FANUC Robot ARC Mate 120*i*D
FANUC Robot M-20*i*D

MECHANICAL UNIT
OPERATOR'S MANUAL

B-84074EN/03

- **Original Instructions**

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

SAFETY PRECAUTIONS

This chapter must be read before using the robot.

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

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

1 DEFINITION OF USER

The 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 safety fence

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

- Operator is not allowed to work in the safety fence.
- Programmer/Teaching operator and maintenance technician is allowed to work in the safety fence. Works carried out in the safety fence include transportation, installation, teaching, adjustment, and maintenance.
- To work inside the safety fence, the person must be trained on proper robot operation.

Table 1 (a) lists the work outside the safety fence. In this table, the symbol "○" means the work allowed to be carried out by the worker.

Table 1 (a) List of work outside the fence

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

In the robot operating, 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.

- Check this manual thoroughly, and keep it handy for the future reference.

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 sandwiched 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.

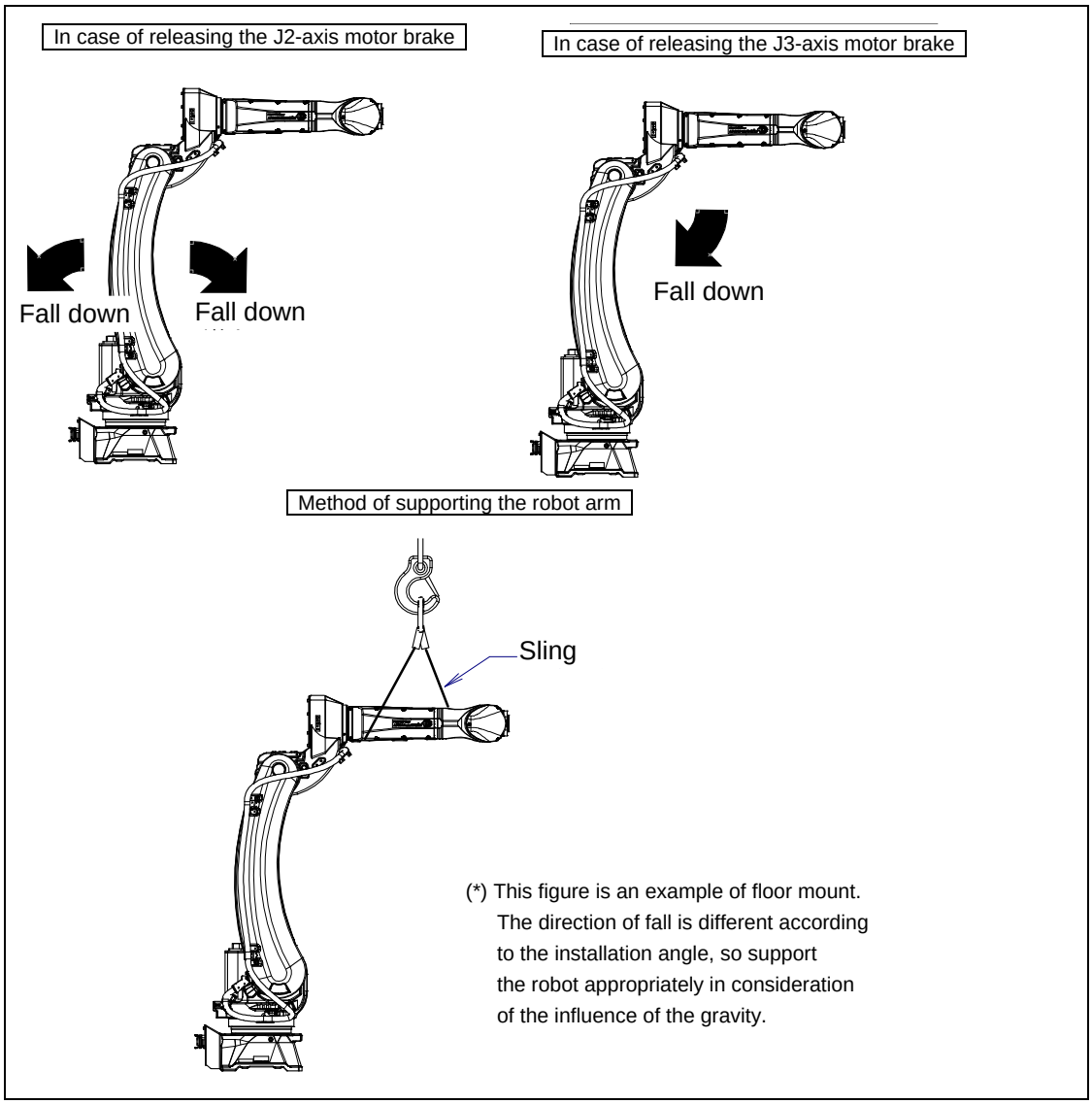


Fig. 3 (a) Releasing J2 and J3 motor brake and measures

4 WARNING & CAUTION LABEL

(1) Greasing and degreasing label

Fig. 4 (a) Greasing and degreasing label

Description

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

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

> ⚠ **CAUTION**
> See Section 7.3 Maintenance for explanations about specified greases, the amount of grease to be supplied, and the locations of grease and degrease outlets for individual models.

(2) Step-on prohibitive label

Fig. 4 (b) Step-on prohibitive label

Description

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

(3) High-temperature warning label

Fig. 4 (c) High-temperature warning label

Description

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

(4) Transportation label

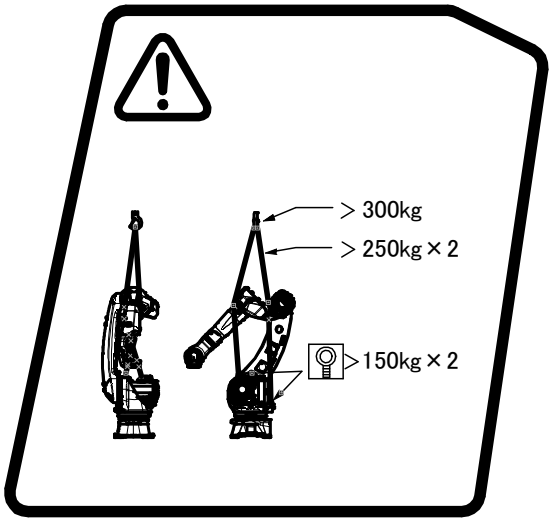


Fig. 4 (d) Transportation label

Description

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

- Use a crane with a load capacity of 300kg or greater.
- Use two slings with each load capacity of 250 kg 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 for explanations about the posture a specific model should take when it is transported.

(5) High current attention label

Fig. 4 (e) High current attention Label

Description

Do not access during energized high current inside.

(6) Operating space and payload label

Below label is added when CE specification is specified.

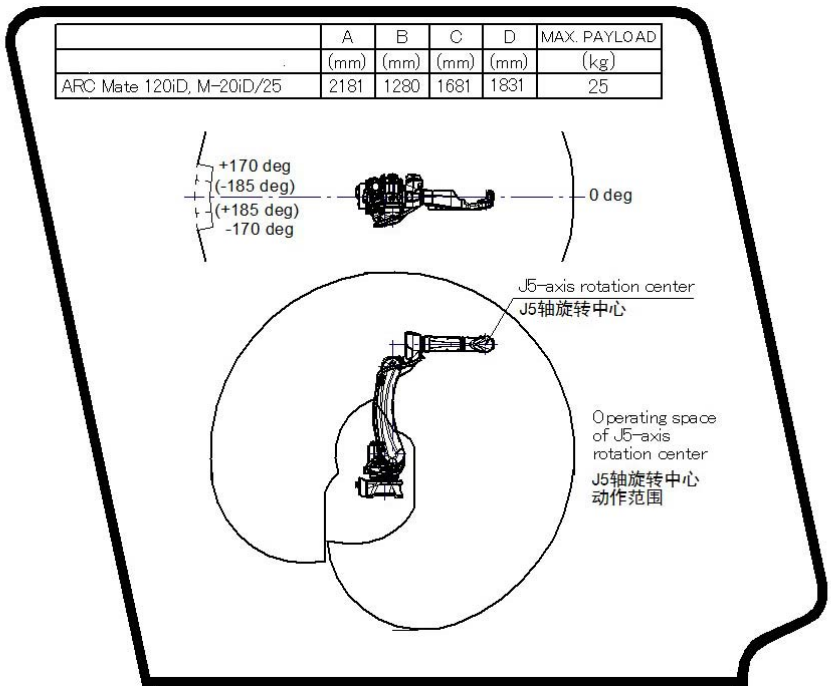


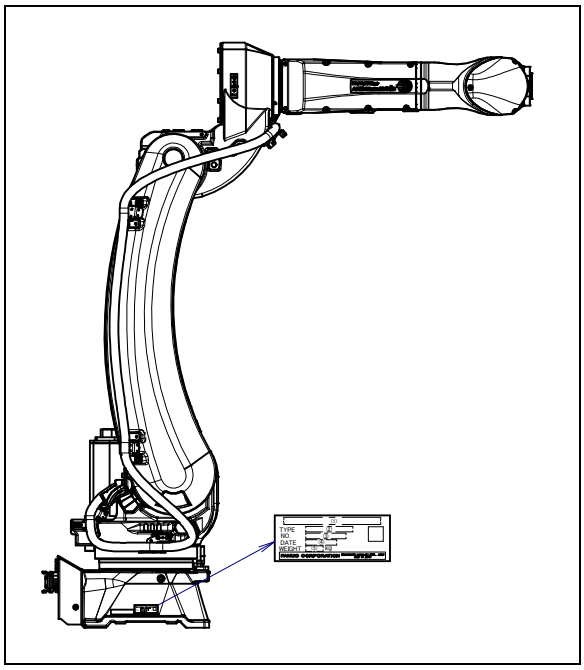
Fig. 4 (f) Operating space and payload label (Example of ARC Mate 120*i*D, M-20*i*D/25)

PREFACE

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

Model name	Mechanical unit specification No.	Maximum load	Remarks
FANUC Robot ARC Mate 120*i*D	A05B-1228-B201	25kg	With all axes brakes
FANUC Robot M-20*i*D/25	A05B-1228-B202	25kg	With all axes brakes
FANUC Robot ARC Mate 120*i*D/12L	A05B-1228-B301	12kg	With all axes brakes
FANUC Robot M-20*i*D/12L	A05B-1228-B302	12kg	With all axes brakes
FANUC Robot ARC Mate 120*i*D/35	A05B-1228-B401	35kg	With all axes brakes
FANUC Robot M-20*i*D/35	A05B-1228-B402	35kg	With all axes brakes

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 (a)

	(1)	(2)	(3)	(4)	(5)
CONTENTS	**Model name**	**TYPE**	**No.**	**DATE**	**WEIGHT kg (Without controller)**
LETTERS	FANUC Robot ARC Mate 120*i*D	A05B-1228-B201	SERIAL NO. IS PRINTED	PRODUCTION YEAR AND MONTH ARE PRINTED	250
	FANUC Robot M-20*i*D/25	A05B-1228-B202			250
	FANUC Robot ARC Mate 120*i*D/12L	A05B-1228-B301			250
	FANUC Robot M-20*i*D/12L	A05B-1228-B302			250
	FANUC Robot ARC Mate 120*i*D/35	A05B-1228-B401			250
	FANUC Robot M-20*i*D/35	A05B-1228-B402			250

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*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, maintenance engineer, system designer Topics: Robot functions, operations, programming, setup, interfaces, alarms Use: Robot operation, teaching, system design
	MAINTENANCE MANUAL **R-30*i*B Plus :** **B-83195EN** **R-30*i*B Mate Plus:** **B-83525EN**	Intended readers: Trained maintenance worker, system designer Topics: Installation, start-up, connection, maintenance Use: Installation, start-up, connection, maintenance

This manual uses following terms.

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

TABLE OF CONTENTS

1 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 it by using the eyebolts and the transport equipment properly.

> **⚠ WARNING**
> 1 When hoisting or lowering the robot with a crane or forklift, move it slowly, and with great care. When placing the robot on the floor, exercise care to prevent the installation surface of the robot from striking the floor.
> 2 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).
> 3 Use the transport equipment only for transportation. Do not use the forklift pockets to secure the robot.
> 4 Before moving the robot by using crane, check and tighten any loose bolts on the forklift pockets.
> 5 Do not pull eyebolts sideways.

1) Transportation using a crane (Fig. 1.1 (a), (b))
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.

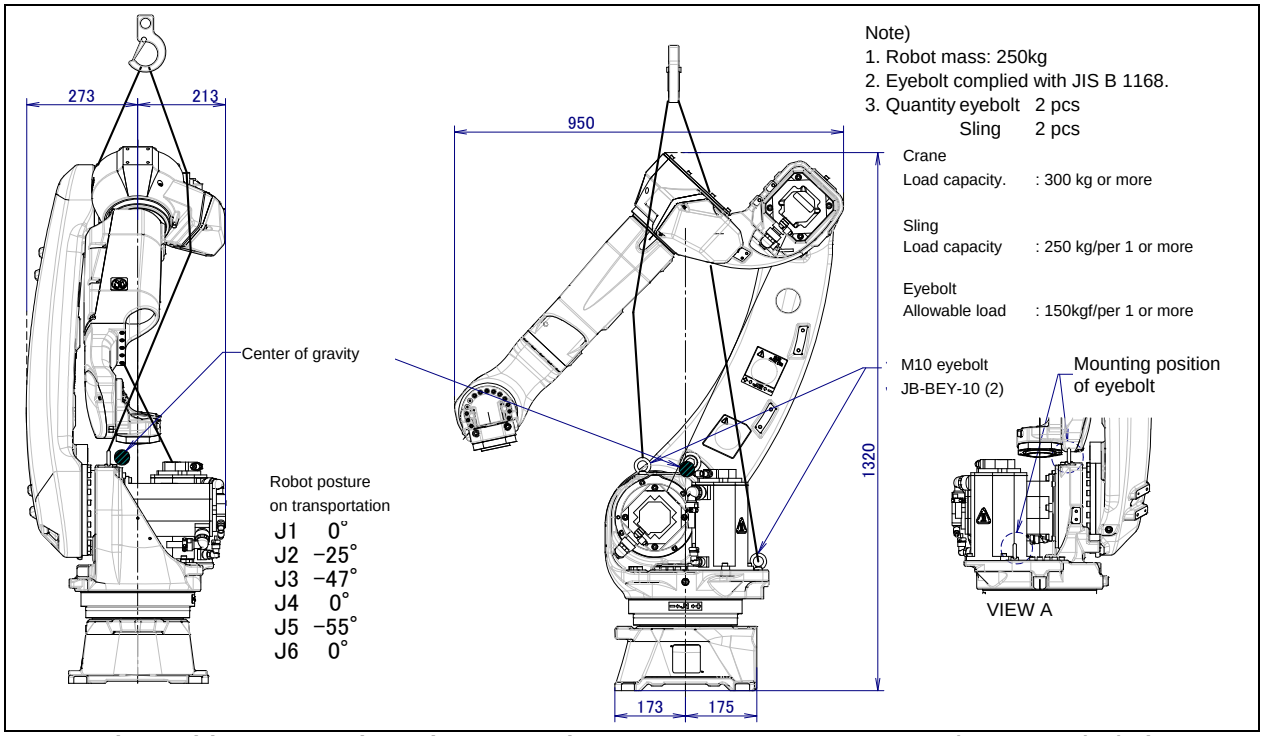


Fig. 1.1 (a) Transportation using a crane (ARC Mate 120*i*D, ARC Mate 120*i*D/35, M-20*i*D/25/35)

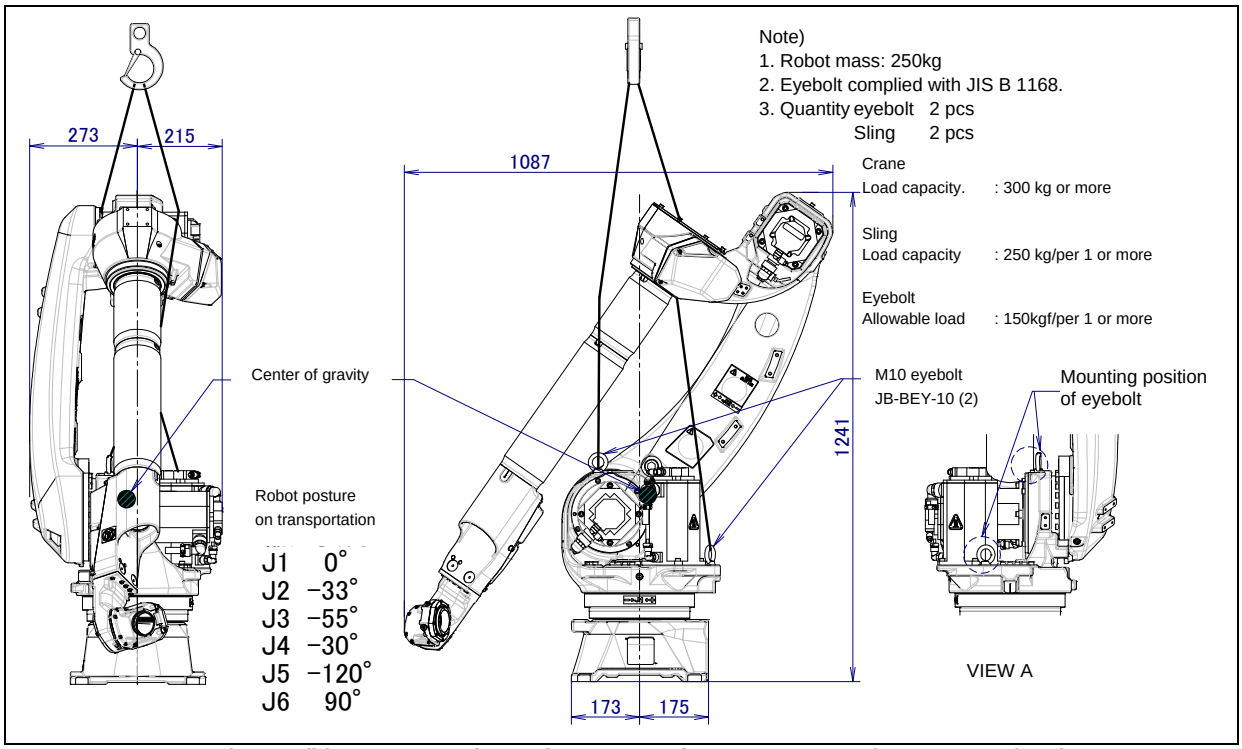


Fig. 1.1 (b) Transportation using a crane (ARC Mate 120*i*D/12L, M-20*i*D/12L)

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

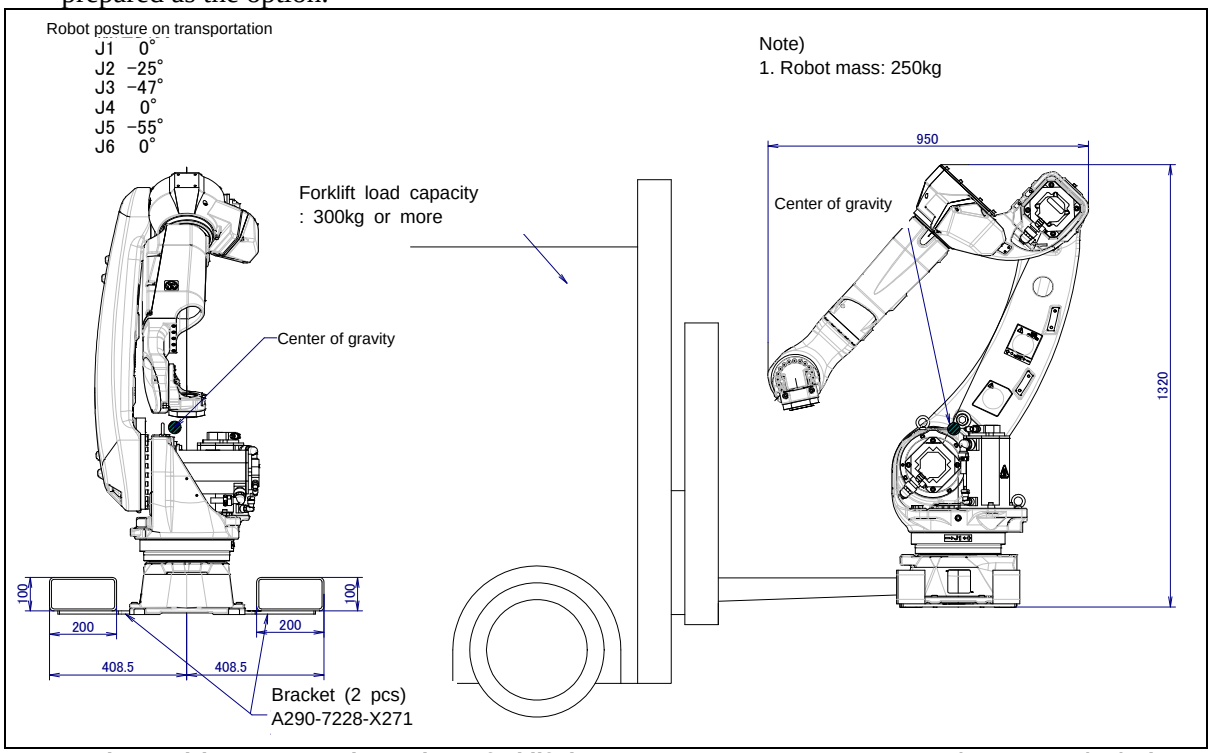


Fig. 1.1 (c) Transportation using a forklift (ARC Mate 120*i*D, ARC Mate 120*i*D/35, M-20*i*D/25/35)

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

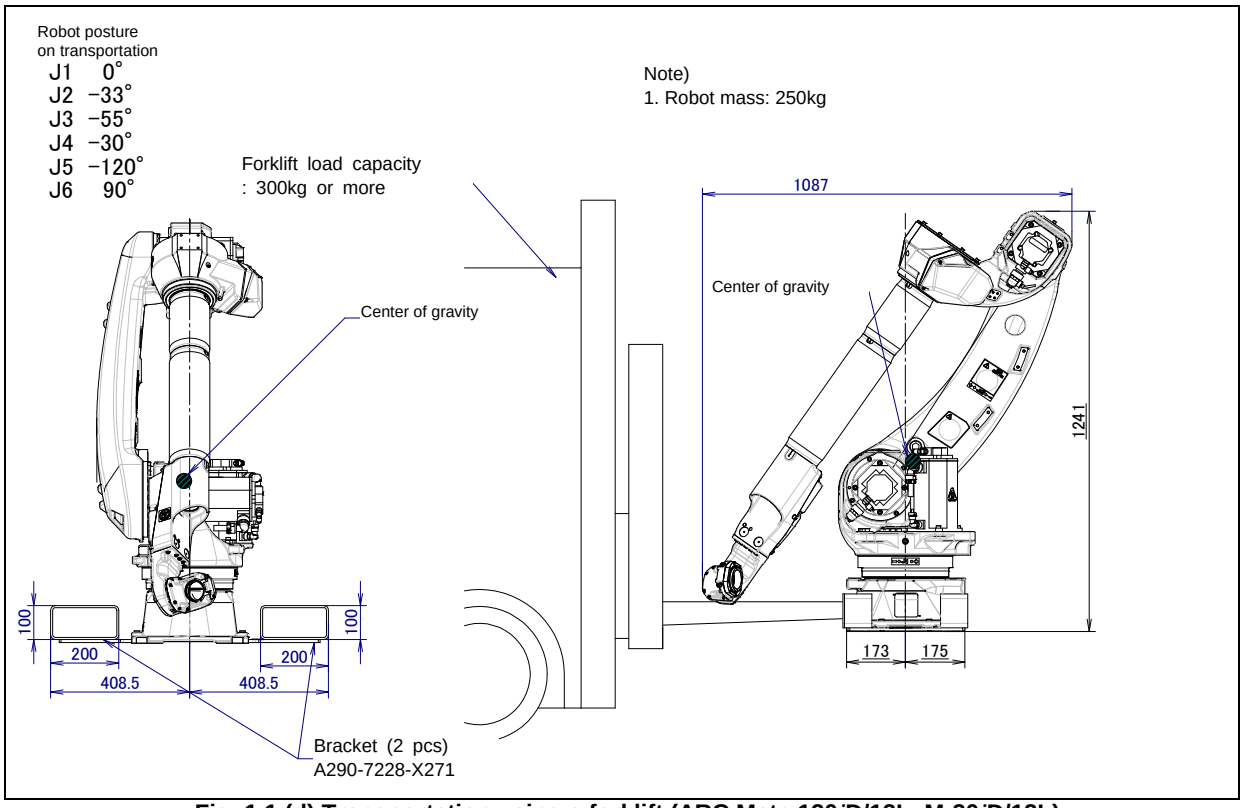


Fig. 1.1 (d) Transportation using a forklift (ARC Mate 120*i*D/12L, M-20*i*D/12L)

> ⚠ **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.

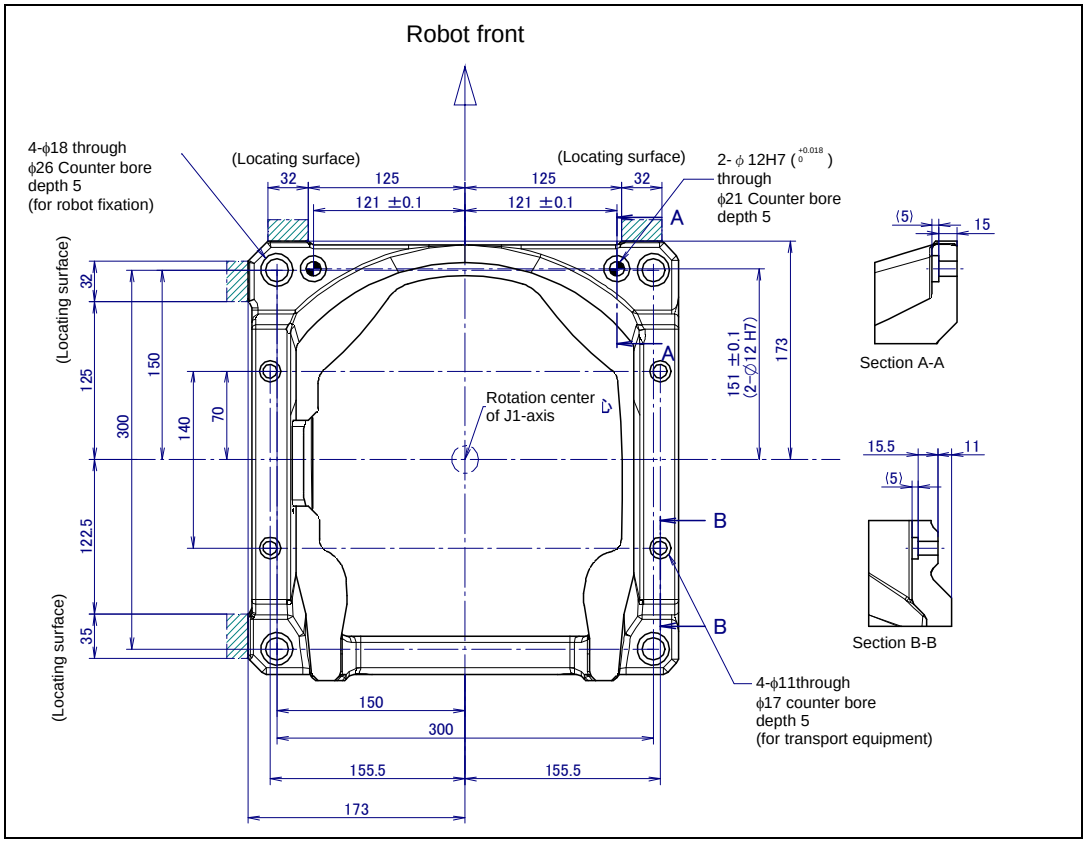


Fig. 1.2 (a) Dimensions of the robot base

1.2.1 Installation Method

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 mounting face.

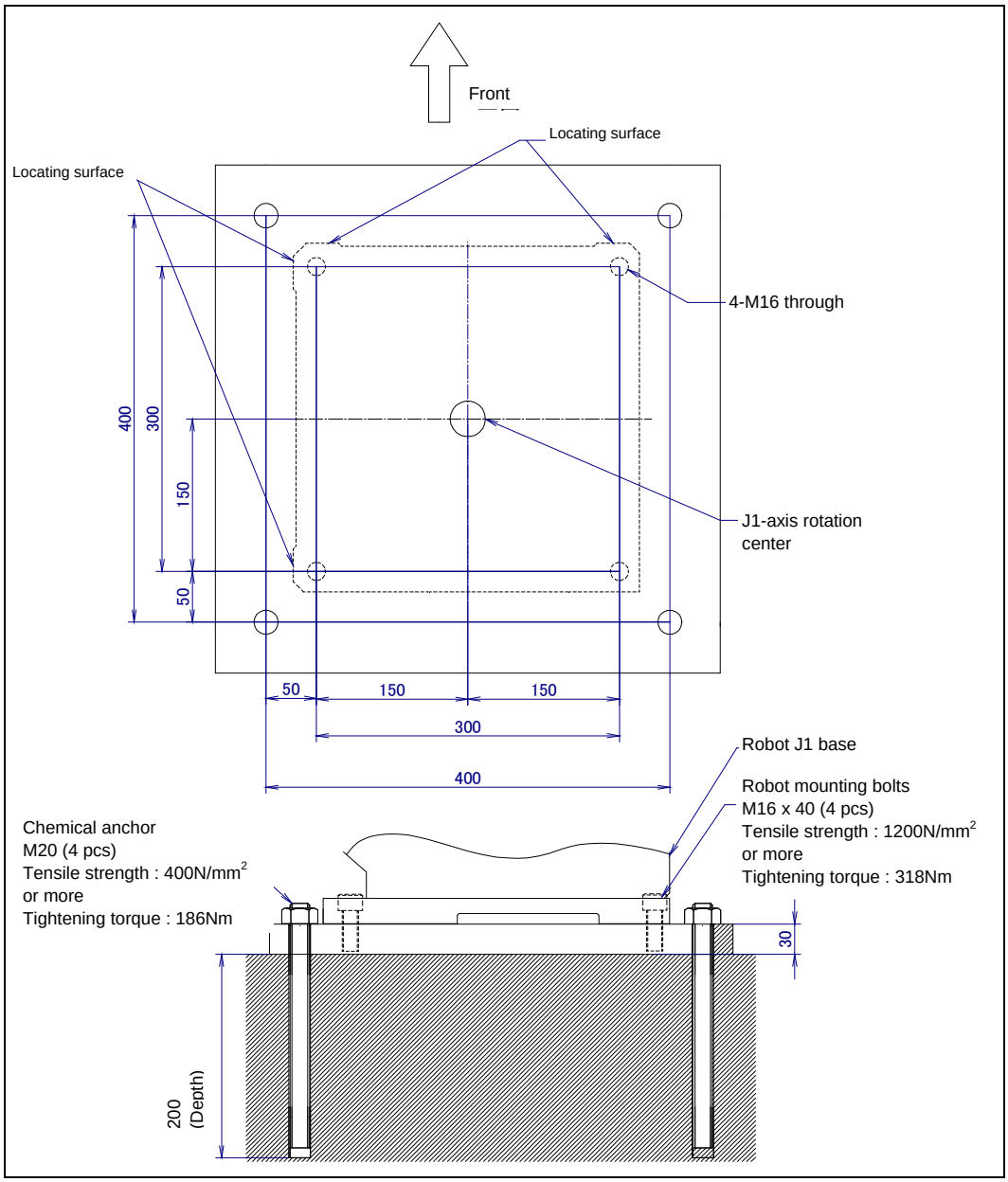


Fig. 1.2.1 (a) Example of installing the robot

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.
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.
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) and Table 1.2.1 (a) to (c) show the force and moment applied to the Robot base. Table 1.2.1 (d), (e) indicate the stopping distance and time of the J1 through J3 axes until the robot stops by Power-Off stop or by Smooth 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 (c) 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*D, M-20*i*D/25)

	Vertical moment MV [Nm](kgfm)	Force in vertical direction FV [N] (kgf)	Horizontal moment MH [Nm] (kgfm)	Force in horizontal direction FH [N] (kgf)
During stillness	1592 (162)	2633 (269)	0 (0)	0 (0)
During acceleration or deceleration	3798 (388)	3473 (354)	749 (76)	1405 (143)
During Power-Off stop	7257 (768)	5278 (539)	2851 (291)	2436 (249)
During Smooth stop	3803 (388)	3469 (354)	762 (78)	1409 (144)

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

	Vertical moment MV [Nm](kgfm)	Force in vertical direction FV [N] (kgf)	Horizontal moment MH [Nm] (kgfm)	Force in horizontal direction FH [N] (kgf)
During stillness	1325 (135)	2580 (263)	0 (0)	0(0)
During acceleration or deceleration	2266 (231)	2971 (303)	402 (41)	466 (48)
During Power-Off stop	6459 (659)	4916 (502)	3764(384)	2679 (273)
During Smooth stop	2204 (225)	3298 (337)	732 (75)	1757 (179)

Table 1.2.1 (c) Force and moment that act on J1 base (ARC Mate 120*i*D/35, M-20*i*D/35)

	Vertical moment MV [Nm](kgfm)	Force in vertical direction FV [N] (kgf)	Horizontal moment MH [Nm] (kgfm)	Force in horizontal direction FH [N] (kgf)
During stillness	1761 (180)	2549 (260)	0 (0)	0 (0)
During acceleration or deceleration	3844 (392)	3386 (345)	549 (56)	715 (73)
During Power-Off stop	9254 (944)	5851 (597)	2049 (209)	1468 (150)
During Smooth stop	3757 (383)	3351 (342)	730 (75)	781 (80)

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*D, M-20*i*D/25	Stopping time [ms]	276	344	200
	Stopping distance [deg] (rad)	24.02 (0.42)	30.41 (0.53)	18.79 (0.33)
ARC Mate 120*i*D/12L, M-20*i*D/12L	Stopping time [ms]	164	184	100
	Stopping distance [deg] (rad)	17.49 (0.31)	16.16 (0.28)	5.72 (0.10)
ARC Mate 120*i*D/35, M-20*i*D/35	Stopping time [ms]	144	176	160
	Stopping distance [deg] (rad)	13.83	14.09	9.69

Table 1.2.1 (e) Stopping time and distance until the robot stopping by Smooth stop after input of stop signal

Model		J1-axis	J2-axis	J3-axis
ARC Mate 120*i*D, M-20*i*D/25	Stopping time [ms]	464	472	512
	Stopping distance [deg] (rad)	24.66 (0.43)	33.25 (0.58)	44.02 (0.77)
ARC Mate 120*i*D/12L, M-20*i*D/12L	Stopping time [ms]	492	384	396
	Stopping distance [deg] (rad)	39.81 (0.69)	27.63 (0.48)	17.87 (0.32)
ARC Mate 120*i*D/35, M-20*i*D/35	Stopping time [ms]	472	432	464
	Stopping distance [deg] (rad)	38.6 (0.67)	38.7 (0.68)	26.0 (0.45)

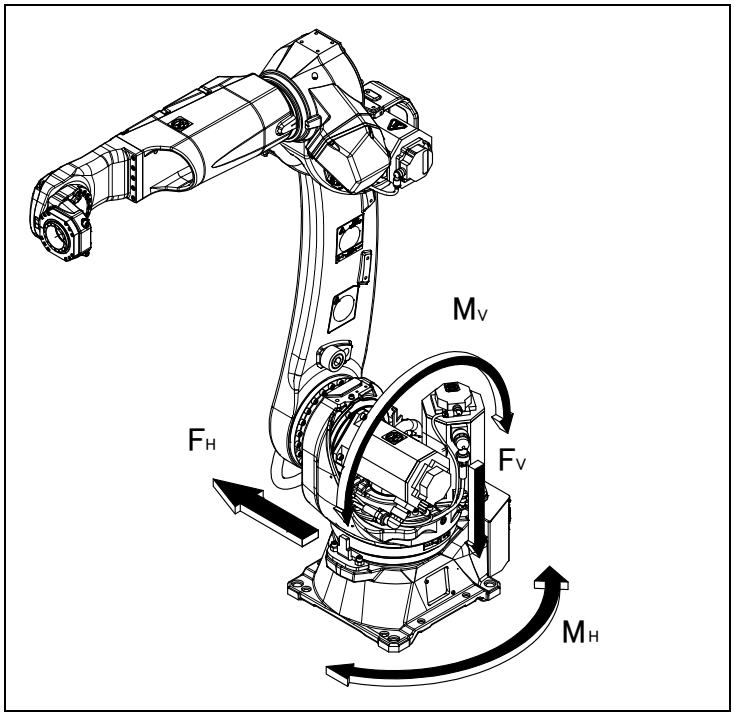


Fig. 1.2.1 (b) Force and moment that acts on J1 base

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

```
ROBOT MAINTENANCE          CTRL START MANU

Setup Robot System Variables

  Group  Robot Library/Option Ext Axes
  1      M-20iD/25                   0




[TYPE]ORD NO       AUTO       MANUAL
```

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

```
*******Group 1 Initialization***********
*************M-20iD/25*******************


--- 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 mount angle referring to Fig.1.2.2 (a).

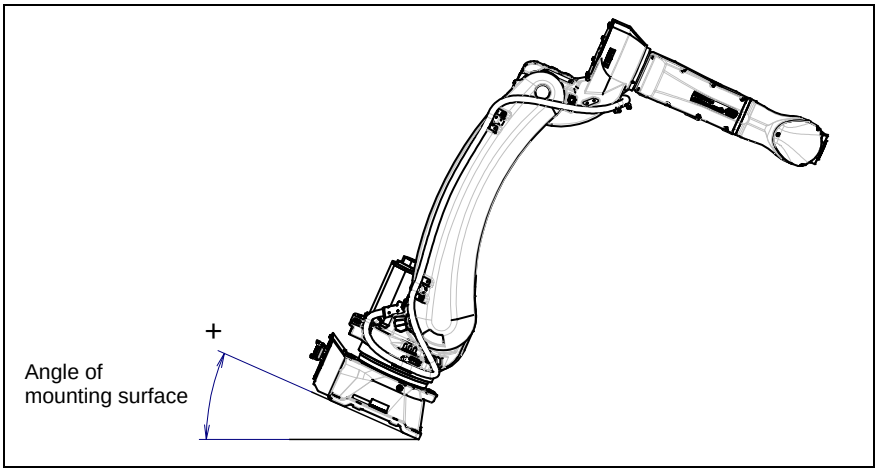
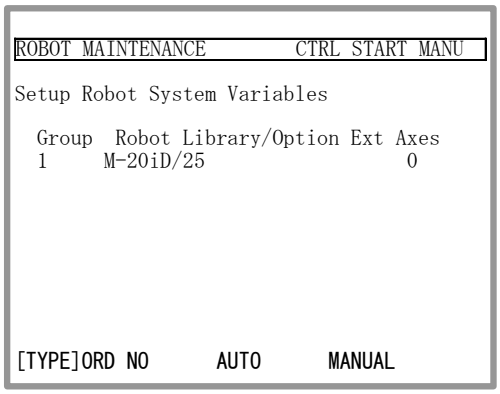


Fig.1.2.2 (a) Mounting angle

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



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

1.3 MAINTENANCE AREA

Fig. 1.3 (a) shows the maintenance area of the mechanical unit. Be sure to leave enough room for the robot to be mastered. See Chapter 8 for mastering information.

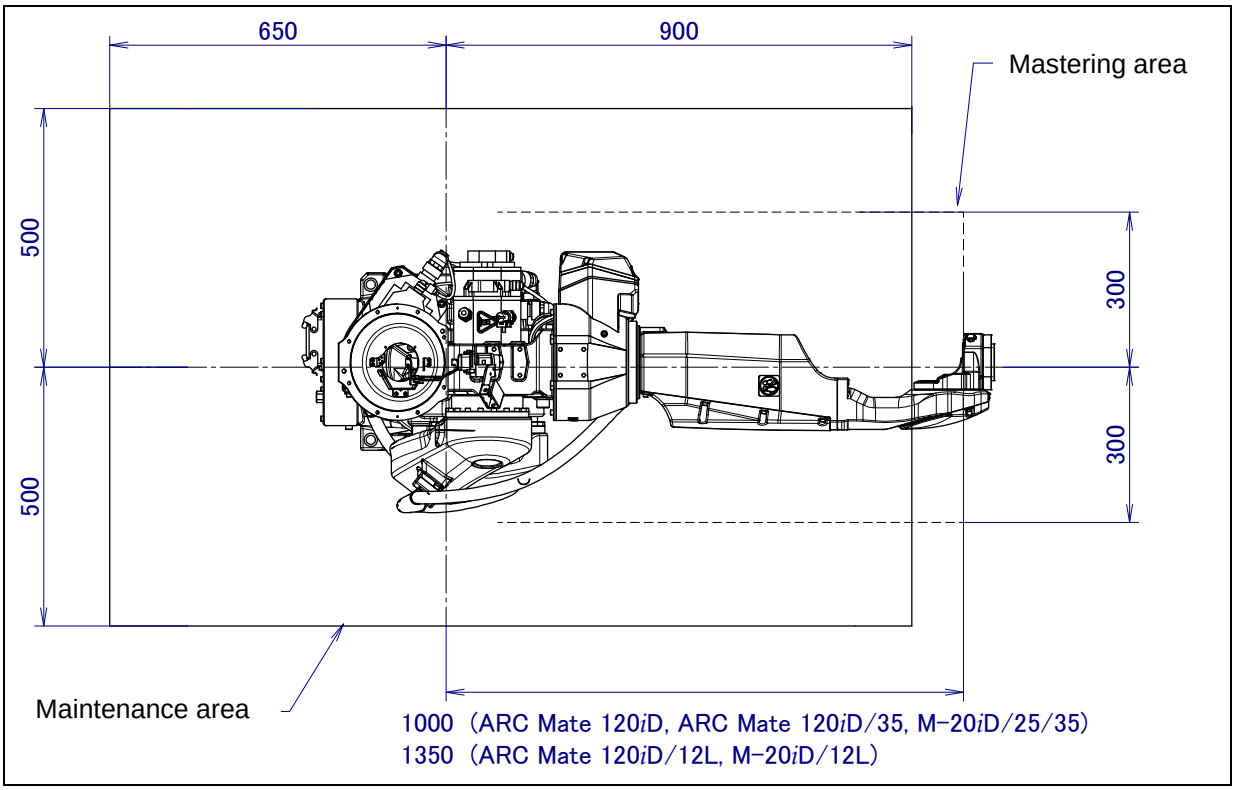


Fig. 1.3 (a) Maintenance area

1.4 INSTALLATION CONDITIONS

Refer to specification of Section 3.1 about installation conditions.

2 CONNECTION WITH THE CONTROLLER

2.1 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 Don't use 10m or longer coiled cable without first untying it. The long coiled cable could heat up and become damaged.

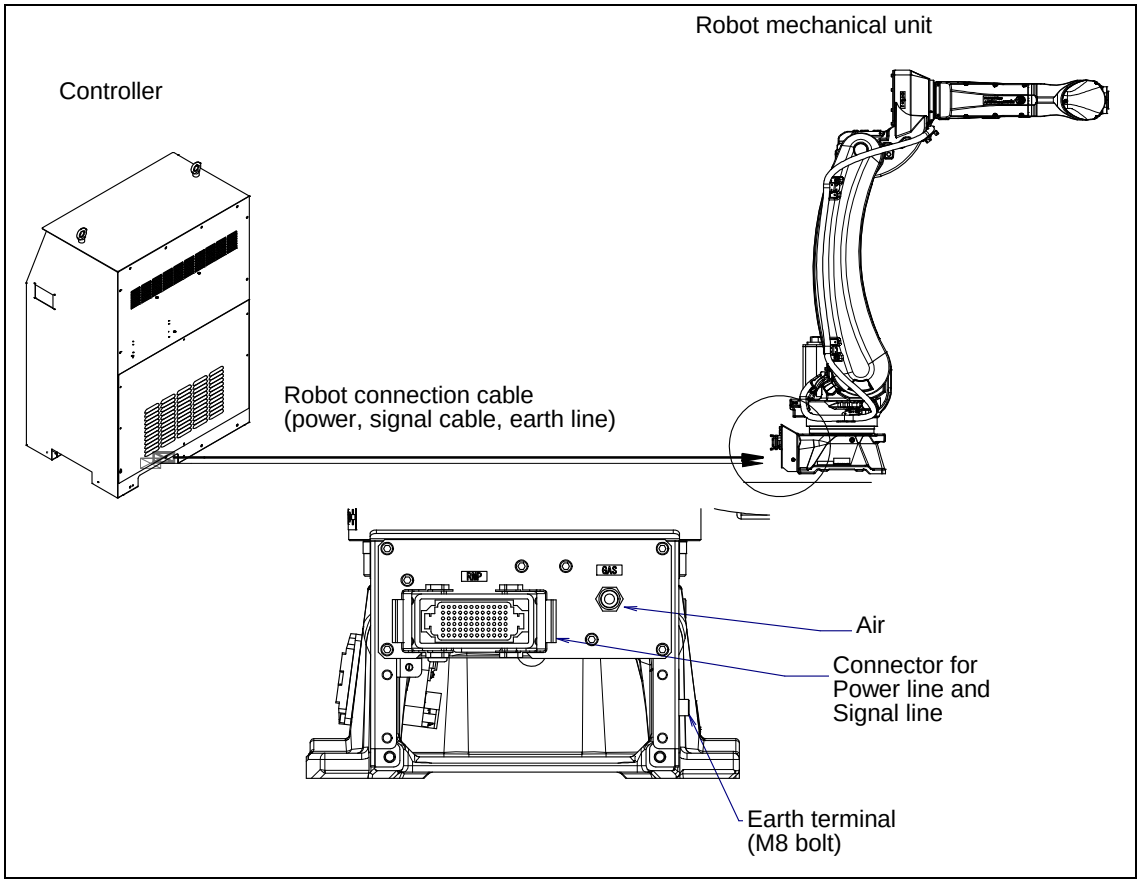


Fig. 2.1 (a) Cable connection

3 BASIC SPECIFICATIONS

3.1 ROBOT CONFIGURATION

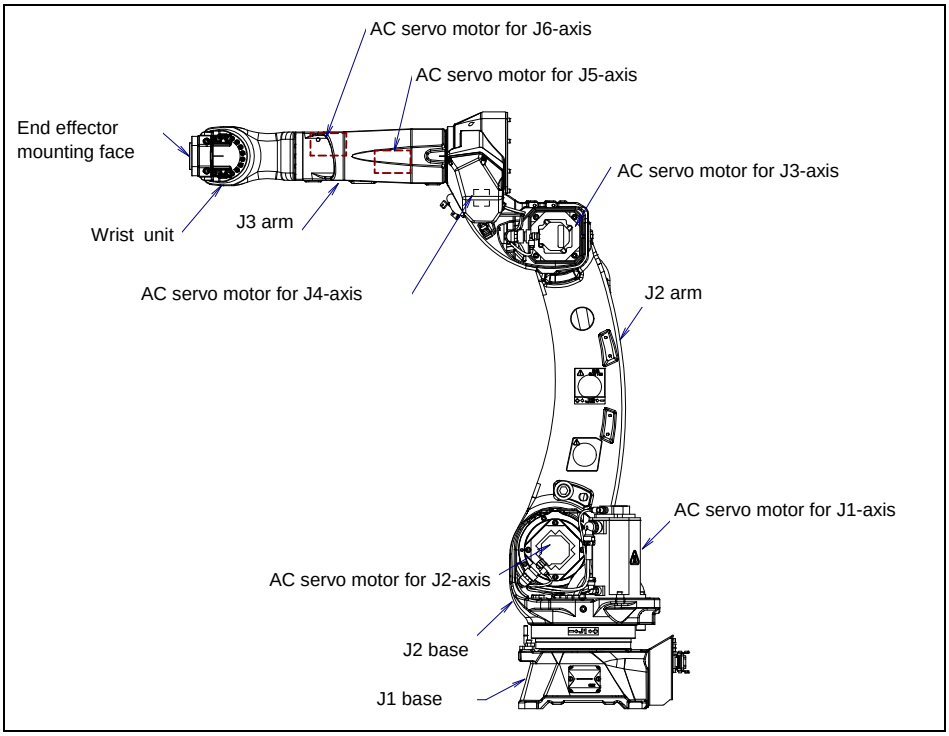


Fig. 3.1 (a) Mechanical unit configuration

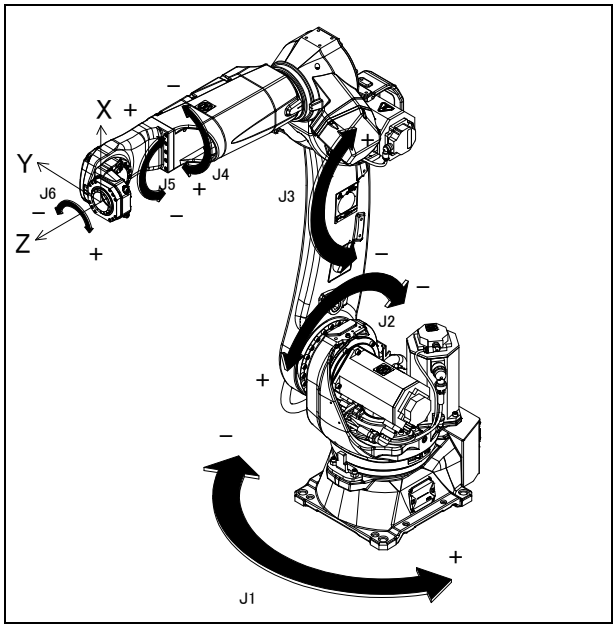


Fig. 3.1 (b) Each axes coordinates and mechanical interface coordinates

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

Specifications (NOTE 1) (1/1)

Item		Specification			
Model		ARC Mate 120*i*D M-20*i*D/25			ARC Mate 120*i*D/12L M-20*i*D/12L
Type		Articulated type			
Controlled axes		6 axes(J1, J2, J3, J4, J5, J6)			
Installation(NOTE 2)		Floor, Upside-down, Wall & Angle mount			
Motion range	J1-axis	Upper limit /Lower limit	170°(2.97rad) /-170°(-2.97rad) 185°(3.23rad) /-185°(-3.23rad) (option)		
	J2-axis	Upper limit /Lower limit	160°(2.79rad)/ -100°(-1.74rad)		
	J3-axis	Upper limit /Lower limit	268.4°(4.68rad)/-190°(-3.32rad)		
	J4-axis	Upper limit /Lower limit	200°(3.49rad) /-200°(-3.49rad)		
	J5-axis	Upper limit /Lower limit	Cable integrated type	140°(2.44rad)/-140°(-2.44rad)	
			Conventional dress out type	180°(3.14rad)/-180°(-3.14rad)	
	J6-axis	Upper limit /Lower limit	Cable integrated type	270°(4.71rad)/-270°(-4.71rad)	
			Conventional dress out type	450°(7.85rad)/-450°(-7.85rad)	
Max motion speed (NOTE 3)	J1-axis	210°/s (3.67rad/s)			210°/s (3.67rad/s)
	J2-axis	210°/s (3.67rad/s)			210°/s (3.67rad/s)
	J3-axis	265°/s (4.63rad/s)			265°/s (4.63rad/s)
	J4-axis	420°/s (7.33rad/s)			420°/s (7.33rad/s)
	J5-axis	420°/s (7.33rad/s)			450°/s (7.85rad/s)
	J6-axis	720°/s(12.57rad/s)			720°/s(12.57rad/s)
Maximum load	At wrist	25 kg			12 kg
	On J3 arm (NOTE 4)	40 kg			36 kg
Allowable load moment at wrist	J4-axis	52.0 N·m			22.0 N·m
	J5-axis	52.0 N·m			22.0 N·m
	J6-axis	32.0 N·m			9.8 N·m
Allowable load inertia at wrist	J4-axis	2.40 kg·m^2			0.65 kg·m^2
	J5-axis	2.40 kg·m^2			0.65 kg·m^2
	J6-axis	1.20 kg·m^2			0.17 kg·m^2
Repeatability (NOTE 5)		±0.02 mm			±0.03 mm
Mass		250kg			
Acoustic noise level		67.8dB (NOTE 6)			
Installation environment		Ambient temperature: 0 to 45℃ (NOTE 7) 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 8)			

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 for further evaluation before running production.
2 In case of ARC Mate 120*i*D, M-20*i*D/25, when the Wall & Angle mount is specified, the 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 is influenced by load of wrist. See Section 4.2 for detail.
5 Compliant with ISO9283.
6 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

7 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.
8 Contact the service representative, if the robot is to be used in an environment or a place subjected to hot/cold temperatures, severe vibrations, heavy dust, cutting fluid splash and or other foreign substances.

Specifications (NOTE 1) (2/2)

Item		Specification		
Model		ARC Mate 120*i*D/35 M-20*i*D/35		
Type		Articulated type		
Controlled axes		6 axes(J1, J2, J3, J4, J5, J6)		
Installation(NOTE 2)		Floor, Upside-down, Wall & Angle mount		
Motion range	J1-axis	Upper limit /Lower limit	170°(2.97rad)/-170°(-2.97rad) 185°(3.23rad)/-185°(-3.23rad) (option)	
	J2-axis	Upper limit /Lower limit	160°(2.79rad)/100°(-1.74rad)	
	J3-axis	Upper limit /Lower limit	268.4°(4.68rad)/-190°(-3.32rad)	
	J4-axis	Upper limit /Lower limit	200°(3.49rad)/-200°(-3.49rad)	
	J5-axis	Upper limit /Lower limit	Cable integrated type	140°(2.44rad)/-140°(-2.44rad)
			Conventional dress out type	180°(3.14rad)/-180°(-3.14rad)
	J6-axis	Upper limit /Lower limit	Cable integrated type	270°(4.71rad)/-270°(-4.71rad)
			Conventional dress out type	450°(7.85rad)/-450°(-7.85rad)
Max motion speed (NOTE 3)	J1-axis	180°/s (3.14rad/s)		
	J2-axis	180°/s (3.14rad/s)		
	J3-axis	200°/s (4.54rad/s)		
	J4-axis	350°/s (6.11rad/s)		
	J5-axis	350°/s (6.11rad/s)		
	J6-axis	400°/s (6.98rad/s)		
Maximum load	At wrist	35 kg		
	On J3 arm (NOTE 4)	20 kg		
Allowable load moment at wrist	J4-axis	110.0 N·m		
	J5-axis	110.0 N·m		
	J6-axis	60.0 N·m		
Allowable load inertia at wrist	J4-axis	4.00 kg·m2		
	J5-axis	4.00 kg·m2		
	J6-axis	1.50 kg·m2		
Repeatability (NOTE 5)		±0.03 mm		
Mass		250kg		
Acoustic noise level		67.8dB (NOTE 6)		
Installation environment		Ambient temperature: 0 to 45℃ (NOTE 7) 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 8)		

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 for further evaluation before running production.
2 When the Wall & Angle mount is specified, the 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 is influenced by load of wrist. See Section 4.2 for detail.
5 Compliant with ISO9283.
6 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

7 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.
8 Contact the service representative, if the robot is to be used in an environment or a place subjected to hot/cold temperatures, severe vibrations, heavy dust, cutting fluid splash and or other foreign substances.

Table 3.1 (a) The dustproof and waterproof characteristics

	Normal specification
Wrist (*) +J3 arm	IP67
Other part	IP54

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

(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 including chlorine / gasoline
   (c) Amine type detergent
   (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) Don 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 WORK ENVELOPE

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

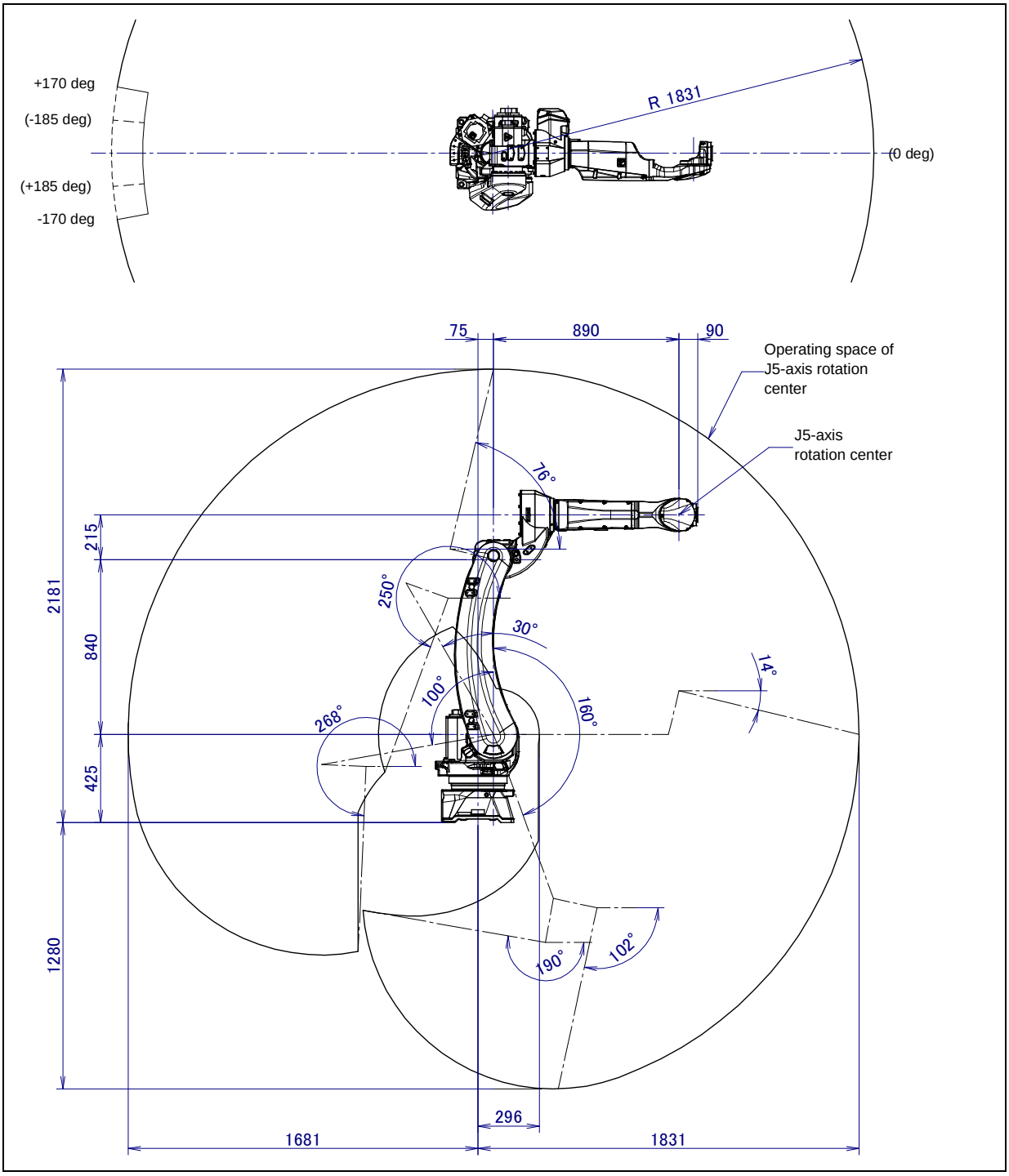


Fig. 3.2 (a) Operating space (ARC Mate 120*i*D, ARC Mate 120*i*D/35, M-20*i*D/25/35)

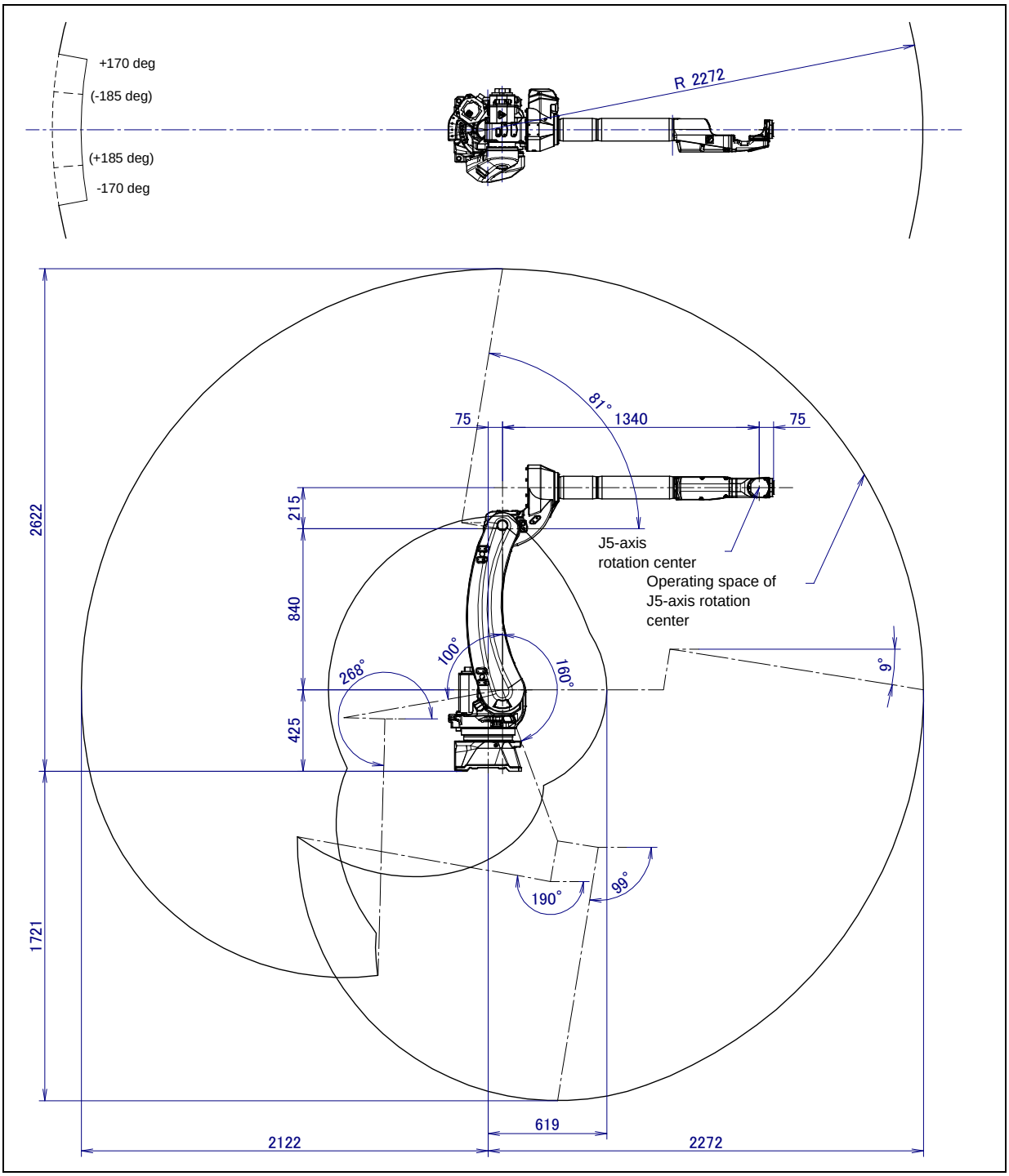


Fig. 3.2 (b) Operating space (ARC Mate 120*i*D/12L, M-20*i*D/12L)

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.

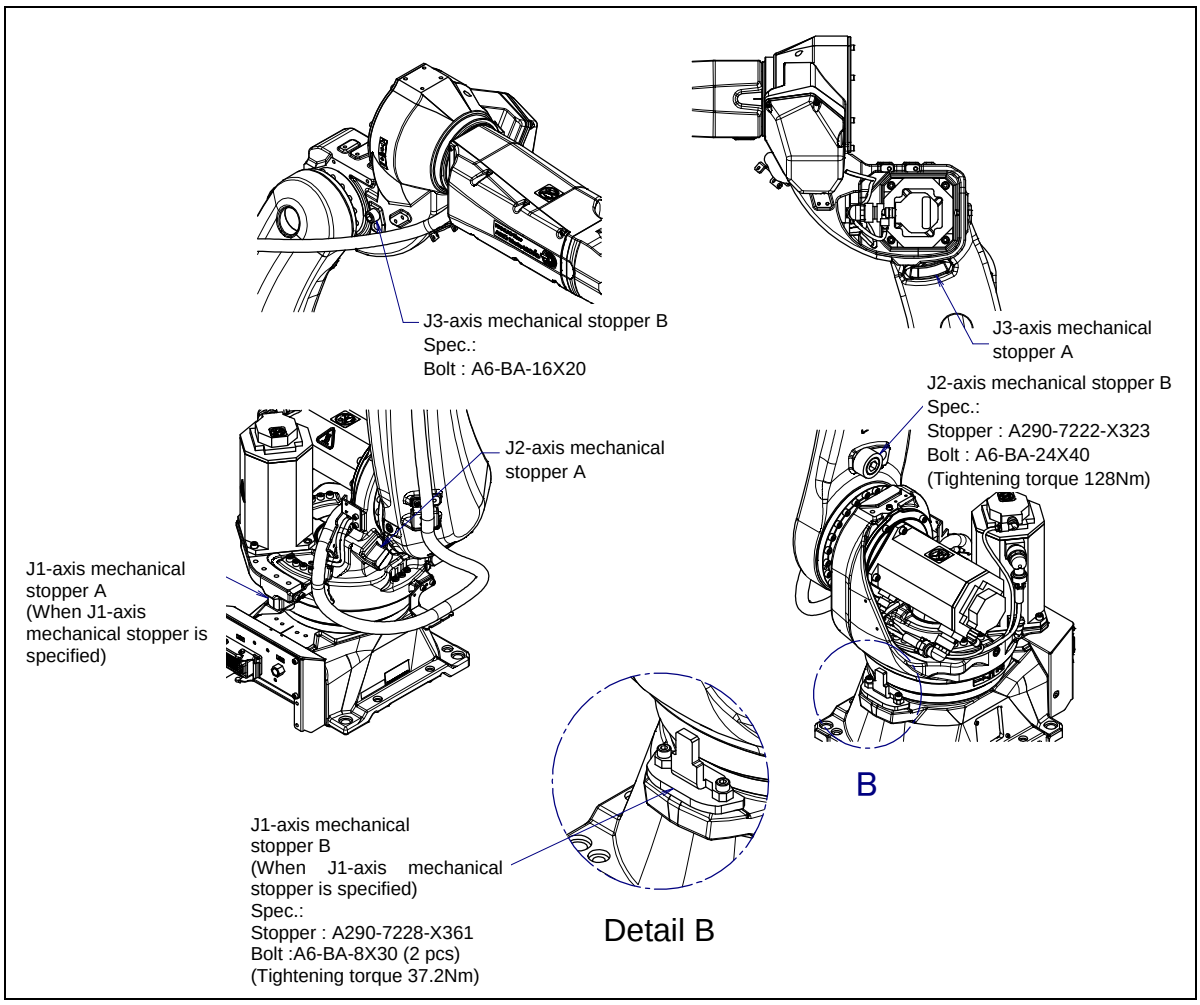


Fig. 3.3 (a) Position of mechanical stopper

When the J1-axis mechanical stopper and J1-axis adjustable mechanical stopper (option) is not used, attach the label and protect the mounting face. If label has no adhesive force or it is lost, order and attach it.

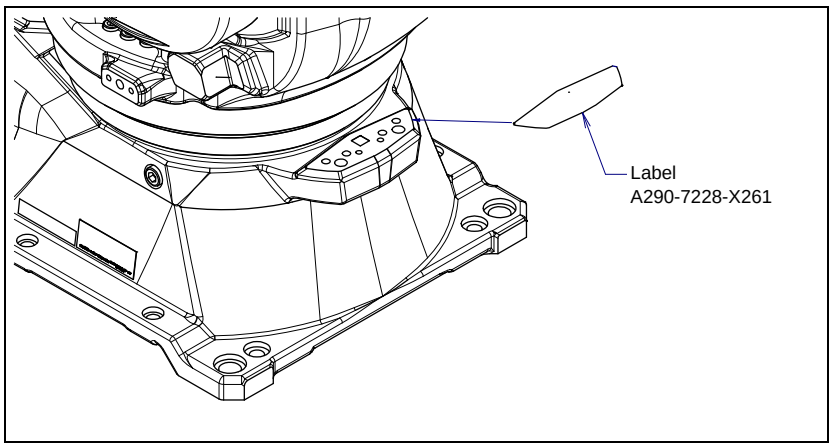


Fig. 3.3 (b) Protection label for J1-axis mechanical stopper mounting position

> ⚠ **WARNING**
> If spatter etc. attached to the mounting face or the tap, the J1-axis mechanical stopper and J1-axis adjustable mechanical stopper (option) cannot be installed correctly, and there is a possibility that the robot does not stop.

Fig. 3.3 (c) to 3.3 (i) show the zero point and motion limit and maximum stopping distance (stopping distance in condition of maximum speed and maximum load) of each axis.

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

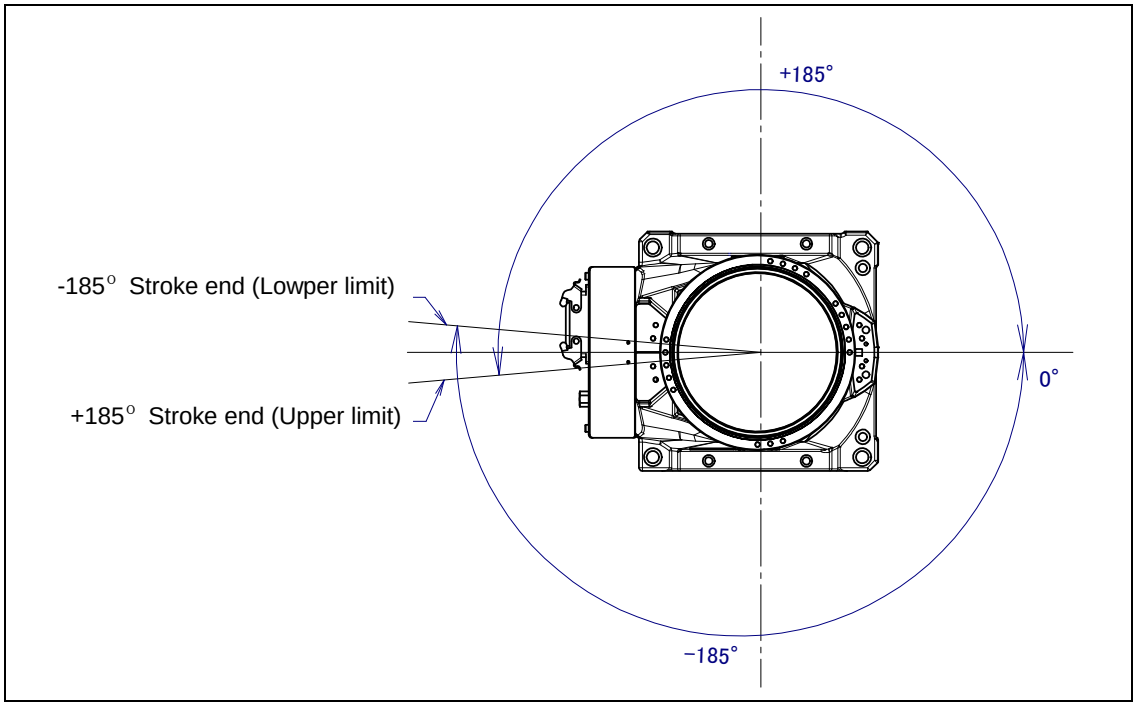


Fig. 3.3 (c) J1-axis motion limit (When mechanical stopper option is not selected)

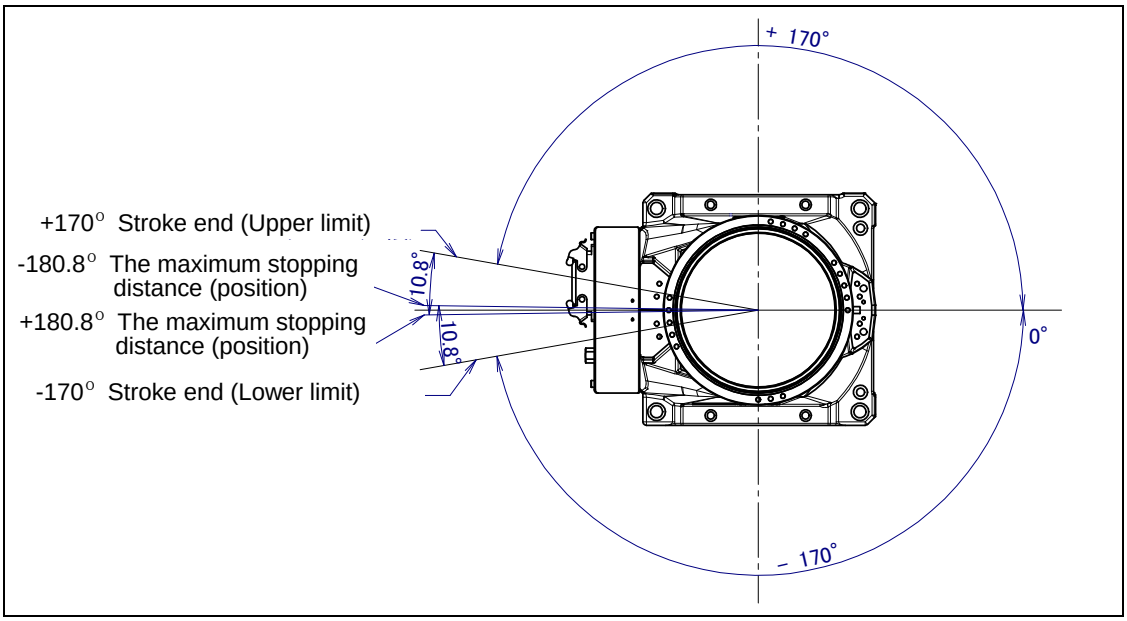


Fig. 3.3 (d) J1-axis motion limit (When mechanical stopper is selected)

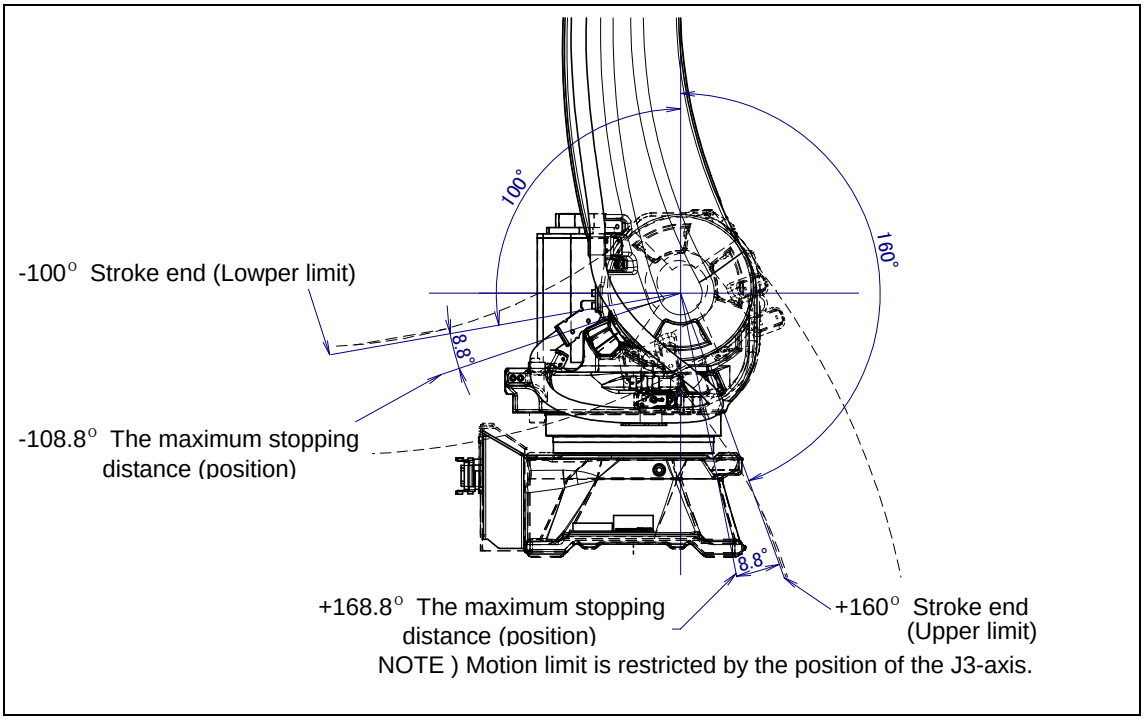


Fig. 3.3 (e) J2-axis motion limit

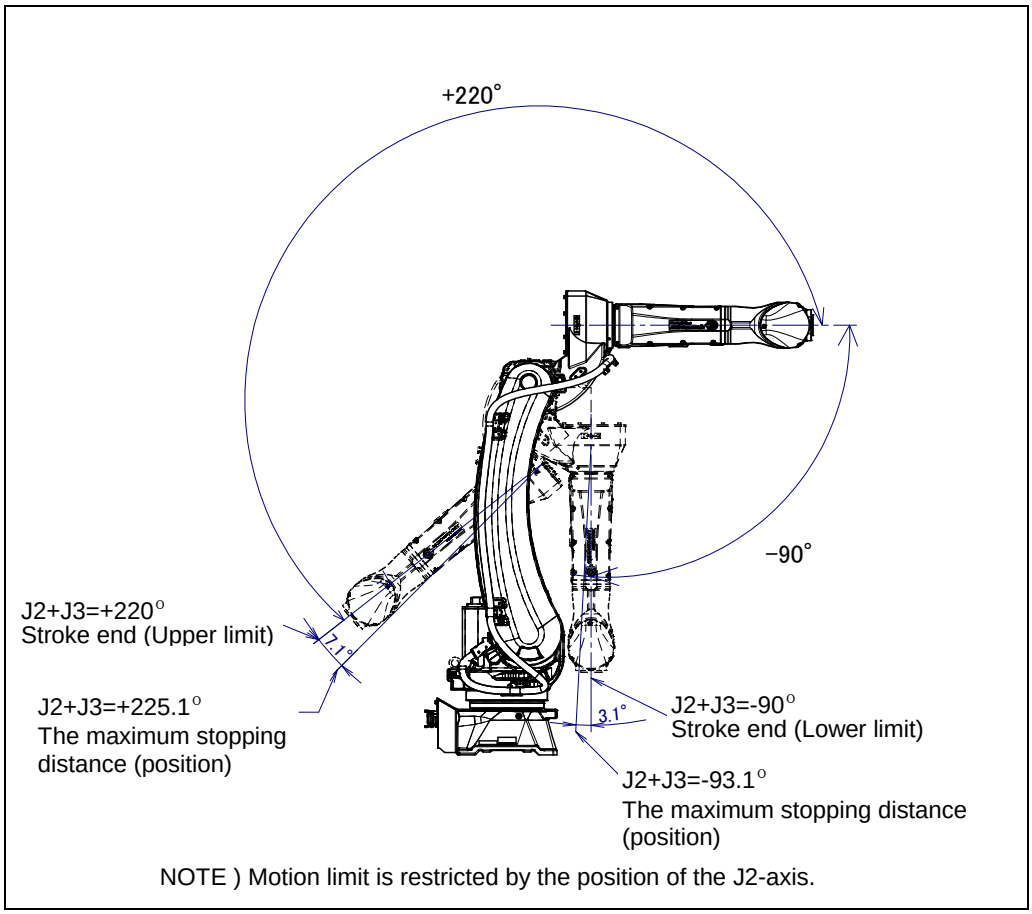


Fig. 3.3 (f) J3-axis motion limit

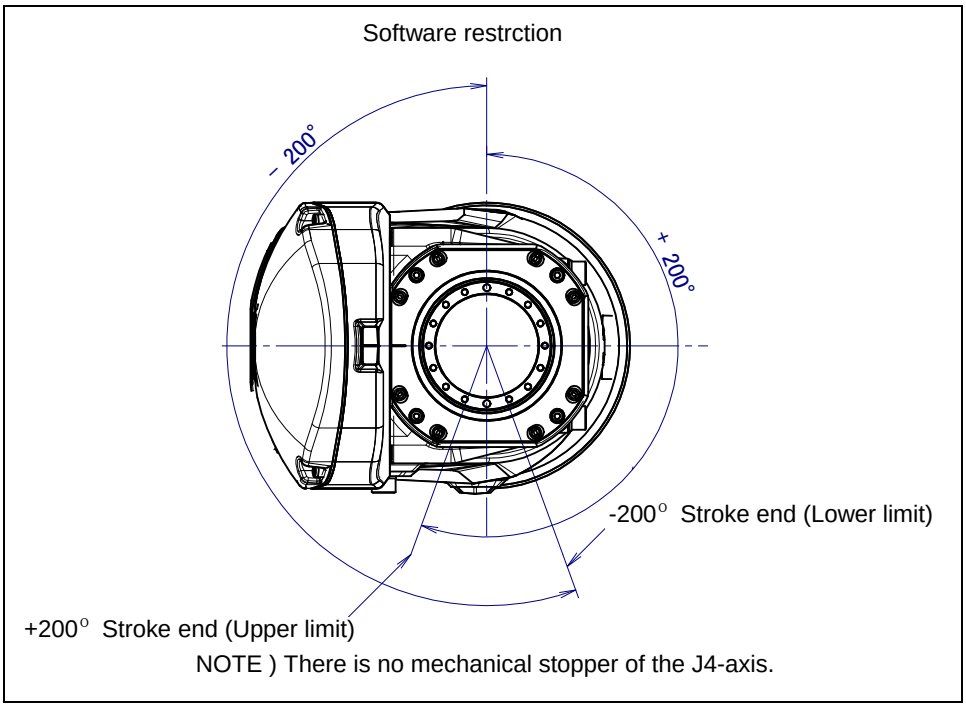


Fig. 3.3 (g) J4-axis motion limit

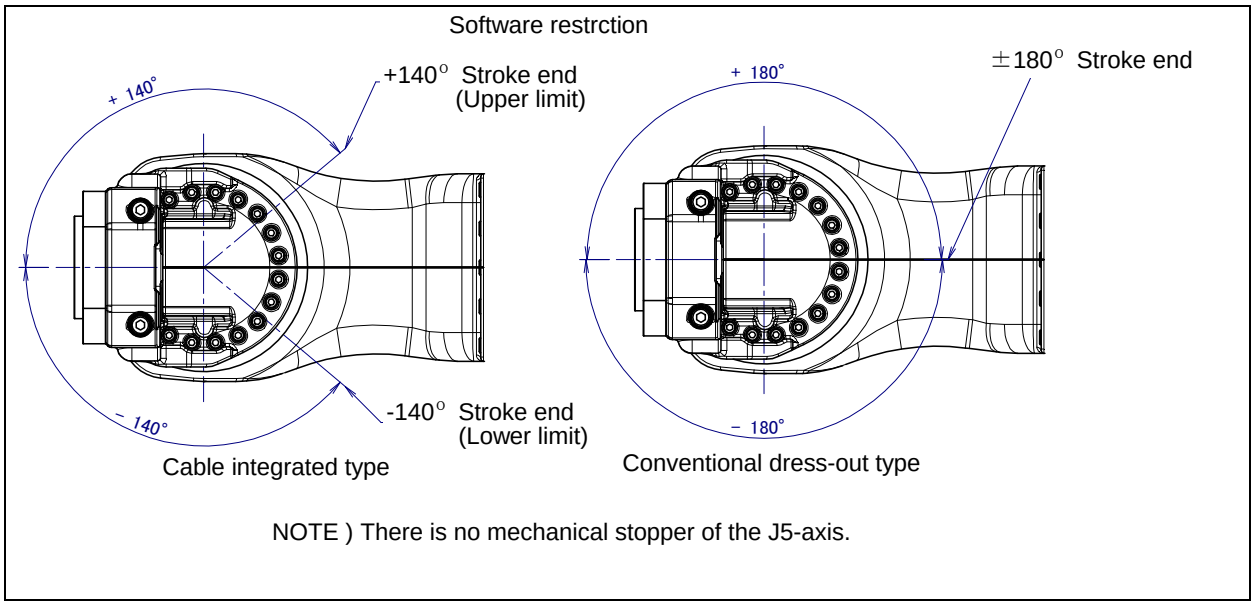


Fig. 3.3 (h) J5-axis motion limit

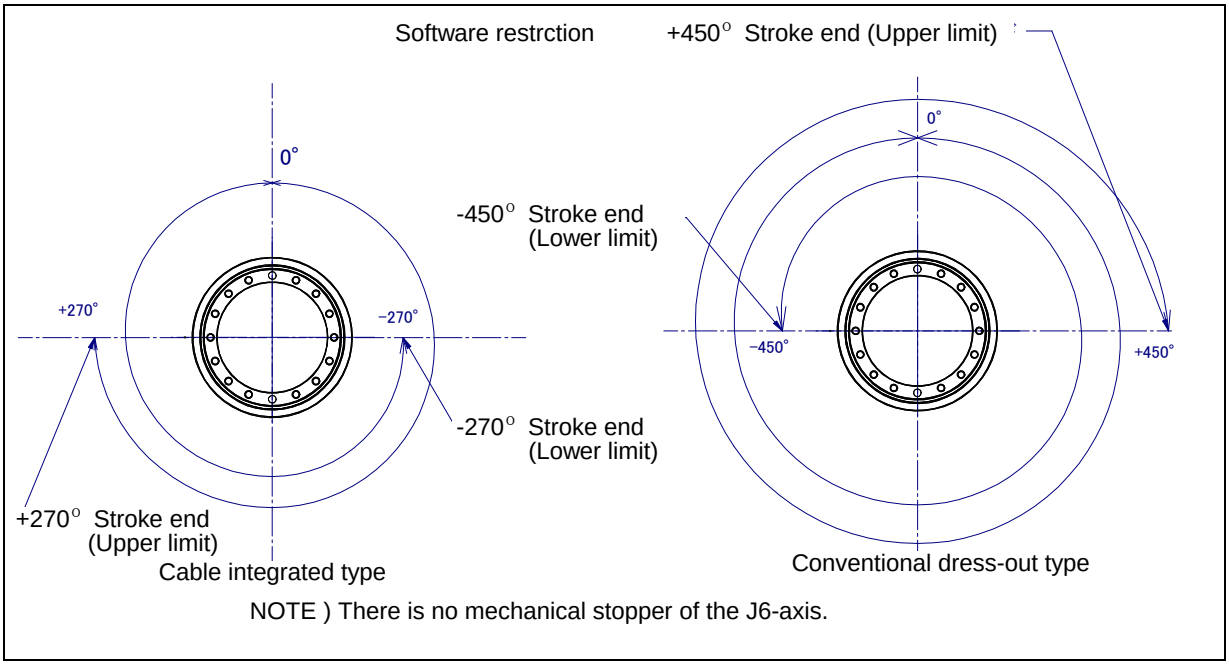


Fig. 3.3 (i) J6-axis motion limit

3.4 MOTION RANGE ACCORDING TO CABLE INTEGRATION

In ARC Mate 120*i*D, M-20*i*D cable is integrated hollow part of J3 arm is standard. (It is “Cable integrated type” in the following). When the robot is shipped, is set to the range of motion of “Cable integrated type”. The case where conduit is inserted in the J3 arm hollow part, and the cable is passed as shown in Fig. 3.4 (a) is defined as "Cable integrated".
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”.

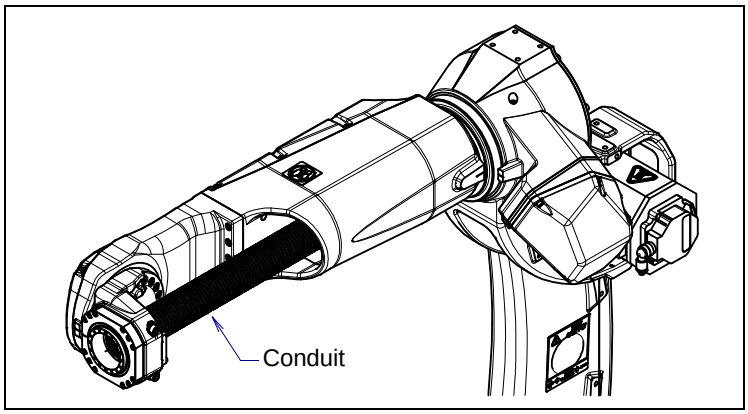


Fig. 3.4 (a) Example of “Cable integrated”

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
   （J5:-140  .. 140, J6:-270  ..  270[deg]）
2: Conventional dress-out
   (J5:-180  ..  180, J6:-450  ..  450[deg])

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

1) Note about “Cable integrate” 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-1228-J701#□□□] is needed. Refer to Section 10.2 about replacing 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.

3.5 WRIST LOAD CONDITIONS

- Fig. 3.5 (a) to (c) are diagrams showing the allowable load that can be applied to the wrist section.
- Apply a load within the region indicated in the graph.
- Apply the conditions of the allowable load moment and the allowable load inertia. See Section 3.1 about the allowable load moment and the allowable load inertia.
- See Section 4.1 about mounting of end effector.

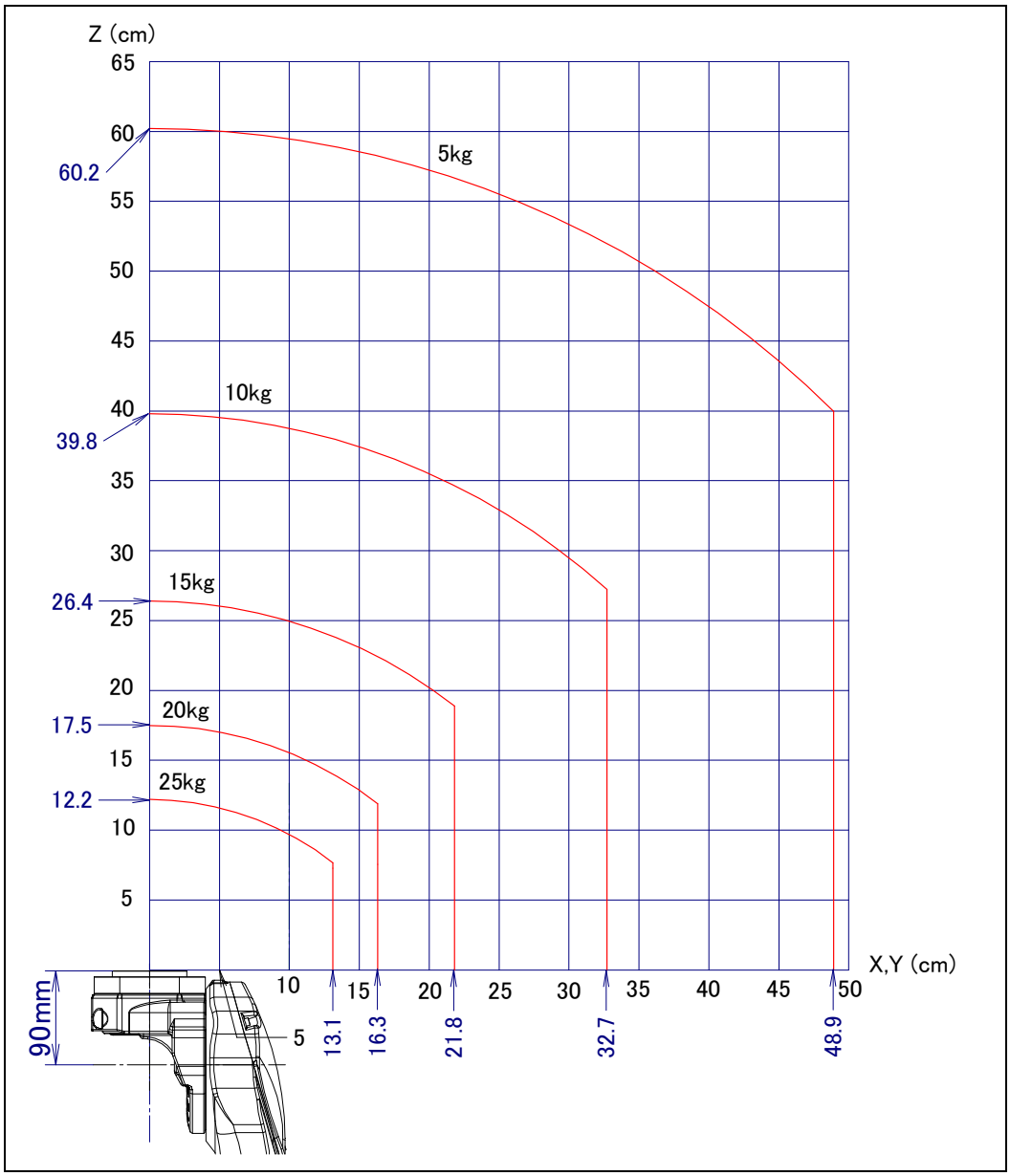


Fig. 3.5 (a) Wrist load diagram (ARC Mate 120*i*D, M-20*i*D/25)

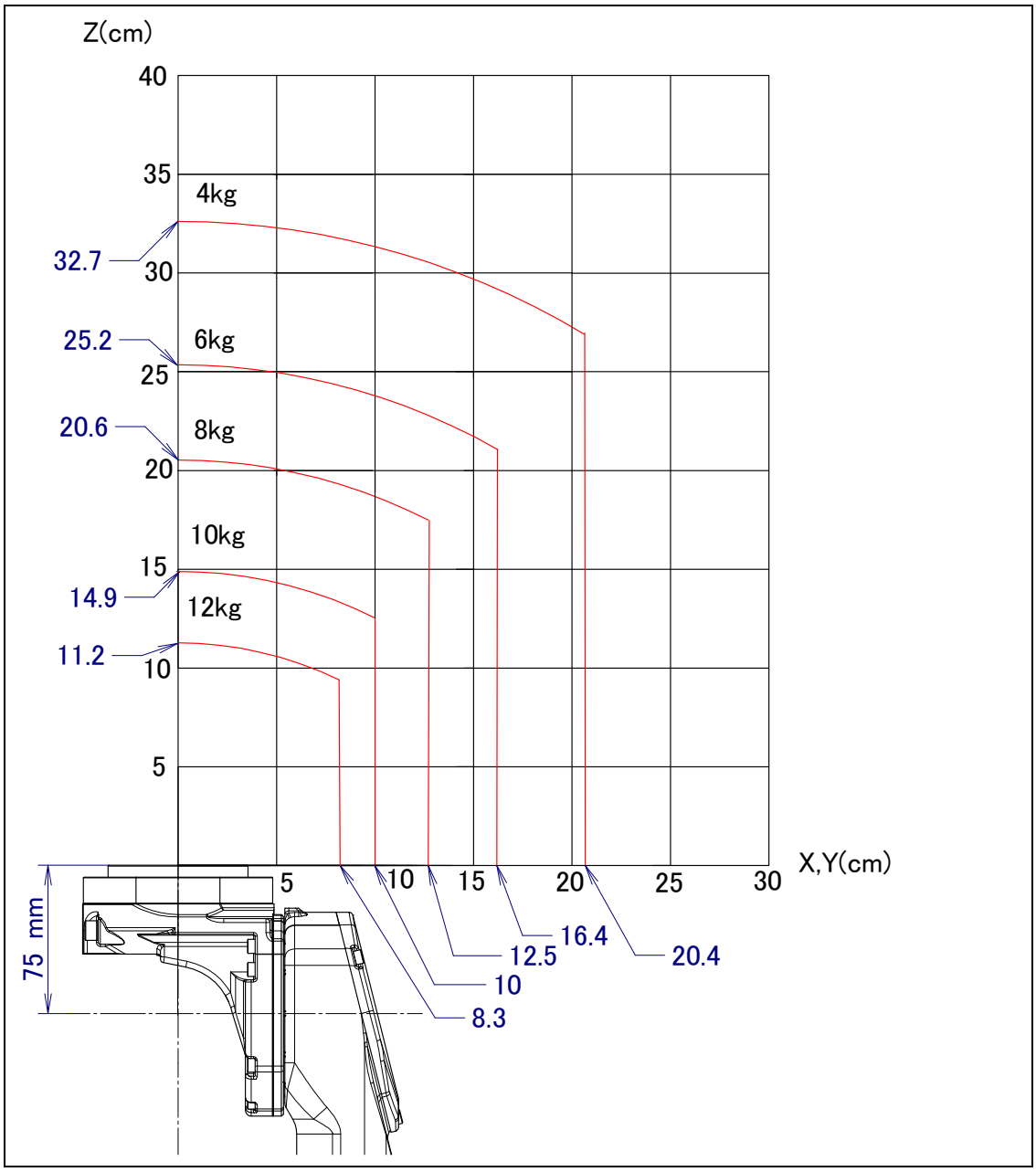


Fig. 3.5 (b) Wrist load diagram (ARC Mate 120*i*D/12L, M-20*i*D/12L)

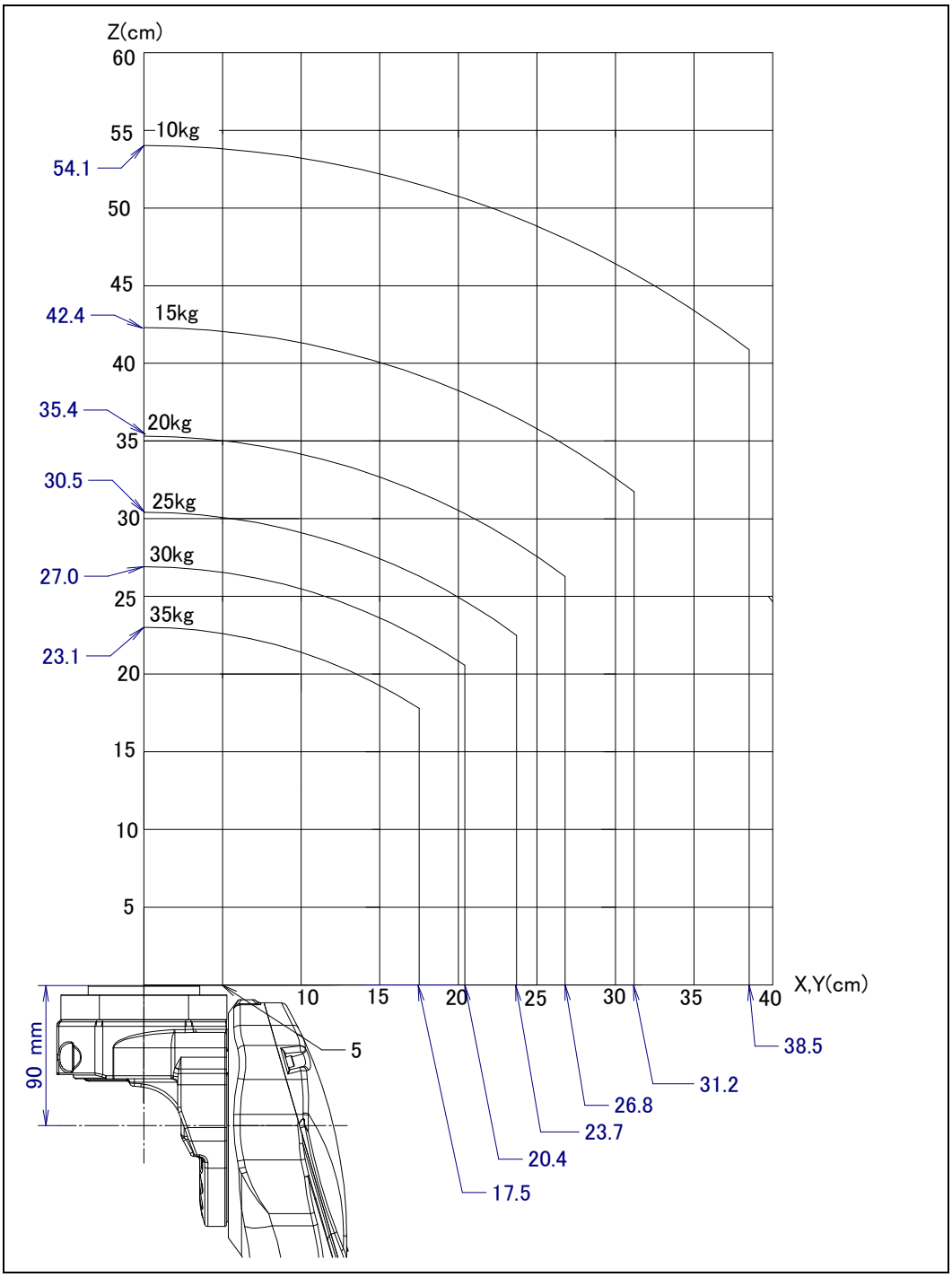


Fig. 3.5 (c) Wrist load diagram (ARC Mate 120*i*D/35, M-20*i*D/35)

3.6 OPERATING AREA FOR INCLINATION INSTALLATION

When the robot ARC Mate 120*i*D, ARC Mate 120*i*D/35, M-20*i*D/25/35 are installed on an angle, the operating area is limited to that angle. The robot can't rest except for within the ranges that are shown in the Fig. 3.6 (a) to (d).
ARC Mate 120*i*D/12L, M-20*i*D/12L do not have such restriction.

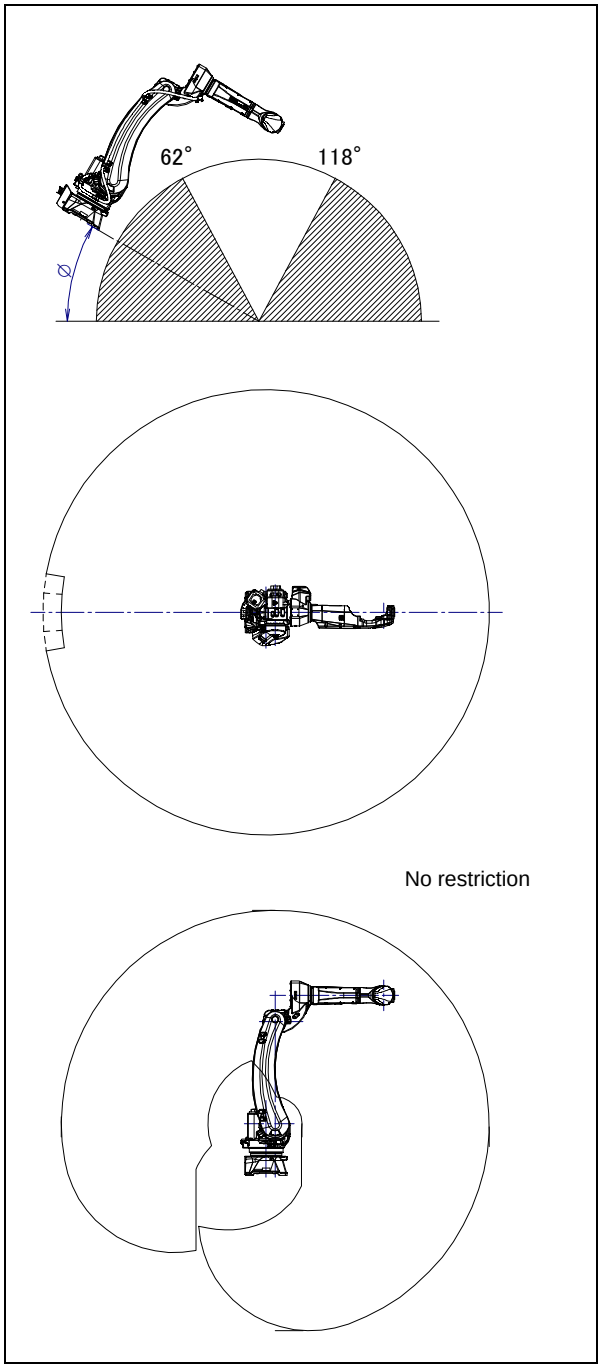


Fig. 3.6 (a) Installation area (1) operating area (ARC Mate 120*i*D, M-20*i*D/25)
(0°≦ϕ≦62°, 118°≦ϕ≦180°)

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

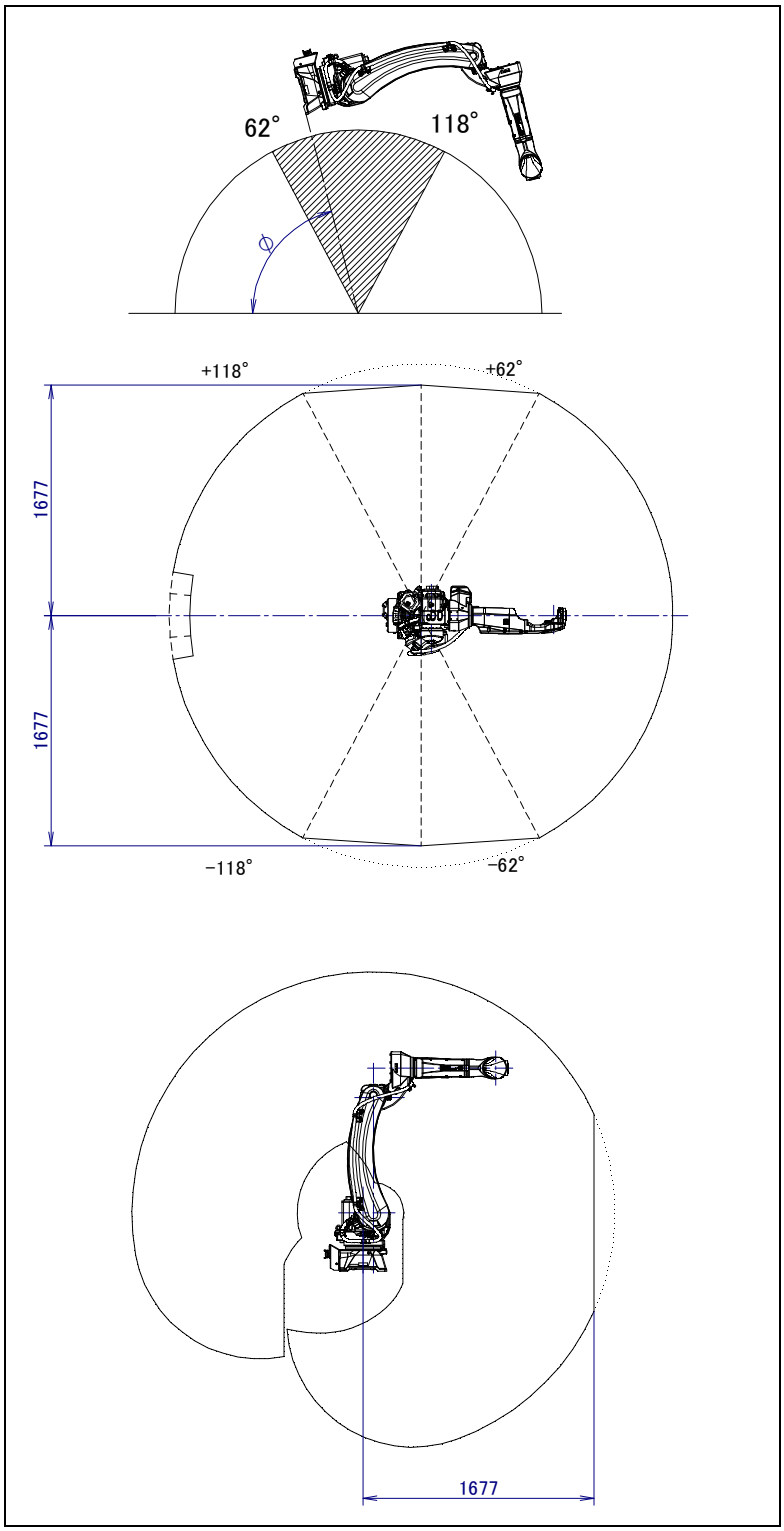


Fig. 3.6 (b) Installation area (2) operating area (ARC Mate 120*i*D, M-20*i*D/25) (62°<ϕ<118°)

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

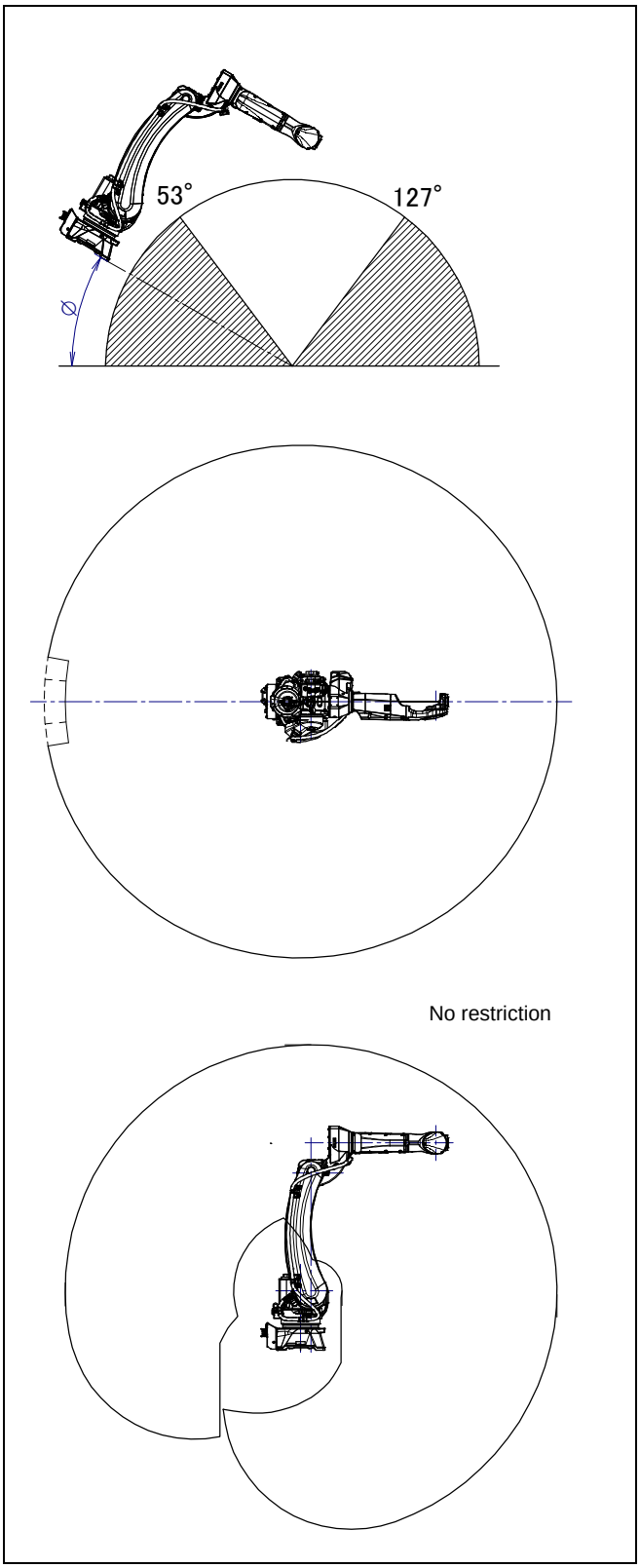


Fig. 3.6 (c) Installation area (1) operating area (ARC Mate 120*i*D/35, M-20*i*D/35)
(0°≦ϕ≦53°, 127°≦ϕ≦180°)

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

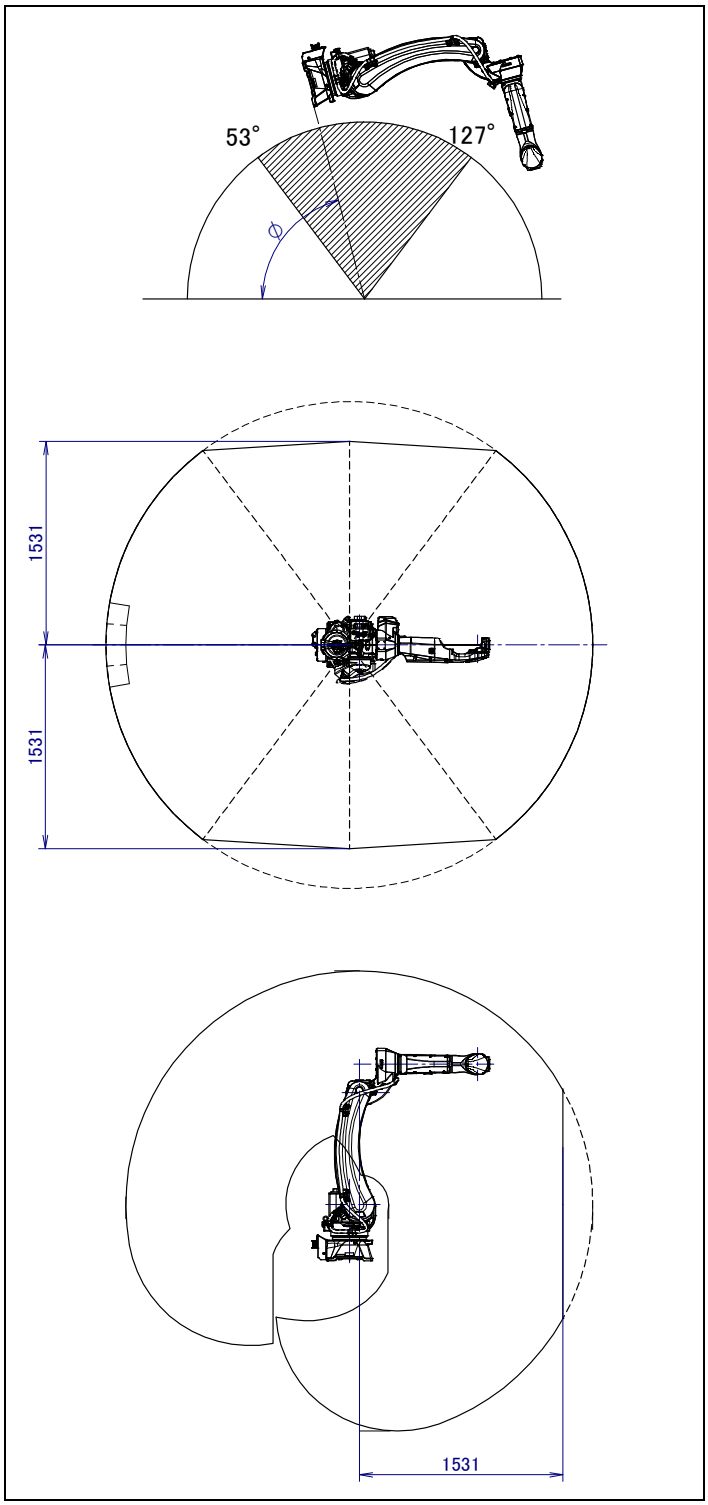


Fig. 3.6 (d) Installation area (2) operating area (ARC Mate 120*i*D/35, M-20*i*D/35) (53°<ϕ<127°)

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

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) shows 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 pinholes. 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.

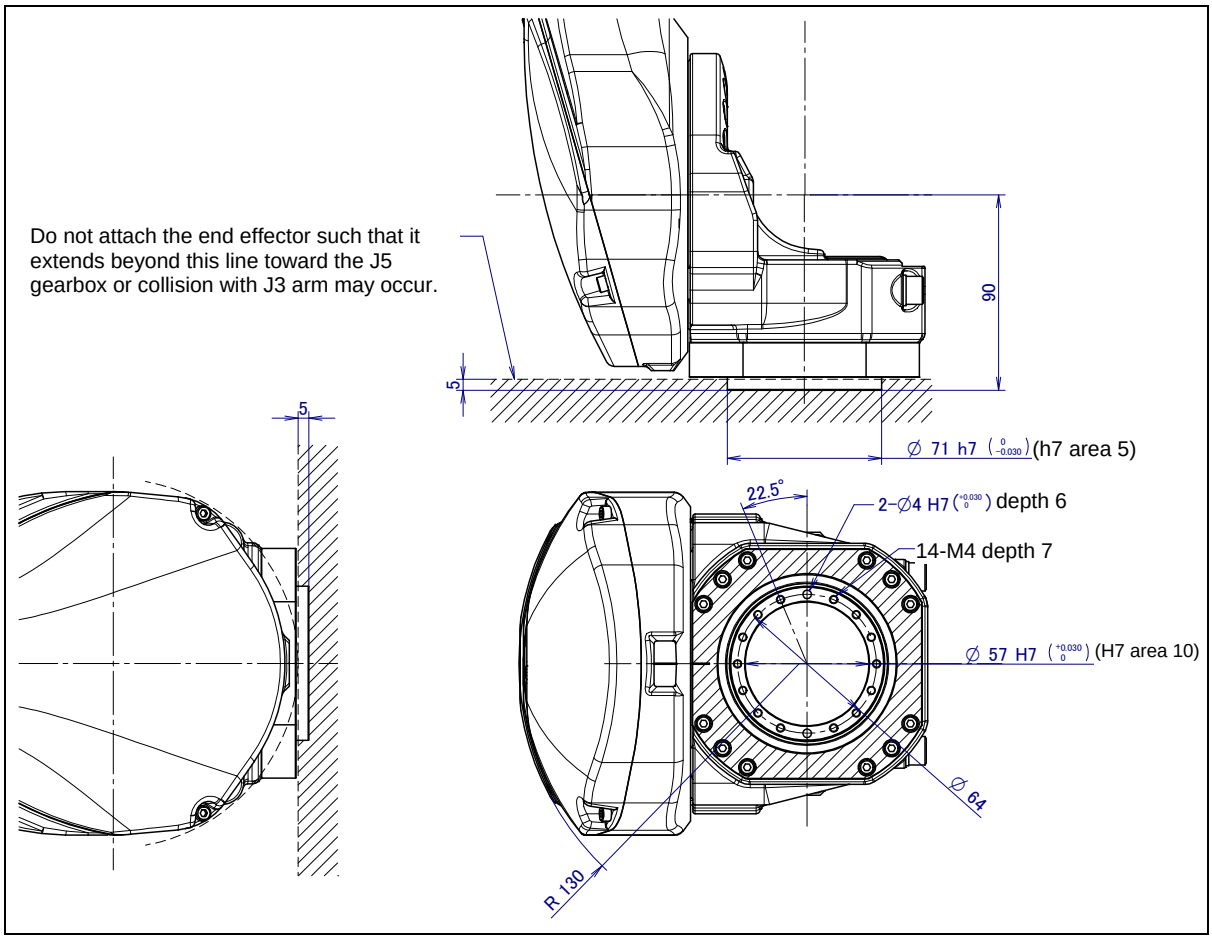


Fig. 4.1 (a) End effector interface (ARC Mate 120*i*D, ARC Mate 120*i*D/35, M-20*i*D/25/35)

⚠ CAUTION
Do not remove the M4 bolts of shaped area. If they are removed, the robot does not return to the original state.

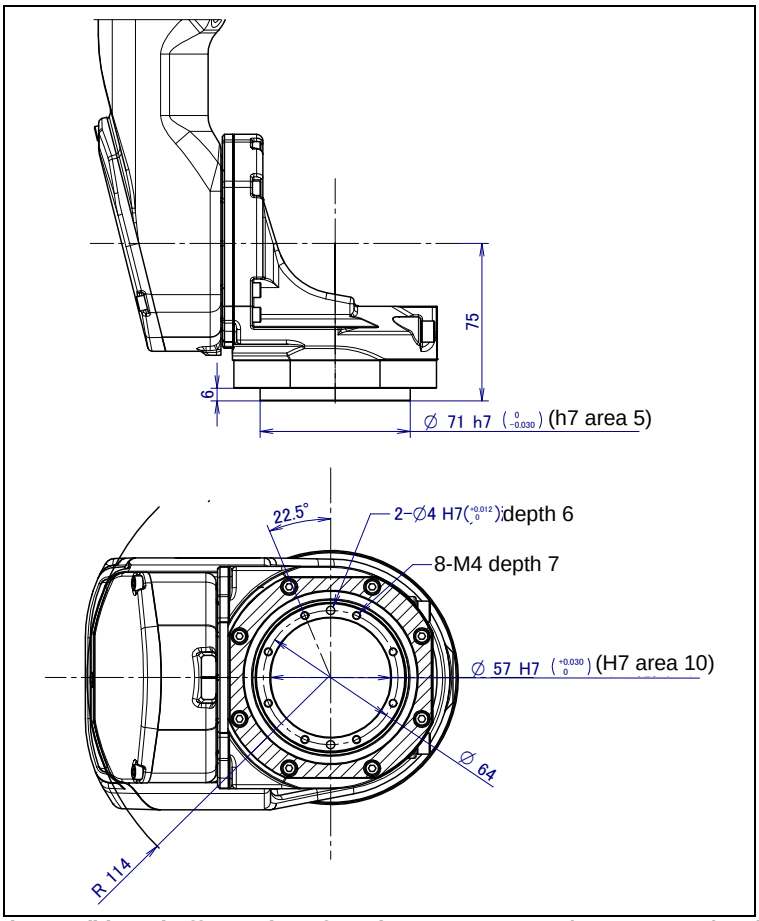


Fig. 4.1 (b) End effector interface (ARC Mate 120*i*D/12L, M-20*i*D/12L)

> ⚠ **CAUTION**
> Do not remove the M4 bolts of shaped area. If they are removed, the robot does not return to the original state.

4.2 EQUIPMENT MOUNTING FACE

Fig. 4.2 (a) show load condition. As shown in Fig. 4.2 (b), (c), tapped holes are provided to install equipment to the robot.

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

W: Mass of the end effector mounting face
A,B,C : Mass of equipment on the J3 casing
D : Mass of equipment on the J2 arm

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

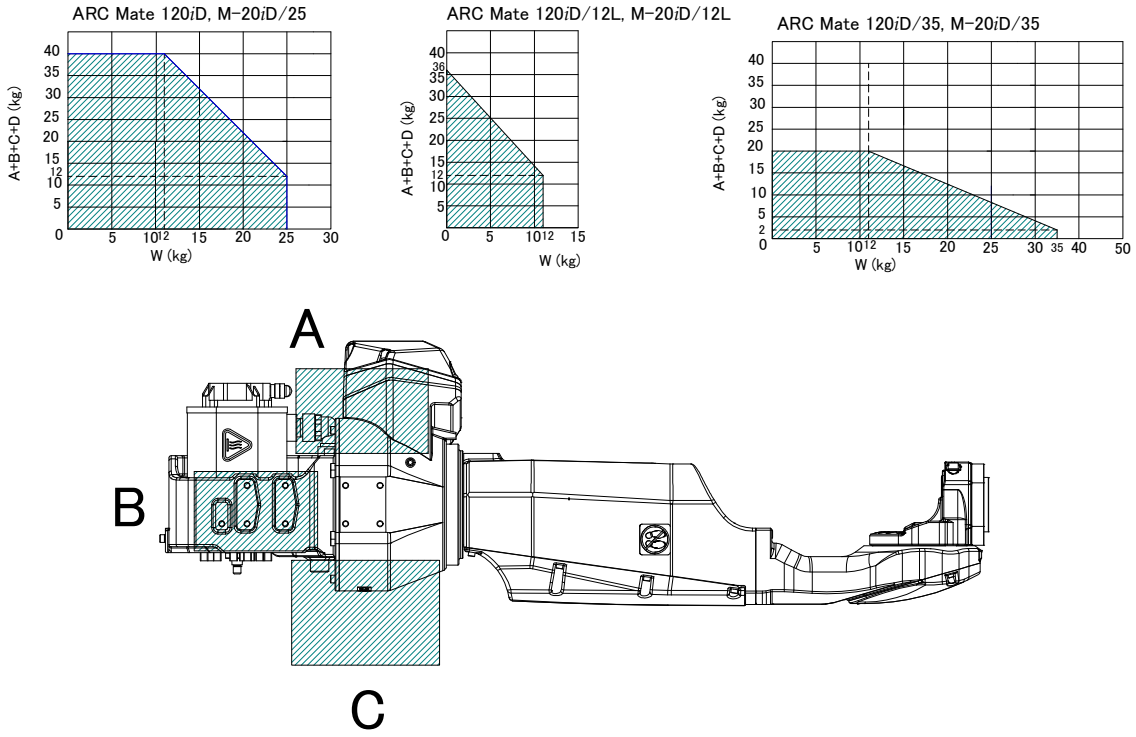


Fig. 4.2 (a) Loading condition

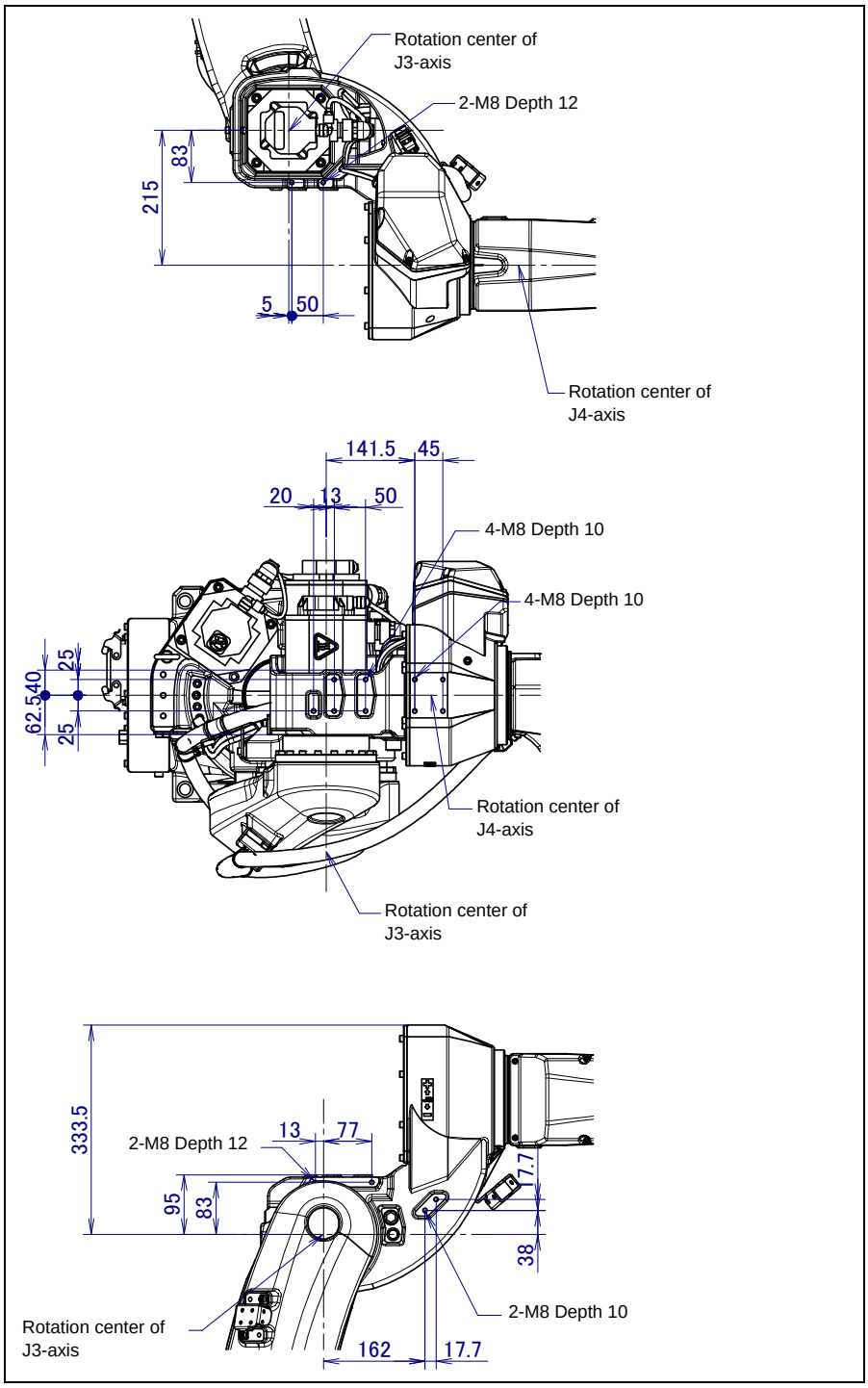


Fig. 4.2 (b) Equipment mounting faces (1/2) (A+B+C part)

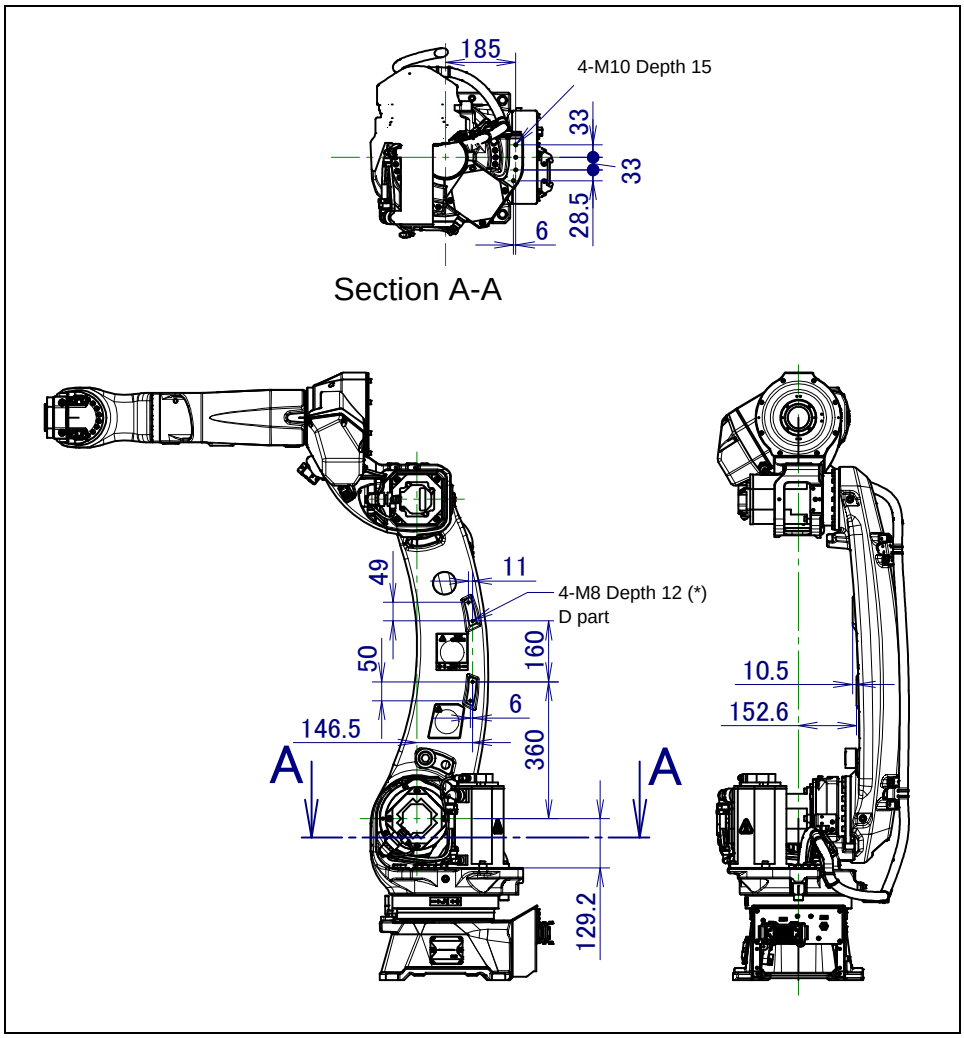


Fig. 4.2 (c) Equipment mounting faces (2/2) (D part + J2 base)

> ⚠ **CAUTION**
> Be careful equipment in (*) part not interfere with the J3 casing.

4.3 LOAD SETTING

> ⚠ **CAUTION**
> Set the correct load condition parameter before the robot runs. Do not operate the robot in over when its payload is exceeded or incorrect. Do not exceed the allowable payload including connection cables. Operation in with the robot over payload may result in troubles such as reducer life reduction.

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

```
MOTION PERFORMANCE                    JOINT 10%
    Group1
No.   PAYLOAD[kg]          Comment
 1          25.00   [                    ]
 2           0.00   [                    ]
 3           0.00   [                    ]
 4           0.00   [                    ]
 5           0.00   [                    ]
 6           0.00   [                    ]
 7           0.00   [                    ]
 8           0.00   [                    ]
 9           0.00   [                    ]
10           0.00   [                    ]


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

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

```
MOTION PAYLOAD SET                    JOINT 10%

    Group 1
 1 Schedule No[          1]:[Comment          ]
 2 PAYLOAD                    [kg]       25.00
 3 PAYLOAD CENTER  X [cm]                -7.99
 4 PAYLOAD CENTER  Y [cm]                 0.00
 5 PAYLOAD CENTER  Z [cm]                 6.44
 6 PAYLOAD INERTIA X [kgfcms^2]           0.13
 7 PAYLOAD INERTIA Y [kgfcms^2]           0.14
 8 PAYLOAD INERTIA Z [kgfcms^2]           0.07

 [TYPE] GROUP NUMBER   DEFAULT   HELP
```

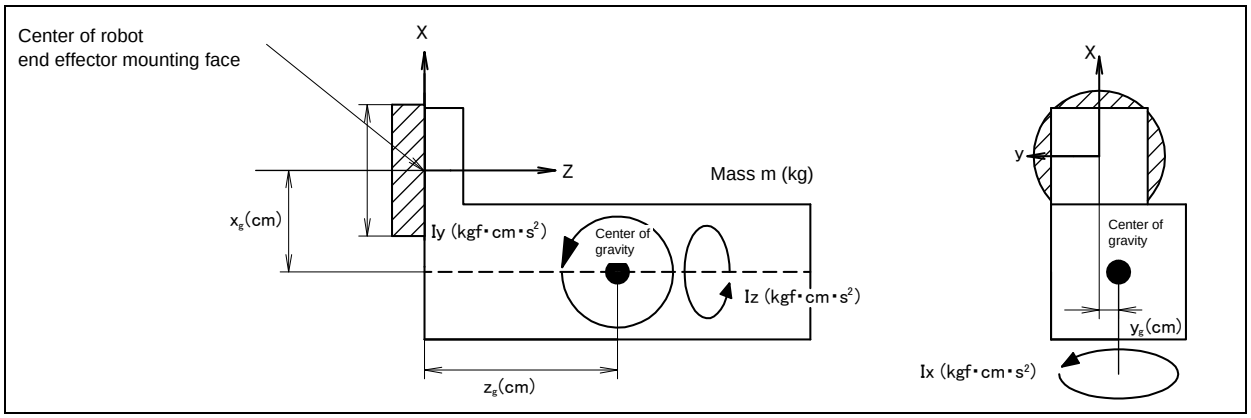


Fig. 4.3 (a) Standard tool coordinate

6 Set the payload, gravity center position, and inertia around the gravity center on the MOTION PAYLOAD SET screen. The X, Y, and Z directions displayed on this screen correspond to the respective standard tool coordinates (with no tool coordinate system set up). When values are entered, the following message appears: “Path and 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 multi group 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. Click F5 ([SETIND]), and enter the desired payload setting condition number.

9 On the list screen, pressing F4 ARMLOAD brings you to the equipment-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 your local FANUC representative if you install equipments on J2 base.)
ARMLOAD AXIS #3[kg] : Mass of the load on the J3 casing, (wrist side)
the confirmation message “Path and Cycle time will change. Set it?” appears. Select F4 YES or F5 NO. Once the mass of equipment is entered, it is put in effect by turning the power off and on again.

5 PIPING AND WIRING TO THE END EFFECTOR

⚠ WARNING

- Only use appropriately-specified mechanical unit cables.
- Do not add user cables or hoses inside of the mechanical unit.
- Please do not obstruct the movement of the mechanical unit 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.

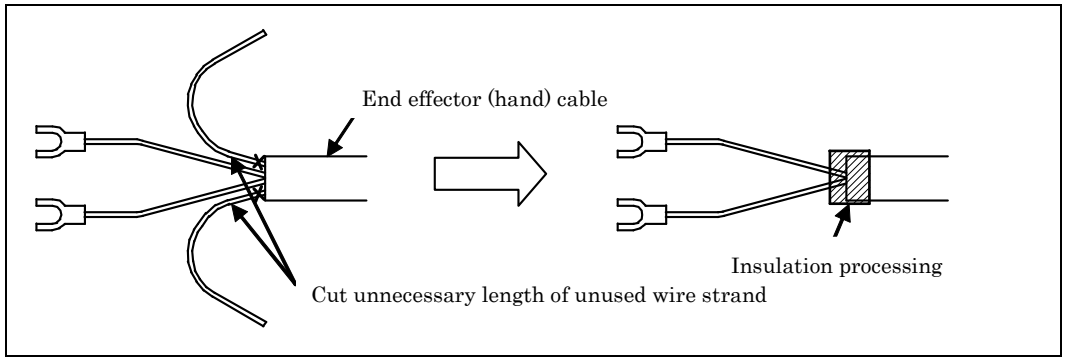


Fig. 5 (a) Treatment method of end effector (hand) cable

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-1228-H201#☐☐ A05B-1228-H205#☐☐	Rc3/8 X1	None	Outer 8mm Inner 5mm 1 pc
A05B-1228-H221#☐☐ A05B-1228-H222#☐☐ A05B-1228-H223#☐☐ A05B-1228-H224#☐☐		Rc3/8 X1	

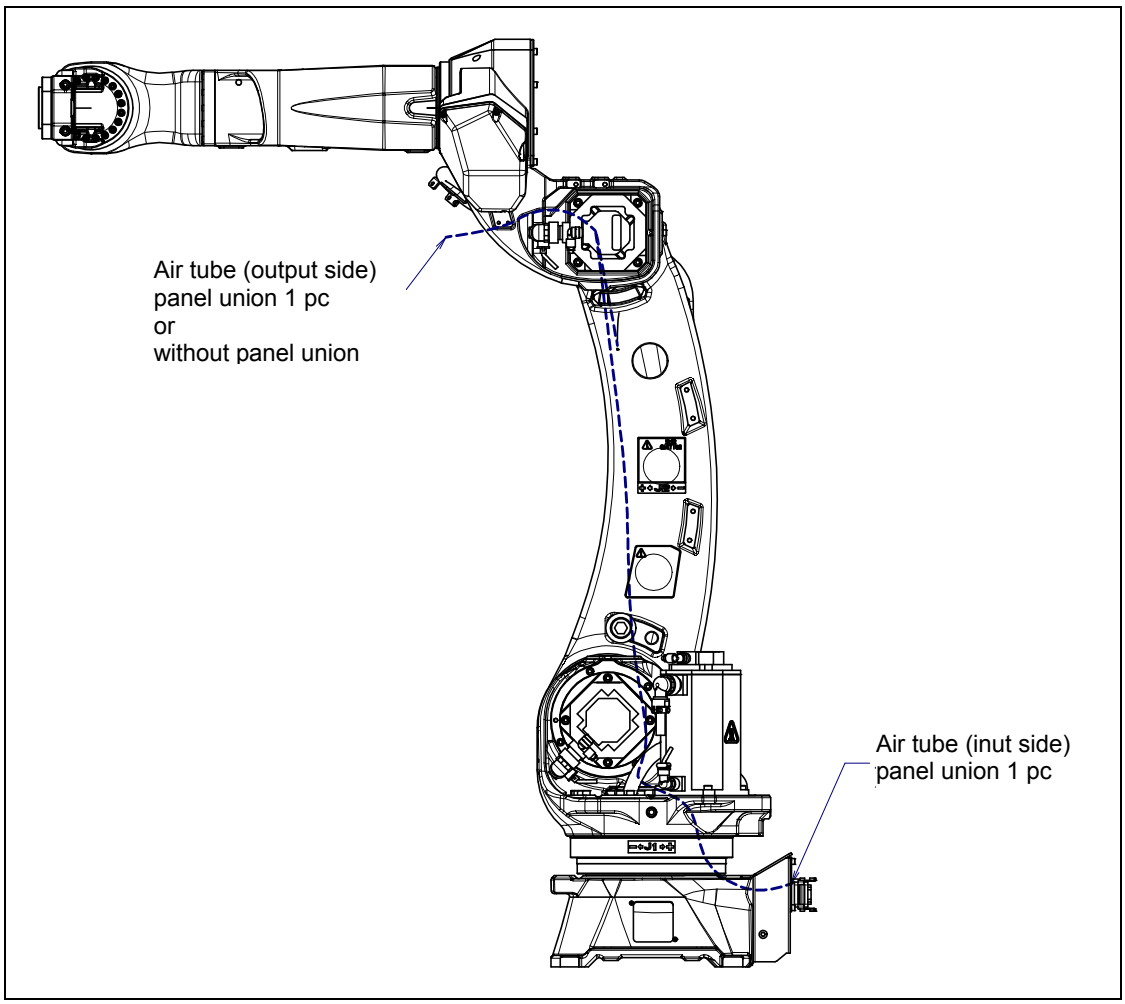


Fig. 5.1 (a) Air supply (option)

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.

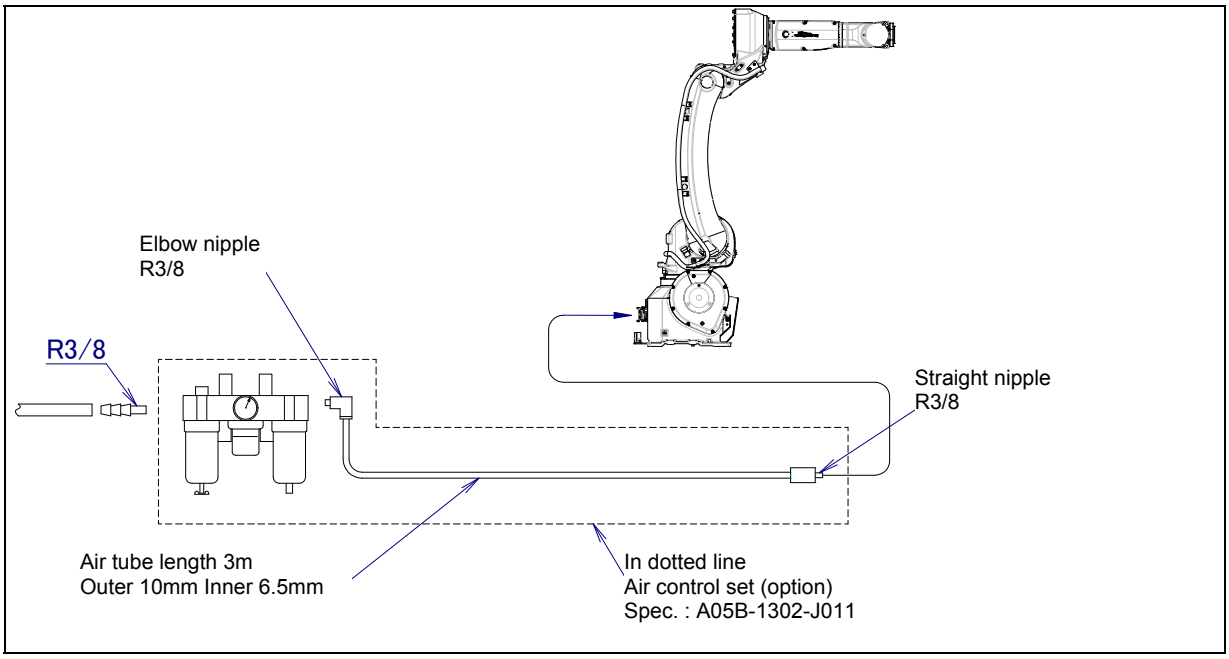


Fig. 5.2 (a) Air piping (option)

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.

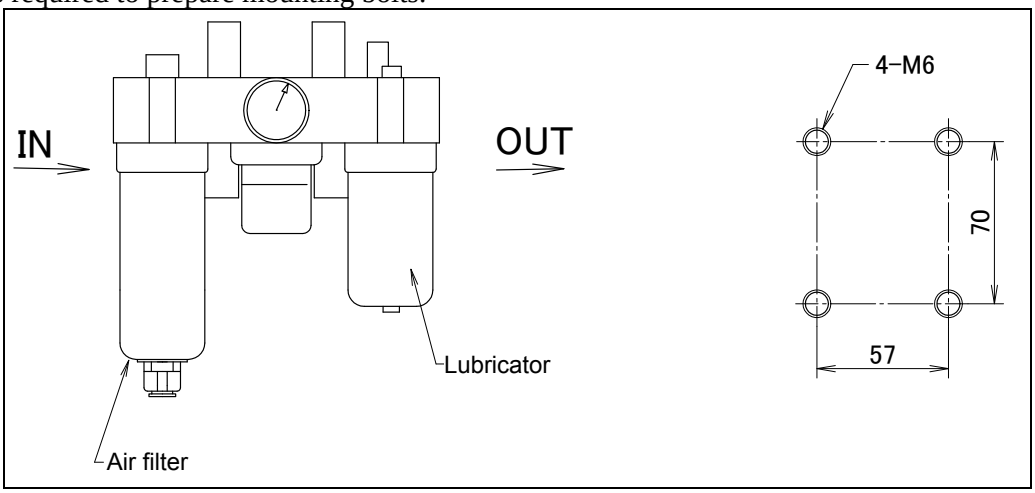


Fig. 5.2 (b) Air control set option (option)

NOTE
The capacity values of the air control set are determined 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 (a) to (f) show the position of the option cable interface. EE (RI/RO), welding power supply cable, Wire feeder cable, user cable usable to 3D Laser Vision sensor and force sensor, Ethernet cable, camera cable are prepared as options.

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

EE(RI/RO) interface	: EE
Welding power supply cable interface	: W/P
Wire feeder cable interface	: W/F
User cable usable to 3D Laser Vision sensor and force sensor	: ASi
Ethernet cable	: ES
Camera cable	: CAM

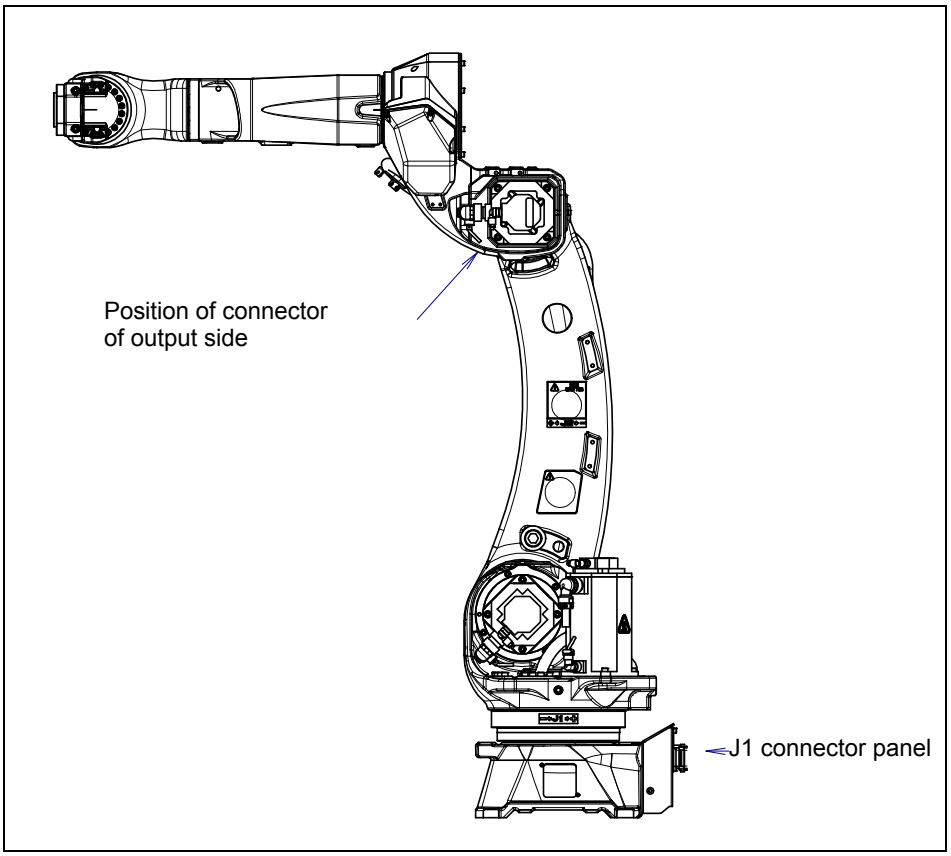


Fig. 5.3 (a) Interface for option cable (option)

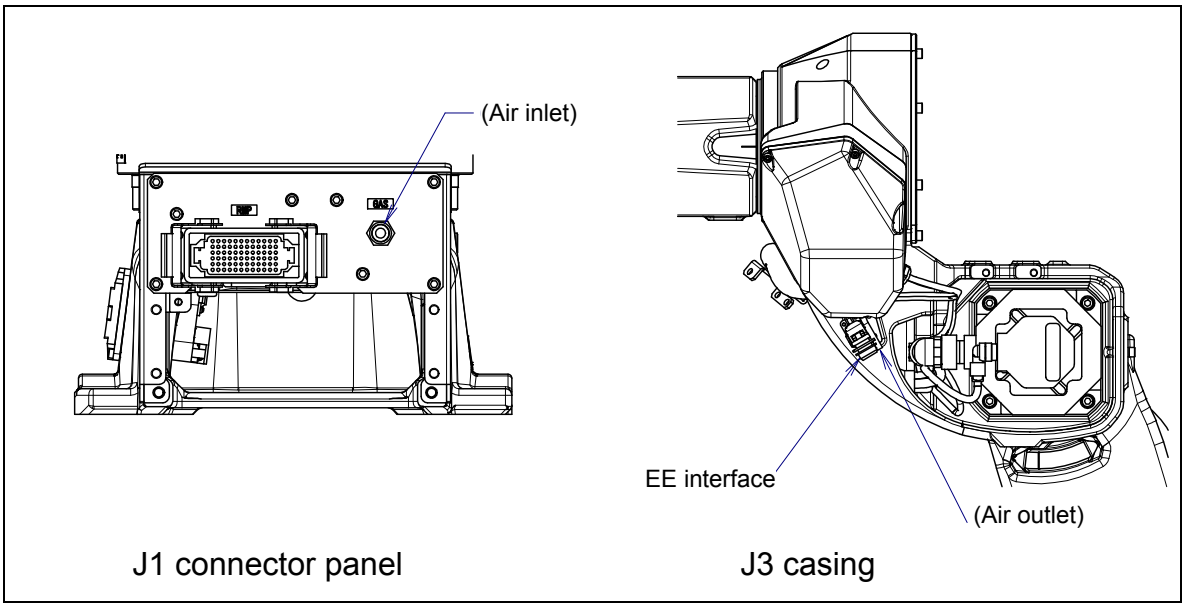


Fig. 5.3 (b) Interface for option cable (When A05B-1228-H201#25, H221#25 are specified)

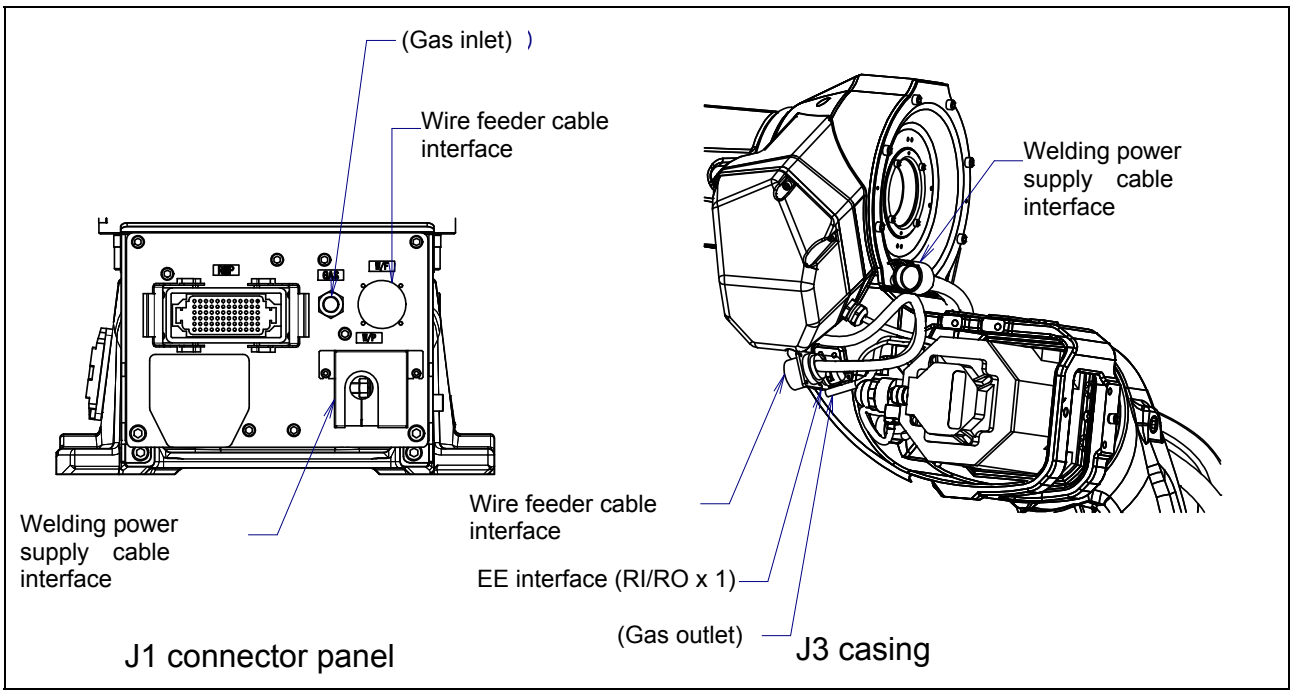


Fig. 5.3 (c) Interface for option cable (When A05B-1228-H205#☐☐ is specified)

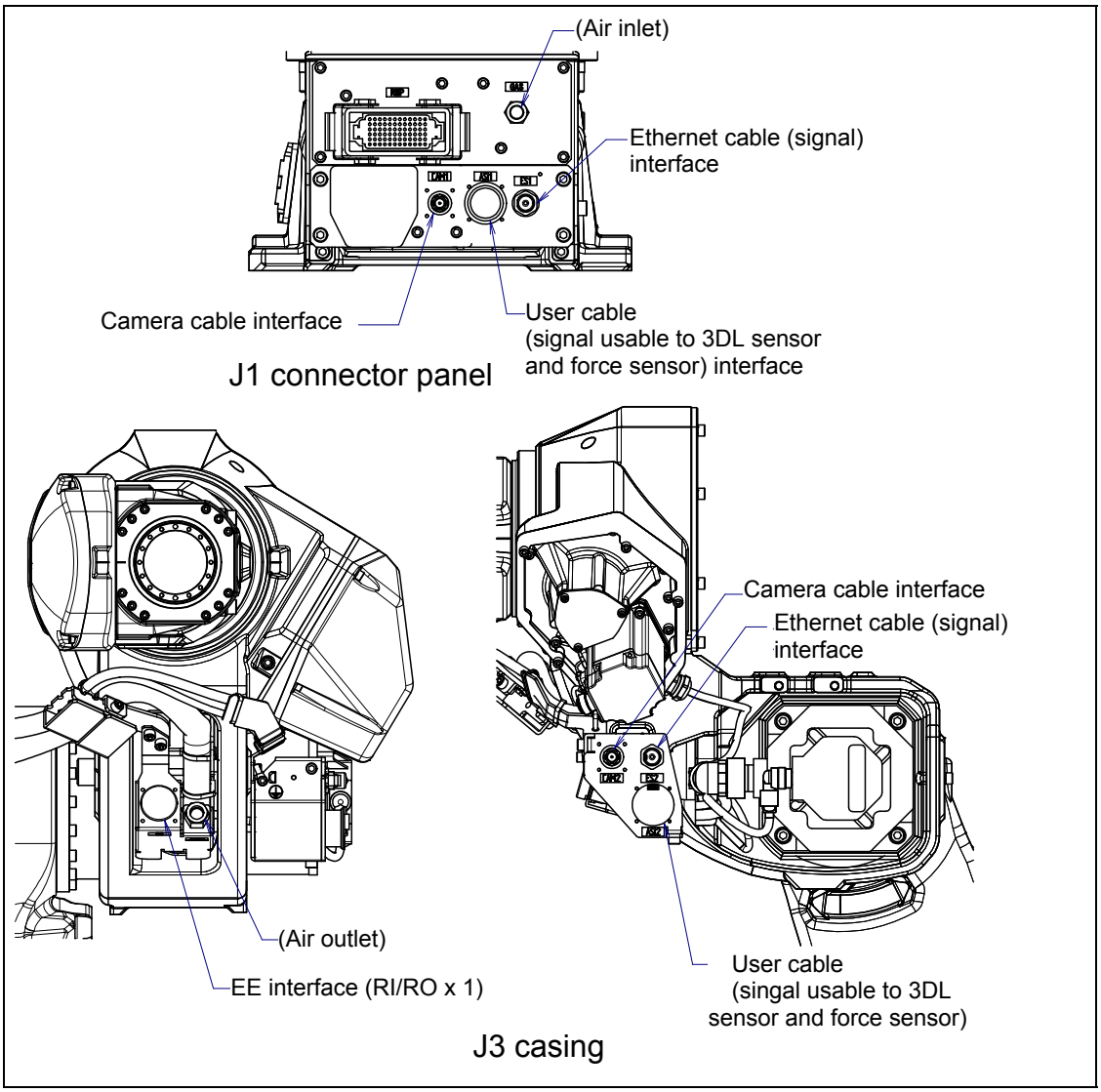


Fig. 5.3 (d) Interface for option cable (When A05B-1228-H222#□□ is specified)

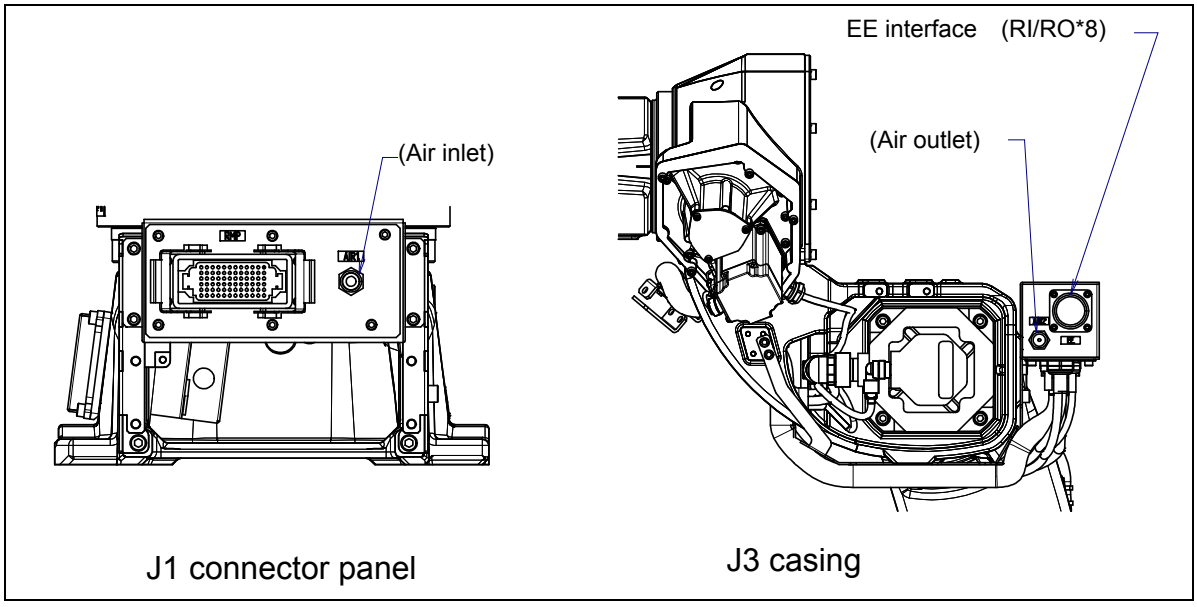


Fig. 5.3 (e) Interface for option cable (When A05B-1228-H223#□□ is specified)

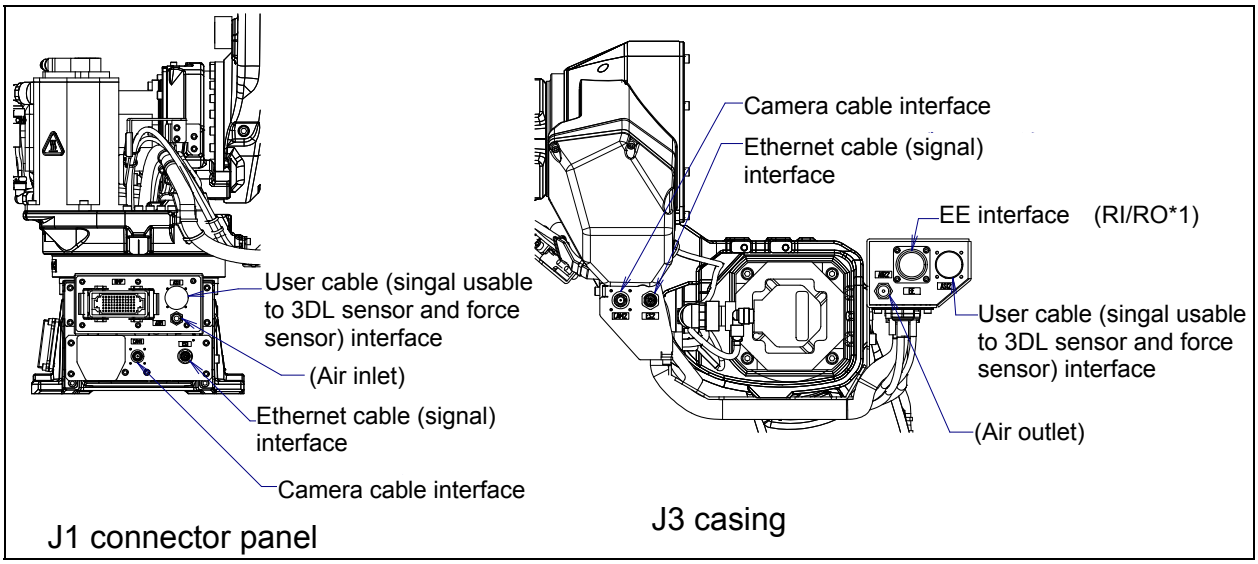


Fig. 5.3 (f) Interface for option cable (When A05B-1228-H224#☐☐ is specified)

1 EE interface (RI/RO) (option)
Fig. 5.3 (g) and (h) show the pin layout for the EE interface (RI/RO).

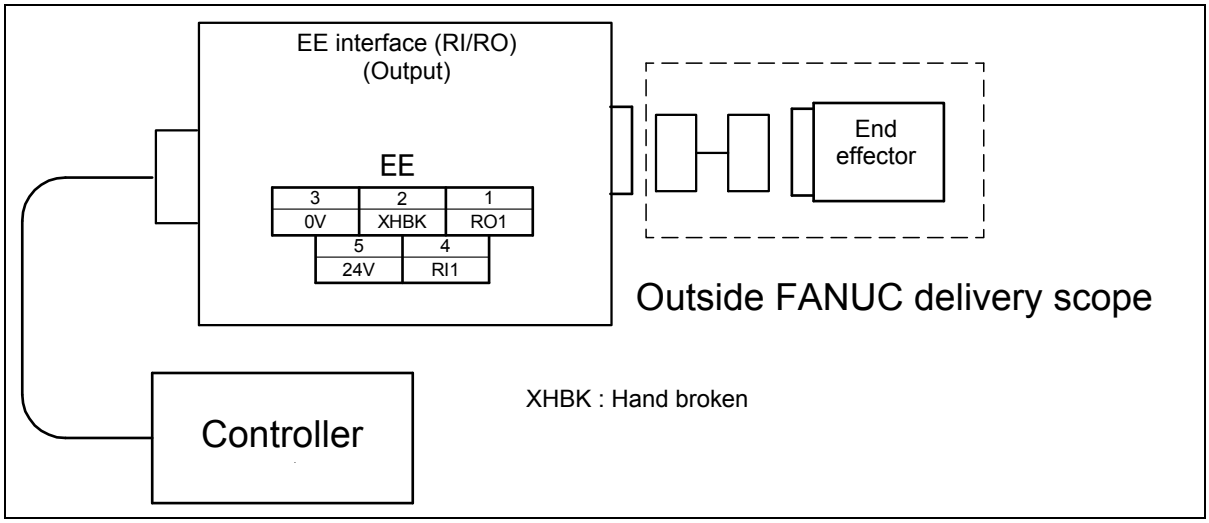


Fig. 5.3 (g) Pin layout for EE interface (RI/RO) RI/RO x 1 (option)
(When A05B-1228-H201#25 is specified)

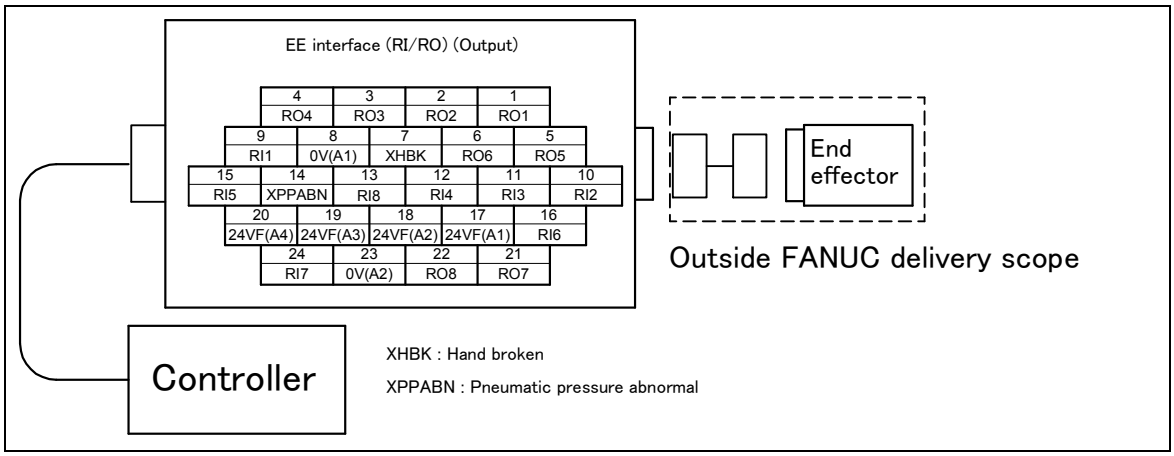


Fig. 5.3 (h) Pin layout for EE interface (RI/RO) RI/RO x 8 (option)
(When A05B-1228-H221#25 is specified)

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

2 Wire feeder power supply Interface (W/F)(option)
Fig. 5.3 (i) to (k) show the pin layout for the wire feeder power supply interface.

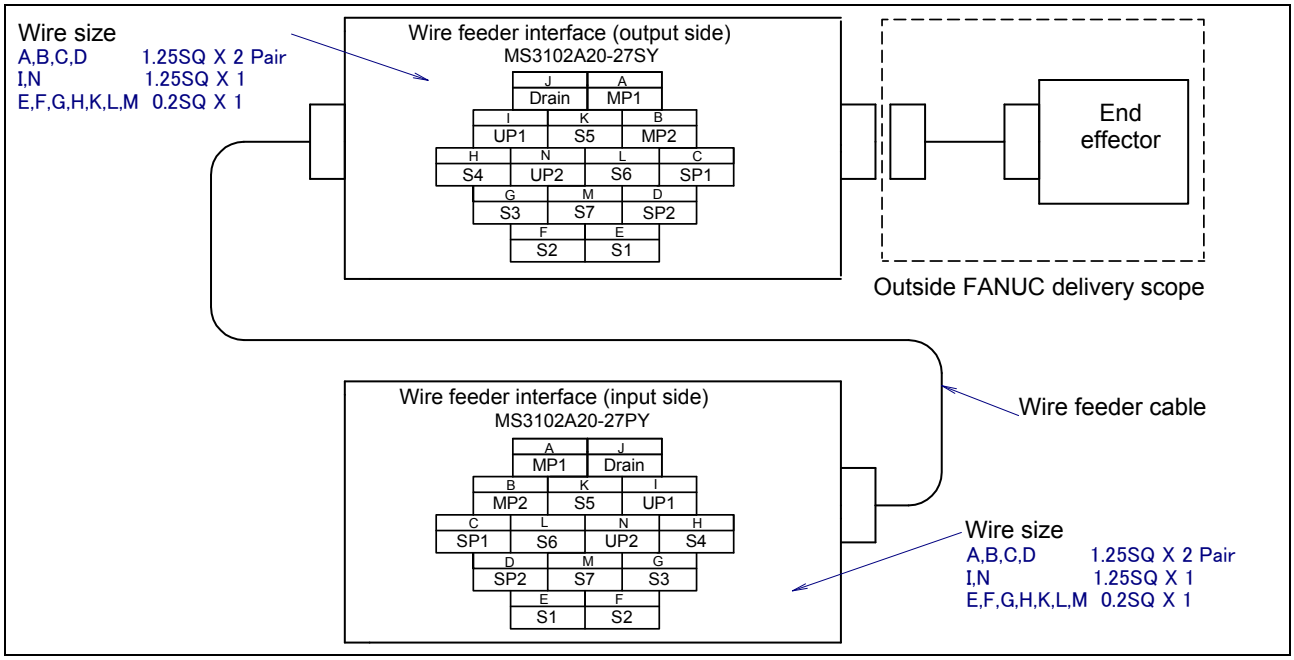


Fig. 5.3 (i) Pin layout for LINCOLN wire feeder power supply (W/F) interface (option)
(When A05B-1228-H205#25L, H205#HLL are specified)

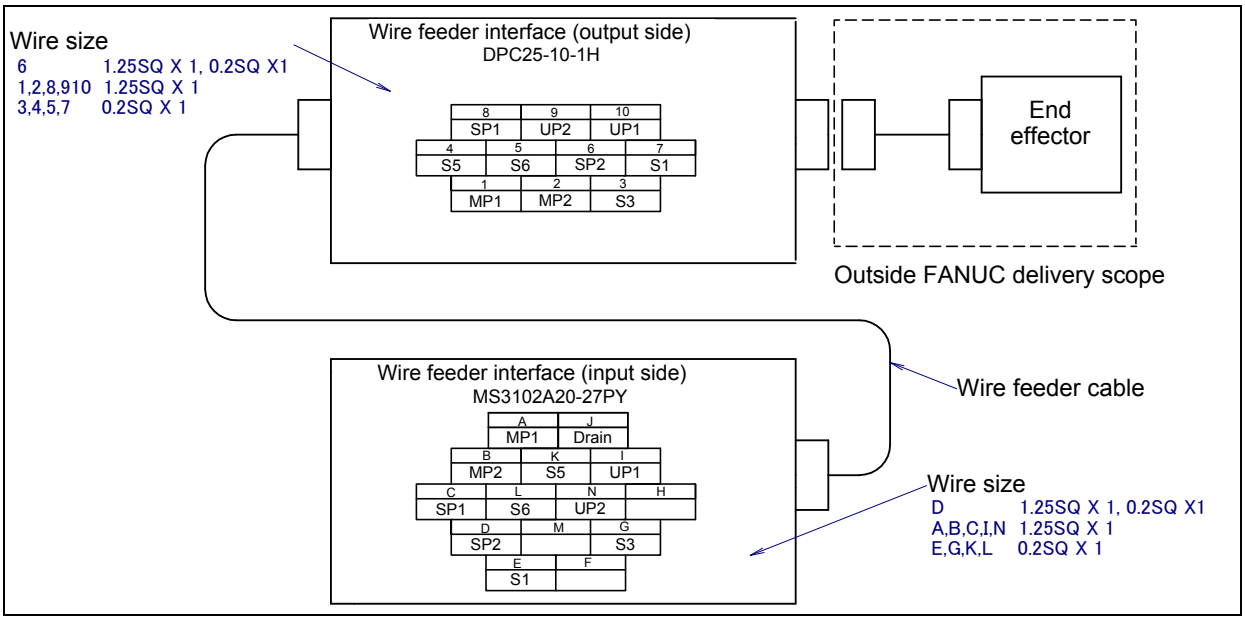


Fig. 5.3 (j) Pin layout for DAIHEN wire feeder (W/F) power supply interface (option)
(When A05B-1228-H205#25D, H205#HLD are specified)

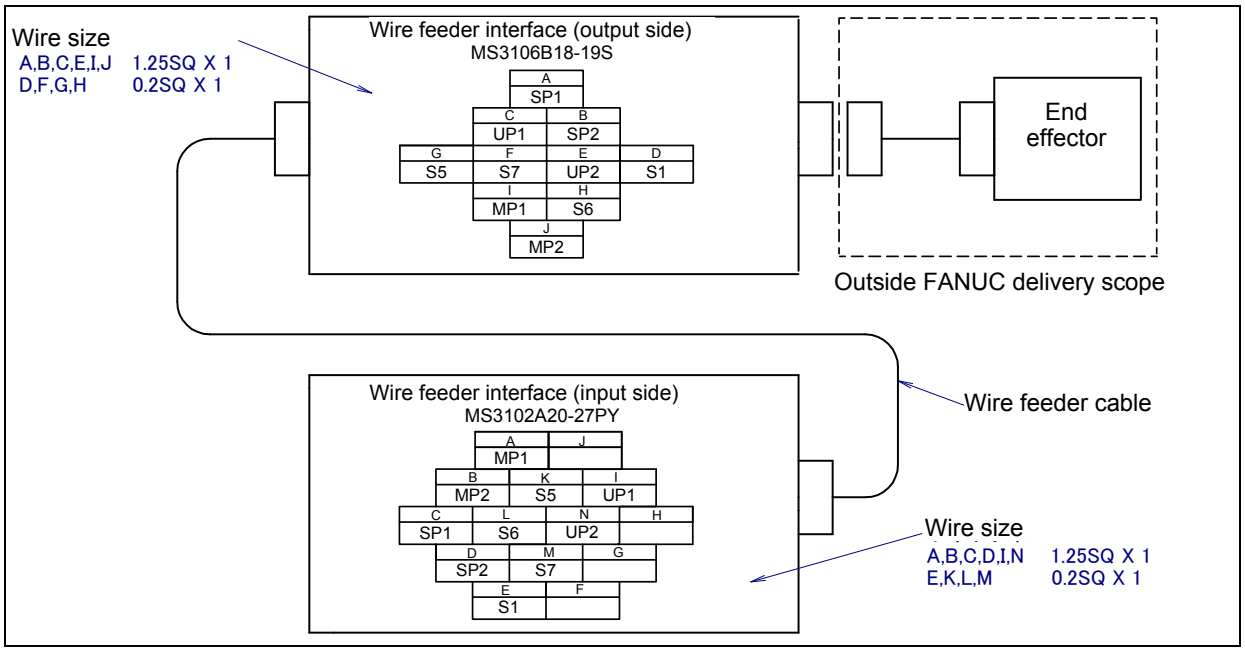


Fig. 5.3 (k) Pin layout for FANUC wire feeder (W/F) power supply interface (option)
(When A05B-1228-H205#25H, H205#HLH are specified)

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

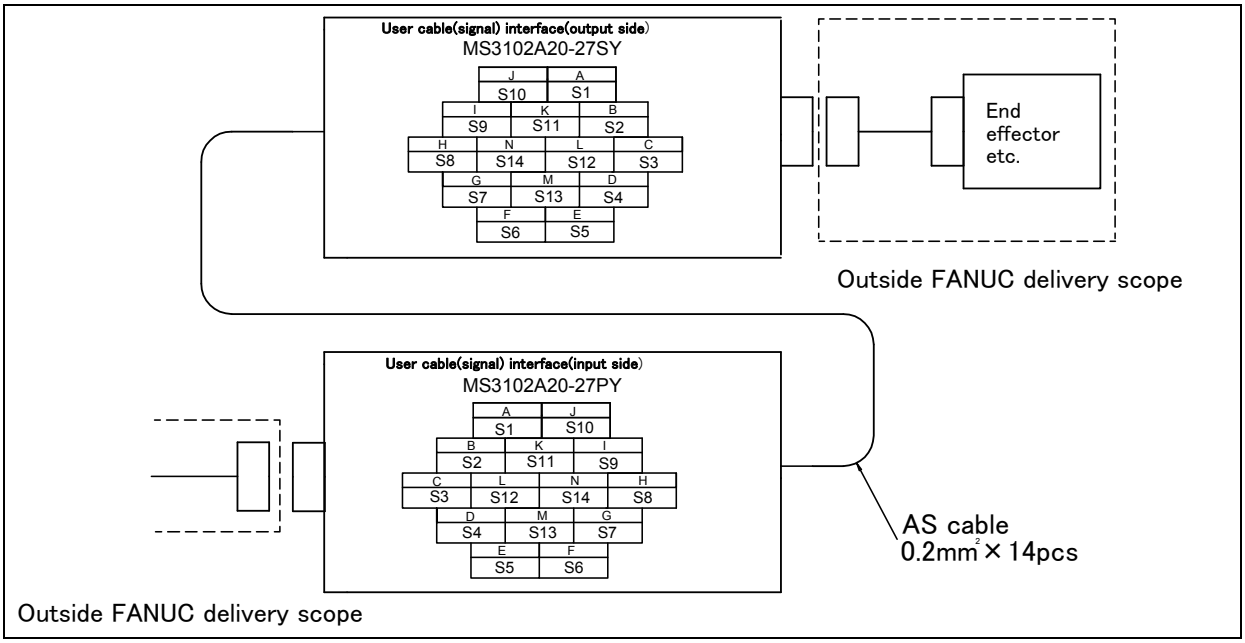


Fig. 5.3 (l) Pin layout for user cable
(signal usable to 3D Laser Vision Sensor and Force Sensor) (ASi) interface (option)
(When A05B-1228-H222#☐☐ are specified)

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

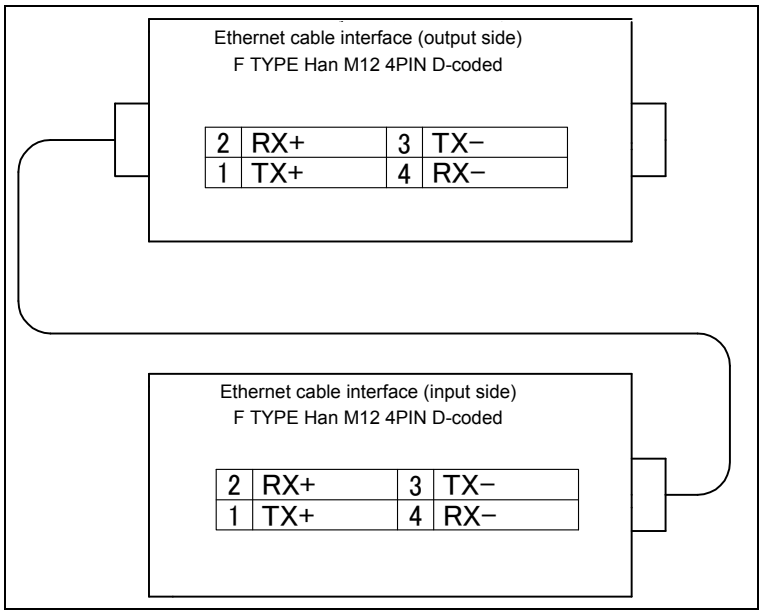


Fig. 5.3 (m) Pin layout for Ethernet (ES) cable interface (option)
(When A05B-1228-H222#□□ are specified)

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/ROX8) 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), ASi	Straight plug : MS3106B20-27SY (*1) Elbow plug : MS3108B20-27SY or a compatible product Clamp : MS3057-12A (*1) (FANUC spec. : A05B-1221-K843 Straight plug (*1) and clamp (*1) are included)	Straight plug : MS3106B20-27PY (*2) Elbow plug : MS3108B20-27PY or a compatible produce Clamp : MS3057-12A (*2) (FANUC spec. :A05B-1221-K841 Straight plug (*1) and clamp (*1) are included)	Fujikura.Ltd Japan Aviation Electronics Industry, Ltd.
W/F(*2)	Connector Straight plug : MS3106B20-27SY (*1) Elbow plug : MS3108B20-27SY or a compatible product Clamp MS3057-12A (*1) (FANUC spec. : A05B-1221-K843 Straight plug (*1) and clamp (*1) are included)	DPC25-10A-1H (FANUC spec.: A63L-0101-0074#S)	Input side Fujikura.Ltd Japan Aviation Electronics Industry, Ltd. Output side TOUA WIRELESS CO.
W/F(*3)	Connector Straight plug : MS3106B20-27SY (*1) Elbow plug : MS3108B20-27SY or a compatible product Clamp MS3057-12A (*1) (FANUC spec. : A05B-1221-K843 Straight plug (*1) and clamp (*1) are included)	Receptacle : MS3101A18-19P (*2) or a compatible produce Clamp MS3057-10A (*2)	Input side Fujikura.Ltd Japan Aviation Electronics Industry, Ltd.
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

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 a direct current 40V.
(*1) for LINCOLN wire feeder
(*2) for DAIHEN wire feeder
(*3) for FANUC 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), ASi	MS3102A20-27PY	MS3102A20-27SY	Fujikura.Ltd Japan Aviation Electronics Industry, Ltd
W/F (*2)	MS3102A20-27PY	DPC25-10C-1H	TOUA WIRELESS CO.
W/F(*3)	MS3102A20-27PY	MS3106B18-19S	Fujikura.Ltd Japan Aviation Electronics Industry, Ltd
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
(*3) for FANUC wire feeder

Table 5.3 (c) Connector specifications (on the Mechanical unit side when the M-20*i*D/25/12L/35 severe dust/liquid protection option is specified reference)

Component name	Model	Maker/dealer
Receptacle	JL05-2A24-28SC-F0-R	Japan Aviation Electronics Industry, Ltd. etc
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)

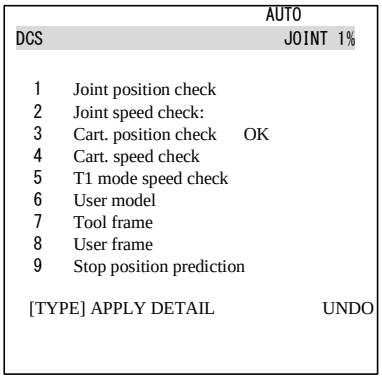
The robot motion can be restricted with DCS (Dual check safety) function by using the following software. For J2/J3-axis, the same effect as J1-axis adjustable mechanical stopper described at Section 6.2 can be obtained. The robot motion can be restricted at any angle and position if it is in robot motion 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)

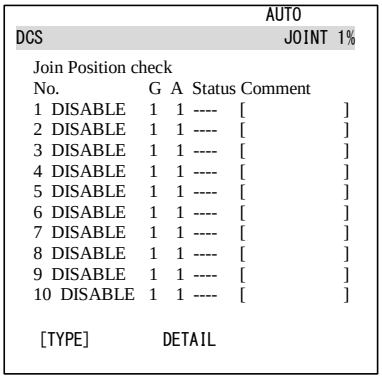
As an example, we shows the procedure to set $\pm 30^{o}$ for J2-axis in here. Refer to Controller Dual check safety function Operator's Manual (B-83184EN) for details of other setting, function and DCS stop position prediction.

Setting procedure

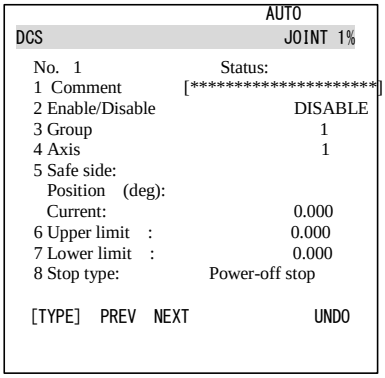
1 Press the [MENU] key to display the screen menu.
2 Press [0 NEXT] and press [6 SYSTEM].
3 Press the F1 ([TYPE]).
4 Select [DCS]. The following screen will be displayed.



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

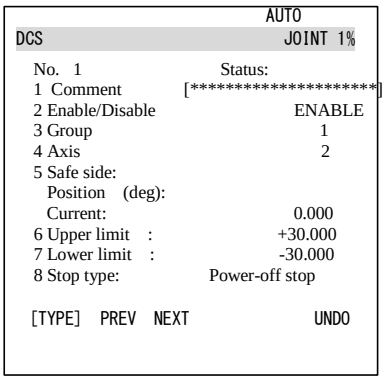


6 Move the cursor to [1], then press the [DETAIL].

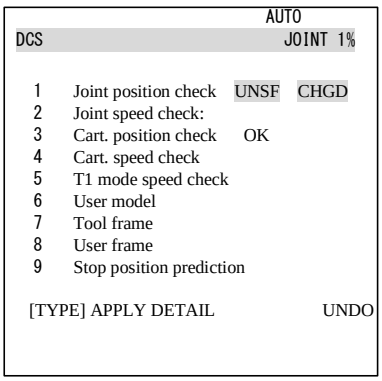


7 Move the cursor to [DISABLE], then press [CHOICE], set the status to [ENABLE].
8 Move the cursor to [Group], then input the robot group number, then press the [ENTER] key.
9 Move the cursor to [Axis], then input “2”, then press the [ENTER] key.
10 Move the cursor to [Upper limit] right side, then input “30”, then press the [ENTER] key.
11 Move the cursor to [Lower limit] right side, then input “-30”, then press the [ENTER] key.

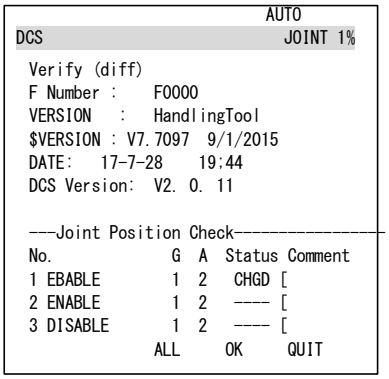
> ⚠ **WARNING**
> If only the operating space is set using Joint Position Check, the robot stops after it goes beyond the workspace. When the motor power is shut down, the robot’s momentum causes it to move some distance before it completely stops. The actual "Robot Stop Position" will be beyond the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



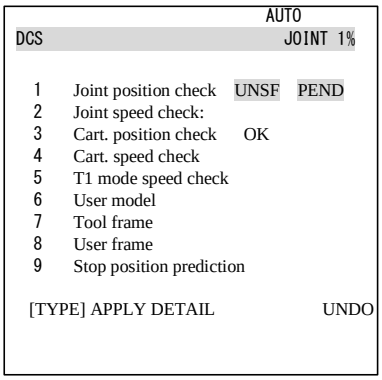
12 Press the [PREV] key two times, back to the first screen.



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.

Item		Movable range
J1-axis adjustable mechanical stopper	Upper limit	Settable in steps of 30° degrees in a range of -160° to +170° degrees
	Lower limit	Settable in steps of 30° degrees in the range of -170° to +160° degrees
	Space between the upper and lower limits.	A space of 40° 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).

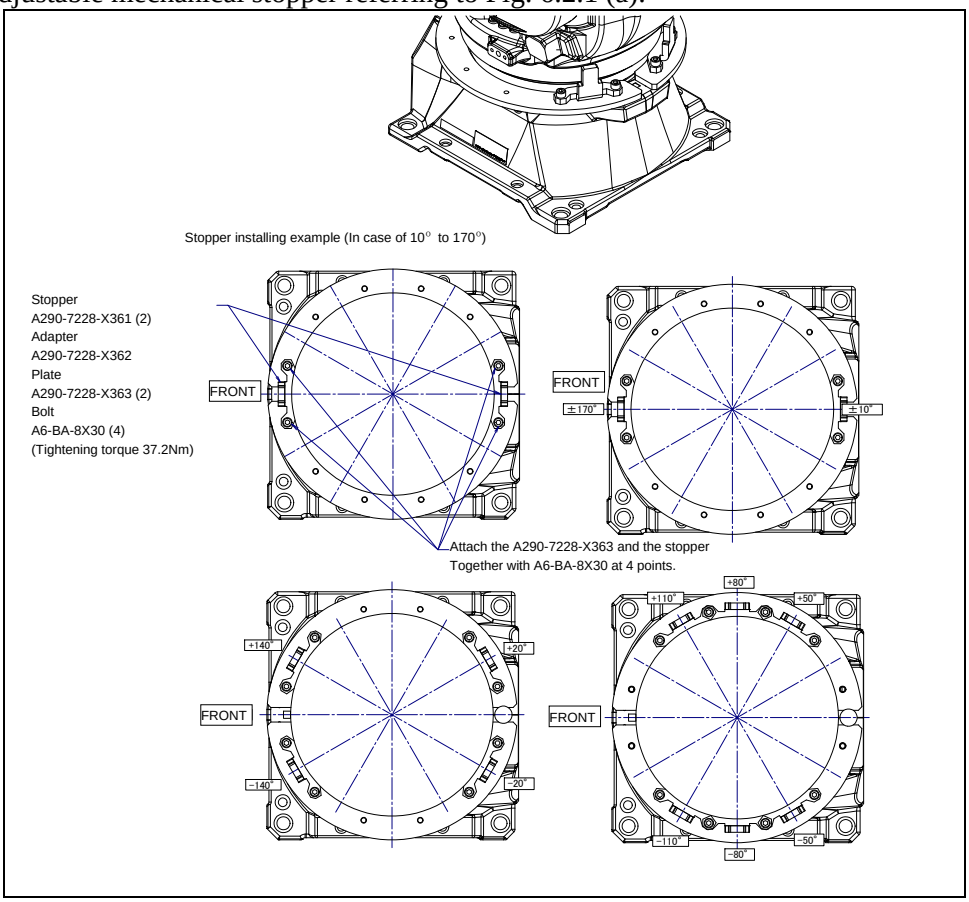


Fig. 6.2.1 (a) Installing of J1 axis adjustable stopper

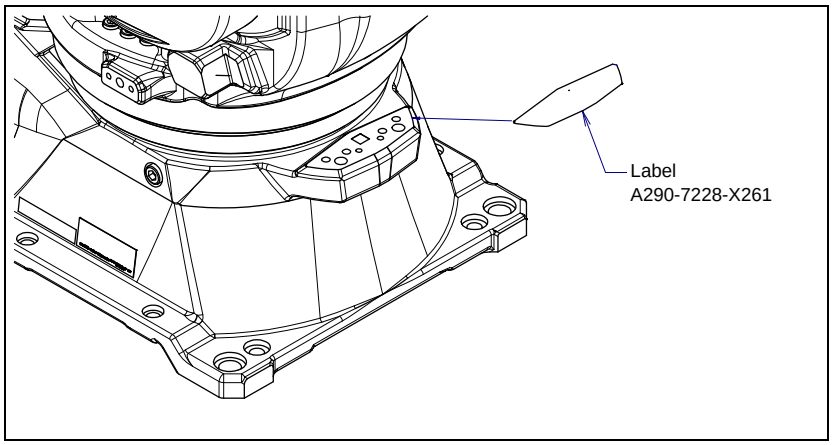


Fig. 6.2.1 (b) Protection label for J1-axis adjustable mechanical stopper mounting position

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 100%
Group1 1/16

AXIS	GROUP	LOWER	UPPER	
1	1	-180.00	180.00	deg
2	1	-90.00	145.00	deg
3	1	-180.00	267.00	deg
4	1	-190.00	190.00	deg
5	1	-180.00	180.00	deg
6	1	-450.00	450.00	deg
7	1	0.00	0.00	mm
8	1	0.00	0.00	mm
9	1	0.00	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	-90.0	145.00	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

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 PERIODIC MAINTENANCE

7.1.1 Daily Checks

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

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 vibration or abnormal noises occur. When vibration or abnormal noises occur, perform measures referring to the following section: **⇒"9.1 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: **⇒"9.1 TROUBLESHOOTING"(symptom : Displacement)**
Peripheral equipment for proper operation	Check whether the peripheral equipment operate properly according to commands from the robot and the peripheral equipment.
Brakes for each axis	Check that the end effector drops 5 mm or less when the servo power is turned off. If the end effector (hand) drops more than the prescribed amount, perform the measures as described in the following section: **⇒"9.1 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: **⇒"CONTROLLER OPERATOR'S MANUAL (Alarm Code List)(B-83284EN-1)"**

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	○					Cleaning the controller ventilation system	Confirm the controller ventilation system is not dusty. If dust has accumulated, remove it.	20
	○					Check for external damage or peeling paint	Check whether the robot has external damage or peeling paint due to the interference with the peripheral equipment. If an interference occurs, eliminate the cause. Also, if the external damage is serious, and causes a problem in which the robot will not operate, replace the damaged parts.	1
	○					Check for water	Check whether the robot is subjected to water or cutting fluid. If water is found, remove the cause and wipe off the liquid.	2
	○ 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. **⇒"7.2.3 Check the Mechanical Unit Cables and Connectors"**	3
	○ Only 1st check	○				Check for damage to the end effector (hand) cable	Check whether the end effector cables are unevenly twisted or damaged. If damage is found, replace the damaged cables.	4
	○ 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. **⇒"7.2.3 Check the Mechanical Unit Cables and Connectors"**	5
	○ 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"**	6

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	○				Retightening the external main bolts	Retighten the robot installation bolts, bolts to be removed for inspection, and bolts exposed to the outside. Refer to the recommended bolt tightening torque guidelines at the end of the manual. An adhesive to prevent bolts from loosening is applied to some bolts. If the bolts are tightened with greater than the recommended torque, the adhesive might be removed. Therefore, follow the recommended bolt tightening torque guidelines when retightening the bolts.	7
	○ Only 1st check	○				Check the fixed mechanical stopper and the adjustable mechanical stopper	Check that there is no evidence of a collision on the fixed mechanical stopper, the adjustable mechanical stopper, and check that the stopper mounting bolts are not loose. **⇒"7.2.4 Check of Fixed Mechanical Stopper and Adjustable Mechanical Stopper"**	8
	○ 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) Insulation failure might occur when the spatter has collected around the wrist flange or welding torch, and there is a possibility of damaging the robot mechanism by the welding current. (See Appendix C)	9
		○				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"**	10
			○			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.	17
				○		Replacing the grease and oil of J1, J2, 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"**	11 to 15
					○	Replacing the mechanical unit cable	Replace the mechanical unit cable Contact your local FANUC representative for information regarding replacing the cable.	16
			○			Replacing the Material handling (M/H) conduit	Replace the Material handling (M/H) conduit Contact your local FANUC representative for information regarding replacing the conduit.	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/R-30*i*B Mate Plus CONTROLLER MAINTENANCE MANUAL (B-83525EN)"**	21

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.

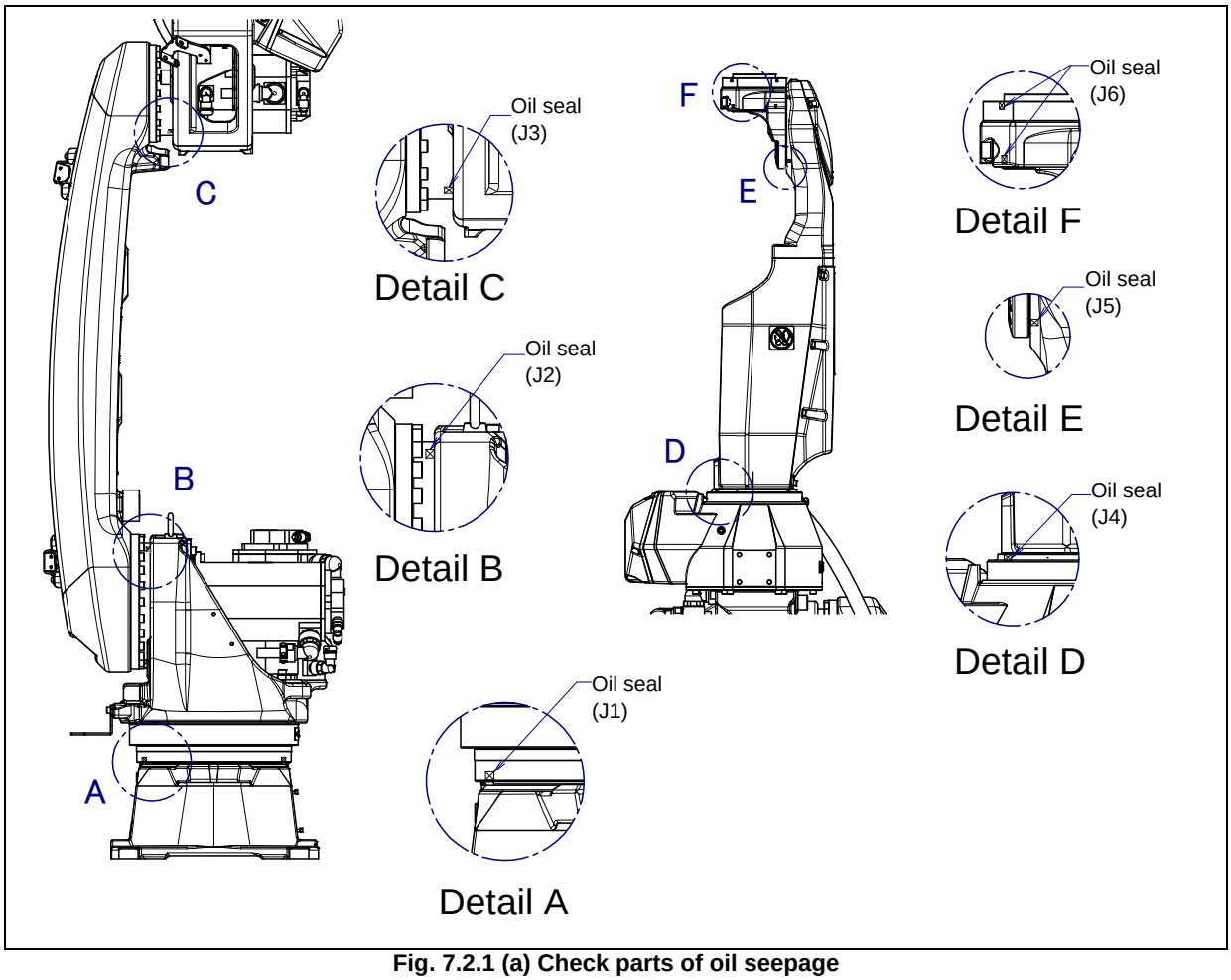


Fig. 7.2.1 (a) Check parts of oil seepage

Management

- Oil might accumulate on the outside of the seal lip depending on the movement condition or environment of the axis. If the oil viscosity changes, the oil might drip depending on the axis movement. To prevent oil spots, be sure to wipe away any accumulated oil under the axis components in Fig. 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 can be restored by venting the grease outlet. (When opening the grease outlet of J1,J2 and J3-axis, refer to Subsection 7.3.2 and ensure that grease is not expelled onto the machine or tooling. When opening the oil outlet of J4 to J6-axis, put a oil pan 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.
  ⇒**"9.1 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 regulator 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 lubricator control knob. Under normal usage, the lubricator will be empty in about 10 to 20 days.
3	Lubricator oil level	Check to see that the air control set oil level is within the specified level.
4	Leakage from hose	Check the joints, tubes, etc. for leaks. Retighten the joints or replace parts, as required.
5	Drain	Check the drain and release it. If the quantity of the drained liquid is significant, examine the setting of the air dryer on the air supply side.

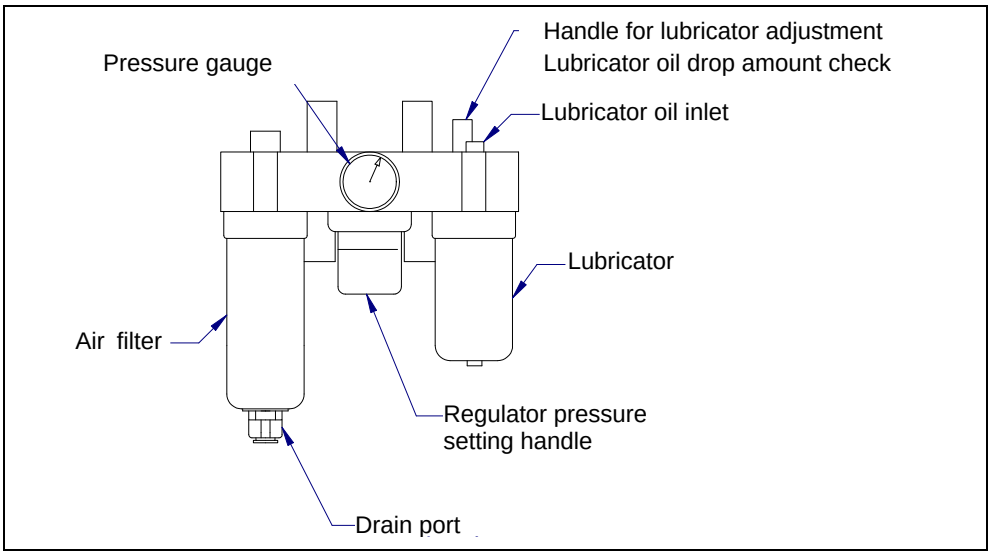


Fig. 7.2.2 (a) Air control set (option)

7.2.3 Check the Mechanical Unit Cables and Connectors

Inspection points of the mechanical unit cables and welding cables

Check the cables for visible damage that has been exposed. Closely inspect movable parts.
Clean any spatter that might be found.

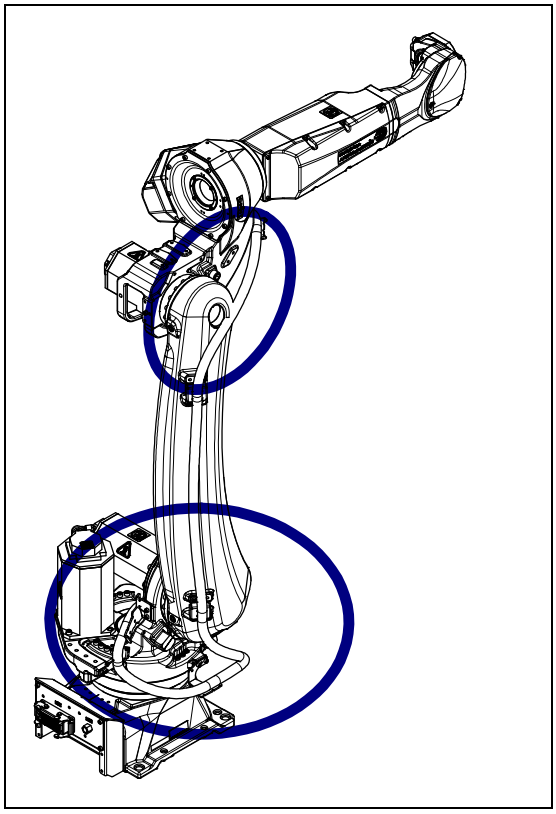


Fig. 7.2.3 (a) Inspection points of the mechanical unit cables

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/Ground terminal : Check the terminal for tightness.

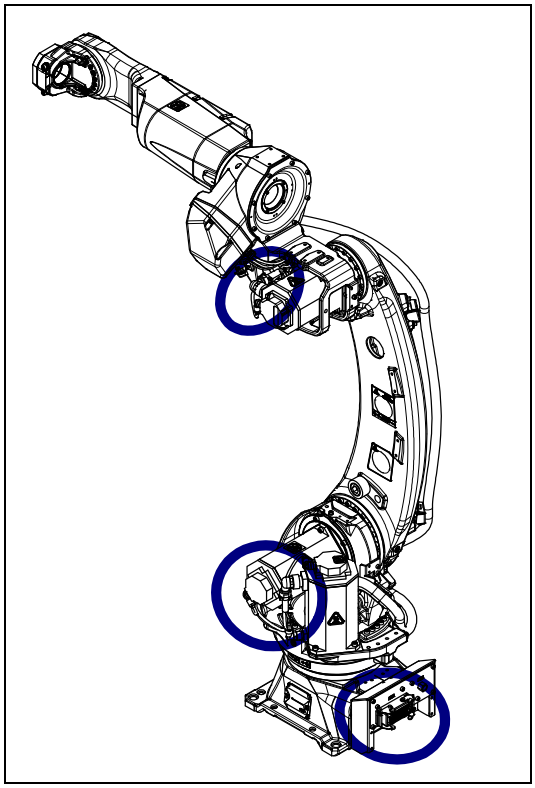


Fig. 7.2.3 (b) Connector Inspection points

7.2.4 Check of Fixed Mechanical Stopper and Adjustable Mechanical Stopper

- Check that there is no evidence of a collision on the fixed 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.

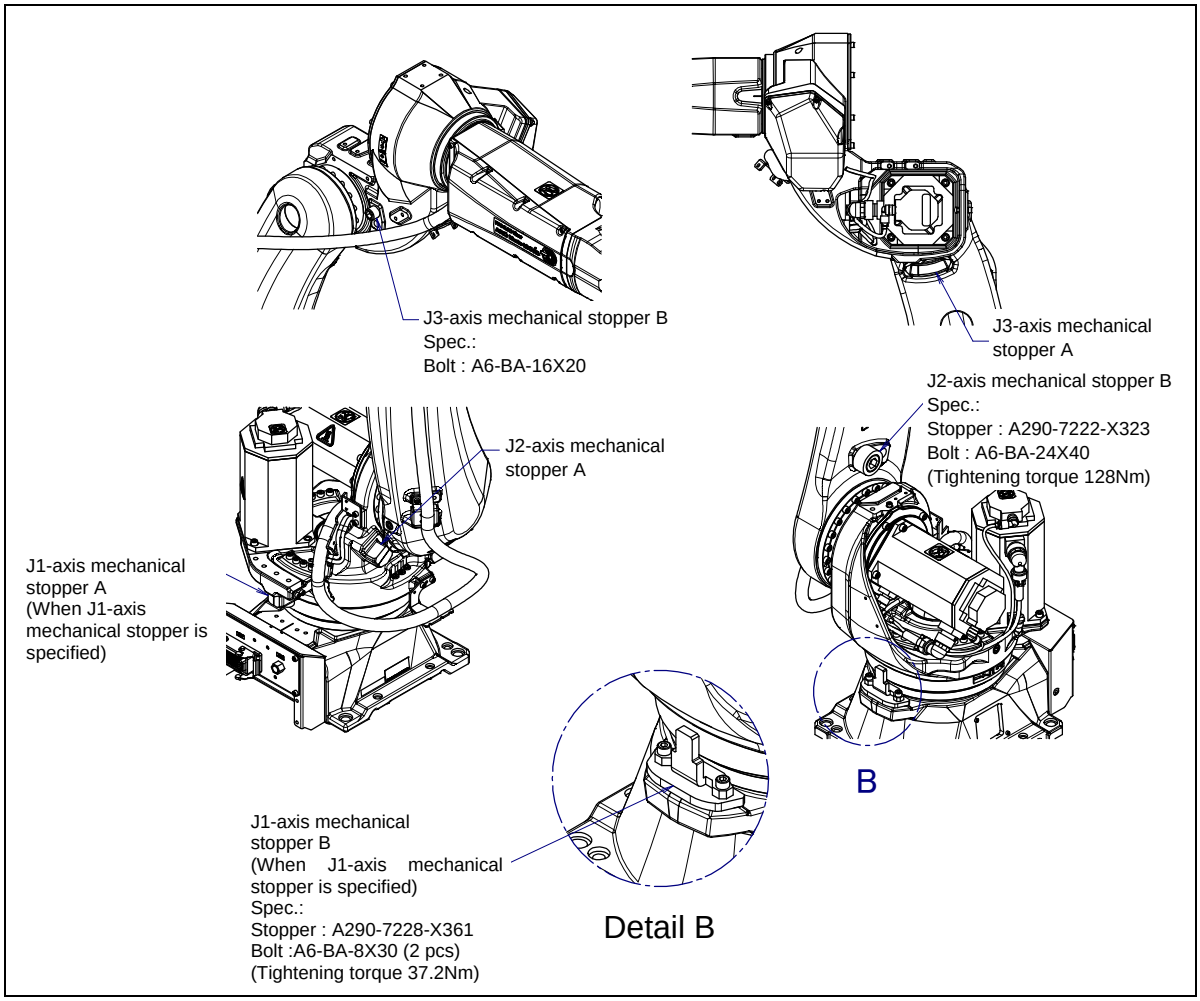


Fig. 7.2.4 (a) Check of fixed mechanical stopper and adjustable mechanical stopper

7.3 MAINTENANCE

7.3.1 Replacing the Batteries (1 year (3840 hours) checks)

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

Procedure for replacing the battery

1 Press the EMERGENCY STOP button to prohibit the 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)) If it cannot be removed, tap it on its side with a plastic hammer to loosen the cap before you remove it.
3 Take out the old batteries from the battery case. At this time, the battery can be taken out by pulling the stick in the center of the battery box.
4 Insert new batteries into the battery case. Pay attention to the direction of the batteries.
5 Close the battery case cap.

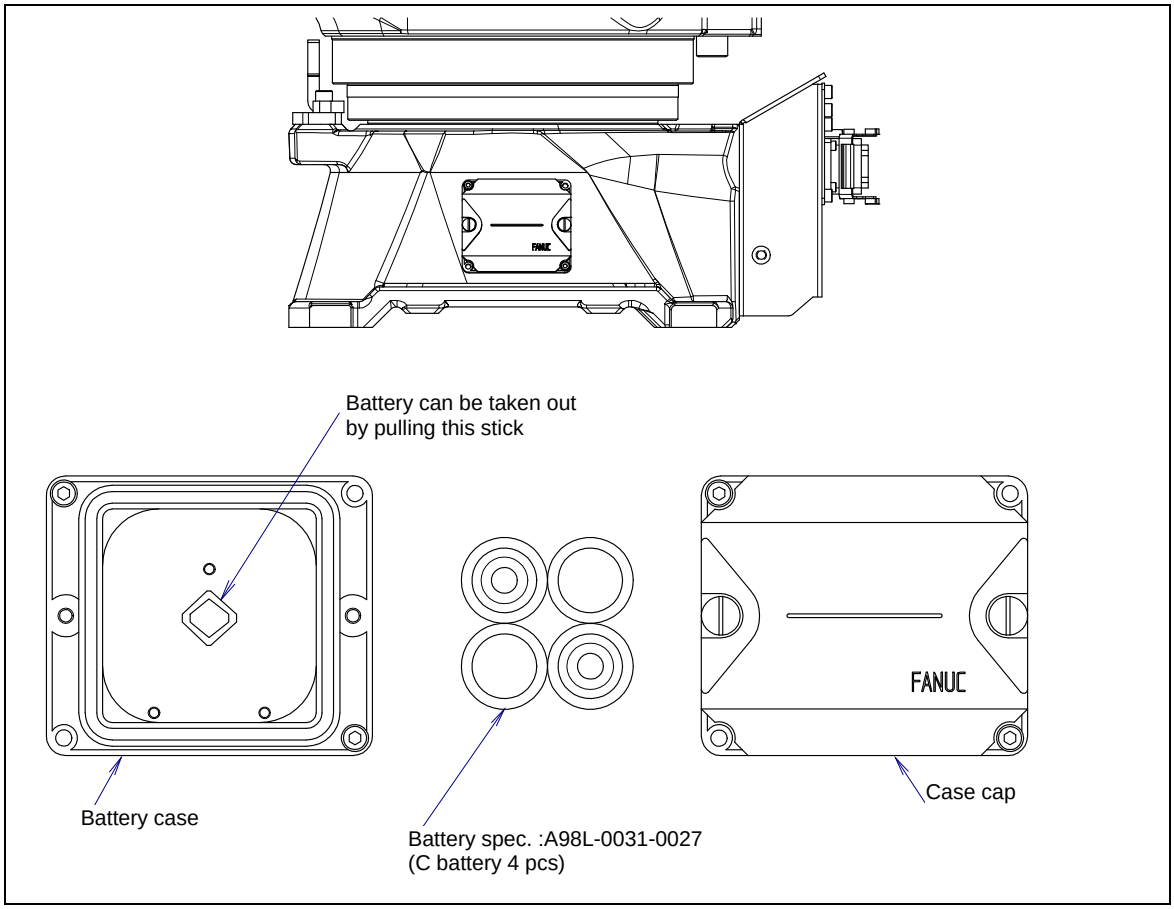


Fig. 7.3.1 (a) Replacing the battery

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

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

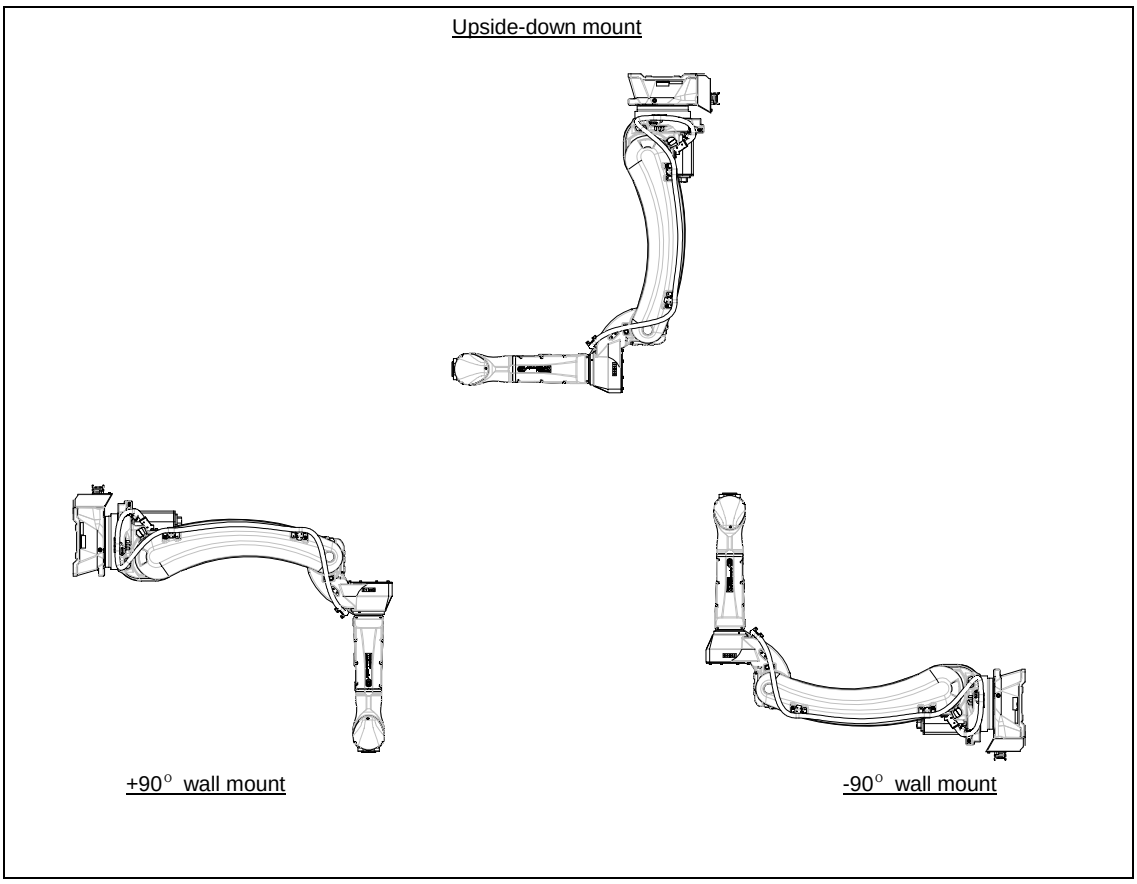


Fig. 7.3.2 (a) Installation method

7.3.2.1 Grease replacement procedure for the reducer (J1/J2/J3-axis)

⚠ CAUTION

Failure to supply grease correctly may cause an increase of the internal pressure of the grease bath. Such pressure increase will then damage the seal, which in turn leads to grease leakage and abnormal robot operation.
When performing greasing, therefore, observe the following precautions.

1 Before starting to grease, remove the seal bolt 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 slipping accidents and catching fire, completely remove any excess grease from the floor or robot.
7 Grease nipple kit spec. : A05B-1227-K002

Table 7.3.2.1 (a) Grease name and amount to be replaced at regular intervals of three years (11520 hours)

Greasing points	Amount of grease to be applied	Gun tip pressure	Specified grease
J1-axis reducer	1250 g (1380ml)	0.1MPa or less (NOTE)	Kyodo Yushi VIGOGREASE RE0 (Specification: A98L-0040-0174)
J2-axis reducer	830 g (920ml)		
J3-axis reducer	300 g (330ml)		

NOTE

When a manual pump is used for greasing, the standard rate is one pumping cycles 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) Grease supplying posture (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		-90°				
	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°		0°	0°			
	Wall mount +90°		0°	0°			

1 Move the robot to the greasing Posture described in Table.7.3.2.1 (b).
2 Turn off controller power.
3 Remove the bolt and the seal washer from grease outlet. (Fig.7.3.2.1 (a))
4 Remove the bolt and the seal washer 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 7.3.2.2. At this time, drain grease according to Table 7.3.2.1 (c) to make space of grease bath.

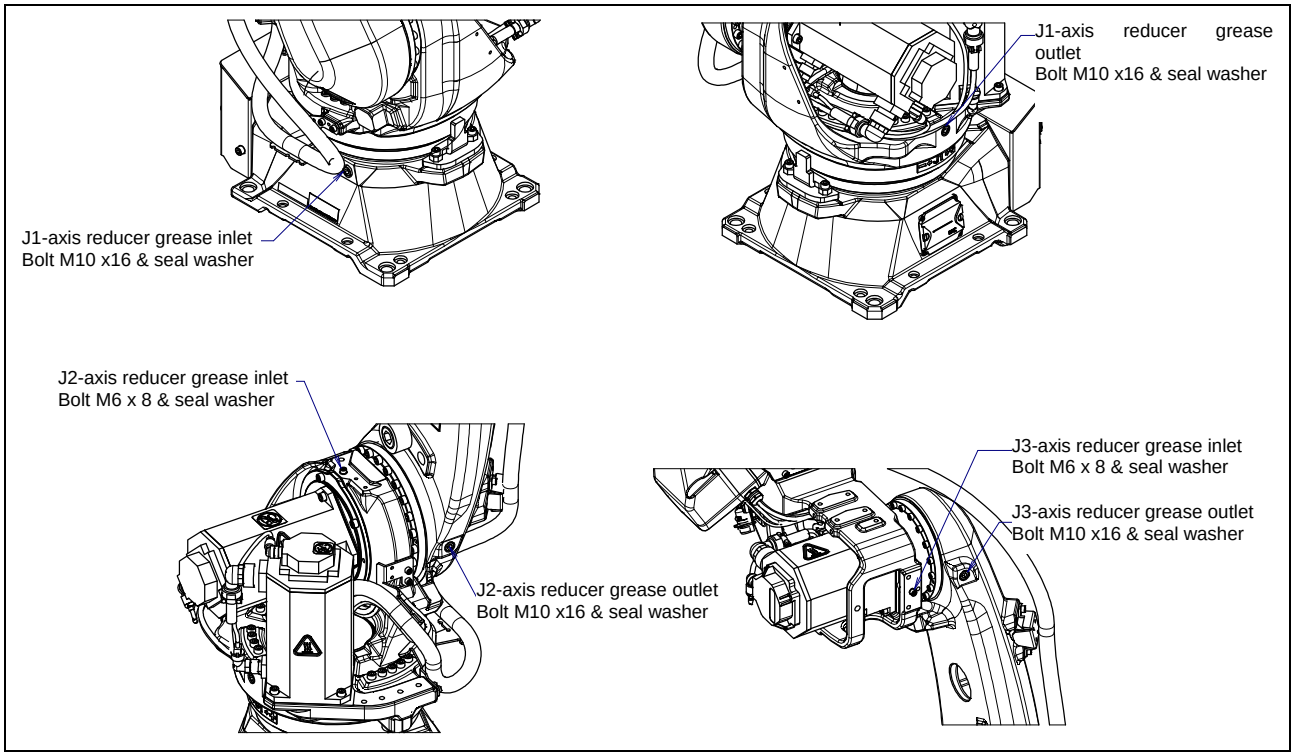


Fig. 7.3.2.1 (a) Greasing point of J1/J2/J3-axis reducer

Table 7.3.2.1 (c) Drain grease amount for releasing remaining pressure

Operation axis	Drain grease amount
J1-axis	160ml
J2-axis	180ml
J3-axis	55ml

Table 7.3.2.1 (d) Specification of seal washers

Parts name	Specification
seal washer (M6)	A30L-0001-0048#6M
seal washer (M10)	A30L-0001-0048#10M

7.3.2.2 Procedure for releasing remaining pressure from the grease bath (J1/J2/J3-axis)

After applying grease, operate the robot more than 10 minutes as instructed below with the bolts, seal washers and the grease nipple of the grease inlet and outlet uncapped to release the remaining pressure within the grease bath. Attach a recovery bag below the grease inlet and outlet to prevent output grease from splattering.

<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, 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. After completion of the operation, attach the bolts and seal washers to the grease inlets and outlets. When reusing the seal bolts, be sure to seal them with seal tape.

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 the J4-axis gearbox

⚠ 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 7.3.2.5, 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 7.3.2.3 (a) Oil name and amount of oiling of standard to be replaced at regular intervals of three years (11520 hours)

Oiling points	Amount of oil to be applied NOTE)	Gun tip pressure	Specified oil
J4-axis gearbox	640 g (750ml)	0.1MPa or less	JXTG Nippon Oil & Energy Corporation BONNOC AX68 (Specification: A98L-0040-0233)

NOTE) It is not a regulated amount injection.

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

Table 7.3.2.3 (b) Oiling posture (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°			
	Wall mount -90°	0°		-90°			
	Wall mount +90°			90°			

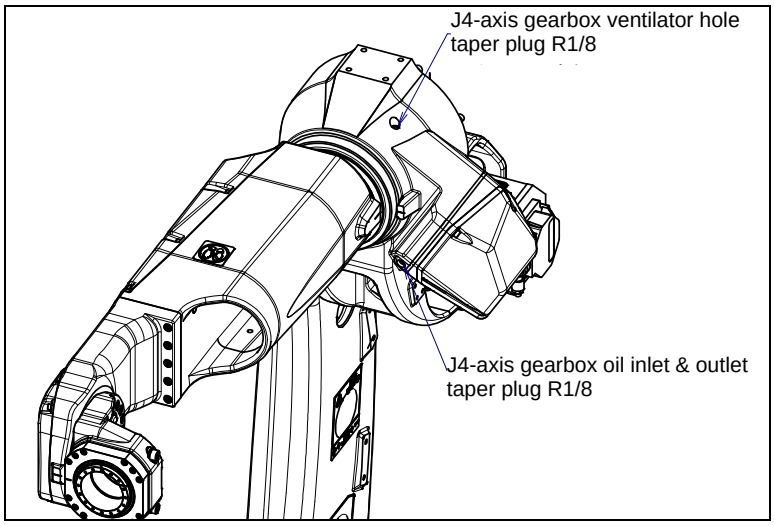


Fig. 7.3.2.3 (a) Greasing point of J4-axis gearbox

Table 7.3.2.3 (c) Specification of taper plugs

Parts name	Specification
taper plug (R1/8)	A97L-0001-0436#2-1D

Exhausting oil method

1 Move the robot to the oil discharge Posture for J4-axis gearbox described in Table 7.3.2.3 (b).
2 Turn off controller power.
3 Put the oil pan under the oil outlet. Then remove the plug or the seal bolt of the oil inlet/outlet and ventilator hole, and discharge the oil. (See Fig. 7.3.2.3 (b).)

Oiling method

Supply oil according to the description below.

1 Install oil injection nipple with a valve (A05B-1224-K006) to oil inlet.
2 Install the oil tray with a valve (A05B-1227-K007) to the J1-axis gearbox ventilator hole.
3 Confirm the valve is open, according to Fig. 7.3.2.3 (b), supply oil by using oil injection gun (A05B-1221-K005). In this time, install adapter for keeping of oiling posture. (It is appendix of A05B-1224-K006). If oil comes out to oil tray from ventilator hole, stop supplying oil, close the valve of the oil injection nipple, then remove the oil gun.
4 Attach seal bolt to the ventilator hole. Replace seal bolt by new one. When reusing taper plugs, be sure to wind it with seal tape.
5 Remove the oil injection nipple, attach the taper plug to oil inlet.
In this time, oil may drop. Set the oil pan under it and attach the seal bolts immediately.
Replace the taper plug by new one. When reusing taper plugs, be sure to wind it with seal tape.
6 Release the remaining pressure using the procedure given in Subsection 7.3.2.5.

> ⚠ **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.

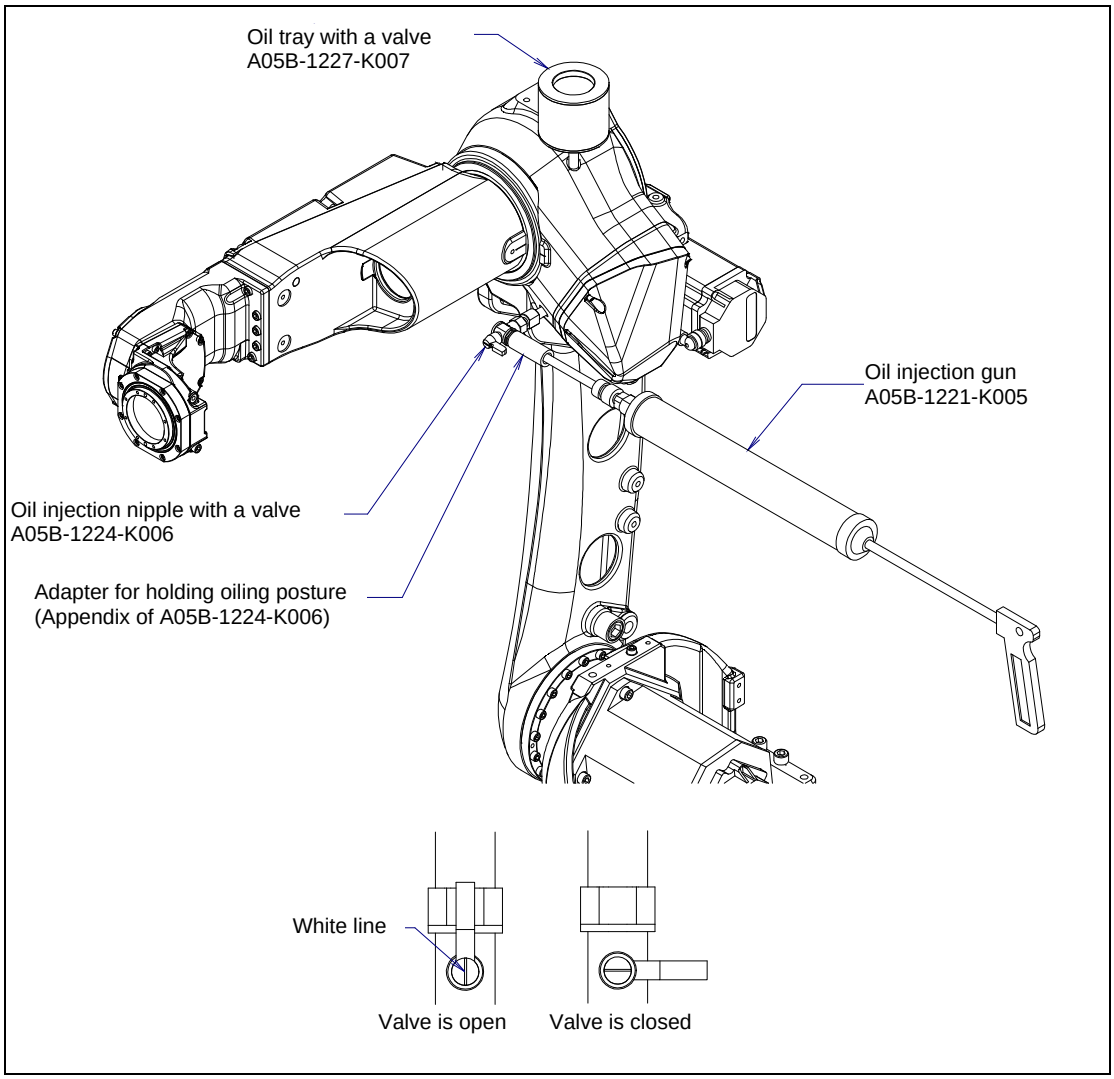


Fig. 7.3.2.3 (b) Oil injection by oil gun (oiling of J4-axis gearbox)

7.3.2.4 Oil replacement procedure for the J5/J6- axis gearbox

⚠ 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 7.3.2.5, 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 7.3.2.4 (a) Oil name and amount of oiling of standard to be replaced at regular intervals of three years (11520 hours)

Oiling points	Amount of oil to be applied (total capacity of the oil bath) NOTE)	Gun tip pressure	Specified oil
J5/J6-axis gearbox	680 g (800ml) *1	0.1MPa or less	JXTG Nippon Oil & Energy Corporation BONNOC AX68 (Specification: A98L-0040-0233)
	280 g (330ml) *2		

NOTE) It is not a regulated amount injection.
*1 : ARC Mate 120*i*D, ARC Mate 120*i*D/35, M-20*i*D/25/35
*2 : ARC Mate 120*i*D/12L, M-20*i*D/12L

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

Table 7.3.2.4 (b) Oiling posture (J5/J6-axis gearbox)

Oiling points		Posture					
		J1	J2	J3	J4	J5	J6
J5/J6-axis gearbox	Floor mount	Arbitrary	Arbitrary	0°	0°	0°	Arbitrary
	Upside-down mount			0°	180°		
	Wall mount -90°	0°		90°	0°		
	Wall mount +90°			90°	180°		
J5/J6-axis gearbox releasing remaining pressure	Floor mount	Arbitrary		20° to 90°	-90°	Arbitrary	Arbitrary
	Upside-down mount			-20° to -90°	-90°		
	Wall mount -90°	0°		0° to 70°	90°		
	Wall mount +90°			110° to 180°	-90°		

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

Exhausting oil method

1 Move the robot to the posture for oil replacing described in Table 7.3.2.4 (b).
2 Turn off controller power.
3 Put the oil pan under the oil outlet.
4 Remove two bolts and seal washers of oil outlet. Then remove the bolt and the seal washer of the oil inlet See Fig.7.3.2.4 (a). In this time, if you remove bolt of oil inlet firstly, you can prevent spilling oil on surroundings.
5 Install the bolt and the seal washer to the oil outlet (lower side) after all oil is exhausted.

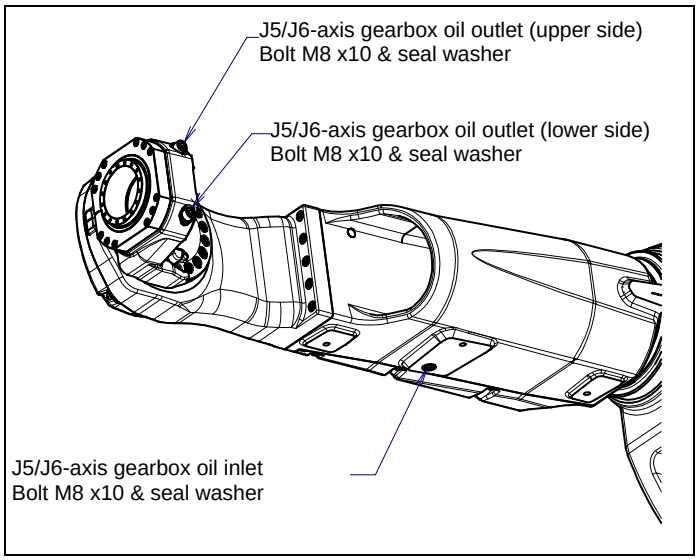


Fig. 7.3.2.4 (a) Oil inlet and outlet

Table 7.3.2.4 (c) Specification of seal washer and taper plug

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

Injecting oil method

(1) Install the oil adapter (appendix) and oil injection nipple with valve (A05B-1224-K006) to oil inlet (Fig.7.3.2.4 (c)) referring to Fig.7.3.2.4 (b).
(2) Confirm valve of oil inlet and oil outlet are open referring to Fig.7.3.2.4 (b). Supply oil to J5/J6-axis gearbox by oil injection gun (A05B-1221-K005). If oil comes out in oil tray from oil outlet (upper side), stop supplying oil, close the valve oil injection nipple, and remove oil gun
(3) Attach the bolt and the seal washer to oil outlet (upper side).
(4) Remove the oil injection nipple with a valve, attach the bolt and the seal washer to the oil inlet. In this time, oil may drop. Set a oil pan under the oil inlet and attach the bolt and the seal washer immediately.
(5) Release the remaining pressure using the procedure given in Subsection 7.3.2.5.

> ⚠ **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.

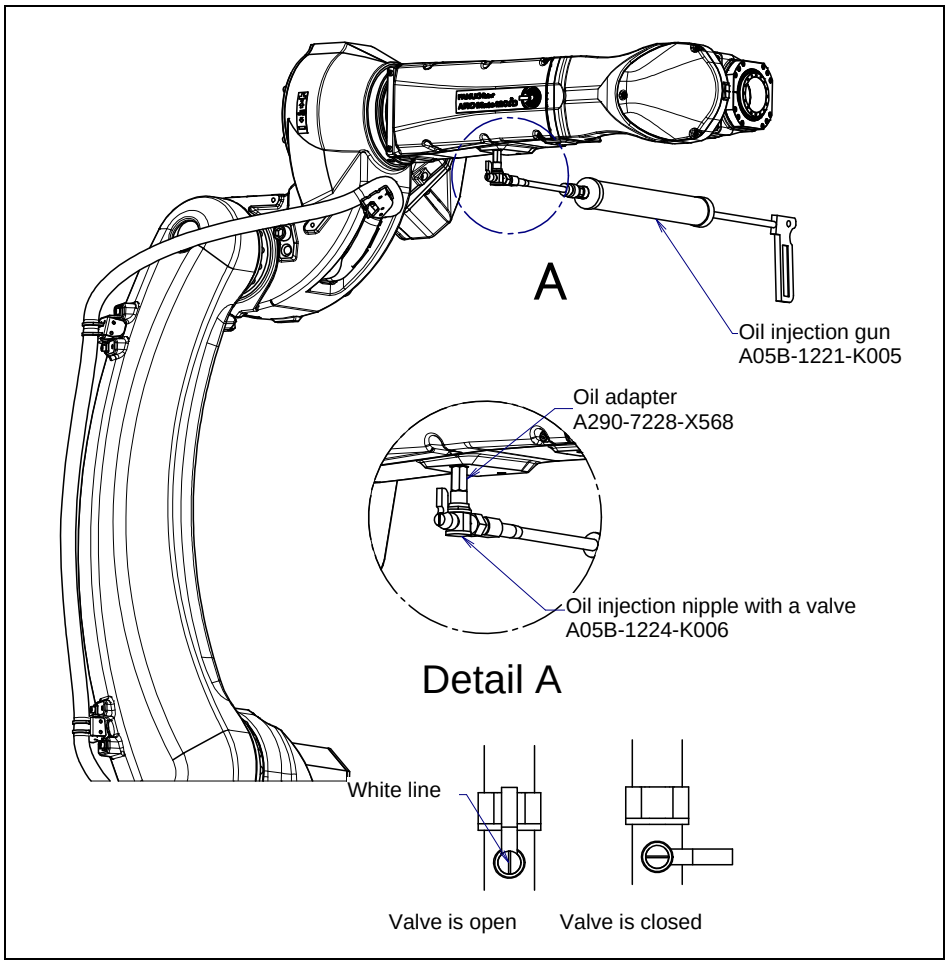


Fig. 7.3.2.4 (b) Oil injection by oil gun

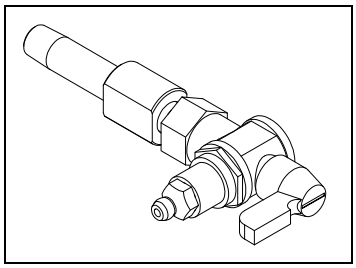


Fig. 7.3.2.4 (c) Oil injection nipple with valve (A05B-1224-K006)

7.3.2.5 Procedure for Releasing remaining pressure from the Oil bath (J4/J5/J6-axis)

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

In case of J4-axis gearbox

If confirmed then please operate robot J4 axis during 10 minutes or more, at 100% override, making 90 degrees motion. Keep the taper plugs attached during this operation. When completed, move the robot posture so that J4-gearbox oil outlet is right above. (In case of floor mount, J3=0°.) Remaining pressure release at once if oil inlet/outlet is opened. After operation, wipe the oil that adheres to the surface of the robot off when confirming it and close the oil inlet/outlet completely.

In case of J5/J6-axis gearbox

Move the robot to posture for releasing the remaining pressure. Operate robot J5 and J6 axis during 10 minutes or more, at 100% override, making 90 degrees motion on both axis. When completed, move the robot posture so that the oil outlets is right above. (In case of floor mount, J3=0° and J4=-90°.) Remaining pressure release at once if one of oil outlet is opened. (Be careful that oil is not spattered when opening the oil outlet.)
Wipe the oil that adheres to the surface of the robot off when confirming it and tighten bolts of oil inlet completely.
If the above operation cannot be performed due to the environment, 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.) After completion of the operation, attach the taper plug to the oil inlets. When you supply grease or oil to plural axes, you can run the plural 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, the taper plug, and the oil adapter, be sure to seal the thread part with seal tape.
> As for the seal washer, In one side, rubber 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 seal washer by viewing. If it is damaged obviously, replace it by new one.
> See Table 7.3.2.4 (c) about specification of seal bolts and seal washer.

7.4 STORAGE

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

8 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**
> 1 In case of ARC Mate 120*i*D, M-20*i*D 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.
> 2 In case of performing mastering with gravity compensation is enabled, if load setting (See Section 4.3) is not correct, it will influence the precision of the mastering.

8.1 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

There are following mastering methods.

Table 8.1 (a) Type of mastering

Fixture position mastering	Mastering performed with the mastering fixture before shipping.
Zero-position mastering (witness mark mastering)	Mastering which performed with all axes set at the 0-degree position. A zero-position mark (witness mark) is attached to each robot axis. This mastering is performed with all axes aligned to their respective witness marks.
Quick mastering	This is performed at a user-specified position. The corresponding count value is obtained from the rotation count of the Pulsecoder connected to the relevant motor and the rotation angle within one rotation. Quick mastering uses the fact that the absolute value of a rotation angle within one rotation will not be lost. (All axes at the same time)
Quick mastering for single axis	This is performed at a user-specified position for one axis. The corresponding count value is obtained from the rotation count of the Pulsecoder connected to the relevant motor and the rotation angle within one rotation. Quick mastering uses the fact that the absolute value of a rotation angle within one rotation will not be lost.
Single axis mastering	Mastering which performed for one axis at a time. The mastering position for each axis can be specified by the user. Useful in performing mastering on a specific axis.
Mastering data entry	Enter the Mastering data directly.

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.

This section describes zero-position mastering, quick mastering, 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 Before performing mastering, it is recommended that you back up the current mastering data.
3 When the motion range is mechanically 360 degrees or more, if J1/J4 axis to which the cables are connected is turned one turn beyond the correct mastering position, the cables in the mechanical unit will be damaged. 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 state of the internal cables, and perform mastering in the correct position. For the checking procedure, see Fig. 8.1 (a) and (b).

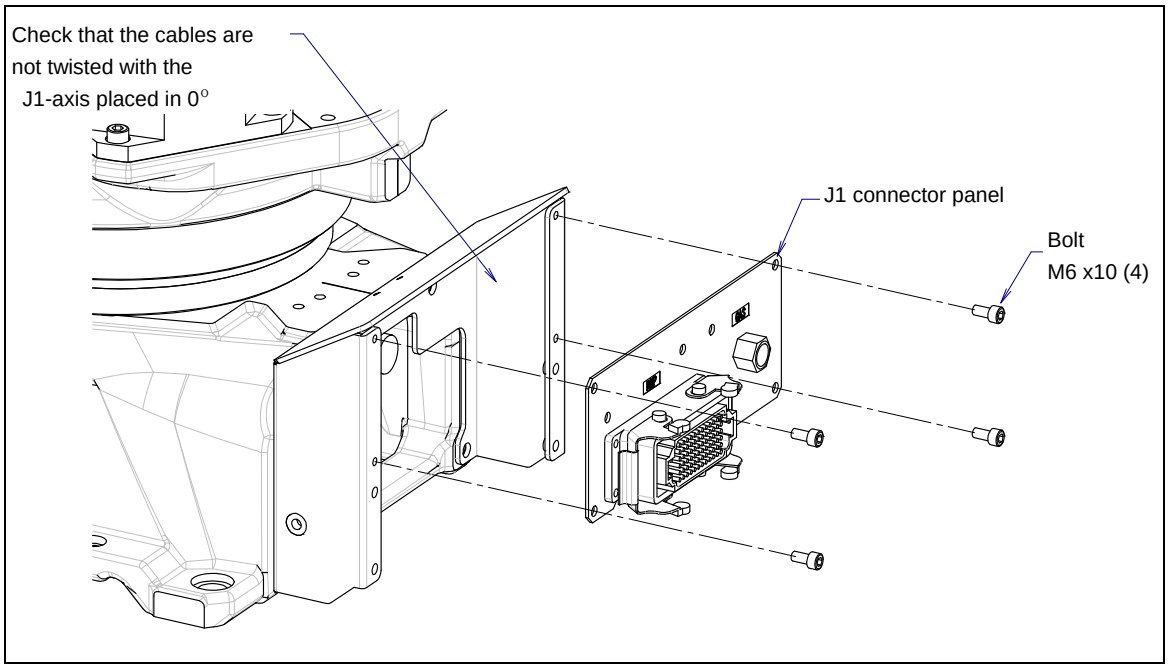


Fig. 8.1 (a) Confirming the state of cable (J1-axis)

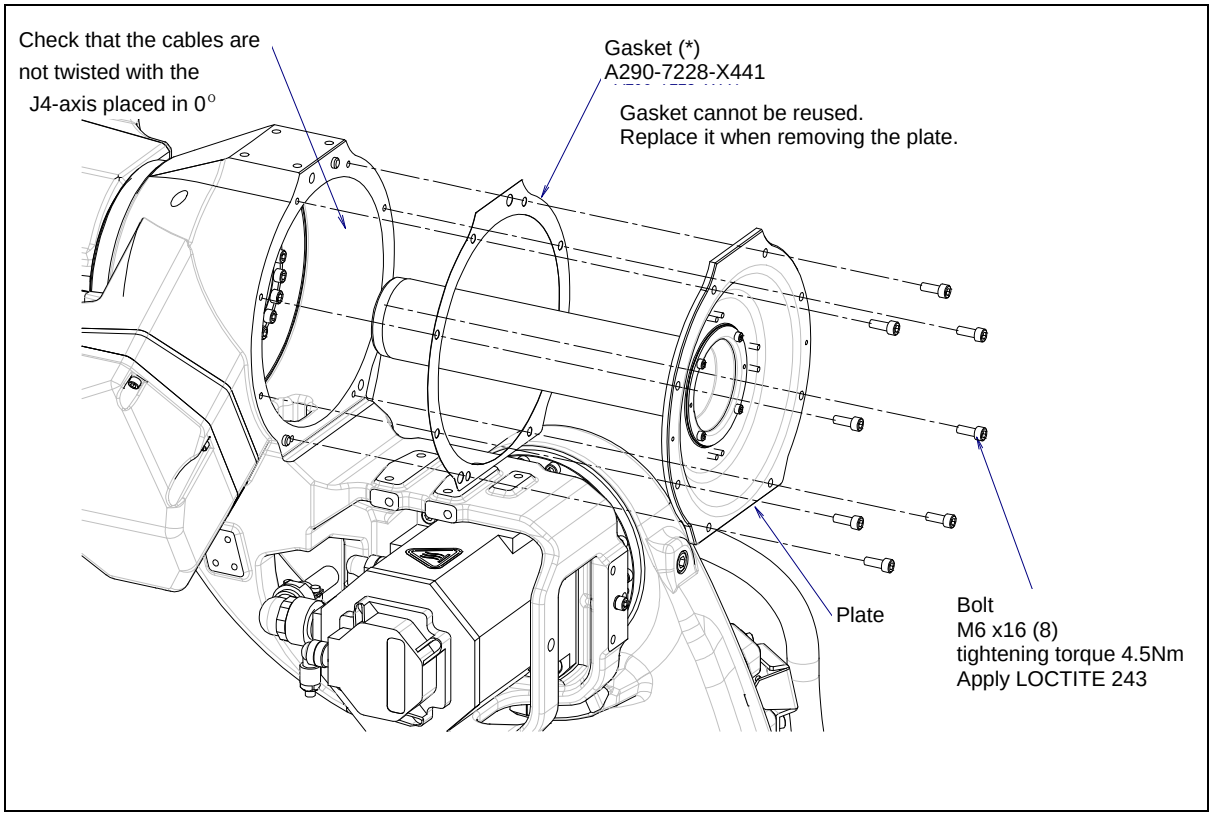


Fig. 8.1 (b) Confirming the state of cable (J4-axis)

8.2 RESETTING ALARMS AND PREPARING FOR MASTERING

Before performing mastering because a motor is replaced, you must 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 steps 1 to 6.
   1 Press the [MENU] key to display the screen menu.
   2 Press [0 NEXT] and select [6 SYSTEM].
   3 Press F1 [TYPE], and select [SYSTEM Variable] from the menu.
   4 Place the cursor on $MASTER_ENB, then key in [1] and press [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 to display the screen menu.
   2 Press [0 NEXT] and select [6 SYSTEM].
   3 Press F1 [TYPE], and select [Master/Cal] from the menu.
   4 Press the F3 [RES_PCA], then press F4 [YES].
   5 Turn off the controller power and on again.

3 To reset the "SRVO-075 Pulse not established " alarm, follow steps 1 to 2.
   1 When the controller power is turned on again, 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 [FAULT RESET].

8.3 ZERO POSITION MASTERING

Zero-position mastering (witness mark mastering) is performed with all axes set at the 0-degree position. A zero-position mark (witness mark) is attached to each robot axis (Fig. 8.3 (a)). This mastering is performed with all axes set at the 0-degree position using their respective witness marks.

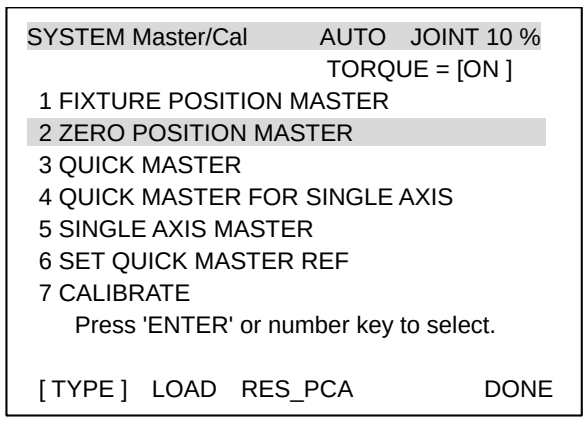
Zero-position mastering involves a visual check. It cannot be so accurate. It should be used only as a quick-fix method.

Procedure of Zero-position Mastering

1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE]. Then select [Variables] from the menu.
4 If $DMR_GRP[group].$GRAV_MAST=1, set the gravity compensation to enabled, if it is 0, set the gravity compensation to disabled. In addition release the brake control.

NOTE
Gravity compensation can be set to enabled/disabled by setting the system variables as follows:
$PARAM_GROUP[group].$SV_DMY_LNK[8] : FALSE(disabled) or TRUE (enabled)
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.
(Mastering can be performed without setting of gravity compensation. However, it will affect precision.)

5 Press the [MENU] key to display the screen menu.
6 Select [0 NEXT] and press [6 SYSTEM].
7 Press F1 [TYPE].
8 Select [Master/Cal].



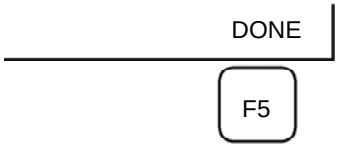
9 Jog the robot into a posture for mastering.
10 Select [2 Zero Position Master]. Press F4 [YES].

```
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
```

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

```
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 Calibrated! Cur Jnt Ang(deg):
    <    0.0000> <    0.0000> <    0.0000>
    <    0.0000> <    0.0000> <    0.0000>
```

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



13 Return the setting of the gravity compensation.
14 Return brake control to original setting, and cycle power of the controller.

Table 8.3 (a) Posture with position marks (witness mark) aligned

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

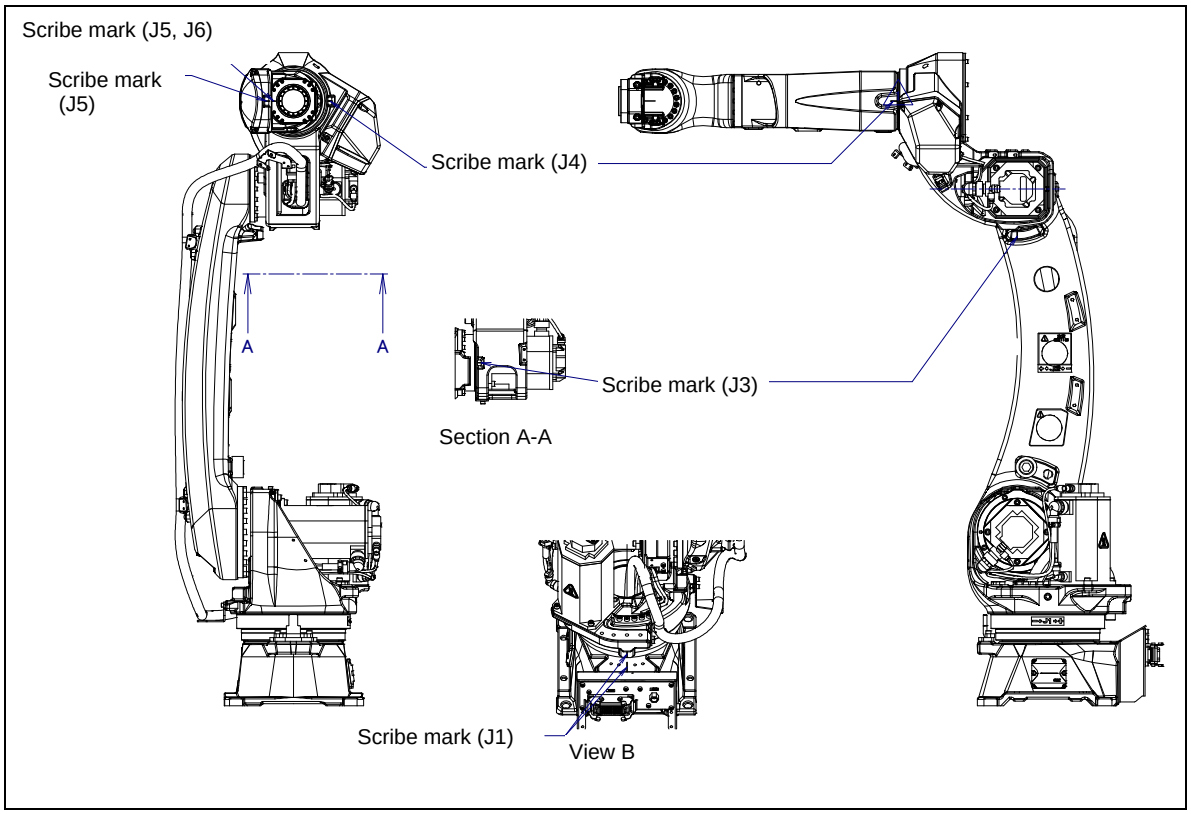


Fig. 8.3 (a) Zero-position mark (witness mark) for each axis

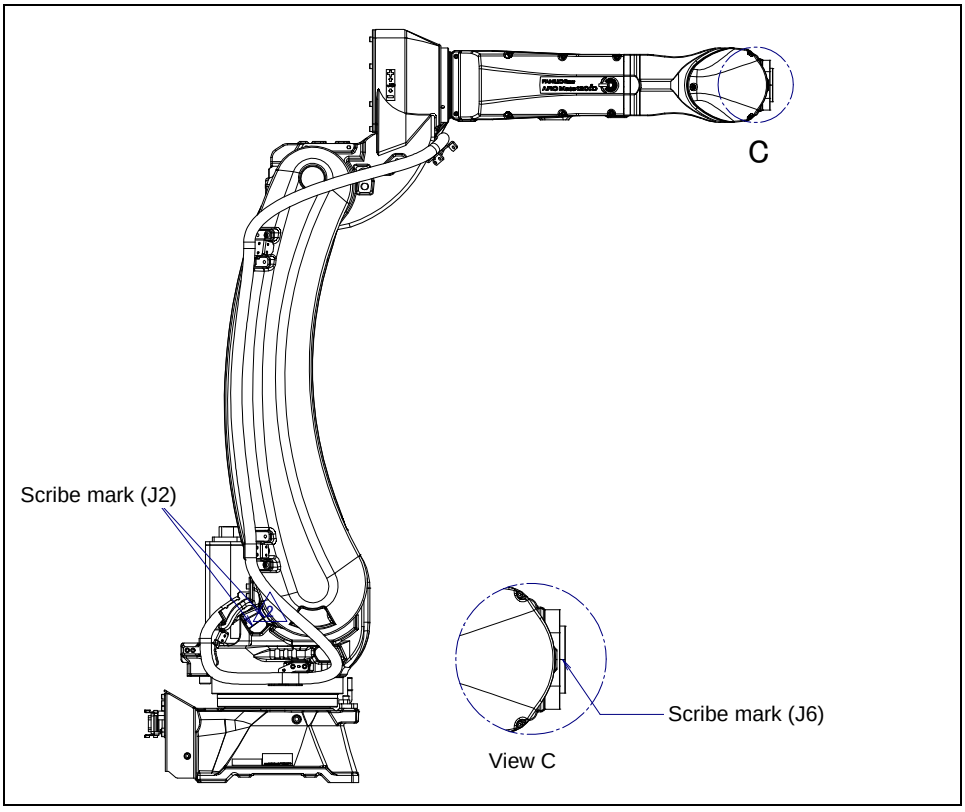


Fig. 8.3 (b) Zero-position mark (witness mark) for each axis

8.4 QUICK MASTERING

Quick mastering is performed at a user-specified position. The pulse count value is obtained from the rotation speed 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.

Quick mastering is factory-performed at the position indicated in Table 8.3 (a). Do not change the setting unless there is any problem.

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

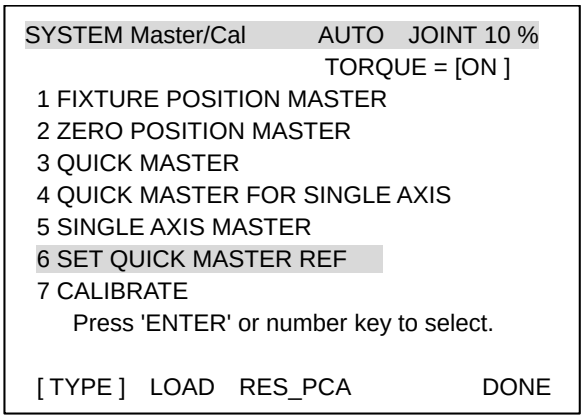
⚠ CAUTION
1 Quick mastering can be used, if the pulse count value is lost, for example, because a low voltage has been detected on the backup battery for the pulse counter.
2 Quick mastering cannot be used, after the Pulsecoder is replaced or after the mastering data is lost from the robot controller.

Procedure Recording the Quick Mastering Reference Position

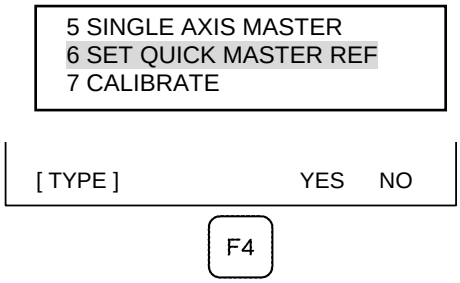
1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE]. Then select [Variables] from the menu.
4 If $DMR_GRP[group].$GRAV_MAST=1, set the gravity compensation to enabled, if it is 0, set the gravity compensation to disabled. In addition release the brake control.

NOTE
Gravity compensation can be set to enabled/disabled by setting the system variables as follows:
$PARAM_GROUP[group].$SV_DMY_LNK[8] : FALSE(disabled) or TRUE (enabled)
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.
(Mastering can be performed without setting of gravity compensation. However, it will affect precision.)

5 Select [SYSTEM].
6 Select [Master/Cal]. Master/Cal screen will be displayed.



7 Jog the robot to the quick mastering reference position.
8 Select [6 SET QUICK MASTER REF] and press F4 [YES]. Quick mastering reference position will be set.



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

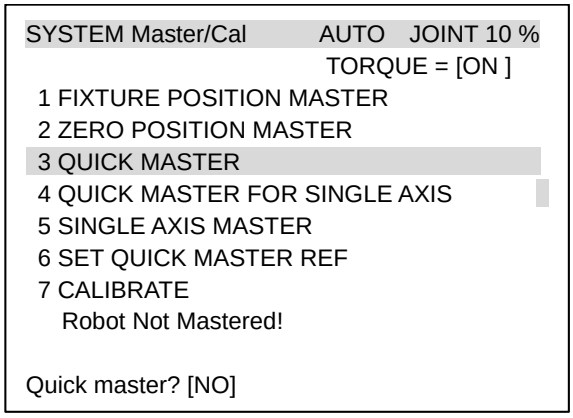
> ⚠ **CAUTION**
> If the robot has lost mastering data due to mechanical disassembly or repair, you cannot perform this procedure. In this case, perform Fixture position mastering or zero –position mastering is required to restore mastering data.

Procedure of Quick Mastering

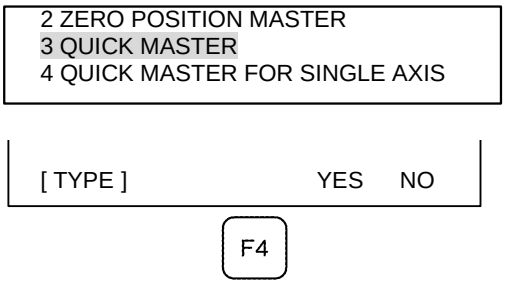
1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE]. Then select [Variables] from the menu.
4 If $DMR_GRP[group].$GRAV_MAST=1, set the gravity compensation to enabled, if it is 0, set the gravity compensation to disabled. In addition release the brake control.

NOTE
Gravity compensation can be set to enabled/disabled by setting the system variables as follows:
$PARAM_GROUP[group].$SV_DMY_LNK[8] : FALSE(disabled) or TRUE (enabled)
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.
(Mastering can be performed without setting of gravity compensation. However, it will affect precision.)

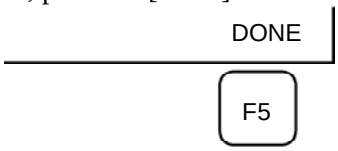
5 Display the Master/Cal screen.



6 Jog the robot to the quick mastering reference position.
7 Select [3 QUICK MASTER] and press F4 [YES]. Quick mastering reference position will be set.



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



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

8.5 QUICK MASTERING FOR SINGLE AXIS

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

Quick mastering is factory-performed at the position indicated in Table 8.3 (a). Do not change the setting unless there is any problem.

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

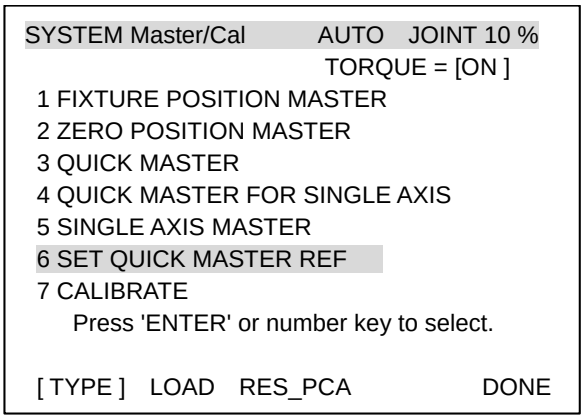
⚠ CAUTION
1 Quick mastering can be used, if the pulse count value is lost, for example, because a low voltage has been detected on the backup battery for the pulse counter.
2 Quick mastering cannot be used, after the Pulsecoder is replaced or after the mastering data is lost from the robot controller.

Procedure Recording the Quick Mastering Reference Position

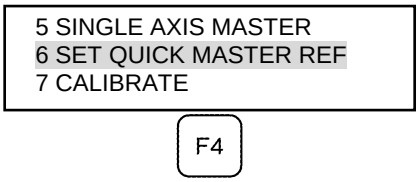
1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE]. Then select [Variables] from the menu.
4 If $DMR_GRP[group].$GRAV_MAST=1, set the gravity compensation to enabled, if it is 0, set the gravity compensation to disabled. In addition release the brake control.

NOTE
Gravity compensation can be set to enabled/disabled by setting the system variables as follows:
$PARAM_GROUP[group].$SV_DMY_LNK[8] : FALSE(disabled) or TRUE (enabled)
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.
(Mastering can be performed without setting of gravity compensation. However, it will affect precision.)

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



7 Jog the robot to the quick mastering reference position.
8 Select [6 SET QUICK MASTER REF] and press F4 [YES]. Quick mastering reference position will be set.



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

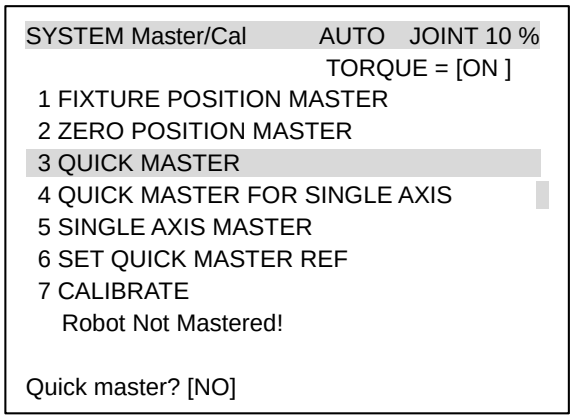
⚠ CAUTION
If the robot has lost mastering data due to mechanical disassembly or repair, you cannot perform this procedure. In this case, perform Fixture position mastering or zero –position mastering is required to restore mastering data.

Procedure of Quick Mastering for single axis

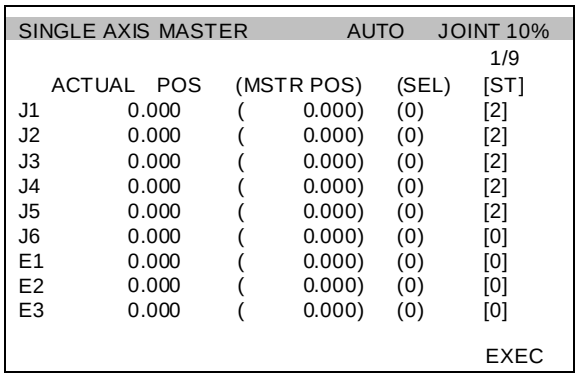
1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE]. Then select [Variables] from the menu.
4 If $DMR_GRP[group].$GRAV_MAST=1, set the gravity compensation to enabled, if it is 0, set the gravity compensation to disabled. In addition release the brake control.

NOTE
Gravity compensation can be set to enabled/disabled by setting the system variables as follows:
$PARAM_GROUP[group].$SV_DMY_LNK[8] : FALSE(disabled) or TRUE (enabled)
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.
(Mastering can be performed without setting of gravity compensation. However, it will affect precision.)

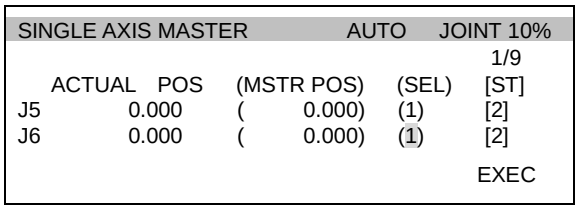
5 Display the Master/Cal screen.



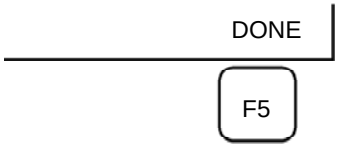
6 Select [4 QUICK MASTER FOR SINGLE AXIS]. quick master for single axis screen will be displayed.



7 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.



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



12 If gravity compensation is disabled, set it to enabled.
13 Return brake control to original setting, and cycle power of the controller.

8.6 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.

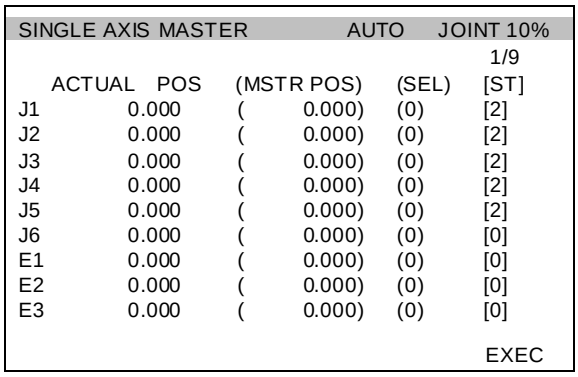


Table 8.6 (a) Items set in single axis mastering

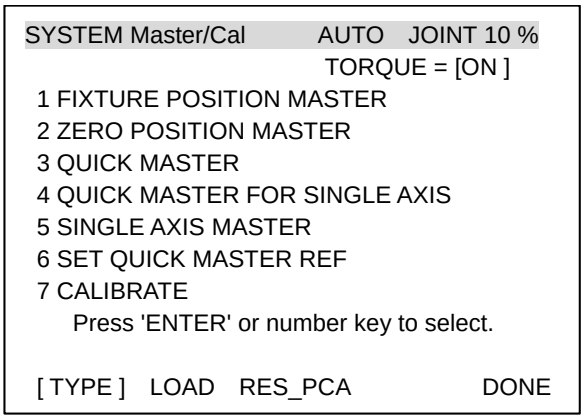
Item	Description
Current position (ACTUAL AXIS)	The current position of the robot is displayed for each axis in degree units.
Mastering position (MSTR POS)	A mastering position is specified for an axis to be subjected to single axis mastering. It would be convenient if it is set to the 0 degree position.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

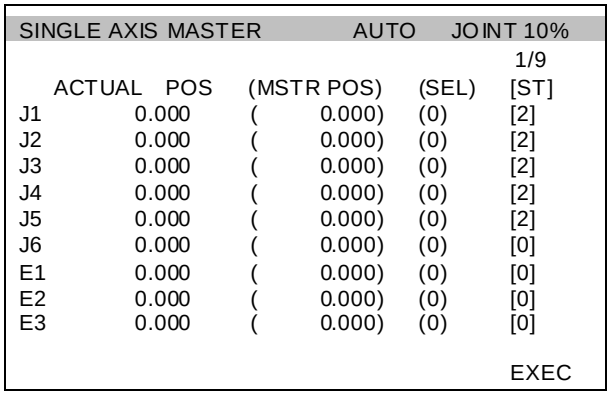
1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE]. Then select [Variables] from the menu.
4 If $DMR_GRP[group].$GRAV_MAST=1, set the gravity compensation to enabled, if it is 0, set the gravity compensation to disabled. In addition release the brake control.

NOTE
Gravity compensation can be set to enabled/disabled by setting the system variables as follows:
$PARAM_GROUP[group].$SV_DMY_LNK[8] : FALSE(disabled) or TRUE (enabled)
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.
(Mastering can be performed without setting of gravity compensation. However, it will affect precision.)

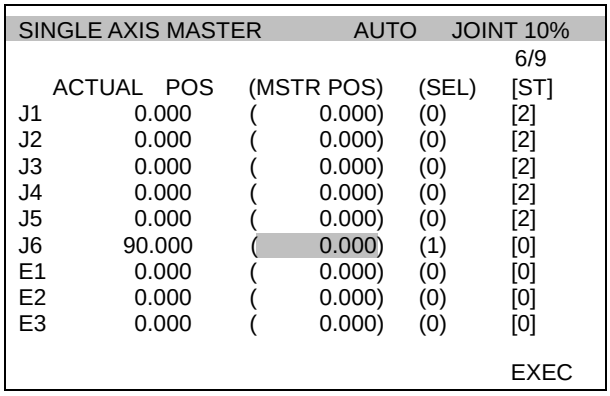
5 Select [6 SYSTEM].
6 Select [Master/Cal].



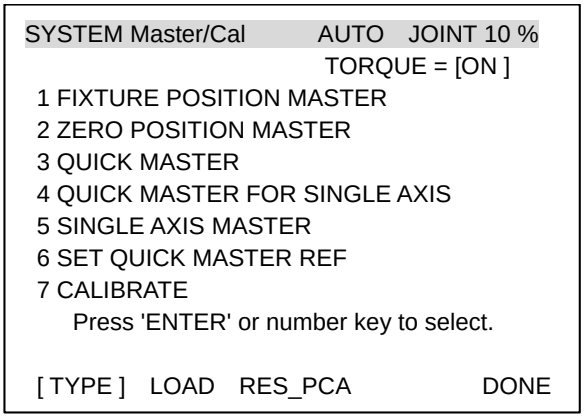
7 Select [5 SINGLE AXIS MASTER]. The following screen will be displayed.



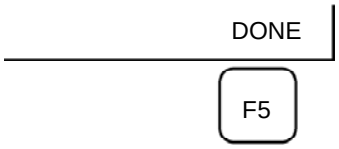
8 For the axis to which to perform single axis mastering, set (SEL) to "1." Setting of [SEL] is available for one or more axes.
9 Turn off brake control, then jog the robot to the mastering position.
10 Enter axis data for the mastering position.
11 Press F5 [EXEC]. Mastering is performed. So, [SEL]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



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



13 Select [7 CALIBRATE], then press F4 [YES]. Positioning is performed. Alternatively, turn off the controller power and on again. Positioning is performed.
14 After positioning is completed, press F5 [DONE].



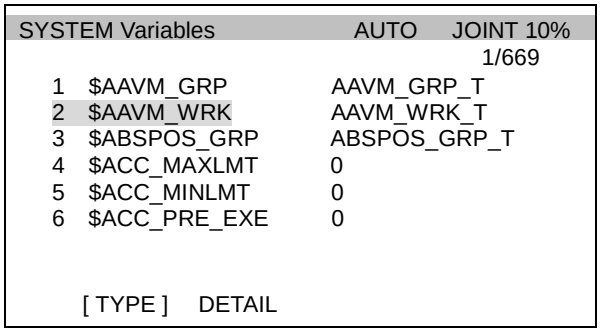
15 Return the setting of the gravity compensation.
16 Return brake control to original setting, and cycle power of the controller.

8.7 MASTERING DATA ENTRY

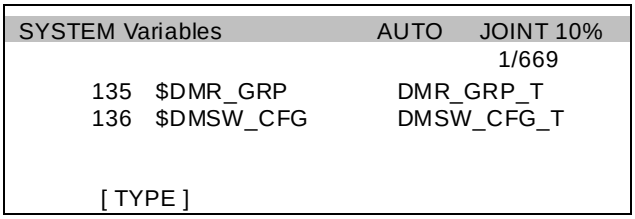
This function enables mastering data values to be assigned directly to a system variable. It can be used if mastering data has been lost but the pulse count is preserved.

Mastering data entry method

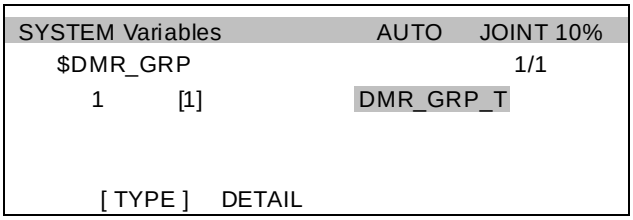
1 Press the [MENU] key, then press [0 NEXT] and select [6 SYSTEM].
2 Press F1 [TYPE]. Select [Variables]. The system variable screen appears.

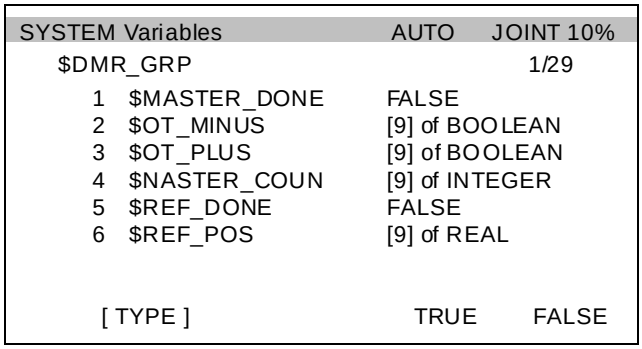


3 Change the mastering data. The mastering data is saved to the $DMR_GRP.$MASTER_COUN system variable.

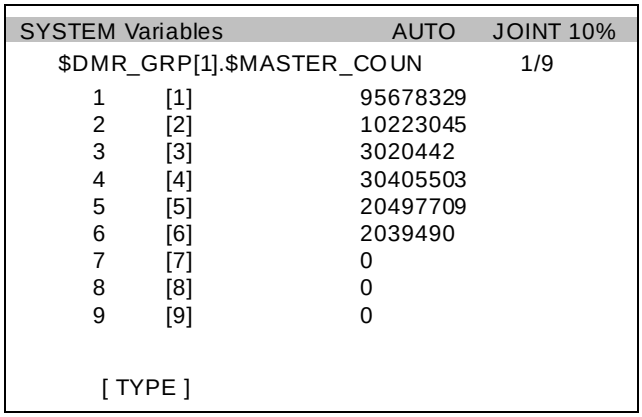


4 Select $DMR_GRP.

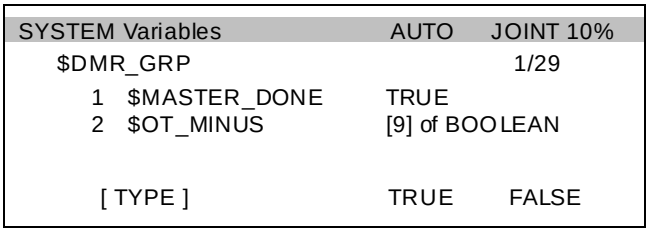




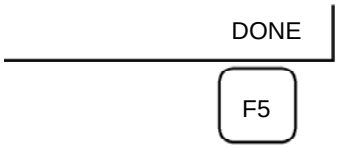
5 Select $MASTER_COUN, and enter the mastering data you have recorded.



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].



8.8 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 meets 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 8.3 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 described in 2. Alternatively, the mastering data in system variable $DMR_GRP.$MASTER_COUN may have been overwritten as a result of an operation error or some other reason.
Compare the data with the values indicated on the supplied data sheet. This system variable is overwritten whenever mastering is performed. Whenever mastering is performed, record the value of the system variable on the data sheet.

2 Alarm 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. Confirm if the alarm will disappear by performing a pulse reset (See Section 8.2.). 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 notification like CKAL, RCAL, PHAL, CSAL, DTERR, CRCERR, STBERR, and SPHAL may have trouble with Pulsecoder, contact your local FANUC representative.

9 TROUBLESHOOTING

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

9.1 TROUBLESHOOTING

Table 9.1 (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.

Table 9.1 (a) Troubleshooting

Symptom	Description	Cause	Measure
Vibration Noise	- The J1 base lifts off the floor plate as the robot operates. - There is a gap between the J1 base and floor plate. - 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 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, which, in turn, leads to vibration.	- If a bolt is loose, apply LOCTITE and tighten it to the appropriate torque. - Adjust the floor plate surface flatness to within the specified tolerance. - If there is any foreign material between the J1 base and floor plate, remove it.
	- The rack or floor plate vibrates during operation of the robot.	[Rack or floor] - It is likely that the rack or floor is not sufficiently rigid. - If the rack or floor is not sufficiently rigid, reaction from the robot deforms the rack or floor, leading to vibration.	- Reinforce the rack or floor to make it more rigid. - If it is impossible to reinforce the rack or floor, modify the robot control program; doing so might reduce the amount of vibration.
	- Vibration becomes more serious when the robot adopts a specific posture. - If the operating speed of the robot is reduced, vibration stops. - Vibration is most noticeable when the robot is accelerating. - Vibration occurs when two or more axes operate at the same time.	[Overload] - It is likely that the load on the robot is greater than the maximum rating. - It is likely that the robot control program is too demanding for the robot hardware. - It is likely that the ACCELERATION value is excessive.	- Check the maximum load that the robot can handle once more. If the robot is found to be overloaded, reduce the load, or modify the robot control program. - Vibration in a specific portion can be reduced by modifying the robot control program while slowing the robot and reducing its acceleration (to minimize the influence on the entire cycle time).

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- Vibration 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.	[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 the gear tooth surface or the rolling surface of bearing and reducer. - It is likely that foreign material caught in a gear, bearing, or within a reducer caused damage on the tooth surface or rolling contact surface of the bearing, or reducer. - It is likely that foreign material caught in a gear, bearing, or within a reducer cause 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 one axis at a time to determine which axis is vibrating. - Remove the motor, and replace the gear, the bearing, and the reducer. For the spec. of parts and the method of replacement, contact FANUC. - Using the robot within its maximum rating prevents problems with the drive mechanism. - Regularly changing the grease with a specified type can help prevent problems. - Using the specified grease or oil at the recommended interval will prevent problems.

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

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

Symptom	Description	Cause	Measure
Motor overheating	- The ambient temperature of the installation location increases, causing the motor to overheat. - After a cover was attached to the motor, the motor overheated. - After the robot control program or the load was changed, the motor overheated.	[Ambient temperature] - It is likely that the motor overheated along with the ambient temperature rose, and could not release heat. [Operating condition] - It is likely that the overcurrent 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 overheat. - If there is a source of heat near, it is advisable to install shielding to protect the motor from heat radiation. - Relaxing the robot control program and load condition is effective to reduce the average current. Thus, prevent overheat. - The teach pendant can monitor the average current. Check the average current when the robot control program launched.
	- After a robot control parameter (load setting etc.) was changed, the motor overheated.	[Parameter] - If data input for a workpiece is invalid, the robot cannot be accelerated or decelerated normally, so the average current increases, leading to overheat.	- As for load setting, Input an appropriate parameter referring to Section 4.3 of the operator's manual.
	- Symptom other than stated above	[Mechanical section problems] - It is likely that problems occurred in the mechanical unit drive mechanism, thus placing an excessive load on the motor. [Motor problems] - It is likely that a failure of the motor brake resulted in the motor running with the brake applied, thus placing an excessive load on the motor. - It is likely that a failure of the motor prevented it from delivering its rated performance, thus causing an excessive current to flow through the motor.	- Repair the mechanical unit while referring to the above descriptions of vibration, noise, and rattling. - Check that, when the servo system is energized, the brake is released. If the brake remains applied to the motor all the time, replace the motor. - If the average current falls after the motor is replaced, it indicates that the first motor was faulty.

Symptom	Description	Cause	Measure

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

Dropping axis	- An axis drops because the brake does not function. - An axis drops gradually when it should be at rest.	[Brake drive relay and motor] - It is likely that brake drive relay contacts are stuck to each other to 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 has entered the motor, causing the brake to slip.	- Check whether the brake drive relay contacts are stuck to each other. If they are found to be stuck, replace the relay. - If the brake shoe is worn out, if the brake main body is damaged, or if oil or grease has entered the motor, replace the motor. - J4-axis cable has movable part .So if robot exceeds stroke limit, load depends on cable and it may cause damage of cables. If robot exceeds stroke limit, remove plate of back of J4, return axis to motion range during checking condition of cables. If nylon band is cut, attach new articles. If you operate robot with cable tie is cut, it cause damage of cables. (See Section 8.1).

Symptom	Description	Cause	Measure
Displacement	- The robot operates at a point other than the taught position. - The repeatability is not within the tolerance.	[Mechanical section problems] - If the repeatability is unstable, probable causes are a failure in the drive mechanism or a loose bolt. - If the repeatability becomes stable, it is likely that a collision imposed an excessive load, leading to slipping on the base surface or the mating surface of an arm or reducer. - It is likely that the Pulsecoder is faulty.	- If the repeatability is unstable, repair the mechanical section by referring to the above descriptions of vibration, noise, and rattling. - If the repeatability is stable, correct the taught program. The problem will not occur 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 rewritten in such a way that the robot origin was shifted.	- Re-enter the previous mastering data, which is known to be correct. - If correct mastering data is unavailable, perform mastering again.
BZAL alarm occurred	- BZAL is displayed on the teach pendant screen	- It is likely that the voltage of the memory backup battery is low. - It is likely that the Pulsecoder cable is defective.	- Replace the battery. - Replace the cable.

Table 9.1 (b) End effector mounting face 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 MATERIAL HANDLING CONDUIT (OPTION)

10.1 NOTES WHEN CABLE IS ATTACHED TO MATERIAL HANDLING CONDUIT

(1) 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, so replace it regularly.

(2) The cable is recommended to be clamped at a position 70mm or more away for the wrist side. A position 30mm or more away is recommended for the J3 back side. In case of M-20*i*D/25/35, adjust the length of the cable between clamping to 950±5mm. In case of M-20*i*D/12L, adjust the length of the cable between clamping to 1500±5mm. Please absorb extra length to the 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 10.1 (a) Recommended cables and air tube

Cable name	Maker	Spec of FANUC	Specifications
End effector cable	Oki cable co. Ltd	A66L-0001-0459	0.2mm^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 0.08mm^2 2-core Cable for moving part
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 (Outside diameter=ϕ6mm, Inside diameter=ϕ4mm)

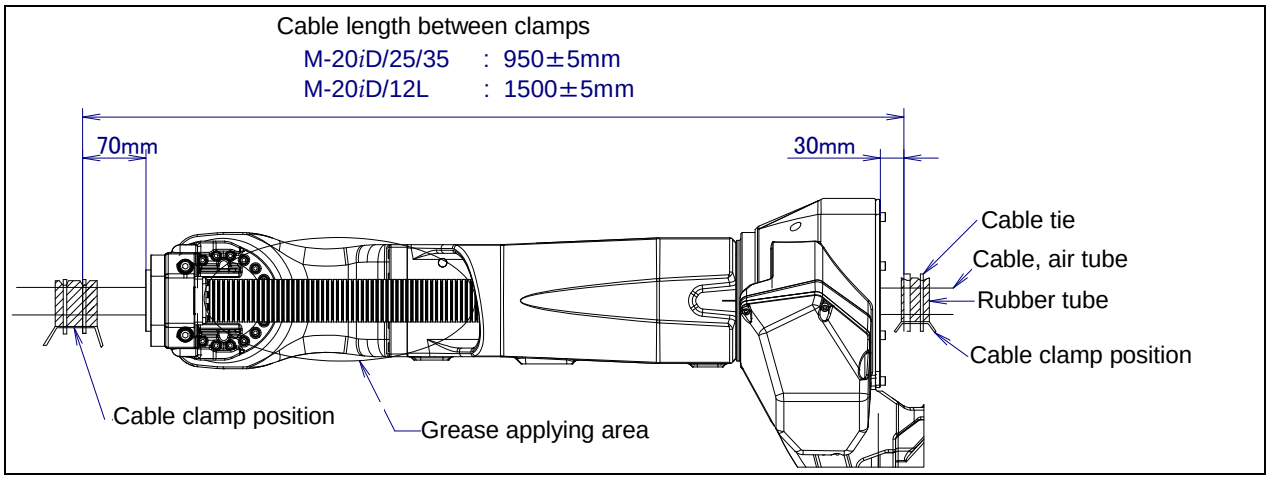


Fig. 10.1 (a) Cable length between clamp

(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.

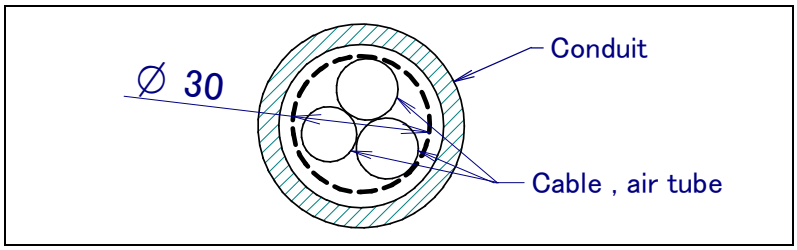


Fig. 10.1 (b) Diameter of cable and air tube in conduit

(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.

10.2 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 10.2 (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 strands 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 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 and white powder is generated to reduce friction of rotation. This is not trouble. Fluoric resin ring is expendable supplies. (Spec: A290-7221-X571) 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. If the robot is operated with fluoric resin rig is broken, it causes early damage of conduit.

APPENDIX

A PERIODIC MAINTENANCE TABLE

FANUC Robot ARC Mate 120*i*D, ARC Mate 120*i*D/12L/35, M-20*i*D/25/12L/35 Periodic Maintenance Table

Items		Accumulated operating 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 for water	0.1H	-		○	○	○	○	○	○	○	○	○	○	○
	3	Check the mechanical cable and welding power cable (Damaged or twisted)	0.1H	-		○			○				○			
	4	Check the end effector (hand) cable	0.1H	-		○			○				○			
	5	Check the motor connector. (Loosening)	0.1H	-		○			○				○			
	6	Tighten the end effector bolt	0.1H	-		○			○				○			
	7	Tighten the cover and main bolt	1.0H	-		○			○				○			
	8	Check the fixed mechanical stopper and adjustable mechanical stopper	0.1H	-		○			○				○			
	9	Remove spatter and dust etc.	1.0H			○			○				○			
	10	Replacing battery *3	0.1H	-					●				●			
	11	Replacing grease of J1 axis gearbox	0.5H	1380ml												
	12	Replacing grease of J2 axis reducer	0.5H	920ml												
	13	Replacing grease of J3 axis reducer	0.5H	330ml												
	14	Replacing oil of J4 axis gearbox	0.5H	750ml												
	15	Replacing oil of J5 and J6 axis gearbox	0.5H	800ml (*4) 330ml (*5)												
	16	Replacing cable of mechanical unit	4.0H	-												
	17	Replacing Mechanical unit welding power cable	4.0H	-									●			
	18	Replacing the M/H conduit	1.0H	-									●			
Controller	19	Check the robot cable, teach pendant cable and robot connecting cable	0.2H	-		○			○				○			
	20	Cleaning the controller ventilation system	0.2H	-	○	○	○	○	○	○	○	○	○	○	○	○
	21	Replacing battery *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.

*4 : ARC Mate 120***i***D, M-20***i***D/25

*5 : ARC Mate 120***i***D/12L, M-20***i***D/12L

3 years 11520	12480	13440	14400	4 years 15360	16320	17280	18240	5 years 19200	20160	21120	22080	6 years 23040	24000	24960	25920	7 years 26880	27840	28800	29760	8 years 30720	Item
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		1
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		2
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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. When finished, remove all the excess LOCTITE when you are finished screwing the bolts into the threaded holes.

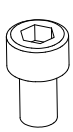
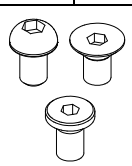
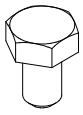
Use the following strength bolts. Comply with any bolt specification instructions.
Hexagon socket head bolt made of steel:

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

Hexagon bolt, stainless bolt, special shape bolt (button bolt, low-head bolt, flush bolt .etc.)
Tensile strength 400N/mm^2 or more

Refer to the following tables if the bolts tightening torque are 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.

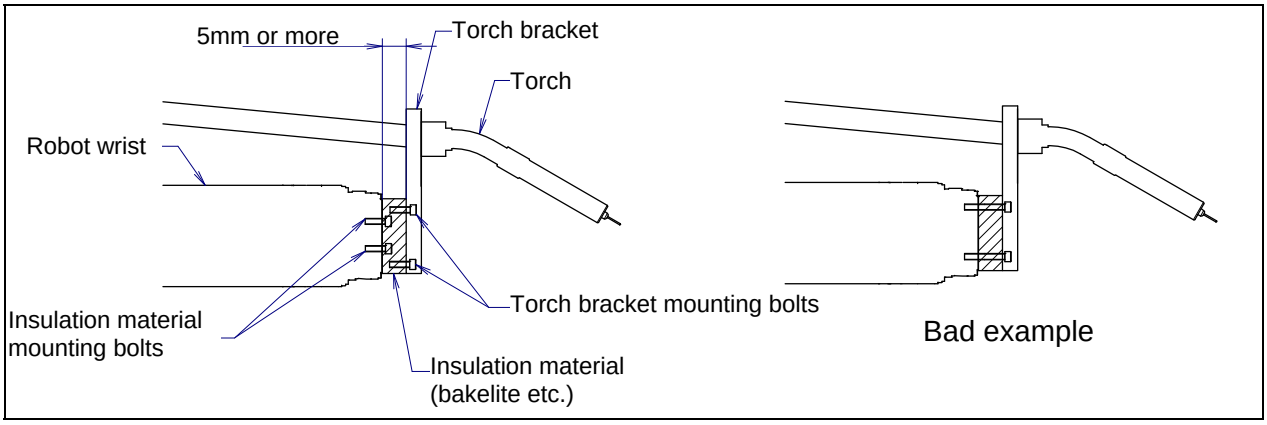


Fig. C.1 (a) Insulation at the wrist

- 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.

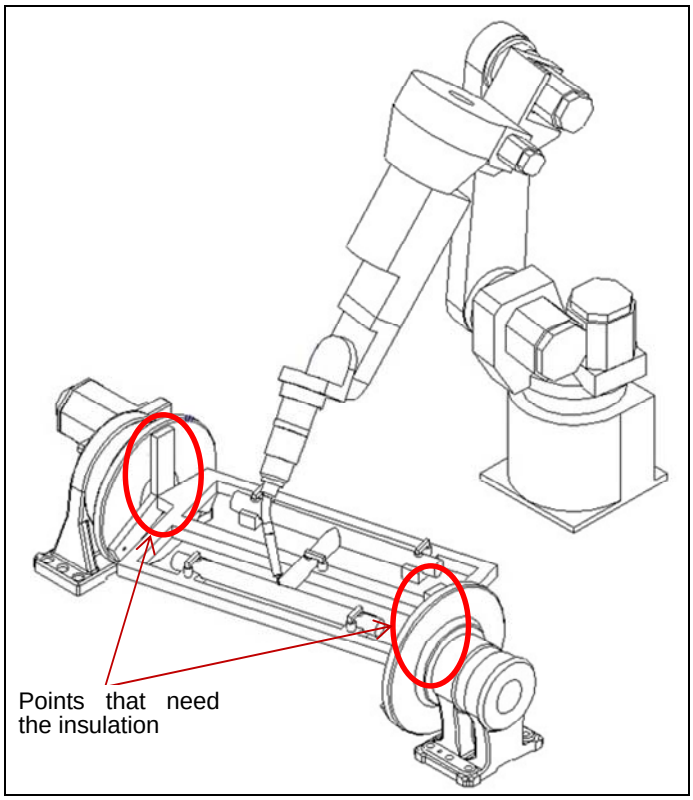


Fig. C.2 (a) Insulation at the additional axis

D CONTROL OF MULTIPLE ROBOTS

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.

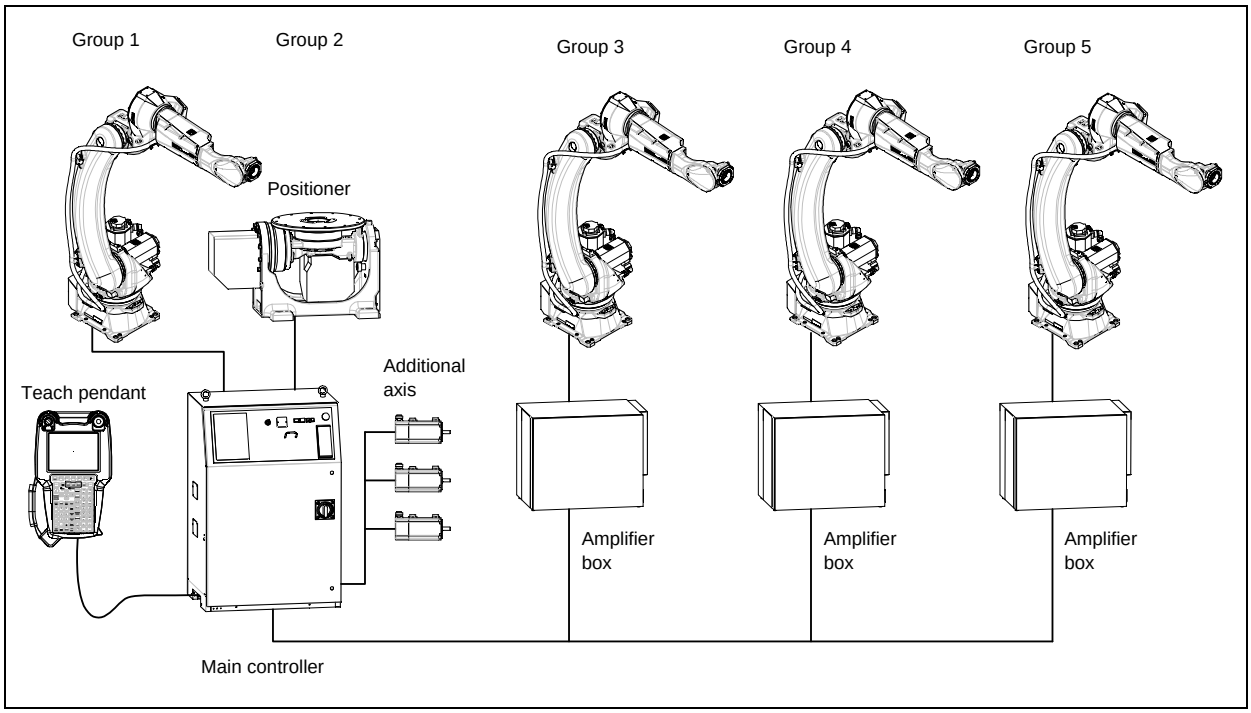


Fig. D (a) Example of Control of multiple robots

When multiple robots are controlled with one controller, select the appropriate servo card of controller from Table D (a).

Table D (a) Servo card when multiple robots are controlled (R-30*i*B Plus, R-30*i*B Mate Plus)

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

(Note) It can be used only when auxiliary axes are not specified.

INDEX

REVISION RECORD

Edition	Date	Contents
03	Jun, 2020	・Addition of ARC Mate 120*i*D/35, M-20*i*D/35 ・Correction of errors
02	Jan., 2020	・Addition of ARC Mate 120*i*D/12L, M-20*i*D/12L ・Correction of errors
01	Mar., 2019	

B-84074EN/03

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