FANUC Robot M-1*i*A

MECHANICAL UNIT
OPERATOR'S MANUAL

B-83084EN/10

- **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	○	○	○
Maintain for operator's panel		○	
Maintain for teach pendant			○

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 pinched by the robot), brake release unit can be used to move the robot axes without drive power.
Please order following unit and cable.

Name	Specification
Brake release unit	A05B-2560-J460 (Input voltage AC100-115V single phase) A05B-2560-J461 (Input voltage AC200-240V single phase)
Robot connection cable	A05B-2560-J480 (5m) A05B-2560-J481(10m)
Power cable	A05B-2560-J470 (5m) (AC100-115V Power plug) (*) A05B-2560-J471(10m) (AC100-115V Power plug) (*) A05B-2560-J472 (5m) (AC100-115V or AC200-240V No power plug) A05B-2560-J473(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 supporting Robot arm by a block etc. before releasing a brake.

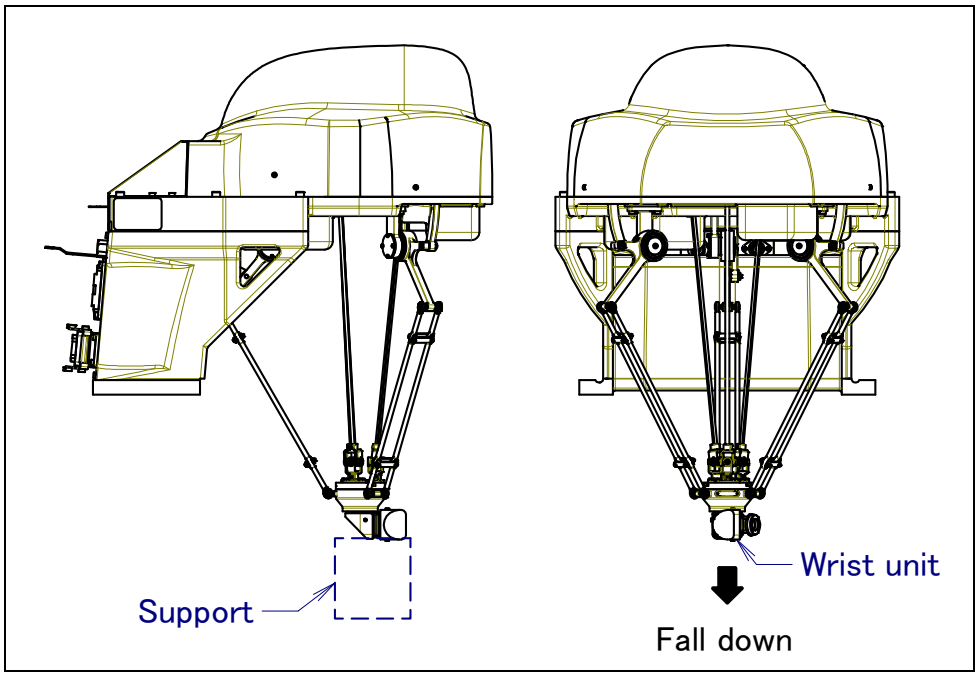


Fig. 3 (a) Arm operation by the release of motor brake and measures

4 WARNING & CAUTION LABEL

(1) Transportation attention label

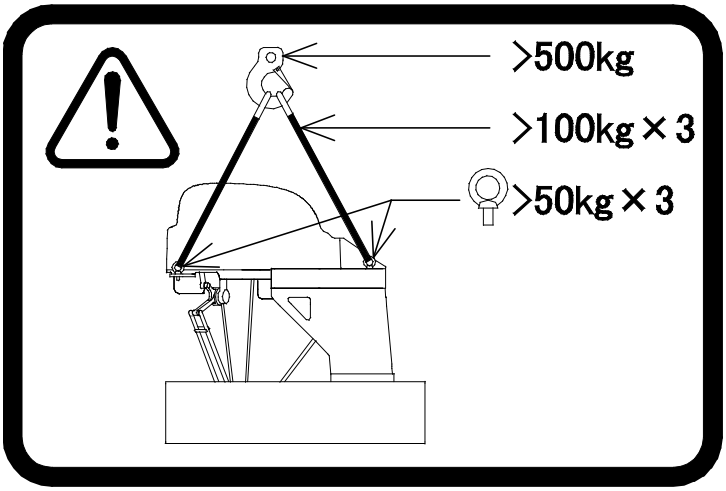


Fig. 4 (a) Transportation attention label

Description

1) Use a crane having a load capacity of 500 kg or greater.
2) Use at least three slings each having a load capacity of 100 kg or greater.
3) Use at least three eyebolts each having a allowable load of 490 N (50 kgf) or greater.

(2) Operating space and payload label

Below label is added when CE specification is specified.

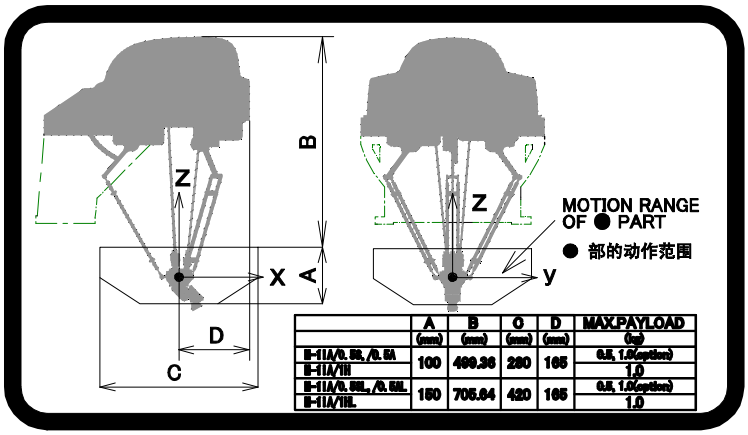


Fig. 4 (b) Operating space and payload label

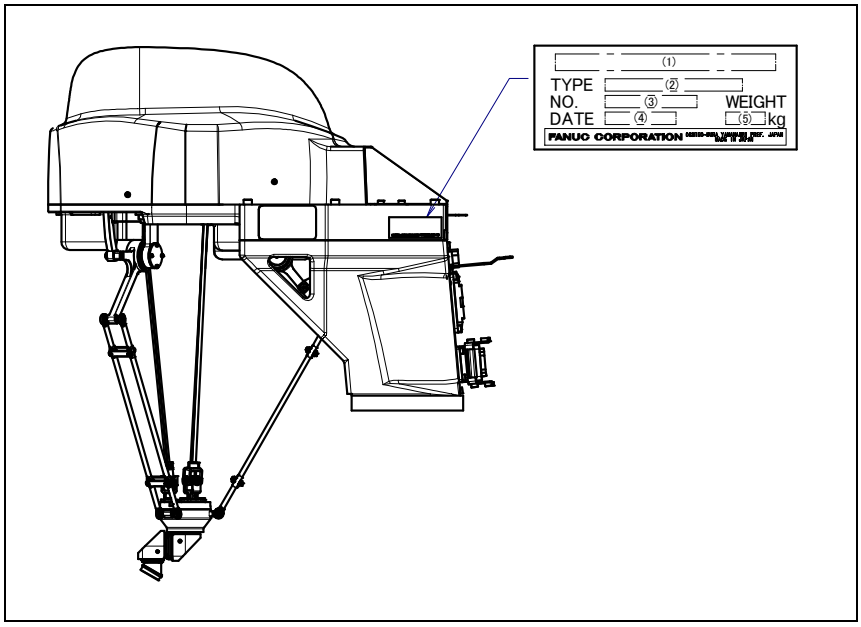
PREFACE

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

Model name	Mechanical unit specification No.	Maximum load
FANUC Robot M-1*i*A/0.5S	A05B-1522-B201	0.5kg 1kg (NOTE)
FANUC Robot M-1*i*A/0.5A	A05B-1522-B202	
FANUC Robot M-1*i*A/1H	A05B-1522-B203	1kg
FANUC Robot M-1*i*A/0.5SL	A05B-1522-B204	0.5kg 1kg (NOTE)
FANUC Robot M-1*i*A/0.5AL	A05B-1522-B205	
FANUC Robot M-1*i*A/1HL	A05B-1522-B206	1kg

NOTE
When 1 kg payload option is specified.

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



Position of label indicating mechanical unit specification number

TABLE 1)

	(1)	(2)	(3)	(4)	(5)
CON TENTS	**MODEL NAME**	**TYPE**	**No.**	**DATE**	**WEIGHT kg (without controller)**
LETTERS	FANUC Robot M-1*i*A/0.5S	A05B-1522-B201	SERIAL NO. IS PRINTED	PRODUCTION YEAR AND MONTH ARE PRINTED	14
	FANUC Robot M-1*i*A/0.5A	A05B-1522-B202			17
	FANUC Robot M-1*i*A/1H	A05B-1522-B203			12
	FANUC Robot M-1*i*A/0.5SL	A05B-1522-B204			17
	FANUC Robot M-1*i*A/0.5AL	A05B-1522-B205			20
	FANUC Robot M-1*i*A/1HL	A05B-1522-B206			15

RELATED MANUALS

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

SAFETY HANDBOOK B-80687EN All persons who use the FANUC Robot and system designer must read and understand thoroughly this handbook		Intended readers: Operator, system designer Topics: Safety items for robot system design, operation, maintenance
R-30*i*A Mate controller	OPERATOR'S MANUAL LR HANDLING TOOL **B-83134EN-1** ALARM CODE LIST **B-83124EN-6**	Intended readers : Operator, programmer, Teaching operator, Maintenance technician, System designer Topics : Robot functions, Operations, Programming, Setup, Interfaces, Alarms Use : Robot operation, Teaching, System design
	MAINTENANCE MANUAL Standard: **B-82725EN** **B-82725EN-1** (For Europe) **B-82725EN-2** (For RIA) Open air type: **B-82965EN-1**	Intended readers : Maintenance technician, System designer Topics : Installation, Start-up, Connection, Maintenance Use : Installation, Start-up, Connection, Maintenance
R-30*i*B Mate, R-30*i*B Mate Plus controller	OPERATOR'S MANUAL Basic Operation **B-83284EN** Alarm Code List **B-83284EN-1** Optional Function **B-83284EN-2**	Intended readers : Operator, programmer, Teaching operator, Maintenance technician, System designer Topics : Robot functions, Operations, Programming, Setup, Interfaces, Alarms Use : Robot operation, Teaching, System design
	MAINTENANCE MANUAL **B-83525EN** Open Air : **B-83555EN**	Intended readers : Maintenance technician, System designer Topics : Installation, Start-up, Connection, Maintenance Use : Installation, Start-up, Connection, Maintenance

This manual uses following terms.

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

TABLE OF CONTENTS

1 TRANSPORTATION AND INSTALLATION

1.1 TRANSPORTATION

Use a crane to transport the robot. When transporting the robot, be sure to change the posture of the robot to that shown Fig. 1.1 (a), (b), (c) and lift by using the eyebolts and the transport equipment at their points.

Transportation using a crane (Fig. 1.1 (a), (b), (c))
Fasten the M6 eyebolts of special transport equipment and lift the robot by the four slings.

NOTE
1 When lifting the robot, notice so that the motor, connectors or cables of the robot are not damaged by slings.
2 When hoisting or lowering the robot with a crane, move it slowly with great care. When placing the robot on the floor, exercise care to prevent the installation surface of the robot from striking the floor strongly.
3 Be sure to remove end effector before transporting robot.
4 When transporting or installing the robot, please be careful not to touch the drive shaft, the links and the wrist.

⚠ WARNING
Use the transport equipment only to transport the robot. Do not use the transport equipment to secure the robot.
Before moving the robot by using transport equipment, check and tighten any loose bolts on the transport equipment.

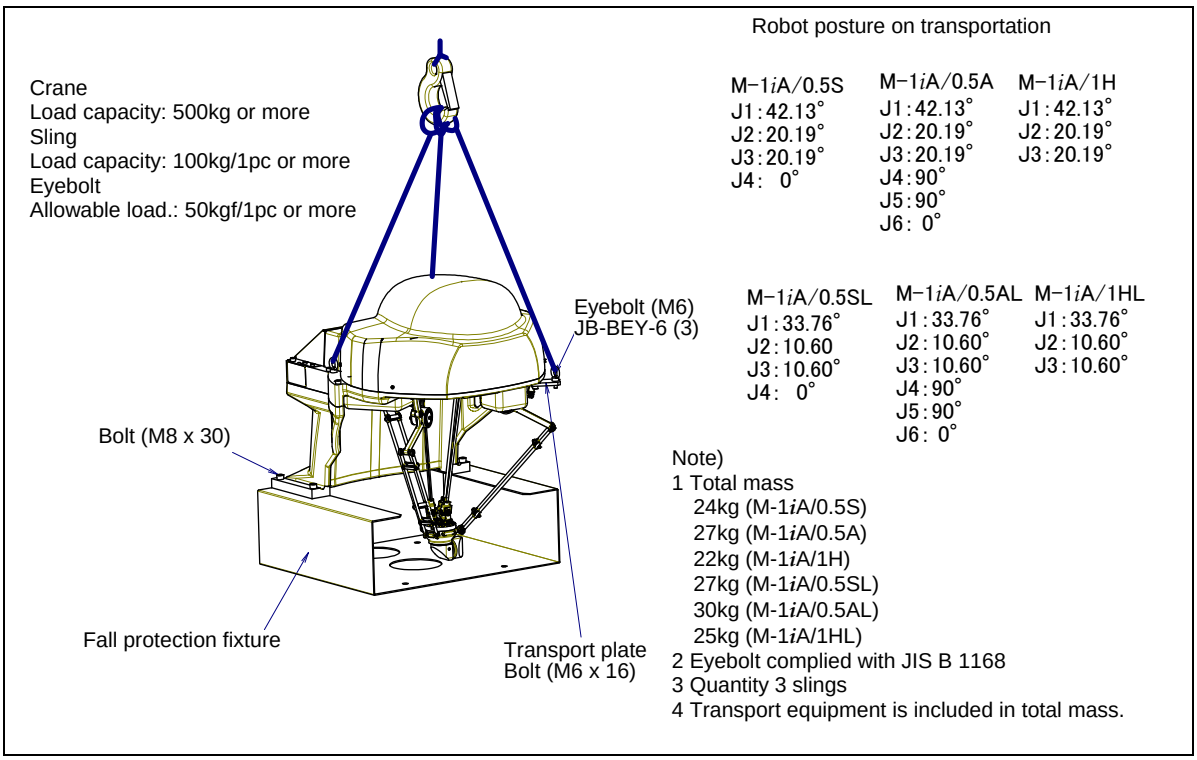


Fig. 1.1 (a) Transportation using a crane (with stand)

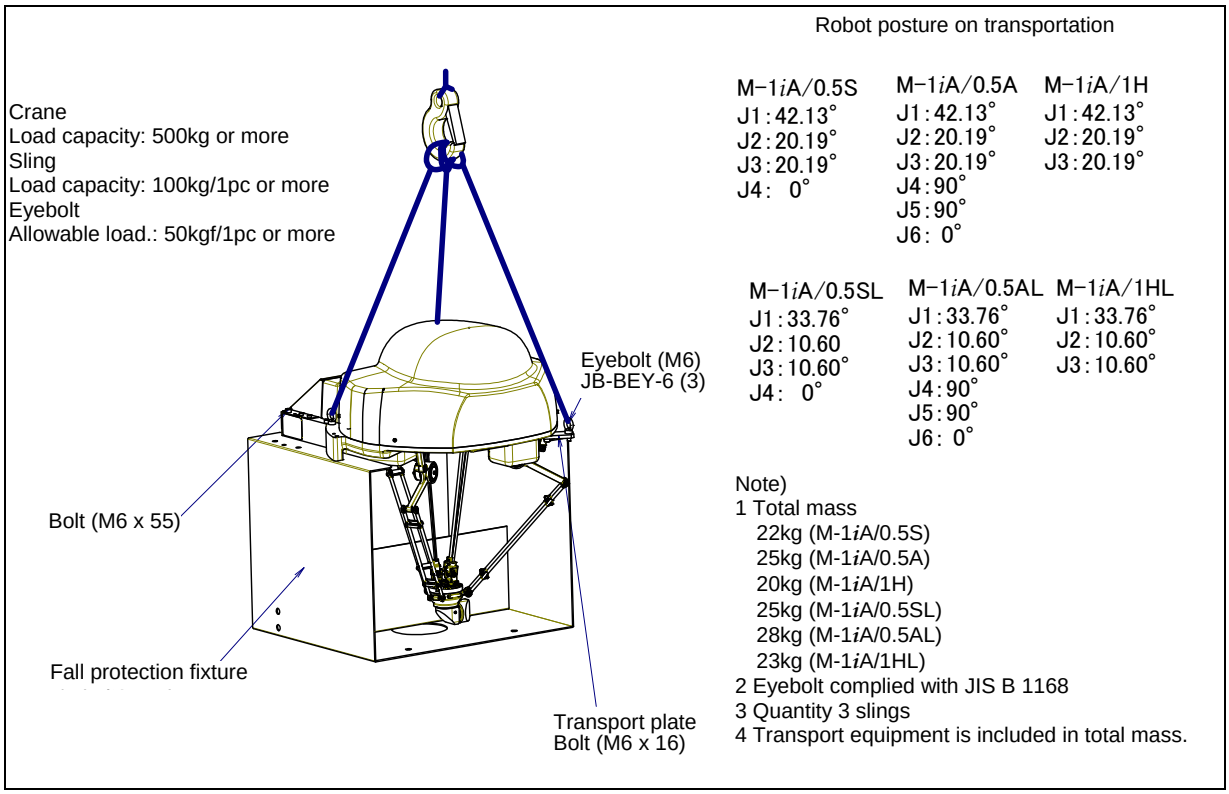


Fig. 1.1 (b) Transportation using a crane (no stand A and no stand B)

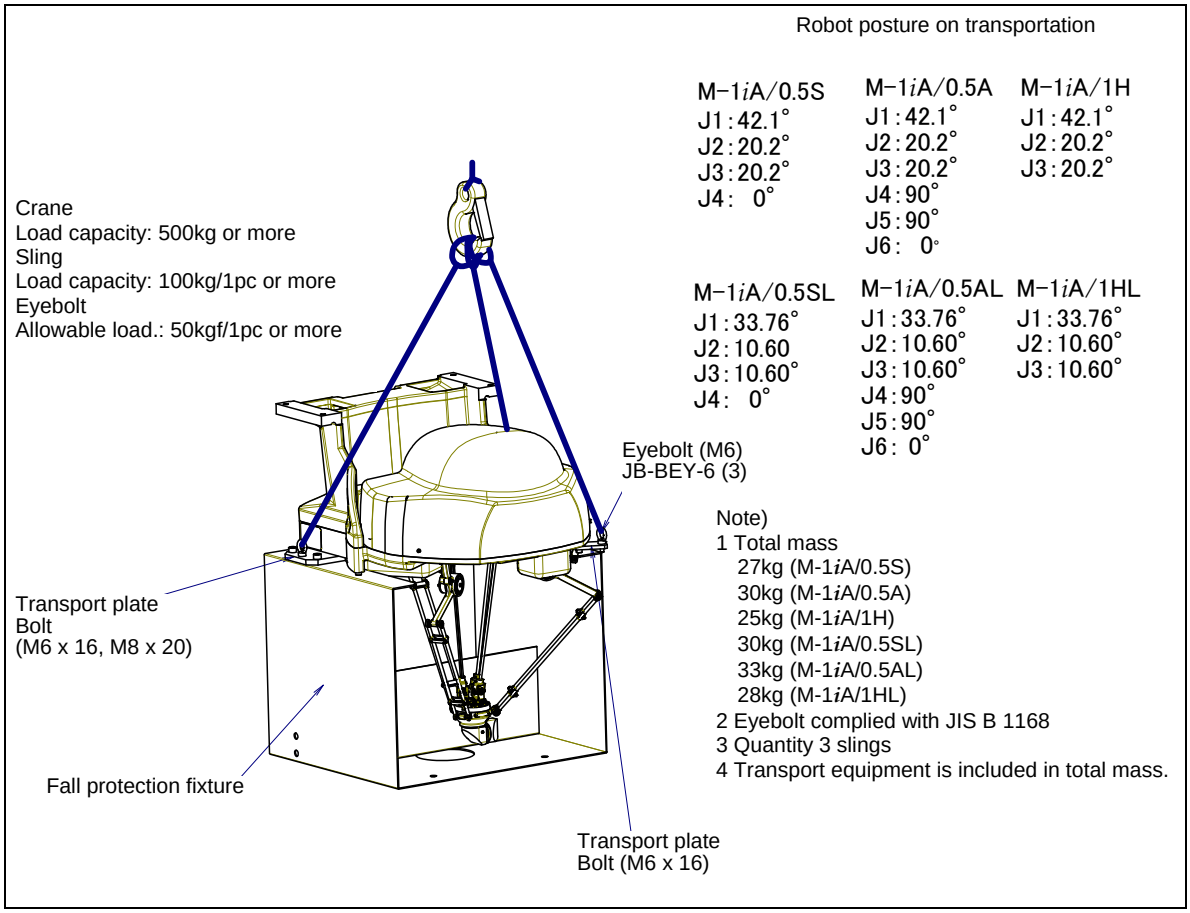


Fig. 1.1 (c) Transportation using a crane (ceiling mount)

1.2 INSTALLATION

Fig. 1.2 (a) to (f) show the robot base dimensions.
Meet the following requirements about the character frequency of robot pedestal.

Character frequency > 50Hz

⚠ CAUTION
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 0.5°.If robot base is placed on uneven ground, it may result in the base breakage or low performance of the robot.

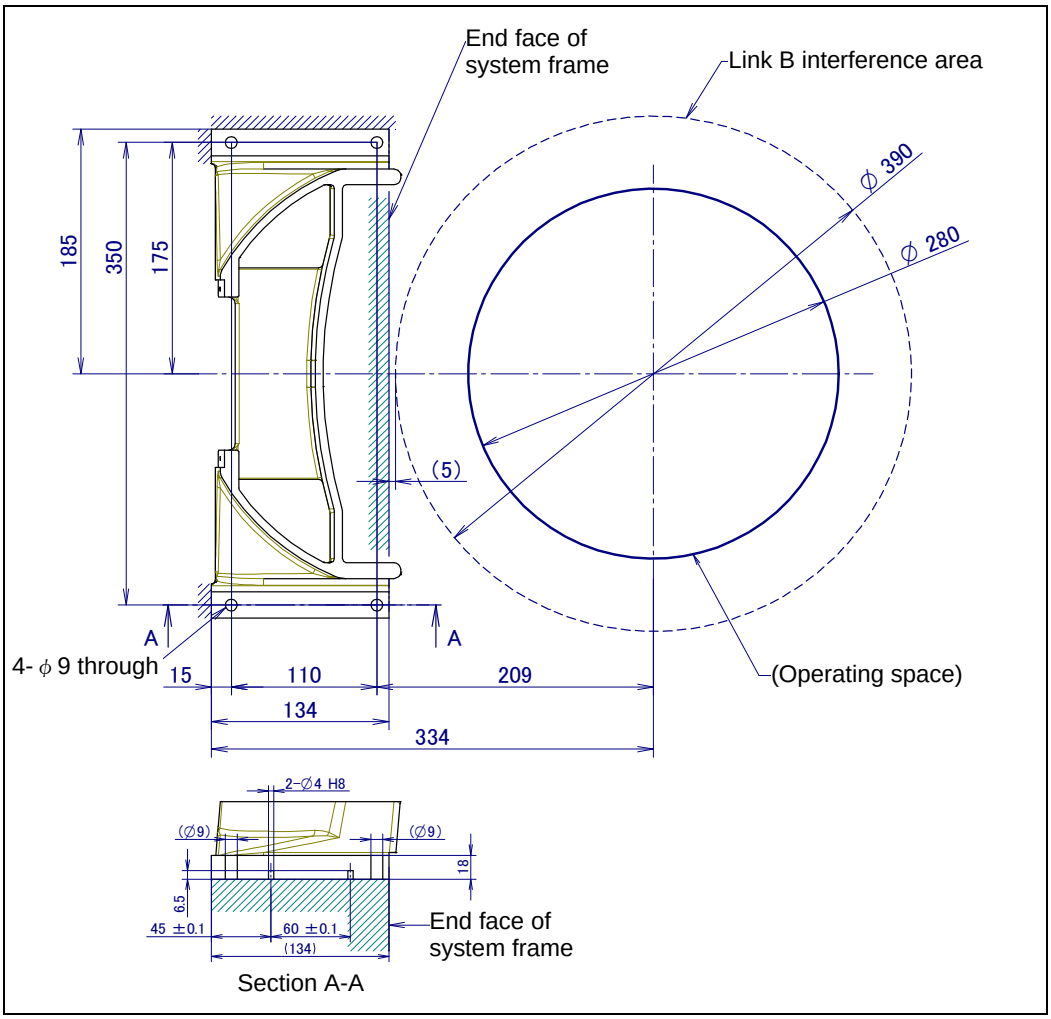


Fig. 1.2 (a) Dimension of robot base (with stand) (M-1*i*A/0.5S/0.5A/1H)

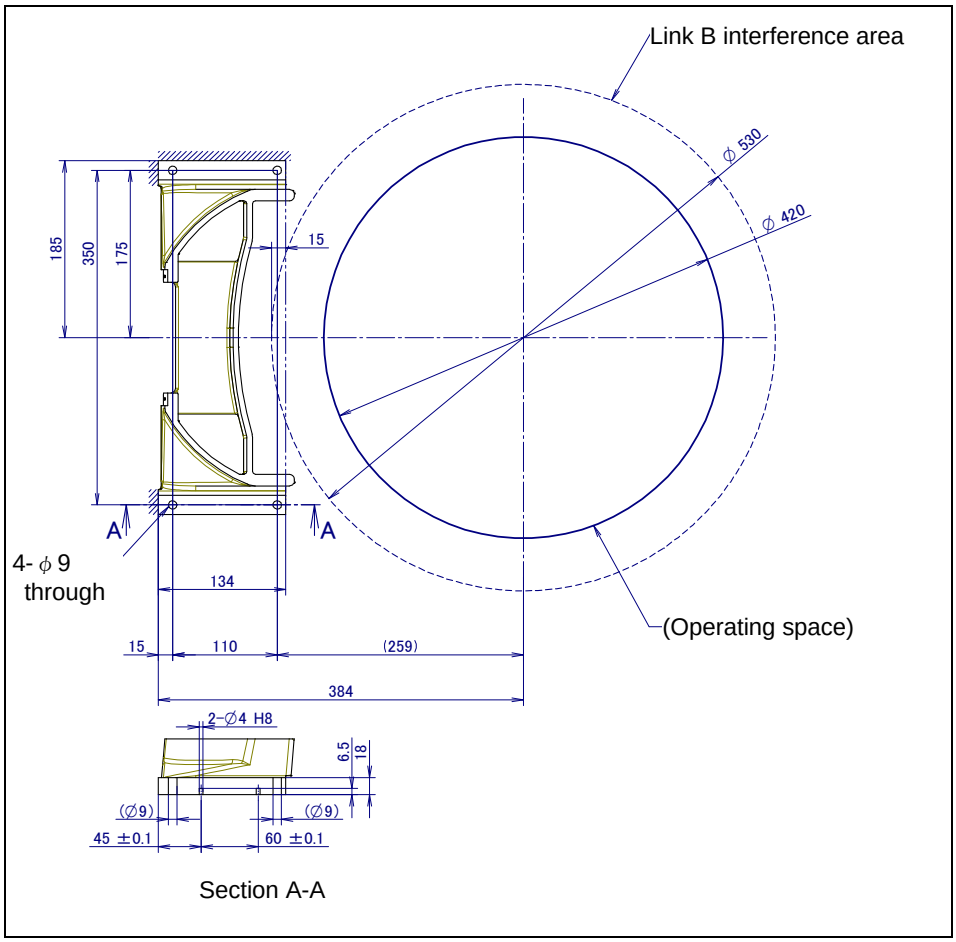


Fig. 1.2 (b) Dimension of robot base (with stand) (M-1*i*A/0.5SL/0.5AL/1HL)

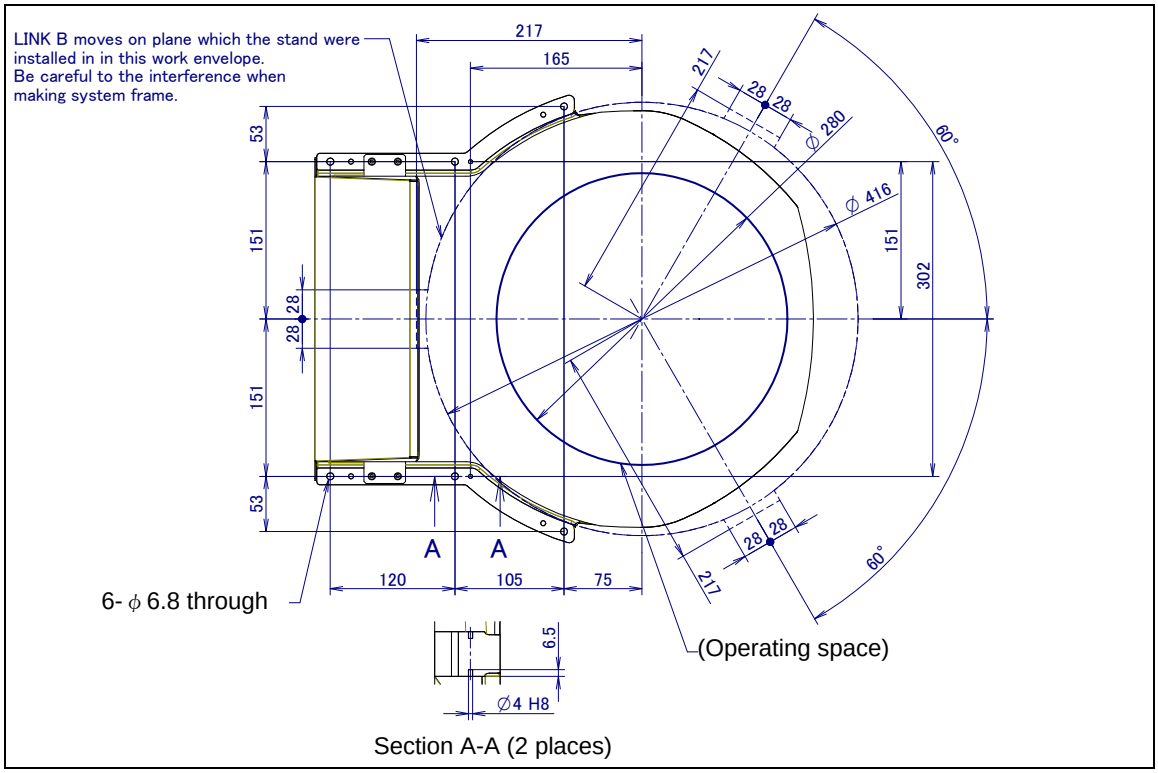


Fig. 1.2 (c) Dimension of robot base (no stand A and no stand B) (M-1*i*A/0.5S/0.5A/1H)

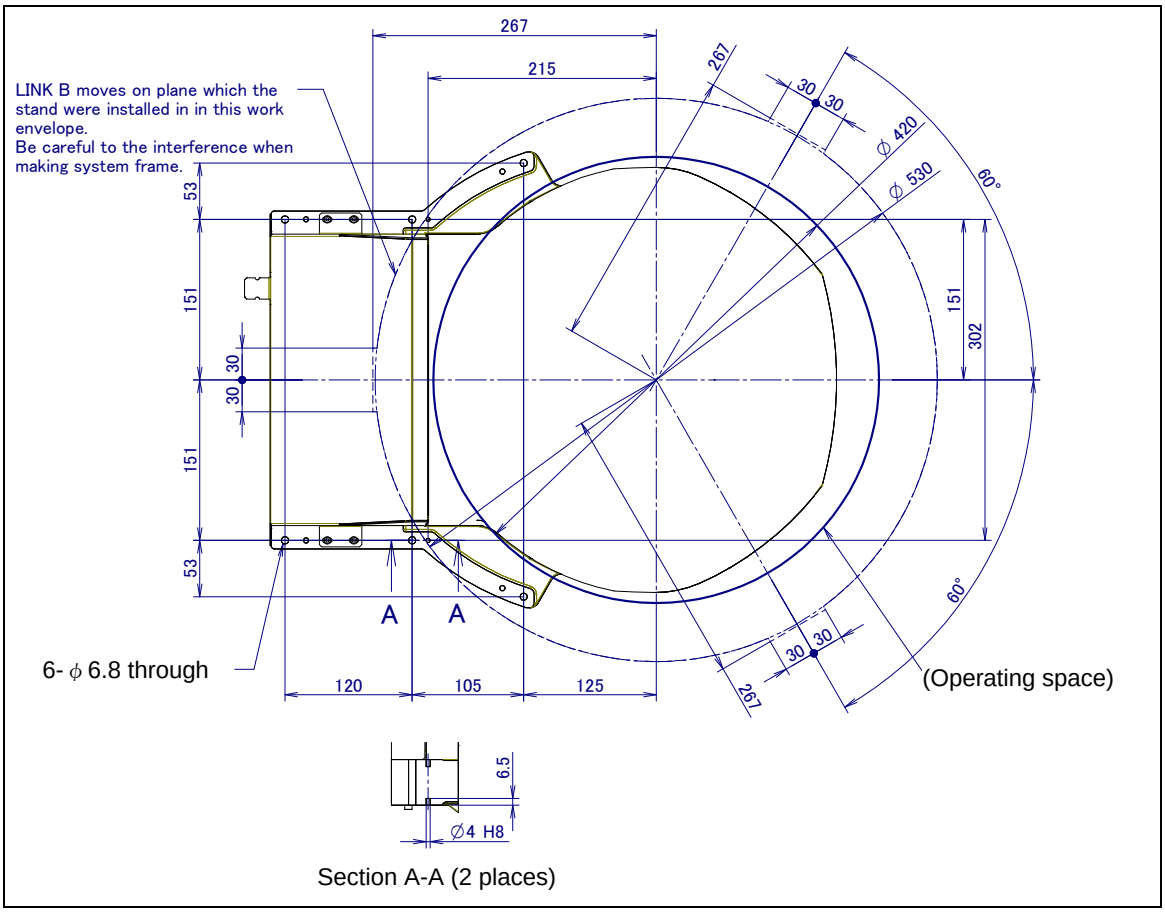


Fig. 1.2 (d) Dimension of robot base (no stand A and no stand B) (M-1*i*A/0.5SL/0.5AL/1HL)

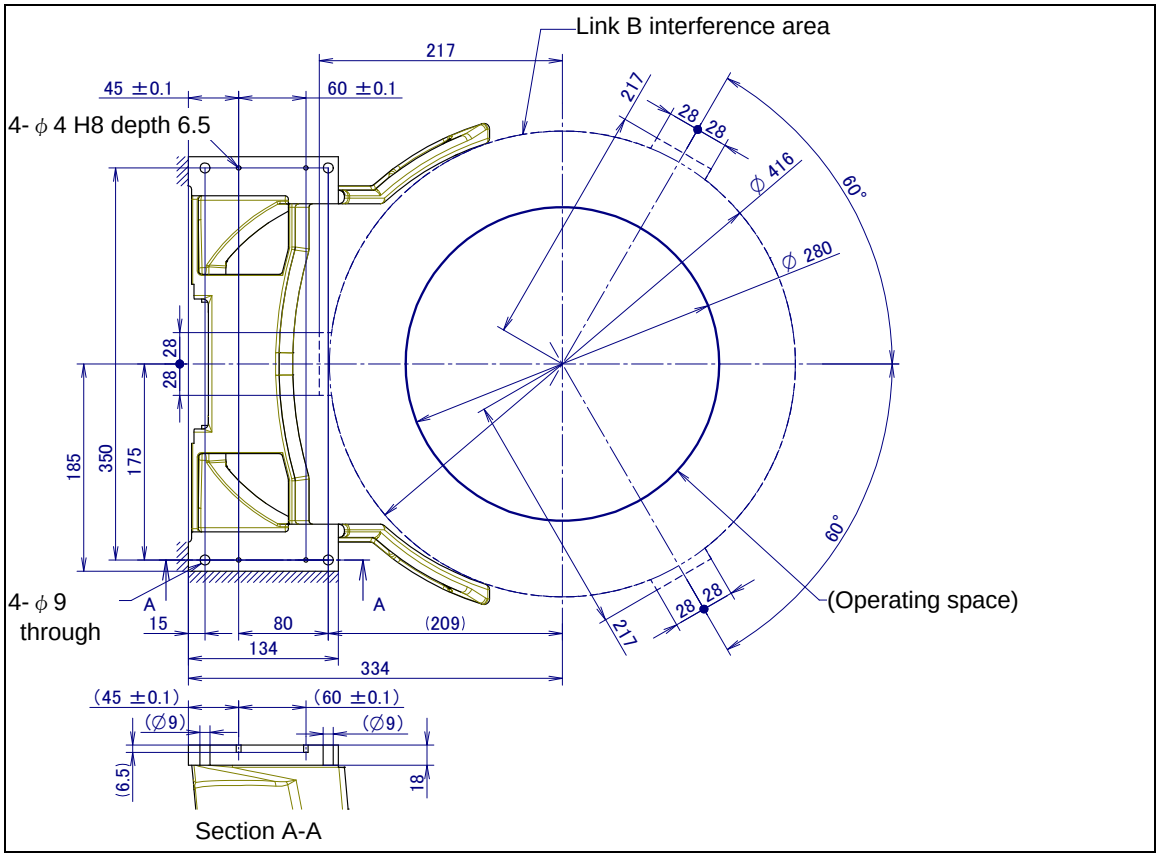


Fig. 1.2 (e) Dimension of robot base (ceiling mount) (M-1*i*A/0.5S/0.5A/1H)

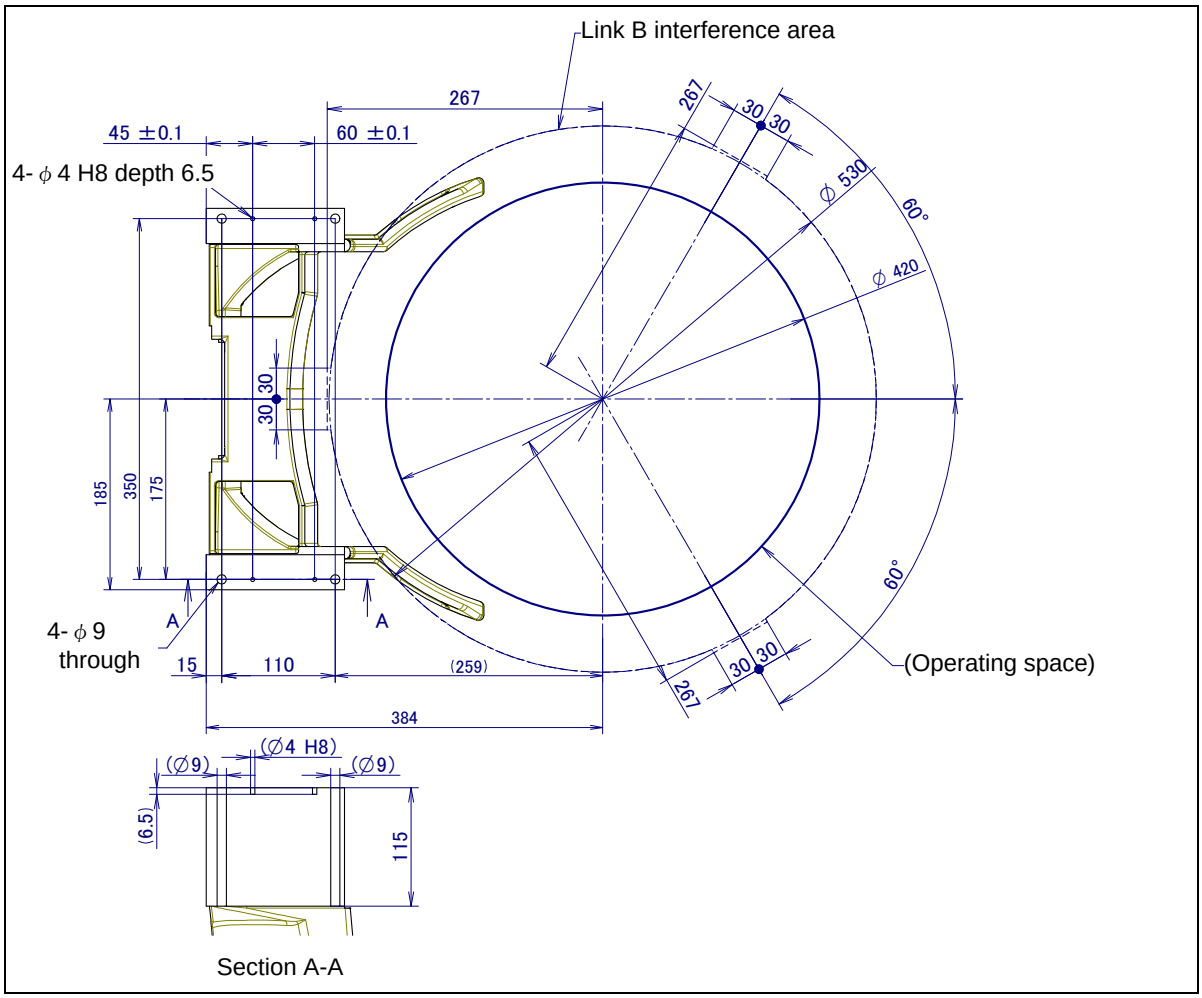


Fig. 1.2 (f) Dimension of robot base (ceiling mount) (M-1*i*A/0.5SL/0.5AL/1HL)

Fig. 1.2 (g) and Table 1.2 (a), (b) indicate the force and moment applied to the robot base.
Table 1.2 (c), (d) indicate the stopping distance and time until the robot stopping by Power-Off stop or by Controlled stop after input of the stop signal.
Refer to the data when considering the strength of the installation face.

Table 1.2 (a) Force and moment that acts on robot base (M-1*i*A/0.5S/0.5A/1H)

	Bending moment Mv (Nm)	Force in vertical condition Fv (N)	Twisting moment Mh (Nm)	Force in horizontal direction Fh (N)
Static	58.2	220.5	0	0
Acceleration/ Deceleration	77.7	269.0	11.0	44.8
Power-Off stop	119.7	450.7	42.8	208.6

Table 1.2 (b) Force and moment that acts on robot base (M-1*i*A/0.5SL/0.5AL/1HL)

	Bending moment Mv (Nm)	Force in vertical condition Fv (N)	Twisting moment Mh (Nm)	Force in horizontal direction Fh (N)
Static	58.2	263.8	0	0
Acceleration/ Deceleration	89.5	282.8	18.2	42.2
Power-Off stop	288.0	466.8	73.6	298.0

Table1.2 (c) Stopping time and distance until the robot stopping by Power-Off stop after input of stop signal

Model		X	Y	Z
M-1*i*A/0.5A M-1*i*A/0.5S	Stopping time [msec]	31	31	22
	Stopping distance [mm]	48	48	21
M-1*i*A/1H	Stopping time [msec]	33	33	24
	Stopping distance [mm]	42	42	18
M-1*i*A/0.5AL M-1*i*A/0.5SL	Stopping time [msec]	47	47	31
	Stopping distance [mm]	150	150	28
M-1*i*A/1HL	Stopping time [msec]	36	36	25
	Stopping distance [mm]	107	107	25

Table1.2 (d) Stopping time and distance until the robot stopping by Controlled stop after input of stop signal

Model		X	Y	Z
M-1*i*A/0.5A M-1*i*A/0.5S	Stopping time [msec]	95	95	60
	Stopping distance [mm]	171	171	61
M-1*i*A/1H	Stopping time [msec]	322	322	214
	Stopping distance [mm]	138	138	45
M-1*i*A/0.5AL M-1*i*A/0.5SL	Stopping time [msec]	346	346	314
	Stopping distance [mm]	235	235	67
M-1*i*A/1HL	Stopping time [msec]	285	285	290
	Stopping distance [mm]	193	193	68

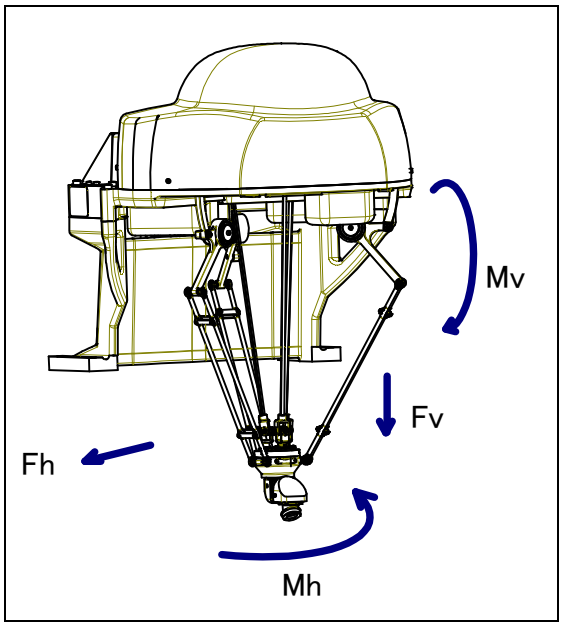


Fig. 1.2 (g) Force and moment that acts on robot base

1.2.1 Angle of Mounting Surface Setting

If robot is used except floor mount, be sure to set the mounting angle referring to the procedure below. Refer to specification of Section 3.1 about installation specifications.

1. When performing a robot initial start

1 With the [F1] key and the [F5] key held down on the teach pendant, set the power breaker on the controller to ON. Next, Select 3, Init start.

2 Input the angle of mounting surface to floor surface setting and the angle of robot to mounting surface setting as shown in Fig. 1.2.1 (a).

```
*******Group 1 Initialization***********
*************M-iA/0.5S*************

--Angle of Mounting Surface  --
--to Floor Surface setting --

Enter angle (-180 - +180[deg])->

Default value = 0.000
```

```
*******Group 1 Initialization***********
*************M-iA/0.5S*************

--Angle of Robot to  --
--Mounting Surface setting --

Enter angle (-180 - +180[deg])->

Default value = 0.000
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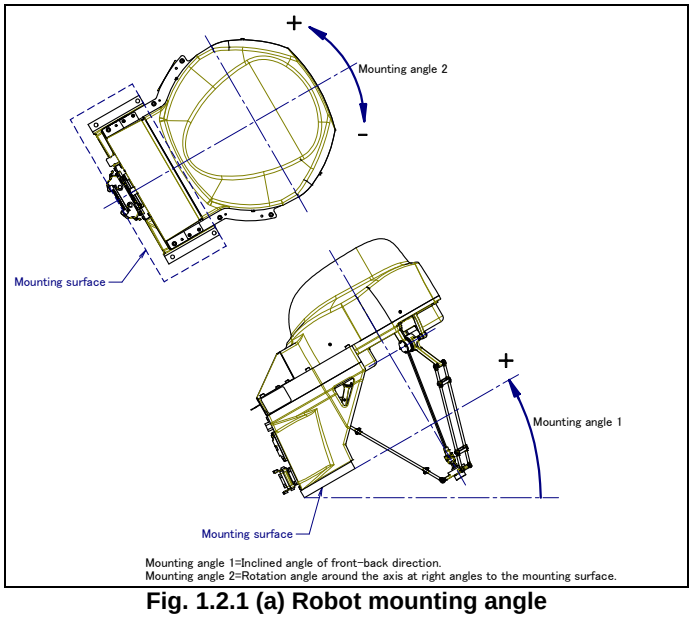
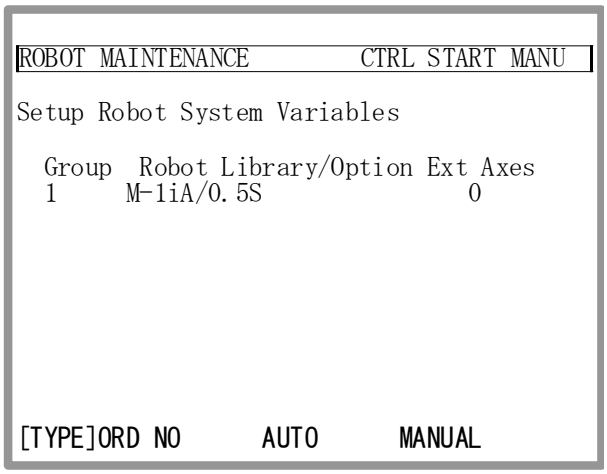


Fig. 1.2.1 (a) Robot mounting angle

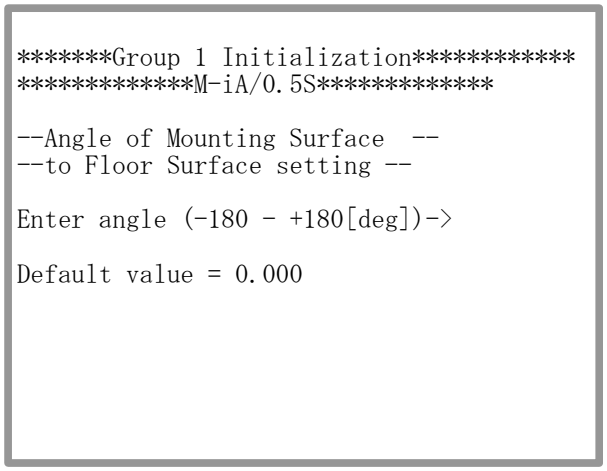
2. When changing the setting angle

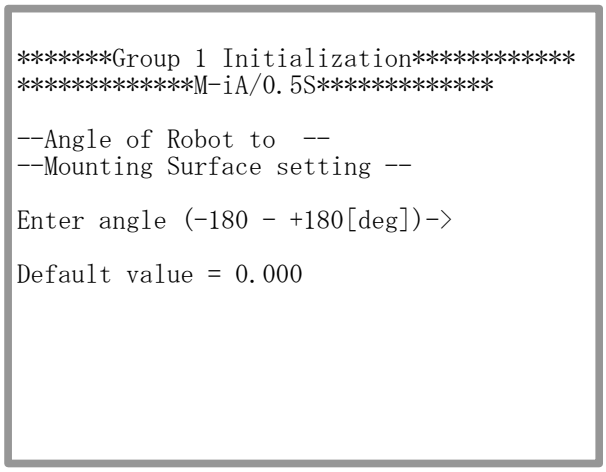
To change the setting angle, perform the procedure below.
Refer to specification of Section 3.1 about installation specifications.

1 Turn on the controller with the [PREV] and the [NEXT] key pressed. Then select “3. Controlled start”.
2 Press “TYPE” key and select “MAINTENANCE”.
3 Select the robot which you would like to change the setting angle and press F4 “AUTO”.

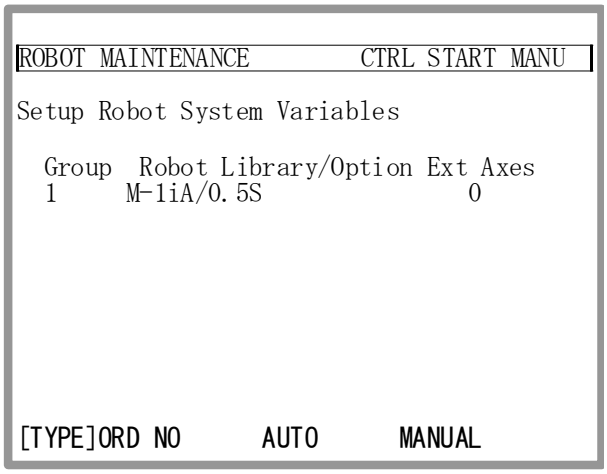


4 Press the [F4] key.
5 Press the [ENTER] key until the screen below will be displayed.
6 Input the angle of mounting surface to floor surface setting and the angle of robot to mounting surface setting as shown in Fig.1.2.1.





7 Press the [ENTER] key until screen below will be 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. See Chapter 8 for mastering.

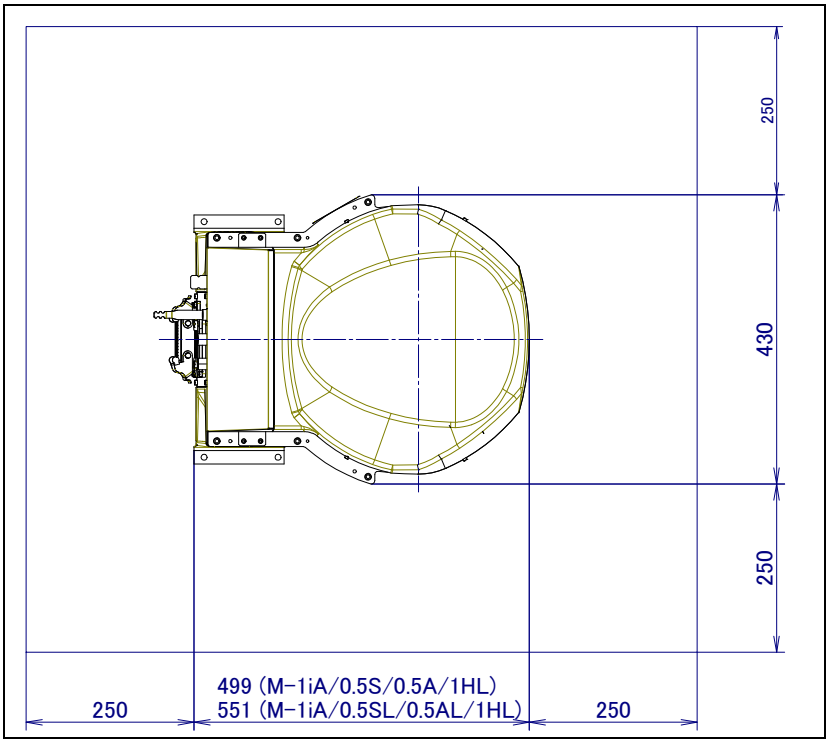


Fig. 1.3 (a) Maintenance area

1.4 INSTALLATION CONDITIONS

Refer to the specifications found in Section 3.1.

2 CONNECTION WITH THE CONTROLLER

2.1 CONNECTION WITH THE CONTROLLER

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

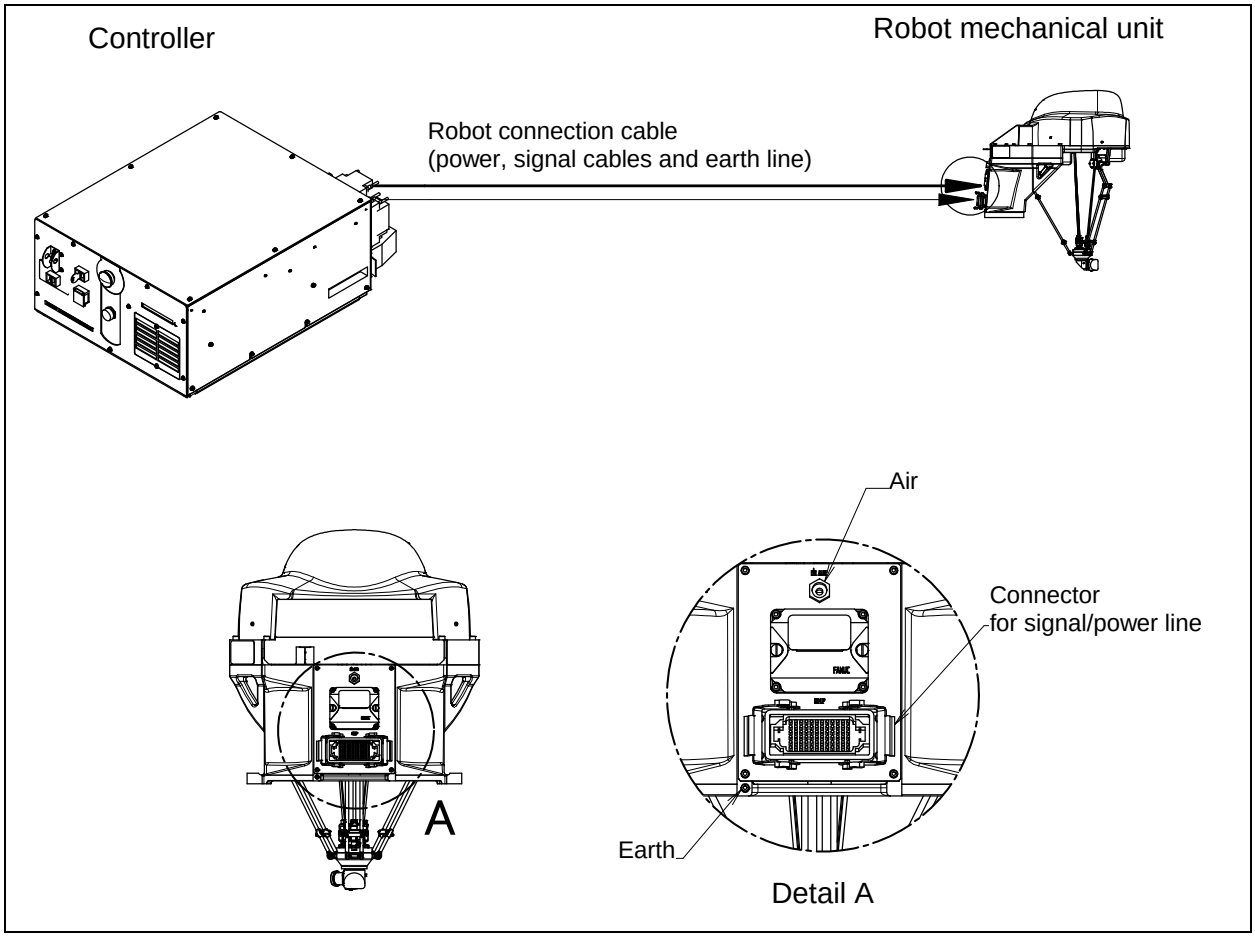


Fig. 2.1 (a) Cable connection (with stand)

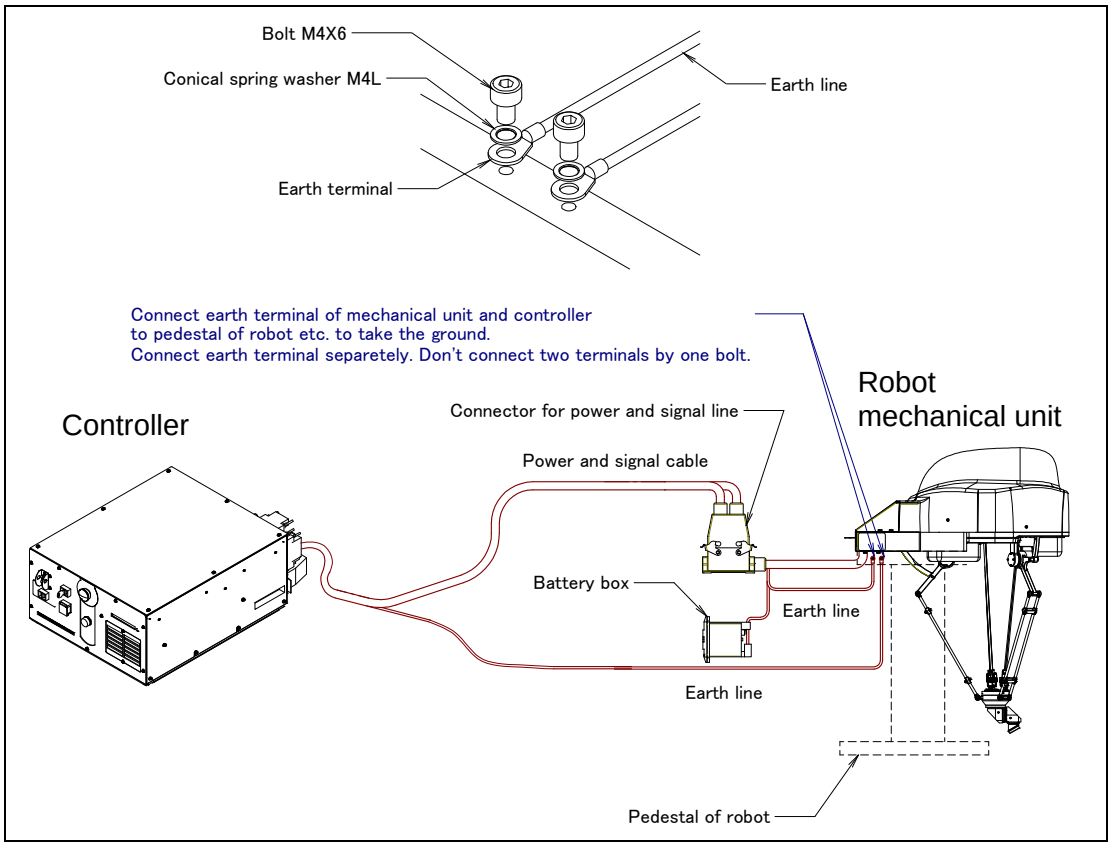


Fig. 2.1 (b) Cable connection (no stand A)

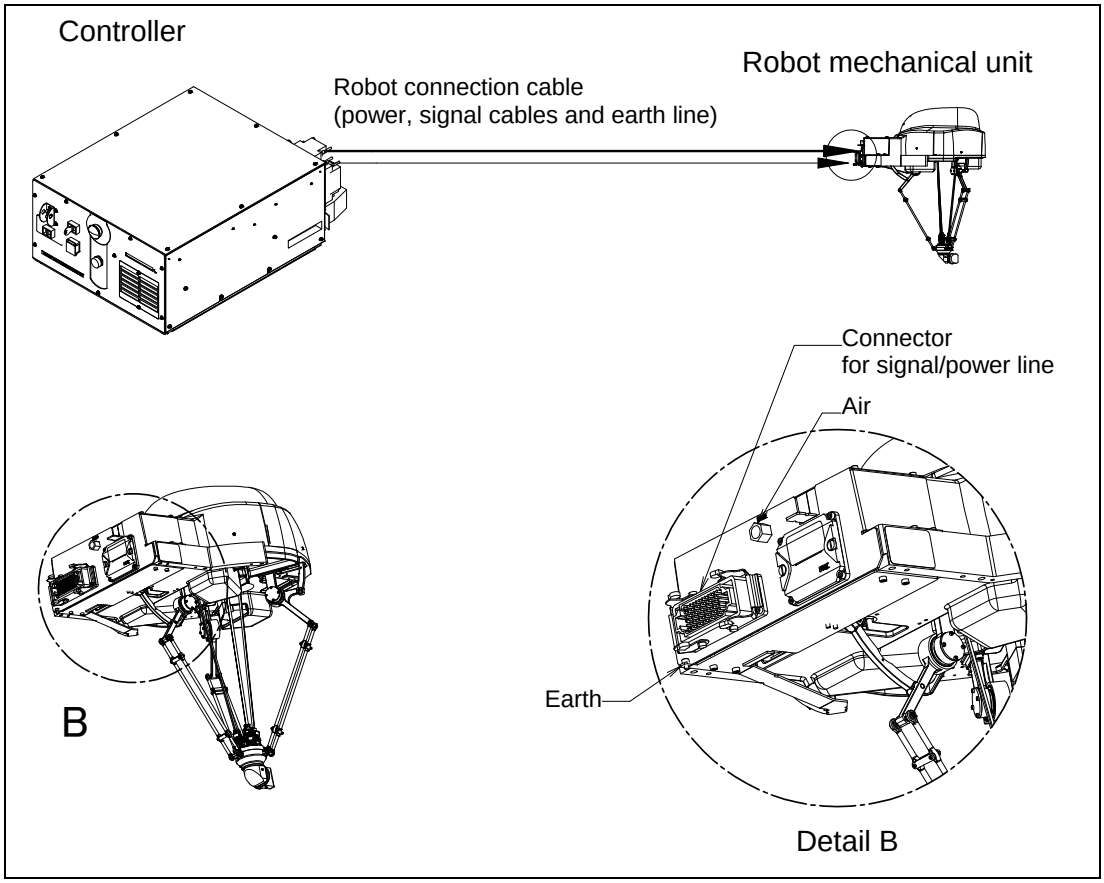


Fig. 2.1 (c) Cable connection (no stand B)

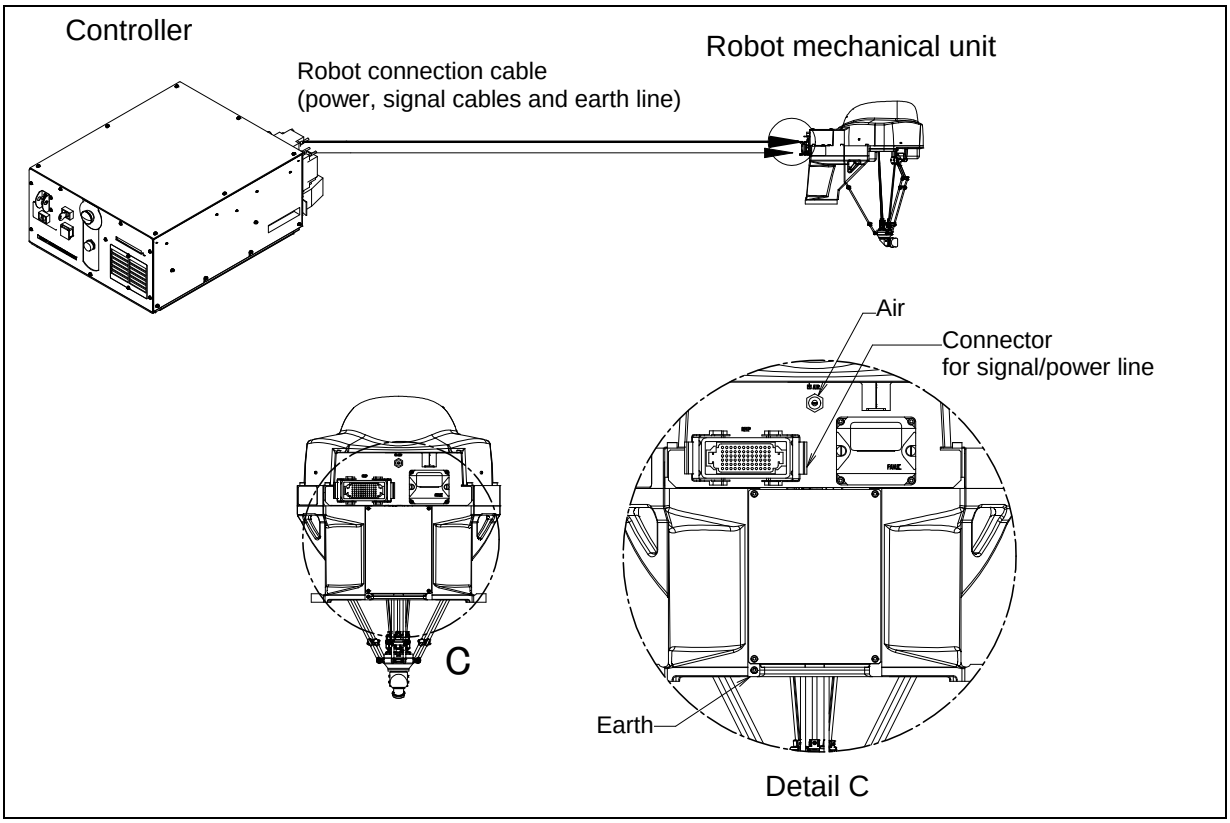


Fig. 2.1 (d) Cable connection (no stand B) (additional stand option)

3 BASIC SPECIFICATIONS

3.1 ROBOT CONFIGURATION

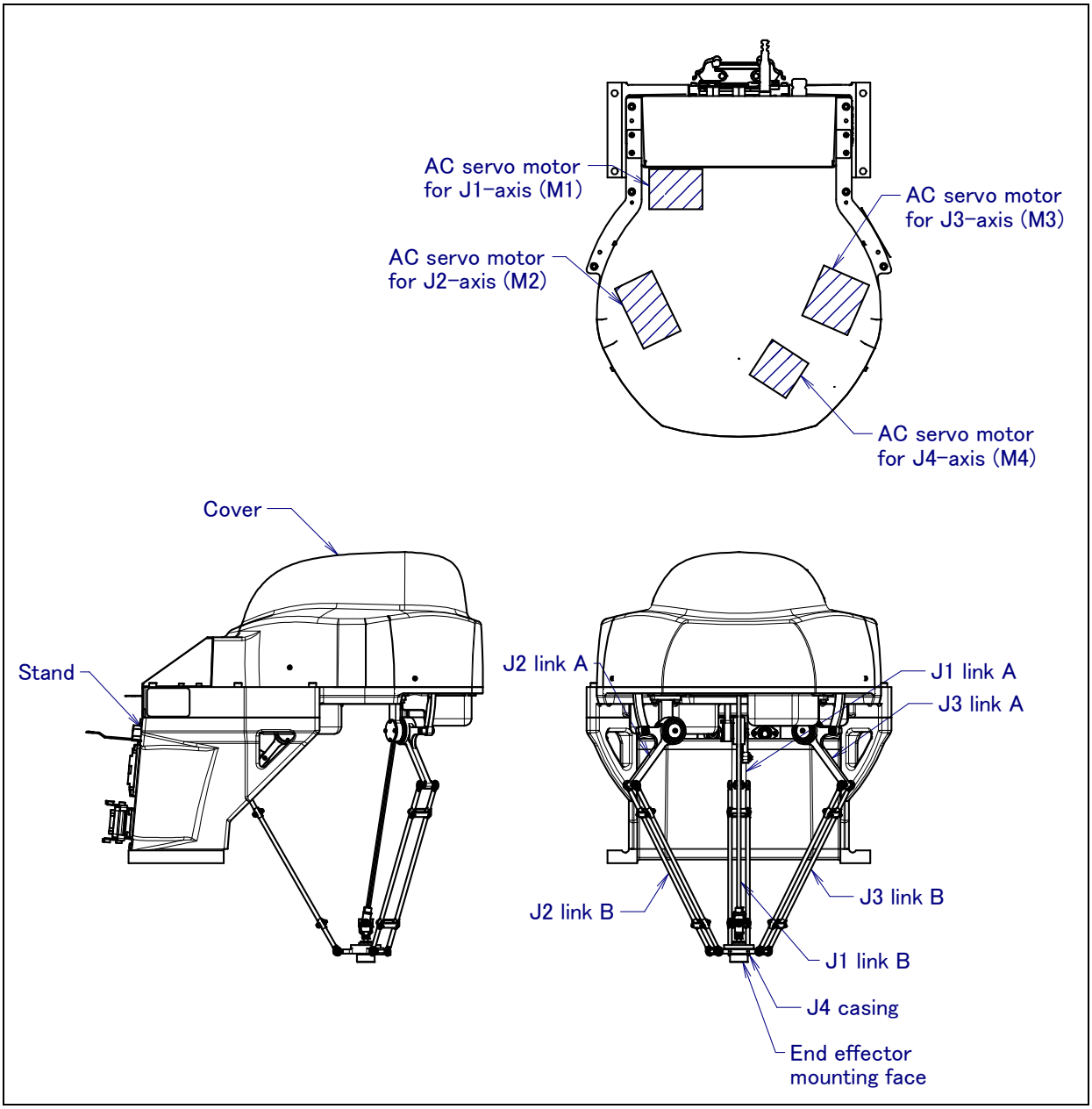


Fig. 3.1 (a) Mechanical unit configuration (M-1*i*A/0.5S/0.5SL)

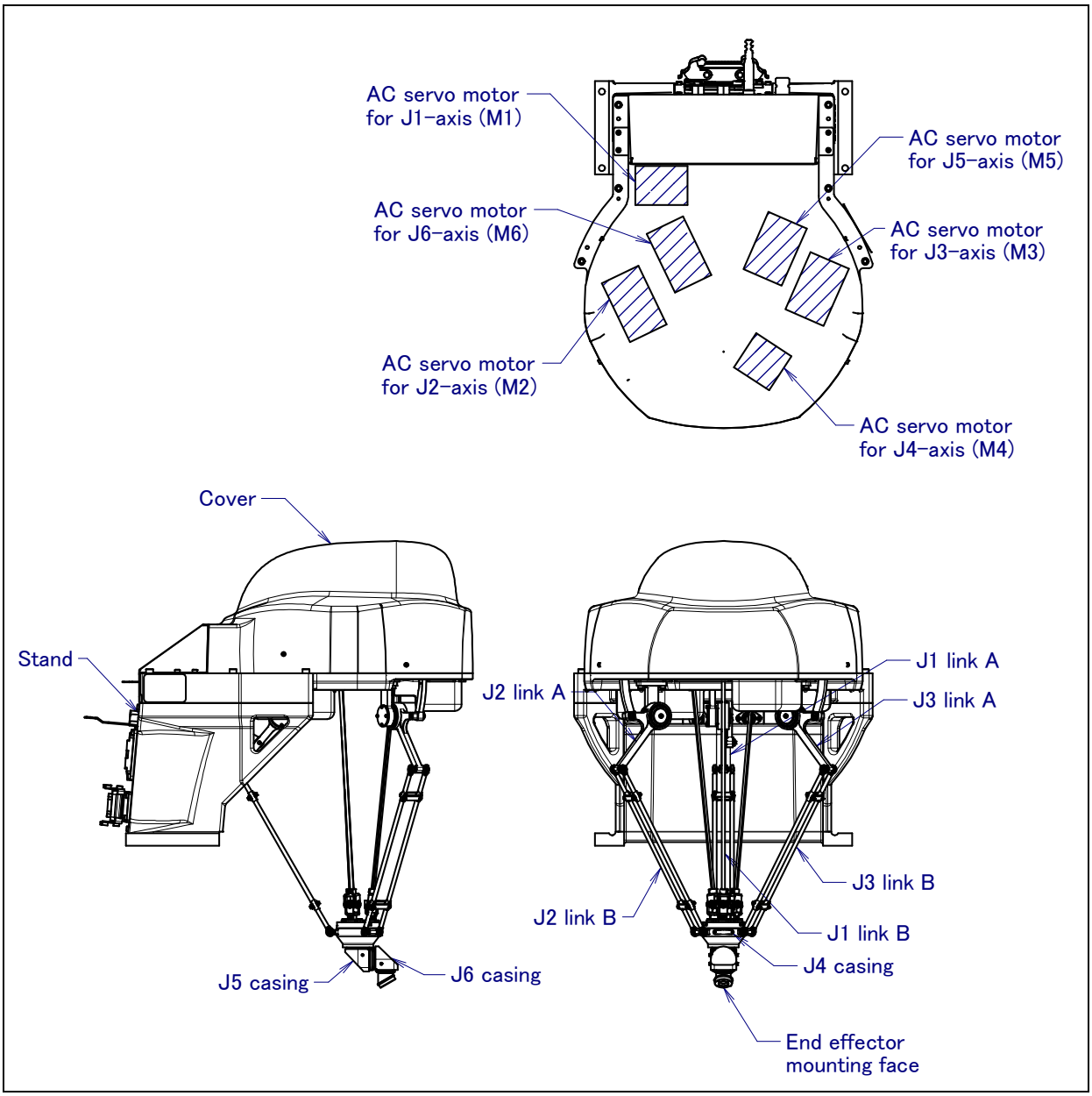


Fig. 3.1 (b) Mechanical unit configuration (M-1*i*A/0.5A/0.5AL)

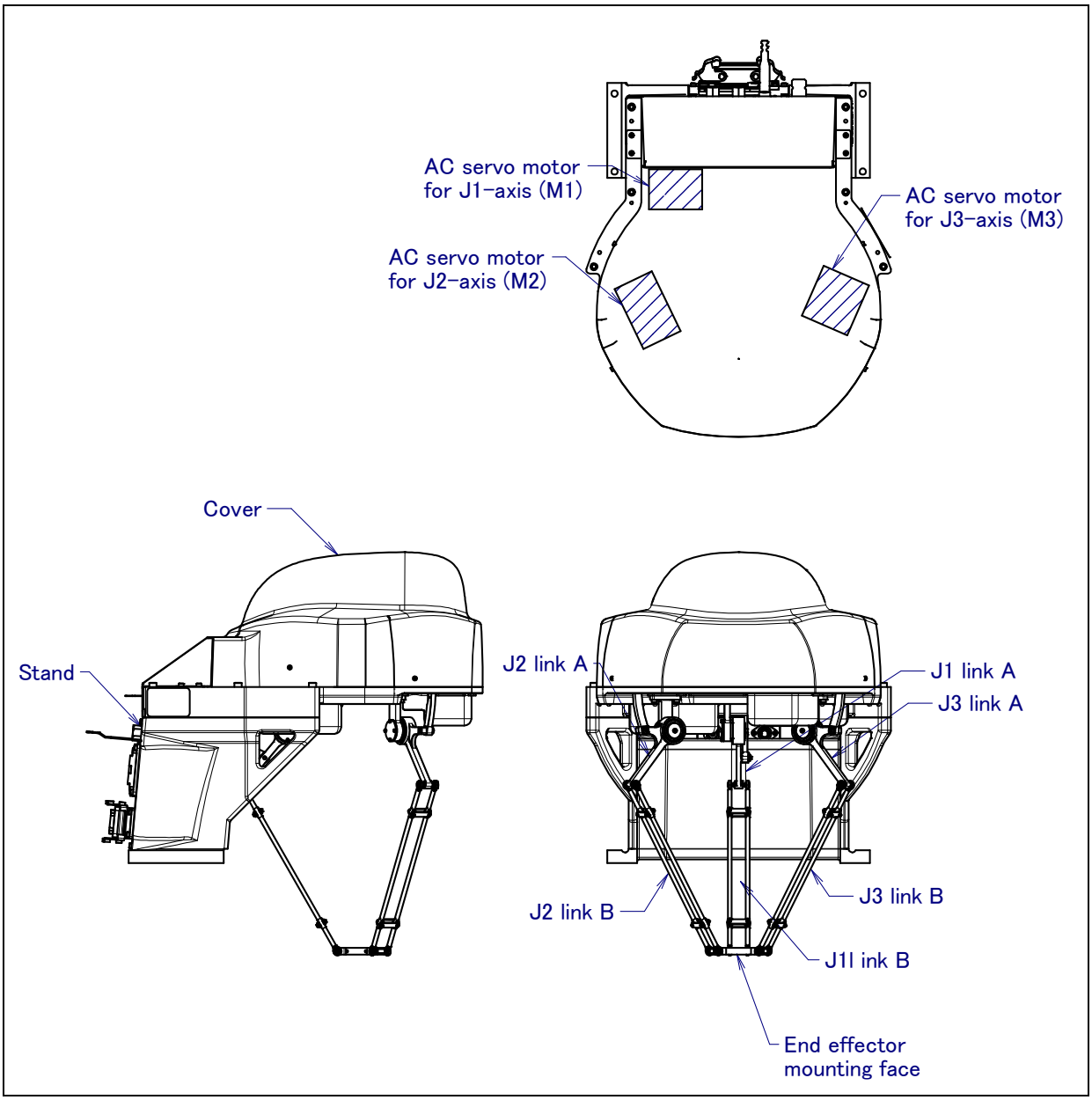


Fig. 3.1 (c) Mechanical unit configuration (M-1*i*A/1H/1HL)

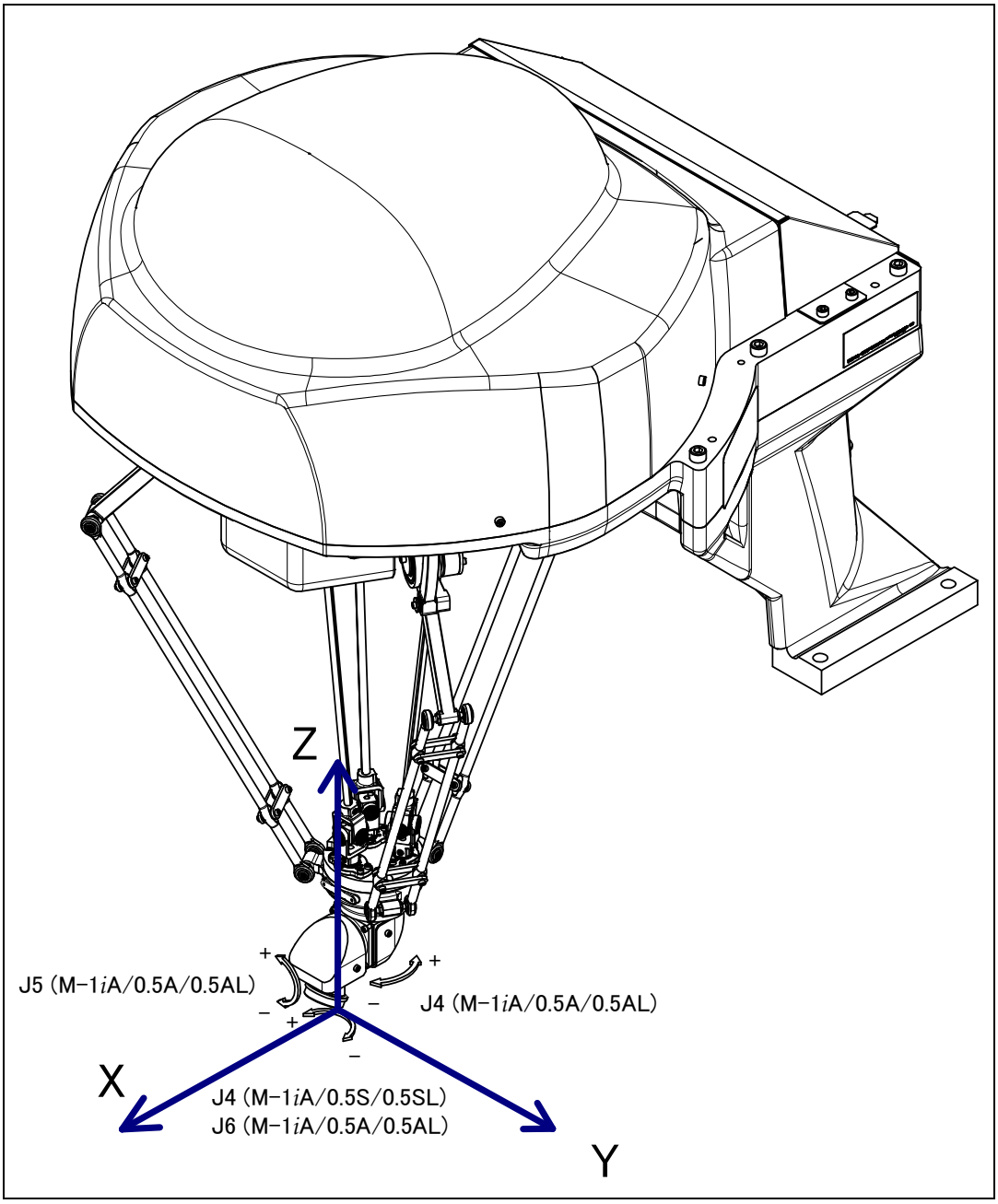


Fig. 3.1 (d) Each axes coordinates

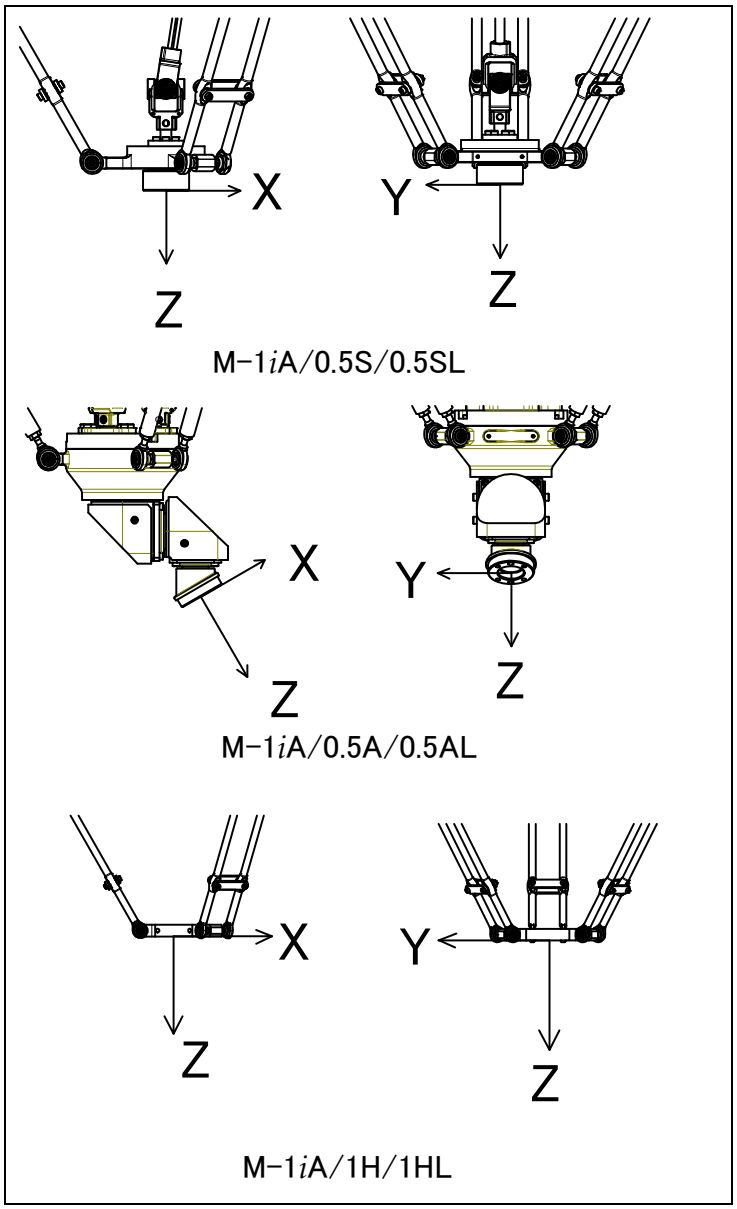


Fig. 3.1 (e) Mechanical interface coordinates

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

Table 3.1 (a) Specifications (1/2)

	M-1*i*A/0.5S	**M-1*i*A/0.5A**	**M-1*i*A/1H**
Type	Parallel link mechanism robot		
Controlled axes	4-axes (J1, J2, J3, J4)	6-axes (J1, J2, J3, J4, J5, J6)	3-axes (J1, J2, J3)
Installation	Floor, Ceiling	Floor, Angle, Ceiling	Floor, Ceiling
Work envelope	Diameter 280 mm, Height 100 mm		
Max.payload	0.5kg (option : 1kg)		1kg
Drive method	Electric servo drive by AC servo motor		
Wrist maximum speed (NOTE 1)	3000 deg/s (J4)	1440 deg/s (J4, J5, J6)	
Repeatability	±0.02mm		
Dust.proof and drip.proof mechanism	Conform to IP20		
Mass	20kg (with stand)	23kg (with stand)	18kg (with stand)
	14kg (without stand)	17kg (without stand)	12kg (without stand)
Acoustic noise level	61.2dB (NOTE 2)		
Installation environment	Ambient temperature: 0 to 45℃ (NOTE 3) 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 4)		

Table 3.1 (b) Specifications (2/2)

	M-1*i*A/0.5SL	**M-1*i*A/0.5AL**	**M-1*i*A/1HL**
Type	Parallel link mechanism robot		
Controlled axes	4-axes (J1, J2, J3, J4)	6-axes (J1, J2, J3, J4, J5, J6)	3-axes (J1, J2, J3)
Installation	Floor, Ceiling	Floor, Angle, Ceiling	Floor, Ceiling
Work envelope	Diameter 420 mm, Height 150 mm		
Max.payload	0.5kg (option : 1kg)		1kg
Drive method	Electric servo drive by AC servo motor		
Wrist maximum speed (NOTE 1)	3000 deg/s (J4)	1440 deg/s (J4, J5, J6)	
Repeatability	±0.03mm		
Dust.proof and drip.proof mechanism	Conform to IP20		
Mass	23kg (with stand)	26kg (with stand)	21kg (with stand)
	17kg (without stand)	20kg (without stand)	15kg (without stand)
Acoustic noise level	57.6dB (NOTE 2)		
Installation environment	Ambient temperature: 0 to 45℃ (NOTE 3) 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 4)		

NOTE

1 During short distance motions, the axis speed may not reach the maximum value stated.
2 This value is equivalent continuous A-weighted sound pressure level that applied with ISO11201 (EN31201). This value is measured with the following conditions.
   - Maximum load and speed
   - Operating mode is AUTO
3 When the robot is used in a low temperature environment that is near to 0ºC, or the robot is not operated for a long time in an environment that is less than 0ºC, for example during a holiday or overnight, viscous resistance of the drive train may cause occurrence of collision detect alarm (SRVO –050) etc. In this case, we recommend performing a warm up operation for several minutes.
4 Contact the service representative, if the robot is to be used in an environment or a place subjected to hot/cold temperatures, severe vibrations, heavy dust, cutting oil splash and or other foreign substances.

⚠ CAUTION

They should be installed in the environment of “Pollution degree 2” regulated in IEC 60664-1 (JIS C 0664).”Pollution degree 2” means cleanly environment like an office.

3.2 A MECHANICAL UNIT EXTERNAL DIMENSIONS AND OPERATING SPACE

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

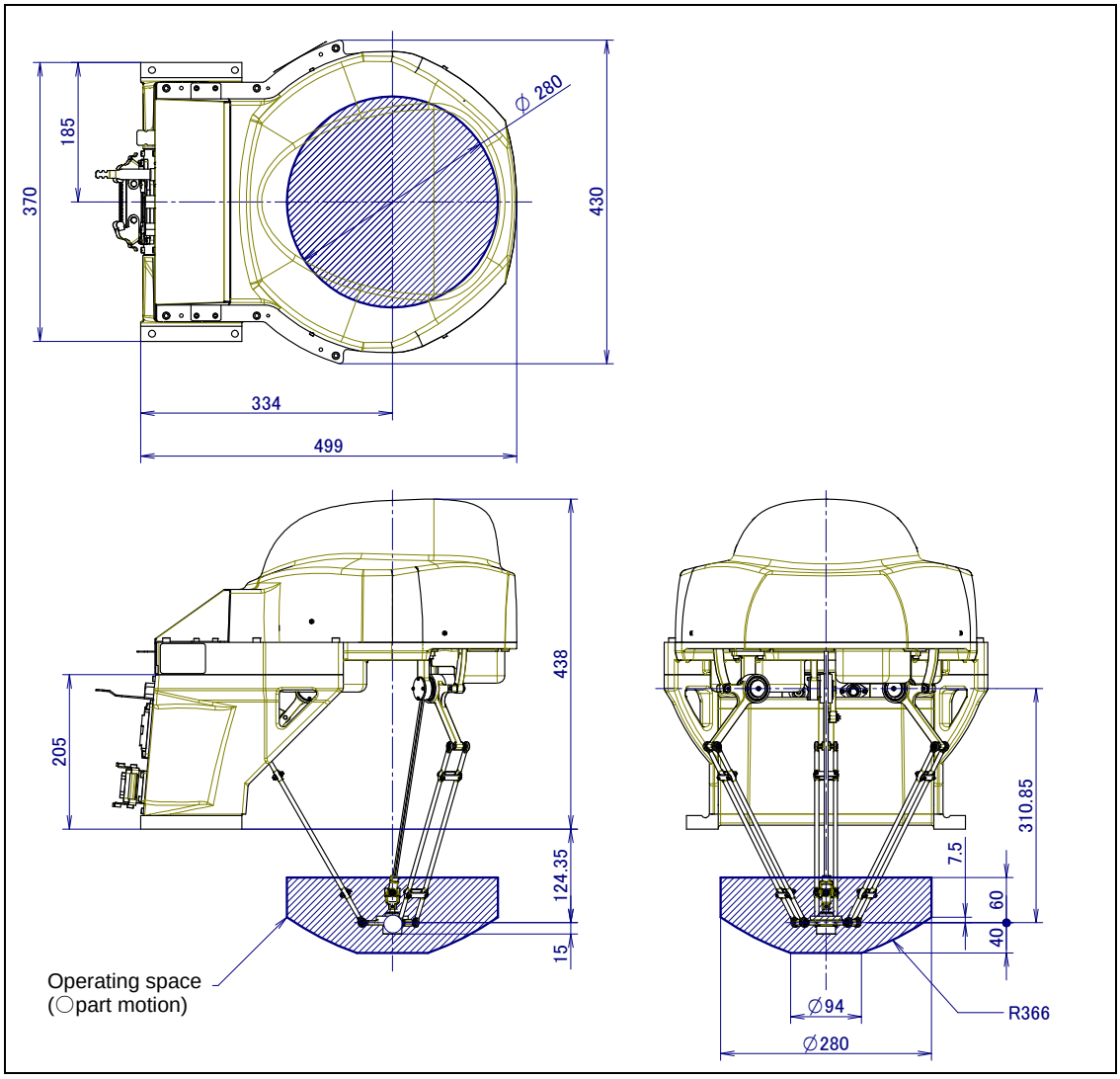


Fig. 3.2 (a) Operating space (M-1*i*A/0.5S) (with stand)

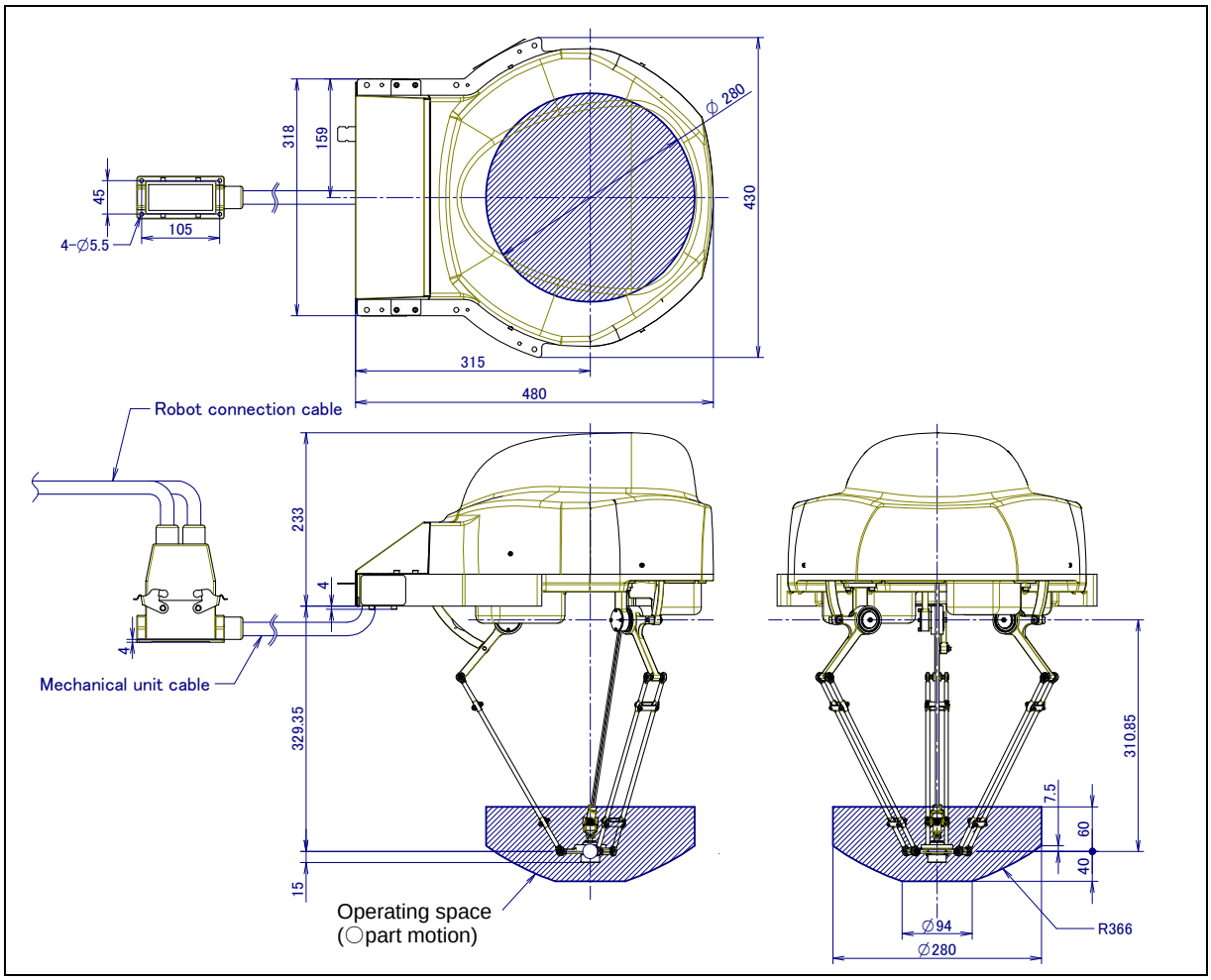


Fig. 3.2 (b) Operating space (M-1*i*A/0.5S) (no stand A)

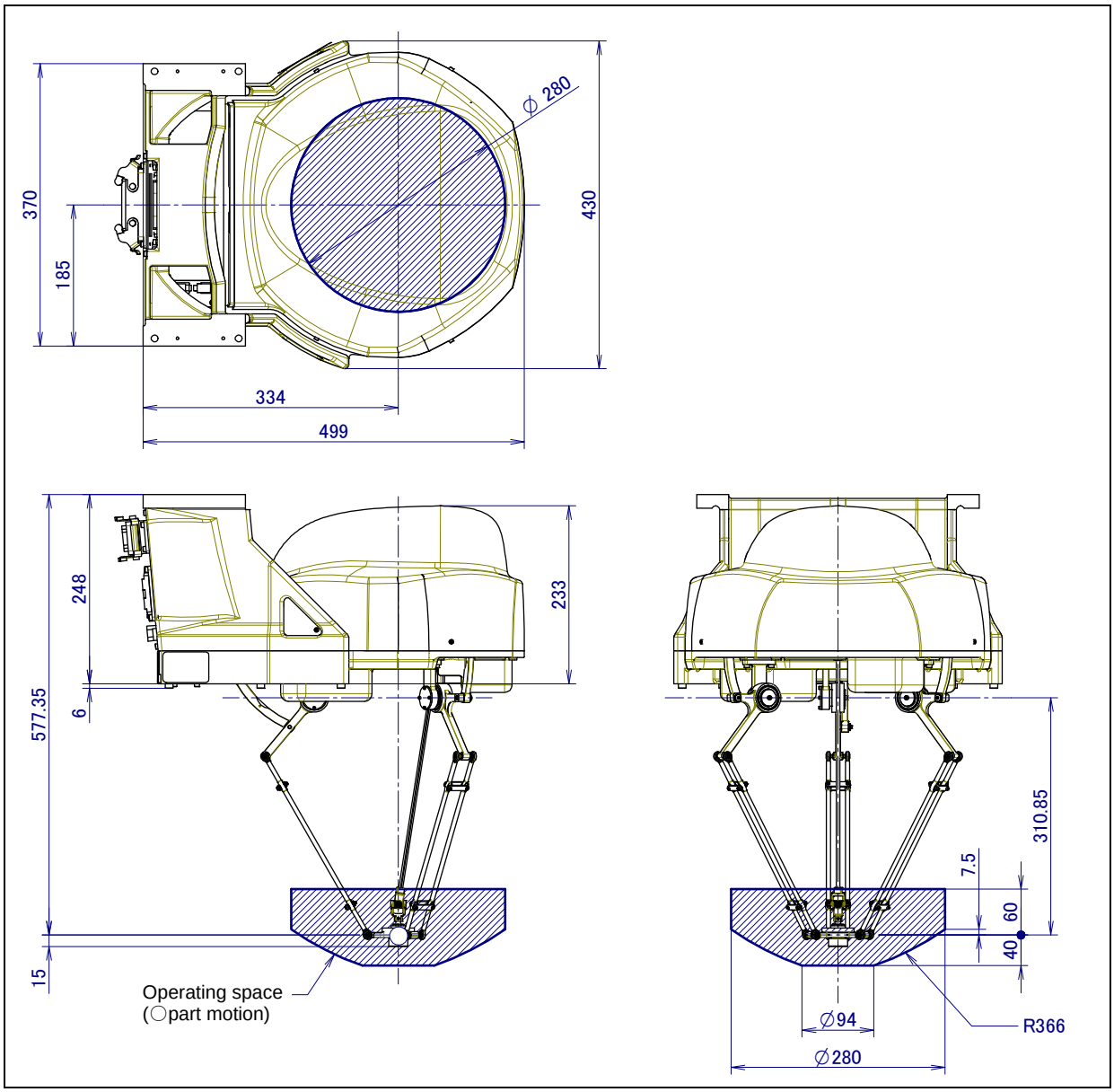


Fig. 3.2 (c) Operating space (M-1*i*A/0.5S) (ceiling mount)

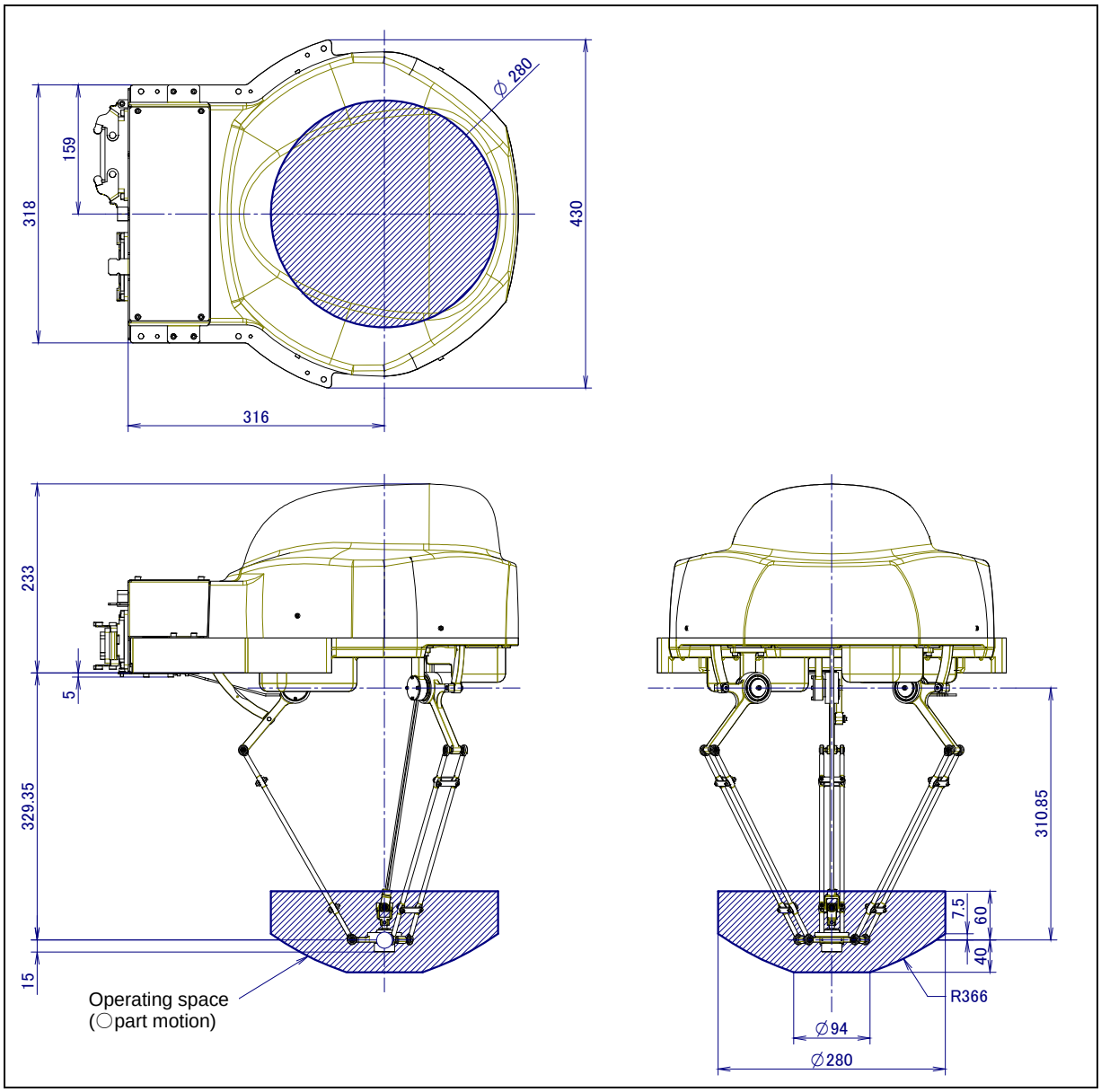


Fig. 3.2 (d) Operating space (M-1*i*A/0.5S) (no stand B)

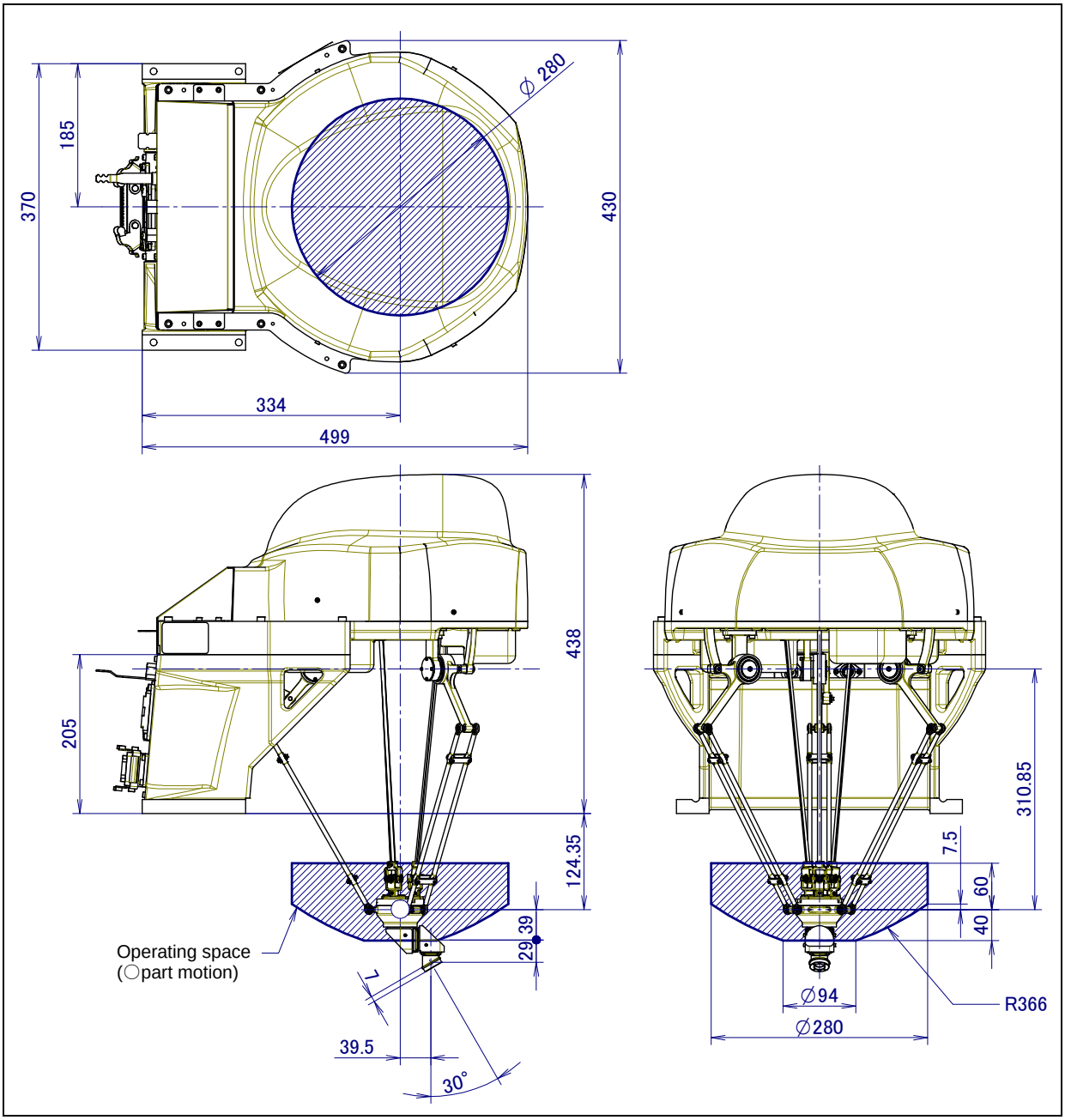


Fig. 3.2 (e) Operating space (M-1*i*A/0.5A) (with stand)

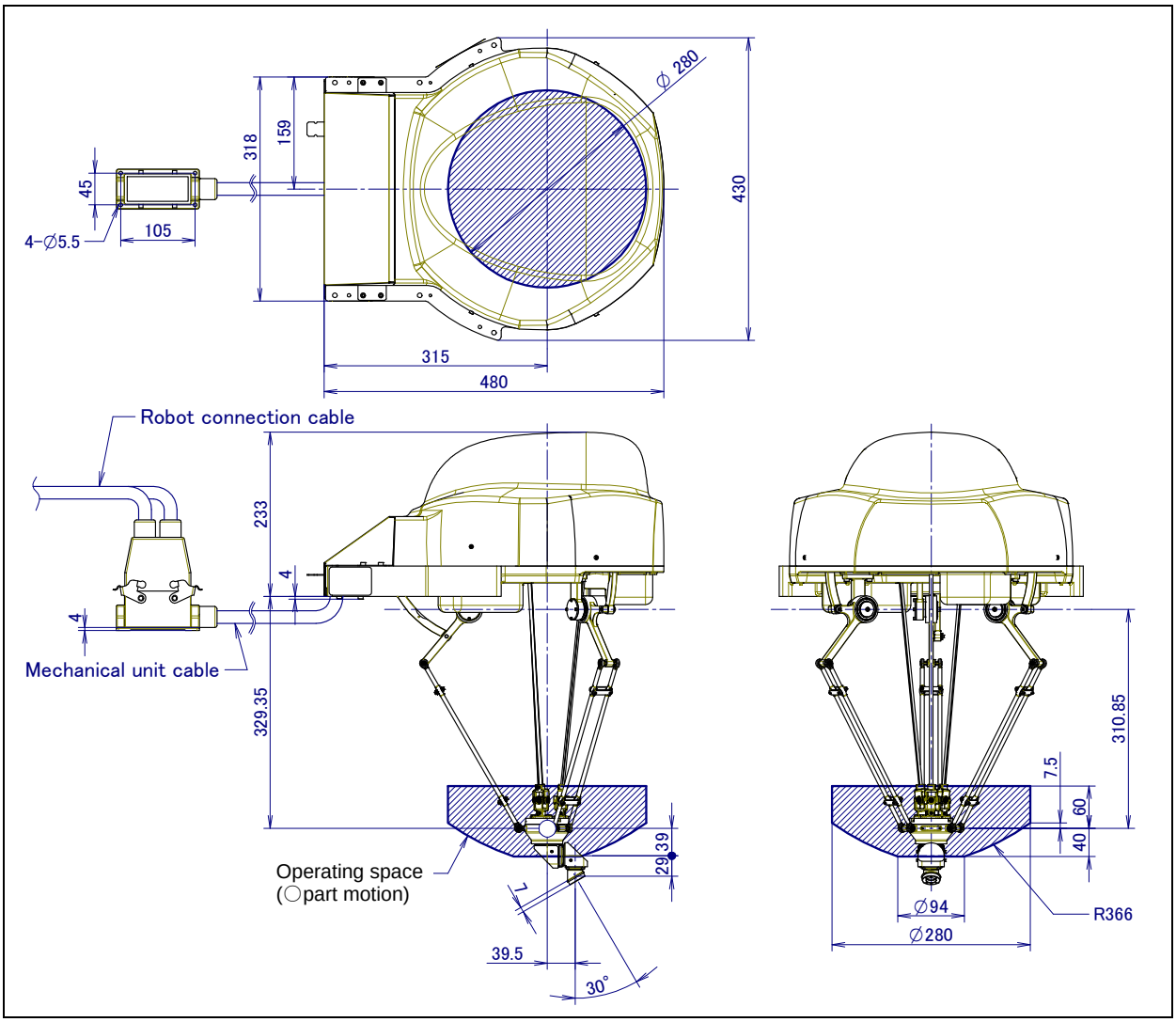


Fig. 3.2 (f) Operating space (M-1*i*A/0.5A) (no stand A)

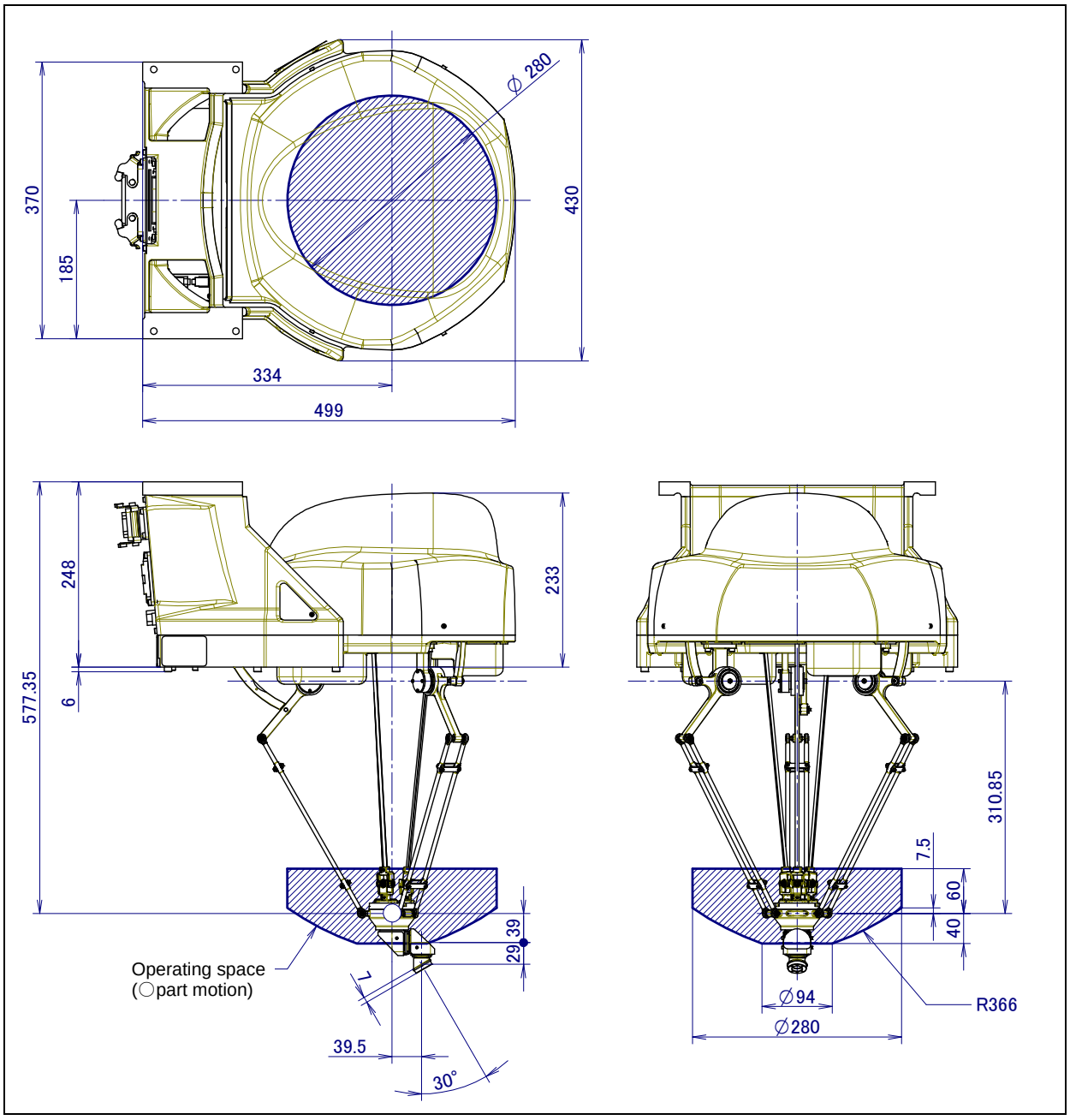


Fig. 3.2 (g) Operating space (M-1*i*A/0.5A) (ceiling mount)

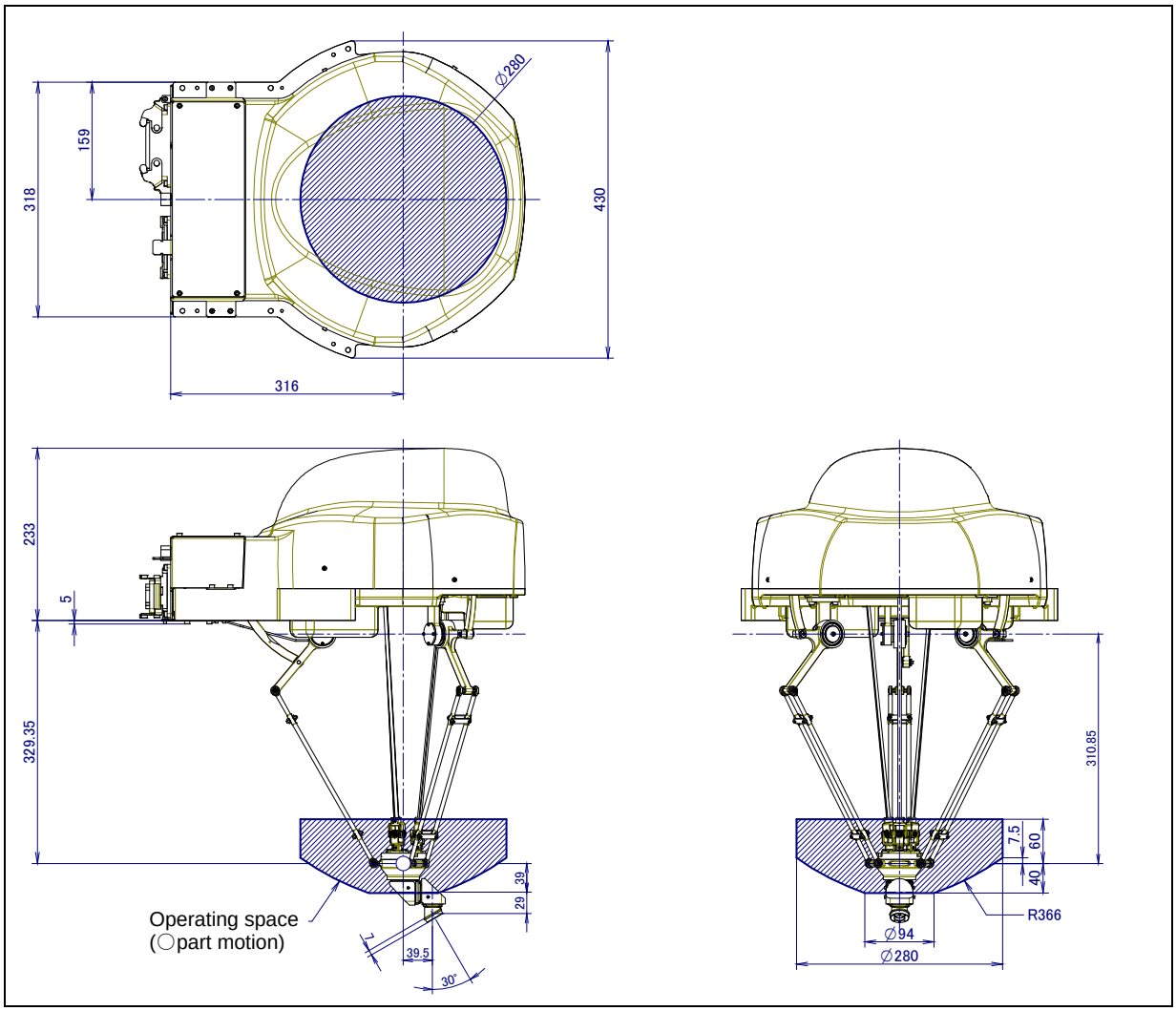


Fig. 3.2 (h) Operating space (M-1*i*A/0.5A) (no stand B)

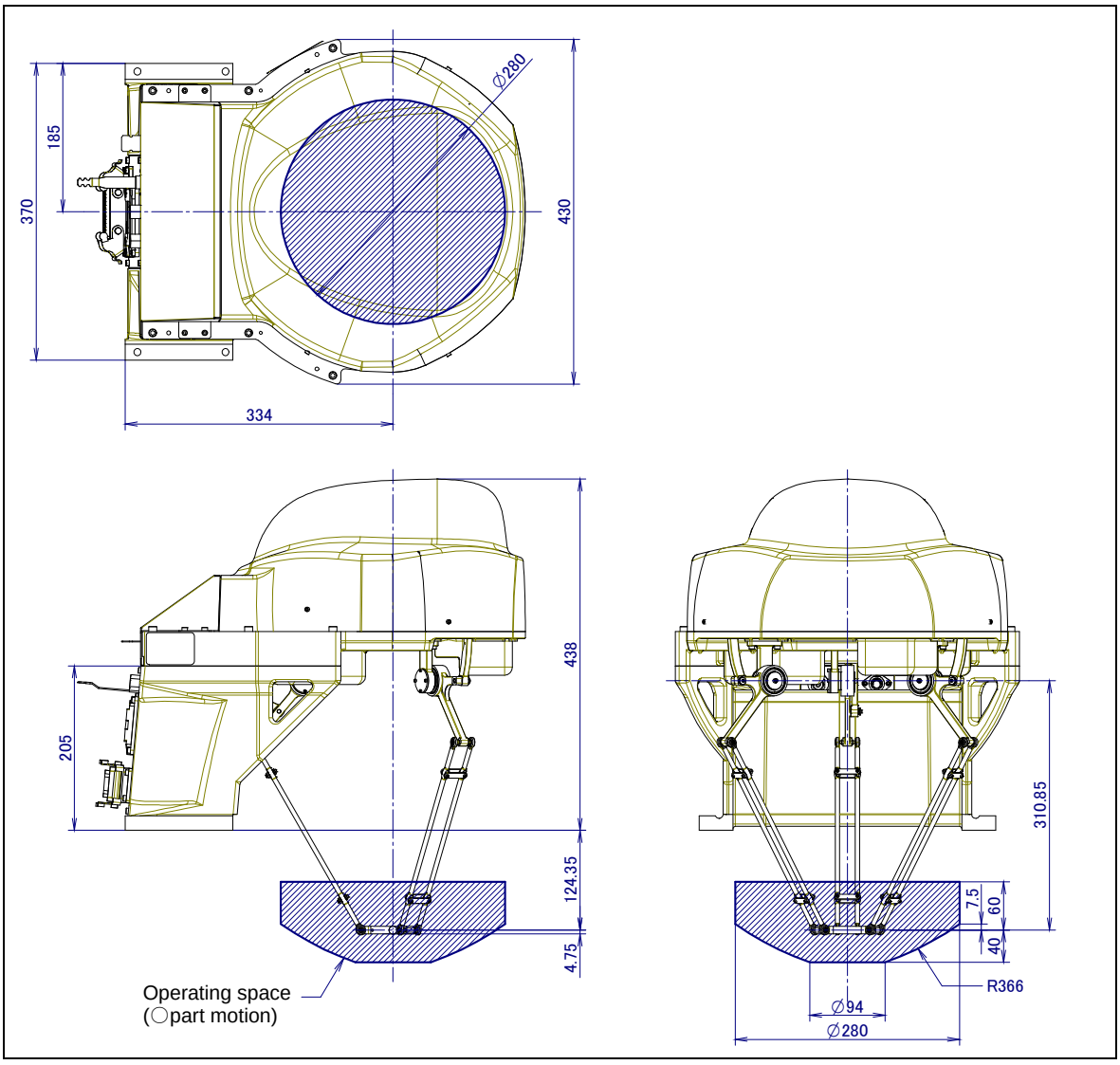


Fig. 3.2 (i) Operating space (M-1*i*A/1H) (with stand)

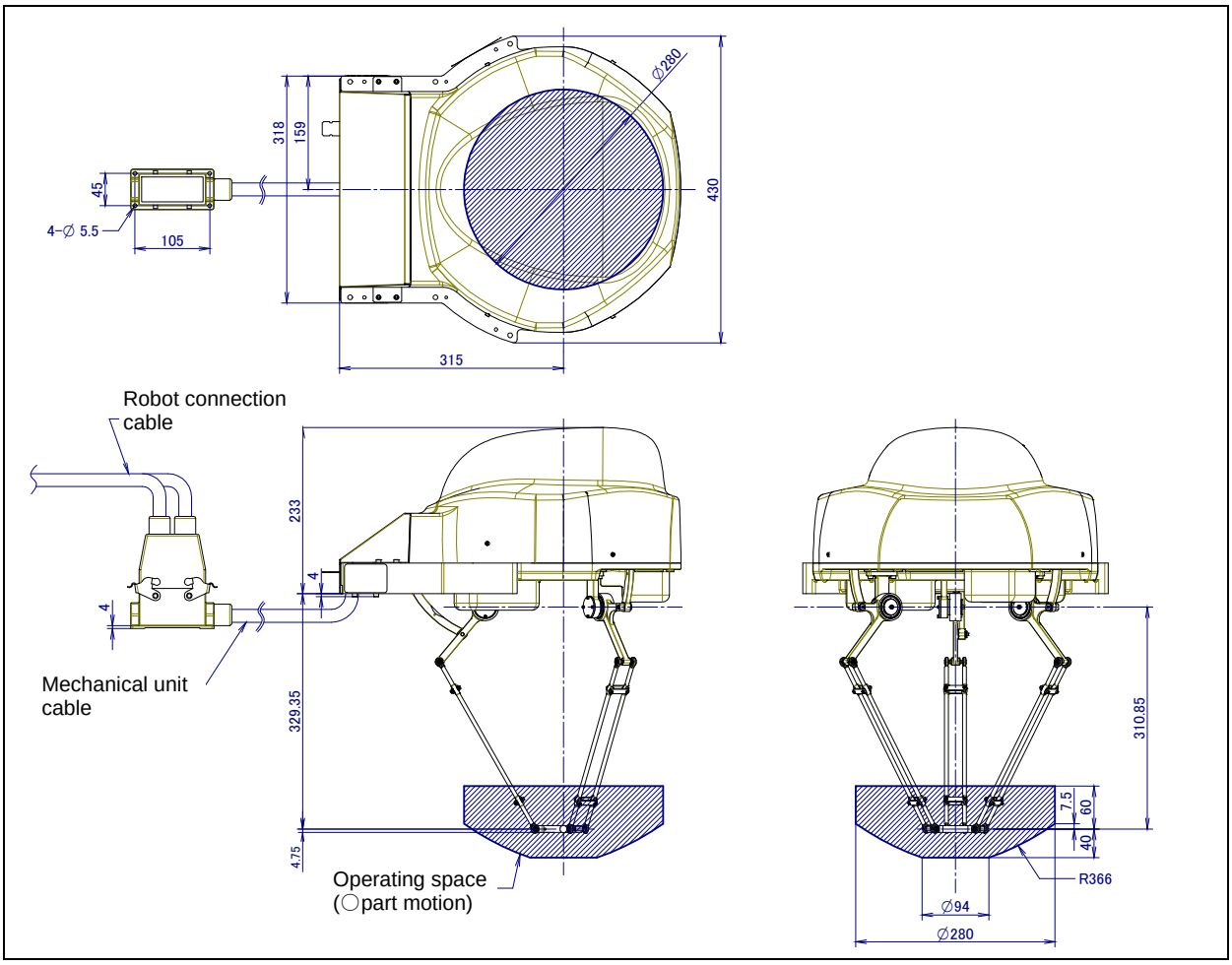


Fig. 3.2 (j) Operating space (M-1*i*A/1H) (no stand A)

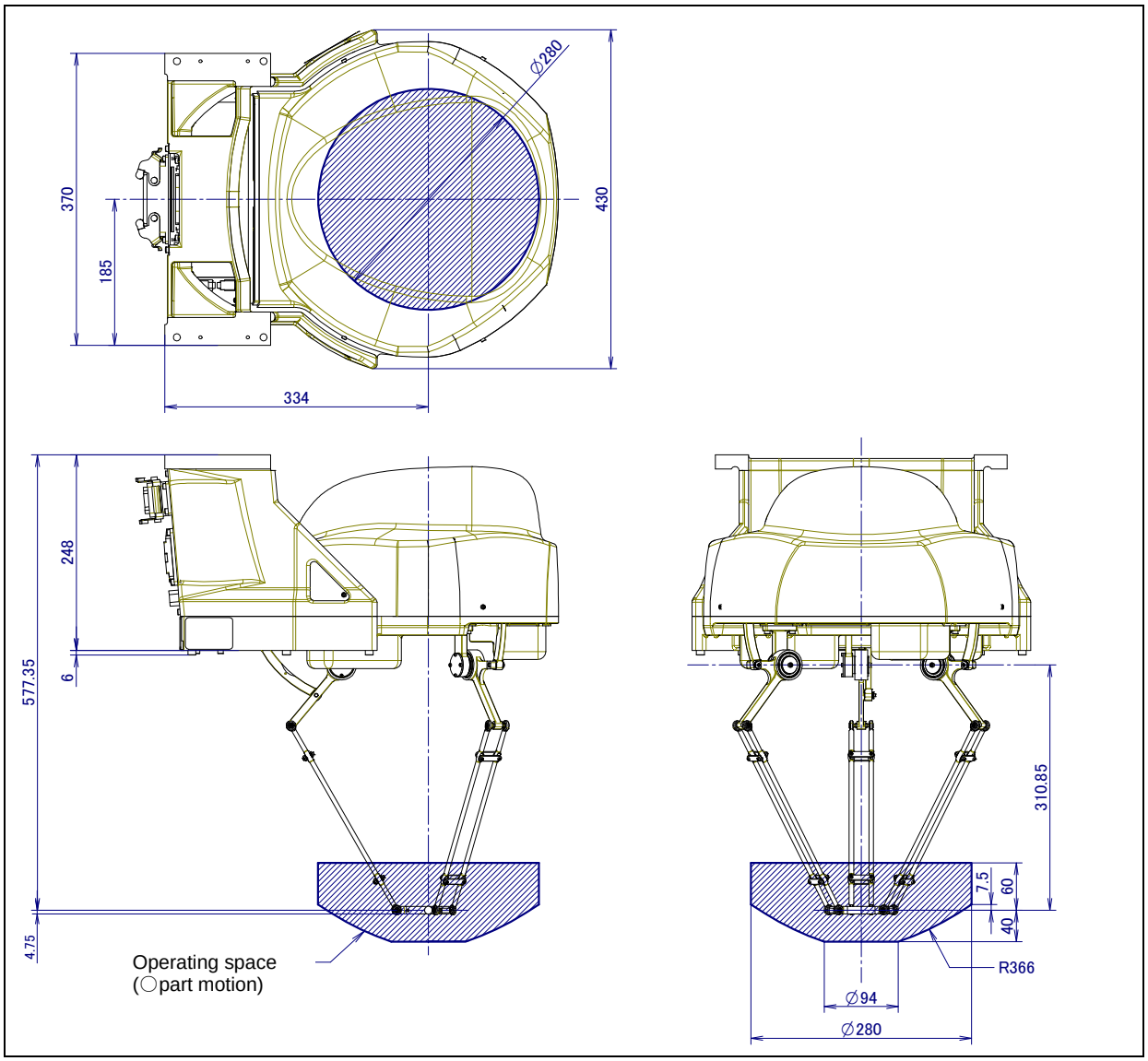


Fig. 3.2 (k) Operating space (M-1*i*A/1H) (ceiling mount)

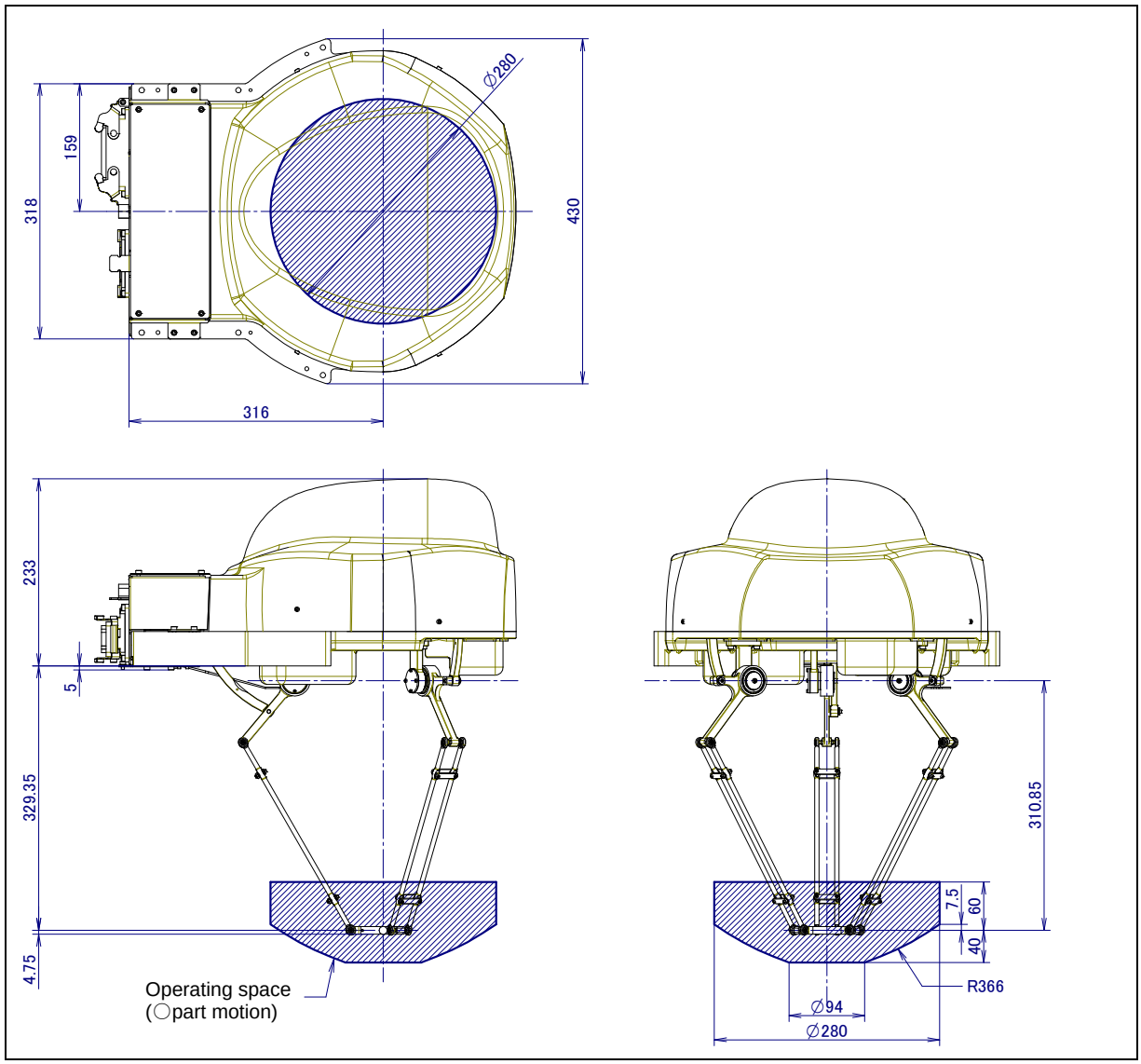


Fig. 3.2 (l) Operating space (M-1*i*A/1H) (no stand B)

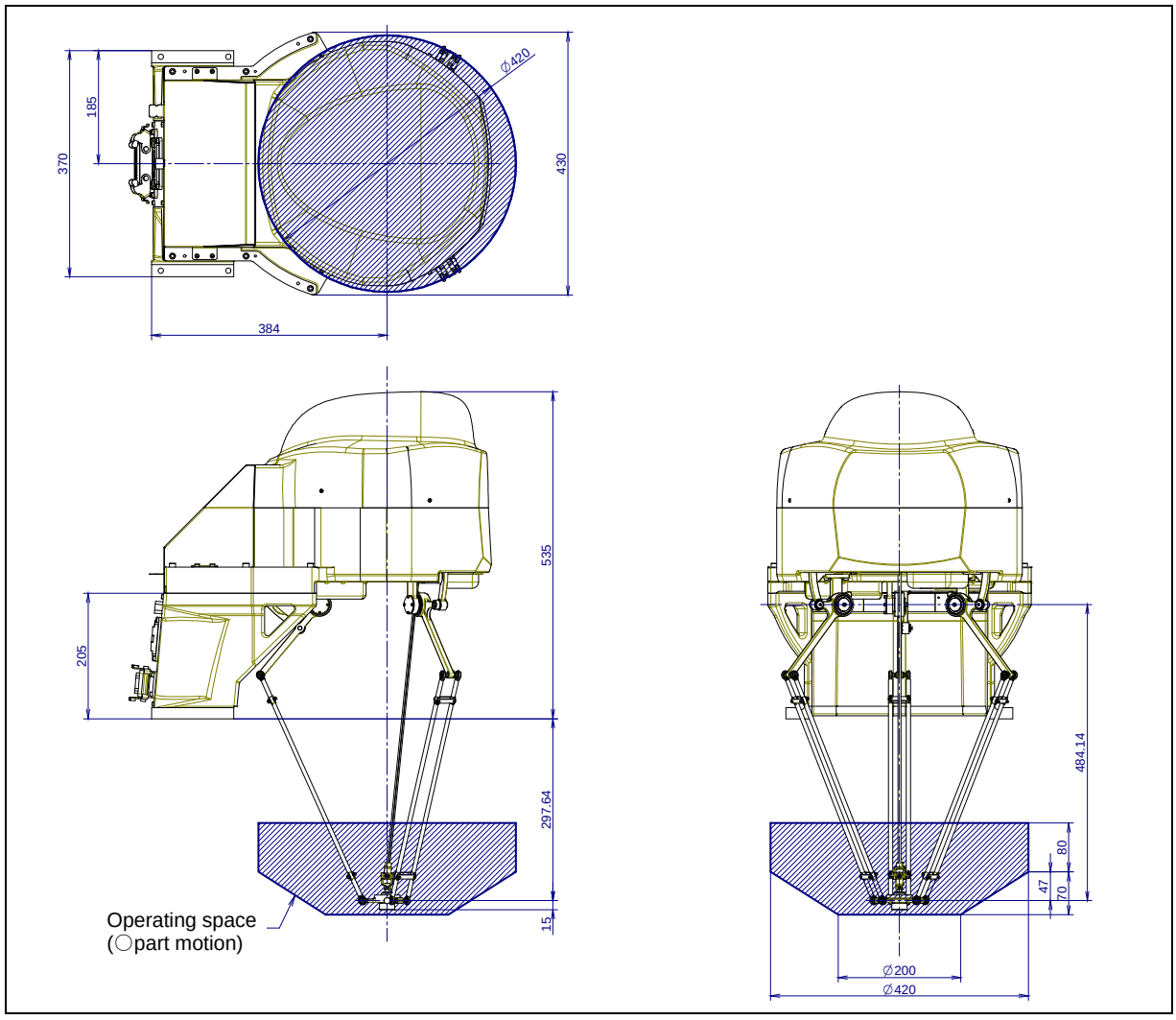


Fig. 3.2 (m) Operating space (M-1*i*A/0.5SL) (with stand)

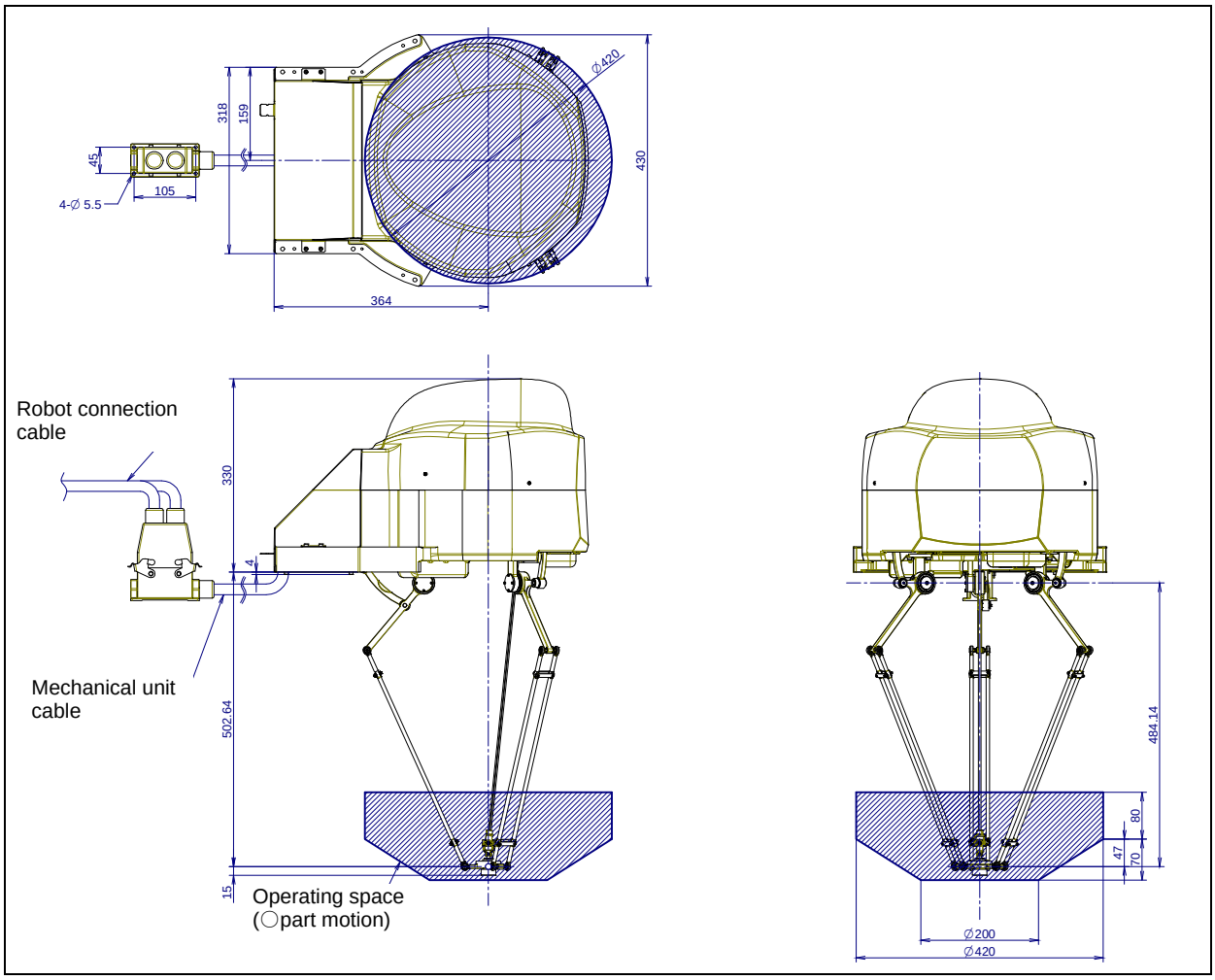


Fig. 3.2 (n) Operating space (M-1*i*A/0.5SL) (no stand A)

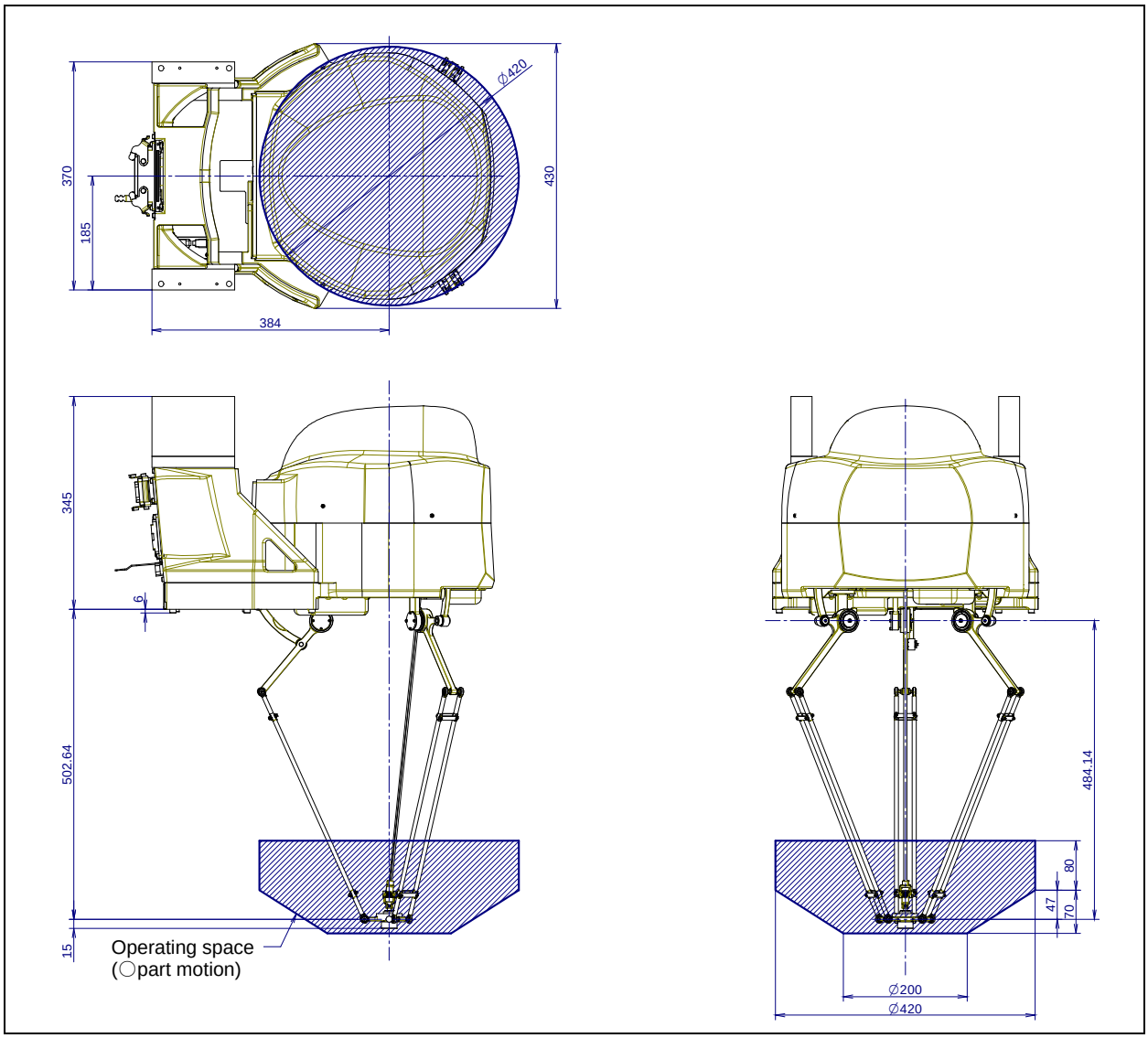


Fig. 3.2 (o) Operating space (M-1*i*A/0.5SL) (ceiling mount)

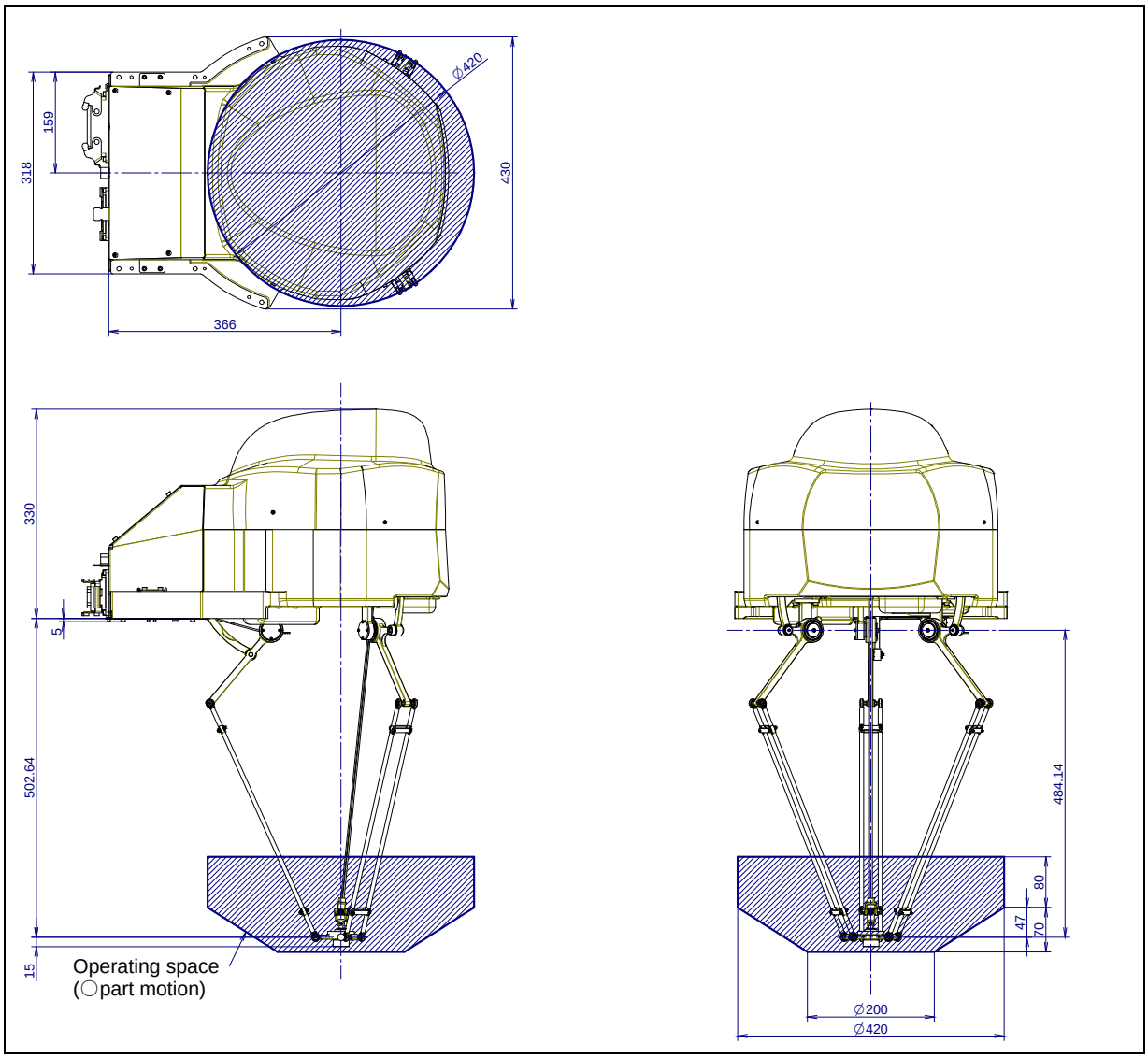


Fig. 3.2 (p) Operating space (M-1*i*A/0.5SL) (no stand B)

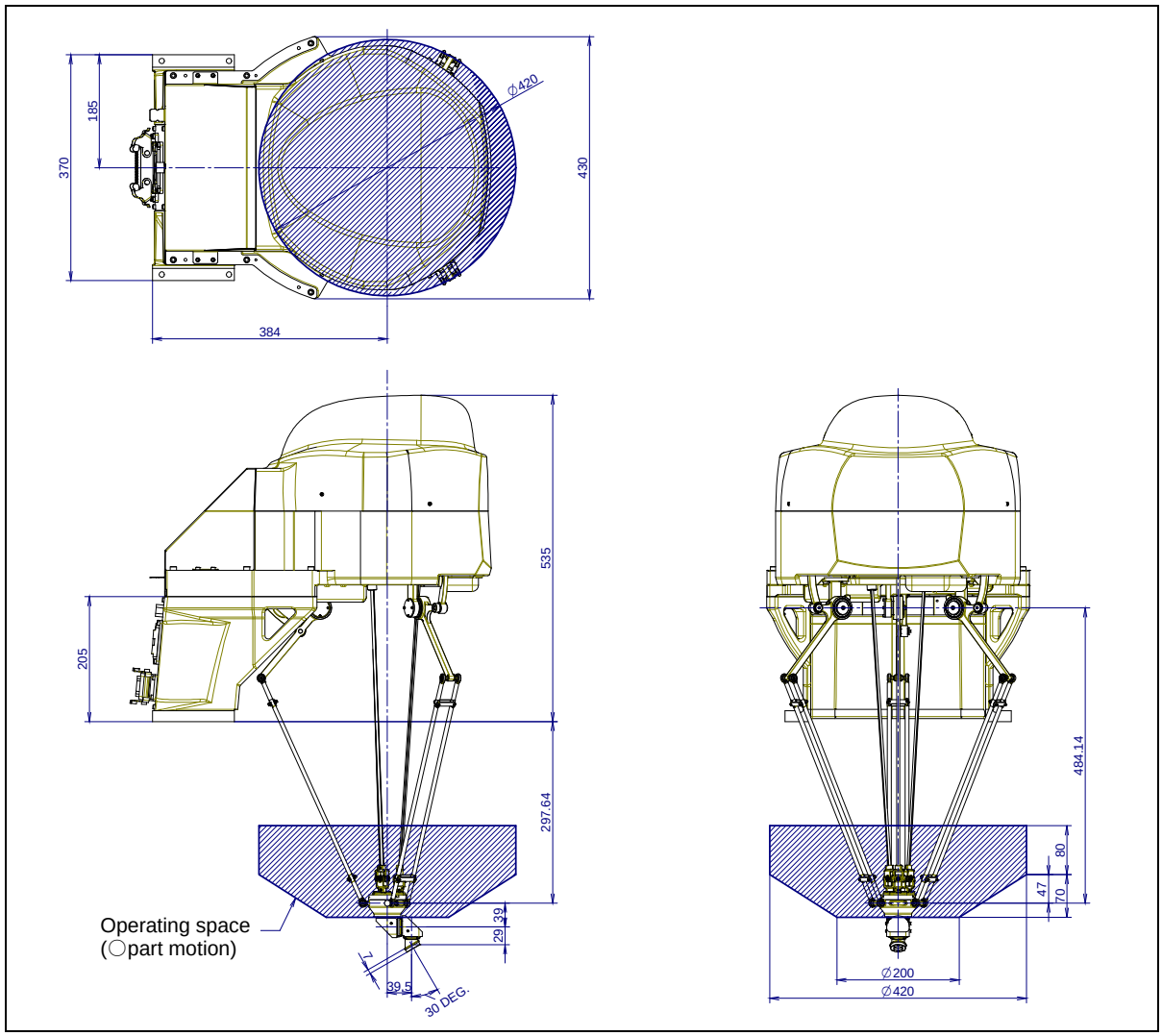


Fig. 3.2 (q) Operating space (M-1*i*A/0.5AL) (with stand)

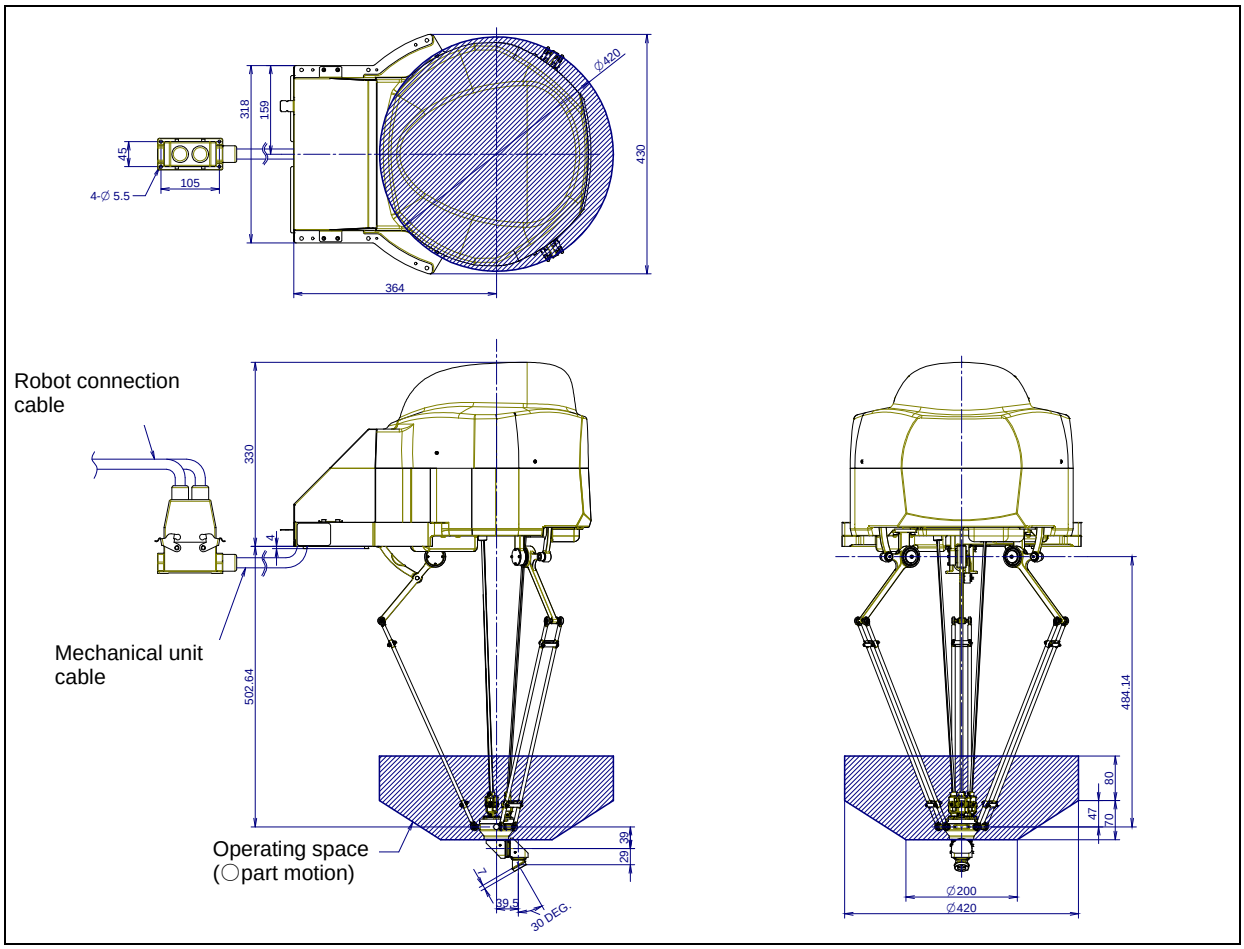


Fig. 3.2 (r) Operating space (M-1*i*A/0.5AL) (no stand A)

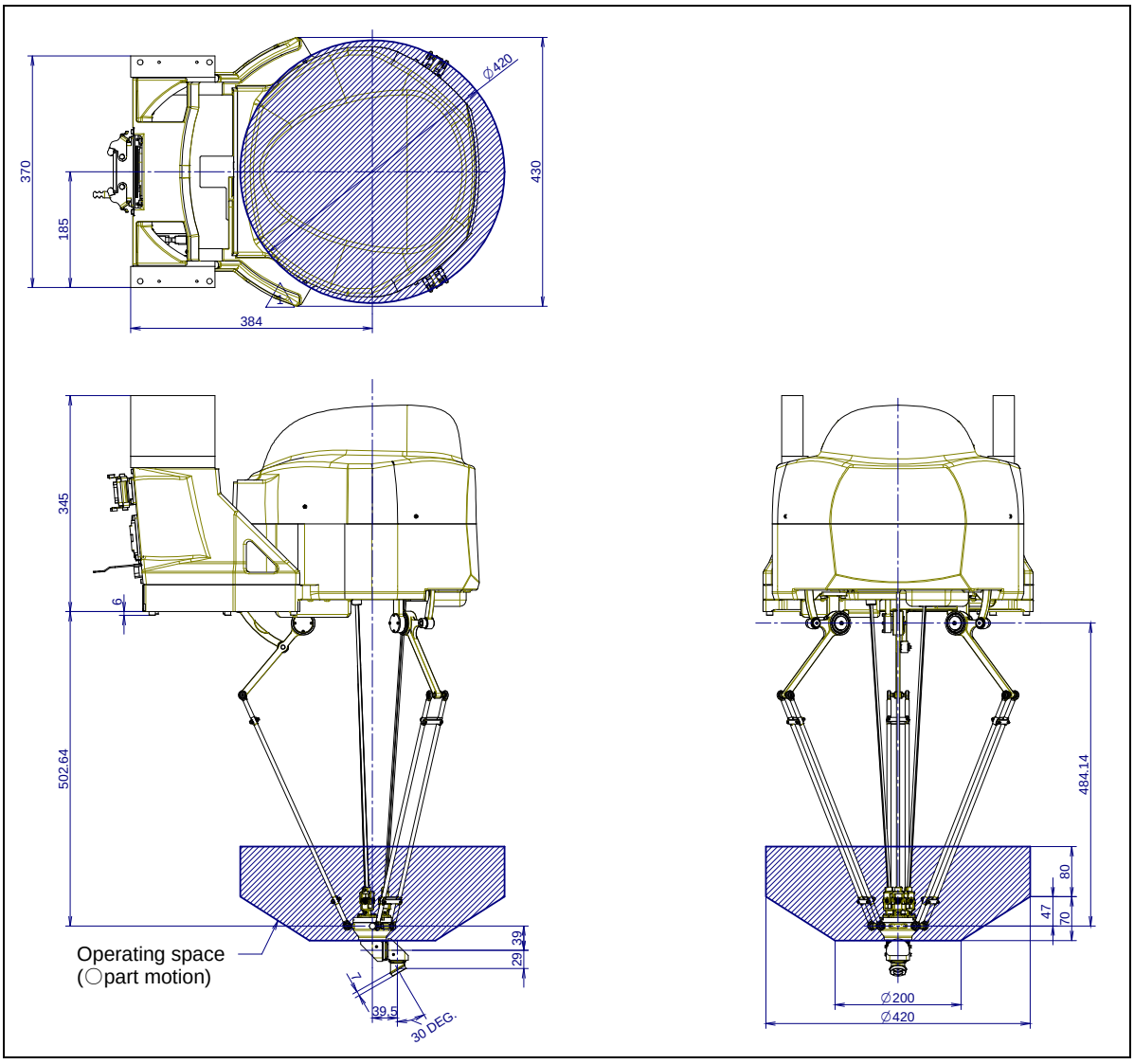


Fig. 3.2 (s) Operating space (M-1*i*A/0.5AL) (ceiling mount)

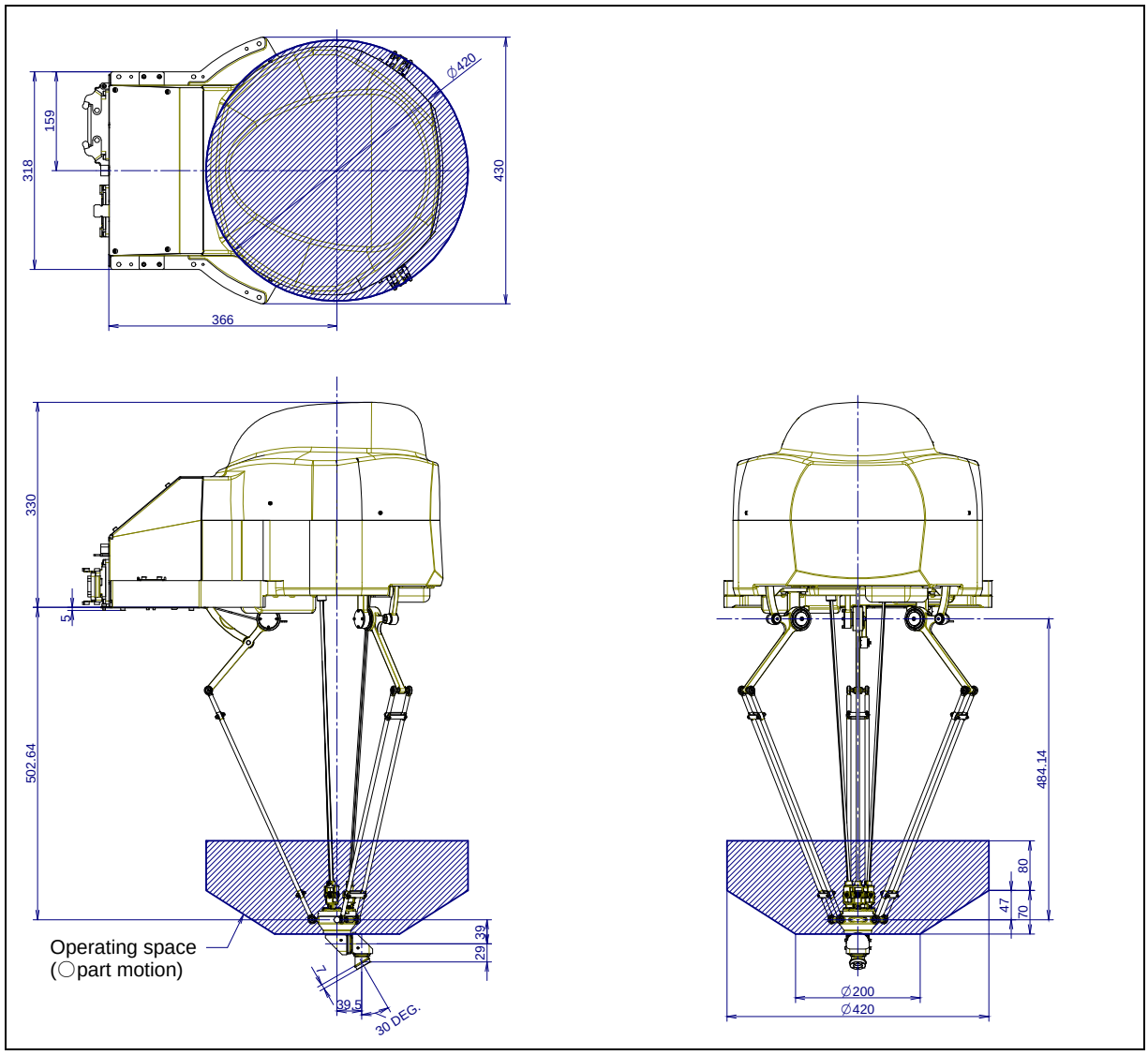


Fig. 3.2 (t) Operating space (M-1*i*A/0.5AL) (no stand B)

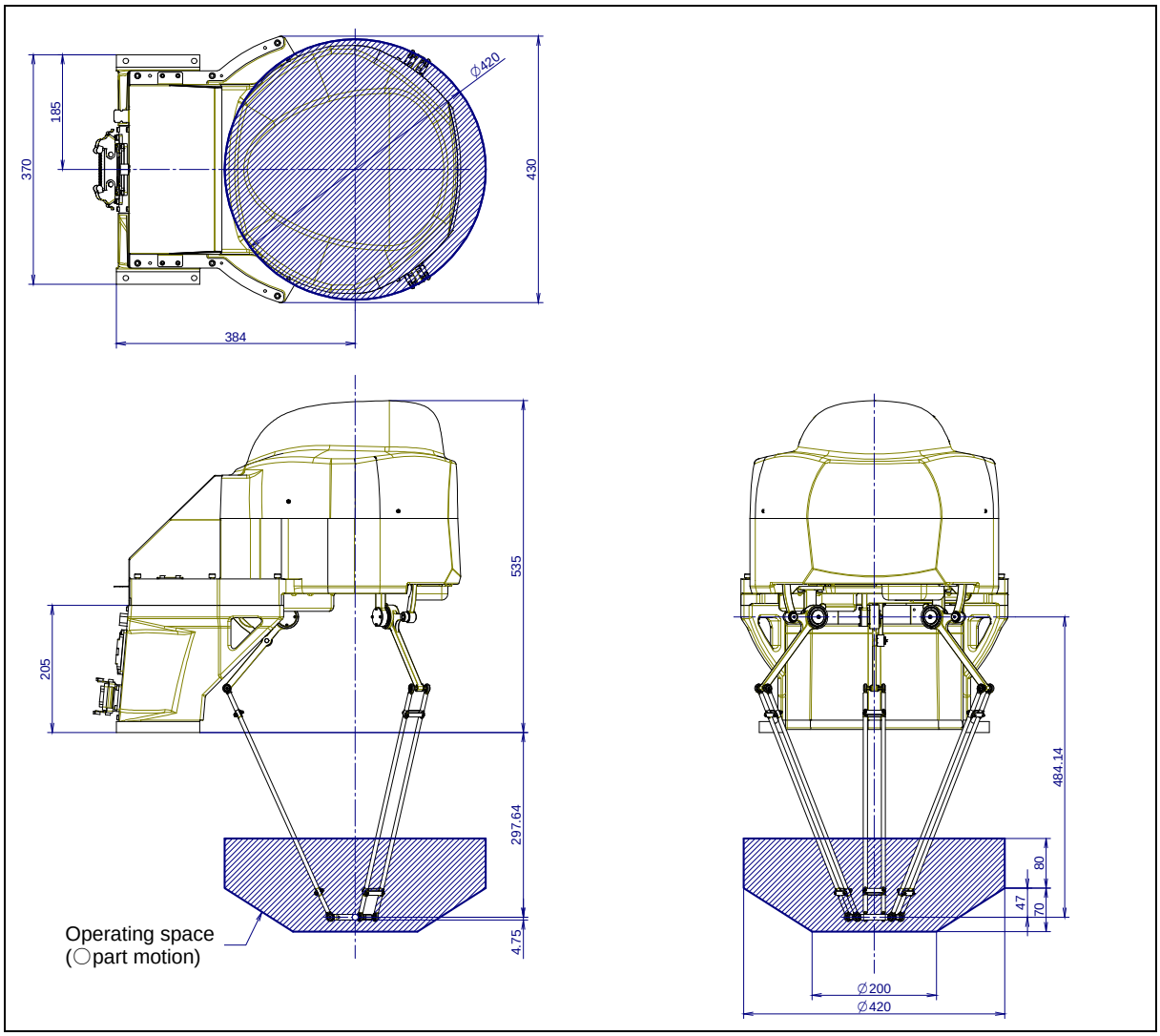


Fig. 3.2 (u) Operating space (M-1*i*A/1HL) (with stand)

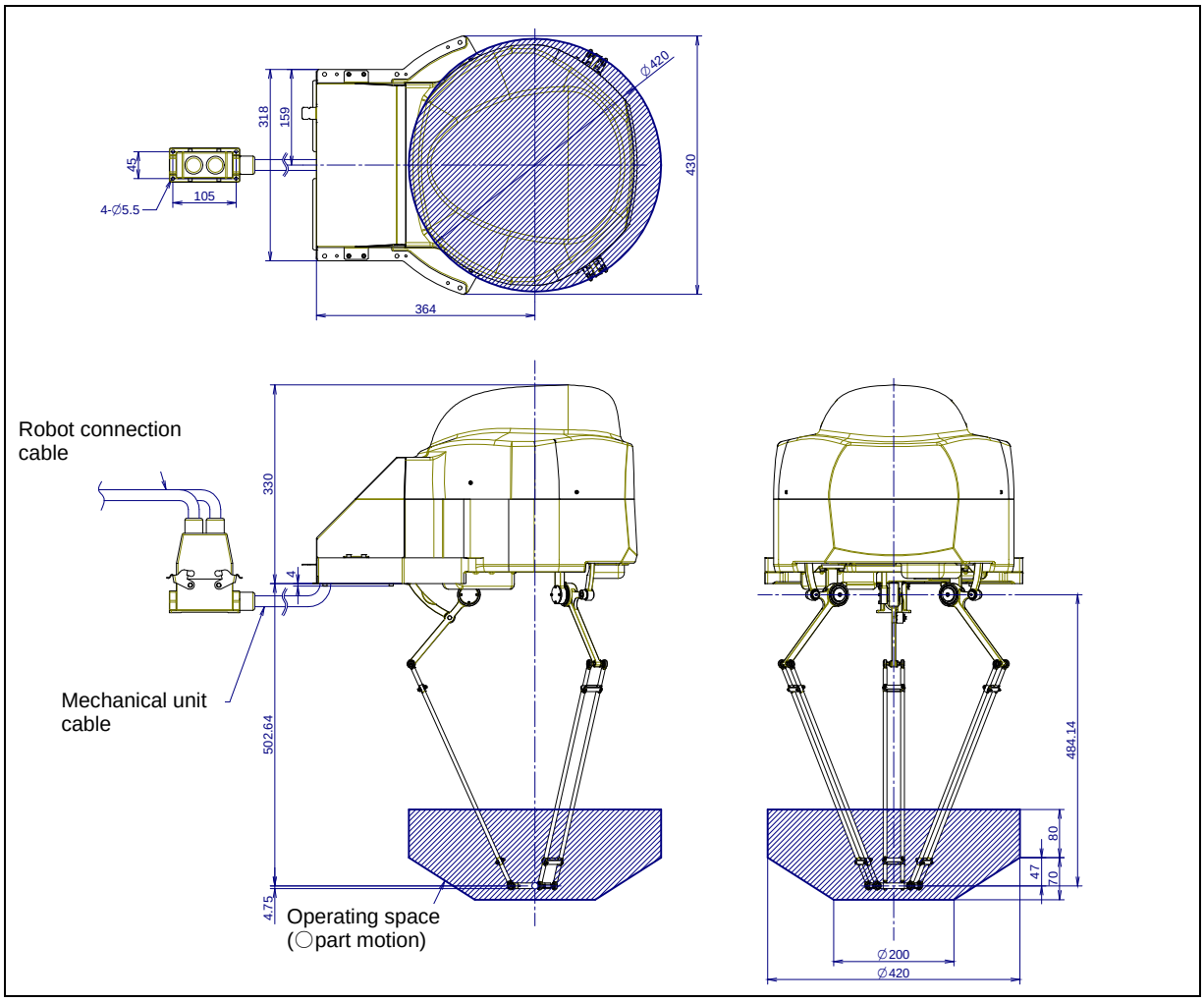


Fig. 3.2 (v) Operating space (M-1*i*A/1HL) (no stand A)

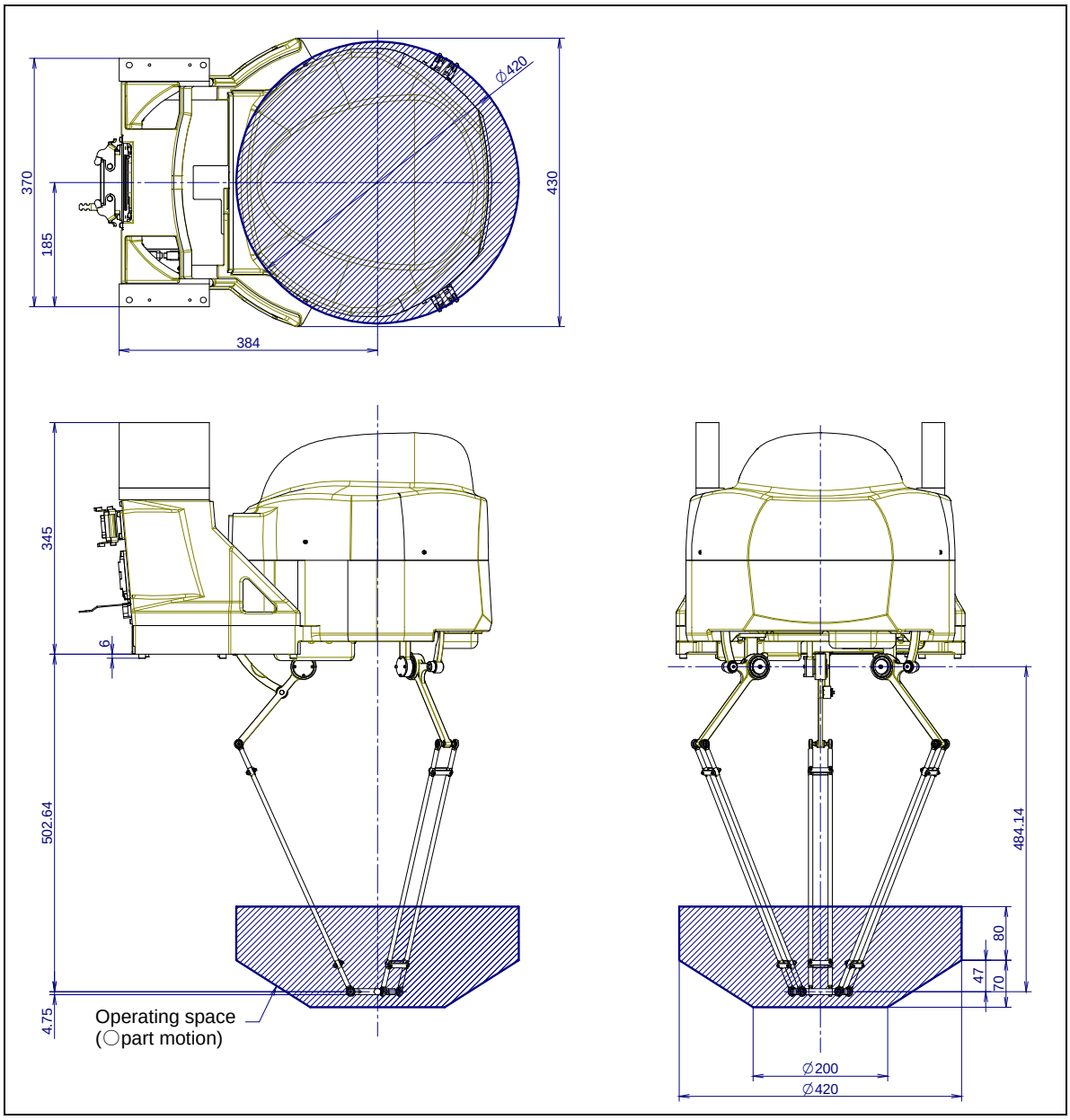


Fig. 3.2 (w) Operating space (M-1*i*A/1HL) (ceiling mount)

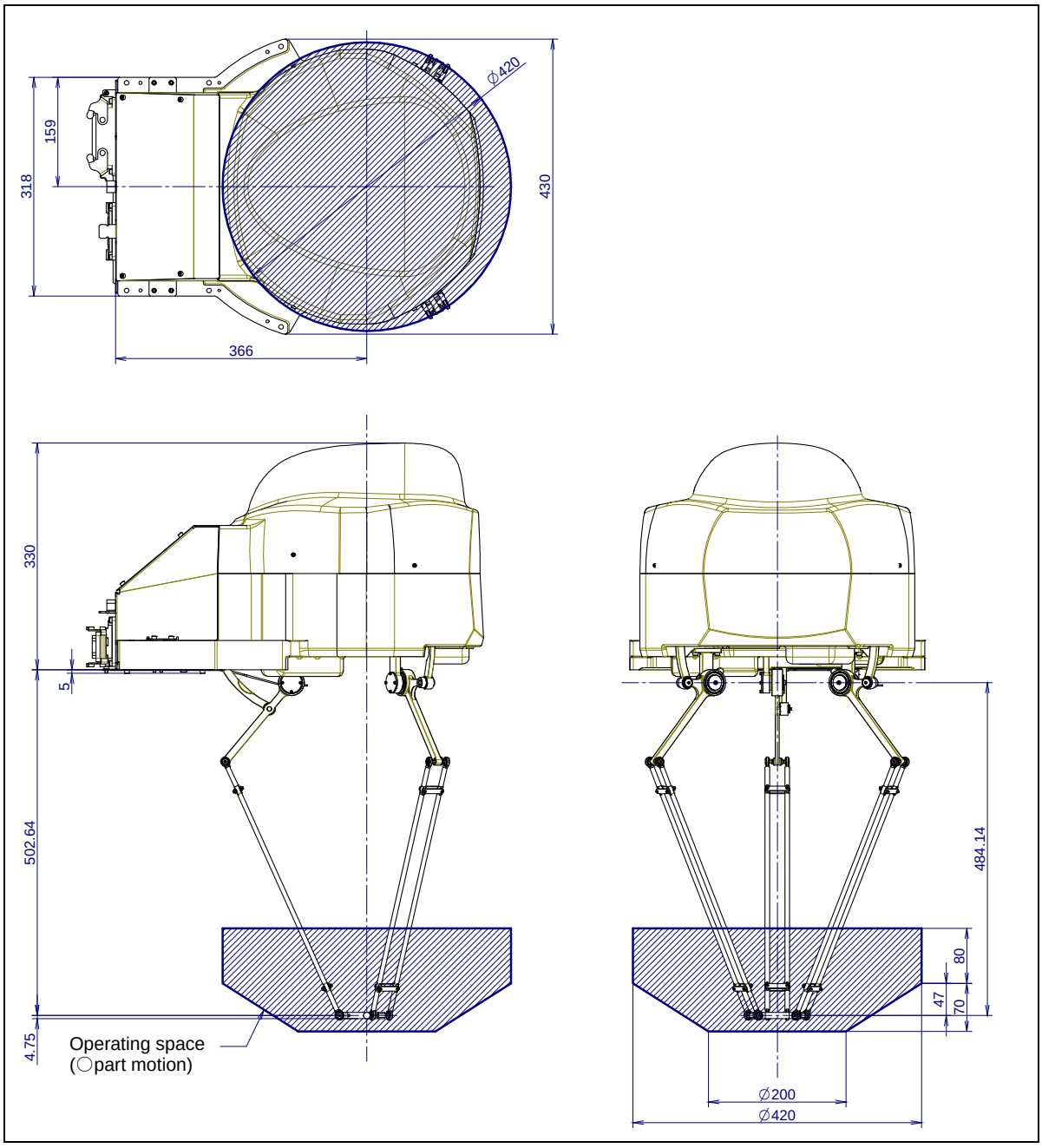


Fig. 3.2 (x) Operating space (M-1*i*A/1HL) (no stand B)

3.3 WRIST LOAD CONDITIONS

Fig. 3.3 (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.
- See Section 4.1 about the mounting of an end effector.

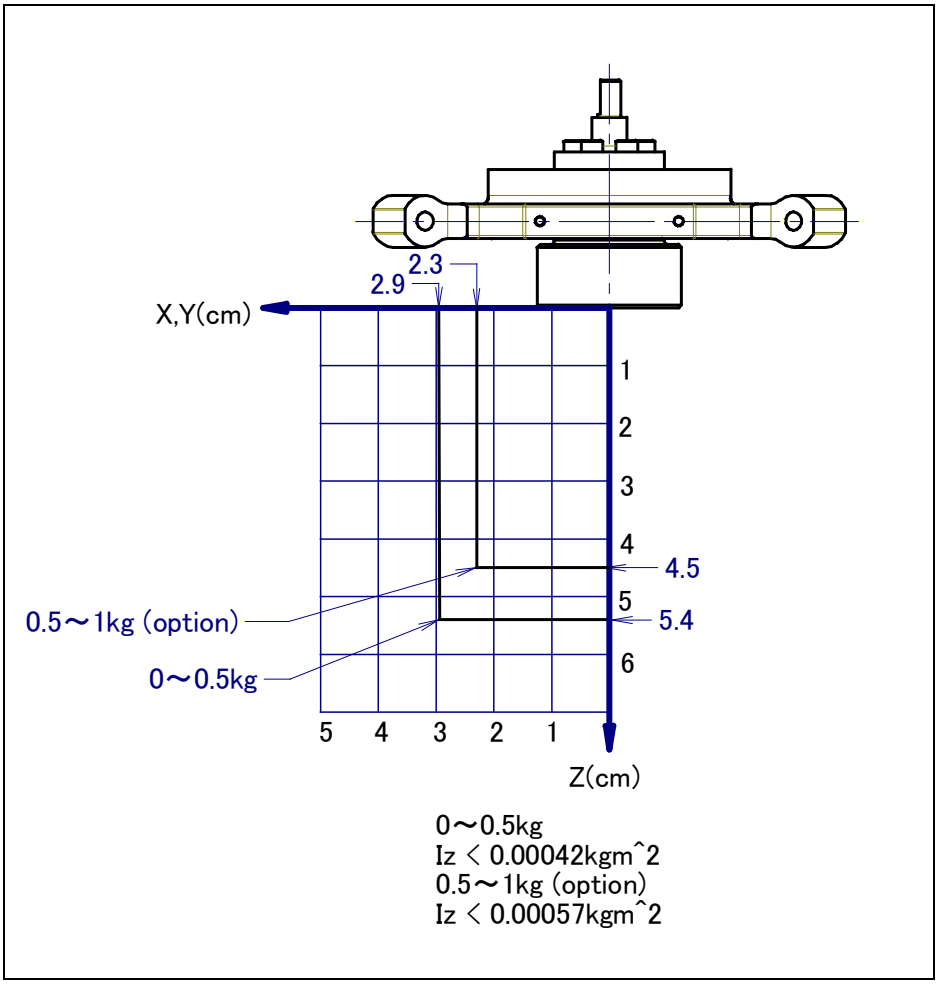


Fig. 3.3 (a) Wrist load diagram (M-1*i*A/0.5S/0.5SL)

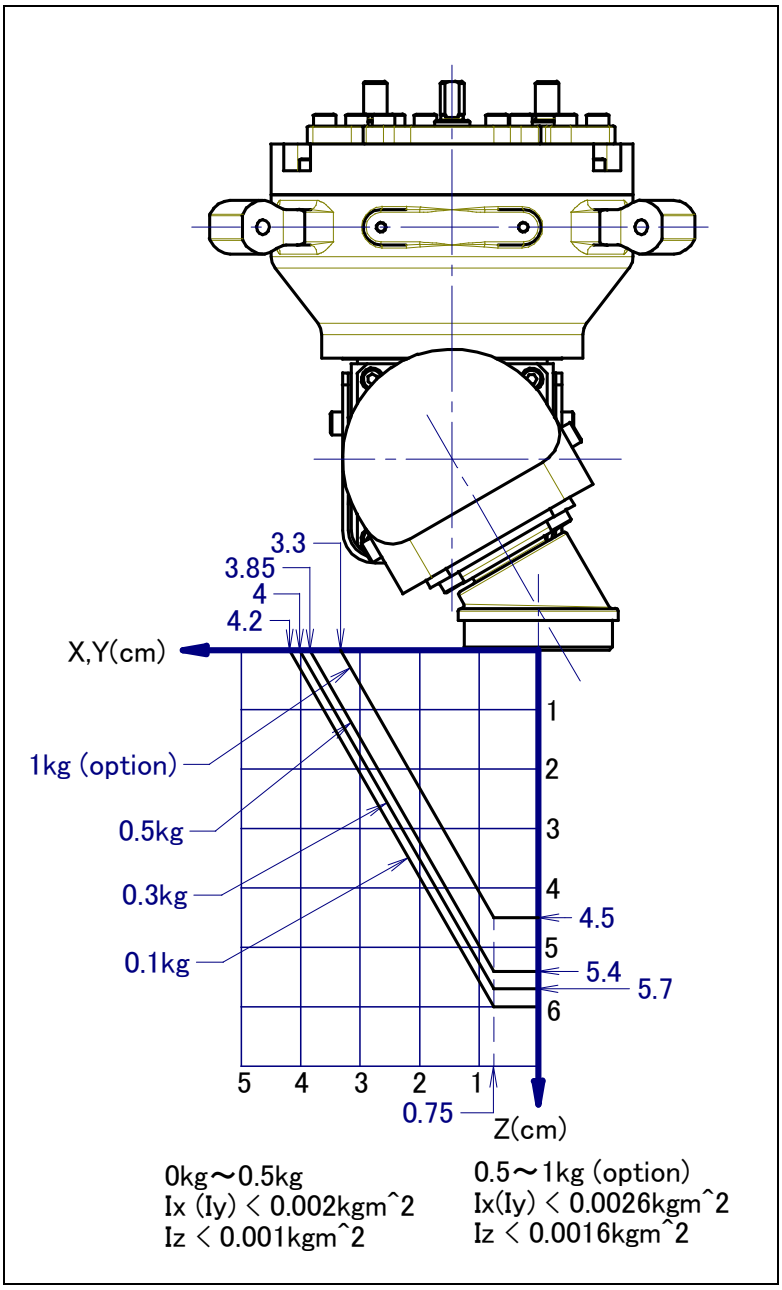


Fig. 3.3 (b) Wrist load diagram (M-1*i*A/0.5A/0.5AL)

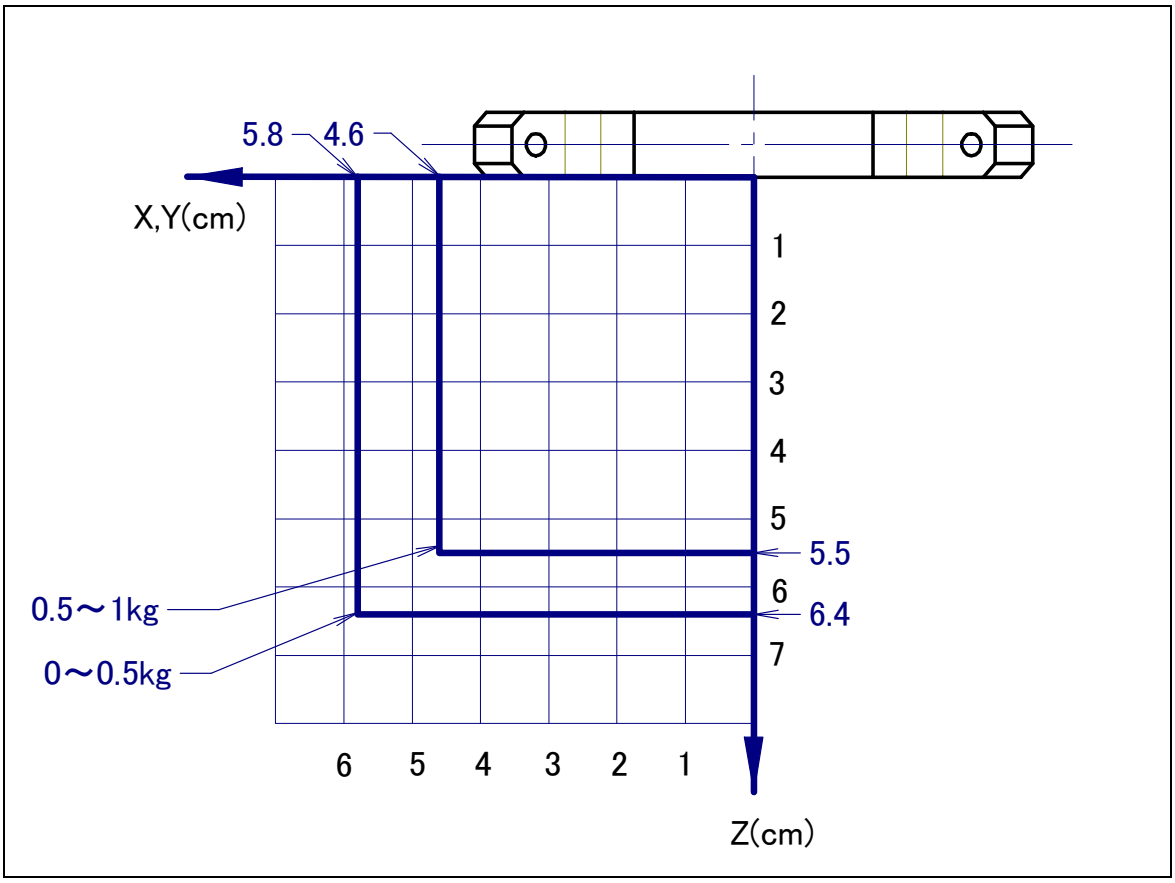


Fig. 3.3 (c) Wrist load diagram (M-1*i*A/1H/1HL)

4 EQUIPMENT INSTALLATION TO THE ROBOT

4.1 END EFFECTOR INSTALLATION TO WRIST

Fig. 4.1 (a) to (c) are the diagrams for end effector interface dimension. Select screws and positioning pins of a length that matches the depth of the tapped holes and pin holes. See Appendix B “Bolt tightening torque” for tightening torque specifications.

⚠ CAUTION
1 Notice the tooling coupling depth to wrist flange should be shorter than the flange coupling length.
2 When installing the end effector or performing maintenance after the installation, take care not to put large moment and load on the wrist.

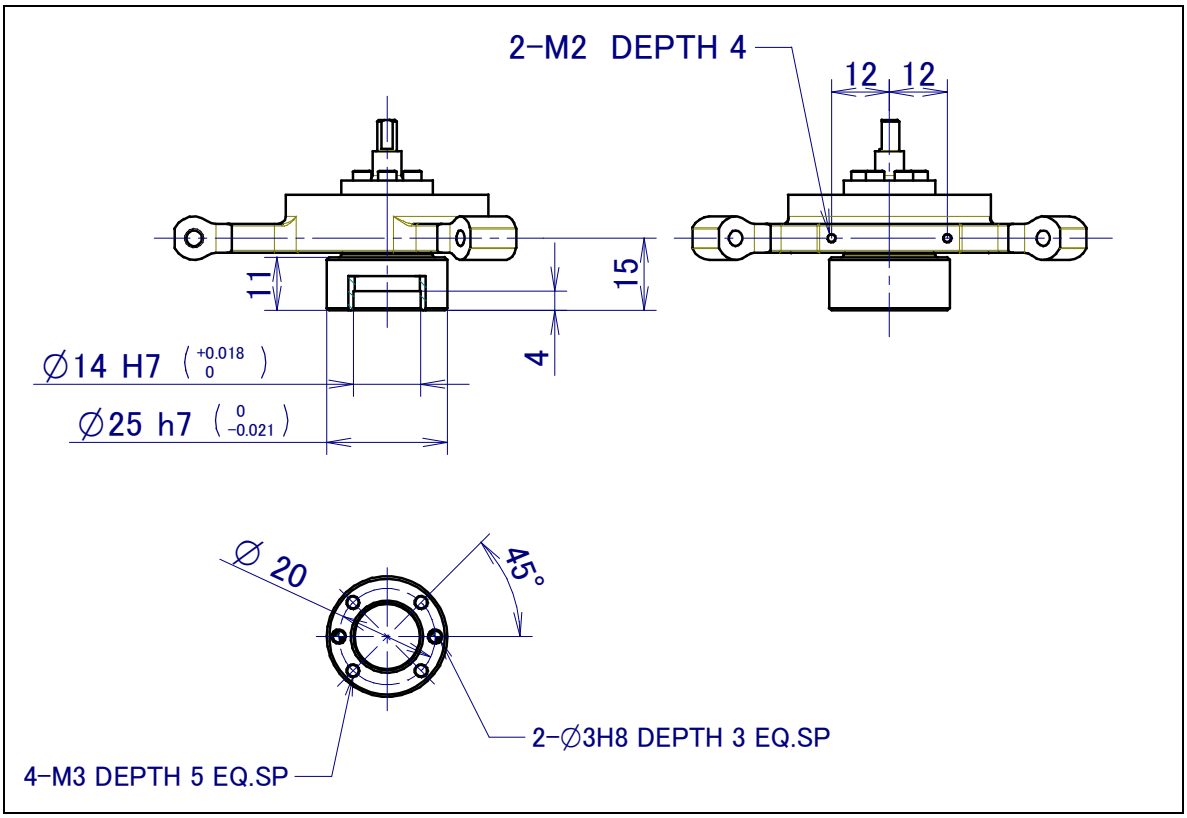


Fig. 4.1 (a) End effector interface dimension (M-1*i*A/0.5S/0.5SL)

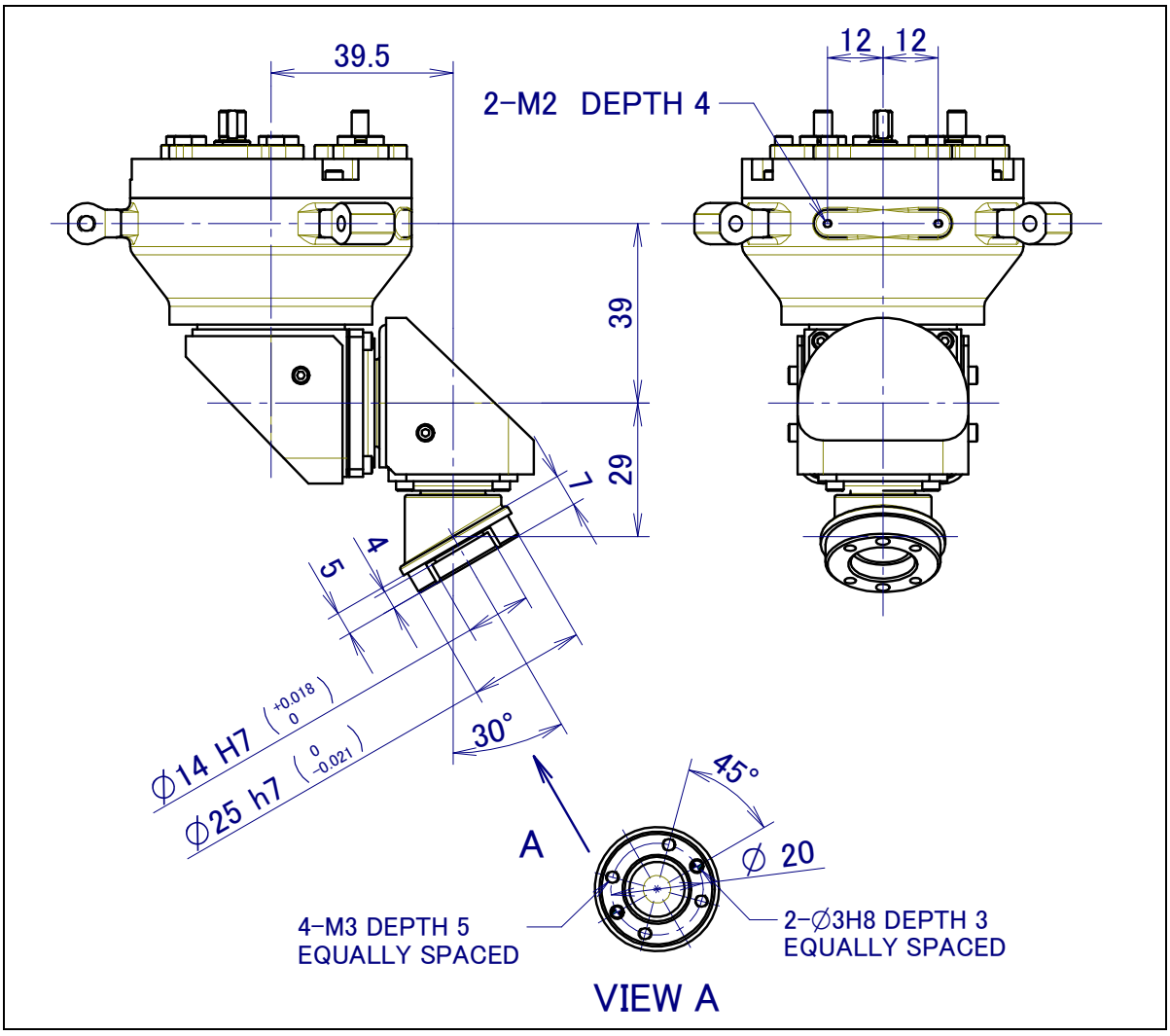


Fig. 4.1 (b) End effector interface dimension (M-1*i*A/0.5A/0.5AL)

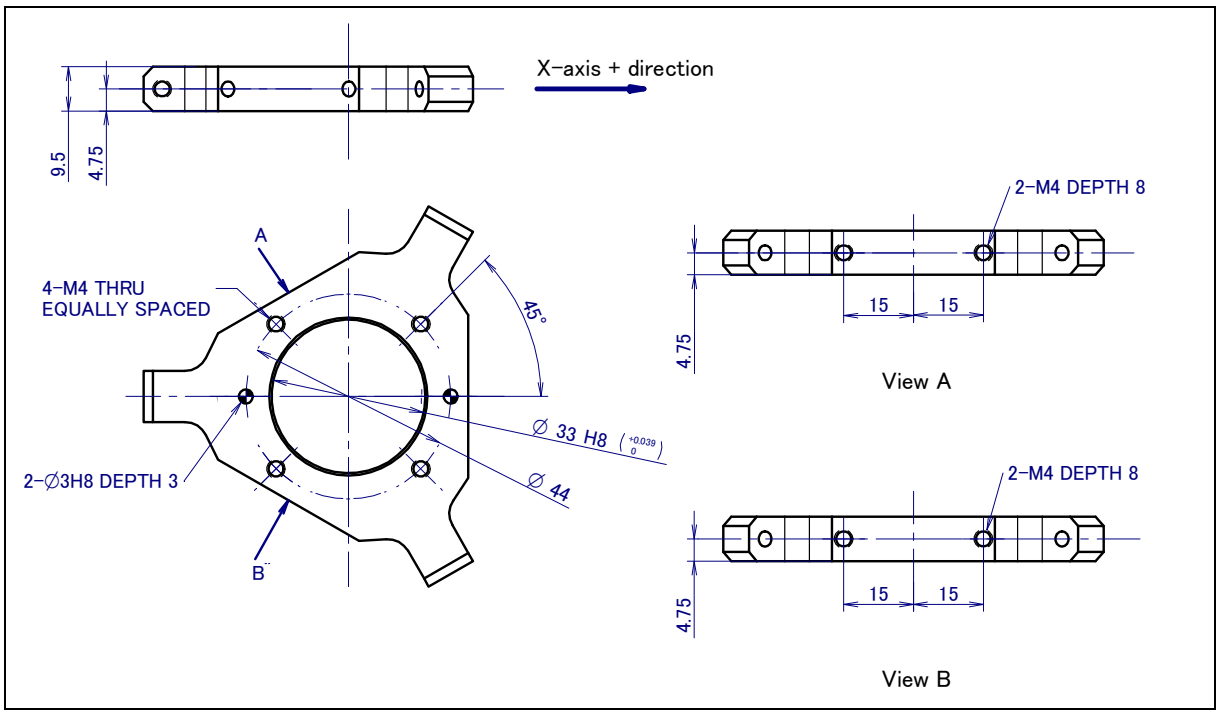


Fig. 4.1 (c) End effector interface dimension (M-1*i*A/1H/1HL)

4.2 LOAD SETTING

> ⚠ **CAUTION**
> Remember to set load condition parameter. Otherwise, there is a possibility that trouble occurs such as reducer life reduction. Don't exceed allowable payload including connection cables and its swing.

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

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

```
MOTION PERFORMANCE        JOINT   10 %
     Group1
No.    PAYLOAD[kg]          Comment
 1                0.50      [                    ]
 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  DETIAL  ARMLOAD  SETTND>
          IDENT                        >
```

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

```
MOTION PAYLOAD SET        JOINT        100 %

     Group1
1    Schedule No [     1]:    [ Comment          ]
2    PAYLOAD                  [ kg ]          0.50
3    PAYLOAD  CENTER  X       [ cm ]          0.7654
4    PAYLOAD  CENTER  Y       [ cm ]          0.00
5    PAYLOAD  CENTER  Z       [ cm ]          5.4484
6    PAYLOAD  INERTIA  X      [kgfcmsˆ2]      2.0972
7    PAYLOAD  INERTIA  Y      [kgfcmsˆ2]      2.3716
8    PAYLOAD  INERTIA  Z      [kgfcmsˆ2]      1.421

 [ TYPE ]  GROUP  NUMBER  DEFAULT  HELP
```

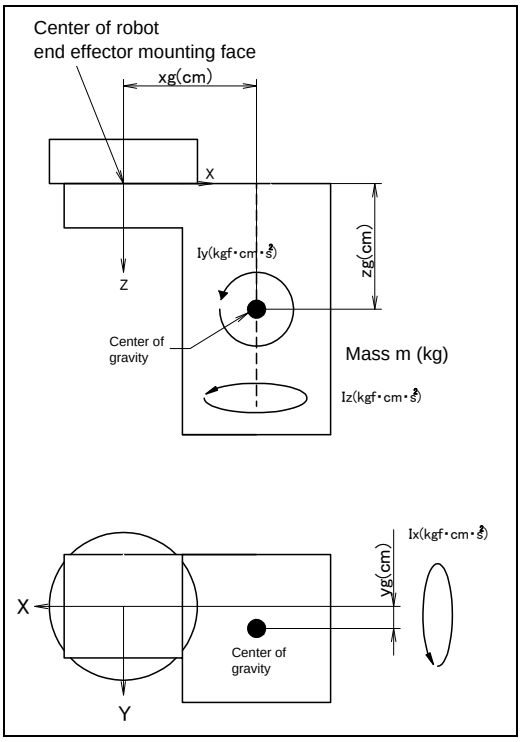


Fig. 4.2 (a) Standard tool coordinate

6 Set the payload, gravity center position, and inertia around the gravity center on the MOTION PAYLOAD SET screen. The X, Y, and Z directions displayed on this screen correspond to the respective standard tool coordinates (with no tool coordinate system set up). When values are entered, the following message appears: "Path and Cycletime will change. Set it?" Respond to the message with F4 ([YES]) or F5 ([NO]).

7 Pressing the F3 ([NUMBER]) will bring you to the MOTION PAYLOAD SET screen for another condition

8 Press the [PREV] key to return to the list screen. Press F5 SETIND, and enter a desired load setting condition number.

4.3 JOINT COVER (OPTION)

It is possible to diminish the generation of the abrasion powder by installing the joint cover (option) as shown in Fig. 4.3 (a). This option is not for server dust/liquid protection. Please be careful.

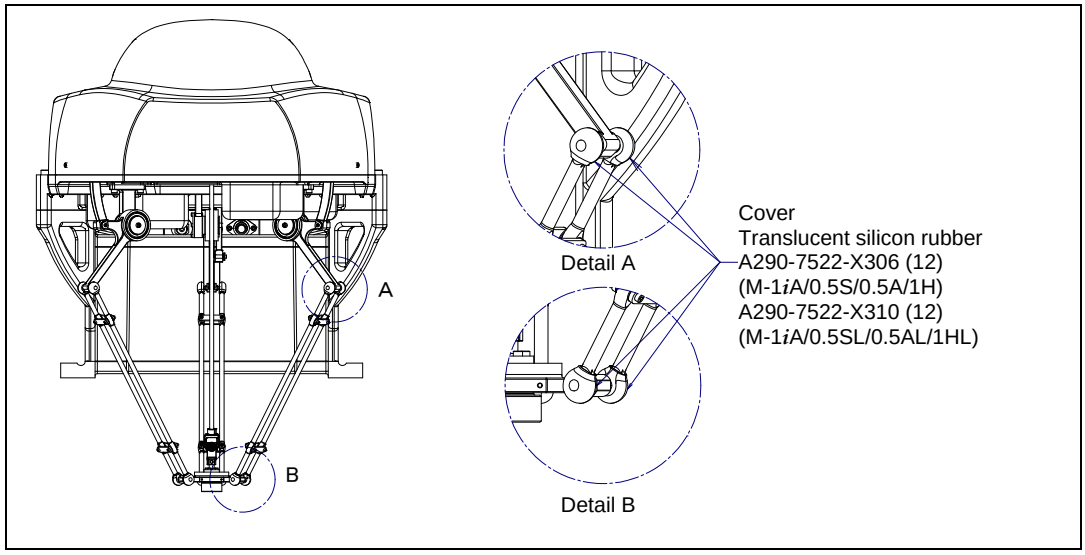


Fig. 4.3 (a) Joint cover

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 the outside of the mechanical unit.
- Please do not perform remodeling (adding a protective cover, or secure an additional outside cable) that obstructs the behavior of the cable.
- When external equipment is installed on 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 the end effector, robot faults, or damage to robot electrical hardware. In addition, electric shock could occur when touching the power cables.

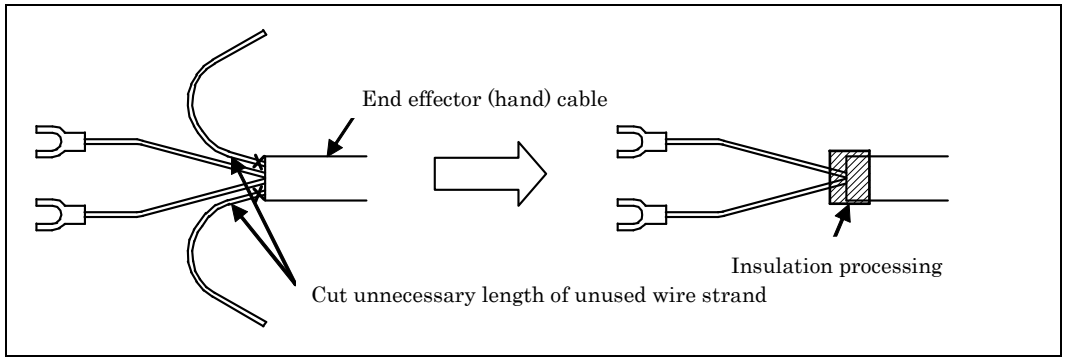


Fig. 5 (a) Treatment method of end effector (hand) cable

5.1 AIR SUPPLY AND EE(RI) INTERFACE (OPTION)

Fig.5.1 (a) shows the position of air supply and EE interface position and pin layout.
Optional solenoid valves can be mounted as shown in Table 5.1 (a). Plugs are inserted in all the ports used for supplying air before the robot is shipped. To use the air circuit, you must remove the plugs and connect the couplings with the ports.
When the solenoid valve is to be replaced, the entire manifold should be replaced.

Table 5.1 (a) Optional solenoid valves

Option spec.	Description	Solenoid (Manifold) spec	Remarks	RO
A05B-1522-J001	Double solenoids x 1	A97L-0218-0121#D1 (manufactured by SMC)	2 position x 1	RO1 to 2
A05B-1522-J002	Double solenoids x 2	A97L-0218-0121#D2 (manufactured by SMC)	2 position x 2	RO1 to 4
A05B-1522-J003	Double solenoids x 3	A97L-0218-0121#D3 (manufactured by SMC)	2 position x 3	RO1 to 6

Available section area of the solenoid valve : 1.98mm^2 (CV value : 0.11)

⚠ CAUTION
1 The connector to be plugged into the interface and the cable attached to that connector should be prepared by the customer.
2 When the robot is shipped, a cap is mounted on the end effector interface. When the interface is not used, mount the cap on the interface.

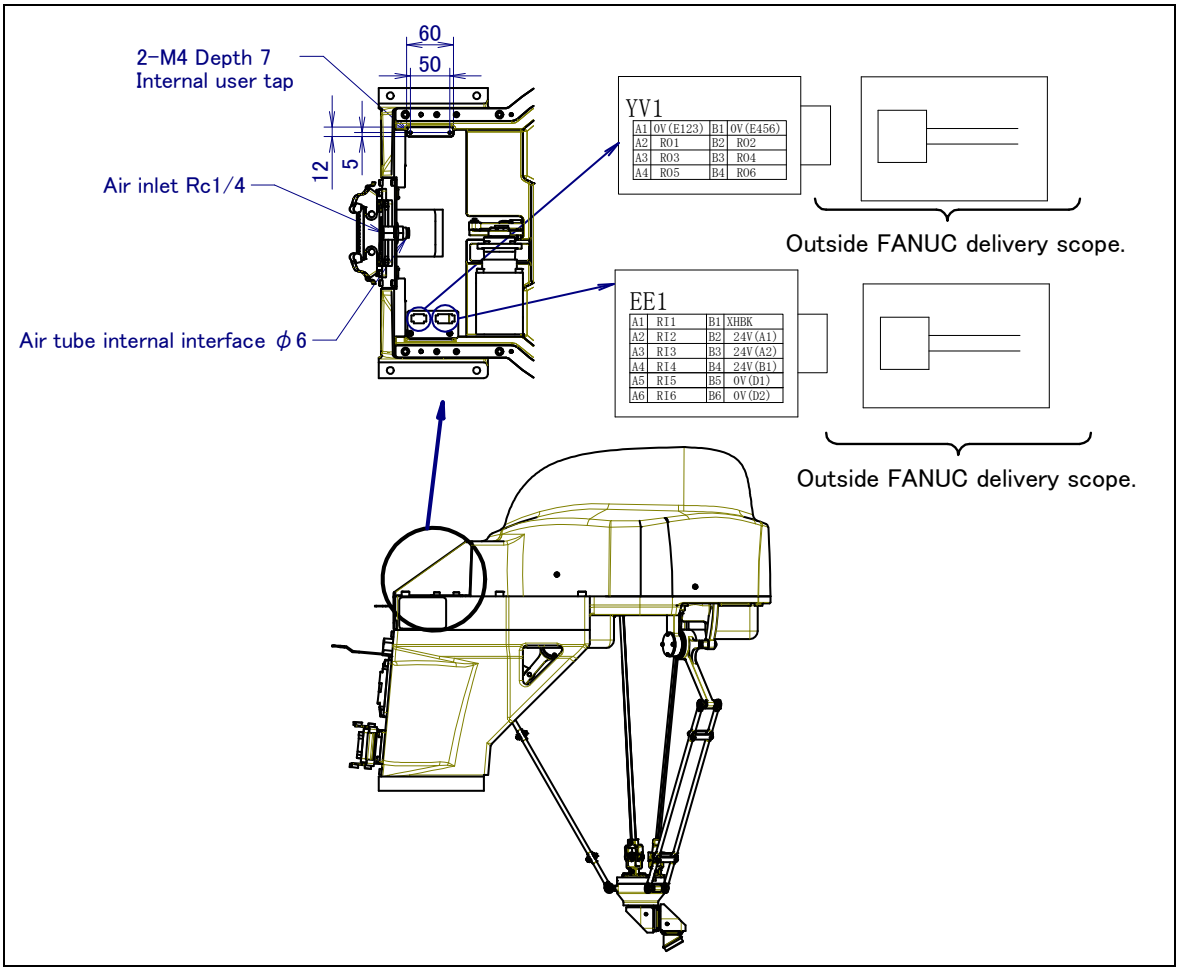


Fig. 5.1 (a) Air supply and EE (RI) interface

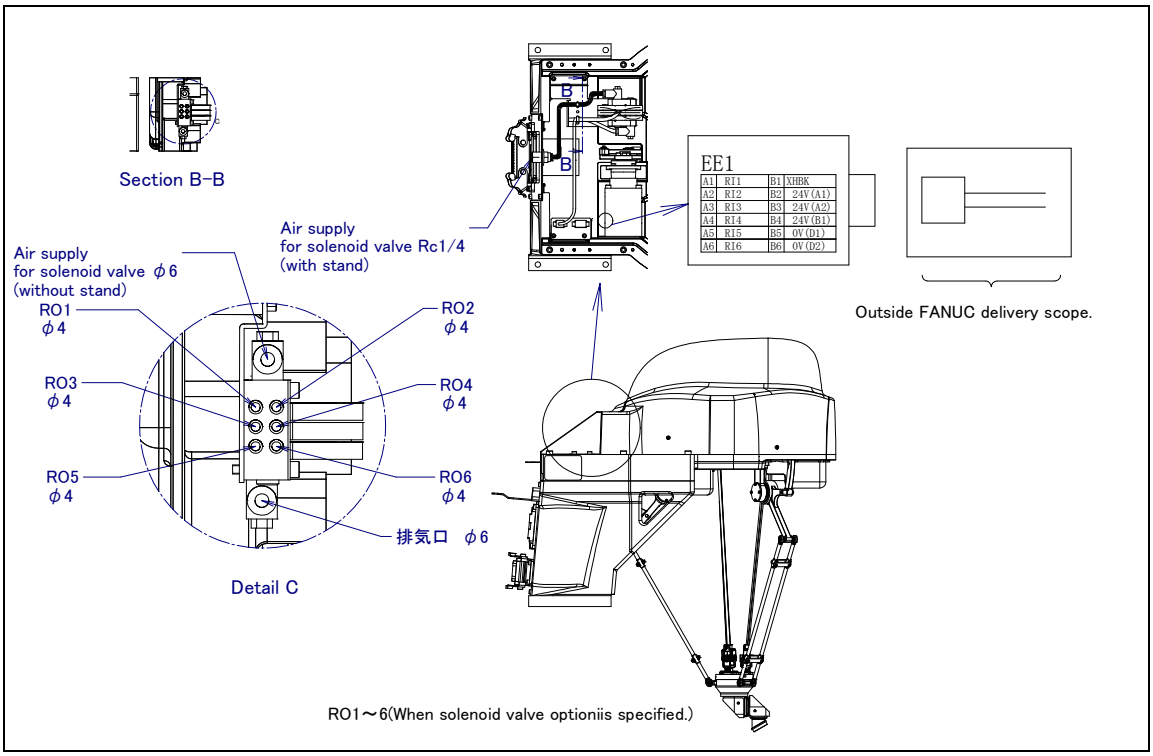


Fig. 5.1 (b) Air supply and EE (RI) interface (When solenoid valve option is specified.)

> **⚠ CAUTION**
> For wiring of the peripheral device to the EE interface, refer to the Chapter 4 of manuals below, too.
> R-30*i*A Mate Controller Maintenance Manual (B-82725EN)
> For Europe R-30*i*A Mate Controller Maintenance Manual (B-82725EN-1)
> RIA R15.06-1999COMPLIANT R-30*i*A Mate Controller Maintenance Manual (B-82725EN-2)
> R-30*i*A Mate Controller Open Air Maintenance Manual (B-82965EN-1)
> R-30*i*B Mate Controller Maintenance Manual (B-83525EN)
> R-30*i*B Mate Controller Open Air Maintenance Manual (B-83555EN)

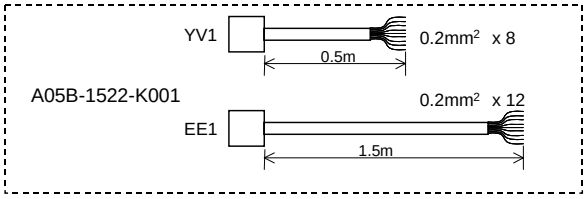
Connector specifications

Table 5.1 (b) shows connectors for EE interface.

Table 5.1(b) Supported connectors (user side)

Maker/Dealer	MAKER SPEC			FANUC SPEC	Q'tt
TYCO ELETORONICS AMP CO. Ltd	YV1	CONNECTOR	1-1827864-4	A63L-0002-0066#R08DX	1
		CONTACT	1827587-2	A63L-0002-0066#CRMB	8
	EE1	CONNECTOR	1-1827864-6	A63L-0002-0066#R12DX	1
		CONTACT	1827587-2	A63L-0002-0066#CRMB	12

Below is prepared as option cable kit.



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.

Fig. 5.1 (c) shows window for user free cabling.

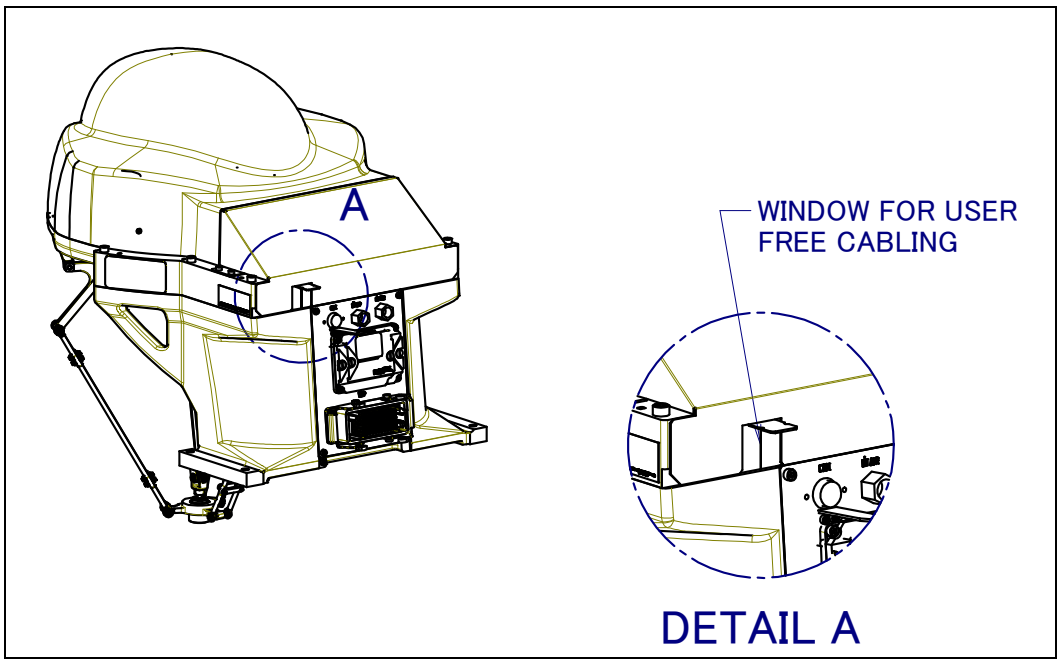


Fig. 5.1 (c) Window for user free cabling

Fig. 5.1 (d) shows wiring method of wiring along user piping and wiring tag.

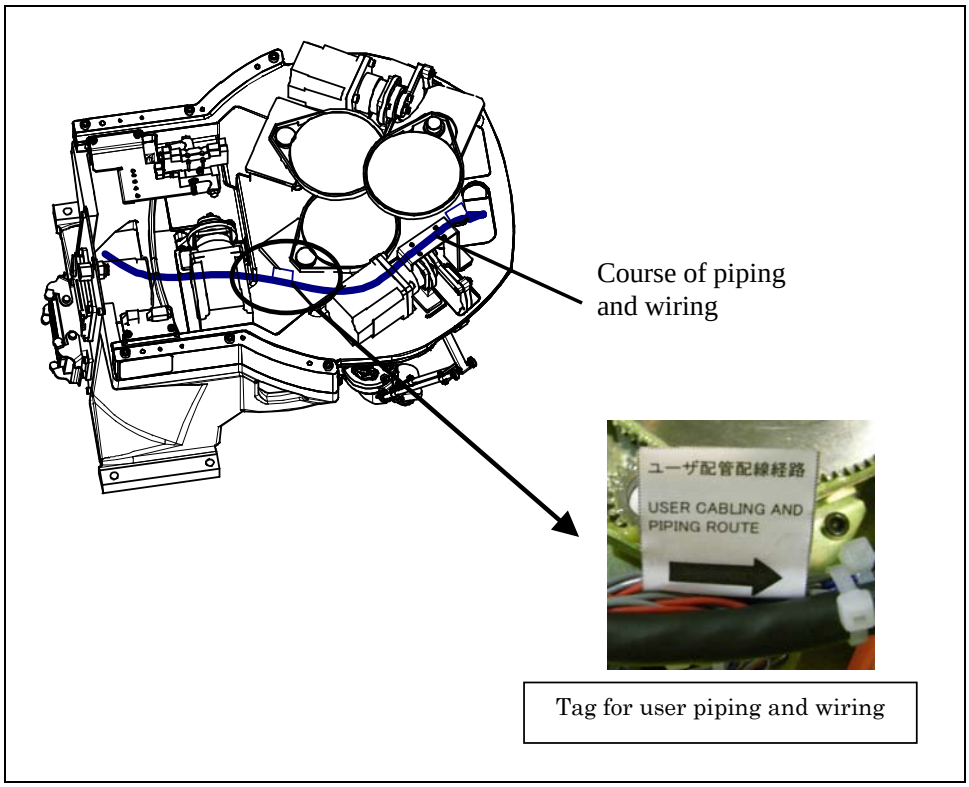


Fig. 5.1 (d) wiring method of wiring along user piping and wiring tag

Fig. 5.1 (e) shows method of using cable clamp option.

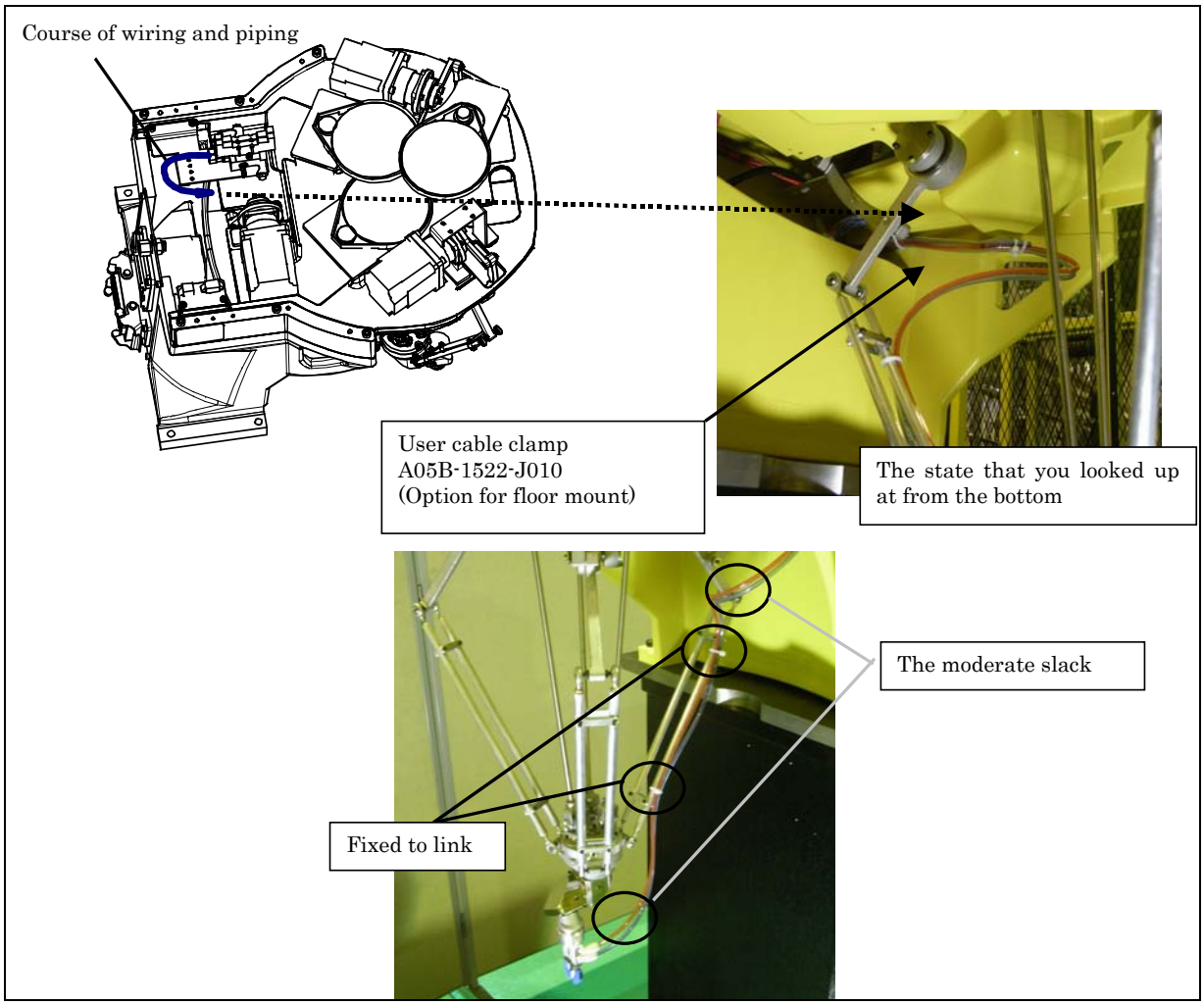


Fig. 5.1 (e) method of using cable clamp option

5.2 CAMERA CABLE (OPTION)

Fig. 5.2 (a), (b) show the camera cable interface.

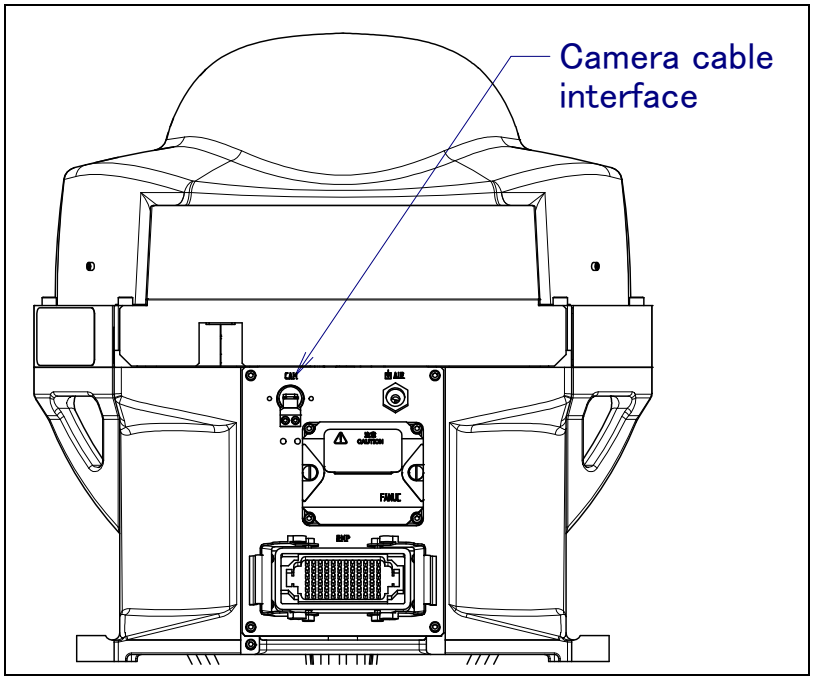


Fig. 5.2 (a) Camera cable interface (With stand, ceiling)

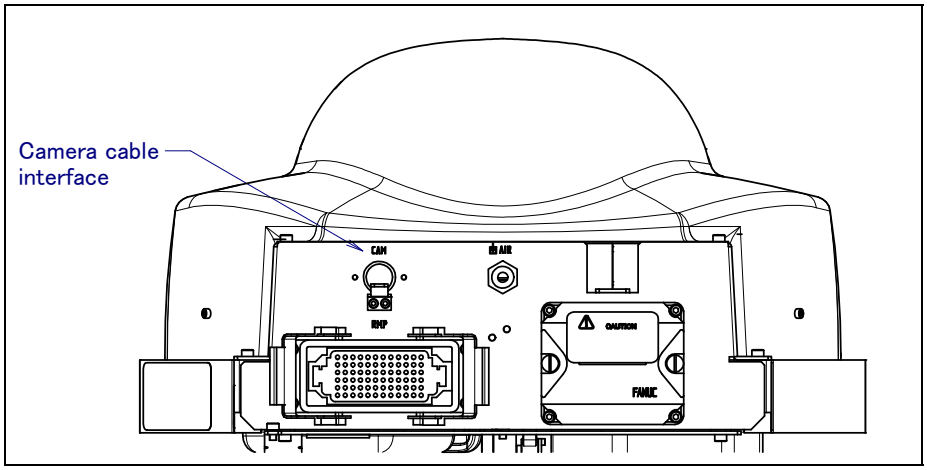


Fig. 5.2 (b) Camera cable interface (no stand B)

6 CHECKS AND MAINTENANCE

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

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

6.1 CHECKS AND MAINTENANCE

6.1.1 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 Oil accumulation	Check there is oil on the sealed part of each joint. If there is an oil seepage, clean them. Clean the accumulated oil on the lower side of the drive shaft (upper side of he universal joints). (There is no drive shaft for M-1*i*A/1H/1HL.) **⇒"6.2.1 Confirmation of Oil Seepage and Oil Accumulation"**
Abrasion	Check there is no abrasion on each parts. **⇒"6.2.1 Confirmation of Oil Seepage and Oil Accumulation"**
Air control set	(When air control set is used) **⇒"6.2.2 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: **⇒"8.1 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: **⇒"8.1 TROUBLESHOOTING" (Symptom : Displacement)**
Peripheral equipment for proper operation	Check whether the peripheral equipment operates properly according to commands from the robot and the peripheral equipment.
Brakes for each axis	Check that the end effector drops 0.2 mm or less when servo power is turned off. If the end effector (hand) drops, perform the measures as described in the following section: **⇒"8.1 TROUBLESHOOTING"(symptom : Dropping axis)**
Warnings	Check whether unexpected warnings occur in the alarm screen on the teach pendant. If unexpected warnings occur, perform the measures as described in the following manual: **⇒"R-30*i*B/R-30*i*B Mate/R-30*i*B Plus/R-30*i*B Mate Plus CONTROLLER OPERATOR'S MANUAL (Alarm Code List)(B-83284EN-1) or R-30*i*A/R-30*i*A Mate CONTROLLER OPERATOR'S MANUAL (Alarm Code List)(B-83124EN-6)"**

6.1.2 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 No.
1 month 320h	3 months 960h	6 months 1920h	1 year 3840h	1.5 years 5760h	2 years 7680h	4 years 15360h			
○ Only 1st check	○						Retightening LINK B mounting par	Check the looseness of LINK B part (12 places), if they are loosened, remove the LOCTITE 243, then apply LOCTITE 243 on the thread and retighten them. **⇒"6.2.3 Retightening the Link B"**	6
○ Only 1st check	○						Check the wear of the LINK B ball joint part	Check the wear of the LINK B ball joint part. If looseness is large and it cause a bad influence on the robot accuracy, replace it. (See Fig. 6.2.3.)	7
○ Only 1st check	○						Cleaning the controller ventilation system	Confirm that the controller ventilation system is not dusty. If dust has accumulated, remove it.	18
	○						Check for external damage or peeling paint	Check whether the robot has external damage or peeling paint due to contact with the peripheral equipment. If unintended contact has occurred, 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 oils. If water is found, remove the cause and wipe off the liquid.	2
	○ Only 1st check		○				Check the exposed connectors	Check the exposed connectors. **⇒"6.2.6 Check the Connectors"**	3
	○ 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"**	4
	○ Only 1st check		○				Retightening the cover bolts and external main bolts	Retighten the robot installation bolts, bolts that have been 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	5

Check and maintenance intervals (Period, Accumulated operating time)							Check and maintenance item	Check points, management and maintenance method	Periodic maintenance No.
1 month 320h	3 months 960h	6 months 1920h	1 year 3840h	1.5 years 5760h	2 years 7680h	4 years 15360h			
	○ Only 1st check		○				Clean foreign material s such as dust , powder	Check that foreign materials such as dust , powder does not exist on the robot main body. If foreign materials have accumulated, remove them. Especially, clean the robot movable parts well (each joint the gear cover, and the wrist axis rotation parts). When checking and cleaning the drive shafts, please be careful no to push the shaft on the drive shaft. **⇒"6.2.5 Cleaning the Wrist Axis Rotation Part and the Wrist Gears"**	8
	○ Only 1st Check		○				Check for damage to the end effector (hand) cable	Check whether the end effector connection cables are unevenly twisted or damaged. If damage is found, replace the damaged cables.	9
○	○						Check the joint cover (option)	If joint covers (option) are installed, clean them. Confirm there is no abrasion or the breakage. If they are broken, replace them by new articles. **⇒"6.2.4 Check and Clean the Joint Cover (option)"**	10
	○ Only 1st Check		○				Cleaning the grease around the wrist input gear	Clean the grease of the around of wrist input gear after removing cover. **⇒"6.2.5 Cleaning the Wrist Axis Rotation Part and the Wrist Gears"**	14
	○ 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.	17
		○					Supply grease to wrist input gears (M-1*i*A/0.5S/ 0.5A/0.5SL/0 .5AL)	Grease wrist input gear. **⇒"6.3.2 Applying the Grease of the Wrist Input Gears and Drive Shaft"**	12

Check and maintenance intervals (Period, Accumulated operating time)							Check and maintenance item	Check points, management and maintenance method	Periodic maintenance No.
1 month 320h	3 months 960h	6 months 1920h	1 year 3840h	1.5 years 5760h	2 years 7680h	4 years 15360h			
		○					Supply grease to Drive shafts (M-1*i*A/0.5S/ 0.5A/0.5SL/0 .5AL)	Supply grease to drive shafts. **⇒"6.3.2 Applying the Grease of the Wrist Input Gears and Drive Shaft"**	13
					○		Replacing the link B, washers and drive shafts	Replace the link B, washers and drive shafts.. Contact your local FANUC representative for information regarding replacing these parts.	15
			○ (*)	○ (*)			Replacing the batteries	Replace the mechanical unit batteries (*) Replacing interval differs depend on the mounting types. built-in batteries : 1 years (3840 hours) external batteries: 1.5 years (5760 hours) Regardless of operating time, replace batteries at these intervals. **⇒"6.3.1 Replacing the Batteries"**	11
						○	Replacing reducers etc.	Replace reducers, arm assemblies and the wrist unit. Contact your local FANUC representative for information regarding replacing these parts.	16
						○	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 MATE/R-30*i*B MATE Plus CONTROLLER MAINTENANCE MANUAL (B-83525EN) ・ R-30*i*B MATE CONTROLLER Open Air MAINTENANCE MANUAL (B-83555EN) ・ R-30*i*A MATE CONTROLLER MAINTENANCE MANUAL (B-82725EN) ・ For Europe R-30*i*A MATE CONTROLLER MAINTENANCE MANUAL (B-82725EN-1) ・ RIA R15.06-19999 COMPLIANT R-30*i*A MATE CONTROLLER MAINTENANCE MANUAL (B-82725EN-2) ・ R-30*i*A MATE CONTROLLER Open Air MAINTENANCE MANUAL (B-82965EN-1)	19

6.2 CHECK POINTS

6.2.1 Confirmation of Oil Seepage and Oil Accumulation

Check items

Check to see whether there is an oil seepage on the bearings. If there are oil contents, clean them.
Clean the accumulated oil on the lower side of the drive shaft (upper side of he universal joints).
(1 point for M-1*i*A/0.5S/0.5SL, 3 points for M-1*i*A/0.5A/0.5AL) (There is no drive shaft for M-1*i*A/1H/1HL.) Check the status such as abrasion on washers, the link B joint parts and drives shafts. (See Fig. 6.2.1 (a) to (c))

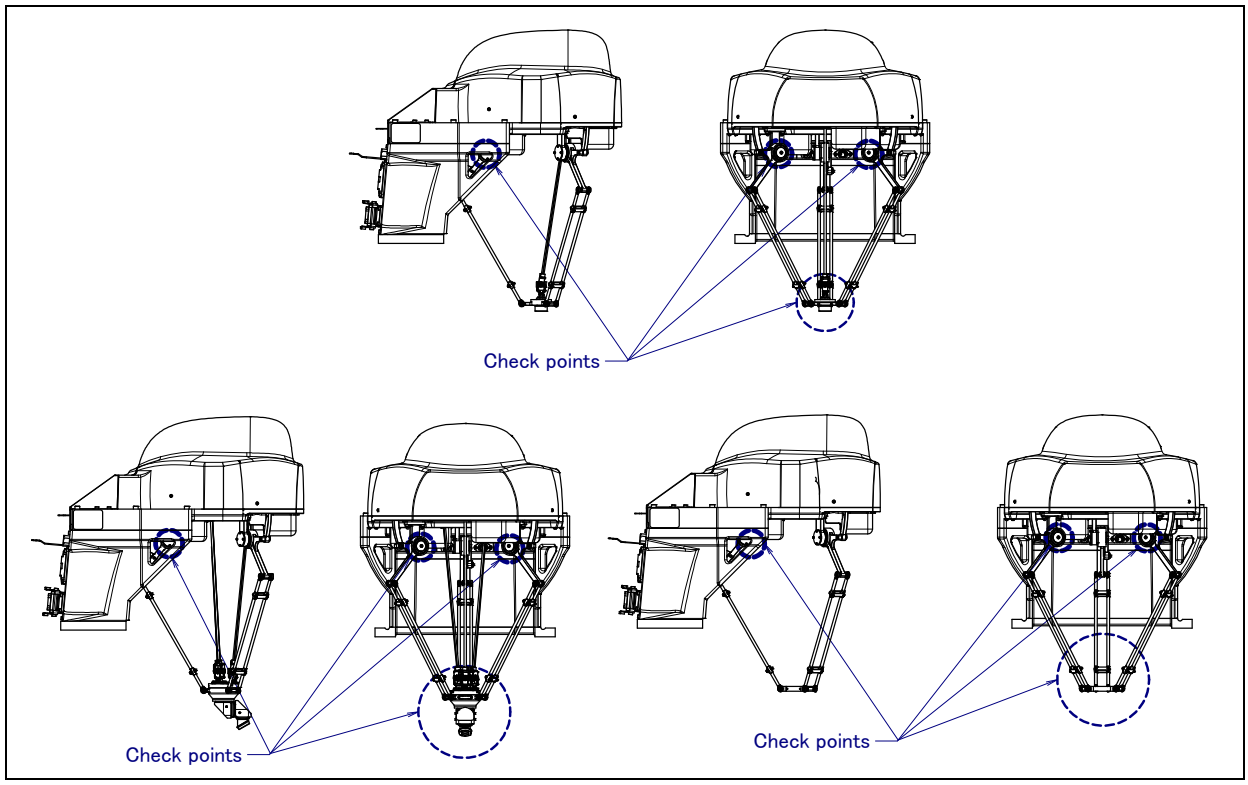


Fig. 6.2.1 (a) Check points of oil seepage

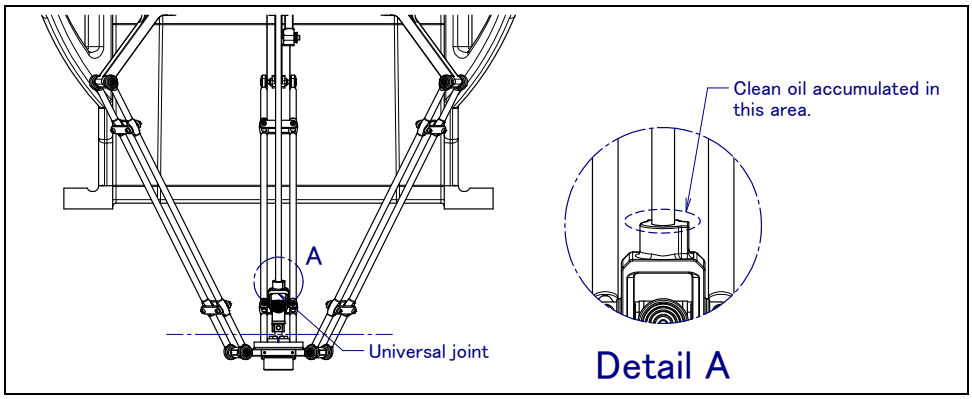


Fig. 6.2.1 (b) Cleaning parts of accumulated oil (example of M-1*i*A/0.5S J4-axis)

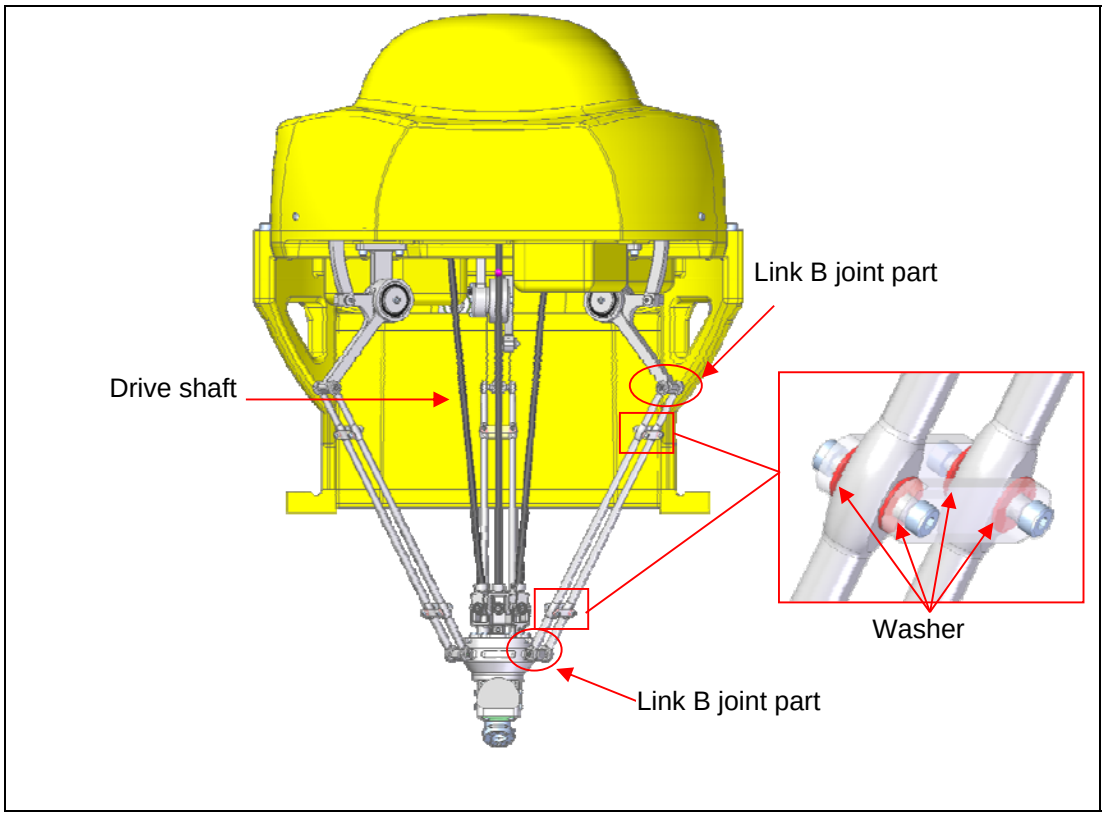


Fig. 6.2.1 (c) Check points of abrasion and rust

Check points

Washer (24 pcs)	: Abrasion・deformation・crack
Link B joint part (12 locations)	: Abrasion
Drive shaft (3 locations)	: Abrasion・rust

6.2.2 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 air pressure using the pressure gauge on the air control set as shown in Fig. 6.2.2 (a). If it does not meet the specified pressure of 0.49MPa (5 kgf/cm^2), adjust it using the regulator pressure setting handle.
2	Leakage from hose	Check the joints, tubes, etc. for leaks. Repair leaks, or replace parts, as required.
3	Drain	Check the drain and empty it. When the quantity of liquid in the drain is excessive, examine the setting of the air dryer on the air supply side.

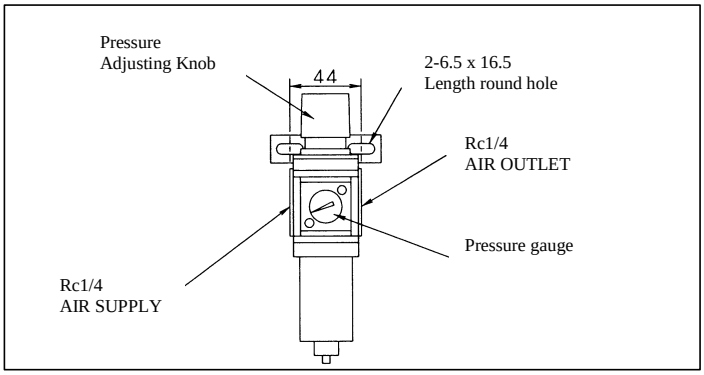


Fig. 6.2.2 (a) Air control set (option)

6.2.3 Retightening the Link B

Check the tightness of LINK B part (12 places), if they are loosened, remove the LOCTITE 243, then apply LOCTITE 243 on the thread and retighten them.

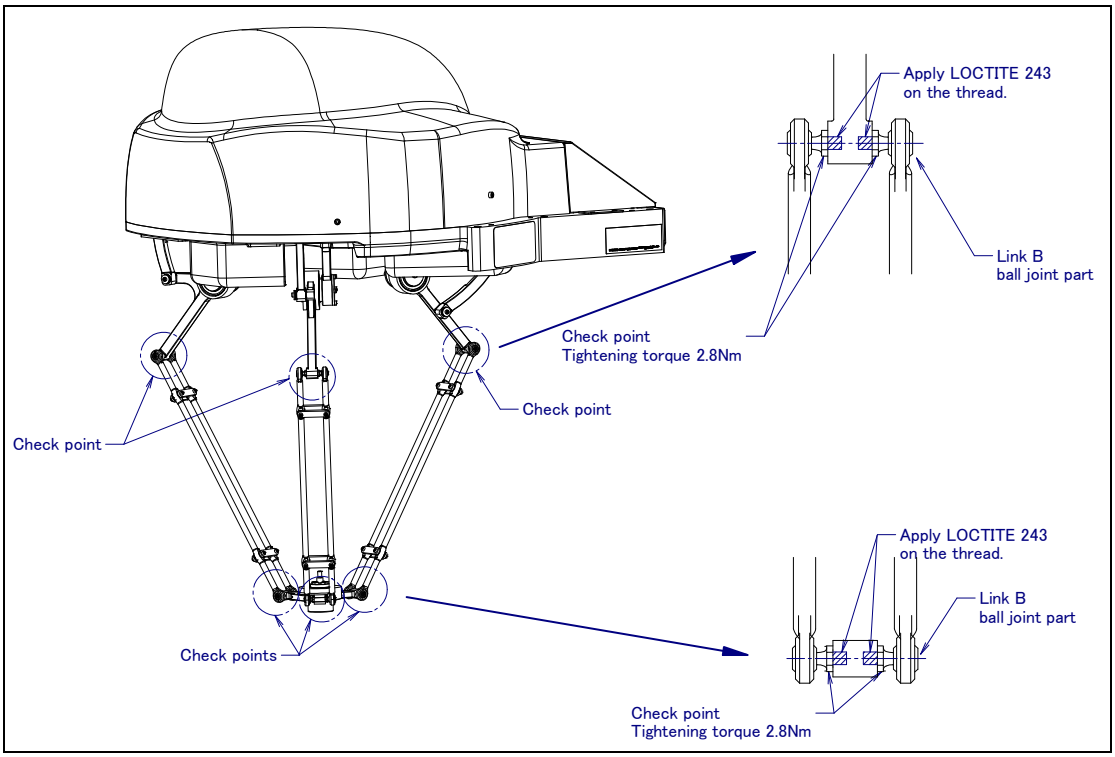


Fig. 6.2.3 (a) Checking points of LINK B

6.2.4 Check and clean the joint cover (OPTION)

If joint covers (option) are installed, clean them. Confirm there is no abrasion or the breakage. If they are broken, replace them by new articled.

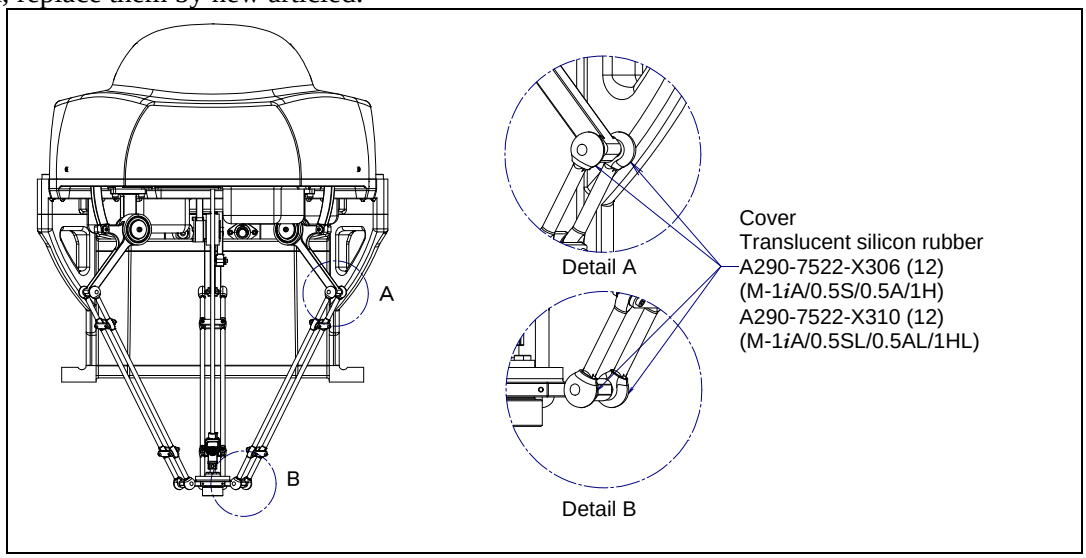


Fig. 6.2.4 (a) Check the joint cover (option)

6.2.5 Cleaning the Wrist Axis Rotation Parts and the Wrist Gears (M-1*i*A/0.5S/0.5A/0.5SL/0.5AL)

Cleaning points

Clean up the dirty splattered grease around the wrist axis rotation parts (except M-1*i*A/1H/1HL), gears and the gear cover.

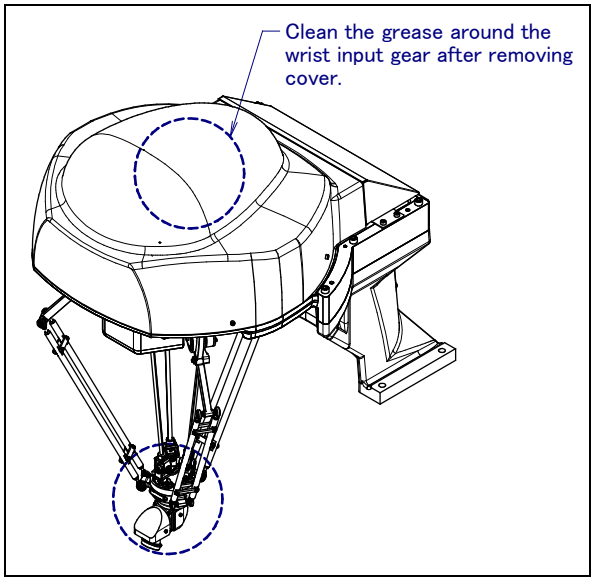


Fig. 6.2.5 (a) Cleaning points of the wrist axis rotation parts and the wrist gear

NOTE
When checking and cleaning the drive shafts, please be careful no to push the shaft on the drive shaft.

6.2.6 Check the Connectors

Inspection points of the connectors

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

Check items

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

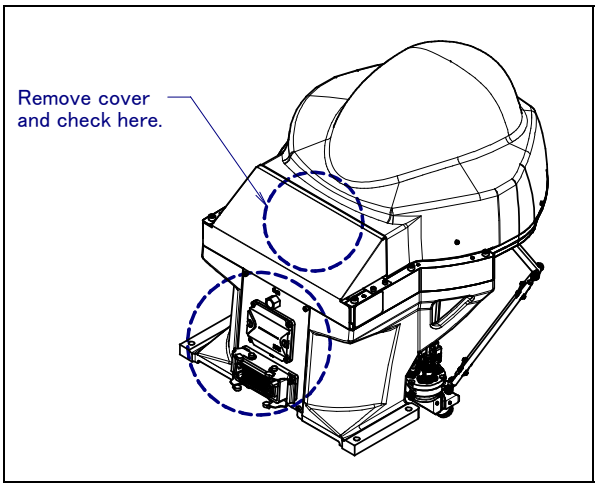


Fig. 6.2.6 (a) Connector Inspection points

6.3 MAINTENANCE

6.3.1 Replacing the Batteries (1-Year (3840 Hours) Maintenance (With Stand/No Stand B)) (1.5-Year (5760 Hours) Maintenance (No Stand A))

The position data of each axis is preserved by the backup batteries. The batteries need to be replaced every 1 year in case of with stand/no stand B 1.5 years in case of no stand A. Also, use the following procedure to replace them when the backup battery voltage drop alarm occurs.

Procedure of replacing the battery (with stand /no stand B)

1 Press the EMERGENCY STOP button to prohibit robot motion.

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

2 Remove the battery case cap. (Fig. 6.3.1 (a))
3 Take out the old batteries from the battery case.
4 Insert new batteries into the battery case. Pay attention to the direction of batteries.
5 Close the battery case cap.

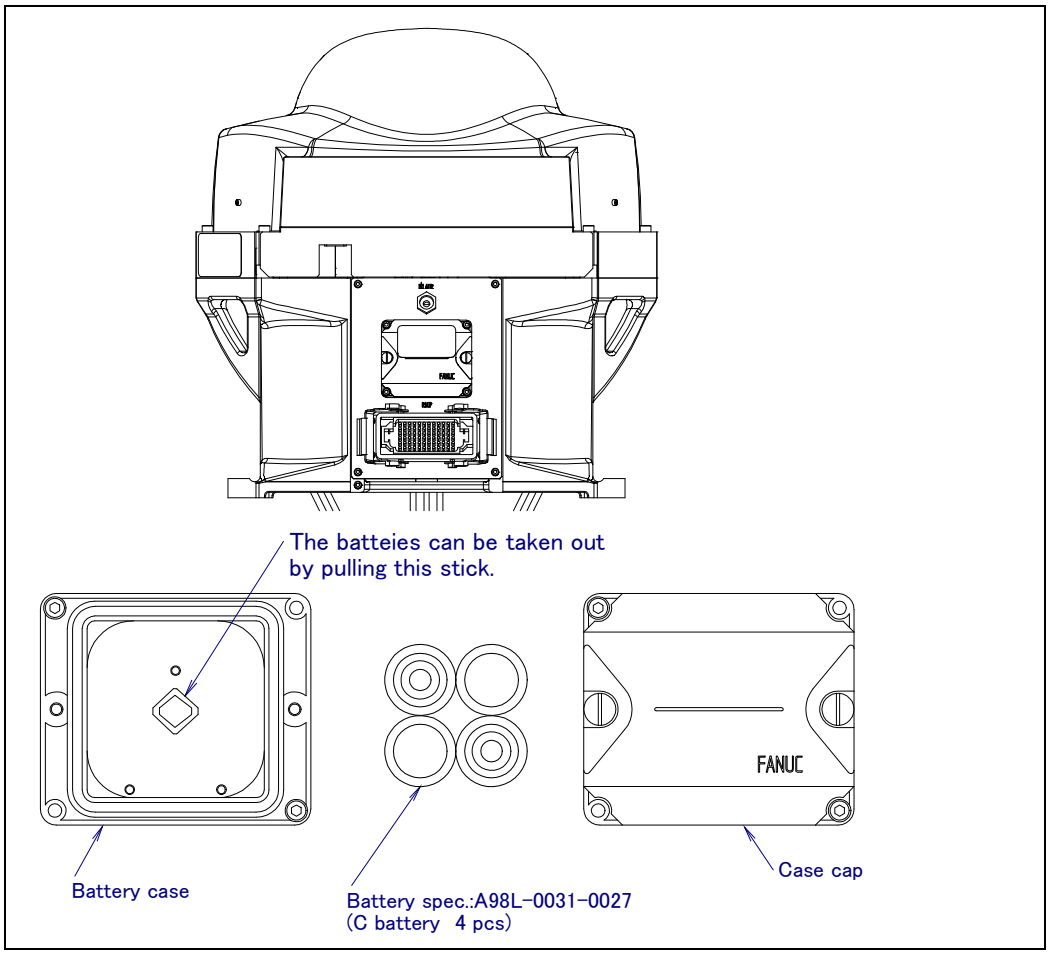


Fig. 6.3.1 (a) Replacing Batteries (with stand/no stand B)

Procedure of replacing the battery (no stand A)

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

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

2 Remove the battery case cap. (Fig. 6.3.1 (b))
3 Take out the old batteries from the battery case.
4 Insert new batteries into the battery case. Pay attention to the direction of batteries.
5 Close the battery case cap.

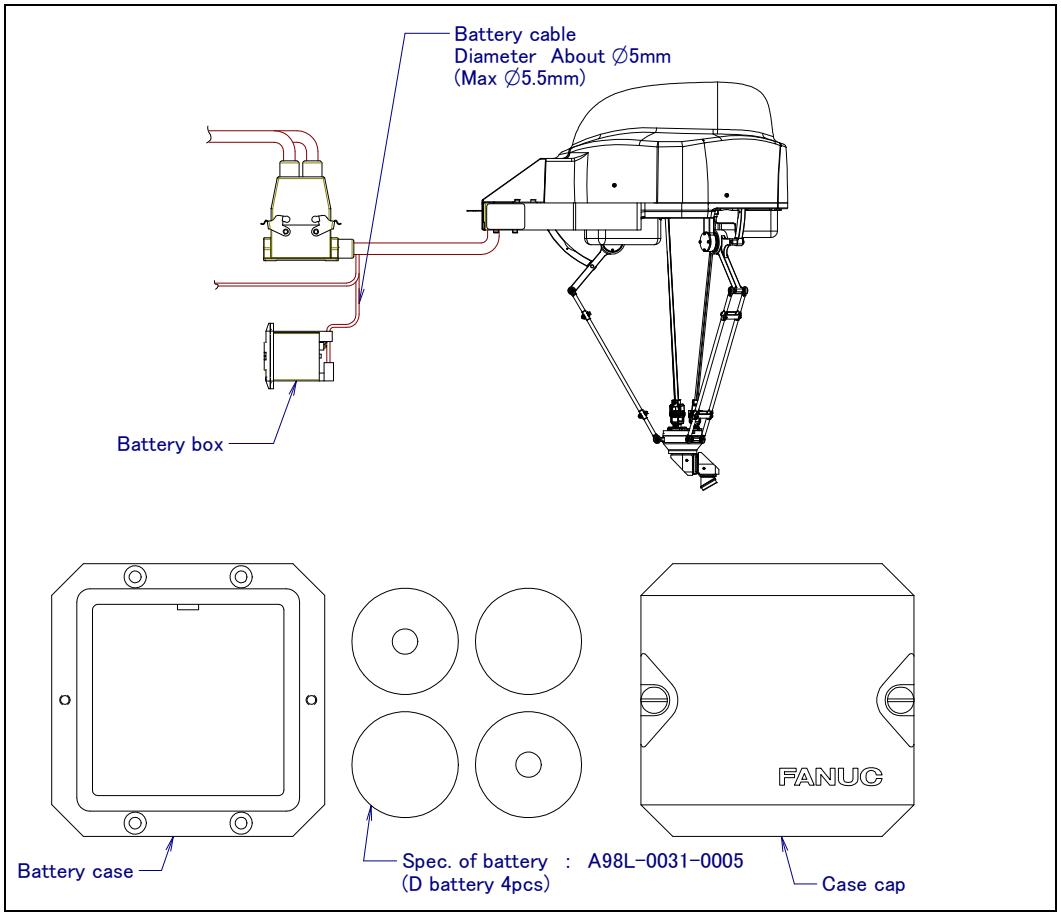


Fig. 6.3.1 (b) Replacing Batteries (no stand A)

Fig. 6.3.1 (c) shows the external size of external battery box.
When the battery box needs to be built into the controller or other internal units, refer to the external dimensions shown in Fig. 6.3.1 (c)
The battery box can be fixed by using M4 flat–head screws. (The bolts do not come with the system.)
A maximum of six terminals can be attached to the backplane of the battery box.

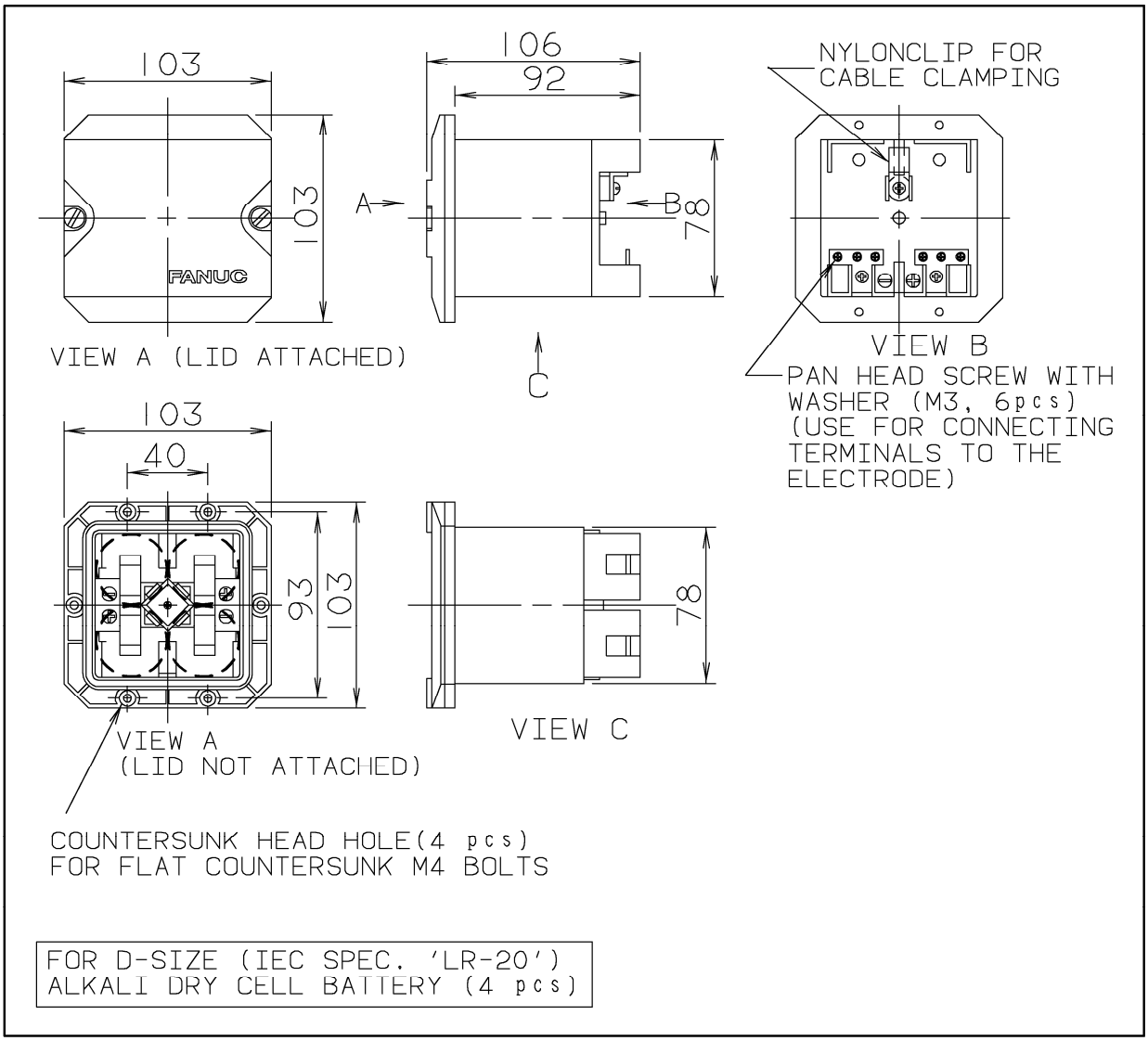


Fig. 6.3.1 (c) External dimensions of the battery box

6.3.2 Applying the Grease of the Wrist Input Gear and Drive Shaft (M-1*i*A/0.5S/0.5A/0.5SL/0.5AL) (6 months (1920 Hours) Maintenance)

Supply grease to wrist input gear and the drive shafts at the intervals recommended below based on every 6 months or 1920 hours, whichever comes first. See table 6.3.2 (a) for the grease name and the quantity.

Table 6.3.2 (a) Grease for 6-months (1920 hours) periodical replacement

Supply position	Quantity	Grease name
Wrist input gear	Proper quantity	JXTG Nippon Oil & Energy Corporation TOUGHLIX GREASE RB2 (old name: LCG335) Spec: A98L-0040-0252#0.4kg
Drive shafts	Proper quantity	

For grease replacement or replenishment, move the wrist to the stroke end of the upper side.

> ⚠ **CAUTION**
> Failure to follow proper lubrication procedures may cause the suddenly increase of the grease bath internal pressure and the damage to the seal, which could lead to grease leakage and abnormal operation. When greasing, observe the following cautions.
> 1 Use specified grease. Use of non-approved grease may damage the gear or lead to other problems.
> 2 To prevent slipping accidents and catching fire, completely remove any excess grease from the floor or robot.
> 3 When apply grease to the drive shaft, be careful not to push the shaft.

1 Turn off controller power.
2 Remove the cover.
3 Supply new grease to the gear of J4 to J6-axes referring to Fig. 6.3.2 (a).
In case of M-1iA/0.5S/0.5SL there are two places for J4-axis.
In case of M-1*i*A/0.5A/0.5AL there are six places for J4 to J6-axes.
4 Supply new grease to the drive shafts groove with a brush or a cylinder referring to Fig. 6.3.2 (b).
In case of M-1*i*A/0.5S/0.5SL there is one place for J4-axis.
In case of M-1*i*A/0.5A/0.5AL there are three places for J4 to J6-axes.
5 Clean up the dirty splattered grease around the gear and gear cover.
6 Attach the cover.

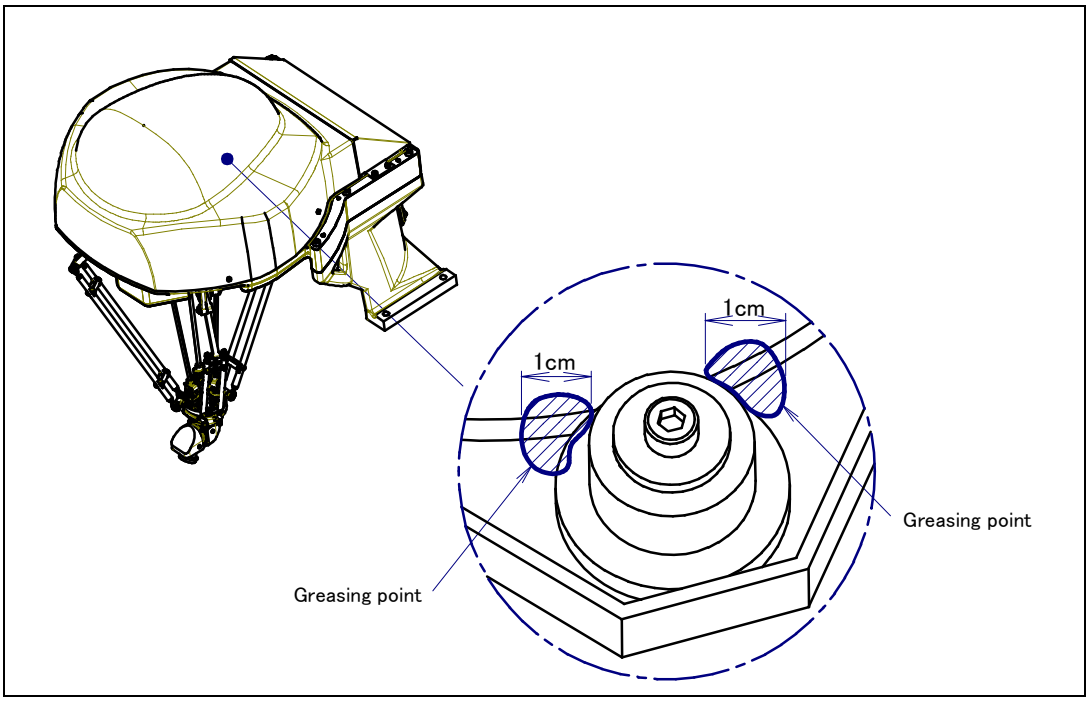


Fig. 6.3.2 (a) Supply grease to J4 to J6 gears

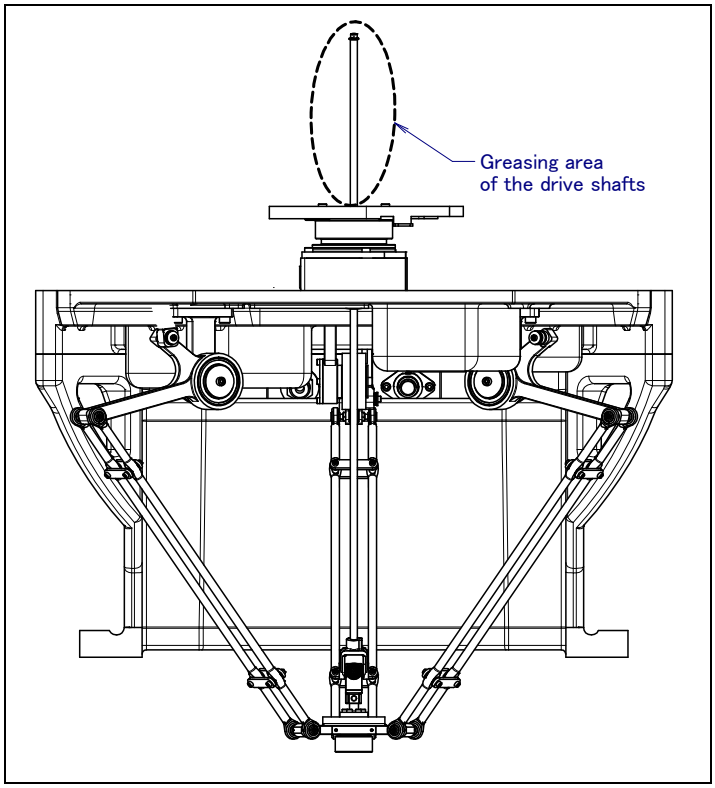


Fig. 6.3.2 (b) Supply grease to J4 to J6 drive shafts (example of J4-axis)

6.4 STORAGE

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

7 MASTERING

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

7.1 OVERVIEW

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

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

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

Types of Mastering

Table 7.1 (a) describes the following mastering methods. Note that "Quick Mastering for Single Axis" is not supported in software version 7DC2 (V8.20P) or earlier.

Table 7.1 (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.

Once performing the mastering, the positioning or the calibration are indispensable. The Positioning is a manipulation which recognize the robot current position loading the current pulse count.

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

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

7.2 RESETTING ALARMS AND PREPARING FOR MASTERING

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

Alarm displayed

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

Procedure

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

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

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

7.3 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. 7.3 (a) to (c)). This mastering is performed with all axes set at the 0-degree position using their respective witness marks.

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

Zero-position Mastering Procedure

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

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

 [ TYPE ]   LOAD   RES_PCA                DONE
```

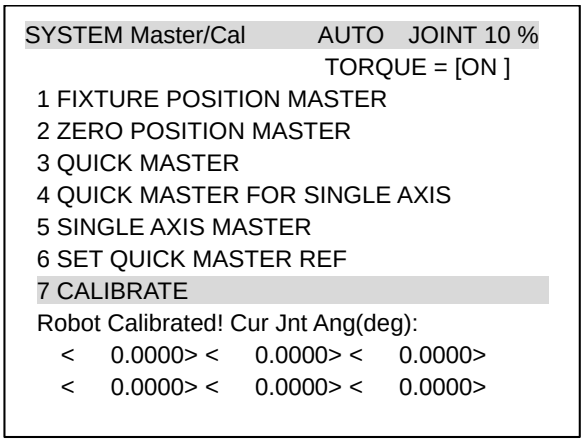
5 Release brake control, and jog the robot into a posture for mastering.

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

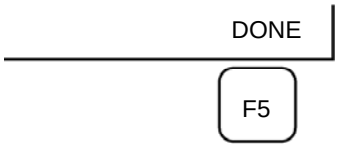
6 Select [2 ZERO POSITION MASTER]. Press F4 [YES].

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

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



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



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

Table 7.3 (a) Posture with zero-position marks (witness mark) aligned

Axis	Position
J1-axis	0 deg
J2-axis	0 deg
J3-axis	0 deg
J4-axis	0 deg
J5-axis	0 deg
J6-axis	0 deg

NOTE
There is no J5, J6-axis for M-1*i*A/0.5S/0.5SL
There is no J4, J5, J6-axis for M-1*i*A/1H/1HL

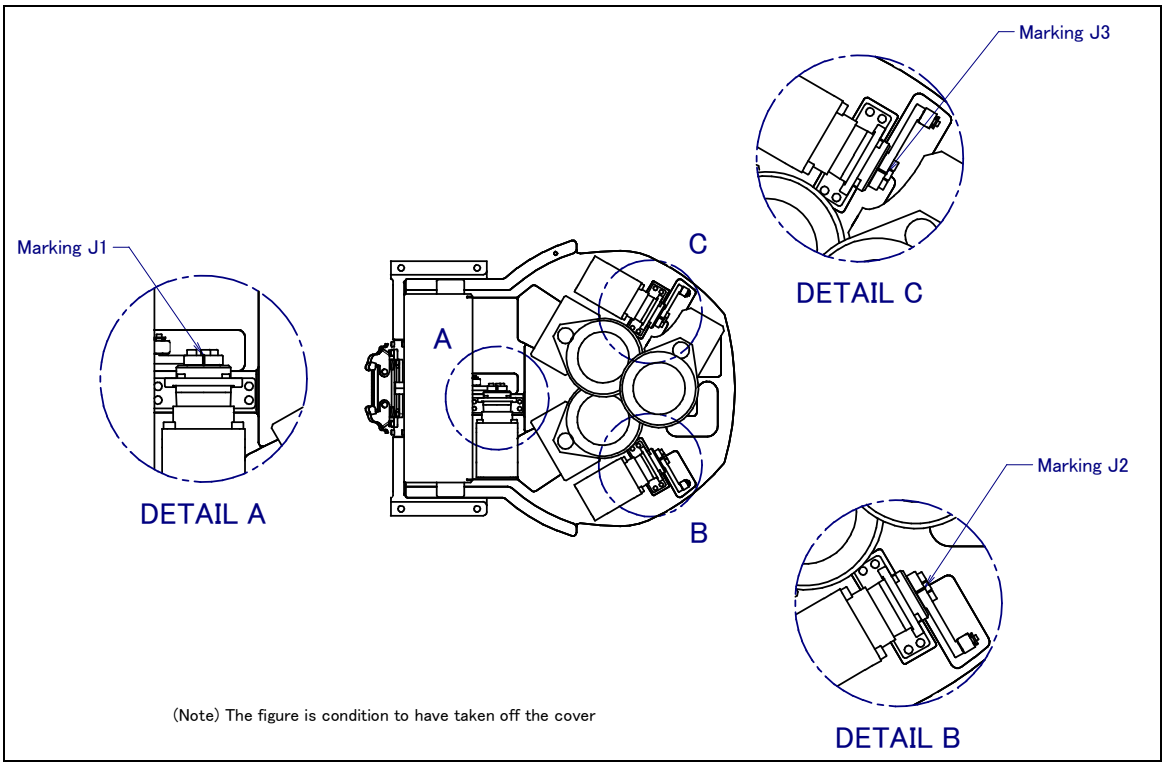


Fig. 7.3 (a) Zero-position mark (witness mark) for each axis (1/3)

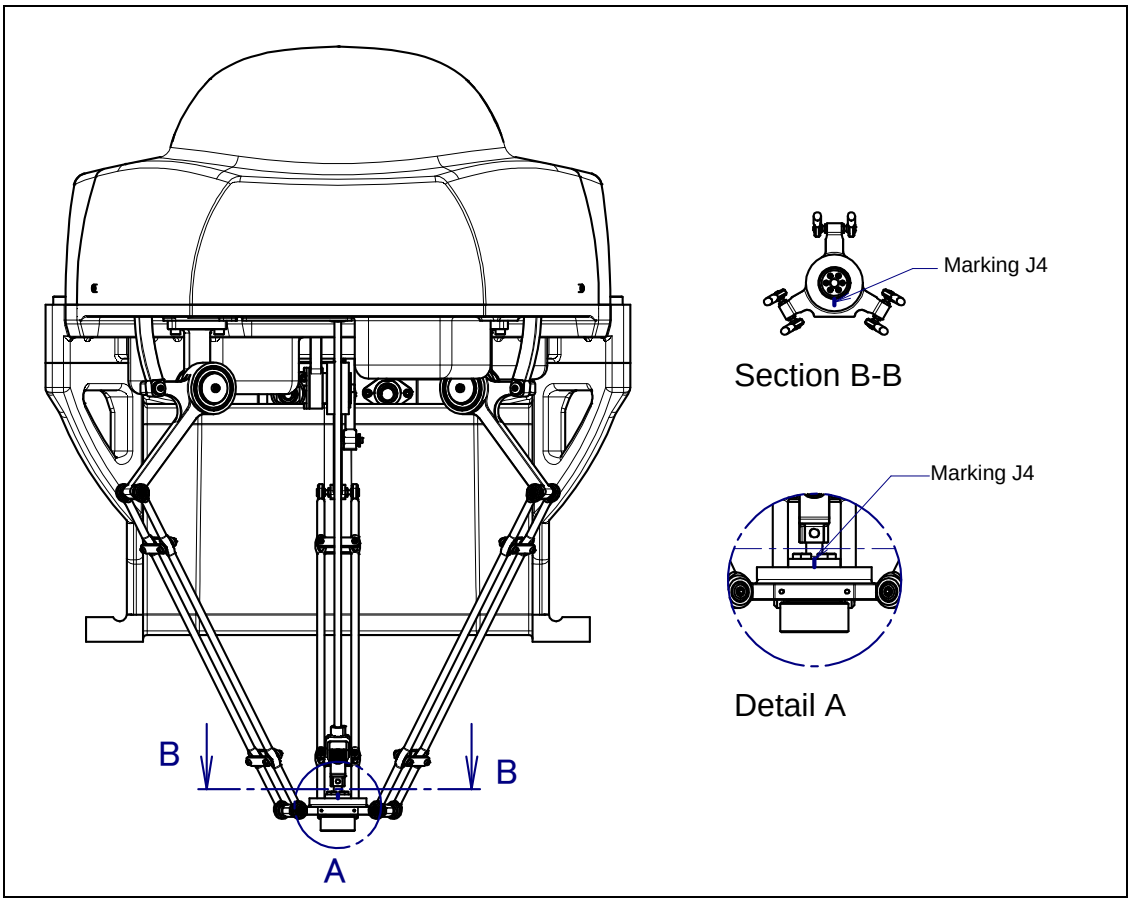


Fig. 7.3 (b) Zero-position mark (witness mark) for each axis (2/3) (M-1*i*A/0.5S/0.5SL)

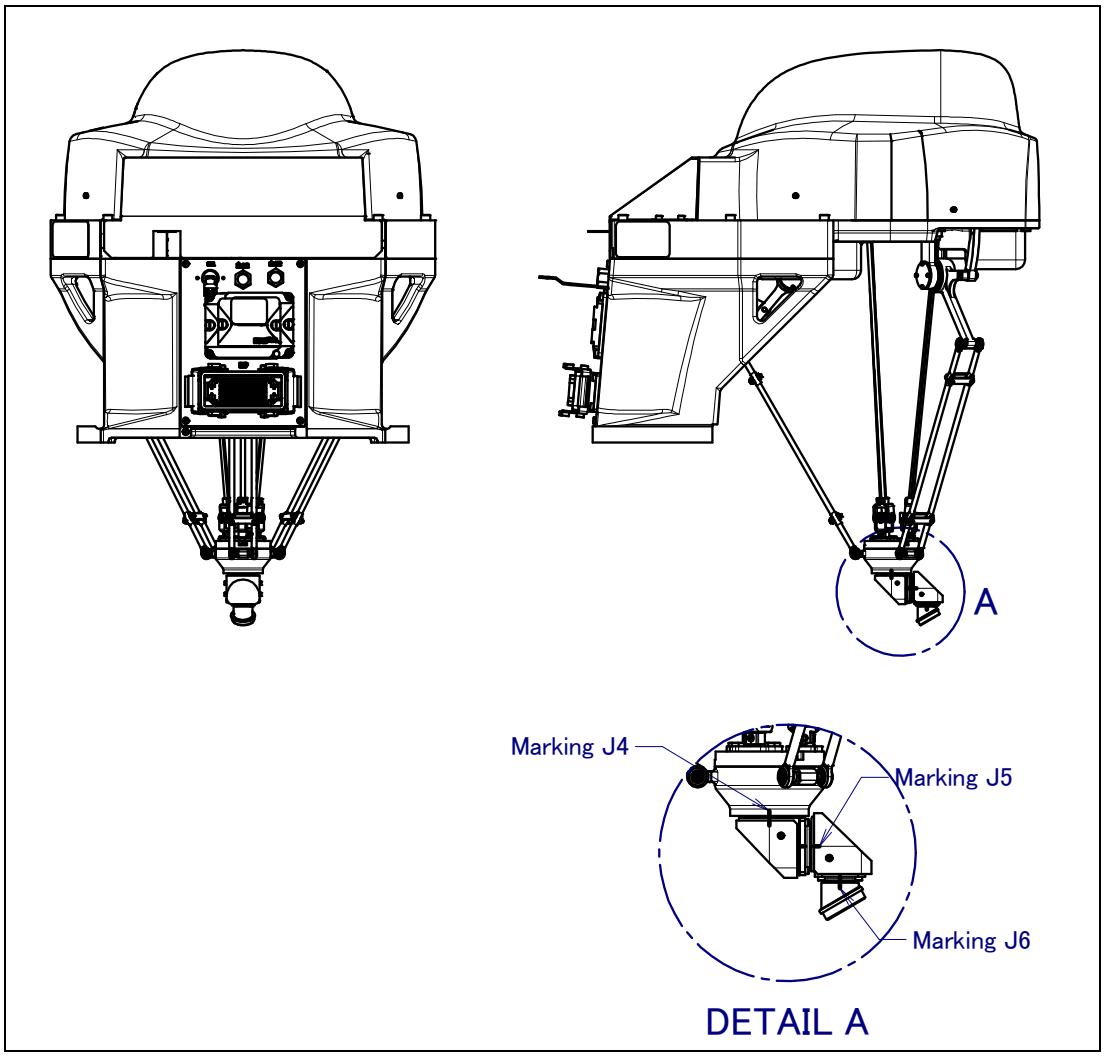


Fig. 7.3 (c) Zero-position mark (witness mark) for each axis (3/3) (M-1*i*A/0.5A/0.5AL)

7.4 QUICK MASTERING

Quick mastering is performed at a user-specified position for each 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 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 7.3. If possible, do not change the setting.

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

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

Procedure for Recording the Quick Mastering Reference Position

1 Select SYSTEM.
2 Select Master/Cal. Master/Cal screen will be displayed.

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

[ TYPE ]   LOAD   RES_PCA                DONE
```

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

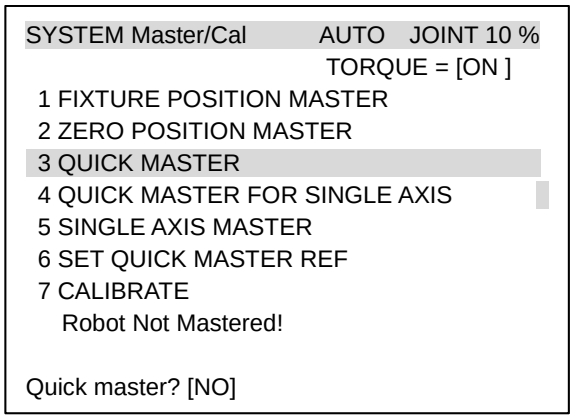
```
 5 SINGLE AXIS MASTER
 6 SET QUICK MASTER REF
 7 CALIBRATE
```

F4

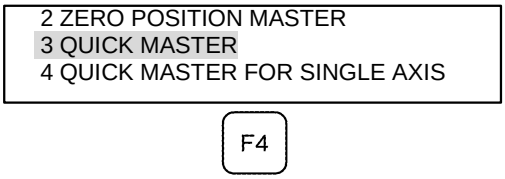
> ⚠ **CAUTION**
> If the robot has lost mastering data due to mechanical disassembly or repair, you cannot perform this procedure. In this case, perform Fixture position mastering or Zero position mastering to restore mastering data.

Procedure of Quick Mastering

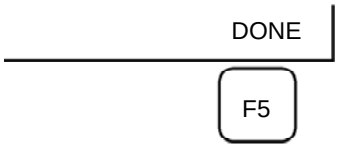
1 Display the Master/Cal screen.



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



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



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

7.5 QUICK MASTERING FOR SINGLE AXIS

Quick mastering for a single axis 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 fact that the absolute value of a rotation angle within one rotation will not be lost.

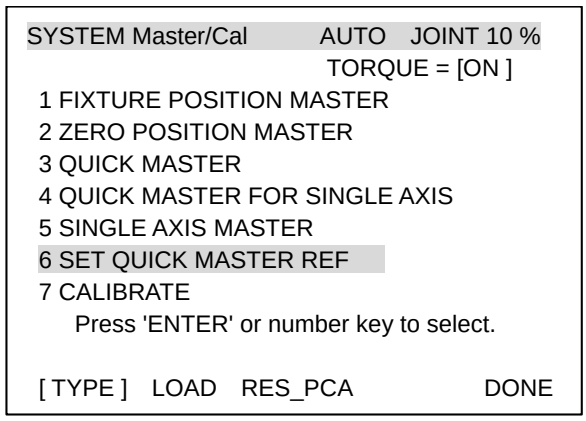
Quick mastering is factory-performed at the position indicated in Table 7.3. If possible, do not change the setting.

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

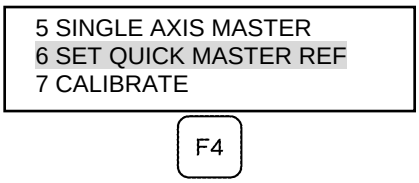
> ⚠ **CAUTION**
> 1 Quick mastering can be used, if the pulse count value is lost, for example, because a low voltage has been detected on the backup battery for the pulse counter.
> 2 Quick mastering cannot be used, after the Pulsecoder is replaced or after the mastering data is lost from the robot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

Procedure for Recording the Quick Mastering Reference Position

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



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



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

Procedure of Quick Mastering for single axis

1 Display the Master/Cal screen.

```
SYSTEM Master/Cal          AUTO   JOINT 10 %
                                  TORQUE = [ON ]
 1 FIXTURE POSITION MASTER
 2 ZERO POSITION MASTER
 3 QUICK MASTER
 4 QUICK MASTER FOR SINGLE AXIS
 5 SINGLE AXIS MASTER
 6 SET QUICK MASTER REF
 7 CALIBRATE
   Robot Not Mastered!

Quick master? [NO]
```

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

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

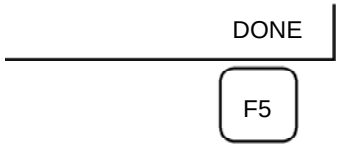
                                                EXEC
```

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

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

                                                EXEC
```

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



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

7.6 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.

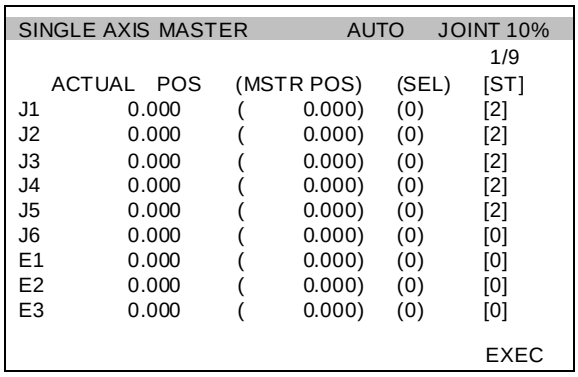


Table 7.6 (a) Items set in single axis mastering

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

Procedure of Single axis mastering

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

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

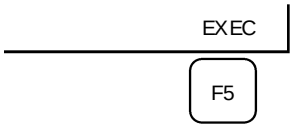
 [ TYPE ]  LOAD  RES_PCA              DONE
```

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

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

                                          EXEC
```

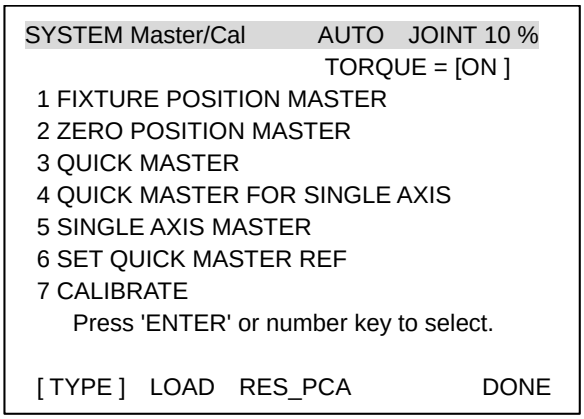
4 For the axis to which to perform single axis mastering, set (SEL) to “1.” Setting of [SEL] is available for one or more axes.
5 Turn off brake control, then jog the robot to the mastering position.
6 Enter axis data for the mastering position.
7 Press F5 [EXEC]. Mastering is performed. So, [SEL] is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




```
SINGLE AXIS MASTER          AUTO    JOINT 10%
                                          6/9
   ACTUAL  POS    (MSTR POS)    (SEL)   [ST]
J1        0.000   (     0.000)   (0)     [2]
J2        0.000   (     0.000)   (0)     [2]
J3        0.000   (     0.000)   (0)     [2]
J4        0.000   (     0.000)   (0)     [2]
J5        0.000   (     0.000)   (0)     [2]
J6       90.000   (     0.000)   (1)     [0]
E1        0.000   (     0.000)   (0)     [0]
E2        0.000   (     0.000)   (0)     [0]
E3        0.000   (     0.000)   (0)     [0]

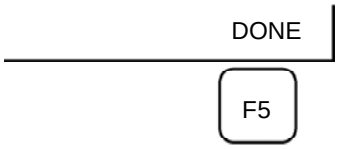
                                          EXEC
```

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



9 Select [7 CALIBRATE], then press F4 [YES]. Positioning is performed. Alternatively, turn off the controller power and on again. Positioning is performed.

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



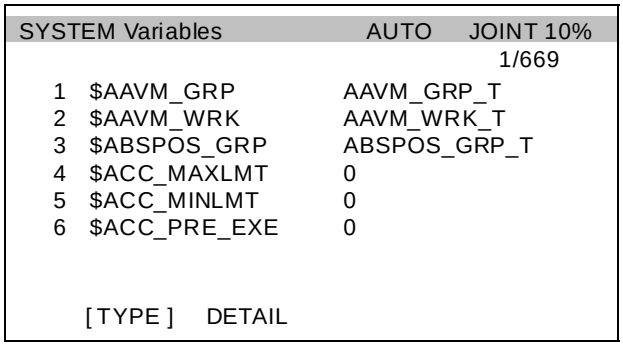
11 Return brake control to original setting, and cycle power of the controller.

7.7 MASTERING DATA ENTRY

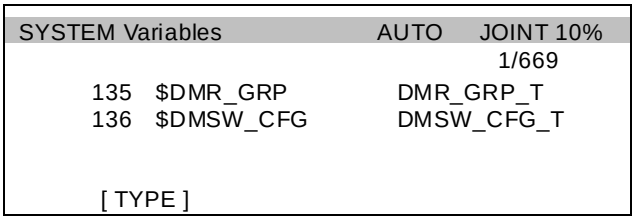
This function enables mastering data values to be assigned directly to a system variable. It can be used if mastering data has been lost but the pulse count is preserved.

Mastering data entry method

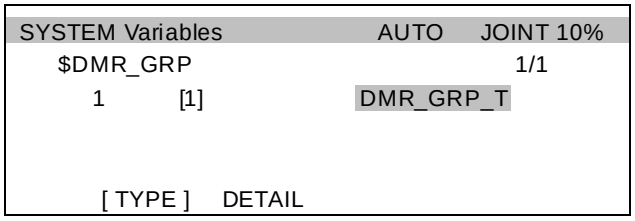
1 Press the [MENU] key, then press [0 NEXT] and select [6 SYSTEM].
2 Press F1 [TYPE]. Select [Variables]. The system variable screen will be displayed.

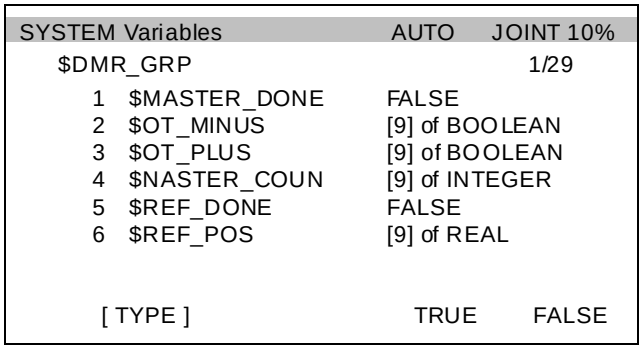


3 Change the mastering data. The mastering data is saved to the $DMR_GRP.$MASTER_COUN system variable.

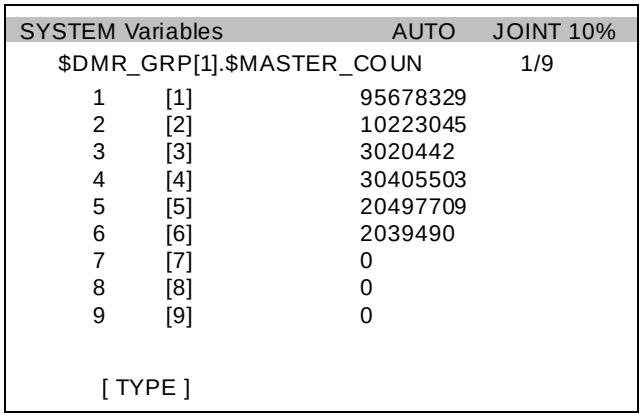


4 Select $DMR_GRP.

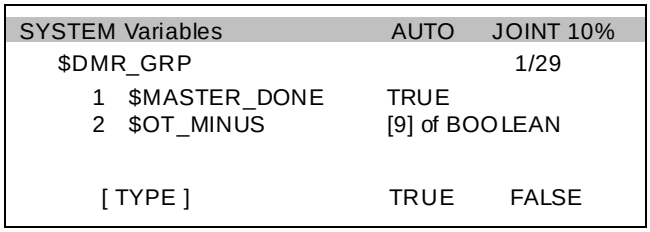




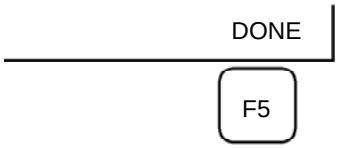
5 Select $MASTER_COUN, and enter the mastering data you have recorded.



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



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



7.8 VERIFYING MASTERING

1 How to verify that the robot is mastered properly:
Usually, positioning is performed automatically when the power is turned on. To check whether mastering has been performed correctly, examine if the current displayed position matches the actual robot position by using one or more of the procedures described below:
(1) Reproduce a particular point in a program. Check whether the point agrees with the specified position.
(2) Set all axes of the robot to their 0-degree (0 rad) positions. Check that the zero-degree position marks indicated in Section 7.3 are aligned. There is no need to use a visual aid.

If the displayed and actual positions do not match, the counter value for a Pulsecoder may have been invalidated as a result of an alarm 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 types displayed during mastering and their solution method:
(1) BZAL alarm
This alarm is displayed if the Pulsecoder's backup battery voltage decreases to 0 V while the power to the controller is disconnected. Furthermore, if the Pulsecoder connector is removed for cable replacement, etc. this alarm is displayed as the voltage decreases to 0. Check to see if the alarm will disappear by performing a pulse reset (See Section 7.2.). Then, cycle controller power and check if the alarm disappears or not.
The battery may be drained if the alarm is still displayed. Perform a pulse reset, and turn off and on the controller power after replacing the battery. Note that, if this alarm is displayed, all the original data held by the Pulsecoder will be lost. Mastering is required.
(2) BLAL alarm
This alarm is displayed if the voltage of the Pulsecoder's backup battery has fallen to a level where backup is no longer possible. If this alarm is displayed, replace the battery with a new one immediately while keeping the power turned on. Check whether the current position data is valid, using the procedure described in 1.
(3) Alarm notification like CKAL, RCAL, PHAL, CSAL, DTERR, CRCERR, STBERR, and SPHAL may have trouble with Pulsecoder, contact your local FANUC representative.

8 TROUBLESHOOTING

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

8.1 TROUBLESHOOTING

Table 8.1 (a) shows the problems that may occur in the mechanical unit and their probable causes. If you cannot pinpoint the cause of a failure or which measures to take, contact your local FANUC representative.

Table 8.1 (a) TROUBLESHOOTING

Symptom	Description	Cause	Measure
Vibration Noise	- The base or pedestal lifts off the floor plate as the robot operates. - There is a gap between the base or pedestal and floor plate. - A base or stand retaining bolt is loose.	[Base or pedestal fastening] - It is likely that the robot base or pedestal 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 floor plate and floor plate. - If the robot is not securely fastened to the floor plate, the base or pedestal lifts the floor plate as the robot operates, allowing the base or pedestal 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 matter between the base or pedestal 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 reinforcing the rack or floor is impossible, modify the robot control program; doing so might reduce the amount of vibration.

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

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

Symptom	Description	Cause	Measure
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 - Base retaining bolt - Arm retaining bolt - Casting retaining bolt - End effecter retaining bolt
	- There is lost motion in the bearing of a joint	[Damage to the bearing, release of the pre-load] - A probable cause is that excessive force was applied to the bearing of the joint due to impact or overload, damaging the bearing or releasing the pre-load.	- Check the movement of the joints during operation to identify the faulty joint. - Remove each leg, move the top and bottom joints manually to check whether the bearings are damaged and whether there is lost motion. If a bearing is damaged or the pre-load is released, replace the unit containing the joint. This problem can be avoided by avoiding use at overload.

Symptom	Description	Cause	Measure
Motor over-heating	- The motor overheated due to a rise in temperature in the installation area. - After changing the Robot control program or the load, the motor overheated.	[Ambient temperature] - It is likely that the motor overheated when the ambient temperature rose, and could not dissipate the heat. [Operating condition] - It is likely that the overcurrent is above the specified permissive average current.	- Reducing the ambient temperature is the most effective means of preventing overheat. - If there is a source of heat near the motor, it is advisable to install shielding to protect the motor from heat radiation. - Relaxing the robot control program and load condition is an effective way to reduce the average current. Thus, prevent overheating. - The teach pendant can monitor the average current. Check the average current when the robot control program launched.
	- After a control parameter (load setting etc.) was changed, the motor overheated.	[Parameter] - If data input for a workpiece is invalid, the robot cannot be accelerate or decelerate normally, so the average current increases, leading to the motor overheating.	- As for load setting, Input an appropriate parameter referring to Section 4.2.
	- 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	- Grease is leaking from the mechanical unit.	[Poor sealing] - Probable causes are a crack in the casting, 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 oil seal might be damaged if extraneous dust scratches the lip of the oil seal.	- If a crack develops in the casting, sealant can be used as a quick-fix to prevent further grease leakage. However, the component should be replaced as soon as possible, because the crack might extend. - Oil seals are used in the locations stated below. - Inside the reducer - Inside of the wrist
Dropping axis	- An axis falls because the brake went out. - An axis falls while standing still.	[Brake drive relay and motor] - It is likely that brake drive relay contacts are stuck to each other and keep the brake current flowing, thus preventing the brake from operating when the motor is reenergized. - It is likely that the brake shoe has worn out or the brake main body is damaged, preventing the brake from operating efficiently. - It is likely that oil or grease soak through the motor, causing the brake to slip.	- Check whether the brake drive relays are stuck to each other or not. If they are found to be stuck, replace the relays. - Replace the motor after confirming whether the following symptoms have occurred. - Brake shoe is worn out - Brake main body is damaged - Oil soaked through the motor

Symptom	Description	Cause	Measure
Displacement	- The robot moves to 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 reoccur unless another collision occurs. - If the Pulsecoder is faulty, replace the motor.
	- Displacement occurs only in specific peripheral equipment.	[Peripheral equipment displacement] - It is likely that an external force was applied to the peripheral equipment, thus shifting its position relative to the robot.	- Correct the setting of the peripheral equipment position. - Correct the taught program.
	- Displacement occurred after a parameter was changed.	[Parameter] - It is likely that the mastering data was 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.

APPENDIX

A PERIODIC MAINTENANCE TABLE

FANUC Robot M-1*i*A Periodic Maintenance Table

Items			Check time	Grease amount	First check 320	3 months 960	6 months 1920	9 months 2880	1 year 3840	4800	5760	6720	2 years 7680	8640	9600	10560
		Accumulated operating time (H) / Cycle count *4	—	—		3455	6910k	10365k	13820k	17275k	20730k	24185k	27640k	31095k	34550k	38005k
Mechanical unit	1	Check for external damage or peeling paint	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	2	Check for water	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	3	Check the exposed connector (Loosening)	0.2H	—		○			○				○			
	4	Tighten the end effector bolt	0.2H	—		○			○				○			
	5	Tighten the cover and main bolt.	2.0H	—		○			○				○			
	6	Retighten the LINK B mounting part	0.2H	—	○	○	○	○	○	○	○	○	○	○	○	○
	7	Check the wear of the LINK B ball joint part	0.2H	—	○	○	○	○	○	○	○	○	○	○	○	○
	8	Remove dust, powder etc.	1.0H	—		○			○				○			
	9	Check the end effector (hand) cable	0.1H	—		○			○				○			
	10	Check the joint cover	0.1H	—	○	○	○	○	○	○	○	○	○	○	○	○
	11	Replacing battery. (With stand/no stand B) (*5)	0.1H	—					●				●			
		Replacing battery. (No stand A) (*5)	0.1H	—							●					
	12	Supply grease to wrist input gears (*1)	0.5H	Proper quantity			●		●		●		●		●	
	13	Supply grease to drive shafts (*1)	0.5H	Proper quantity			●		●		●		●		●	
	14	Clean the around of wrist input gear (*1)	0.1H	—		○	○		○		○		○		○	
	15	Replacing the link B, washers and the drive shaft	1.0H	—									●			
	16	Replacing reducers etc.	4.0H													
Controller	17	Check the robot cable, teach pendant cable and robot connecting cable	0.2H	—		○			○				○			
	18	Cleaning the controller ventilation system	0.2H	—	○	○	○	○	○	○	○	○	○	○	○	○
	19	Replacing battery (*2)(*5)	0.1H	—												

*1 M-1*i*A/1H/1HL does not have the wrist input gear

*2 Refer to the following manuals.
R-30*i*A Mate Controller Maintenance Manual (B-82725EN)
For Europe R-30*i*A Mate Controller Maintenance Manual (B-82725EN-1)
RIA R15.06-1999COMPLIANT R-30*i*A Mate Controller Maintenance Manual (B-82725EN-2)
R-30*i*A Mate Controller Open Air Maintenance Manual (B-82965EN-1)
R-30*i*B Mate/ R-30*i*B Mate Plus Controller Maintenance Manual (B-83525EN)
R-30*i*B Mate Controller Maintenance Manual (B-83555EN)

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

*4 If the hand for multiple work is used and picking (placing) motion is required at each work, make the picking (placing) times to be cycle count.

*5 Regardless of the operating time, replace the mechanical unit batteries at 1 year or 1.5 year, replace controller batteries at 4 years.

3 years 11520	12480	13440	14400	4 years 15360	16320	17280	18240	5 years 19200	20160	21120	22080	6 years 23040	24000	24960	25920	7 years 26880	27840	28800	29760	8 years 30720	Item
41460k	44915k	48370k	51825k	55280k	58735k	62190k	65645k	69100k	72555k	76010k	79645k	82920	86375k	89830k	93285k	96740k	100195k	103650k	107105k		
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		1
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		2
○				○				○				○				○					3
○				○				○				○				○					4
○				○				○				○				○					5
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		6
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		7
○				○				○				○				○					8
○				○				○				○				○					9
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		10
●				●				●				●				●					11
●						●						●						●			
●		●		●		●		●		●		●		●		●		●			12
●		●		●		●		●		●		●		●		●		●			13
○		○		○		○		○		○		○		○		○		○			14
				●								●									15
				●																	16
○				○				○				○				○					17
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		18
				●																	19

Overhaul

B PERIODIC MAINTENANCE PARTS

Contact your local FANUC representative for replacing procedure.

(a) Replacing parts at 2 years (7680 hours)

We recommend replacing the following parts at the intervals based on every 2 years or 7680 hours, whichever comes first.

Item	Parts	Specification	0.5S	0.5SL	0.5A	0.5AL	1H	1HL
1	Link B	A290-7522-V301	6	-	6	-	6	-
		A290-7522-V302	-	6	-	6	-	6
2	Washer	A290-7522-X305	24					
3	Drive shaft	A290-7522-V403	1	-	3	-	-	
		A290-7522-V406	-	1	-	3		

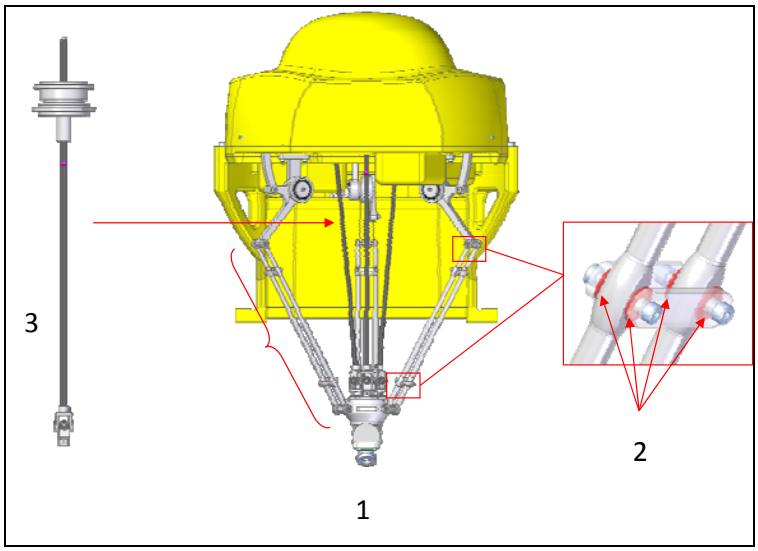


Fig. B (a) Periodic replacing parts (1/2)

(b) Replacing parts 4 years (15360 hours)

We recommend replacing the following parts at the intervals based on every 4 years or 15360 hours, whichever comes first.

Item	Parts	Specification	0.5S	0.5SL	0.5A	0.5AL	1H	1HL
4	Reducer	A97L-0218-0872#45	3					
5	J1 arm assembly	A290-7522-V202	1	-	1	-	1	-
		A290-7522-V206	-	1	-	1	-	1
6	J2 arm assembly	A290-7522-V203	1	-	1	-	1	-
		A290-7522-V207	-	1	-	1	-	1
7	J3 arm assembly	A290-7522-V204	1	-	1	-	1	-
		A290-7522-V208	-	1	-	1	-	1
8	Wrist unit	A290-7522-T501	1		-		-	
		A290-7522-T502	-		1			

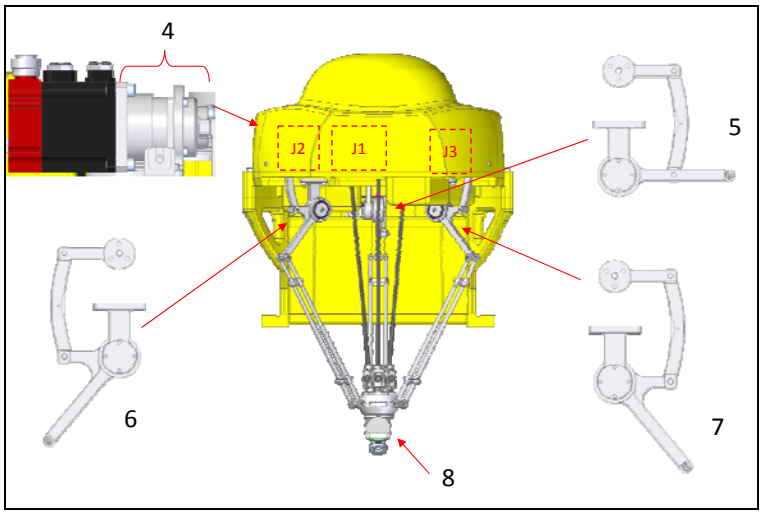


Fig. B (b) Periodic replacing parts (2/2)

Under the high speed and acceleration operation or the dusty and misty environment, the deterioration of parts may make progress quickly. Under such the condition and environment, the replacement intervals should be shortened.

C MOUNTING BOLT TORQUE LIST

NOTE

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

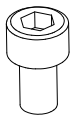
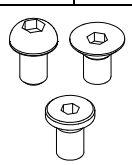
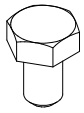
Use the following strength bolts. Comply with any bolt specification instructions.
Hexagon socket head bolt made of steel:

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

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

Refer to the following tables if the bolts tightening torque is not specified.

Recommended bolt tightening torques **Unit: Nm**

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

INDEX

REVISION RECORD

Edition	Date	Contents
10	Jul, 2019	• Addition of Checks and Maintenance items • Correction of errors
09	Jul, 2017	• Addition of R-30*i*B Mate Plus Controller • Correction of errors
08	Dec., 2015	• Addition of quick master for single axis • Correction of errors
07	Feb., 2014	• Addition of M-1*i*A/0.5SL/0.5AL/1HL • Correction of errors
06	Jul., 2013	• Addition of R-30*i*B Mate Controller • Addition of M-1*i*A/1H • Addition of joint cover option • Correction of errors
05	Jan., 2012	• Addition of stand B • Addition of check of oil seepage • Correction of errors
04	Nov., 2010	• Addition of stop type of robot • Addition of stopping time and distance when controlled stop is executed • Addition of method of piping and wiring • Correction of errors
03	Mar., 2010	• Addition of 1kg payload option • Addition of solenoid valve option
02	Dec., 2009	• Addition of check of LINK B • Correction of errors
01	Aug., 2009	

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