FANUC Robot M-2*i*A

MECHANICAL UNIT
OPERATOR'S MANUAL

B-83504EN/06

- **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.

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

Name	Specification
Brake release unit	A05B-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.

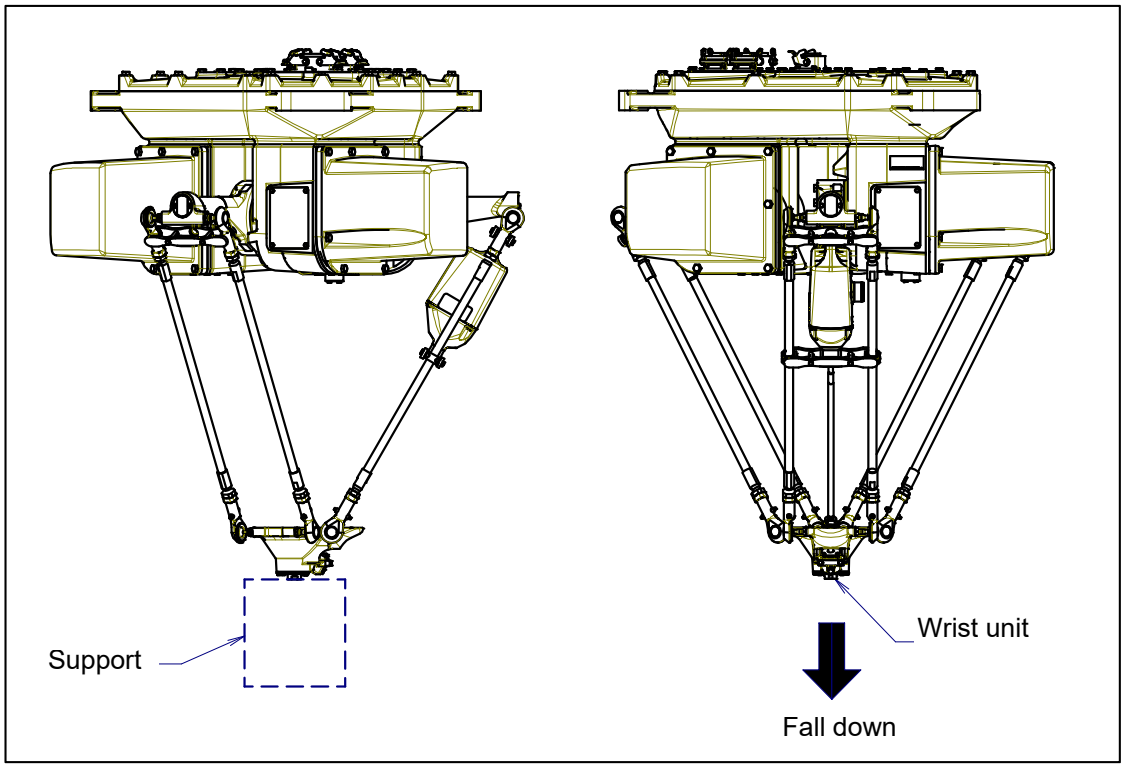


Fig. 3 (a) Arm operation by the release of motor brake and measures

4 WARNING & CAUTION LABEL

(1) Transportation caution label 1

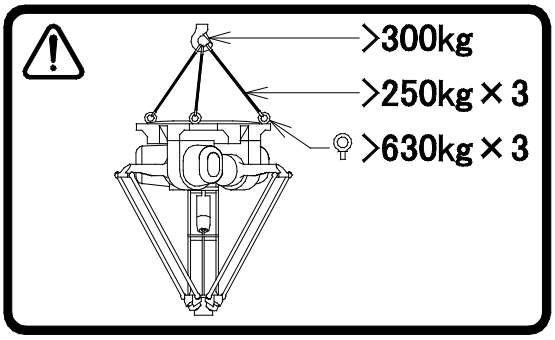


Fig. 4 (a) Transportation caution label

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 or greater.
- Use three eyebolts with each load capacity of 6174 N (630 kgf) or greater.

(2) Transportation caution label 2

Fig. 4 (b) Transportation caution label

Description

Keep the following in mind when transporting the robot.

- Do not pull eyebolts sideways.

(3) Operating space and payload label

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

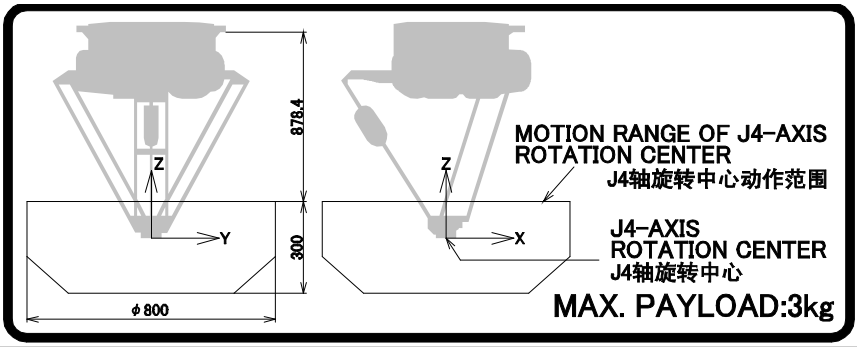


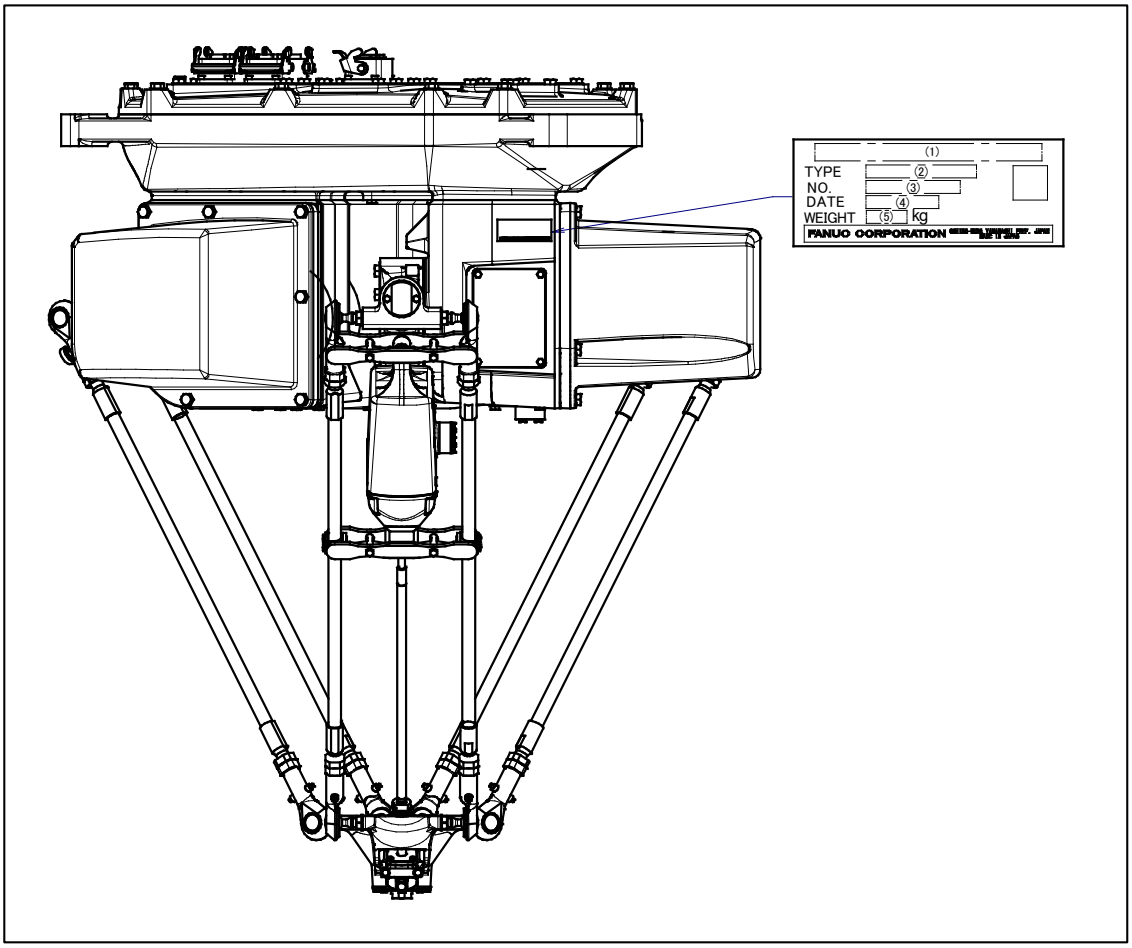
Fig. 4 (c) Operating space and payload label (Example of M-2*i*A/3S)

PREFACE

This manual explains operation procedures for the following mechanical units:

Model name	Mechanical unit specification No.	Maximum load
FANUC Robot M-2*i*A/3S	A05B-1524-B201	3kg
FANUC Robot M-2*i*A/3S	A05B-1524-B207	
FANUC Robot M-2*i*A/3SL	A05B-1524-B202	
FANUC Robot M-2*i*A/3SL	A05B-1524-B208	
FANUC Robot M-2*i*A/6H	A05B-1524-B203	6kg
FANUC Robot M-2*i*A/6H	A05B-1524-B209	
FANUC Robot M-2*i*A/6HL	A05B-1524-B204	
FANUC Robot M-2*i*A/6HL	A05B-1524-B210	
FANUC Robot M-2*i*A/3A	A05B-1524-B205	3kg
FANUC Robot M-2*i*A/3A	A05B-1524-B211	
FANUC Robot M-2*i*A/3AL	A05B-1524-B206	
FANUC Robot M-2*i*A/3AL	A05B-1524-B212	

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



Position of label indicating mechanical unit specification number

TABLE 1)

	(1)	(2)	(3)	(4)	(5)
CONTENTS	**MODEL NAME**	**TYPE**	**No.**	**DATE**	**WEIGHT kg (without controller)**
LETTERS	FANUC Robot M-2*i*A/3S	A05B-1524-B201 A05B-1524-B207	SERIAL NO IS PRINTED	PRODUCTION YEAR AND MONTH ARE PRINTED	130
	FANUC Robot M-2*i*A/3SL	A05B-1524-B202 A05B-1524-B208			130
	FANUC Robot M-2*i*A/6H	A05B-1524-B203 A05B-1524-B209			125
	FANUC Robot M-2*i*A/6HL	A05B-1524-B204 A05B-1524-B210			125
	FANUC Robot M-2*i*A/3A	A05B-1524-B205 A05B-1524-B211			140
	FANUC Robot M-2*i*A/3AL	A05B-1524-B206 A05B-1524-B212			140

RELATED MANUALS

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

Safety handbook **B-80687EN** All persons who use the FANUC Robot and system designer must read and understand thoroughly this handbook		Intended readers: Operator , system designer Topics: Safety items for robot system design, operation, maintenance
R-30*i*B R-30*i*B Mate R-30*i*B Plus, R-30*i*B Mate Plus **controller**	OPERATOR'S MANUAL Basic Operation **B-83284EN** Alarm Code List **B-83284EN-1** Optional Function **B-83284EN-2**	Intended readers: Operator, programmer, 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 (Open Air) :** **B-83555EN**	Intended readers: Maintenance technician, system designer Topics: Installation, start-up, connection, maintenance Use: Installation, start-up, connection, maintenance

This manual uses following terms.

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

TABLE OF CONTENTS

1 TRANSPORTATION AND INSTALLATION

1.1 TRANSPORTATION

Use a crane to transport the robot. When transporting the robot, be sure to change the posture of the robot to that shown Fig.1.1 (a) 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, be careful not to damage motors, connectors, or cables of the robot 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.

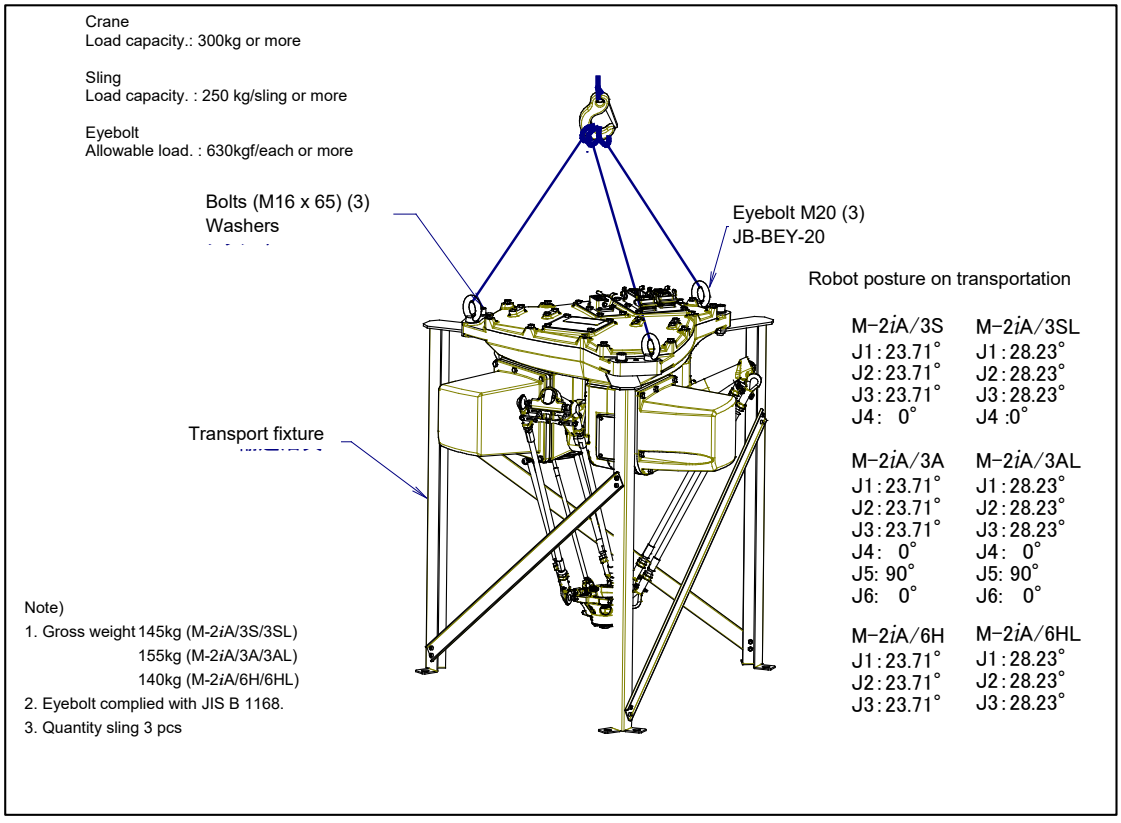


Fig. 1.1 (a) Transportation using a crane

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.

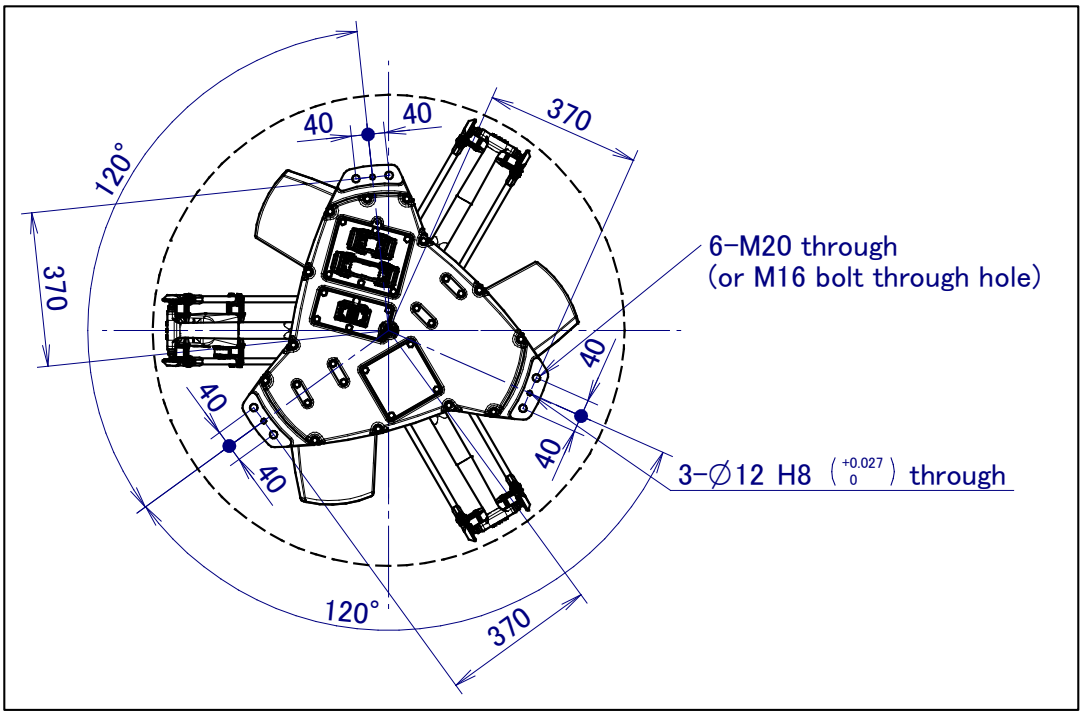


Fig. 1.2 (a) Dimension of robot base

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

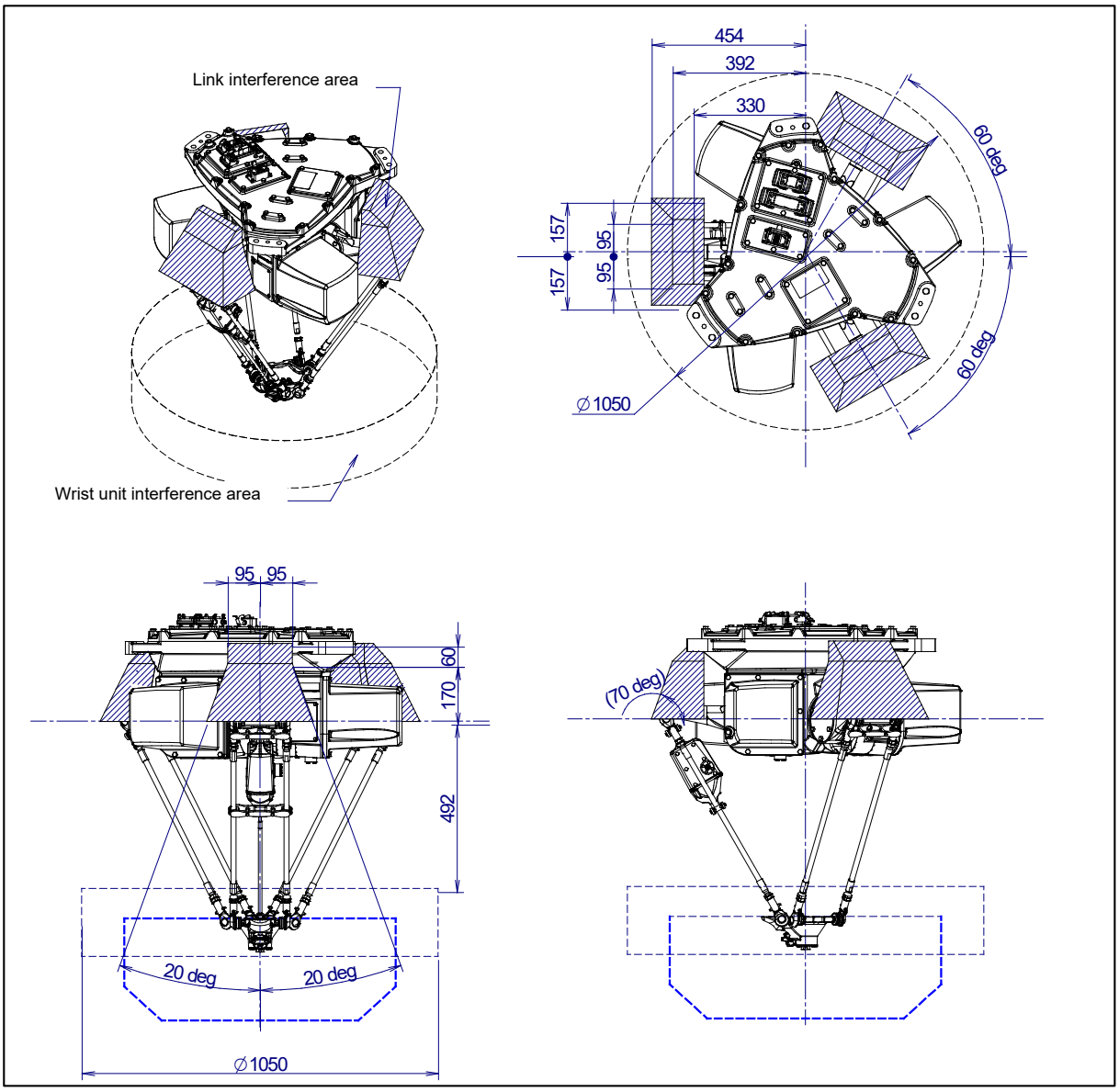


Fig. 1.2 (b) Link interference area (M-2*i*A/3S/3A/6H)

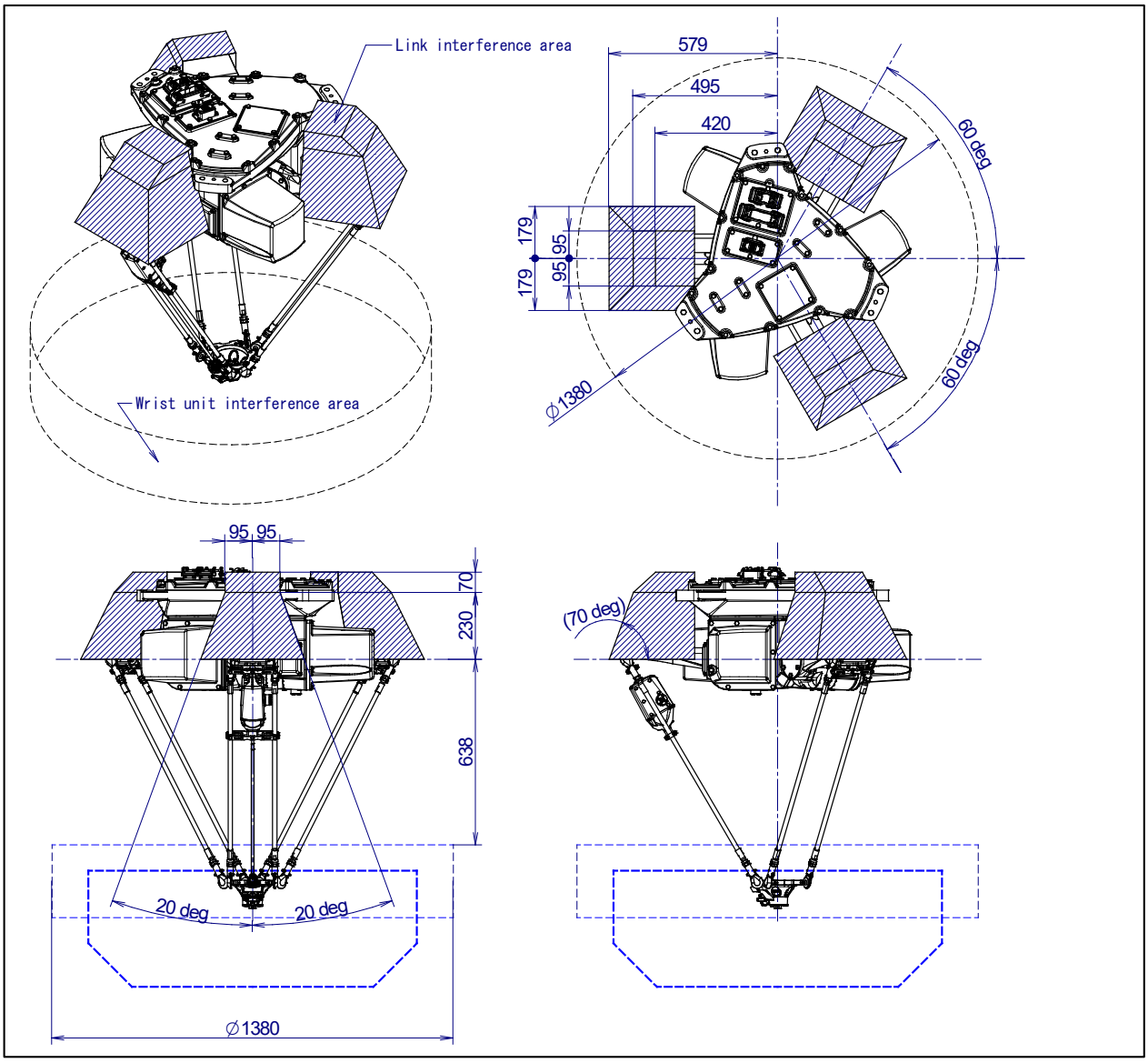


Fig. 1.2 (c) Link interference area (M-2*i*A/3SL/3AL/6HL)

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.

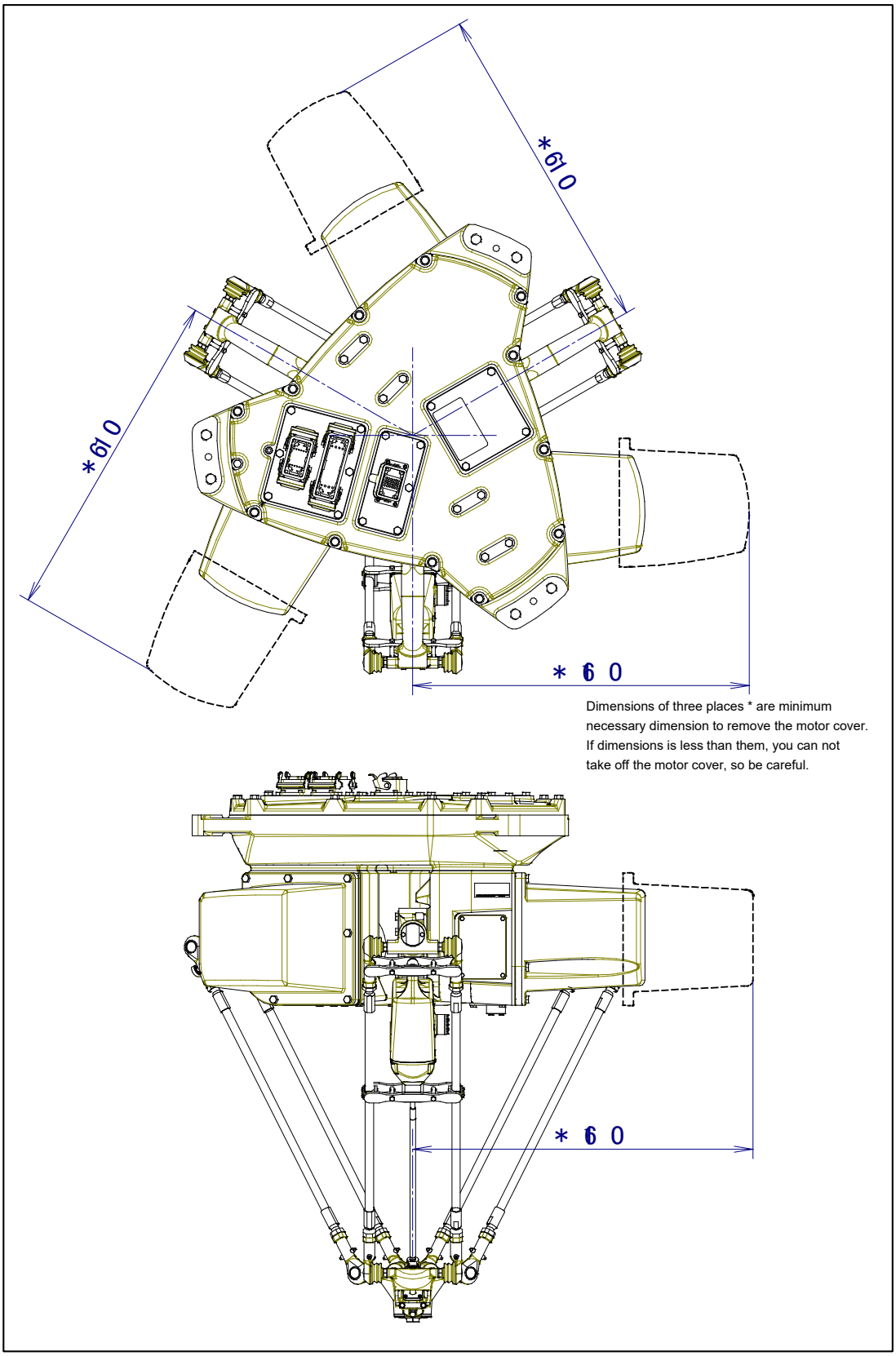


Fig. 1.2 (d) Dimensions required to remove the motor cover

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 are less than them, you can not take off the motor cover, so be careful.

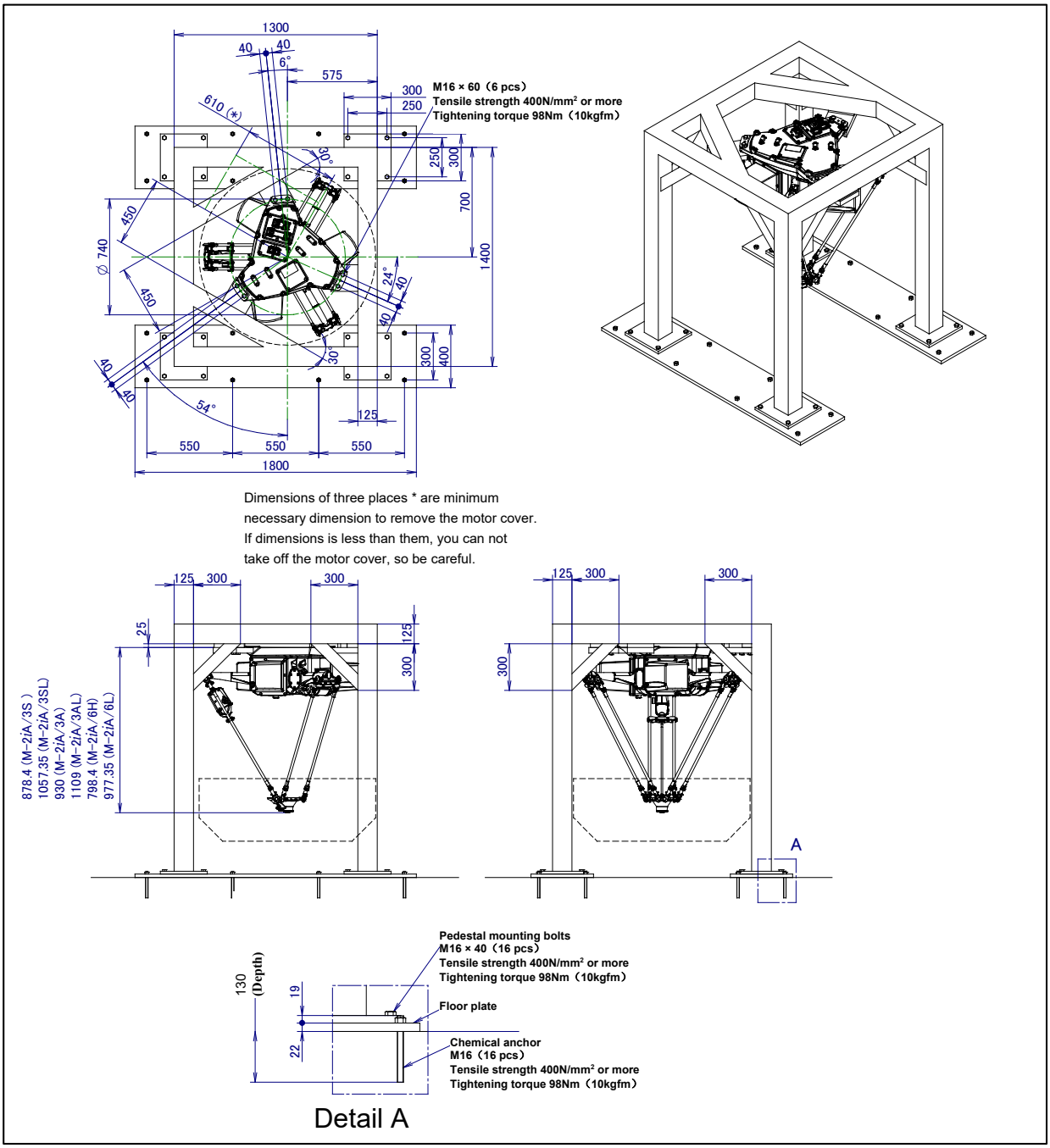


Fig. 1.2 (e) Example of design dimension of pedestal

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

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

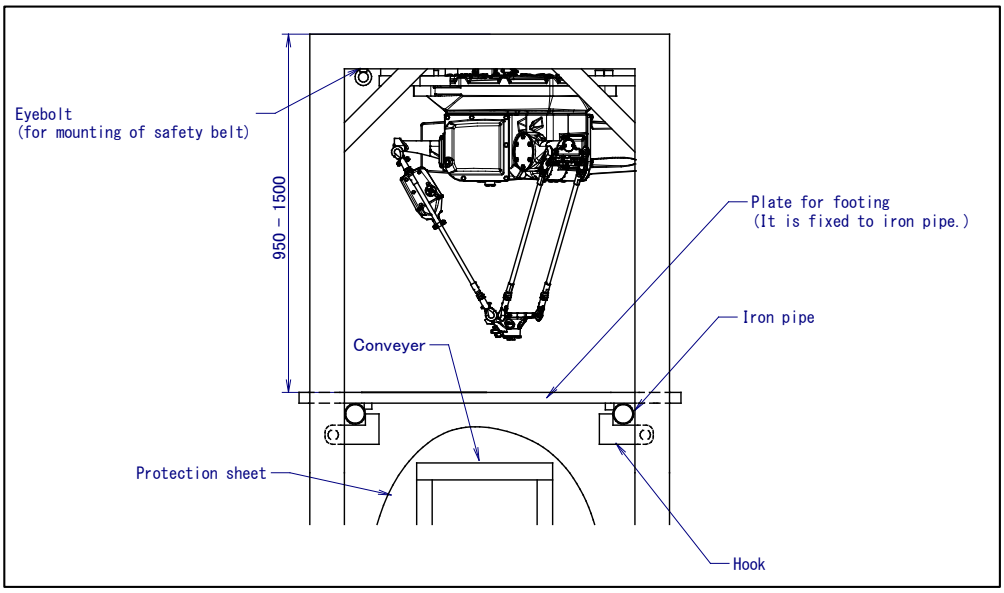


Fig. 1.2 (f) Example of footing

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.

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	1372	0	0
Acceleration/ Deceleration	754	1852	220	701
Power-Off stop	1993	3044	1297	2040

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-2*i*A/3S	Stopping time [ms]	71	71	30
	Stopping distance [mm]	305	305	65
M-2*i*A/3SL	Stopping time [ms]	86	86	34
	Stopping distance [mm]	345	345	72
M-2*i*A/3A	Stopping time [ms]	68	68	29
	Stopping distance [mm]	198	198	46
M-2*i*A/3AL	Stopping time [ms]	280	280	274
	Stopping distance [mm]	394	394	144
M-2*i*A/6H	Stopping time [ms]	111	111	105
	Stopping distance [mm]	153	153	45
M-2*i*A/6HL	Stopping time [ms]	75	75	34
	Stopping distance [mm]	405	405	132

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-2*i*A/3S	Stopping time [ms]	146	146	96
	Stopping distance [mm]	364	364	128
M-2*i*A/3SL	Stopping time [ms]	237	237	114
	Stopping distance [mm]	529	529	171
M-2*i*A/3A	Stopping time [ms]	97	97	28
	Stopping distance [mm]	276	276	61
M-2*i*A/3AL	Stopping time [ms]	378	378	251
	Stopping distance [mm]	558	558	192
M-2*i*A/6H	Stopping time [ms]	279	279	259
	Stopping distance [mm]	422	422	165
M-2*i*A/6HL	Stopping time [ms]	271	271	170
	Stopping distance [mm]	546	546	220

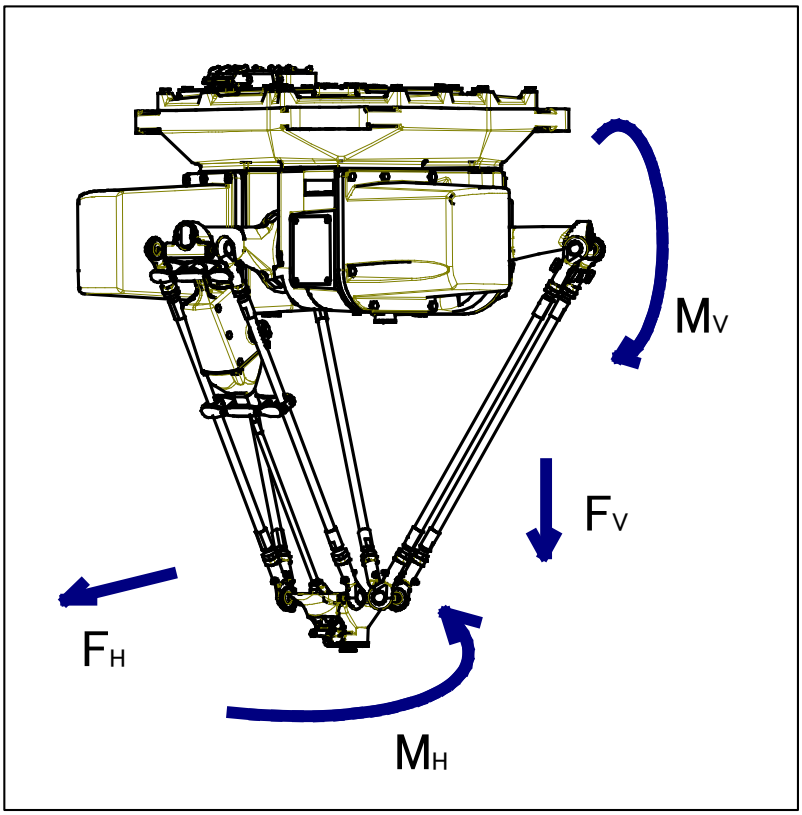


Fig. 1.2 (g) Force and moment that acts on robot base

1.3 MAINTENANCE AREA

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

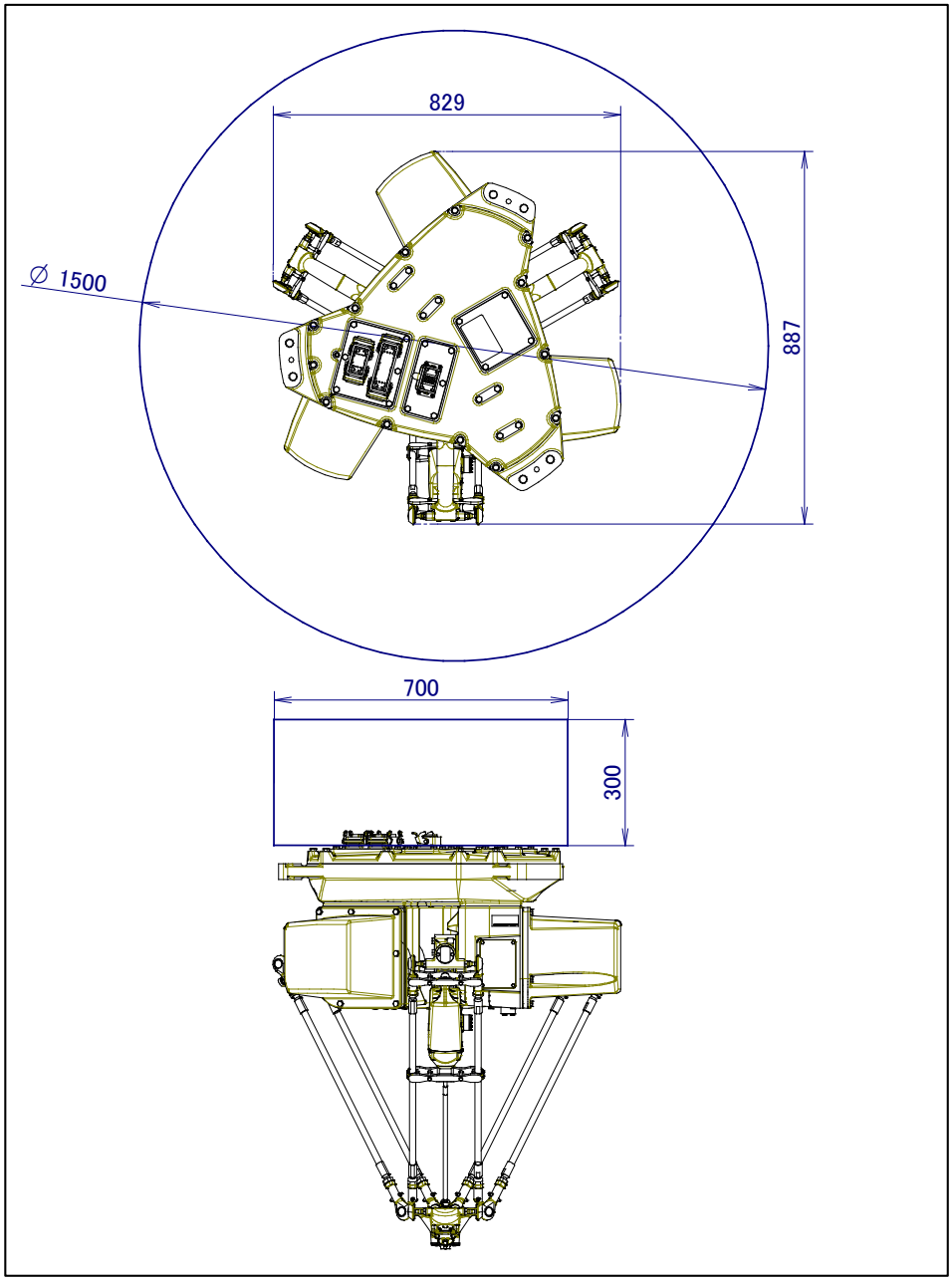


Fig. 1.3 (a) Maintenance area

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.

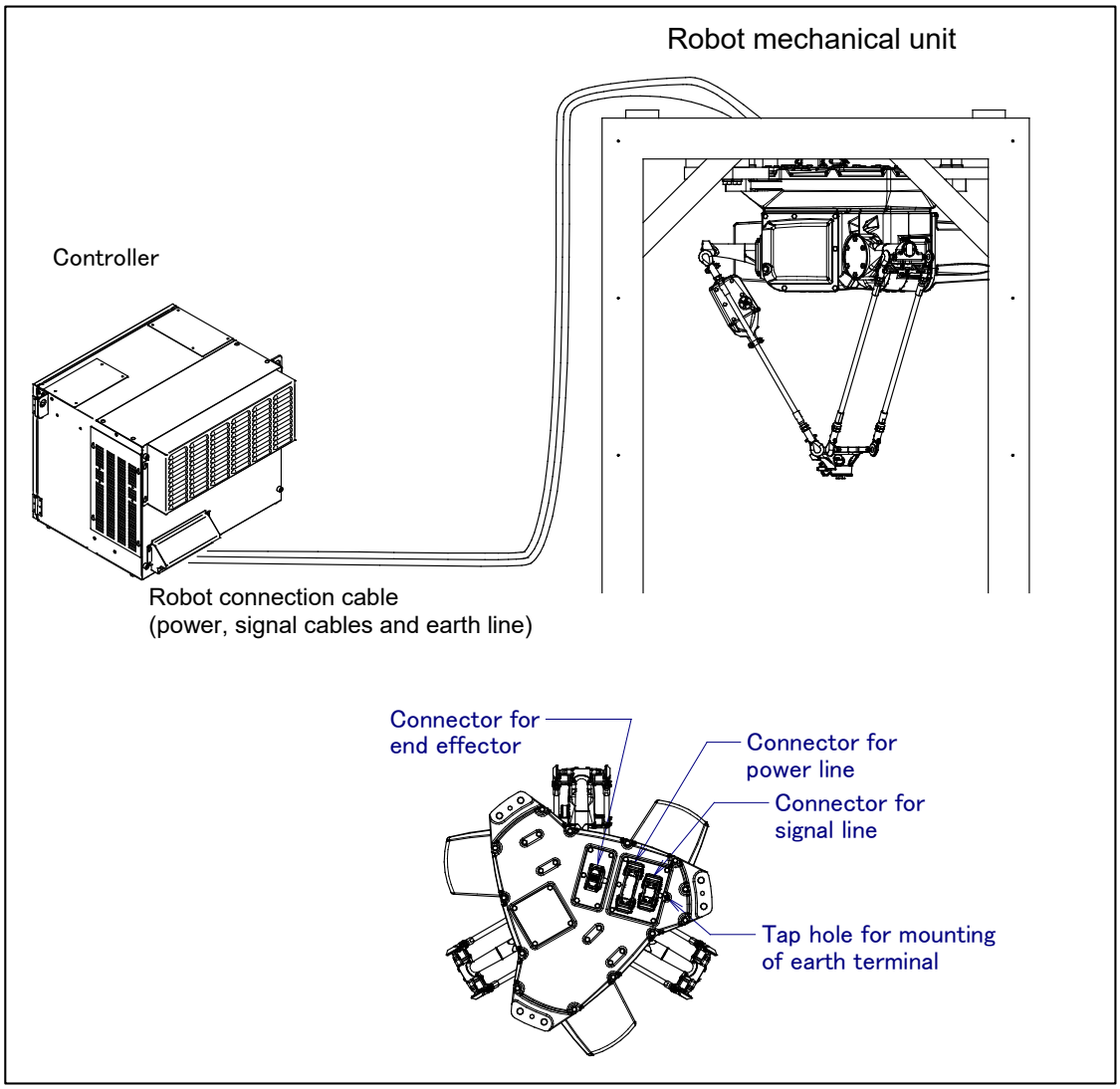


Fig. 2 (a) Cable connection

3 BASIC SPECIFICATIONS

3.1 ROBOT CONFIGURATION

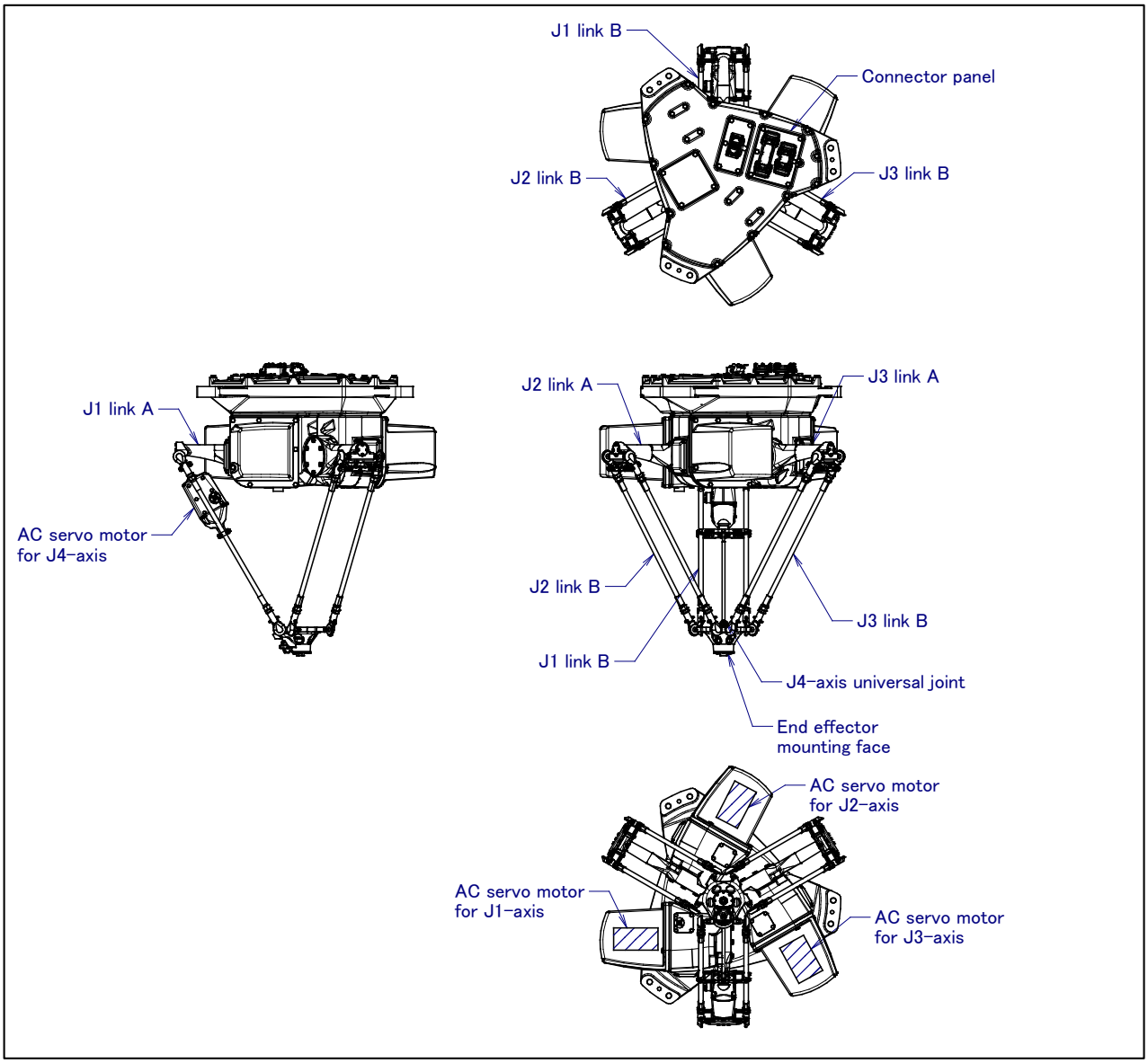


Fig. 3.1 (a) Mechanical unit configurations (M-2*i*A/3S/3SL)

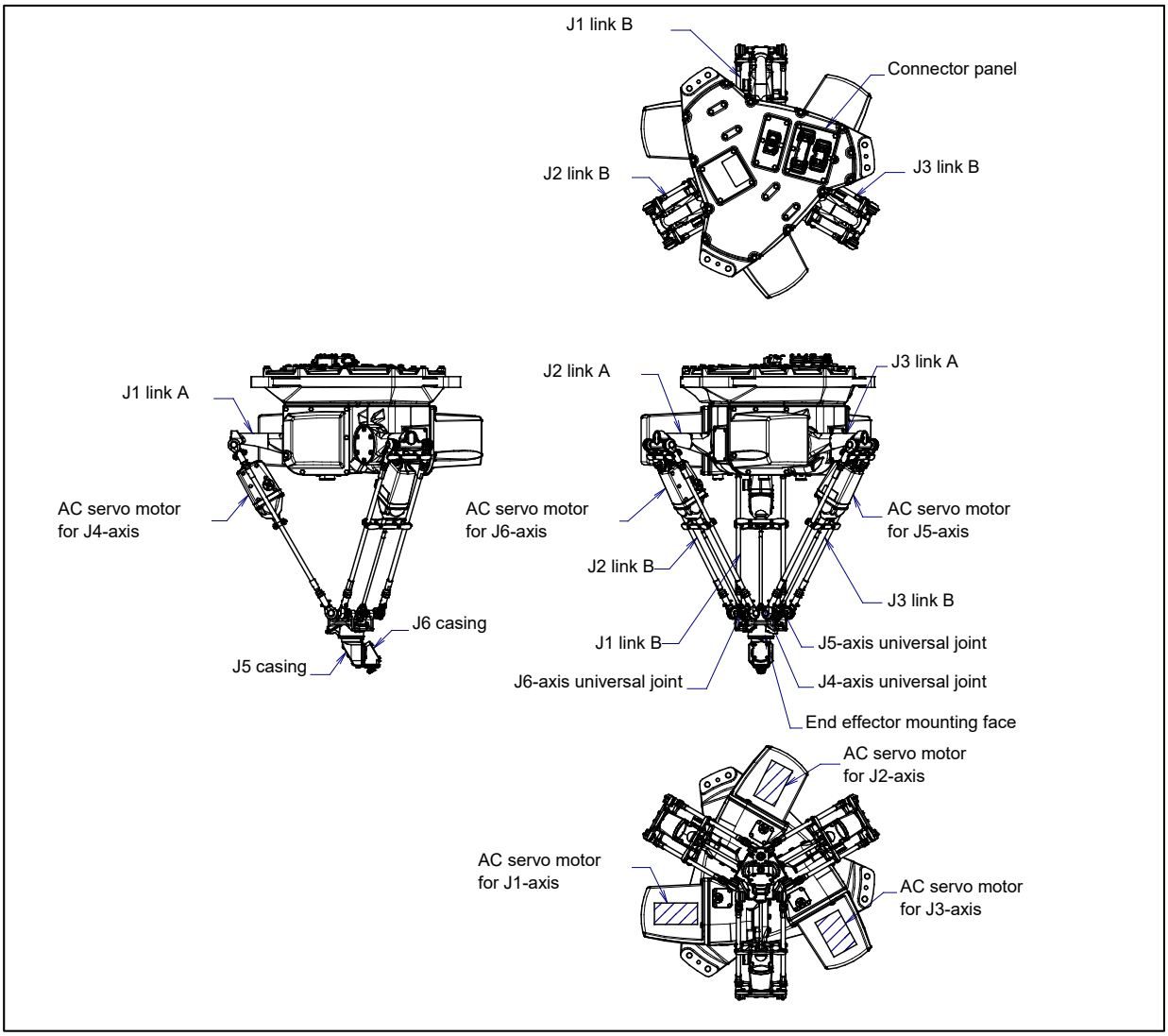


Fig. 3.1 (b) Mechanical unit configurations (M-2*i*A/3A/3AL)

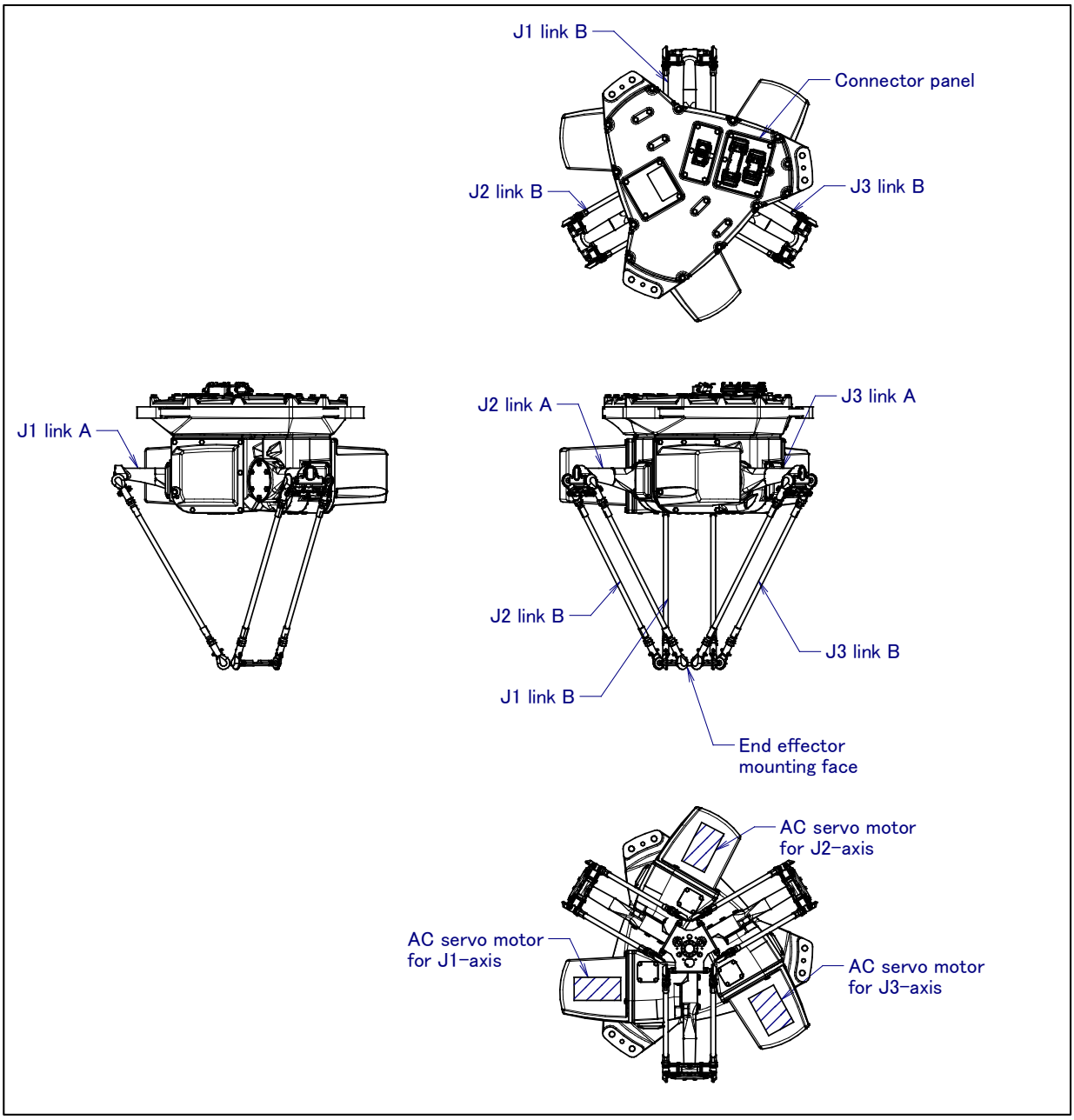


Fig. 3.1 (c) Mechanical unit configurations
(M-2*i*A/6H/6HL)

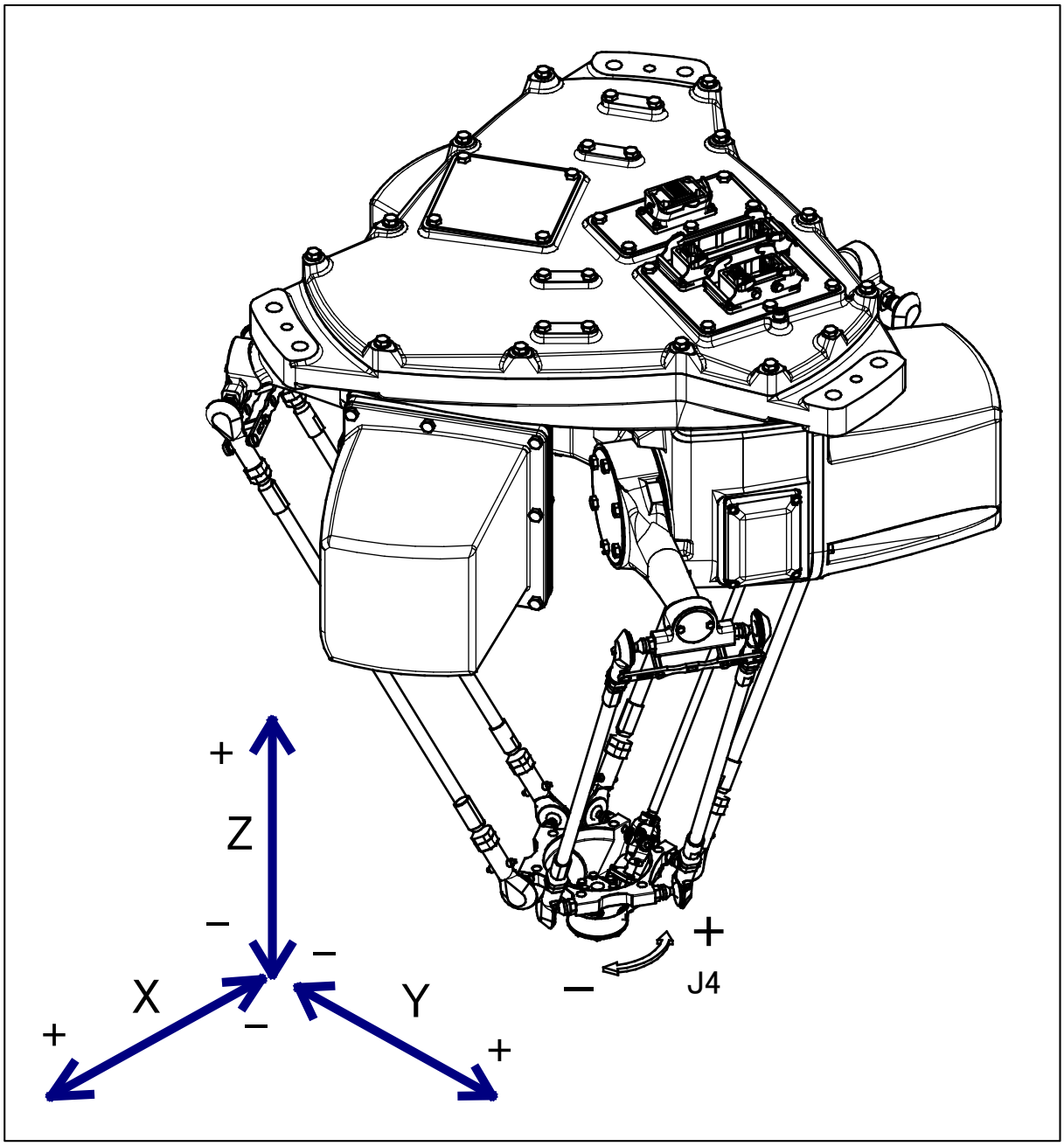


Fig. 3.1 (d) Each axes coordinates (M-2*i*A/3S/3SL)

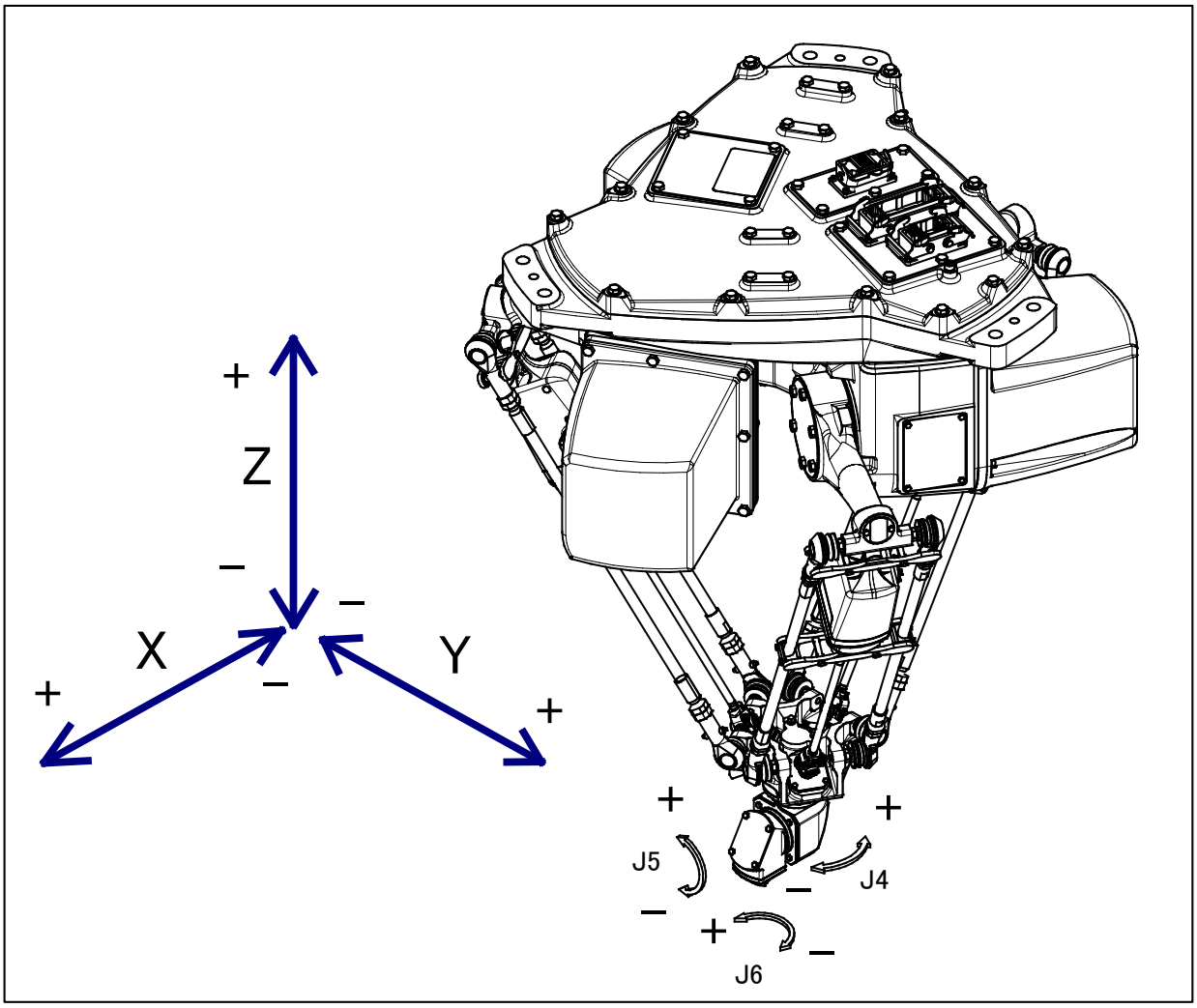


Fig. 3.1 (e) Each axes coordinates (M-2*i*A/3A/3AL)

NOTE
M-2*i*A/6H/6HL do not have the J4-axis.

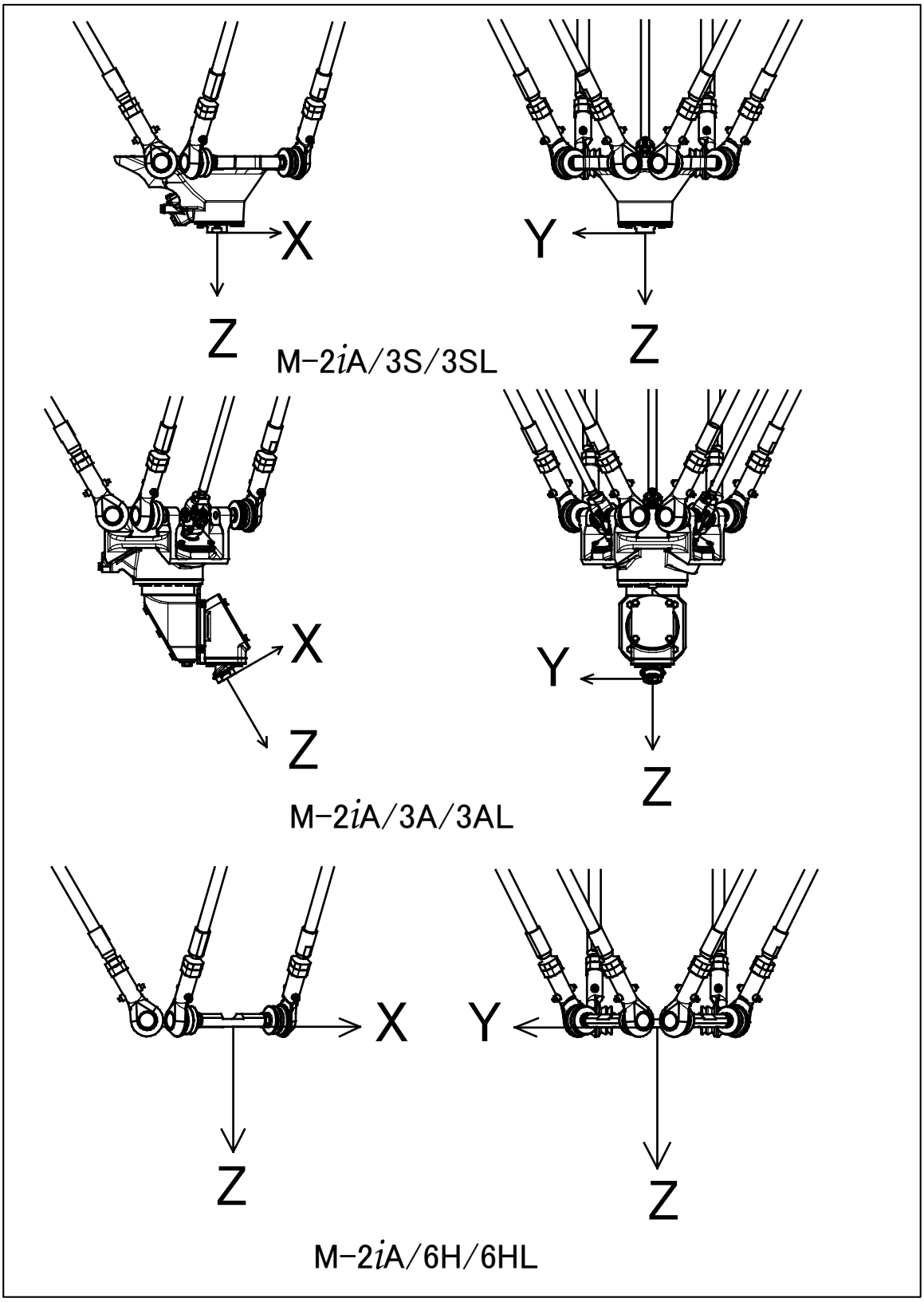


Fig. 3.1 (f) Mechanical interface coordinates

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

Table 3.1 (a) Specifications (Note 1) (1/3)

		M-2*i*A/3S	M-2*i*A/3SL
Type		Parallel link mechanism robot	
Controlled axes		4-axes (J1, J2, J3, J4)	
Installation		Ceiling	
Motion range (Max.speed) (NOTE 2)	J1 to J3	Diameter 800 mm, Height 300 mm	Diameter 1130 mm, Height 400 mm
	J4	720º (3500º/s) (NOTE 3) 12.57 rad (61.09 rad/s)	
		720º (1750º/s) (NOTE 3) 12.57 rad (30.54 rad/s)	
Max.payload (NOTE 4)		3kg	
Repeatability (NOTE 5)		±0.03mm	
Dust.proof and drip.proof mechanism		Conform to IP69K (NOTE 6)	
Drive method		Electric servo drive by AC servo motor	
Robot mass		130kg	
Acoustic noise level		73.7dB (NOTE 7)	
Installation environment		Ambient temperature: 0 to 45℃ (NOTE 8) Ambient humidity: Normally 75%RH or less (No dew or frost allowed) Short time 95%Rh or less (Within 1 month) Permissible altitude: Above the sea 1000m or less Vibration acceleration: 4.9m/s^2 (0.5G) or less Free of corrosive gases (NOTE 9) Free of fire	

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 high inertia mode (option) in lower half.
4 Refer to Section 3.3 about load condition of the wrist.
5 Compliant with ISO9283.
6 A protection cover is necessary for robot the connection cables.
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 robot is used in low temperature environment that is near to 0ºC, or not operated for a long time in the environment that is less than 0ºC in a holiday or the night, 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.

Table 3.1 (b) Specifications (NOTE 1) (2/3)

		M-2*i*A/3A	M-2*i*A/3AL
Type		Parallel link mechanism robot	
Controlled axes		6-axes (J1, J2, J3, J4, J5, J6)	
Installation		Ceiling	
Motion range (Max.speed) (NOTE 2)	J1 to J3	Diameter 800 mm, Height 300 mm	Diameter 1130 mm, Height 400 mm
	J4	720º (1700º/s) 12.57 rad (29.67 rad/s)	
	J5	300º (1700º/s) 5.24 rad (29.67 rad/s)	
	J6	720º (1700º/s) 12.57 rad (29.67 rad/s)	
Max.payload (NOTE 3)		3kg	
Repeatability (NOTE 4)		±0.03mm	
Dust.proof and drip.proof mechanism		Conform to IP69K (NOTE 5)	
Drive method		Electric servo drive by AC servo motor	
Robot mass		140kg	
Acoustic noise level		73.7dB (NOTE 6)	
Installation environment		Ambient temperature: 0 to 45℃ (NOTE 7) Ambient humidity: Normally 75%RH or less (No dew or frost allowed) Short time 95%Rh or less (Within 1 month) Permissible altitude: Above the sea 1000m or less Vibration acceleration: 4.9m/s^2 (0.5G) or less Free of corrosive gases (NOTE 8) Free of fire	

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 Refer to Section 3.3 about load condition of the wrist.
4 Compliant with ISO9283.
5 A protection cover is necessary for robot the connection cables.
6 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

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

Table 3.1 (c) Specifications (NOTE 1) (3/3)

		M-2*i*A/6H	M-2*i*A/6HL
Type		Parallel link mechanism robot	
Controlled axes		3-axes (J1, J2, J3)	
Installation		Ceiling	
Motion range	J1 to J3	Diameter 800 mm, Height 300 mm	Diameter 1130 mm, Height 400 mm
Max.payload (NOTE 2)		6kg	
Repeatability (NOTE 3)		±0.03mm	
Dust.proof and drip.proof mechanism		Confirm to IP69K (NOTE 4)	
Drive method		Electric servo drive by AC servo motor	
Robot mass		125kg	
Acoustic noise level		73.7dB (NOTE 5)	
Installation environment		Ambient temperature: 0 to 45℃ (NOTE 6) Ambient humidity: Normally 75%RH or less (No dew or frost allowed) Short time 95%Rh or less (Within 1 month) Permissible altitude: Above the sea 1000m or less Vibration acceleration: 4.9m/s^2 (0.5G) or less Free of corrosive gases (NOTE 7) Free of fire	

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 Refer to Section 3.3 about load condition of the wrist.
3 Compliant with ISO9283.
4 A protection cover is necessary for robot the connection cables.
5 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
6 When robot is used in low temperature environment that is near to 0ºC, or not operated for a long time in the environment that is less than 0ºC in a holiday or the night, collision detection alarm (SRVO-050) etc. may occur since the resistance of the drive mechanism could be high immediately after starting the operation. In this case, we recommend performing the warm up operation for several minutes.
7 Contact the service representative, if the robot is to be used in an environment or a place subjected to hot/cold temperatures, severe vibrations, heavy dust, water, water vapor, cutting oil, cleaning fluid splash and or other contaminations.

3.2 MECHANICAL UNIT EXTERNAL DIMENSIONS AND OPERATING SPACE

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

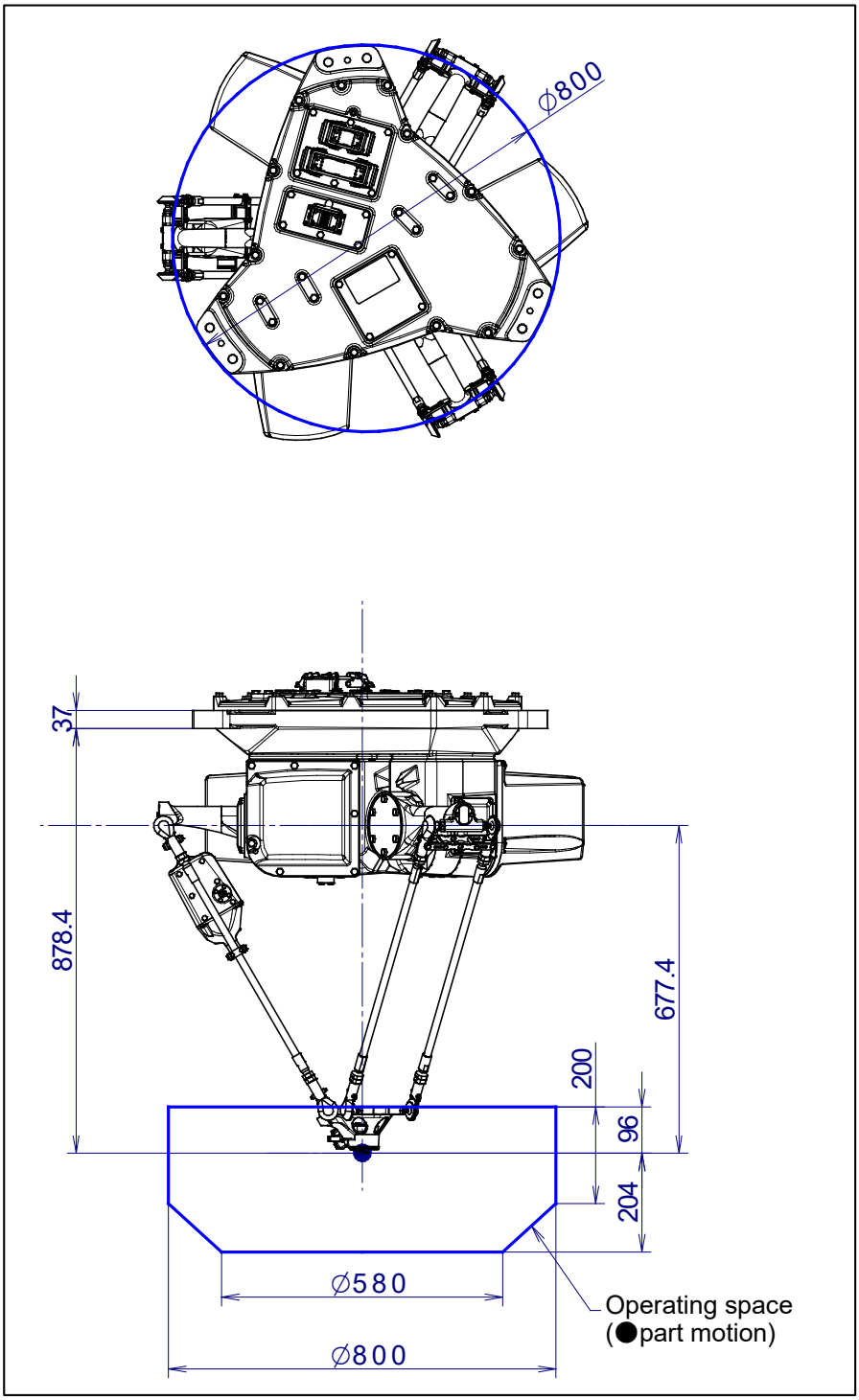


Fig. 3.2 (a) Operating space (M-2*i*A/3S)

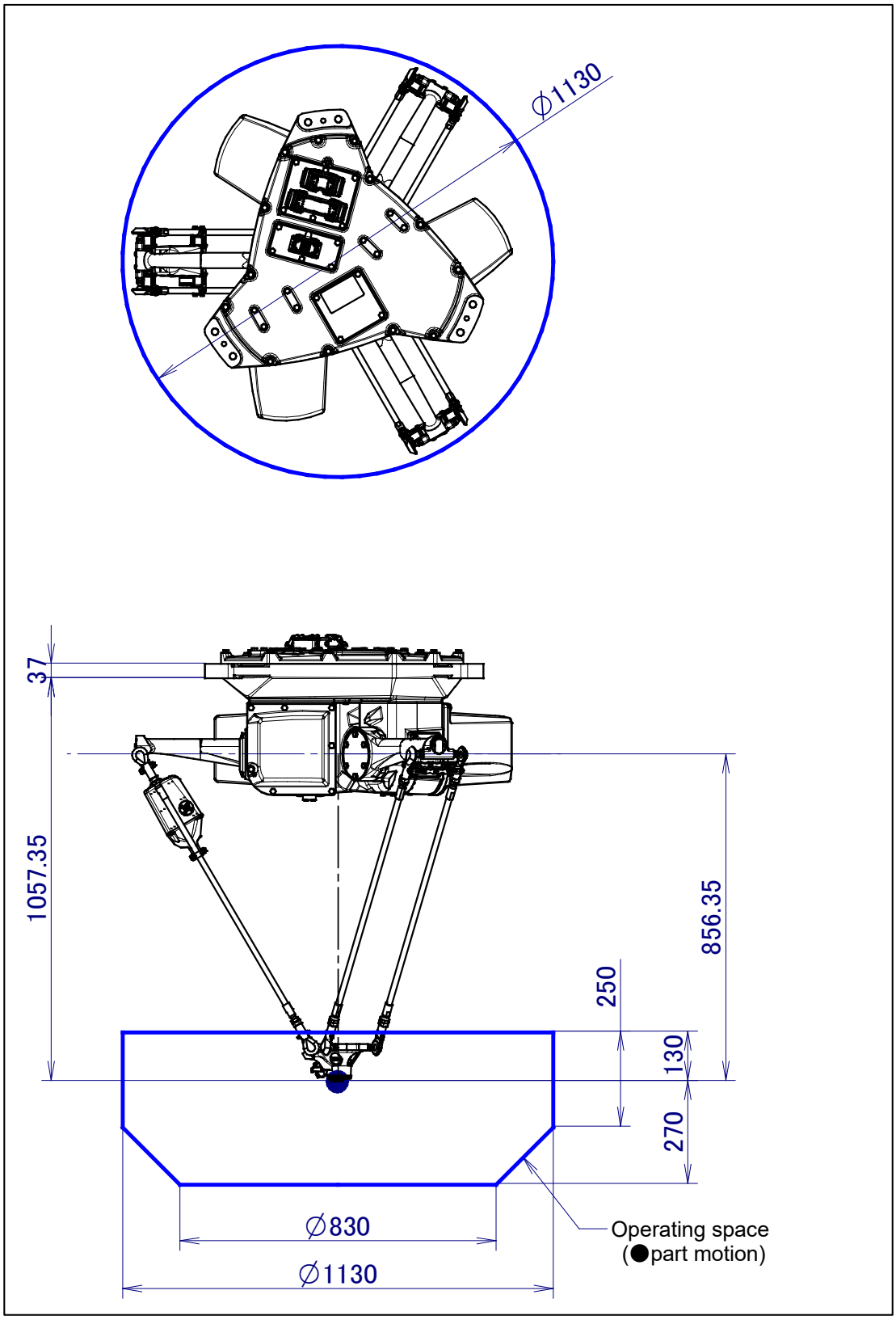


Fig. 3.2 (b) Operating space (M-2*i*A/3SL)

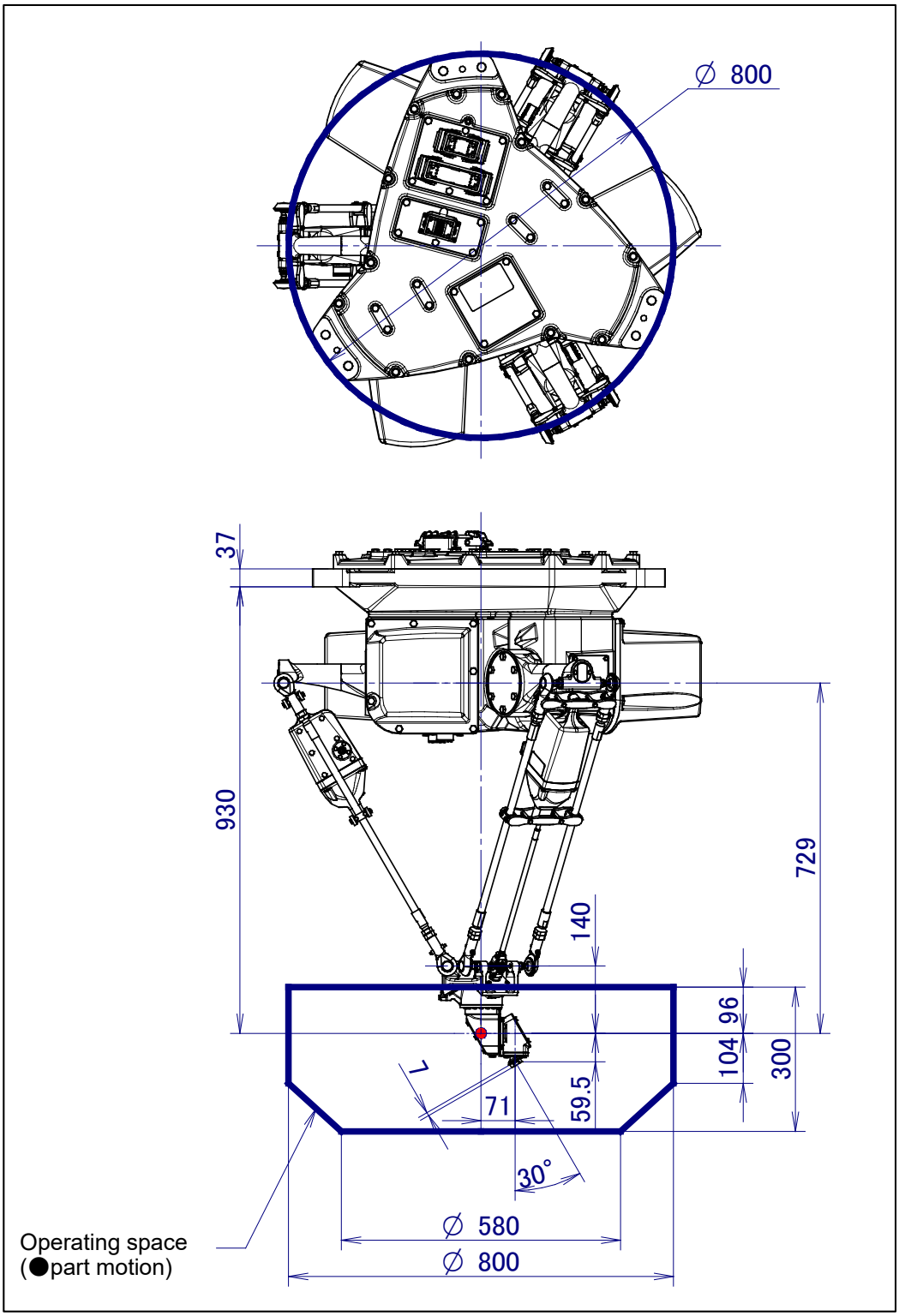


Fig. 3.2 (c) Operating space (M-2*i*A/3A)

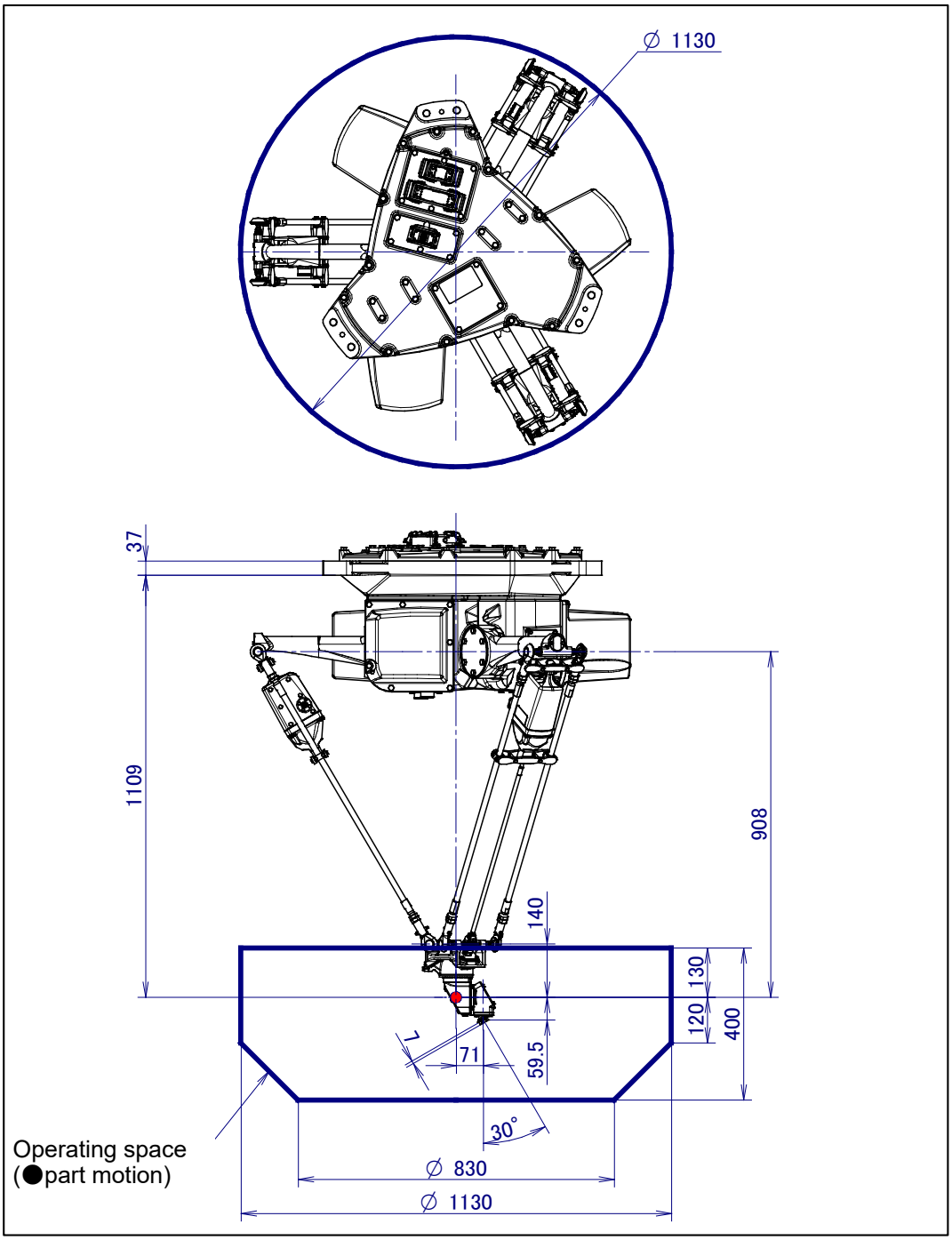


Fig. 3.2 (d) Operating space (M-2*i*A/3AL)

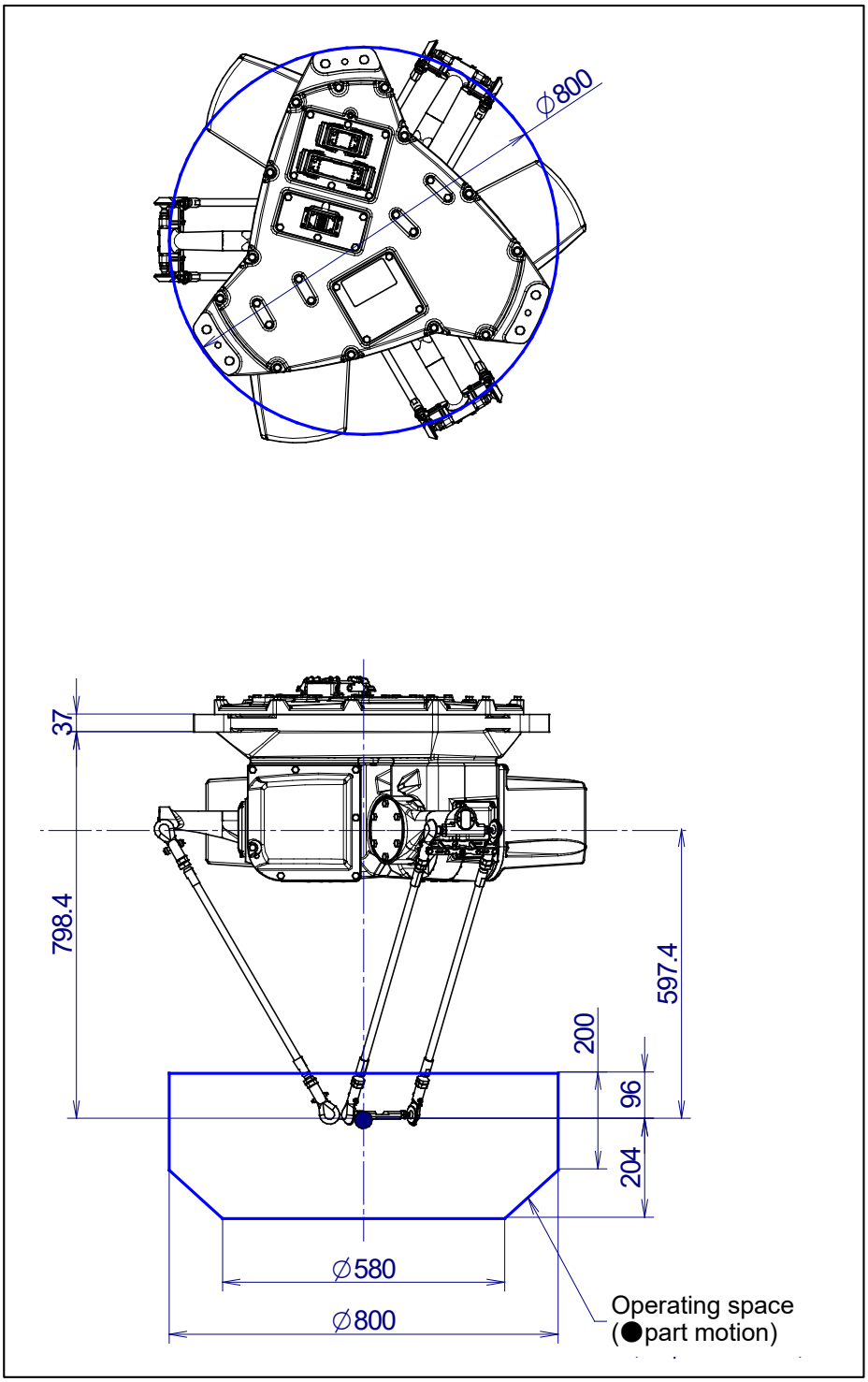


Fig. 3.2 (e) Operating space (M-2*i*A/6H)

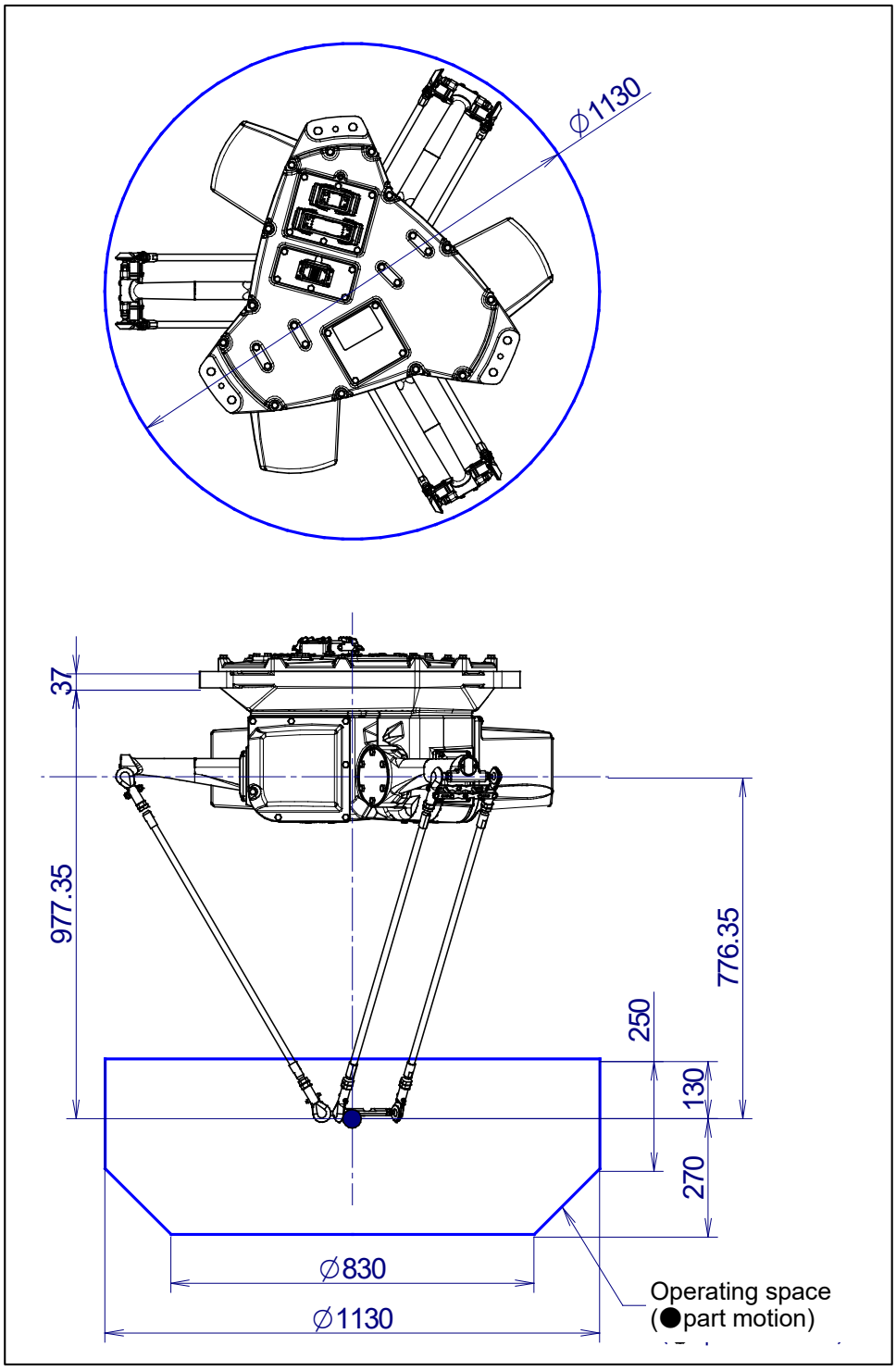


Fig. 3.2 (f) Operating space (M-2*i*A/6HL)

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.

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 3 kg, the inertia is within the allowable value, but if the wrist load is 1 kg, the inertia is over.

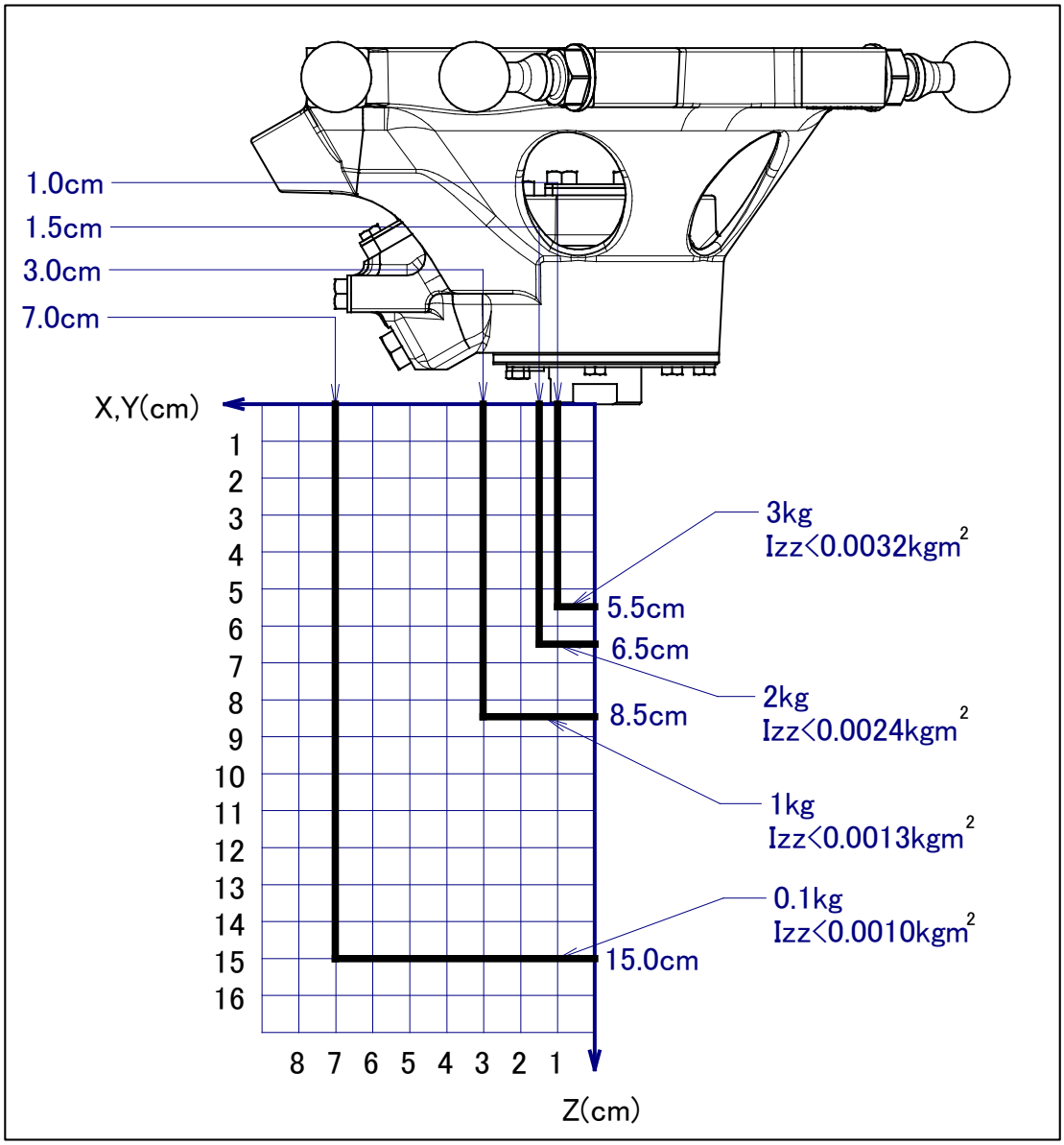


Fig. 3.3 (a) Wrist load diagram (M-2*i*A/3S/3SL) (standard inertia mode)

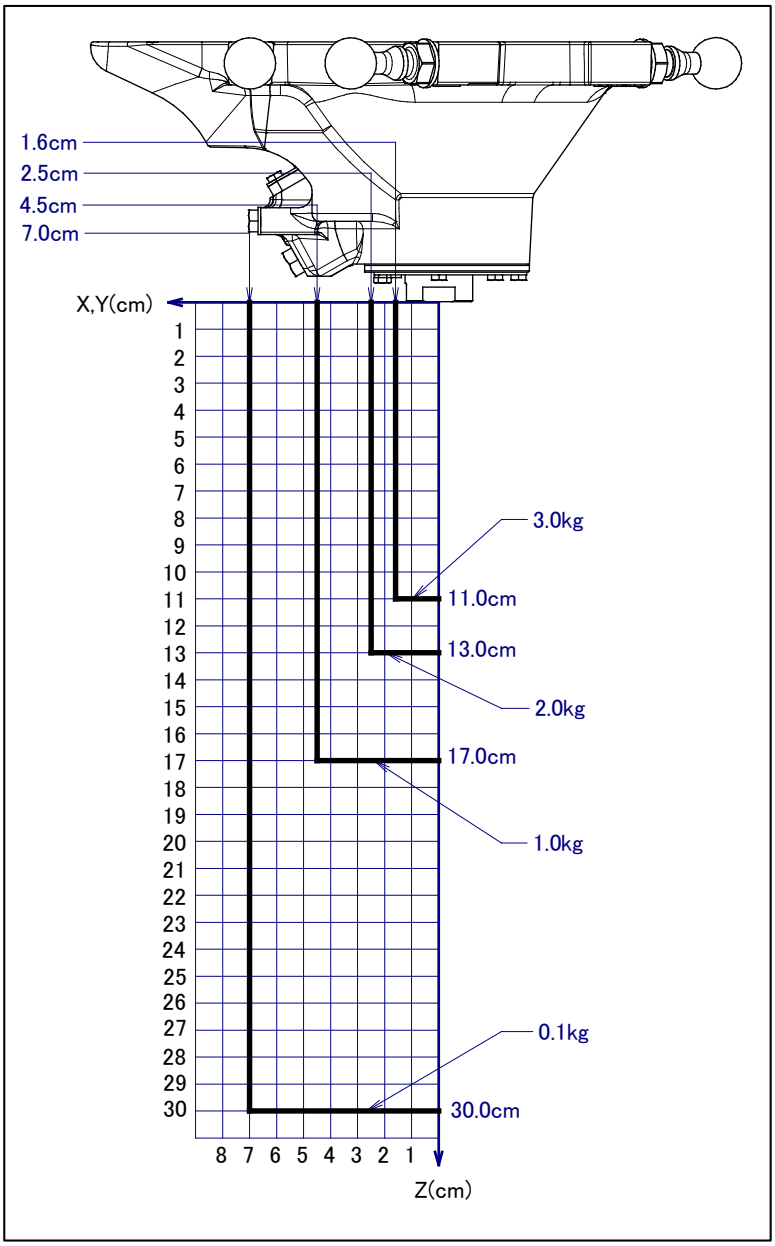


Fig. 3.3 (b) Wrist load diagram (M-2*i*A/3S/3SL) (high inertia mode)

Table 3.3 (a) Allowable offset value for shape inertia

Izz [kgm^2]	X, Y [cm]	Z [cm]
Izz ≦ 0.022	0.1kg : 7 or less 1.0kg : 4.5 or less 2.0kg : 2.5 or less 3.0kg : 1.6 or less	0.1kg : 30 1.0kg : 17 2.0kg : 13 3.0kg : 11
0.022 < Izz ≦ 0.055	0.1kg : -7000/33 × (Izz-0.022)+7 or less 1.0kg : -1500/11 × (Izz-0.022)+4.5 or less 2.0kg : -2500/33 × (Izz-0.022)+2.5 or less 3.0kg : -1600/33 × (Izz-0.022)+1.6 or less	0.1kg : 30 1.0kg : 17 2.0kg : 13 3.0kg : 11

Note) When high inertia option is specified, J4-axis max speed is restricted to 1750deg/sec.
Z direction offset values is depend on only mass.

Refer to Section 4.4 about change procedure to high inertia mode.

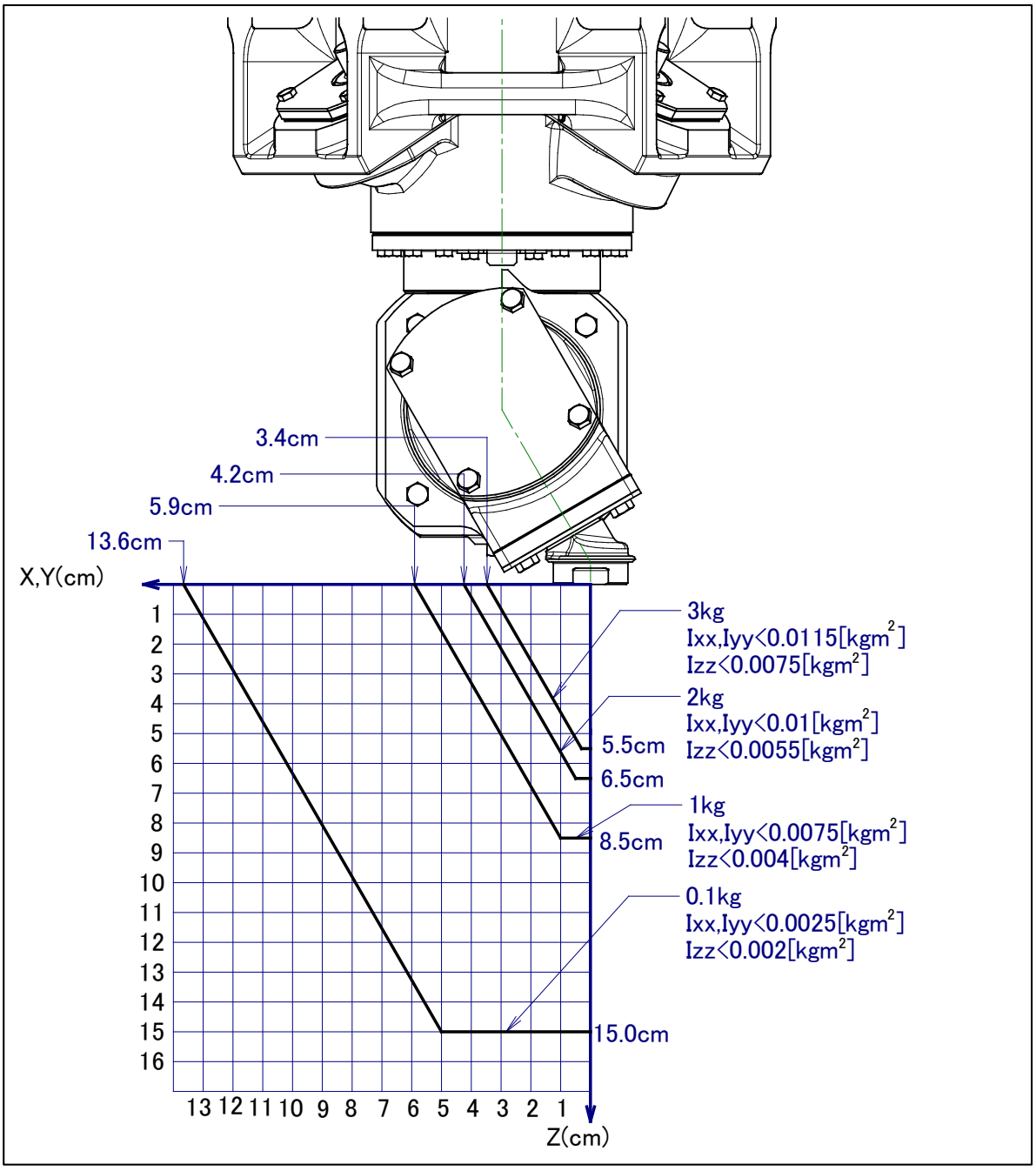


Fig. 3.3 (c) Wrist load diagram (M-2*i*A/3A/3AL)

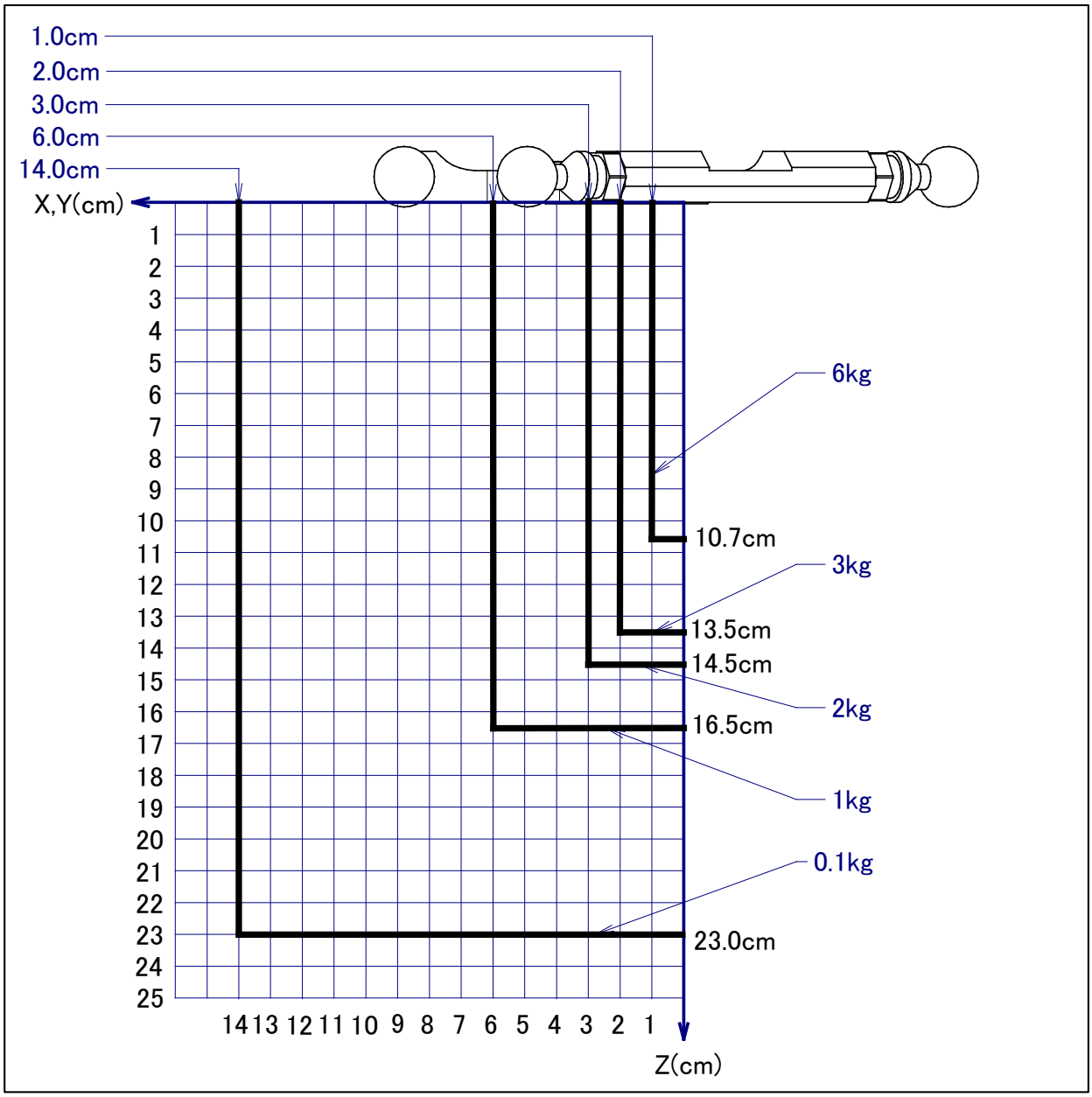


Fig. 3.3 (d) Wrist load diagram (M-2*i*A/6H/6HL)

4 EQUIPMENT INSTALLATION TO THE ROBOT

4.1 END EFFECTOR INSTALLATION TO WRIST

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

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

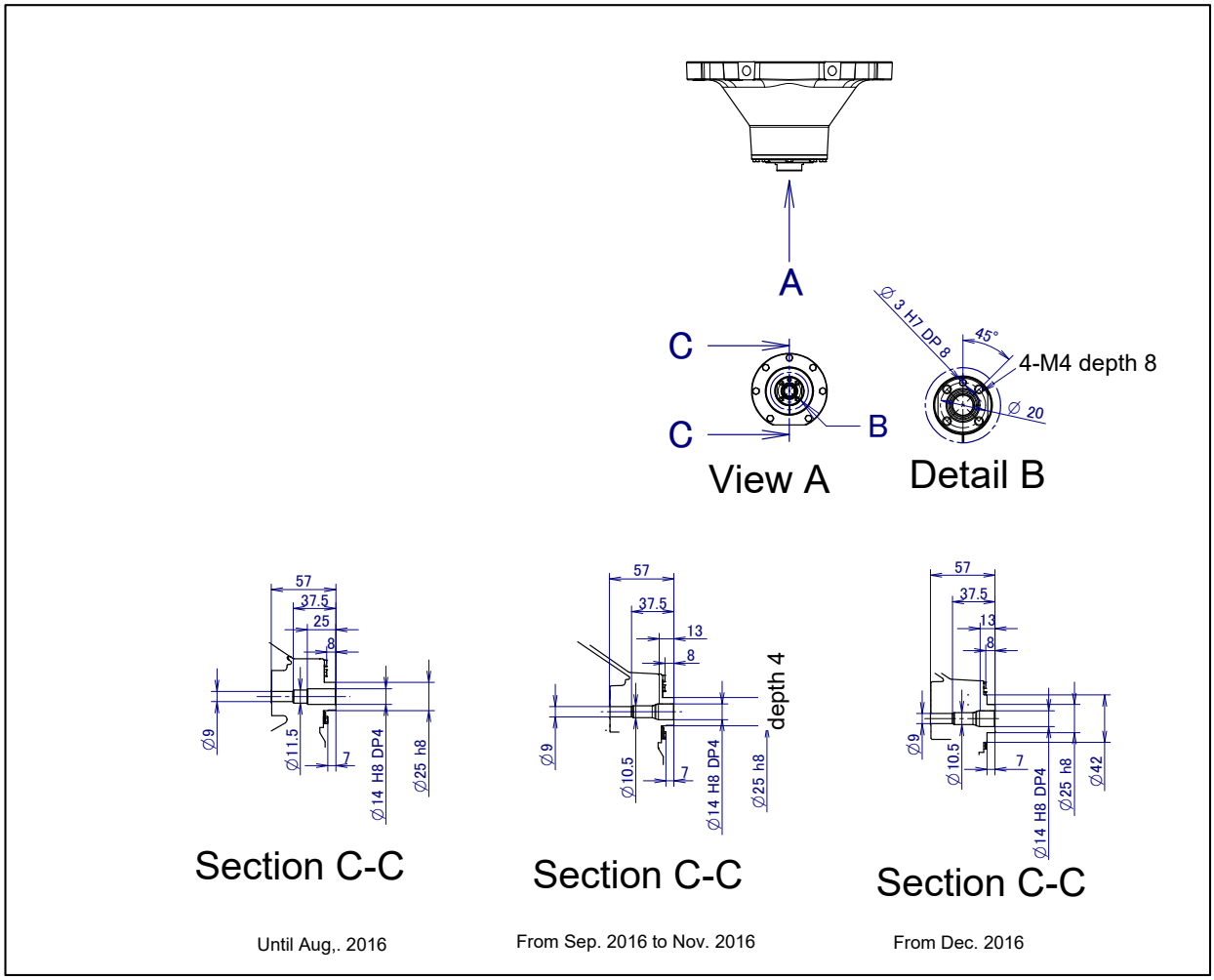


Fig. 4.1 (a) End effector interface (M-2*i*A/3S/3SL)

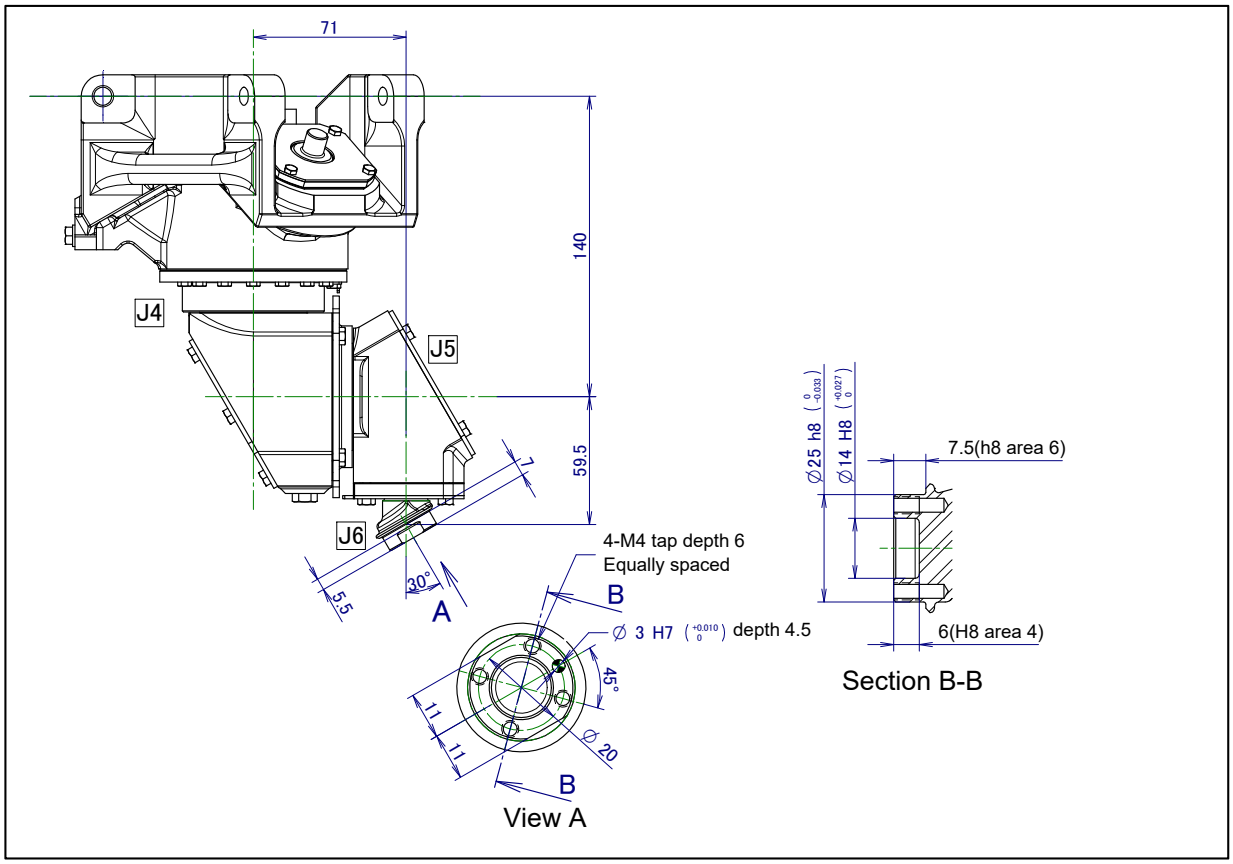


Fig. 4.1 (b) End effector interface (M-2*i*A/3A/3AL)

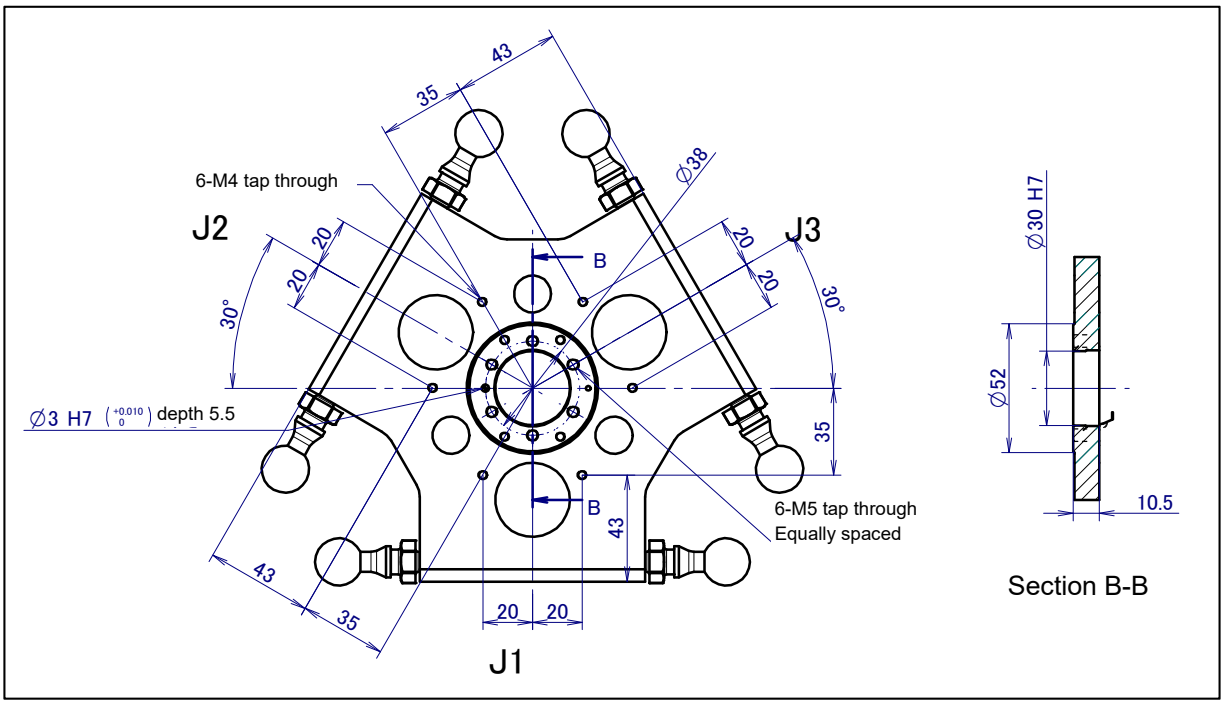


Fig. 4.1 (c) End effector interface (M-2*i*A/6H/6HL)

4.2 EQUIPMENT MOUNTING FACE

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

⚠ CAUTION

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

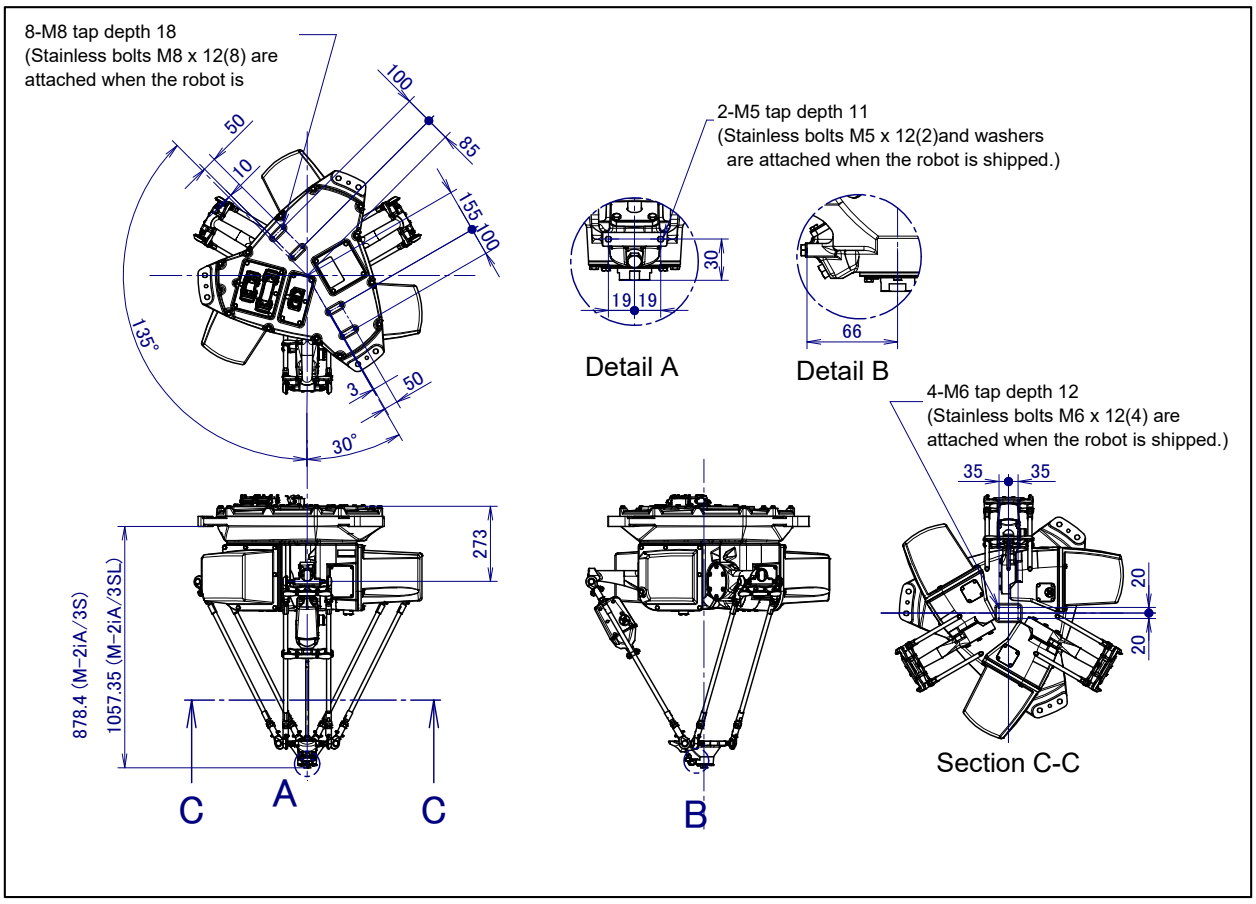


Fig. 4.2 (a) Equipment mounting faces (M-2*i*A/3S/3SL)

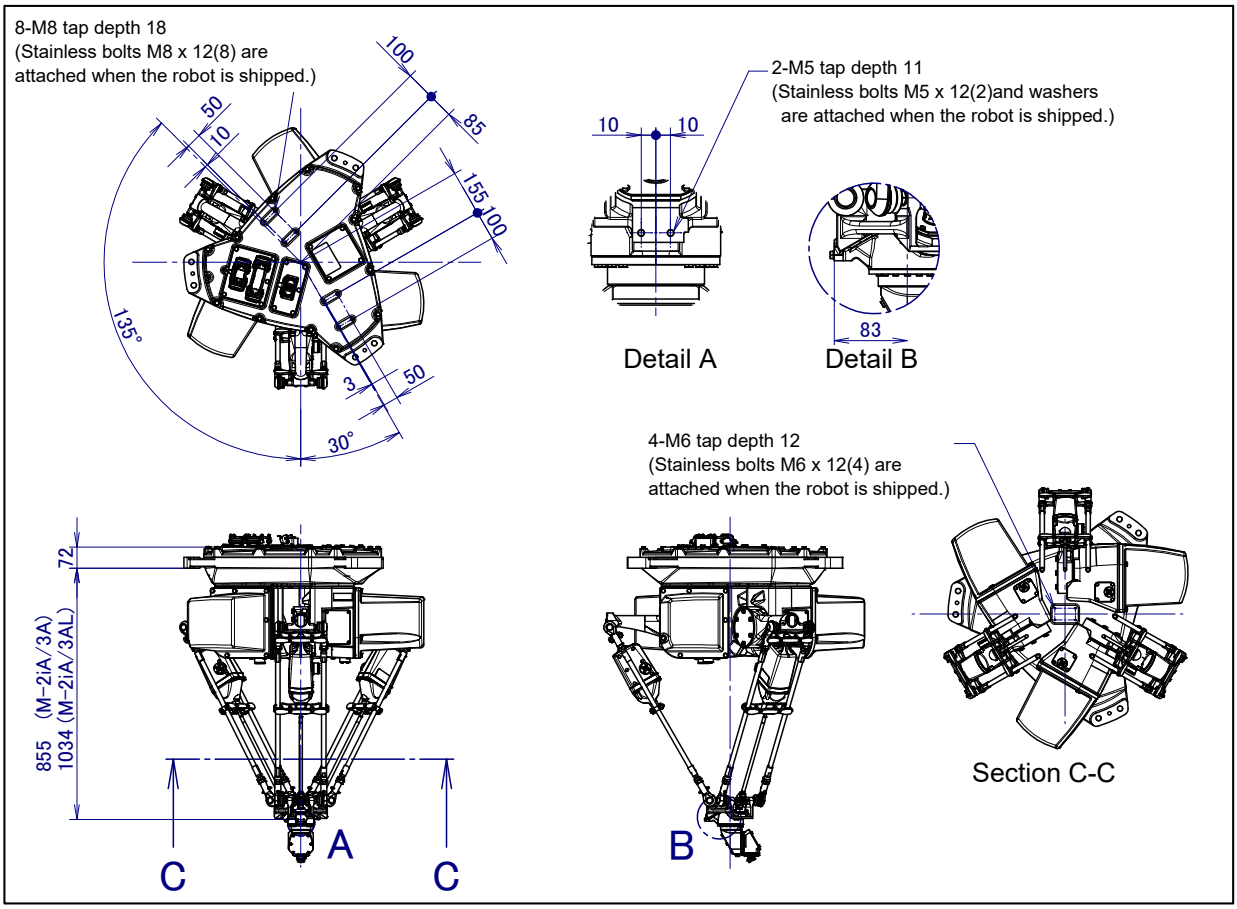


Fig. 4.2 (b) Equipment mounting faces (M-2*i*A/3A/3AL)

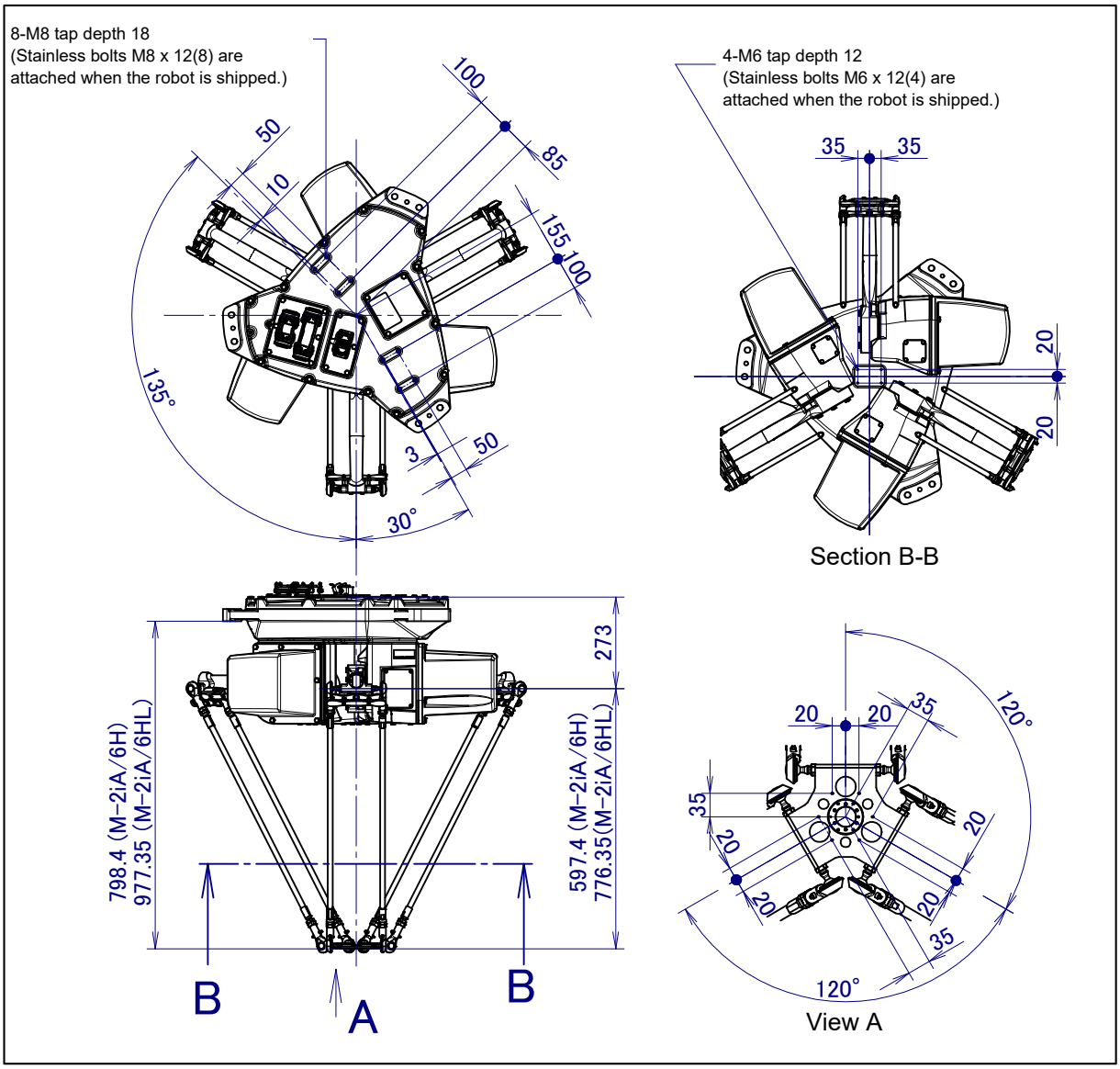


Fig. 4.2 (c) Equipment mounting faces (M-2*i*A/6H/6HL)

4.3 LOAD SETTING

> ⚠ **CAUTION**
> 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.

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

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

```
MOTION PERFORMANCE                    JOINT 10%
   Group1
No.  PAYLOAD[kg]          Comment
 1          3.00  [                    ]
 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]          3.00
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]   56.00
6 PAYLOAD INERTIA Y   [kgfcms^2]   59.00
7 PAYLOAD INERTIA Z   [kgfcms^2]   15.00

[TYPE]  GROUP  NUMBER  DEFAULT  HELP
```

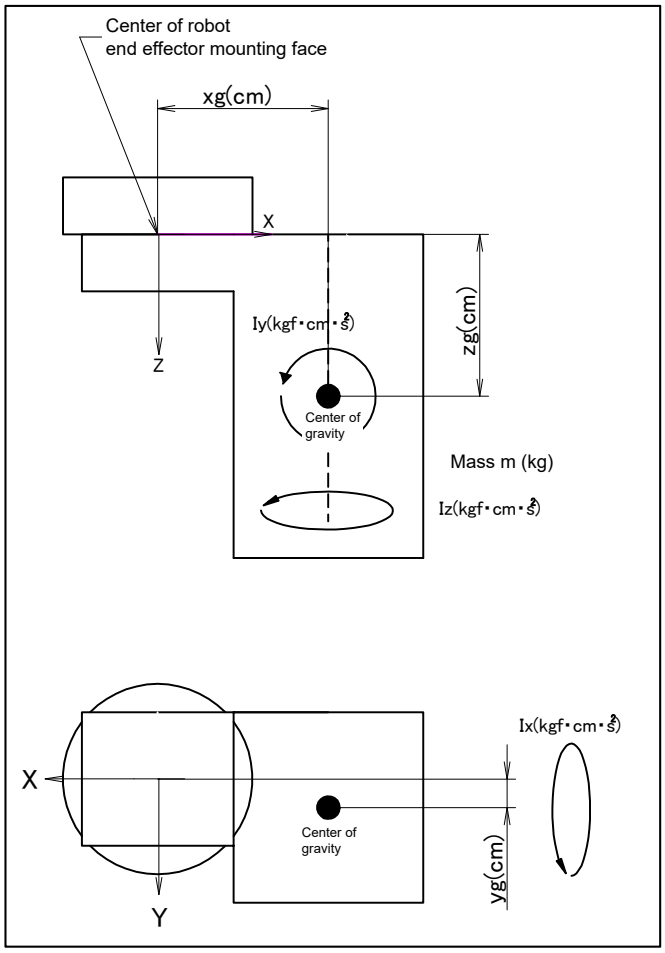


Fig. 4.3 (a) Standard tool coordinate

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

7 Pressing F3 ([NUMBER]) will bring you to the MOTION PAYLOAD SET screen for another condition number. For a 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 stored 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 To refer to present value of joint load, move cursor to $LINKB_F_PCT and press input key.

```
System variables                joint  1%
$GNKT_VAR[1].  $LINKB_F_PCT

 1    [1]        12.345
 2    [2]        67.890
 3    [3]        98.765
```

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

```
System variables                joint  1%
$GNKT_VAR[1].  $LINKB_F_MAX

 1    [1]        12.345
 2    [2]        67.890
 3    [3]        98.765
```

4.5 M-2*i*A/3S/3SL HIGH INERTIA MODE (OPTION)

About M-2*i*A/3S/3SL High Inertia Option

In M-2*i*A/3S/3SL, 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. The parameter is changed by the following methods.

1 Turn on the controller with [PREV] key and [NEXT] key pressed.
Then select "3. Controlled start".
2 Press the [MENU] key and select "9. MAINTENANCE".
3 You will see a screen similar to the following.
Press arrow (↑ , ↓) keys and move the cursor to "M-2*i*A/3S" or "M-2*i*A/3SL". Then press F4, MANUAL.

```
ROBOT MAINTENANCE
                                        1/10
     Setup Robot System Variables

       Group  Robot Library/Option  Ext Axes
         1    M-2iA/3S                 0
```

4 Set "Standard Inertia Mode" or "High Inertia Mode" on the INERTIA MODE SETTING screen.

```
ROBOT MAINTENANCE
     ******** Group 1 Initialization ********

     -------  INERTIA MODE SETTING  -------

     1. Standard Inertia Mode
     2. High Inertia Mode

      Select Inertia Mode (1 or 2)->
```

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

This function needs M-2*i*A/3S/3SL High Inertia Option (A05B-2660-J562). M-2*i*A/3S/3SL are set in standard inertia mode when robot is shipped.

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.

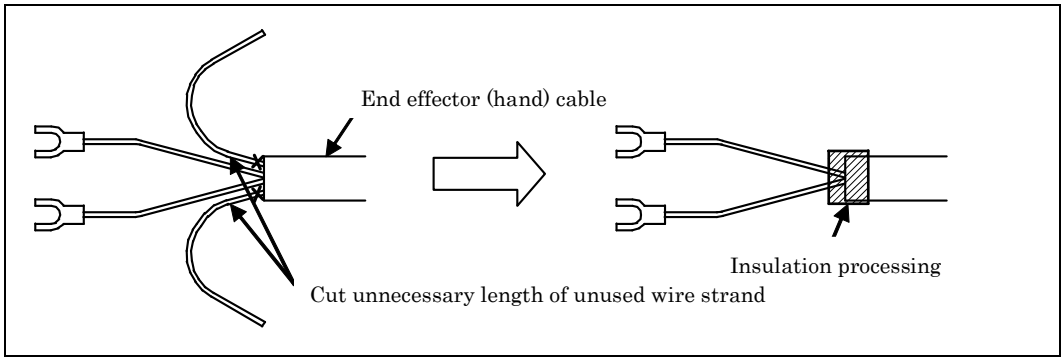


Fig. 5 (a) Treatment method of end effector (hand) cable

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.

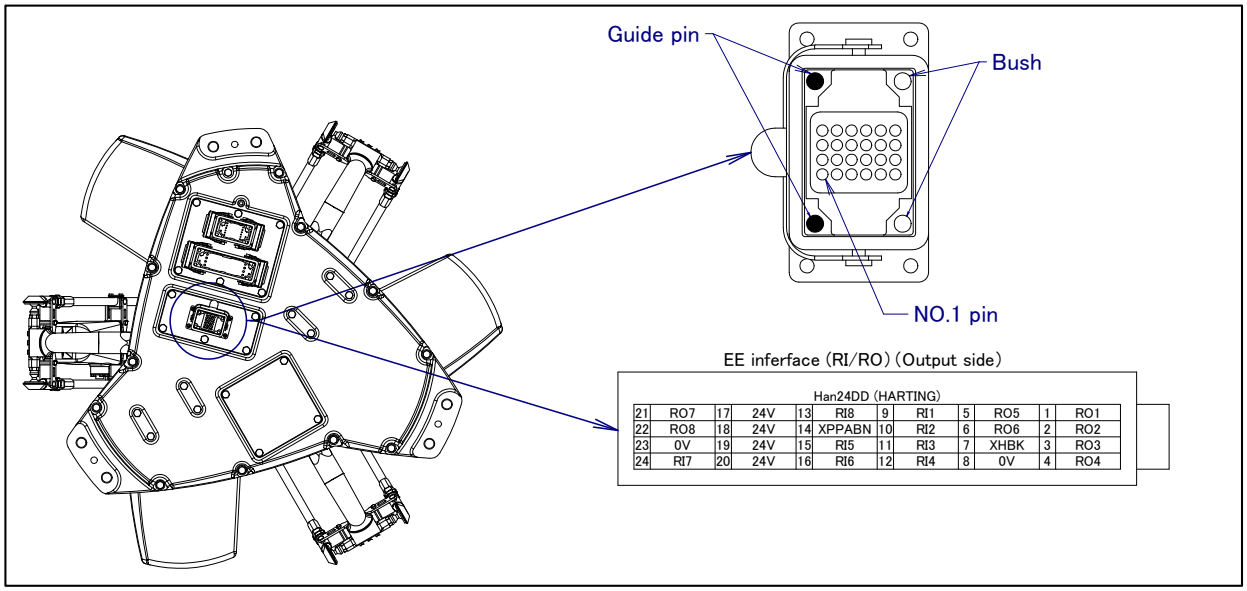


Fig. 5.1 (a) EE interface (RI/RO signal)

> ⚠ **CAUTION**
> For wiring of the peripheral device to the EE interface, refer to the Chapter 4 of "CONNECTION" 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 09 15 000 6204 09 33 000 9908 09 33 000 9909	Harting Electronic CO., LTD

Table 5.1 (b) Connector specifications (User side)

Cable	Output side		Maker /dealer
EE(RI/RO)	Hood (Note)	09 30 006 1540 Side entry 1541 0542 0543 ↓ 1440 Top entry 1441 0442 0443	Harting Electronic CO., LTD
	Insert	09 16 024 3001	
	Contact (24 pcs)	09 15 000 6104 AWG 26-22 6103 AWG 20 6105 AWG 18 6102 AWG 18 6101 AWG 16 6106 AWG 14	
	Clamp (Note)	09 00 000 5085 5086 5090 5094 Many other types are available	
	Guide pin (2 pcs)	09 33 000 9908	
	Bush (2 pcs)	09 33 000 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 operation time/year vs. the 3840 hours/year should be used to calculate the new (higher) frequencies. For example, when using the robot 7680 hours a year with a recommended maintenance interval of 3 years or 11520 hours, use the following calculation to determine the maintenance frequency: 3 years / 2 = perform maintenance every 1.5 years.
2 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.

6.1 PERIODIC 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 there is oil on the sealed part of each joint. If there is an oil seepage, clean them. **⇒"6.2.1 Confirmation of oil seepage and abrasion"**
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 that the taught positions of the robot have not deviated from the previously taught positions. If displacement occurs, perform the measures as described in the following section: **⇒"8.1 TROUBLESHOOTING"(symptom : Displacement)**
Peripheral equipment for proper operation	Check whether the peripheral equipment operate properly according to commands from the robot and the peripheral equipment.
Brakes for each axis	Check that the end effector drops 0.2 mm or less when the servo power is turned off. If the end effector (hand) drops more than the prescribed amount, perform the measures as described in the following section: **⇒"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: **⇒"CONTROLLER OPERATOR'S MANUAL (Alarm Code List)(B-83284EN-1)"**

6.1.2 Periodic Checks and Maintenance

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

Check and maintenance intervals (Period, Accumulated operating time)								Check and maintenance item	Check points, management and maintenance method	Periodic maintenance 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	○							Cleaning the controller ventilation system	Confirm the controller ventilation system is not dusty. If dust has accumulated, remove it.	19
	○							Check for external damage or peeling paint	Check whether the robot has external damage or peeling paint due to the interference with the peripheral devices. If an interference occurs, eliminate the cause. Also, if the external damage is serious, and causes a problem in which the robot will not operate, replace the damaged parts.	1
	○							Check for 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 cable connected to the teach pendant, operation box and robot are unevenly twisted or damaged. If damage is found, replace the damaged cables.	18
	○ 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.	8
	○ Only 1st check		○					Check link B	Check the LINK B part (6 places) are tightened, if they are loosened, retighten them. Check the tightness of the nuts. Check whether there is no damaged, transformation or crack on the rubber **⇒"6.2.2 Check the Link B"**	6
	○							Visual check of wrist motor cable (Except M-2*i*A/6H/6HL)	Check there is no kink or failure on the tube of the wrist motor cable	9
	○ Only 1st check		○					Check the connection of the connector panel	Check the tightening of the connector panel. **⇒"6.2.3 Check the Mechanical Unit Connectors"**	3

Check and maintenance intervals (Period, Accumulated operating time)								Check and maintenance item	Check points, management and maintenance method	Periodic maintenance table No.
1 month 320h	3 months 960h	6 months 1920h	1 year 3840h	1.5 years 5760h	2 years 7680h	3 years 11520h	4 years 15360h			
	○ 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. Especially, clean the robot movable parts well (each joint, around the wrist axis rotation part). **⇒"6.2.4 Cleaning"**	7
	○ 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.	10
		○						Cleaning and grease the link B (seal type)	**Clean and grease the link B (seal type)** **⇒"6.3.3 Cleaning and grease of the link B (seal type)"**	11
				○				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"**	12
			○					Replacing the oil of the reducer and wrist	Replace the grease and oil of each axis reducer and gearbox **⇒"6.3.2 Replacing the Grease and Oil of the Drive Mechanism"**	13,14
					○			Replacing the rod support kit etc.	Replace the rod support kit A,B, the link B (boot type) and wrist cables. Contact your local FANUC representative for information regarding replacing method.	16

Check and maintenance intervals (Period, Accumulated operating time)								Check and maintenance item	Check points, management and maintenance method	Periodic maintenance table No.
1 month 320h	3 months 960h	6 months 1920h	1 year 3840h	1.5 years 5760h	2 years 7680h	3 years 11520h	4 years 15360h			
							○	Replacing the mechanical unit cable	Replace the mechanical unit cable Contact your local FANUC representative for information regarding replacing the cable.	15
							○	Replacing the wrist unit etc.	Replace the link B (seal type), wrist motor units, rod support kit C, drive shafts, universal joints, and fan motors. Contact your local FANUC representative for information regarding replacing method.	17
							○	Replacing the controller batteries	Replace the controller batteries. Regardless of operating time, replace batteries at 4 years. ⇒Chapter 7 Replacing batteries of manuals below. - **R-30*i*B CONTROLLER MAINTENANCE MANUAL (B-83195EN)** - **R-30*i*B Mate CONTROLLER MAINTENANCE MANUAL (B-83525EN)** - **R-30*i*B Mate Open Air type CONTROLLER MAINTENANCE MANUAL (B-83555EN)**	20

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. If there is oil seepage which cause dropping, wipe off it.

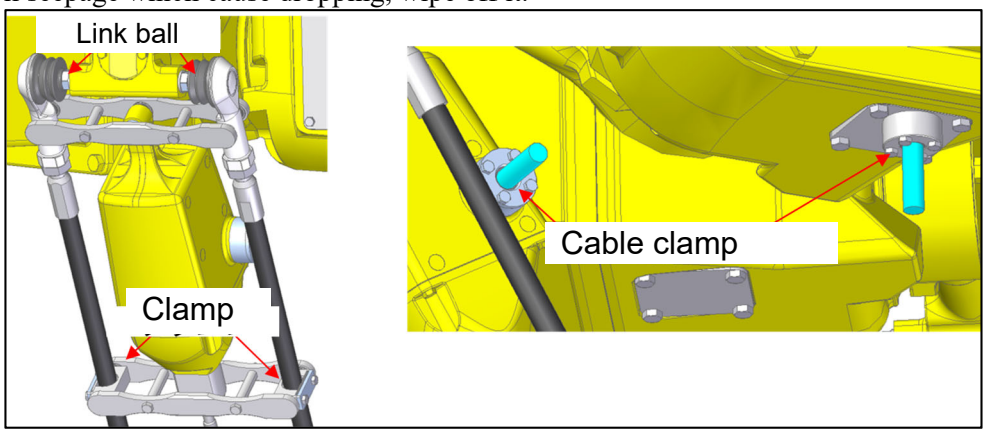


Fig. 6.2.1 (a) check points

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

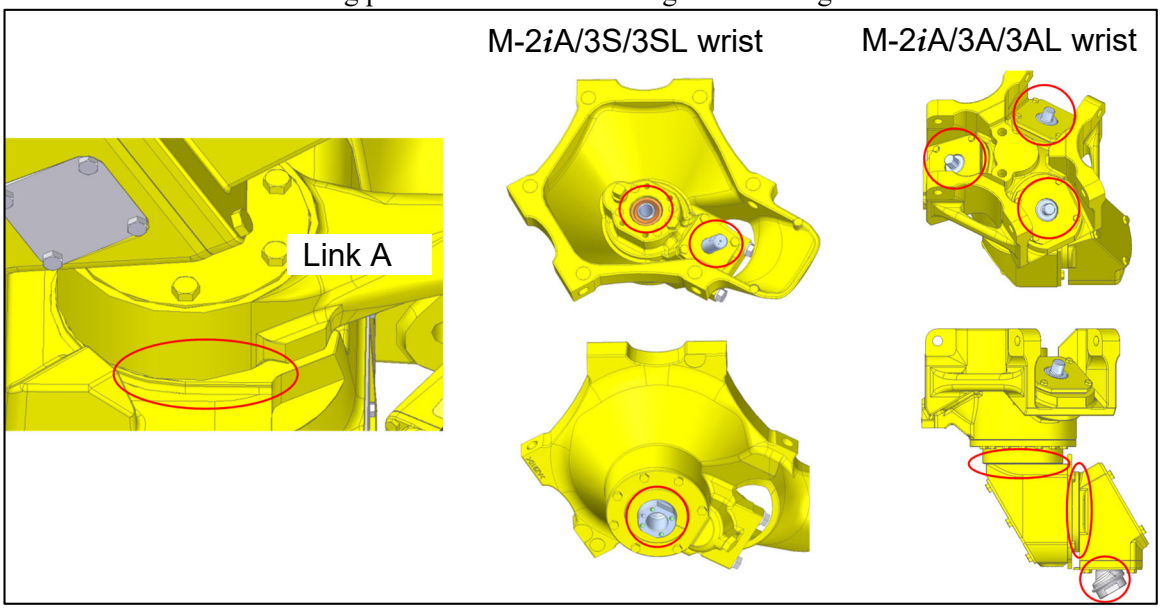


Fig. 6.2.1 (b) check points

Management

- Oil might accumulate on the outside of the seal lip depending on the movement condition or environment of the axis. If the oil viscosity changes, the oil might drip depending on the axis movement. To prevent oil spots, be sure to wipe away any accumulated oil under the axis components in Fig. 6.2.1 (b) before you operate the robot.
- If there is much quantity of oil seepage, you can improve it by replacing oil.
- In case of high duty use of the robot, and/or a high temperature installation environment, the internal pressure of the oil bath may rise. For these cases please consider relieving the internal pressure, after robot operation, by opening the appropriate oil inlet. When doing so, please be careful to avoid possible oil splattering.

  ⇒"8.1 TROUBLESHOOTING"(symptom : Oil leakage)

6.2.2 Check the Link B

Check the LINK B part (6 places) are tightened, if they are loosened, retighten them. Check the tightness of the nuts. Check whether there is no damaged, transformation or crack on the rubber. (See Fig. 6.2.2 (a), (b))

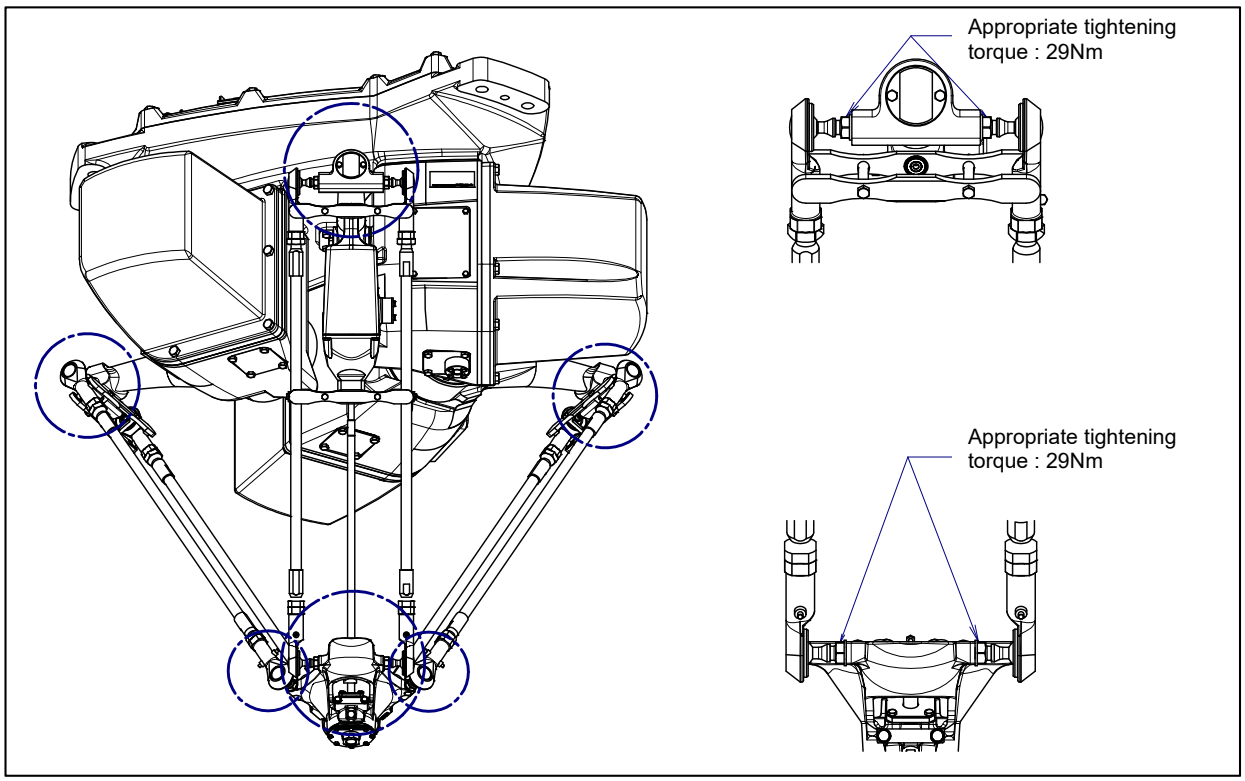


Fig. 6.2.2 (a) Check points of link B (1/2)

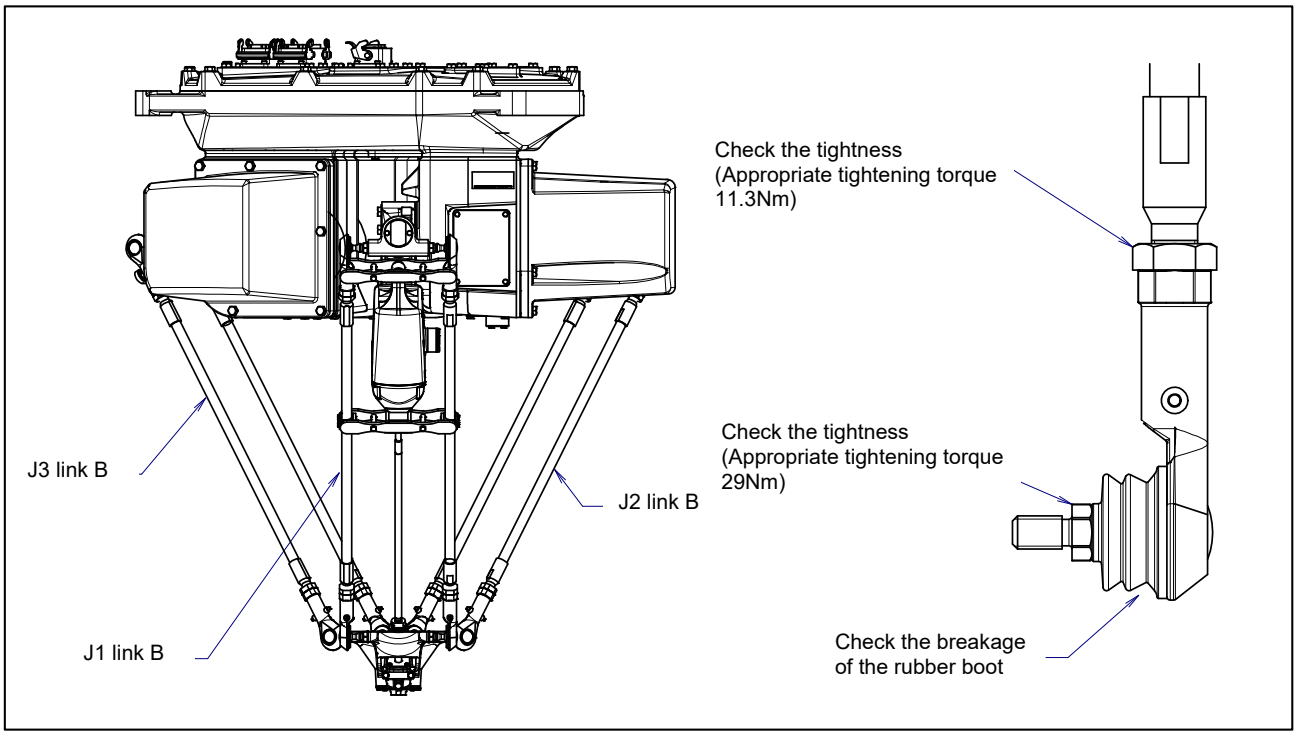


Fig. 6.2.2 (b) Check points of link B (2/2)

6.2.3 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.

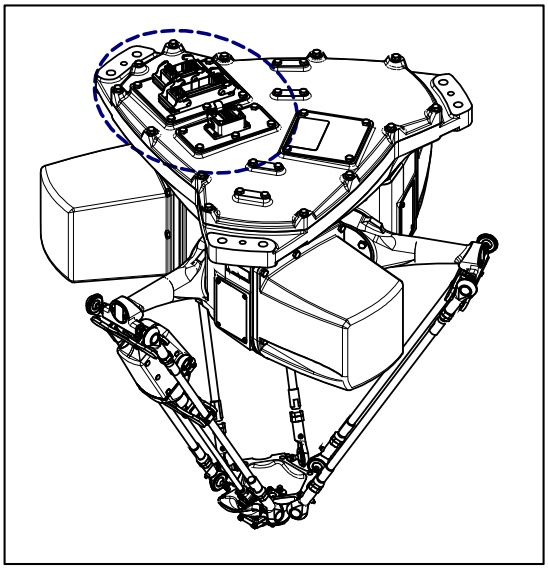


Fig. 6.2.3 (a) Connector Inspection points

6.2.4 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.

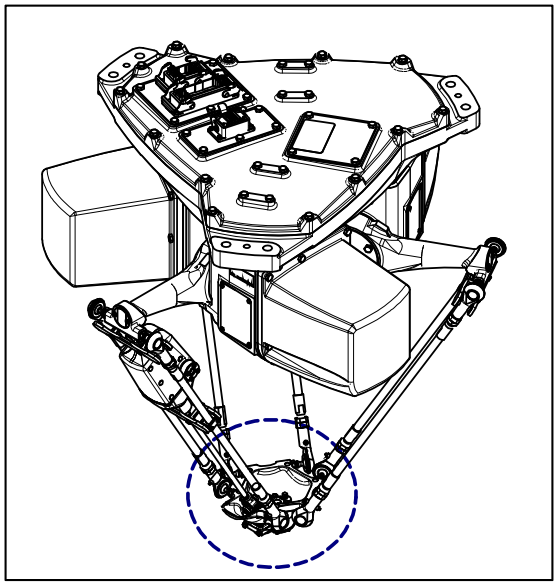


Fig. 6.2.4 (a) Cleaning part

6.3 MAINTENANCE

6.3.1 Replacing the Batteries (1.5-year Maintenance)

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

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

1 Press the EMERGENCY STOP button to prohibit robot motion.

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

2 Remove the 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. At this time, replace the gasket by new one.
Apply LOCTITE 243 to plate mounting bolt.

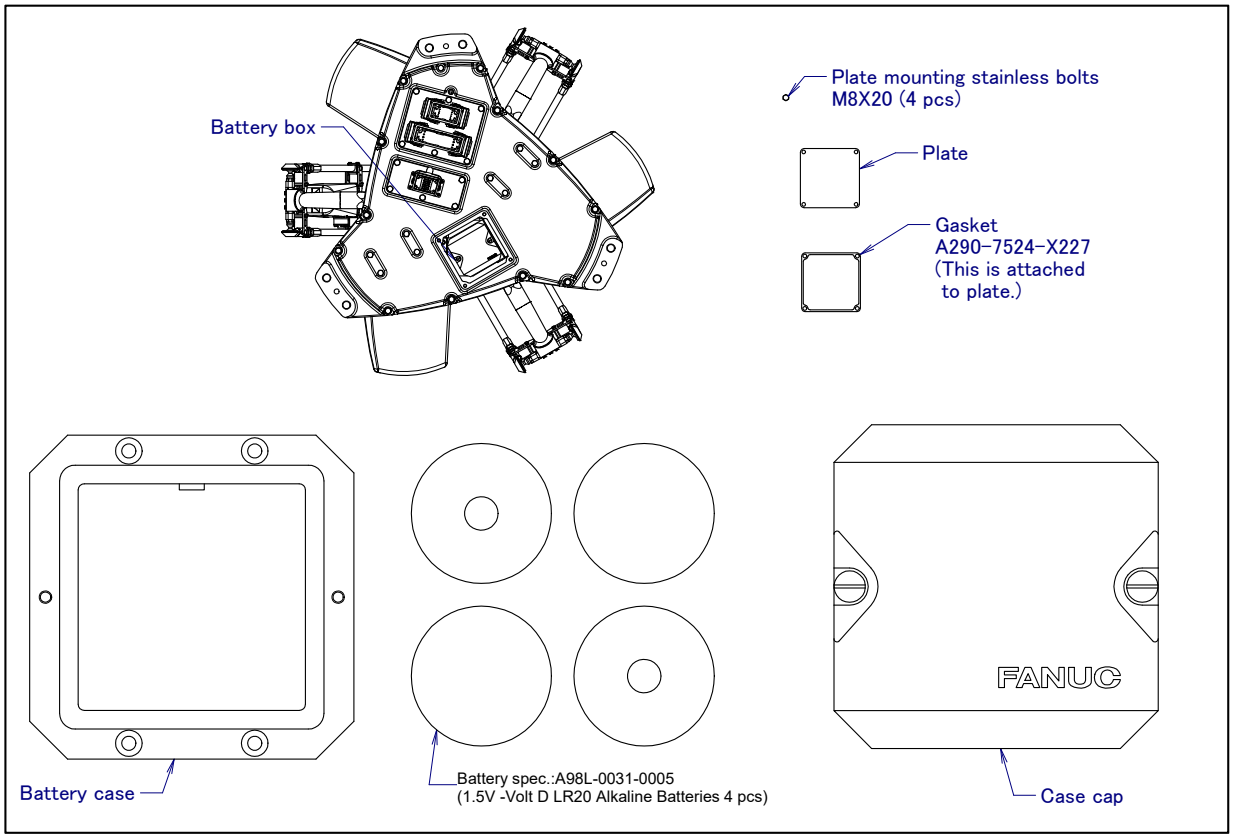


Fig. 6.3.1 (a) Replacing batteries (if built-in batteries are specified)

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

1 Press the EMERGENCY STOP button to prohibit robot motion.

> **⚠ 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.

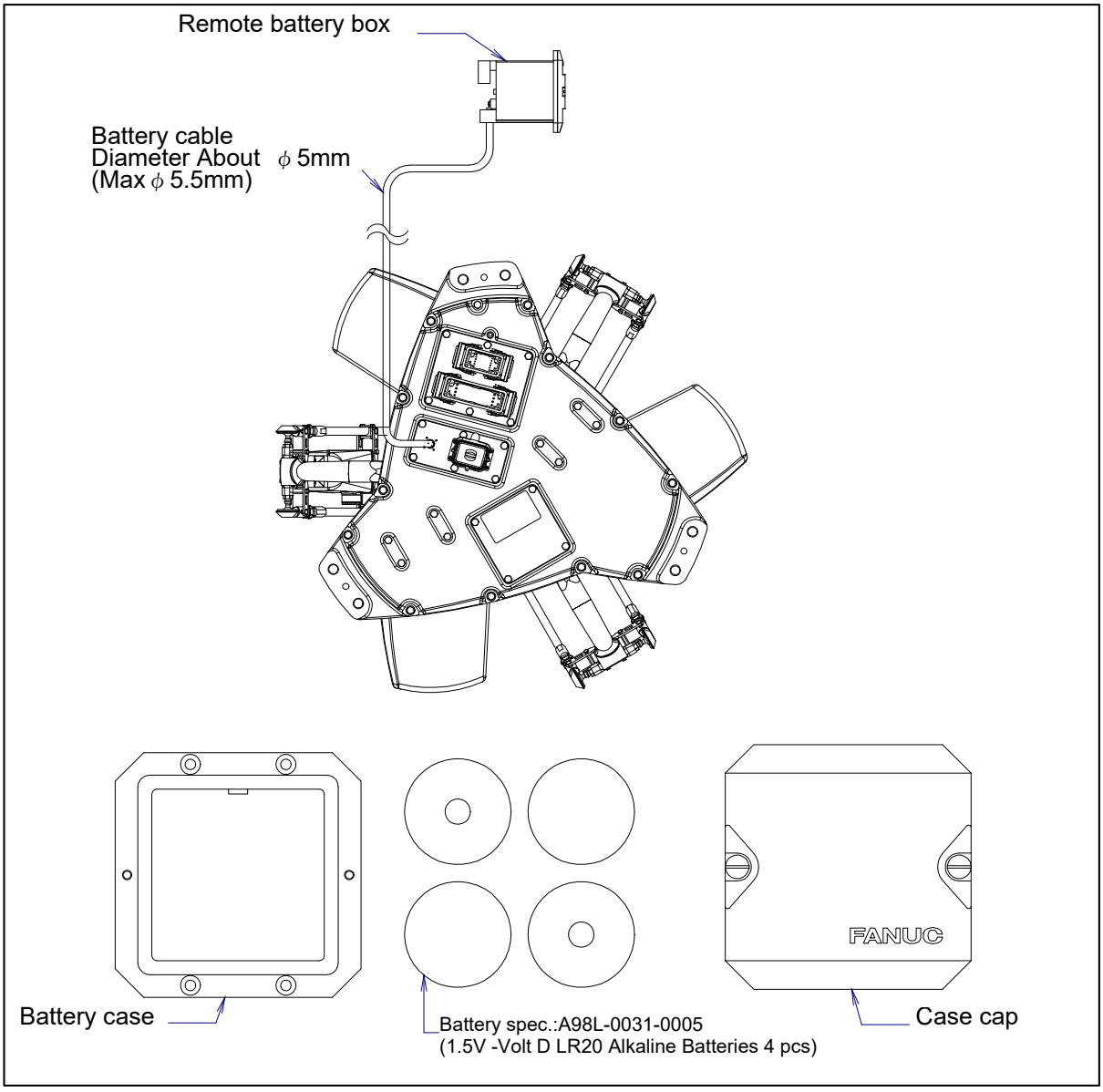


Fig. 6.3.1 (b) Replacing the battery (if external batteries are specified)

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.

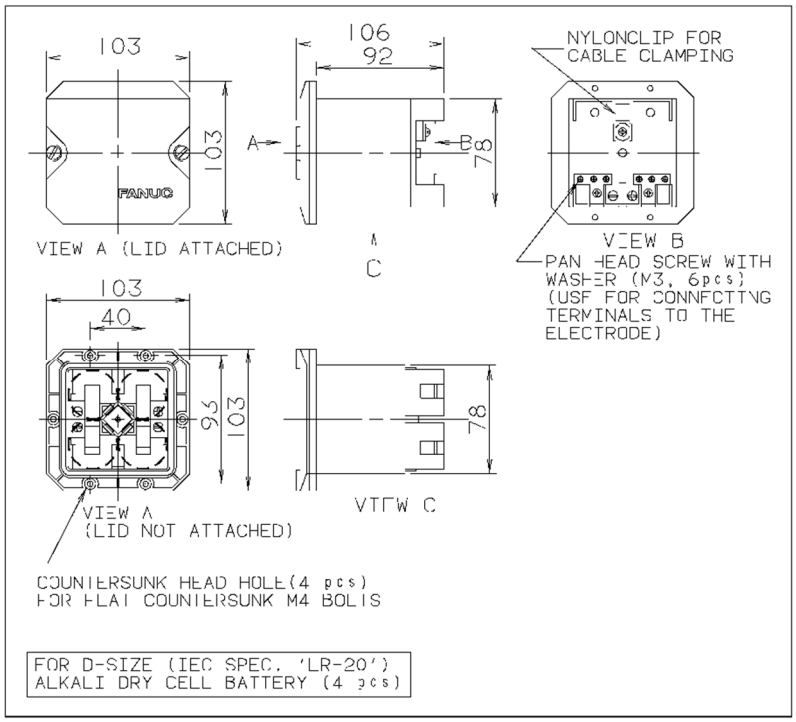


Fig. 6.3.1 (c) External dimensions of the battery box

6.3.2 Replacing the Oil of the Drive Mechanism (1-year (3840 Hours) Maintenance)

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 6.3.2 (a) for the oil name and the quantity.

Table 6.3.2 (a) Oil for 1-year (3840 hours) periodical replacement

Model	Supply position	Quantity	Oil name
M-2*i*A	J1 to J3-axis reducer	Each 230ml (*1) Each 300ml (*2)	Spec: A98L-0040-0255
	Wrist (M-2*i*A/3S/3SL)	22ml	
	Wrist (M-2*i*A/3A/3AL)	300ml	

(*1) Robot which manufacturing No. is R14Y02347 (Made in Nov., 2014) or later
(*2) Robot which manufacturing No. is before than R14Y02347 (Made in Nov., 2014)

For oil replacement or replenishment, use the arbitrary posture.

> ⚠ **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, 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. 6.3.2 (a).
3 Remove bolts, cover and gasket referring to Fig. 6.3.2 (b).
4 Put collection bottle under oil outlet and remove taper plug of oil outlet. After discharge is started, open taper plug of ventilator hole. (If ventilator hole is opened before discharge is started, oil shed. so open ventilator hole after discharge is started.)
5 If all oil is discharged, 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 required 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. Replace the gasket by new one. Apply LOCTITE 243 to hole of cover mounting bolts.

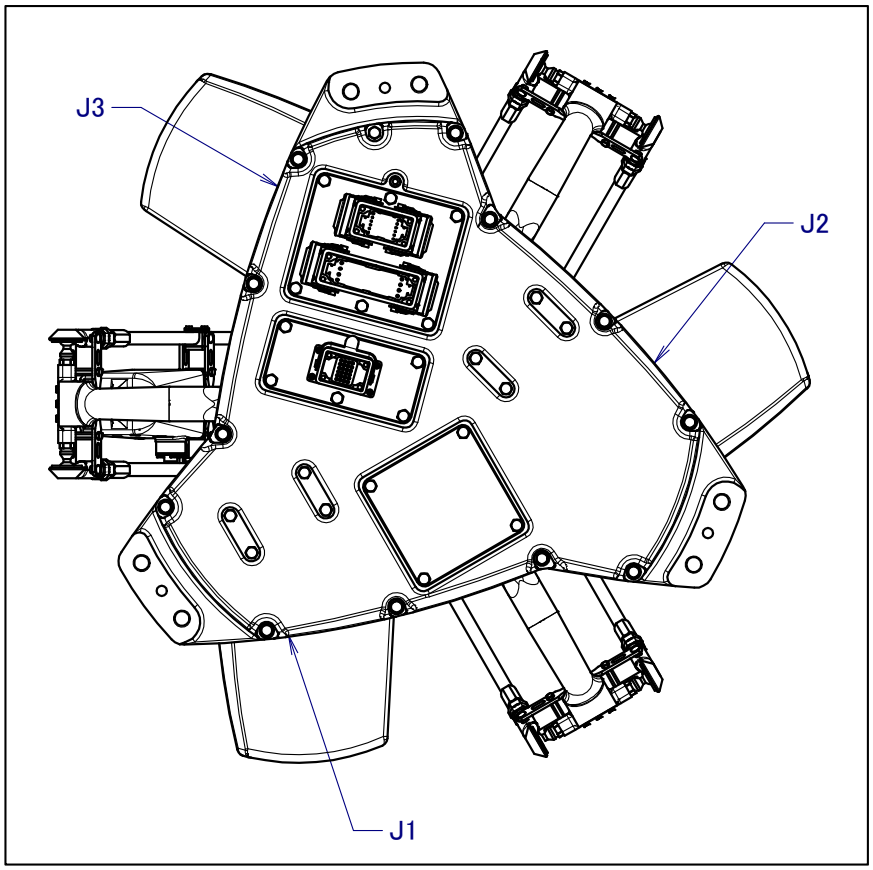


Fig. 6.3.2 (a) Position of major axis reducer

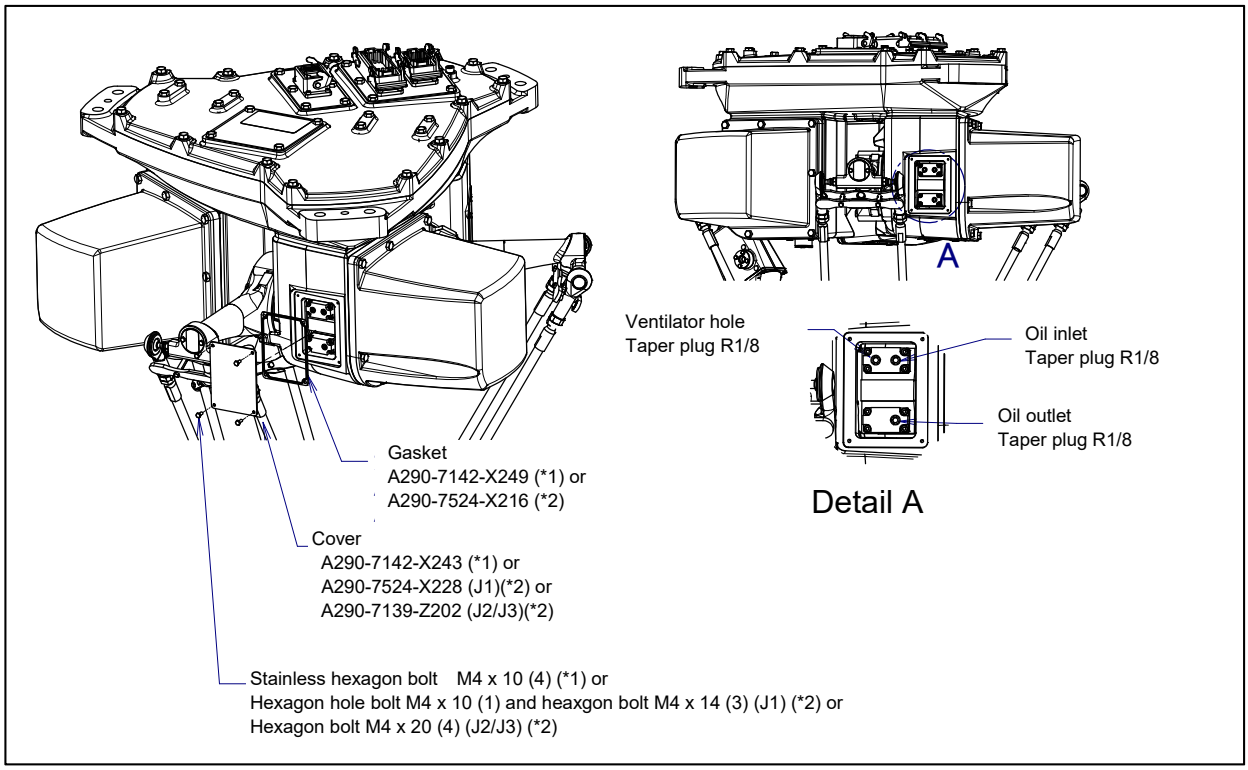


Fig. 6.3.2 (b) Supply oil to major axis

(*1) Robot which is shipped from Jul., 2015
(*2) Robot which is shipped before Jun., 2015

Oiling of wrist axis
M-2*i*A/3S/3SL

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. Square (octagonal) socket whose width across flat is 7mm can be used to open and close taper plug of oil inlet of wrist.
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 required amount oil to wrist unit.
5 Attach the taper plug and the seal bolt of oil inlet and ventilator hole. If you reuse the taper plug and the seal bolt, be sure to seal it with seal tape.

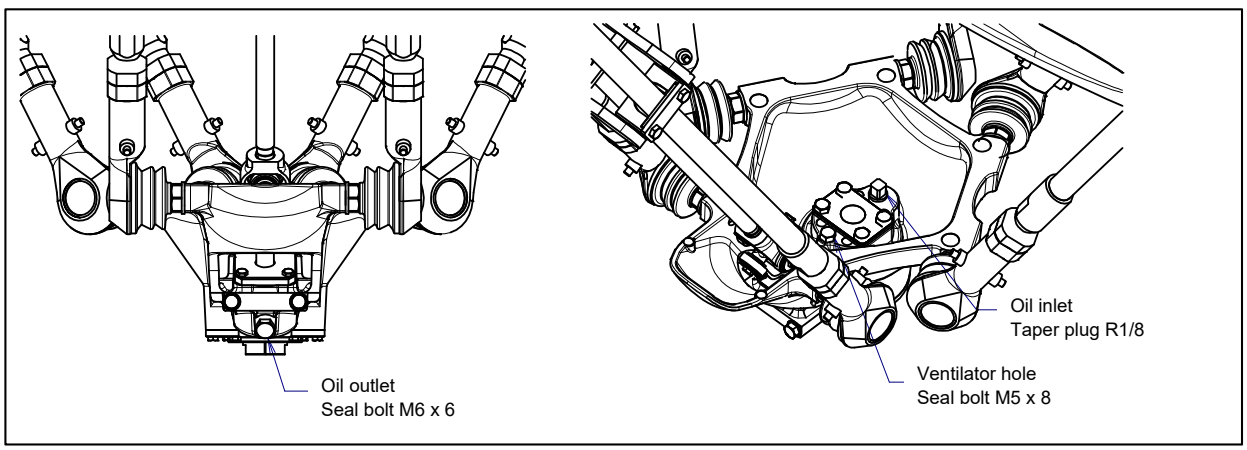


Fig. 6.3.2 (c) Supply oil to wrist axis (M-2*i*A/3S/3SL)

M-2*i*A/3A/3AL

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. Square (octagonal) socket whose width across flat is 7mm can be used to open and close taper plug of oil inlet of wrist.
3 If all oil is discharged, supply required amount oil to wrist unit.
4 Attach the taper plug of the ventilator hole. If you reuse the taper plug, be sure to seal it with seal tape.
5 Attach the seal bolt of oil inlet & outlet. If you reuse the seal bolt, be sure to seal it with seal tape.

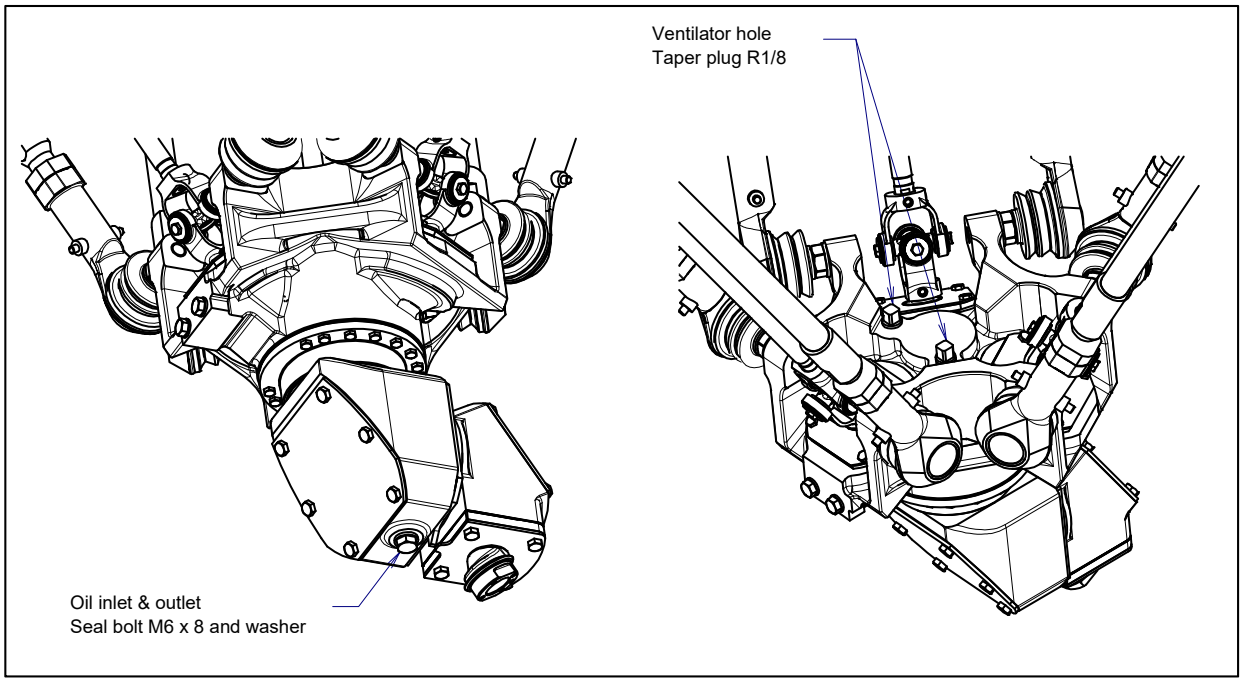


Fig. 6.3.2 (d) Supply oil to wrist axis (M-2*i*A/3A/3AL)

6.3.3 Cleaning and grease of the link B (seal type) (6 months (1920 Hours) Maintenance)

If the link B (seal type) is used, periodic maintenance is required. Clean and grease it at the intervals based on every 6 months, 1920 hours and cycle whichever comes first. For rust prevention, perform cleaning and greasing even if the robot is not used for a long term. If there are foreign materials or rust, short the maintenance interval.

1 Clean old grease and foreign material on the ball surface. Foreign materials such as iron powder cause premature failure of the link ball.
2 Supply grease with syringe etc.

Specified grease Spec. : A98L-0040-0187#0.4KG

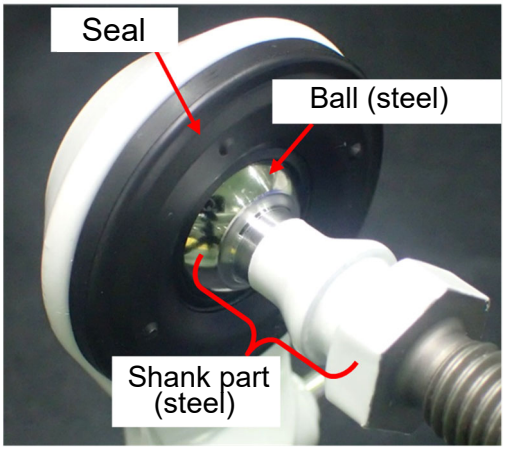


Fig. 6.3.3 (a) Status after cleaning

Fig. 6.3.3 (b) Status after supplying grease

Fig. 6.3.3 (c) Syringe

3 Paste the grease on the ball and no paint part of the shank.
4 Wipe off grease so that grease remains thinly.

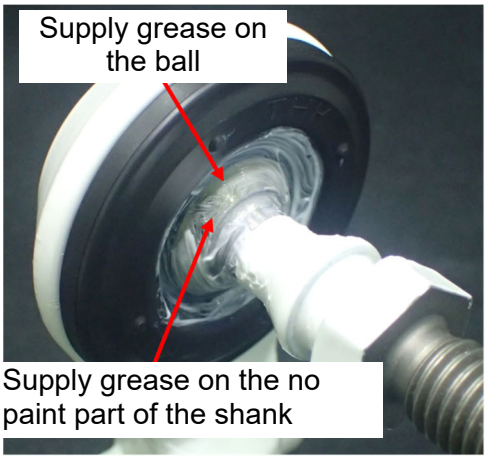


Fig. 6.3.3 (d) Status after pasting

Fig. 6.3.3 (e) Status after wiping off

6.4 CLEANING (WHEN WHITE EPOXY PAINTING IS SPECIFIED)

6.4.1 Cleaning the Robot

M-2*i*A can be washed with sprinkling water or cleaner diluted properly when white epoxy painting is specified.

If strong water jet strike the robot, the water jet might hurt the waterproof function of robot. 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-2*i*A can be spray washed and kept in sanitary condition by daily cleaning.

The cleaners in Table 6.4.2 (a) have been proven to have no harmful effects on the robot surface of M-2***i***A when White epoxy paint is specified. Other cleaners have to be checked in order to know the impact to the robot surface. Please contact your local FANUC representative if other cleaners are to be used.

Alcohol and organic solvent may have a damaging effect on the robot surface. Do not use them when cleaning the 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 cleaners have to be rinsed diligently and should never remain on the robot surface. The robot surface cannot stay in contact with an acid cleaner continuously for over 15 minutes.
3 The use of the cleaners in Table 6.4.2 (a) might be restricted by the laws of the country or the region in which the robot is used, making them difficult to obtain.
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 is required under the following conditions:

- Motor replacement
- Pulsecoder replacement
- Reducer replacement
- Link B, Link Balls, 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 Before performing mastering, it is recommended that you back up the current mastering data.

Mastering procedure of M-2*i*A/3S/3SL/3A/3AL are 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.

At first, in case of M-2*i*A/3S/3A, robot move to J1/J2/J3 to 0º. In case of M-2*i*A/3SL/3AL, robot move to J1/J2/J3 to 9.305º. Then 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 has been replaced, it is necessary to release the relevant alarm and display the positioning menu.

Alarm displayed

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

Procedure

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

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

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

7.3 ZERO POSITION MASTERING (M-2*i*A/3S/3SL/3A/3AL)

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

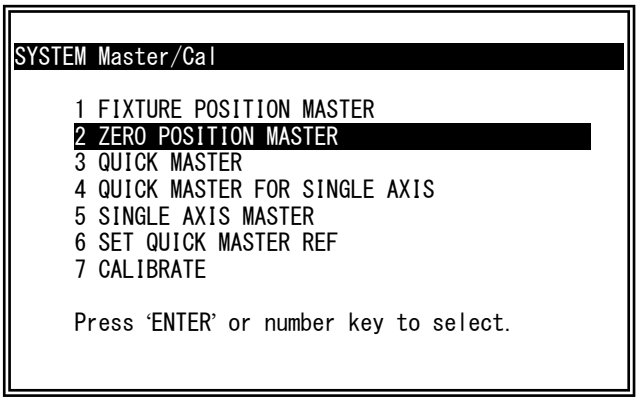
Zero-position mastering involves a visual check, and might not be highly accurate. It should be used only as a quick-fix method.

Zero-position Mastering Procedure

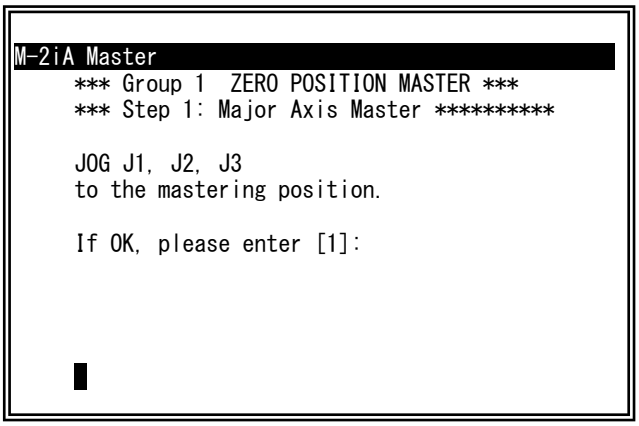
1 Press the [MENU] key.
2 Select NEXT and press SYSTEM.
3 Press F1, [TYPE] and select Master/Cal.

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

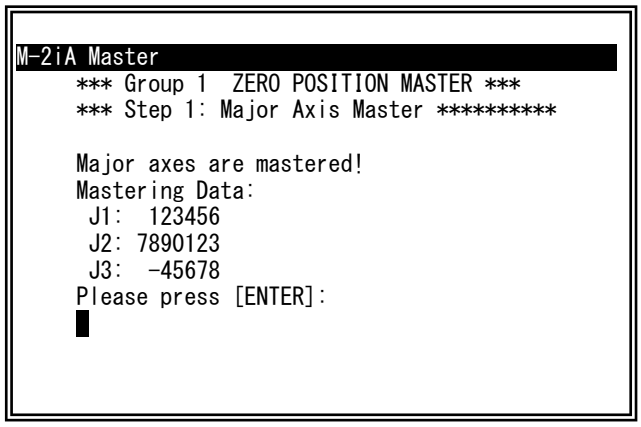
4 Select [2 ZERO POSITION MASTER] and press F4 [Yes].



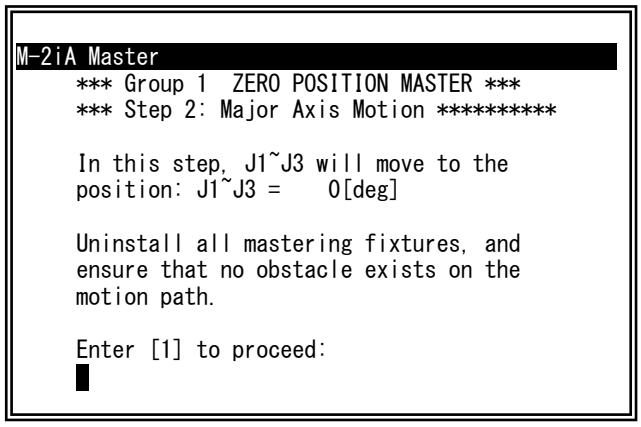
5 The interactive mastering starts. First, do major axis mastering.

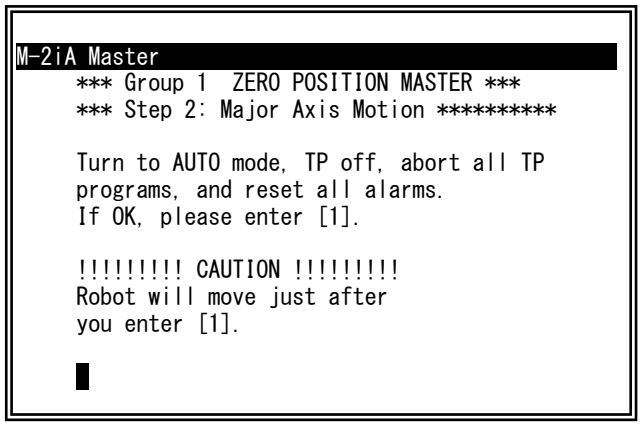


6 Enter [1], then major axes are mastered.



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-2iA 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-2iA Master
     *** Group 1  ZERO POSITION MASTER ***
     *** Step 3: Wrist Axis Master **********

     Wrist axes are mastered!
     Mastering Data:
      J4:  498623
     Please press [ENTER]:
```

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

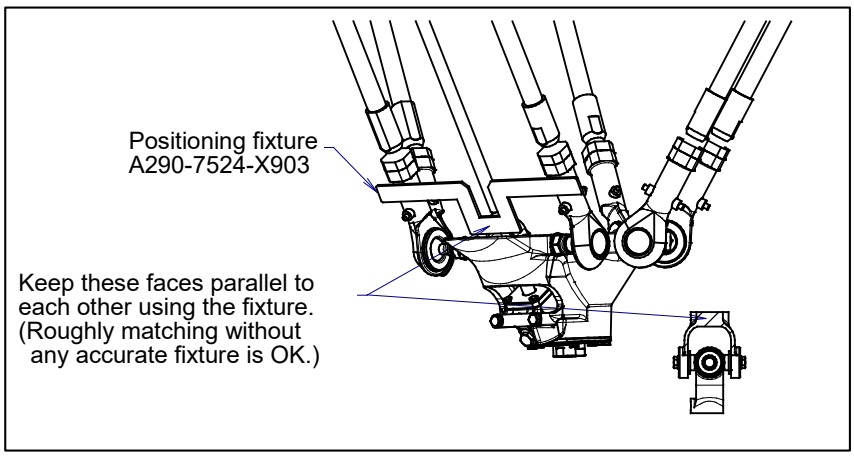
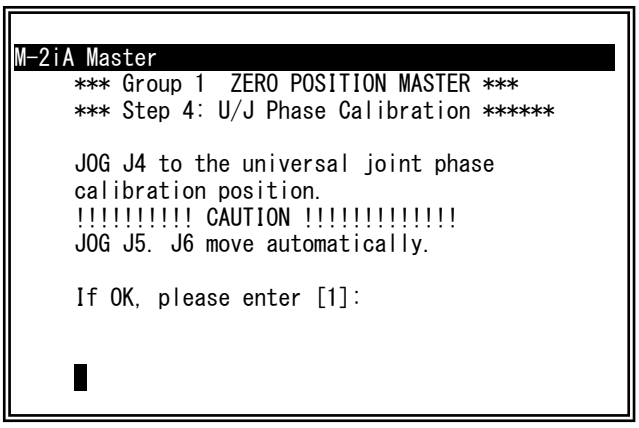
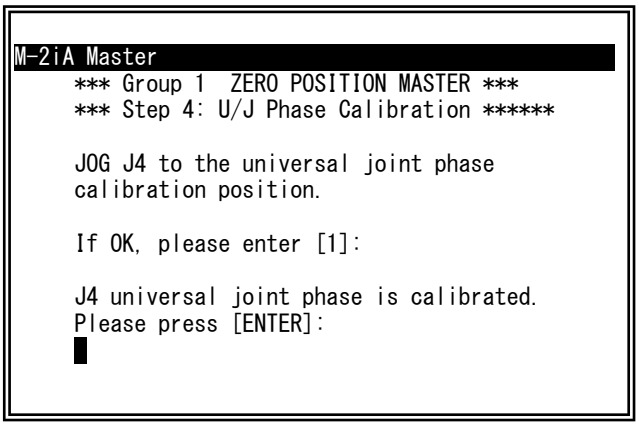


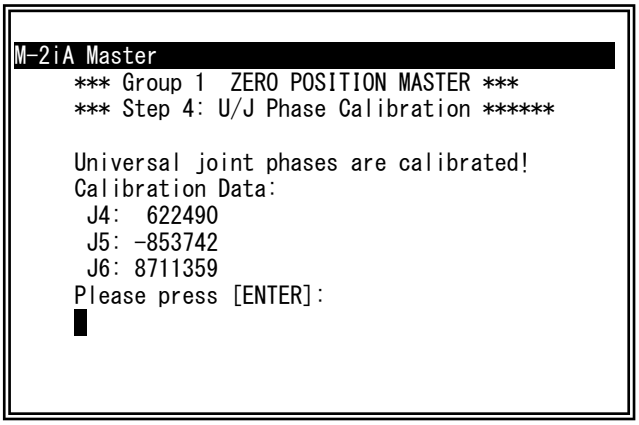
Fig. 7.3 (a) Universal joint phase calibration



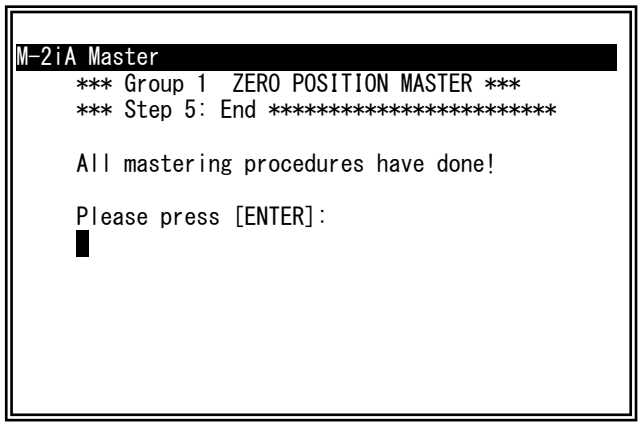
12 Enter [1], then J4-axis universal joint phase is calibrated.



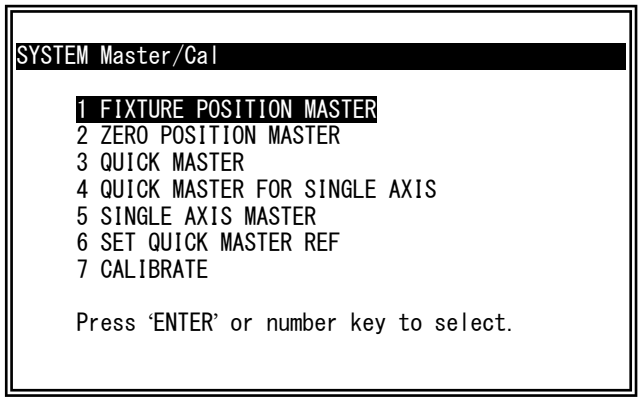
13 Next, calibrate J5/J6-axis universal joint phase calibration. (Only in case of M-2*i*A/3A/3AL)
When all universal joint phases are calibrated, calibration data will be displayed.



14 Then, you finish the mastering procedures.



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



16 Select [7 CALIBRATE] then press the [ENTER] key 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-2*i*A/3S/3SL.

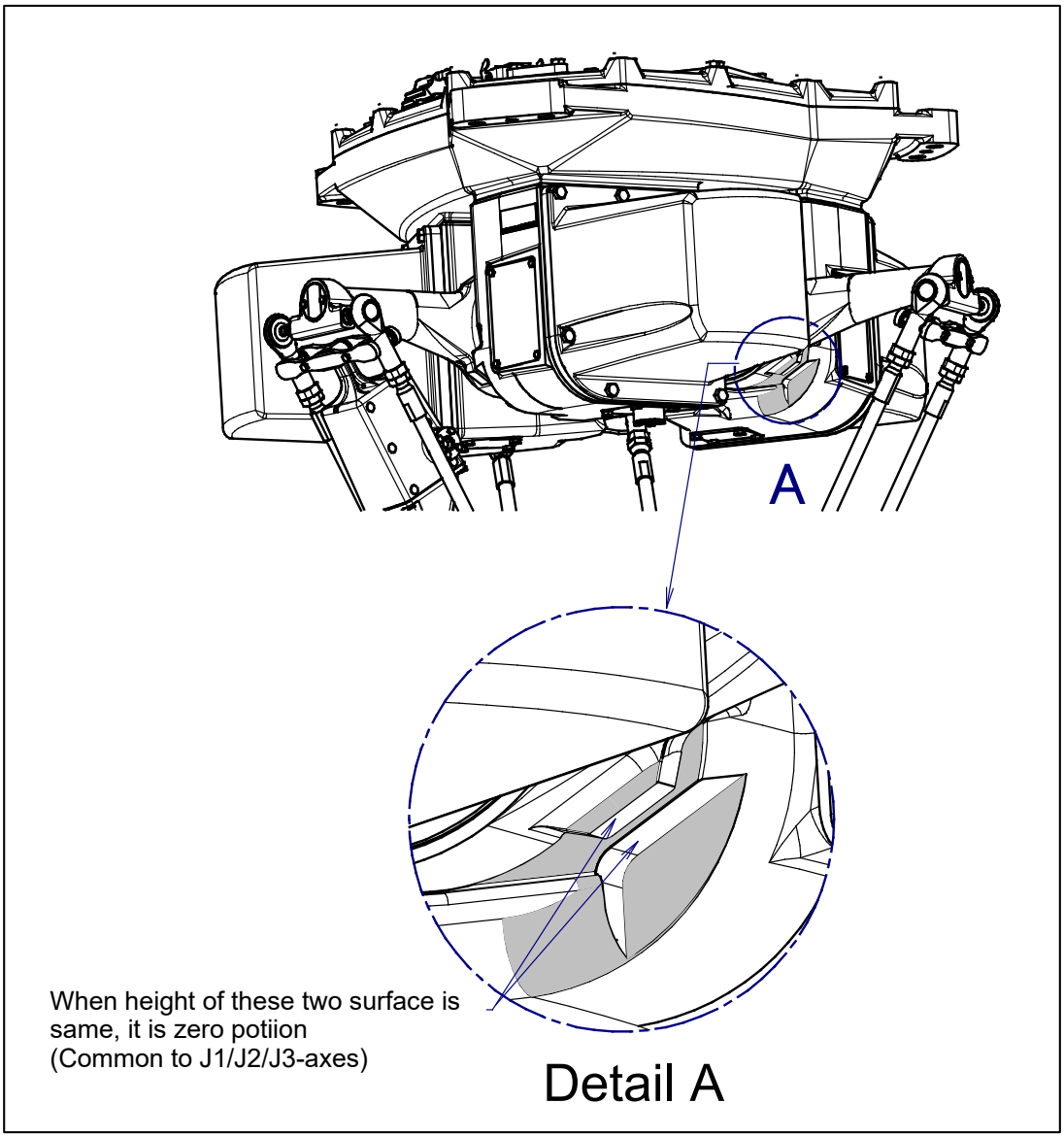


Fig. 7.3 (b) Marking position (1/3)

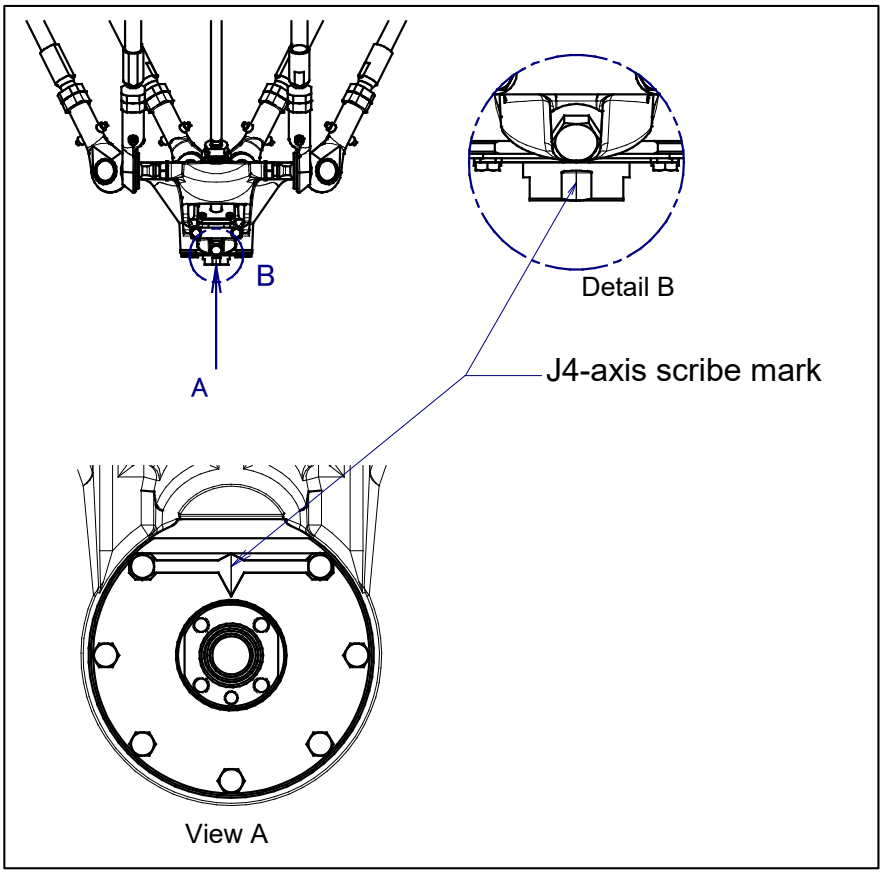


Fig. 7.3 (c) Marking position (2/3) (M-2*i*A/3S/3SL)

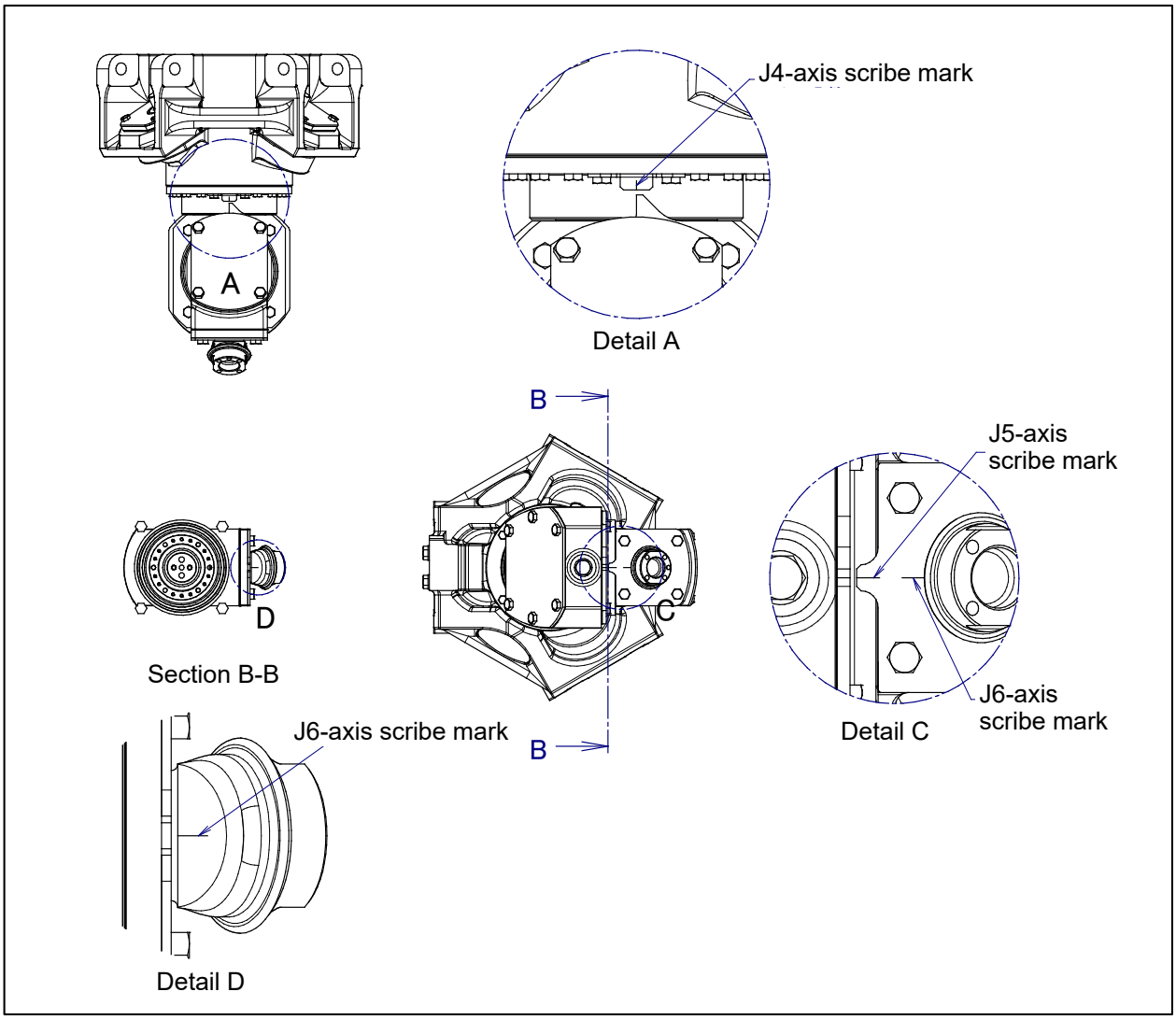


Fig. 7.3 (d) Marking position (3/3) (M-2*i*A/3A/3AL)

7.4 ZERO POSITION MASTERING (M-2*i*A/6H/6HL)

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.

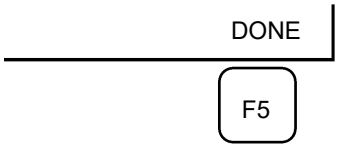
6 Select [2 Zero Position Master].

```
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.

```
SYSTEM Master/Cal          AUTO   JOINT 10 %
                                  TORQUE = [ON ]
 1 FIXTURE POSITION MASTER
 2 ZERO POSITION MASTER
 3 QUICK MASTER
 4 QUICK MASTER FOR SINGLE AXIS
 5 SINGLE AXIS MASTER
 6 SET QUICK MASTER REF
 7 CALIBRATE
Robot Calibrated! Cur Jnt Ang(deg):
   <    0.0000> <    0.0000> <    0.0000>
   <    0.0000> <    0.0000> <    0.0000>
```

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-2*i*A/3S/3SL/3A/3AL)

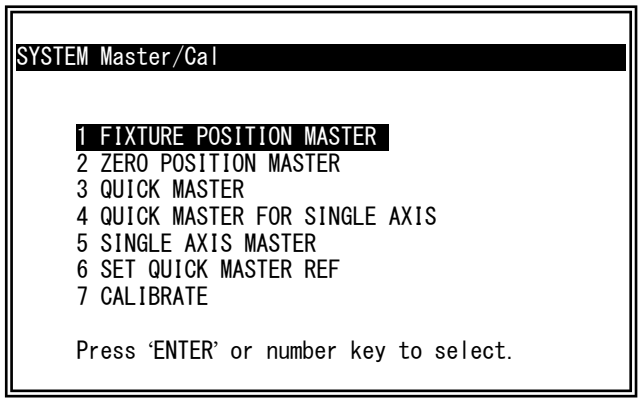
Quick Mastering provides a quick recovery of mastering when pulse count is reset due to battery run-out etc. The procedure of Quick Mastering is simple and easy because this method does not require either a special operation for wrist axis or an accurate positioning like other mastering method. However, Quick Mastering cannot 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 (→ reference position setting).
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.

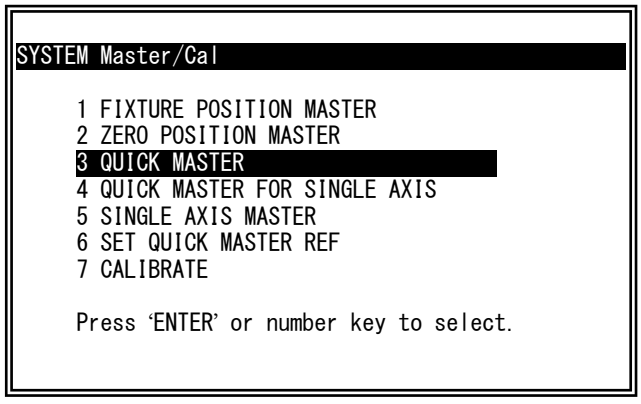
How to do Quick Mastering

Required conditions
- 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.

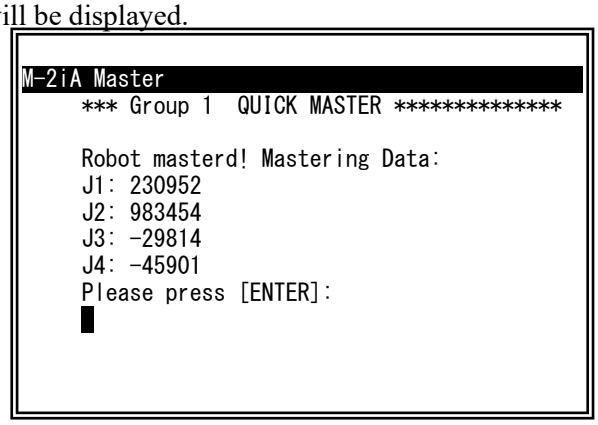
Procedure
1 Go to the [Master/Cal] menu.



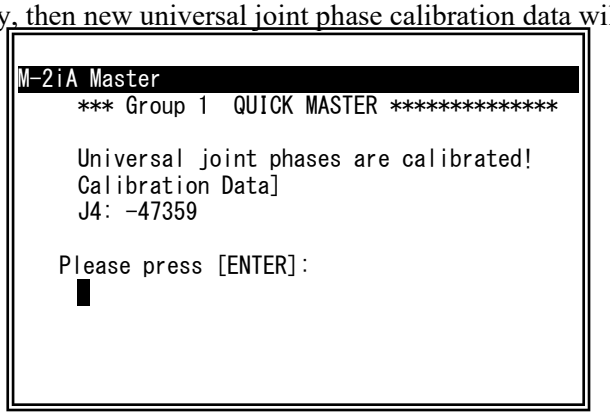
2 Jog the robot to the quick mastering position (reference position). Quick Mastering can compensate position errors within half rotation of the motor. Therefore, you need only a brief visual check for positioning.
3 Select [3 QUICK MASTER] and press F4 [Yes].



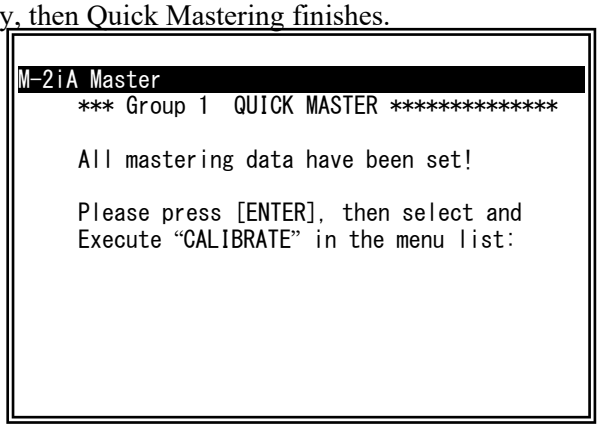
4 New mastering data will be displayed.



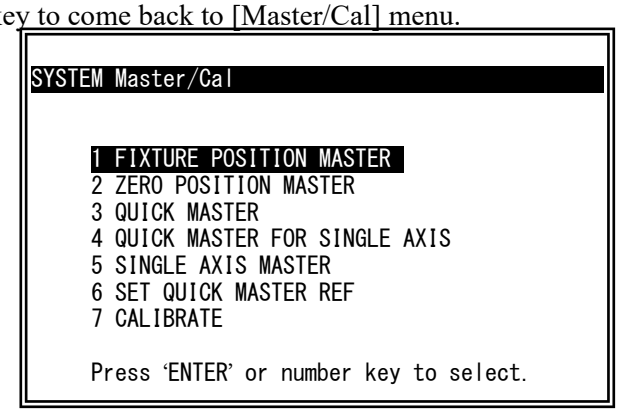
5 Press the [ENTER] key, then new universal joint phase calibration data will be displayed.



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



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



8 Select [7 CALIBRATE] then press the [ENTER] key to calibrate the robot.

How to set Reference Position

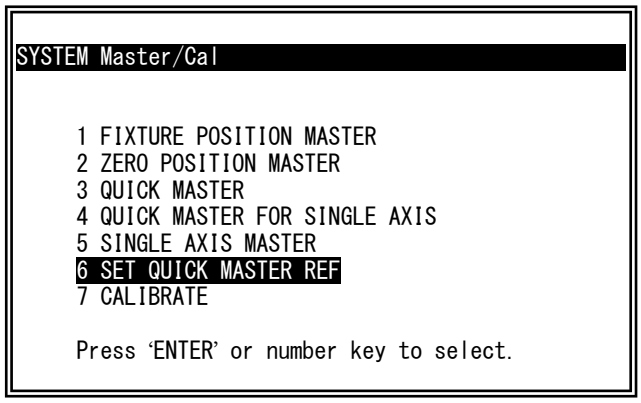
This procedure is for setting/changing the quick mastering reference position.

Required conditions

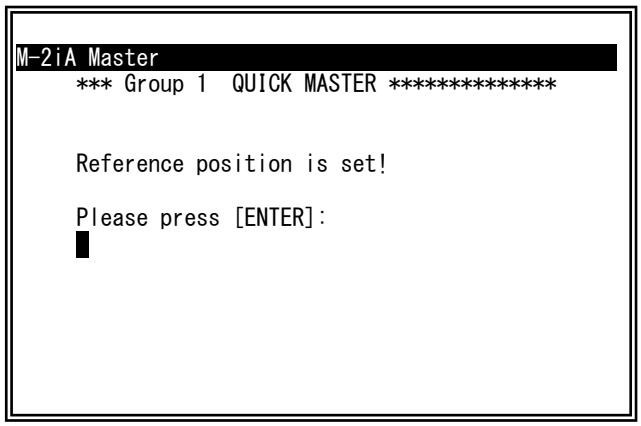
- Mastering and Calibration is done.
- Angle of major axis (J1-J3) is almost equal to each other. The tolerance margin is 1 deg.

Procedure

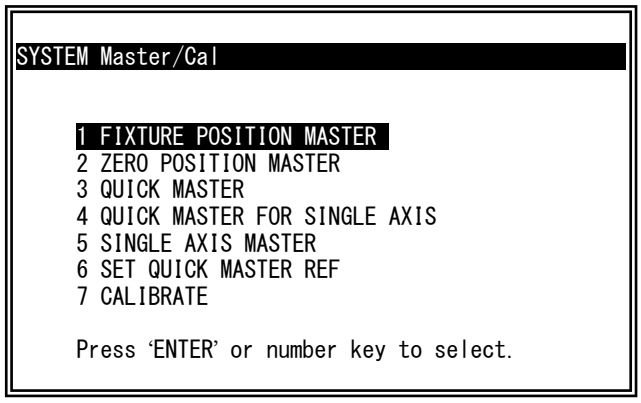
1 Select [6 SET QUICK MASTER REF] and press F4 [Yes].



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.



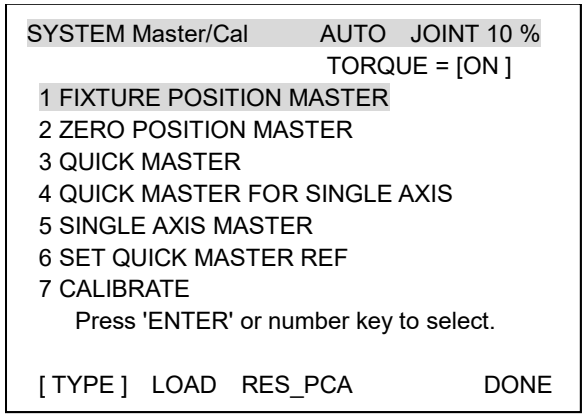
7.6 QUICK MASTERING (M-2*i*A/6H/6HL)

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. 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.)

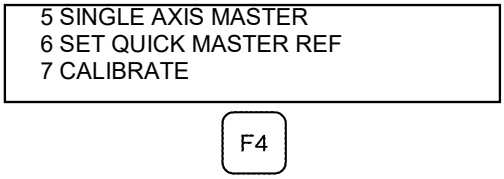
> ⚠ **CAUTION**
> 1 Quick mastering can be used, if the pulse count value is lost, for example, because a low voltage has been detected on the backup battery for the pulse counter.
> 2 Quick mastering cannot be used, after the motor is replaced or after the mastering data is lost from the robot controller.

Procedure Recording the Quick Mastering Reference Position

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



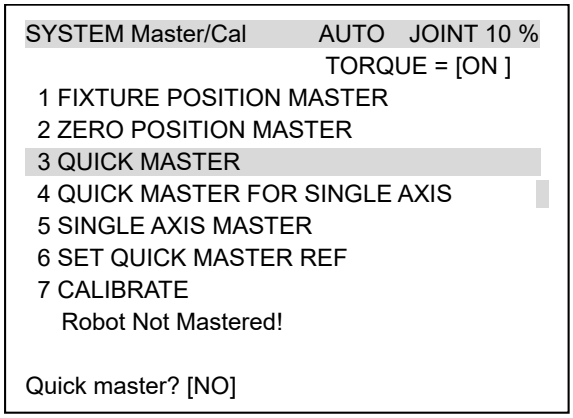
3 Release brake control, and jog the robot to the quick mastering reference position.
4 Select [6 SET QUICK MASTER REF] and press F4 [YES]. Quick mastering reference position is saved.



> ⚠ **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.

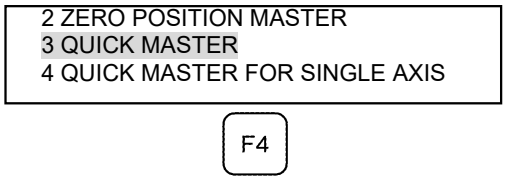
Procedure of Quick Mastering

1 Display the Master/Cal screen.



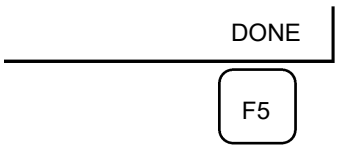
2 Release brake control, and jog the robot to the quick mastering reference position.

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 [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-2*i*A/3S/3SL/3A/3AL)

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.

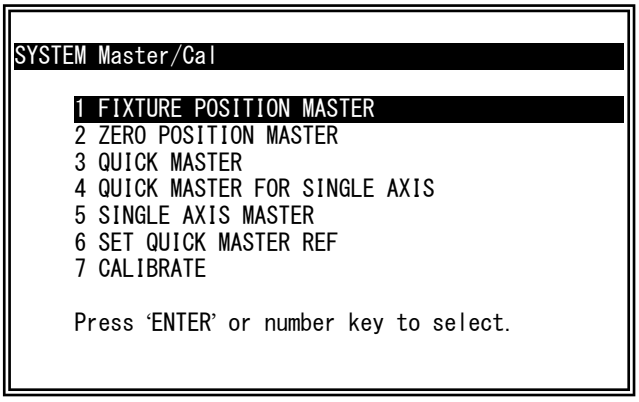
How to do Quick Mastering for single axis

Required conditions

- Software version is 7DC3 or later. (Quick Mastering for single axis cannot be used in case of 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.

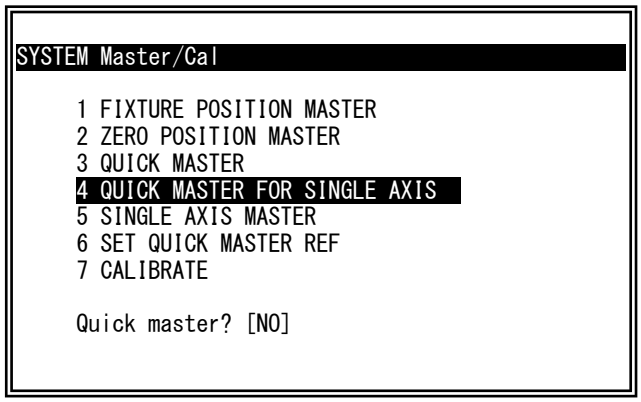
Procedure

1 Go to the [Master/Cal] menu.

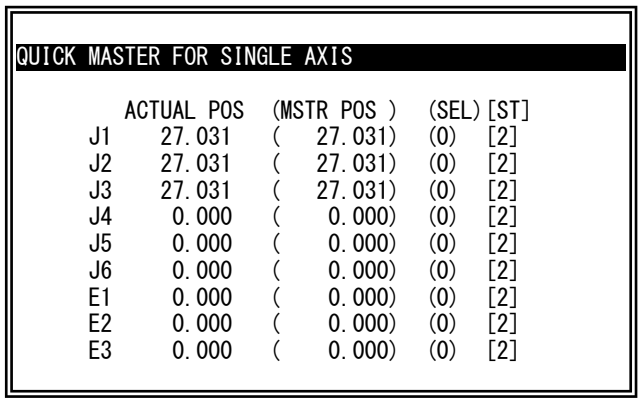


2 Jog the robot to the quick mastering position (reference position). Quick Mastering can compensate position errors within half rotation of the motor. Therefore, you need only a brief visual check for positioning.

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

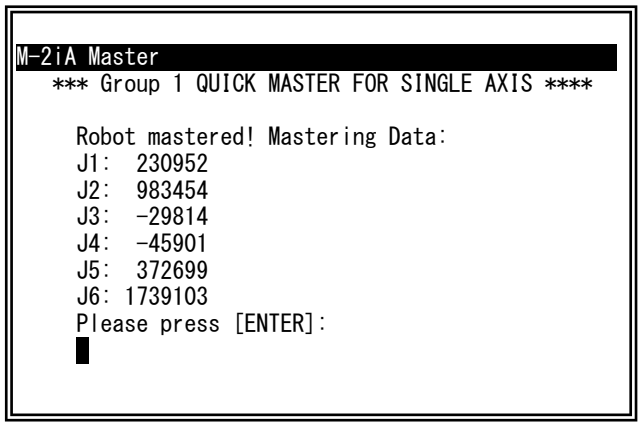


4 QUICK MASTER FOR SINGLE AXIS screen will be displayed.

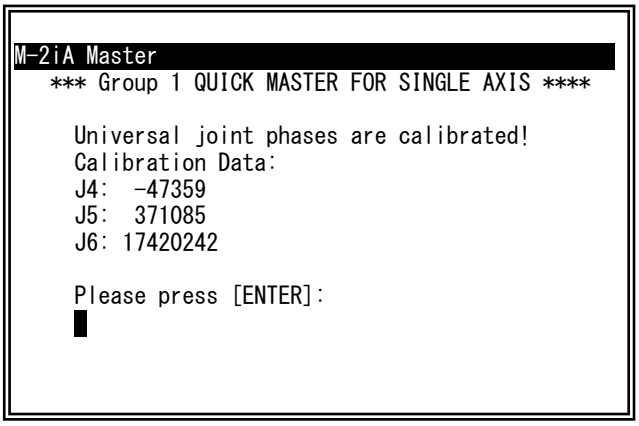


5 Enter 1 to SEL setting field of the axis to be mastered. SEL can be specified one axis at a time or plural axes simultaneously.
6 Jog the robot to the mastering position.
7 Press F5, EXEC. The mastering is performed. [ST] is re-set to 2 by this operation.

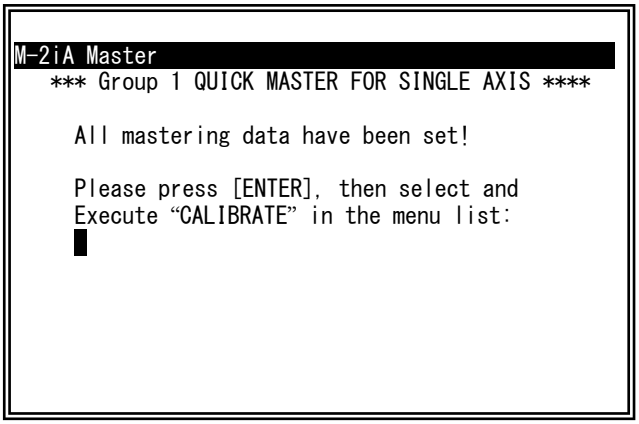
NOTE
At this time, [SEL] is not re-set to 0. [SEL] is re-set to 0 when cycling power of the controller.



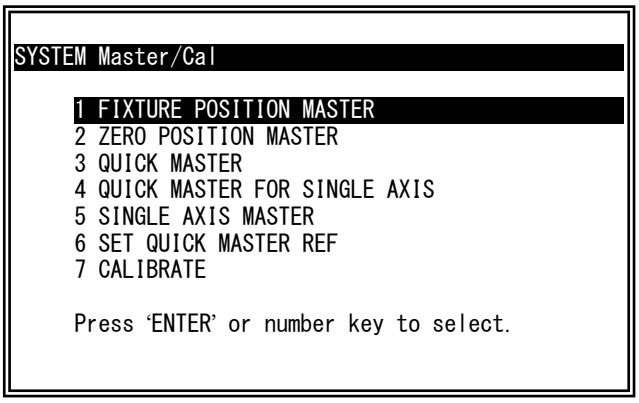
8 Press the [ENTER] key, then new universal joint phase calibration data will be displayed.



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



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



11 Select [7 CALIBRATE] then press the [ENTER] key to calibrate the robot.

How to set Reference Position

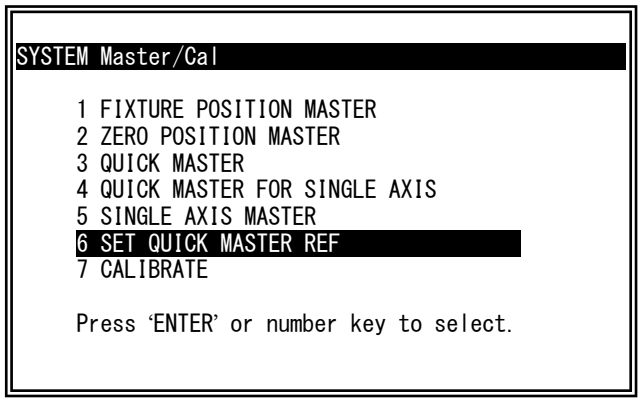
This is the procedure for setting/changing the quick mastering reference position.

Required conditions

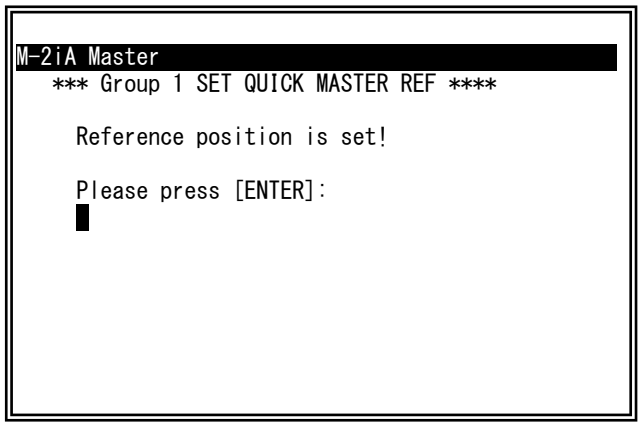
- Software version is 7DC3 or later. (Reference position cannot be set in case of 7DC2 or before.)
- Mastering and Calibration is done.
- Angle of major axis (J1-J3) is almost equal to each other. The tolerance margin is 1deg.

Procedure

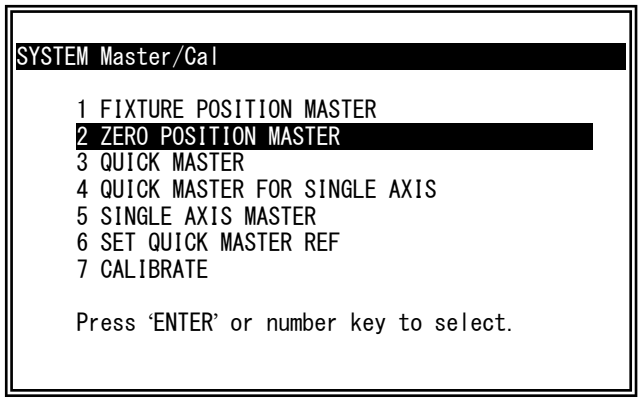
1 Select [6 SET QUICK MASTER REF] and press F4 [Yes].



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-2*i*A/6H/6HL)

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

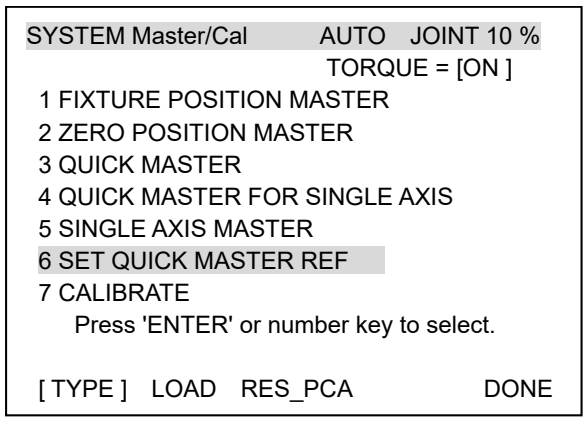
Quick mastering is factory-performed at the position indicated in Table 8.3. Do not change the setting unless there is any problem.

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.)

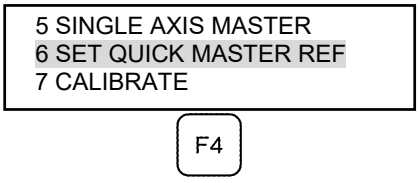
> ⚠ **CAUTION**
> 1 Quick mastering can be used, if the pulse count value is lost, for example, because a low voltage has been detected on the backup battery for the pulse counter.
> 2 Quick mastering cannot be used, after the motor is replaced or after the mastering data is lost from the robot controller.

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 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
```

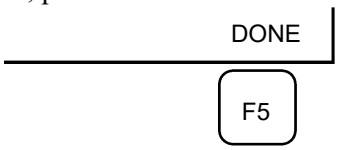
3 Move the cursor to the [SEL] column for the unmastered axis and press the numeric key [1]. Setting of [SEL] is available for one or more axes.

```
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-2*i*A/3S/3SL/3A/3AL)

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.

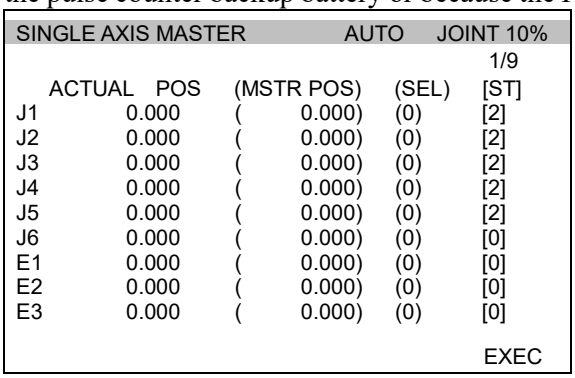
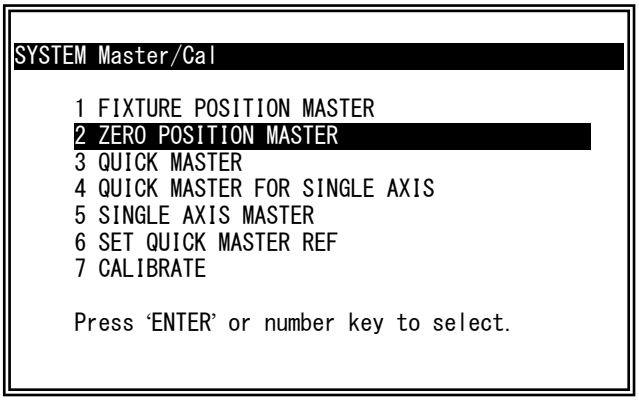


Table 7.9 (a) Items set in single axis mastering

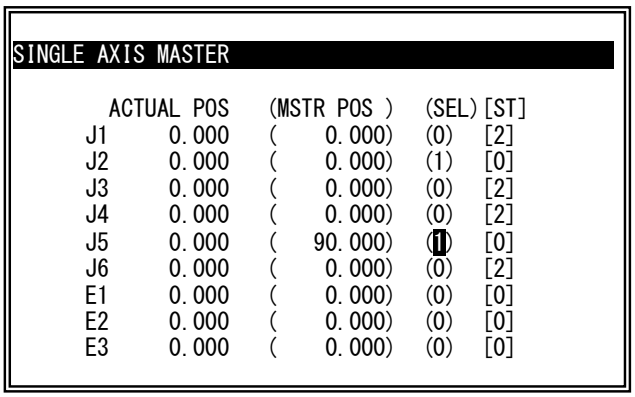
Item	Description
Current position (Actual axis)	The current position of the robot is displayed for each axis in degree units.
Mastering position (MSTR pos)	A mastering position is specified for an axis to be subjected to single axis mastering. It would be convenient to set to it to the 0_ position.
SEL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

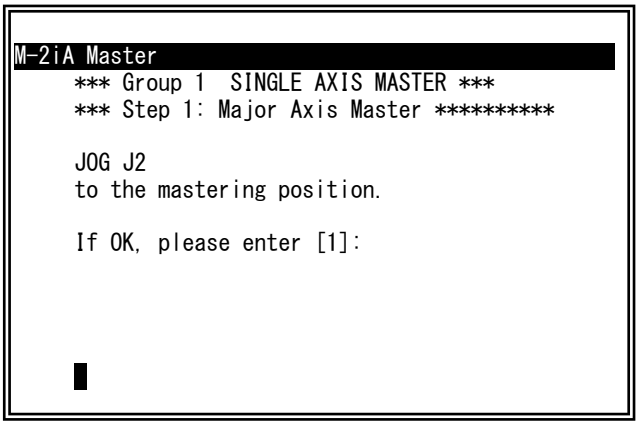


NOTE
If RUNNING or PAUSED program exists, ABORT it beforehand.
Otherwise, you can not proceed to the following step.

2 Select axis that you would like to perform mastering and mastering position. Then press [F5 Execute].



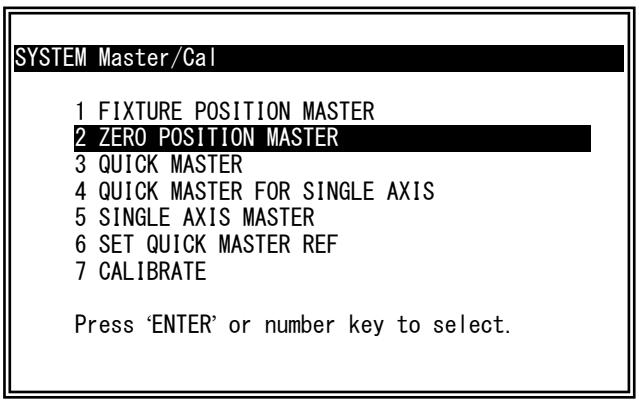
3 The interactive mastering starts.



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 the [Enter] to come back to [Master/Cal] menu.



If all axes have been mastered, select [7 CALIBRATE] then press the [ENTER] to calibrate the robot.

7.10 SINGLE AXIS MASTERING (M-2*i*A/6H/6HL)

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.

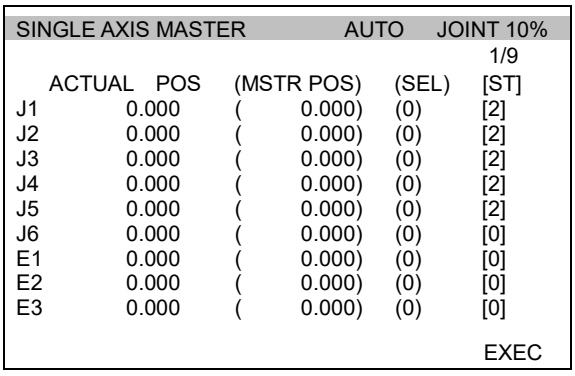


Table 7.10 (a) Items set in single axis mastering

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.

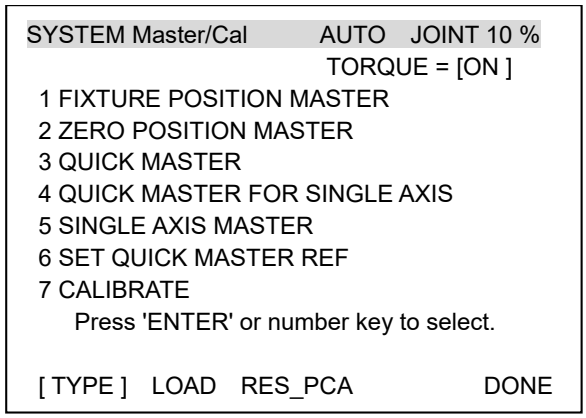
```
SINGLE AXIS MASTER          AUTO    JOINT 10%
                                          1/9
    ACTUAL   POS    (MSTR POS)    (SEL)   [ST]
J1          0.000   (     0.000)  (0)     [2]
J2          0.000   (     0.000)  (0)     [2]
J3          0.000   (     0.000)  (0)     [2]
J4          0.000  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

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

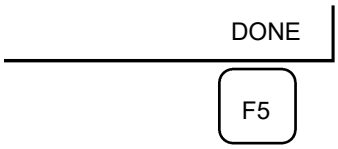
```
SINGLE AXIS MASTER          AUTO    JOINT 10%
                                          1/9
    ACTUAL   POS    (MSTR POS)    (SEL)   [ST]
J1          0.000   (     0.000)  (0)     [2]
J2          0.000   (     0.000)  (0)     [2]
J3          0.000   (     0.000)  (0)     [2]
J4          0.000  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

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].



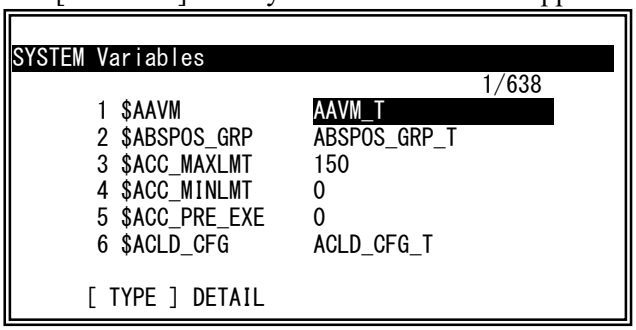
11 Return brake control to original setting, and cycle power of the controller .

7.11 MASTERING DATA ENTRY

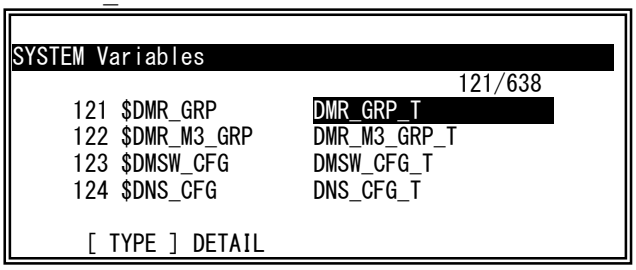
You can enter mastering data directly to system variables. You can use this way when the system lost the mastering data but keeps the pulse count.

Mastering data entry

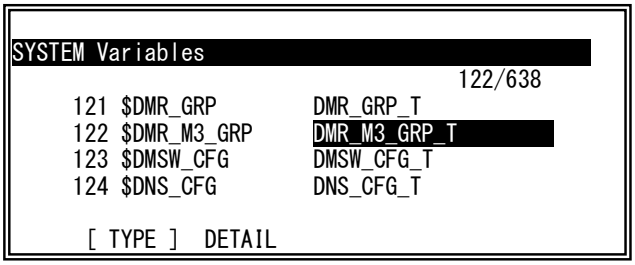
1 Press the [MENU] key, then press NEXT and select SYSTEM.
2 Press F1, [TYPE]. Select [Variables]. The system variable screen appears.



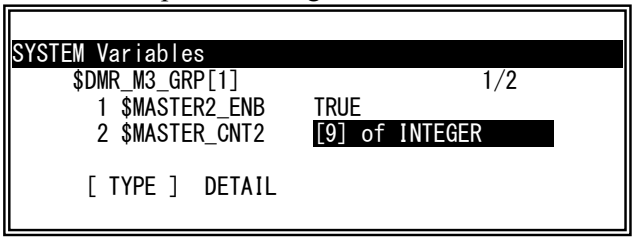
3 The mastering data is saved in $DMR_GRP.$MASTER_COUN and $DMR_M3_GRP.$MASTER_CNT2.



4 Select “$DMR_M3_GRP.

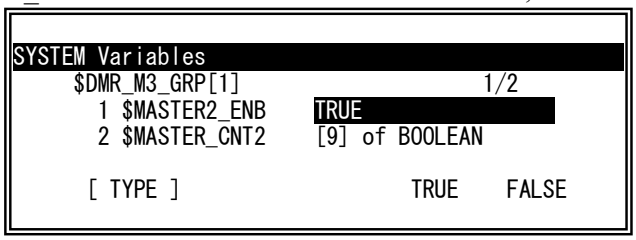


5 Select “$MASTER_CNT2” and input mastering data which is recorded.

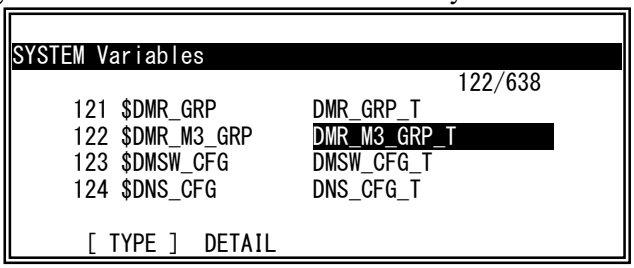


6 Press the [PREV] key.

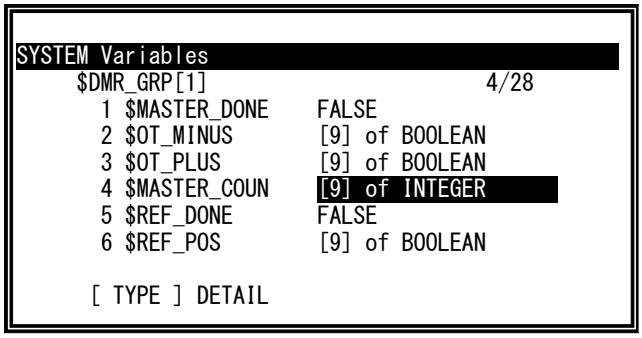
7 Confirm “$MASTER2_ENB” is set to “TRUE”. If it is “FALSE”, set it to “TRUE”.



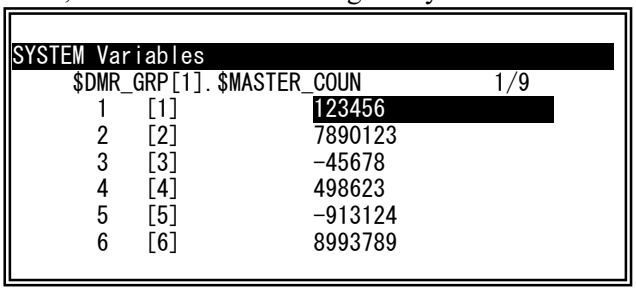
8 Press the [PREV] key twice to return to the root screen of system variables.



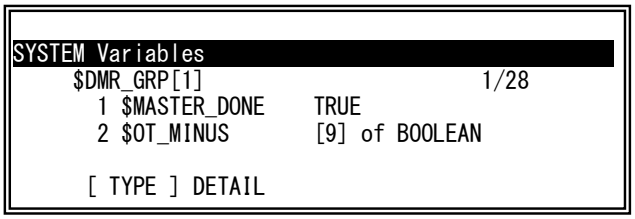
9 Select $DMR_GRP.



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

7.12 Q&A (M-2*i*A/3S/3SL/3A/3AL)

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-2*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 pressing the [FCTN] key >[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 situation, interactive mastering cannot be resumed.
- A message "Mastering procedure will be aborted" will be shown. Press the [ENTER] key 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.

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 :
for M-2*i*A/3S/3A : J1,J2,J3=0°
for M-2*i*A/3SL/3AL: J1,J2,J3=9.305°
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 If you try to set $DMR_GRP.$MASTER_DONE = TRUE when $DMR_M3_GRP.$MASTER2_ENB = FALSE, this warning is posted. For direct Mastering data entry, set $DMR_M3_GRP.$MASTER2_ENB = TRUE first. After that, set $DMR_GRP.$MASTER_DONE = TRUE

7.13 CHECKING THE MASTERING

1 Checking whether mastering has been made correctly
Usually, positioning is performed automatically at power-on. To check whether mastering has been made correctly, note whether the displayed current position agrees with the actual robot position. Use the procedure described below:

(1) Reproduce a particular point in a program. Check whether the point agrees with the specified position.
(2) Set all axes of the robot to their 0-degree (0 rad) positions. Check that the zero-degree position marks indicated in Section 7.3 are aligned. There is no need to use 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 below 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 Alarms that may be output during mastering and remedy for it
(1) BZAL alarm
This alarm is output if the voltage of the Pulsecoder's backup battery falls to 0 V while the power to the controller is disconnected. Also, if Pulsecoder connector is removed for replacing cables etc. this alarm is output because voltage becomes to 0. To clear the alarm, fit a new battery, execute the pulse reset (See section 7.2.), then turn the power off then on again and confirm alarm is not output.
Battery might be weak if you can’t reset alarm, then replace battery to new one, perform pulse reset, turn off and on the controller power. Note that, if this alarm occurs, all data originally held by the Pulsecoder will have been lost. Mastering must be performed again.
(2) BLAL alarm
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) CKAL, RCAL, PHAL, CSAL, DTERR, CRCERR, STBERR, and SPHAL, alarms
Contact the FANUC because the Pulsecoder may be defective.

8 TROUBLESHOOTING

The cause of a failure in the mechanical unit may be difficult to localize, because failures can arise from many interrelated factors. If you fail to take the correct measures, the failure may be aggravated. Therefore, you must analyze the symptoms of the failure precisely so that the true cause can be found.

8.1 TROUBLESHOOTING

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

Table 8.1 (a) Troubleshooting

Symptom	Description	Cause	Measure
Vibration Noise	- The base or pedestal lifts off the floor plate as the robot operates. - There is a gap between the base or pedestal and floor plate. - A base or stand retaining bolt is loose.	[Base or pedestal fastening] - It is likely that the robot base or pedestal is not securely fastened to the floor plate. - Probable causes are a loose bolt, an insufficient degree of surface flatness, or foreign material caught between the floor plate and floor plate. - If the robot is not securely fastened to the floor plate, the J1 base lifts the floor plate as the robot operates, allowing the base and floor plates to strike each other. That, in turn, leads to vibration.	- If a bolt is loose, apply LOCTITE and tighten it to the appropriate torque. - Adjust the floor plate surface flatness to within the specified tolerance. - If there is any foreign material between the base or pedestal and floor plate, remove it.
	- The rack or floor plate vibrates during operation of the robot.	[Rack or floor] - It is likely that the rack or floor is not rigid enough. - If they are not rigid enough, counterforce can deform the rack or floor, and cause vibration.	- Reinforce the rack or floor to make it more rigid. - If reinforcing the rack or floor is impossible, modify the robot control program; doing so might reduce the vibration.
	- Vibration becomes more serious when the robot is in a specific posture. - If the operating speed of the robot is reduced, vibration stops. - Vibration is most noticeable when the robot is accelerating. - Vibration occurs when two or more axes operate at the same time.	[Overload] - It is likely that the load on the robot is heavier than the maximum rating. - It is likely that the robot control program is too demanding for the robot hardware. - It is likely that the ACCELERATION value is excessive.	- Check the maximum load that the robot can handle or not. If the robot is overloaded, reduce the load, or modify the robot control program. - Vibration can be reduced by re-modifying the robot control program; reducing speed or acceleration with minimizing the influence on the entire cycle time.

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- Vibration or noise was first noticed after the robot collided with an object or the robot was overloaded for a long period. - The oil of the vibrating or noise occurring axis has not been exchanged for a long period. - Cyclical vibration and noise occur.	[Gear, bearing, or reducer] - It is likely that the collision or overload applied an excessive force to the drive mechanism, thus damaging the tooth surface or rolling contact surface of a bearing, or reducer. - Prolonged use with overloaded may cause the fretting fatigue on gear tooth surface or rolling surface of bearing and reducer. - It is likely that foreign material caught in a gear, bearing, or within a reducer has caused damage on the gear tooth surface or rolling surface of the bearing, or reducer. - It is likely that foreign material caught in a gear, bearing, or within a reducer is causing vibration. - It is likely that, because the 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 by neglect greasing.	- Operate each axis at individually to judge which axis has been vibrating. - Remove the motor, and replace the gear, the bearing, and the reducer. For the specification of parts and the procedure of replacement, contact your local FANUC representative. - Using the robot within its maximum rating prevents problems with the drive mechanism. - Specific type and period of oil change will prevent troubles.

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, refer to Chapter 4. - If vibration occurs only when the robot assumes a specific posture, it is likely that there is a mechanical problem. - Shake the movable part cable while the robot is at rest, and check whether an alarm occurs. If an alarm or any other abnormal condition occurs, replace the mechanical unit cable. - Check whether the cable jacket of the robot connection cable is damaged. If so, replace the connection cable, and check whether vibration still occurs. - Check whether the sheath of the power cable is damaged. If so, replace the power cable, and check whether vibration still occurs. - Check that the robot is supplied with the rated voltage. - Check that the robot control parameter is set to a valid value. If it is set to an invalid value, correct 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 Peripheral] - If the robot is not grounded properly, electrical noise can be induced on the grounding wire, preventing commands from being transferred accurately, thus will lead to vibrate. - If the robot is grounded at an unsuitable point, its grounding potential becomes unstable, and noise is likely to be induced on the grounding line, thus will lead to vibrate.	- Connect the grounding wire firmly to ensure a reliable ground potential thereby preventing extraneous electrical noise.
Rattling	- While the robot is not supplied with power, pushing it with the hand causes tottering part of the mechanical unit. - There is a gap on the mounting face of the mechanical unit.	[Mechanical unit coupling bolt] - It is likely that overloading or a collision has loosened a mounting bolt in the robot mechanical unit.	- Check 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 - Reducer - Base - Arm - Casting - End effector
	- 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 motor overheated due to a rise in temperature in the installation area. - After changing the Robot control program or the load, the motor overheated.	[Ambient temperature] - It is likely that the motor overheated when the ambient temperature rose, and could not dissipate the heat. [Operating condition] - It is likely that the overcurrent is above the specified permissive average current.	- Reducing the ambient temperature is the most effective means of preventing overheating. - If there is a source of heat near the motor, it is advisable to install shielding to protect the motor from heat radiation. - Relaxing the robot control program and load condition is an effective way to reduce the average current. Thus, prevent overheating. - The teach pendant can 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 unit problems] - It is likely that problems occurred in the mechanical unit drive mechanism, thus placing an excessive load on the motor. [Motor problems] - It is likely that motor brake failure locked on the break, and cause the motor overloaded. - It is likely that a failure of the motor prevented it from delivering its rated performance, thus causing an excessive current to flow into the motor. - It is likely that cooling fan is broken.(J1 to J3-axis)	- Repair the mechanical unit referring to the above descriptions of vibration, noise, and rattling. - Check that, when the servo system is energized, the brake is released. If the brake remains applied to the motor all the time, replace the motor. - Judgment is possible if the average current decreased after replacing the motor, the former motor had been defected. - If the cooling fan is broken, replace it by new one.

Symptom	Description	Cause	Measure

Oil leakage	- Oil leaks from the mechanical unit.	[Poor sealing]
		- Probable causes are a crack in the casting, a damaged oil seal, or a loose seal bolt.
		- The casting may crack with excessive force caused in collision.
		- An oil seal may be damaged if extraneous dust scratches the lip of the oil seal.
			- If the casting cracks, sealant can be used as a quick-fix to prevent further grease leakage. However, the component must be replaced as soon as possible, as the crack will widen.
			- Oil seals are used in the locations stated below.
			  - Inside the reducer
			  - Inside the wrist

Grease leakage	- Grease leaks from the mechanical unit.	- Rubber boot of the Link Ball may be broken.	- Confirm that the rubber boot of the Link Ball is broken. If it is broken, replace the Link Ball

Dropping axis	- An axis falls because the brake went out.
	- An axis falls while standing still.
		[Brake drive relay and motor]
		- It is likely that brake drive relay contacts are stuck to each other and keep the brake current flowing, thus preventing the brake from operating when the motor is reenergized.
		- It is likely that the brake shoe has worn out or the brake main body is damaged, preventing the brake from operating efficiently.
		- It is likely that oil or grease soak through the motor, causing the brake to slip.
			- Check whether the brake drive relay contacts stuck each other or not. If they are found to be stuck, replace the relay.
			- Replace the motor confirmed following symptoms.
			  - Brake shoe is worn out
			  - brake main body is damaged
			  - Oil soak through the motor

Displacement	- The robot moves to a point other than the taught position. - The repeatability is not within the tolerance.	[Mechanical unit problems] - If the repeatability is unstable, probable causes are a failure in the drive mechanism or a loose bolt, and so on. - If the repeatability is stable, it is likely that collision by an excessive load caused slip on the fasting surface of each axis arm, and reducer. - It is likely that the Pulsecoder is faulty.	- If the repeatability is unstable, repair the mechanical unit by referring to the above descriptions of vibration, noise, and rattling. - If the repeatability is stable, correct the taught program. The problem will not reoccur unless another collision occurs. - If the Pulsecoder is faulty, replace the motor.
	- Displacement occurs only in specific peripheral equipment.	[Peripheral equipment displacement] - It is likely that an external force was applied to the peripheral equipment, thus shifting its position relative to the robot.	- Correct the setting of the peripheral equipment position. - Correct the taught program.

Symptom	Description	Cause	Measure
Displacement (Continued)	- Displacement occurred after a parameter was changed.	[Parameter] - It is likely that the mastering data was overwritten, and the origin had misaligned.	- Re-enter the previous optimal mastering data. - If optimal mastering data is unavailable, perform mastering again.
CLALM alarm occurred. Move error excess alarm occurred.	- Ambient temperature of the robot installation location is low, CLALM alarm is displayed on the teach pendant screen. - Ambient 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 influence on 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.
		- It is likely that rated voltage is not supplied due to the voltage drop.	- Check that the robot is supplied with the proper rated voltage.
BZAL alarm occurred	- BZAL is displayed on the teach pendant screen	- It is likely that the voltage of the memory backup battery is low. - It is likely that the Pulsecoder cable is defective.	- Replace the battery. - Replace the cable.

APPENDIX

A PERIODIC MAINTENANCE TABLE

FANUC Robot M-2*i*A **Periodic Maintenance Table**

Items			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
Accumulated operating time (H)			Cycle count *5	—		5000k	10000k	15000k	20000k	25000k	30000k	35000k	40000k	45000k	50000k	55000k
Mechanical unit	1	Check for external damage or peeling paint	0.1H	-		○	○	○	○	○	○	○	○	○	○	○
	2	Check for water	0.1H	-		○	○	○	○	○	○	○	○	○	○	○
	3	Check the connector on the connector plate. (Loosening)	0.2H	—		○			○				○			
	4	Tighten the end effector bolt.	0.2H	—		○			○				○			
	5	Tighten the cover and main bolt.	2.0H	—		○			○				○			
	6	Check the LINK B	0.1H	—		○			○				○			
	7	Remove spatter and dust etc	1.0H	—		○			○				○			
	8	Check the end effector (hand) cable	0.1H	—		○			○				○			
	9	Visually check the wrist motor cable (except M-2*i*A/6H/6HL)	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	10	Check the operation of the cooling fan	0.1H	—		○			○				○			
	11	Cleaning and greasing of the link B (seal type)	0.5H	—			○		○		○		○		○	
	12	Replacing batteries(*6)	0.1H	—							●					
	13	Supply oil to J1/J2/J3-axis reducer	0.1H	Each230ml(*1) Each 300m(*2)					●				●			
	14	Supply oil to wrist (M-2*i*A/3S/3SL/3A/3AL)	0.1H	22ml(3S/3SL) 300ml(3A/3AL)					●				●			
	15	Replacing mechanical unit cable	2.0H	—												
	16	Replacing the rod support kit etc.	1.0H	—									●			
	17	Replacing the wrist unit etc.	8.0H	—												
Controller	18	Check the robot cable, teach pendant cable and robot connecting cable	0.2H	—		○			○				○			
	19	Cleaning the ventilator	0.2H	—	○	○	○	○	○	○	○	○	○	○	○	○
	20	Replacing battery (*1)(*6)	0.1H	—												

*1 Robot which manufacturing No. is R14Y02347 (Made in Nov., 2014) or later

*2 Robot which manufacturing No. is before than R14Y02347 (Made in Nov., 2014)

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

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

*5 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.

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

3 years 11520	12480	13440	14400	4 years 15360	16320	17280	18240	5 years 19200	20160	21120	22080	6 years 23040	24000	24960	25920	7 years 26880	27840	28800	29760	8 years 30720	Item
60000k	65000k	70000k	75000k	80000k	85000k	90000k	95000k	100000k	105000k	110000k	115000k	120000k	125000k	130000k	135000k	140000k	145000k	150000k	155000k	160000k	
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		1
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		2
○				○				○				○				○					3
○				○				○				○				○					4
○				○				○				○				○					5
○				○				○				○				○					6
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○				○				○				○				○					10
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				●																	20

Overhaul

B PERIODIC MAINTENANCE PARTS

Contact your local FANUC representative for replacing procedure.

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

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

Item	Parts	Specification	3S	3SL	3A	3AL	6H	6HL
1	Rod support kit A	A05B-1524-K313	1		3		-	
2	Rod support kit B	A05B-1524-K316	1		3		-	
3	Link B(boot type)	A290-7524-V312	6	-	6	-	6	-
		A290-7524-V313	-	6	-	6	-	6
4	Wrist cable (4-axis)	A05B-1524-D009	1		-		-	
	Wrist cable (6-axis)	A05B-1524-D010	-		3		-	

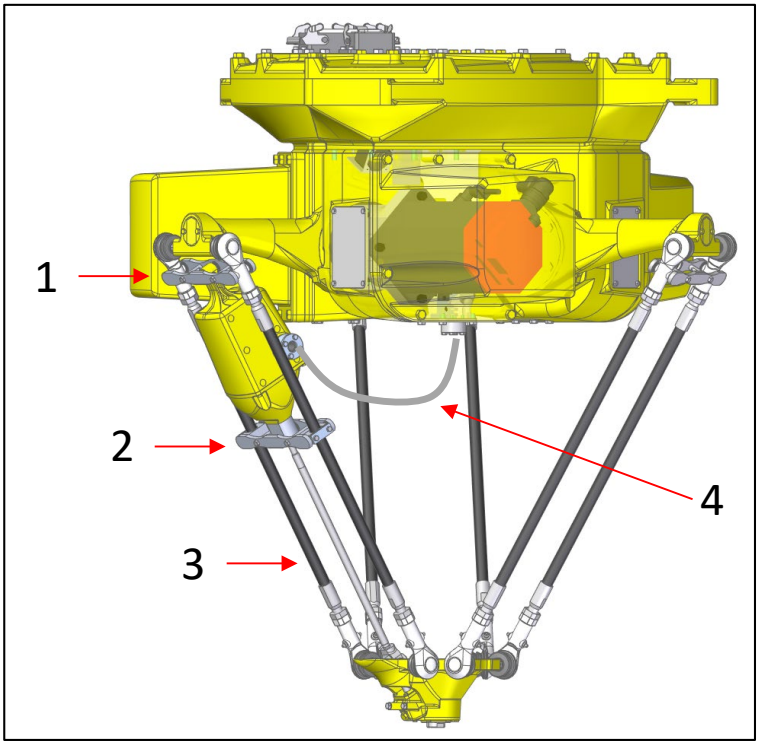


Fig. B (a) Periodic replacing parts (2 years)

(b) 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	3S	3SL	3A	3AL	6H	6HL
5	Link B (seal type)	A290-7524-V319	-	6	-	6	-	6	-
		A290-7524-V320	-	-	6	-	6	-	6
6	Wrist motor unit (including the wrist cable)	A05B-1524-K329	White	1		-		-	
		A05B-1524-K330	Yellow						
		A05B-1524-K331	White	-		3		-	
		A05B-1524-K332	Yellow						
7	Rod support kit C	A05B-1524-K315	-	2		-		3	
8	Drive shaft	A290-7524-X306	-	1	-	-		-	
		A290-7524-X314	-	-	1				
		A290-7524-X336	-	-		3	-	-	
		A290-7524-X337	-			-	3		
9	Universal joint	A290-7524-V305	-	1		3		-	
10	Wrist unit	A05B-1524-K509	White	1		-		-	
		A05B-1524-K510	Yellow						
		A05B-1524-K505	White	-		1		-	
		A05B-1524-K506	Yellow						

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

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

Item	Parts	Specification	Color	3S	3SL	3A	3AL	6H	6HL
11	Fan assembly (option)	A290-7524-V701	-	3					
12	Reducer	A97L-0318-0211#21	-	3					

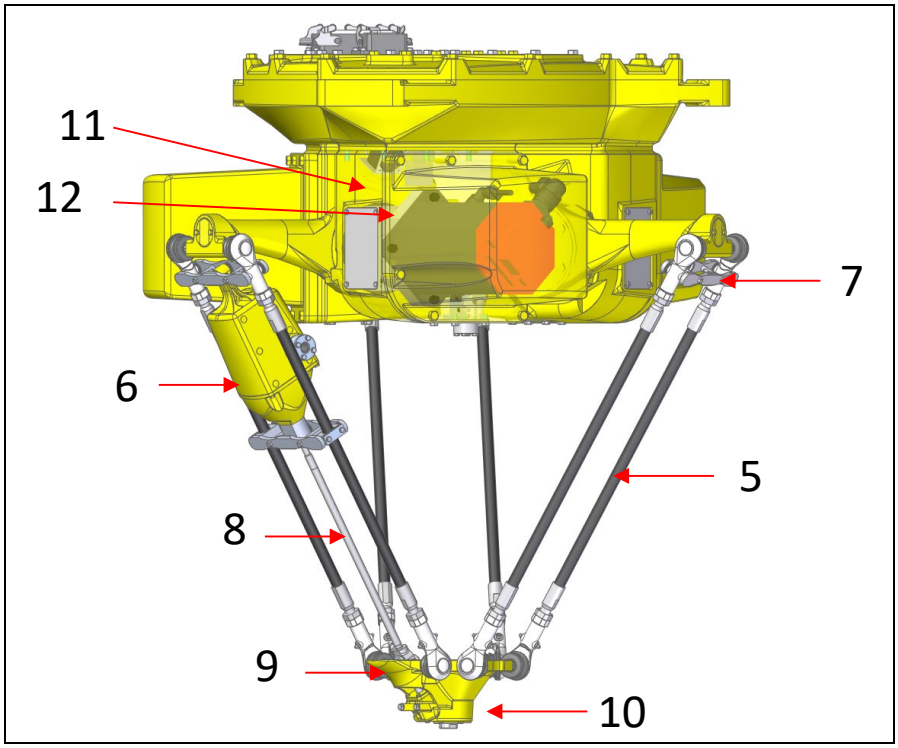


Fig. B (b) Periodic replacing parts (4 years, 8 years)

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

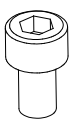
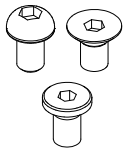
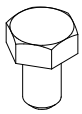
Use the following strength bolts. Comply with any bolt specification instructions.
Hexagon socket head bolt made of steel:

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

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

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

Recommended bolt tightening torques **Unit: Nm**

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

INDEX

REVISION RECORD

Edition	Date	Contents
06	Nov.,2021	• Addition of new mechanical units models • Correction of errors
05	Aug.,2019	• Addition of periodic maintenance items • Correction of errors
04	Feb.,2017	• Addition of dimensions for removing motor covers • Correction of errors
03	Dec.,2015	• Addition of M-2*i*A/3A/3AL • Addition of remote type battery • Addition of quick mastering for single axis • Correction of errors
02	Jul.,2013	• Addition of R-30*i*B Mate • Addition of M-2*i*A/6H/6HL • Addition of change procedure for the high intertie mode • Correction of errors
01	Dec.,2012	

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