FANUC Robot M-410*iC*/110/185/315/500

MECHANICAL UNIT

OPERATOR'S MANUAL

B-83584EN/07

- **Original Instructions**

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

The products in this manual are controlled based on Japan's "Foreign Exchange and Foreign Trade Law". The export from Japan may be subject to an export license by the government of Japan.
Further, re-export to another country may be subject to the license of the government of the country from where the product is re-exported. Furthermore, the product may also be controlled by re-export regulations of the United States government.
Should you wish to export or re-export these products, please contact FANUC for advice.

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

SAFETY PRECAUTIONS

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

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

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

1 DEFINITION OF USER

Personnel can be classified as follows.

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

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

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

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

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

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

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

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

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

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

2 DEFINITION OF SAFETY NOTATIONS

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

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

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

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

Name	Specification
Brake release unit	A05B-2450-J350 (Input voltage AC100-115V single phase) A05B-2450-J351 (Input voltage AC200-240V single phase)
Robot connection cable	A05B-2450-J360 (5m) (M-410*i*C/185/315 no pedestal, M-410*i*C/110/500) A05B-2450-J361(10m) (M-410*i*C/185/315 no pedestal, M-410*i*C/110/500) A05B-2525-J045 (5m) (M-410*i*C/185/315 pedestal type) A05B-2525-J046(10m) (M-410*i*C/185/315 pedestal type)
Power cable	A05B-2525-J010 (5m) (AC100-115V Power plug) (*) A05B-2525-J011(10m) (AC100-115V Power plug) (*) A05B-2450-J364 (5m) (AC100-115V or AC200-240V No power plug) A05B-2450-J365(10m) (AC100-115V or AC200-240V No power plug)

(*) These do not support CE marking.

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

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

⚠ WARNING
Robot arm would fall down by releasing its brake because of gravity. In case of M-410*i*C/500, 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 effector. Therefore it is strongly recommended to take adequate measures such as hanging Robot arm by a crane before releasing a brake.

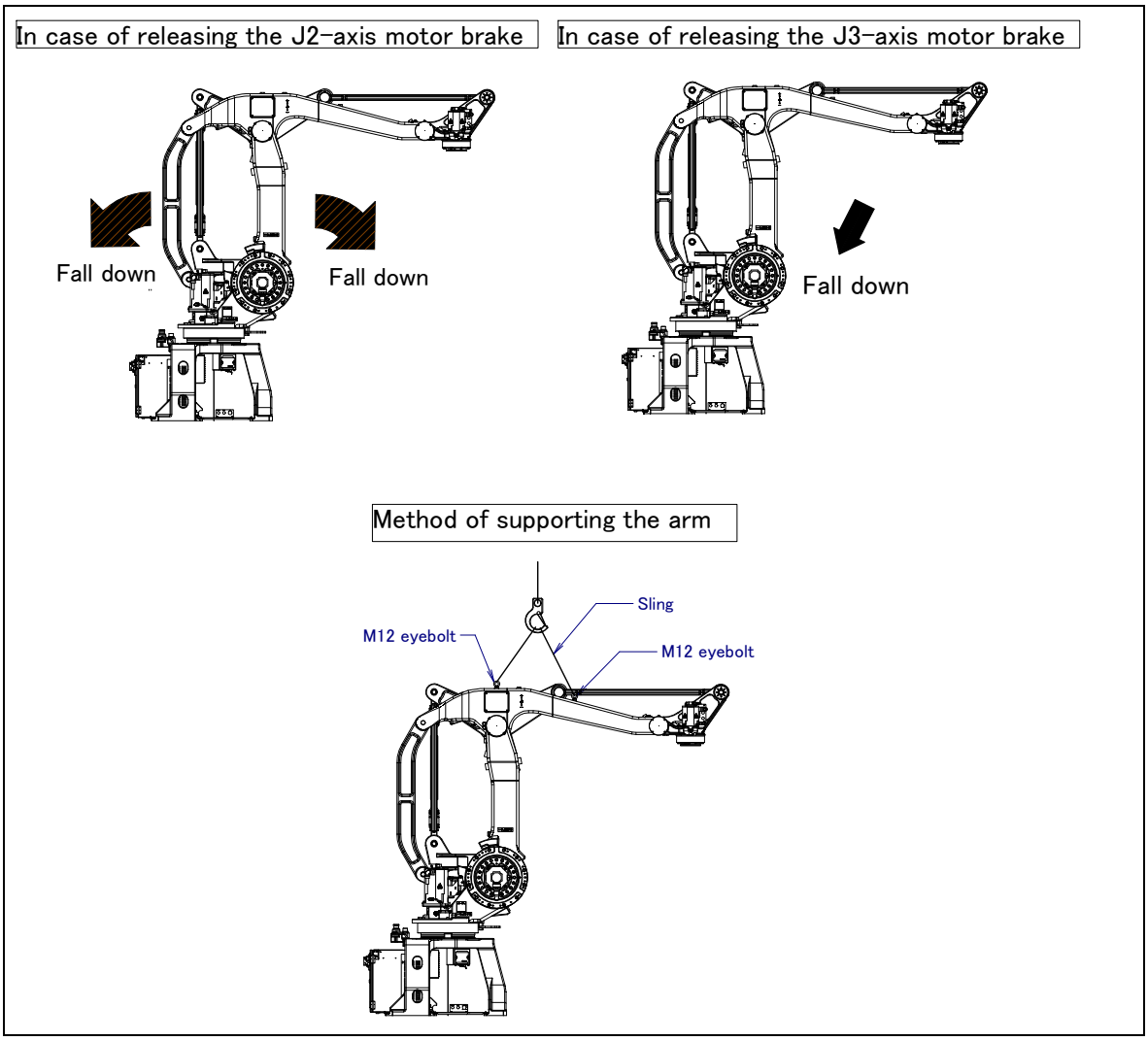


Fig. 3 (a) Releasing J2/J3-axis motor brake and measures (M-410*i*C/110/185/315)

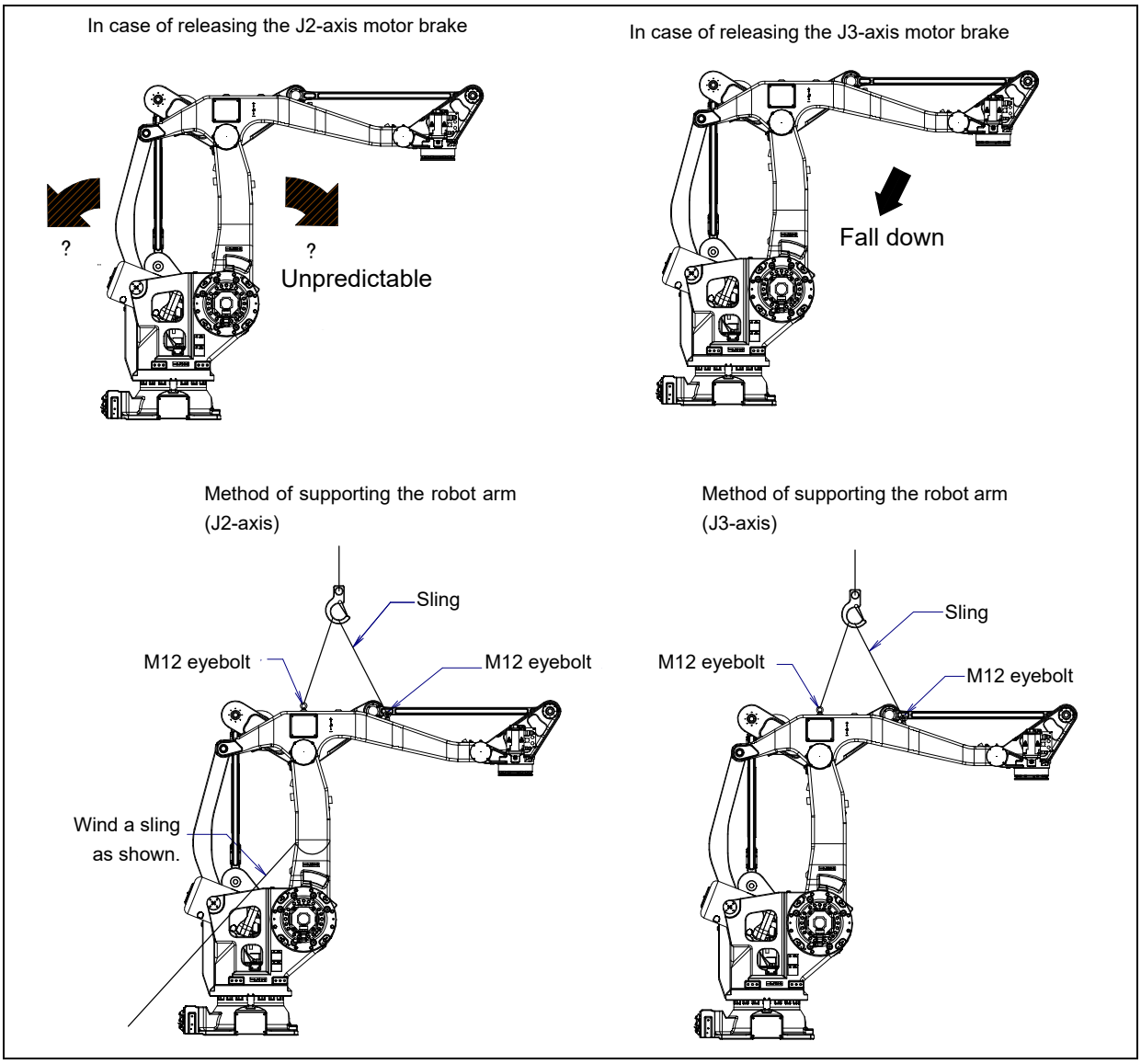


Fig. 3 (b) Releasing J2/J3-axis motor brake and measures (M-410*i*C/500)

4 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.

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

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

(2) Step-on prohibitive label

Fig. 4 (b) Step-on prohibitive label

Description

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

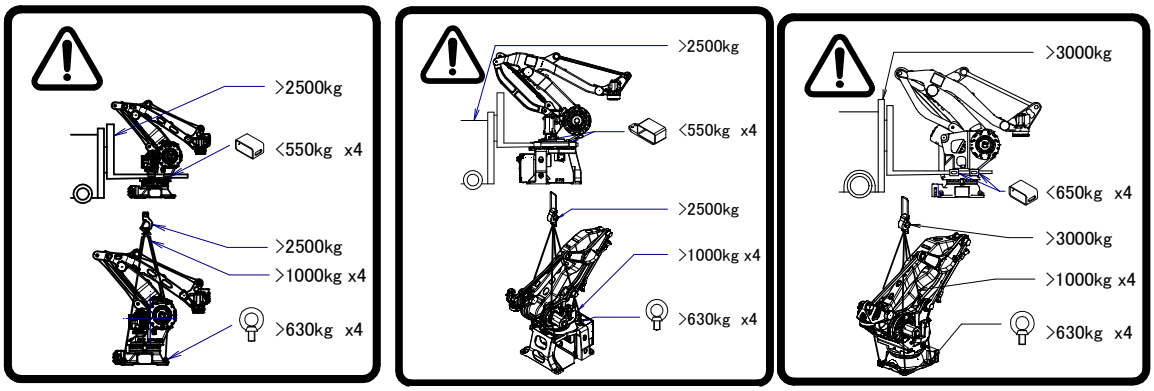
(3) High-temperature warning label

Fig. 4 (c) High-temperature warning label

Description

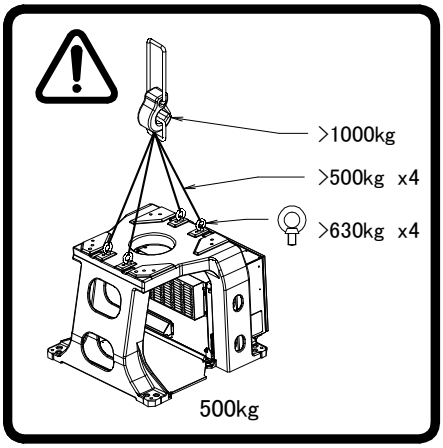
Be cautious about a section where this label is affixed, as the section generates heat. If you have to inevitably touch such a section when it is hot, use a protective tool such as heat-resistant gloves.

(4) Transportation label



M-410*i*C/110 **M-410*i*C/185/315** **M-410*i*C/500**

Fig. 4 (d) Transportation label (1/2)



Pedestal for M-410*i*C/500

Fig. 4 (e) Transportation label (2/2)

Description

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

In case of M-410*i*C/110/185/315

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 allowable load 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 with each load capacity of 1000 kg or greater.
   - Use four eyebolts with each allowable load of 6174 N (630 kgf) or greater.

In case of M-410*i*C/500

1) Using a forklift
   - Use a forklift having a load capacity of 3000 kg or greater.
   - Keep the total weight of the robot to be transported to within 2600kg, because the allowable load of the forklift bracket (option) is 6370 N (650 kgf).
2) Using a crane (Robot)
   - Use a crane with a load capacity of 3000 kg or greater.
   - Use four slings with each load capacity of 1000 kg or greater.
   - Use four eyebolts with each allowable load of 6174 N (630 kgf) or greater.
3) Using a crane (Pedestal)
   - Use a crane with a load capacity of 1000 kg or greater.
   - Use four slings with each load capacity of 500 kg or greater.
   - Use four eyebolts with each allowable load of 6174 N (630 kgf) or greater.

⚠ CAUTION
See Section 1.1 TRANSPORTATION for explanations about the posture a specific model should take when it is transported.

(5) Balancer replacement label (M-410*i*C/500)

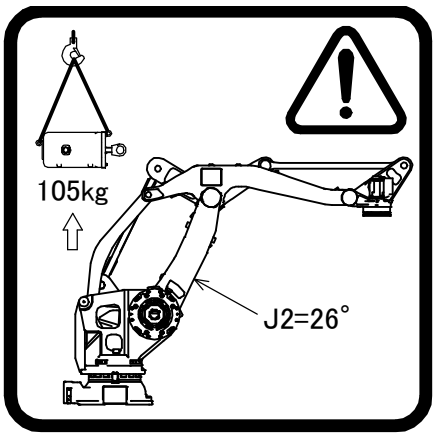


Fig. 4 (f) Balancer replacement label

Description

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

- W*h*ile replacing the balancer keep the J2-axis at 26°.
- The mass of the balancer is 105 kg.

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

(6) Transportation caution label

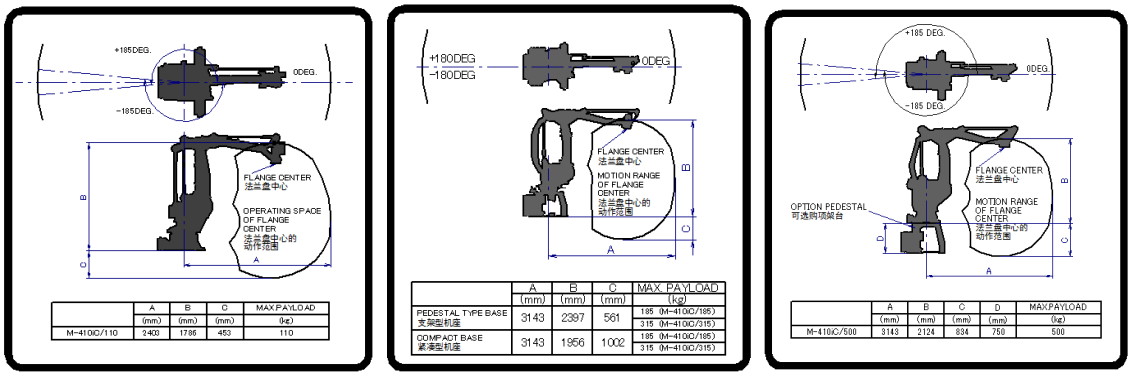
Fig. 4 (g) Transportation caution label (for eyebolt option)

Description

When replacing the balancer, observe the instructions indicated on this label.
Do not pull eyebolts sideways when transporting the robot.

(7) Operating space and payload label (When CE specification is specified)

The following label is added:



M-410*i*C/110 **M-410*i*C/185/315** **M-410*i*C/500**

Fig. 4 (h) Operating space and payload label

(8) Mastering caution label (M-410*i*C/110/500)

Fig. 4 (i) 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°.

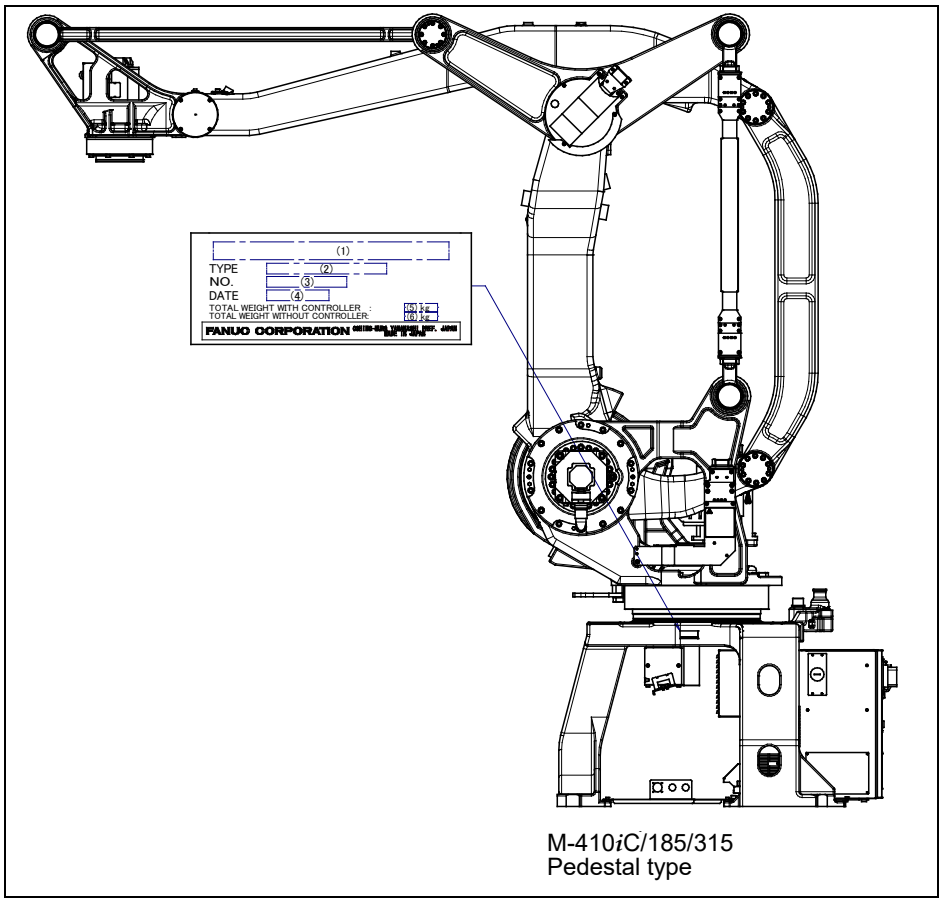
PREFACE

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

Model name	Mechanical unit specification No.	Maximum load	Remarks
FANUC Robot M-410*i*C/110	A05B-1046-B201	110kg	no pedestal
FANUC Robot M-410*i*C/185	A05B-1044-B201	185kg	Pedestal type
FANUC Robot M-410*i*C/185	A05B-1044-B202	185kg	No pedestal
FANUC Robot M-410*i*C/315	A05B-1044-B203	315kg	Pedestal type
FANUC Robot M-410*i*C/315	A05B-1044-B204	315kg	No pedestal
FANUC Robot M-410*i*C/500	A05B-1045-B201	500kg	No pedestal (*)

(*) Pedestal is an option.

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.

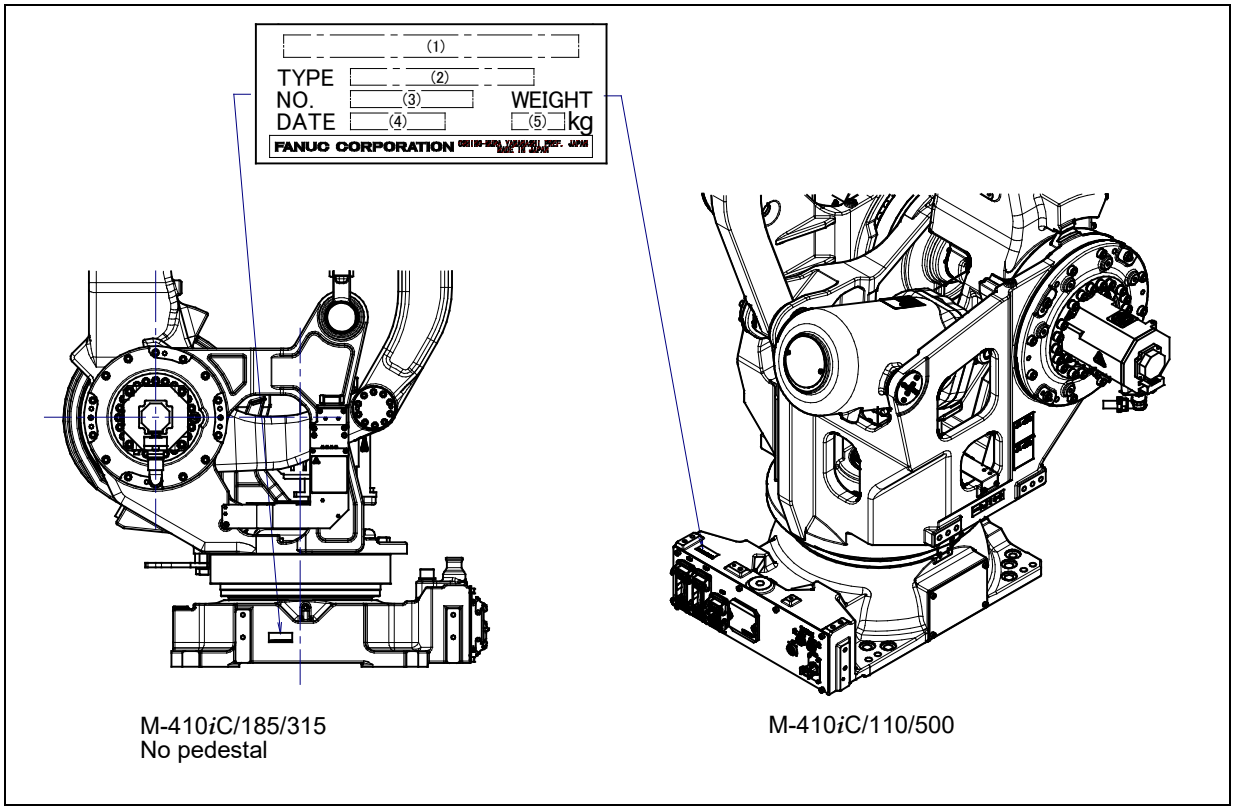


M-410*i*C/185/315
Pedestal type

Position of the label which the mechanical unit specification number is stated (1/2)

TABLE 1)

	(1)	(2)	(3)	(4)	(5)	(6)
CONTENTS	**MODEL NAME**	**TYPE**	**No.**	**DATE**	**WEIGHT kg (Including controller)**	**WEIGHT kg (Not including controller)**
LETTERS	FANUC Robot M-410*i*C/185	A05B-1044-B201	SERIAL NO. IS PRINTED	PRODUCTION YEAR AND MONTH ARE PRINTED	1600	1480
	FANUC Robot M-410*i*C/315	A05B-1044-B203			1600	1480



Position of the label which the mechanical unit specification number is stated (2/2)

TABLE 2)

	(1)	(2)	(3)	(4)	(5)
CONTENTS	**MODEL NAME**	**TYPE**	**No.**	**DATE**	**WEIGHT kg**
LETTERS	FANUC Robot M-410*i*C/110	A05B-1046-B201	SERIAL NO. IS PRINTED	PRODUCTION YEAR AND MONTH ARE PRINTED	1030
	FANUC Robot M-410*i*C/185	A05B-1044-B202			1330
	FANUC Robot M-410*i*C/315	A05B-1044-B204			1330
	FANUC Robot M-410*i*C/500	A05B-1045-B201			1910

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 Plus controller	OPERATOR'S MANUAL Basic Operation **B-83284EN** Alarm Code List **B-83284EN-1** Optional Function **B-83284EN-2**	Intended readers: Operator, programmer, maintenance person, system designer Topics: Robot functions, operations, programming, setup, interfaces, alarms Use: Robot operation, teaching, system design
	MAINTENANCE MANUAL **B-83195EN**	Intended readers: Maintenance person, 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. Fig.1.1 (a) to (i) show the transport posture.

⚠ WARNING

1 Please follow notes when it is necessary to transport robot with the end effector and the base plate installed.
   - The entire position of center of gravity is changed by installing the tool and the base plate. Please note the balance enough.
   - The tool swings by the vibration etc. 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.
2 Use the forklift pockets only to transport the robot with a forklift. Do not use the forklift pockets to secure the robot.
3 Before moving the robot by using forklift pockets, check and tighten any loose bolts on the forklift pockets.
4 Do not pull eyebolts sideways.
5 Prevent the forks of the forklift from having impact on transport equipment.
6 Do not thread a chain or the like through transport equipment.

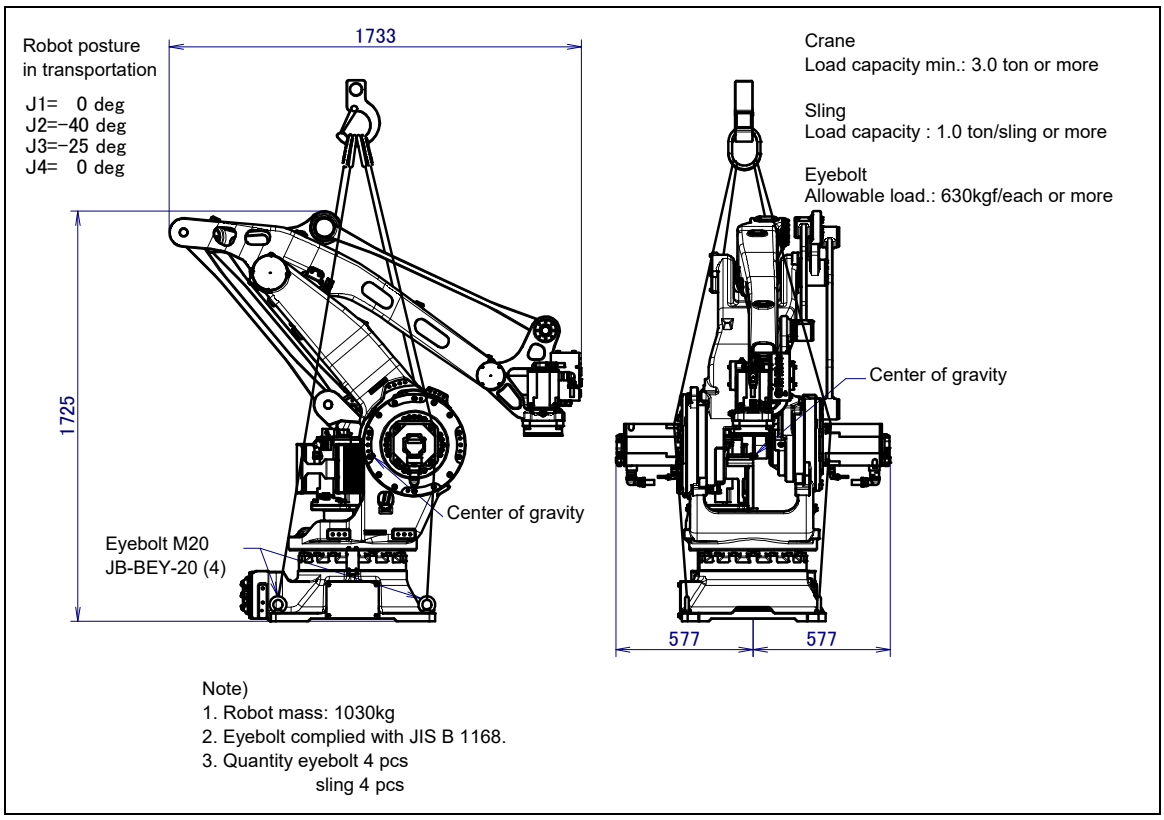


Fig. 1.1 (a) Transportation using a crane (M-410*i*C/110)

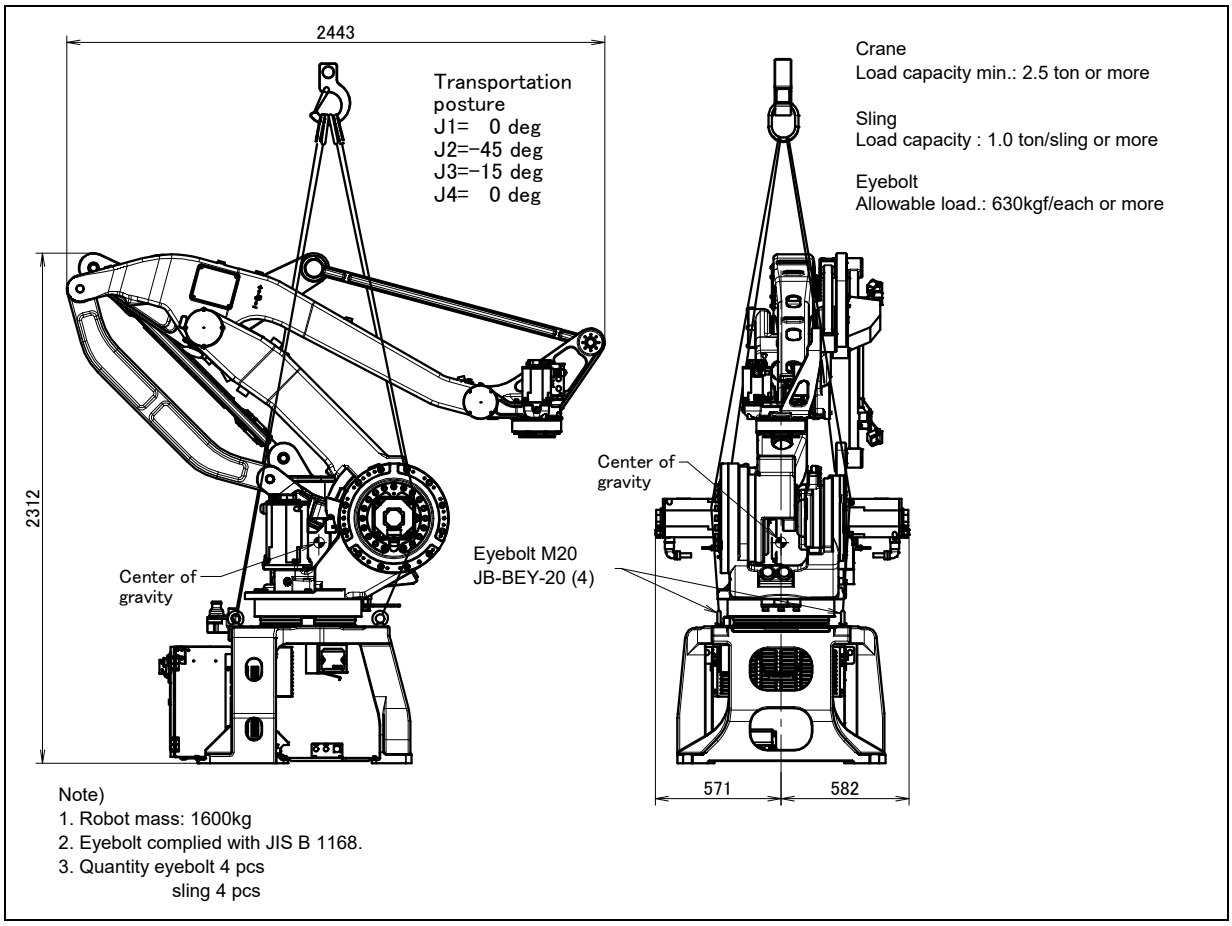


Fig. 1.1 (b) Transportation using a crane (pedestal type) (M-410*i*C/185/315)

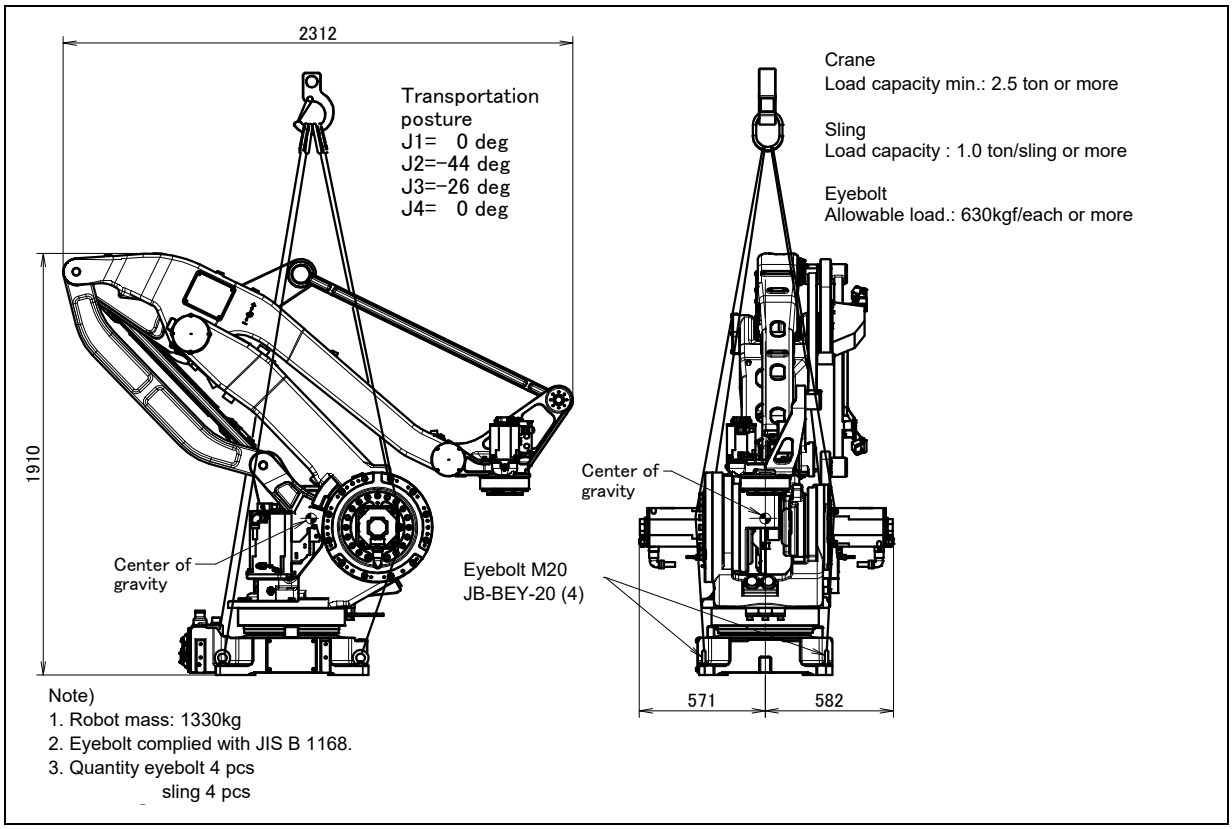


Fig. 1.1 (c) Transportation using a crane (no pedestal) (M-410*i*C/185/315)

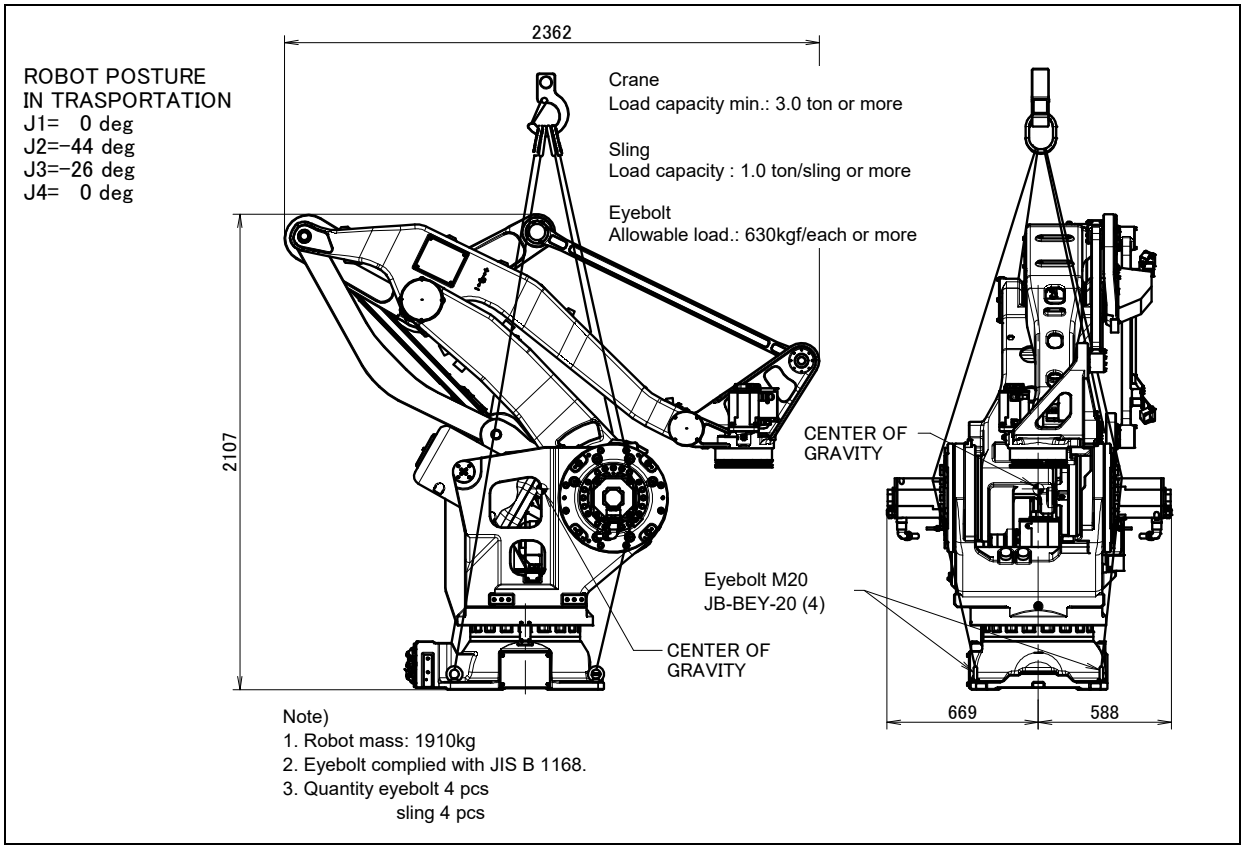


Fig. 1.1 (d) Transportation using a crane (M-410*i*C/500)

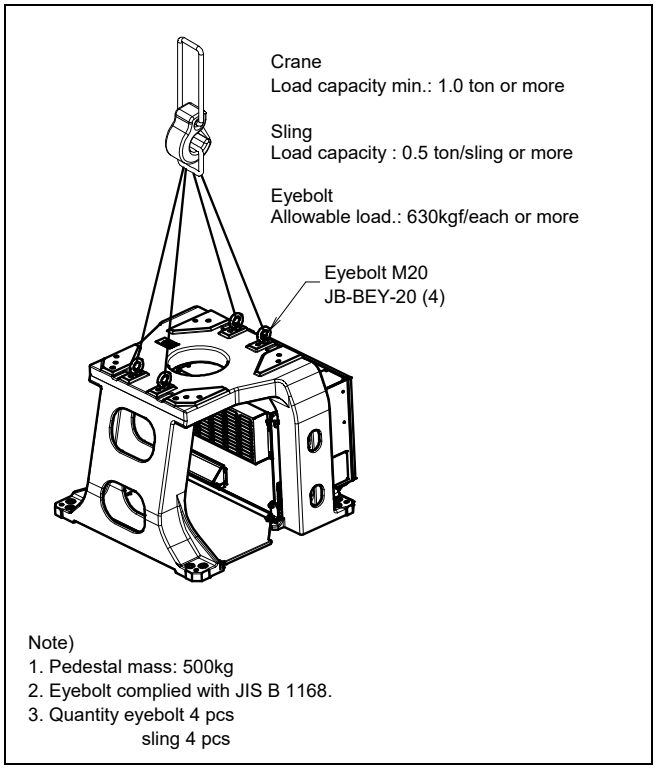


Fig. 1.1 (e) Transportation using a crane (pedestal for M-410*i*C/500)

> ⚠ **CAUTION**
> In case of M-410*i*C/500 pedestal type, be sure to transport the robot and the pedestal separately.

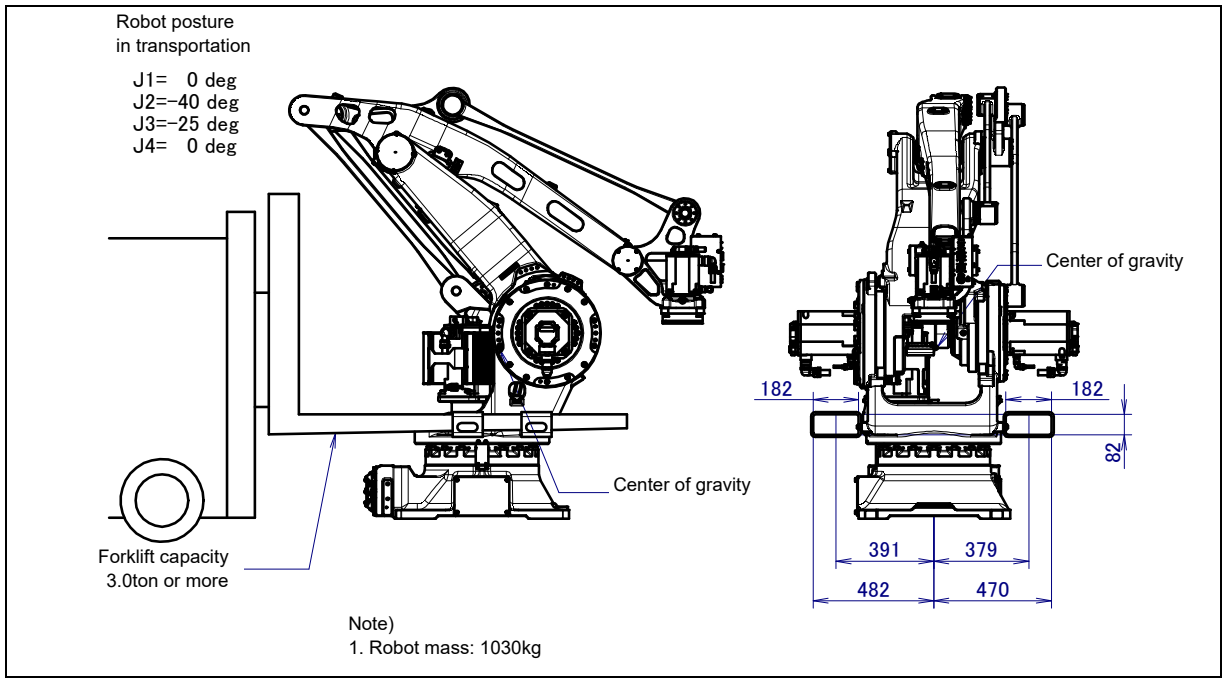


Fig. 1.1 (f) Transportation using a forklift (M-410*i*C/110)

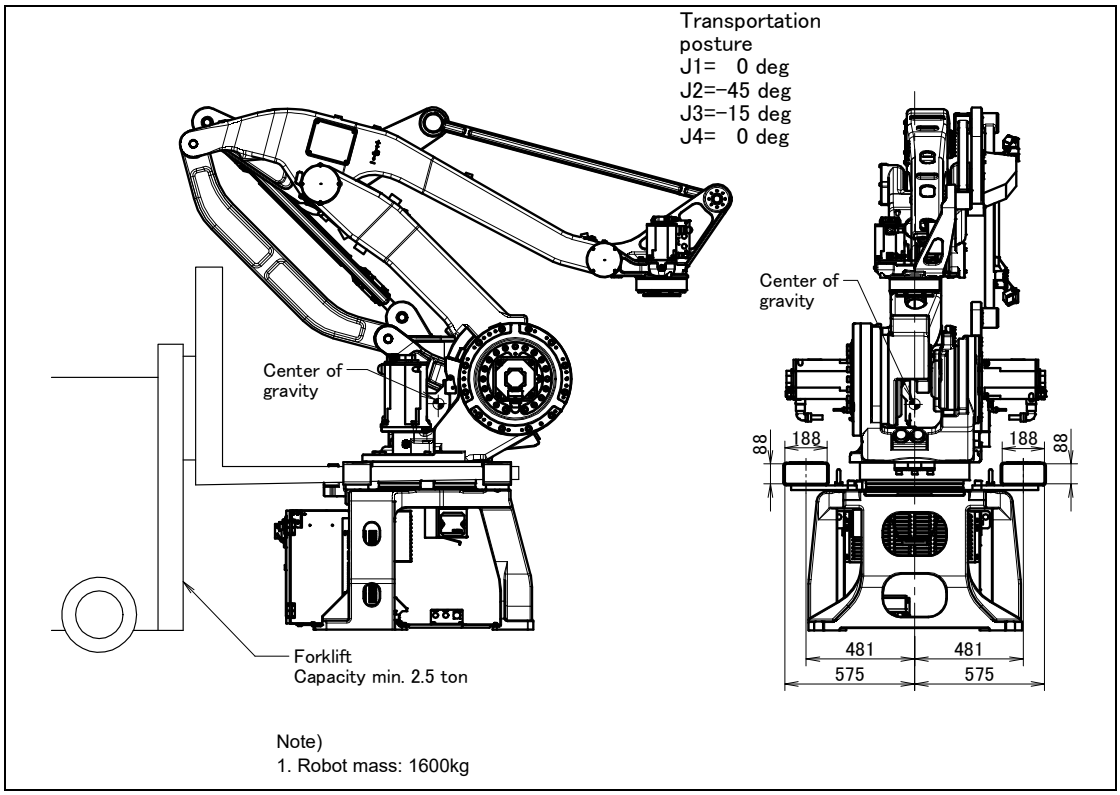


Fig. 1.1 (g) Transportation using a forklift (pedestal type) (M-410*i*C/185/315)

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

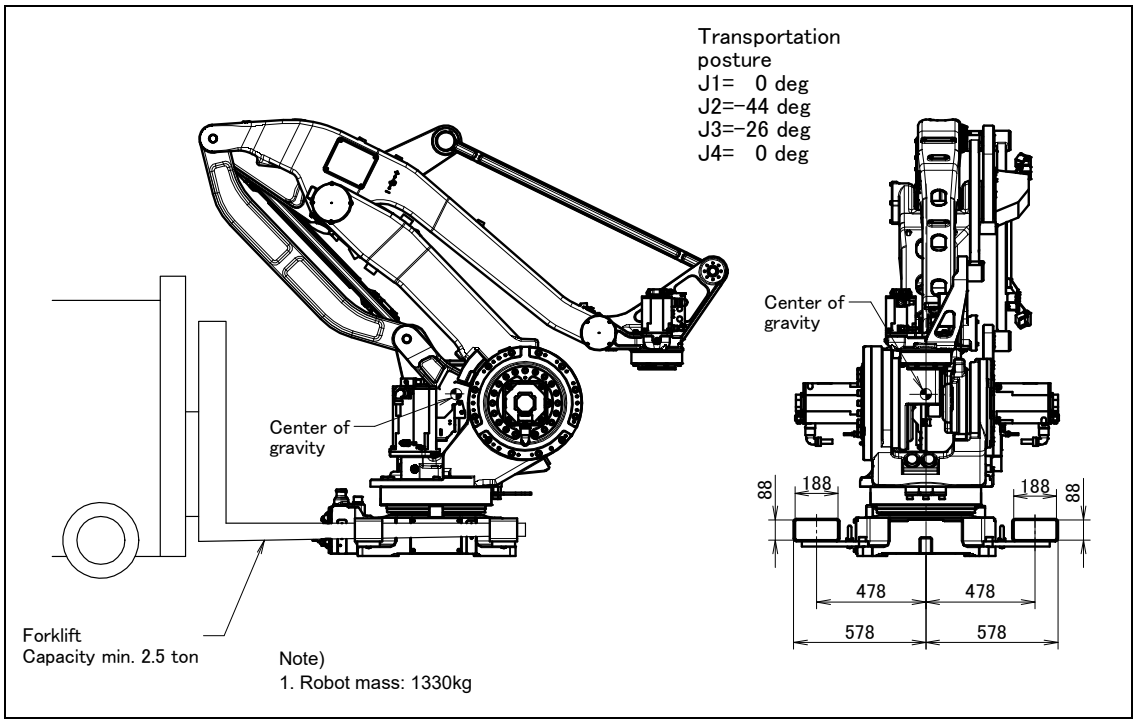


Fig. 1.1 (h) Transportation using a forklift (no pedestal) (M-410*i*C/185/315)

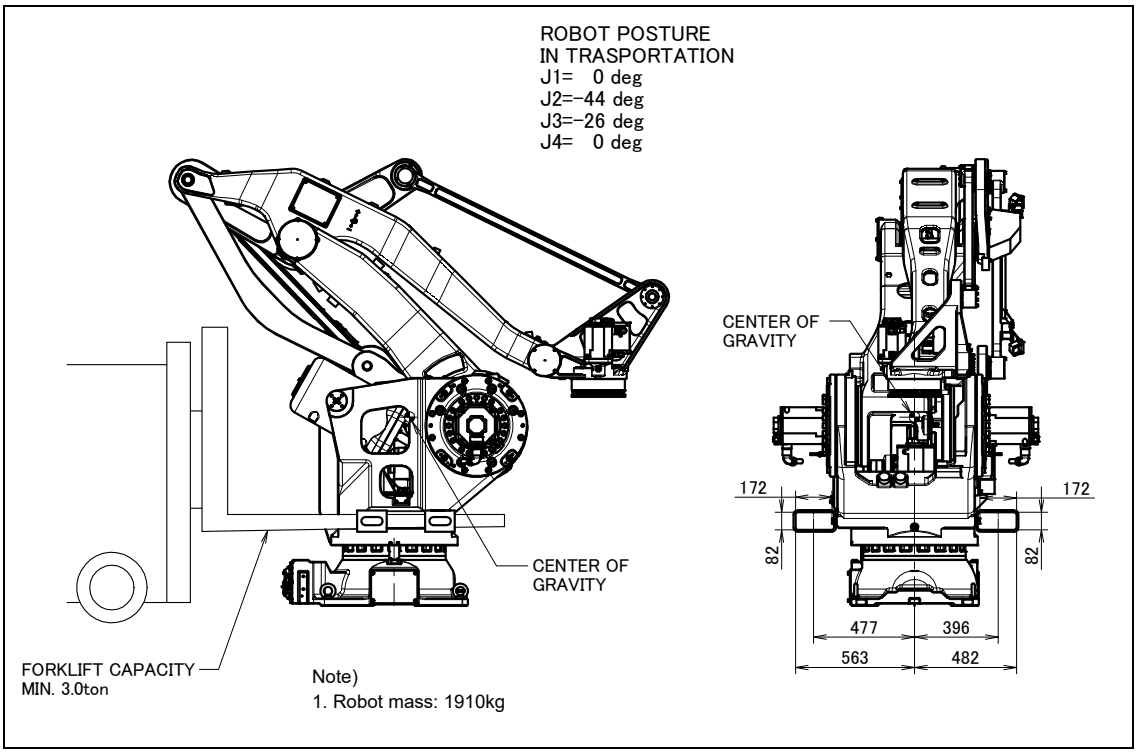


Fig. 1.1 (i) Transportation using a forklift (M-410*i*C/500)

> ⚠ **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.

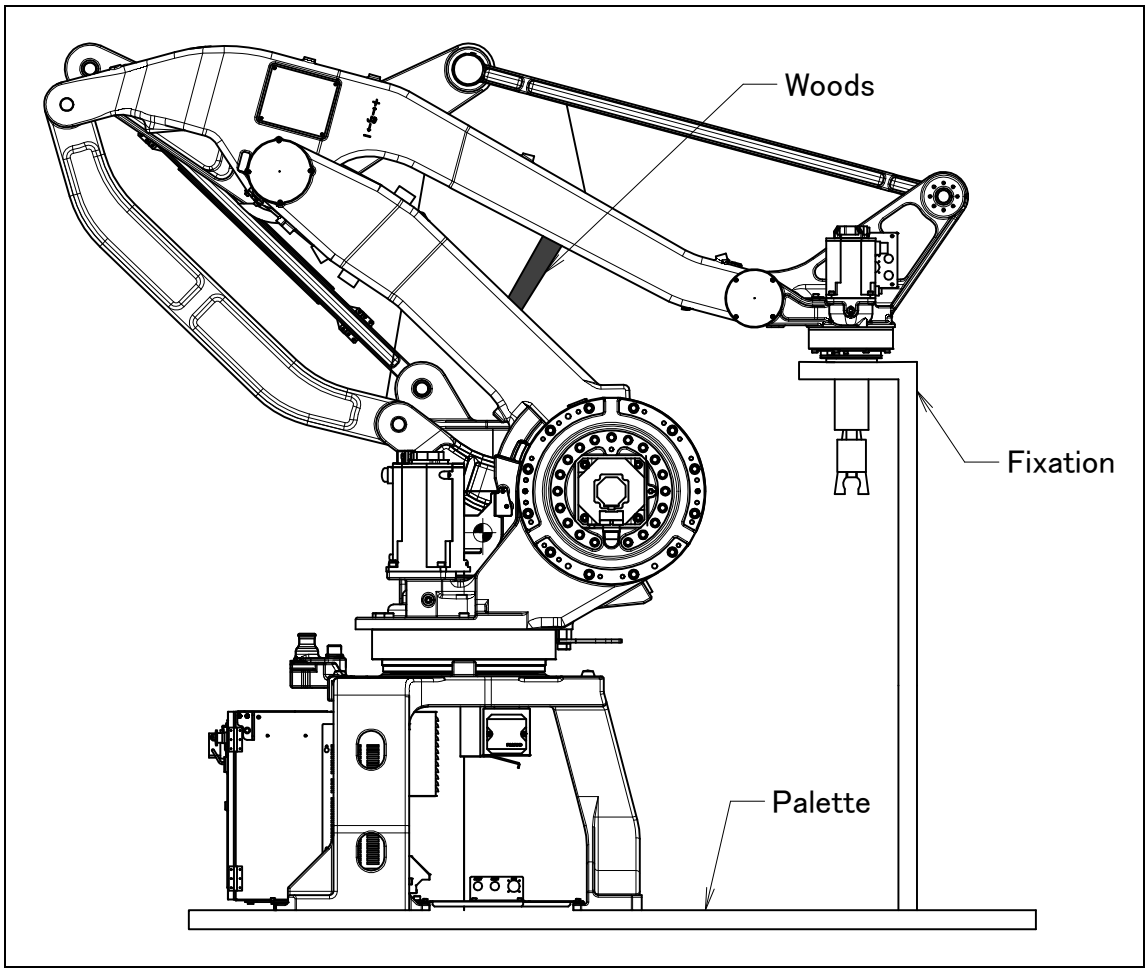


Fig. 1.1.1 (a) Example of securing the arm during transportation when an end effector is attached

1.2 INSTALLATION

Fig. 1.2 (a) to (d) show 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.

⚠ CAUTION

1 If the robot base is secured directly to the floor with chemical anchors, the anchors may fail due to fluctuating load during robot operation.
2 Do not provide leveling (with a wedge, for example) between the robot base and floor plate. Otherwise, any robot vibration may be accentuated due to the robot not being in close contact with the floor plate.

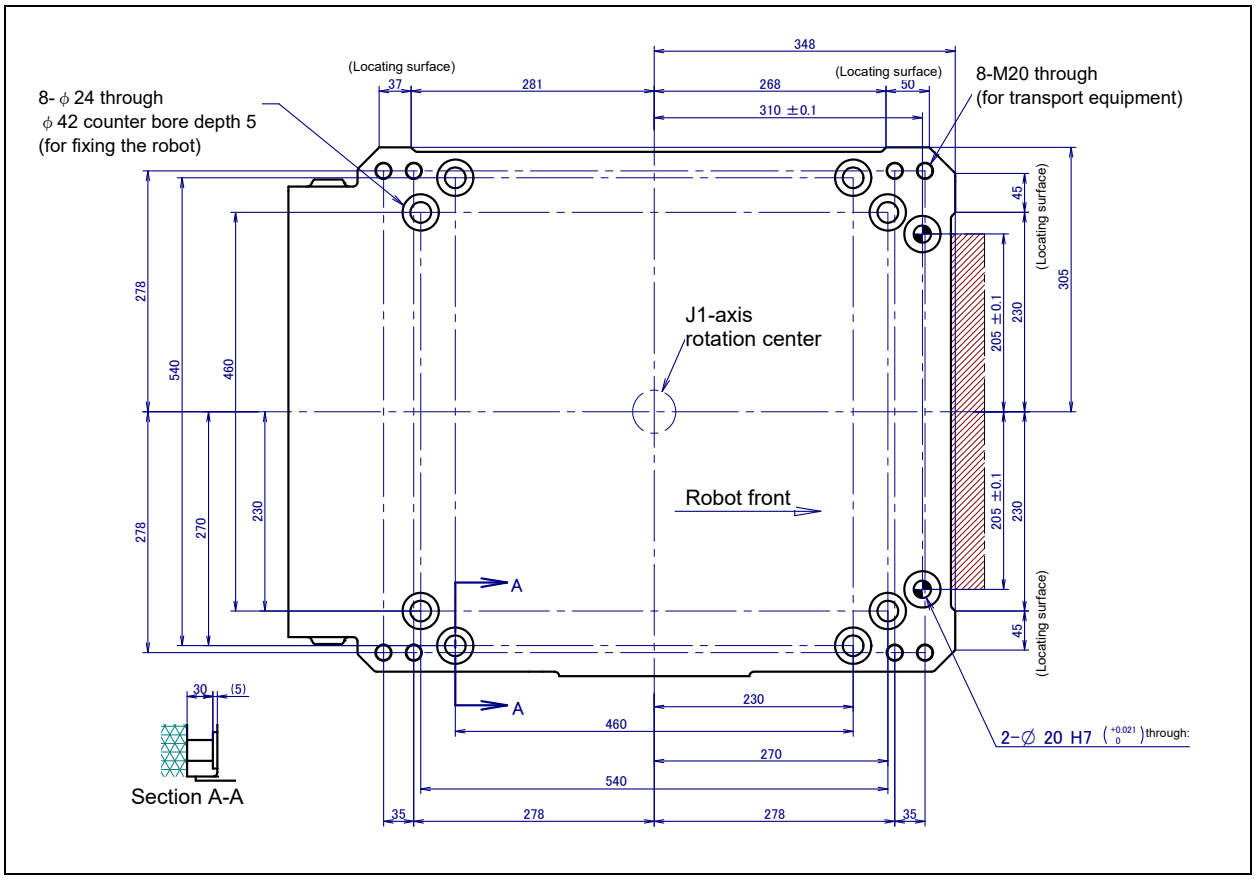


Fig. 1.2 (a) Installation hole dimensions of the robot base (M-410*i*C/110)

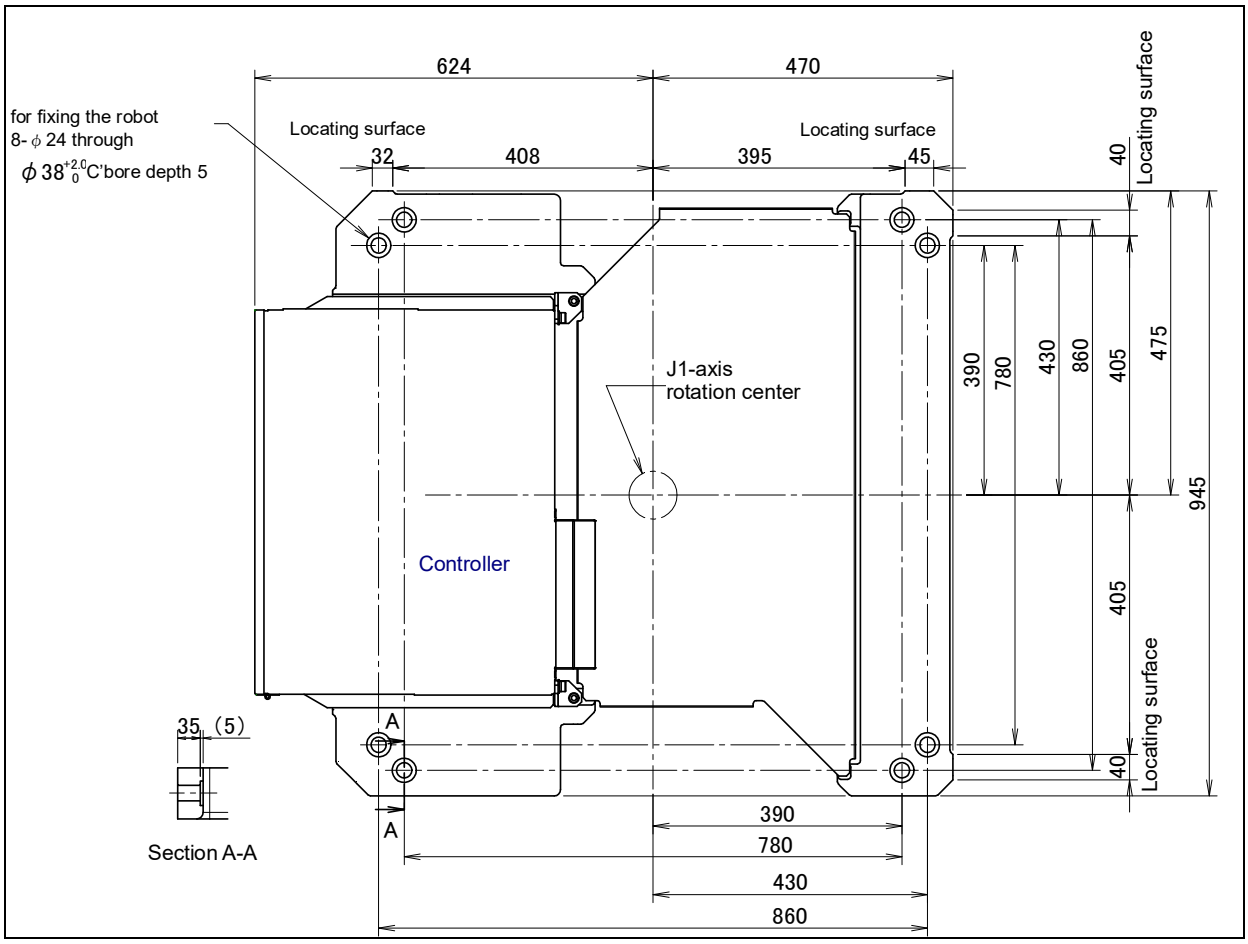


Fig. 1.2 (b) Installation hole dimensions of the robot base (pedestal type) (M-410*i*C/185/315/500)

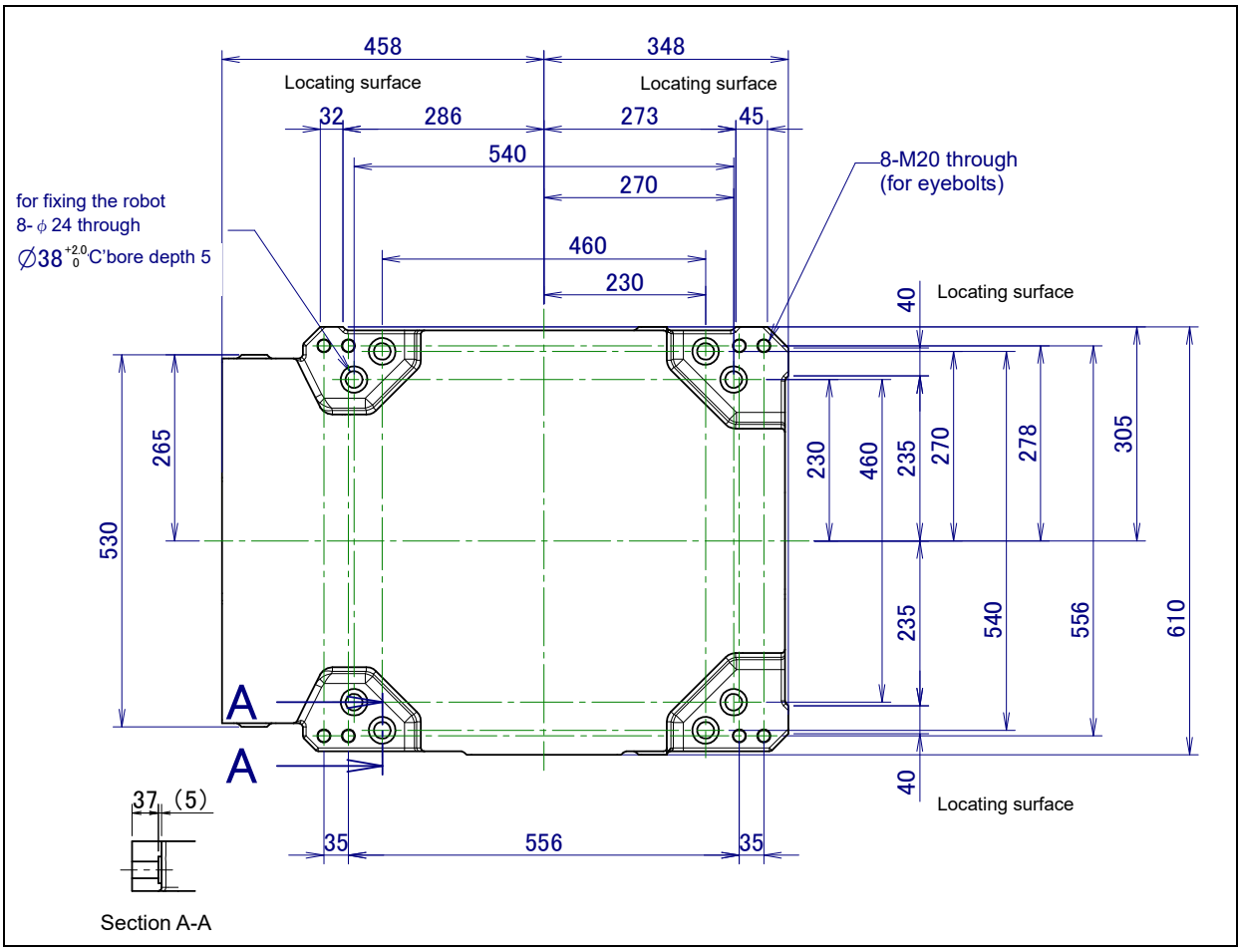


Fig. 1.2 (c) Installation hole dimensions of the robot base (no pedestal) (M-410*i*C/185/315)

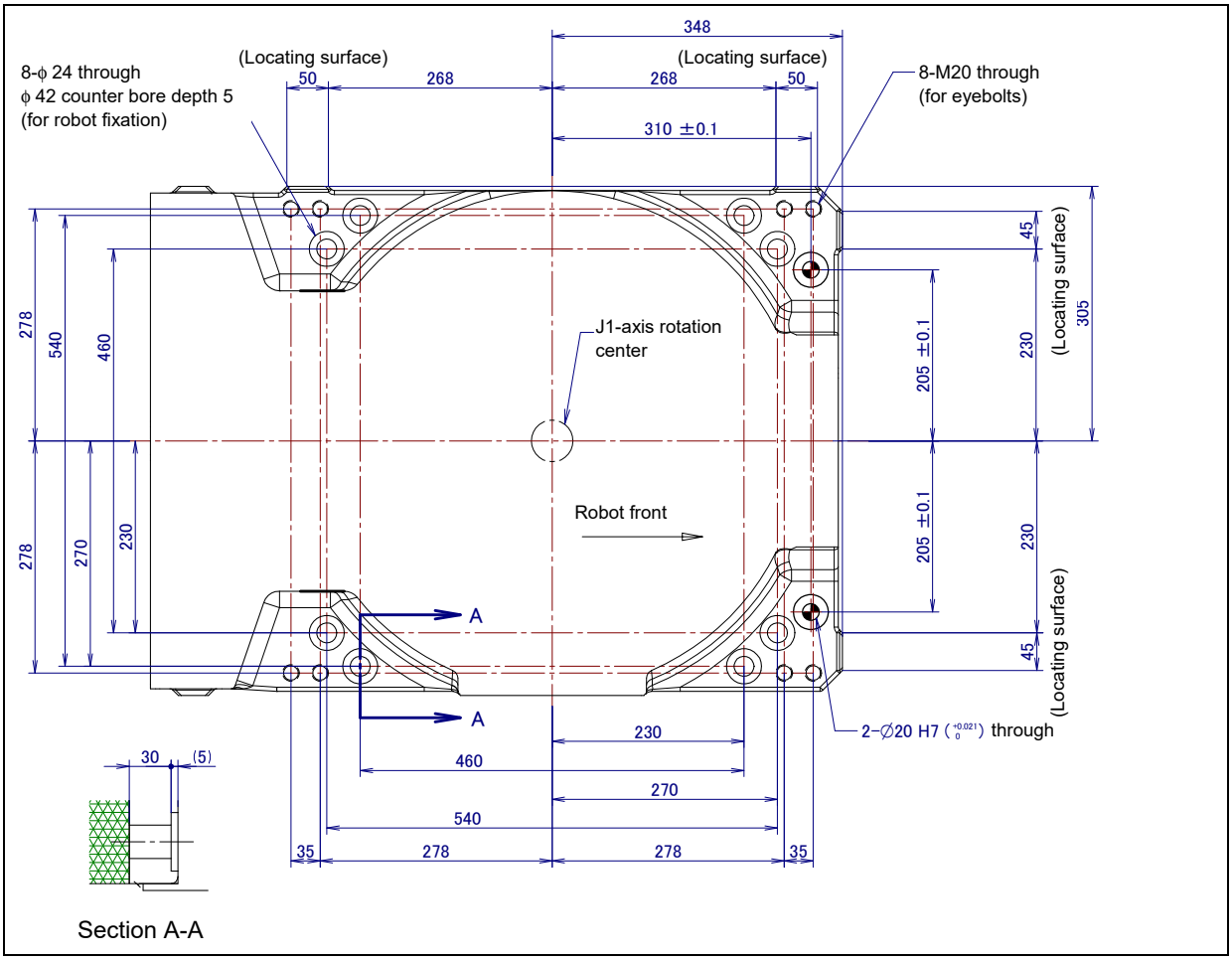


Fig. 1.2 (d) Installation hole dimensions of the robot base (no pedestal) (M-410*i*C/500)

1.2.1 Actual Installation Example

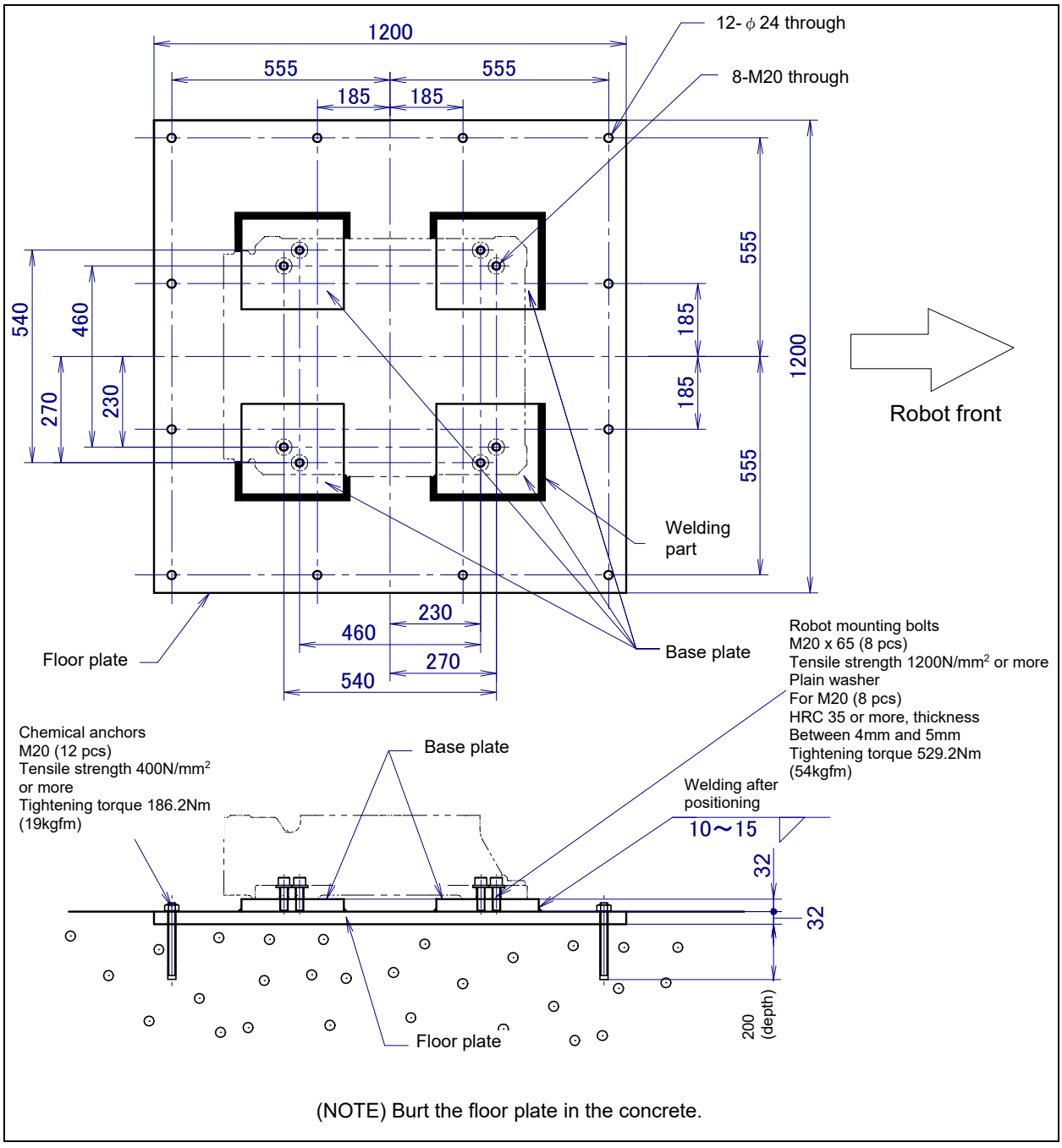
The following show three actual examples of the robot installation. Select a method according to the customer's installation environment, and install the robot.

- Installation example I Fig. 1.2.1 (a), (c), (e), (g), (i)
  The floor plate is imbedded in concrete and fastened with M20 (Tensile strength 400N/mm^2 or more) chemical anchors. Also fasten the base plate to the robot base using 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 II Fig. 1.2.1 (b), (d), (f), (h), (j)
  The floor plate is not imbedded in concrete. The floor plate is fastened 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).

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.

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) Burt the floor plate in the concrete.

Fig. 1.2.1 (a) Sample installation 1 (M-410*i*C/110)

NOTE

The customer should prepare the following parts:

- Eight robot securing bolts : M20 x 65 (tensile strength greater or equal to 1200N/mm^2)
- Eight plain washers : M20
- Twelve chemical anchors : M20 (tensile strength greater or equal to 400N/mm^2)
- One floor plate : 32t in thickness

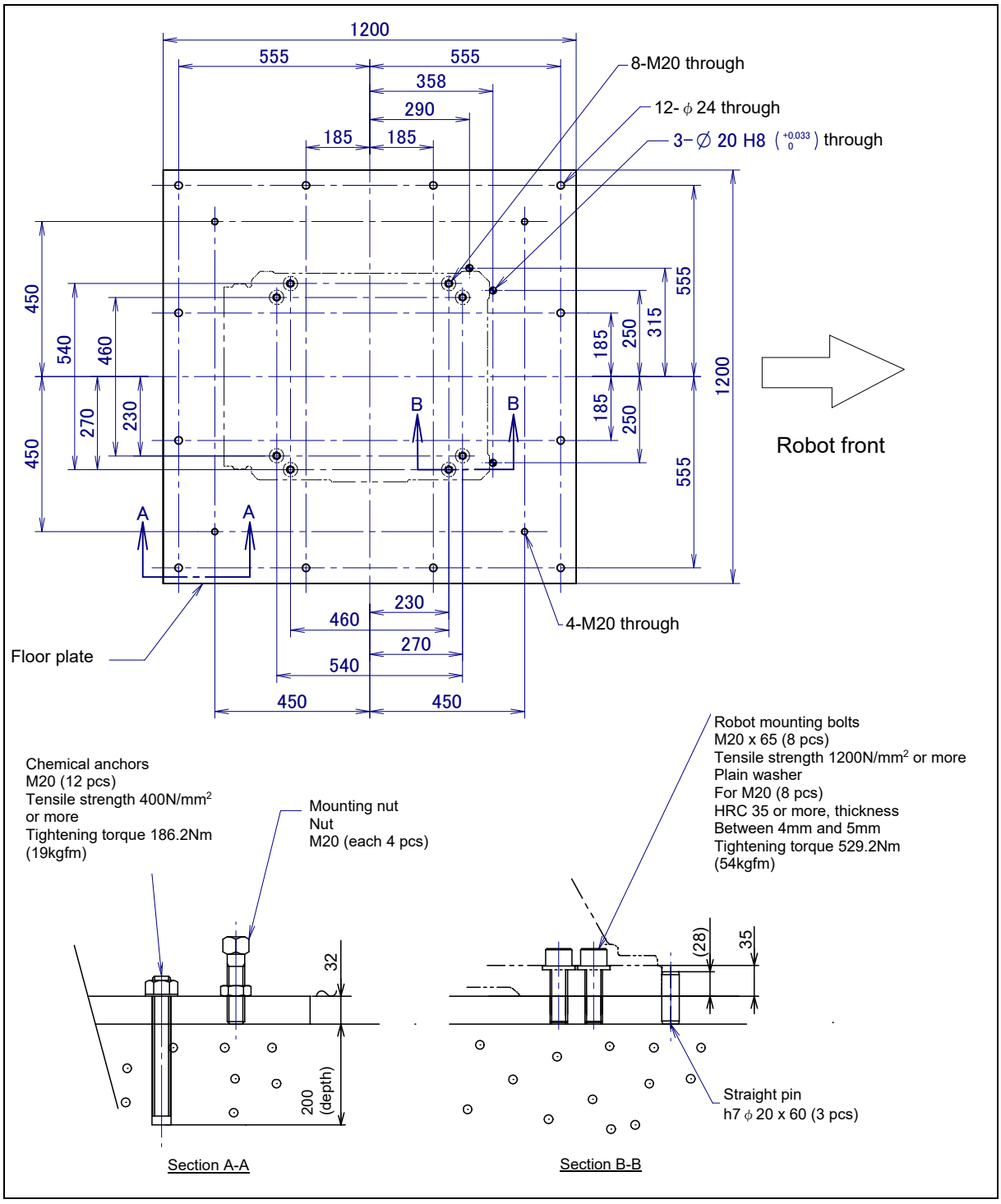


Fig. 1.2.1 (b) Sample installation 2 (M-410*i*C/110)

NOTE

The customer should prepare the following parts:

- Eight robot securing bolts : M20 x 65 (tensile strength greater or equal to 1200N/mm^2)
- Eight plain washers : M20
- Twelve chemical anchors : M20 (tensile strength greater or equal to 400N/mm^2)
- Four fixing screws : M20
- Four nuts : M20
- Three parallel pins : Φ20
- One floor plate : 32t in thickness

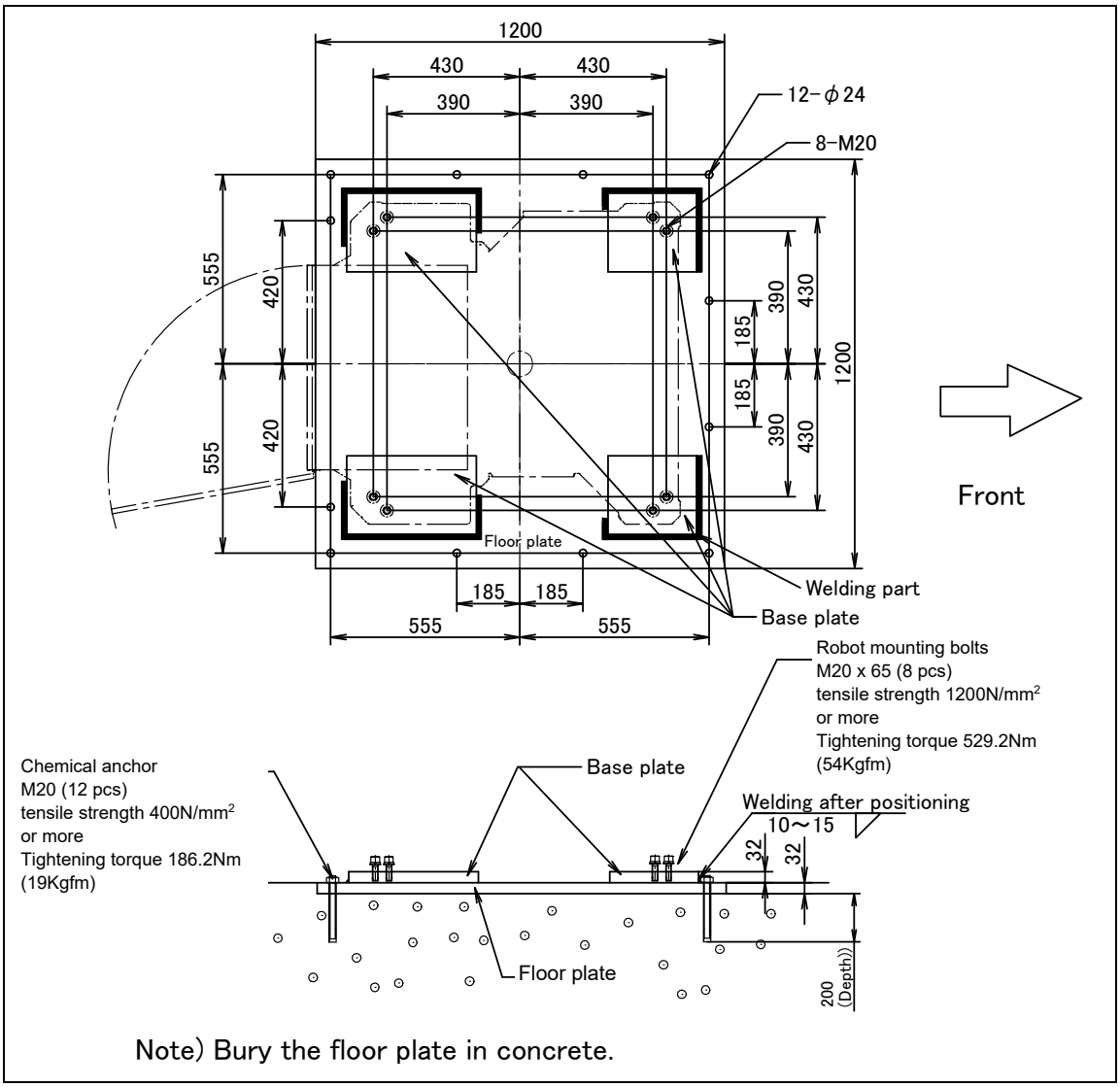


Fig. 1.2.1 (c) Sample installation 1 (pedestal type) (M-410*i*C/185/315)

NOTE

The customer should prepare the following parts:

- Eight robot securing bolts : M20 x 65 (tensile strength greater or equal to 1200N/mm^2)
- Twelve chemical anchors : M20 (tensile strength greater or equal to 400N/mm^2)
- One floor plate : 32t in thickness

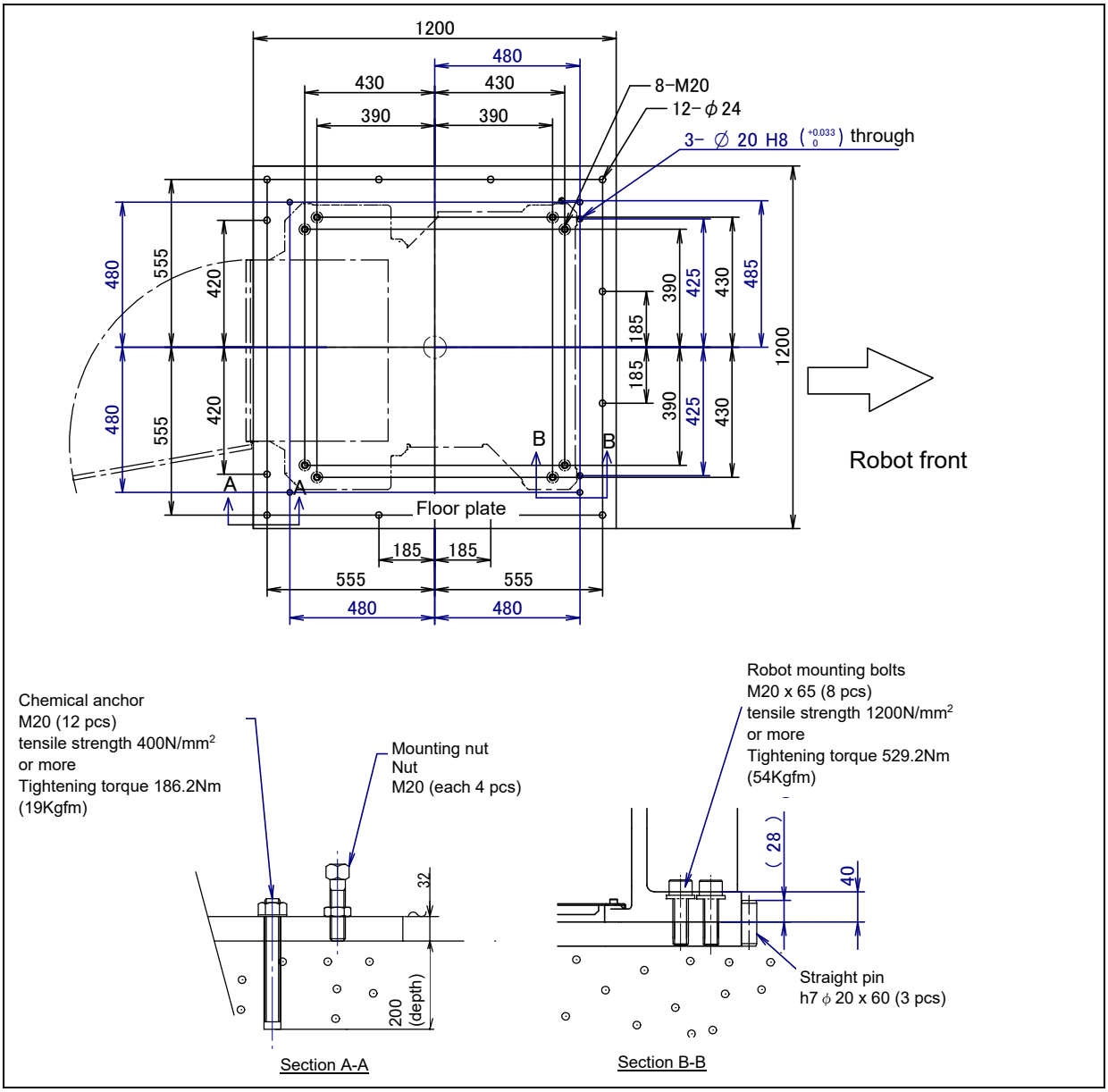


Fig. 1.2.1 (d) Sample installation 2 (pedestal type) (M-410*i*C/185/315)

NOTE

The customer should prepare the following parts:

- Eight robot securing bolts : M20 x 65 (tensile strength greater or equal to 1200N/mm^2)
- Twelve chemical anchors : M20 (tensile strength greater or equal to 400N/mm^2)
- Four fixing screws : M20
- Four nuts : M20
- Three parallel pins : Φ20
- One floor plate : 32t in thickness

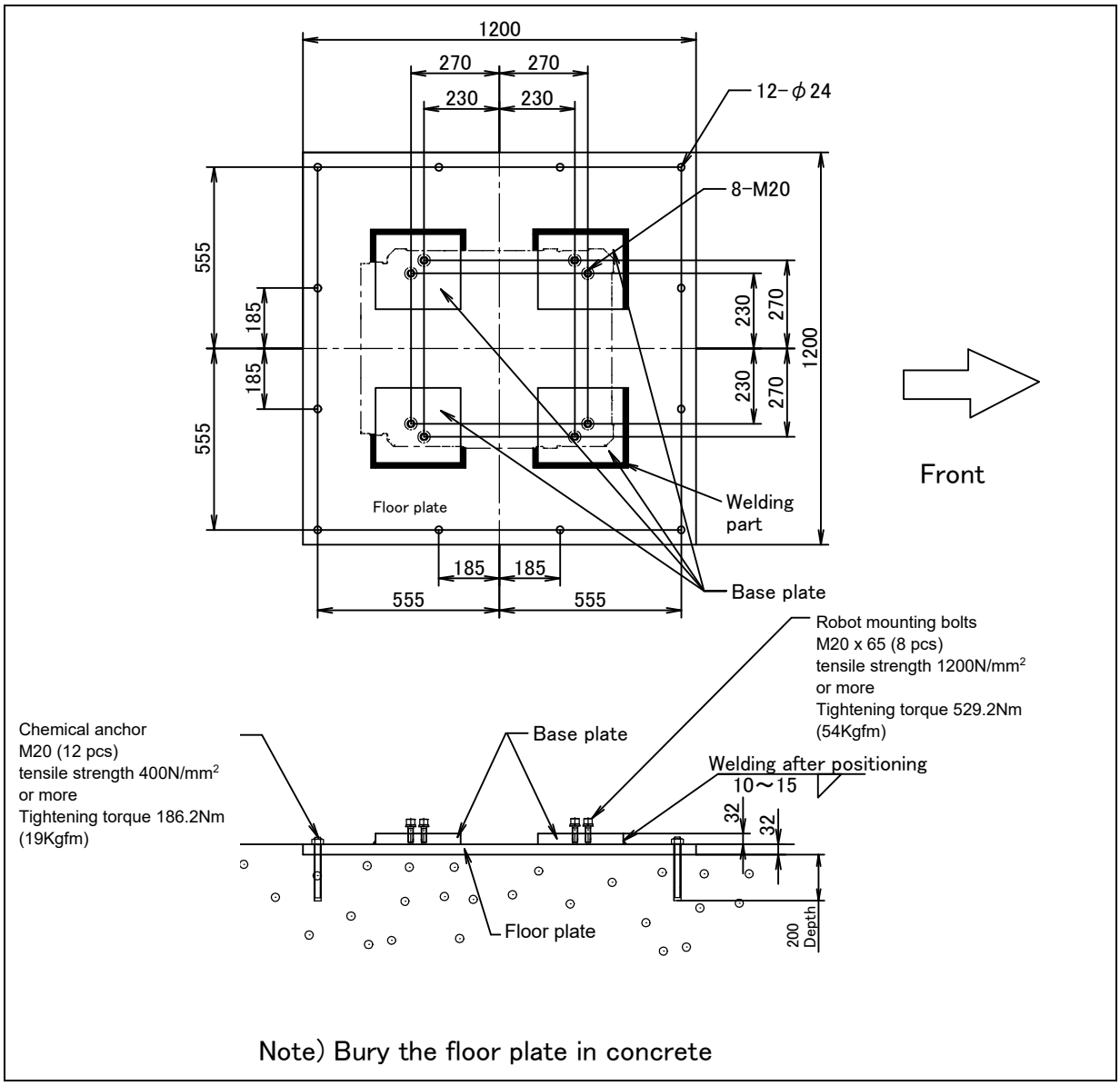


Fig. 1.2.1 (e) Sample installation 1 (no pedestal) (M-410*i*C/185/315)

NOTE

The customer should prepare the following parts:

- Eight robot securing bolts : M20 x 65 (tensile strength greater or equal to 1200N/mm^2)
- Twelve chemical anchors : M20 (tensile strength greater or equal to 400N/mm^2)
- One floor plate : 32t in thickness

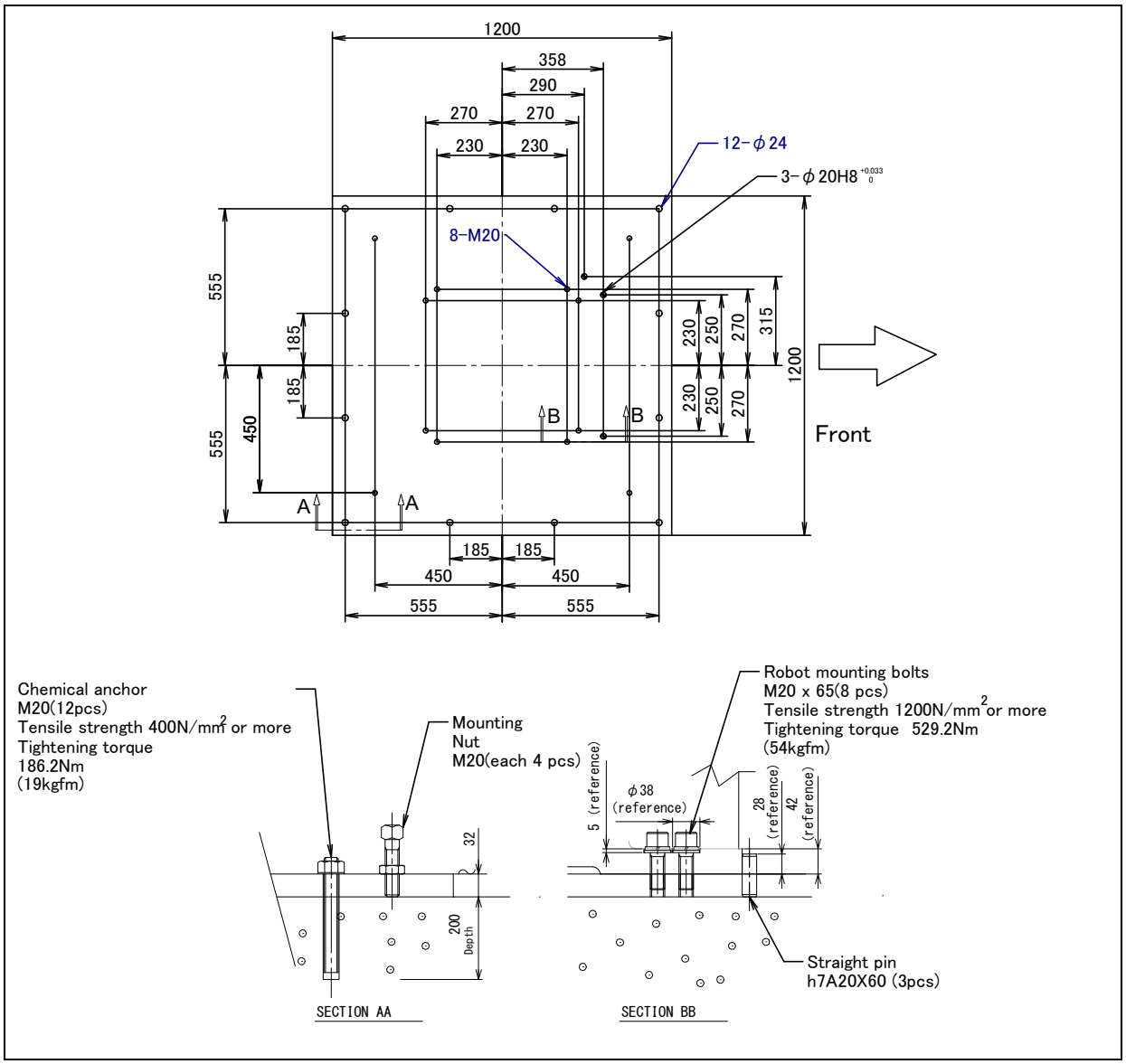


Fig. 1.2.1 (f) Sample installation 2 (no pedestal) (M-410*i*C/185/315)

NOTE

The customer should prepare the following parts:

- Eight robot securing bolts : M20 x 65 (tensile strength greater or equal to 1200N/mm^2)
- Twelve chemical anchors : M20 (tensile strength greater or equal to 400N/mm^2)
- Four fixing screws : M20
- Four nuts : M20
- Three parallel pins : Φ20
- One floor plate : 32t in thickness

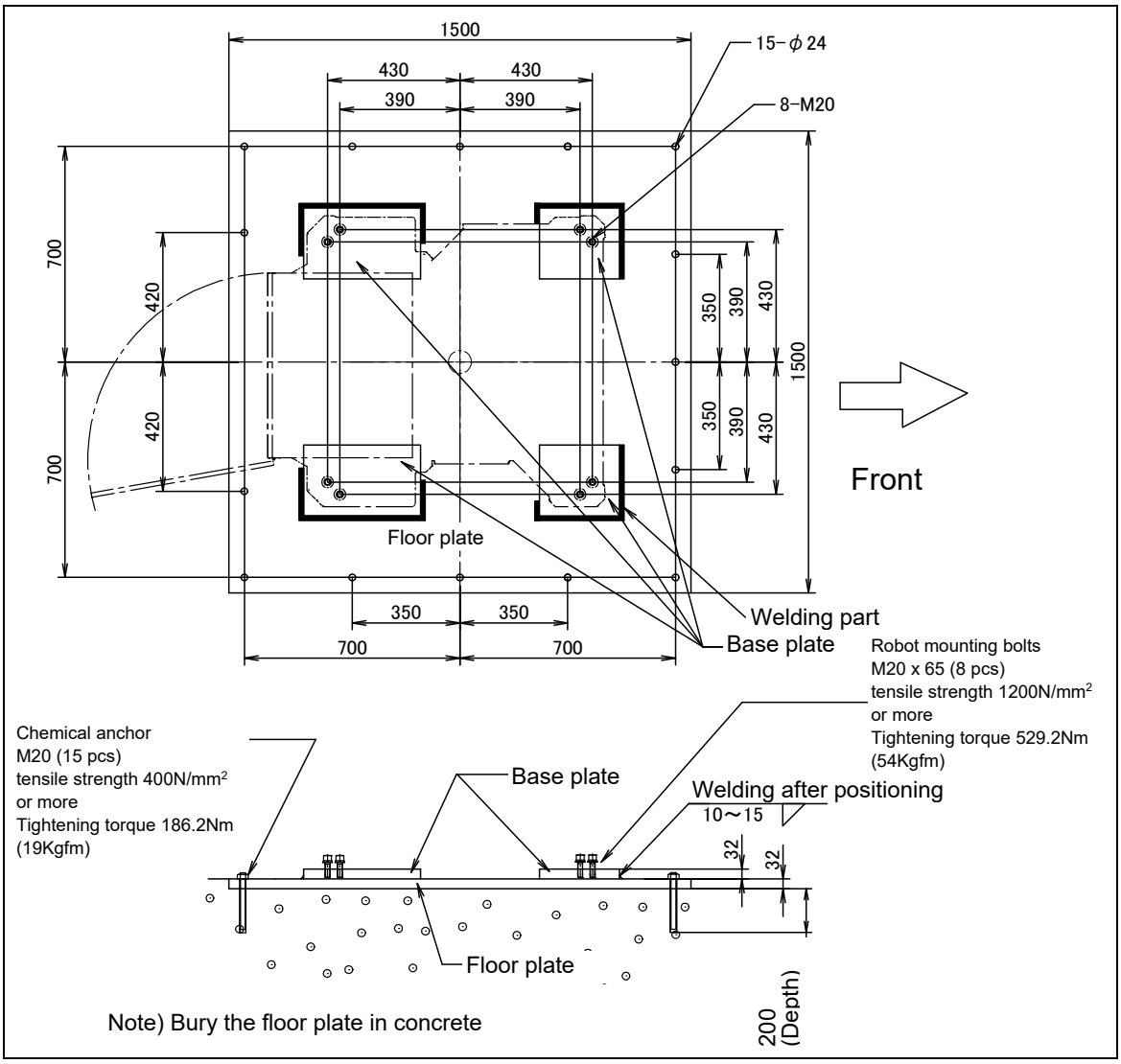


Fig. 1.2.1 (g) Sample installation 1 (pedestal type) (M-410*i*C/500)

NOTE

The customer should prepare the following parts:

- Eight robot securing bolts : M20 x 65 (tensile strength greater or equal to 1200N/mm^2)
- Fifteen chemical anchors : M20 (tensile strength greater or equal to 400N/mm^2)
- One floor plate : 32t in thickness

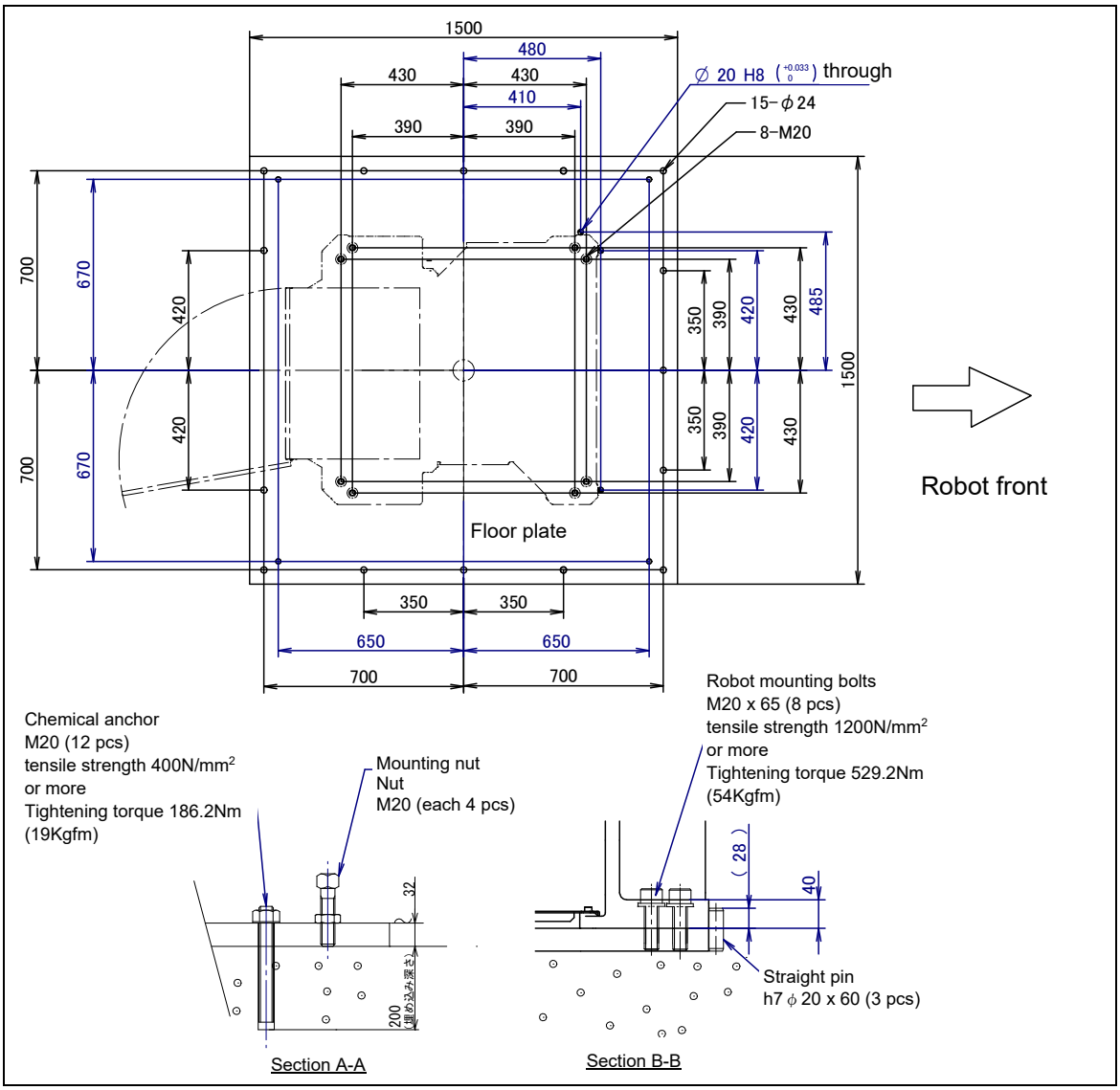


Fig. 1.2.1 (h) Sample installation 2 (pedestal type)(M-410*i*C/500)

NOTE

The customer should prepare the following parts:

- Eight robot securing bolts : M20 x 65 (tensile strength greater or equal to 1200N/mm^2)
- Twelve chemical anchors : M20 (tensile strength greater or equal to 400N/mm^2)
- Four fixing screws : M20
- Four nuts : M20
- Three parallel pins : Φ20
- One floor plate : 32t in thickness

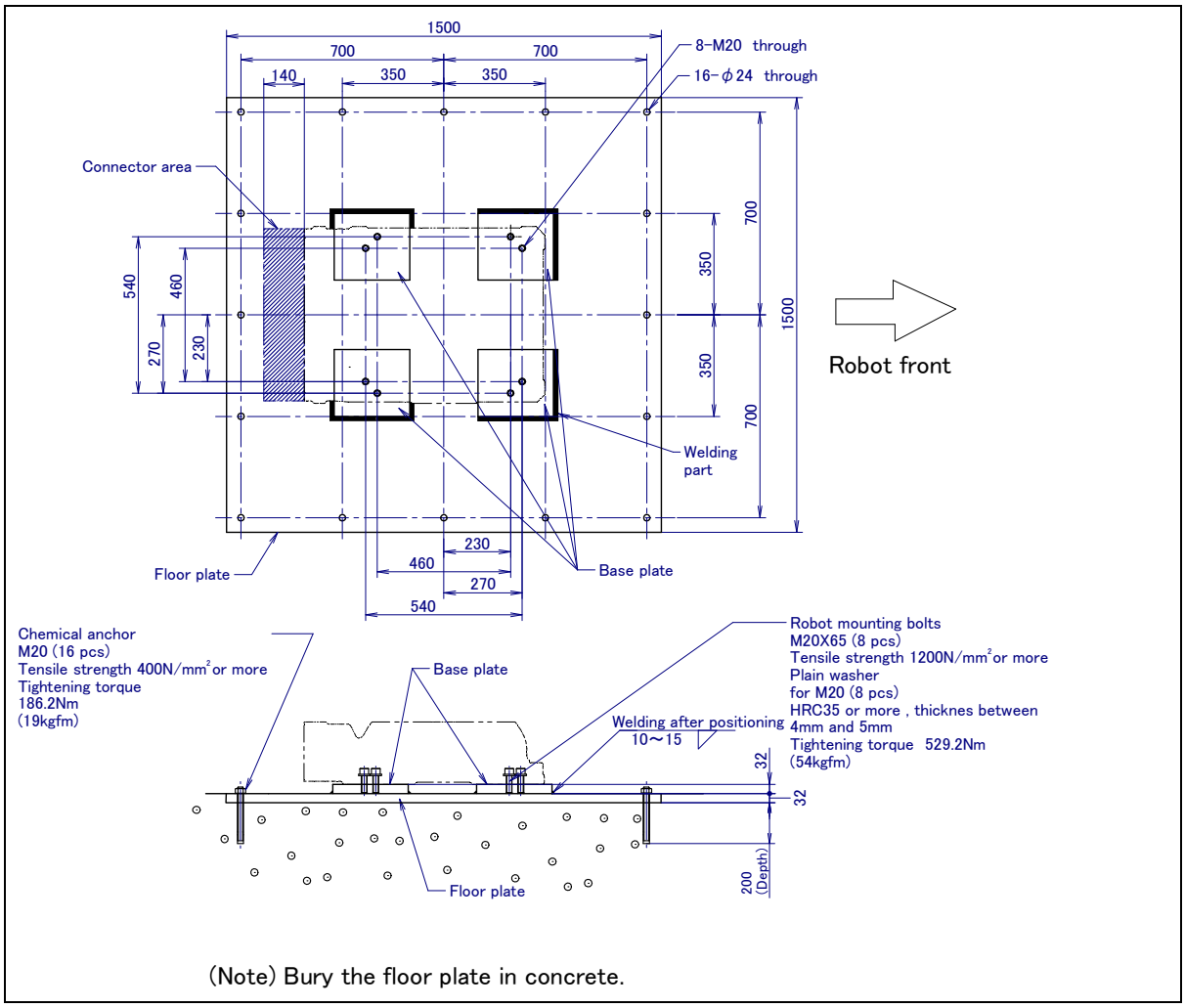


Fig. 1.2.1 (i) Sample installation (no pedestal) (M-410*i*C/500)

NOTE

The customer should prepare the following parts:

- Eight robot securing bolts : M20 x 65 (tensile strength greater or equal to 1200N/mm^2)
- Eight plain washers : M20
- Sixteen chemical anchors : M20 (tensile strength greater or equal to 400N/mm^2)
- One floor plate : 32t in thickness

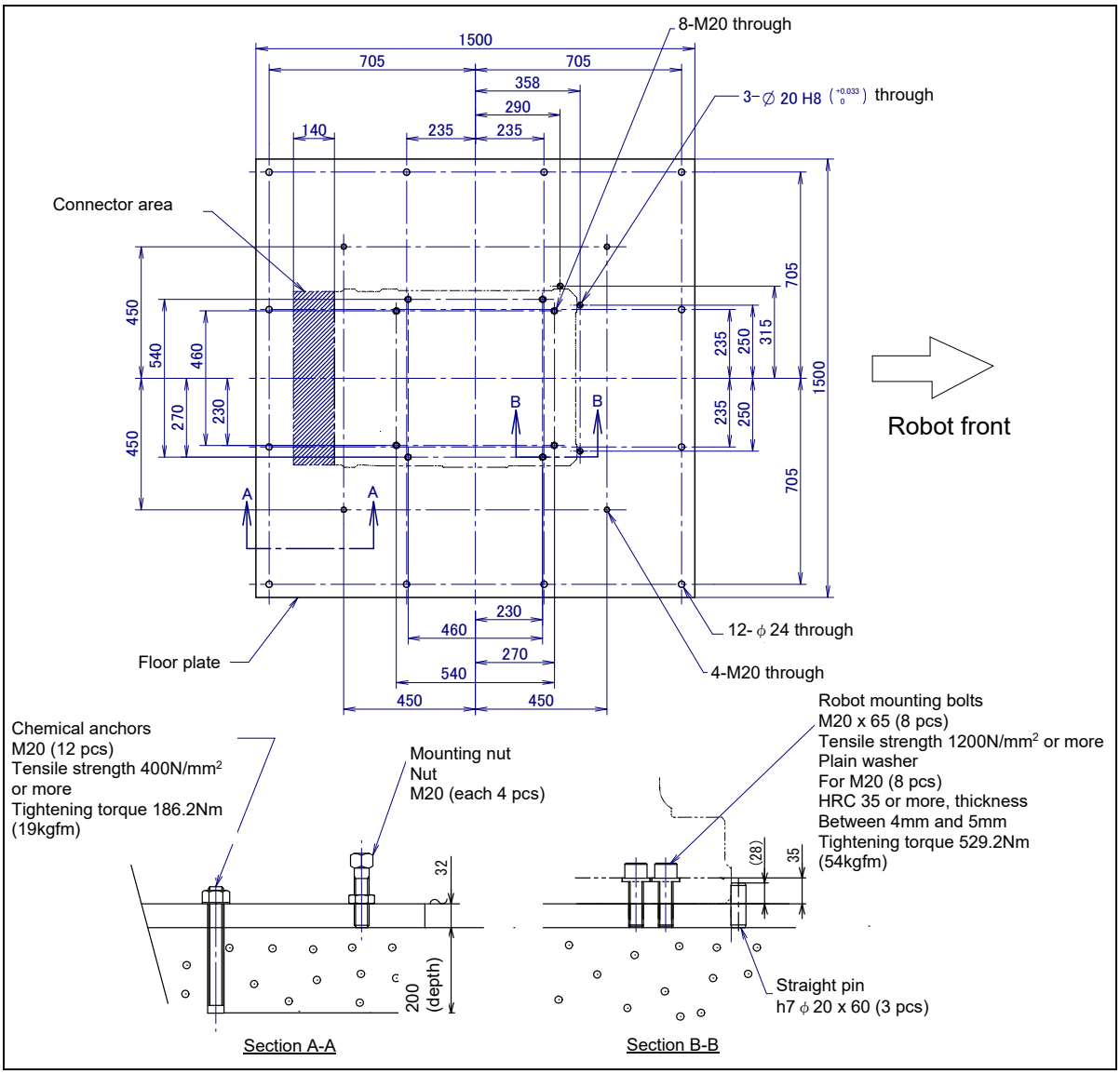


Fig. 1.2.1 (j) Actual installation example 2 (no pedestal) (M-410*i*C/500)

NOTE

The customer should prepare the following parts:

- Eight robot securing bolts : M20 x 65 (tensile strength greater or equal to 1200N/mm^2)
- Eight plain washers : M20
- Twelve chemical anchors : M20 (tensile strength greater or equal to 400N/mm^2)
- Four fixing screws : M20
- Four nuts : M20
- Three parallel pins : Φ20
- One floor plate : 32t in thickness

Fig. 1.2.1 (k) and Table 1.2.1 (a) to (d) indicate the force and moment applied to the base plate at the time of Power-off stop of the robot. Table 1.2.1 (e) to (g) indicate the stopping distance and time of the J1 to J3-axis until the robot stops by Power-Off stop or by Controlled stop or Smooth stop after input of the stop signal. Refer to the data when considering the strength of the installation face.

NOTE
Table 1.2.1 (e) to (g) 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 (e) is affected by the robot operating status and number of times of the Servo-Off stop. Periodically measure the real values and confirm those.

Table 1.2.1 (a) Force and moment that act on base (M-410*i*C/110)

	Static	Dynamic Acceleration /Deceleration	Power-off stop
Vertical moment :M_V	8100Nm (820kgfm)	20600Nm (2100kgfm)	30800Nm (3140kgfm)
Force in vertical direction :F_V	14000N (1430kgf)	17000N (1730kgf)	21700N (2220kgf)
Horizontal moment :M_H	0 Nm (0 kgfm)	5000Nm (510kgfm)	5800Nm (590kgfm)
Force in horizontal direction :F_H	0 N (0 kgf)	8600N (870kgf)	8700N (890kgf)

Table 1.2.1 (b) Force and moment that act on base (M-410*i*C/185)

	Static	Dynamic Acceleration /Deceleration	Power-off stop
Vertical moment :M_V	13700Nm (1400kgfm)	44800Nm (4570kgfm)	65000Nm (6630kgfm)
Force in vertical direction :F_V	17500N (1785kgf)	31600N (3230kgf)	38100N (3890kgf)
Horizontal moment :M_H	0 Nm (0 kgfm)	10400Nm (1060kgfm)	11600Nm (1190kgfm)
Force in horizontal direction :F_H	0 N (0 kgf)	14200N (1450kgf)	15700N (1600kgf)

Table 1.2.1 (c) Force and moment that act on base (M-410*i*C/315)

	Static	Dynamic Acceleration /Deceleration	Power-off stop
Vertical moment :M_V	18000Nm (1840kgfm)	56600Nm (5780kgfm)	67100Nm (6850kgfm)
Force in vertical direction :F_V	18600N (1900kgf)	34800N (3550kgf)	41700N (4260kgf)
Horizontal moment :M_H	0 Nm (0 kgfm)	14100Nm (1440kgfm)	14400Nm (1470kgfm)
Force in horizontal direction :F_H	0 N (0 kgf)	9400N (960kgf)	10800N (1100kgf)

Table 1.2.1 (d) Force and moment that act on base (M-410*i*C/500)

	Static	Dynamic Acceleration /Deceleration	Power-off stop
Vertical moment :M_V	27100Nm (2770kgfm)	58300Nm (5950kgfm)	103900Nm (10600kgfm)
Force in vertical direction :F_V	28500N (2910kgf)	33300N (3400kgf)	56000N (5710kgf)
Horizontal moment :M_H	0 Nm (0 kgfm)	10700Nm (1090kgfm)	44000Nm (4490kgfm)
Force in horizontal direction :F_H	0 N (0 kgf)	11000N (1120kgf)	21000N (2140kgf)

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

Model		J1-axis	J2-axis	J3-axis
M-410*i*C/110	Stopping time [ms]	640	136	152
	Stopping distance [deg] (rad)	45.2 (0.79)	9.6 (0.17)	11.6 (0.20)
M-410*i*C/185	Stopping time [ms]	928	340	236
	Stopping distance [deg] (rad)	52.7 (0.92)	24.7 (0.43)	14.3 (0.25)
M-410*i*C/315	Stopping time [ms]	644	252	228
	Stopping distance [deg] (rad)	27.3(0.48)	12.9(0.23)	12.9(0.23)
M-410*i*C/500	Stopping time [ms]	708	252	204
	Stopping distance [deg] (rad)	24.8 (0.43)	11.6 (0.20)	9.0 (0.16)

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

Model		J1-axis	J2-axis	J3-axis
M-410*i*C/185	Stopping time [ms]	1156	1140	1084
	Stopping distance [deg] (rad)	82.0 (1.43)	68.1 (1.19)	59.5 (1.04)
M-410*i*C/315	Stopping time [ms]	812	804	796
	Stopping distance [deg] (rad)	39.5 (0.69)	43.1 (0.75)	46.0 (0.80)
M-410*i*C/500	Stopping time [ms]	972	972	964
	Stopping distance [deg] (rad)	43.6 (0.76)	43.6 (0.76)	43.4 (0.76)

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

Model		J1-axis	J2-axis	J3-axis
M-410*i*C/110	Stopping time [ms]	700	392	288
	Stopping distance [deg] (rad)	49.4 (0.86)	24.6 (0.43)	19.0 (0.33)
M-410*i*C/185	Stopping time [ms]	1084	604	444
	Stopping distance [deg] (rad)	70.8 (1.24)	38.7 (0.68)	29.6 (0.52)
M-410*i*C/315	Stopping time [ms]	732	532	492
	Stopping distance [deg] (rad)	35.9 (0.63)	29.3 (0.51)	27.0 (0.47)
M-410*i*C/500	Stopping time [ms]	884	452	516
	Stopping distance [deg] (rad)	37.1 (0.65)	18.8 (0.33)	21.4 (0.37)

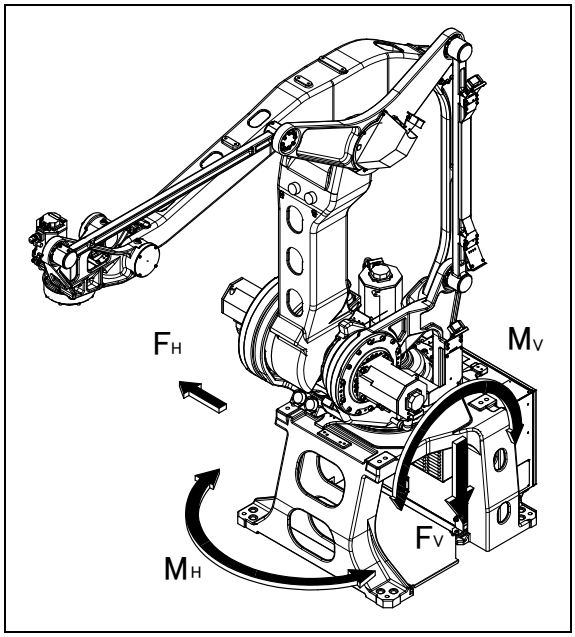


Fig. 1.2.1 (k) Force and moment that acts on base

1.3 MAINTENANCE AREA

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

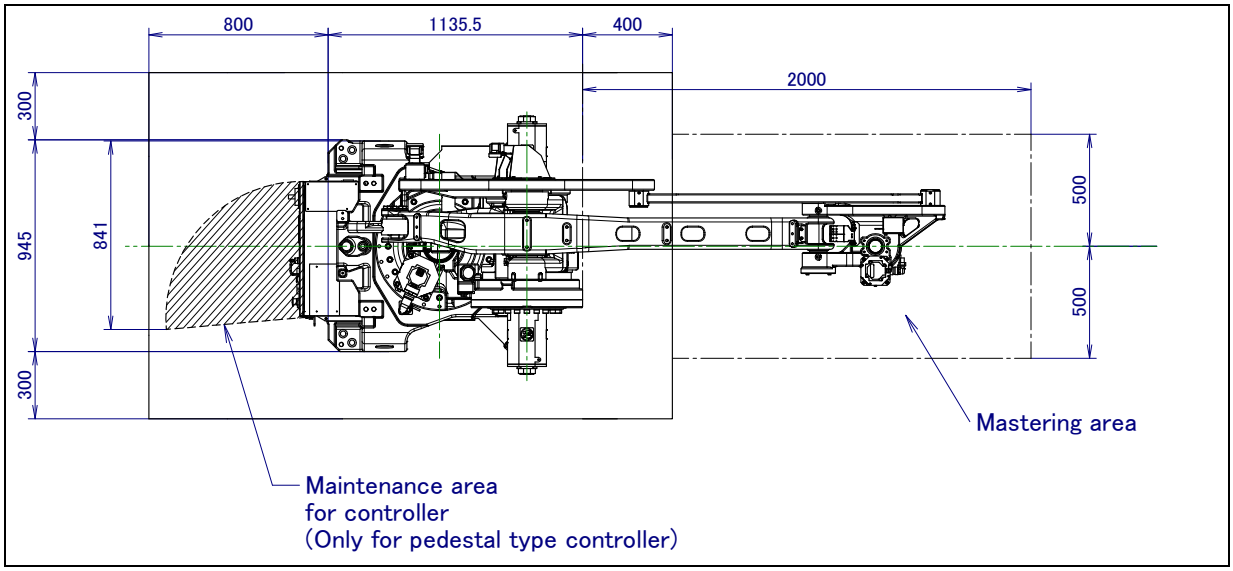


Fig. 1.3 (a) Maintenance area

1.4 INSTALLATION CONDITIONS

Refer to specification of Section 3.1 for installation conditions.

⚠ CAUTION

1 If the robot M-410*i*C/500 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 to the cable jacket can cause water intrusion. Take care not to damage the cable jacket when installing the robot. Replace the cable if it is damaged.

3 Liquid intrusion into the balancer of the M-410*i*C/500 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

In case of the M-410*i*C/185/315 pedestal type, cable of controller is connected to motor of robot directly.
In case of M-410***i***C/185/315 no pedestal and M-410*i*C/110/500, the robot is connected with the controller via the power cable, signal cable, and the earth cable. Connect these cables to the connectors on the back of the J1 base.
In case of M-410***i***C/500 pedestal type, pass the robot connection cable and the earth line through the metal plate as shown in Fig. 2.1 (c) and fix it with a cable tie.

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

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

> ⚠ **CAUTION**
> 1 Before connecting the cables, be sure to turn off the power.
> 2 Do not use 10m or longer coiled cable without untying. The long coiled cable will heat and damage itself.

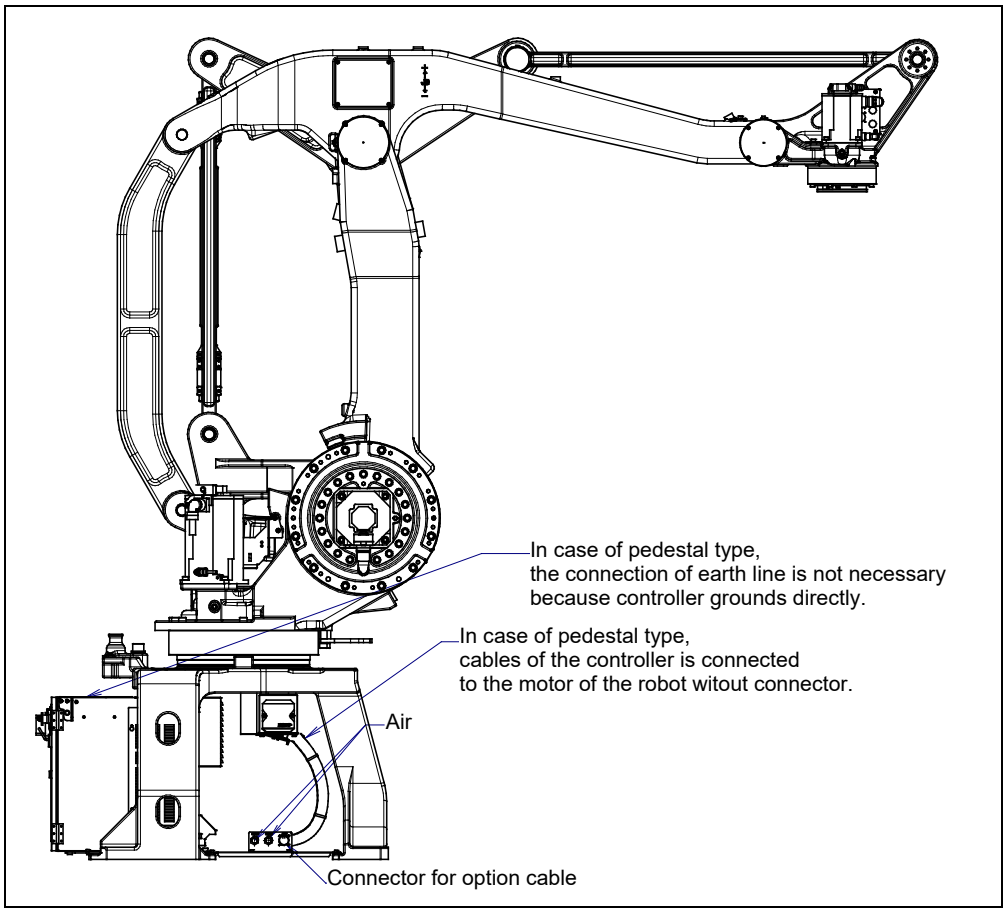


Fig. 2.1 (a) Cable connection (M-410*i*C/185/315 pedestal type)

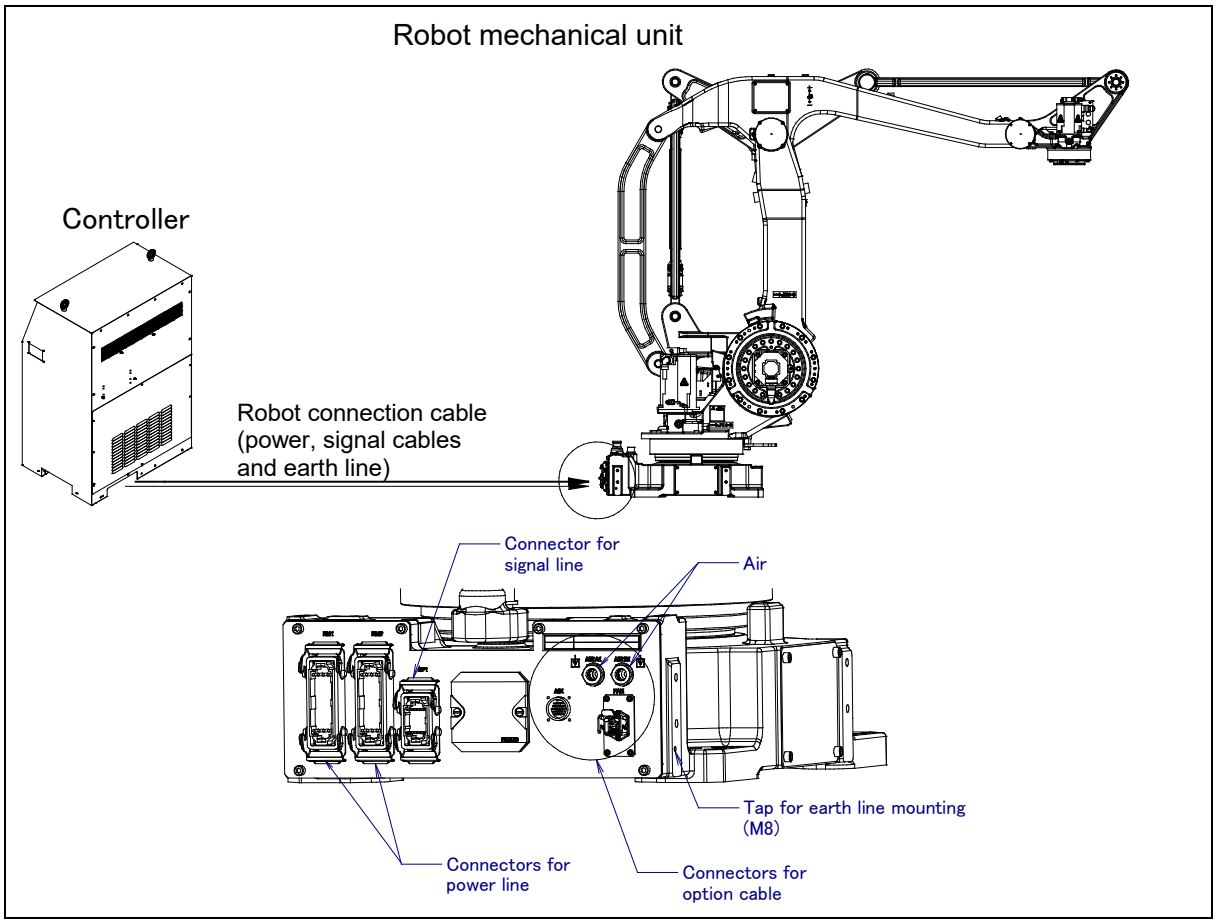


Fig. 2.1 (b) Cable connection (M-410*i*C/185/315 no pedestal and M-410*i*C/110/500)

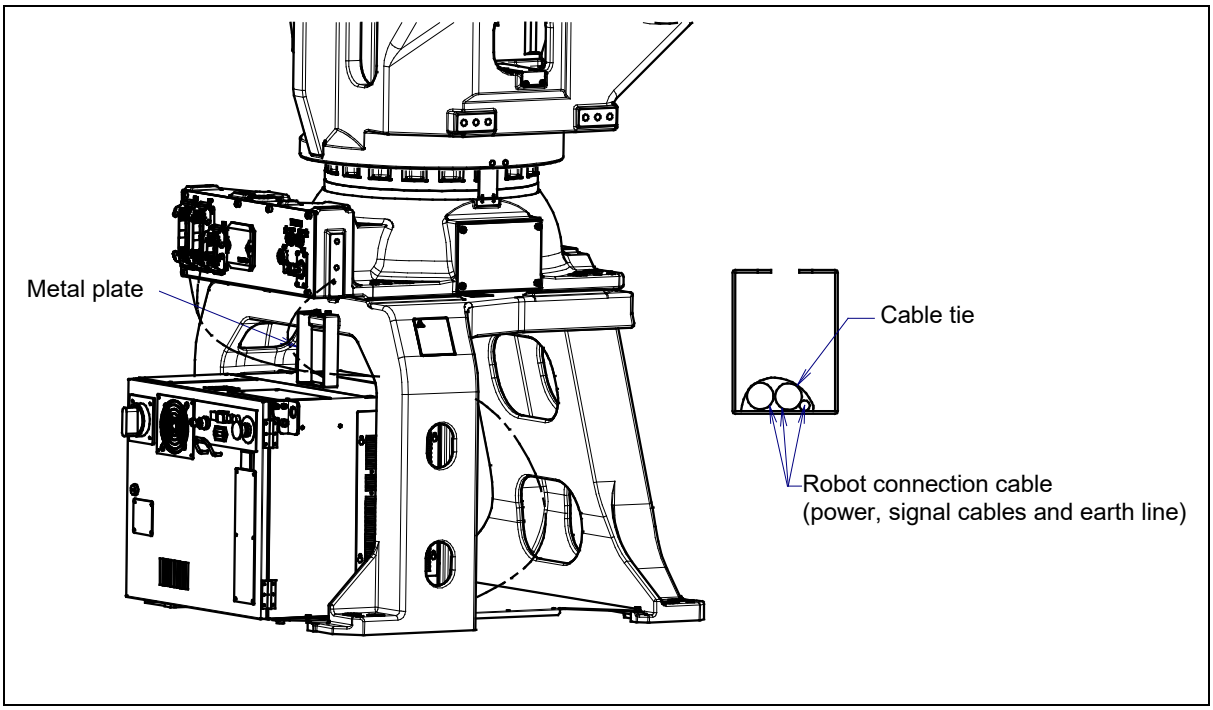


Fig. 2.1 (c) Cable connection (M-410*i*C/500 pedestal type)

3 BASIC SPECIFICATIONS

3.1 ROBOT CONFIGURATION

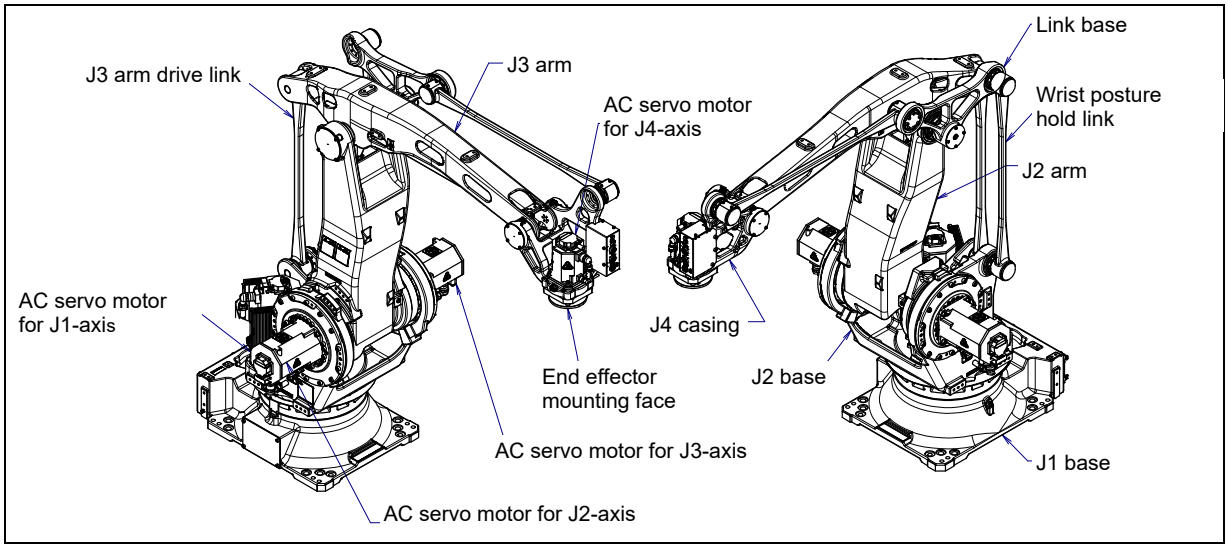


Fig. 3.1 (a) Mechanical unit configuration (M-410*i*C/110)

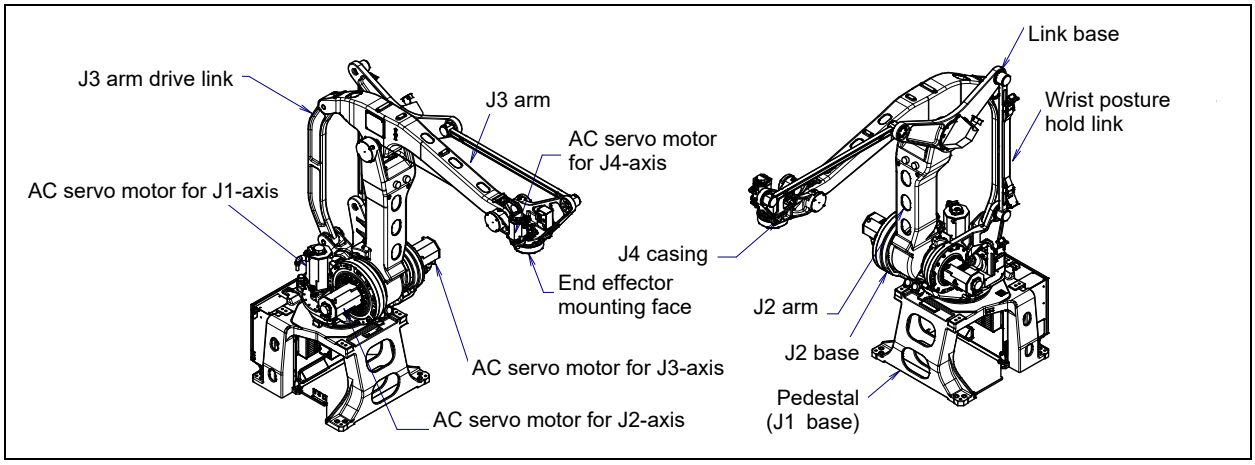


Fig. 3.1 (b) Mechanical unit configuration (M-410*i*C/185/315)

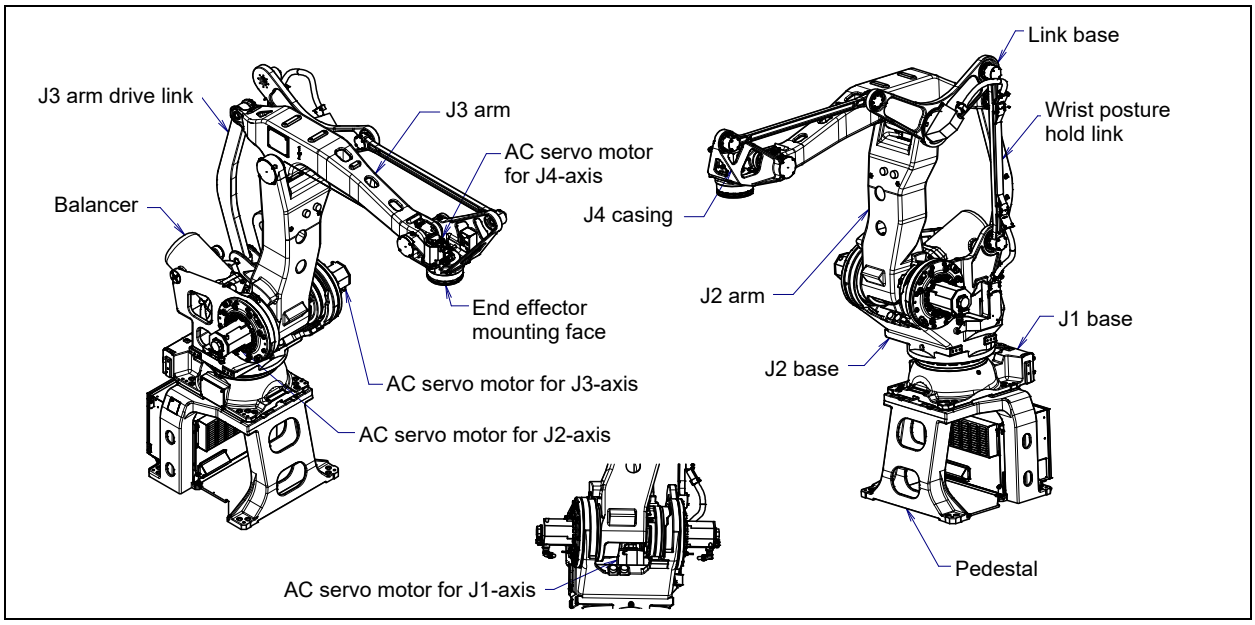


Fig. 3.1 (c) Mechanical unit configuration (M-410*i*C/500)

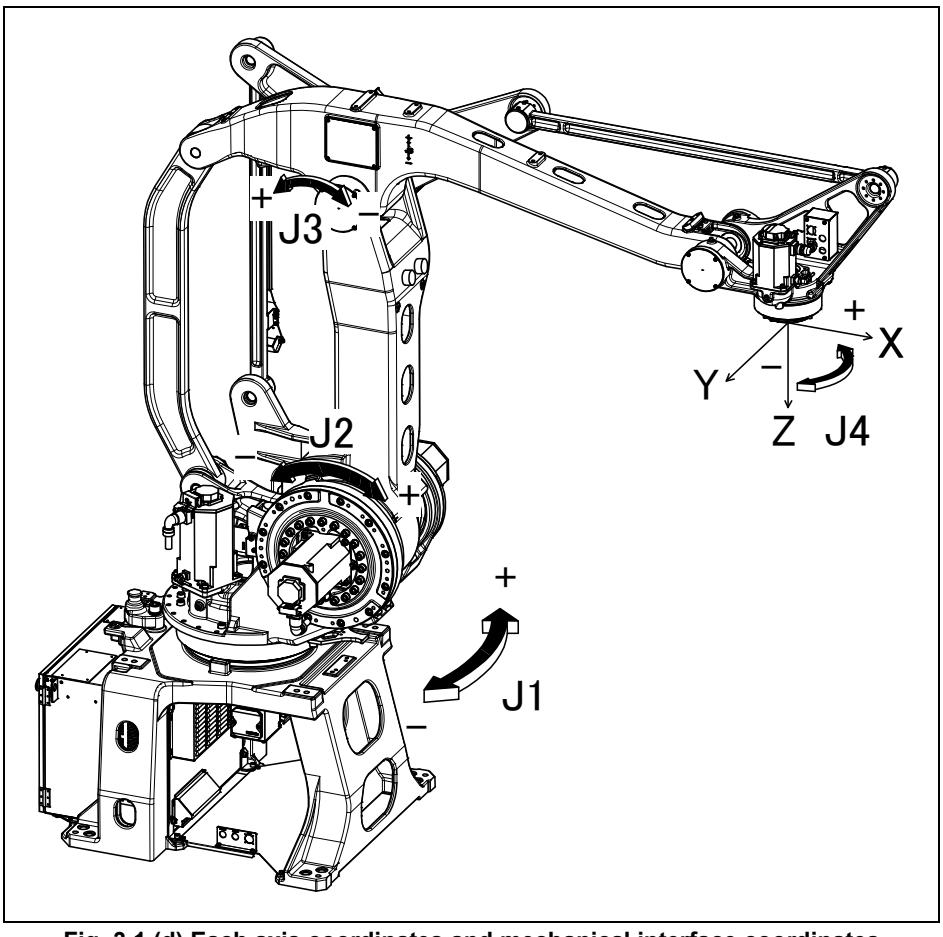


Fig. 3.1 (d) Each axis coordinates and mechanical interface coordinates

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

Specifications (NOTE 1) (1/3)

Item		M-410*i*C/110
Controlled axes		4-axes (J1, J2, J3, J4)
Reach		2403mm
Installation		Floor mount
Motion range (Max. speed) (NOTE 2)	J1-axis	370° (145°/s) 6.46rad (2.53rad/s)
	J2-axis	125° (130°/s) 2.18rad (2.27rad/s)
	J3-axis	140° (140°/s) 2.44rad (2.44rad/s)
	J4-axis	720° (420°/s) 12.57rad (7.33rad/s)
Max. payload	At wrist (NOTE 3)	110kg
	On J2 base	550kg
	On J3 arm (NOTE 3)	30kg
Allowable load inertia at wrist		53kg-m^2 (540kgf-cm-s^2)
Drive method		Electric servo drive by AC servo motor
Repeatability		±0.05mm (NOTE 4)
Mass		1030kg
Acoustic noise level		75.3dB (NOTE 5)
Installation environment		Ambient temperature: 0 to 45°C (NOTE 6) Ambient humidity: Normally 75%RH or less (No dew or frost allowed) Short time 95%Rh or less (Within 1 month) Permissible altitude: Above the sea 1000m or less Vibration acceleration : 4.9m/s^2 (0.5G) or less Free of corrosive gases (NOTE 7)

NOTE

1 Even if the robot is used according to the defined specifications, motion programs might shorten reducer life or cause the robot to overheat. Use ROBOGUIDE (system design support tool by FANUC) for further evaluation before running production.
2 During short distance motions, the axis speed may not reach the maximum value stated.
3 Prevent the total of the load at wrist and on J3 arm from exceeding Max. payload at wrist. Please refer to Section 3.5 for details.
In case of M-410*i*C, avoid keeping J3 arm horizontally with max payload for a long time to prevent occurrence of the overheat alarm.
4 Compliant with ISO 9283.
5 This value is equivalent continuous A-weighted sound pressure level that applied with ISO11201 (EN31201). This value is measured with the following conditions.
- Maximum load and speed
- Operating mode is AUTO

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

Specifications (NOTE 1) (2/3)

Item		M-410*i*C/185	M-410*i*C/315
Controlled axes		4-axes (J1, J2, J3, J4)	
Reach		3143mm	
Installation		Floor mount	
Motion range (Max. speed) (NOTE 2)	J1-axis	360°(140°/s) 6.28rad(2.44rad/s)	360°(90°/s) 6.28rad(1.57rad/s)
	J2-axis	144°(140°/s) 2.51rad(2.44rad/s)	144°(100°/s) 2.51rad(1.75rad/s)
	J3-axis	136°(140°/s) 2.37rad(2.44rad/s)	136°(110°/s) 2.37rad(1.92rad/s)
	J4-axis	720°(305°/s) 12.57rad(5.32rad/s)	720°(195°/s) 12.57rad(3.40rad/s)
Max. payload	At wrist (NOTE 3)	185kg	315kg
	On J2 base	550kg	
	On J3 arm (NOTE 3)	30kg	
Allowable load inertia at wrist		88kg-m^2 (898kgf-cm-s^2)	155kg-m^2 (1580kgf-cm-s^2)
Drive method		Electric servo drive by AC servo motor	
Repeatability (NOTE 4)		±0.05mm	
Mass		Pedestal type : 1600kg (including the controller) No pedestal : 1330kg (not including the controller)	
Acoustic noise level		75.3dB (NOTE 5)	
Installation environment		Ambient temperature: 0 to 45°C (NOTE 6) Ambient humidity: Normally 75%RH or less (No dew or frost allowed) Short time 95%Rh or less (Within 1 month) Permissible altitude: Above the sea 1000m or less Vibration acceleration : 4.9m/s^2 (0.5G) or less Free of corrosive gases (NOTE 7)	

NOTE

1 Even if the robot is used according to the defined specifications, motion programs might shorten reducer life or cause the robot to overheat. Use ROBOGUIDE (system design support tool by FANUC) for further evaluation before running production.
2 During short distance motions, the axis speed may not reach the maximum value stated.
3 Prevent the total of the load at wrist and on J3 arm from exceeding Max. payload at wrist. Please refer to Section 3.5 for details.
In case of M-410*i*C, avoid keeping J3 arm horizontally with max payload for a long time to prevent occurrence of the overheat alarm.
4 Compliant with ISO 9283.
5 This value is equivalent continuous A-weighted sound pressure level that applied with ISO11201 (EN31201). This value is measured with the following conditions.
- Maximum load and speed
- Operating mode is AUTO

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

Specifications (NOTE 1) (3/3)

Item		M-410*i*C/500
Controlled axes		4-axes (J1, J2, J3, J4)
Reach		3143mm
Installation		Floor mount
Motion range (Max. speed) (NOTE 2)	J1-axis	370°(85°/s) 6.46rad(1.48rad/s)
	J2-axis	144°(85°/s) 2.51rad(1.48rad/s)
	J3-axis	136°(85°/s) 2.37rad(1.48rad/s)
	J4-axis	720°(200°/s) 12.57rad(3.49rad/s)
Max. payload	At wrist (NOTE 3)	500kg
	On J2 base	550kg
	On J3 arm (NOTE 3)	30kg
Allowable load inertia at wrist		250kg-m^2 (2550kgf-cm-s^2)
Drive method		Electric servo drive by AC servo motor
Repeatability (NOTE 4)		±0.5mm
Mass		Pedestal type : 2410kg (including the controller) No pedestal : 1910kg (not including the controller)
Acoustic noise level		75.3dB (NOTE 5)
Installation environment		Ambient temperature: 0 to 45°C (NOTE 6) Ambient humidity: Normally 75%RH or less (No dew or frost allowed) Short time 95%Rh or less (Within 1 month) Permissible altitude: Above the sea 1000m or less Vibration acceleration : 4.9m/s^2 (0.5G) or less Free of corrosive gases (NOTE 7) (NOTE 8)

NOTE

1 Even if the robot is used according to the defined specifications, motion programs might shorten reducer life or cause the robot to overheat. Use ROBOGUIDE (system design support tool by FANUC) for further evaluation before running production.
2 During short distance motions, the axis speed may not reach the maximum value stated.
3 Prevent the total of the load at wrist and on J3 arm from exceeding Max. payload at wrist. Please refer to Section 3.5 for details.
In case of M-410*i*C, avoid keeping J3 arm horizontally with max payload for a long time to prevent occurrence of the overheat alarm.
4 Compliant with ISO 9283.
5 This value is equivalent continuous A-weighted sound pressure level that applied with ISO11201 (EN31201). This value is measured with the following conditions.
- Maximum load and speed
- Operating mode is AUTO

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

3.2 MECHANICAL UNIT EXTERNAL DIMENSIONS AND OPERATING SPACE

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

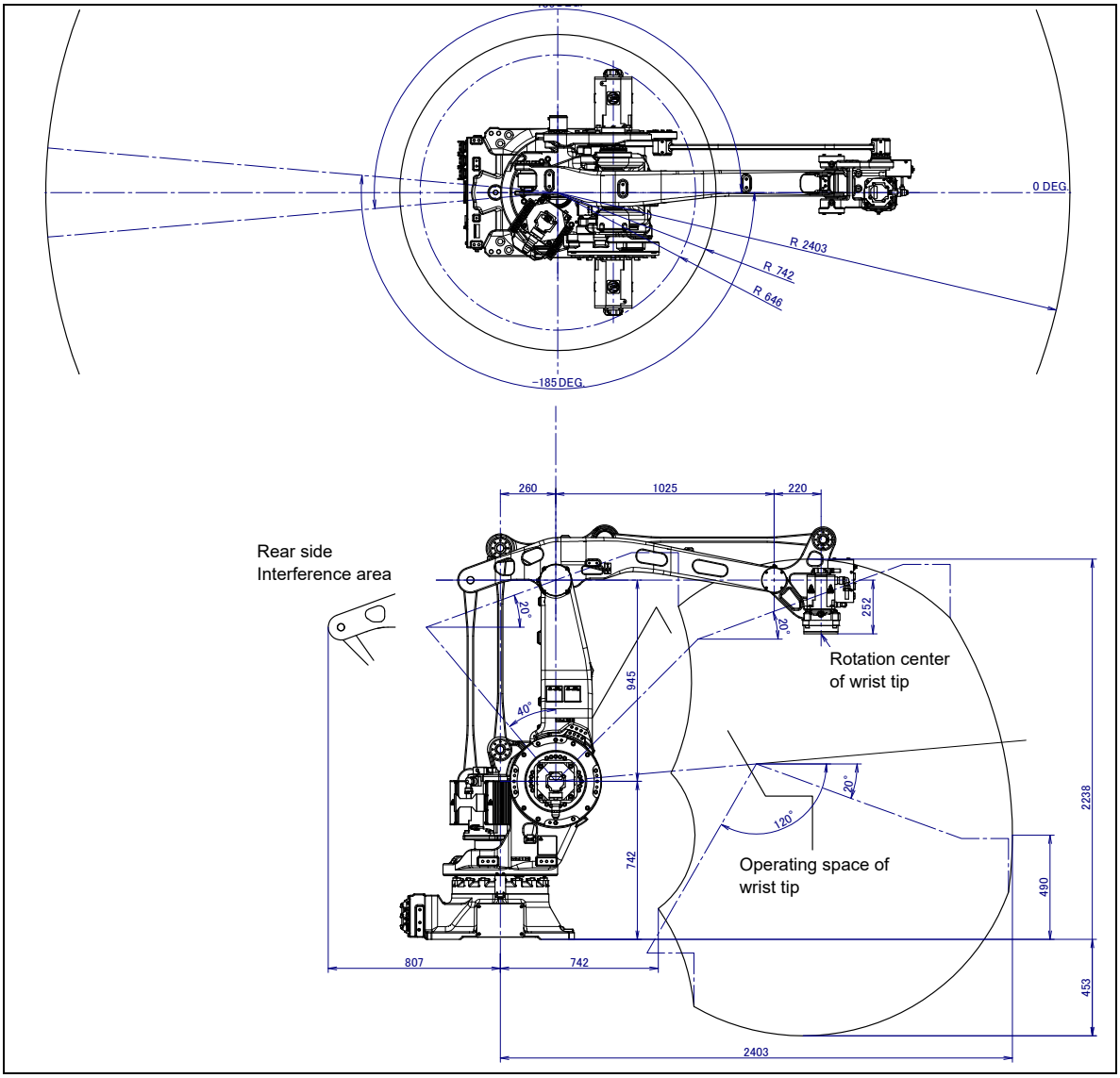


Fig. 3.2 (a) Operating space (M-410*i*C/110)

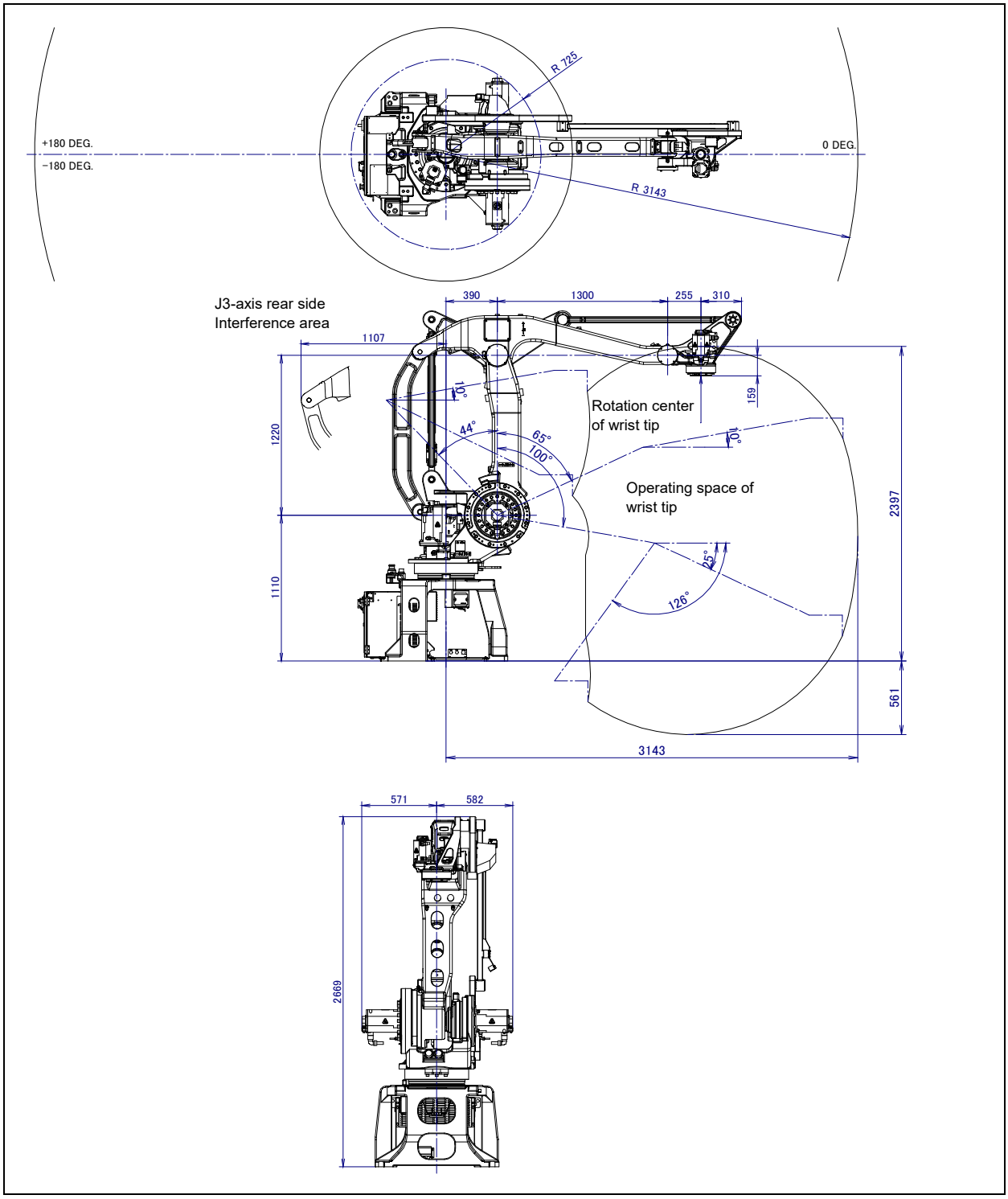


Fig. 3.2 (b) Operating space (pedestal type) (M-410*i*C/185/315)

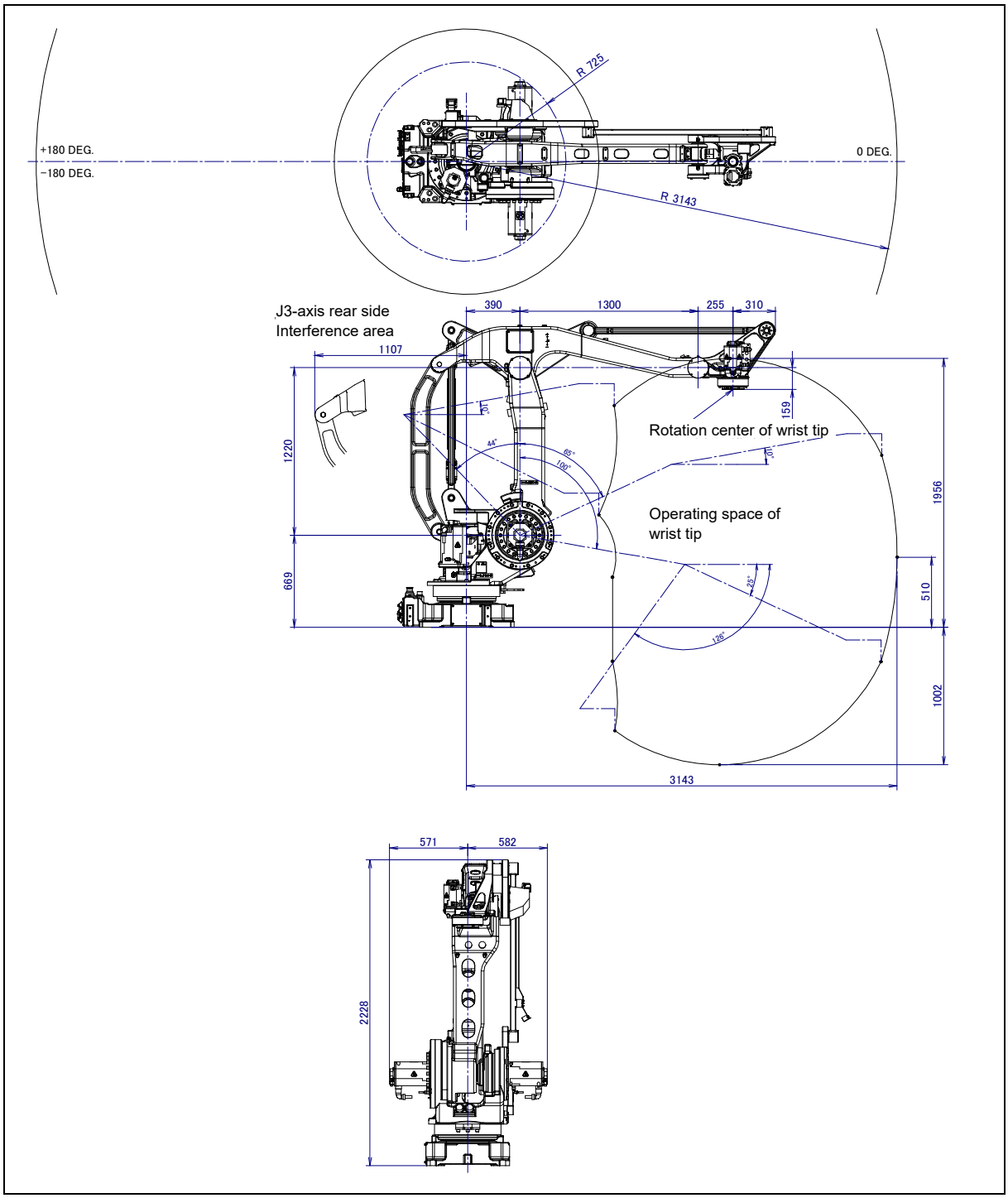


Fig. 3.2 (c) Operating space (no pedestal) (M-410*i*C/185/315)

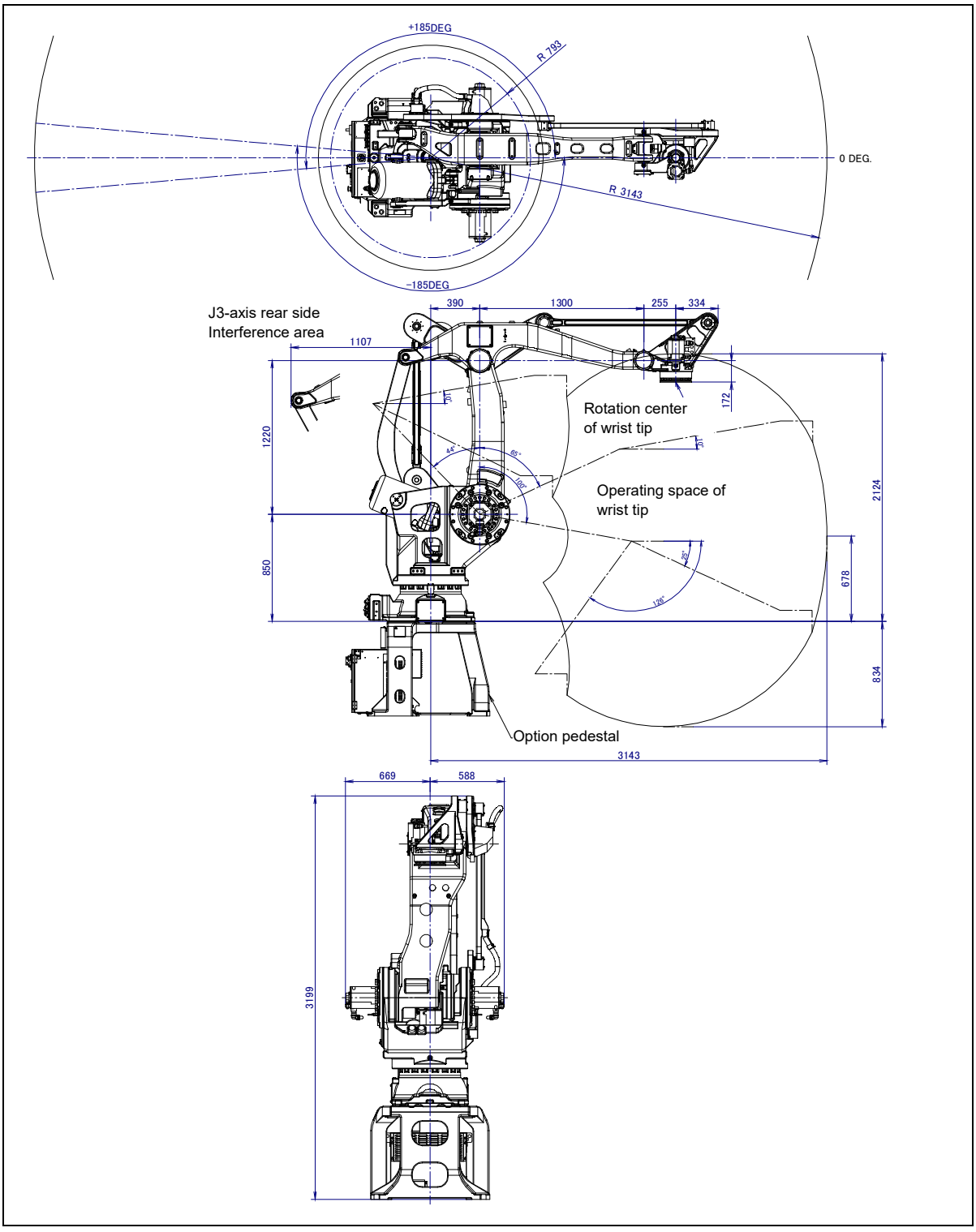


Fig. 3.2 (d) Operating space (pedestal type) (M-410*i*C/500)

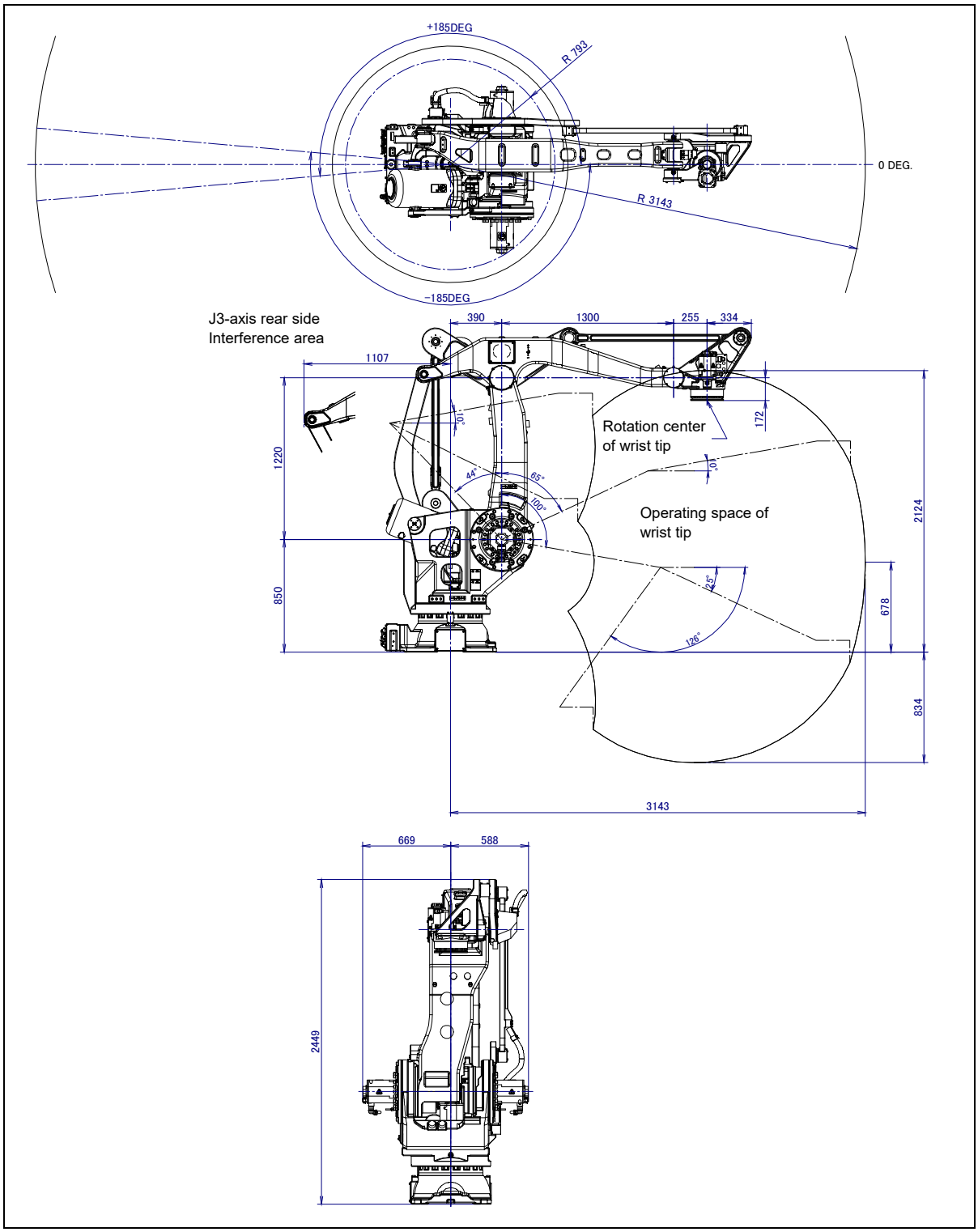


Fig. 3.2 (e) Operating space (no pedestal) (M-410*i*C/500)

3.3 ZERO POINT POSITION AND MOTION LIMIT

Zero point and software motion limit are provided for each controlled axis. The robot cannot exceed the software motion limit unless there is a failure of the system causing loss of zero point position or there is a system error.

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.
In addition, the motion range limit by a mechanical stopper is also prepared to improve safety.

Fig. 3.3 (a) shows the position of mechanical stopper.

Only in case of J1-axis, robot stops by transforming mechanical stopper. There is no mechanical stopper for J4-axis. Only in case of J1 axis, robot stops by transforming mechanical stopper. Be sure to exchange transformed stopper to new one. Tight the bolts according to Appendix B. Replace mechanical stopper of J1-axis referring to Fig. 3.3 (a). Don’t reconstruct the mechanical stopper. There is a possibility that the robot doesn't stop normally.

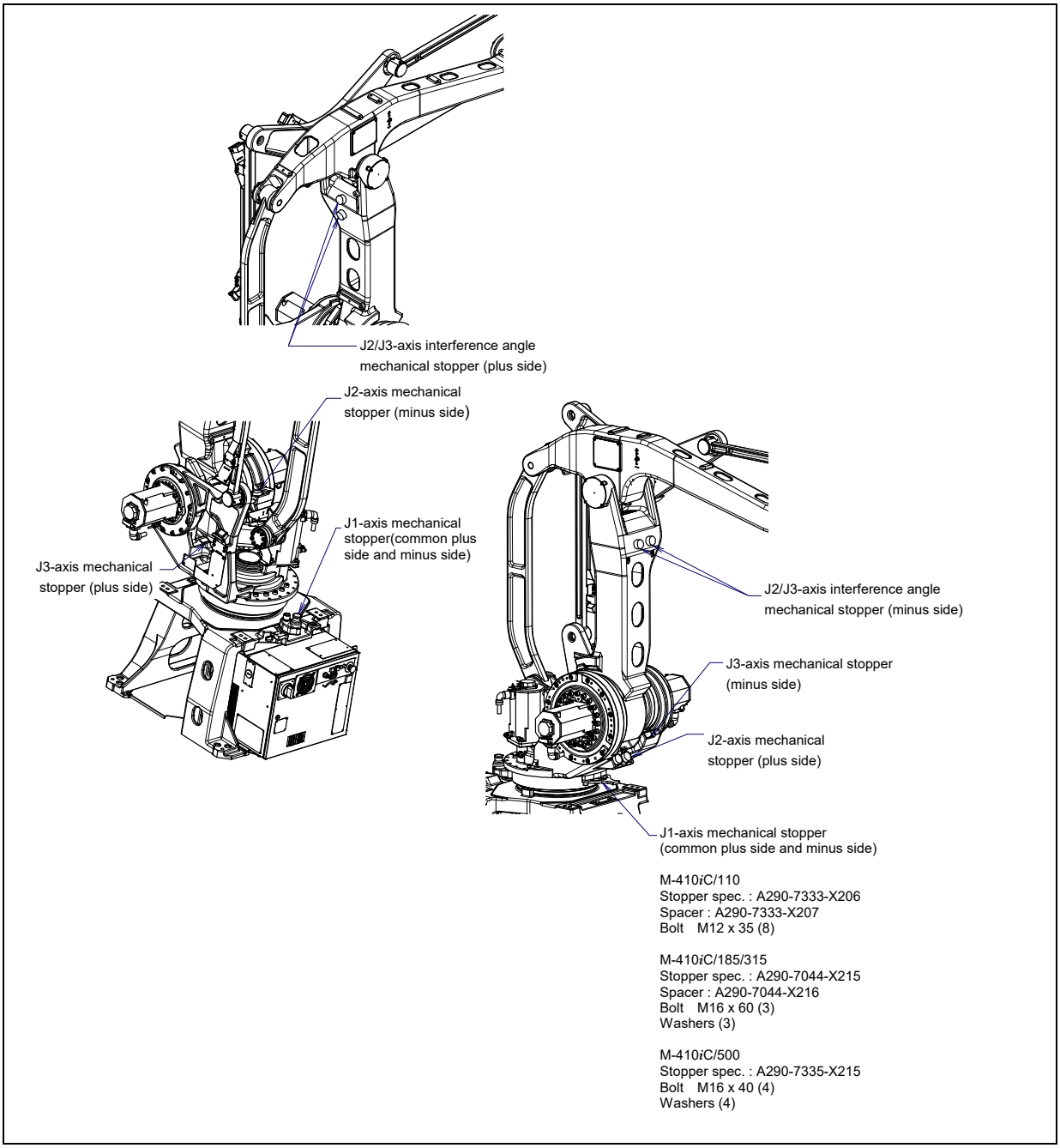


Fig. 3.3 (a) Position of mechanical stopper

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

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

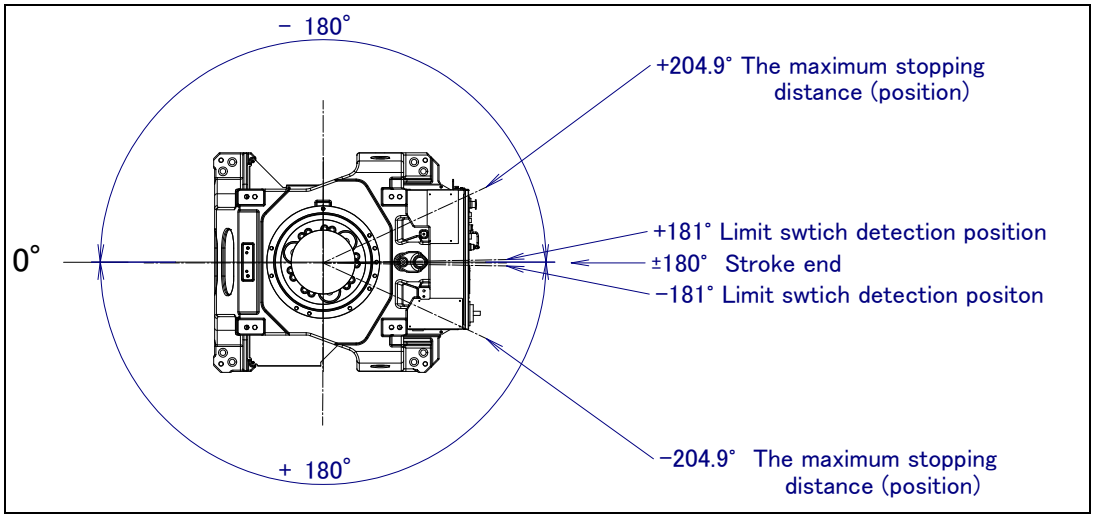


Fig. 3.3 (b) J1-axis motion limit (M-410*i*C/185/315 or M-410*i*C/110/500 When mechanical stopper is specified)

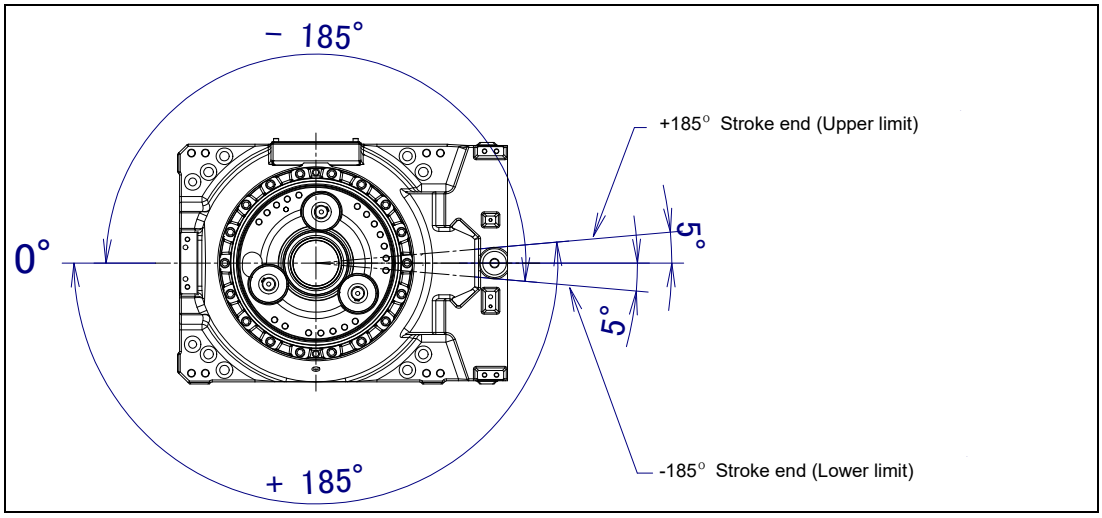


Fig. 3.3 (c) J1-axis motion limit (M-410*i*C/110/500 When mechanical stopper is not specified)

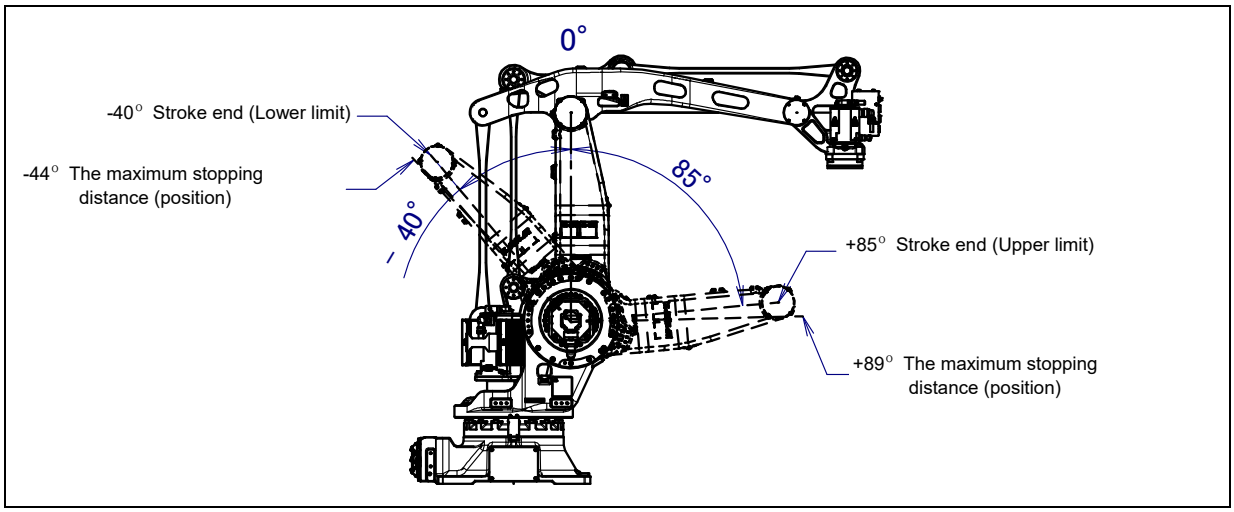


Fig. 3.3 (d) J2-axis motion limit (M-410*i*C/110)

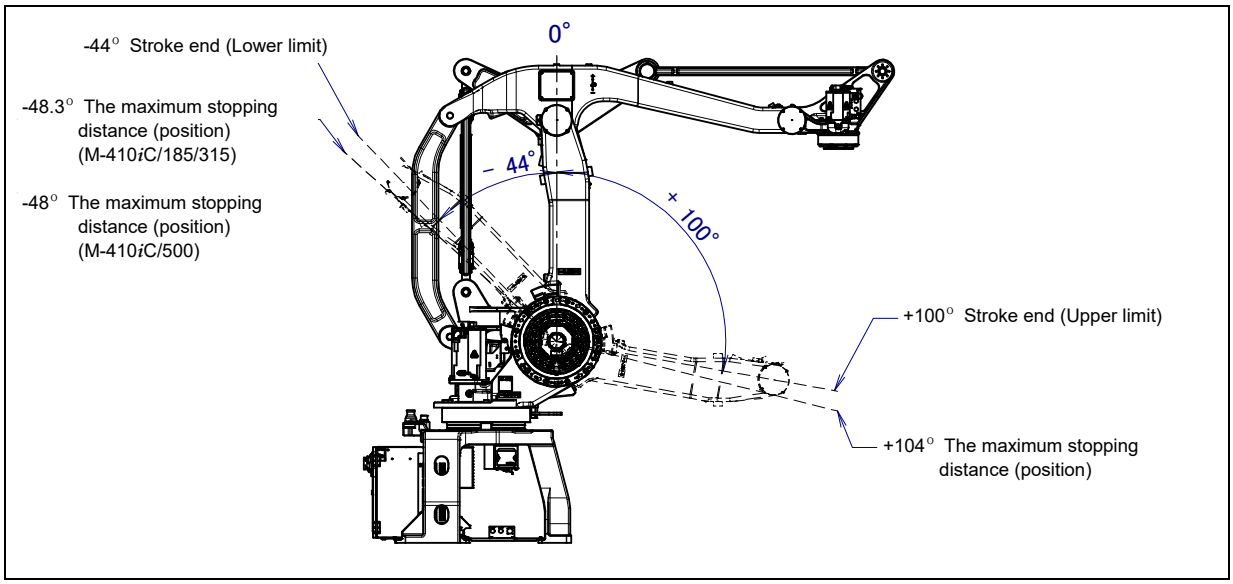


Fig. 3.3 (e) J2-axis motion limit (M-410*i*C/185/315/500)

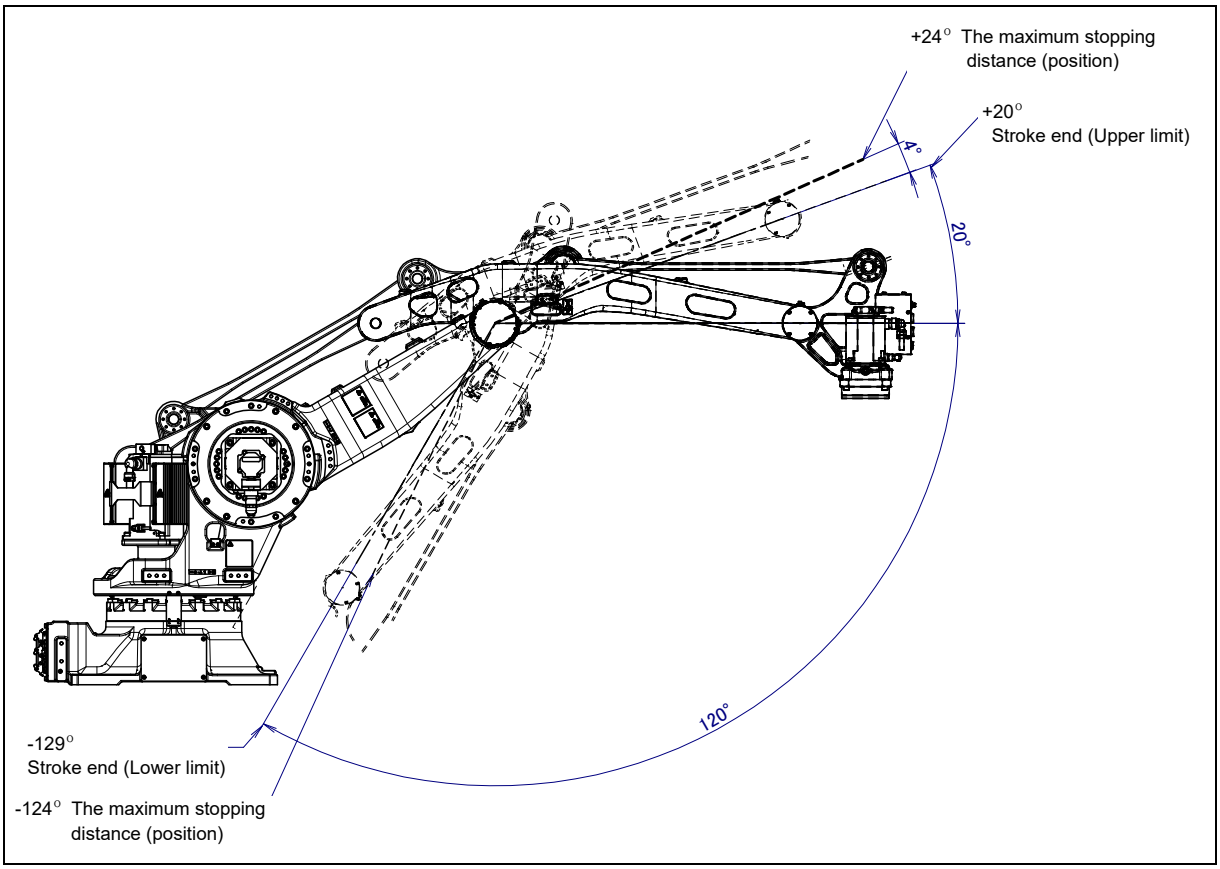


Fig. 3.3 (f) J3-axis motion limit (M-410*i*C/110)

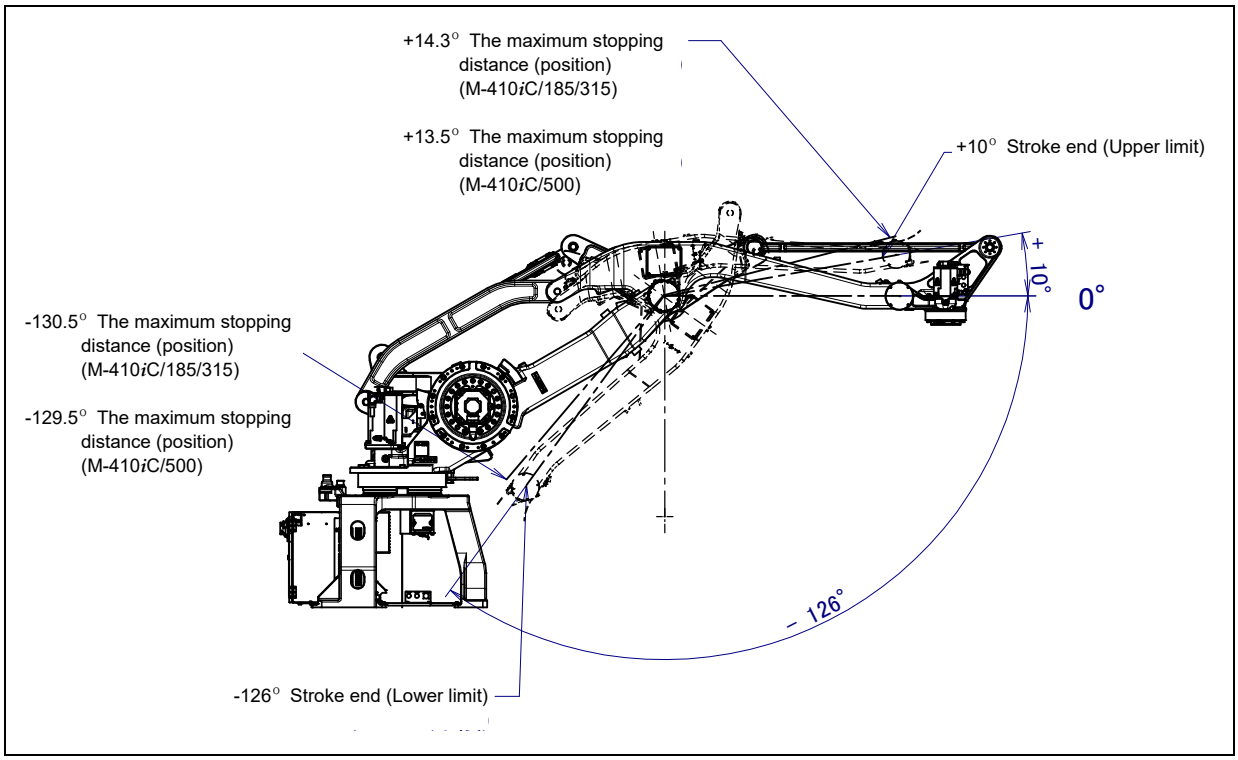


Fig. 3.3 (g) J3-axis motion limit (M-410*i*C/185/315/500)

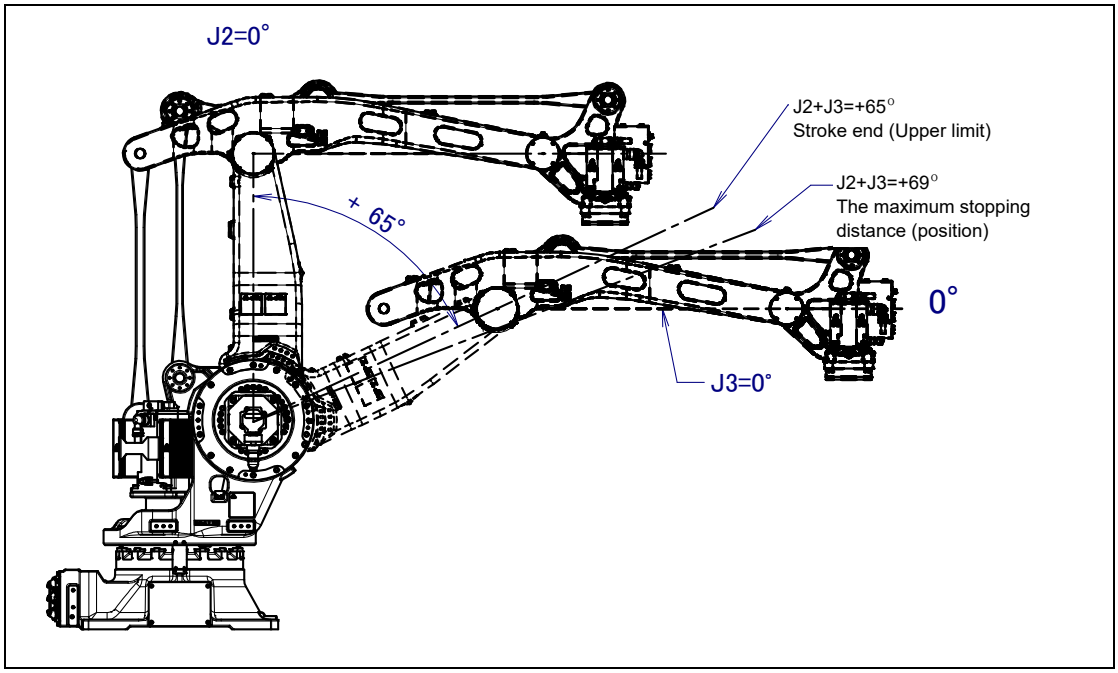


Fig. 3.3 (h) J2/J3-axis interference angle (plus side) (M-410*i*C/110)

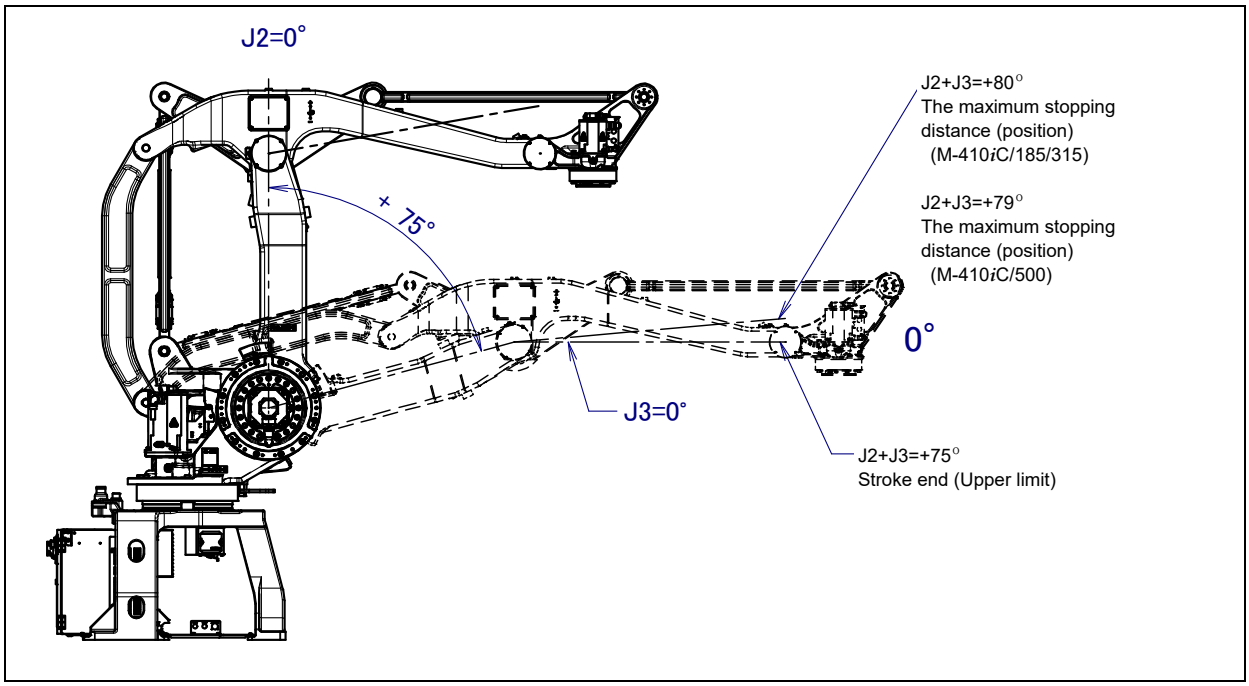


Fig. 3.3 (i) J2/J3-axis interference angle (plus side) (M-410*i*C/185/315/500)

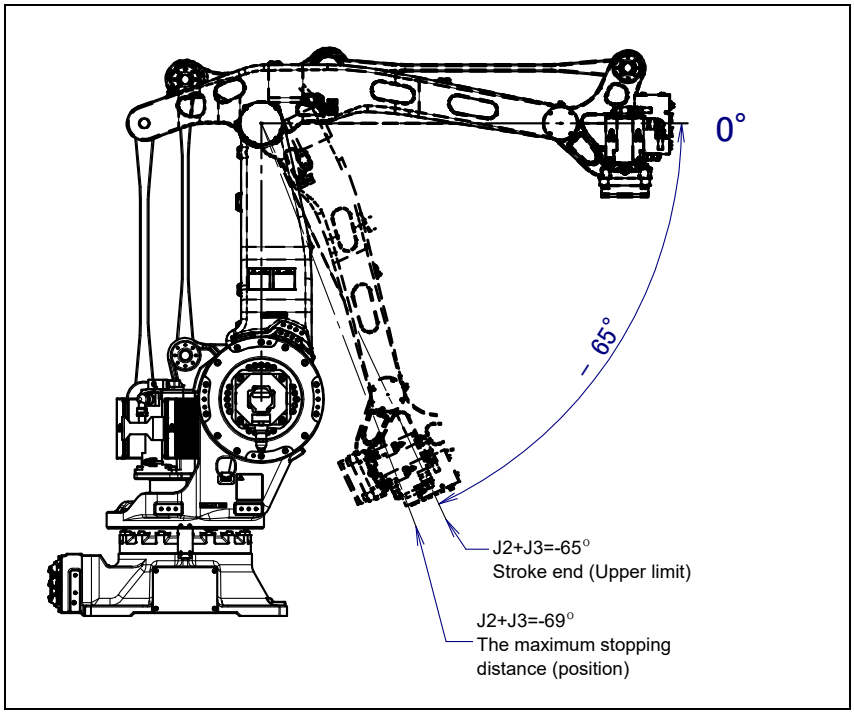


Fig. 3.3 (j) J2/J3-axis interference angle (minus side) (M-410*i*C/110)

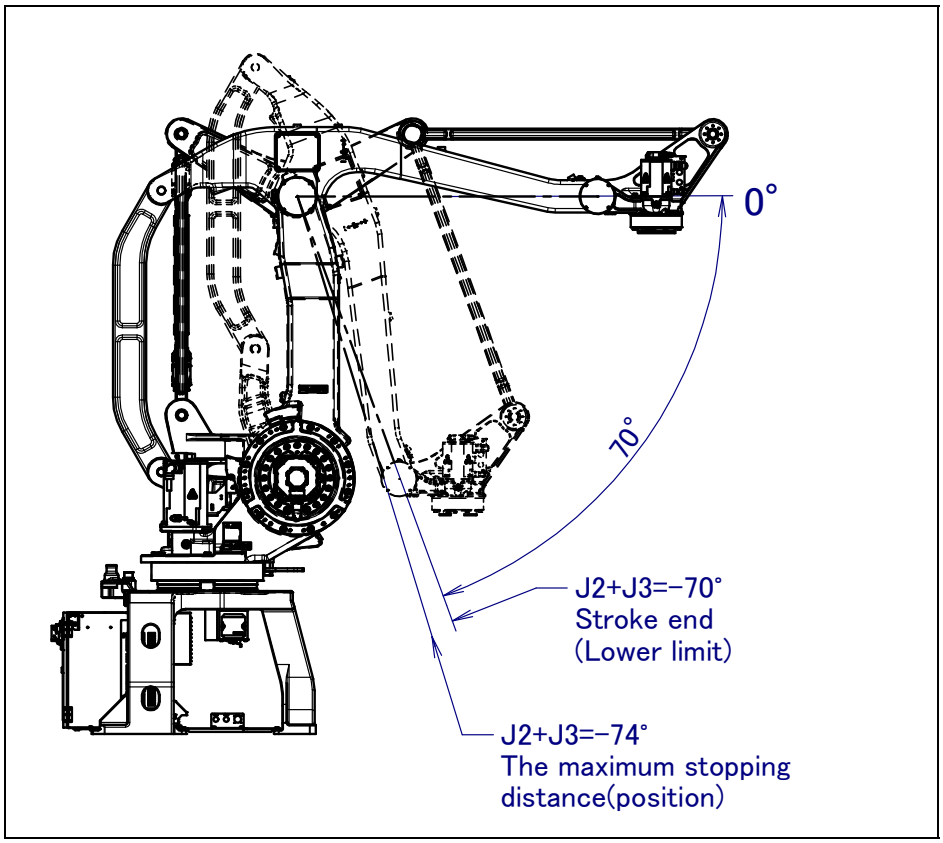


Fig. 3.3 (k) J2/J3-axis interference angle (minus side) (M-410*i*C/185/315/500)

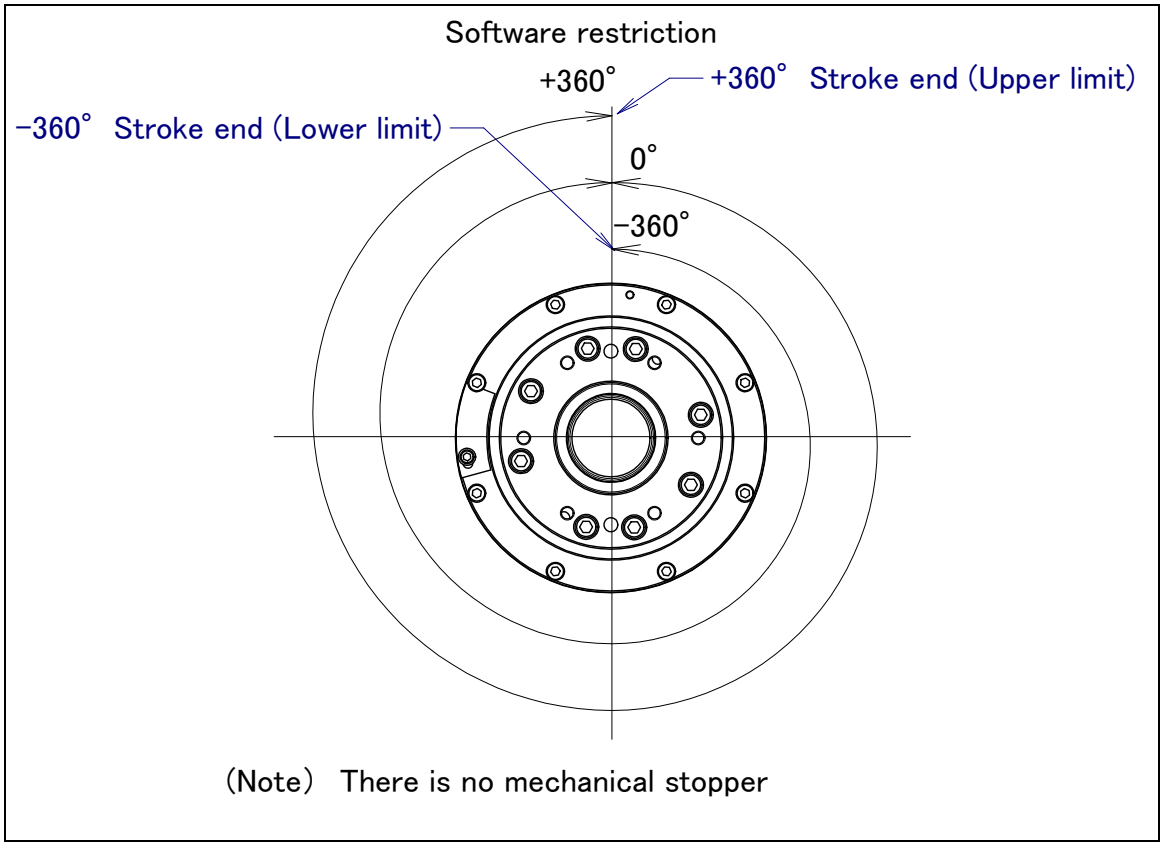


Fig. 3.3 (l) J4-axis motion limit

3.4 WRIST LOAD CONDITIONS

Fig. 3.4 (a) to (d) show the relationships between the horizontal offset of the center of gravity of the wrist load and the permissible load inertia. See Section 3.1 about allowable load moment and inertia at wrist.
See Fig. 3.4 (e) to check whether the center of gravity of the load is inside or outside of the wrist.
See Fig. 3.4 (f) for explanations about the vertical offset of the center of gravity of the wrist load.
Keep the wrist load within a range graphically shown in Fig. 3.4 (a) to (d).
See Fig. 3.4 (g) for explanations about how to calculate the load inertial.

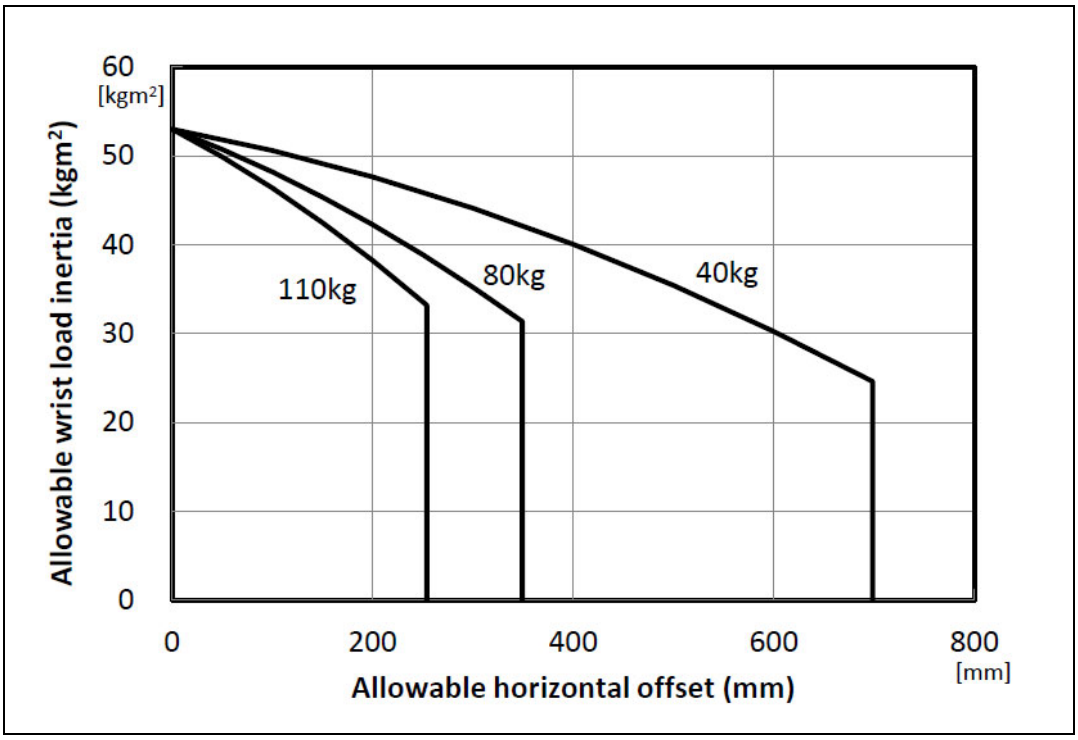


Fig. 3.4 (a) Diagram of the permissible load for the wrist section (M-410*i*C/110)

NOTE
Allowable vertical offset is 1000mm from wrist flange.

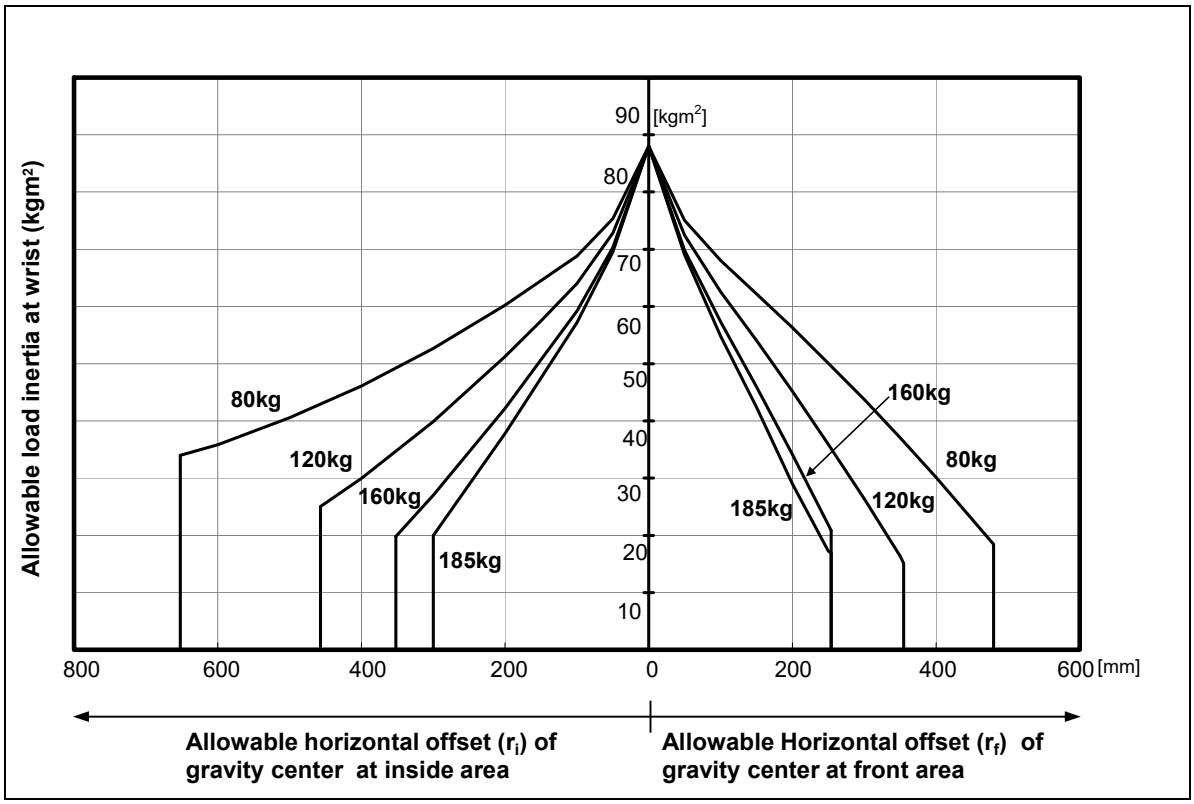


Fig. 3.4 (b) Diagram of the permissible load for the wrist section (M-410*i*C/185)

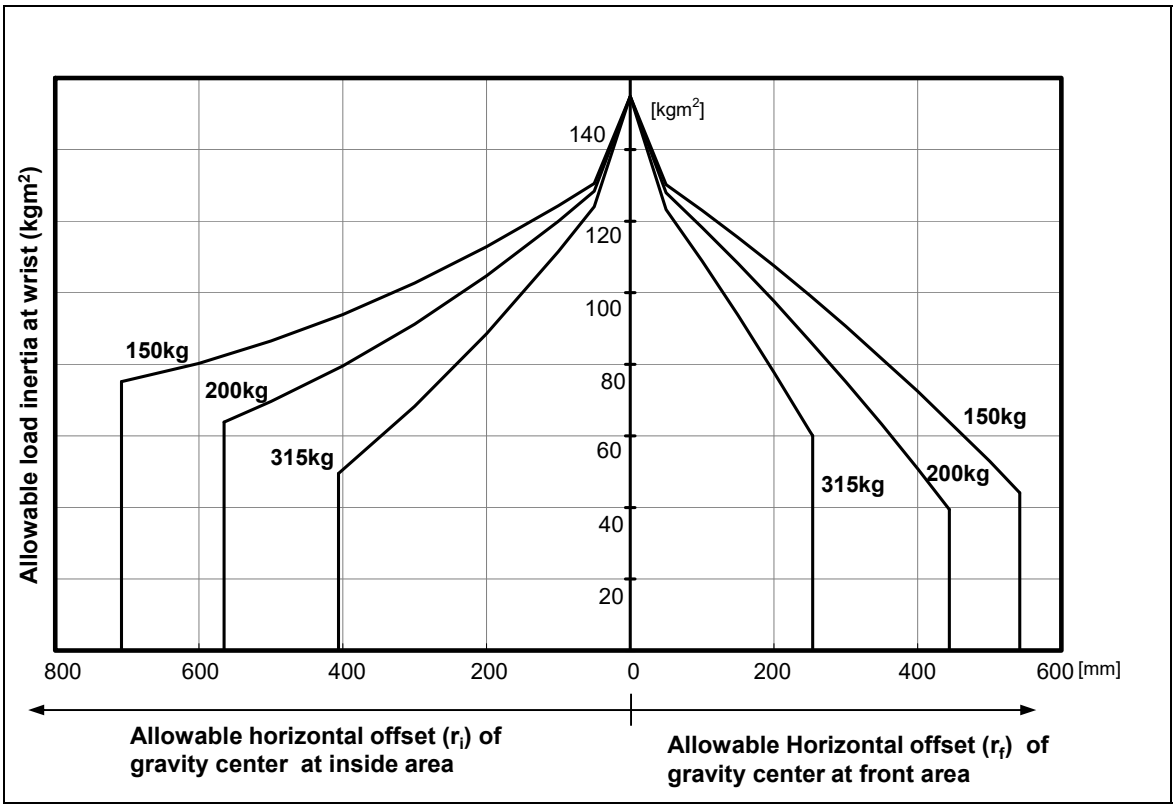


Fig. 3.4 (c) Diagram of the permissible load for the wrist section (M-410*i*C/315)

NOTE
Allowable vertical offset is 1000mm from wrist flange.

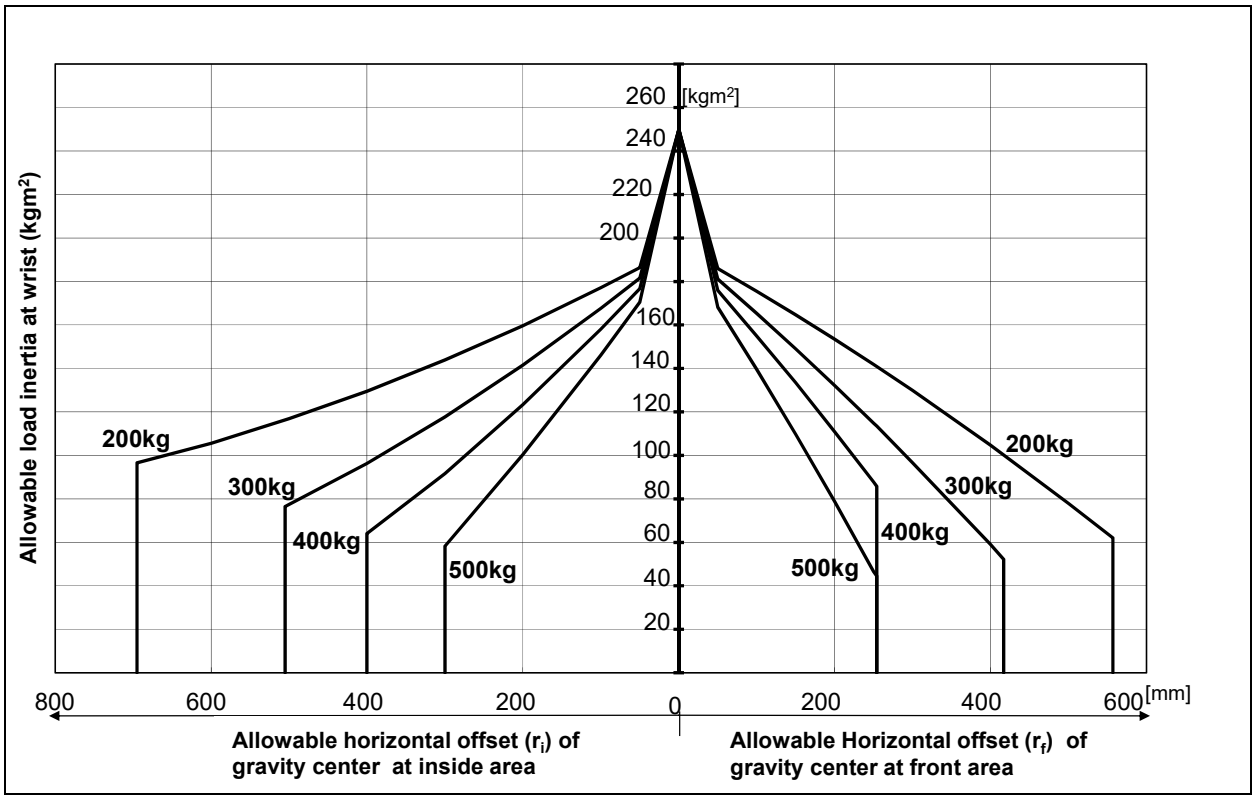


Fig. 3.4 (d) Diagram of the permissible load for the wrist section (M-410*i*C/500)

NOTE
Allowable vertical offset is 1000mm from wrist flange.

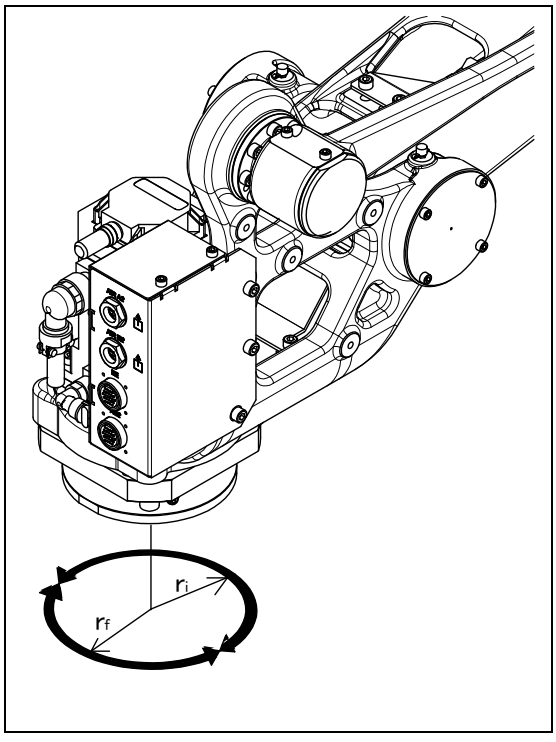


Fig. 3.4 (e) Allowable wrist load condition

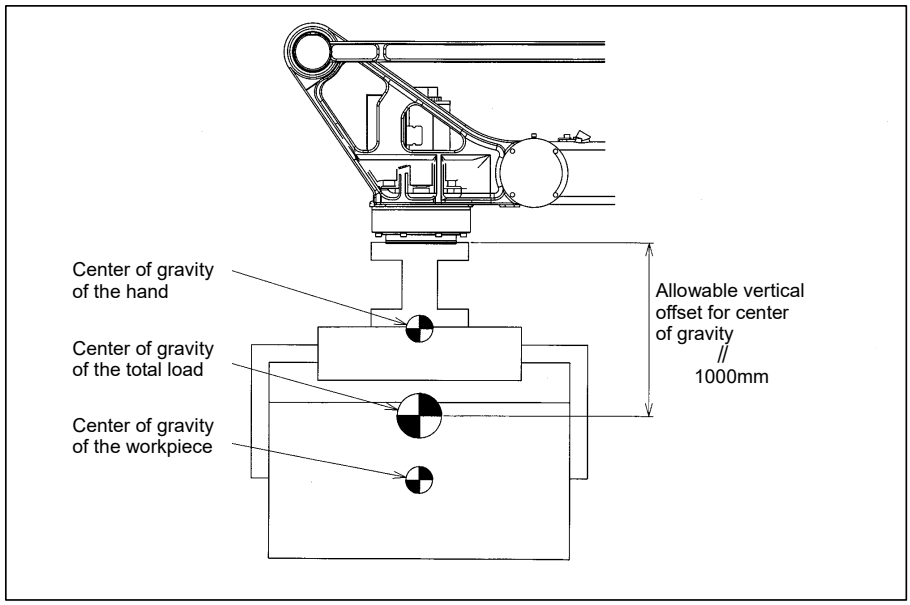


Fig. 3.4 (f) Allowable wrist load condition

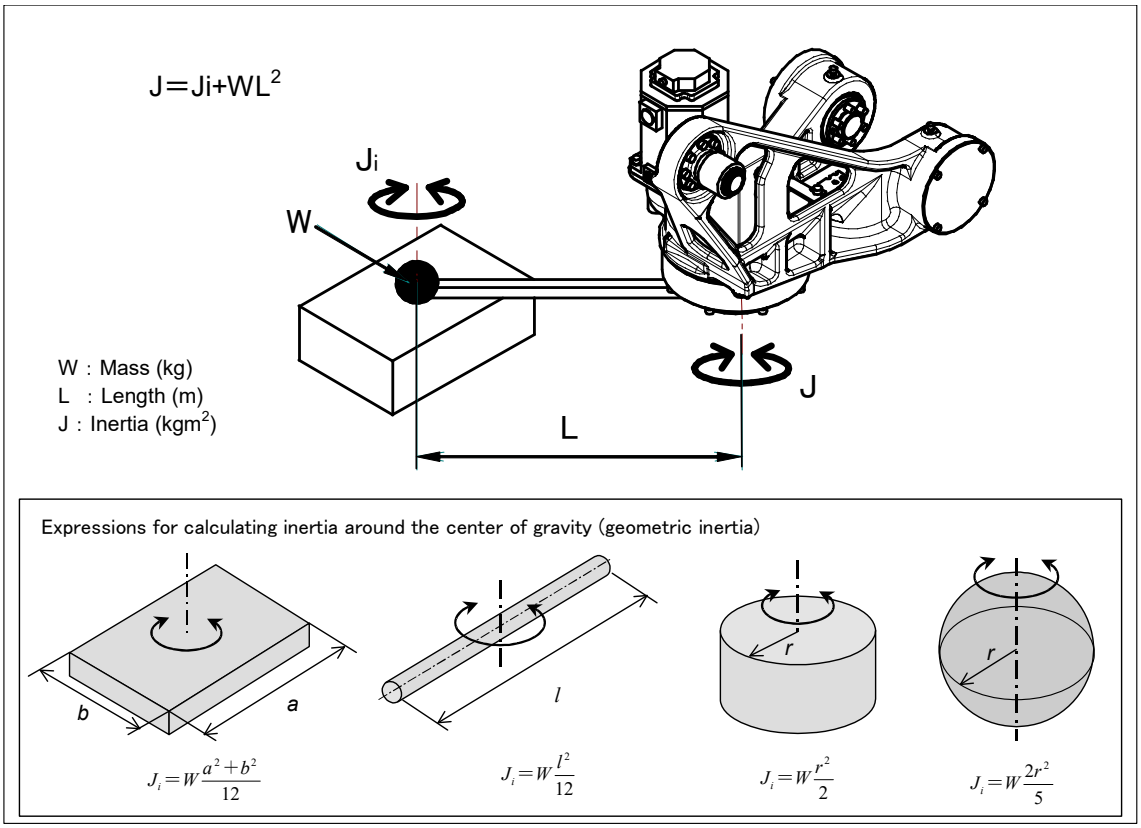


Fig. 3.4 (g) Calculating inertia

The total inertia around the wristaxis is the sum of the horizontal offset inertia of a workpiece and the geometric inertia around the center of the gravity of the workpiece. It ca be calculated as shown above.

NOTE
If a hand or workpiece has a complicated shape, divide it into simple shapes as shown above. Calculate the geometric inertia and offset inertia of each shape, then obtain their sum.

3.5 LOAD CONDITIONS ON J2 BASE, J3 ARM

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

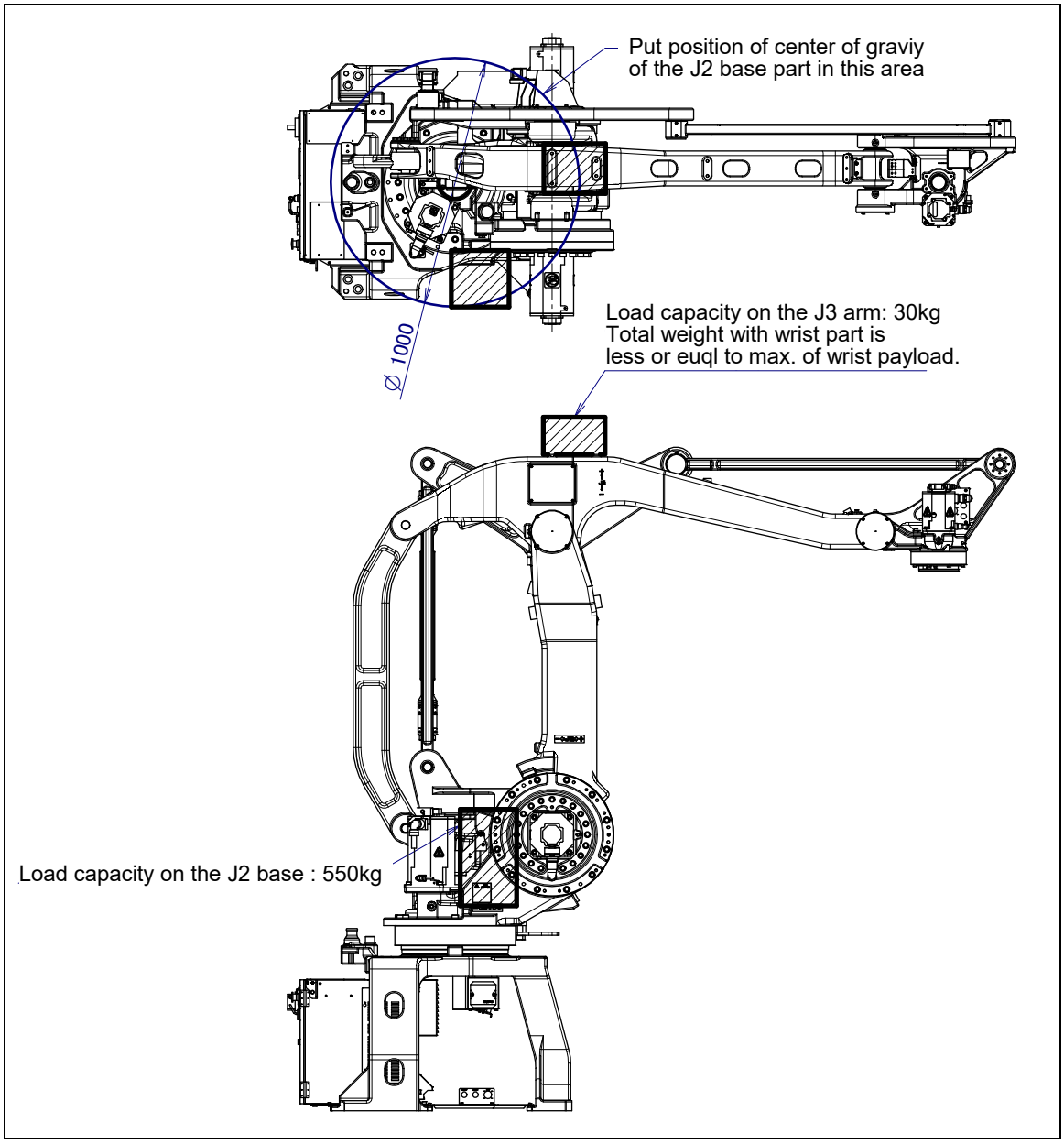


Fig. 3.5 (a) J2 base/J3 arm load condition

4 EQUIPMENT INSTALLATION TO THE ROBOT

4.1 END EFFECTOR INSTALLATION TO WRIST

Fig. 4.1 (a) to (c) show the figures for installing end effectors on the wrist. Select screws and positioning pins of a length that matches the depth of the tapped holes and pin holes. See APPENDIX B "Recommended bolt tightening torques" for tightening torque specifications.

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

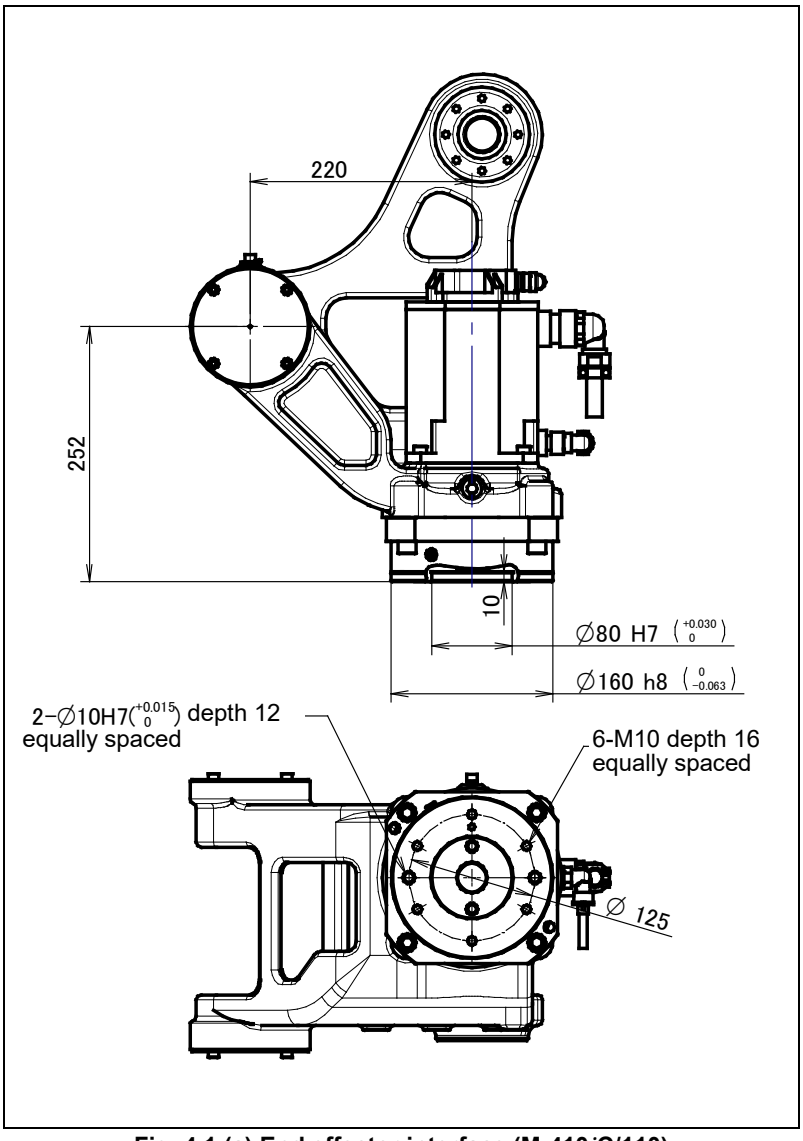


Fig. 4.1 (a) End effector interface (M-410*i*C/110)

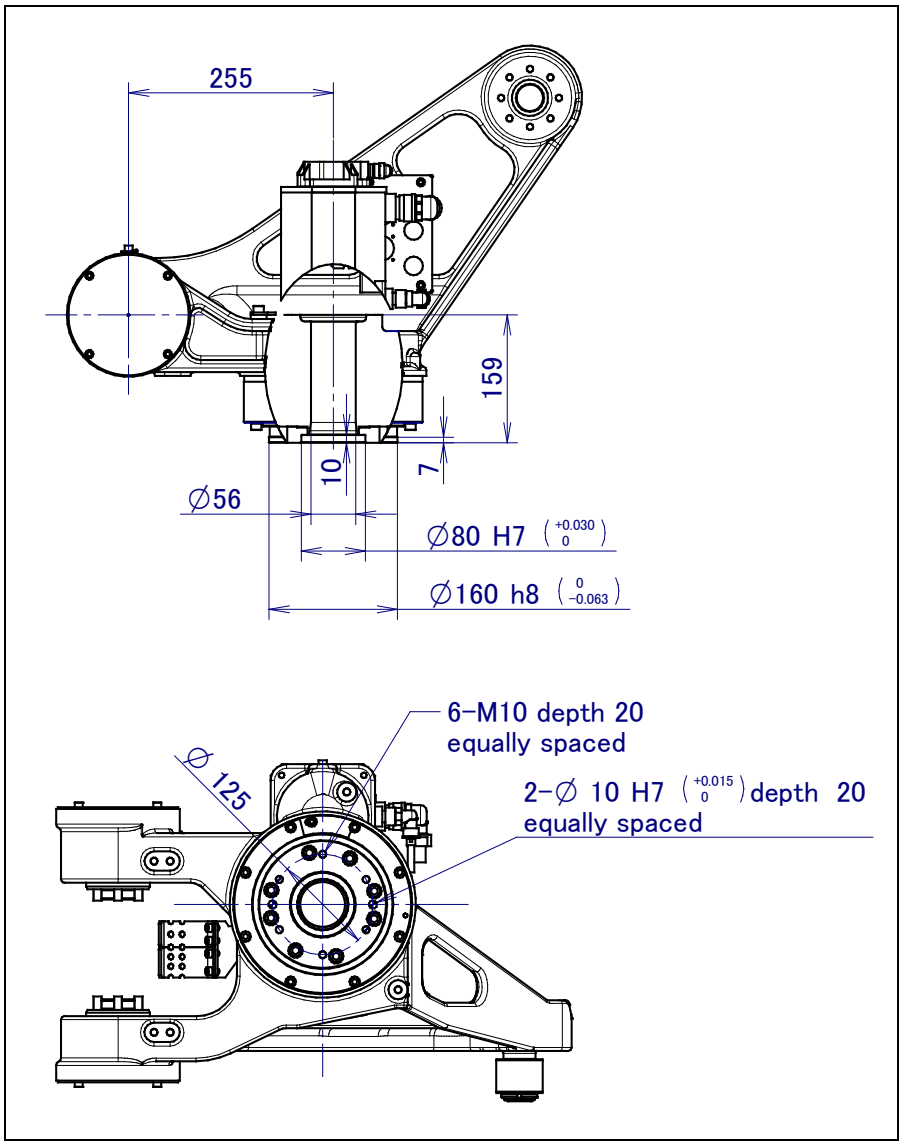


Fig. 4.1 (b) End effector interface (M-410*i*C/185/315)

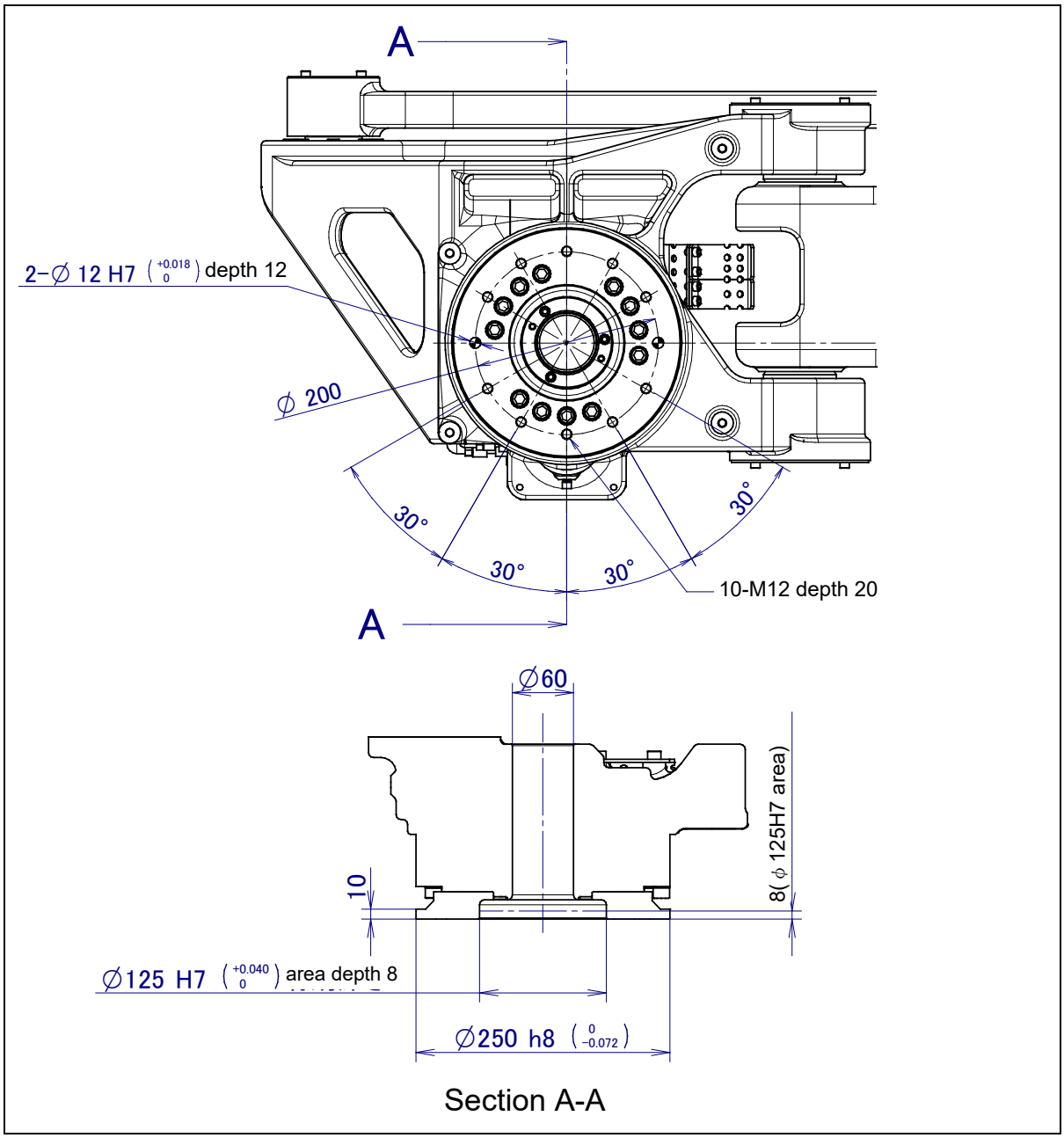


Fig. 4.1 (c) End effector interface (M-410*i*C/500)

4.2 EQUIPMENT MOUNTING FACE

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

⚠ CAUTION

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

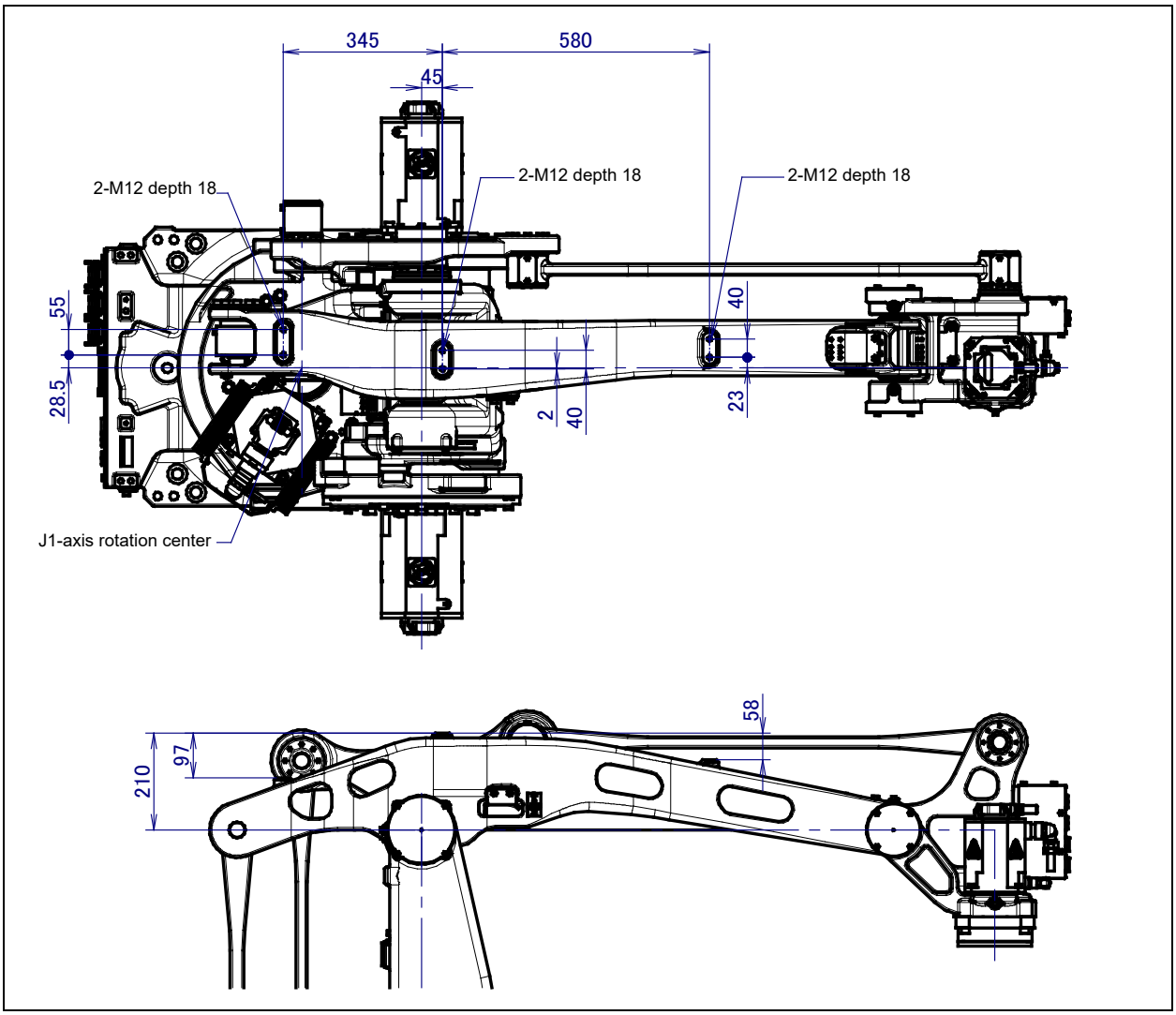


Fig. 4.2 (a) Equipment mounting faces (M-410*i*C/110)

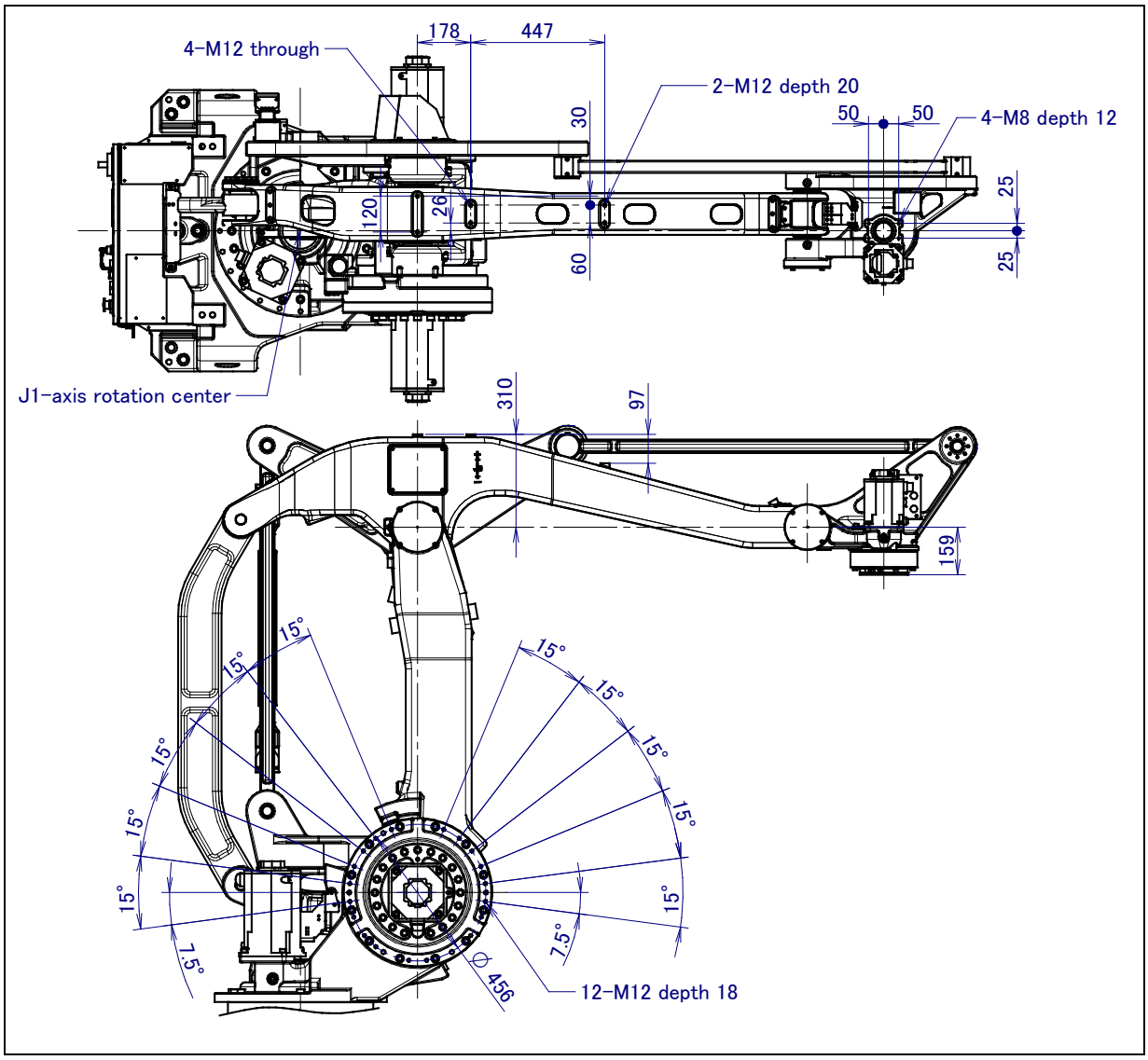


Fig. 4.2 (b) Equipment mounting faces (M-410*i*C/185/315)

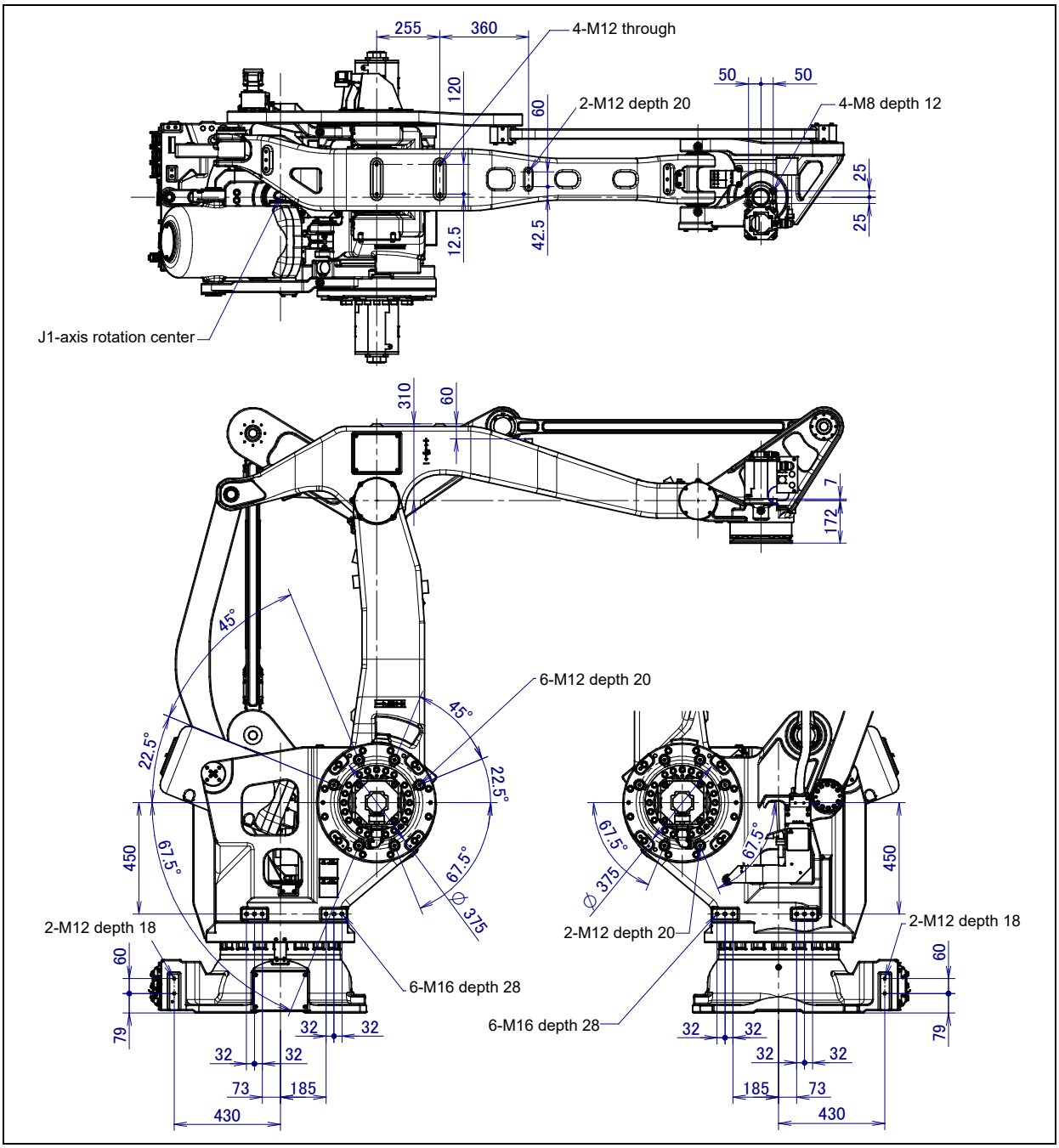


Fig. 4.2 (c) Equipment mounting faces (M-410*i*C/500)

4.3 LOAD SETTING

⚠ CAUTION

1 Set the load condition parameter before the robot runs. Do not operate the robot in over when its payload is exceeded. Do not exceed the allowable payload including connection cables. Operation in with the robot over payload may occur 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 Optional Function OPERATOR’S MANUAL (B-83284EN-2).

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

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

```
MOTION PERFORMANCE                    JOINT 10%
    Group1
No.   PAYLOAD[kg]          Comment
 1          185.00   [                    ]
 2            0.00   [                    ]
 3            0.00   [                    ]
 4            0.00   [                    ]
 5            0.00   [                    ]
 6            0.00   [                    ]
 7            0.00   [                    ]
 8            0.00   [                    ]
 9            0.00   [                    ]
10            0.00   [                    ]


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

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

```
MOTION PAYLOAD SET                    JOINT 10%

    Group 1
 1 Schedule No[          1]:[Comment          ]
 2 PAYLOAD                [kg]          185.00
 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
```

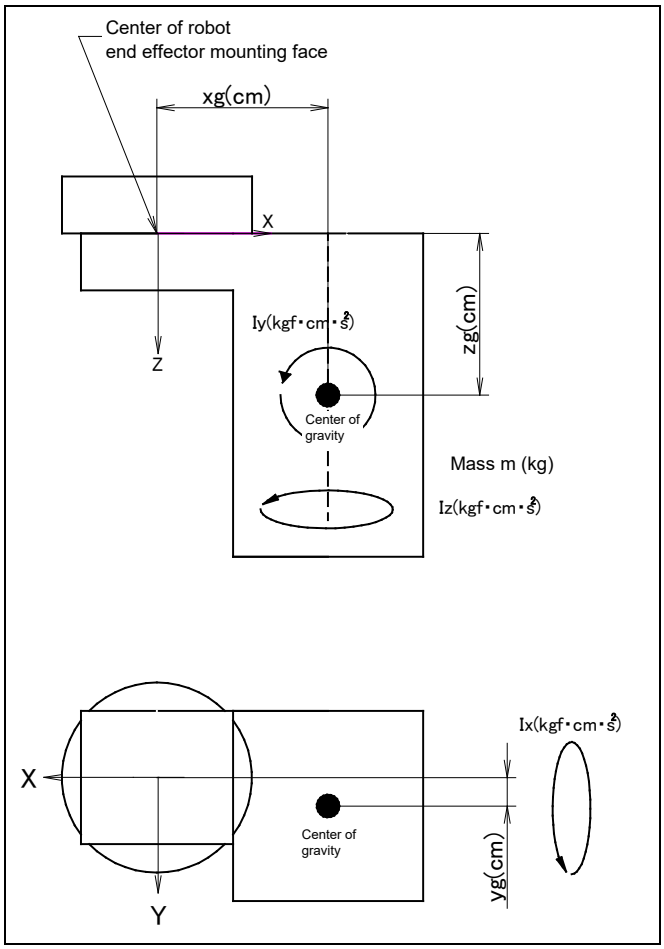


Fig. 4.3 (a) Standard tool coordinate

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 Cycle time will change. Set it?” Respond to the message with F4 ([YES]) or F5 ([NO]).

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

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

9 On the list screen, pressing F4 ARMLOAD brings you to the device-setting screen.

```
MOTION ARMLOAD SET          JOINT   100%

   Group 1
 1 ARM LOAD AXIS #1 [kg]          550.00
 2 ARM LOAD AXIS #3 [kg]           30.00

[ TYPE  ]    GROUP          DEFAULT   HELP
```

10 Specify the weight of the load on the J2 base and J3 arm as follows:
ARMLOAD AXIS #1[kg] : Weight of the load on the J2 base
ARMLOAD AXIS #3[kg] : Weight of the load on the J3 arm
The following message appears: “Path and Cycletime will change. Set it?” Select F4 ([YES]) or F5 ([NO]). Once the arm payload is 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 outside of mechanical unit.
- Please do not perform remodeling (adding a protective cover, or secure an additional outside cable) that obstructs the behavior of the outcrop of the cable.
- When external equipment is installed in the robot, make sure that it does not interfere with other parts of the robot.
- Cut and discard any unnecessary length of wire strand of the end effector (hand) cable. Insulate the cable with seal tape. (See Fig. 5 (a))
- If you have end effector wiring and a process that develops static electricity, keep the end effector wiring as far away from the process as possible. If the end effector and process must remain close, be sure to insulate the cable.
- Be sure to seal the connectors of the user cable and terminal parts of all cables to prevent water from entering the mechanical unit. Also, attach the cover to the unused connector.
- Frequently check that connectors are tight and cable jackets are not damaged.
- When precautions are not followed, damage to cables might occur. Cable failure may result in incorrect function of end effector, robot faults, or damage to robot electrical hardware. In addition, electric shock could occur when touching the power cables.

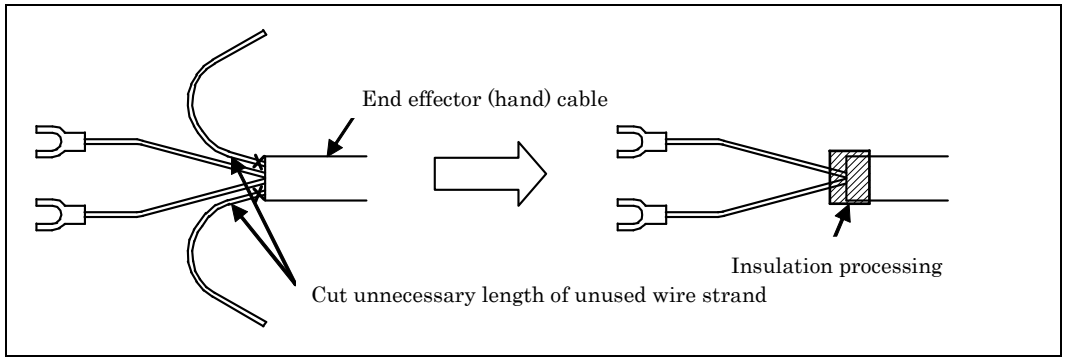


Fig. 5 (a) Treatment method of end effector (hand) cable

5.1 AIR SUPPLY (OPTION)

Robot has two air-pressure supply openings on the robot base or back of the J1 base and the wrist axis unit used to supply air pressure to the end effector. The connector is an Rc3/8 female (ISO).
As couplings are not supplied, it will be necessary to prepare couplings which suit to the hose size.

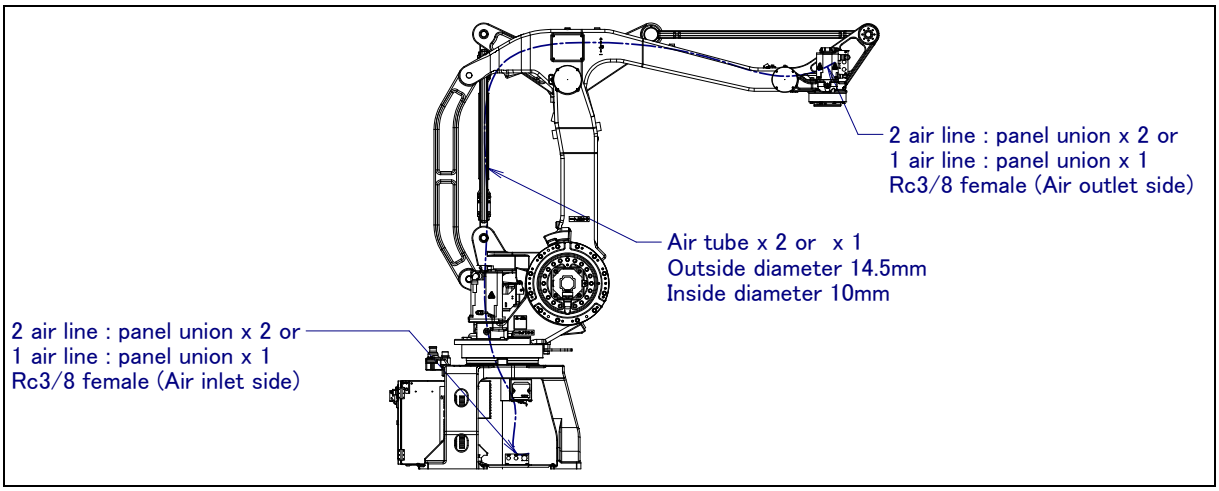


Fig. 5.1 (a) Air supply (M-410*i*C/185/315 pedestal type)

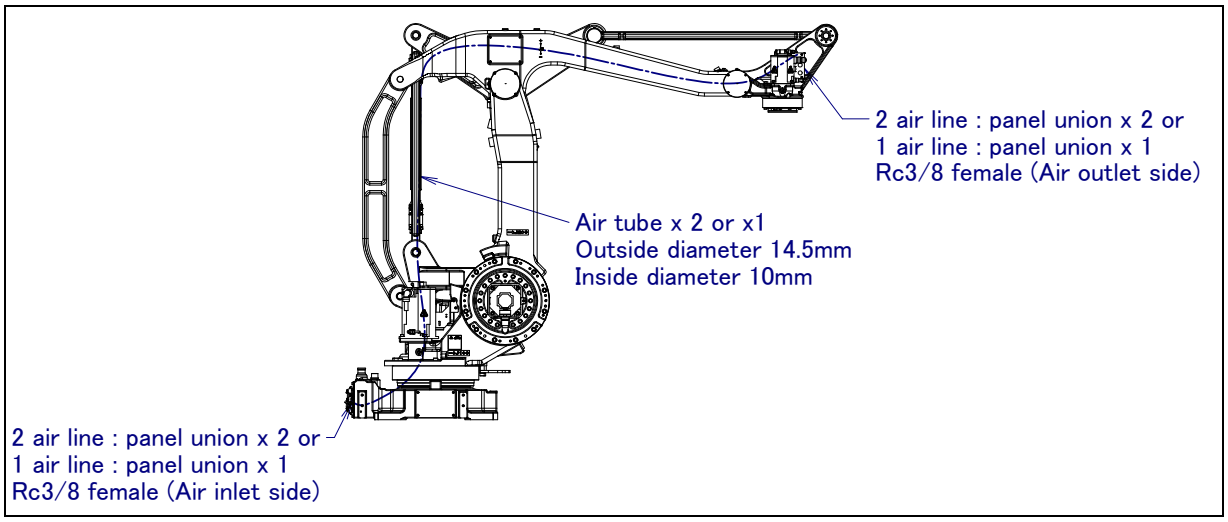


Fig. 5.1 (b) Air supply (M-410*i*C/185/315 no pedestal and M-410*i*C/110/500)

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.

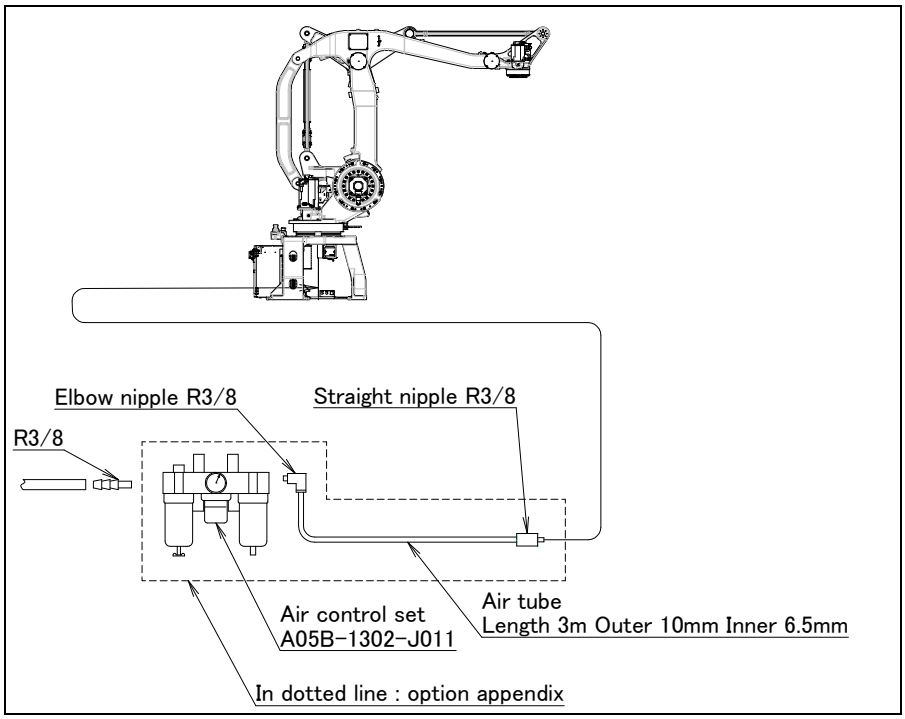


Fig. 5.2 (a) Air piping (option)

Air control set

For the lubricator of air control set, fill in turbine oil #90 to #140 to the specified level. The machine tool builder is required to prepare mounting bolts.

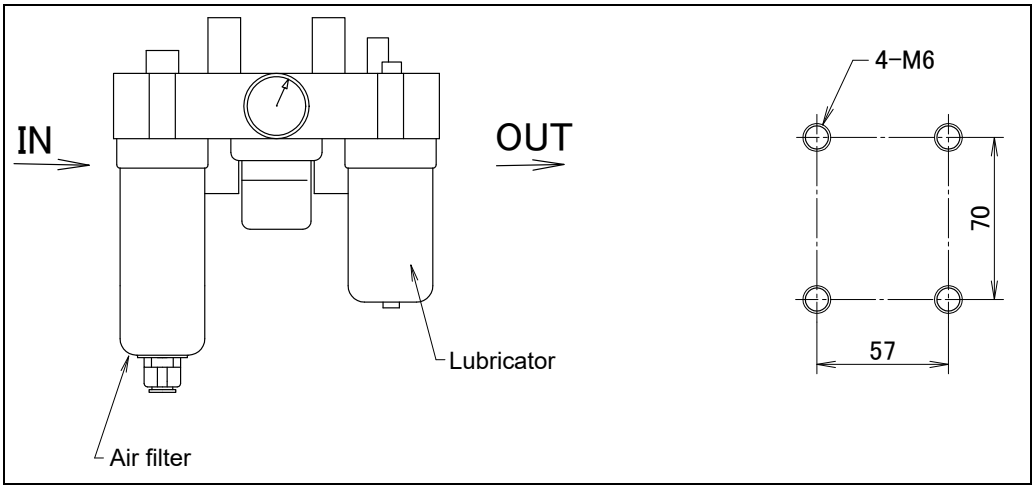


Fig. 5.2 (b) Air control set option (option)

NOTE
The capacity of the air control set is as follows.
These values must not be exceeded.

Air pressure	Supply air pressure	0.49 to 0.69MPa(5 to7kgf/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), (b) show the position of the option cable interface. Fig. 5.3 (c) to (f) show the option cable interface. EE interface (RI/RO), user cable (signal lines/signal usable to force sensor and 3D Laser Vision sensor), additional axis motor cable (Pulsecoder), additional axis motor cable (power, brake), camera cable and Ethernet cable as options.

NOTE
Each option cable is written as shown below on the connector panel.
EE(RI/RO) interface : EE
User cable (signal) : AS
User cable (signal usable to force sensor and 3D Laser Vision sensor) : ASi
Additional axis motor cable (Pulsecoder): ARP
Additional axis motor cable (power, brake): ARM
Camera cable : CAM
Ethernet cable : ES

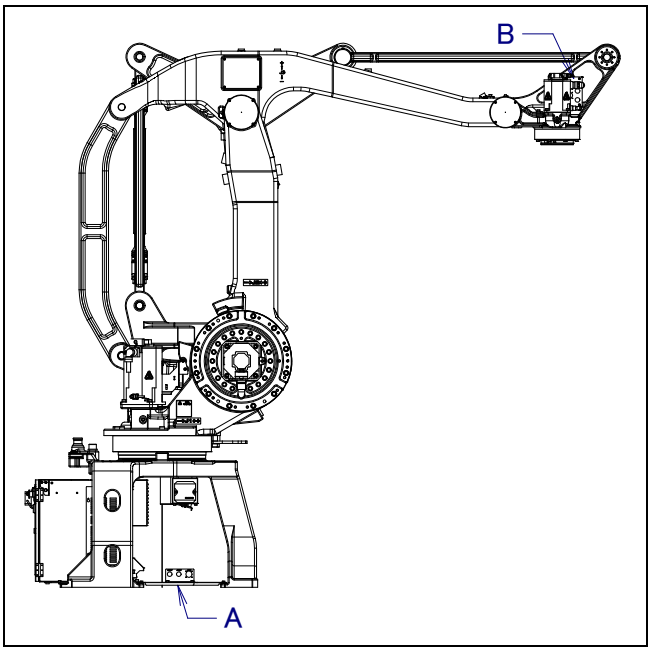


Fig. 5.3 (a) Interface for optional cable (M-410*i*C/185/315 pedestal type)

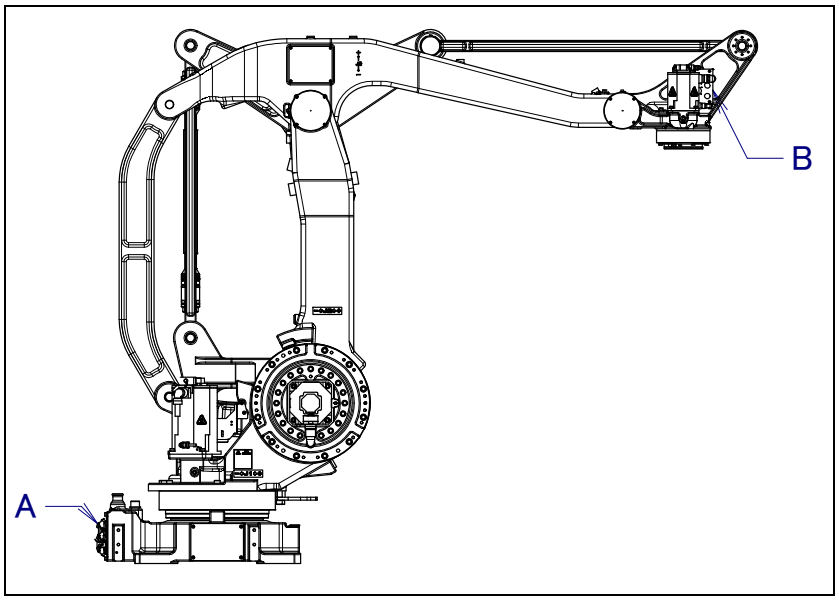


Fig. 5.3 (b) Interface for optional cable (M-410*i*C/185/315 no pedestal and M-410*i*C/110/500)

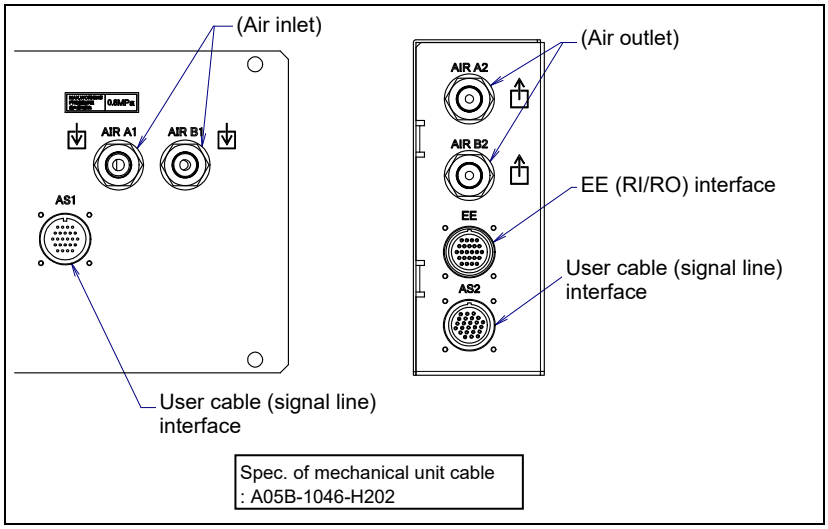


Fig. 5.3 (c) option cable interface (M-410*i*C/110)

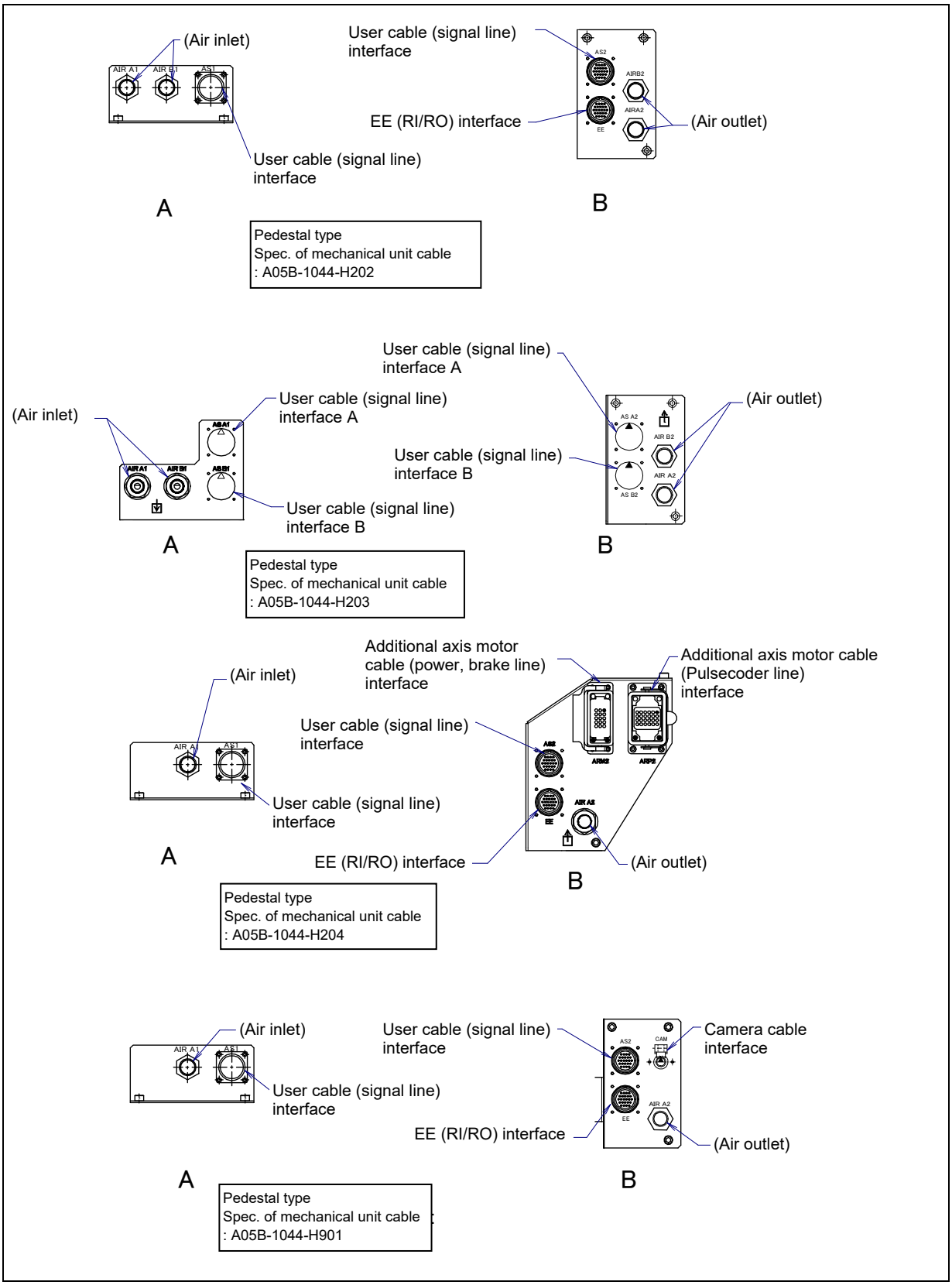


Fig. 5.3 (d) option cable interface (M-410*i*C/185/315 pedestal type)

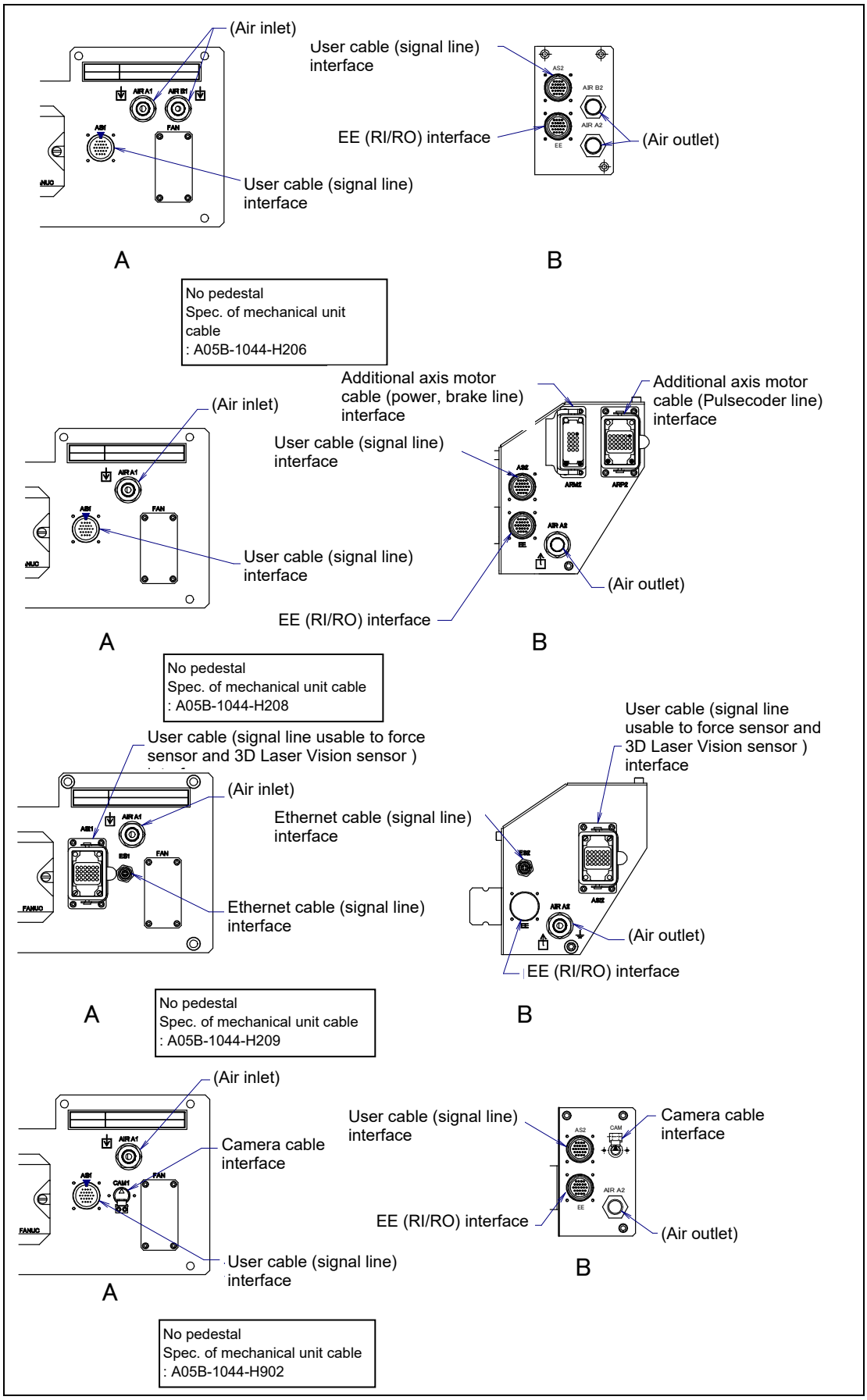


Fig. 5.3 (e) option cable interface (M-410*i*C/185/315 no pedestal)

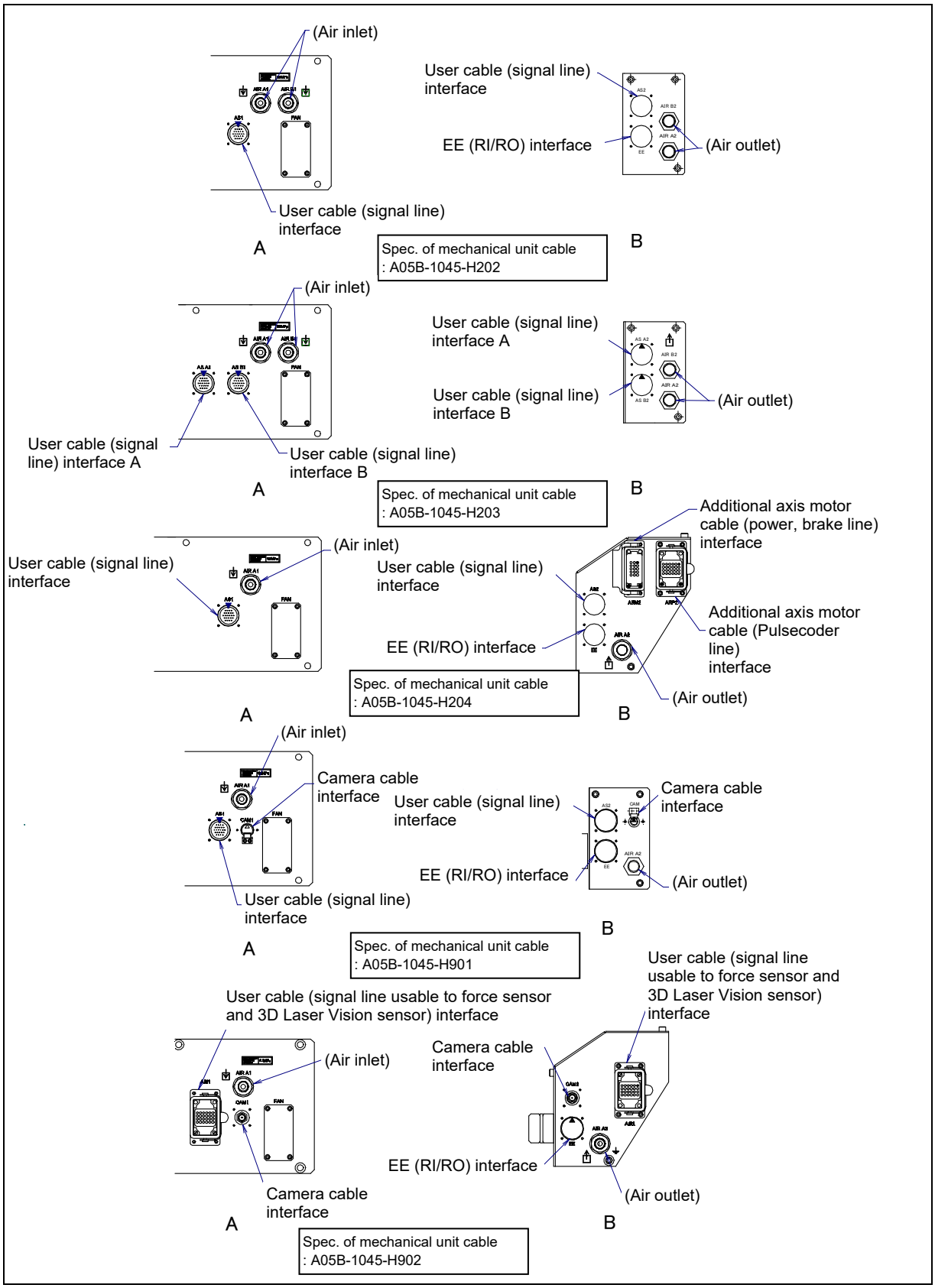


Fig. 5.3 (f) option cable interface (M-410*i*C/500)

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

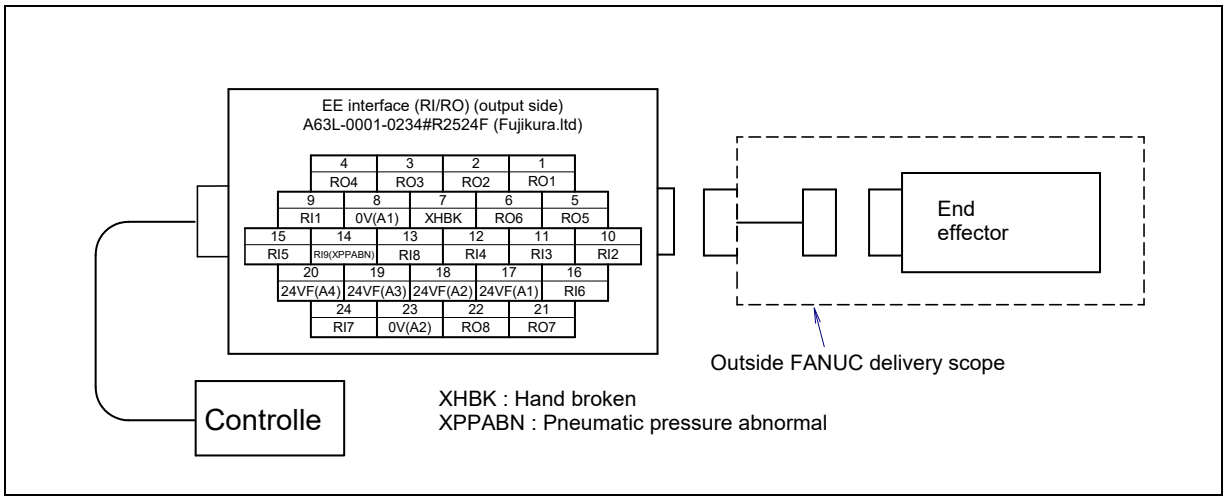


Fig. 5.3 (g) Pin layout for EE interface (RI/RO) (option)

> ⚠ **CAUTION**
> To wire the peripheral device to the EE interface, refer to the ELECTRICAL CONNECTIONS Chapter of the MAINTENANCE MANUAL (B-83195EN).

2 User cable (signal line) (AS) Interface (option)
Fig. 5.3 (h) shows pin layout for user cable (signal line) interface.

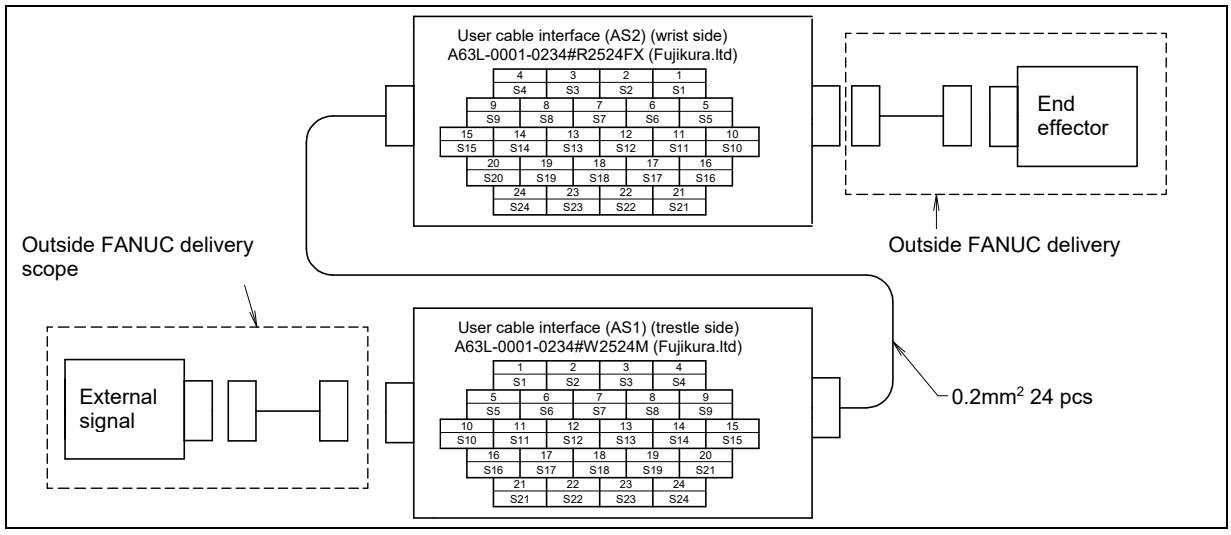


Fig. 5.3 (h) Pin layout for user cable (signal line) (AS) interface (option)

3 User cable (signal line usable to force sensor and 3D Laser Vision sensor) (ASi)
Fig. 5.3 (i) 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.

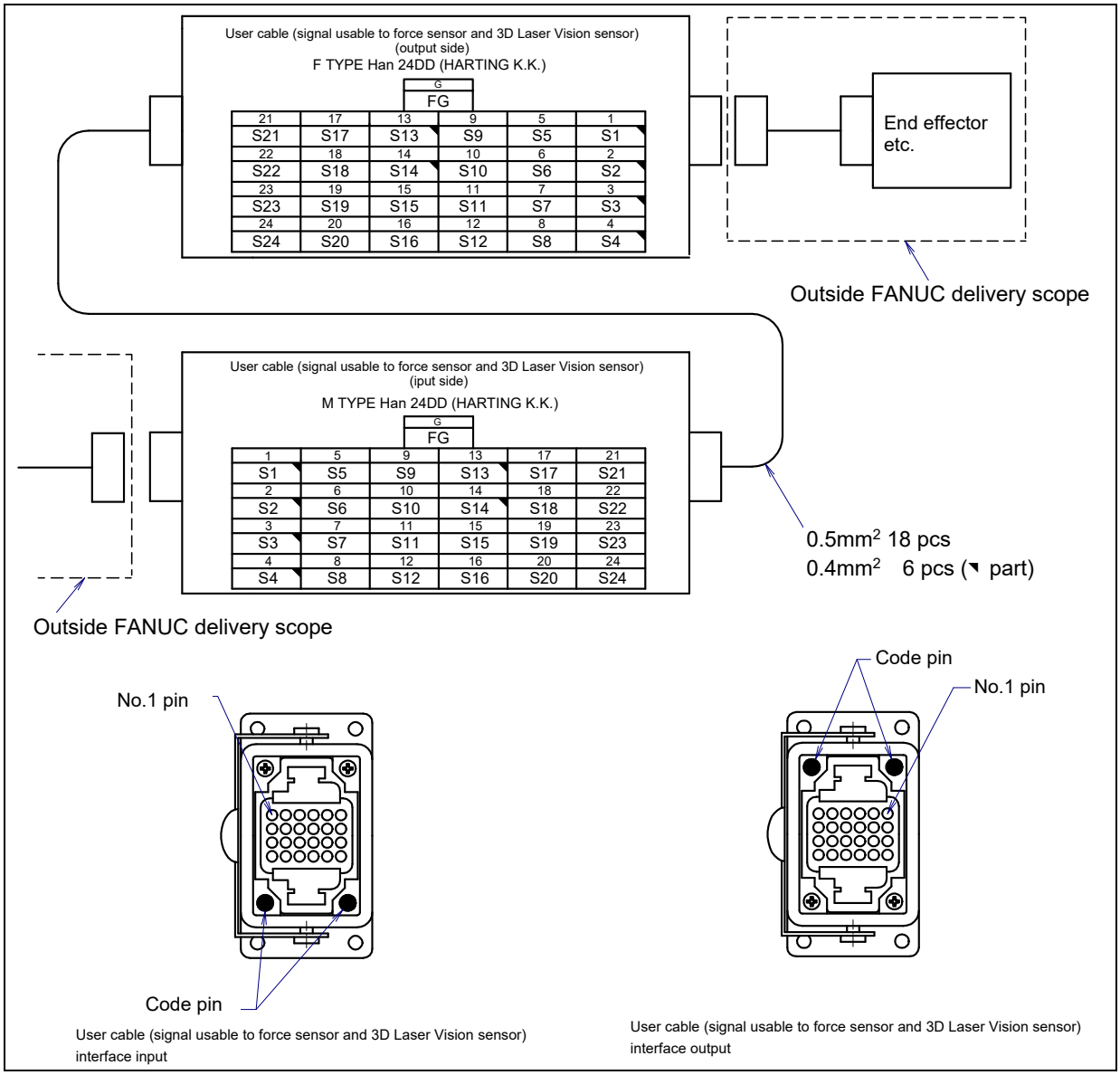


Fig. 5.3 (i) Pin layout for user cable (signal line usable to force sensor and 3D Laser Vision sensor) (ASi) interface and code pin layout (option)

4 Additional axis motor cable (ARP, ARM) Interface (option)
Fig. 5.3 (j) shows pin layout for additional axis motor cable interface.

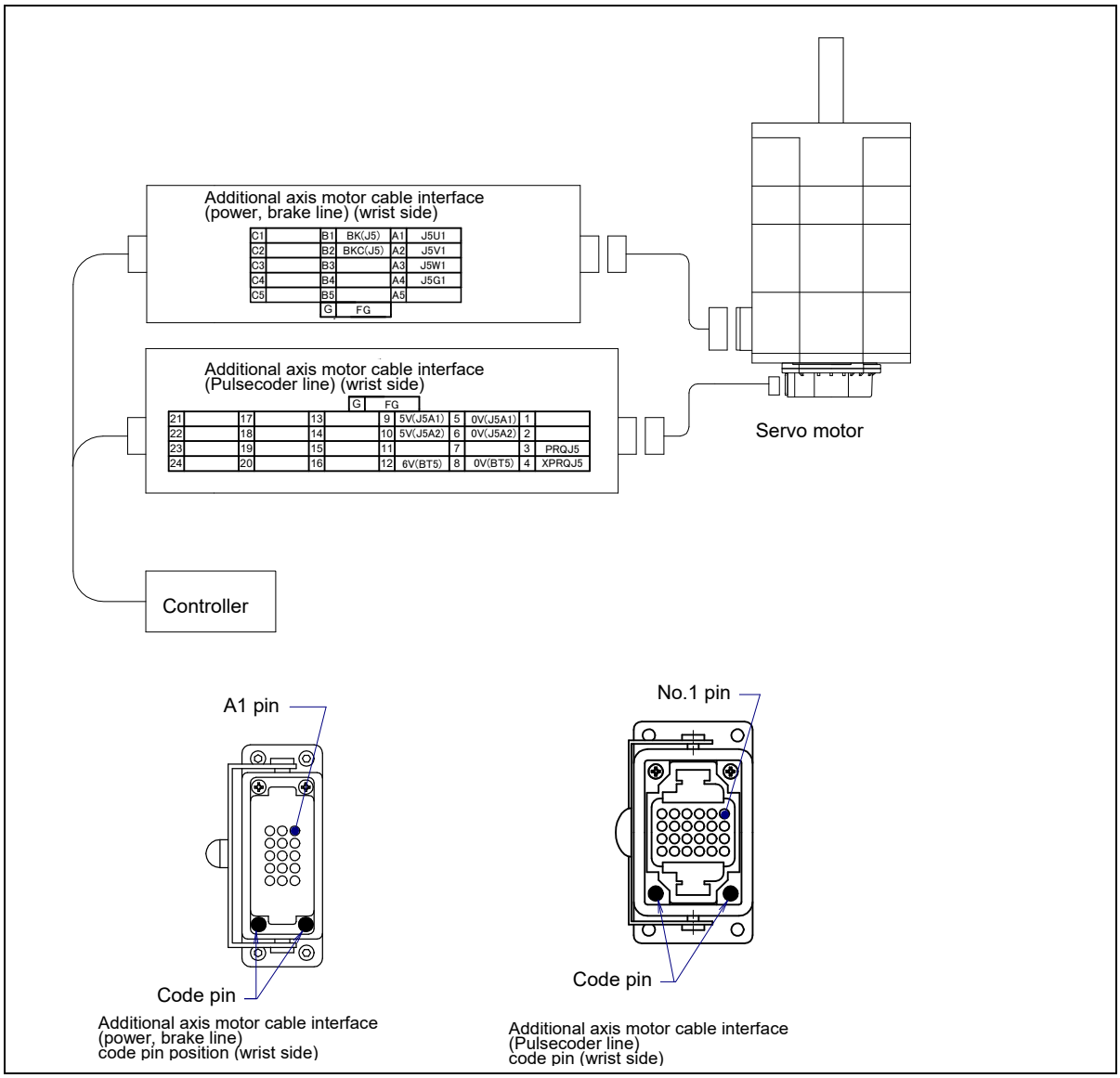


Fig. 5.3 (j) Pin layout for additional axis motor cable (ARP, ARM) interface (option)

NOTE
For details of connectors, 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.

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

ARP	α motor, β motor	αi, αi –B motor, βi, βi-B motor
SPD	SD	-
XSPD	*SD	-
PRQ	REQ	RD
XPRQ	*REQ	*RD

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

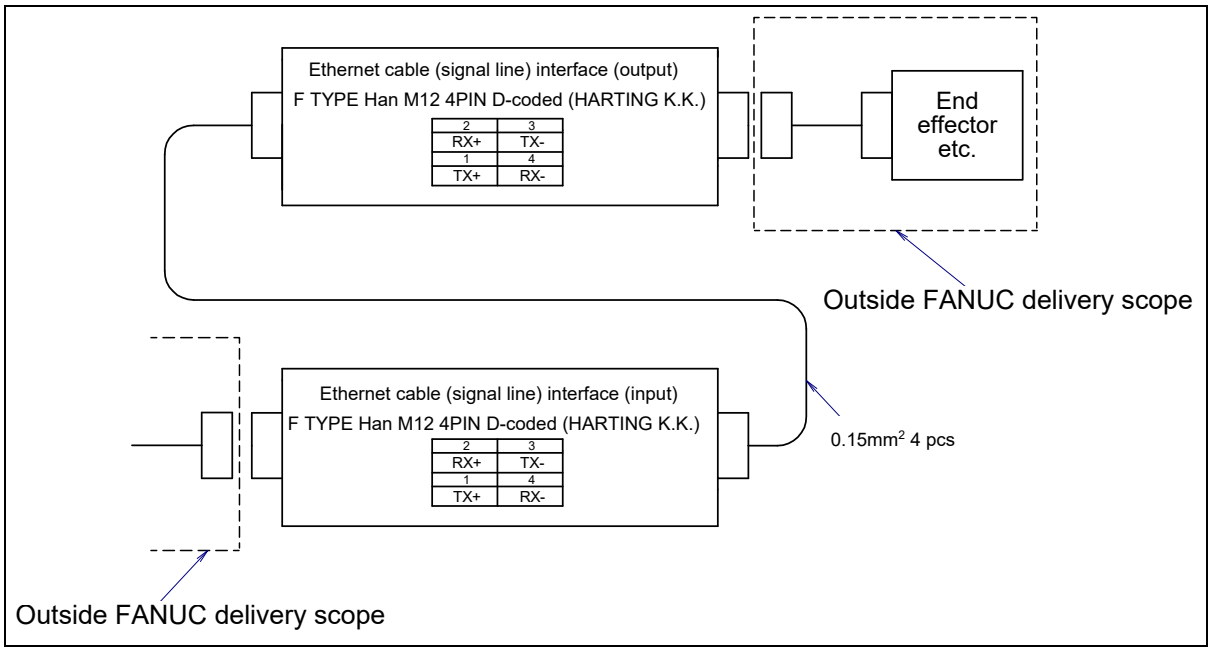


Fig. 5.3 (k) Pin layout for Ethernet cable (signal line) (ES) interface (option)

Connector specifications

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

Cable	Input side (J1 base)		Output side (wrist side)		Maker /dealer
EE(RI/RO)	———		FANUC spec.: A63L-0001-0234#R2524F		Fujikura Ltd.
AS	FANUC spec: A63L-0001-0234#W2524M		FANUC spec.: A63L-0001-0234#R2524FX		
ASi	Housing Insert Contact Code pin	09 30 006 0301 09 16 024 3001 09 15 000 6103 09 30 000 9901	Housing Insert Contact Code pin	09 30 006 0301 09 16 024 3101 09 15 000 6203 09 30 000 9901	HARTING K.K.
ARP	———		Housing Insert Contact Code pin	09 30 006 0301 (1 pc /1 robot) 09 16 024 3101 (1 pc /1 robot) 09 15 000 6204 (8 pcs/1 robot) 09 30 000 9901 (2 pcs/1 robot)	
ARM	———		Hosing Insert Contact Contact Code pin	09 20 010 0301 (1 pc /1 robot) 09 21 015 3101 (1 pc /1 robot) 09 15 000 6201 (2 pcs/1 robot) 09 15 000 6206 (4 pcs/1 robot) 09 30 000 9901 (2 pcs/1 robot)	
ES	Connector Contact	21 03 882 2425 09 67 000 7476	Connector Contact	21 03 882 2425 09 67 000 7476	

Table 5.3 (c) Connector specifications (User side)

Cable	Input side (J1 base)		Output side (wrist side)		Maker /dealer
EE(RI/RO)	———		JMSP2524M (*1) Straight JMLP2524M Angle		Fujikura Ltd.
AS	JMSP2524F (*2) Straight plug		JMSP2524MX (*3) Straight plug		
ASi	Hood (NOTE 2)	09 30 006 1540 Side entry 1541 ↓ 0542 ↓ 0543 ↓ 1440 Top entry 1441 ↓ 0442 ↓ 0443 ↓	Hood	←The same	HARTING K.K.
	Insert	09 16 024 3101	Insert	09 16 024 3001	
	Contact (NOTE 2)	09 15 000 6204 AWG 26-22 6203 AWG 20 6205 AWG 18 6202 AWG 18 6201 AWG 16 6206 AWG 14	Contact (NOTE 2)	09 15 000 6104 AWG 26-22 6103 AWG 20 6105 AWG 18 6102 AWG 18 6101 AWG 16 6106 AWG 14	
	Clamp (NOTE 2)	09 00 000 5083 5086 5090 5094 etc. Many other types are available	Clamp	←The same	
	Code pin	09 30 000 9901	Code pin	09 30 000 9901	
ES	Connector	21 03 882 1415	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	←The same	

NOTE

Underlined parts are attached. Below shows spec. to order in our company.
(*1)A63L-0001-0234#S2524M
(*2)A63L-0001-0234#S2524F
(*3)A63L-0001-0234#S2524MX

6 AXIS LIMIT SETUP

When axis limits are defined, the motion range of the robot can be changed from the standard value. The motion range of the robot axes can be restricted because of:
- Used motion range limitations
- Tools and peripheral equipment interfere each other in some areas.
- Length of the cable or hose attached to the application is limited.

Three methods are provided not to exceed the motion range of the robot:
- Axis limit by DCS (All axes (option))
- Axis limit by adjustable mechanical stopper (J1-axis (option))
- Axis limit by adjustable mechanical stopper and switches (J1-axis (option))

⚠ WARNING
1 Changing the motion range of any axis affects the operation range of the robot. To avoid trouble, carefully consider a possible effect of the change to the movable range of each axis in advance. Otherwise, it is likely that an unexpected condition occurs; for example, an alarm may occur in a previous 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. The robot cannot move beyond them. For the J1-axis, it is possible to re-position the mechanical stoppers. For J2/J3-axis, the mechanical stoppers are fixed. For the J4-axis, only DCS limits are available.
4 Changing J2 and J3-axes interference angles is impossible.
5 Adjustable mechanical stoppers (J1-axis) are deformed in a collision to stop the robot. Once a stopper is subject to a collision, it can no longer assure its original strength and, therefore, may not stop the robot. When this happens, replace it with a new one.

6.1 CHANGE AXIS LIMIT BY DCS (OPTION)

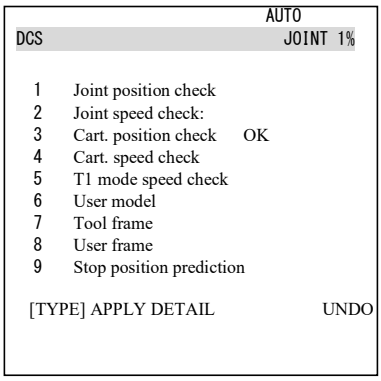
The robot motion can be restricted with DCS (Dual check safety) function by using the following software. For J2/J3-axis, the same effect as J1-axis adjustable mechanical stopper as shown in Section 6.2 can be obtained. The robot motion can be restricted at any angle and position if it is in robot motion area. DCS functions are certified to meet the requirements of International Standard ISO13849-1 and IEC61508 approved by notified body. If only the operating space is set using Joint Position Check, the robot stops after it goes beyond the workspace. When the motor power is shut down, the robot's momentum causes it to move some distance before it completely stops. The actual "Robot Stop Position" will be beyond the workspace. To stop the robot within the robot workspace, use the DCS Stop Position Prediction function. The stop position prediction is disabled by default.

・ DCS position/speed check function (J567)

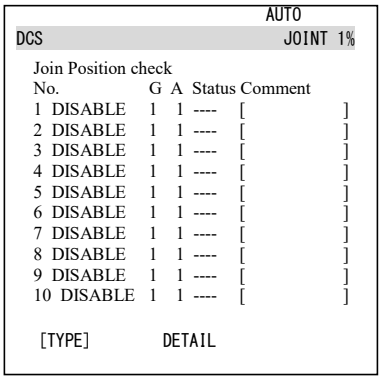
As an example, we shows the procedure to set $\pm 90^{o}$ for J2-axis in here. Refer to Dual check safety function Operator's Manual (B-83184EN) for details of other setting, function and DCS stop position prediction.

Setting procedure

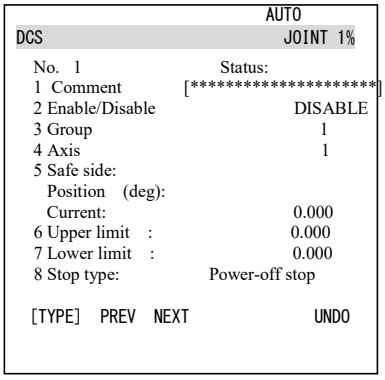
1 Press the [MENU] key to display the screen menu.
2 Press [0 NEXT] and press [6 SYSTEM].
3 Press the F1 (]TYPE]).
4 Select [DCS]. The following screen will be displayed.



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

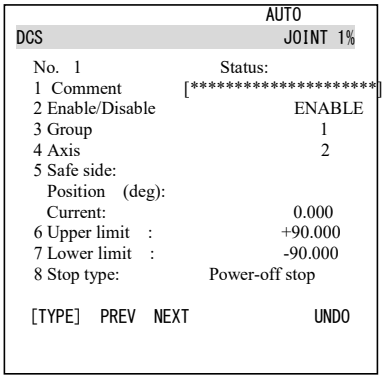


6 Move the cursor to [1], then press the [DETAIL].

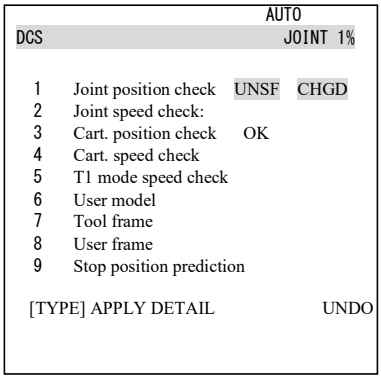


7 Move the cursor to [DISABLE], then press [CHOICE], set the status to [ENABLE].
8 Move the cursor to [Group], then input the robot group number, then press the [ENTER] key.
9 Move the cursor to [Axis], then input “2”, then press the [ENTER] key.
10 Move the cursor to [Upper limit] right side, then input “90”, then press the [ENTER] key.
11 Move the cursor to [Lower limit] right side, then input “-90”, then press the [ENTER] key.

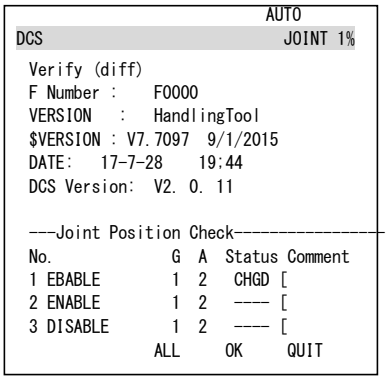
⚠ WARNING
If only the operating space is set using Joint Position Check, the robot stops after it goes beyond the workspace. When the motor power is shut down, the robot’s momentum causes it to move some distance before it completely stops. The actual "Robot Stop Position" will be beyond the workspace.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



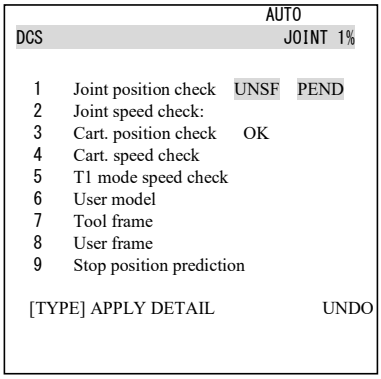
12 Press the [PREV] key two times, back to the first screen.



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 J1-AXIS STROKE MODIFICATION (OPTION)

For the J1-axes, Adjustable mechanical stopper (option) can be installed in addition to standard mechanical stopper. It is possible to re-position adjustable mechanical stoppers. In addition, if the limit switch (option) is specified, the limit switch-based movable range can be changed by changing the dog positions. Change the position of the 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 (M-410*i*C/110)

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

Table 6.2 (b) motion range that can be set by the adjustable mechanical stopper and space between the upper and lower limits (M-410*i*C/185/315)

Item		Settable motion range
J1-axis adjustable mechanical stopper, limit switch	Upper limit	Settable in steps of 15° in a range of -135° to +180°.
	Lower limit	Settable in steps of 15° in a range of -180° to +135°.
	Space between the upper and lower limits	A space of 45° or more is required.

Table 6.2 (c) motion range that can be set by the adjustable mechanical stopper and space between the upper and lower limits (M-410*i*C/500)

Item		Settable motion range
J1-axis adjustable mechanical stopper, limit switch	Upper limit	Settable in steps of 5° in a range of –110° to +180°.
	Lower limit	Settable in steps of 5° in a range of -180° to +110°.
	Space between the upper and lower limits	A space of 70° or more is required.

NOTE
1 If the newly set operation range does not include 0°, it is necessary to change it by zero position mastering so that 0° is included.
2 When adjustable mechanical stopper is ordered, mounting bolt is attached.
3 When motion range is changed by adjustable mechanical stopper, be sure to set the motion range of soft same refer to “(b) Changing the parameter setting”.

(a) Changing the mechanical stopper and the dog (option) position.
Change the mechanical position and the dog position as shown in Fig. 6.2 (a) to (e).

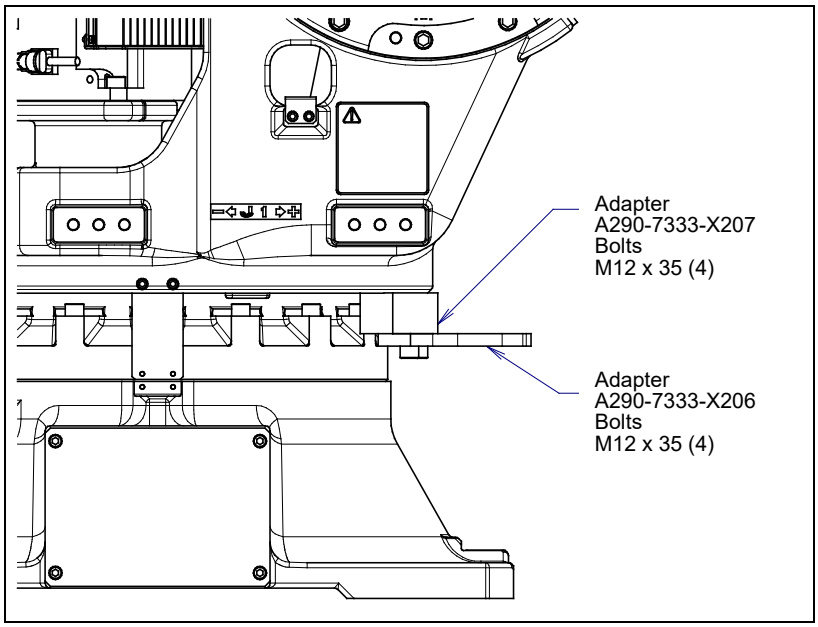


Fig. 6.2 (a) Mounting the J1-axis adjustable mechanical stopper (option) (M-410*i*C/110)

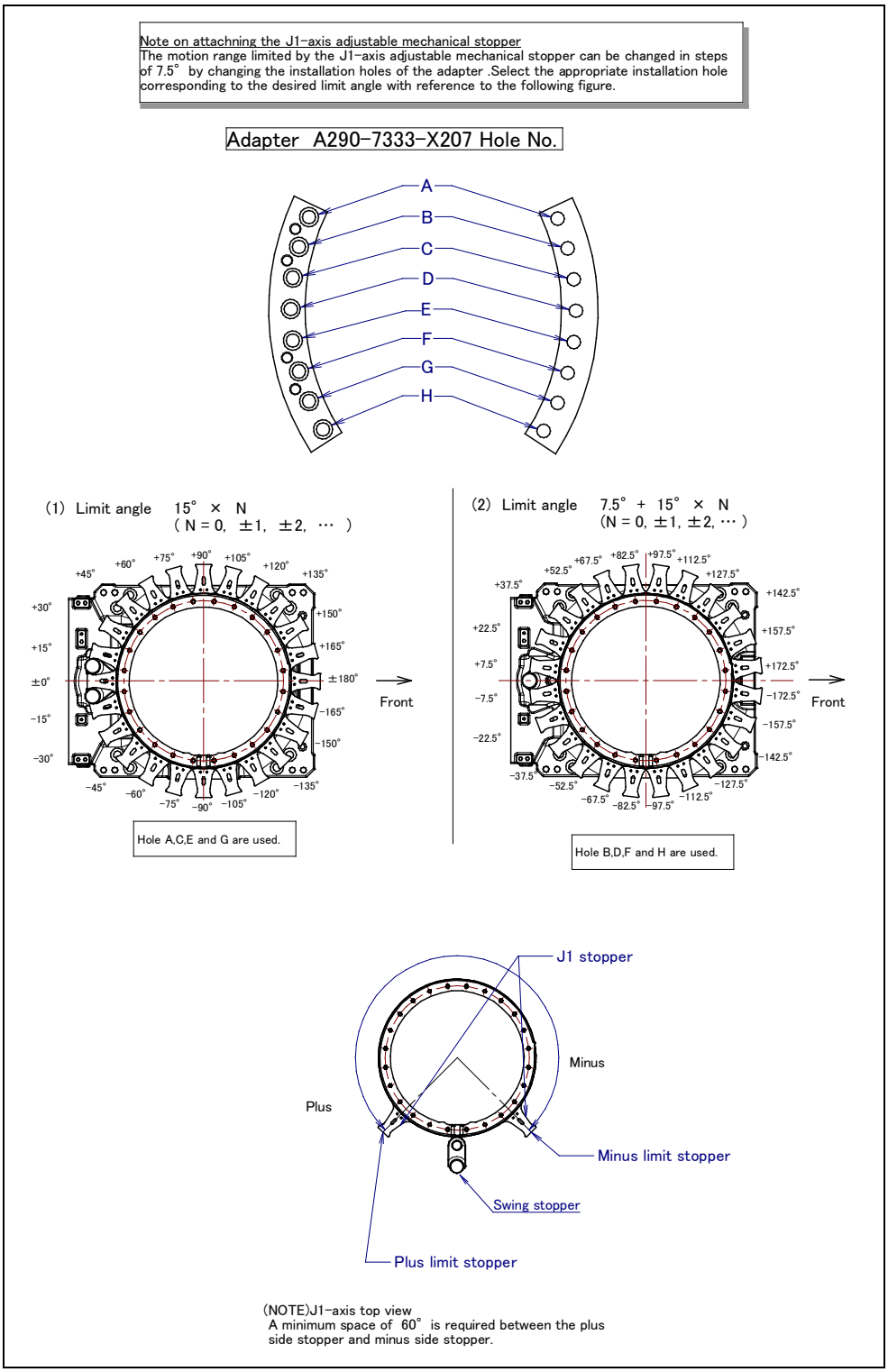
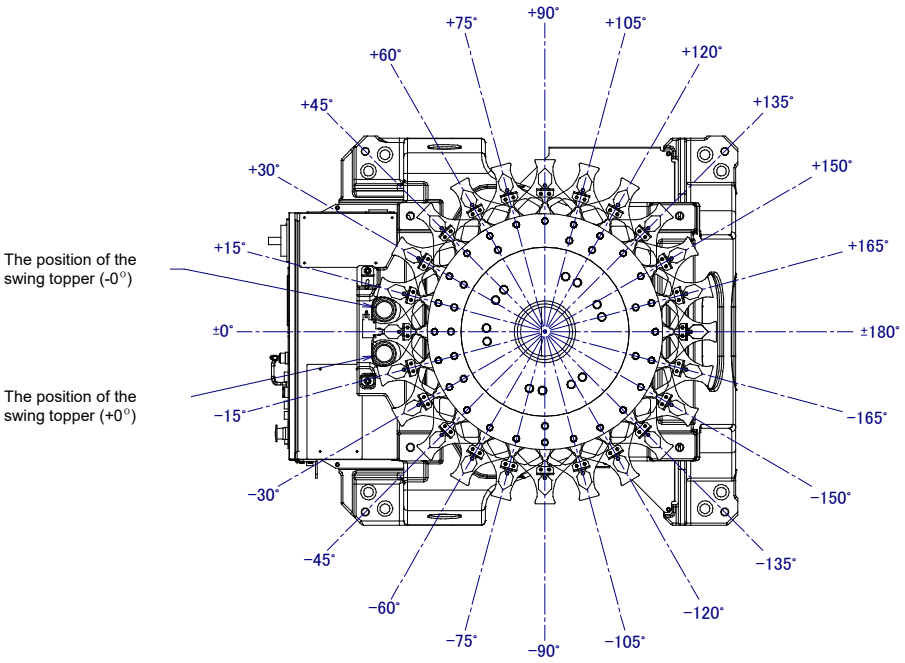


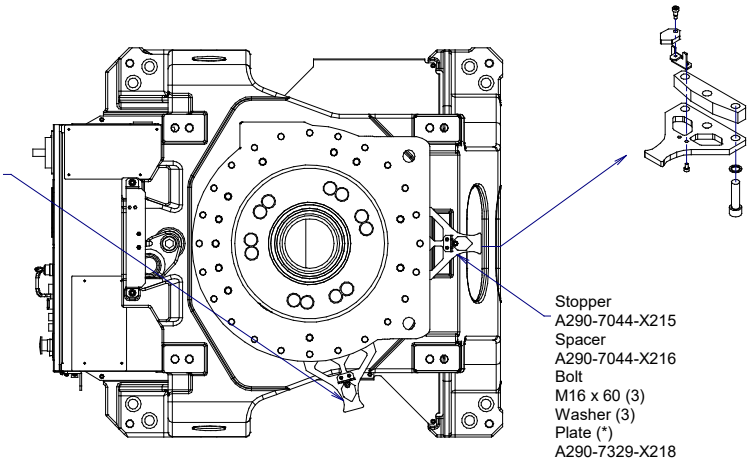
Fig. 6.2 (b) J1-axis adjustable mechanical stopper position and motion area (option) **(M-410*i*C/110)**

Note on attaching J1-axis mechanical stopper

The motion range limited by mechanical stopper can be changed in steps of 15° by chaging the Installation hole.
Select the appropriate installation hole corresponding to the desired limit angle referring to figure below.



(Note)
J1-axis top view
A minimum space of 45° is required between the plus side stopper
And minus side stopper.
Be careful to the position of +0° and -0°.



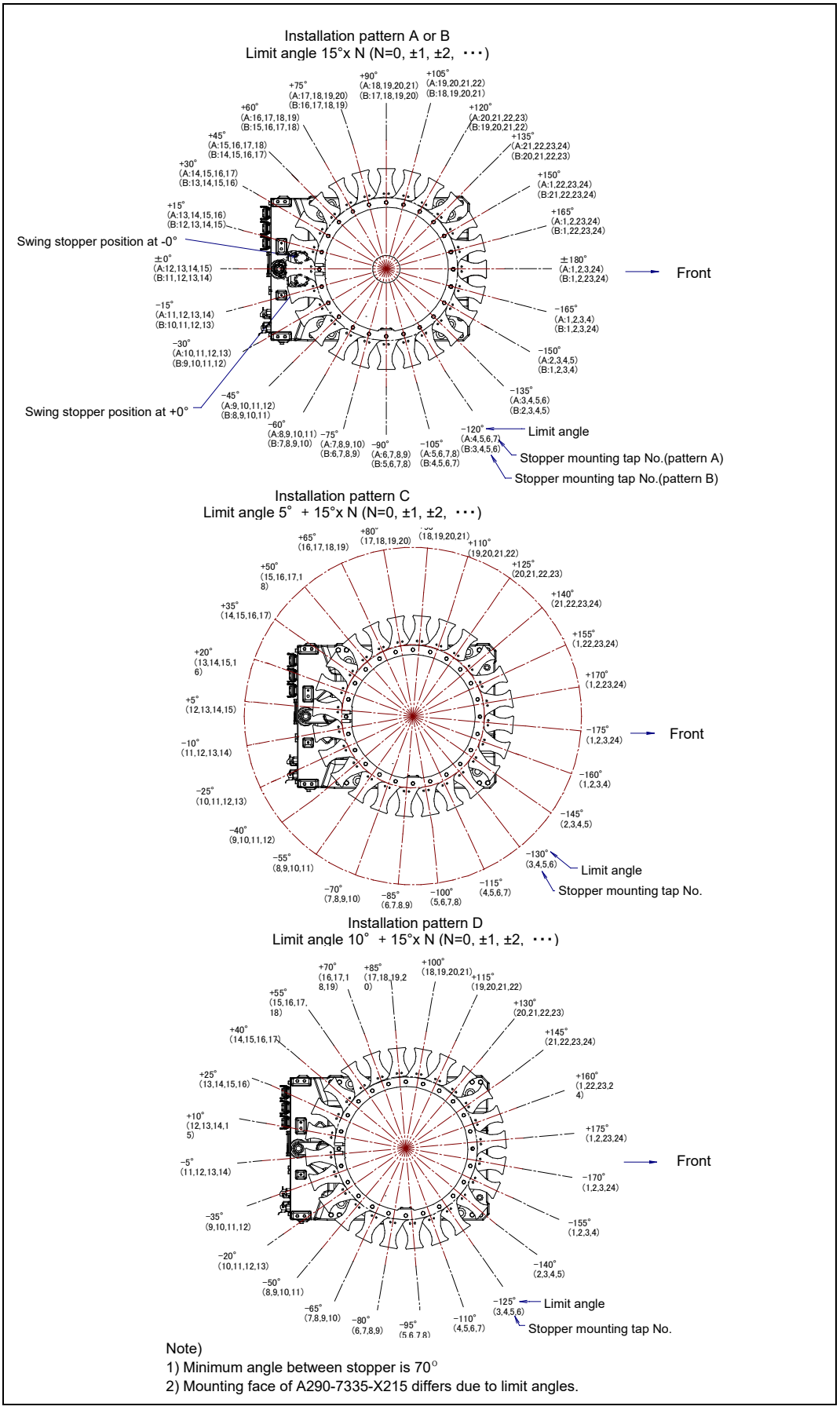
Stopper
A290-7044-X215
Spacer
A290-7044-X216
Bolt
M16 x 60 (3)
Washer (3)
Plate (*)
A290-7329-X218
Bolt (*)
M6 x10 (2)
Dog (*)
A290-7313-X220
Shoulder bolt (*)
M8 x 10

Stopper setting example
(In case of J1-axis -105° to +180°)

Stopper
A290-7044-X215
Spacer
A290-7044-X216
Bolt
M16 x 60 (3)
Washer (3)
Plate (*)
A290-7329-X218
Bolt (*)
M6 x10 (2)
Dog (*)
A290-7313-X220
Shoulder bolt (*)
M8 x 10

(*) When the limit switch is specified

Fig. 6.2 (c) J1-axis adjustable mechanical stopper position and motion area (option) **(M-410*i*C/185/315)**



Note)
1) Minimum angle between stopper is 70°
2) Mounting face of A290-7335-X215 differs due to limit angles.

Fig. 6.2 (d) J1-axis adjustable mechanical stopper position and motion area (option) **(M-410*i*C/500) (1/2)**

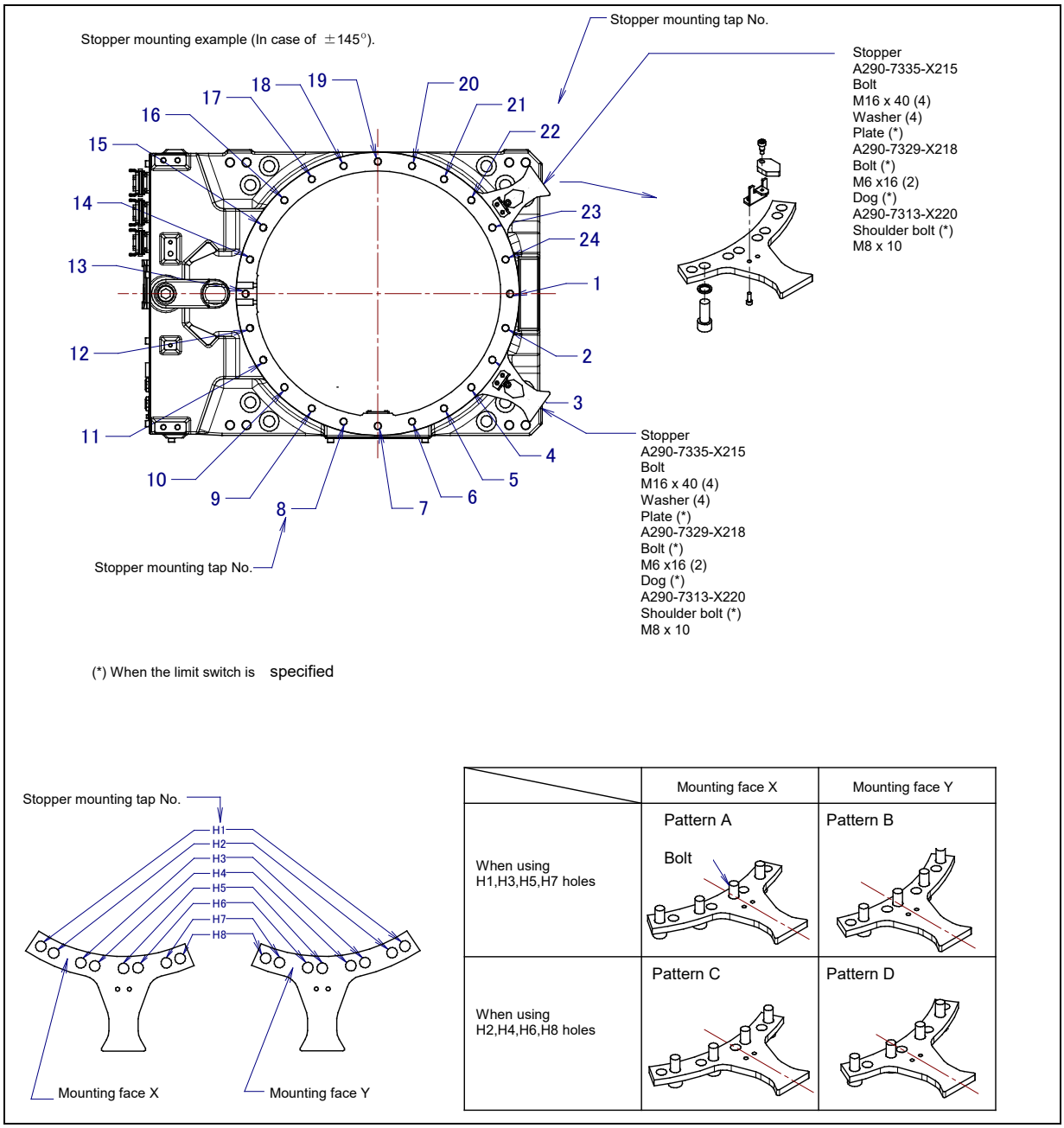
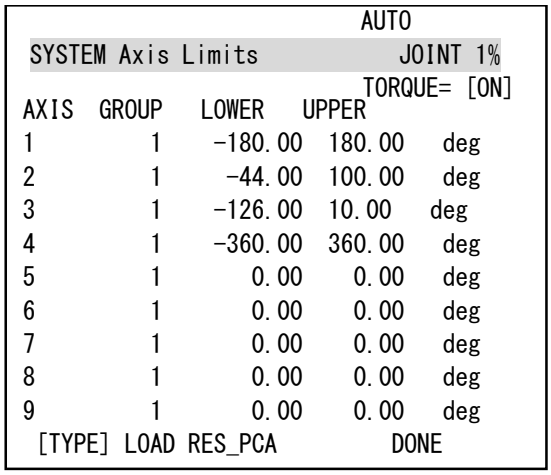


Fig. 6.2 (e) J1-axis adjustable mechanical stopper position and motion area (option) **(M-410*i*C/500) (2/2)**

(b) Changing the parameter setting

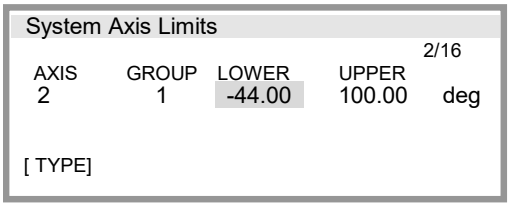
Setting procedure

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 [Axis Limits]. The following screen will be displayed.



NOTE
The setting value 0.00 indicates that the robot does not have the axis.

5 Move the cursor to the desired axis range and type the new value using the numeric keys on the teach pendant.



6 Perform the setting for J-axis as Table 6.2 (d) to (f).

Table 6.2 (d) Modification of system variable (M-410*i*C/110)

Positions	System variable	
	Lower stroke limit $PARAM_GROUP$LOWERLIMS[1]	Upper stroke limit $PARAM_GROUP.$UPPERLIMS[1]
0° to +180° (in steps of 15°)	Mounting angle of minus side stopper	-
0° to -180° (in steps of 15°)	-	Mounting angle of plus side stopper

Table 6.2 (e) Modification of system variable (M-410*i*C/185/315)

Positions	System variable	
	Lower stroke limit $PARAM_GROUP$LOWERLIMS[1]	Upper stroke limit $PARAM_GROUP.$UPPERLIMS[1]
0° to +180° (in steps of 15°)	Mounting angle of minus side stopper	-
0° to -180° (in steps of 15°)	-	Mounting angle of plus side stopper

Table 6.2 (f) Modification of system variable (M-410*i*C/500)

Positions	System variable	
	Lower stroke limit $PARAM_GROUP$LOWERLIMS[1]	Upper stroke limit $PARAM_GROUP.$UPPERLIMS[1]
0° to +180° (in steps of 5°)	Mounting angle of minus side stopper	-
0° to -180° (in steps of 5°)	-	Mounting angle of plus side stopper

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

⚠ WARNING

1 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.
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 J1 axis 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.
5 Do not add threaded holes to the frame, or do not use a self-made stopper to control the J1 stroke at any angle other than the one specified; otherwise, robot operation may be dangerous.

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 (g) and Fig. 6.2 (f). 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 exchange such “transformed” stopper.

Table 6.2 (g) The maximum stopping distance (position) of adjustable mechanical stopper

	Plus side	Minus side
J1-axis	+24.9°	-24.9°

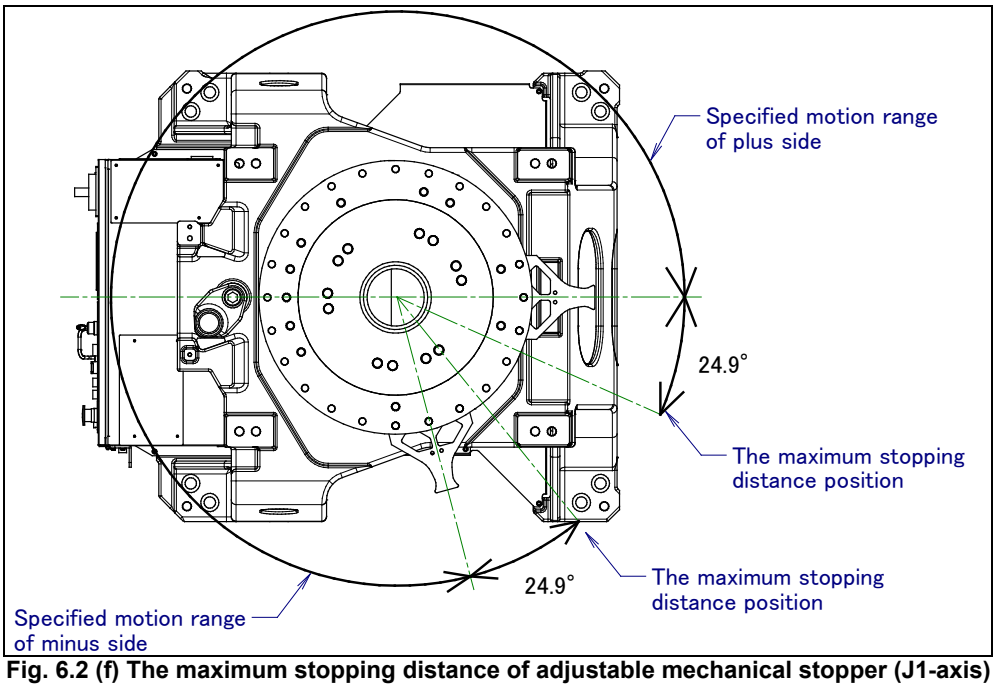


Fig. 6.2 (f) The maximum stopping distance of adjustable mechanical stopper (J1-axis)

6.3 ADJUSTING LIMIT SWITCHES OF J1-AXIS (OPTION)

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

1 Set the $MOR_GRP.$CAL_DONE system parameter to FALSE. This disables the stroke end specified by the software. As a result, the operator can rotate the robot around the J1-axis by a jog feed which goes beyond the stroke end.
2 Loosen the two M8 x 12 bolts and two M4 x 25 bolts that secure the J1-axis limit switch.
3 Adjust the switch position so that the robot activates the limit switch when approximately 1.0 degree from each stroke end. When the dog is pressed, only one side of the pushing width indication lines on the end of the switch must be hidden.
4 When the limit switch operates and detects overtravel (OT), the robot stops, and an error message, "OVERTRAVEL", is displayed. To restart the robot, hold on the SHIFT key and press the RESET key. Then, while holding on the SHIFT key, release the J1 axis from the limit by JOG feed.
5 Check that the robot also activates the limit switch when the robot is approx. 1.0 degree from the opposite stroke end in the same way as above. If the limit switch does not operate at the position, adjust the position of the switch again.
6 Set the $MOR_GRP.$CAL_DONE system parameter to TRUE.
7 Turn off the power, then turn it on again to restart the controller.

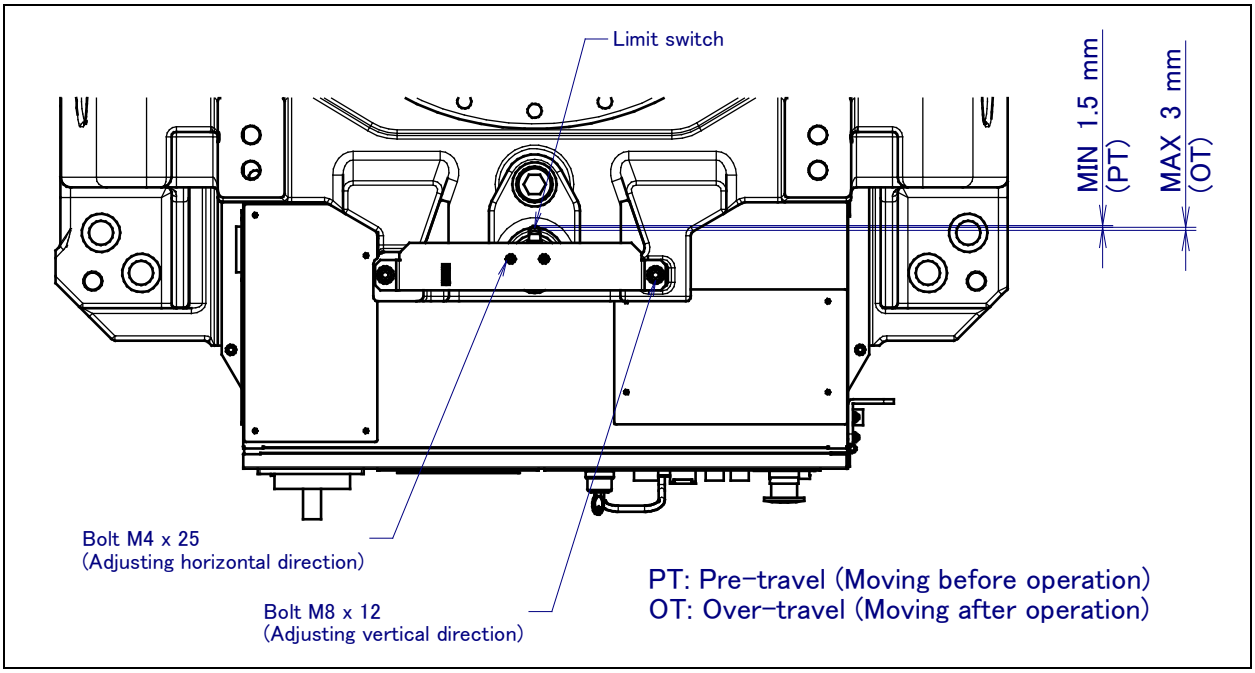


Fig. 6.3 (a) Adjusting J1-axis OT (option)

7 CHECKS AND MAINTENANCE

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

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

7.1 CHECKS AND MAINTENANCE

7.1.1 Daily Checks

Check the following items when necessary before daily system operation.

Check items	Check points and management
Oil seepage	Check whether there is oil on the sealed part of each joint. If there is oil seepage, clean them. **⇒"7.2.1 Confirmation of Oil Seepage"**
Air control set	(When air control set is used) **⇒"7.2.2 Confirmation of the Air Control Set"**
Vibration, abnormal noises	Check whether vibration or abnormal noises occur. When vibration or abnormal noises occur, perform measures referring to the following section: **⇒"9.1 TROUBLESHOOTING" (symptom: Vibration, Noise)**
Positioning accuracy	Check that the taught positions of the robot have not deviated from the previously taught positions. If displacement occurs, perform the measures as described in the following section: **⇒"9.1 TROUBLESHOOTING" (Symptom: Displacement)**
Peripheral equipment for proper operation	Check whether the peripheral equipment operate properly according to commands from the robot and the peripheral equipment.
Brakes for each axis	Check that the end effector drops 1.2 mm or less when the servo power is turned off. If the end effector (hand) drops more than the prescribed amount, perform the measures as described in the following section: **⇒"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: **⇒"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 items	Check points, management and maintenance methods	Periodic maintenance table No.
1 month 320h	3 months 960h	1 year 3840h	1.5 years 5760h	3 years 11520h	4 years 15360h			
○ Only 1st check	○					Cleaning the controller ventilation system	Confirm the controller ventilation system is not dusty. If dust has accumulated, remove it.	24
	○					Check the external damage or peeling paint	Check whether the robot has external damage or peeling paint due to the interference with the peripheral equipment. If an interference occurs, eliminate the cause. Also, if the external damage is serious, and causes a problem in which the robot will not operate, replace the damaged parts.	1
	○					Check for damage of the cable protective sleeve	Check the mechanical unit cable protective sleeves for holes or tears. If damage is found, replace the cable protective sleeve. If the cable protective sleeve is damaged due to interference with peripheral devices, eliminate the cause, **⇒"7.2.3 Check the Mechanical Unit Cables and Connectors"**	2
	○					Check the wear debris of the J1-axis swing stopper	Check whether wear debris has accumulated on the J1-axis swing stopper rotation part. If serious wear is evident on the part that generated the wear debris, replace the part.	3
	○					Check for water	Check whether the robot is subjected to water or cutting oils. If liquid was found, remove the cause, and wipe 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.	23
	○ Only 1st check	○				Check for damage to the mechanical unit cable (movable part)	Observe the movable part of the mechanical unit cable, and check for damage. Also, check whether the cables are excessively bent or unevenly twisted. **⇒"7.2.3 Check the Mechanical Unit Cables and Connectors"**	5
	○ Only 1st check	○				Check for damage to the end effector (hand) cable	Check whether the end effector cables are unevenly twisted or damaged. If damage is found, replace the damaged cables.	6

Check and maintenance intervals (Period, Accumulated operating time)						Check and maintenance items	Check points, management and maintenance methods	Periodic maintenance table No.
1 month 320h	3 months 960h	1 year 3840h	1.5 years 5760h	3 years 11520h	4 years 15360h			
	○ Only 1st check	○				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 are installed, removed in the inspection, and exposed. 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 that the stopper mounting bolts are not loose. Check that the J1-axis swing stopper rotates smoothly. **⇒"7.2.4 Check of Fixed Mechanical Stopper and Adjustable Mechanical Stopper"**	10
	○ Only 1st check	○				Clean spatters, sawdust and dust	Check that spatters, sawdust, or dust does not exist on the robot main body. If dust has accumulated, remove it. Especially, clean the robot movable parts well (each joint, and the cable protective sleeve).	11
	○ Only 1st check	○				Check the operation of the cooling fan	(When cooling fans are installed on the each axis motor) Check whether the cooling fans are operating correctly. If the cooling fans do not operate, replace them.	12
			○			Replacing the mechanical unit batteries	Replace the mechanical unit batteries. Regardless of operating time, replace batteries at 1.5 years. **⇒"7.3.2 Replacing the Batteries"**	13
		○				Supply grease to balancer bush (only M-410*i*C/500)	Supply grease to the balancer bushing **⇒"7.3.1 Greasing of Bearing and Balance Bushing"**	18
				○		Supply grease to J3 arm connection part bearing	Supply grease to the J3 arm connection part bearing. **⇒"7.3.1 Greasing of Bearing and Balance Bushing"**	19

Check and maintenance intervals (Period, Accumulated operating time)						Check and maintenance items	Check points, management and maintenance methods	Periodic maintenance table No.
1 month 320h	3 months 960h	1 year 3840h	1.5 years 5760h	3 years 11520h	4 years 15360h			
				○		Supply grease to J3 base connection part bearing	Supply grease to the J3 base connection part bearing. **⇒"7.3.1 Greasing of Bearing and Balance Bushing"**	20
				○		Supply grease to wrist connection part bearing	Supply grease to the wrist connection part bearing **⇒"7.3.1 Greasing of Bearing and Balance Bushing"**	21
				○		Replacing the grease of drive mechanism	Replace the grease of each axis reducer and gearbox. **⇒"7.3.3 Replacing the Grease of the Drive Mechanism"**	14 to 17
					○	Replacing the mechanical unit cable	Replace the mechanical unit cable Contact your local FANUC representative for information regarding replacing the cable.	22
					○	Replacing the controller batteries	Replace the controller batteries. Regardless of operating time, replace batteries at 4 years. **⇒Chapter 7 Replacing batteries of MAINTENANCE MANUAL (B-83195EN)"**	25

7.2 CHECK POINTS

7.2.1 Confirmation of Oil Seepage

Check items

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

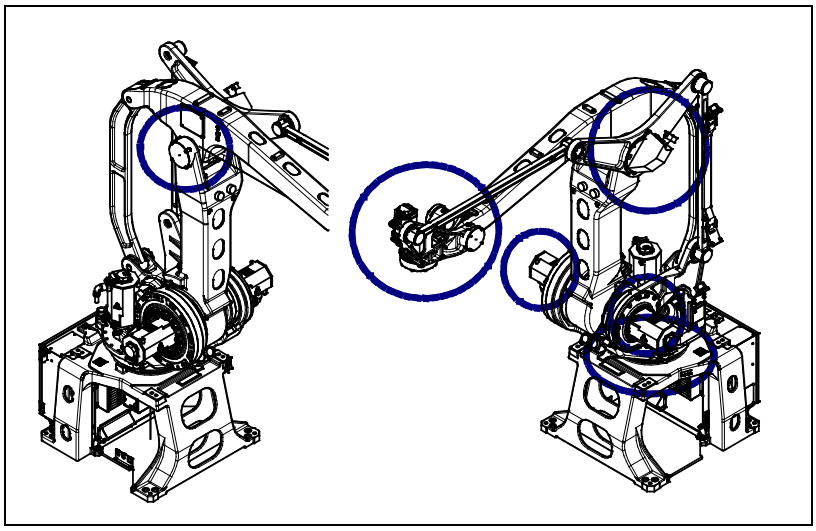


Fig. 7.2.1 (a) Check parts of oil seepage

Management

- Oil might accumulate on the outside of the seal lip depending on the movement condition or environment of the axis. If the oil viscosity changes, the oil might drip depending on the axis movement. To prevent oil spots, be sure to wipe away any accumulated oil under the axis components in Fig. 7.2.1 (a) 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**
> 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.

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

7.2.2 Confirmation of the Air Control Set (option)

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

Item	Check items	Check points
1	Air pressure	Check the air pressure using the pressure gauge on the air control set as shown in Fig. 7.2.2 (a). If it does not meet the specified pressure of 0.49 to 0.69 MPa (5-7 kgf/cm^2), adjust it using the regulator pressure-setting handle.
2	Lubricator oil mist quantity	Check the number of oil drops during operation. If it does not meet the specified value (1 drop/10-20 sec), adjust it using the lubricator control knob. Under normal usage, the lubricator will be empty in about 10 to 20 days.
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. If the quantity of the drained liquid is significant, examine the setting of the air dryer on the air supply side.

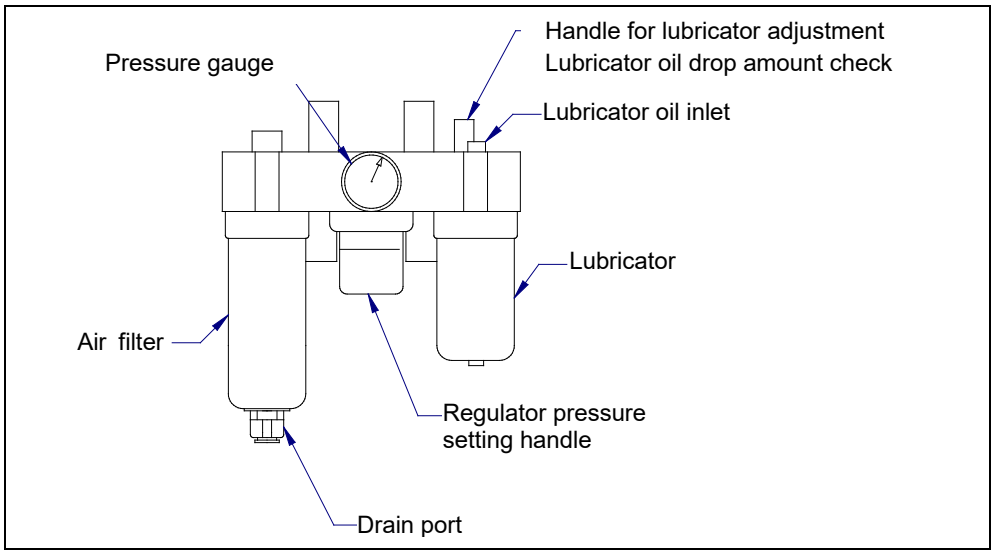


Fig. 7.2.2 (a) Air control set (option)

7.2.3 Check the Mechanical Unit Cables and Connectors

Check points of the mechanical unit cables

Movable parts of J1, the upper side and lower side of link for wrist posture maintenance of rear side of J2 arm, movable part in uniting part of J2 to J3 and J3 to J4 and fixed department cable J2/J3 connection part who interferes easily in peripherals.

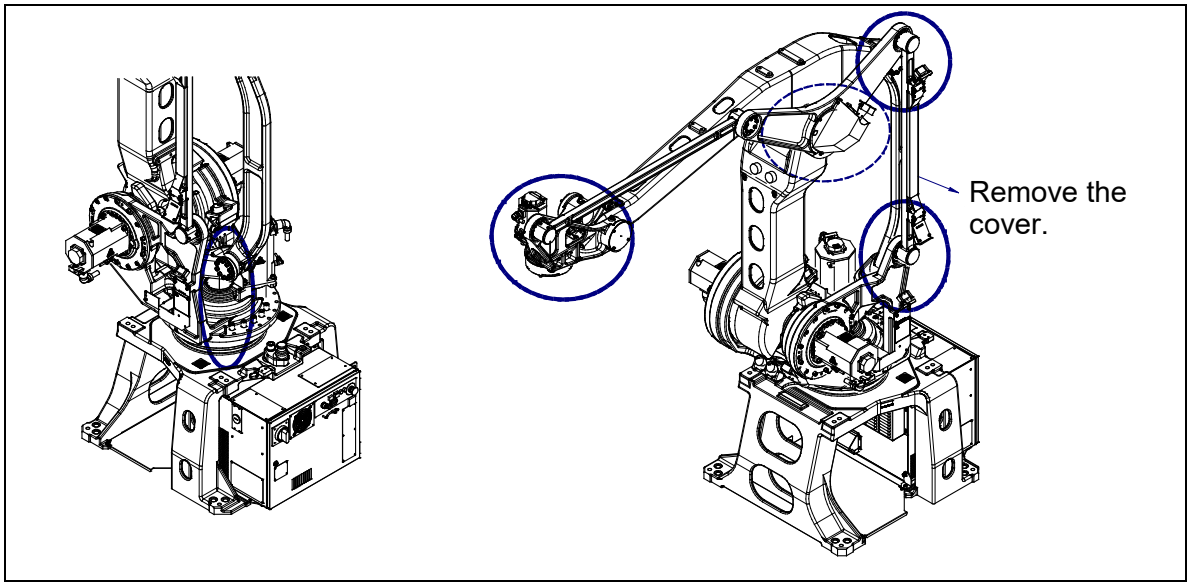


Fig. 7.2.3 (a) Inspection points of the mechanical unit cables

Check items

＜Cable protective sleeve＞

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

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

＜Cables＞

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

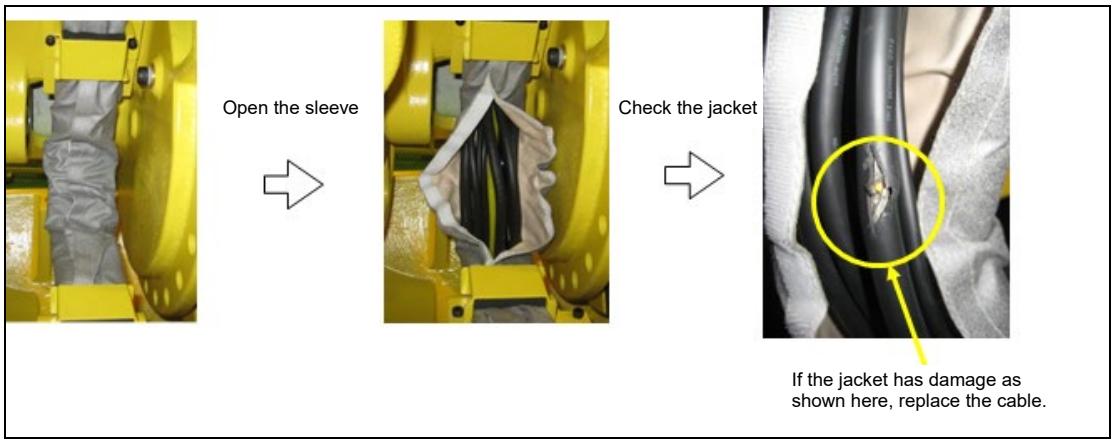


Fig. 7.2.3 (c) Cable check method

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

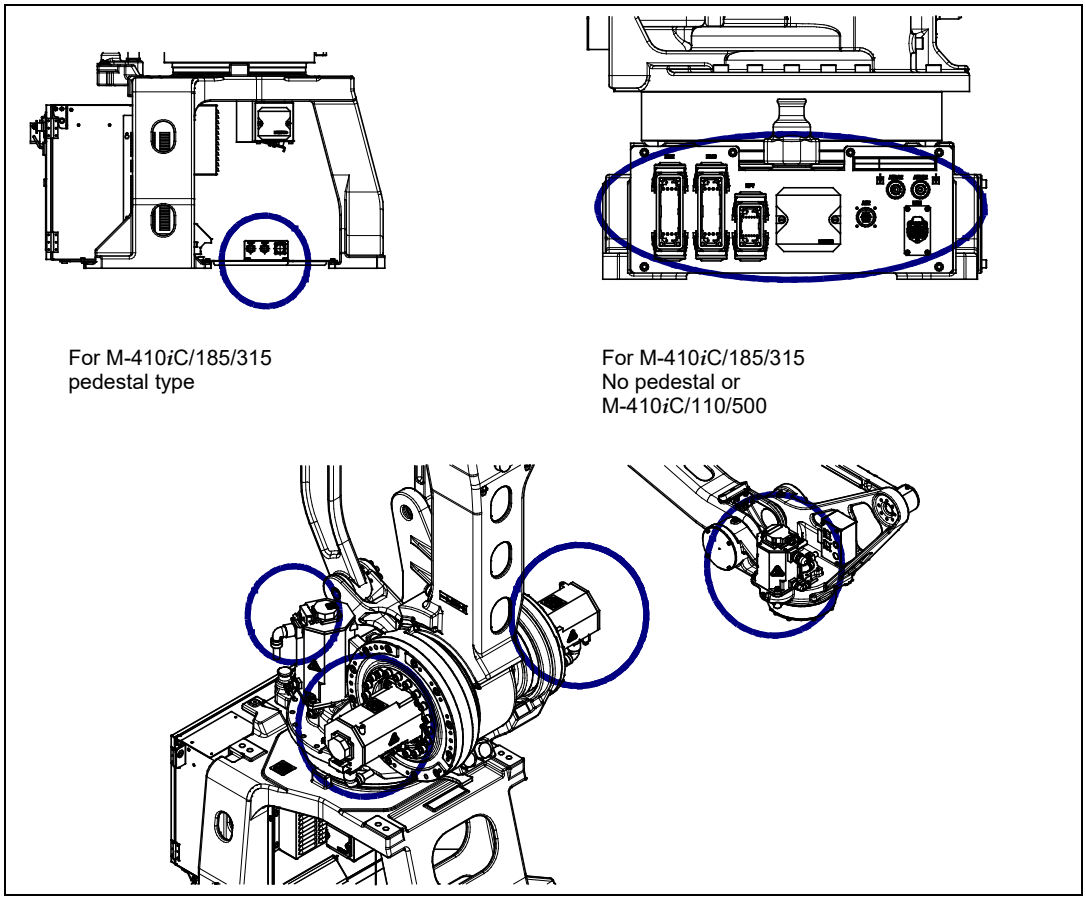


Fig. 7.2.3 (d) Connector Inspection points

7.2.4 Check of Fixed Mechanical Stopper and Adjustable Mechanical Stopper

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

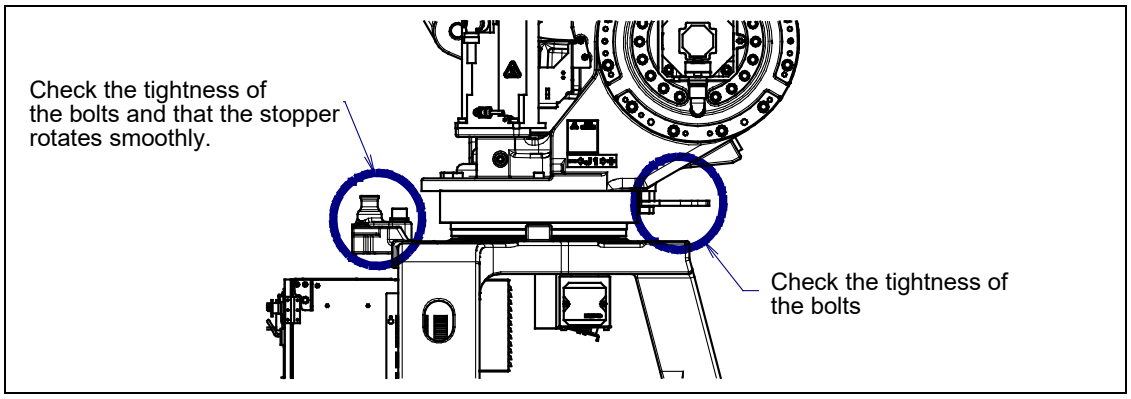


Fig. 7.2.4 (a) Check of fixed mechanical stopper and adjustable mechanical stopper

7.3 MAINTENANCE

7.3.1 Greasing of Bearing and Balance Bushing (1-year Checks (3840 Hours) or 3-years (11520 Hours) Checks)

Be sure to supply grease to the machine at the timing (cumulative operation time or period whichever earlier) specified in Table 7.3.1 (a) to (b). Adjust the greasing timing if your robot is installed in an adverse environment. Supply grease immediately if water is splashed on the robot.
Fig. 7.3.1 (b) to (f) indicate the greasing points of the bearings. When greasing the bearing of the J3 arm connection part, remove the seal bolt in Fig. 7.3.1 (b), (c) before greasing. If the seal bolt is reused, be sure to seal it with seal tape.

Table 7.3.1 (a) Greasing the Balancer Bushing (M-410*i*C/500)

Recommended grease	Amount of grease	Greasing interval
Showa Shell Sekiyu K. K. SHELL ALVANIA GREASE S2 (Spec.: A98L-0004-0602#CTG)	10 ml for each (Two points)	1 year or every 3840 hours of accumulated operating time whichever comes first

Table 7.3.1 (b) Greasing of the bearing

Supply position	Recommended grease	Amount of grease	Accumulated operating time (duration)
J3 arm connecting position bearing greasing point	Showa Shell Sekiyu K. K. SHELL ALVANIA GREASE S2 (Spec.: A98L-0004-0602#CTG)	20ml (Two points)	3 years or every 11520 hours of accumulated operating time whichever comes first
J3 base bearing connecting position		20ml	
Wrist connecting position bearing		10ml (Two points)	

NOTE
1 After grease is supplied, old grease is pushed out from the bearing's rotating section. Wipe off the old grease immediately after greasing and, as required, after operations of 50 to 100 hours.
2 If the robot is high-duty, requiring a cooling unit (fan), shorten the standard greasing cycle to half.

Table 7.3.1 (c) Substitutes for ALVANIA GREASE S2

Maker	Grease name
MOBIL OIL	MOBILACKS EP2
JXTG Nippon Oil & Energy Corporation	NIPPON MITSUBISHI MULTINOC 2
JXTG Nippon Oil & Energy Corporation	EPNOC AP-2
IDEMITSU KOHSAN	EPONEX GREASE NO.2
COSMO OIL	DYNAMAX NO.2
Showa Shell Sekiyu K.K.	Shell Gadus S2 V100 2

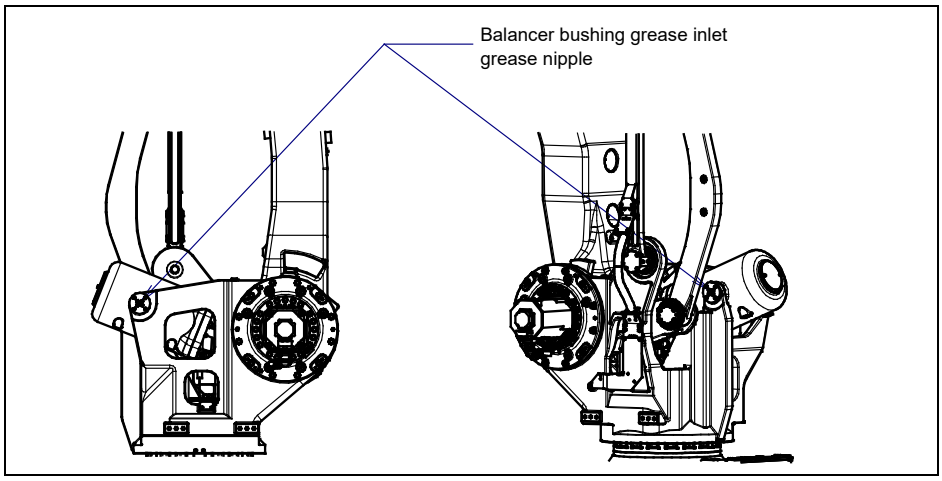


Fig. 7.3.1 (a) Greasing for balancer bushing (M-410*i*C/500)

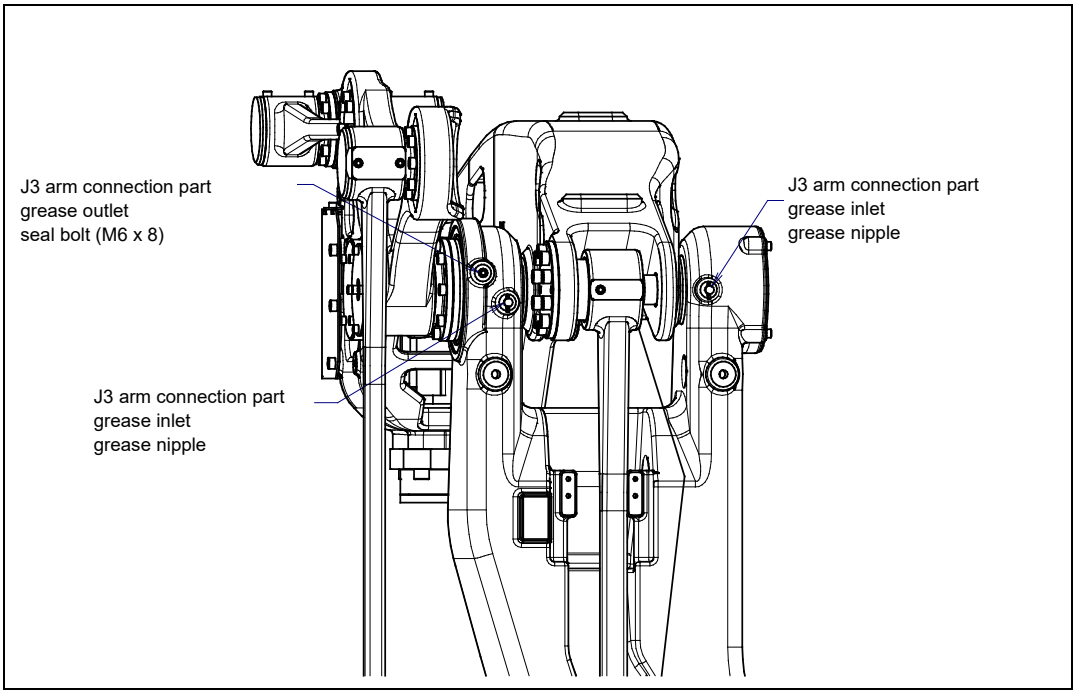


Fig. 7.3.1 (b) Greasing for the bearing of the J3 arm connection part (M-410*i*C/110)

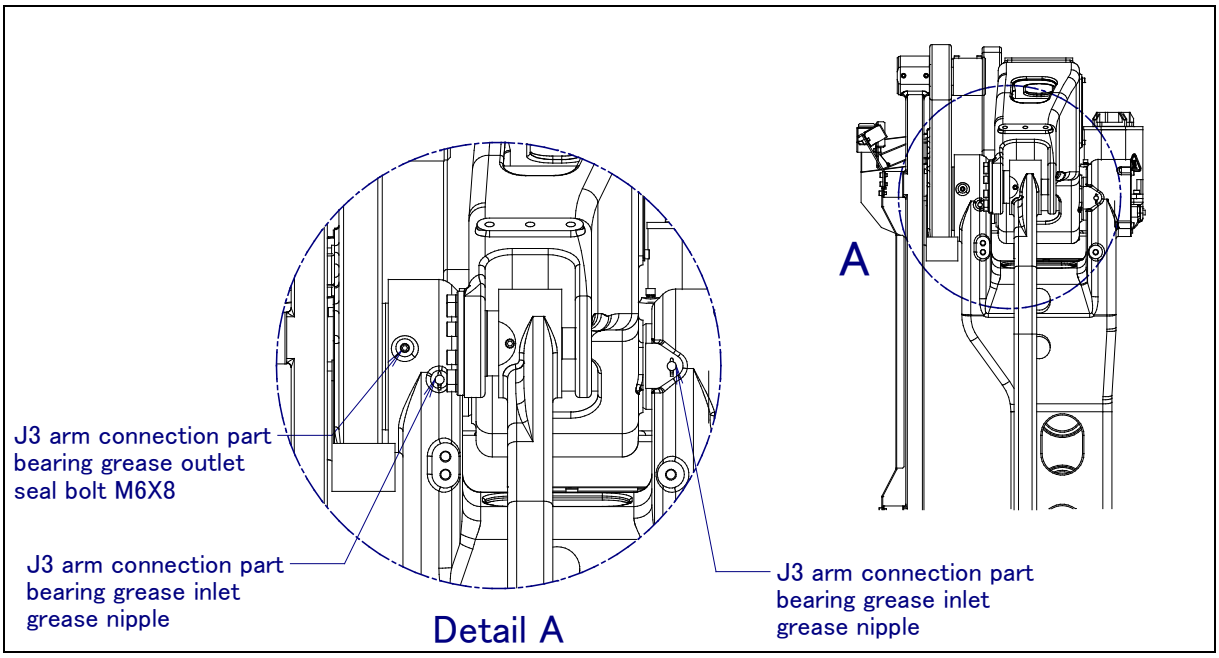


Fig. 7.3.1 (c) Greasing for the bearing of the J3 arm connection part (M-410*i*C/185/315)

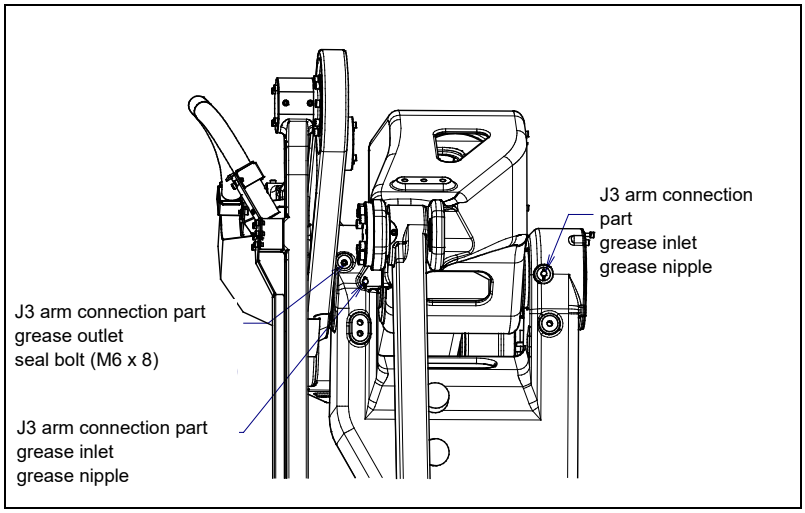


Fig. 7.3.1 (d) Greasing for the bearing of the J3 arm connection part (M-410*i*C/500)

Table 7.3.1 (d) Specification of the seal bolt

Parts name	Specifications
Seal bolt (M6 x 8)	A97L-0218-0417#060808

⚠ CAUTION
1 Before greasing, remove the seal bolt at the grease outlet.
2 Apply grease slowly with a manual pump.

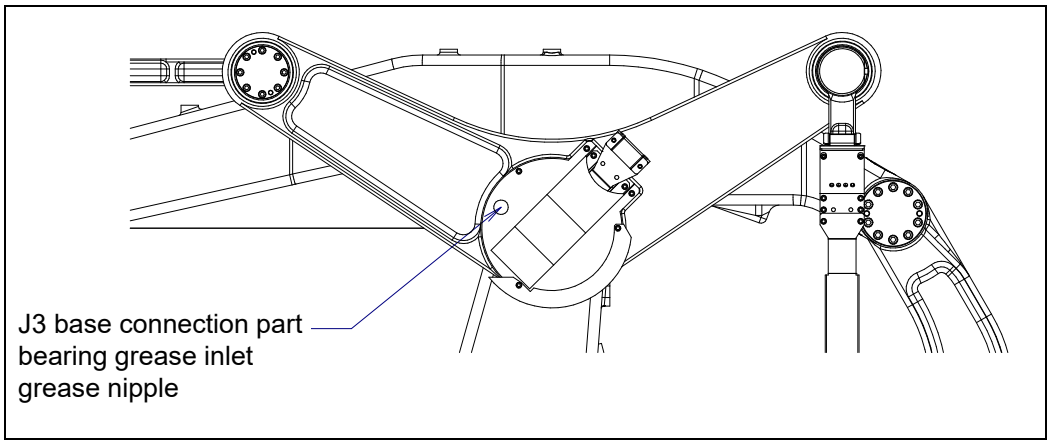


Fig. 7.3.1 (e) Greasing for bearing J3 base

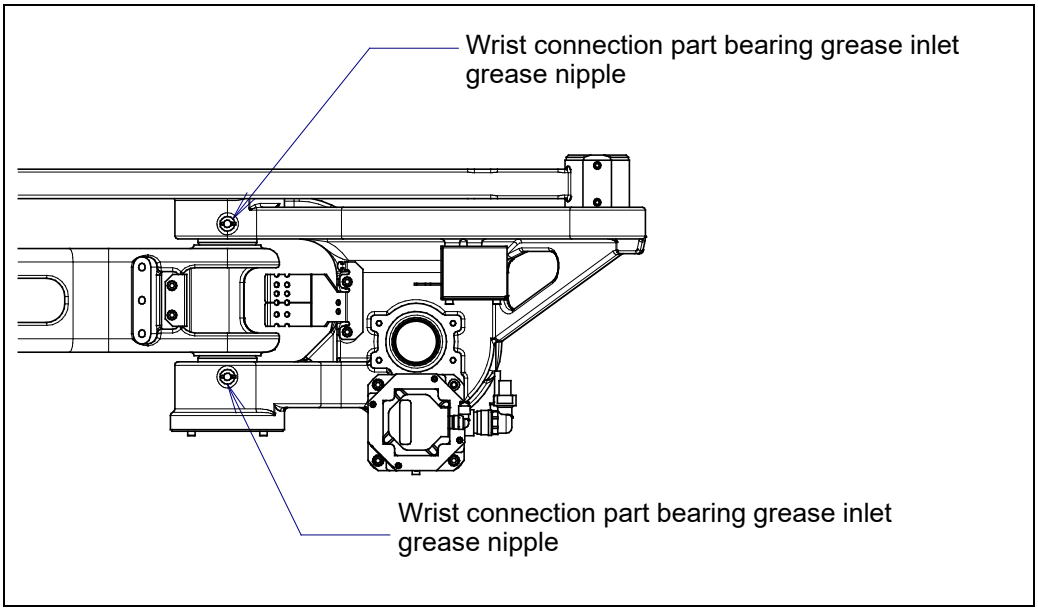


Fig. 7.3.1 (f) Greasing for bearing wrist connection

7.3.2 Replacing the Batteries (1.5-year Checks)

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

Procedure for replacing the battery

1 Press the EMERGENCY STOP button to prohibit 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. Pay attention to the direction of the batteries.
5 Close the battery case cap.

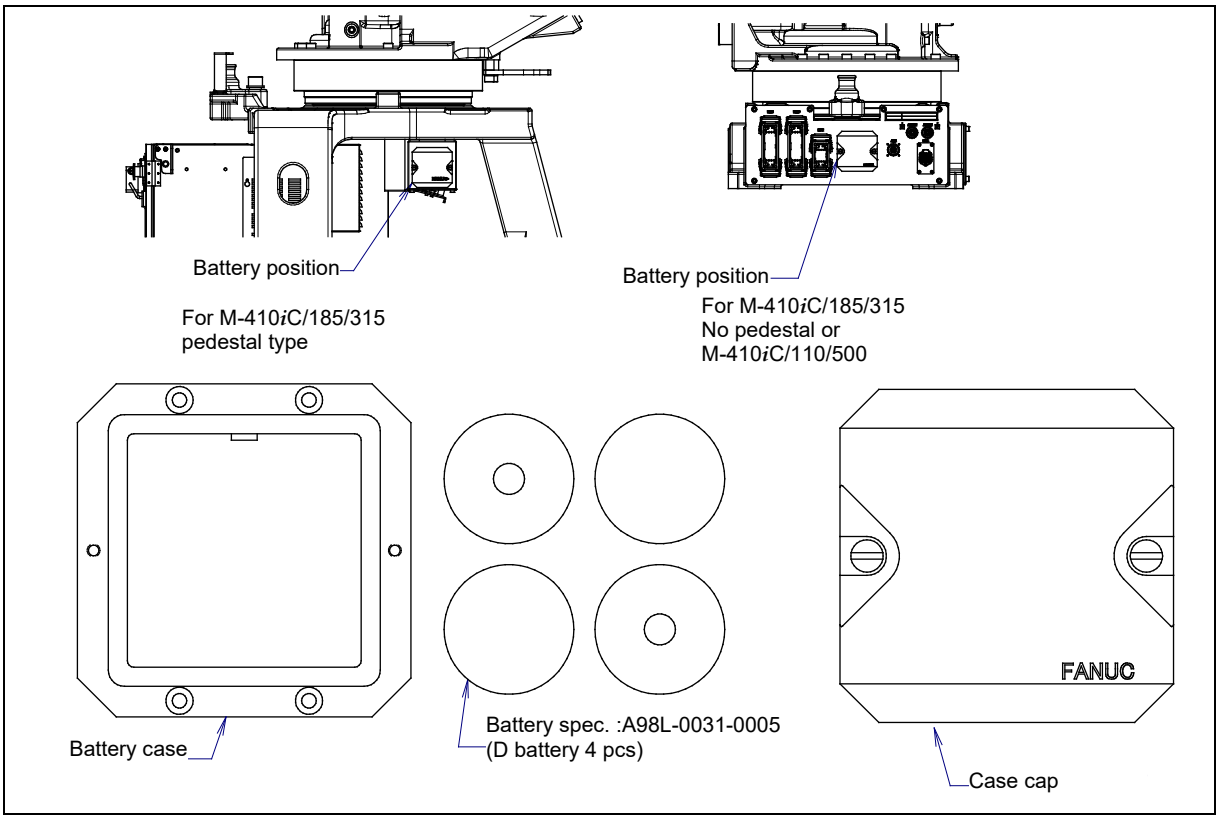


Fig.7.3.2 (a) Replacing batteries

7.3.3 Replacing the Grease of the Drive Mechanism (3-year (11520 Hours) Checks)

According to the procedures below, replace the grease of the reducers of the J1/J2/J3/J4 -axes, 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-year (11520 hours) periodic replacement

Model	Grease supplying position	Grease name	Quantity	Gun tip pressure
M-410*i*C/110	J1-axis reducer	Spec.: A98L-0040-0174	4250g (4730ml)	0.15MPa (NOTE)
	J2-axis reducer		1600g (1800ml)	
	J3-axis reducer		1500g (1700ml)	
	J4-axis reducer		400g (440ml)	
M-410*i*C/185/315	J1-axis reducer		6400g (7100ml)	
	J2-axis reducer		2800g (3170ml)	
	J3-axis reducer		1500g (1700ml)	
	J4-axis reducer		1220g (1400ml)	
M-410*i*C/500	J1-axis reducer		5950g (6620ml)	
	J2-axis reducer		2450g (2730ml)	
	J3-axis reducer		2450g (2730ml)	
	J4-axis reducer		950g (1080ml)	

NOTE
When a manual pump is used for greasing, the standard rate is two pumping cycles per three 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 postures indicated below.

Table 7.3.3 (b) Postures for greasing

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

NOTE
In a high-duty environment where, for example, a cooling unit (fan) is used, grease must be replaced every half the specified standard period.

⚠ CAUTION

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

1 Before starting to grease, remove the seal bolt or the taper plug to allow the grease to come out.
2 Supply grease slowly without applying excessive force, using a manual pump.
3 Whenever possible, avoid using a compressed-air pump, powered by the factory air supply.
  Even when using a compressed-air pump is unavoidable, set the gun tip pressure (see Table 7.3.3 (a).) to 0.15MPa or less during application of the grease.
4 Use grease only of the specified type. Grease of a type other than that specified may damage the reducer or lead to other problems.
5 After greasing, release the remaining pressure within the grease bath as described in the procedure in Subsection 7.3.4.
6 To prevent an accident such as a fall or fire, remove all the excess grease from the floor and robot.
7 If no old grease is pushed out from the grease outlet or if only an extremely small amount of old grease is pushed out when new grease is supplied into the grease inlet, it is likely that grease is leaking because of a damaged seal or a similar break.

Grease replacement procedure for the J1-axis, J2-axis, J3-axis, and J4-axis reducers

> **⚠ CAUTION**
> Be careful not to confuse the grease inlet of the J4-axis reducer with the grease inlet of the wrist link bearing in Fig. 7.3.1 (e) of Subsection 7.3.1 because they are close to each other.

1 Move the robot to the greasing posture described in Table 7.3.3 (b).
2 Turn off controller power.
3 Remove the seal bolt shown the Fig. 7.3.3 (a) to (f) from the grease outlet.
4 Keep greasing until the new grease pushes the old grease out from each grease outlet.
5 After applying grease, release the remaining pressure within the grease bath as described in the procedure in Subsection 7.3.4.

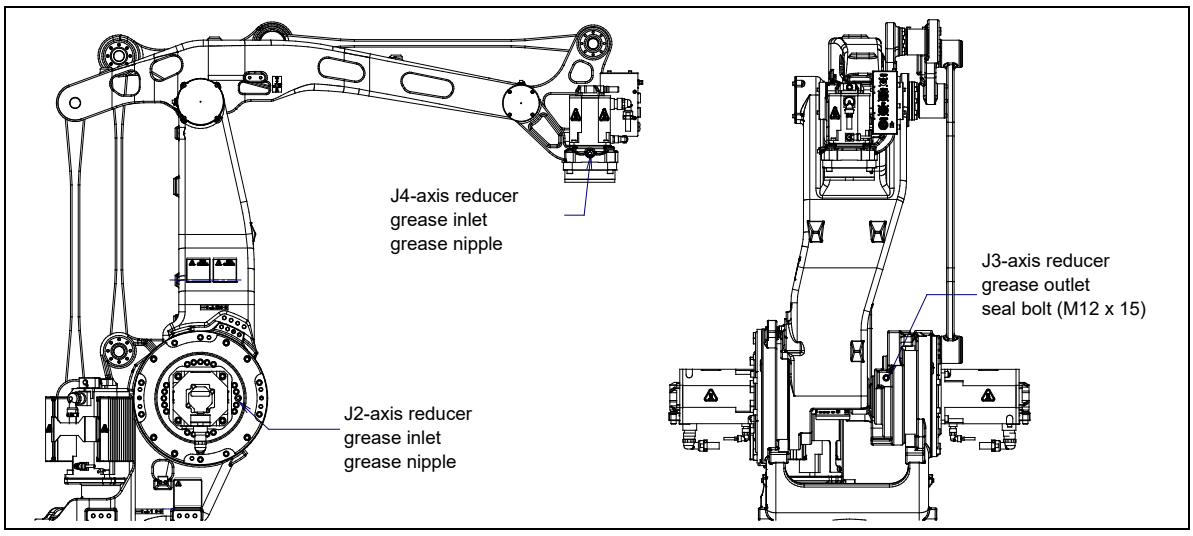


Fig. 7.3.3 (a) Replacing grease of the reducers (1/2) (M-410*i*C/110)

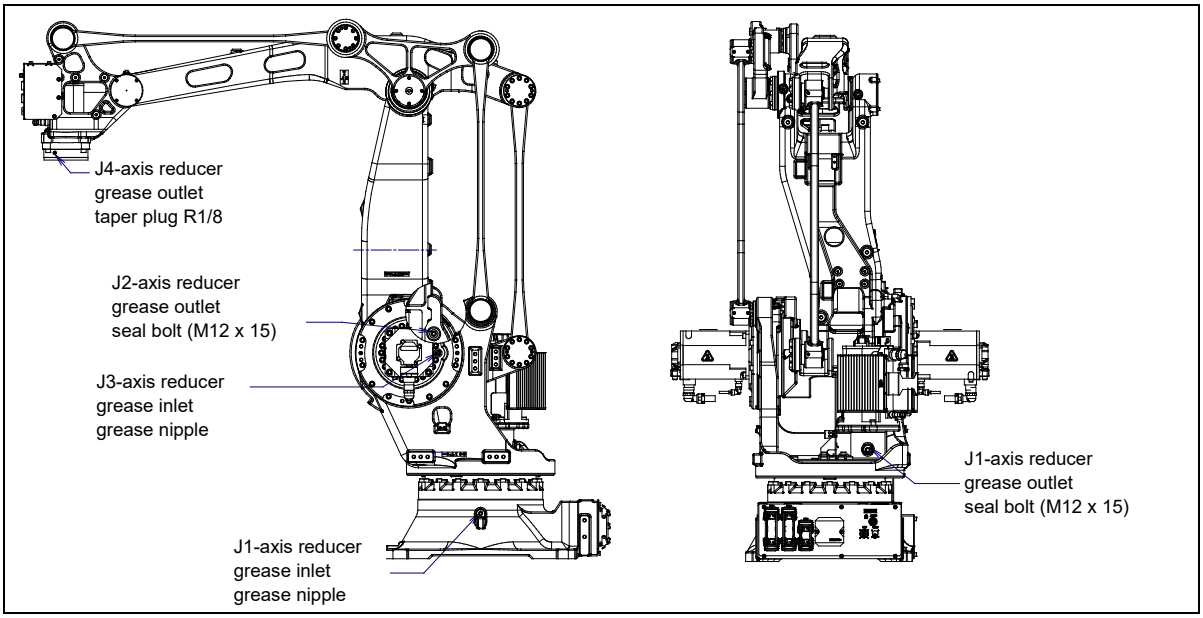


Fig. 7.3.3 (b) Replacing grease of the reducers (2/2) (M-410*i*C/110)

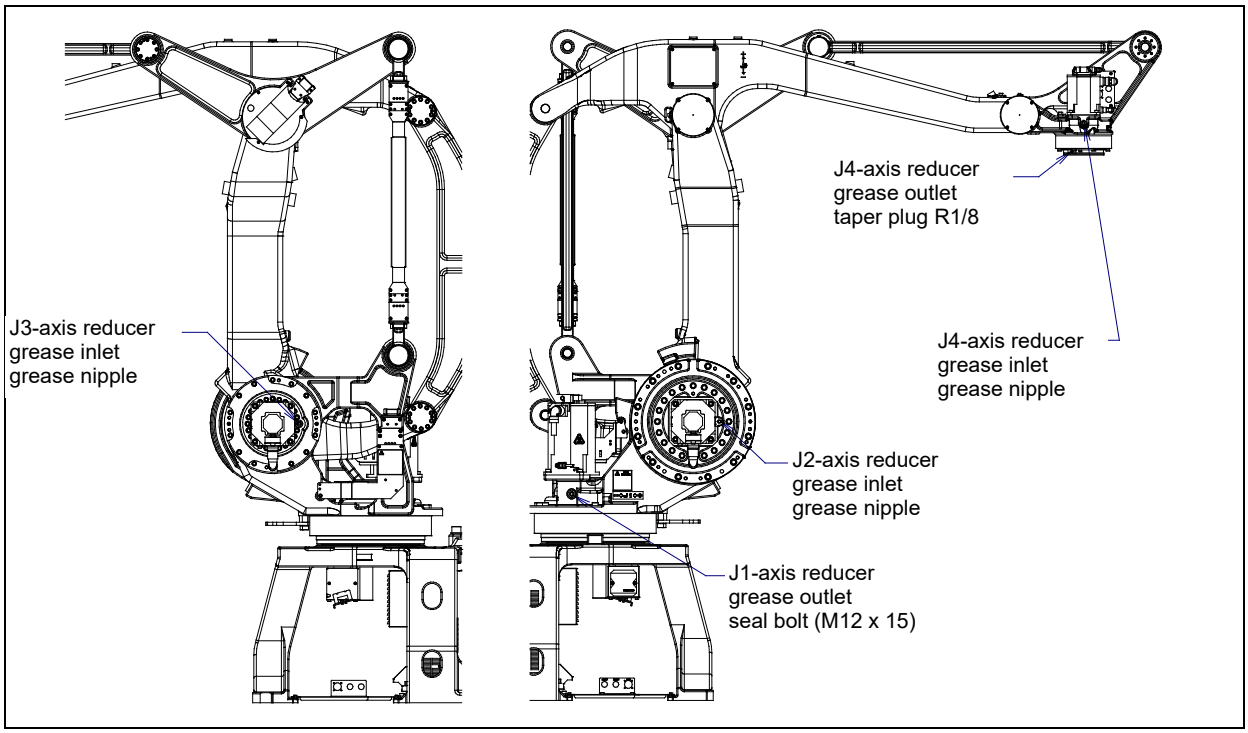


Fig. 7.3.3 (c) Replacing grease of the reducers (1/2) (M-410*i*C/185/315)

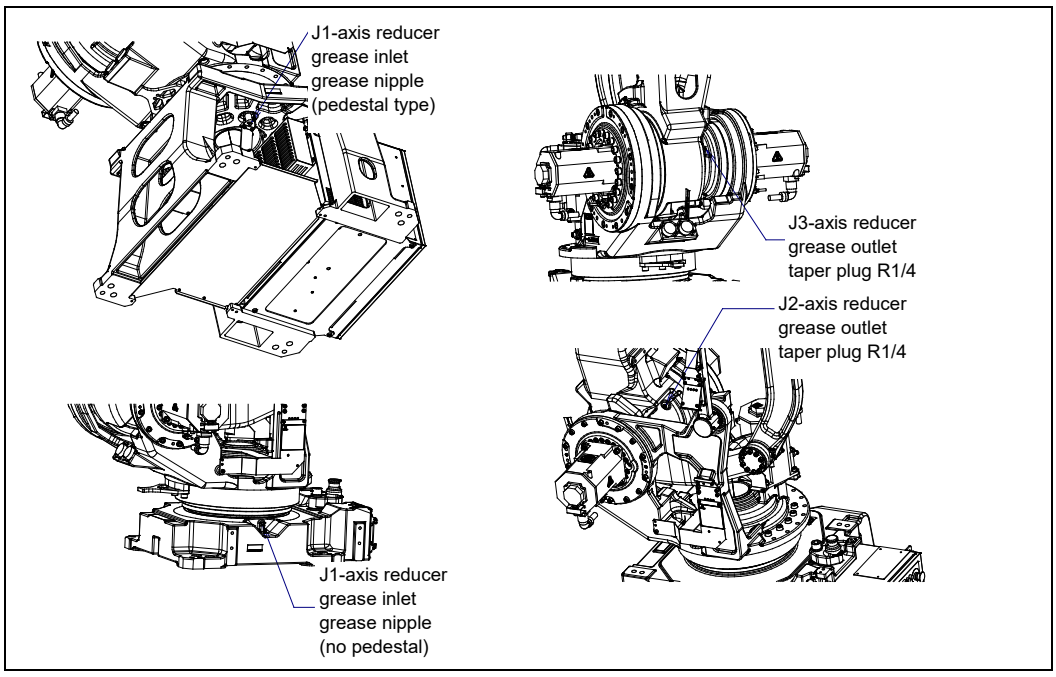


Fig. 7.3.3 (d) Replacing grease of the reducers (2/2) (M-410*i*C/185/315)

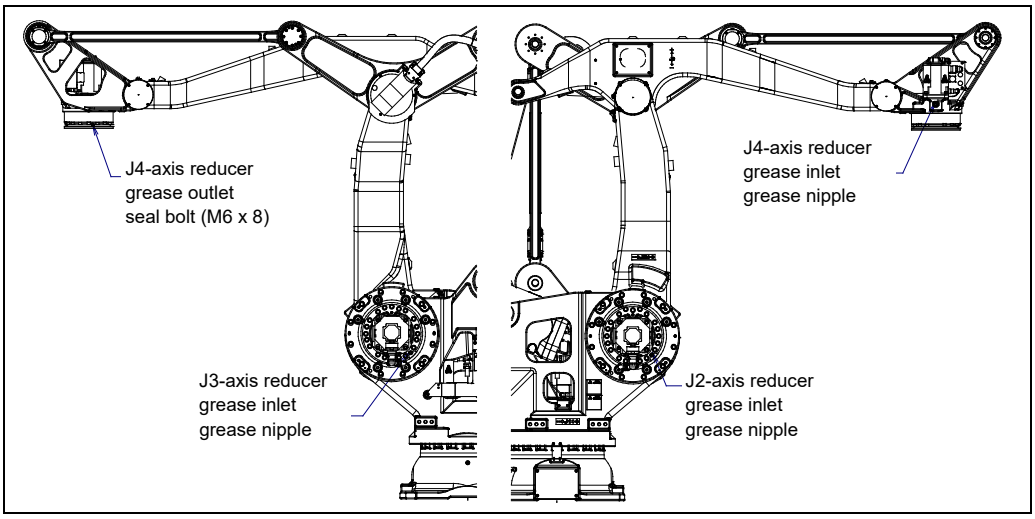


Fig. 7.3.3 (e) Replacing grease of the reducers (1/2) (M-410*i*C/500)

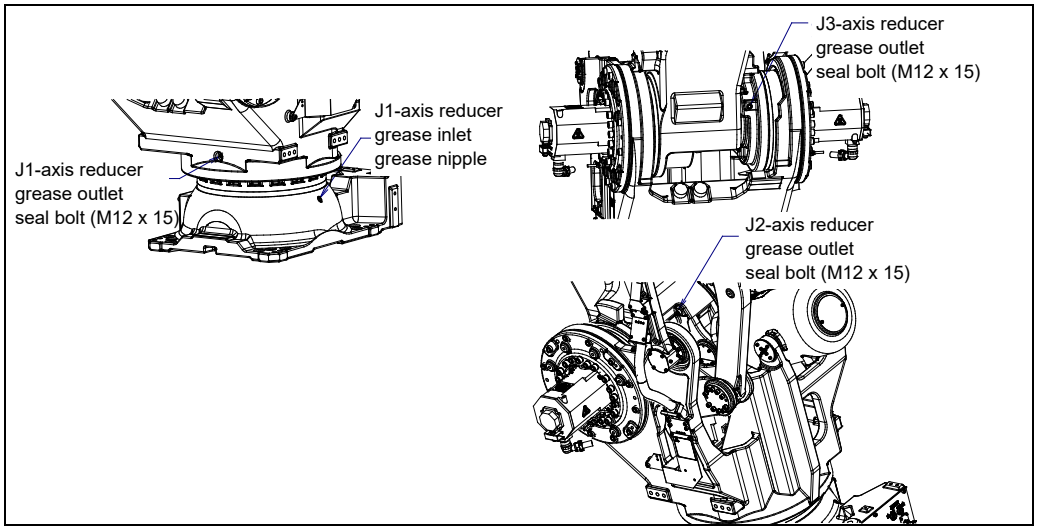


Fig. 7.3.3 (f) Replacing grease of the reducers (2/2) (M-410*i*C/500)

Table 7.3.3 (c) Specifications of the seal bolt and the taper plugs

Parts name	Specifications
Seal bolt (M6 x 8)	A97L-0218-0417#060808
Seal bolt (M12 x 15)	A97L-0218-0417#121515
Taper plug (R1/4)	A97L-0001-0436#2-2D
Taper plug (R1/8)	A97L-0001-0436#1-1D

7.3.4 Procedure for Releasing Remaining Pressure from the Grease Bath

To release the remaining pressure in the grease bath after applying grease, operate the robot for 20 minutes or more as described in the table below with the grease nipple of the grease inlet and the taper plug or seal bolt of the grease outlet left open for the J1-axis reducer and J4-axis reducer, and the taper plug of the grease outlet left open for the J2-axis reducer and J3-axis reducer.
Attach the reclaim bags under the grease inlet and grease outlet to prevent spilled grease from splattering.

Operating axis / Grease replacement part	J1-axis	J2-axis	J3-axis	J4-axis
J1-axis reducer	Axis angle of 80° or more OVR 50%	Arbitrary		
J2-axis reducer	Arbitrary	Axis angle of 90° or more OVR 50%	Arbitrary	
J3-axis reducer	Arbitrary		Axis angle of 60° or more OVR 50%	Arbitrary
J4-axis reducer	Arbitrary			Axis angle of 60° or more OVR 100%

If the above operations cannot be performed because of workcell constraints, adjust the operating time according to the operating angle. (For example, when only an axis angle of only 30° can be achieved instead of 60°, perform the operation for 40 minutes, which is double the specified time of 20 minutes.)
If you grease to multiple axes, you can exercise multiple axes at the same time.
After the above operation is performed, attach the grease nipple to the grease inlet and the seal bolt to the grease outlet. When the seal bolt, taper plug or grease nipple is reused, be sure to seal it with seal tape.

7.4 STORAGE

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

8 MASTERING

Mastering 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. In case of M-410*i*C/110/500, 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 is required under the following conditions:

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

> ⚠ **CAUTION**
> Robot data (including mastering data) and Pulsecoder data are backed up by their respective backup batteries. Data will be lost if the batteries 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. Note that "Quick Mastering for Single Axis" is not supported in software version 7DC2 (V8.20P) or earlier.

Table 8.1 (a) Type of mastering

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

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

This section describes zero-position mastering, quick mastering, 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 robot may behave unexpectedly. This is very dangerous. For the reason the Master/Cal screen is designed to appear only when the $MASTER_ENB system variable is 1 or 2. After performing positioning, press F5 [DONE] on the Master/Cal screen. The $MASTER_ENB system variable is reset to 0 automatically, thus hiding the Master/Cal screen will disappear.
> 2 It is recommended that the current mastering data be backed up before mastering is performed.

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), (b)). This mastering is performed with all axes set at the 0-degree position using their respective witness marks.

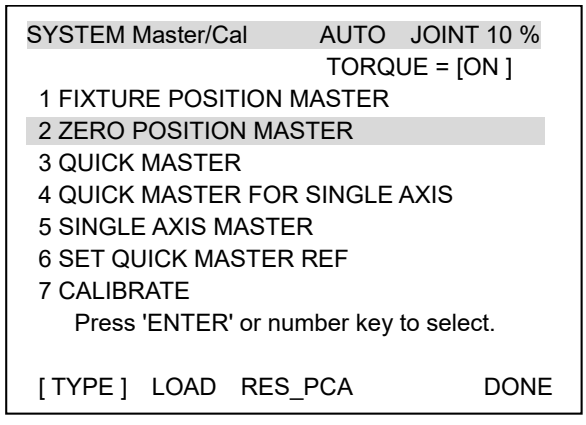
Zero-position mastering involves a visual check, and might not be highly accurate. It should be used only as a quick-fix method.

Zero-position Mastering Procedure

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

NOTE
Gravity compensation can be set to enabled/disabled by setting the system variables as follows:
$PARAM_GROUP[group].$SV_DMY_LNK[8] : FALSE or TRUE
Brake control can be released by setting the system variables as follows:
$PARAM_GROUP.SV_OFF_ALL : FALSE
$PARAM_GROUP.SV_OFF_ENB[*] : FALSE (for all axes)
After changing the system variables, cycle power of the controller.
(Mastering can be performed without setting of gravity compensation. However, it will affect precision.)

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



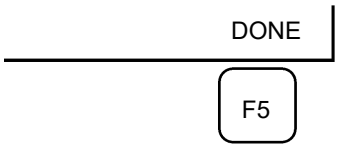
9 Jog the robot into a posture for mastering.
10 Select [2 Zero Position Master]. Press F4 [YES].

```
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. Turning on the power always causes positioning to be performed.

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

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



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

Table 8.3 (a) Posture with position marks aligned

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

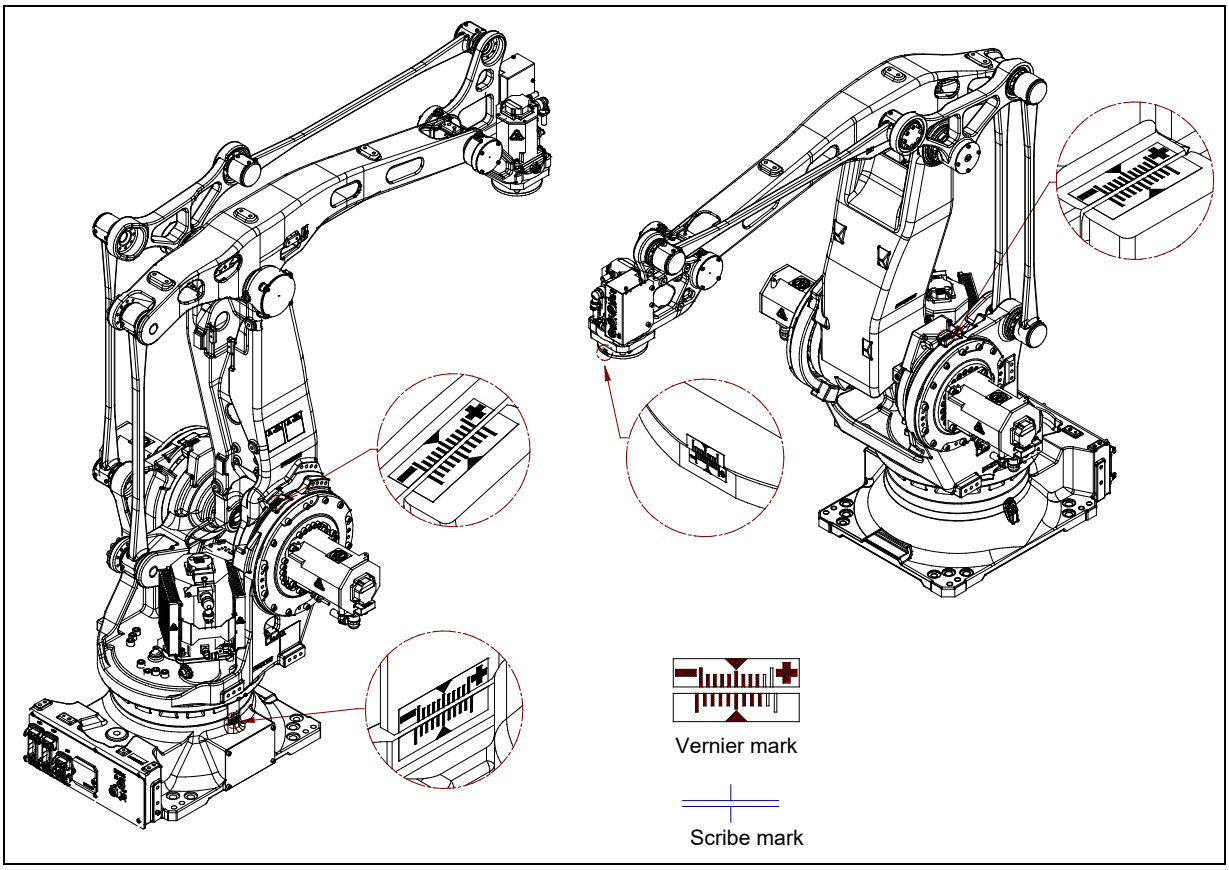


Fig. 8.3 (a) Witness mark for each axis (M-410*i*C/110)

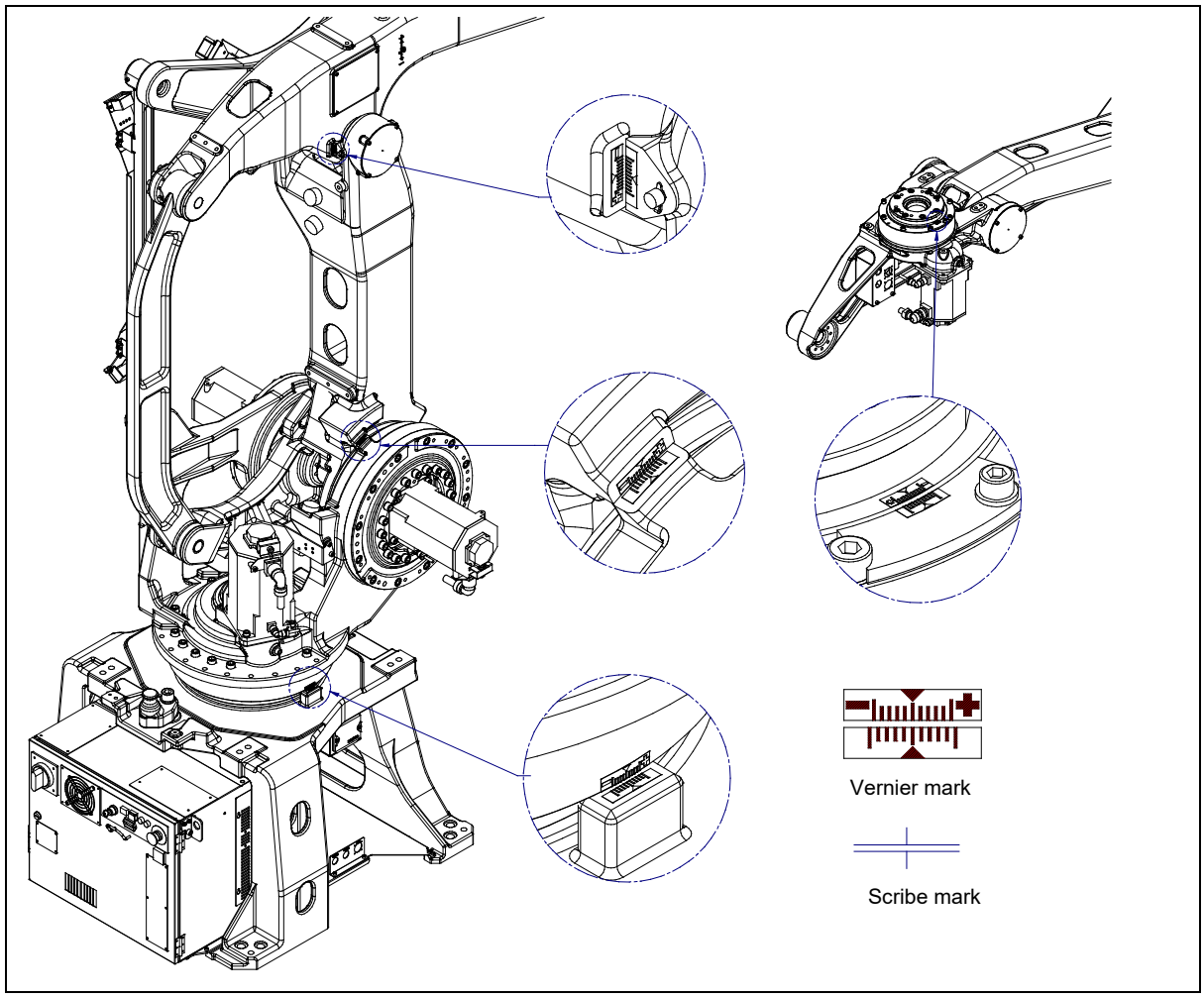


Fig. 8.3 (b) Witness mark for each axis (M-410*i*C/185/315)

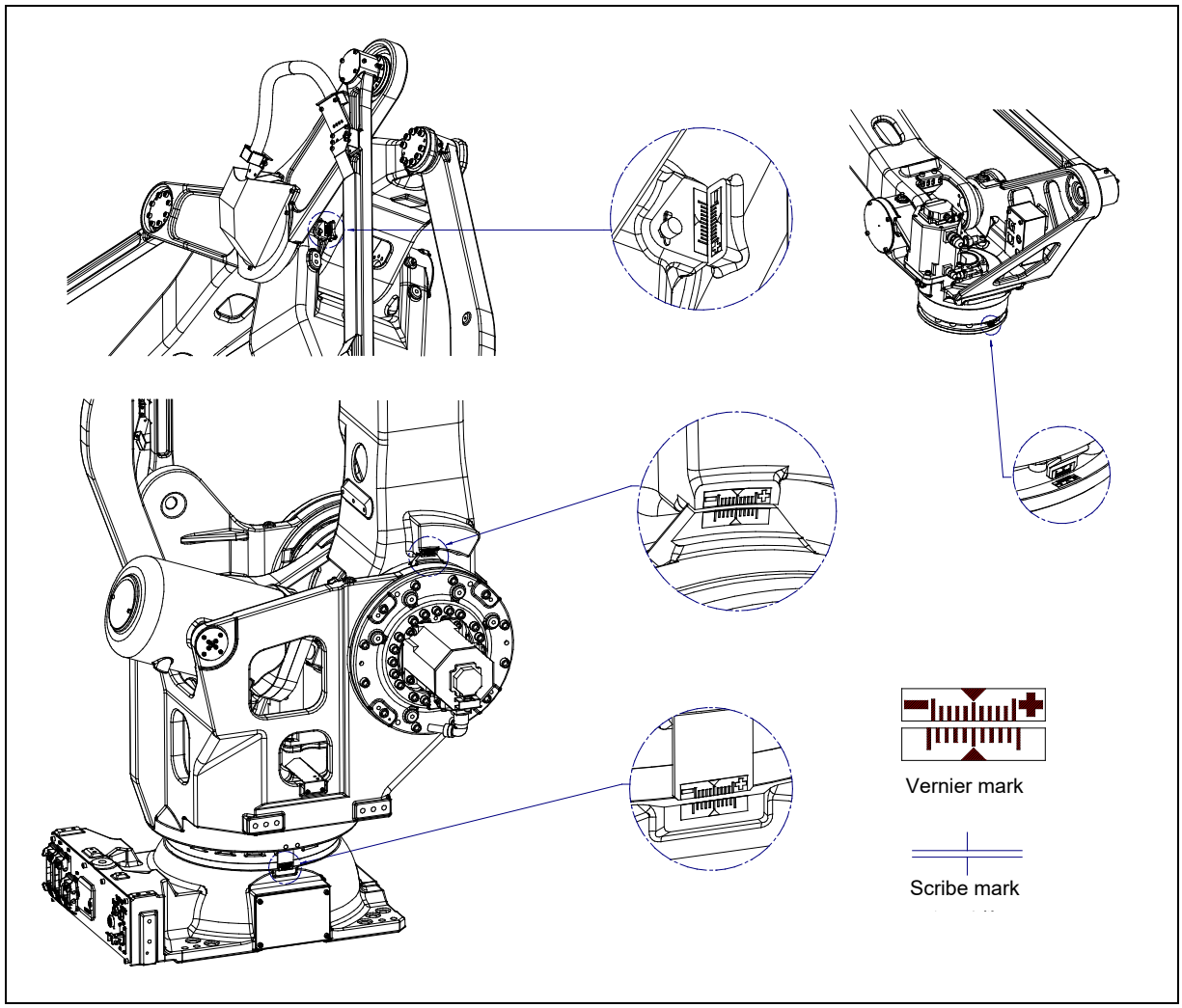


Fig. 8.3 (c) Witness mark for each axis (M-410*i*C/500)

8.4 QUICK MASTERING

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

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

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

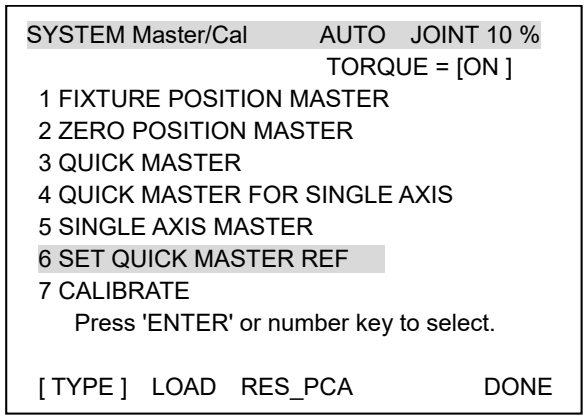
⚠ CAUTION
1 Quick mastering can be used, if the pulse count value is lost, for example, because a low voltage has been detected on the backup battery for the pulse counter.
2 Quick mastering cannot be used, after the Pulsecoder is replaced or after the mastering data is lost from the robot controller.

Procedure Recording the Quick Mastering Reference Position

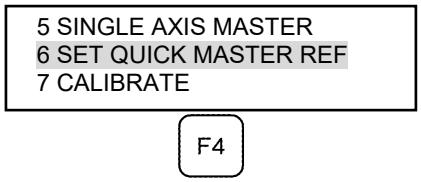
1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE]. Then select [Variables] from the menu.
4 If $DMR_GRP[group].$GRAV_MAST=1, set the gravity compensation to enabled, if it is 0, set the gravity compensation to disabled. In addition release the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

NOTE
Gravity compensation can be set to enabled/disabled by setting the system variables as follows:
$PARAM_GROUP[group].$SV_DMY_LNK[8] : FALSE or TRUE
Brake control can be released by setting the system variables as follows:
$PARAM_GROUP.SV_OFF_ALL : FALSE
$PARAM_GROUP.SV_OFF_ENB[*] : FALSE (for all axes)
After changing the system variables, cycle power of the controller.
(Mastering can be performed without setting of gravity compensation. However, it will affect precision.)

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 will be set.



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

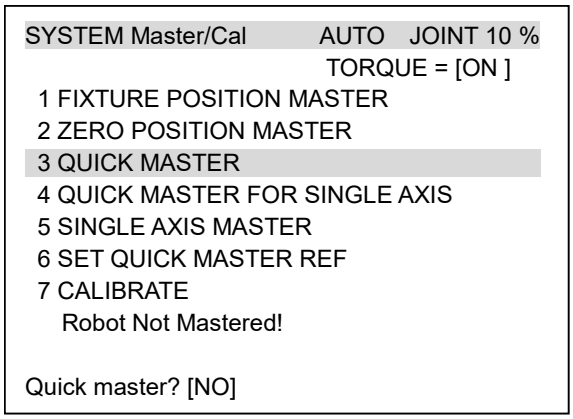
> ⚠ **CAUTION**
> If the robot has lost mastering data due to mechanical disassembly or repair, you cannot perform this procedure. In this case, perform Fixture position mastering or Zero position mastering to restore mastering data.

Procedure of Quick Mastering

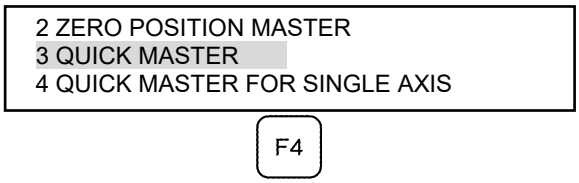
1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE]. Then select [Variables] from the menu.
4 If $DMR_GRP[group].$GRAV_MAST=1, set the gravity compensation to enabled, if it is 0, set the gravity compensation to disabled. In addition release the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

> **NOTE**
> Gravity compensation can be set to enabled/disabled by setting the system variables as follows:
> $PARAM_GROUP[group].$SV_DMY_LNK[8] : FALSE or TRUE
> Brake control can be released by setting the system variables as follows:
> $PARAM_GROUP.SV_OFF_ALL : FALSE
> $PARAM_GROUP.SV_OFF_ENB[*] : FALSE (for all axes)
> After changing the system variables, cycle power of the controller.
> (Mastering can be performed without setting of gravity compensation. However, it will affect precision.)

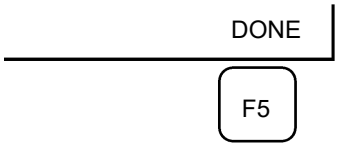
5 Display the Master/Cal screen.



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



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



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

8.5 QUICK MASTERING FOR SINGLE AXIS

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

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

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

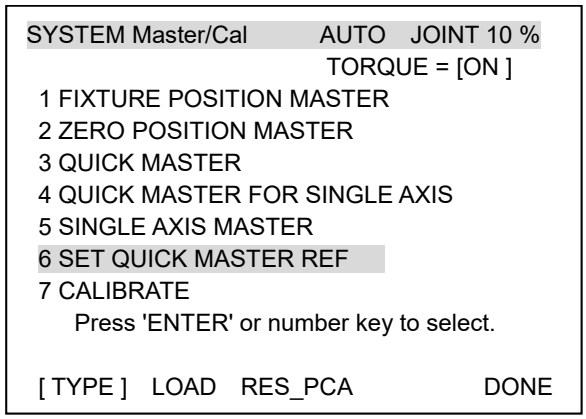
⚠ CAUTION
1 Quick mastering can be used, if the pulse count value is lost, for example, because a low voltage has been detected on the backup battery for the pulse counter.
2 Quick mastering cannot be used, after the Pulsecoder is replaced or after the mastering data is lost from the robot controller.

Procedure Recording the Quick Mastering Reference Position

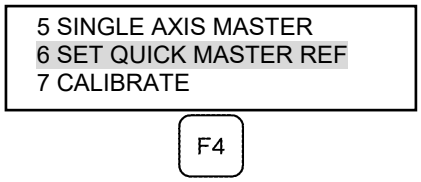
1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE]. Then select [Variables] from the menu.
4 If $DMR_GRP[group].$GRAV_MAST=1, set the gravity compensation to enabled, if it is 0, set the gravity compensation to disabled. In addition release the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

NOTE
Gravity compensation can be set to enabled/disabled by setting the system variables as follows:
$PARAM_GROUP[group].$SV_DMY_LNK[8] : FALSE or TRUE
Brake control can be released by setting the system variables as follows:
$PARAM_GROUP.SV_OFF_ALL : FALSE
$PARAM_GROUP.SV_OFF_ENB[*] : FALSE (for all axes)
After changing the system variables, cycle power of the controller.
(Mastering can be performed without setting of gravity compensation. However, it will affect precision.)

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 will be set.



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

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

Procedure of Quick Mastering for single axis

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

> **NOTE**
> Gravity compensation can be set to enabled/disabled by setting the system variables as follows:
> $PARAM_GROUP[group].$SV_DMY_LNK[8] : FALSE or TRUE
> Brake control can be released by setting the system variables as follows:
> $PARAM_GROUP.SV_OFF_ALL : FALSE
> $PARAM_GROUP.SV_OFF_ENB[*] : FALSE (for all axes)
> After changing the system variables, cycle power of the controller.
> (Mastering can be performed without setting of gravity compensation. However, it will affect precision.)

5 Display the Master/Cal screen.

```
SYSTEM Master/Cal          AUTO   JOINT 10 %
                                  TORQUE = [ON ]
 1 FIXTURE POSITION MASTER
 2 ZERO POSITION MASTER
 3 QUICK MASTER
 4 QUICK MASTER FOR SINGLE AXIS
 5 SINGLE AXIS MASTER
 6 SET QUICK MASTER REF
 7 CALIBRATE
   Robot Not Mastered!

Quick master? [NO]
```

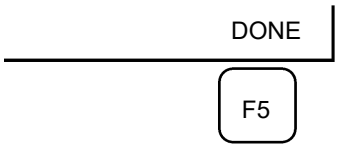
6 Select [4 QUICK MASTER FOR SINGLE AXIS]. The quick master for single axis screen will be displayed.

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

                                            EXEC
```

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.

```
SINGLE AXIS MASTER              AUTO   JOINT 10%
                                              1/9
    ACTUAL   POS    (MSTR POS)     (SEL)   [ST]
J5          0.000   (     0.000)   (0)     [2]
J6          0.000   (     0.000)   (0)     [0]

                                          EXEC
```

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 [ENTER] key. Calibration is executed. Calibration is executed by cycling power.
11 After completing the calibration, press F5 Done.



12 If gravity compensation is disabled, set it to enabled.
13 Return brake control to original setting, and cycle power of the controller.

8.6 SINGLE AXIS MASTERING

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

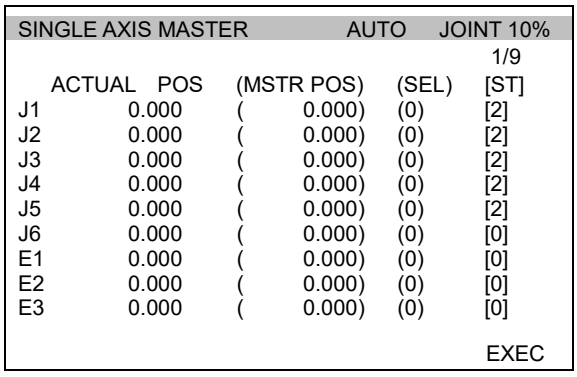


Table 8.6(a) Items set in single axis mastering

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

Procedure of Single axis mastering

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

NOTE
Gravity compensation can be set to enabled/disabled by setting the system variables as follows:
$PARAM_GROUP[group].$SV_DMY_LNK[8] : FALSE or TRUE
Brake control can be released by setting the system variables as follows:
$PARAM_GROUP.SV_OFF_ALL : FALSE
$PARAM_GROUP.SV_OFF_ENB[*] : FALSE (for all axes)
After changing the system variables, cycle power of the controller.
(Mastering can be performed without setting of gravity compensation. However, it will affect precision.)

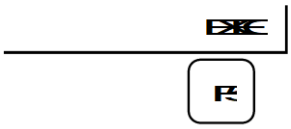
5 Select [6 SYSTEM].
6 Select [Master/Cal].

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

 [ TYPE ]   LOAD   RES_PCA                DONE
```

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

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

                                              EXEC
```

8 For the axis to which to perform single axis mastering, set (SEL) to "1." Setting of [SEL] is available for one or more axes.
9 Jog the robot to the mastering position.
10 Enter axis data for the mastering position.
11 Press F5 [EXEC]. Mastering is performed. So, [SEL] is reset to 0, and [ST] is re-set to 2 or 1.



SINGLE AXIS MASTER AUTO JOINT 10%

6/9

	ACTUAL POS	(MSTR POS)	(SEL)	[ST]
J1	0.000	(0.000)	(0)	[2]
J2	0.000	(0.000)	(0)	[2]
J3	0.000	(0.000)	(0)	[2]
J4	0.000	(0.000)	(0)	[2]
J5	0.000	(0.000)	(0)	[2]
J6	90.000	(0.000)	(1)	[0]
E1	0.000	(0.000)	(0)	[0]
E2	0.000	(0.000)	(0)	[0]
E3	0.000	(0.000)	(0)	[0]

EXEC

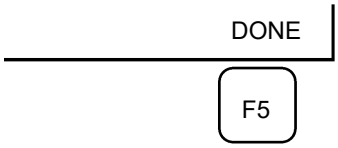
12 When single axis mastering is completed, press the [PREV] key to resume the previous screen.

SYSTEM Master/Cal AUTO JOINT 10 %
TORQUE = [ON]

1 FIXTURE POSITION MASTER
2 ZERO POSITION MASTER
3 QUICK MASTER
4 QUICK MASTER FOR SINGLE AXIS
5 SINGLE AXIS MASTER
6 SET QUICK MASTER REF
7 CALIBRATE
Press 'ENTER' or number key to select.

[TYPE] LOAD RES_PCA DONE

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



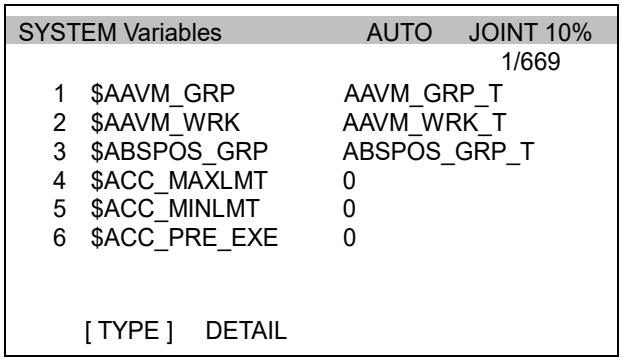
15 Return the setting of the gravity compensation.
16 Return brake control to original setting, and cycle power of the controller.

8.7 MASTERING DATA ENTRY

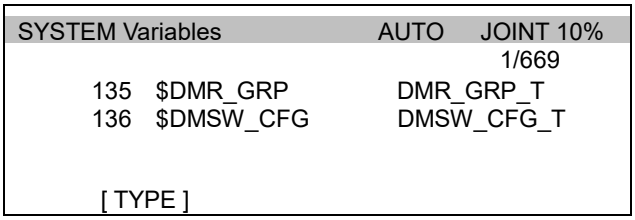
This function enables mastering data values to be assigned directly to a system variable. It can be used if mastering data has been lost but the pulse count is preserved.

Mastering data entry method

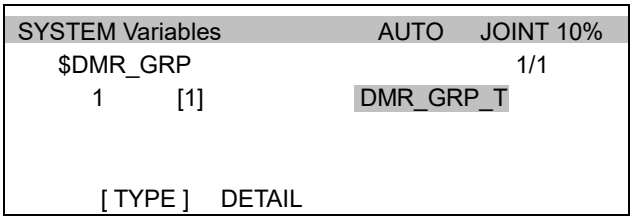
1 Press the [MENU] key, then press [0 NEXT] and select [6 SYSTEM].
2 Press F1 [TYPE]. Select [Variables]. The system variable screen appears.

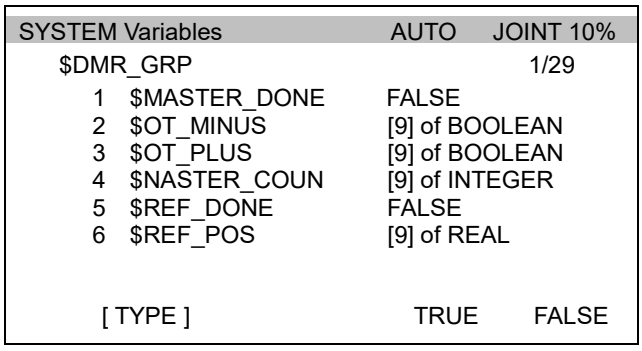


3 Change the mastering data.
The mastering data is saved to the $DMR_GRP.$MASTER_COUN system variable.

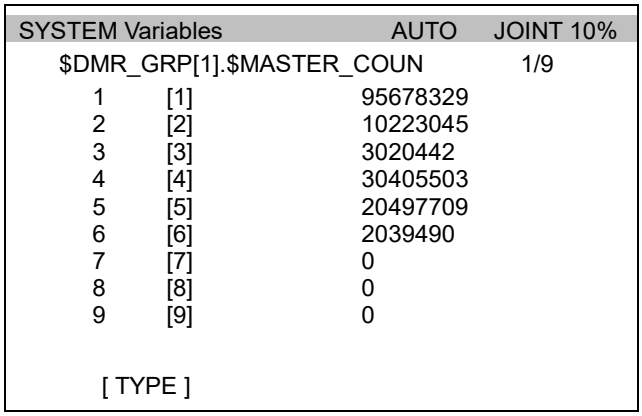


4 Select $DMR_GRP.

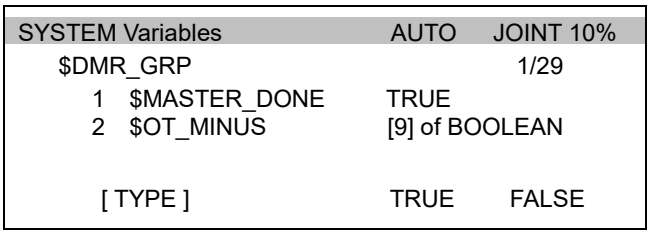




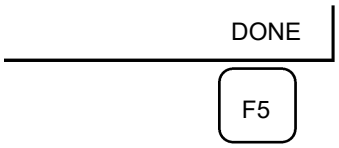
5 Select $MASTER_COUN, and enter the mastering data you have recorded.



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 VERFYING MASTERING

1 How to verify that the robot is mastered properly:
Usually, positioning is performed automatically when the power is turned on. To check whether mastering has been performed correctly, examine if the current displayed position matches the actual robot position by using one or more of the procedures 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 the OPERATOR'S MANUAL are aligned. There is no need to use a visual aid.

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

2 Alarm types displayed during mastering and their solution method:
(1) BZAL alarm
This alarm is displayed if the Pulsecoder's backup battery voltage decreases to 0 V while the power to the controller is disconnected. Furthermore, if the Pulsecoder connector is removed for cable replacement, etc. this alarm is displayed as the voltage decreases to 0. Check to see if the alarm will disappear by performing a pulse reset (See Section 8.2.). Then, cycle controller power and 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
Warn this alarm is output if the voltage of the Pulsecoder's backup battery has fallen to a level where backup is no longer possible. If this alarm is output, fit a new battery immediately while keeping the power turned on. Check whether the current position data is valid, using the procedure described in 1.
(3) Alarm notification like CKAL, RCAL, PHAL, CSAL, DTERR, CRCERR, STBERR, and SPHAL may have trouble with Pulsecoder, contact your local FANUC representative.

9 TROUBLESHOOTING

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

9.1 TROUBLESHOOTING

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

Table 9.1 (a) Troubleshooting

Symptom	Description	Cause	Measure
Vibration Noise	- The J1 base lifts off the floor plate as the robot operates. - There is a gap between the J1 base and floor 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 contamination caught between the base plate and floor plate. - If the robot is not securely fastened to the floor plate, the J1 base lifts the floor plate as the robot operates, allowing the base and floor plates to strike each other which leads to vibration.	- If a bolt is loose, apply LOCTITE and tighten it with the appropriate torque. - Adjust the floor plate surface flatness to within the specified tolerance. - If there is any foreign matter between the J1 base and floor plate, remove it.
	- 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 it is impossible to reinforce the rack or floor, modify the robot control program; doing so will reduce the amount of vibration.
	- 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 ~~re-~~modifying the robot teach pendant program ; reducing speed or acceleration while minimizing the effect on the entire cycle time.

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- Vibration or noise was first noticed after the robot collided with an object or the robot was overloaded for a long period. - The grease of the vibrating or noise occurring axis has not been replaced for a long period. - Periodic vibration and noise occurs.	[Gear, bearing, or reducer] - It is likely that the collision or overload applied an excessive force to the drive mechanism, thus damaging the geartooth 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 contamination 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 contamination caught in a gear, bearing, or within a reducer is causing vibration. - It is likely that, because the grease has not been changed for a long period, fretting occurred on the gear tooth surface or rolling surface of a bearing, or reducer due to metal fatigue or inadequate lubrication.	- Operate one axis at a time to determine which axis is vibrating. - Remove the motor, and replace the gear, the bearing, and the reducer. For the spec. of parts and the method of replacement, contact your local FANUC representative. - Using the robot within its maximum rating prevents problems with the drive mechanism. - Supplying the specified grease at the recommended interval will prevent problems.

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- The cause of problem cannot be identified from examination of the floor, rack, or mechanical section.	[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 robot control parameter was set.	- Refer to the Controller Maintenance Manual for troubleshooting related to the controller and amplifier. - Replace the motor of the axis that is vibrating, and check whether vibration still occurs. Contact your local FANUC representative for replacing methods. - If vibration occurs only when the robot assumes a specific posture, it is likely that there is a mechanical problem. - Shake the movable part cable while the robot is at rest, and check whether an alarm occurs. If an alarm or any other abnormality occurs, replace the mechanical unit cable. - Check whether the cable jacket of the robot connection cable is damaged. If so, replace the connection cable, and check whether vibration still occurs. - Check whether the power cable jacket is damaged. If so, replace the power cable, and check whether vibration still occurs. - Check that the robot is supplied with the rated voltage. - Check that the robot control parameter is set to a valid value. If it is set to an invalid value, correct it. Contact your local FANUC representative for further information if necessary.

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- There is 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 abnormal noise after replacing grease. - There is an abnormal noise after a long time pause. - There is an abnormal noise during operation at low speed.	- There may be an abnormal noise when using other than the specified grease. - Even for the specified grease, there may be an abnormal noise during operation at low speed immediately after replacement or after a long 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. (M-410*i*C/500)	- Liquid might intrude into the balancer, and it caused the spring to corrode and break.	- Prevent liquid splashing on the balancer.
Rattling	- While the robot is not supplied with power, pushing it with the hand causes part of the mechanical unit to wobble. - There is a gap on the mounting surface of the mechanical unit.	[Mechanical section coupling bolt] - It is likely that overloading or a collision has loosened a mounting bolt in the robot mechanical section.	- Check that the following bolts for each axis are tight. If any of these bolts is loose, apply LOCTITE and tighten it to the appropriate torque. - Motor retaining bolt - Reducer retaining bolt - Reducer shaft retaining bolt - Base retaining bolt - Arm retaining bolt - Casting retaining bolt - End effector retaining bolt

Symptom	Description	Cause	Measure
Motor overheating	- The motor overheated due to a rise in temperature in the installation area. - After changing the Robot control program or the load, the motor overheated.	[Ambient temperature] - It is likely that the motor overheated when the ambient temperature rose, and could not dissipate the heat. [Operating condition] - It is likely that the overcurrent is above the specified permissive average current.	- Reducing the ambient temperature is the most effective means of preventing overheat. - Having the surroundings of the motor well ventilated enables the motor to release heat efficiently, thus preventing overheating. - If there is a source of heat near the motor, it is advisable to install shielding to protect the motor from heat radiation. - Relaxing the robot control program and the load condition is an effective way to reduce the average current, thus preventing overheat. - The teach pendant can monitor the average current. Check the average current when the robot control program launched.
	- After a control parameter (load setting etc.) was changed, the motor overheated.	[Parameter] - If data input for a workpiece is invalid, the robot cannot be 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.
	- Symptom other than stated above	[Mechanical problems] - It is likely that problems occurred in the mechanical unit drive mechanism, thus placing an excessive load on the motor. [Motor problems] - It is likely that a failure of the motor brake resulted in the motor running with the brake applied, thus placing an excessive load on the motor. - It is likely that a failure of the motor prevented it from delivering its rated performance, thus causing an excessive current to flow through the motor. - It is likely that cooling fan is broken.	- Repair the mechanical unit referring to the above descriptions of vibration, noise, and rattling. - Check that, when the servo system is energized, the brake is released. If the brake remains applied to the motor all the time, replace the motor. - If the average current of the motor decreases after replacement, then the former motor was defective. - If the cooling fan is broken, replace it with a new one.

Symptom	Description	Cause	Measure

Grease leakage	- Grease is leaking from the mechanical unit.	[Poor sealing]
		- Probable causes are a crack in the casting, a broken O-ring, a damaged oil seal, or a loose seal bolt.
		- A crack in a casting can occur due to excessive force that might be caused in a collision.
		- An O-ring can be damaged if it is pinched or cut during disassembling or re-assembling.
		- An oil seal might be damaged if extraneous dust scratches the lip of the oil seal.
		- A loose seal bolt might allow grease to leak along the threads.
		- Problems with the grease nipple or threads.
			- If a crack develops in the casting, sealant can be used as a quick-fix to prevent further grease leakage. However, the component should be replaced as soon as possible, because the crack might extend.
			- O-rings are used in the locations listed below.
			  - Motor coupling section
			  - Reducer (case and shaft) coupling section
			  - Link 1 coupling section
			- Replace the grease nipple.

Dropping axis	- An axis falls because the brake failed.
	- 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 penetrated 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 penetrated the motor

Symptom	Description	Cause	Measure
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 fasting 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.
BZAL alarm occurred.	- BZAL is displayed on the teach pendant screen.	- It is likely that the voltage of the memory backup battery is low. - It is likely that the Pulsecoder cable is defective.	- Replace the batteries. - Replace the cable.

APPENDIX

A PERIODIC MAINTENANCE TABLE

FANUC Robot M-410*i*C/110 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 J1-axis swing stopper	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	4	Check for water	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	5	Check the mechanical cable (damaged or twisted)	0.2H	—		○			○				○			
	6	Check the end effector (hand) cable	0.2H	—		○			○				○			
	7	Check the motor connector (loosening)	0.2H	—		○			○				○			
	8	Tighten the end effector bolt.	0.2H	—		○			○				○			
	9	Tighten the cover and main bolt	2.0H	—		○			○				○			
	10	Check the mechanical stopper	1.0H	—		○			○				○			
	11	Clean spatters, sawdust and dust	0.1H	—		○			○				○			
	12	Check the operation of the cooling fan	0.1H	—		○			○				○			
	13	Replacing batteries. *4	0.1H	—							●					
	14	Replacing grease of J1-axis reducer *1	1.0H	4750ml												
	15	Replacing grease of J2-axis reducer *1	0.6H	1800ml												
	16	Replacing grease of J3-axis reducer *1	0.5H	1700ml												
	17	Replacing grease of J4-axis reducer *1	0.5H	440ml												
	19	Apply greasing to bearing of J3 arm connection*1 (2 location)	0.1H	20ml each												
	20	Apply greasing to the J3 base cross roller bearing*1	0.1H	20ml												
	21	Apply greasing to connection parts of wrist *1 (2 locations)	0.1H	10ml each												
	22	Replacing mechanical unit cable	4.0H	—												
Controller	23	Check the robot cable, teach pendant cable and robot connecting cable	0.2H	—		○			○				○			
	24	Cleaning the controller ventilation system	0.2H	—	○	○	○	○	○	○	○	○	○	○	○	○
	25	Replacing batteries *2 *4	0.1H	—												

*1 Refer to this manual about greasing points.

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

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

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

3 years 11520	12480	13440	14400	4 years 15360	16320	17280	18240	5 years 19200	20160	21120	22080	6 years 23040	24000	24960	25920	7 years 26880	27840	28800	29760	8 years 30720	Items
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		1
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		2
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		3
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				●																	25

Overhaul

FANUC Robot M-410*i*C/185/315 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 J1-axis swing stopper	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	4	Check for water	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	5	Check the mechanical cable (damaged or twisted)	0.2H	—		○			○				○			
	6	Check the end effector (hand) cable	0.2H	—		○			○				○			
	7	Check the motor connector (loosening)	0.2H	—		○			○				○			
	8	Tighten the end effector bolt.	0.2H	—		○			○				○			
	9	Tighten the cover and main bolt	2.0H	—		○			○				○			
	10	Check the mechanical stopper	1.0H	—		○			○				○			
	11	Clean spatters, sawdust and dust	0.1H	—		○			○				○			
	12	Check the operation of the cooling fan	0.1H	—		○			○				○			
	13	Replacing batteries *4	0.1H	—							●					
	14	Replacing grease of J1-axis reducer *1	1.0H	7100ml												
	15	Replacing grease of J2-axis reducer *1	0.6H	3170ml												
	16	Replacing grease of J3-axis reducer *1	0.5H	1700ml												
	17	Replacing grease of J4-axis reducer *1	0.5H	1400ml												
	19	Apply greasing to bearing of J3 arm connection*1 (2 location)	0.1H	20ml each												
	20	Apply greasing to the J3 base cross roller bearing*1	0.1H	20ml												
	21	Apply greasing to connection parts of wrist *1 (2 locations)	0.1H	10ml each												
	22	Replacing mechanical unit cable	4.0H	—												
Controller	23	Check the robot cable, teach pendant cable and robot connecting cable	0.2H	—		○			○				○			
	24	Cleaning the controller ventilation system	0.2H	—	○	○	○	○	○	○	○	○	○	○	○	○
	25	Replacing battery *2 *4	0.1H	—												

*1 Refer to this manual about greasing points.

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

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3 years 11520	12480	13440	14400	4 years 15360	16320	17280	18240	5 years 19200	20160	21120	22080	6 years 23040	24000	24960	25920	7 years 26880	27840	28800	29760	8 years 30720	Items
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		1
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		2
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Overhaul

FANUC Robot M-410*i*C/500 **Periodic Maintenance Table**

Items		Items \ Accumulated operating time (H)	Check time	Grease amount	First check 320	3 months 960	6 months 1920	9 months 2880	1 year 3840	4800	5760	6720	2 years 7680	8640	9600	10560
Mechanical unit	1	Check for external damage or peeling paint	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	2	Check damages of the cable protective sleeves	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	3	Check wear debris of J1-axis swing stopper	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	4	Check for water	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	5	Check the mechanical cable. (damaged or twisted)	0.2H	—		○			○				○			
	6	Check the end effector (hand) cable	0.2H	—		○			○				○			
	7	Check the motor connector. (loosening)	0.2H	—		○			○				○			
	8	Tighten the end effector bolt.	0.2H	—		○			○				○			
	9	Tighten the cover and main bolt.	2.0H	—		○			○				○			
	10	Check the mechanical stopper	1.0H	—		○			○				○			
	11	Clean spatters, sawdust and dust	0.1H	—		○			○				○			
	12	Check the operation of the cooling fan	0.1H	—		○			○				○			
	13	Replacing batteries *4	0.1H	—							●					
	14	Replacing grease of J1-axis reducer *1	1.0H	6620ml												
	15	Replacing grease of J2-axis reducer *1	0.6H	2730ml												
	16	Replacing grease of J3-axis reducer *1	0.6H	2730ml												
	17	Replacing grease of J4-axis reducer *1	0.5H	1080ml												
	18	Apply greasing to balancer bush*1 (2 location)	0.1H	10ml each					●				●			
	19	Apply greasing to bearing of J3 arm connection*1 (2 location)	0.1H	20ml each												
	20	Apply greasing to the J3 base cross roller bearing*1	0.1H	20ml												
	21	Apply greasing to connection parts of wrist *1 (2 locations)	0.1H	10ml each												
	22	Replacing mechanical unit cable	4.0H	—												
Controller	23	Check the robot cable, teach pendant cable and robot connecting cable	0.2H	—		○			○				○			
	24	Cleaning the controller ventilation system	0.2H	—	○	○	○	○	○	○	○	○	○	○	○	○
	25	Replacing batteries *2 *4	0.1H	—												

*1 Refer to this manual about greasing points.

*2 Refer to “REPLACING UNITS Chapter of MAINTENANCE ” of the following manuals.
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*3 ●: requires order of parts ○: does not require order of parts

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3 years 11520	12480	13440	14400	4 years 15360	16320	17280	18240	5 years 19200	20160	21120	22080	6 years 23040	24000	24960	25920	7 years 26880	27840	28800	29760	8 years 30720	Items
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		1
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		2
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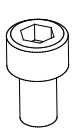
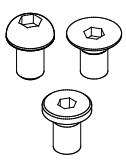
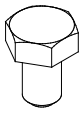
Overhaul

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. When finished, remove all the excess LOCTITE when you are finished screwing the bolts into the threaded holes.

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

Recommended bolt tightening torques **Unit: Nm**

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

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REVISION RECORD

Edition	Date	Contents
07	Mar., 2021	• Addition of option cables • Correction of errors
06	Feb., 2018	• Addition of M-410*i*C/110 • Correction of errors
05	Jul, 2017	• Addition of R-30*i*B Plus controller • Correction of errors
04	Oct., 2016	• Correction of errors
03	Dec., 2015	• Addition of M-410*i*C/500 • Addition of quick mastering for single axis • Correction of errors
02	Nov., 2013	• Addition of M-410*i*C/315 • Correction of errors
01	Jul., 2013	

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