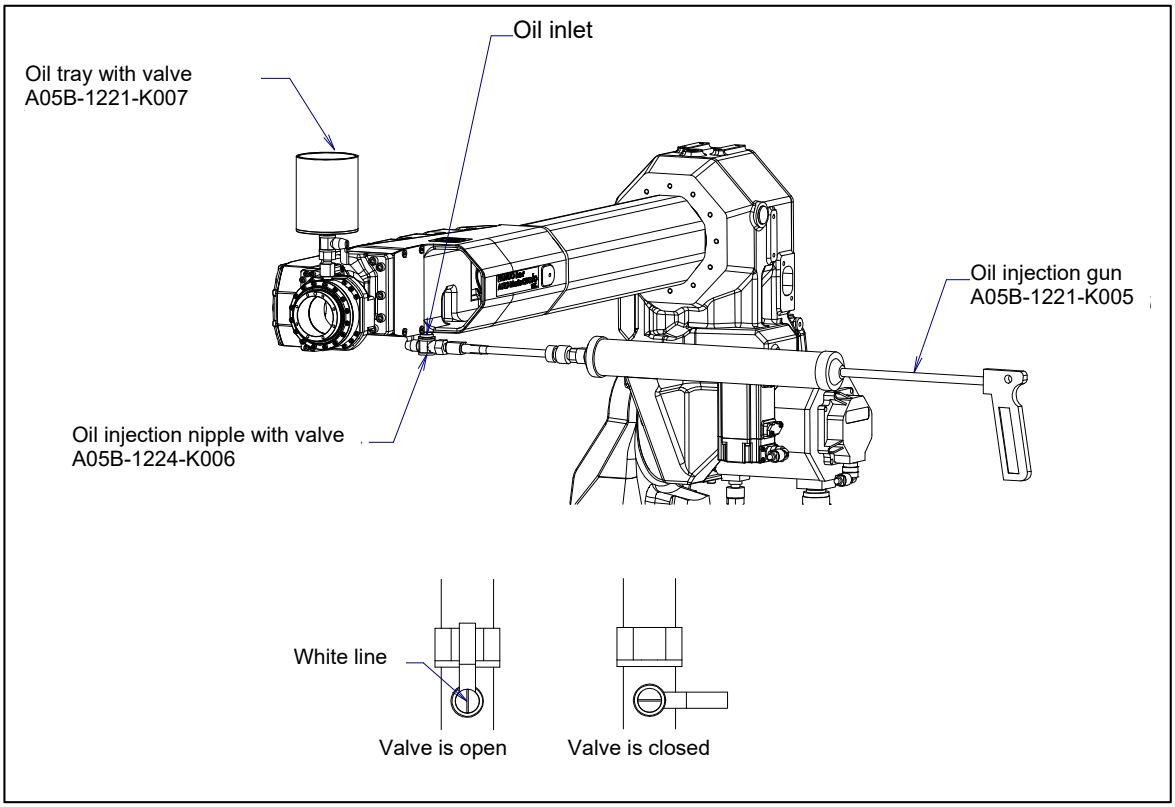


Fig. 7.3.2.5 (d) Oil injection with an oil gun (ARC Mate 120*i*C/12L, M-20*i*A/12L)

B When oil gun is not used

(1) Remove extra low bolt and seal washer of ventilator hole and second oil inlet of Fig.7.3.2.5 (a), (b) and supply oil. When the adaptor for oiling (A290-7221-X591) is used, oiling is easy. (See Fig. 7.2.3.5 (g)). In case of using adaptor for oiling, install it to second oil inlet. remove J5/J6-axis gearbox ventilator hole and supply oil. The amounts of oiling are about as many as two adaptors. It takes about five minutes to oil as many as one cup.

(2) When oil starts coming out from ventilator hole, remove oil adapter for oiling if it's mounted, close the ventilator hole, move robot to the posture (confirm oiling) and confirm amount of oil sight glass. (See Fig.7.3.2.5 (e), (f)) If oil is not sufficient, replenish it by a syringe fountain pen filler.

(3) Move the robot to the posture (replenishment) and add oil from second oil inlet (M6). If about 15ml of oil is added, oil starts coming out from oil inlet. Then close the oil inlet.

(4) Move robot to the posture for J5/J6-axis gearbox (confirm oiling) of Table 7.3.2.5 (b). In this time, rotate the J4-axis to +/- direction and confirm oil does not decrease. If it decreased, move the robot to the posture for J5/J6-axis gearbox (confirm oiling) of Table 7.3.2.5 (b). And add oil from second oil inlet (M6) by a syringe fountain pen filler.

(5) Release remaining pressure using the procedure given in Subsection 7.3.2.6.

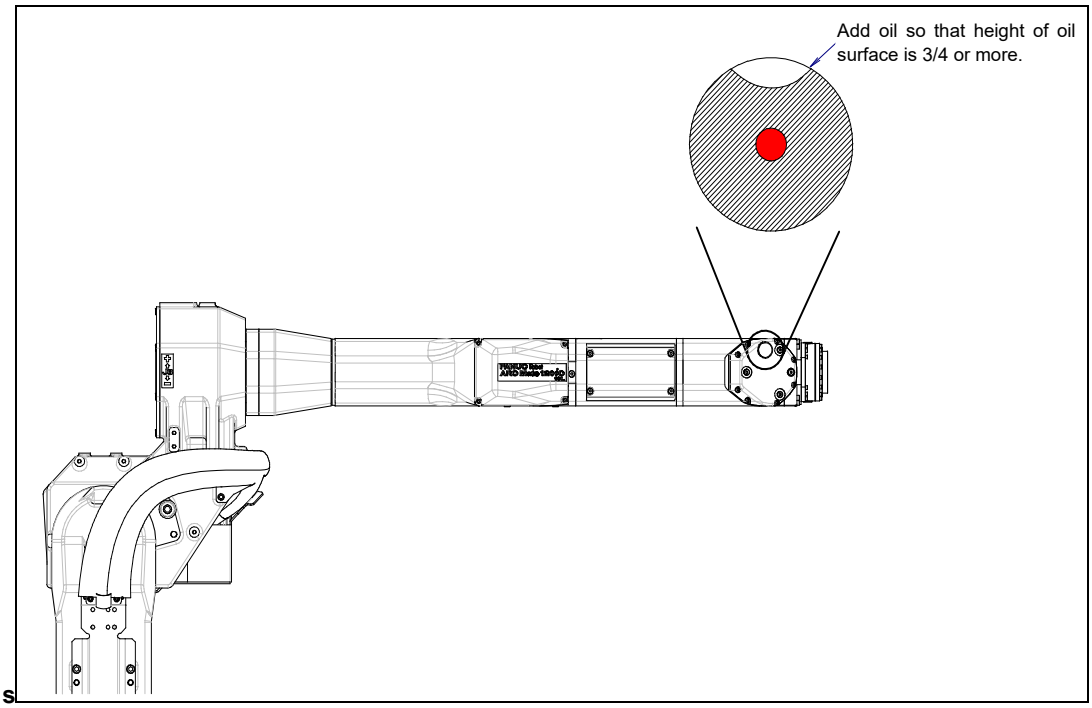


Fig. 7.3.2.5 (e) Standard of oil sight glass (supplying oil for J5/J6-axis gearbox) (ARC Mate 120*i*C/10L, M-20*i*A/10L)

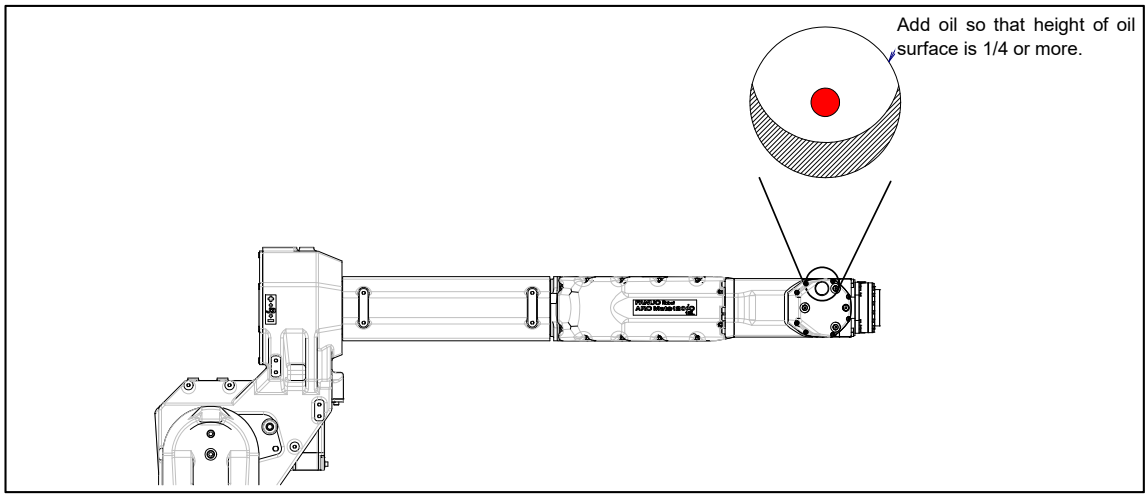


**Fig. 7.3.2.5 (f) Standard of oil sight glass (supplying oil for J5/J6-axis gearbox)
(ARC Mate 120*i*C/12L, M-20*i*A/12L)**

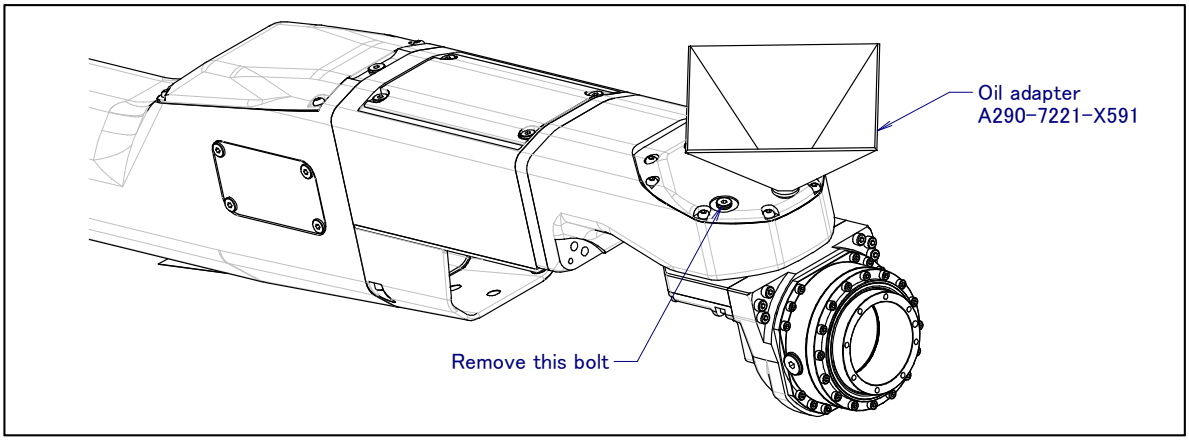


**Fig.7.3.2.5 (g) Oil adapter (supplying oil J5/J6-axis gearbox)
(ARC Mate 120*i*C/10L/12L, M-20*i*A/10L/12L)**

7.3.2.6 Procedure for releasing remaining pressure from oil bath (J4 to J6-axis)

After replacing oil, please do the following operation to adjust the amount of oil properly.

In case of J4-axis gearbox

Confirm that oil level seen in oil sight glass is as per Fig. 7.3.2.3 (e). If confirmed then please operate robot J4 axis during 10 minutes or more, at 100% override, making 90° motion (or more). Keep plug and seal bolt attached during this operation. When completed, move the robot to the posture outlet comes to right above position (In case of floor mount, J3=0 ^{o}.) and remove seal bolt of J4-axis gearbox oil outlet. Remaining pressure is released at once if it is removed. After operation, confirm whether the oil side of the oil sight glass has come above Fig. 7.3.2.3 (e), and attach plug of the oil inlet. In case oil level is insufficient, please add oil from the oil outlet with the syringe etc. Wipe the oil that adheres to the surface of the robot and attach the taper plug on the oil inlet, the seal bolt on the oil outlet completely then attach seal bolt of oil outlet.

In case of J5/J6-axis gearbox

1 For ARC Mate 120*i*C, M-20*i*A

Confirm that oil level seen in oil sight glass is as per Fig. 7.3.2.4 (d). If it is confirmed, then move robot to the confirming posture described in Table 7.3.2.4 (b). Attach extra low bolt and seal washer of the oil inlet but keep it loose. Operate robot J5 and J6 axis during 10 minutes or more, at 100% override, making 90° motion (or more) on both axes. In this time, make program that move both of J5-axis and J6-axis.

When completed, move the robot to the confirming posture. Remaining pressure release at once if the ventilator hole is opened. Confirm that oil level seen in oil sight glass is as per Fig.7.3.2.4 (d). At this time, please rotate the J4 axis in the direction of +/-, move robot to the posture of confirming posture, and confirm that the amount of oil doesn't decrease. If it is decreased, move robot to the confirming posture again and add oil from the oil inlet or the ventilator hole with the syringe etc. when decreasing. Wipe off the oil that adhered to the surface of the robot and attach the extra low bolt and seal washer on the oil inlet/outlet completely.

2 For ARC Mate 120*i*C/10L, M-20*i*A/10L, ARC Mate 120*i*C/12L, M-20*i*A/12L

Confirm that oil level seen in oil sight glass is as Fig. 7.3.2.5 (e) and (f). Then move the robot to the posture J5/J6-axis (release remaining pressure), attach extra low bolt and seal washer to second oil inlet but keep them loose. Operate robot J5 and J6 axis during 10 minutes or more, at 100% override, making 90° motion (or more) on both axes. In this time, make program that move both of J5-axis and J6-axis.

When completed, move the robot to the J5/J6-axis confirming posture. Remaining pressure is released at once if the second oil inlet (M5) is opened. For ARC Mate 120*i*C/10L, M-20*i*A/10L, confirm that oil level is 3/4 or more. For ARC Mate 120*i*C/12L, M-20*i*A/12L, confirm that oil level is 1/4 or more. At this time, please rotate the J4 axis in the direction of +/-, and confirm that the amount of oil doesn't decrease. If it is decreased, move robot to the posture J5/J6-axis gearbox (replenish oil) and add oil from the second oil inlet with the syringe etc. After it is confirmed, wipe off the oil adhered to the surface of the robot and attach the extra low bolt on the oil inlet.

If the above operation cannot be performed due to the environment of the robot, adjust the operating time according to the operating angle. (When the maximum allowable axis angle is 45 degrees, perform the twice operation for 20 minutes or more.)
If you grease or oil multiple axes, you can exercise multiple axes at the same time.

After replacing grease or oil, the internal pressure of the grease bath or oil bath may rise if the robot is operated again under frequent inversion movement or a high temperature environment. In these cases, you can return to normal internal pressure by releasing the grease outlet or oil outlet just after robot operation. (When opening grease outlet or oil outlet, be sure that grease or oil is not spattered.)

⚠ CAUTION
When reusing the seal bolt and taper plug, be sure to seal the threads with seal tape. As for the seal washer, the rubber side sticks to the entire and the other side, rubber sticks to only around hole and rubber sticks is incomplete state, Attach later face to bolt side. Confirm the seal washer is in good condition. If it is damaged, replace it with a new one.
See Table 7.3.2.3 (c), Table 7.3.2.4 (c) and Table 7.3.2.5 (c) about for seal bolt and seal washer specifications.

7.4 STORAGE

When storing the robot, place it on a level surface with the same posture that was used for transportation. (See Section 1.1.)

8 CHECKS AND MAINTENANCE (M-20*i*A/20M/35M)

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

NOTE
The periodic maintenance procedures described in this chapter assume that the FANUC robot is used for up to 3840 hours a year. In cases where robot use exceeds 3840 hours/year, adjust the given maintenance frequencies accordingly. The ratio of actual 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 interval should be divided by 2.

8.1 CHECKS AND MAINTENANCE

8.1.1 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. **⇒"8.2.1 Confirmation of Oil Seepage"**
Air control set	(When air control set is used) **⇒"8.2.2 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: **⇒"10.1 TROUBLESHOOTING"(symptom：Vibration, Noise)**
Positioning accuracy	Check that the taught positions of the robot have not deviated from the previously taught positions. If displacement occurs, perform the measures as described in the following section: **⇒"10.1 TROUBLESHOOTING"(Symptom：Displacement)**
Peripheral equipment for proper operation	Check whether the peripheral equipment operates properly according to commands from the robot and the peripheral equipment.
Brakes for each axis	Check that the droppage of the end effector mounting face is within 5 mm when the servo power is turned off. If the end effector (hand) drops, perform the measures as described in the following section: **⇒"10.1 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)"**

8.1.2 Periodic Checks and Maintenance

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

Check and maintenance intervals (Operating time, Accumulated operating time)						Check and maintenance item	Check points, management and maintenance method	Periodic maintenance table No.
1 month 320h	3 months 960h	1 year 3840h	2 years 7680h	3 years 11520h	4 years 15360h			
○ Only 1st check	○					Cleaning the controller ventilation system	Check whether dust is accumulated in the controller ventilation system. Remove the dust if it exists.	20
	○					Check the external damage or peeling paint	Check whether the robot has external damage or peeling paint due to 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. **⇒"8.2.3 Check the Mechanical Unit Cables and Connectors"**	2
	○					Check for water	Check whether the robot is subjected to water or cutting oils. If liquid is found, remove the cause, and wipe the liquid off.	3
	○ 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.	19
	○ Only 1st check	○				Check for damage to the mechanical unit cable (movable part) and welding cable	Observe the movable part of the mechanical unit cable and welding cable, and check for damage. Also, check whether the cables are excessively bent or unevenly twisted. **⇒"8.2.3 Check the Mechanical Unit Cables and Connectors"**	4
	○ Only 1st check	○				Check for damage to the end effector (hand) connection cable	Check whether the end effector connection cables are unevenly twisted or damaged. If damage is found, replace the damaged cables.	5

Check and maintenance intervals (Operating time, Accumulated operating time)						Check and maintenance item	Check points, management and maintenance method	Periodic maintenance table No.
1 month 320h	3 months 960h	1 year 3840h	2 years 7680h	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. **⇒"8.2.3 Check the Mechanical unit Cables and Connectors"**	6
	○ Only 1st check	○				Retightening the end effector mounting bolts	Retighten the end effector mounting bolts. Refer to the following section for tightening torque information: **⇒" 4.1 END EFFECTOR INSTALLATION TO WRIST"**	7
	○ Only 1st check	○				Retightening the external main bolts	Retighten the bolts which were installed, removed, or exposed during inspection. Refer to the recommended bolt tightening torque guidelines at the end of the manual. Some bolts are attached with adhesive. Tightening the bolts with a torque greater than what is recommended might damage the adhesive. Therefore, follow the recommended bolt tightening torque guidelines when retightening the bolts.	8
	○ 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 that the stopper mounting bolts are not loose. **⇒"8.2.4 Check of Fixed Mechanical Stopper and Adjustable Mechanical Stopper"**	9
	○ 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).	10
		○				Replacing the mechanical unit batteries	Replace the mechanical unit batteries. Regardless of operating time, replace batteries at 1 year. **⇒"8.3.1 Replacing the Batteries"**	11
		○				Apply grease	Grease the J6-axis reducer **⇒"8.3.2 Greasing**	17
				○		Replacing the grease of J1 to J3- axis reducer and J4 to J5-axis gearbox	Replace the grease of each axis reducer and gearbox **⇒"8.3.3 Replacing the Grease of the Drive Mechanism"**	12 to 16
					○	Replacing the mechanical unit cable	Replace the mechanical unit cable Contact your local FANUC representative for information regarding replacing the cable.	18
					○	Replacing the controller batteries	Replace the controller batteries. Regardless of operating time, replace batteries at 4 years. **⇒Chapter 7 Replacing batteries of R-30*i*B /R-30*i*B Plus CONTROLLER MAINTENANCE MANUAL (B-83195EN) or R-30*i*B Mate CONTROLLER MAINTENANCE MANUAL (B-83525EN)"**	21

8.2 CHECK POINTS

8.2.1 Confirmation of Oil Seepage

Check items

Check there is oil on sealed part of each joint parts. If there is oil seepage, clean them.

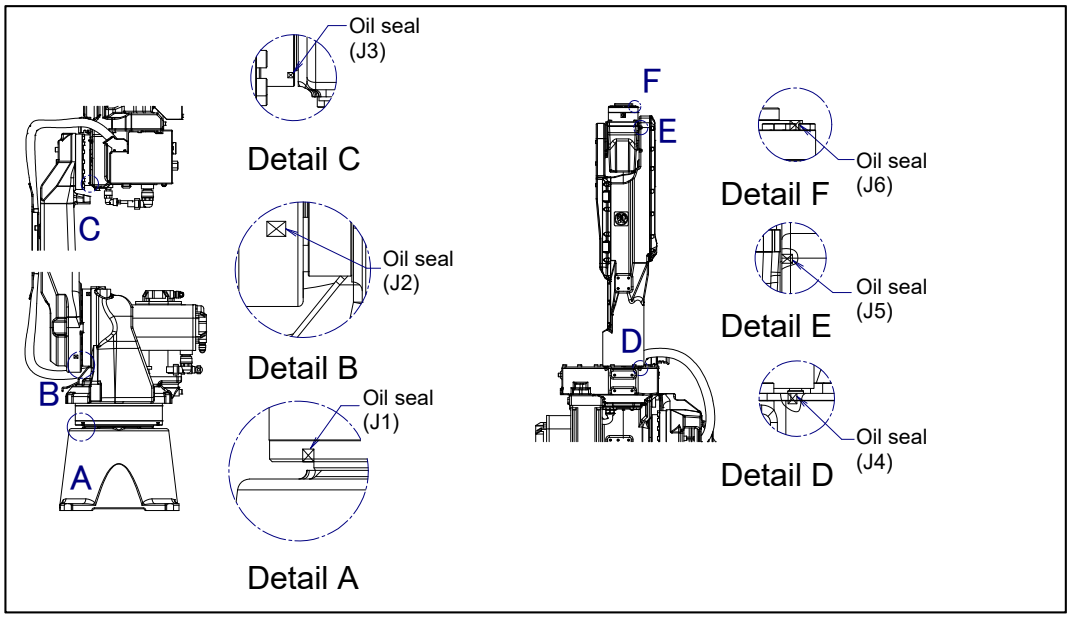


Fig. 8.2.1 (a) Check parts of oil seal

Management

- Oil might accumulate on the outside of the seal lip depending on the movement condition or environment of the axis. If the oil changes to a state of liquid, 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 before you operate the robot.
- In case of oil seepage, please consider replacing the grease. This replacement potentially can help improving the seepage situation.
- Also, motors might become hot and the internal pressure of the grease bath may increase 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 Subsection 8.3.2 and 8.3.3 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.
  ⇒”10.1 TROUBLESHOOTING”(symptom：Grease leakage , Oil leakage)

8.2.2 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. 8.2.2 (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 handle for lubricator adjustment. The lubricator becomes empty in about 10 to 20 days under normal operation.
3	Lubricator oil level	Check to see that the air control set oil level is within the specified level.
4	Leakage from hose	Check the joints, tubes, etc. for leaks. Retighten the joints or replace parts, as required.
5	Drain	Check the drain and release it. When quantity of the drain is remarkable, examine the setting of the air dryer to the air supply side.

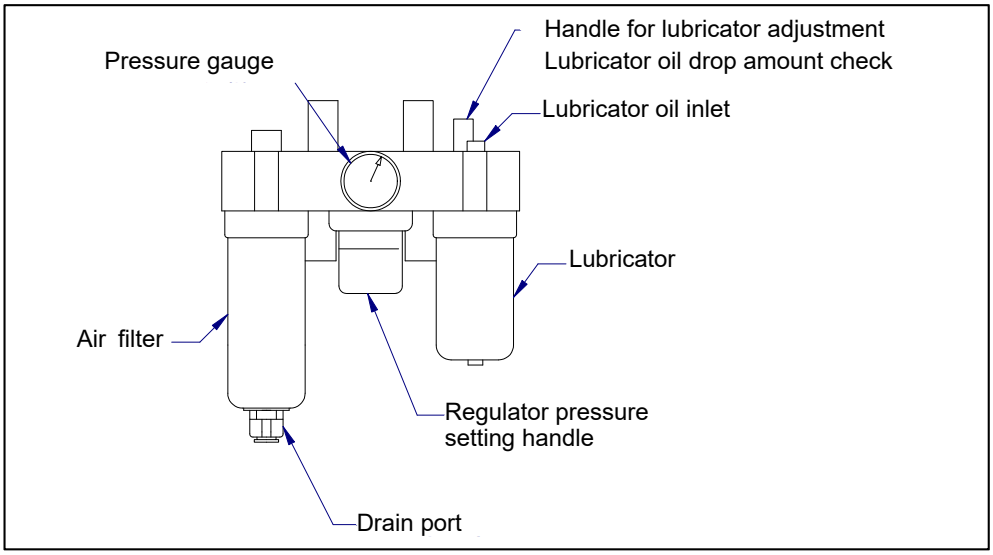


Fig. 8.2.2 (a) Air control set (option)

8.2.3 Check the Mechanical Unit Cables and Connectors

Inspection points of the mechanical unit cables and welding cables

Check the cable for damage that has been exposed. Take special care for movable parts.
Clean it when the spatter adheres.

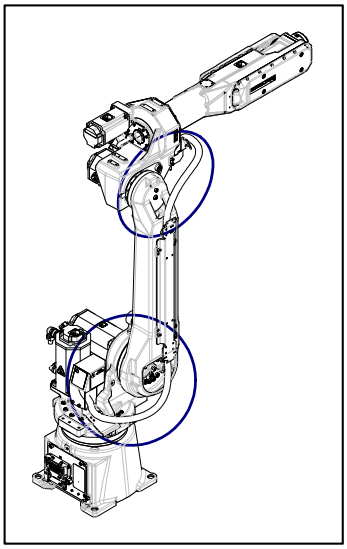


Fig. 8.2.3 (a) Inspection points of the mechanical unit cables

Check points

＜Cable protective sleeve＞

- Check that no holes or tears exist on the cable protective sleeves.
- If there is damage as shown in Fig. 8.2.3 (b), replace the cable protective sleeves.

Fig. 8.2.3 (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.

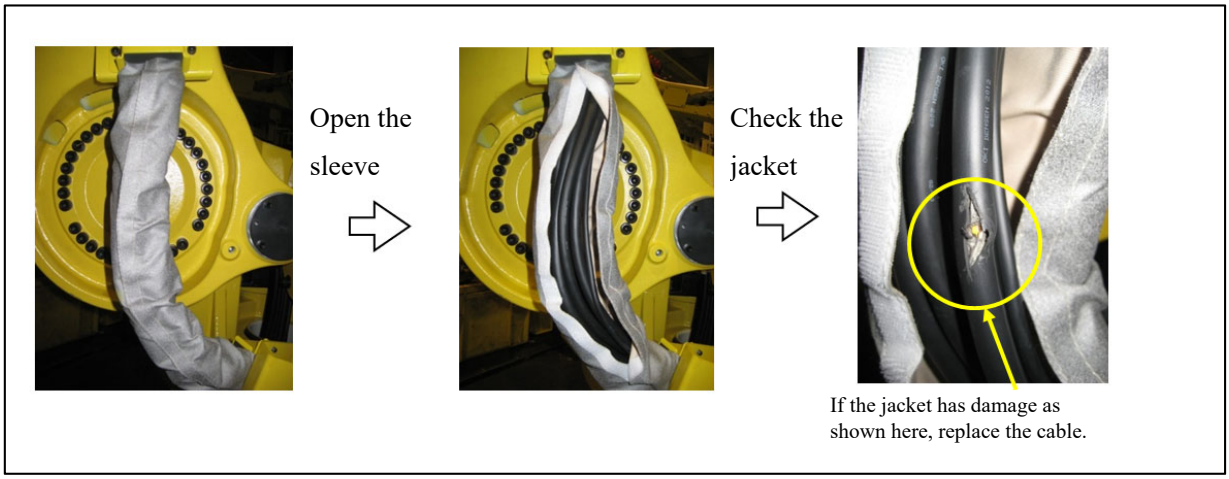


Fig. 8.2.3 (c) Cable check method

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

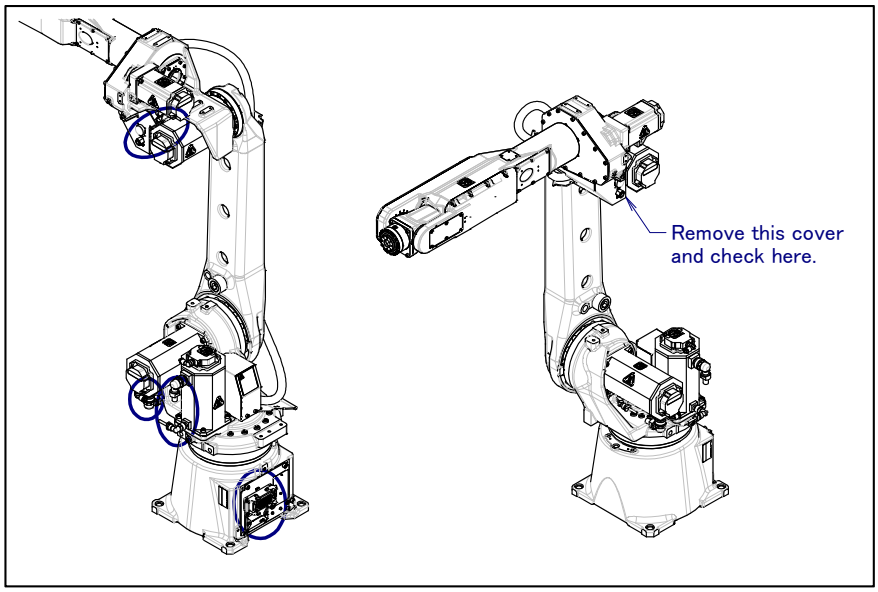


Fig. 8.2.3 (d) Connector Inspection points

8.2.4 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 looseness 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.
- Refer to Section 6.2 of the operator's manual for details regarding the adjustable mechanical stopper.

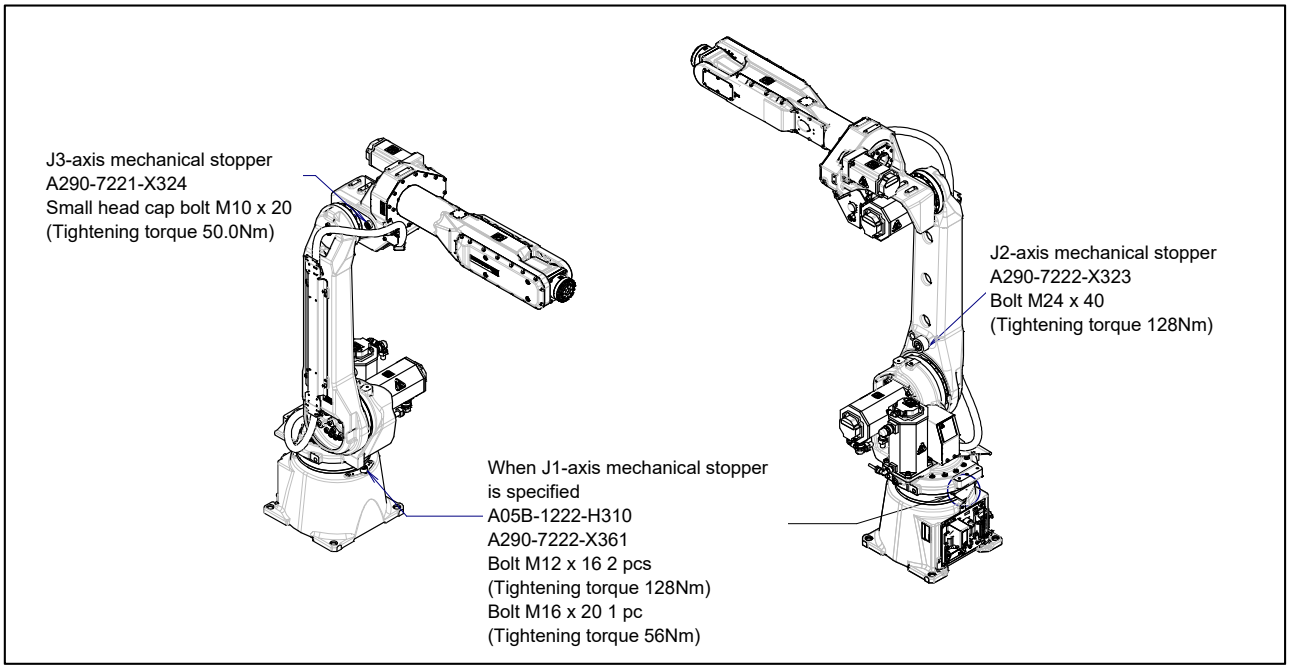


Fig. 8.2.4 (a) Check of mechanical stopper and adjustable mechanical stopper

8.3 MAINTENANCE

8.3.1 Replacing the Batteries (1-year checks)

The position data of each axis is preserved by the backup batteries. The batteries need to be replaced every 1 year. Also, use the following procedure to replace when the backup battery voltage drop alarm occurs.

Procedure of replacing the battery

1 Press the EMERGENCY STOP button to stop robot motion.

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

2 Remove the battery case cap. (Fig. 8.3.1 (a), (b)) If it cannot be removed, tap it to side direction with a plastic hammer.
3 Take out the old batteries from the battery case. In this time, battery can be taken out by pulling the stick of the center of the battery box.
4 Insert new batteries into the battery case. Pay attention to the direction of batteries.
5 Close the battery case cap.

> ⚠ **CAUTION**
> When using a robot with the severe dust/liquid protection option, remove the cover from the battery case as shown in Fig. 8.3.1 (b) to replace the battery. After replacing the battery, reinstall the cover. At this time, please be sure to replace gasket with new one for severe dust/liquid protection. When placing a gasket on a battery cover, please be sure no gaps exist.

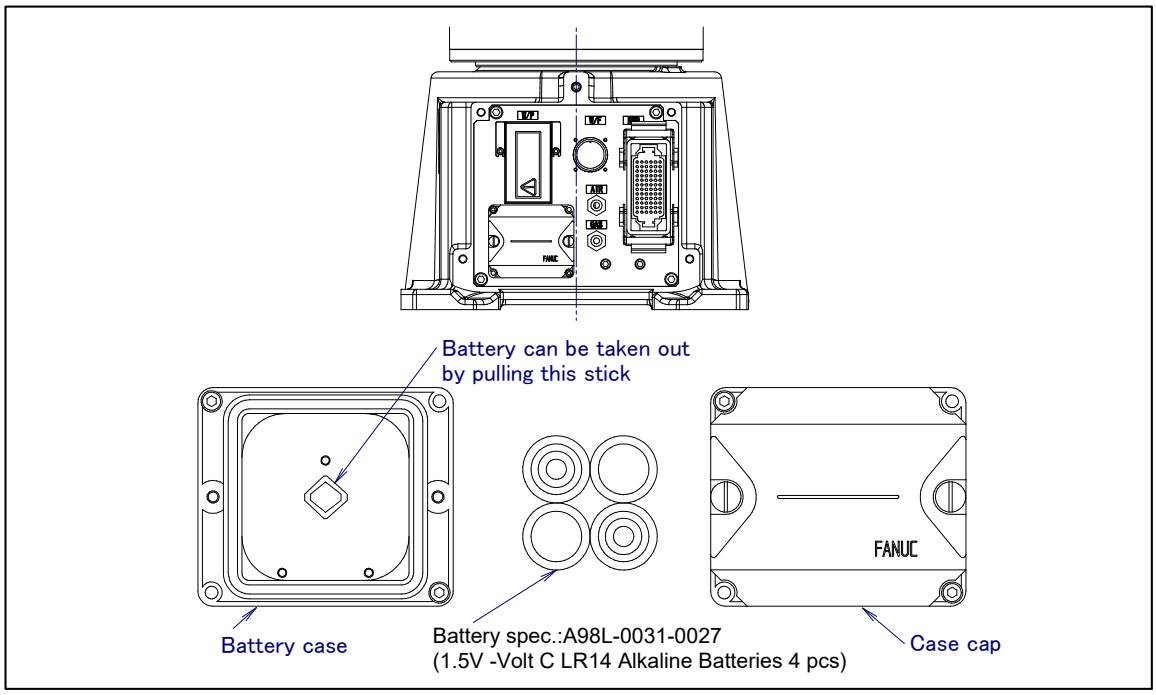


Fig. 8.3.1 (a) Replacing the battery

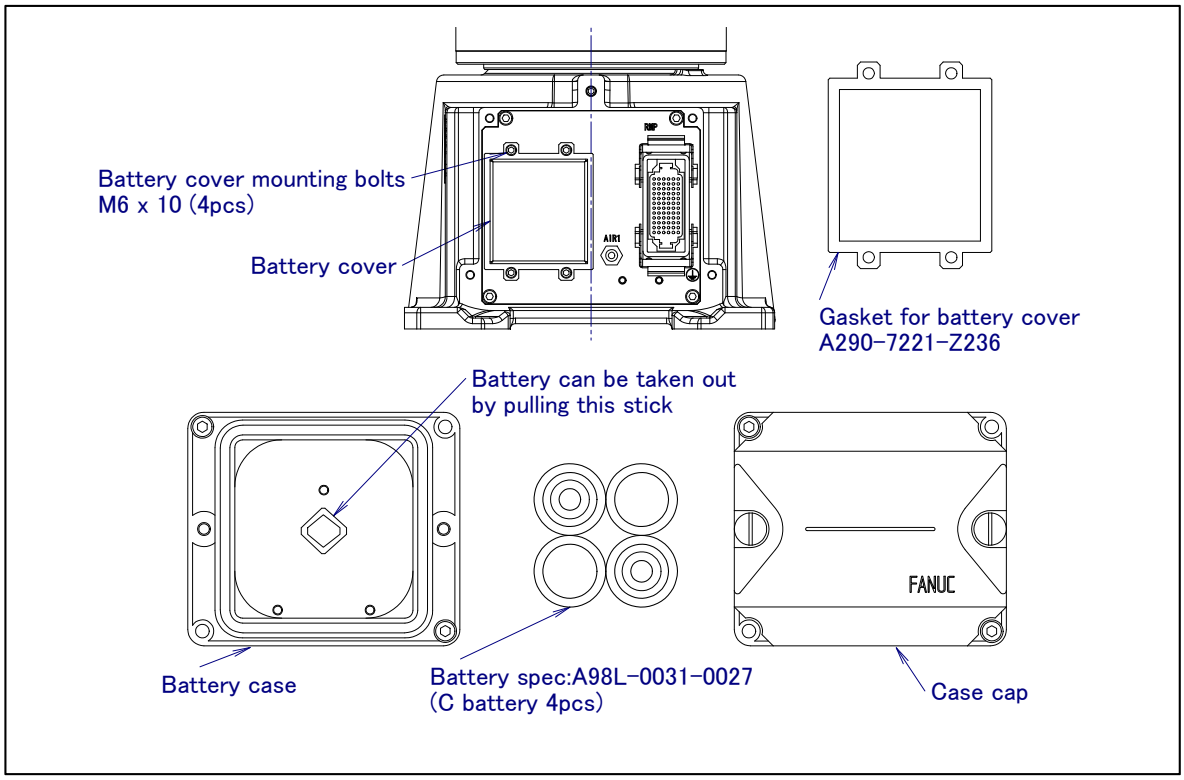


Fig. 8.3.1 (b) Replacing the battery (When severe dust/liquid protection option is specified)

8.3.2 Greasing

Following is the greasing procedure for J6-axis reducer.
When greasing the robot, keep its power turned off.

i) Replenish the J6-axis reducer with grease about every 12 months or after 3840 hours of operation.
ii) See Fig.8.3.2 (a) and Table 8.3.2 (a) for greasing points and the method.
iii) After applying grease, release the remaining pressure within the grease bath as described in the procedure in Subsection 8.3.3.4.

Table 8.3.2 (a) Greasing points

Greasing point	Specified grease	Amount of grease	Gun tip pressure	Greasing method
J6-axis reducer	Specification : A98L-0040-0230	44ml (39g)	0.1 MPa or less (NOTE)	Remove the Extra low bolts and sealing washers of the J6-axis grease inlet and outlet, and attach the supplied grease nipple of the J6-axis to the grease inlet of the J6-axis. After greasing, remove the grease nipple, and attach the extra low bolts and sealing washers to the grease inlet and outlet.

NOTE
When using a hand pump, apply grease approximately once per two seconds.

⚠ CAUTION
If you grease incorrectly, the pressure in the grease bath may increase steeply, leading to a broken seal, which will eventually cause grease leakage or malfunction. When greasing, be sure to follow the cautions stated in Subsection 8.3.3.2.

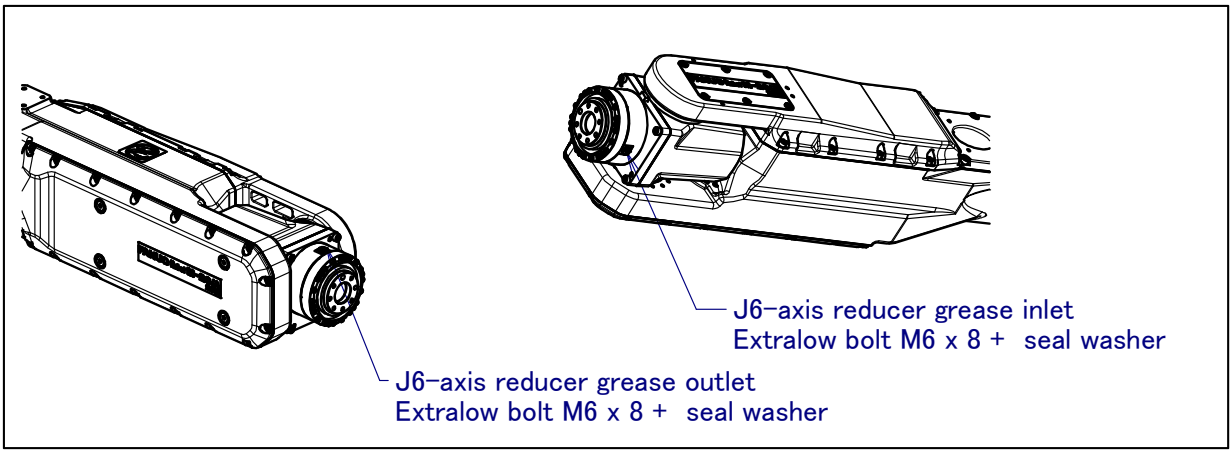


Fig. 8.3.2 (a) J6-axis grease supply position

Table 8.3.2 (b) Specification of the taper plug

Parts name	Specification
Seal washer (M6)	A30L-0001-0048#6M

8.3.3 Replacing the Grease of the Drive Mechanism (3-year (11520 hours) checks)

According to the procedures below, replace the grease of the reducers of J1, J2, and J3 axes and J4/J5-axis gearbox every 3 years or 11520 hours, whichever comes first.

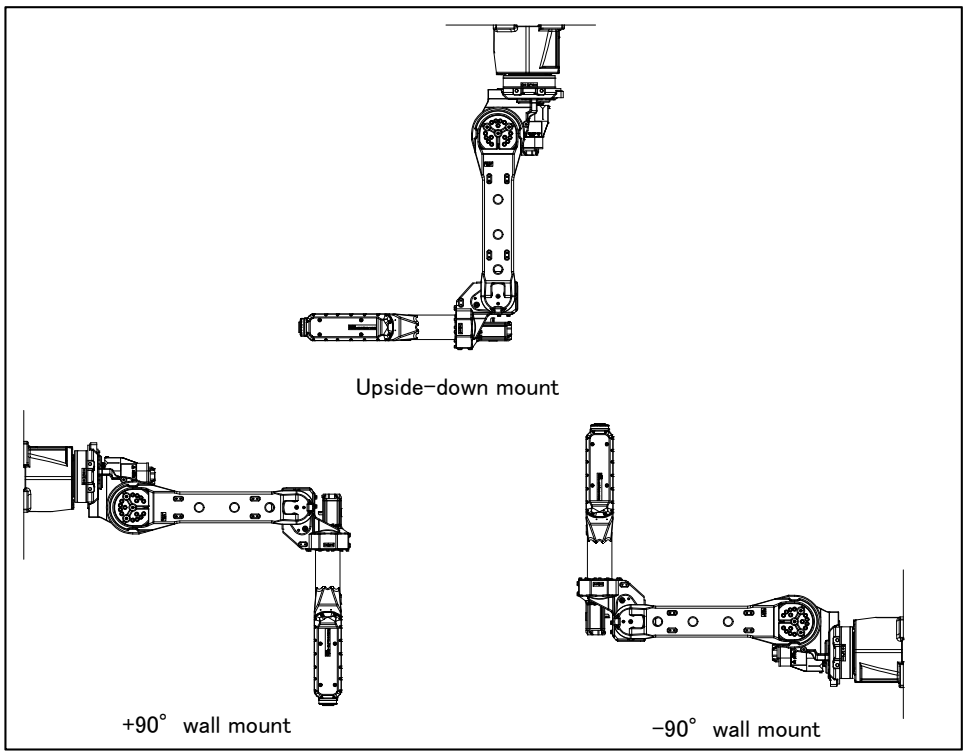


Fig. 8.3.3 (a) Installation method

8.3.3.1 Grease replacement procedure for J1 to J3-axis reducer

⚠ CAUTION

Failure to follow proper greasing procedures may cause a sudden increase of the grease bath internal pressure and damage to the seal. This 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 of the grease outlet to allow the grease to come out.
2 Supply grease slowly, using a manual pump. (once per two seconds)
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 8.3.3.1 (a)).
4 Use grease only of the specified type. Grease of a type other than that specified may damage the reducer or lead to other problems.
5 After greasing, release remaining pressure from the grease bath using the procedure given in Subsection 8.3.3.3, and then close the grease outlet.
6 To prevent an accident such as a fall or fire, remove all the excess grease from the floor and robot.

Table 8.3.3.1 (a) Grease name and amount (J1/J2/J3-axis reducer)

Grease supplying position	Amount of grease to be applied	Gun tip pressure	Specified grease
J1-axis reducer	1000g (1110ml)	0.1MPa or less (NOTE)	(Specification: A98L-0040-0174)
J2-axis reducer	850g(940ml)		
J3-axis reducer	340g(380ml)		

NOTE

When using a hand pump, apply grease approximately once per two 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 body a suit if necessary.

For grease replacement or replenishment, use the Postures indicated below. Consider relative angle of from posture of floor mount when robot is angle mount.

Table 8.3.3.1 (b) Postures for greasing (J1/J2/J3-axis reducer)

Grease supplying position		Posture					
		J1	J2	J3	J4	J5	J6
J1-axis reducer grease supplying posture	Floor mount	Arbitrary	Arbitrary	Arbitrary	Arbitrary	Arbitrary	Arbitrary
	Upside-down mount						
	Wall mount -90°						
	Wall mount +90°						
J2-axis reducer grease supplying posture	Floor mount)		0°	Arbitrary			
	Upside-down mount		0°				
	Wall mount -90°		90°				
	Wall mount +90°		-90°				
J3-axis reducer grease supplying posture	Floor mount		0°	0°			
	Upside-down mount		0°	180°			
	Wall mount -90°		90°	-90°			
	Wall mount +90°		-90°	90°			

1 Move the robot to the greasing posture described in Table 8.3.3.1 (b).
2 Turn off the controller power.
3 Remove the seal bolt or taper plug from grease outlet. (Fig.8.3.3.1 (a))
J1-axis : 1 location (seal bolt M8 x 10)
J2-axis : 3 locations (seal bolt M8 x 10)
J3-axis : 1 locations (J3-axis reducer first grease outlet ,seal bolt M8 x 10)
*Robot has 2 grease outlet. Remove only first grease outlet.
4 Remove the seal bolt or taper plug from grease inlet and attach grease nipple.
5 Keep greasing until the new grease pushes out the old grease and comes out from each grease outlet.
6 Release remaining pressure using the procedure given in Subsection 8.3.3.3. In case of upside-down mount, pull out about 130ml grease of the J1-axis to make space of grease bath.

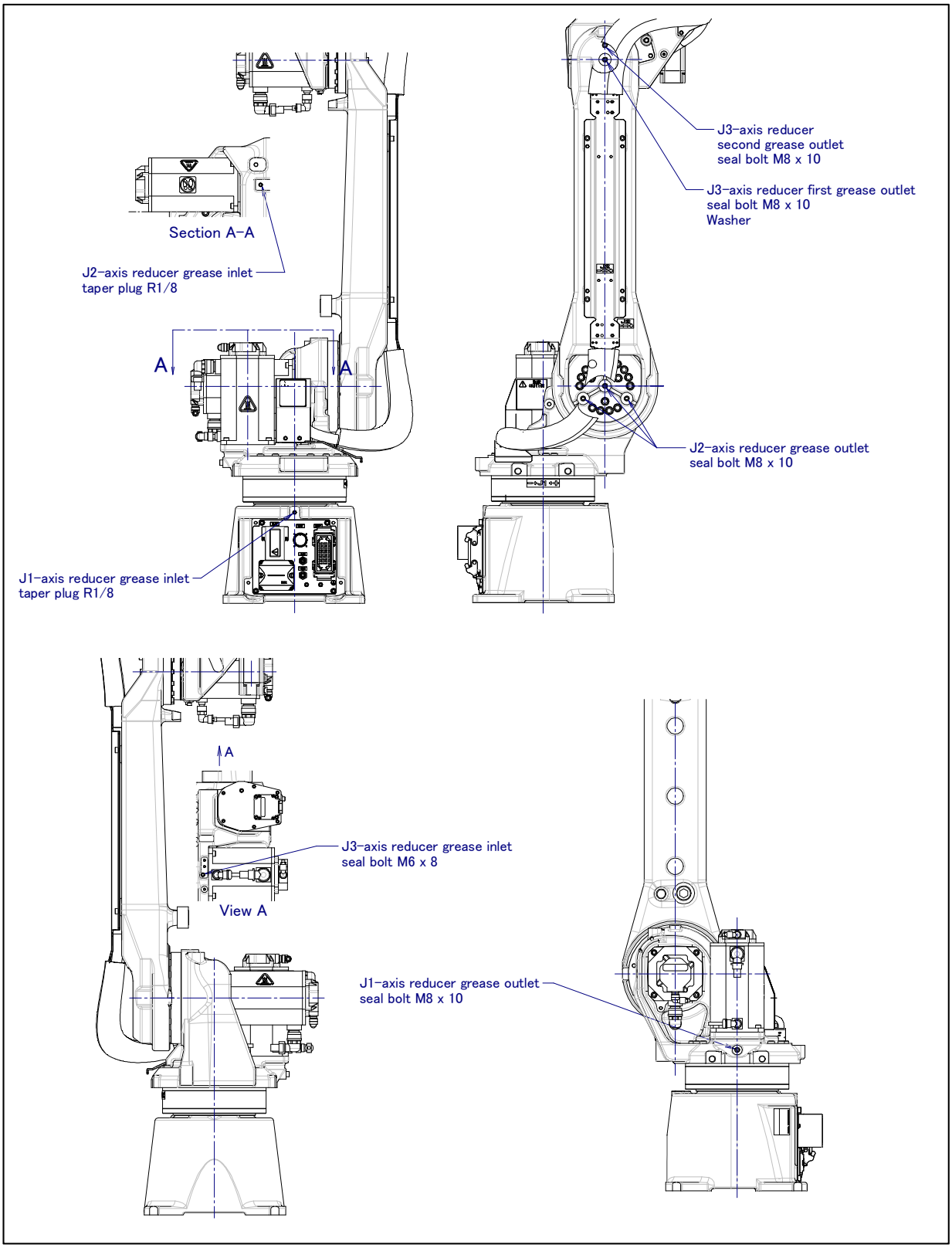


Fig. 8.3.3.1 (a) Greasing point of J1 to J3-axis reducer

Table 8.3.3.1 (c) Specification of the seal bolts and the taper plug

Parts name	Specification
Seal bolt (M6 x 8)	A97L-0218-0417#060808
Seal bolt (M8 x 10)	A97L-0218-0417#081010
taper plug (R1/8)	A97L-0001-0436#1-1D

8.3.3.2 Grease replacement procedure for J4/J5-axis gearbox

⚠ CAUTION

Failure to follow proper greasing procedures may cause a sudden increase of the grease bath internal pressure and damage to the seal. This 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 grease out.
2 Supply grease slowly, using a manual pump. (once per two seconds)
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 8.3.3.2 (a)).
4 Use grease only of the specified type. Grease of a type other than that specified may damage the reducer or lead to other problems.
5 After greasing, release remaining pressure from the grease bath using the procedure given in Subsection 8.3.3.4, and then close the grease outlet.
6 To prevent an accident such as a fall or fire, remove all the excess grease from the floor and robot.

Table 8.3.3.2 (a) Grease name and amount (J4/J5-axis gearbox)

Greasing points	Amount of grease to be applied	Gun tip pressure	Specified grease
J4-axis gearbox	1100g (1220ml)	0.1MPa or less (NOTE)	(Specification: A98L-0040-0174)
J5-axis gearbox	1000g(1110ml)		

NOTE

When using a hand pump, apply grease approximately once per two seconds.

For grease replacement or replenishment, use the Postures indicated below. Consider relative angle of from posture of floor mount when robot is angle mount.

Table 8.3.3.2 (b) Grease supplying posture (J4/J5-axis gearbox)

Greasing points		Posture					
		J1	J2	J3	J4	J5	J6
J4-axis gearbox Greasing posture	Floor mount	Arbitrary	Arbitrary	0°	Arbitrary	Arbitrary	Arbitrary
	Upside-down mount			0°			
	-90° wall mount			90°			
	+90° wall mount			90°			
J5-axis gearbox Greasing posture	Floor mount	Arbitrary	Arbitrary	-90°			
	Upside-down mount			90°			
	-90° wall mount	0°	0°	180°			
	+90° wall mount			0°			

1 Move the robot to the greasing posture described in Table 8.3.3.2 (b).
2 Turn off the controller power.
3 Remove the seal bolt. (Fig.8.3.3.2(a))
J4-axis : 1 location (seal bolt M6 x 8)
J5-axis : 1 location (bolt M8 x 12 + seal washer)
4 Remove the seal bolt or taper plug from grease inlet and attach grease nipple.
5 Keep greasing until the new grease pushes out the old grease and comes out from each grease outlet.
6 Release remaining pressure using the procedure given in Subsection 8.3.3.4.

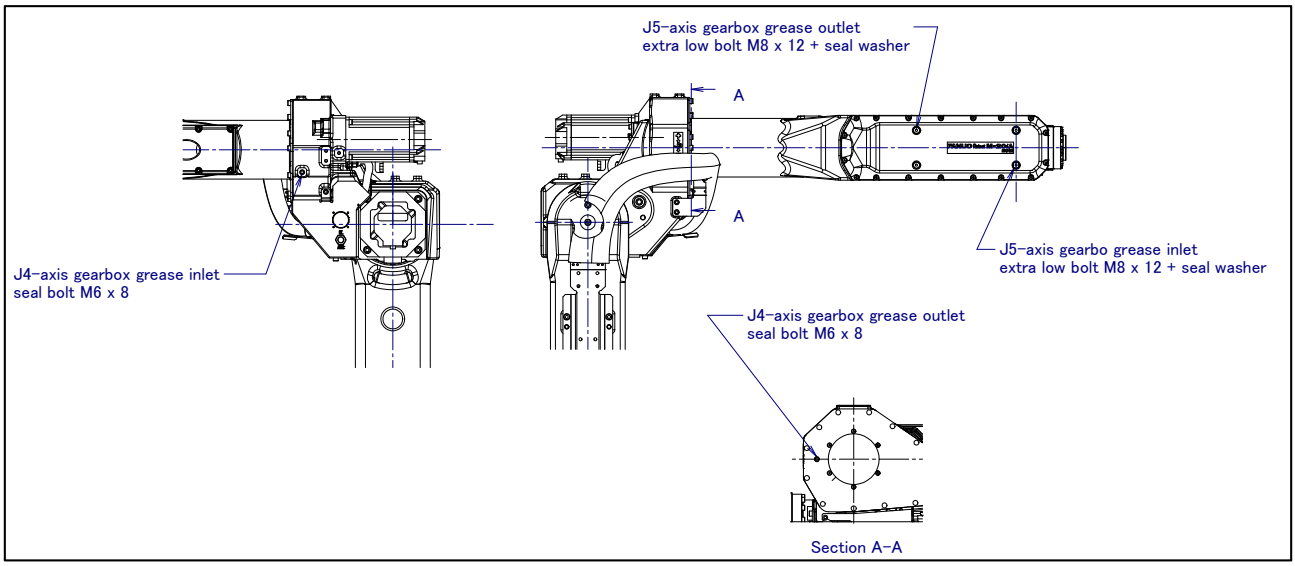


Fig. 8.3.3.2 (a) Greasing point of J4/J5-axis gearbox (M-20*i*A/20M/35M)

Table 8.3.3.2 (c) Spec. of the seal bolt and the seal washer

Parts name	Specification
Seal bolt (M6 x 8)	A97L-0218-0417#060808
Seal washer (M8)	A30L-0001-0048#8M

8.3.3.3 Procedure for releasing remaining pressure from the grease bath (J1 to J3-axis)

After applying grease, operate the robot as instructed below with the plug and seal bolt of the grease inlet and outlet uncapped to release the remaining pressure within the grease bath. In case of J2-axis, there are three seal bolts for grease outlet. In case of J3-axis, robot has two grease outlet. So uncap all of them. Attach a recovery bag below the grease inlet and outlet to prevent output grease from splattering.

<table>
<tr><th>Operating axis / Grease replacement part</th><th>J1-axis</th><th>J2-axis</th><th>J3-axis</th><th>J4-axis</th><th>J5-axis</th><th>J6-axis</th></tr>
<tr><td>J1-axis reducer</td><td>Axis angle of 60° or more OVR 100%</td><td colspan="5">Arbitrary</td></tr>
<tr><td>J2-axis reducer</td><td>Arbitrary</td><td>Axis angle of 60° or more OVR 100%</td><td colspan="4">Arbitrary</td></tr>
<tr><td>J3-axis reducer</td><td colspan="2">Arbitrary</td><td>Axis angle of 60° or more OVR 100%</td><td colspan="3">Arbitrary</td></tr>
</table>

If the above operation cannot be performed due to the environment of the robot, adjust the operating time according to the operating angle. (When the maximum allowable axis angle is 30°, perform the twice operation for 20 minutes or more.) After completion of the operation, attach the plug and seal bolts to the grease inlets and outlets. When reusing the seal bolts or grease nipples, be sure to seal them with seal tape. If you grease multiple axes, you can exercise multiple axes at the same time.

After replacing grease, internal pressure of grease bath may rise if robot is operated again under frequent inversion movement or high temperature environment. In these cases, you can return internal pressure by releasing grease out let just after operation of robot. (When opening grease outlet, pay attention grease is not scattered.)

After replacing grease, the internal pressure of the grease bath may rise if the robot is operated again under frequent inversion movement or a high temperature environment. In these cases, you can return to normal internal pressure by releasing the grease outlet just after robot operation. (When opening grease outlet, be sure that grease or oil is not spattered.)

8.3.3.4 Procedure for releasing remaining pressure from the grease bath (J4 to J6-axis)

To release remaining pressure, perform the procedure below.
(For the J4-axis)
Operate the robot as described in the table below for at least 10 minutes, with the seal bolts removed from the grease inlet and outlet.

(For the J5-axis gearbox)
- After greasing, remove the grease nipple from the grease inlet.
- Move the robot to J3=-90°, perform ±90° repeating operation during 5 minutes for only J5-axis. Make wait time between 2 points 0, perform the running with position pass is fine.
- After 5 minutes, confirm about 50ml grease is pulled out. (just as volume of 2 golf balls.)
- Attach the bolts and seal washers of grease inlet and outlet.

(For the J6-axis)
Operate the robot as described in the table below for at least 10 minutes, with the extra low bolts and seal washers removed from the grease inlet and outlet.

Attach a recovery bag below the grease inlet and outlet to prevent output grease from splattering.

<table>
<tr><th>Operating axis / Grease replacement part</th><th>J1-axis</th><th>J2-axis</th><th>J3-axis</th><th>J4-axis</th><th>J5-axis</th><th>J6-axis</th></tr>
<tr><td>J4-axis gearbox</td><td colspan="3">Arbitrary</td><td>Axis angle of 60° or more OVR 100%</td><td colspan="2">Arbitrary</td></tr>
<tr><td>J5-axis gearbox</td><td colspan="4">Arbitrary</td><td>Axis angle of 180° or more OVR 100%</td><td>Arbitrary</td></tr>
<tr><td>J6-axis reducer</td><td colspan="5">Arbitrary</td><td>Axis angle of 60° or more OVR 100%</td></tr>
</table>

If the above operation cannot be performed due to the environment of the robot, adjust the operating time according to the operating angle. (When the maximum allowable axis angle is 30 degrees, perform the twice operation for 20 minutes or more.) If you grease multiple axes, you can exercise multiple axes at the same time. (except J5-axis) After completion of the operation, attach the taper plug, seal bolts or bolts and seal washers to the grease inlets and outlets. When reusing the seal bolts or the taper plug, be sure to seal them with seal tape.

After replacing grease, the internal pressure of the grease bath may rise if the robot is operated again under frequent inversion movement or a high temperature environment. In these cases, you can return to normal internal pressure by releasing the grease outlet just after robot operation. (When opening grease outlet, be sure that grease or oil is not spattered.)

8.4 STORAGE

When storing the robot, place it on a level surface with the same posture that was used for transportation. (See Section 1.1.)

9 MASTERING

Mastering associates 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.

> ⚠ **CAUTION**
> In case of R-30*i*B/R-30*i*B Plus controller, when arc tool (3kg payload specification) is specified for ARC Mate *i*C series, mastering is performed with gravity compensation function enabled in our factory before shipment. Please refer to Chapter 11 of controller optional function operator's manual (B-83284EN-2) for details of the gravity compensation function.

9.1 OVERVIEW

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

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

> ⚠ **CAUTION**
> Robot data (including mastering data) and Pulsecoder data are backed up by their respective backup batteries. Data will be lost if the batteries die. Replace the batteries in the controller and mechanical units periodically. An alarm will alert you when battery voltage is low.

Types of Mastering

Table 9.1 (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 9.1 (a) Type of mastering

Fixture position mastering	Mastering performed before shipping using the mastering fixture. .
Zero-position mastering (witness mark mastering)	Mastering 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	Mastering 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	Mastering 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	Mastering performed for one axis at a time. The mastering position for each axis can be specified by the user. This is useful when performing mastering on a specific axis.
Mastering data entry	Enter the Mastering data directly.

Once performing the mastering, the positioning (calibration) is indispensable. The Positioning is an operation which recognizes the robot current position loading the pulse count value.

This section describes zero-position mastering, quick mastering, quick mastering for single axis, single-axis mastering, and mastering data entry. For more detailed 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 It is recommended that the current mastering data be backed up before mastering is performed.
3 When the motion range is mechanically 360 degrees or more, turning any of the axes (J1-axis and J4-axis) to which the cables are connected one turn in the correct mastering position will damage the cables in the mechanical unit. If the correct rotation position is not clear because the axis is moved too much during mastering, remove the connector panel or cover, check the states of the internal cables, and perform mastering in the correct position. For the checking procedure, see Fig. 9.1 (a) to (c).

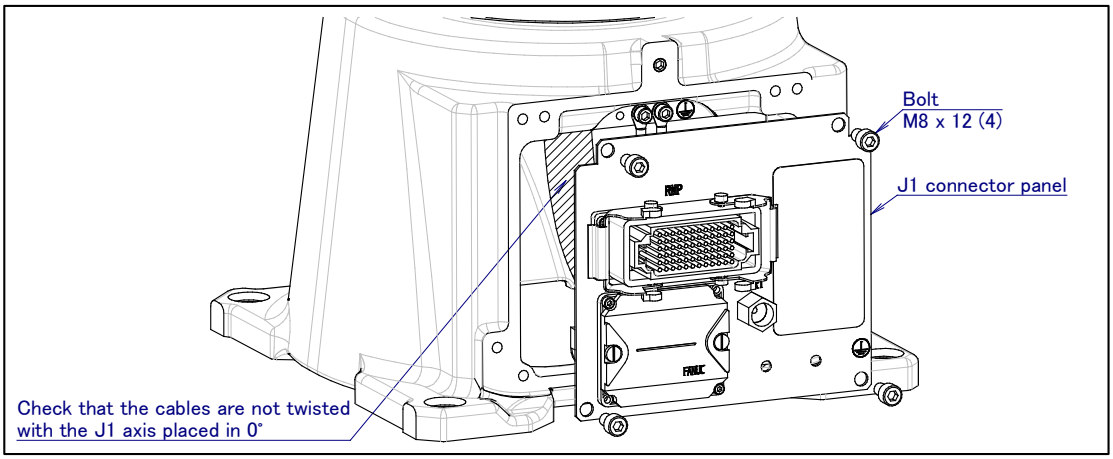


Fig. 9.1 (a) Check the cables statement (J1-axis)

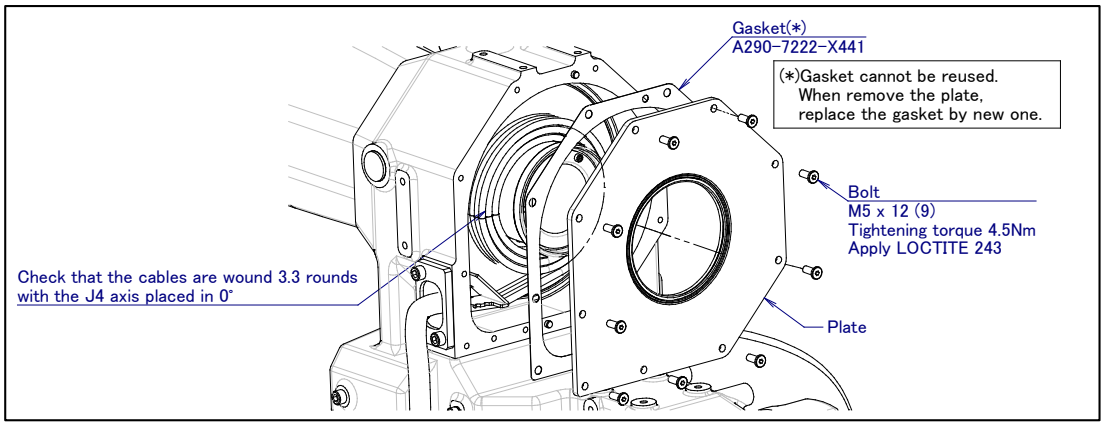


Fig. 9.1 (b) Check the cables statement (J4-axis)
(ARC Mate 120*i*C, ARC Mate 120*i*C/10L/12L, M-20*i*A, M-20*i*A/10L/12L)

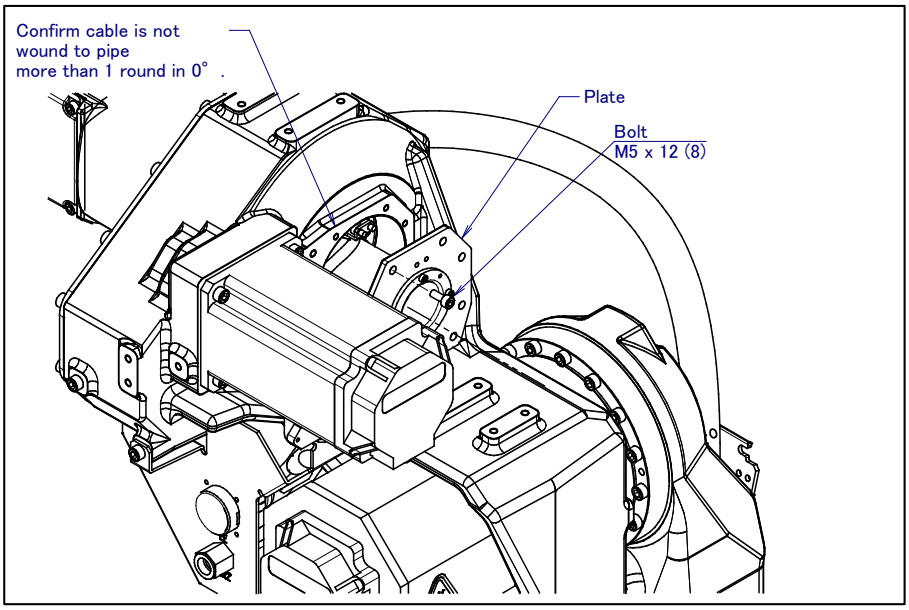


Fig. 9.1 (c) Check the cables statement (J4-axis)
(M-20*i*A/20M/35M)

9.2 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.

9.3 ZERO POSITION MASTERING

Zero position mastering (witness mark mastering) is performed with all axes set at the 0-degree position. A zero-position mark (witness mark) is attached to each robot axis. 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.
2 Select NEXT and press 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
```

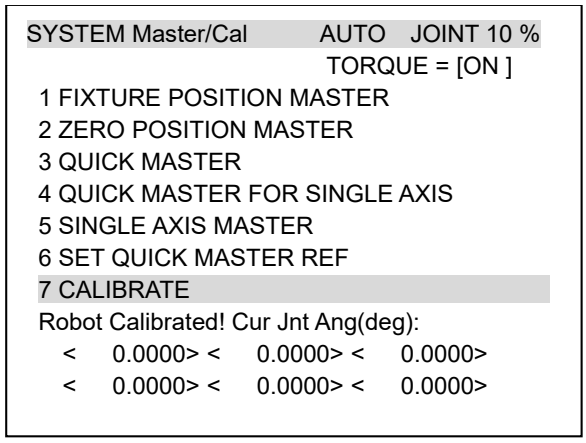
5 Release brake control, and jog the robot into a posture for mastering.

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.

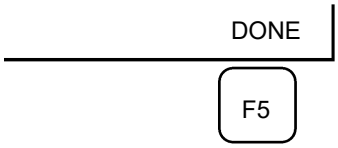
6 Select [2 Zero Position Master]. Press F4[YES].

```
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.



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



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

Table 9.3 (a) Posture with position marks aligned

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

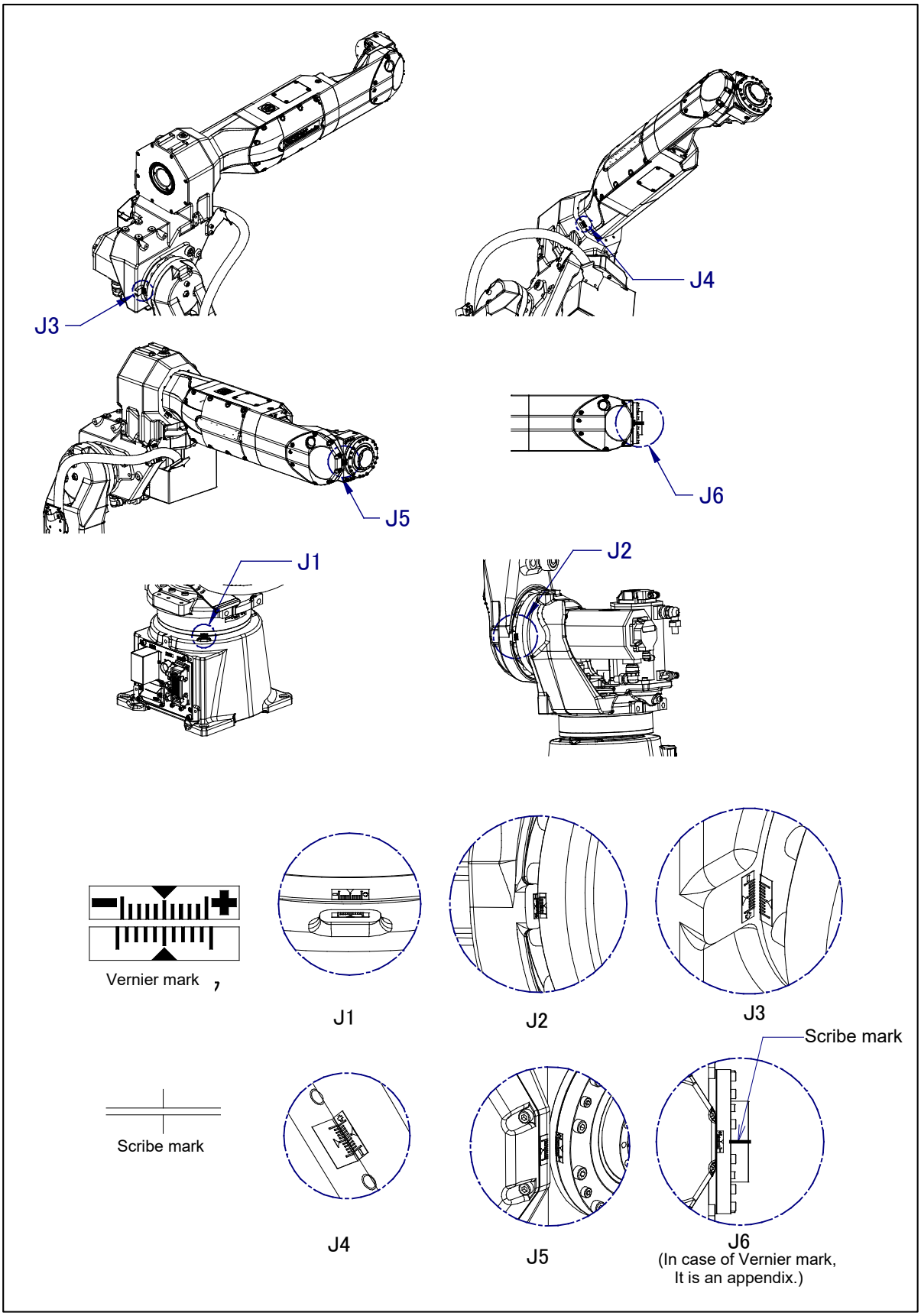


Fig. 9.3 (a) Marking position of each axis
(ARC Mate 120*i*C, M-20*i*A, ARC Mate 120*i*C/10L/12L, M-20*i*A/10L/12L)

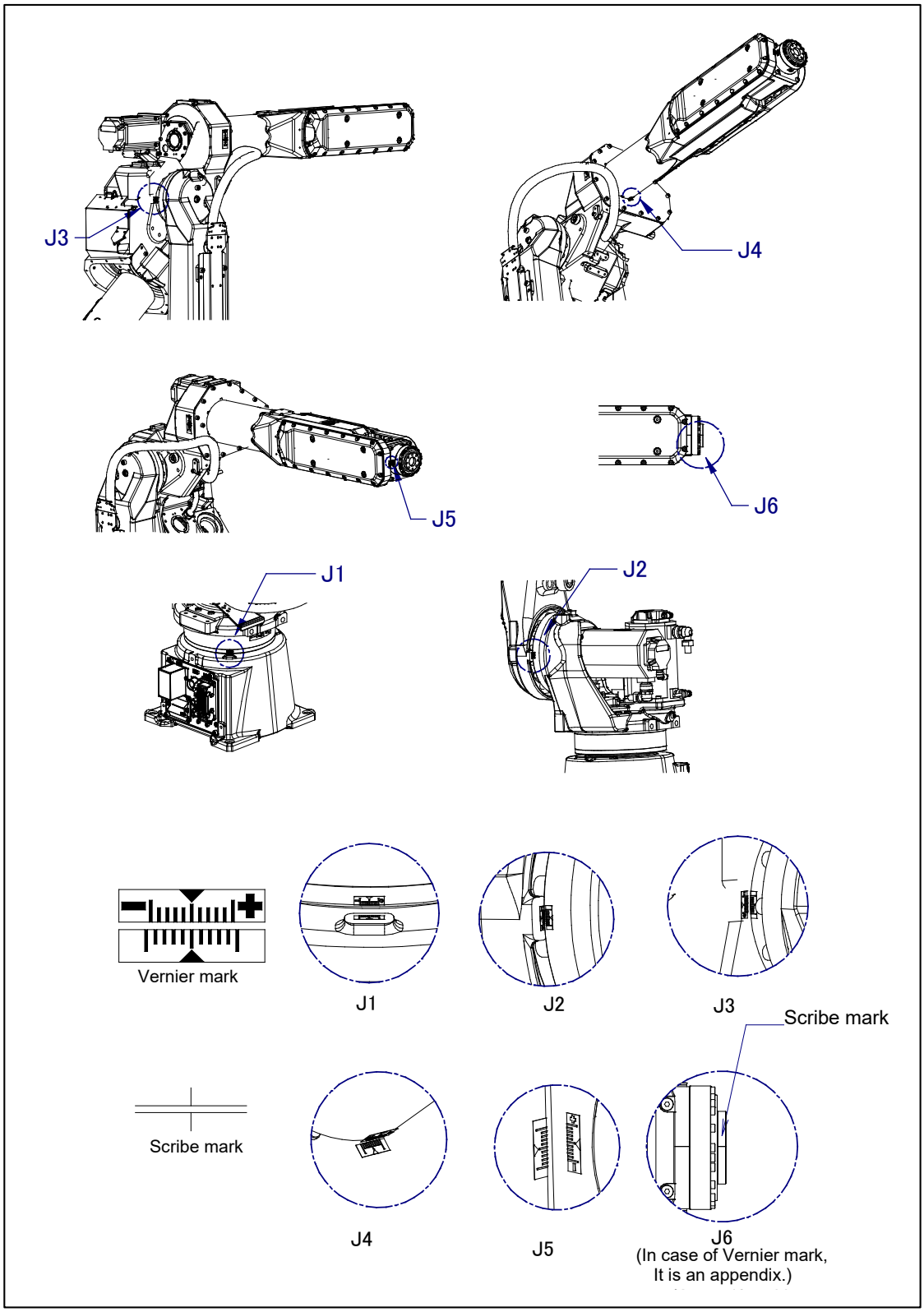


Fig. 9.3 (b) Marking position of each axis (M-20*i*A/20M/35M)

9.4 QUICK MASTERING

Quick mastering is performed at a user-specified position for one axis. The pulse count is calculated from "number of revolutions" and "Pulsecoder value within one revolution" of the motor. Quick mastering uses the fact that "Pulsecoder value within one revolution" is kept even if "number of revolutions" is lost due to an empty of the battery.

Quick mastering is factory-performed at the position indicated in Table 9.3(a). If possible, do not change the setting.

If it is impossible to set the robot at the position mentioned above, it is necessary to re-set the quick mastering reference position using the following method. (It would be convenient to set up a marker that can work in place of the witness mark.)

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

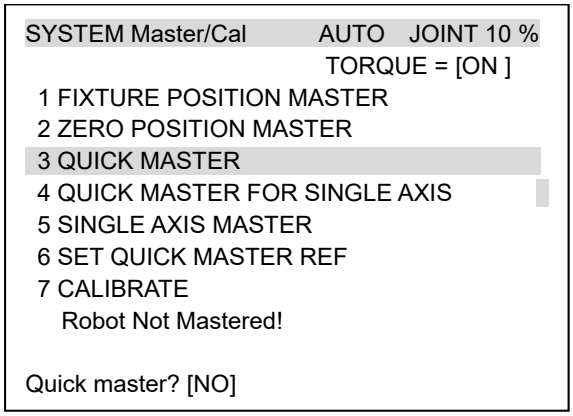
```
 5 SINGLE AXIS MASTER
 6 SET QUICK MASTER REF
 7 CALIBRATE
```

F4

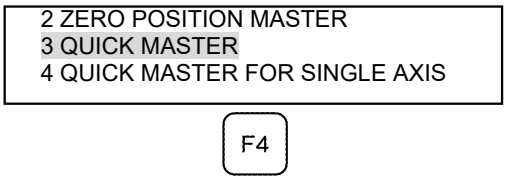
⚠ CAUTION
If the robot has lost mastering data due to mechanical disassembly or repair, you cannot perform this procedure. In this case, perform Fixture position mastering or zero –position mastering is required to restore mastering data.

Procedure Quick Mastering

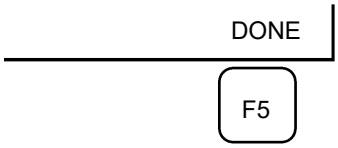
1 Display the Master/Cal screen.



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 Move the cursor to [7 CALIBRATE] and press [ENTER] key.
Calibration is executed. Calibration is executed by power on again.
5 After completing the calibration, press F5 Done.



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

9.5 QUICK MASTERING FOR SINGLE AXIS

Quick mastering is performed at a user-specified position for one axis. The pulse count is calculated from "number of revolutions" and "Pulsecoder value within one revolution" of the motor. Quick mastering uses the fact that "Pulsecoder value within one revolution" is kept even if "number of revolutions" is lost due to an empty of the battery.

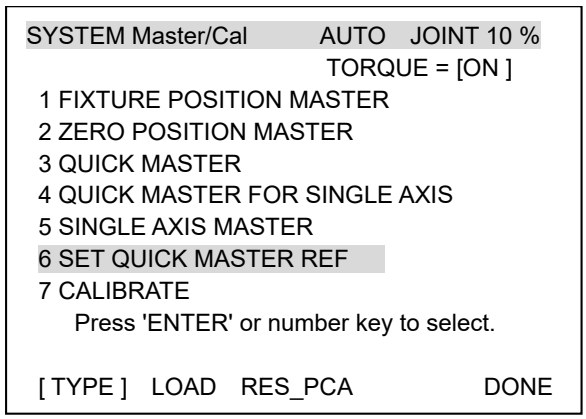
Quick mastering is factory-performed at the position indicated in Table 9.3(a) If possible, do not change the setting.

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.)

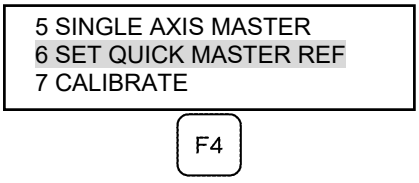
⚠ CAUTION
1 Quick mastering can be used, if the pulse count value is lost, for example, because a low voltage has been detected on the backup battery for the pulse counter.
2 Quick mastering cannot be used, after the motor is replaced or after the mastering data is lost from the robot controller.

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 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
   Robot Not Mastered!

Quick master? [NO]
```

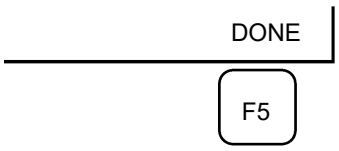
2 Select [4 QUICK MASTER FOR SINGLE AXIS]. You will see the quick master for single axis screen.

```
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
```

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.

```
SINGLE AXIS MASTER              AUTO    JOINT 10%
                                                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 or 1.
6 Move the cursor to CALIBRATE and press [ENTER] key. Calibration is executed. Calibration is executed by power on again.
7 After completing the calibration, press F5 Done.



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

9.6 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.

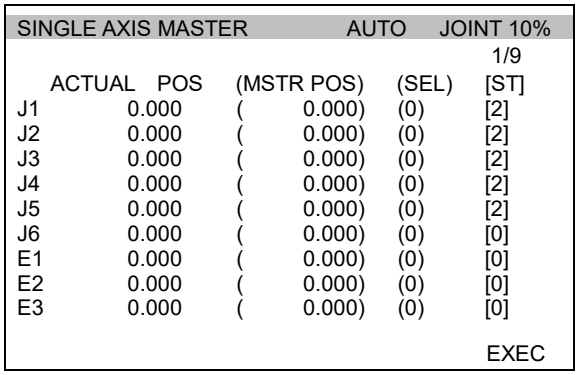
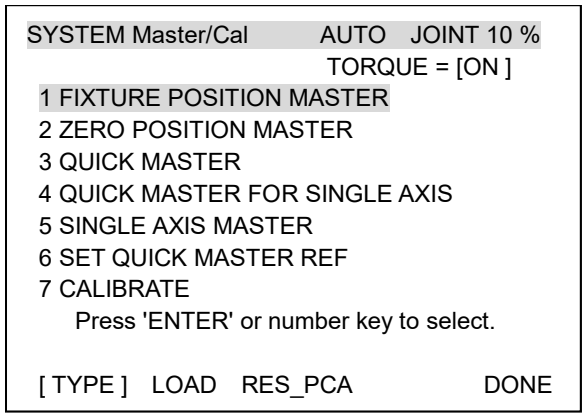


Table 9.6 (a) Items set in single axis mastering

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 the 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 Mastering a Single Axis

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



3 Select [5 SINGLE AXIS MASTER]. You will see a screen similar to the following.

```
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
```

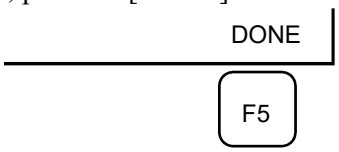
4 For the axis to which to perform single axis mastering, set (SEL) to "1." Setting of [SEL] is available for one or more axes.
5 Turn off brake control, then jog the robot to the mastering position
6 Enter axis data for the mastering position.
7 Press F5 [EXEC]. Mastering is performed. Therefore, SEL 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] page key to resume the previous 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
```

9 Select [7 CALIBRATE], then press F4 [YES]. Positioning is performed. Alternatively, switch the power off and on again. Positioning is performed.
10 After positioning is completed, press F5 [DONE].



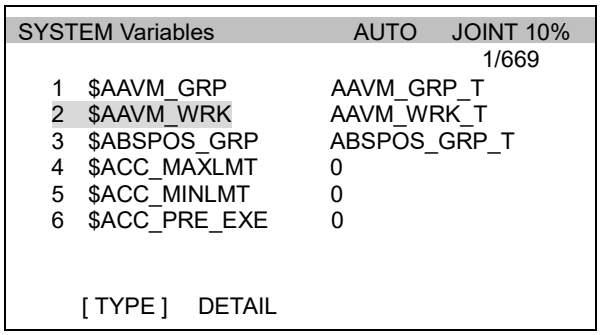
11 Return brake control to original setting, and cycle power of the controller.

9.7 MASTERING DATA ENTRY

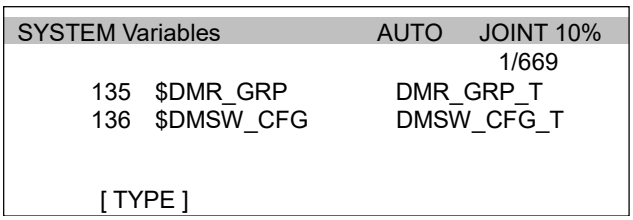
This function enables mastering data values to be assigned directly to a system variable. It can be used if mastering data has been lost but the pulse count is preserved.

Mastering data entry method

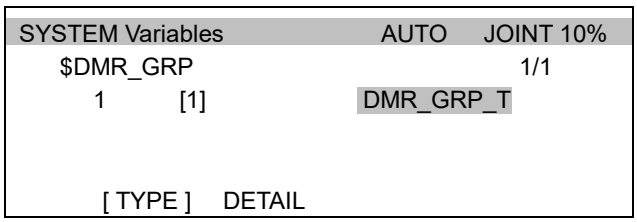
1 Press the [MENU] key, then press [0 NEXT] and select [6 SYSTEM].
2 Press F1 [TYPE]. Select [Variables]. The system variable screen appears.

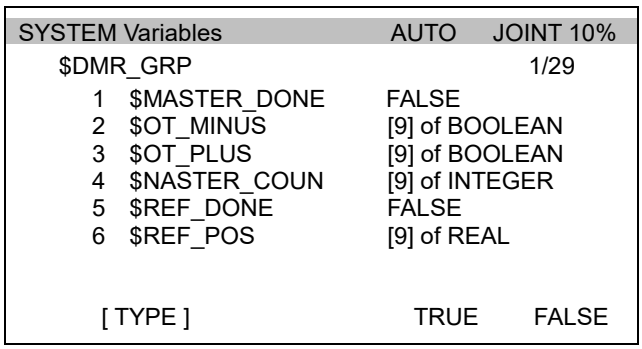


3 Change the mastering data. The mastering data is saved to the $DMR_GRP.$MASTER_COUN system variable.

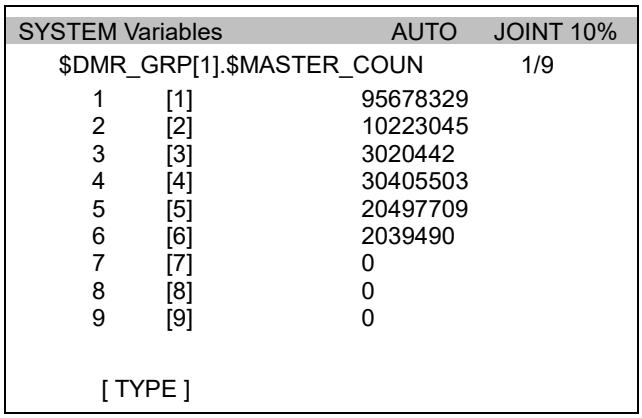


4 Select $DMR_GRP.

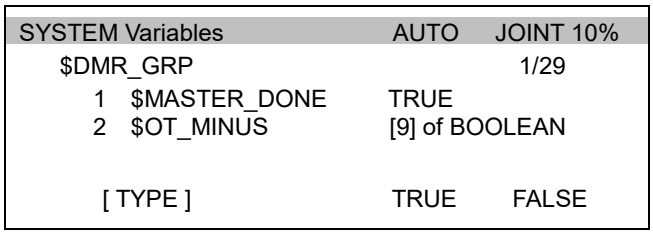




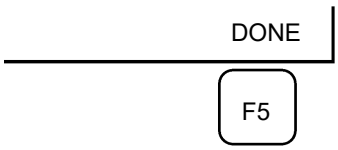
5 Select $MASTER_COUN, and enter the mastering data you have recorded.



6 Press [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].



9.8 VERIFYING MASTERING

1 How to verify that the robot is mastered properly:
Usually, positioning is performed automatically when the power is turned on. To check whether mastering has been performed correctly, examine if the current displayed position matches the actual robot position by using 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 Section 9.3 of OPERATOR'S MANUAL are aligned. There is no need to use a visual aid.

If the displayed and actual positions do not match, the counter value for a Pulsecoder may have been invalidated as a result of an alarm Section 2. Alternatively, the mastering data in system variable $DMR_GRP.$MASTER_COUN may have been overwritten as a result of an operation error or for 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 type 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 Section 9.2.). Then, cycle power of the controller to 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.
(3) Alarm notifications like CKAL, RCAL, PHAL, CSAL, DTERR, CRCERR, STBERR, and SPHAL may indicate trouble with Pulsecoder, contact your local FANUC representative.

10 TROUBLESHOOTING

The source of mechanical unit problems may be difficult to be identified 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.

10.1 TROUBLESHOOTING

Table 10.1 (a) shows the major troubleshooting symptoms 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. For troubleshooting except the mechanical unit, refer to "CONTROLLER MAINTENANCE MANUAL (B-83195EN etc.)" and Alarm Code List (B-83284EN-1).

Table 10.1 (a) Problems and causes and measure

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. - A J1 base retaining bolt is loose.	[J1 base fastening] - It is likely that the robot J1 base is not securely fastened to the floor plate. - Probable causes are a loose bolt, an insufficient degree of surface flatness, or foreign material caught between the J1 base plate and floor plate. - If the robot is not securely fastened to the floor plate, the J1 base lifts the floor plate as the robot operates, allowing the base and floor plates to strike each other. That, in turn, leads to vibration.	- If a bolt is loose, apply LOCITE and tighten it to the appropriate torque. - Adjust the floor plate surface flatness to within the specified tolerance. - If there is any foreign matter between the J1 base and floor plate, eliminate them.
	- 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 reinforcing the rack or floor is impossible, modify the robot control program; doing so might reduce the vibration.
	- Vibration becomes more serious when the robot is in 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 heavier 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 or not. If the robot is overloaded, reduce the load, or modify the robot control program. - Vibration can be reduced by re-modifying the robot control program; reducing speed or acceleration with minimizing the influence on the entire cycle time.

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- Vibration was first noticed after the robot collided with an object or the robot was overloaded for a long period. - The grease of the vibrating axis has not been exchanged for a long period. - There is vibration or unusual sound just after replacing grease or oil or parts. - Cyclical vibration and noise occur.	[Broken gear, bearing, or reducer] - It is likely that collision or overload applied an excessive force on the drive mechanism, thus damaging the tooth surface or rolling contact surface of a bearing, or reducer. - Prolonged overloaded use may cause fretting fatigue on gear tooth surface or rolling surface of bearing and reducer. - It is likely that foreign material caught in a gear, bearing, or within a reducer has caused damage on the gear tooth surface or rolling surface of the bearing, or reducer. - It is likely that foreign material caught in a gear, bearing, or within a reducer is causing vibration. - It is likely that, because the grease has not been changed for a long period, fretting occurred on the tooth surface or rolling contact surface of a bearing, or reducer due to metal fatigue. - There is a possibility of Grease or oil has not been exchanged accurately. The amount of grease or oil may be insufficient.	- Operate each axis at individually to judge which axis has been vibrating. - Confirm the oil side of the oil sight glass of J4 to J6-axis. Replenish oil when the oil side has not reached above the half. - Remove the motor, and replace the gear, the bearing, and the reducer. For the specification of parts and the procedure of replacement, contact your local FANUC representative. - Using the robot within its maximum rating prevents problems with the drive mechanism. - Specific type and period of grease change will prevent troubles. - If vibration cannot be removed by replacing grease or oil, Perform continuous operation before replacing grease or oil, then it may be improved.
	- There is some relationship between the vibration of the robot and the operation of a machine near the robot.	[Noise from Peripheral] - If the robot is not grounded properly, electrical noise can be 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 will lead to vibrate.	- Connect the grounding wire firmly to ensure a reliable ground potential thereby preventing extraneous electrical noise.

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- 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 abnormal noise even when using the specified grease, operate for one or two days as an experiment. Generally, any abnormal noise will disappear.
	- 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 connection cable between the mechanical unit and the controller 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. - Also, replace the motor of the axis that is vibrating, and check whether vibration still occurs. For the method of replacement, Contact your local FANUC representative. - If vibration occurs only when the robot assumes a specific posture, it is likely that 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 abnormal condition occurs, replace the mechanical unit cable. - Check whether the cable jacket connecting the mechanical unit and controller 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
Rattling	- While the robot is not supplied with power, pushing it with the hand causes tottering part of the mechanical unit. - There is a gap on the mounting face of the mechanical unit.	[Mechanical unit coupling bolt] - It is likely that overloading or a collision has loosened a mounting bolt in the robot mechanical unit.	- Check the following mounting bolts tightness for each axis. If any of these bolts is loose, apply LOCTITE and bolt down with appropriate torque. - Motor - Reducer r - Reducer shaft - Base - Arm - Casting - End effector
Motor overheating	- The motor overheated due to a rise in temperature in the installation area. - After a cover was attached to the motor, the motor overheated. - 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 accelerate or decelerate normally, so the average current increases, leading to the motor overheating.	- As for load setting, Input an appropriate parameter referring to Section 4.3.
	- Symptom other than stated above	[Mechanical unit 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 motor brake failure locked on the break, and cause the motor overloaded. - It is likely that a failure of the motor prevented it from delivering its rated performance, thus causing an excessive current to flow into the motor.	- Repair the mechanical unit 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. - Judgment is possible if the average current decreased after replacing the motor, the former motor had been defected.

Symptom	Description	Cause	Measure
Grease leakage Oil leakage	- Grease or oil leaks 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. - The casting may crack with excessive force caused in a collision. - An O-ring can be damaged if it is trapped or cut during disassembling or re-assembling. - An oil seal may be damaged if extraneous dust scratches the lip of the oil seal. - A loose seal bolt may allow grease to leak along the threads.	- If the casting cracks, sealant can be used as a quick-fix to prevent further grease leakage. However, the component must be replaced as soon as possible, as the crack will widen. - O-rings are used in the locations listed below. - Motor coupling section - Reducer (case and shaft) coupling section - Wrist connecting part - J3 arm coupling section - Inside the wrist - Oil seals are used in the locations stated below. - Inside the reducer - Inside the wrist - Seal bolts are used in the locations stated below. - Grease or oil outlet - For fixation of the covers
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 unit problems] - If the repeatability is unstable, probable causes are a failure in the drive mechanism or a loose bolt, and so on. - If the repeatability is stable, it is likely that collision by an excessive load caused slip on the fasting surface of each axis arm, and reducer. - It is likely that the Pulsecoder is faulty.	- If the repeatability is unstable, repair the mechanical unit by referring to the above descriptions of vibration, noise, and rattling. - If the repeatability is stable, correct the taught program. The problem will not reoccur unless another collision occurs. - If the Pulsecoder is faulty, replace the motor.
	- Displacement occurs only in specific peripheral equipment.	[Peripheral equipment displacement] - It is likely that an external force was applied to the peripheral equipment, thus shifting its position relative to the robot.	- Correct the setting of the peripheral equipment position. - Correct the taught program.
	- Displacement occurred after a parameter was changed.	[Parameter] - It is likely that the mastering data was overwritten, and the origin had misaligned.	- Re-enter the previous optimal mastering data. - If optimal mastering data is unavailable, perform mastering again.
CLALM alarm occurred. Move error excess alarm occurred.	- Ambient temperature of the robot installation location is low, CLALM alarm is displayed on the teach pendant screen. - Temperature of the robot installation position is low, “Move error excess” alarm is displayed on the teach pendant screen.	[Peripheral temperature] - When the robot is used in a low temperature environment that is near to 0ºC, or the robot is not operated for a long time in an environment that is less than 0ºC, there will be a large viscous resistance of the drive train immediately after starting which will cause the alarm.	- Perform a warm up operation or a low speed operation for several minutes.

Symptom	Description	Cause	Measure
CLALM alarm occurred. Move error excess alarm occurred.	- After changing the motion program or the load condition, the CLALM alarm is displayed. - After changing the motion program or the load condition, the “Move error excess” alarm is displayed.	- It is likely that a robot collision occurred.	- If a robot collision has occurred, press the [RESET] key while pressing the [SHIFT] key. Then, jog the robot in the opposite direction while pressing the [SHIFT] key. - Check the motion program.
		[Overload] - It is likely that load exceeded the permissible value. - It is likely that the motion program is too severe for the robot. ・ Excessive motion due to a large acceleration. ・ Tight motion such as reverse motion using “CNT”. ・ Linear motion occurs near singularity point where axes revolve in high speed.	- Check the permissible value of the robot payload. If the load exceeds the permissible value, reduce the load or change the motion program. - Consider minimizing the cycle time by reducing the speed or acceleration, and changing the motion program. - Check that the load setting is performed correctly.
	- None of the symptoms stated above are the problem.	- It is likely the vibration occurred.	- Refer to the Symptoms: Vibration, Noise section of this troubleshooting for more information.
		- If the power source voltage drops below the rating, a vibration might occur.	- Check that the robot is supplied with the proper rated voltage.
BZAL alarm displayed	- BZAL is displayed on the teach pendant screen	- It is likely that the voltage of the memory backup battery is low. - It is likely that the Pulsecoder cable is defective.	- Replace the battery. - Replace the cable.

Table 10.1 (b) Allowable drops

At power off	5mm
At emergency stop	5mm

NOTE
Each value indicates the amount by which an end effector mounting face may fall.

10.2 CHANGE THE COLLISION DETECTION PARAMETER

The collision detection parameter is coordinated beforehand for every robot. You can usually use it in the state at the time of shipment if load setting is right. We recommend the use in the state of the standard setting as much as possible. When it is necessary to lower the sensitivity of the collision detection, you can change it to be hard to false detection a collision detection parameter by carrying out the following KAREL programs. It is recommended to change a program so that the power does not depend on a robot before carrying out the program. (Except for ARC Mate 120*i*C/12L, M-20*i*A/20M/12L/35M)

ARC Mate 120*i*C 3kg payload specification
· hi03m2ia.pc
ARC Mate 120*i*C/10L 3kg payload specification
· hi03m22t.pc

M-20*i*A 20kg payload specification
· highm2ia.pc
M-20*i*A/10L 10kg payload specification
· highm21l.pc

Practice method of KAREL program is same to KAREL for changing wrist payload specification, so refer to Section 4.4.

If you want to return it to an original parameter, execute KAREL program below.

ARC Mate 120*i*C 3kg payload specification
· no03m2ia.pc
ARC Mate 120*i*C/10L 3kg payload specification
· no03m22t.pc

M-20*i*A 20kg payload specification
· normm2ia.pc
M-20*i*A/10L 10kg payload specification
· normm21l.pc

In the case of a following software version, these are applied.

In case of ARC Mate 120*i*C, ARC Mate 120*i*C/10L
7DA3/36 (V7.30P/36) or later, 7DA4/20(V7.40P/20) or later, 7DA5/13(V7.50P/13) or later, 7DA7/05(V7.70P/05) or later, 7DC1(V8.10P) and first version of these later software

In case of M-20*i*A, M-20*i*A/10L
7DA3/36 (V7.30P/36) or later, 7DA4/20(V7.40P/20) or later, 7DA5/12(V7.50P/12) or later, 7DA7/05(V7.70P/05) or later, 7DC1(V8.10P) and first version of these later software

11 MATERIAL HANDLING CONDUIT (OPTION)

11.1 NOTES FOR ASSEMBLING CABLES TO M/H CONDUIT

(1) M/H(Material Handling) conduit is the option to protect hand cable etc. You can prevent cables interference with arm directly by installing this and can postpone life of cables. Instead conduit is expendable supplies, so replace it regularly.

(2) The cable is recommended to be clamped at a position 70mm for the wrist side. A position 30mm or more away is recommended for the J4 back side. In case of M-20*i*A, adjust the length of the cable between clamping to 970±5mm. In case of M-20*i*A/10L and 12L, adjust the length of the cable between clamping to 1175±5mm. Please absorb extra length to Conduit. If cables are not clamped, cable and conduit may break. Be sure to clamp cables.

(3) Apply shell Alvania grease S2 to the surface of cables and air tubes inside the conduit to prevent cables and air tubes from damage. If grease is not applied, it causes early damage of cables and conduit.

Table 11.1 (a) Recommended cables and air tube

Cable name	Maker	Spec of FANUC	Specifications
End effector cable	Oki cable co. Ltd	A66L-0001-0459	0.2mm²24-core Cable for moving part
Signal line 3DV sensor cable	Oki cable co. Ltd	A66L-0001-0464#1	0.2mm² 2-core 4 pairs (8-core) Cable for moving part
Power line	Oki cable co. Ltd	A66L-0001-0401#10	1.25mm²10-core Cable for moving part
Force sensor cable	Okano cable co. Ltd	A66L-0001-0178#03P	0.3mm² 2-core 3 pairs (6-core) Cable for moving part
3D Laser Vision sensor camera cable	Hitachi cable co. Ltd	A66L-0001-0525	0.26mm² 4-core 0.13mm² 2-core Cable for moving part 0.08mm² 2-core
LED lighting cable	Hitachi cable co. Ltd	A66L-0001-0143	0.2mm² 6-core Cable for moving part
Air tube	SMC	A97L-0218-0010	TU0604 (Outer diameter=ϕ6mm, Inside diameter=ϕ4mm)

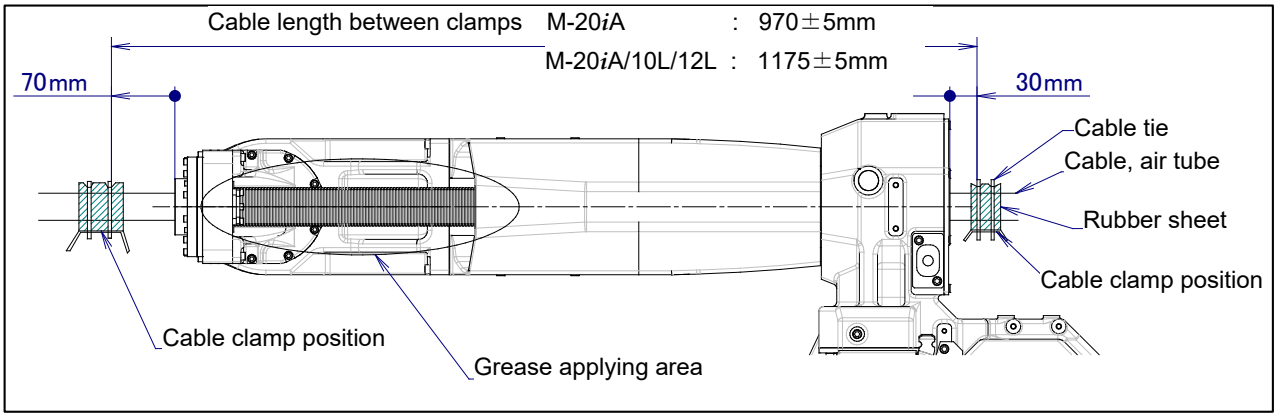


Fig. 11.1 (a) Cable length between clamps

(4) Please make sure that all cables form a bunch 30mm or less in diameter as shown in the figure so that the cables do not rub at the edge of the J6 hollow flange. If filling degree exceed the recommended value, it causes premature failure of cables and the conduit.

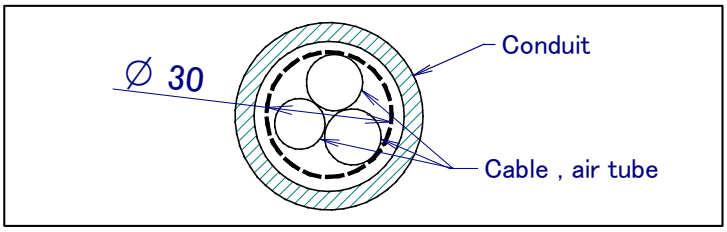


Fig. 11.1 (b) Outer diameter of cable and air tube in conduit

(5) It is recommended to install a protect ring, if necessary, so that neither cables nor the bolt attached to the J6 midair flange may interfere.
(6) Please roll cables in the rubber seat etc. so as not to damage the surfaces of the cables by the edge of the cable tie, and bind them with a cable tie.

11.2 WRIST CABLE KIT

Cable kits that include M/H conduit, cables and air tube between J4 connector panels to hand (recommend by FANUC) are prepared as options. When assembling them, refer to Fig.11.2 (a), (b).
When these options are specified, these wrist cable kits are added to the normal M/H conduit when they are shipped.

Table 11.2 (a) Wrist cable kit (M-20*i*A)

Model	Name	Specification	Constitution
M-20*i*A	Force sensor wrist cable kit	A05B-1222-J736	Material handling conduit, Force sensor wrist cable End effector wrist cable (RI/RO for each 8 points), Air ϕ6 x 4
	3D Laser Vision sensor wrist cable kit	A05B-1222-J752	Material handling conduit, 3D Laser Vision sensor wrist cable End effector wrist cable (RI/RO for each 8 points), Air ϕ6 x 4
	Force & 3D Laser Vision sensor wrist cable kit	A05B-1222-J757	Material handling conduit, Force sensor wrist cable 3D Laser Vision sensor wrist cable End effector wrist cable (RI/RO for each 8 points), Air ϕ6 x 4

NOTE
Refer to Section 11.1 about clamp position near J4/J6 holes exist, lengths between cable clamp and notes.

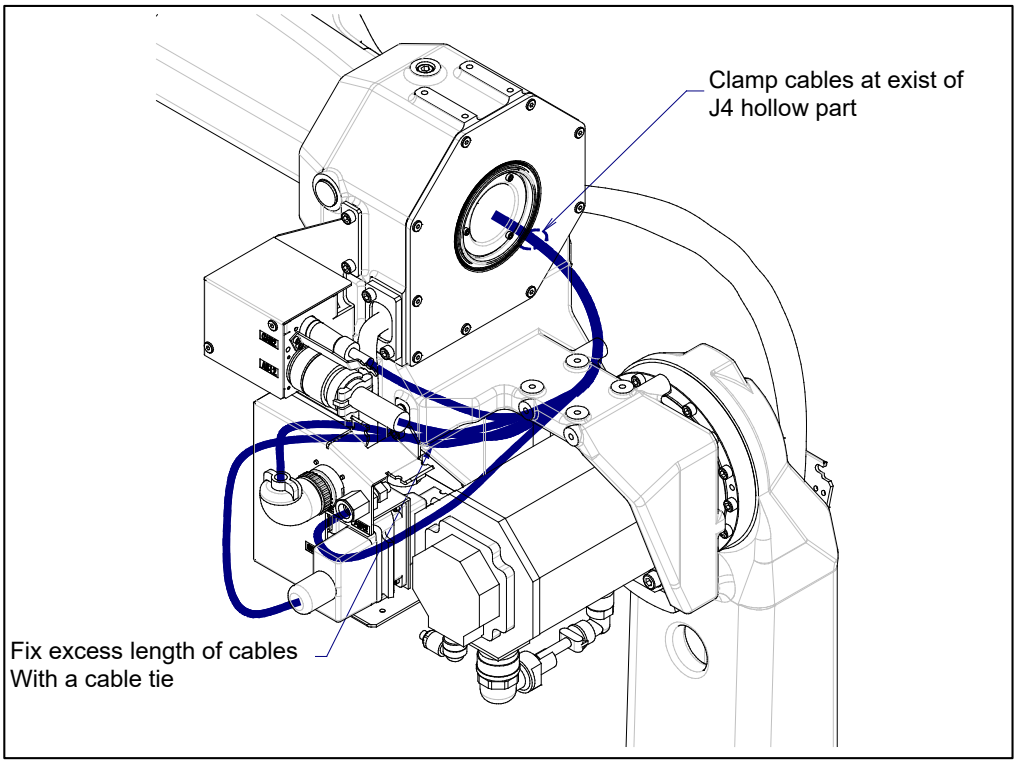


Fig. 11.2 (a) Cabling around J3 casing

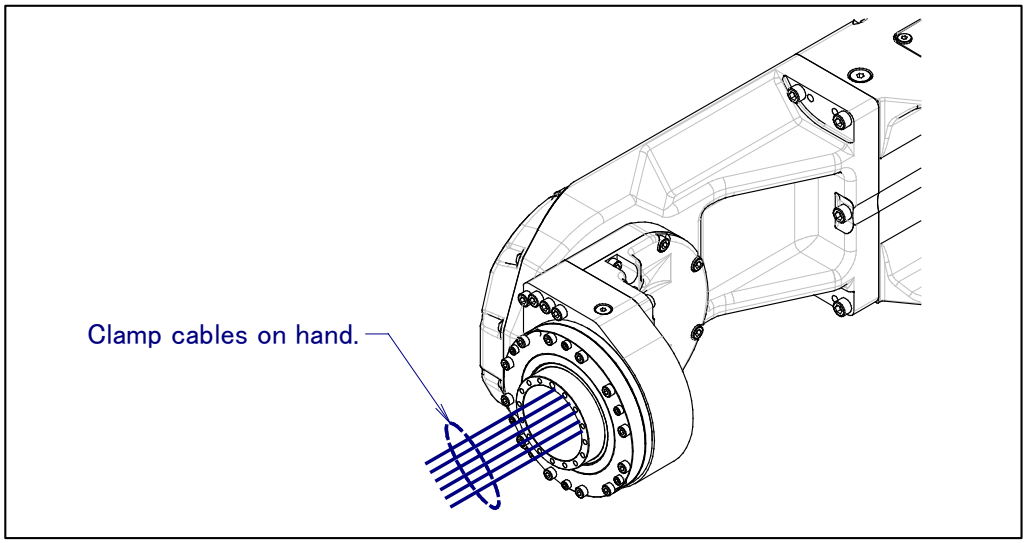


Fig. 11.2 (b) Cabling around wrist

When you set solenoid valve to J3 casing, use EE wrist cable relay kit (specification: A05B-1221-J736).

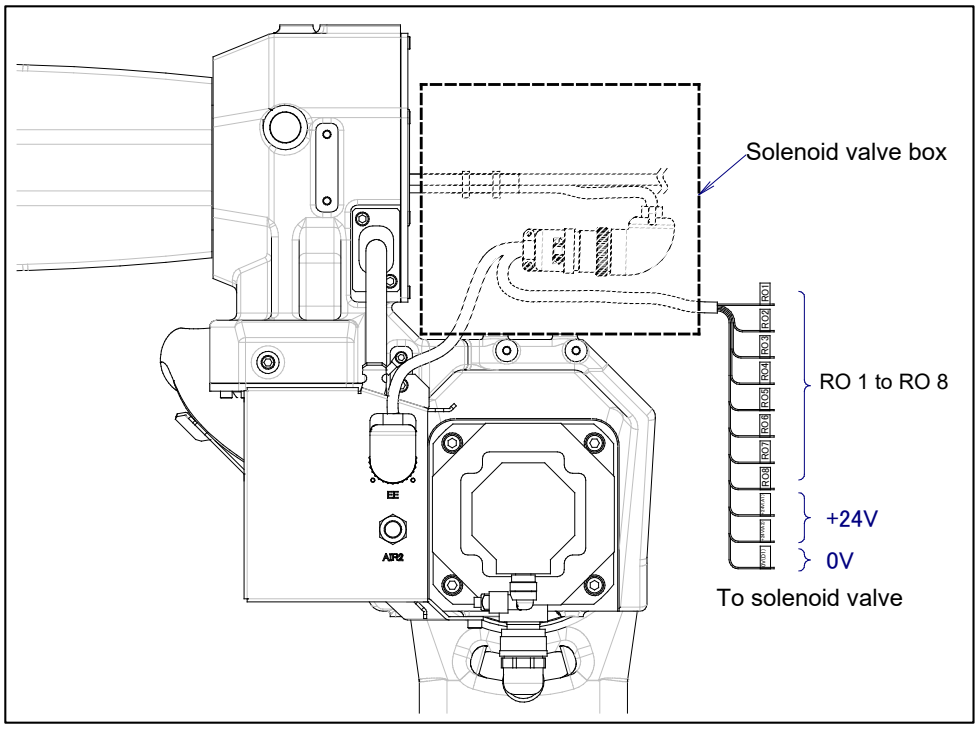


Fig. 11.2 (c) End effector wrist cable relay kit

11.3 OTHER NOTES

(1) When M/H conduit is installed, limiting J6 axis range of motion to ±190° is recommended. Cable life shortens when the range exceeds ±190° though it is possible to use a range of motion more than this (maximum ±270°).

Table 11.3 (a) Regular exchange cycle

	Exchange cycle
J5-axis:±140°	Cycle that is shorter among 1.2 million cycles (As one cycle every 30 seconds) and 2 years
J6-axis:±190°	

NOTE
Please note that it is a standard at the replacing cycle when the cable wire strand and the air tube of the FANUC recommendation are used. If cable is not clamped or grease is not applied or filling degree of cable in conduit is over or robot is operated with J6 fluoric resin ring is broken, it causes early damage of cables and conduit.

(2) Please examine the structure that the cutting powder etc. do not invade in Conduit when you specify M/H conduit and severe dust/liquid protection option simultaneously.

(3) Fluoric resin ring is installed to J6 hollow part. White powder is generated to reduce friction of rotation, but this is not trouble. Fluoric resin ring is expendable supply. Two years are aims in an exchange period. If you operate robot with the state that hard mine dust is attached to rotated part, exchange period may shortens. If robot is operated with fluoric resin rig is broken, it causes early damage of conduit.

12 NO DUST MATERIAL HANDLING CONDUIT (OPTION)

(1) NO DUST M/H (Material Handling) conduit is option to protect hand cable etc. You can prevent cables interference with arm directly by installing this and can postpone life of cables. Instead conduit is expendable supplies replace it regularly.

(2) Please prepare rubber bush as Fig. 12 (c). Please make thickness between wrist flange and tip of rubber bush is 9mm, thickness of rubber bush is 6mm. In case of J3 casing side, please make thickness between back of J3 casing and tip of rubber bush is 11.4mm and thickness of rubber bush is 6mm.Make length of cable between rubber bush is 944±5mm and absorb extra length to Conduit.

(3) The longevity of the cable improves by spreading grease on the surface of the cable in Conduit. Alvania grease S2 is recommended. In this case, please use the cable with performance that can endure oil. If grease is not applied, it causes early damage of cables and conduit.

(4) Confirm there is no gap in slit part of rubber bush. When there is a gap, clean degree turn worse. Please be careful.

Table 12 (a) Recommended cables and air tube

Cable name	Maker	Spec of FANUC	Specifications
End effector cable	Oki cable co. Ltd	A66L-0001-0459	0.2mm^2 24-core Cable for moving part
Signal line 3DV sensor cable	Oki cable co. Ltd	A66L-0001-0464#1	0.2mm^2 2-core 4 pairs (8-core) Cable for moving part
Power line	Oki cable co. Ltd	A66L-0001-0401#10	1.25mm^2 10-core Cable for moving part
Force sensor cable	Okano cable co. Ltd	A66L-0001-0178#03P	0.3mm^2 2-core 3 pairs (6-core) Cable for moving part
3DV sensor camera cable	Hitachi cable co. Ltd	A66L-0001-0525	0.26mm^2 4-core 0.13mm^2 2-core Cable for moving part 0.08mm^2 2-core
LED lighting cable	Hitachi cable co. Ltd	A66L-0001-0143	0.2mm^2 6-core Cable for moving part
Air tube	SMC	A97L-0218-0010	TU0604 (Outer diameter=ϕ6mm, Inside diameter=ϕ4mm)

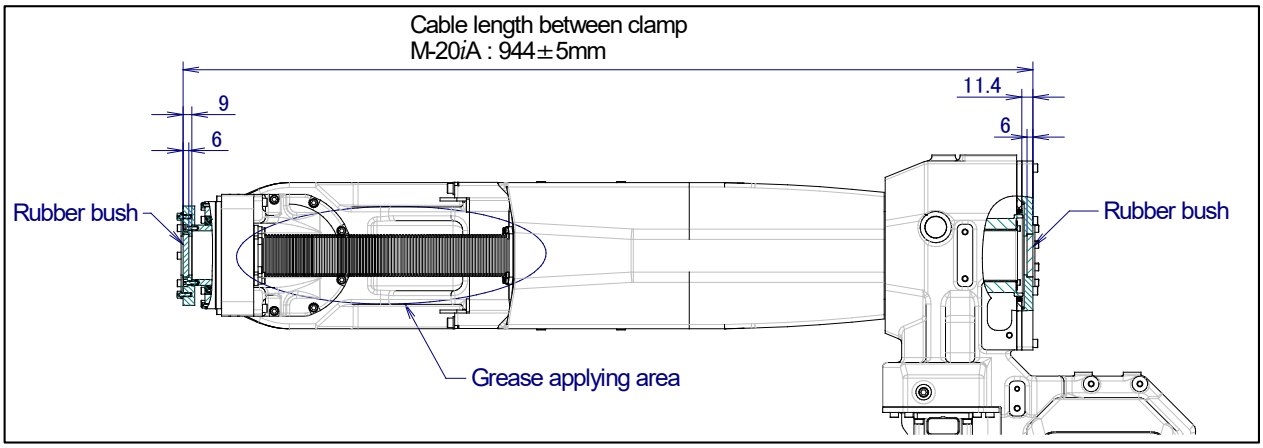


Fig.12 (a) Cable length between clamps

(5) Please install circumscription yen of bunches of cables on 30mm or less as shown in figure so that cables should not rub at the edge of the J6 hollow flange. If filling degree is over, it causes early damage of cables and conduit.

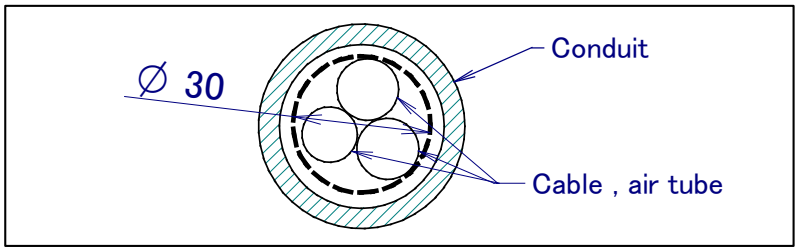
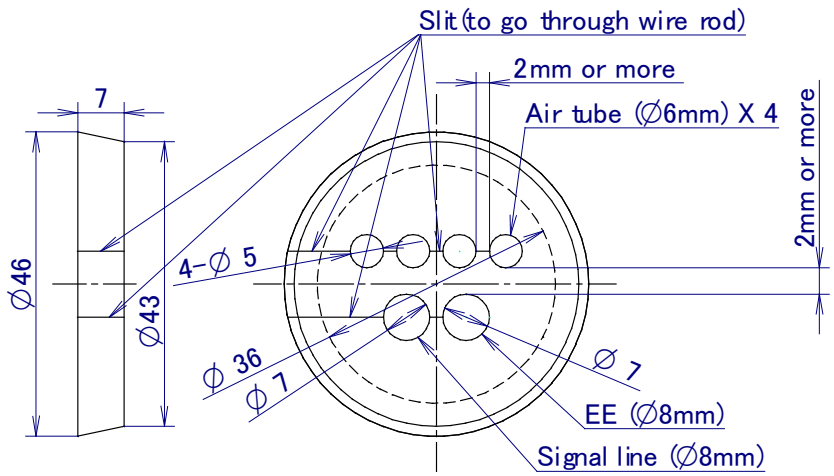


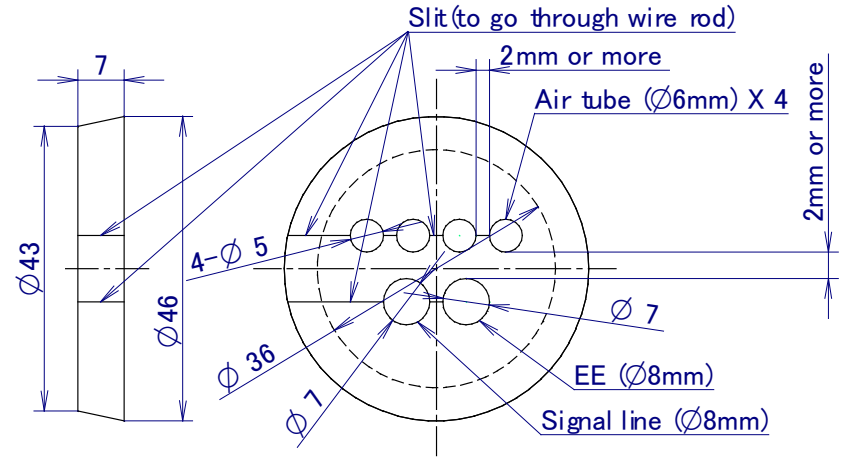
Fig. 12 (b) Outer diameter of cable and air tube in conduit

(6) Refer to figure below about shape of rubber bush and structure of cables in conduit.

Shape of rubber bush of back of J3 casing side



Shape of rubber bush of wrist side



[Example of four ϕ6 air tube ,EE(ϕ8mm) and signal line (ϕ8mm)]
- Design rubber bush so that diameter of hole is smaller 1mm than air tube and cable sheet.
- Post air tube and wire rod in dotted line of ϕ36mm.
- The direction of taper is reversed in case of back of J3 casing side and wrist side.
- Secure the wall thickness more than 2mm between holes.
- Flouring rubber , the hardness between 30 to 50 is recommended.

Fig.12 (c) Shape of rubber bush (example)

(7) Refer to figure below about structure of seal of back of J3 casing.

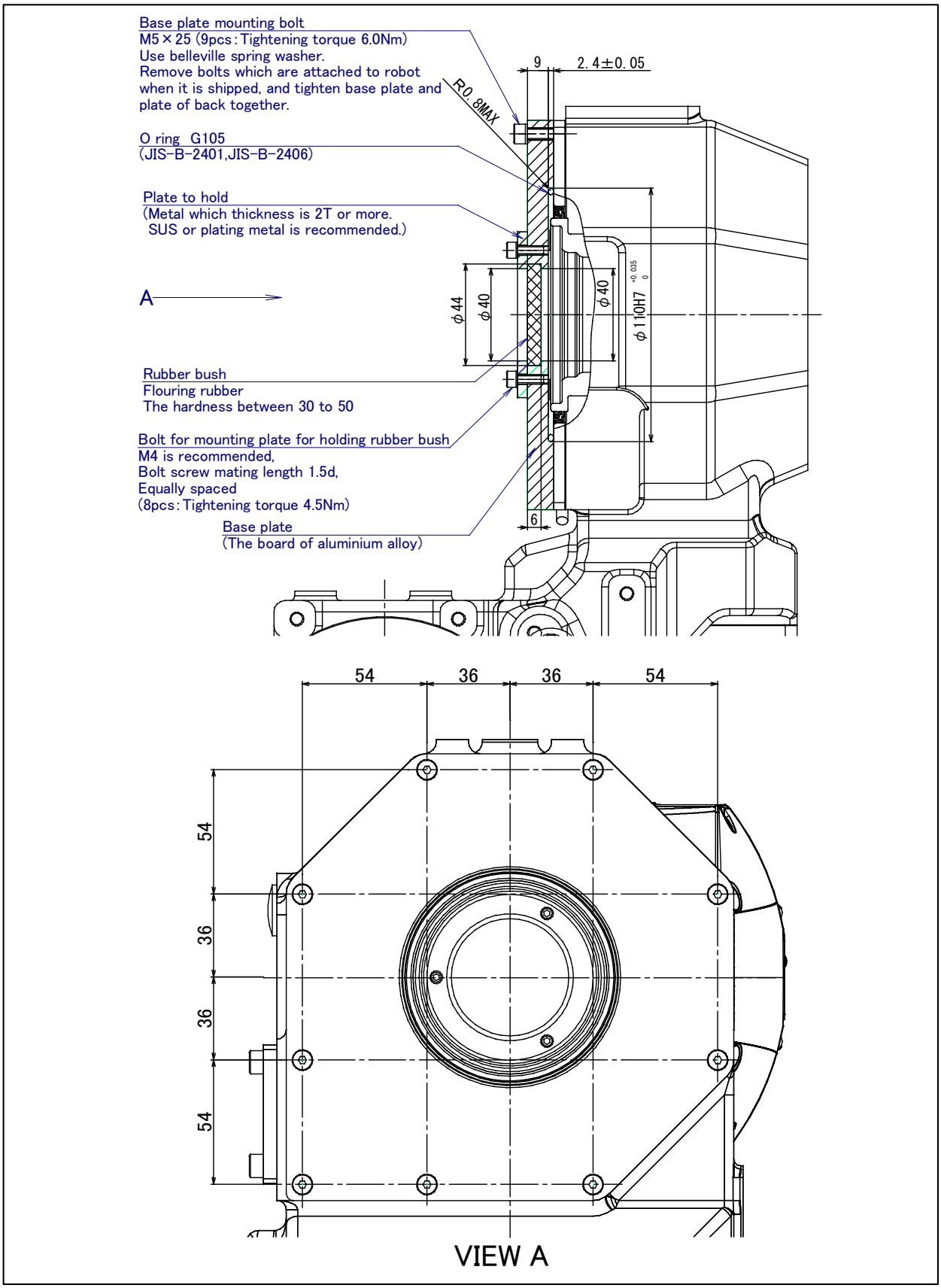


Fig.12 (d) Structure of seal of back of J3 casing

(8) Refer to figure below about structure of seal of wrist. If wrist is not sealed, dust come from hollow hole. Be sure to seal wrist.

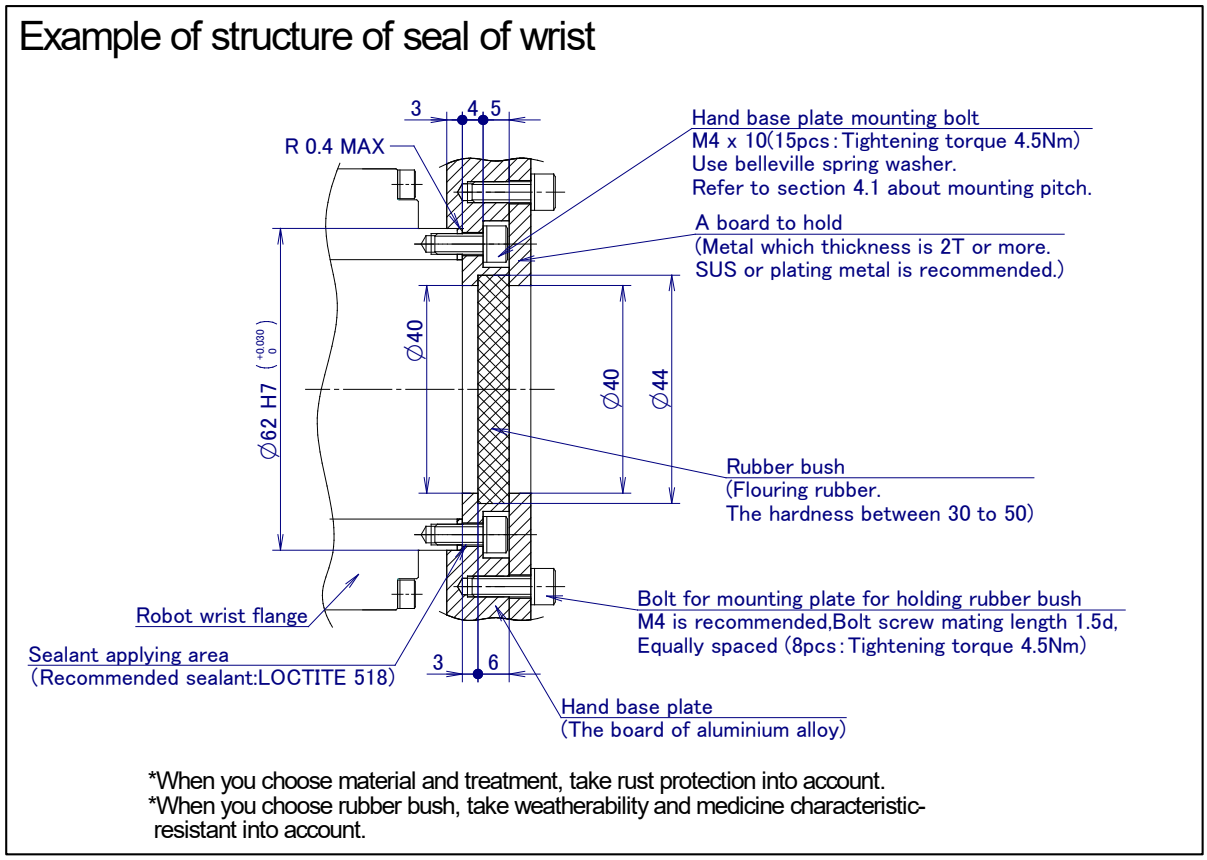


Fig.12 (e) Structure of seal of wrist (example)

(9) When No dust M/H conduit is installed, use by the range limitation of J6 axis range of motion ±190° is recommended. The longevities of cables shorten when using it exceeding ±190° though it is possible to use even in range of motion more than this (maximum ±270°). For J5-axis use it motion range in ±120°. If J5-axis move more than ±120°, it cause break of conduit, be careful.

NOTE
If cable is not clamped or grease is not applied or filling degree of cable in conduit is over, it causes early damage of cables and conduit.

(10) Specification is ISO class 5 (equal to clean class 100).

Fig.12 (b) Regular exchange cycle

	Exchange cycle
J5-axis:±140°	Cycle that is shorter among 1.2 million cycles (As one cycle every 30 seconds) and 2 years
J6-axis:±190°	

NOTE
Please note that it is a standard at the replacing cycle when the cable wire strand and the air tube of the FANUC recommendation are used. If cable is not clamped or grease is not applied or filling degree of cable in conduit is over or robot is operated with J6 fluoric resin ring is broken, it causes early damage of cables and conduit.

13 TIG WELDING OPTION

When TIG welding option is specified, install Noise shield plate as below. (It is attached when robot is shipped.)

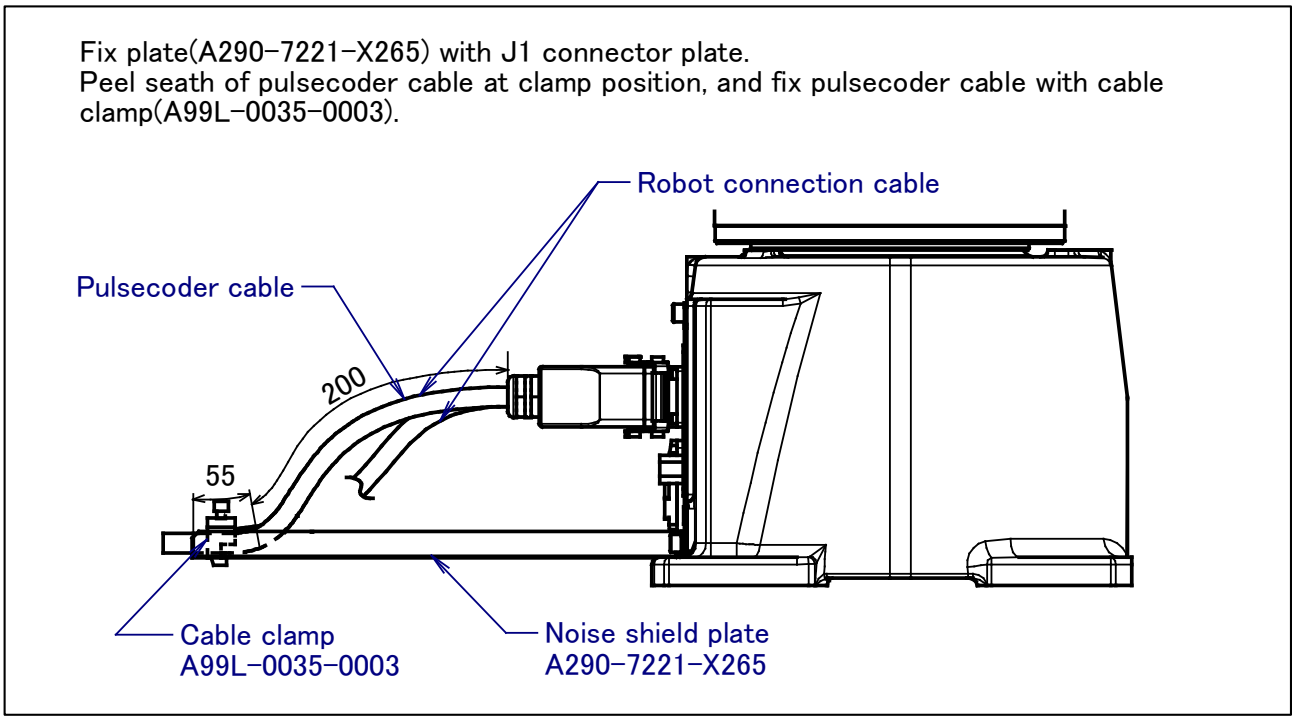


Fig.13 (a) Attaching of noise shield plate

APPENDIX

A PERIODIC MAINTENANCE TABLE

FANUC Robot ARC Mate 120*i*C, ARC Mate 120*i*C/10L/12L, M-20*i*A, M-20*i*A/10L/12L
Periodic Maintenance Table

Items			Working time (H) / Check time	Oil 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 sleeve	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	3	Check for water	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	4	Check the mechanical cable and welding cable. (Damaged or twisted)	0.1H	—		○			○				○			
	5	Check the end effector (hand) cable	0.1H	—		○			○				○			
	6	Check the motor connector. and exposed connector (Loosening)	0.1H	—		○			○				○			
	7	Tighten the end effector bolt.	0.1H	—		○			○				○			
	8	Retightening external main bolts	1.0H	—		○			○				○			
	9	Check the mechanical stopper and adjustable mechanical stopper.	0.1H	—		○			○				○			
	10	Clean spatters, sawdust and dust	1.0H	—		○			○				○			
	11	Check the oil sight glass of J4 to J6 axis	0.1H	—	○	○	○	○	○	○	○	○	○	○	○	○
	12	Replacing batteries *6	0.1H	—					●				●			
	13	Replacing grease of J1 axis reducer	0.5H	1110ml												
	14	Replacing grease of J2 axis reducer	0.5H	940ml												
	15	Replacing grease of J3 axis reducer	0.5H	380ml												
	16	Replacing oil of J4 axis gearbox	0.5H	822ml												
	17	Replacing oil of J5 and J6 axis gearbox	0.5H	822ml(*1) 400ml(*2) 390ml(*3)												
	18	Replacing cable of mechanical unit	4.0H	—												
	19	Replacing cable of Mechanical unit welding power	4.0H	—									●			
	20	Replacing M/H(Material Handling) conduit/No dust M/H conduit	1.0H	—									●			
	21	Fluoric resin ring	0.1H	—	○	○	○	○	○	○	○	○	●	○	○	○
Controller	22	Check the robot cable, teach pendant cable and robot connecting cable	0.2H	—		○			○				○			
	23	Cleaning the controller ventilation system	0.2H	—	○	○	○	○	○	○	○	○	○	○	○	○
	24	Replacing batteries *4 *6	0.1H	—												

*1 ARC Mate 120*i*C, M-20*i*A *2 ARC Mate 120*i*C/10L, M-20*i*A/10L *3 ARC Mate 120*i*C/12L, M-20*i*A/12L

*4 Refer to "REPLACING UNITS Chapter of MAINTENANCE" of the following manuals .
R-30*i*A CONTROLLER MAINTENANCE MANUAL (Standard) (B-82595EN),
R-30*i*A CONTROLLER MAINTENANCE MANUAL (CE specifications) (B-82595EN-1),
R-30*i*A CONTROLLER MAINTENANCE MANUAL (RIA specifications) (B-82595EN-2),
R-30*i*A Mate CONTROLLER MAINTENANCE MANUAL (Standard) (B-82725EN),
R-30*i*A Mate CONTROLLER MAINTENANCE MANUAL (CE specifications) (B-82725EN-1),
R-30*i*A Mate CONTROLLER MAINTENANCE MANUAL (RIA specifications) (B-82725EN-2),
R-30*i*B/R-30*i*B Plus CONTROLLER MAINTENANCE MANUAL (B-83195EN),
R-30*i*B Mate CONTROLLER MAINTENANCE MANUAL (B-83525EN)

*5 ●: requires order of parts
○: does not require order of parts

*6 Regardless of the operating time, replace the mechanical unit batteries at 1 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
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				●																	24

Overhaul

FANUC Robot M-20*i*A/20M/35M Periodic Maintenance Table

Items			Working time (H) Check time	Grease amount	First check 320	3 months 960	6 months 1920	9 months 2880	1 year 3840	4800	5760	6720	2 years 7680	8640	9600	10560
Mechanical unit	1	Check for external damage or peeling paint	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	2	Check damages of the cable protective sleeve	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	3	Check for water	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	4	Check the mechanical cable. (Damaged or twisted)	0.2H	—		○			○				○			
	5	Check the end effector (hand) cable	0.2H	—		○			○				○			
	6	Check the motor connector. and exposed connector (Loosening)	0.2H	—		○			○				○			
	7	Tighten the end effector bolt.	0.1H	—		○			○				○			
	8	Retightening external main bolts	1.0H	—		○			○				○			
	9	Check the mechanical stopper and adjustable mechanical stopper.	0.1H	—		○			○				○			
	10	Clean spatters, sawdust and dust	1.0H	—		○			○				○			
	11	Replacing batteries *3	0.1H	—					●				●			
	12	Replacing grease of J1 axis reducer	0.5H	1110ml												
	13	Replacing grease of J2 axis reducer	0.5H	940ml												
	14	Replacing grease of J3 axis reducer	0.5H	380ml												
	15	Replacing grease of J4 axis gearbox	0.5H	1220ml												
	16	Replacing grease of J5 axis gearbox	0.5H	1110ml												
	17	Supply grease of J6-axis reducer	0.5H	44ml					●				●			
	18	Replacing cable of mechanical unit	4.0H	—												
Controller	19	Check the robot cable, teach pendant cable and robot connecting cable	0.2H	—		○			○				○			
	20	Cleaning the ventilator	0.2H	—	○	○	○	○	○	○	○	○	○	○	○	○
	21	Replacing batteries *1 *3	0.1H	—												

*1 Refer to “REPLACING UNITS Chapter of MAINTENANCE ” of the following manuals .
R-30*i*B/R-30*i*B Plus CONTROLLER MAINTENANCE MANUAL (B-83195EN),
R-30*i*B Mate /R-30*i*B Mate Plus CONTROLLER MAINTENANCE MANUAL (B-83525EN)

*2 ●: requires order of parts
○: does not require order of parts

*3 Regardless of the operating time, replace the mechanical unit batteries at 1 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
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				●																	21

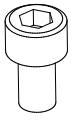
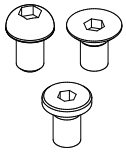
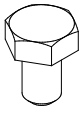
Overhaul

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 plating bolt: Tensile strength 1000N/mm^2 or more
Hexagon bolt, stainless bolt, special shape bolt (button bolt, low-head bolt, flush bolt .etc.)
Tensile strength 400N/mm^2 or more
Refer to the following tables if the bolts tightening torque is not specified.

Recommended bolt tightening torques **Unit: Nm**

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

C INSULATION ABOUT ARC WELDING ROBOT

The arc welding robot performs welding, using a welding torch attached to its end effector mounting face via a bracket. Because a high welding current flows through the welding torch, the insulating material must not permit bolting directly from the welding torch bracket to mounting face plate.

If no due consideration is taken, a poor insulation caused by a pileup of spatter can allow the welding current to leak into robot mechanical units, possibly damaging the motor or melting the mechanical unit cable jackets.

C.1 INSULATION AT THE WRIST

Please be careful to the following contents.

- Insulate the end effector mounting surface. Insulation material which is inserted between the end effector mounting surface and the welding torch bracket must be different, and bolt them separately referring to Fig. C.1 (a).
- Insert the insulating material between the torch bracket and faceplate to ensure the two are electrically isolated. When installing the insulating material, be sure to set the crack in the torch holder away from that of the insulating material to prevent spatter from getting in the cracks.
- Allow a sufficient distance (at least 5 mm) at the insulating materials in case a pileup of spatter should occur.

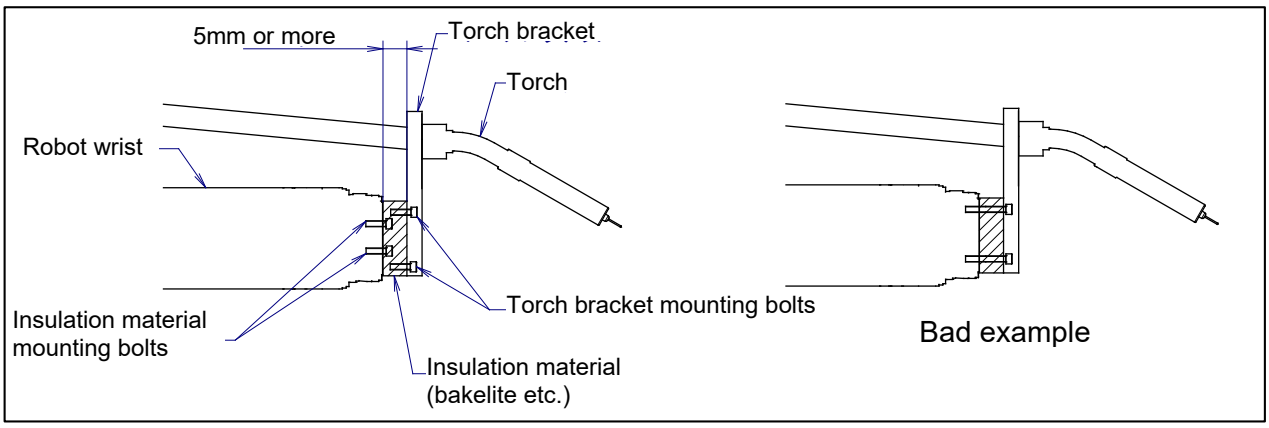


Fig. C.1 (a) Insulation at the wrist

- Even after the insulation is reinforced, it is likely that, if a pileup of spatter grows excessively, current may leak. Periodically remove the spatter.

C.2 INSULATION AT THE ADDITIONAL AXIS

If welding fixtures are installed to the additional axis, Perform insulation against between welding fixtures and the additional axis to prevent welding electric current intrusion. If the follower unit is used, perform insulation against between welding fixtures and follower unit to prevent welding electric current intrusion into the housing.

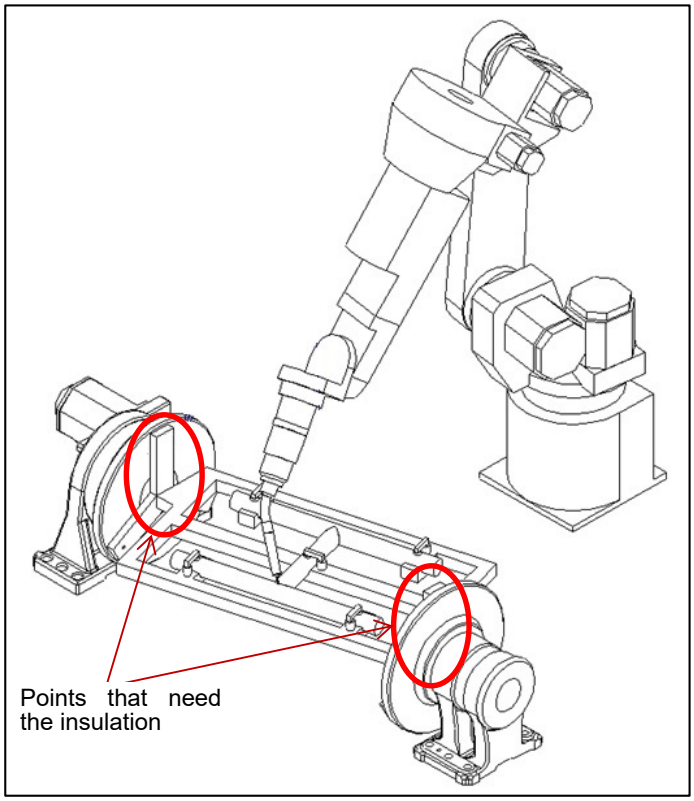


Fig. C.2 (a) Insulation at the additional axis

D CONTROL OF MULTIPLE ROBOTS

In case of R-30*i*A, R-30*i*A Mate, one controller can control up to four robots. Moreover, one controller can control up to eight groups, 56 axes.
In case of R-30*i*B, R-30*i*B Mate, R-30*i*B Plus and R-30*i*B Mate Plus, one controller can control up to four robots. Moreover, one controller can control up to eight groups, 72 axes.

NOTE
"Group" means the gathering of independent movable axes.

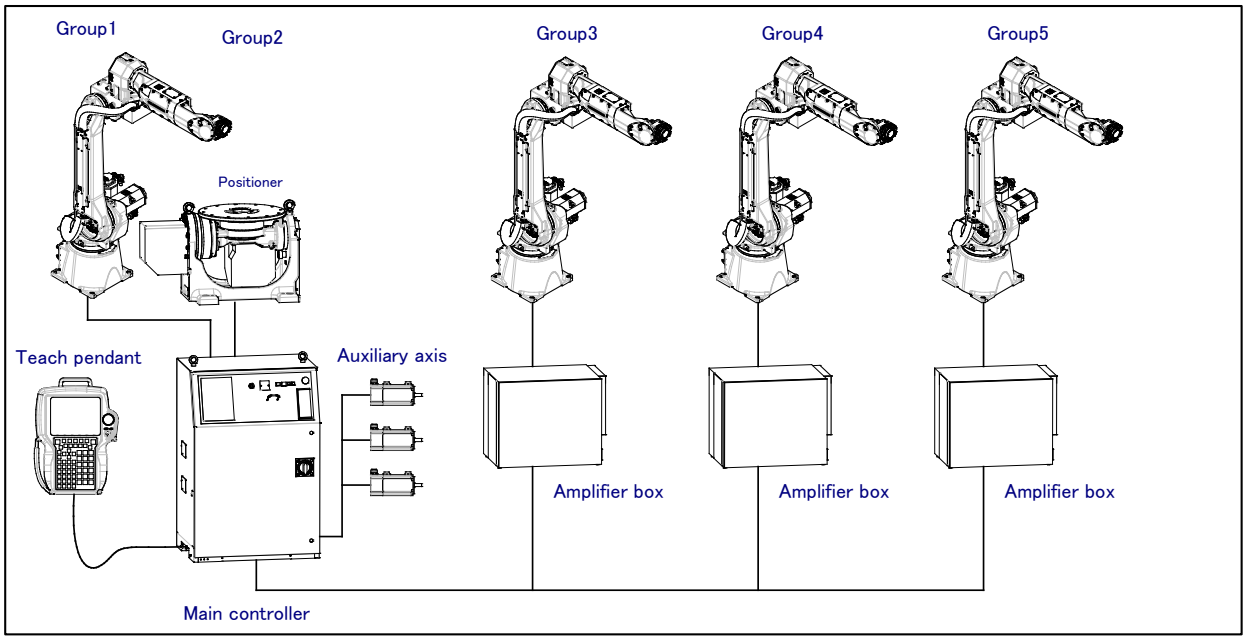


Fig. D (a) Control of multiple robots

When multiple robots are controlled with one controller, select the appropriate servo card and auxiliary axis board of controller from Table D (a) to (c).

Table D (a) Servo card and auxiliary axis board when multiple robots are controlled (R-30*i*A, R-30*i*A Mate)

Number of robots	Servo card and auxiliary axis board	Remarks
2 (NOTE1)	A05B-2500-H042 (16 axes)	Max. 4 auxiliary axes can be used in total of robot 1st and 2nd
3	A05B-2500-H044 (24 axes)	Max. 4 auxiliary axes can be used in total of robot 1st and 2nd Max. 2 auxiliary axes can be used in robot 3rd
4 (NOTE1)	A05B-2500-H042 (16 axes) + A05B-2500-J030 (16 axes) (NOTE2) A05B-2550-J020 (16 axes) (NOTE3)	Max. 4 auxiliary axes can be used in total of robot 1st and 2nd Max. 4 auxiliary axes can be used in total of robot 3rd and 4th

Table D (b) Servo card and auxiliary axis board when multiple robots are controlled (R-30*i*B, R-30*i*B Mate)

Number of robots	Servo card and auxiliary axis board	Remarks
2	A05B-2600-H041 (12 axes) (Note 4) A05B-2600-H042 (18 axes)	Max. 6 auxiliary axes can be used in total of robot 1st and 2nd
3	A05B-2600-H042 (18 axes) (Note 4) A05B-2600-H043 (24 axes)	Max. 6 auxiliary axes can be used in total of robot 1st , 2nd and 3rd
4	A05B-2600-H043 (24 axes) (Note 4) A05B-2600-H044 (36 axes)	Max. 12 auxiliary axes can be used in total of robot 1st , 2nd ,3rd and 4th

Table D (c) Servo card and auxiliary axis board when multiple robots are controlled (R-30*i*B Plus, R-30*i*B Mate Plus)

Number of robots	Servo card and auxiliary axis board	Remarks
2	A05B-2670-H041 (12 axes) (Note 4) A05B-2670-H042 (18 axes)	Max. 6 auxiliary axes can be used in total of robot 1st and 2nd
3	A05B-2670-H042 (18 axes) (Note 4) A05B-2670-H043 (24 axes)	Max. 6 auxiliary axes can be used in total of robot 1st , 2nd and 3rd
4	A05B-2670-H043 (24 axes) (Note 4) A05B-2670-H044 (36 axes)	Max. 12 auxiliary axes can be used in total of robot 1st , 2nd, 3rd and 4th

(NOTE1) One robot is needed to assign in 8 axes of servo card in case of Model to which high–sensitivity collision detection is supported as default like ARC Mate *i*C series etc.
Therefore, A05B-2500-H040 (8 axes) cannot be used in case of two robots.
Similarly, A05B-2500-H044 (24 axes) cannot be used in case of four robots.
(NOTE2) Select this one when the controller is R-30*i*A.
(NOTE3)Select this one when the controller is R-30*i*A Mate.
(NOTE4)It can be used only when auxiliary axes are not specified.

INDEX

REVISION RECORD

Edition	Date	Contents
14	Jan.,2022	• Correction of errors
13	Sep.,2020	• Addition of R-30*i*B Mate Plus Controller • Addition of new specification (A05B-1225-B351, B352) • Correction of errors
12	Feb.,2017	• Addition of R-30*i*B Plus Controller • Addition of new specification (A05B-1225- B251,B252) • Correction of errors
11	Jun,2016	• Addition of new specification (A05B-1225-) • Correction of errors
10	Jul.,2015	• Addition of quick master for single axis • Correction of errors
09	Jun.,2014	• Addition of ARC Mate 120*i*C/12L and M-20*i*A/12L • Correction of errors
08	Mar.,2014	• Addition of M-20*i*A/35M • Correction of errors
07	Oct.,2013	• Addition of R-30*i*B Mate Controller • Change of oiling method of J4-axis gearbox • Correction of errors
06	Sep.,2012	• Addition of R-30*i*B Controller • Addition of M-20*i*A/20M • Correction of errors
05	Sep.,2011	• Change of oiling method of J4, J5/J6-axis gearbox • Addition of oil seepage • Addition of external dimension of ISO flange adapter • Addition of note about M/H conduit and No dust M/H conduit • Correction of errors
04	Jul., 2010	• Addition of stop type of robot • Addition of stopping time and distance when controlled stop is executed • Correction of errors
03	Feb., 2010	• Addition of no dust M/H conduit • Addition of insulation • Addition of control of multiple robots • Change the oil replacement procedure for J4 and J5/J6 gear box
02	Sep., 2008	• Addition of sever dust/liquid protection option • Addition of TIG welding option • Correction of errors
01	Jul., 2008	

B-82874EN/14