FANUC Robot M-900*i*A/200P

MECHANICAL UNIT

OPERATOR'S MANUAL

B-82954EN/04

- **Original Instructions**

Before using the Robot, be sure to read the "FANUC Robot Safety Manual (B-80687EN)" and understand the content.

- No part of this manual may be reproduced in any form.
- All specifications and designs are subject to change without notice.

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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 have tried as much as possible to describe all the various matters.
However, we cannot describe all the matters which must not be done, or which cannot be done, because there are so many possibilities.
Therefore, matters which are not especially described as possible in this manual should be regarded as "impossible".

SAFETY PRECAUTIONS

Thank you for purchasing FANUC Robot.
This chapter describes the precautions which must be observed to ensure the safe use of the robot.
Before attempting to use the robot, be sure to read this chapter thoroughly.

Before using the functions related to robot operation, read the relevant operator's manual to become familiar with those functions.

If any description in this chapter differs from that in the other part of this manual, the description given in this chapter shall take precedence.

For the safety of the operator and the system, follow all safety precautions when operating a robot and its peripheral devices installed in a work cell.
In addition, refer to the “FANUC Robot SAFETY HANDBOOK (B-80687EN)”.

1 WORKING PERSON

The personnel can be classified as follows.

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

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

Maintenance engineer:
- Operates the robot
- Teaches robot inside the safety fence
- Maintenance (adjustment, replacement)

- An operator cannot work inside the safety fence.
- A programmer, teaching operator, and maintenance engineer can work inside the safety fence. The working activities inside the safety fence include lifting, setting, teaching, adjusting, maintenance, etc.
- To work inside the fence, the person must be trained on proper robot operation.

During the operation, programming, and maintenance of your robotic system, the programmer, teaching operator, and maintenance engineer should take additional care of their safety by using the following safety precautions.

- Use adequate clothing or uniforms during system operation
- Wear safety shoes
- Use helmet

2 DEFINITION OF WARNING, CAUTION AND NOTE

To ensure the safety of user 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 attempting to use the oscillator.

⚠WARNING
Applied when there is a danger of the user being injured or when there is a danger of both the user being injured and the equipment being damaged if the approved procedure is not observed.

⚠CAUTION
Applied when there is a danger of the equipment being damaged, if the approved procedure is not observed.

NOTE
Notes are used to indicate supplementary information other than Warnings and Cautions.

- Read this manual carefully, and store it in a sales place.

3 WORKING PERSON SAFETY

Working person safety is the primary safety consideration. Because it is very dangerous to enter the operating space of the robot during automatic operation, adequate safety precautions must be observed. The following lists the general safety precautions. Careful consideration must be made to ensure working person safety.

(1) Have the robot system working persons attend the training courses held by FANUC.

FANUC provides various training courses. Contact our sales office for details.

(2) Even when the robot is stationary, it is possible that the robot is still in a ready to move state, and is waiting for a signal. In this state, the robot is regarded as still in motion. To ensure working person safety, provide the system with an alarm to indicate visually or aurally that the robot is in motion.
(3) Install a safety fence with a gate so that no working person can enter the work area without passing through the gate. Install an interlocking device, a safety plug, and so forth in the safety gate so that the robot is stopped as the safety gate is opened.

The controller is designed to receive this interlocking signal of the door switch. When the gate is opened and this signal received, the controller stops the robot (Please refer to "STOP TYPE OF ROBOT" in SAFETY PRECAUTIONS for detail of stop type). For connection, see Fig.3 (a) and Fig.3 (b).

(4) Provide the peripheral devices with appropriate grounding (Class A, Class B, Class C, and Class D).

(5) Try to install the peripheral devices outside the work area.
(6) Draw an outline on the floor, clearly indicating the range of the robot motion, including the tools such as a hand.
(7) Install a mat switch or photoelectric switch on the floor with an interlock to a visual or aural alarm that stops the robot when a working person enters the work area.
(8) If necessary, install a safety lock so that no one except the working person in charge can turn on the power of the robot.

The circuit breaker installed in the controller is designed to disable anyone from turning it on when it is locked with a padlock.

(9) When adjusting each peripheral device independently, be sure to turn off the power of the robot
(10) Operators should be ungloved while manipulating the operator's panel or teach pendant. Operation with gloved fingers could cause an operation error.
(11) Programs, system variables, and other information can be saved on memory card or USB memories. Be sure to save the data periodically in case the data is lost in an accident.
(12) The robot should be transported and installed by accurately following the procedures recommended by FANUC. Wrong transportation or installation may cause the robot to fall, resulting in severe injury to workers.
(13) In the first operation of the robot after installation, the operation should be restricted to low speeds. Then, the speed should be gradually increased to check the operation of the robot.
(14) Before the robot is started, it should be checked that no one is in the area of the safety fence. At the same time, a check must be made to ensure that there is no risk of hazardous situations. If detected, such a situation should be eliminated before the operation.
(15) When the robot is used, the following precautions should be taken. Otherwise, the robot and peripheral equipment can be adversely affected, or workers can be severely injured.
- Avoid using the robot in a flammable environment.
- Avoid using the robot in an explosive environment.
- Avoid using the robot in an environment full of radiation.
- Avoid using the robot under water or at high humidity.
- Avoid using the robot to carry a person or animal.
- Avoid using the robot as a stepladder. (Never climb up on or hang from the robot.)

(16) When connecting the peripheral devices related to stop(safety fence etc.) and each signal (external emergency , fence etc.) of robot. be sure to confirm the stop movement and do not take the wrong connection.
(17) When preparing trestle, please consider security for installation and maintenance work in high place according to Fig.3 (c). Please consider footstep and safety bolt mounting position.

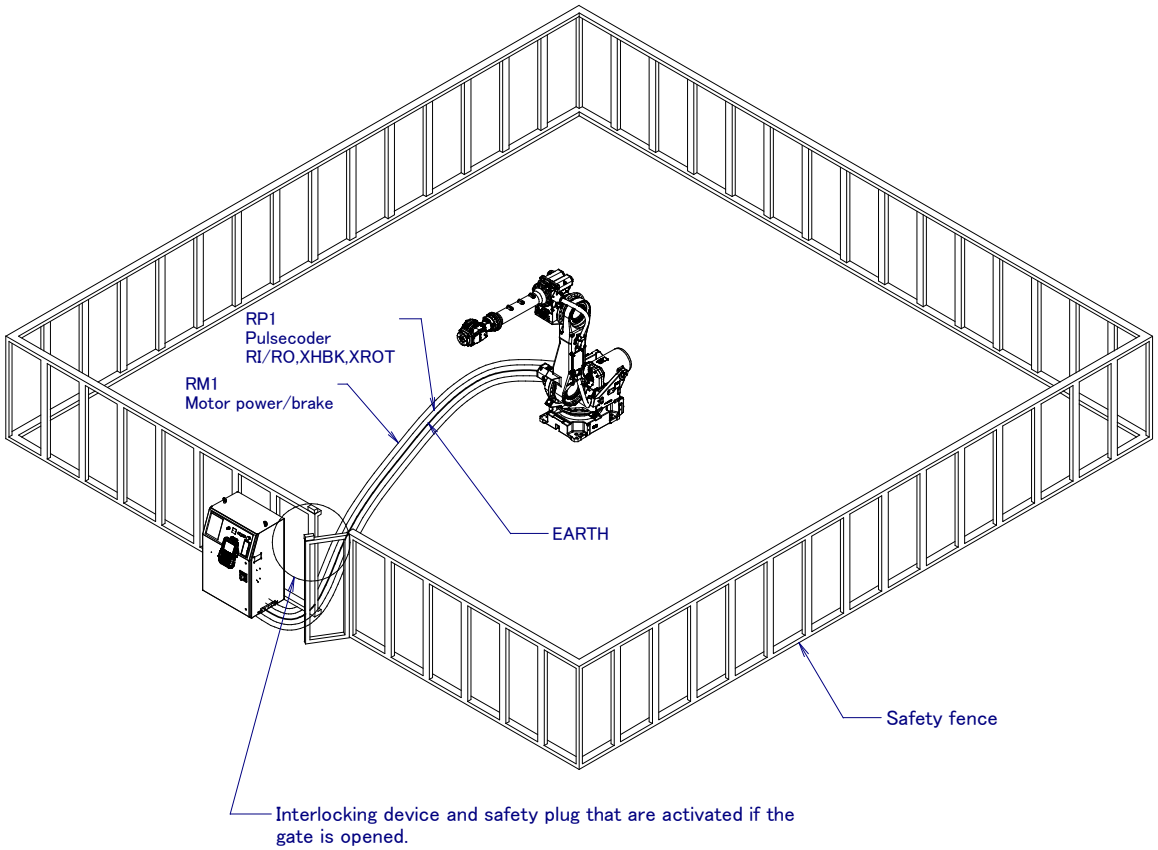


Fig. 3 (a) Safety fence and safety gate

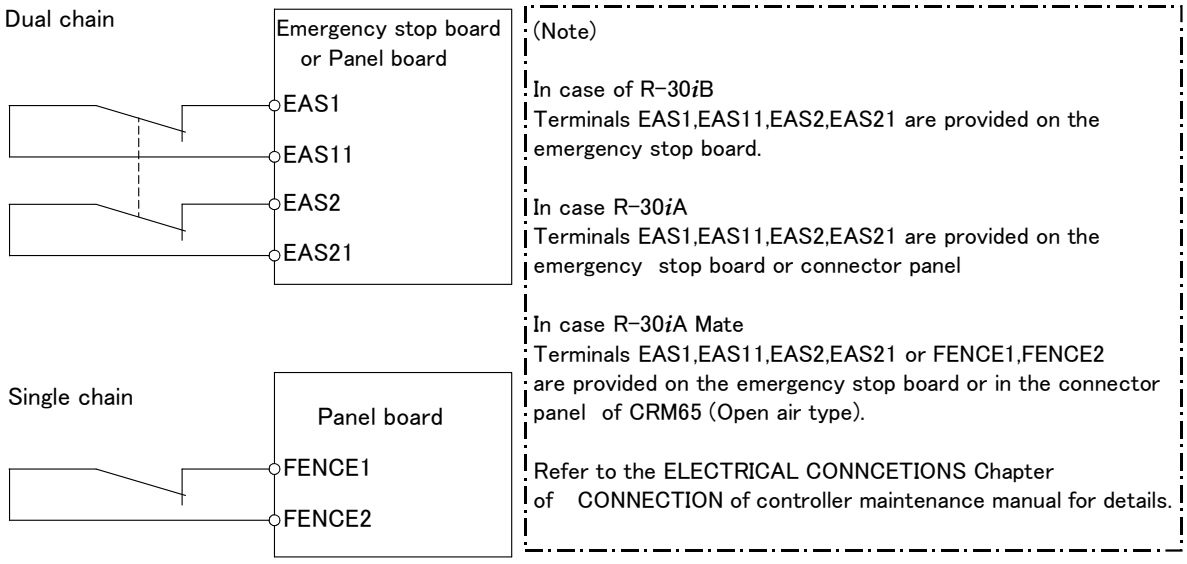


Fig. 3 (b) Limit switch circuit diagram of the safety fence

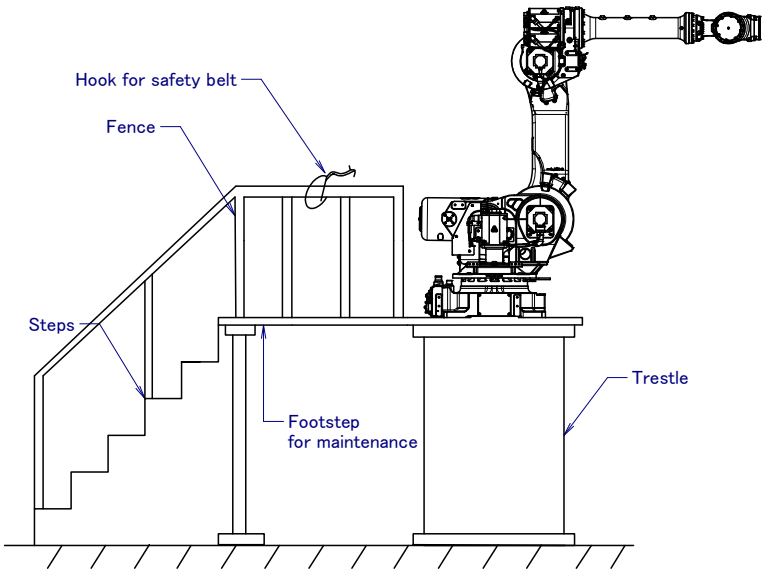


Fig.3 (c) Footstep for maintenance

3.1 OPERATOR SAFETY

The operator is a person who operates the robot system. In this sense, a worker who operates the teach pendant is also an operator. However, this section does not apply to teach pendant operators.

(1) If you do not have to operate the robot, turn off the power of the robot controller or press the EMERGENCY STOP button, and then proceed with necessary work.
(2) Operate the robot system at a location outside of the safety fence
(3) Install a safety fence with a safety gate to prevent any worker other than the operator from entering the work area unexpectedly and to prevent the worker from entering a dangerous area.
(4) Install an EMERGENCY STOP button within the operator's reach.

The robot controller is designed to be connected to an external EMERGENCY STOP button. With this connection, the controller stops the robot operation (Please refer to "STOP TYPE OF ROBOT" in SAFETY PRECAUTIONS for detail of stop type), when the external EMERGENCY STOP button is pressed. See the diagram below for connection.

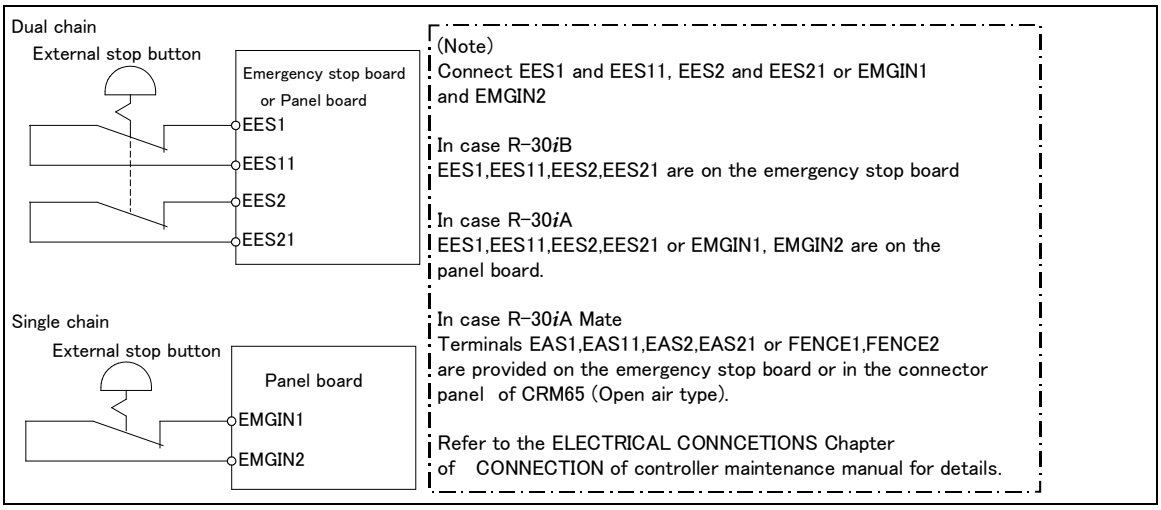


Fig.3.1 Connection diagram for external emergency stop button

3.2 SAFETY OF THE PROGRAMMER

While teaching the robot, the operator must enter the work area of the robot. The operator must ensure the safety of the teach pendant operator especially.

(1) Unless it is specifically necessary to enter the robot work area, carry out all tasks outside the area.
(2) Before teaching the robot, check that the robot and its peripheral devices are all in the normal operating condition.
(3) If it is inevitable to enter the robot work area to teach the robot, check the locations, settings, and other conditions of the safety devices (such as the EMERGENCY STOP button, the DEADMAN switch on the teach pendant) before entering the area.
(4) The programmer must be extremely careful not to let anyone else enter the robot work area.
(5) Programming should be done outside the area of the safety fence as far as possible. If programming needs to be done in the area of the safety fence, the programmer should take the following precautions:
   - Before entering the area of the safety fence, ensure that there is no risk of dangerous situations in the area.
   - Be prepared to press the emergency stop button whenever necessary.
   - Robot motions should be made at low speeds.
   - Before starting programming, check the entire system status to ensure that no remote instruction to the peripheral equipment or motion would be dangerous to the user.

Our operator panel is provided with an emergency stop button and a key switch (mode switch) for selecting the automatic operation mode (AUTO) and the teach modes (T1 and T2). Before entering the inside of the safety fence for the purpose of teaching, set the switch to a teach mode, remove the key from the mode switch to prevent other people from changing the operation mode carelessly, then open the safety gate. If the safety gate is opened with the automatic operation mode set, the robot stops (Please refer to "STOP TYPE OF ROBOT" in SAFETY PRECAUTIONS for detail of stop type). After the switch is set to a teach mode, the safety gate is disabled. The programmer should understand that the safety gate is disabled and is responsible for keeping other people from entering the inside of the safety fence. (In case of R-30*i*A Mate Controller standard specification, there is no mode switch. The automatic operation mode and the teach mode is selected by teach pendant enable switch.)

Our teach pendant is provided with a DEADMAN switch as well as an emergency stop button. These button and switch function as follows:
(1) Emergency stop button: Causes an emergency stop (Please refer to "STOP TYPE OF ROBOT" in SAFETY PRECAUTIONS for detail of stop type) when pressed.
(2) DEADMAN switch: Functions differently depending on the teach pendant enable/disable switch setting status.
   (a) Disable: The DEADMAN switch is disabled.
   (b) Enable: Servo power is turned off when the operator releases the DEADMAN switch or when the operator presses the switch strongly.
   Note) The DEADMAN switch is provided to stop the robot when the operator releases the teach pendant or presses the pendant strongly in case of emergency. The R-30*i*B/R-30*i*A/ R-30*i*A Mate employs a 3-position DEADMAN switch, which allows the robot to operate when the 3-position DEADMAN switch is pressed to its intermediate point. When the operator releases the DEADMAN switch or presses the switch strongly, the robot stops immediately.

The operator's intention of starting teaching is determined by the controller through the dual operation of setting the teach pendant enable/disable switch to the enable position and pressing the DEADMAN switch. The operator should make sure that the robot could operate in such conditions and be responsible in carrying out tasks safely.

Based on the risk assessment by FANUC, number of operation of DEADMAN SW should not exceed about 10000 times per year.

The teach pendant, operator panel, and peripheral device interface send each robot start signal. However the validity of each signal changes as follows depending on the mode switch and the DEADMAN switch of the operator panel, the teach pendant enable switch and the remote condition on the software.

In case of R-30*i*B/R-30*i*A controller or CE or RIA specification of R-30*i*A Mate controller

Mode	Teach pendant enable switch	Software remote condition	Teach pendant	Operator panel	Peripheral device
AUTO mode	On	Local	Not allowed	Not allowed	Not allowed
		Remote	Not allowed	Not allowed	Not allowed
	Off	Local	Not allowed	Allowed to start	Not allowed
		Remote	Not allowed	Not allowed	Allowed to start
T1, T2 mode	On	Local	Allowed to start	Not allowed	Not allowed
		Remote	Allowed to start	Not allowed	Not allowed
	Off	Local	Not allowed	Not allowed	Not allowed
		Remote	Not allowed	Not allowed	Not allowed

T1,T2 mode: DEADMAN switch is effective.

In case of standard specification of R-30*i*A Mate controller

Teach pendant enable switch	Software remote condition	Teach pendant	Peripheral device
On	Ignored	Allowed to start	Not allowed
Off	Local	Not allowed	Not allowed
	Remote	Not allowed	Allowed to start

(6) (Only when R-30*i*B/R-30*i*A Controller or CE or RIA specification of R-30*i*A Mate controller is selected.) To start the system using the operator's panel, make certain that nobody is the robot work area and that there are no abnormal conditions in the robot work area.
(7) When a program is completed, be sure to carry out a test operation according to the procedure below.
  (a) Run the program for at least one operation cycle in the single step mode at low speed.
  (b) Run the program for at least one operation cycle in the continuous operation mode at low speed.
  (c) Run the program for one operation cycle in the continuous operation mode at the intermediate speed and check that no abnormalities occur due to a delay in timing.
  (d) Run the program for one operation cycle in the continuous operation mode at the normal operating speed and check that the system operates automatically without trouble.
  (e) After checking the completeness of the program through the test operation above, execute it in the automatic operation mode.
(8) While operating the system in the automatic operation mode, the teach pendant operator should leave the robot work area.

3.3 SAFETY OF THE MAINTENANCE ENGINEER

For the safety of maintenance engineer personnel, pay utmost attention to the following.

(1) During operation, never enter the robot work area.
(2) A hazardous situation may arise when the robot or the system, are kept with their power-on during maintenance operations. Therefore, for any maintenance operation, the robot and the system should be put into the power-off state. If necessary, a lock should be in place in order to prevent any other person from turning on the robot and/or the system. In case maintenance needs to be executed in the power-on state, the emergency stop button must be pressed.
(3) If it becomes necessary to enter the robot operation range while the power is on, press the emergency stop button on the operator panel, or the teach pendant before entering the range. The

maintenance personnel must indicate that maintenance work is in progress and be careful not to allow other people to operate the robot carelessly.

(4) When entering the area enclosed by the safety fence, the maintenance worker must check the entire system in order to make sure no dangerous situations exist. In case the worker needs to enter the safety area whilst a dangerous situation exists, extreme care must be taken, and entire system status must be carefully monitored.

(5) Before the maintenance of the pneumatic system is started, the supply pressure should be shut off and the pressure in the piping should be reduced to zero.

(6) Before the start of teaching, check that the robot and its peripheral devices are all in the normal operating condition.

(7) Do not operate the robot in the automatic mode while anybody is in the robot work area.

(8) When you maintain the robot alongside a wall or instrument, or when multiple workers are working nearby, make certain that their escape path is not obstructed.

(9) When a tool is mounted on the robot, or when any moving device other than the robot is installed, such as belt conveyor, pay careful attention to its motion.

(10) If necessary, have a worker who is familiar with the robot system stand beside the operator panel and observe the work being performed. If any danger arises, the worker should be ready to press the EMERGENCY STOP button at any time.

(11) When replacing a part, please contact FANUC service center. If a wrong procedure is followed, an accident may occur, causing damage to the robot and injury to the worker.

(12) When replacing or reinstalling components, take care to prevent foreign material from entering the system.

(13) When handling each unit or printed circuit board in the controller during inspection, turn off the circuit breaker to protect against electric shock.
If there are two cabinets, turn off the both circuit breaker.

(14) A part should be replaced with a part recommended by FANUC. If other parts are used, malfunction or damage would occur. Especially, a fuse that is not recommended by FANUC should not be used. Such a fuse may cause a fire.

(15) When restarting the robot system after completing maintenance work, make sure in advance that there is no person in the work area and that the robot and the peripheral devices are not abnormal.

(16) When a motor or brake is removed, the robot arm should be supported with a crane or other equipment beforehand so that the arm would not fall during the removal.

(17) Whenever grease is spilled on the floor, it should be removed as quickly as possible to prevent dangerous falls.

(18) The following parts are heated. If a maintenance worker needs to touch such a part in the heated state, the worker should wear heat-resistant gloves or use other protective tools.
- Servo motor
- Inside the controller
- Reducer
- Gearbox
- Wrist unit

(19) Maintenance should be done under suitable light. Care must be taken that the light would not cause any danger.

(20) When a motor, reducer, or other heavy load is handled, a crane or other equipment should be used to protect maintenance workers from excessive load. Otherwise, the maintenance workers would be severely injured.

(21) The robot should not be stepped on or climbed up during maintenance. If it is attempted, the robot would be adversely affected. In addition, a misstep can cause injury to the worker.

(22)When performing maintenance work in high place, secure a footstep and wear safety belt.

(23) After the maintenance is completed, spilled oil or water and metal chips should be removed from the floor around the robot and within the safety fence.

(24) When a part is replaced, all bolts and other related components should put back into their original places. A careful check must be given to ensure that no components are missing or left not mounted.

(25) In case robot motion is required during maintenance, the following precautions should be taken :

- Foresee an escape route. And during the maintenance motion itself, monitor continuously the whole system so that your escape route will not become blocked by the robot, or by peripheral equipment.
- Always pay attention to potentially dangerous situations, and be prepared to press the emergency stop button whenever necessary.

(26) The robot should be periodically inspected. (Refer to the robot mechanical manual and controller maintenance manual.) A failure to do the periodical inspection can adversely affect the performance or service life of the robot and may cause an accident

(27) After a part is replaced, a test operation should be given for the robot according to a predetermined method. (See TESTING section of "Controller operator's manual".) During the test operation, the maintenance staff should work outside the safety fence.

4 SAFETY OF THE TOOLS AND PERIPHERAL DEVICES

4.1 PRECAUTIONS IN PROGRAMMING

(1) Use a limit switch or other sensor to detect a dangerous condition and, if necessary, design the program to stop the robot when the sensor signal is received.

(2) Design the program to stop the robot when an abnormal condition occurs in any other robots or peripheral devices, even though the robot itself is normal.

(3) For a system in which the robot and its peripheral devices are in synchronous motion, particular care must be taken in programming so that they do not interfere with each other.

(4) Provide a suitable interface between the robot and its peripheral devices so that the robot can detect the states of all devices in the system and can be stopped according to the states.

4.2 PRECAUTIONS FOR MECHANISM

(1) Keep the component cells of the robot system clean, and operate the robot in an environment free of grease, water, and dust.

(2) Don't use unconfirmed liquid for cutting fluid and cleaning fluid.

(3) Employ a limit switch or mechanical stopper to limit the robot motion so that the robot or cable does not strike against its peripheral devices or tools.

(4) Observe the following precautions about the mechanical unit cables. When theses attentions are not kept, unexpected troubles might occur.
- Use mechanical unit cable that have required user interface.
- Don't add user cable or hose to inside of mechanical unit.
- Please do not obstruct the movement of the mechanical unit cable when cables are added to outside of mechanical unit.
- In the case of the model that a cable is exposed, Please do not perform remodeling (Adding a protective cover and fix an outside cable more) obstructing the behavior of the outcrop of the cable.
- Please do not interfere with the other parts of mechanical unit when install equipments in the robot.

(5) The frequent power-off stop for the robot during operation causes the trouble of the robot. Please avoid the system construction that power-off stop would be operated routinely. (Refer to bad case example.) Please execute power-off stop after reducing the speed of the robot and stopping it by hold stop or cycle stop when it is not urgent. (Please refer to "STOP TYPE OF ROBOT" in SAFETY PRECAUTIONS for detail of stop type.)
(Bad case example)

- Whenever poor product is generated, a line stops by emergency stop.
- When alteration was necessary, safety switch is operated by opening safety fence and power-off stop is executed for the robot during operation.
- An operator pushes the emergency stop button frequently, and a line stops.
- An area sensor or a mat switch connected to safety signal operate routinely and power-off stop is executed for the robot.

(6) Robot stops urgently when collision detection alarm (SRVO-050) etc. occurs. The frequent urgent stop by alarm causes the trouble of the robot, too. So remove the causes of the alarm.

5 SAFETY OF THE ROBOT MECHANISM

5.1 PRECAUTIONS IN OPERATION

(1) When operating the robot in the jog mode, set it at an appropriate speed so that the operator can manage the robot in any eventuality.
(2) Before pressing the jog key, be sure you know in advance what motion the robot will perform in the jog mode.

5.2 PRECAUTIONS IN PROGRAMMING

(1) When the work areas of robots overlap, make certain that the motions of the robots do not interfere with each other.
(2) Be sure to specify the predetermined work origin in a motion program for the robot and program the motion so that it starts from the origin and terminates at the origin.
Make it possible for the operator to easily distinguish at a glance that the robot motion has terminated.

5.3 PRECAUTIONS FOR MECHANISMS

(1) Keep the work areas of the robot clean, and operate the robot in an environment free of grease, water, and dust.

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

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

   Please order following unit and cable.

Name	Specification
Brake release unit	A05B-2450-J350 (Input voltage AC100-115V single phase) A05B-2450-J351 (Input voltage AC200-240V single phase)
Robot connection cable	A05B-2450-J360 (5m) A05B-2450-J361 (10m)
Power cable	A05B-2525-J010 (5m) (AC100-115V Power plug) (*) A05B-2525-J011 (10m) (AC100-115V Power plug) (*) A05B-2450-J364 (5m) (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.

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

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

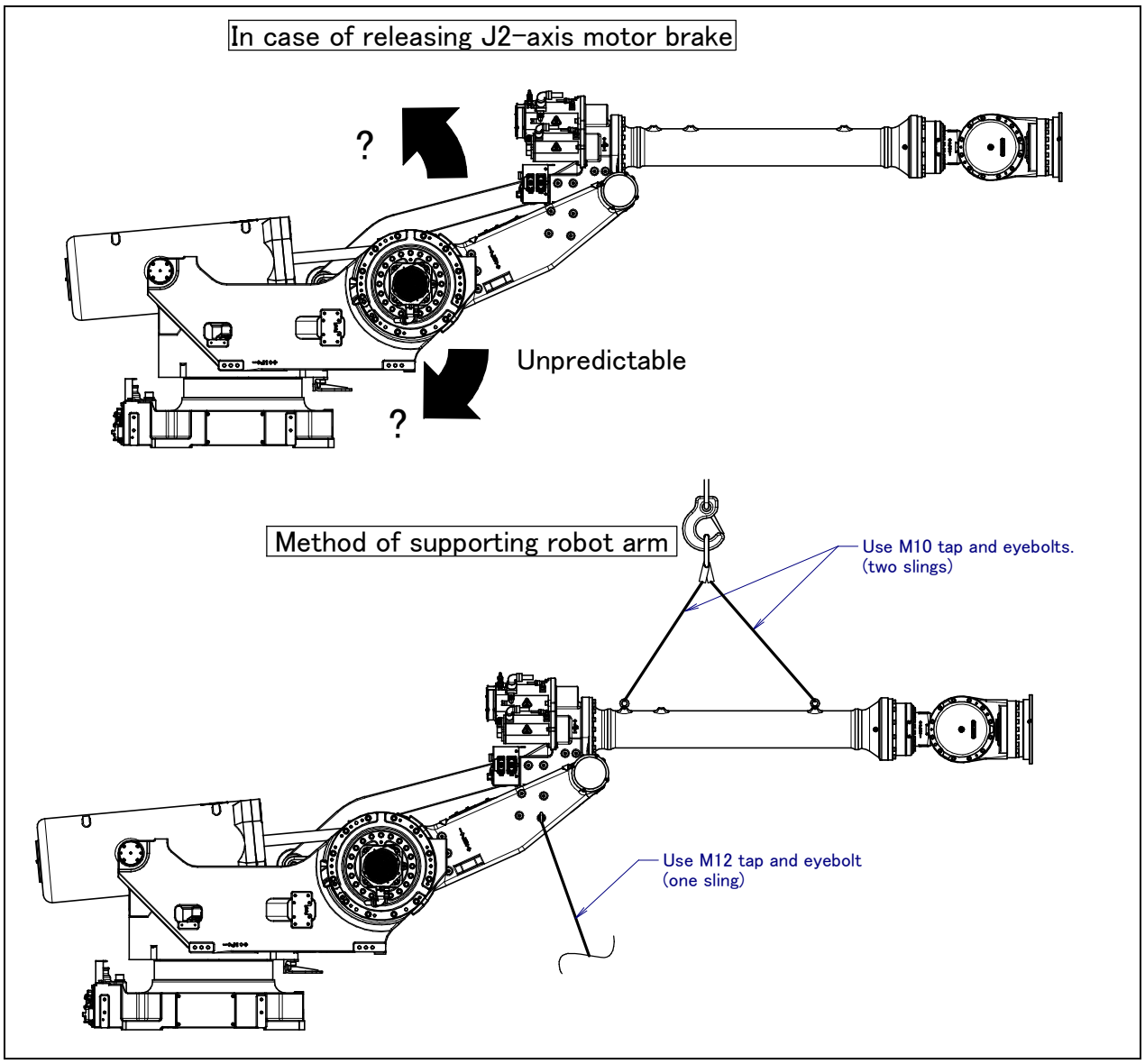


Fig.5.4 (a) Releasing J2 motor brake and measures

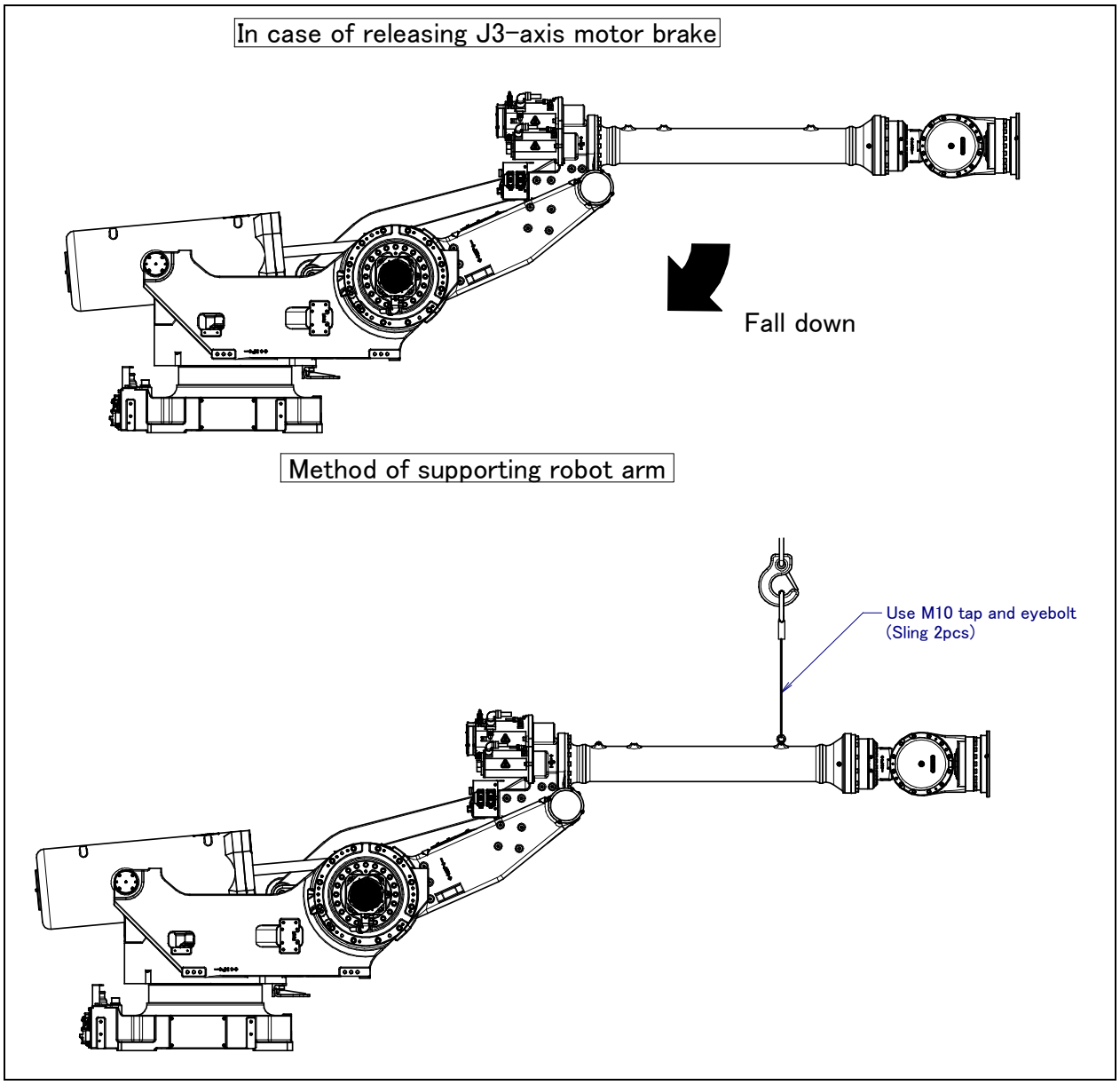


Fig.5.4 (b) Releasing J3 motor brake and measures

6 SAFETY OF THE END EFFECTOR

6.1 PRECAUTIONS IN PROGRAMMING

(1) To control the pneumatic, hydraulic and electric actuators, carefully consider the necessary time delay after issuing each control command up to actual motion and ensure safe control.
(2) Provide the end effector with a limit switch, and control the robot system by monitoring the state of the end effector.

7 STOP TYPE OF ROBOT

The following three robot stop types exist:

Power-Off Stop (Category 0 following IEC 60204-1)

Servo power is turned off and the robot stops immediately. Servo power is turned off when the robot is moving, and the motion path of the deceleration is uncontrolled.
The following processing is performed at Power-Off stop.

- An alarm is generated and servo power is turned off.
- The robot operation is stopped immediately. Execution of the program is paused.

Controlled stop (Category 1 following IEC 60204-1)

The robot is decelerated until it stops, and servo power is turned off.
The following processing is performed at Controlled stop.

- The alarm "SRVO-199 Controlled stop" occurs along with a decelerated stop. Execution of the program is paused.
- An alarm is generated and servo power is turned off.

Hold (Category 2 following IEC 60204-1)

The robot is decelerated until it stops, and servo power remains on.
The following processing is performed at Hold.

- The robot operation is decelerated until it stops. Execution of the program is paused.

> ⚠ **WARNING**
> The stopping distance and stopping time of Controlled stop are longer than the stopping distance and stopping time of Power-Off stop. A risk assessment for the whole robot system, which takes into consideration the increased stopping distance and stopping time, is necessary when Controlled stop is used.

When the emergency stop button is pressed or the FENCE is open, the stop type of robot is Power-Off stop or Controlled stop. The configuration of stop type for each situation is called *stop pattern*. The stop pattern is different according to the controller type or option configuration.

There are the following 3 Stop patterns.

Stop pattern	Mode	Emergency stop button	External Emergency stop	FENCE open	SVOFF input	Servo disconnect
A	AUTO	P-Stop	P-Stop	C-Stop	C-Stop	P-Stop
	T1	P-Stop	P-Stop	-	C-Stop	P-Stop
	T2	P-Stop	P-Stop	-	C-Stop	P-Stop
B	AUTO	P-Stop	P-Stop	P-Stop	P-Stop	P-Stop
	T1	P-Stop	P-Stop	-	P-Stop	P-Stop
	T2	P-Stop	P-Stop	-	P-Stop	P-Stop
C	AUTO	C-Stop	C-Stop	C-Stop	C-Stop	C-Stop
	T1	P-Stop	P-Stop	-	C-Stop	P-Stop
	T2	P-Stop	P-Stop	-	C-Stop	P-Stop

P-Stop: Power-Off stop
C-Stop: Controlled stop
-: Disable

The following table indicates the Stop pattern according to the controller type or option configuration.

Option	R-30*i*B
Standard	A (*)
Controlled stop by E-Stop (A05B-2600-J570)	C (*)

(*) R-30*i*B does not have servo disconnect.

Option	R-30*i*A				R-30*i*A Mate		
	Standard (Single)	Standard (Dual)	RIA type	CE type	Standard	RIA type	CE type
Standard	B (*)	A	A	A	A (**)	A	A
Stop type set (Stop pattern C) (A05B-2500-J570)	N/A	N/A	C	C	N/A	C	C

(*) R-30*i*A standard (single) does not have servo disconnect.

(**) R-30*i*A Mate Standard does not have servo disconnect, and the stop type of SVOFF input is Power-Off stop.

The stop pattern of the controller is displayed in "Stop pattern" line in software version screen. Please refer to "Software version" in operator's manual of controller for the detail of software version screen.

"Controlled stop by E-Stop" option

When "Controlled stop by E-Stop" (A05B-2600-J570) option (In case of R-30*i*A/R-30*i*A Mate, it is Stop type set (Stop pattern C) (A05B-2500-J570)) is specified, the stop type of the following alarms becomes Controlled stop but only in AUTO mode. In T1 or T2 mode, the stop type is Power-Off stop which is the normal operation of the system.

Alarm	Condition
SRVO-001 Operator panel E-stop	Operator panel emergency stop is pressed.
SRVO-002 Teach pendant E-stop	Teach pendant emergency stop is pressed.
SRVO-007 External emergency stops	External emergency stop input (EES1-EES11, EES2-EES21) is open. (R-30*i*A/R-30*i*B controller)
SRVO-194 Servo disconnect	Servo disconnect input (SD4-SD41, SD5-SD51) is open. (R-30*i*A controller)
SRVO-218 Ext.E-stop/Servo Disconnect	External emergency stop input (EES1-EES11, EES2-EES21) is open. (R-30*i*A Mate/R-30*i*B controller)
SRVO-408 DCS SSO Ext Emergency Stop	In DCS Safe I/O connect function, SSO[3] is OFF.
SRVO-409 DCS SSO Servo Disconnect	In DCS Safe I/O connect function, SSO[4] is OFF.

Controlled stop is different from Power-Off stop as follows:

- In Controlled stop, the robot is stopped on the program path. This function is effective for a system where the robot can interfere with other devices if it deviates from the program path.
- In Controlled stop, physical impact is less than Power-Off stop. This function is effective for systems where the physical impact to the mechanical unit or EOAT (End Of Arm Tool) should be minimized.
- The stopping distance and stopping time of Controlled stop is longer than the stopping distance and stopping time of Power-Off stop, depending on the robot model and axis. Please refer to the operator's manual of a particular robot model for the data of stopping distance and stopping time.

In case of R-30*i*A or R-30*i*A Mate, this function is available only in CE or RIA type hardware.

When this option is loaded, this function cannot be disabled.

The stop type of DCS Position and Speed Check functions is not affected by the loading of this option.

⚠ WARNING
The stopping distance and stopping time of Controlled stop are longer than the stopping distance and stopping time of Power-Off stop. A risk assessment for the whole robot system, which takes into consideration the increased stopping distance and stopping time, is necessary when this option is loaded.

7.1 WARNING LABEL

(1) Greasing and degreasing label

Fig. 7.1 (a) Greasing and degreasing label

Description

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

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

NOTE
See MAINTENANCE 7.2.3 REPLACING GREASE OF THE DRIVE MECHANISM for explanations about specified greases, the amount of grease to be supplied, and the locations of grease and degrease outlets for individual models.

(2) Disassembly prohibitive label

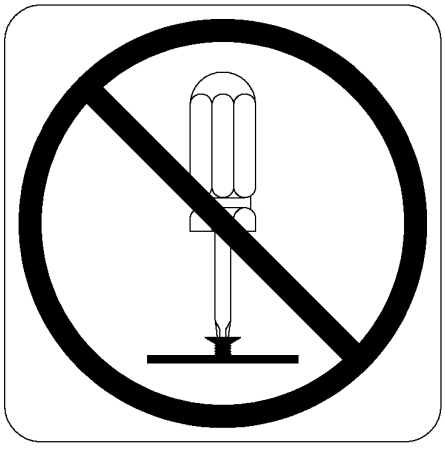


Fig. 7.1 (b) Disassembly prohibitive label

Description

Do not disassemble the balancer unit because it contains a spring, which may cause serious danger (for the M-900*i*A, a disassembly prohibitive label is affixed only to the balancer).

(3) Step-on prohibitive label

Fig. 7.1 (c) Step-on prohibitive label

Description

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

(4) Turn off breakers before maintenance label

Fig. 7.1 (d) Turn off breakers before maintenance label

Description

Turn off both breakers before maintenance.

(5) High-temperature warning label

Fig. 7.1 (e) High-temperature warning label

Description

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

(6) Transportation label

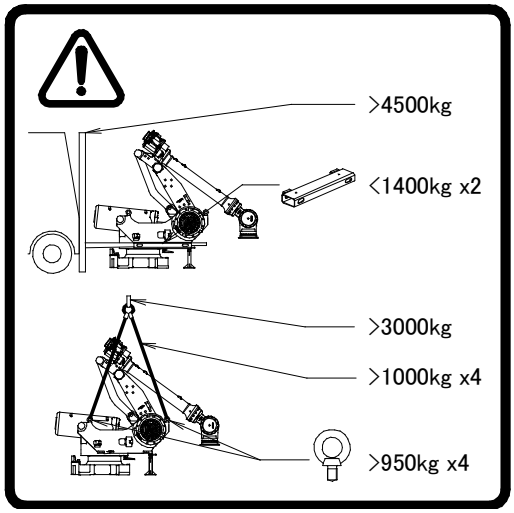


Fig. 7.1 (f) Transportation label

Description

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

1. Using a forklift
   - Use a forklift having a load capacity of 4,500 kg or greater.
   - Keep the total weight of the robot to be transported to within 2,800 kg, because the withstand load of the forklift bracket is 13,720 N (1,400 kg)
2. Using a crane
   - Use a crane having a load capacity of 3,000 kg or greater.
   - Use at least four slings each having a withstand load of 9,800 N (1,000 kgf) or greater.
   - Use at least four eyebolts each having a withstand load of 9,310 N (950 kgf) or greater.

NOTE
See CONNECTION 1.1 TRANSPORTATION for explanations about the posture a specific model should take when it is transported.

(7) Balancer replacement label

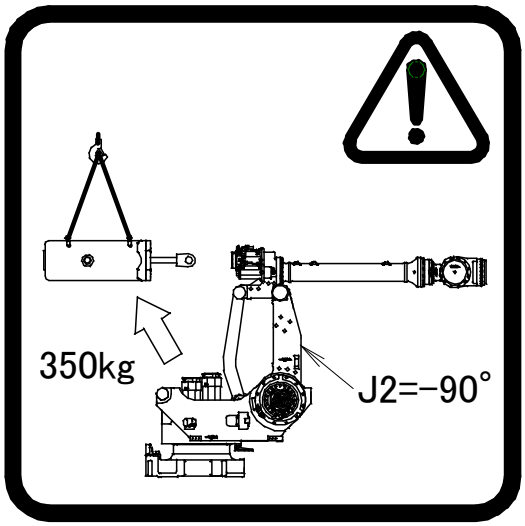


Fig. 7.1 (g) Balancer replacement label

Description

When replacing the balancer, observe the instructions indicated on this label.

- When replacing the balancer, keep the J2 axis –90 deg.
- Use a balancer having a weight of 350 kg.

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

(8) Waterproof label (This label is attached to J1, J2, J3, and J6 motors)

Fig. 7.1 (h) Waterproof label

Description

Keep water away from the fan.

(9) Motion range, Max. payload label
(When CE specification is specified)

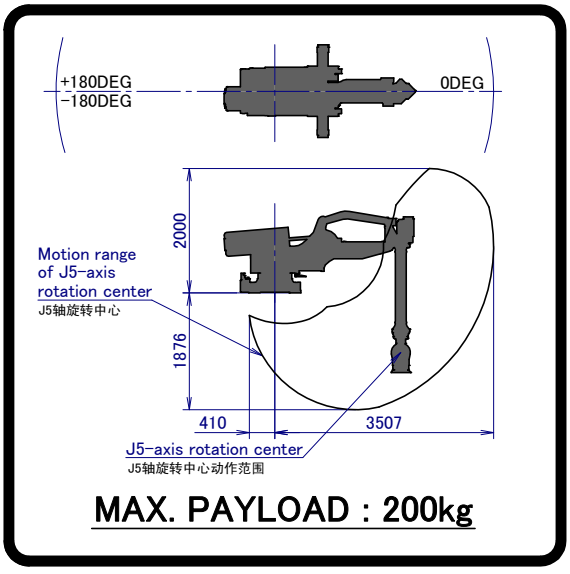


Fig. 7.1 (i) Motion range, max. payload label

(10) Transportation prohibitive label
(When transportation equipment option is specified)

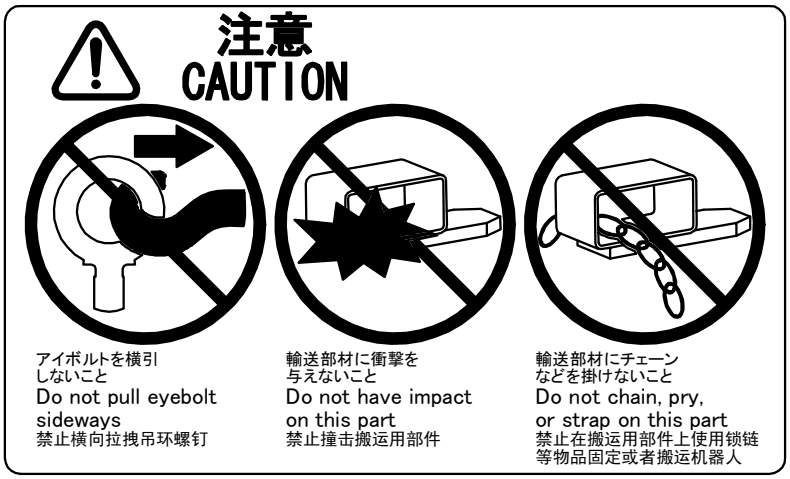


Fig.7.1 (j) Transportation prohibitive label

Description

Keep the following in mind when transporting the robot.

1. Do not pull eyebolts sideways.
2. Prevent the forks of the forklift from having impact on a transport equipment.
3. Do not thread a chain or the like through a transport equipment.

PREFACE

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

Model name	Mechanical unit specification No.	Maximum load
FANUC Robot M-900*i*A/200P	A05B-1327-B531	200kg
	A05B-1327-B601	

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

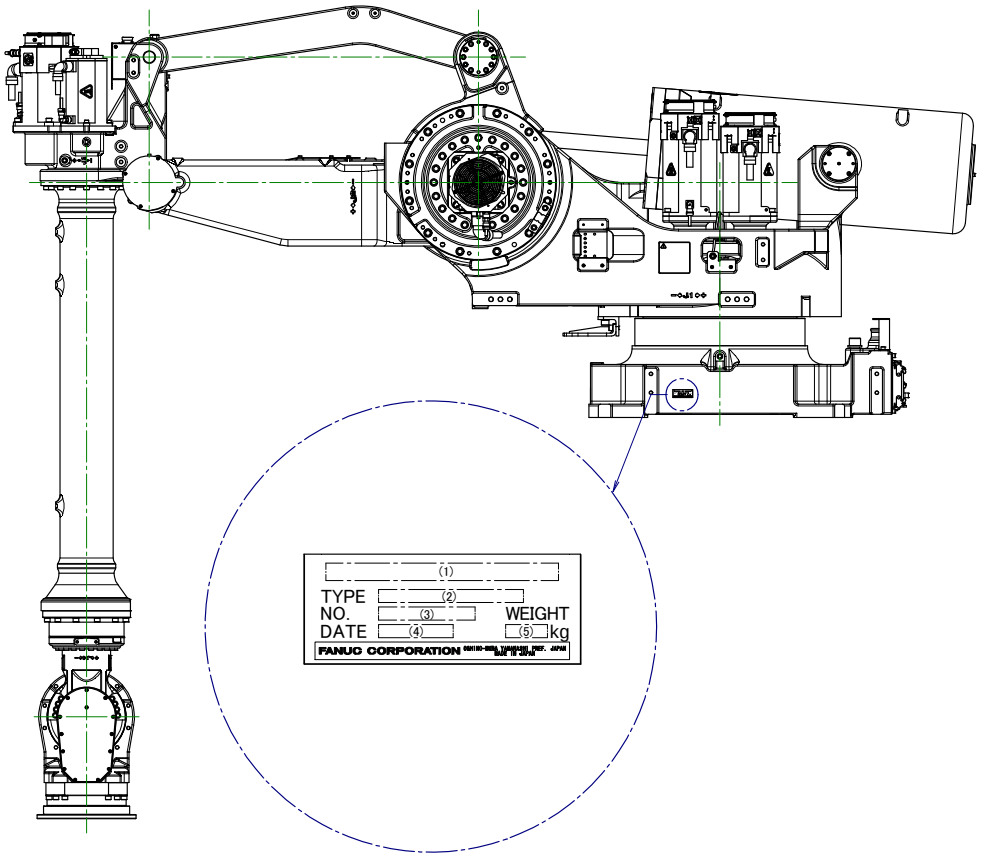


TABLE 1

	(1)	(2)	(3)	(4)	(5)
CONTENTS	-	TYPE	No.	DATE	WEIGHT (Without controller)
LETTERS	FANUC Robot M-900*i*A/200P	A05B-1327-B531 A05B-1327-B601	PRINT SERIAL NO.	PRINT PRODUCTION YEAR AND MONTH	2670kg

Position of label indicating mechanical unit specification number

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 : All persons who use FANUC Robot, system designer Topics : Safety items for robot system design, operation, maintenance
R-30*i*A controller	OPERATOR'S 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 person, system designer Topics : Robot functions, operations, programming, setup, interfaces, alarms Use : Robot operation, teaching, system design
	MAINTENANCE MANUAL B-82595EN B-82595EN-1 (For Europe) B-82595EN-2 (For RIA)	Intended readers : Maintenance person, system designer Topics : Installation, connection to the controller, maintenance Use : installation, start-up, connection, maintenance
R-30*i*B controller	OPERATOR'S MANUAL **(**Basic Function**)** B-83284EN OPERATOR'S MANUAL **(**Alarm Code List**)** B-83284EN-1 Optional Function OPERATOR'S MANUAL B-83284EN-2 Dispense Function OPERATOR'S MANUAL B-83284EN-5	Intended readers : Operator, programmer, maintenance person, system designer Topics : Robot functions, operations, programming, setup, interfaces, alarms Use : Robot operation, teaching, system design
	MAINTENANCE MANUAL B-83195EN	Intended readers : Maintenance person, system designer Topics : Installation, connection to peripheral equipment, maintenance Use : Installation, start-up, connection, maintenance

TABLE OF CONTENTS

1 TRANSPORTATION AND INSTALLATION

1.1 TRANSPORTATION

The robot can be transported by crane or forklift.
Fig.1.1(a),(b) show the transport posture.

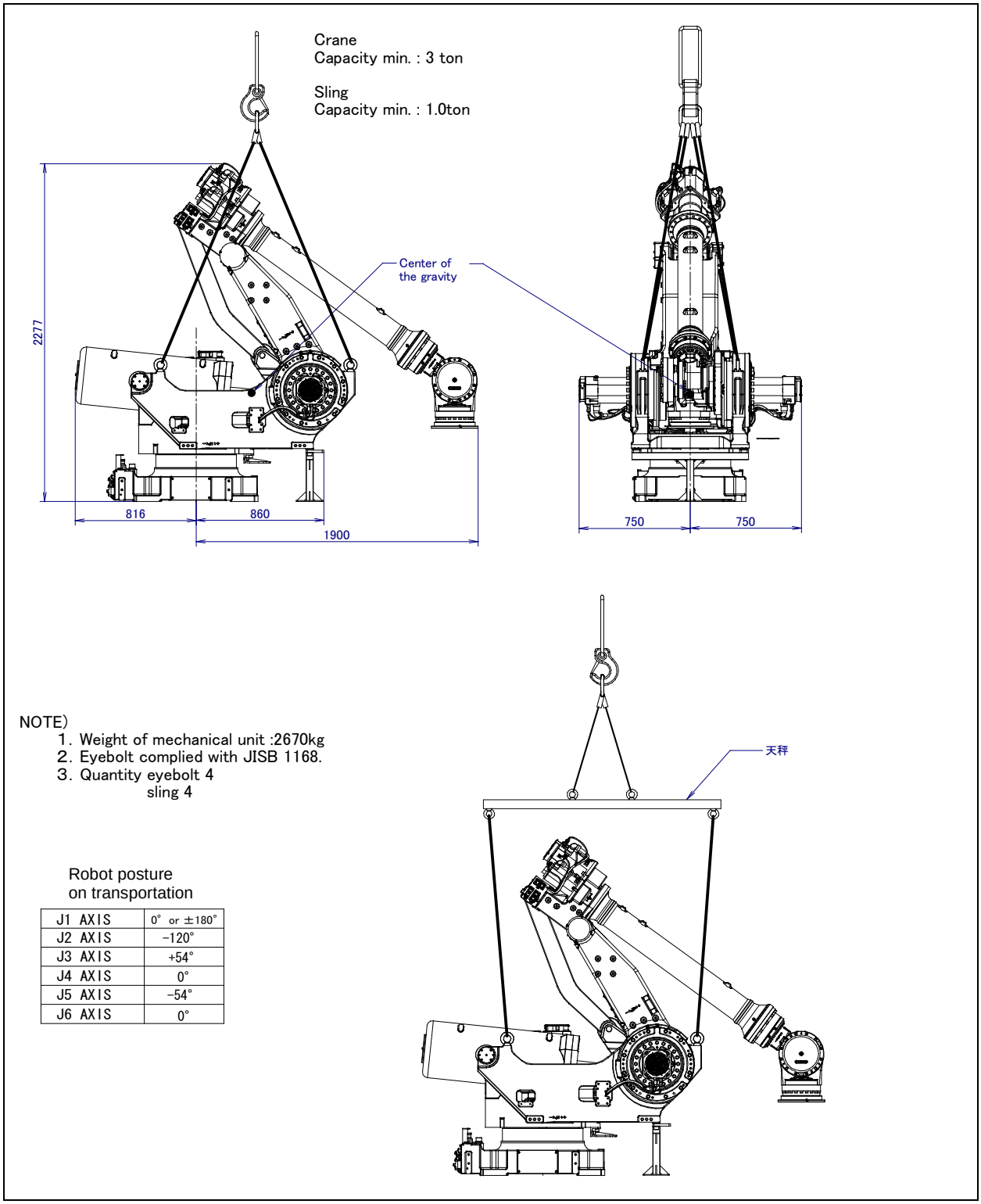
⚠ CAUTION

Please follow notes when it is necessary to transport robot with the base plate installed.

- The entire position of center of gravity is changed by installing the tool and the base plate. Please note the balance enough.
- The tool swings by the vibration etc. When transported, and there is a possibility that an excessive load acts on the robot. Secure the end effector firmly according to Subsection 1.1.1.
- When you lift robot with the base plate installed, please lift up not the robot but the base plate.

Use the forklift pockets only to transport the robot with a forklift. Do not use the forklift pockets to secure the robot.
Before moving the robot by using forklift pockets, check and tighten any loose bolts on the forklift pockets.

Do not pull eyebolts sideways
Prevent the forks of the forklift from having impact on a transport equipment.
Do not thread a chain or the like through a transport equipment.



NOTE)
1. Weight of mechanical unit :2670kg
2. Eyebolt complied with JISB 1168.
3. Quantity eyebolt 4
sling 4

Robot posture
on transportation

J1 AXIS	0° or ±180°
J2 AXIS	−120°
J3 AXIS	+54°
J4 AXIS	0°
J5 AXIS	−54°
J6 AXIS	0°

Fig. 1.1 (a) Transportation using a crane

Robot posture
on transportation

J1 AXIS	0° or ±180°
J2 AXIS	−120°
J3 AXIS	+54°
J4 AXIS	0°
J5 AXIS	−54°
J6 AXIS	0°

NOTE) 1.Weight of mechanical unit 2670kg.

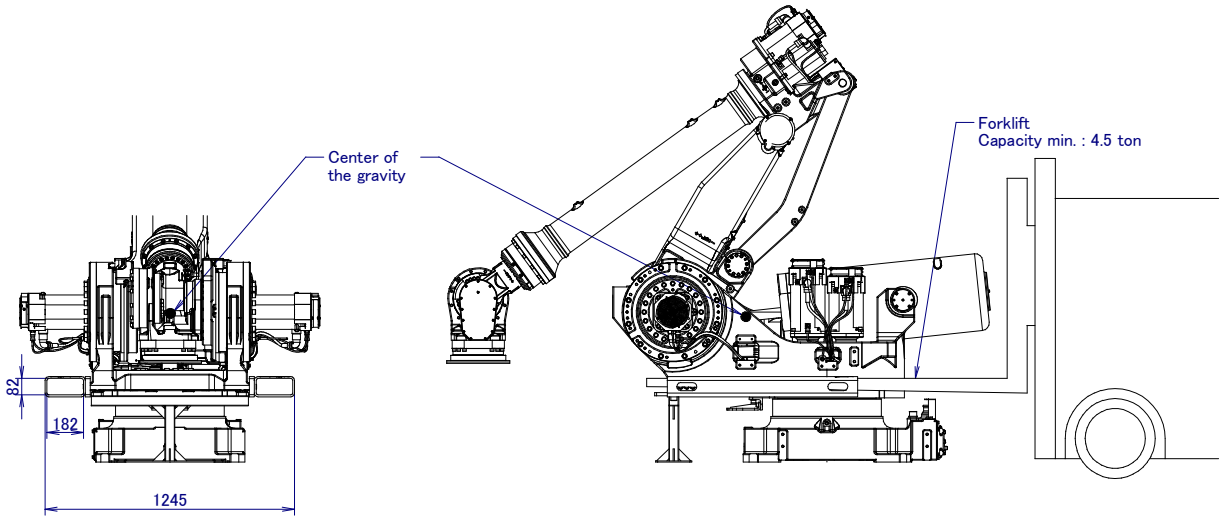


Fig. 1.1 (b) Transportation using a forklift

⚠CAUTION
Exercise care to prevent the fork of the forklift from striking transport equipment strongly.

1.1.1 Transportation with an End Effector Attached

When transporting a robot with an end effector such as a welding gun or hand attached, secure the arm with wood. If the arm is not secured, the end effector may oscillate for a cause such as vibration during transportation, thus imposing a large impact load on the reducer of the robot and damaging the reducer at an earlier stage.

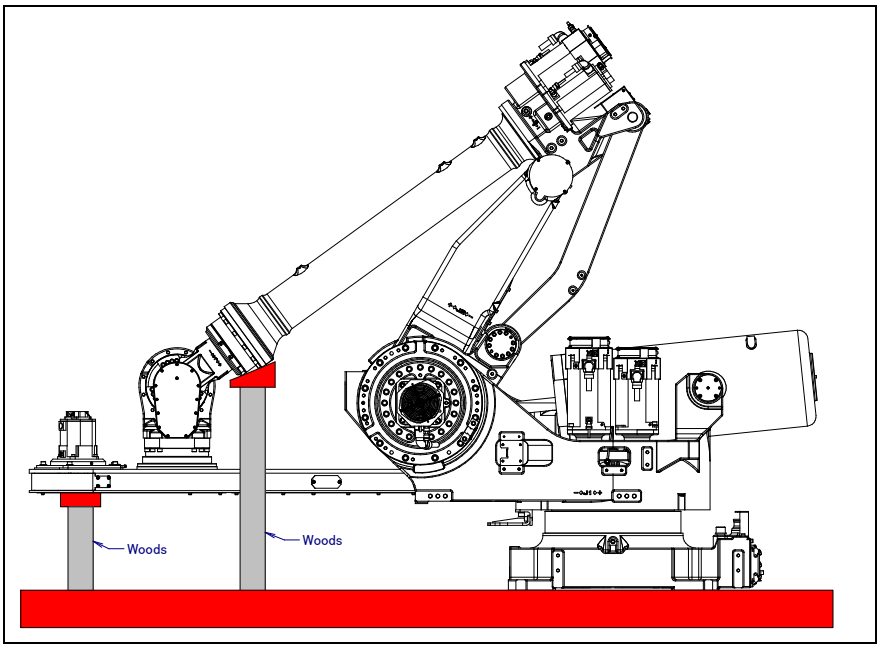


Fig. 1.1.1 Example of securing the arm during transportation when an end effector is attached

1.2 INSTALLATION

When setting robot up with a trestle:
This chapter illustrates method setting robot up with tre trestle.
Fig.1.2(a) shows the dimension of robot base. Fig1.2(b),(c) show the installation method.

The floor plate is imbedded in concrete and fastened with twelve M20 (strength classification 4.8) chemical anchors. Also fasten the trestle to the floor plate using sixteen M20 bolts (strength classification 12.9) as Fig 1.2(b).

Fix robot to trestle using robot mounting twelve M20×65 bolts (strength classification 12.9) as Fig 1.2(c).

Please prepare trestle and chemical anchor by customer. The strength of the chemical anchor depends on the concrete strength. See the design guideline of the manufacturer for the execution of the chemical anchor and consider the safety ratio sufficiently before use.

⚠ CAUTION
Do not provide leveling (with a wedge, for example) between the robot base and floor plate. Otherwise, any robot vibration may be accentuated due to the robot not being in close contact with the floor plate.

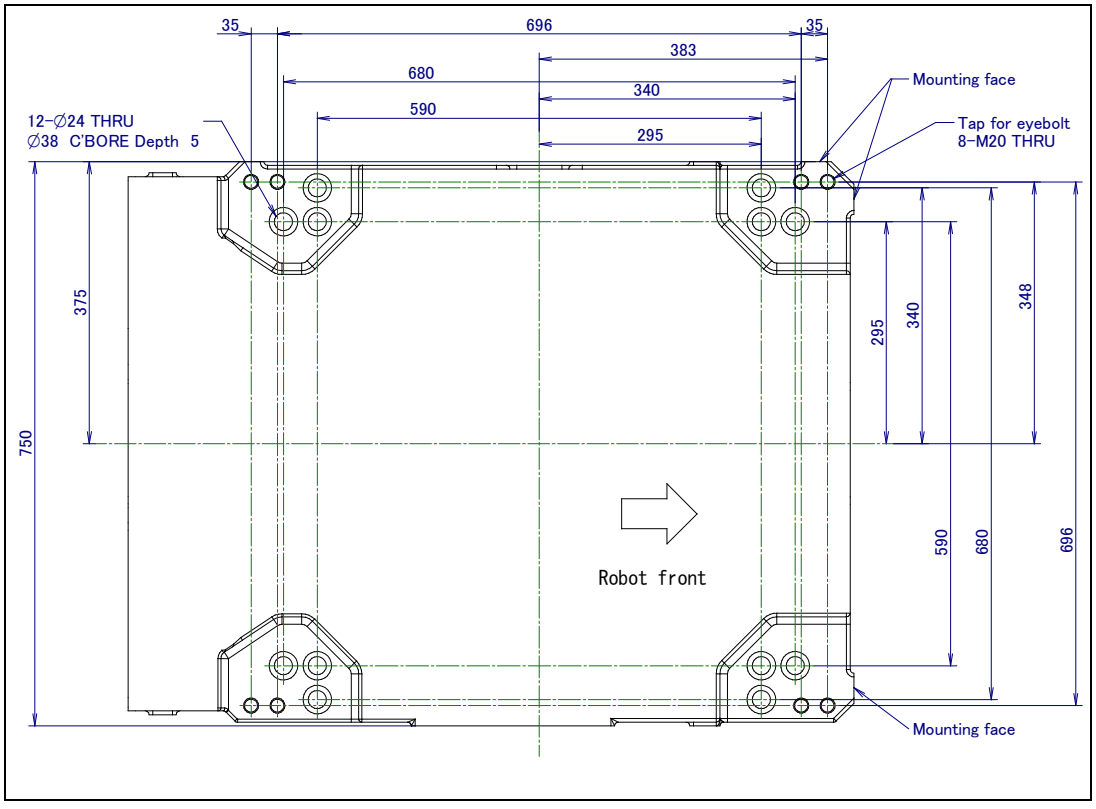


Fig. 1.2 (a) Dimension of robot base

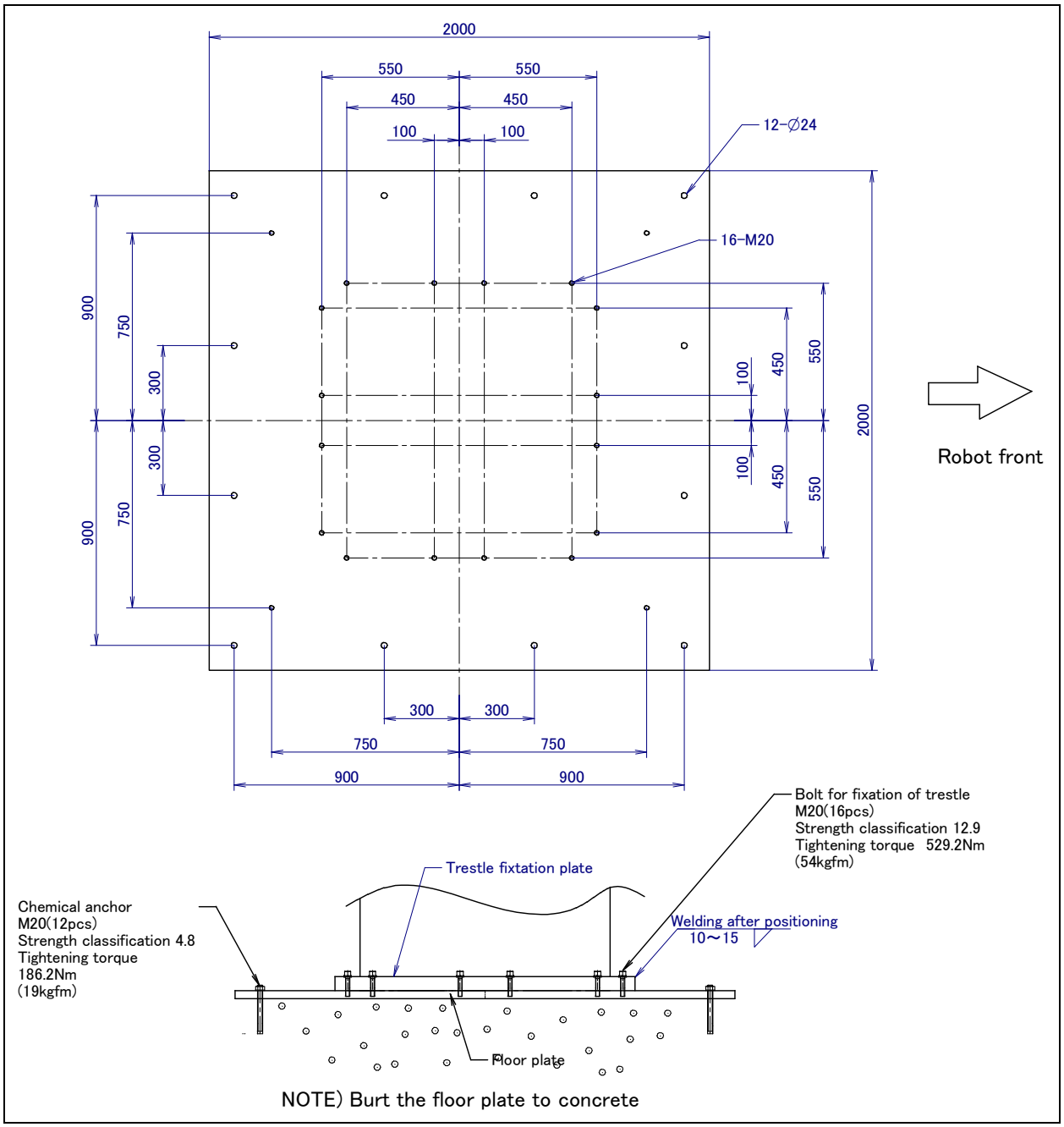


Fig. 1.2 (b) Installation method (1/2)

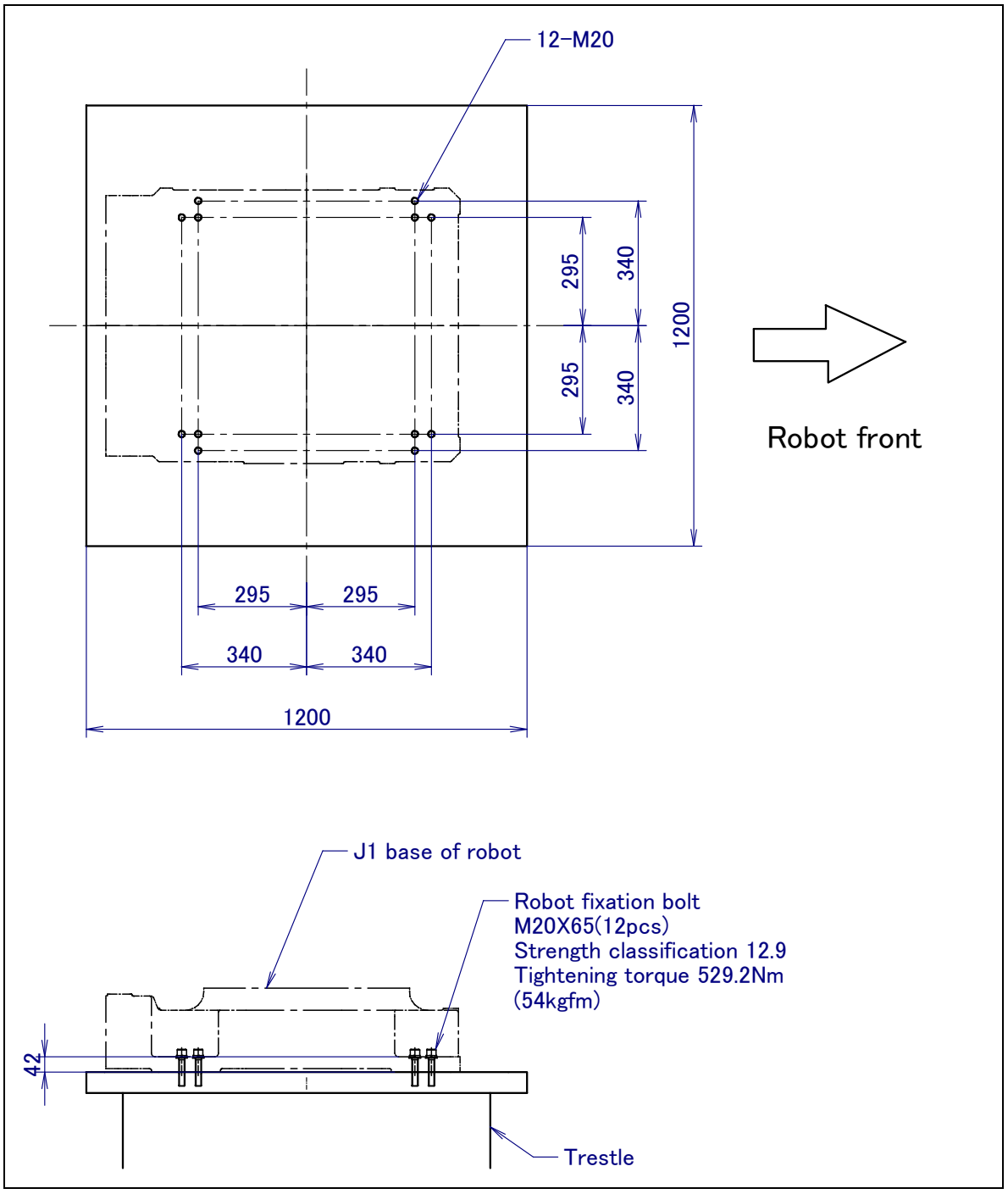


Fig. 1.2 (c) Installation method (2/2)

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

Table 1.2 (a) Force and moment during emergency stop

	Static	Dynamic Acceleration/Deceleration	E.stop
Vertical moment MV : M_V	28.42kNm (2,900kgfm)	51.94kNm (5,300kgfm)	133.28kNm (13,600kgfm)
Force in vertical direction : F_V	29.40kN (3,000kgf)	36.26kN (3,700kgf)	59.78kN (6,100kgf)
Horizontal moment : M_H	0 Nm (0 kgfm)	25.48kNm (2,600kgfm)	52.92kNm (5,400kgfm)
Force in horizontal direction : F_H	0 N (0 kgf)	19.60kN (2,000kgf)	45.08kN (4,600kgf)

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

Model		J1-axis	J2-axis	J3-axis
M-900*i*A/200P	Stopping time [ms]	878	202	309
	Stopping distance [deg] (rad)	42.4(0.74)	10.4 (0.18)	15.7 (0.27)

※ override **:** 100%
※ Max payload, max speed and max inertia posture

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

Model		J1-axis	J2-axis	J3-axis
M-900*i*A/200P	Stopping time [ms]	731	722	733
	Stopping distance [deg] (rad)	45.5 (0.79)	39.4 (0.69)	39.1 (0.68)

※ override **:** 100%
※ Max payload, max speed and max inertia posture

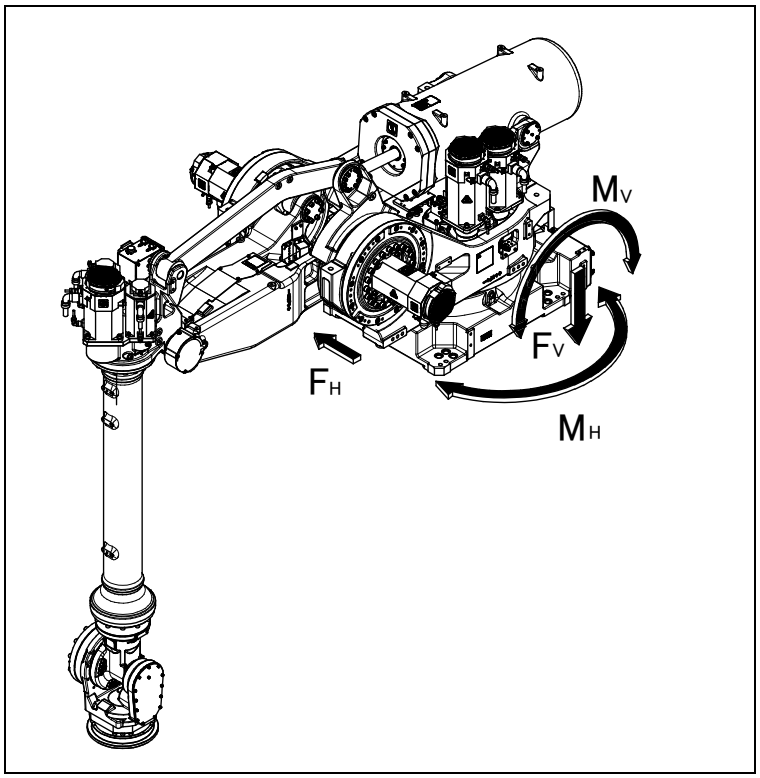


Fig. 1.2 (d) Force during Power-Off stop

1.3 MAINTENANCE AREA

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

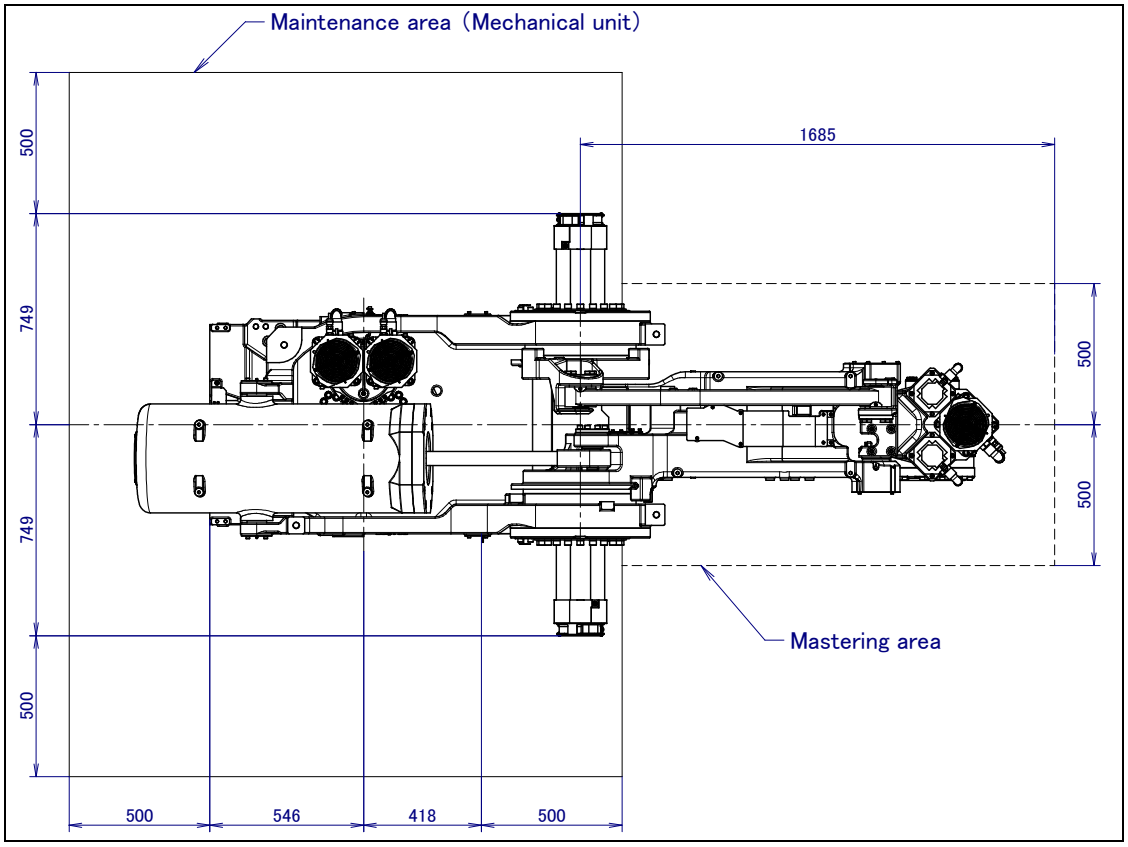


Fig. 1.3 Maintenance area

1.4 INSTALLATION SPECIFICATIONS

Refer to specifications of Section 3.1 about installation specifications.

2 CONNECTION WITH THE CONTROLLER

2.1 CONNECTION WITH THE CONTROLLER

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

⚠ CAUTION
1 Before connecting the cables, be sure to turn off the controller power.
2 When turn on the controller power, be sure to turn on the power of 2nd controller previously.
3 Don't use 10m or longer coiled cable without untying. The long coiled cable will heat and damage itself.

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

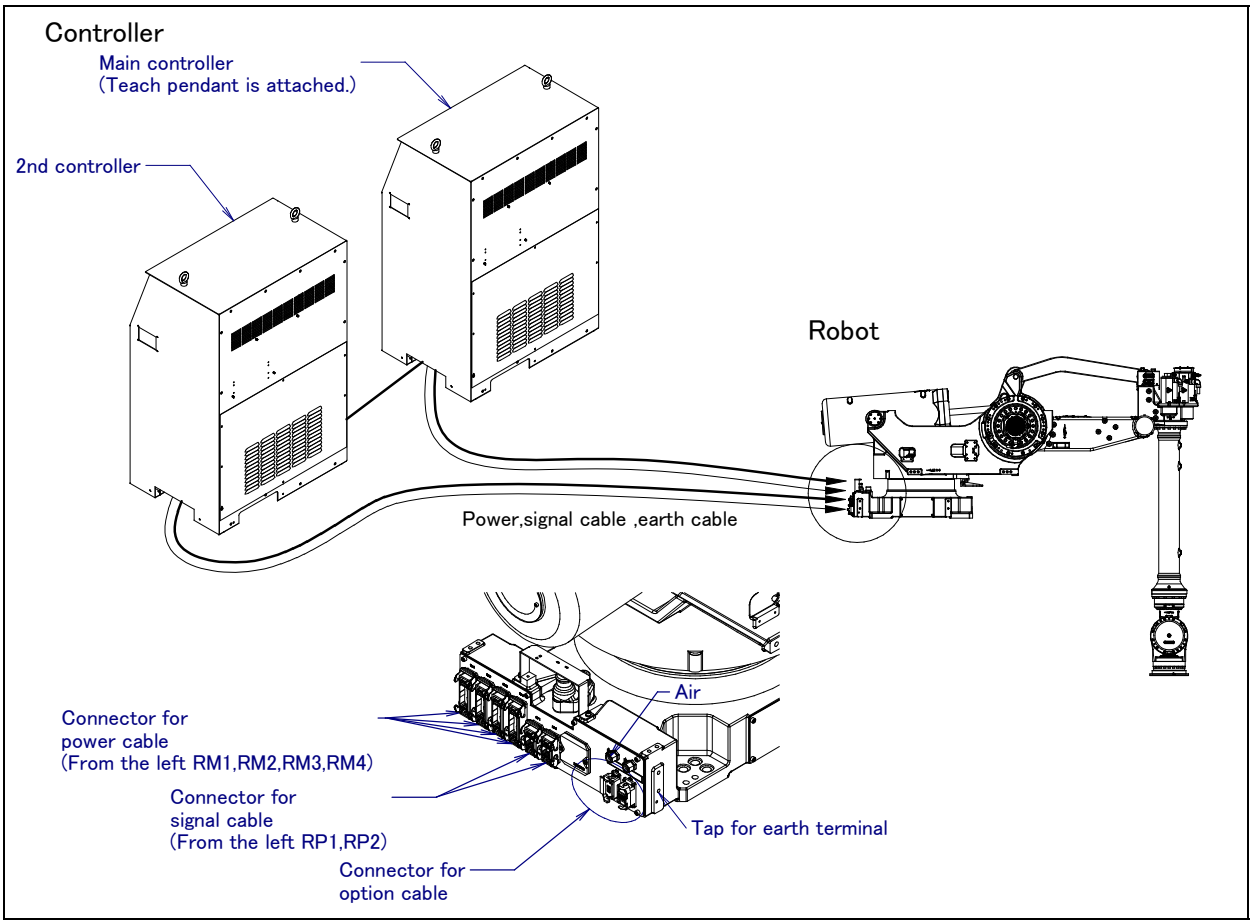


Fig. 2.1 Cable connection

3 BASIC SPECIFICATIONS

3.1 ROBOT CONFIGURATION

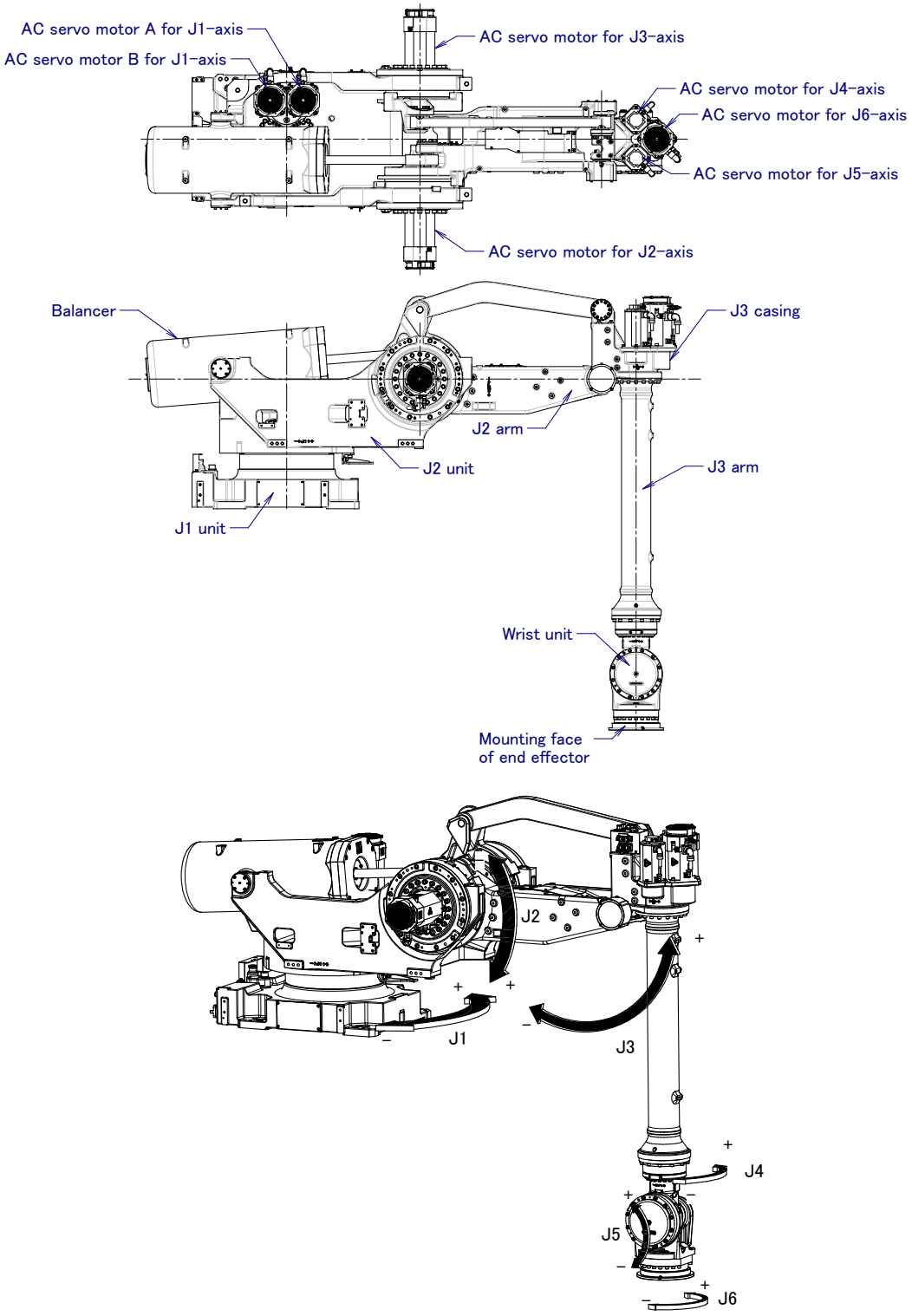


Fig. 3.1 Mechanical unit configuration and each axes coordinates

Table 3.1 Specifications

Model			M-900*i*A/200P
Type			Articulated type
Controlled axes			6axes(J1, J2, J3, J4, J5, J6)
Installation			Rack mount
Motion range	J1-axis	Upper limit	180° (3.14rad)
		Lower limit	-180° (-3.14rad)
	J2-axis	Upper limit	60° (1.05rad)
		Lower limit	-120° (-2.09rad)
	J3-axis	Upper limit	90° (1.57rad)
		Lower limit	-90° (-1.57rad)
	J4-axis	Upper limit	360° (6.28rad)
		Lower limit	-360° (-6.28rad)
	J5-axis	Upper limit	115° (2.01rad)
		Lower limit	115° (-2.01rad)
	J6-axis	Upper limit	360° (6.28rad)
		Lower limit	-360° (-6.28rad)
Maximum speed (Note 1)	J1-axis		110°/s (1.92rad/s)
	J2-axis		95°/s (1.66rad/s)
	J3-axis		95°/s (1.66rad/s)
	J4-axis		95°/s (1.66rad/s)
	J5-axis		95°/s (1.66rad/s)
	J6-axis		165°/s (2.88rad/s)
Maximum load	At the wrist (Note 2)		200 kg
	On the J3 arm (Note2)		25kg
Allowable load moment at wrist	J4-axis		2200 N・m (225 kgf・m)
	J5-axis		2200 N・m (225 kgf・m)
	J6-axis		715.N・m (73 kgf・m)
Allowable load inertia at wrist	J4-axis		431.2 kg・m^2 (4400 kgf・cm・s^2)
	J5-axis		431.2 kg・m^2 (4400 kgf・cm・s^2)
	J6-axis		392 kg・m^2 (4000 kgf・cm・s^2)
Drive method			Electric servo drive by AC servo motor
Repeatability			±0.3mm
Mass			2670 kg
Acoustic noise level			74.2dB NOTE This value is equivalent continuous A-weighted sound pressure level that applied with ISO11201 (EN31201). This value is measured with the following conditions. - Maximum load and speed - Operating mode is AUTO
Installation environment			Ambient temperature: 0 to 45℃ (Note 3) Ambient humidity: Normally 75%RH or less (No dew or frost allowed) Short time 95%Rh or less (Within 1 month) Permissible altitude: Above the sea 1000m or less Vibration: 0.5Gor less Free of corrosive gases (Note 4)

NOTE

1 In case of short distance motion, the axis speed doesn't reach maximum one.
2 Prevent the total weight of at wrist and on the J3 arm from exceeding 200kg.
3 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
4	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 foreign substances.

3.2 MECHANICAL UNIT OPERATION AREA AND INTERFERENCE AREA

Fig. 3.2 shows the robot interference area. When installing peripheral devices, be careful to clear away any objects that are the robot and the robot's motion path in normal operation.

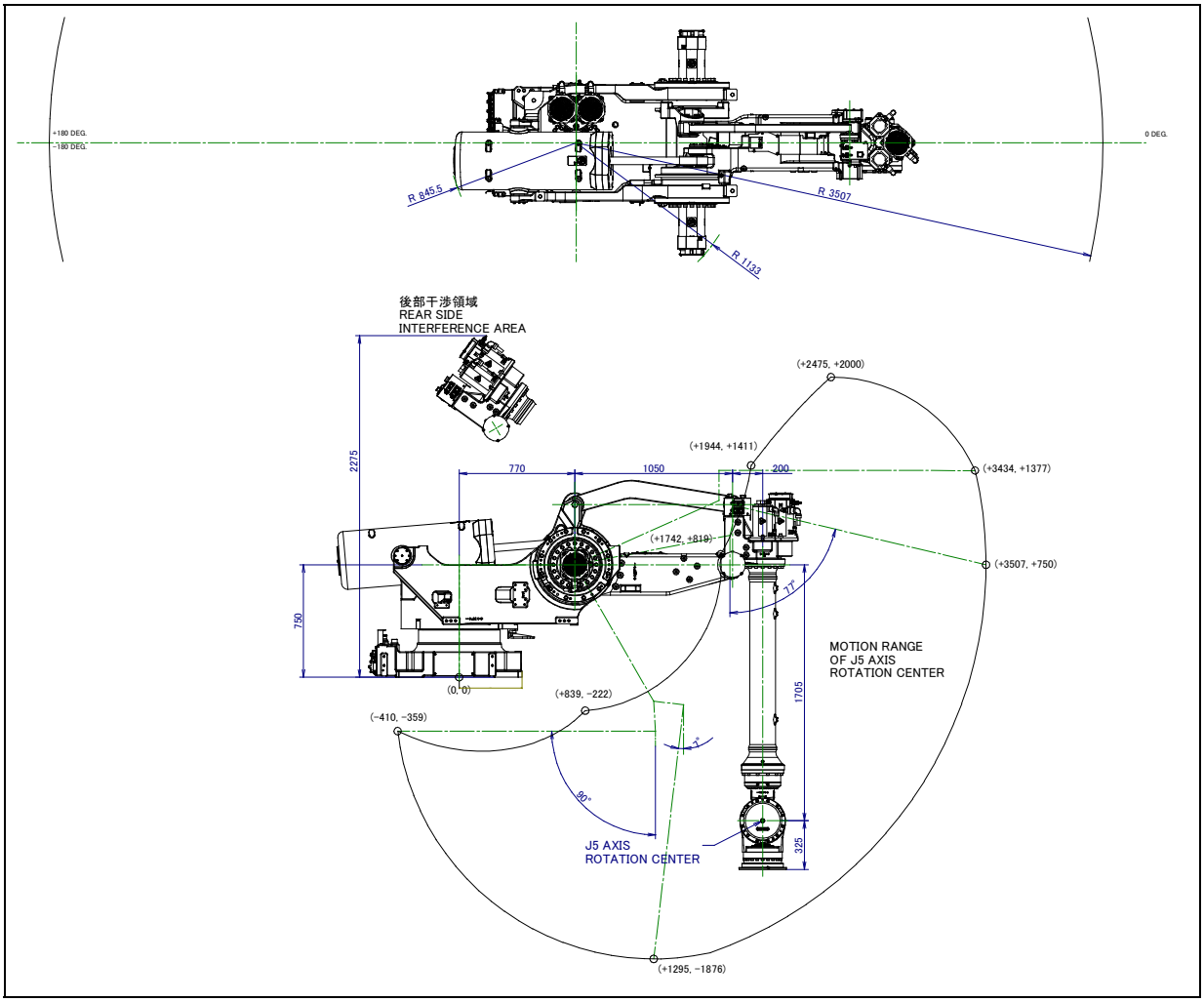


Fig. 3.2 Interference area

3.3 ZERO POINT POSITION AND MOTION LIMIT

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

Exceeding the software motion limit of a controlled axis is called overtravel (OT). Overtravel is detected at both ends of the motion limit for each axis.
In addition, the motion range limit by a mechanical stopper is also prepared to improve safety.

Fig.3.3 (a) shows the position of mechanical stopper. In case of J1 axis, robot stops by transforming mechanical stopper(movable side). Be sure to exchange transformed stopper to new one. Don't reconstruct the mechanical stopper. There is a possibility that the robot doesn't stop normally.
Fig.3.3 (b) - (g) show the zero point, and mechanical stopper position of each axis.

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

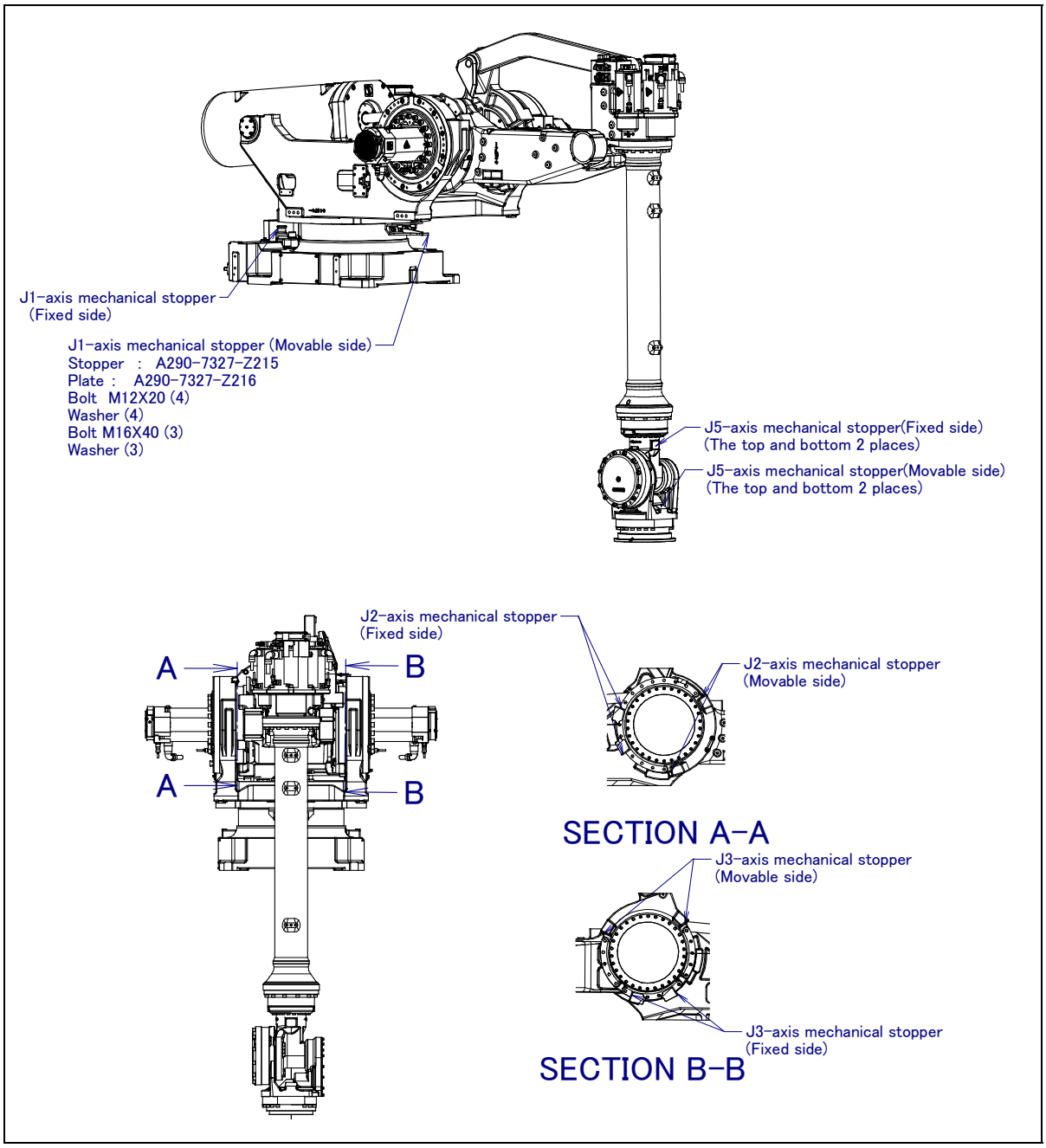


Fig. 3.3 (a) Position of mechanical stopper

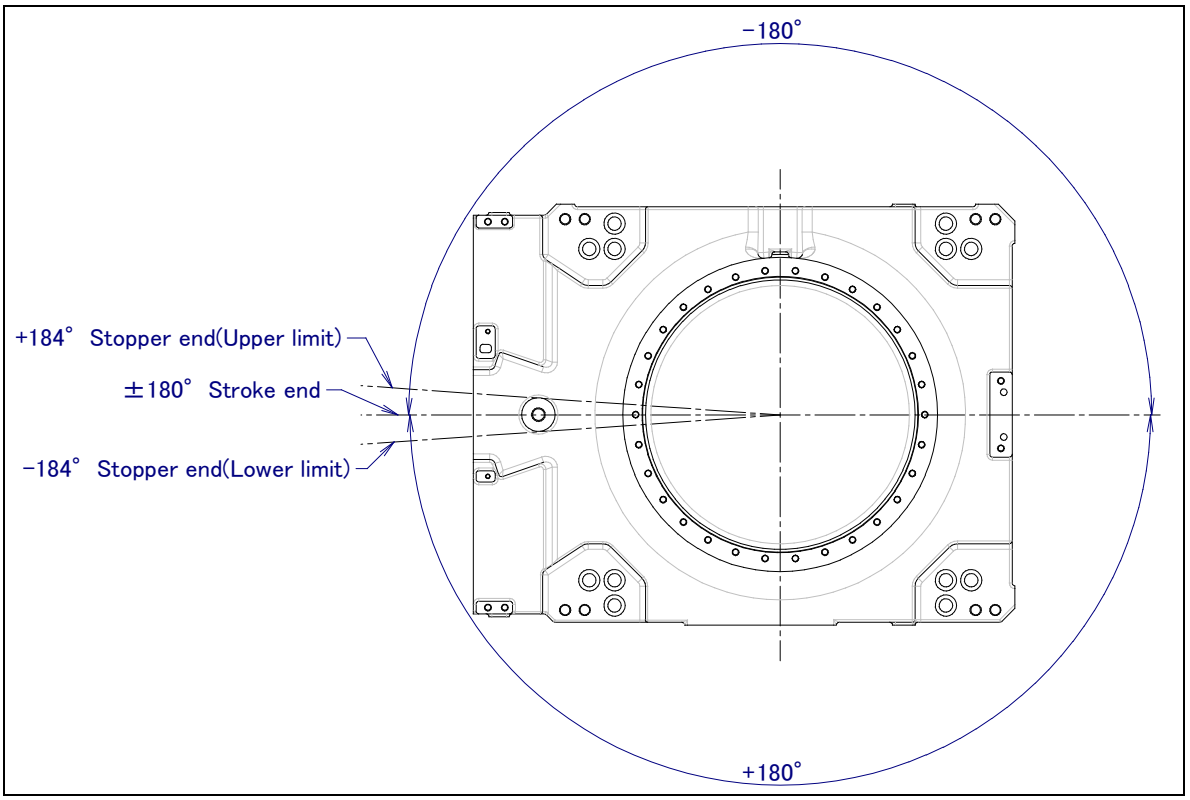


Fig. 3.3 (b) J1-axis motion limit

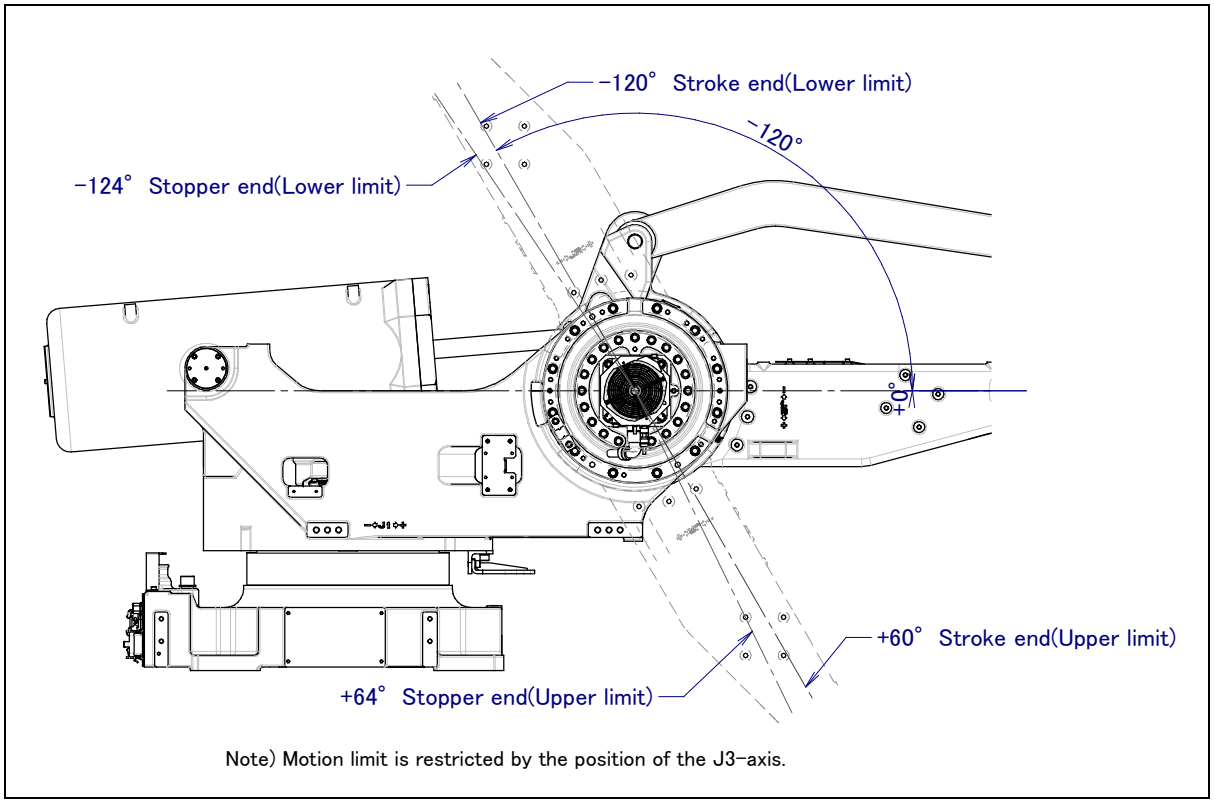


Fig. 3.3 (c) J2-axis motion limit

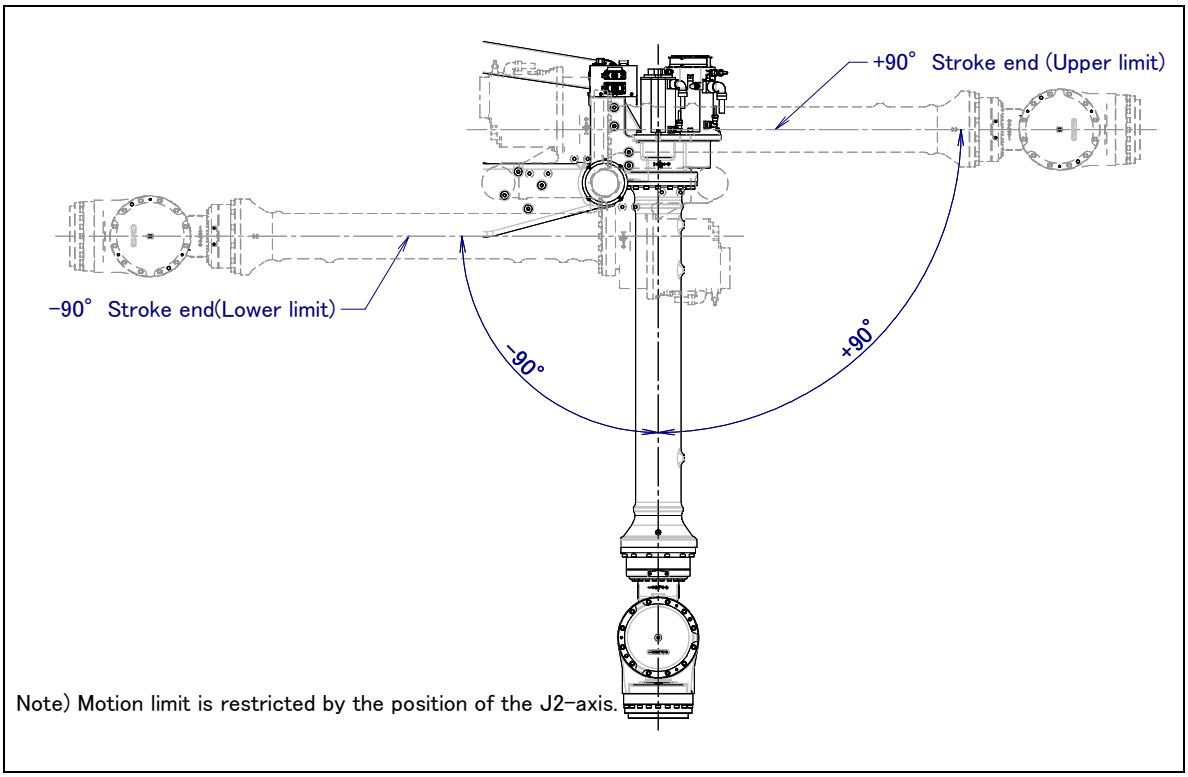


Fig. 3.3 (d) J3-axis motion limit

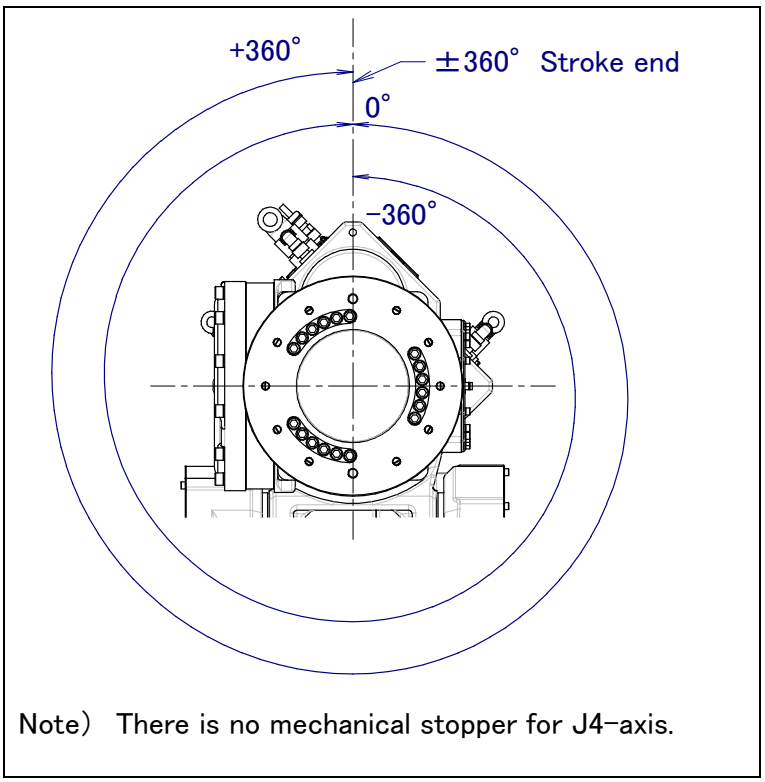


Fig. 3.3 (e) J4-axis motion limit

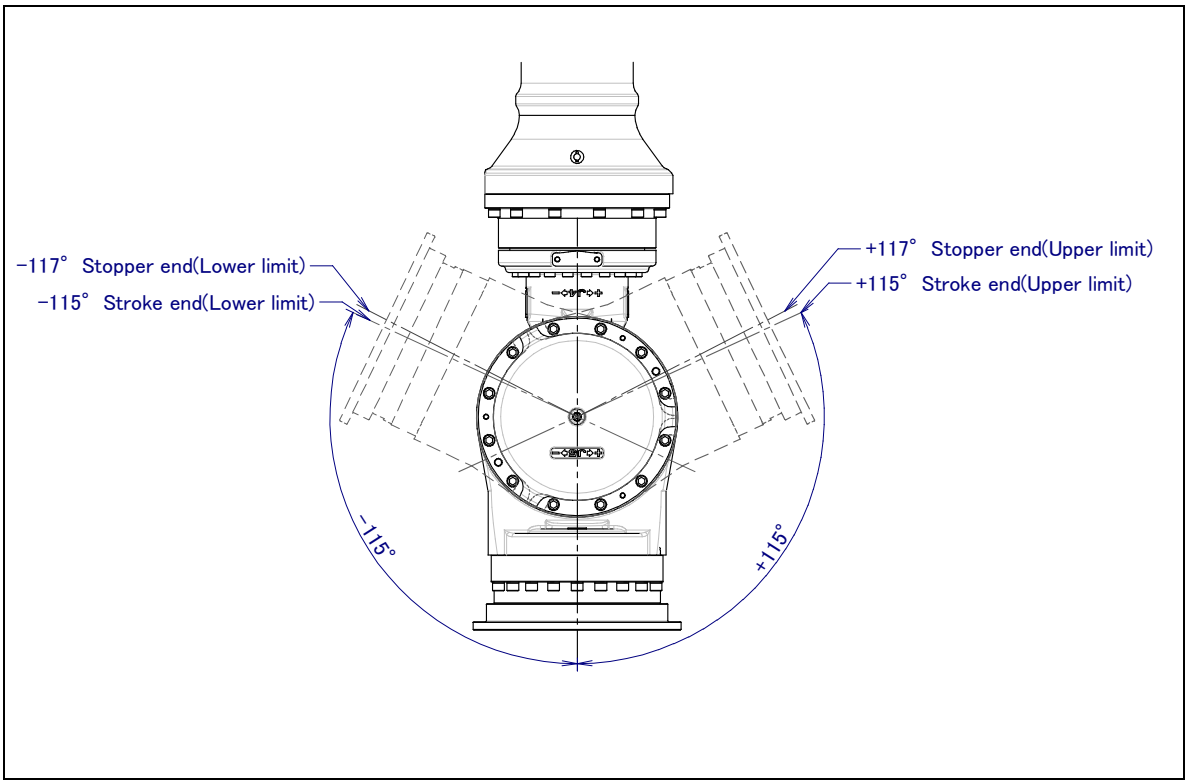


Fig. 3.3 (f) J5-axis motion limit

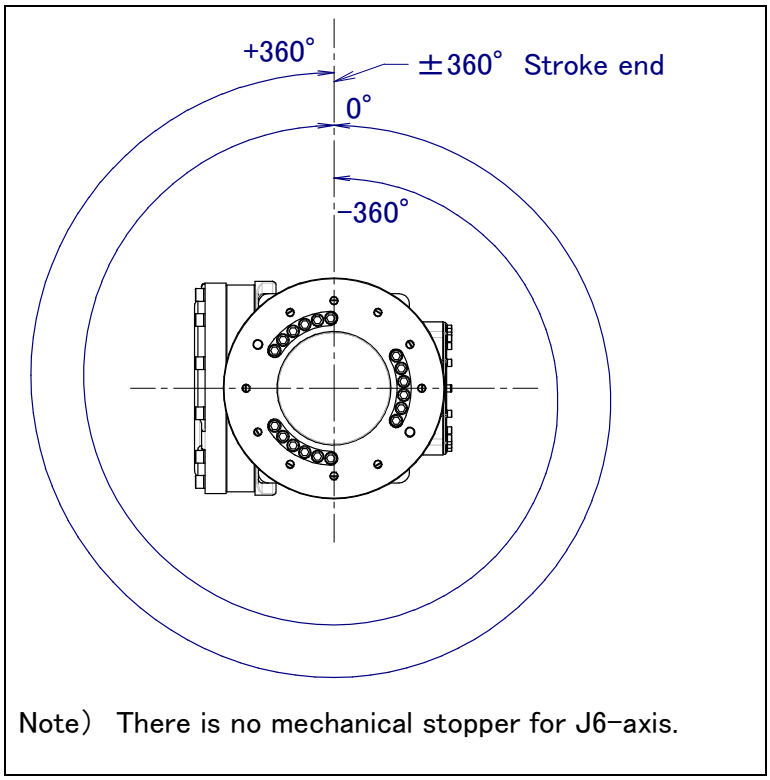


Fig. 3.3 (g) J6-axis motion limit

3.4 WRIST LOAD CONDITIONS

Fig. 3.4 is diagram to limit loads applied to the wrist. Apply a load within the region indicated in the graph. In addition, please use it to meet the requirement of the allowable load moment and inertia at wrist, too. See the 3.1 about allowable load moment and inertia at wrist.

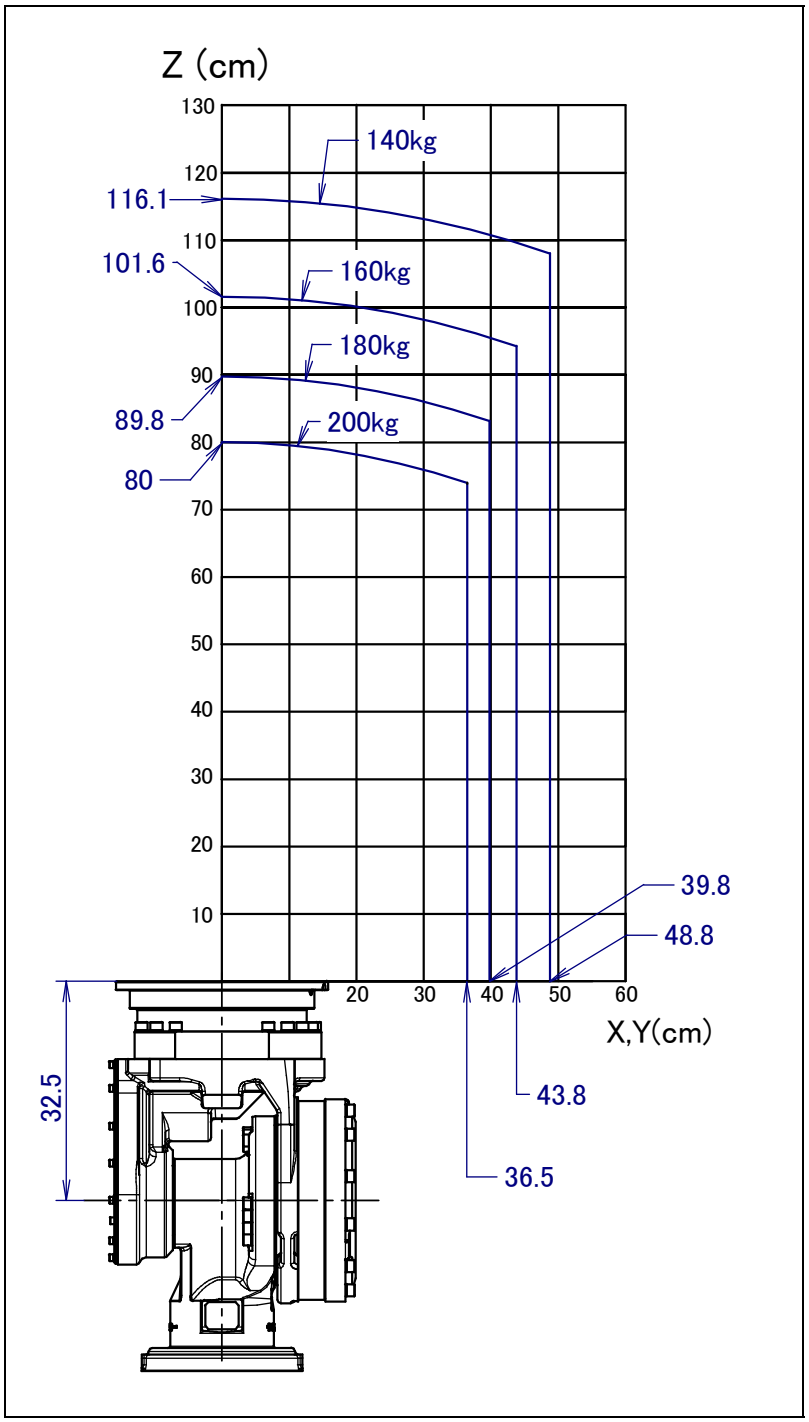


Fig. 3.4 Wrist load diagram

3.5 LOAD CONDITION ON EQUIPMENT MOUNTING FACE

Table 3.5 and Fig. 3.5 show J2 base and J3 casing load condition.

Table 3.5 J2 base / J3 arm load condition

Mounting position	Load capacity	Condition
J2 base	-	The load can not be put.
J3 arm	25kg	See Fig. 3.5 for the condition of a gravity position. Prevent the total with Wrist from exceeding 200kg.

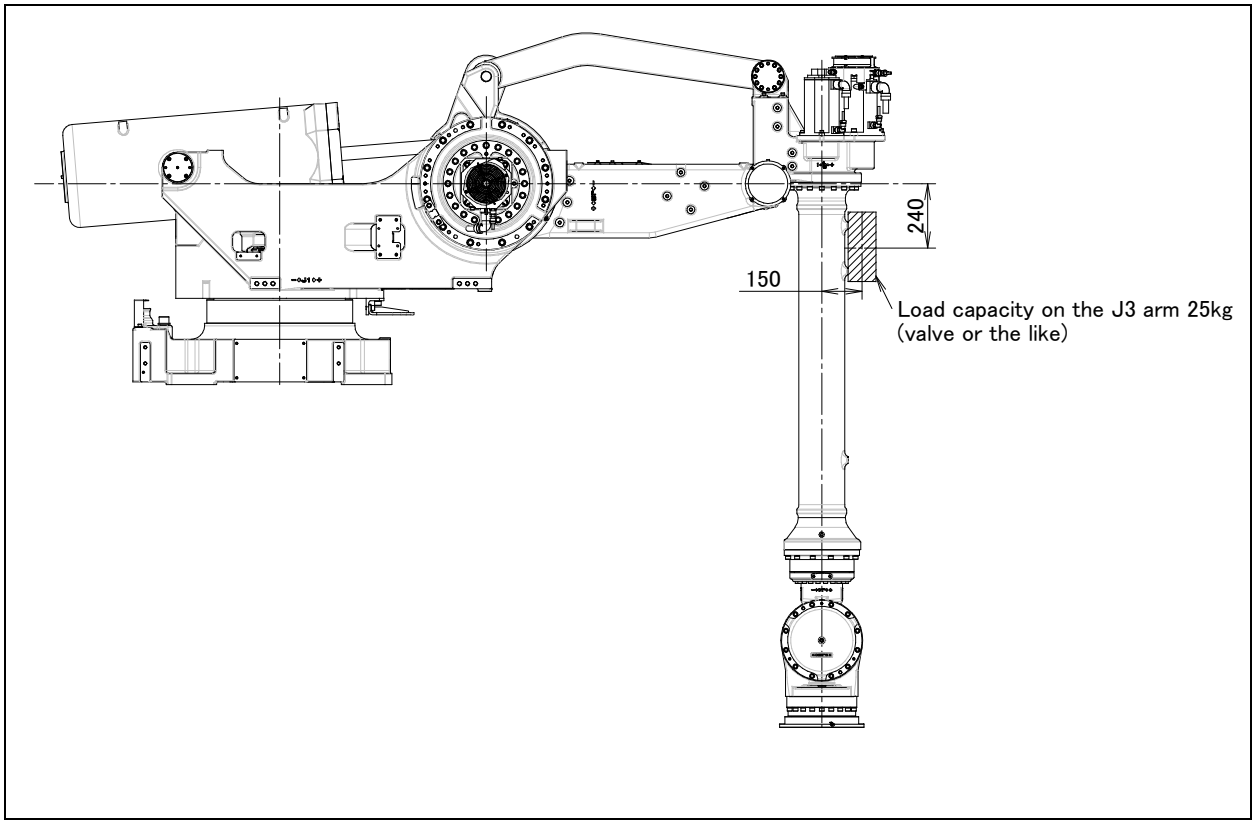


Fig. 3.5 Load condition of equipment mounting face

4 MECHANICAL COUPLING TO THE ROBOT

4.1 MECHANICAL COUPLING OF END EFFECTOR TO WRIST

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

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

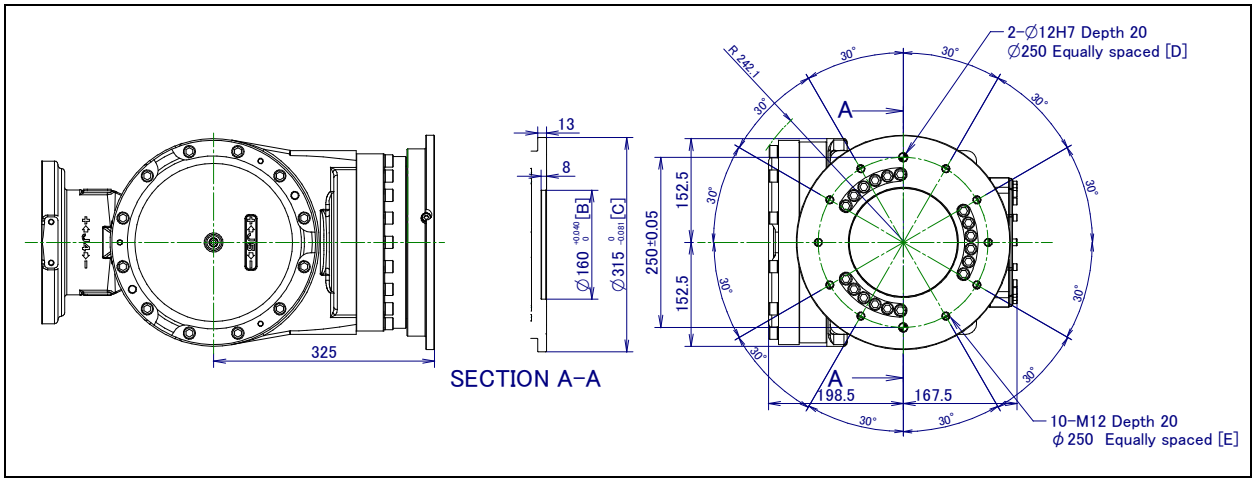


Fig. 4.1 End effector interface

4.2 EQUIPMENT MOUNTING FACE

As shown in Fig. 4.2 tapped holes are provided to install equipments to the robot.

⚠CAUTION
Never perform additional machining operations such as drilling or tapping on the robot body. This can seriously affect the safety and functions of the robot.

NOTE
Note that the use of a tapped hole not shown in the following figure is not assured. Please do not tighten both with the tightening bolts used for mechanical unit.

NOTE
Equipments should be installed so that mechanical unit cable does not interfere. If equipments interfere, the mechanical unit cable might be disconnected, and unexpected troubles might occur.

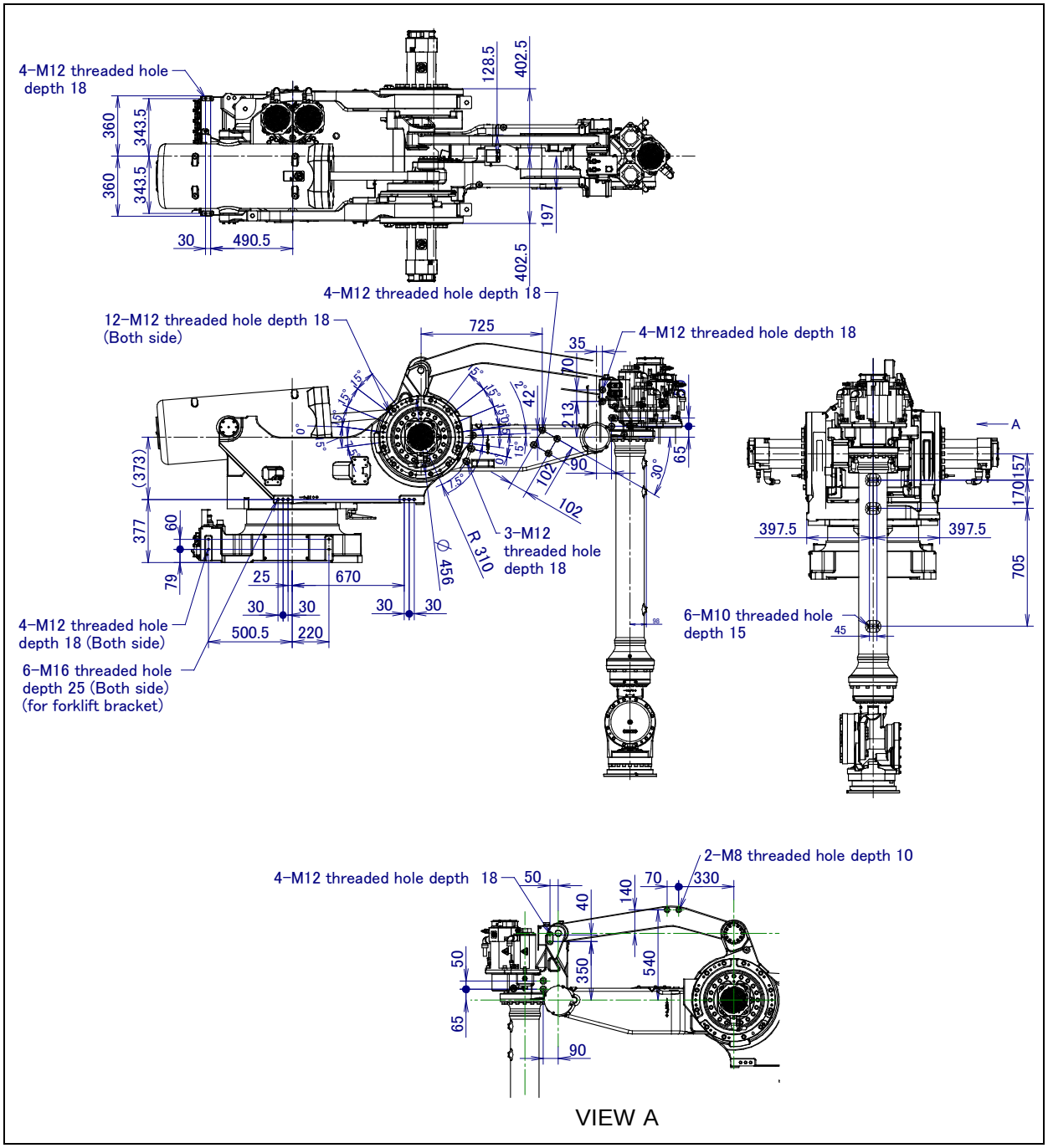


Fig. 4.2 Equipment mounting faces

4.3 LOAD SETTING

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

Motion performance screens

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

1 Click the [MENUS] key to display the screen menu.
2 Select "6 SYSTEM" from the next page,
3 Click F1 ([TYPE]).
4 Select "MOTION." The MOTION PERFORMANCE screen appears.

```
MOTION PERFORMANCE                    JOINT 10%
   Group1
No.   PAYLOAD[kg]          Comment
 1          175.00    [                    ]
 2            0.00    [                    ]
 3            0.00    [                    ]
 4            0.00    [                    ]
 5            0.00    [                    ]
 6            0.00    [                    ]
 7            0.00    [                    ]
 8            0.00    [                    ]
 9            0.00    [                    ]
10            0.00    [                    ]

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

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

```
MOTION PAYLOAD SET              JOINT   100%

   Group 1
   Schedule No[   1]:[Comment          ]
 1 PAYLOAD             [kg]        175.00
 2 PAYLOAD CENTER  X   [cm]         -7.99
 3 PAYLOAD CENTER  Y   [cm]          0.00
 4 PAYLOAD CENTER  Z   [cm]          6.44
 5 PAYLOAD INERTIA X   [kgfcms^2]    0.13
 6 PAYLOAD INERTIA Y   [kgfcms^2]    0.14
 7 PAYLOAD INERTIA Z   [kgfcms^2]    0.07

 [TYPE]  GROUP  NUMBER  DEFAULT  HELP
```

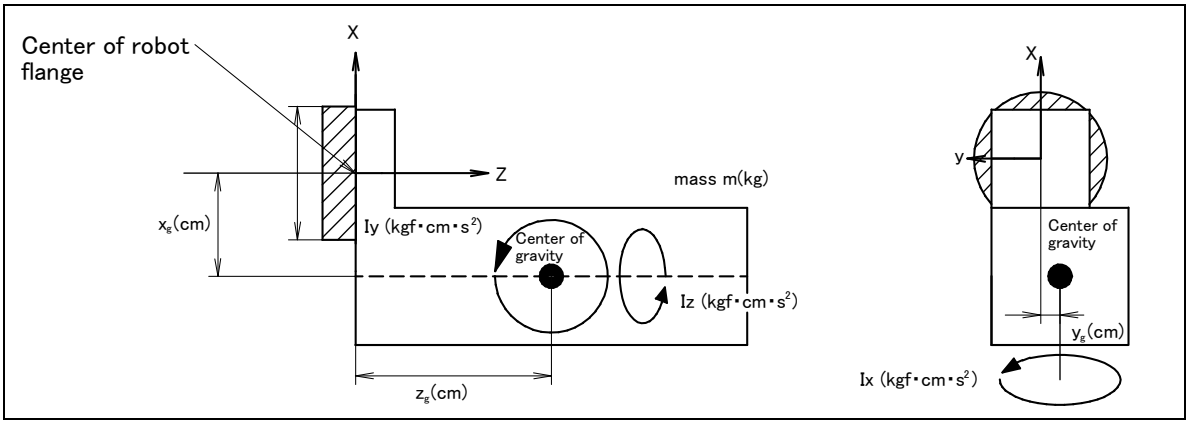


Fig. 4.3 Standard tool coordinate

6 Set the payload, gravity center position, and inertia around the gravity center on the MOTION PAYLOAD SET screen. The X, Y, and Z directions displayed on this screen correspond to the respective standard tool coordinates (with no tool coordinate system set up). When values are entered, the following message appears: “Path and Cycle time will change. Set it?” Respond to the message with F4 ([YES]) or F5 ([NO]).

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

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

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

```
MOTION ARMLOAD SET                JOINT   100%

   Group 1
 1 ARM LOAD AXIS #1 [kg]              0.00
 2 ARM LOAD AXIS #3 [kg]             25.00

[ TYPE ]    GROUP          DEFAULT   HELP
```

10 Specify the mass of the loads on the J2 base and J3 arm. When you enter ARMLOAD AXIS #1[kg]: Mass of the load on the J2 base and ARMLOAD AXIS #3[kg]: Mass of the load on the J3 arm, the confirmation message “Path and Cycle time will change. Set it?” appears. Select F4 YES or F5 NO. Once the mass of a device is entered, it is put in effect by turning the power off and on again.

5 PIPING AND WIRING TO THE END EFFECTOR

⚠ WARNING

- Use mechanical unit cables that have required user interface.
- Don't add user cable or hose to inside of 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 and fix an outside cable more) obstructing the behavior of the outcrop of the cable.
- Please do not interfere with the other parts of mechanical unit when equipment is installed in the robot.
- Cut unnecessary length of wire rod. Make insulation processing like winding acetate tape. (See Fig.5)
- If you can not prevent electrostatic charge of work and end effector, keep away an end effector (a hand) cable from an end effector and a work as much as possible, when wiring it. When they come to close unavoidable, make insulation processing between them.
- Be sure to seal connectors of hand side and robot side and terminal parts of cables, to prevent water from entering the mechanical unit. Also, attach cover to unused connector.
- Check looseness of connector and wound of coating of cables routinely.

When these attentions are not kept, unexpected troubles might occur.

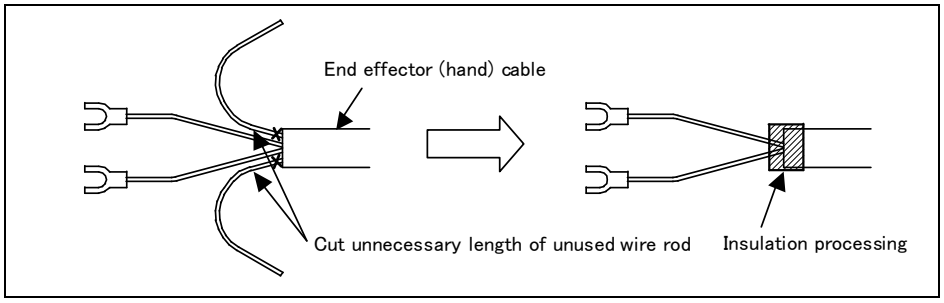


Fig.5 Treatment method of end effector (hand) cable

5.1 AIR SUPPLY (OPTION)

Robot has air inlet and air outlet on the back of the J1 base and the J3 casing. The connector is a Rc1/2 female. As coupling are not supplied, it will be necessary to prepare couplings which suit to the hose size.

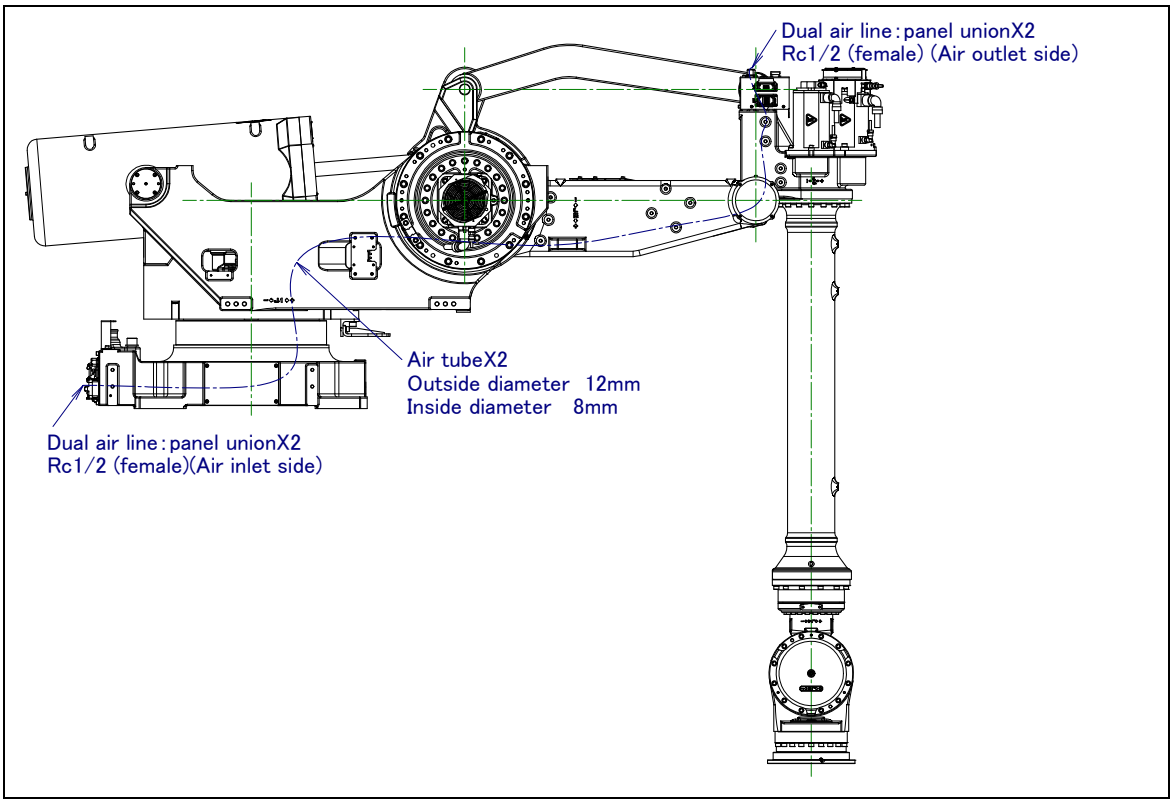


Fig. 5.1 Air supply (option)

5.2 AIR PIPING (OPTION)

Fig. 5.2 (a) shows how to connect air hose to the robot. If the air control set is specified as an option, the air hose between the mechanical unit and the air control set is provided. Mount the air control set using the information in Fig. 5.2 (b).

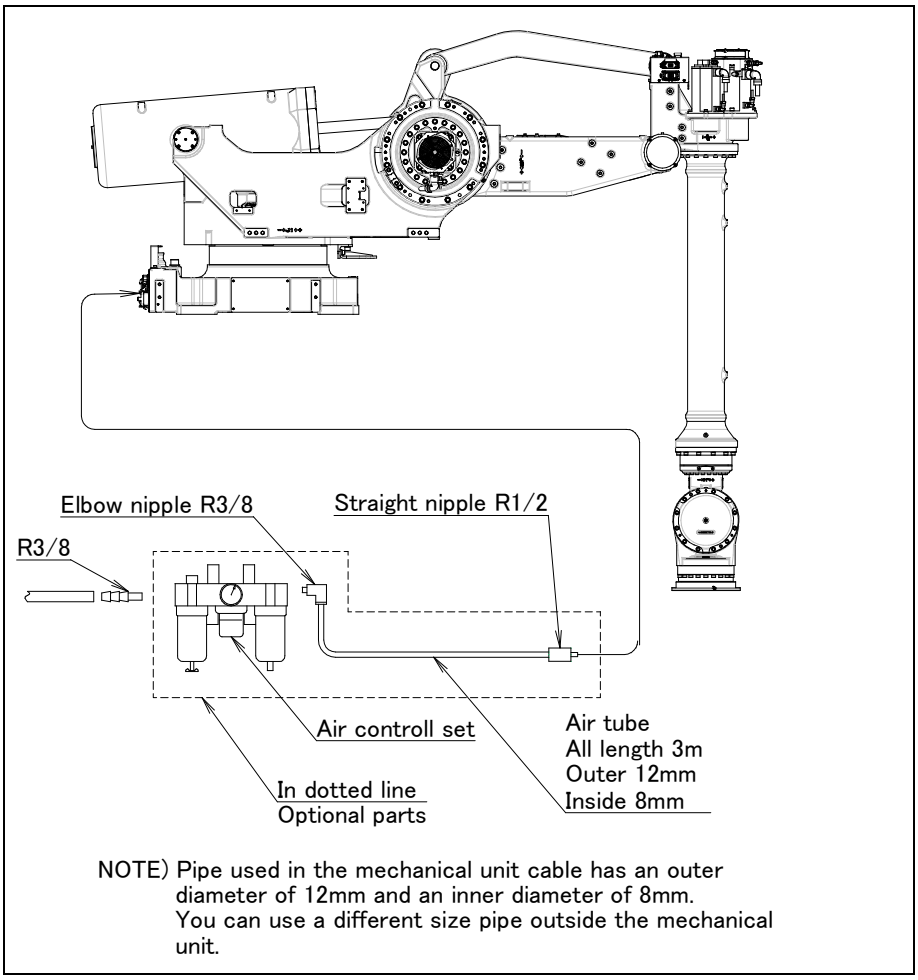


Fig. 5.2 (a) Air piping (option)

Air control set

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.

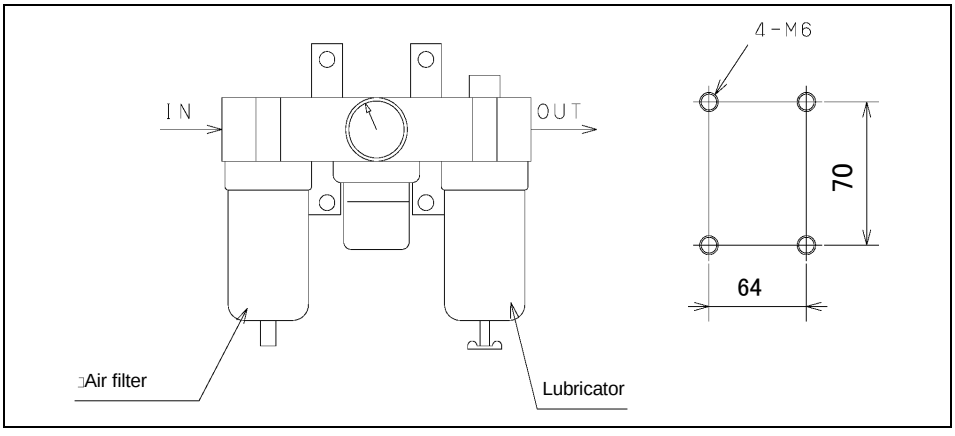


Fig. 5.2 (b) Air control set option

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

Air pressure	Supply air pressure	0.49 to 0.69MPa (5 to 7kgf/cm^2), Setting: 0.49MPa (5kgf/cm^2)
	Amount of consumption	Maximum instantaneous amount 150Nl/min(0.15Nm^3/min)

5.3 INTERFACE FOR OPTION CABLE (OPTION)

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

NOTE
Each option cable is written like below on connector panel
EE(RI/RO) interface : EE
User cable (signal) : AS
User cable (power) : AP
Additional axis motor cable (Pulsecoder) : ARP
Additional axis motor cable (power,brake) : ARM

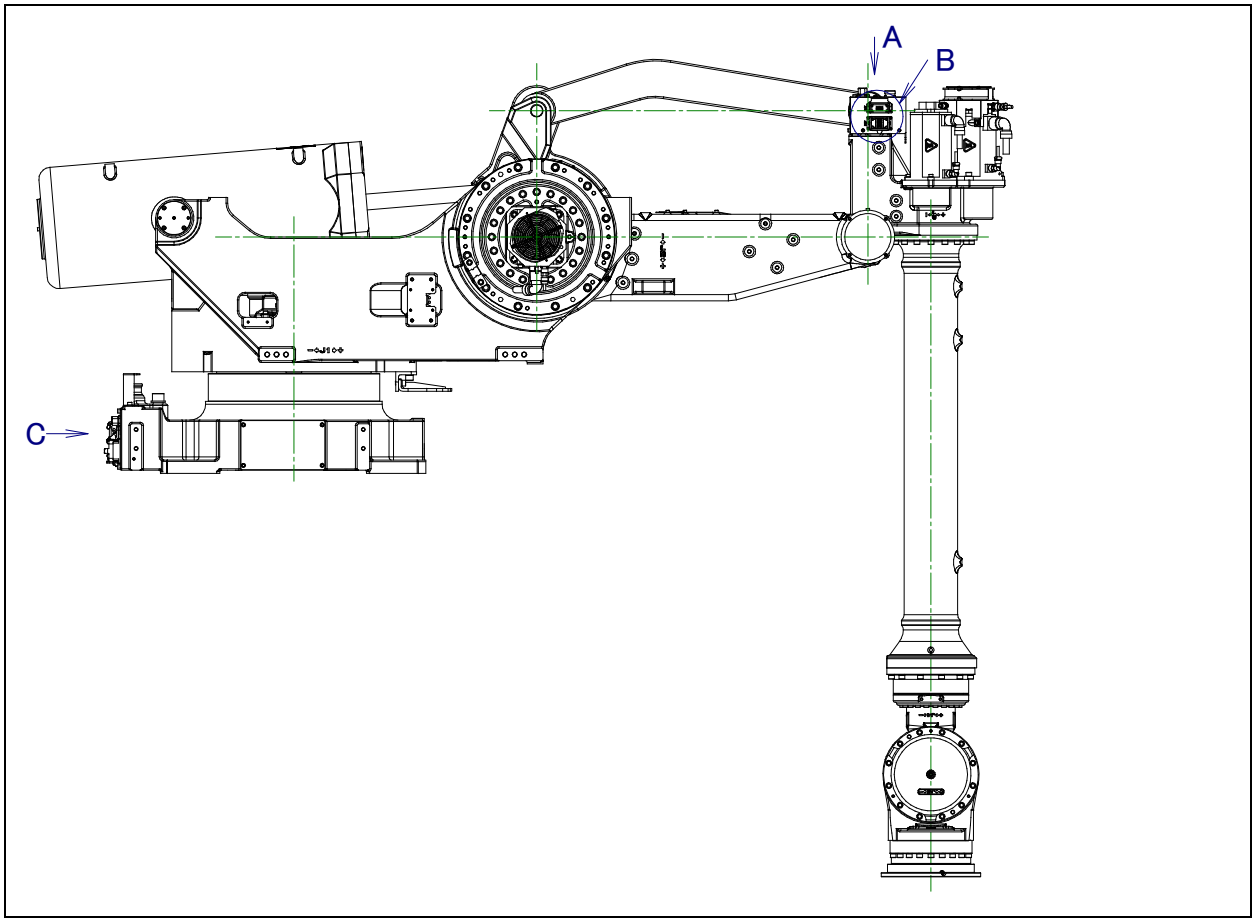


Fig. 5.3 (a) Interface for optional cable (OPTION)

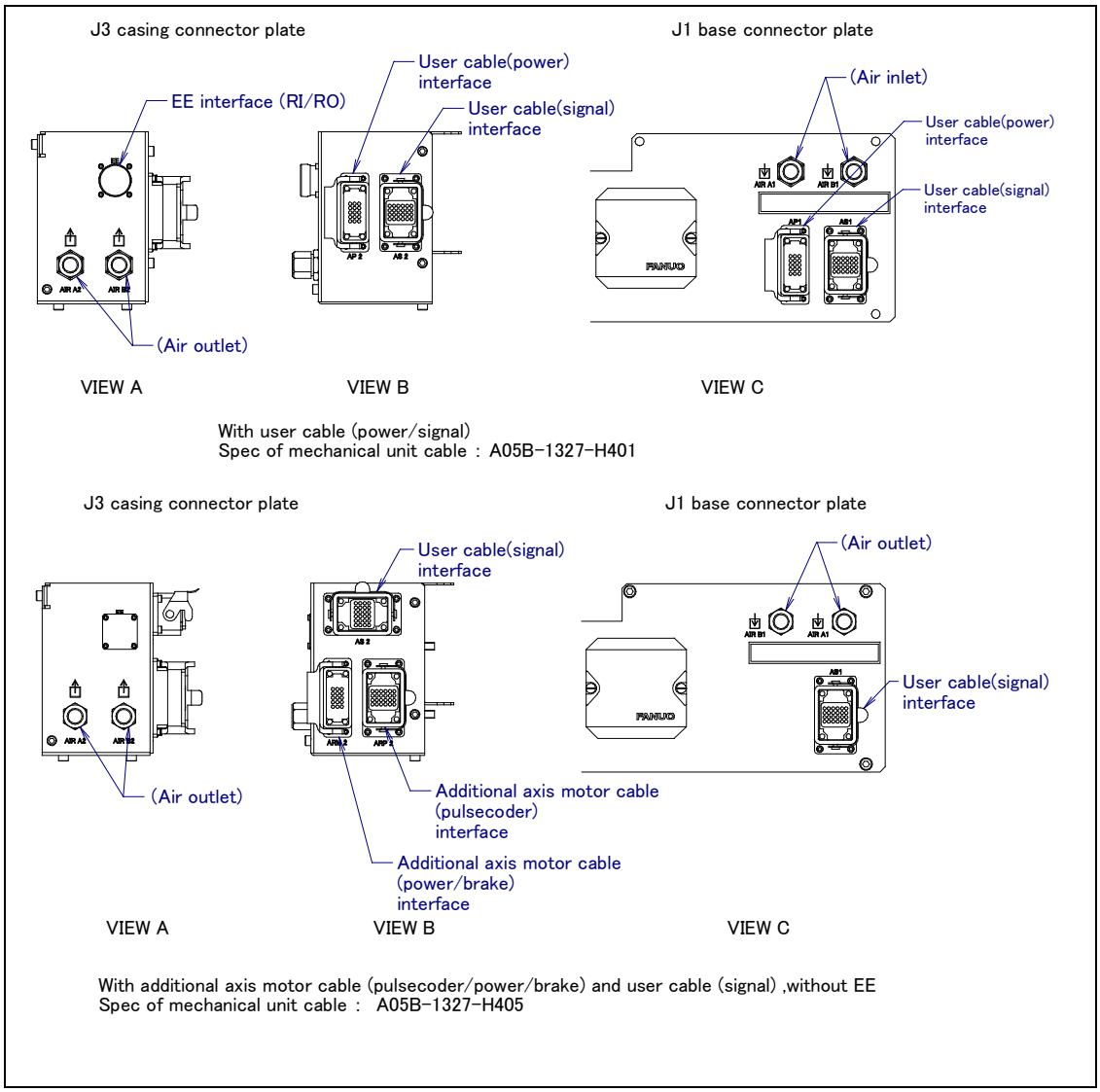


Fig. 5.3 (b) Interface for option cable

1 EE interface (RI/RO) (Option)

Fig. 5.3 (c) shows pin layout for EE interface (RI/RO).

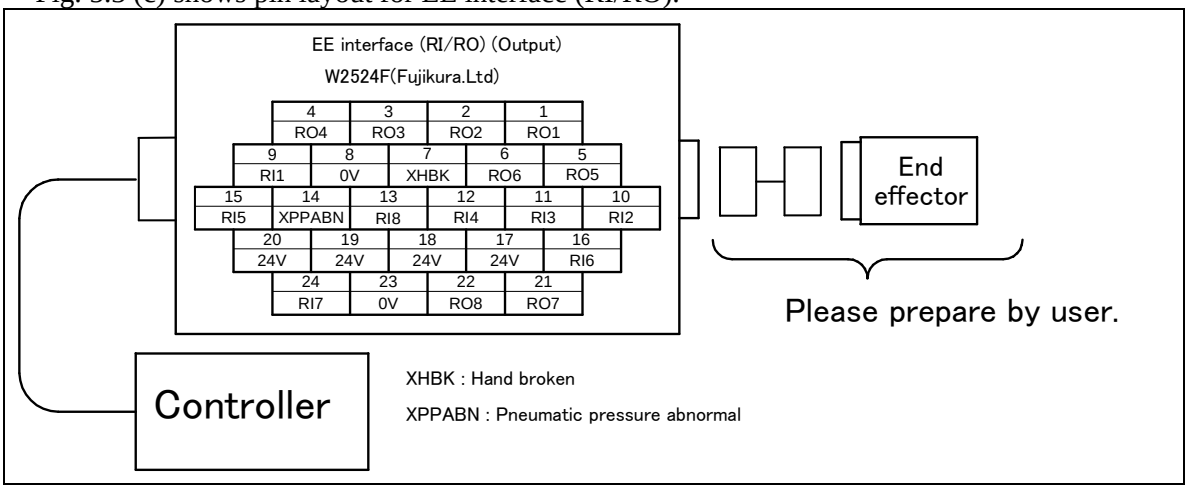


Fig. 5.3 (c) Pin layout for EE interface(RI/RO) (option)

2 User cable (signal line) Interface (option)

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

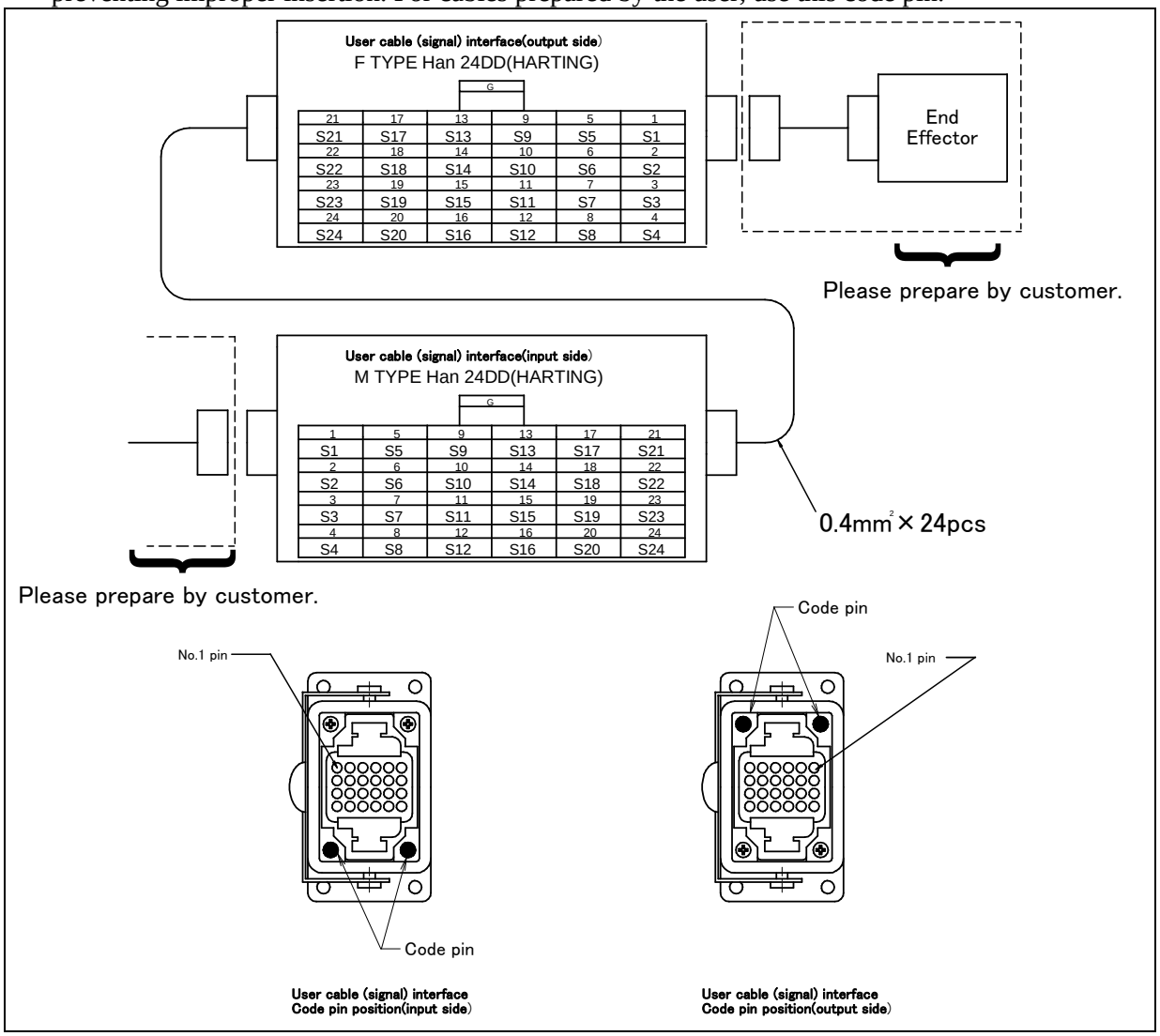


Fig. 5.3 (d) Pin layout for user cable (signal line) interface and code pin layout (option)

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

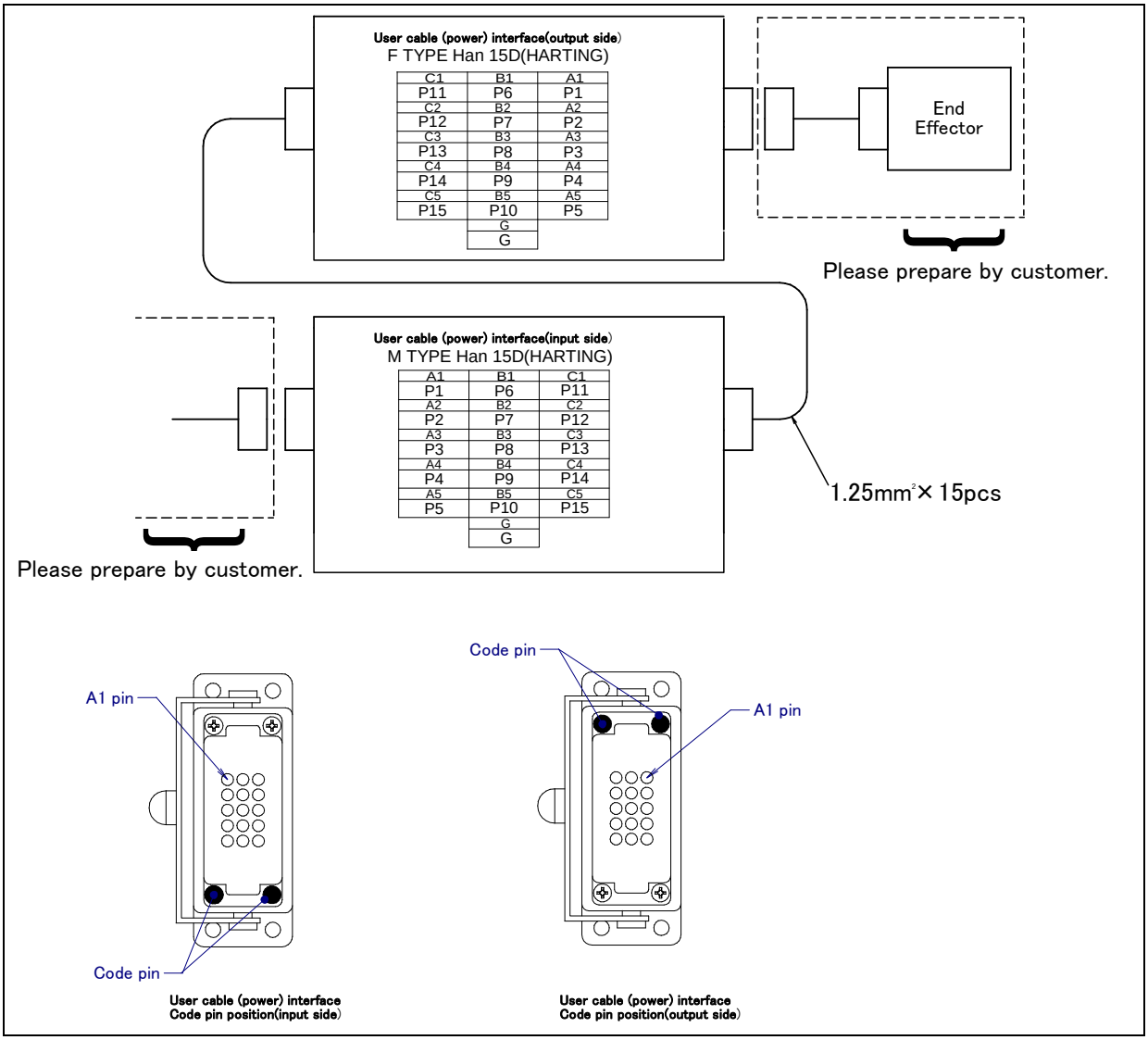


Fig. 5.3 (e) Pin layout for user cable (power line) interface and code pin layout (option)

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

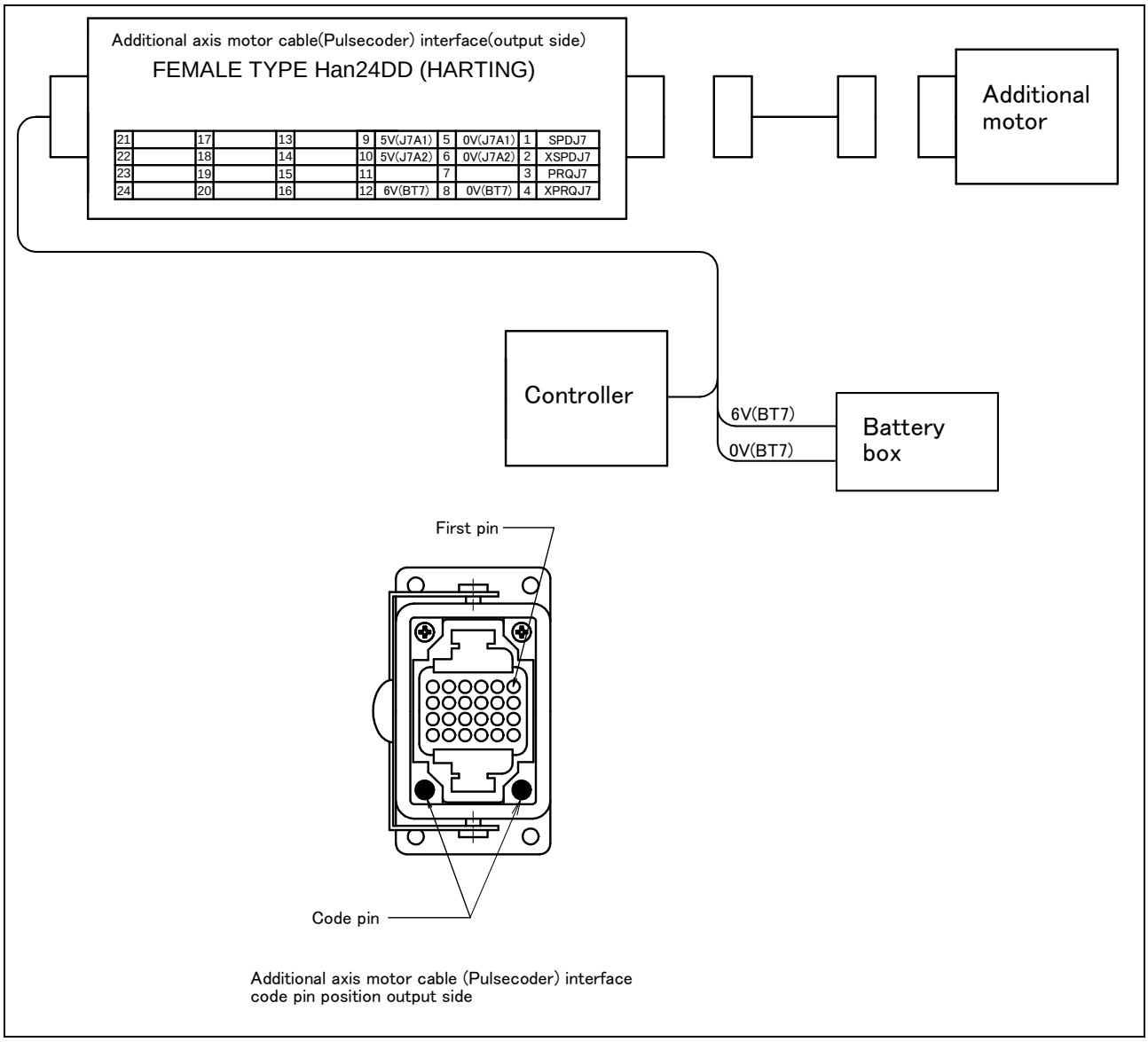


Fig. 5.3 (f) Pin layout of the additional axis motor cable (Pulsecoder cable) interface and layout position of the code pin (option)

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

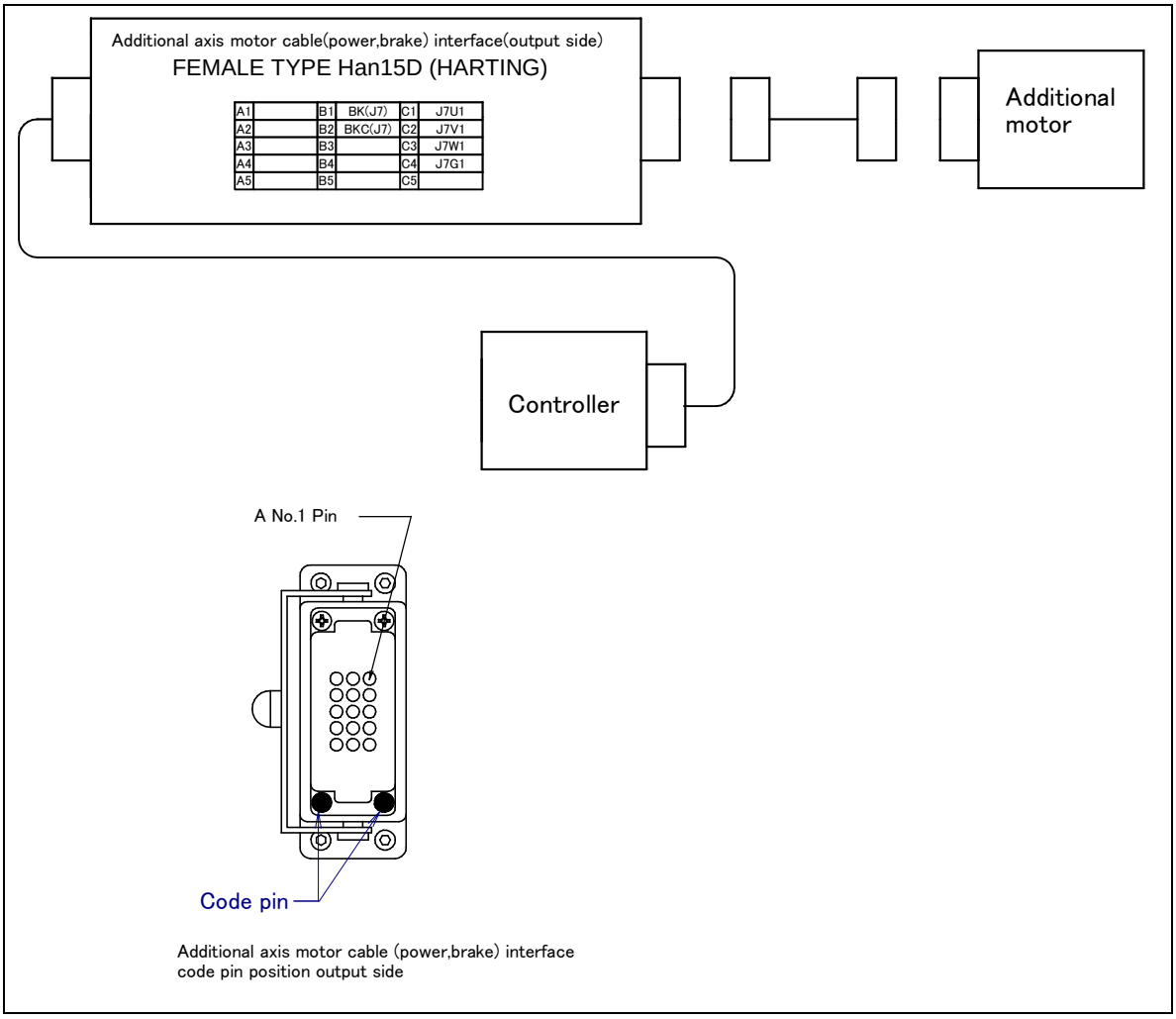


Fig. 5.3 (g) Pin layout of the additional axis motor cable (power and brake cables) interface and layout position of the code pin (option)

Connector specifications

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

Cable	Input side (J1 base)		Output side (J3 casing)		Maker /dealer
EE (RI/RO)	———		JMWR2524F		Fujikura Ltd.
AS	Housing Insert Contact Code pin	09 30 006 0301 09 16 024 3001 (Han 24DD M) 09 15 000 6103 09 30 000 9901	Housing Insert Contact Code pin	09 30 006 0301 09 16 024 3101 (Han 24DD F) 09 15 000 6203 09 30 000 9901	HARTING Electronic CO., LTD
AP	Housing Insert Contact Code pin	09 20 010 0301 09 21 015 3001 (Han 15D M) 09 15 000 6103 09 30 000 9901	Housing Insert Contact Code pin	09 20 010 0301 09 21 015 3101 (Han 15D F) 09 15 000 6203 09 30 000 9901	
ARP	———		Housing Insert Contact Code pin	09 30 006 0301 09 16 024 3101 (Han 24DD F) 09 15 000 6203 09 30 000 9901	
ARM	———		Housing Insert Contact Code pin	09 20 010 0301 09 21 015 3101 (Han 15D F) 09 15 000 6201 09 30 000 9901	

Table 5.3 (b) Connector specifications (User side)

Cable	Input side (J1 base)		Output side (J3 casing)		Maker /dealer
EE (RI/RO)	———		JMSP2524M Straight (Appendix) (FANUC spec. : A63L-0001-0234#S2524M) JMLP2524M Angle		Fujikura Ltd.
AS	Hood Select one	09 30 006 1540 Side entry 1541 0542 0543 1440 Top entry 1441 0442 0443	Hood	←The same	HARTING Electronic CO., LTD
	Insert	09 16 024 3101 (Han 24DD F)	Insert	09 16 024 3001 (Han 24DD M)	
	Contact Select one	09 15 000 6204 AWG 26-22 6203 AWG 20 6205 AWG 18 6202 AWG 18 6201 AWG 16 6206 AWG 14	Contact	09 15 000 6104 AWG 26-22 6103 AWG 20 6105 AWG 18 6102 AWG 18 6101 AWG 16 6106 AWG 14	
	Clamp Select one	09 00 000 5083 5086 5090 5094 etc. Many other types are available	Clamp	←The same	
	Code pin	09 30 000 9901	Code pin	09 30 000 9901	

Cable	Input side (J1 base)		Output side (J3 casing)		Maker /dealer
AP	Hood Select one	09 20 015 1541 Side entry 0540 ↓ 0541 ↓ 1440 Top entry 0440 ↓ 0441 ↓	Hood	←The same	HARTING Electronic CO., LTD
	Insert	09 21 015 3101 (Han 15D F)	Insert	09 21 015 3001 (Han 15D M)	
	Contact Select one	09 15 000 6204 AWG 26-22 6203 AWG 20 6205 AWG 18 6202 AWG 18 6201 AWG 16 6206 AWG 14	Contact	09 15 000 6104 AWG 26-22 6103 AWG 20 6105 AWG 18 6102 AWG 18 6101 AWG 16 6106 AWG 14	

Table 5.3 (c) continued from previous page) Connector specifications (User side)

Cable	Input side (J1 base)		Output side (J3 casing)		Maker /dealer
AP	Clamp Select one	09 00 000 5083 5086 5090 5094 etc. Many other types are available	Clamp	←The same	HARTING Electronic CO., LTD
	Code pin	09 30 000 9901	Code pin	09 30 000 9901	

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

6 AXIS LIMITS SETUP

Axis limits define the motion range of the robot. The operating range of the robot axes can be restricted because of:

- Work area limitations
- Tooling and fixture interference points
- Cable and hose lengths

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

- Axis limit software settings (All axes)
- Axis limit adjustable mechanical stopper ((J1, J2, J3 axis) option)
- Axis limit switches ((J1, J2, J3 axis) option)

⚠ CAUTION

1 Changing the motion range of any axis affects the operation range of the robot. To avoid trouble, carefully consider a possible effect of the change to the movable range of each axis in advance. Otherwise, it is likely that an unexpected condition occurs; for example, an alarm may occur in a previous taught position.
2 For the J1, J2, and J3 axes, do not count merely on software-based limits to the movable range when changing the movable range of the robot. Use mechanical stoppers together so that damage to peripheral equipment and injuries to human bodies can be avoided. In this case, make the software-specified limits match the limits based on the mechanical stoppers.
3 Mechanical stoppers are physical obstacles. The robot cannot move beyond them. For the J1, J2, and J3 axes, it is possible to re-position the mechanical stoppers. For J5 axis, the mechanical stoppers are fixed. For the J4 and J6 axes, only software-specified limits are available.
4 For changing J2 andJ3 axes interference angles, only mechanical stoppers are available; a sotware-specified movable range cannot be changed.
5 Adjustable mechanical stoppers (J1, J2, and J3 axes) are deformed in a collision to stop the robot. Once a stopper is subject to a collision, it can no longer assure its original strength and, therefore, may not stop the robot. When this happens, replace it with a new one.

6.1 SETTING MOTION LIMITATION BY SOFTWARE

Upper and lower axis limits about motion range can be changed by software settings. The limits can be set for all axes. The robot stops the motion if the robot reaches to the limits.

Setting procedure

1 Press MENUS.
2 Select SYSTEM.
3 Press F1, [TYPE].
4 Select Axis Limits. You will see a screen similar to the following.

System Axis Limits JOINT 100%

Group1 1/16

AXIS	GROUP	LOWER	UPPER	
1	1	-150.00	150.00	deg
2	1	-60.00	75.00	deg
3	1	-110.00	50.00	deg
4	1	-240.00	240.00	deg
5	1	-115.00	115.00	deg
6	1	-360.00	360.00	deg
7	1	0.00	0.00	mm
8	1	0.00	0.00	mm
9	1	0.00	0.00	mm

[TYPE]

NOTE
0 indicates the robot does not have these axes.

5 Move the cursor to the axis limit you want to set. Type the new value using the numeric keys on the teach pendant.

⚠WARNING
Do not depend on J1, J2, and J3 axis limit software settings to cotrol the motion range of your robot. Use the axis limit switches or hardstops also; otherwise injury to personnel or damage to equipment could occur.

6 Repeat Steps 5 through 6 until you are finished setting the axis limits.
7 Turn off the controller and then turn it back on again in the cold start mode so the new information can be used.

⚠WARNING
You must turn off the controller and then turn it back on to use the new information; otherwise injury to personnel or damage to equipment could occur.

6.2 ADJUSTABLE MECHANICAL STOPPER SETTING

For the J1, J2, and J3 axes, Adjustable mechanical stopper (option) can be installed in addition to standard mechanical stopper. It is possible to re-position adjustable mechanical stoppers. Also, the limit switch-based movable range can be changed by changing the dog positions. Dog of J1-axis is set in the position same as J1-axis mechanical stopper.

Table 6.2 Adjustable mechanical stopper and limit switch

Item		
J1-axis adjustable mechanical stopper and limit switch	Upper limit	Settable in steps of 7.5° degrees in a range of –135° to +180° degrees.
	Lower limit	Settable in steps of 7.5° degrees in a range of -180° to +135° degrees.
	Space between the upper and lower limit	A space of 45° degrees or more is required.
J2-axis adjustable mechanical stopper	Upper limit	Settable in steps of 15° degrees in a range of -105° to +45° degrees. A is also provided at the upper limit +60° degrees of the standard movable range.
	Lower limit	Settable in steps of 15° degrees in a range of -105° to +45° degrees. A mechanical stopper is also provided at the upper limit -120° degrees of the standard movable range.
	Space between the upper and lower limit	A space of 15° degrees or more is required.
J2-axis limit switch	Upper limit	Settable in steps of 15° degrees in the range of -105° to +45° degrees. Also settable to the upper limit +60° degrees of the standard movable range.
	Lower limit	Settable in steps of 15° degrees in the range of -105° to +45° degrees. Also settable to the lower limit -120° degrees of the standard movable range.
	Space between the upper and lower limit	A space of 15° degrees or more is required.
J3-axis adjustable mechanical stopper	Upper limit	Settable in steps of 15° degrees in a range of –75° to +75° degrees. A mechanical stopper is also provided at the upper limit +90° degrees of the standard movable range.
	Lower limit	Settable in steps of 15° degrees in a range of -75° to +75° degrees. A mechanical stopper is also provided at the upper limit -90° degrees of the standard movable range.
	Space between the upper and lower limit	A space of 15° degrees or more is required.
J3-axis limit switch	Upper limit	Settable in steps of 15° degrees in the range of -75° to +75° degrees. Also settable to the upper limit +90° degrees of the standard movable range.
	Lower limit	Settable in steps of 15° degrees in the range of -75° to +75° degrees. Also settable to the lower limit -90° degrees of the standard movable range.
	Space between the upper and lower limit	A space of 15° degrees or more is required.

⚠CAUTION

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

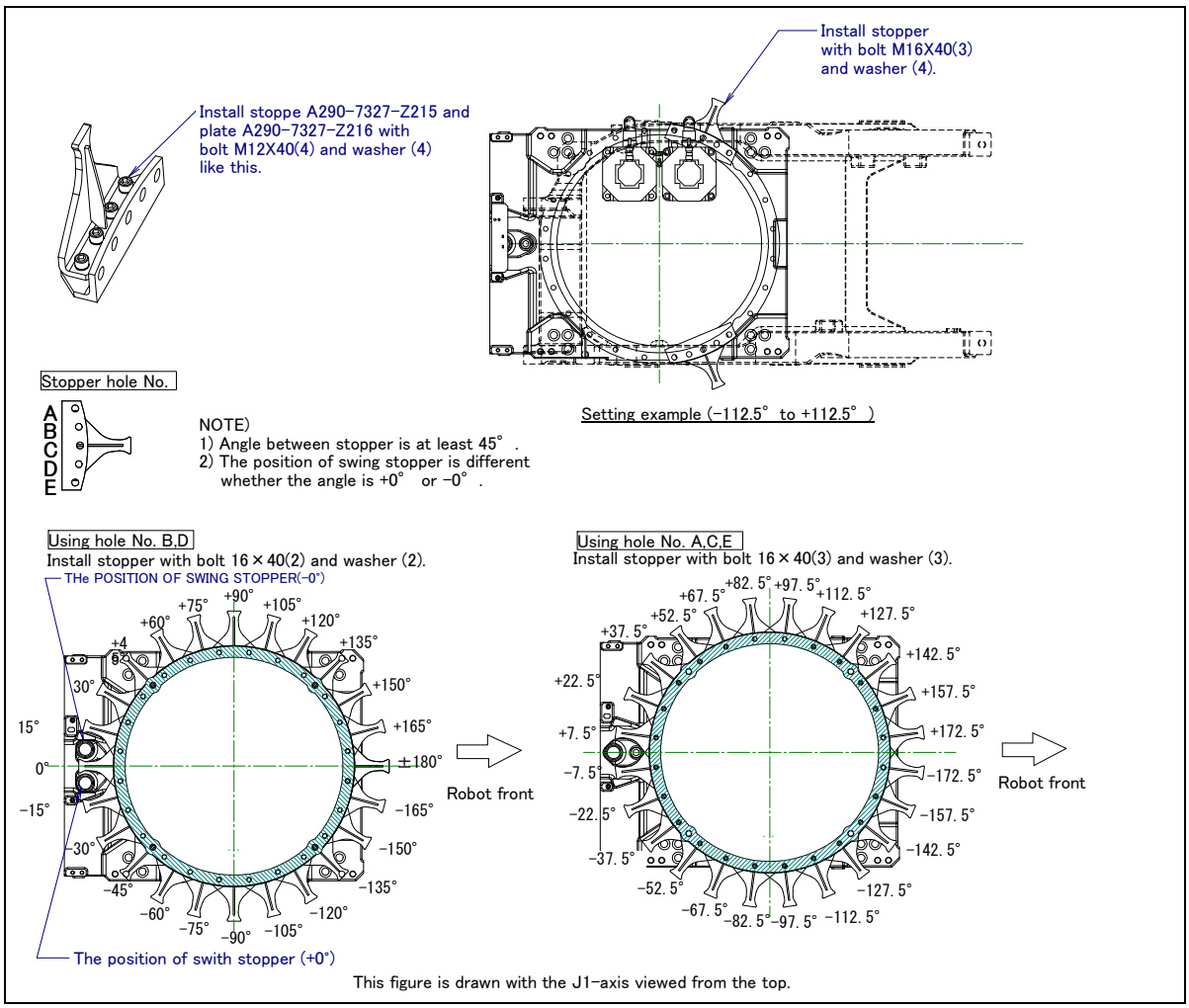


Fig. 6.2 (a) Adjustable mechanical stopper locations of J1-axis (option)

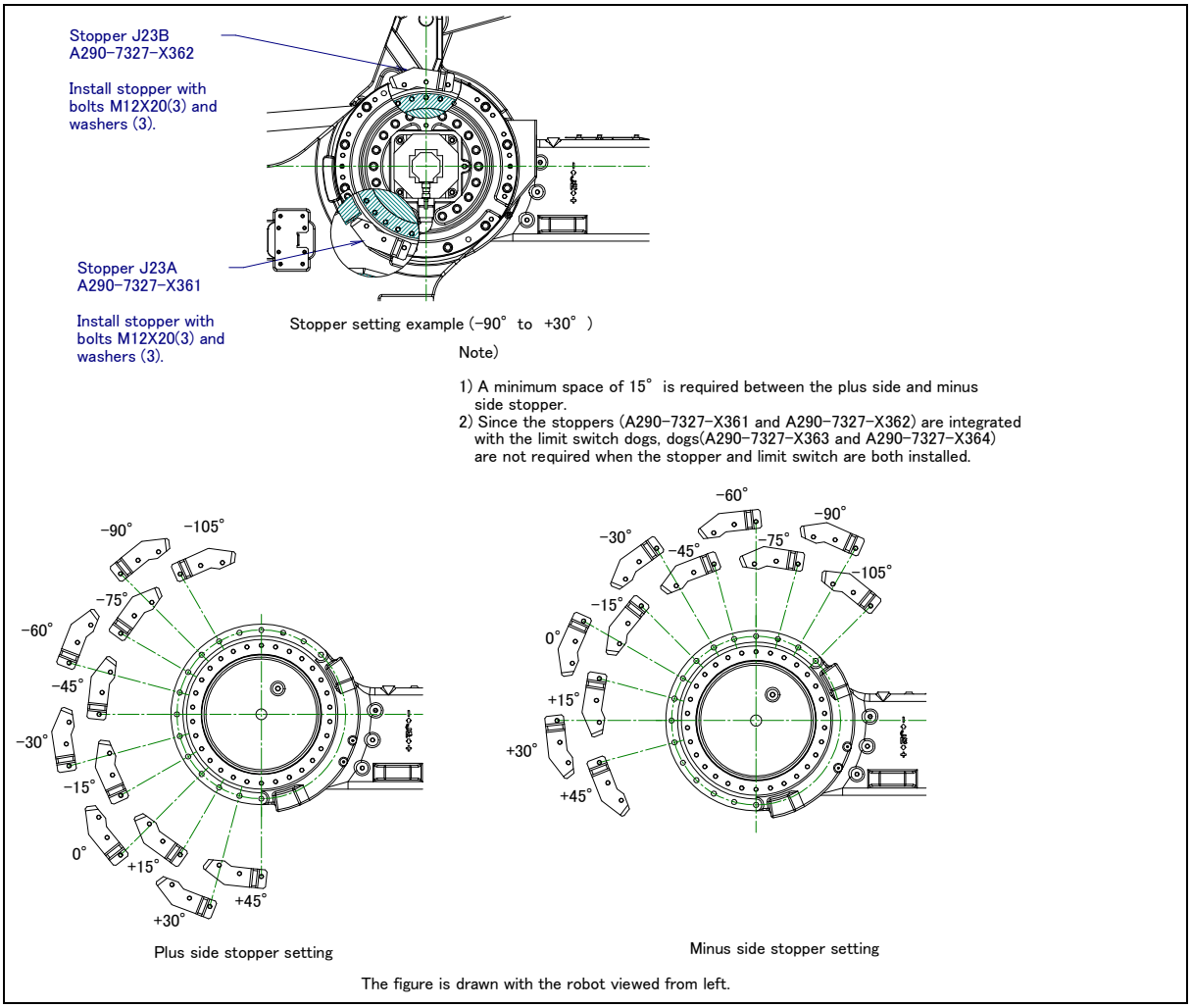


Fig. 6.2 (b) Adjustable mechanical stopper locations of J2-axis (option)

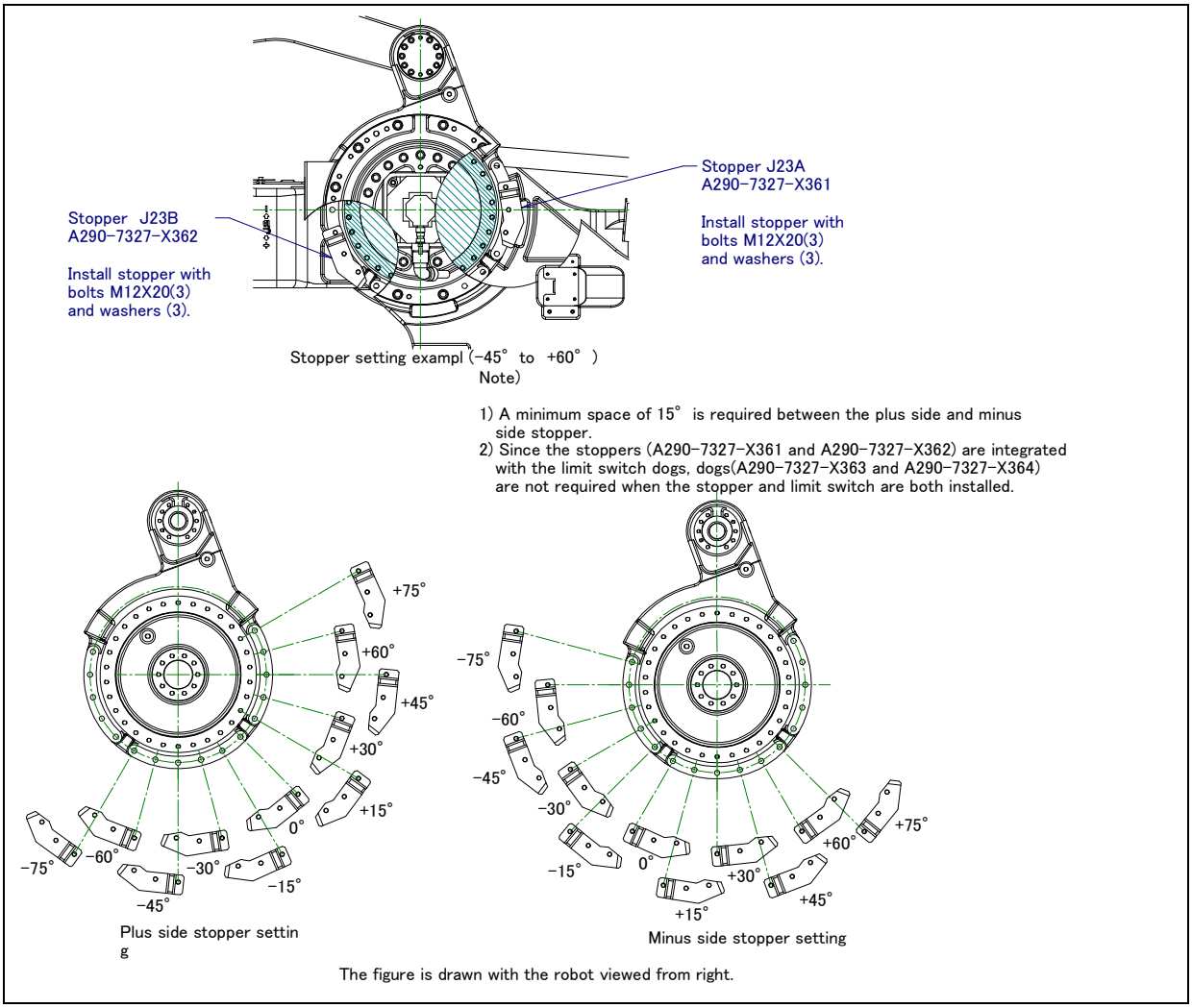
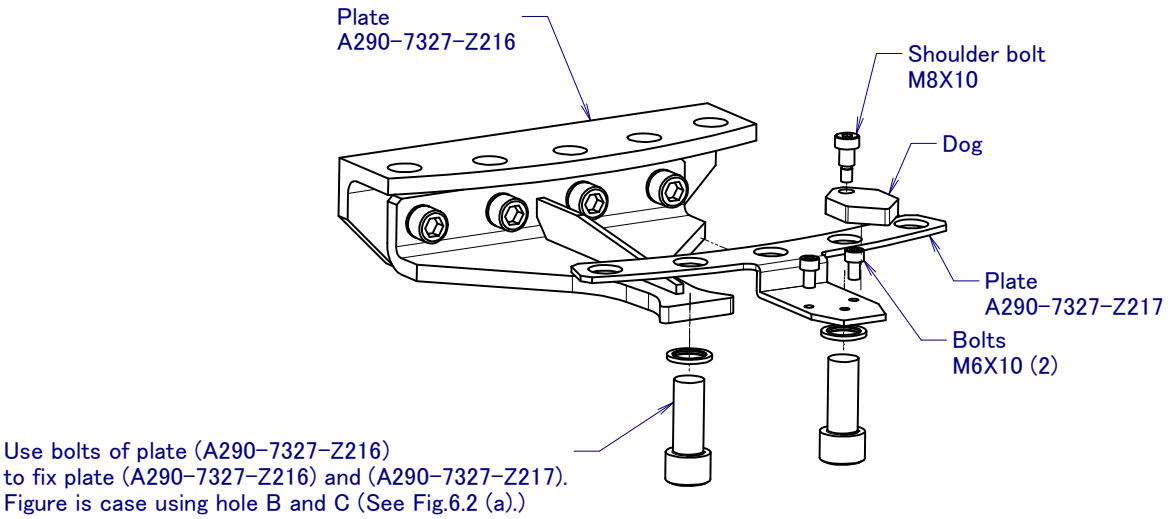


Fig. 6.2 (c) Adjustable mechanical stopper locations of J3-axis (option)

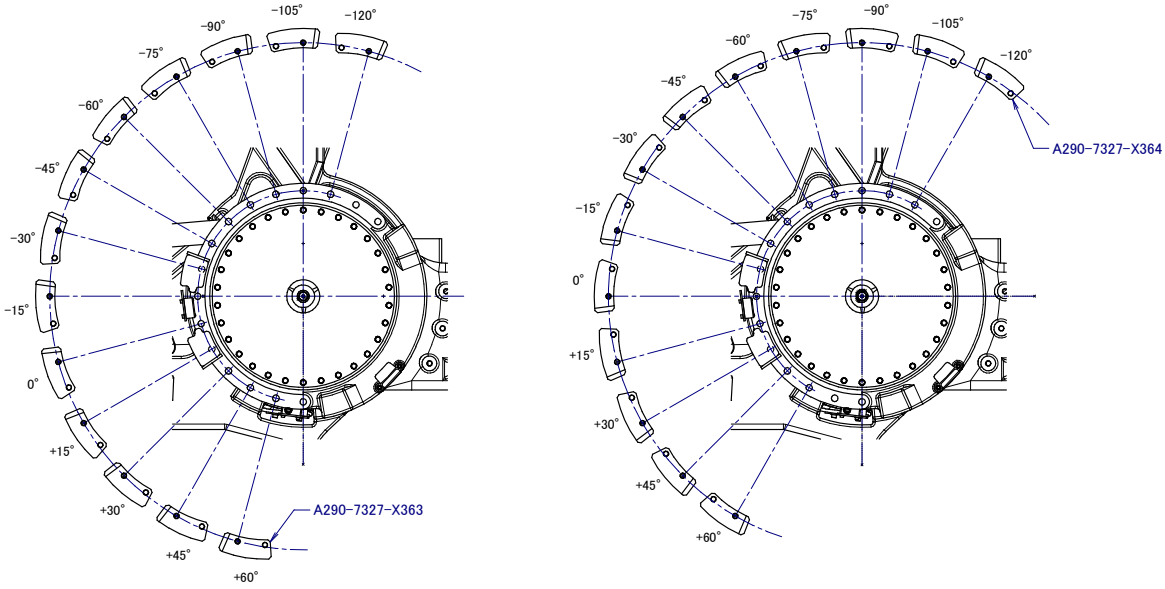
6.3 CHANGING THE MOTION RANGE BY THE LIMIT SWITCH (OPTION)

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



Motion range you can set are same to J1-axis mechanical stopper.
See Fig.6.2 (a).

Fig. 6.3 (a) Dog of J1-axis (Option)



Dog mounting position at plus side

Dog mounting position at minus side

(NOTE)
J2-axis left view
A minimum space of 15° is required between the plus side dog and minus side dog

Fig. 6.3 (b) Dog of J2-axis (Option)

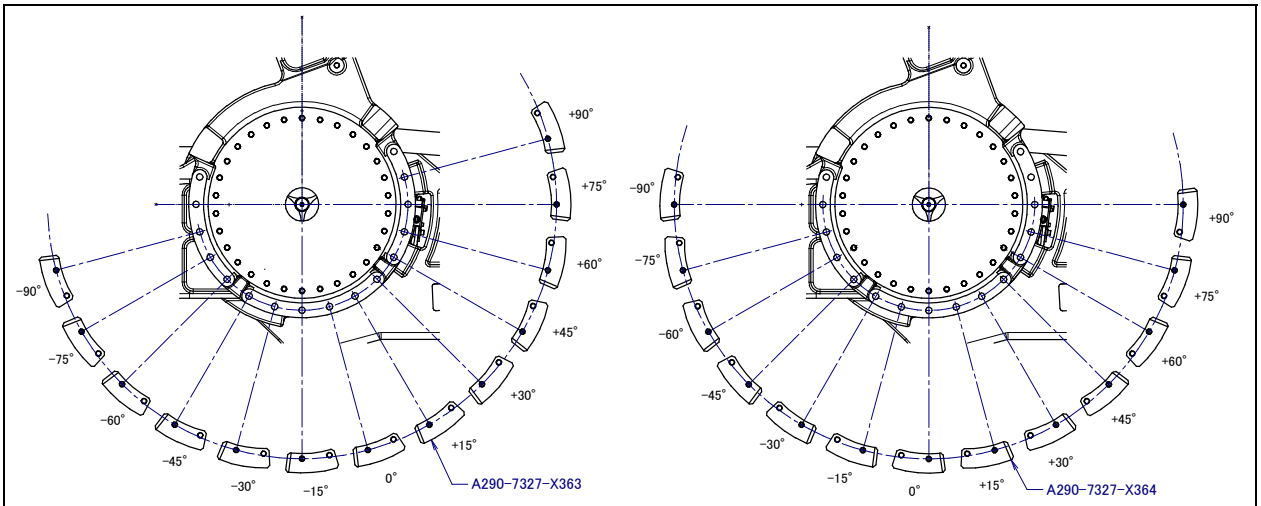


Fig. 6.3 (c) Dog of J3-axis (Option)

6.4 ADJUSTING LIMIT SWITCH (OPTION)

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

ADJUSTING PROCEDURE

1 Set the $MOR_GRP.$CAL_DONE system parameter to FALSE. This disables the motion limit specified by the software. As a result, the operator can rotate the robot by a jog feed which goes beyond the motion limit.

2 Loosen the following bolts.
J1-axis : M8×12 2 pcs M4×25 2 pcs
J2-axis : M12×20 2 pcs M6×10 2 pcs
J3-axis : M12×20 2 pcs M6×10 2 pcs
J2/J3-axis interference angle: : M4×6 4 pcs

3 Move the limit switch so that the robot activates it at about 0.5° before the stroke end. Step on the dog, and position the limit switch in such a place that only one of the step-on allowance indication lines at the tip of the switch is hidden.

4 When the limit switch operates and detects overtravel (OT), the robot stops, and an error message, "OVERTRAVEL", is displayed. To restart the robot, hold on the SHIFT key and press the RESET key. Then, while holding on the SHIFT key, move the adjusting axis off the OT limit switch by jogging in joint mode.

5 Check that the robot also activates the limit switch when the robot is approx. 0.5° from the opposite stroke end in the same way as above. If the limit switch does not operate at the position, adjust the position of the switch again.

6 Set the $MOR_GRP.$CAL_DONE system parameter to TRUE.

7 Turn off the power, then turn it on again to restart the controller.

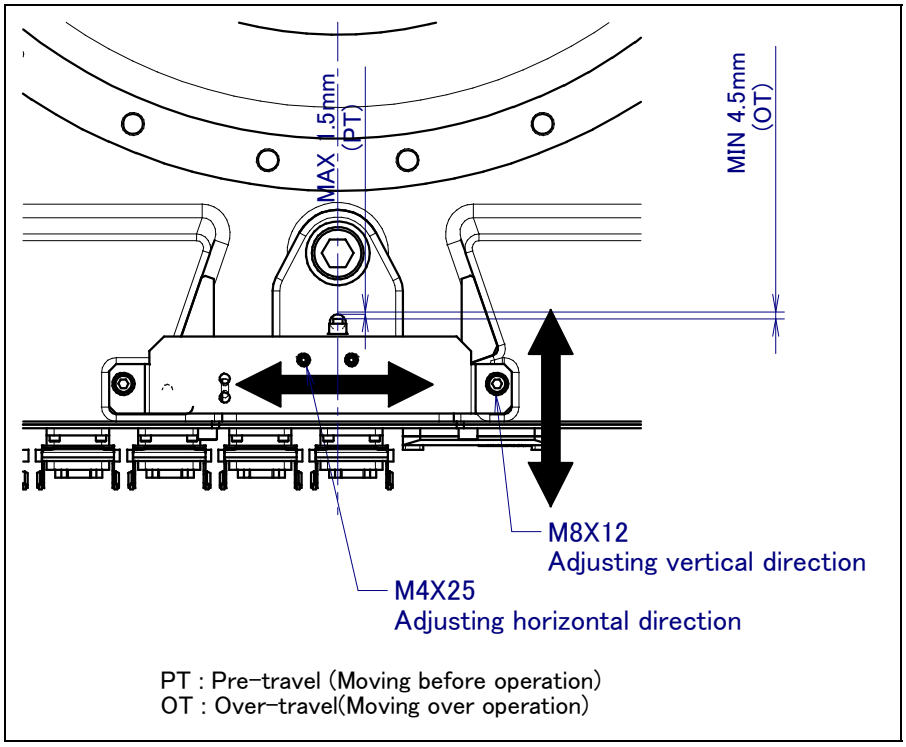


Fig. 6.4 (a) Adjusting J1-axis limit switch (option)

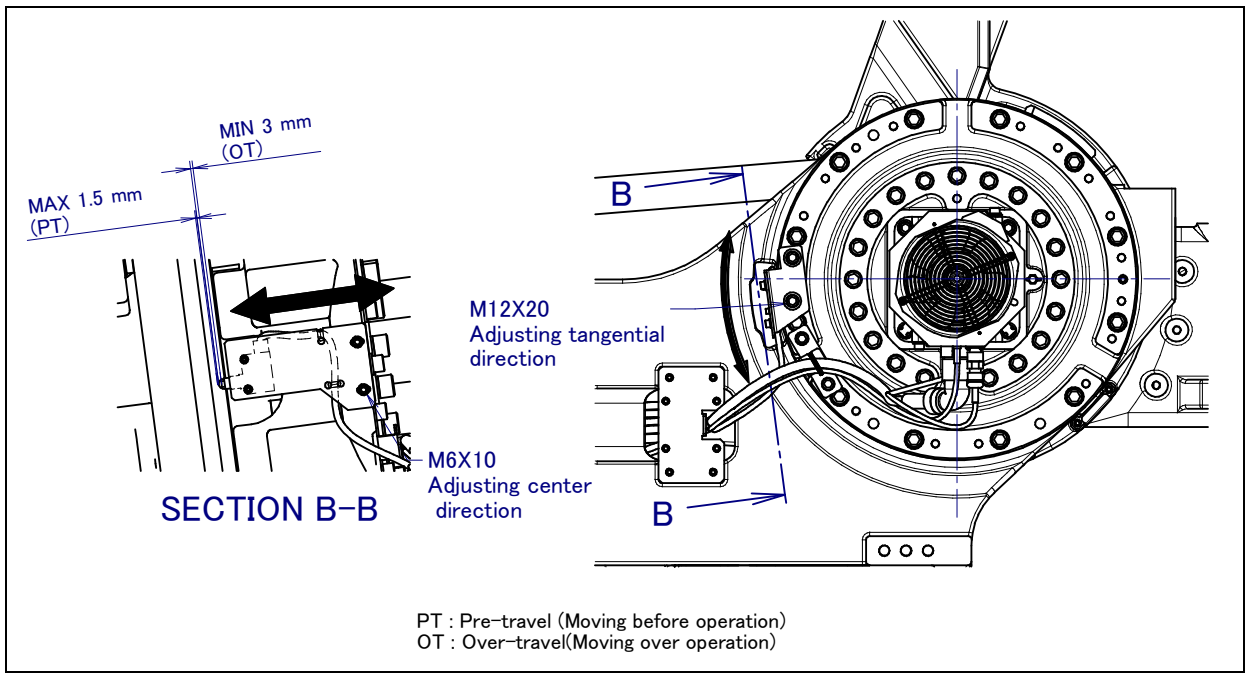


Fig. 6.4 (b) Adjusting J2-axis limit switch (option)

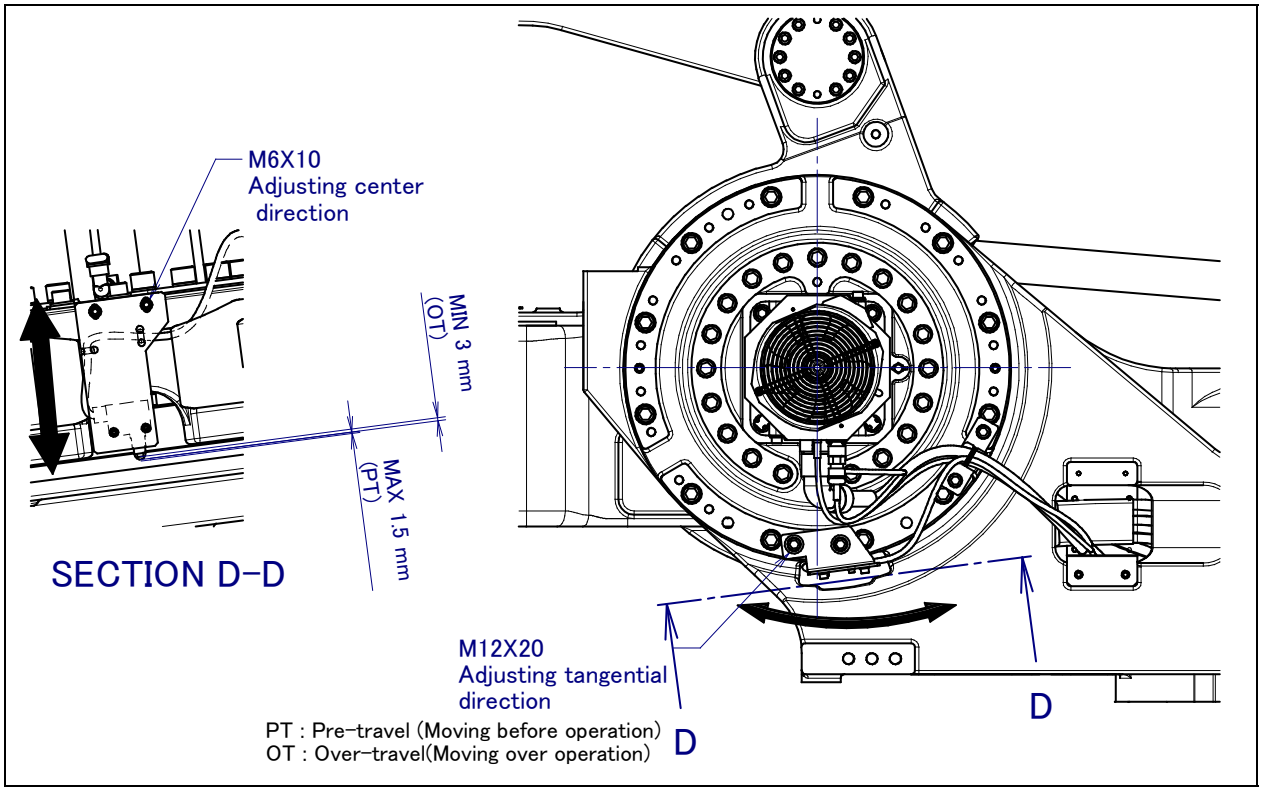


Fig. 6.4 (c) Adjusting J3-axis limit switch (option)

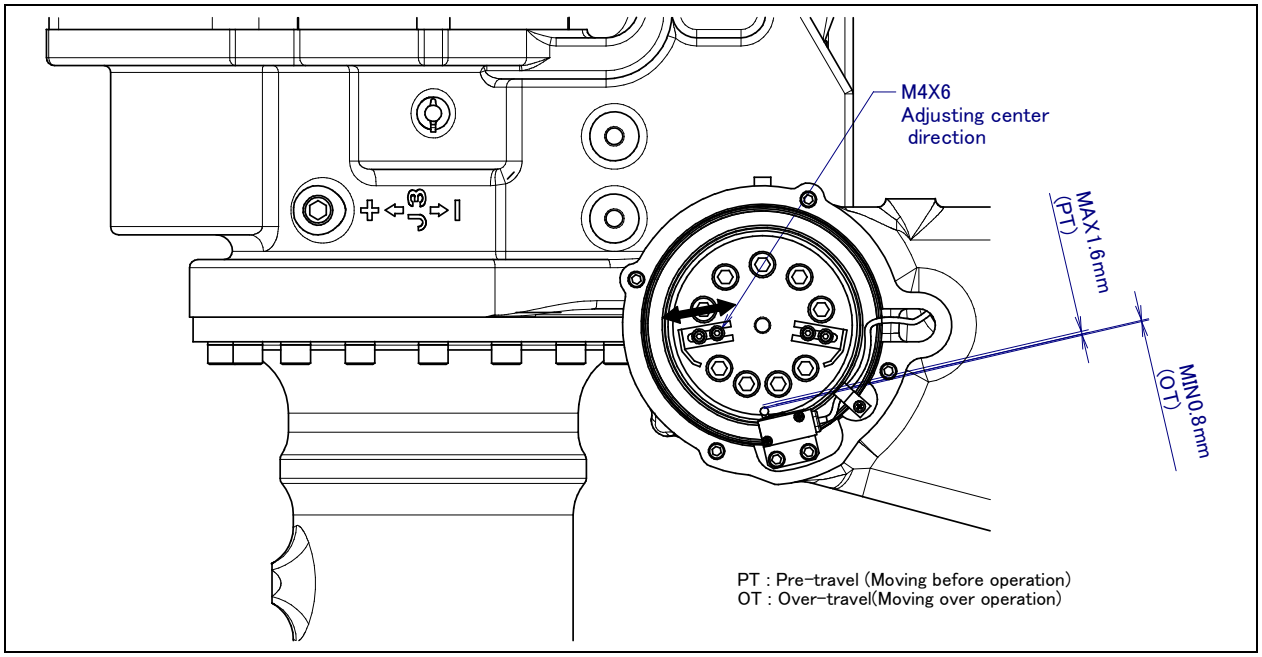


Fig. 6.4 (d) Adjusting J2/J3-axis limit switch (option)

7 CHECKS AND MAINTENANCE

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

NOTE
The periodic maintenance procedures described in this chapter assume that the FANUC robot is used for up to 3840 hours a year. When using the robot beyond this total operating time, correct the maintenance frequencies shown in this chapter by calculation in proportion to the difference between the actual operating time and 3840 hours/year.

7.1 PERIODIC MAINTENANCE

7.1.1 Daily Checks

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

(1) Before turning on power

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

Note 1) About exudation of oil

Check items

- Check there is exudation of oil on sealed part of each joint parts.
- Depending on robot motion, environment condition, etc. some oil exudation may be noticed on the outside of the oil seal lips. Be aware these exudations may accumulate and finally form oil drops, which may get spilt depending on robot motion. Therefore, before starting operation of robot, please wipe off all oil exudation.
- In case of high duty use of the robot, and/or a high temperature installation environment, the internal pressure of the oil bath may rise.
  For these cases please consider relieving the internal pressure, after robot operation, by opening the appropriate oil outlet. When doing so, please be careful to avoid possible oil splattering referring to Subsection 7.2.3 and pay attention grease or oil is not scattered.)

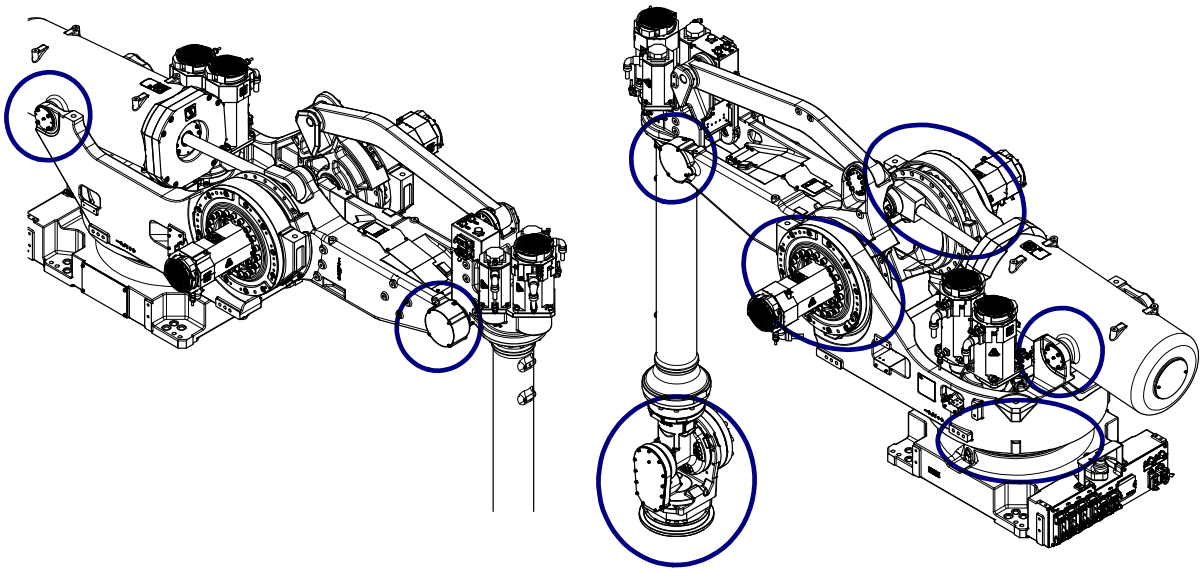


Fig.7.1.1 (a) Check parts of oil exudation

Check items

Wipe off the oil contents of each joint part which has oil seal.

When air control set is combined

Item	Check items	Check points
1	Air pressure	Check air pressure using the pressure gauge on the air regulator as shown in Fig.7.1.1. If it does not meet the specified pressure of 0.49 to 0.69 MPa (5-7 kgf/cm^2), adjust it using the regulator pressure-setting handle.
2	Lubricator oil mist quantity	Check the 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.
3	Lubricator oil level	Check to see that the lubricator level is within the specified level.
4	Leakage from hose	Check the joints, tubes, etc. for leaks. Repair leaks, or replace parts, as required.
5	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.

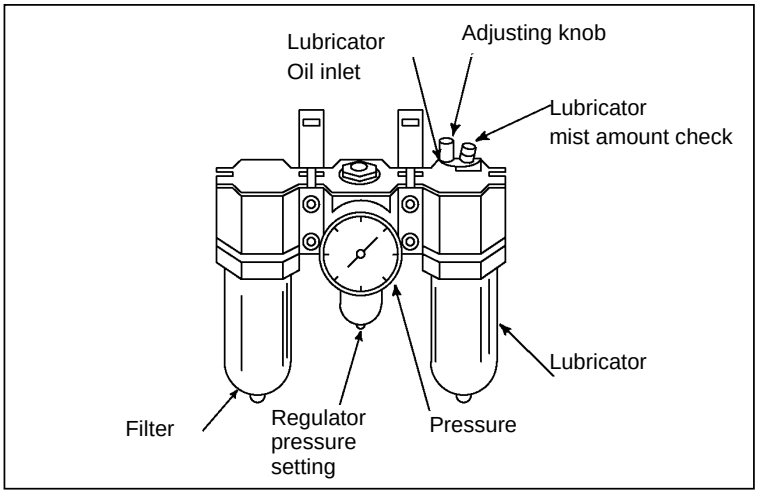


Fig.7.1.1 (b) Air control set

(2) After automatic operation

Item	Check items	Check points
1	Vibration, abnormal noises, and motor heating	Check whether the robot moves along and about the axes smoothly without unusual vibration or sounds. Also, check whether the temperatures of the motors are 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 devices for proper operation	Check whether the peripheral devices 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.

7.1.2 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 Subsection 7.1.4.)

Item	Check items	Check points
1	Controller cable and robot connecting cable	Check whether the cable connected to the teach pendant and robot is unevenly twisted.

7.1.3 First 3-month (960 hours) Checks

Check the following items in the cycle that is shorter among every three months and 960 hours. Additional inspection areas and times should be added to the table according to the robot's working conditions, environment, etc. (See the Subsection 7.1.5.)

Item	Check items	Check points
1	Mechanical unit cable	Check whether the jackets of the mechanical unit cables and welding 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. (NOTE1)
2	Retightening external main bolts	Retighten the end-effecter mounting bolts and external main bolts. (NOTE2)
3	Check the mechanical stopper and adjustable mechanical stopper	Check the looseness of mounting bolts of mechanical stopper and adjustable mechanical stopper. Particular, check swing stopper of J1-axis rotates smoothly (NOTE3)
4	Cleaning and checking each part	Clean each part (remove chips, etc.) and check component parts for cracks and flaws. (NOTE4)
5	Check the end effector (hand) cable	Confirm whether there is wound in the cable
6	Check the fan	Confirm whether the fan operates normally.
7	Check the teach pendant cable, operation box connecting cable and robot connecting cable.	Check whether the cable connected to the teach pendant operation box 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

Fixed part cables likely to interfere with the J1, J2, and J3 movable parts and peripheral devices For the J1-axis, inspect the cables from the side by removing the metal plate on the side of the J1 base.

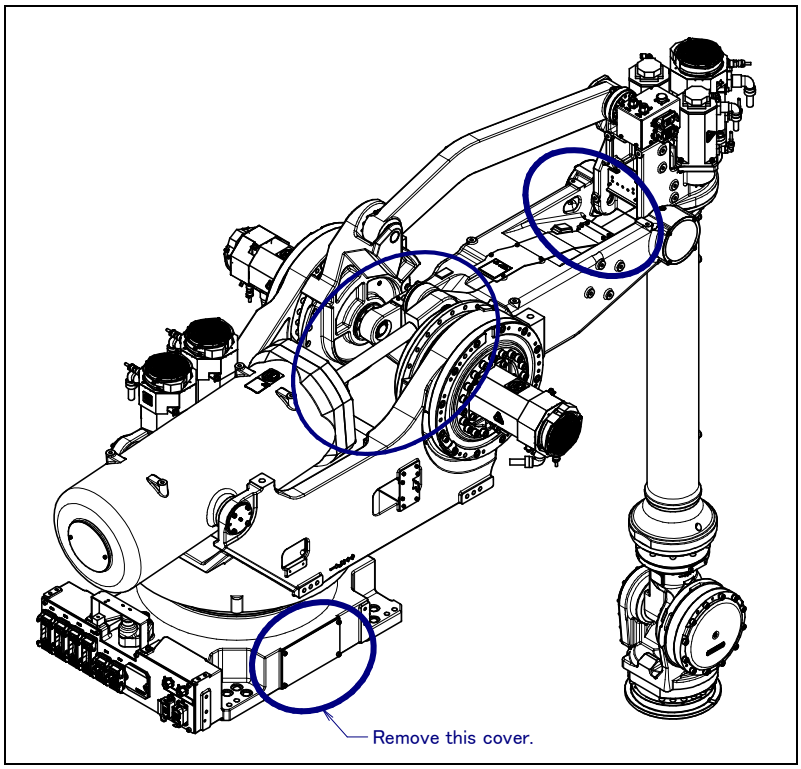


Fig. 7.1.3 (a) Check items of mechanical unit cable

Check items

For cables with a cable protection sheet, open the cable protection sheet before making the check. Check the cables for a sheath break and wear.
If wires of the cable appear, replace it.

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 connector for looseness.

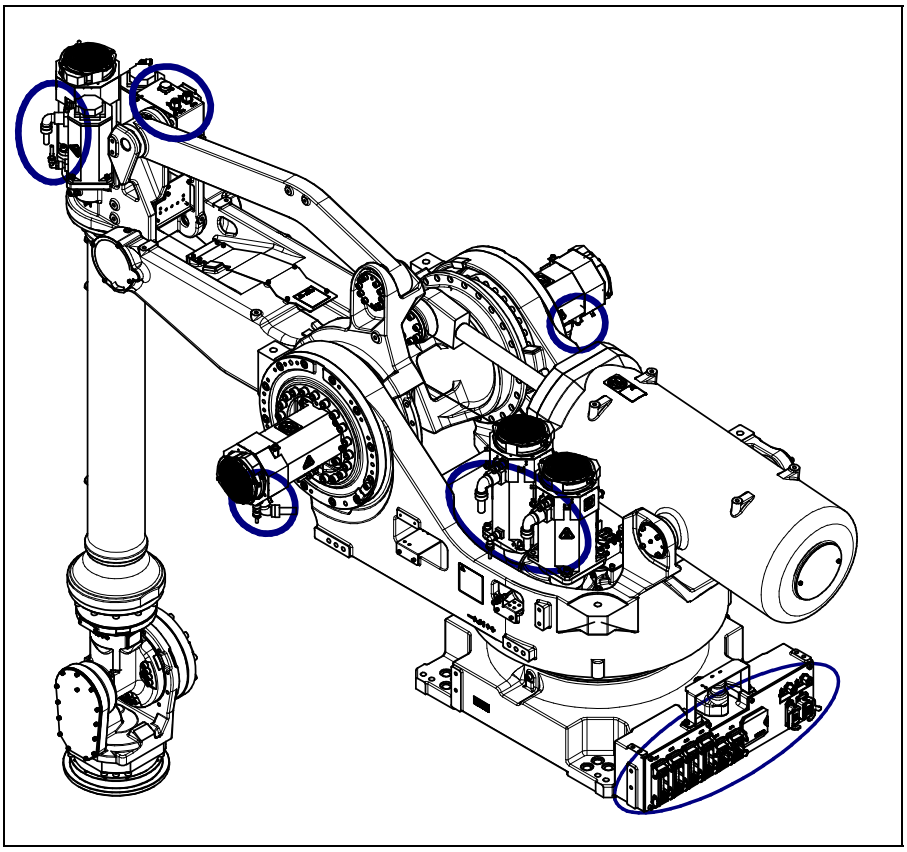


Fig. 7.1.3 (b) Check items of connector

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) Check of mechanical stopper and adjustable mechanical stopper.

- Check the looseness of stopper mounting bolts. If they are loose, they are needed to be retightened. Especially, check the looseness of mounting bolts of J1-axis swing stopper.
- Check that J1-axis swing stopper rotates smoothly.

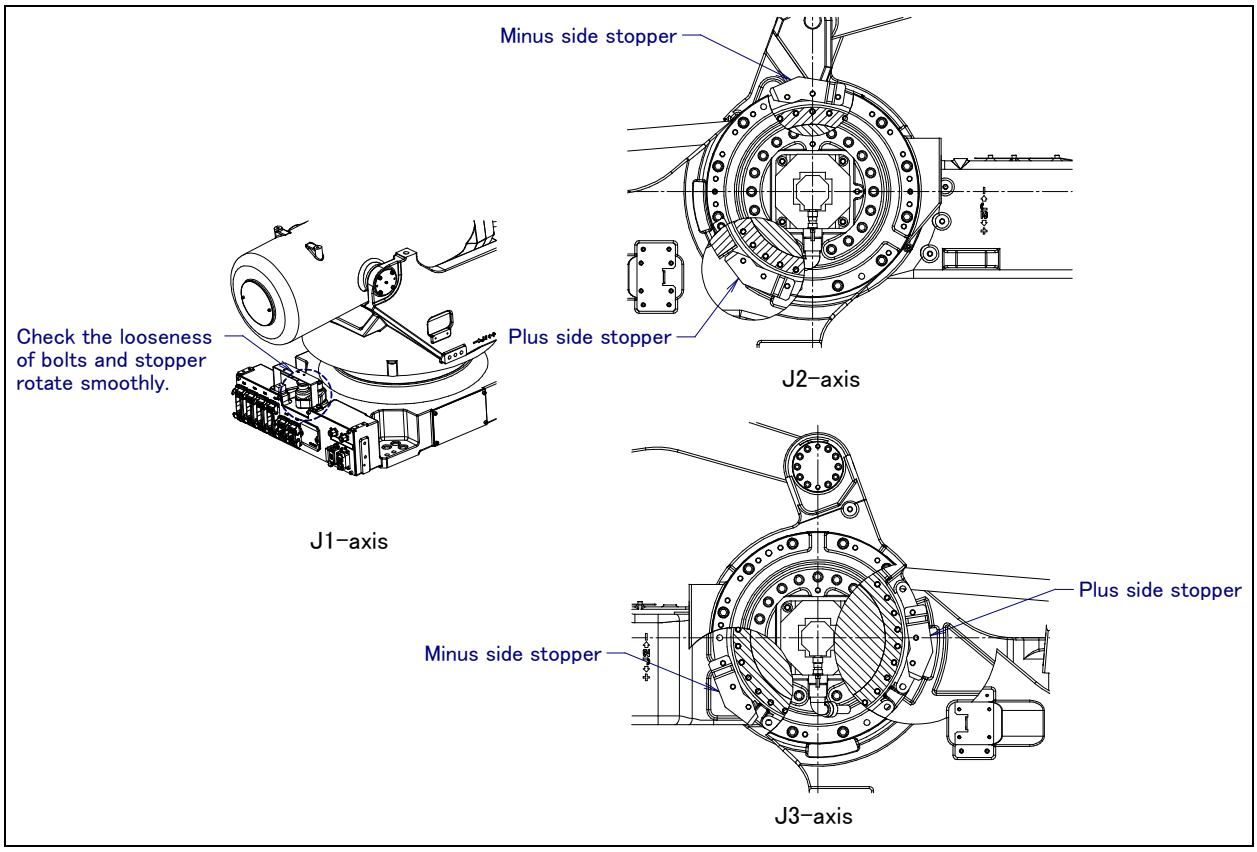


Fig. 7.1.3 (c) Check of mechanical stopper and adjustable mechanical stopper

NOTE 4) Cleaning

Necessary cleaning points, dust on the flat part, sedimentation of spatters

Clean sediments periodically.
In particular, clean the following points carefully.

1. Vicinity of the balancer rod and shaft

→ If chippings or spatters are attached to the bushing, abnormal wear may be caused.

2. Vicinity of the wrist axis and oil seal

→ If chippings or spatters are attached to the oil seal, an oil leak may be caused.

- Check if the vicinity of the necessary inspection points, wrist part, and J3 arm significantly wears due to rubbing against the welding cable or hand cable.
- Check if there is a trace of a collision around the gun or hand.
- Check the reducer or grease bath for an oil leak. If oil can be found a day after wiping oil, an oil leak may be caused.

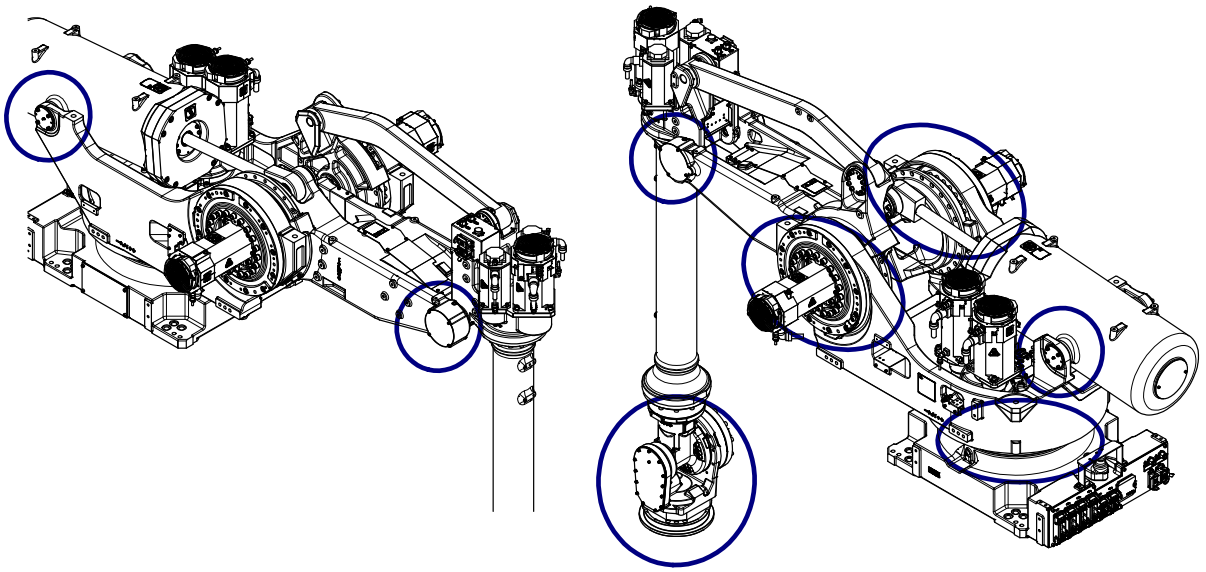


Fig. 7.1.3 (d) Cleaning part

7.1.4 3-month (960 hours) Checks

Check the following items in the cycle that is shorter between every three months and 960 hours of operating. Additional inspection areas and times should be added to the table according to the robot's working conditions, environment, etc.

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

7.1.5 1-year (3,840 hours) Checks

Check the following items in the cycle that is shorter among every year and 3,840 hours.

Item	Check items	Check points
1	Greasing balancer bushing	(See Section 7.2.1.)
2	Mechanical unit cable	(See Section 7.1.3.)
3	Retighten of major external bolts	(See Section 7.1.3.)
4	Check the mechanical stopper and adjustable mechanical stopper	(See Section 7.1.3.)
5	Cleaning and checking each part	(See Section 7.1.3.)
6	Check the end effector (hand) cable	(See Section 7.1.3.)
7	Check the fan	(See Section 7.1.3.)
8	Replacing grease of each axis reducer and gearbox	Replace grease of reducer. (See Section 7.2.3.)
9	Greasing the J2/J3-axis connection taper roller	(See Section 7.2.1.)
10	Check the teach pendant cable, operation box connecting cable and robot connecting cable.	(See Section 7.1.3.)

7.1.6 1.5-year (5,760 hours) Checks

Check the following items in the cycle that is shorter among every 1.5 years and 5,760 hours.

Item	Check items	Check points
1	Battery	Replace battery in the mechanical unit. Refer to Section 7.2.2

7.1.7 2-year (7,680 hours) Checks

Check the following items once every 2 years (7,680 hours).

Item	Check items	Check points
1	Replace the mechanical unit cable	Contact FANUC about replacing method

7.2 MAINTENANCE

7.2.1 Greasing the Balancer Bush and J2/J3-axis Connection Taper Roller (1 year (3840 hours) periodic maintenance)

Be sure to grease the balancer bush and J2/J3-axis connection taper roller at specified intervals as shown in Tables 7.2.1 (a) and 7.2.1 (b). When the installation environment of the robot is bad, however, greasing needs to be made as appropriate. If water splashes on the robot, supply grease immediately. Fig. 7.2.1 (a),(b) show the greasing points.

Table 7.2.1 (a) Greasing the balancer bush

Greasing points	Recommended grease	Amount of grease	Greasing interval
Balancer bush	Showa Shell Sekiyu K. K. Shell Alvania grease S2 Specification: A97L-0001-0179#2	each 10ml (2 locations)	interval that is shorter among 1 year and every 3840 hours of accumulated operation
J2/J3-axis connection taper roller		each 20 ml (2 location	

Table 7.2.1 (b) Grease alternative to Shell Alvania GREASE S2

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

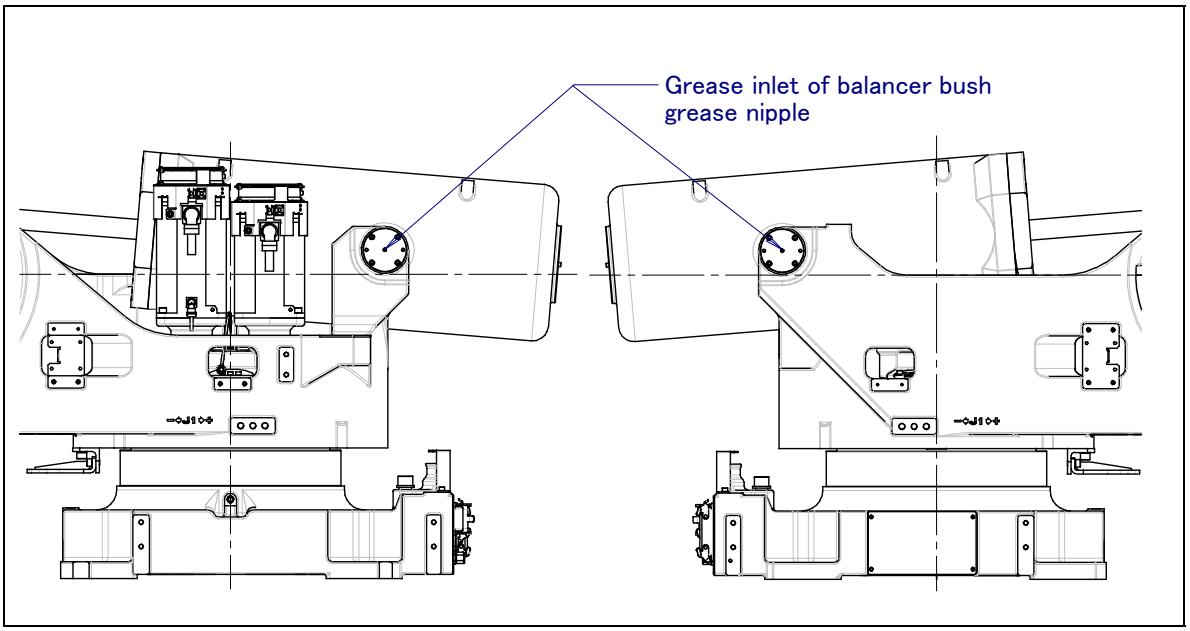


Fig. 7.2.1 (a) Balancer bush greasing points

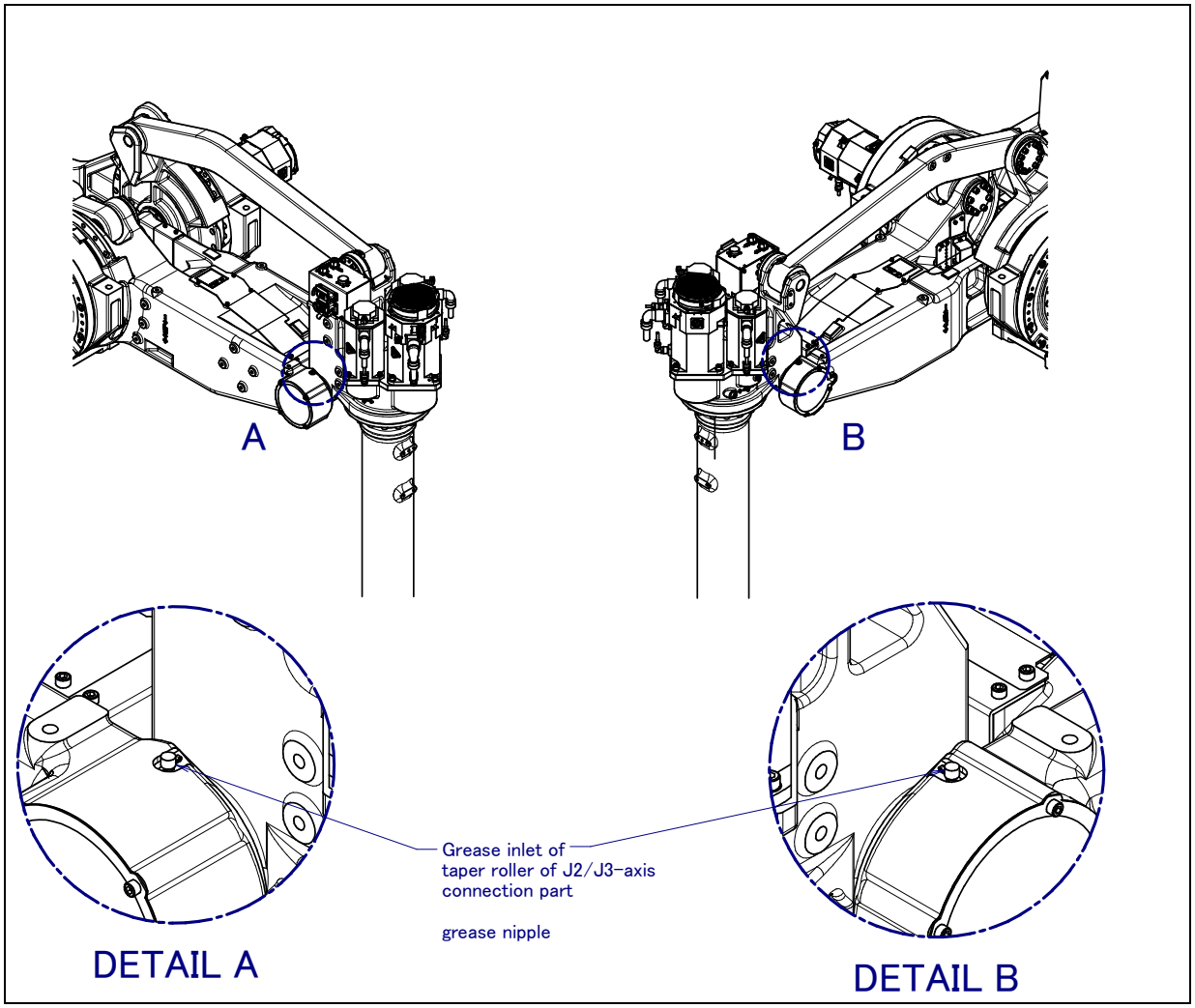


Fig. 7.2.1 (b) J2/J3-axis connection taper roller greasing points

7.2.2 Replacing the Batteries (1.5 year checks)

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

Procedure of replacing the battery

1 Keep the power on. Press the EMERGENCY STOP button to prohibit the robot motion.

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

2 Remove the battery case cap. (Fig. 7.2.2)
3 Take out the old batteries from the battery case.
4 Insert new batteries into the battery case. Pay attention to the direction of batteries.
5 Close the battery case cap.

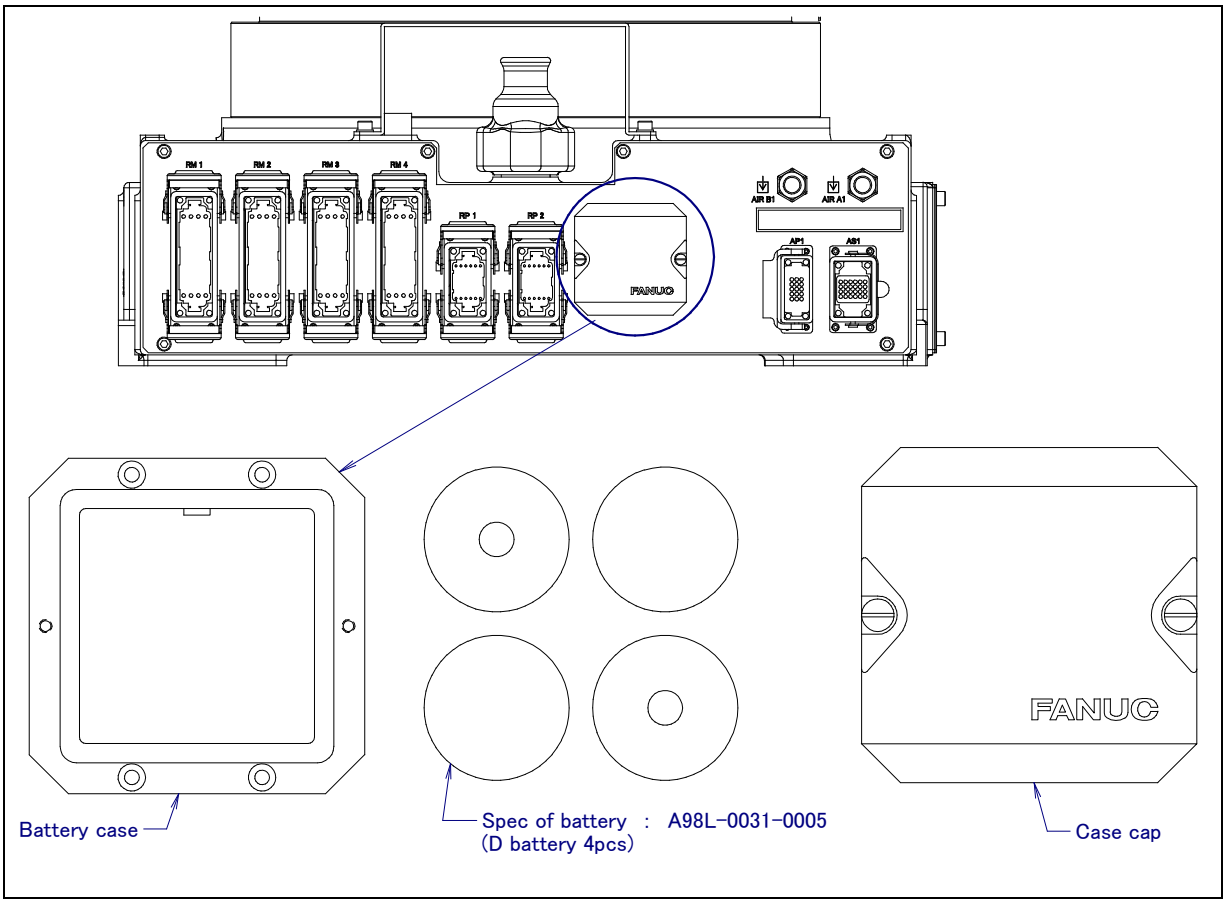


Fig. 7.2.2 Replacing the battery

7.2.3 Replacing the Grease of the Drive Mechanism (1 years (3,840 hours) checks)

Replace the grease of the reducers of J1, J2, and J3 axes, the J4-axis gearbox, and the wrist in the cycle that is shorter among every year and 3,840 hours of operating, by using the following procedures.
See table 7.2.3 (a) for the grease name and the quantity.

Table 7.2.3 (a) Grease name and amount to be replaced at regular intervals of 1 year (3,840 hours)

Greasing points	Amount of grease to be applied	Gun tip pressure	Specified grease
J1-axis reducer	10000g (11000ml)	0.15MPa or less (NOTE)	Kyodo Yushi VIGOGREASE RE0 (Specification: A98L-0040-0174)
J2-axis reducer	2500g (2900ml)		
J3-axis reducer	2300g (2600ml)		
J4-axis gearbox	2100g (2400ml)		
wrist 1	3000g (3300ml)		
wrist 2	1700g (1900ml)		

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

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

Table 7.2.3 (b) Postures for greasing

Supply position	Posture					
	J1	J2	J3	J4	J5	J6
J1-axis reducer	Arbitrary	Arbitrary	Arbitrary	Arbitrary	Arbitrary	Arbitrary
J2-axis reducer		-90°				
J3-axis reducer		-90°	90°			
J4-axis gearbox		Arbitrary	90°			
Wrist			90°	0°	0°	0°

⚠ CAUTION
If greasing is performed incorrectly, the internal pressure of the grease bath may suddenly increase, possibly causing damage to the seal, which would in turn lead to grease leakage and abnormal operation. When performing greasing, therefore, observe the following cautions.

1 Before starting to grease, open the grease outlet (remove the plug or seal bolt from the grease outlet).
2 Supply grease slowly, using a manual pump.
3 Whenever possible, avoid using an air pump, which is powered by the factory air supply.
If the use of an air pump is unavoidable, supply grease with the pump at a pressure lower than or equal to the gun tip pressure (see Table 7.2.3 (a)).
4 Use grease only of the specified type. Grease of a type other than that specified may damage the reducer or lead to other problems.
5 After greasing, release remaining pressure from the grease bath using the procedure given in Section 7.2.3.3, and then close the grease outlet.
6 To prevent accidents caused by slipping, completely remove any excess grease from the floor or robot.

7.2.3.1 Grease replacement procedure for J1 to J3-axis reducer and J4-axis gearbox

1 Move the robot to the greasing posture described in Table 7.2.3 (b).
2 Turn off the power.
3 Remove the grease outlet.
(In case of J4-axis and J4-axis, seal bolt ,In case of J2-axis and J3-axis, taper plug with sealant)

4 Keep greasing until the new grease pushes out the old grease and comes out from each grease outlet.
5 Release remaining pressure using the procedure given in Section 7.2.3.3.

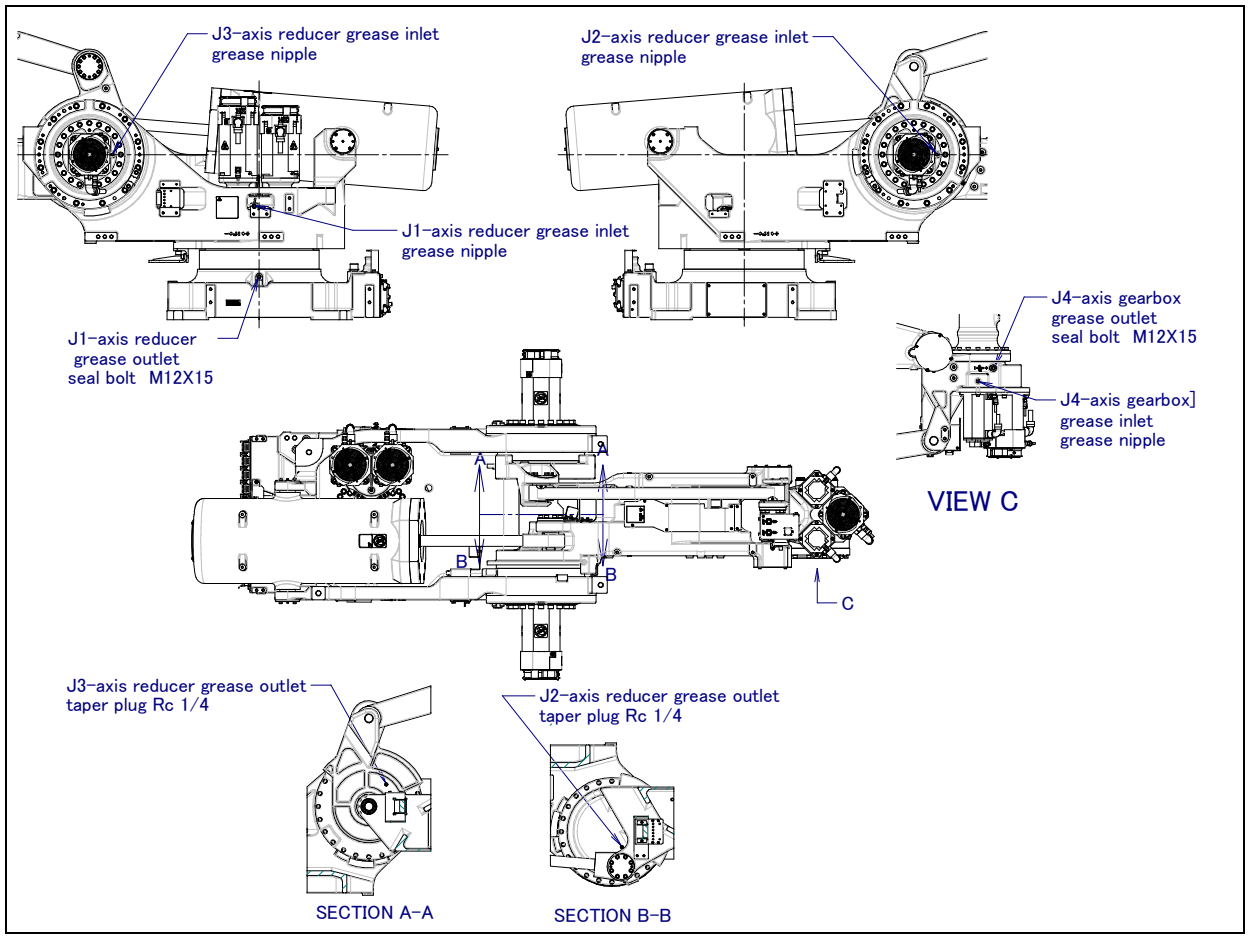


Fig.7.2.3.1 Replacing grease of J1 to J3-axis reducer and J4-axis gearbox

7.2.3.2 Grease replacement procedure for wrist

1 Move the robot to the greasing posture described in table 7.2.3 (b).
2 Turn off the power.
3 Remove the taper plug of wrist grease outlet 1 (Fig. 7.2.3.2) .
4 Supply grease to the wrist grease inlet until new grease outputs from wrist outlet 1.
5 Attach the taper plug to wrist grease outlet 1.
6 Next, remove the taper plug of wrist grease outlet 2.
7 Supply new grease through the wrist grease inlet until new grease is output from wrist grease outlet 2.
8 Release remaining pressure using the procedure given in Section 7.2.3.3.

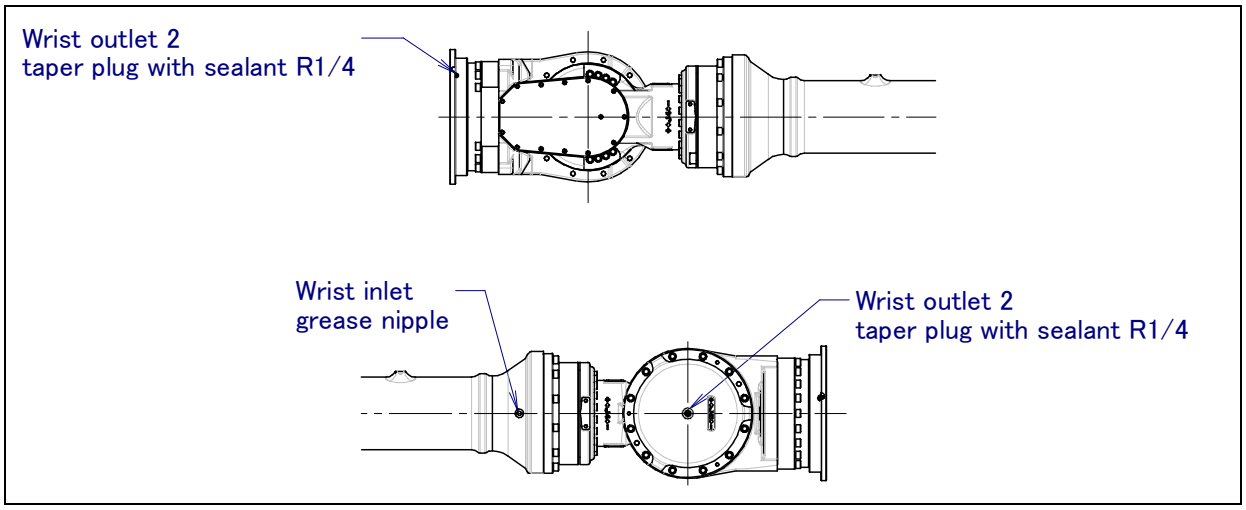


Fig. 7.2.3.2 Replacing grease of the wrist

7.2.3.3 Procedure for releasing remaining pressure from the grease bath

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

Grease replacement position	Motion angle	OVR	Operating time	Open point
J1-axis reducer	80° or more	50%	20 minutes	A
J2-axis reducer	90° or more	50%	20 minutes	A
J3-axis reducer	70° or more	50%	20 minutes	A
J4-axis gearbox	J4 : 60° or more J5 : 110° or more J6 : 60° or more	100%	20 minutes	B
Wrist	J4 : 60° or more J5 : 110° or more J6 : 60° or more	100%	10 minutes	C

In the case of A
Open the grease inlets and outlets and perform running.

In the case of B
Open the grease outlets only and perform running.

In the case of C
Open all of the grease inlets and outlets shown below and perform running.

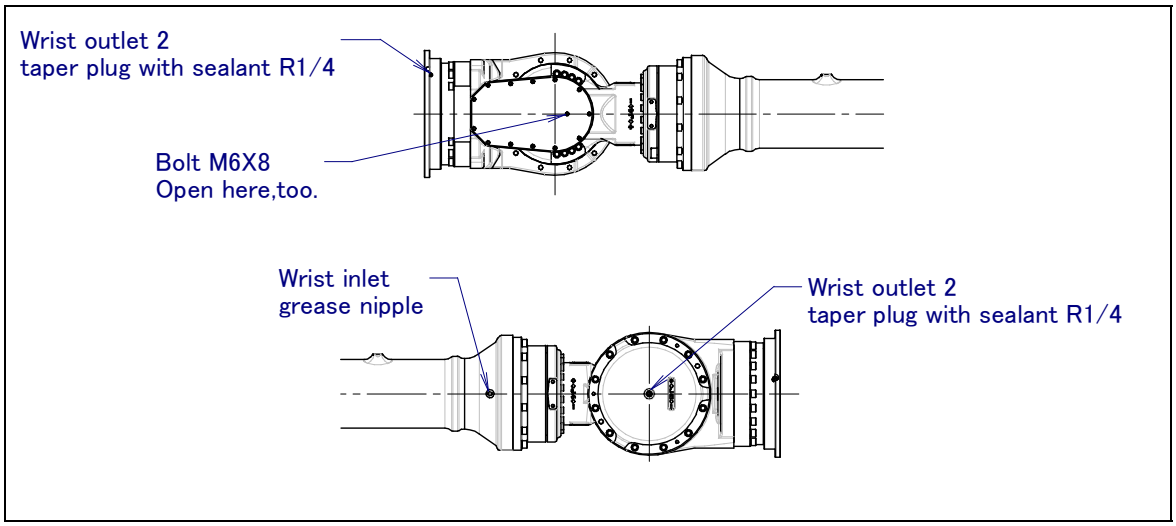


Fig. 7.2.3.3 Open points for releasing remaining pressure from the wrist

If the above operation cannot be performed due to the environment of the robot, prolong the operating time so that an equivalent operation can be performed. (If only half of the predetermined motion angle can be set, perform an operation for a period of time twice as long as the specified time.) After completion of the operation, attach the seal bolts or taper plug and grease nipples to the grease inlets and outlets. When reusing the seal bolts and grease nipples, be sure to seal them with seal tape.

7.3 STORAGE

To store the robot, set it to the same posture as that used for transportation. (See Section 1.1.)

8 MASTERING

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

8.1 GENERAL

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

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

> ⚠ **CAUTION**
> Robot data (including mastering data) and pulsecoder data are backed up by their respective backup batteries. Data will be lost if the batteries go dead. Replace the batteries in the control and mechanical units periodically. An alarm will be issued to warn the user of a low battery voltage.

Types of Mastering

There are five methods of the following mastering.

Table 8.1 Type of mastering

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

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

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

> ⚠ **CAUTION**
> If mastering is performed incorrectly, the robot may behave unexpectedly. This is very dangerous. So, 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.

> ⚠ **CAUTION**
> It is recommended that the current mastering data be backed up before mastering is performed. Use mastering data of without additional axis to with additional axis and opposite can not be done.

8.2 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

Step

1 Display the positioning menu by following steps 1 to 6.
   1 Press the screen selection 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] again, 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 the screen selection 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 [TRUE].
   5 Turn off the controller power and on again.

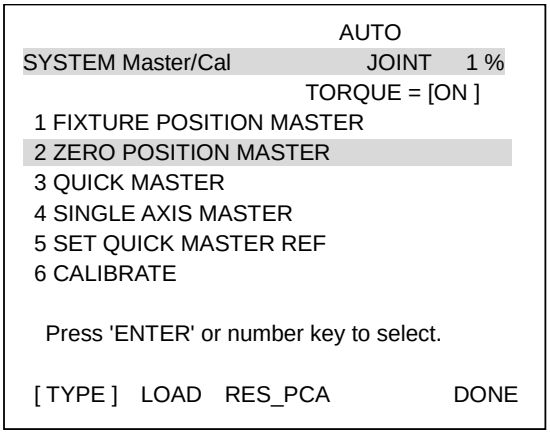
3 To reset the "Servo 075 Pulse not established" alarm, follow steps 1 to 3.
   1 When the controller power is switched on again, the message "Servo 075 Pulse mismatch" appears again.
   2 Move the axis for which the message mentioned above has appeared till alarm disappears when press [FAULT RESET]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

8.3 ZERO POSITION MASTERING

Zero-position mastering (witness mark mastering) is performed with all axes set at the 0-degree position. A zero-position mark (witness mark) is attached to each robot axis.(Fig.8.3) This mastering is performed with all axes set at the 0-degree position using their respective witness marks.
Zero-position mastering involves a visual check. It cannot be so accurate. It should be used only as a quick-fix method.

Procedure of Mastering

1. Press MENUS.
2. Select NEXT and press SYSTEM.
3. Press F1, [TYPE].
4. Select Master/Cal.

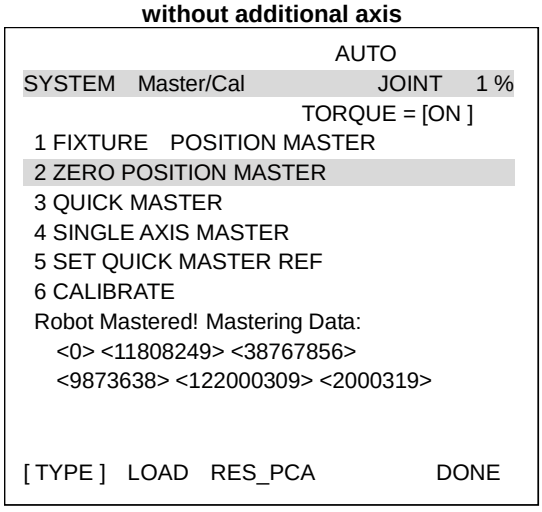


5. Release brake control, and jog the robot into a posture for mastering.

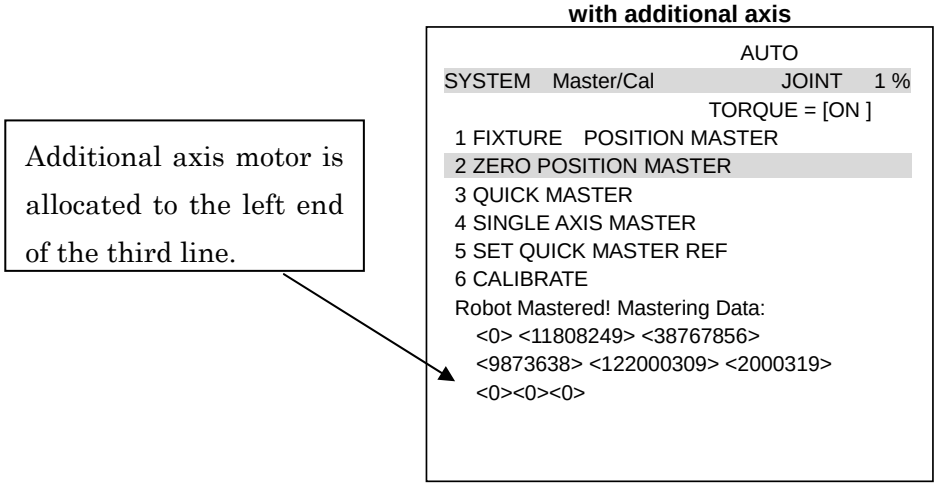
NOTE
Brake control can be released by setting the system variables as follows:
$PARAM_GROUP.SV_OFF_ALL: FALSE
$PARAM_GROUP.SV_OFF_ENB[*]: FALSE (for all axes)
After changing the system variables, turn off the controller power and on again.

6. Select Zero Position Master.

without additional axis

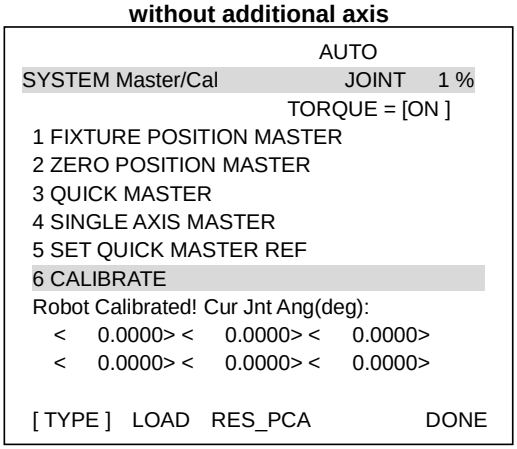


with additional axis

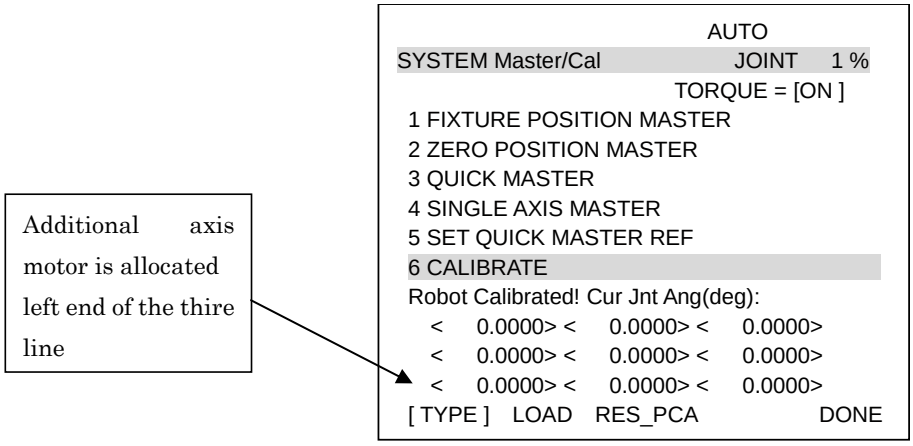


7. Press F4, YES. Mastering will be performed automatically. Alternatively, turn off the controller power and on again. Turning on the controller power always causes positioning to be performed.

without additional axis



with additional axis



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

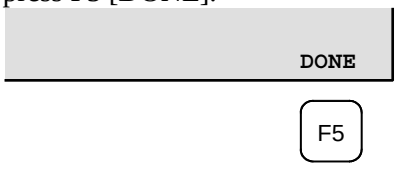


Table 8.3 Posture with position marks aligned

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

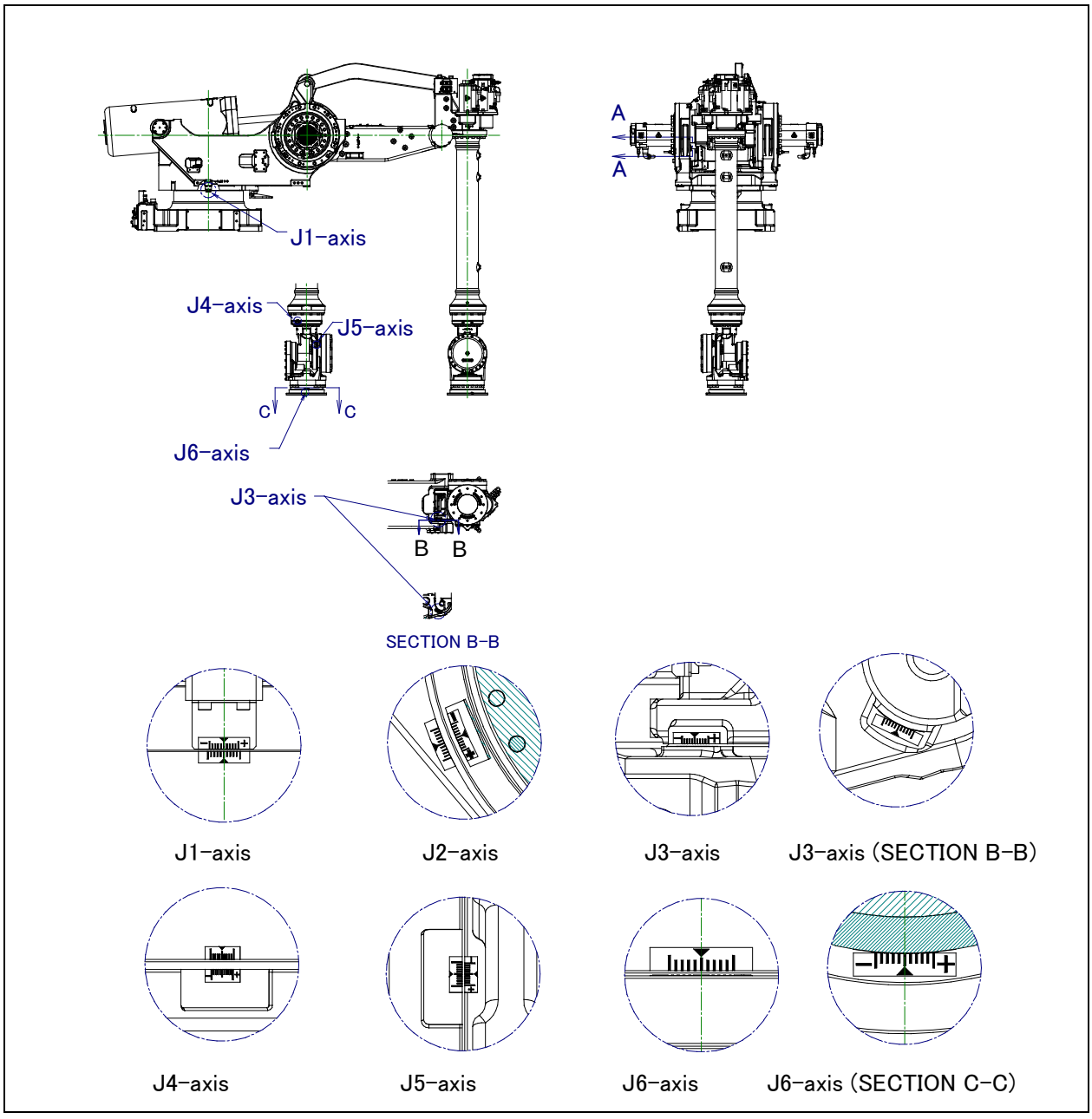


Fig. 8.3 Witness mark position (Example of vernier mark)

8.4 QUICK MASTERING

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

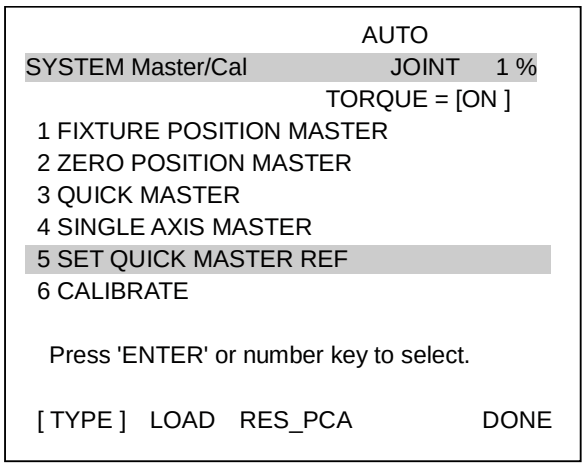
Quick mastering is factory-performed at the position indicated in Table 8.3. Do not change the setting unless there is any problem.

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.)

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

Procedure Recording the Quick Master Reference Position

1 Select SYSTEM.
2 Select Master/Cal.

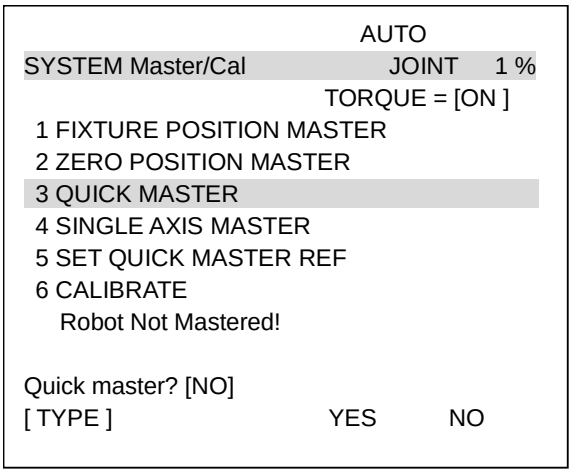


3 Release brake control, and jog the robot to the quick mastering reference position.
4 Set quick master ref? [NO] Move the cursor to SET QUICK MASTER REF and press ENTER. Press F4, YES.

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

Procedure of Quick Mastering

1 Display the Master/Cal screen.



2 Release brake control, and jog the robot to the quick mastering reference position.
3 Quick master? [NO] Move the cursor to QUICK MASTER and press ENTER. Press F4, YES. Quick mastering data is memorized.

```
Quick master? [NO]
```

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.

8.5 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 case of M-900*i*A/200P, please note that an axis to which the TP screen is displayed and an actual axis are different.
Be sure to perform mastering of J1-axis motor A and J1-axis motor B at the same time.

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

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

In case of with additional axis, the motor is allocated as follows.

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

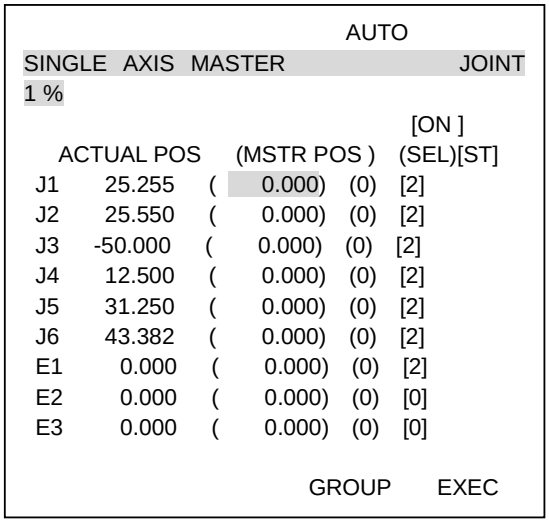
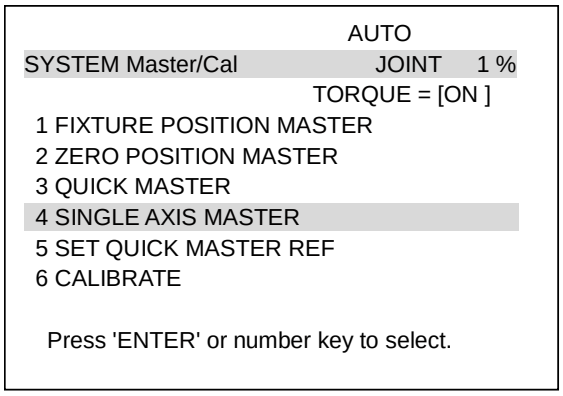


Table 8.5 Items set in single axis mastering

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

Procedure of Single axis mastering

1 Select SYSTEM.
2 Select Master/Cal.



3 Select 4, Single Axis Master. You will see a screen similar to the following.

```
                                        AUTO
SINGLE AXIS MASTER                    JOINT    1 %
                                              [ON ]
    ACTUAL POS     (MSTR POS )    (SEL)[ST]
J1      25.255  (     0.000)  (0)  [2]
J2      25.550  (     0.000)  (0)  [2]
J3     -50.000  (     0.000)  (0)  [2]
J4      12.500  (     0.000)  (0)  [2]
J5      31.250  (     0.000)  (0)  [2]
J6      43.382  (     0.000)  (0)  [2]
E1       0.000  (     0.000)  (0)  [2]
E2       0.000  (     0.000)  (0)  [0]
E3       0.000  (     0.000)  (0)  [0]

                                  GROUP    EXEC
```

4. Move the cursor to the SEL column for the unmastered axis and press the numeric key "1." Setting of SEL is available for one or more axes.
5. Turn off brake control as required, then jog the robot to the mastering position
6. Enter axis data for the mastering position.

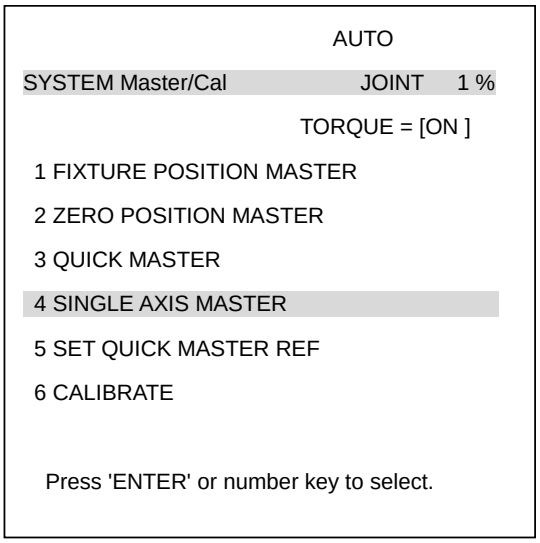
```
                                        AUTO
                                      JOINT    1 %
                                              5/9
    (MSTR POS )    (SEL)[ST]
(     0.000)  (0)  [0]
(     0.000)  (0)  [0]

                                  GROUP    EXEC
```

```
                                        AUTO
SINGLE AXIS MASTER                    JOINT    1 %
                                              5/9
    ACTUAL POS     (MSTR POS )    (SEL)[ST]
J5      31.250  (     0.000)  (1)  [0]
J6      43.382  (    90.000)  (1)  [0]

                                  GROUP    EXEC
```

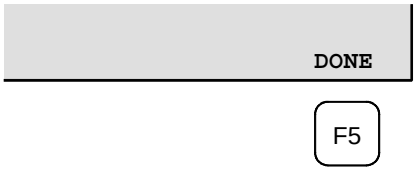
7. Press F5 [EXEC]. Mastering is performed. So, SEL is reset to 0, and ST is re-set to 2 or 1.

```
                                        AUTO
SINGLE AXIS MASTER                    JOINT    1 %
                                              [ON ]
    ACTUAL POS     (MSTR POS )    (SEL)[ST]
J1      25.255  (     0.000)  (0)  [2]
J2      25.255  (     0.000)  (0)  [2]
J3     -50.000  (     0.000)  (0)  [2]
J4      12.500  (     0.000)  (0)  [2]
J5       1.000  (     0.000)  (0)  [2]
J6      90.000  (    90.000)  (0)  [2]
E1      25.255  (     0.000)  (0)  [2]
E2       0.000  (     0.000)  (0)  [0]
E3       0.000  (     0.000)  (0)  [0]

                                  GROUP    EXEC
```

8. When single axis mastering is completed, press the previous page key to resume the previous screen.



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

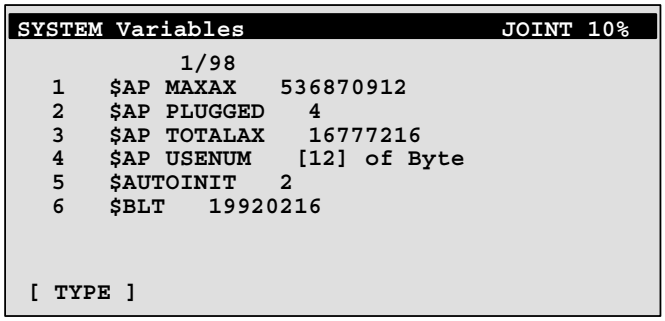


8.6 MASTERING DATA ENTRY

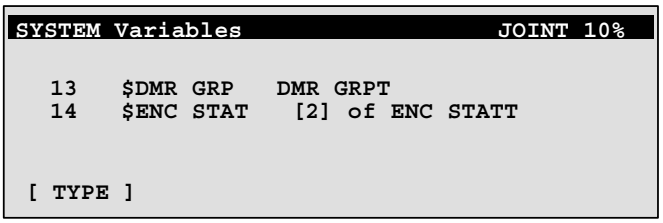
This function enables mastering data values to be assigned directly to a system variable. It can be used if mastering data has been lost but the pulse count is preserved.

Mastering data entry method

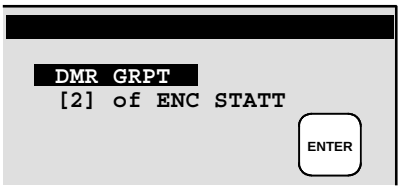
1. Press MENUS, then press NEXT and select SYSTEM.
2. Press F1, [TYPE]. Select [Variables]. The system variable screen appears.

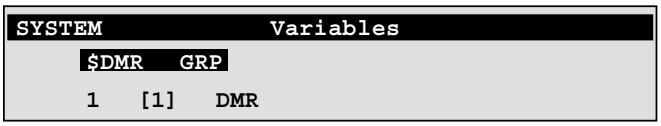


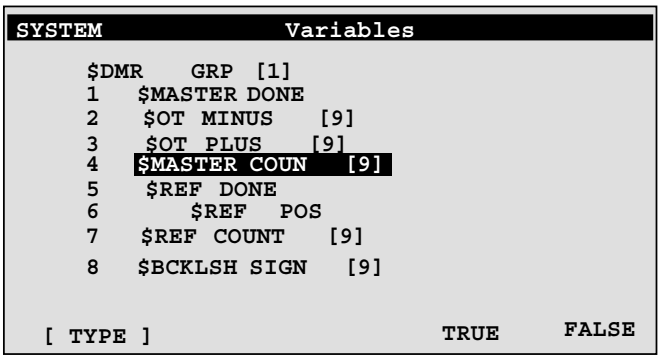
3 Change the mastering data.
The mastering data is saved to the
$DMR_GRP.$MASTER_COUN system variable.



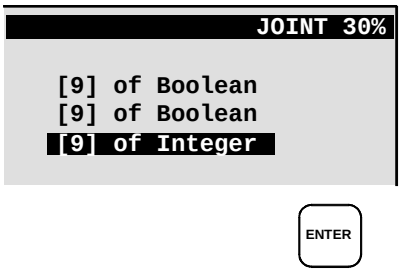
4 Select $DMR_GRP.

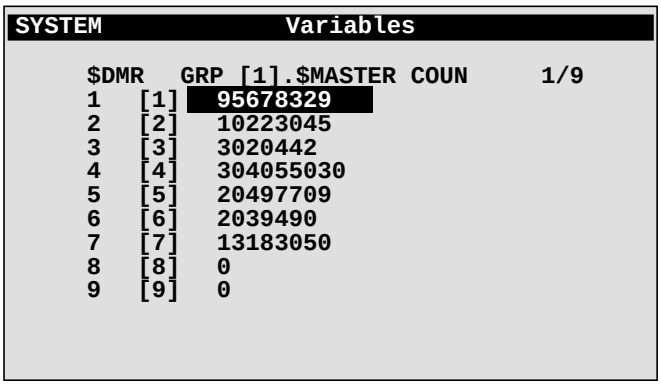




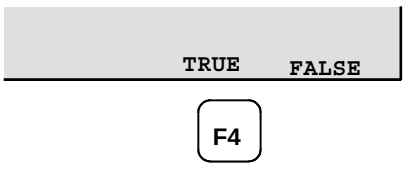


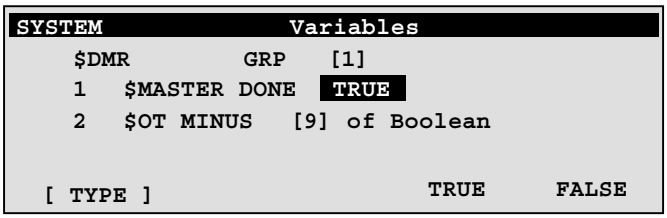
5 Select $MASTER_COUN, and enter the mastering data you have recorded.



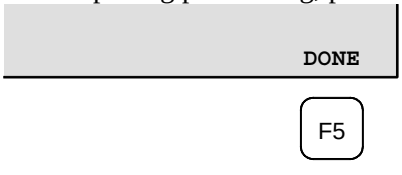


6 Press the PREV key.
7 Set $MASTER_DONE to TRUE.





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



8.7 CHECKING THE MASTERING

1 Checking whether mastering has been made correctly

Usually, positioning is performed automatically at power-on. To check whether mastering has been made correctly, note whether the displayed current position agrees with the actual robot position. Use the procedure described below:

(1) Reproduce a particular point in a program. Check whether the point agrees with the specified position.
(2) Set all axes of the robot to their 0-degree (0rad) positions. Check that the zero-degree position marks indicated in Section 8.3 are aligned. There is no need to use any visual aid.
(3) Using fixtures, set the robot to the mastering position in the same way as when performing mastering. Check that the displayed current position agrees with the actual mastering position.

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. 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 Section 8.2.), 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 output if the voltage of the pulsecoder's backup battery has fallen to a level where backup is no longer possible. If this alarm is output, fit a new battery immediately while keeping the power turned on. Check whether the current position data is valid, using the procedure described in 1.

(3) CKAL, RCAL, PHAL, CSAL, DTERR, CRCERR, STBERR, and SPHAL, alarms
Contact the FANUC because the pulsecoder may be defective.

9 TROUBLESHOOTING

9.1 OVERVIEW

The cause of a failure in the mechanical unit may be difficult to localize, because failures can arise from many interrelated factors. If you fail to take the correct measures, the failure may be aggravated. So, it is necessary to analyze the symptoms of the failure precisely so that the true cause can be found.

9.2 FAILURES, CAUSES AND MEASURES

Table 9.2 lists the major failures that may occur in the mechanical unit and their probable causes. If you cannot pinpoint a failure cause or which measures to apply, contact FANUC.

Table 9.2 Failures, causes and measures

Symptom	Description	Cause	Measure
Vibration Noise	- As the robot operates, its base plate lifts off the floor plate. - There is a gap between the base plate and the floor plate. - There is a crack in the weld that fastens the base plate to the floor plate.	[Base plate and floor plate fastening] - It is likely that the base plate is not securely fastened to the floor plate because of poor welding. - If the base plate is not securely fastened to the floor plate, it lifts as the robot operates, allowing the base and floor plates to strike each other which, in turn, leads to vibration.	- Re-weld the base plate to the floor plate. - If the weld is not strong enough, increase its width and length.
	- The J1 base lifts off the base plate as the robot operates. - There is a gap between the J1 base and base plate. - A J1 base retaining bolt is loose.	[J1 base fastening] - It is likely that the robot J1 base is not securely fastened to the base plate. - Probable causes are a loose bolt, an insuffcient degree of surface flatness, or foreign material caught between the base plate and floor plate. - If the robot is not securely fastened to the base plate, the J1 base lifts the base plate as the robot operates, allowing the base and floor plates to strike each other wihich, in turn, leads to vibration.	- If a bolt is loose, apply LOCTITE and tighten it to the appropriate torque. - Adjust the base plate surface flatness to within the specified tolenrance. - If there is any foreign material between the J1 base and base plate, remove it. - Apply adhesive between the J1 base and base plate.

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- Apply epoxy to the floor surface and re-install the plate.	[Rack or floor] - It is likely that the rack or floor is not suffciently 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.
	- Vibration becomes more serious when the robot adopts a specific posture. - If the operating speed of the robot is reduced, vibration stops. - Vibration is most noticeable when the robot is accelerating. - Vibration occurs when two or more axes operate at the same time.	[Overload] - It is likely that the load on the robot is greater than the maximum rating. - It is likely that the robot control program is too demanding for the robot hardware. - It is likely that the ACCELERATION value is excessive.	- Check the maximum load that the robot can handle once more. If the robot is found to be overloaded, reduce the load, or modify the robot control program. - Vibration in a specific portion can be reduced by modifying the robot control program while slowig the robot and reducing its acceleration (to minimize the influenece on the entire cycle time).
	-Vibration or noise was first noticed after the robot collided with an object or the robot was overloaded for a long period. -The grease of the vibrating or noise occurring axis has not been exchanged for a long period.	[Broken gear, bearing, or reducer] - It is likely that collision or overload applied an excessive force on the drive mechanism, thus damaging the geartooth surface or rolling surface of a bearing, or reducer. - It is likely that prolonged use of the robot while overloaded caused fretting of the gear tooth surface or rolling surface of a bearing, or reducer due to resulting metal fatigue. - It is likely that foreign material caught in a gear, bearing, or within a reducer caused damage on the gear tooth surface or rolling surface of the bearing, or reducer. - It is likely that foreign material caught in a gear, bearing, or within a reducer cause 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. These factors all generate cyclic vibration and noise.	- 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 FANUC. - Using the robot within its maximum rating prevents problems with the drive mechanism. - Regularly changing the grease with a specified type 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 a connection cable between them has an intermittent break, vibration might occur. - If the power 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. For the method of replacement, contact FANUC. - Check that the robot is supplied with the rated voltage. - Check whether the sheath of the 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.

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- There is some relationship between the vibration of the robot and the operation of a machine near the robot.	[Noise from 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.
	- 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 face of the mechanical unit.	[Mechanical section coupling bolt] - It is likely that overloading or a collision has loosened a mounting bolt in the robot mechanical section.	- Check that the following bolts for each axis are tight. If any of these bolts is loose, apply LOCTITE and tighten it to the appropriate torque. - Motor retaining bolt - Reducer retaining bolt - Reducer shaft retaining bolt - Base retaining bolt - Arm retaining bolt - Casting retaining bolt - End effecter retaining bolt

Symptom	Description	Cause	Measure
Motor overheating	- The ambient temperature of the installation location increases, causing the motor to overheat. - After the robot control program or the load was changed, the motor over-heated.	[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. - If there is a source of heat near the motor, it is advisable to install shielding to protect the motor from heat radiation.
	- After a control parameter was changed, the motor overheated.	[Parameter] - If data input for a workpiece is invalid, the robot cannot be accelerated or decelerated normally, so the average current increases, leading to overheating.	- Input an appropriate parameter as described in CONTROLLER OPERATOR'S MANUAL.
	- Symptom other than stated above	[Mechanical section problems] - It is likely that problems occurred in the mechanical unit drive mechanism, thus placing an excessive load on the motor. [Motor problems] - It is likely that a failure of the motor brake resulted in the motor running with the brake applied, thus placing an excessive load on the motor. - It is likely that a failure of the motor prevented it from delivering its rated performance, thus causing an excessive current to flow through the motor. -It is likely that fan is broken.	- 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. - If the fan is broken, replace it to new one.

Symptom	Description	Cause	Measure

Grease leakage	- Grease is leaking from the mechanical unit.	[Poor sealing]
		- Probable causes are a crack in the casting, a broken O-ring, a damaged oil seal, or a loose seal bolt.
		- A crack in a casting can occur due to excessive force that might be caused in 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.
			  - Motor coupling section
			  - Reducer (case and shaft) coupling section
			  - Wrist coupling section
			  - J3 arm coupling section
			  - Inside the wrist
			- Oil seals are used in the locations stated below.
			  - Inside the reducer
			  - Inside the wrist
			- Seal bolts are used in the locations stated below.
			  - Grease drain outlet
			- Replace the grease nipple.

Dropping axis	- An axis drops because the brake does not function. - An axis drops gradually when it should be at rest.	[Brake drive relay and motor] - It is likely that brake drive relay contacts are stuck to each other to keep the brake current flowing, thus preventing the brake from operating when the motor is deenergized. - 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 has entered the motor, causing the brake to slip.	- Check whether the brake drive relay contacts are stuck to each other. If they are found to be stuck, replace the relay. - If the brake shoe is worn out, if the brake main body is damaged, or if oil or grease has entered the motor, replace the motor.

Symptom	Description	Cause	Measure
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 or reducer. - It is likely that the Pulsecoder is abnormal.	- 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. - If the Pulsecoder is abnormal, replace the motor or the Pulsecoder.
	- Displacement occurs only in a specific peripheral unit.	[Peripheral unit displacement] - It is likely that an external force was applied to the peripheral unit, thus shifting its position relative to the robot.	- Correct the setting of the peripheral unit position. - Correct the taught program.
	- Displacement occurred after a parameter was changed.	[Parameter] - It is likely that the mastering data was rewritten in such a way that the robot origin was shifted.	- Re-enter the previous mastering data, which is known to be correct. - If correct mastering data is unavailable, perform mastering again.
BZAL alarm occured	- BZAL is displayed on the controller screen	-The voltage of the memory backup battery may be low. -The Pulsecoder cable may be broken.	- Replace the battery. - Replace the cable.

APPENDIX

A PERIODIC MAINTENANCE TABLE

FANUC Robot M-900*i*A/200P Periodic Maintenance Table

		Items \ Working time (H)	Check time	Grease amount	First check 320	3 months 960	6 months 1920	9 months 2880	1 year 3840	4800	5760	6720	2 years 7680	8640	9600	10560
Mechanical unit	1	Check 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	Check the mechanical stopper and adjustable mechanical	0.1H	—		○			○				○			
	6	Remove spatter and dust etc.	1.0H	—		○			○				○			
	7	Check the end effector (hand) cable	0.1H	—		○			○				○			
	8	Check the fan	0.1H	—		○			○				○			
	9	Replacing battery.	0.1H	—							●					
	10	Replacing grease of J1 axis reducer	1.3H	9000ml					●				●			
	11	Replacing grease of J2 axis reducer	0.5H	2200ml					●				●			
	12	Replacing grease of J3 axis reducer	0.5H	2000ml					●				●			
	13	Replacing grease of J4 axis gearbox	0.5H	1900ml					●				●			
	14	Replacing grease of wrist (wrist1, wrist 2)	0.9H	7330ml					●				●			
	15	Greasing of the balancer bush	0.1H	10ml each					●				●			
	16	Greasing of the J2/J3-axis connection taper roller	0.1H	20ml each					●				●			
	17	Replacing cable of mechanical unit	4.0H	—									●			
Controller	18	Check the robot cable, teach pendant cable and robot connecting cable	0.2H	—		○			○				○			
	19	Cleaning the ventilator	0.2H	—	○	○	○	○	○	○	○	○	○	○	○	○
	20	Replacing battery *1	0.1H	—												

*1 Refer to manual of controller.

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

3 years 11520	12480	13440	14400	4 years 15360	16320	17280	18240	5 years 19200	20160	21120	22080	6 years 23040	24000	24960	25920	7 years 26880	27840	28800	29760	8 years 30720	Item
○				Overhaul				○				○				○				Overhaul	1
○								○				○				○					2
○								○				○				○					3
○								○				○				○					4
○								○				○				○					5
○								○				○				○					6
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○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		19
				●																	20

B MOUNTING BOLT TORQUE LIST

NOTE

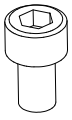
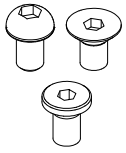
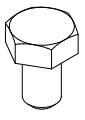
When applying LOCTITE to the important bolt tightening points, make sure that it is applied to the entire longitudinal portion in the engaging section of the female threads. If it is applied to the male threads, the bolts may be loosened because sufficient adhesion cannot be obtained. Remove the dust within the bolts and taps and wipe oil off the engaging section. Make sure that there is no solvent in the taps. Be sure to wipe the excess LOCTITE after tightening bolt.

Use bolt which strengths are below.
But if it is specified in text, obey it.
Hexagon socket head bolt made by steel
Size is M22 or less : Tensile strength 1200N/mm^2 or more
Size is M24 or more : Tensile strength 1000N/mm^2 or more
All size of bolt of the plating : 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

If no tightening torque is specified for a bolt, tighten it according to this table.

Recommended bolt tightening torques **Unit: Nm**

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

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REVISION RECORD

Edition	Date	Contents
04	Oct.,2012	• Addition of R-30*i*B • Addition of note for low temperature • Addition of check of oil exudation • Correction of errors
03	Nov.,2010	• Addition of stop type of robot • Addition of stopping time and distance when controlled stop is executed • Addition note about end effector (hand) cable • Correction of errors
02	Apr.,2010	• Change of max speed of J4/J5-axes • Addition of check of stopper • Correction of errors
01	Jul.,2008	

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