FANUC Robot M-800*i*A

MECHANICAL UNIT

OPERATOR'S MANUAL

B-84204EN/02

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┌─────────────────────────────────────────────────────────────┐
│   ●   Original Instructions                                   │
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Thank you very much for purchasing FANUC Robot.

Before using the Robot, be sure to read the "FANUC Robot SAFETY HANDBOOK (B-80687EN)" and understand the content.

The products in this manual are controlled based on Japan's "Foreign Exchange and Foreign Trade Law". The export from Japan may be subject to an export license by the government of Japan.

Further, re-export to another country may be subject to the license of the government of the country from where the product is re-exported. Furthermore, the product may also be controlled by re-export regulations of the United States government.

Should you wish to export or re-export these products, please contact FANUC for advice.

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

SAFETY PRECAUTIONS

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

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

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

1   **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 "○" 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	○	○	○
Select operating mode (AUTO/T1/T2)		○	○
Select remote/local mode		○	○
Select robot program with teach pendant		○	○
Select robot program with external device		○	○
Start robot program with operator's panel	○	○	○
Start robot program with teach pendant		○	○
Reset alarm with operator's panel		○	○
Reset alarm with teach pendant		○	○
Set data on teach pendant		○	○
Teaching with teach pendant		○	○
Emergency stop with operator's panel	○	○	○
Emergency stop with teach pendant	○	○	○
Operator's panel maintenance			○
Teach pendant maintenance			○

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

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

2   DEFINITION OF SAFETY NOTATIONS

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

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

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

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

Name	Specification
Brake release unit	A05B-2450-J350 (Input voltage AC100-115V single phase) A05B-2450-J351 (Input voltage AC200-240V single phase)
Robot connection cable	A05B-2450-J360 (5m) A05B-2450-J361(10m)
Power cable	A05B-2525-J010 (5m) (AC100-115V Power plug) (*) A05B-2525-J011(10m) (AC100-115V Power plug) (*) A05B-2450-J364 (5m) (AC100-115V or AC200-240V No power plug) A05B-2450-J365(10m) (AC100-115V or AC200-240V No power plug)

(*)   These do not support CE marking.

(2) Please make sure that adequate numbers of brake release units are available and readily accessible for robot system before installation.

(3)   Regarding how to use brake release unit, please refer to Robot controller maintenance manual.

NOTE

   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.
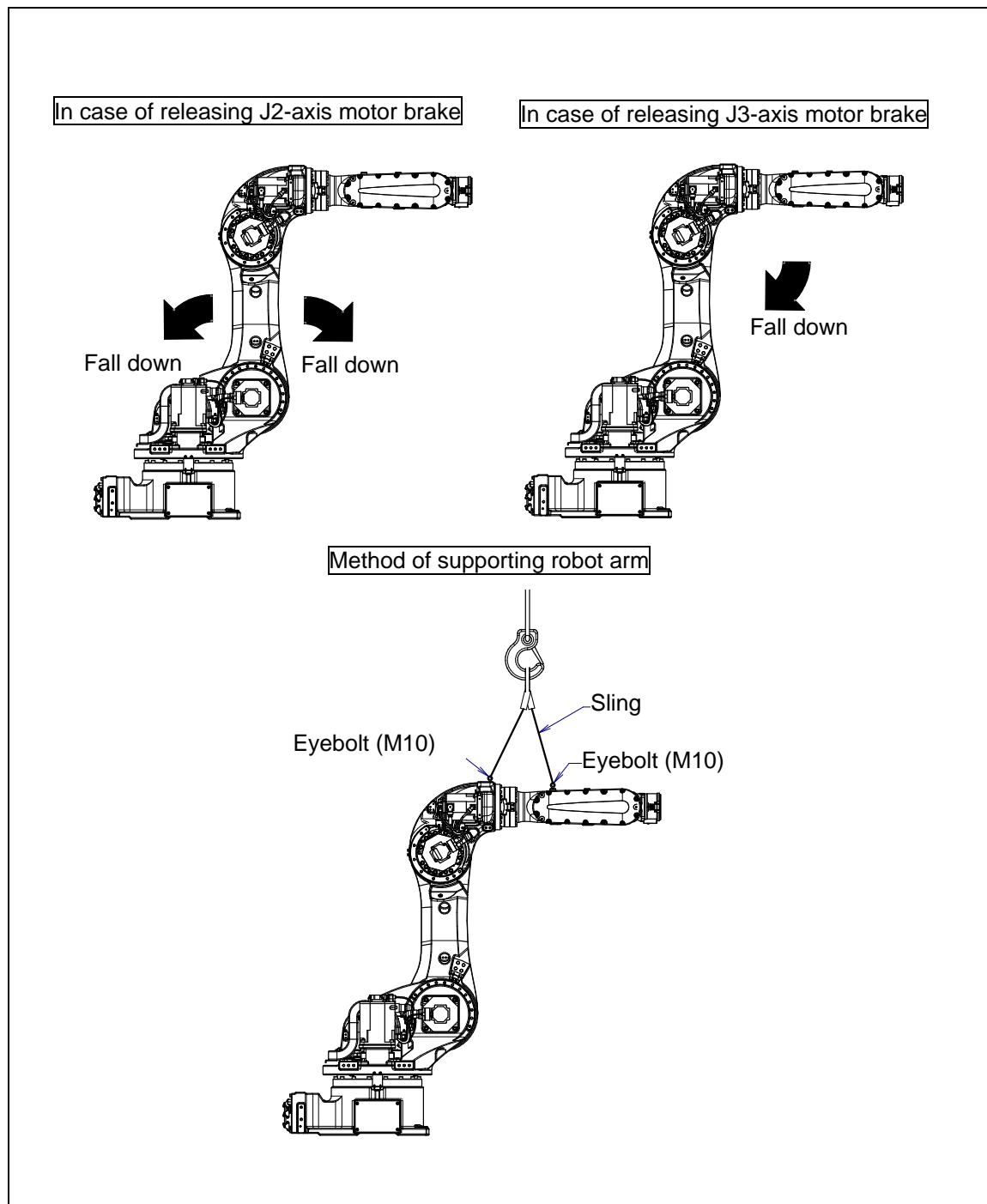
s-4

In case of releasing J2-axis motor brake

In case of releasing J3-axis motor brake

Fall down Fall down

Fall down

Method of supporting robot arm

Sling

Eyebolt (M10)

Eyebolt (M10)

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

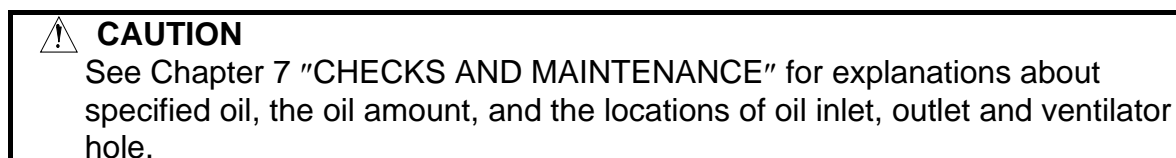# 4   DANGER & WARNING & CAUTION LABEL

(1)   Oiling label

Fig. 4 (a) Oiling Label

Description

When oiling, observe the instructions indicated on this label.
1)   Be sure to open the ventilator hole at oiling.
2)   Use a manual pump at oiling.
3)   Be sure to use designated oil.

> ⚠ **CAUTION**
> See Chapter 7 ″CHECKS AND MAINTENANCE″ for explanations about specified oil, the oil amount, and the locations of oil inlet, outlet and ventilator hole.

(2)   Step-on prohibitive label

Fig. 4 (b) Step-on Prohibitive Label

Description

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

(3)   High-temperature warning label

Fig. 4 (c) High-temperature warning label

Description

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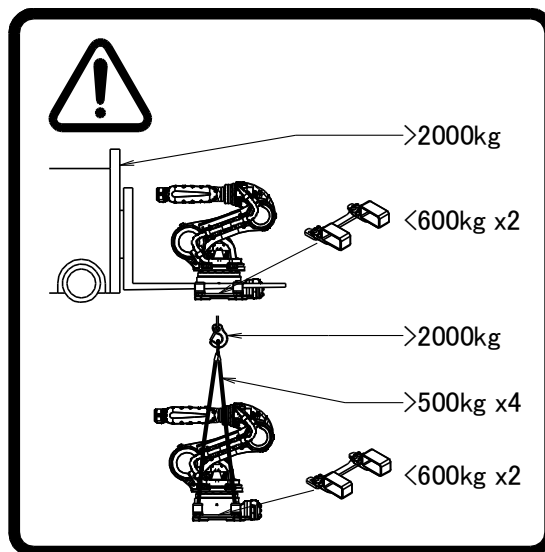
(4)   Transportation label

Fig. 4 (d) Transportation label

Description

When transporting the robot, observe the instructions indicated on this label.
1)   Using a forklift
- Use a forklift having a load capacity of 2000 kg or greater.
- Keep the total weight of the robot to be transported to within 1200 kg, because the load capacity of the forklift bracket (option) is 5880 N (600 kgf).
2)   Using a crane
- Use a crane with a load capacity of 2000 kg or greater.
- Use four slings with each load capacity of 500 kg or greater.
- Keep the total weight of the robot to be transported to within 1200 kg, because the load capacity of the forklift bracket (option) is 5880N (600kgf).

> ⚠ **CAUTION**
> Transportation labels are model-specific. Before transporting the robot, see the transportation label affixed to the J2 arm side.
> See Section 1.1 TRANSPORTATION for explanations about the posture a specific model should take when it is transported.

(5)   Operating space and payload (capacity) label
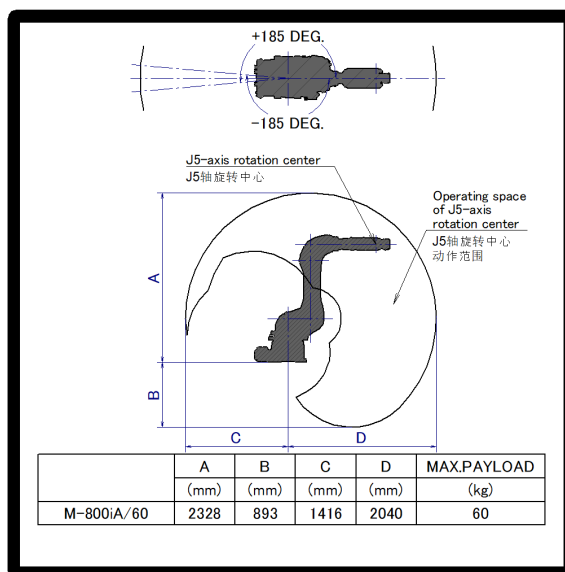When CE specification is specified, the following label is added:

Fig. 4 (e) Operating space and payload label

(6)   Danger label
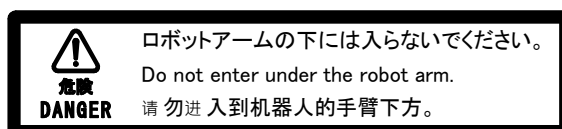When CE specification is specified, the following label is added:

Fig. 4 (f) Danger label

Description

> ⚠ **DANGER**
> Do not enter under the robot arm.

(7)　　Transportation caution label

(When transport equipment option is specified.)

Fig. 4 (g) Transportation caution label(When transport equipment option is specified.)

Description

Keep the following in mind when transporting the robot.

1)　Do not pull eyebolts sideways.
2)　Prevent the forks of the forklift from having impact on a transport equipment.
3)　Do not thread a chain or the like through a transport equipment.

(8)　　Mastering caution label

Fig. 4 (h) Mastering caution label

Description

Keep the following in mind when performing the mastering. The motion limits are temporarily invalid during mastering. Cables may be damaged if the J1-axis exceeds +/-185$^{\text{o}}$.

(9)   Standard label for *i*RCalibration signature

Fig. 4 (i) Standard label for *i*RCalibration signature
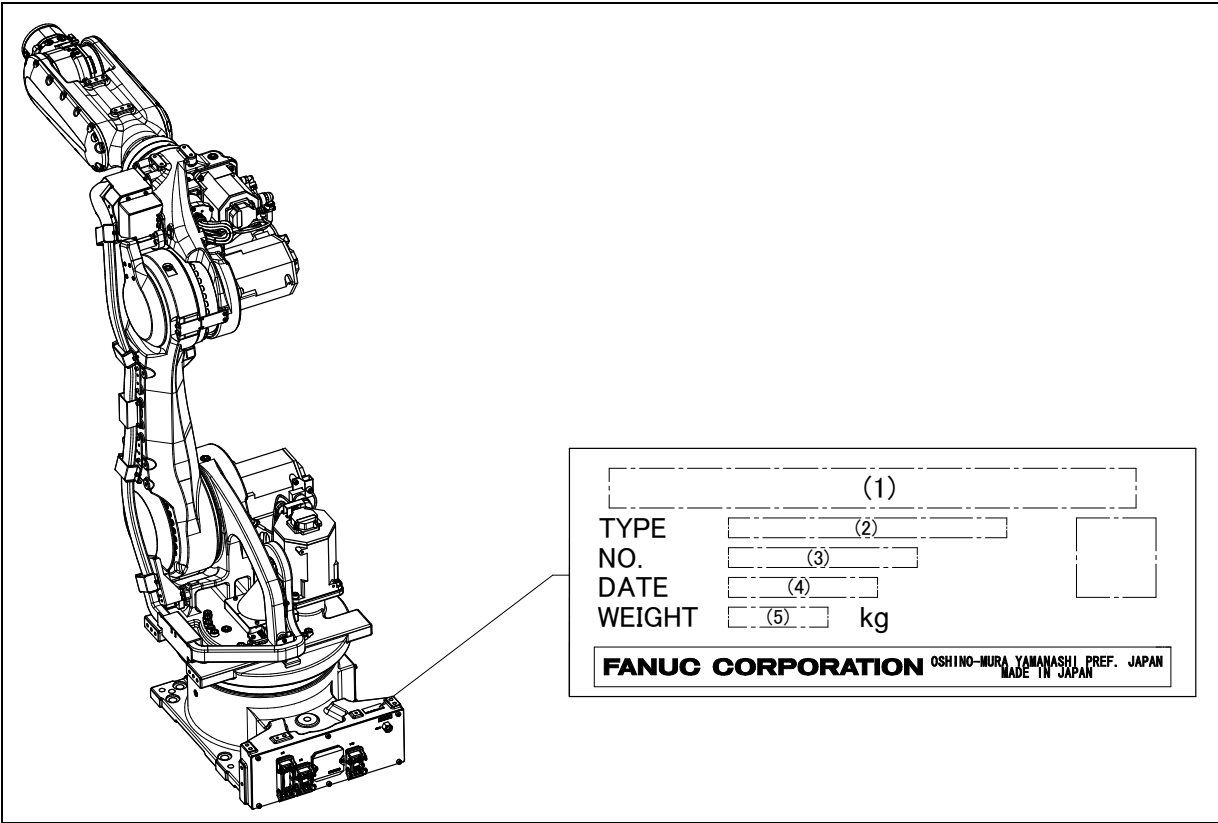
Description
*i*RCalibration signature is performed, so the robot is calibrated with high accuracy.

PREFACE

This manual explains operation procedures for the following robot mechanical units:

Model name	Mechanical unit specification No.	Max. payload
FANUC Robot M-800*i*A/60	A05B-1127-B201	60kg

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

	(1)		
TYPE	(2)		
NO.	(3)		
DATE	(4)		
WEIGHT	(5)	kg	

FANUC CORPORATION OSHINO-MURA YAMANASHI PREF. JAPAN MADE IN JAPAN

Position of label indicating mechanical unit specification number

TABLE 1 (a)

	(1)	(2)	(3)	(4)	(5)
CONTENTS	**MODEL NAME**	**TYPE**	**No.**	**DATE**	**WEIGHT kg (without controller)**
LETTERS	FANUC Robot M-800*i*A/60	A05B-1127-B201	SERIAL NO. IS PRINTED	PRODUCTION YEAR AND MONTH ARE PRINTED	820

RELATED MANUALS

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

SAFETY HANDBOOK **B-80687EN**
All persons who use the FANUC Robot and system designer must read and understand thoroughly this handbook
		Intended readers:
		  Operator, System designer
		Topics:
		  Safety items for robot system design, Operation, Maintenance

R-30*i*B Plus controller	OPERATOR'S MANUAL
	(Basic Function)
	  B-83284EN
	OPERATOR'S MANUAL
	(Alarm Code List)
	  B-83284EN-1
	Optional Function
	OPERATOR'S MANUAL
	  B-83284EN-2
	Arc Welding Function
	OPERATOR'S MANUAL
	  B-83284EN-3
	Spot Welding Function
	OPERATOR'S MANUAL
	  B-83284EN-4
	Dispense Function
	OPERATOR'S MANUAL
	  B-83284EN-5
	Servo Gun Function
	OPERATOR'S MANUAL
	  B-83264EN
		Intended readers:
		  Operator, Programmer, Maintenance technician, System designer
		Topics:
		  Robot functions, Operations, Programming, Start-up, Interfaces, Alarms
		Use:
		  Robot operation, Teaching, System design

	Maintenance manual
	R-30*i*B, R-30*i*B Plus:
	  B-83195EN
		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 or a forklift to transport the robot. When transporting the robot, be sure to change the posture of the robot to that shown below and lift it by using the transport equipment properly. Transport equipment is common in crane and forklift.
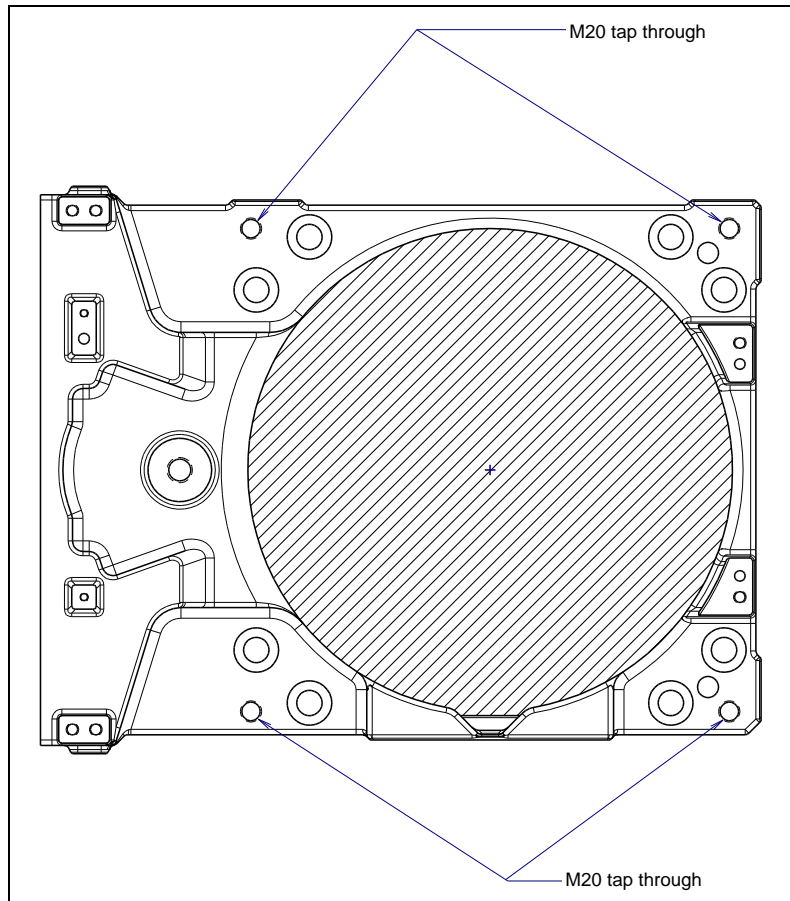
Fig. 1.1 (a) Position of the transport equipment mounting

(1)   Transportation using a crane (Fig. 1.1 (b))
      Attach specific transport equipment and lift the robot by the four slings.

⚠ **CAUTION**
When lifting the robot, notice so that the motor, connectors or cables of the robot are not damaged by slings.

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(2)   Transportation using a forklift (Fig. 1.1 (c))
      Perform it by attaching specific transport equipment.

⚠ **WARNING**
1   When hoisting or lowering the robot with a crane or forklift, move it slowly with great care.   When placing the robot on the floor, exercise care to prevent the installation surface of the robot from striking the floor.
2   Detach the end effectors and the floor plate before transporting the robot. If the robot need to be transported with the floor plate or end effectors attached, take the following precautions:
    ・   The entire position of center of gravity is changed by installing the end effector and the floor plate. Please note the balance enough.
    ・   The end effector swings by the vibration when transported, and there is a possibility that an excessive load acts on the robot. Secure the end effector firmly according to Subsection 1.1.1.
    ・   When you lift robot with the floor plate installed, please lift up not the robot but the floor plate.
3   Use the transport equipment only to transport the robot. Do not use the transport equipment to secure the robot.
4   Before moving the robot by using transport equipment, check the bolts on the transport equipment and tighten any loose bolts if any.
5   When J1/J2-axis motor covers (option) are installed, be sure to remove them before transporting robot with a crane.

Robot posture on transportation

Crane
Load capacity. : 2.0 ton or more

Sling
Load capacity. : 0.5 ton/sling or more

J1	0º or ±180º
J2	-70º
J3	0º
J4	0º
J5	0º
J6	0º

NOTE)
  1. Machine mass 820 kg
  2. Quantity sling 4 pcs

1252

1224

Center of gravity

Transport equipment

467.8   255

268   268

Spread bar

Center of gravity

Fig. 1.1 (b) Transportation using a crane

Robot posture on transportation

J1	0º or ±180º
J2	-70º
J3	0º
J4	0º
J5	0º
J6	0º

NOTE)
1. Machine mass 820 kg

Center of gravity

188

88

950

Transport
equipment

Forklift
Load capacity. : 2.0 ton or more

Fig. 1.1 (c) Transportation using a forklift

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

1.1.1   Transportation with an End Effector Attached

When transporting a robot with an end effector such as a welding gun or hand attached, secure the arm with wood. If the arm is not secured, the end effector may oscillate for a cause such as vibration during transportation, as a result, a large impact load, imposes on the reducer of the robot, cause premature failure of the reducer.
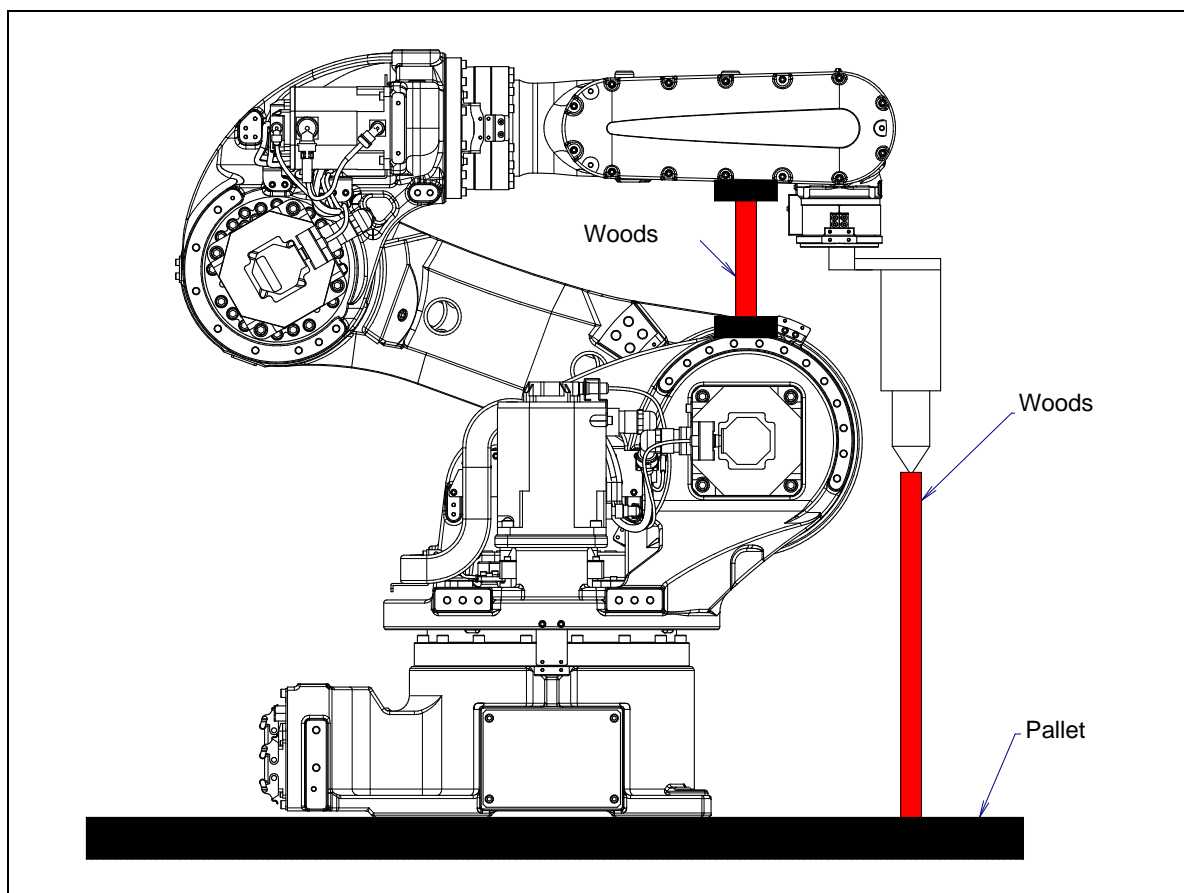
Fig. 1.1.1 (a) Example of securing the arm during transportation when an end effector is attached

1.2   INSTALLATION

Fig. 1.2 (a) shows the robot base dimensions. Avoid placing any object in front of the robot on the locating surface to facilitate the installation of the mastering fixture. (Shaded portion)
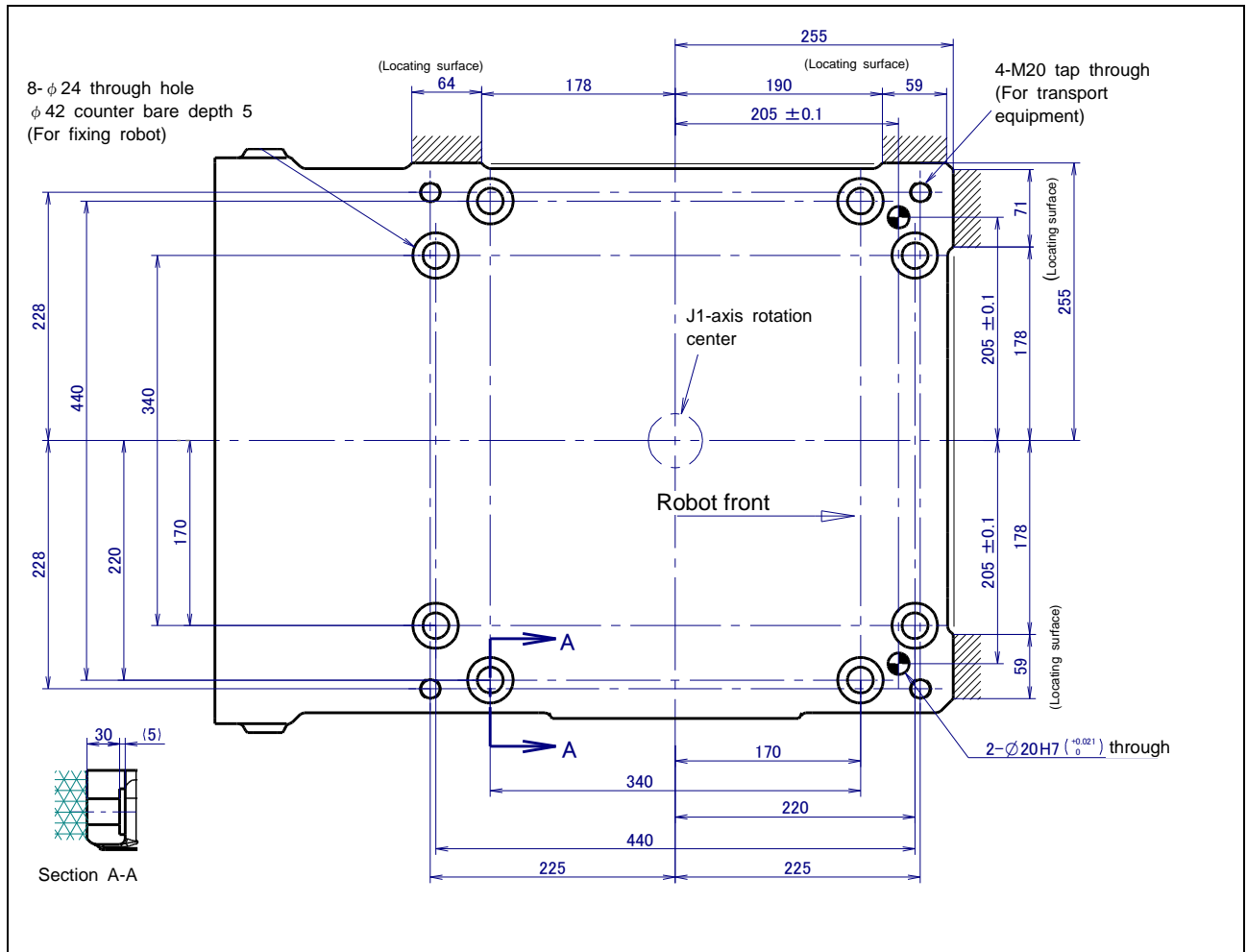
Fig. 1.2 (a) Dimension of robot base

Fig. 1.2 (b) and Table 1.2 (a) indicate the force and moment applied to the base plate at the time of Power-off stop of the robot. Table 1.2 (b) and (c) indicate the stopping distance and time of the J1 to J3 axis until the robot stopping by Power-Off stop or by Smooth stop after input of the stop signal. Refer to the data when considering the strength of the installation face.

> **NOTE**
> Table 1.2 (b) and (c) are measured reference values complied with ISO 10218-1. Values differ depending on each robot individual difference, payload and the program. So confirm the real value by measurement. Values in Table 1.2 (b) are affected by the robot operating status and number of times of times of Power-Off stop. Periodically measure the real values and confirm those.

Table 1.2 (a) Force and moment during Power-Off stop

Model	Vertical moment M_V [kNm (kgfm)]	Force in vertical direction F_V [kN (kgf)]	Horizontal moment M_H [kNm (kgfm)]	Force in horizontal direction F_H [kN (kgf)]
M-800iA/60	38.22 (3900)	27.44 (2800)	16.66 (1700)	25.48 (2600)
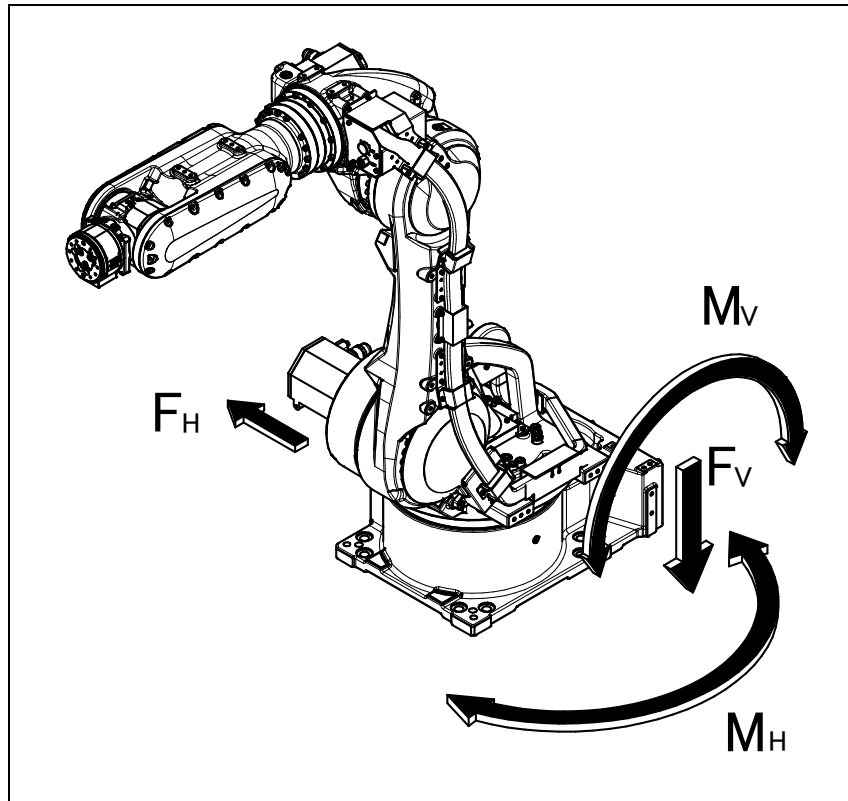
Fig. 1.2 (b) Force and moment that acts during Power-Off stop

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

Model		J1-axis	J2-axis	J3-axis
M-800iA/60	Stopping time [ms]	272	232	128
	Stopping distance [deg] (rad)	21.4 (0.37)	16.0 (0.28)	10.4 (0.18)

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

Model		J1-axis	J2-axis	J3-axis
M-800iA/60	Stopping time [ms]	576	604	428
	Stopping distance [deg] (rad)	45.2 (0.79)	42.4 (0.74)	32.7 (0.57)

1.2.1   Installation Method

The following shows three methods for installation of the robot. Select a method according to the customer's installation environment, and install the robot.

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

- Installation method I   Fig. 1.2.1 (a)
  The floor plate is imbedded in concrete and fastened with twelve M20 (Tensile strength 400N/mm^2 or more) chemical anchors. Also fasten the base plate to the robot base using eight M20 x 65 bolts (Tensile strength 1200N/mm^2 or more). Next, position the robot, and weld the base plate to the floor plate. (Floor length is 10 to 15mm.) (The base plate is prepared as the option.)

- Installation method II   Fig. 1.2.1 (b)
  The floor plate is not imbedded in concrete.   The floor plate is fastened at the twelve points with M20 chemical anchors (Tensile strength 400N/mm^2 or more) and the inclination of the floor plate is adjusted with the four fixing screws. The robot is positioned with the robot base pushed against the three ϕ20 parallel pins inserted into the floor plate and the robot base is fastened on the floor plate with eight M20 x 65 bolts (Tensile strength 1200N/mm^2).

- Installation method III   Fig. 1.2.1 (c)
  The installation method is generally the same as described above except that the parallel pins for pushing the robot base are not used.

  The following parts are required to install the robot.
  (○ : Parts needs to be prepared.)

Required parts	Remarks	Method I	Method II	Method III
Robot mounting bolts	M20 x 65 (Tensile strength 1200N/mm^2 or more) 8 pcs	○	○	○
Plain washers	For M20 (HRC 35 or more, thickness between 4 and 5 mm) 8 pcs	○	○	○
Chemical anchors	M20 (Tensile strength 400N/mm^2 or more) 12 pcs	○	○	○
Floor plate	Thickness 32t 1 pc	○	○	○
Base plates	Thickness 32t 4 pcs	○		
Fixing screws	M20 4 pcs		○	○
Nuts	M20 4 pcs		○	○
Parallel pins	ϕ 20 3 pcs		○	

NOTE
- Customer must provide all necessary arrangements for the actual installation work (such as welding and anchoring).
- 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 0.5⁰.
  If robot base is placed on uneven ground, it may result in the base breakage or low performance of the robot.
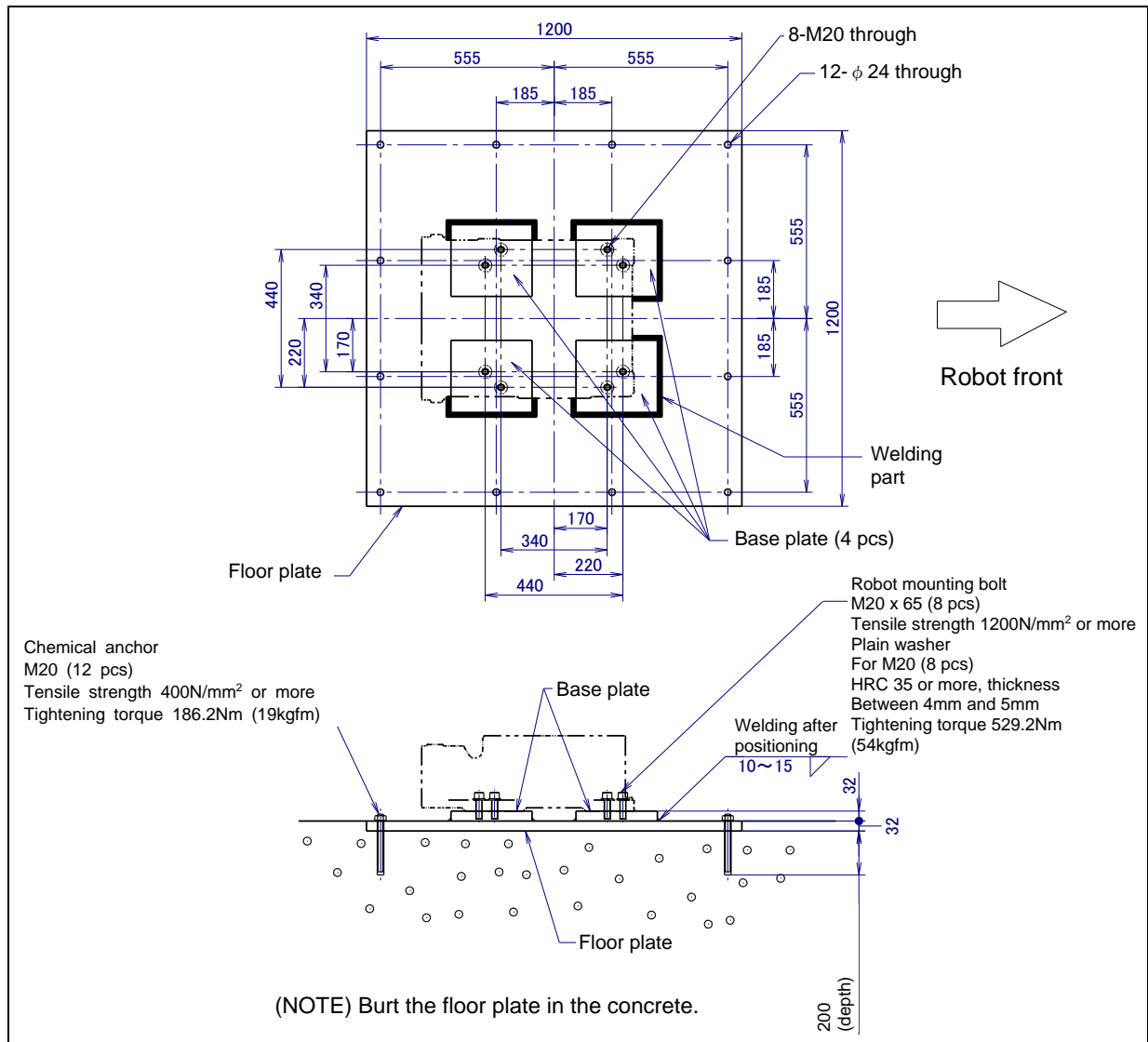
Fig. 1.2.1 (a) Installation method Ⅰ
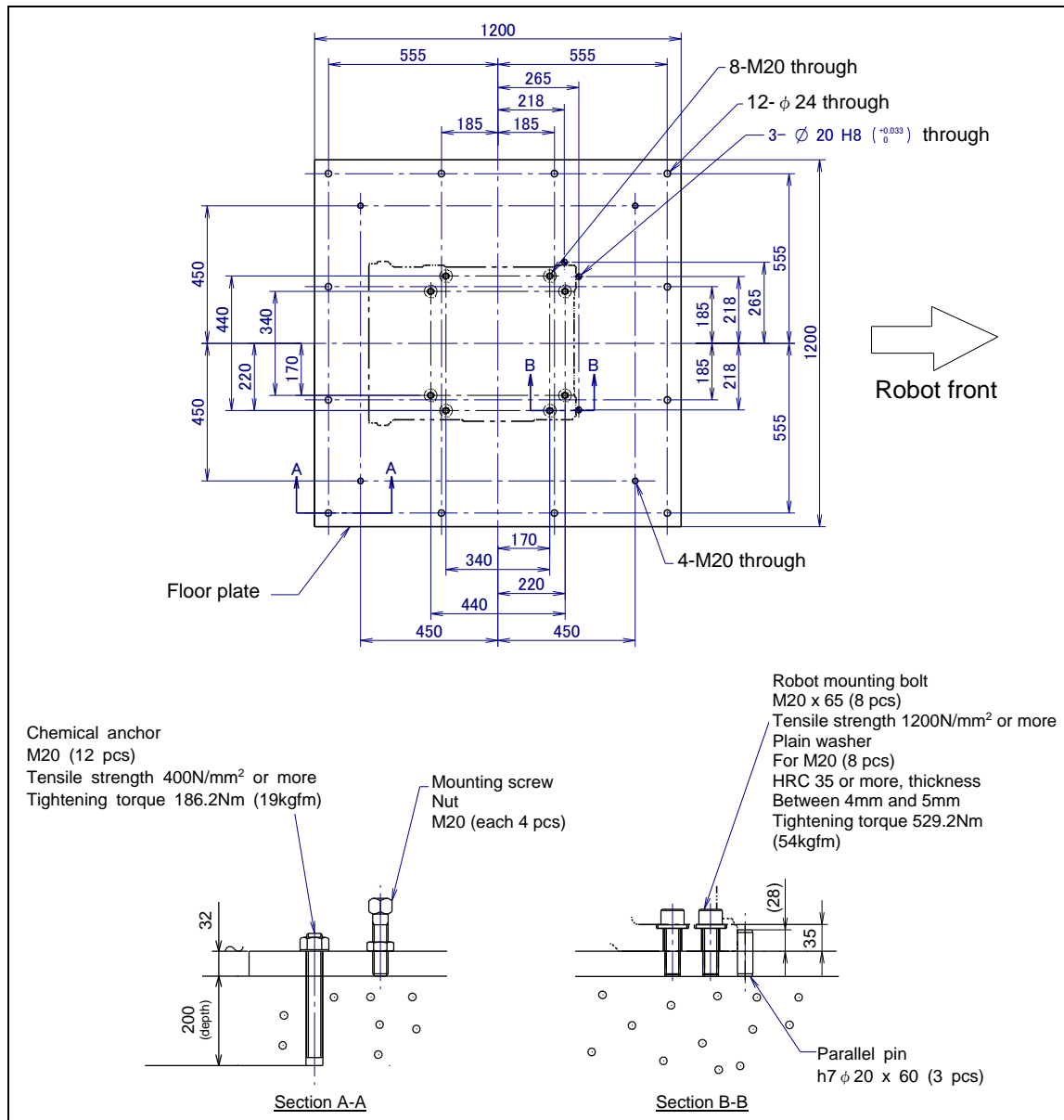
Fig.1.2.1 (b) Installation method Ⅱ
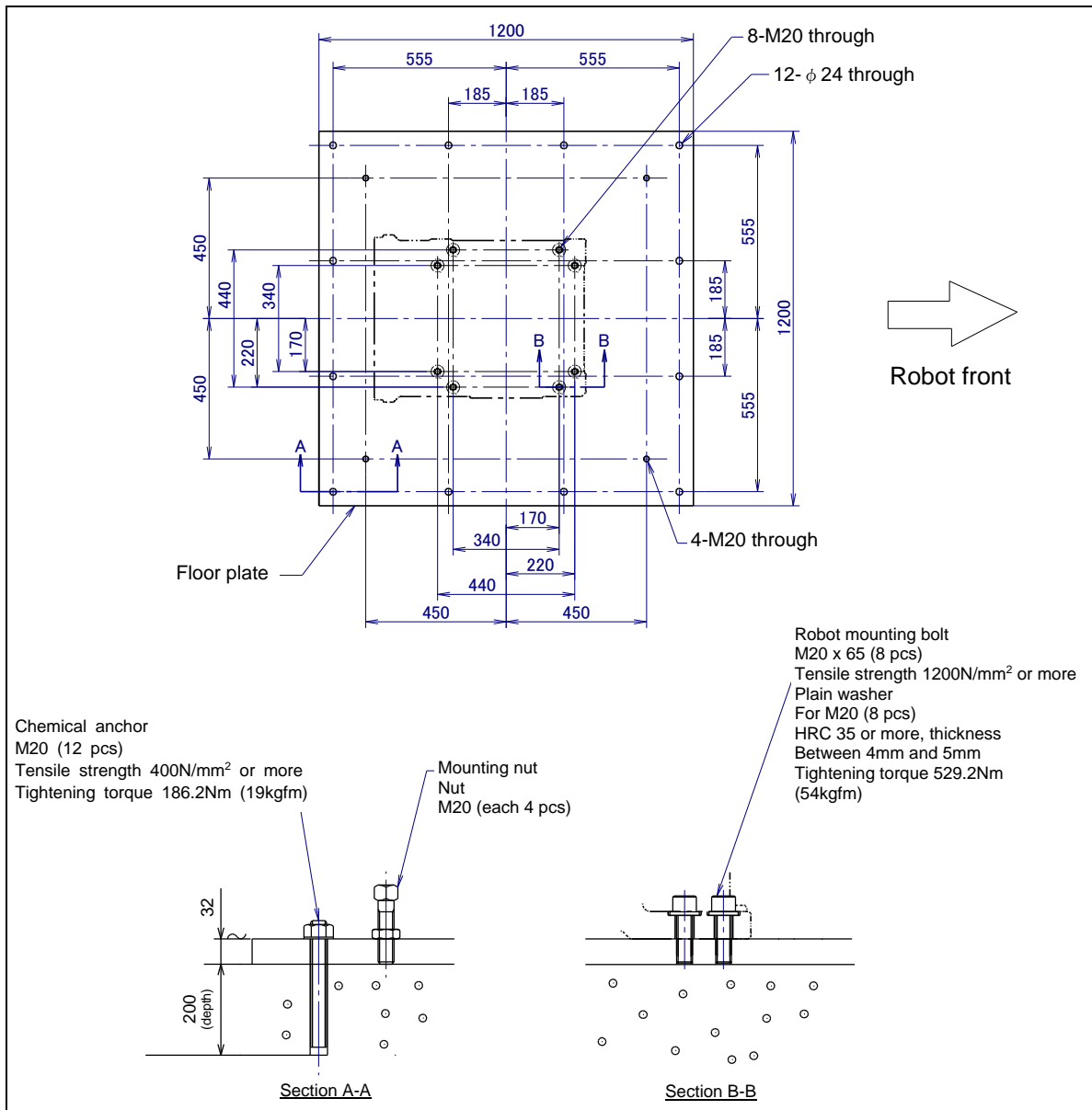
Fig. 1.2.1 (c) Installation method Ⅲ

1.3   MAINTENANCE AREA

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

Maintenance area (Mechanical unit)

1500

600
307
277
600

300
300

Mastering area

423   255

800   900
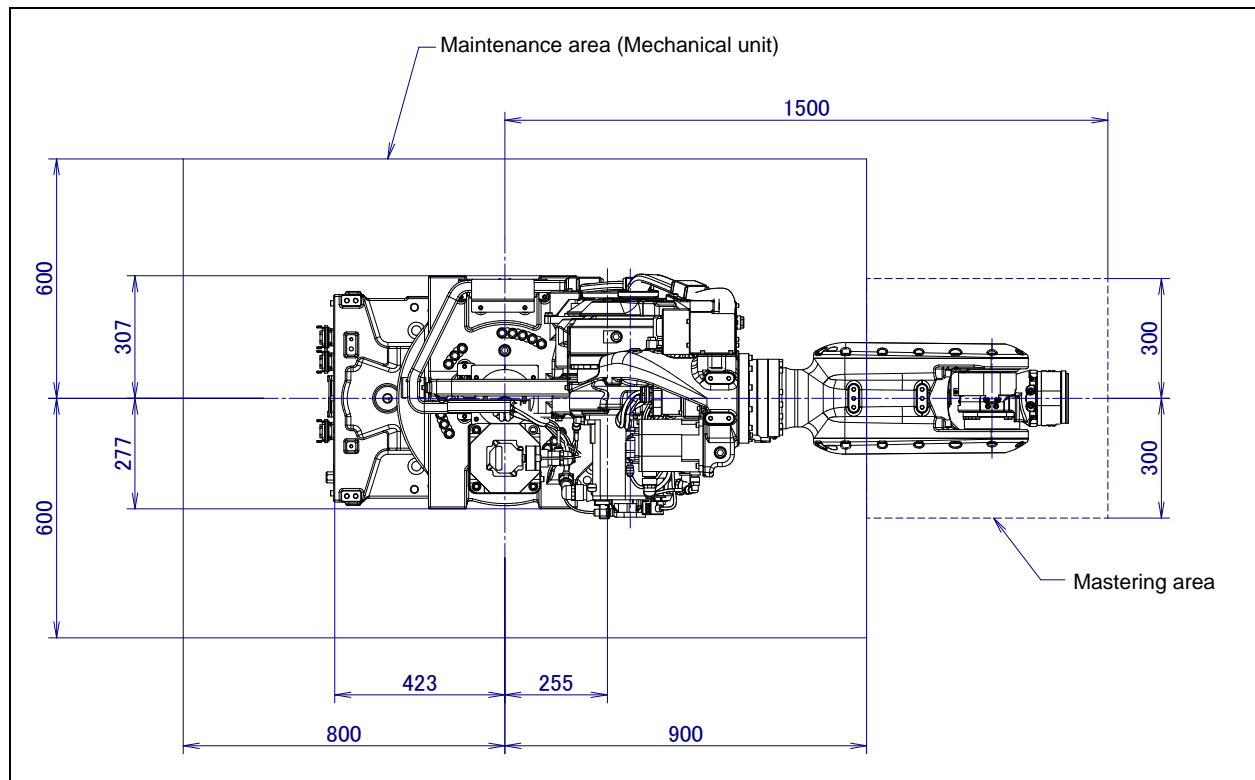
Fig. 1.3 (a) Maintenance area

1.4   INSTALLATION CONDITIONS

Refer to the caution below and the specifications found in Section 3.1 concerning installation conditions.

⚠ **CAUTION**
  Damage of the cable jacket can cause water intrusion. Take care when installing the cable and exchange it if it is damaged.

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 robot base. For details on air and option cables, see Chapter 5.

⚠ **WARNING**
    Before turning on controller power, be sure to connect the robot and controller with the earth line (ground). Otherwise, there is the risk of electrical shock.

⚠ **CAUTION**
1 Before connecting the cables, be sure to turn off the controller power.
2 Do not use 10m or longer coiled cable without first untying it. The long coiled cable will heat up and become damaged.

Fig. 2 (a) Cable connection

3   BASIC SPECIFICATIONS

3.1   ROBOT CONFIGURATION

Fig. 3.1 (a) Mechanical unit configuration, each axis coordinates, and mechanical interface coordinates

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

Specifications NOTE 1)

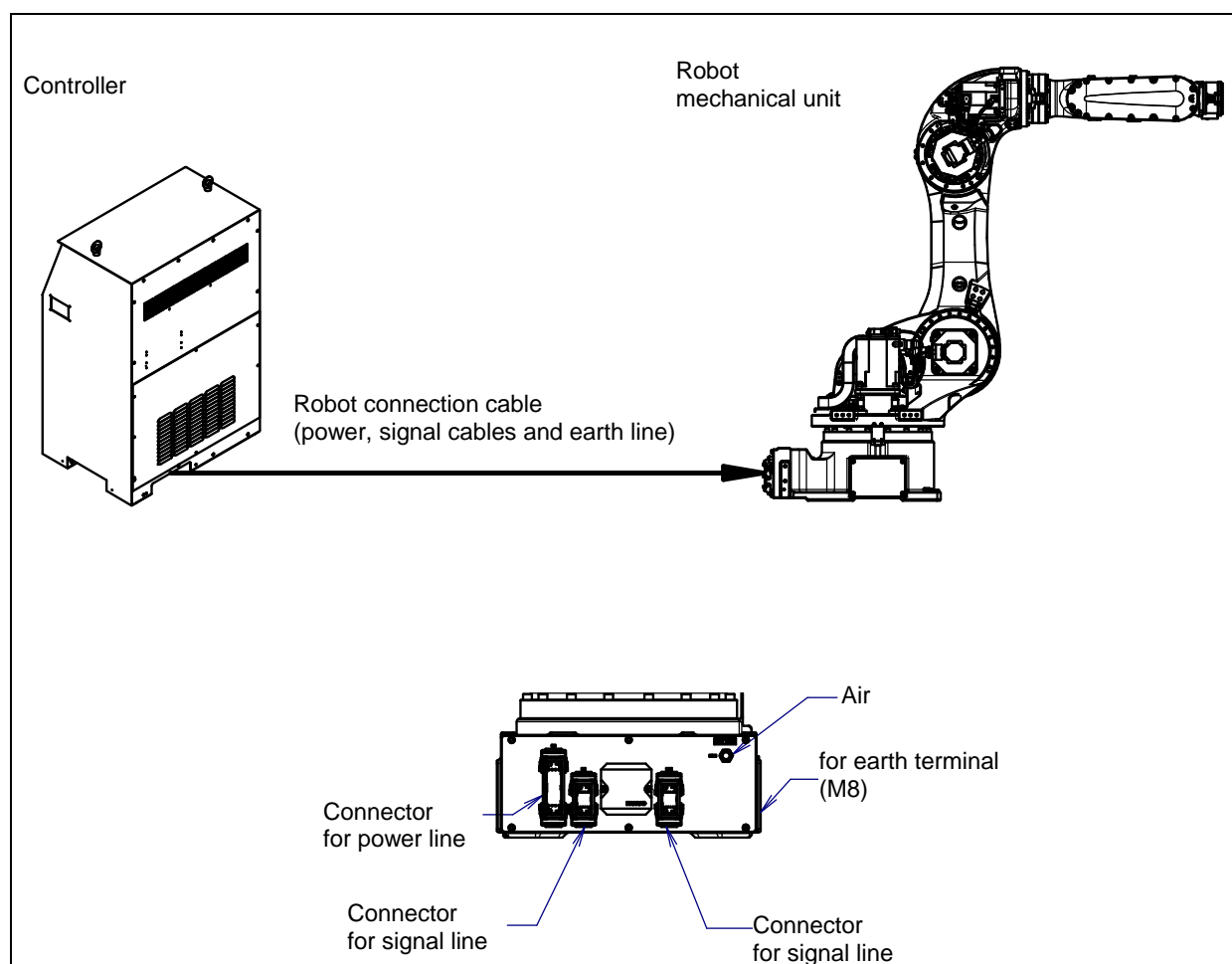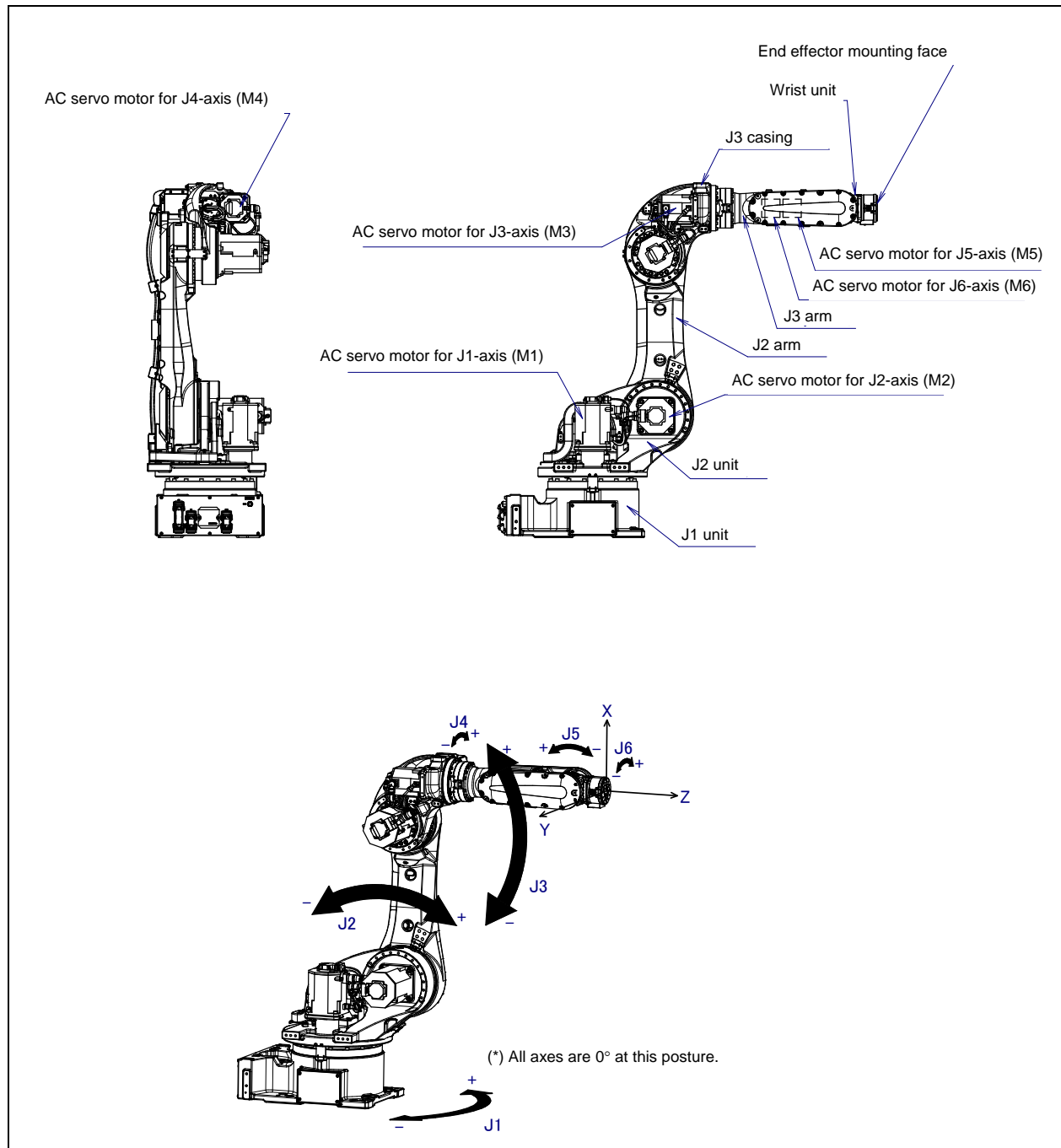| Model			M-800*i*A/60	
Type			Articulated type	
Controlled axes			6 axes (J1, J2, J3, J4, J5, J6)	
Installation			Floor mount	
Motion range	J1-axis	Upper limit	185° (3.23rad)	
		Lower limit	-185° (-3.23rad)	
	J2-axis	Upper limit	135° (2.36rad)	
		Lower limit	-90° (-1.57rad)	
	J3-axis	Upper limit	180° (3.14rad)	
		Lower limit	-160° (-2.79rad)	
	J4-axis	Upper limit	360° (6.28rad)	
		Lower limit	-360° (-6.28rad)	
	J5-axis	Upper limit	125° (2.18rad)	
		Lower limit	-125° (-2.18rad)	
	J6-axis	Upper limit	360° (6.28rad)	
		Lower limit	-360° (-6.28rad)	
Max. motion speed NOTE2)	J1-axis		150°/s (2.62rad/s)	
	J2-axis		150°/s (2.62rad/s)	
	J3-axis		150°/s (2.62rad/s)	
	J4-axis		260°/s (4.54rad/s)	
	J5-axis		260°/s (4.54rad/s)	
	J6-axis		400°/s (6.98rad/s)	
Max. payload	At wrist		60kg	
	On J3 arm		21kg (A)	$5/3 \times (A) + (B) \leq 35kg$
	On J3 casing		35kg (B)	
Allowable load moment at wrist	J4-axis		210N·m (21.4kgf·m)	
	J5-axis		210N·m (21.4kgf·m)	
	J6-axis		130N·m (13.3kgf·m)	
Allowable load inertia at wrist	J4-axis		30kg·m^2 (305.9kgf·cm·s^2)	
	J5-axis		30kg·m^2 (305.9kgf·cm·s^2)	
	J6-axis		20kg·m^2 (203.9kgf·cm·s^2)	
Drive method			Electric servo drive by AC servo motor	
Repeatability (NOTE 3)			±0.015mm	
Mass			820kg	
Acoustic noise level			70dB or less NOTE 4)	
Installation environment			Ambient temperature : 0 to 45°C NOTE 5) Ambient humidity: Normally 75%RH or less (No condensation allowed.) Short time (Within one month) 95%Rh or less (No condensation allowed.) Permitted altitude: Up to 1000 m above sea level. Vibration acceleration : 4.9m/s^2 (0.5G) or less Free of corrosive gases NOTE 6)	

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.

NOTE 2) During short distance motions, the axis speed may not reach the maximum value stated.

NOTE 3) Compliant with ISO 9283

NOTE 4) This value is the 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

NOTE 5) When the robot is used in a low temperature environment that is near to 0°C, or the robot is not operated for a long time in an environment that is less than 0°C , for example during a holiday or overnight, viscous resistance of the drive train may cause occurrence of collision detect alarm (SRVO –050) etc. In this case, we recommend performing a warm up operation for several minutes.

NOTE 6) Contact the service representative, if the robot is to be used in an environment or a place subjected to hot/cold temperatures, severe vibrations, heavy dust, water, water vapor, cutting oil, cleaning fluid splash and or other foreign materials.

The following table lists the IEC60529-based Severe dust/liquid protection characteristics of the M-800*i*A.

	Standard
J3 arm and wrist	IP54
Main body	IP54 (*)

(*)   Except some connectors

Main body : IP 54 (*)   J3 arm + Wrist : IP 54
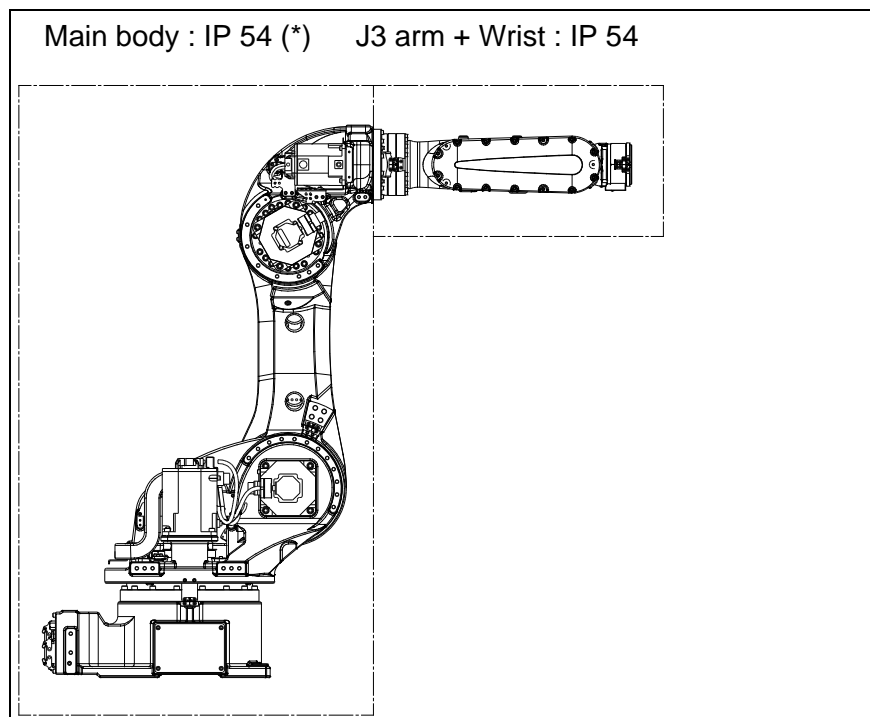
Fig. 3.1 (b) Severe dust/liquid protection characteristics of M-800*i*A

NOTE
　　Definition of IP code
　　Definition of IP 54
　　5= Dust-tight: Ingress of dust is not entirely prevented, but it must not enter in
　　　　sufficient quantity to interfere with the satisfactory of the equipment.
　　4= Protection from water immersion: Water splashing against the enclosure from
　　　　any direction shall have no harmful effect.

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

* Example: in case motor surface is exposed to water for a long time, liquid may invade inside the motor and cause failure.

3.2 MECHANICAL UNIT EXTERNAL DIMENSIONS AND OPERATING SPACE

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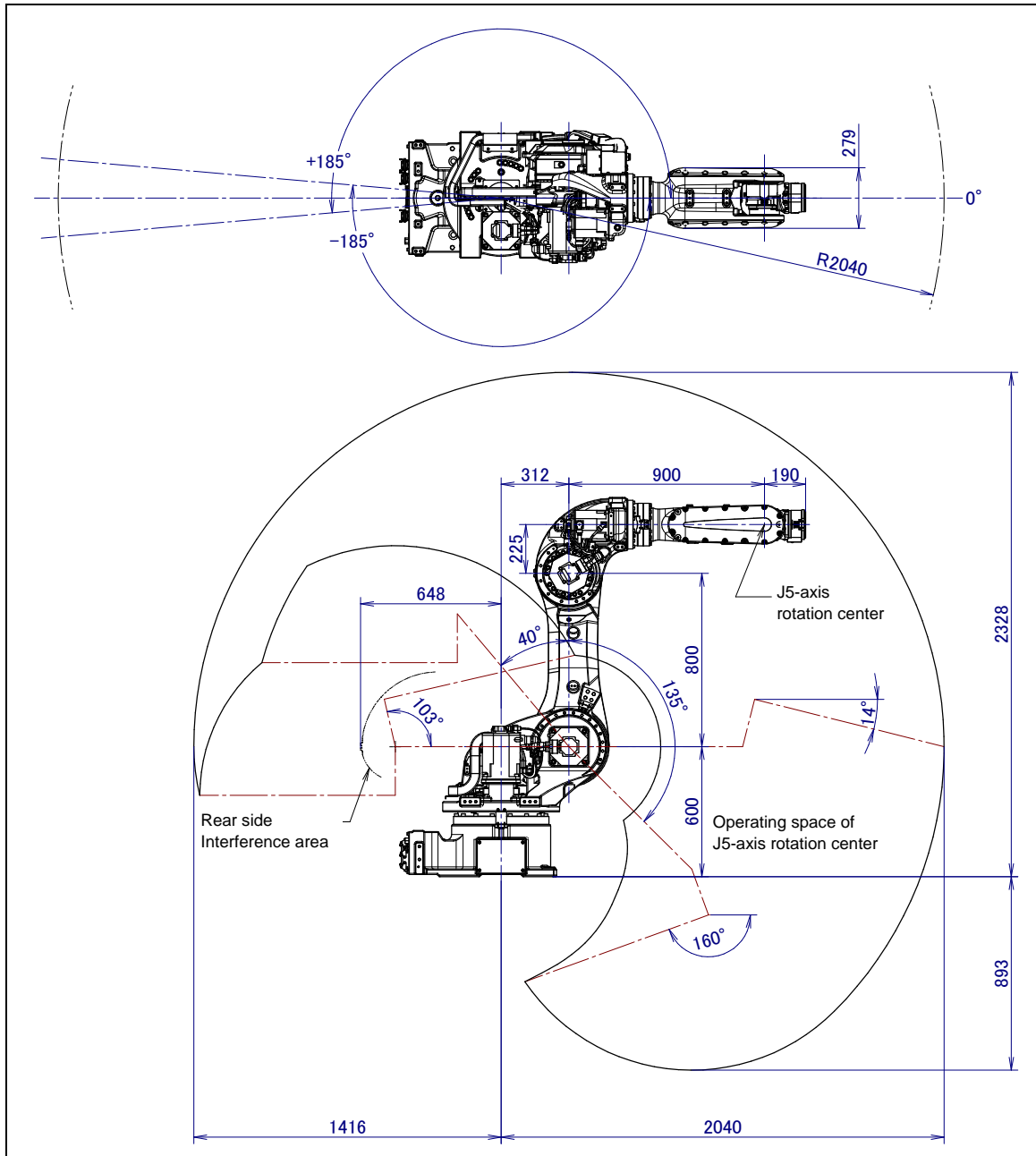
Fig. 3.2 (a) Operating space

3.3 ZERO POINT POSITION AND MOTION LIMIT

Zero point and motion range are provided for each controlled axis. Exceeding the software motion limit of a controlled axis is called overtravel (OT). Overtravel is detected at both ends of the motion limit for J1 axis. The robot cannot exceed the motion range unless there is a loss of zero point position due to abnormalities in servo system or system error. In addition, the motion range limit by a mechanical stopper is also prepared to improve safety.

Fig. 3.3 (a) shows the position of fixed mechanical stopper. In case of J1-axis (option), robot stops by transforming fixed mechanical stopper (movable side). Be sure to replace transformed stopper to new one. Tighten bolts with regulated torque referring to Appendix B. Replace mechanical stopper of J1-axis referring to Section 6.2.

⚠ **WARNING**
Do not reconstruct the fixed mechanical stopper. There is a possibility that the robot doesn't stop normally.
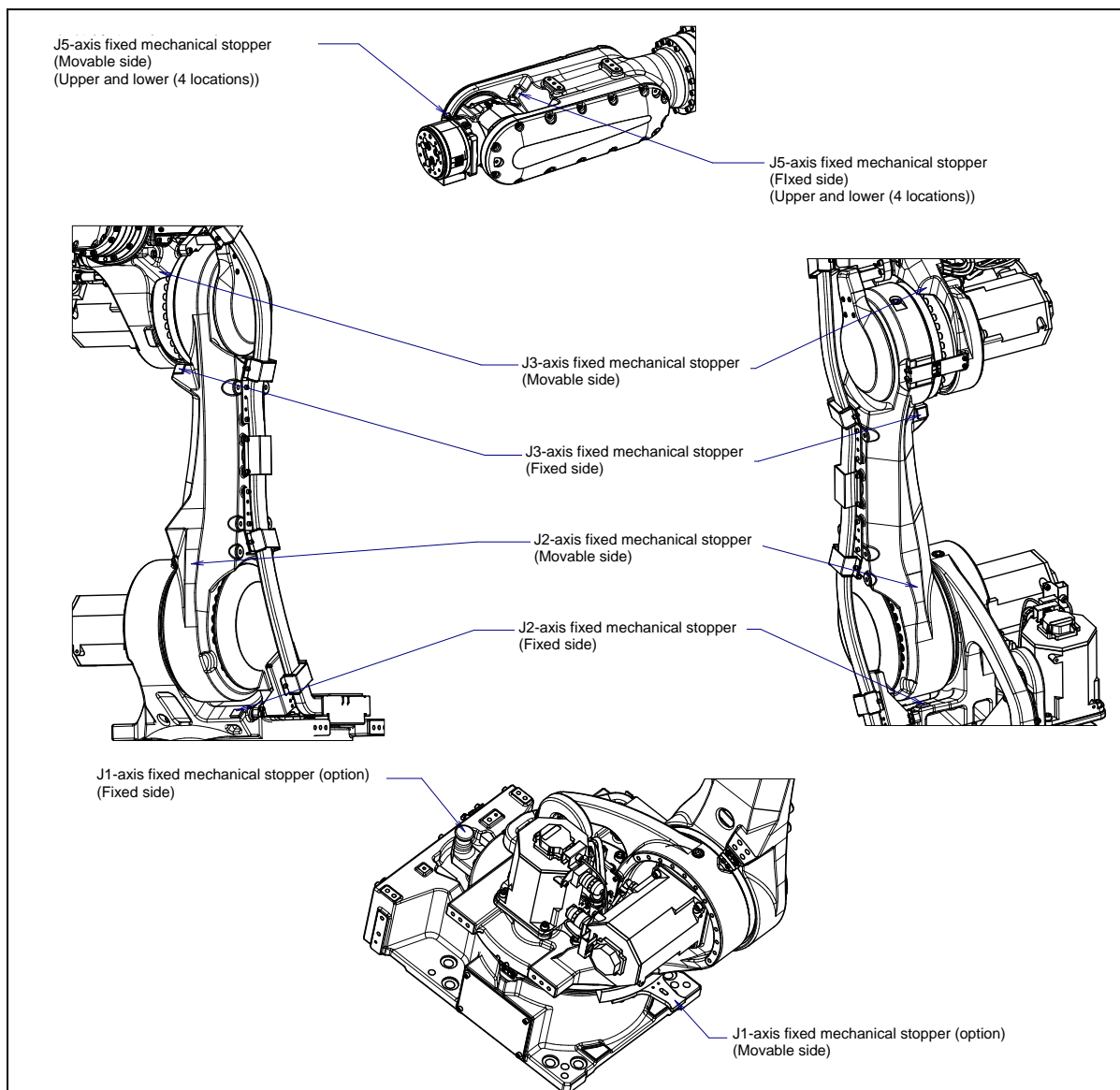
Fig. 3.3 (a) Position of mechanical stopper

Fig.3.3 (b) to (h) show the zero point, motion limit, limit switch detection position, and maximum stopping distance (stopping distance in condition of max. speed and max. load) of each axis.

* The motion range can be changed. For information on how to change the motion range, see Chapter 6, "AXIS LIMITS SETUP".
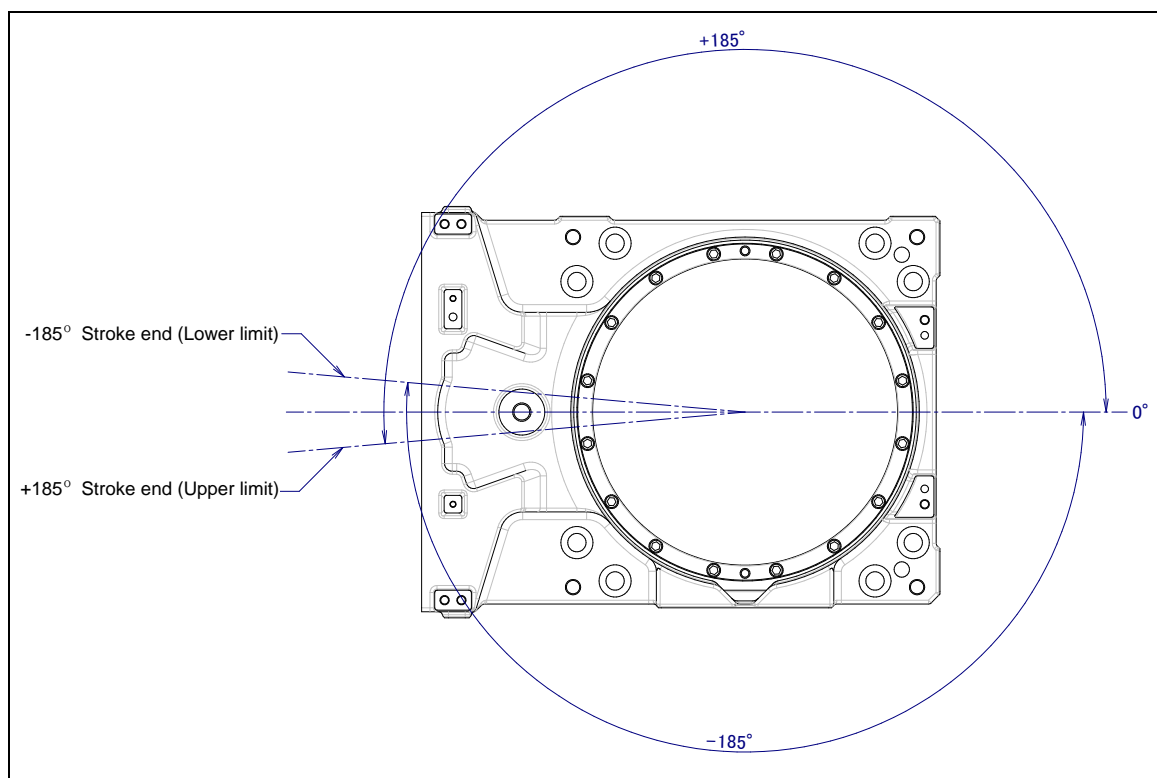
Fig. 3.3 (b) J1-axis motion limit (When fixed mechanical stopper is not specified)
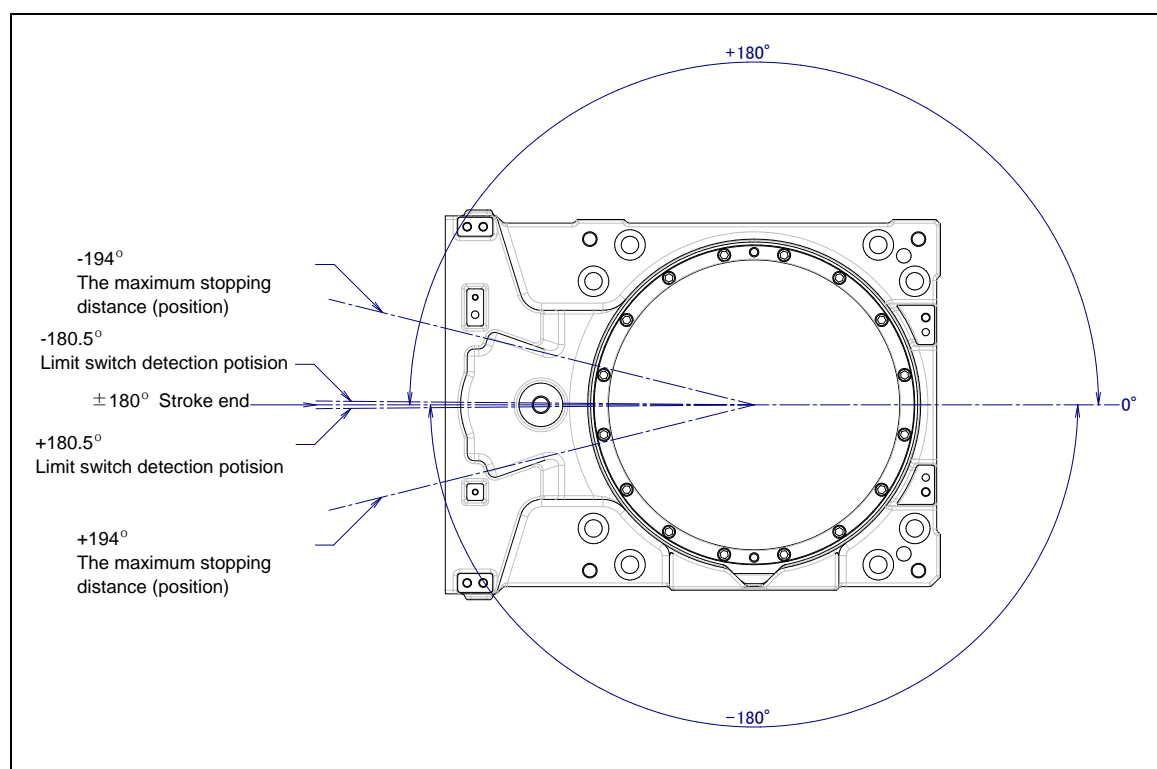
Fig. 3.3 (c) J1-axis motion limit (When fixed mechanical stopper is specified)

-90° Stroke end (Lower limit)

-95°
The maximum stopping
distance (position)

+135° Stroke end (Upper limit)

+140°
The maximum stopping distance
(position)

(Note) Motion limit is restricted by the position of the J3-axis.
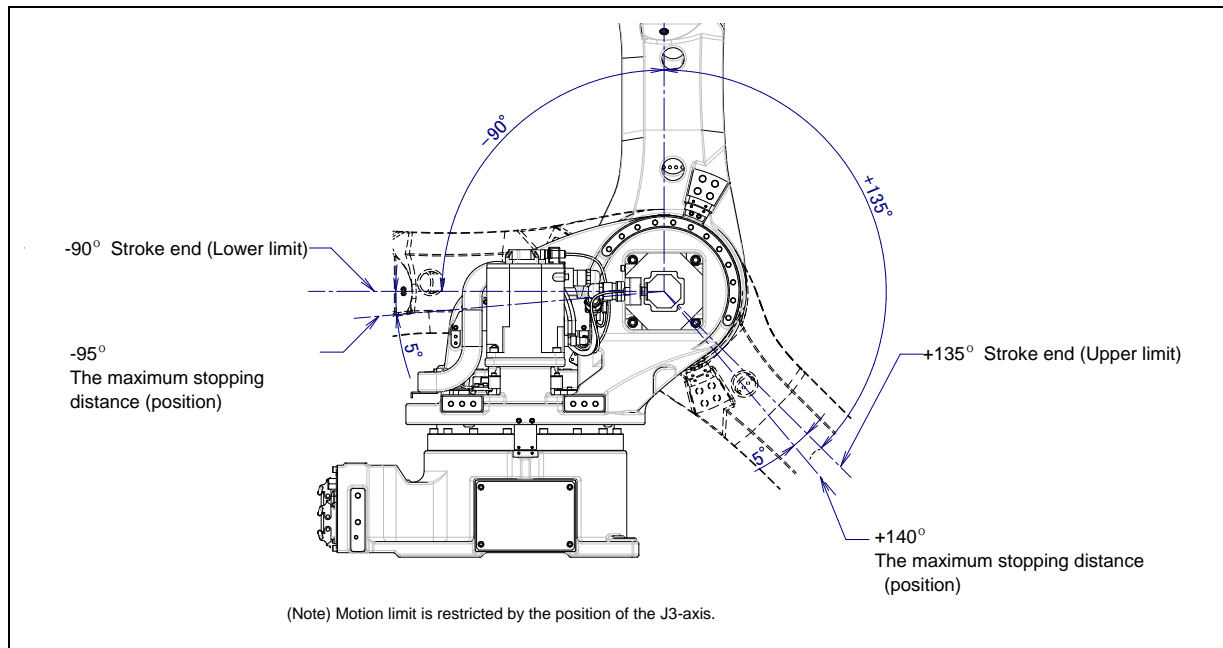
Fig. 3.3 (d) J2-axis motion limit

J2+J3=+140° Stroke end
(Upper limit)

J2+J3=+145°
The maximum stopping distance (position)

J2+J3=-82°
The maximum stopping distance (position)

0°

J2+J3=-77° Stroke end
(Lower limit)
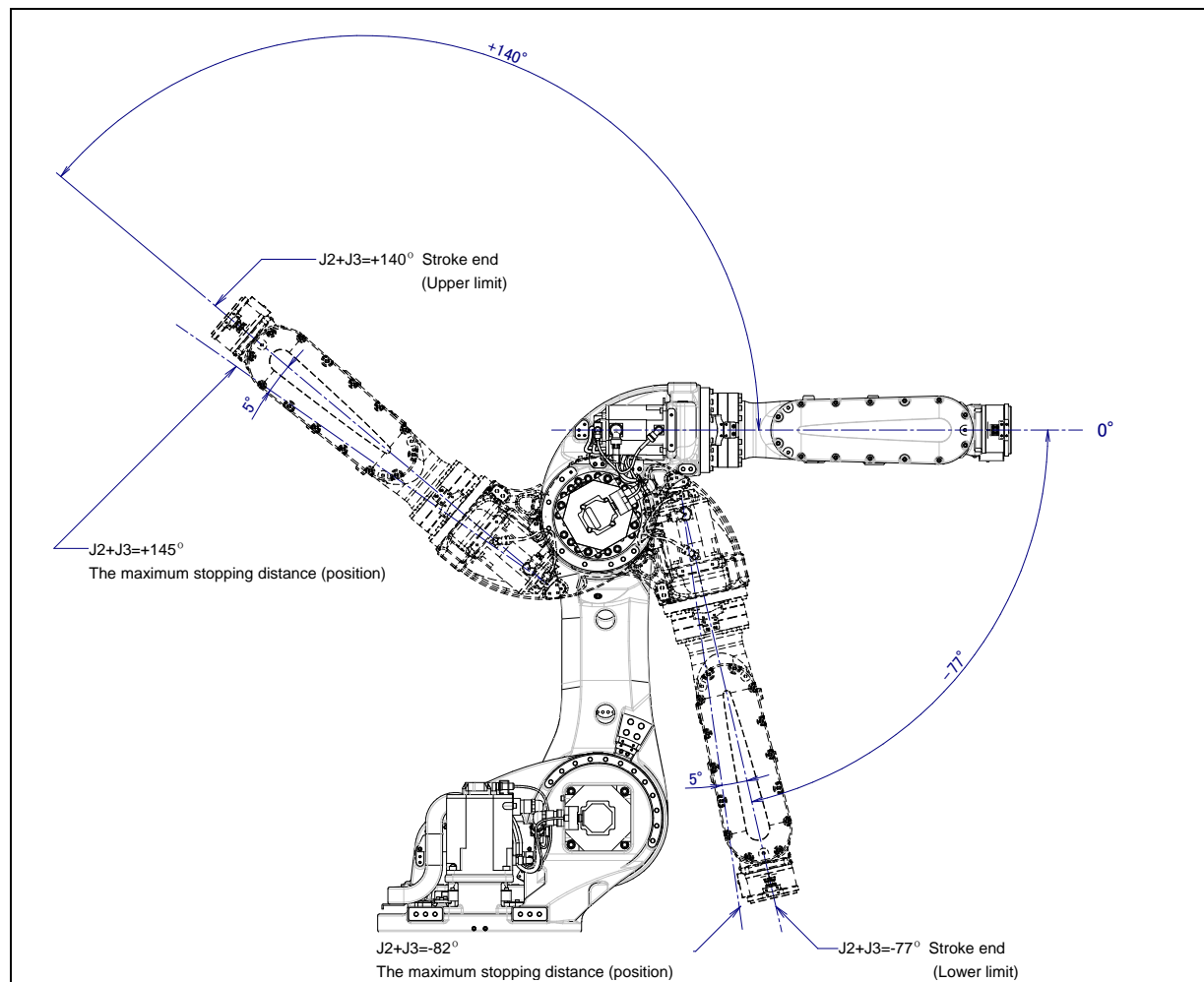
Fig. 3.3 (e) J3-axis motion limit

(NOTE) J4-axis does not have the mechanical stopper.
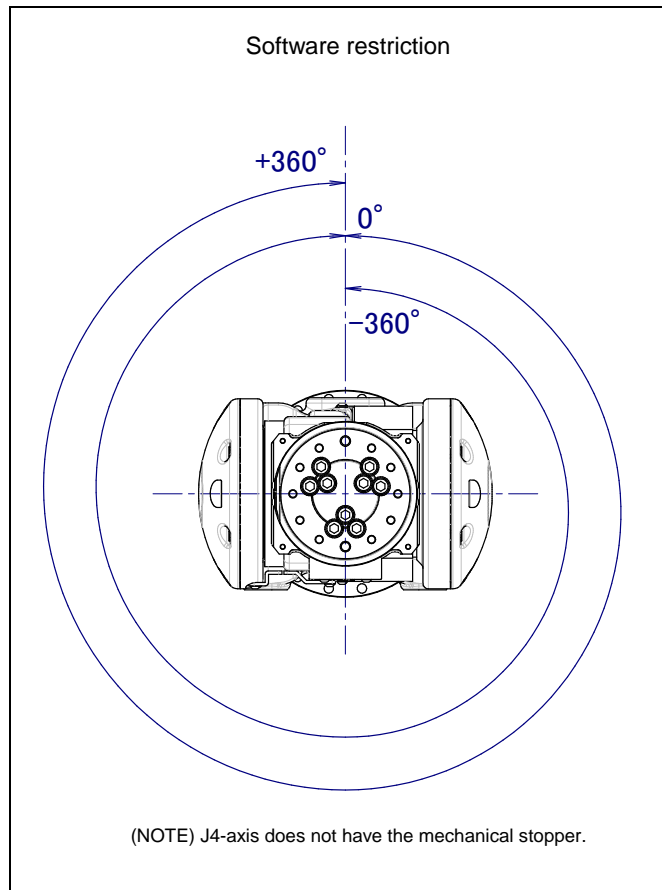
Fig. 3.3 (f) J4-axis motion limit

+125° Stroke end (Upper limit)

+127°
The maximum stopping distance
(position)

+125°

0°

-127°
The maximum stopping distance
(position)

-125°

-125° Stroke end (Lower limit)
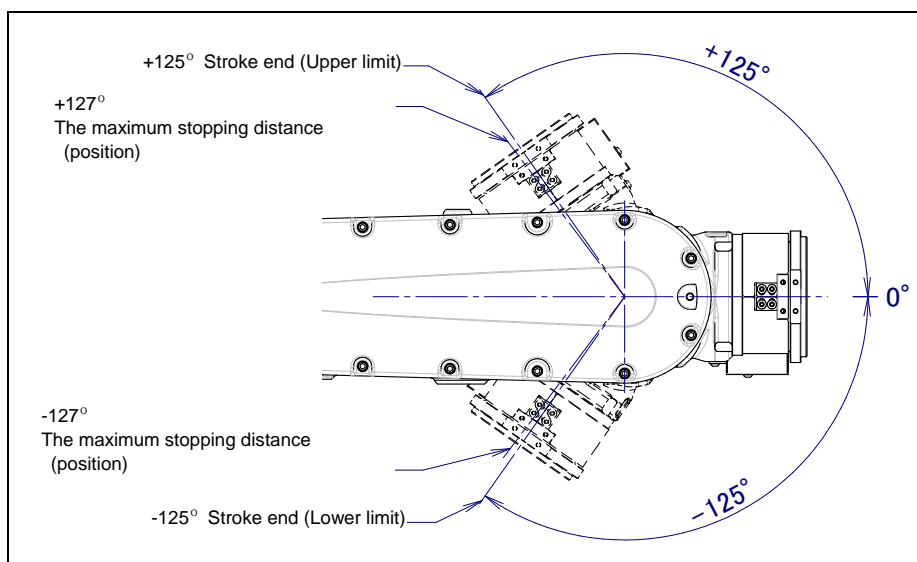
Fig. 3.3 (g) J5-axis motion limit

Software restriction

+360°

0°

−360°

(NOTE) J6-axis does not have the mechanical stopper.
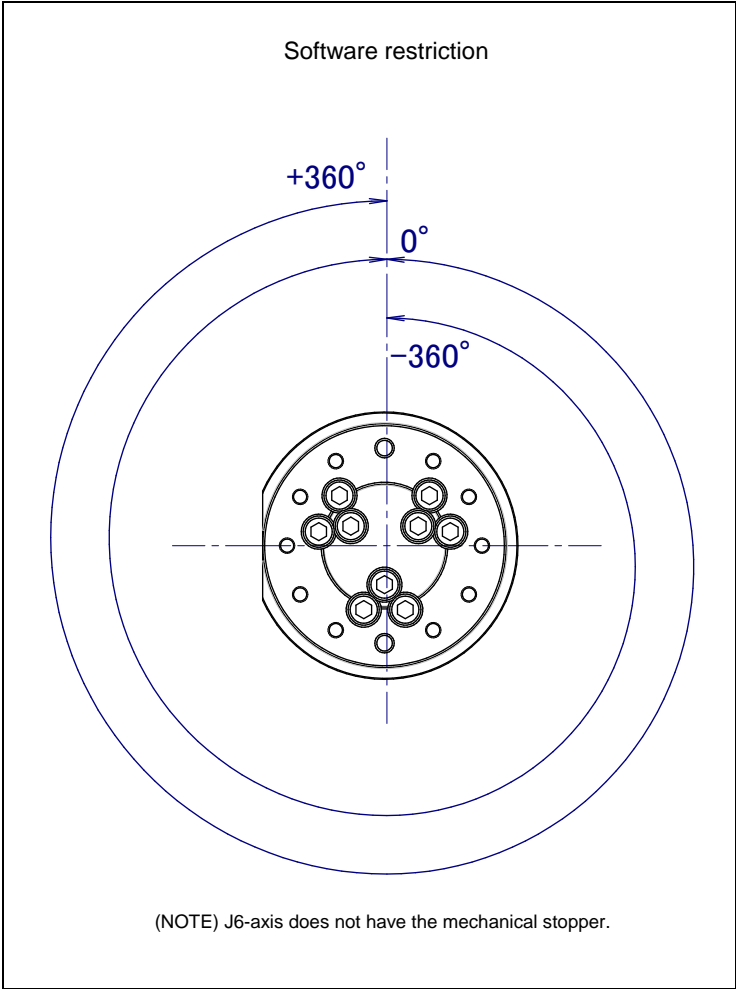
Fig. 3.3 (h) J6-axis motion limit

3.4   WRIST LOAD CONDITIONS

Fig. 3.4 (a) is a diagram to limit loads applied to the wrist.
·   Apply a load within the region indicated in the graph.
·   Apply the conditions of the allowable load moment and the allowable load inertia.
     See Section 3.1 about the allowable load moment and the allowable load inertia.
·   See Section 4.1 about the mounting of the end effector.
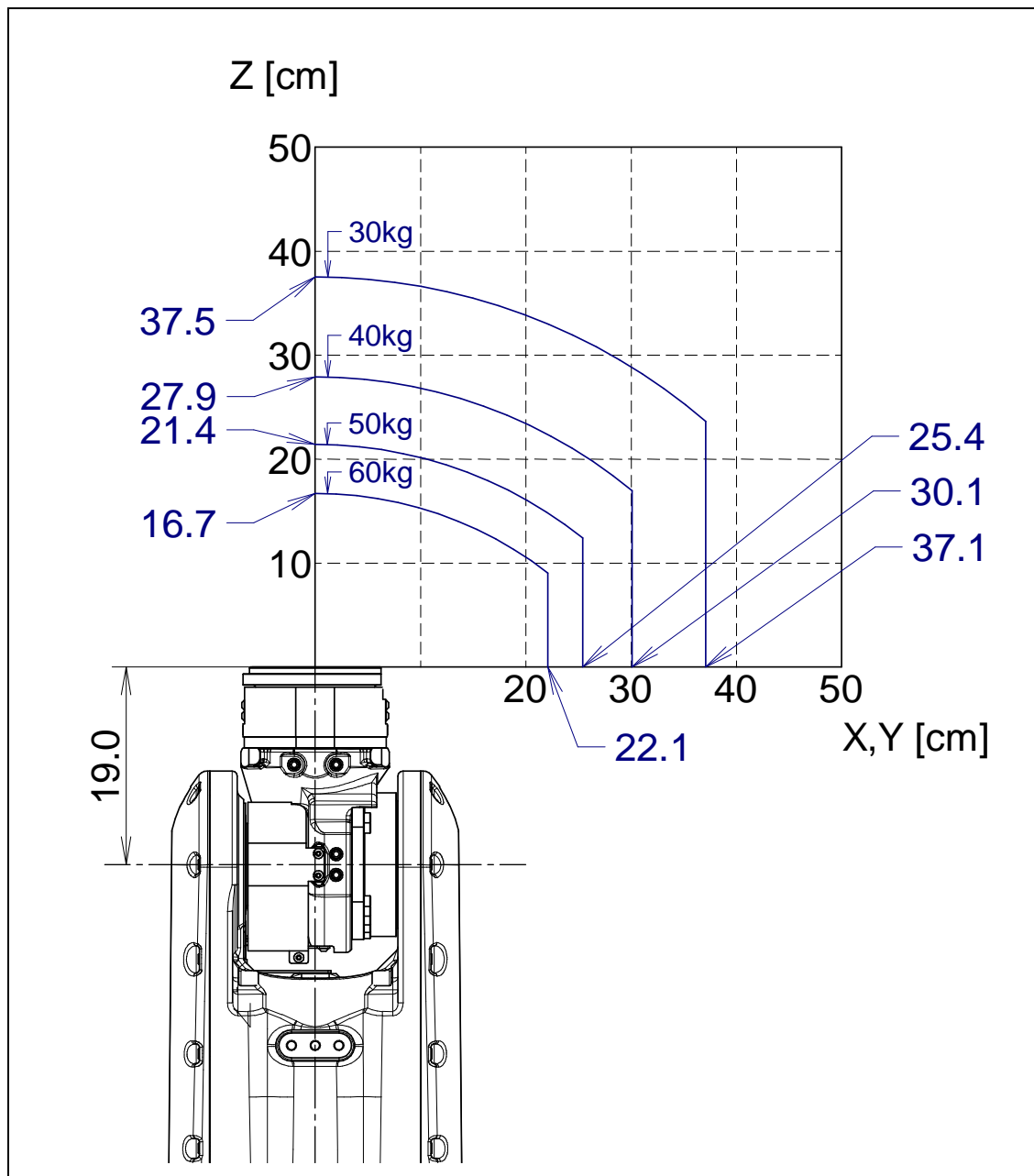
Fig. 3.4 (a) Wrist load diagram (ISO flange)
(M-800iA/60)

3.5 LOAD CONDITIONS ON J3 ARM AND J3 CASING

Fig. 3.5 (a) shows J3 arm and J3 casing load condition.
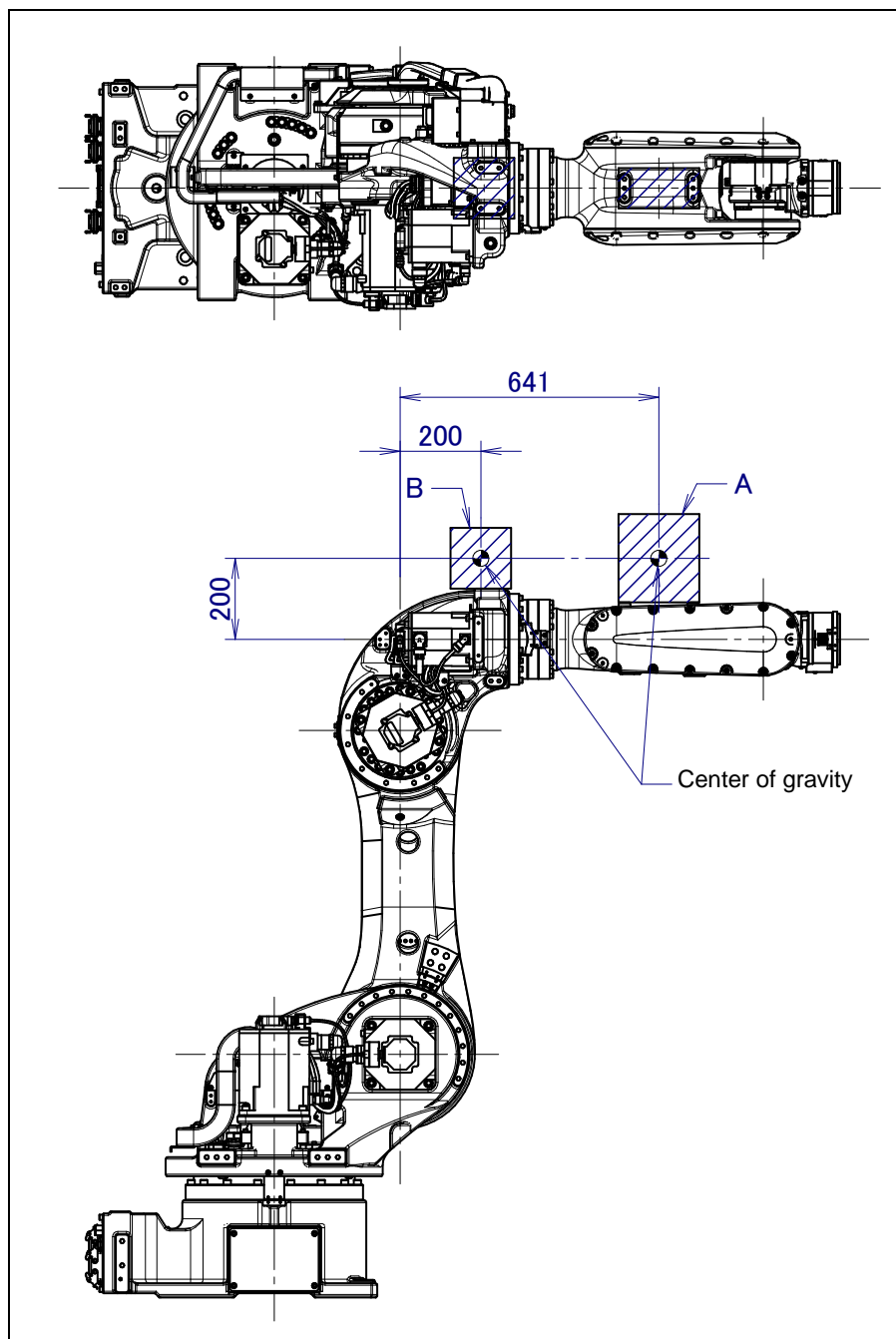
Fig. 3.5 (a) J3 arm/J3 casing load condition

Table 3.5 (a) J3 casing and J3 arm load condition

J3 arm load weight (A)	J3 casing load weight (B)
21kg or less	35kg or less
5/3 x (A)+(B) ≤ 35kg	

> ⚠ **CAUTION**
> You cannot bet load on J2 base.

4   EQUIPMENT INSTALLATION TO THE ROBOT

4.1   END EFFECTOR INSTALLATION TO WRIST

Fig. 4.1 (a) shows the figures for installing end effectors on the wrist. To fasten the end effector, position it by two pin holes, then lock it using screws. Select screws and positioning pins of a length that matches the depth of the tapped holes and pin holes.

Then fasten ten M8 bolts for fixing the end effector with following torque below.

M8:   37.2±1.86Nm (380±19kgfcm)

> ⚠ **CAUTION**
> Notice the tooling coupling depth to wrist flange should be shorter than the flange coupling length.
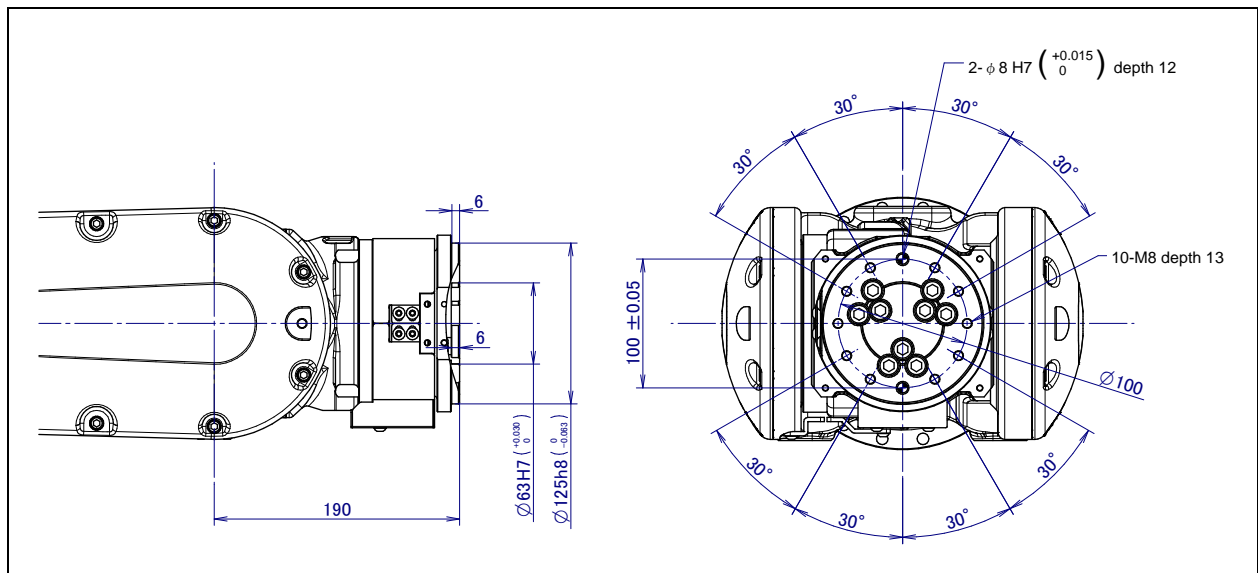
Fig. 4.1 (a) End effector mounting face (ISO flange)

4.2   EQUIPMENT MOUNTING FACE

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

> ⚠ **CAUTION**
> 1   Never perform additional machining operation such as drilling or tapping on the robot body. This can seriously affect the safety and function of the robot.
> 2   When using a user tap shown in Fig. 4.2 (a), keep the center of gravity position of the equipment according to Section 3.5.
> 3   Equipment should be installed so that mechanical unit cable does not interfere. If equipment interfere, the mechanical unit cable might be disconnected, and unexpected troubles might occur.
> 4   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.
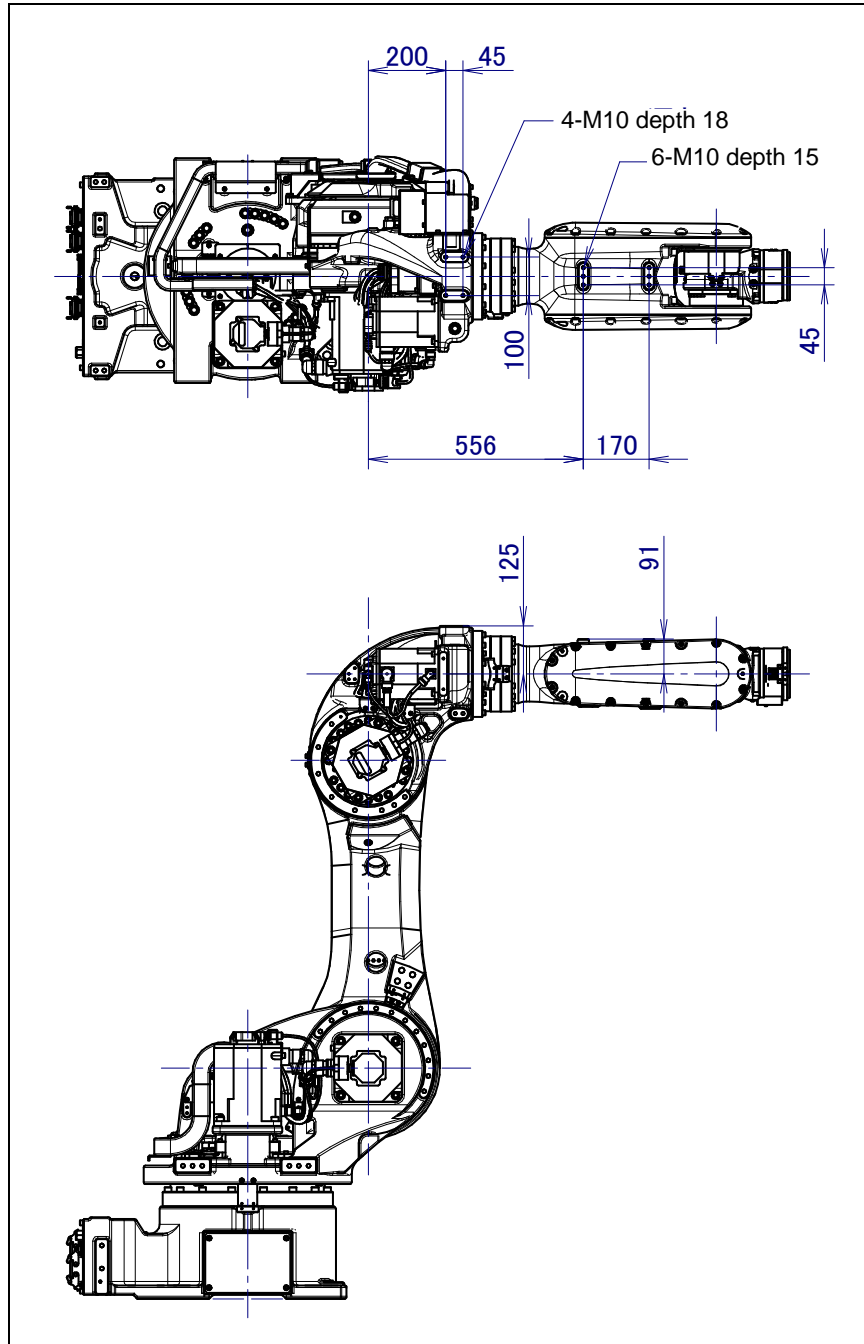
Fig. 4.2 (a) Equipment mounting faces

4.3 LOAD SETTING

```
⚠ CAUTION
1  Set the correct load condition parameter before the robot runs. Do not operate
   the robot in over when its payload is exceeded or incorrect. Do not exceed the
   allowable payload including connection cables. Operation in with the robot over
   payload may result in troubles such as reducer life reduction.
2  WHEN PERFORMING LOAD ESTIMATION AFTER PARTS REPLACEMENT
   If wrist axis motors (J5/J6-axis) or reducers are replaced, payload estimation
   accuracy may decrease. Perform calibration of load estimation without the load
   such as hand before performing load estimation.
   Refer to Chapter 9 "LOAD ESTIMATION" in the Controller
   Optional Function OPERATOR'S MANUAL (B-83284EN-2).
```

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           60.00      [                    ]
2            0.00      [                    ]
3            0.00      [                    ]
4            0.00      [                    ]
5            0.00      [                    ]
6            0.00      [                    ]
7            0.00      [                    ]
8            0.00      [                    ]
9            0.00      [                    ]
10           0.00      [                    ]


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

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

```
MOTION/PAYLOAD SET            JOINT   100%

   Group 1
1 Schedule No[        1]:[Comment          ]
2 PAYLOAD              [kg]          60.00
3 PAYLOAD CENTER  X [cm]           -28.53
4 PAYLOAD CENTER  Y [cm]             0.00
5 PAYLOAD CENTER  Z [cm]            27.78
6 PAYLOAD INERTIA X [kgfcms^2]      56.84
7 PAYLOAD INERTIA Y [kgfcms^2]      59.39
8 PAYLOAD INERTIA Z [kgfcms^2]      15.10

[TYPE] GROUP NUMBER   DEFAULT   HELP
```
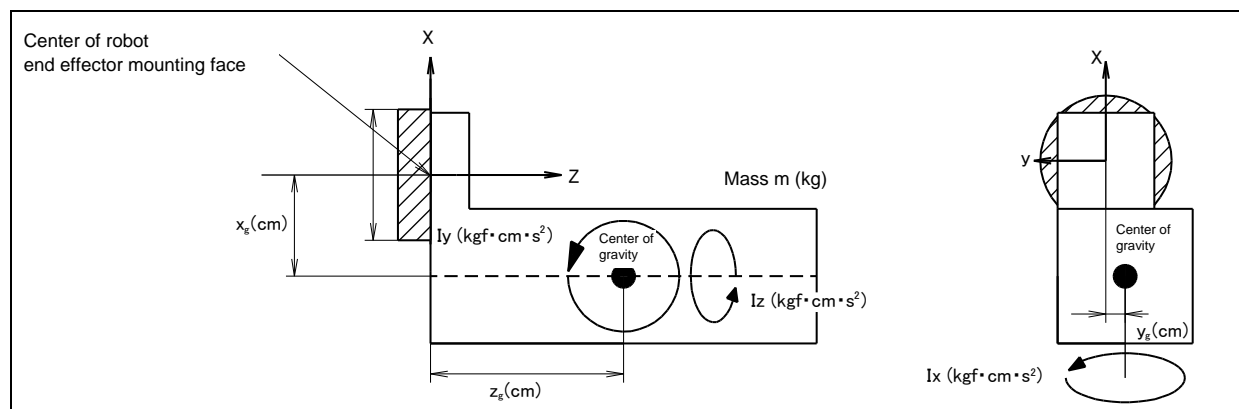
Fig. 4.3 (a) Standard tool coordinate

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

7   Press 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.

9   On the MOTION PERFORMANCE screen, pressing F4 [ARMLOAD] to display the MOTION ARMLOAD SET screen.
    (* This screen differs depending on the robot model.)

```
MOTION/ARMLOAD SET          JOINT  100%

   Group 1
 1 J3 ARM LOAD      [kg]         0.00
 2 J3 CASING LOAD   [kg]        35.00

[ TYPE ]    GROUP        DEFAULT  HELP
```

10 Specify the weight of the load on the J3 arm and J3 casing as follows:
    J3 ARM LOAD [kg]:   Weight of the load on the J3 arm
    J3 CASING LOAD [kg]:   Weight of the load on the J3 casing
    The following message will be displayed: "Path and Cycletime will change. Set it?" Select F4 ([YES]) or F5 ([NO]). Once the loads are set up, the settings are completed by switching the power off and on again.

5 PIPING AND WIRING TO THE END EFFECTOR

⚠ **WARNING**

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

End effector (hand) cable

Insulation processing

Cut unnecessary length of unused wire strand
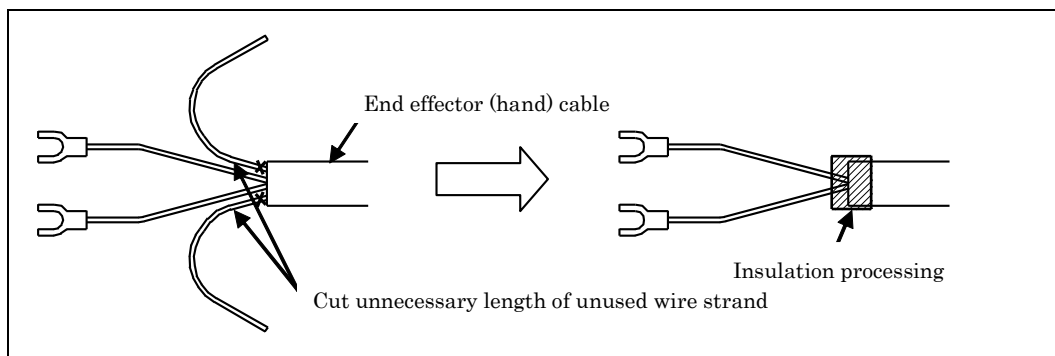
Fig. 5 (a) Treatment method of end effector (hand) cable

5.1 AIR SUPPLY (OPTION)

Robot has air inlet and air outlet openings on the back of the J1 base and the side of the J3 casing used to supply air pressure to the end effector. The connector is a Rc1/2 female (ISO). As couplings are not supplied, it will be necessary to prepare couplings which suit to the tube size.

Dual air lines: panel union x 2 or
Single air line: panel union x 1
Rc1/2 female (Air outlet side)

Air tube 2 pcs or
Air tube 1 pc
Outside diameter 12mm
Inside diameter 8.5mm

Dual air lines: panel union x 2 or
Single air line: panel union x 1
Rc1/2 female (Air inlet side)
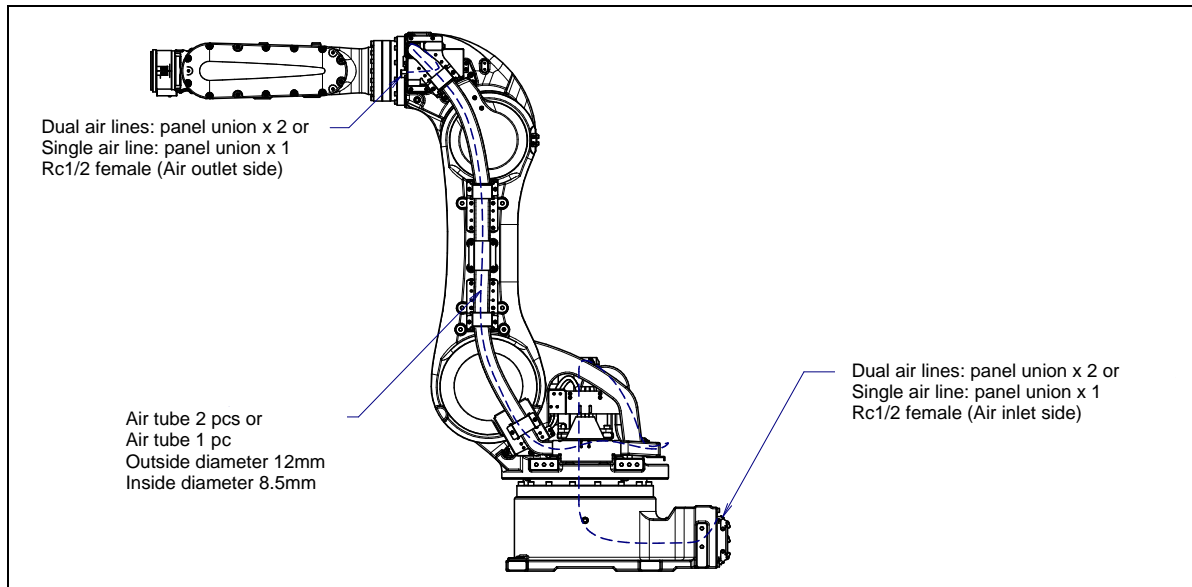
Fig. 5.1 (a) Air supply (option)

5.2   AIR PIPING (OPTION)

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

Elbow nipple R3/8

Straight nipple R1/2

R3/8

Air control set
Spec.: A05B-1311-J011

Air tube
All length 3m
Outer 12mm, Inside 8mm

In dotted line Optional parts
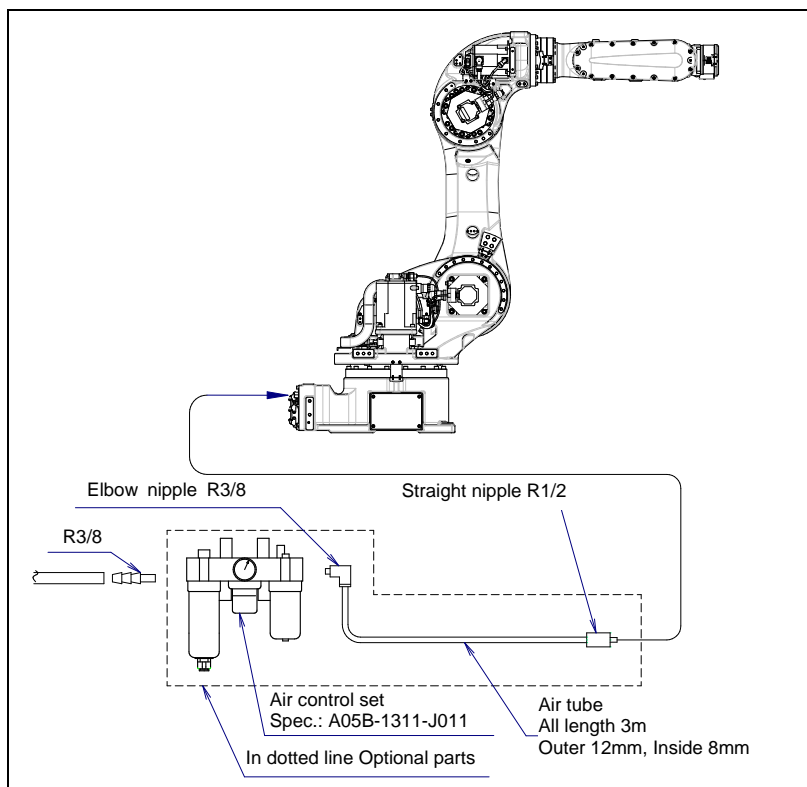
Fig. 5.2 (a) Air piping (option)

Air control set

Fill the lubricator having air control set to the specified level with turbine oil #90 to #140. The machine tool builder is required to prepare mounting bolts. This is outside FANUC delivery scope.

IN

OUT

4−M6

70

57

Lubricator

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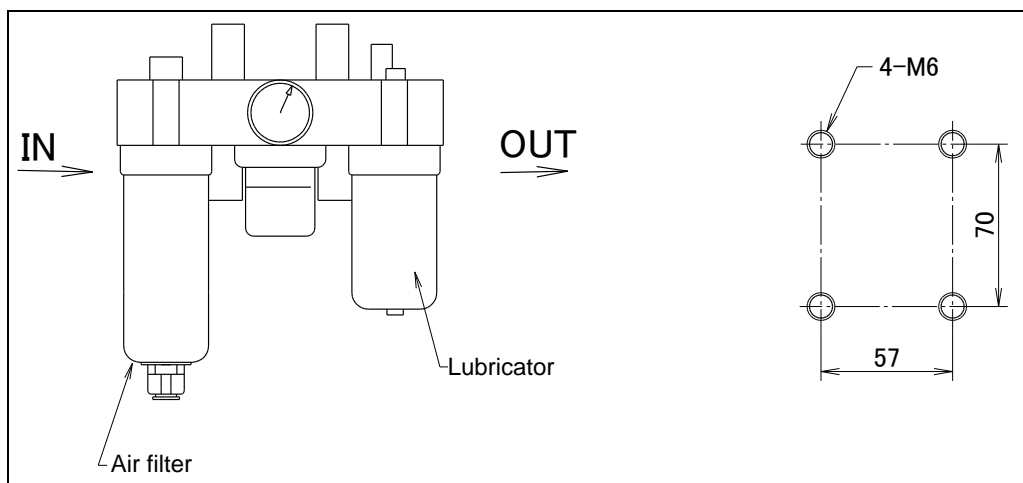
Fig. 5.2 (b) Air control set (option)

> **NOTE**
> The capacity values of the three air components are determined as follows.
> These values must not be exceeded.

Air pressure	Supply air pressure	0.49 to 0.69MPa (5 to 7kgf/cm²) Setting: 0.49MPa (5kgf/cm²)
	Amount of consumption	Maximum instantaneous amount 150Nl/min (0.15Nm³/min)

5.3   INTERFACE FOR OPTION CABLE (OPTION)

Fig. 5.3 (a) shows the position of the option cable interface. Fig 5.3 (b) shows the option cable interface. EE interface (RI/RO) and DeviceNet cable (signal line and power line) as options.

> **NOTE**
> Each option cable is written as shown below on the connector panel.
> EE interface (RI/RO)   : EE
> DeviceNet cable (signal)   : DS
> DeviceNet cable (power)   : DP
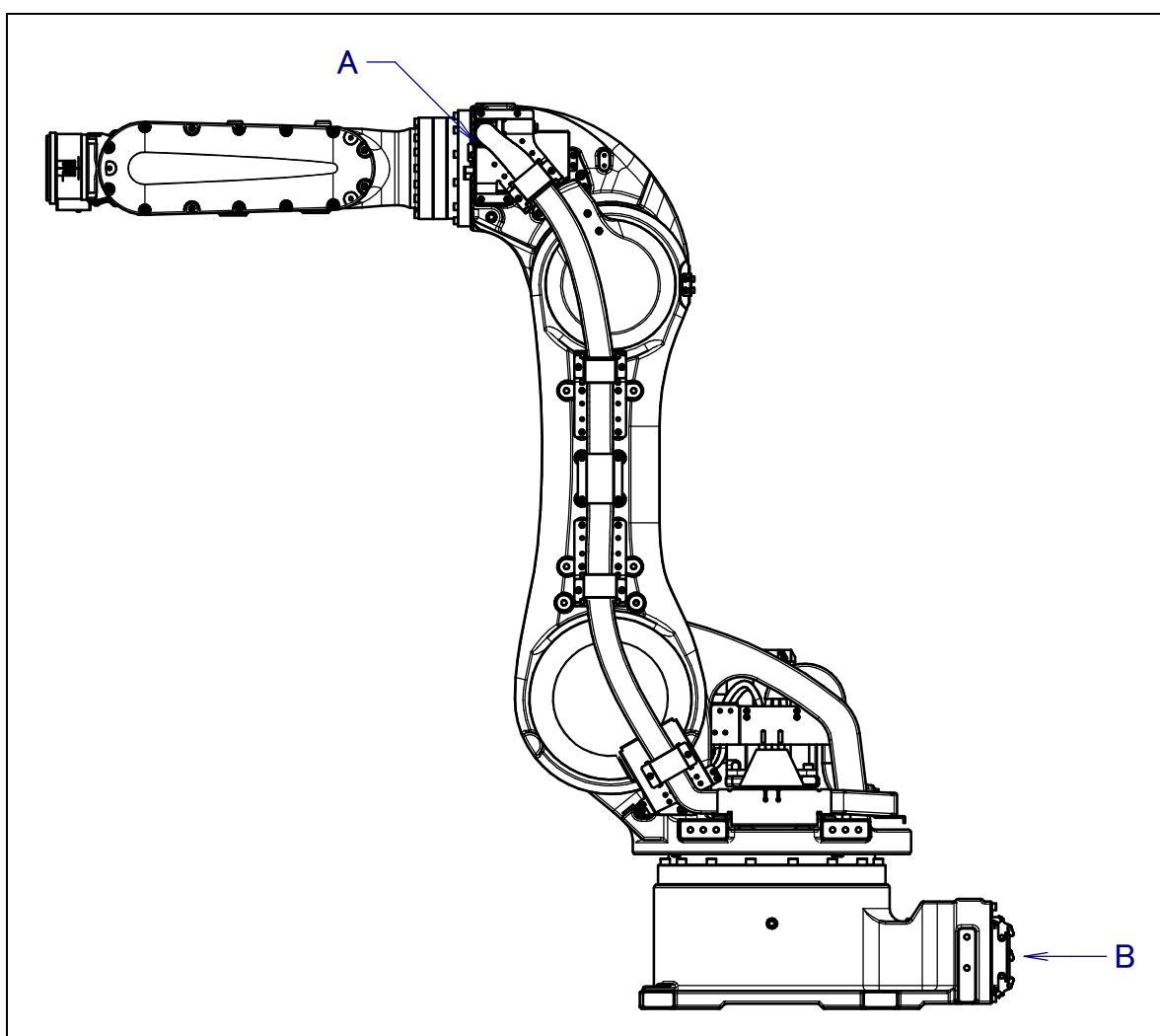
Fig. 5.3 (a) Position of interface for optional cable (option)

J3 casing connector plate (output side)   J1 base connector plate (input side)

EE interface (RI/RO)

(Air inlet)

(Air outlet)

View A   View B

With AIR x 1

Mechanical unit cable spec. : A05B-1127-H501

J3 casing connector plate (output side)   J1 base connector plate (input side)

DeviceNet cable (signal)
interface

(Air inlet)

DeviceNet cable (signal)
interface   EE   interface

DeviceNet cable (power)
interface   (Air outlet)

DeviceNet cable (power)
interface

View A   View B

With DeviceNet cable (signal line/power line) and AIR x 1

Mechanical unit cable spec. : A05B-1127-H507

Fig. 5.3 (b) Interface for option cable

1   EE interface (RI/RO) (option)
     Fig. 5.3 (c) shows pin layout for EE interface (RI/RO).

EE interface (RI/RO) (output)

W2524F (Fujikura Ltd.)

4	3	2	1
RO4	RO3	RO2	RO1

9	8	7	6	5
RI1	0V(A1)	XHBK	RO6	RO5

15	14	13	12	11	10
RI5	XPPABN	RI8	RI4	RI3	RI2

20	19	18	17	16
24VF(A4)	24VF(A3)	24VF(A2)	24VF(A1)	RI6

24	23	22	21
RI7	0V(A2)	RO8	RO7

End
effector

Outside FANUC delivery scope

Controller

XHBK : Hand broken

XPPABN : Pneumatic pressure abnormal
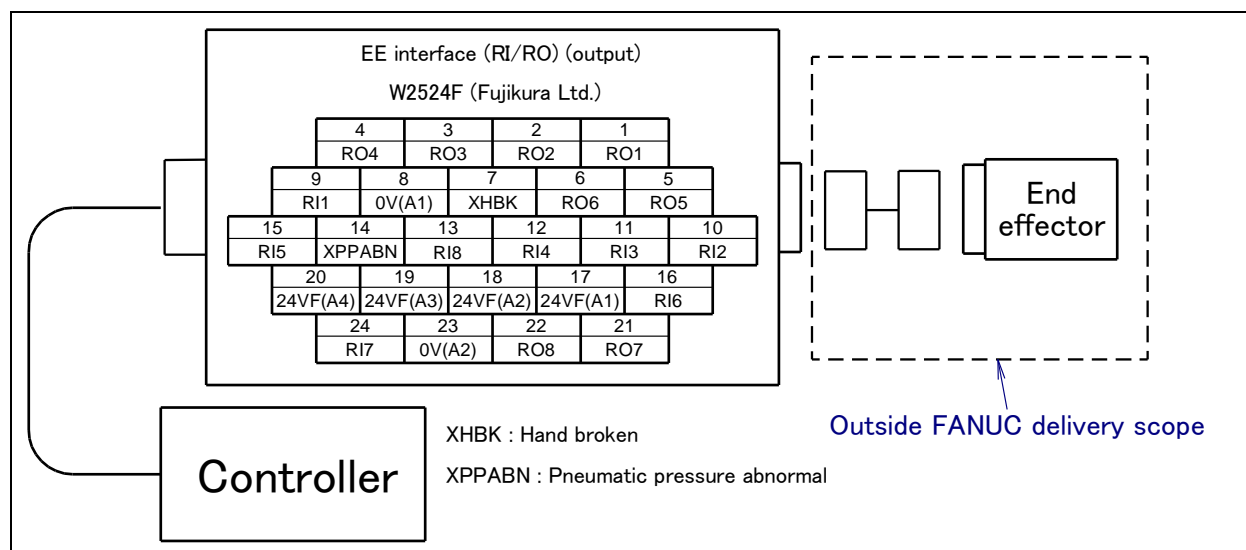
Fig. 5.3 (c) Pin layout for EE interface (RI/RO) (option)

2   DeviceNet cable (signal) (DS) interface (option)
    Fig. 5.3 (d) shows pin layout for DeviceNet cable (signal) interface.
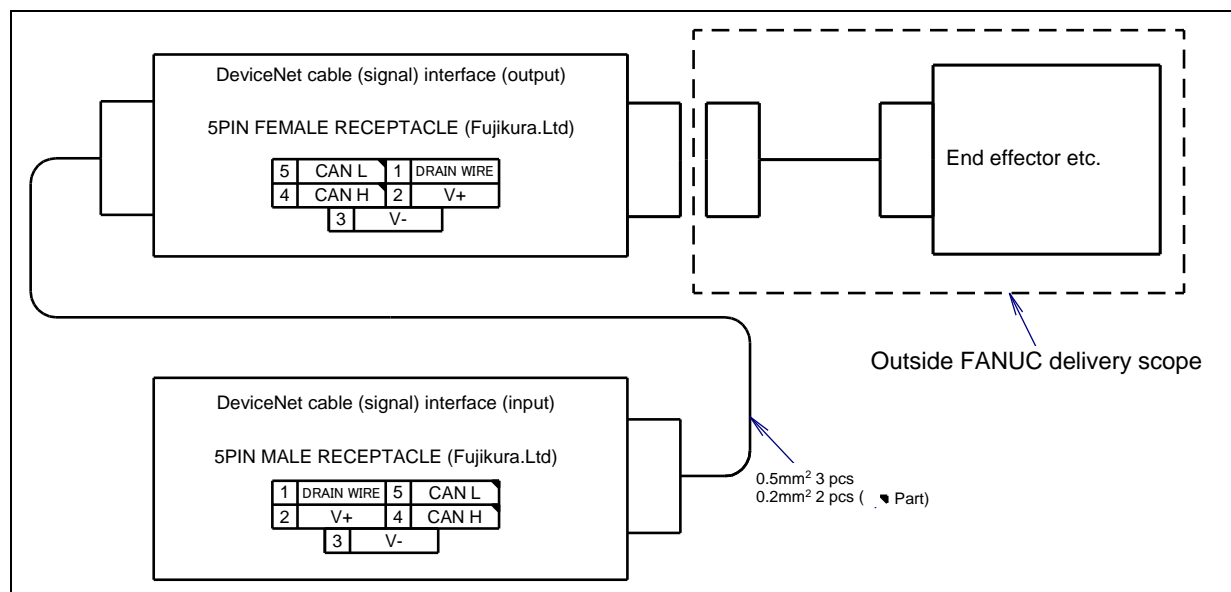
Fig. 5.3 (d) Pin layout for DeviceNet cable (signal) (DS) interface (option)

3   DeviceNet cable (power) (DP) interface (option)
    Fig. 5.3 (e) shows pin layout for DeviceNet cable (power) interface.

Fig. 5.3 (e) Pin layout for DeviceNet cable (power) (DP) interface (option)

Connector specifications

Table 5.3 (a) Connector specifications (Mechanical unit side)

Cable	Input side (J1 base)	Output side (J3 casing)	Maker /dealer
EE (RI/RO)	———	JMWR2524F	Fujikura Ltd.

Table 5.3 (b) Connector specifications (User side)

Cable	Input side (J1 base)	Output side (J3 casing)	Maker /Dealer
EE (RI/RO)	———	JMSP2524M (*1)　　Straight JMLP2524M　　　　Angle	Fujikura Ltd.

Table 5.3 (c) Connector specifications (DeviceNet cable, Mechanical unit side)

Cable	Input side (J1 base)		Maker /dealer	Output side (J3 casing)	Maker /dealer
DS	CM03A-R5P-S-2		Fujikura Ltd.	CM03A-PR5S-S-2	Fujikura Ltd.
DP	Housing Insert Contact	09 30 006 0301 09 32 010 3001 09 33 000 6104	HARTING K.K.	CM03A-PR4S-S-2	Fujikura Ltd.

Table 5.3 (d) Connector specifications (DeviceNet cable, User side)

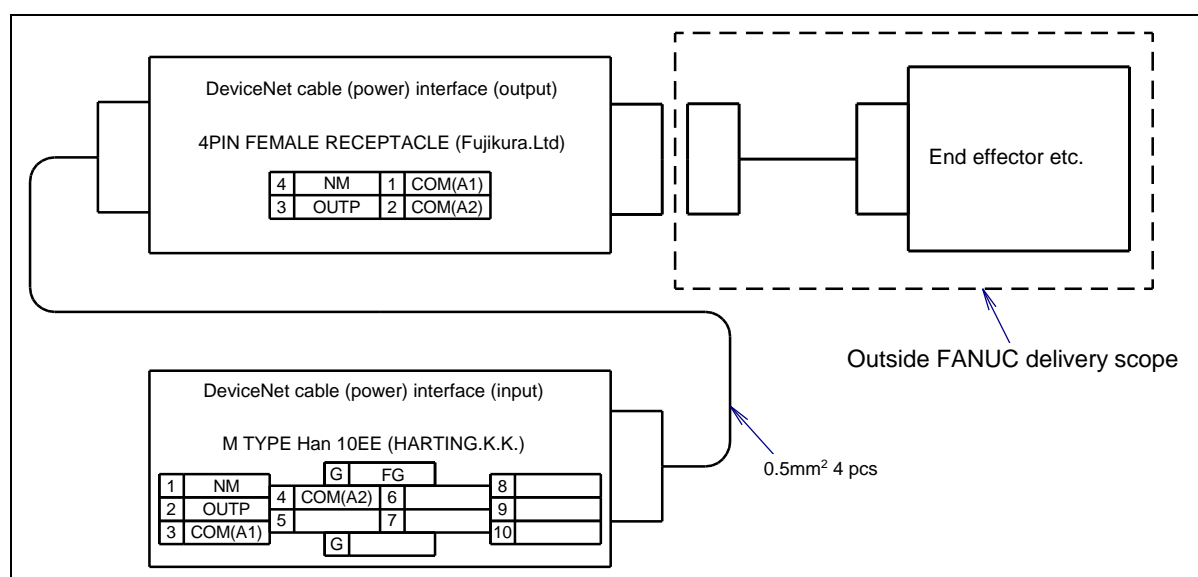| Cable	Input side (J1 base)		Maker /dealer	Output side (J3 casing)	Maker /dealer
DS	MINI connector for use on the device net 5-pin, FEMALE CM03-P5S		Fujikura Ltd.	MINI connector for use on the device net 5-pin, MALE CM03-J5P	Fujikura Ltd.
DP	Hood (NOTE 2)	09 30 006 1540　　Side entry 　　　　　1541 　　　　　0542 　　　　　0543 　　　　　1440　　Top entry 　　　　　1441 　　　　　0442 　　　　　0443	HARTING K.K.	MINI connector for use on the device net 4-pin, MALE CM03-J4P	Fujikura Ltd.
	Insert	09 32 010 3101			
	Contact (NOTE 2)	09 33 000 6220　　AWG 20 　　　　　6214　　AWG 18 　　　　　6205　　AWG 18 　　　　　6204　　AWG 16 　　　　　6202　　AWG 14 　　　　　6207　　AWG 12			
	Clamp (NOTE 2)	09 00 000 5083 　　　　　5086 　　　　　5090 　　　　　5094 Many other types are available.			

> **NOTE**
> 1　Underlined parts are attached. Below shows spec. to order in our company.
> 　(*1)A63L-0001-0234#S2524M
> 2　For details, such as the dimensions, of the parts listed above, refer to the related catalogs offered by the respective manufactures, or contact your local FANUC representative.

6   AXIS LIMITS SETUP

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

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

There are three methods used to prevent the robot from going beyond the necessary motion range.

-    Limit axis motion range by DCS (All axes (option))
-    Limit axis motion range adjustable mechanical stopper (J1-axis (option))
-    Limit axis motion range by adjustable mechanical stopper and switches (J1-axis (option))

⚠ **WARNING**

1   Changing the motion range of any axis affects the operating range of the robot. To avoid trouble, carefully consider any possible effect of the change to the movable range of each axis in advance. Otherwise, it is likely that an unexpected condition will occur; for example, an alarm may occur in a previously taught position.

2   For J1-axis, use adjustable mechanical stoppers, for J2/J3-axes, use DCS function so that damage to peripheral equipment and injuries to human bodies can be avoided.

3   Mechanical stoppers are physical obstacles. For J1-axis, it is possible to re-position the adjustable mechanical stoppers. But the robot cannot move beyond them. For J5-axis, the mechanical stoppers are fixed. For the J4 and J6-axes, only DCS-specified limits are available.

4   For changing J2 andJ3-axes interference angles, DCS specified movable range cannot be used.

5   Adjustable mechanical stoppers (J1-axis) are deformed in a collision to stop the robot. Once a stopper is subject to a collision, it can no longer assure its original strength and, therefore, may not stop the robot. When this happens, replace it with a new one.

6.1   CHANGE AXIS LIMIT BY DCS (OPTION)

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

- DCS position/speed check function (J567)

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

Setting procedure

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

```
                               AUTO
DCS                        JOINT 1%

   1    Joint position check
   2    Joint speed check:
   3    Cart. position check    OK
   4    Cart. speed check
   5    T1 mode speed check
   6    User model
   7    Tool frame
   8    User frame
   9    Stop position prediction

   [TYPE] APPLY DETAIL             UNDO
```

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

```
                               AUTO
DCS                        JOINT 1%

Join Position check
No.          G A Status Comment
 1 DISABLE   1  1 ----  [          ]
 2 DISABLE   1  1 ----  [          ]
 3 DISABLE   1  1 ----  [          ]
 4 DISABLE   1  1 ----  [          ]
 5 DISABLE   1  1 ----  [          ]
 6 DISABLE   1  1 ----  [          ]
 7 DISABLE   1  1 ----  [          ]
 8 DISABLE   1  1 ----  [          ]
 9 DISABLE   1  1 ----  [          ]
10 DISABLE   1  1 ----  [          ]

   [TYPE]       DETAIL
```

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

```
                              AUTO
DCS                       JOINT 1%

 No.  1              Status:
 1 Comment         [********************]
 2 Enable/Disable           DISABLE
 3 Group                         1
 4 Axis                          1
 5 Safe side:
   Position   (deg):
   Current:                   0.000
 6 Upper limit   :            0.000
 7 Lower limit   :            0.000
 8 Stop type:       Power-off stop

 [TYPE]  PREV  NEXT             UNDO
```

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

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

```
                              AUTO
DCS                       JOINT 1%

 No.  1              Status:
 1 Comment         [********************]
 2 Enable/Disable           ENABLE
 3 Group                         1
 4 Axis                          2
 5 Safe side:
   Position   (deg):
   Current:                   0.000
 6 Upper limit   :           +30.000
 7 Lower limit   :           -30.000
 8 Stop type:       Power-off stop

 [TYPE]  PREV  NEXT             UNDO
```

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

```
                              AUTO
DCS                       JOINT 1%


 1    Joint position check   UNSF  CHGD
 2    Joint speed check:
 3    Cart. position check      OK
 4    Cart. speed check
 5    T1 mode speed check
 6    User model
 7    Tool frame
 8    User frame
 9    Stop position prediction

 [TYPE] APPLY DETAIL            UNDO
```

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

```
                                  AUTO
DCS                          JOINT 1%

 Verify (diff)
 F Number :    F0000
 VERSION   :  HandlingTool
 $VERSION : V7.7097  9/1/2015
 DATE:   17-7-28    19:44
 DCS Version: V2. 0. 11


 ---Joint Position Check--------------
 No.           G  A  Status Comment
 1 EBABLE      1  2   CHGD [
 2 ENABLE      1  2   ---- [
 3 DISABLE     1  2   ---- [
               ALL     OK    QUIT
```

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

```
                                  AUTO
DCS                          JOINT 1%

 1    Joint position check   UNSF   PEND
 2    Joint speed check:
 3    Cart. position check     OK
 4    Cart. speed check
 5    T1 mode speed check
 6    User model
 7    Tool frame
 8    User frame
 9    Stop position prediction

 [TYPE] APPLY DETAIL                UNDO
```

16   Cycle the power of the controller in the cold start mode so the new settings are enabled.

⚠ **WARNING**
   You must cycle the power of the controller to enable the new setting. If you fail to
   do so, the robot does not work normally and it may injure personnel or damage
   the equipment.

6.2   ADJUSTABLE MECHANICAL STOPPER AND LIMIT SWITCH SETTING (OPTION)

For the J1-axis, adjustable mechanical stopper (option) can be installed. It is possible to re-position adjustable mechanical stoppers. Change the position of the adjustable mechanical stoppers according to the desired movable range. For the J1-axis, the limit switch-based movable range can be used together. Refer to Section 6.3 and 6.4 for details.

Table 6.2 (a) Motion range that can be set by the adjustable mechanical stopper and space between the upper and lower limits

Item		Settable motion range
J1-axis adjustable mechanical stopper, limit switch	Upper limit	Settable in steps of 7.5° in the range of -120° to +180°
	Lower limit	Settable in steps of 7.5° in the range of -180° to +120°
	Space between the upper and lower limits	A space of 60° or more is required.

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

6.2.1   Installing adjustable mechanical stopper option

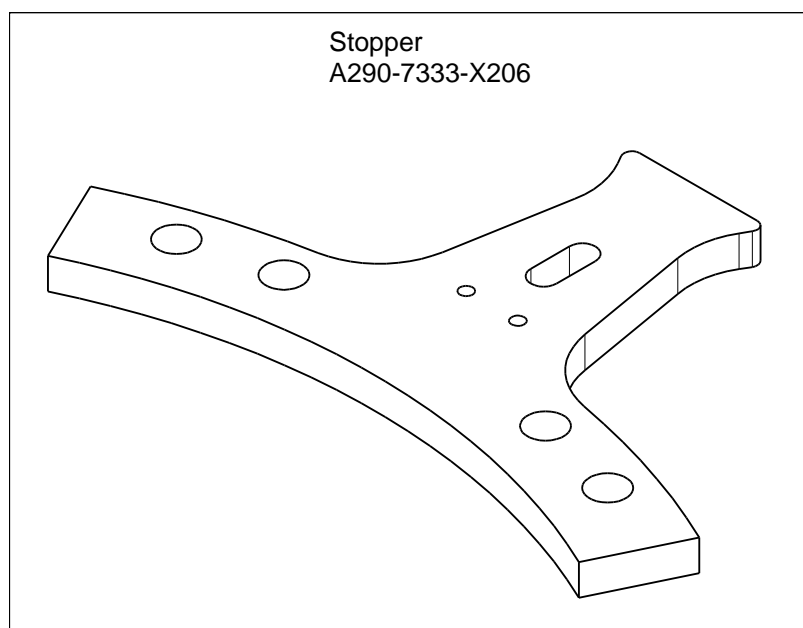Attach adjustable mechanical stoppers referring to Fig. 6.2.1 (a) to (c).

Fig. 6.2.1 (a) J1-axis adjustable mechanical stopper (option)

Bolt M24 x 80
Tightening torque 128Nm (13.1kgfm)
Apply LOCTITE 243
Washer

Collar
A290-7333-X205

Stopper
A290-7333-V012#A

Adapter
A290-7333-X207
Bolts
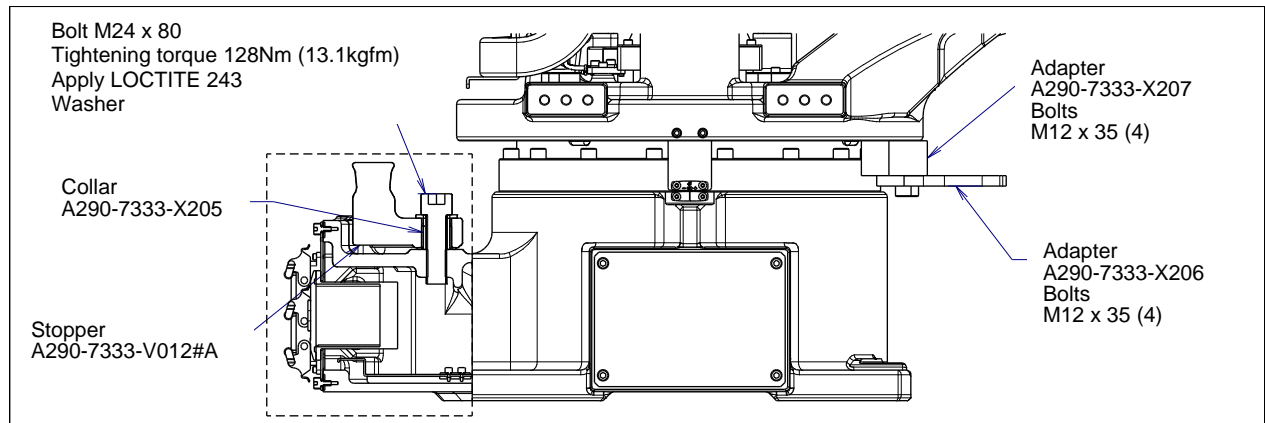M12 x 35 (4)

Adapter
A290-7333-X206
Bolts
M12 x 35 (4)

Fig. 6.2.1 (b) Mounting the J1-axis adjustable mechanical stopper (1/2)
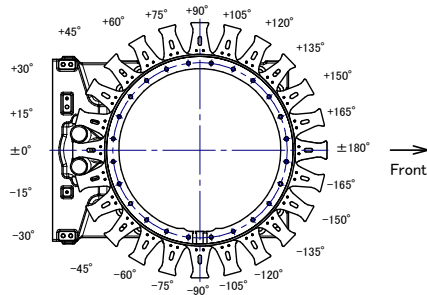
Note on attachning the J1-axis adjustable mechanical stopper
The motion range limited by the J1-axis adjustable mechanical stopper can be changed in steps
of 7.5° by changing the installation holes of the adapter. Select the appropriate installation hole
corresponding to the desired limit angle with reference to the following figure.

Adapter A290-7333-X207 Hole No.
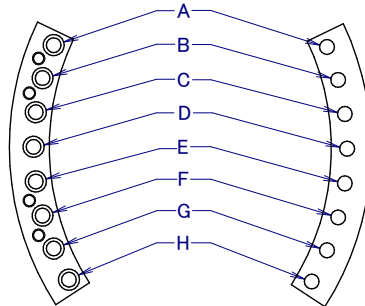
(1) Limit angle   15° × N
     (N = 0, ±1, ±2, ···)

Hole A,C,E and G are used.

(2) Limit angle   7.5° + 15° × N
     (N = 0, ±1, ±2, ···)

Hole B,D,F and H are used.

J1 stopper
Minus
Plus
Minus limit stopper
Swing stopper
Plus limit stopper
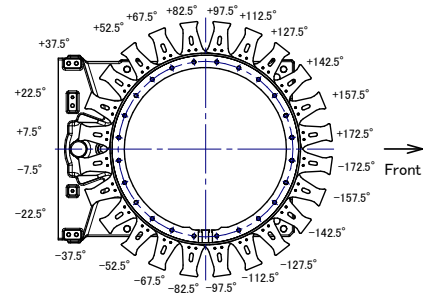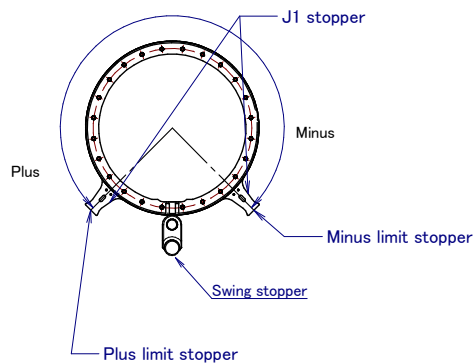
(NOTE) J1-axis top view
        A minimum space of 60° is required between the plus side and minus side stopper.

Fig. 6.2.1 (c) Mounting the J1-axis adjustable mechanical stopper (2/2)

6.2.2   Changing the parameter setting

Setting procedure

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

```
System Axis Limits                   JOINT 100%
   Group1                                  1/16
   AXIS     GROUP     LOWER    UPPER
   1          1       -185.00   185.00    deg
   2          1        -76.00    60.00    deg
   3          1       -132.00   180.00    deg
   4          1       -360.00   360.00    deg
   5          1       -125.00   125.00    deg
   6          1       -360.00   360.00    deg
   7          1          0.00     0.00    mm
   8          1          0.00     0.00    mm
   9          1          0.00     0.00    mm


[ TYPE]
```

NOTE
   0.00 indicates the robot does not have these axes.

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

```
System Axis Limits
                                            2/16
   AXIS      GROUP   LOWER      UPPER
   2          1      -90.00     135.00    deg


[ TYPE]
```

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

⚠ **WARNING**
1   You must turn off the controller and then turn it back on to use the new information; otherwise, the old settings remain valid and could cause personnel injury or equipment damage.
2   After changing system variables, be sure to run the robot at a low speed and make sure that the robot stops at the ends of the stroke.
3   If a collision should occur, the adjustable mechanical stopper becomes deformed to absorb energy, so that the robot can stop safely. If the stopper is deformed by mistake, replace it.
4   Do not depend on parameter settings to control the motion range of your robot.

6.2.3 The maximum stopping distance (position) of adjustable mechanical stopper

The adjustable mechanical stopper is a mechanism that can be adjusted in its position. The robot can work safely inside the adjusted motion range, up to the maximum range as shown in Table 6.2.3 (a) and Fig. 6.2.3 (a). A robot attempting to travel beyond this set range of motion, will be stopped by these stoppers, by collision; and therefore the robot will remain contained within the setup range.
Stopping the robot will cause the mechanical stopper to be "transformed" (means: permanently damaged). Be sure to replace the deformed stopper before using the robot again.

Table 6.2.3 (a) The maximum stopping distance (position) of adjustable mechanical stopper

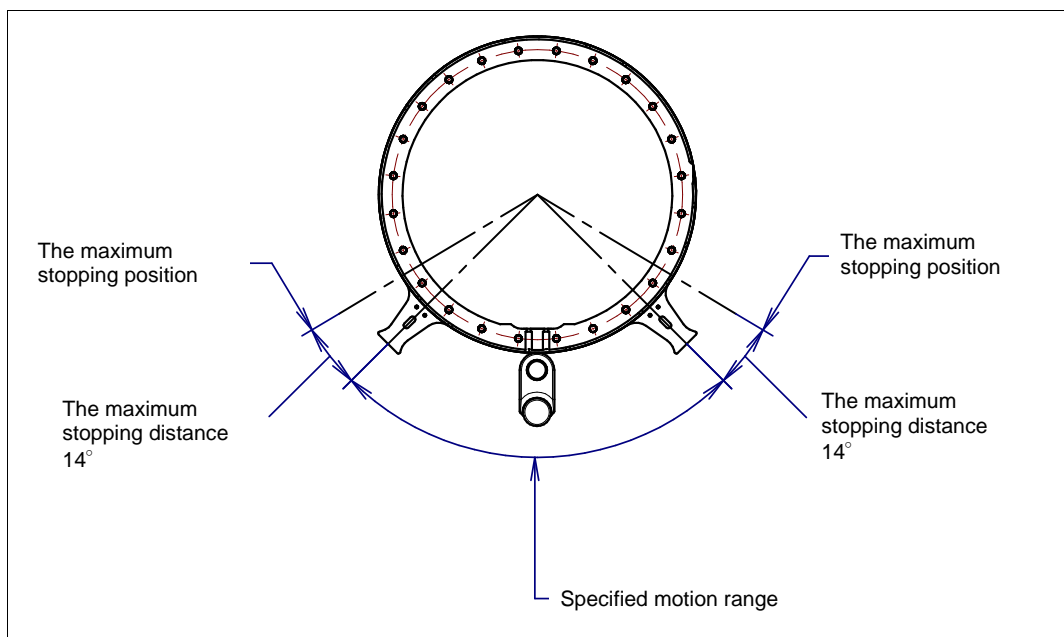|	Plus side	Minus side
J1-axis	+14°	-14°

Fig. 6.2.3 (a) The maximum stopping distance (position) of adjustable mechanical stopper of J1-axis

6.3   CHANGING THE MOTION RANGE BY THE LIMIT SWITCH (OPTION)

The limit switch is an over travel switch, which interrupts power to the servo motor and stops the robot when turned on. The limit switch is optionally provided for the J1-axis.

To change the motion range by the limit switch, move the dog. The following figure shows the relationship between the dog position and the motion range.

The dog of the J1-axis is placed in the same position as with the adjustable mechanical stopper.
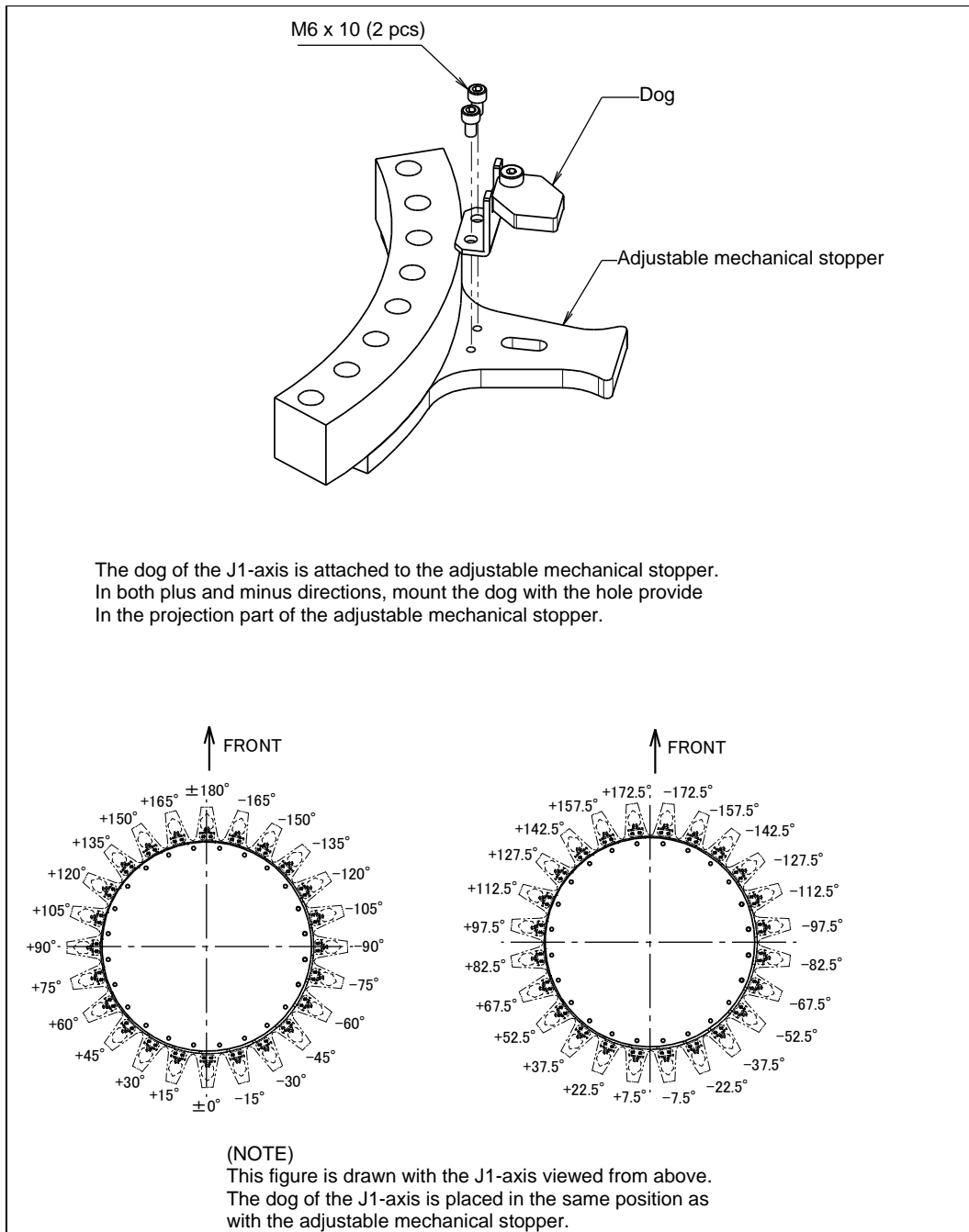

Fig. 6.3 (a) J1-axis dog position and motion range (option)

6.4 ADJUSTING LIMIT SWITCH (OPTION)

After the motion range is changed by the adjustable mechanical stopper and limit switch, be sure to make adjustment.

ADJUSTING PROCEDURE

1. Set the $MOR_GRP.$CAL_DONE system parameter to FALSE. This disables the motion limit specified by the software. As a result, the operator can rotate the robot by a jog feed which goes beyond the motion limit.
2. Loosen the following bolts that hold the limit switch.
   J1-axis : M8 x 12   2 pcs   M4 x 25   2 pcs
3. Move the limit switch so that the robot activates it at about 0.5° before the stroke end. Step on the dog, and position the limit switch in such a place that only one of the step-on allowance indication lines at the tip of the switch is hidden.
4. When the limit switch operates and detects overtravel (OT), the robot stops, and an error message, "OVERTRAVEL", is displayed. To restart the robot, hold on the [SHIFT] key and press the [RESET] key. Then, while holding on the [SHIFT] key, move the adjusting axis off the OT limit switch by jogging in joint mode.
5. Check that the robot also activates the limit switch when the robot is approx. 0.5° from the opposite stroke end in the same way as above. If the limit switch does not operate at the position, adjust the position of the switch again.
6. Set the $MOR_GRP.$CAL_DONE system parameter to TRUE.
7. Turn off the controller power, then turn it on again to restart the controller.
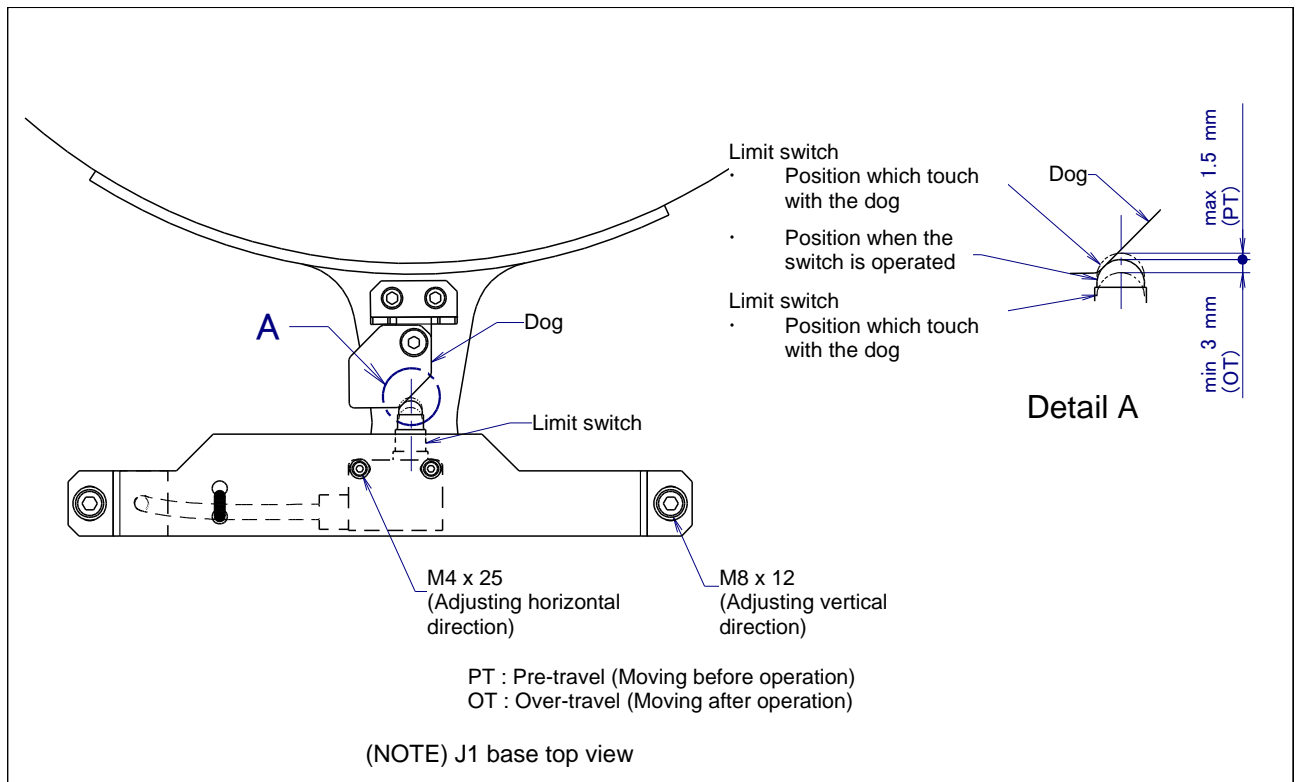

Fig. 6.4 (a) Adjusting J1-axis limit switch (option)

7   CHECKS AND MAINTENANCE

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

NOTE
    The periodic maintenance procedures described in this chapter assume that the FANUC robot is used for up to 3840 hours a year. In cases where robot use exceeds 3840 hours/year, adjust the given maintenance frequencies accordingly. The ratio of actual operation time/year vs. the 3840 hours/year should be used to calculate the new (higher) frequencies. For example, when using the robot 7680 hours a year with a recommended maintenance interval of 3 years or 11520 hours, use the following calculation to determine the maintenance frequency: 3 years / 2 = perform maintenance every 1.5 years.

7.1   CHECKS AND MAINTENANCE

7.1.1   Daily Checks

Check the following items when necessary before daily system operation.

Check items	Check points and management
Oil seepage	Check to see if there is oil on the sealed part of each joint. If there is an oil seepage, clean it. ⇒**"7.2.1 Confirmation of Oil Seepage"**
Air control set	(When air control set is used) ⇒**"7.2.2 Confirmation of the Air Control Set"**
Vibration, abnormal noises	Check whether vibration or abnormal noises occur. When vibration or abnormal noises occur, perform measures referring to the following section: ⇒**"9.1 TROUBLESHOOTING"(Symptom : Vibration, Noise)**
Positioning accuracy	Check that the taught positions of the robot have not deviated from the previously taught positions. When the displacement occurs, perform the measures as described in the following section: ⇒**"9.1 TROUBLESHOOTING"(Symptom : Displacement)**
Peripheral equipment for proper operation	Check whether the peripheral equipment operate properly according to commands from the robot and the peripheral equipment.
Brakes for each axis	Check that the end effector drops 0.2 mm or less when the servo power is turned off. If the end effector (hand) drops, perform the measures as described in the following section: ⇒**"9.1 TROUBLESHOOTING"(Symptom : Dropping axis)**
Warnings	Check whether unexpected warnings occur in the alarm screen on the teach pendant. If unexpected warnings occur, perform the measures as described in the following manual: ⇒**"CONTROLLER OPERATOR'S MANUAL (Alarm Code List)(B-83284EN-1)"**

7.1.2　　Periodic Checks and Maintenance

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

Check and maintenance intervals (Period, Accumulated operating time)						Check and maintenance items	Check points, management and maintenance methods	Periodic maintenance table No.
1 month 320h	3 months 960h	1 year 3840h	1.5 years 5760h	3 years 11520h	4 years 15360h			
$\bigcirc$ Only 1st check	$\bigcirc$					Cleaning the controller ventilation system	Confirm the controller ventilation system is not dusty. If dust has accumulated, remove it.	23
	$\bigcirc$					Check the external damage or peeling paint	Check whether the robot has external damage or peeling paint due to the interference with the peripheral equipment. If an interference occurs, eliminate the cause. Also, if the external damage is serious, and causes a problem in which the robot will not operate, replace the damaged parts.	1
	$\bigcirc$					Check the damages of the cable protective sleeves	Check whether the mechanical unit cable protective sleeves have holes or tears. If damage is found, replace the cable protective sleeve. If the cable protective sleeve is damaged due to the interference with peripheral equipment, eliminate the cause. ⇒**"7.2.3 Check the Mechanical Unit Cables and Connectors"**	2
	$\bigcirc$					Check the wear debris of the J1-axis swing stopper	Check whether wear debris is generated on the J1-axis swing stopper rotation part. If serious wear occurs on the part that generated the wear debris, replace the part.	3
	$\bigcirc$					Check for water	Check whether the robot is subjected to water or cutting oils. If liquid is found, remove the cause, and wipe off the liquid.	4
$\bigcirc$ Only 1st check	$\bigcirc$					Check for damages to the teach pendant cable, the operation box connection cable or the robot connection cable	Check whether the cable connected to the teach pendant, operation box and robot are unevenly twisted or damaged. If damage is found, replace the damaged cables.	22
$\bigcirc$ Only 1st check	$\bigcirc$					Check for damage to the mechanical unit cable (movable part)	Observe the movable part of the mechanical unit cable, and check for damage. Also, check whether the cables are excessively bent or unevenly twisted. ⇒**"7.2.3 Check the Mechanical Unit Cables and Connectors"**	5
$\bigcirc$ Only 1st Check	$\bigcirc$					Check for damage to the end effector (hand) connection cable	Check whether the end effector connection cables are unevenly twisted or damaged. If damage is found, replace the damaged cables.	6
$\bigcirc$ Only 1st check	$\bigcirc$					Check the connection of each axis motor and other exposed connectors	Check the connection of each axis motor and other exposed connectors. ⇒**"7.2.3 Check the Mechanical Unit Cables and Connectors"**	7

Check and maintenance intervals (Period, Accumulated operating time)						Check and maintenance items	Check points, management and maintenance methods	Periodic maintenance table No.
1 month 320h	3 months 960h	1 year 3840h	1.5 years 5760h	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"	8
	○ Only 1st check	○				Retightening the external main bolts	Retighten the bolts which were installed, removed, or exposed during inspection. Refer to the recommended bolt tightening torque guidelines at the end of the manual. Some bolts are attached with adhesive. 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.	9
	○ Only 1st check	○				Check the fixed mechanical stopper and the adjustable mechanical stopper	Check that there is no evidence of a collision on the fixed mechanical stopper, the adjustable mechanical stopper, and check that the stopper mounting bolts are not loose. Check that the J1-axis swing stopper rotates smoothly. ⇒"7.2.4 Check of Fixed Mechanical Stopper and Adjustable Mechanical Stopper"	10
	○ Only 1st check	○				Clean spatters, sawdust and dust	Check that spatters, sawdust, or dust does not exist on the robot main body. If dust has accumulated, remove it. Especially, clean the robot movable parts well (each joint and the cable protective sleeves).	11
	○ Only 1st check	○				Check the operation of the cooling fan	(When cooling fans are installed on the each axis motor) Check whether the cooling fans are operating correctly. If the cooling fans do not operate, replace them.	12
			○			Replacing the mechanical unit batteries	Replace the mechanical unit batteries. Regardless of operating time, replace batteries at 1.5 years. ⇒"7.3.1 Replacing the Batteries"	13
				○		Replacing the oil of each axis reducer	Replace the oil of each axis reducer and gearbox. ⇒"7.3.2 Replacing the Oil of the Drive Mechanism"	14 to 19
					○	Replacing the mechanical unit cable	Replace the mechanical unit cable. Contact your local FANUC representative for information regarding replacing the cable.	20
					○	Replacing the controller batteries	Replace the controller batteries. Regardless of operating time, replace batteries at 4 years. ⇒"Chapter 7 Replacing batteries of CONTROLLER MAINTENANCE MANUAL(B-83195EN)"	24

7.2   **CHECK POINTS**

7.2.1   **Confirmation of Oil Seepage**

<u>Check items</u>
Confirm whether there is an oil seepage on the rotating parts of each joint axis.
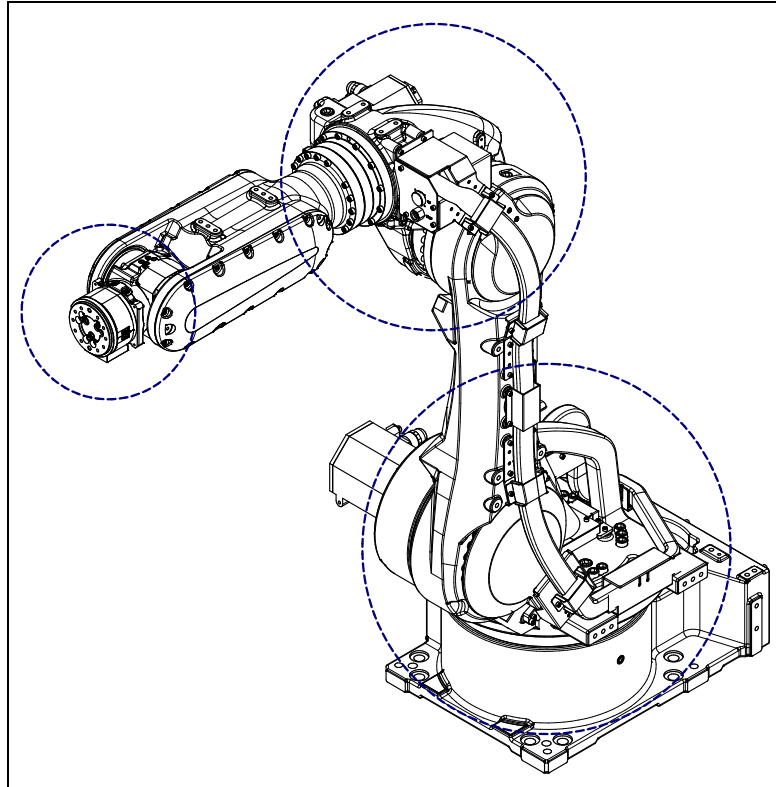

Fig. 7.2.1 (a) Check points of oil seepage

<u>Management</u>
- Oil might accumulate on the outside of the seal lip depending on the movement condition or environment of the axis. If the oil changes to a state of liquid, the oil might drip depending on the axis movement. To prevent oil spots, be sure to wipe away any accumulated oil under the axis components before you operate the robot.
- Also, drive mechanisms might become hot and the internal pressure of the oil bath might rise by frequent repetitive movement and use in high temperature environments. In these cases, normal internal pressure can be restored by venting the oil inlet. (When opening the oil inlet, refer to Subsection 7.3.2.)
- If you must wipe oil frequently, and opening the oil inlet does not stop the seepage, perform the measures below.
     ⇒**"9.1 TROUBLESHOOTING" (Symptom：Oil leakage)**

7.2.2   Confirmation of the Air Control Set (option)

When an air control set is used, check the items below.

| Item	Check items	Check points
1	Air pressure	Check the air pressure using the pressure gauge on the air control set as shown in Fig. 7.2.2 (a). If it does not meet the specified pressure of 0.49 to 0.69 MPa (5-7 kgf/cm^2), adjust it using the regulator pressure-setting handle.
2	Lubricator oil mist quantity	Check the number of oil drops during operation. If it does not meet the specified value (1 drop/10-20 sec), adjust it using the lubricator control knob. The lubricator becomes empty in about 10 to 20 days under normal operation.
3	Lubricator oil level	Check to see that the air control set oil level is within the specified level.
4	Leakage from hose	Check the joints, tubes, etc. for leaks. Retighten the joints or replace parts, as required.
5	Drain	Check the drain and release it. When quantity of the drain is remarkable, examine the setting of the air dryer to the air supply side.
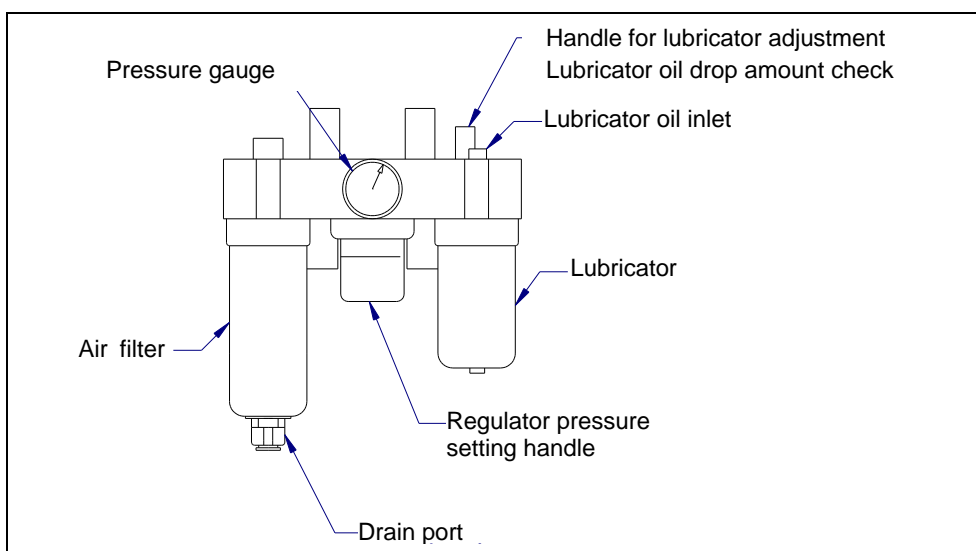
Fig. 7.2.2 (a) Air control set (option)

7.2.3 **Check the Mechanical Unit Cables and Connectors**

Check points of the mechanical unit cables

J1, J2, and J3 movable parts and fixed part cables can interfere with the peripheral equipment

* For the J1-axis, inspect the cables from above the J2 base and from the side by removing the metal plate on the side of the J1 base.
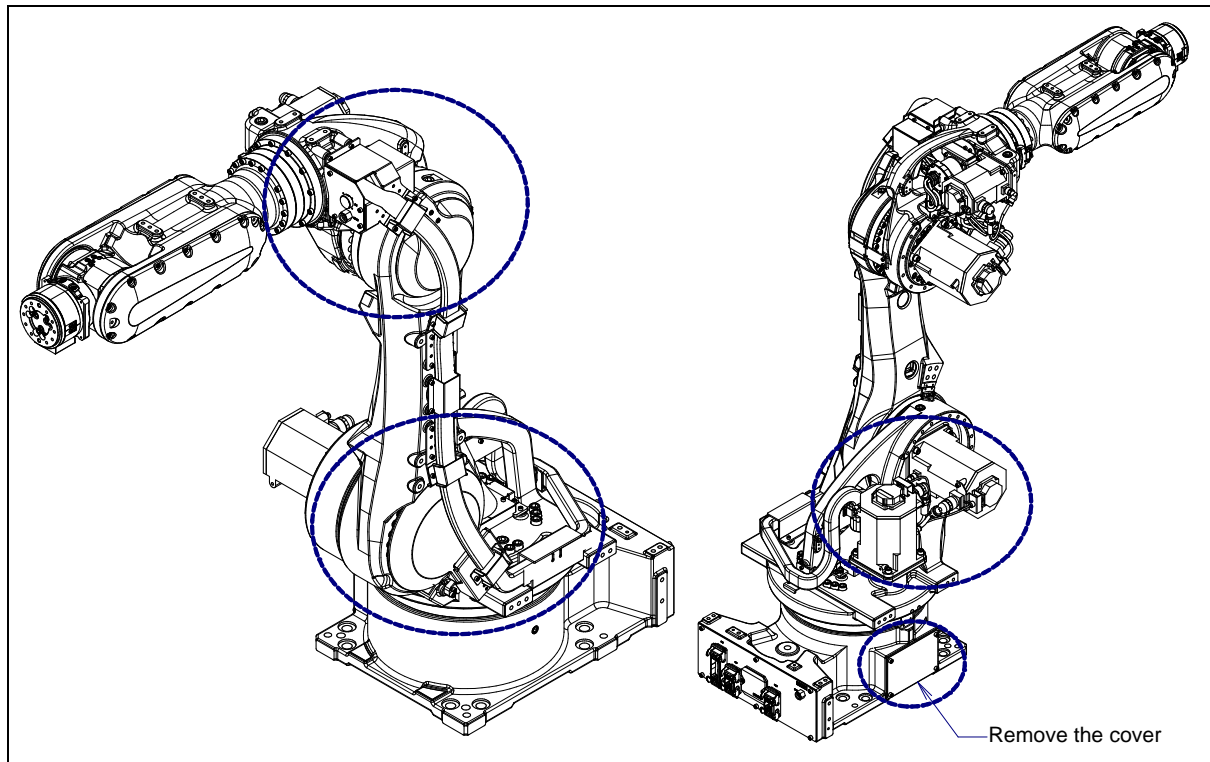

Remove the cover

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

Check items

＜Cable protective sleeve＞

- Check that no holes or tears exist on the cable protective sleeves.
- If there is damage as shown in Fig. 7.2.3 (b), replace the cable protective sleeves.

Fig. 7.2.3 (b) Damage on the cable protective sleeve

＜Cables＞
- Check that there is no wear or damage on the cable jacket.
- If the inside wire strands are exposed due to wear or damage, replace the cables.

Open the sleeve

Check the jacket

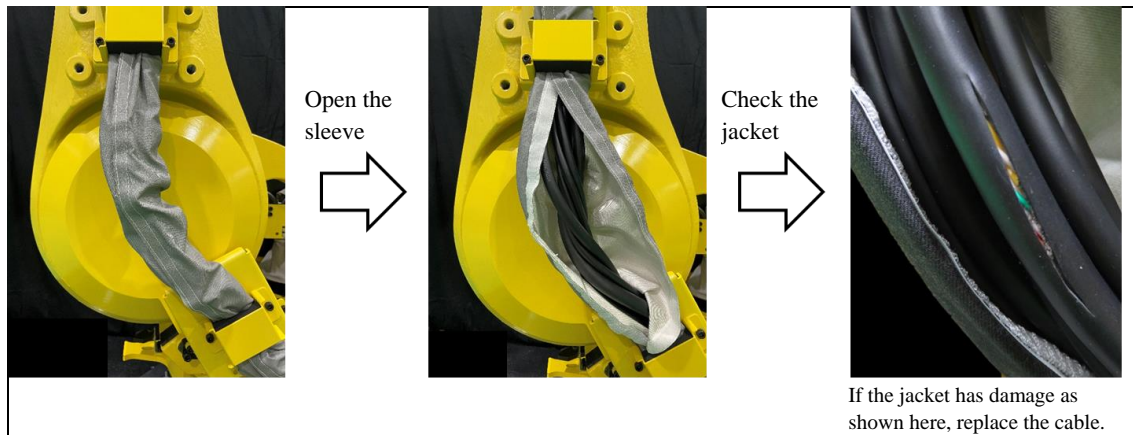If the jacket has damage as shown here, replace the cable.

Fig. 7.2.3 (c) Cable check method

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

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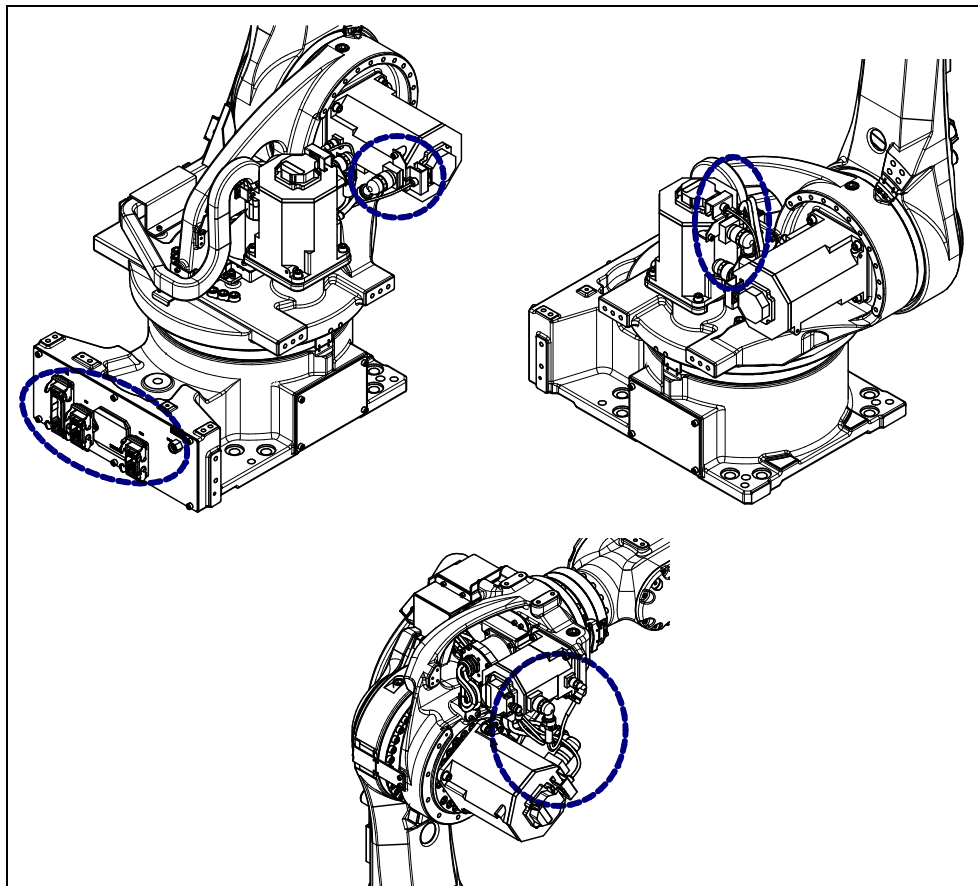- Earth terminal: Check the terminal for tightness.

Fig. 7.2.3 (d) Connector Inspection points

7.2.4   Check of Fixed Mechanical Stopper and Adjustable Mechanical Stopper

- Check that there is no evidence of a collision on the mechanical stopper and the adjustable mechanical stopper. If there is evidence of a collision on the stopper, replace the parts.
- Check the looseness of the stopper mounting bolts. If they are loose, retighten them. Be sure to check the looseness of the mounting bolts of the J1-axis swing stopper.
- Check that the J1-axis swing stopper rotates smoothly.
- Refer to Section 6.2 of the operator's manual for details regarding the adjustable mechanical stopper.
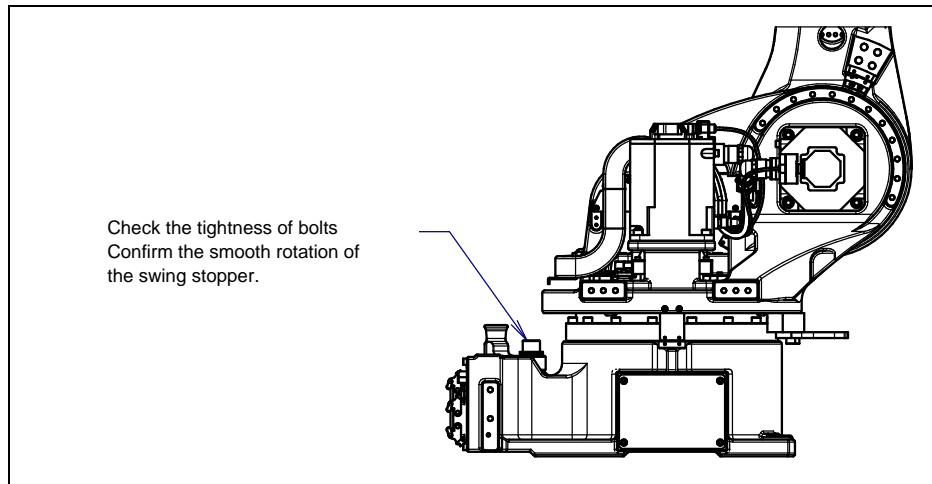
Check the tightness of bolts
Confirm the smooth rotation of
the swing stopper.

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

7.3   MAINTENANCE

7.3.1   Replacing the Batteries (1.5 years (5760 hours) Periodic 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 of replacing the battery
1   Press the EMERGENCY STOP button to stop the robot motion.

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

2   Remove the battery case cap. (Fig. 7.3.1 (a))
3   Take out the old batteries from the battery case.
4   Insert new batteries into the battery case while observing their correct direction.
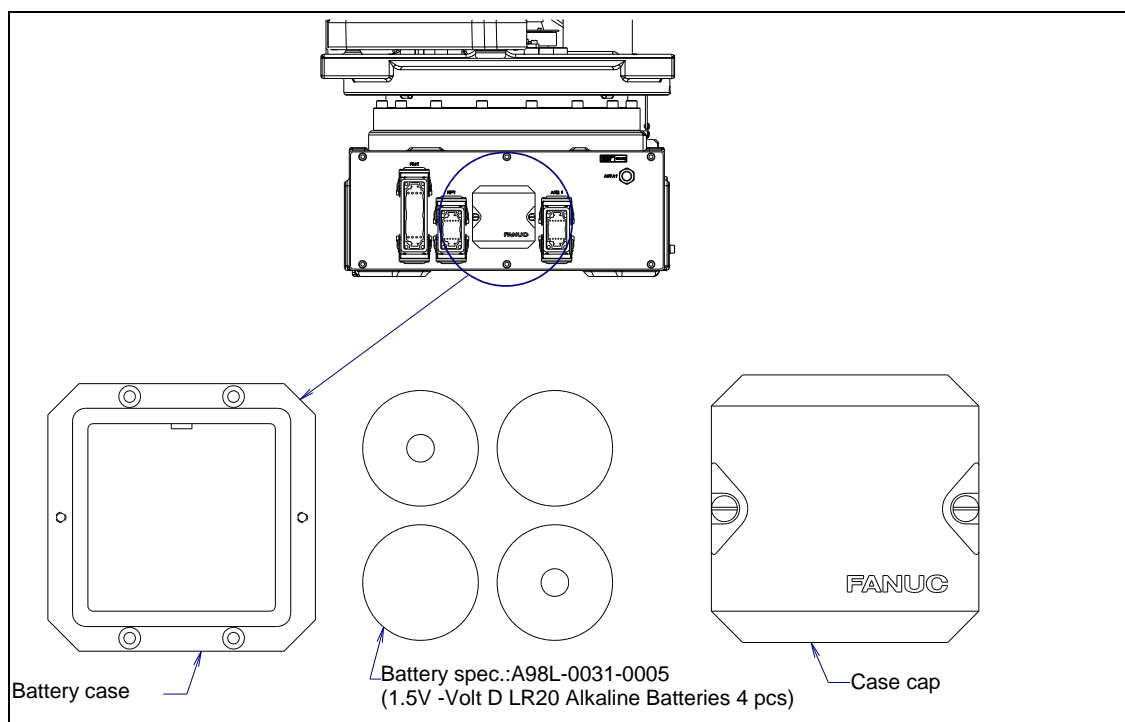5   Close the battery case cap.

Battery case

Battery spec.:A98L-0031-0005
(1.5V -Volt D LR20 Alkaline Batteries 4 pcs)

Case cap

Fig. 7.3.1 (a) Replacing the battery

7.3.2   Replacing the Oil of the Drive Mechanism (3 years (11520 hours) Periodic Maintenance)

According to below, replace the oil of the reducers of J1 to J6 at the intervals based on every 3 years or 11520 hours, whichever comes first. See Table 7.3.2 (a) for the oil name and the quantity.

Table 7.3.2 (a) Oil for 3-years (11520 hours) periodical replacement

Models	Oiling point	Quantity	Gun tip pressure	Specified oil
M-800*i*A/60	J1-axis reducer	4350g (5000ml)	0.15MPa or less (NOTE)	Spec. : A98L-0040-0323
	J2-axis reducer	2300g (2640ml)		
	J3-axis reducer	1740g (2000ml)		
	J4-axis reducer	1130g (1290ml)		
	J5-axis reducer	200g (230ml)		
	J6-axis reducer	170g (195ml)		

For oil replacement or replenishment, use the postures indicated below.

Table 7.3.2 (b) Postures for oiling

Supply position	Posture					
	J1	J2	J3	J4	J5	J6
J1-axis reducer	Arbitrary	Arbitrary	Arbitrary	Arbitrary	Arbitrary	Arbitrary
J2-axis reducer						
J3-axis reducer		0°				
J4-axis reducer		Arbitrary	0°			
J5/J6-axis reducer				0°	0°	

> ⚠ **CAUTION**
> 1 There is severe risk of gear damage in case robot is operated with oil shortage. Please make sure the gearbox is always filled with correct amount of oil.
> 2 Failure to supply oil correctly may cause damage to the seal, which would in turn lead to oil leakage and abnormal operation. Use specified oil. Use of non-approved oil may damage the reducer or lead to other problems.

1   Move the robot to the oiling posture described in Table 7.3.2 (b).
2   Turn off controller power.
3   Put an oil pan or the like under the oil outlet.
4   Remove seal bolts of the oil outlet and the ventilator hole (only for J5, J6-axis), then drain all oil.
5   Install seal bolts or taper plugs in the oil outlet. When reusing the seal bolts or the taper plugs, be sure to seal them with seal tape.
6   Remove the taper plug of the oil inlet.
7   Add the specified oil and quantity as shown in Table 7.3.2 (a) to the oil inlet for each axis. Note: Measure the amount carefully and account for any spillage to ensure that appropriate amount is added to each axis.
8   Attach taper plugs in the oil inlet and ventilator hole (only for J5, J6-axis). When reusing the taper plugs, be sure to seal them with seal tape.
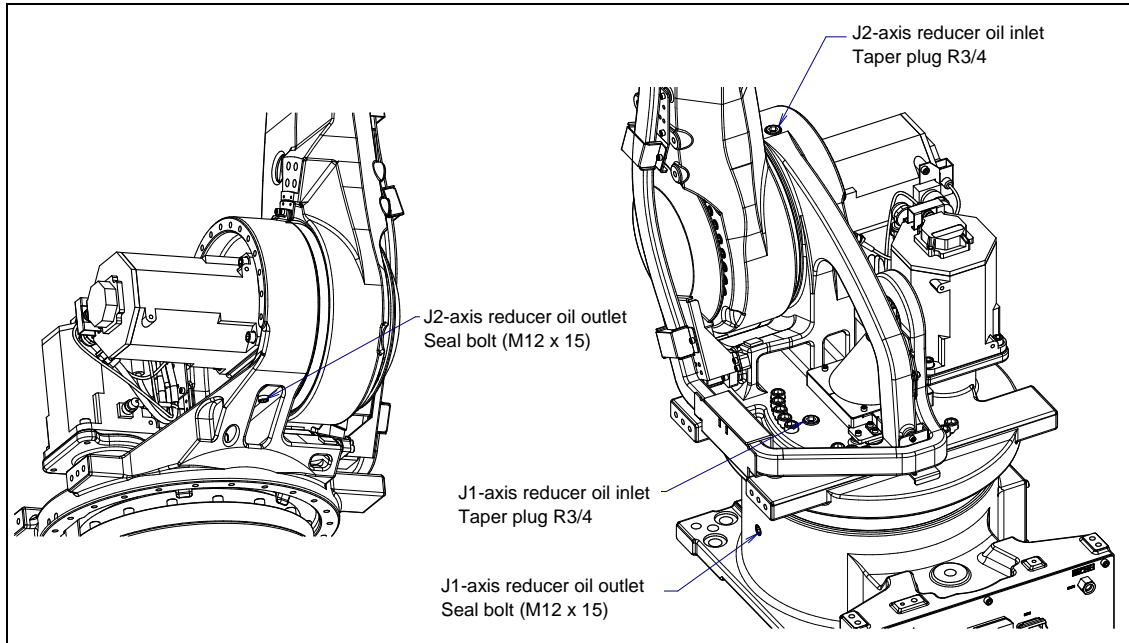
Fig. 7.3.2 (a) Replacing oil of the J1/J2-axis reducer
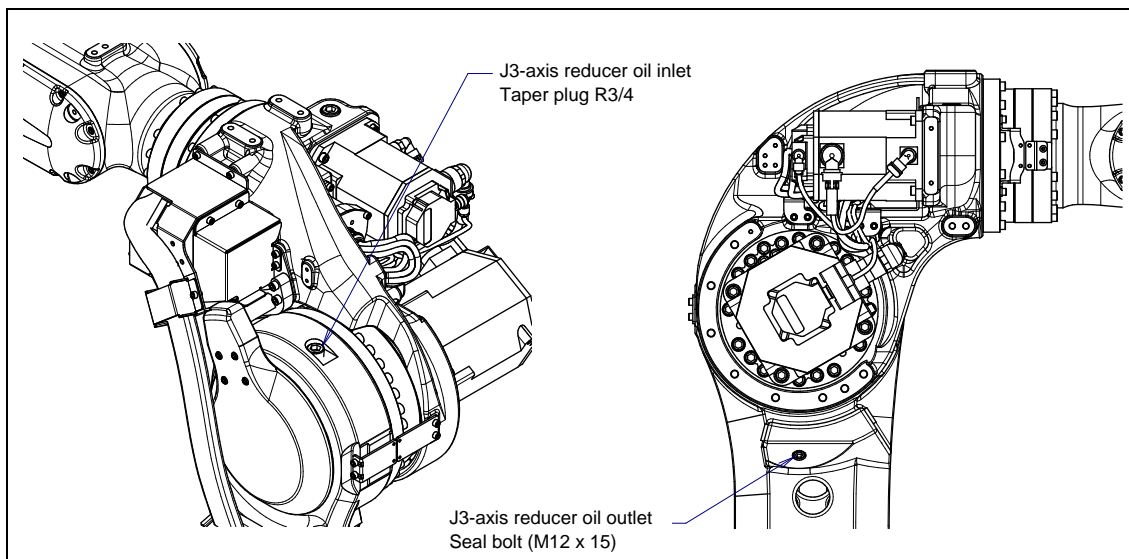
Fig. 7.3.2 (b) Replacing oil of the J3-axis reducer
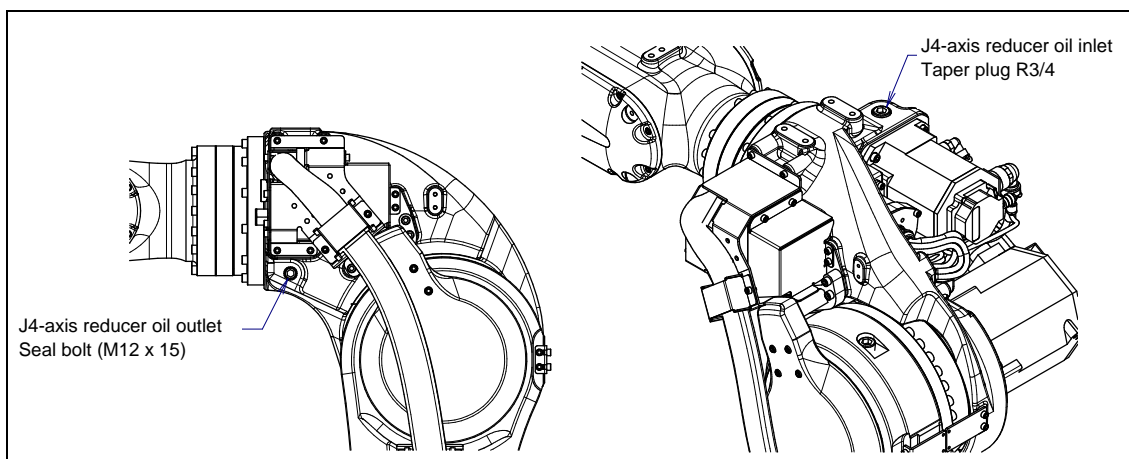
Fig. 7.3.2 (c) Replacing oil of the J4-axis reducer
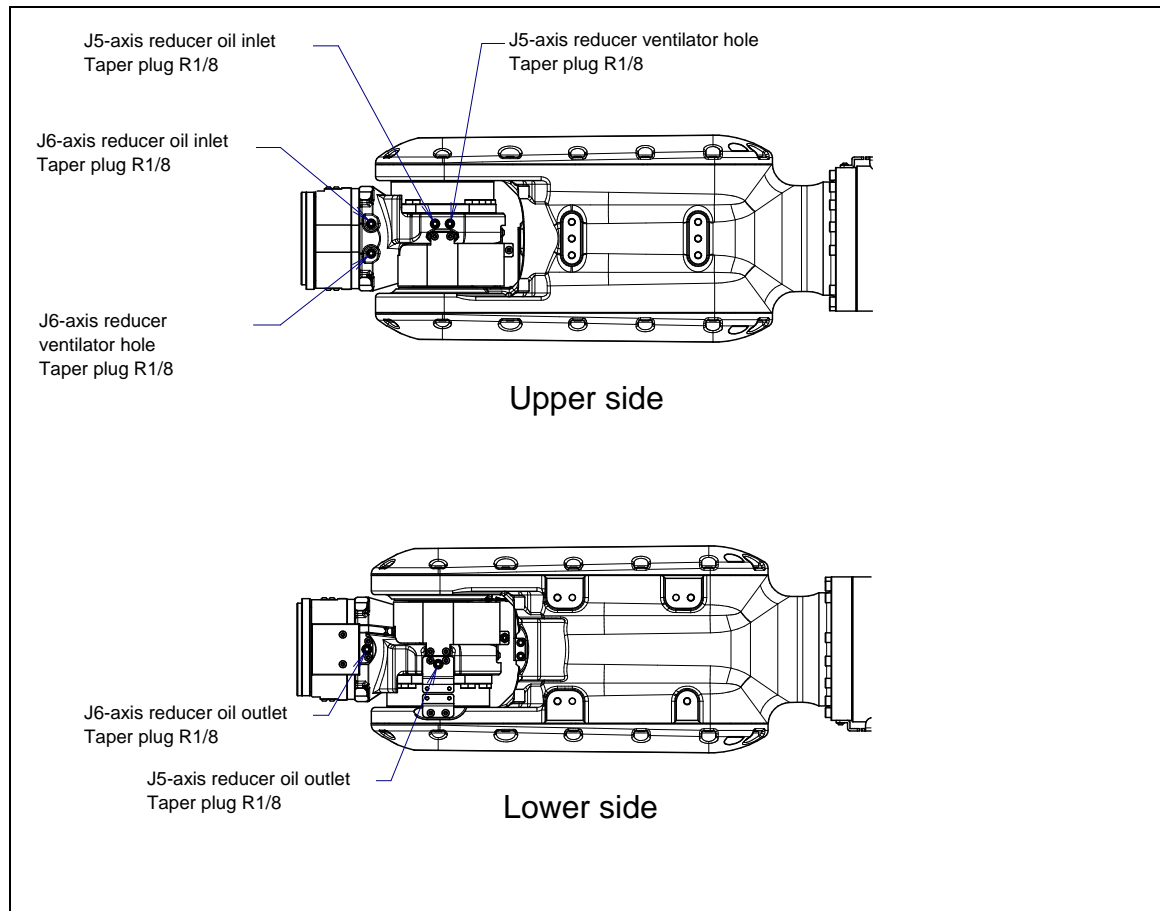
Fig. 7.3.2 (d) Replacing oil of the J5/J6-axis reducer

Table 7.3.2 (c) Spec. of seal bolts and taper plugs

Parts name	Specifications
Seal bolt (M12)	A97L-0218-0417#121515
Taper plug (R1/8)	A97L-0001-0436#2-1D
Taper plug (R3/4)	A97L-0001-0436#2-6D

7.4   STORAGE

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

8   MASTERING

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

> ⚠ **CAUTION**
> The motion limits are temporarily invalid during mastering. Cables may be damaged if the J1-axis exceeds +/-185⁰.

8.1   OVERVIEW

The current position of the robot is determined according to the pulse count value supplied from the Pulsecoder on each axis.
Mastering is factory-performed. It is unnecessary to perform mastering in daily operations. However, mastering becomes necessary after:
· Motor replacement
· Pulsecoder replacement
· Scale replacement
· Sensor cable replacement
· Reducer replacement
· 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 8.1 (a) describes the following mastering methods.

Table 8.1 (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 performed at a user-specified position. The corresponding count value is obtained from the rotation count of the Pulsecoder connected to the relevant motor and the rotation angle within one rotation. Quick mastering uses the fact that the absolute value of a rotation angle within one rotation will not be lost. (All axes at the same time)
Quick mastering for single axis	This is performed at a user-specified position for one axis. The corresponding count value is obtained from the rotation count of the Pulsecoder connected to the relevant motor and the rotation angle within one rotation. Quick mastering uses the fact that the absolute value of a rotation angle within one rotation will not be lost.
Single-axis mastering	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, you must 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 accurate mastering (fixture position mastering), contact your local FANUC representative.

> ⚠ **CAUTION**
> 1 M-800*i*A series has been calibrated with high accuracy since the shipment. If mastering except for Quick mastering (including Quick mastering for single axis) is performed, the accuracy may deteriorate and *i*RCalibration signature recalibration will be required. Contact your local FANUC representative if necessary.
> 2 If mastering is performed incorrectly, the robot may behave unexpectedly. This is very dangerous. Therefore, the positioning screen is designed to appear only when the $MASTER_ENB system variable is 1 or 2. After performing positioning, press F5 [DONE] on the positioning screen. The $MASTER_ENB system variable is reset to 0 automatically, thus hiding the positioning screen.
> 3 Before performing mastering, it is recommended that you back up the current $SYSMAST.SV file.

8.2　ENABLING/DISABLING OF THE *i*RCalibration SIGNATURE FUNCTION

In case of M-800*i*A series, setting the *i*RCalibration signature to DISABLE is required before performing mastering.

> **NOTE**
> If *i*RCalibration signature function is set to disable, TCP position will change.

Procedure for setting of enabling/disabling
1　Press the [MENU] key.
2　Press [0 NEXT] and select [4 STATUS].
3　Press F1[TYPE], select "Signature status" from the menu. Signature status screen will be displayed.
4　Select "2 Signature", then press F4[ENABLE]/F5[DISABLE].
5　Cycle power of the controller.
6　Display the signature status screen. Then confirm the "2 Signature" is change to F4[ENABLE]/F5[DISABLE].

8.3 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.

If "SRVO-062 BZAL" alarm or "SRVO-068 DTERR" alarm occurred, and you cannot release the alarm, Please check there is no faulty wiring or disconnected part.

8.4   ZERO POSITION MASTERING

Zero-position mastering (witness mark mastering) is performed with all axes set at the 0-degree position.
A zero-position mark (witness mark) is attached to each robot axis. (Fig. 8.4 (a)) This mastering is performed with all axes set at the 0-degree position using their respective witness marks.
Zero-position mastering involves a visual check, and might not be highly accurate. It should be used only as a quick-fix method.

Zero-position Mastering Procedure
1   According to Subsection 8.2, set the signature to disable.
2   Press the [MENU] key to display the screen menu.
3   Select [0 NEXT] and press [6 SYSTEM].
4   Press F1 [TYPE], display the screen change menu.
5   Select [Master/Cal]. The positioning screen will be displayed.

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


[ TYPE ]   LOAD   RES_PCA              DONE
```

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

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

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

```
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>
```

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

DONE

F5

10   Cycle power of the controller.
11   Set the signature to enable referring to Subsection 8.2.

Table 8.4 (a) Posture with position marks (witness mark) aligned

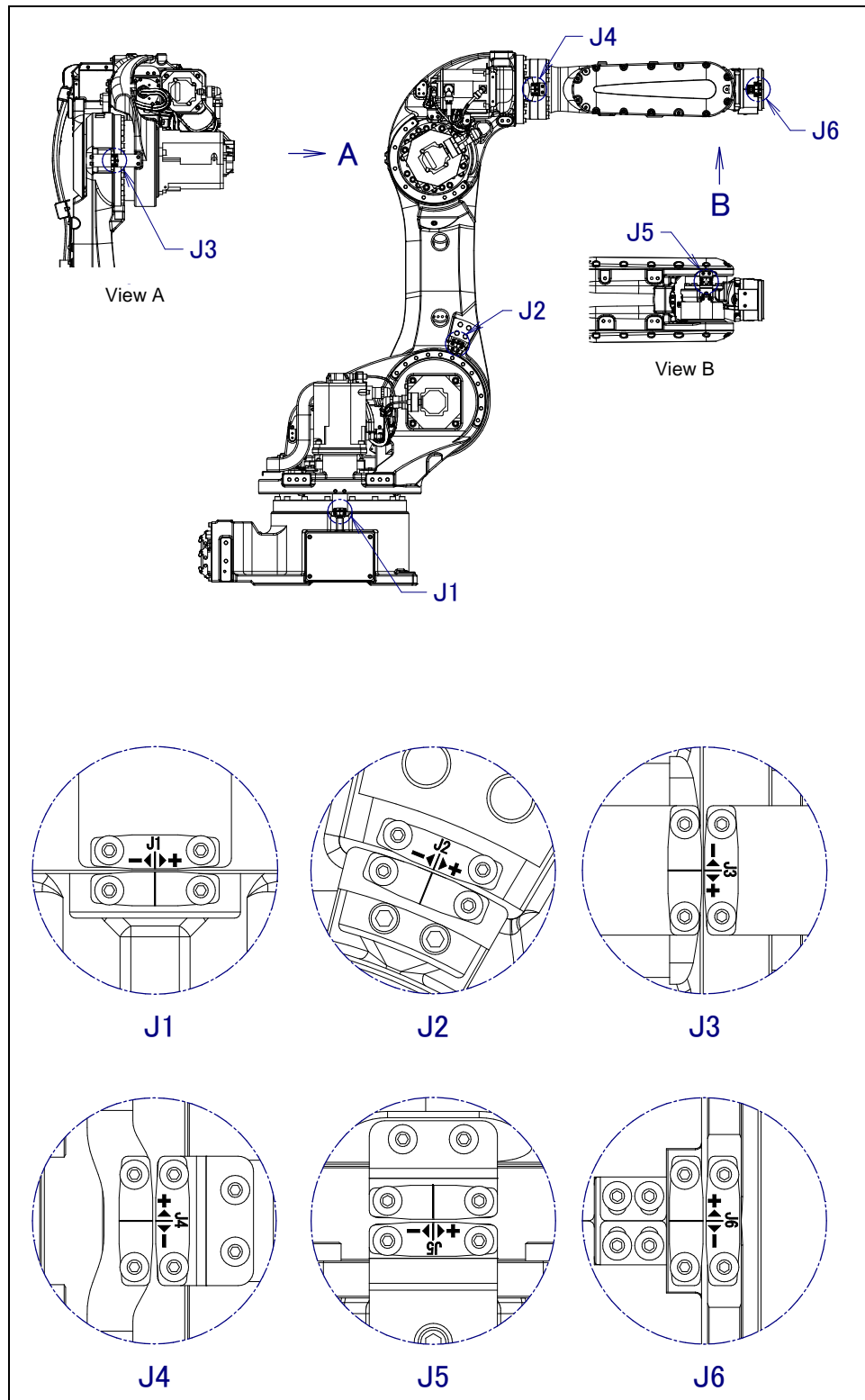| Axis	Position
J1-axis	0 deg
J2-axis	0 deg
J3-axis	0 deg (NOTE) When J2-axis is 0 deg.
J4-axis	0 deg
J5-axis	0 deg
J6-axis	0 deg

Fig. 8.4 (a) Zero-position mark (witness mark) for each axis

8.5   QUICK MASTERING

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 fact that the absolute value of a rotation angle within one rotation will not be lost.

Quick mastering is factory-performed at the position indicated in Table 8.4 (a). If possible, do not change the setting.

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

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

Procedure Recording the Quick Mastering Reference Position
1   Select [6 SYSTEM].
2   Select [Master/Cal]. The positioning screen will be displayed.

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

[ TYPE ]   LOAD   RES_PCA           DONE
```

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

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

```
F4
```

5   Cycle power of the controller.

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

Procedure of Quick Mastering

1 According to Subsection 8.2, set the signature to disable.
2 Press the [MENU] key to display the screen menu.
3 Select [0 NEXT] and press [6 SYSTEM].
4 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]
```

5 Jog the robot to the quick mastering reference position.
6 Move the cursor to [3 QUICK MASTER] and press [ENTER]. Press F4 [YES]. Quick mastering
   data is saved.

```
2 ZERO POSITION MASTER
3 QUICK MASTER
4 QUICK MASTER FOR SINGLE AXIS
```
        F4

7 Select [7 CALIBRATE] and press F4 [YES]. Calibration is executed. Calibration is also executed by
   cycling power.
8 After completing the calibration, press F5 [Done].

                DONE
              F5

9 Cycle power of the controller.
10 According to Subsection 8.2, set the signature to enable.

8.6   QUICK MASTERING FOR SINGLE AXIS

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

Quick mastering is factory-performed at the position indicated in Table 8.3 (a). If possible, do not change the setting.

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

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

Procedure Recording the Quick Mastering Reference Position
1   Select [6 SYSTEM].
2   Select [Master/Cal]. The positioning screen will be displayed.

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

[ TYPE ]   LOAD   RES_PCA            DONE
```

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

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

```
F4
```

5   Cycle power of the controller.

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

Procedure of Quick Mastering for single axis

1 According to Subsection 8.2, set the signature to disable.
2 Press the [MENU] key to display the screen menu.
3 Select [0 NEXT] and press [6 SYSTEM].
4 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]
```

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

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

                                        EXEC
```

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

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

7 Jog the robot to the quick mastering reference position.
8 Press F5 [EXEC]. Mastering is performed. So, (SEL) is reset to 0, and [ST] is re-set to 2.
9 Select [7 CALIBRATE] and press F4 [YES]. Calibration is executed. Calibration is also executed by cycling power.
10 After completing the calibration, press F5 Done.

DONE

F5
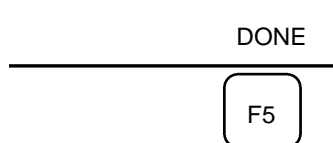
11   Cycle power of the controller.
12   According to Subsection 8.2, set the signature to enable.

8.7   SINGLE AXIS MASTERING

Single axis mastering is performed for one axis at a time. The mastering position for each axis can be specified by the user.
Single axis mastering can be used, if mastering data for a specific axis is lost, for example, because a low voltage has been detected on the pulse counter backup battery or because the Pulsecoder has been replaced.

```
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
```

Table 8.6 (a) Items set in single axis mastering

Item	Description
Current position (ACTUAL AXIS)	The current position of the robot is displayed for each axis in degree units.
Mastering position (MSTR POS)	A mastering position is specified for an axis to be subjected to single axis mastering. It would be convenient 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   According to Subsection 8.2, set the signature to disable.
2   Press the [MENU] key to display the screen menu.
3   Select [0 NEXT] and press [6 SYSTEM].
4   Select [Master/Cal]. The positioning screen will be displayed.

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


 [ TYPE ]   LOAD   RES_PCA            DONE
```

5   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
```

6   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.
7   Jog the robot to the mastering position.
8   Enter axis data for the mastering position.
9   Press F5 [EXEC]. Mastering is performed. So, (SEL) is reset to 0, and [ST] is re-set to 2 or 1.

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

                                           EXEC
```

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

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


[ TYPE ]   LOAD   RES_PCA              DONE
```

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

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

```
                    DONE
 ───────────────────────────┐
                     ┌──────┐
                     │  F5  │
                     └──────┘
```

13   Cycle power of the controller.

14   According to Subsection 8.2, set the signature to enable.

- 71 -

8.8   MASTERING DATA ENTRY

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

> **NOTE**
>   Mastering data entry of M-800iA Series needs the back up of $SYSMAST.SV file.

Mastering data entry method

1   Turn off the controller power.
2   With [PREV] key and [NEXT] key held down, turn on the controller power. The configuration menu will be displayed.
3   Select [3. Controlled start]. The setting screen for the controlled start menu will be displayed.
4   Press the [MENU] key and select [5 FILE].
5   Place the cursor on the back up of $SYSMAST.SV file, then press F3 [LOAD] and press F4 [YES].
6   Press [FCTN] key and select [1 START (COLD)]. A cold start is performed.
7   Press the [MENU] key, then select [0 NEXT] and press [6 SYSTEM].
8   Select [Variables]. The system variable screen will be displayed.
9   Select $DMR_GRP.

```
                                    AUTO
SYSTEM Variables                         JOINT 1%
 $DMR_GRP                                1/1
     1      [1]            DMR_GRP_T
```

```
                                    AUTO
SYSTEM Variables                         JOINT 1%

 $DMR_GRP                                1/29

     1    $MASTER_DONE      FALSE
     2    $OT_MINUS         [9] of BOOLEAN
     3    $OT_PLUS          [9] of BOOLEAN
     4    $MASTER_COUNT      [9] of INTEGER
     5    $REF_DONE         FALSE
     6    $REF_POS          [9] of REAL
     7    $REF_COUNT         [9] of INTEGER
     8    $BCKLSH SIGN      [9] of BOOLEAN


   [ TYPE ]                TRUE      FALSE
```

10   Set $MASTER_DONE to TRUE.

```
                                AUTO
SYSTEM Variables                 JOINT 1%

 $DMR GRP                        1/1
   1  $MASTER_DONE   TRUE
   2  $OT MINUS      [9] of BOOLEAN
[TYPE]                TRUE   FALSE
```

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

```
                                    DONE

                                  ┌─────┐
                                  │ F5  │
                                  └─────┘
```
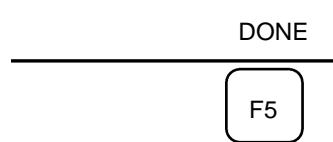
8.9   VERIFYING MASTERING

1   How to verify that the robot is mastered properly:
    Usually, positioning is performed automatically when the power is turned on. To check whether mastering has been performed correctly, examine if the current displayed position matches the actual robot position by using the procedure described below:
    (1) Reproduce a particular point in a program. Check whether the point agrees with the specified position.
    (2) Set all axes of the robot to their 0-degree (0 rad) positions. Check that the zero-degree position marks indicated in Section 8.4 of the OPERATOR'S MANUAL are aligned. There is no need to use a visual aid.
         If the displayed and actual positions do not match, the counter value for a Pulsecoder may have been invalidated as a result of an alarm described in 2. Alternatively, the mastering data in system variable $DMR_GRP.$MASTER_COUN may have been overwritten as a result of an operation error or some other reason.
         Compare the data with the values indicated on the supplied data sheet. This system variable is overwritten whenever mastering is performed. Whenever mastering is performed, record the value of the system variable on the data sheet.
2   Alarm types displayed during mastering and their solution method:
    (1) BZAL alarm
         This alarm is displayed if the Pulsecoder's backup battery voltage decreases to 0 V while the power to the controller is disconnected. Furthermore, if the Pulsecoder connector is removed for cable replacement, etc. this alarm is displayed as the voltage decreases to 0. Check to see if the alarm will disappear by performing a pulse reset (See Section 8.3.). Then, cycle power of the controller to check if the alarm disappears or not.
         The battery may be drained if the alarm is still displayed. Perform a pulse reset, and turn off and on the controller power after replacing the battery. Note that, if this alarm is displayed, all the original data held by the Pulsecoder will be lost. Mastering is required.
    (2) BLAL alarm
         This alarm is displayed if the voltage of the Pulsecoder's backup battery has fallen to a level where backup is no longer possible. If this alarm is displayed, replace the battery with a new one immediately while keeping the power turned on. Check whether the current position data is valid, using the procedure described in 1.
    (3) Alarm notification like CKAL, RCAL, PHAL, CSAL, DTERR, CRCERR, STBERR, and SPHAL may have trouble with Pulsecoder, contact your local FANUC representative.

9   TROUBLESHOOTING

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

9.1   TROUBLESHOOTING

Table 9.1 (a) shows the major troubleshooting symptoms that may occur in the mechanical unit and their probable causes. If you cannot pinpoint the cause of a failure 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 9.1 (a) Troubleshooting

Symptom	Description	Cause	Measure
Vibration Noise	- As the robot operates, its base plate lifts off the floor plate. - There is a gap between the base plate and the floor plate. - There is a crack in the weld that fastens the base plate to the floor plate.	[Base plate and floor plate fastening] - It is likely that the base plate is not securely fastened to the floor plate because of poor welding. - If the base plate is not securely fastened to the floor plate, it lifts as the robot operates, allowing the base and floor plates to strike each other which, in turn, leads to vibration.	- Re-weld the base plate to the floor plate. - If the weld is not strong enough, increase its width and length.
	- The J1 base lifts off the base plate as the robot operates. - There is a gap between the J1 base and base plate. - A J1 base retaining bolt is loose.	[J1 base fastening] - It is likely that the robot J1 base is not securely fastened to the base plate. - Probable causes are a loose bolt, an insufficient degree of surface flatness, or contamination caught between the base plate and floor plate. - If the robot is not securely fastened to the base plate, the J1 base lifts the base plate as the robot operates, allowing the base and floor plates to strike each other which, in turn, leads to vibration.	- If a bolt is loose, apply LOCTITE and tighten it with the appropriate torque. - Adjust the base plate surface flatness to within the specified tolerance. - If there is any contamination, remove it. - Apply adhesive between the J1 base and base plate.
	- 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 deforms the rack or floor, and causes 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.

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

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 the invalid value parameter was set.	- Refer to the Controller Maintenance Manual for troubleshooting related to the controller and amplifier. - Replace the motor of the axis that is vibrating, and check whether vibration still occurs. For the method of replacement, contact your local FANUC representative. - If vibration occurs only when the robot assumes a specific posture, it is likely that a cable in the mechanical unit is broken. - Shake the movable part cable while the robot is at rest, and check whether an alarm occurs. If an alarm or any other abnormal condition occurs, replace the mechanical unit cable. - Check whether the cable jacket of the robot connection cable is damaged. If so, replace the connection cable, and check whether vibration still occurs. - Check whether the power cable jacket is damaged. If so, replace the power cable, and check whether vibration still occurs. - Check that the robot is supplied with the rated voltage. - Check that the robot control parameter is set to a valid value. If it is set to an invalid value, correct it. Contact your local FANUC representative for further information if necessary.

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

Rattling	- While the robot is not supplied with power, pushing it by hand wobbles part of the mechanical unit.
	- There is a gap on the mounting surface of the mechanical unit.
		[Mechanical unit mounting 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 with the appropriate torque.
			  - Motor retaining bolt
			  - Reducer retaining bolt
			  - Reducer shaft retaining bolt
			  - Base retaining bolt
			  - Arm retaining bolt
			  - Casting retaining bolt
			  - End effector retaining bolt

Motor overheat	- The motor overheated due to the temperature in the installation area rose. - After a cover was attached to the motor, the motor overheated. - After changing the Robot control program or the load, the motor overheat.	[Ambient temperature] - It is likely that the motor overheated along with the ambient temperature rose, and could not release heat. [Operating condition] - It is likely that the overcurrent is above the specified permissive average current.	- Reducing the ambient temperature is the most effective means of preventing overheat. - Having the surroundings of the motor well ventilated enables the motor to release heat efficiently, thus preventing overheat. - If there is a source of heat near the motor, it is advisable to install shielding to protect the motor from heat radiation. - Relaxing the robot control program and load condition is effective to reduce the average current. Thus, prevent overheat. - The teach pendant can monitor the average current. Check the average current when the robot control program launched.

Symptom	Description	Cause	Measure
Motor overheat (Continued)	- After a robot control parameter (load setting etc.) was changed, the motor overheated.	[Parameter] - If data input for a workpiece is invalid, the robot cannot be accelerated or decelerated normally, so the average current increases, leading to motor overheat.	- As for load setting, Input an appropriate parameter referring to Section 4.3 of the operator's manual.
	- Symptom other than stated above	[Mechanical section problems] - It is likely that problems occurred in the mechanical unit drive mechanism, thus placing an excessive load on the motor. [Motor problems] - It is likely that a failure of the motor brake resulted in the motor running with the brake applied, thus placing an excessive load on the motor. - It is likely that a failure of the motor prevented it from delivering its rated performance, thus causing an excessive current to flow through the motor. - It is likely that cooling fan is broken.	- 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. - If the average current falls after the motor is replaced, it indicates that the former motor was faulty. - If the cooling fan is broken, replace it with a new one.

Oil leakage	- Oil leaks from the mechanical unit.	[Poor sealing]
		- Probable causes are a crack in the casting, a damaged O-ring, a damaged oil seal, a loose seal bolt, or a loose taper plug.
		- The casting may crack with excessive force caused in collision.
		- An O-ring can be damaged if it is trapped or cut during disassembling or re-assembling.
		- An oil seal may be damaged if dust scratches the lip.
		- A loose seal bolt or a taper plug may allow oil to leak along the threads.
			- If the casting cracks, sealant can be used as a quick-fix to prevent further oil leakage. However, the component must be replaced as soon as possible, as the crack will widen.
			- O-rings are used in the locations listed below.
			  - Motor coupling section
			  - Reducer (case and shaft) coupling section
			  - Wrist coupling section
			  - J3 arm coupling section
			  - Inside the wrist
			- Oil seals are used in the locations stated below.
			  - Inside the reducer
			  - Inside the wrist
			- Seal bolts and taper plugs are used in the locations stated below.
			  - Oil inlet/outlet
			  - Oil ventilator hole

Symptom	Description	Cause	Measure

Dropping axis	- An axis falls because the brake does not function.
	- An axis falls gradually when it should be at rest.
		[Brake drive relay and motor]
		- It is likely that brake drive relay contacts are stuck to each other 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 has been damaged, preventing the brake from operating efficiently.
		- It is likely that oil soak through the motor, causing the brake to slip.
			- Check whether the brake drive relay contacts are stuck each other or not. If they are found to be stuck, replace the relays.
			- Replace the motor after confirming following symptoms.
			  - Brake shoe is worn out
			  - Brake main body is damaged
			  - Oil soak through the motor

Displace-ment	- 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. - If the repeatability becomes stable, it is likely that a collision imposed an excessive load, leading to slipping on the base surface or the fastening surface of each axis arm or reducer. - It is likely that the Pulsecoder is faulty.	- If the repeatability is unstable, repair the mechanical unit by referring to the above descriptions of vibration, noise, and rattling. - If the repeatability is stable, correct the taught program. The problem will not reoccur unless another collision occurs. - If the Pulsecoder is faulty, replace the motor.
	- Displacement occurs only in specific peripheral equipment.	[Peripheral equipment displacement] - It is likely that an external force was applied to the peripheral equipment, thus shifting its position relative to the robot.	- Correct the setting of the peripheral equipment position. - Correct the taught program.
	- Displacement occurred after a parameter was changed.	[Parameter] - It is likely that the mastering data was overwritten, and the robot origin had misaligned.	- Re-enter the previous optimal mastering data. - If correct mastering data is unavailable, perform mastering again.

Symptom	Description	Cause	Measure
CLALM alarm occurred. Move error excess alarm occurred.	- Ambient temperature of the robot installation location is low, CLALM alarm is displayed on the teach pendant screen. - Temperature of the robot installation position is low, "Move error excess" alarm is displayed on the teach pendant screen.	[Peripheral temperature] - When the robot is used in a low temperature environment that is near to 0ºC, or the robot is not operated for a long time in an environment that is less than 0ºC, there will be a large viscous resistance of the drive train immediately after starting which will cause the alarm.	- Perform a warm up operation or a low speed operation for several minutes.
	- After changing the motion program or the load condition, the CLALM alarm is displayed. - After changing the motion program or the load condition, the "Move error excess" alarm is displayed.	- It is likely that a robot collision occurred.	- If a robot collision has occurred, press the [RESET] key while pressing the [SHIFT] key. Then, jog the robot in the opposite direction while pressing the [SHIFT] key. - Check the motion program.
		[Overload] - It is likely that load exceeded the permissible value. - It is likely that the motion program is too severe for the robot. · Tight motion such as reverse motion using "CNT". · Linear motion occurs near singularity point where axes revolve in high speed.	- Check the permissible value of the robot payload. If the load exceeds the permissible value, reduce the load or change the motion program. - Consider minimizing the cycle time by reducing the speed or acceleration, and changing the motion program. - Check that the load setting is performed correctly.
	- None of the symptoms stated above are the problem.	- It is likely the vibration occurred.	- Refer to the Symptoms: Vibration, Noise section of this troubleshooting for more information.
		- If the power source voltage drops below the rating, a vibration might occur.	- Check that the robot is supplied with the proper rated voltage.
BZAL alarm displayed.	- BZAL alarm 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.
Encoder alarm displayed	- Primary encoder alarm is displayed on the teach pendant screen.	- The cause of the alarms occurring at the same time is Pulsecoder.	- Check the Pulsecoder.
	- Secondary encoder alarm is displayed on the teach pendant screen.	- The cause of the alarms occurring at the same time is secondary encoder.	- Contact your local FANUC representative.

APPENDIX

A   PERIODIC MAINTENANCE TABLE

FANUC Robot M-800*i*A/60   **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
Mechanical unit	1	Check for external damage or peeling paint	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	2	Check damages of the cable protective sleeves	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	3	Check wear debris of the J1-axis swing stopper	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	4	Check for water	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	5	Check damages of the mechanical unit cable (movable part)	0.2H	—		○			○				○			
	6	Check damage of the end effector (hand) cable	0.1H	—		○			○				○			
	7	Check tightness of motors and connectors.	0.2H	—		○			○				○			
	8	Retighten the end effector bolts	0.2H	—		○			○				○			
	9	Retighten the main bolts.	2.0H	—		○			○				○			
	10	Check the fixed mechanical stopper and the adjustable mechanical stopper	0.1H	—		○			○				○			
	11	Clean spatters, sawdust and dust	0.1H	—		○			○				○			
	12	Check the operation of the cooling fan	0.1H	—		○			○				○			
	13	Replacing the mechanical unit batteries *3 *1 *3	0.1H	—							●					
	14	Replacing the oil of J1-axis reducer *1	1.0H	5000 ml												
	15	Replacing the oil of J2-axis reducer *1	0.5H	2640 ml												
	16	Replacing the oil of J3-axis reducer *1	0.5H	2000 ml												
	17	Replacing the oil of J4-axis reducer *1	0.5H	1290 ml												
	18	Replacing the oil of J5-axis reducer *1	0.2H	230ml												
	19	Replacing the oil of J6-axis reducer *1	0.2H	195ml												
	20	Replacing the mechanical unit cable	4.0H	—												
	21	Replacing the belts *4	—	—												
Controller	22	Check the robot cable, teach pendant cable and robot connection cable	0.2H	—		○			○				○			
	23	Cleaning the ventilator	0.2H	—	○	○	○	○	○	○	○	○	○	○	○	○
	24	Replacing battery *1 *3 *1 *3	0.1H	—												

*1   For descriptions about the items marked with an asterisk (*), refer to "REPLACING UNITS Chapter" of this manual or the following manual.
      R-30*i*B/R-30*i*B Plus CONTROLLER MAINTENANCE MANUAL (B-83195EN)

*2   ●: Requires order of parts

      ○: Does not require order of parts

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	Items
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		1
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		2
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		3
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		4
○				○				○				○				○					5
○				○				○				○				○					6
○				○				○				○				○					7
○				○				○				○				○					8
○				○				○				○				○					9
○				○				○				○				○					10
○				○				○				○				○					11
○				○				○				○				○					12
●						●						●						●		Overhaul	13
●												●									14
●												●									15
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○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		23
				●																	24

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

*4   Contact your local FANUC representative for the belt's overhaul.

B   STRENGTH OF BOLT AND BOLT TORQUE LIST

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

Use the following strength bolts. Comply with any bolt specification instructions as specified.

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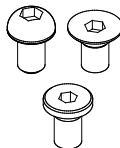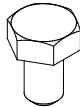
Refer to the following tables if the bolts tightening torque are not specified.

Recommended bolt tightening torques   Unit: Nm

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

INDEX

REVISION RECORD

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01	Jul., 2020	

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