FANUC Robot F-200*i*B

MECHANICAL UNIT

OPERATOR'S MANUAL

B-81724EN/01

- **Original Instructions**

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

This manual can be used with controllers labeled R-30*i*A or R-J3*i*C. If you have a controller labeled R-J3*i*C, you should read R-30*i*A as R-J3*i*C throughout this manual.

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

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

SAFETY PRECAUTIONS

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

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

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

1 PERSONNEL

Personnel can be classified as follows.

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

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

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

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

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

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

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

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

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

2 DEFINITION OF SAFETY NOTATIONS

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

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

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

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

Name	Specification
Brake release unit	A05B-2450-J350 (Input Voltage AC100-115V single-phase) A05B-2450-J351 (Input Voltage AC200-240V single-phase)
Robot connection cable	A05B-2450-J370 (5m) A05B-2450-J371 (10m)
Power cable	A05B-2525-J010 (5m) (AC100-115V Power plug) (*) A05B-2525-J011 (10m) (AC100-115V Power plug) (*) A05B-2450-J364 (5m) (No power plug) A05B-2450-J365 (10m) (No power plug)

(*) These do not support CE marking.

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

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

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

⚠ WARNING
Robot arm would fall down by releasing its brake because of gravity. Therefore it is strongly recommended to take adequate measures such as hanging Robot arm by a crane before releasing a brake.

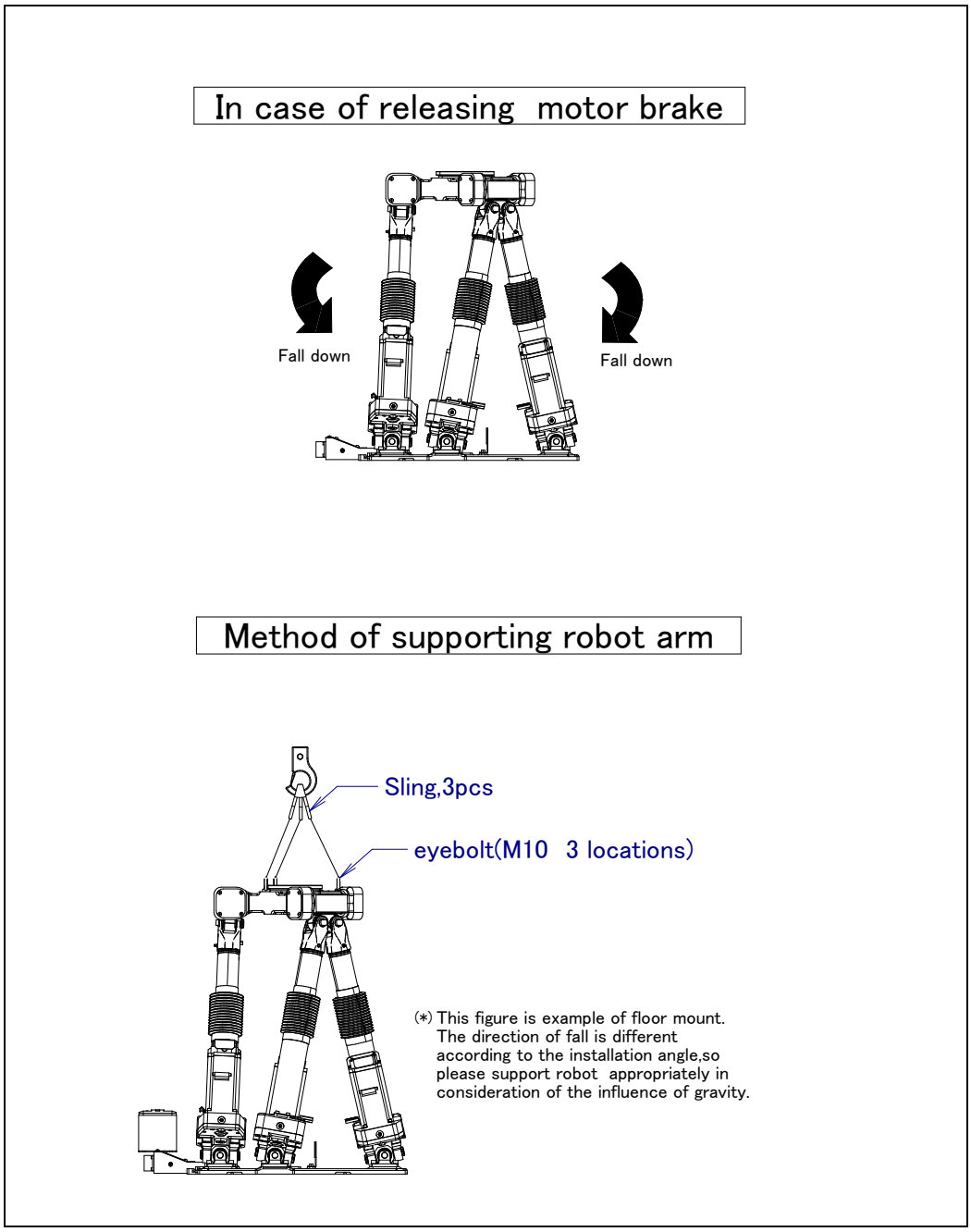


Fig. 3 (a) Arm operation by the release of J2,J3-axis motor brakes and measures

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.

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

> ⚠ **CAUTION**
> See Section 3.1 ″ GREASE REPLACEMENT for explanations about specified grease, the grease amount, and the locations of grease and degrease 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 or controller as it may adversely affect the robot or controller and you may get hurt if you lose your footing as well.

(3) High-temperature warning label

Fig. 4 (c) High-temperature warning label

Description

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

(4) Transportation label

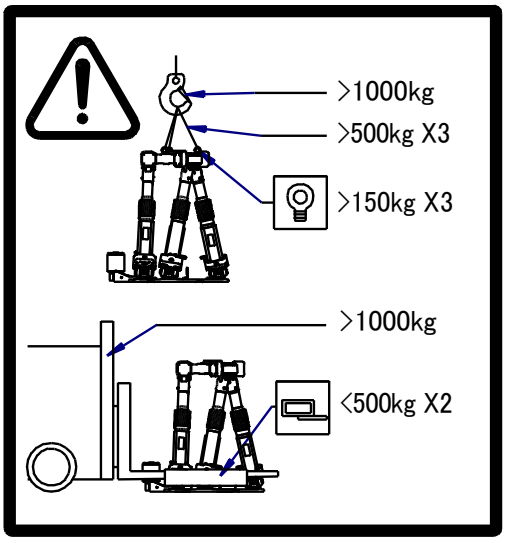


Fig. 4 (d) Transportation label

Description

When transporting the robot, observe the instructions indicated on this label. The above label indicates the following:

1) Using a crane
   - Use a crane having a load capacity of 1000 kg or greater.
   - Use at least two slings each having a load capacity of 4900 N (500 kgf) or greater.
   - Use at least three eyebolts each having a load capacity of 1470 N (150 kgf) or greater.

2) Using a forklift
   - Use a forklift having a load capacity of 1000 kg or greater.
   - Keep the total weight of the robot to be transported to within 1000 kg because the load capacity of the forklift bracket (option) is 4900 N (500 kgf).

NOTE
See Section 9.1 TRANSPORTATION for explanations about the posture a specific model should take when it is transported.

(5) Operating space and payload mark label

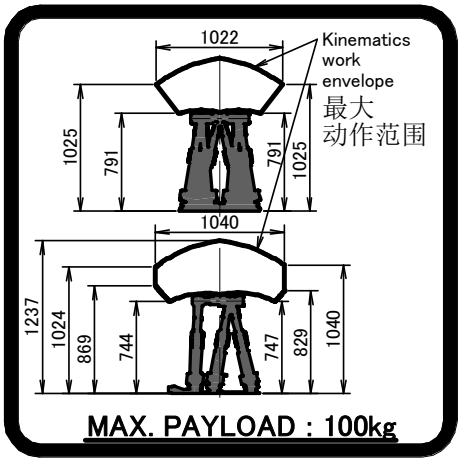


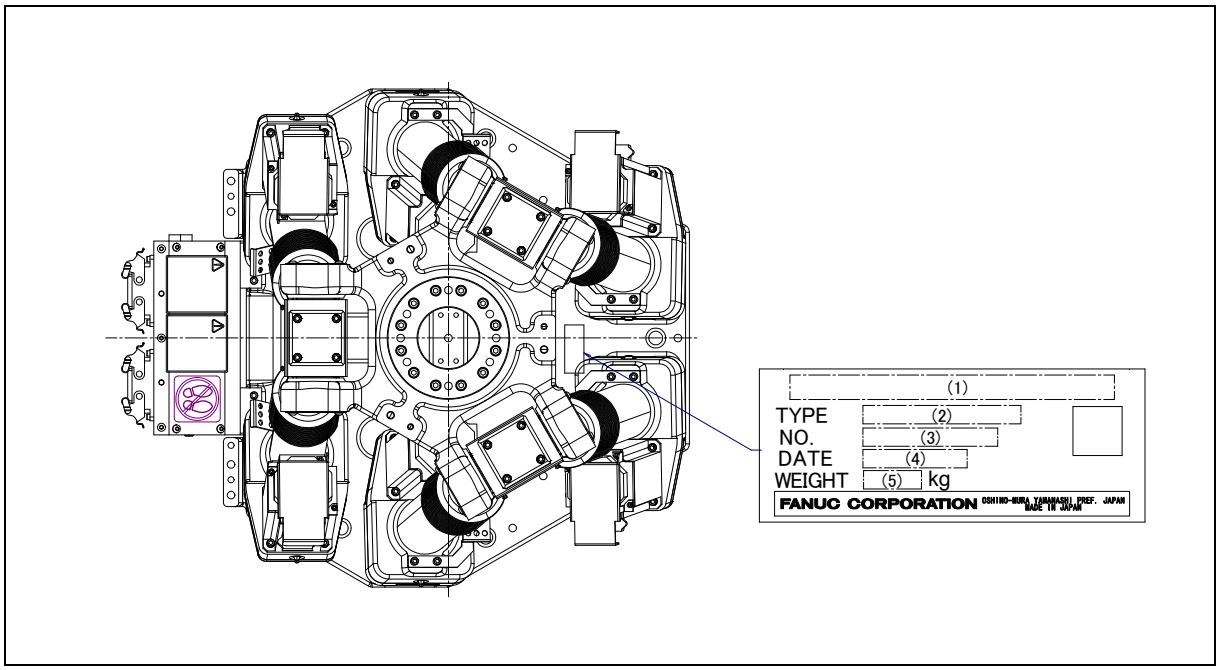
Fig.4 (e) Operating space and payload mark label

PREFACE

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

Model name	Mechanical unit specification No.	Maximum load	controller
FANUC Robot F-200*i*B	A05B-1517-B211	100kg	R-J3*i*B
	A05B-1517-B221	100kg	R-30*i*A R-30*i*B

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



Position of label Indicating mechanical unit specification number

	(1)	(2)	(3)	(4)	(5)
CONTENTS	**MODEL NAME**	**TYPE**	**No.**	**DATE**	**WEIGHT (without controller)**
LETTERS	FANUC Robot F-200*i*B	A05B-1517-B211 A05B-1517-B221	SERIAL NO. IS PRINTED	PRODUCTION YEAR AND MONTH ARE PRINTED	190

Specifications (NOTE 1)

Items	Specifications
Type	Stewart Platform type parallel-mechanism
Controlled axes	6 Axes (J1, J2, J3, J4, J5, J6)
Installation	Floor, Upside-down
Motion range (all axes are same)	431mm (660 to 1091mm)
Speed (NOTE 2)	Vertical 300mm/s Horizontal 1500mm/s
Max. load capacity	100kg
Allowable load moment at wrist	588N·m (60kgf·m)
Allowable load inertia at wrist	36kg·m^2 (367kgf·cm·s^2)
Drive method	Electric servo drive by AC servo motor
Repeatability	±0.1mm
Weight of mechanical unit	Approx. 190kg
Acoustic noise level	78.1dB (NOTE 3)
Installation environment	Ambient temperature 0 to 45℃(NOTE 4) Ambient humidity Normally : 75% RH or less (No condensation allowed.) Permitted altitude: Up to 1000 m above sea level. Vibration : 0.5G or less Free of corrosive gases (NOTE 5)

(NOTE 1) Even if the robot is used according to the defined specifications, motion programs might shorten reducer life or cause the robot to overheat. Use ROBOGUIDE (system design support tool by FANUC) for further evaluation before running production.
(NOTE 2) During short distance motions, the axis speed may not reach the maximum value stated.
(NOTE 3) This value is the equivalent continuous A-weighted sound pressure level that applied with ISO11201 (EN31201). This value is measured with the following conditions.
- Maximum load and speed
- Operating mode is AUTO

(NOTE 4) When robot is used in low temperature environment that is near to 0ºC,or robot is not operated for a long time in the environment that is less than 0ºC in a holiday or the night, because viscous resistance of the drive train is so big that may cause occurrence of collision detect alarm (SRVO –050) etc. In this case, we recommend performing the warm up operation for several minutes.
(NOTE 5) Contact the service representative, if the robot is to be used in an environment or a place subjected to severe vibrations, heavy dust, cutting oil splash and or other contaminations.

⚠CAUTION
Note that the cable in the mechanical part is different between the model supporting the R-J3*i*B controller and the model supporting the R-30*i*A/R-30*i*B controller.

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-J3*i*B controller	Setup and Operations manual SPOT TOOL **B-81464EN-1** HANDLING TOOL **B-81464EN-2** SEALING TOOL **B-81464EN-4**	Intended readers : Operator, programmer, maintenance technician, system designer Topics : Robot functions, operations, programming, setup, interfaces, alarms Use : Robot operation, teaching, system design
	Maintenance manual Standard : **B-81465EN** CE : **B-81465EN-1**	Intended readers: Maintenance person, system designer Topics: Installation, start-up, connection, maintenance Use: Installation, start-up, connection, maintenance
R-30*i*A controller	Setup and Operations manual SPOT TOOL+ **B-83124EN-1** HANDLING TOOL **B-83124EN-2** DISPENSE TOOL **B-83124EN-4** ALARM CODE LIST **B-83124EN-6** SERVO GUN FUNCTION **B-82634EN**	Intended readers : Operator, programmer, maintenance technician, system designer Topics : Robot functions, operations, programming, setup, interfaces, alarms Use : Robot operation, teaching, system design
	Maintenance manual Standard: **B-82595EN** CE: **B-82595EN-1** RIA: **B-82595EN-2**	Intended readers: Maintenance technician, system designer Topics: Installation, start-up, connection, maintenance Use: Installation, start-up, connection, maintenance

R-30*i*B controller	Operations manual (Basic Operation) **B-83284EN** Operations manual (Alarm Code List) **B-83284EN-1** Operations manual (Optional Function) **B-83284EN-2** SPOT WELDING FUNCTION Operations manual **B-83284EN-4** DISPENSE TOOL FUNCTION Operations manual **B-83284EN-5** Servo Gun Function Operations manual **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

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1 CONFIGURATION

The configuration of the mechanical unit is shown in Fig.1 (a).

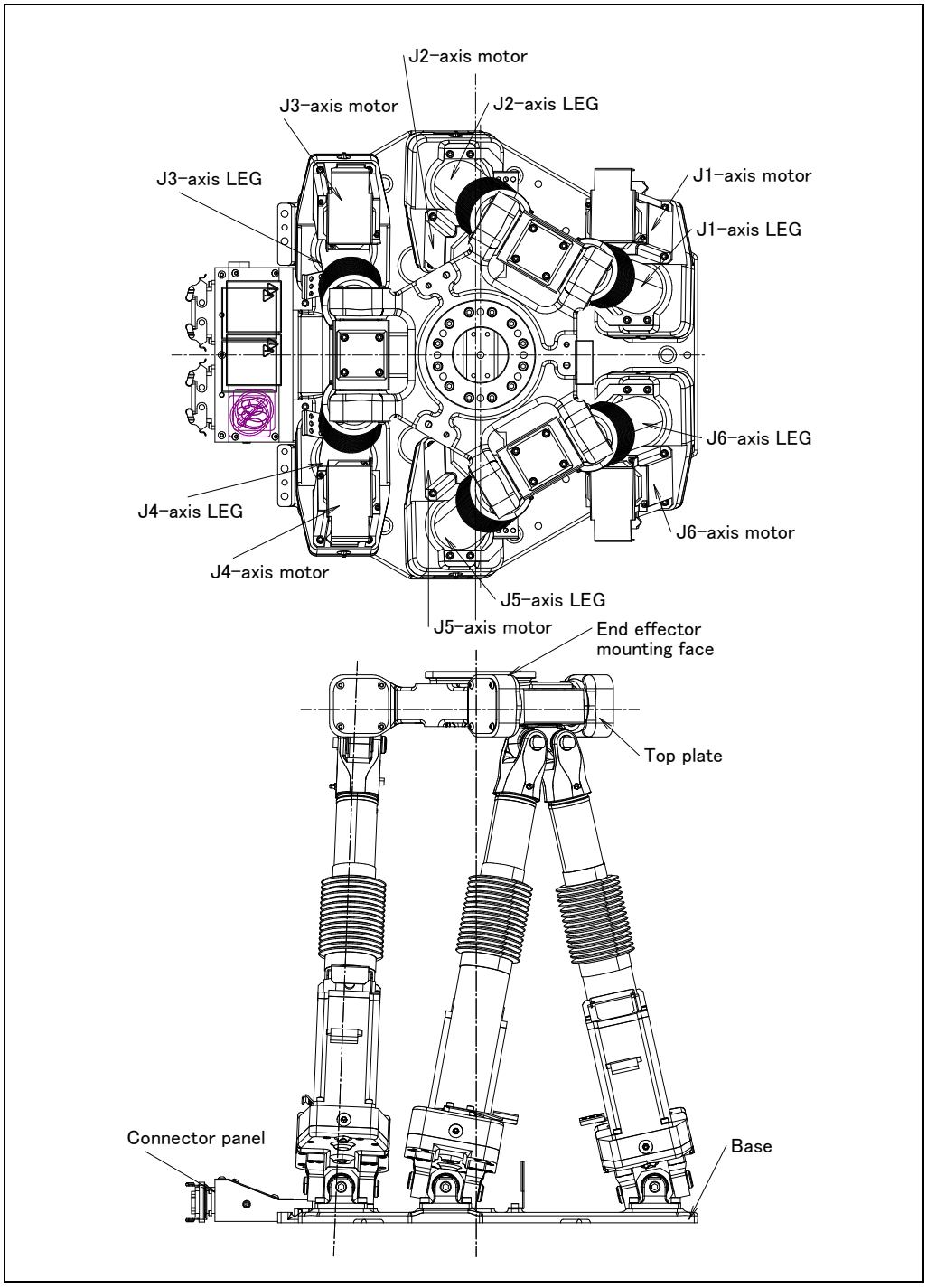


Fig.1 (a) Mechanical unit configuration

2 CHECKS AND MAINTENANCE

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

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

2.1 DAILY CHECKS

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

Before turning on power

Item	Check items	Check points
1	Oil seepage	Check there is oil seepage on sealed part of each joint parts. (Note 1)

NOTE 1) About oil seepage

Check items

- Check whether there is exudation of oil on sealed part of each joint parts.
- Oil seepage may be attached slightly to outside of lip depending on the movement condition and environment. If this oil changes to a state of liquid, it may drip depending on the movement.
  You can prevent oil from dripping by wiping the oil which is accumulated to under part of oil seal before operation.
- Also, motors may become the high temperature and the internal pressure of grease bath or oil bath may rise by frequent repetition movement and use in the high temperature environment.
  In these cases, you can restore internal pressure by releasing grease outlet or oil outlet just after operation of robot. (When opening grease outlet, refer to Section 3.1 and pay attention grease or oil is not scattered.)

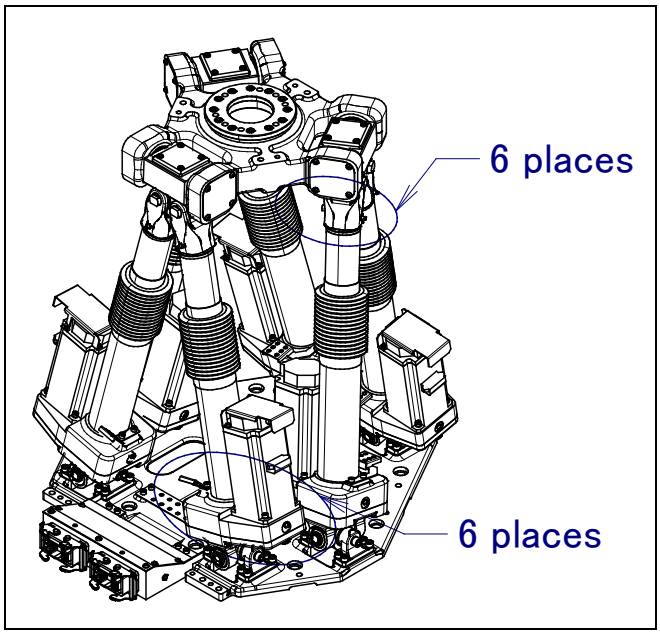


Fig.2.1 (a) Check parts of oil seepage

Check items

Wipe off the oil contents of each joint part which has oil seal.
In case of the air control set is specified

Item	Check items	Check points
1	Clean the joint surroundings	If contaminations are accumulated on the joint surroundings, remove those.
2	Air pressure	Check air pressure using the pressure gauge on the air regulator as shown in Fig.2.1 (b). 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.
3	Lubricator oil mist quantity	Check the drop quantity during wrist or hand motion. If it does not meet the specified value (1 drop/10-20 sec), adjust it using the lubricator control knob. Under normal usage the lubricator becomes empty in about 10 to 20 days under normal operation.
4	Lubricator oil level	Check to see that the lubricator level is within the specified level.
5	Leakage from hose	Check the joints, tubes, etc. for leaks. Repair leaks, or replace parts, as required.
6	Drain	Check drain and release it. When quantity of the drain is remarkable, examine the setting of the air dryer to the air supply side.

> ⚠ **CAUTION**
> If the robot operates with contamination accumulated around the joint, a malfunction or deformation may occur in the joint or leg unit.
> It is recommended that the full cover option and cable cover options be used in an environment that suffers a large accumulation of foreign matters.

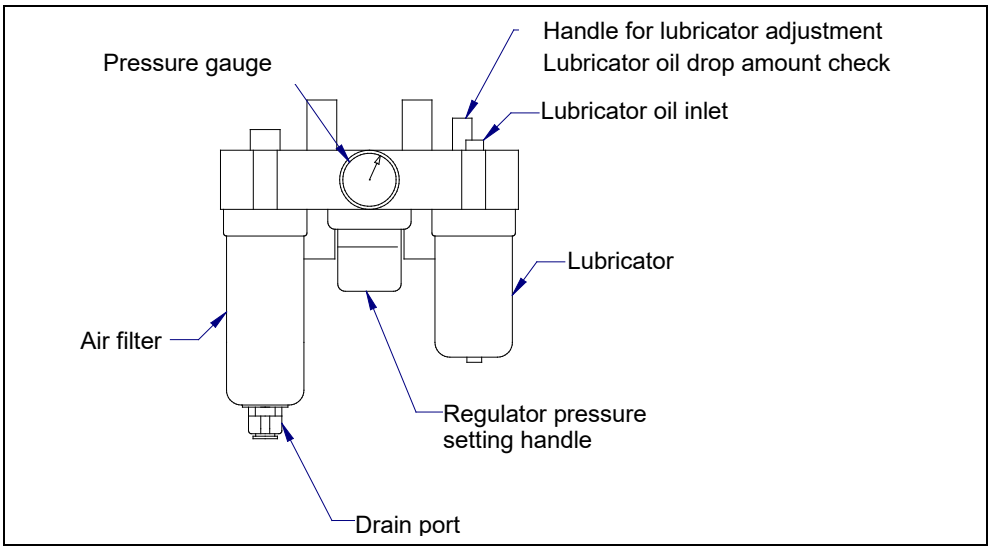


Fig.2.1 (b) Air control set

> **⚠ CAUTION**
> If the robot is operated with contaminations accumulated on the joint surrounding, It may cause malfunction or failure of the joints or the arms. If the sediments are Much, we recommend using the full cover option and the cable cover option.

After turning on power

Item	Check items	Check points
1	Vibration, abnormal noises, and motor heating	Check whether the all axes move smoothly without unusual vibration or sounds. Also, check whether the temperature of the motors is excessively high.
2	Changing repeatability	Check to see that the stop positions of the robot have not deviated from the previous stop positions.
3	Peripheral equipment for proper operation	Check whether the peripheral equipment operate properly according to commands from the robot.
4	Brakes for each axis	Check that the end effector drops within 0.2 mm when the power is cut.

2.2 FIRST 1-MONTH (320 HOURS) CHECKS

Check the following items once every one-month (320 hours). Additional inspection areas and times should be added to the table according to the robot's working conditions, environment, etc. Then every 3 months thereafter. (See the Section 2.4.)

Item	Check items	Check points
1	Ventilation portion of controller	If the ventilation portion of the controller is dusty, clean the unit.

2.3 FIRST 3-MONTH CHECKS (960 HOURS)

Check the following items at the first quarterly inspection, then every year (3840 hours) thereafter.(See the Section 2.5.)

Item	Check items	Check points
1	Cables used in mechanical unit	Check whether the jackets of the mechanical unit cables are damaged. Also check whether the cables are excessively bent or unevenly twisted. Check that the connectors of the motors and connector panels are securely engaged. (Note 1)
2	Retightening external main bolts	Retighten the end-effecter mounting bolts and external main bolts.(Note 2)
3	Cleaning and checking each part	Clean each part (remove chips, etc.) and check component parts for cracks and flaws. (Note 3)
4	Check the end effector (hand) cable	Confirm whether there is damage in the cable.
5	Examination of the oil film on the ball screw	Stretch each leg, then remove the bellows. Examine whether the oil film on the ball screw has run out. If the legs cannot be stretched, remove the bellows and the bellows pipe for examination. (Note 4)
6	Check the teach pendant cable, operation box connecting cable and robot connecting cable	Check whether the cables connected to the teach pendant and robot are unevenly twisted.

NOTE 1) Inspection points and check items of the mechanical unit cables and connectors

Inspection points of the mechanical unit cables

Check the cable between connector plate and motor for damage.
Clean it when the spatter adheres.

Check items

For cables with a cable cover, open the cover before inspection
Check the cables for a sheath breakage and wear.
If wires of the cable appear, replace the cable.

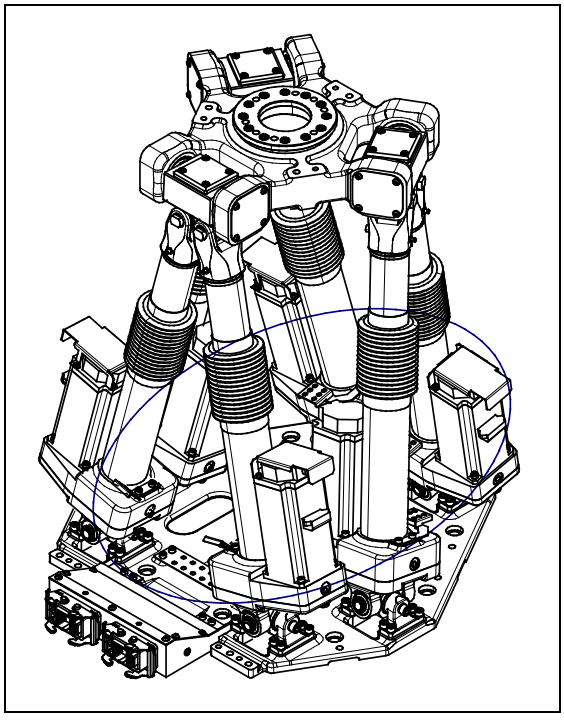


Fig. 2.3 (a) Inspection points of the mechanical unit cables

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

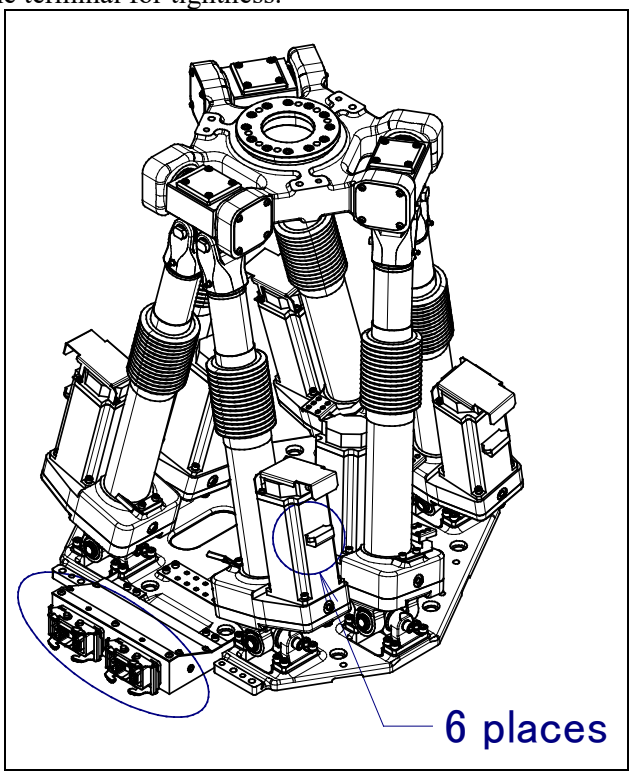


Fig. 2.3 (b) Inspection points of connectors

NOTE 2) Points to be retightened

- The end effecter mounting bolts, robot installation bolts, and bolts to be removed for inspection need to be retightened.
- The bolts exposed to the outside of the robot need to be retightened.
  For the tightening torque, see the recommended bolt tightening torque shown in the Appendix.
  A loose prevention agent (adhesive) is applied to some bolts. If the bolts are tightened with greater than the recommended torque, the loose prevention agent may be removed. So, follow the recommended tightening torque when retightening them.

NOTE 3) Cleaning

- Check that there are not piling up of the spatter, peripheral equipment cable, and a big foreign body on the base. The leg unit runs aground when there is a foreign body on the base, and the ball screw might be damaged.
- Check if there is a trace of a collision around the gun or hand.
- Check the grease bath (6 locations) for an oil leak.

→ If oil can be found a day after wiping oil, an oil leak may be caused.

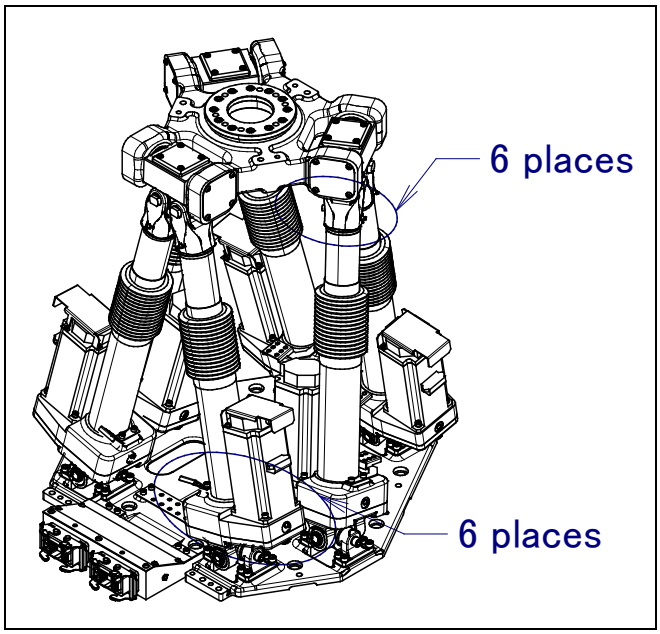


Fig. 2.3 (c) Cleaning points

NOTE 4) Examination of the Oil Film on the Ball Screw

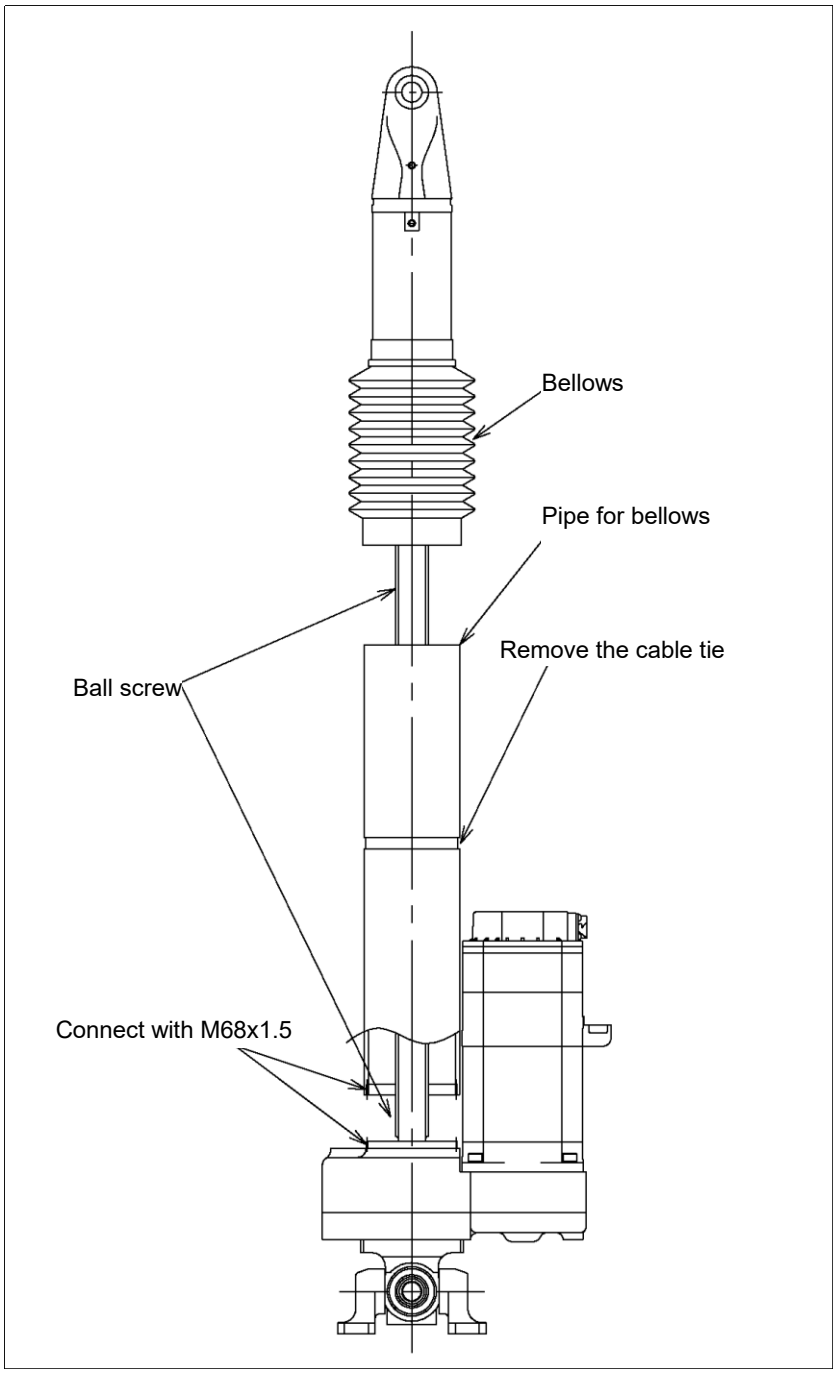


Fig.2.3 (d) Examination of the oil film on the ball screw

NOTE

It is permissible to use a heat gun to soften the sealant on the threads of the pipe where it connects to the gearbox. Upon reassembly, please apply sealant; LOCTITE 518.

2.4 3-MONTH (960 HOURS) CHECKS

Check the following item at the first one-months (320 hours), then every 3-month thereafter. (See the Subsection 2.2.)

Item	Check items	Check points
1	Ventilation portion of controller	(See Section 2.2.)

2.5 6- MONTH (1920 HOURS) CHECKS

Check the following item at the intervals based on 6 months or 1920 hours, whichever comes first.

Item	Check items	Check points
1	Greasing of the ball screw	Grease the ball screw. (See Section 3.3.)

2.6 1-YEAR (3840 HOURS) CHECKS

Check the following items at the intervals based on 1 year or 3840 hours, whichever comes first.

Item	Check items	Check points
1	Cables used in mechanical unit	(See Section 2.3.)
2	Retightening external main bolts	(See Section 2.3.)
3	Cleaning each parts and inspection	(See Section 2.3.)
4	Check the end effector (hand) cable	(See Section 2.3.)
5	Check the robot cable, teach pendant cable and robot connecting cable	(See Section 2.3.)

2.7 1.5-YEAR (5760 HOURS) CHECKS

Check the following item at the intervals based on 1.5 year or 5760 hours, whichever comes first.

Item	Check items	Check points
1	Battery	Replace battery in the mechanical unit. (See Section 3.4)

2.8 3-YEAR (11520 HOURS) CHECKS

Check the following item at the intervals based on 3 years or 11520 hours, whichever comes first.

Item	Check items	Check points
1	Replacement of the grease in the gearbox	Replace the grease in the gearbox. (See Section 3.1.)

2.9 4-YEAR (15360 HOURS) CHECKS

Check the following item at the intervals based on 4 years or 15360 hours, whichever comes first.

Item	Check items	Check points
1	Replace the mechanical unit cable	Replace mechanical unit cable. Contact your local FANUC representative for the replacing method.

3 PERIODIC MAINTENANCE

3.1 REPLACING GREASE OF THE DRIVE MECHANISM

According to below, replace the grease of the J1 to J6-axis gearbox at the intervals based on every 3 years or 11520 hours, whichever comes first.

Table 3.1 (a) Grease for 3-year periodical replacement

Supply position	Grease name	Quantity	Gun tip pressure
J1 to J6-axis gearbox	Spec.: A98L-0040-0174#2KG	Each 265 cm^3 (230g)	0.1 MPa or less (Note 1)

NOTE
When a manual pump is used for greasing, the standard rate is one pumping cycles per two 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.

Posture at greasing

When replacing and replenishing grease, set the robot to a posture with about the same lengths on all axes. When replacing or replenishing grease, posture the robot such that all axes are 668 mm or shorter. To replace or replenish grease when the robot is postured with the axes 668 mm or longer, remove the silencer (M5) and stuff the hole in advance.

Replacing procedure of grease

1 Remove the full cover (option) from the robot where applicable (see Section 3.5).
2 Turn off controller power.
3 Remove the grease seal bolt.
4 Apply new grease from the grease inlet until it comes out from the grease outlet.
5 After applying grease, release the remaining pressure within the grease bath as described in the procedure in Section 3.2.
6 Remount the seal bolt at the grease outlet. (For mounting the seal bolt, coil a new seal tape.)
7 Remount the full cover (option) to the robot where applicable (see Section 3.5).

⚠ 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) A grease inlet may optionally have a plug. Replace the plug with the attached grease nipple and then start greasing.
(3) Supply grease slowly, using a manual pump.
(4) 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 3.1 (a)).
(5) Use specified grease. Use of non-approved grease may damage the reducer or lead to other problems.
(6) After greasing, release remaining pressure from the grease bath using the procedure given in Subsection 3.2, and then close the grease inlet, the grease outlet and the ventilator hole.
(7) To prevent an accident such as a fall or fire, remove all the excess grease from the floor and robot.

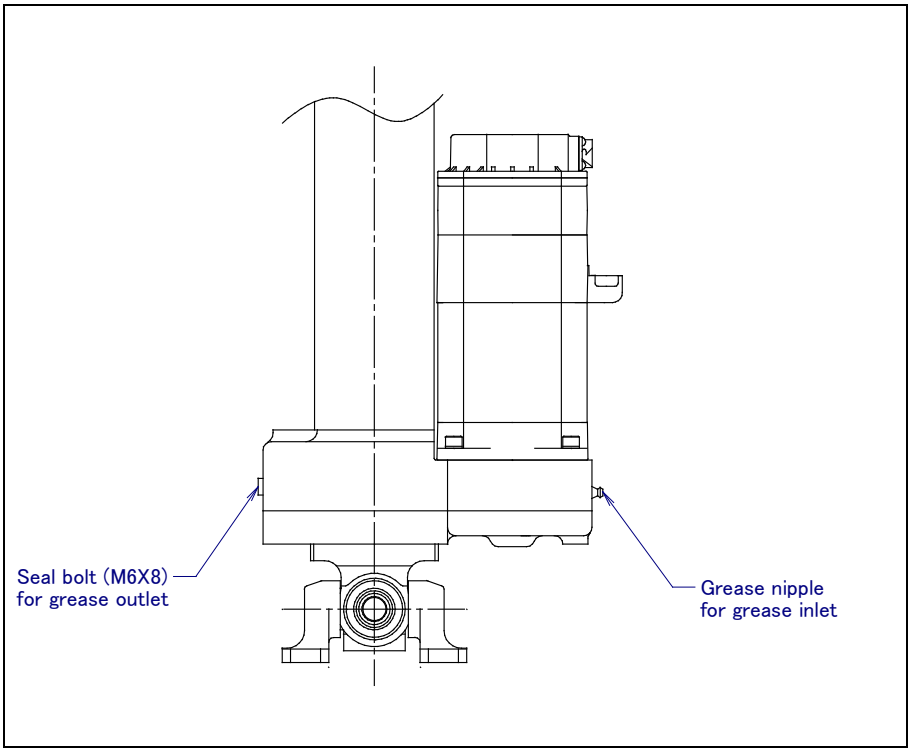


Fig.3.1 (a) Replacing grease of gearbox (J1,J3,J4,J6-axis)

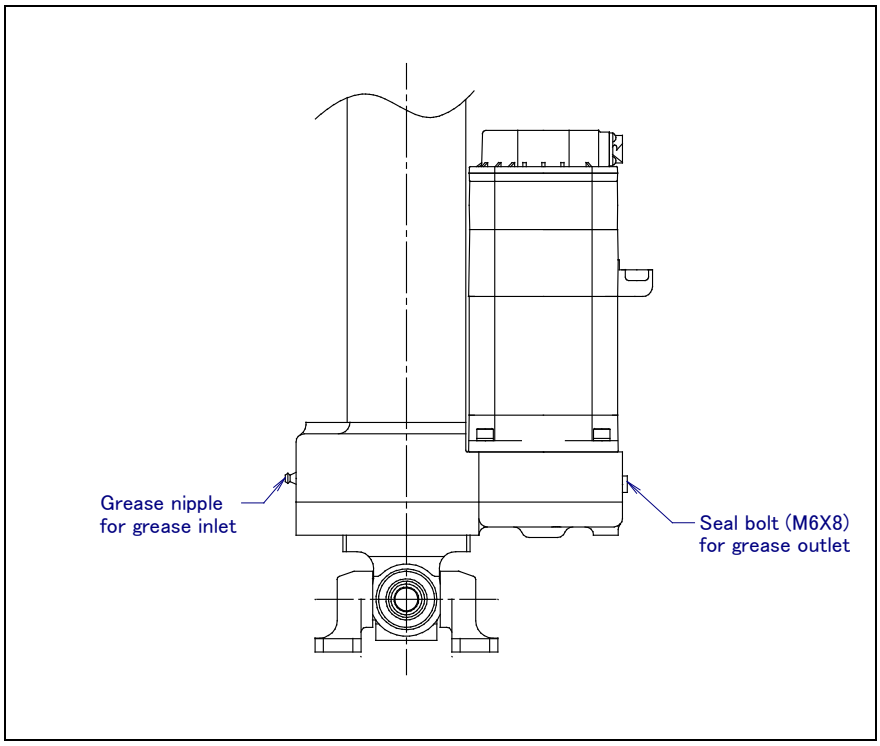


Fig.3.1 (b) Replacing grease of gearbox (J2,J5-axis)

3.2 PROCEDURE FOR RELEASING THE GREASE REMAINING PRESSURE

After applying grease, operate the robot as instructed below with the seal bolt of the grease outlet uncapped to release the remaining pressure within the grease bath. Attach a recovery bag below the grease outlet to prevent output grease from splattering.

Perform program operation for the time specified below with the grease outlet uncapped in order to release the remaining pressure. Perform program operation for ten minutes or more by setting a position to 300 mm in the Z-axis direction and a repetition operation of OVR 100%.

When the above operation is impossible due to ambient conditions, adjust the operating time according to the operating distance. 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 movement distance is 150 mm, perform the operation for 20 minutes or more.) Upon completion of the above operation, attach the seal bolt to the grease outlet. When reusing the seal bolt, be sure to seal it with seal tape.

3.3 GREASING THE BALL SCREW

Supply grease to the parts periodically. If the robot is installed in a severe environment, apply grease whenever necessary. If water splashes on the robot, apply grease immediately. Table and Fig. 3.3 (a) show greasing points. Table 3.3 (b) shows substitute greases.
After greasing, slowly make some 20 full-stroke (660 to 1091 mm) reciprocating motions of the ball screw, so that the grease is applied to the entire ball screw. If full-stroke motions are impossible, remove the bellows and the pipe for the bellows, then directly apply grease to the stroke portion of the ball screw.

Table 3.3 (a) Greasing points

Positions	Grease	Amount	Greasing interval
J1 to J6 axis ball screw	Shell Lubricants SHELL ALVANIA GREASE S2 (Spec: A98L-0004-0602#CTG)	100 cm^3 each	6 months

Table 3.3 (b) Substitutes for ALVANIA GREASE S2

Maker	Grease name
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 Lubricant	Shell Gadus S2 V100 2

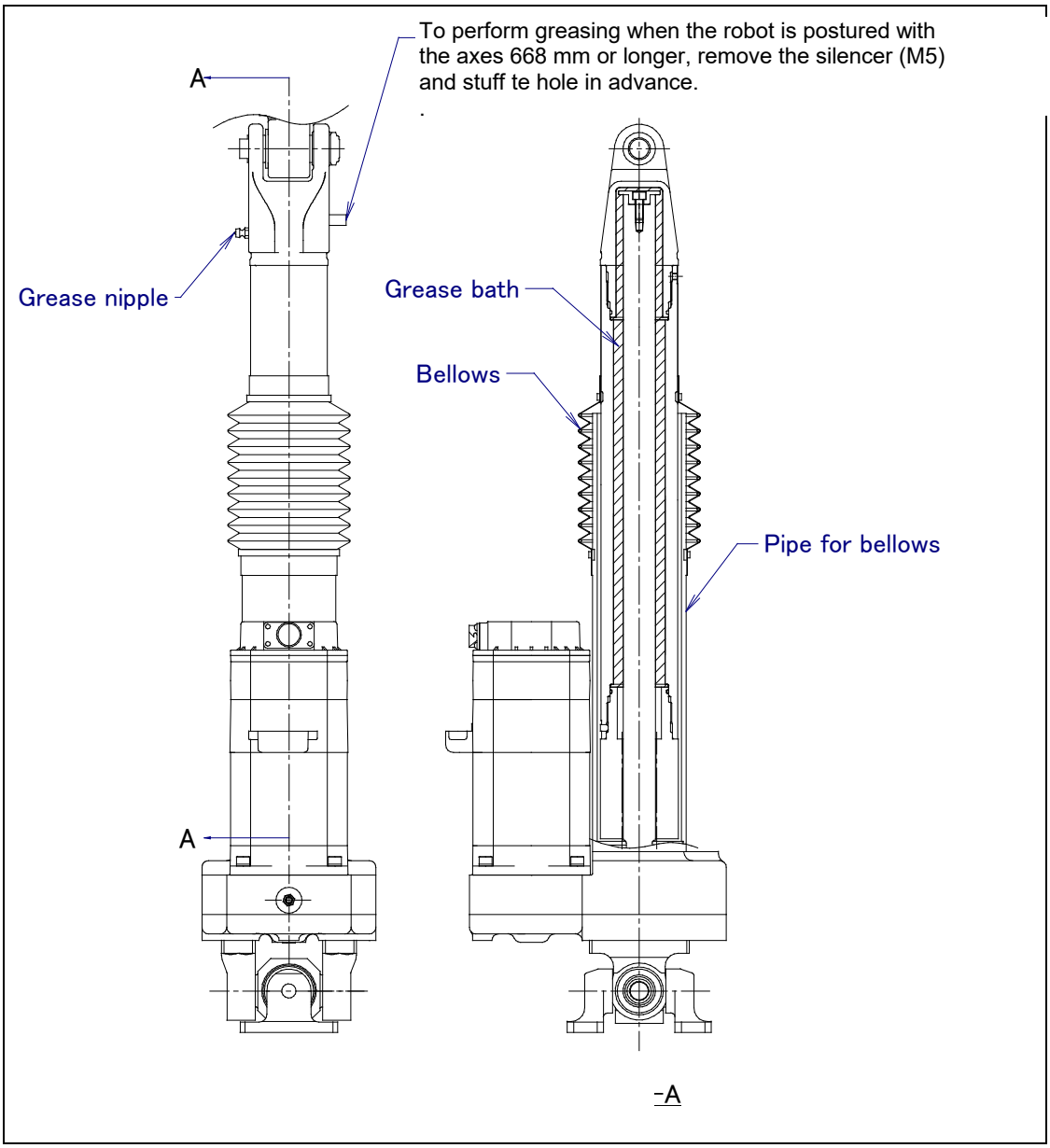


Fig.3.3 (a) Greasing points

3.4 REPLACING THE BATTERIES

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.
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.

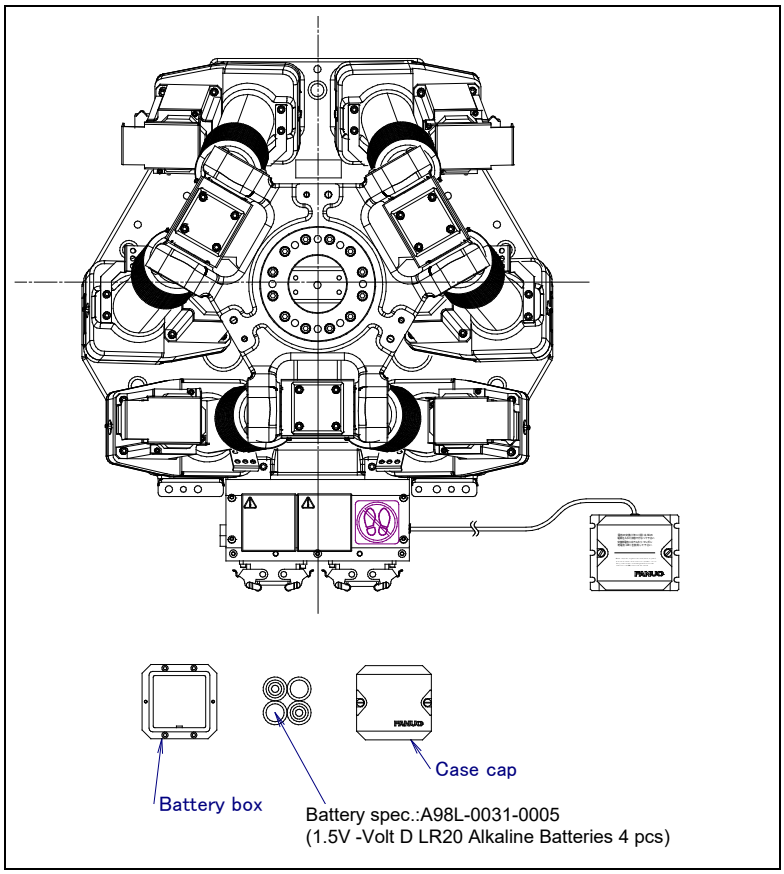


Fig.3.4 (a) Replacing battery

3.5 REPLACING THE FULL COVER (OPTION)

Disassembly

1 Set the robot in a posture in such a way that its all axes are almost the same in length, and turn off the power.
2 Remove the M8 screws (3), and then the plates (2).
3 Open Velcro C, B, and A in that order, and open the top plate Velcro.

Assembly

1 Set the robot in a posture in such a way that its all axes are almost the same in length, and turn off the power.
2 Put the jacket (1) on the robot so that Velcro A and B face to the connector panel.
3 Align their counterparts an the jacket (1) with the screw holes and top plate Velcro, and fasten the jacket with the M8 screws (3) and plates (2).
4 Close Velcro A and B in that order on the open/close part of the jacket (1).
5 Close Velcro C on the support plate at the bottom of the robot.

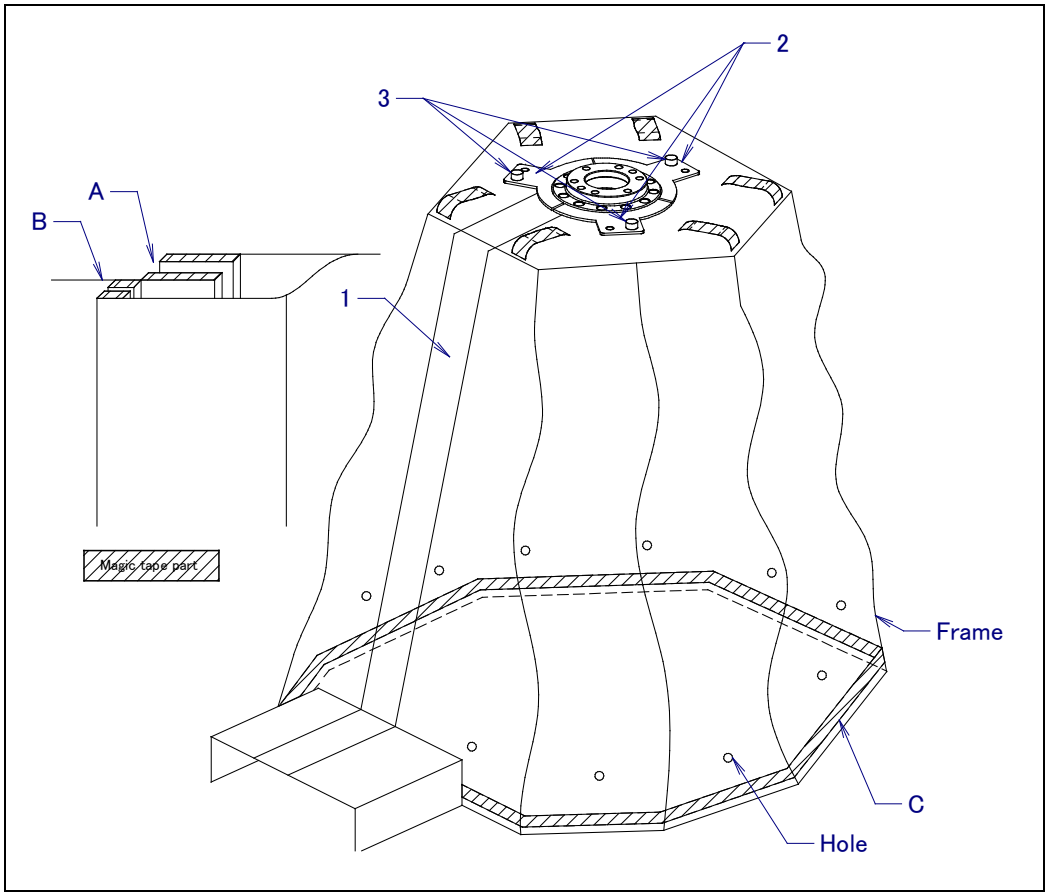


Fig.3.5 (a) Replacing full cover (option)

Table 3.5 (a) Replacing full cover (option)

	Name	Specifications	Q'ty	LOCTITE	Torque (N-m)
1	JACKET	A290-7517-Y222	1		
2	PLATE	A290-7517-Y219	3		
3	BOLT	A6-BA-8X10	3		See the torque list in Appendix.

⚠ CAUTION
Full cover option has a rubber sponge for filling the center hole of faceplate. To avoid entrance of any matter from the hole, don't remove the rubber sponge.
If the jacket falls due to setting the robot upside down, pass a cable tie through thee hole at the bottom of the jacket and fix it to the frame.

4 TROUBLE SHOOTING

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.

4.1 TROUBLESHOOTING

Table 4.1 (a) shows the major troubleshooting that may occur in the mechanical unit and their probable causes. If you cannot pinpoint a failure cause or which measures to take, contact your local FANUC representative.

Table 4.1 (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 floor plate and the plate securing the base plate of the robot. - There are cracks at the weld between the floor plate and the plate securing the base plate of the robot.	[Securing the plate securing the base plate of the robot to the floor plate] - A probable cause is that the weld between the floor plate and the plate securing the base plate of the robot is cracked, so that the plate is not secured properly to the floor plate. - If the plate securing the base plate of the robot is not secured properly to the floor plate, the plate will float during the operation of the robot, and the resulting impact will cause vibration.	- Re-weld the plate securing the base plate to the floor plate to secure it. - If the weld is not strong enough, increase its width and length.
	- During the operation of the robot, the base plate of the robot is floating from the plate securing the base plate. - There is a gap between the base plate of the robot and the plate securing it. - The bolts securing the base plate of the robot are loose.	[Securing the base plate of the robot] - A probable cause is that the base plate of the robot is not secured properly to the plate securing it. - Probable causes are loose bolts, the plate securing the base plate of the robot being not sufficiently flat, and contamination being caught. - If the base plate of the robot is not secured properly to the plate securing it, the base plate will float from the plate during the operation of the robot, and the resulting impact will cause vibration.	- If a bolt is loose, apply LOCTITE and tighten it to the appropriate torque. - Modify the plate securing the base plate of the robot so that its flatness falls within the tolerance. - If there is any contamination, remove it. - Apply adhesive between the base plate of the robot and the plate securing it.
Vibration Noise (Continued)	Vibration of rack or floor occurs when the robot is operating.	[Rack or floor] - It is likely that the rack or floor is not sufficiently rigid. -If the rack or floor is not sufficiently rigid, reaction from the robot deforms the rack or floor, leading to vibration.	- Reinforce the rack or floor to make it more rigid. - If it is impossible to reinforce the rack or floor, modify the robot control program; doing so might reduce the amount of vibration.

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- Vibration becomes more serious when the robot adopts a specific posture. - If the operating speed of the robot is reduced, vibration stops. - Vibration is most notice able when the robot is accelerating. - Vibration occurs when two or more axes operate at the same time.	[Overload] - It is likely that the load on the robot is greater than the maximum rating. - It is likely that the robot control program is too demanding for the robot hardware. - It is likely that the ACCELERATION value is excessive.	- Check the maximum load that the robot can handle once more. If the robot is found to be overloaded, reduce the load, or modify the robot control program. - Vibration in a specific portion can be reduced by modifying the robot control program while slowing the robot and reducing its acceleration (to minimize the influence on the entire cycle time).
	- Vibration or noise was first noticed after the robot collided with an object or the robot was overloaded for a long period. - The grease of the vibrating or noise occurring axis has not been replaced for a long period. - Cyclical vibration and noise occurs.	[Gear, bearing, or reducer, belt] - It is likely that collision or overload applied an excessive force on the drive mechanism, thus damaging the gear tooth surface or rolling surface of a bearing, or reducer. - Prolonged overloaded use may cause fretting fatigue on the gear tooth surface or rolling surface of the bearing and reducer. - It is likely that a contamination caught in a gear, bearing, or within a reducer has damaged the gear tooth surface or rolling surface of the bearing, or reducer. - It is likely that a contamination caught in a gear, bearing, or within a reducer is causing vibration. - It is likely that, because the grease has not been changed for a long period, fretting occurred on the gear tooth surface or rolling surface of a bearing, or reducer due to metal fatigue or inadequate lubrication.	- Operate one axis at a time to determine which axis is vibrating. - Remove the motor, and replace the gear, the bearing, and the reducer. For the spec. of parts and the method of replacement, contact your local FANUC representative. - Using the robot within its maximum rating prevents problems with the drive mechanism. - 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 section.	[Controller, cable, and motor] - If a failure occurs in a controller circuit, preventing control commands from being supplied to the motor normally, or preventing motor information from being sent to the controller normally, vibration might occur. - If the Pulsecoder develops a fault, vibration might occur because information about the motor position cannot be transferred to the controller accurately. - 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 section 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 section has an intermittent break, vibration might occur because commands cannot be sent to the motor accurately. - If the controller is installed separately from the mechanical section, and a connection cable between them has an intermittent break, vibration might occur. - If the power source voltage drops below the rating, vibration might occur. - If a robot control parameter is set to an invalid value, vibration might occur.	- Refer to the Controller Maintenance Manual for troubleshooting related to the controller and amplifier. - Replace the Pulsecoder for the motor of the axis that is vibrating, and check whether the vibration still occurs. - Also, replace the motor of the axis that is vibrating, and check whether vibration still occurs. - Check that the robot is supplied with the rated voltage. - Check whether the sheath of the Robot power cord is damaged. If so, replace the power cord, and check whether vibration still occurs. - Check whether the sheath of the cable connecting the mechanical section and controller is damaged. If so, replace the connection cable, and check whether vibration still occurs. - 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 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.
	- There is some relationship between the vibration of the robot and the operation of a machine near the robot.	[Noise from a nearby machine] - If the robot is not grounded properly, electrical noise is induced on the grounding wire, preventing commands from being transferred accurately, thus leading to vibration. - If the robot is grounded at an unsuitable point, its grounding potential becomes unstable, and noise is likely to be induced on the grounding line, thus leading to vibration.	- Connect the grounding wire firmly to ensure a reliable ground potential and prevent extraneous electrical noise.

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- 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 unusual sound even for specified grease, perform operation for one or two days on an experiment. Generally, an usual sound will disappear.
Rattling	- While the robot is not supplied with power, pushing it with the hand causes part of the mechanical unit to wobble. - There is a gap on the mounting surface of the mechanical unit.	[Mechanical section coupling bolt] - It is likely that overloading or a collision has loosened a mounting bolt in the robot mechanical section.	Check that the following bolts for each axis are tight. If any of these bolts is loose, apply LOCTITE and tighten it to the appropriate torque. - Motor retaining bolt - Base retaining bolt - Joint-securing bolt - Gearbox-securing bolt - End effector retaining bolt
	- There is lost motion in the bearing of a joint	[Damage to the bearing, release of the pre-load] - A probable cause is that excessive force was applied to the bearing of the joint due to impact or overload, damaging the bearing or releasing the pre-load.	- Check the movement of the joints during operation to identify the faulty joint. - Remove each leg, move the top and bottom joints manually to check whether the bearings are damaged and whether there is lost motion. If a bearing is damaged or the pre-load is released, replace the unit containing the joint. - This problem can be avoided by avoiding use at overload.
Motor overheating	- The ambient temperature of the installation location increases, causing the motor to overheat. - After a cover was attached to the motor, the motor overheated. - After the robot control program or the load was changed, the motor overheated.	[Ambient temperature] - It is likely that a rise in the ambient temperature prevented the motor from releasing heat efficiently, thus leading to overheating. [Operating condition] - It is likely that the robot was operated with the maximum average current exceeded.	The teach pendant can be used to monitor the average current. Check the average current when the robot control program is running. The allowable average current is specified for the robot according to its ambient temperature. Contact FANUC for further information. - Relaxing the robot control program and conditions can reduce the average current, thus preventing overheating. - Reducing the ambient temperature is the most effective means of preventing overheating. - Having the surroundings of the motor well ventilated enables the motor to release heat efficiently, thus preventing overheating. Using a fan to direct air at the motor is also effective. - If there is a source of heat near the motor, it is advisable to install shielding to protect the motor from heat radiation.

Symptom	Description	Cause	Measure
Motor overheating	- After a robot control parameter (load setting etc.) was changed, the motor overheated.	[Parameter] - If data input for a workpiece is invalid, the robot cannot be accelerate or decelerate normally, so the average current increases, leading to the motor overheating.	- As for load setting, Input an appropriate parameter referring to Section 8.3.
	- Symptom other than stated above	[Mechanical section problems] - It is likely that problems occurred in the mechanical unit drive mechanism, thus placing an excessive load on the motor. [Motor problems] - It is likely that a failure of the motor brake resulted in the motor running with the brake applied, thus placing an excessive load on the motor. - It is likely that a failure of the motor prevented it from delivering its rated performance, thus causing an excessive current to flow through the motor.	Repair the mechanical unit while referring to the above descriptions of vibration, noise, and rattling. - Check that, when the servo system is energized, the brake is released. - If the brake remains applied to the motor all the time, replace the motor. - If the average current falls after the motor is replaced, it indicates that the first motor was faulty.
Grease leakage	- Grease is leaking from the mechanical unit.	[Poor sealing] - Probable causes are a crack in the casting, a broken O-ring, a damaged oil seal, or a loose seal bolt. - A crack in a casting can occur due to excessive force that might be caused in collision. - An O-ring can be damaged if it is trapped or cut during disassembling or re-assembling. - An oil seal might be damaged if extraneous dust scratches the lip of the oil seal. - A loose seal bolt might allow grease to leak along the threads. - Problems with the grease nipple or threads.	- If a crack develops in the casting, sealant can be used as a quick-fix to prevent further grease leakage. However, the component should be replaced as soon as possible, because the crack might extend. - O-rings are used in the locations listed below. Refer to the relevant parts manual for detailed descriptions of their replacement. - Motor-fastening section - Ball screw nut connection section - Pipe connection section - Oil seals are used in the locations stated below. Refer to the relevant parts manual for detailed descriptions of their replacement. - Joint on the top plate - Joint on the base plate - Gearbox - Seal bolts are used in the locations stated below. Refer to the relevant parts manual for detailed descriptions of their replacement. - Joint connection section in the gearbox - Grease outlet - Replace the grease nipple.

Symptom	Description	Cause	Measure
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. [Overload - It is likely that the load on the robot is heavier than the maximum rating.	- 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 - Check the maximum load that the robot can handle or not. If the robot is overloaded, reduce the load.
Displacement	- The robot operates at a point other than the taught position. - The repeatability is not within the tolerance.	[Mechanical section problems] - If the repeatability is unstable, probable causes are a failure in the drive mechanism or a loose bolt. - If the repeatability becomes stable it is likely that a collision imposed an excessive load, leading to slipping on the base surface or the mating surface of an arm.	- If the repeatability is unstable, repair the mechanical section 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.
	- 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 rewritten in such a way that the robot origin was shifted. - A failure in the Pulsecoder is considered.	- Re-enter the previous mastering data, which is known to be correct. - If correct mastering data is unavailable, perform mastering again. - When a failure is found in the Pulsecoder, replace the motor or Pulsecoder.
BZAL alarm occurred	- BZAL alarm is displayed on the teach pendant screen	- It is likely that the voltage of the memory backup battery is low. - It is likely that the Pulsecoder cable is defective.	- Replace the battery. - Replace the cable.

5 ADJUSTMENTS

Each part of the mechanical unit is carefully adjusted at the factory before shipment. Therefore it is usually unnecessary for the customer to make adjustments at the time of delivery. However, after for a long period of use or after parts are replaced, adjustments may be required.

5.1 MASTERING

Mastering is an operation performed to associate the distance 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.

5.1.1 Overview

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

- Motor replacement.
- Pulsecoder replacement.
- 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 go dead. Replace the batteries in the controller and mechanical units periodically. An alarm will be issued to warn the user of a low battery voltage.

Mastering method

Table 5.1.1 (a) describes the following mastering methods.

Table 5.1.1 (a) Types of mastering

Fixture position mastering	In the F-200*i*B, this function is not used.
Zero-position mastering (witness mark mastering)	A marking is provided for each axis of the robot. Mastering is performed by moving the robot to the marking positions on all axes. In the F-200*i*B, marking is performed at the position of 668 mm on all axes.
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.
Single axis mastering	This is performed for one axis at a time. The mastering position for each axis can be specified by the user. It is effective for mastering for a specific axis only. In the F-200*i*B, this function is used for mastering by the use of a fixture.
Mastering data entry	Mastering data is entered 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, quick mastering for single axis, single-axis mastering, and mastering data entry. For more accurate mastering (fixture position mastering), contact your local FANUC representative.

⚠ CAUTION
1 If mastering is performed incorrectly, the positioner may behave unexpectedly. This is very dangerous. Therefore, the positioning screen is designed to appear only when the $MASTER_ENB system variable is 1 or 2. After performing positioning, press F5 [DONE] on the positioning screen. The $MASTER_ENB system variable is reset to 0 automatically, thus hiding the positioning screen.
2 It is recommended that you back up the current mastering data before performing mastering.

5.1.2 Resetting Alarms and Preparing for Mastering

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

Alarm displayed

"Servo 062 BZAL" or "Servo 075 Pulse not established"

Procedure

1 Display the positioning menu by following steps 1 to 6.
   1 Press the [MENU] key.
   2 Press [0 NEXT] and select [6 SYSTEM].
   3 Press F1 [TYPE], and select [SYSTEM Variable] from the menu.
   4 Place the cursor on $MASTER_ENB, then key in "1" and press [ENTER].
   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 "Servo 062 BZAL" alarm, follow steps 1 to 5.
   1 Press [MENU] key.
   2 Press [0 NEXT] and select [6 SYSTEM].
   3 Press F1 [TYPE], and select [Master/Cal] from the menu.
   4 Press the F3 RES_PCA, then press F4 [YES].
   5 Turn off the controller power and on again

3 To reset the "Servo 075 Pulse not established" alarm, follow steps 1 to 2.
   1 When the controller power is turned on again, the message "Servo 075 Pulse not established" appears again.
   2 Move the axis for which the message mentioned above has appeared till alarm disappears when press [FAULT RESET] in either direction.

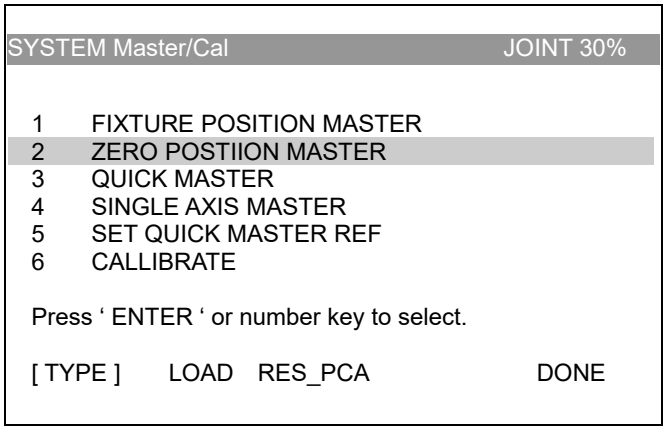
If "SRVO-062 BZAL" alarm or "SRVO-068 DTERR" alarm occurred, and you cannot release the alarm, Please check there is no faulty wiring or disconnected part.

5.1.3 Zero Position Mastering

Zero position master refers to mastering performed at the position where scribe marks are located. The robot is moved to the marking-off positions (668 mm) on all axes to perform mastering.
Zero position mastering is visual adjustment and, therefore, may not be accurate.
Use this mastering as an emergency measure.

Mastering

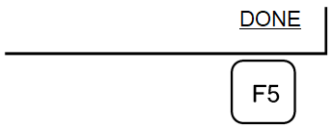
1 Press the [MENU] key.
2 Press [0 NEXT] and select [6 SYSTEM].
3 Press F1, [TYPE].
4 Select [Master/Cal].



5 Release brake control, and jog the robot into a posture for mastering.

NOTE
Brake control can be released by setting the system variables as follows:
$PARAM_GROUP. SSV_OFF _ALL : FALSE
$PARAM_GROUP. SSV_OFF _ENB[*] : FALSE (for all axes)
After changing the system variables, switch the controller power off and on again.

6 Select Fixture Position Master.
7 Select [6 CALIBRATE] and press F4 [YES]. Mastering will be performed automatically. Alternatively, switch the power off and on again. Turning power on always causes positioning to be performed.
8 After positioning is completed, press F5 [DONE].



9 Return brake control to original setting, and turn off the controller power and on again.

Table 5.1.3 (a) Scribe mark position

All axes	668 mm

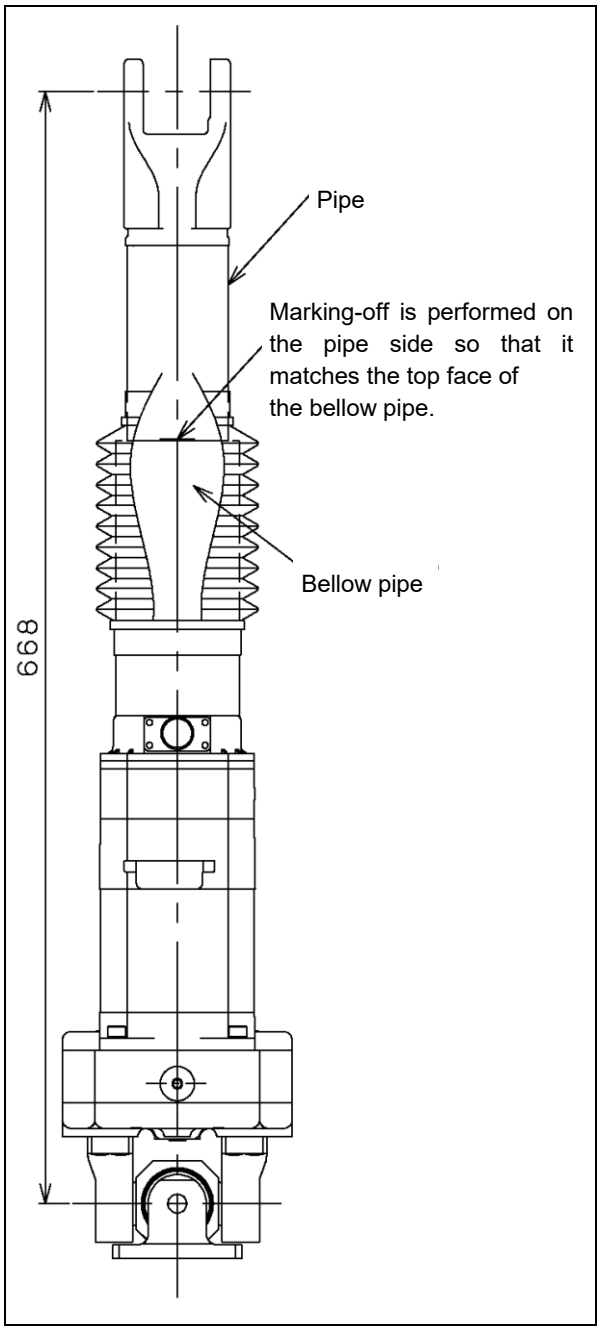


Fig.5.1.3 (a) Zero position mark position (J1-, J3, J4, and J6-axes)

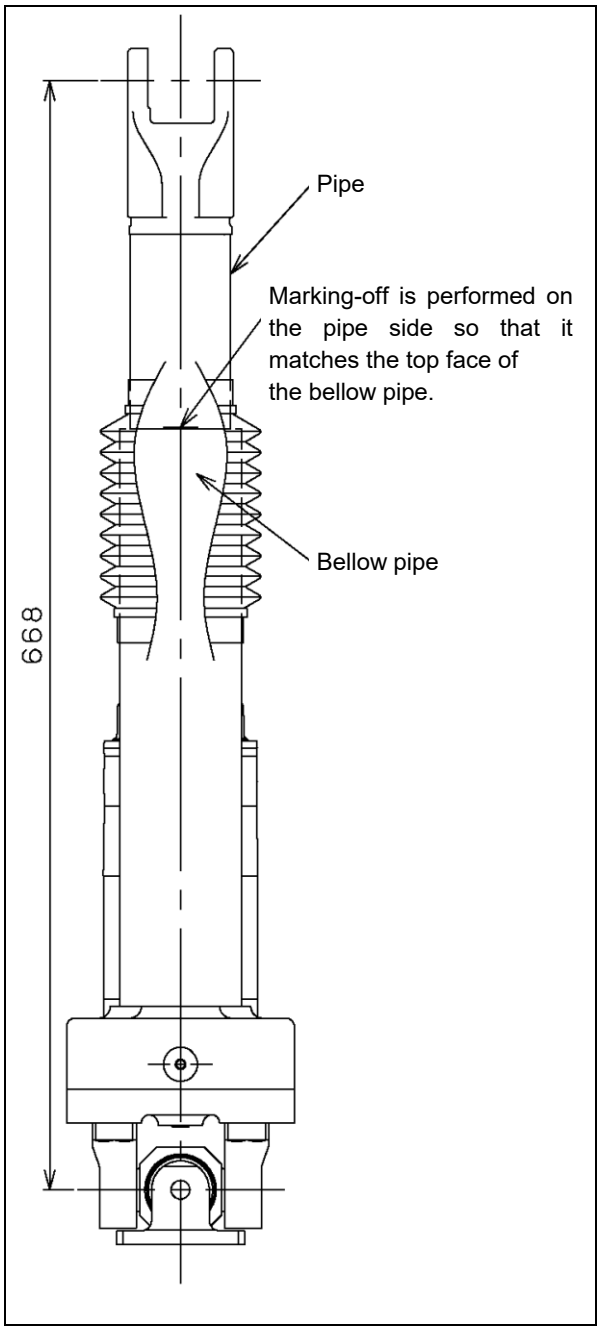


Fig.5.1.3 (b) Zero position mark position (J2- and J5-axes)

5.1.4 Quick Mastering

Quick mastering 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.

Quick mastering is factory-performed at the position indicated in Table 5.1.4. Do not change the setting unless there is a problem.

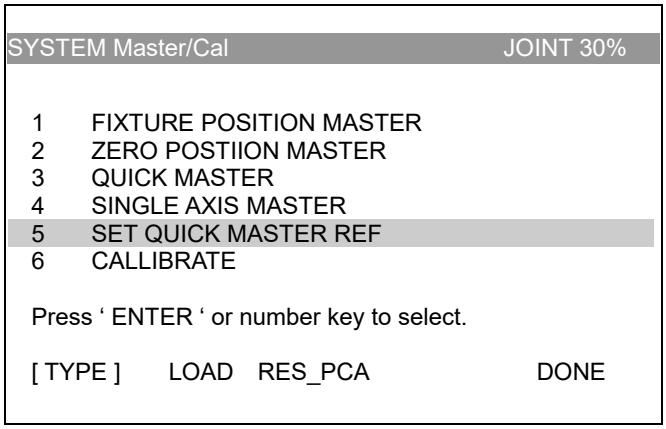
If it is impossible to set the robot at the position mentioned above, it is necessary to re-set the quick mastering reference position using the following method. (It would be convenient to set up a marker that can work in place of the witness mark.)

> **⚠NOTE**
> 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 Master Reference Position

Step

1 Select SYSTEM.
2 Select Master/Cal.



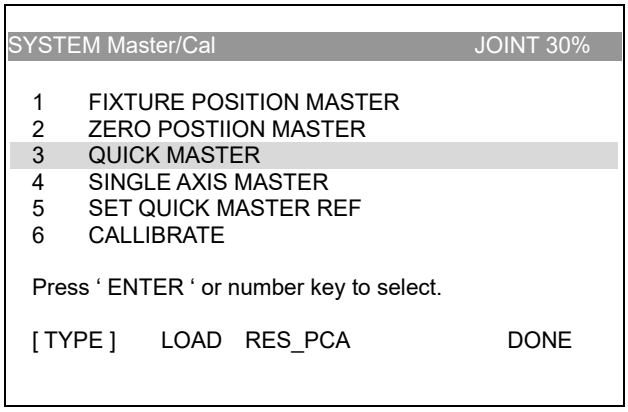
3 Release brake control, and jog the robot to the quick mastering reference position.
4 Move the cursor to SET QUICK MASTER REF and press ENTER. Press F4, YES.

> **⚠ NOTE**
> If the robot has lost mastery due to mechanical disassembly or repair, you cannot perform this procedure. In this case, master to a fixture or master to zero degrees to restore robot mastery.

Procedure Quick Mastering

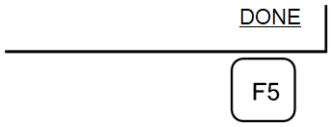
Step

1 Display the Master/Cal screen.



2 Release brake control, and jog the robot to the quick mastering reference position.

3 Move the cursor to QUICK MASTER and press ENTER. Press F4, YES. Quick mastering data is memorized.
4 Move the cursor to CALIBRATE and press ENTER. Calibration is executed. Calibration is executed by power on again.
5 After completing the calibration, press F5, DONE.



6 Return brake control to original setting, and turn off the controller power and on again.

5.1.5 Single Axis Mastering

Single axis mastering is performed for one axis at a time. The mastering position for each axis can be specified by the user.
Single axis mastering can be used, if mastering data for a specific axis is lost, for example, because a low voltage has been detected on the pulse counter backup battery or because the Pulsecoder has been replaced. In the F-200*i*B, this function is also used for mastering by the use of a fixture.

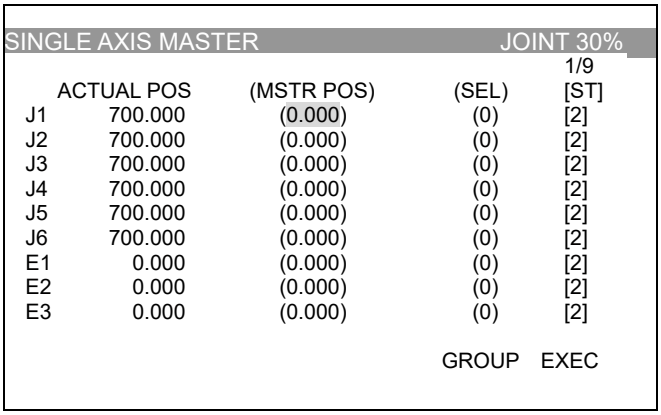


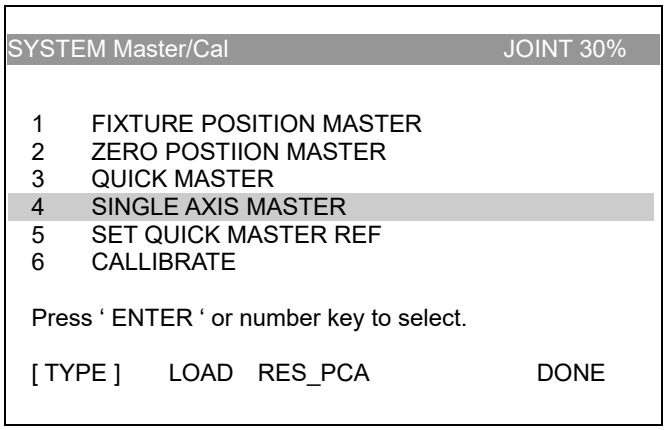
Table 5.1.5 (a) Items set in single-axis mastering

Item	Description
Current position (ACTUAL POS)	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.

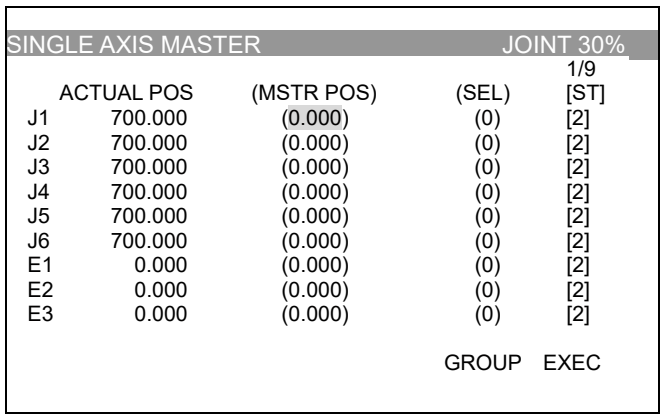
Procedure for Single Axis Mastering

Step

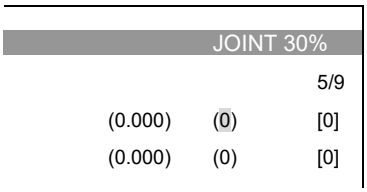
1 Select [6 SYSTEM].
2 Select [Master/Cal].

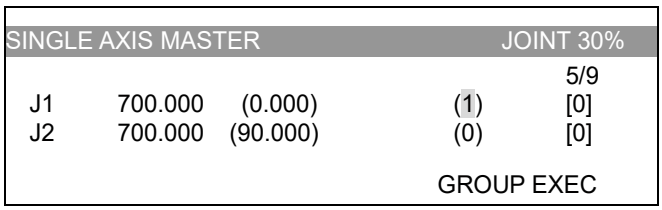


3 Select 4, SINGLE AXIS MASTER. The following screen will be displayed.

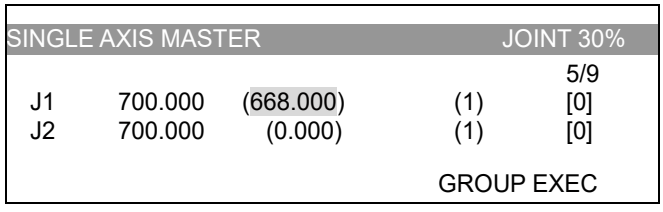


4 Move the cursor to the (SEL) column for the unmastered axis and press the numeric key "1." Setting of (SEL) is available per one axis or per plural axes.

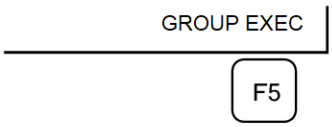




5 Turn off brake control as required, then jog the robot to the mastering position.
6 Enter axis data for the mastering position.



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



SINGLE AXIS MASTER JOINT 30%

1/9

	ACTUAL POS	(MSTR POS)	(SEL)	[ST]
J1	700.000	(668.000)	(0)	[2]
J2	700.000	(0.000)	(0)	[2]
J3	700.000	(0.000)	(0)	[2]
J4	700.000	(0.000)	(0)	[2]
J5	700.000	(0.000)	(0)	[2]
J6	700.000	(0.000)	(0)	[2]
E1	0.000	(0.000)	(0)	[2]
E2	0.000	(0.000)	(0)	[2]
E3	0.000	(0.000)	(0)	[2]

[TYPE] GROUP EXEC

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

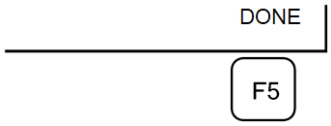
SYSTEM Master/Cal JOINT 30%

1 FIXTURE POSITION MASTER
2 ZERO POSITION MASTER
3 QUICK MASTER
4 SINGLE AXIS MASTER
5 SET QUICK MASTER REF
6 CALIBRATE

Press 'ENTER' or number key to select.

[TYPE] DONE

9 Select [6 CALIBRATE], then press F4 [YES]. Positioning is performed.
Alternatively, switch the power off and on again. Positioning is performed.
10 After positioning is completed, press F5 [DONE].



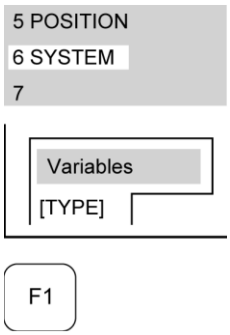
11 Return brake control to original setting, and turn off the controller power and on again.

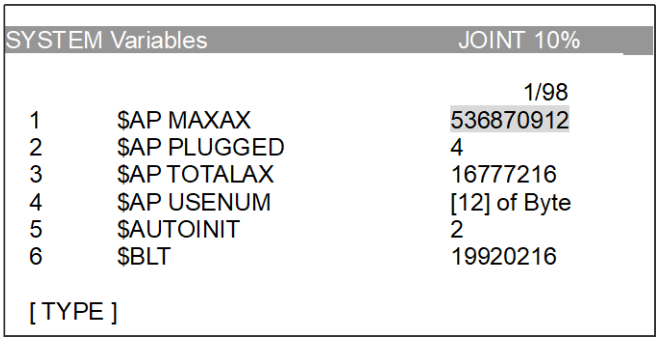
5.1.6 Mastering Data Entry

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

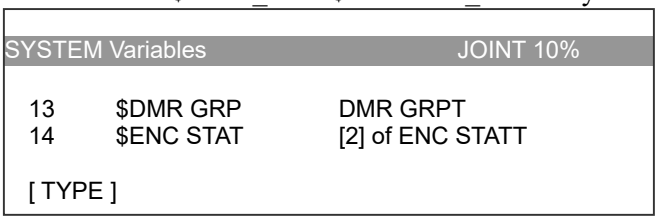
Mastering Data entry method

Step
1 Select [6 SYSTEM] and press ENTER.
2 Press F1 [TYPE] to select.

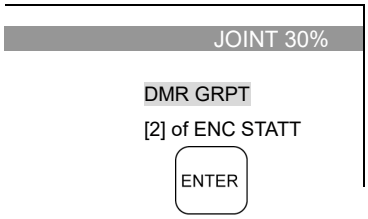


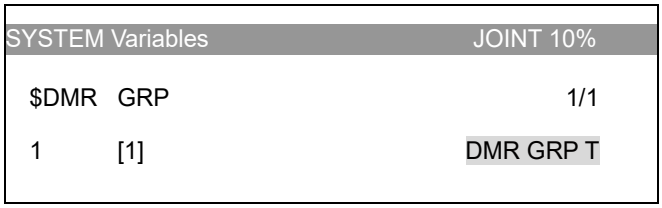


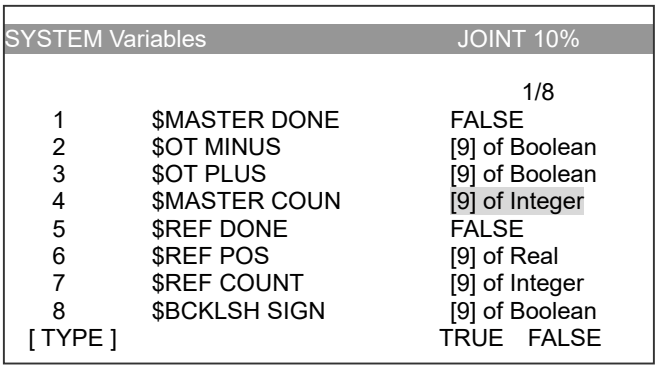
3 Change the mastering data.
The mastering data is saved to the $DMR_GRP.$MASTER_COUN system variable.



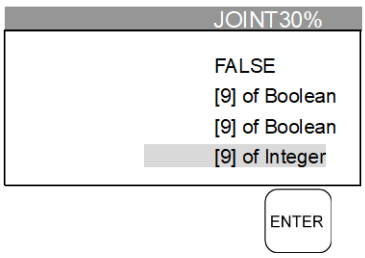
4 Select $DMR_GRP.

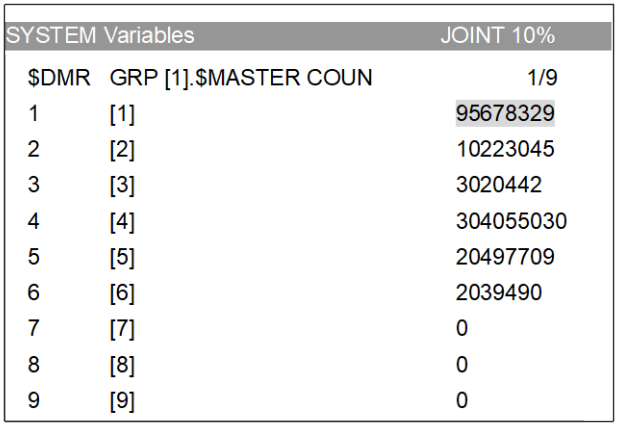




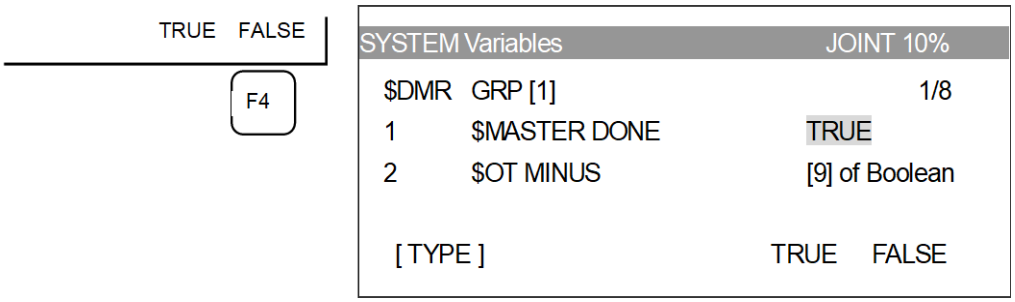


5 Select $MASTER_COUN, and enter the mastering data you have recorded.

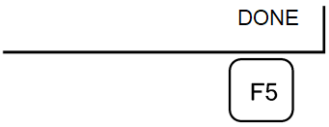




6 Press the previous page key.
7 Set $MASTER_DONE to TRUE



8 Display the positioning screen, and select [6 CALIBRATE], then press F4 [YES].
9 After completing positioning, press F5 [DONE].



5.2 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 668mm positions. Check that the zero-degree position marks indicated in Subsection 5.1.3 are aligned. There is no need to use any 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 below 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 Alarms that may be output during mastering and remedy for it
(1) BZAL alarm
This alarm is output if the voltage of the Pulsecoder's backup battery falls to 0 V while the power to the controller is disconnected. Also, if Pulsecoder connector is removed for replacing cables etc. this alarm is output because voltage becomes to 0. To clear the alarm, fit a new battery, execute the pulse reset (See Subsection 5.1.2.), then turn the power off then on again and confirm alarm is not output.
Battery might be weak if you can't reset alarm, then replace battery to new one , perform pulse reset , turn off and on the controller power. Note that, if this alarm occurs, all data originally held by the Pulsecoder will have been lost. Mastering must be performed again.
(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 of this Subsection.

(3) Alarm notification like CKAL, RCAL, PHAL, CSAL, DTERR, CRCERR, STBERR, and SPHAL may have trouble with Pulsecoder, contact your local FANUC representative.

6 PIPING AND WIRING

Fig.6 (a) and (b) show the wiring diagram and the connector locations of the mechanical unit.

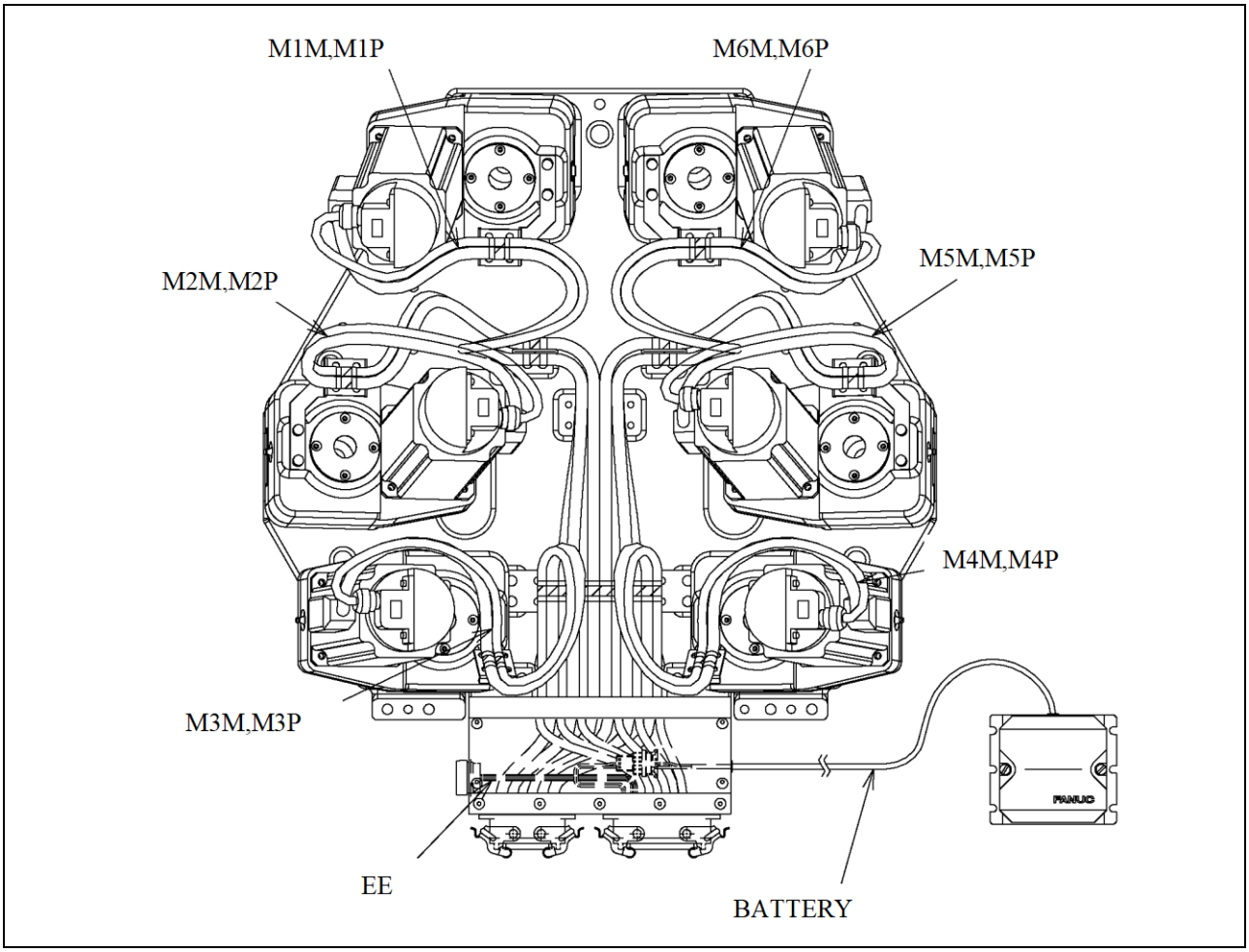


Fig.6 (a) Wiring diagram in mechanical unit

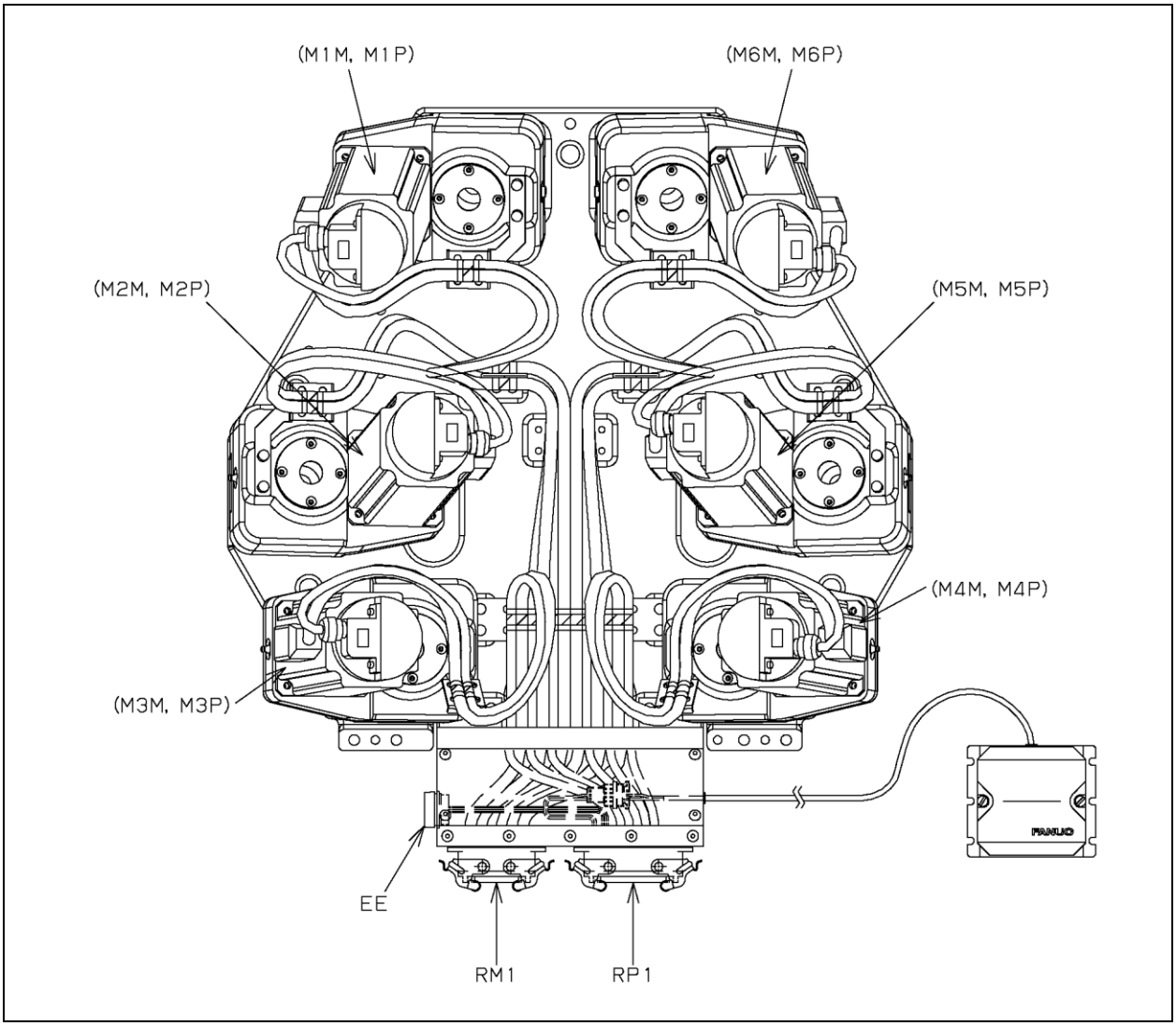


Fig.6 (b) Connector locations

7 ROBOT INTERFERENCE AREA

Fig.7 (a) shows the external dimensions of the robot.
When installing peripheral devices, be careful to clear away any objects that are in the robot's motion path in normal operation. Fig.7 (b) shows the operation range of the robot.

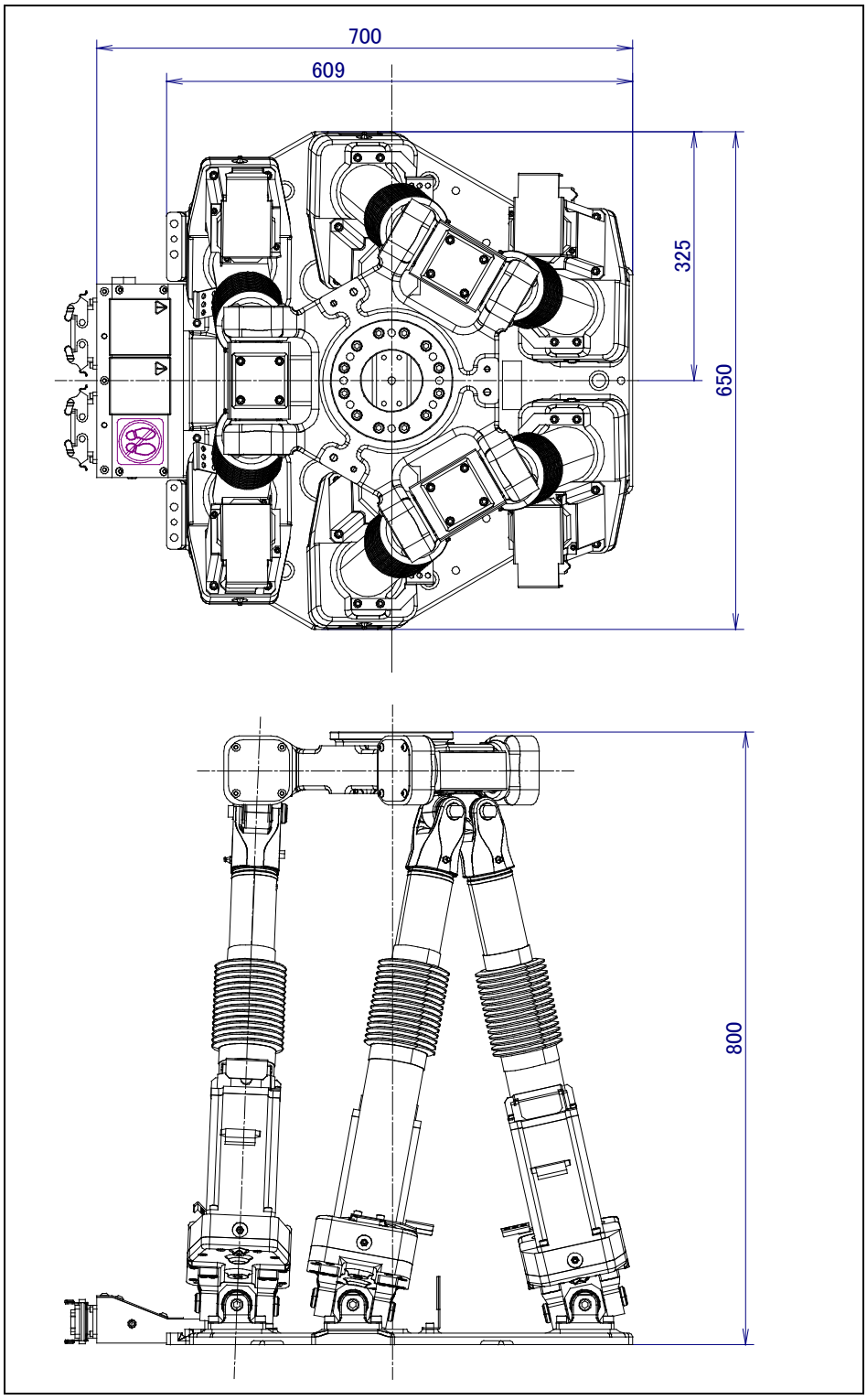


Fig.7 (a) External dimensions of the mechanical unit

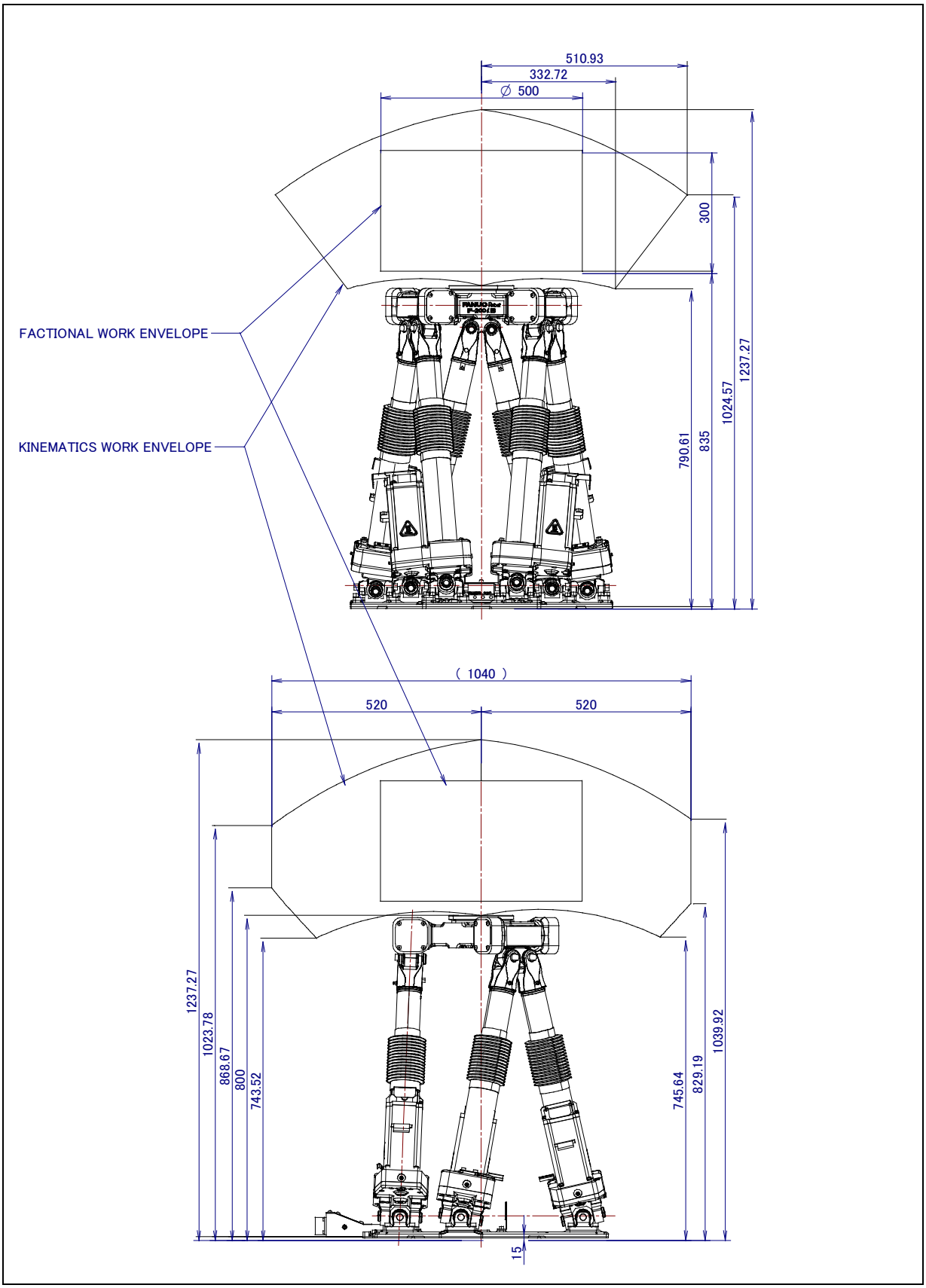


Fig.7 (b) Operation space

8 EQUIPMENT INSTALLATION TO THE ROBOT

8.1 WRIST LOAD CONDITIONS

Fig.8.1 (a) is diagram to limit loads applied to the wrist. Apply a load within the region indicated in the graph.

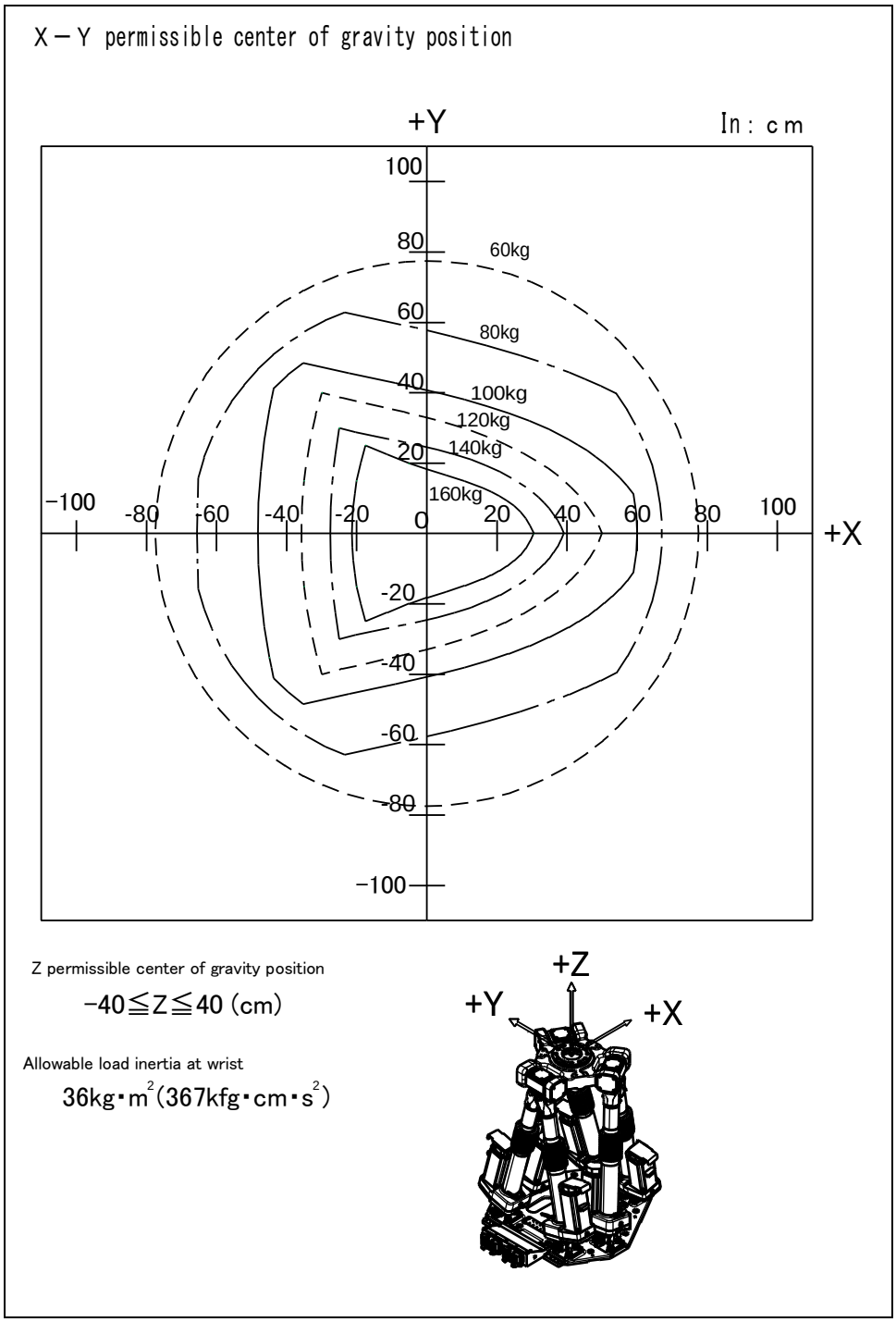


Fig.8.1 (a) Wrist load diagram

8.2 MECHANICAL COUPLING OF END EFFECTOR TO WRIST

Fig.8.2 (a) to (d) are the diagram for installing end effectors on the wrist.
To fasten the end effector, first position it with two pin holes at C using fitting A or B, then lock it using six tapping screws at D. Select screws and positioning pins of a length that matches the depth of the tapped and pin holes.

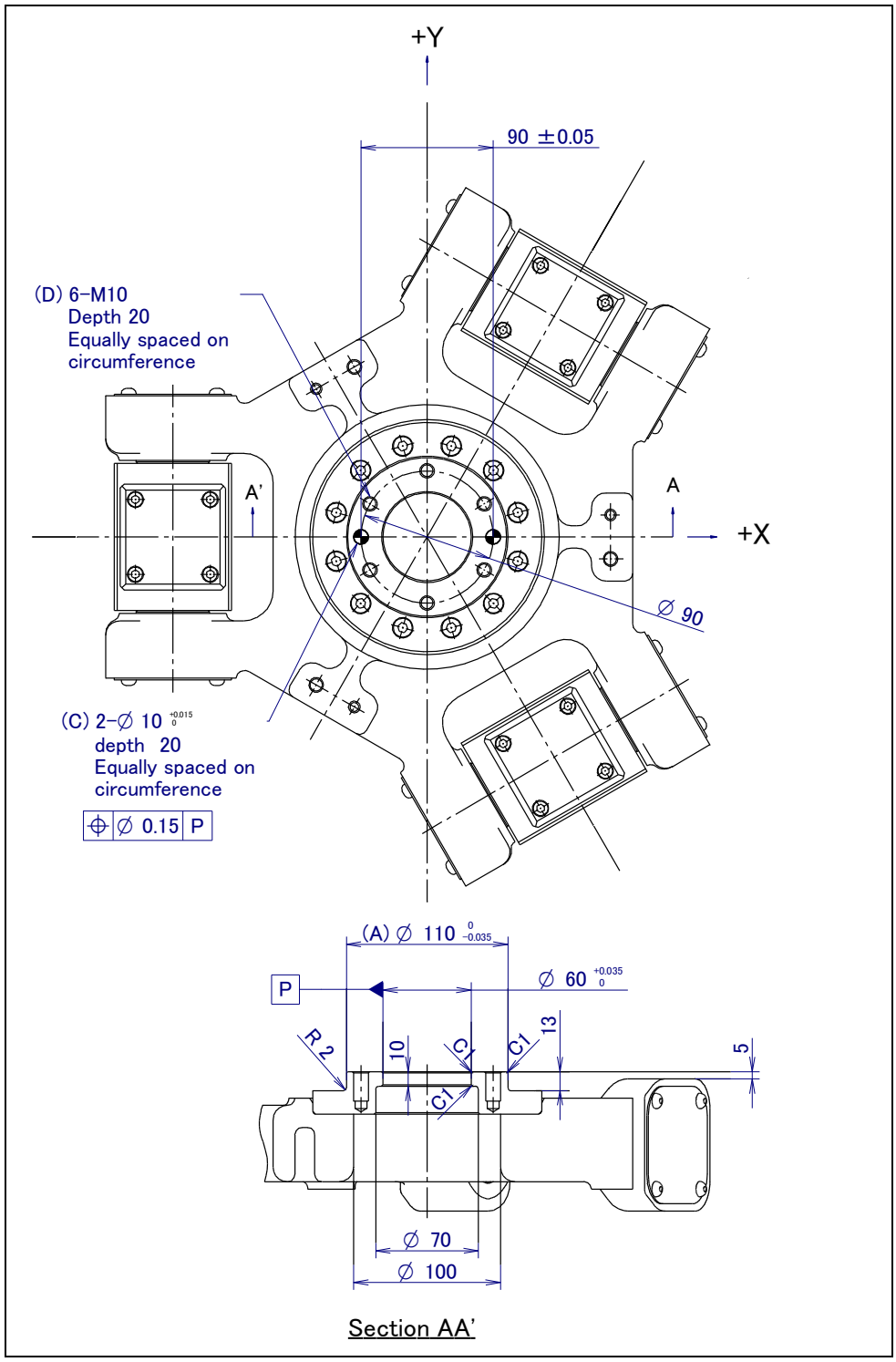


Fig.8.2 (a) End effector mounting face (standard flange)

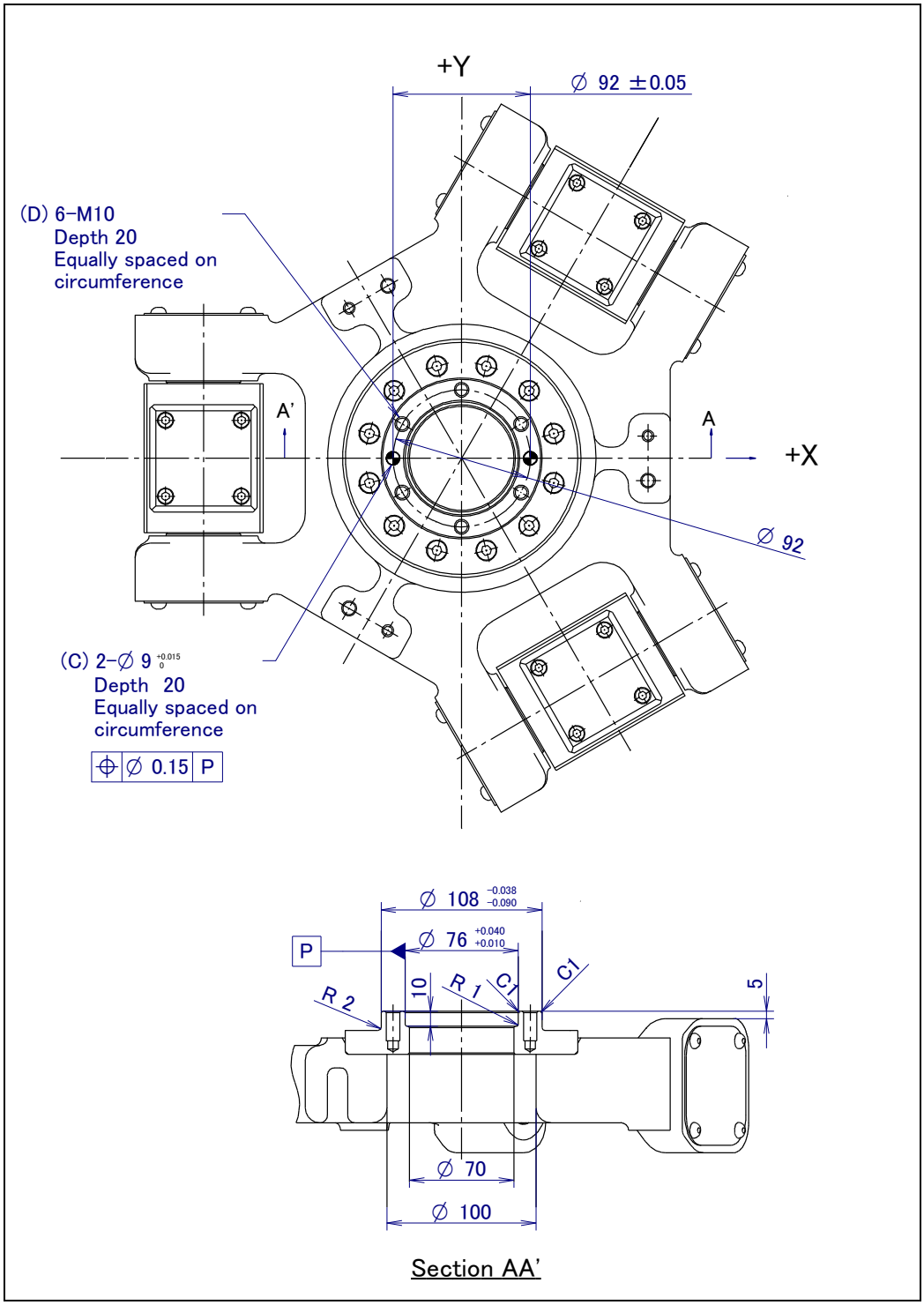


Fig.8.2 (b) End effector mounting face (special flange)

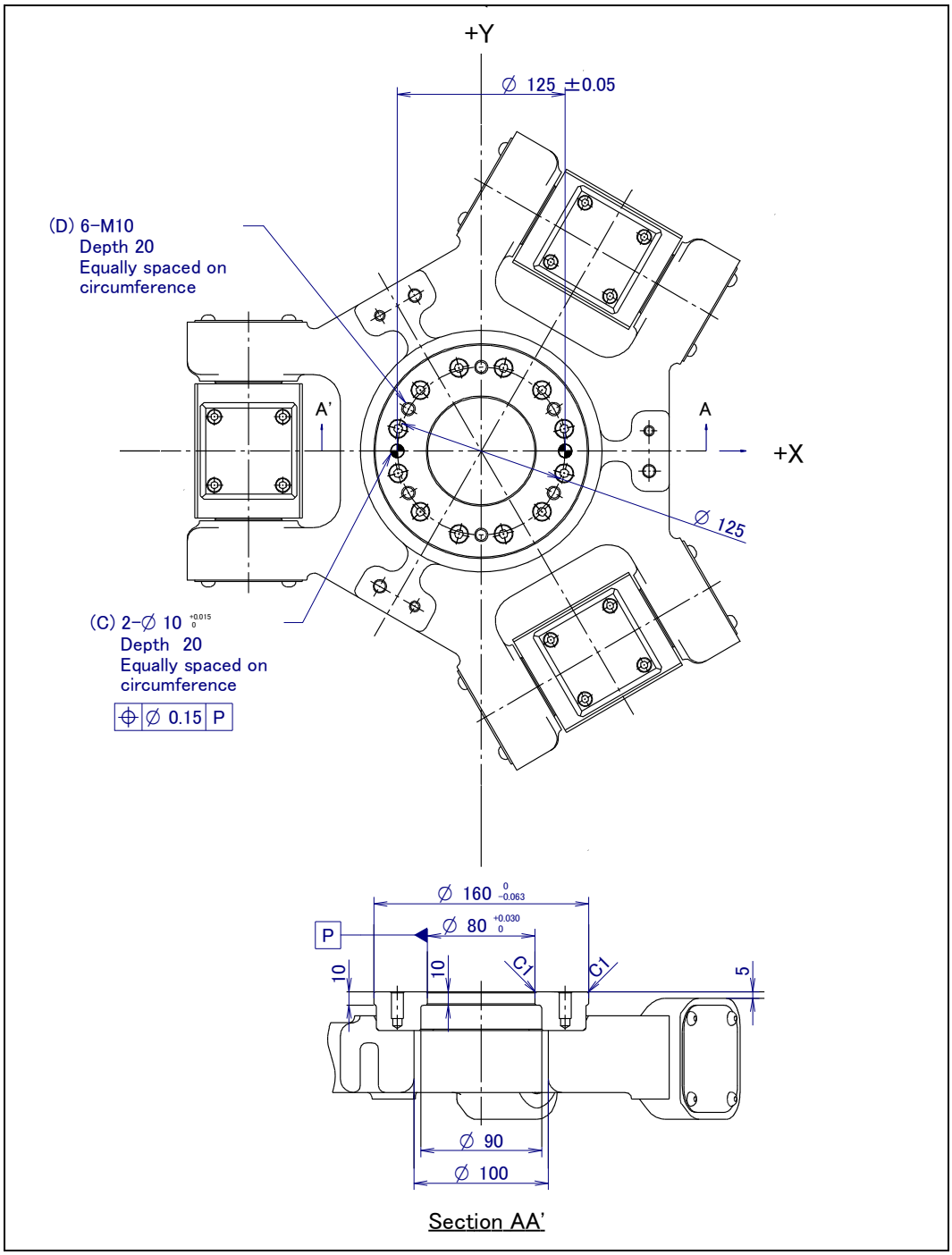


Fig.8.2 (c) End effector mounting face (ISO flange-not insulated)

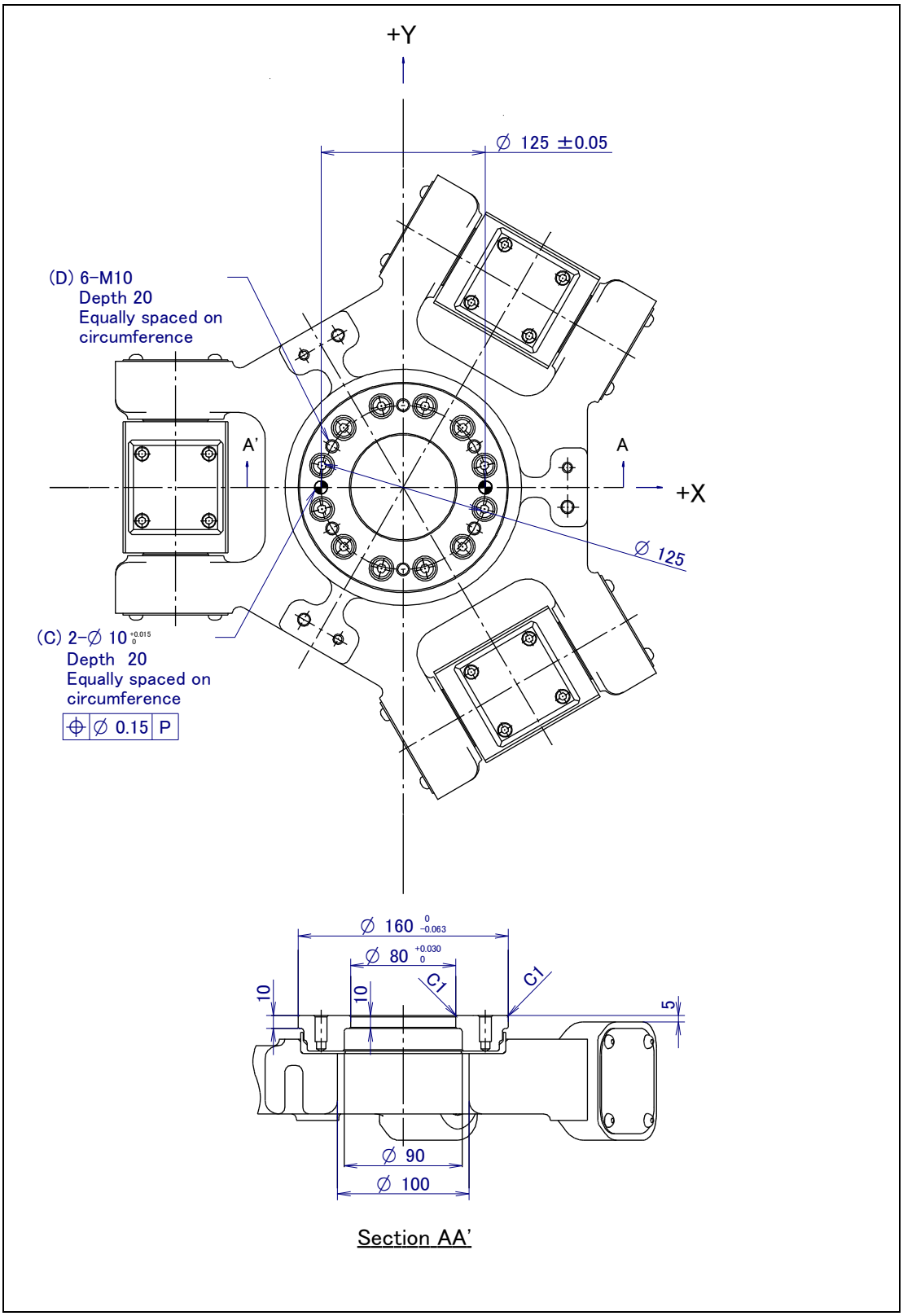


Fig.8.2 (d) End effector mounting face (insulated ISO flange)

8.3 SETTING THE LOAD

Enter the mass and the inertia of the hand mounted to the wrist, as described below:

(1) Press the [MENU] key to display the screen menu.
(2) Press zero for next screen and select [6 SYSTEM].
(3) Press F1, TYPE, to display the screen switching menu and select variable.
(4) Select item [Motion]. The load setting number selection screen is displayed. Select the load setting number used.
(5) Press F3, DETAIL, to display the load setting screen.
(6) Enter the load weight, the position of the center of gravity of the load, and the load inertia. The load weight and the load inertia, as used here, refer to the X, Y, and Z coordinates and the inertia about the X-, Y-, and Z-axes in the absolute coordinate system with its origin at the center of the flange, with the robot being set to a posture with zero degrees.

MOTION/PAYLOAD SET			JOINT 10%
			1/8
	Group 1		
1	Schedule No [1]:	[	]
2	PAYLOAD	[kg]	100.00
3	PAYLOAD CENTER X	[cm]	60.00
4	PAYLOAD CENTER Y	[cm]	0.00
5	PAYLOAD CENTER Z	[cm]	0.00
6	PAYLOAD INERTIA X	[kgfcms^2]	361.00
7	PAYLOAD INERTIA Y	[kgfcms^2]	0.00
8	PAYLOAD INERTIA Z	[kgfcms^2]	361.00

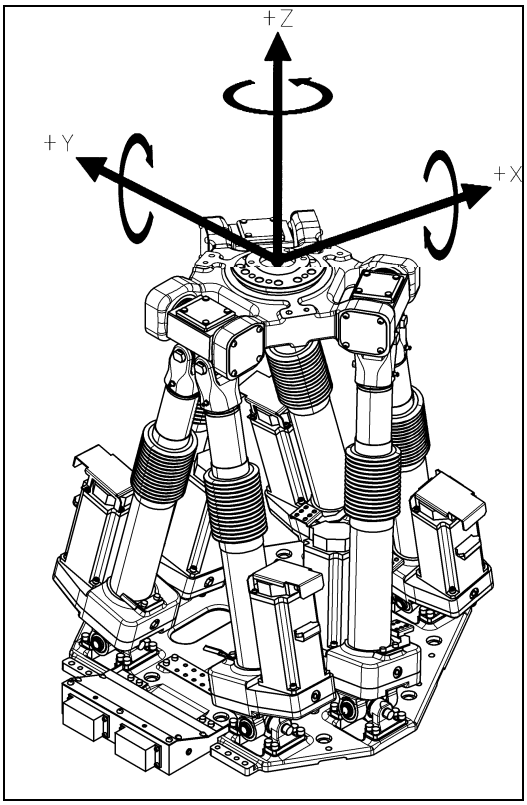


Fig.8.3 (a) Setting load

8.4 EE INTERFACE

⚠ 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 cable 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 rod of the end effector (hand) cable. Insulate the cable with seal tape.
- 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 end effector and robot 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.

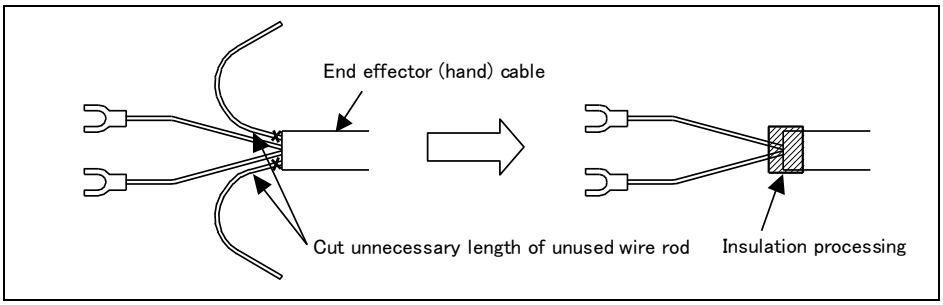


Fig.8.4 (a) Treatment method of end effector (hand) cable

Fig. 8.4 (b) shows the position of the optional cable interface.
The end effector (RDI/RDO) or (RI/RO) is provided as standard.

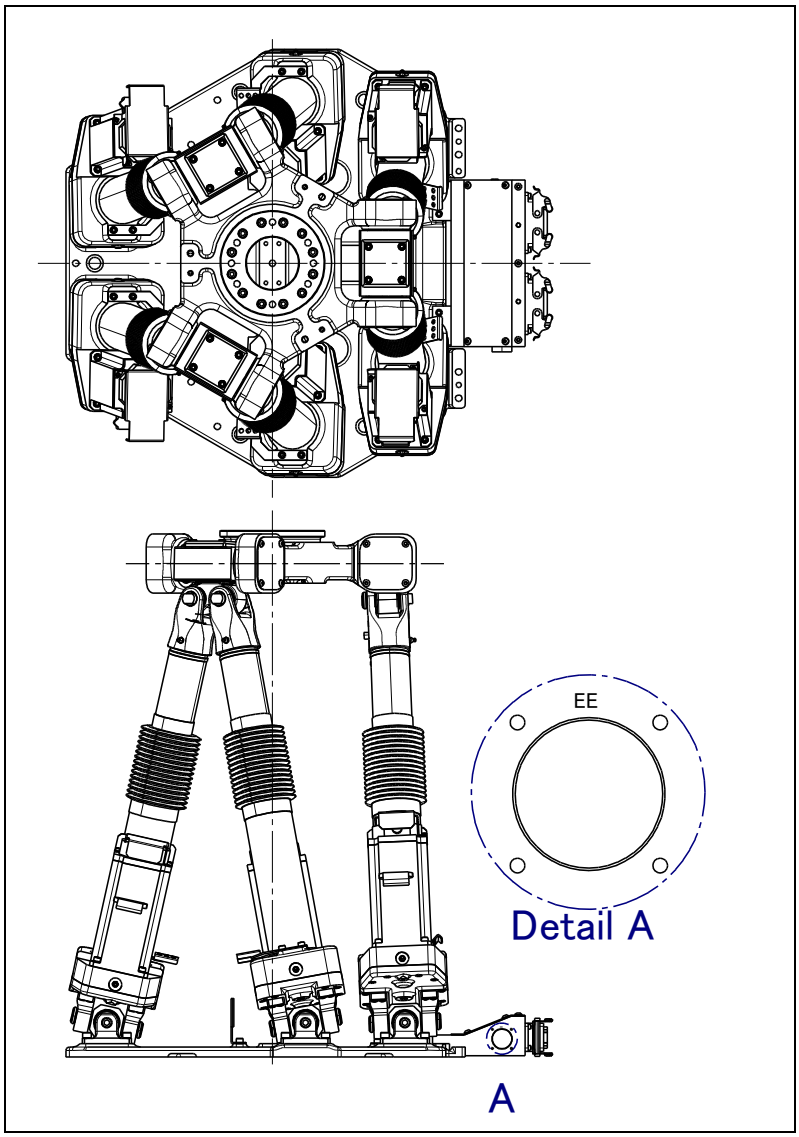


Fig.8.4 (b) Position of the EE interface

Fig. 8.4 (c) and (d) show the pin arrangement of the EE interface (RDI/RDO) or (RI/RO).

> ⚠ **WARNING**
> The RDO signal for the R-J3*i*B controller and the RO signal for the R-30*i*A/R-30*i*B controller are incompatible with each other because different output formats are used. For details, refer to the Chapter 4 of CONNECTION of controller maintenance manuals.

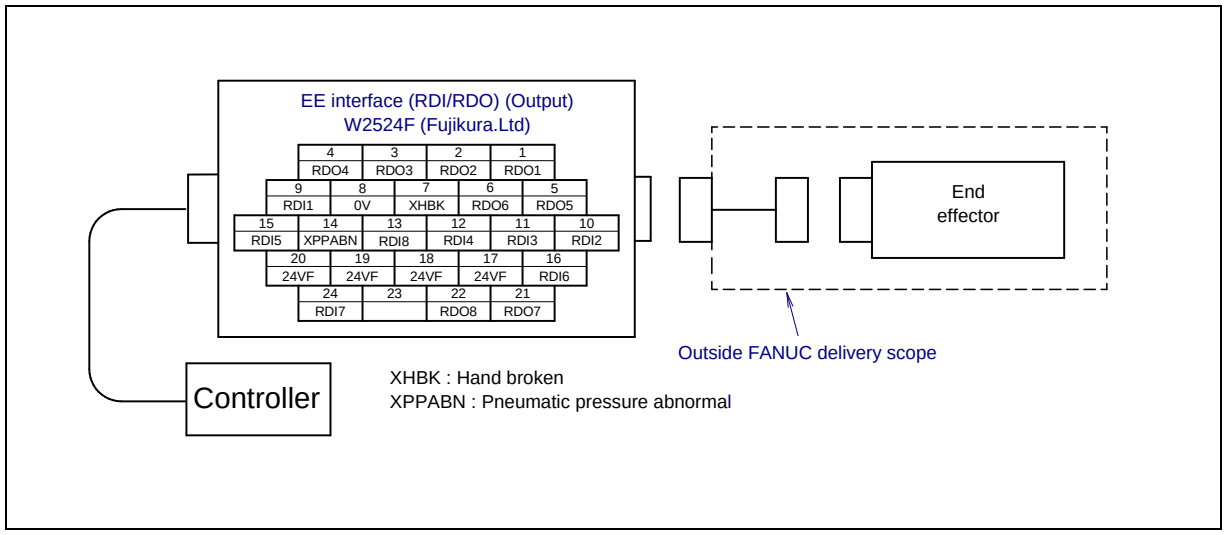


Fig.8.4 (c) Pin arrangement (R-J3*i*B) of the EE interface (RDI/RDO).

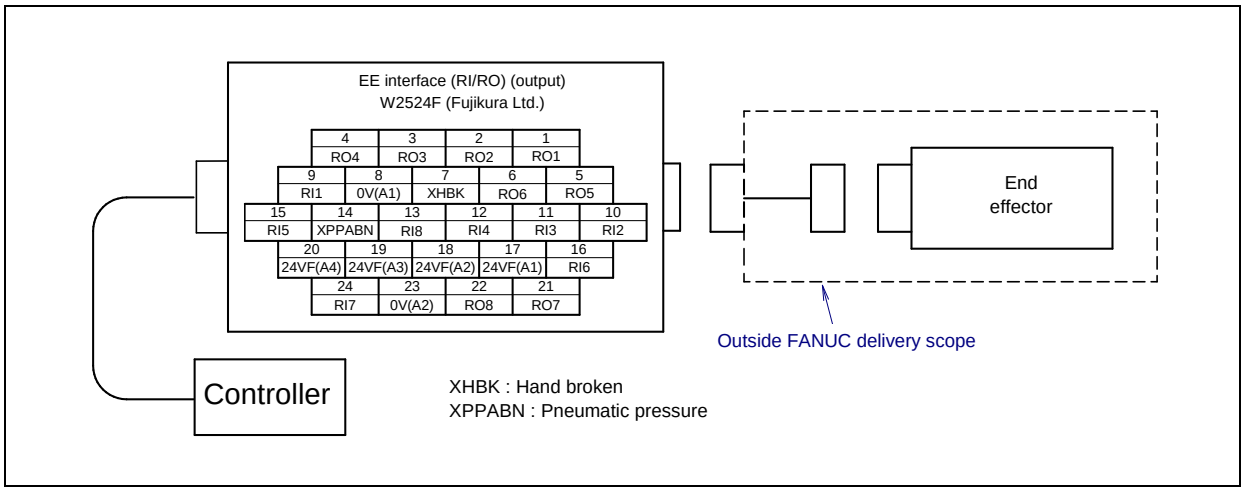


Fig. 8.4 (d) Pin arrangement (R-30*i*A/R-30*i*B) of the EE interface (RI/RO).

Connector specifications

Table 8.4 (a) Connector specifications (Mechanical Unit)

Cable name	Output (connector panel)	Maker/Dealer
RDI/RDO or RI/RO	JMR2524F	Fujikura.Ltd

Table 8.4 (b) Connector specifications (User)

Cable name	Output (connector panel)	Maker/Dealer
RDI/RDO or RI/RO	JMSP2524M straight plug (supplied) (FANUC spec.: A63L-0001-0234#S2524M) JMLP2524M angle plug	Fujikura.Ltd

NOTE
For details of dimensions and for other information, refer to the catalog available from the manufacturer or contact your local FANUC representative.

9 TRANSPORTATION AND INSTALLATION

9.1 TRANSPORTATION

1) Transportation using a crane
The robot can be transported by lifting it. When transporting the robot, be sure to change the posture of the robot to that shown in Fig.9.1 (a) and lift by attaching sling to the three M10 eyebolts.

2) Transportation using a forklift
The robots can also be transported using a forklift (Refer to Fig.9.1 (b)). Transport materials are available as an option.

⚠CAUTION
For the F-200*i*B, the battery case is separated and, therefore, transport the robot with the battery case secured to the connector panel together with the cable of about 7 m, as shown in Fig. 9.1 (a) and (b).

⚠WARNING
When tools or additional units are attached, the center of gravity of the robot deviates, possibly causing instability during transportation. If the robot becomes unstable, remove the tools and take the transportation posture. This returns the center of gravity to the normal position. It is recommended that tools and additional units be transported separately from the robot.

The forklift transportation materials can be used only for transportation with a forklift. Do not use the forklift transportation materials for other transportation means. Do not use the transportation materials to fix the robot.

Before transporting the robot with the transporting materials, check the fixing bolts of the transportation materials and tighten the loose bolts.

NOTE） 1.Machine weight is approximately 190kg
2. Eyebolts complied with JISB 1168.
3. Quantity eyebolt 4
sling 4
4.Do not ship with a tool exceeding the rated load attached.
5.Do not lift robot with a plate attached.

Robot posture on transportation

J1 AXIS	668 mm
J2 AXIS	668 mm
J3 AXIS	668 mm
J4 AXIS	668 mm
J5 AXIS	668 mm
J6 AXIS	668 mm

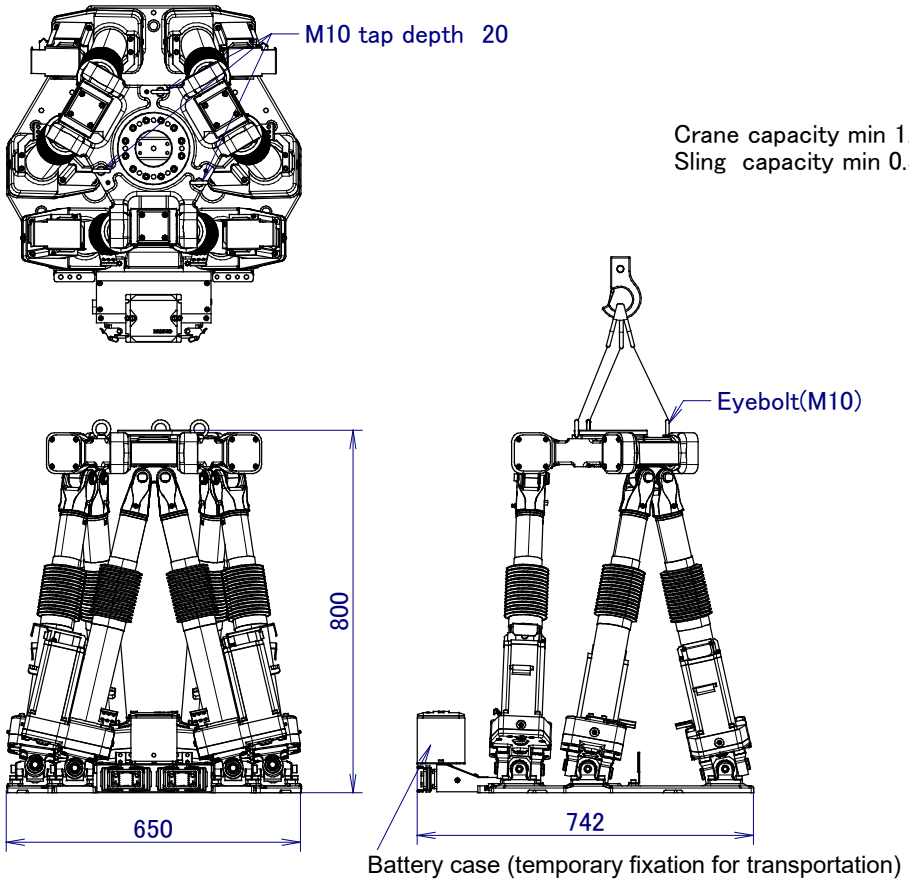


Fig.9.1 (a) Transportation using a crane

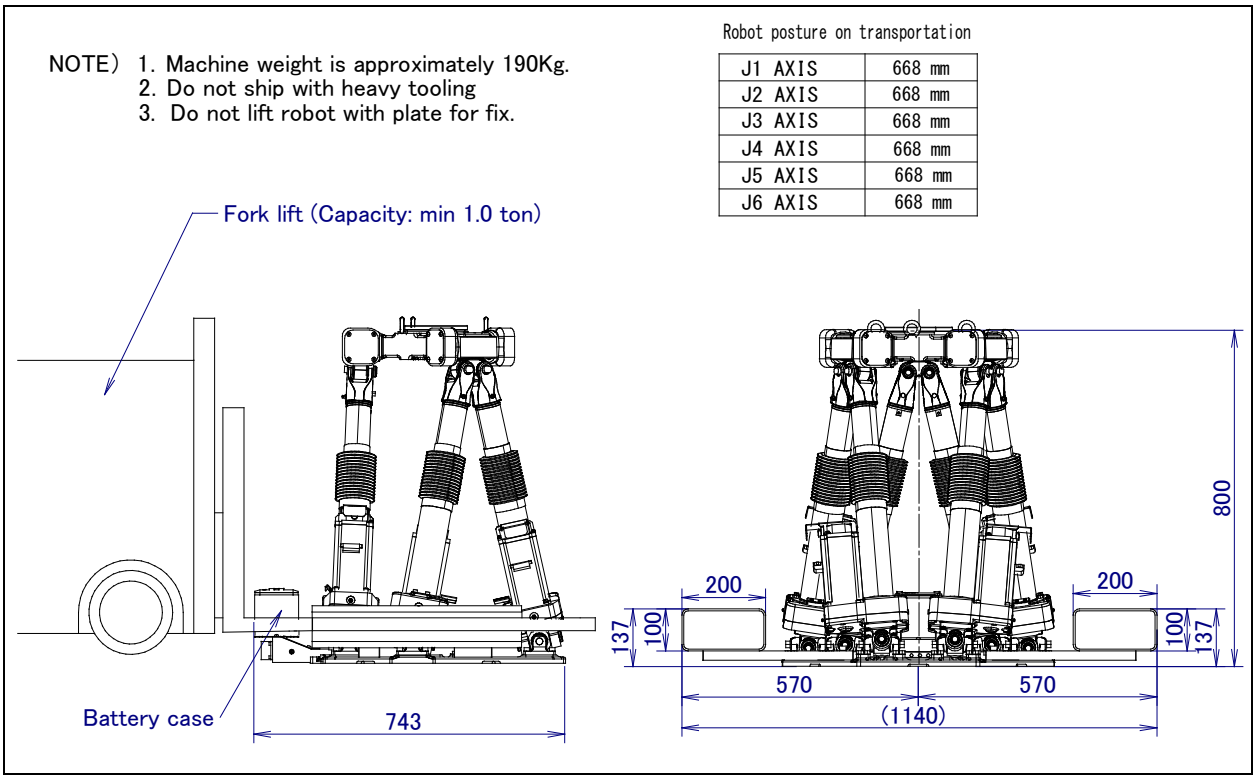


Fig.9.1 (b) Transportation using a forklift

9.2 INSTALLATION

Fig.9.2 (a) shows the robot base dimensions. Fig.9.2 (b) shows actual examples of robot installation.
In Fig.3.2 (b), the floor plate is imbedded in concrete and fastened with four M20 (Tensile strength: 400N/mm^2) chemical anchors. Also fasten the block to the robot base using nine M16 x 35 bolts (Tensile strength: 1200N/mm^2). Next, position the robot, and weld the base plate to the floor plate. (Foot length is 10 to 15mm.)
Use hexagon socket bolts as the M16 x 35 bolts and embed their heads in the counterbored holes without placing washers.
It is recommended that the flatness of the block be 0.01 (Blocks are provided as options.)

⚠ CAUTION
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 0.5°.
If robot base is placed on uneven ground, it may result in the base breakage or low performance of the robot.

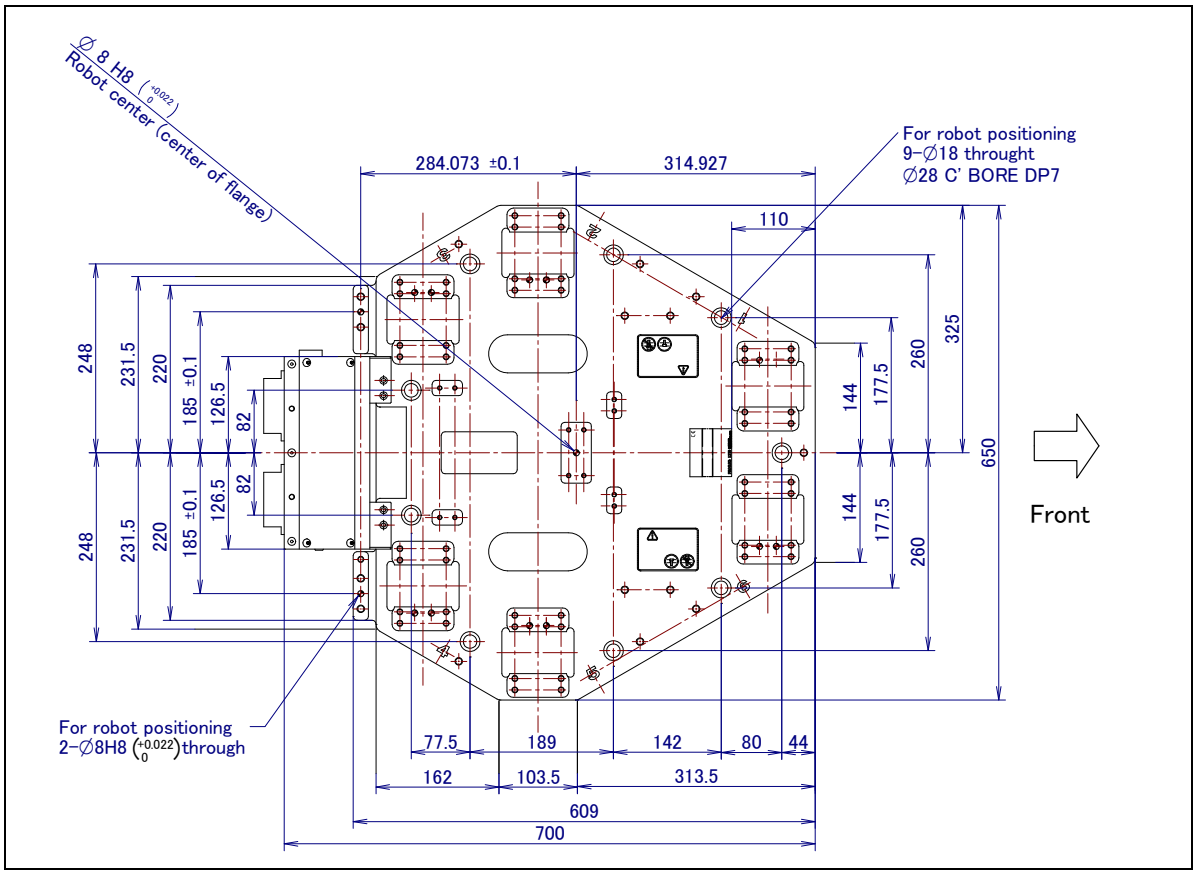


Fig.9.2 (a) Dimensions of the robot base

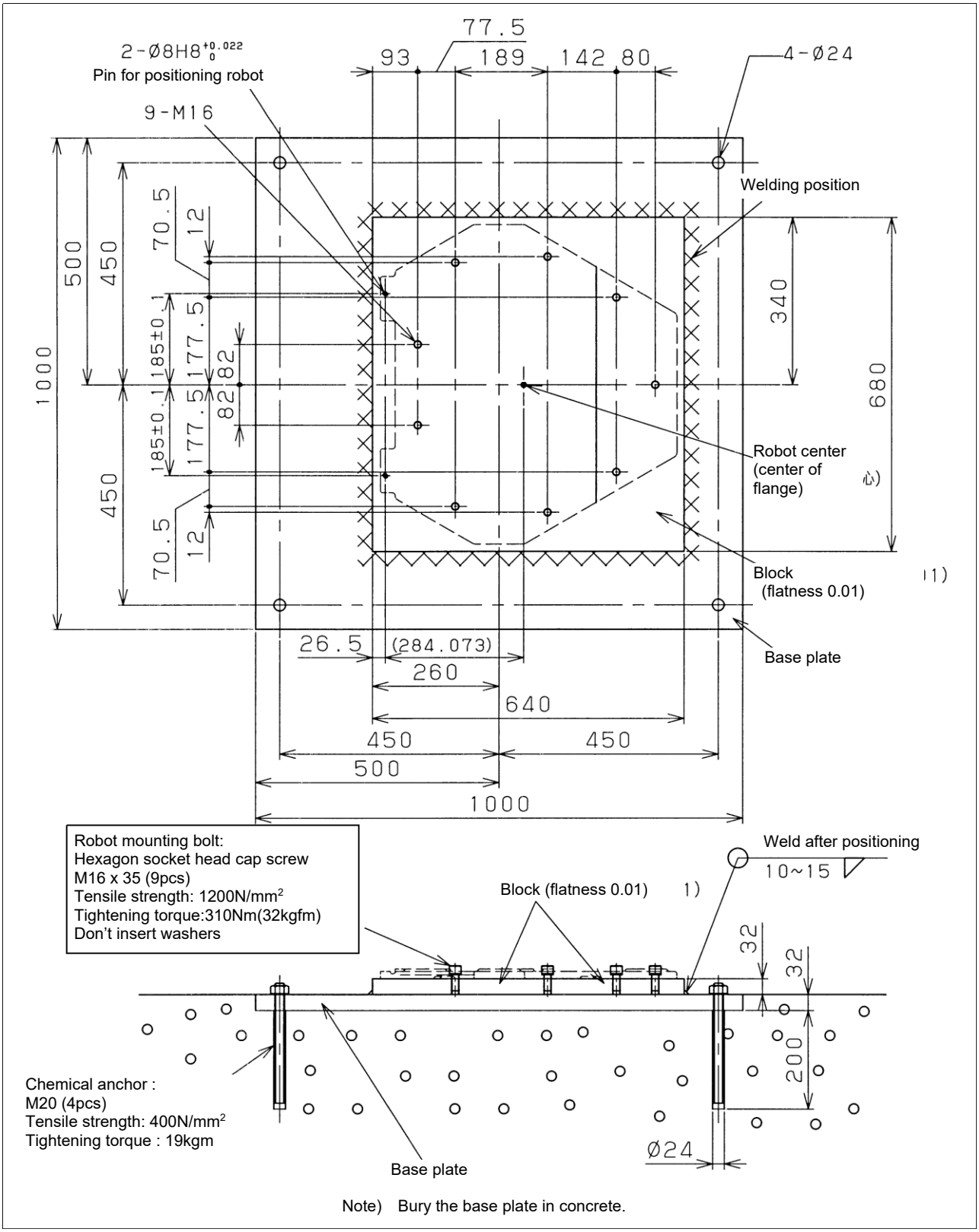


Fig.9.2 (b) Actual installation example

⚠CAUTION

1 Parts to be provided by the customer:
- Robot mounting bolts :
  Hexagon socket head cap screw M16x35
  (Tensile strength: 1200N/mm^2) 9pcs.
- Chemical anchors: M20 (Tensile strength: 400N/mm^{2}s) 4pcs.
- Block : thickness 32t 1pcs.
- Floor plate : thickness 32t 1pcs.
- Straight pin : ϕ8 2pcs.

2 Please use hexagon socket head cap screw for the robot mounting bolt, and bury the bolt head into the bore without washers.

3 Peripheral device parts, such as connection cables for devices, should not be place on the robot. Don't operate the robot with maintenance tools or any foreign objects on the robot. It will cause damage of mechanical unit by interference.

4 Daily cleaning of the robot base to be performed, especially the robot is placed in an environment that suffers a large accumulation of foreign matters. In such severe environment, full cover option is recommended to avoid interference trouble.

5 Installation work (welding, anchoring, etc.) is prepared by the customer.

Fig. 9.2 (d) and Table 9.2 (a) show the force and the moment that apply to the base plate at Power-Off stop time and at acceleration/deceleration time and at reset time.
Table 9.2 (b) and (c) indicates the coasting time and distance until the robot stopping by Power-Off stop or by Controlled stop after input of the stop signal. Fig.9.2 (c) indicate the measurement condition.

Table 9.2 (a) Force and moment apply to the base plate

	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)]
At Power-Off stop	2.25 (230)	70.6 (7200)	10.8 (1100)	44.1 (4500)
At acceleration/ deceleration	0.49 (50)	44.1 (4500)	1.27 (130)	27.4 (2800)
At reset	0.00 (0)	29.4 (3000)	0	0

Table 9.2 (b) Stopping time and distance until the robot stopping by Power-Off stop after input of stop signal

Motion & Conditions	Time (ms)	Distance (mm)	ΔW, ΔP, ΔR (deg)
(-519,0,1023,0,0,0) to (519,0,1023,0,0,0), Estop at X=0	150	189	0.245, 0.340, 0.269
(0,510,1025,0,0,0) to (0,-510,1025,0,0,0), Estop at Y=0	190	145	0.165, 1.178, 8.999
(0,0,835,0,0,40) to (0,0,835,0,0,-40), Estop at R=0	150	16	0.185,0.326,12.314

*Numbers in () indicate (X, Y, Z, W, P, R) in the world coordinate.

Table 9.2 (c) Stopping time and distance until the robot stopping by Controlled stop after input of stop signal

Motion & Conditions	Time (ms)	Distance (mm)
(0,510,1025,0,0,0) to (0,-510,1025,0,0,0), Controlled stop at Y=150	500	636
(-519,0,1023,0,0,0) to (519,0,1023,0,0,0), Controlled stop at X=-160	540	672

*Numbers in () indicate (X, Y, Z, W, P, R) in the world coordinate.

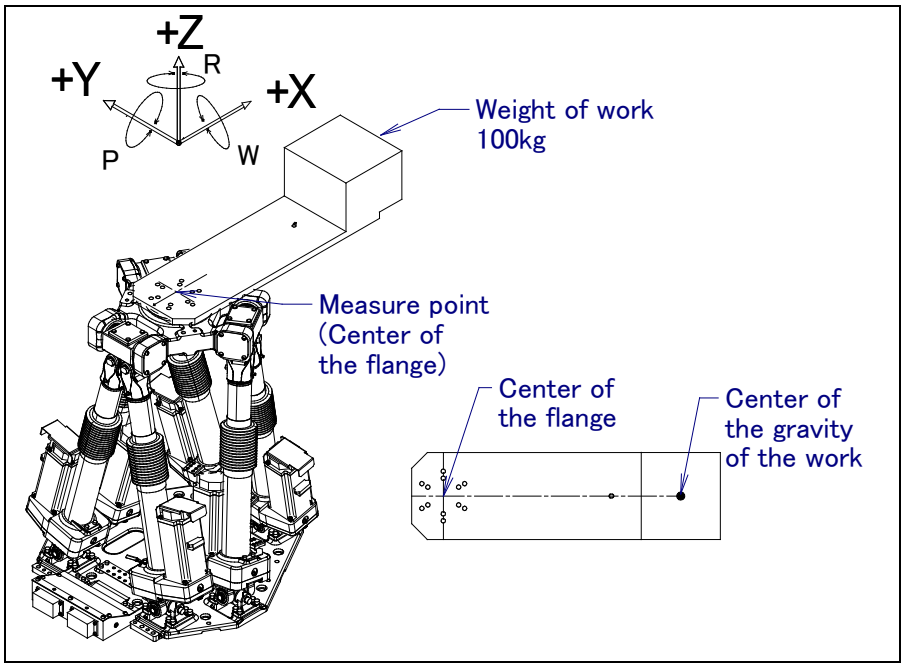


Fig.9.2 (c) Measurement condition

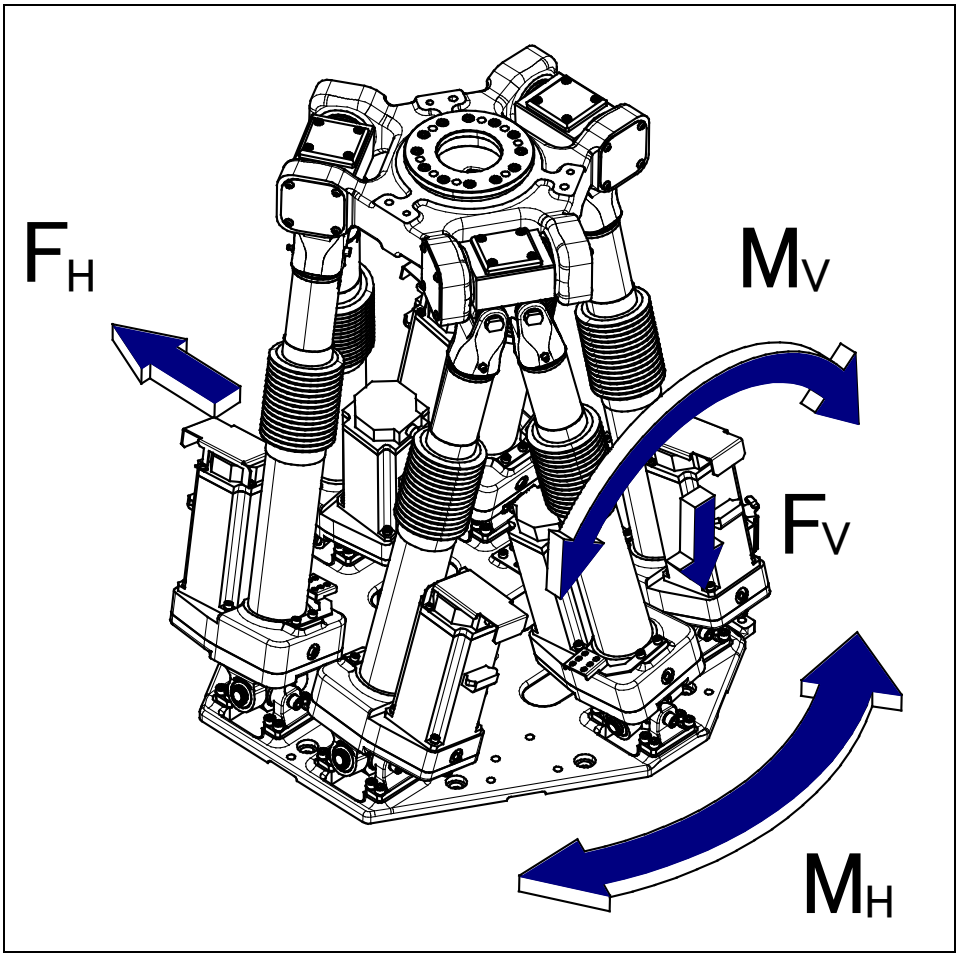


Fig.9.2 (d) Force and moment apply to the baseplate

For the F-200*i*B, the battery case is tacked at the position identified in Fig. 9.1 (a) before delivery. The customer is responsible for securing the battery case to an outside, safe location. Fig 9.2 (e) shows the outline drawing of the battery case.

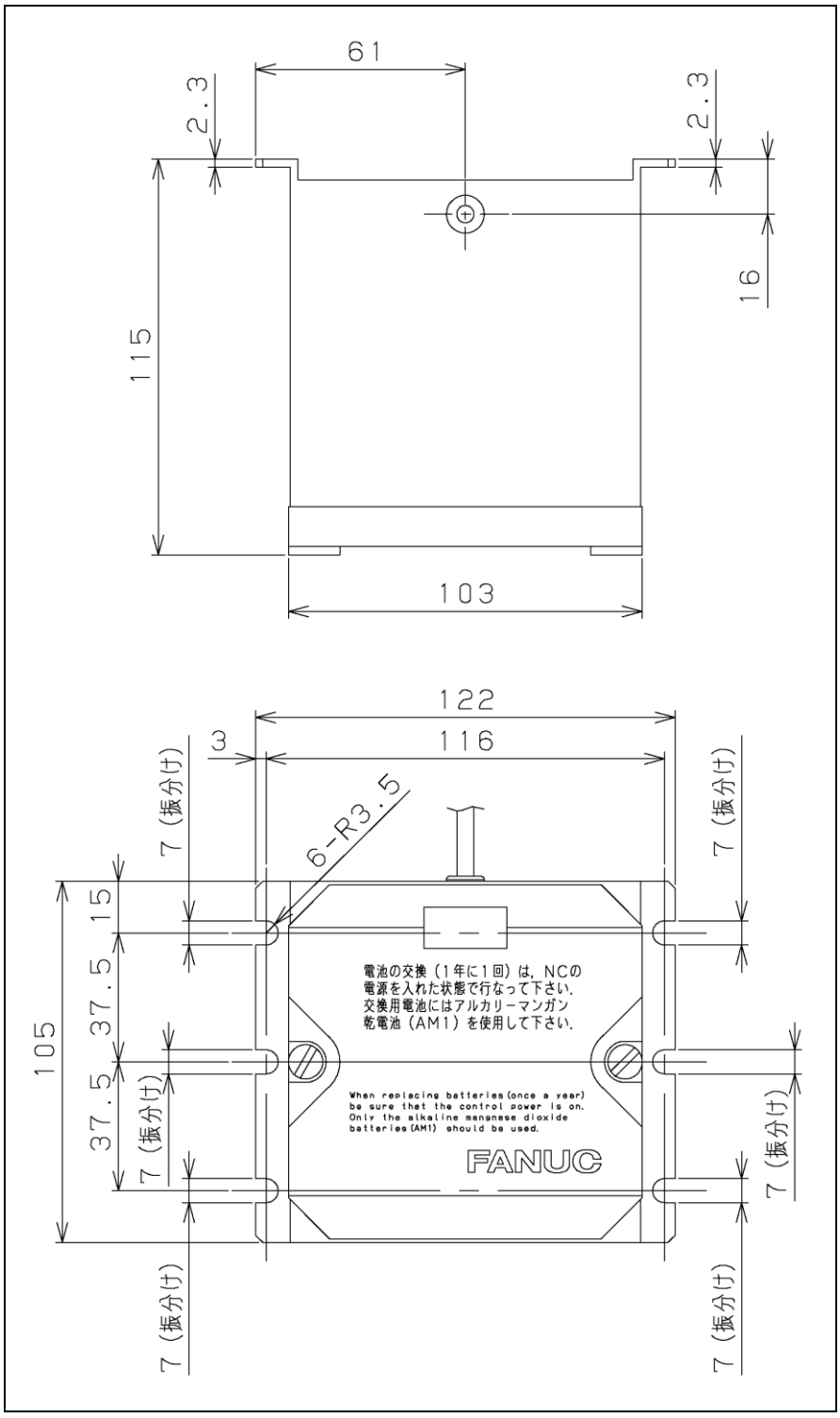


Fig.9.2 (e) Battery case

9.3 MAINTENANCE AREA

Fig. 9.3 (a) shows the layout of the maintenance space.

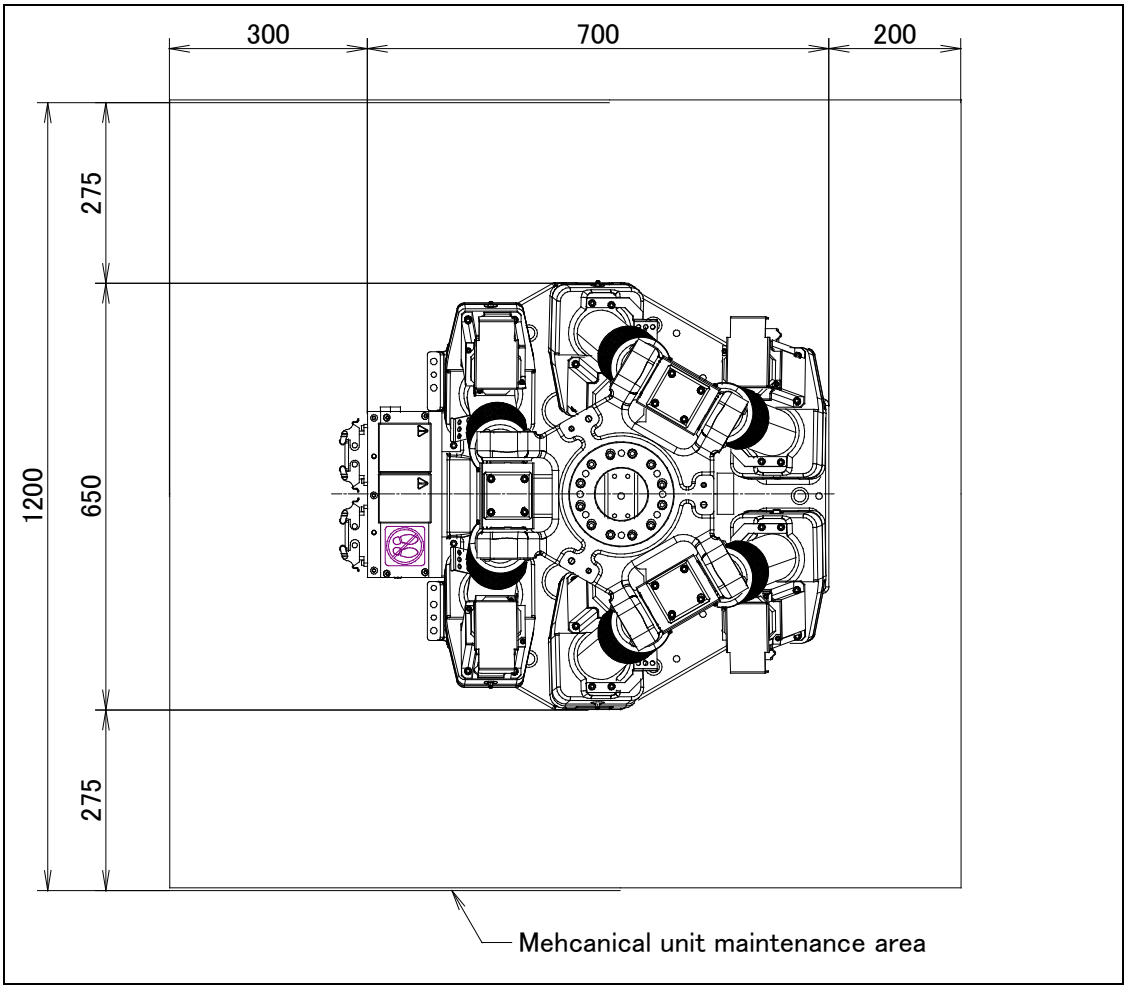


Fig.9.3 (a) Maintenance area

9.4 AIR CONTROL SET (OPTION)

To mount the optional set of three air items, the tapped holes shown in Fig. 9.4(a) are required. They must be prepared by the customer.
Fill the lubricator having three air components to the specified level with turbine oil #90 to #140. The machine tool builder is required to prepare mounting bolts.

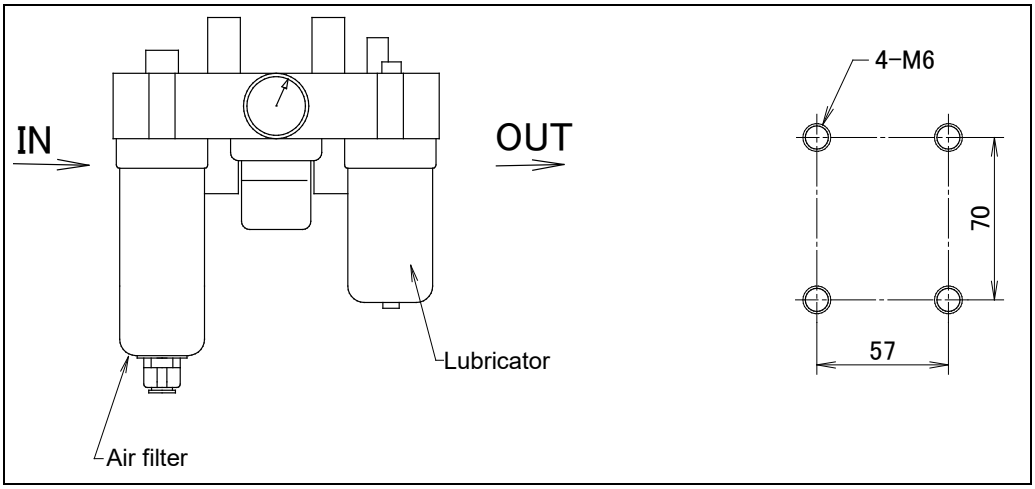


Fig.9.4 (a) Air control set option

9.5 INSTALLATION SPECIFICATIONS

Refer to specification of "PREFACE" about installation specifications.

9.6 STORAGE

When storing the robot, place it on a level surface with the same posture for transportation. (See 9.1)

10 CONNECTION WITH THE CONTROLLER

The robot is connected with the controller via the power cable, the signal cable and the earth cable. Connect these cables to the connectors on the back of the robot base. For details on air and option cables, see Chapter 8.

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

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

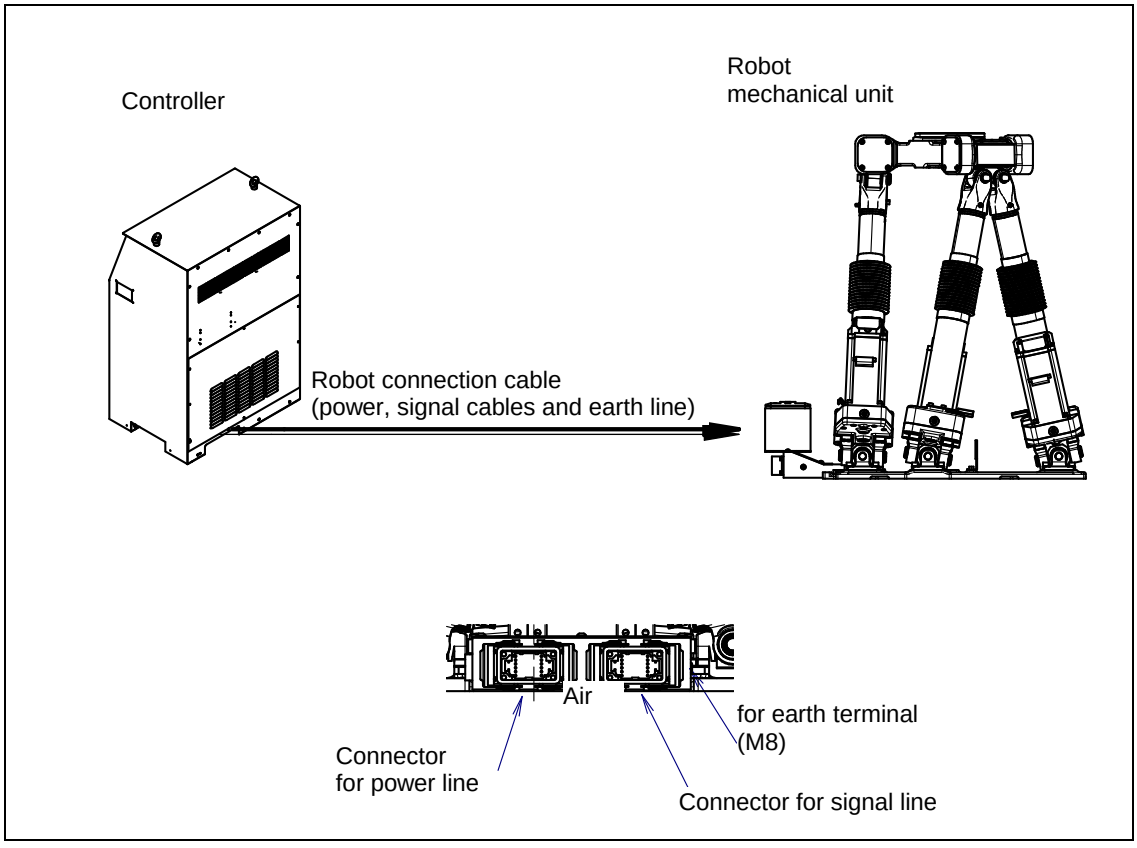
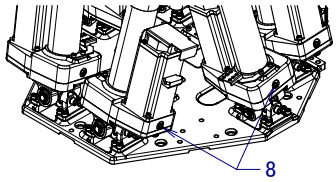
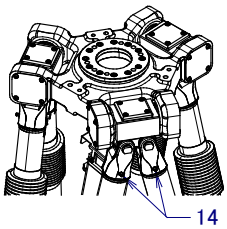


Fig. 10 (a) Cable connection

APPENDIX

A PERIODIC MAINTENANCE

FANUC Robot F-200*i*B Periodic Maintenance Table

	Items \ Accumulated operating time (H)		Check time	Grease amount	First check 320	3 month 960	6 month 1920	9 month 2880	1 years 3840	4800	5760	6720	2 years 7680	8640	9600	10560
Mechanical unit	1	Check the mechanical cable. (damaged or twisted)	0.2H	—		○			○				○			
	2	Check the motor connector. (loosening)	0.2H	—		○			○				○			
	3	Tighten the end effector bolt.	0.2H	—		○			○				○			
	4	Tighten the cover and main bolt.	2.0H	—		○			○				○			
	5	Remove spatter and dust etc.	1.0H	—		○			○				○			
	6	Check the end effector (hand) cable	0.1H	—		○			○				○			
	7	Replacing batteries *4	0.1H	—							●					
	8	Greasing of J1 to J6-axis gearbox *1	0.5H	265ml each	  **Position of grease nipple**											
	9															
	10															
	11															
	12															
	13															
	14	Greasing to the ball screws *1	0.5H	100ml each			●		●		●		●		●	
	15	Replacing cable of mechanical unit *	4.0H													
Controller	16	Check the robot cable, teach pendant cable and robot connecting cable	0.2H	—		○			○				○			
	17	Cleaning the ventilator	0.2H	—	○	○	○	○	○	○	○	○	○	○	○	○
	18	Replacing batteries *2 *4	0.1H	—												

*1 Refer to this manual about greasing points.
*2 Refer to Chapter 7 of MAINTENANCE of controller maintenance manual
*3 ●: requires order of parts
○: does not require order of parts
*4 Regardless of the operating time, replace the mechanical unit batteries at 1.5 year, replace controller batteries at 4 years.

3 years 11520	12480	13440	14400	4 years 15360	16320	17280	18240	5 years 19200	20160	21120	22080	6 years 23040	24000	24960	25920	7 years 26880	27840	28800	29760	8 years 30720	Items
○				○				○				○				○				Overhaul	1
○				○				○				○				○					2
○				○				○				○				○					3
○				○				○				○				○					4
○				○				○				○				○					5
○				○				○				○				○					6
●						●						●						●			7
●												●									8
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●		●		●		●		●		●		●		●		●		●			14
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○				○				○				○				○					16
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		17
				●																	18

B STRENGTH OF BOLT AND BOLT TORQUE LIST

NOTE

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

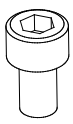
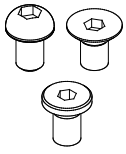
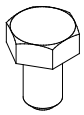
Use the following strength bolts. Comply with any bolt specification instructions.
Hexagon socket head bolt made of steel:

Size M22 or less: Tensile strength 1200N/mm^2 or more
Size M24 or more: Tensile strength 1000N/mm^2 or more
All size plating bolt: Tensile strength 1000N/mm^2 or more

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

Refer to the following tables if the bolts tightening torque 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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