FANUC Robot M-3*i*A

MECHANICAL UNIT
OPERATOR'S MANUAL

B-83154EN/07

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- **Original Instructions**

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

- No part of this manual may be reproduced in any form.
- All specifications and designs are subject to change without notice.

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

SAFETY PRECAUTIONS

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

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

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

1 PERSONNEL

Personnel can be classified as follows.

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

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

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

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

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

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

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

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

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

2 DEFINITION OF SAFETY NOTATIONS

To ensure the safety of users and prevent damage to the machine, this manual indicates each precaution on safety with "**WARNING**" or "**CAUTION**" according to its severity. Supplementary information is indicated by "**NOTE**". Read the contents of each **"WARNING"**, "**CAUTION**" and "**NOTE**" before using the robot.

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

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

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

Name	Specification
Brake release unit	A05B-2660-J350 (Input voltage AC100-115V single phase) A05B-2660-J351 (Input voltage AC200-240V single phase)
Robot connection cable	A05B-2660-J360 (5m) A05B-2660-J361(10m)
Power cable	A05B-2660-J010 (5m) (AC100-115V Power plug) (*) A05B-2660-J011(10m) (AC100-115V Power plug) (*) A05B-2660-J364 (5m) (AC100-115V or AC200-240V No power plug) A05B-2660-J365(10m) (AC100-115V or AC200-240V No power plug)

(*) These do not support CE marking.

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

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

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

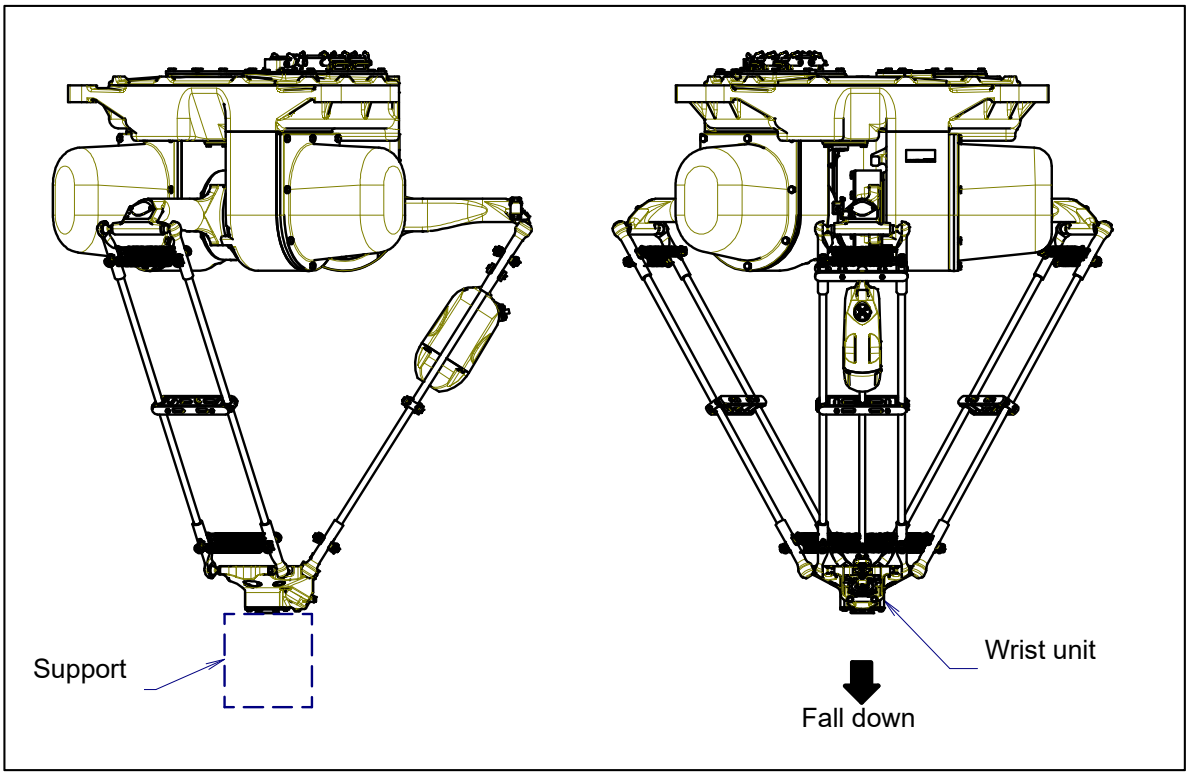


Fig. 3 (a) Arm operation by the release of motor brake and measures

4 PRECAUTIONS FOR MECHANISM

In case of M-3*i*A, excessive collision or excessive overload sometimes causes link disconnection for minimizing the damage. Please contact your local FANUC representative when link disconnection occurred. Suddenly stop may cause link disconnection, too. When you operate stop signal from the outside, make circuit so that robot stops by Controlled stop firstly and Power-Off stop is operated after robot stops. (Refer to “STOP TYPE OF ROBOT” in SAFETY HANDBOOK (B-80687EN)

5 WARNING & CAUTION LABEL

(1) Transportation label

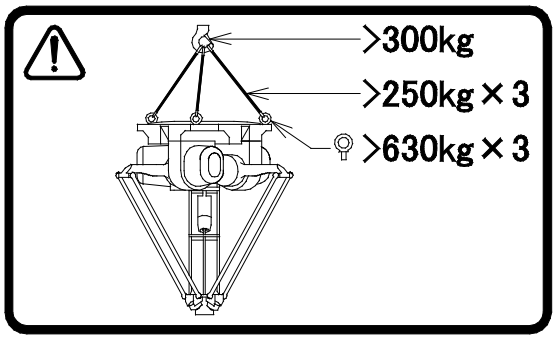


Fig. 5 (a) Transportation Label

Description

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

- Use a crane with a load capacity of 300 kg or greater.
- Use three slings with each load capacity of 250 kg.
- Use three eyebolts with each load capacity of 6174 N (630 kgf).

(2) Transportation prohibitive label

Fig. 5 (b) Transportation prohibitive label

Description

Keep the following in mind when transporting the robot.

- Do not pull eyebolts sideways.

(3) Operation space and load capacity label

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

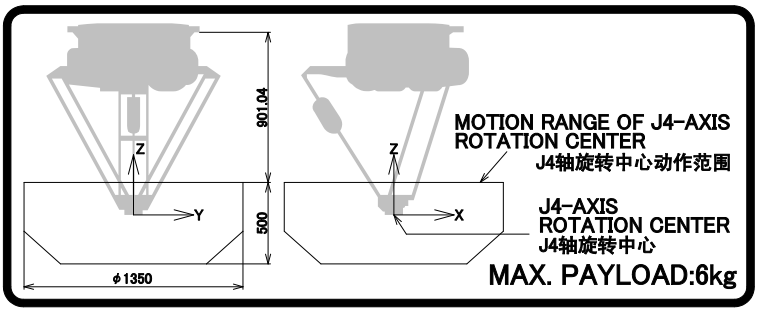


Fig.5 (c) Operation space and load capacity label (Example of M-3*i*A/6S (A05B-1523-B203))

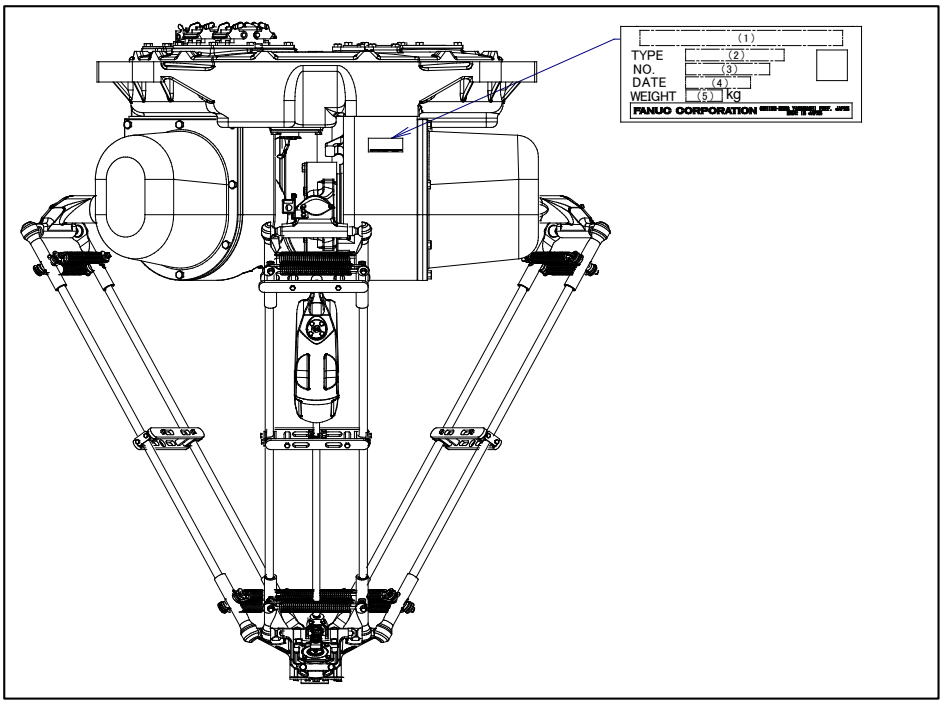
PREFACE

This manual explains maintenance procedures for the following mechanical units:

Model name	Mechanical unit specification No.	Maximum load
FANUC Robot M-3*i*A/6S	A05B-1523-B201	6kg
FANUC Robot M-3*i*A/6A	A05B-1523-B202	
FANUC Robot M-3*i*A/6S	A05B-1523-B203	6 kg (8 kg (NOTE))
FANUC Robot M-3*i*A/12H	A05B-1523-B204	12kg

NOTE
When 8 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)
CONTENTS	**MODEL NAME**	**TYPE**	**No.**	**DATE**	**WEIGHT kg (without controller)**
LETTERS	FANUC Robot M-3*i*A/6S	A05B-1523-B201	SERIAL NO. IS PRINTED	PRODUCTION YEAR AND MONTH ARE PRINTED	160
	FANUC Robot M-3*i*A/6A	A05B-1523-B202			175
	FANUC Robot M-3*i*A/6S	A05B-1523-B203			160
	FANUC Robot M-3*i*A/12H	A05B-1523-B204			155

RELATED MANUALS

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

Safety handbook B-80687EN All persons who use the FANUC Robot and system designer must read and understand thoroughly this handbook		Intended readers: Operator, system designer Topics: Safety items for robot system design, operation, maintenance
R-30*i*A controller	Setup and Operations manual HANDLING TOOL B-83124EN-2 ALARM CODE LIST B-83124EN-6	Intended readers: Operator, programmer, maintenance technician, system designer Topics: Robot functions, operations, programming, setup, interfaces, alarms Use: Robot operation, teaching, system design
	Maintenance manual B-82595EN B-82595EN-1 (For Europe) B-82595EN-2 (For RIA)	Intended readers: Maintenance technician, system designer Topics: Installation, start-up, connection, maintenance Use: Installation, start-up, connection, maintenance
R-30*i*A Mate controller	Operations manual LR HANDLING TOOL B-83134EN-1 ALARM CODE LIST B-83124EN-6	Intended readers: Operator, programmer, maintenance technician, system designer Topics: Robot functions, operations, programming, setup, interfaces, alarms Use: Robot operation, teaching, system design
	Maintenance manual 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, R-30*i*B Mate, R-30*i*B Plus, R-30*i*B Mate Plus controller	Operations manual Basic Operation B-83284EN Alarm Code List B-83284EN-1 OPTIONAL FUNCTION B-83284EN-2	Intended readers: Operator, programmer, maintenance technician, system designer Topics: Robot functions, operations, programming, setup, interfaces, alarms Use: Robot operation, teaching, system design
	Maintenance manual R-30*i*B, R-30*i*B Plus: B-83195EN R-30*i*B Mate, R-30*i*B Mate Plus: B-83525EN R-30*i*B Mate, R-30*i*B Mate Plus (Open air type) : 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

The robot can be transported by a crane. When transporting the robot, be sure to change the posture of the robot to that shown Fig.1.1 and lift by using the eyebolts and the transport fixture at their points.
Transportation using a crane (Fig. 1.1 (a))
Fasten the M20 eyebolts at the three points of special transport equipment and lift the robot by the three 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.

⚠ 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.

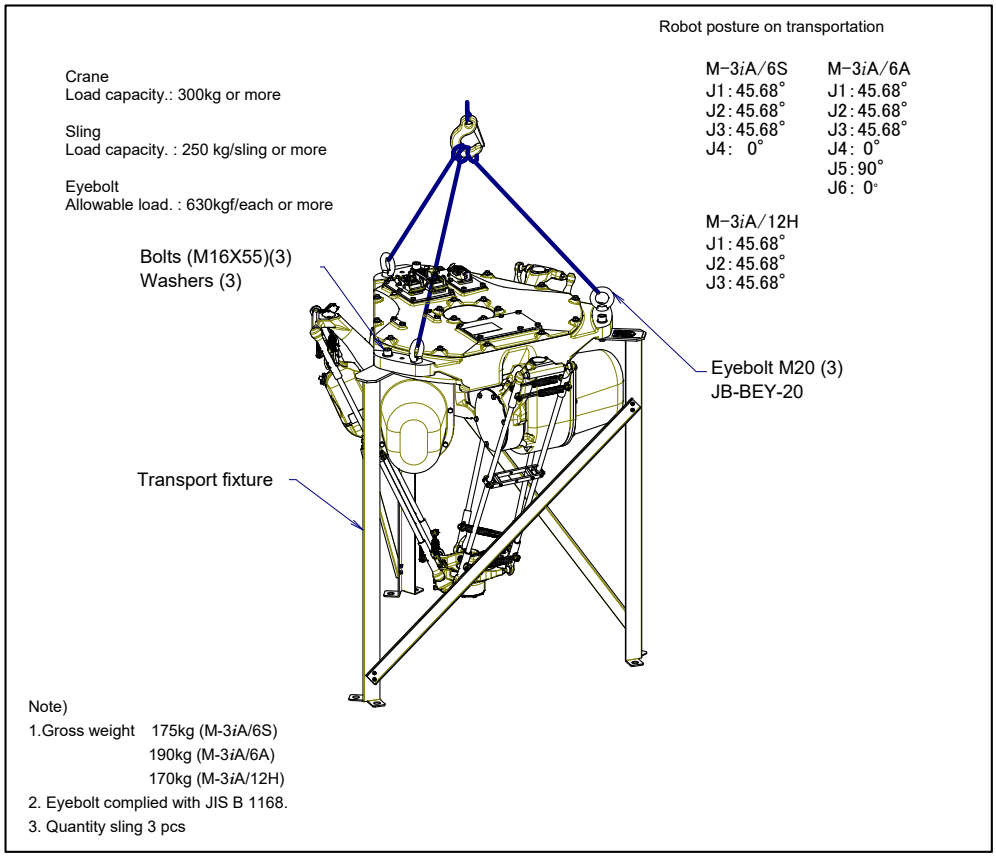


Fig. 1.1 (a) Transportation using a crane

When force sensor (option) is specified

When force sensor (option) is specified, force sensor cable is fixed by masking tape as Fig.1.1 (b). If robot is moved in this situation, it may cause the disconnection of the cable. According to the user's application, clamp it correctly and use it.

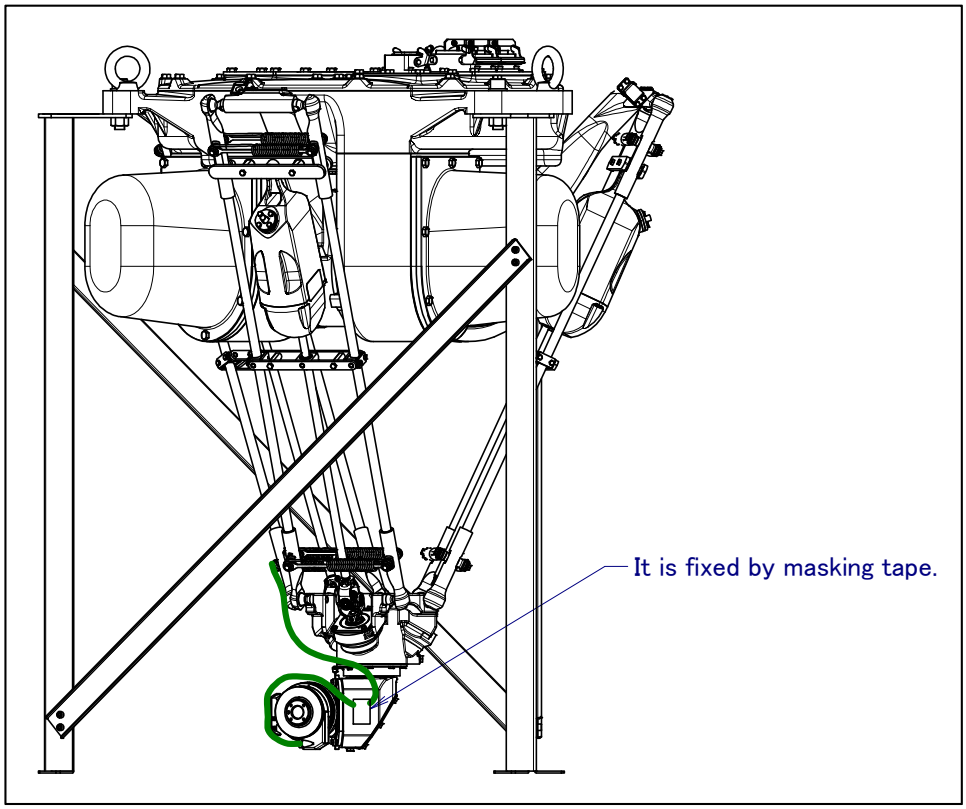


Fig. 1.1 (b) Force sensor cable

1.2 INSTALLATION

Fig. 1.2 (a) shows the robot base dimensions.

> **⚠ 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.

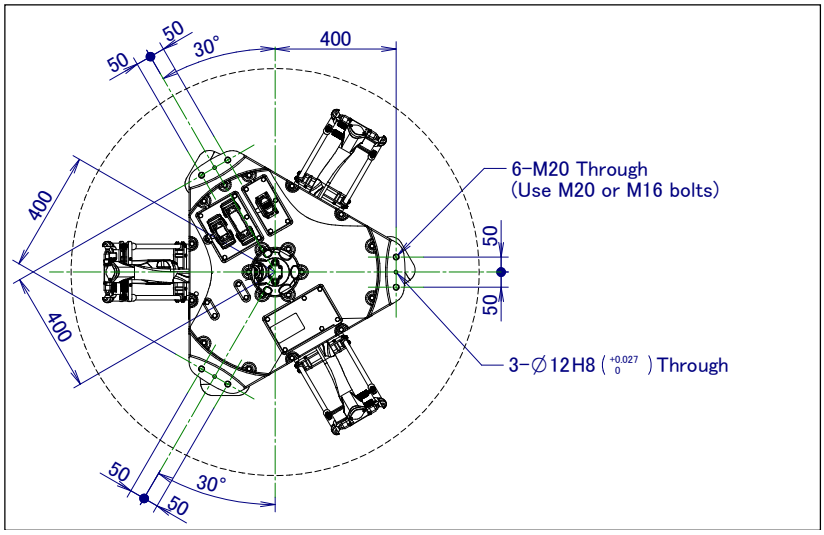


Fig. 1.2 (a) Dimension of robot base

Fig.1.2 (b),(c) show link interference area.

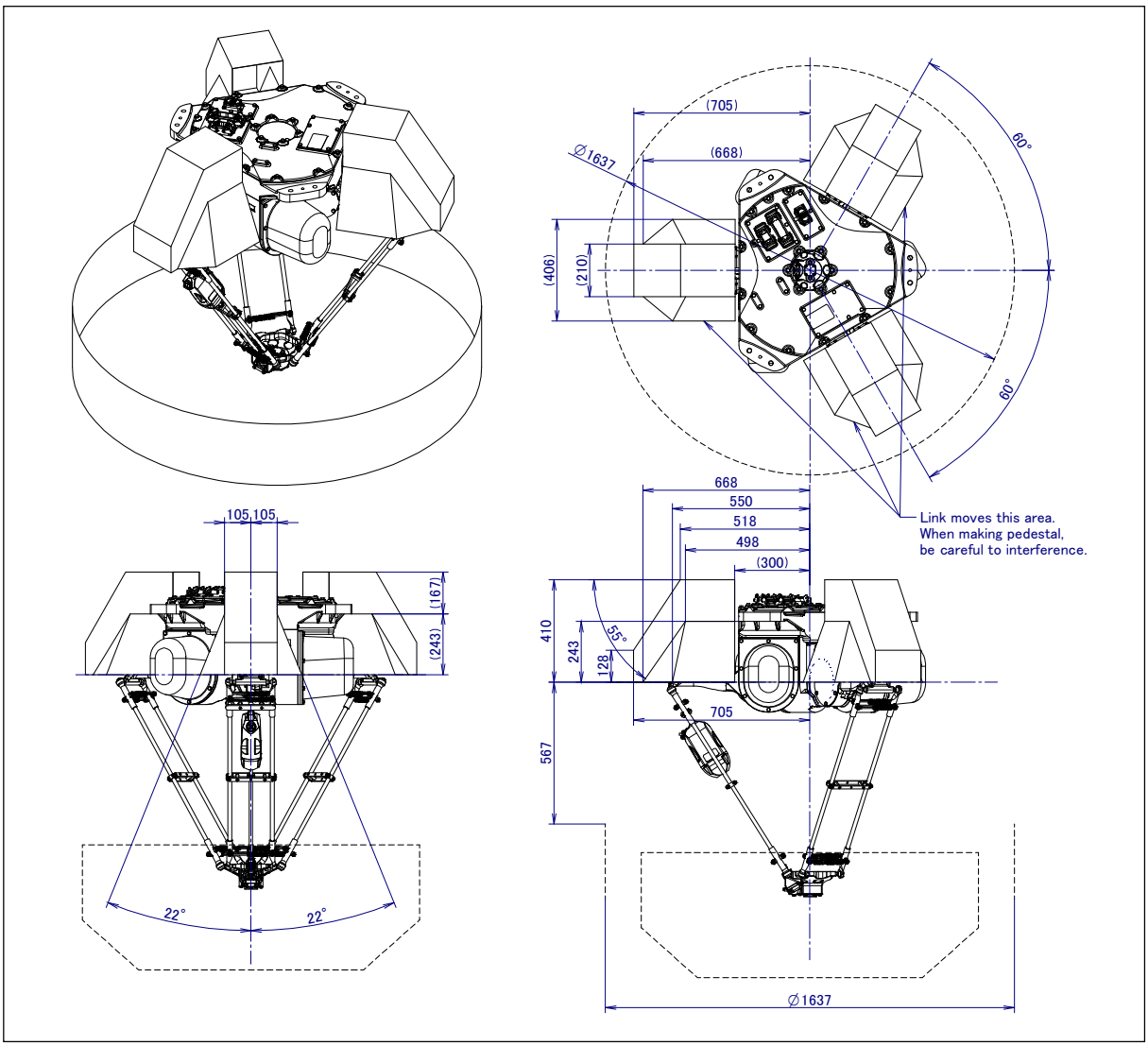


Fig. 1.2 (b) Link interference area (M-3*i*A/6S/6A)

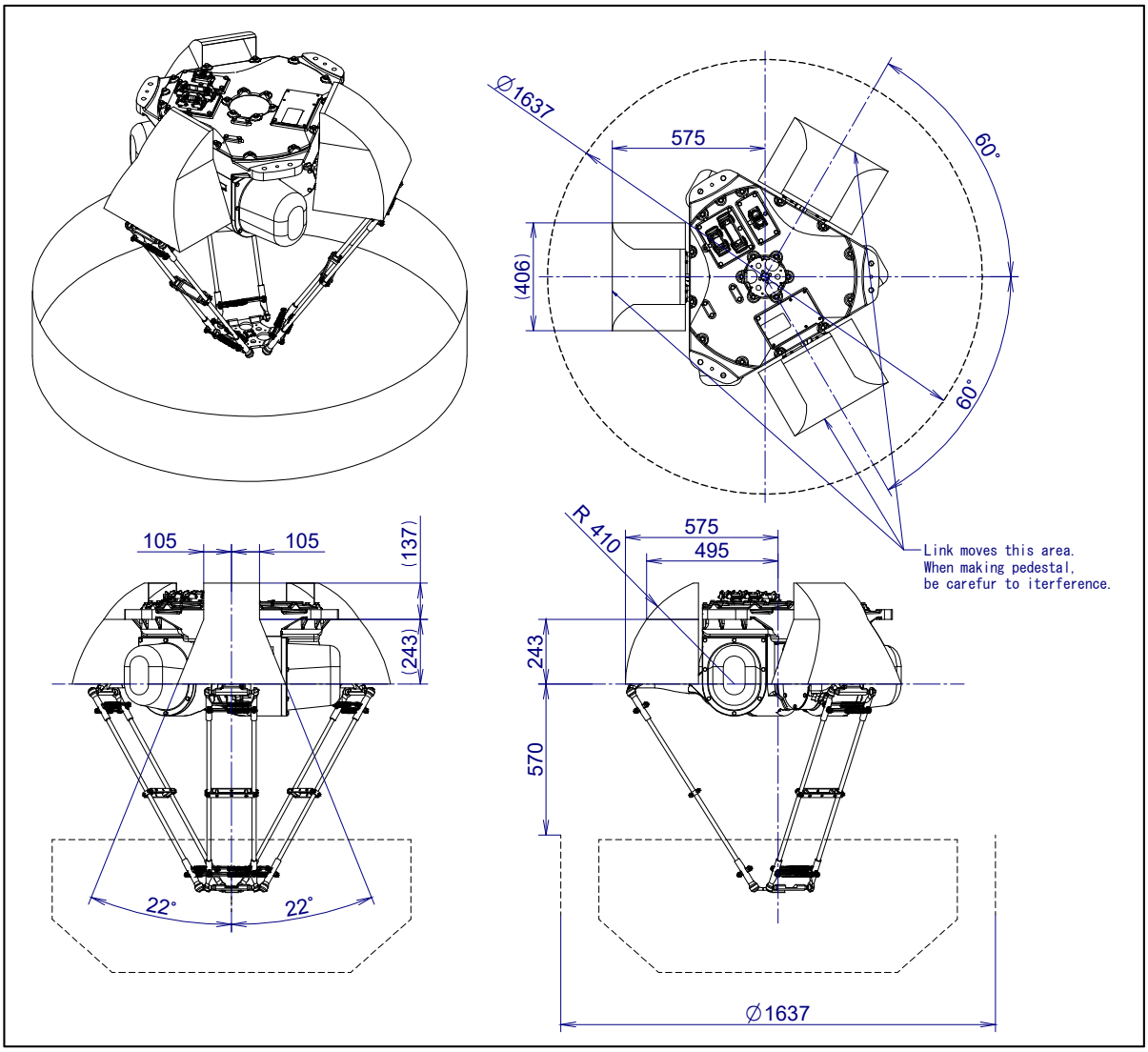


Fig. 1.2 (c) Link interference area (M-3*i*A/12H)

Fig. 1.2 (d) shows minimum dimensions required to remove motor cover. When designing a pedestal, be sure to keep this dimensions. In addition, when installing a camera etc., be sure to keep these dimensions.

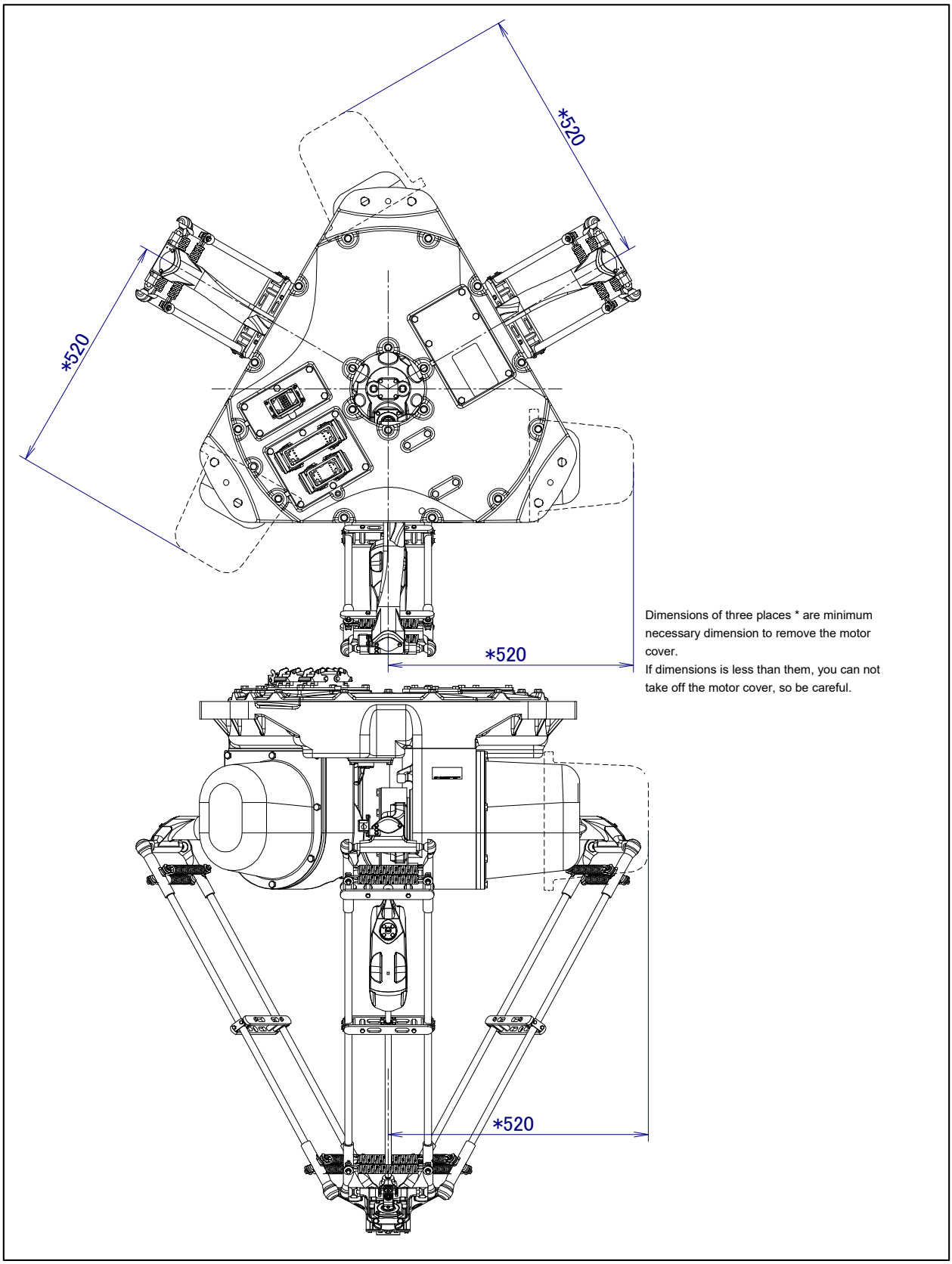


Fig. 1.2 (d) Dimensions required to remove the moto cover

Fig.1.2 (e) shows example of design dimension of pedestal. Refer to this when designing pedestal. Dimensions of three places * are minimum necessary dimension to remove the motor cover. If dimensions is less than them, you can not take off the motor cover, so be careful.

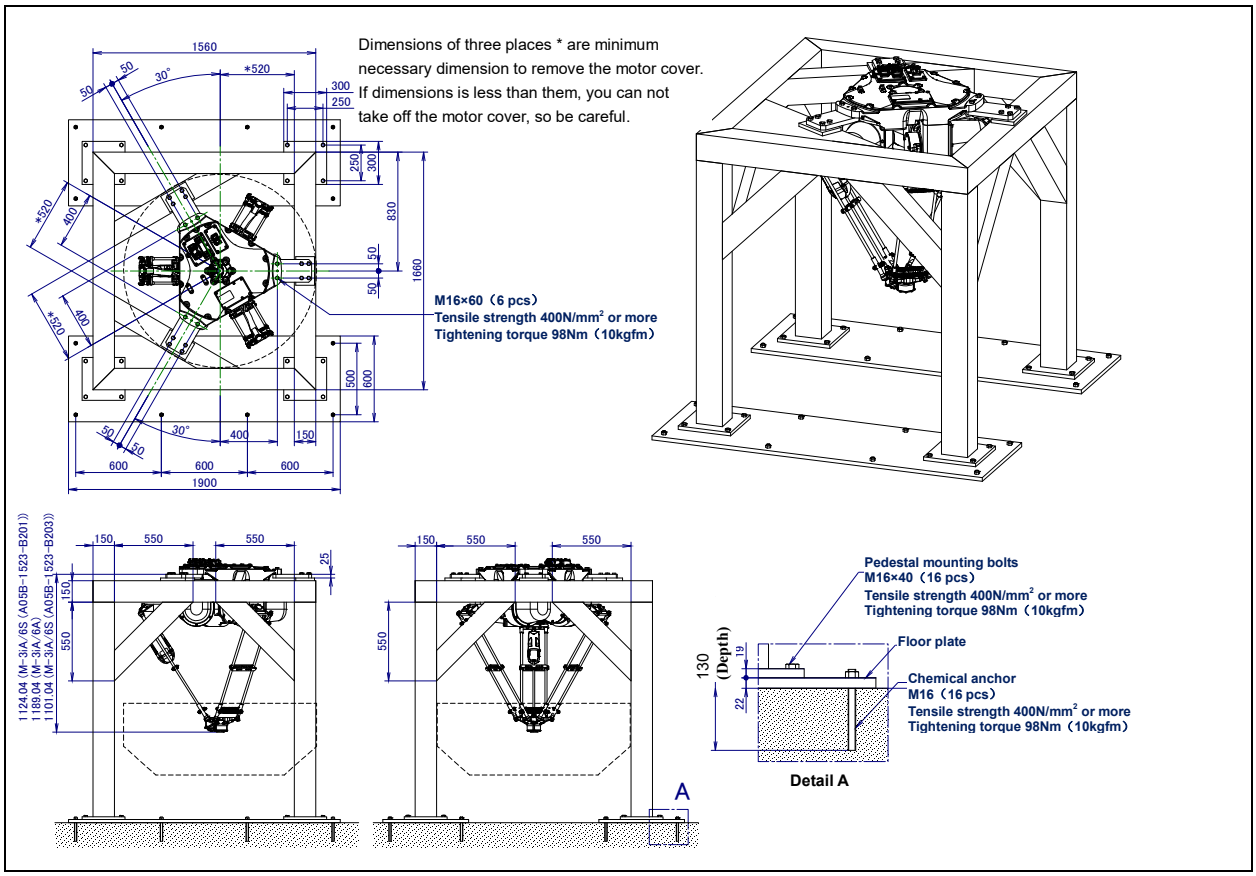


Fig. 1.2 (e) Example of design dimension of pedestal

> **⚠ WARNING**
> When preparing trestle, please consider security for installation and maintenance work in high place. Please consider footstep and safety belt mounting position.

We recommend prepare footing for maintenance work referring to Fig.1.2 (f).

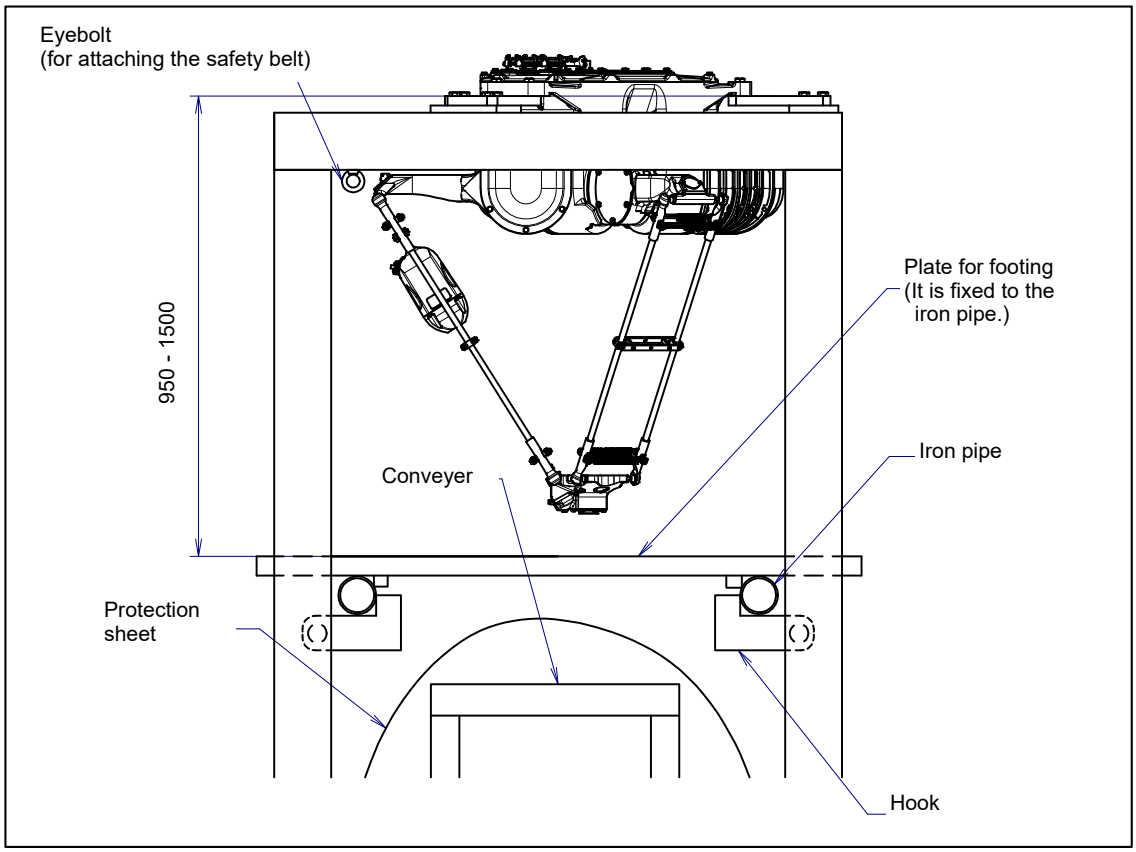


Fig. 1.2 (f) Example of footing

Fig. 1.2 (g) and Table 1.2 (a) indicate the force and moment applied to the robot base.
Table 1.2 (b),(c) 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.

NOTE
Table 1.2 (b) and (c) are measured reference value complied with ISO10218-1. Values differs depending on each robot individual difference, payload and the program. So confirm the real value by measurement. Values in Table 1.2 (b) is affected by the robot operating status and number of times of the servo-off stop. Periodically measure the real values and confirm those.

Table 1.2 (a) Force and moment that act on robot base (All models)

	Bending moment M_V (Nm)	Force in vertical condition F_V (N)	Twisting moment M_H (Nm)	Force in horizontal direction F_H (N)
Static	0.0	1544	0	0
Acceleration/ Deceleration	1460.0	1830	33.1	1252
Power-Off stop	3180.0	4269	298	2597

Table 1.2 (b) Stopping time and distance until the robot stopping by Power-Off stop after input of stop signal

Model		X	Y	Z
M-3*i*A	Stopping time [ms]	80	80	80
	Stopping distance [mm]	284	284	284

Table 1.2 (c) Stopping time and distance until the robot stopping by Controlled stop after input of stop signal

Model		X	Y	Z
M-3*i*A	Stopping time [ms]	724	724	510
	Stopping distance [mm]	702	702	277

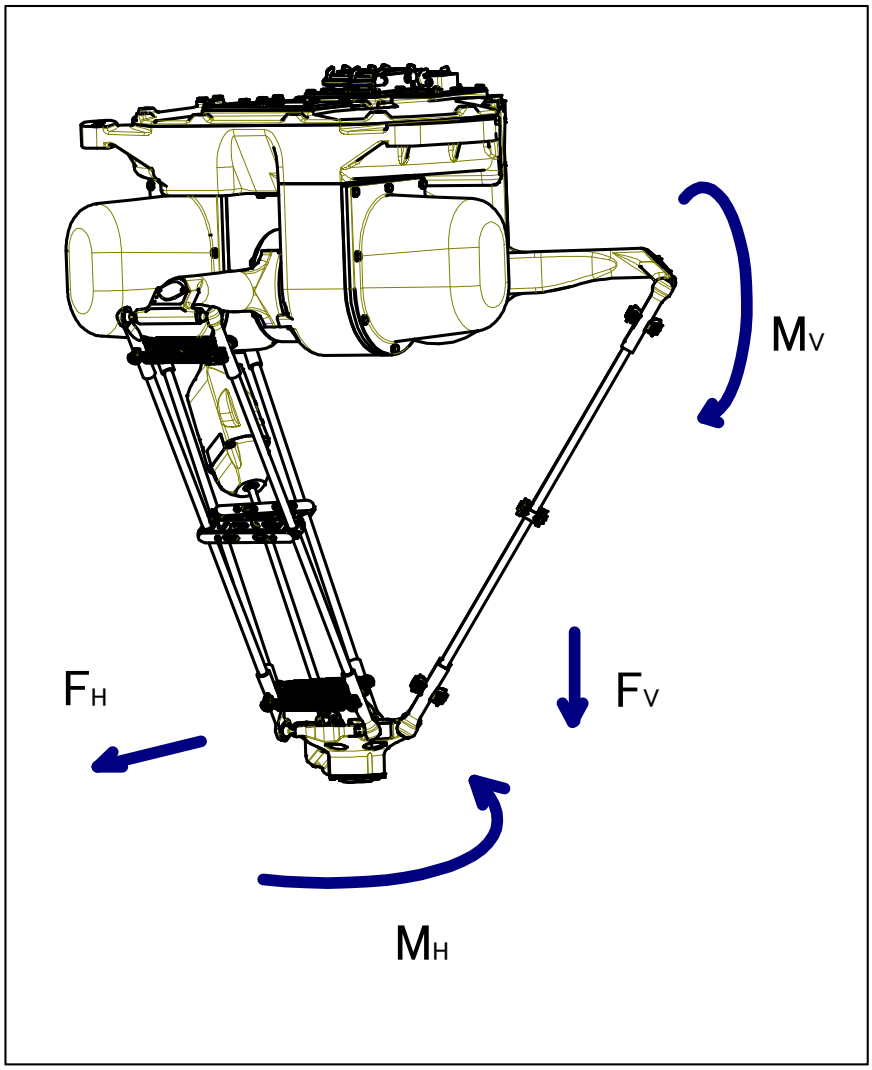


Fig. 1.2 (g) Force and moment that acts on robot base

1.3 MAINTENANCE AREA

Fig. 1.3 (a) shows the maintenance area of the mechanical unit. See Chapter 8 for the mastering.

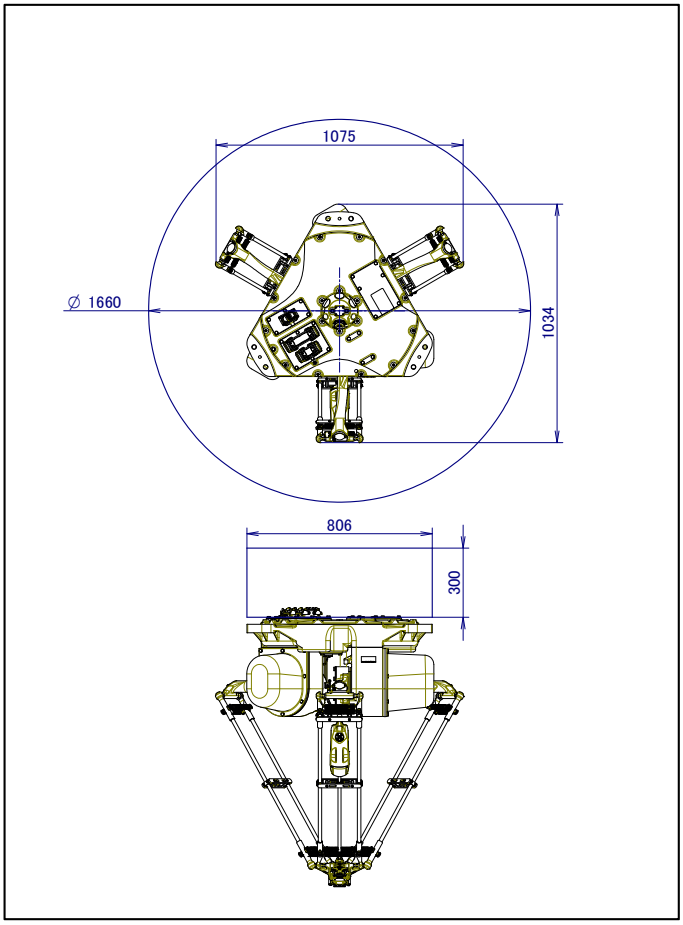


Fig. 1.3 (a) Maintenance area

1.4 INSTALLATION CONDITIONS

Refer to specification of Section 3.1 about installation conditions.

2 CONNECTION WITH THE CONTROLLER

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 base.
For details of option cables, see Chapter 5.

> ⚠ **WARNING**
> Before turning on controller power, be sure to connect robot and controller with the earth line. 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 untying. The long coiled cable will heat and damage itself.

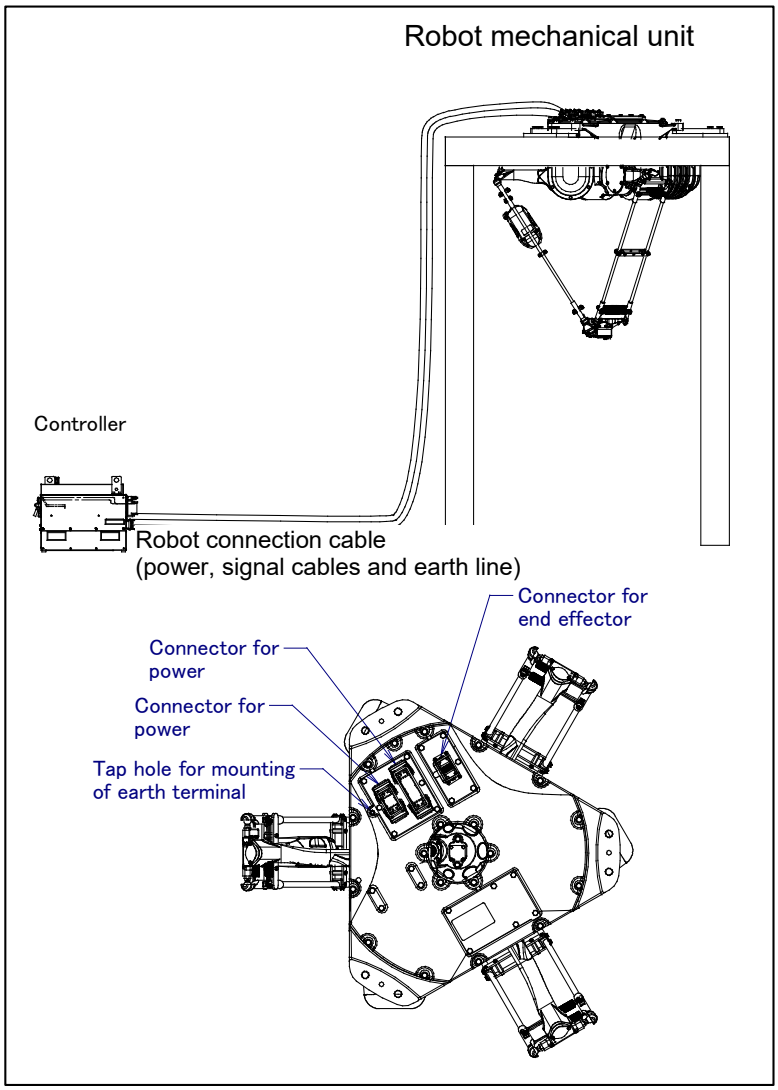


Fig. 2 (a) Cable connection

3 BASIC SPECIFICATIONS

3.1 ROBOT CONFIGURATION

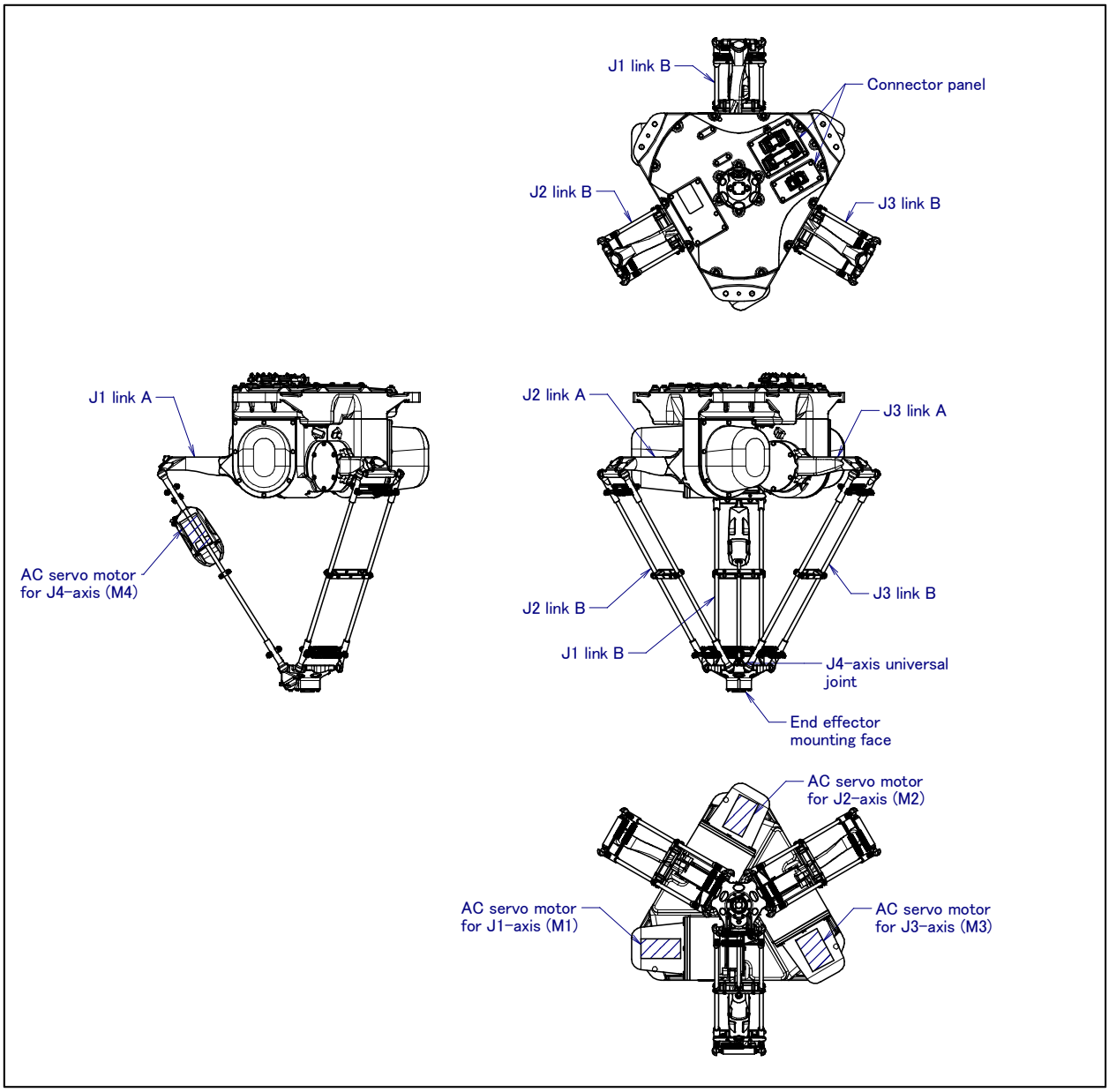


Fig. 3.1 (a) Mechanical unit configuration (M-3*i*A/6S)

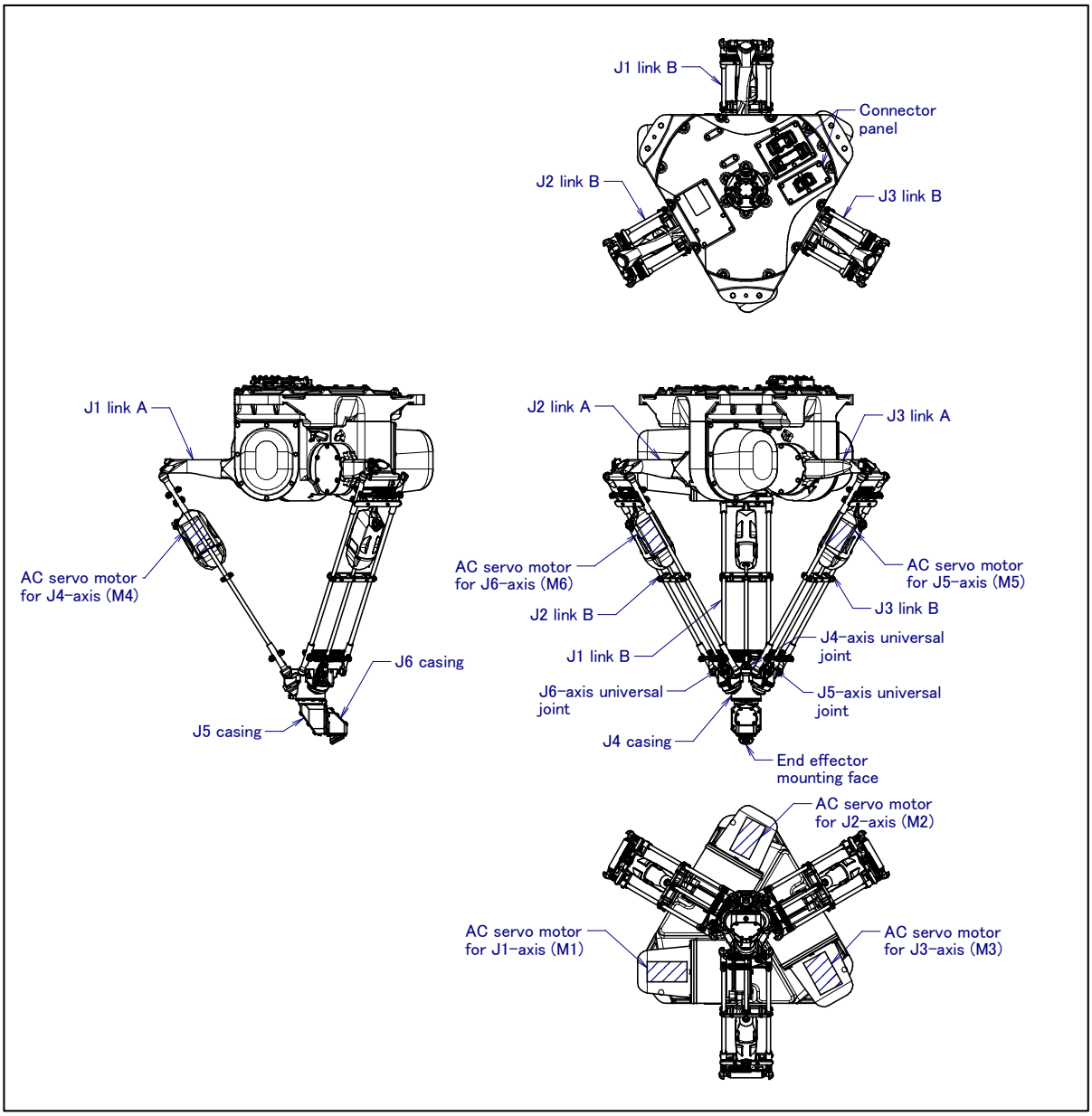


Fig. 3.1 (b) Mechanical unit configuration (M-3*i*A/6A)

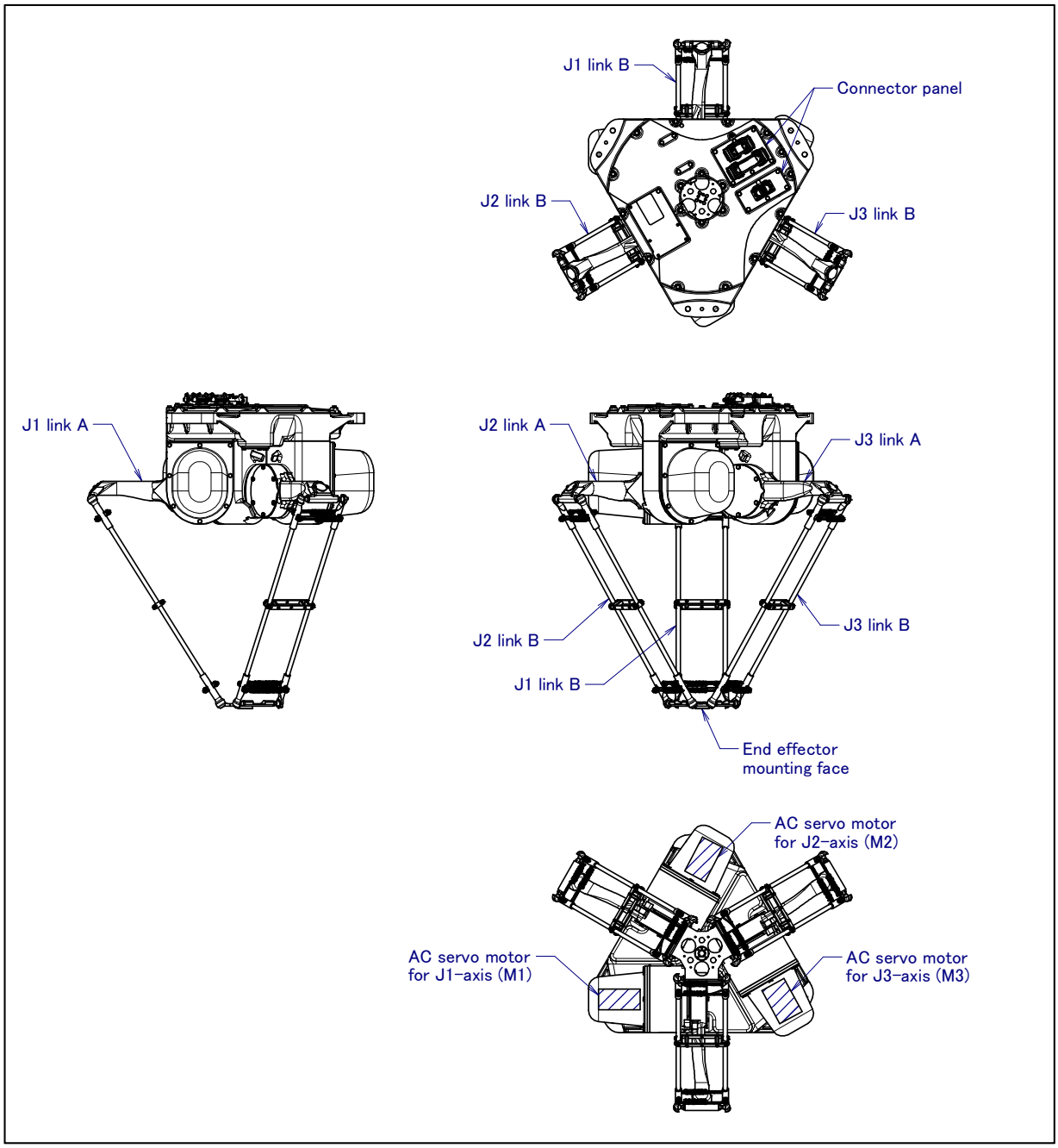


Fig. 3.1 (c) Mechanical unit configuration (M-3*i*A/12H)

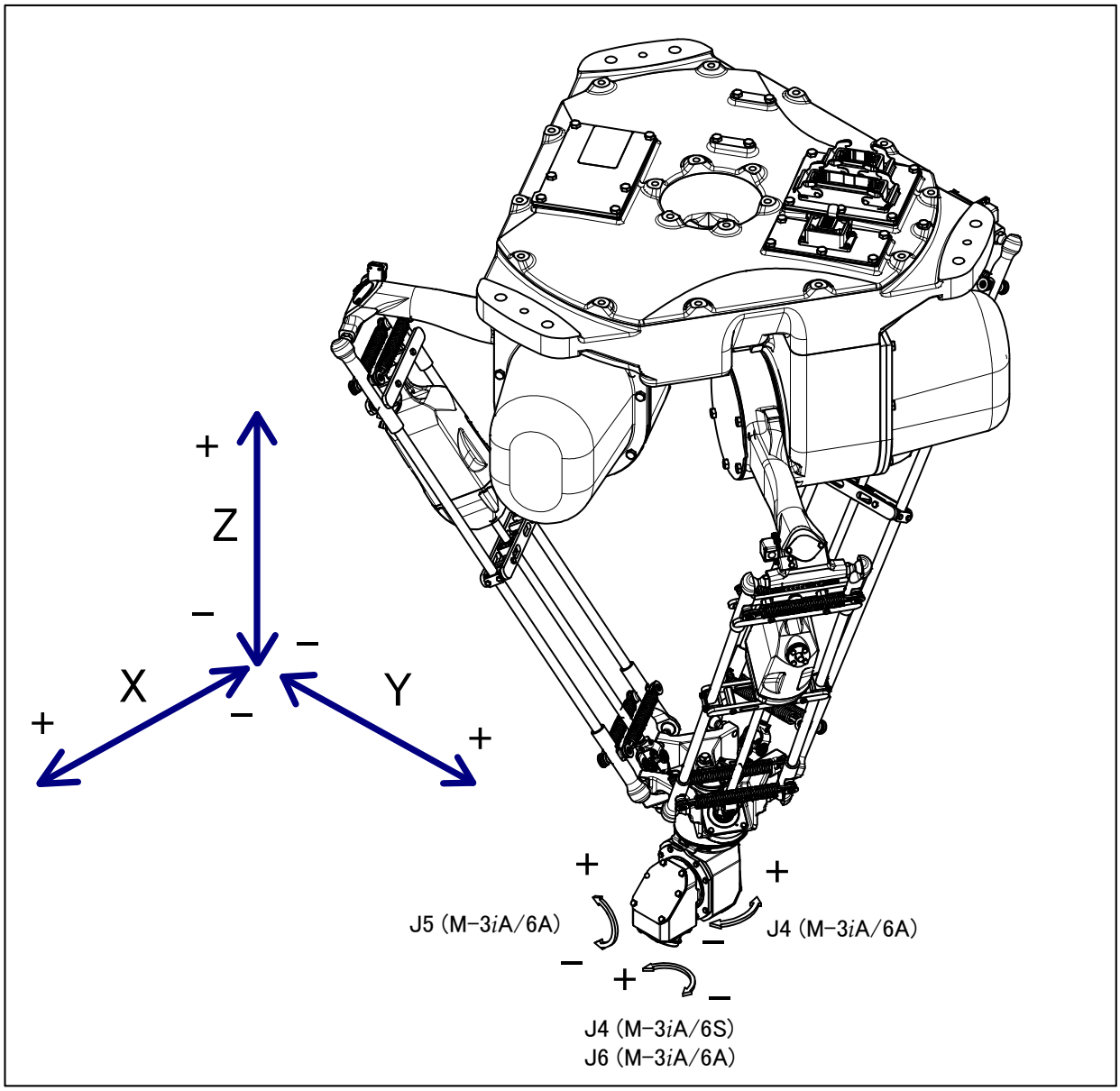


Fig. 3.1 (d) Each axes coordinates

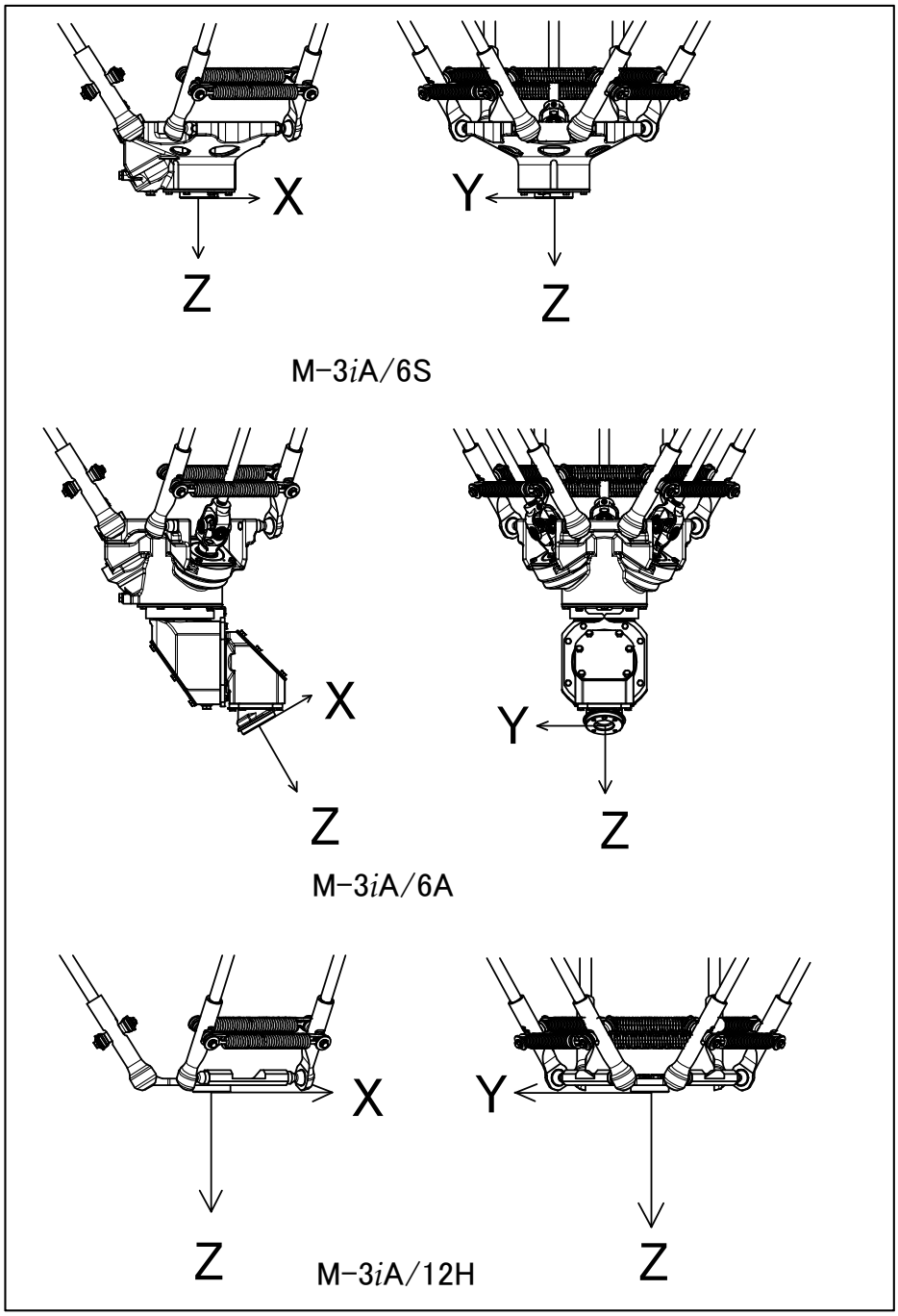


Fig. 3.1 (e) Mechanical interface coordinates

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

Table 3.1 (a) Specifications (NOTE 1)

		M-3*i*A/6S	M-3*i*A/6A	M-3*i*A/12H
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		Ceiling		
Motion range (Max.speed) (NOTE 2)	J1-J3	Diameter 1350 mm, Height 500 mm		
	J4	(Note 3) 720º (4000°/s) 12.57 rad (69.81 rad/s) (Note 3) 720º (2000°/s) 12.57 rad (34.91 rad/s)	720º (2000°/s) 12.57 rad (34.90 rad/s)	
	J5		300º (2000°/s) 5.24 rad (34.90 rad/s)	
	J6		720º (2000°/s) 12.57 rad (34.90 rad/s)	
Max.payload (NOTE 4)		6kg (8 kg (NOTE 5))	6kg	12kg
Repeatability		±0.03mm		
Dust.proof and drip.proof mechanism		Conform to IP67		
Drive method		Electric servo drive by AC servo motor		
Mass		160kg	175kg	155kg
Acoustic noise level		79.2dB (NOTE 7)		
Installation environment		Ambient temperature: 0 to 45℃ (NOTE 8) Ambient humidity : Normally 75%RH or less (No dew or frost allowed) Short time (Within 1 month) 95%Rh or less (No dew or frost allowed) Permissible altitude : Above the sea 1000m or less Vibration acceleration : 4.9m/s^2 (0.5G) or less Free of corrosive gases (NOTE 9)		

NOTE

1 Even if the robot is used according to the defined specifications, motion programs might shorten reducer life or cause the robot to overheat. Use ROBOGUIDE (system design support tool by FANUC) for further evaluation before running production.
2 During short distance motions, the axis speed may not reach the maximum value stated.
3 The value in standard inertia mode is shown in upper half and the value in 8kg option in lower half. For details, see Section 4.5.
4 Refer to Section 3.3 about load condition of wrist.
5 This value is for 8kg option. Refer to Section 4.5 for change method.
6 Compliant with ISO9283.
7 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

8 When the robot is used in a low temperature environment that is near to 0ºC, or not operated for a long time in the environment that is less than 0ºC (during a holiday or during the night), a collision detection alarm (SRVO-050) etc. may occur since the resistance of the drive mechanism could be high immediately after starting the operation. In this case, we recommend performing the warm up operation for several minutes.
9 Contact the service representative, if the robot is to be used in an environment or a place subjected to hot/cold temperatures, severe vibrations, heavy dust, water, water vapor, cutting oil, cleaning fluid splash and or other contaminations.

NOTE

M-3*i*A/6A moves very fast, so J4/J5/J6-axes are always set to move only at the joint motion to prevent vibration or link disconnection by sudden movement of wrist. So if you teach control to interpolate a tool path such as linear, circular. etc. and change the position of wrist at the same time, tip of tool may not draw expected linear or circular. (If you maintain the position of wrist, control to interpolate a tool path operates as usual.)

3.2 MECHANICAL UNIT OPERATION AREA AND OPERATING SPACE

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

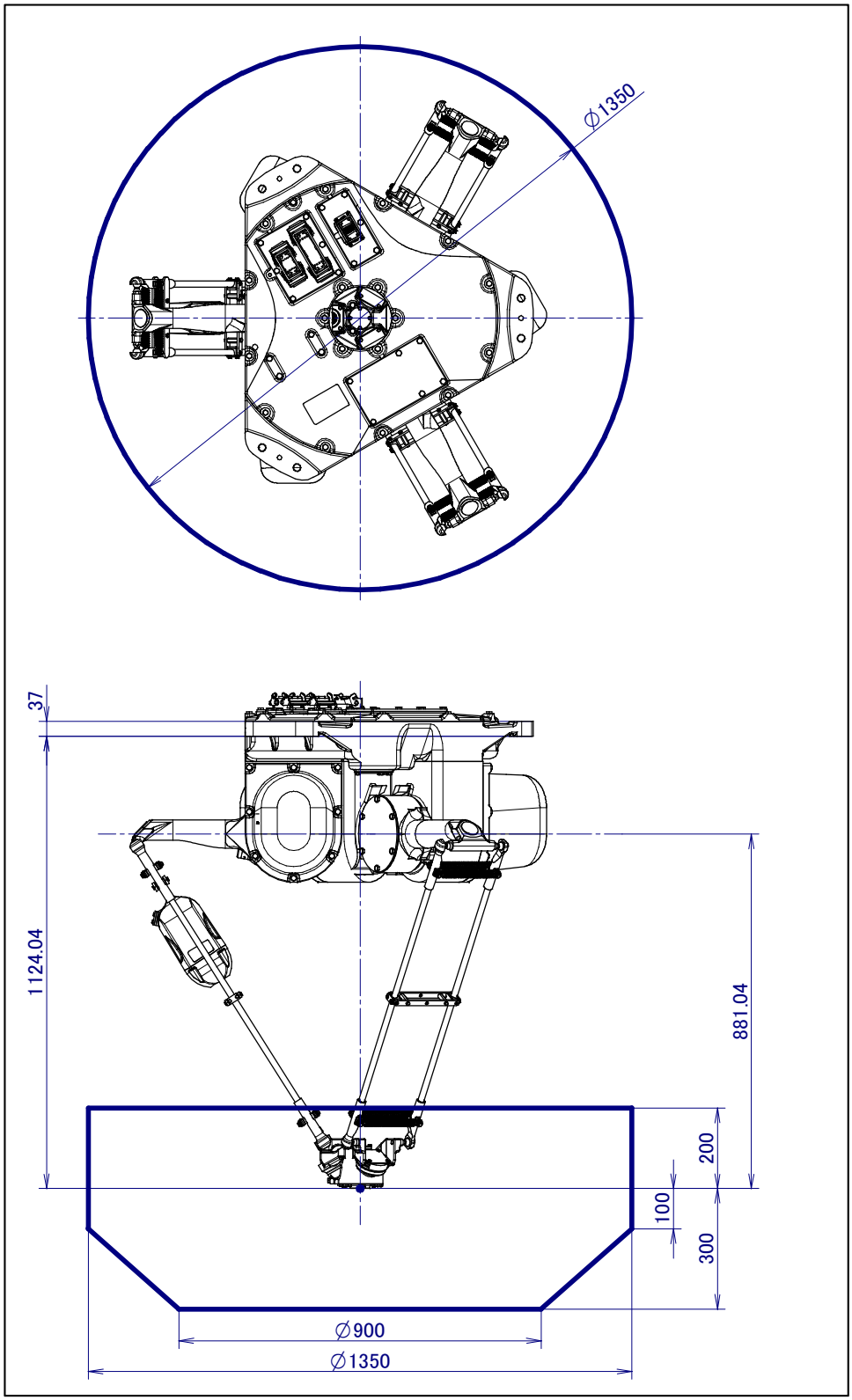


Fig. 3.2 (a) Operating space (M-3*i*A/6S (A05B-1523-B201))

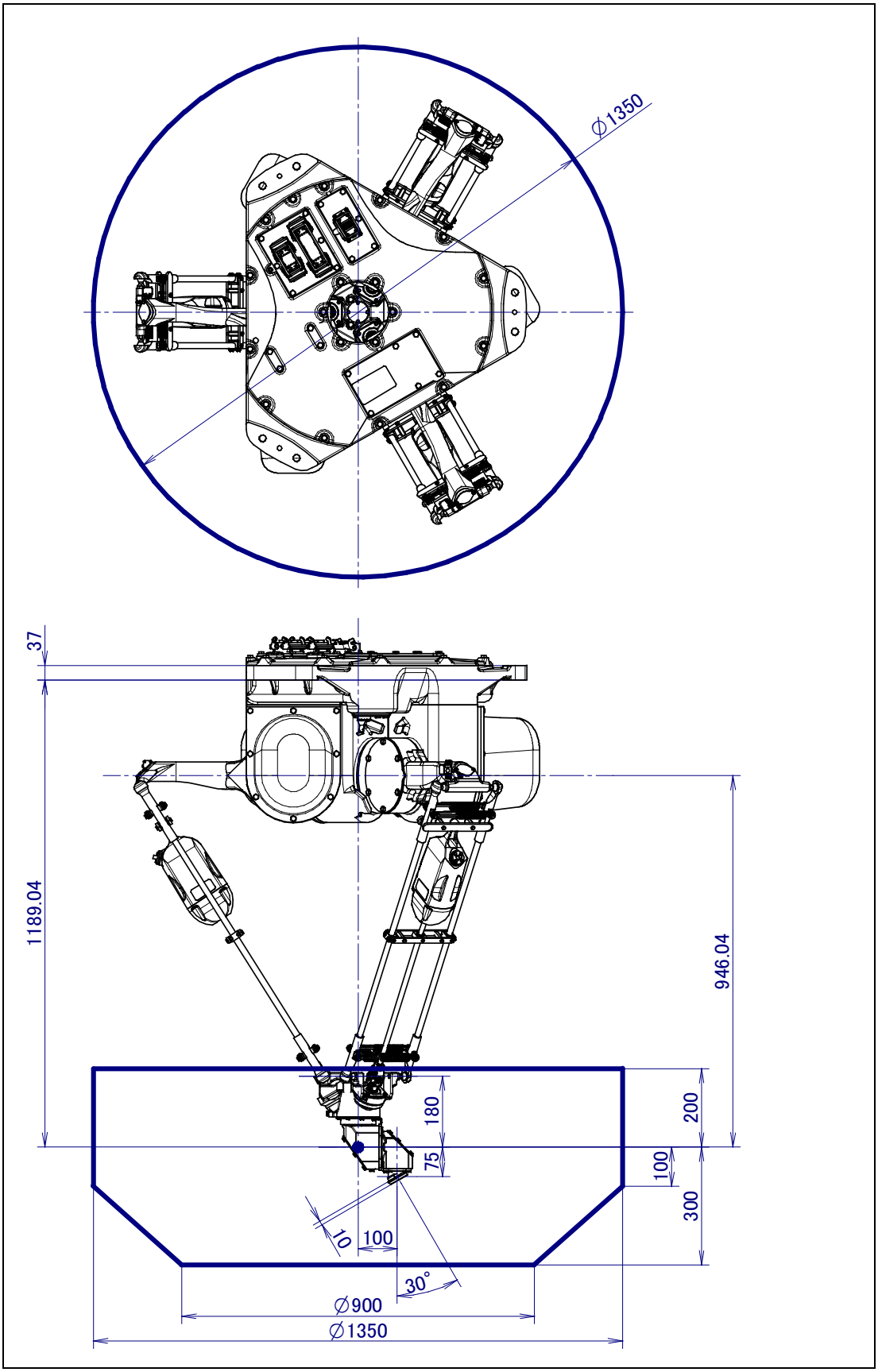


Fig. 3.2 (b) Operating space (M-3*i*A/6A)

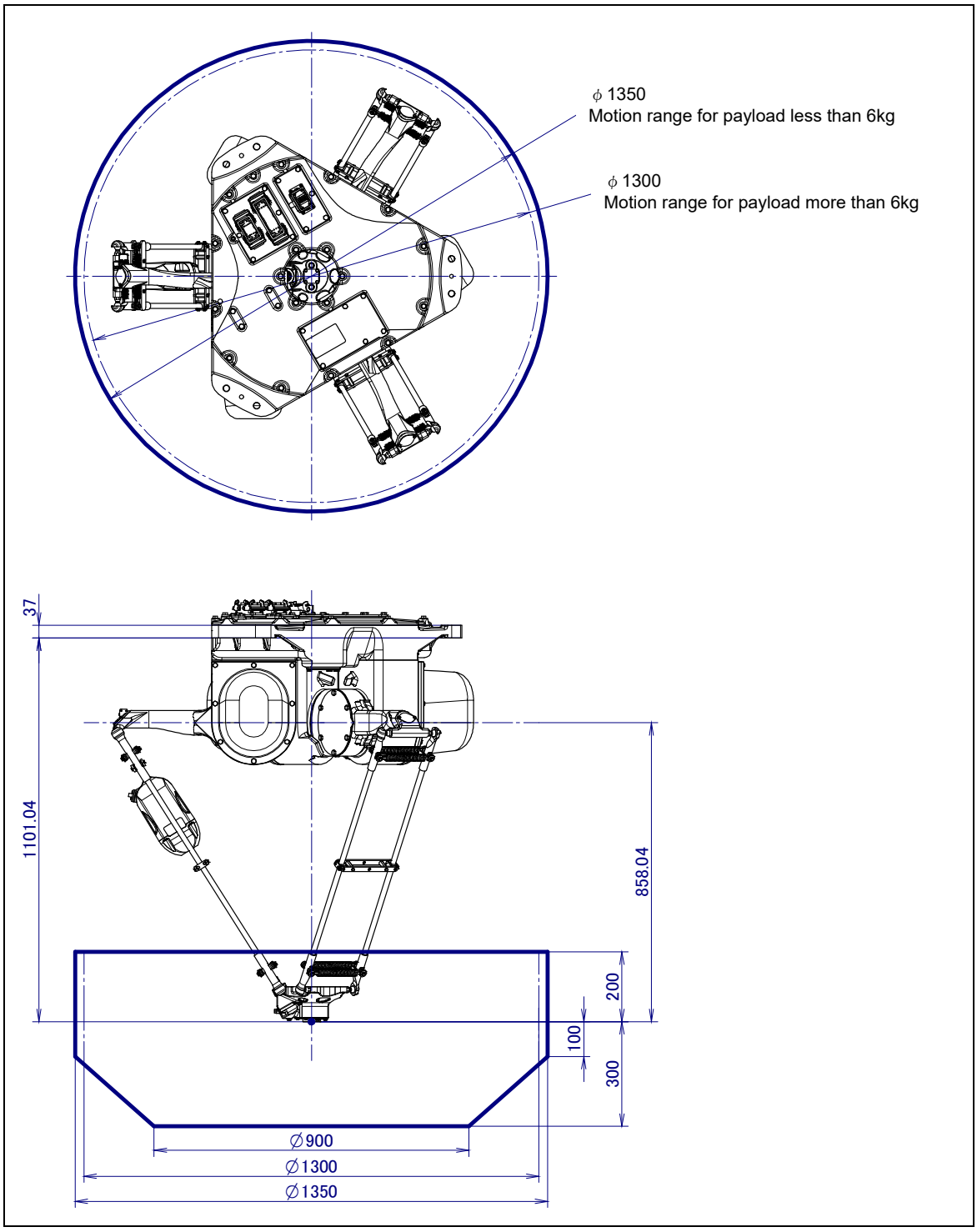


Fig. 3.2 (c) Operating space (M-3*i*A/6S (A05B-1523-B203))

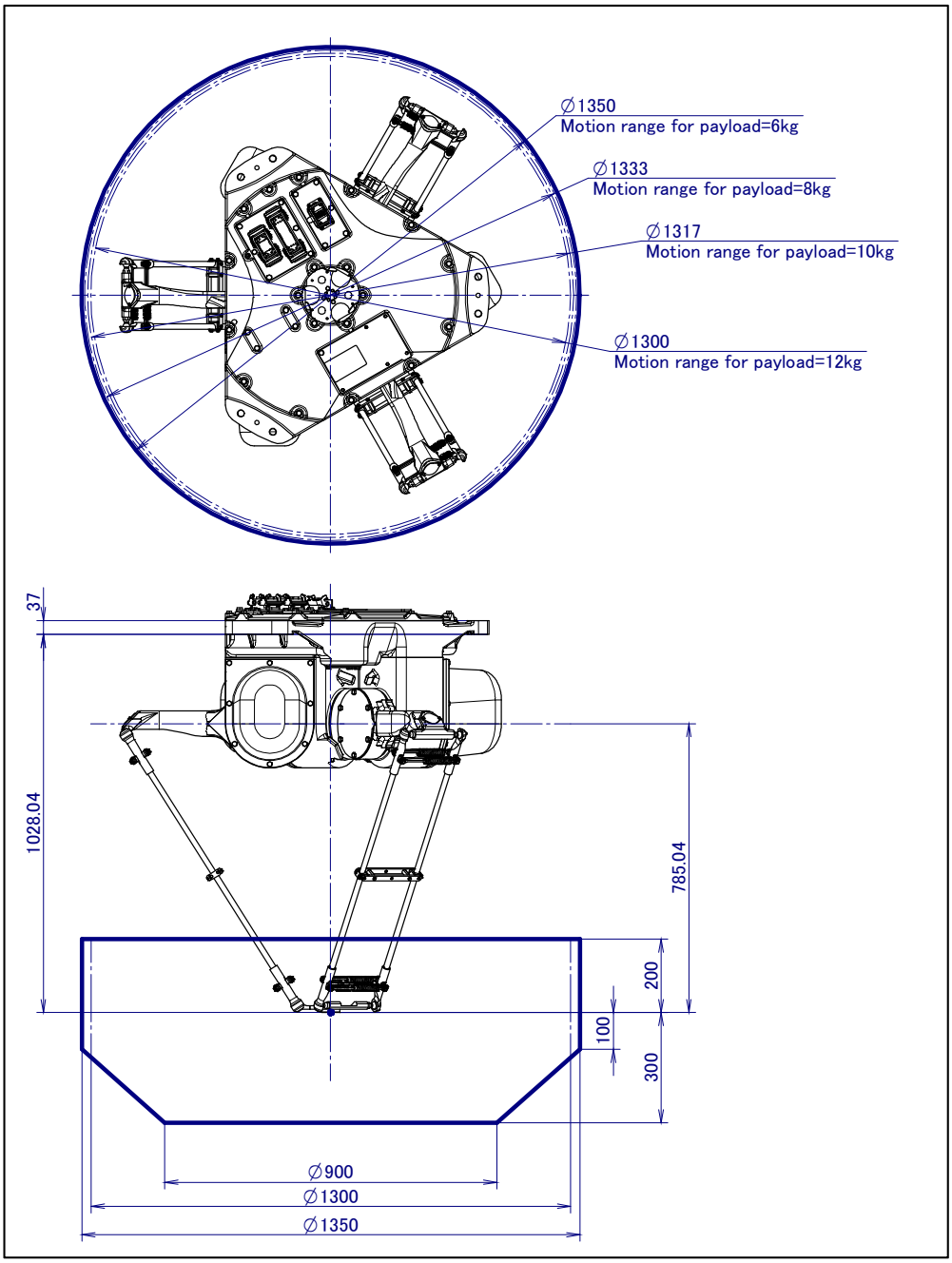


Fig. 3.2 (d) Operating space (M-3*i*A/12H)

> **⚠ CAUTION**
> In case of M-3*i*A/12H, Motion range changes according to wrist part payload. Load setting is performed, motion range is automatically changed to correct one. Refer to Section 4.3 for load setting.

3.3 WRIST LOAD CONDITIONS

Fig. 3.3 (a) to (d) are diagrams to limit loads applied to the wrist.

- Apply a load within the region indicated in the graph.
- See Section 4.1 about mounting of end effector.

> **⚠ WARNING**
> In case of M-3*i*A, excessive collision or excessive overload sometimes causes link disconnection for minimizing the damage. If the link disconnection occurred, contact your local FANUC representative.

> **NOTE**
> In this robot, as the wrist load decreases, the allowable inertia of the wrist also decreases. For example, with the same inertia, if the wrist load is 6 kg, the inertia is within the allowable value, but if the wrist load is 1 kg, the inertia is over.

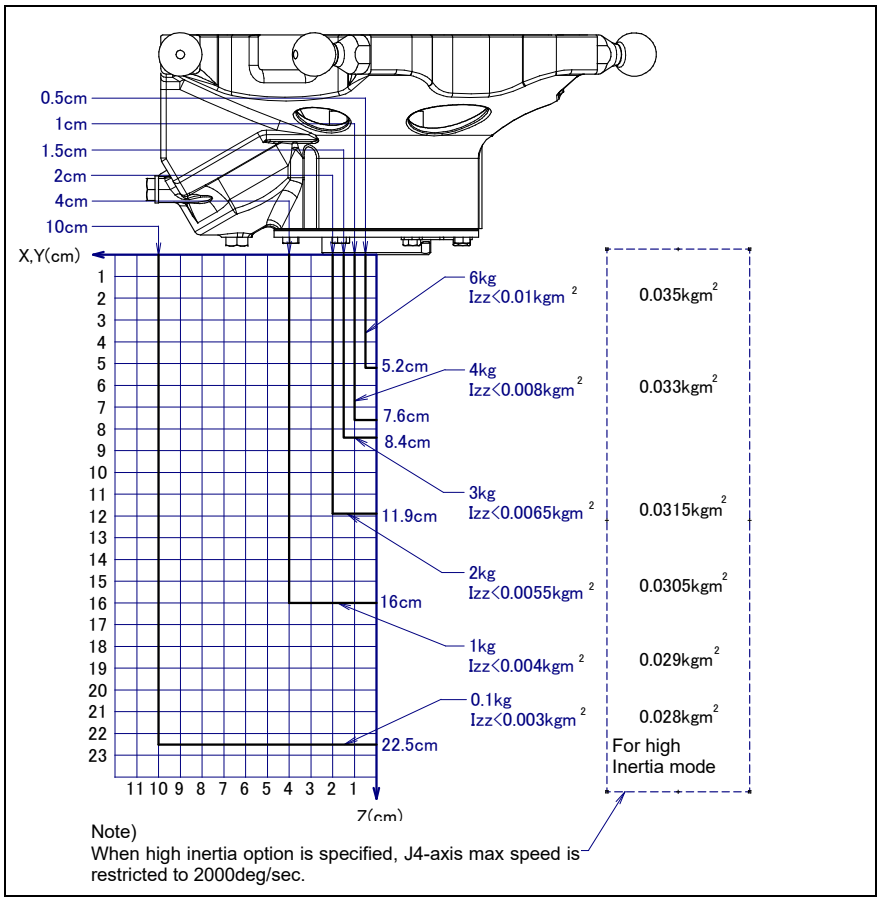


Fig. 3.3 (a) Wrist load diagram (M-3*i*A/6S: standard inertia mode, high inertia mode)

M-3*i*A/6S high inertia mode

1. For software version V8.10P/11 or before, refer to Fig. 3.3 (a).
2. For high mode of software version V8.10P/12 or later, refer to Fig. 3.3 (b). However, tolerance payload is 6kg or less.
3. For 8kg option of V8.20P/17,V8.30P/02 or later, refer to Fig. 3.3 (b).

NOTE
The name “High inertia mode” was changed to “8kg option” in the middle.

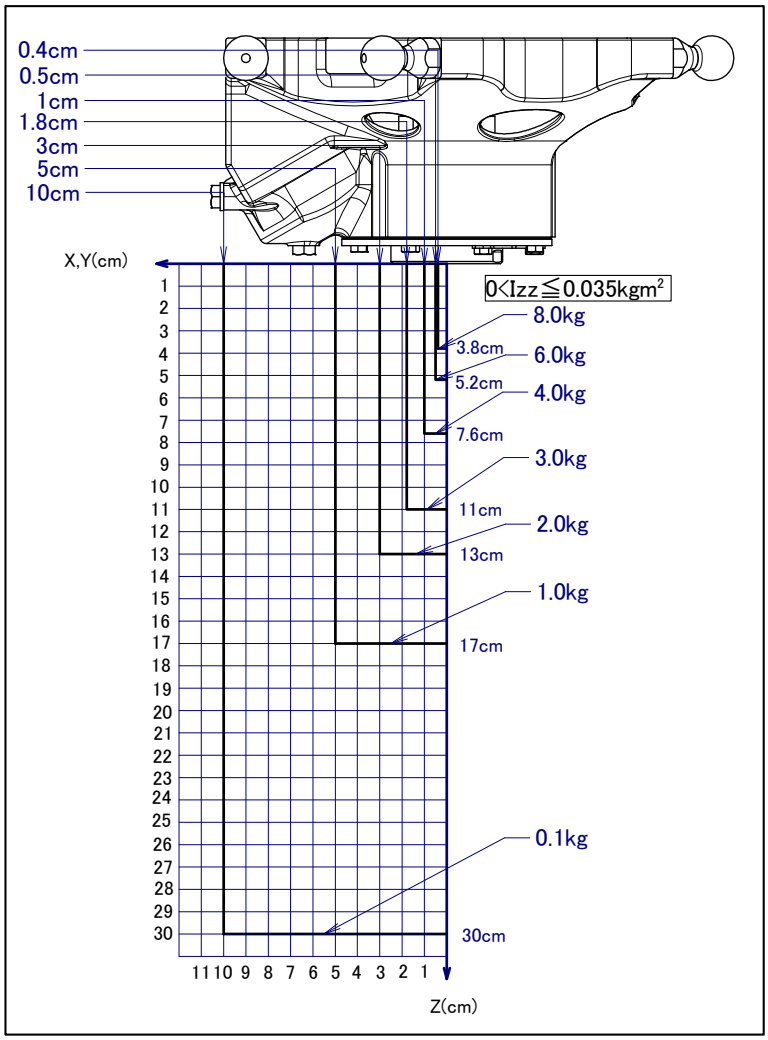


Fig. 3.3 (b) Wrist load diagram (M-3*i*A/6S: high inertia mode, 8kg option)

Table 3.3 (a) Allowable offset value for shape inertia

Izz [kgm^2]	X, Y [cm]	Z [cm]
0.035< Izz < 0.060	0.1kg : -400*(Izz-0.035)+10 or less	0.1kg : 30
	1.0kg : -200*(Izz-0.035)+5 or less	1.0kg : 17
	2.0kg : -120*(Izz-0.035)+3 or less	2.0kg : 13
	3.0kg : -72*(Izz-0.035)+1.8 or less	3.0kg : 11
	4.0kg : -40*(Izz-0.035)+1 or less	4.0kg: 7.6
	6.0kg : -20*(Izz-0.035)+0.5 or less	6.0kg: 5.2
	8.0kg : -16*(Izz-0.035)+0.4 or less	8.0kg : 3.8
Izz = 0.060	0	0.1kg : 30 1.0kg : 17 2.0kg : 13 3.0kg : 11 4.0kg: 7.6 6.0kg: 5.2 8.0kg : 3.8

Note) When high inertia option is specified, J4-axis max speed is restricted to 2000deg/sec.
Z direction offset values is depend on only mass.

Refer to Section 4.5 about change procedure to 8 kg option.

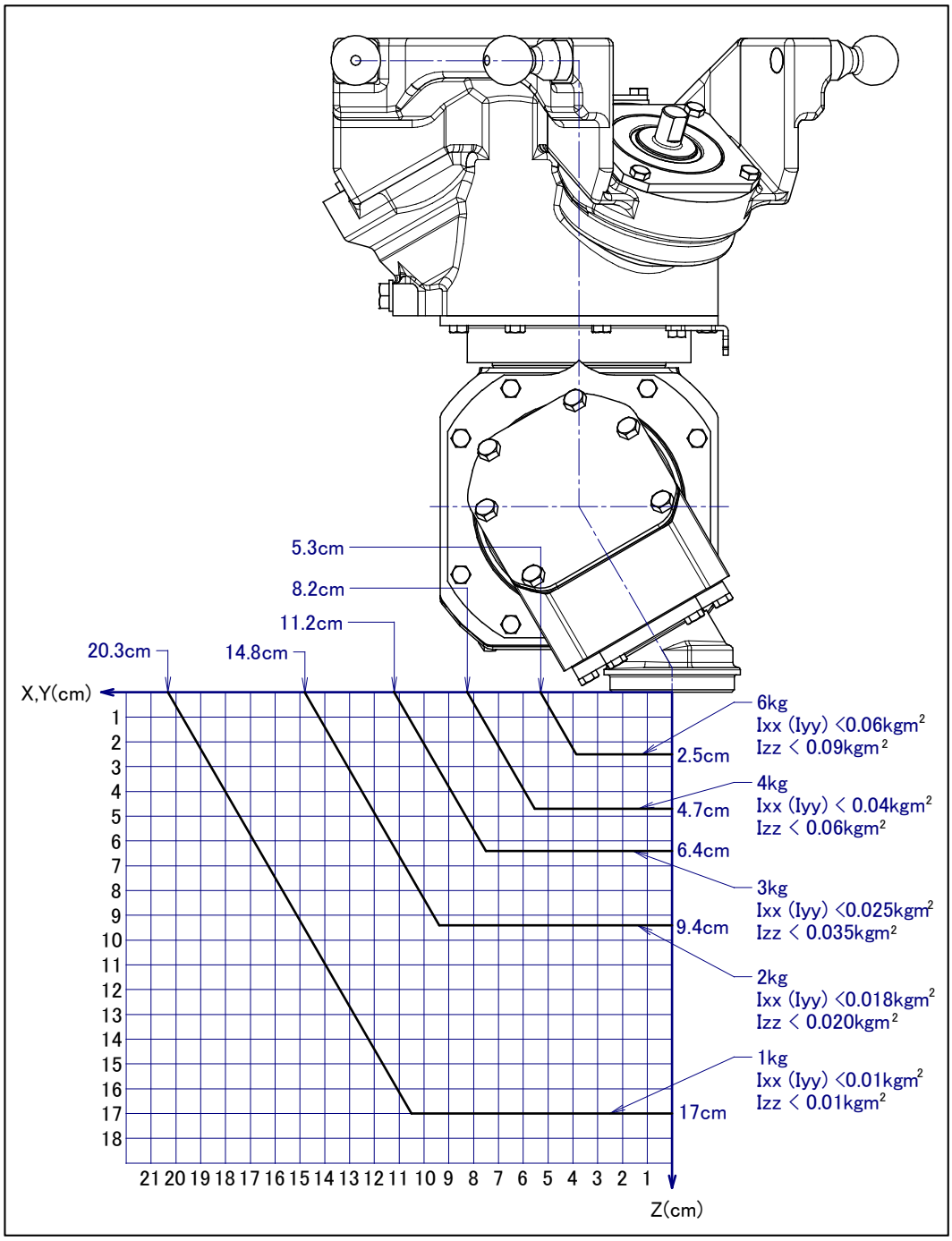


Fig. 3.3 (c) Wrist load diagram (M-3*i*A/6A)

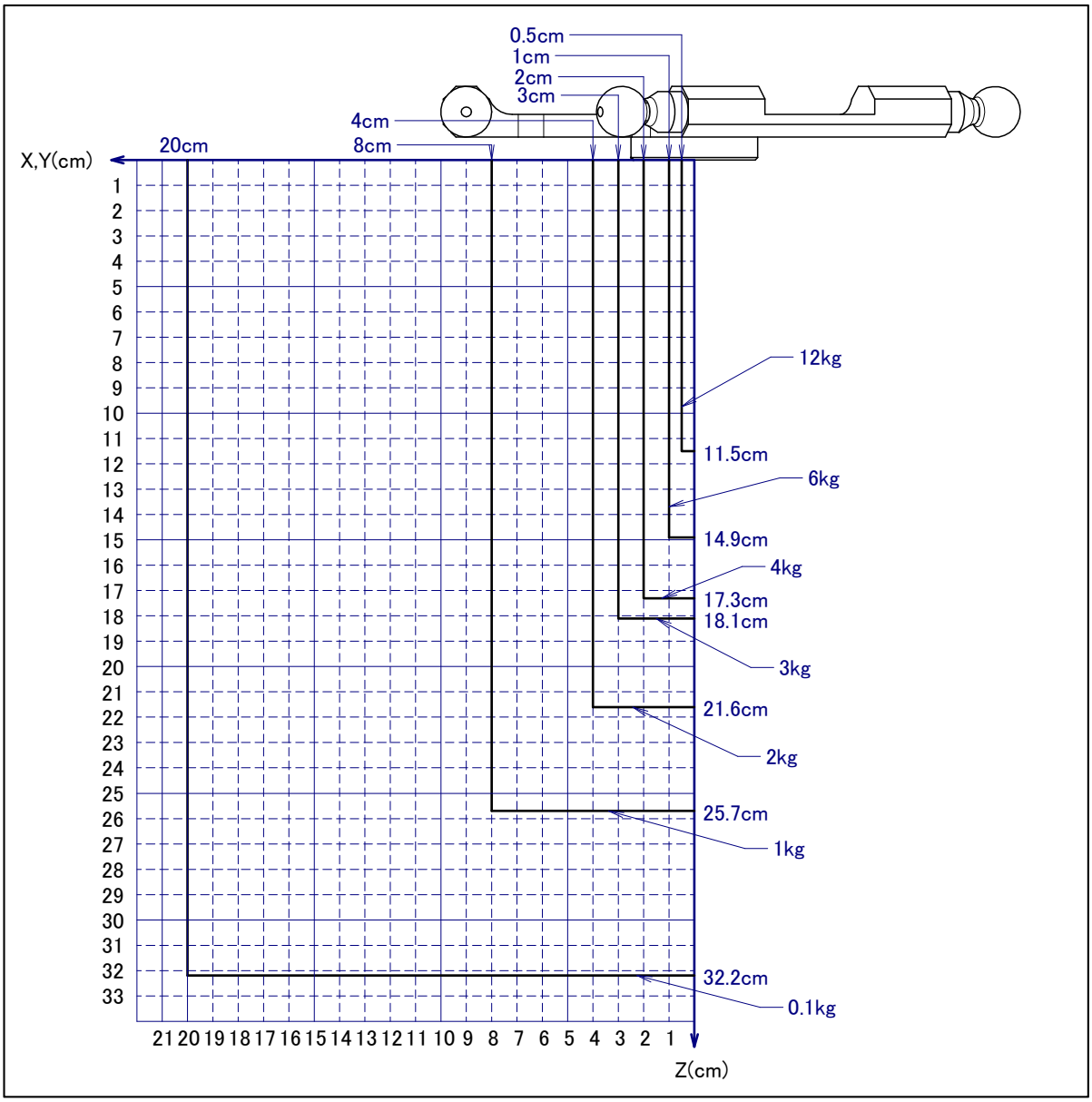


Fig. 3.3 (d) Wrist load diagram (M-3*i*A/12H)

4 EQUIPMENT INSTALLATION TO THE ROBOT

4.1 END EFFECTOR INSTALLATION TO WRIST

Fig. 4.1 (a) to (d) are the figure for installing end effectors on the wrist. Select screws and positioning pins of a length that matches the depth of the tapped holes and pin holes.
See Appendix B “Bolt tightening torque” for tightening torque specifications.

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

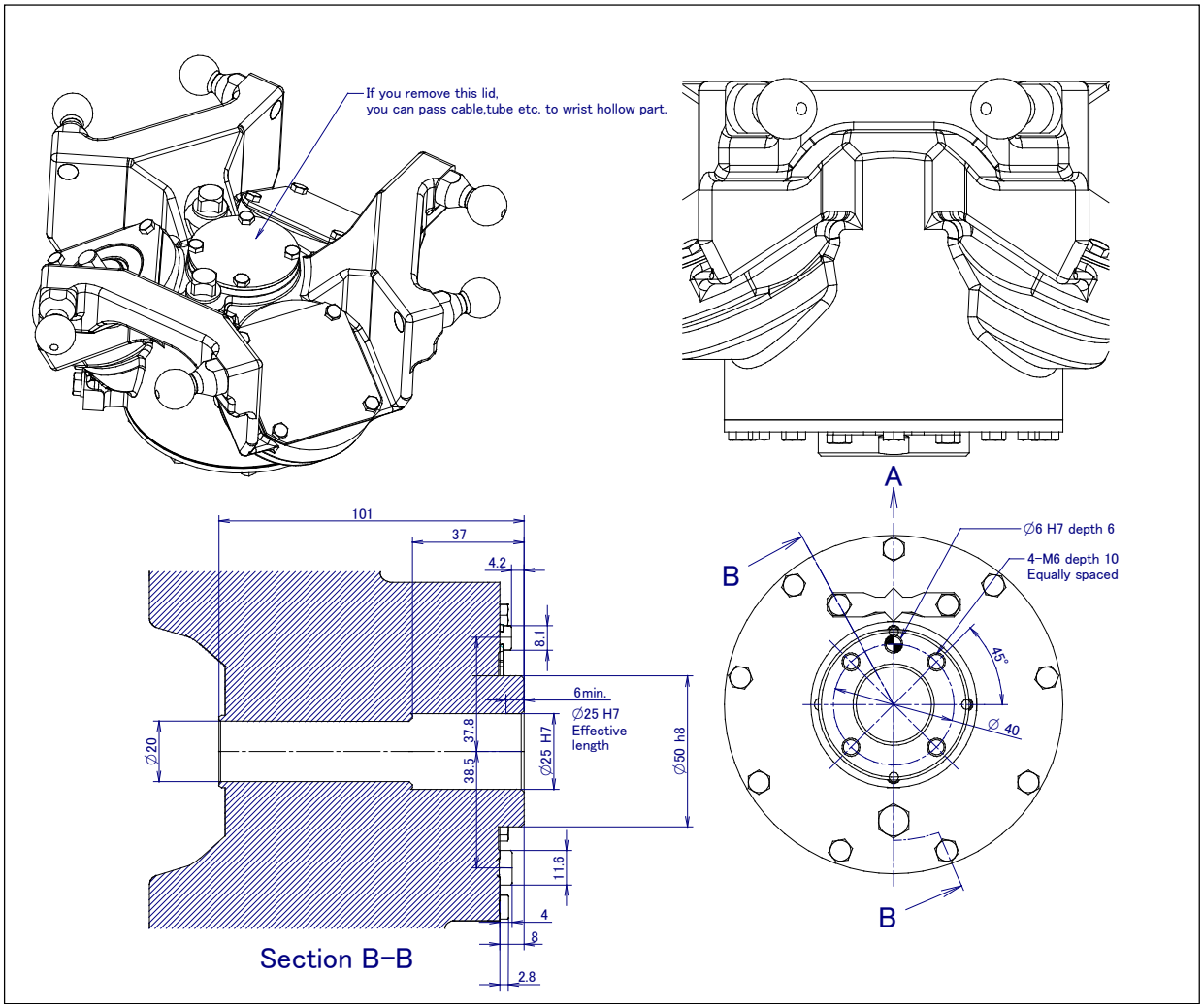


Fig. 4.1 (a) End effector interface (M-3*i*A/6S (A05B-1523-B201))

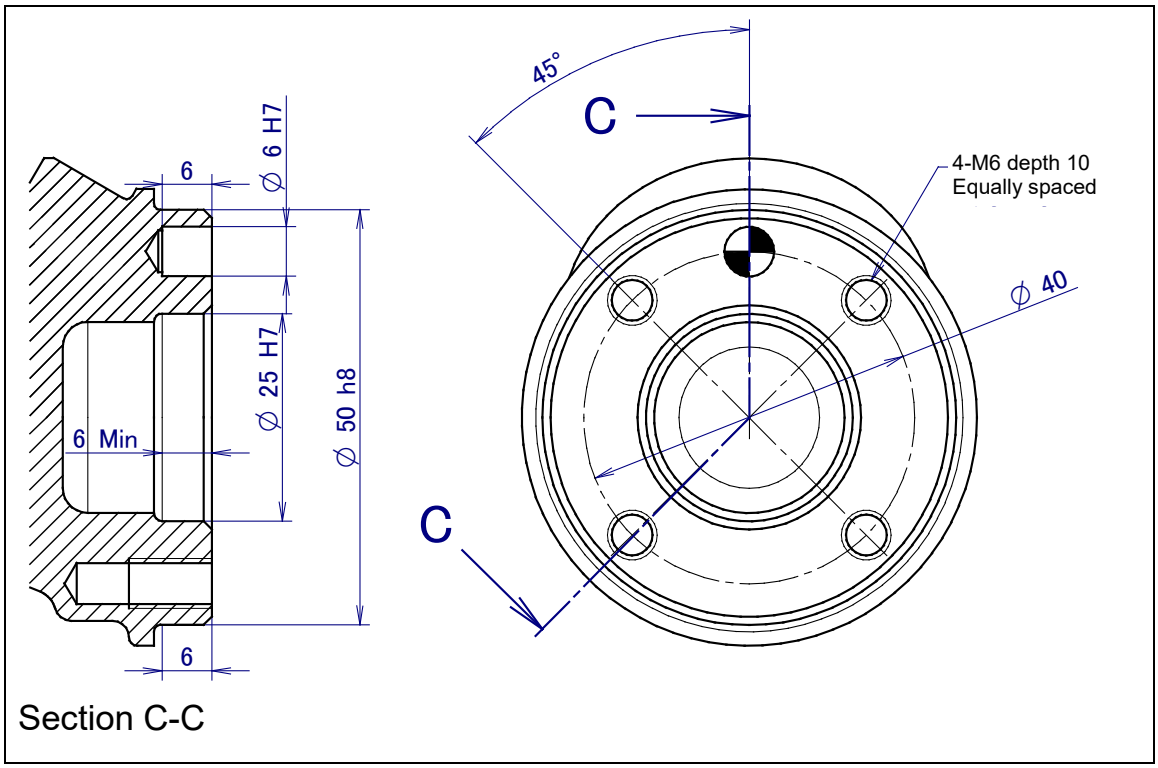


Fig. 4.1 (b) End effector interface (M-3*i*A/6A)

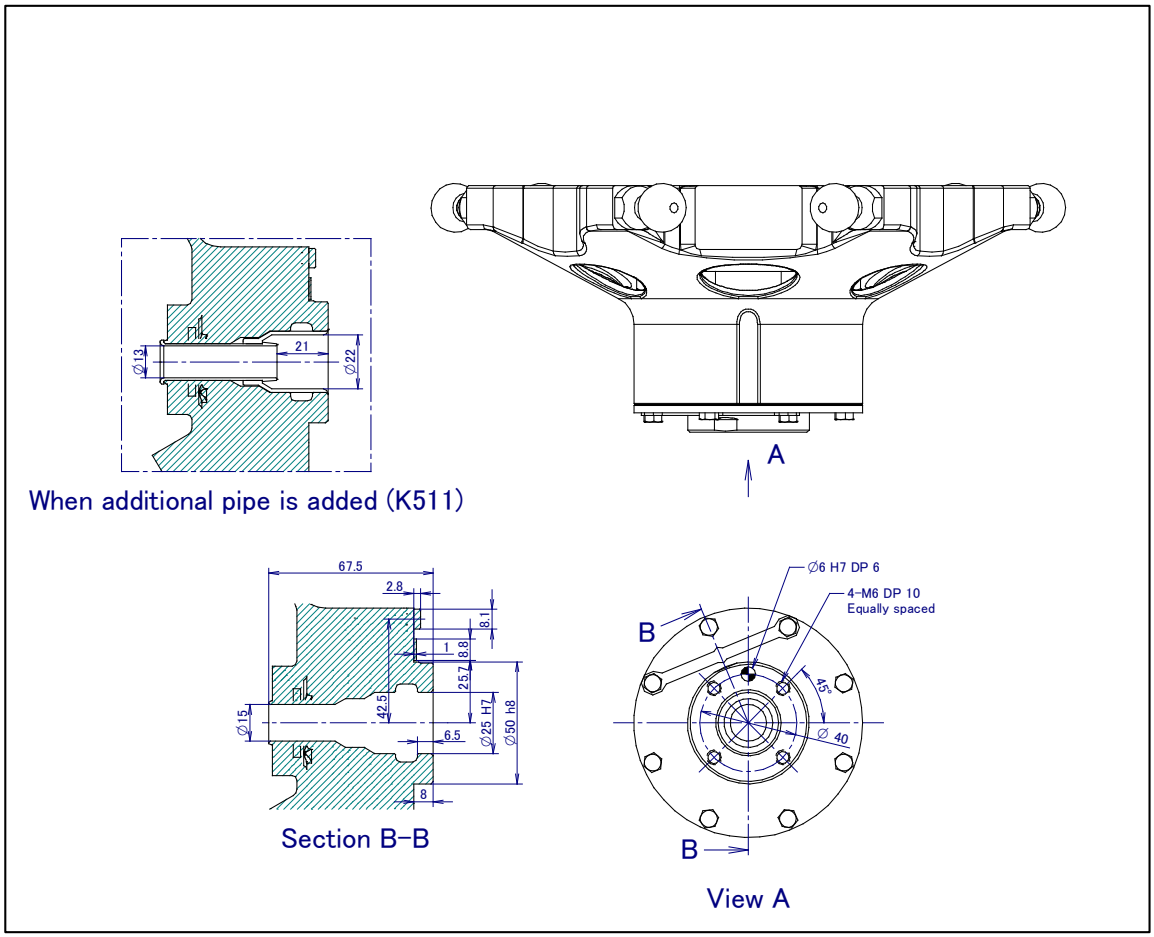


Fig. 4.1 (c) End effector interface (M-3*i*A/6S (A05B-1523-B203))

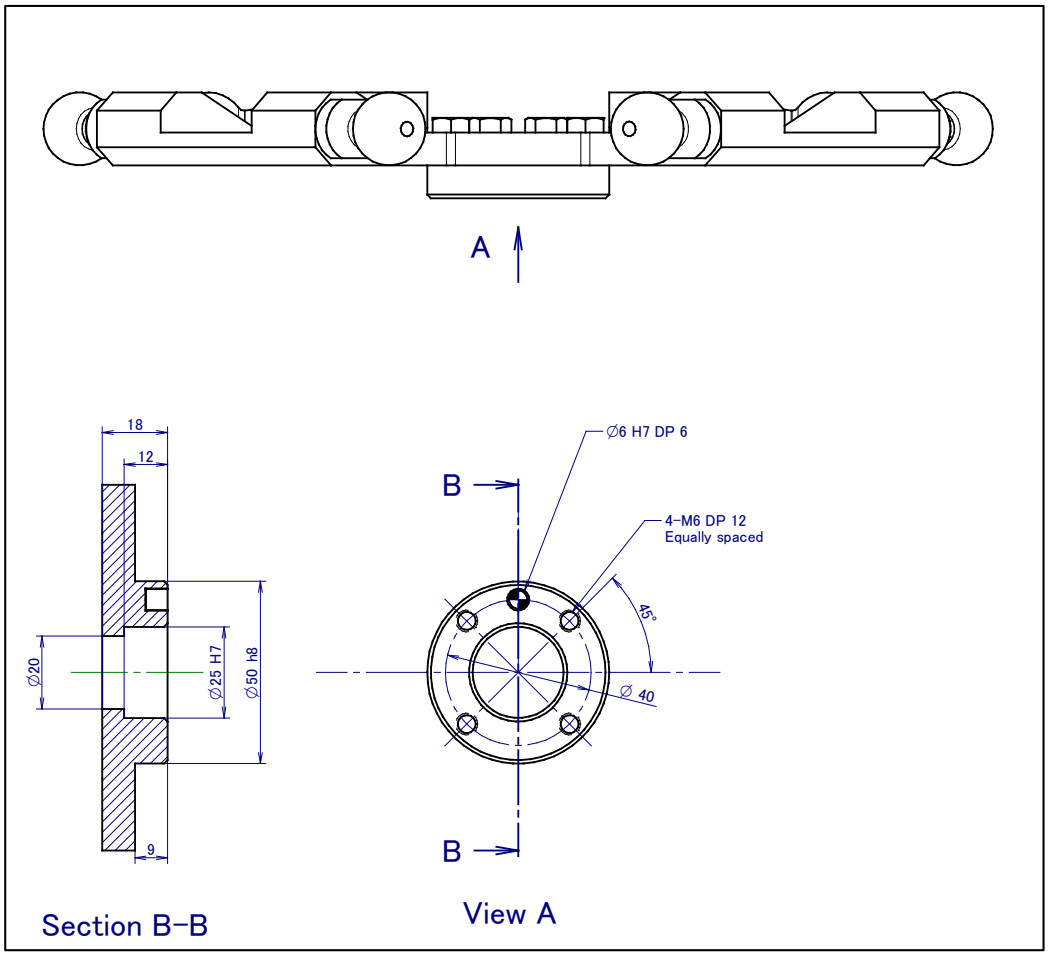


Fig. 4.1 (d) End effector interface (M-3*i*A/12H)

4.2 EQUIPMENT MOUNTING FACE

As shown in Fig. 4.2 (a) to (d) tapped holes are provided to install equipment to the robot.

⚠ CAUTION

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

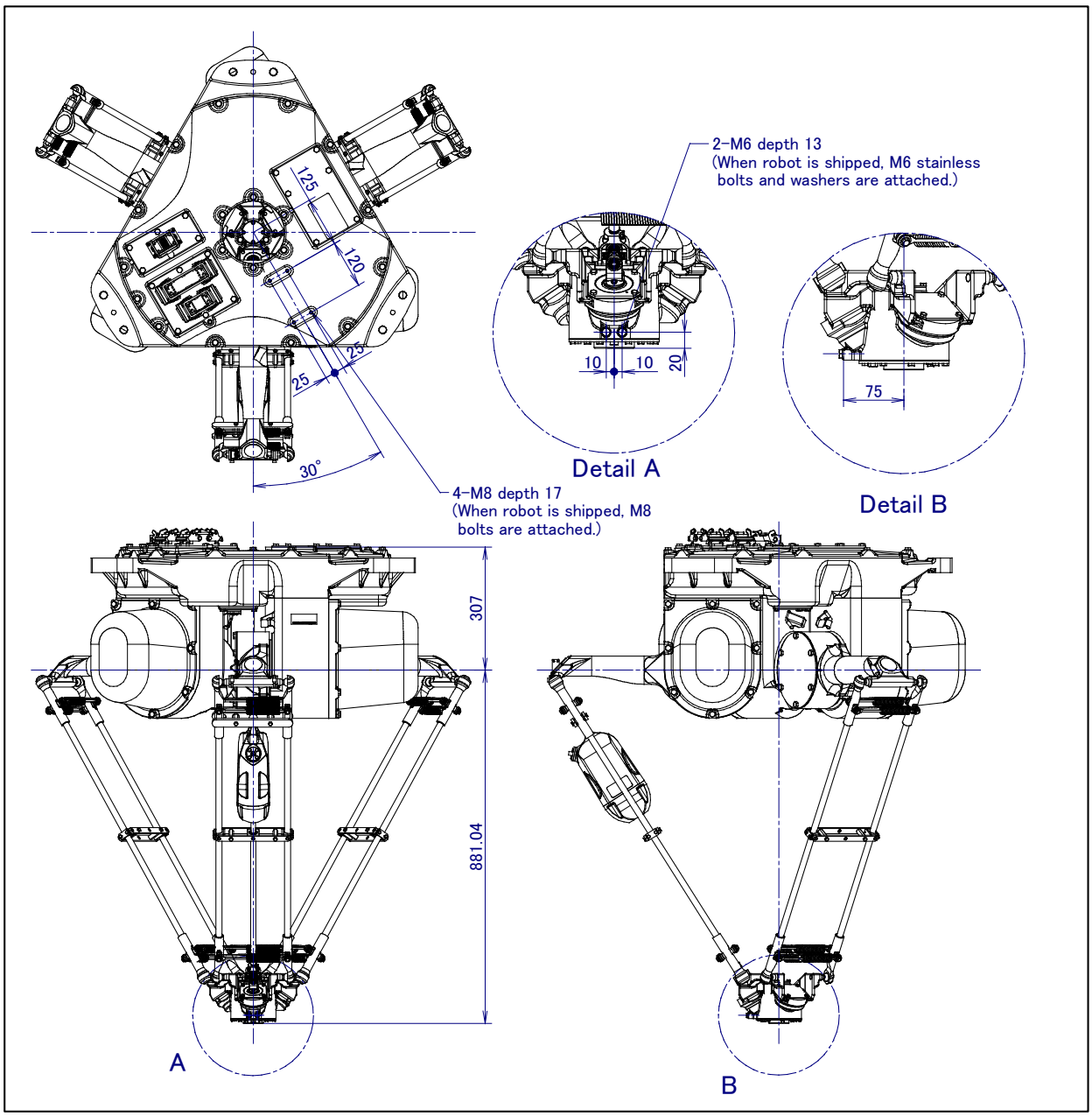


Fig. 4.2 (a) Equipment mounting faces (M-3*i*A/6S (A05B-1523-B201))

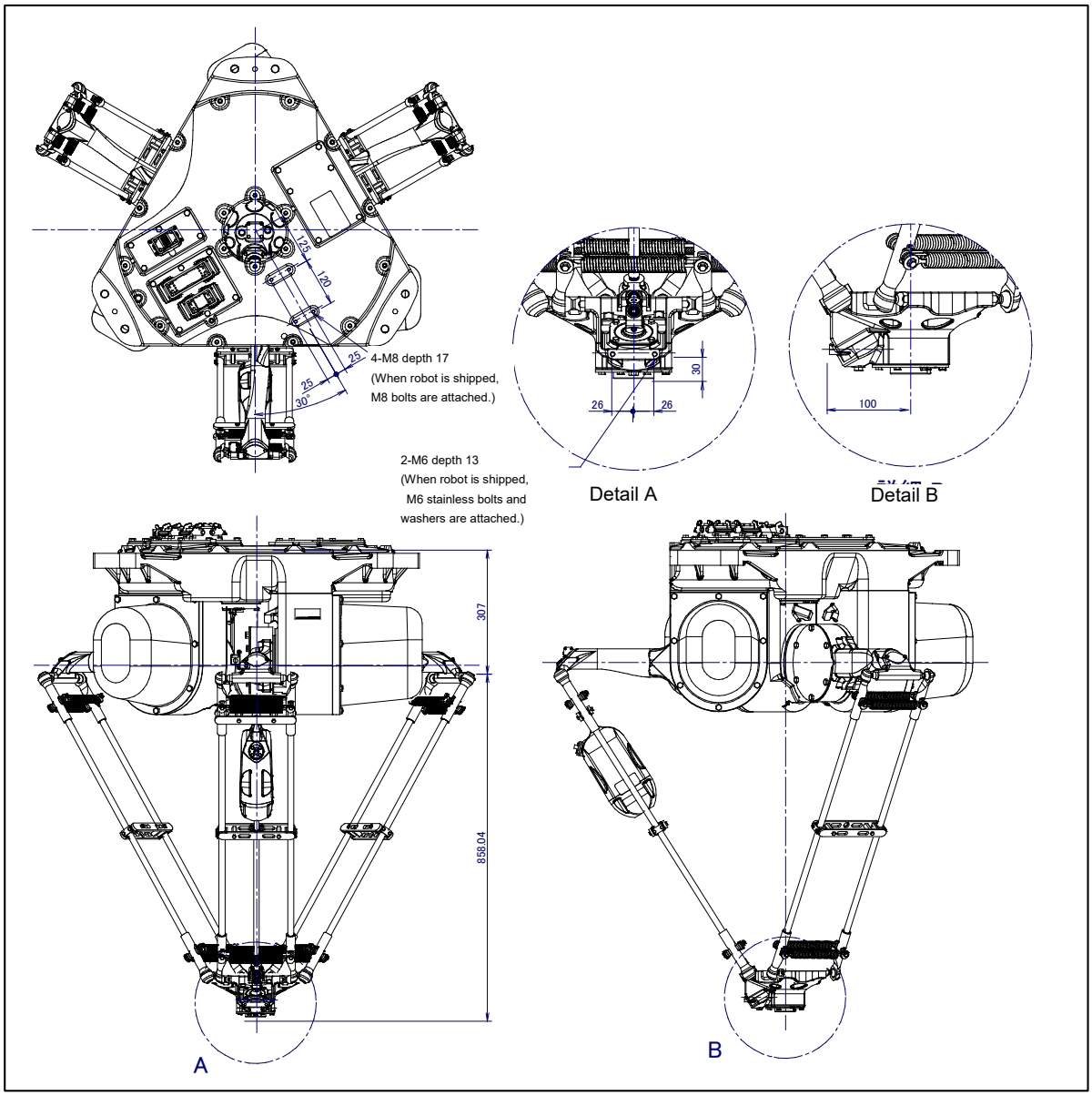


Fig. 4.2 (b) Equipment mounting faces (M-3*i*A/6A)

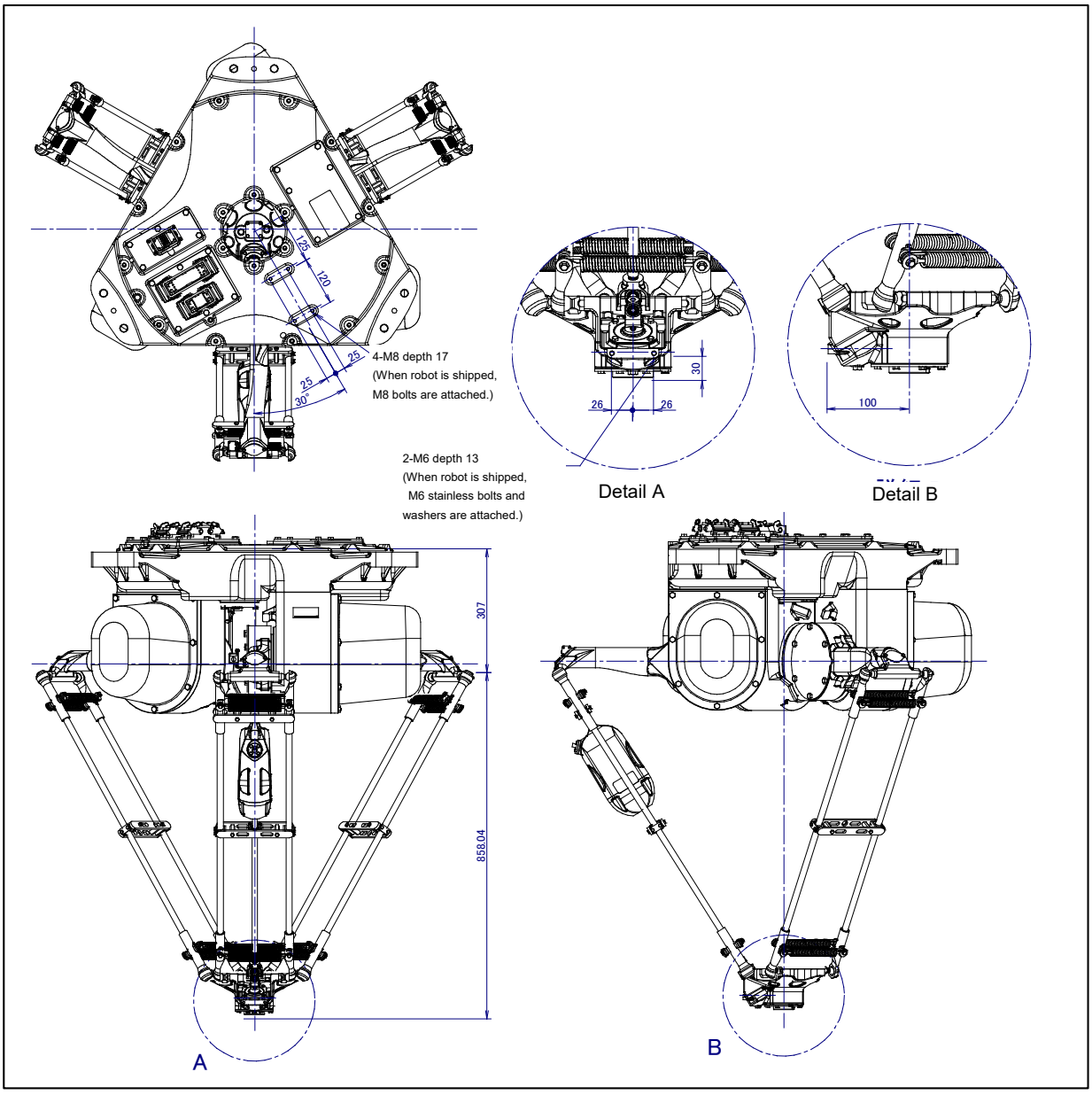


Fig. 4.2 (c) Equipment mounting faces (M-3*i*A/6S (A05B-1523-B203))

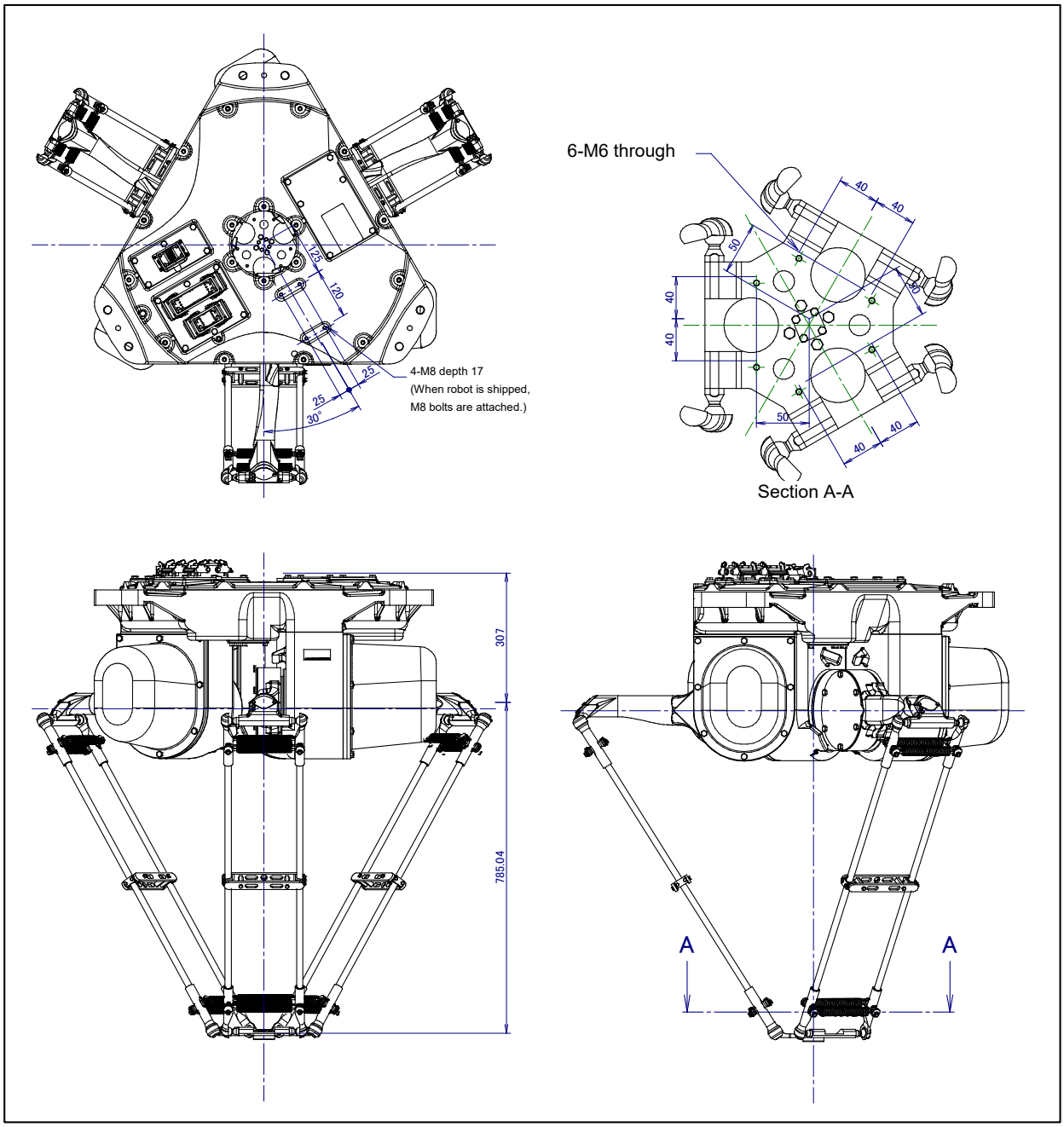


Fig. 4.2 (d) Equipment mounting faces (M-3*i*A/12H)

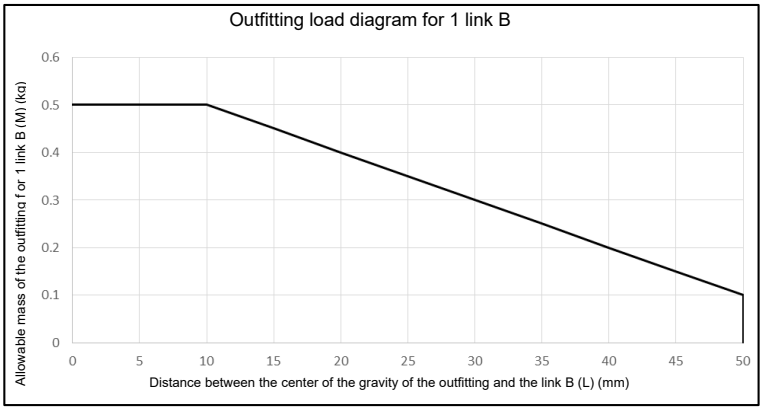
4.2.1 Allowable load of the link B

When installing such as piping to the link B, follow the following allowable load.

- For 1 link B, make the load less than 0.5kg and make distance less than 50mm.
- Add total mass of the outfitting to the load mass of the load setting.

Table 4.2.1 (a) Allowable load of the link B

Distance between the center of the gravity of the outfitting and the link B (L)	±10mm	±20mm	±40mm	±50mm
Allowable mass of the outfitting for 1 link B (M)	0.5kg	0.4kg	0.2kg	0.1kg



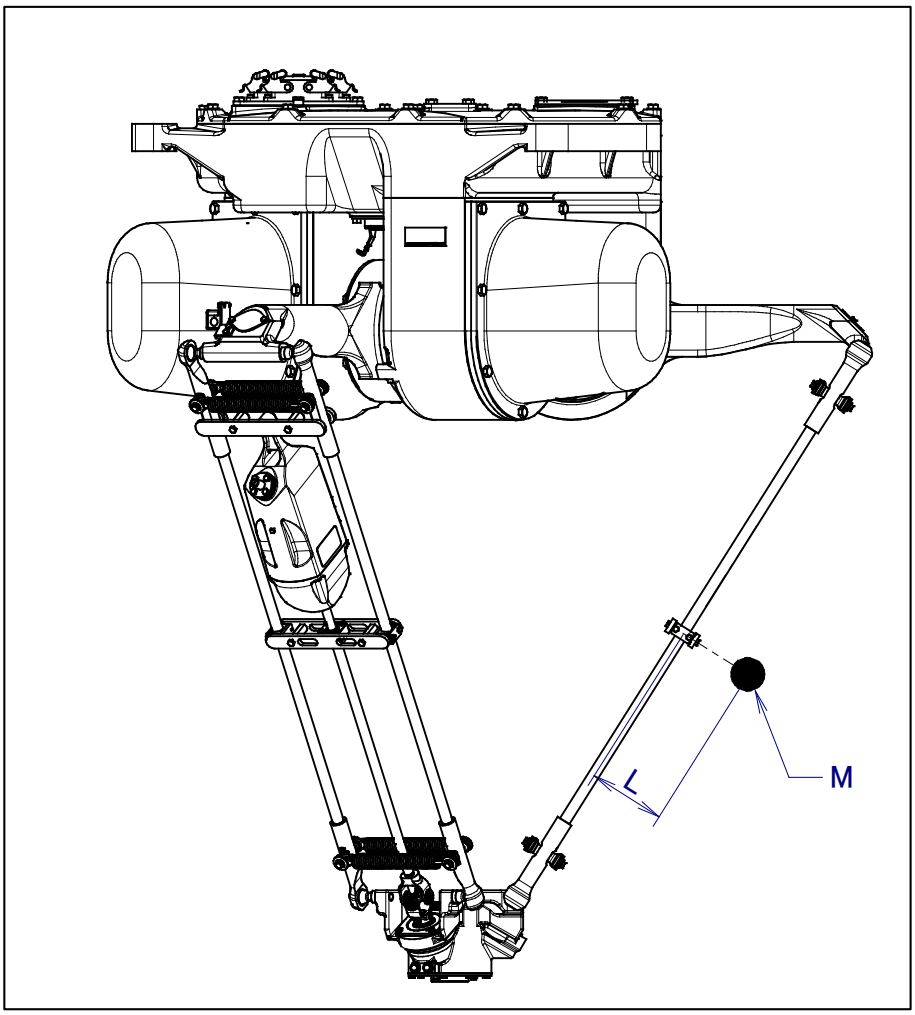


Fig. 4.2.1 (a) Allowable load of the link B

4.3 LOAD SETTING

⚠ CAUTION

1 Set load condition parameter before robot runs. Do not operate the robot in over payload. Don't exceed allowable payload including connection cables and its swing. Operation in over payload may occur troubles such as reducer life reduction.
2 Excessive collision or excessive overload sometimes causes link disconnection for minimizing the damage. The recovering procedure is mentioned in Subsection 6.3.3 of operator's manual.
3 In case of M-3*i*A/12H, Motion range changes according to wrist part payload. Load setting is performed, motion range is automatically changed to correct one.

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

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

```
MOTION PERFORMANCE                    JOINT 10%
    Group1
 No.   PAYLOAD[kg]          Comment
  1                6.00    [                  ]
  2                0.00    [                  ]
  3                0.00    [                  ]
  4                0.00    [                  ]
  5                0.00    [                  ]
  6                0.00    [                  ]
  7                0.00    [                  ]
  8                0.00    [                  ]
  9                0.00    [                  ]
 10                0.00    [                  ]

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

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

```
MOTION PAYLOAD SET              JOINT   100%

   Group 1
   Schedule No[   1]:[Comment          ]
 1 PAYLOAD             [kg]          6.00
 2 PAYLOAD CENTER  X   [cm]          0.00
 3 PAYLOAD CENTER  Y   [cm]          0.00
 4 PAYLOAD CENTER  Z   [cm]          0.49
 5 PAYLOAD INERTIA X   [kgfcms^2]  100.00
 6 PAYLOAD INERTIA Y   [kgfcms^2]  100.00
 7 PAYLOAD INERTIA Z   [kgfcms^2]    0.05

 [TYPE]  GROUP  NUMBER  DEFAULT  HELP
```

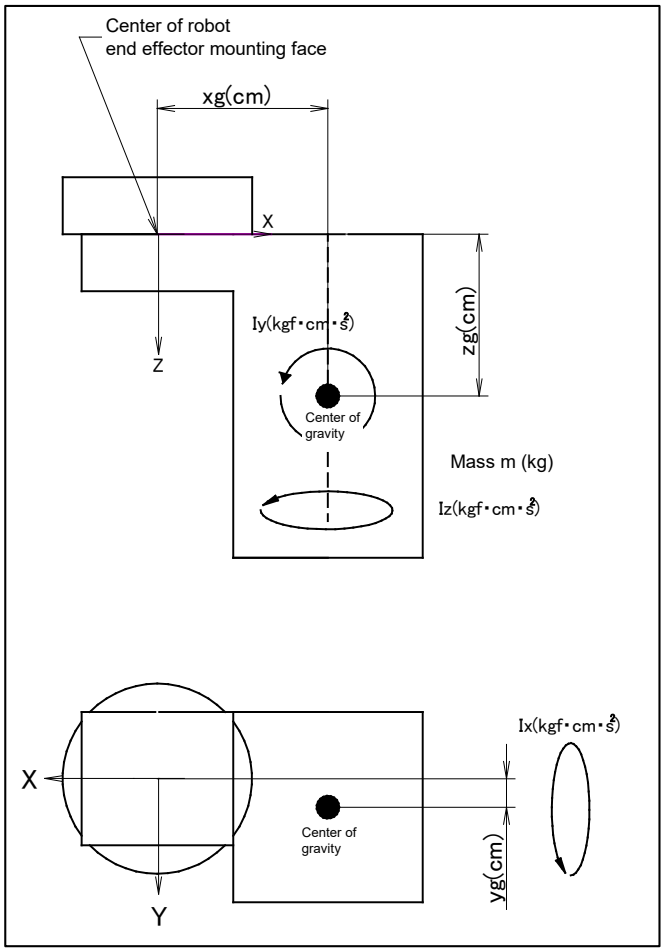


Fig. 4.3 (a) Standard tool coordinate

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

7 Pressing F3 ([NUMBER]) will bring you to the MOTION PAYLOAD SET screen for another condition number. For a multigroup system, pressing F2 ([GROUP]) will bring you to the MOTION PAYLOAD SET screen for another group

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

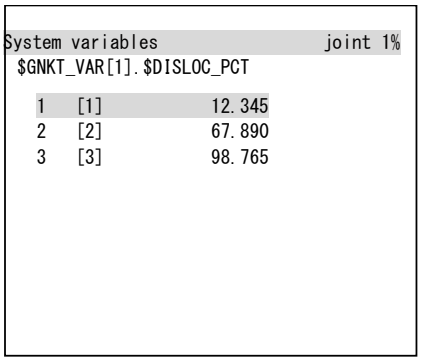
4.4 JOINT LOAD MONITOR

⚠ CAUTION

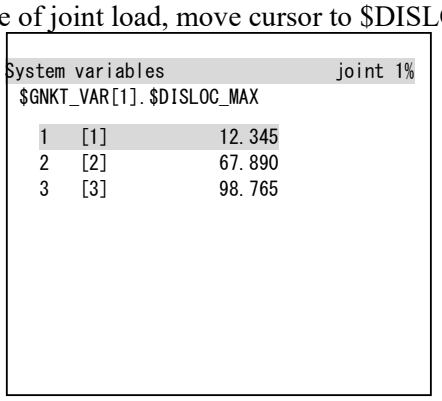
1 Link disconnection may occur when warning message is displayed in the program. When executing program, adjust speed and ACC to prevent warning message is displayed.
2 When tracking is executed, the value of joint load changes by the position of work. Perform trial run enough and confirm warning message is not displayed.
3 This function is calculated by the load information. So it is necessary to set load information. Be sure to perform load setting referring to Section. If load weight , position of center of gravity of load and inertia of center of gravity in not set correctly, you cannot obtain correct result.

Joint load monitor is function to guess the possibility of link disconnection when program is executed. If you execute program or test execution is executed, present value of joint load is stored to $DISLOC_PCT which is in system variables $GNKT_VAR. and max of joint load is se to $DISLOC_MAX. if value is 100 or more, warning message is displayed and link disconnection may occur. (When software version is 7DA7/15 or later, robot slows down and stops.)
Warning message is displayed as “MOTN-522 Load joint excess. (G group number J axis number L line number program name) About the movement that a warning message produced, please perform measures to loosen the change of the instruction position, movement speed while referring to joint load by the following methods.

1 Press the [MENU] key to display the screen menu.
2 Select “6 SYSTEM” from the next page.
3 Press F1 ([TYPE]).
4 Select “System variables”. Then system variables screen is displayed.
5 Move cursor to $GNKT_VAR and press input key.
6 If you would like to refer present value of joint load, move cursor to $DISLOC_PCT and press input key.



7 If you want to refer max value of joint load, move cursor to $DISLOC_MAX and press input key.



4.5 M-3*i*A/6S 8kg MODE (HIGH INERTIA MODE) (OPTION)

About M-3*i*A/6S 8kg (high inertia mode) Option

In M-3*i*A/6S, the best two servo motion parameters are prepared depending on the magnitude of load inertia. The best addition and subtraction velocity operation can be achieved by setting the parameter matched to the load inertia mode.

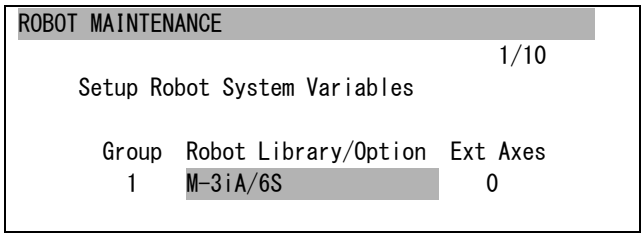
This function needs M-3*i*A/6S 8kg option (high inertia mode) (for R-30*i*A/R-30*i*A Mate Controller : A05B-2560-J595, for R-30*i*B/R-30*i*B Mate Controller :A05B-2660-J595). M-3*i*A/6S is set in standard inertia mode when robot is shipped.

NOTE
The name “High inertia mode” was changed to “8kg option” in the middle.

For Software version V8.10P/12 or later (8kg option or high inertia mode)

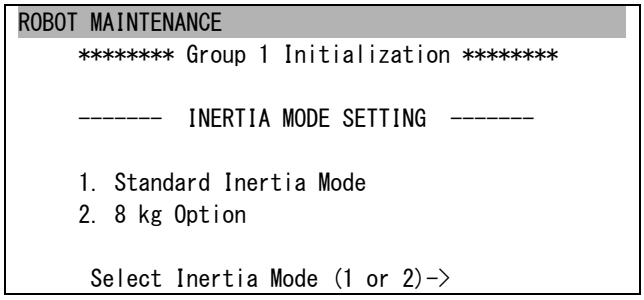
The parameter is changed by the following methods.

1 Turn ON the controller with the [PREV] key and the [NEXT] key pressed.
Then select “3. Controlled start”.
2 Press MENU key and select “9. MAINTENANCE”.
3 The following screen will be displayed.
Press arrow (↑ , ↓) keys and move the cursor to “M-3*i*A/6S” . Then press F4, MANUAL.



4 Set “Standard Inertia Mode” or “8 kg Option” on the INERTIA MODE SETTING screen.
(“High Inertia Mode” is displayed on the controlled start screen instead of 8kg option depend on the software version.)

⚠ WARNING
In case of V8.10 of software version V8.10P/12 or later or V8.20 of software version V8.20P/16 or before or V8.30 of software version V8.30P/01 or before, it is high inertia mode. Allowable payload is 6kg or less.



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

For Software version V8.10P/11 or before (Software version high inertia mode)

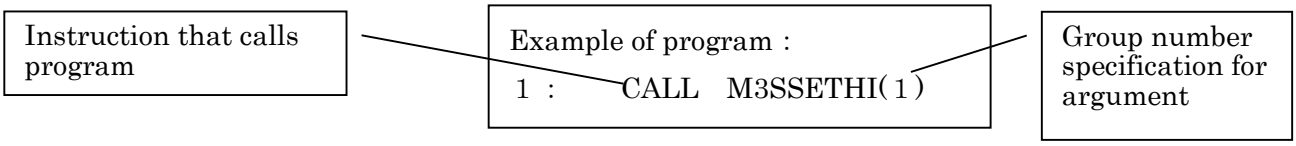
The parameter is changed by executing the following KAREL programs (It is abbreviated as KAREL for Changing method of wrist payload specification thereafter.)

- M3SSETST.PC: Standard inertia mode
- M3SSETHI.PC: High inertia mode

Method of shifting (Software version V8.10P/11 or before)

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

1) Method of executing KAREL program by using "Call program" → Refer to Subsection 4.5.1
   - The KAREL program is set in the program call instruction of the TP program and the parameter is set by specifying with the argument that shows the group number, and executing it. The parameter of M-3*i*A/6S of a specific group can be switched in this method.



2) Method of executing KAREL program directly → Refer to Subsection 4.5.2
   - Select and execute the KAREL program in program select screen.
   - Two or more M-3*i*A/6S exists in the multi group system, and it is possible to change in this method bringing the parameter of two or more M-3*i*A/6S together to set the parameter for the same load as them.

NOTE

1 Execute KAREL for Changing method of wrist payload specification in the state of cold start mode.
2 Be careful that the tracks and the cycle time of an existing instruction program change if KAREL for changing method of load inertia specification is executed.

It depends as follows, and it explains the method of executing KAREL for Changing method of load inertia specification.

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

∗ The following procedures assume the thing of changing M-3*i*A/6S of the first group to the 8kg option.

Execution procedure

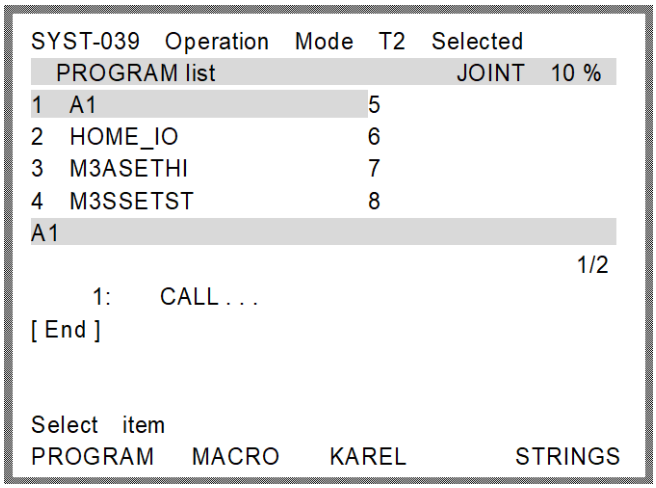
1 Call the system variable screen.

MENU key → Select "System" and press F1 key(screen) → Select "System variables"

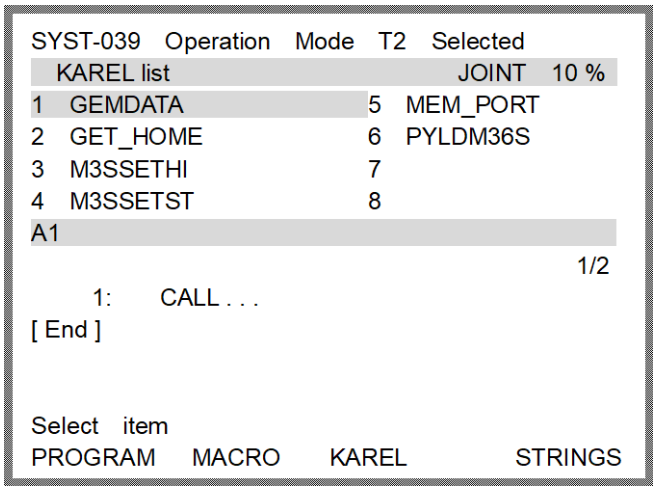
2 Set system variables $KAREL_ENB to 1.
3 Open TP program edit screen.
4 Select "call program" from among the program instruction

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

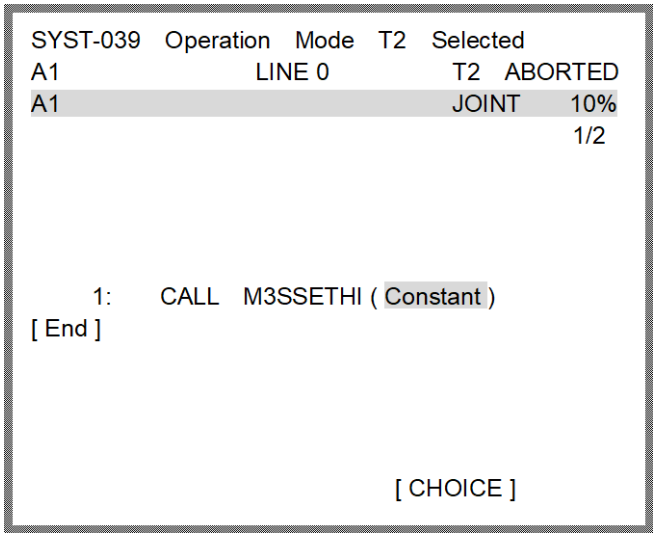
Then, the following screens are displayed.



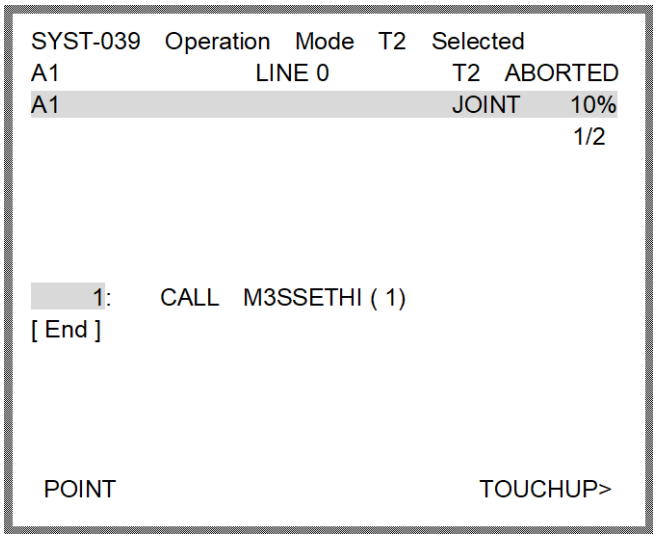
5 Press F3 key (KAREL). Then, select KAREL M3SSETHI of high inertia mode from among that because it becomes the following screens.



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



7 The group number (It is 1 here) is put with the cursor in “Constant”.



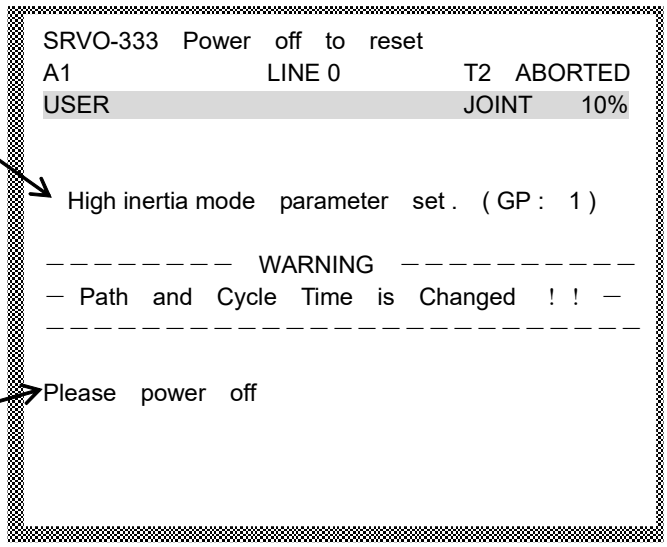
8 Execute this program.

Push FWD key while pushing SHIFT key.

Then, the following screens are displayed. This shows the thing that KAREL M3SSETHI.PC of high inertia mode is executed.

This means mode is changed to high inertia mode.

Please turn off the controller power and turn it on.



9 Turn on the controller power again.

The change of the parameter ends above.

4.5.2 Method of Executing KAREL Program Directly

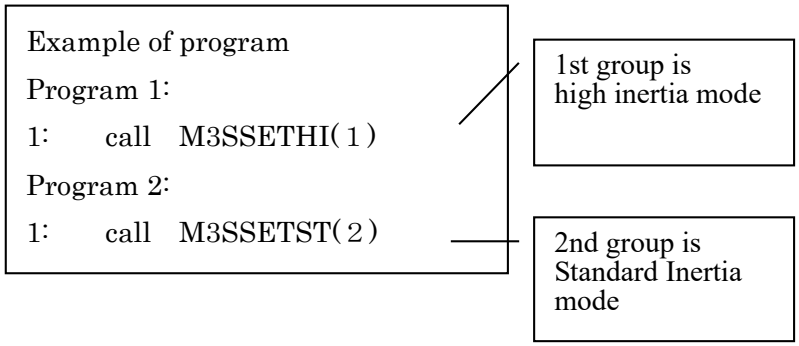
Use scene

For instance, it is assumed that the following multi group systems exist.
1st group: M-3*i*A/6S
2nd group: M-3*i*A/6S
3rd group: M-3*i*A/6A
When the method of the explanation in this chapter is used to do M-3*i*A/6S of the 1st group and 2nd group here to high inertia mode, it is possible to set the 1st group and 2nd group to the parameter of high inertia mode at the same time.

NOTE

If you want to M-3*i*A/6S of 1st group to high inertia mode and M-3*i*A/6S of 2nd group to standard inertia mode, Method of this chapter cannot be used.
In that case, please make two programs as follows, and do the parameter change by the method of Chapter 1.

1 Turn on the controller power again after executing the program 1.
2 Turn on the controller power again after executing the program 2.



Execution procedure

1 Call the system variable screen.

MENU key → Press F1 key (screen) after selecting "system" → Select system variables

2 Set system variables $KAREL_ENB to 1.

3 Call program select screen and select "

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

Then, three KAREL programs are displayed as follows.

```
A1                    LINE 0              T2   ABORTED
Select                                G1      JOINT      10%
                   710186   bytes   free            1/7
No .     Program   name          Comment
  1   GEMDATE          PC   [ GEM   Vars             ]
  2   GET_HOME         PC   [ Get   Home   Pos       ]
  3   M3SSETHI         PC   [ High inertia mode]
  4   M3SSETST         PC   [ standard   inertia     ]
  5   MEM_PORT         PC   [                        ]
  6   PYLDM36S         PC   [ M-3iA/6S   payload     ]


[ TYPE ]   CREATE   DELETE   MONITOR   [ ATTR ] >
```

4 Match the cursor to the KAREL program of the load that wants to be set, and push the ENTER key. It is time when it selected M3SSETHI.PC that is KAREL of high inertia mode as follows. The selected program name is displayed to two places as follows.

Selected program name is shown.

```
M3SSETHI              LINE 0              T2   ABORTED
Select                                G1      JOINT      10%
                   710186   bytes   free            3/7
No .     Program   name          Comment
  1   GEMDATE          PC   [ GEM   Vars             ]
  2   GET_HOME         PC   [ Get   Home   Pos       ]
  3   M3SSETHI         PC   [High inertia mode ]
  4   M3SSETST         PC   [ standard   inertia     ]
  5   MEM_PORT         PC   [                        ]
  6   PYLDM36S         PC   [ M-3iA/6S   payload     ]


M3SSETHI   is   selected
[ TYPE ]   CREATE   DELETE   MONITOR   [ ATTR ] >
```

5 Execute the program.

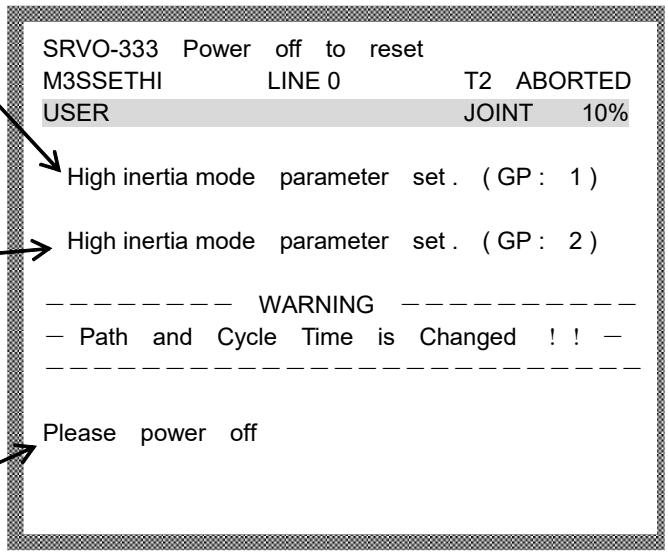
Push FWD key while pushing SHIFT key.

Then, the following screens are displayed. This is case of executing KAREL M3SSETHI.PC of high inertia mode.

This means 1st group is changed to high inertia mode.

This means 2nd group is changed to high inertia mode.

Please turn off the controller power and turn it on.



6 Turn on the controller power again.

The change of the parameter ends above.

5 PIPING AND WIRING TO THE END EFFECTOR

⚠ WARNING

- Only use appropriately-specified mechanical unit cables.
- Do not add user cables or hoses inside of the mechanical unit.
- Please do not obstruct the movement of the mechanical unit when cables are added to outside of mechanical unit.
- Please do not perform remodeling (adding a protective cover, or secure an additional outside cable) that obstructs the behavior of the outcrop of the cable.
- When external equipment is installed in the robot, make sure that it does not interfere with other parts of the robot.
- Cut and discard any unnecessary length of wire strand of the end effector (hand) cable. Insulate the cable with seal tape. (See Fig. 5 (a))
- If you have end effector wiring and a process that develops static electricity, keep the end effector wiring as far away from the process as possible. If the end effector and process must remain close, be sure to insulate the cable.
- Be sure to seal the connectors of the user cable and terminal parts of all cables to prevent water from entering the mechanical unit. Also, attach the cover to the unused connector.
- Frequently check that connectors are tight and cable jackets are not damaged.
- When precautions are not followed, damage to cables might occur. Cable failure may result in incorrect function of end effector, robot faults, or damage to robot electrical hardware. In addition, electric shock could occur when touching the power cables.

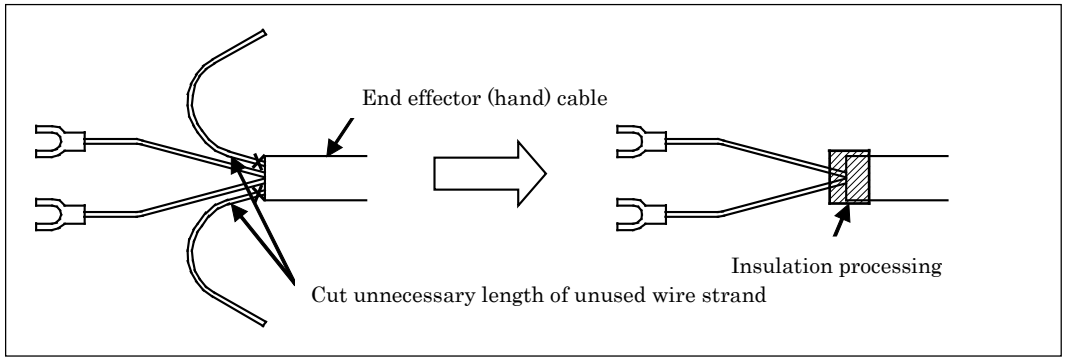
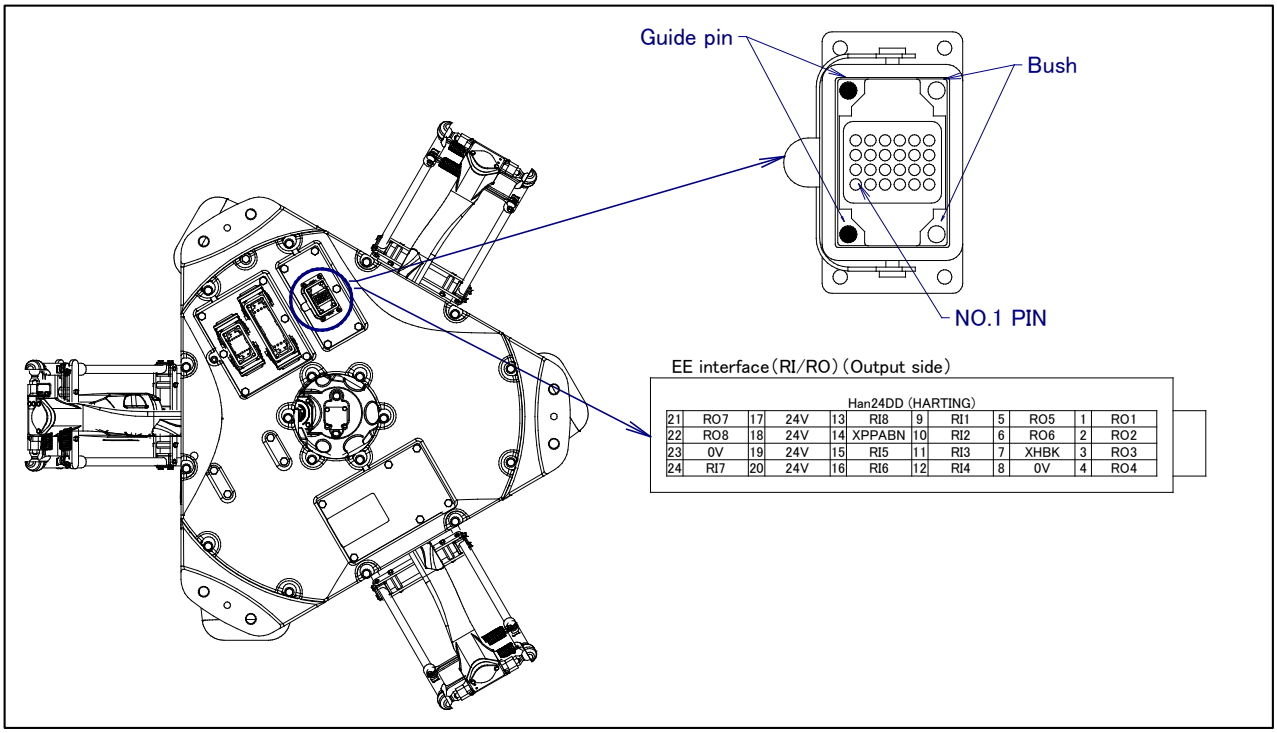


Fig. 5 (a) Treatment method of end effector (hand) cable

5.1 EE (RI/RO) INTERFACE

Fig. 5.1 (a) shows the position and pin lay out of the EE (RI/RO) interface.
The connector has a code pin for preventing improper insertion.



21	RO7	17	24V	13	RI8	9	RI1	5	RO5	1	RO1
22	RO8	18	24V	14	XPPABN	10	RI2	6	RO6	2	RO2
23	0V	19	24V	15	RI5	11	RI3	7	XHBK	3	RO3
24	RI7	20	24V	16	RI6	12	RI4	8	0V	4	RO4

Fig. 5.1 (a) EE interface (RI/RO signal)

> **⚠ CAUTION**
> For wiring of the peripheral device to the EE interface, refer to the ELECTPROCAL CONNECSTIONS Chapter of CONTROLLER MAINTENANCE MANUAL, too.

Connector specifications

Table 5.1 (a) Connector specifications (Mechanical unit side)

Cable	Output side		Maker /dealer
EE(RI/RO)	Housing Insert Contact Guide pin Bush	09 30 006 0301 09 16 024 3101 (Han 24DD F) 09 15 000 6204 09 33 000 9908 09 33 000 9909	Harting K.K.

Table 5.1 (b) Connector specifications (User side)

Cable	Output side		Maker /dealer
EE(RI/RO)	Hood	09 30 006 1540 Side entry 1541 1440 Top entry (FANUC specification : A63L-0001-0453#06B1440) 1441	Harting K.K.
	Insert	09 16 024 3001 (Han 24DD M) (FANUC specification A63L-0001-0453#24DDM)	
	Contact	09 15 000 6104 AWG 26-22 (FANUC specification : A63L-0001-0453#CA6104) 6103 AWG 20 6105 AWG 18 6102 AWG 18 6101 AWG 16 6106 AWG 14	
	Clamp	151D 152D (FANUC specification A63L-0001-0453#A-152D) 153D	
	Guide pin	09 33 000 9908 (FANUC specification A63L-0001-0453#A-9908)	
	Bushing	09 33 000 9909 (FANUC specification A63L-0001-0453#A-9909)	

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

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
1 The periodic maintenance procedures described in this chapter assume that the FANUC robot is used for up to 3840 hours a year. In cases where robot use exceeds 3840 hours/year, adjust the given maintenance frequencies accordingly. The ratio of actual operating time/year vs. the 3840 hours/year should be used to calculate the new (higher) frequencies. For example, when using the robot 7680 hours a year, the maintenance frequency should be doubled – i.e. the interval should be divided by 2.
2 Repair the paint detachment immediately if damaged during the maintenance work. Once leaving those damages without any proper repair, the corrosion and chemical resistance will not maintain. This repair work is especially important for the white epoxy paint.

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	Check to see if there is oil on the sealed part of each joint. If there is an oil seepage, clean it. **⇒"6.2.1 Confirmation of oil seepage"**
Abrasion	Check there is abrasion on each part. **⇒"6.2.1 Confirmation of oil seepage and abrasion"**
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 whether the taught positions of the robot have not deviated from the previous taught positions. When the displacement occurs, perform the measures as described in the following section: **⇒"8.1 TROUBLESHOOTING"(Symptom : Displacement)**
Peripheral equipment for proper operation	Check whether the peripheral equipment operate properly according to commands from the robot and the peripheral equipment.
Brakes for each axis	Check that the end effector mounting face drops within 0.2 mm 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/R-30*i*B Compact 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 total operating time or the accumulated operating time, whichever comes first. (○ : Item needs to be performed.)

Check and maintenance intervals (Operating time, Accumulated operating time)								Check and maintenance item	Check points, management and maintenance method	Periodic maintenance table No.
1 month 320h	3 months 960h	6 months 1920h	1 year 3840h	1.5 years 5760h	2 years 7680h	3 years 11520h	4 years 15360h			
○ Only 1st check	○							Check the abrasion of bush of connection part between link A and link B and between link B and wrist and plastic slider backlash	Check abrasion status of bush, if distance is less than permissible value, replace bush by new articles. Check the displacement of the plastic slider backlash. If displacement is more than permissible value, replace it. **⇒" 6.2.2 Check the abrasion of bush of connection part between link A and link B and between link B and wrist unit connection part and plastic slider displacement"**	7
○ Only 1st check	○							Cleaning the controller ventilation system	If the controller ventilation system is dusty, turn off power and clean the unit.	21
	○							Check the external damage or peeling paint	Check whether the robot has external damage or peeling paint due to the interference with the peripheral equipment. If an interference occurs, eliminate the cause. Also, if the external damage is serious, and causes a problem in which the robot will not operate, replace the damaged parts.	1
	○							Check for 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 for damages to the teach pendant cable, the operation box connection cable or the robot connection cable	Check whether the cables connected to the teach pendant, operation box and robot are unevenly twisted or damaged. If damage is found, replace the damaged cables.	20
	○ Only 1st Check		○					Check for damage to the end effector (hand) cable	Check whether the end effector cables are unevenly twisted or damaged. If damage is found, replace the damaged cables.	9

Check and maintenance intervals (Operating time, Accumulated operating time)								Check and maintenance item	Check points, management and maintenance method	Periodic maintenance table No.
1 month 320h	3 months 960h	6 months 1920h	1 year 3840h	1.5 years 5760h	2 years 7680h	3 years 11520h	4 years 15360h			
	○ Only 1st check		○					Check link B - Carbon link - Spring - Plastic bush for spring - Drive shaft - Rod support - Universal joint	- Check whether there is not damaged, transformation or crack on the link B (carbon). - Check there is no damage, transformation or crack on the drive shaft, the rod supports, the universal joints and the springs. Check there is no abrasion on the plastic bush. Check the set screws are tightened. **⇒"6.2.3 Check the Link B"**	6
	○ Only 1st check							Visual check of wrist motor cable (Except M-3*i*A/12H)	Check there is no kink or damage on the tube of the wrist motor cable	10
	○ Only 1st check		○					Check the connection of the connector panel	Check the tightening of the connector panel. **⇒"6.2.4 Check the mechanical unit 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 external main bolts	Retighten the robot installation bolts, bolts to be removed for inspection, and bolts exposed to the outside. Refer to the recommended bolt tightening torque guidelines at the end of the manual. An adhesive to prevent bolts from loosening is applied to some bolts. If the bolts are tightened with greater than the recommended torque, the adhesive might be removed. Therefore, follow the recommended bolt tightening torque guidelines when retightening the bolts.	5
	○ Only 1st check		○					Clean foreign materials such as dust or powder	Check that foreign materials such as dust or powder does not exist on the robot main body. If there is any, remove them. Especially, clean the robot movable parts well (each joint, around the wrist axis rotation part). **⇒"6.2.5 Cleaning"**	8
	○ Only 1st check		○					Check the operation of the cooling fan	(When cooling fans are installed on the major axis motor) Check whether noise does not occur at the cooling fan. If noise occurs, replace them. Contact your local FANUC representative about replacing methods.	11

Check and maintenance intervals (Operating time, Accumulated operating time)								Check and maintenance item	Check points, management and maintenance method	Periodic maintenance table No.
1 month 320h	3 months 960h	6 months 1920h	1 year 3840h	1.5 years 5760h	2 years 7680h	3 years 11520h	4 years 15360h			
		○						Apply grease to the spherical joint	Apply grease to the spherical joint. **⇒"6.3.2 Apply grease to the spherical joint"**	12
			○					Replacing plastic parts	Replace plastic parts. Contact your local FANUC representative for information regarding replacing the cable.	17
				○				Replacing the mechanical unit batteries	Replace the mechanical unit batteries. Regardless of operating time, replace batteries at 1.5 years. **⇒"6.3.1 Replacing the batteries"**	13
					○			Replacing the motor support kit	Replace the motor support kit. Contact your local FANUC representative for information regarding replacing those.	18
			○					Replacing the oil of the reducer and wrist	Replace the oil of each axis reducer and gearbox **⇒"6.3.3 Replacing the oil of the Drive Mechanism"**	14 – 15
							○	Replacing the parts such as reducers	Replacing the parts such as reducers. Contact your local FANUC representative for information regarding replacing those.	19
							○	Replacing the controller batteries	Replace the controller batteries. Regardless of operating time, replace batteries at 4 years. **⇒Refer to "Chapter 7 Replacing batteries" in the following maintenance manuals.** - **R-30*i*B/ R-30*i*B Plus CONTROLLER MAINTENANCE MANUAL (B-83195EN)** - **R-30*i*B Mate/R-30*i*B Mate Plus CONTROLLER MAINTENANCE MANUAL (B-83525EN)** - **R-30*i*B Mate/R-30*i*B Mate Plus Open Air type CONTROLLER MAINTENANCE MANUAL (B-83555EN)** - **R-30*i*A CONTROLLER MAINTENANCE MANUAL (B-82595EN)** - **R-30*i*A Mate CONTROLLER MAINTENANCE MANUAL (B-82725EN)** - **R-30*i*A Mate Open Air type CONTROLLER MAINTENANCE MANUAL (B-82965EN-1)**	22

6.2 CHECK POINTS

6.2.1 Confirmation of Oil Seepage and Abrasion

Check items

Check whether there is abrasion, oil seepage, transformation and crack. If there is oil seepage, clean it. Grease is applied on sliding parts (*). If there is oil seepage which cause dropping, wipe off it.

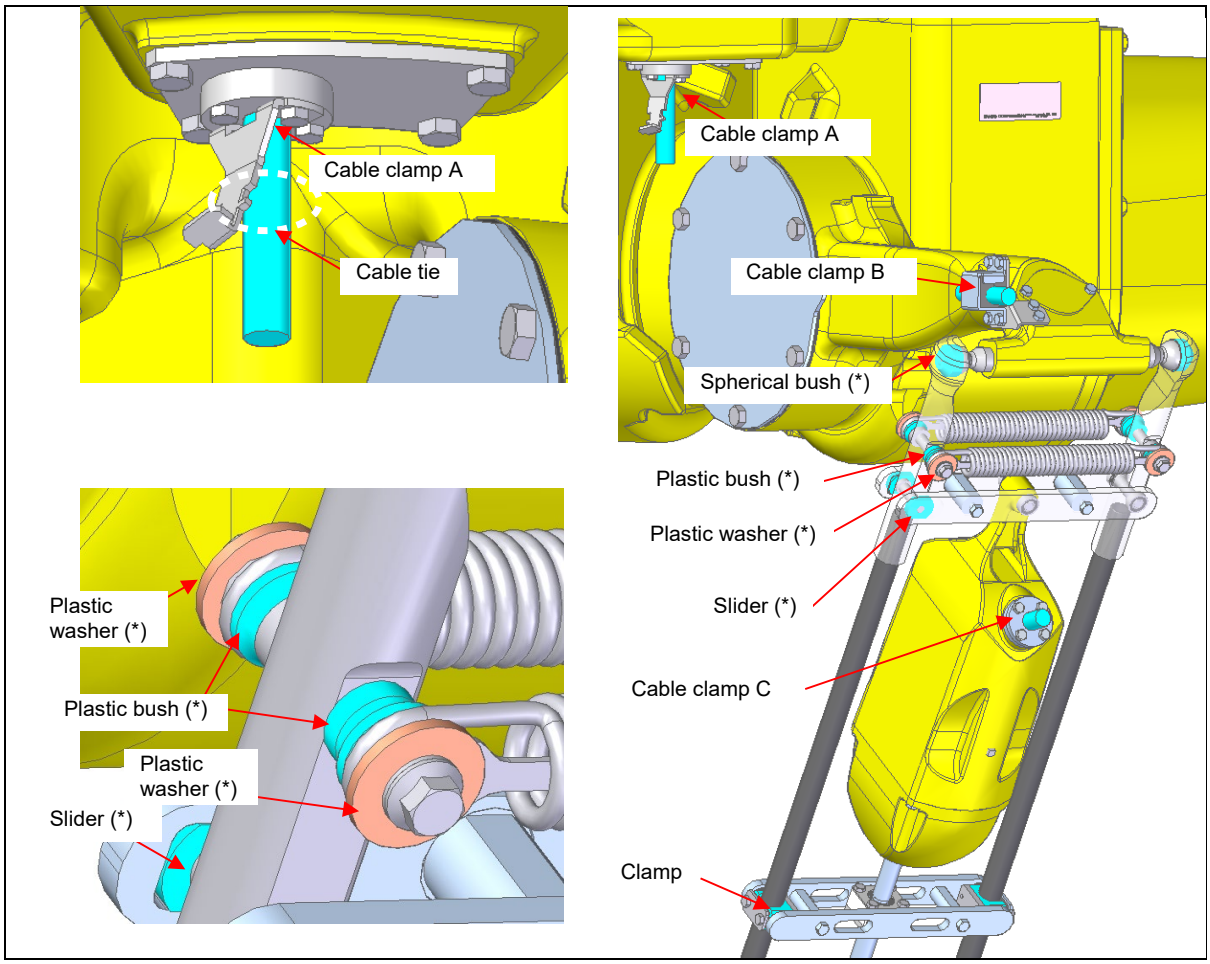


Fig. 6.2.1 (a) Check points

Oil seals are used in the following position. Check the leakage of oil and grease.

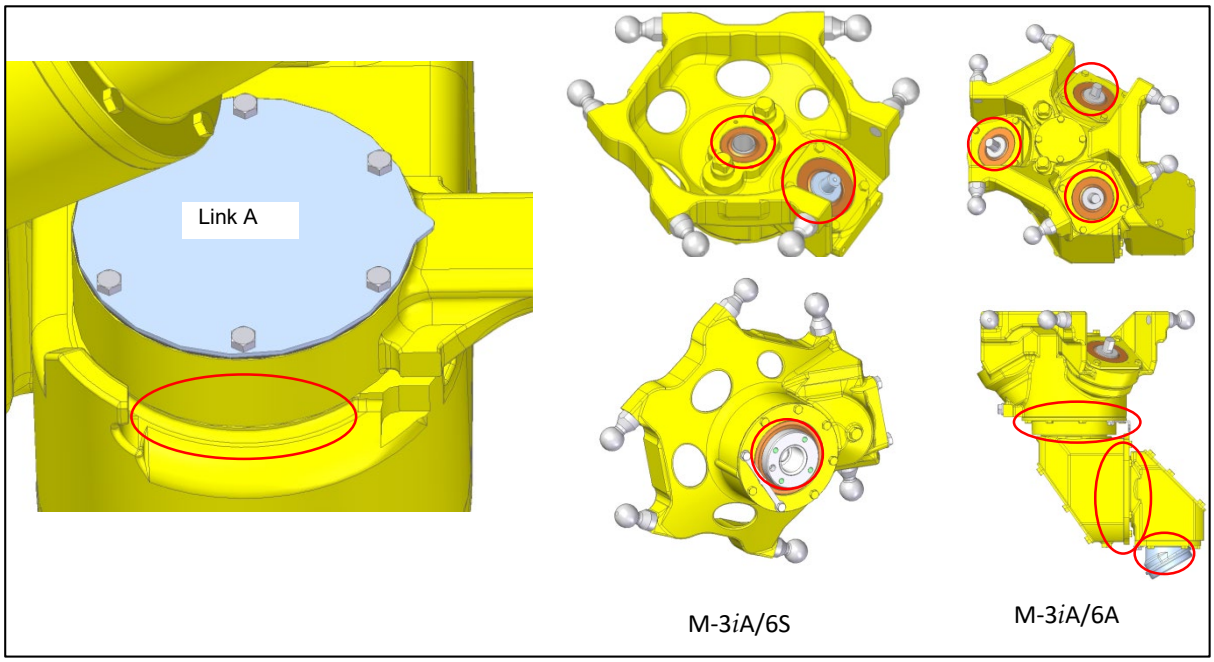


Fig. 6.2.1 (b) Oil seal locations

Management

- Oil might accumulate on the outside of the seal lip depending on the movement condition or environment. If the oil changes to a state of liquid, the oil might fall depending on the axis movement. To prevent oil spots, be sure to wipe away any accumulated oil under oil seals of Fig. 6.2.1 (a), (b) before you operate the robot.
- Oil content is exposed on bush part or spring part. In that case wipe them off.
- In case of oil seepage, please consider replacing the oil. This replacement potentially can help improve the seepage situation.
- If you must wipe oil frequently, and opening the grease outlet does not stop the seepage, perform the measures below.

  ⇒"8.1 TROUBLESHOOTING"(symptom : Oil leakage)

6.2.2 Check the abrasion of bush of connection part between link A and link B and between link B and wrist unit connection part and plastic bush displacement

Check abrasion status of bush (12 places), if distance is less than permissible value, replace bush to new articles. (See Fig.6.2.2 (a))

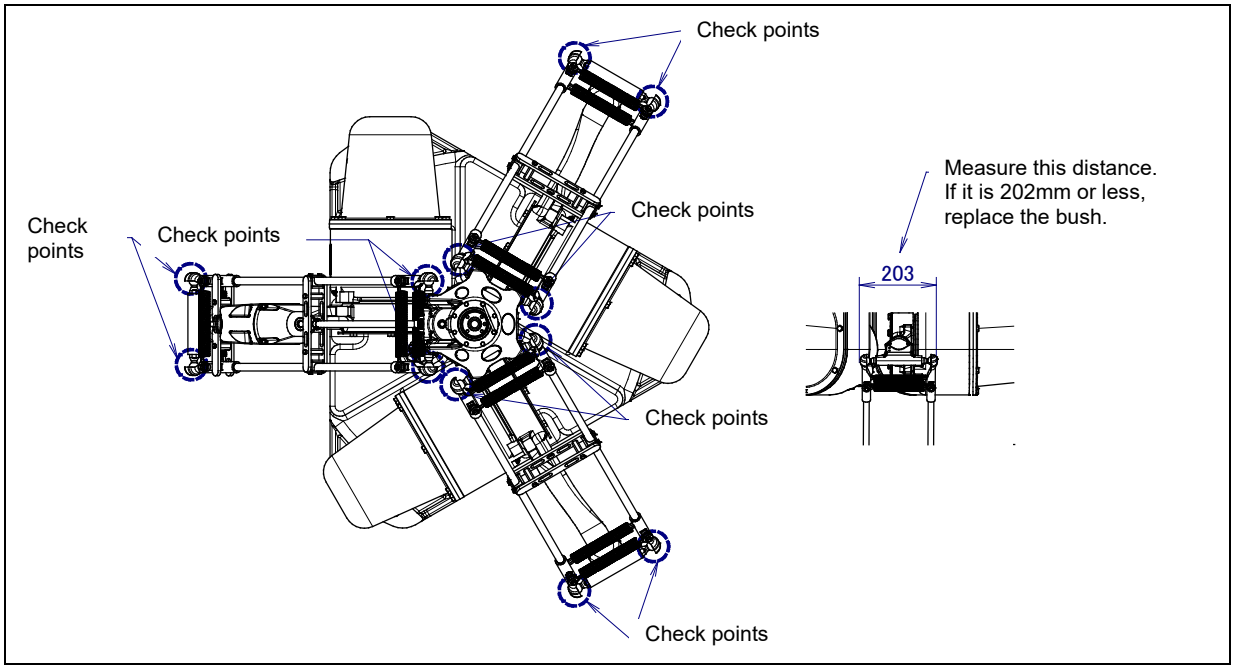


Fig.6.2.2 (a) Checking points of link A and B connecting part bush

Measure the displacement of the following points for check the abrasion amount of the slider. Push up the support plate and measure the displacement by scale etc. If the measured value is more than 1mm, schedule to replace it. (Except M-3*i*A/12H.)

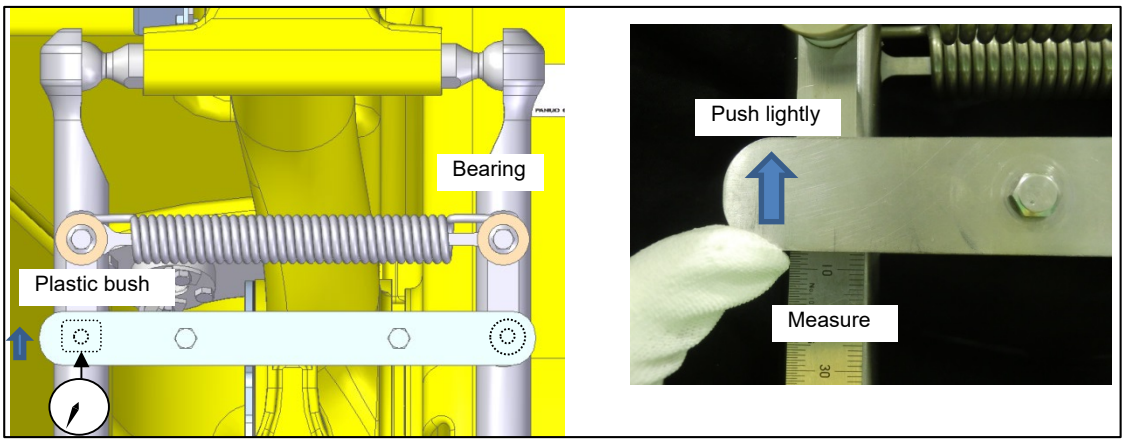


Fig. 6.2.2 (b) Check point of the plastic slider

6.2.3 Check the Link B

- Check there is no damage, transformation or crack on the link B.

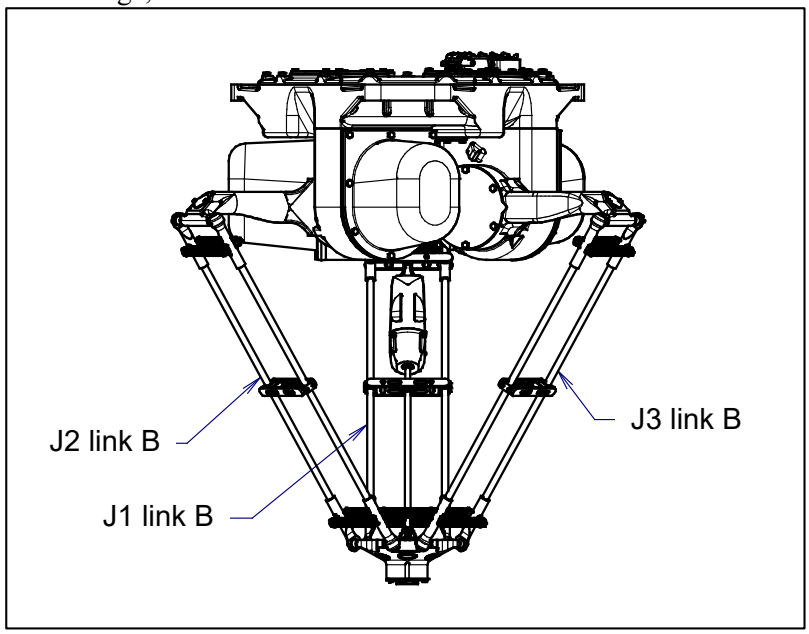


Fig. 6.2.3 (a) Check link B

Check there is no damage, transformation or crack on the drive shaft, the rod supports, the universal joints and the springs. Check there is no abrasion on the plastic bush for spring. Check the set screws are tightened.

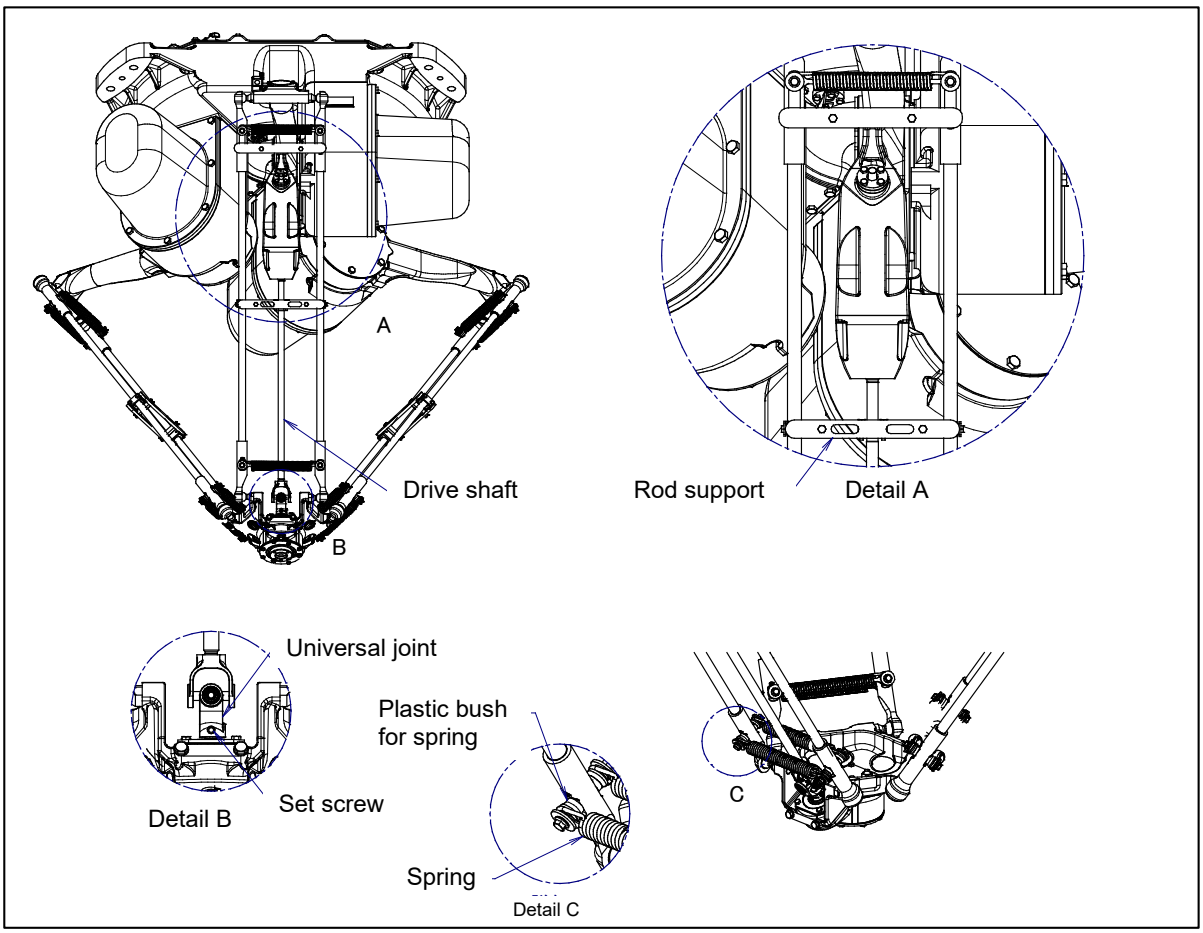


Fig. 6.2.3 (b) Check the drive shaft, rod supports, universal joints, springs and plastic bush for spring

6.2.4 Check the Mechanical Unit Connectors

Inspection points of the connectors

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

Check items

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

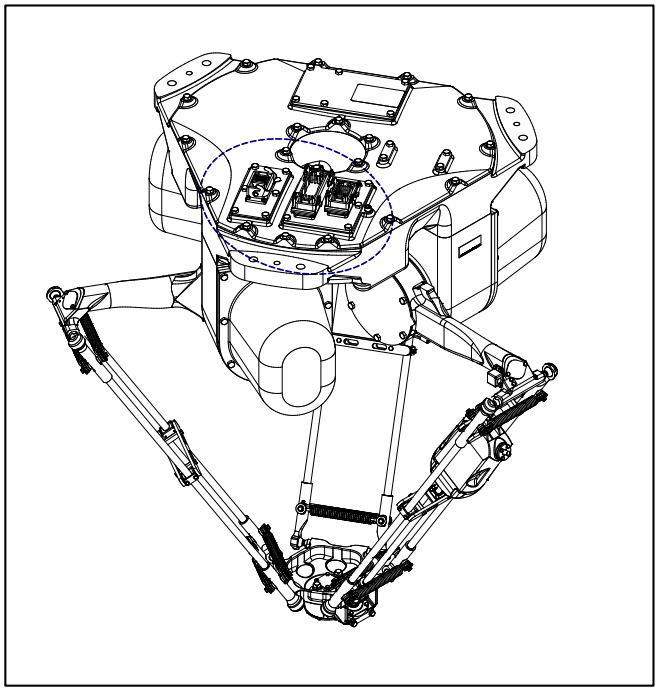


Fig. 6.2.4 (a) Connector Inspection points

6.2.5 Cleaning

Necessary cleaning points, dust on the flat part, accumulation of weld spatter and oil
Clean sediments periodically. In particular, clean the following points carefully.

Vicinity of the wrist axis and oil seal
If chippings or spatters are attached to the oil seal, an oil leak may be occurred.

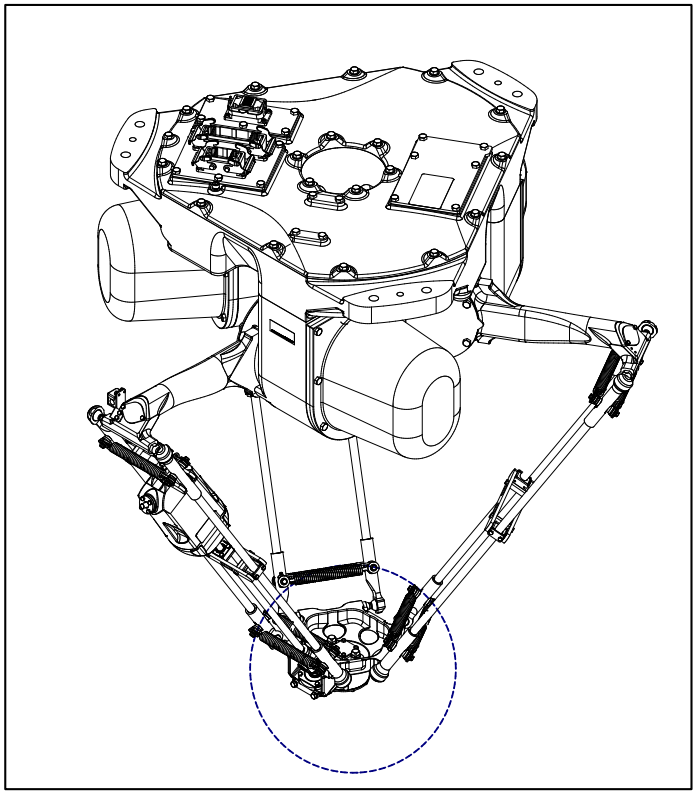


Fig. 6.2.5 (a) Cleaning part

6.3 MAINTENANCE

6.3.1 Replacing the Batteries (1.5-year (5760 Hours) Checks)

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

Procedure of replacing the battery (if built-in batteries are specified)

1 Keep the power on. 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 plate mounting stainless bolts and remove the plate.
3 Remove the battery case cap. (Fig.6.3.1 (a))
4 Take out the old batteries from the battery case.
5 Insert new batteries into the battery case. Pay attention to the direction of batteries.
6 Close the battery case cap.
7 Attach the plate and the gasket. In this time, replace the gasket by new one.
Apply LOCTITE 243 to plate mounting bolt.

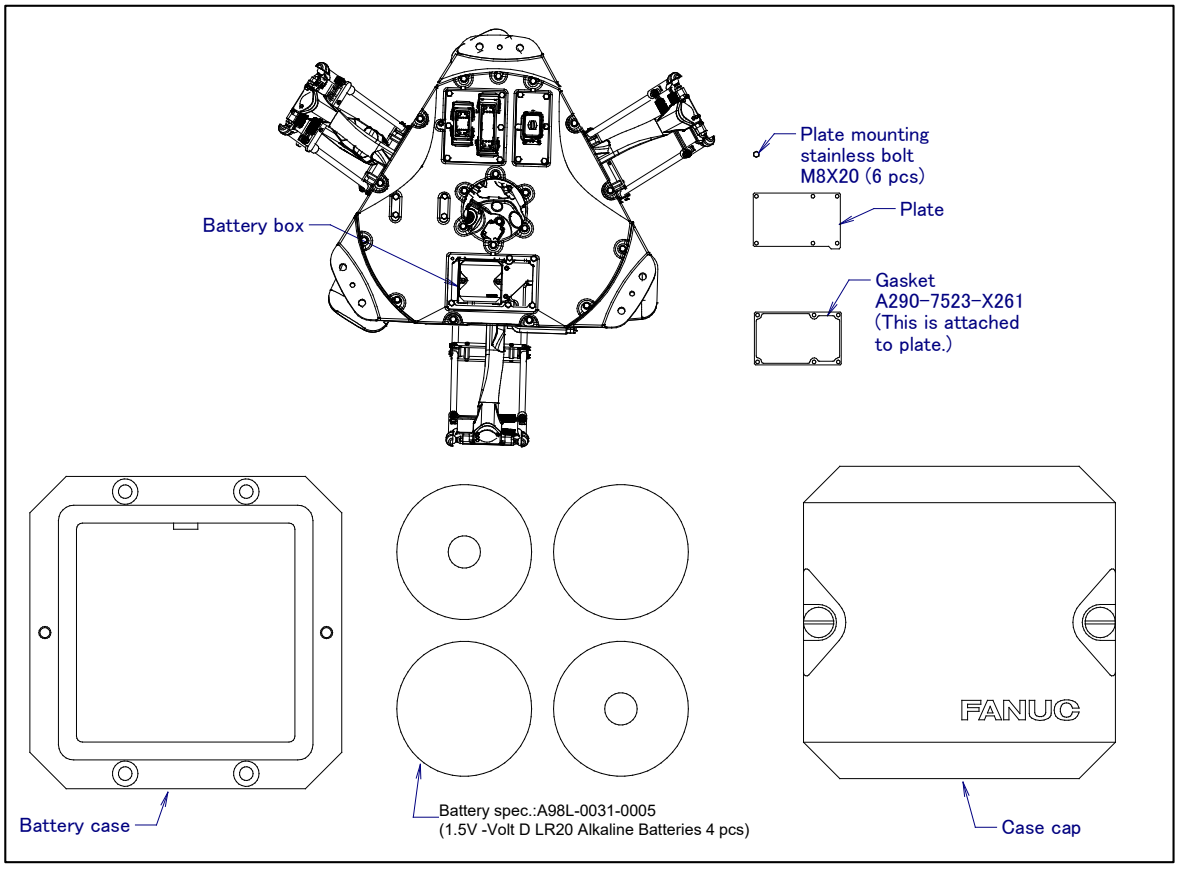


Fig. 6.3.1 (a) Replacing batteries (if built-in batteries are specified)

Procedure of replacing the battery (if external batteries are specified)

1 During battery replacement, hold down the emergency stop button for the sake of safety.

> **⚠ CAUTION**
> Be sure to keep the power supply turned 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 Uncap the battery case (Fig. 6.3.1 (b)).
3 Take out the old batteries from the battery case.
4 Insert new batteries into the battery case while observing their correct orientation.
5 Cap the battery case.

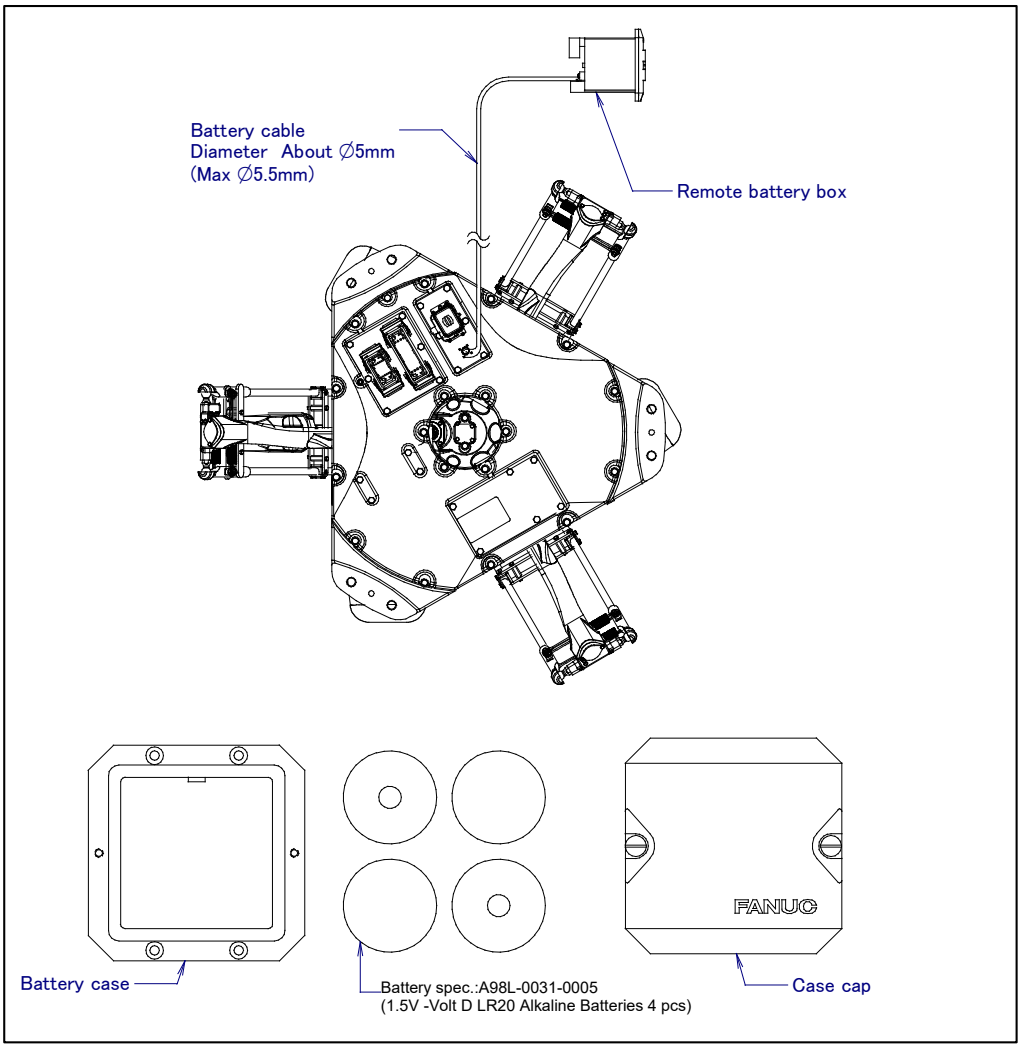


Fig. 6.3.1 (b) Replacing the battery (if external batteries are specified)

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.

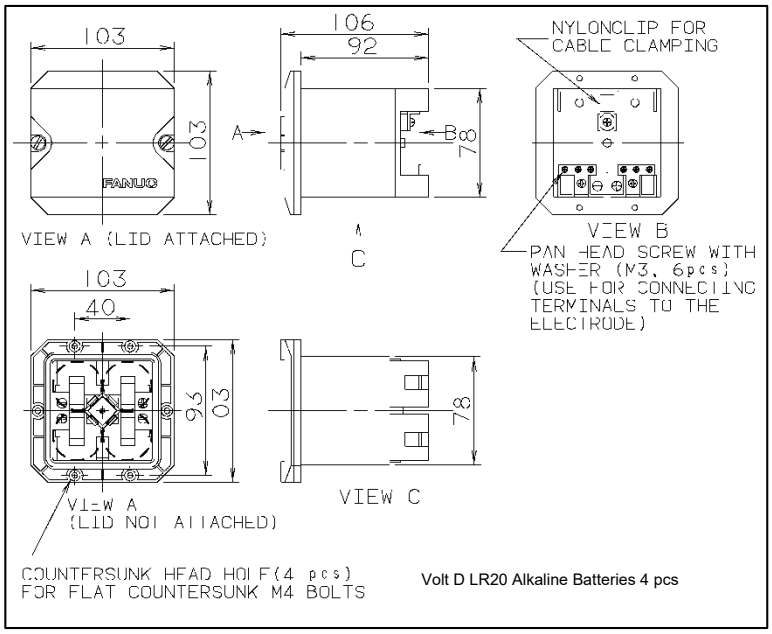


Fig. 6.3.1 (c) External dimensions of the battery box

6.3.2 Apply grease to the spherical joint (6 months (1920 Hours) Checks)

Apply grease and clean the spherical joint at the intervals based on every 6 month, 1920 hours and cycle whichever comes first.

1 Remove old grease and foreign materials on the spherical joint surface.
2 Apply 0.05 to 0.1ml grease on the spherical joint with a syringe etc. (See Fig. 6.3.2 (b))
(Specified grease : A98L-0040-0226#0.05KG)
3 Apply grease to the spherical joint surface. (See Fig. 6.3.2 (c))
4 Operate the robot about 10 times in robot motion area to acclimate the grease.
5 Wipe off excessive grease so that grease remains thinly. (See Fig. 6.3.2 (d))
6 Grease may come from inside during initial operation. Check it at 30 hours, wipe off grease which might cause dropping. (See Fig. 6.3.2 (e))

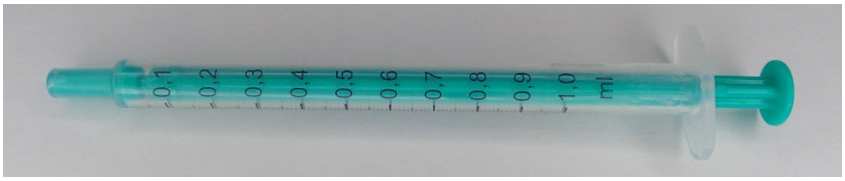


Fig. 6.3.2 (a) Syringe example

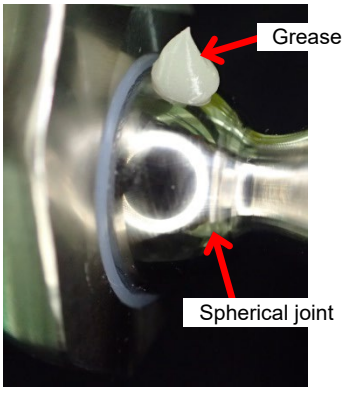


Fig. 6.3.2 (b) Grease applied status (0.05ml)

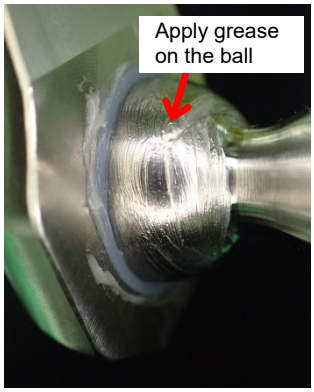


Fig. 6.3.2 (c) Grease applied status

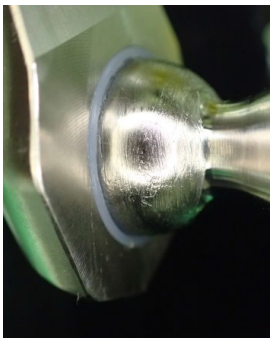


Fig. 6.3.2 (d) After wiping off

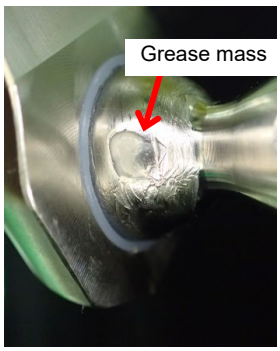


Fig. 6.3.2 (e) Grease mass

6.3.3 Replacing the Oil of the Drive Mechanism (1-year (3840 Hours) Checks)

Replace the oil of the reducers of J1, J2, and J3 axes, and the wrist in the cycle that is shorter among every years and 3840 hours of operating, by using the following procedures.
See table 6.3.3 (a) for the oil name and the quantity.

Table 6.3.3 (a) Oil for 1-year (3840 hours) periodical replacement

Model	Supply position	Quantity	Oil name
M-3*i*A/6S (A05B-1523-B201)	J1 to J3-axis reducer	Each 390ml	Spec: A98L-0040-0255
	Wrist	410ml	
M-3*i*A/6A	J1 to J3-axis reducer	Each 390ml	
	Wrist	850ml	
M-3*i*A/6S (A05B-1523-B203)	J1 to J3-axis reducer	Each 390ml	
	Wrist	140ml	
M-3*i*A/12H	J1 to J3-axis reducer	Each 390ml	

For oil replacement or replenishment, use the posture of Table 6.3.3 (b).

Table 6.3.3 (b) Posture for oiling

Supply position	Posture					
	J1	J2	J3	J4	J5	J6
J1-axis reducer	0°	Arbitrary	Arbitrary	Arbitrary	Arbitrary	Arbitrary
J2-axis reducer	Arbitrary	0°	Arbitrary			
J3-axis reducer	Arbitrary	Arbitrary	0°			
Wrist (M-3*i*A/6S)	Arbitrary	Arbitrary	Arbitrary	Arbitrary		
Wrist (M-3*i*A/6A)	Arbitrary	Arbitrary	Arbitrary	Arbitrary	Arbitrary	Arbitrary

⚠ CAUTION

Failure to supply oil correctly may cause damage to the seal, which would in turn lead to oil leakage and abnormal operation. When performing oiling, therefore, observe the following cautions.

1 Use specified oil. Use of non-approved oil may damage the reducer or lead to other problems.
2 To prevent slipping accidents and catching fire, completely remove any excess oil from the floor or robot.

Oiling of major axis (common to J1/J2/J3-axis)

1 Turn off the controller power.
2 Confirm the position of reducer referring to Fig.6.3.3 (a).
3 Remove stainless bolt, cover and gasket referring to Fig.6.3.3 (b).
4 Put collection bottle under oil outlet and remove taper plug of oil outlet. After exhausting is started, open taper plug of ventilator hole. (If ventilator hole is opened before exhausting is started, oil shed. So open ventilator hole after exhausting is started.)
5 If all oil is exhausted, attach taper plug to oil outlet. .If you reuse taper plug, be sure to seal it with seal tape.
6 Open oil inlet and ventilator hole and supply regulated amount oil to reducer.
7 Attach taper plug of oil inlet and ventilator hole. .If you reuse taper plug, be sure to seal it with seal tape.
8 Attach cover and gasket. Be sure to replace gasket to new one for effects of severe dust/liquid protection. Apply LOCTITE 243 to cover mounting stainless bolts.

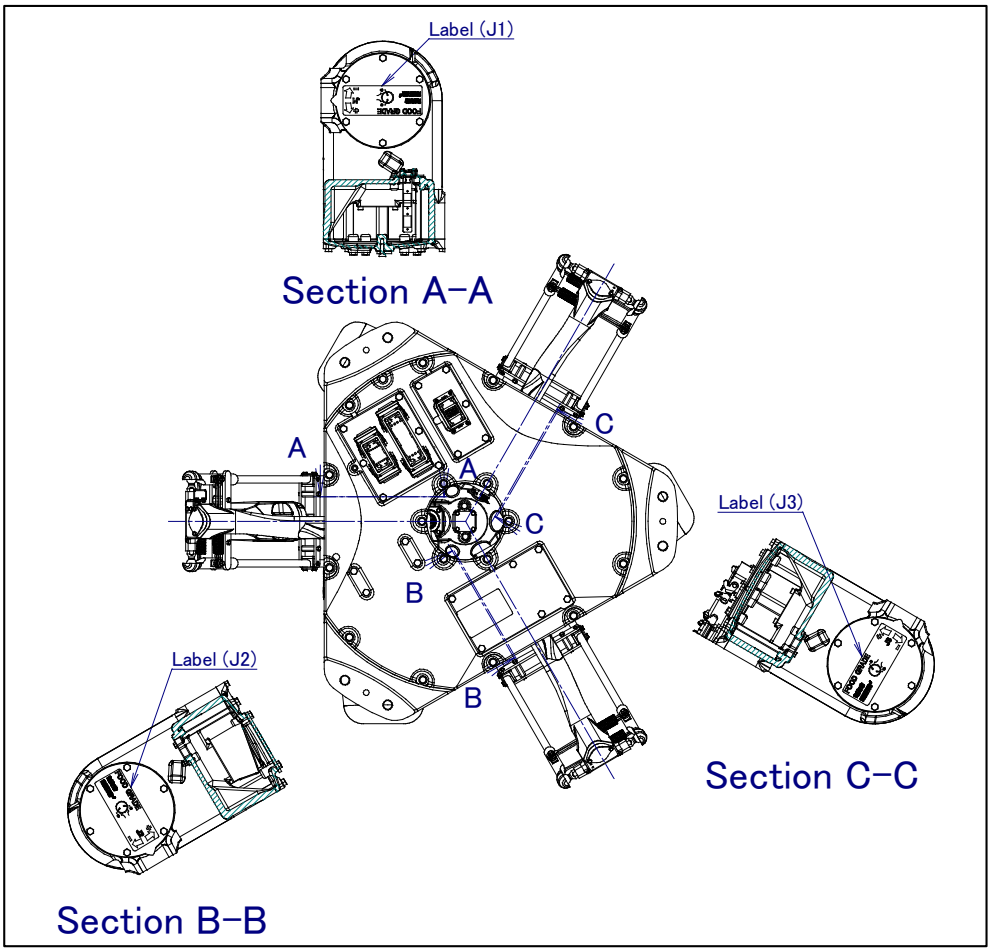


Fig. 6.3.3 (a) Position of major axis reducer

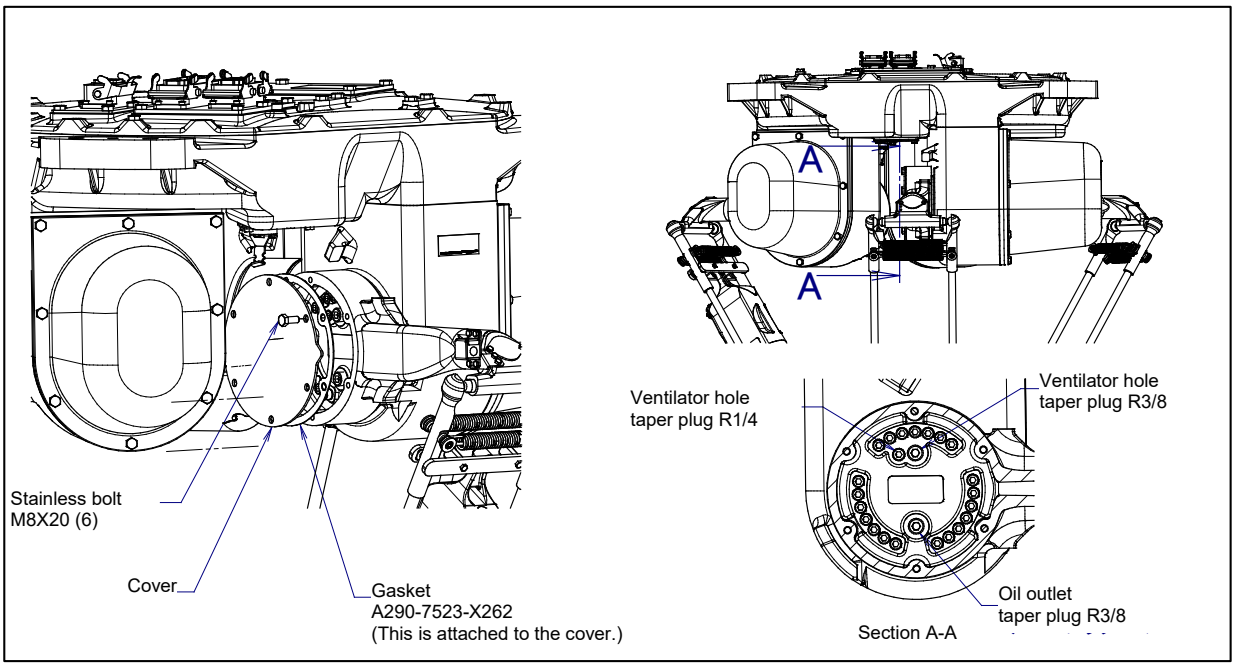


Fig. 6.3.3 (b) Supply oil to major axis

Oiling of wrist axis

1 Turn off the controller power.
2 Put collection bottle under oil outlet and remove bolt of oil outlet. Next, remove taper plug of ventilator hole. 12 angle socket whose width across flat is 14mm can be used open and close taper plug of oil inlet of wrist.
In case of M-3*i*A/6S, you can pull out oil by inserting tube to oil inlet if you cannot open oil outlet by the position of hand. The plug length of the tube is 80mm need from a grease nipple.
3 If all oil is discharged, attach bolt to oil outlet. If you reuse bolt, be sure to seal it with seal tape.
4 Open oil inlet and ventilator hole and supply regulated amount oil to wrist unit.
5 Attach taper plug of oil inlet and ventilator hole. If you reuse taper plug, be sure to seal it with seal tape.

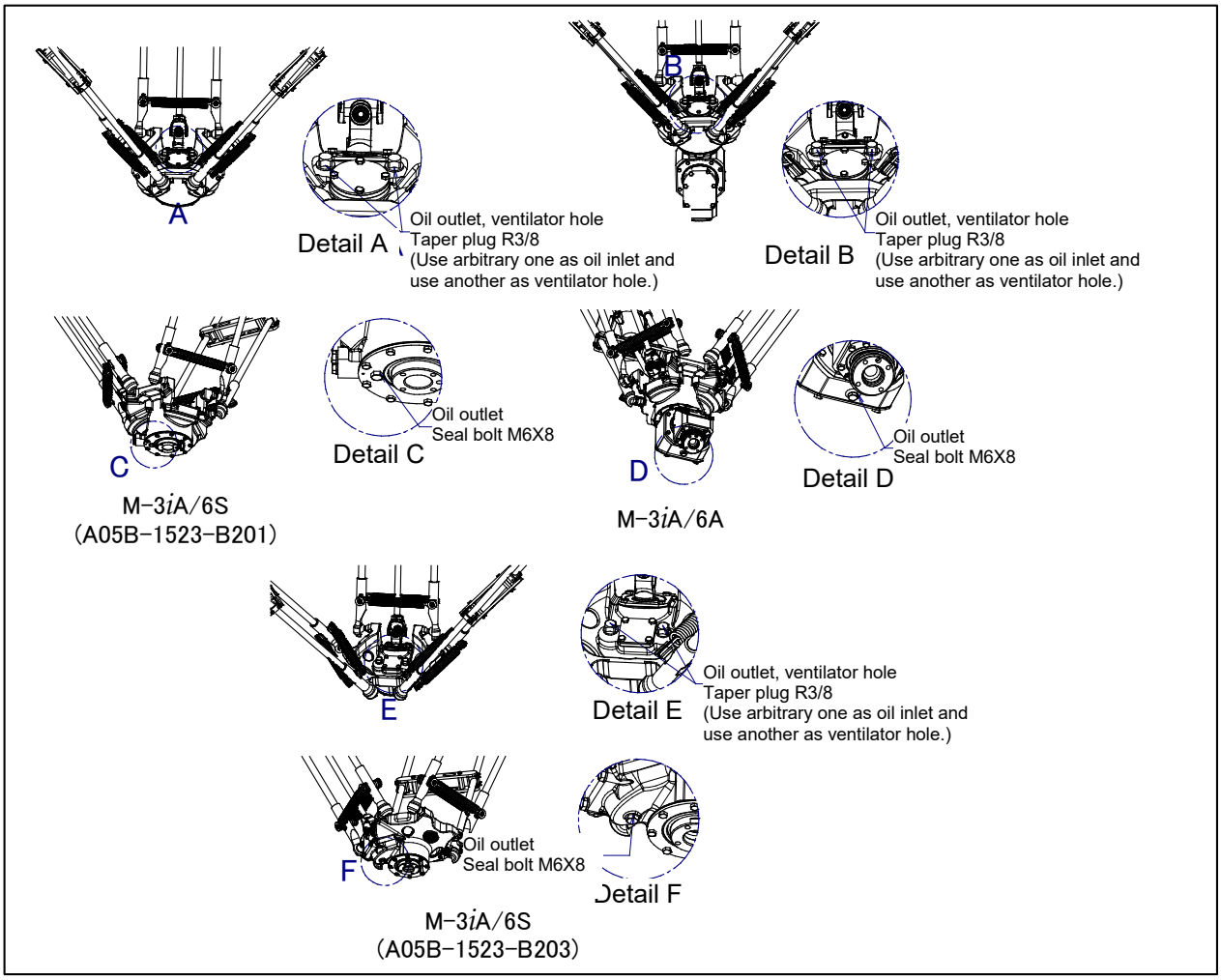


Fig. 6.3.3 (c) Supply oil to wrist axis

6.4 CLEANING (When white epoxy painting is specified)

6.4.1 Cleaning the Robot

M-3*i*A can be washed with sprinkling water or cleaner diluted properly when white epoxy painting is specified.

If strong jet strike robot, it is probable that the jet causes excessive water pressure and destroy waterproof of robot arm. The water or cleaner should be sprinkled from the shower nozzle.

Stains stuck on the robot surface should be wiped with a cloth. Do not brush robot surface hard, because brushing has possibility to affect the coating on robot surface and sealing on the robot joints.

Do not sprinkle water or cleaner on the controller.

6.4.2 Cleaner

When the White Epoxy Painting Option which is resistant to approved chemicals is specified, the M-3*i*A can be spray washed and kept in sanitary condition by daily cleaning.

The cleaners shown in table 6.4.2 (a) have been proven to have no harmful effects to the robot surface of M-3*i*A when White epoxy paint is specified. Contact your local FANUC representative for use of cleansers that are not shown in table 6.4.2 (a).

Make sure the cleaner is properly diluted. If you use cleaner whose dilution ratio is not correct, it may cause damage to the robot surface. Please use a cleaner and water at a temperature equal to or less than 50 degrees Celsius.

Alcohol and organic solvent may have damage the robot surface. Do not use them to clean robot.

Table 6.4.2 (a) Cleaners whose harmlessness for the robot surface is confirmed

NAME	MAKER	TYPE	MAIN INGREDIENT	DILUTION RATE (NOTE 1)
Geron Ⅳ	ANDERSON	Sanitizer	Quaternary ammonium chloride	0.2%
Reg13	ANDERSON	Sanitizer	Sodium hypochloride	0.15%
FOMENT	ANDERSON	Alkali cleaner	Potassium hydroxide Sodium hypochlorite	1.5%
SUPERLOX X-40	ANDERSON	Acid cleaner	Phosphoric acid	1.5%
SAN-TEC 5	ANDERSON	Acid cleaner	Hydrogen peroxide Acetic acid Peroxyacetic acid	0.2%

NOTE
1 DILUTION RATE = STOCK SOLUTION / (STOCK SOLUTION+WATER)
2 Acid cleaner have to be rinsed diligently and it should never remain on the robot surface. Robot surface cannot contact with acid cleaner continuously for over 15 minute.
3 The use of cleaner in Table 6.4.2 (a) might be restricted by the law of the country or the region, and obtaining is difficult.
4 In case the robot paint got damaged during maintenance work, please carefully repair that damage. If such paint damage is not repaired, corrosion and chemical resistance cannot be secured anymore. This repair work is especially important for the white epoxy paint.

6.5 STORAGE

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

7 MASTERING

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

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
- Link B, Drive shaft, Wrist unit replacement
- Cable replacement
- Batteries for pulse count backup in the mechanical unit have gone dead

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

Types of Mastering

Table 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	This is performed using a mastering fixture before the machine is shipped from the factory.
Zero-position mastering (witness mark mastering)	This is performed with all axes set at the 0-degree position. A zero-position mark (witness mark) is attached to each robot axis. This mastering is performed with all axes aligned to their respective witness marks.
Quick mastering	This is used for a quick recovery of mastering when pulse count is reset due to battery run-out etc. In order to use this, you need to set a reference position in advance. (all axes at the same time)
Quick mastering for single axis	This is used for a quick recovery of mastering for single axis when pulse count is reset due to battery run-out etc. In order to use this, you need to set a reference position in advance.
Single-axis mastering	This is performed for one axis at a time. The mastering position for each axis can be specified by the user. This is useful in performing mastering on a specific axis.
Mastering data entry	Mastering data is entered directly.

Once mastering is performed, it is necessary to carry out positioning, or calibration. Positioning is an operation in which the controller reads the current pulse count value to sense the current position of the robot.

This section 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 the reason, the Master/Cal screen is designed to appear only when the $MASTER_ENB system variable is 1 or 2. After performing positioning, press the F5 ([DONE]) on the Master/Cal screen. The $MASTER_ENB system variable is reset to 0 automatically. And the Master/Cal screen will disappear.
2 It is recommended that the current mastering data be backed up before mastering is performed.

Mastering procedure of M-3*i*A is different from other FANUC robot because it has special structure.
You perform mastering with dialog as below.
1 You perform basic axis (J1 to J3) mastering.
2 Move the basic axis and straight the universal joint. (Auto program is executed.)
3 You perform wrist axis mastering.
4 Match the phase of universal joint one by one.

You must move J1,J2,J3 to 27.0320º before you master wrist axis on Fixture position mastering, Zero-position mastering and Single-axis mastering. This motion is automatically done.

7.2 RESETTING ALARMS AND PREPARING FOR MASTERING

Before performing mastering because a motor is 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 the 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 the 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 the F1 ([TYPE]), and select [Master/Cal] from the menu.
  4 Place the cursor on the F3 ([RES_PCA]), then press the 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 cycle power of the controller, the message "SRVO-075 Pulse not established" appears again.
  2 Move the axis for which the message mentioned above has appeared till alarm disappears when press [FAULT RESET] in either direction.

7.3 ZERO POSITION MASTERING (M-3*i*A/6S/6A)

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

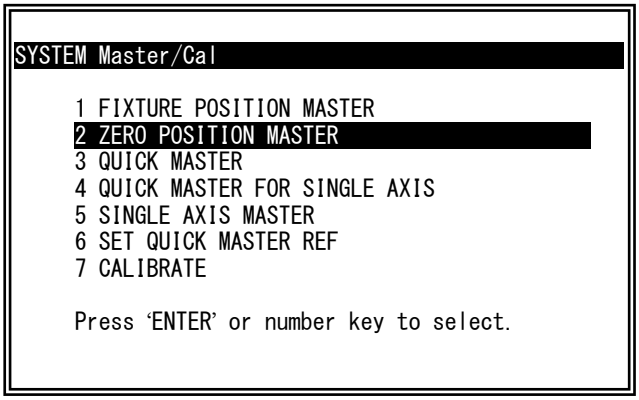
Zero-position mastering involves a visual check. It cannot be so accurate. It should be used only as a quick-fix method.

Procedure of Zero-position Mastering

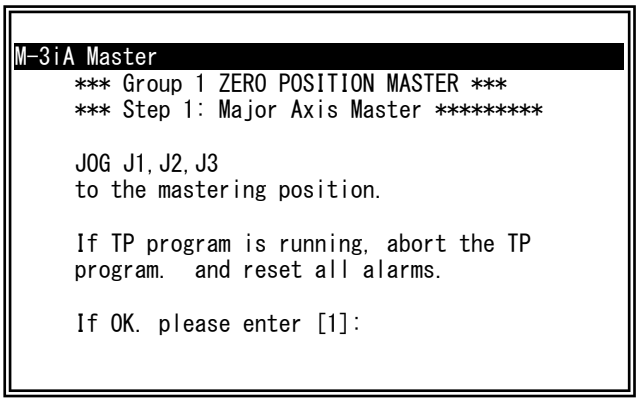
1 Press the [MENU] key.
2 Select NEXT and press SYSTEM.
3 Press F1, [TYPE] and select Master/Cal.

NOTE
If RUNNING or PAUSED program exists, ABORT it beforehand.
Otherwise, you can not proceed to the following step.

4 Select [ZERO POSITION MASTER] and press F4 [Yes].

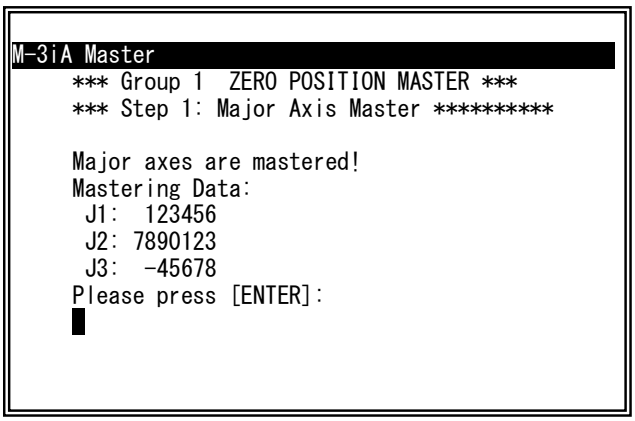


5 The interactive mastering starts. First, do major axis mastering.

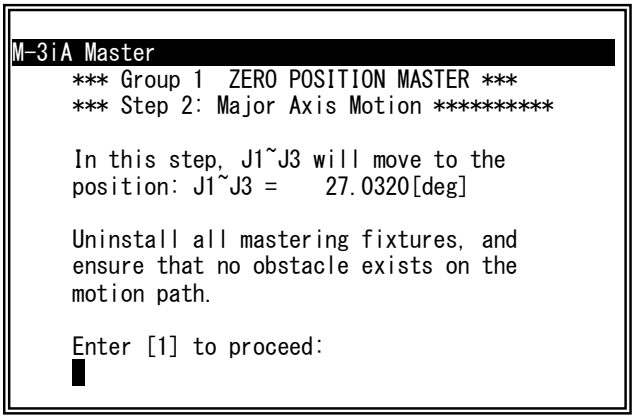


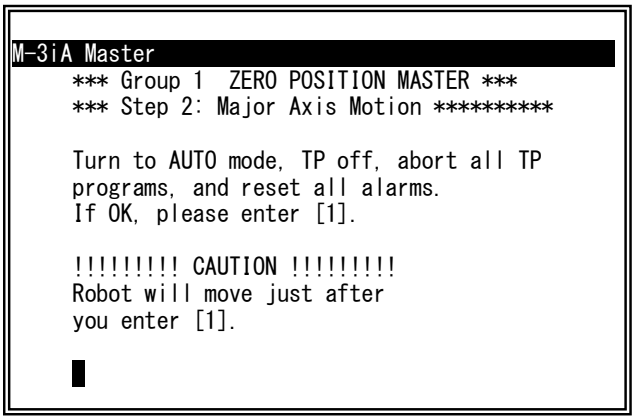
NOTE
If you use a LEGACY (monochrome) teach pendant, the title lines ("M-3*i*A Master" to "Step 1: Major Axis Master") are not displayed.

6 Enter [1], then major axes are mastered.



7 Before you master wrist axis, you need to move major axes to make a special configuration: the upper and lower shafts of the universal joint should be in a straight line. This process is automated. Enter [1] to proceed.





8 Turn to AUTO mode and TP off, reset all alarm and enter [1].
Then, major axes automatically move.

9 Turn to T1/T2 mode and TP on.
Then do wrist axis mastering. Jog wrist axis to the mastering position.

```
M-3iA Master
     *** Group 1  ZERO POSITION MASTER ***
     *** Step 3: Wrist Axis Master **********

     Turn to T1 or T2 mode and TP on,
     then JOG wrist axes to adjust J4
     to the mastering position.

     If OK, please enter [1]:
```

10 Enter [1], then wrist axes are mastered.

```
M-3iA Master
     *** Group 1  ZERO POSITION MASTER ***
     *** Step 3: Wrist Axis Master **********

     Wrist axes are mastered!
     Mastering Data:
      J4:  498623
      J5: -913124
      J6: 8993789
     Please press [ENTER]:
```

11 Calibrate universal joint phase. Jog J4-axis to the position for universal joint phase calibration. (See Fig.7.3 (a))

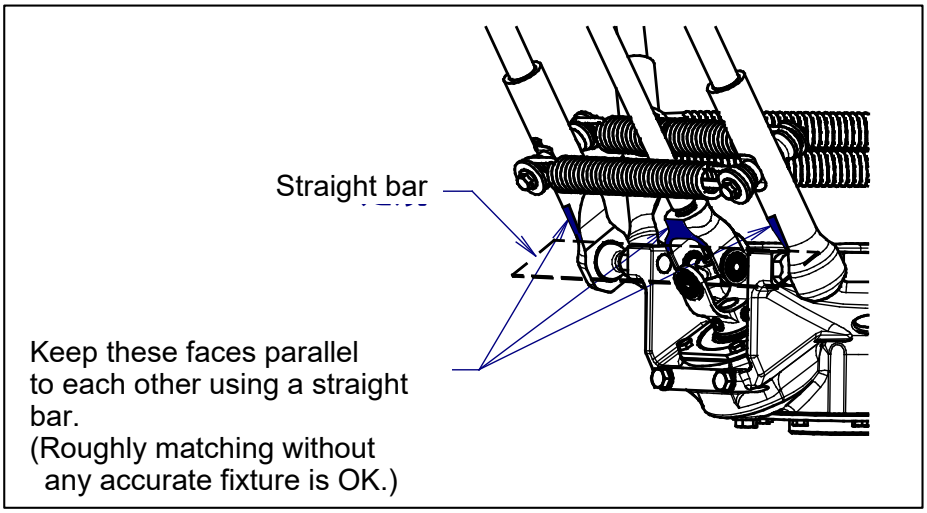
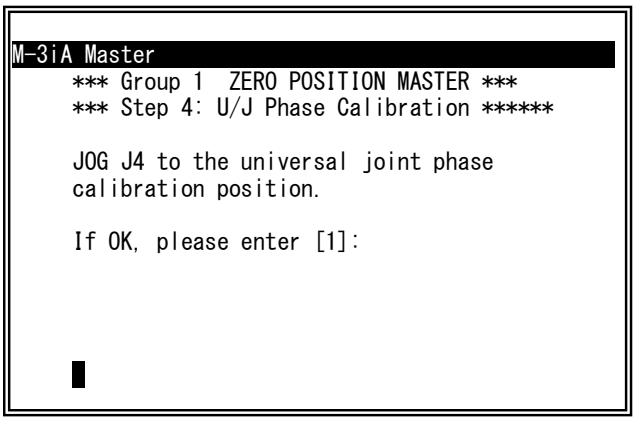
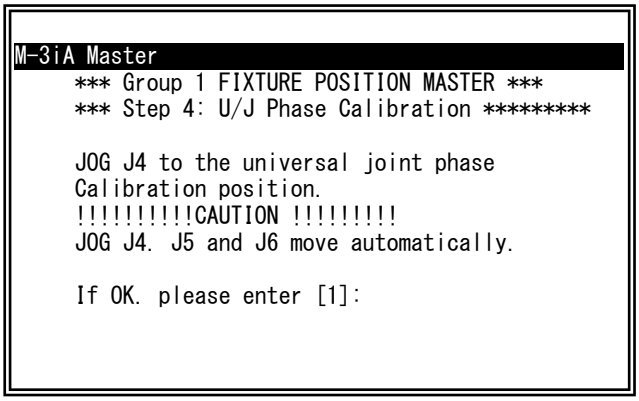


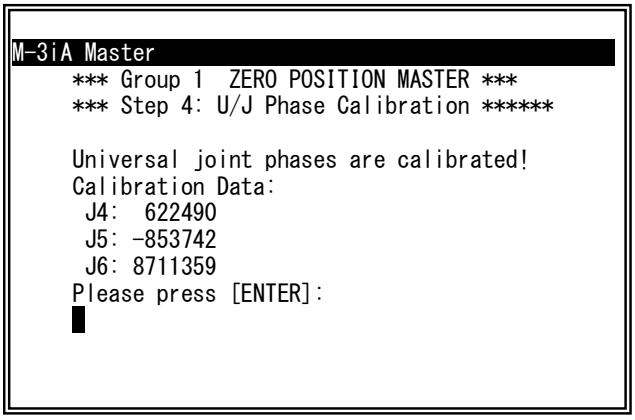
Fig.7.3 (a) Universal joint phase calibration



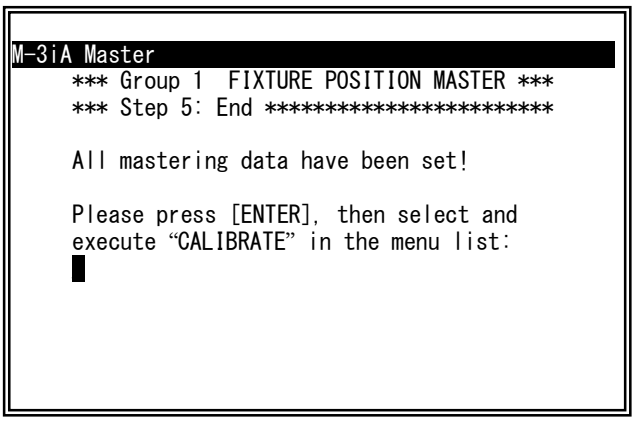
12 Enter [1], then J4-axis universal joint phase is calibrated.



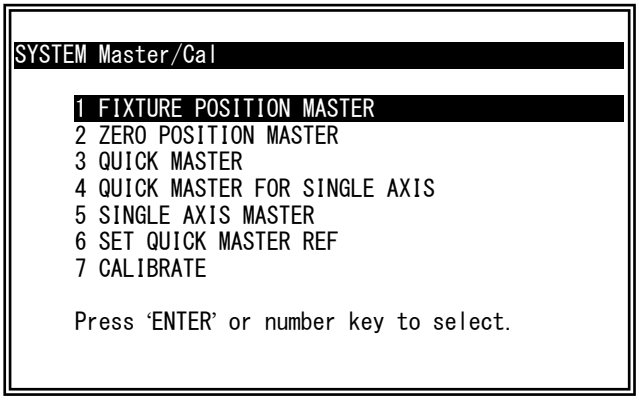
13 Next, calibrate J5/J6-axis universal joint phase calibration. (Only in case of M-3*i*A/6A)
When all universal joint phases are calibrated, calibration data is displayed.



14 Then, you finish the mastering procedures.



15 Press the [ENTER] to come back to [Master/Cal] menu.



16 Select [CALIBRATE] then press the [ENTER] to calibrate the robot.

Table 7.3 (a) Posture with position marks 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-3*i*A/6S.

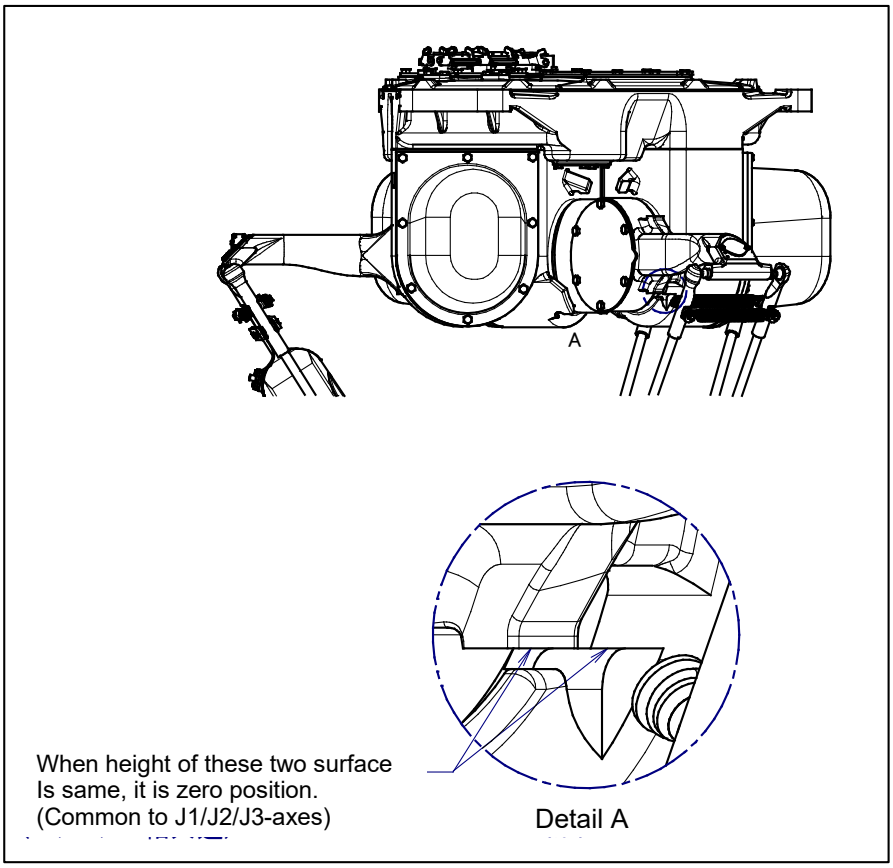


Fig. 7.3 (b) Marking position (1/4)

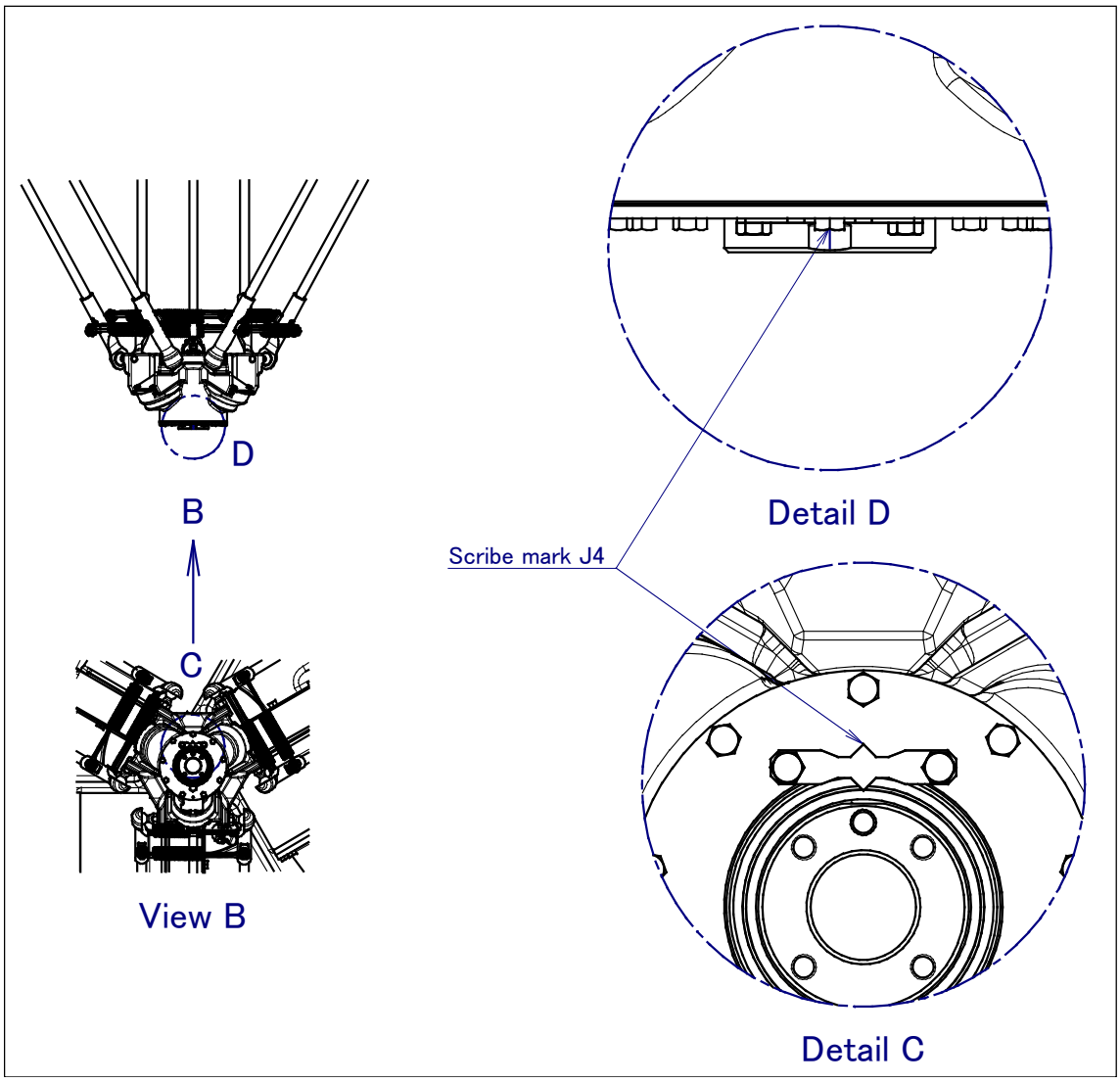


Fig. 7.3 (c) Marking position (2/4) (M-3*i*A/6S (A05B-1523-B201))

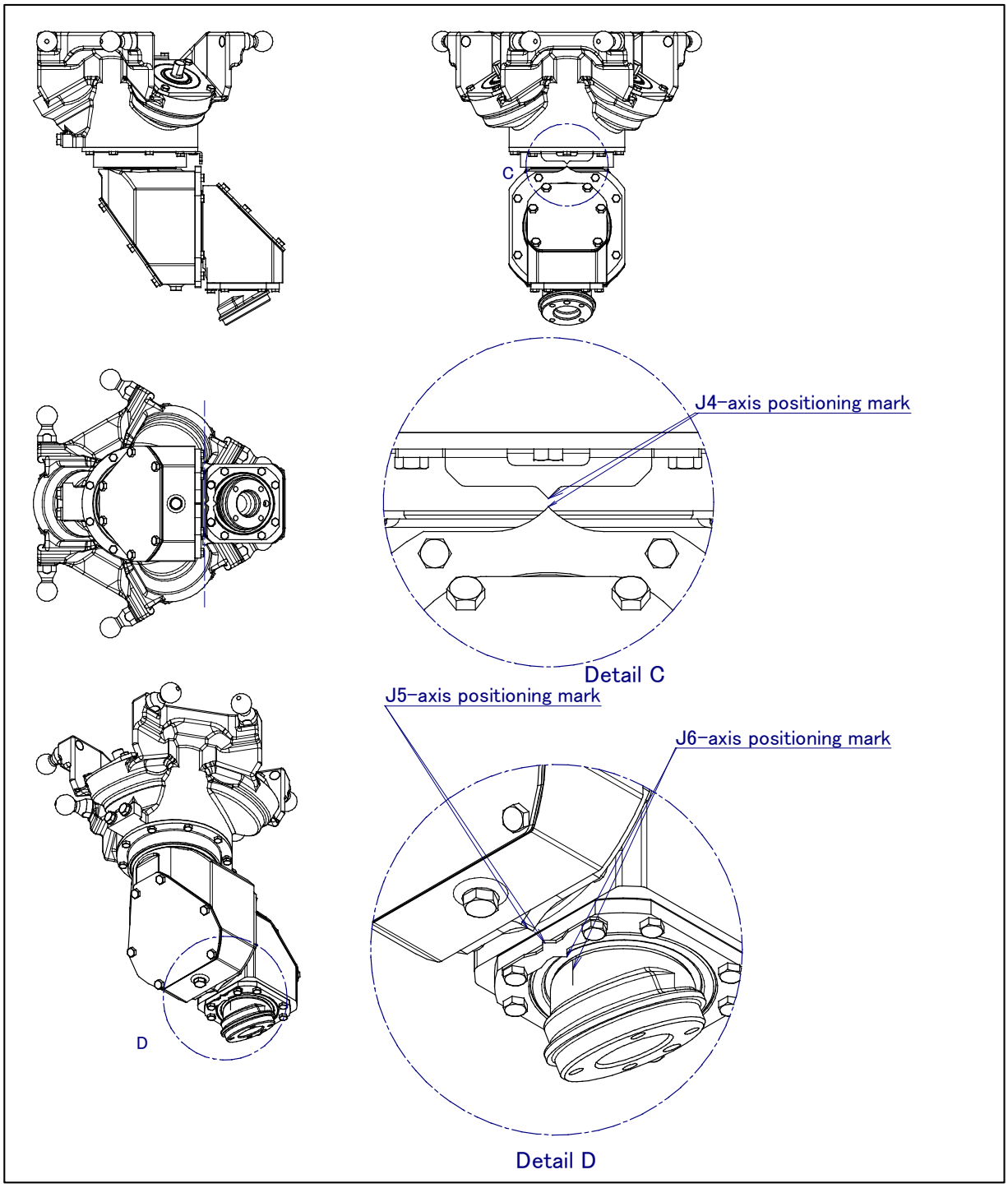


Fig. 7.3 (d) Marking position (3/4) (M-3*i*A/6A)

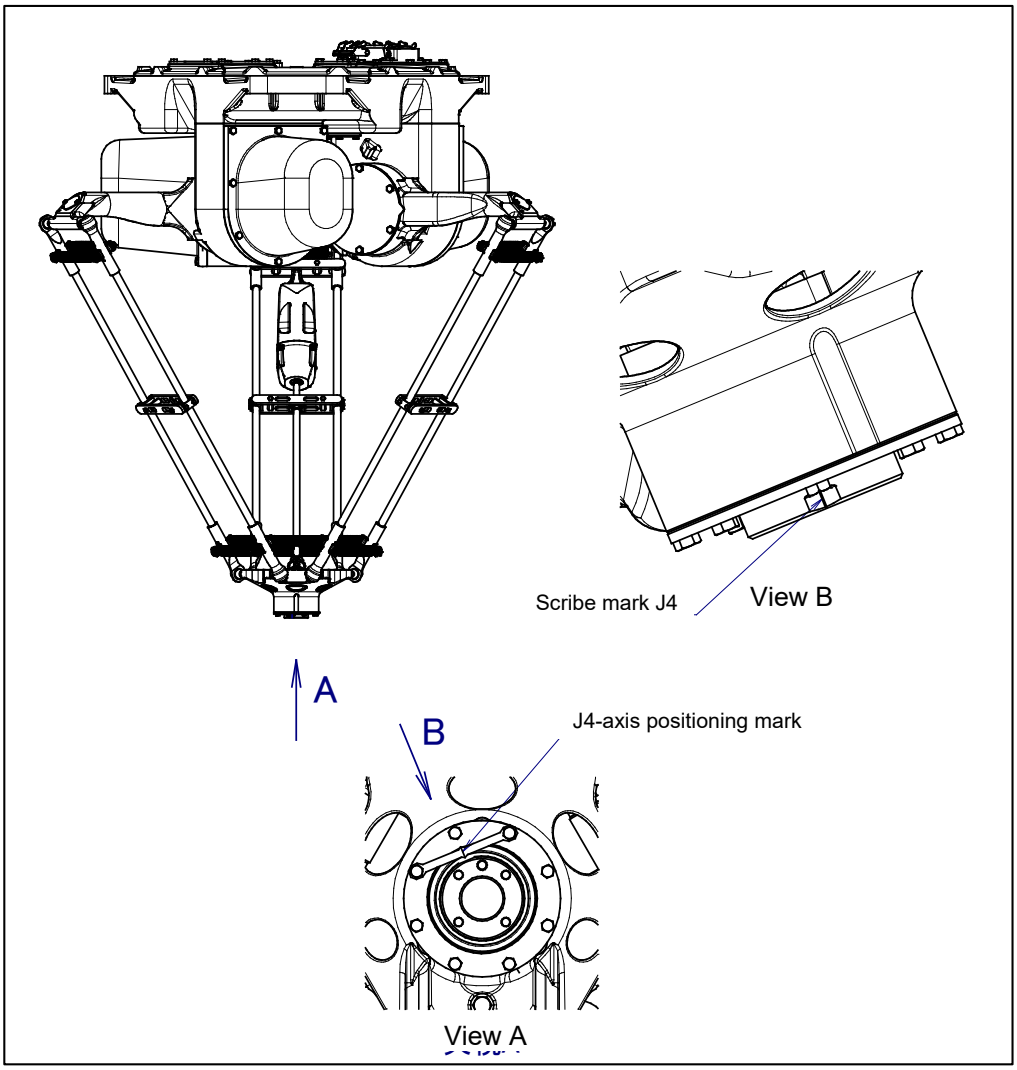


Fig. 7.3 (e) Marking position (4/4) (M-3*i*A/6S (A05B-1523-B203))

7.4 ZERO POSITION MASTERING (M-3*i*A/12H)

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

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

Procedure of Zero-position Mastering

1 Press the [MENU] key.
2 Select [NEXT] key and press SYSTEM.
3 Press F1, [TYPE].
4 Select Master/Cal.

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

 [ TYPE ]   LOAD   RES_PCA                DONE
```

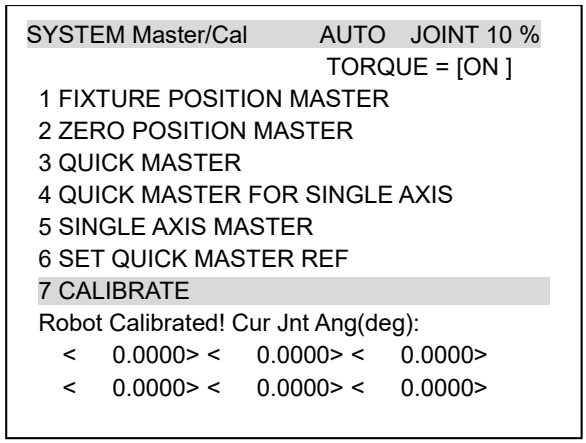
5 Release brake control, and jog the robot into a posture for mastering.

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

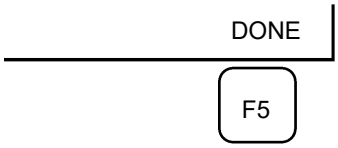
6 Select [2 Zero Position Master].

```
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 Press F4, YES. Mastering will be performed automatically. Alternatively, turn the power off and on again. Turning the power on always causes positioning to be performed.



8 After completing the calibration, press F5 Done.



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

Table 7.4 (a) Posture with zero-position marks (witness mark) aligned

Axis	Position
J1-axis	0 deg
J2-axis	0 deg
J3-axis	0 deg

Please refer to Fig. 7.3 (b) to (d) about zero-position mark.

7.5 QUICK MASTERING (M-3*i*A/6S/6A)

Quick Mastering provides a quick recovery of mastering when pulse count is reset due to battery run-out etc. The pulse count value is obtained from the rotation times of the Pulsecoder connected to the relevant motor and the rotation angle within one rotation. Quick mastering uses the character that the absolute value of a rotation angle within one rotation will not be lost. The procedure of Quick Mastering is simple and easy because this method does not require either a special operation for wrist axis or an accurate positioning like other mastering method. However, Quick Mastering can NOT be used when the mastering data is lost due to mechanical maintenance such as Pulsecoder replacement or mechanical disassembly.

To perform Quick Mastering, a quick mastering position (reference position) must be set in advance. If the mastering data is changed by performing mastering except Quick Mastering, you need to set a reference position again (→How to set Reference Position).
The reference position must be set at a position where the angle of major axis (J1-J3) is almost equal to each other. As long as this condition is satisfied, you can set a reference position at any position. By default, the reference position is preset to the zero position before factory shipment. If your robot cannot move to the zero position due to its installation environment, change the reference position.

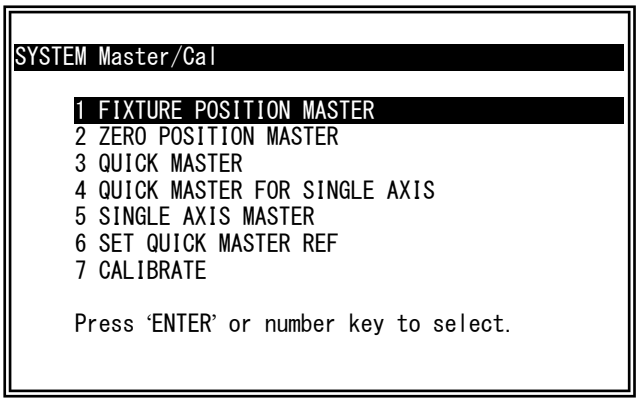
How to do Quick Mastering

Required conditions

- Software version is 7DA7/07 or later.
- The quick mastering position (reference position) is set.
- Pulsecoder is not changed after reference position set.
- Mechanical disassembly which leads to mastering data loss is not done after reference position set.

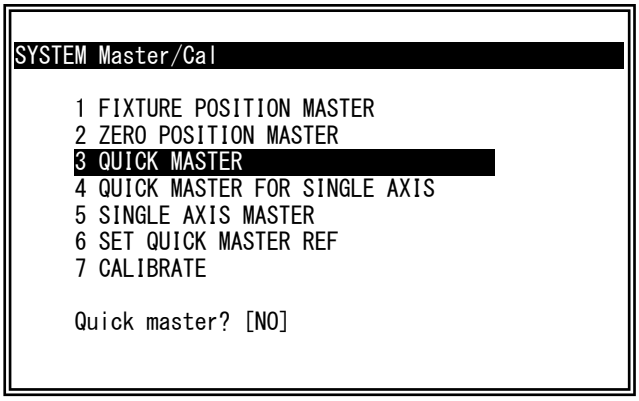
Procedure

1 Go to the [Master/Cal] menu.

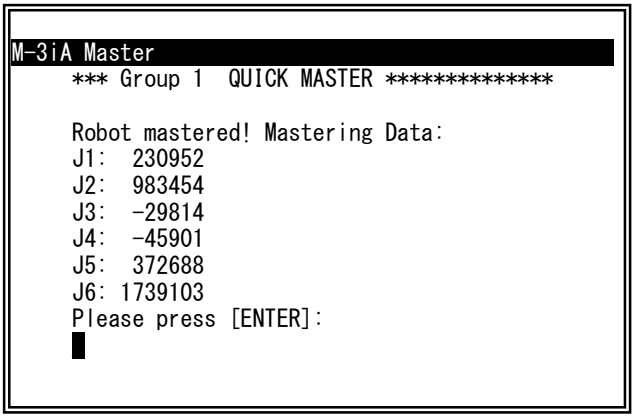


2 Jog the robot to the quick mastering position (reference position). Quick Mastering can compensate position errors within half rotation of the motor. Therefore, you need only a brief visual check for positioning.

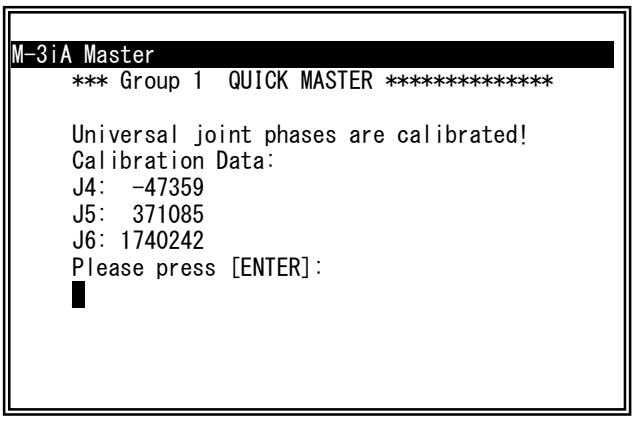
3 Select "3 QUICK MASTER" and press F4 [Yes].



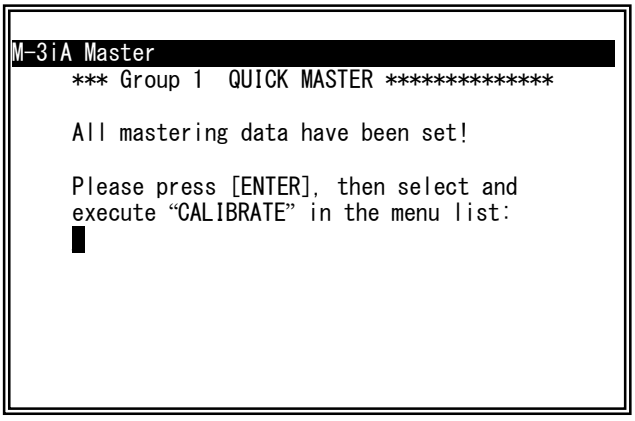
4 New mastering data is displayed.



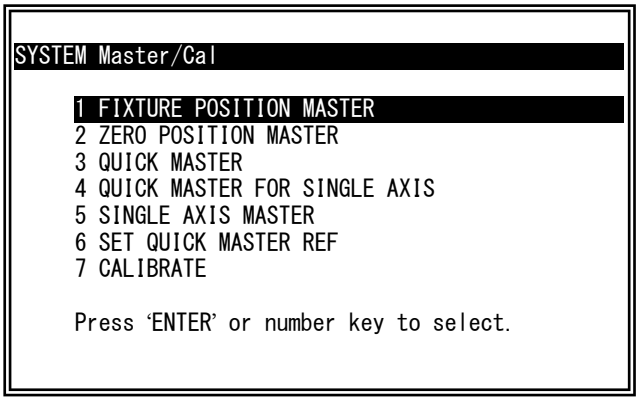
5 Press the [ENTER] key, then new universal joint phase calibration data is displayed.



6 Press the [ENTER] key, then Quick Mastering finishes.



7 Press the [ENTER] key to come back to [Master/Cal] menu.



8 Select [CALIBRATE] then press the [ENTER] key to calibrate the robot.

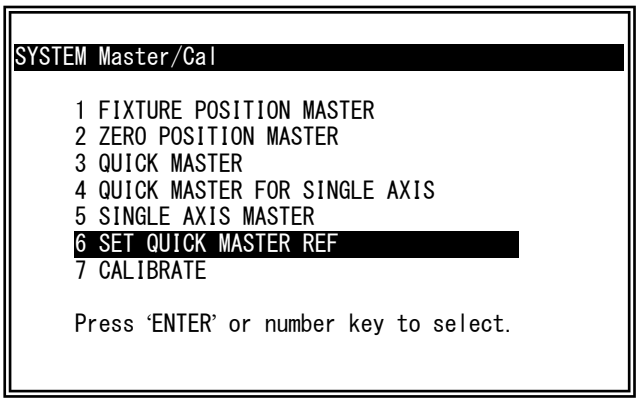
How to set Reference Position

Required conditions

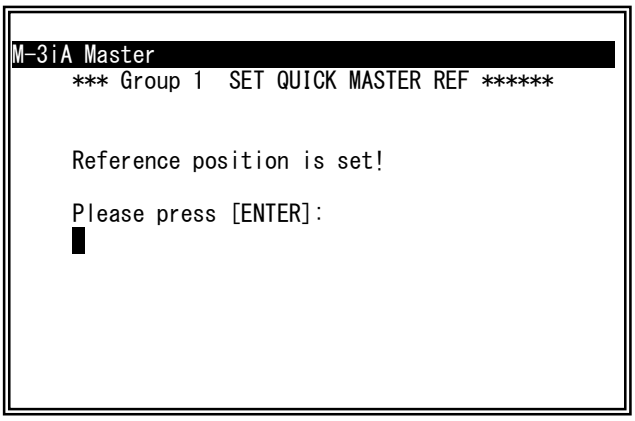
- Software version is 7DA7/07 or later.
- Mastering and Calibration is done.
- Angle of major axis (J1-J3) is almost equal to each other. The tolerance margin is 1deg.

Procedure

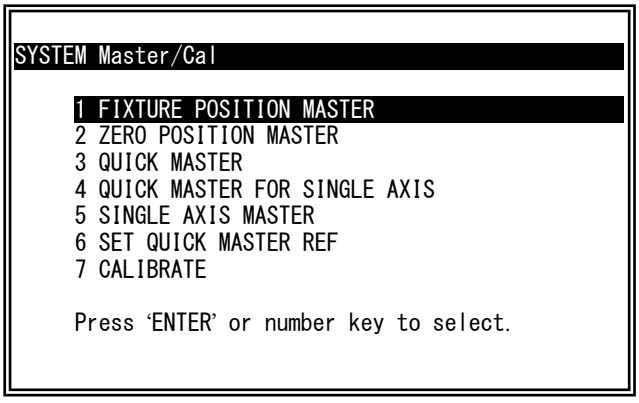
1 Select [SET QUICK MASTER REF] and press F4 [Yes].



2 The following message will be displayed.



3 Press the [ENTER] key to come back to [Master/Cal] menu. Now Reference Position Set is completed.



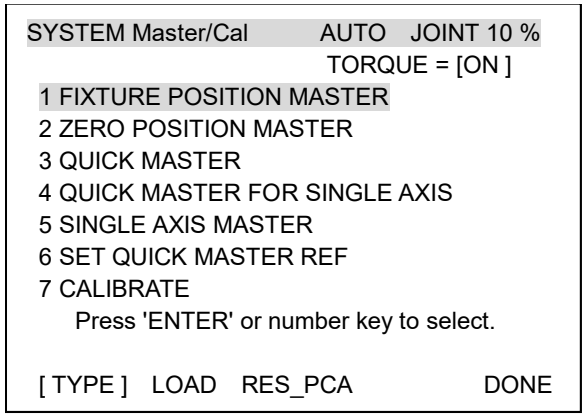
7.6 QUICK MASTERING (M-3*i*A/12H)

Quick mastering is performed at a user-specified position. The pulse count value is obtained from the rotation times of the Pulsecoder connected to the relevant motor and the rotation angle within one rotation. Quick mastering uses the character that the absolute value of a rotation angle within one rotation will not be lost.
Quick mastering is factory-performed at the position indicated in Table 7.4 (a). Do not change the setting unless there is any problem.
If setting the robot at the position mentioned above is impossible, you must re-set the quick mastering reference position using the following method. (It would be convenient to set up a marker that can work in place of the witness mark.)

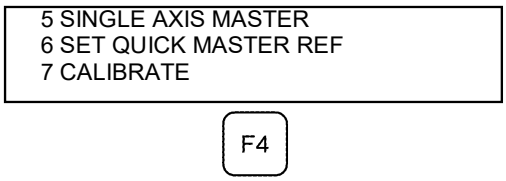
⚠ CAUTION
1 Quick mastering can be used, if the pulse count value is lost, for example, because a low voltage has been detected on the backup battery for the pulse counter.
2 Quick mastering cannot be used, after the motor is replaced or after the mastering data is lost from the robot controller.

Procedure Recording the Quick Mastering Reference Position

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



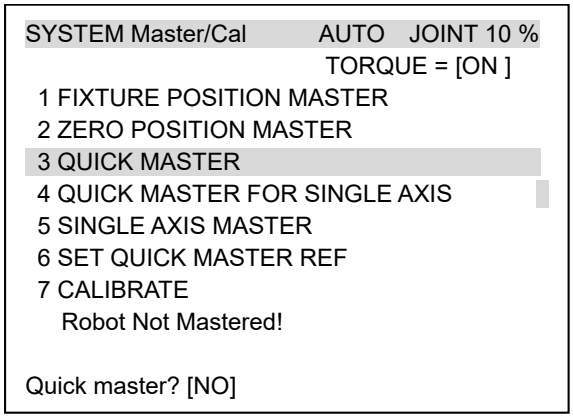
3 Release brake control, and jog the robot to the quick mastering reference position.
4 Select [6 SET QUICK MASTER REF] and press F4 [YES]. Quick mastering reference position is saved.



⚠ 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.

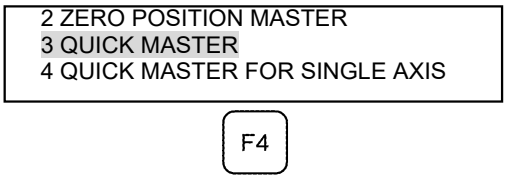
Procedure of Quick Mastering

1 Display the Master/Cal screen.



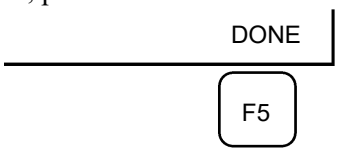
2 Release brake control, and jog the robot to the quick mastering reference position.

3 Move the cursor to [3 QUICK MASTER] and press the [ENTER] key. Press F4 [YES]. Quick mastering data is saved.



4 Select [7 CALIBRATE] and press the [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.

7.7 QUICK MASTERING FOR SINGLE AXIS (M-3*i*A/6S/6A)

Quick Mastering provides a quick recovery of mastering when pulse count is reset due to battery run-out etc. The pulse count value is obtained from the rotation times of the Pulsecoder connected to the relevant motor and the rotation angle within one rotation. Quick mastering uses the character that the absolute value of a rotation angle within one rotation will not be lost. The procedure of Quick Mastering is simple and easy because this method does not require either a special operation for wrist axis or an accurate positioning like other mastering method. However, Quick Mastering can NOT be used when the mastering data is lost due to mechanical maintenance such as Pulsecoder replacement or mechanical disassembly.

To perform Quick Mastering, a quick mastering position (reference position) must be set in advance. If the mastering data is changed by performing mastering except Quick Mastering, you need to set a reference position again (→How to set Reference Position).
The reference position must be set at a position where the angle of major axis (J1-J3) is almost equal to each other. As long as this condition is satisfied, you can set a reference position at any position. By default, the reference position is preset to the zero position before factory shipment. If your robot cannot move to the zero position due to its installation environment, change the reference position.

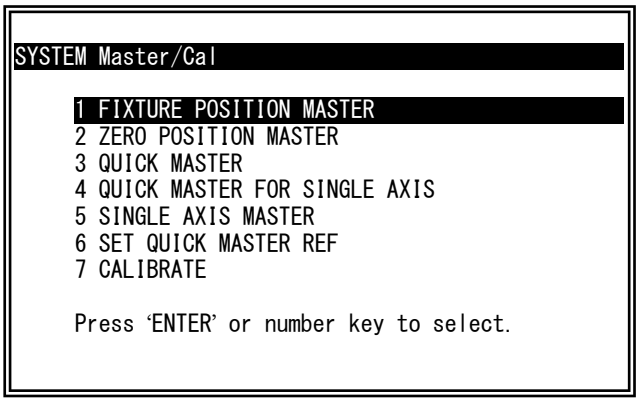
How to do Quick Mastering

Required conditions

- Software version is 7DC3 or later. (Quick mastering for single axis cannot be used when soft version is 7DC2 or before.)
- The quick mastering position (reference position) is set.
- Pulsecoder is not changed after reference position set.
- Mechanical disassembly which leads to mastering data loss is not done after reference position set.

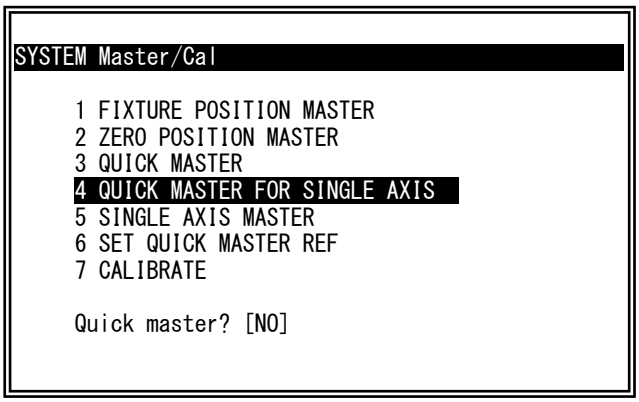
Procedure

1 Go to the [Master/Cal] menu.

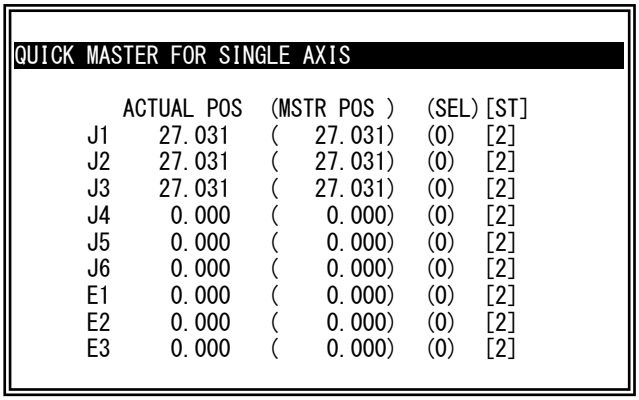


2 Jog the robot to the quick mastering position (reference position). Quick Mastering can compensate position errors within half rotation of the motor. Therefore, you need only a brief visual check for positioning.

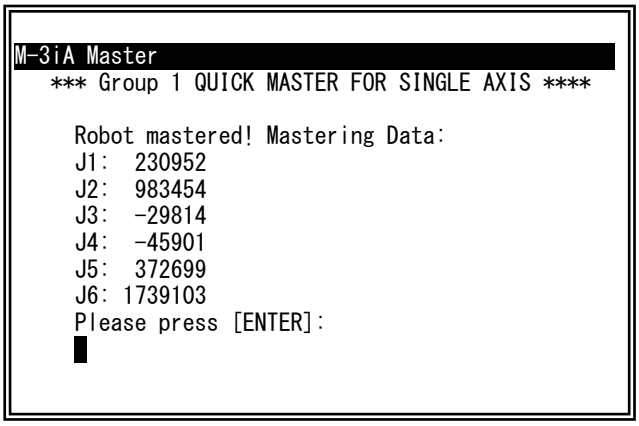
3 Select "4 QUICK MASTER FOR SINGLE AXIS" and press F4 [Yes].



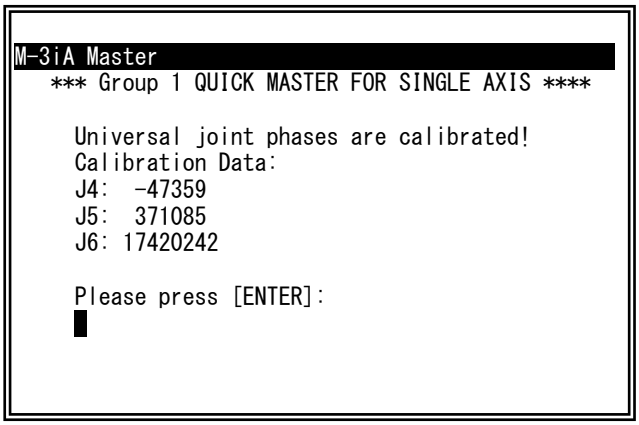
4 QUICK MASTER FOR SINGLE AXIS screen is displayed.



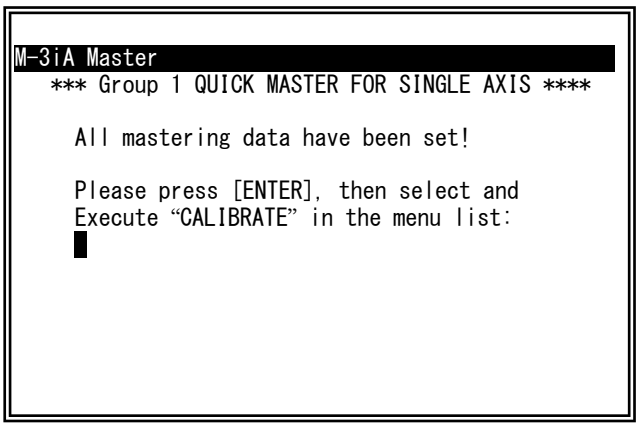
5 Enter 1 to SEL setting field of the axis to be mastered. SEL can be specified one axis at a time or plural axes simultaneously.
6 Jog the robot to the mastering position.
7 Press F5, EXEC. The mastering is performed. This operation sets 0 to SEL and 2 to ST.



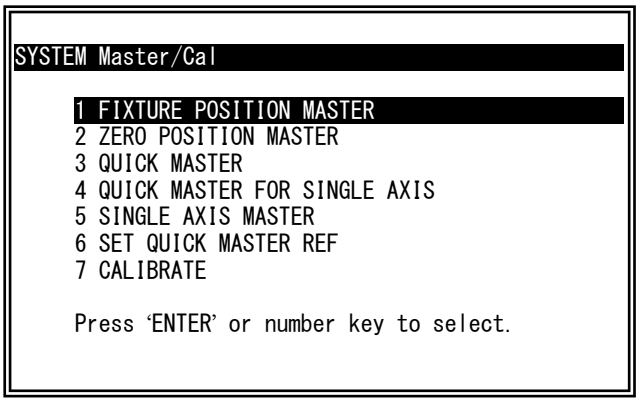
8 Press the [ENTER] key, then new universal joint phase calibration data is displayed.



9 Press the [ENTER] key, then Quick Mastering finishes.



10 Press the [ENTER] key to come back to [Master/Cal] menu.



11 Select [CALIBRATE] then press [ENTER] to calibrate the robot.

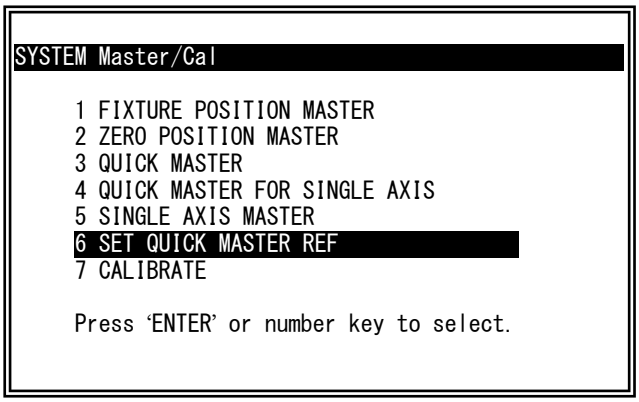
How to set Reference Position

Required conditions

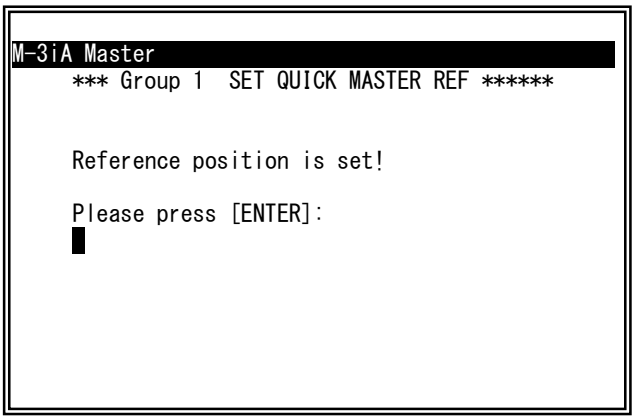
- Software version is 7DC3 or later.
- Mastering and Calibration is done.
- Angle of major axis (J1-J3) is almost equal to each other. The tolerance margin is 1deg.

Procedure

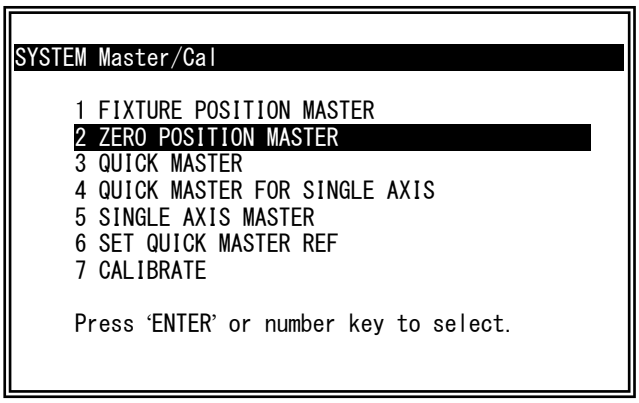
1 Select [SET QUICK MASTER REF] and press F4 [Yes].



2 The following message will be displayed.



3 Press the [ENTER] key to come back to [Master/Cal] menu. Now Reference Position Set is completed.



7.8 QUICK MASTERING FOR SINGLE AXIS (M-3*i*A/12H)

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

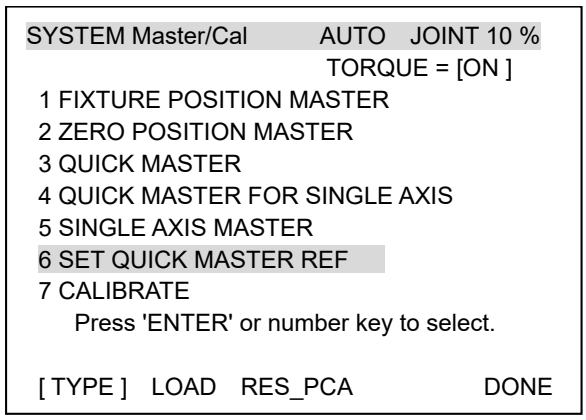
Quick mastering is factory-performed at the position indicated in Table 7.3 (a). Do not change the setting unless there is any problem.

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

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

Procedure Recording the Quick Mastering Reference Position

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



3 Release brake control, and jog the robot to the quick mastering reference position.

4 Select [6 SET QUICK MASTER REF] and press F4 [YES]. Quick mastering reference position 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 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]. Quick master for single axis 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
```

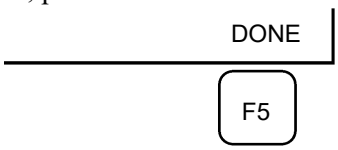
3 Move the cursor to the [SEL] column for the unmastered axis and press the numeric key [1]. Setting of [SEL] is available for one or more axes.

```
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, and [ST] is re-set to 2 by this operation.

NOTE
At this time, [SEL] is not re-set to 0. [SEL] is re-set to 0 when cycling power of the controller.

6 Select [7 CALIBRATE] and press the [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.

7.9 SINGLE AXIS MASTERING (M-3*i*A/6S/6A)

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.

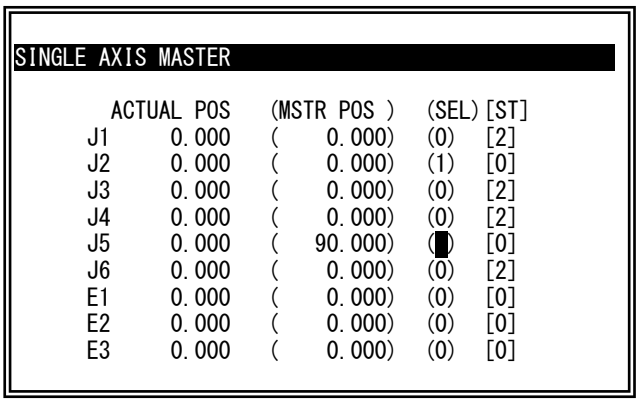
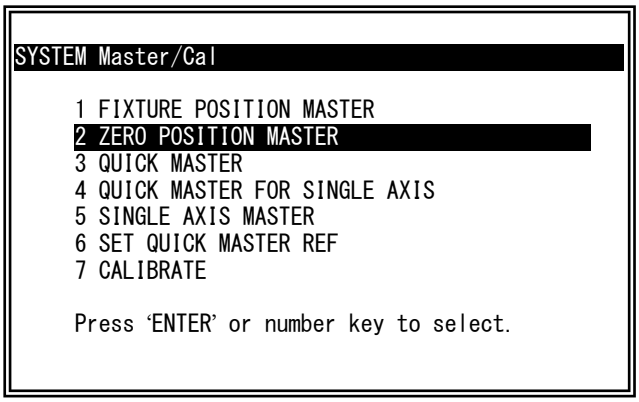


Table 7.9 (a) Items set in single axis mastering

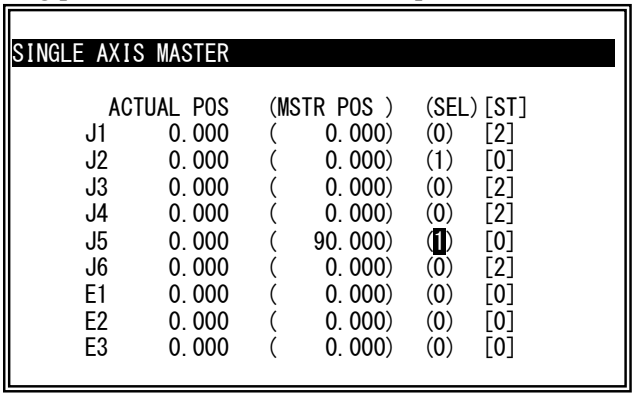
Item	Description
Current position (Actual axis)	The current position of the robot is displayed for each axis in degree units.
Mastering position (MSTR pos)	A mastering position is specified for an axis to be subjected to single axis mastering. It would be convenient to set to it to the 0_ position.
SEL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

1 Select [SINGLE AXIS MASTER] from [Master/Cal] menu.

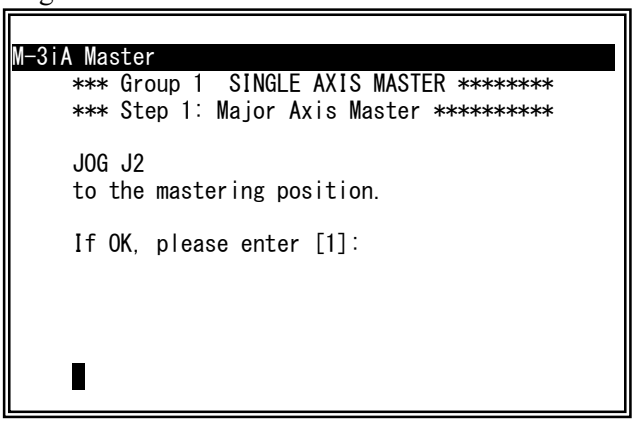


NOTE
If RUNNING or PAUSED program exists, ABORT it beforehand.
Otherwise, you can not proceed to the following step.

2 Select axis and mastering position to be mastered. Then press [F5 Execute].



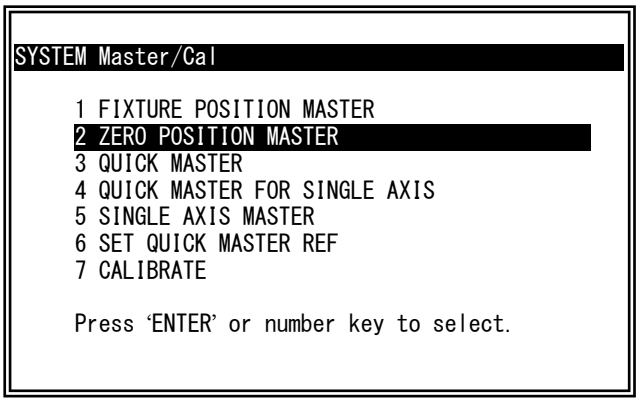
3 The interactive mastering starts.



The rest of procedure is the same as [ZERO POSITION MASTER]
But you can omit some steps according to the selected axis.

- If wrist axis is not selected.
  You are to do only [Step 1: Major Axis Master].
- If major axis is not selected.
  You are to do [Step 2 : Major Axis Motion], [Step 3 :Wrist Axis Master] and [Step 4 : U/J Phase calibration].

If all procedures are finished, press [Enter] to come back to [Master/Cal] menu.



If all axes have been mastered, select [CALIBRATE] then press [ENTER] to calibrate the robot.

7.10 SINGLE AXIS MASTERING (M-3*i*A/12H)

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.

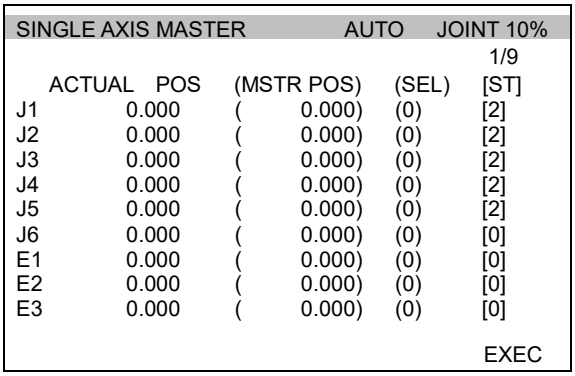


Table 7.10 (a) Items set in single axis mastering

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 to set to it to the 0_ position.
SEL	This item is set to 1 for an axis to be subjected to single axis mastering. Usually, it is 0.
ST	This item indicates whether single axis mastering has been completed for the corresponding axis. It cannot be changed directly by the user. The value of the item is reflected in $EACHMST_DON (1 to 9). 0: Mastering data has been lost. Single axis mastering is necessary. 1: Mastering data has been lost. (Mastering has been performed only for the other interactive axes.) Single axis mastering is necessary. 2: Mastering has been completed.

Procedure of Single axis mastering

1 Select [6 SYSTEM].
2 Select [Master/Cal]. The positioning screen appears.

```
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
```

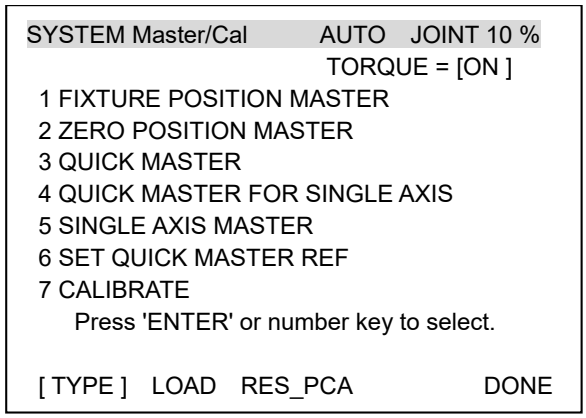
3 Select [5 SINGLE AXIS MASTER]. The following screen will be displayed.

```
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
```

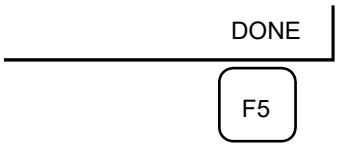
4 Move the cursor to the [SEL] column for the unmastered axis and press the numeric key [1]. Setting of [SEL] is available for one or more axes.
5 Turn off brake control, then jog the robot to the mastering position.
6 Enter axis data for the mastering position.
7 Press F5 [EXEC]. Mastering is performed. So, [ST] is re-set to 2 or 1.

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

                                          EXEC
```

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



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



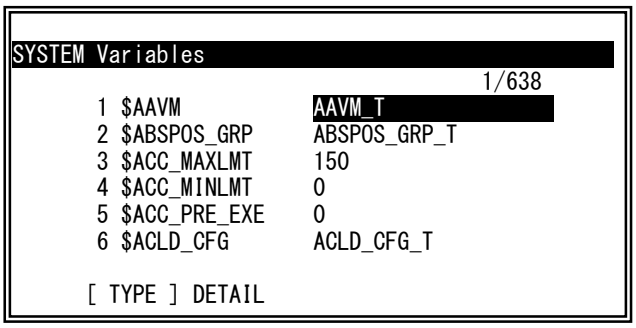
11 Return brake control to original setting, and cycle power of the controller .

7.11 MASTERING DATA ENTRY

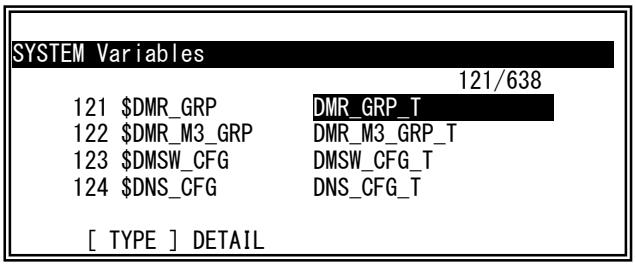
You can enter mastering data directly to system variables. You can use this way when the system lost the mastering data but keeps the pulse count.

Mastering data entry

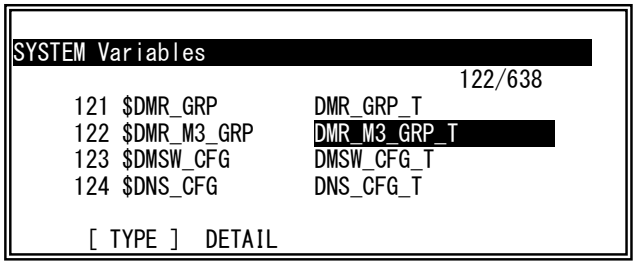
1 Press the [MENU] key, then press NEXT and select SYSTEM.
2 Press F1, [TYPE]. Select [Variables]. The system variable screen appears.

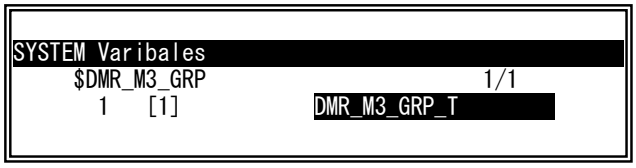


3 The mastering data is saved in $DMR_GRP.$MASTER_COUN and $DMR_M3_GRP.$MASTER_CNT2.

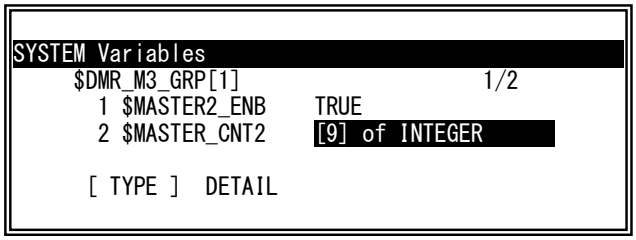


4 Select “$DMR_M3_GRP.

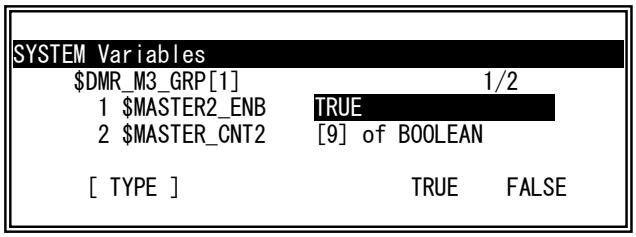




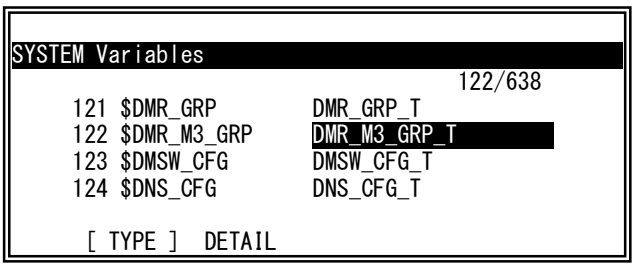
5 Select “$MASTER_CNT2” and input mastering data which is recorded.



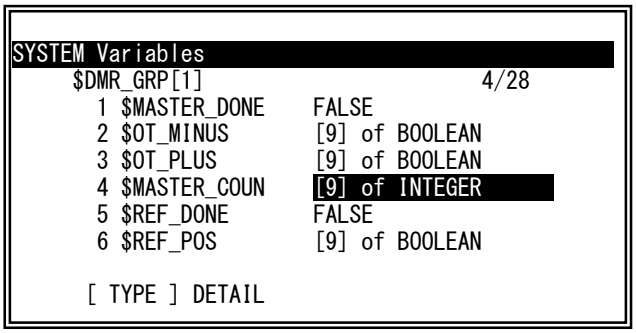
6 Press PREV key.
7 Confirm “$MASTER2_ENB” is set to “TRUE”. If it is “FALSE”, set it to “TRUE”.



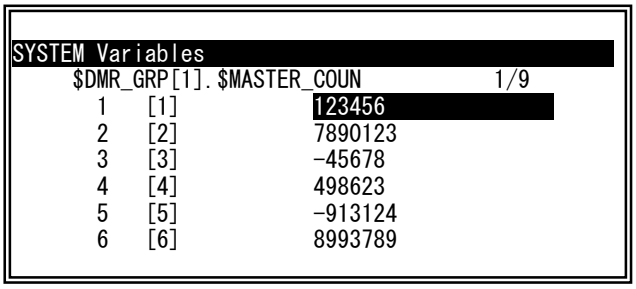
8 Press the [PREV] key twice to return to the root screen of system variables.



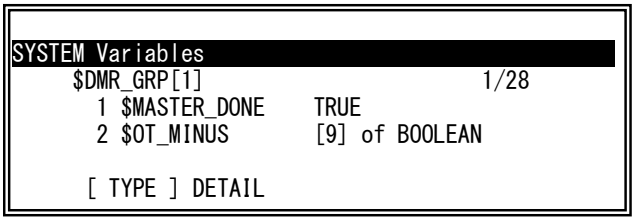
9 Select $DMR_GRP.



10 Select $MASTER_COUN, then enter the mastering data you have recorded.



11 Press the [PREV] key.
12 Set $MASTER_DONE to TRUE.



13 Cycle the controller power.
14 Go to [Master/Cal] menu and press F5 “DONE”.

7.12 Q&A

Q Can I change the screen from the interactive mastering dialog to other display?
A Yes. You can come back to the mastering dialog display by pressing [MENU] and [9 User].
Although display of title lines ("M-3*i*A Master" to "Step 1: Major Axis Master") will disappear, you can proceed with no problem.

Q How to abort the interactive mastering dialog.
A You can abort it by selecting [Function]>[1.ABORT (ALL)].
Be sure to perform mastering again from the first step. If you do not perform it, the robot will fall to a wrong mastering status.

Q The interactive mastering is stopped by error during [Step 2 : Major Axis Motion] and cannot be resumed. What should we do?
Q The interactive mastering is stopped by [HOLD] command during [Step 2 : Major Axis Motion] and cannot be resumed. What should we do?
A In this case, you cannot resume the interactive mastering.
- If software version is 7DA7/07 or later, a message "Mastering procedure will be aborted" will be shown. Press [ENTER] to return to [Master/Cal] menu. The wrist axis will not be mastered due to the interruption during mastering process. Perform mastering procedure again to complete mastering.
- If software version is 7DA7/06 or before, no message will be displayed. You must select the [FCTN] key>[1.ABORT (ALL)], then perform mastering again from the first step. If you do not perform it, the robot will fall to a wrong mastering status.

Q What needs to be done in case a wrist axis was moved by mistake (when performing wrist axis mastering; or when matching the phase of the universal joint) ?
A please jog the robot back to its original position by manual operation. The original position is J1,J2,J3=27.032º .
Note : this operation has an acceptable positional tolerance of ±0.1 deg.

Q Message "Robot Not Mastered!" is displayed and interactive mastering dialog does not start.
A Press the [FCTN] key >[1. ABORT (ALL)] and try mastering again.

Q Warning "SRVO-421 Jnt Phs not calibrated(G1)" is displayed.
A On 7DA7/09 or later software version, if you try to set $DMR_GRP.$MASTER_DONE = TRUE when $DMR_M3_GRP.$MASTER2_ENB = FALSE, this warning is posted. On 7DA7/09 or later software version, for direct Mastering data entry, set $DMR_M3_GRP.$MASTER2_ENB = TRUE first. After that, set $DMR_GRP.$MASTER_DONE = TRUE

7.13 VERIFYING MASTERING

1 How to verify that the robot is mastered properly:
Usually, positioning is performed automatically when the power is turned on. To check whether mastering has been performed correctly, examine if the current displayed position meets the actual robot position by using the procedure described below:
(1) Reproduce a particular point in a program. Check whether the point agrees with the specified position.
(2) Set all axes of the robot to their 0-degree (0 rad) positions. Check that the zero-degree position marks indicated in Section 7.3 of OPERATOR'S MANUAL are aligned. No need of any 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 7.2. Alternatively, the mastering data in system variable $DMR_GRP.$MASTER_COUN may have been overwritten as a result of an operation error or some other reason.
Compare the data with the values indicated on the supplied data sheet. This system variable is overwritten whenever mastering is performed. Whenever mastering is performed, record the value of the system variable on the data sheet.

2 Alarm type displayed during mastering and their Solution methodology
(1) BZAL alarm
This alarm is alert if the Pulsecoder's backup battery voltage decreases to 0 V while the power to the controller is disconnected. Furthermore, if Pulsecoder connector is removed for replacing cables etc. this alarm is output as the voltage decreased to 0. Confirm if the alarm will disappear by performing pulse reset (See Section 7.2.). And then cycle power of the controller to check if the alarm disappears or not.
The battery may be drained if the alarm is still displayed. Perform pulse reset, turn off and on the controller power after replacing the battery. Note that, if this alarm displayed, all the original data held by the Pulsecoder will be lost. Mastering is required.
(2) BLAL alarm
Warn this alarm is output if the voltage of the Pulsecoder's backup battery has fallen to a level where backup is no longer possible. If this alarm is output, fit a new battery 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 be identified because of overlapping causes. Problems may become further complicated, if they are not corrected properly. Therefore, you must keep an accurate record of problems and take proper corrective actions.

8.1 TROUBLESHOOTING

Table 8.1 (a) shows the major troubleshooting that may occur in the mechanical unit and their probable causes. If you cannot pinpoint a failure cause or which measures to take, contact your local FANUC representative. For troubleshooting except the mechanical unit, refer to "CONTROLLER MAINTENANCE MANUAL (B-83195EN etc.)" and Alarm Code List (B-83284EN-1).

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 contamination 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 contamination, 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 or noise occurring axis has not been exchanged for a long period. - Cyclical vibration and noise occur.	[Broken gear, bearing, or reducer] - It is likely that collision or overload applied an excessive force on the drive mechanism, thus damaging the geartooth surface or rolling surface of a bearing, or reducer. - It is likely that prolonged use of the robot while overloaded caused fretting of the gear tooth surface or rolling surface of a bearing, or reducer due to resulting metal fatigue. - It is likely that contamination caught in a gear, bearing, or within a reducer caused damage on the gear tooth surface or rolling surface of the bearing, or reducer. - It is likely that contamination caught in a gear, bearing, or within a reducer cause vibration. - It is likely that, because the oil has not been changed for a long period, fretting occurred on the gear tooth surface or rolling surface of a bearing, or reducer due to metal fatigue.	- Operate one axis at a time to determine which axis is vibrating. - Remove the motor, and replace the gear, the bearing, and the reducer. For the spec. of parts and the method of replacement, contact your FANUC representative. - Using the robot within its maximum rating prevents problems with the drive mechanism. - Regularly changing the oil with a specified type can help prevent problems.

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

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- There is some relationship between the vibration of the robot and the operation of a machine near the robot.	[Noise from a nearby machine] - If the robot is not grounded properly, electrical noise is induced on the grounding wire, preventing commands from being transferred accurately, thus leading to vibration. - If the robot is grounded at an unsuitable point, its grounding potential becomes unstable, and noise is likely to be induced on the grounding line, thus leading to vibration.	- Connect the grounding wire firmly to ensure a reliable ground potential and prevent extraneous electrical noise.
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 effector 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.

Symptom	Description	Cause	Measure
Motor over-heating	- The ambient temperature of the installation location increases, causing the motor to overheat. - After the robot control program or the load was changed, the motor overheated.	[Ambient temperature] - It is likely that a rise in the ambient temperature prevented the motor from releasing heat efficiently, thus leading to overheating. [Operating condition] - It is likely that the robot was operated with the maximum average current exceeded.	- Reducing the ambient temperature is the most effective means of preventing overheating. - If there is a source of heat near the motor, it is advisable to install shielding to protect the motor from heat radiation. - Relaxing the robot control program and conditions can reduce the average current, thus preventing overheating. - The teach pendant can be used to monitor the average current. Check the average current when the robot control program is running.
	- After a control parameter (load setting etc.) was changed, the motor overheated.	[Parameter] - If data input for a workpiece is invalid, the robot cannot be accelerated or decelerated normally, so the average current increases, leading to overheating.	- As for load setting, Input an appropriate parameter referring to Section 4.3.
	- Symptom other than stated above	[Mechanical section problems] - It is likely that problems occurred in the mechanical unit drive mechanism, thus placing an excessive load on the motor. [Motor problems] - It is likely that a failure of the motor brake resulted in the motor running with the brake applied, thus placing an excessive load on the motor. - It is likely that a failure of the motor prevented it from delivering its rated performance, thus causing an excessive current to flow through the motor. - It is likely that cooling fan is broken. (J1 to J3-axis)	- Repair the mechanical unit while referring to the above descriptions of vibration, noise, and rattling. - Check that, when the servo system is energized, the brake is released. If the brake remains applied to the motor all the time, replace the motor. - If the average current falls after the motor is replaced, it indicates that the first motor was faulty. - If the cooling fan is broken, replace it by new one.

Symptom	Description	Cause	Measure

Oil leakage	- Oil 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 oil 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 the wrist

Dropping axis	- An axis drops because the brake does not function. - An axis drops gradually when it should be at rest.	[Brake drive relay and motor] - It is likely that brake drive relay contacts are stuck to each other to keep the brake current flowing, thus preventing the brake from operating when the motor is deenergized. - 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 has entered the motor, causing the brake to slip.	- Check whether the brake drive relay contacts are stuck to each other. If they are found to be stuck, replace the relay. - If the brake shoe is worn out, if the brake main body is damaged, or if oil has entered the motor, replace the motor.
Displacement	- The robot operates at a point other than the taught position. - The repeatability is not within the tolerance.	[Mechanical section problems] - If the repeatability is unstable, probable causes are a failure in the drive mechanism or a loose bolt. - If the repeatability becomes stable it is likely that a collision imposed an excessive load, leading to slipping on the base surface or the mating surface of an arm or reducer. - It is likely that the Pulsecoder is abnormal.	- If the repeatability is unstable, repair the mechanical section by referring to the above descriptions of vibration, noise, and rattling. - If the repeatability is stable, correct the taught program. Variation will not occur unless another collision occurs. - If the Pulsecoder is abnormal, replace the motor.

Symptom	Description	Cause	Measure
Displacement	- Displacement occurs only in a specific peripheral unit.	[Peripheral unit displacement] - It is likely that an external force was applied to the peripheral unit, thus shifting its position relative to the robot.	- Correct the setting of the peripheral unit position. - Correct the taught program.
	- Displacement occurred after a parameter was changed.	[Parameter] - It is likely that the mastering data was rewritten in such a way that the robot origin was shifted.	- Re-enter the previous mastering data, which is known to be correct. - If correct mastering data is unavailable, perform mastering again.
CLALM alarm occurred. Move error excess alarm occurred.	- Ambient temperature of the robot installation location is low, CLALM alarm is displayed on the teach pendant screen. - Temperature of the robot installation position is low, “Move error excess” alarm is displayed on the teach pendant screen.	[Peripheral temperature] - When the robot is used in a low temperature environment that is near to 0ºC, or the robot is not operated for a long time in an environment that is less than 0ºC, there will be a large viscous resistance of the drive train immediately after starting which will cause the alarm.	- Perform a warm up operation or a low speed operation for several minutes.
	- After changing the motion program or the load condition, the CLALM alarm is displayed. - After changing the motion program or the load condition, the “Move error excess” alarm is displayed.	- It is likely that a robot collision occurred.	- If a robot collision has occurred, press the [RESET] key while pressing the [SHIFT] key. Then, jog the robot in the opposite direction while pressing the [SHIFT] key. - Check the motion program.
		[Overload] - It is likely that load exceeded the permissible value. - It is likely that the motion program is too severe for the robot. ・ Excessive motion due to a large “ACC (value)”. ・ Tight motion such as reverse motion using “CNT”. ・ Linear motion occurs near singularity point where axes revolve in high speed.	- Check the permissible value of the robot payload. If the load exceeds the permissible value, reduce the load or change the motion program. - Consider minimizing the cycle time by reducing the speed or acceleration, and changing the motion program. - Check that the load setting is performed correctly.
	- None of the symptoms stated above are the problem.	- It is likely the vibration occurred.	- Refer to the Symptoms: Vibration, Noise section of this troubleshooting for more information.
		- If the power source voltage drops below the rating, a vibration might occur.	- Check that the robot is supplied with the proper rated voltage.

Symptom	Description	Cause	Measure
Joints of robot are removed.	- Joints of robot are removed.	- Excessive collision or excessive overload sometimes causes link disconnection for minimizing the damage.	- Contact your local FANUC representative for restoring method..
BZAL alarm occurred	- BZAL is displayed on the teach pendant screen	- It is likely that the voltage of the memory backup battery is low. - It is likely that the Pulsecoder cable is defected.	- Replace the battery. - Replace the cable.

APPENDIX

A PERIODIC MAINTENANCE TABLE

FANUC Robot M-3*i*A Periodic Maintenance Table

Items		Accumulated operating time (H))	Check time	Oil 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
			Cycle count (*3)	—		5000k	10000k	15000k	20000k	25000k	30000k	35000k	40000k	45000k	50000k	55000k
Mechanical unit1	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	Retighten the end effector mounting bolts	0.2H	—		○			○				○			
	5	Retighten the external main bolts.	2.0H	—		○			○				○			
	6	Check the link B - Carbon link - Spring - Plastic bush for spring - Drive shaft - Rod support - Universal joint	0.1H	—		○			○				○			
	7	Check the abrasion of spherical plastic bush of connection parts between link A and link B and between link B and wrist, slider bush diplacement	0.2H	—	○	○	○	○	○	○	○	○	○	○	○	○
	8	Remove spatter and dust etc	1.0H	—		○			○				○			
	9	Check the end effector (hand) cable	0.1H	—		○			○				○			
	10	Visually check the wrist motor cable (except M-3*i*A/12H)	0.1H	—		○			○				○			
	11	Check the operation of the cooling fan	0.1H	—		○			○				○			
	12	Apply grease and cleaning the spherical joint	0.1H	Proper quantity			●		●		●		●		●	
	13	Replacing battery (*4)	0.1H	—							●					
	14	Supply oil to J1/J2/J3-axis reducer	0.1H	each 390ml					●				●			
	15	Supply oil to wrist (M-3*i*A/6S)	0.1H	410ml(B201) 140ml(B203)					●				●			
		Supply oil to wrist (M-3*i*A/6A)	0.1H	850ml					●				●			
	16	Apply grease to the spherical joint	0.1H	0.05 to 0.1mℓ			●		●		●		●		●	
	17	Replacing plastic parts	1.0H	—					●				●			
	18	Replacing motor support kits	1.0H	—									●			
	19	Replacing parts such as reducers.	8.0H	—												
Controller	20	Check the robot cable, teach pendant cable and robot connecting cable	0.2H	—		○			○				○			
	21	Cleaning the controller ventilation system	0.2H	—	○	○	○	○	○	○	○	○	○	○	○	○
	22	Replacing battery (*1)(*4)	0.1H	—												

*1 Refer to “REPLACING UNITS Chapter of MAINTENANCE” of the following manuals.
R-30*i*A CONTROLLER MAINTENANCE MANUAL (Standard) (B-82595EN),
R-30*i*A CONTROLLER MAINTENANCE MANUAL (For Europe) (B-82595EN-1),
R-30*i*A CONTROLLER MAINTENANCE MANUAL (For RIA) (B-82595EN-2),
R-30*i*B/R-30*i*B Plus CONTROLLER MAINTENANCE MANUAL (B-83195EN)
R-30*i*B Mate/R-30*i*B Mate Plus CONTROLLER MAINTENANCE MANUAL (B-83525EN)
R-30*i*B Mate/R-30*i*B Mate Plus CONTROLLER OPEN AIR TYPE MAINTENANCE MANUAL (B-83555EN)

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

*3 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.

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

3 years 11520	12480	13440	14400	4 years 15360	16320	17280	18240	5 years 19200	20160	21120	22080	6 years 23040	24000	24960	25920	7 years 26880	27840	28800	29760	8 years 30720	
60000k	65000k	70000k	75000k	80000k	85000k	90000k	95000k	10000k	10500k	10000k	11500k	12000k	12500k	13000k	13500k	14000k	14500k	15000k	15500k	16000k	Item
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		1
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		2
○				○				○				○				○					3
○				○				○				○				○					4
○				○				○				○				○					5
○				○				○				○				○					6
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		7
○				○				○				○				○					8
○				○				○				○				○					9
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		10
○				○				○				○				○					11
●		●		●		●		●		●		●		●		●		●			12
●						●						●						●			13
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●				●				●				●				●					
●				●				●				●				●					16
●		●		●		●		●		●		●		●		●		●			17
				●								●									18
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○				○				○				○				○					20
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		21
				●																	22

Overhaul

B PERIODIC MAINTENANCE PARTS

Contact your local FANUC representative for replacing procedure.

(a) Replacing parts at 1 years (3840 hours)

We recommend replacing the following parts at the intervals based on every 1 year or 3840 hours, whichever comes first.

Item	Parts	Specification	6S(B201)	6S(B203)	6A	12H
1	SPHERICAL BUSH	A290-7523-X321	12			
2	PLASTIC BUSH	A290-7523-X351	12			
3	PLASTIC BUSH	A290-7523-X352	12			
4	WASHER	A6-WM-5SUS	24			
5	PLASTIC WASHER	A98L-0040-0248#M10	24			
6	SLIDER	A290-7523-X334	2		6	-
7	CLAMP	A290-7523-X358	6			
8	RUBBER SHEET	A290-7523-X343	6			

(b) 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	6S(B201)	6S(B203)	6A	12H
9	Motor support kit	A05B-1523-K313	1		3	-

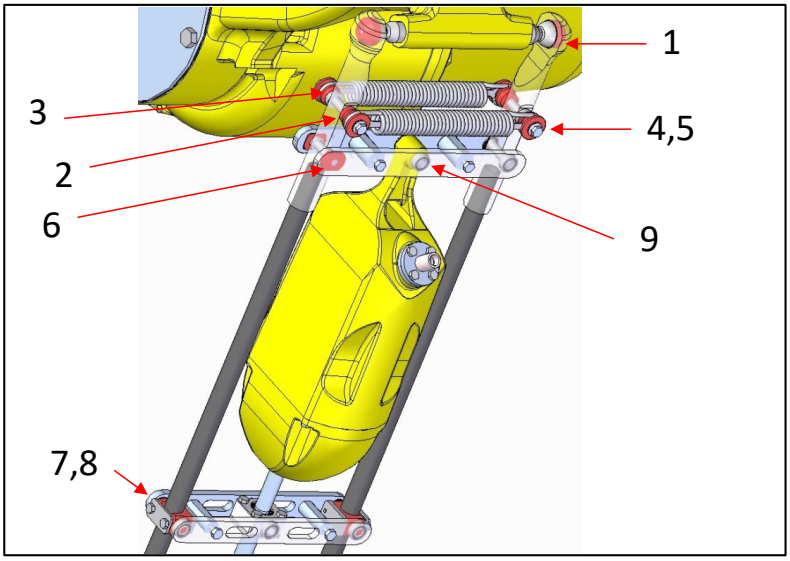


Fig. B (a) Periodic replacing parts (1 years, 2years)

(c) Replacing parts at 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	Color	6S(B201)	6S(B203)	6A	12H
10	Spring kit	A05B-1523-K321	-	12			
11	Link B	A290-7523-V301		2	2	6	-
12	Link B	A290-7523-V302		4	4	-	6
13	Wrist motor unit	A05B-1523-K307	White	1	-	-	-
		A05B-1523-K308	Yellow				
		A05B-1523-K325	White	-	1		
		A05B-1523-K326	Yellow				
		A05B-1523-K309	White		-	3	
		A05B-1523-K310	Yellow				
14	Rod support kit A	A05B-1523-K322	-	1		3	
15	Rod support kit B	A05B-1523-K323		2		-	3
16	Drive shaft kit	A05B-1523-K311		1		3	-
17	Universal joint	A290-7523-V305		1		3	
18	Wrist unit	A05B-1523-K521	White	1	-	-	
		A05B-1523-K522	Yellow				
		A05B-1523-K530	White	-	1	-	
		A05B-1523-K531	Yellow				
		A05B-1523-K532	-				
		A05B-1523-K523	White		-	1	
		A05B-1523-K524	Yellow				

(d) Replacing parts at 8 years (30720 hours)

We recommend replacing the following parts at the intervals based on every 8 years or 30720 hours, whichever comes first.

Item	Parts	Specification	Color	6S(B201)	6S(B203)	6A	12H
19	Fan ASSY (option)	A290-7523-V701	-	3			
20	Reducer	A97L-0218-0894#32N	-	3			
21	Gear	A290-7525-X234	-	3			
22	Spherical joint	A290-7523-X213	-	6			

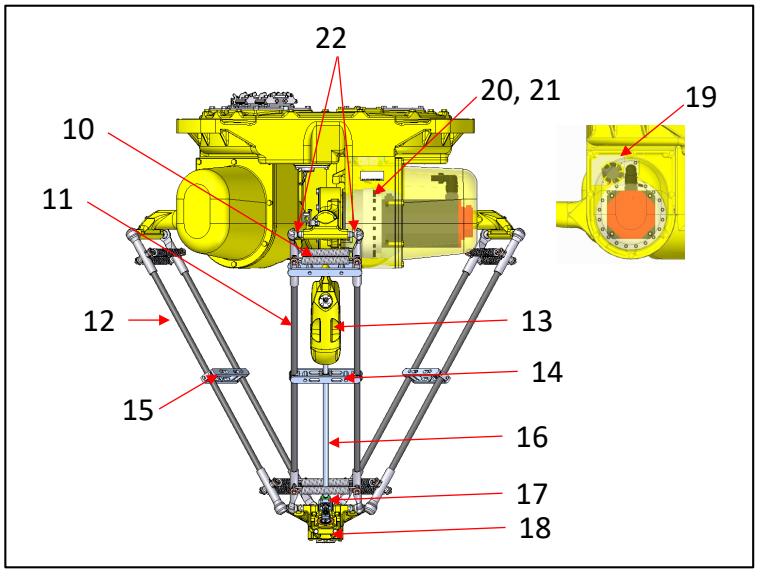


Fig. B (b) Periodic replacing parts (4 years, 8years)

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.

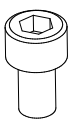
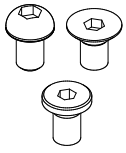
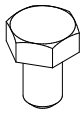
C STRENGTH OF BOLT AND BOLT TORQUE LIST

NOTE

When applying LOCTITE to a part, spread the LOCTITE on the entire length area 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 the oil on the engaging section. Make sure that there is no solvent left in the threaded holes. In this case, remove all the excess LOCTITE when you are finished screwing the bolts into the threaded holes.

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

Recommended bolt tightening torques **Unit: Nm**

Nominal diameter	Hexagon socket head bolt (steel)		Hexagon socket head bolt (stainless)		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	———	———	———	———	———	———
								

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REVISION RECORD

Edition	Date	Contents
07	Feb., 2022	• Change of periodic replacement parts • Corrections of errors
06	Nov., 2019	• Addition of items of checks and maintenance • Corrections of errors
05	Dec., 2014	• Addition of R-30*i*B Mate • Correction of replacing method of spherical plastic bush • Addition of 8kg option • Addition of quick master for single axis • Corrections of errors
04	May, 2012	• Addition of M-3*i*A/12H • Addition of R-30*i*B • Addition of explanation of footing • Change of example of pedestal • Corrections of errors
03	Sep., 2011	• Addition of M-3*i*A/6S (A05B-1523-B203) • Addition of Remote type battery • Corrections of errors
02	Nov., 2010	• Addition of stop type of robot • Addition of stopping time and distance when controlled stop is executed • Addition note of end effector (hand) cable • Addition of high inertia mode of M-3*i*A/6S • Addition of joint load monitor • Corrections of errors
01	May, 2010	

B-83154EN/07