FANUC Robot M-900*i*B/700/700E/400L

MECHANICAL UNIT

OPERATOR'S MANUAL

B-83444EN/06

- **Original Instructions**

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

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

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

SAFETY PRECAUTIONS

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

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

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

1 PERSONNEL

Personnel can be classified as follows.

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

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

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

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

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

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

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

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

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

2 DEFINITION OF SAFETY NOTATIONS

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

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

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

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

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

(*) These do not support CE marking.

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

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

⚠ WARNING
Robot arm would fall down by releasing its brake because of gravity. Especially because spring balancers are used for J2-axis and counter balancer is used for J3-axis, it is hard to predict J2/J3-arm movement by the condition of Robot posture and end effecter. Therefore, it is strongly recommended to take adequate measures such as hanging Robot arm by a crane before releasing a brake.

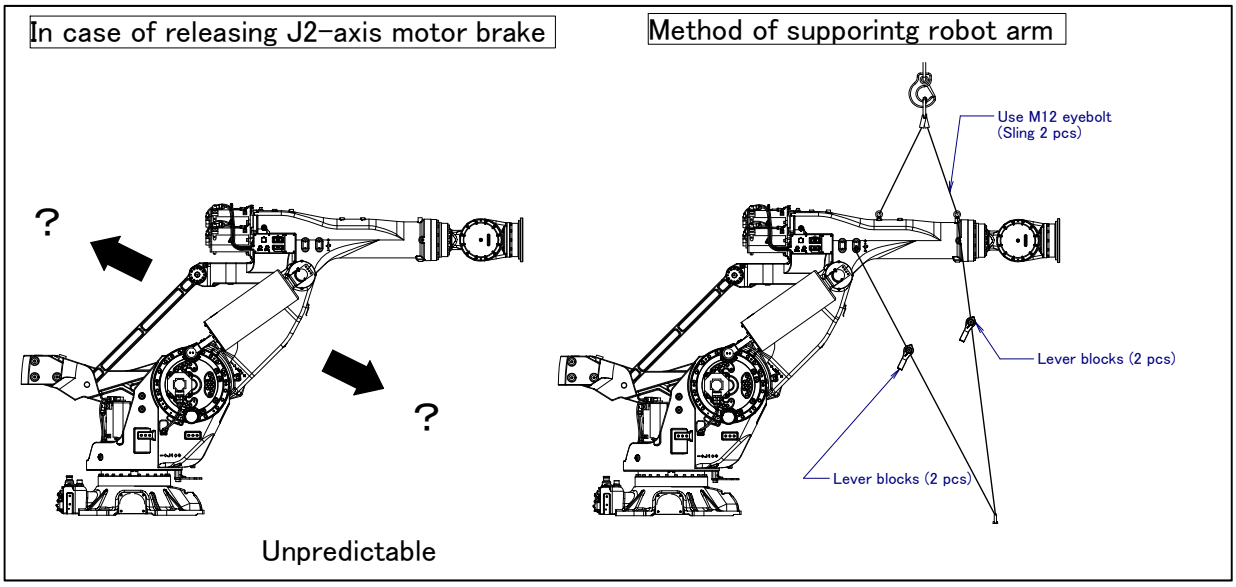


Fig. 3 (a) Releasing J2 motor brake and measures

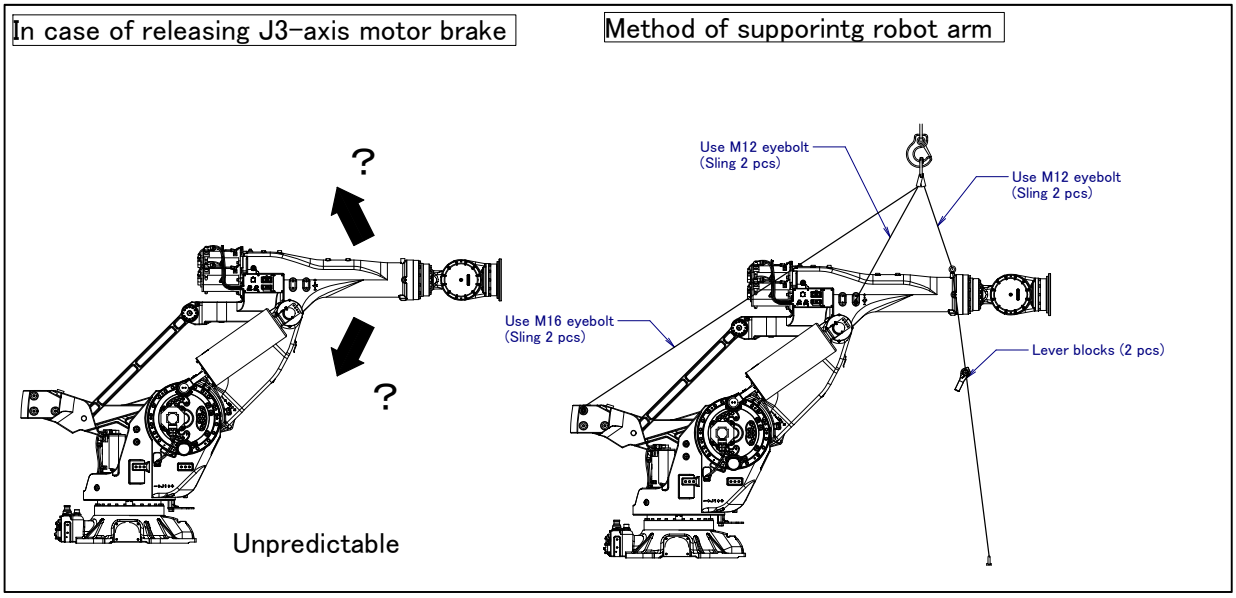


Fig. 3 (b) Releasing J3 motor brake and measures

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

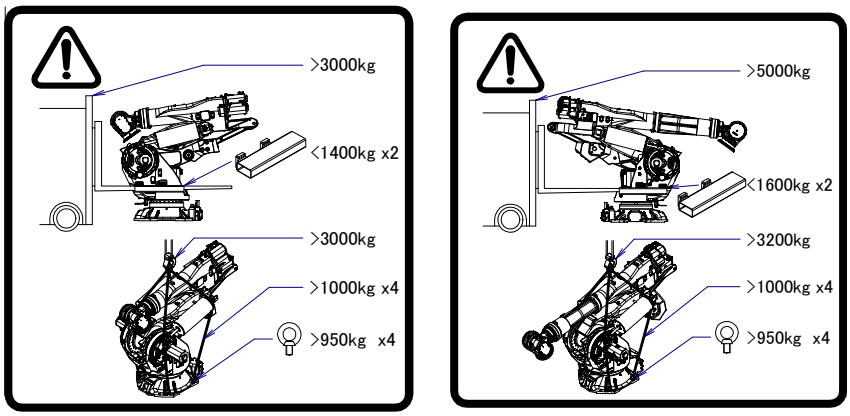


Fig. 4 (d) Transportation label

Description

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

1) Using a forklift

M-900*i*B/700

- Use a forklift with a load capacity of 3000 kg or greater.
- Keep the total mass of the robot to be transported to within 2800 kg, because the allowable load of the forklift bracket (option) is 13720 N (1400 kgf).

M-900*i*B/400L

- Use a forklift with a load capacity of 5000 kg or greater.
- Keep the total weight of the robot to be transported to within 3200 kg, because the allowable load of the forklift bracket (option) is 15680 N (1600 kgf).

2) Using a crane

- In case M-900*i*B/700, use a crane with a load capacity of 3000 kg or greater.
- In case M-900*i*B/400L, use a crane with a load capacity of 3200 kg or greater.
- Use four slings with each load capacity of 1000 kg or greater.
- Use two eyebolts with each allowable load of 9310 N (950 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

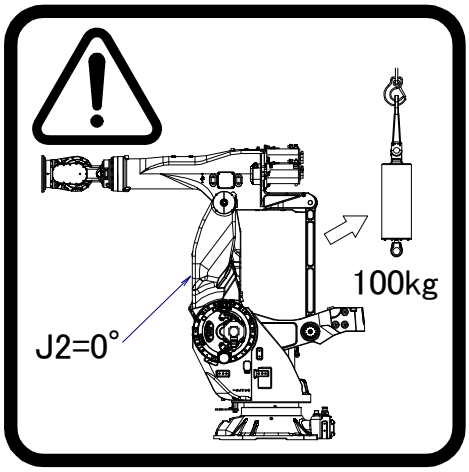


Fig. 4 (e) Balancer replacement label

Description

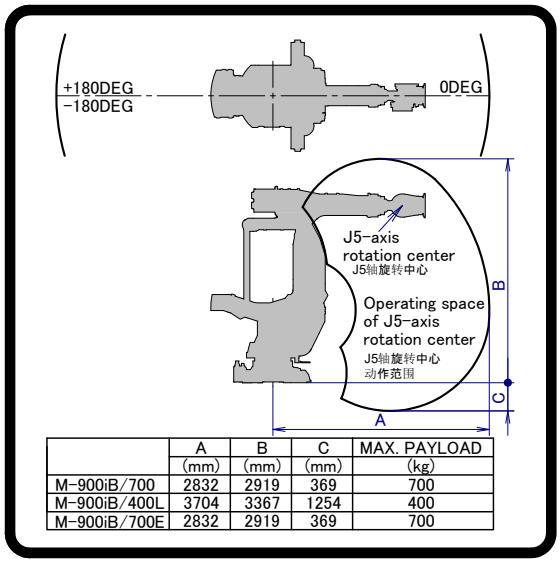
When replacing the balancer, observe the instructions indicated on this label.
The above balancer replacement label indicates the following:

- While replacing the balancer, keep the J2-axis at 0°.
- The mass of the balancer is 100 kg.

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

(6) Operating space and payload label

Below label is added when CE specification is specified.



	A (mm)	B (mm)	C (mm)	MAX. PAYLOAD (kg)
M-900iB/700	2832	2919	369	700
M-900iB/400L	3704	3367	1254	400
M-900iB/700E	2832	2919	369	700

Fig. 4 (f) Operating space and payload label

(7) Transportation caution label

(When transport equipment option is specified.)

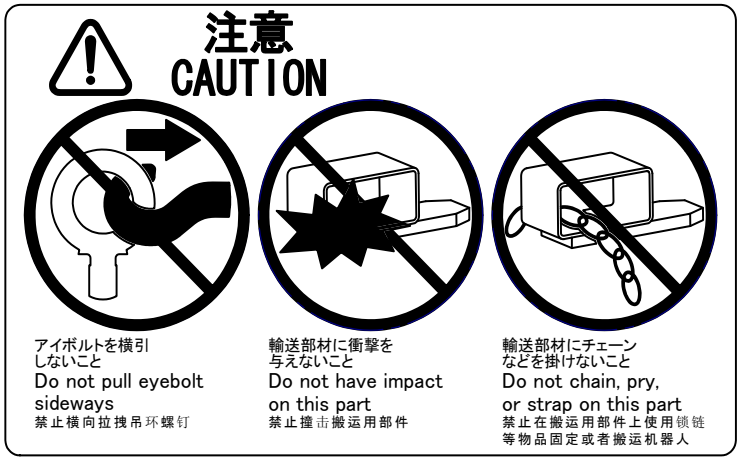


Fig. 4 (g) Transportation caution label

Description

Keep the followings in mind when transporting the robot.

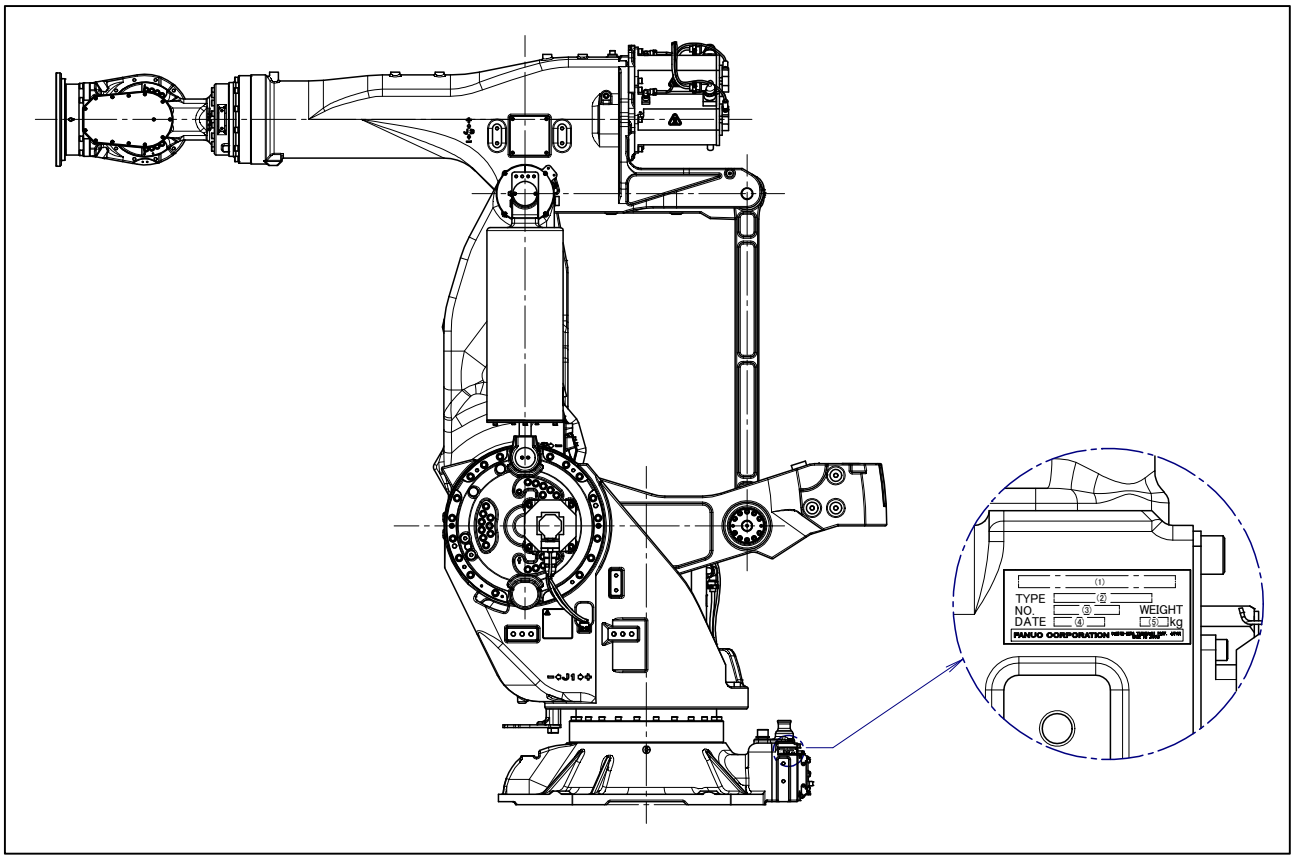
1) Do not pull eyebolts sideways.
2) Do not have impact on this part.
3) Do not chain, pry or strap on this part.

PREFACE

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

Model name	Mechanical unit specification No.	Maximum load
FANUC Robot M-900*i*B/700	A05B-1332-B201	700kg
FANUC Robot M-900*i*B/700E	A05B-1332-B202	700kg
FANUC Robot M-900*i*B/400L	A05B-1332-B203	400kg

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



Position of label indicating mechanical unit specification number

TABLE 1

	(1)	(2)	(3)	(4)	(5)
CONTENTS	**MODEL NAME**	**TYPE**	**No.**	**DATE**	**WEIGHT (kg)**
LETTERS	FANUC Robot M-900*i*B/700	A05B-1332-B201	SERIAL NO. IS PRINTED	PRODUCTION YEAR AND MONTH ARE PRINTED	2800
	FANUC Robot M-900*i*B/700E	A05B-1332-B202			3030
	FANUC Robot M-900*i*B/400L	A05B-1332-B203			3150

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 controlle**r	Operations manual Basic Operation **B-83284EN** Alarm Code List **B-83284EN-1** Optional Function **B-83284EN-2** Spot Welding Function **B-83284EN-4** Dispense Function **B-83284EN-5** Servo Gun Function **B-83264EN**	Intended readers: Operator, programmer, maintenance technician, system designer Topics: Robot functions, operations, programming, setup, interfaces, alarms Use: Robot operation, teaching, system design
	Maintenance manual **B-83195EN**	Intended readers: Maintenance technician, system designer Topics: Installation, start-up, connection, maintenance Use: Installation, start-up, connection, maintenance

This manual uses following terms.

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

TABLE OF CONTENTS

APPENDIX

1 TRANSPORTATION AND INSTALLATION

1.1 TRANSPORTATION

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

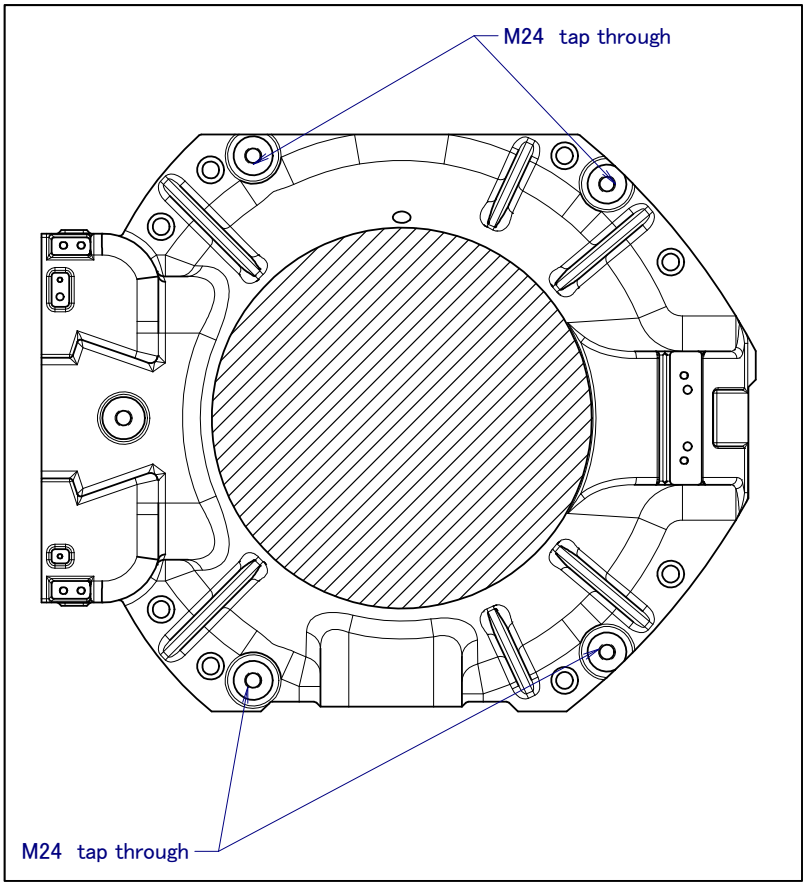


Fig. 1.1 (a) Position of the eyebolt mounting

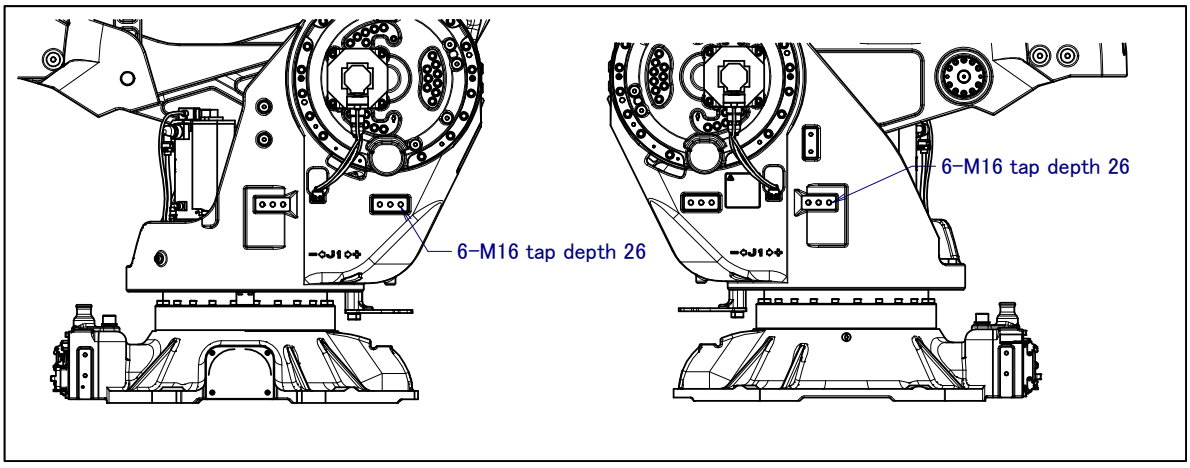


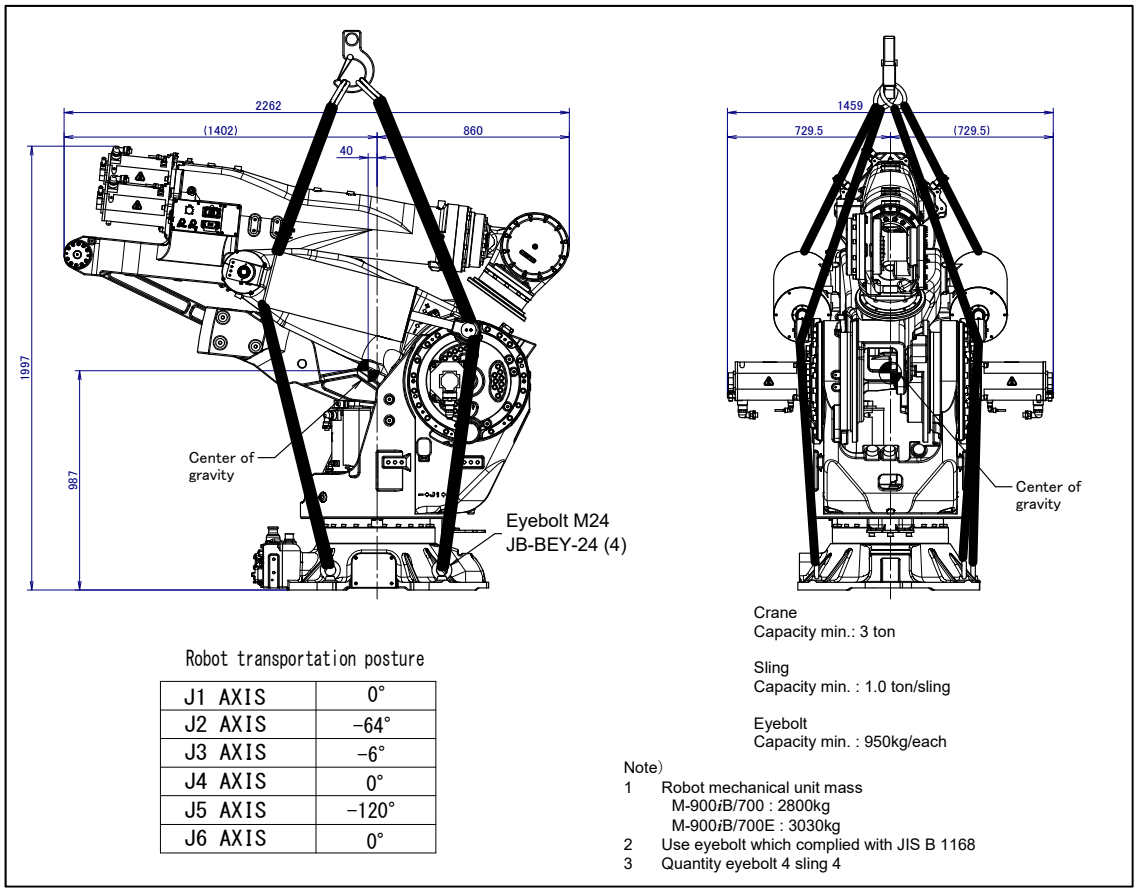
Fig. 1.1 (b) Position of the forklift bracket mounting

(1) Transportation using a crane (Fig. 1.1 (c), (d))
Fasten the M24 eyebolts at the points of J1 and lift the robot by the four slings.

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

(2) Transportation using a forklift (Fig. 1.1 (e), (f))
Perform it by attaching special transport equipment to J2 base side.

⚠ WARNING
1 When hoisting or lowering the robot with a crane or forklift, move it slowly with great care. When placing the robot on the floor, exercise care to prevent the installation surface of the robot from striking the floor.
2 Detach the end effectors and base plate before transporting the robot. If the robot must necessarily be transported with the base plate attached, take the following precautions:
・ Robot becomes unstable when it is transported with the end effector applied to wrist, and it is dangerous.
Please be sure to remove the end effector when robot is transported. Be extremely careful to keep the robot in balance.
If the base plate is attached, the center of gravity of the entire robot changes.
When lifting the robot, be sure to lift the base plate instead of the robot.
3 Use the forklift transport equipment only to transport the robot with a forklift. Do not use the forklift transport equipment to secure the robot.
Before moving the robot by using transport equipment, check the bolts on the transport equipment and tighten any loose bolts if any.
4 When J2/J3-axis motor covers (option) are installed, be sure to remove them before transporting robot with a crane.



Robot transportation posture

J1 AXIS	0°
J2 AXIS	-64°
J3 AXIS	-6°
J4 AXIS	0°
J5 AXIS	-120°
J6 AXIS	0°

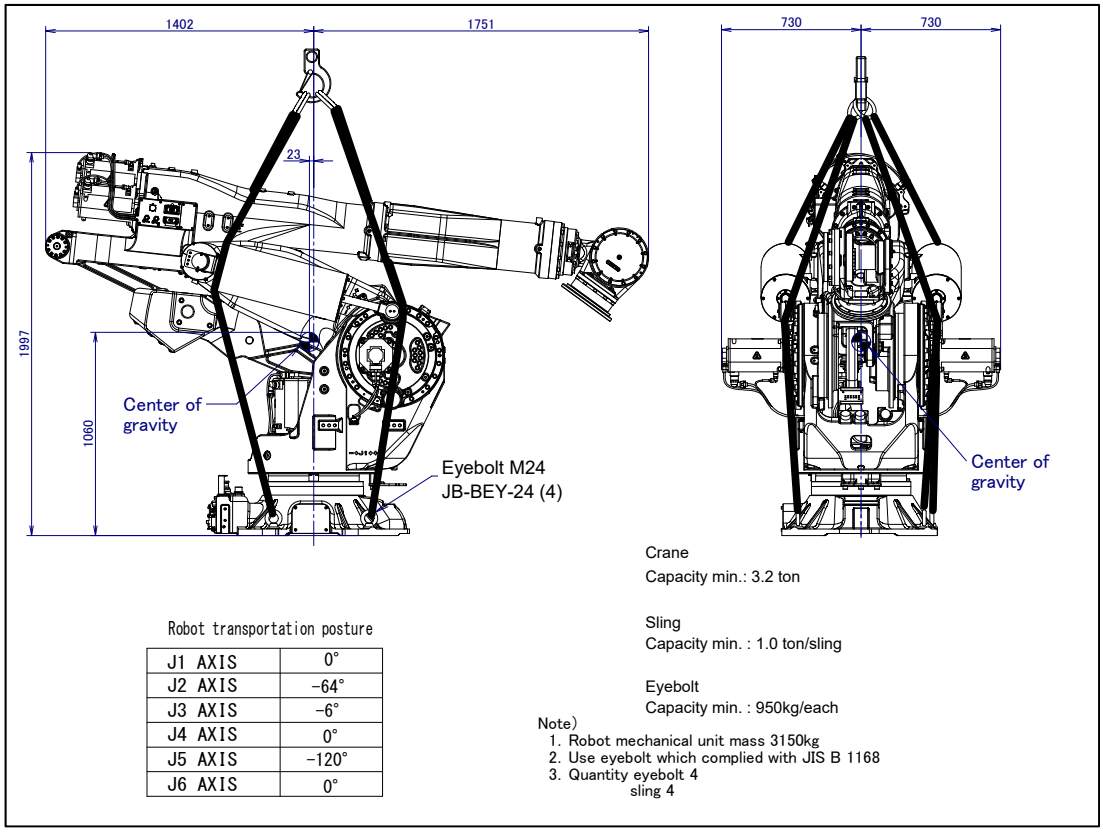
Crane
Capacity min.: 3 ton

Sling
Capacity min. : 1.0 ton/sling

Eyebolt
Capacity min. : 950kg/each

Note)
1 Robot mechanical unit mass
M-900*i*B/700 : 2800kg
M-900*i*B/700E : 3030kg
2 Use eyebolt which complied with JIS B 1168
3 Quantity eyebolt 4 sling 4

Fig. 1.1 (c) Transportation using a crane (M-900*i*B/700/700E)



Robot transportation posture

J1 AXIS	0°
J2 AXIS	-64°
J3 AXIS	-6°
J4 AXIS	0°
J5 AXIS	-120°
J6 AXIS	0°

Crane
Capacity min.: 3.2 ton

Sling
Capacity min. : 1.0 ton/sling

Eyebolt
Capacity min. : 950kg/each

Note)
1. Robot mechanical unit mass 3150kg
2. Use eyebolt which complied with JIS B 1168
3. Quantity eyebolt 4
sling 4

Fig. 1.1 (d) Transportation using a crane (M-900*i*B/400L)

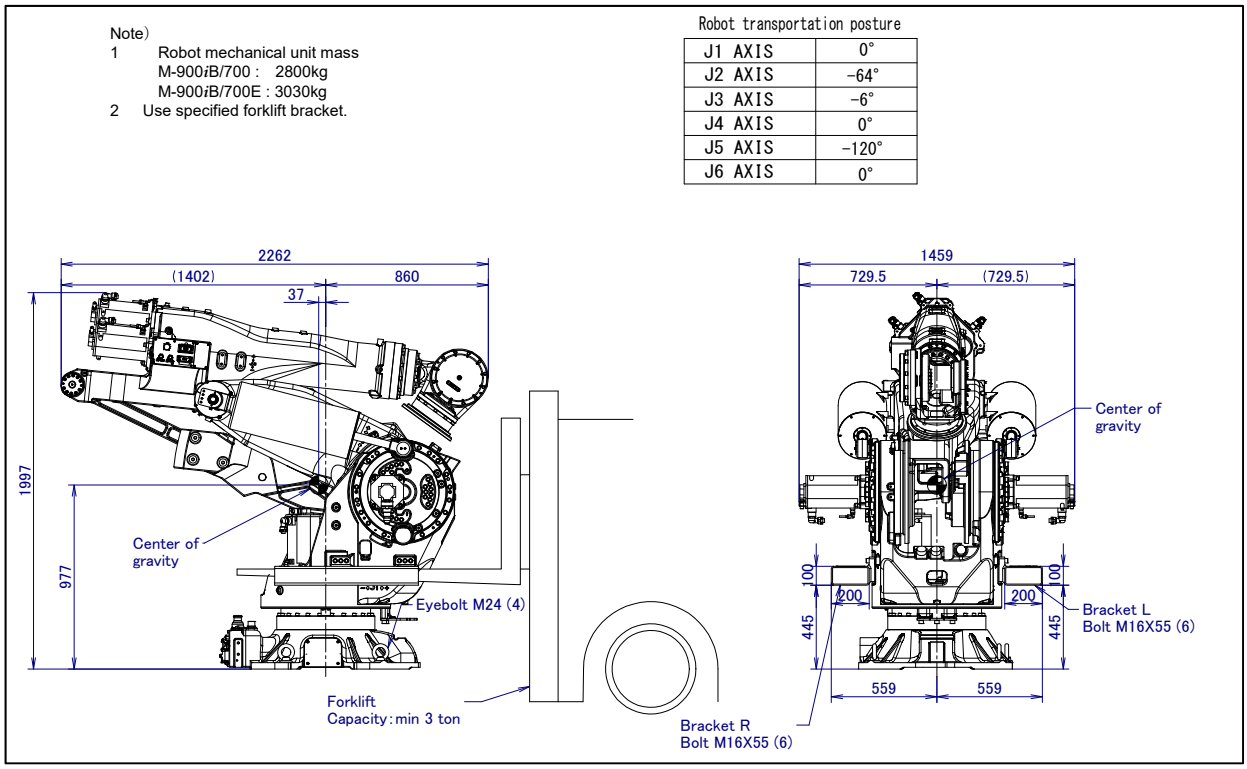


Fig. 1.1 (e) Transportation using a forklift (M-900*i*B/700/700E)

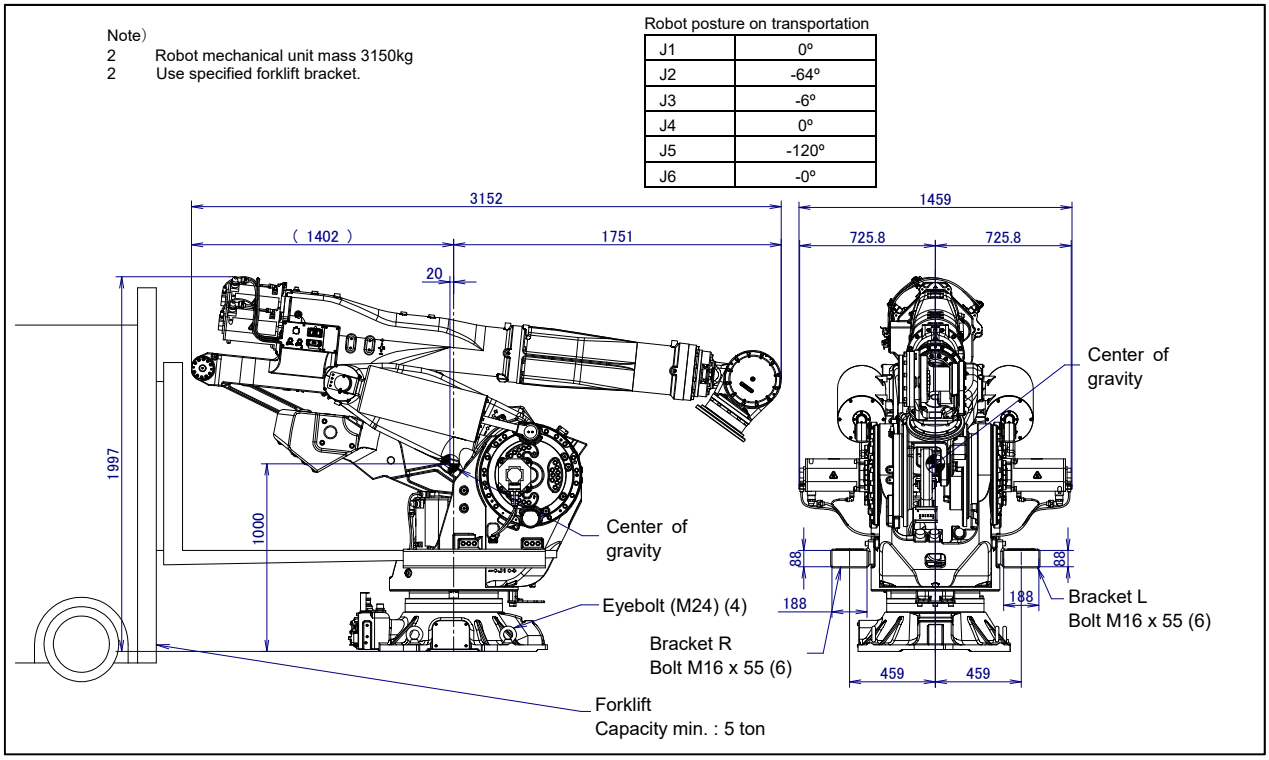


Fig. 1.1 (f) Transportation using a forklift (M-900*i*B/400L)

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

1.2 INSTALLATION

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

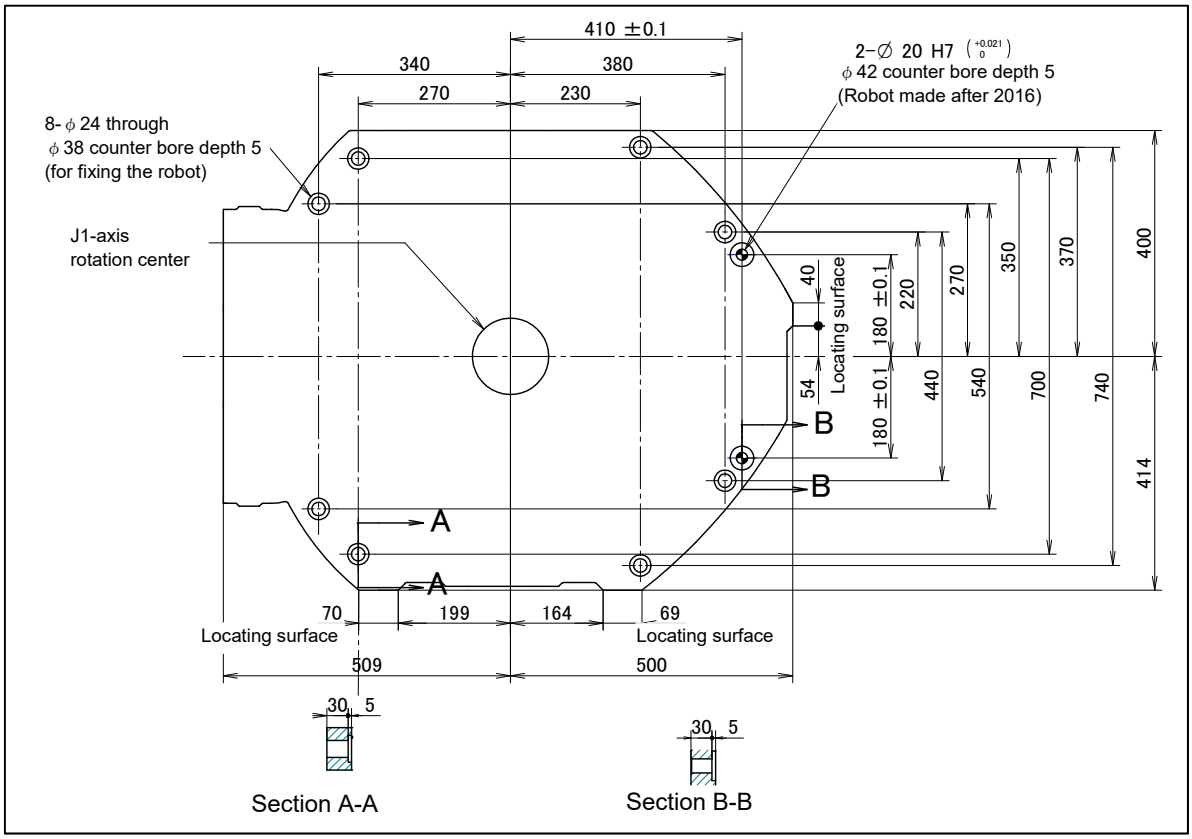


Fig. 1.2 (a) Dimension of robot base

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

NOTE
Table 1.2 (d) to (f) 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 (d) 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 (a) Force and moment during Power off stop (M-900*i*B/700)

	Vertical moment M_V [kNm (kgfm)]	Force in vertical direction F_V [kN (kgf)]	Horizontal moment M_H [kNm (kgfm)]	Force in horizontal direction F_H [kN (kgf)]
During Power-Off stop	117.6 (12000)	65.7 (6700)	26.5 (2700)	36.3 (3700)
During acceleration	49.0 (5000)	42.1 (4300)	12.7 (1300)	13.7 (1400)
Static	37.2 (3800)	38.2 (3900)	0.0 (0)	0.0 (0)

Table 1.2 (b) Force and moment during Power off stop (M-900*i*B/700E)

	Vertical moment M_V [kNm (kgfm)]	Force in vertical direction F_V [kN (kgf)]	Horizontal moment M_H [kNm (kgfm)]	Force in horizontal direction F_H [kN (kgf)]
During Power-Off stop	119.6 (12200)	65.7 (6700)	27.4 (2800)	36.3 (3700)
During acceleration	52.9 (5400)	44.1 (4500)	14.7 (1500)	14.7 (1500)
Static	39.2 (4000)	40.2 (4100)	0.0 (0)	0.0 (0)

Table 1.2 (c) Force and moment during Power off stop (M-900*i*B/400L)

	Vertical moment M_V [kNm (kgfm)]	Force in vertical direction F_V [kN (kgf)]	Horizontal moment M_H [kNm (kgfm)]	Force in horizontal direction F_H [kN (kgf)]
During Power-Off stop	117.6 (12000)	65.7 (6700)	27.4 (2800)	36.3 (3700)
During acceleration	49.0 (5000)	42.1 (4300)	15.7 (1600)	13.7 (1400)
Static	37.2 (3800)	39.2 (4000)	0.0 (0)	0.0 (0)

Table 1.2 (d) 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-900*i*B/700	Stopping time [ms]	1172	252	372
	Stopping distance [deg] (rad)	45.8 (0.80)	10.0 (0.17)	16.8 (0.29)
M-900*i*B//700E	Stopping time [ms]	1311	271	467
	Stopping distance [deg] (rad)	45.7 (0.80)	9.7 (0.17)	19.3 (0.34)
M-900*i*B/400L	Stopping time [ms]	1068	252	540
	Stopping distance [deg] (rad)	42.6(0.74)	10.2(0.18)	22.8(0.40)

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

Model		J1-axis	J2-axis	J3-axis
M-900*i*B/700	Stopping time [ms]	1212	1196	1188
	Stopping distance [deg] (rad)	51.1 (0.89)	47.6 (0.83)	47.1 (0.82)
M-900*i*B/400L	Stopping time [ms]	1196	1204	1204
	Stopping distance [deg] (rad)	49.8 (0.87)	50.4 (0.88)	49.8 (0.87)

Table 1.2 (f) 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-900*i*B/700	Stopping time [ms]	1184	810	750
	Stopping distance [deg] (rad)	45.6 (0.80)	30.2 (0.53)	30.2 (0.53)
M-900*i*B//700E	Stopping time [ms]	1247	859	919
	Stopping distance [deg] (rad)	46.8 (0.82)	32.8 (0.57)	28.8 (0.50)
M-900*i*B/400L	Stopping time [ms]	1078	988	1016
	Stopping distance [deg] (rad)	42.7 (0.75)	38.6 (0.67)	37.8 (0.66)

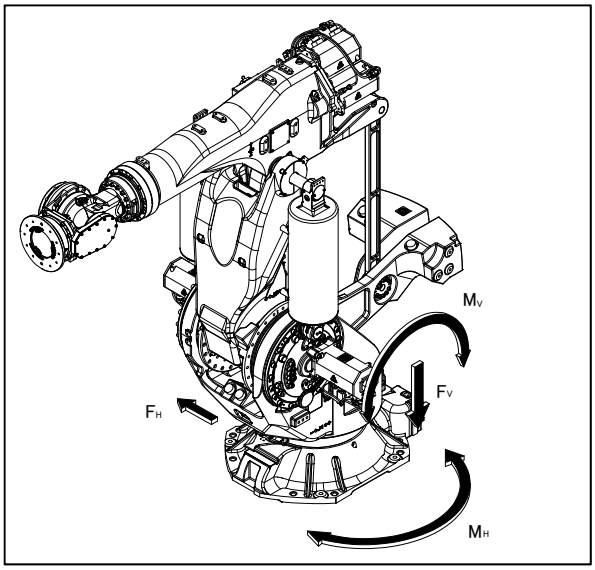


Fig. 1.2 (b) Force and moment that acts on robot base

1.2.1 Actual Installation Example

Fig. 1.2.1 (a) shows actual examples of robot installations. In Fig. 1.2.1 (a), the floor plate is imbedded in concrete and fastened with twelve M20 (tensile strength 400N/mm^2 or more) chemical anchors. Also, fasten the base plate to the robot base using eight M20 x 60 bolts (tensile strength 1200N/mm^2 or more strength). Next, position the robot, and weld the base plate to the floor plate. (Foot length is 10 to 15mm.)
(The base plate is prepared as an option.)

NOTE
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.

⚠ CAUTION
1 Parts to be provided by the customer:

Robot mounting bolts:	M20 x 60 (tensile strength 1200N/mm^2 or more)	8 pcs.
Chemical anchors:	M20 (tensile strength 400N/mm^2 or more)	12 pcs.
Base plates:	Thickness 32t	4 pcs.
Floor plate:	Thickness 32t	1 pc.

2 Installation work (welding, anchoring, etc.) is repaired by the customer.
3 Flatness of robot installation surface must be less than or equal to 0.5mm.
Inclination of robot installation surface must be less than or equal to 0.5º.
If robot base is placed on uneven ground, it may result in the base breakage or low performance of the robot.

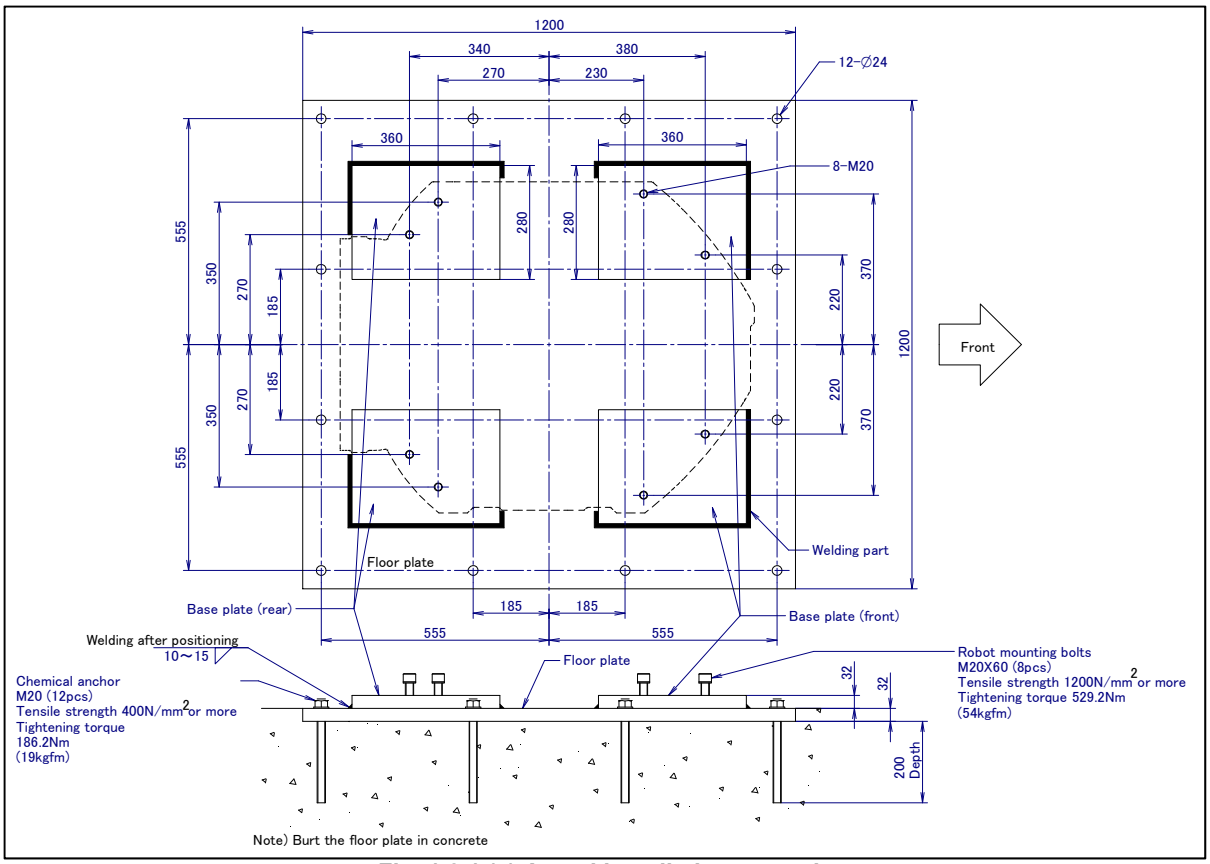


Fig. 1.2.1 (a) Actual installation example

1.3 MAINTENANCE AREA

Fig. 1.3 (a) and (b) show 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.

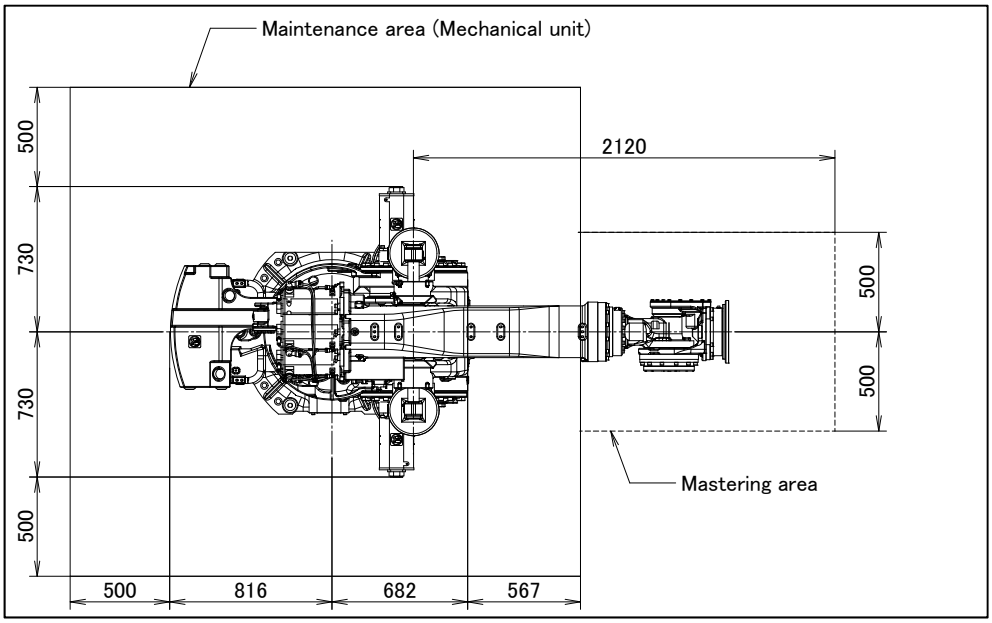


Fig. 1.3 (a) Maintenance area (M-900*i*B/700/700E)

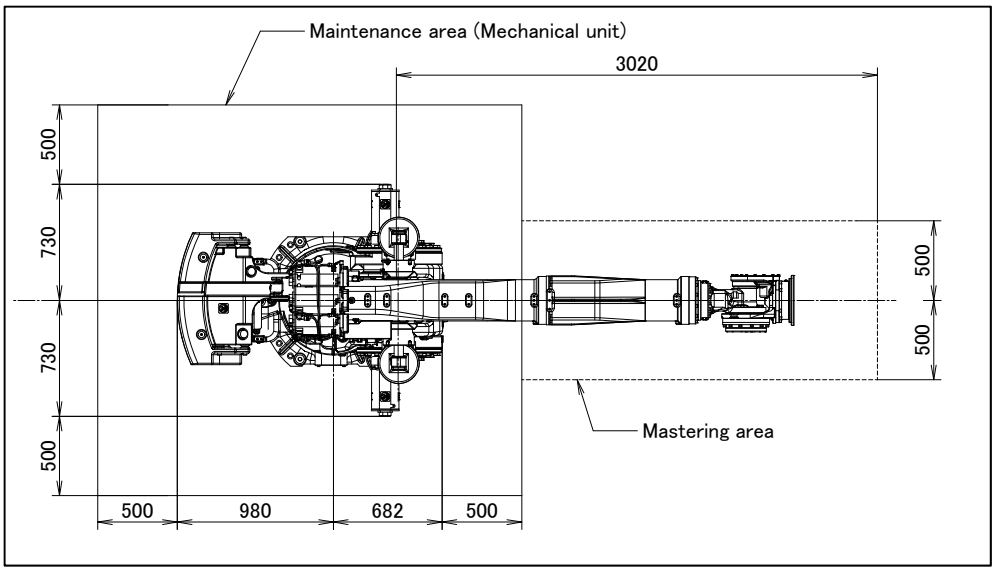


Fig. 1.3 (b) Maintenance area (M-900*i*B/400L)

1.4 INSTALLATION CONDITIONS

Refer to specification of Section 3.1 about installation conditions.

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

2 CONNECTION WITH THE CONTROLLER

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

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

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

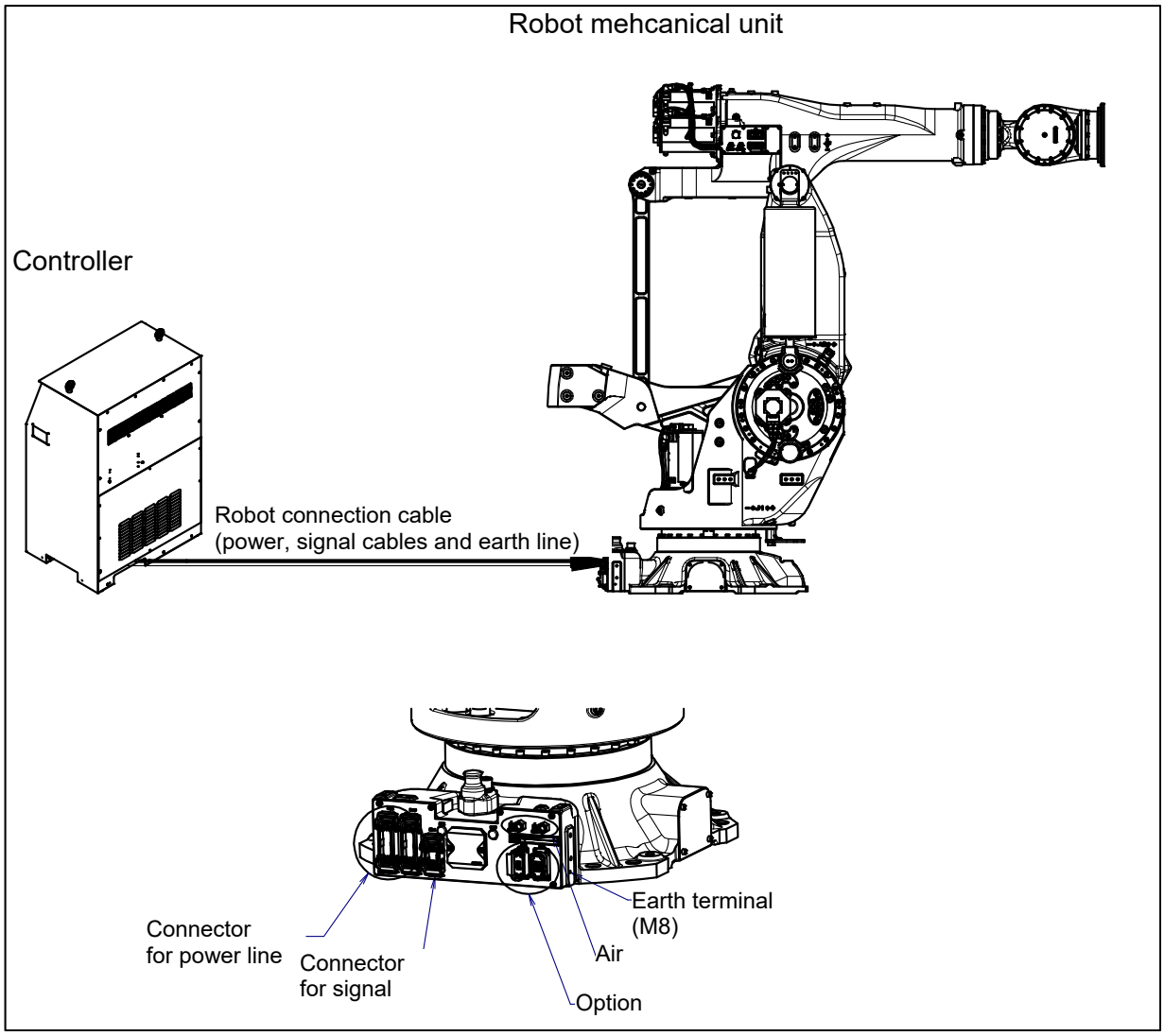


Fig. 2 (a) Cable connection

3 BASIC SPECIFICATIONS

3.1 ROBOT CONFIGURATION

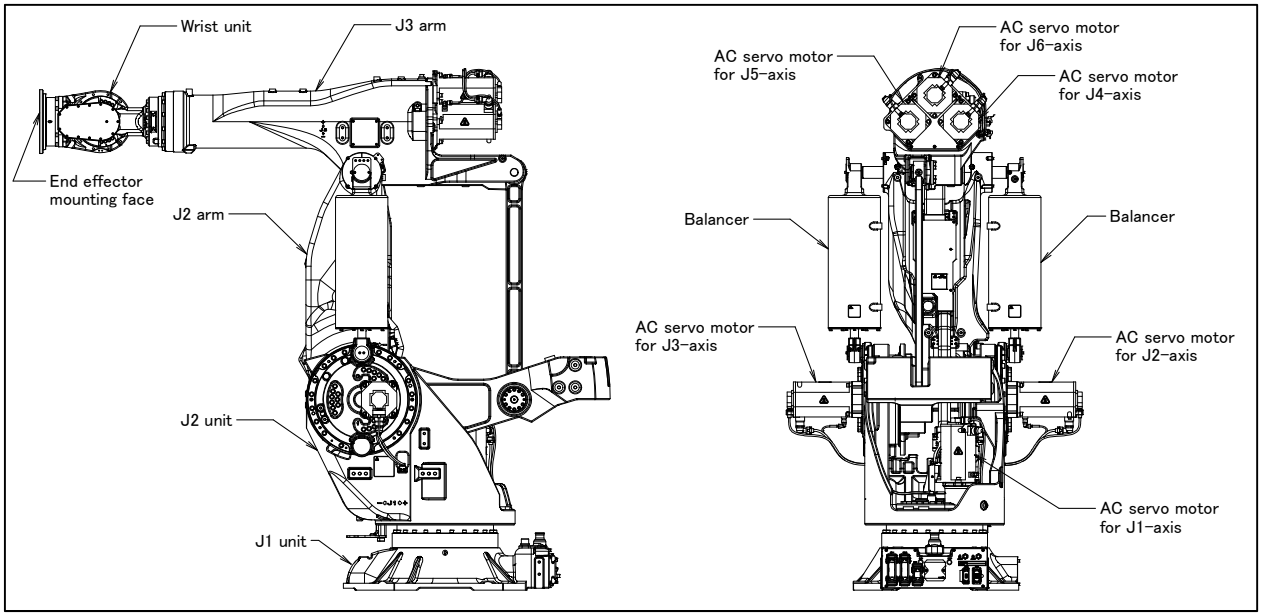


Fig. 3.1 (a) Mechanical unit configuration

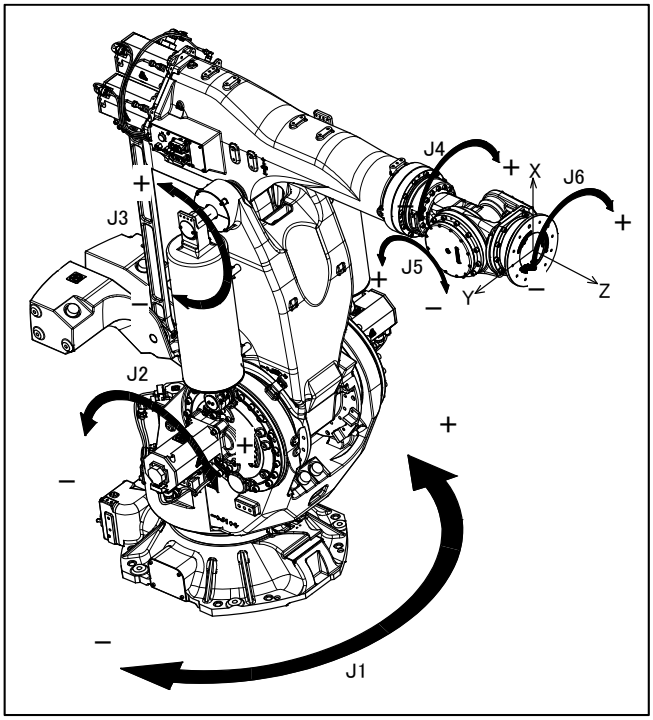


Fig. 3.1 (b) Each axes coordinates and mechanical interface coordinates

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

Table 3.1 (a) Specifications (Note 1)

		M-900*i*B/700	M-900*i*B/700E	M-900*i*B/400L
Type		Articulated type		
Controlled axes		6-axes (J1, J2, J3, J4, J5, J6)		
Installation		Floor mount		
Motion range (Upper limit / Lower limit)	J1-axis	180°(3.14rad) / -180°(-3.14rad) 168°(2.93rad) / -168°(-2.93rad) (Note 2)		
	J2-axis	90°(1.57rad) / - 64°(-1.12rad)		
	J3-axis	30°(0.52rad) / -130°(-2.27rad)		
	J4-axis	360°(6.28rad) / -360°(-6.28rad) 168°(2.93rad) / -168°(-2.93rad) (Note 2)		
	J5-axis	122°(2.13rad) / -122°(-2.13rad)		
	J6-axis	360°(6.28rad) / -360°(-6.28rad)		
Maximum speed (Note 3)	J1-axis	80°/s (1.40rad/s)		
	J2-axis	80°/s (1.40rad/s)		
	J3-axis	80°/s (1.40rad/s)		
	J4-axis	100°/s (1.75rad/s)		
	J5-axis	100°/s (1.75rad/s)		
	J6-axis	160°/s (2.79rad/s)		
Max. payload	At wrist	700kg	700kg	400kg
	On J2 base	550kg		
	On J3 arm	25kg		
Allowable load moment at wrist	J4-axis	3400N·m (347kgf·m)	5000N·m (510kgf·m)	2744N·m (280kgf·m)
	J5-axis	3400N·m (347kgf·m)	5000N·m (510kgf·m)	2744N·m (280kgf·m)
	J6-axis	1725N·m (176kgf·m)	2800N·m (286kgf·m)	1725N·m (176kgf·m)
Allowable load inertia at wrist	J4-axis	1098kg·m^2 (11200kgf·cm·s^2)		
	J5-axis	1098kg·m^2 (11200kgf·cm·s^2)		
	J6-axis	444kg·m^2 (4532kgf·cm·s^2)		
Drive method		Electric servo drive by AC servo motor		
Repeatability		±0.1mm (Note 4)		
Mass		2800kg	3030kg	3150kg
Acoustic noise level		76.3dB (Note 5)		
Installation environment		Ambient temperature : 0 to 45℃ (Note 6) Ambient humidity : Normally 75%RH or less (No condensation allowed.) Short time (Within 1 month) 95%Rh or less (No condensation allowed.) 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.

Note 2) When accuracy and stiffness enhancement option is specified.

Note 3) During short distance motions, the axis speed may not reach the maximum value stated.

Note 4) Compliant with ISO 9283.

Note 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

Note 6) When robot is used in low temperature environment that is near to 0ºC, or not operated for a long time in the environment that is less than 0ºC in a holiday or the night, collision detection alarm (SRVO-050) etc. may occur since the resistance of the drive mechanism could be high immediately after starting the operation. In this case, we recommend performing the warm up operation for several minutes.

Note 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.

The following table lists the IEC60529-based dustproof and waterproof characteristics of the M-900*i*B. Refer to Chapter 10 about severe dust/liquid protection package (option).

	Standard	Severe dust/liquid protection package (option)
J3 arm and wrist section	IP67	IP67
Drive unit of the main body	IP66	IP66
Main body	IP54 (*)	IP56

(*) Except some connectors

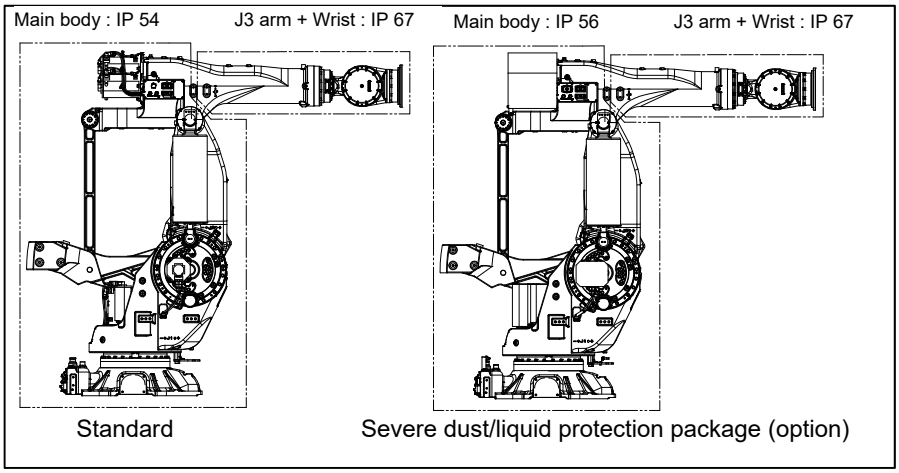


Fig. 3.1 (c) Severe dust/liquid protection characteristics of M-900*i*B

NOTE
Definition of IP code
Definition of IP 67
6=Dust-tight
7=Protection from water immersion
Definition of IP 66
6=Dust-tight
6=Protection from powerful water jets
Definition of IP 54
5=Dust-protected
4=Protection from splashing water
Definition of IP 56
5=Dust-protected
6=Protection from powerful water jets

Performance of resistant chemicals and resistant solvents is as follows.

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

3.2 MECHANICAL UNIT EXTERNAL DIMENSIONS AND OPERATING SPACE

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

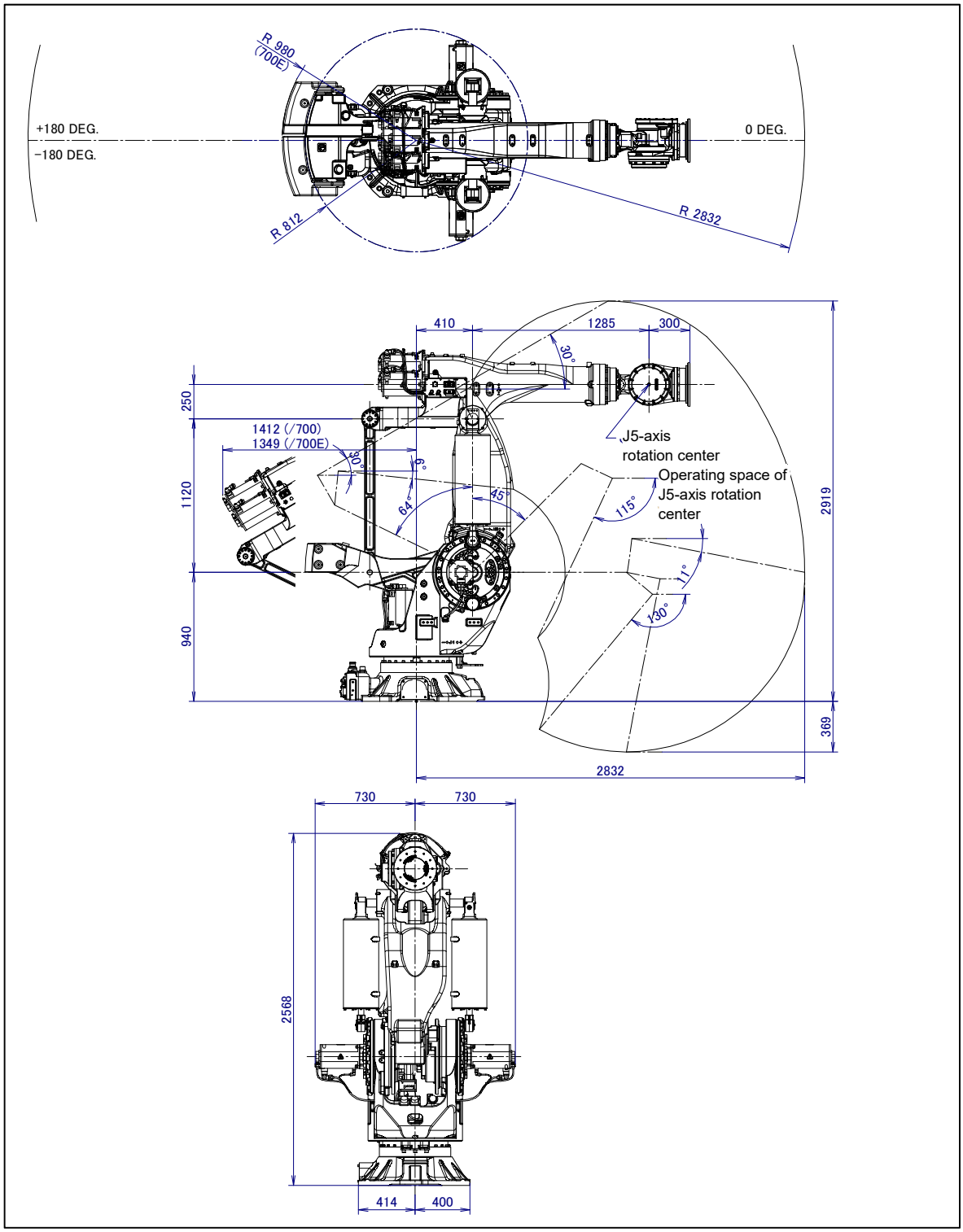
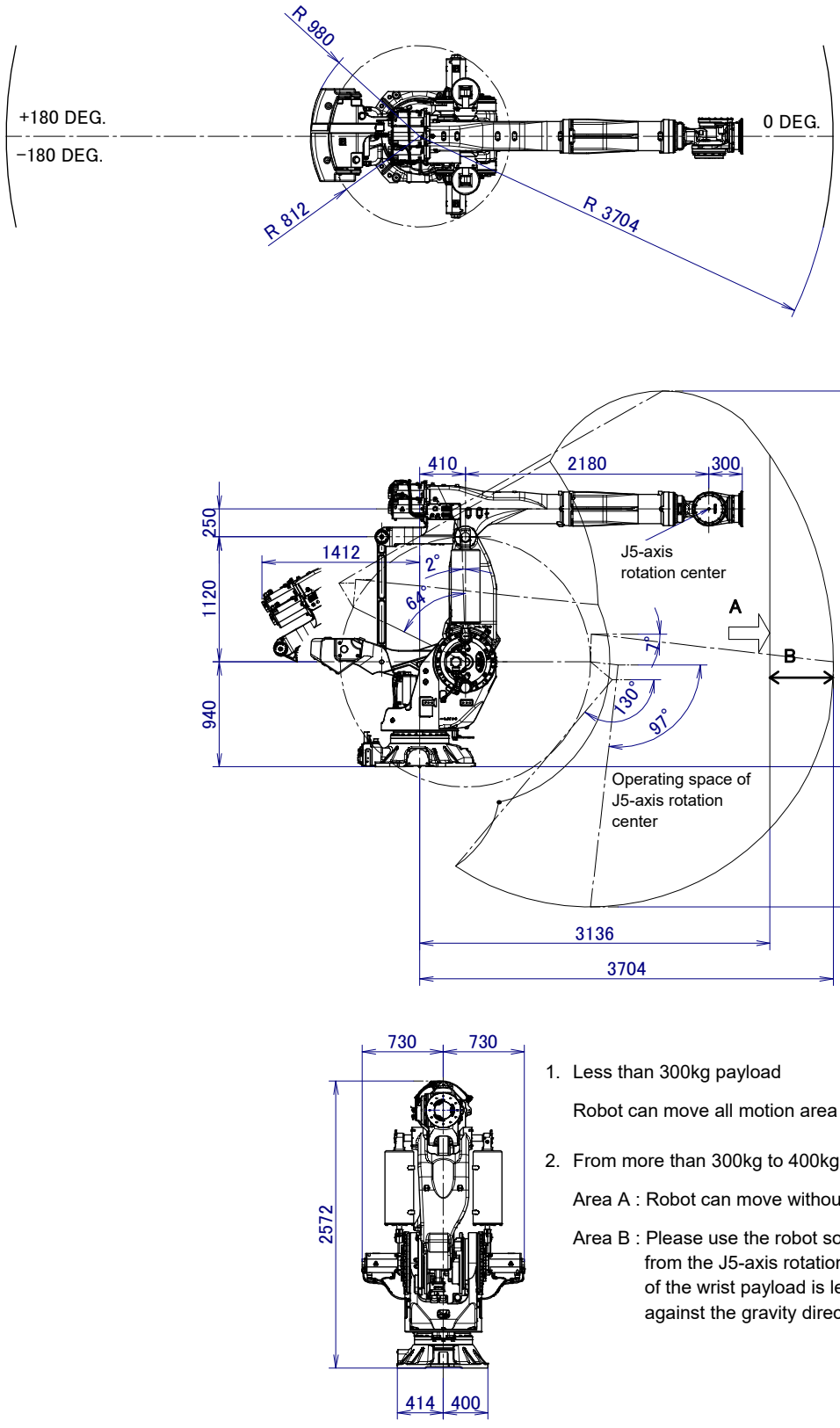


Fig. 3.2 (a) Operating space (M-900*i*B/700/700E)



1. Less than 300kg payload

   Robot can move all motion area without restriction.

2. From more than 300kg to 400kg payload

   Area A : Robot can move without restriction.

   Area B : Please use the robot so that the vector from the J5-axis rotation center to the CofG of the wrist payload is less than 30 degrees against the gravity direction.

Fig. 3.2 (b) Operating space (M-900*i*B/400L)

3.3 ZERO POINT POSITION AND MOTION LIMIT

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

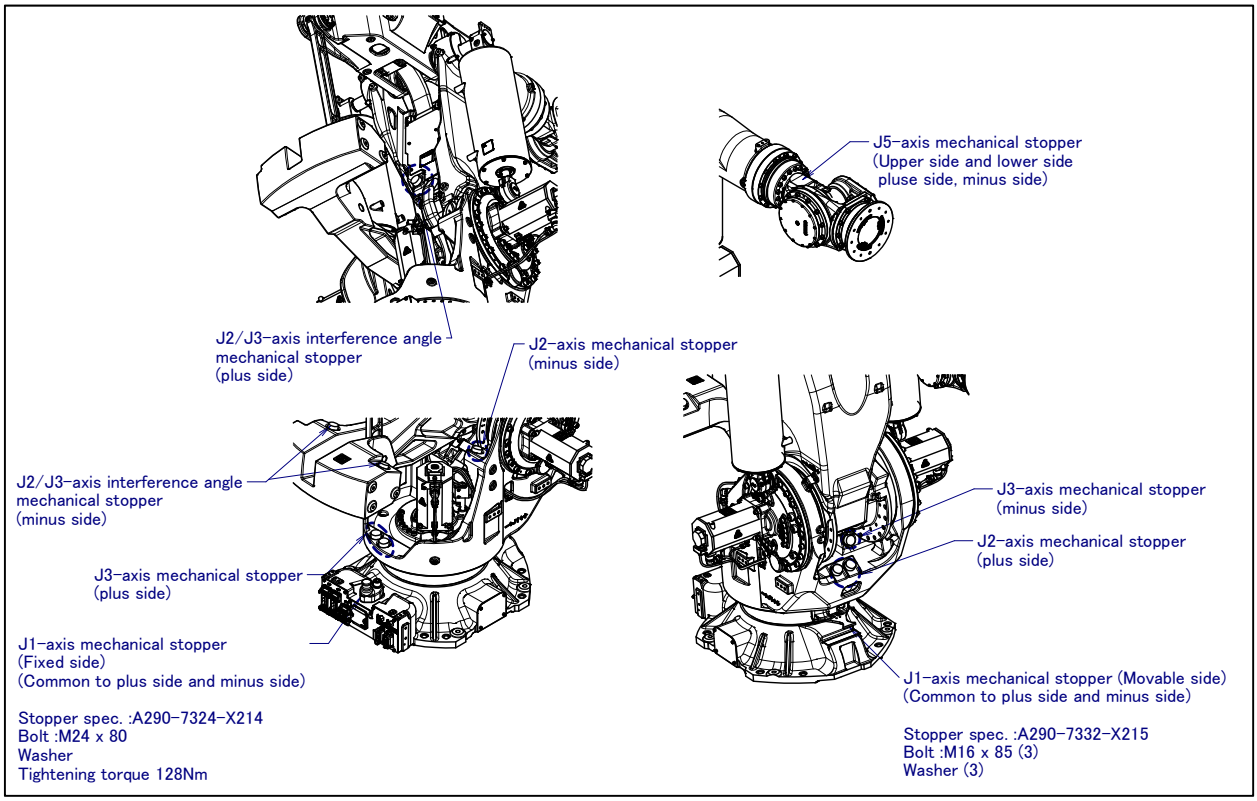


Fig. 3.3 (a) Position of mechanical stopper

Fig.3.3 (b) to (i) 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”.

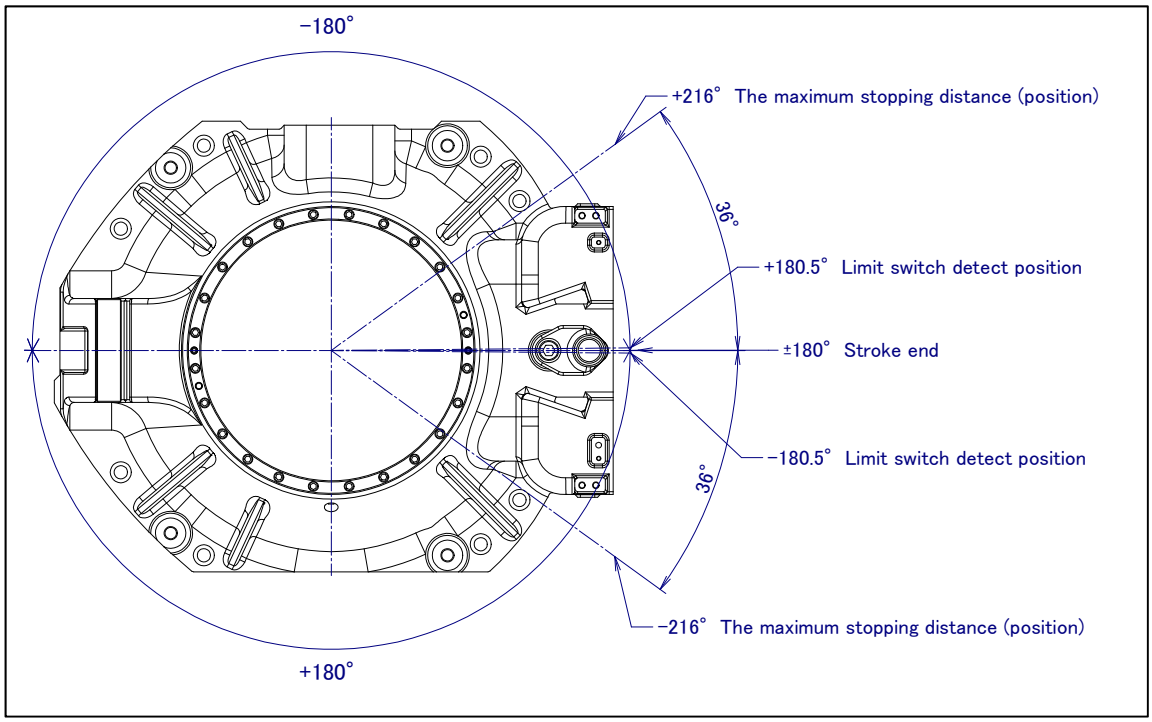


Fig. 3.3 (b) J1-axis motion limit

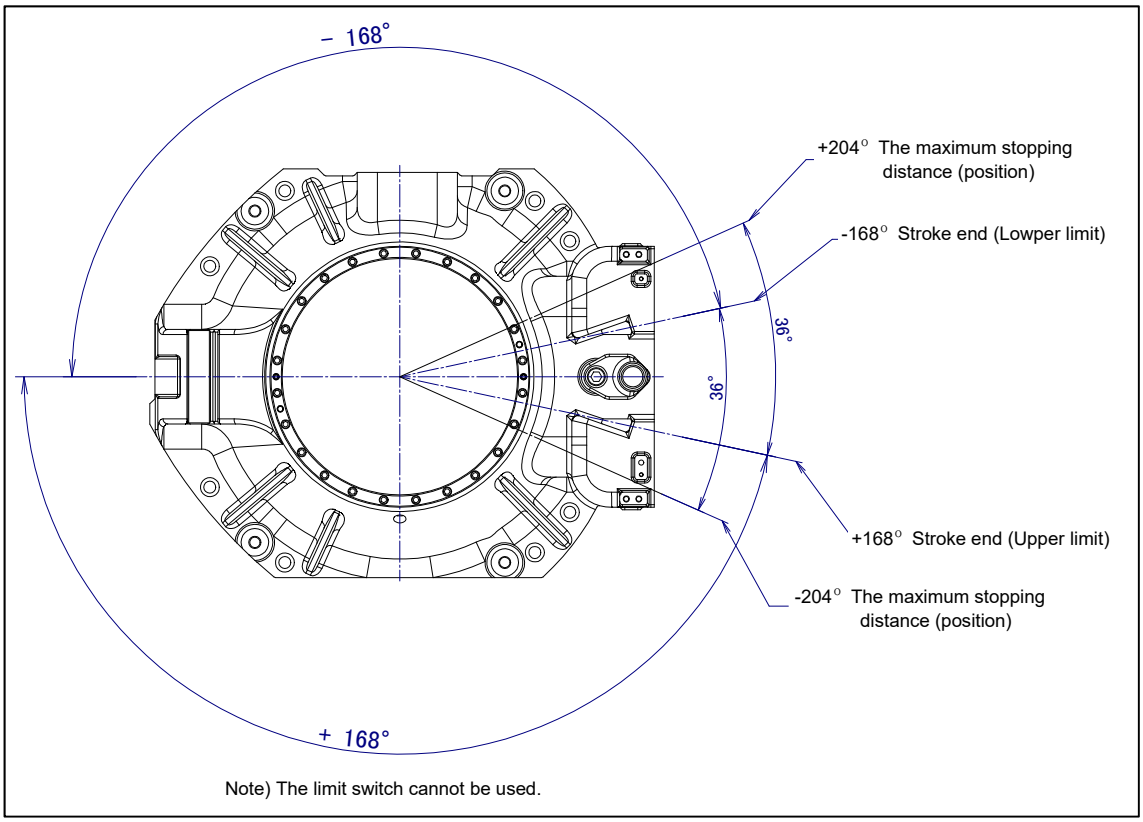


Fig. 3.3 (c) J1-axis motion limit
(When accuracy and stiffness enhancement option is specified)

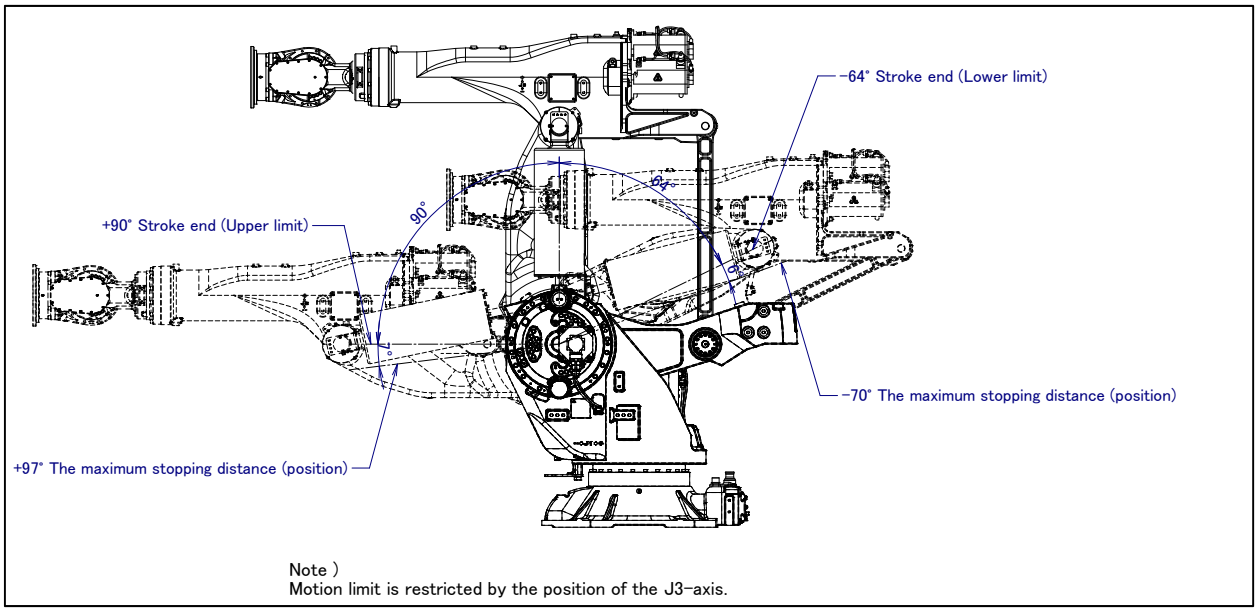


Fig. 3.3 (d) J2-axis motion limit

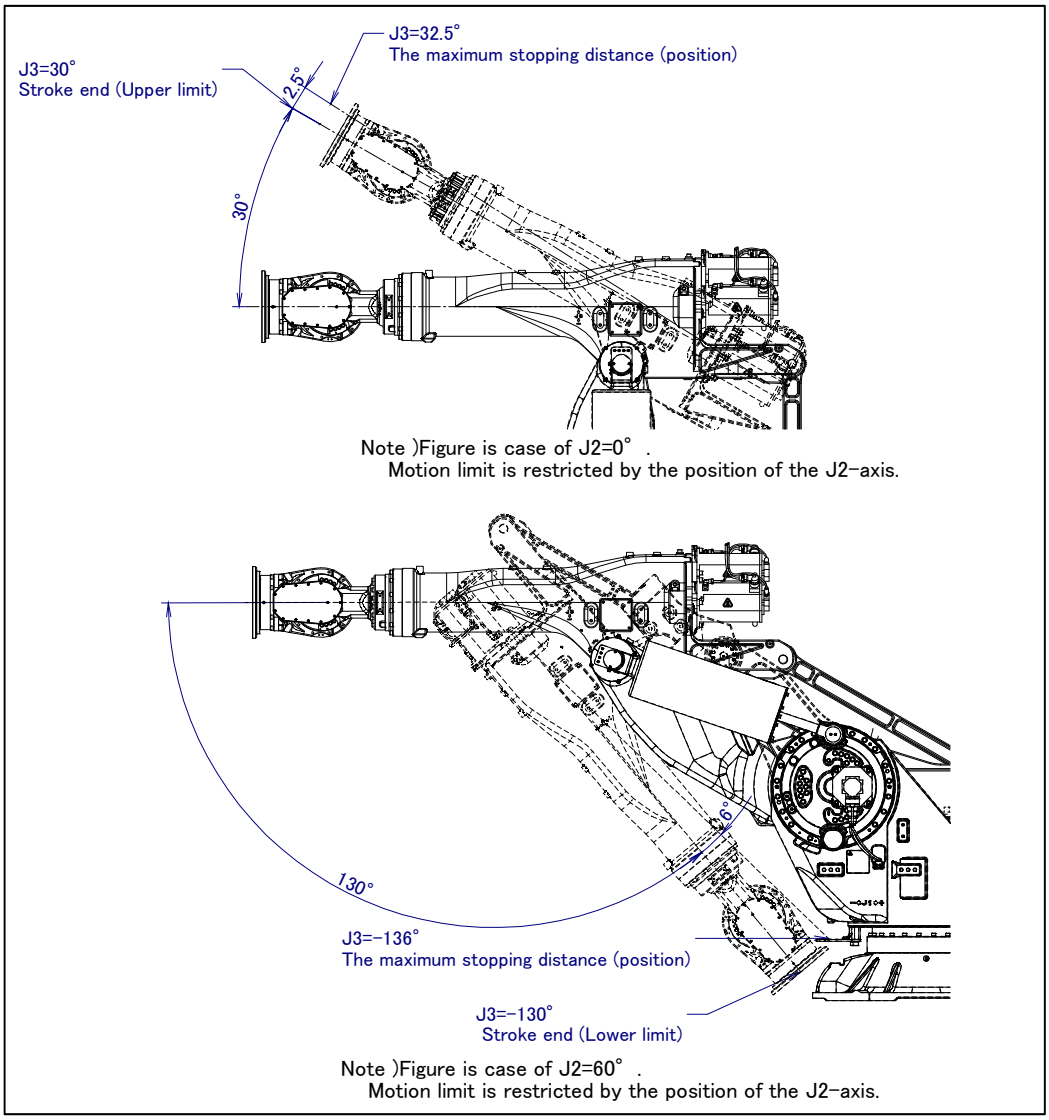


Fig. 3.3 (e) J3-axis motion limit

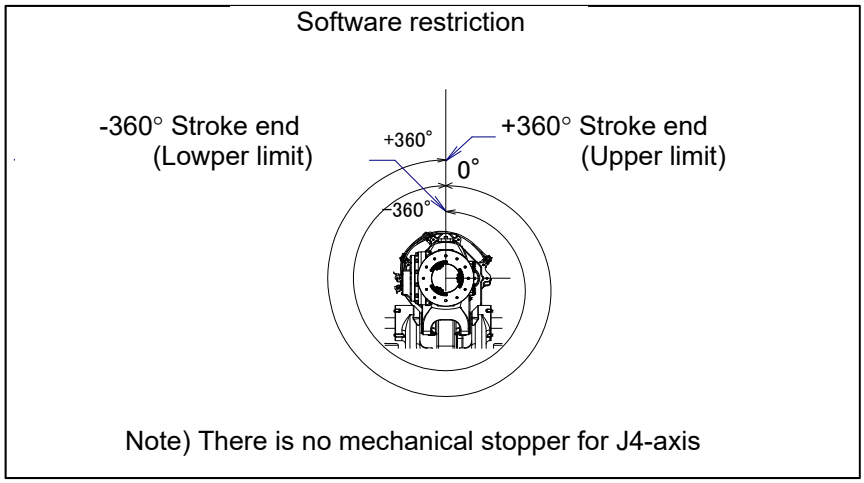


Fig. 3.3 (f) J4-axis motion limit

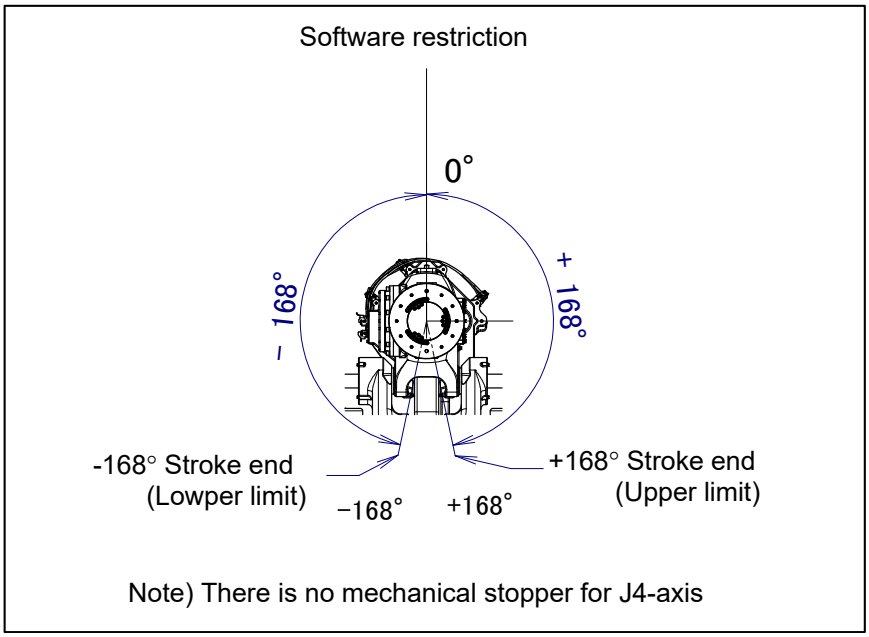


Fig. 3.3 (g) J4-axis motion limit
(When accuracy and stiffness enhancement option is specified)

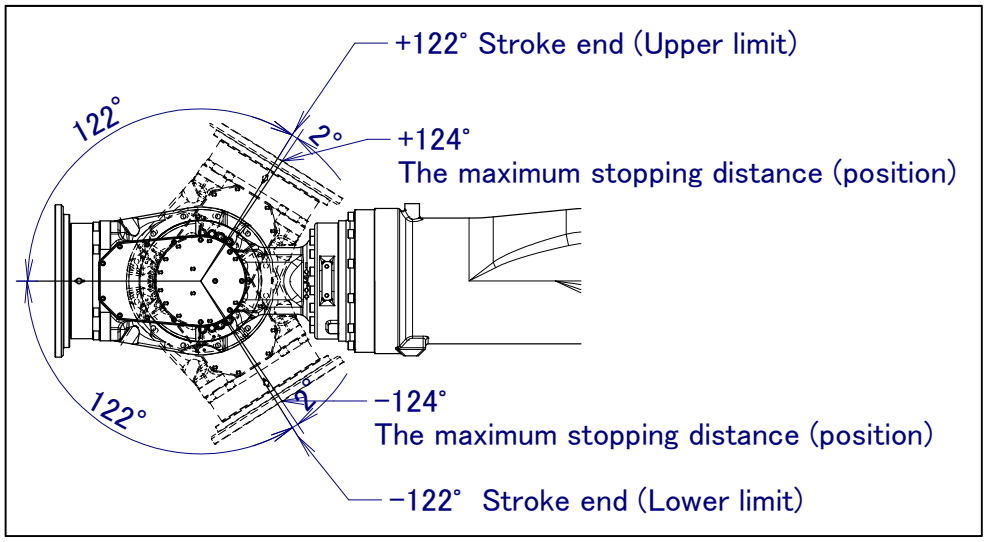


Fig. 3.3 (h) J5-axis motion limit

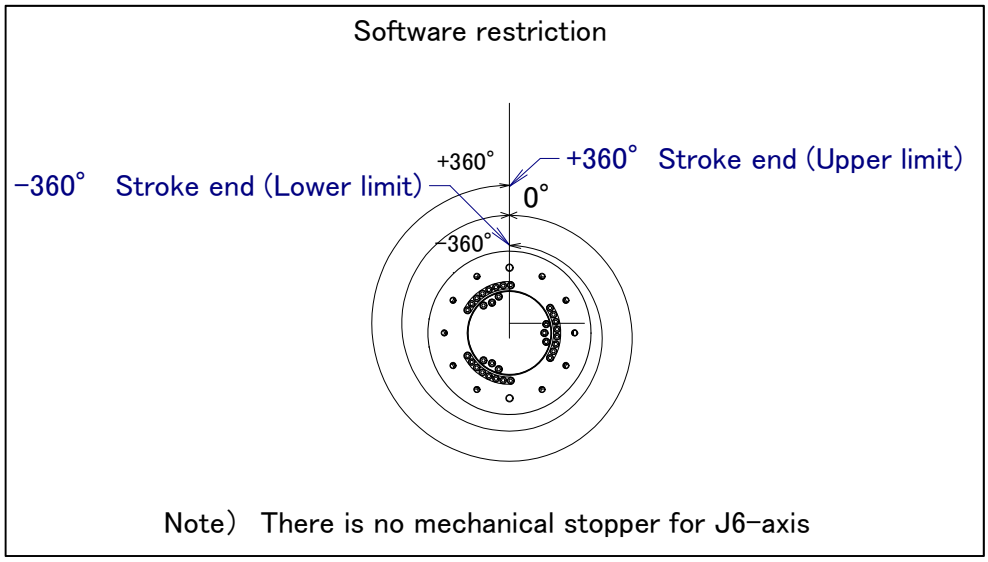


Fig. 3.3 (i) J6-axis motion limit

3.4 WRIST LOAD CONDITIONS

Fig. 3.4 (a) to (f) are diagrams showing the allowable load that can be applied to the wrist section.

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

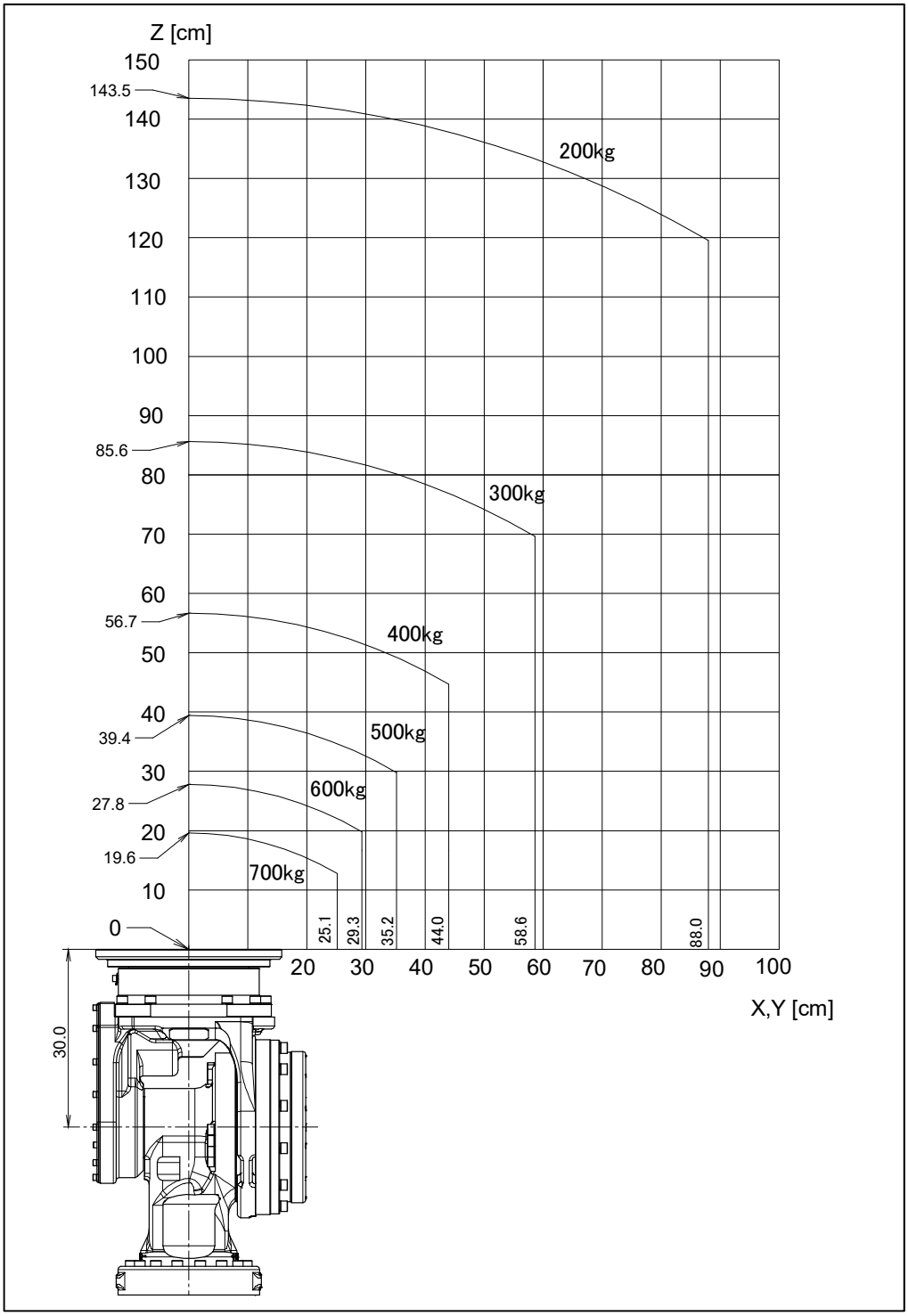


Fig. 3.4 (a) Wrist load diagram (M-900*i*B/700) (ISO flange)

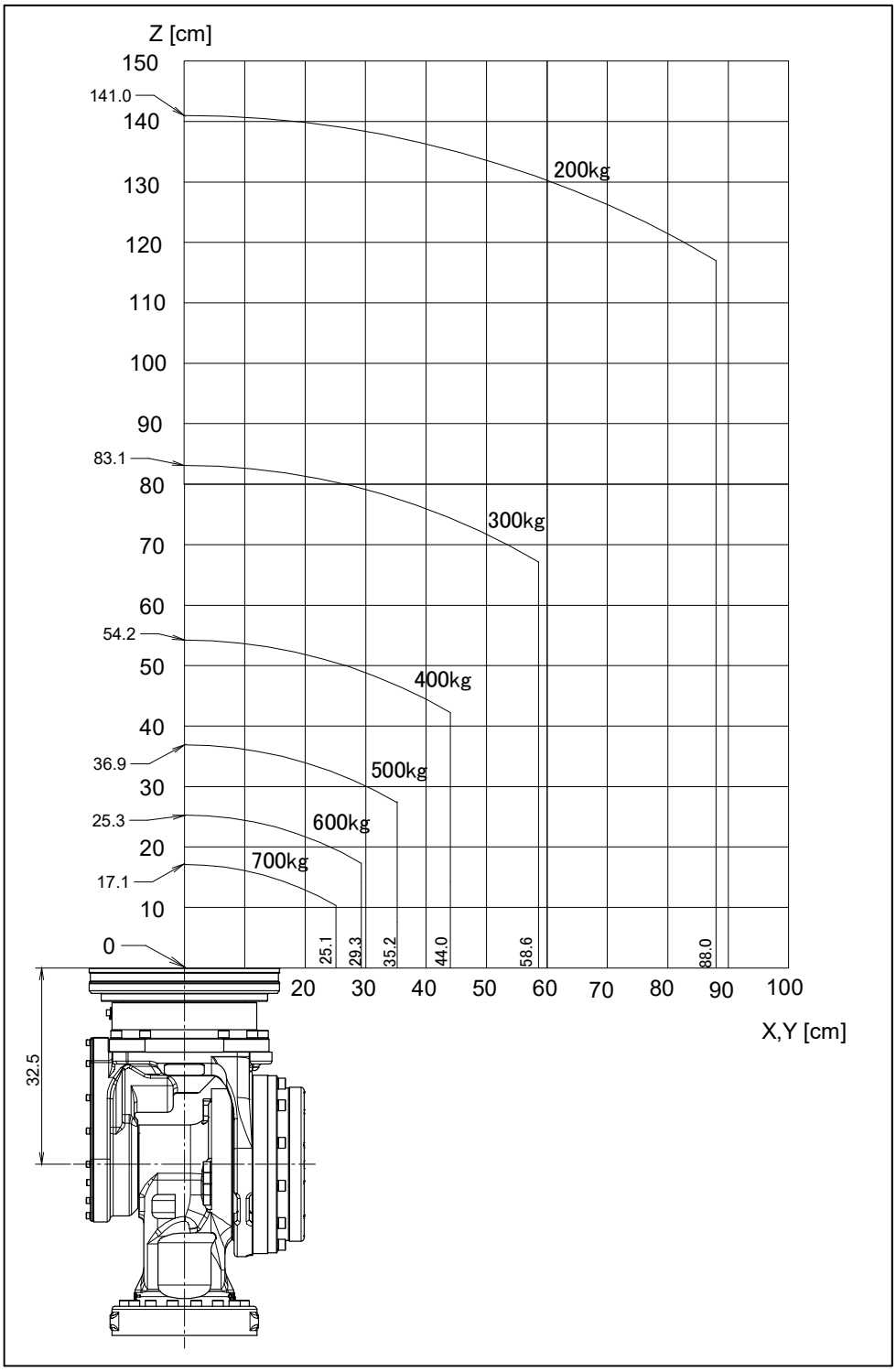


Fig. 3.4 (b) Wrist load diagram (M-900*i*B/700) (Insulated ISO flange)

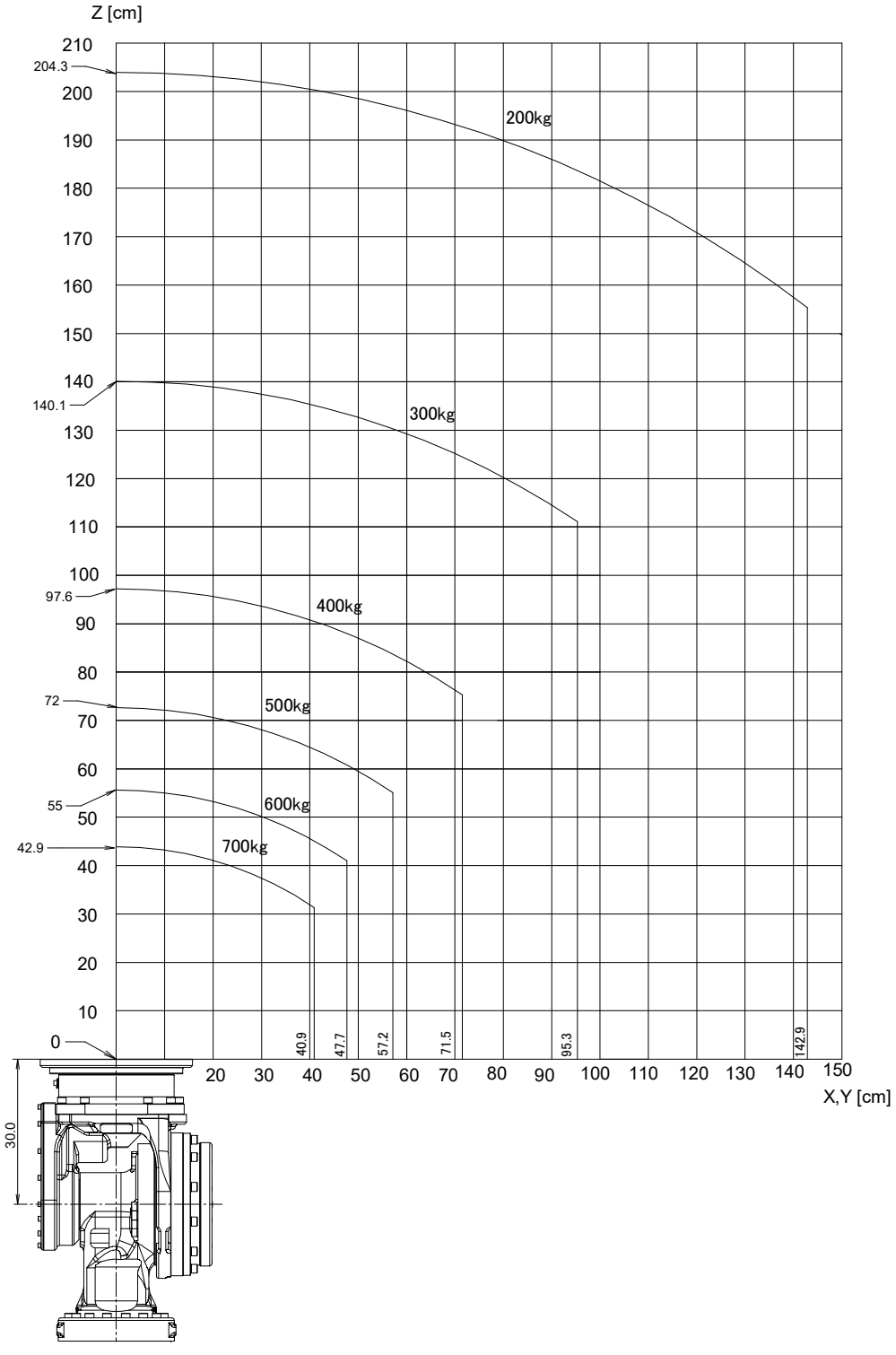


Fig. 3.4 (c) Wrist load diagram (M-900*i*B/700E) (ISO flange)

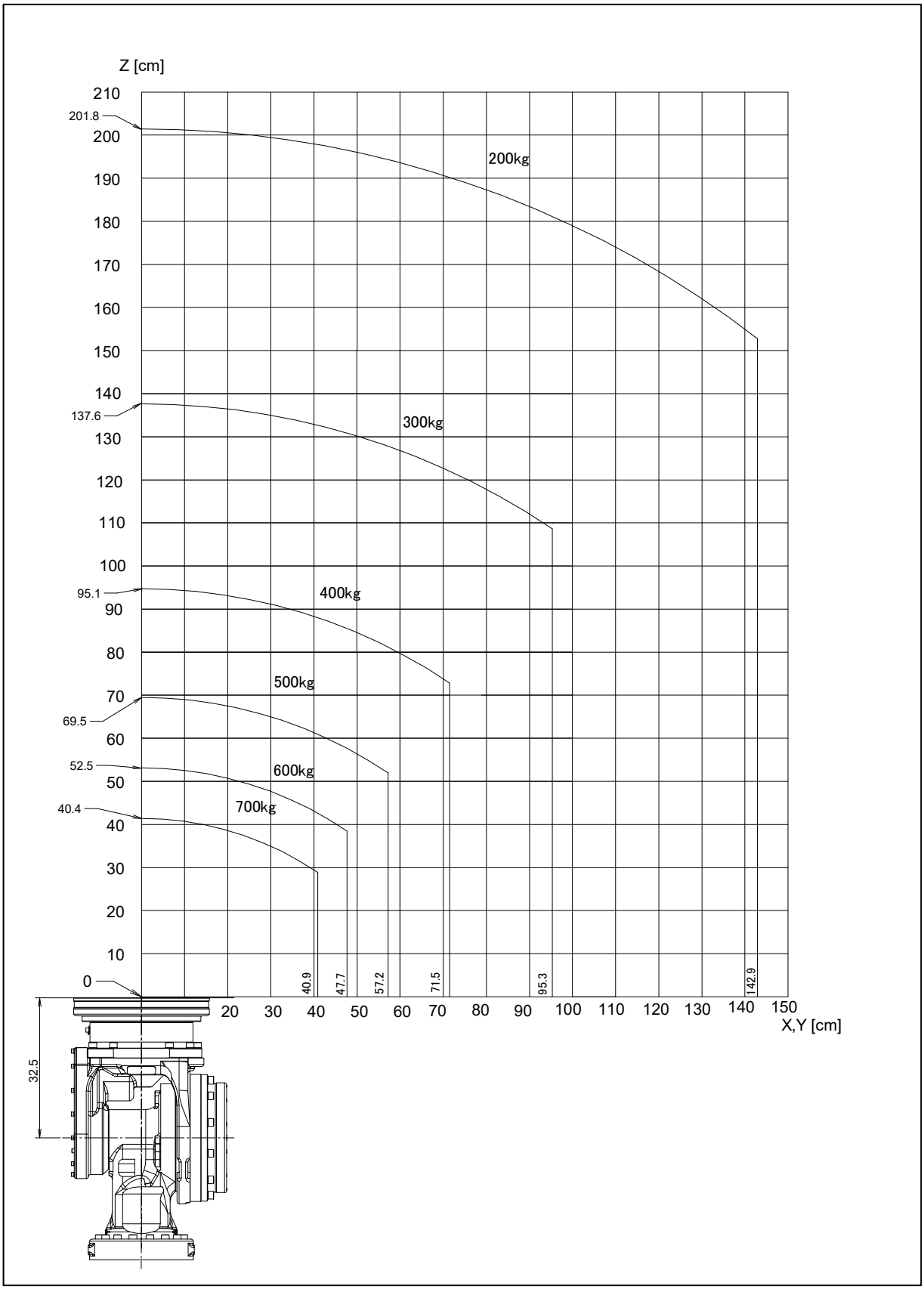


Fig. 3.4 (d) Wrist load diagram (M-900*i*B/700E) (Insulated ISO flange)

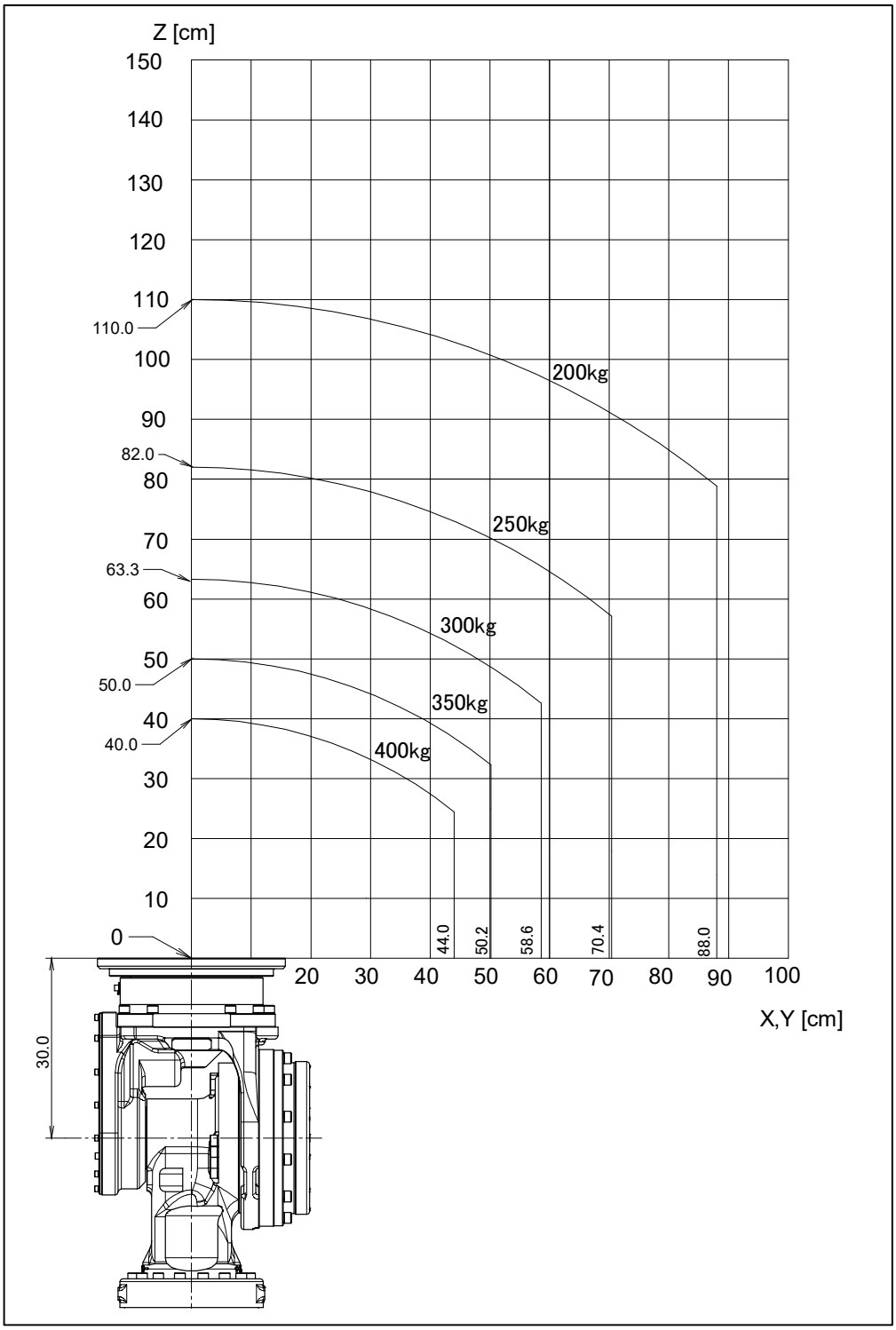


Fig. 3.4 (e) Wrist load diagram (M-900*i*B/400L) (ISO flange)

NOTE
In case of M-900*i*B/400L, the operating space of the wrist is restricted when the wrist payload is over 300kg. Refer to Section 3.2 about the operating space.

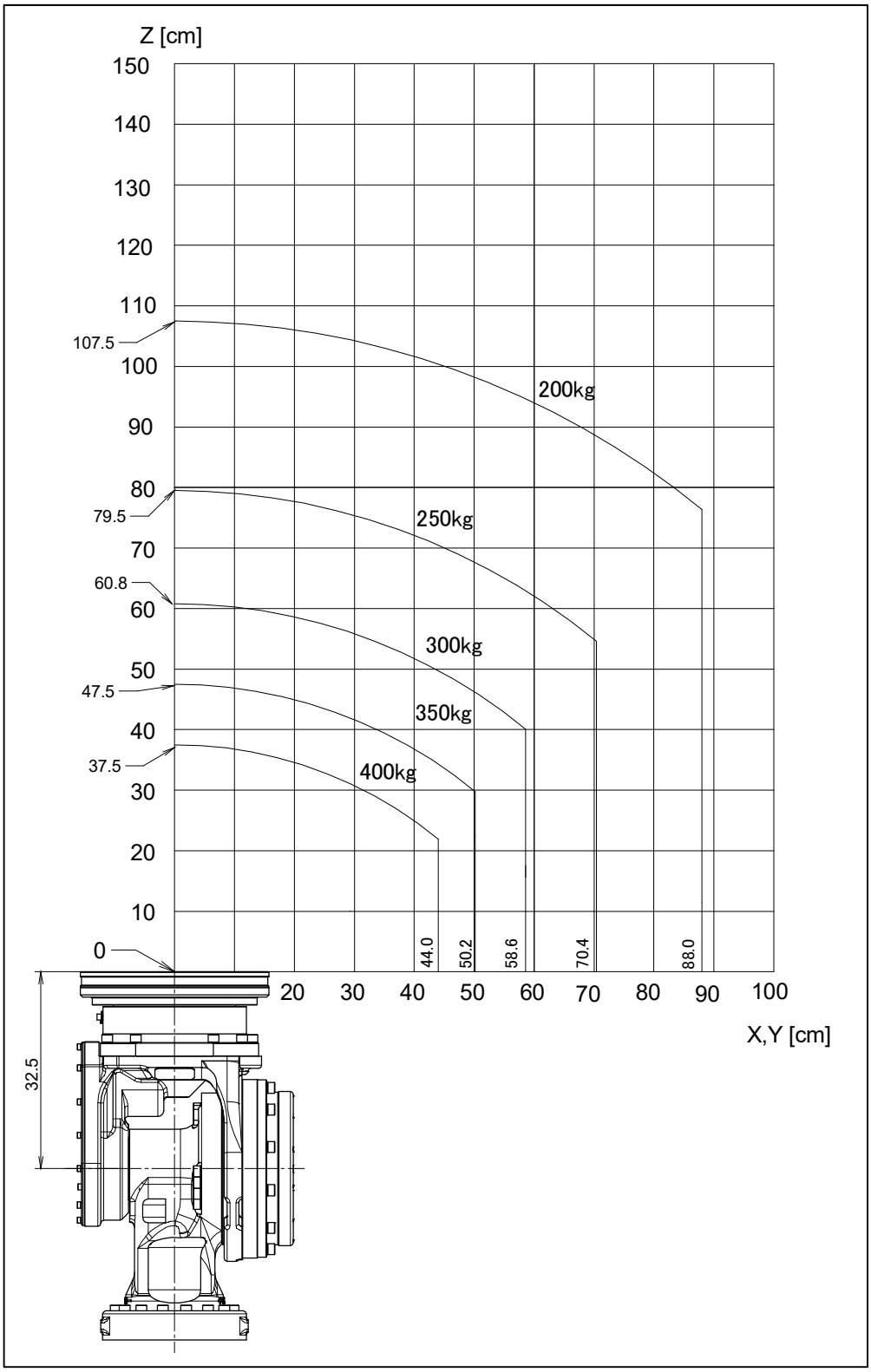


Fig. 3.4 (f) Wrist load diagram (M-900*i*B/400L) (Insulated ISO flange)

NOTE
In case of M-900*i*B/400L, the operating space of the wrist is restricted when the wrist payload is over 300kg. Refer to Section 3.2 about the operating space.

3.5 LOAD CONDITIONS ON J2 BASE/J3 ARM

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

Table 3.5 (a) Installation conditions of loads to be added

Installation site	Loads	Condition
J2 base	550kg	The center of gravity must lie within a radius of 500 mm from the rotation center of the J1 axis.
J3 arm	25kg	See Fig. 3.5 (a) for the positional condition of the center of gravity.

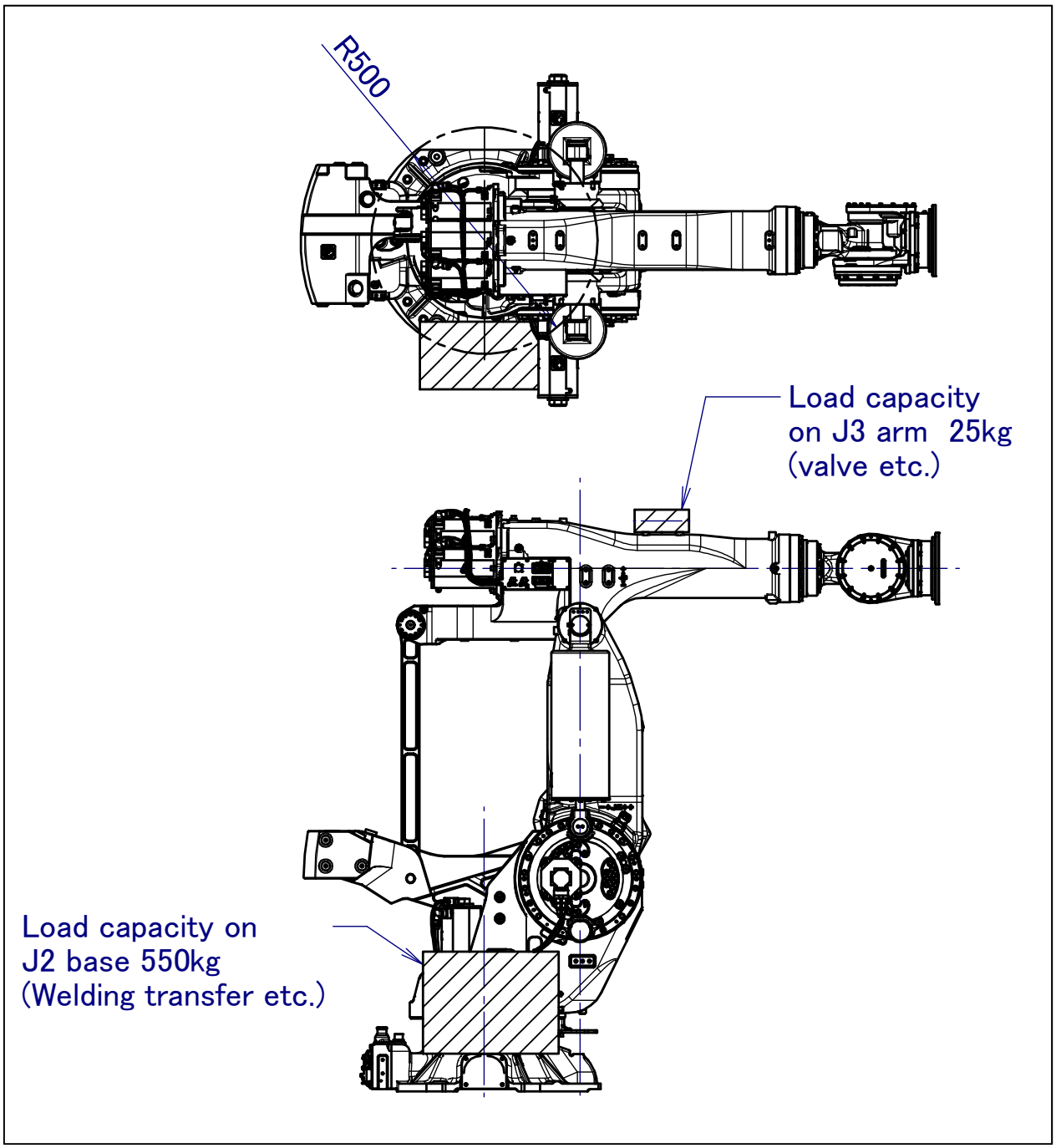


Fig. 3.5 (a) J2 base/J3 arm load condition

4 EQUIPMENT INSTALLATION TO THE ROBOT

4.1 END EFFECTOR INSTALLATION TO WRIST

Fig. 4.1 (a) and (b) show the figures for installing end effectors on the wrist. To fasten the end effector, first position it with two pin holes at [D] using fitting [B] or [C], then lock it using screws at [E]. Select screws and positioning pins of a length that matches the depth of the tapped holes and pin holes. Fasten the bolt for fixing the end effector with following torque: 128.4 ± 6.4 Nm (1310 ± 65kg fcm)

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

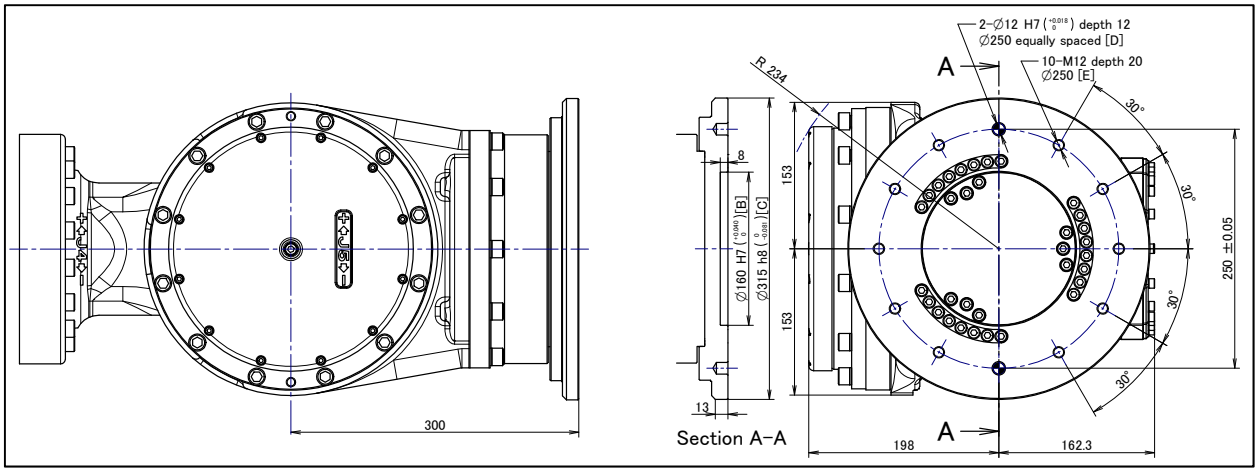


Fig. 4.1 (a) End effector interface (ISO flange)

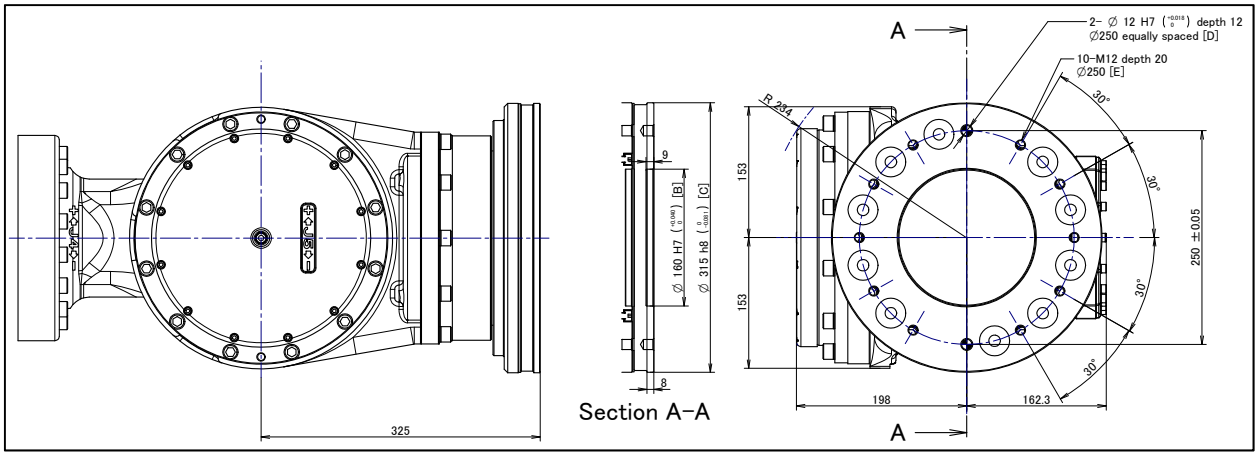


Fig. 4.1 (b) End effector interface (Insulated ISO flange)

4.2 EQUIPMENT MOUNTING FACE

As shown in Fig. 4.2 (a) to (d), 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.

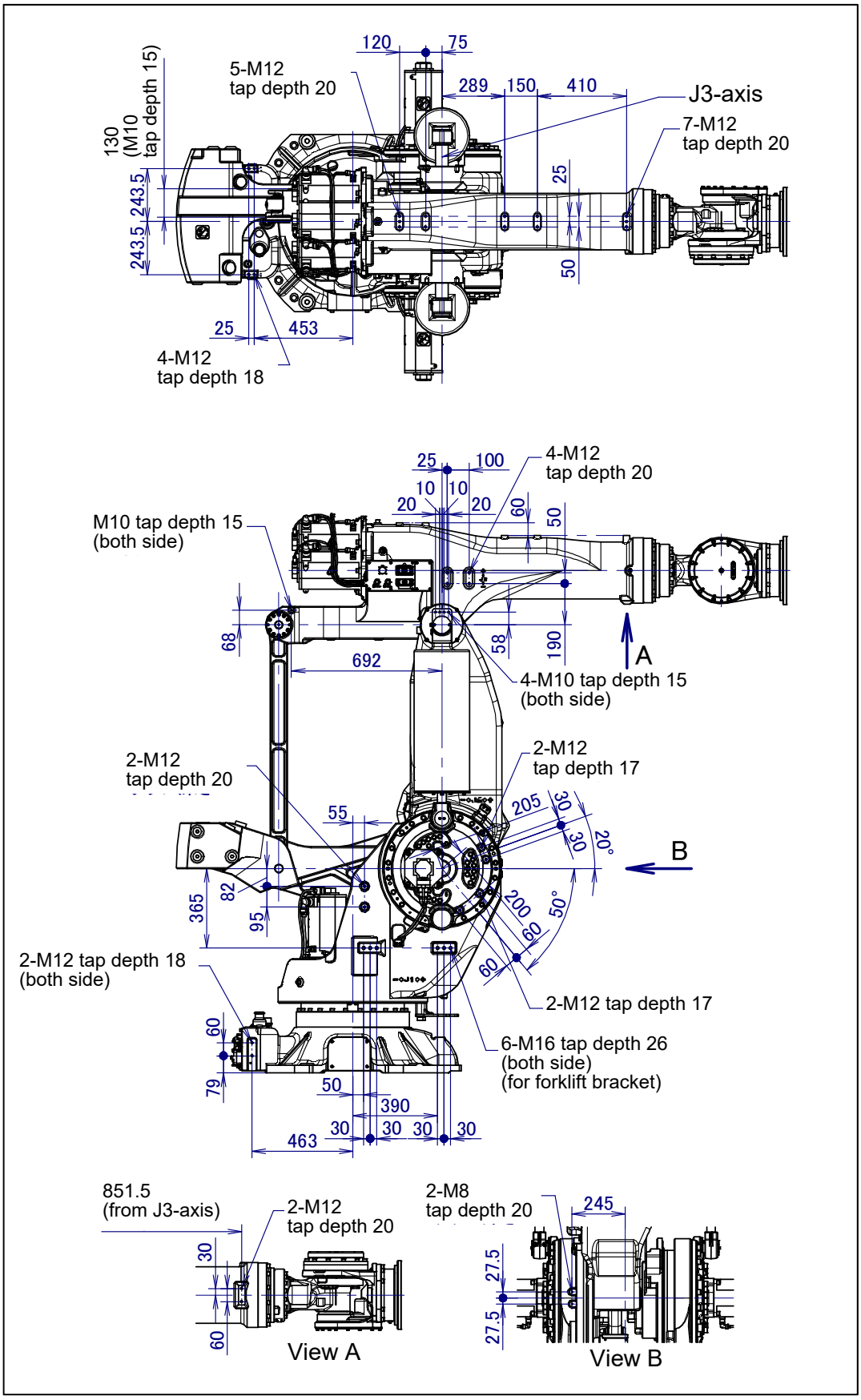


Fig. 4.2 (a) Equipment mounting faces (M-900*i*B/700/700E) (1/2)

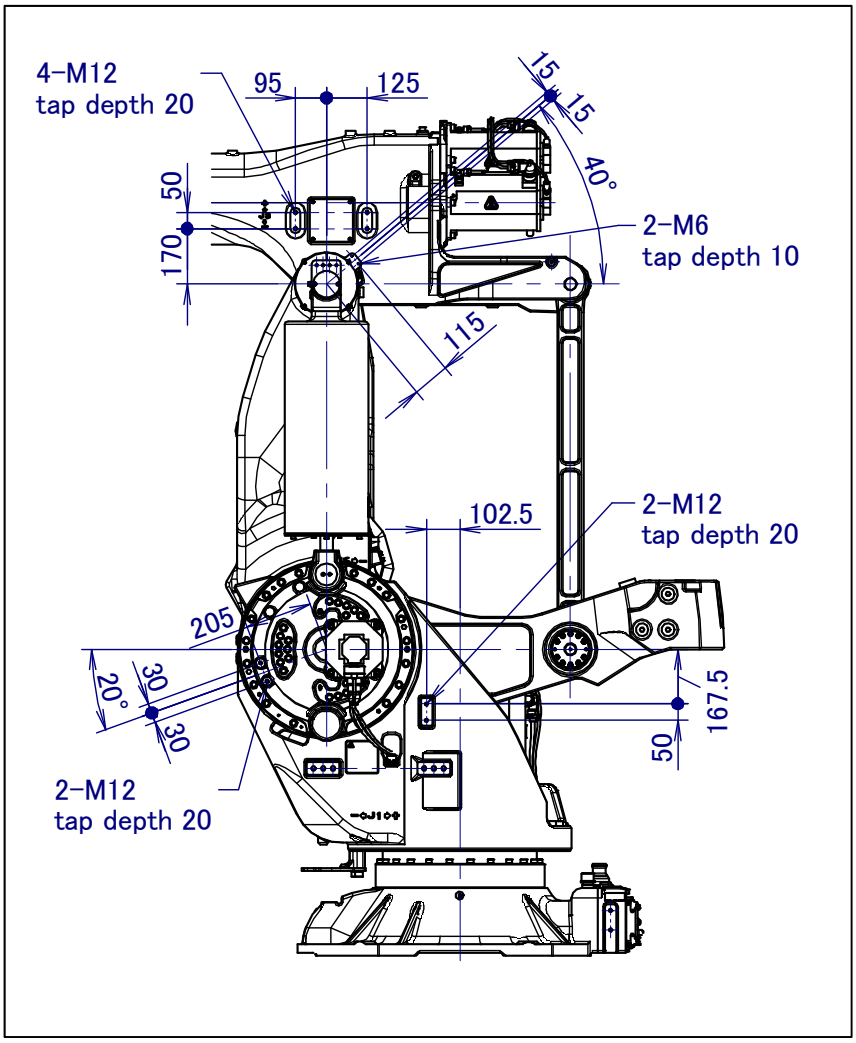


Fig. 4.2 (b) Equipment mounting faces (M-900*i*B/700/700E) (2/2)

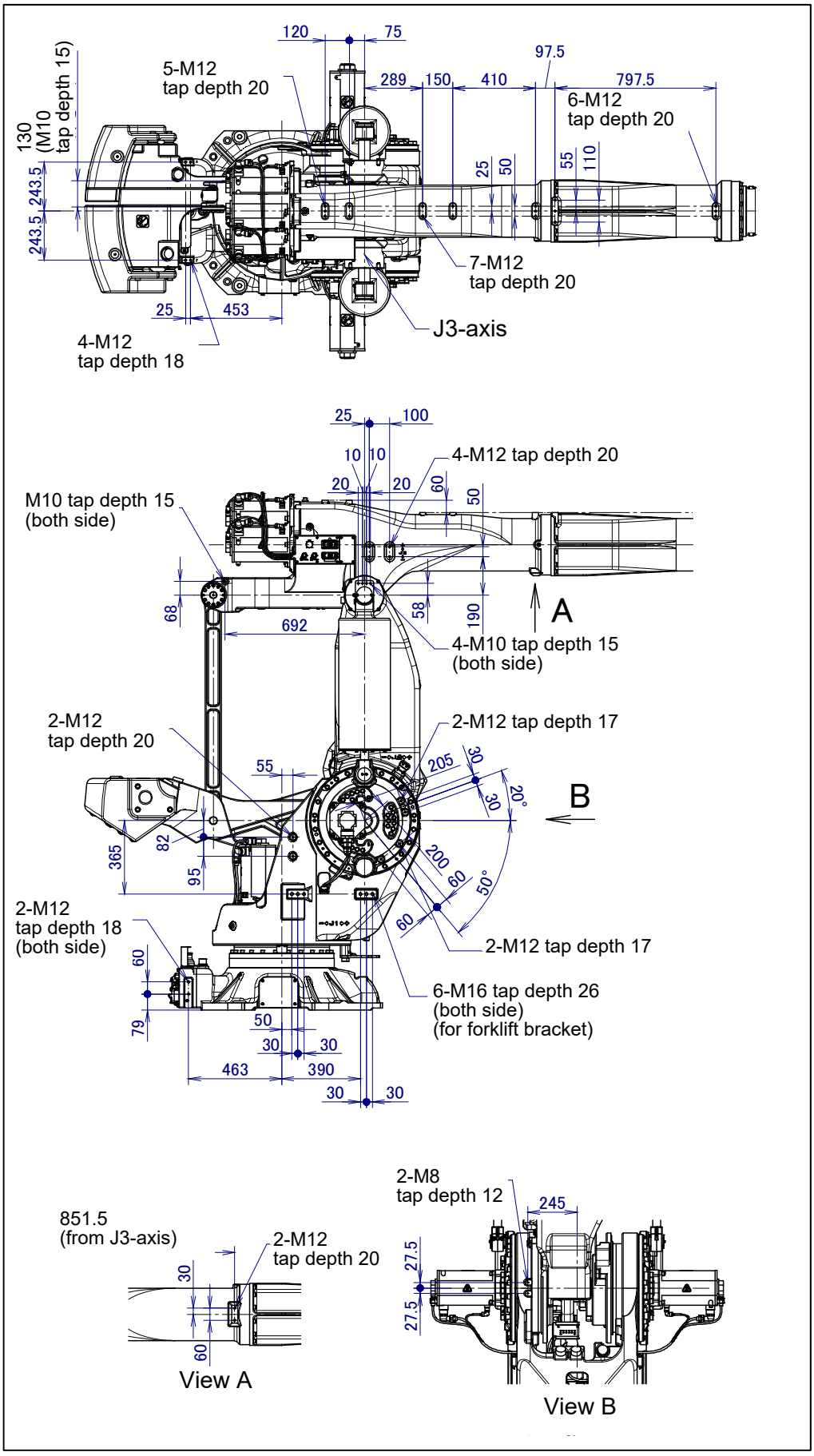


Fig. 4.2 (c) Equipment mounting faces (M-900*i*B/400L) (1/2)

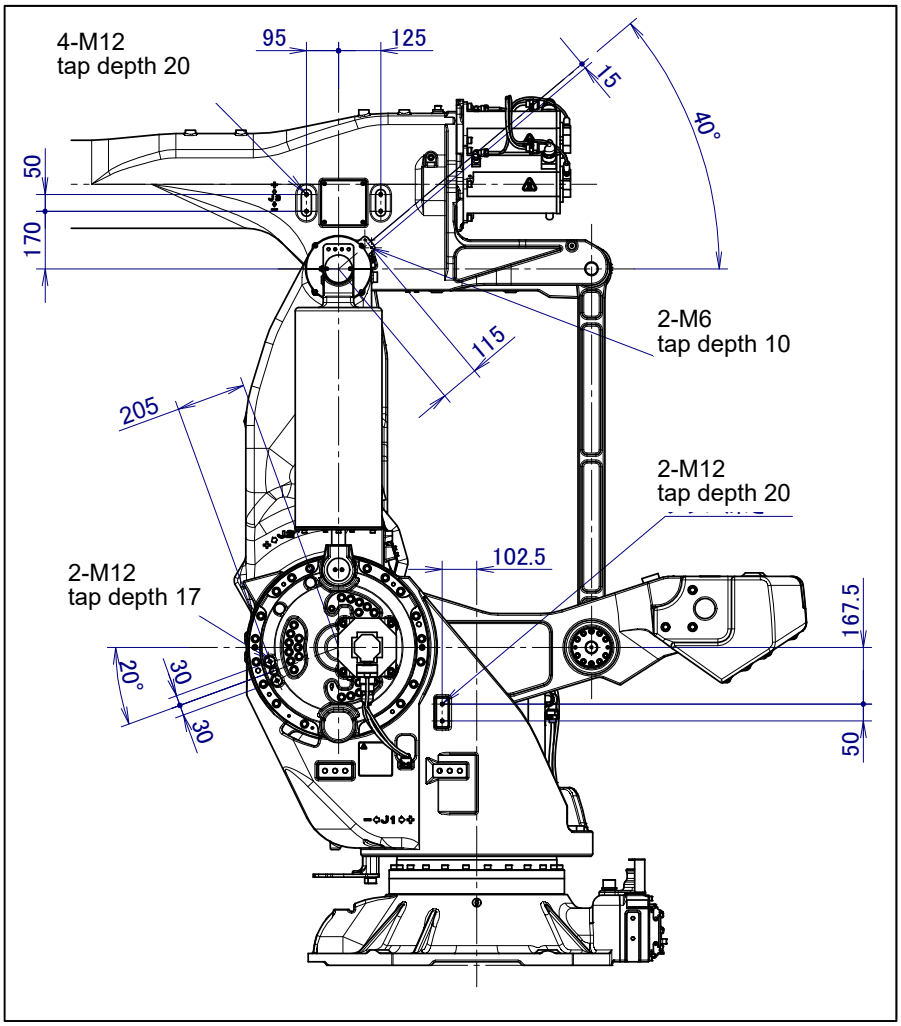


Fig. 4.2 (d) Equipment mounting faces (M-900*i*B/400L) (2/2)

4.3 LOAD SETTING

⚠ CAUTION

1 Set load condition parameter before operating the robot. Do not operate the robot in over payload reduction. Don't exceed allowable payload including connection cables and its swing. Otherwise troubles such as degradation of reducer life may occur.

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

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

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

```
MOTION PERFORMANCE                    JOINT 10%
   Group1
No.   PAYLOAD[kg]          Comment
 1          700.00    [                    ]
 2            0.00    [                    ]
 3            0.00    [                    ]
 4            0.00    [                    ]
 5            0.00    [                    ]
 6            0.00    [                    ]
 7            0.00    [                    ]
 8            0.00    [                    ]
 9            0.00    [                    ]
10            0.00    [                    ]

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

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

```
MOTION PAYLOAD SET              JOINT   100%

   Group 1
   Schedule No[   1]:[Comment          ]
 1 PAYLOAD             [kg]          700.00
 2 PAYLOAD CENTER  X   [cm]          -28.53
 3 PAYLOAD CENTER  Y   [cm]            0.00
 4 PAYLOAD CENTER  Z   [cm]           27.78
 5 PAYLOAD INERTIA X   [kgfcms^2]    560.84
 6 PAYLOAD INERTIA Y   [kgfcms^2]    590.39
 7 PAYLOAD INERTIA Z   [kgfcms^2]    150.10

 [TYPE]  GROUP  NUMBER  DEFAULT  HELP
```

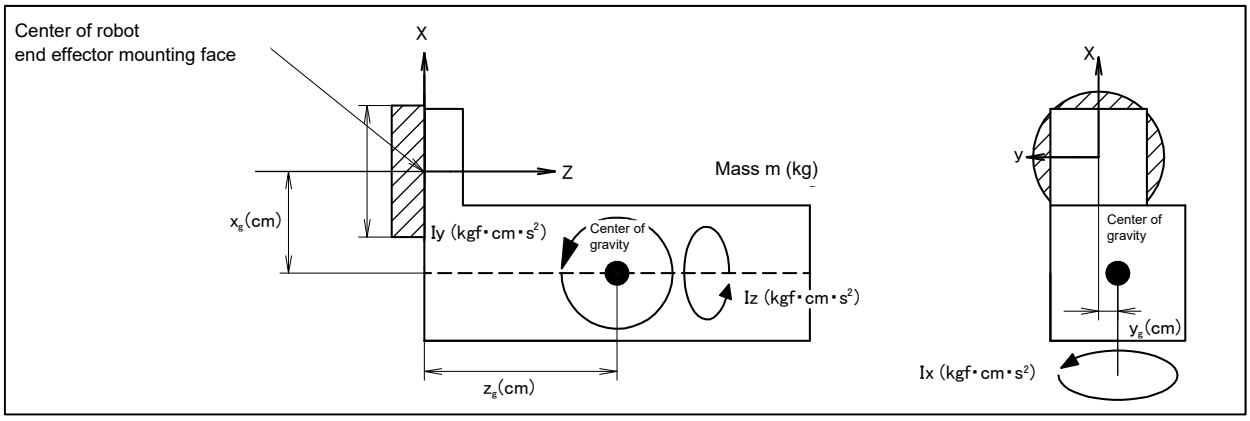


Fig. 4.3 (a) Standard tool coordinate

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

9 On the list screen, pressing F4 (ARMLOAD) brings you to 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]           25.00

[ 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.

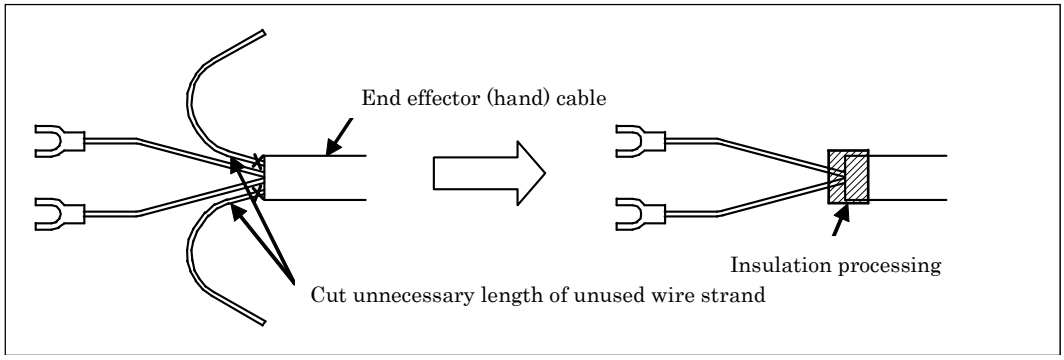


Fig. 5 (a) Treatment method of end effector (hand) cable

5.1 AIR SUPPLY (OPTION)

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

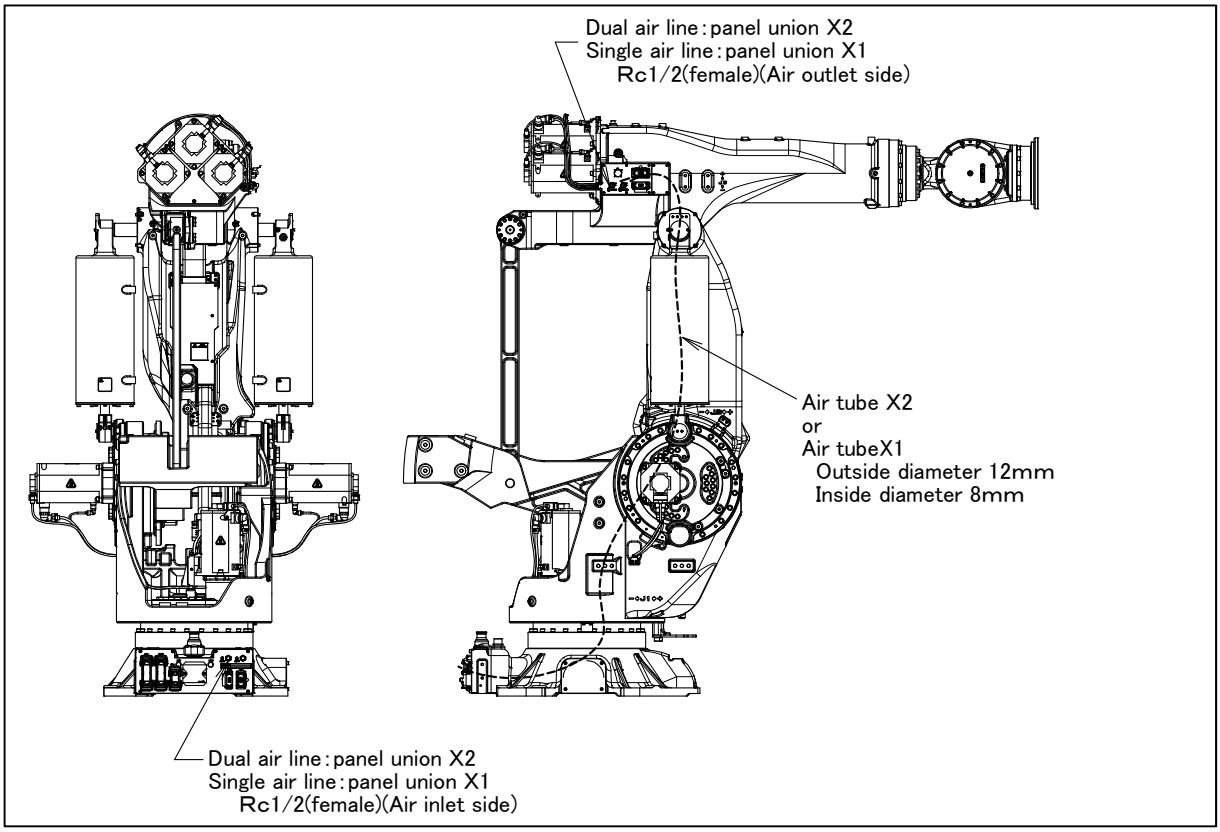


Fig. 5.1 (a) Air supply (option)

5.2 AIR PIPING (OPTION)

Fig. 5.2 (a) shows how to connect air hose to the robot. If the air control set is specified as an option, the air hose between the mechanical unit and the air control set is provided. A tap holes shown in Fig.5.2 (b) are necessary for the installation of three points of air sets. This is outside FANUC delivery scope.

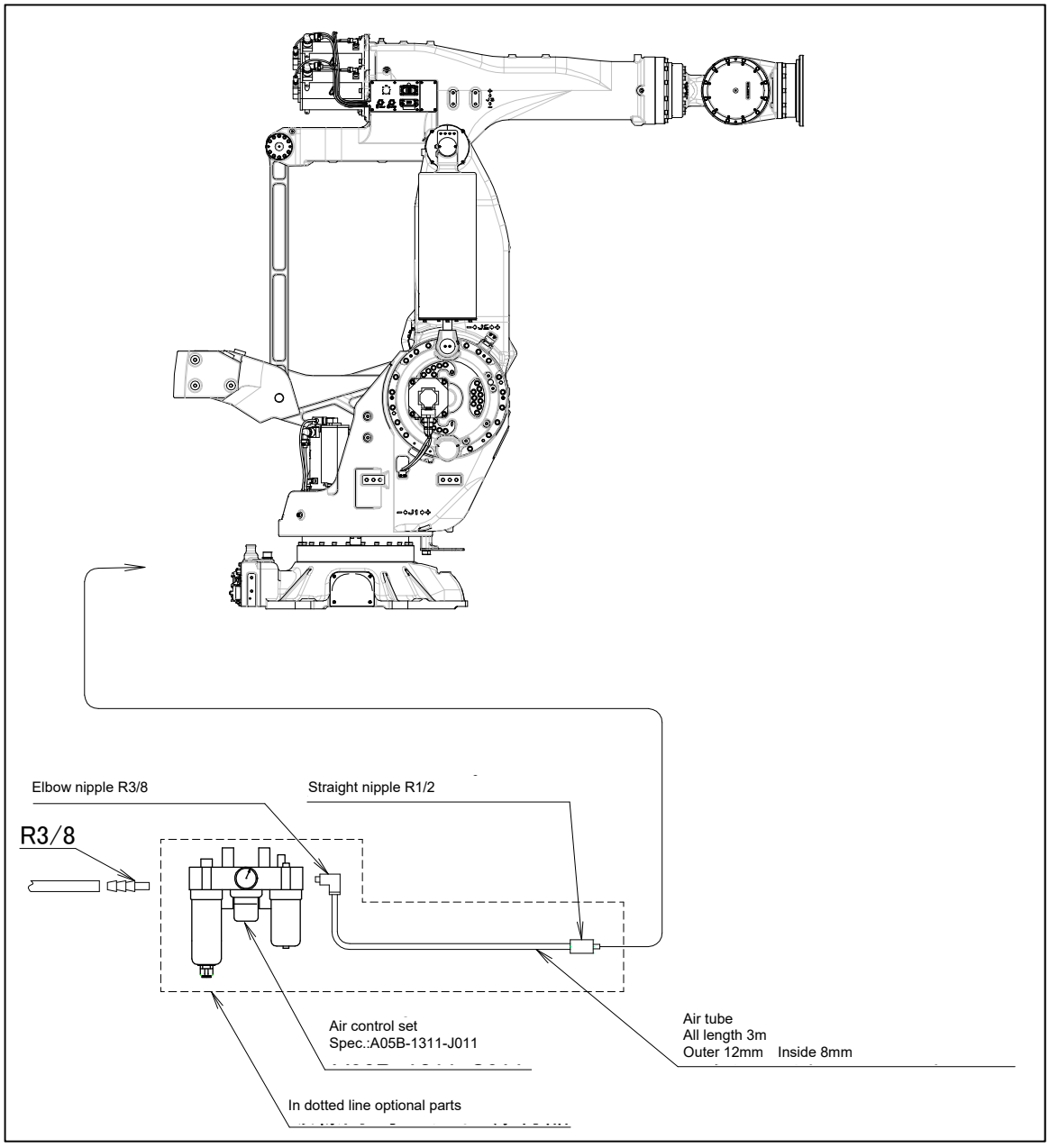


Fig. 5.2 (a) Air piping (option)

Air control set

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

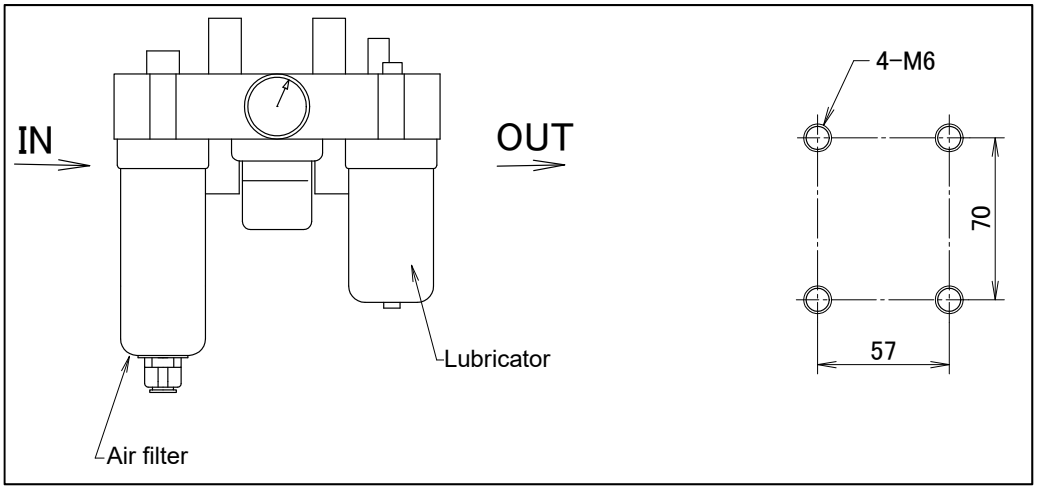


Fig. 5.2 (b) Air control set option (option)

NOTE
The capacity 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 to 7kgf/cm^2) Setting: 0.49MPa (5kgf/cm^2)
	Amount of consumption	Maximum instantaneous amount 150Nl/min (0.15Nm^3/min)

5.3 INTERFACE FOR OPTION CABLE (OPTION)

Fig. 5.3 (a) shows the position of the option cable interface. Fig 5.3 (b) to (d) show the option cable interface. EE interface (RI/RO), user cable (signal line , signal line usable to force sensor and 3D laser sensor and power line), DeviceNet cable (signal line, power line) , additional axis motor cable (Pulsecoder line, power, brake line) ,camera cable, Ethernet cable, accuracy and stiffness enhancement option cable as options.

NOTE

1 Each option cable is written as shown below on the connector panel.

EE(RI/RO) interface	: EE
User cable (signal)	: AS
User cable (power)	: AP
User cable (signal usable to force sensor and 3D Vision sensor)	: ASi
DeviceNet cable (signal line)	: DS
DeviceNet cable (power line)	: DP
Additional axis motor cable (Pulsecoder line)	: ARP
Additional axis motor cable (power, brake line)	: ARM
Camera cable	: CAM
Ethernet cable	: ES
Accuracy and stiffness enhancement option cable	: ARE

2 Specifications of camera cable for R-30*i*B/R-30*i*B Mate and R-30*i*B Plus/R-30*i*B Mate Plus are different.

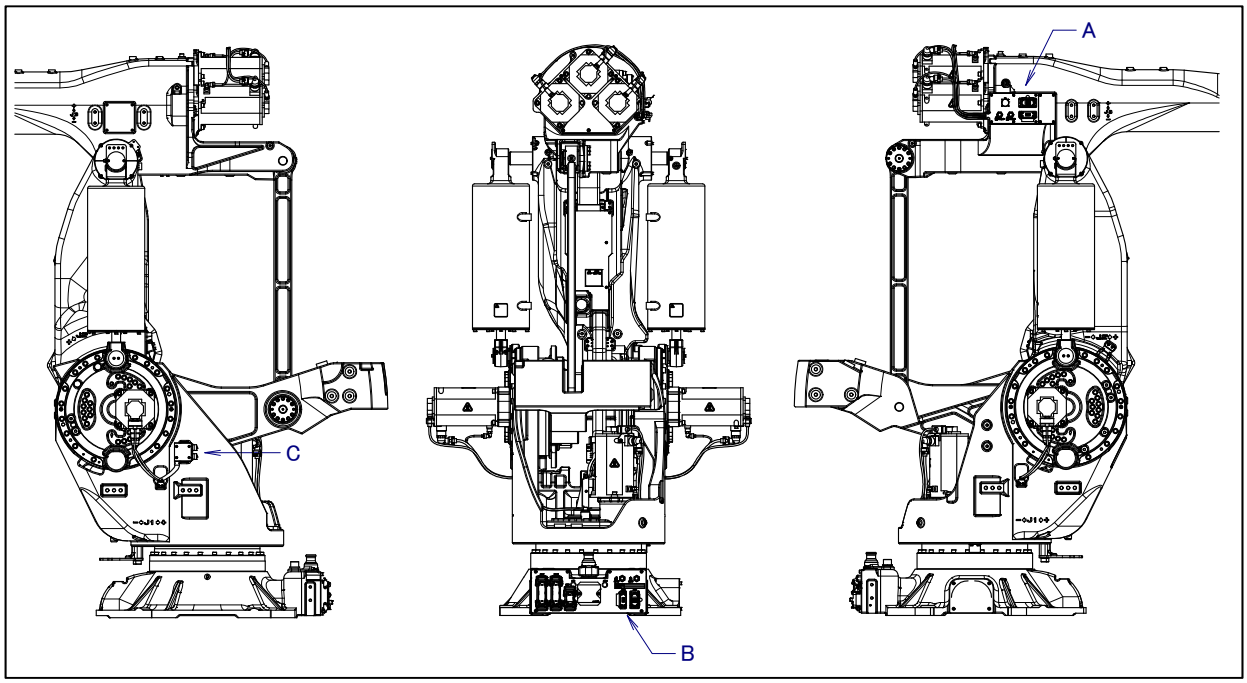


Fig. 5.3 (a) Position of interface for optional cable (option)

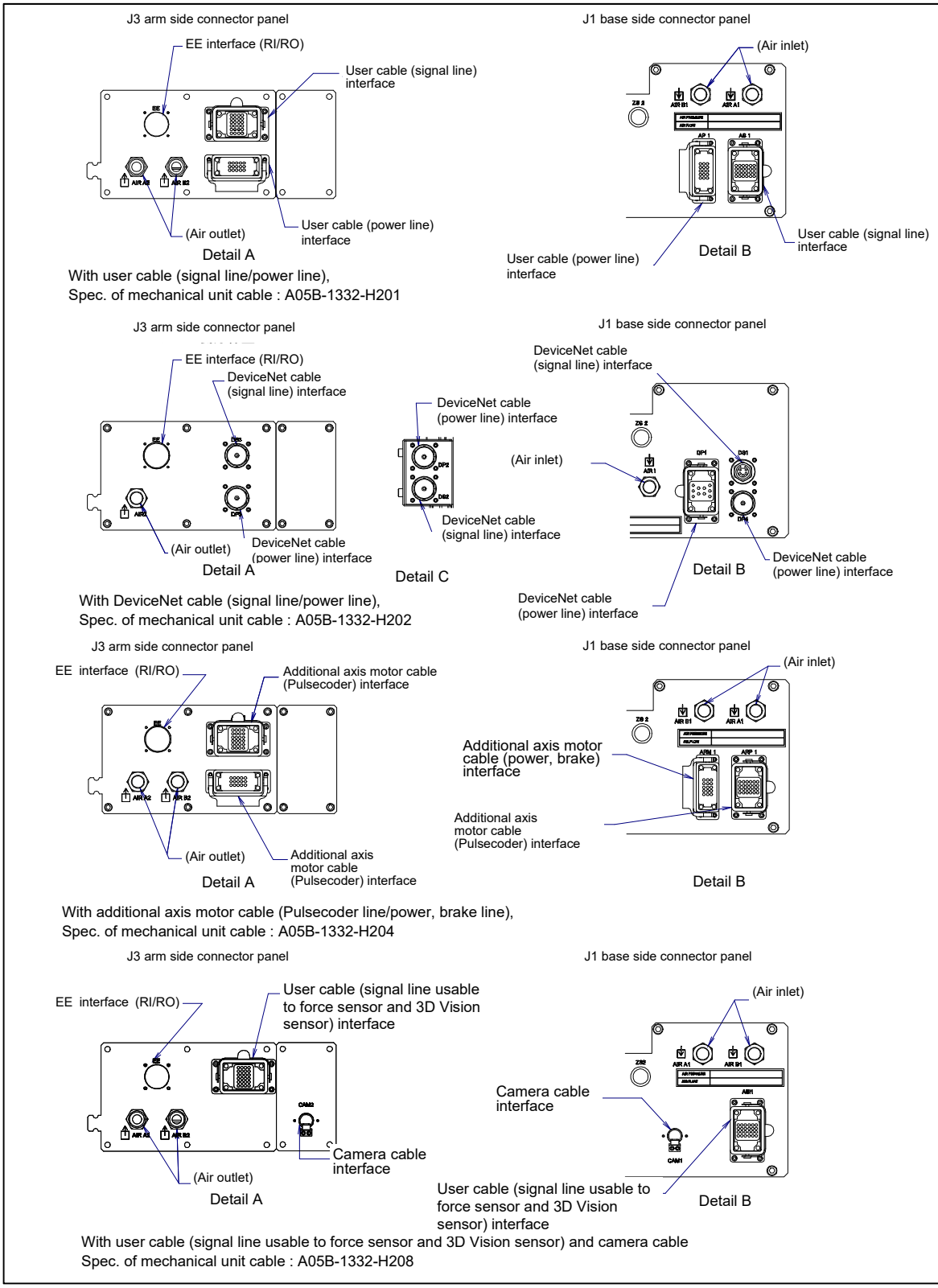
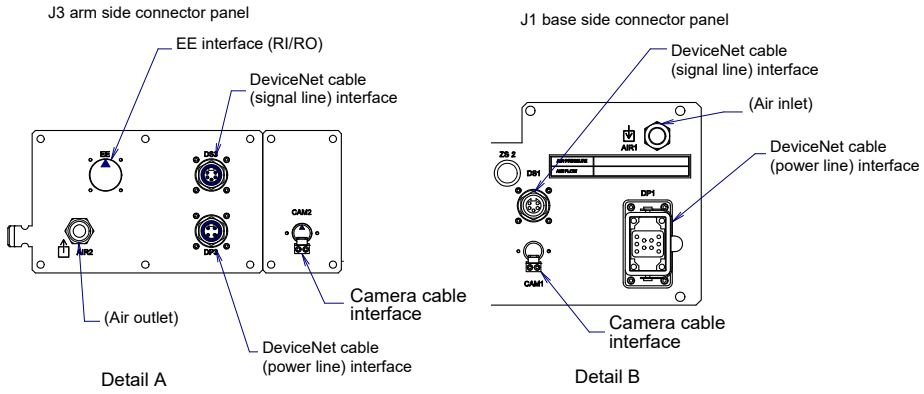
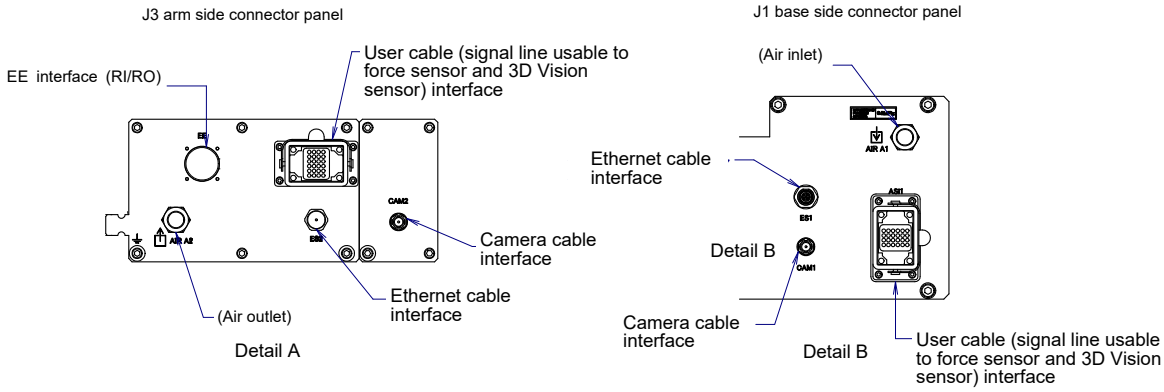


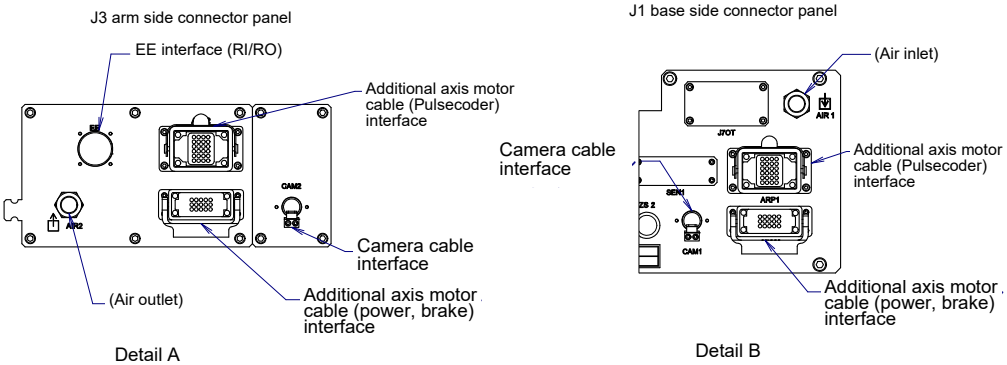
Fig. 5.3 (b) Option cable interface (1/3)



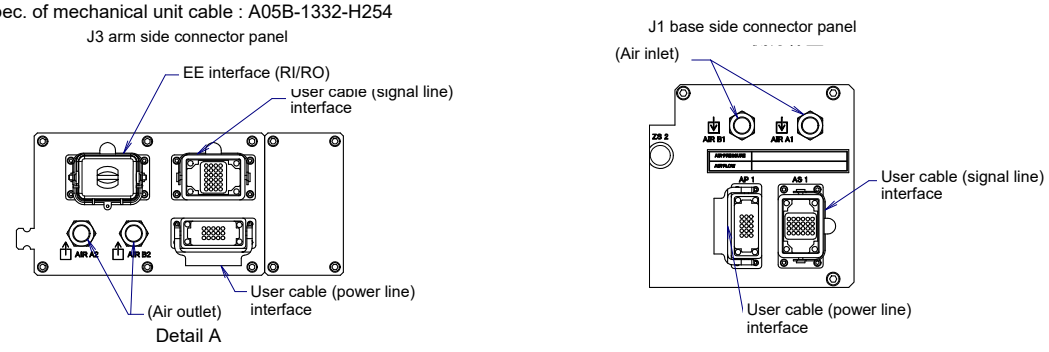
With DeviceNet cable (signal line/power line) and camera cable
Spec. of mechanical unit cable : A05B-1332-H216



With user cable (signal line usable to force sensor and 3D Vision sensor), camera cable and Ethernet cable
Spec. of mechanical unit cable :
R-30*i*B Plus : A05B-1332-H223

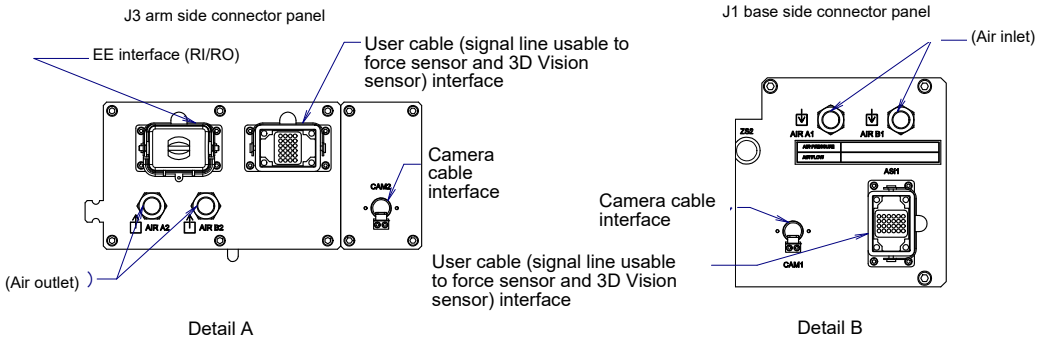


With additional axis motor cable (Pulsecoder line/power,brake line)
and camera cable
Spec. of mechanical unit cable : A05B-1332-H254

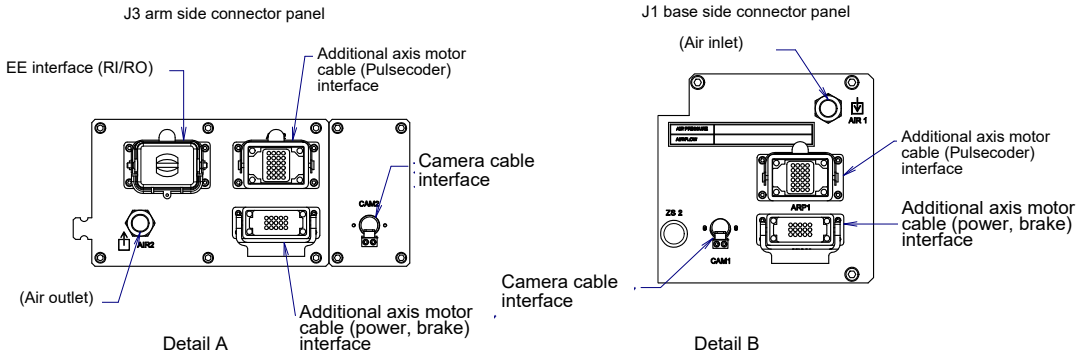


With user cable (signal line/power line) for severe dust/liquid protection option
Spec. of mechanical unit cable : A05B-1332-H301

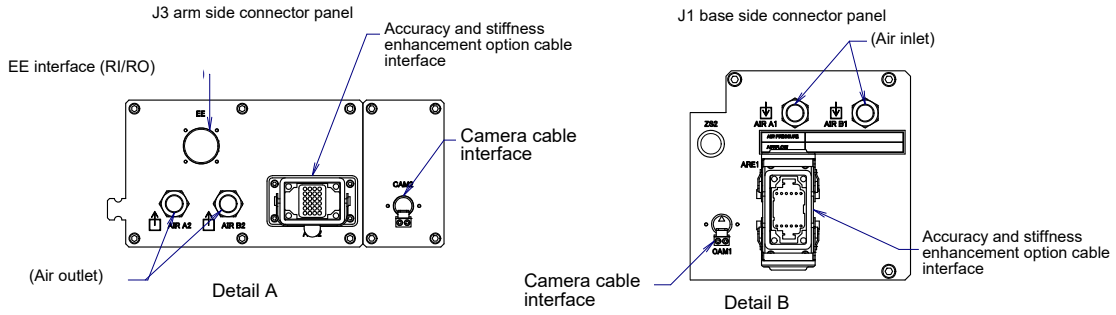
Fig. 5.3 (c) Option cable interface (2/3)



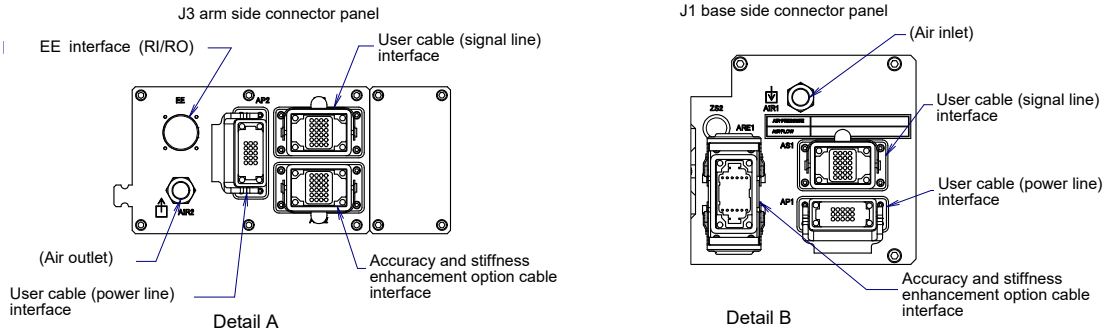
With user cable (signal line usable to force sensor and 3D Vision sensor), camera cable for severe dust/liquid protection option
Spec. of mechanical unit cable : A05B-1332-H308



With additional axis motor cable (Pulsecoder line/power,brake line) for severe dust/liquid protection option
Spec. of mechanical unit cable
R-30*i*B : A05B-1332-H354
R-30*i*B Plus : A05B-1332-H327



With camera cable and accuracy and stiffness enhancement option cable
Spec. of mechanical unit cable
R-30*i*B : A05B-1332-H401
R-30*i*B Plus : A05B-1332-H403



With user cable (signal line/power line) and accuracy and stiffness enhancement option cable
Spec. of mechanical unit cable : A05B-1332-H402

Fig. 5.3 (d) Option cable interface (3/3)

1 EE interface (RI/RO) (option)

Fig. 5.3 (e), (f) show the pin layout for the EE interface (RI/RO). When severe dust/liquid protection package is specified, the connector has guide pins and bushes for preventing improper insertion. For cables prepared by the user, use these guide pins and bushes.

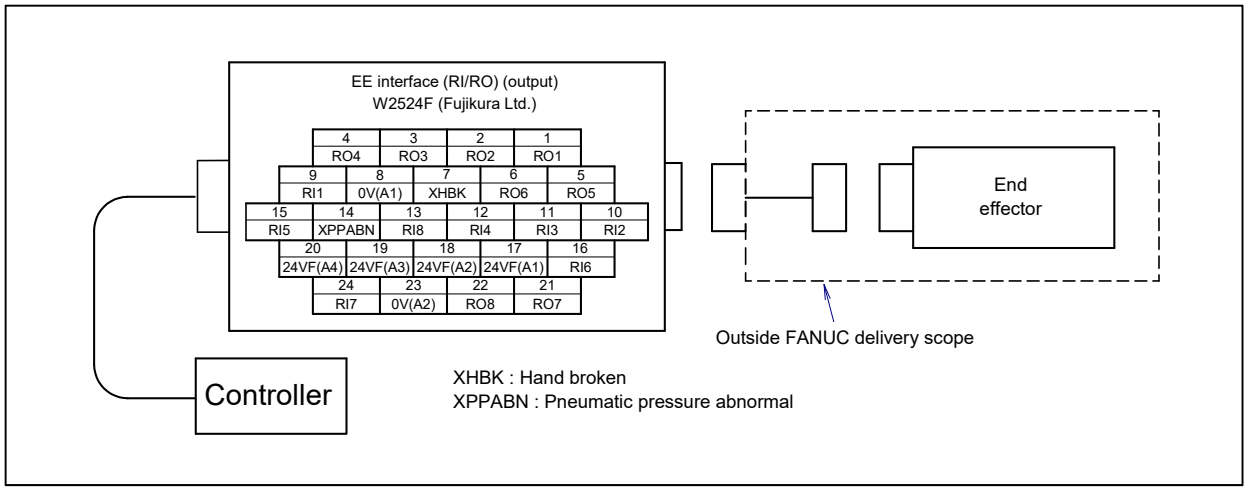


Fig. 5.3 (e) Pin layout for EE interface(RI/RO) (option)

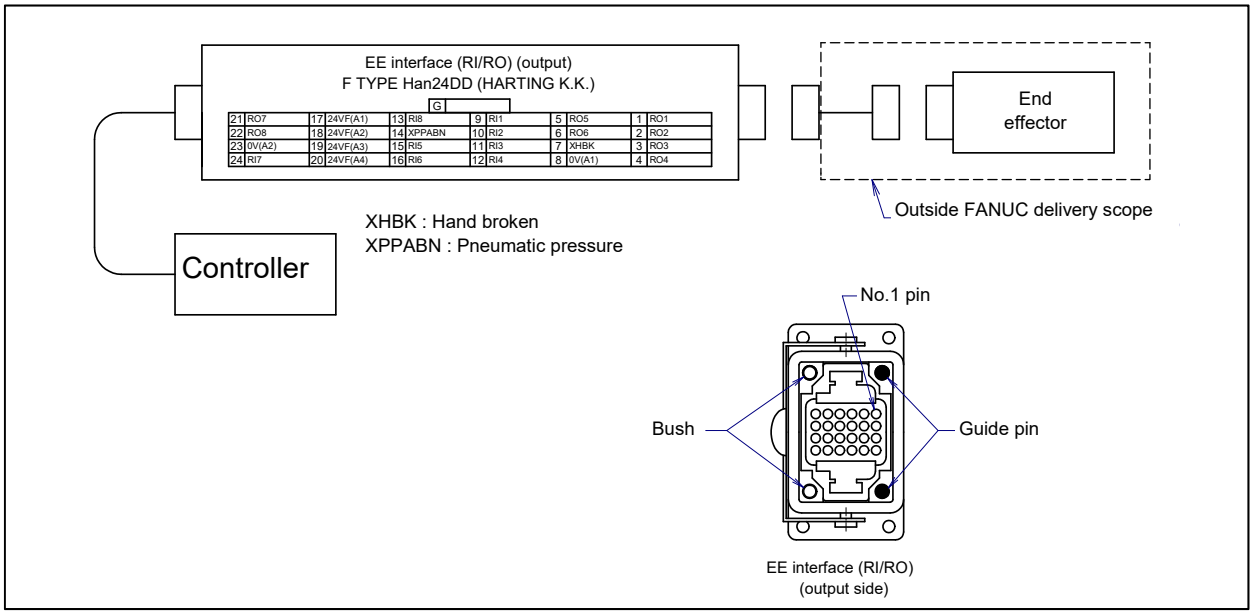


Fig. 5.3 (f) Pin layout for EE interface(RI/RO)
(When severe dust/liquid protection package is specified) (option)

2 User cable (signal line) (AS) Interface (option)
Fig. 5.3 (g) shows the pin layout for the user cable (signal line) interface. The connector has a code pin for preventing improper insertion. The code pin is required for the cable which is prepared by the user.

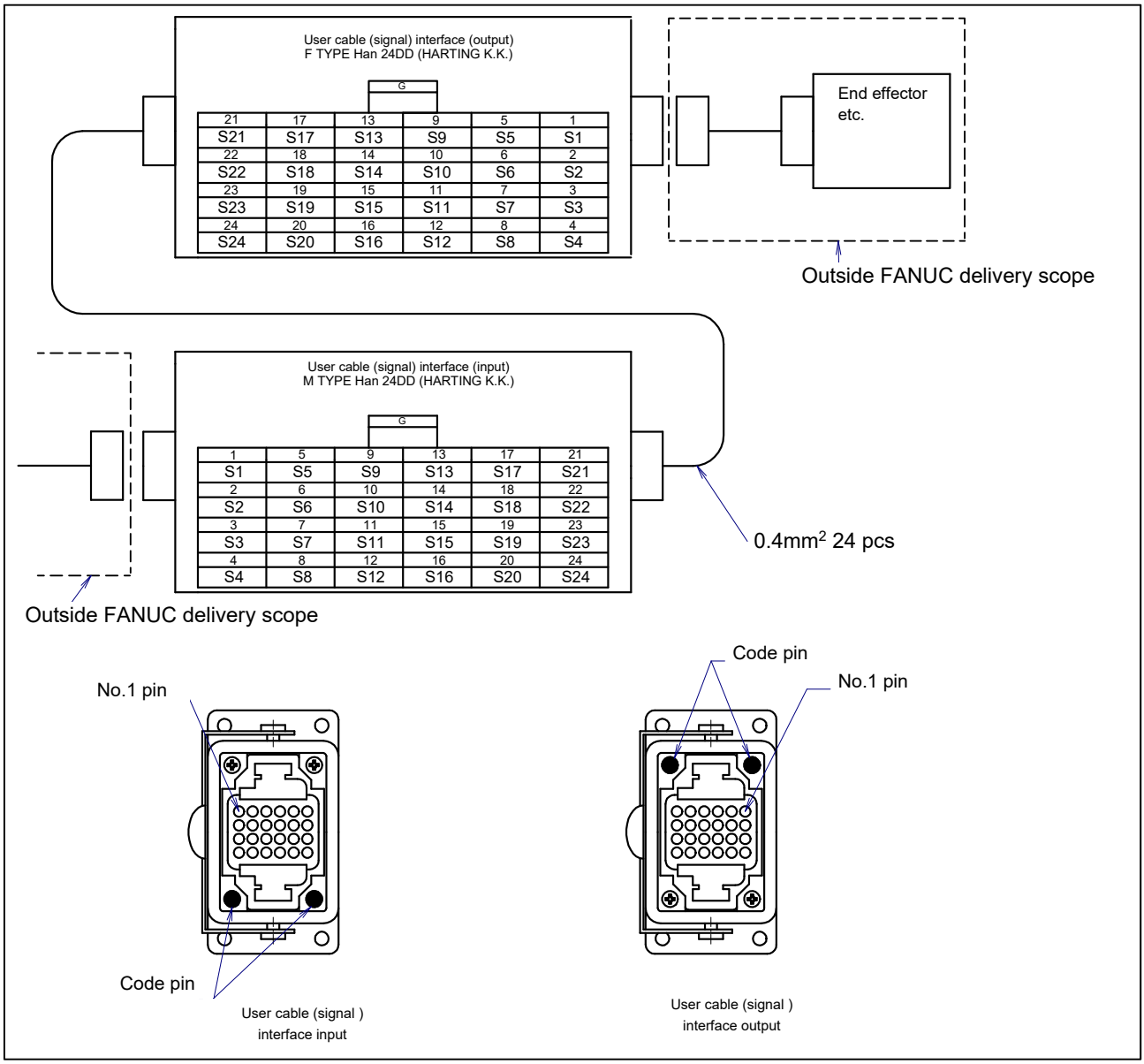


Fig. 5.3 (g) Pin layout and code pin position for user cable (signal) (AS) interface (option)

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

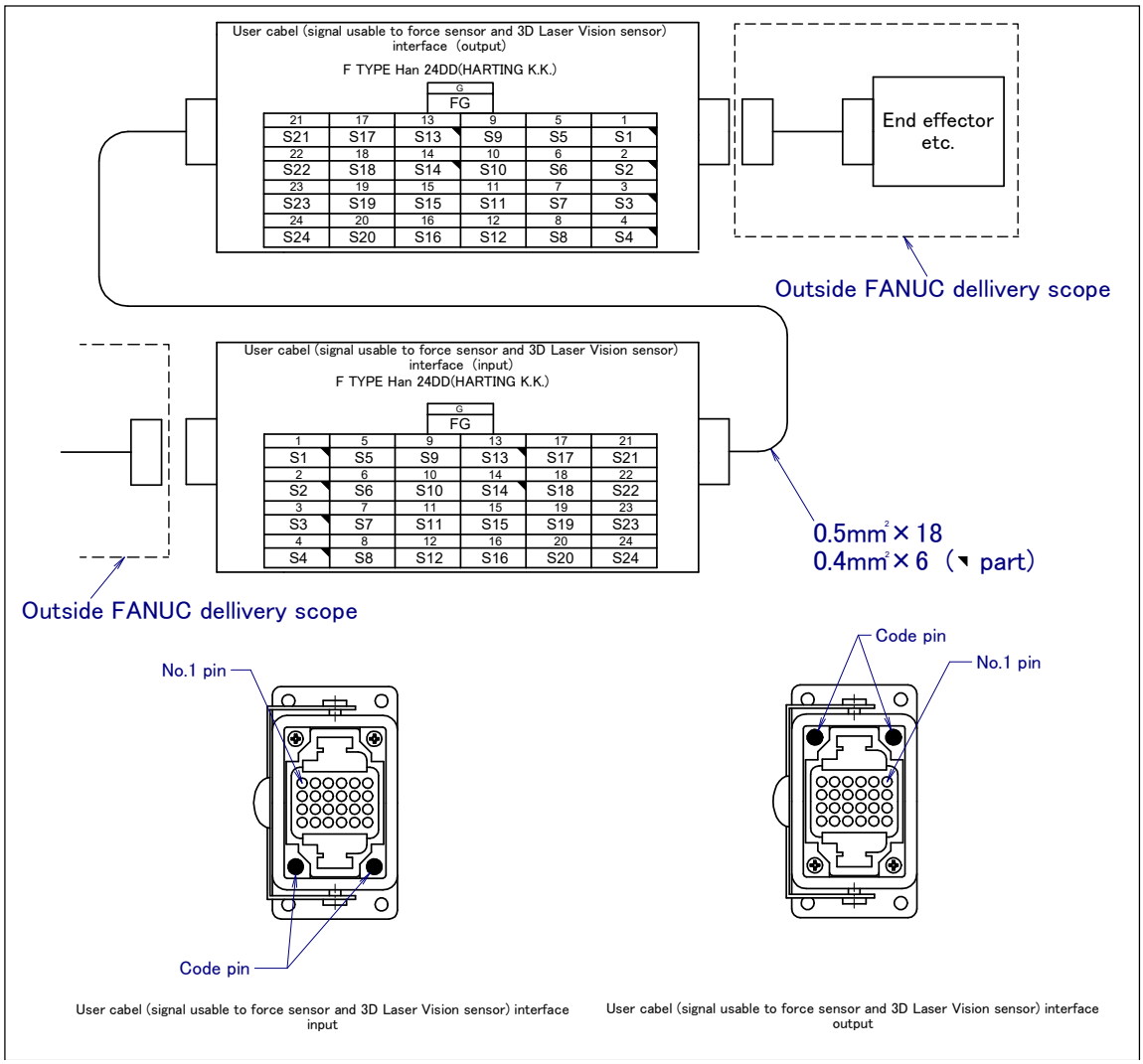


Fig. 5.3 (h) Pin layout for user cable (signal line usable to force sensor and 3D Laser Vision sensor) (ASi) interface and code pin layout (option)

4 User cable (power line) (AP) Interface (option)
Fig. 5.3 (i) shows the pin layout for the user cable (power line) interface.
The connector has a code pin for preventing improper insertion. The code pin is required for the cable which is prepared by the user.

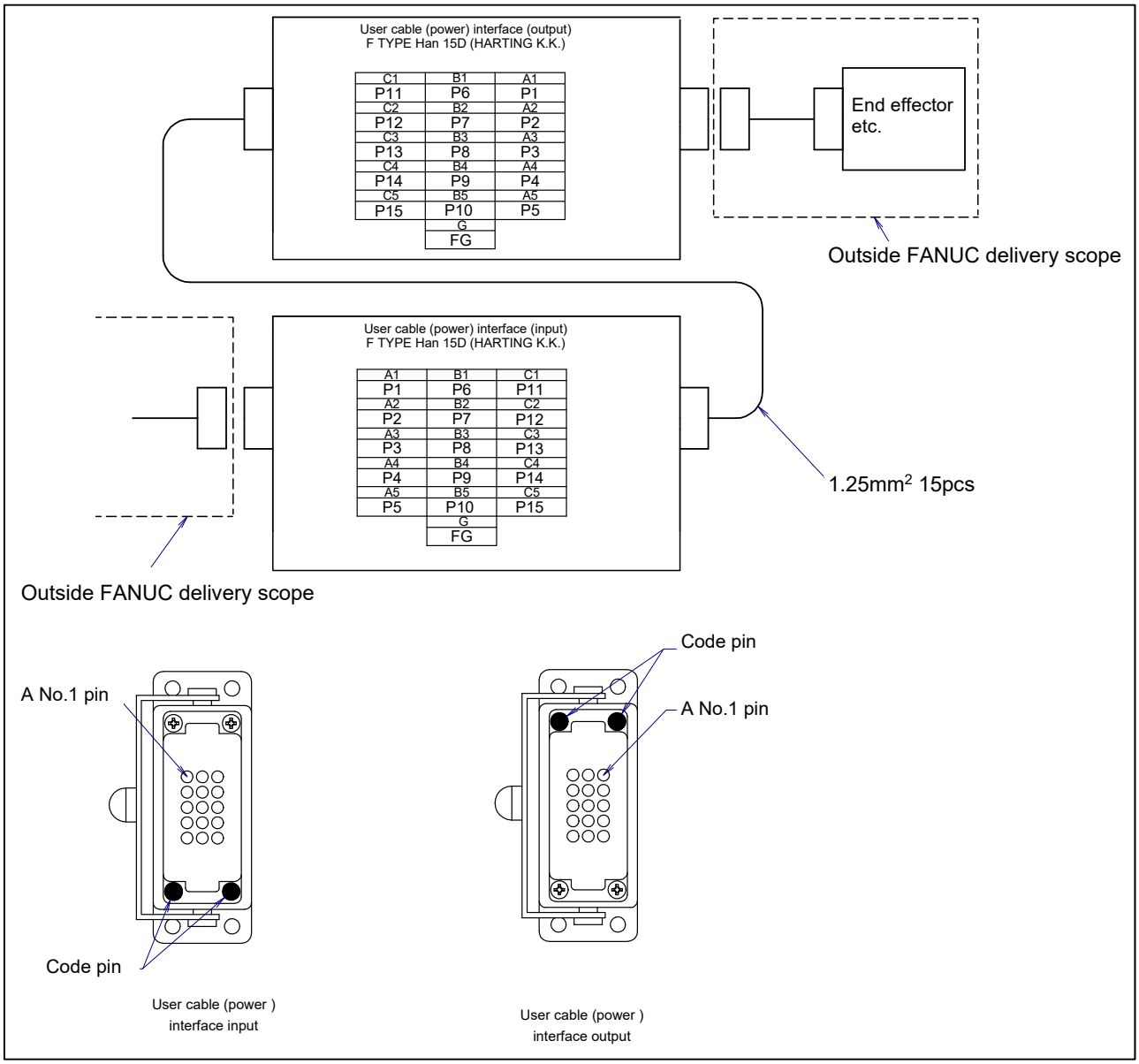


Fig. 5.3 (i) Pin layout for user cable (power line) (AP) interface and code pin layout (option)

5 DeviceNet cable (signal line) (DS) interface (option)
Fig. 5.3 (j) shows the pin layout for the DeviceNet cable (signal line) interface.

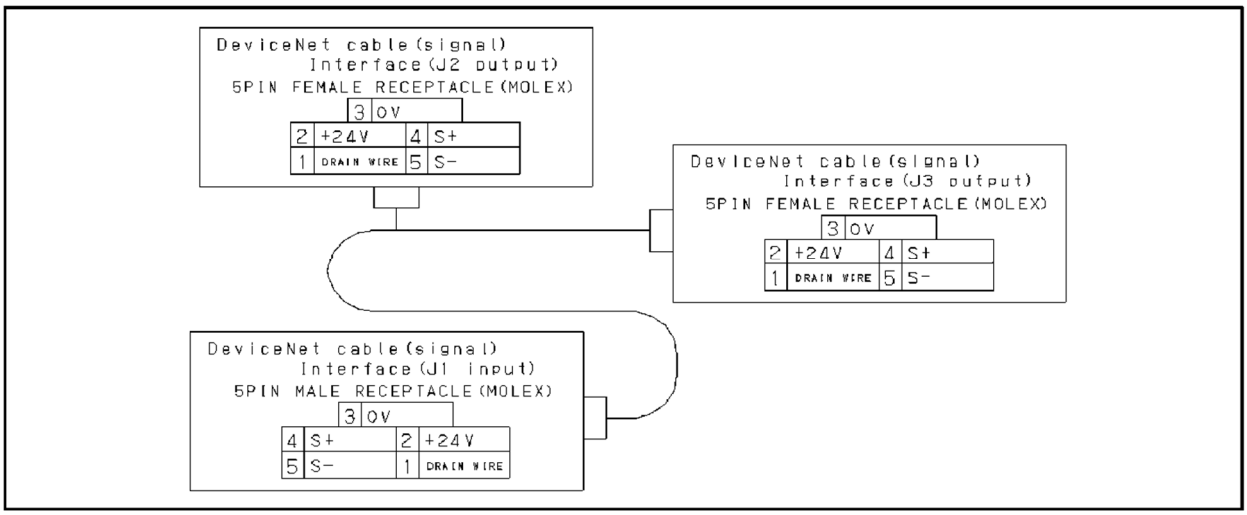


Fig. 5.3 (j) Pin layout for DeviceNet cable (signal line) (DS) interface (option)

6 DeviceNet cable (power line) (DP) interface (option)
Fig. 5.3 (k) shows the pin layout for the DeviceNet cable (power line) interface.

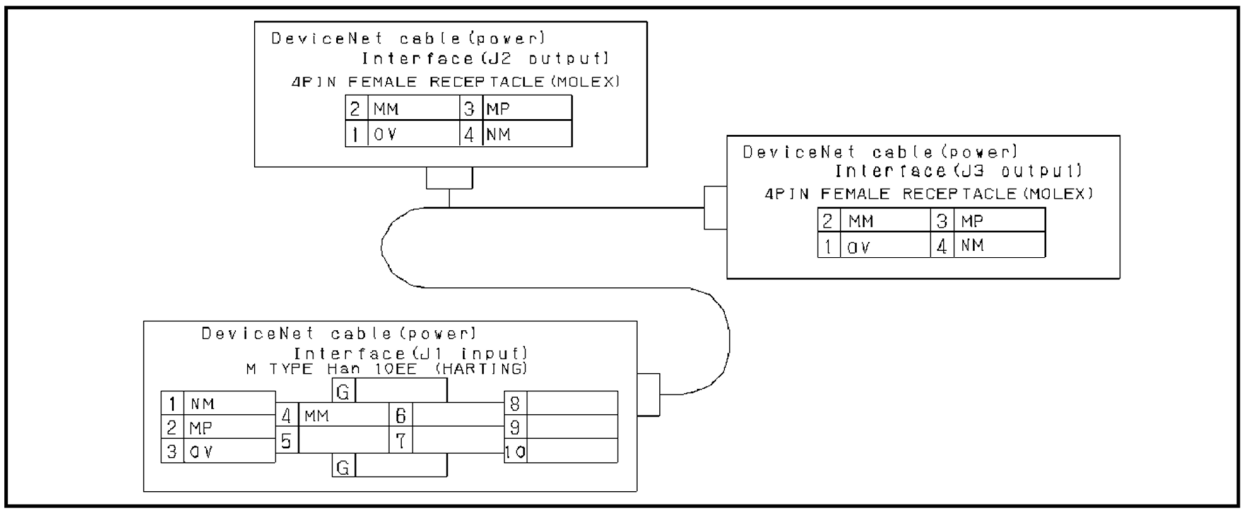


Fig. 5.3 (k) Pin layout for DeviceNet cable (power line) (DP) interface (option)

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

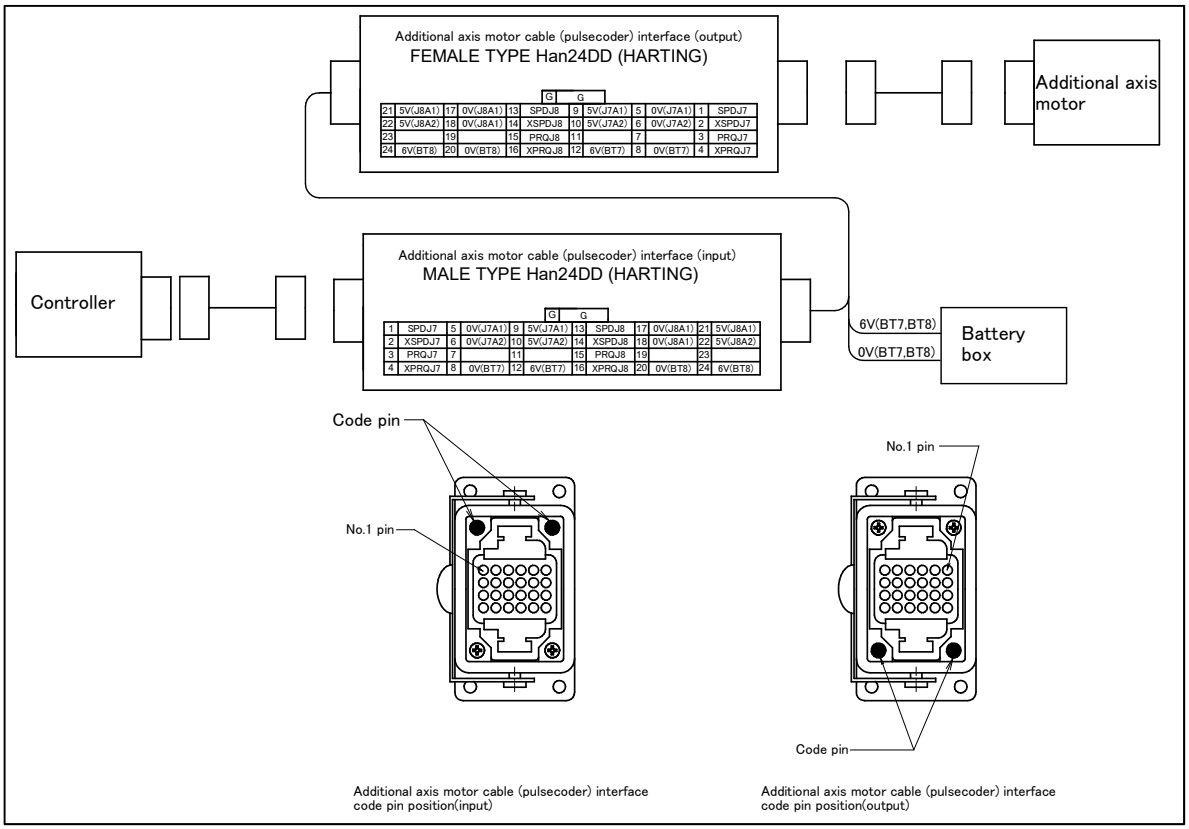


Fig. 5.3 (l) Pin layout and code pin position of the additional axis motor cable (Pulsecoder cable) (ARP) interface and layout position of the code pin (option)

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

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

8 Additional axis motor cable (power and brake cables) (ARM) interface (option)
Fig. 5.3 (m) shows the pin layout of the additional axis motor cable (power and brake cables) interface. The connector has a code pin for preventing improper insertion.

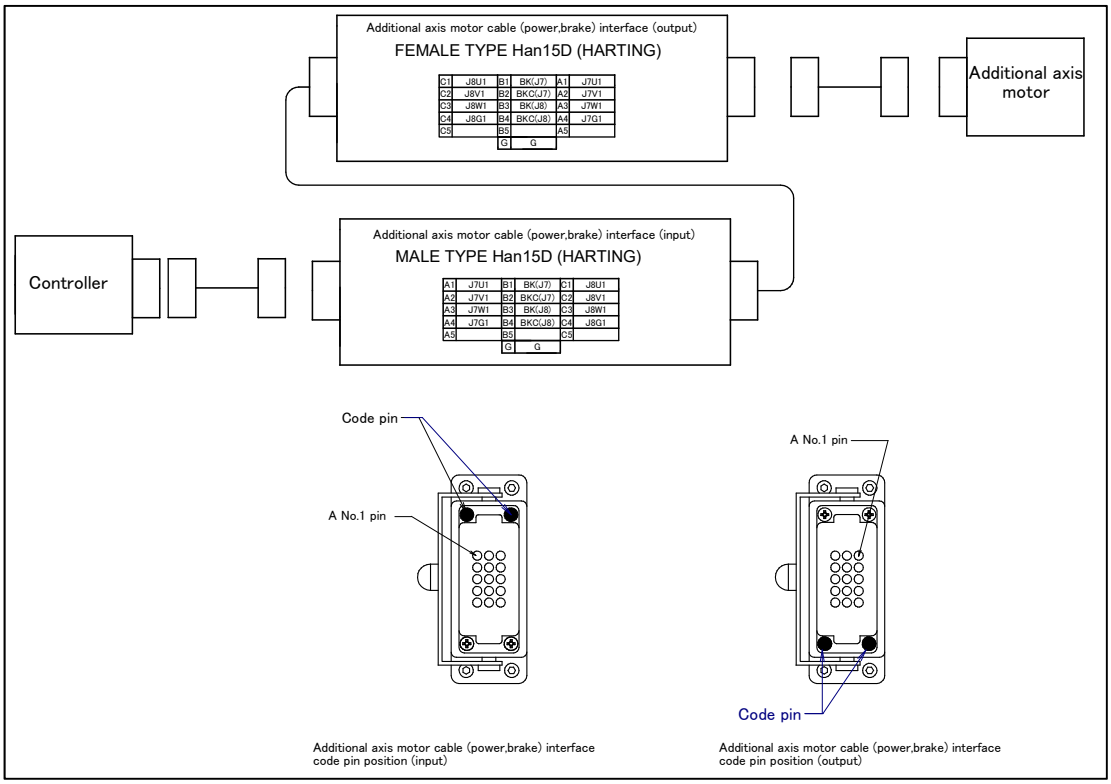


Fig. 5.3 (m) Pin layout and code pin position of the additional axis motor cable (power and brake cables) (ARM) interface and layout position of the code pin (option)

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

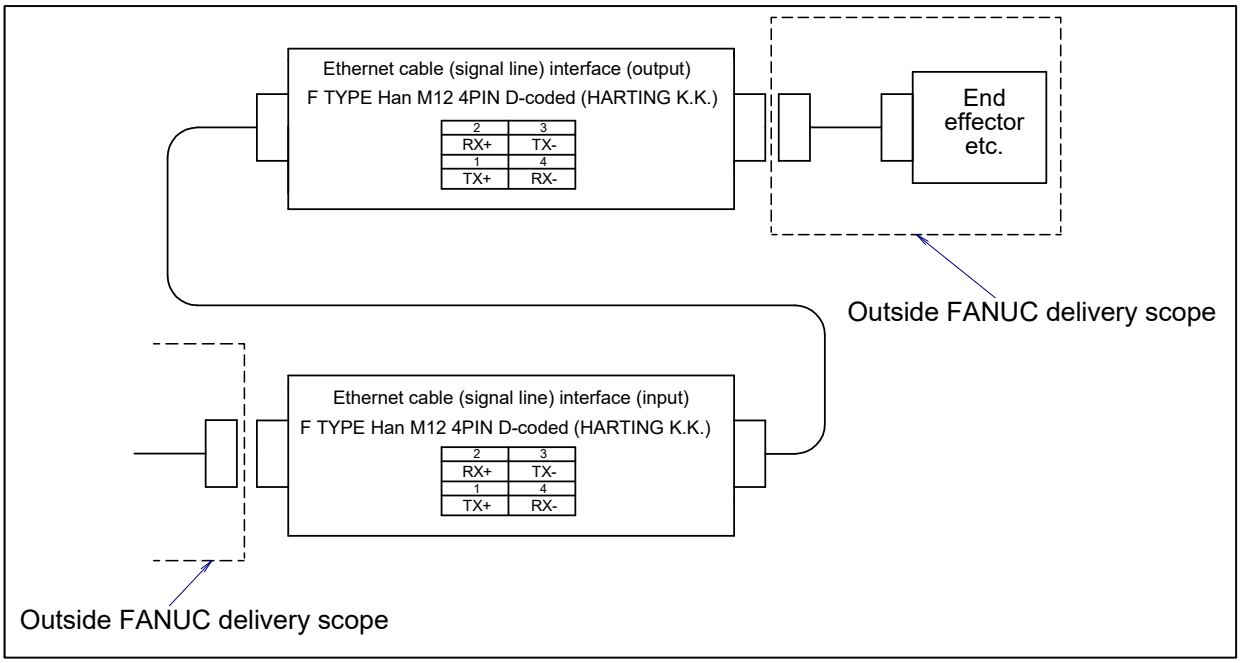


Fig. 5.3 (n) Pin layout for Ethernet cable (signal line) (ES) interface (option)

Connector specifications

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

Cable	Input side (J1 base)		Output side (J3 arm)		Maker /dealer
EE (RI/RO)	———		JMWR2524F		Fujikura Ltd.
AS ASi	Housing Insert Contact Code pin	09 30 006 0301 09 16 024 3001 09 15 000 6103 09 30 000 9901	Housing Insert Contact Code pin	09 30 006 0301 09 16 024 3101 09 15 000 6203 09 30 000 9901	HARTING K.K.
AP	Housing Insert Contact Code pin	09 20 010 0301 09 21 015 3001 09 15 000 6103 09 30 000 9901	Housing Insert Contact Code pin	09 20 010 0301 09 21 015 3101 09 15 000 6203 09 30 000 9901	
ARP	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	
ARM	Housing Insert Contact Code pin	09 20 010 0301 09 21 015 3001 09 15 000 6101 09 30 000 9901	Housing Insert Contact Code pin	09 20 010 0301 09 21 015 3101 09 15 000 6201 09 30 000 9901	
ES	Connector Contact	21 03 882 2425 09 67 000 7476	Connector Contact	21 03 882 2425 09 67 000 7476	
EE (RI/RO) (When severe dust/liquid protection package is specified)	———	———	Housing Insert Contact Guide pin Bush	09 30 006 0301 09 16 024 3101 09 15 000 6204 09 33 000 9908 09 33 000 9909	

Table 5.3 (c) Connector specifications (DeviceNet cable) (mechanical unit side)

Cable	Input side (J1 base)		Maker /dealer	Output side (J2 base)	Output side (J3 casing)	Maker /dealer
DS	CM03A-R5P-S-2		Fujikura Ltd.	CM03A-PR5S-S-2	CM03A-PR5S-S-2	Fujikura Ltd.
DP	Housing Insert Contact	09 30 006 0301 09 32 010 3001 09 33 000 6104	HARTING Electronic CO., LTD.	CM03A-PR4S-S-2	CM03A-PR4S-S-2	Fujikura Ltd.

Table 5.3 (d) Connector specifications (User side)

Cable	Input side (J1 base)		Output side (J3 arm)		Maker /Dealer
EE (RI/RO)	_____		JMSP2524M (*1) Straight JMLP2524M Angle		Fujikura Ltd.
AS ASi	Hood (NOTE 2)	09 30 006 1540 Side entry 1541 ↓ 0542 0543 ↓ 1440 Top entry 1441 ↓ 0442 0443 ↓	Hood (NOTE 2)	←Same as left	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 (NOTE 2)	←Same as left	
	Code pin	09 30 000 9901	Code pin	09 30 000 9901	

Table 5.3 (e) Connector specification (user side)

Cable	Input side (J1 base)		Output side (J3 arm)		Maker /Dealer
AP	Hood (NOTE 2)	09 20 010 1541 Side entry 0540 ↓ 0541 1440 Top entry 0440 0441 ↓	Hood (NOTE 2)	←Same as left	HARTING K.K
	Insert	09 21 015 3101	Insert	09 21 015 3001	
	Contact (NOTE 2)	09 15 000 6204 AWG 26-22 6203 AWG 20 6205 AWG 18 6202 AWG 18 6201 AWG 16 6206 AWG 14	Contact (NOTE 2)	09 15 000 6104 AWG 26-22 6103 AWG 20 6105 AWG 18 6102 AWG 18 6101 AWG 16 6106 AWG 14	
	Clamp (NOTE 2)	09 00 000 5083 5086 5090 5094 etc. Many other types are available	Clamp (NOTE 2)	←Same as left	
	Code pin	09 30 000 9901	Code pin	09 30 000 9901	
ES	Connector	21 03 882 1415	Connector	←Same as left	
	Contact (NOTE 2)	09 67 000 7576 AWG 28-24 5576 AWG 26-22 8576 AWG 24-20 3576 AWG 22-18	Contact (NOTE 2)	←Same as left	
EE (RI/RO) (When severe dust/liquid protection package is specified)	———		Hood (NOTE 2)	09 30 006 1540 Side entry 1541 ↓ 0542 0543 1440(*2) Top entry 1441 ↓ 0442 0443	
			Insert	09 16 024 3001 (*3)	
			Contact (24 pcs)	09 15 000 6104 (*4) AWG 26-22 6103 AWG 20 6105 AWG 18 6102 AWG 18 6101 AWG 16 6106 AWG 14	
			Clamp (NOTE 2)	09 00 000 5085 (*5) 5086 5090 5094 Many other types are available	
			Guide pin (2 pcs)	09 33 000 9908 (*6)	
			Bush (2 pcs)	09 33 000 9909 (*7)	

NOTE 1
Underlined parts are attached. Below shows spec. to order in our company.
(*1)A63L-0001-0234#S2524M
(*2)A63L-0001-0453#06B1440
(*3)A63L-0001-0453#24DDM
(*4)A63L-0001-0453#CA6104
(*5)A63L-0001-0453#A-152D
(*6)A63L-0001-0453#A-9908
(*7)A63L-0001-0453#A-9909

Table 5.3 (f) Connector specifications (DeviceNet cable, user side)

Cable	Input side (J1 base)			Maker /Dealer	Output side (J2 base)	Output side (J3 arm)	Maker /Dealer
DS	MINI connector for use on the device net, 5-pin female CM03A-P5S			Fujikura. Ltd	MINI connector for use on the device net, 5-pin male CM03-J5P	MINI connector for use on the device net, 5-pin male CM03-J5P	Fujikura. Ltd
DP	Hood (NOTE 2)	09 30 006 1540	Side entry	HARTING K.K	MINI connector for use on the device net, 4-pin male CM03-J4P	MINI connector for use on the device net, 4-pin male CM03-J4P	Fujikura. Ltd
		1541					
		0542					
		0543					
		1440	Top entry				
		1441					
		0442					
		0443					
	Insert	09 32 010 3101					
	Contact (NOTE 2)	09 33 000 6220	AWG20				
		6214	AWG18				
		6205	AWG18				
		6204	AWG16				
		6202	AWG14				
		6207	AWG12				
	Clamp (NOTE 2)	09 00 000 5083					
		5086					
		5090					
		5094	etc.				

NOTE 2
For details, such as the dimensions, of the parts listed above, refer to the related catalogs offered by the respective manufactures, or contact your local FANUC representative.

6 AXIS LIMIT SETUP

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

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

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

- Limit axis motion range by DCS (All axes (option))
- Limit axis motion range adjustable mechanical stopper (J1/J2/J3-axes (option))
- Limit axis motion range by limit switches (J1/J2/J3-axes (option))

⚠ WARNING

1 Changing the motion range of any axis affects the operating range of the robot. To avoid trouble, carefully consider any possible effect of the change to the movable range of each axis in advance. Otherwise, it is likely that an unexpected condition will occur; for example, an alarm may occur in a previously taught position.
2 For J1-axis, use adjustable mechanical stoppers, for J2/J3-axis, use the adjustable mechanical stoppers or DCS function so that damage to peripheral equipment and injuries to human bodies can be avoided.
3 Mechanical stoppers are physical obstacles. For J1 to J3-axis, it is possible to re-position the adjustable mechanical stoppers. But the robot cannot move beyond them. For J5-axis, the mechanical stoppers are fixed. For the J4 and J6-axes, only DCS-specified limits are available.
4 For changing J2 andJ3-axes interference angles, only adjustable mechanical stoppers are available; DCS specified movable range cannot be changed.
5 Adjustable mechanical stoppers (J1, J2, and J3-axes) are deformed in a collision to stop the robot. Once a stopper is subject to a collision, it can no longer assure its original strength and, therefore, may not stop the robot. When this happens, replace it with a new one.

6.1 CHANGE AXIS LIMIT BY DCS (OPTION)

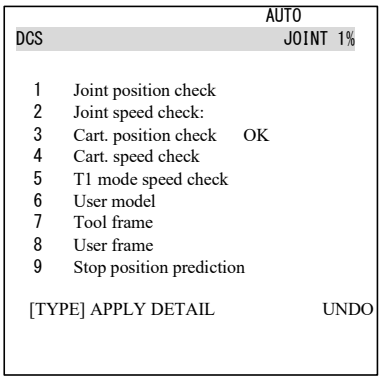
The robot motion can be restricted with DCS (Dual check safety) function by using the following software. For J2/J3-axis, the same effect as adjustable mechanical stopper described in Section 6.2 can be obtained. The robot motion can be restricted at any angle and position if it is in robot motion area.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

- DCS position/speed check function (J567)

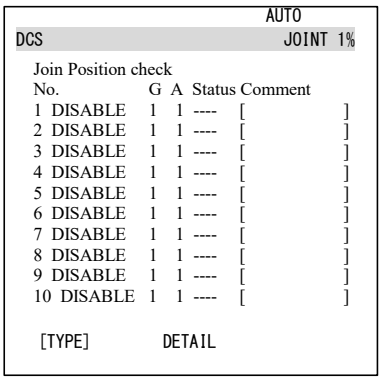
As an example, we shows the procedure to set $\pm 30^{o}$ for J2-axis in here. Refer to Dual check safety function Operator's Manual (B-83184EN) for details of other setting, function and DCS stop position prediction.

Setting procedure

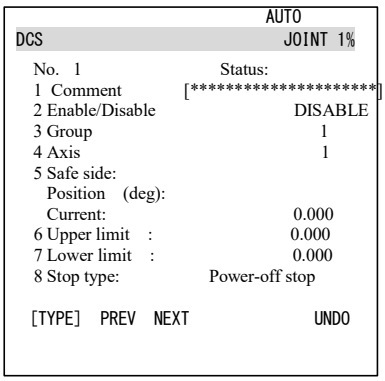
1 Press the [MENU] key to display the screen menu.
2 Press [0 NEXT] and press [6 SYSTEM].
3 Press the F1 ([TYPE]).
4 Select [DCS]. The following screen will be displayed.



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

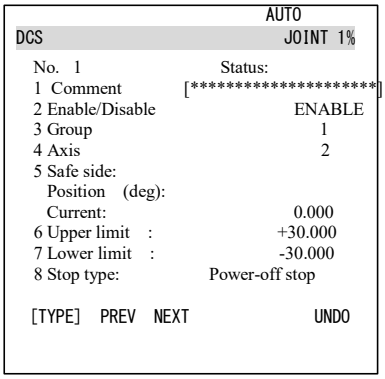


6 Move the cursor to [1], then press the [DETAIL].

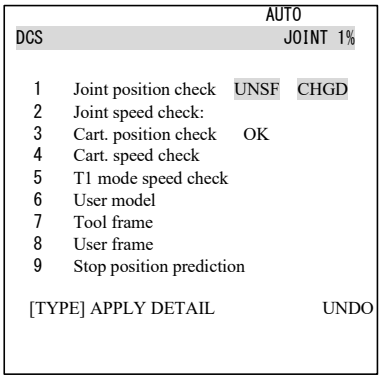


7 Move the cursor to [DISABLE], then press [CHOICE], set the status to [ENABLE].
8 Move the cursor to [Group], then input the robot group number, then press the [ENTER] key.
9 Move the cursor to [Axis], then input “2”, then press the [ENTER] key.
10 Move the cursor to [Upper limit] right side, then input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

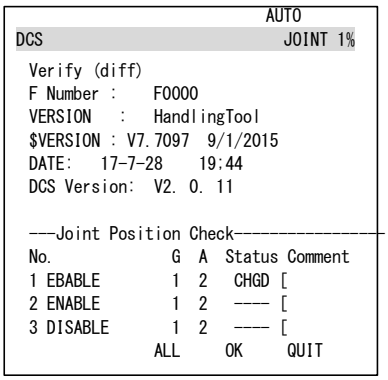
⚠ WARNING
If only the operating space is set using Joint Position Check, the robot stops after it goes beyond the workspace. When the motor power is shut down, the robot's momentum causes it to move some distance before it completely stops. The actual "Robot Stop Position" will be beyond the workspace.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



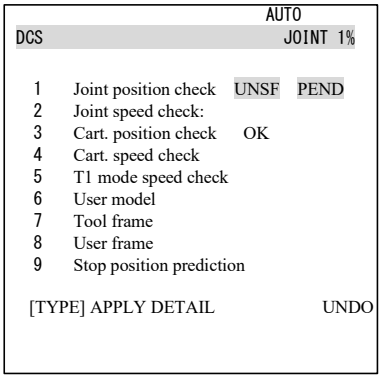
12 Press the [PREV] key two times, back to the first screen.



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



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



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

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

6.2 ADJUSTABLE MECHANICAL STOPPER AND LIMIT SWITCH SETTING (OPTION)

For the J1, J2, and J3 axes, Adjustable mechanical stopper (option) can be installed in addition to standard mechanical stopper. Motion range can be changed by changing mounting position of adjustable mechanical stopper. Change the position of the mechanical stoppers according to the desired movable range. For the J, J2, and J3 axes, the limit switch-based movable range can be used together. Refer to Section 6.3 and 6.4 for details

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

Item		
J1-axis adjustable mechanical stopper, limit switch	Upper limit	Settable in steps of 7.5° degrees in a range of –180° to +180° degrees.
	Lower limit	Settable in steps of 7.5° degrees in a range of -180° to +180° degrees.
	Space between the upper and lower limit	A space of 37.5° degrees or more is required.
J2-axis adjustable mechanical stopper	Upper limit	Settable in steps of 15° degrees in a range of –60° to +75° degrees. A fixed mechanical stopper is also provided at the upper limit +90° degrees of the standard movable range.
	Lower limit	Settable in steps of 15° degrees in a range of –60° to +75° degrees. A fixed mechanical stopper is also provided at the upper limit -64° degrees of the standard movable range.
	Space between the upper and lower limit	A space of 15° degrees or more is required.
J2-axis limit switch	Upper limit	Settable in steps of 15° degrees in a range of –60° to +90° degrees.
	Lower limit	Settable in steps of 15° degrees in a range of –60° to +75° degrees. A fixed mechanical stopper is also provided at the upper limit -64° degrees of the standard movable range.
	Space between the upper and lower limit	A space of 15° degrees or more is required.

Item		
J3-axis adjustable mechanical stopper	Upper limit	Settable in steps of 15° degrees in a range of –120° to +15° degrees. A mechanical stopper is also provided at the upper limit +30° degrees of the standard movable range.
	Lower limit	Settable in steps of 15° degrees in a range of –120° to +15° degrees. A mechanical stopper is also provided at the upper limit -130° degrees of the standard movable range.
	Space between the upper and lower limit	A space of 15° degrees or more is required.
J3-axis limit switch	Upper limit	Settable in steps of 15° degrees in a range of –120° to +30° degrees. Also settable to the upper limit +30° degrees of the standard movable range.
	Lower limit	Settable in steps of 15° degrees in a range of –130° to +15° degrees.
	Space between the upper and lower limit	A space of 15° degrees or more is required.

NOTE
If the newly set operation range does not include 0°, it is necessary to change it by zero degree mastering so that 0° is included.

6.2.1 Installing adjustable mechanical stopper option

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

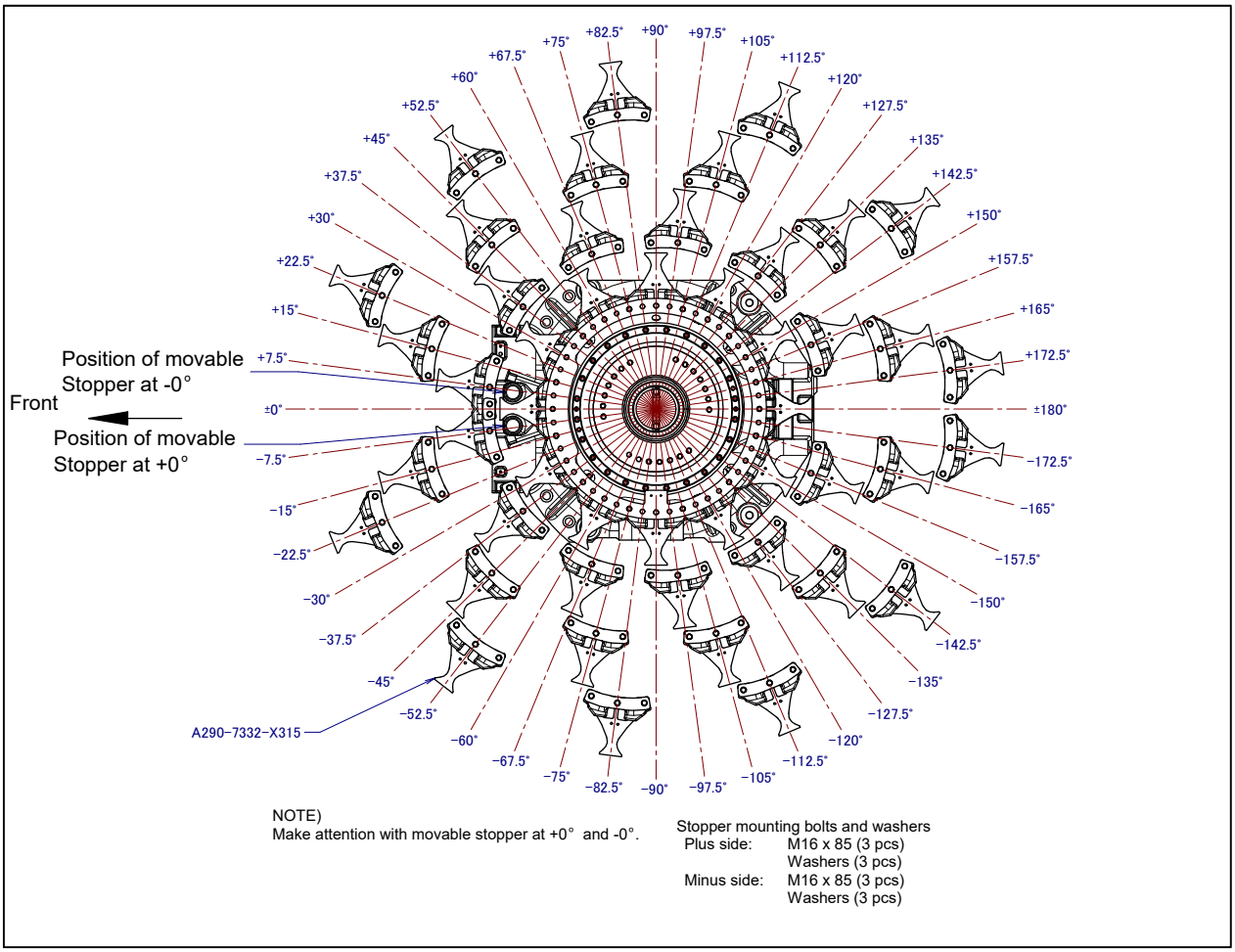


Fig. 6.2.1 (a) Change the J1-axis mechanical adjustable Stopper (Option)

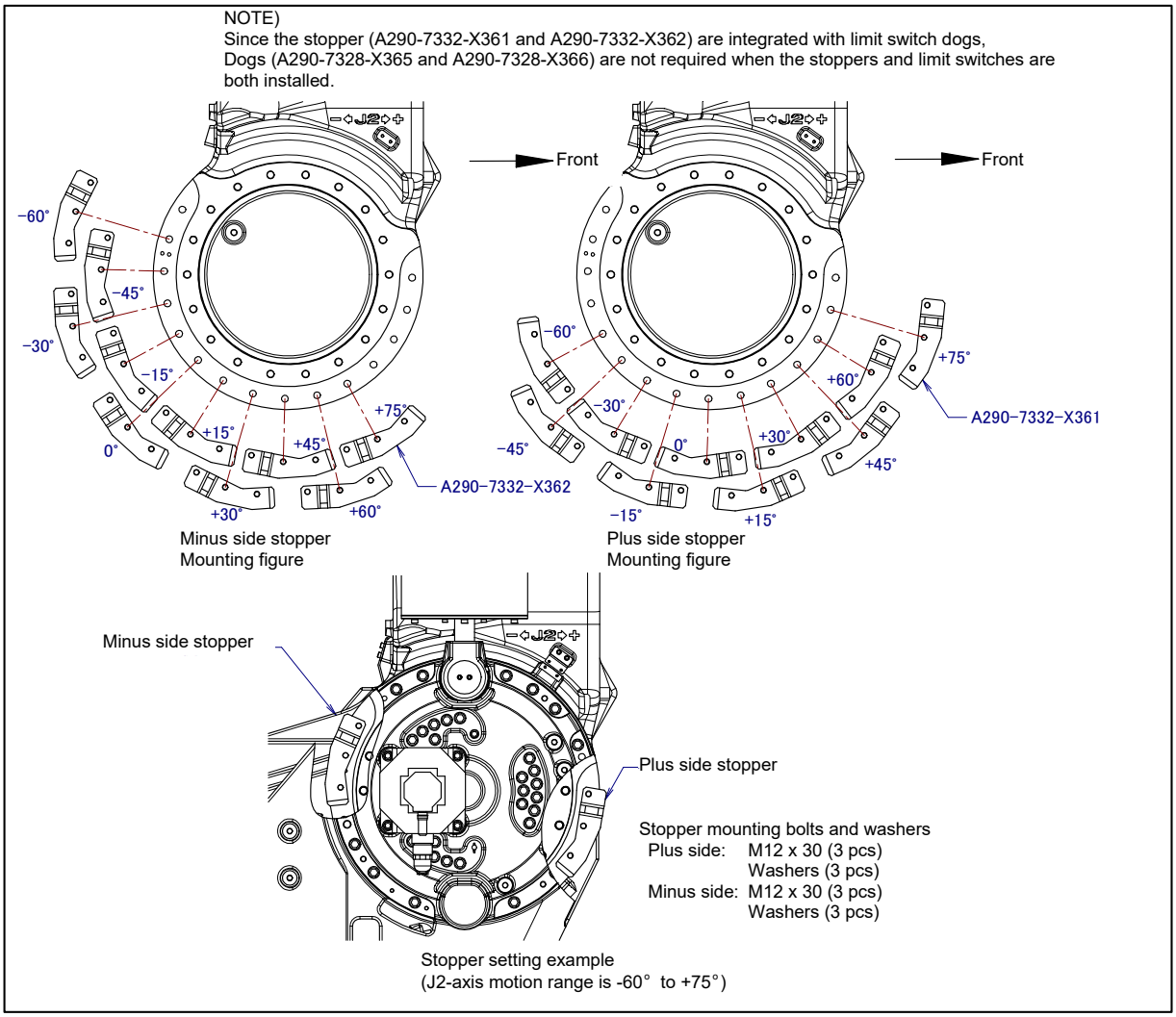


Fig. 6.2.1 (b) Change the J2-axis mechanical adjustable Stopper (Option)

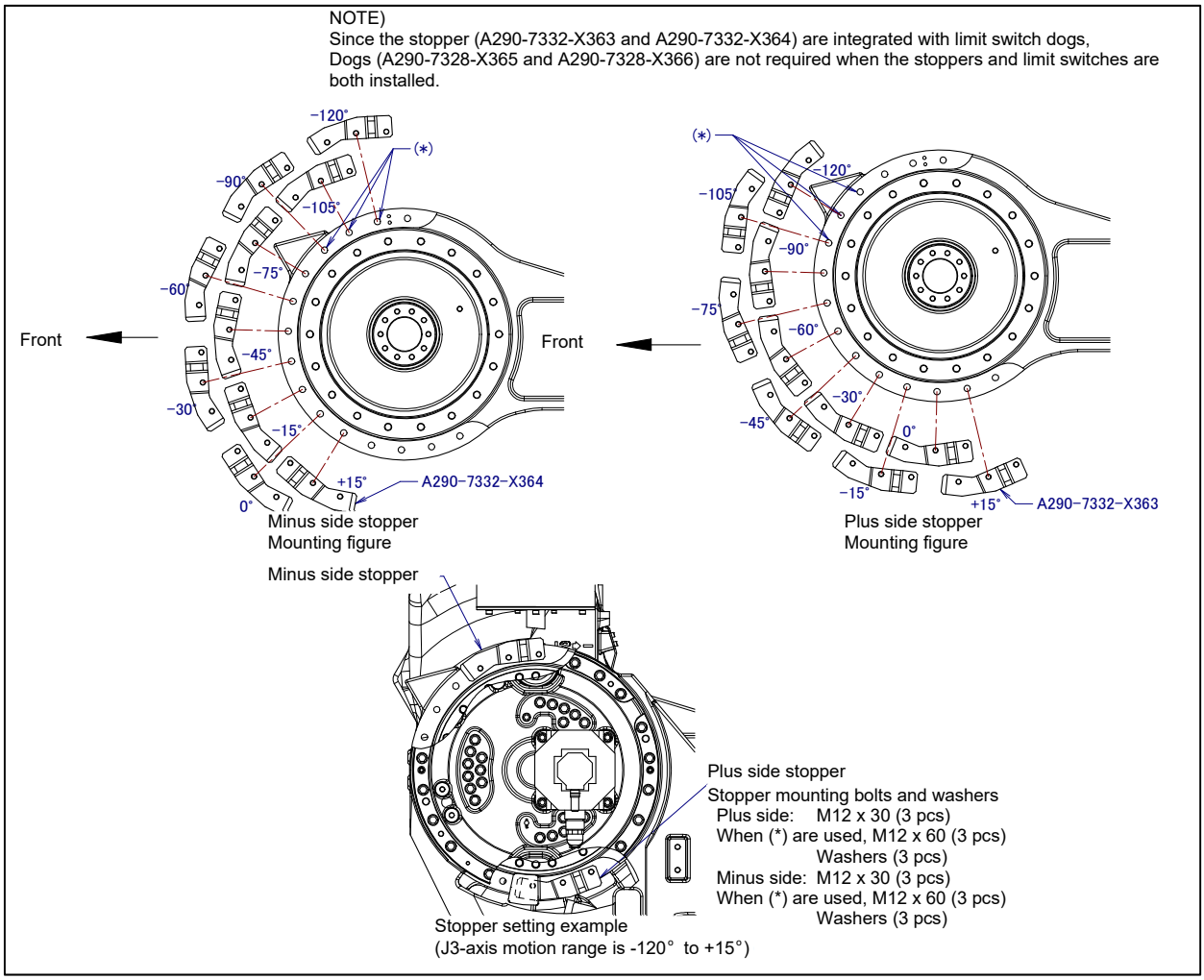


Fig. 6.2.1 (c) Change the J3-axis mechanical adjustable Stopper (Option)

6.2.2 Changing the parameter setting

Setting procedure

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

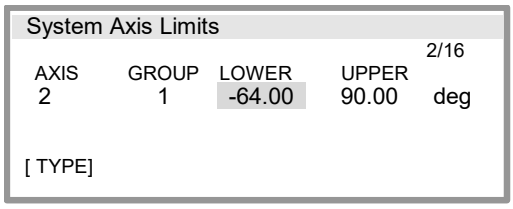
System Axis Limits JOINT 100%
Group1 1/16

AXIS	GROUP	LOWER	UPPER	
1	1	-180.00	180.00	deg
2	1	-64.00	90.00	deg
3	1	-130.00	30.00	deg
4	1	-360.00	360.00	deg
5	1	-122.00	122.00	deg
6	1	-360.00	360.00	deg
7	1	0.00	0.00	mm
8	1	0.00	0.00	mm
9	1	0.00	0.00	mm

[TYPE]

NOTE
0.00 indicates the robot does not have these axes.

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



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

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

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

The adjustable mechanical stopper is a mechanism that can be adjusted in its position. The robot can work safely inside the adjusted motion range, up to the maximum range as shown in Table 6.2.3 (a) and Fig. 6.2.3 (a) to (c).
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” (permanently damaged). Be sure to replace the deformed stopper before using the robot again.

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

	Plus side	Minus side
J1-axis	+36°	-36°
J2-axis	+ 6°	- 6°
J3-axis	+ 8°	- 8°

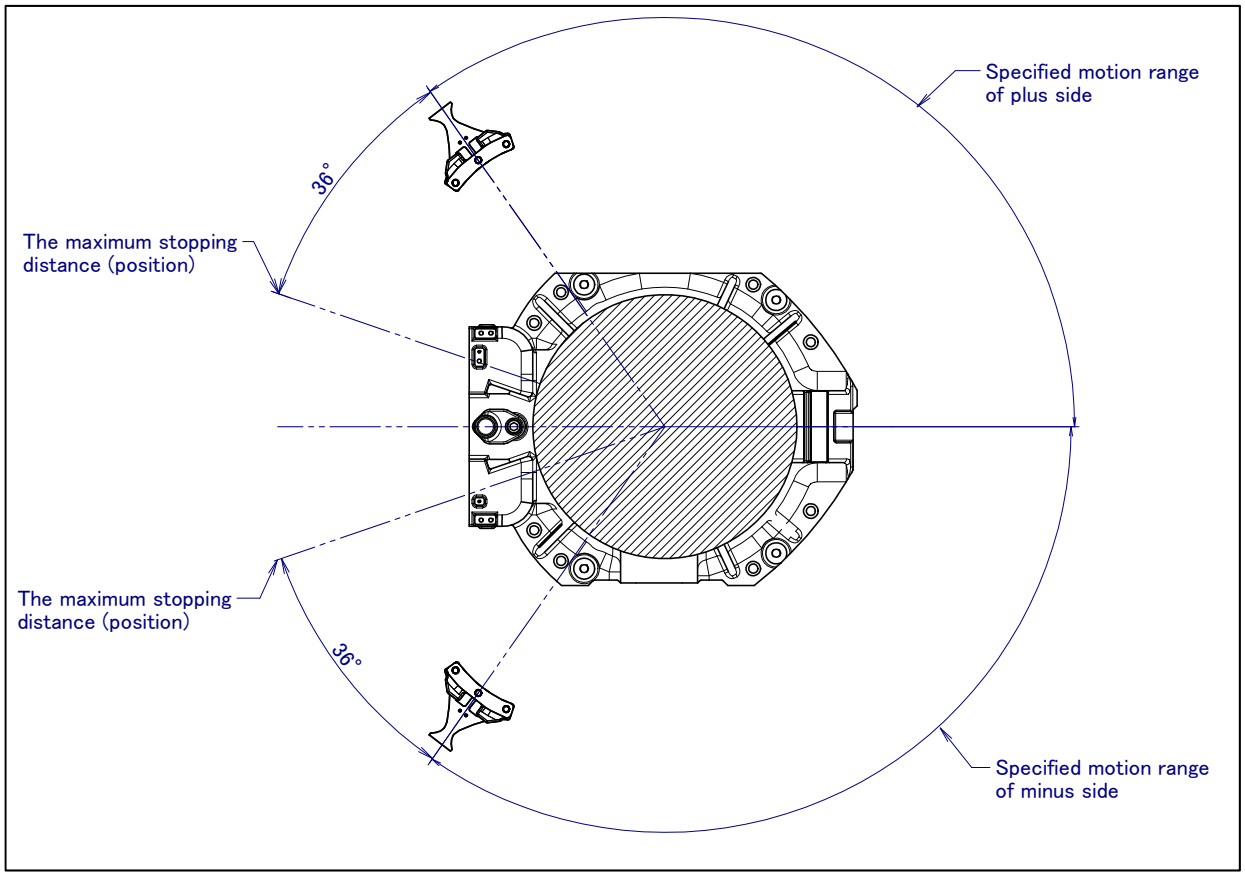


Fig. 6.2.3 (a) The maximum stopping distance of adjustable mechanical stopper of J1-axis

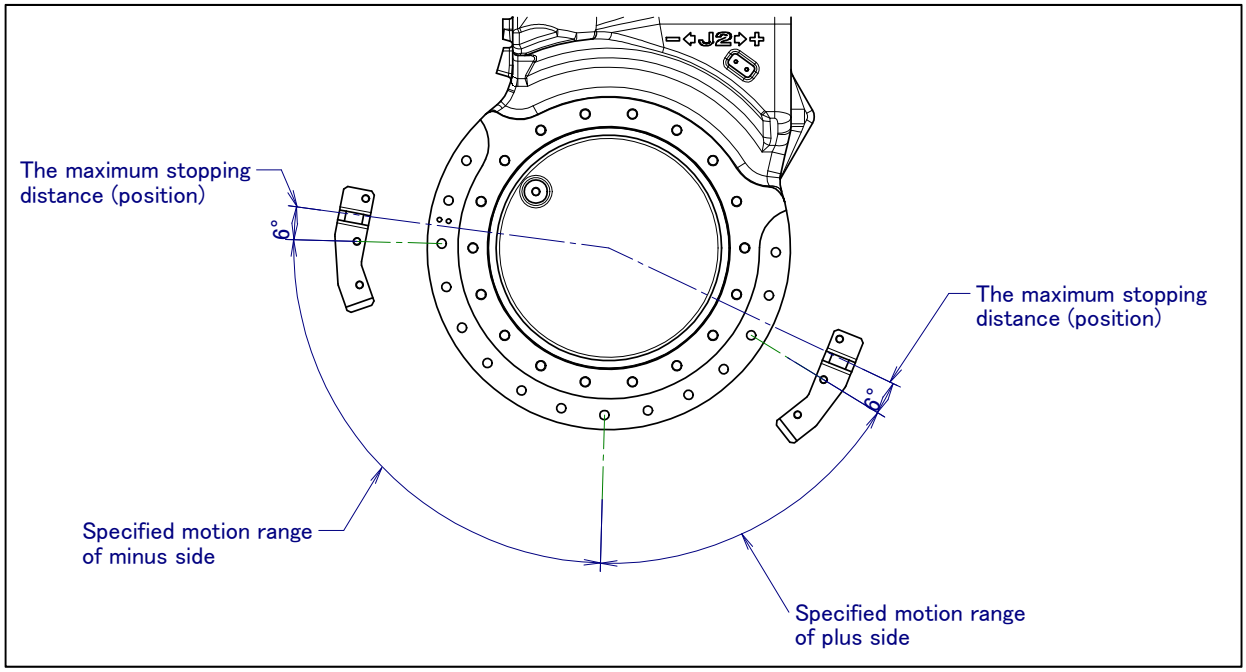


Fig. 6.2.3 (b) The maximum stopping distance of adjustable mechanical stopper of J2-axis

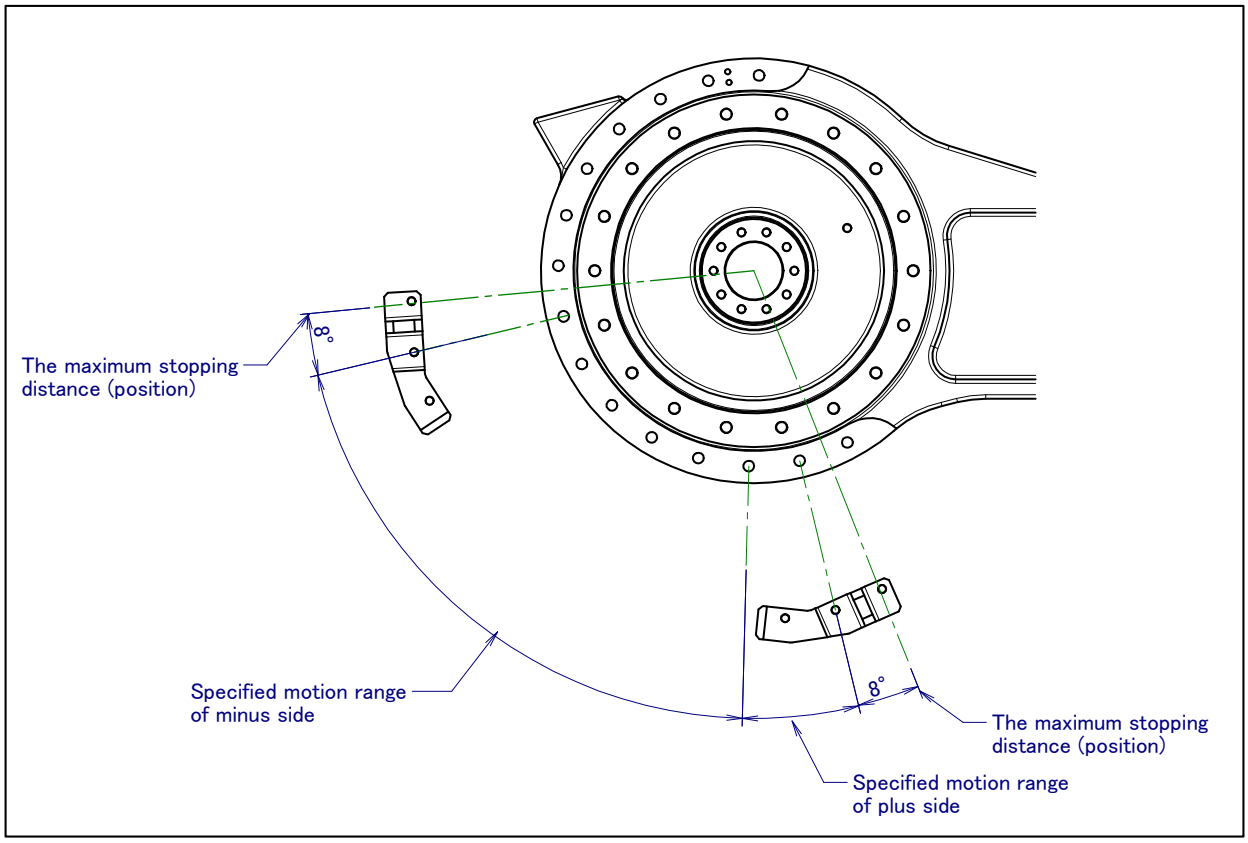


Fig. 6.2.3 (c) The maximum stopping distance of adjustable mechanical stopper of J3-axis

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

The limit switch is an over travel switch, which interrupts power to the servo motor and stops the robot when turned on. The limit switch is optionally provided for the J1,J2,J3-axis.
To change the motion range by the limit switch, move the dog. The following figure shows the relationship between the dog position and the motion range.
The dog is placed in the same position as with the adjustable mechanical stopper.

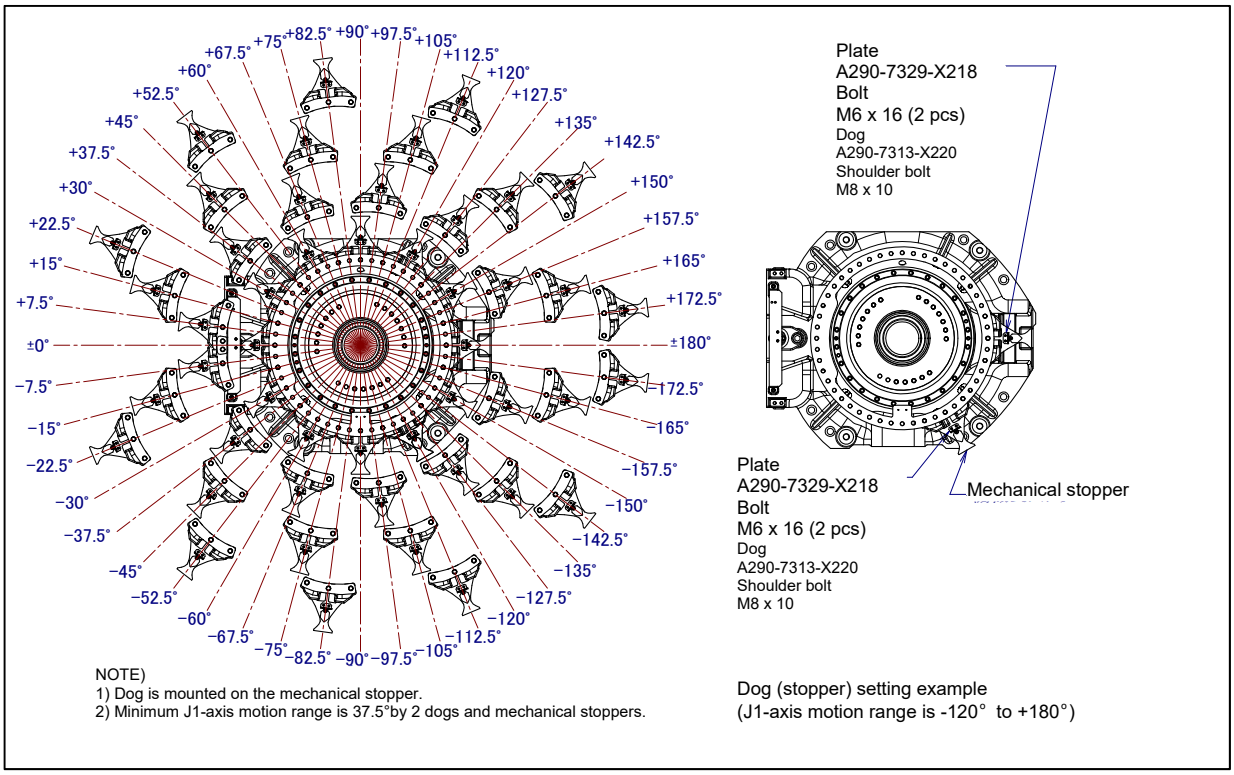


Fig. 6.3 (a) Change of J1-axis dog (option)

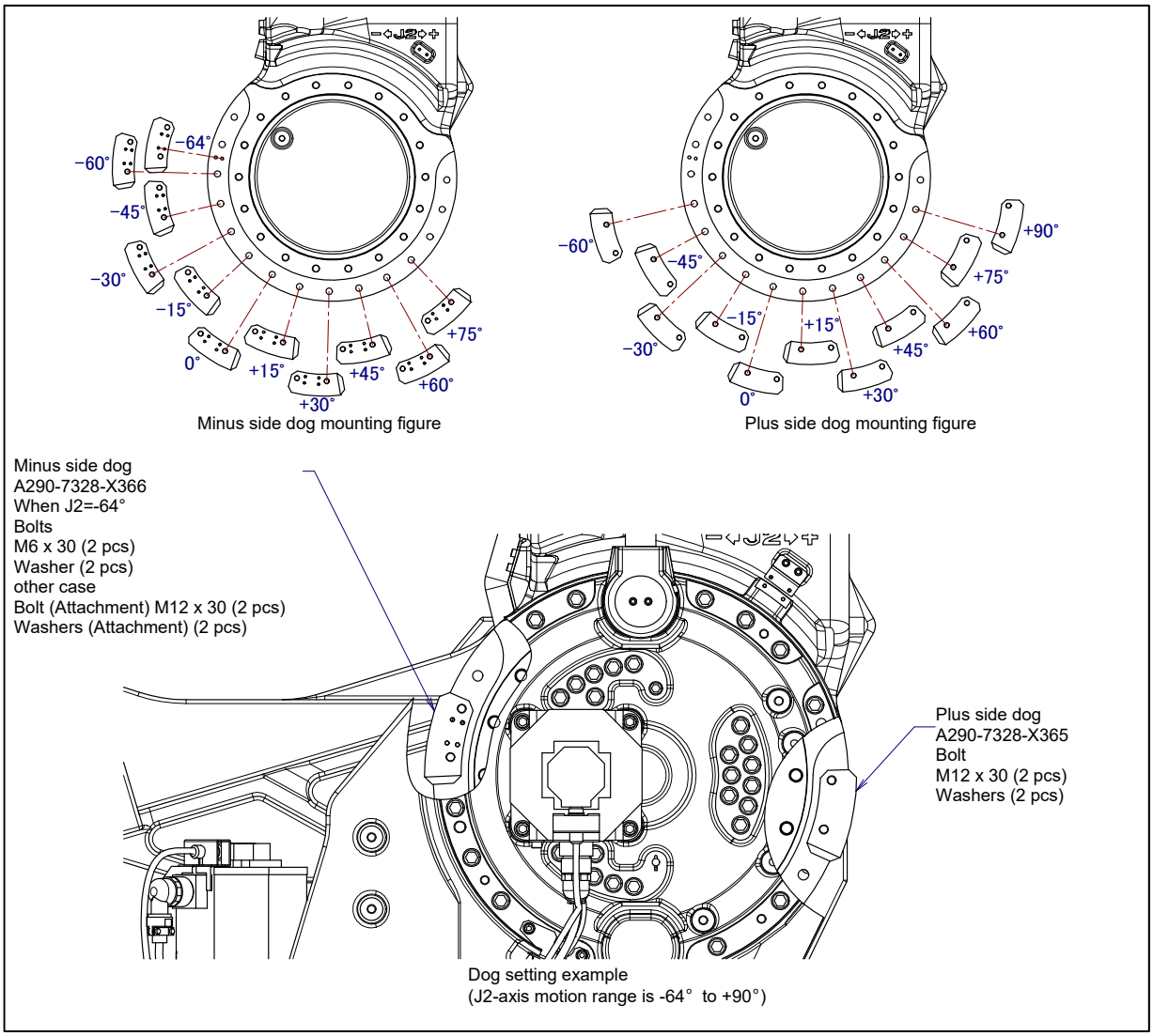


Fig. 6.3 (b) Change of J2-axis dog (option)

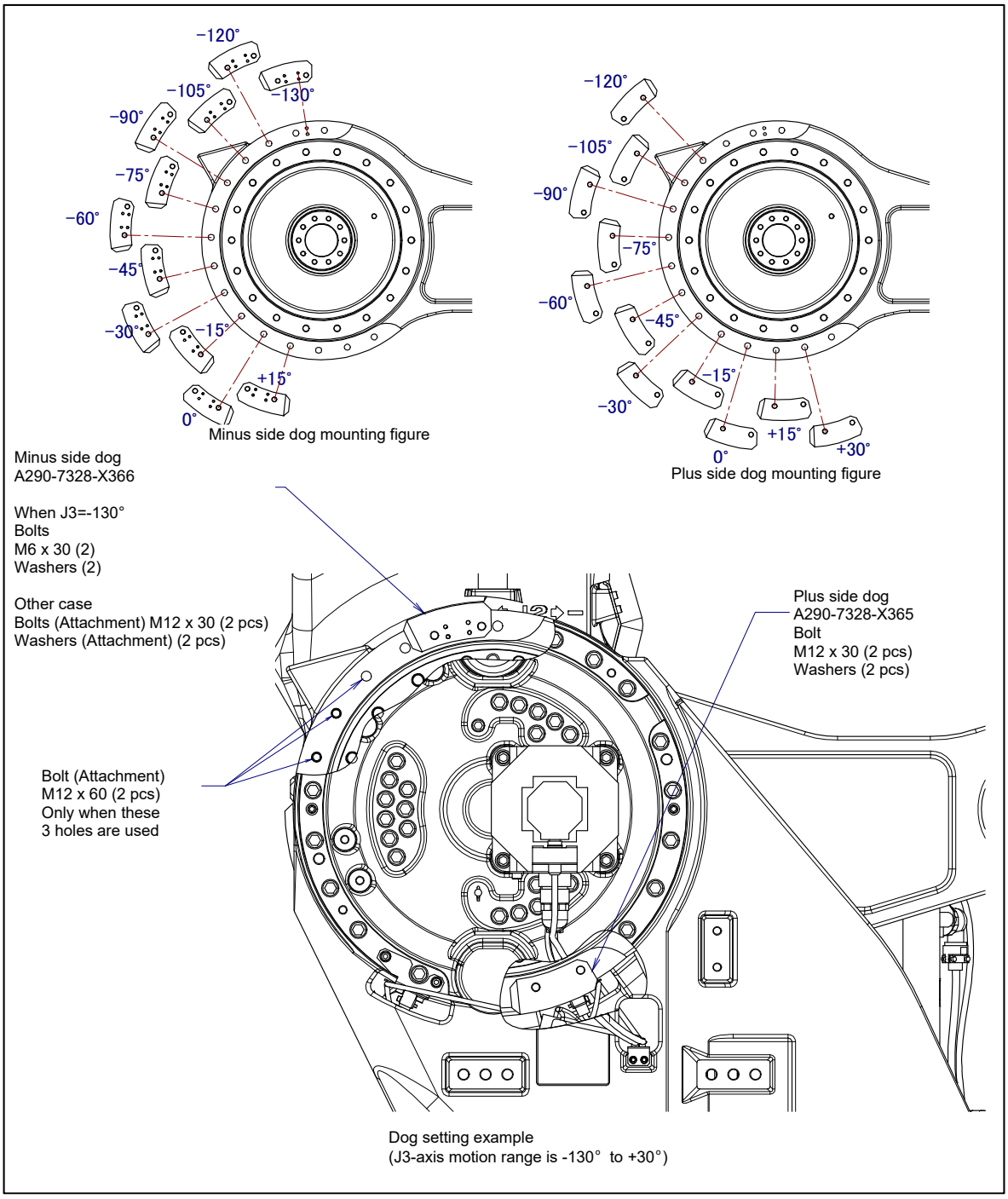


Fig. 6.3 (c) Dog position and motion range of J3-axis (Option)

6.4 ADJUSTING LIMIT SWITCH (OPTION)

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

ADJUSTING PROCEDURE

1 Set the $MOR_GRP.$CAL_DONE system parameter to FALSE. This disables the motion limit specified by the software. As a result, the operator can rotate the robot by a jog feed which goes beyond the motion limit.
2 Loosen the following bolts that hold the limit switch.
J1-axis : M8 x 12 2 pcs M4 x 25 2 pcs
J2-axis : M8 x 16 2 pcs M6 x 10 2 pcs
J3-axis : M8 x 16 2 pcs M6 x 10 2 pcs
3 Move the limit switch so that the robot activates it at about 0.5° before the stroke end. Step on the dog, and position the limit switch in such a place that only one of the step-on allowance indication lines at the tip of the switch is hidden.
4 When the limit switch operates and detects overtravel (OT), the robot stops, and an error message, "OVERTRAVEL", is displayed. To restart the robot, hold on the SHIFT key and press the RESET key. Then, while holding on the SHIFT key, move the adjusting axis off the OT limit switch by jogging in joint mode.
5 Check that the robot also activates the limit switch when the robot is approx. 0.5° from the opposite stroke end in the same way as above. If the limit switch does not operate at the position, adjust the position of the switch again.
6 Set the $MOR_GRP.$CAL_DONE system parameter to TRUE.
7 Turn off the power, then turn it on again to restart the controller.

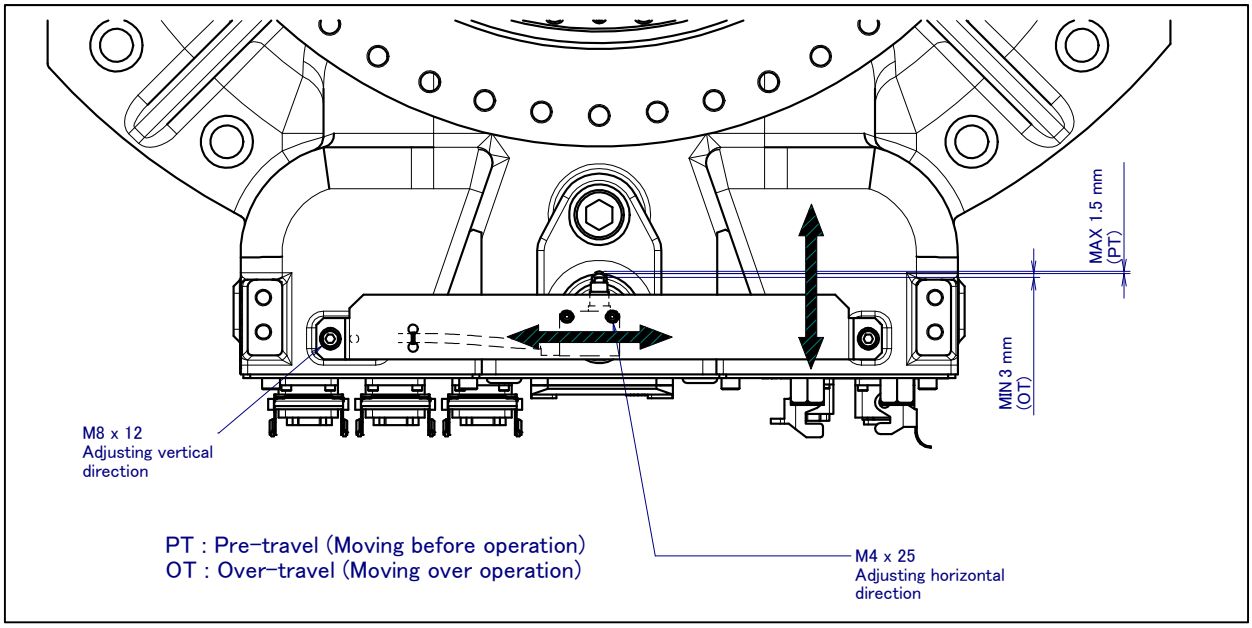


Fig. 6.4 (a) Adjusting J1-axis limit switch (Option)

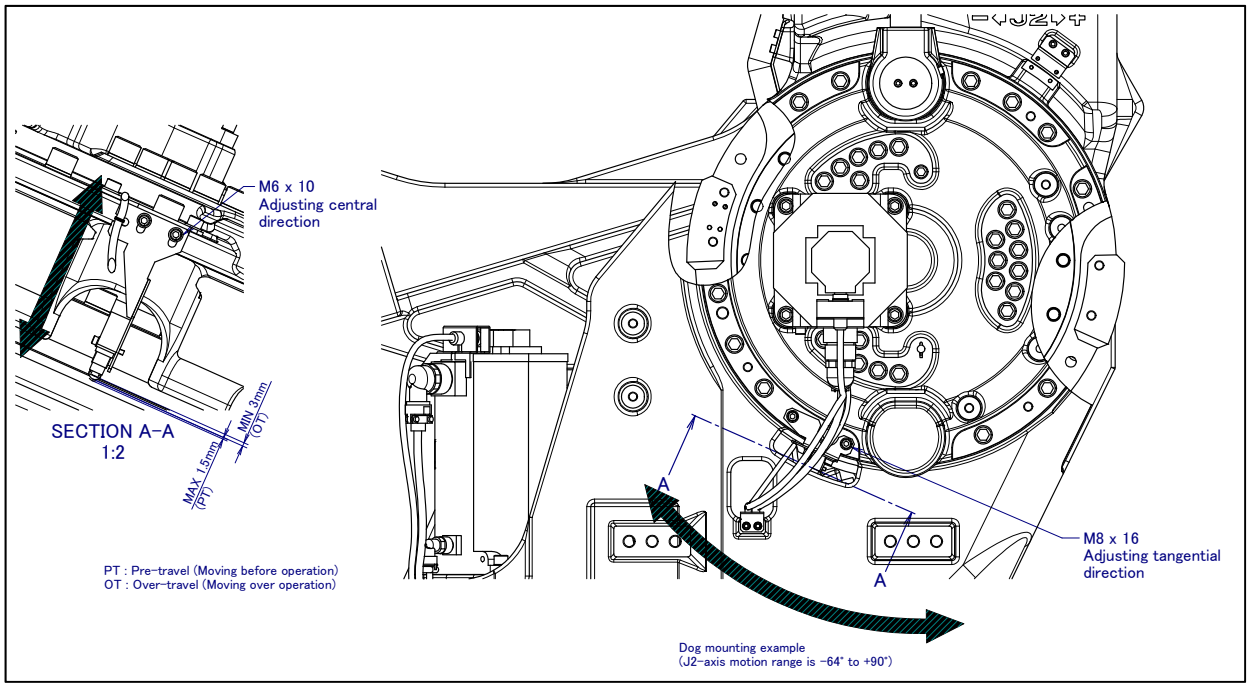


Fig. 6.4 (b) Adjusting J2-axis limit switch (Option)

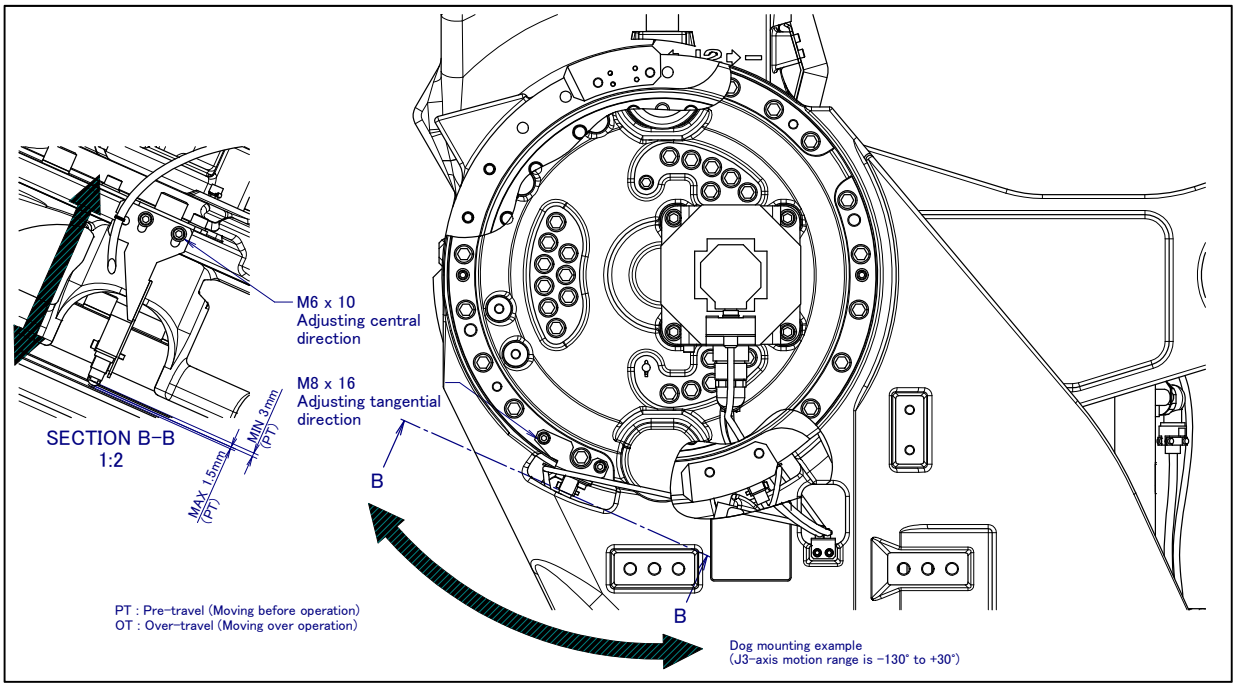


Fig. 6.4 (c) Adjusting J3-axis limit switch (Option)

7 CHECKS AND MAINTENANCE

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

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

7.1 CHECKS AND MAINTENANCE

7.1.1 Daily Checks

Check the following items when necessary before daily system operation.

Check items	Check points and management
Oil seepage	Check to see if there is oil on the sealed part of each joint. If there is an oil seepage, clean it. **⇒"7.2.1 Confirmation of Oil Seepage"**
Air control set	(When air control set is used) **⇒"7.2.2 Confirmation of the Air Control Set"**
Vibration, abnormal noises	Check whether vibration or abnormal noises occur. When vibration or abnormal noises occur, perform measures referring to the following section: **⇒"9.1 TROUBLESHOOTING"(symptom : Vibration, Noise)**
Positioning accuracy	Check whether the taught positions of the robot have not deviated from the previous taught positions. When the displacement occurs, perform the measures as described in the following section: **⇒"9.1 TROUBLESHOOTING"(Symptom : Displacement)**
Peripheral equipment for proper operation	Check whether the peripheral equipment operate properly according to commands from the robot and the peripheral equipment.
Brakes for each axis	Check that the droppage of the end effector is within 0.3 mm when the servo power turned off. If the end effector (hand) drops, perform the measures as described in the following section: **⇒"9.1 TROUBLESHOOTING"(symptom : Dropping axis)**
Warnings	Check whether unexpected warnings occur in the alarm screen on the teach pendant. If unexpected warnings occur, perform the measures as described in the following manual: **⇒"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.	23
	○					Check the external damage or peeling paint	Check whether the robot has external damage or peeling paint due to the interference with the peripheral devices. If an interference occurs, eliminate the cause. Also, if the external damage is serious, and causes a problem in which the robot will not operate, replace the damaged parts.	1
	○					Check the damages of the cable protective sleeves	Check whether the cable protective sleeves of the mechanical unit cable have holes or tears. If damage is found, replace the cable protective sleeve. If the cable protective sleeve is damaged due to the 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 is generated on the J1-axis swing stopper rotation part. If serious wear occurs on the part that generated the wear debris, replace the part.	3
	○					Check for water	Check whether the robot is subjected to water or cutting oils. If liquid was found, remove the cause, and wipe the liquid off.	4
	○ Only 1st check	○				Check for damages to the teach pendant cable, the operation box connection cable or the robot connection cable	Check whether the cable connected to the teach pendant, operation box and robot are unevenly twisted or damaged. If damage is found, replace the damaged cables.	22
	○ Only 1st check	○				Check for damage to the mechanical unit cable (movable part)	Observe the movable part of the mechanical unit cable, and check for damage. Also, check whether the cables are excessively bent or unevenly twisted. **⇒"7.2.3 Check the Mechanical Unit Cables and Connectors"**	5
	○ Only 1st Check	○				Check for damage to the end effector (hand) cable	Check whether the end effector cables are unevenly twisted or damaged. If damage is found, replace the damaged cables.	6
	○ Only 1st check	○				Check the connection of each axis motor and other exposed connectors	Check the connection of each axis motor and other exposed connectors. **⇒"7.2.3 Check the Mechanical Unit Cables and Connectors"**	7

Check and maintenance intervals (Period, Accumulated operating time)						Check and maintenance items	Check points, management and maintenance methods	Periodic maintenance table No.
1 month 320h	3 months 960h	1 year 3840h	1.5 years 5760h	3 years 11520h	4 years 15360h			
	○ Only 1st check	○				Retightening the end effector mounting bolts	Retighten the end effector mounting bolts. Refer to the following section for tightening torque information: **⇒"4.1 END EFFECTOR INSTALLATION TO WRIST"**	8
	○ Only 1st check	○				Retightening the external main bolts	Retighten the bolts which are installed, removed during the inspection, and exposed. Refer to the recommended bolt tightening torque guidelines at the end of the manual. Some bolts are attached with adhesive. Tightening the bolts with a torque greater than what is recommended, might damage the adhesive. Therefore, follow the recommended bolt tightening torque guidelines when retightening the bolts.	9
	○ Only 1st check	○				Check the mechanical stopper and the adjustable mechanical stopper	Check that there is no evidence of a collision on the mechanical stopper, the adjustable mechanical stopper, and check the looseness of the stopper mounting bolts. Check that the J1-axis swing stopper rotates smoothly. **⇒"7.2.4 Check of Fixed Mechanical Stopper and Adjustable Mechanical Stopper"**	10
	○ Only 1st check	○				Clean spatters, sawdust and dust	Check that spatters, sawdust, or dust does not exist on the robot main body. If dust has accumulated, remove it. Especially, clean the robot movable parts well (each joint, 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 J2/J3-axis connection part bearing	Supply grease to J3 link taper roller part and J2/J3-axis connection part bearing **⇒"7.3.1 Greasing of J3 Link Taper Roller Part and J2/J3-axis Connection Part Taper Roller Part"**	19 20
				○		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 - 18
					○	Replacing the mechanical unit cable	Replace the mechanical unit cable Contact your local FANUC representative for information regarding replacing the cable.	21
					○	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)"**	24

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.

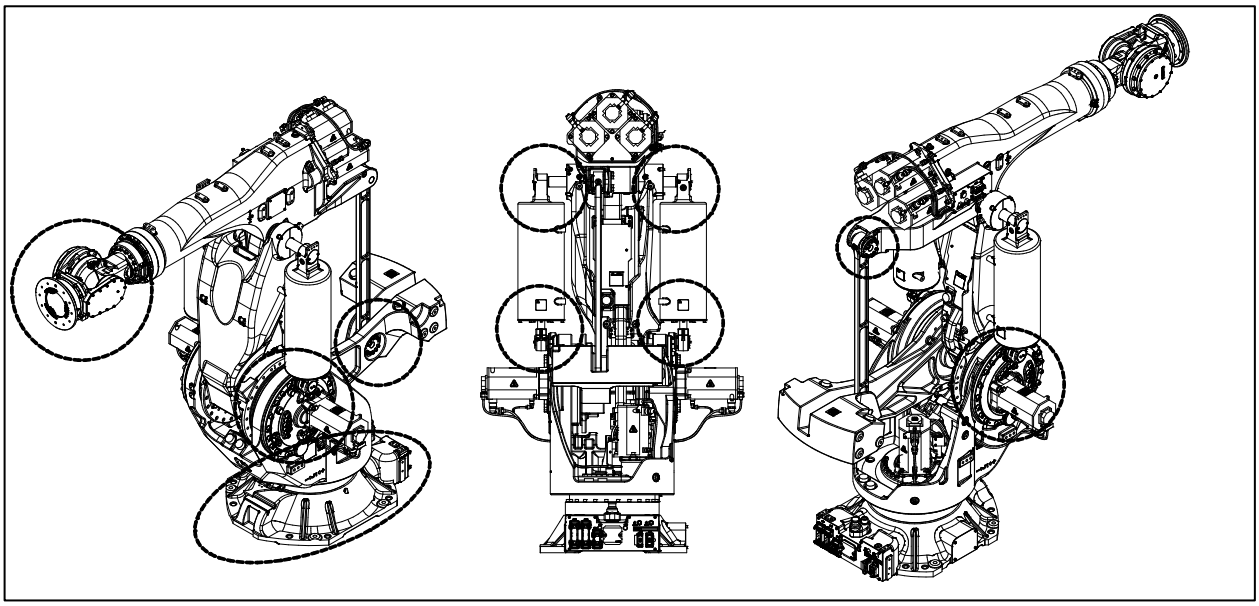


Fig. 7.2.1 (a) Check parts of oil seepage

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

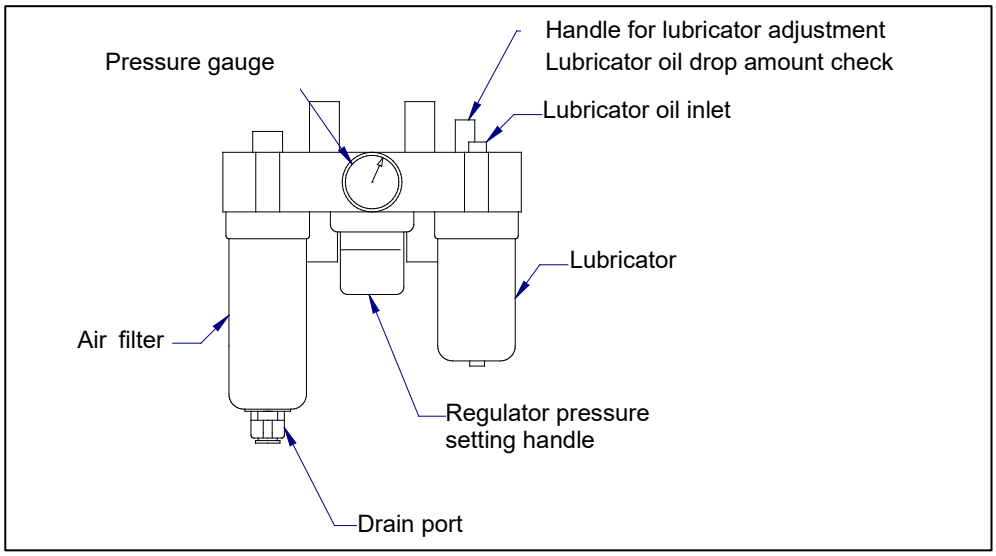


Fig. 7.2.2 (a) Air control set (option)

7.2.3 Check the Mechanical Unit Cables and Connectors

Check points of the mechanical unit cables
Fixed part cables likely to interfere with the J1, J2, and J3 movable parts and peripheral devices
For the J1-axis, remove plate of side of J1 base and inspect the cables from above the J2 base and side of J1 base.

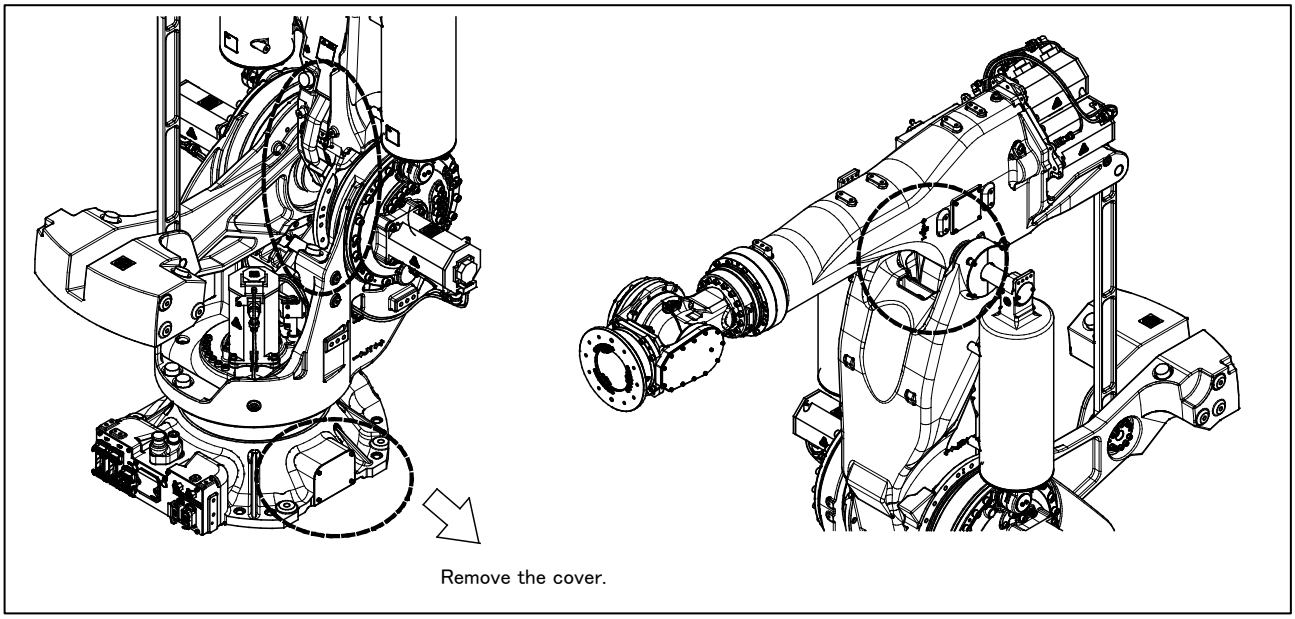


Fig. 7.2.3 (a) Inspection points of the mechanical unit cables

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

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

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

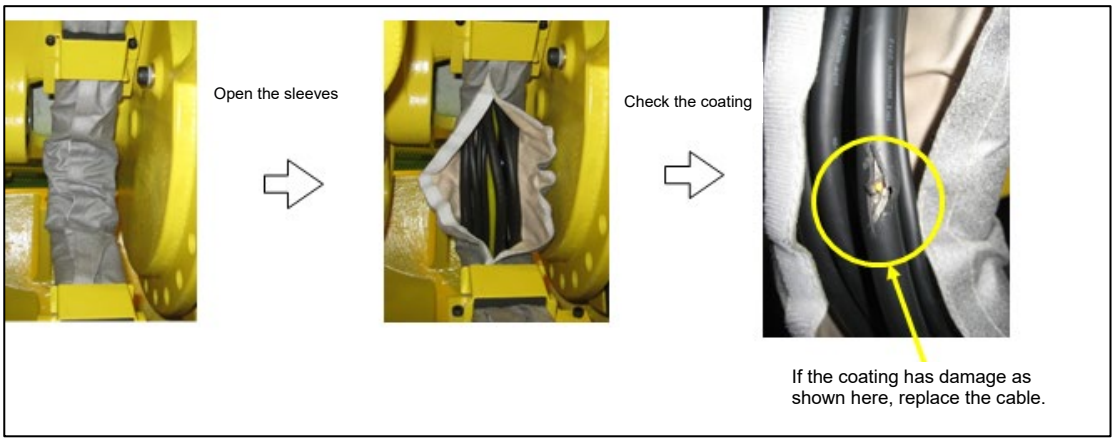


Fig. 7.2.3 (c) Cable check method

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

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

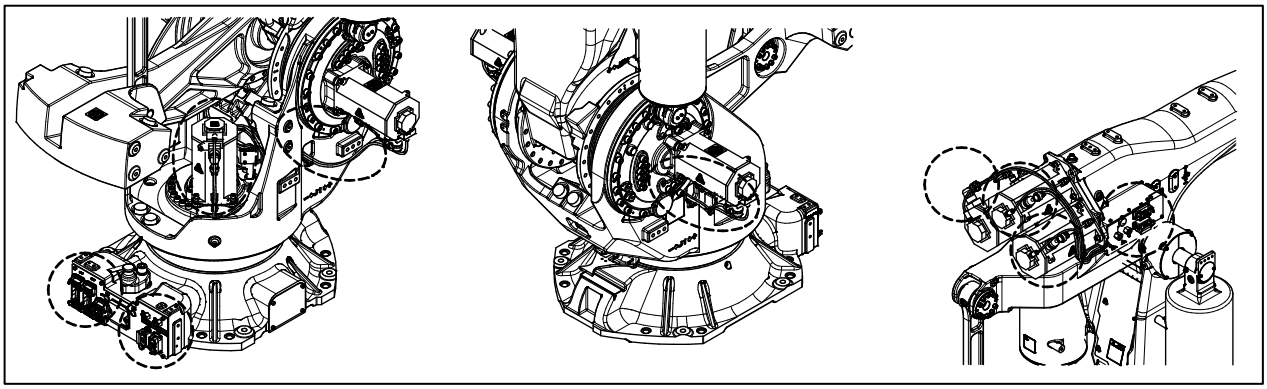


Fig. 7.2.3 (d) Connector Inspection points

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.

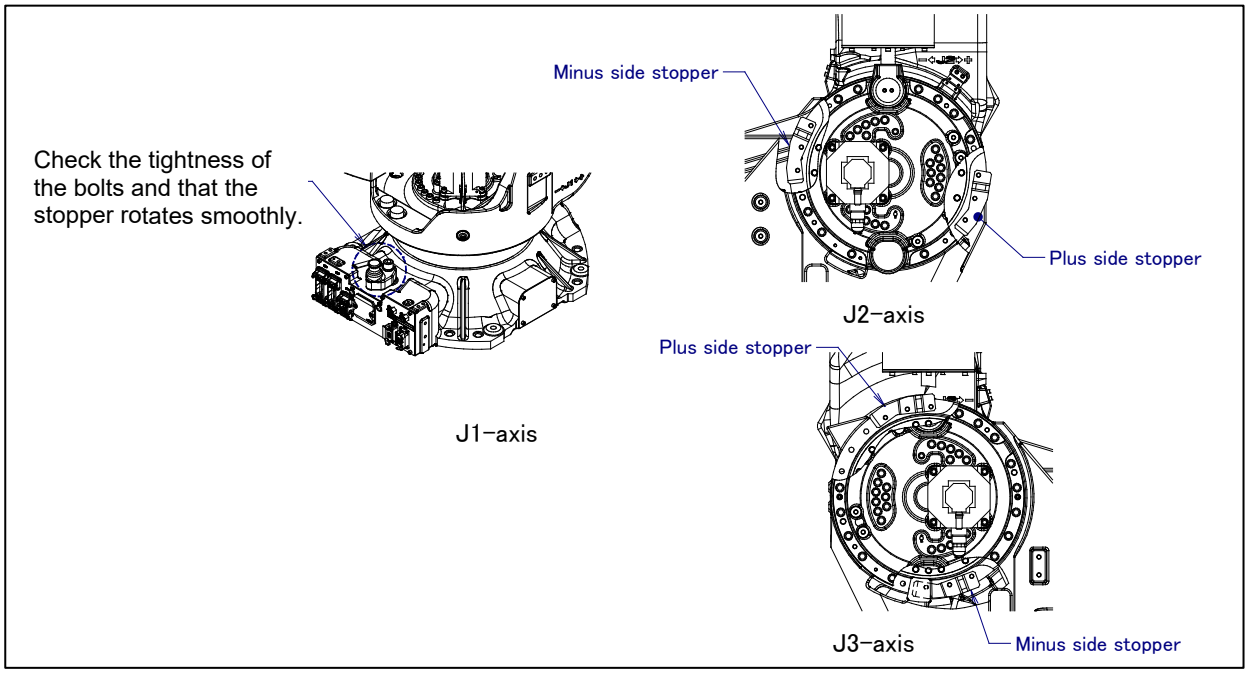


Fig. 7.2.4 (a) Check of fixed mechanical stopper and adjustable mechanical stopper

7.3 MAINTENANCE

7.3.1 Greasing of J3 Link Taper Roller Part and J2/J3-axis Connection Part Taper Roller Part (3-year check (11,520 hours))

Be sure to supply grease to J3 link taper roller part and J2/J3-axis connection part taper roller part specified in Table 7.3.1 (a), 7.3.1 (b).Adjust the greasing timing if your robot is installed in an adverse environment. Supply grease immediately if water is splashed to the robot.
Fig. 7.3.1 (a), (b) indicate greasing points of J3 link taper roller part and J2/J3-axis connection part taper roller.

Table 7.3.1 (a) Greasing of J3 link taper roller part and J2/J3-axis connection part taper roller part

Supply position	Recommended grease	Amount of grease	Greasing interval
J3 link taper roller part Grease inlet	Shell Lubricants Shell Alvania Grease S2 (Spec. : A98L-0004-0602#CTG)	30ml (2 points)	3 years or every 11520 hours of accumulated operation
J2/J3-axis connection part Taper roller Grease inlet		20ml (2 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 when required after operations of 50 to 100 hours since the greasing.
2 If the robot is used at the high-duty that requires a cooling unit (fan), shorten the standard greasing cycle to half.

Table 7.3.1 (b) Substitutes for ALVANIA GREASE S2

Exxon Mobil	Mobilux EP2
ENEOS	Multinoc 2
ENEOS	Epinoc grease AP(N)2
Idemitsu Kosan Co., Ltd.	Eponex grease No. 2
Cosmo Oil Co., Ltd.	Dynamax No. 2
Shell Lubricants	Shell Gadus S2 V100 2

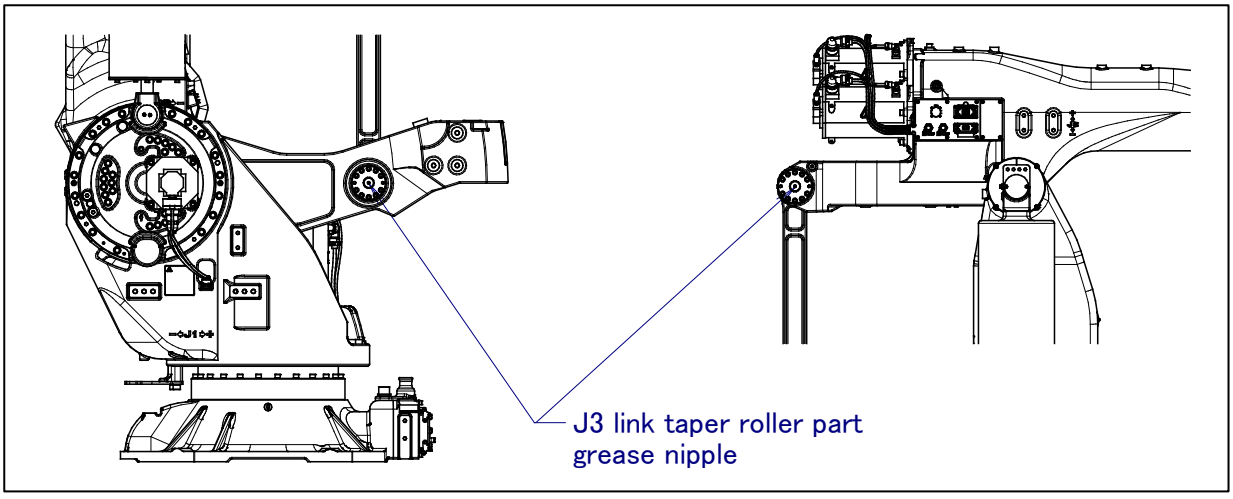


Fig. 7.3.1 (a) J3 link taper roller part grease supply position

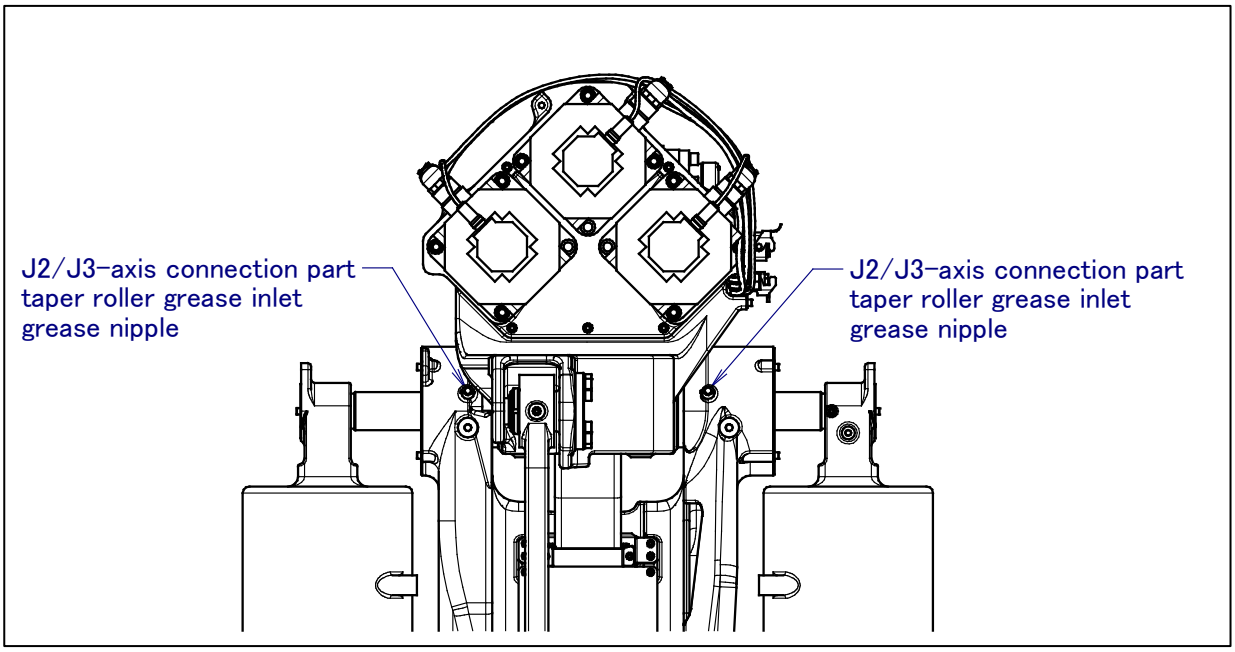


Fig. 7.3.1 (b) J2/J3-axis connection part taper roller grease supply position

Table 7.3.1 (c) Spec. of the grease nipple

Parts name	Specifications
Grease nipple	A97L-0218-0013#A610

⚠ CAUTION
Using a manual greasing pump, grease gently and slowly.

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.

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 batteries.
5 lose the battery case cap.

> ⚠ **CAUTION**
> When using a robot with the severe dust/liquid protection option, remove the cover from the battery case as shown in Fig.7.3.2 (b) to replace the battery. After replacing the battery, reinstall the cover. At this time, please be sure to replace gasket with new one for severe dust/liquid protection.

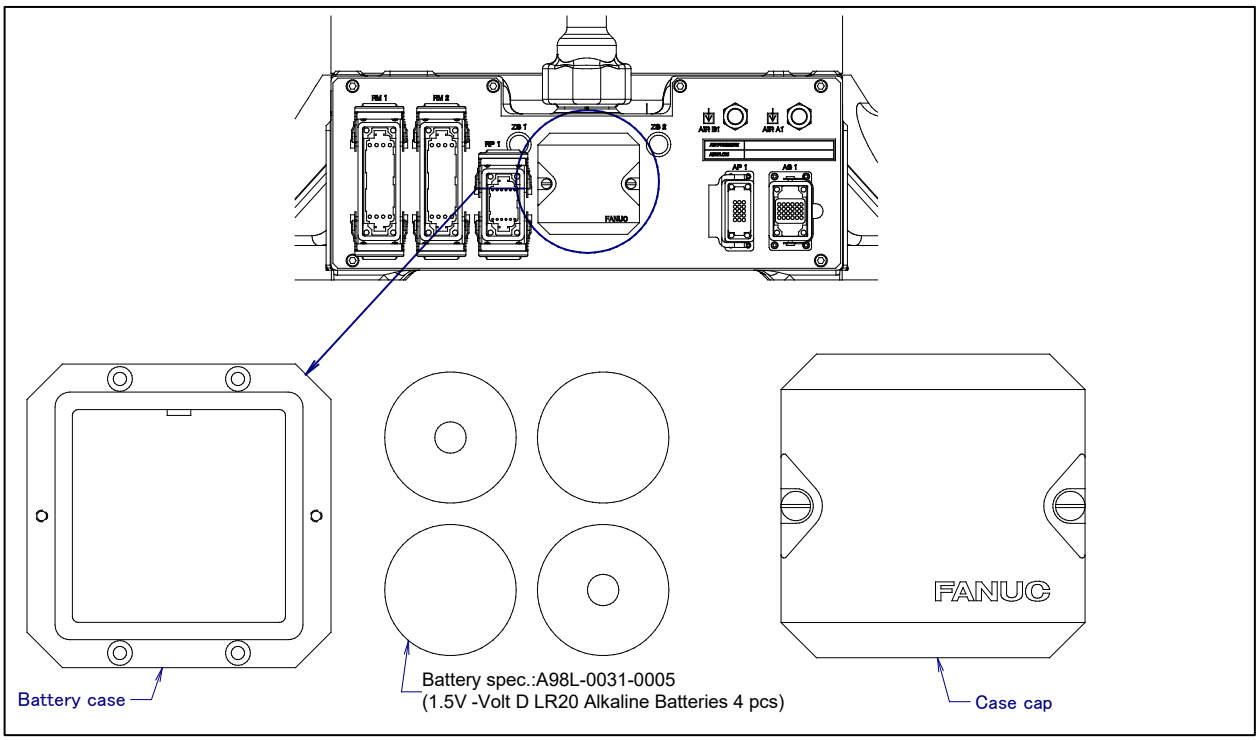


Fig. 7.3.2 (a) Replacing batteries

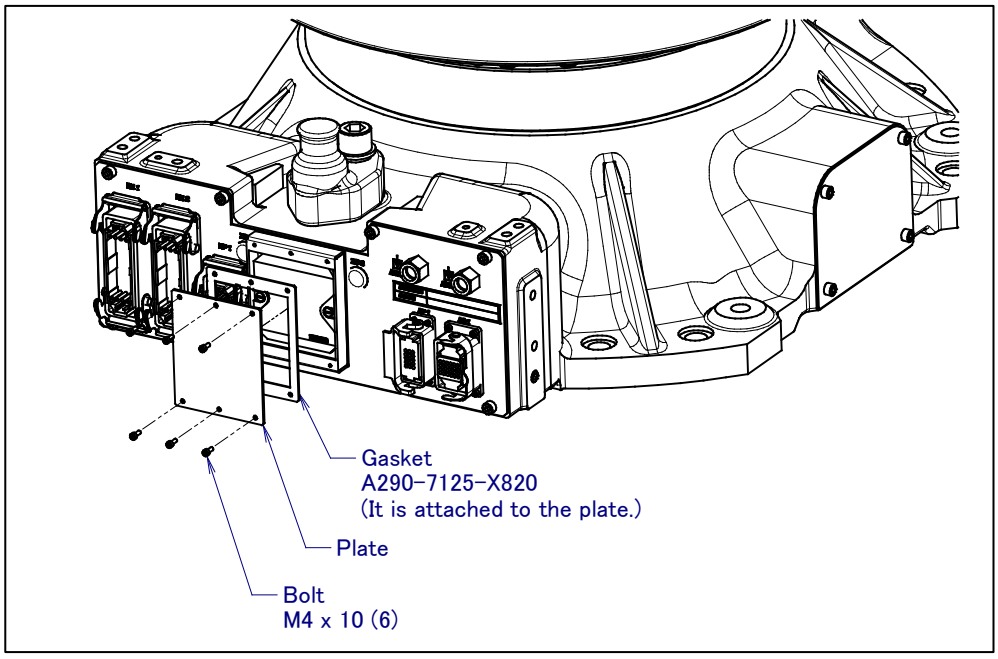


Fig. 7.3.2 (b) Removing the battery cover plate (When severe dust/liquid protection is specified)

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

According to below, replace the grease of the reducers of J1/J2/J3, J4/J5/J6-axis gearbox and the wrist at the intervals based on every 3 years or 11520 hours, whichever comes first. See Table 7.3.3 (a) for the grease name and the quantity.

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

Models	Grease supplying position	Quantity	Gun tip pressure	Grease bane
M-900*i*B/700 M-900*i*B/700E M-900*i*B/400L	J1-axis reducer	6100g (7000ml)	0.15MPa or less (NOTE)	Spec:A98L-0040-0174
	J2-axis reducer	4500g (5200ml)		
	J3-axis reducer	4500g (5200ml)		
	J4/J5/J6-axis gearbox	4000g (4600ml)		
	Wrist 1	2440g (2800ml)		
	Wrist 2	2440g (2800ml)		

NOTE
When using a hand pump, apply grease at a rate of approximately twice 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	J5	J6
J1-axis reducer	Arbitrary	Arbitrary	Arbitrary	Arbitrary	Arbitrary	Arbitrary
J2-axis reducer						
J3-axis reducer						
J4/J5/J6-axis gearbox			0°			
Wrist			0°	0°	0°	0°

⚠ 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 cautions.

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

Grease replacement procedure for the J1-axis reducer and J4/J5/J6-axis gearbox

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

Grease replacement procedure for the J2-axis, J3-axis reducers

1 Move the robot to the greasing posture described in Table 7.3.3 (b).
2 Turn off the controller power.
3 Remove the taper plug or seal bolt of grease outlet 1. (See Fig. 7.3.3 (a), (b))
4 Supply new grease until new grease is output from the grease outlet 1.
5 Attach the taper plug or seal bolt of grease outlet 1.
6 Remove the seal bolt of the grease outlet 2
7 Supply new grease until new grease is output from the grease outlet 2.
8 After applying grease, release the remaining pressure within the grease bath as described in the procedure in Subsection 7.3.4.

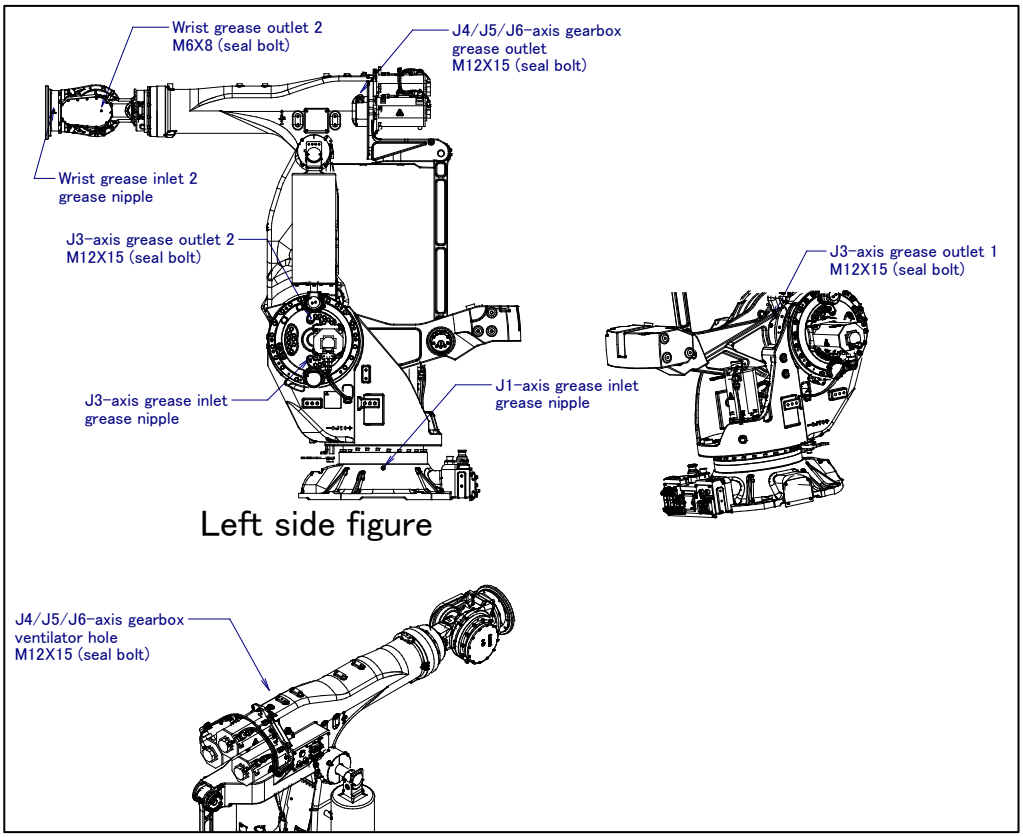


Fig. 7.3.3 (a) replacing grease of reducers (1/2)

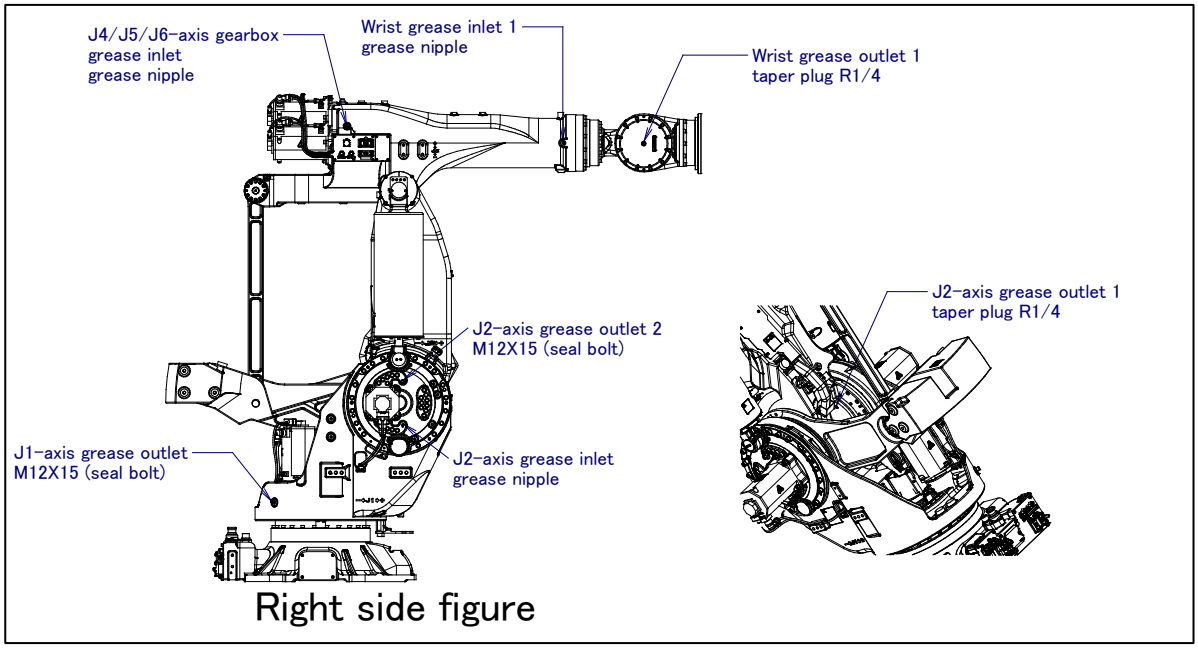


Fig. 7.3.3 (b) replacing grease of reducers (2/2)

Table 7.3.3 (c) Spec. of the seal bolt, the taper plug and the grease nipple

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

Grease replacement procedure for the wrist

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

7.3.4 Procedure for Releasing Remaining Pressure from the Grease Bath

After applying grease, operate the robot as instructed below to release the remaining pressure within the grease bath. Attach a recovery bag below the grease inlet and outlet to prevent output grease from splattering.

Grease replacement position	Motion angle	OVR	Operating time	Open points
J1-axis reducer	80° or more	50%	20 minutes	Grease inlet, outlet
J2-axis reducer	90° or more	50%	20 minutes	All grease inlets, outlets
J3-axis reducer	70° or more	50%	20 minutes	
J4/J5/J6-axis gearbox	J4 : 60° or more J5 : 120° or more J6 : 60° or more	100%	20 minutes	Grease outlet
Wrist	J4 : 60° or more J5 : 120° or more J6 : 60° or more	100%	20 minutes	All grease inlets, outlets

When the above operation is impossible due to ambient conditions, perform the program operation for a time equivalent to the above. (When the maximum allowable axis angle is half the specified angle, run the program for twice the specified time.) Upon completion of the above operation, attach the grease nipple or the seal bolt to each the grease inlet and outlet. When reusing the grease nipple and the seal bolt, 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**
> In case of performing mastering with gravity compensation (option) is enabled, if load setting (See Section 4.3) is not correct, it will influence the precision of the mastering.

8.1 OVERVIEW

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

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

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

Types of Mastering

Table 8.1 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.
Single axis vision axis mastering (option)	This is performed for one axis at a time with high precision by using vision. This is useful in performing mastering on a specific axis.
Mastering data entry	Enter the Mastering data directly.

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

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

> **⚠ CAUTION**
> 1 If mastering is performed incorrectly, the robot may behave unexpectedly. This is very dangerous. For this 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 then reset to 0 automatically, and the Master/Cal screen will disappear.
> 2 Before performing mastering, it is recommended that you back up the current mastering data.

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

When iRCalibration signature function (A05B-2600-R726) is specified, setting the *i*RCalibration signature to DISABLE is required before performing mastering.

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

Procedure for setting of enabling/disabling

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

8.3 RESETTING ALARMS AND PREPARING FOR MASTERING

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

Alarm displayed

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

Procedure

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

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

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

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

8.4 ZERO POSITION MASTERING (WHEN *i*RCalibration SIGNATURE FUNCTION IS NOT SPECIFIED)

Zero position mastering (witness mark mastering) is performed with all axes set at the 0-degree position. A zero-position mark (witness mark) is attached to each robot axis (Fig. 8.4 (a)). This mastering is performed with all axes set at the 0-degree position using their respective witness marks.

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

Zero-position Mastering Procedure

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

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

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

```
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
```

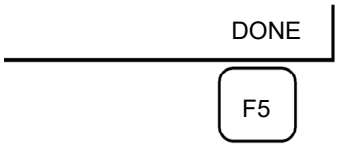
9 Jog the robot into a posture for mastering.
10 Select [2 ZERO POSITION MASTER]. Press F4 [YES].

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

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

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

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



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

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

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

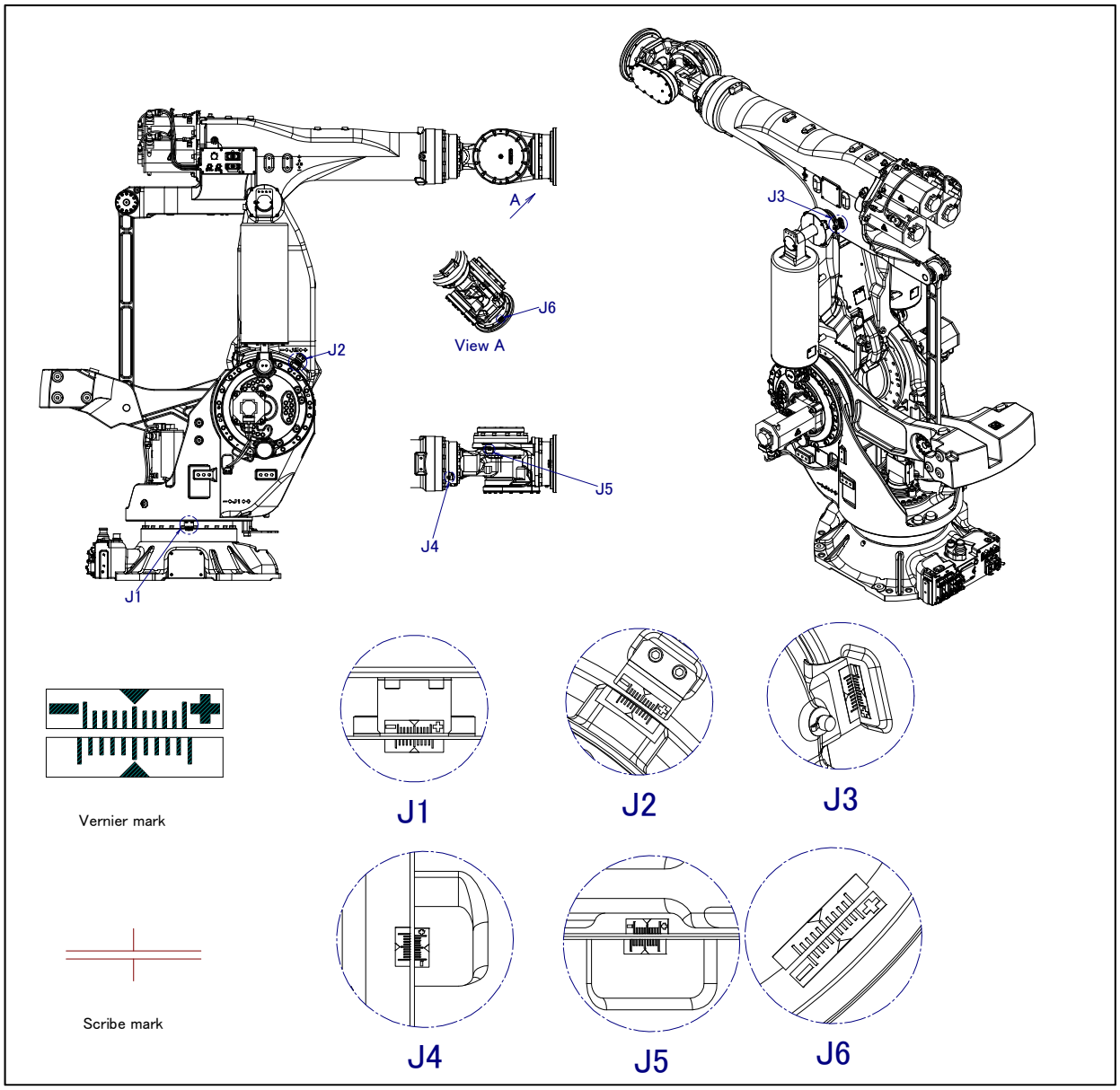


Fig. 8.3 (a) Zero-position mark (witness mark) for each axis

8.5 ZERO POSITION MASTERING (WHEN *i*RCalibration SIGNATURE FUNCTION IS SPECIFIED)

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

Zero-position Mastering Procedure

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

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

 [ TYPE ]   LOAD   RES_PCA                DONE
```

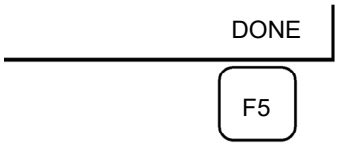
6 Jog the robot into a posture for mastering.
7 Select [2 Zero Position Master]. Press F4 [YES].

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

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

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

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



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

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

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

8.6 QUICK MASTERING (WHEN *i*RCalibration SIGNATURE FUNCTION IS NOT SPECIFIED)

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.)

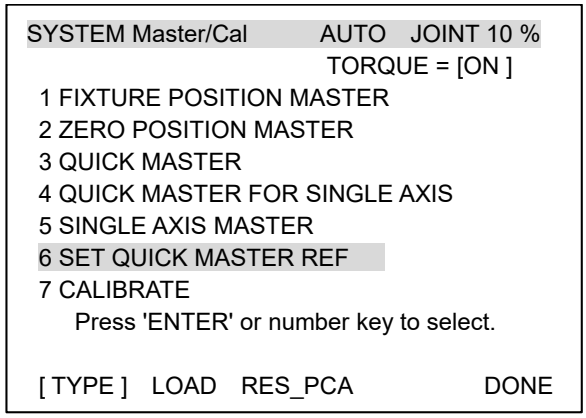
⚠ CAUTION
1 Quick mastering can be used, if the pulse count value is lost, for example, because a low voltage has been detected on the backup battery for the pulse counter.
2 Quick mastering cannot be used, after the motor is replaced or after the mastering data is lost from the robot controller.

Procedure Recording the Quick Mastering Reference Position

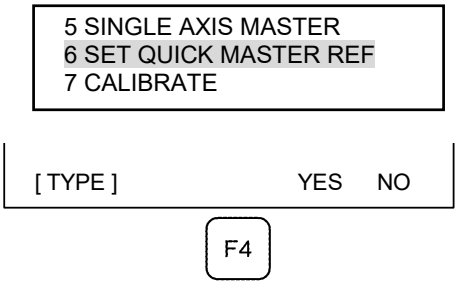
1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE]. Then select [Variables] from the menu.
4 If $DMR_GRP [group].$GRAV_MAST=1, set the gravity compensation to enabled, if it is 0, set the gravity compensation to disabled. In addition release the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

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

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



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



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

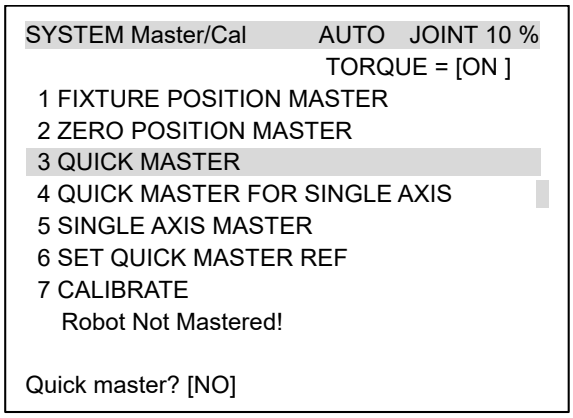
> **⚠ CAUTION**
> If the robot has lost mastering data due to mechanical disassembly or repair, you cannot perform this procedure. In this case, perform Fixture position mastering or Zero position mastering to restore mastering data.

Procedure of Quick Mastering

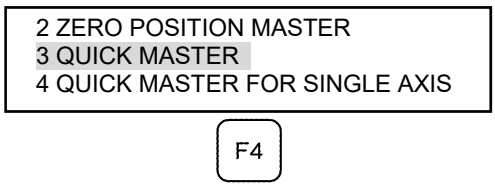
1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE]. Then select [Variables] from the menu.
4 If $DMR_GRP [group].$GRAV_MAST=1, set the gravity compensation to enabled, if it is 0, set the gravity compensation to disabled. In addition release the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

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

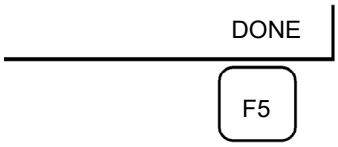
5 Display the Master/Cal screen.



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



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 the original setting, and cycle power of the controller.

8.7 QUICK MASTERING (WHEN *i*RCalibration SIGNATURE FUNCTION IS SPECIFIED)

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

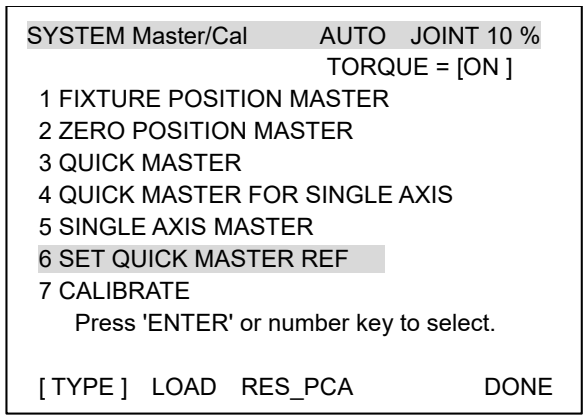
Quick mastering is factory-performed at the position indicated in Table 8.4 (a). If possible, do not change the setting.

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

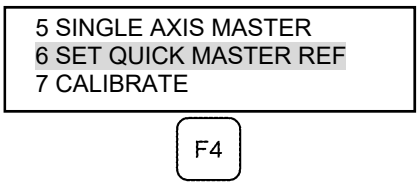
> ⚠ **CAUTION**
> 1 Quick mastering can be used, if the pulse count value is lost, for example, because a low voltage has been detected on the backup battery for the pulse counter.
> 2 Quick mastering cannot be used after the mastering data is lost from the robot controller.

Procedure Recording the Quick Mastering Reference Position

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



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

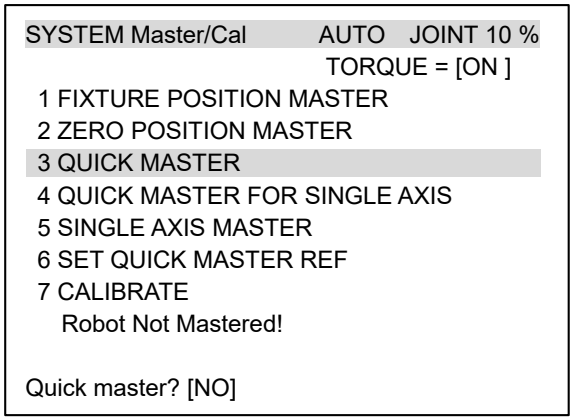


5 Cycle power of the controller.

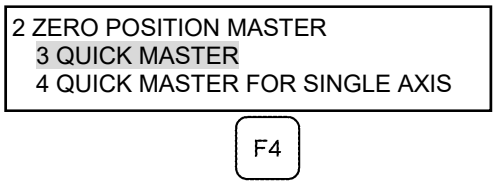
> **⚠ CAUTION**
> If the robot has lost mastering data due to mechanical disassembly or repair, you cannot perform this procedure. In this case, perform Fixture position mastering or Zero position mastering to restore mastering data.

Procedure of Quick Mastering

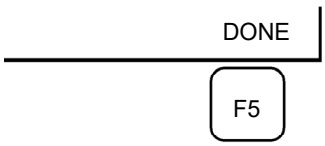
1 According to Subsection 8.2, set the signature to disable.
2 Press the [MENU] key to display the screen menu.
3 Select [0 NEXT] and press [6 SYSTEM].
4 Display the Master/Cal screen.



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



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



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

8.8 QUICK MASTERING FOR SINGLE AXIS (WHEN *i*RCalibration SIGNATURE FUNCTION IS NOT SPECIFIED)

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 8.4 (a). Do not change the setting unless there is any problem.

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

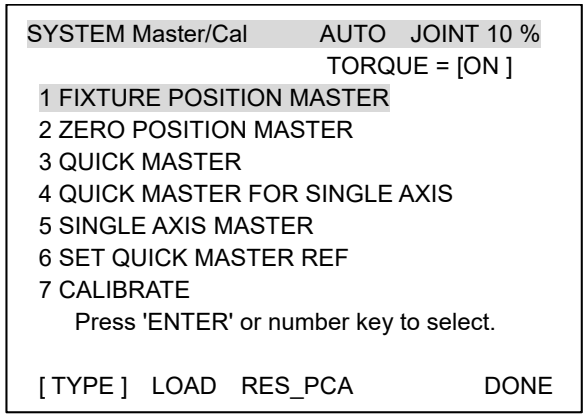
⚠ CAUTION
1 Quick mastering can be used, if the pulse count value is lost, for example, because a low voltage has been detected on the backup battery for the pulse counter.
2 Quick mastering cannot be used, after the motor is replaced or after the mastering data is lost from the robot controller.

Procedure Recording the Quick Mastering Reference Position

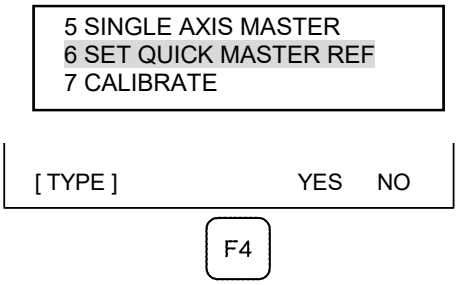
1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE]. Then select [Variables] from the menu.
4 If $DMR_GRP [group].$GRAV_MAST=1, set the gravity compensation to enabled, if it is 0, set the gravity compensation to disabled. In addition release the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

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

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



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



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

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

Procedure of Quick Mastering for single axis

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

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

5 Display the Master/Cal screen.

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

 [ TYPE ]   LOAD   RES_PCA                DONE
```

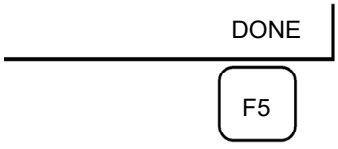
6 Select [4 QUICK MASTER FOR SINGLE AXIS]. You will see the quick master for single axis screen.

```
                                   AUTO JOINT 1%
QUICK MASTER FOR SINGLE AXIS
                                                    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.

```
                                   AUTO JOIN 1%
QUICK MASTER FOR SINGLE AXIS
                                                    1/9
    ACTUAL   POS    (MSTR POS)     (SEL)    [ST]
J5          0.000   (     0.000)   (1)      [2]
J6          0.000   (     0.000)   (1)      [2]

                                                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 F4 [YES]. Calibration is executed. Calibration is executed by cycling power.
11 After completing the calibration, press F5 [DONE].



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

8.9 QUICK MASTERING FOR SINGLE AXIS (WHEN *i*RCalibration SIGNATURE FUNCTION IS SPECIFIED)

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

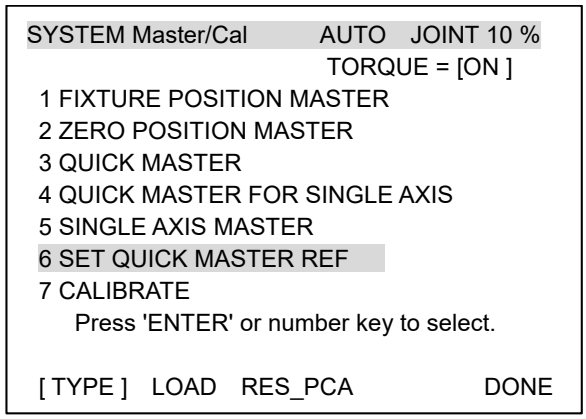
Quick mastering is factory-performed at the position indicated in Table 8.3 (a). If possible, do not change the setting.

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

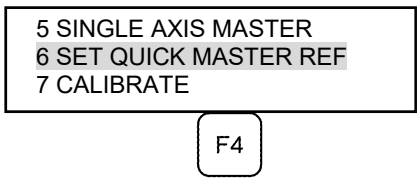
⚠ CAUTION
1 Quick mastering can be used, if the pulse count value is lost, for example, because a low voltage has been detected on the backup battery for the pulse counter.
2 Quick mastering cannot be used after the mastering data is lost from the robot controller.

Procedure Recording the Quick Mastering Reference Position

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



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



5 Cycle power of the controller.

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

Procedure of Quick Mastering for single axis

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

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

Quick master? [NO]
```

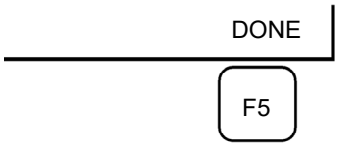
5 Select [4 QUICK MASTER FOR SINGLE AXIS]. You will see the quick master for single axis screen.

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

                                                EXEC
```

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

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

                                                EXEC
```

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



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

8.10 SINGLE AXIS MASTERING (WHEN iRCalibration SIGNATURE FUNCTION IS NOT SPECIFIED)

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

SINGLE AXIS MASTER AUTO JOINT 10%

1/9

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

EXEC

Table 8.6 (a) Items set in single axis mastering

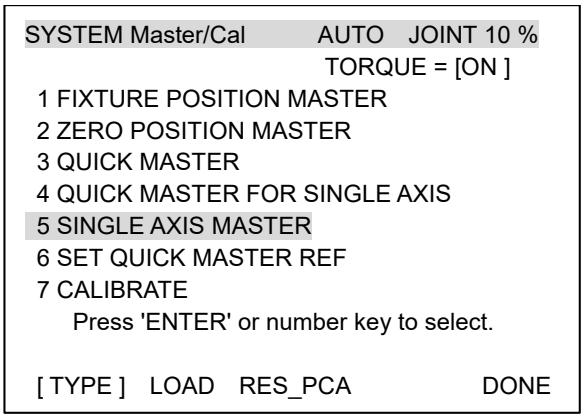
Item	Description
Current position (ACTUAL AXIS)	The current position of the robot is displayed for each axis in degree units.
Mastering position (MSTR POS)	A mastering position is specified for an axis to be subjected to single axis mastering. It would be convenient if it is set to 0 degree position.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

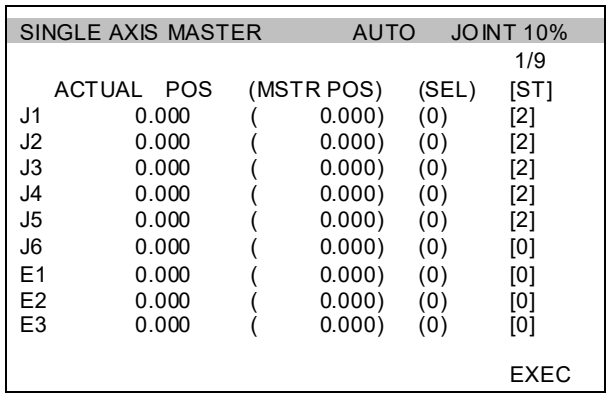
1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE]. Then select [Variables] from the menu.
4 If $DMR_GRP [group].$GRAV_MAST=1, set the gravity compensation to enabled, if it is 0, set the gravity compensation to disabled. In addition release the 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 (disabled) or TRUE (enabled)
Brake control can be released by setting the system variables as follows:
$PARAM_GROUP.SV_OFF_ALL : FALSE
$PARAM_GROUP.SV_OFF_ENB[*] : FALSE (for all axes)
After changing the system variables, cycle power of the controller.

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



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



8 Move the cursor to the [SEL] column for the unmastered axis and press the numeric key [1]. Setting of [SEL] is available for one or more axes.
9 Turn off brake control, then jog the robot to the mastering position.
10 Enter axis data for the mastering position.

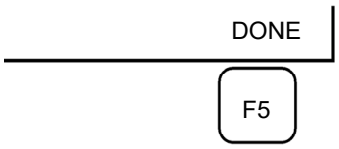
11 Press F5 [EXEC]. Mastering is performed. So, [SEL] is reset to 0, and [ST] is re-set to 2 or 1.

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

                                        EXEC
```

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

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

 [ TYPE ]   LOAD   RES_PCA              DONE
```

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



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

8.11 SINGLE AXIS MASTERING (WHEN *i*RCalibration SIGNATURE FUNCTION IS SPECIFIED)

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

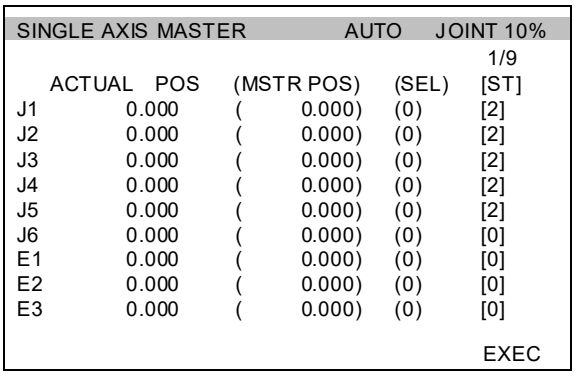
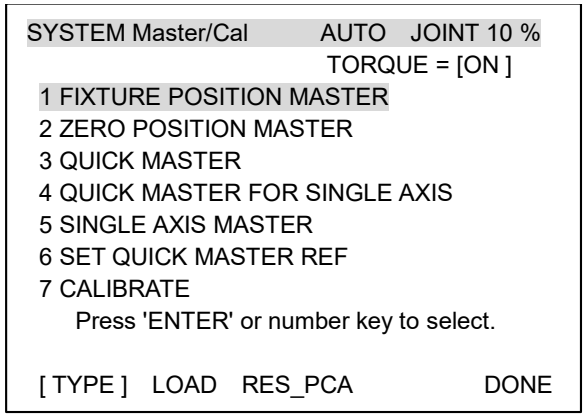


Table 8.6 (a) Items set in single axis mastering

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

Procedure of Single axis mastering

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



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

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

                                          EXEC
```

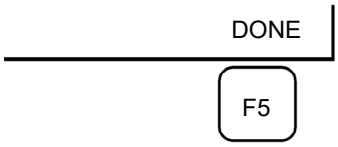
6 Move the cursor to the (SEL) column for the unmastered axis and press the numeric key [1]. Setting of (SEL) is available for one or more axes.
7 Jog the robot to the mastering position.
8 Enter axis data for the mastering position.
9 Press F5 [EXEC]. Mastering is performed. So, (SEL) is reset to 0, and [ST] is re-set to 2 or 1.

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

                                          EXEC
```

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

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

 [ TYPE ]   LOAD   RES_PCA              DONE
```

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



13 Cycle power of the controller.
14 According to Subsection 8.2, set the signature to enable.

8.12 SINGLE AXIS VISION AXIS MASTERING

Single axis mastering can be performed with high precision by using vision axis master. Target mark have cover plate as Fig. 8.12 (a). Refer to Fig. 8.12 (b) about target jig. Refer to VISION AXIS MASTER chapter of *i*RCalibration operator's manual (B-83724EN) about vision axis master. Refer to Table 8.12 (a) about measurement position. (Only M-900*i*B/700)

Table 8.12 (a) Measurement position for vision axis mastering

Measured axis	posture					
	J1-axis	J2-axis	J3-axis	J4-axis	J5-axis	J6-axis
J1-axis	0°	Arbitrary				
J2-axis	Arbitrary	0°				
J3-axis	Arbitrary	0°				
J4-axis	Arbitrary		0°			
J5-axis	Arbitrary		0°			
J6-axis	Arbitrary		0°			

Reference data setting function is executed in the FANUC robot factory before shipping the robot. There is not tool attached. However, the weight of a tool can cause an error in the reference data. After a tool is attached, the *reference data setting* function should be performed and saved again. (This new reference data needs to be used if the mastering status needs to be recovered.)

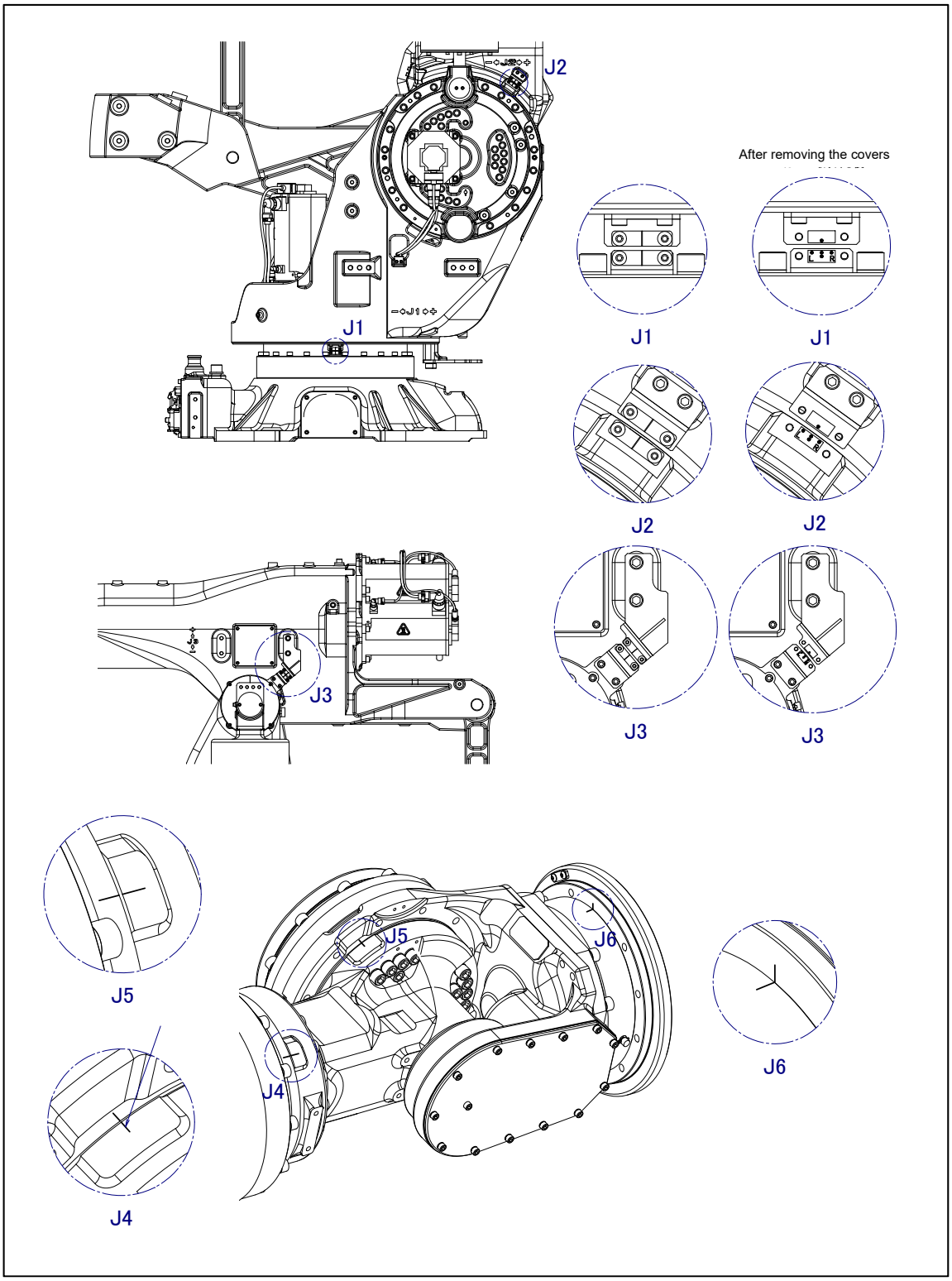


Fig. 8.12 (a) Target mark cover plate

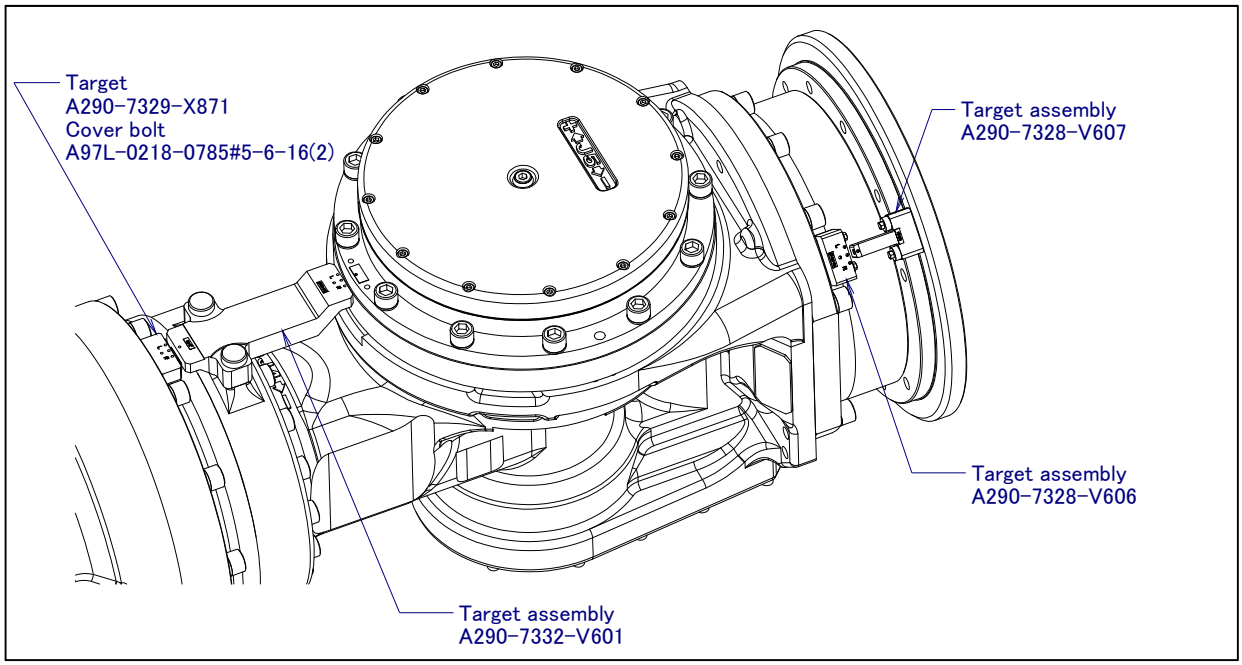


Fig. 8.12 (b) Target jig

8.13 MASTERING DATA ENTRY (WHEN *i*RCalibration SIGNATURE FUNCTION IS SPECIFIED)

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

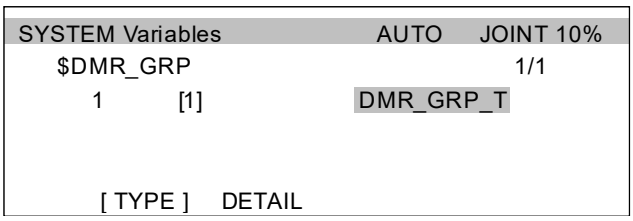
1 Press the [MENU] key, then press [0 NEXT] and select [6 SYSTEM].
2 Press F1 [TYPE]. Select [Variables]. The system variable screen will be displayed.

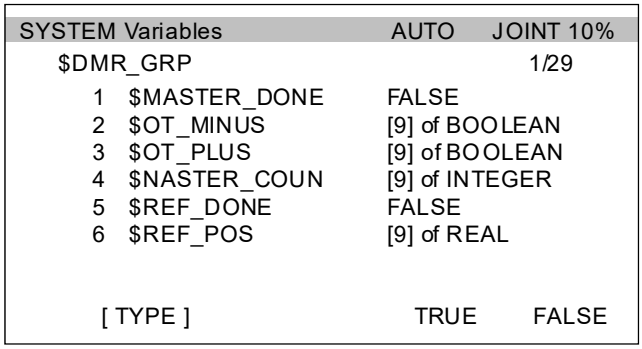
```
SYSTEM Variables                AUTO    JOINT 10%
                                              1/669
  1  $AAVM_GRP                  AAVM_GRP_T
  2  $AAVM_WRK                  AAVM_WRK_T
  3  $ABSPOS_GRP                ABSPOS_GRP_T
  4  $ACC_MAXLMT                0
  5  $ACC_MINLMT                0
  6  $ACC_PRE_EXE               0


     [ TYPE ]    DETAIL
```

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

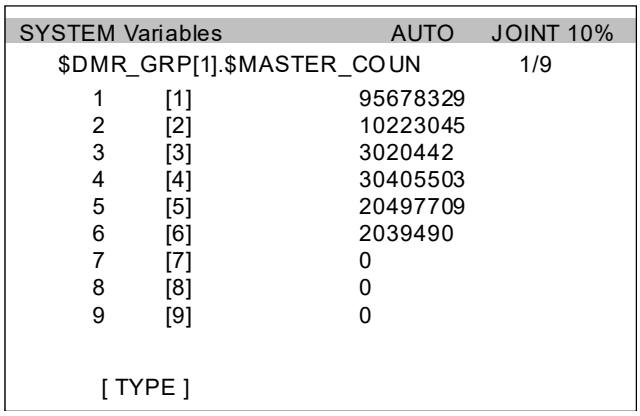
```
SYSTEM Variables                AUTO    JOINT 10%
                                              1/669
  135  $DMR_GRP                  DMR_GRP_T
  136  $DMSW_CFG                 DMSW_CFG_T


     [ TYPE ]
```

4 Select $DMR_GRP.

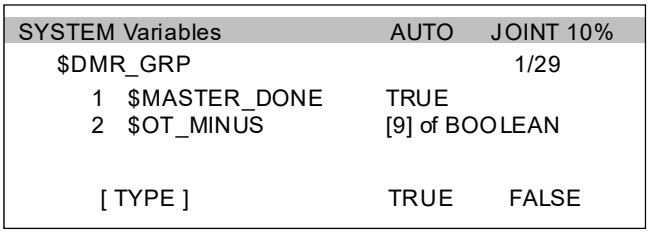




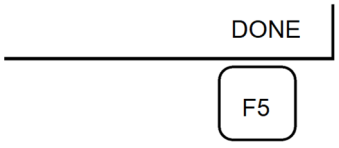
5 Select $MASTER_COUN, and enter the mastering data you have recorded.



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



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



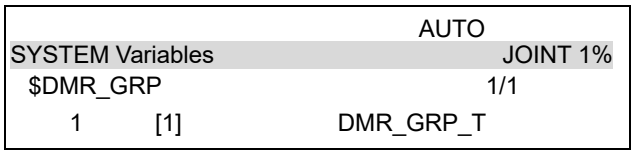
8.14 MASTERING DATA ENTRY (WHEN *i*RCalibration SIGNATURE FUNCTION IS SPECIFIED)

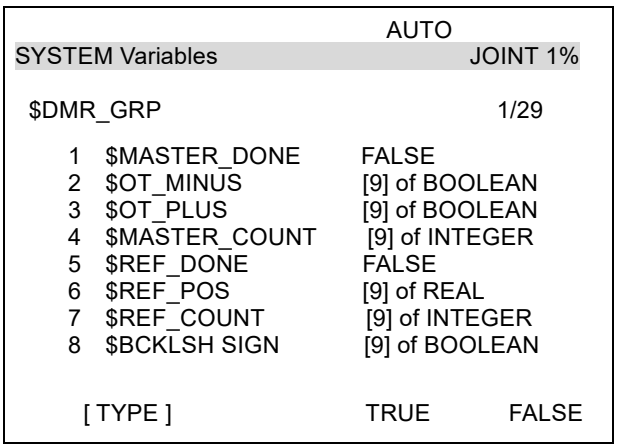
This function enables mastering data values to be assigned directly to a system variable. It can be used if mastering data has been lost but the pulse count is preserved.

NOTE
Mastering data entry needs the back up of $SYSMAST.SV file.

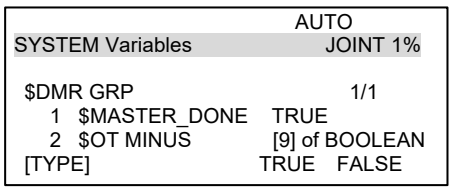
Mastering data entry method

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

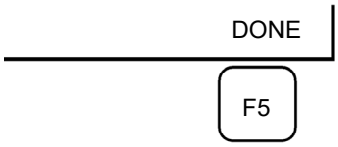




10 Set $MASTER_DONE to TRUE.



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



8.15 VERIFYING MASTERING

1 How to verify that the robot is mastered properly:
Usually, positioning is performed automatically when the power is turned on. To check whether mastering has been performed correctly, examine if the current displayed position meets the actual robot position by using the procedure described below:
(1) Reproduce a particular point in a program. Check whether the point agrees with the specified position.
(2) Set all axes of the robot to their 0-degree (0 rad) positions. Check that the zero-degree position marks indicated in Section 8.4 of Operator's Manual are aligned. There is no need to use a visual aid.

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

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

9 TROUBLESHOOTING

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

9.1 TROUBLESHOOTING

Table 9.1 (a) shows the major troubleshooting symptoms that may occur in the mechanical unit and their probable causes. If you cannot pinpoint a failure cause or which measures to take, contact your local FANUC representative. For troubleshooting except the mechanical unit, refer to "CONTROLLER MAINTENANCE MANUAL (B-83195EN etc.)" and Alarm Code List (B-83284EN-1).

Table 9.1 (a) Troubleshooting

Symptom	Description	Cause	Measure
Vibration noise	- As the robot operates, its base plate lifts off the floor plate. - There is a gap between the base plate and the floor plate. - There is a crack in the weld that fastens the base plate to the floor plate.	[Base plate and floor plate fastening] - It is likely that the base plate is not securely fastened to the floor plate because of poor welding. - If the robot is not securely fastened to the floor plate, the J1 base lifts the floor plate as the robot operates, allowing the base and floor plates to strike each other. That, in turn, leads to vibration.	- Re-weld the base plate to the floor plate. - If the weld is not strong enough, increase its width and length.
	- The J1 base lifts off the base plate as the robot operates. - There is a gap between the J1 base and base plate. - A J1 base retaining bolt is loose.	[J1 base fastening] - It is likely that the robot J1 base is not securely fastened to the base plate. - Probable causes are a loose bolt, an insufficient degree of surface flatness, or contamination caught between the base plate and floor plate. - If the robot is not securely fastened to the floor plate, the J1 base lift from the ground. Thus may cause the collision, and lead to vibration.	- If a bolt is loose, apply LOCTITE and tighten it to the appropriate torque. - Adjust the base plate surface flatness to within the specified tolerance. - If there is any contamination, eliminate them. - Apply adhesive between the J1 base and base plate.
	- The rack or floor plate vibrates during operation of the robot.	[Rack or floor] - It is likely that the rack or floor is not rigid enough. - If they are not rigid enough, counterforce can deform the rack or floor, and cause vibration.	- Reinforce the rack or floor to make it more rigid. - If reinforcing the rack or floor is impossible, modify the robot control program; doing so might reduce the vibration.

Symptom	Description	Cause	Measure
Vibration noise	- Vibration becomes more serious when the robot is in a specific posture. - If the operating speed of the robot is reduced, vibration stops. - Vibration is most noticeable when the robot is accelerating. - Vibration occurs when two or more axes operate at the same time.	[Overload] - It is likely that the load on the robot is heavier than the maximum rating. - It is likely that the robot control program is too demanding for the robot hardware. - It is likely that the ACCELERATION value is excessive.	- Check the maximum load that the robot can handle or not. If the robot is overloaded, reduce the load, or modify the robot control program. - Vibration can be reduced by re-modifying the robot control program; reducing speed or acceleration with minimizing the influence on the entire cycle time.
	- 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 exchanged for a long period. - Cyclical vibration and noise occur.	[Gear, bearing, or reducer] - It is likely that collision or overload applied an excessive force on the drive mechanism, thus damaging the gear tooth surface or rolling surface of a bearing, or reducer. - Prolonged use with overloaded may cause the fretting fatigue on gear tooth surface or rolling surface of bearing and reducer. - It is likely that contamination caught in a gear, bearing, or within a reducer has caused damage on the gear tooth surface or rolling surface of the bearing, or reducer. - It is likely that 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 by neglect greasing.	- Operate each axis at individually to judge which axis has been vibrating. - Remove the motor, and replace the gear, the bearing, and the reducer. For the specification of parts and the procedure of replacement, contact your local FANUC representative. - Using the robot within its maximum rating prevents problems with the drive mechanism. - Regularly greasing with the specified grease can help prevent problems.

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- The cause of problem cannot be identified from examination of the floor, rack, or mechanical unit.	[Controller, cable, and motor] - If a failure occurs in a controller circuit, preventing control commands from being supplied to the motor normally, or preventing motor information from being sent to the controller normally, vibration might occur. - Pulsecoder defect may be the cause of the vibration as the motor cannot propagate the accurate position to the controller. - If the motor becomes defective, vibration might occur because the motor cannot deliver its rated performance. - If a power line in a movable cable of the mechanical unit has an intermittent break, vibration might occur because the motor cannot accurately respond to commands. - If a Pulsecoder wire in a movable part of the mechanical unit has an intermittent break, vibration might occur because commands cannot be sent to the motor accurately. - If a robot connection cable has an intermittent break, vibration might occur. - If the power supply cable is about to be snapped, vibration might occur. - If the power source voltage drops below the rating, vibration might occur. - It may vibrate when an invalid value parameter was set.	- Refer to the Controller Maintenance Manual for troubleshooting related to the controller and amplifier. - Replace the motor of the axis that is vibrating, and check whether vibration still occurs. For the method of replacement, contact your local FANUC representative. - If vibration occurs only when the robot assumes a specific posture, it is likely that a cable in the mechanical unit is broken. - Shake the movable part cable while the robot is at rest, and check whether an alarm occurs. If an alarm or any other abnormal condition occurs, replace the mechanical unit cable. - Check whether the 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 FANUC for further information if necessary.

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- There is some relationship between the vibration of the robot and the operation of a machine near the robot.	[Noise from Peripheral] - If the robot is not grounded properly, electrical noise can be induced on the grounding wire, preventing commands from being transferred accurately, thus will lead to vibrate. - If the robot is grounded at an unsuitable point, its grounding potential becomes unstable, and noise is likely to be induced on the grounding line, thus will lead to vibrate.	- Connect the grounding wire firmly to ensure a reliable ground potential thereby preventing extraneous electrical noise.
	- There is an unusual sound after replacement of grease. - There is an unusual sound after a long period of time. - There is an unusual sound during operation at low speed.	- There may be an unusual sound when using other than the specified grease. - Even for the specified grease, there may be an unusual sound during operation at low speed immediately after replacement or after a long period of time.	- Use the specified grease. - When there is an abnormal noise even when using the specified grease, operate for one or two days as an experiment. Generally, the abnormal noise will disappear.
Rattling	- While the robot is not supplied with power, pushing it with the hand causes tottering part of the mechanical unit. - There is a gap on the mounting face of the mechanical unit.	[Mechanical unit coupling bolt] - It is likely that overloading or a collision has loosened a mounting bolt in the robot mechanical unit.	- Check the following retaining bolts tightness for each axis. If any of these bolts is loose, apply LOCTITE and bolt down with appropriate torque. - Motor - Reducer - Reducer shaft - Base - Arm - End effector

Symptom	Description	Cause	Measure
Motor overheating	- The motor overheated due to a rise in temperature in the installation area. - After a cover was attached to the motor, the motor overheated. - After changing the Robot control program or the load, the motor overheated.	[Ambient temperature] - It is likely that a rise in the ambient temperature or attaching the motor cover prevented the motor from releasing heat efficiently, thus leading to overheating. [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 load condition is an effective way to reduce the average current. Thus, prevent overheating. - 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 of the operator's manual.
	- Symptom other than stated above	[Mechanical unit problems] - It is likely that problems occurred in the mechanical unit drive mechanism, thus placing an excessive load on the motor. [Motor problems] - It is likely that motor brake failure locked on the break, and cause the motor overloaded. - It is likely that a failure of the motor prevented it from delivering its rated performance, thus causing an excessive current to flow into the motor. - It is likely that cooling fan is broken.	- Repair the mechanical unit referring to the above descriptions of vibration, noise, and rattling. - Check that, when the servo system is energized, the brake is released. If the brake remains applied to the motor all the time, replace the motor. - Judgment is possible if the average current decreased after replacing the motor, the former motor had been defected. - If the cooling fan is broken, replace it by new one.

Symptom	Description	Cause	Measure
Grease leakage	- Grease leaks from the mechanical unit.	[Poor sealing] - Probable cause is a crack in the casting, a broken O-ring, a damaged oil seal, or a loose seal bolt. - The casting may crack with excessive force caused in collision. - An O-ring can be damaged if it is trapped or cut during disassembling or re-assembling. - An oil seal may be damaged if extraneous dust scratches the lip of the oil seal. - A loose seal bolt may allow grease to leak along the threads. - Problems with the grease nipple or threads	- If a crack develops exist 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 propagate. - O-rings are used in the locations listed below. - Motor coupling section - Reducer (case and shaft) coupling section - Wrist coupling section - J3 arm coupling section - Inside the wrist - Oil seals are used in the locations stated below. - Inside the reducer - Inside the wrist - Seal bolts are used in the locations stated below. - Grease drain outlet - Replace the grease nipple.
Dropping axis	- An axis falls because the brake went out. - An axis falls while standing still.	[Brake drive relay and motor] - It is likely that brake drive relay contacts are stuck to each other and keep the brake current flowing, thus preventing the brake from operating when the motor is reenergized. - It is likely that the brake shoe has worn out or the brake main body is damaged, preventing the brake from operating efficiently. - It is likely that oil or grease soak through the motor, causing the brake to slip.	- Check whether the brake drive relays are stuck to each other or not. If they are found to be stuck, replace the relays. - Replace the motor after confirming whether the following symptoms have occurred. - Brake shoe is worn out - Brake main body is damaged - Oil soaked through the motor

Symptom	Description	Cause	Measure
Displace-ment	- The robot moves to a point other than the taught position. - The repeatability is not within the tolerance.	[Mechanical unit problems] - If the repeatability is unstable, probable causes are a failure in the drive mechanism or a loose bolt, and so on. - If the repeatability is stable, it is likely that collision by an excessive load caused slip on the fasting surface of each axis arm, and reducer. - It is likely that the Pulsecoder is abnormal.	- If the repeatability is unstable, repair the mechanical unit by referring to the above descriptions of vibration, noise, and rattling. - If the repeatability is stable, correct the taught program. Variation will not occur unless another collision occurs. - If the Pulsecoder is abnormal, replace the motor or the Pulsecoder.
	- Displacement occurs only in a specific peripheral unit.	[Peripheral unit displacement] - It is likely that an external force was applied to the peripheral unit, thus shifting its position relative to the robot.	- Correct the setting of the peripheral unit position. - Correct the taught program.
	- Displacement occurred after a parameter was changed.	[Parameter] - It is likely that the mastering data was overwritten, and the origin had misaligned.	- Re-enter the previous optimal mastering data. - If optimal mastering data is unavailable, perform mastering again.

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

10 SEVERE DUST/LIQUID PROTECTION OPTION

10.1 SEVERE DUST/LIQUID PROTECTION PACKAGE (OPTION)

The package is intended to improve the dustproof and waterproof characteristics of the robot so that it can be used in a severe environment.
Refer to Section 3.1 about dustproof and waterproof characteristics of the M-900*i*B.

NOTE
Contact your FANUC representative for confirmation that the Severe Dust/liquid protection package is suitable for your environment.

Model	Severe dust/liquid protection specification
M-900*i*B/700	A05B-1332-J801
M-900*i*B/400L	A05B-1332-J802

10.2 PROTECTION PACKAGE

The following table lists the major differences between the M-900*i*B standard specification and severe dust/liquid protection package.

	Standard specification	Dust-proof/drip-proof enhancement option	
	Entire mechanical unit	Main unit	J3 arm and wrist
Bolts	Black oxide finish steel bolt Black oxide finish washer	FR coating bolt Black chromate washer Stainless bolt Black oxide finish steel bolt	FR coating bolt Stainless bolt Black chromate washer
Cover		J1-axis motor cover J2-axis motor cover J3-axis motor cover J4, J5, J6-axis motor cover Battery box cover Cable cover in mechanical unit (for all exposed cables)	
J3 connector plate EE (RI/RO) connector	Non-waterproof connector	Waterproof connector	

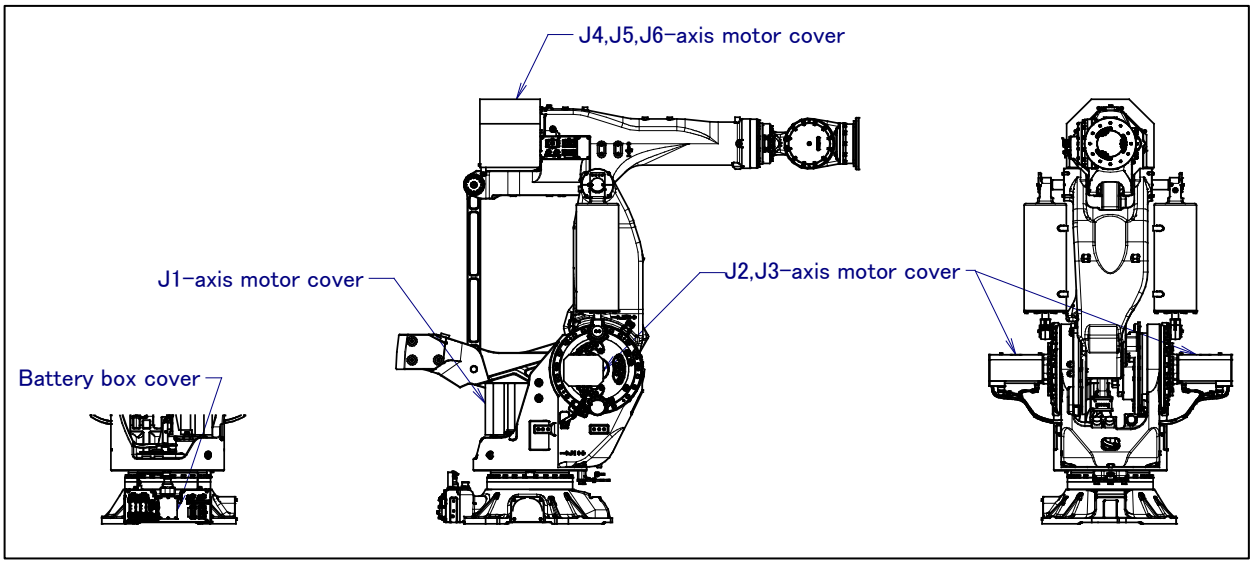


Fig. 10.2 (a) Configuration of the severe dust/liquid protection package

APPENDIX

A PERIODIC MAINTENANCE TABLE

FANUC Robot M-900*i*B/700/700E/400L **Periodic Maintenance Table**

Items		Accumulated operating time (H)	Check time	Grease amount	First check 320	3 months 960	6 months 1920	9 months 2880	1 year 3840	4800	5760	6720	2 years 7680	8640	9600	10560
Mechanical unit	1	Check for external damage or peeling paint	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	2	Check damages of the cable protective sleeves	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	3	Check wear debris of 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	0.1H	—		○			○				○			
	7	Check the motor connector. (loosening)	0.2H	—		○			○				○			
	8	Tighten the end effector bolt.	0.1H	—		○			○				○			
	9	Tighten the cover and main bolt.	2.0H	—		○			○				○			
	10	Check the mechanical stopper and adjustable mechanical stopper	0.1H	—		○			○				○			
	11	Clean spatters, sawdust and dust	0.1H	—		○			○				○			
	12	Check the operation of the cooling fan	0.1H	—		○			○				○			
	13	Replacing batteries *3	0.1H	—							●					
	14	Replacing grease of J1 axis reducer	1.0H	7000ml												
	15	Replacing grease of J2 axis reducer	1.0H	5200ml												
	16	Replacing grease of J3 axis reducer	1.0H	5200ml												
	17	Replacing grease of J4/J5/J6- axis gearbox	1.0H	4600ml												
	18	Replacing grease of the wrist axis (J5/J6)	1.0H	5600ml												
	19	Supply grease to J2/J3-axis connection part taper roller	0.1H	Each 20ml												
	20	Supply grease to J3 link taper Roller part	0.1H	Each 30ml												
	21	Replacing cable of mechanical unit	4.0H	—												
Controller	22	Check the robot cable, teach pendant cable and robot connecting cable	0.2H	—		○			○				○			
	23	Cleaning the ventilator	0.2H	—	○	○	○	○	○	○	○	○	○	○	○	○
	24	Replacing batteries *1 *3	0.1H	—												

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

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

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

3 years 11520	12480	13440	14400	4 years 15360	16320	17280	18240	5 years 19200	20160	21120	22080	6 years 23040	24000	24960	25920	7 years 26880	27840	28800	29760	8 years 30720	Item
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		1
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		2
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		3
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		4
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○				○				○				○				○					6
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				●																	24

B STRENGTH OF BOLT AND BOLT TORQUE LIST

NOTE

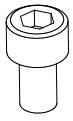
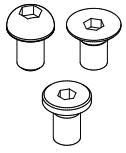
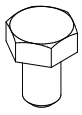
When applying LOCTITE to a part, spread the LOCTITE on the entire length of the engaging part of the female thread. If applied to the male threads, poor adhesion can occur, potentially loosening the bolt. Clean the bolts and the threaded holes and wipe off any oil on the engaging section. Make sure that 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 M20 or less: Tensile strength 1200N/mm^2 or more
Size M22 or more: Tensile strength 1000N/mm^2 or more
All size plated bolt: Tensile strength 1000N/mm^2 or more

Hexagon bolt, stainless bolt, special shape bolt (button bolt, low-head bolt, flush bolt .etc.)
Tensile strength 400N/mm^2 or more
Refer to the following tables if the bolts tightening torque is not specified.

Recommended bolt tightening torques **Unit: Nm**

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

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REVISION RECORD

Edition	Date	Contents
06	Jan, 2023	• Addition of M-900*i*B/700E • Addition of mastering procedure for *i*RCalibration signature function • Correction of errors
05	Feb, 2022	• Addition of option cables • Correction of errors
04	Jun, 2017	• Addition of R-30*i*B Plus Controller • Correction of errors
03	Sep., 2015	• Addition of quick mastering for single axis • Correction of errors
02	Oct., 2013	• Addition of M-900*i*B/400L • Addition of severe dust/liquid protection option • Change of grease replacing procedure of J2/J3-axes • Correction of errors
01	Aug., 2012	

B-83444EN/06