FANUC Robot M-1000*i*A

MECHANICAL UNIT

OPERATOR'S MANUAL

B-84394EN/01

- **Original Instructions**

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

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 must be read before using the robot.

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

For the safety of the operator and the system, follow all safety precautions when operating a robot and its peripheral equipment installed in a work cell.
For safe use of FANUC robots, you must read and follow the instructions in “FANUC Robot 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. Works 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 safety fence. In this table, the symbol “O” means the work allowed to be carried out by the worker.

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

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

	Operator	Programmer or Teaching operator	Maintenance technician
Emergency stop with operator's panel	○	○	○
Emergency stop with teach pendant	○	○	○
Operator's panel maintenance			○
Teach pendant maintenance			○

In the robot operating, programming and maintenance, the operator, programmer/teaching operator and maintenance technician take care of their safety using at least the following safety protectors.

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

2 DEFINITION OF SAFETY NOTATIONS

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

Symbol	Definitions
⚠**DANGER**	Used if an emergent danger resulting in the death or serious injury of the user is expected to occur if he or she fails to observe the approved procedure.
⚠**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-2600-J350 (Input voltage AC100-115V single phase) A05B-2450-J361 (Input voltage AC200-240V single phase)
Robot connection cable	A05B-2617-J300 (5m) A05B-2617-J301(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)

(*) Not supporting CE Marking.

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

⚠ CAUTION
Robot systems installed without adequate number of brake release units or similar means are not in compliance with EN ISO 10218-1 nor with the Machinery Directive and therefore cannot bear the CE marking.

⚠ WARNING
Robot arm would fall down by releasing its brake because of gravity. Especially because spring balancer is used for J2-axis, it is hard to predict J2-arm movement by the condition of Robot posture and end effecter. Therefore it is strongly recommended to take adequate measures such as hanging Robot arm by a crane before releasing a brake.

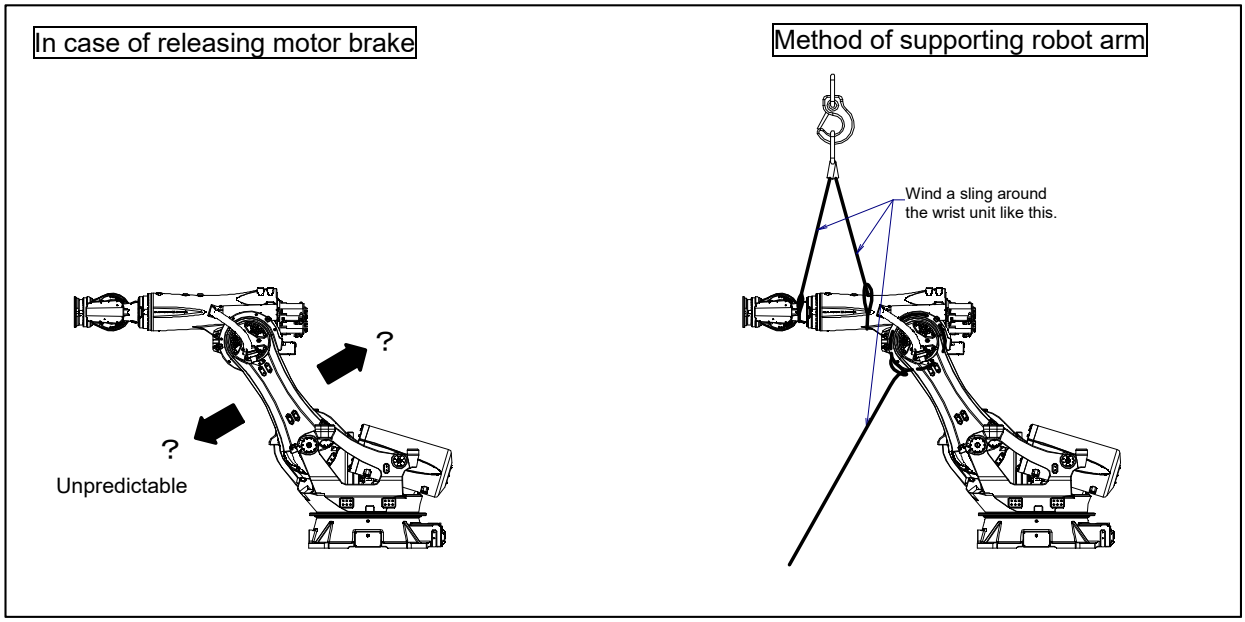


Fig. 3 (a) Arm operation by the release of J2-axis motor brake and measures

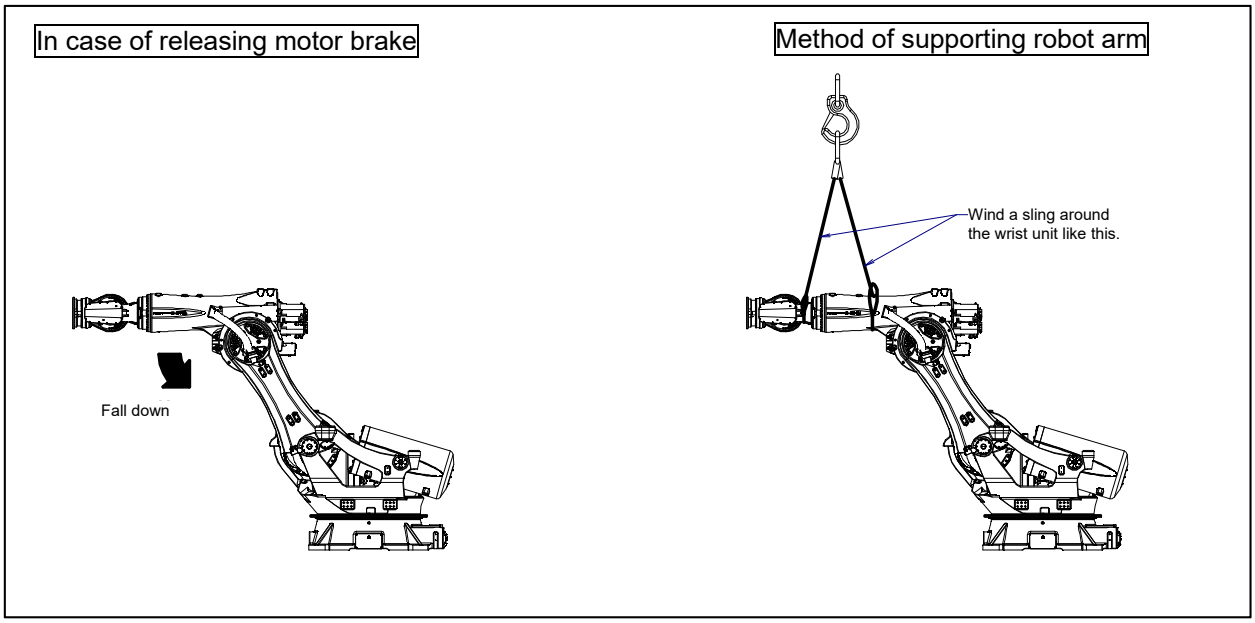


Fig. 3 (b) Arm operation by the release of J3-axis motor brake and measures

4 DANGER & WARNING & CAUTION LABEL

(1) Greasing and degreasing label

Fig. 4 (a) Greasing and degreasing label

Description

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

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

> **⚠CAUTION**
> See Chapter 7 ″CHECKS AND MAINTENANCE″ for explanations about specified grease, grease amount, and the locations of grease and degrease outlets for individual models.

(2) Disassembly prohibitive label

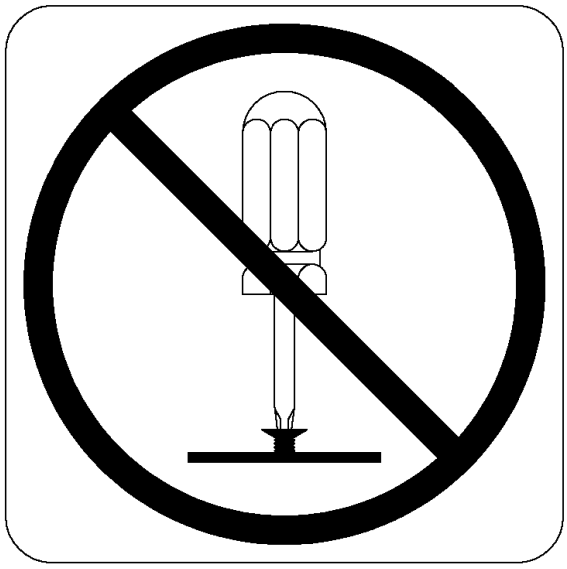


Fig. 4 (b) Disassembly prohibitive label

Description

Do not disassemble the balancer unit because it contains a spring, which may cause serious danger (For the M-1000*i*A, a disassembly prohibitive label is affixed only to the balancer.).

(3) Step-on prohibitive label

Fig. 4 (c) 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.

(4) Turn off breakers before maintenance label

Fig. 4 (d) Turn off breakers before maintenance label

Description

Turn off both breakers before maintenance.

(5) High-temperature warning label

Fig. 4 (e) 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.

(6) Transportation label

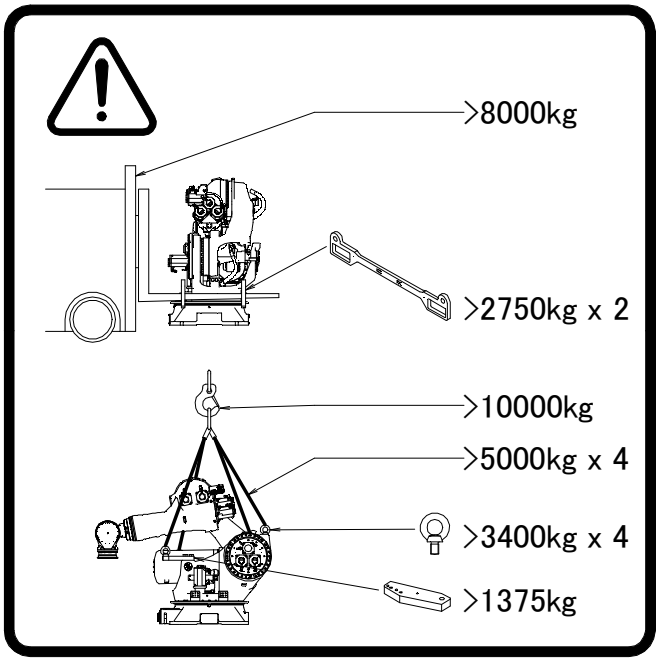


Fig. 4 (f) Transportation label

Description

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

1) Using a forklift
- Use a forklift having a load capacity of 8000 kg or greater.
- Keep the total weight of the robot to be transported to within 5500 kg, because the load capacity of the forklift bracket (option) is 26950 N (2750 kgf).

2) Using a crane
- Use a crane with a load capacity of 10000 kg or greater.
- Use four slings each with each load capacity of 5000 kg or greater.
- Use four eyebolts with each allowable load of 33320 N (3400 kgf) or greater.
- The load capacity of the transport equipment for eyebolt (option) is 13475 N (1375 kgf). Keep the total weight of the robot to be transported to within 5500 kg.

> ⚠ **CAUTION**
> Transportation labels are model-specific. Before transporting the robot, see the transportation label affixed to the transport equipment.
> See Section 1.1 TRANSPORTATION of operator's manual for explanations about the posture a specific model should take when it is transported.

(7) Balancer replacement label

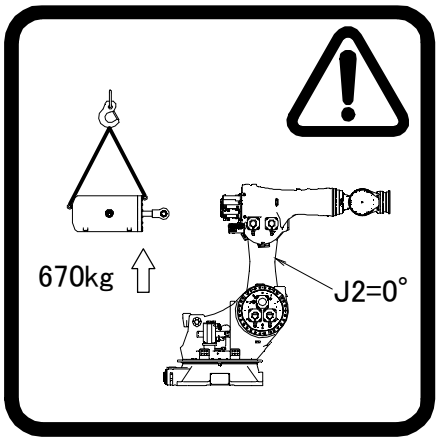


Fig. 4 (g) Balancer replacement label

Description

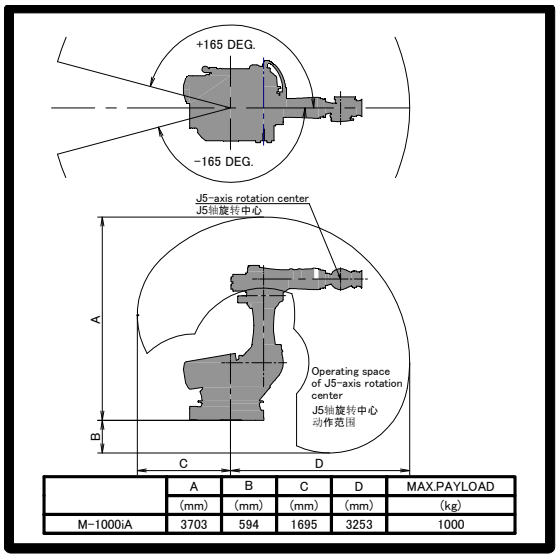
When replacing the balancer, observe the instructions indicated on this label.
The balancer replacement label above indicates the following:

- While replacing the balancer, keep the J2-axis at 0°.
- The mass of the balancer is 670 kg.

> ⚠ **CAUTION**
> For information about balancer replacement, contact your local FANUC representative.

(8) Operating space and payload label

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



	A	B	C	D	MAX.PAYLOAD
	(mm)	(mm)	(mm)	(mm)	(kg)
M-1000iA	3703	594	1695	3253	1000

Fig. 4 (h) Operating space and payload label

(9) Danger label

When CE specification is specified, the following label is added:

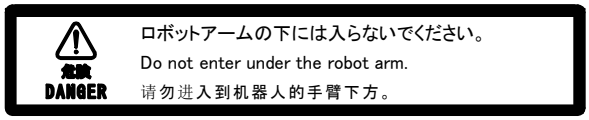


Fig. 4 (i) Danger label

Description

DANGER
Do not enter under the robot arm.

(10) Transportation caution label

Fig. 4 (j) Transportation caution label (for eyebolt option)

Description

Do not pull eyebolts sideways when transporting the robot.

(11) Mastering caution label

Fig. 4 (k) Mastering caution label

Description

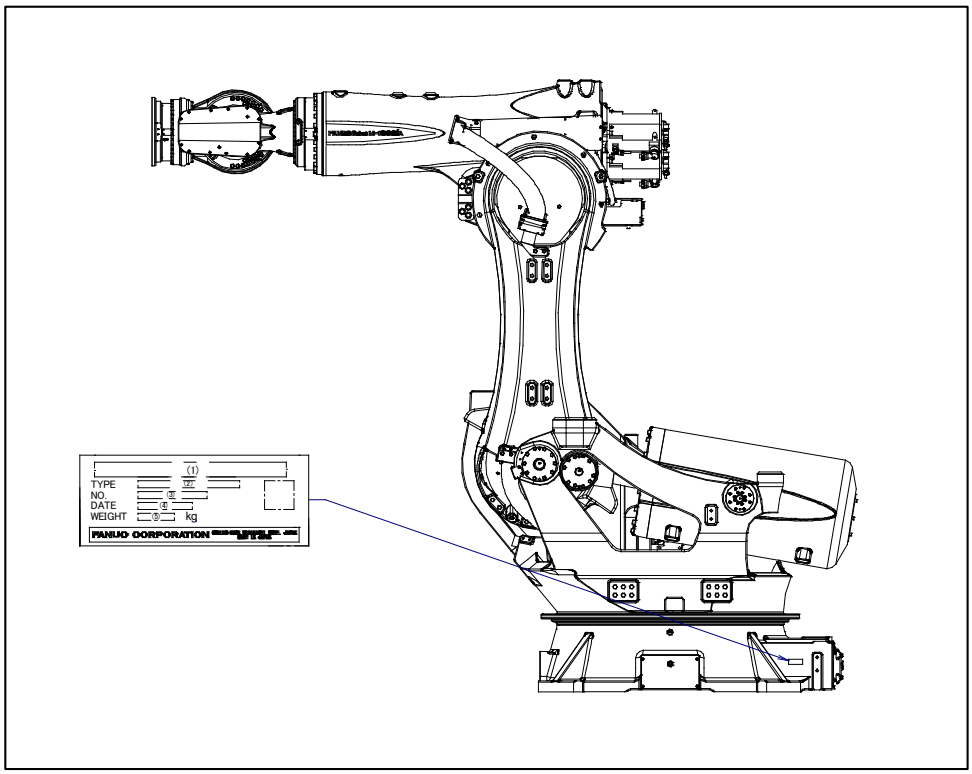
Keep the following in mind when performing the mastering. The motion limits are temporarily invalid during mastering. Cables may be damaged if the J1-axis exceeds +/-185^{O}.

PREFACE

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

Model name	Mechanical unit specification No.	Maximum load
FANUC Robot M-1000*i*A	A05B-1340-B201	1000kg

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



Position of label indicating mechanical unit specification number

	(1)	(2)	(3)	(4)	(5)
CONTENTS	MODEL NAME	TYPE	No.	DATE	WEIGHT kg (without controller)
LETTERS	FANUC Robot M-1000*i*A	A05B-1340-B201	SERIAL NO. IS PRINTED	PRODUCTION YEAR AND MONTH ARE PRINTED	5300

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 Operation**)** **B-83284EN** OPERATOR'S MANUAL **(**Alarm Code List**)** **B-83284EN-1** Optional Function OPERATOR'S MANUAL **B-83284EN-2** 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 engineer, system designer Topics : Robot functions, operations, programming, setup, interfaces, alarms Use : Robot operation, teaching, system design
	MAINTENANCE MANUAL **B-83195EN**	Intended readers : Maintenance engineer, system designer Topics : Installation, start-up, connection, maintenance Use : Installation, start-up, connection, maintenance

This manual uses following terms.

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

TABLE OF CONTENTS

1 TRANSPORTATION AND INSTALLATION

1.1 TRANSPORTATION

Use a crane to transport the robot. Before transporting the robot, be sure to change the posture of the robot to that shown below and lift by using the eyebolts and the transport equipment at designed points.

(1) Transportation using a crane (Fig. 1.1 (b))
Fasten the M42 eyebolts at the four points of special transport equipment and lift the robot by the four slings.

> ⚠ **CAUTION**
> When lifting the robot, be careful not to damage motors, connectors, or cables of the robot by slings.

(2) Transportation using a forklift (Fig. 1.1 (c))
The robot is transported with the specific transport equipment attached on the J2 base side.

> ⚠ **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 base plate before transporting the robot. If the robot must necessarily be transported with the base plate attached, take the following precautions:
> ・ Robot becomes unstable when it is transported with the end effector applied to wrist, and it is dangerous.
> Please be sure to remove the end effector when robot is transported. Be extremely careful to keep the robot in balance.
> If the base plate is attached, the center of gravity of the entire robot changes.
> When lifting the robot, be sure to lift the base plate instead of the robot.
> 3 Use the forklift transport equipment only to transport the robot with a forklift. Do not use the forklift transport equipment to secure the robot.
> Before moving the robot by using transport equipment, check the bolts on the transport equipment and tighten any loose bolts if any.

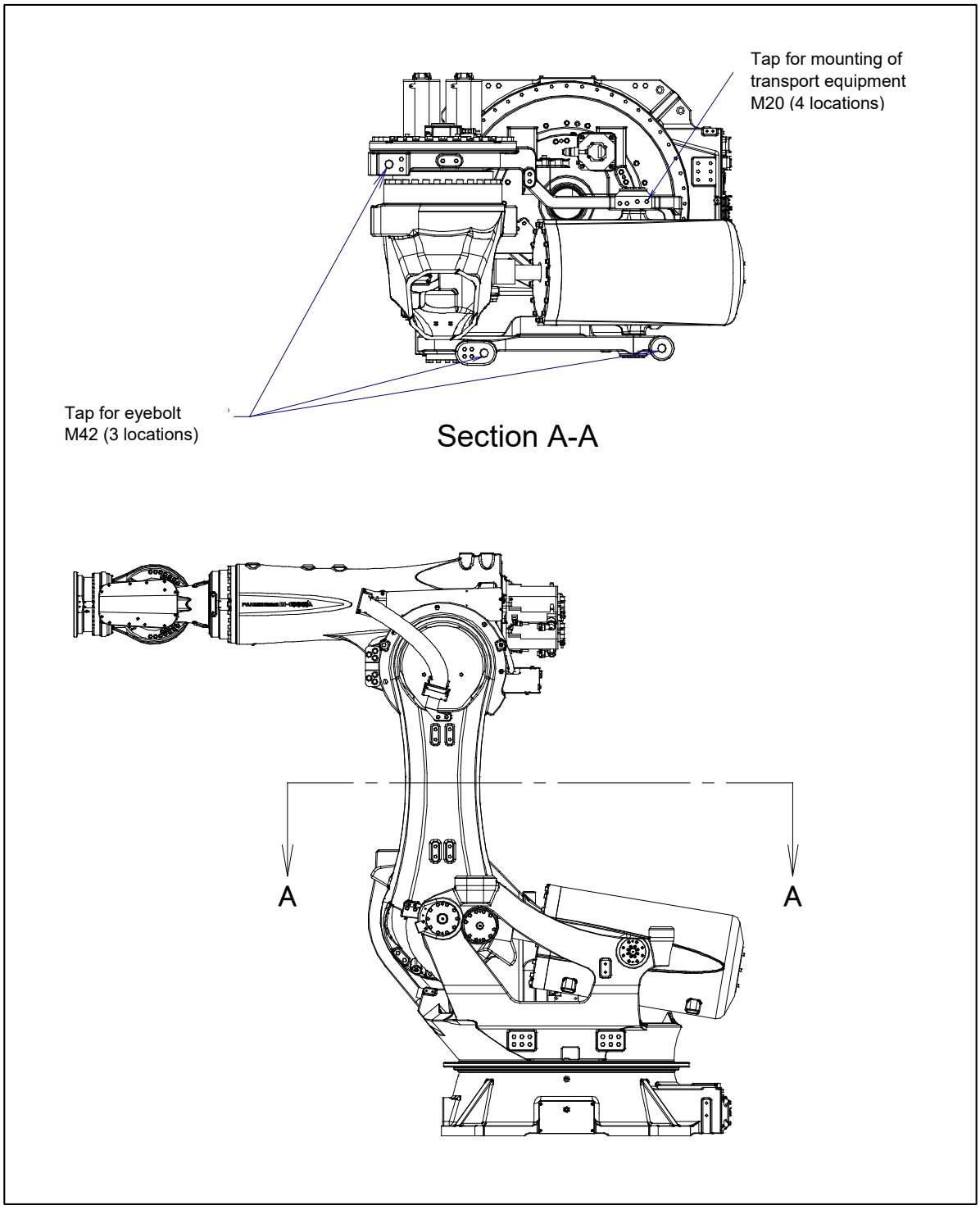


Fig. 1.1 (a) Position of the transport equipment and eyebolt mounting

Note)
1. Robot mechanical unit mass : 5300kg
2. Eyebolt complied with JIS B 1168.
3. Quantity eyebolt 4 pcs
   sling 4 pcs

Crane
Capacity min.: 10.0 ton
Sling
Capacity min for weight. : 5.0 ton/sling
Eyebolt
Allowable load. : 3400kgf/each or more

Robot posture on transportation

J1	0°
J2	-43°
J3	190°
J4	0°
J5	80°
J6	0°

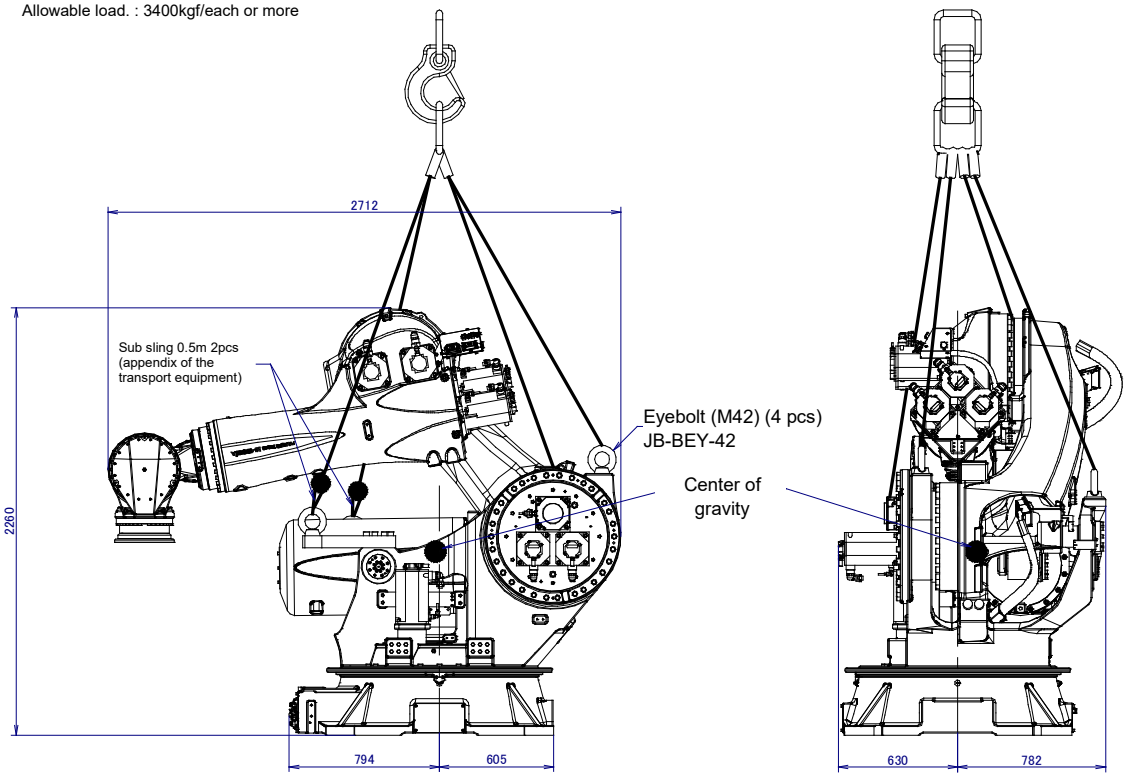


Fig. 1.1 (b) Transportation using a crane

Note)
1. Robot mechanical unit mass : 5300kg

Robot posture on transportation

J1	0º
J2	-43º
J3	190º
J4	0º
J5	80º
J6	0º

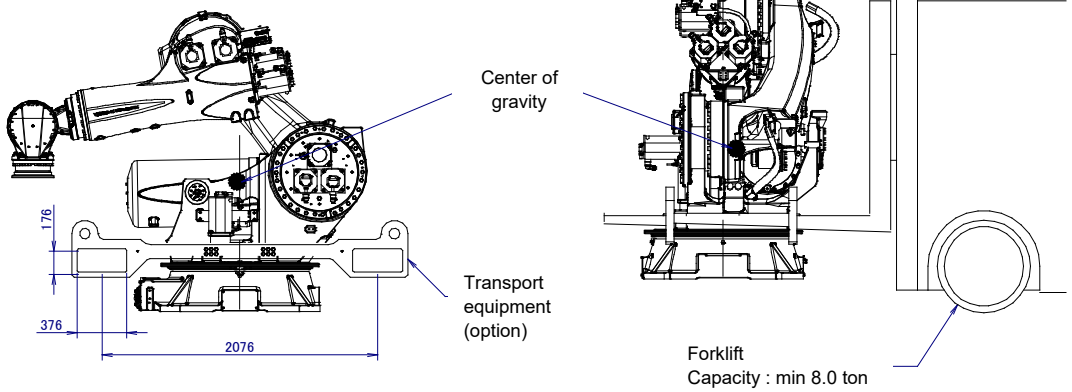


Fig. 1.1 (c) Transportation using a forklift

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

1.2 INSTALLATION

Fig. 1.2 (a) shows the robot base dimensions. Avoid placing any object in front of the robot on the locating surface.

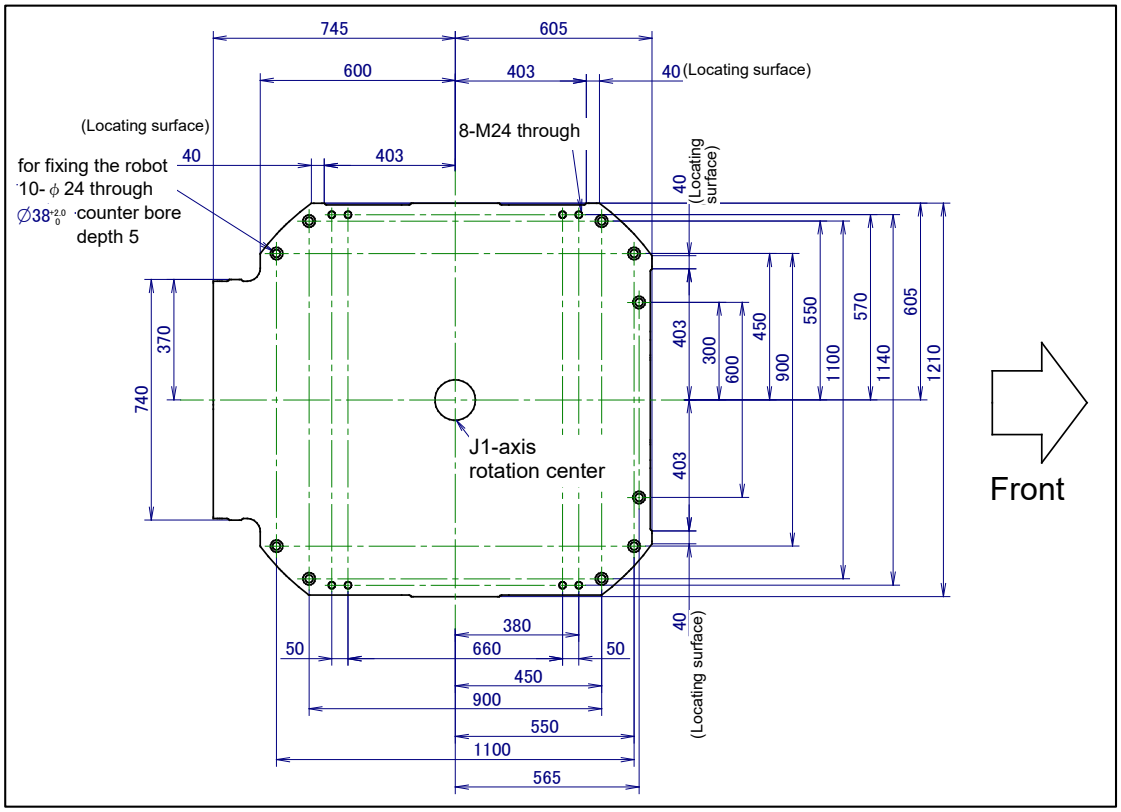


Fig. 1.2 (a) Dimension of robot base

Fig. 1.2 (c) 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 angle and time of the J1 to J3 axis until the robot stopping by Power-Off stop or by Controlled stop after input of the stop signal. Refer to the data when considering the strength of the installation face.

NOTE

Table 1.2 (b) to (c) are measured reference value complied with ISO10218-1. Values differs depending on each robot individual difference, payload and the program. So confirm the real value by measurement. Values in Table 1.2 (b) is affected by the robot operating status and number of times of the 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-1000*i*A	162.7 (16600)	93.1 (9500)	25.5 (2600)	34.3 (3500)

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

Model		J1-axis	J2-axis	J3-axis
M-1000*i*A	Stopping time [ms]	1084	324	346
	Stopping angle [deg] (rad)	30.5(0.53)	6.5(0.11)	8.2(0.14)

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

Model		J1-axis	J2-axis	J3-axis
M-1000*i*A	Stopping time [ms]	1386	1396	1180
	Stopping angle [deg] (rad)	43.5(0.76)	28.1(0.49)	30.5(0.53)

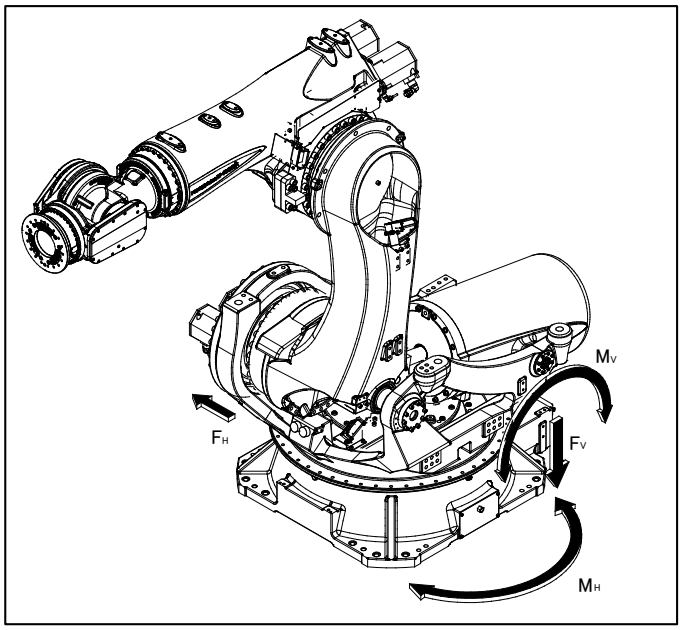


Fig. 1.2 (c) Force and moment that acts during Power-Off stop

1.2.1 Actual Installation Example

The following show actual examples of the robot installation.

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 example 1 : Fig. 1.2.1 (a)
  The floor plate is imbedded in concrete and fastened with M20 (tensile strength 400N/mm^2 or more) chemical anchors. Also fasten the base plate to the robot base using M20 x 75 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 following parts are required to install the robot.

- Installation example 2 : Fig. 1.2.1 (b)
  The floor plate is not imbedded in concrete. The floor plate is fastened at the sixteen 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 base is fastened on the floor plate with ten M20 x 75 bolts (Tensile strength 1200N/mm^2 or more).

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

Required parts	Remarks	Example 1	Example 2
Robot mounting bolts	M20 x 75 (Tensile strength 1200N/mm^2 or more) 10 pcs	○	○
Plain washers	For M20 (HRC 35 or more, thickness between 4 and 5 mm) 10 pcs	○	○
Chemical anchors	M20 (Tensile strength 400N/mm^2 or more) 16 pcs	○	○
Floor plate	Thickness 32t 1 pc	○	○
Base plates	Thickness 32t 4 pcs	○	
Fixing screws	M20 4 pcs		○
Nuts	M20 4 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 0.5º. If robot base is placed on uneven ground, it may result in the base breakage or low performance of the robot.

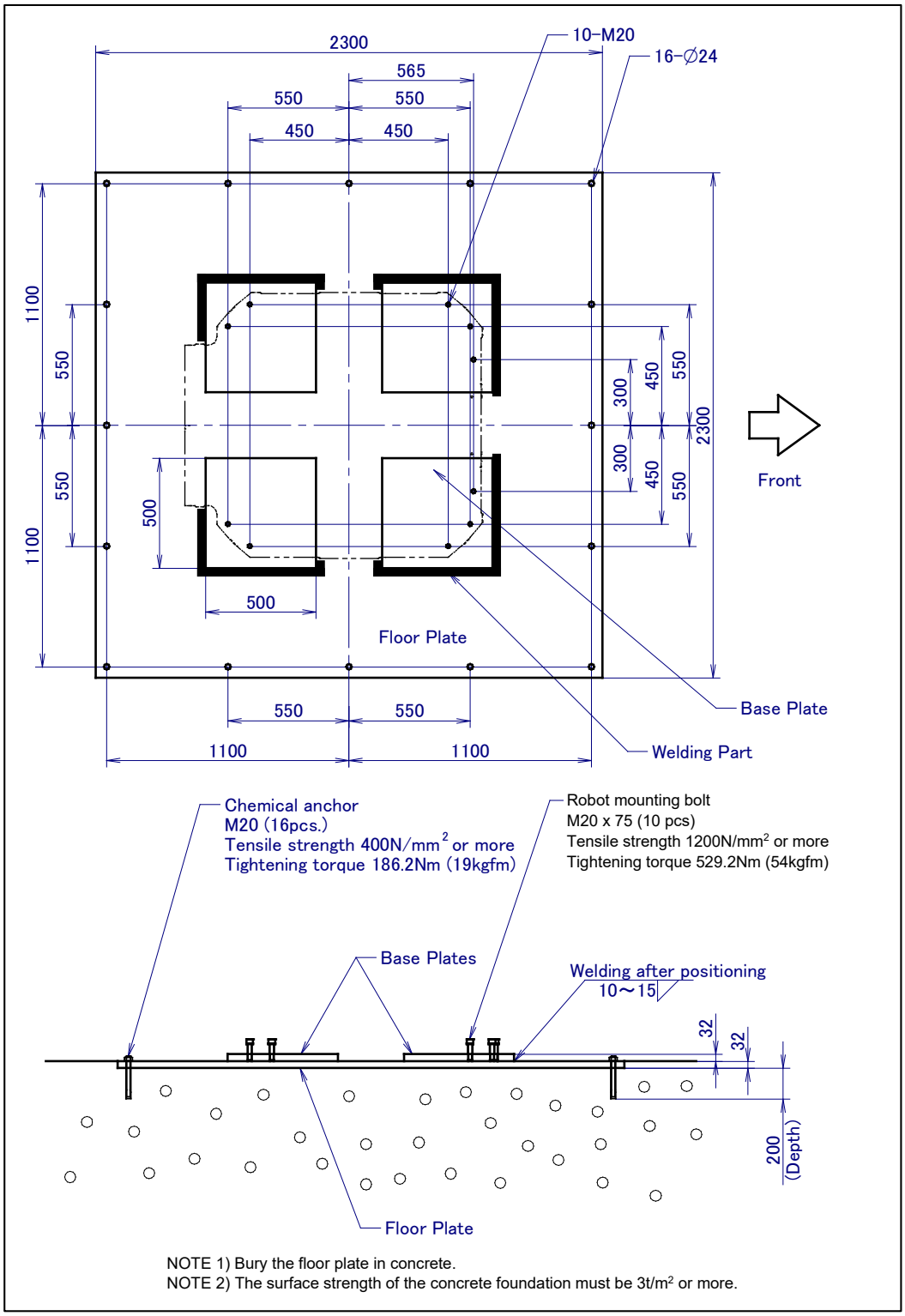
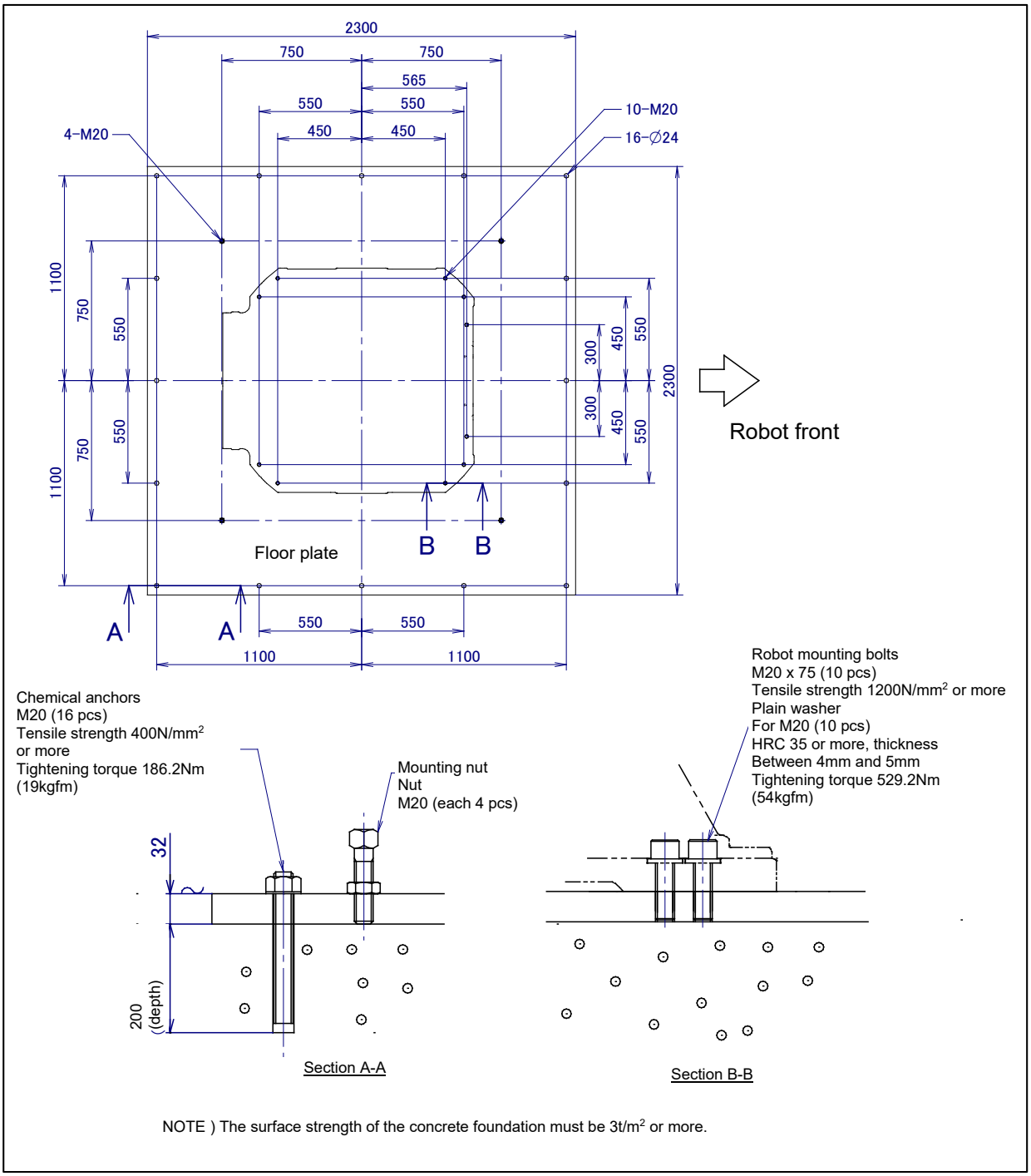


Fig. 1.2.1 (a) Actual installation example 1



NOTE) The surface strength of the concrete foundation must be 3t/m^2 or more.

Fig. 1.2.1 (b) Actual installation example 2

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 information

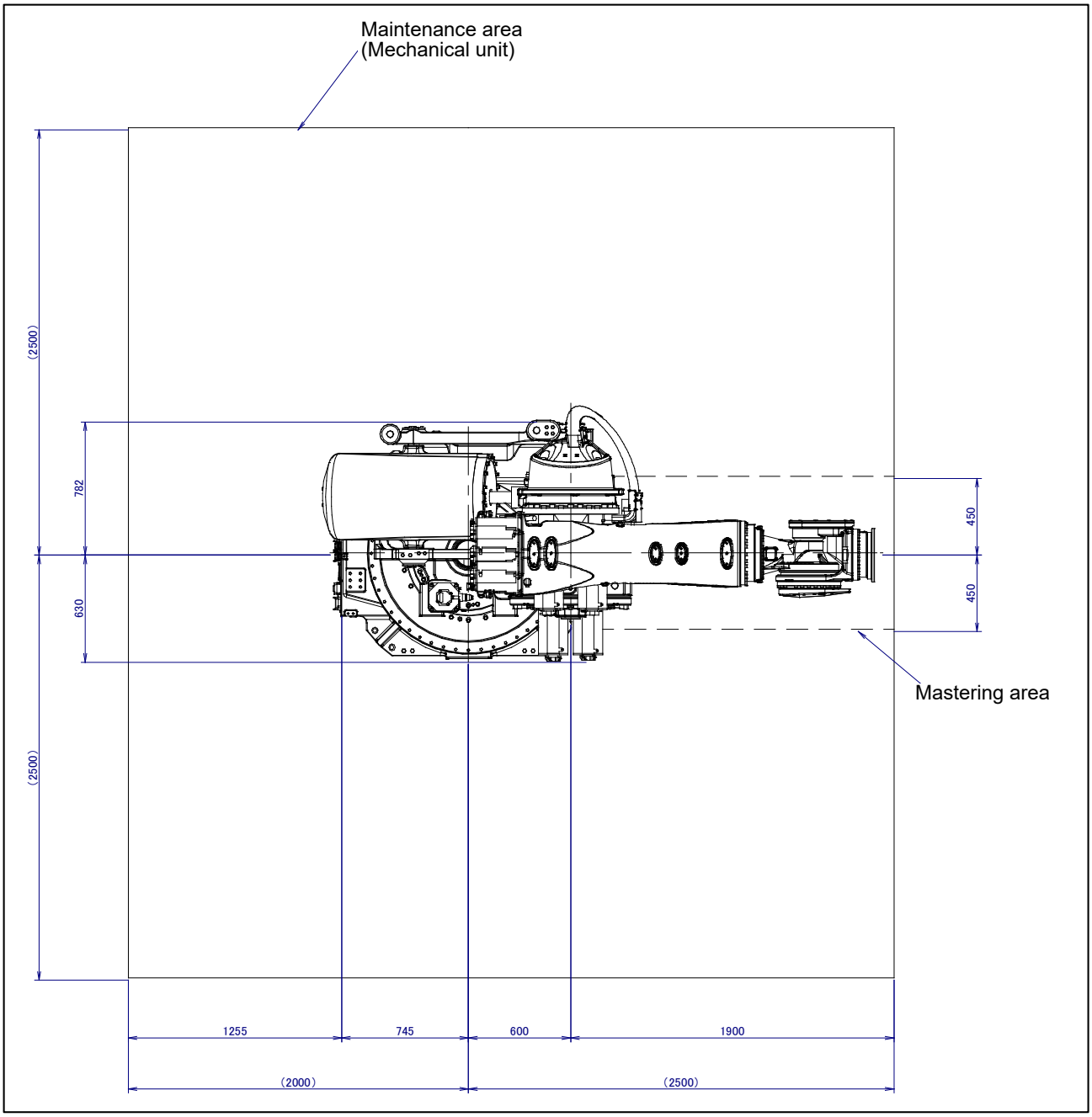


Fig. 1.3 (a) Maintenance area

1.4 INSTALLATION CONDITIONS

See Section 3.1 and caution below about robot installation conditions.

⚠ CAUTION

1 If the robot is used especially in an adverse environment stated below, grease the balancer as required.
   - Dusty environment; for example, an application in which the robot is used to handle tiles or bricks.
   - Environment full of spatters developed in spot welding; for example, an application in which welding spatters deposit and accumulate on and around the balancer

   In addition, if the robot is used in a special environment stated below, use a robot jacket or some other means to protect the balancer support part (which joins with the J2 arm and J2 base) and rod sliding part.
   - Environment where glass abrasive powders and others are used; for example, and application in which the robot or balancer is subjected to splashes of powders in handling and other operations during glass abrasion.
   - Environment where metal powders are used; for example, an application in which the robot or balancer is subjected to splashes of powders in handling and other operations during metal working.

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

3 Liquid intrusion into the balancer inside might cause corrosion of the component parts. Be careful to prevent liquid splashing to the balancer.

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. When turn on the controller power, be sure to turn on the power of slave controller previously.
> 2 Do not use 10m or longer coiled cable without first untying it. The long coiled cable could heat up and become damaged.

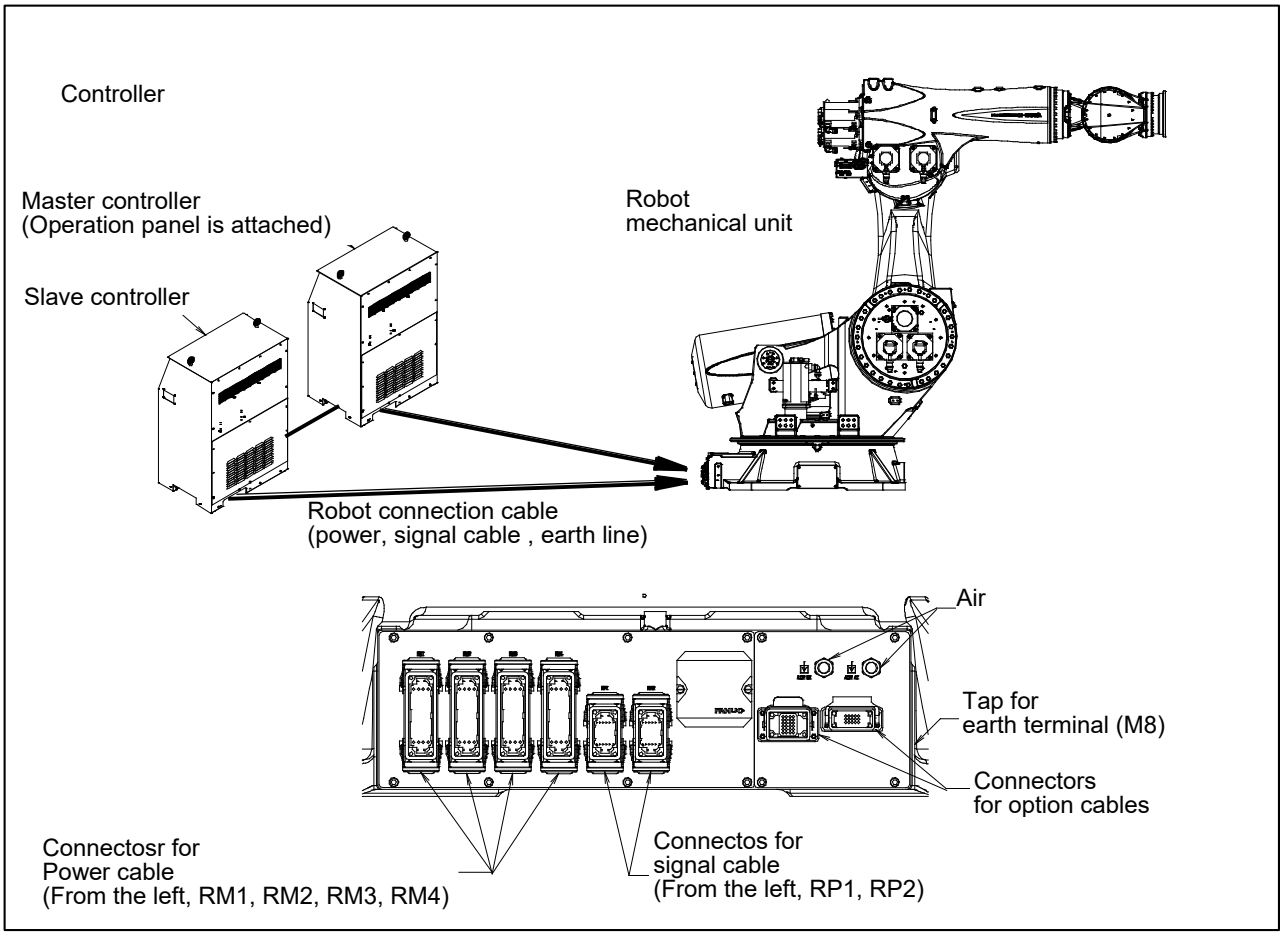


Fig. 2 (a) Cable connection

3 BASIC SPECIFICATIONS

3.1 ROBOT CONFIGURATION

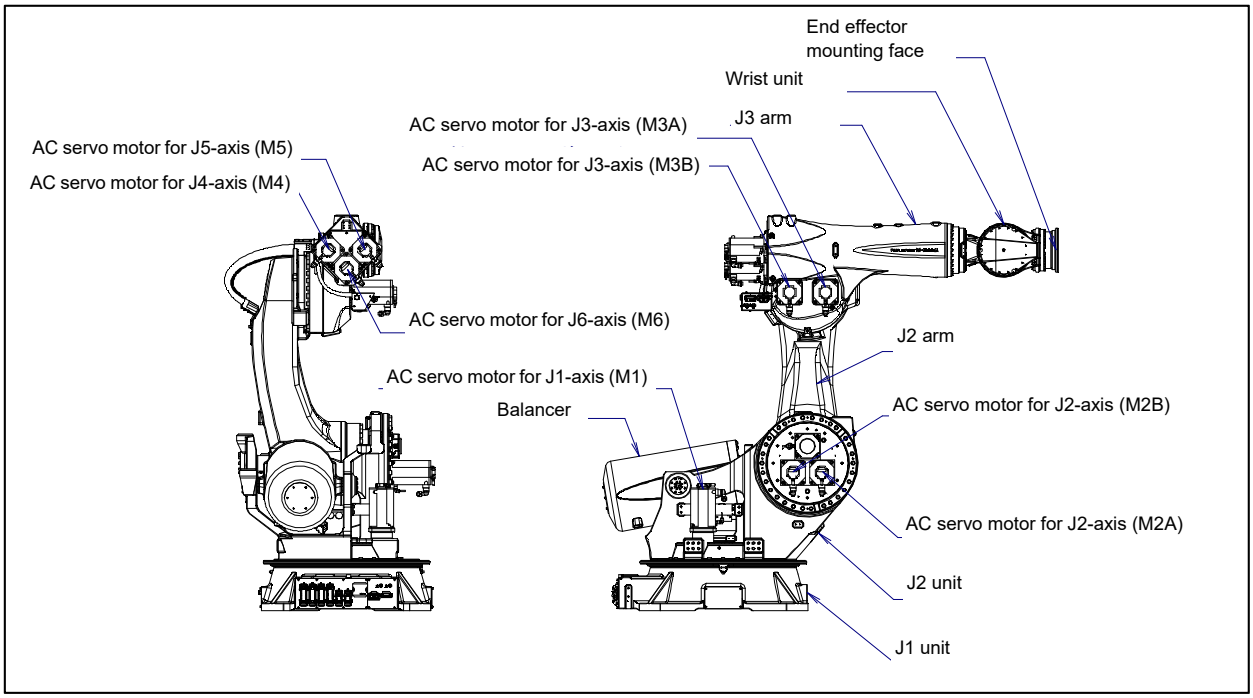


Fig. 3.1 (a) Mechanical unit configuration

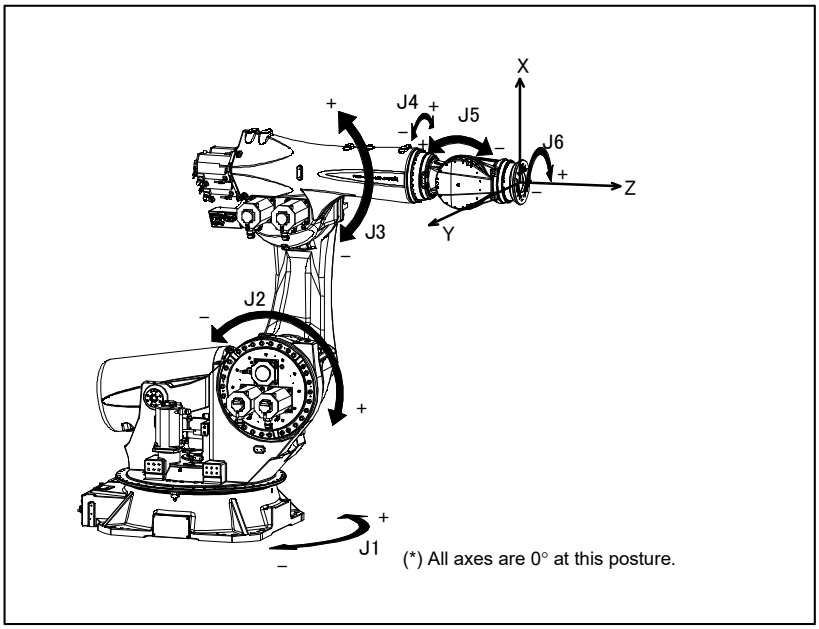


Fig. 3.1 (b) Each axes coordinates and mechanical interface coordinates

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

Table 3.1 (a) Specifications (NOTE 1)

		M-1000*i*A
Type		Articulated type
Controlled axes		6-axes(J1,J2,J3,J4,J5,J6)
Reach		3253mm
Installation		Floor mount
Motion range (Upper limit / Lower limit)	J1-axis	180° (3.14rad)/ -180° (-3.14rad) , 165° (2.87rad)/ -165° (-2.87rad) (option)
	J2-axis	100° (1.74rad)/ -45° (-0.78rad)
	J3-axis	197° (3.43rad)/ -127° (-2.21rad)
	J4-axis	360° (6.28rad) -360° (-6.28rad)
	J5-axis	120° (2.09rad)/ -120° (-2.09rad)
	J6-axis	360° (6.28rad)/ -360° (-6.28rad)
Maximum speed (NOTE 2)	J1-axis	60°/s (1.05 rad/s)
	J2-axis	50°/s (0.87 rad/s)
	J3-axis	50°/s (0.87 rad/s)
	J4-axis	70°/s (1.22 rad/s)
	J5-axis	70°/s (1.22 rad/s)
	J6-axis	85°/s (1.48 rad/s)
Max. payload	At Wrist	1000kg
	On J2 base	550 kg
	On J3 arm	50 kg
Allowable load moment at wrist	J4-axis	8800 N·m (898 kgf·m)
	J5-axis	8800 N·m (898 kgf·m)
	J6-axis	5800 N·m (592 kgf·m)
Allowable load inertia at wrist	J4-axis	1750 kg·m^2 (17857 kgf·cm·s^2)
	J5-axis	1750 kg·m^2 (17857 kgf·cm·s^2)
	J6-axis	840 kg·m^2 (8571 kgf·cm·s^2)
Drive method		Electric servo drive by AC servo motor
Repeatability		±0.1mm (NOTE 3)
Mass		5300 kg
Acoustic noise level		72.0dB (NOTE 4)
Installation environment		Ambient temperature: 0 to 45℃(NOTE 5) Ambient humidity: Normally 75%RH or less (No condensation allowed.) Short time (Within 1 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.
2 During short distance motions, the axis speed may not reach the maximum value stated.
3 Compliant with ISO9283.
4 This value is equivalent continuous A-weighted sound pressure level that applied with ISO11201 (EN31201). This value is measured with the following conditions.
   - Maximum load and speed
   - Operating mode is AUTO
5 When the robot is used in a low temperature environment that is near to 0ºC, or not operated for a long time in the environment that is less than 0ºC (during a holiday or during the night), a collision detection alarm (SRVO-050) etc. may occur since the resistance of the drive mechanism could be high immediately after starting the operation. In this case, we recommend performing the warm up operation for several minutes.
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, cutting oil splash and or other foreign substances.

The following table lists the IEC60529-based dustproof and waterproof characteristics of the M-1000*i*A.

Table 3.1 (c) The dustproof and waterproof characteristics

	Normal specification
Wrist+J3 arm	IP67
Drive unit of the main body	IP66
Other part	IP54 (*)

(*) Except some connectors

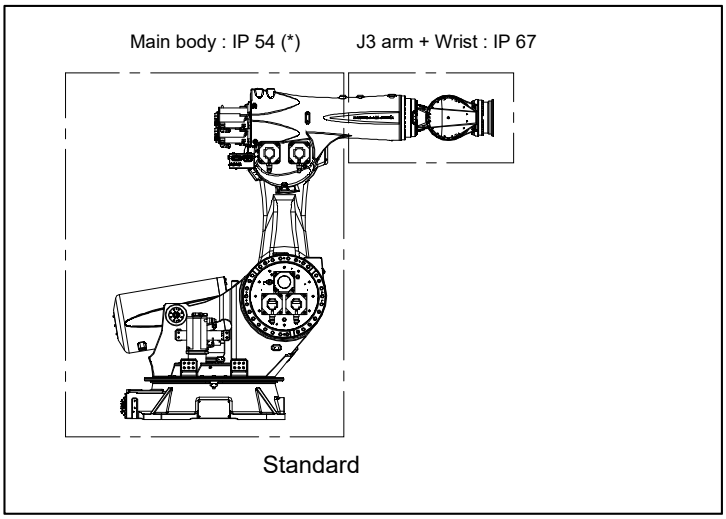


Fig. 3.1 (c) Severe dust/liquid protection characteristics of M-1000*i*A

NOTE

Definition of IP code
Definition of IP 67
6= Dust-tight: Complete protection against contact
7= Protection from water immersion: Ingress of water in harmful quantity shall not be possible when the enclosure is immersed in water under defined conditions of pressure and time.
Definition of IP 66
6= Dust-tight: Complete protection against contact
6= Protection from powerful water jets: Water projected in powerful jets against the enclosure from any direction shall have no harmful effects.
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 cannot be used with the following liquids because there is fear that rubber parts (gasket, oil seal, O-ring etc.) will corrode. (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.

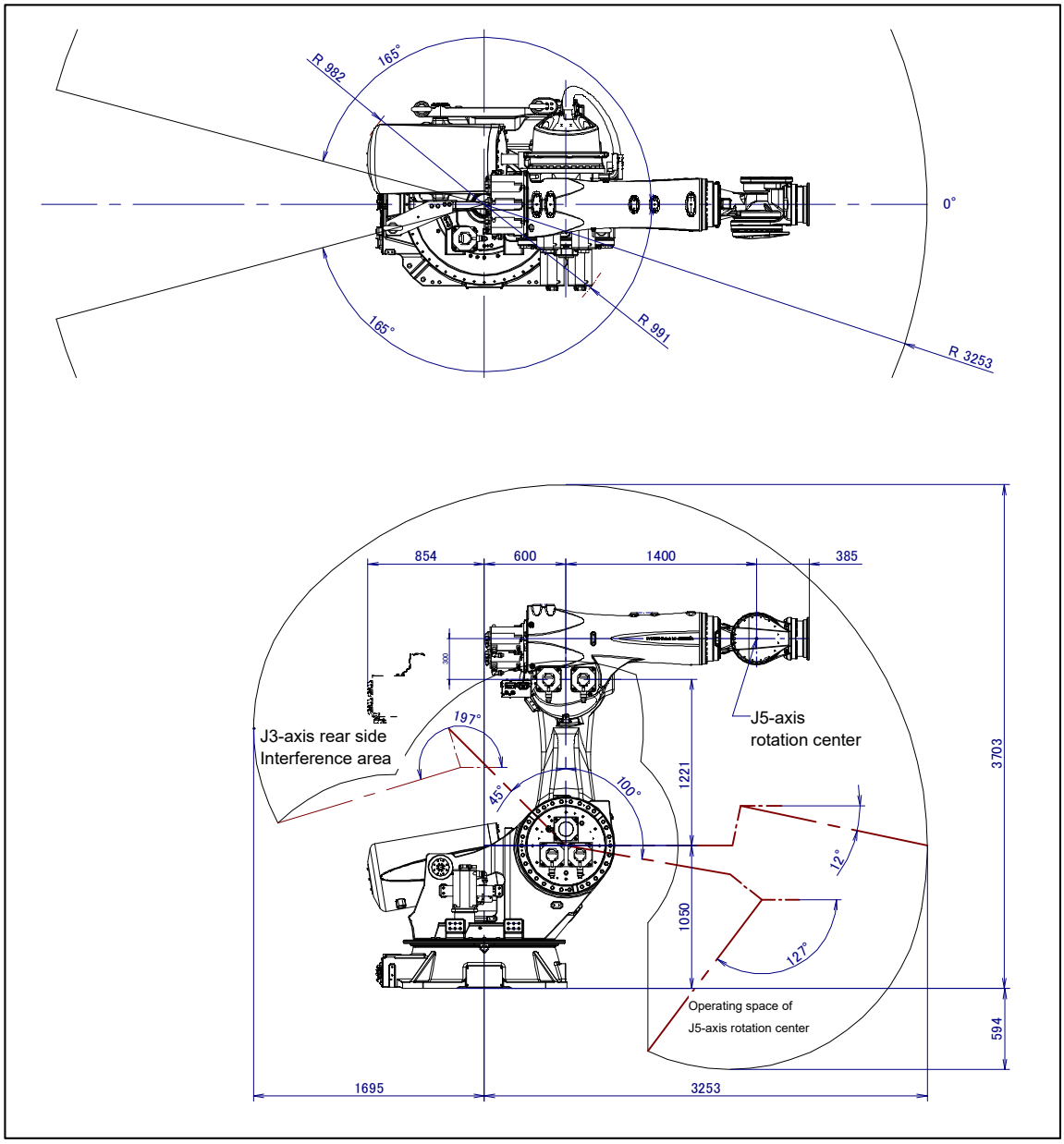


Fig. 3.2 (a) Operating space

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 to J3 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 an adjustable mechanical stopper is also prepared to improve safety.

Fig.3.3 (a) shows the position of mechanical stopper. Only in case of J1, robot stops by transforming fixed mechanical stopper (option). Be sure to exchange transformed stopper to new one. Tighten bolts with regulated torque referring to Appendix B [MOUNTING BOLT TORQUE LIST]. Replace mechanical stopper of J1- axis referring to Fig.3.3 (a).

> ⚠ **WARNING**
> Do not reconstruct the fixed mechanical stopper. There is a possibility that the robot doesn't stop normally.

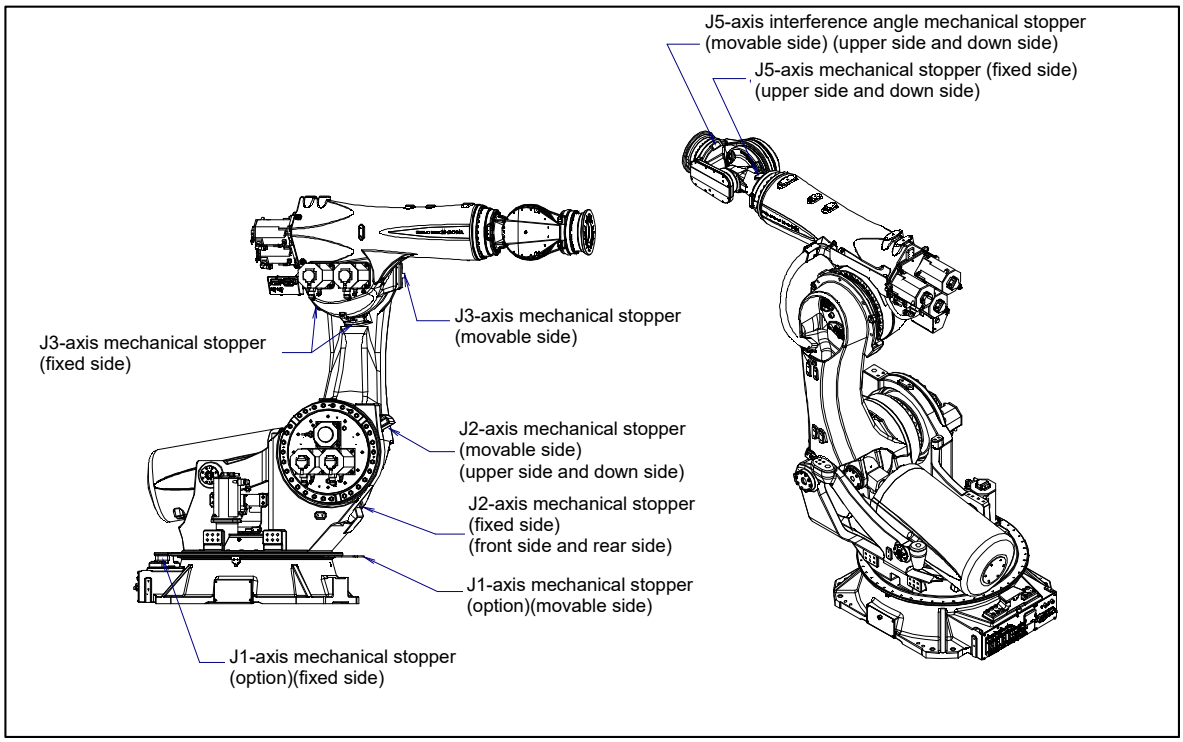


Fig. 3.3 (a) position of fixed mechanical stopper

Fig.3.3 (b) to (g) show the zero point and motion limit (stroke end), limit switch detection position, and max stop 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 LIMIT SETUP”.

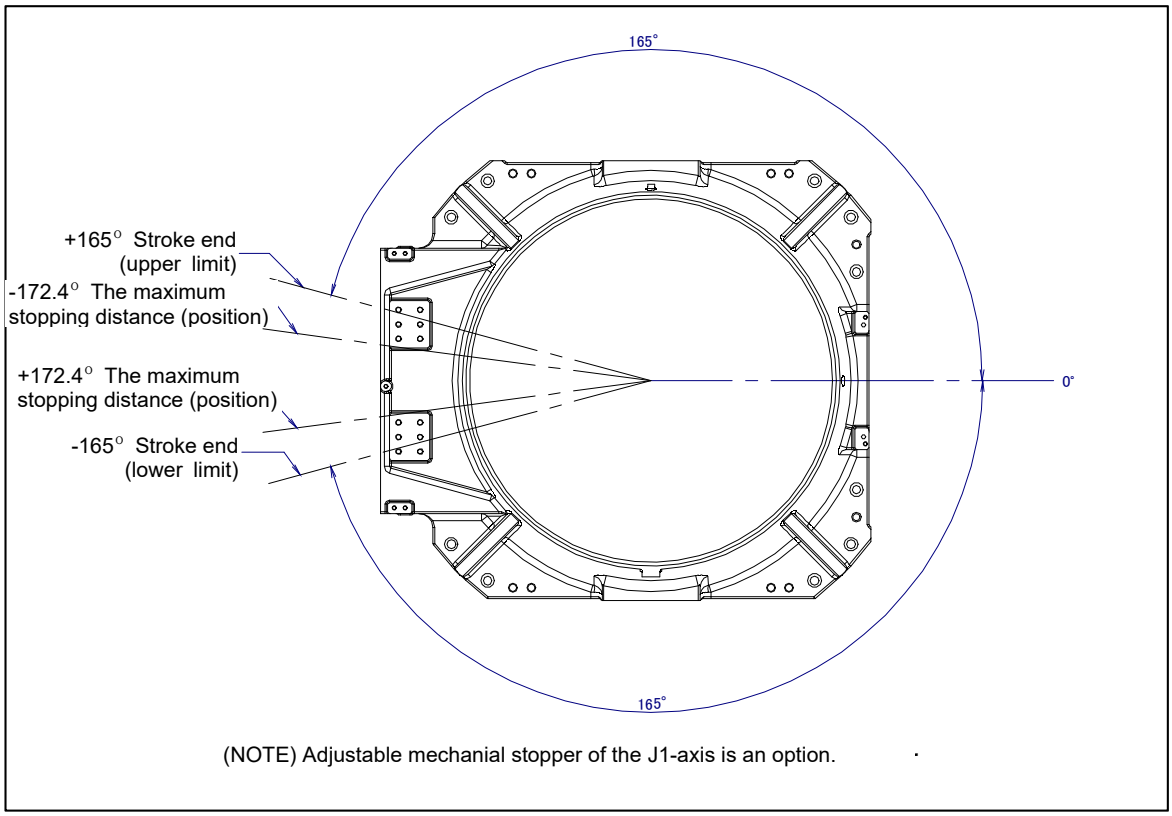


Fig. 3.3 (b) J1-axis motion limit

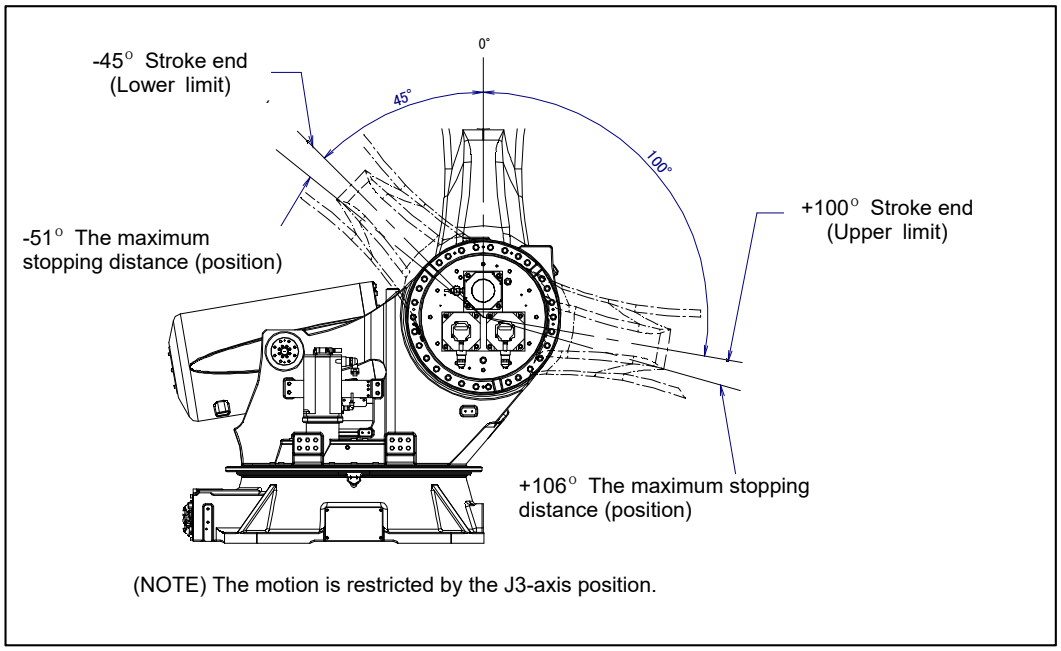


Fig. 3.3 (c) J2-axis motion limit

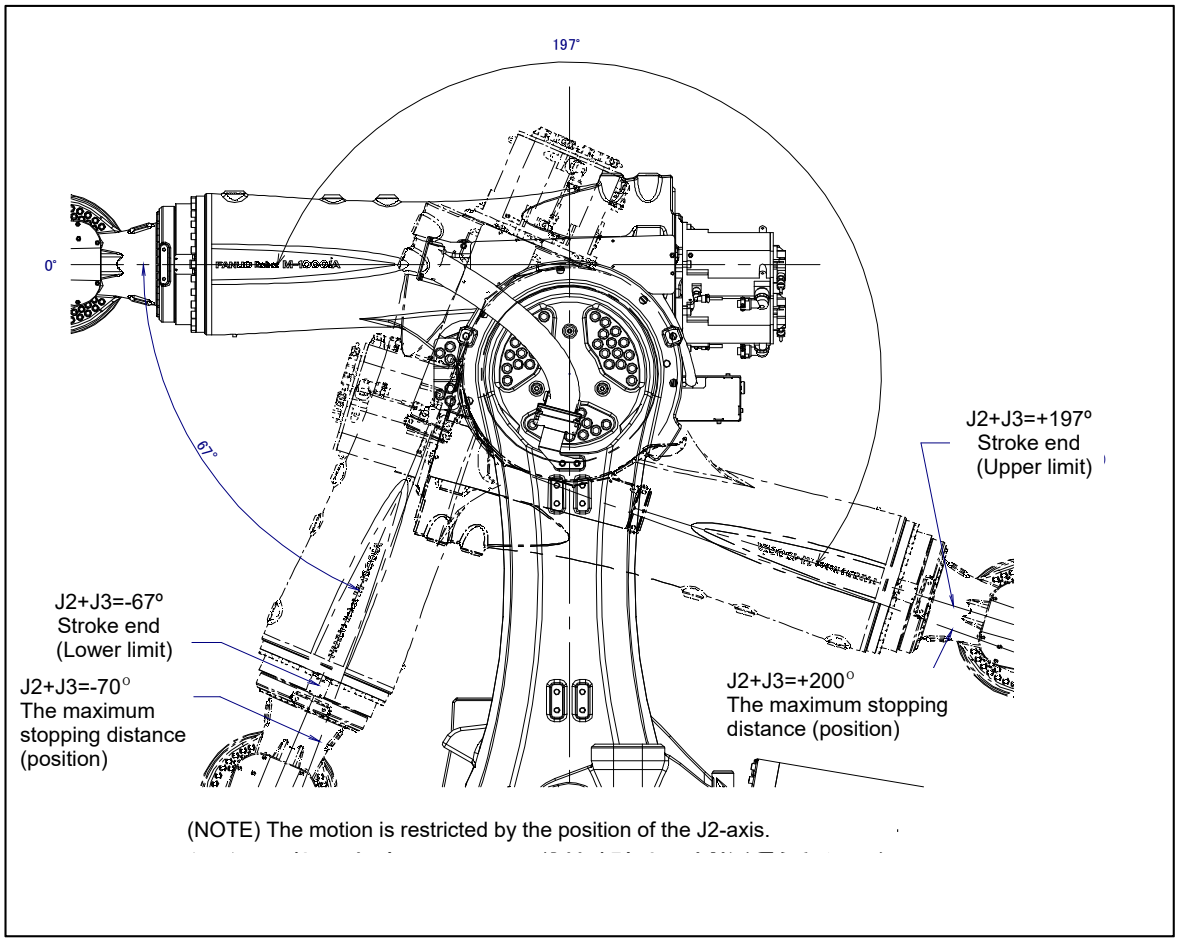


Fig. 3.3 (d) J3-axis motion limit

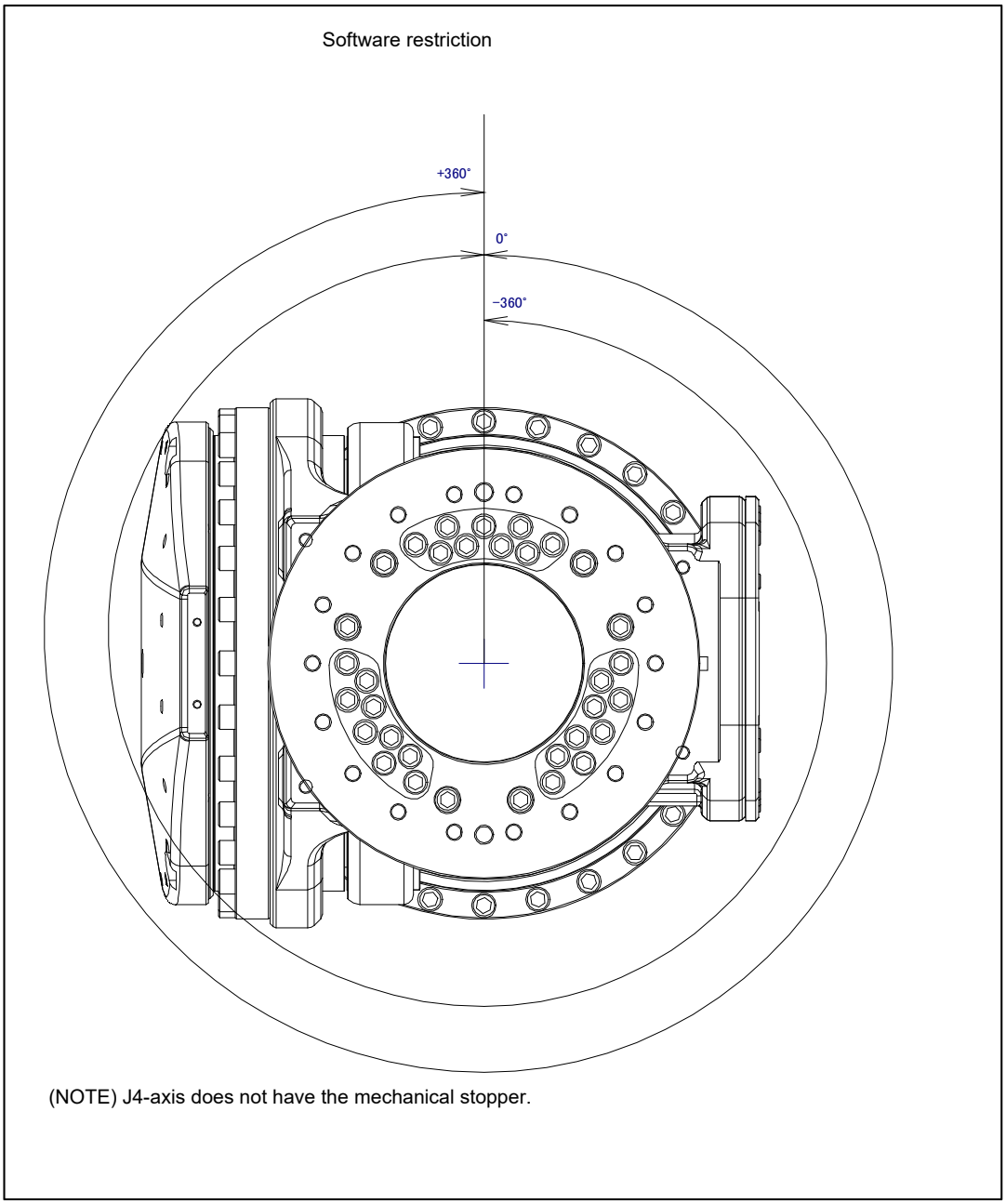


Fig. 3.3 (e) J4-axis motion limit

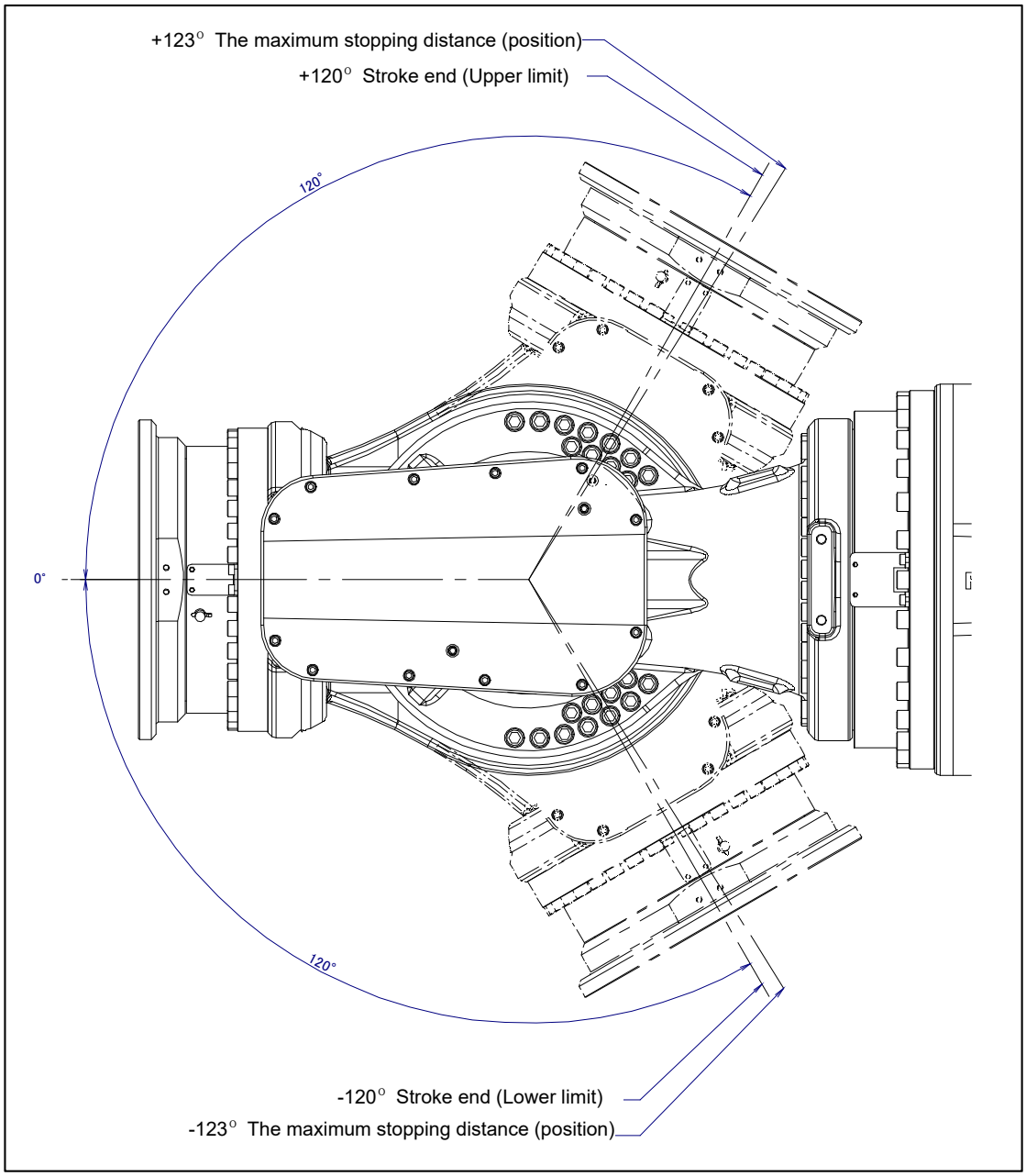


Fig. 3.3 (f) J5-axis motion limit

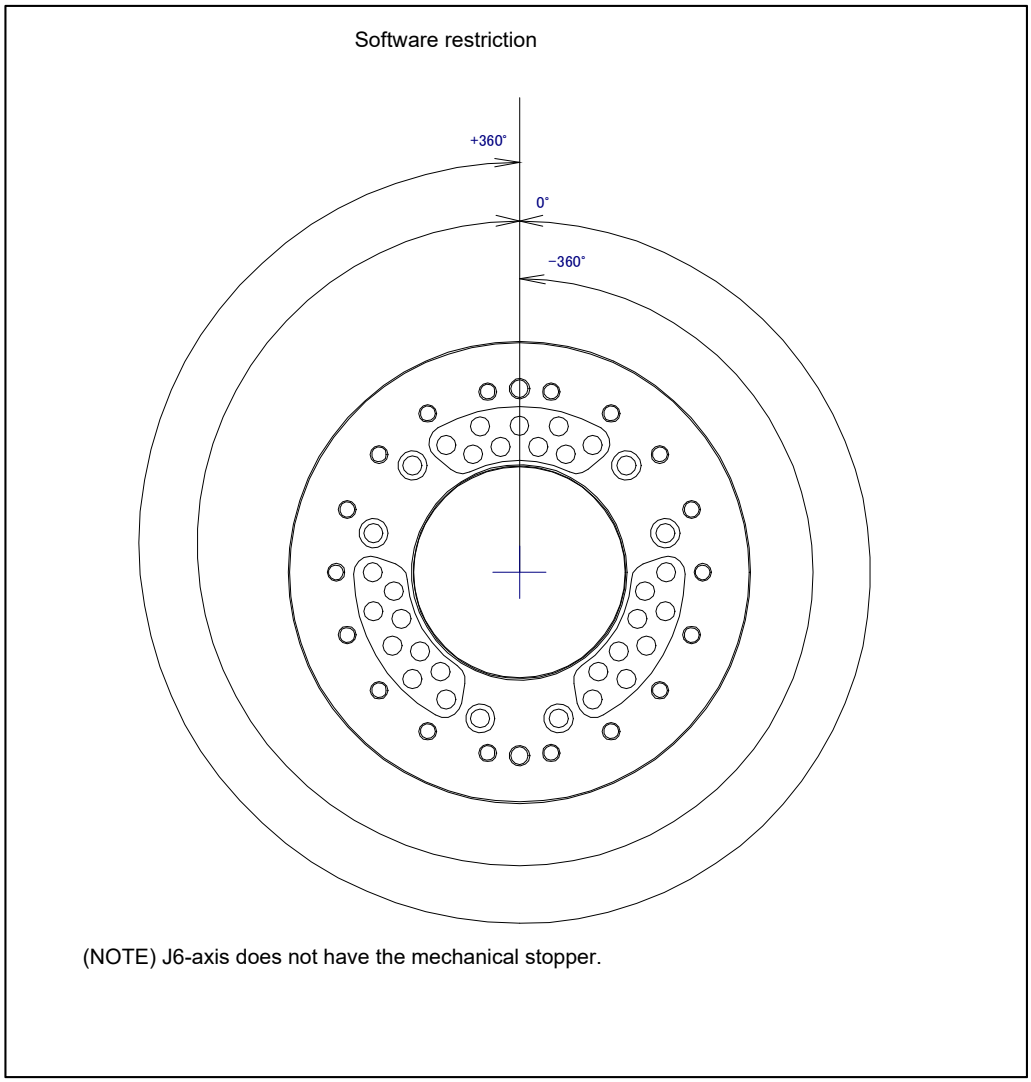


Fig. 3.3 (g) J6-axis motion limit

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 end effector.

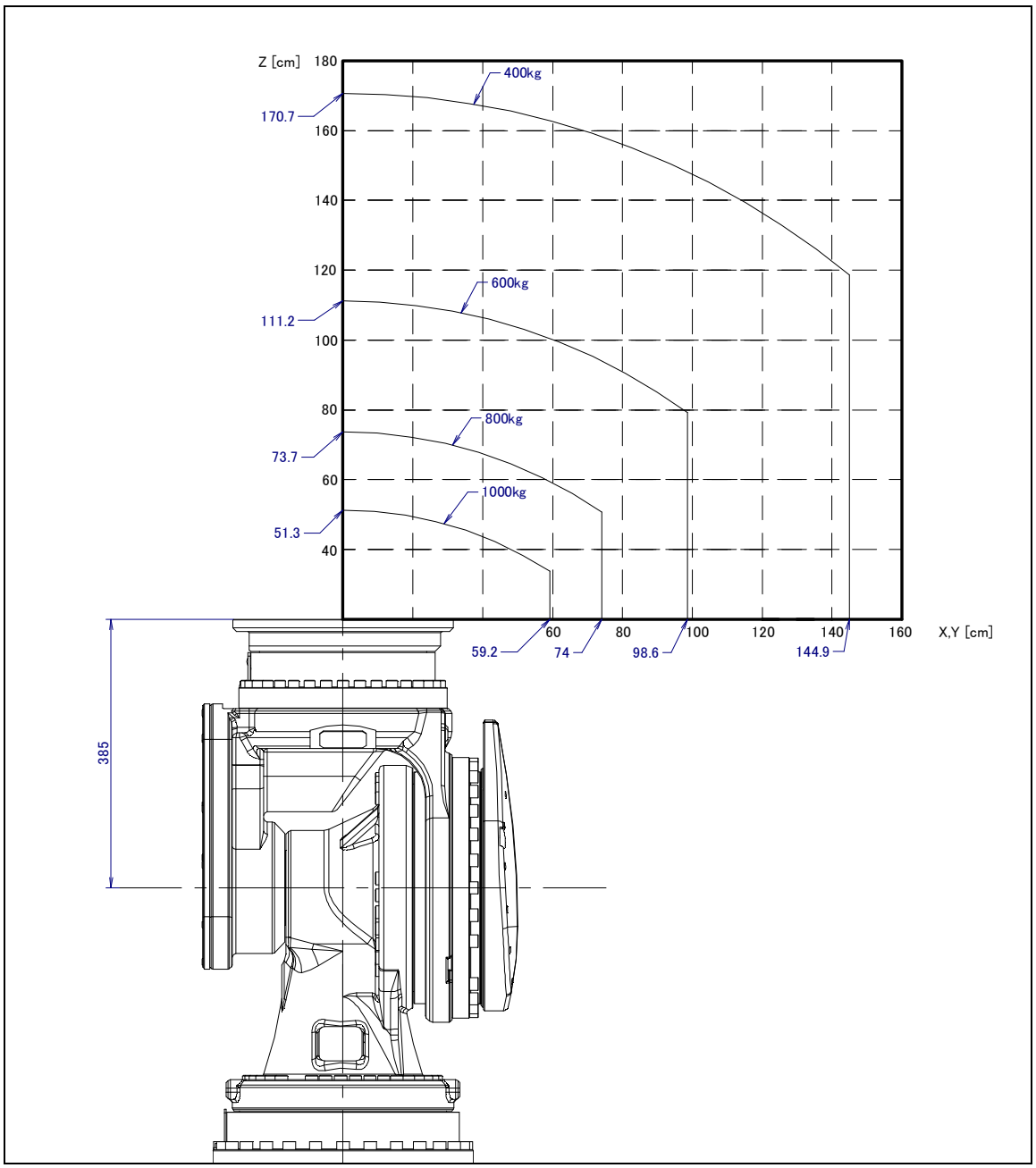


Fig. 3.4 (a) Wrist load diagram

3.5 LOAD CONDITIONS ON J2 BASE AND J3 ARM

Table 3.5 (a) and Fig. 3.5 (a) show J2 base and J3 arm load condition.

Table 3.5 (a) J3 arm load condition

Load on the J3 arm (A)	Load on the J3 arm (B)
50kg or less	50kg or less
(A)+(B)≦50kg	

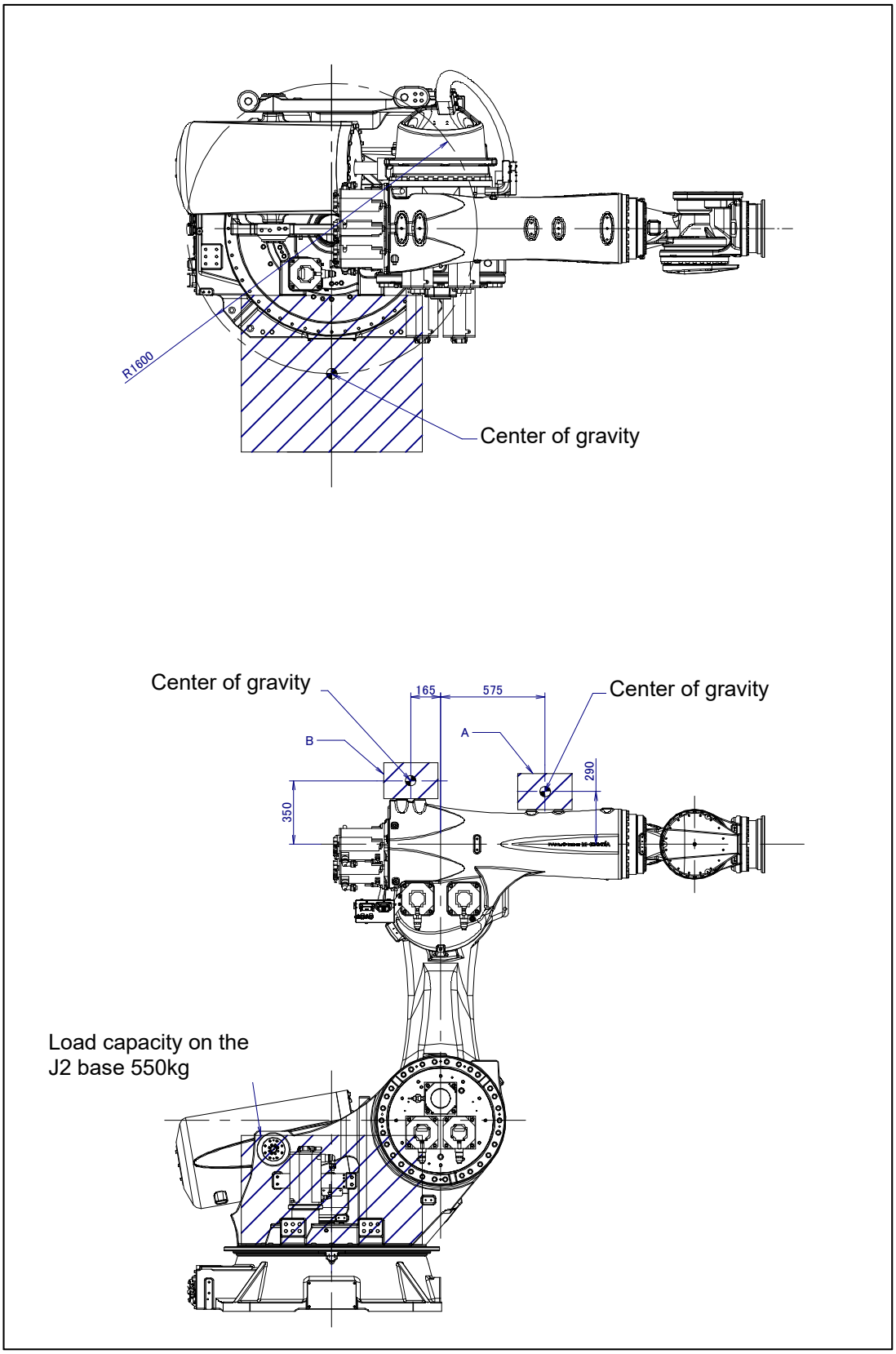


Fig. 3.5 (a) J2 base/J3 arm load condition

4 EQUIPMENT INSTALLATION TO THE ROBOT

4.1 END EFFECTOR INSTALLATION TO WRIST

Fig. 4.1 (a) shows the diagram for installing end effectors on the wrist. Select screws and positioning pins considering the depth of the tapped holes and pin holes.
Tighten the bolts according to "APPENDIX B STRENGTH OF BOLT AND BOLT TORQUE LIST".

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

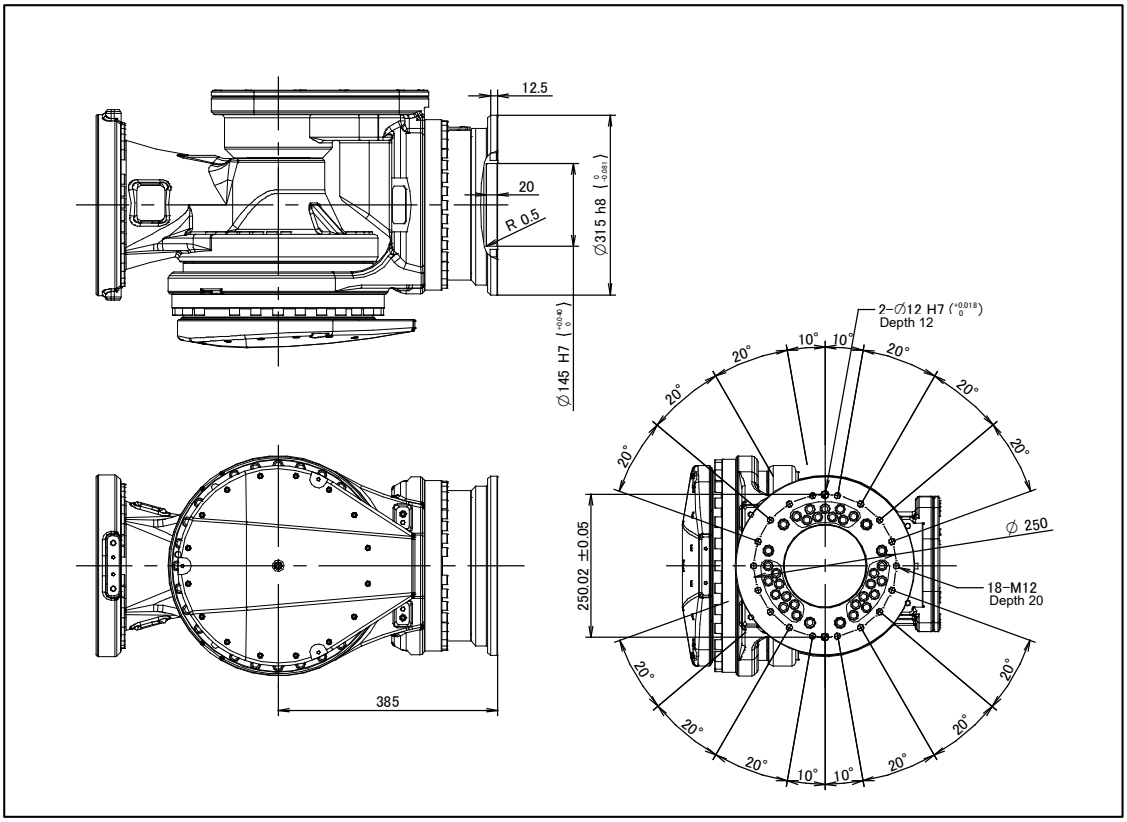


Fig. 4.1 (a) End effector mounting face

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 operations such as drilling or tapping on the robot body. This can seriously affect the safety and functions of the robot.
2 Note that the use of a tapped hole not shown in the following figure is not assured. Please do not install equipment using the bolts of the mechanical unit.
3 Equipment should be installed so that mechanical unit cable does not interfere. If equipment interferes, the mechanical unit cable might be disconnected, and unexpected troubles might occur.

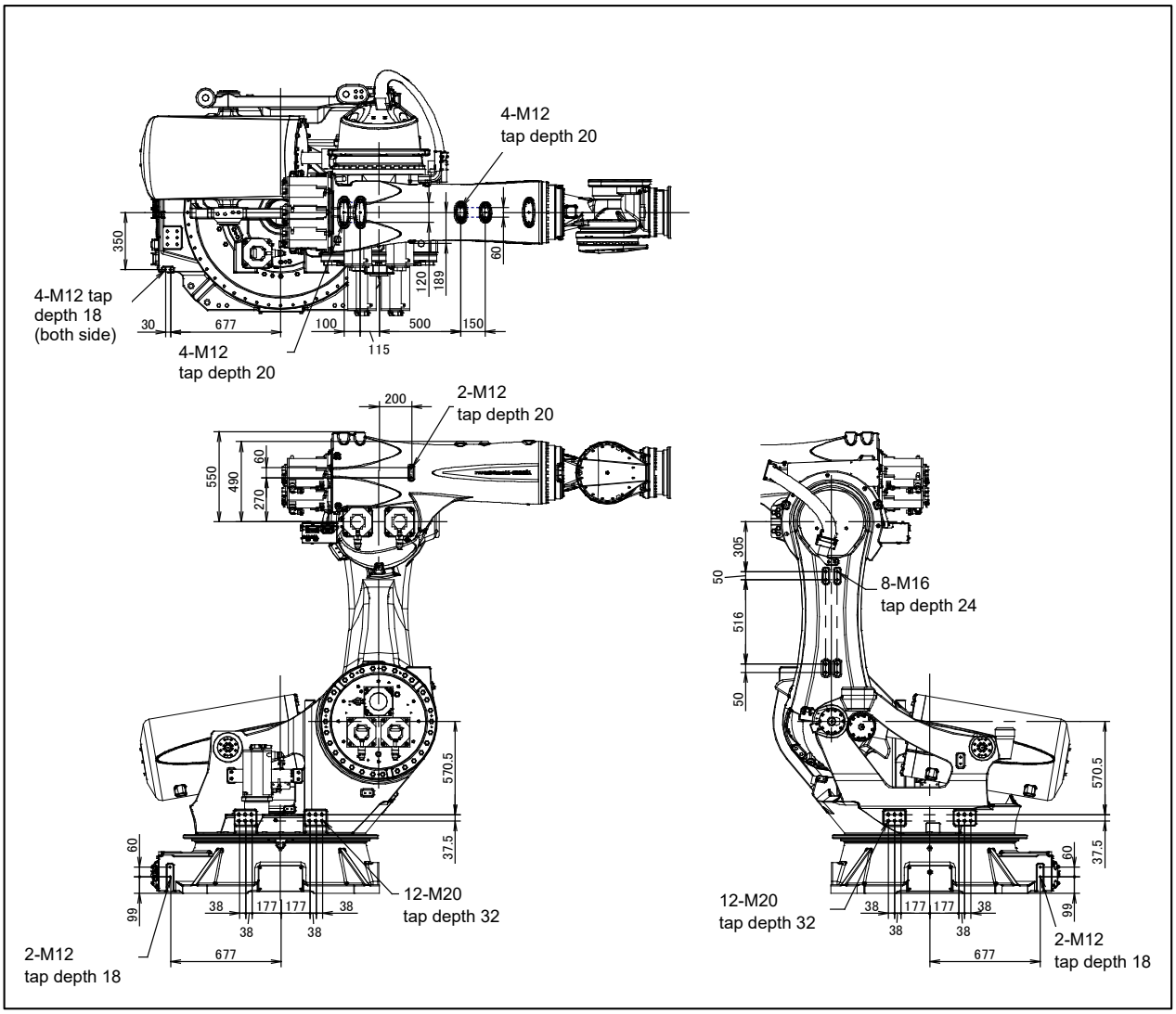


Fig. 4.2 (a) Equipment mounting faces

4.3 LOAD SETTING

⚠ CAUTION

1 Set the correct load condition parameter before the robot runs. Do not operate the robot with its payload exceeded or incorrect. Do not exceed the allowable payload including connection cables. Operation with exceeding payload may result in troubles such as reducer life reduction.

2 WHEN PERFORMING LOAD ESTIMATION AFTER PARTS REPLACEMENT
If wrist axes (J5/J6-axis) motors or reducers are replaced, estimation accuracy may go down. Perform the calibration for load estimation before performing load estimation. Refer to below.
- Chapter 9 “LOAD ESTIMATION” in Controller Optional Function OPERATOR’S MANUAL (B-83284EN-2).

The MOTION PERFORMANCE screens include the MOTION PAYLOAD SET screen for setting payload information, and MOTION ARMLOAD SET screen for setting 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          1000.00    [                    ]
 2             0.00    [                    ]
 3             0.00    [                    ]
 4             0.00    [                    ]
 5             0.00    [                    ]
 6             0.00    [                    ]
 7             0.00    [                    ]
 8             0.00    [                    ]
 9             0.00    [                    ]
10             0.00    [                    ]

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

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

```
MOTION/PAYLOAD SET              JOINT   100%

   Group 1
   Schedule No[   1]:[Comment          ]
 1 PAYLOAD             [kg]        1000.00
 2 PAYLOAD CENTER  X   [cm]          -59.15
 3 PAYLOAD CENTER  Y   [cm]            0.00
 4 PAYLOAD CENTER  Z   [cm]           29.06
 5 PAYLOAD INERTIA X   [kgfcms^2]  2174.27
 6 PAYLOAD INERTIA Y   [kgfcms^2]  5212.38
 7 PAYLOAD INERTIA Z   [kgfcms^2]  4666.81

 [TYPE]  GROUP  NUMBER  DEFAULT  HELP
```

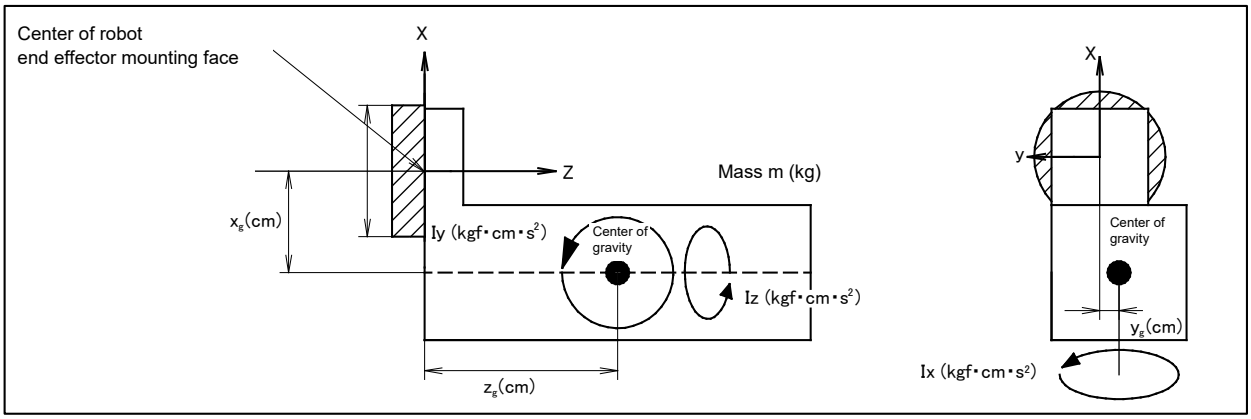


Fig. 4.3 (a) Standard tool coordinate

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

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

9 On the list screen, pressing F4 ([ARMLOAD]) brings you to MOTION/ARMLOAD SET screen.

```
MOTION/ARMLOAD SET          JOINT    10%

  Group 1
1 J2 BASE LOAD              [kg]   550.00
2 J3 ARM LOAD1              [kg]    50.00
3 J3 ARM LOAD2              [kg]     0.00
[ TYPE ]    GROUP        DEFAULT   HELP
```

10 Specify the weight of the load on the J2 base, J3 arm as follows:

J2 BASE LOAD [kg]: Weight of the load on the J2 base
J3 ARM LOAD1 [kg]: Weight of the load on the J3 arm 1
J3 ARM LOAD2 [kg]: Weight of the load on the J3 arm 2

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 cycling power of the controller.

5 PIPING AND WIRING TO THE END EFFECTOR

⚠ WARNING

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

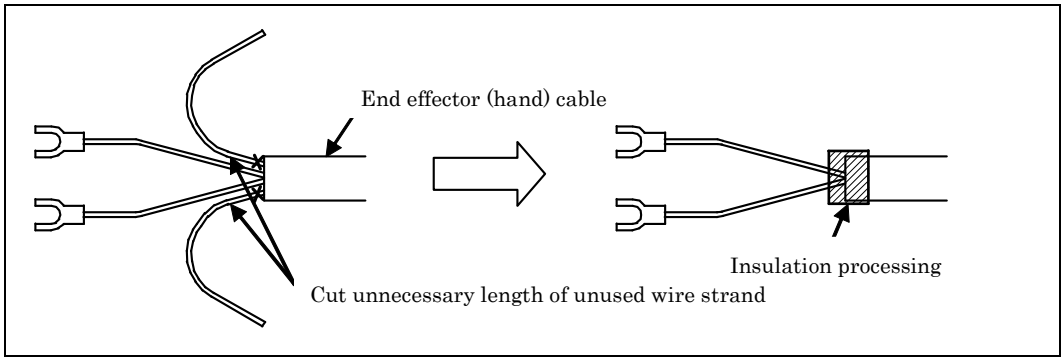


Fig. 5 (a) Treatment method of end effector (hand) cable

5.1 AIR SUPPLY (OPTION)

Robot has air inlet and air outlet on the robot base or back of the J1 base and the back of the J3 arm used to supply air pressure to the end effector. The connector is an Rc1/2 female.
As couplings are not supplied, it will be necessary to prepare couplings, which suit to the tube size.

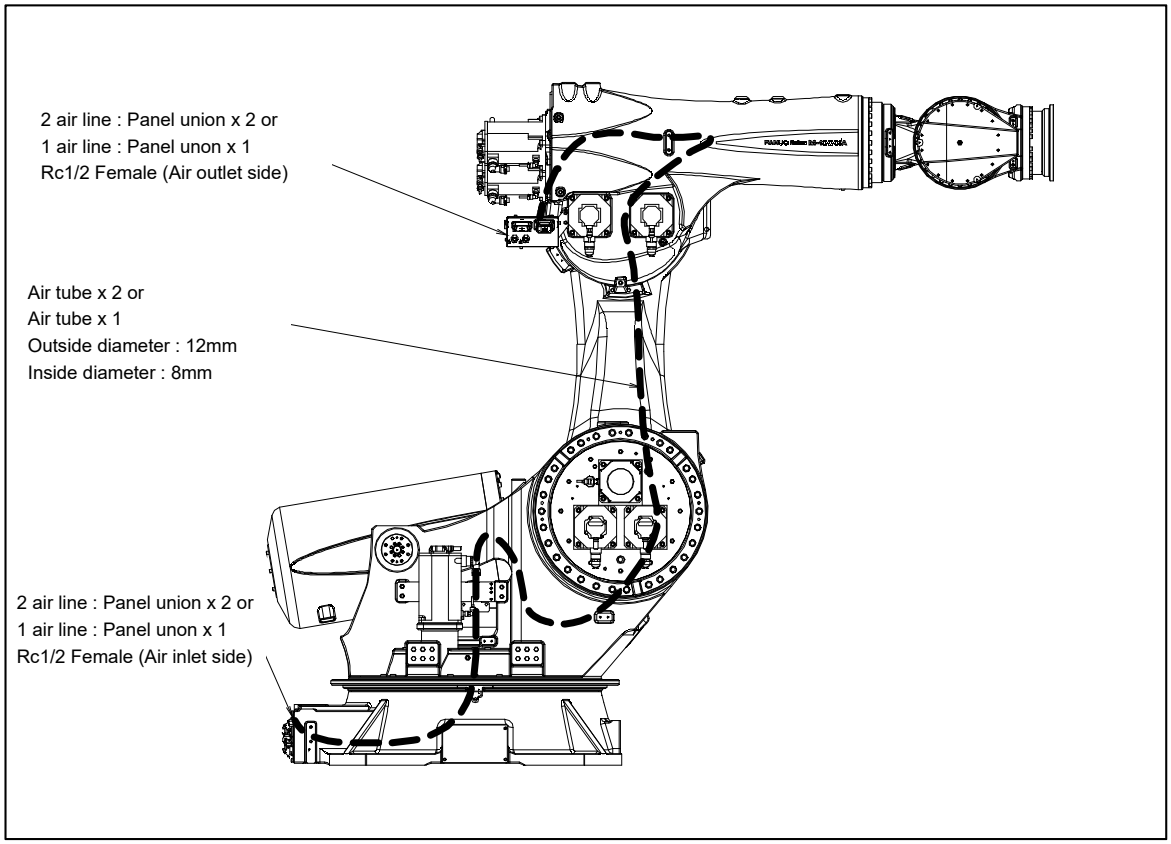
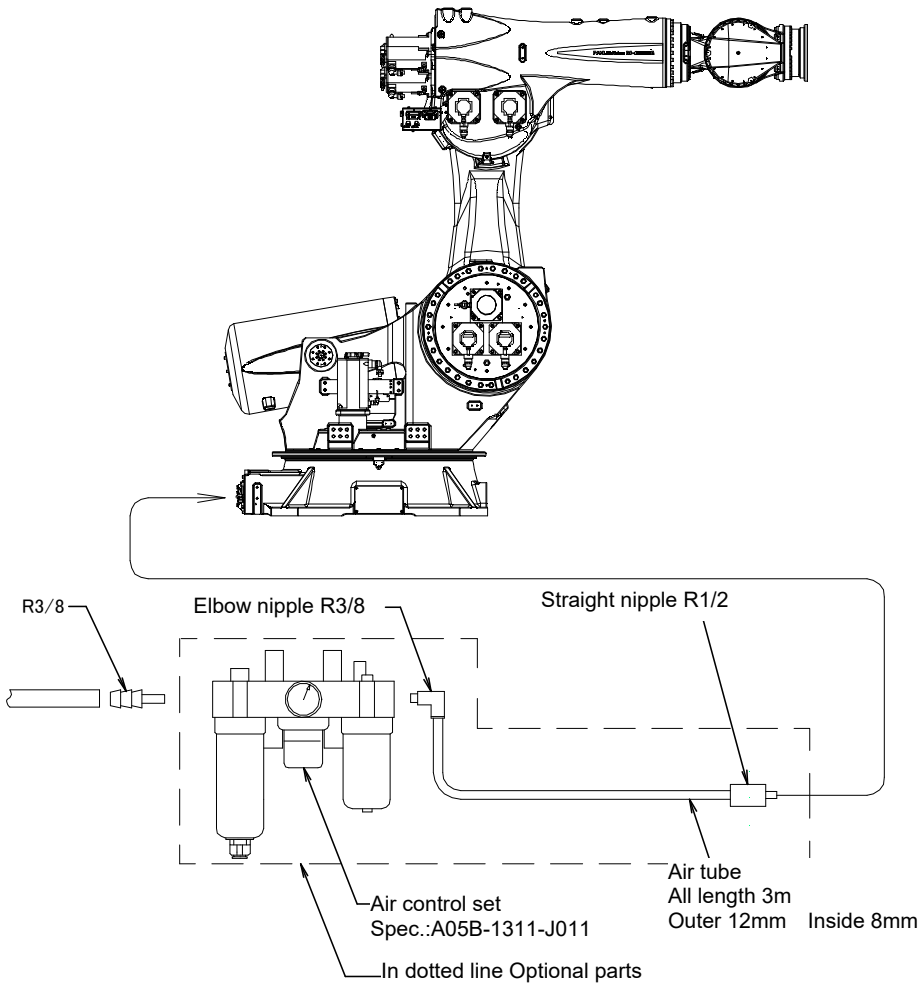


Fig. 5.1 (a) Air supply (option)

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.



NOTE)
Pipe used in the mechanical unit has an outer diameter of 12mm and an inner diameter of 8mm.
You can use a different size pipe outside the mechanical unit.

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.

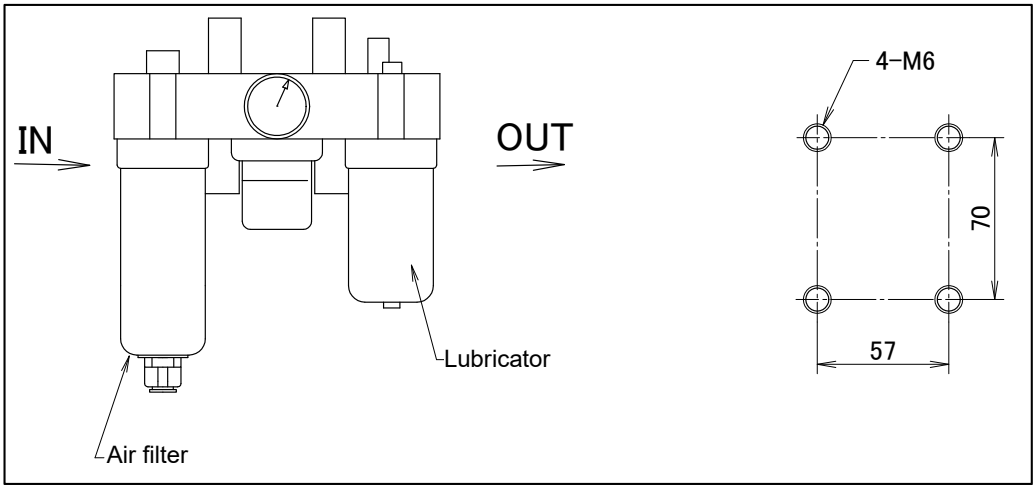


Fig. 5.2 (b) Air control set (option)

NOTE
The capacity value of the 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/cm^2) Setting: 0.49MPa (5kgf/cm^2)
	Amount of consumption	Maximum instantaneous amount 150Nl/min (0.15Nm^3/min)

5.3 INTERFACE FOR OPTION CABLE (OPTION)

Fig. 5.3 (a) shows the position of the option cable interface. Fig 5.3 (b) shows the option cable interface. EE (RI/RO) interface, user cable (signal line/power line) and additional axis motor cable (Pulsecoder line/power, brake line) are prepared as options.

NOTE
Each option cable is written as shown below on the connector panel.
EE(RI/RO) interface : EE
User cable (signal) : AS
User cable (power) : AP

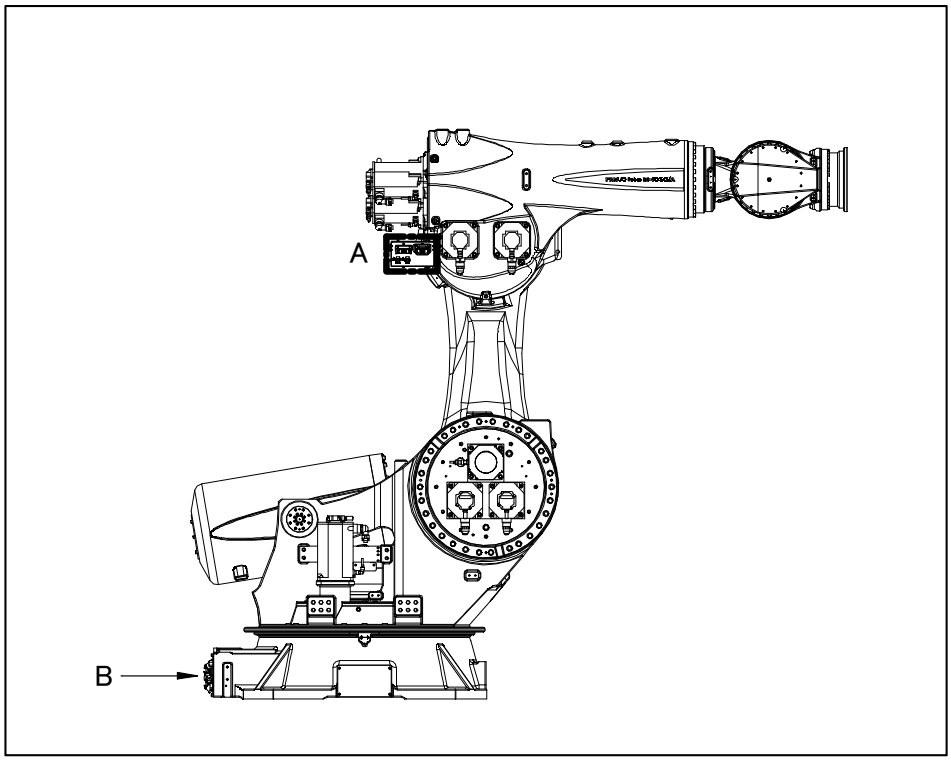


Fig. 5.3 (a) Interface for option cable

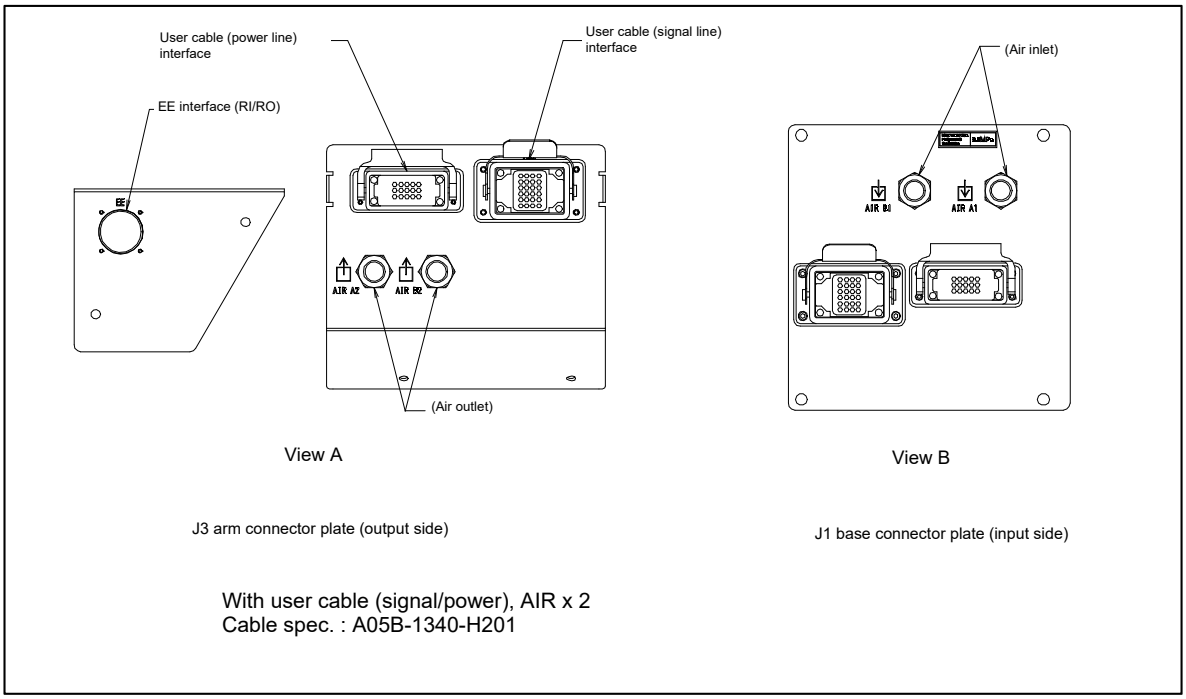


Fig. 5.3 (b) option cable interface

1 End effector interface (RI/RO) (option)
Fig. 5.3 (c) shows pin layout for end effector interface (RI/RO). When severe dust/liquid protection package is specified, the connector has guide pins and bushes for preventing improper insertion. For cables prepared by the user, use these guide pins and bushes.

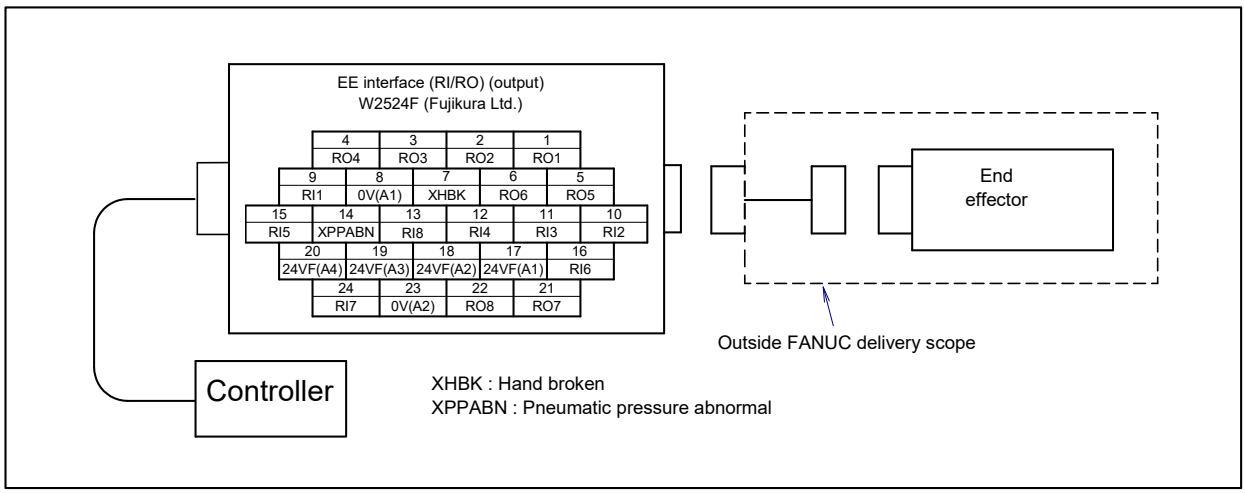


Fig. 5.3 (c) Pin layout for end effector interface (RI/RO) (option)

> ⚠ **CAUTION**
> For wiring of the peripheral device to the EE interface, refer to the Chapter 4 of CONNECTION section of CONTROLLER MAINTENANCE MANUAL, too.

2 User cable (signal line) (AS) Interface (option)
Fig. 5.3 (d) shows pin layout for user cable (signal line) interface. The connector has a code pin for preventing improper insertion. For cables prepared by the user, use this code pin.

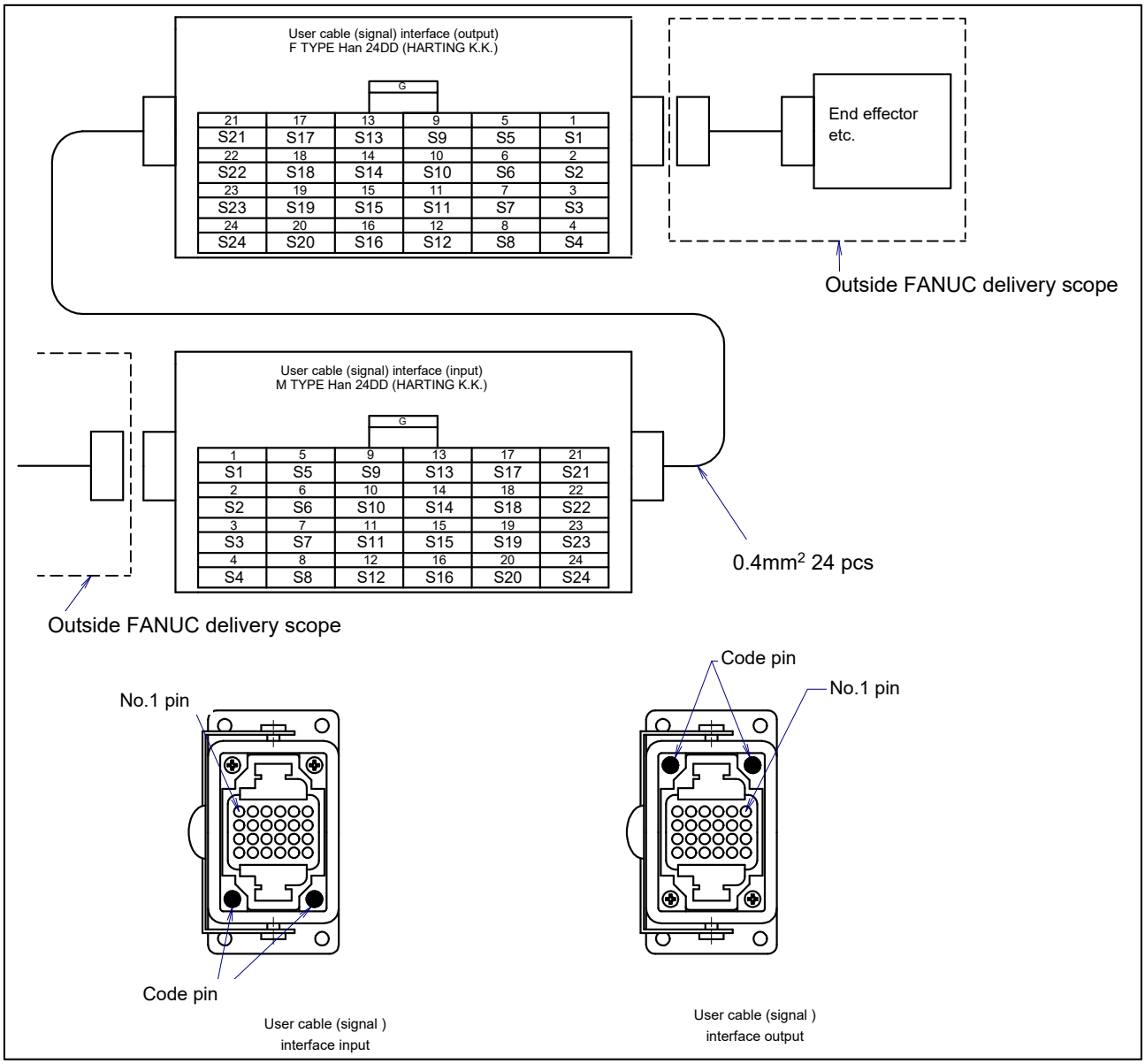


Fig. 5.3 (d) Pin layout and code pin position for user cable (signal line) (AS) interface (option)

4 User cable (power line) (AP) Interface (option)
Fig. 5.3 (e) shows pin layout for user cable (power line) interface.
The connector has a code pin for preventing improper insertion. For cables prepared by the user, use this code pin.

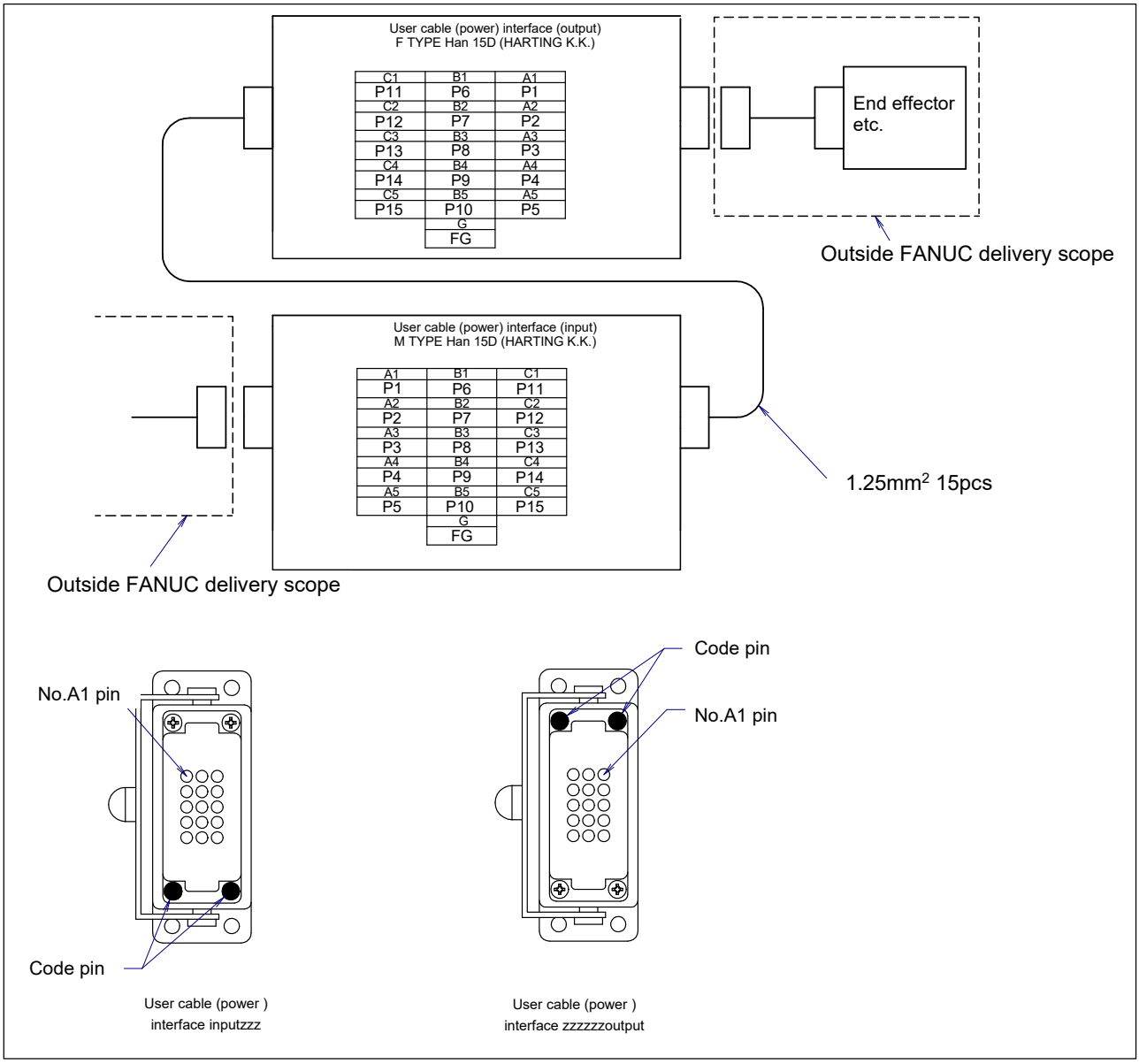


Fig. 5.3 (e) Pin layout for user cable (power line) (AP) interface and code pin layout (option)

Connector specifications

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

Cable	Input side (J1 base)		Output side (J3 casing)		Maker /Dealer
EE (RI/RO)	———		JMWR2524F		Fujikura Ltd.
AS	Housing Insert Contact Code pin	09 30 006 0301 09 16 024 3001 09 15 000 6103 09 30 000 9901	Housing Insert Contact Code pin	09 30 006 0301 09 16 024 3101 09 15 000 6203 09 30 000 9901	HARTING K.K.
AP	Housing Insert Contact Code pin	09 20 010 0301 09 21 015 3001 09 15 000 6103 09 30 000 9901	Housing Insert Contact Code pin	09 20 010 0301 09 21 015 3101 09 15 000 6203 09 30 000 9901	

Table 5.3 (c) 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.
AS	Hood (NOTE 2)	09 30 006 1540 Side entry 1541 0542 0543 1440 Top entry 1441 0442 0443	Hood	←The same	HARTING K.K.
	Insert	09 16 024 3101	Insert	09 16 024 3001	
	Contact (NOTE 2)	09 15 000 6204 AWG 26-22 6203 AWG 20 6205 AWG 18 6202 AWG 18 6201 AWG 16 6206 AWG 14	Contact (NOTE 2)	09 15 000 6104 AWG 26-22 6103 AWG 20 6105 AWG 18 6102 AWG 18 6101 AWG 16 6106 AWG 14	
	Clamp (NOTE 2)	09 00 000 5083 5086 5090 5094 etc. Many other types are available	Clamp	←The same	
	Code pin	09 30 000 9901	Code pin	09 30 000 9901	

Cable	Input side (J1 base)		Output side (J3 casing)		Maker /Dealer
AP	Hood (NOTE 2)	09 20 010 1541 Side entry 0540 ↓ 0541 ↓ 1440 Top entry 0440 ↓ 0441	Hood	←The same	HARTING K.K.
	Insert	09 21 015 3101	Insert	09 21 015 3001	
	Contact (NOTE 2)	09 15 000 6204 AWG 26-22 6203 AWG 20 6205 AWG 18 6202 AWG 18 6201 AWG 16 6206 AWG 14	Contact (NOTE 2)	09 15 000 6104 AWG 26-22 6103 AWG 20 6105 AWG 18 6102 AWG 18 6101 AWG 16 6106 AWG 14	
	Clamp (NOTE 2)	09 00 000 5083 5086 5090 5094 etc. Many other types are available	Clamp	←The same	
	Code pin	09 30 000 9901	Code pin	09 30 000 9901	

NOTE 1

Underlined parts are attached. Specifications to order in our company are as follows.

(*1) A63L-0001-0234#S2524M
(*2) A63L-0001-0453#06B1440
(*3) A63L-0001-0453#24DDM
(*4) A63L-0001-0453#CA6104
(*5) A63L-0001-0453#A-152D
(*6) A63L-0001-0453#A-9908
(*7) A63L-0001-0453#A-9909

NOTE 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 axes, you can change the robot's motion range from the standard values. Changing the motion range of the robot is effective under following circumstances:

- Used motion range of the robot is limited.
- There 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 two methods used to prevent the robot from going beyond the necessary motion range. These are

- Limit axis motion range by DCS (All axes (option))
- Limit axis motion 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-axis, use the DCS function so that damage to peripheral equipment and injuries to human bodies can be avoided.
3 Mechanical stoppers are physical obstacles. For J1-axis, it is possible to re-position the adjustable mechanical stoppers. But the robot cannot move beyond them. For 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, only adjustable mechanical stoppers are available; DCS specified movable range cannot be changed.
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)

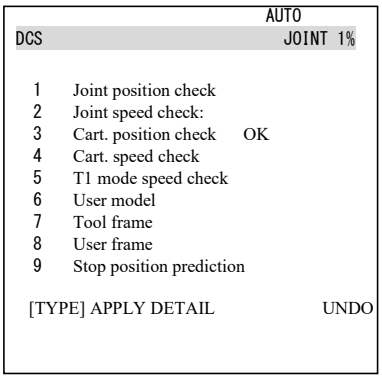
The robot motion can be restricted with DCS (Dual check safety) function by using the following software. For J2/J3-axis, the same effect as adjustable mechanical stopper described in Section 6.2 can be obtained. The robot motion can be restricted at any angle and position if it is in robot motion area. DCS functions are certified to meet the requirements of International Standard ISO13849-1 and IEC61508 approved by 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)

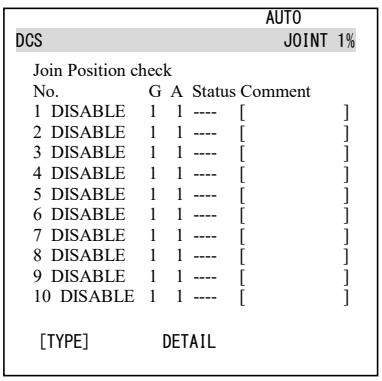
As an example, we shows the procedure to set ±30° for J2-axis in here. Refer to Controller Dual check safety function Operator's Manual (B-83184EN) for details of other setting, function and DCS stop position prediction.

Setting procedure

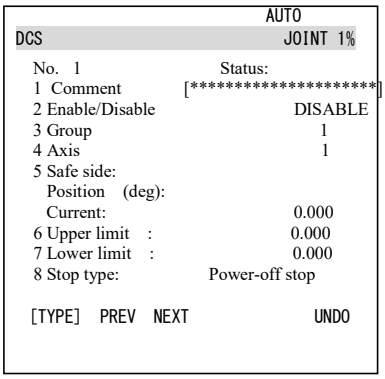
1 Press the [MENU] key to display the screen menu.
2 Press [0 NEXT] and press [6 SYSTEM].
3 Press the F1 ([TYPE]).
4 Select [DCS]. The following screen will be displayed.



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

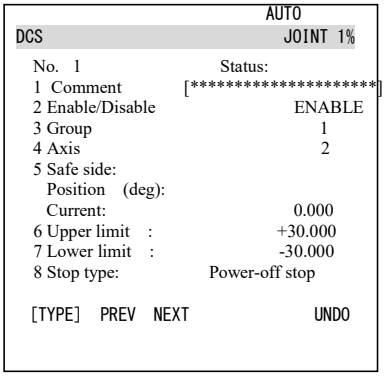


6 Move the cursor to [1], then press the [DETAIL].

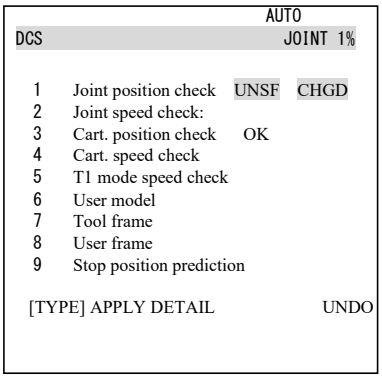


7 Move the cursor to [DISABLE], then press [CHOICE], set the status to [ENABLE].
8 Move the cursor to [Group], then input the robot group number, then press the [ENTER] key.
9 Move the cursor to [Axis], then input “2”, then press the [ENTER] key.
10 Move the cursor to [Upper limit] right side, then input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

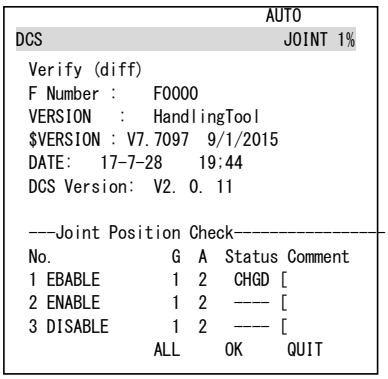
> ⚠ **WARNING**
> If only the operating space is set using Joint Position Check, the robot stops after it goes beyond the workspace. When the motor power is shut down, the robot’s momentum causes it to move some distance before it completely stops. The actual "Robot Stop Position" will be beyond the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



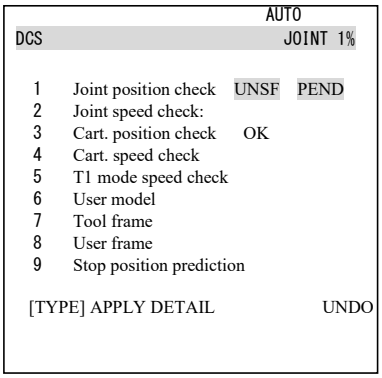
12 Press the [PREV] key two times. Then back to the first screen.



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



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



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

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

6.2 ADJUSTABLE MECHANICAL STOPPER 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.

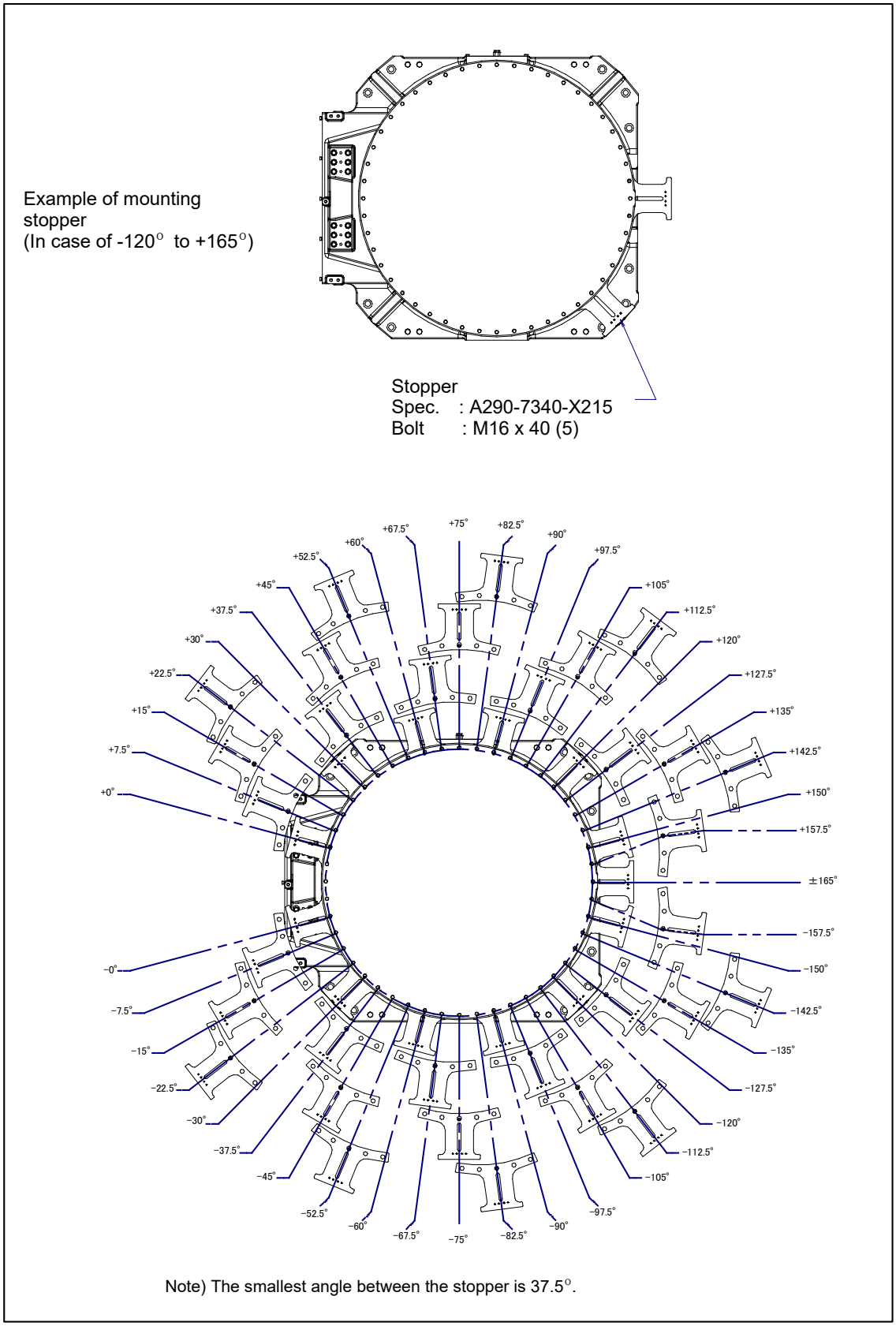
Table 6.2 (a) motion range that can be set by the adjustable mechanical stopper and space between the upper and lower limits

Item		Movable range
J1 axis adjustable mechanical stopper	Upper limit	Settable in steps of 7.5° degrees in a range of -127.5° to +165° degrees
	Lower limit	Settable in steps of 7.5° degrees in the range of -165° to +127.5° degrees
	Space between the upper and lower limits	A space of 37.5° degrees or more is required.

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

6.2.1 Installing Adjustable Mechanical Stopper Option

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



Note) The smallest angle between the stopper is 37.5°.

Fig. 6.2.1 (a) Mounting of J1-Axis adjustable mechanical stopper (Option)

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	-165.00	165.00	deg
2	1	-60.00	100.00	deg
3	1	-130.00	35.00	deg
4	1	-360.00	360.00	deg
5	1	-120.00	120.00	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 JOINT 100%
Group1 1/16

AXIS	GROUP	LOWER	UPPER	
2	1	-60.00	100.00	deg

[TYPE]

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

⚠ WARNING
1 You must turn off the controller and then turn it back on to activate the new settings; 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	+7.4°	-7.4°

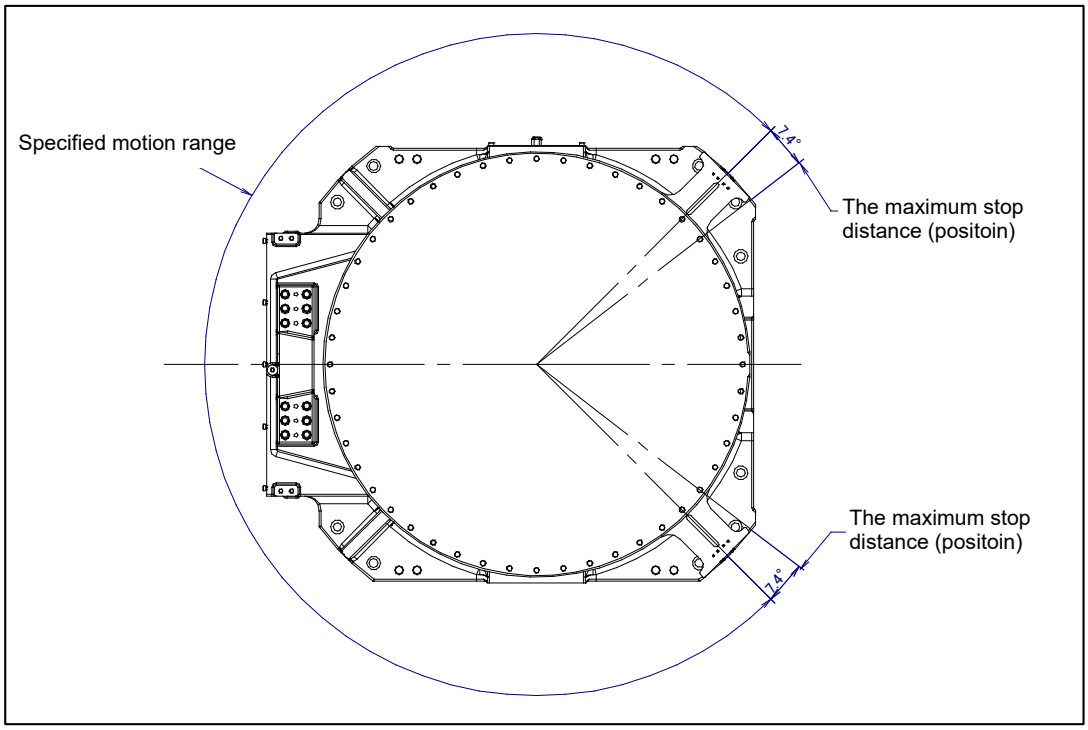


Fig. 6.2.3 (a) The maximum stop distance of J1-axis adjustable mechanical stopper

7 CHECKS AND MAINTENANCE

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

NOTE
The periodic maintenance procedures described in this chapter assume that the FANUC robot is used for up to 3840 hours a year. In cases where robot use exceeds 3840 hours/year, adjust the given maintenance frequencies accordingly. The ratio of actual operating time/year vs. the 3840 hours/year should be used to calculate the new (higher) frequencies. For example, when using the robot 7680 hours a year, the maintenance frequency should be doubled – i.e. the interval should be divided by 2.

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. If displacement occurs, perform the measures as described in the following section: **⇒"9.1 TROUBLESHOOTING"(Symptom : Displacement)**
Peripheral equipment for proper operation	Check whether the peripheral equipment operate properly according to commands from the robot and the peripheral equipment.
Brakes for each axis	Check that the droppage of the end effector is within 0.2 mm when the servo power 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 total operating time or the accumulated operating time, whichever comes first. (○ : Item needs to be performed.)

Check and maintenance intervals (Operating time, Accumulated operating time)						Check and maintenance 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	○					Cleaning the controller ventilation system	Confirm the controller ventilation system is not dusty. If dust has accumulated, remove it.	26
	○					Check the external damage or peeling paint	Check whether the robot has external damage or peeling paint due to the interference with the peripheral devices. If an interference occurs, eliminate the cause. Also, if the external damage is serious, and causes a problem in which the robot will not operate, replace the damaged parts.	1
	○					Check the damages of the cable protective sleeves	Check whether the cable protective sleeves of the mechanical unit cable have holes or tears. If damage is found, replace the cable protective sleeve. If the cable protective sleeve is damaged due to interference with peripheral devices, eliminate the cause. **⇒"7.2.3 Check the Mechanical Unit Cables and Connectors"**	2
	○					Check the wear debris of the balancer and J1-axis swing stopper	Check whether wear debris has accumulated on the following parts. ・ Balancer rod, support part of in frond and behind of the balancer ・ J1-axis swing stopper rotation part. If serious wear is evident on the part that generated the wear debris, replace the part.	3
	○					Check for water	Check whether the robot is subjected to water or cutting oils. If liquid was found, remove the cause, and wipe the liquid off.	4
	○ Only 1st check	○				Check for damages to the teach pendant cable, the operation box connection cable or the robot connection cable	Check whether the cable connected to the teach pendant, operation box and robot are unevenly twisted or damaged. If damage is found, replace the damaged cables.	24
	○ Only 1st check	○				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
	○ Only 1st Check	○				Check for damage to the end effector (hand) cable	Check whether the end effector cables are unevenly twisted or damaged. If damage is found, replace the damaged cables.	6
	○ Only 1st check	○				Check the connection of each axis motor and other exposed connectors	Check the connection of each axis motor and other exposed connectors. **⇒"7.2.3 Check the Mechanical Unit Cables and Connectors"**	7

Check and maintenance intervals (Operating time, 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 during the inspection, and exposed. Refer to the recommended bolt tightening torque guidelines at the end of the manual. Tightening the bolts with a torque greater than what is recommended, might damage the adhesive. 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 he 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 sleeve).	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
		○				Greasing to the J1 bearing and the back of the balancer	Supply grease to the J1 bearing and the bush of back of the balancer bush. **⇒" 7.3.1 Greasing of the J1 bearing part and Bush of the Back of the Balancer, Greasing to the Other Connection Part"**	21
			○			Replacing the mechanical unit batteries	Replace the mechanical unit batteries. Regardless of operating time, replace batteries at 1.5 years. **⇒"7.3.2 Replacing the Batteries"**	13
				○		Supply grease to connection part	Supply grease to the connection part. **⇒"7.3.1 Greasing of the J1 bearing part and Bush of the Back of the Balancer, Greasing to the Other Connection Part"**	23
				○		Replacing the grease and oil of the reducers and the gearbox	Replace the grease and oil of each axis reducer and gearbox **⇒"7.3.3 Replacing the Grease of the Drive Mechanism", "7.3.5 Replacing the Oil of the Drive Mechanism"**	14 to 20
					○	Replacing the mechanical unit cable	Replace the mechanical unit cable Contact your local FANUC representative for information regarding replacing the cable.	24
					○	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)"**	27

7.2 CHECK POINTS

7.2.1 Confirmation of Oil Seepage

Check items

Confirm whether there is oil seepage on the rotating parts of each joint axis.

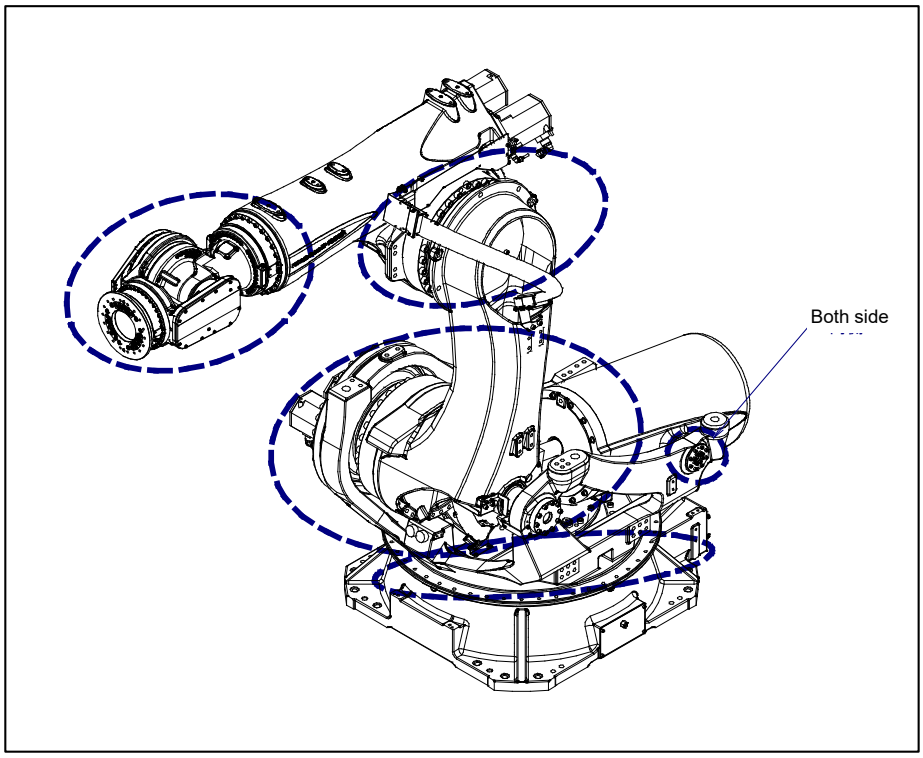


Fig. 7.2.1 (a) Check parts of oil seepage

Management

- Oil might accumulate on the outside of the seal lip depending on the movement condition or environment of the axis. If the oil 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 grease bath may increase rise by frequent repetitive movement and use in high temperature environments. In these cases, normal internal pressure can be restored by venting the grease outlet. (When opening the grease outlet, refer to Subsection 7.3.3 and ensure that grease is not expelled onto the machine or tooling.)

> ⚠ **WARNING**
> Hot grease may come out suddenly when opening the grease outlet. Attach bags for collecting grease and use appropriate protective equipment such as a gloves or protective glasses.

- If you must wipe oil frequently, and opening the grease outlet does not stop the seepage, perform the measures below.
  ⇒"9.1 TROUBLESHOOTING" (symptom : Grease leakage)

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 handle for lubricator adjustment. 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.

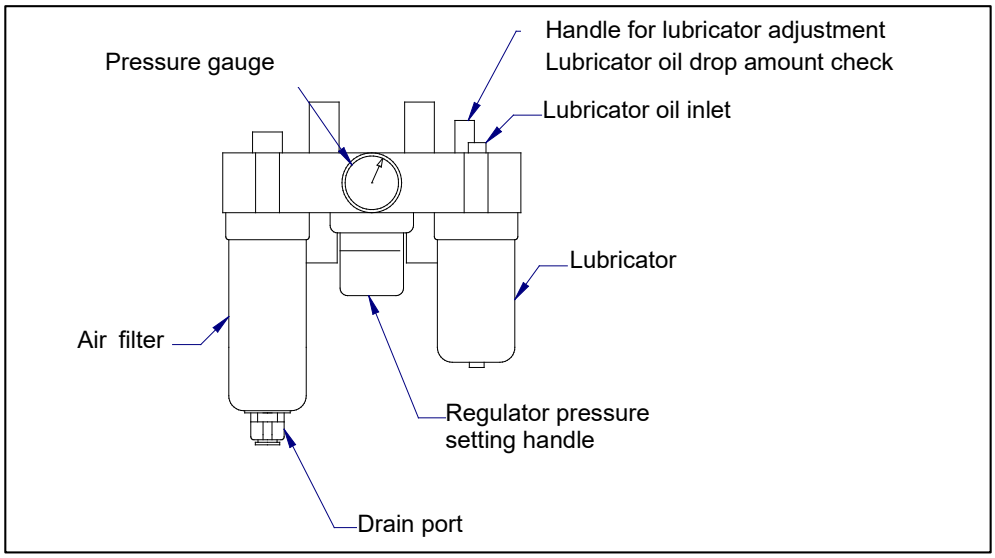


Fig. 7.2.2 (a) Air control set (option)

7.2.3 Check the Mechanical Unit Cables and Connectors

Inspection points of the mechanical unit cables

Fixed part cables likely to interfere with the J1, J2, and J3 movable parts and peripheral devices.
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.

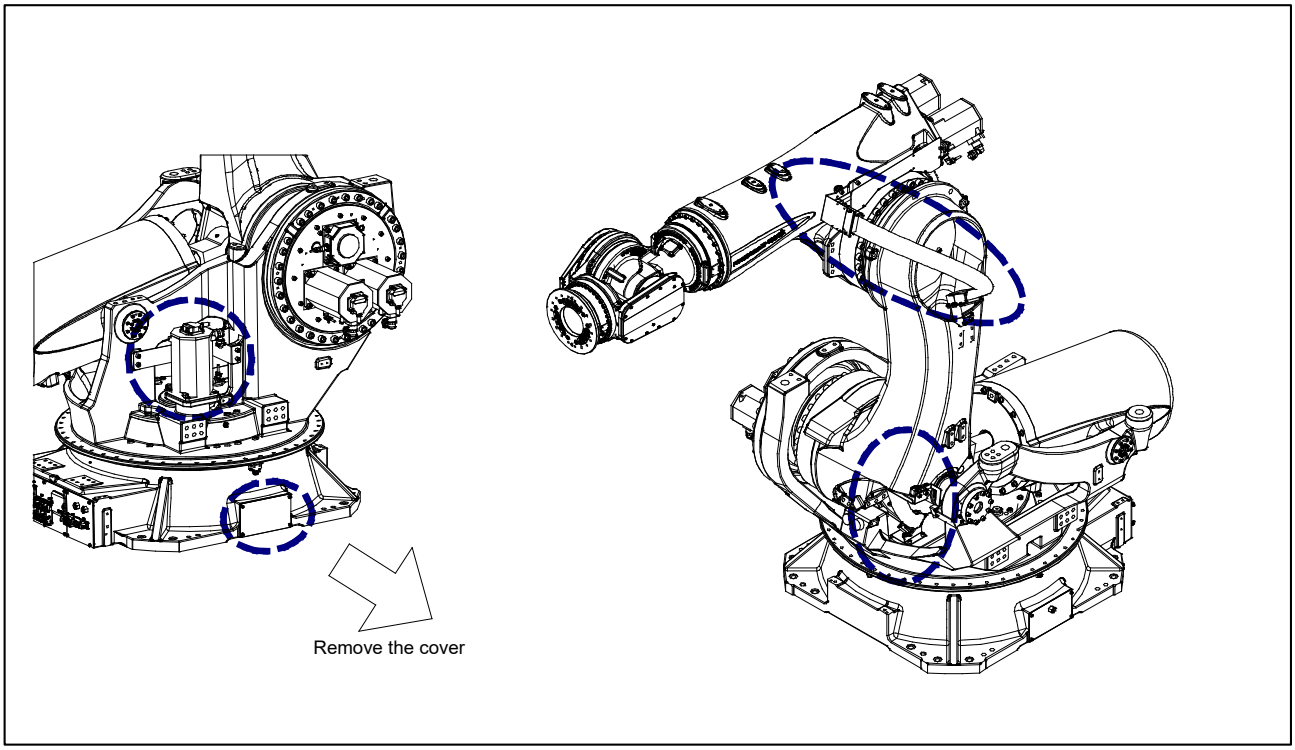


Fig. 7.2.3 (a) Inspection points of the mechanical unit cables

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 coating.
- If the inside wire strands are exposed due to wear or damage, replace the cables.

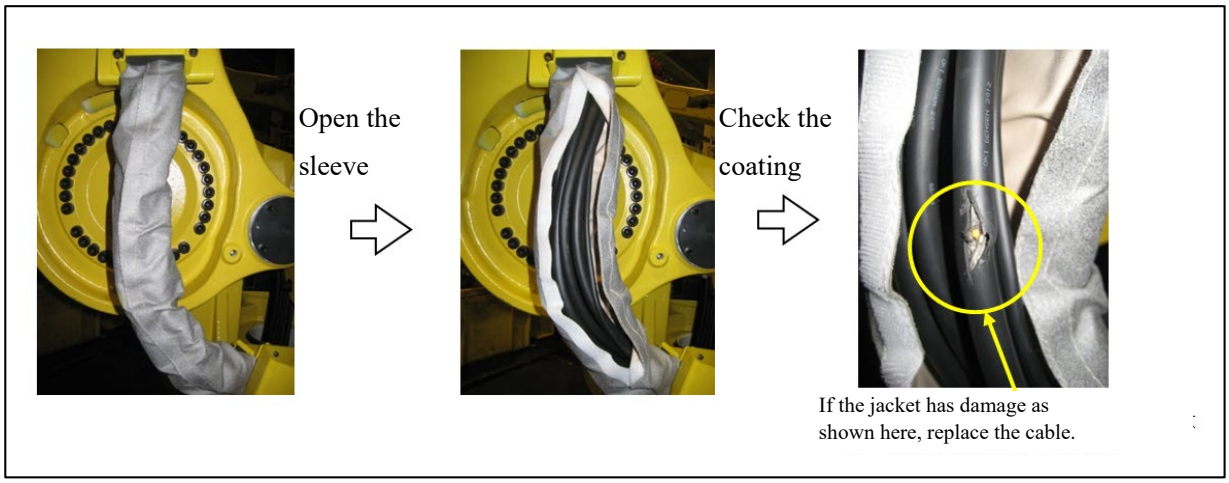


Fig. 7.2.3 (c) Cable check method

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.

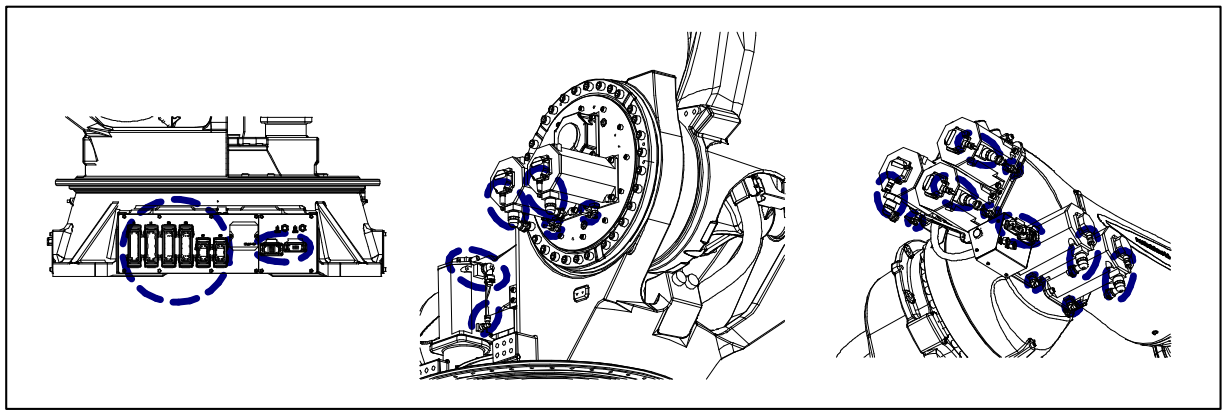


Fig. 7.2.3 (d) Connector Inspection points

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 tightness of the stopper mounting bolts. If they are loose, retighten them.
- Refer to Section 6.2 of the operator's manual for details regarding the adjustable mechanical stopper.

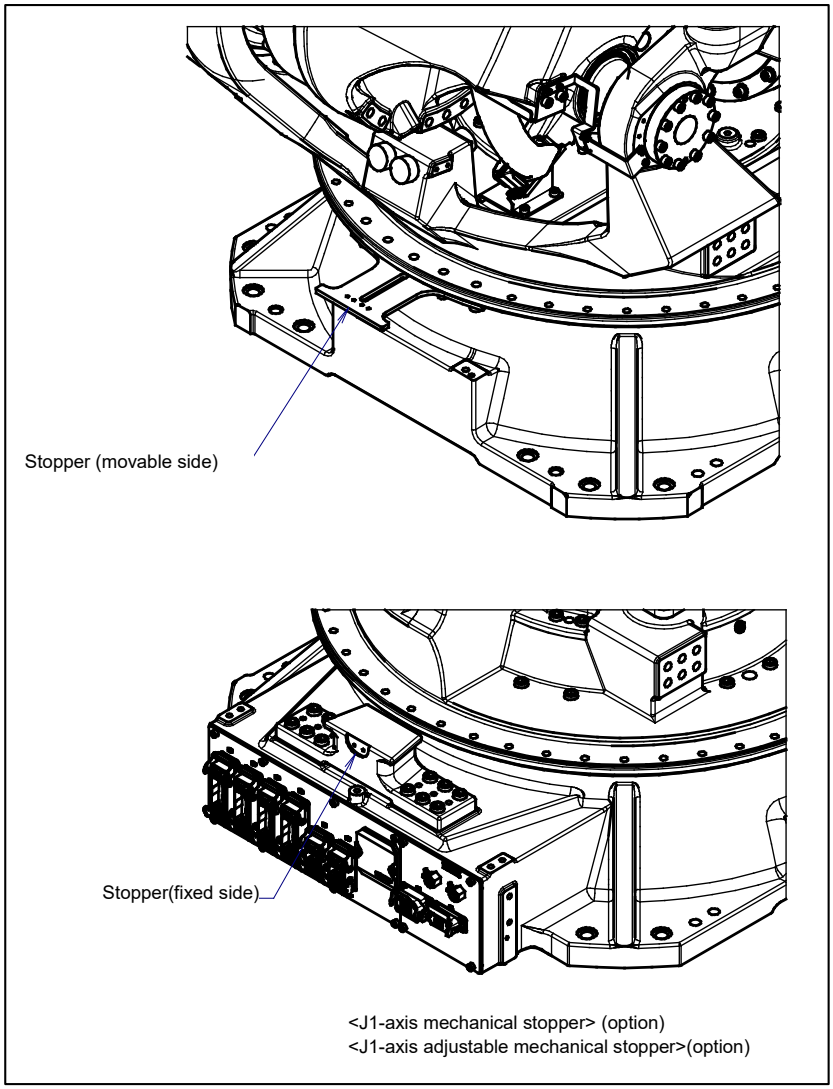


Fig. 7.2.4 (a) Check of fixed mechanical stopper and adjustable mechanical stopper

7.3 MAINTENANCE

7.3.1 Greasing of the J1 bearing part and Bush of the Back of the Balancer (1 year (3840 hours) Periodic Maintenance) Greasing to the Other Connection Part (3 years (11520 hours) Periodic Maintenance)

Be sure to grease the connection parts at specified intervals as shown in Tables 7.3.1 (a). When the installation environment of the robot is bad, however, greasing needs to be made as appropriate. If water splashes on the robot, supply grease immediately Fig. 7.3.1 (a) and (b) show the greasing points.

- Wipe the overflowed grease.
- When greasing to the grease inlet 1,2&3, apply grease during moving the J1-axis.
  1 Grease to grease inlet 1 and 2 20ml each at J1=150º.
  2 Grease to grease inlet 1 and 2 20ml each at J1=90º.
  3 Grease to grease inlet 1 and 2 20ml each at J1=30º.
  4 Grease to grease inlet 2 and 3 20ml each at J1=-30º.
  5 Grease to grease inlet 2 and 3 20ml each at J1=-90º.
  6 Grease to grease inlet 2 and 3 20ml each at J1=-150º.

- Be sure to remove the bolts of the grease outlet before greasing to the grease inlet 6 (taper roller of the balance shaft) and the grease inlet 7 (taper roller under the J2 arm.)

Table 7.3.1 (a) Greasing the bush of the back of the balancer and other connection parts

Greasing points	Amount of grease	Recommended grease	Greasing interval
Grease inlet 1 (J1 bearing part)	60ml	Shell Lubricants Shell Alvania grease S2 Specification: A98L-0004-0602#CTG	J1 bearing part and Bush of the back of the balancer at the interval based on every 1 year or 3840 hours, whichever comes first Other connection parts at the interval based on every 3 years or 11520 hours, whichever comes first
Grease inlet 2 (J1 bearing part)	120ml		
Grease inlet 3 (J1 bearing part)	60ml		
Grease inlet 4 (bush of the back of the balancer)	65ml		
Grease inlet 5 (bush of the back of the balancer)	65ml		
Grease inlet 6 (Taper roller of the balancer shaft)	15ml		
Grease inlet 7 (Taper roller under the J2 arm)	15ml		

Table 7.3.1 (b) Grease Alternative to Shell Alvania Grease S2

Maker	Grease name
MOBIL	MOBILACKS EP2
ENEOS	NIPPON MITSUBISHI MULTINOC 2
ENEOS	EPINOC AP(N)2
IDEMITSU KOHSAN	EPONEX GREASE NO.2
COSMO OIL	DYNAMAX NO.2
Shell Lubricants	Shell Gadus S2 V100 2

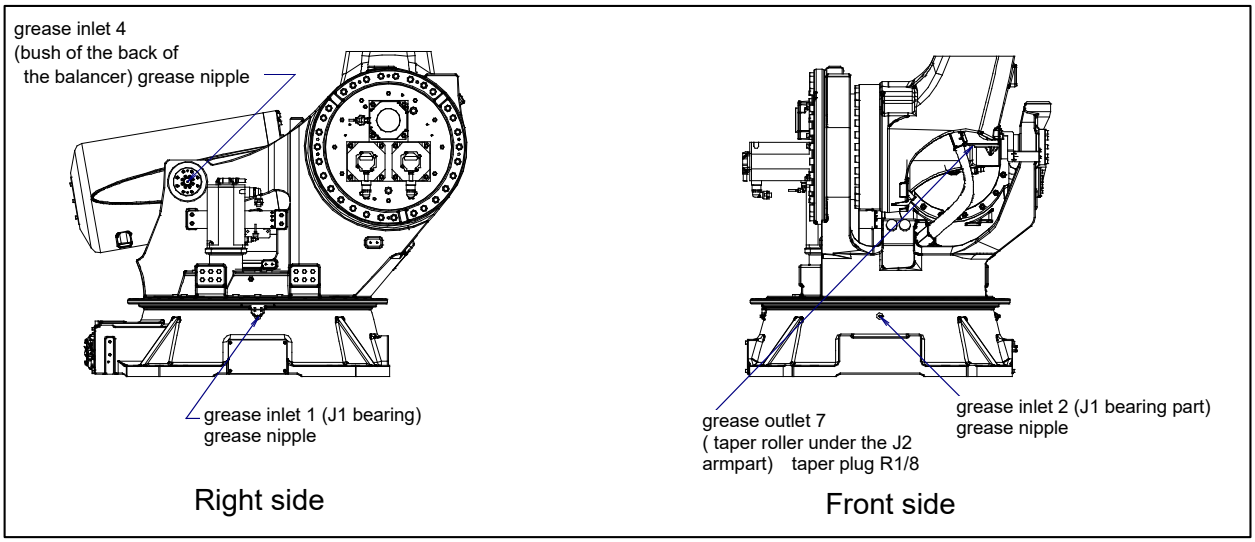


Fig. 7.3.1 (a) Bush of back of balancer and other connection parts greasing points

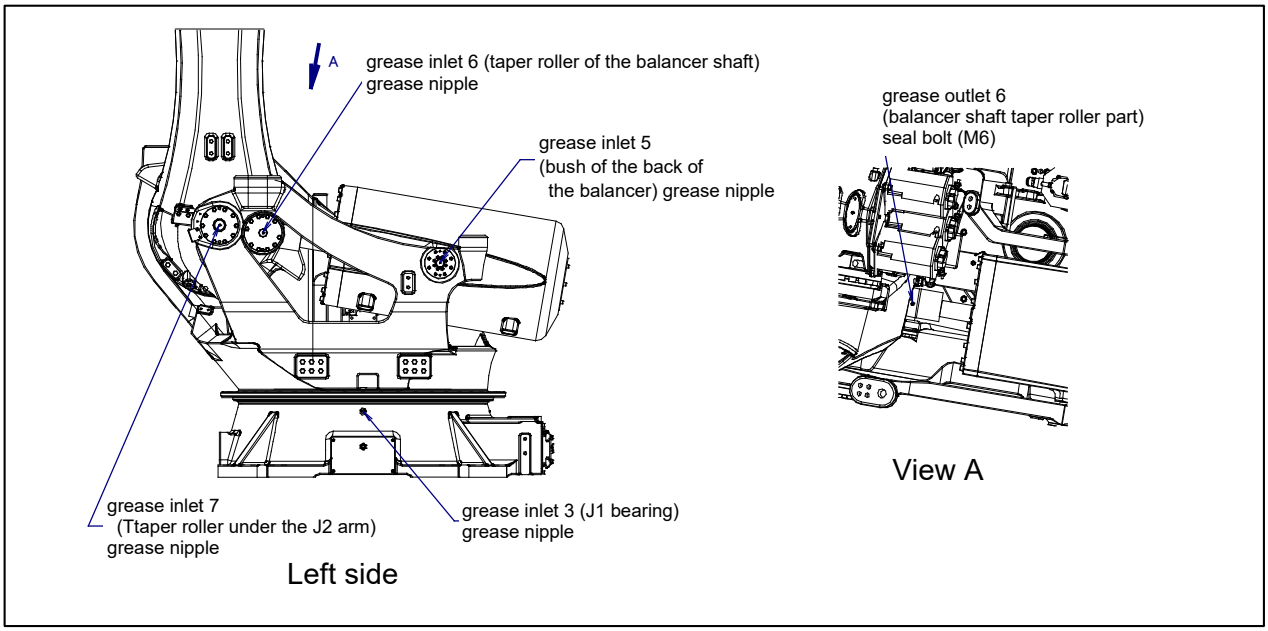


Fig. 7.3.1 (b) Bush of back of balancer and other connection parts greasing points

Table 7.3.1 (c) Spec. of seal bolts

Parts name	Specifications
Seal bolt (M6)	A97L-0218-0417#061616
Taper plug (R1/8)	A97L-0001-0436#1-1D

7.3.2 Replacing the Batteries (1.5 Year Checks)

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

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

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

2 Remove the battery case cap. (Fig. 7.3.2 (a))
3 Take out the old batteries from the battery case.
4 Insert new batteries into the battery case. Pay attention to the direction of batteries.
5 Close the battery case cap.

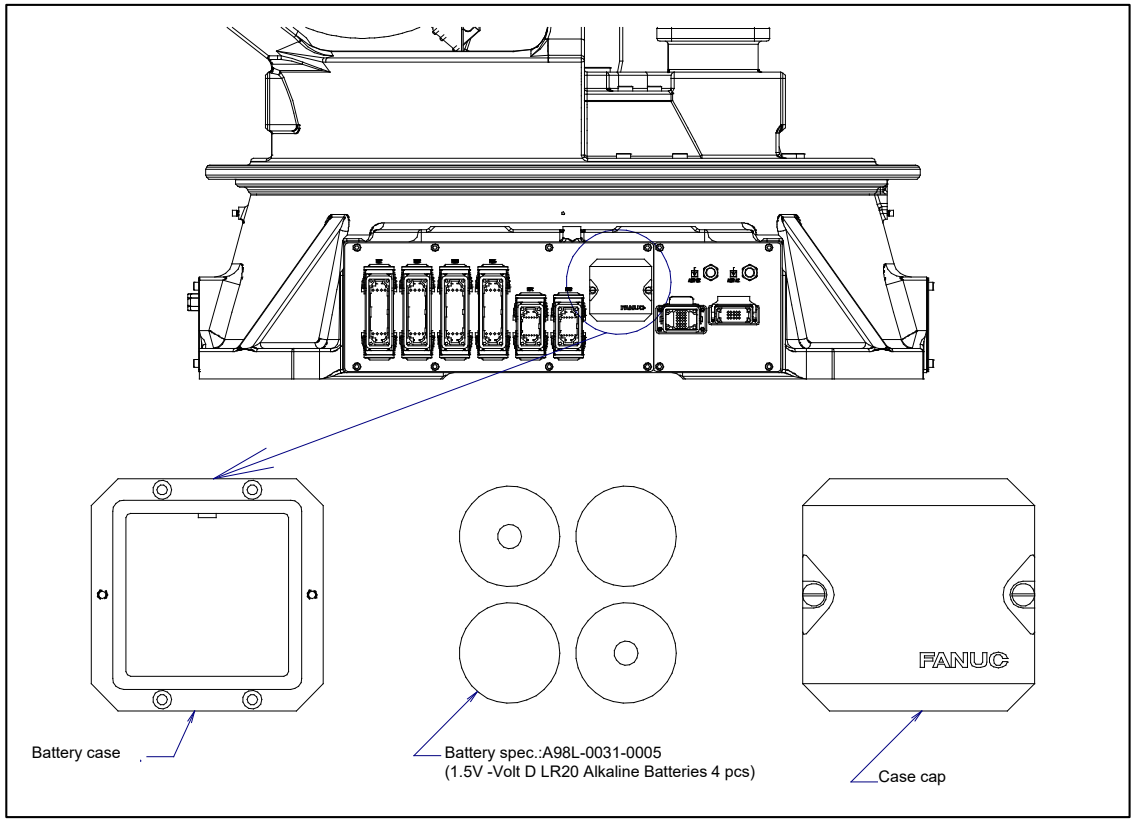


Fig. 7.3.2 (a) Replacing the batteries

7.3.3 Replacing the Grease of the Drive Mechanism (3 years (11520 hours) Checks)

According to below, replace the grease of the reducers of J1 and J3 axes, J4/J5/J6-axis gearbox, and the wrist at the intervals based on every 3 years or 11520 hours, whichever comes first. Refer to Table 7.3.3 (a) for the specified grease and the quantity.

Table 7.3.3 (a) Grease name and amount to be replaced at regular intervals of 3 years (11520 hours)

Models	Grease supplying position	Amount of grease to be applied	Gun tip pressure	Specified grease
M-1000*i*A	J1-axis reducer	12500g (13900ml)	0.15MPa or less (NOTE)	Specification: A98L-0040-0174
	J3-axis reducer	23000g (25600ml)		
	J4/J5/J6-axis gearbox	6600g (7300ml)		
	Wrist 1	12200g (13600ml)		
	Wrist 2	840g (940ml)		
	Wrist 3	1730g (1930ml)		

NOTE
1 When a manual pump is used for greasing, the standard rate is two pumping cycles per three seconds.
2 For J2-axis, refer to Subsection 7.3.5.

⚠ WARNING
Hot grease might eject suddenly when you open the grease outlet. Attach bags for collecting grease, and use appropriate protective equipment such as heat-resistant gloves, protective glasses, a face shield, or a body suit if necessary.

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

Table 7.3.3 (b) Postures for greasing

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

⚠ CAUTION

Failure to follow proper greasing procedures may cause the suddenly increase of the grease bath internal pressure and the damage to the seal, which could lead to grease leakage and abnormal operation. When greasing, observe the following cautions.

1 Before starting to grease, remove the seal bolt or the taper plug to allow the grease to come out.
2 Supply grease slowly, using a manual pump.
3 Whenever possible, avoid using an air pump, which is powered by the factory air supply.
If the use of an air pump is unavoidable, supply grease with the pump at a pressure lower than or equal to the gun tip pressure (see Table 7.3.3 (a)).
4 Use specified grease. Use of non-approved grease may damage the reducer or lead to other problems.
5 After greasing, release remaining pressure from the grease bath using the procedure given in Sub section 7.3.4, and then close the grease outlet.
6 To prevent the accident like fall, fire, remove all the excess grease from the floor and robot.

Grease replacement procedure for J1/J3-axis reducer

1 Move the robot to the greasing posture described in Table 7.3.3 (b).
2 Turn off the controller power.
3 Remove the seal bolt of the grease outlet. (Fig.7.3.3 (a), (b))
4 Keep greasing until the new grease pushes out the old grease and comes out from each grease outlet.
5 Release remaining pressure using the procedure given in Subsection 7.3.4.

Grease replacement procedure for the J4/J5/J6-axis gearbox

1 Move the robot to the greasing posture described in Table 7.3.3 (b).
2 Turn off the controller power.
3 Remove the seal bolt of grease outlet and the taper plug of the ventilator hole. (See Fig. 7.3.3 (b))
4 Supply new grease until new grease is output from the grease outlet 1.
5 Attach the taper plug on the ventilator hole. When reusing the taper plug, be sure to seal them with seal tape.
6 After applying grease, release the remaining pressure within the grease bath as described in the procedure in Subsection 7.3.4.

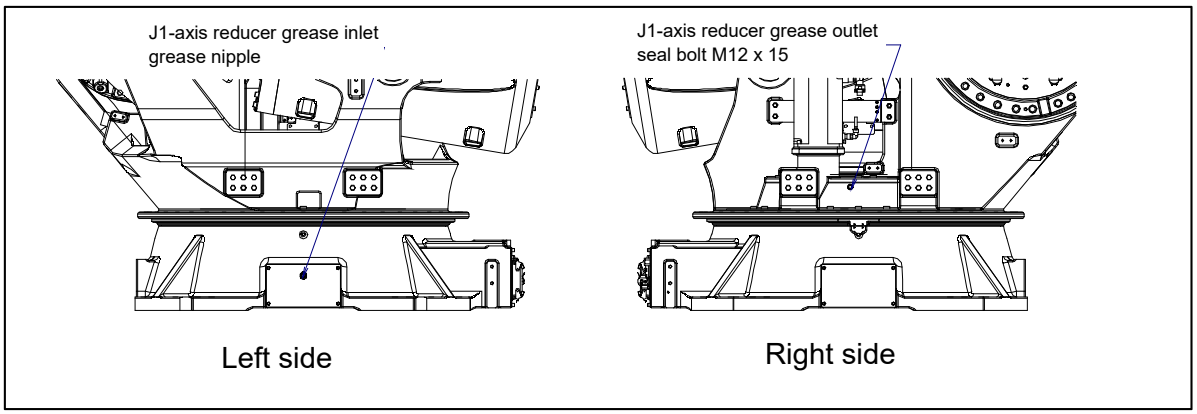


Fig. 7.3.3 (a) Replacing grease of J1 -axis reducer

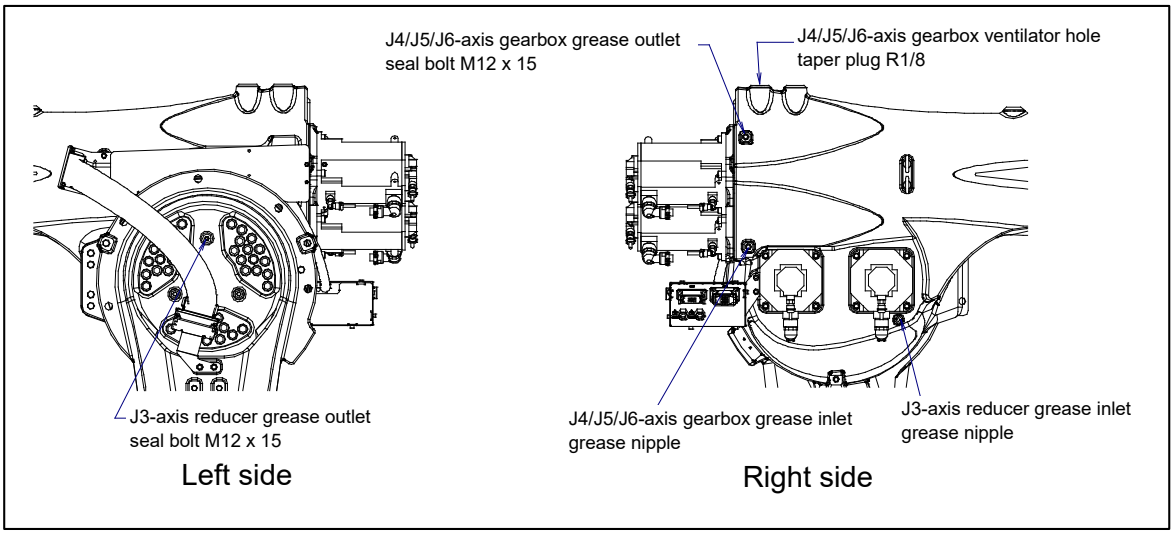


Fig. 7.3.3 (b) Replacing grease of J3-axis reducer and J4/J5/J6-axis gearbox

Grease replacement procedure for wrist

1 Move the robot to the greasing posture described in Table 7.3.3 (b).
2 Turn off the controller power.
3 Remove the taper plug of wrist grease outlet 1 (Fig. 7.3.3 (c)).
4 Supply grease to the wrist grease inlet 1 until new grease outputs from wrist outlet 1.
5 Attach the taper plug to wrist grease outlet 1.
6 Next, remove the taper plug of wrist grease outlet 2 (Fig. 7.3.3 (c))
7 Supply new grease through the wrist grease inlet 2 until new grease is output from wrist grease outlet 2.
8 Next, remove the taper plug of wrist grease outlet 3 (Fig. 7.3.3 (c))
9 Supply new grease through the wrist grease inlet 3 until new grease is output from wrist grease outlet 3.
10 Release remaining pressure using the procedure given in Subsection 7.3.4.

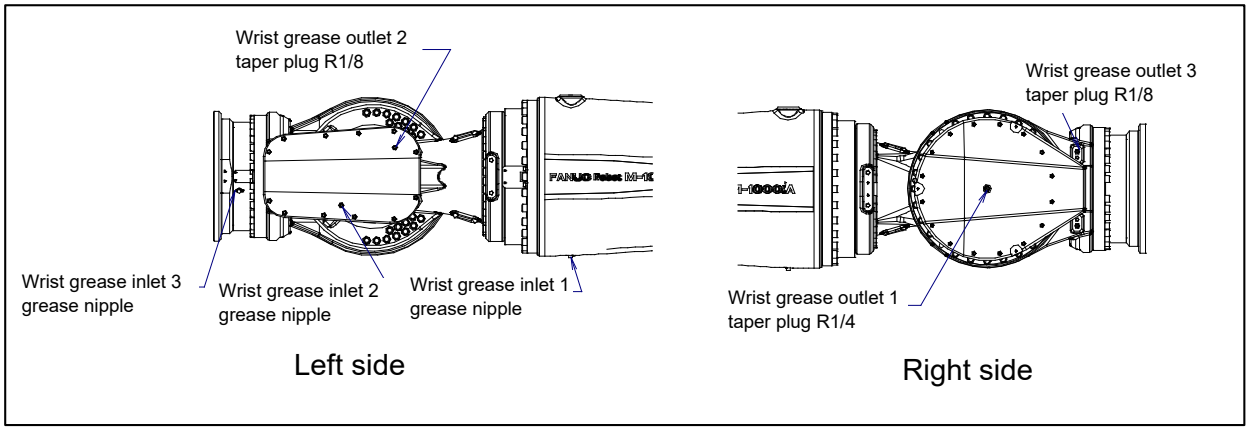


Fig. 7.3.3 (c) Replacing grease of the wrist

Table 7.3.3 (c) Spec. of the seal bolts, taper plugs and the grease nipple

Parts name	Specifications
Seal bolt (M12)	A97L-0218-0417#121515
Taper plug (R1/8)	A97L-0001-0436#1-1D
Taper plug (R1/4)	A97L-0001-0436#2-2D
Grease nipple (except wrist 1&2)	A97L-0218-0013#A610
Grease nipple (wrist 1&2)	A97L-0218-0013#A110

7.3.4 Procedure for Releasing Remaining Pressure from the Grease Bath

Release remaining pressure as described below.
Under the grease inlets and outlets, attach bags for collecting grease so that grease does not spatter when it comes out of the inlets or outlets.

Grease replacement position	Motion angle	OVR	Operating time	Open point
J1-axis reducer	80° or more	50%	20 minutes	Open the grease inlets, outlets and the ventilator hole and perform continuous operation.
J3-axis reducer	70° or more	50%	20 minutes	
J4/J5/J6-axis gearbox	J4 : 60° or more J5 : 120° or more J6 : 60° or more	50%	40 minutes	
Wrist	J4 : 60° or more J5 : 120° or more J6 : 60° or more	50%	40 minutes	

If the above operation cannot be performed due to the environment, adjust the operating time according to the operating angle. (For example, when only half of the predetermined motion angle can be set, perform an operation for a period of time twice as long as the specified time.) If you grease multiple axes, you can exercise multiple axes at the same time. After completion of the operation, attach the seal bolts or taper plug and grease nipples to the grease inlets and outlets. When reusing the seal bolts and grease nipples, be sure to seal them with seal tape.

7.3.5 Replacing the Oil of the Drive Mechanism (3 Years (11520 Hours) Checks)

According to below, replace the oil of the J2-axis reducer at the intervals based on every 3 years or 11520 hours, whichever comes first. Refer to Table 7.3.5 (a) for the specified oil and the quantity.

Table 7.3.5 (a) Oil name and amount to be replaced at regular intervals of 3 years (11520 hours)

Models	Oil supplying position	Amount of oil to be applied	Specified oil
M-1000*i*A	J2-axis reducer	17400g (20000ml)	Spec.: A98L-0040-0323

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

Table 7.3.5 (b) Postures for oiling

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

⚠ CAUTION

1 There is severe risk of gear damage in case robot is operated with oil shortage. Please make sure the gearbox is always filled with correct amount of oil.
2 Failure to supply oil correctly may cause damage to the seal, which would in turn lead to oil leakage and abnormal operation. When performing oiling, therefore, observe the following cautions.
   1 Use specified oil. Use of non-approved oil may damage the reducer or lead to other problems.
   2 After oiling, release remaining pressure from the grease bath using the procedure given in Subsection 7.3.6, and then close the grease outlet.
   3 To prevent an accident such as a fall or fire, remove all the excess oil from the floor and robot.

Oil replacement procedure for the J2 -axis reducer

1 Move the robot to the oil posture described in Table 7.3.5 (b).
2 Turn off controller power.
3 Put the oil pan under the oil outlet.
4 Remove the seal bolt of the ventilator hole and the taper plug of the oil outlet, then pull out oil (Fig. 7.3.5 (a))
5 Attach the taper plug to the oil outlet.
6 Supply oil from the oil inlet, if oil comes to 3/4 height of the oil sight glass, stop oiling.
7 After a few minutes (1 to 2 minutes), oil surface will fall, so add oil so that it comes to 3/4 height of the oil sight glass.
8 Release remaining pressure using the procedure given in Subsection 7.3.6.

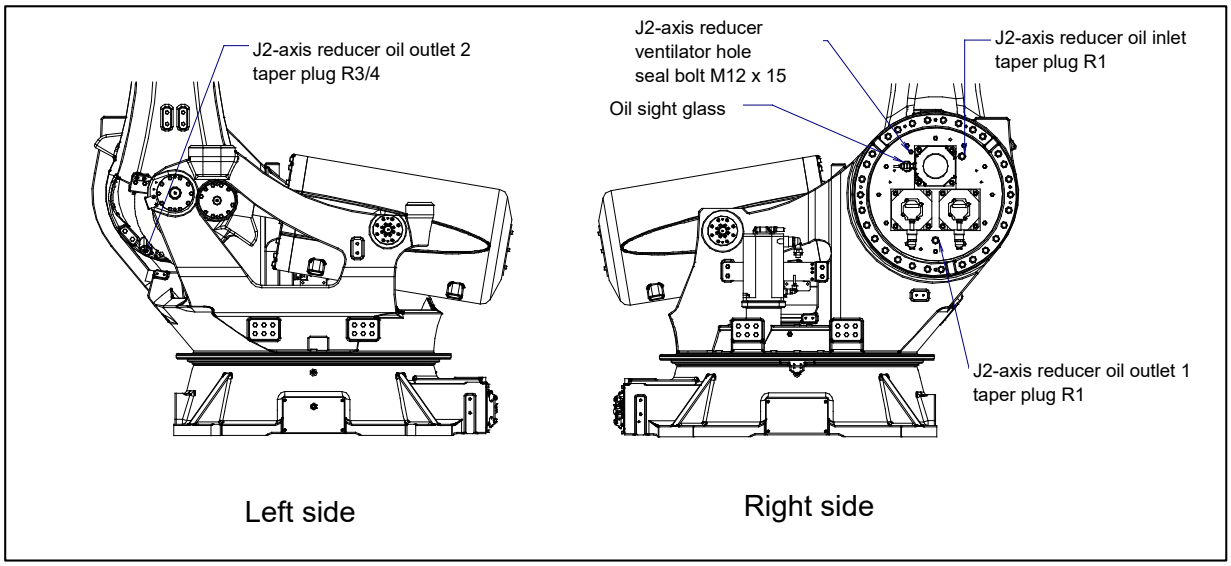


Fig. 7.3.5 (a) Replacing oil of J2-axis reducer

Table 7.3.5 (b) Spec of the seal bolts and taper plugs

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

7.3.6 Procedure for Releasing Remaining Pressure from the Oil Bath

Release remaining pressure as described below. Under the oil inlets and outlets, attach bags for collecting oil so that oil does not spatter when it comes out of the inlets or outlets.

Oil replacement position	Motion angle	OVR	Operating time	Open point
J2-axis reducer	90° or more	50%	20 minutes	Open the oil inlets and the ventilator hole and perform continuous operation.

If the above operation cannot be performed due to the environment, adjust the operating time according to the operating angle. (If only half of the predetermined motion angle can be set, perform an operation for a period of time twice as long as the specified time.) If you grease or oil multiple axes, you can exercise multiple axes at the same time. After completion of the operation, attach the taper plug and the seal bolts. When reusing the taper plug and the seal bolts, be sure to seal them with seal tape.

7.4 STORAGE

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

8 MASTERING

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

> **⚠ CAUTION**
> 1 The motion limits are temporarily invalid during mastering. Cables may be damaged if the J1-axis exceeds +/-185º.
> 2 In case of performing mastering with gravity compensation (option) is enabled, if load setting (See Section 4.3) is not correct, it will influence the precision of the mastering.

8.1 OVERVIEW

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

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

> **⚠ CAUTION**
> Robot data (including mastering data) and Pulsecoder data are backed up by their respective backup batteries. Data will be lost if the batteries are gone dead. 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

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

Once performing the mastering, the positioning (calibration) is indispensable. The Positioning is an operation which recognizes the robot current position loading the pulse count value.

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

> ⚠ **CAUTION**
> 1 If mastering is performed incorrectly, the positioner 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.
> 2 It is recommended that you back up the current mastering data before performing mastering.

8.2 RESETTING ALARMS AND PREPARING FOR MASTERING

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

Alarm displayed

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

Procedure

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

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

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

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.

8.3 ZERO POSITION MASTERING

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

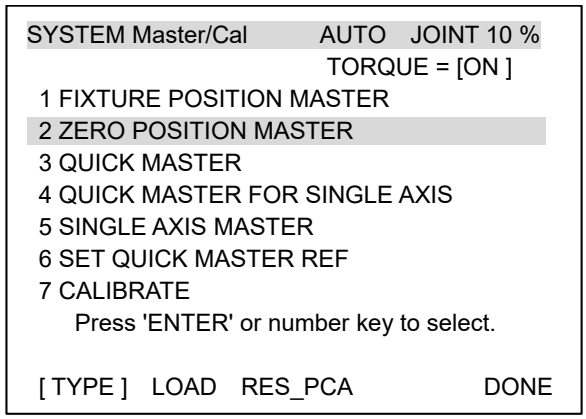
Zero-position mastering involves a visual check, and might not be highly accurate. It should be used only as a quick-fix method.

Zero-position Mastering Procedure

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

NOTE
Gravity compensation can be set to enabled/disabled by setting the system variables as follows:
$PARAM_GROUP[group].$SV_DMY_LNK[8] : FALSE or TRUE
Brake control can be released by setting the system variables as follows:
$PARAM_GROUP.SV_OFF_ALL : FALSE
$PARAM_GROUP.SV_OFF_ENB[*] : FALSE (for all axes)
After changing the system variables, cycle power of the controller.

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



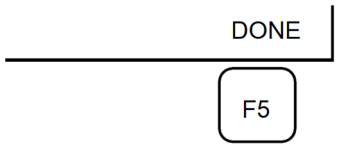
9 Jog the robot into a posture for mastering.
10 Select [2 ZERO POSITION MASTER]. Press F4 [YES].

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

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

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

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



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

Table 8.3 (a) Posture with zero-position marks (Witness mark) aligned

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

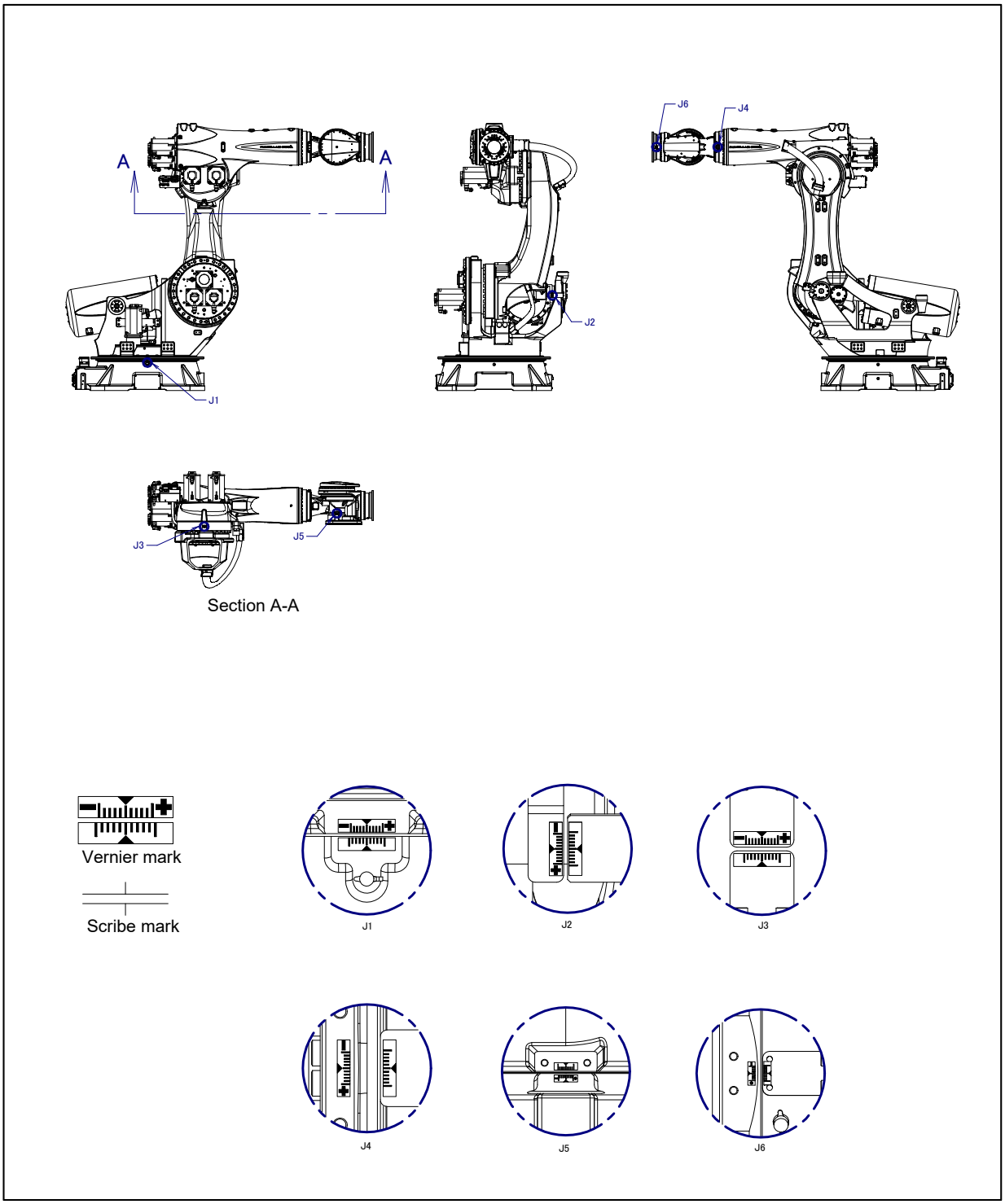


Fig. 8.3 (a) Zero-position mark (Witness mark) for each axis

8.4 QUICK MASTERING

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

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

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

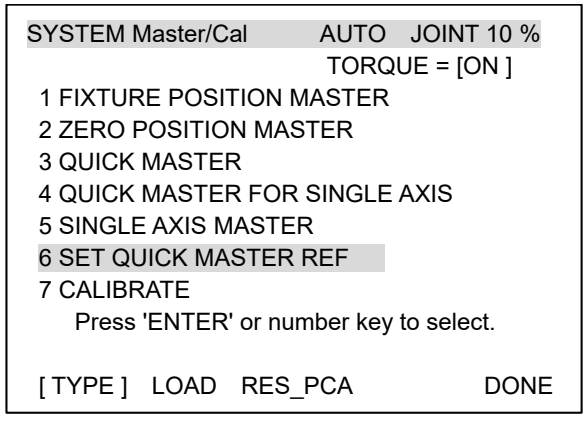
⚠ CAUTION
1 Quick mastering can be used, if the pulse count value is lost, for example, because a low voltage has been detected on the backup battery for the pulse counter.
2 Quick mastering cannot be used, after the Pulsecoder is replaced or after the mastering data is lost from the robot controller.

Procedure Recording the Quick Mastering Reference Position

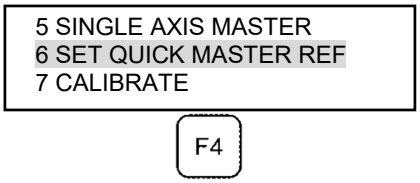
1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE]. Then select [Variables] from the menu.
4 If $DMR_GRP [group].$GRAV_MAST=1, set the gravity compensation to enabled, if it is 0, set the gravity compensation to disabled. In addition release the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

NOTE
Gravity compensation can be set to enabled/disabled by setting the system variables as follows:
$PARAM_GROUP[group].$SV_DMY_LNK[8] : FALSE or TRUE
Brake control can be released by setting the system variables as follows:
$PARAM_GROUP.SV_OFF_ALL : FALSE
$PARAM_GROUP.SV_OFF_ENB[*] : FALSE (for all axes)
After changing the system variables, cycle power of the controller.

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



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



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

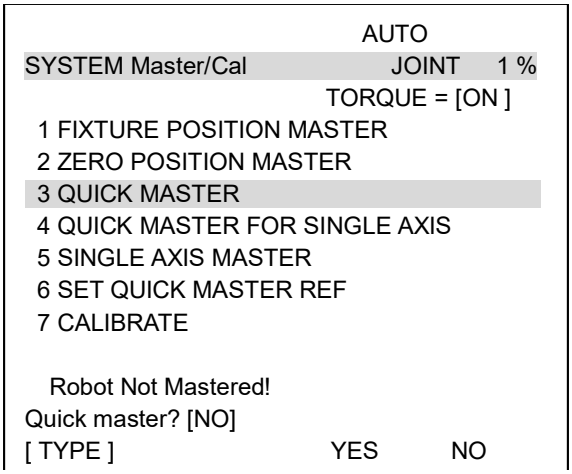
> ⚠ **CAUTION**
> If the robot has lost mastering data due to mechanical disassembly or repair, you cannot perform this procedure. In this case, perform Fixture position mastering or Zero position mastering to restore mastering data.

Procedure of Quick Mastering

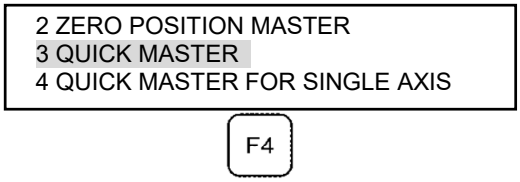
1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE]. Then select [Variables] from the menu.
4 If $DMR_GRP [group].$GRAV_MAST=1, set the gravity compensation to enabled, if it is 0, set the gravity compensation to disabled. In addition release the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

> **NOTE**
> Gravity compensation can be set to enabled/disabled by setting the system variables as follows:
> $PARAM_GROUP[group].$SV_DMY_LNK[8] : FALSE or TRUE
> Brake control can be released by setting the system variables as follows:
> $PARAM_GROUP.SV_OFF_ALL : FALSE
> $PARAM_GROUP.SV_OFF_ENB[*] : FALSE (for all axes)
> After changing the system variables, cycle power of the controller.

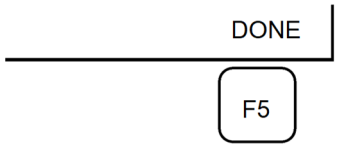
5 Select [6 SYSTEM].



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



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



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

8.5 QUICK MASTERING FOR SINGLE AXIS

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

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

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

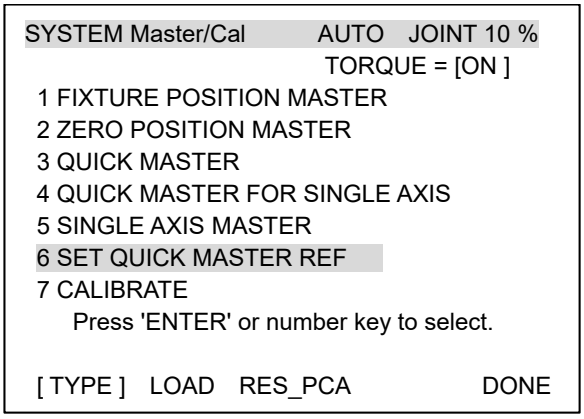
⚠ CAUTION
1 Quick mastering can be used, if the pulse count value is lost, for example, because a low voltage has been detected on the backup battery for the pulse counter.
2 Quick mastering cannot be used, after the Pulsecoder is replaced or after the mastering data is lost from the robot controller.

Procedure Recording the Quick Mastering Reference Position

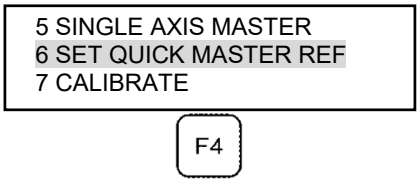
1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE]. Then select [Variables] from the menu.
4 If $DMR_GRP [group].$GRAV_MAST=1, set the gravity compensation to enabled, if it is 0, set the gravity compensation to disabled. In addition release the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

NOTE
Gravity compensation can be set to enabled/disabled by setting the system variables as follows:
$PARAM_GROUP[group].$SV_DMY_LNK[8] : FALSE or TRUE
Brake control can be released by setting the system variables as follows:
$PARAM_GROUP.SV_OFF_ALL : FALSE
$PARAM_GROUP.SV_OFF_ENB[*] : FALSE (for all axes)
After changing the system variables, cycle power of the controller.

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



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



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

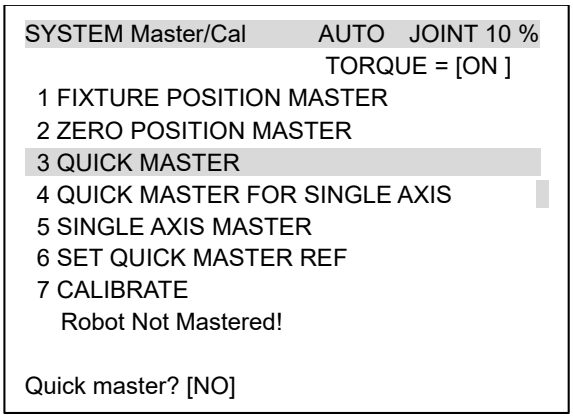
⚠ CAUTION
If the robot has lost mastering data due to mechanical disassembly or repair, you cannot perform this procedure. In this case, perform Fixture position mastering or Zero position mastering to restore mastering data.

Procedure of Quick Mastering for single axis

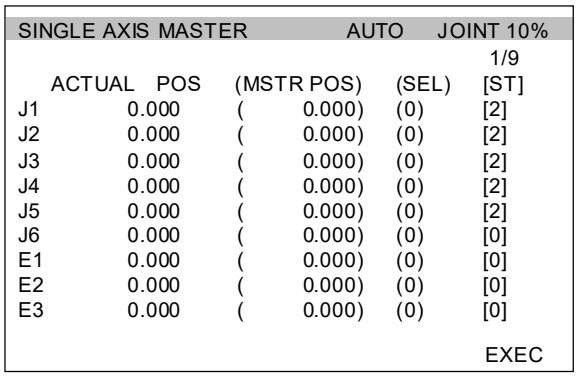
1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE]. Then select [Variables] from the menu.
4 If $DMR_GRP [group].$GRAV_MAST=1, set the gravity compensation to enabled, if it is 0, set the gravity compensation to disabled. In addition release the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

NOTE
Gravity compensation can be set to enabled/disabled by setting the system variables as follows:
$PARAM_GROUP[group].$SV_DMY_LNK[8] : FALSE or TRUE
Brake control can be released by setting the system variables as follows:
$PARAM_GROUP.SV_OFF_ALL : FALSE
$PARAM_GROUP.SV_OFF_ENB[*] : FALSE (for all axes)
After changing the system variables, cycle power of the controller.

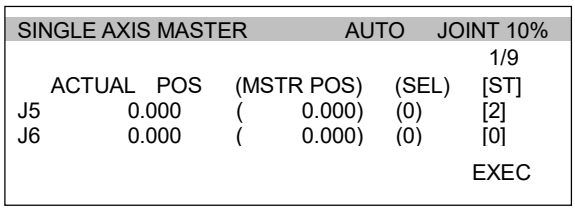
5 Display the Master/Cal screen.



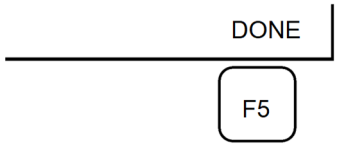
6 Select [4 QUICK MASTER FOR SINGLE AXIS]. The quick master for single axis screen will be displayed.



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



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



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

8.6 SINGLE AXIS MASTERING

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

In case of M-1000*i*A, please note that an axis to which the TP screen is displayed and an actual axis are different.
Be sure to perform mastering of J2-axis motor A and J2-axis motor B at the same time.
It is same for J3-axis motor A and J3-axis motor B

In case of without additional axis, the motor is allocated as follows.

J1: J1-axis motor
J2: J2-axis motor A
J3: J3-axis motor A
J4: J4-axis motor
J5: J5-axis motor
J6: J6-axis motor
E1: J2-axis motor B
E2: J3-axis motor B

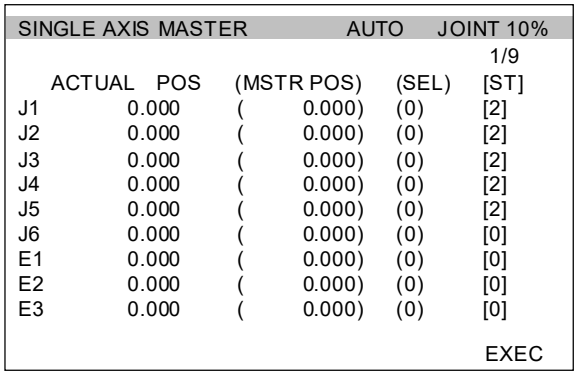


Table 8.6 (a) Items set in single axis mastering

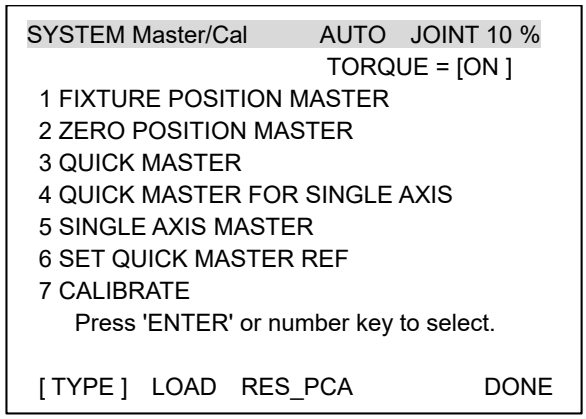
Item	Description
Current position (ACTUAL AXIS)	The current position of the robot is displayed for each axis in degree units.
Mastering position (MSTR POS)	A mastering position is specified for an axis to be subjected to single axis mastering. It would be convenient if it is set to the 0 degree position.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

Procedure of Single axis mastering

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

NOTE
Gravity compensation can be set to enabled/disabled by setting the system variables as follows:
$PARAM_GROUP[group].$SV_DMY_LNK[8] : FALSE or TRUE
Brake control can be released by setting the system variables as follows:
$PARAM_GROUP.SV_OFF_ALL : FALSE
$PARAM_GROUP.SV_OFF_ENB[*] : FALSE (for all axes)
After changing the system variables, cycle power of the controller.

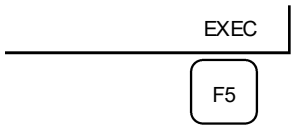
5 Select [6 SYSTEM].
6 Select [Master/Cal].



7 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
```

8 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.
9 Turn off brake control, then jog the robot to the mastering position.
10 Enter axis data for the mastering position.
11 Press F5 [EXEC]. Mastering is performed. So, (SEL) is reset to 0, and [ST] is re-set to 2 or 1.

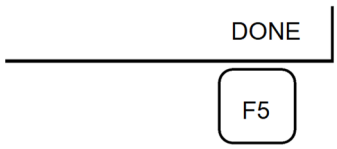



```
SINGLE AXIS MASTER          AUTO    JOINT 10%
                                          6/9
   ACTUAL   POS   (MSTR POS)    (SEL)   [ST]
J1          0.000 (     0.000)  (0)     [2]
J2          0.000 (     0.000)  (0)     [2]
J3          0.000 (     0.000)  (0)     [2]
J4          0.000 (     0.000)  (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
```

12 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
```

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



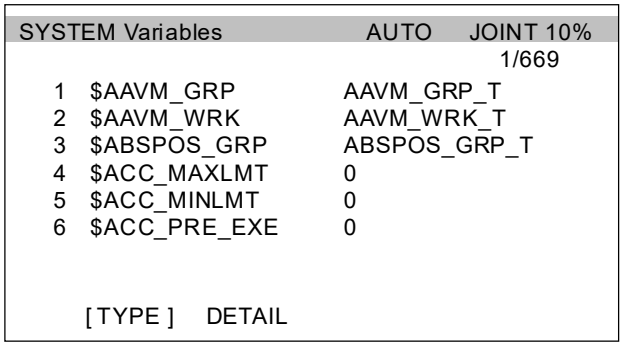
15 Return the setting of the gravity compensation.
16 Return brake control to original setting, and cycle power of the controller.

8.7 MASTERING DATA ENTRY

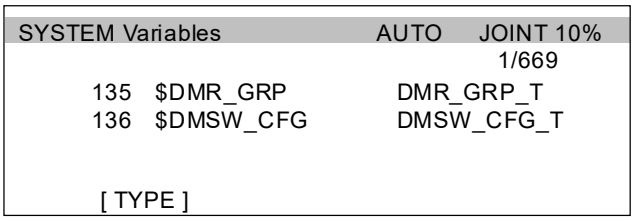
This function enables mastering data values to be assigned directly to a system variable. It can be used if mastering data has been lost but the pulse count is preserved.

Mastering data entry method

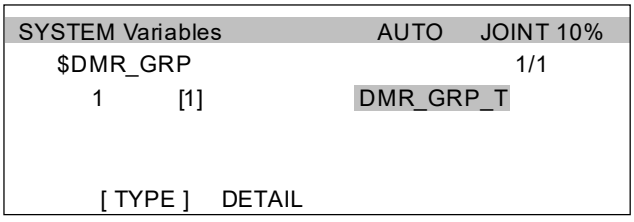
1 Press [MENU] key, then press [0 NEXT] and select [6 SYSTEM].
2 Press F1 [TYPE]. Select [Variables]. The system variable screen will be displayed.

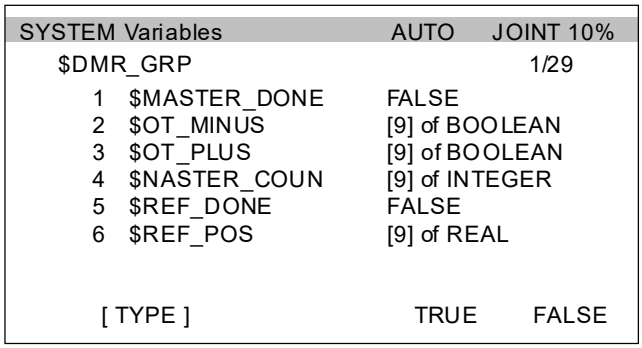


3 Change the mastering data. The mastering data is saved to the $DMR_GRP.$MASTER_COUN system variable.

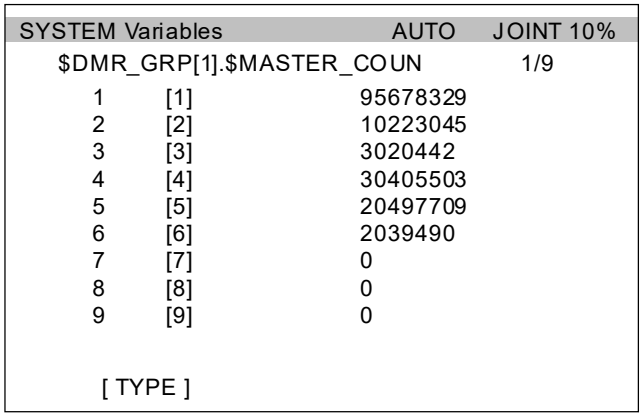


4 Select $DMR_GRP.

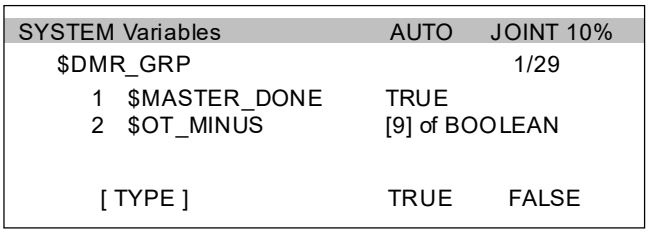




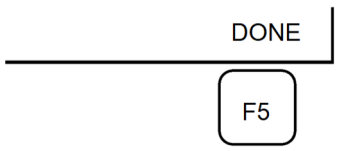
5 Select $MASTER_COUN, and enter the mastering data you have recorded.



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



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



8.8 VERIFYING MASTERING

1 How to verify that the robot is mastered properly:
Usually, positioning is performed automatically when the power is turned on. To check whether mastering has been performed correctly, examine if the current displayed position meets the actual robot position by using the procedure described below:
(1) Reproduce a particular point in a program. Check whether the point agrees with the specified position.
(2) Set all axes of the robot to their 0-degree (0 rad) positions. Check that the zero-degree position marks indicated in Section 8.3 of OPERATOR'S MANUAL are aligned. There is no need to use a visual aid.

If the displayed and actual positions do not match, the counter value for a Pulsecoder may have been invalidated as a result of an alarm described in 2. Alternatively, the mastering data in system variable $DMR_GRP.$MASTER_COUN may have been overwritten as a result of an operation error or some other reason.
Compare the data with the values indicated on the supplied data sheet. This system variable is overwritten whenever mastering is performed. Whenever mastering is performed, record the value of the system variable on the data sheet.

2 Alarm type displayed during mastering and their solution method:
(1) BZAL alarm
This alarm is displayed if the Pulsecoder's backup battery voltage decreases to 0 V while the power to the controller is disconnected. Furthermore, if the Pulsecoder connector is removed for cable replacement, etc. this alarm is displayed as the voltage decreases to 0. Confirm if the alarm will disappear by performing a pulse reset (See Section 8.2.). Then, cycle power of the controller to check if the alarm disappears or not.
The battery may be drained if the alarm is still displayed. Perform a pulse reset, and turn off and on the controller power after replacing the battery. Note that, if this alarm is displayed, all the original data held by the Pulsecoder will be lost. Mastering is required.
(2) BLAL alarm
This alarm is displayed if the voltage of the Pulsecoder's backup battery has fallen to a level where backup is no longer possible. If this alarm is displayed, replace the battery with a new one immediately while keeping the power turned on. Check whether the current position data is valid, using the procedure described in 1.
(3) Alarm notification like CKAL, RCAL, PHAL, CSAL, DTERR, CRCERR, STBERR, and SPHAL may have trouble with Pulsecoder, contact your local FANUC representative.

9 TROUBLESHOOTING

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

9.1 TROUBLESHOOTING

Table 9.1 (a) shows the major troubleshooting symptoms that may occur in the mechanical unit and their probable causes. If you cannot pinpoint a failure cause or which measures to take, contact your local FANUC representative. 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

Symptoms	Descriptions	Causes	Measures
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 surface flatness tolerance, or foreign material caught between the base plate and floor plate. - If the robot is not securely fastened to the floor plate, the J1 base lifts the floor plate as the robot operates, allowing the base and floor plates to strike each other which 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 foreign material between the J1 base and base plate, remove it. - Apply adhesive between the J1 base and base plate.
	- The rack or floor plate vibrates during robot operation.	[Rack or floor] - It is likely that the rack or floor is not rigid enough. - If the rack or floor is not rigid enough, counterforce can deform the rack or floor, and cause vibration.	- Reinforce the rack or floor to make it more rigid. - If reinforcing the rack or floor is impossible, modify the robot control program; doing so will reduce the vibration.

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

Symptoms	Descriptions	Causes	Measures
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 send the accurate position to the controller. - If the motor becomes defective, vibration might occur because the motor cannot deliver its rated performance. - If a power line in a movable cable of the mechanical unit has an intermittent break, vibration might occur because the motor cannot accurately respond to commands. - If a Pulsecoder wire in a movable part of the mechanical unit has an intermittent break, vibration might occur because commands cannot be sent to the motor accurately. - If a robot connection cable has an intermittent break, vibration might occur. - If the power supply cable is about to be snapped, vibration might occur. - If the power source voltage drops below the rating, vibration might occur. - It may vibrate when an invalid value parameter was set.	- Refer to “CONTROLLER MAINTENANCE MANUAL (B-83195EN etc.)” for troubleshooting related to the controller and amplifier. - Replace the motor of the axis that is vibrating, and check whether vibration still occurs. For the method of replacement, contact your local FANUC representative. - If vibration occurs only when the robot assumes a specific posture, it is likely that there is a mechanical problem. - Shake the movable part cable while the robot is at rest, and check whether an alarm occurs. If an alarm or any other abnormality occurs, replace the mechanical unit cable. - Check whether the cable jacket of the robot connection cable is damaged. If so, replace the connection cable, and check whether vibration still occurs. - Check whether the power cable jacket is damaged. If so, replace the power cable, and check whether vibration still occurs. - Check that the robot is supplied with the rated voltage. - Check that the robot control parameter is set to a valid value. If it is set to an invalid value, correct it. Contact your local FANUC representative for further information if necessary.

Symptoms	Descriptions	Causes	Measures
Vibration Noise (Continued)	- There is a 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 causing it to vibrate.	- Connect the grounding wire firmly to ensure a reliable ground potential thereby preventing extraneous electrical noise.
	- There is an unusual sound after replacing grease or oil. - There is an unusual sound after a long time pause. - There is an unusual sound during operation at low speed.	- There may be an unusual sound when using other than the specified grease or oil. - Even for the specified grease or oil, there may be an unusual sound during operation at low speed immediately after replacement or after a long period.	- Use the specified grease or oil. - When there is an abnormal noise even when using the specified grease or oil, operate for one or two days as an experiment. Generally, any abnormal noise will disappear.
	- Unusual noise occurred inside the balancer.	- Liquid might intrude into the balancer, and it caused the spring to corrode and break.	- Prevent liquid splashing on the balancer.
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 face of the mechanical unit.	[Mechanical unit coupling bolt] - It is likely that overloading or a collision has loosened a mounting bolt in the robot mechanical unit.	- Check the following retaining bolts tightness for each axis. If any of these bolts is loose, apply LOCTITE and bolt down with appropriate torque. - Motor retaining bolt - Reducer retaining bolt - Reducer shaft retaining bolt - Base retaining bolt - Arm retaining bolt - Casing retaining bolt - End effector retaining bolt

Symptoms	Descriptions	Causes	Measures
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 an effective way to reduce the average current. Thus, prevent overheat. - The teach pendant can monitor the average current. Check the average current when the robot control program launched.
	- After a robot control parameter (load setting etc.) was changed, the motor overheated.	[Parameter] - If data input for a workpiece is invalid, the robot cannot be accelerate or decelerate normally, so the average current increases, leading to the motor overheating.	- As for load setting, Input an appropriate parameter referring to Section 4.3 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. - Judgment is possible if the average current decreased after replacing the motor, the former motor had been defected. - If the cooling fan is broken, replace it with a new one.

Symptoms	Descriptions	Causes	Measures

Grease leakage	- Grease leaks from the mechanical unit.	[Poor sealing]
		- Probable causes are a crack in the casting, a damaged O-ring, a damaged oil seal or gasket, sealant deterioration or a loose seal bolt.
		- 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 may allow grease to leak along the threads.
		- Problems with the grease nipple.
			- If the casting cracks, sealant can be used as a quick-fix to prevent further grease leakage. However, the component must be replaced as soon as possible, as the crack will widen.
			- 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.
			  - J1-axis cable pipe
			  - Inside the reducer
			  - Inside the wrist
			  - Bush of the back of the balancer
			  - Taper roller of the balancer shaft
			  - Taper roller under the J2 arm
			- Seal bolts are used in the locations stated below.
			  - Grease outlet
			  - J4/J5/J6-axis gearbox ventilator hole
			  - J2-axis oil inlet/outlet
			- Replace the grease nipple.

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

Symptoms	Descriptions	Causes	Measures
Displacement	- The robot moves to a point other than the taught position. - The repeatability is not within the tolerance.	[Mechanical unit problems] - If the robot is not repeatable, probable causes are a failure in the drive mechanism or a loose bolt. - If the robot is repeatable, it is likely that a collision caused slip on the sting surface of each axis arm, and reducer. - It is likely that the Pulsecoder is faulty.	- If the robot is not repeatable, repair the mechanical unit by referring to the above descriptions of vibration, noise, and rattling. - If the robot is repeatable, 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 peripheral equipment position. - Correct the taught program.
	- Displacement occurred after a parameter was changed.	[Parameter] - It is likely that the mastering data was overwritten moving the robot's origin.	- Re-enter the previous optimal mastering data. - If correct mastering data is unavailable, perform mastering again.
CLALM alarm occurred. Move error excess alarm occurred.	- Ambient temperature of the robot installation location is low, CLALM alarm is displayed on the teach pendant screen. - Temperature of the robot installation position is low, "Move error excess" alarm is displayed on the teach pendant screen.	[Peripheral temperature] - When the robot is used in a low temperature environment that is near to 0ºC, or the robot is not operated for a long time in an environment that is less than 0ºC, there will be a large viscous resistance of the drive train immediately after starting which will cause the alarm.	- Perform a warm up operation or a low speed operation for several minutes.
	- After changing the motion program or the load condition, the CLALM alarm is displayed. - After changing the motion program or the load condition, the "Move error excess" alarm is displayed.	- It is likely that a robot collision occurred.	- If a robot collision has occurred, press the [RESET] key while pressing the [SHIFT] key. Then, jog the robot in the opposite direction while pressing the [SHIFT] key. - Check the motion program.

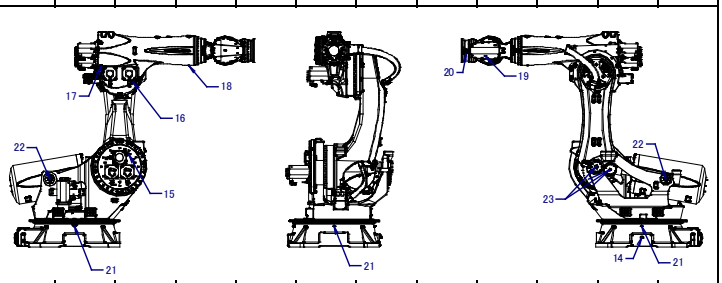
Symptoms	Descriptions	Causes	Measures
CLALM alarm occurred. Move error excess alarm occurred.	- After changing the motion program or the load condition, the CLALM is displayed. - After changing of the motion program or the load condition, the “Move error excess” alarm is displayed.	[Overload] - It is likely that load exceeded the permissible value. - It is likely that the motion program is too severe for the robot. ・ Excessive motion due to a large “ACC (value)”. ・ Tight motion such as reverse motion using “CNT”. ・ Linear motion occurs near singularity point where axes revolve in high speed.	- Check the permissible value of the robot payload. If the load exceeds the permissible value, reduce the load or change the motion program. - Consider minimizing the cycle time by reducing the speed or acceleration, and changing the motion program. - Check that the load setting is performed correctly.
	- None of the symptoms stated above are the problem.	- It is likely the vibration occurred.	- Refer to the Symptoms: Vibration, Noise section of this troubleshooting for more information.
		- If the power source voltage drops below the rating, a vibration might occur.	- Check that the robot is supplied with the proper rated voltage.
BZAL alarm occurred.	- BZAL is displayed on the teach pendant screen.	- It is likely that the voltage of the memory backup battery is low. - It is likely that the Pulsecoder cable is defective.	- Replace the battery. - Replace the cable.

APPENDIX

A PERIODIC MAINTENANCE TABLE

FANUC Robot M-1000*i*A Periodic Maintenance Table

Items			Accumulated operating time (H) / Check time	Grease amount	First check 320	3 months 960	6 months 1920	9 months 2880	1 year 3840	4800	5760	6720	2 years 7680	8640	9600	10560
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 balancer and 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	0.2H	—		○			○				○			
	7	Check tightness of each axis motor and other exposed connector	0.2H	—		○			○				○			
	8	Retightening the end effector mounting bolts	0.1H	—		○			○				○			
	9	Retightening the external main bolts	2.0H	—		○			○				○			
	10	Check the fixed mechanical stopper and the adjustable mechanical stopper	1.0H	—		○			○				○			
	11	Clean spatters, sawdust and dust	0.1H	—		○			○				○			
	12	Check the operation of the cooling fan	0.1H	—		○			○				○			
	13	Replacing the mechanical unit batteries *2*4	0.1H	—							●					
	14	Replacing grease of J1-axis reducer	1.8H	13900ml												
	15	Replacing oil of J2-axis reducer	2.4H	20000ml												
	16	Replacing grease of J3-axis reducer	3.4H	25600ml												
	17	Replacing grease of J4/J5/J6-axis gearbox	1.1H	7300ml												
	18	Replacing grease of the wrist 1 (J4/J5-axis reducer)	2.1H	13600ml												
	19	Replacing grease of the wrist 2 (J6-axis gearbox)	0.8H	940ml												
	20	Replacing grease of the wrist 3 (J6-axis reducer)	0.9H	1930ml												
	21	Greasing to the J1 bearing part	0.5H	*1					●				●			
	22	Greasing to the bush of the back of the balancer	0.5H	Each 65ml					●				●			
	23	Greasing to the connection Parts (5 points)	0.5H	*1												
	24	Replacing cable of mechanical unit	4.0H	—												
Controller	25	Check the robot cable, teach pendant cable and robot connecting cable	0.2H	—		○			○				○			
	26	Cleaning the ventilator	0.2H	—	○	○	○	○	○	○	○	○	○	○	○	○
	27	Replacing batteries *2 *4	0.1H	—												



*1 Greasing point and amount differs depend on the date of the manufacture. Refer to Chapter 7 of this manual

*2 Refer to “REPLACING UNITS Chapter of MAINTENANCE” of the following manuals.
CONTROLLER MAINTENANCE MANUAL (B-83195EN).

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

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

3 years 11520	12480	13440	14400	4 years 15360	16320	17280	18240	5 years 19200	20160	21120	22080	6 years 23040	24000	24960	25920	7 years 26880	27840	28800	29760	8 years 30720	Item
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		1
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		2
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		3
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		4
○				○				○				○				○					5
○				○				○				○				○					6
○				○				○				○				○					7
○				○				○				○				○					8
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○				○				○				○				○					10
○				○				○				○				○					11
○				○				○				○				○					12
●						●						●						●		Overhaul	13
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○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		26
				●																	27

B STRENGTH OF BOLT AND BOLT TORQUE LIST

NOTE

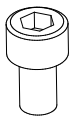
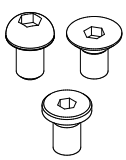
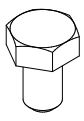
When applying LOCTITE to a part, spread the LOCTITE on the entire length of the engaging part of the female thread. If applied to the male threads, poor adhesion can occur, potentially loosening the bolt. Clean the bolts and the threaded holes and wipe off any oil on the engaging section. Make sure that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

Use the following strength bolts. Comply with any bolt specification instructions.
Hexagon socket head bolt made of steel:
Size M22 or less: Tensile strength 1200N/mm^2 or more
Size M24 or more: Tensile strength 1000N/mm^2 or more
All size plating bolt: Tensile strength 1000N/mm^2 or more

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

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

Recommended bolt tightening torques **Unit: Nm**

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

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