FANUC Robot R-2000*i*D

MECHANICAL UNIT

OPERATOR'S MANUAL

B-84124EN/02

- **Original Instructions**

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

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 SAFETY HANDBOOK (**B-80687EN)**”.

1 DEFINITION OF USER

The personnel can be classified as follows.

Operator:
- Turns the robot controller power on/off
- Starts the robot program from operator panel

Programmer or Teaching operator:
- Operates the robot
- Teaches the robot inside the safety fence

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

- Operator is not allowed to work in the safety fence.
- Programmer/Teaching operator and maintenance technician is allowed to work in the safety fence. Works carried out in the safety fence include transportation, installation, teaching, adjustment, and maintenance.
- To work inside the safety fence, the person must be trained on proper robot operation.

Table 1 (a) lists the work outside the safety fence. In this table, the symbol "○" means the work allowed to be carried out by the worker.

Table 1 (a) List of work outside the fence

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

- Check this manual thoroughly, and keep it handy for the future reference.

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

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

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

(*) Not supporting CE Marking.

(2) Prepare and store adequate numbers of brake release units which are ready and readily accessible for robot system before installation.

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

⚠ CAUTION

Robot systems installed without adequate number of brake release units or similar means are neither in compliance with **EN ISO 10218-1** nor with the Machinery Directive and therefore cannot bear the CE Marking.

⚠ WARNING

Robot arm would fall down by releasing its brake because of gravity. 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.

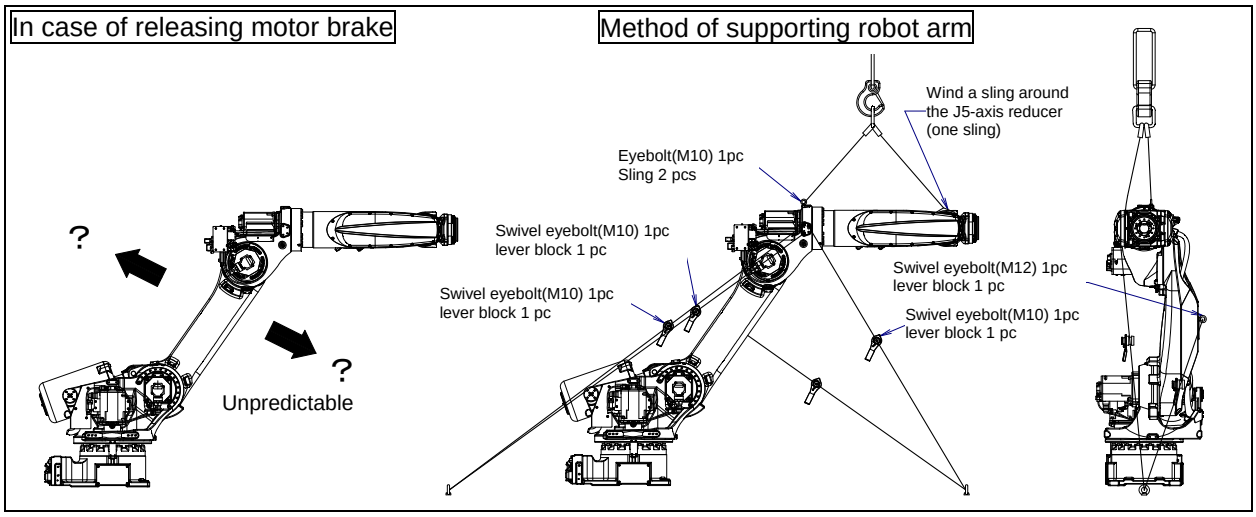


Fig. 3 (a) Releasing J2-axis motor brake and measures

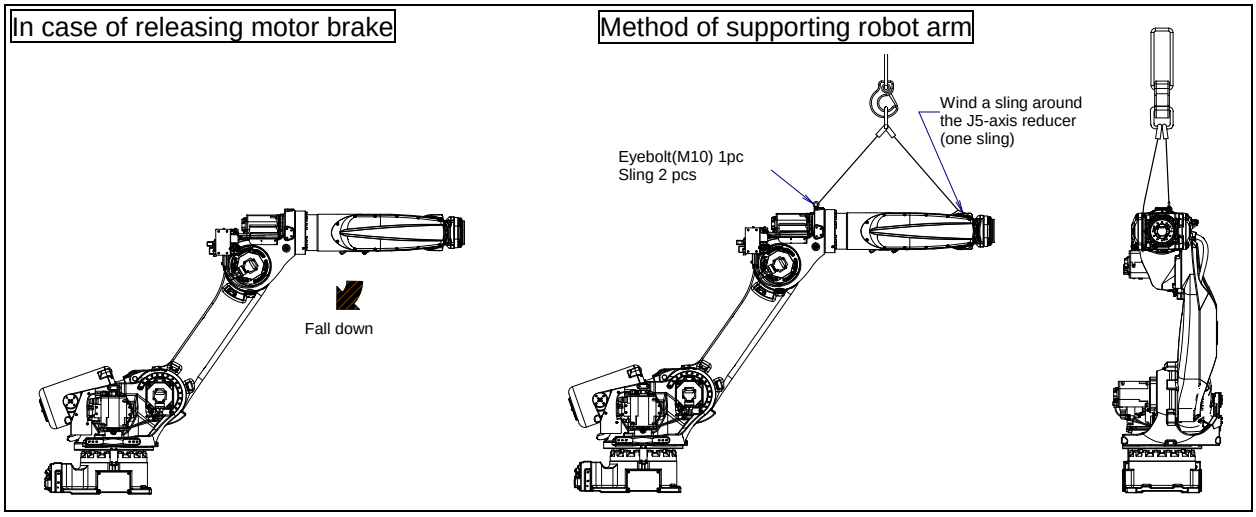


Fig. 3 (b) Releasing J3-axis motor brake and measures

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) When greasing, be sure to keep the grease outlet open.
2) Use a manual pump to grease.
3) Be sure to use a specified grease.

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

(2) Disassembly prohibitive label

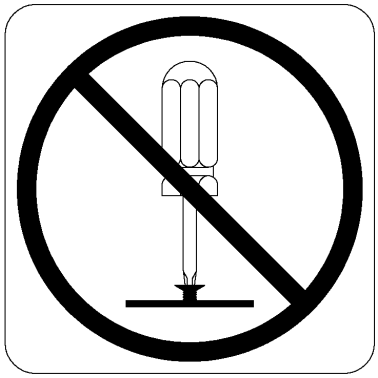


Fig. 4 (b) Disassembly prohibitive label

Description

Do not disassemble the balancer unit because it contains a spring, which may cause serious danger (for the R-2000*i*D, 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) High-temperature warning label

Fig. 4 (d) 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 provision such as heat-resistant gloves.

(5) Transportation label

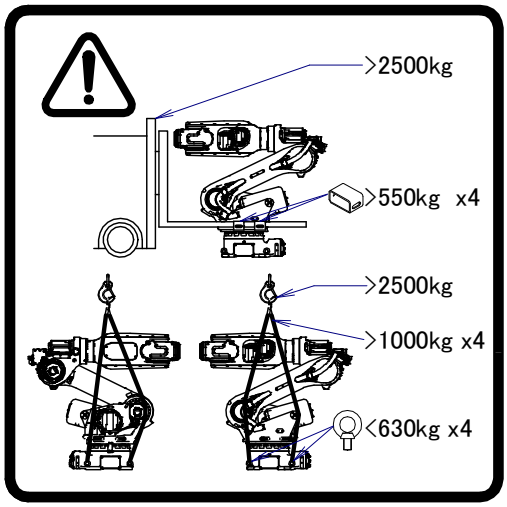


Fig. 4 (e) Transportation label

Description

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

1) Using a forklift
   - Use a forklift having a load capacity of 2500 kg or greater.
   - Keep the total weight of the robot to be transported to within 2200 kg, because the load capacity of the forklift bracket (option) is 5390 N (550 kgf).

2) Using a crane
   - Use a crane with a load capacity of 2500 kg or greater.
   - Use four slings each with each load capacity of 1000 kg or greater.
   - In case of using eyebolts, use four eyebolts with each allowable load of 6174 N (630 kgf) or greater.

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

(6) Balancer replacement label

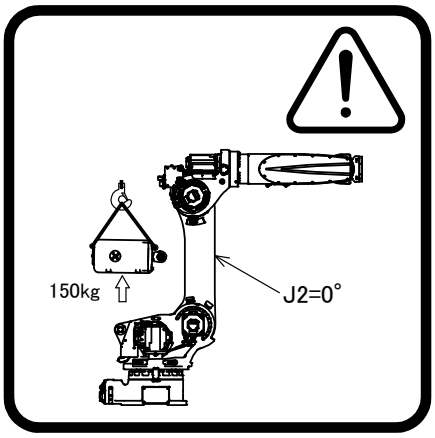


Fig. 4 (f) Balancer replacement label

Description

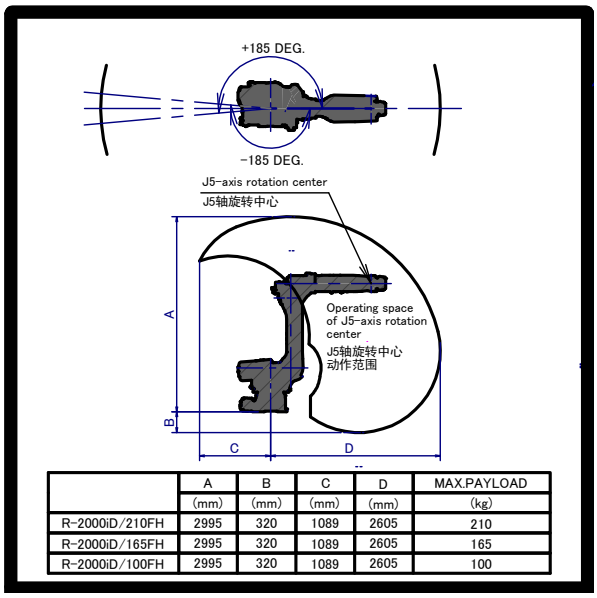
When replacing the balancer, observe the instructions indicated on this label.
The above balancer replacement label indicates the following:

- While replacing the balancer, keep the J2-axis at 0°.
- The mass of the balancer is 150 kg.

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

(7) Operating space and payload (capacity) label

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



	A (mm)	B (mm)	C (mm)	D (mm)	MAX.PAYLOAD (kg)
R-2000iD/210FH	2995	320	1089	2605	210
R-2000iD/165FH	2995	320	1089	2605	165
R-2000iD/100FH	2995	320	1089	2605	100

Fig. 4 (g) Operating space and payload label

(8) Danger label

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

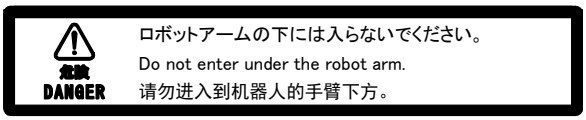


Fig. 4 (h) Danger label

Description

DANGER
Do not enter under the robot arm.

(9) Transportation caution label

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

Description

Do not pull eyebolts sideways when transporting the robot.

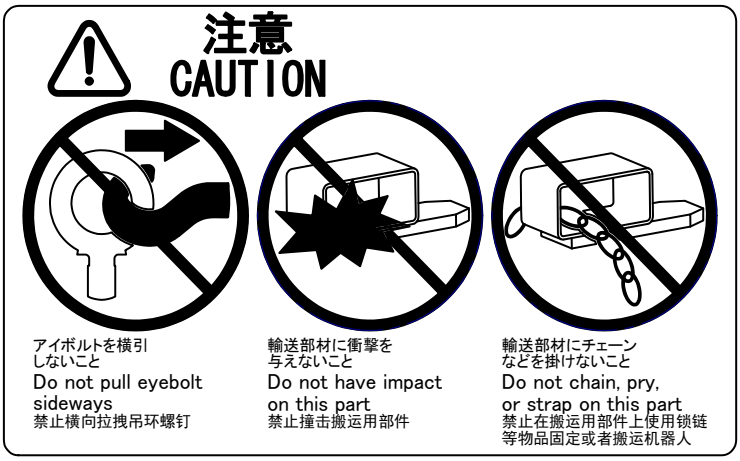


Fig. 4 (j) Transportation prohibitive label
(Example of transport equipment option)

Description

Keep the following in mind when transporting the robot.

1) Do not pull eyebolts sideways.
2) Do not pull hanging hole of this part sideways.
3) Do not thread a chain or the like through a transport equipment.

(10) Mastering caution label

Fig. 4 (k) Mastering caution label

Description

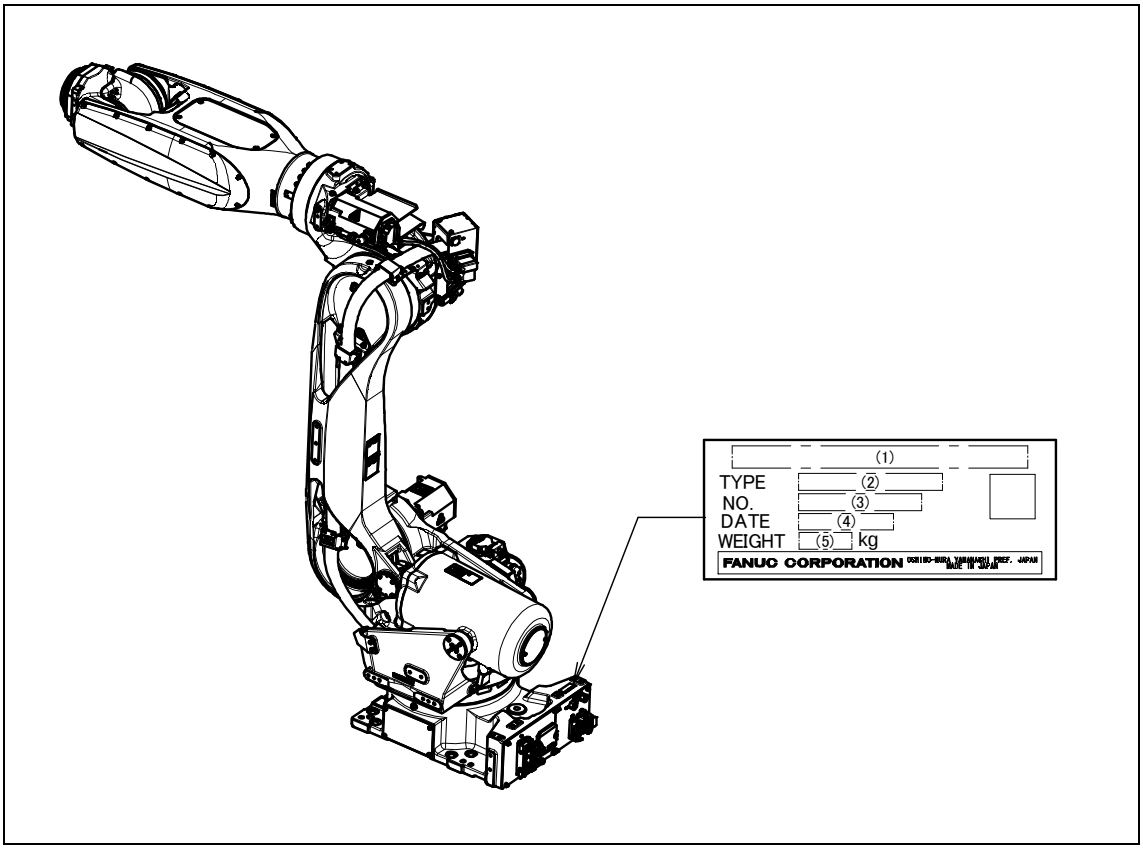
Keep the following in mind when performing the mastering. The motion limits are temporarily invalid during mastering. Cables may be damaged if the J1-axis exceeds +/-185^{o}.

PREFACE

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

Model name	Mechanical unit specification No.	Max. payload
FANUC Robot R-2000*i*D/210FH	A05B-1339-B205	210kg
FANUC Robot R-2000*i*D/165FH	A05B-1339-B201	165kg
FANUC Robot R-2000*i*D/100FH	A05B-1339-B207	100kg

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



Position of label indicating mechanical unit specification number

Table 1 (a)

CONTENTS	(1)	(2)	(3)	(4)	(5)
	MODEL NAME	TYPE	No.	DATE	WEIGHT kg (Without controller)
LETTERS	FANUC Robot R-2000*i*D/210FH	A05B-1339-B205	SERIAL NO. IS PRINTED	PRODUCTION YEAR AND MONTH ARE PRINTED	1150
	FANUC Robot R-2000*i*D/165FH	A05B-1339-B201			
	FANUC Robot R-2000*i*D/100FH	A05B-1339-B207			

RELATED MANUALS

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

SAFETY HANDBOOK B-80687EN All persons who use the FANUC Robot and system designer must read and understand thoroughly this handbook		Intended readers : Operator, System designer Topics : Safety items for robot system design, Operation, Maintenance
R-30*i*B, **R-30*i*B Mate,** **R-30*i*B Plus,** **R-30*i*B Mate Plus** **controller**	OPERATOR'S MANUAL (Basic Operation) **B-83284EN** 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 technician, System designer Topics : Robot functions, Operations, Programming, Start-up, Interfaces, Alarms Use : Robot operation, Teaching, System design
	MAINTENANCE MANUAL **R-30*i*B, R-30*i*B Plus :** **B-83195EN** **R-30*i*B Mate, R-30*i*B Mate Plus :** **B-83525EN**	Intended readers : Maintenance technician, System designer Topics : Installation, Start-up, Connection, Maintenance Use : Installation, Start-up, Connection, Maintenance

This manual uses following terms.

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

TABLE OF CONTENTS

1 TRANSPORTATION AND INSTALLATION

1.1 TRANSPORTATION

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

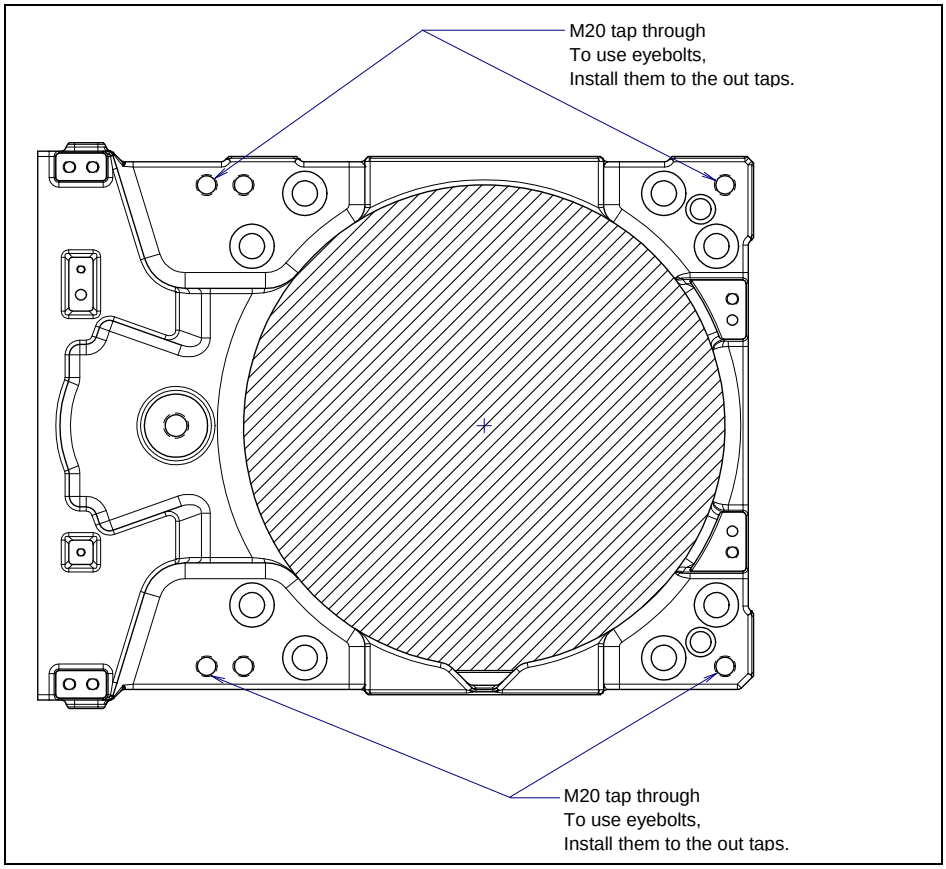


Fig. 1.1 (a) Position of the eyebolts and transportation equipment

(1) Transportation using a crane (Fig. 1.1 (b))
Fasten the M20 eyebolts at the four points and lift the robot by the four slings.

> ⚠ **CAUTION**
> When lifting the robot, be careful not to damage motors, connectors, cables, or J5/J6-axis covers of the robot by slings.

(2) Transportation using a forklift (Fig. 1.1 (c))
The robot is transported with the specific transport equipment attached.
There is a transport equipment to be attached to the J2 base. Transport equipment are prepared as an option.

⚠ WARNING

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

Note)
1 Machine mass 1150 kg
2 Eyebolt complied with JIS B 1168.
3 Quantity eyebolt 4 pcs, sling 4 pcs

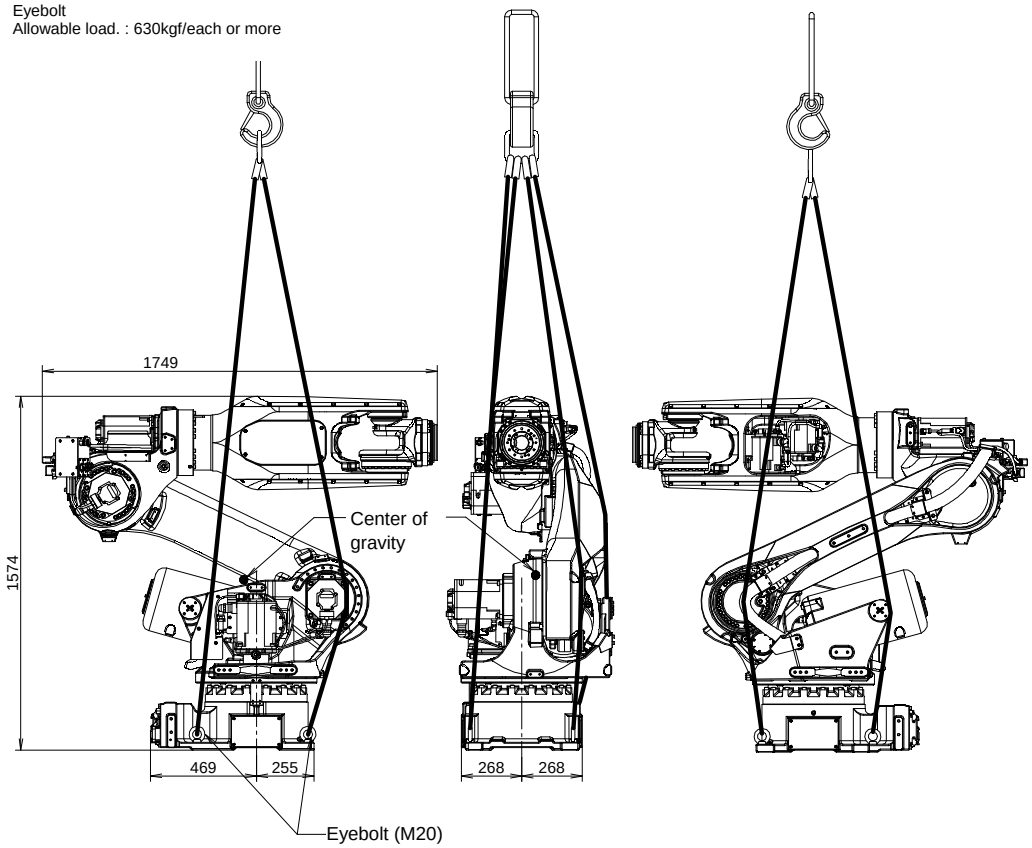
Crane
Load capacity. : 2.5 ton or more

Sling
Load capacity. : 1.0 ton/sling or more

Eyebolt
Allowable load. : 630kgf/each or more

Robot posture on transportation

J1	0º or ±180º
J2	-64º
J3	0º
J4	-90º
J5	Arbitrary
J6	Arbitrary



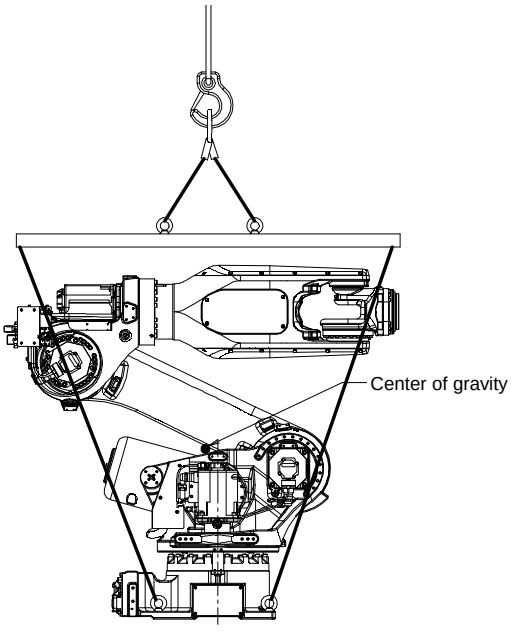


Fig. 1.1 (b) Transportation using a crane

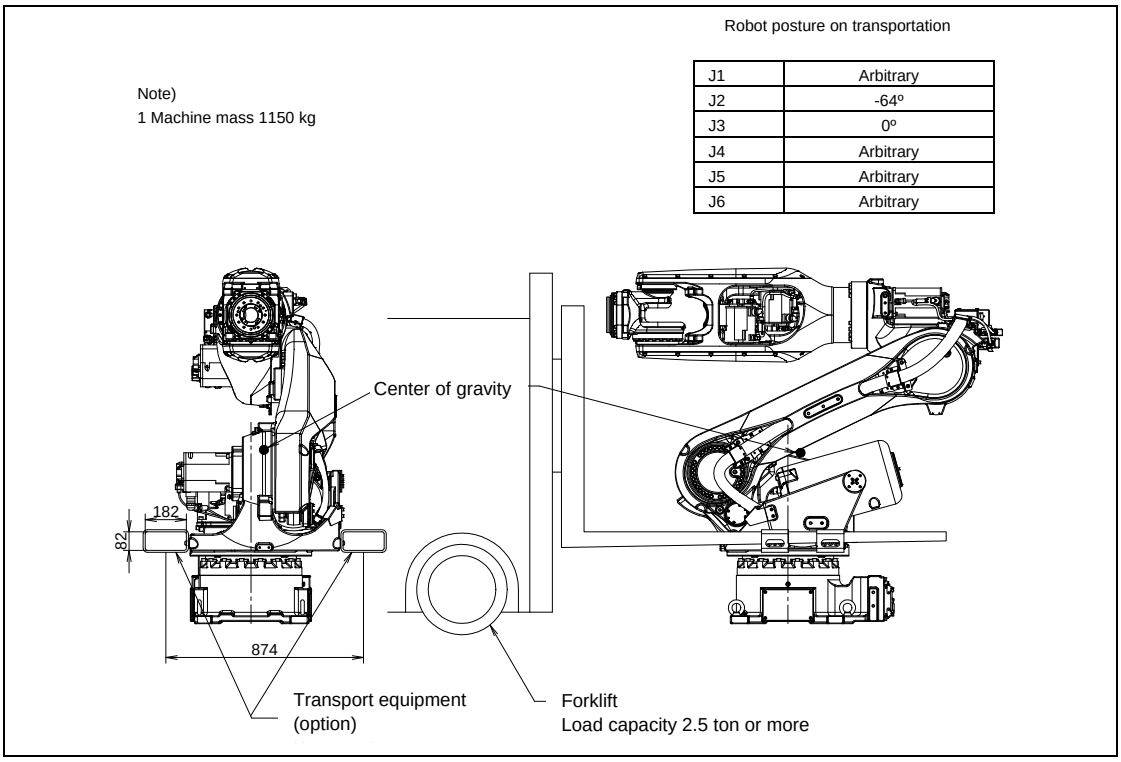


Fig. 1.1 (c) Transportation using a forklift

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

1.1.1 Transportation with an End Effector Attached

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

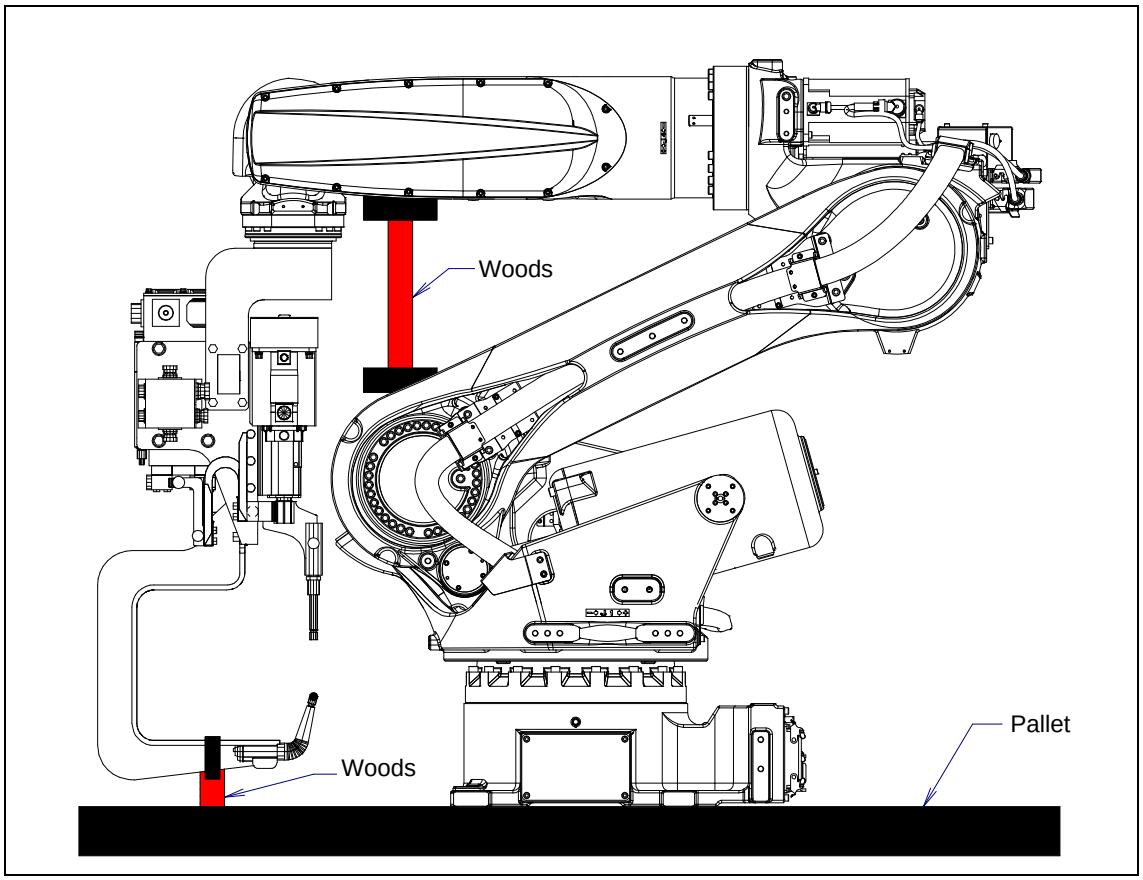


Fig. 1.1.1 (a) Example of securing the arm during transportation when an end effector is attached

1.2 INSTALLATION

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

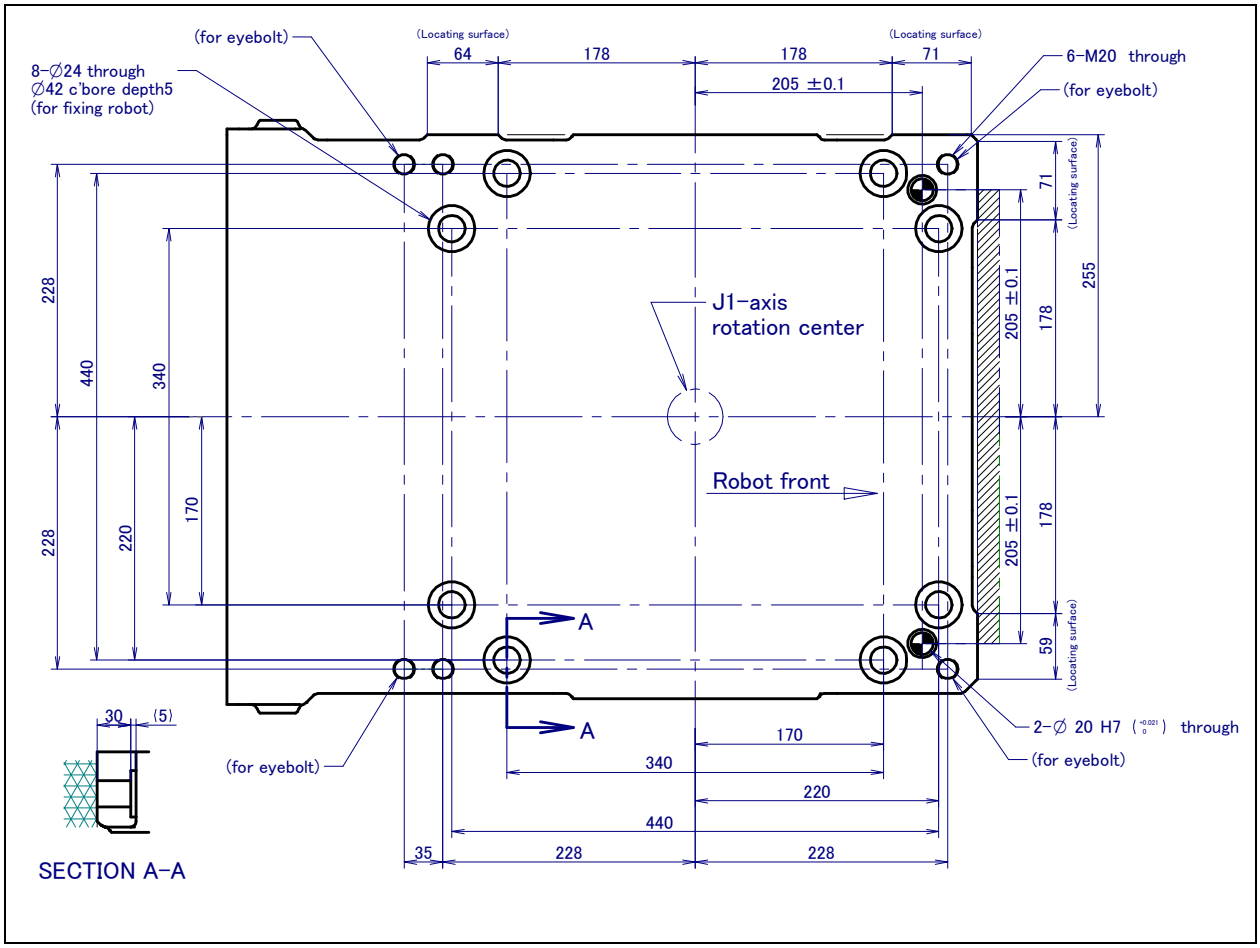


Fig. 1.2 (a) Dimensions of the robot base

1.2.1 Actual Installation Example

The following show three actual examples of the robot installation. Select a method according to the customer's installation environment, and install the robot.

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

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

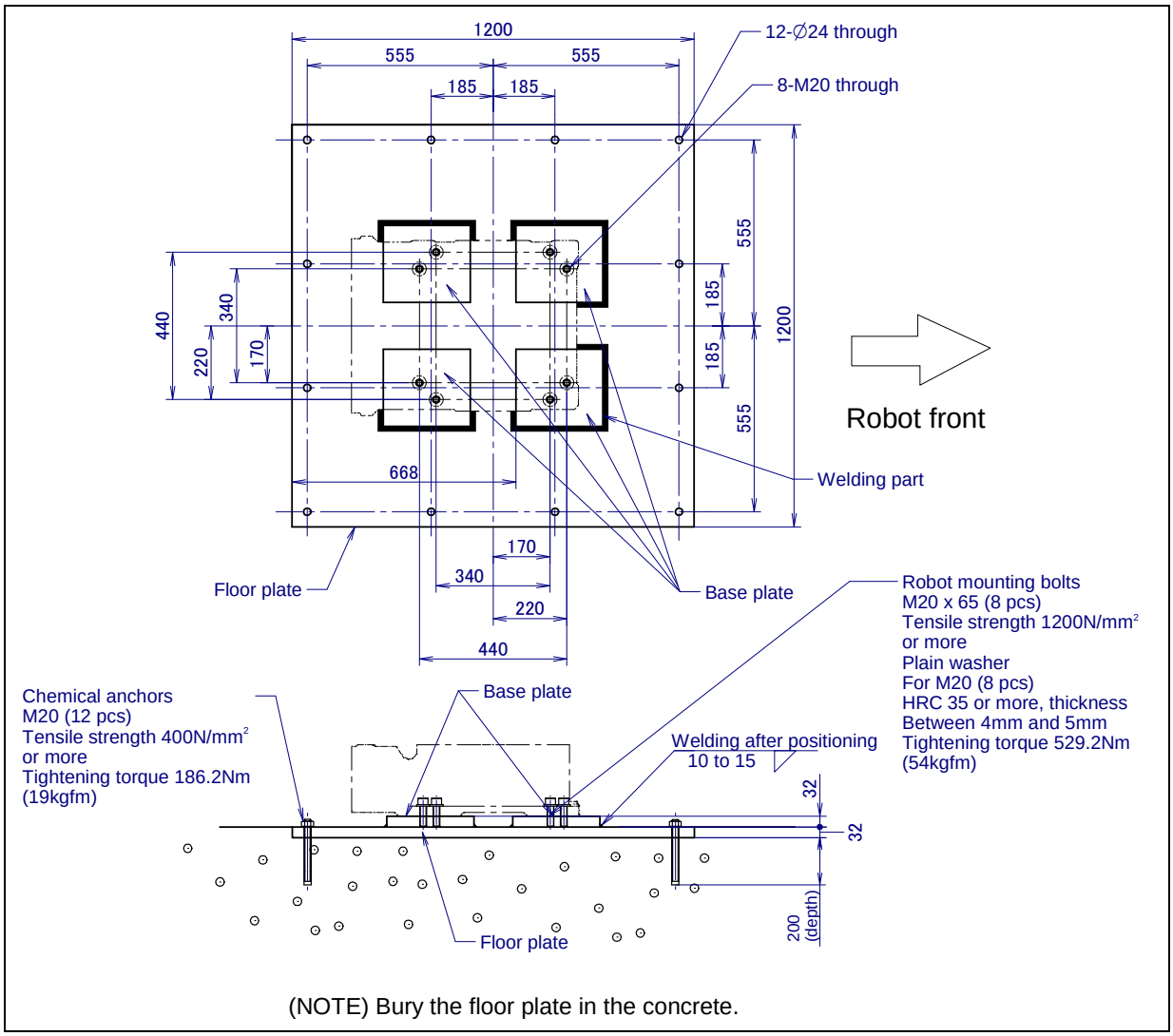
- Installation example method III Fig. 1.2.1 (c)
  The installation method is generally the same as described above except that the parallel pins for pushing the robot base are not used.

The 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.

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

Required parts	Remarks	Example I	Example II	Example III
Robot mounting bolts	M20 x 65 (Tensile strength 1200N/mm^2 or more) 8 pcs	○	○	○
Plain washers	For M20 (HRC 35 or more, thickness between 4 and 5 mm) 8 pcs	○	○	○
Chemical anchors	M20 (Tensile strength 400N/mm^2 or more) 12 pcs	○	○	○
Floor plate	Thickness 32t 1 pc	○	○	○
Base plates	Thickness 32t 4 pcs	○		
Fixing screws	M20 4 pcs		○	○
Nuts	M20 4 pcs		○	○
Parallel pins	ϕ20 3 pcs		○	

NOTE
- Customer must provide all necessary arrangements for the actual installation work (such as welding and anchoring).
- Flatness of robot installation surface must be less than or equal to 0.5mm. Inclination of robot installation surface must be less than or equal to 0.5º. If robot base is placed on uneven ground, it may result in the base breakage or low performance of the robot.



(NOTE) Bury the floor plate in the concrete.

Fig. 1.2.1 (a) Actual installation example I

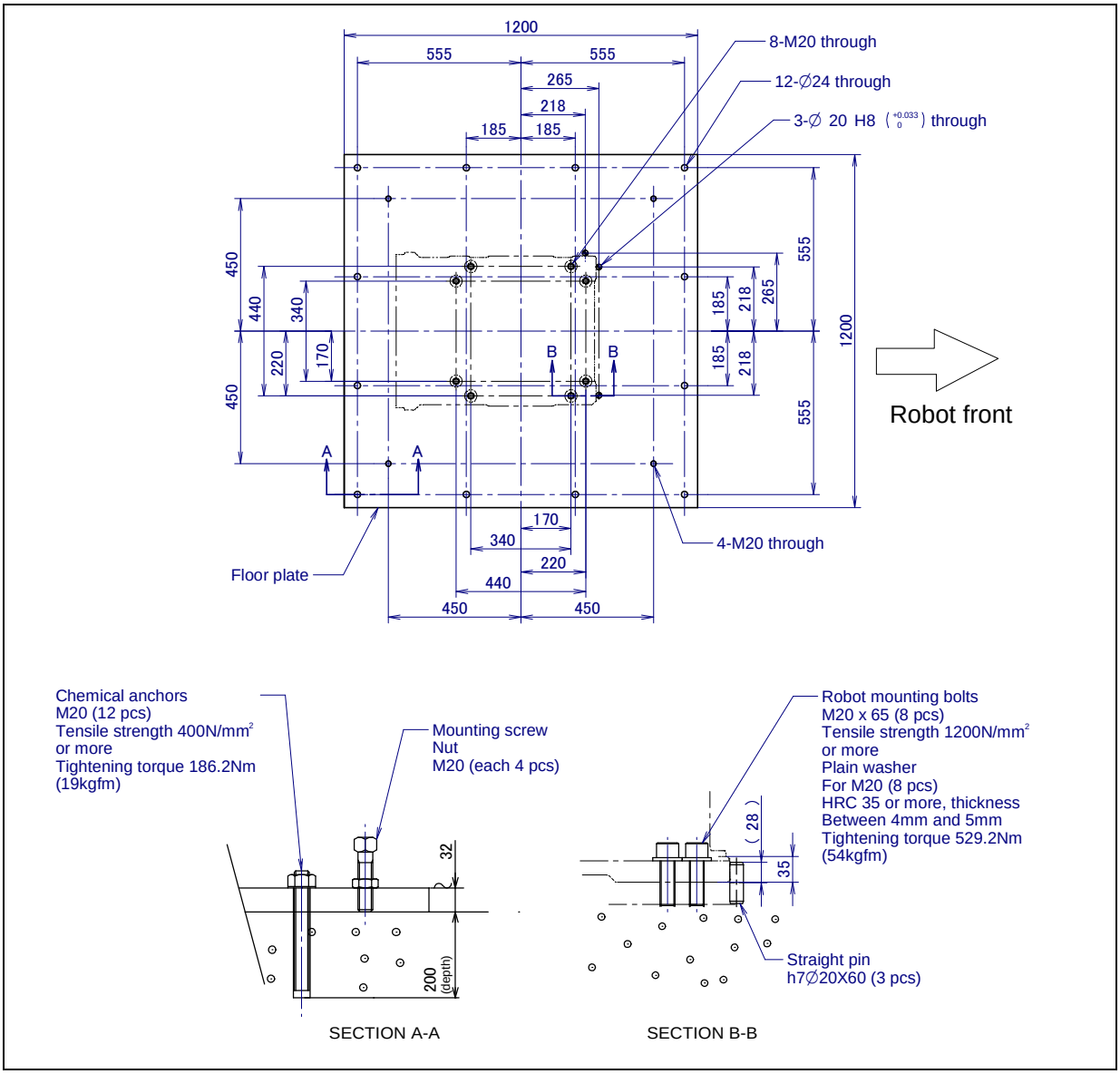


Fig. 1.2.1 (b) Actual installation example II

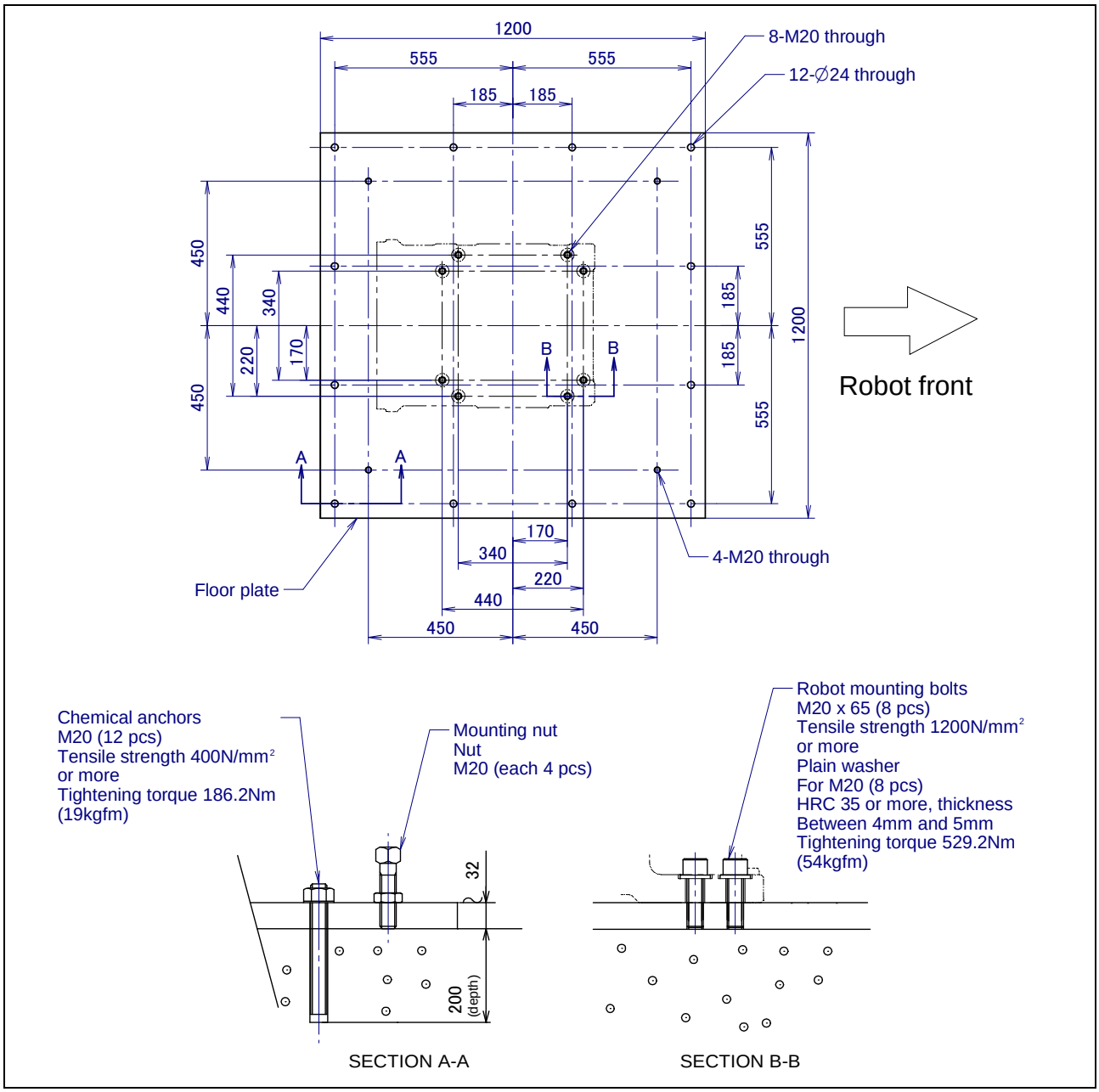


Fig. 1.2.1 (c) Actual installation example III

Fig. 1.2.1 (d) and Table 1.2.1 (a) indicate the force and moment applied to the base plate at the time of Power-off stop of the robot. Table 1.2.1 (b) to (d) indicate the stopping distance and time of the J1 to J3 axis until the robot stopping by Power-Off stop, by Smooth 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 1.2.1 (b) to (d) 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 1.2.1 (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 1.2.1 (a) Force and moment during Power-Off stop

Model	Vertical moment MV [kNm(kgfm)]	Force in vertical direction FV [kN(kgf)]	Horizontal moment MH [kNm(kgfm)]	Force in horizontal direction FH [kN(kgf)]
R-2000*i*D/210FH	76.44 (7800)	41.16 (4200)	25.48 (2600)	32.34 (3300)
R-2000*i*D/165FH	68.60 (7000)	39.20 (4000)	24.50 (2500)	31.36 (3200)
R-2000*i*D/100FH	58.80 (6000)	35.28 (3600)	22.54 (2300)	25.48 (2600)

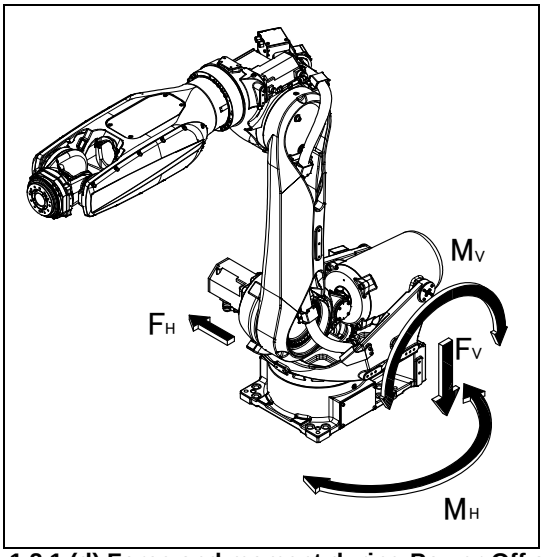


Fig. 1.2.1 (d) Force and moment during Power-Off stop

Table 1.2.1 (b) Stopping time and distance until the robot stopping by Power-Off stop after input of stop signal

Model		J1-axis	J2-axis	J3-axis
R-2000*i*D/210FH	Stopping time [ms]	448	362	182
	Stopping distance [deg] (rad)	26.2 (0.46)	14.4 (0.25)	9.4 (0.16)
R-2000*i*D/165FH	Stopping time [ms]	488	328	172
	Stopping distance [deg] (rad)	30.7 (0.56)	15.4 (0.27)	9.8 (0.17)
R-2000*i*D/100FH	Stopping time [ms]	404	420	228
	Stopping distance [deg] (rad)	21.5 (0.38)	24.4 (0.43)	13.6 (0.24)

Table 1.2.1 (c) Stopping time and distance until the robot stopping by Smooth stop after input of stop signal

Model		J1-axis	J2-axis	J3-axis
R-2000*i*D/210FH	Stopping time [ms]	990	1010	960
	Stopping distance [deg] (rad)	56.4 (0.98)	38.2 (0.67)	37.6 (0.66)
R-2000*i*D/165FH	Stopping time [ms]	830	880	860
	Stopping distance [deg] (rad)	51.9 (0.91)	33.2 (0.58)	40.4 (0.71)
R-2000*i*D/100FH	Stopping time [ms]	760	942	846
	Stopping distance [deg] (rad)	37.7 (0.66)	42.0 (0.73)	48.3 (0.84)

Table 1.2.1 (d) Stopping time and distance until the robot stopping by Controlled stop after input of stop signal

Model		J1-axis	J2-axis	J3-axis
R-2000*i*D/210FH	Stopping time [ms]	1095	1225	1285
	Stopping distance [deg] (rad)	63.6 (1.11)	47.5 (0.83)	52.3 (0.91)
R-2000*i*D/165FH	Stopping time [ms]	1045	1210	1180
	Stopping distance [deg] (rad)	67.1 (1.17)	53.5 (0.93)	58.4 (1.02)
R-2000*i*D/100FH	Stopping time [ms]	850	1076	942
	Stopping distance [deg] (rad)	45.2 (0.79)	53.5 (0.93)	55.5 (0.97)

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.

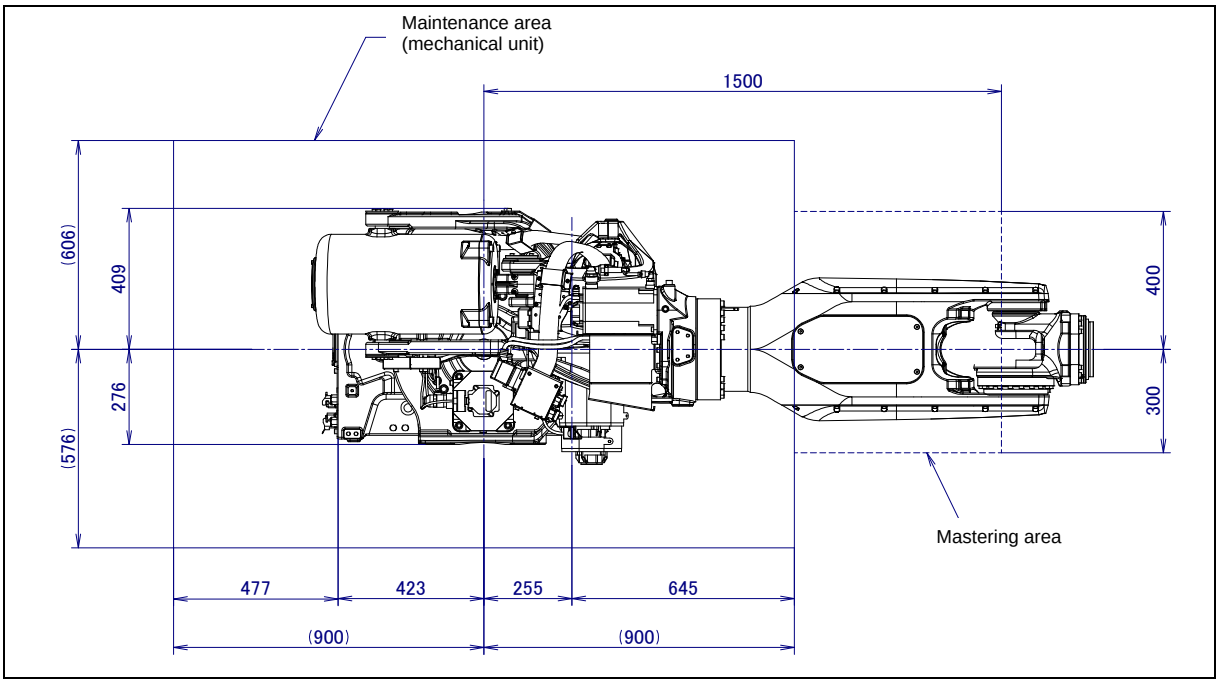


Fig. 1.3 (a) Maintenance area

1.4 INSTALLATION CONDITIONS

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

⚠ 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

2.1 CONNECTION WITH THE CONTROLLER

The robot is connected with the controller via the power cable, the signal cable and the earth cable. Connect these cables to the connectors on the back of the robot base. For details on air and option cables, see Chapter 5.

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

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

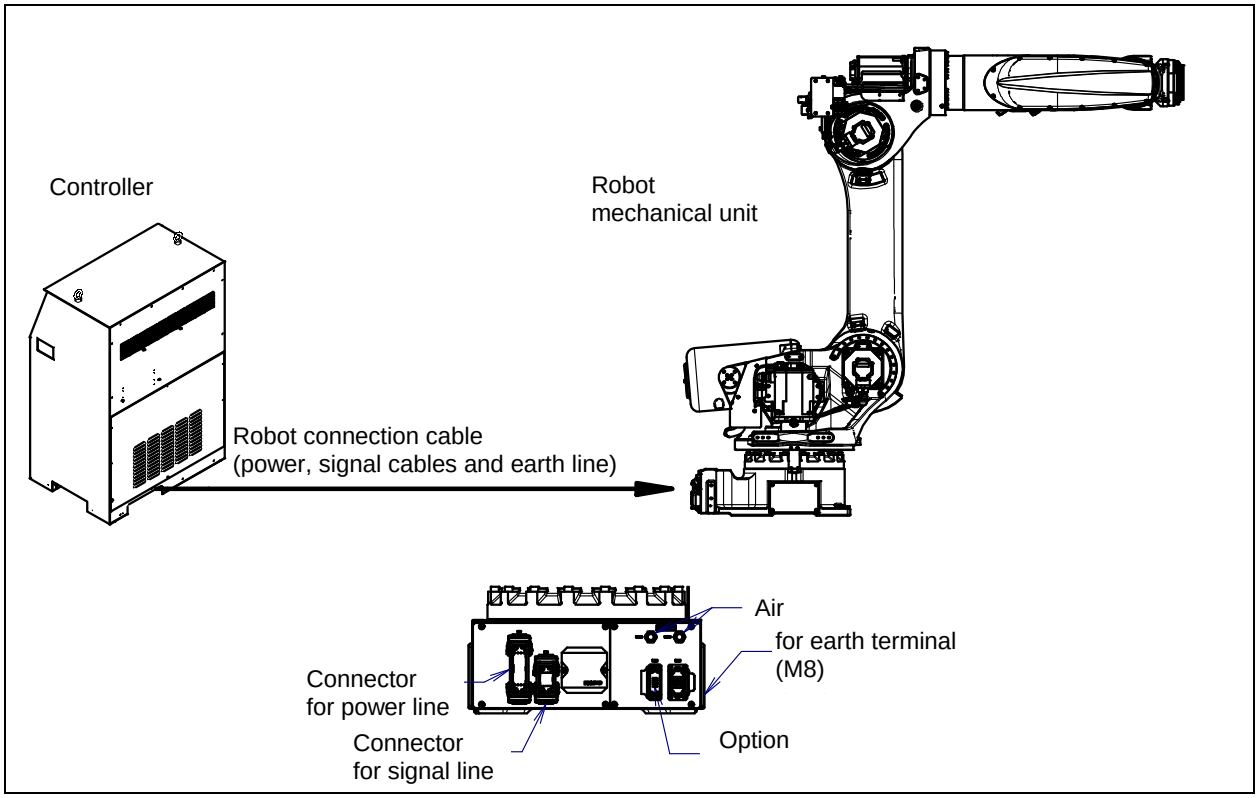


Fig. 2.1 (a) Cable connection

3 BASIC SPECIFICATIONS

3.1 ROBOT CONFIGURATION

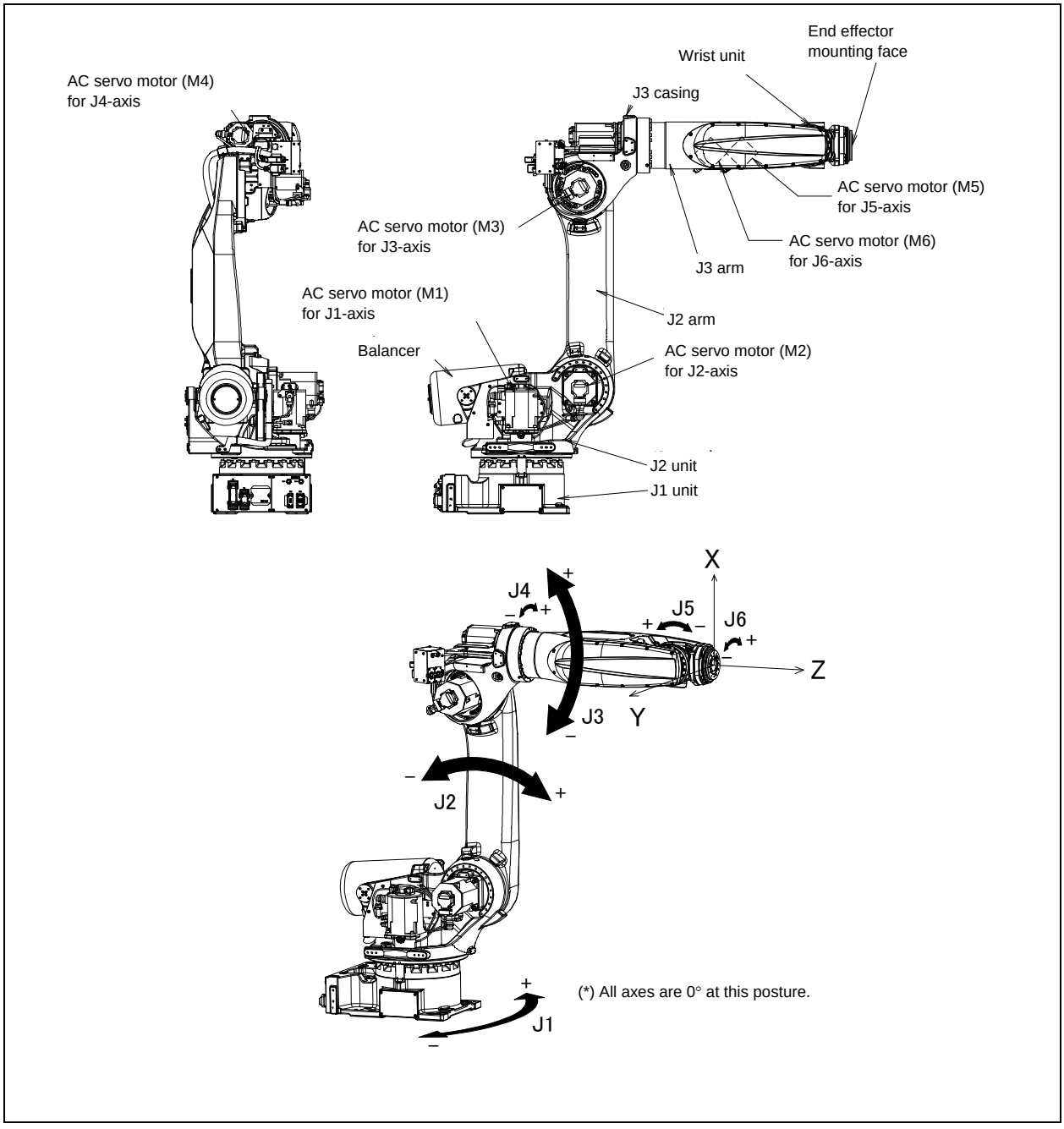


Fig. 3.1 (a) Mechanical unit configuration, each axis coordinates, and mechanical interface coordinates

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

Specifications Note 1)

Type			R-2000*i*D/210FH	R-2000*i*D/165FH	R-2000*i*D/100FH
Type			Articulated Type		
Controlled axis			6 axes(J1,J2,J3,J4,J5,J6)		
Installation			Floor mount		
Motion range	J1-axis	Upper limit	185° (3.23rad)		
		Lower limit	-185° (-3.23rad)		
	J2-axis	Upper limit	76° (1.33rad)		
		Lower limit	-64° (-1.12rad)		
	J3-axis	Upper limit	100° (1.75rad)		
		Lower limit	-136.6° (-2.38rad)		
	J4-axis	Upper limit	210° (3.67rad)		
		Lower limit	-210° (-3.67rad)		
	J5-axis	Upper limit	125° (2.18rad)		
		Lower limit	-125° (-2.18rad)		
	J6-axis	Upper limit	210° (3.67rad)		
		Lower limit	-210° (-3.67rad)		
Max. speed Note 2)	J1-axis		120°/s (2.09rad/s)	130°/s (2.27rad/s)	105°/s (1.83rad/s)
	J2-axis		90°/s (1.57rad/s)	110°/s (1.92rad/s)	130°/s (2.27rad/s)
	J3-axis		100°/s (1.75rad/s)	115°/s (2.01rad/s)	130°/s (2.27rad/s)
	J4-axis		140°/s (2.44rad/s)	175°/s (3.05rad/s)	200°/s (3.49rad/s)
	J5-axis		130°/s (2.27rad/s)	170°/s (2.97rad/s)	160°/s (2.79rad/s)
	J6-axis		220°/s (3.84rad/s)	280°/s (4.89rad/s)	300°/s (5.24rad/s)
Max. payload	At wrist		210kg	165kg	100kg
	On J3 casing		20kg	20kg	50kg
	On J2 base		550kg	550kg	550kg
Allowable load moment at wrist	J4-axis		1380N·m (141kgf·m)	1000N·m (102kgf·m)	850N·m (86.7kgf·m)
	J5-axis		1380N·m (141kgf·m)	1000N·m (102kgf·m)	850N·m (86.7kgf·m)
	J6-axis		735N·m (75kgf·m)	620N·m (63kgf·m)	450N·m (45.9kgf·m)
Allowable load inertia at wrist	J4-axis		228kg·m^2 (2327kgf·cm·s^2)	122kg·m^2 (1245kgf·cm·s^2)	90kg·m^2 (918kgf·cm·s^2)
	J5-axis		228kg·m^2 (2327kgf·cm·s^2)	122kg·m^2 (1245kgf·cm·s^2)	90kg·m^2 (918kgf·cm·s^2)
	J6-axis		196kg·m^2 (2000kgf·cm·s^2)	100kg·m^2 (1020kgf·cm·s^2)	50kg·m^2 (510kgf·cm·s^2)
Drive method			Electric servo drive by AC servo motor		
Repeatability Note 3)			±0.05mm		
Mass			1150kg		
Acoustic noise level			69.8dB Note 4)		
Installation environment			Ambient temperature: 0 to 45°C Note 5) Ambient humidity: Normally 75%RH or less. No dew, nor frost allowed. Short time (within one month) Max 95%RH Height: Up to 1000 meters above the sea level required, no particular provision for attitude. Vibration acceleration : 4.9m/s^2 (0.5G) or less Free of corrosive gases Note 6) Note 7)		

Note 1) Even if the robot is used according to the defined specifications, motion programs might shorten reducer life or cause the robot to overheat. Use ROBOGUIDE (system design support tool by FANUC) for further evaluation before running production.

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

Note 3) Compliant with ISO9283.

Note 4) This value is the equivalent continuous A-weighted sound pressure level that applied with ISO11201 (EN31201). This value is measured with the following conditions.
- Maximum load and speed
- Operating mode is AUTO

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

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

Note 7) Liquid intrusion into the balancer inside might cause corrosion of the component parts. Be careful to prevent liquid splashing to the balancer.

The following table lists the IEC60529-based Severe dust/liquid protection characteristics of the R-2000*i*D.

	Standard
J3 arm and wrist	IP67 (J5/J6-axis Motor : IP65)
Drive unit of the main body	IP66
Main body	IP54 (*)

(*) Except some connectors

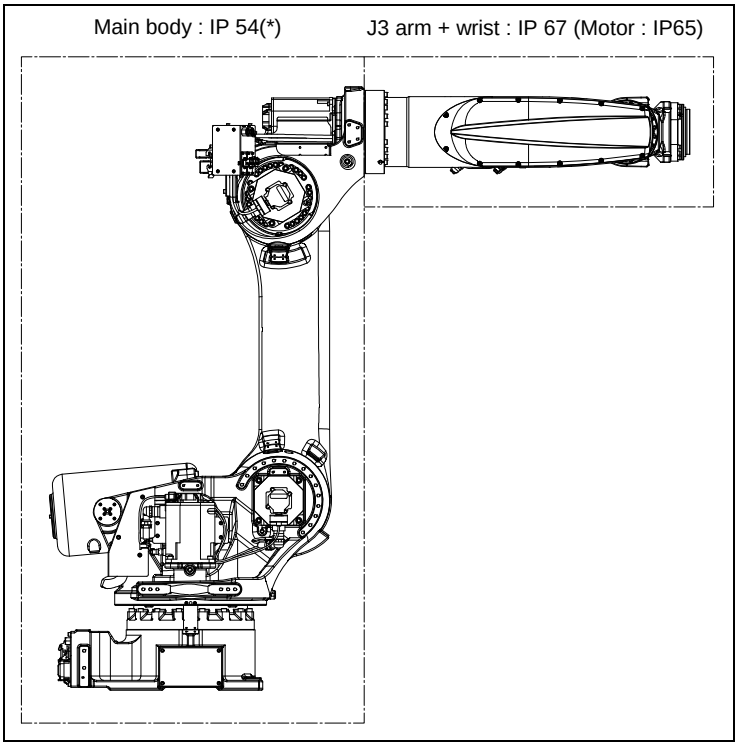


Fig. 3.1 (b) Severe dust/liquid protection characteristics of R-2000*i*D

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 65
6= Dust-tight: Complete protection against contact
5= Protection from water jet: Direct water projected in 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 (including severe dust/liquid protection model) cannot be used with the following liquids. Potentially these liquids will cause irreversible damage to the rubber parts (such as: gaskets, oil seals, O-rings etc.). (As exception to this only liquids tested and approved by FANUC can be used with the robot.)
   (a) Organic solvents
   (b) Cutting fluid including chlorine / gasoline
   (c) Amine type 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.
   * In case of liquid splashing to the balancer, it might cause corrosion and deterioration of the spring and failures.

3.2 MECHANICAL UNIT EXTERNAL DIMENSIONS AND OPERATING SPACE

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

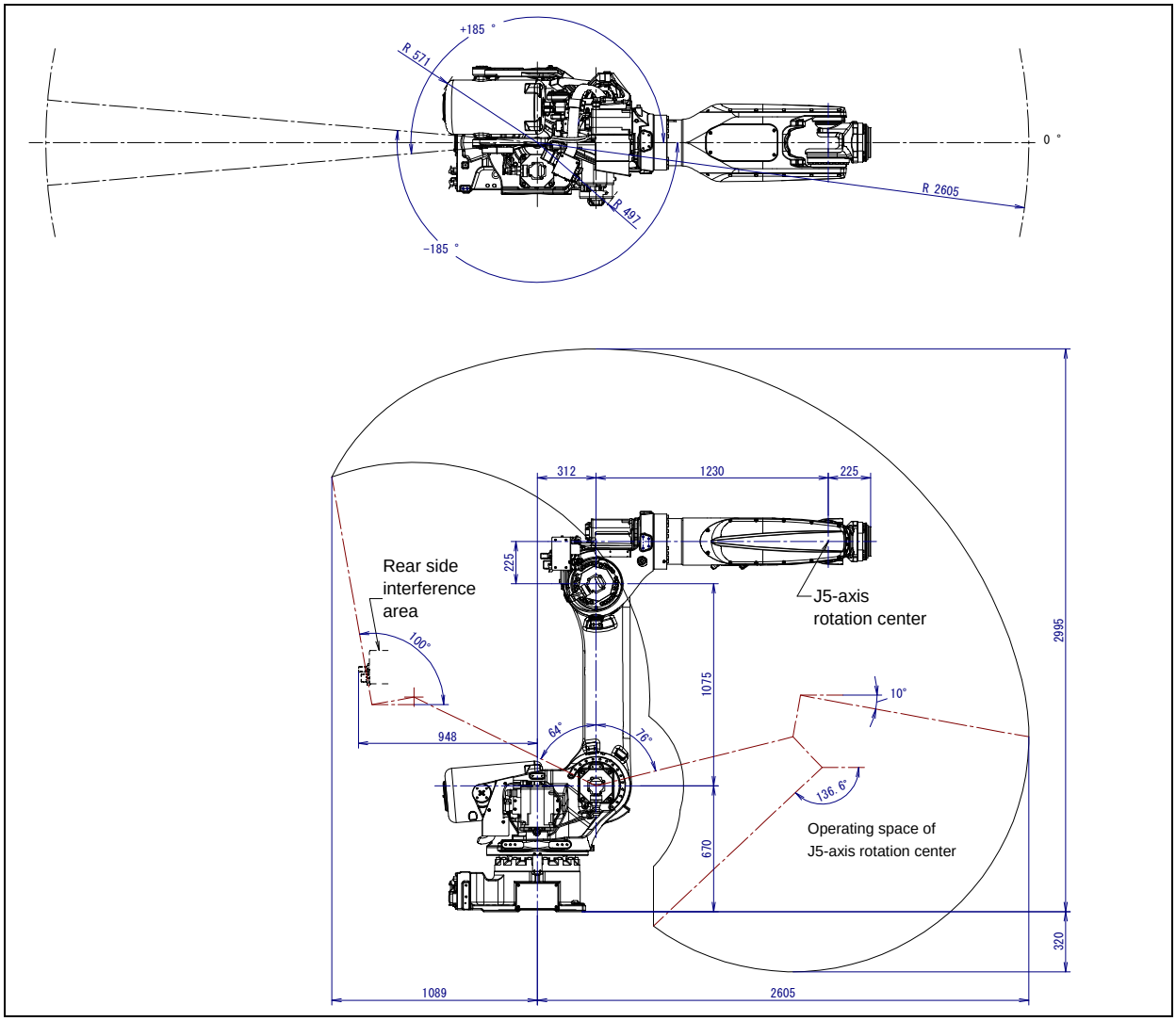


Fig. 3.2 (a) Operating space

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 each axis. The robot cannot exceed the motion range unless there is a loss of zero point position due to abnormalities in servo system or system error. In addition, the motion range limit by a fixed mechanical stopper or limit switch is also prepared to improve safety.

Fig. 3.3 (a) shows the position of fixed mechanical stopper.
Only in case of J1, robot stops by transforming fixed mechanical stopper (option).
Be sure to replace 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 Section 6.2.

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

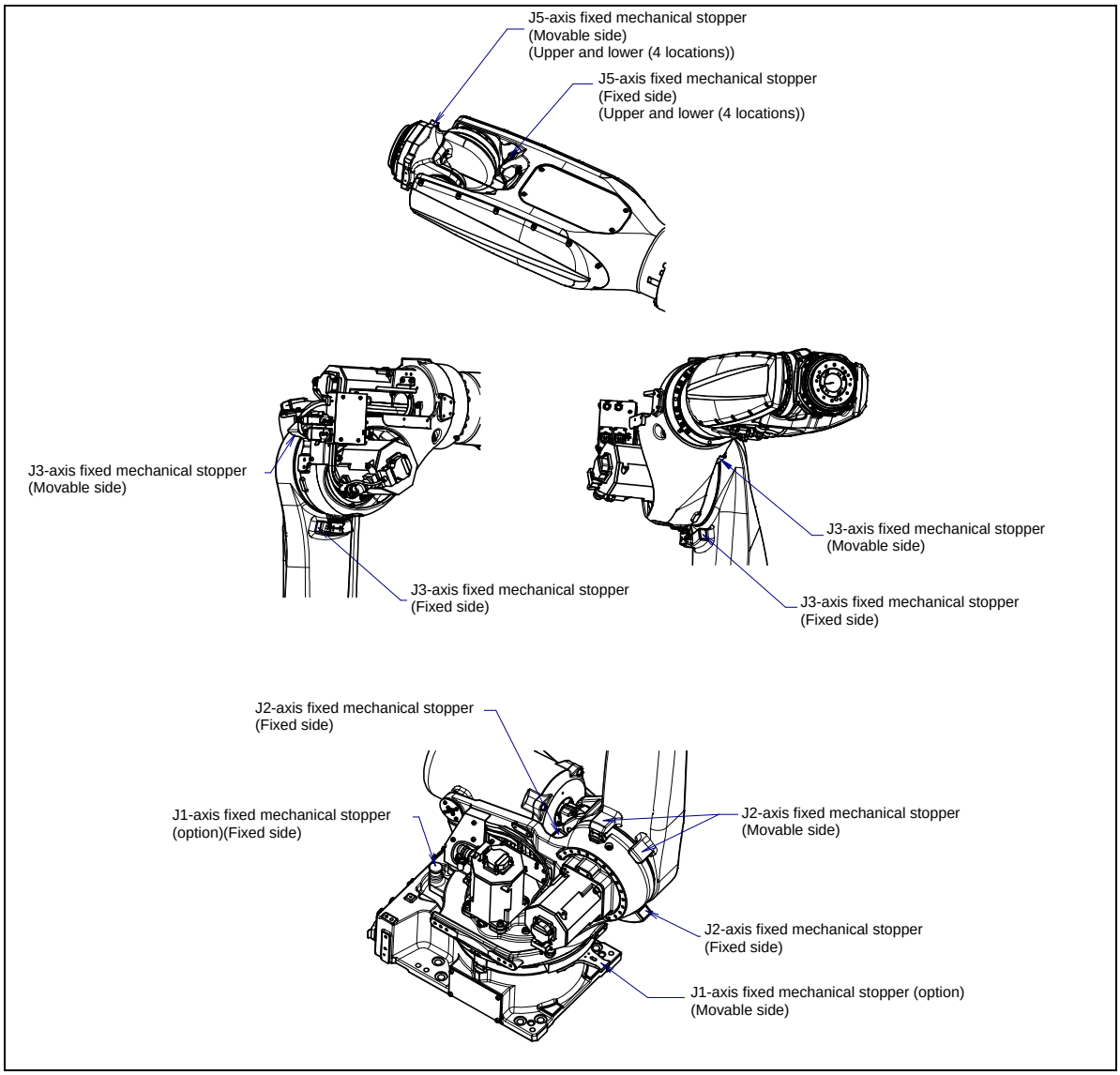


Fig. 3.3 (a) Position of fixed mechanical stopper

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

* The motion range can be changed. For information on how to change the motion range, see Chapter 6, "AXIS LIMITS SETUP".

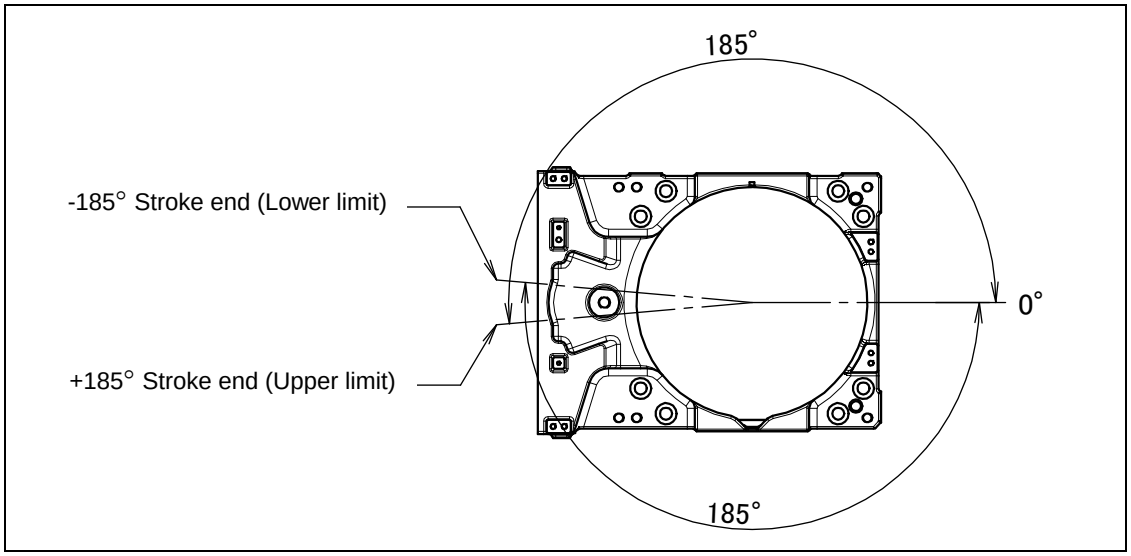


Fig. 3.3 (b) J1-axis motion limit (When fixed mechanical stopper is not specified)

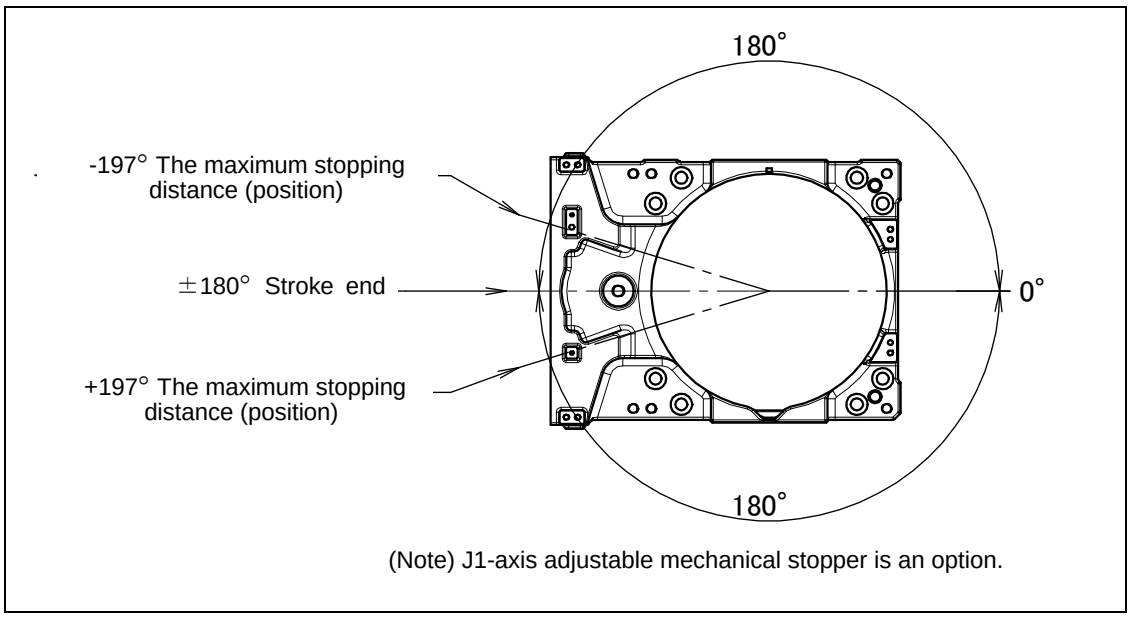
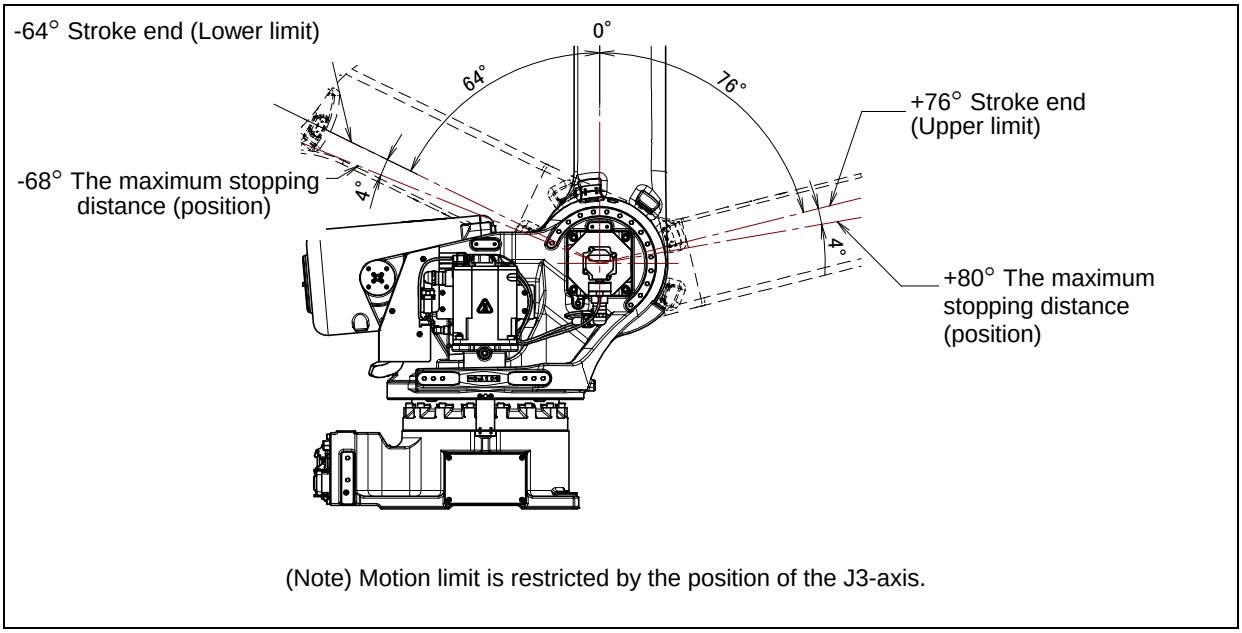
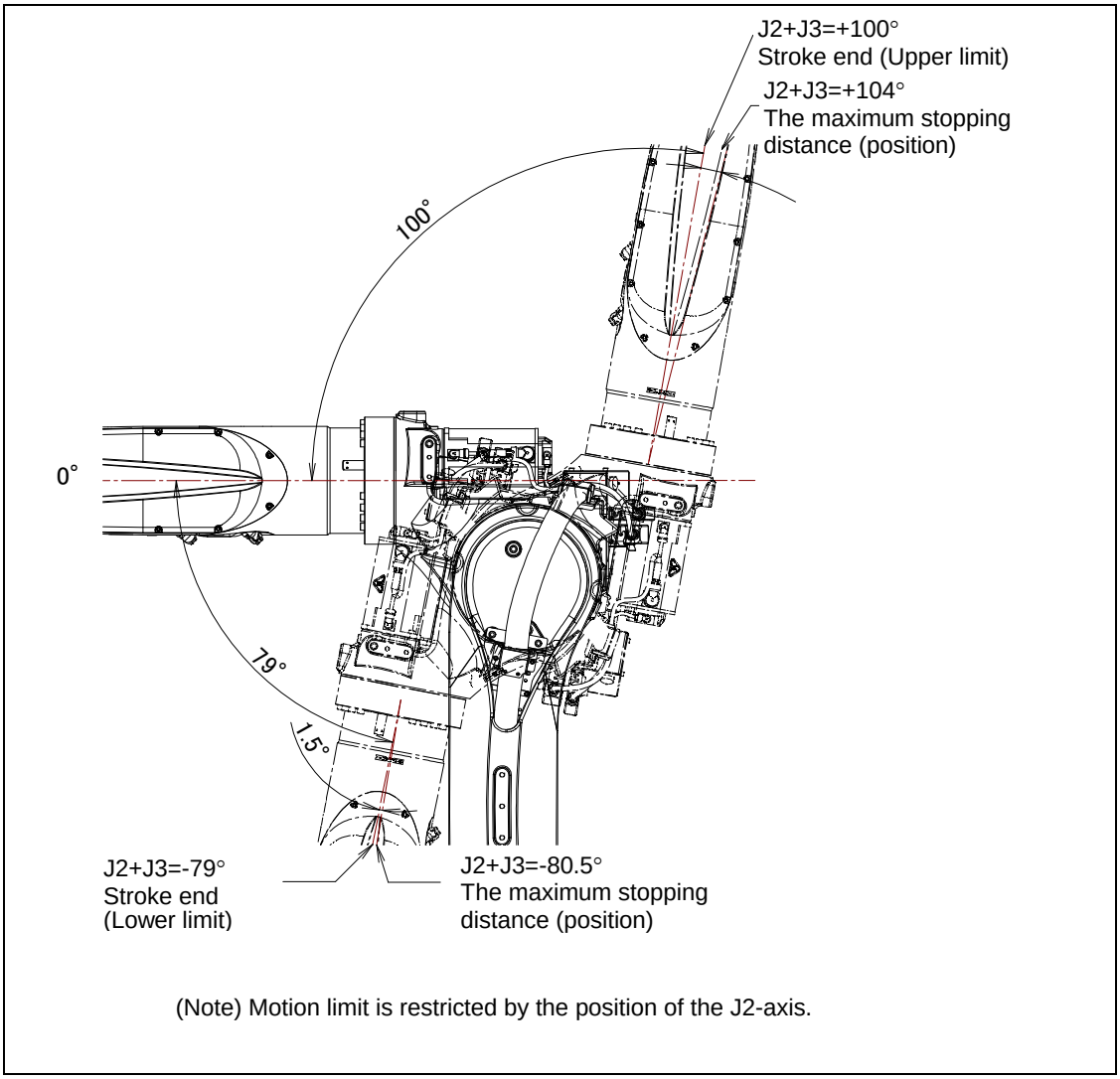


Fig. 3.3 (c) J1-axis motion limit (When fixed mechanical stopper is specified)



(Note) Motion limit is restricted by the position of the J3-axis.

Fig. 3.3 (d) J2-axis motion limit



(Note) Motion limit is restricted by the position of the J2-axis.

Fig. 3.3 (e) J3-axis motion limit

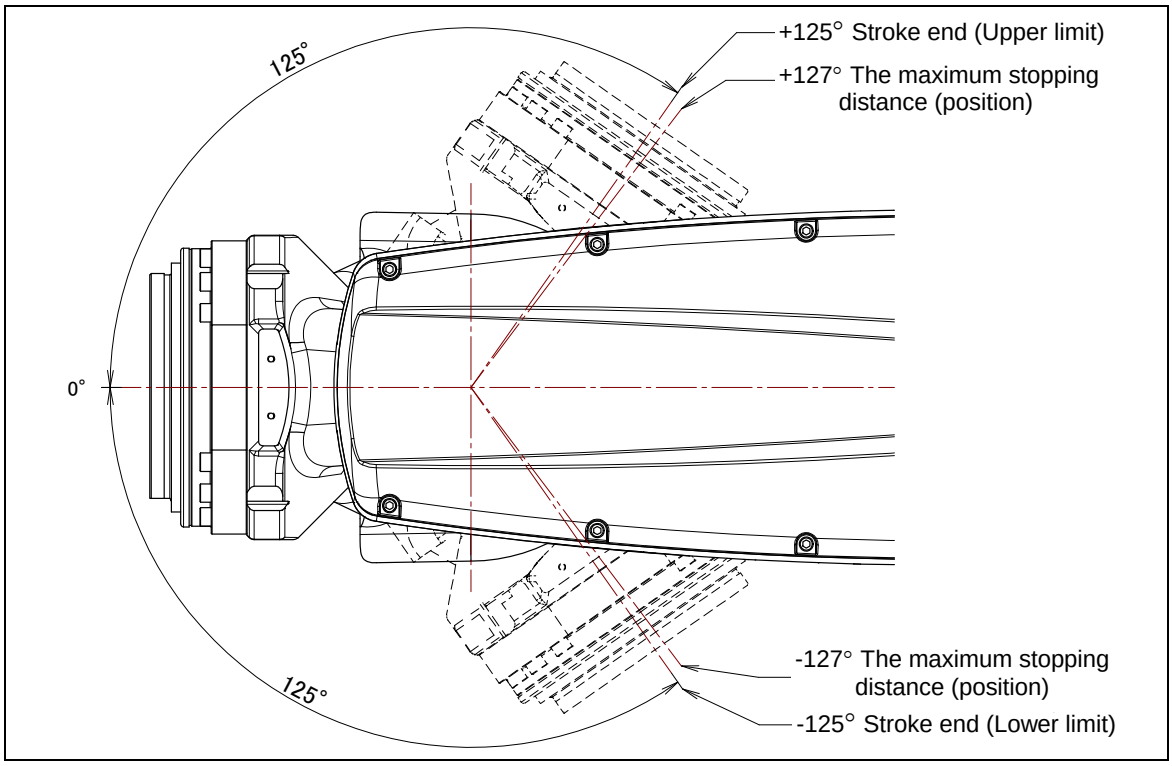
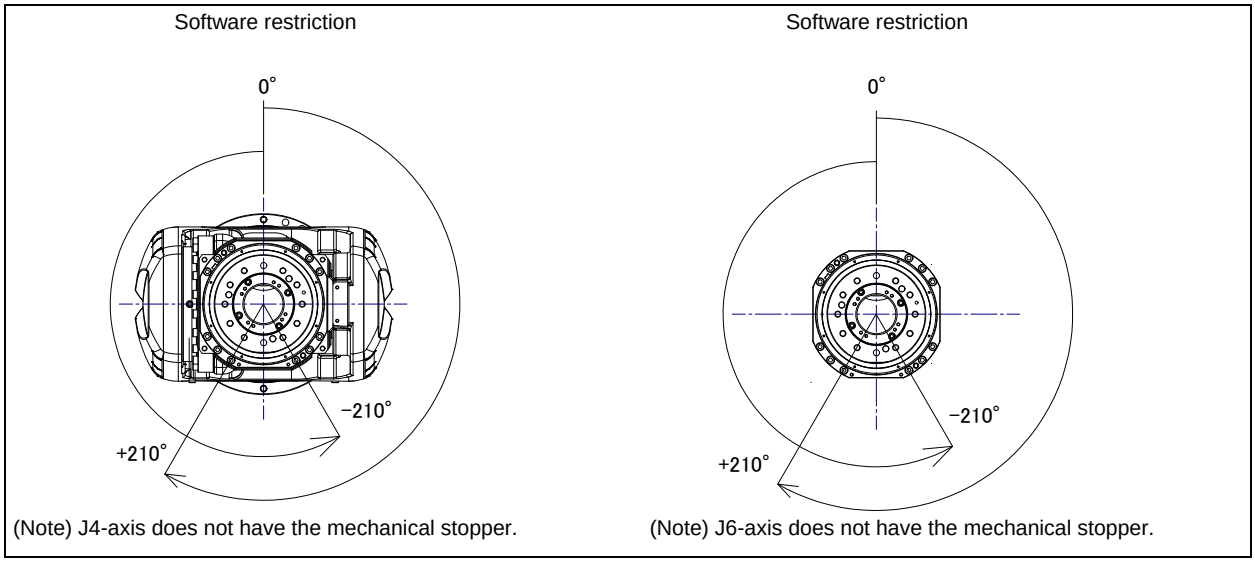


Fig. 3.3 (f) J5-axis motion limit



(Note) J4-axis does not have the mechanical stopper.

Fig. 3.3 (g) J4-axis motion limit

(Note) J6-axis does not have the mechanical stopper.

Fig. 3.3 (h) J6-axis motion limit

3.4 WRIST LOAD CONDITIONS

Fig. 3.4 (a) to (i) are diagrams to limit loads applied to the wrist.

- Apply a load within the region indicated in the graph.
- Apply the conditions of the allowable load moment and the allowable load inertia. See Section 3.1 about the allowable load moment and the allowable load inertia.
- See Section 4.1 about the mounting of the end effector.

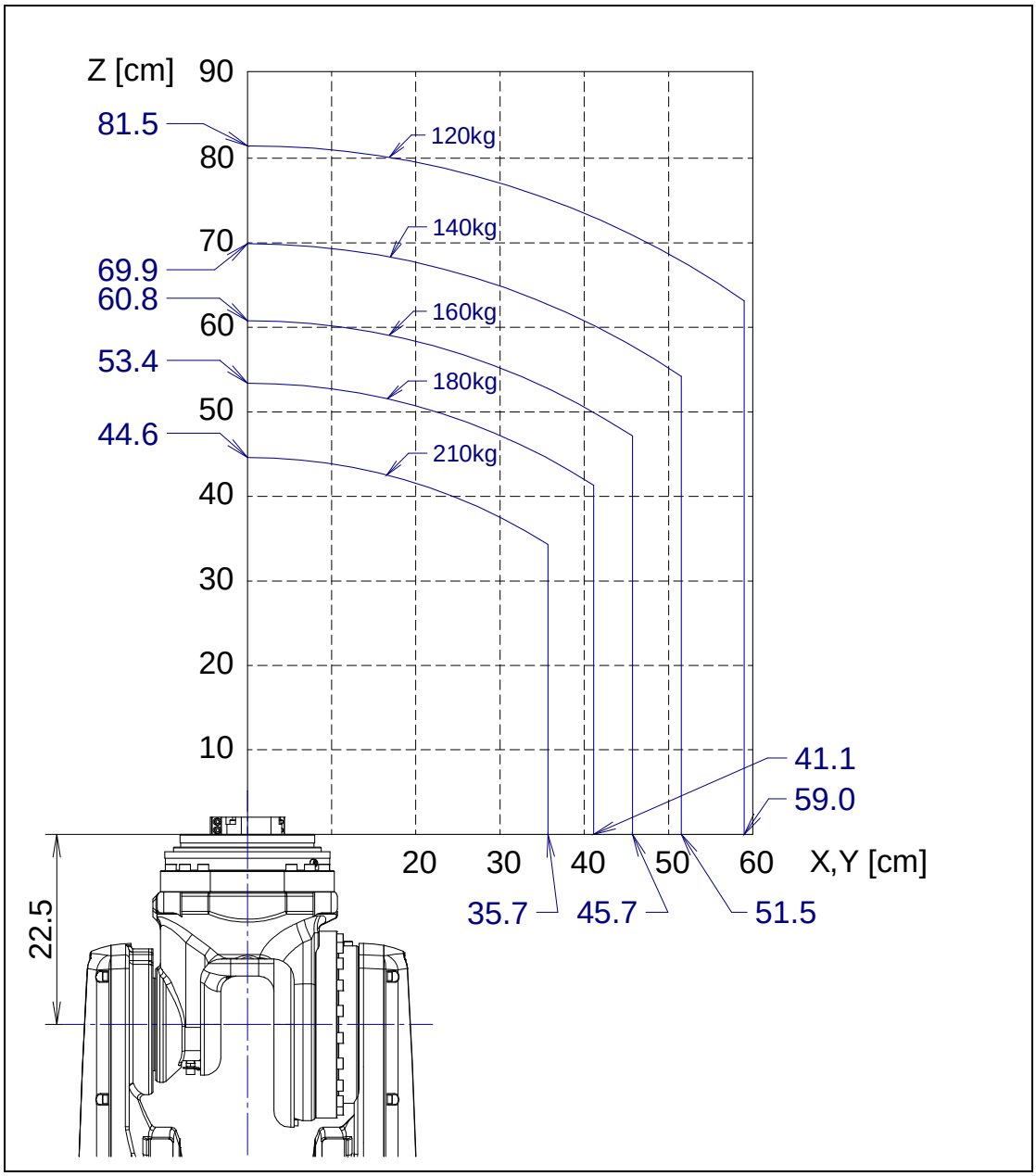


Fig. 3.4 (a) Wrist load diagram (ISO flange)
(R-2000*i*D/210FH)

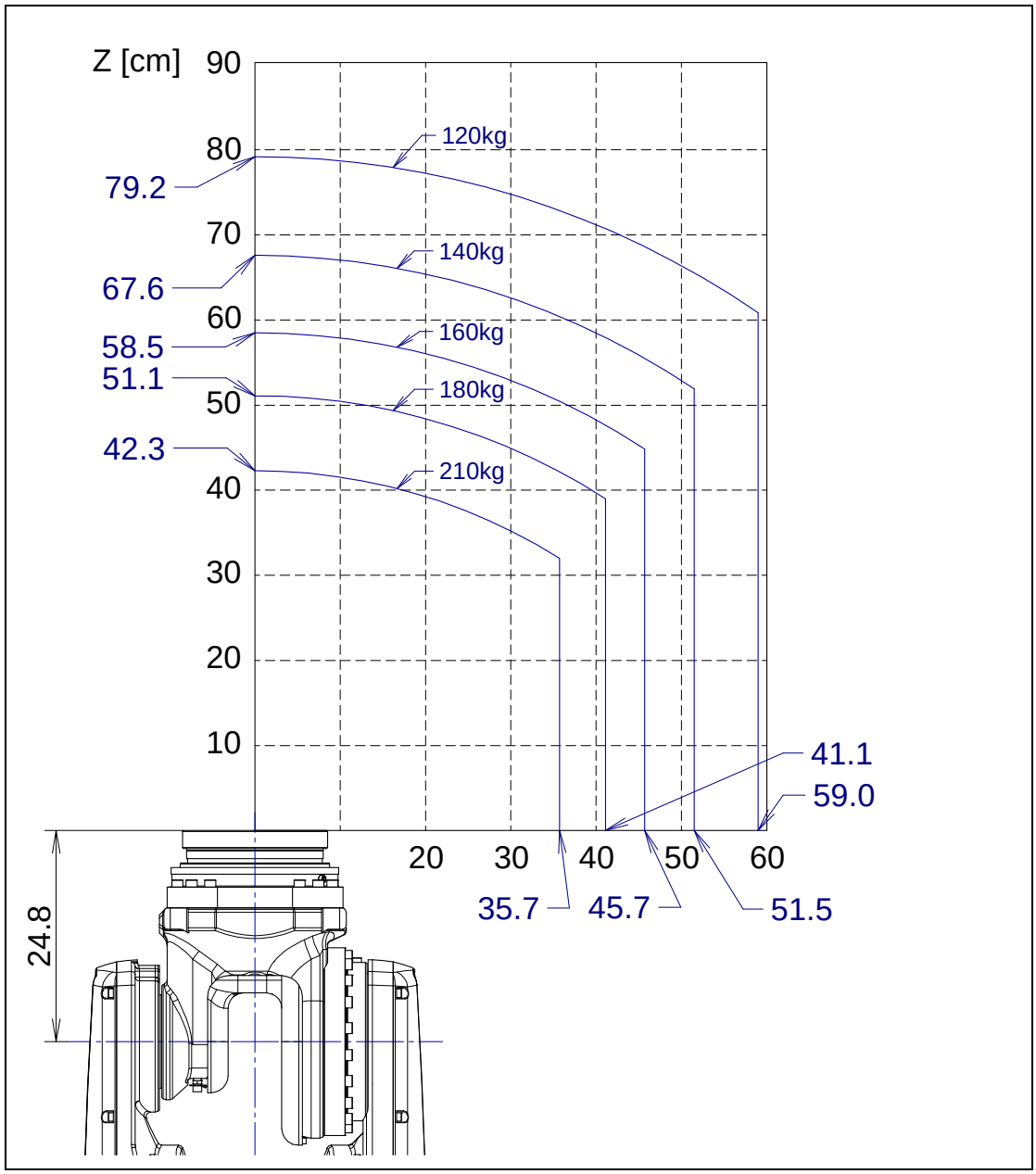


Fig. 3.4 (b) Wrist load diagram (Insulated ISO flange)
(R-2000*i*D/210FH)

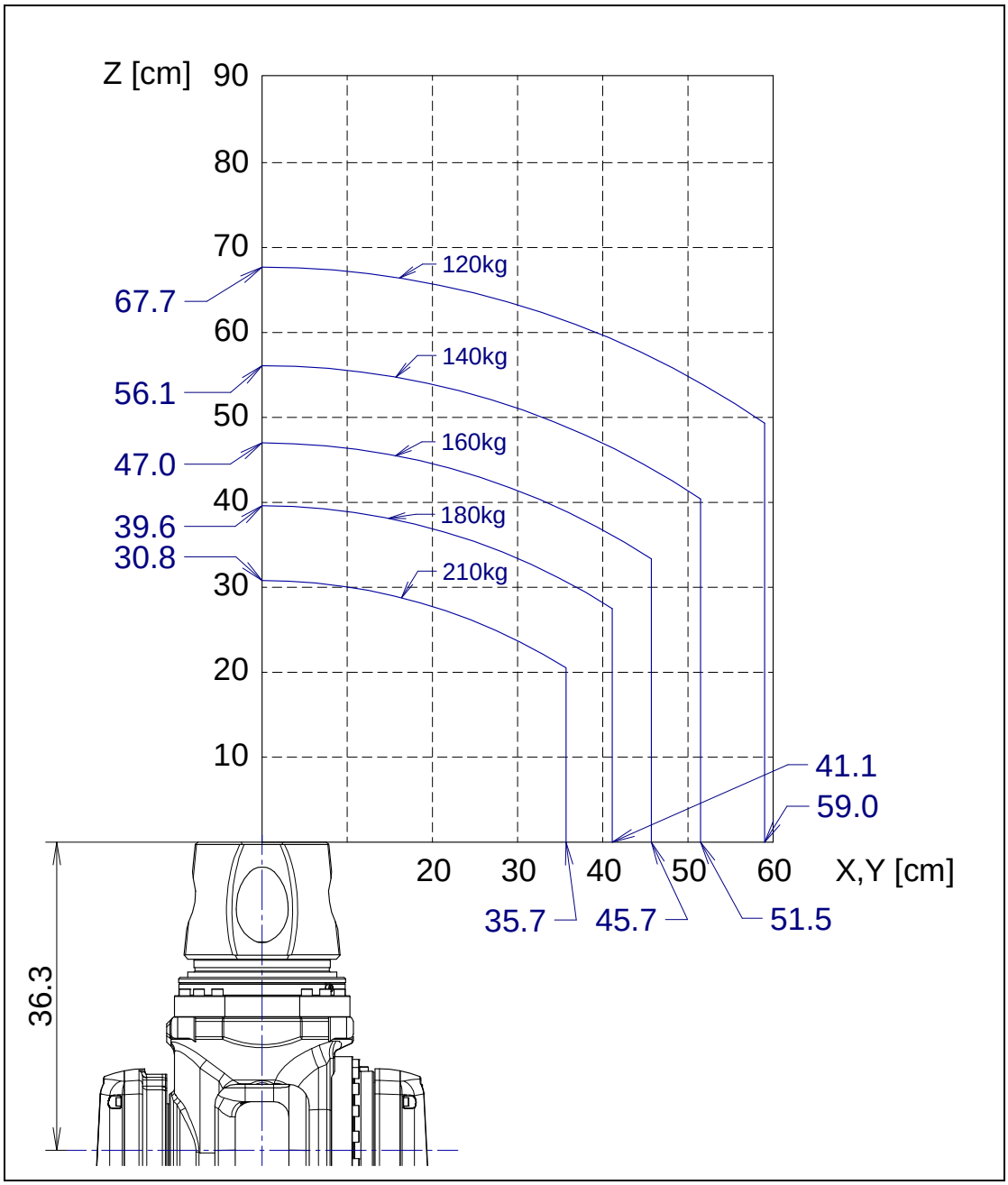


Fig. 3.4 (c) Wrist load diagram (Bracket flange)
(R-2000*i*D/210FH)

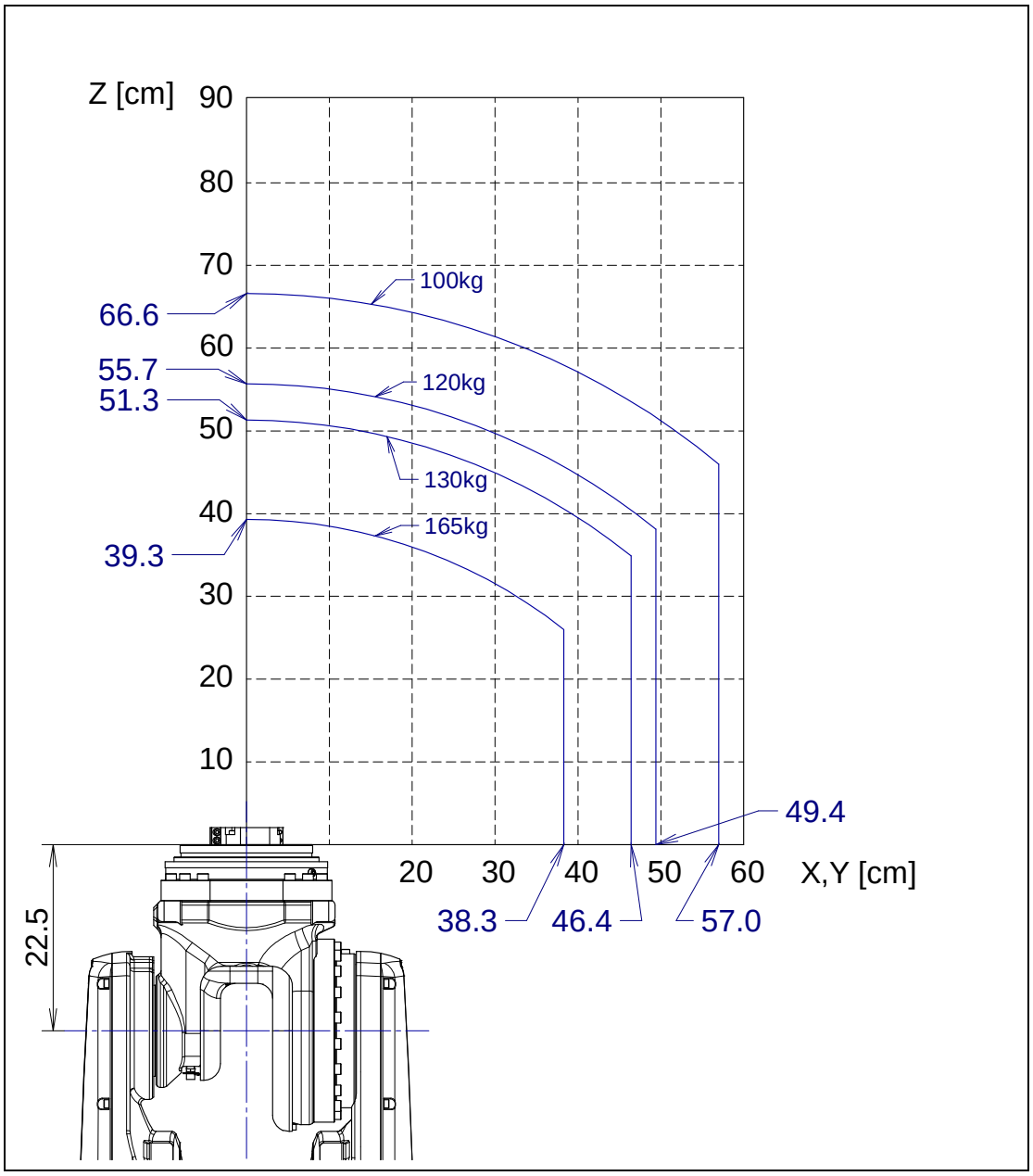


Fig. 3.4 (d) Wrist load diagram (ISO flange)
(R-2000*i*D/165FH)

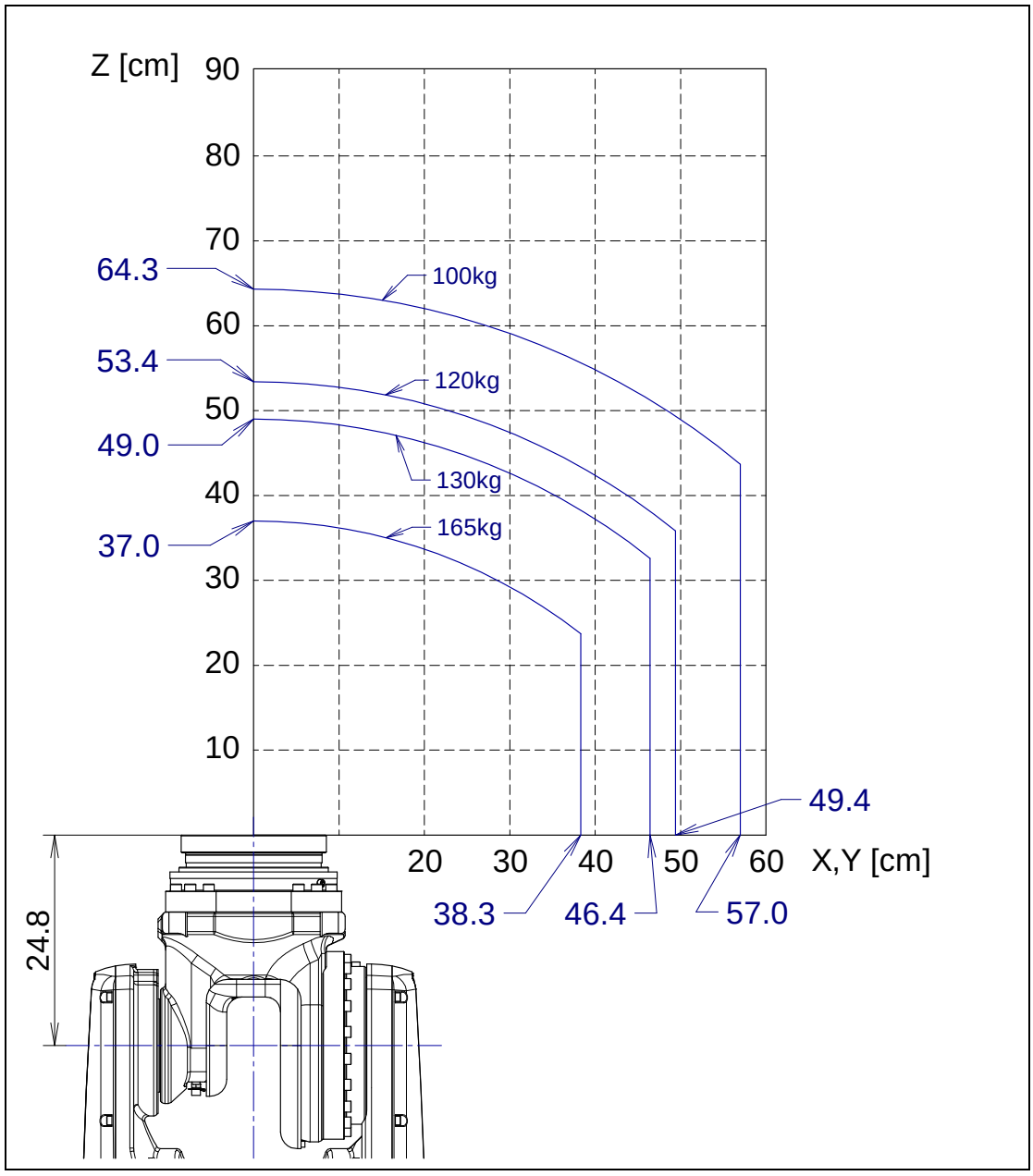


Fig. 3.4 (e) Wrist load diagram (Insulated ISO flange)
(R-2000*i*D/165FH)

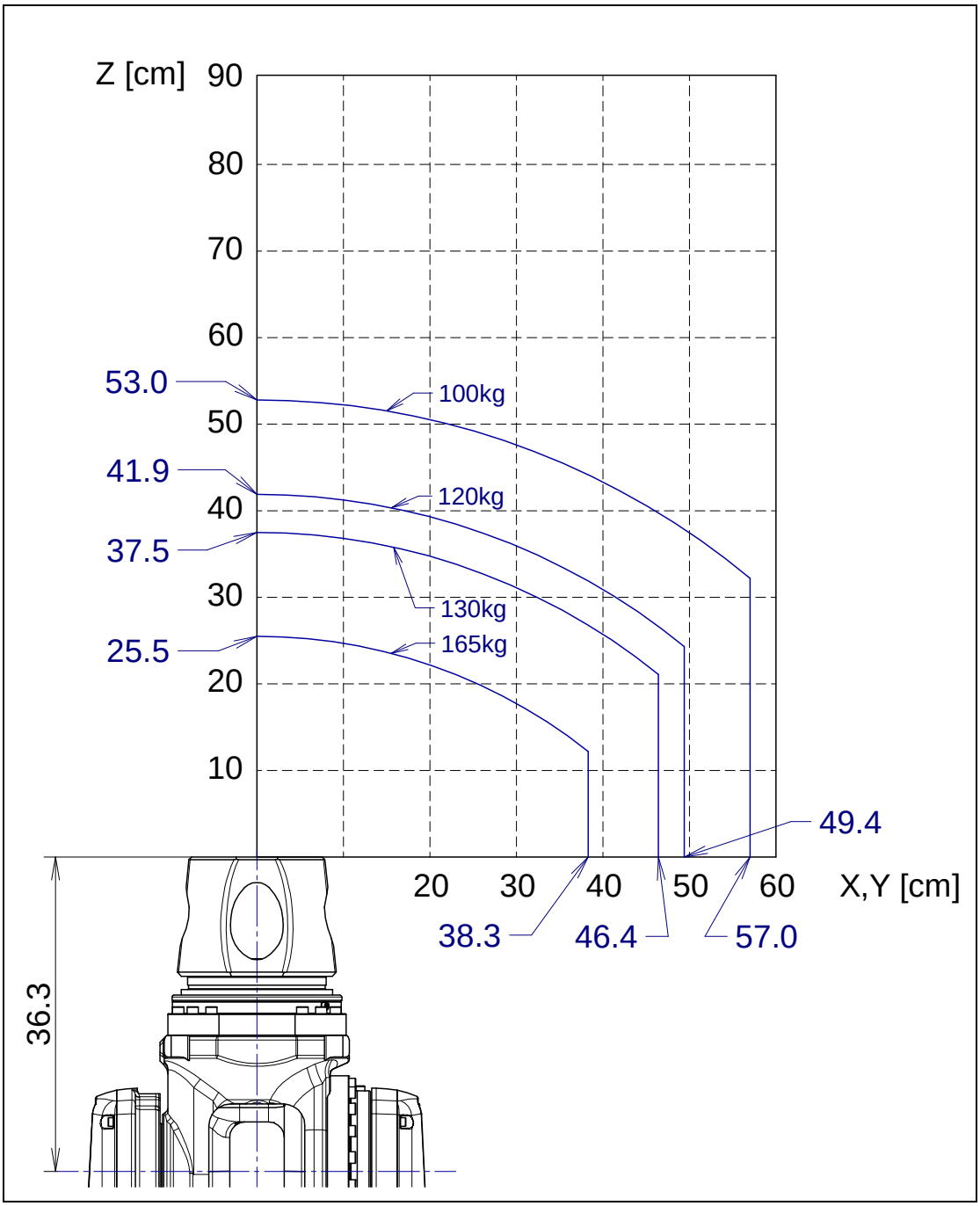


Fig. 3.4 (f) Wrist load diagram (Bracket flange)
(R-2000*i*D/165FH)

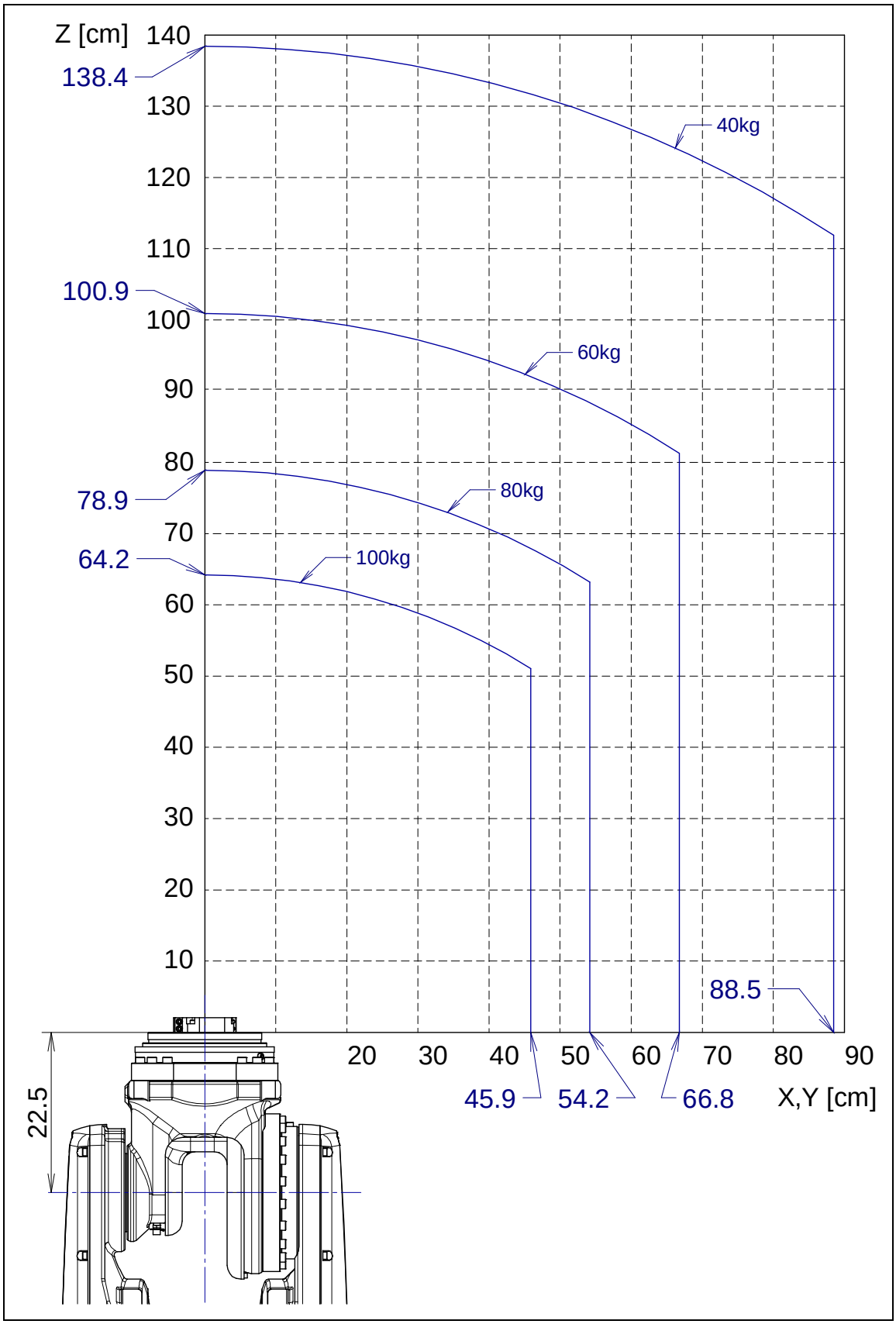


Fig. 3.4 (g) Wrist load diagram (ISO flange)
(R-2000*i*D/100FH)

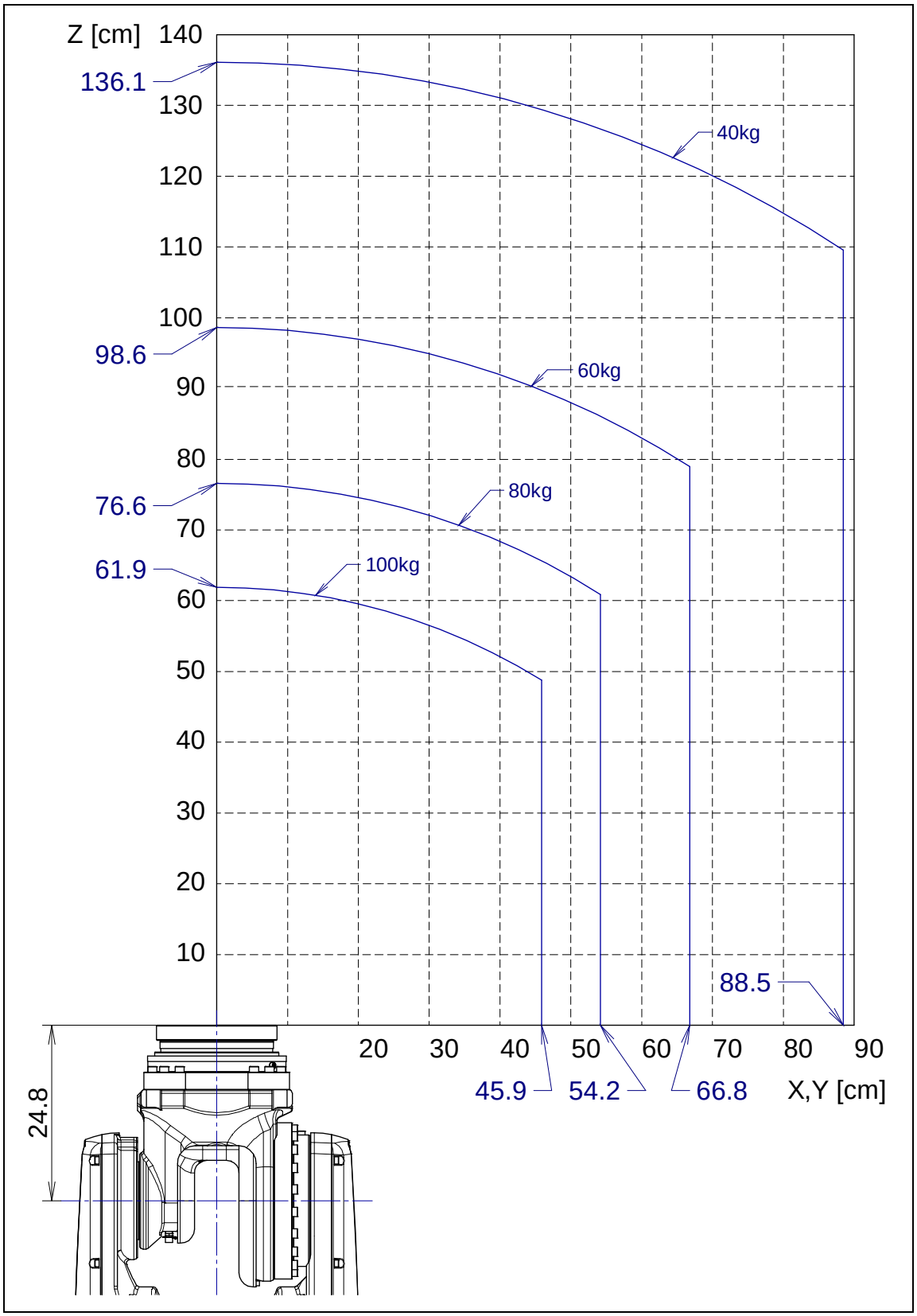


Fig. 3.4 (h) Wrist load diagram (Insulated ISO flange)
(R-2000*i*D/100FH)

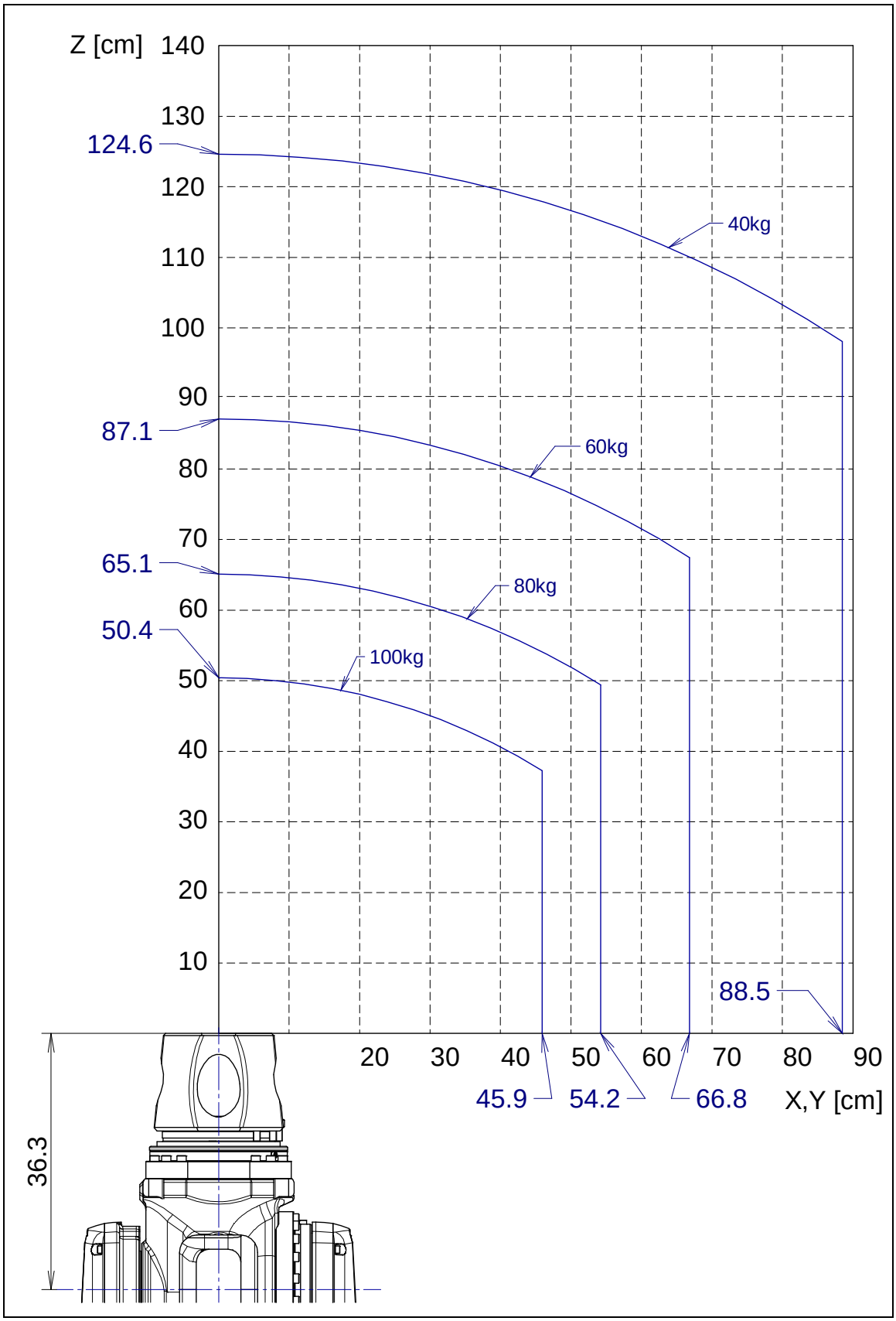


Fig. 3.4 (i) Wrist load diagram (Bracket flange)
(R-2000*i*D/100FH)

3.5 LOAD CONDITIONS ON J2 BASE AND J3 CASING

Fig. 3.5 (a) shows J2 base and J3 casing load condition.

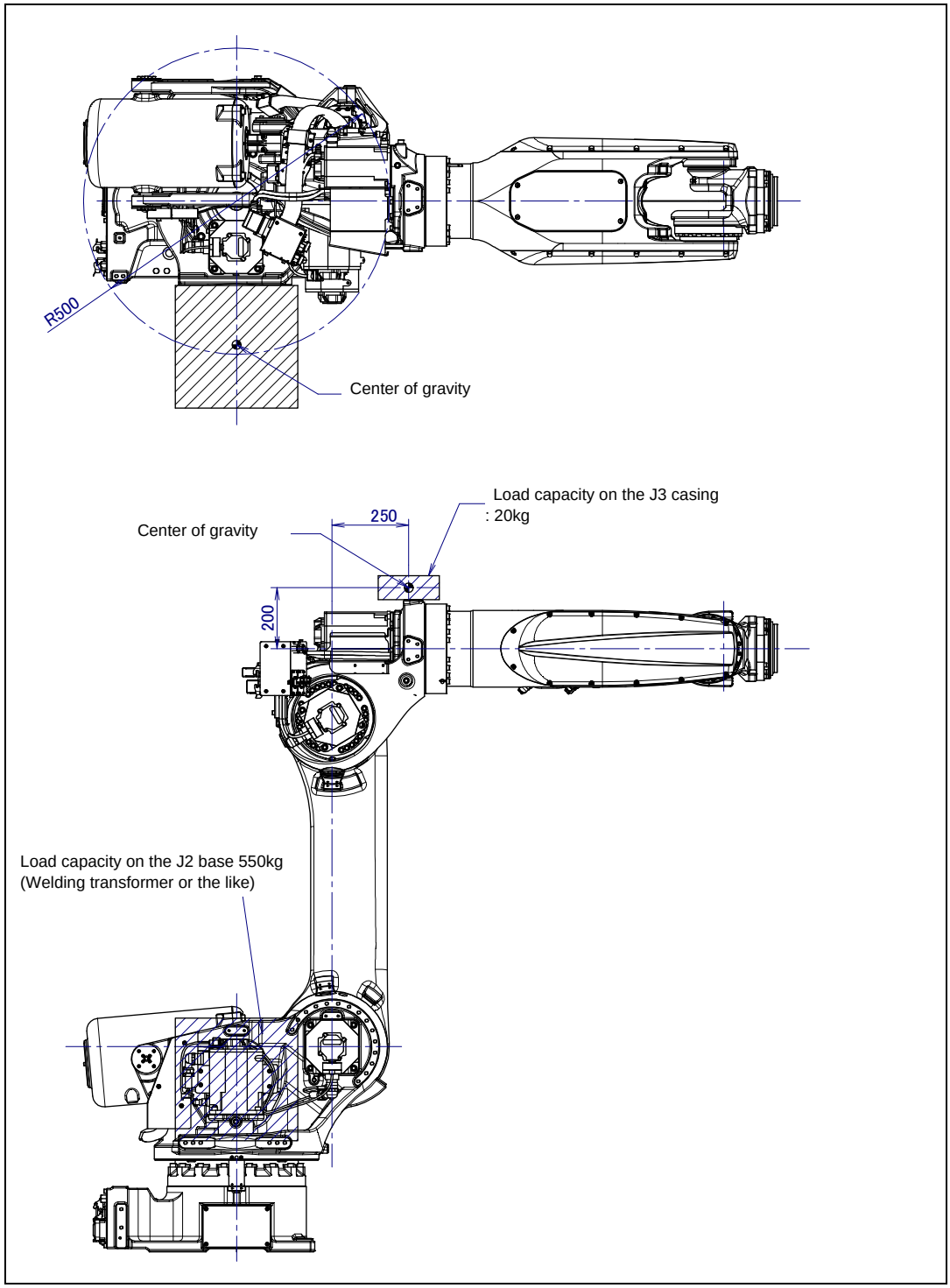


Fig. 3.5 (a) J2 base/J3 casing load condition

4 EQUIPMENT INSTALLATION TO THE ROBOT

4.1 END EFFECTOR INSTALLATION TO WRIST

Fig. 4.1 (a) to (c) are the diagrams for installing end effectors on the wrist. To fasten the end effector, first position it by using fitting [A] (only for the ISO flange) or [D] (only for the bracket flange), two pin holes at [B], then lock it using screws at [C]. Select screws and positioning pins of a length that matches the depth of the tapped and pin holes. Fasten the bolt for fixing the end effector with following torque.

73.5±3.4Nm (750±35kgfcm)

Generally, the ISO flange is specified as the end effecter mounting face. When using the insulated ISO flange, however, the corresponding adaptor needs to be attached.

> ⚠ **CAUTION**
> 1 Notice the tooling coupling depth to wrist flange should be shorter than the flange coupling length.
> 2 It is desirable to attach the end effector with 10 bolts.
> 3 In case of the insulated flange, attach the end effector with 6 bolts and 2 steel dowels used between the end effector and faceplate.

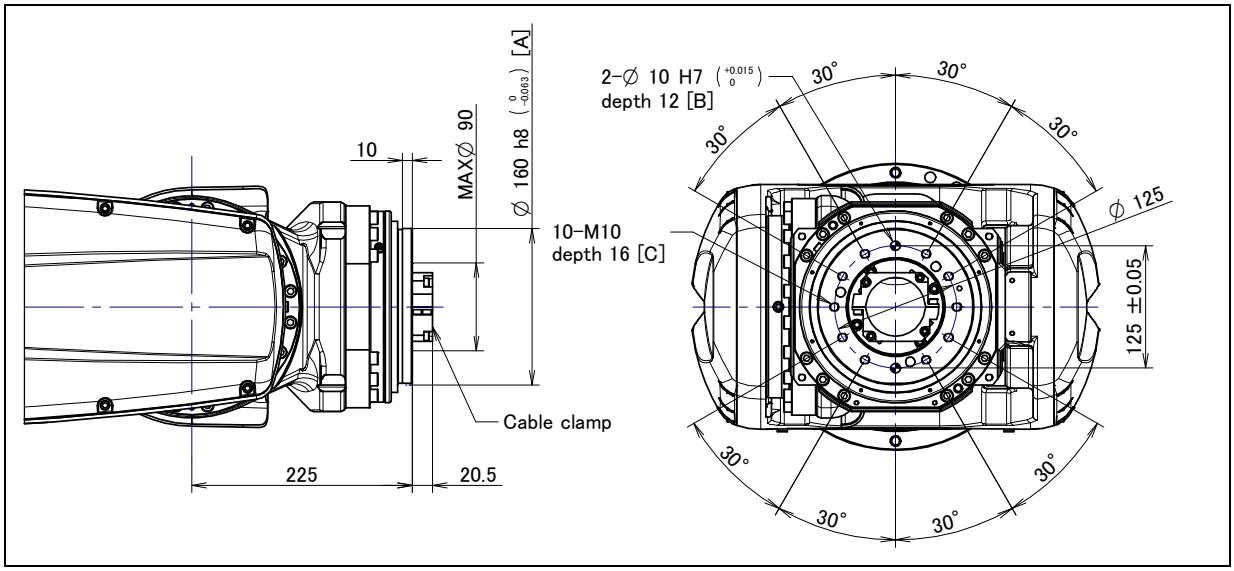


Fig. 4.1 (a) End effector mounting face (ISO flange)

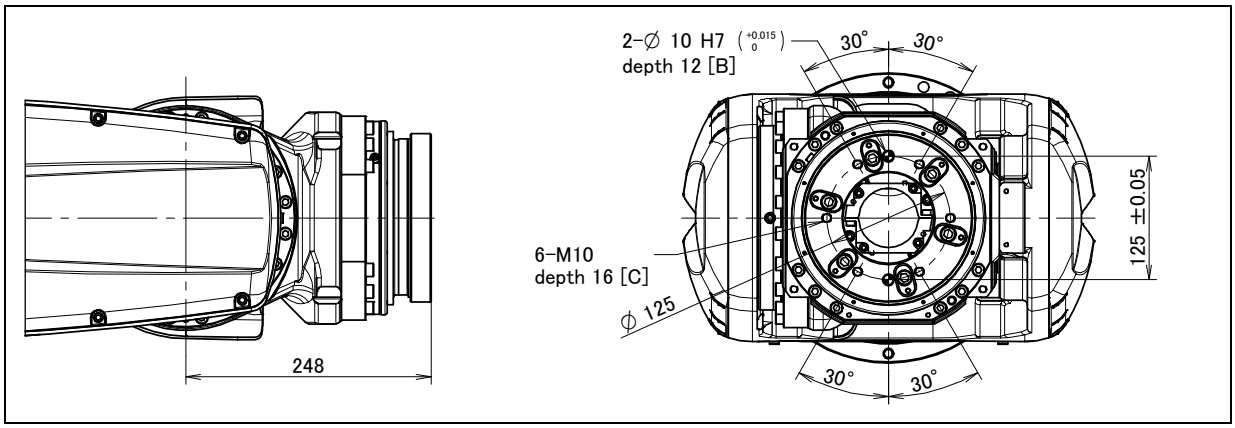


Fig. 4.1 (b) End effector mounting face (Insulated ISO flange)

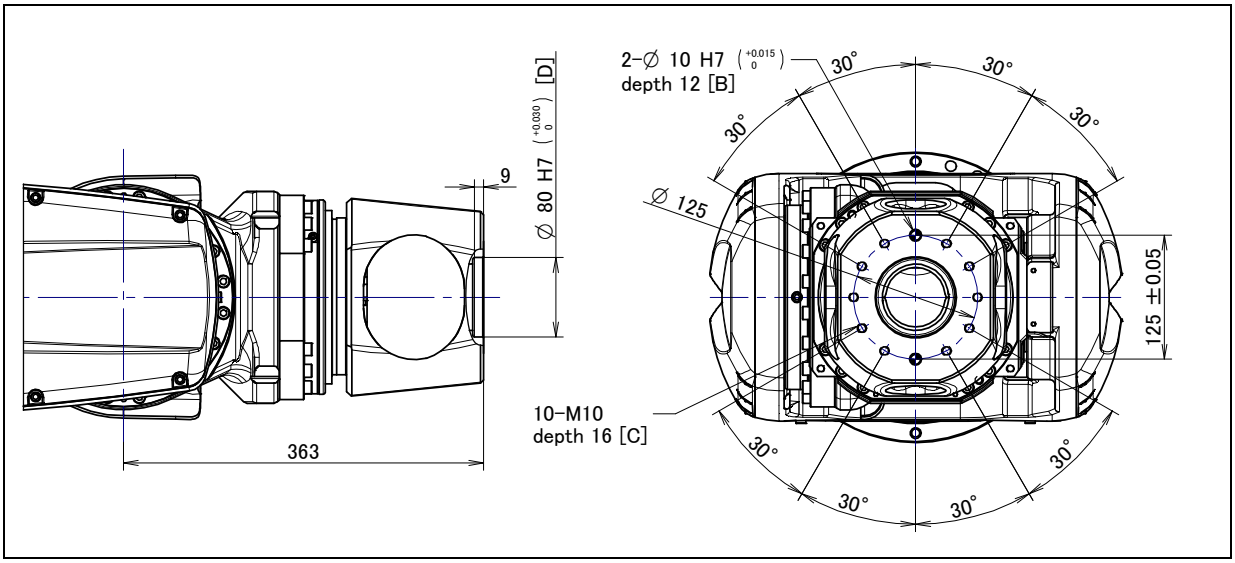


Fig. 4.1 (c) End effector mounting face (Bracket flange)

4.2 EQUIPMENT MOUNTING FACE

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

⚠ CAUTION

1 Never perform additional machining operation such as drilling or tapping on the robot body. This can seriously affect the safety and function of the robot.
2 When using a user tap shown in Fig. 4.2 (a), keep the center of gravity position of the equipment according to Section 3.5.
3 Equipment should be installed so that mechanical unit cable does not interfere. If equipment interfere, the mechanical unit cable might be disconnected, and unexpected troubles might occur.
4 Note that the use of a tapped hole not shown in the following figure is not assured. Please do not tighten both with the tightening bolts used for mechanical unit.

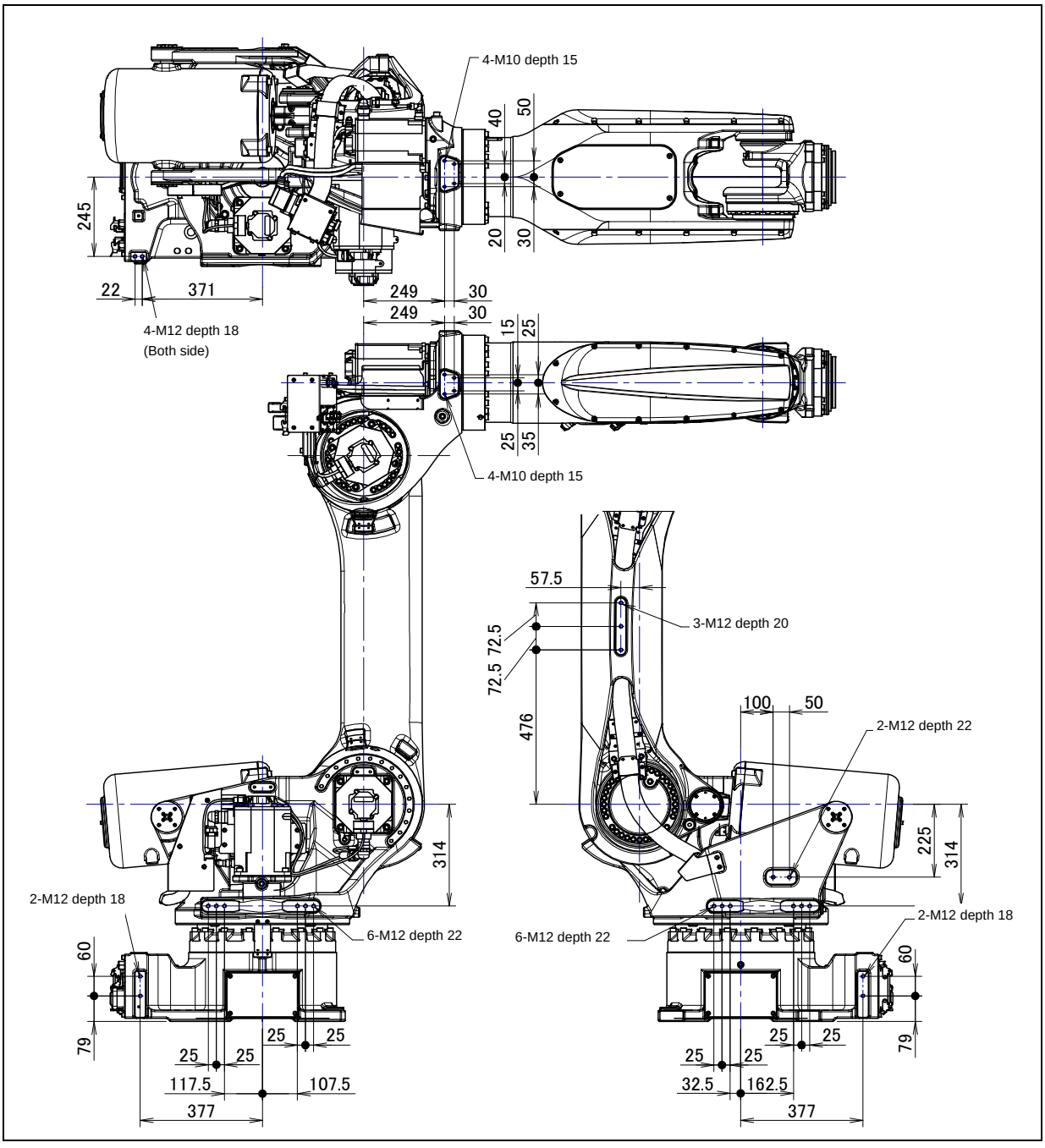


Fig. 4.2 (a) Equipment mounting faces

4.3 LOAD SETTING

⚠ CAUTION

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

2 WHEN PERFORMING LOAD ESTIMATION AFTER PARTS REPLACEMENT
If wrist axis motors (J5/J6-axis) or reducers are replaced, payload estimation accuracy may decrease. Perform calibration of load estimation without the load such as hand before performing load estimation.
Refer to Chapter 9 “LOAD ESTIMATION” in the CONTROLLER Optional Function OPERATOR’S MANUAL

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

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

```
MOTION PERFORMANCE                    JOINT 10%
    Group1
No.   PAYLOAD[kg]          Comment
 1          165.00   [                    ]
 2            0.00   [                    ]
 3            0.00   [                    ]
 4            0.00   [                    ]
 5            0.00   [                    ]
 6            0.00   [                    ]
 7            0.00   [                    ]
 8            0.00   [                    ]
 9            0.00   [                    ]
10            0.00   [                    ]


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

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

```
MOTION PAYLOAD SET                    JOINT 10%

    Group 1
 1 Schedule No[          1]:[Comment          ]
 2 PAYLOAD                  [kg]        165.00
 3 PAYLOAD CENTER  X [cm]               -28.53
 4 PAYLOAD CENTER  Y [cm]                 0.00
 5 PAYLOAD CENTER  Z [cm]                27.78
 6 PAYLOAD INERTIA X [kgfcms^2]          56.84
 7 PAYLOAD INERTIA Y [kgfcms^2]          59.39
 8 PAYLOAD INERTIA Z [kgfcms^2]          15.10

 [TYPE] GROUP NUMBER   DEFAULT   HELP
```

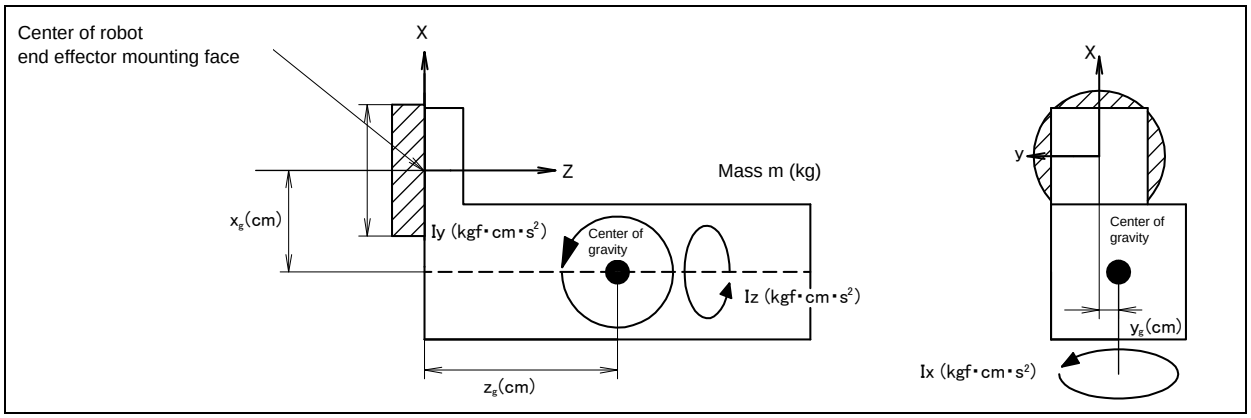


Fig. 4.3 (a) Standard tool coordinate

6 Set the payload, gravity center position, and inertia around the gravity center on the MOTION PAYLOAD SET screen. The X, Y, and Z directions displayed on this screen correspond to the respective standard tool coordinates (with no tool coordinate system set up). When values are entered, the following message appears: “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 the [PREV] key to return to the MOTION PERFORMANCE screen. Press F5 [SETIND], and enter the desired payload setting condition number.

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

```
MOTION ARMLOAD SET                JOINT   100%

      Group 1
1   J2 BASE LOAD [kg]             550.00
2   J3 CASING LOAD [kg]            10.00

[  TYPE  ]     GROUP          DEFAULT   HELP
```

10 Specify the weight of the load on the J2 base and J3 casing as follows:

(*) Load mounting face differs depending on the robot model. Refer to “3.5 LOAD CONDITIONS ON J2 BASE AND J3 CASING”.

J2 BASE LOAD[kg]: Weight of the load on the J2 base
J3 CASING LOAD[kg]: Weight of the load on the J3 casing

The following message appears: “Path and Cycletime will change. Set it?” Select F4 [YES] or F5 [NO]. Once the loads are set up, the settings are completed by switching the power off and on again.

5 PIPING AND WIRING TO THE END EFFECTOR

⚠ WARNING

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

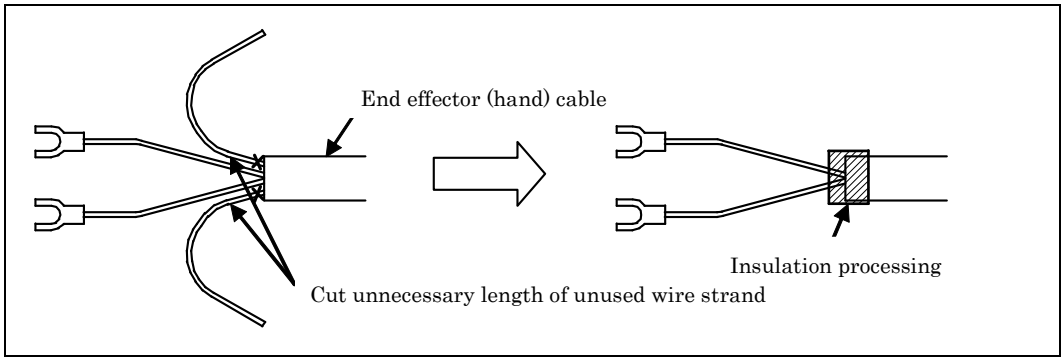


Fig. 5 (a) Treatment method of end effector (hand) cable

5.1 AIR SUPPLY (OPTION)

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

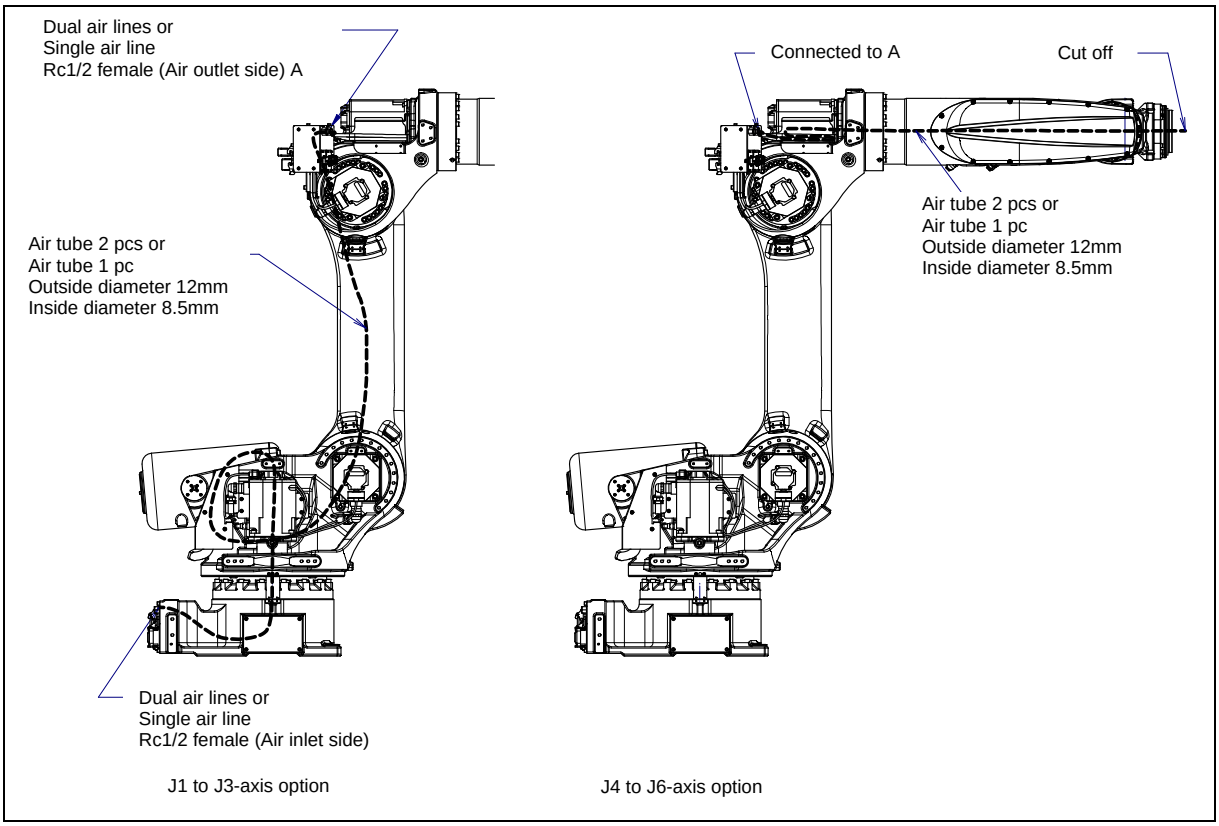


Fig. 5.1 (a) Air supply (option)

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.

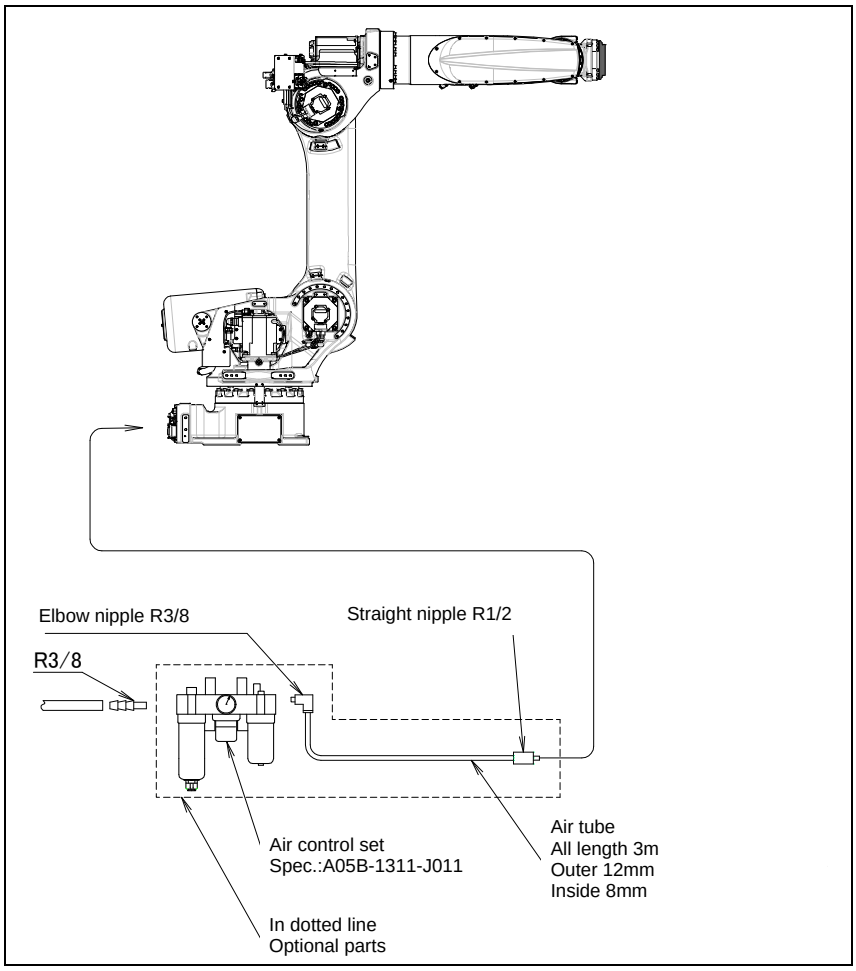


Fig. 5.2 (a) Air piping (option)

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.

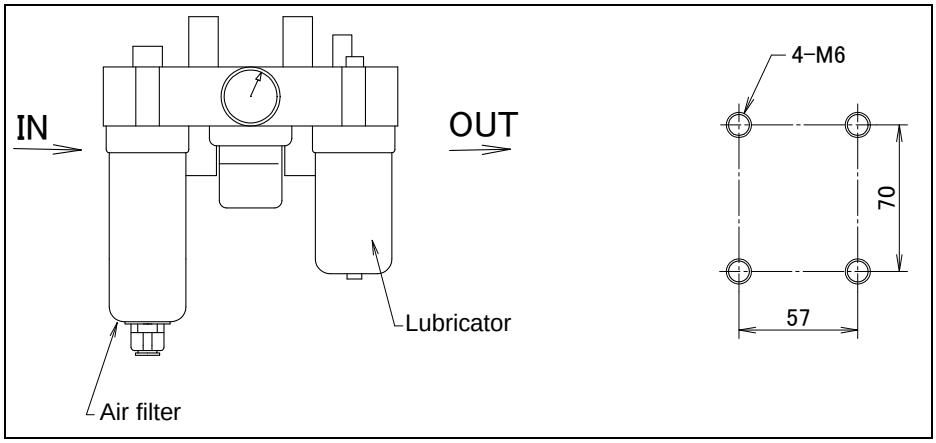


Fig. 5.2 (b) Air control set option (option)

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

Air pressure	Supply air pressure	0.49 to 0.69MPa(5 to 7kgf/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) to (c) show the option cable interface. EE interface (RI/RO), user cable (signal line, signal usable to force sensor and 3D Laser Vision sensor), additional axis motor cable (Pulsecoder line), additional axis motor cable (power, brake line), Ethernet cable (signal line) and camera cable are prepared as options.

NOTE
1. Each option cable is written as shown below on the connector panel.
   EE interface (RI/RO) : EE
   User cable (signal) : AS
   User cable (signal usable to force sensor and 3D Laser Vision sensor) : ASi
   Additional axis motor cable (Pulsecoder) : ARP
   Additional axis motor cable (power, brake) : ARM
   Ethernet cable (signal) : ES
   Camera cable : CAM
2. Specification of the camera cable for R-30*i*B, R-30***i***B Mate differs from the cable for R-30*i*B Plus, R-30*i*B Mate Plus.

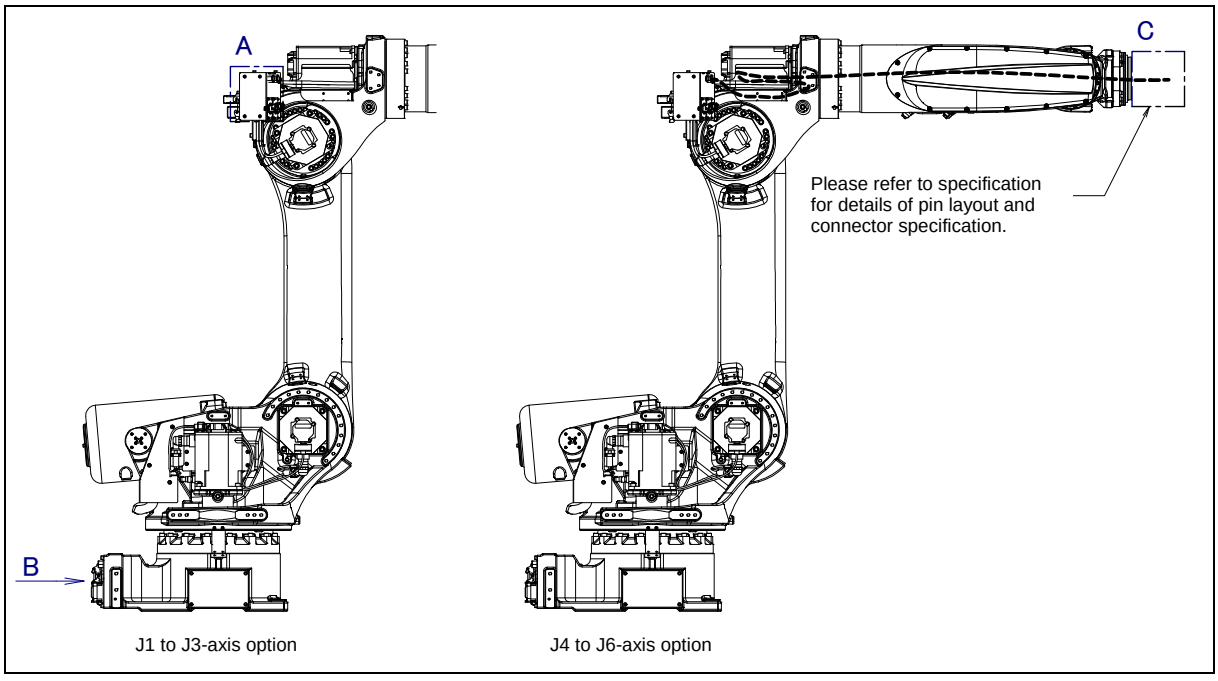
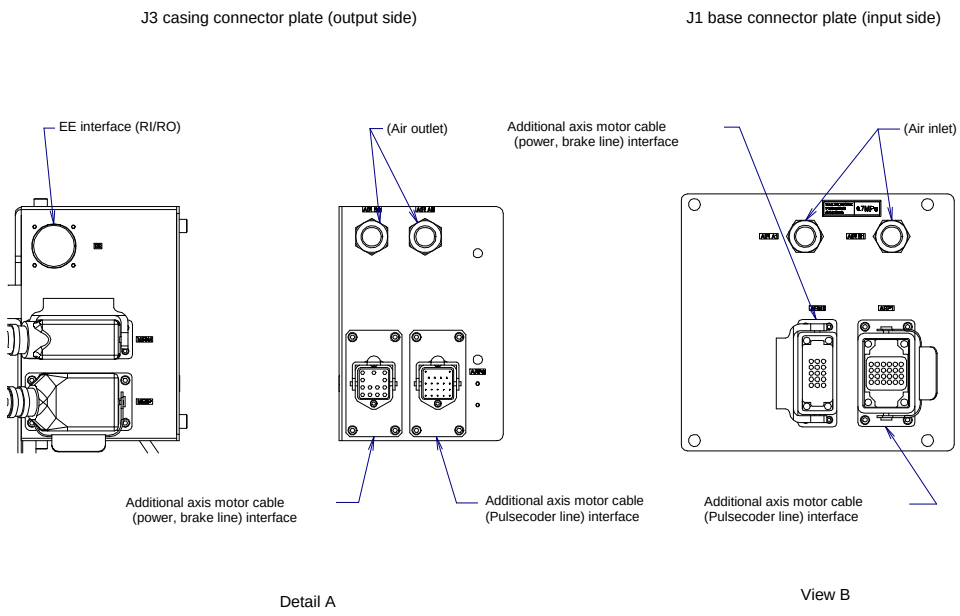
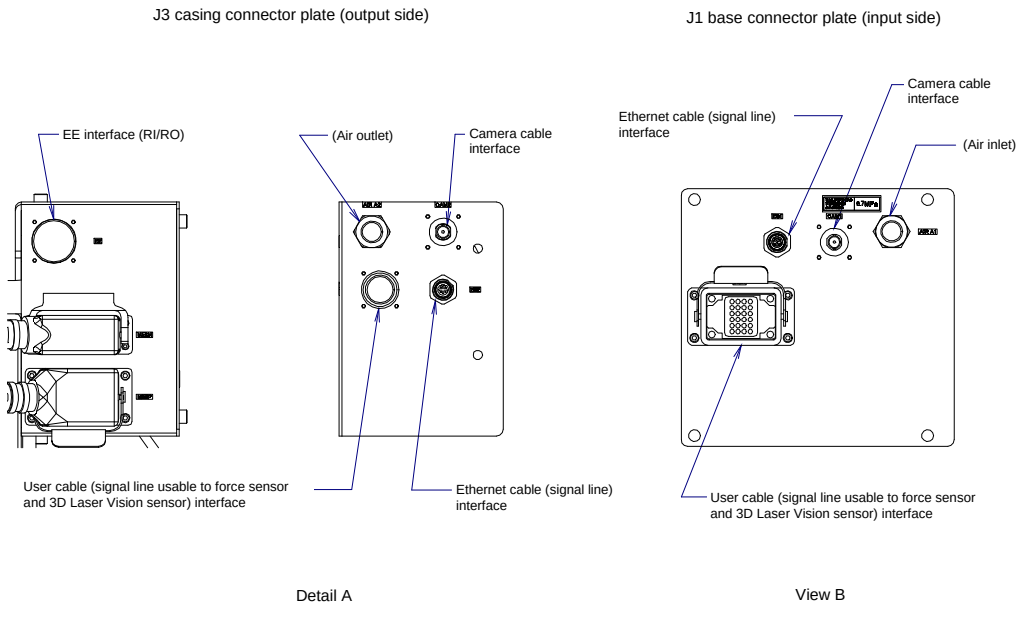


Fig. 5.3 (a) Position of interface for option cable (OPTION)



With additional axis motor cable (Pulsecoder line, power, brake line)

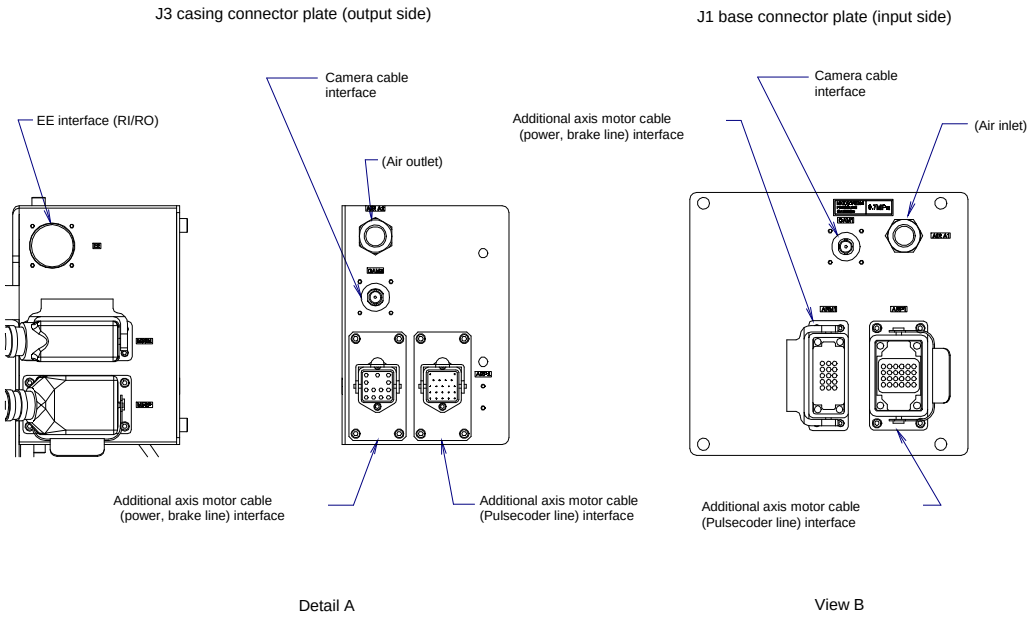
Cable spec.
A05B-1339-H504



With user cable (signal line usable to force sensor and 3D Laser Vision sensor), ethernet cable (signal line) and camera cable

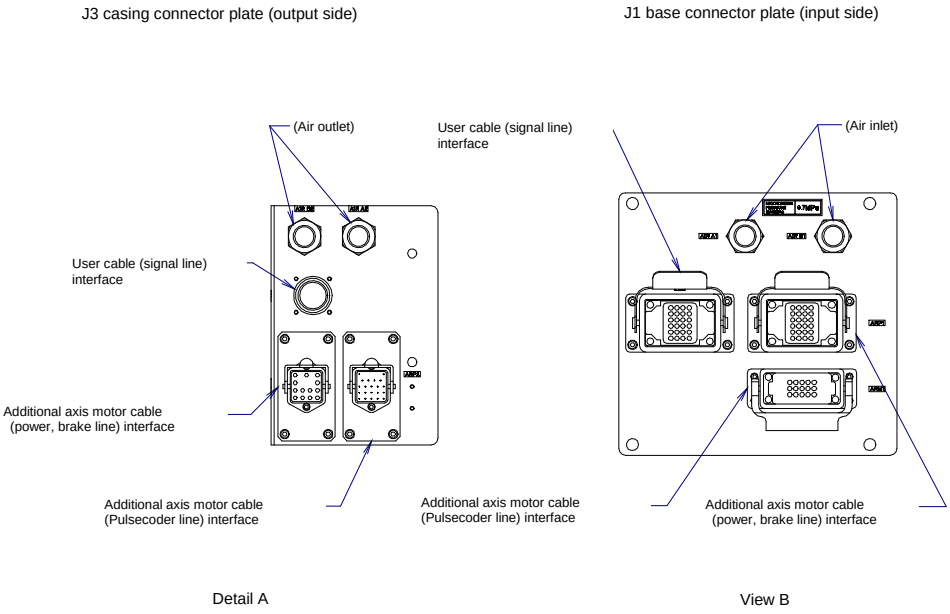
Cable spec.
A05B-1339-H506

Fig. 5.3 (b) Interface for option cable (1/2)



With additional axis motor cable (Pulsecoder line, power, brake line) and camera cable

Cable spec.
A05B-1339-H508



With additional axis motor cable (Pulsecoder line, power, brake line) and user cable (signal line)

Cable spec.
A05B-1339-H553

Fig. 5.3 (c) Interface for option cable (2/2)

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

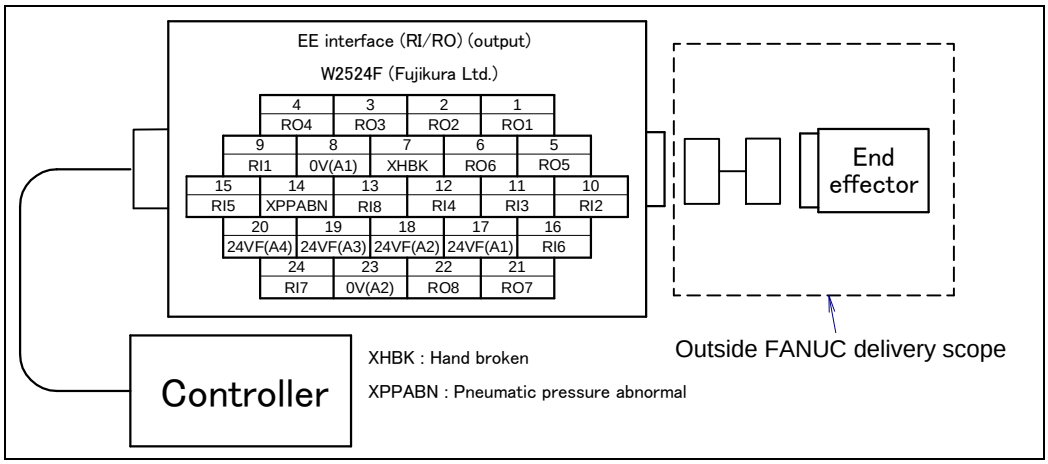


Fig. 5.3 (d) Pin layout for EE interface(RI/RO) (option)

NOTE
For wiring of the peripheral device to the EE interface, refer to the “ELECTRICAL CONNECTIONS Chapter of CONTROLLER MAINTENANCE MANUAL”, too.

2 User cable (signal line) (AS) Interface (option)

Fig. 5.3 (e) shows the pin layout for the user cable (signal line) interface.

The connector has a code pin for preventing improper insertion. The code pin is required for the cable which is prepared by the user.

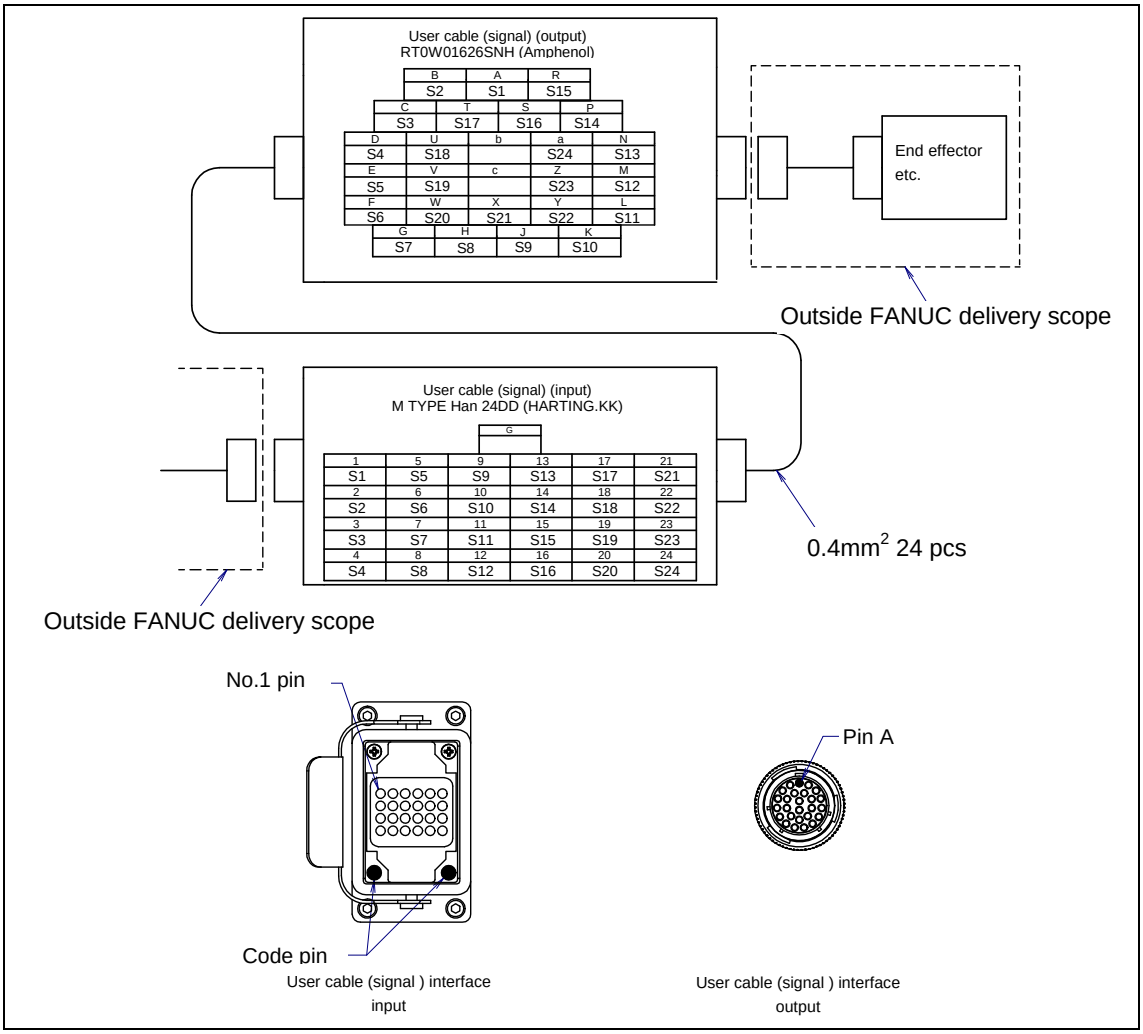


Fig. 5.3 (e) Pin layout for user cable (signal line) (AS) interface and code pin layout (option)

3 User cable (signal line usable to force sensor and 3D Laser Vision sensor) (ASi) Interface (option)
Fig. 5.3 (f) shows the pin layout for the user cable (signal line usable to force sensor and 3D Laser Vision sensor) interface.
The connector has a code pin for preventing improper insertion. The code pin is required for the cable which is prepared by the user.

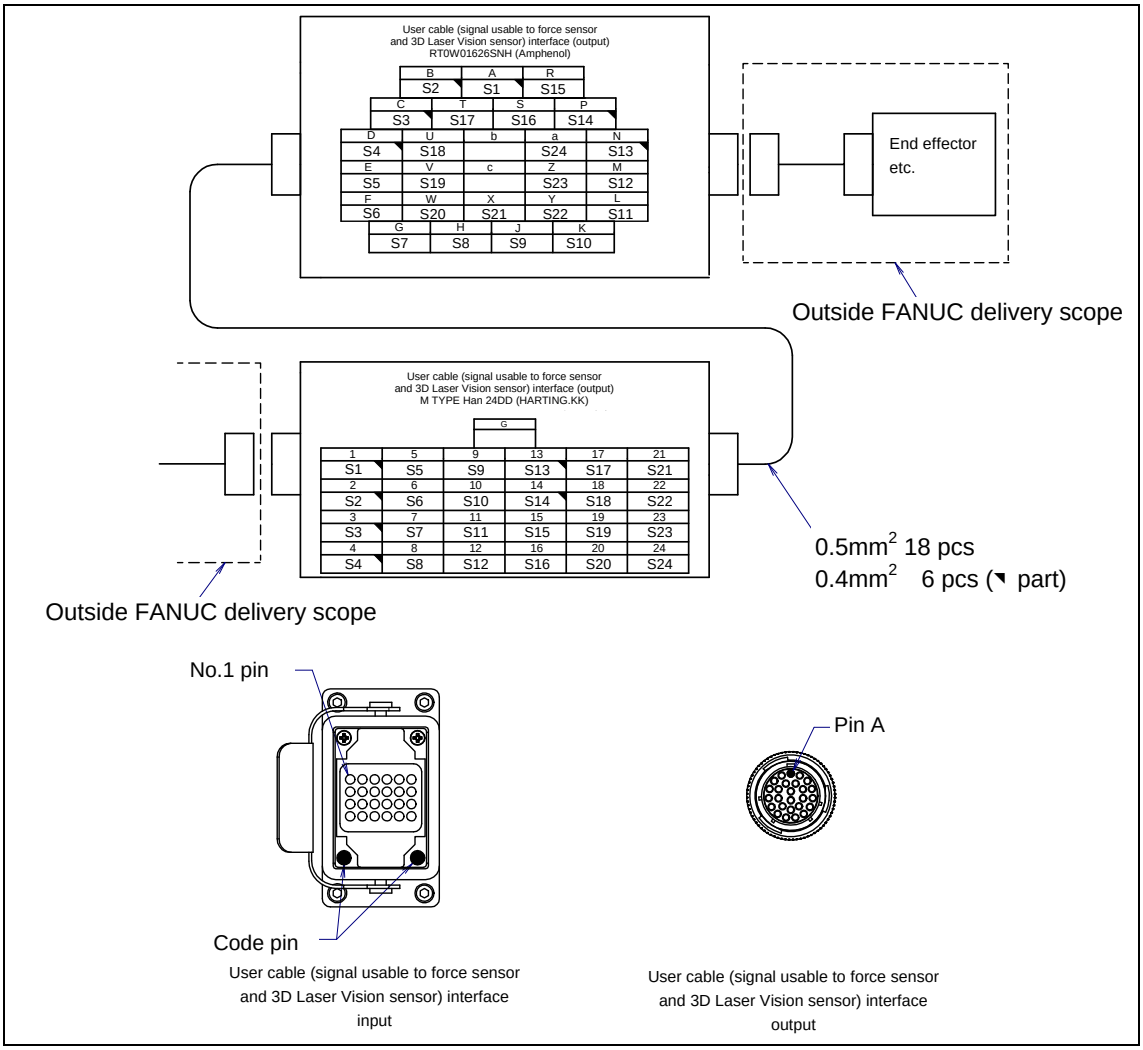


Fig. 5.3 (f) Pin layout for user cable (signal line usable to force sensor and 3D Laser Vision sensor) (ASi) interface and code pin layout (option)

4 Additional axis motor cable (Pulsecoder cable) (ARP) interface (option)
Fig. 5.3 (g) shows the pin layout of the additional axis motor cable (Pulsecoder cable) interface. The connector has a code pin for preventing improper insertion.

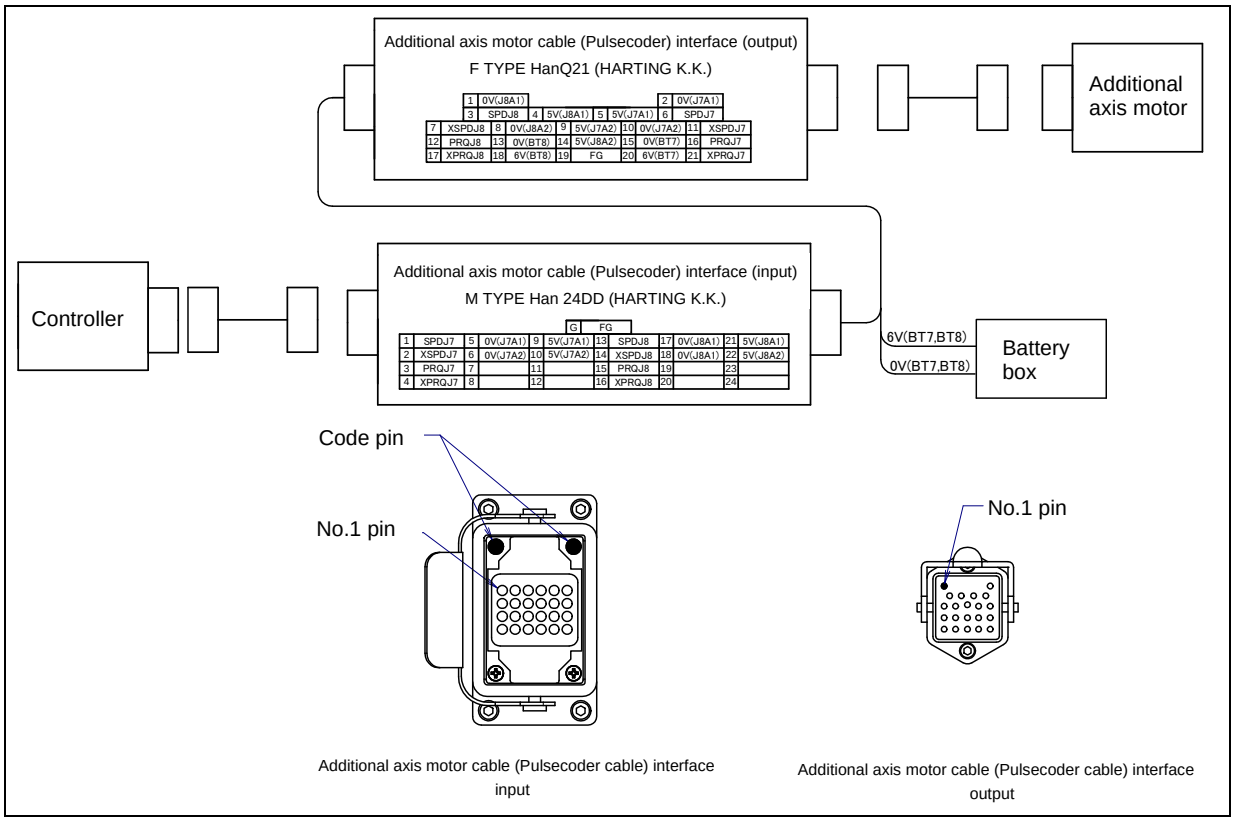


Fig. 5.3 (g) Pin layout of the additional axis motor cable (Pulsecoder cable) (ARP) interface and layout position of the code pin (option)

Table 5.3 (a) Comparative table of signal name according to the motor

ARP	αi, αi –B motor, βi, βi-B motor
SPD	-
XSPD	-
PRQ	RD
XPRQ	*RD

5 Additional axis motor cable (power and brake cables) (ARM) interface (option)
Fig. 5.3 (h) shows the pin layout of the additional axis motor cable (power and brake cables) interface. The connector (input) has a code pin for preventing improper insertion. The connector (output) has a coding element for preventing improper insertion.

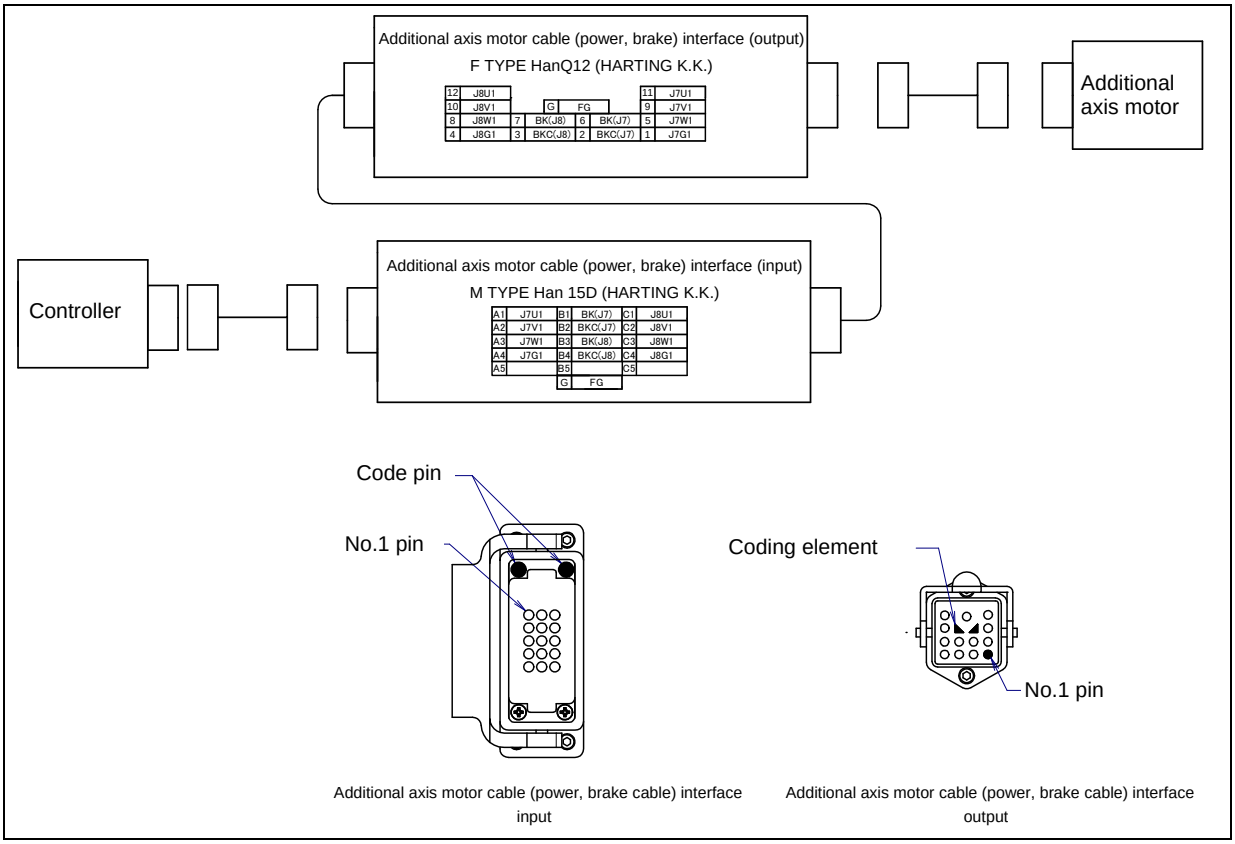


Fig. 5.3 (h) Pin layout of the additional axis motor cable (power and brake cables) (ARM) interface and layout position of the code pin (option)

6 Ethernet cable (signal line) (ES) interface (option)
Fig. 5.3 (i) shows the pin layout of the Ethernet cable (signal line) (ES) interface.

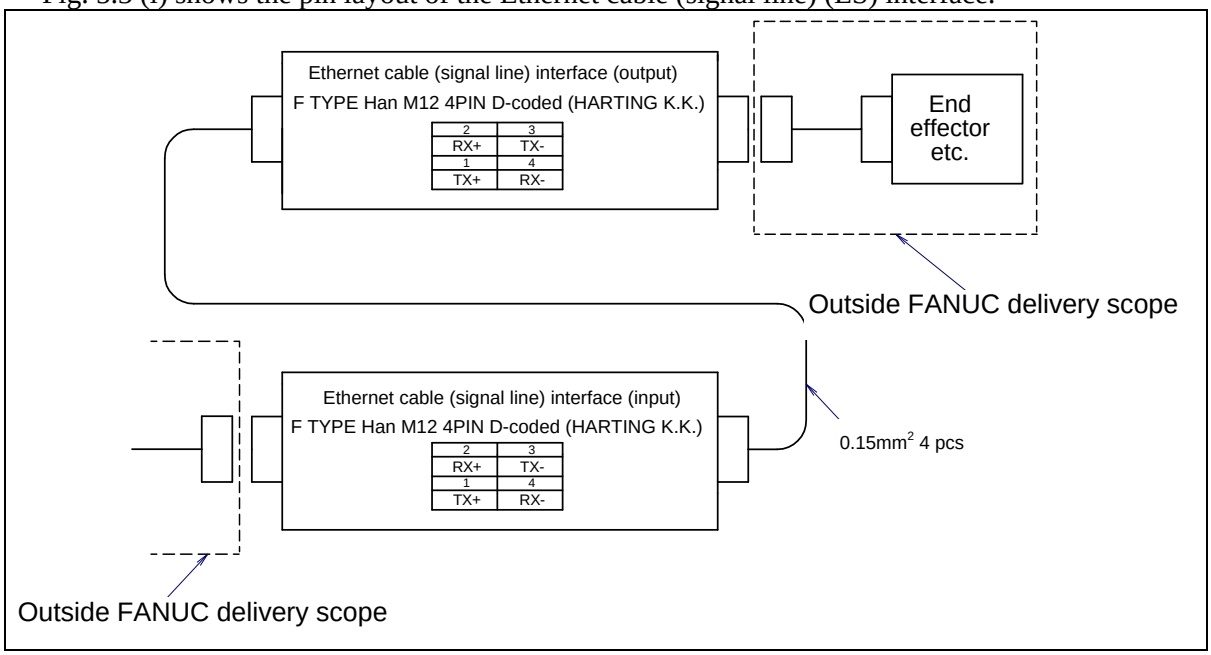


Fig. 5.3 (i) Pin layout for Ethernet cable (signal line) (ES) interface (option)

Connector specifications

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

Cable	Input side (J1 connector panel)		Maker /dealer	Output side (J3 connector panel)		Maker /dealer
EE(RI/RO)	———		—	JMWR2524F		Fujikura Ltd
AS ASi	Housing Insert Contact Code pin	09 30 006 0301 09 16 024 3001 09 15 000 6103 09 30 000 9901	HARTING K.K.	Plug Cable clamp Contact	RT0W01626SNH RT0S-16CG-NS1 SS20W1F	Amphenol
ARP	Housing Insert Contact Contact Code pin	09 30 006 0301 09 16 024 3001 09 15 000 6103 09 15 000 6104 09 30 000 9901		Housing Insert Contact Contact Sealing screw	09 20 003 0301 09 12 021 3101 09 67 000 7276 09 67 000 8276 09 20 000 9918	HARTING K.K.
ARM	Housing Insert Contact Contact Code pin	09 20 010 0301 09 21 015 3001 09 15 000 6101 09 15 000 6106 09 30 000 9901		Housing Insert Contact Contact Coding element Sealing screw	09 20 003 0301 09 12 012 3101 09 15 000 6201 09 15 000 6206 09 12 000 9924 09 20 000 9918	
ES	Connector Contact	21 03 881 2425 09 67 000 7476		Connector Contact	21 03 881 2425 09 67 000 7476	

Table 5.3 (c) Connector specifications (User side) (1/2)

Cable	Input side (J1 connector panel)	Output side (J3 connector panel)		Maker /dealer
EE (RI/RO)	———	JMSP2524M (*1) JMLP2524M	Straight Angle	Fujikura Ltd.

Table 5.3 (d) Connector specifications (User side) (2/2)

Cable	Input side (J1 connector panel)		Maker /dealer	Output side (J3 connector panel)		Maker /dealer
AS ASi	Hood (NOTE 2)	09 30 006 1540 Side entry 1541 ↓ 0542 0543 1440 Top entry 1441 ↓ 0442 0443	HARTING K.K.	Plug	RT0W61626PNH	Amphenol.
	Insert	09 16 024 3101		Cable grand	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)	SP20W1F AWG 22-20 SP24W1F AWG 26-24 SP28W1F AWG 30-28 Many other types are available	
	Clamp (NOTE 2)	09 00 000 5083 5086 5090 5094 etc. Many other types are available				
	Code pin	09 30 000 9901				
ES	Connector	21 03 881 1405		Connector	←The same	
	Contact (NOTE 2)	09 67 000 7576 AWG 28-24 5576 AWG 26-22 8576 AWG 24-20 3576 AWG 22-18		Contact (NOTE 2)	←The same	

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

6 AXIS LIMITS SETUP

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

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

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

- Limit axis motion range by DCS (All axes (option))
- Limit axis motion range adjustable mechanical stopper (J1 -axes (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 and J3-axes interference angles, DCS specified movable range cannot be used.
5 Adjustable mechanical stoppers (J1-axis) are deformed in a collision to stop the robot. Once a stopper is subject to a collision, it can no longer assure its original strength and, therefore, may not stop the robot. When this happens, replace it with a new one.

6.1 CHANGE AXIS LIMIT BY DCS (OPTION)

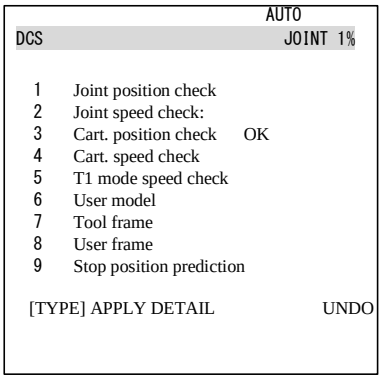
The robot motion can be restricted with DCS (Dual check safety) function by using the following software. The robot motion can be restricted at any angle and position if it is in robot motion area. DCS functions are certified to meet the requirements of International Standard ISO13849-1 and IEC61508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

- DCS position/speed check function (J567)

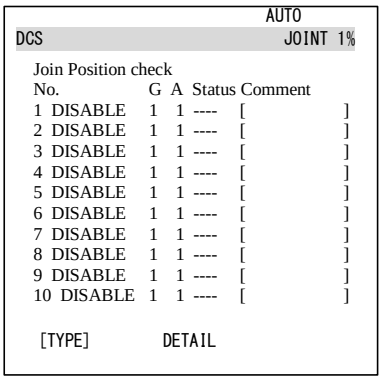
As an example, we shows the procedure to set $\pm 30^{o}$ for J2-axis in here. Refer to Dual check safety function Operator's Manual (B-83184EN) for details of other setting, function and DCS stop position prediction.

Setting procedure

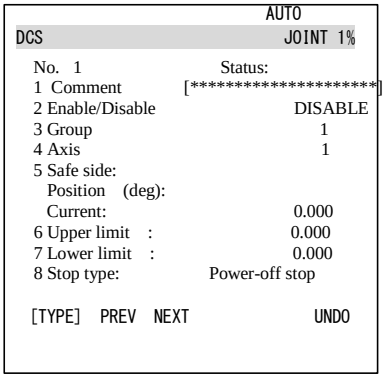
1 Press the [MENU] key to display the screen menu.
2 Press [0 NEXT] and press [6 SYSTEM].
3 Press the F1 ([TYPE]).
4 Select [DCS]. The following screen will be displayed.



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

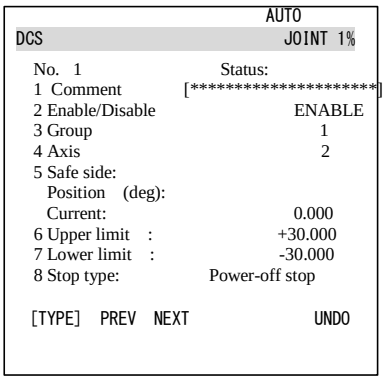


6 Move the cursor to [1], then press the [DETAIL].

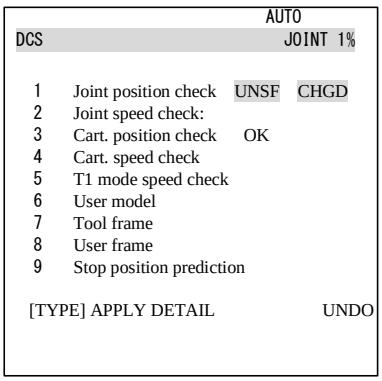


7 Move the cursor to [DISABLE], then press [CHOICE], set the status to [ENABLE].
8 Move the cursor to [Group], then input the robot group number, then press the [ENTER] key.
9 Move the cursor to [Axis], then input “2”, then press the [ENTER] key.
10 Move the cursor to [Upper limit] right side, then input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

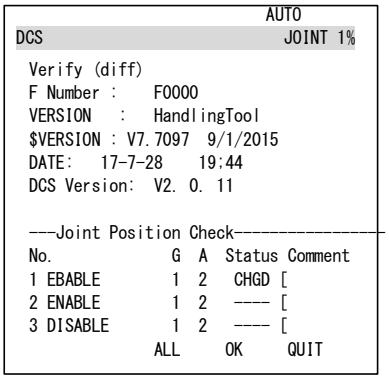
> ⚠ **WARNING**
> If only the operating space is set using Joint Position Check, the robot stops after it goes beyond the workspace. When the motor power is shut down, the robot’s momentum causes it to move some distance before it completely stops. The actual "Robot Stop Position" will be beyond the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



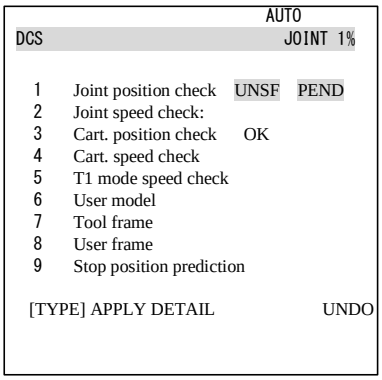
12 Press the [PREV] key two times, back to the first screen.



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 SETTING (OPTION)

For the J1-axes, 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		Settable motion range
J1-axis adjustable mechanical stopper	Upper limit	Settable in steps of 7.5° in the range of -112.5° to +180°
	Lower limit	Settable in steps of 7.5° in the range of -180° to +112.5°
	Space between the upper and lower limits	A space of 67.5° 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 movable mechanical stopper, be sure to set the motion range of soft same refer to Subsection 6.2.2.

6.2.1 Installing adjustable mechanical stopper option

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

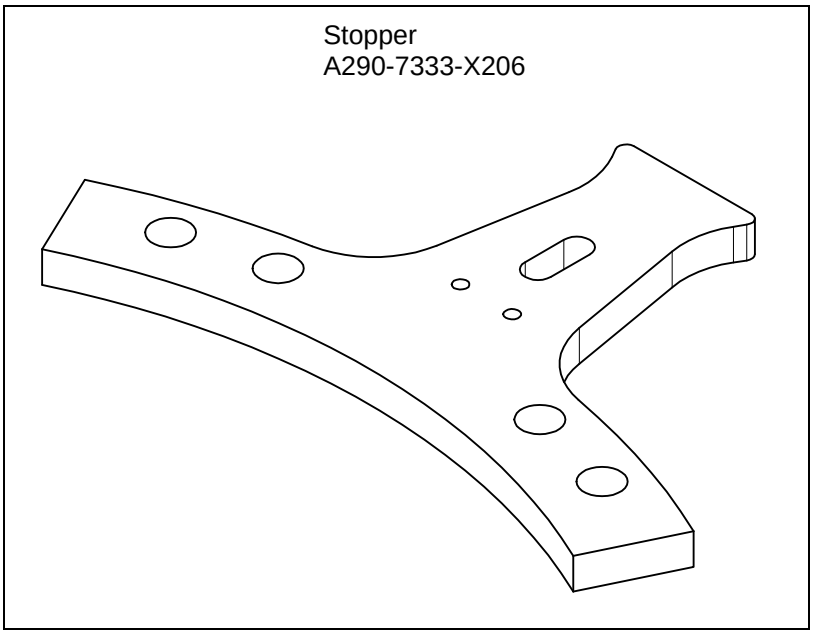


Fig. 6.2.1 (a) J1-axis adjustable mechanical stopper (option)

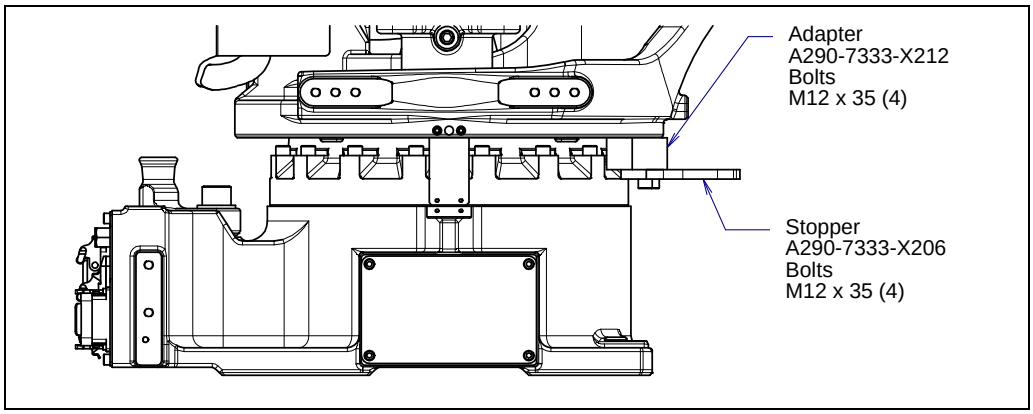
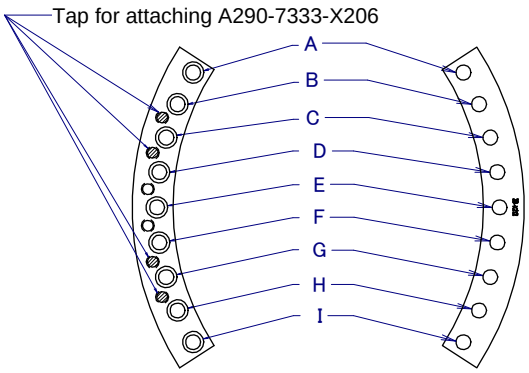


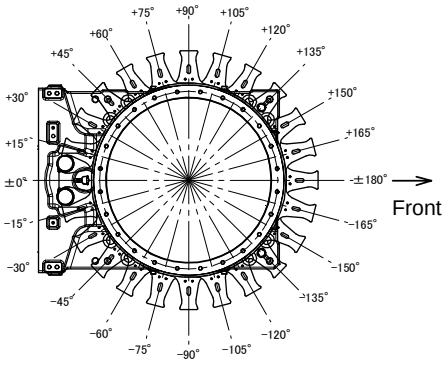
Fig. 6.2.1 (b) Mounting the J1-axis adjustable mechanical stopper (1/2)

Note on attaching the J1-axis adjustable mechanical stopper
The motion range limited by the J1-axis adjustable mechanical stopper can be changed in steps of 7.5°by changing the installation holes of the adapter .Select the appropriate installation hole corresponding to the desired limit angle with reference to the following figure.

Adapter A290-7333-X212 hole number

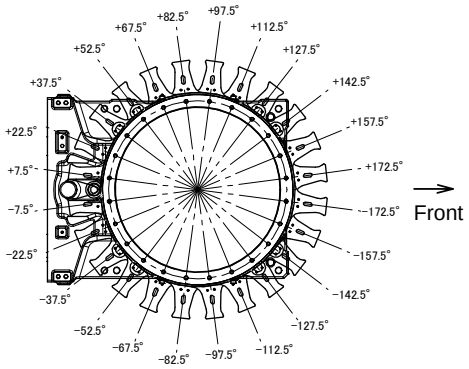


(1) Limit angle 15° × N
（N = 0, ±1, ±2, ⋯ ）

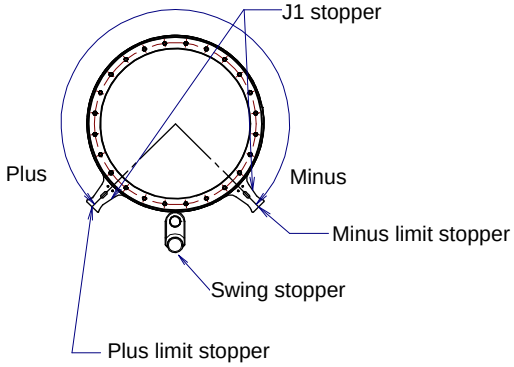


Hole B, D, F and H are used

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



Hole A, C, E, G and I are used



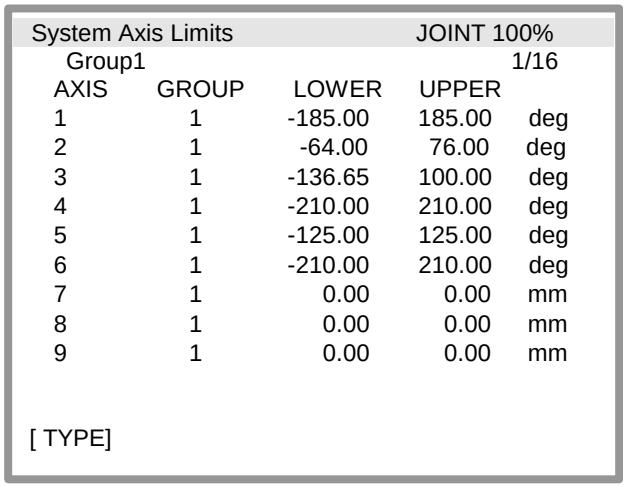
(Note) J1-axis top view
A minimum space of 67.5° is required between the plus side and minus side stopper.

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

6.2.2 Changing the parameter setting

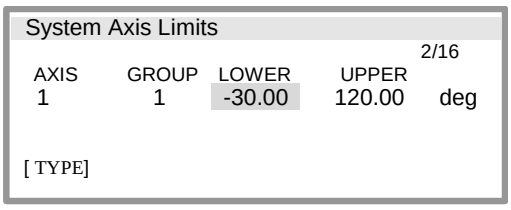
Setting procedure

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



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.



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

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

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

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

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

	Plus side	Minus side
J1-axis	+17°	-17°

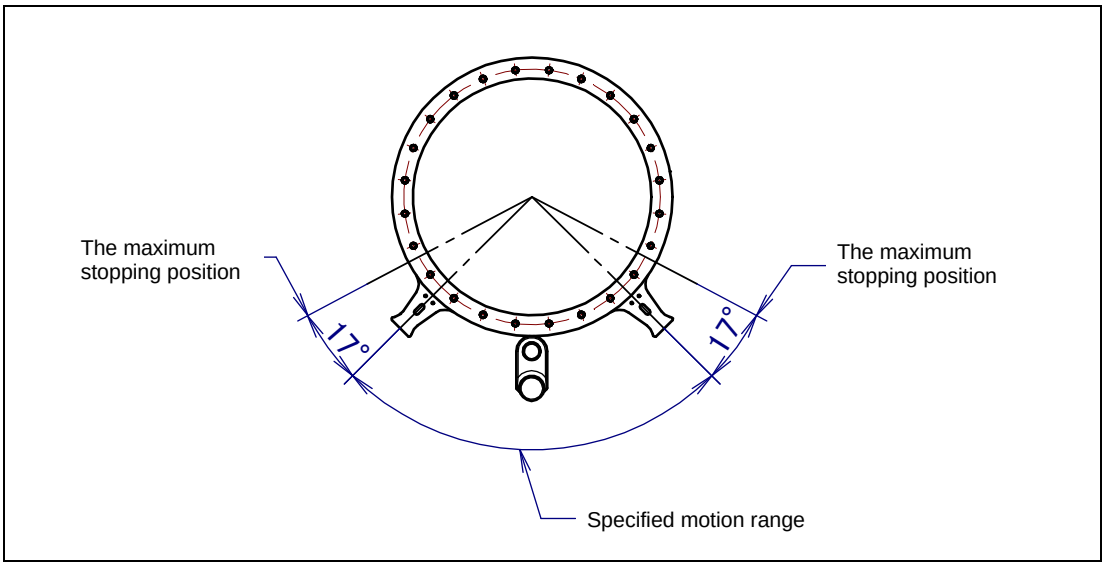


Fig. 6.2.3 (a) The maximum stopping distance of adjustable mechanical stopper of J1-axis

7 CHECKS AND MAINTENANCE

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

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

7.1 CHECKS AND MAINTENANCE

7.1.1 Daily Checks

Clean each part, and visually check component parts for damage before daily system operation. Check the following items when necessary.

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

7.1.2 Periodic Checks and Maintenance

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

Check and maintenance intervals (Period, Accumulated operating time)							Check and maintenance item	Check points, management and maintenance method	Periodic maintenance table No.
1 month 320h	3 months 960h	1 year 3840h	1.5 years 5760h	2 years 7680h	3 years 11520h	4 years 15360h			
○ Only 1st check	○						Cleaning the controller ventilation system	Confirm the controller ventilation system is not dusty. If dust has accumulated, remove it.	25
	○						Check the external damage or peeling paint	Check whether the robot has external damage or peeling paint due to the interference with the peripheral equipment. If an interference occurs, eliminate the cause. Also, if the external damage is serious, and causes a problem in which the robot will not operate, replace the damaged parts.	1
	○						Check 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 the interference with peripheral equipment, eliminate the cause. **⇒"7.2.3 Check the Mechanical Unit Cables and Connectors"**	2
	○						Check wear debris of the balancer and J1-axis swing stopper	Check whether wear debris is generated on the following parts. ・ Balancer rod, support part of in front and behind of the balancer ・ J1-axis swing stopper rotation part If serious wear occurs 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 water is found, remove the cause and wipe off the liquid.	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.	26
	○ 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

Check and maintenance intervals (Period, Accumulated operating time)							Check and maintenance item	Check points, management and maintenance method	Periodic maintenance table No.
1 month 320h	3 months 960h	1 year 3840h	1.5 years 5760h	2 years 7680h	3 years 11520h	4 years 15360h			
	○ Only 1st Check	○					Check for damage to the end effector (hand) connection cable	Check whether the end effector connection cables are unevenly twisted or damaged. If damage is found, replace the damaged cables.	6
	○ 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
	○ Only 1st check	○					Retightening the end effector mounting bolts	Retighten the end effector mounting bolts. Refer to the following section for tightening torque information: **⇒"4.1 END EFFECTOR INSTALLATION TO WRIST"**	8
	○ Only 1st check	○					Retightening the external main bolts	Retighten the bolts which were installed, removed, or exposed during inspection. Refer to the recommended bolt tightening torque guidelines at the end of the manual. Some bolts are attached with adhesive. If the bolts are tightened with greater than the recommended torque, the adhesive might be removed. Therefore, follow the recommended bolt tightening torque guidelines when retightening the bolts.	9
	○ Only 1st check	○					Check the mechanical stopper and the adjustable mechanical stopper	Check that there is no evidence of a collision on the mechanical stopper, the adjustable mechanical stopper, and check the looseness of the stopper mounting bolts. 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, the balancer rod. the support part of in front and behind of the balancer, and the cable protective sleeves).	11
	○ Only 1st check	○					Check the operation of the cooling fan	(When cooling fans are installed on the each axis motor) Check whether the cooling fans are operating correctly. If the cooling fans do not operate, replace them.	12
		○					Greasing to the balancer bush	Supply grease to the balancer bush. **⇒"7.3.1 Greasing the Balancer Bush"**	13
			○				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"**	14

Check and maintenance intervals (Period, Accumulated operating time)							Check and maintenance item	Check points, management and maintenance method	Periodic maintenance table No.
1 month 320h	3 months 960h	1 year 3840h	1.5 years 5760h	2 years 7680h	3 years 11520h	4 years 15360h			
					○		Replacing the grease of each axis reducer	Replace the grease of each axis reducer **⇒"7.3.3 Replacing the Grease of the Drive Mechanism"**	15 to 20
						○	Replacing the mechanical unit cable	Replace the mechanical unit cable Contact your local FANUC representative for information regarding replacing the cable.	21
						○	Replacing the primary axis solution arm	Replace the primary axis solution arm Contact your local FANUC representative for information regarding replacing the cable.	22
				○			Replacing the wrist axis solution arm	Replace the wrist axis solution arm Contact your local FANUC representative for information regarding replacing the cable.	23
						○	Replacing the controller batteries	Replace the controller batteries. Regardless of operating time, replace batteries at 4 years. **⇒"Chapter 7 Replacing batteries of R-30*i*B/R-30*i*B Plus CONTROLLER MAINTENANCE MANUAL (B-83195EN) or R-30*i*B Mate/R-30*i*B Mate Plus CONTROLLER MAINTENANCE MANUAL (B-83525EN)"**	27

7.2 CHECK POINTS

7.2.1 Confirmation of Oil Seepage

Check items

Check to see whether there is an oil seepage on the rotating parts of each joint axis.

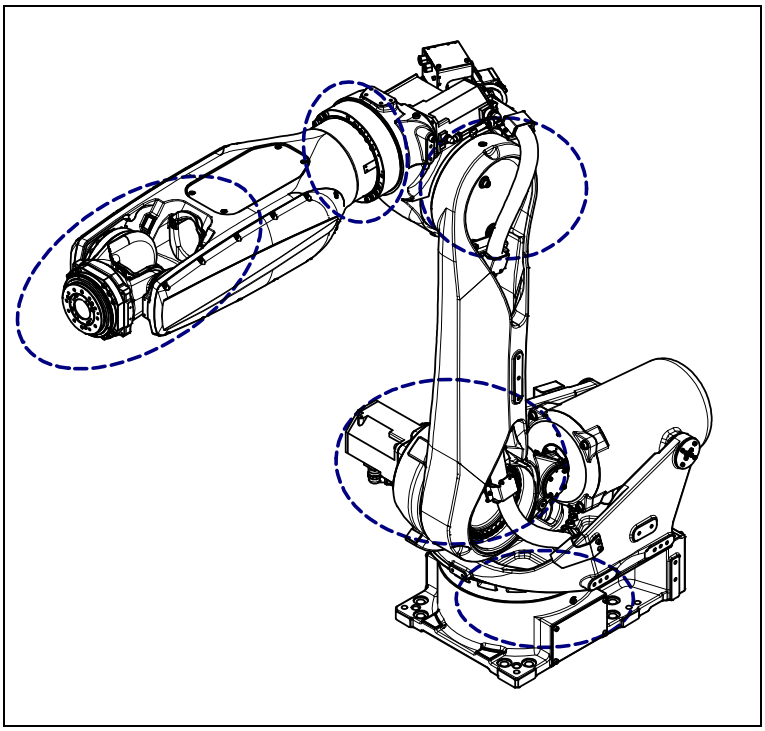


Fig.7.2.1 (a) Check points of oil seepage

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 fall 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 might 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**
> Grease may come out suddenly when opening the grease outlet. Attach bags for collecting grease.

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

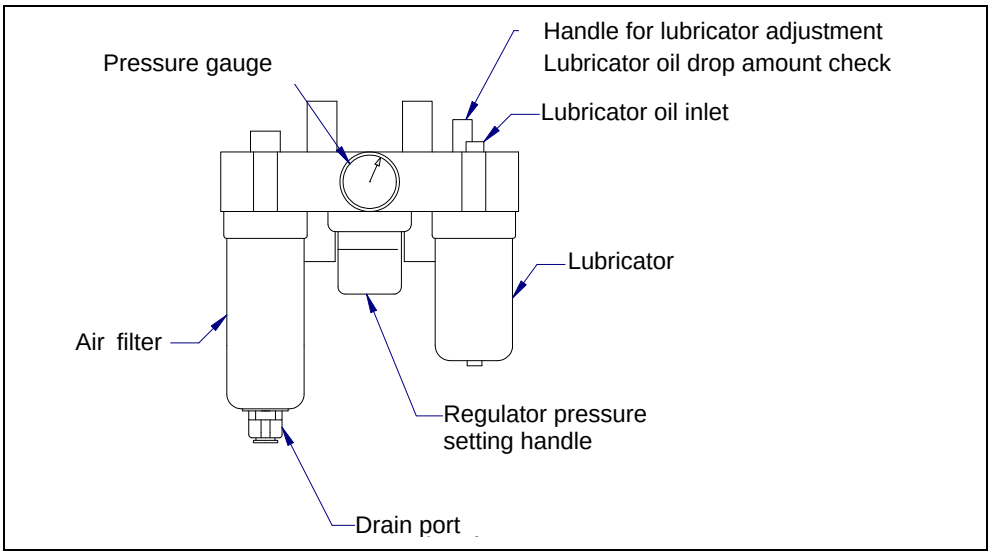


Fig. 7.2.2 (a) Air control set (option)

7.2.3 Check the Mechanical Unit Cables and Connectors

Check points of the mechanical unit cables

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

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

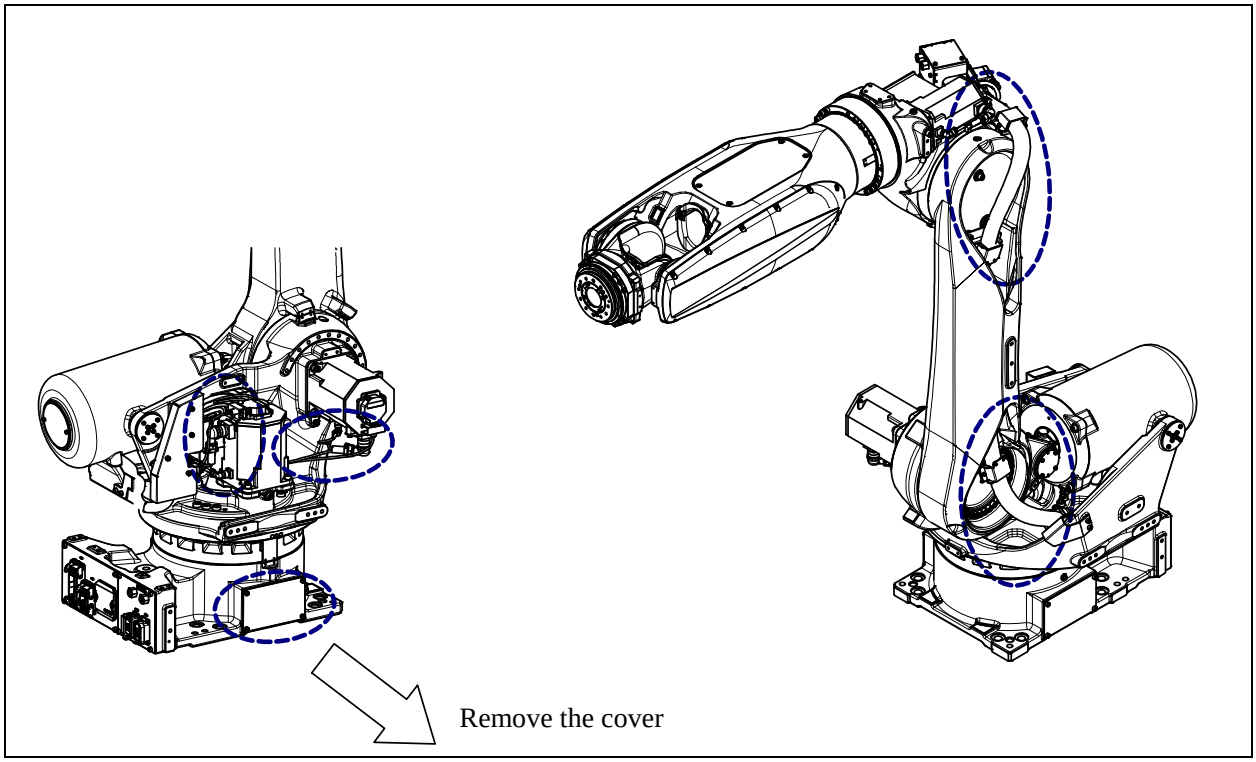


Fig. 7.2.3 (a) Check points of the mechanical unit cables

Check items

＜Cable protective sleeve＞

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

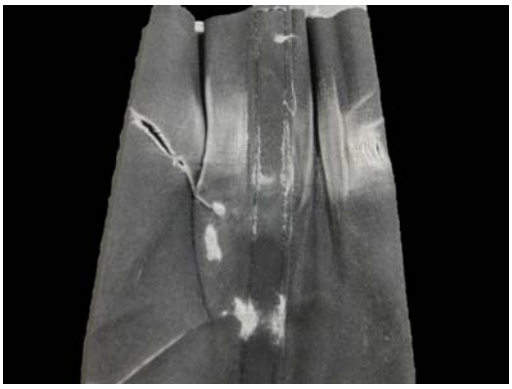


Fig. 7.2.3 (b) Damage on the cable protective sleeve

＜Cables＞

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

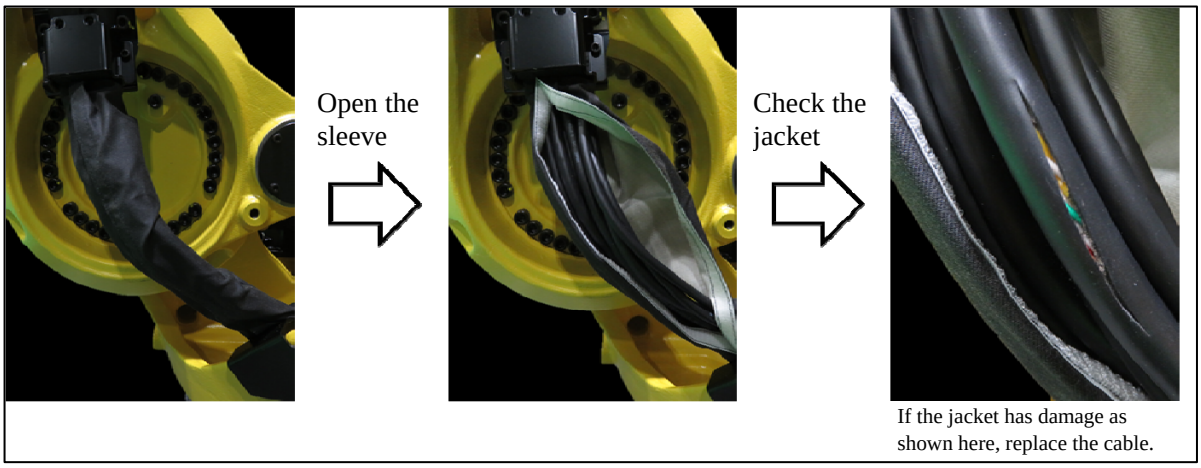


Fig. 7.2.3 (c) Cable check method

Inspection points of the connectors

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

Check items

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

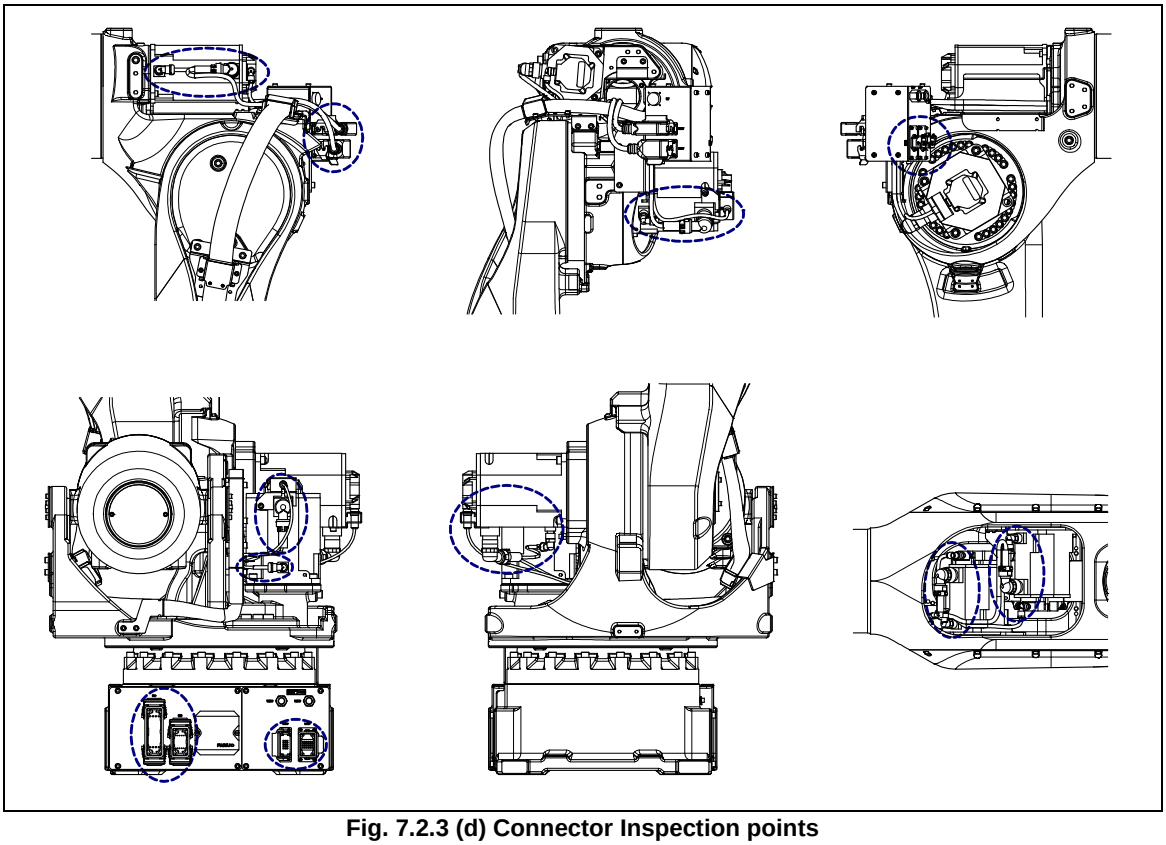


Fig. 7.2.3 (d) Connector Inspection points

7.2.4 Check of Fixed Mechanical Stopper and Adjustable Mechanical Stopper

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

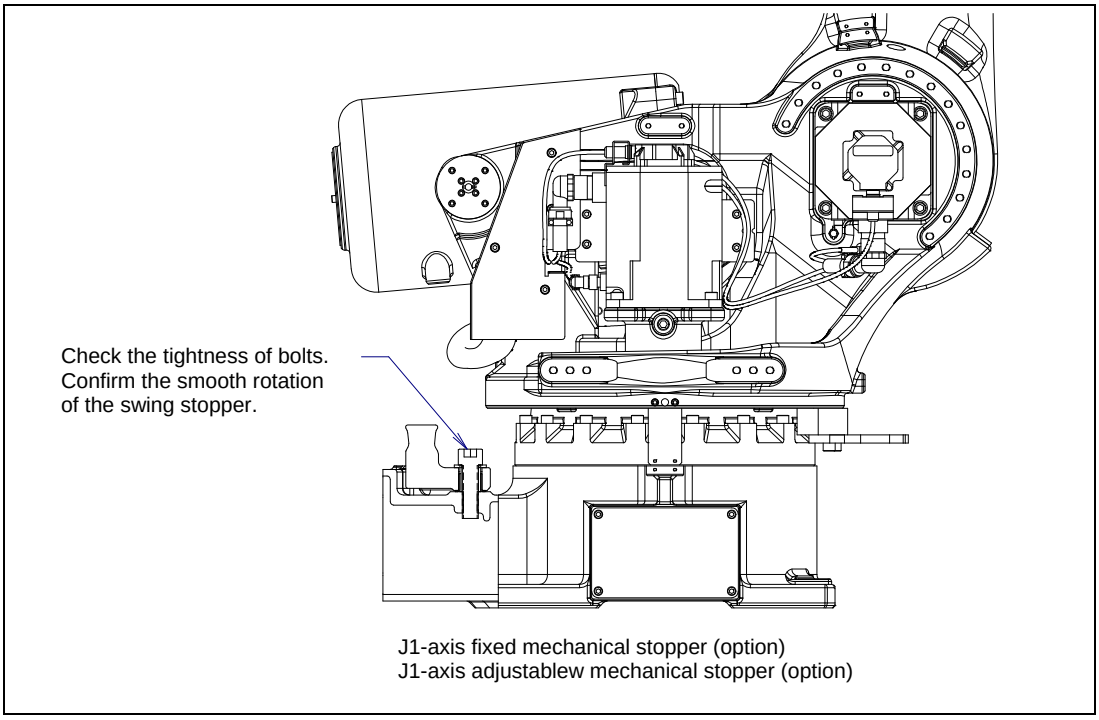


Fig. 7.2.4 (a) Check of fixed mechanical stopper and adjustable mechanical stopper

7.3 MAINTENANCE

7.3.1 Greasing the Balancer Bush (1 year (3840 hours) Periodic Maintenance)

Be sure to grease the balancer bush at specified intervals as shown in Tables 7.3.1 (a) and (b). 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) shows the greasing points of the balancer bush.

Table 7.3.1 (a) Greasing the balancer bush

Recommended grease	Amount of grease	Greasing interval
Showa Shell Sekiyu K. K. Shell Alvania grease S2 Specification: A98L-0004-0602#CTG	10 ml for each (two points)	1 year or every 3840 hours of accumulated operation time

Table 7.3.1 (b) Grease alternative to Alvania GREASE S2

Mobile	Mobilux EP2
JXTG Nippon Oil & Energy Corporation	Multinoc 2
JXTG Nippon Oil & Energy Corporation	Epinoc AP-2
Idemitsu Kosan Co., Ltd.	Eponex grease No. 2
Cosmo Oil Co., Ltd.	Dynamax No. 2
Showa Shell Sekiyu K.K.	Shell Gadus S2 V100 2

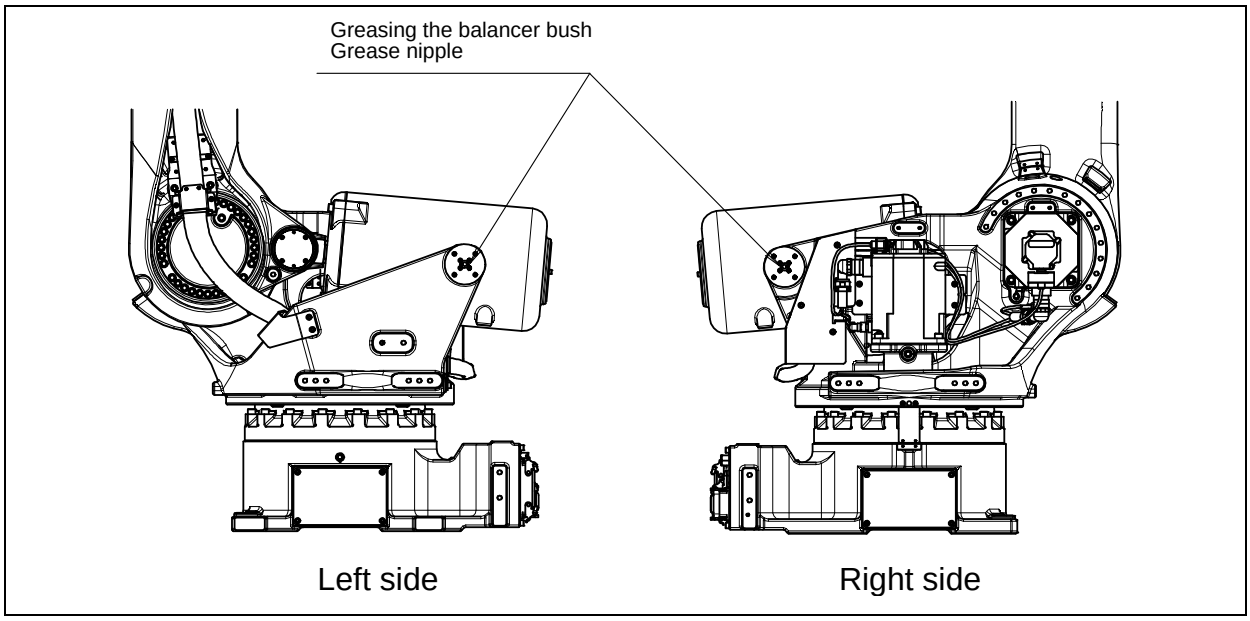


Fig. 7.3.1 (a) Balancer bush greasing points

7.3.2 Replacing the Batteries (1.5 year Periodic Maintenance)

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.

Procedure of replacing the battery

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

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

2 Remove the battery case cap. (Fig. 7.3.2 (a))
3 Take out the old batteries from the battery case.
4 Insert new batteries into the battery case while observing their correct direction.
5 Close the battery case cap.

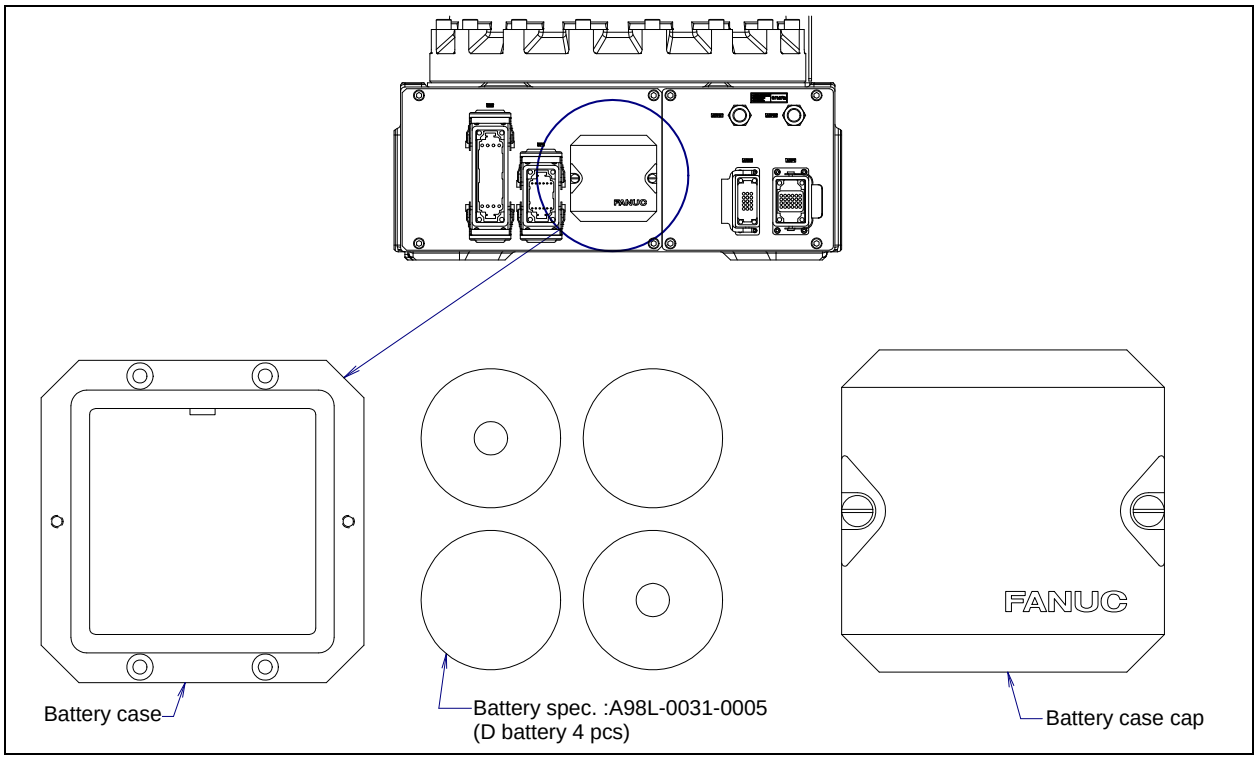


Fig. 7.3.2 (a) Replacing the battery

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

According to below, replace the grease of the reducers of J1/J2/J3/J4 axes, and the wrist at the intervals based on every 3 years or 11520 hours, whichever comes first. See Table 7.3.3 (a) for the grease name and the quantity.

Table 7.3.3 (a) Grease for 3-years (11520 hours) periodical replacement

Models	Greasing point	Quantity	Gun tip pressure	Specified grease
R-2000*i*D/210FH R-2000*i*D/165FH R-2000*i*D/100FH	J1-axis reducer	4250g (4730ml)	0.15MPa or less (NOTE)	Kyodo yushi VIGOGREASE RE0 Spec : A98L-0040-0174
	J2-axis reducer	2170g (2420ml)		
	J3-axis reducer	2440g (2720ml)		
	J4-axis reducer	1510g (1680ml)		
	wrist 1 (J5-axis reducer)	420g (470ml)		
	wrist 2 (J6-axis reducer)	790g (880ml)		

NOTE
When a manual pump is used for greasing, the standard rate is 2 pumping cycles per 3 seconds.

⚠ 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 posture 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
J2-axis reducer		0°				
J3-axis reducer			0°			
J4-axis reducer						
Wrist		Arbitrary		0°	90°	0°

Grease replacement procedure of the reducers of J1/J2/J3/J4 axes

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 from grease outlet (Fig.7.3.3 (a) and (b)).
4 Supply new grease through the grease inlet until new grease is output from grease outlet.
5 Release remaining pressure using the procedure given in Subsection 7.3.4.

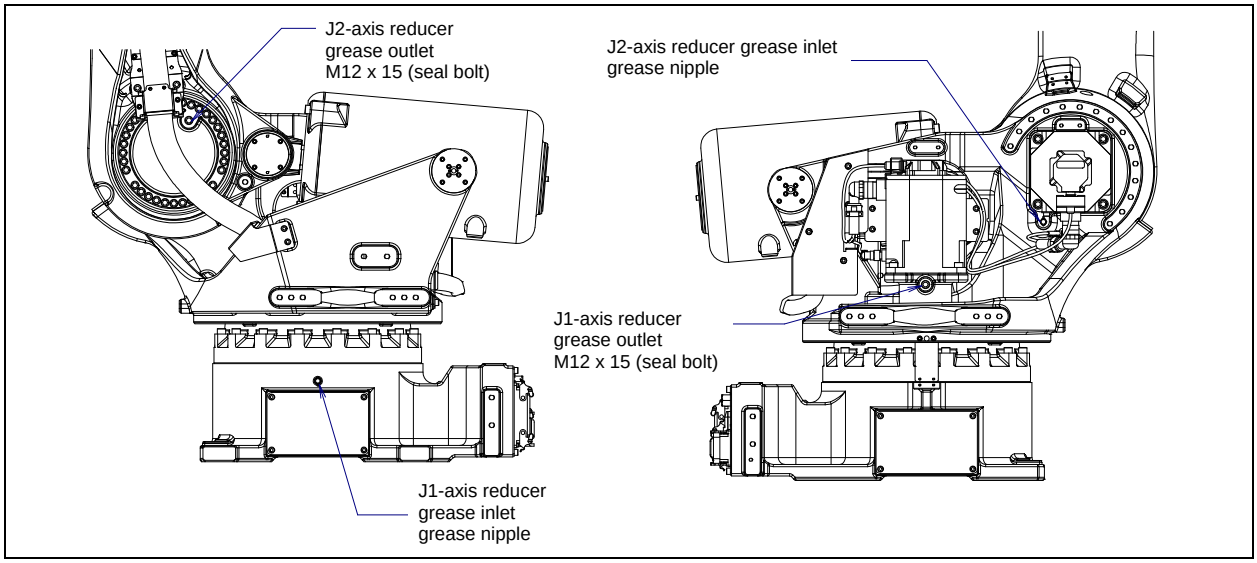


Fig. 7.3.3 (a) Replacing grease of the J1/J2-axis reducer

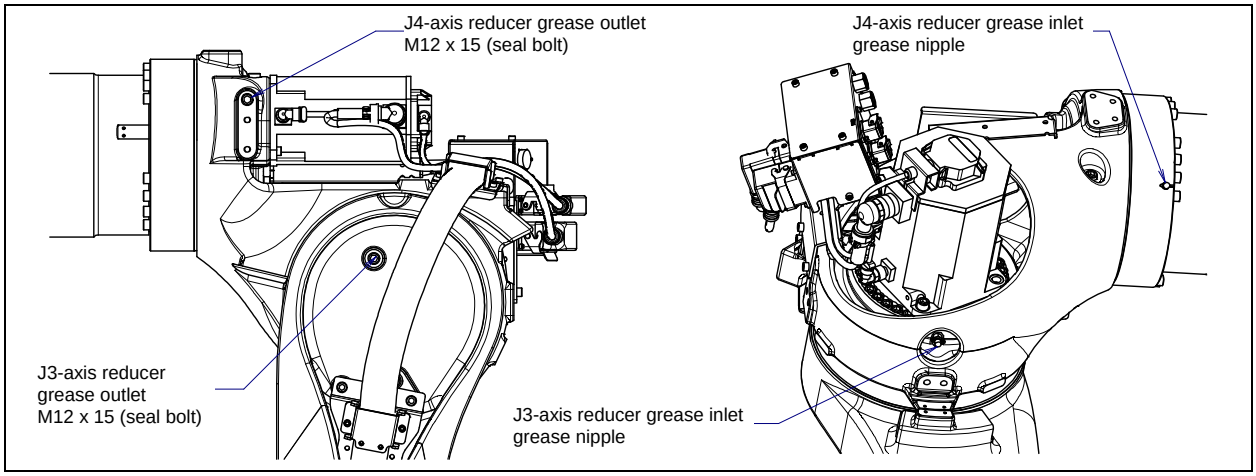


Fig. 7.3.3 (b) Replacing grease of the J3/J4-axis reducer

Grease Replacement Procedure for the Wrist

> **⚠ CAUTION**
> Grease replacing methods differ from R-2000*i*C, R-2000*i*B, R-2000*i*A, please be careful.

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 1 grease outlet (Fig. 7.3.3 (c)).
4 Supply grease to the wrist 1 grease inlet until new grease outputs from wrist 1 grease outlet.
5 Next, remove the seal bolt of wrist 2 grease outlet.
6 Supply new grease through the wrist 2 grease inlet until new grease is output from wrist 2 grease outlet.
7 Release remaining pressure using the procedure given in Subsection 7.3.4.

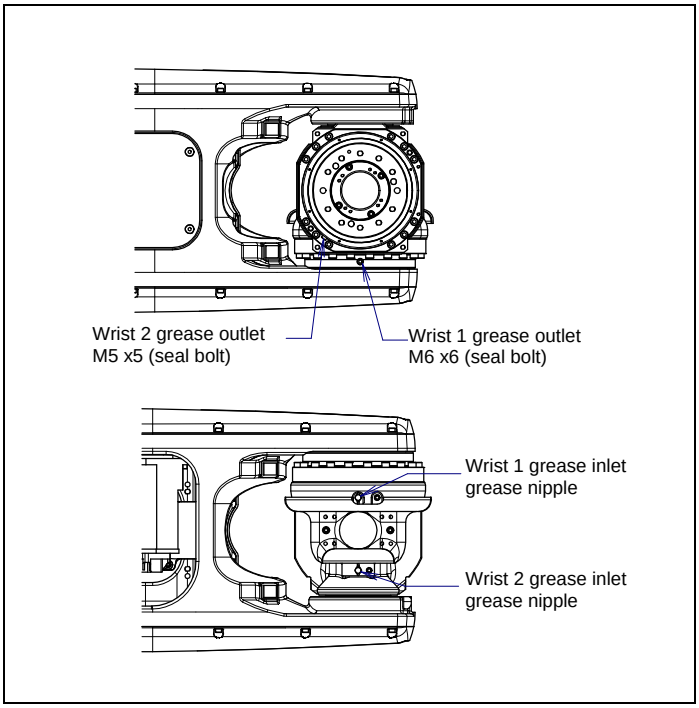


Fig. 7.3.3 (c) Replacing grease of the wrist

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

Parts name	Specifications
Seal bolt (M5)	A97L-0218-0417#050505
Seal bolt (M6)	A97L-0218-0417#060606
Seal bolt (M12)	A97L-0218-0417#121515
Grease nipple (J1 to J4-axis)	A97L-0218-0013#A610
Grease nipple (Wrist)	A97L-0218-0013#A110

⚠ 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 bolts or the taper plugs of the grease outlet 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 Subsection 7.3.4, and then close the grease outlet.
6 To prevent slipping accidents and catching fire, completely remove all any excess grease from the floor or robot.

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	Procedure
J1-axis reducer	80° or more	50%	20 minutes	Open the grease inlets and outlets and perform continuous operation.
J2-axis reducer	90° or more	50%	20 minutes	
J3-axis reducer	70° or more	50%	20 minutes	
J4-axis reducer	60° or more	100%	10 minutes	
Wrist	J5 : 120° or more J6 : 60° or more	100%	10 minutes	

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 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, taper plugs and grease nipples to the grease inlets and outlets. When reusing the seal bolts, taper plugs and grease nipples, 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 that was used for transportation. (See Section 1.1.)

8 MASTERING

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

> ⚠ **CAUTION**
> 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 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 becomes necessary after:

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

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

Types of Mastering

Table 8.1 (a) describes the following mastering methods.

Table 8.1 (a) Type of mastering

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

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

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

> **⚠ CAUTION**
> 1 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.

8.3 ZERO POSITION MASTERING

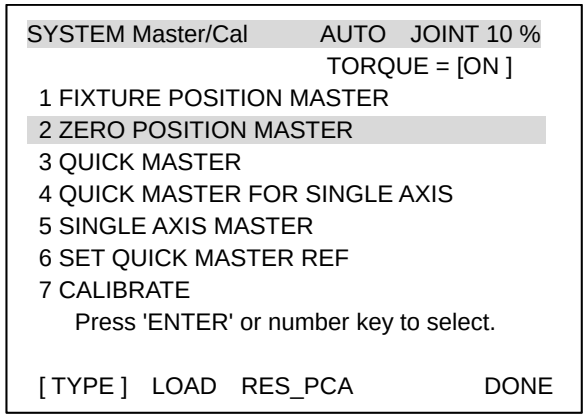
Zero-position mastering (witness mark mastering) is performed with all axes set at the 0-degree position. A zero-position mark (witness mark) is attached to each robot axis. (Fig. 8.3 (a)) This mastering is performed with all axes set at the 0-degree position using their respective witness marks.
Zero-position 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 (disabled) or TRUE (enabled)
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 the [MENU] key to display the screen menu.
6 Select [0 NEXT] and press [6 SYSTEM].
7 Press F1 [TYPE], display the screen change menu.
8 Select [Master/Cal]. The positioning screen will be displayed.



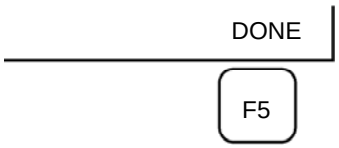
9 Jog the robot into a posture for mastering.
10 Select [2 ZERO POSITION MASTER]. Press F4 [YES].

```
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.

```
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 the original setting, and cycle power of the controller.

Table 8.3 (a) Posture with position marks (witness mark) aligned

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

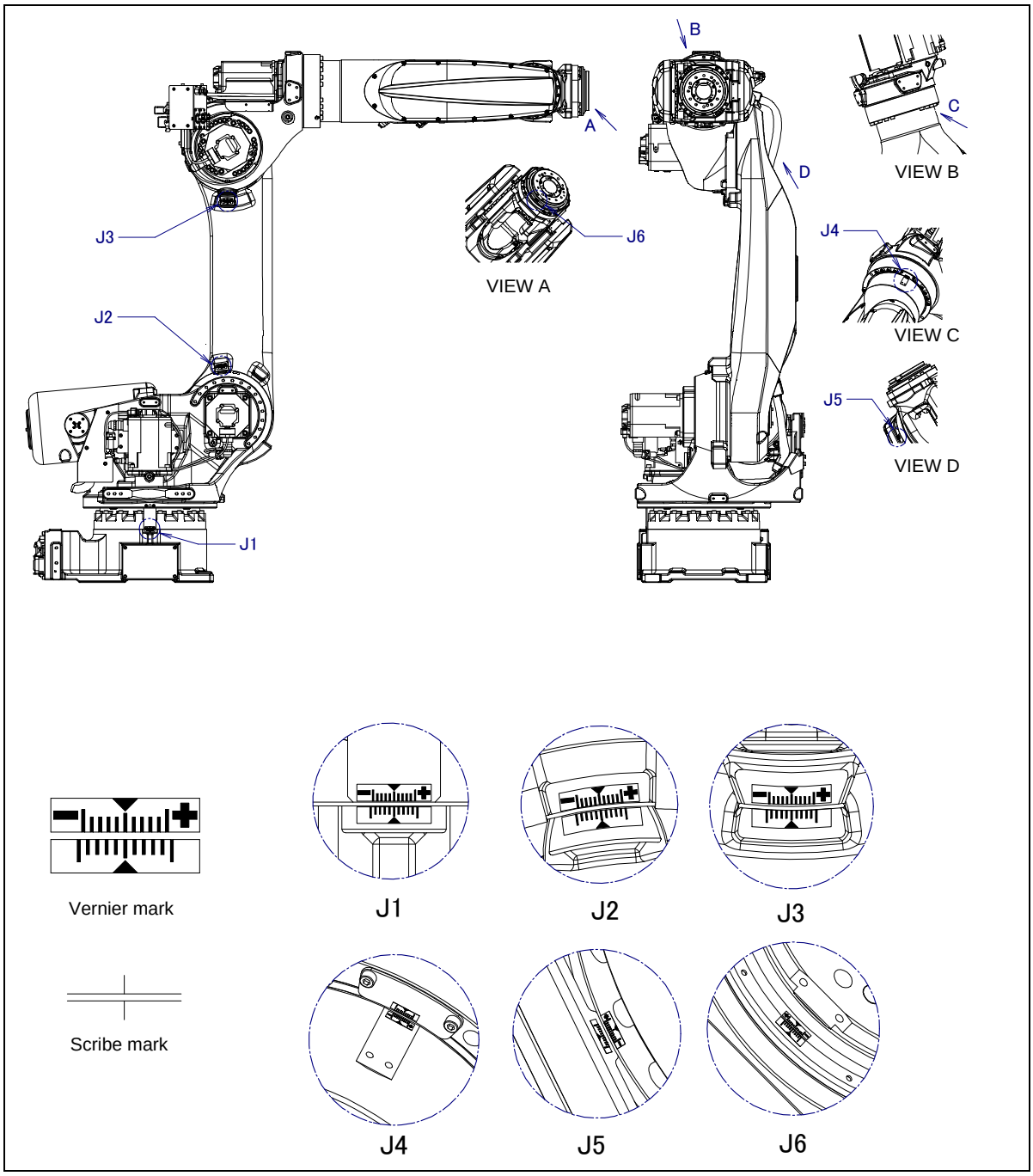


Fig. 8.3 (a) Zero-position mark (witness mark) for each axis

8.4 QUICK MASTERING

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

Quick mastering is factory-performed at the position indicated in Table 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.)

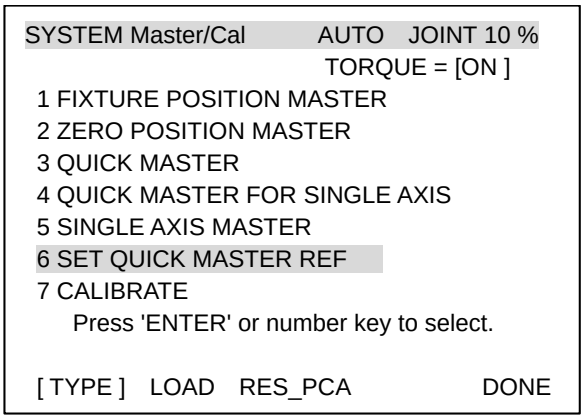
⚠ CAUTION
1 Quick mastering can be used, if the pulse count value is lost, for example, because a low voltage has been detected on the backup battery for the pulse counter.
2 Quick mastering cannot be used, after the Pulsecoder is replaced or after the mastering data is lost from the robot controller.

Procedure Recording the Quick Mastering Reference Position

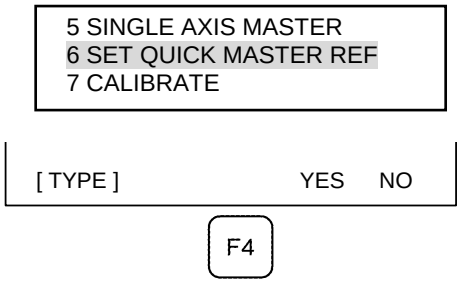
1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE]. Then select [Variables] from the menu.
4 If $DMR_GRP [group].$GRAV_MAST=1, set the gravity compensation to enabled, if it is 0, set the gravity compensation to disabled. In addition release the 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 (disabled) or TRUE (enabled)
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 the original setting, and cycle power of the controller.

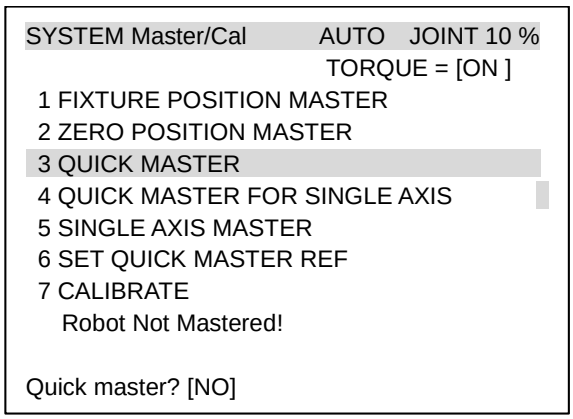
> ⚠ **CAUTION**
> If the robot has lost mastering data due to mechanical disassembly or repair, you cannot perform this procedure. In this case, perform Fixture position mastering or Zero position mastering to restore mastering data.

Procedure of Quick Mastering

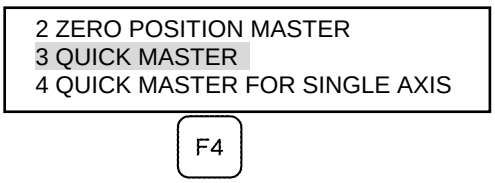
1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE]. Then select [Variables] from the menu.
4 If $DMR_GRP [group].$GRAV_MAST=1, set the gravity compensation to enabled, if it is 0, set the gravity compensation to disabled. In addition release the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

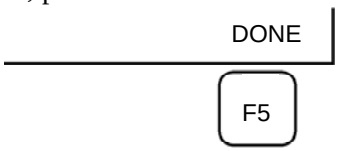
5 Display the Master/Cal screen.



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



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

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

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

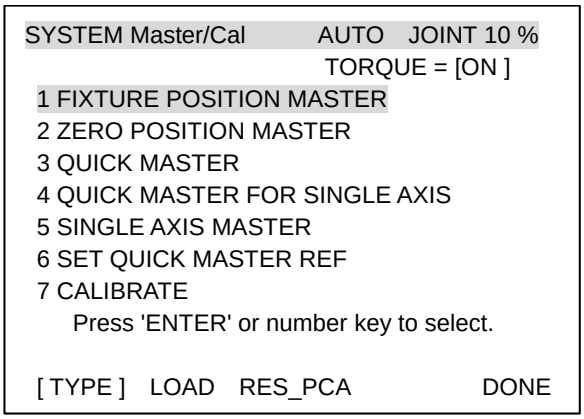
⚠ CAUTION
1 Quick mastering can be used, if the pulse count value is lost, for example, because a low voltage has been detected on the backup battery for the pulse counter.
2 Quick mastering cannot be used, after the Pulsecoder is replaced or after the mastering data is lost from the robot controller.

Procedure Recording the Quick Mastering Reference Position

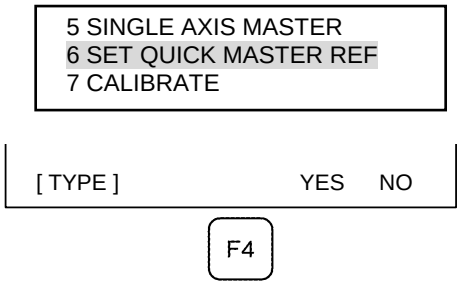
1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE]. Then select [Variables] from the menu.
4 If $DMR_GRP [group].$GRAV_MAST=1, set the gravity compensation to enabled, if it is 0, set the gravity compensation to disabled. In addition release the 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 (disabled) or TRUE (enabled)
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 the original setting, and cycle power of the controller.

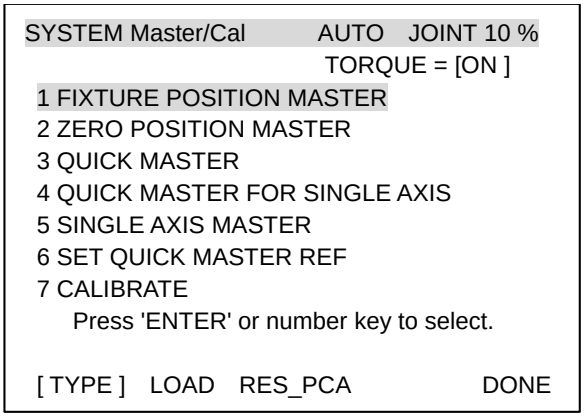
⚠ CAUTION
If the robot has lost mastering data due to mechanical disassembly or repair, you cannot perform this procedure. In this case, perform Fixture position mastering or Zero position mastering to restore mastering data.

Procedure of Quick Mastering for single axis

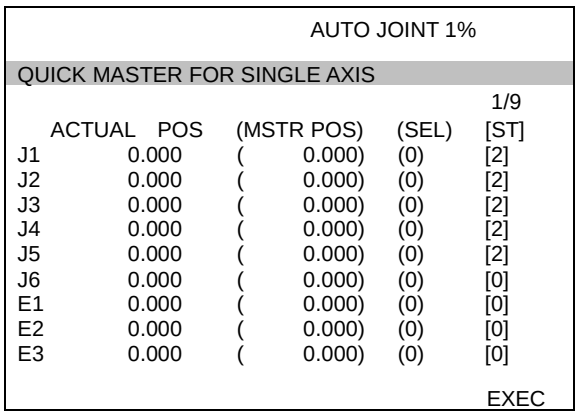
1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE]. Then select [Variables] from the menu.
4 If $DMR_GRP [group].$GRAV_MAST=1, set the gravity compensation to enabled, if it is 0, set the gravity compensation to disabled. In addition release the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

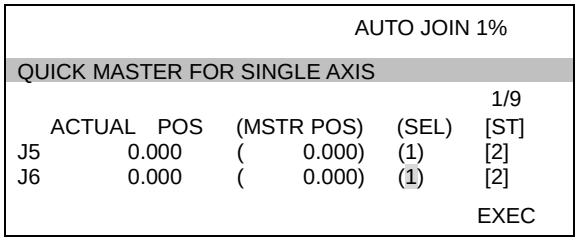
5 Display the Master/Cal screen.



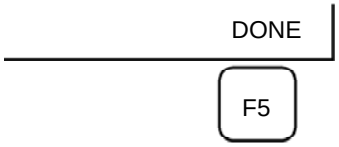
6 Select [4 QUICK MASTER FOR SINGLE AXIS]. You will see the quick master for single axis screen.



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 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 F4 [YES]. 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 the 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.

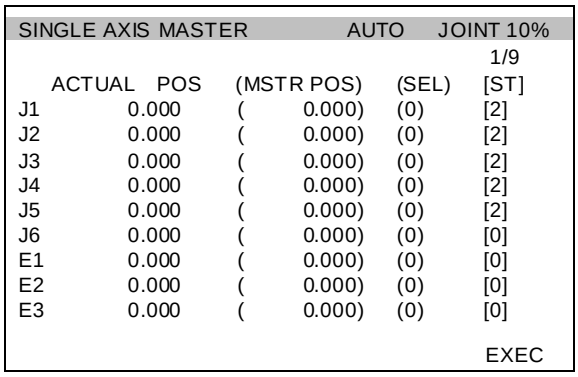


Table 8.6 (a) Items set in single axis mastering

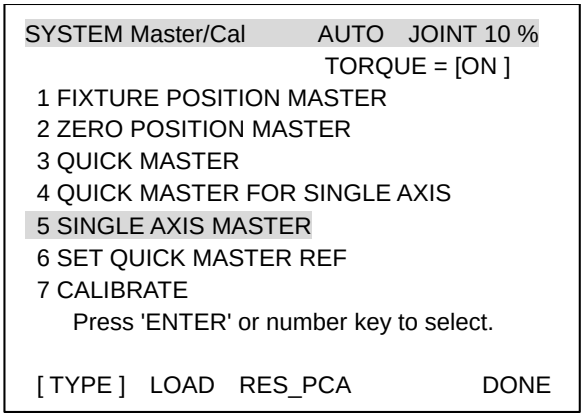
Item	Description
Current position (ACTUAL AXIS)	The current position of the robot is displayed for each axis in degree units.
Mastering position (MSTR POS)	A mastering position is specified for an axis to be subjected to single axis mastering. It would be convenient to set to it to the 0_ position.
SEL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

Procedure of Single axis mastering

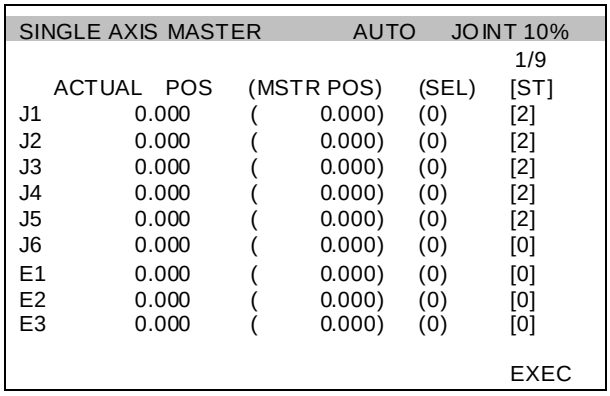
1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE]. Then select [Variables] from the menu.
4 If $DMR_GRP [group].$GRAV_MAST=1, set the gravity compensation to enabled, if it is 0, set the gravity compensation to disabled. In addition release the 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 (disabled) or TRUE (enabled)
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 Select [5 SINGLE AXIS MASTER]. The following screen will be displayed.



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.

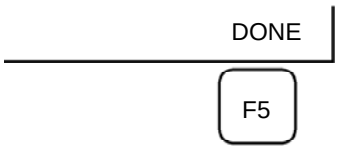
11 Press F5 [EXEC]. Mastering is performed. So, [SEL] is reset to 0, and [ST] is re-set to 2 or 1.

```
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].



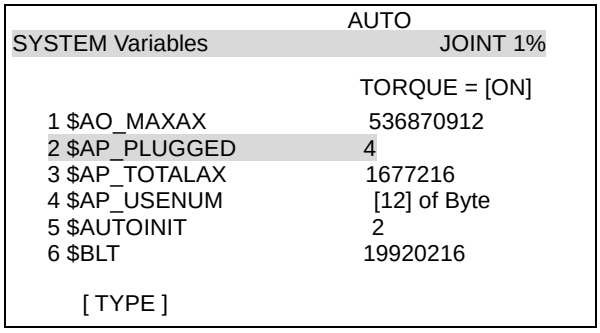
15 Return the setting of the gravity compensation.
16 Return brake control to the original setting, and cycle power of the controller.

8.7 MASTERING DATA ENTRY

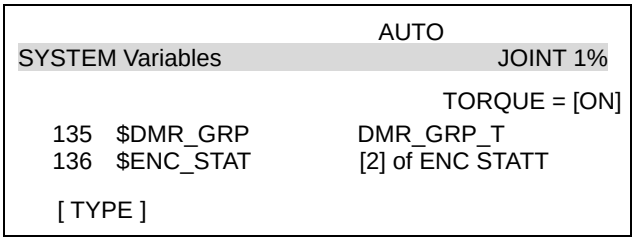
This function enables mastering data values to be assigned directly to a system variable. It can be used if mastering data has been lost but the pulse count is preserved.

Mastering data entry method

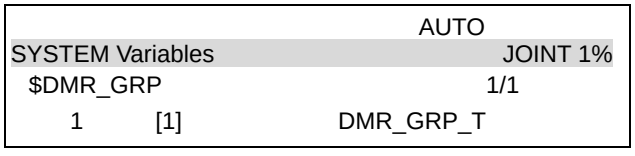
1 Press the [MENU] key, then press [0 NEXT] and select [6 SYSTEM].
2 Press F1 [TYPE]. Select [Variables]. The system variable screen appears.

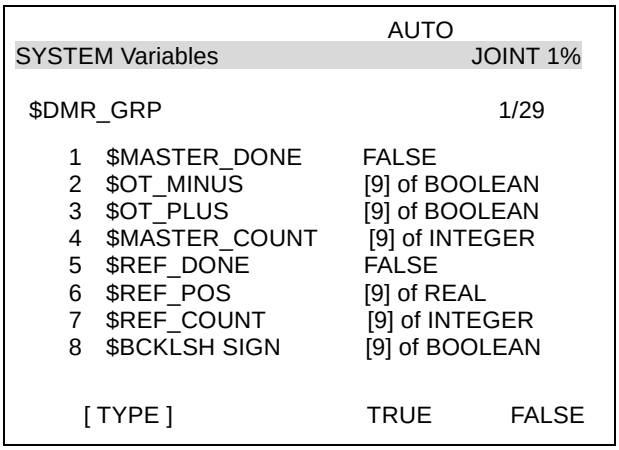


3 Change the mastering data.
The mastering data is saved to the $DMR_GRP.$MASTER_COUN system variable.

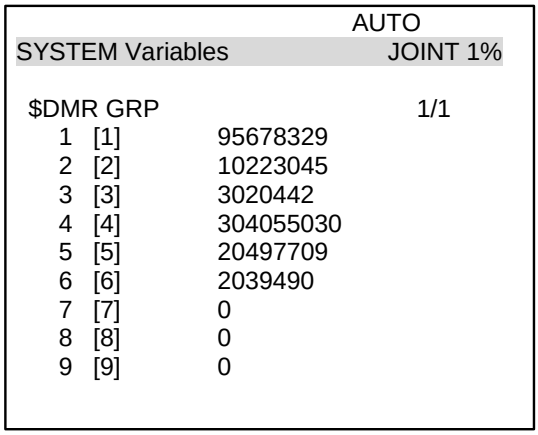


4 Select $DMR_GRP.

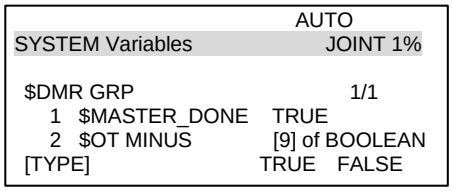




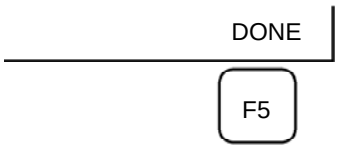
5 Select $MASTER_COUN, and enter the mastering data you have recorded.



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



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



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 the cause of a failure or which measures to take, contact your local FANUC representative. For troubleshooting except the mechanical unit, refer to "CONTROLLER MAINTENANCE MANUAL (B-83195EN etc.)" and Alarm Code List (B-83284EN-1).

Table 9.1 (a) TROUBLESHOOTING

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 to 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 might 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. If the robot is 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, belt] - 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 a foreign material caught in a gear, bearing, or within a reducer has damaged 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. - If noise occurs on a belt driving axis, the belt might be damaged.	- 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. - Contact your local FANUC representative if you are performing the belt check.

Symptoms	Descriptions	Causes	Measures
Vibration Noise (Continued)	- The cause of the 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. - 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. - Even for the specified grease, there may be an unusual sound during operation at low speed immediately after replacement or after a long period of time.	- Use the specified grease. - When there is an abnormal noise even when using the specified grease, 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 cause 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 mounting 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 effecter 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.
			  - Inside the reducer
			  - Inside the wrist
			- A gasket is used in the J1-axis reducer (case side) for robots which were made after Mar. 2020.
			- Sealant is used in the J1-axis reducer (case side) for robots which were made before Feb. 2020.
			- Seal bolts are used in the locations stated below.
			  - Grease 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.

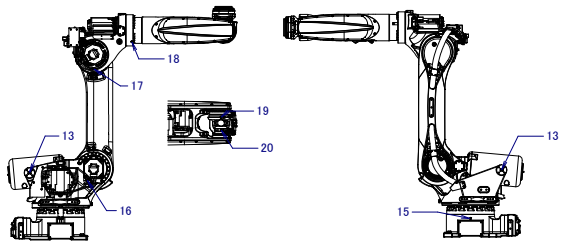
Symptoms	Descriptions	Causes	Measures
CLALM alarm occurred. Move error excess alarm occurred.	- After changing the motion program or the load condition, the CLALM is displayed. - After changing of the motion program or the load condition, the “Move error excess” alarm is displayed.	[Overload] - It is 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 acceleration. ・ Tight motion such as reverse motion using “CNT”. ・ Linear motion occurs near singularity point where axes revolve in high speed.	- Check the permissible value of the robot payload. If the load exceeds the permissible value, reduce the load or change the motion program. - Consider minimizing the cycle time by reducing the speed or acceleration, and changing the motion program. - Check that the load setting is performed correctly.
	- None of the symptoms stated above are the problem.	- It is likely the vibration occurred.	- Refer to the Symptoms: Vibration, Noise section of this troubleshooting for more information.
		- If the power source voltage drops below the rating, a vibration might occur.	- Check that the robot is supplied with the proper rated voltage.
BZAL alarm displayed	- BZAL 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 R-2000*i*D/210FH/165FH/100FH Periodic Maintenance Table

Items			Check time	Grease amount	First check 320	3 months 960	6 months 1920	9 months 2880	1 year 3840	4800	5760	6720	2 years 7680	8640	9600	10560
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	0.1H	—		○			○				○			
	7	Check tightness of each axis motor and other exposed connector	0.2H	—		○			○				○			
	8	Retightening the end effector mounting bolts	0.2H	—		○			○				○			
	9	Retightening the external main bolts	2.0H	—		○			○				○			
	10	Check the fixed mechanical stopper and the adjustable mechanical stopper	0.1H	—		○			○				○			
	11	Clean spatters, sawdust and dust	1.0H	—		○			○				○			
	12	Check the operation of the cooling fan	0.1H	—		○			○				○			
	13	Greasing to the balancer bush *1	0.1H	Each 10ml					●				●			
	14	Replacing the mechanical unit batteries*1*3	0.1H	—							●					
	15	Replacing the grease of J1-axis reducer*1	1.0H	4730ml												
	16	Replacing grease of J2-axis reducer*1	0.5H	2420ml												
	17	Replacing grease of J3-axis reducer*1	0.5H	2720ml												
	18	Replacing grease of J4-axis reducer*1	0.5H	1680ml												
	19	Replacing grease of wrist axis 1 (J5-axis)*1	0.2H	470ml												
	20	Replacing grease of wrist axis 2 (J6-axis)*1	0.5H	880ml												
	21	Replacing the mechanical unit cable	4.0H	—												
	22	Replacing the primary axis Solution arm	2.0H													
	23	Replacing the wrist axis Solution arm	0.5H 2 persons										●			
	24	Replacing the belts *4	—													
Controller	25	Cleaning the controller ventilation system	0.2H	—	○	○	○	○	○	○	○	○	○	○	○	○
	26	Check damages of the teach pendant cable, the operation box connection cable and the robot connection cable	0.2H	—		○			○				○			
	27	Replacing battery *1 *3	0.1H	—												



Position of grease nipple

*1 For descriptions about the items marked with an asterisk (*), refer to "REPLACING UNITS Chapter" of this manual or the following manuals.
R-30*i*B/R-30*i*B Plus CONTROLLER MAINTENANCE MANUAL (B-83195EN),
R-30*i*B Mate/R-30*i*B Mate Plus CONTROLLER MAINTENANCE MANUAL (B-83525EN)

*2 ●: Requires order of parts ○: Does not require order of parts

3 years 11520	12480	13440	14400	4 years 15360	16320	17280	18240	5 years 19200	20160	21120	22080	6 years 23040	24000	24960	25920	7 years 26880	27840	28800	29760	8 years 30720	Items
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				●																	27

Overhaul

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

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

B STRENGTH OF BOLT AND BOLT TORQUE LIST

NOTE

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

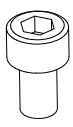
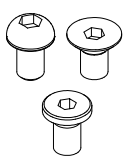
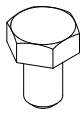
Use the following strength bolts. Comply with any bolt specification instructions.
Hexagon socket head bolt made of steel:

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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REVISION RECORD

Edition	Date	Contents
02	Aug., 2020	・Addition of R-2000iD/100FH ・Correction of errors
01	Jan., 2020	

B-84124EN/02

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