

FANUC Robot **ARC Mate 120iC**
FANUC Robot **M-20iA**

MECHANICAL UNIT
OPERATOR'S MANUAL

B-82874EN/07

- **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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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 robots.

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.
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- (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.

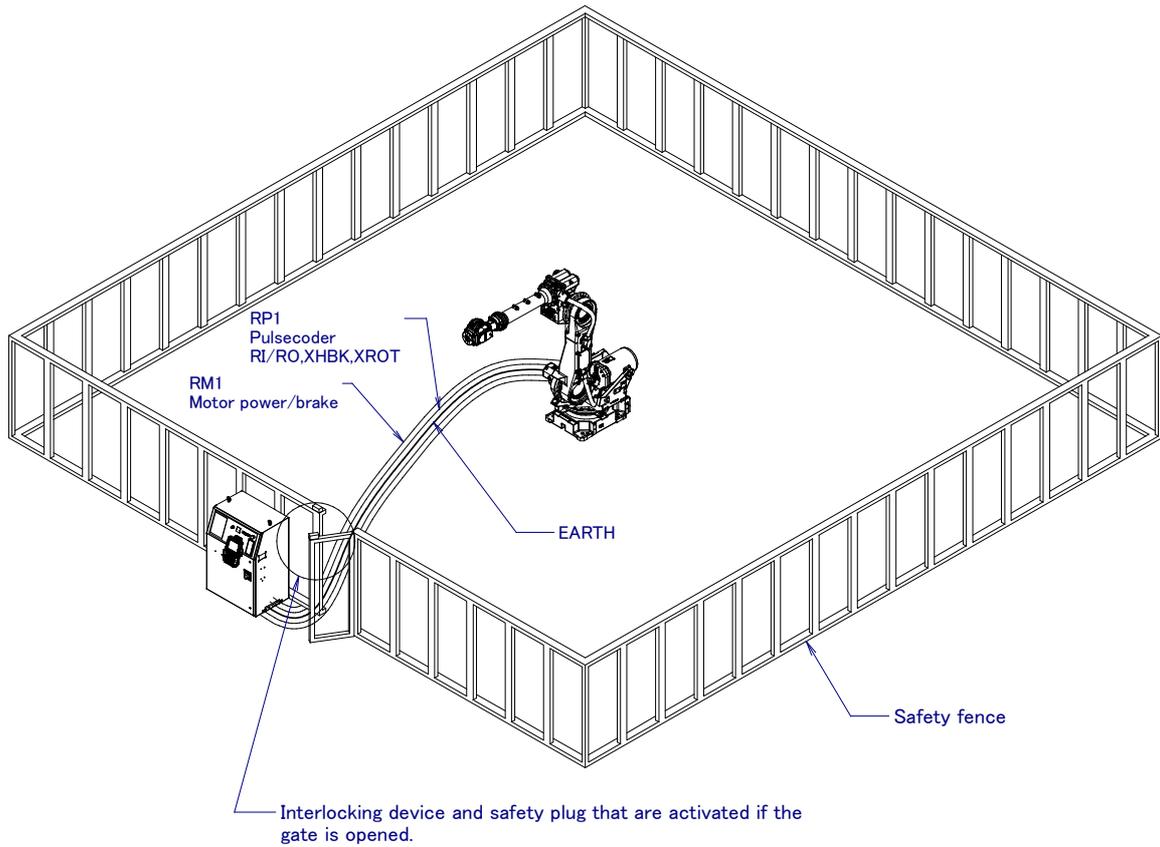


Fig. 3 (a) Safety fence and safety gate

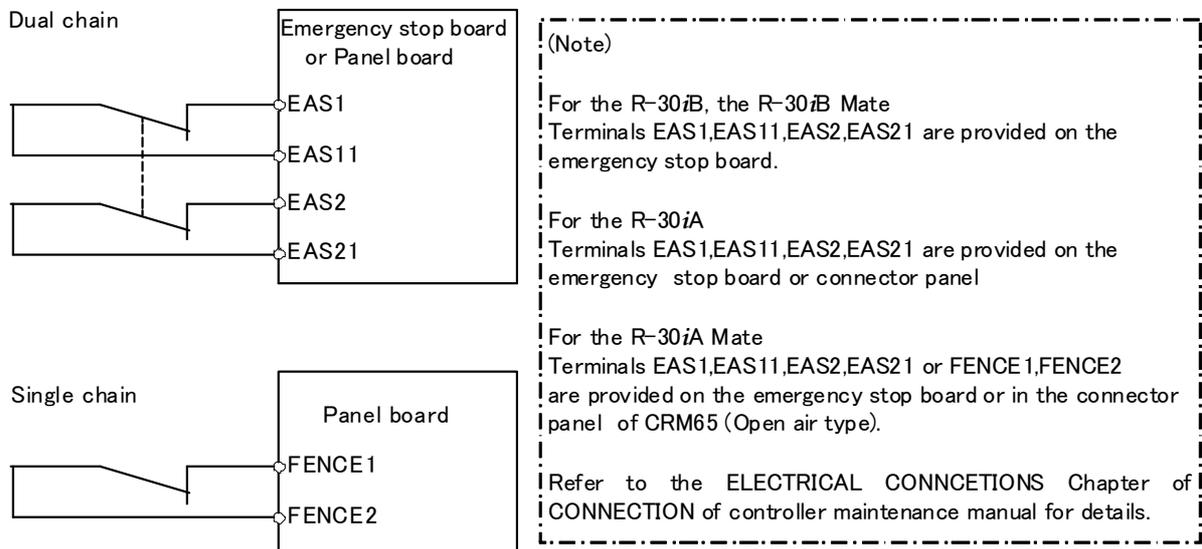


Fig. 3 (b) Limit switch circuit diagram of the safety fence

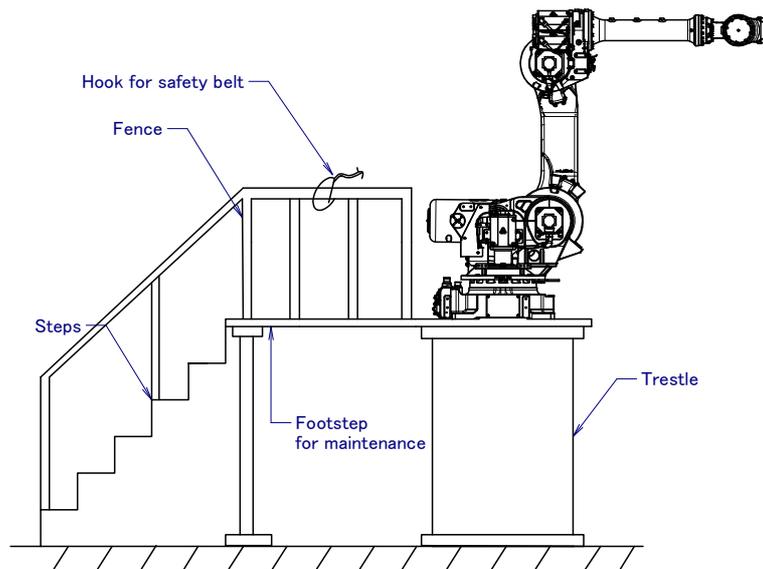


Fig.3 (c) Footstep for maintenance

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.

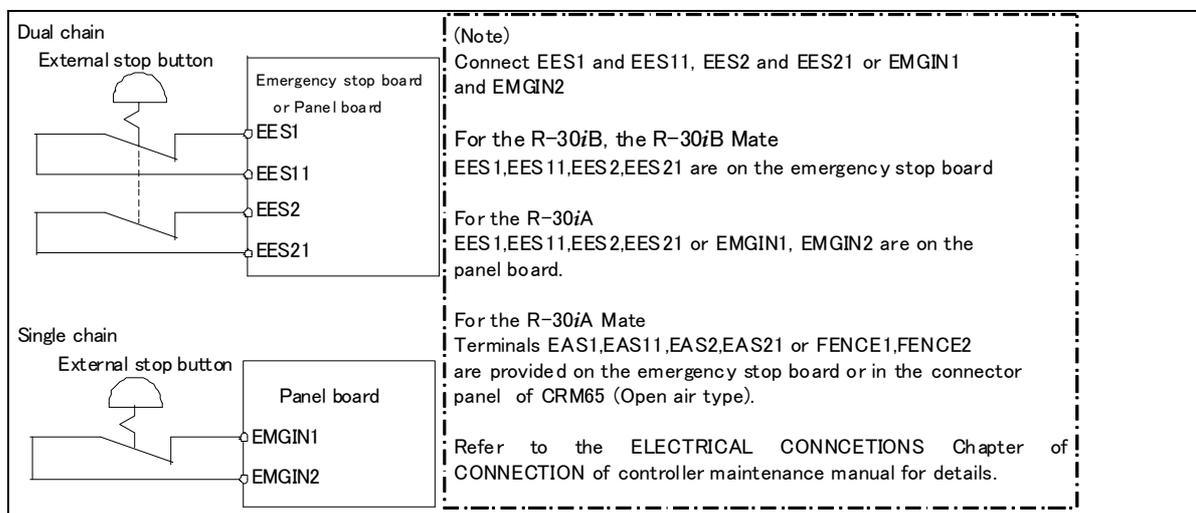


Fig.3.1 Connection diagram for external emergency stop button

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. (For the R-30iA 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-30iB/R-30iA/ R-30iA 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.

For the R-30iB/R-30iA controller or CE or RIA specification of R-30iA 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.

For the standard specification of R-30iA 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-30iB/R-30iA Controller or CE or RIA specification of R-30iA 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 run 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 run 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 matter 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 execution should be given for the robot according to a predetermined method. (See TESTING section of "Controller operator's manual".) During the test execution, 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. Failure to follow precautions may cause mechanical troubles.
 - 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.
 - When installing user peripheral equipment on the robot mechanical unit, please pay attention that equipment does not interfere with the robot itself.
- (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. Please try to avoid unnecessary power-off stops. It may cause 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 sandwiched by the robot), brake release unit can be used to move the robot axes without drive power.
Please order following unit and cable.

Name	Specification
Brake release unit	A05B-2450-J350 (Input voltage AC100-115V single phase) A05B-2450-J351 (Input voltage AC200-240V single phase)
Robot connection cable	A05B-2525-J047 (5m) A05B-2525-J048 (10m)
Power cable	A05B-2525-J010 (5m) (AC100-115V Power plug) (*) A05B-2525-J011 (10m) (AC100-115V Power plug) (*) A05B-2450-J364 (5m) (AC100-115V or AC200-240V No power plug) A05B-2450-J365 (10m) (AC100-115V or AC200-240V No power plug)

(*) These do not support CE marking.

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

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

⚠ CAUTION

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

⚠ WARNING

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

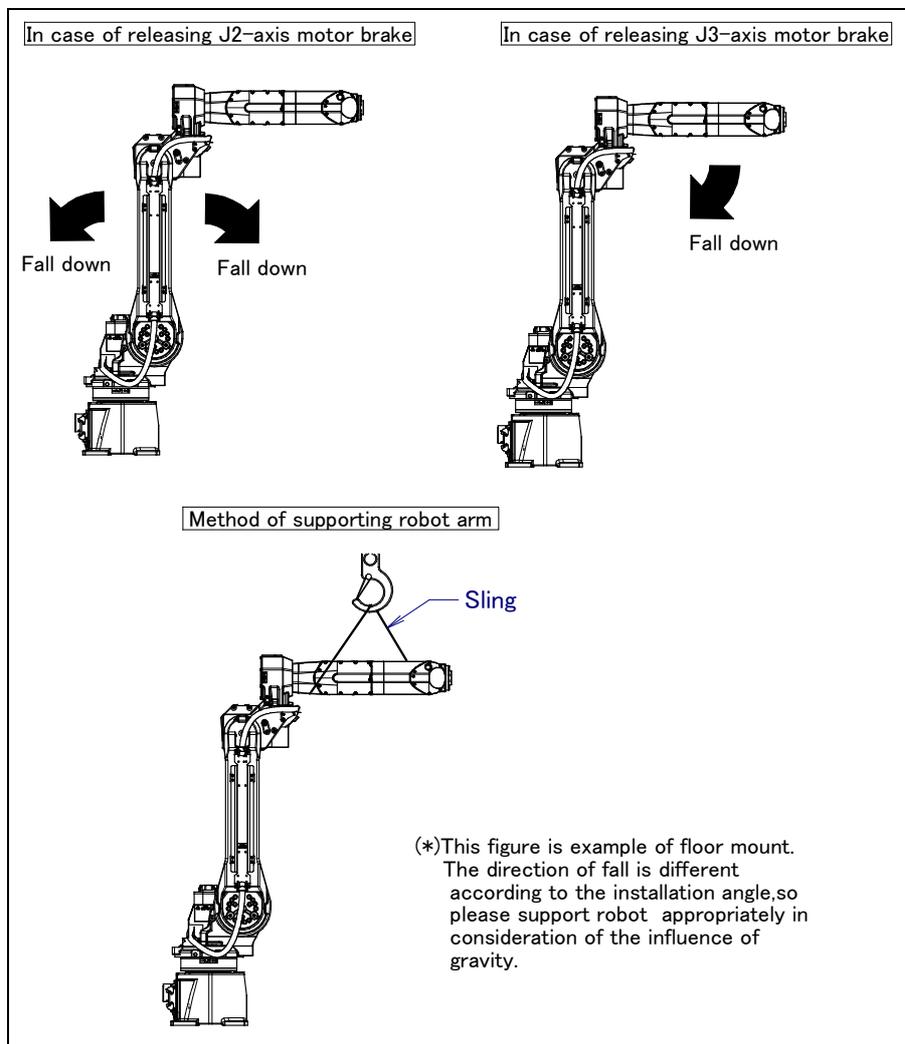


Fig. 5.4 Releasing J2 and J3 motor brake and measures

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-30iB
Standard	A (*)
Controlled stop by E-Stop (A05B-2600-J570)	C (*)

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

Option	R-30iA				R-30iA 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-30iA standard (single) does not have servo disconnect.

(**) R-30iA 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 (For the R-30iA/R-30iA 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-30iA/R-30iB controller)
SRVO-194 Servo disconnect	Servo disconnect input (SD4-SD41, SD5-SD51) is open. (R-30iA controller)
SRVO-218 Ext. E-stop/Servo Disconnect	External emergency stop input (EES1-EES11, EES2-EES21) is open. (R-30iA Mate/R-30iB 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.

For the R-30iA or R-30iA 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.

8 WARNING LABEL

(1) Greasing and degreasing label



Fig. 8 (a) Greasing and degreasing label

Description

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

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

⚠ CAUTION

See Section 7.2 for explanations about specified greases, the amount of grease to be supplied, and the locations of grease and degrease outlets for individual models.

(2) Step-on prohibitive label



Fig. 8 (b) Step-on prohibitive label

Description

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

(3) High-temperature warning label



Fig. 8 (c) High-temperature warning label

Description

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

(4) Transportation label

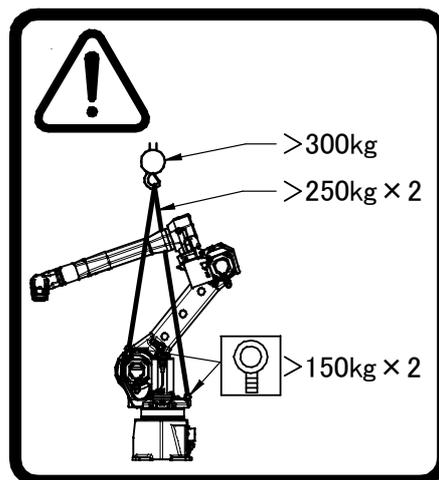


Fig. 8 (d) Transportation label

Description

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

(1) Using a crane

- Use a crane with a load capacity of 2940 N (300kgf) or greater.
- Use two slings with each load capacity of 2450 N (250 kgf) or greater, sling the robot as shown Chapter 1 of operator's manual.
- Use two M10 eyebolts with each load capacity of 1470 N (150 kgf) or greater.

NOTE

See Section 1.1 TRANSPORTATION of operator's manual for explanations about the posture a specific model should take when it is transported.

- (5) Transportation prohibitive label (When transport equipment option A05B-1221-H072 is specified.)



Fig. 8 (e) Transportation prohibitive label

Description

Keep the following in mind when transporting the robot.

- (1) Do not have impact on this part
- (2) Do not chain, pry, or strap on this part

- (6) High current attention label



Fig.8 (f) High current attention Label

Description

Do not access during energized high current inside.

- (7) Range of motion and payload mark label

Below label is added when CE specification is specified.

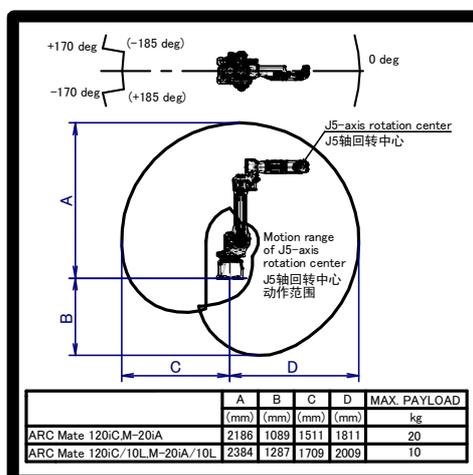


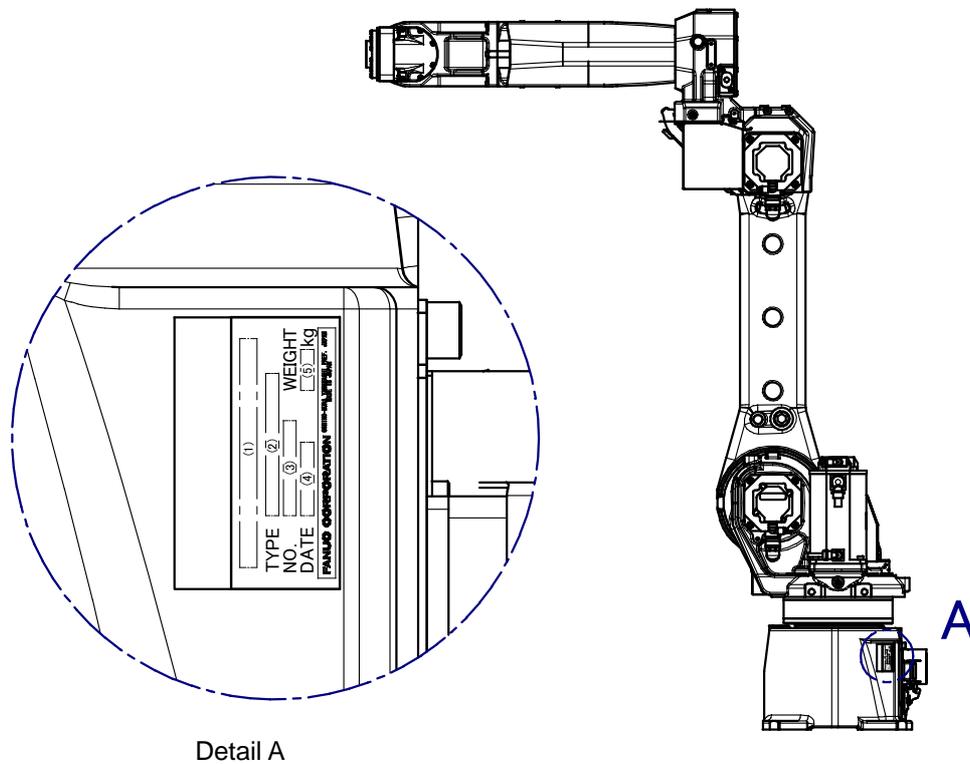
Fig.8 (g) Range of motion and payload mark label

PREFACE

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

Model name	Mechanical unit specification No.	Maximum load
FANUC Robot ARC Mate 120iC	A05B-1222-B201	3kg or 20kg
FANUC Robot M-20iA	A05B-1222-B202	3kg or 20kg
FANUC Robot ARC Mate 120iC/10L	A05B-1222-B301	3kg or 10kg
FANUC Robot M-20iA/10L	A05B-1222-B302	3kg or 10kg
FANUC Robot M-20iA/20M	A05B-1222-B702	20kg

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.



Position of label indicating mechanical unit specification number

TABLE 1)

CONTENTS	(1) Model name	(2) TYPE	(3) No.	(4) DATE	(5) WEIGHT kg (Without controller)
LETTERS	FANUC Robot ARC Mate 120iC	A05B-1222-B201	SERIAL NO. IS PRINTED	PRODUCTION YEAR AND MONTH ARE PRINTED	250
	FANUC Robot M-20iA	A05B-1222-B202			250
	FANUC Robot ARC Mate 120iC/10L	A05B-1222-B301			250
	FANUC Robot M-20iA/10L	A05B-1222-B302			250
	FANUC Robot M-20iA/20M	A05B-1222-B702			250

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-30iA controller	OPERATOR'S MANUAL HANDLING TOOL B-83124EN-2 ARC TOOL B-83124EN-3 DISPENCE TOOL B-83124EN-4 ALARM CODE LIST B-83124EN-6	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 peripheral equipment, maintenance Use: Installation, start-up, connection, maintenance
R-30iA Mate controller	OPERATOR'S MANUAL LR HANDLING TOOL B-83134EN-1 LR ARC TOOL B-83134EN-2 ALARM CODE LIST B-83124EN-6	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-82725EN B-82725EN-1 (For Europe) B-82725EN-2 (For RIA)	Intended readers: Maintenance person, system designer Topics: Installation, connection to peripheral equipment, maintenance Use: Installation, start-up, connection, maintenance

<p>R-30iB/ R-30iB Mate controller</p>	<p>OPERATOR'S MANUAL (Basic Operation) B-83284EN OPERATOR'S MANUAL (Alarm Code List) B-83284EN-1 OPERATOR'S MANUAL (Optional Function) B-83284EN-2 ARC Welding Function OPERATOR'S MANUAL B-83284EN-3 Spot Welding Function OPERATOR'S MANUAL B-83284EN-4 Dispense Function OPERATOR'S MANUAL B-83284EN-5</p>	<p>Intended readers: Operator, programmer, maintenance person, system designer Topics: Robot functions, operations, programming, setup, interfaces, alarms Use: Robot operation, teaching, system design</p>
	<p>MAINTENANCE MANUAL R-30iB : B-83195EN R-30iB Mate: B-83525EN</p>	<p>Intended readers: Maintenance person, system designer Topics: Installation, connection to peripheral equipment, maintenance Use: Installation, start-up, connection, maintenance</p>

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1 TRANSPORTATION AND INSTALLATION

1.1 TRANSPORTATION

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

CAUTION

When hoisting or lowering the robot with a crane or forklift, move it slowly with great care. When placing the robot on the floor, exercise care to prevent the installation surface of the robot from striking the floor strongly.

WARNING

- 1 Robot becomes unstable when it is transported with the end effector or equipment is installed, and it is dangerous. Please be sure to remove end effector when robot is transported.
(Except light thins such as welding torch or wire feeder)
- 2 Use the forklift pockets only to transport the robot with a forklift. Do not use the forklift pockets for any other transportation method. Do not use the forklift pockets to secure the robot.
- 3 Before moving the robot by using crane, check and tighten any loose bolts on the forklift pockets.
- 4 Do not pull eyebolts sideways.

(1) Installation procedure

When J2-axis and J3-axis mechanical stopper is attached, remove them refer to procedure 1 to 3.

- 1 Using JOINT, rotate the J2- and J3-axis sections in the positive direction to such a position that the J2- and J3-axis transportation stoppers can be removed.
- 2 Remove the J2- and J3-axis transportation stoppers (red).
- 3 Remove the two M10 eyebolts from the J2 base. Now you are ready to install the robot.

NOTE

- 1 If an overtravel alarm is issued at 1, hold down the shift key and press the alarm reset key. Then, while holding down the shift key, feed the J2- and J3-axis sections to such a position, using JOINT, that the overtravel condition is released.
- 2 Before moving the J2-axis section, be sure to remove the eyebolt from the J2 base so that the J2-axis stopper does not interfere with the eyebolt.

(2) Transportation using a crane (Fig. 1.1 (a) to (c))

Fasten the M10 eyebolts to the four points of the robot base and lift the robot by the four slings. In this case, please intersect and hang two Slings as shown in figure.

CAUTION

When transporting a robot, be careful not to damage a motor connector with a sling for lifting the robot.

(3) Carrying the robot with a forklift (Fig. 1.1 (d) to (f))

When carrying a robot with a forklift, use special transport equipment. Transport equipment is prepared as the option

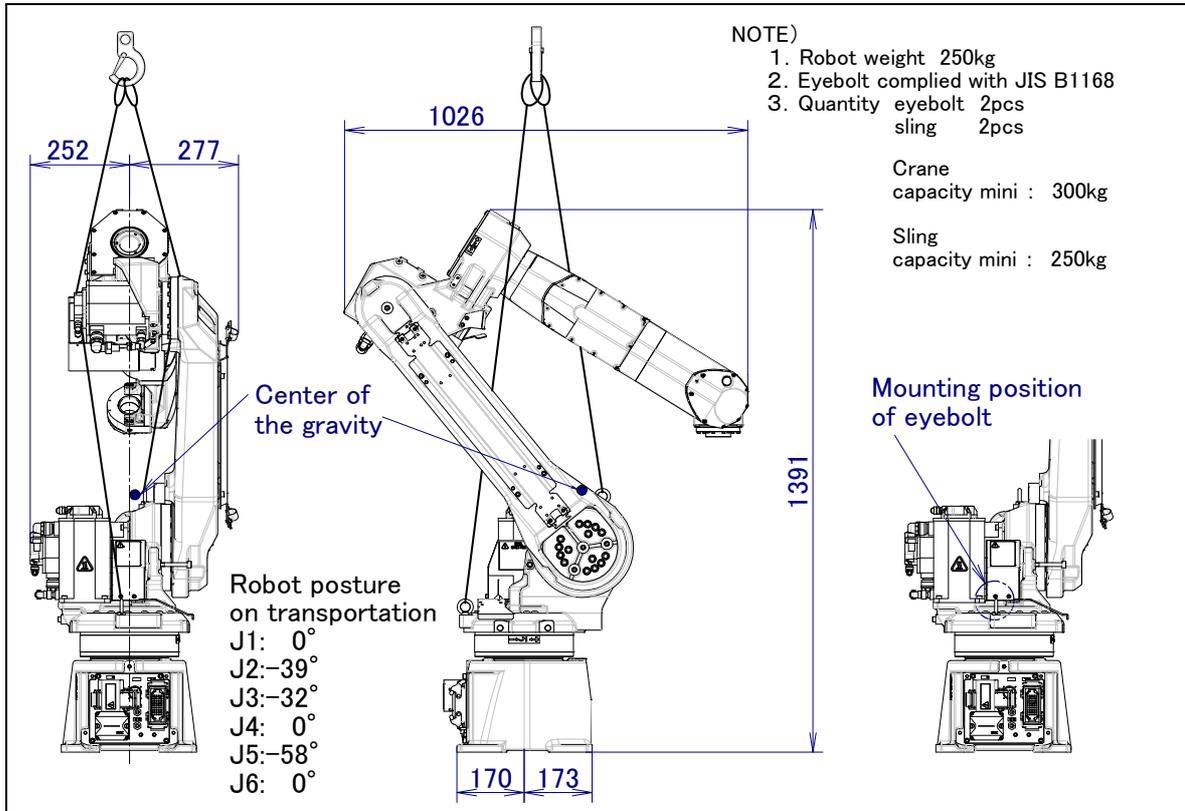


Fig. 1.1 (a) Transportation using a crane (ARC Mate 120iC, M-20iA)

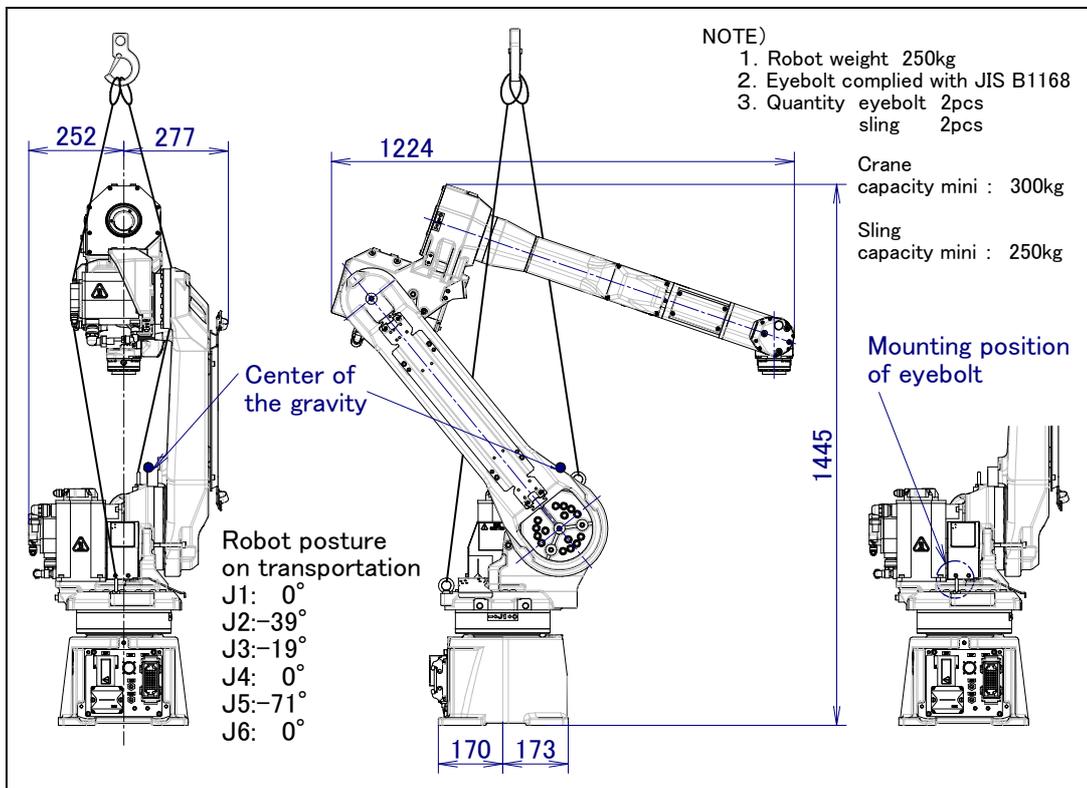


Fig. 1.1 (b) Transportation using a crane (ARC Mate 120iC/10L, M-20iA/10L)

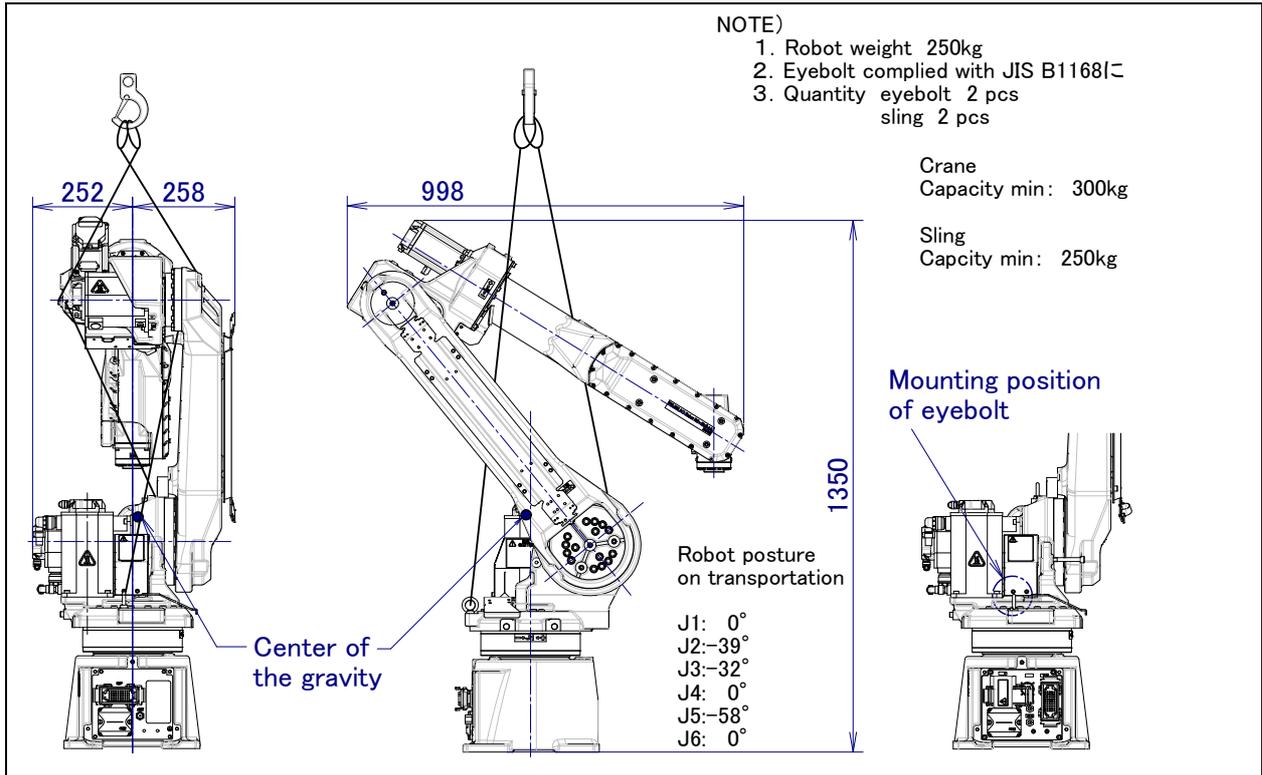


Fig. 1.1 (c) Transportation using a crane (M-20iA/20M)

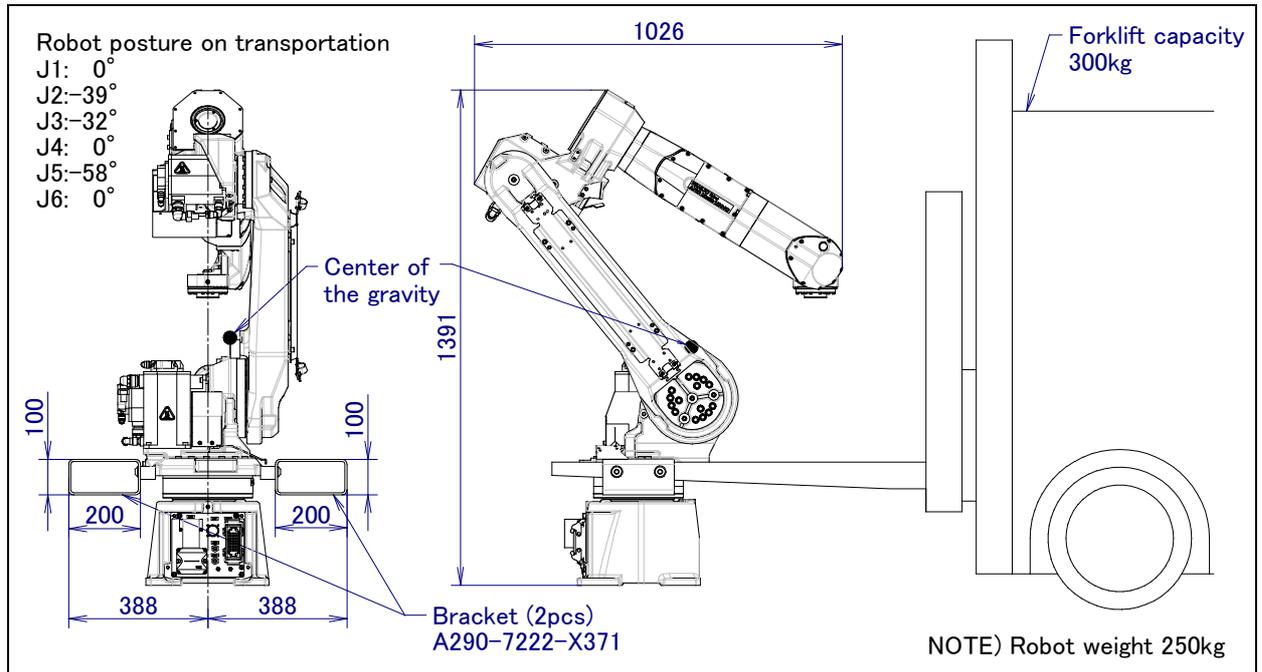


Fig. 1.1 (d) Transportation using a forklift (ARC Mate 120iC, M-20iA)

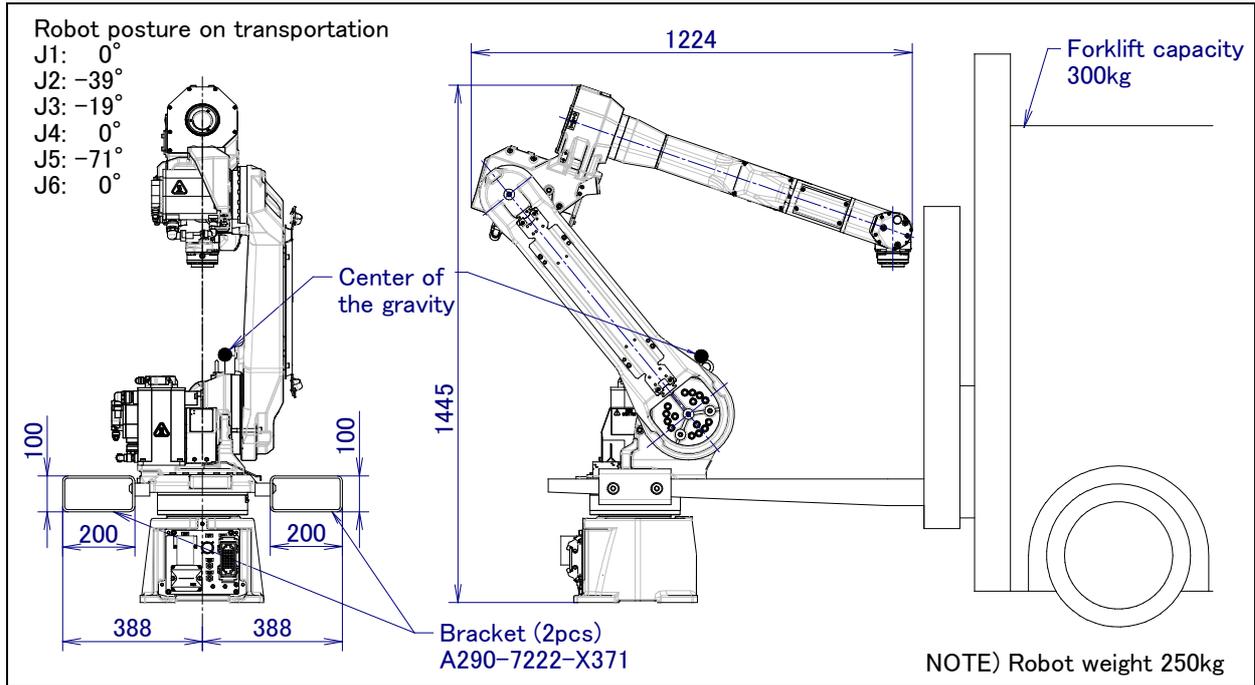


Fig. 1.1 (e) Transportation using a forklift (ARC Mate 120iC/10L, M-20iA/10L)

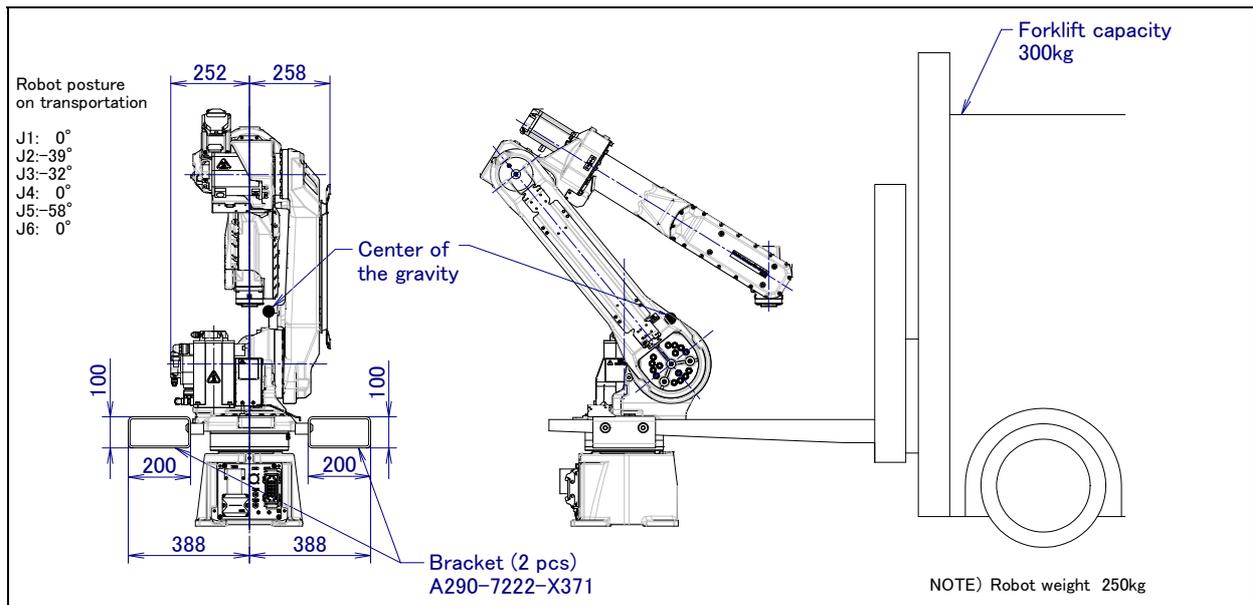


Fig. 1.1 (f) Transportation using a forklift (M-20iA/20M)



CAUTION

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

1.2 INSTALLATION

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

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.

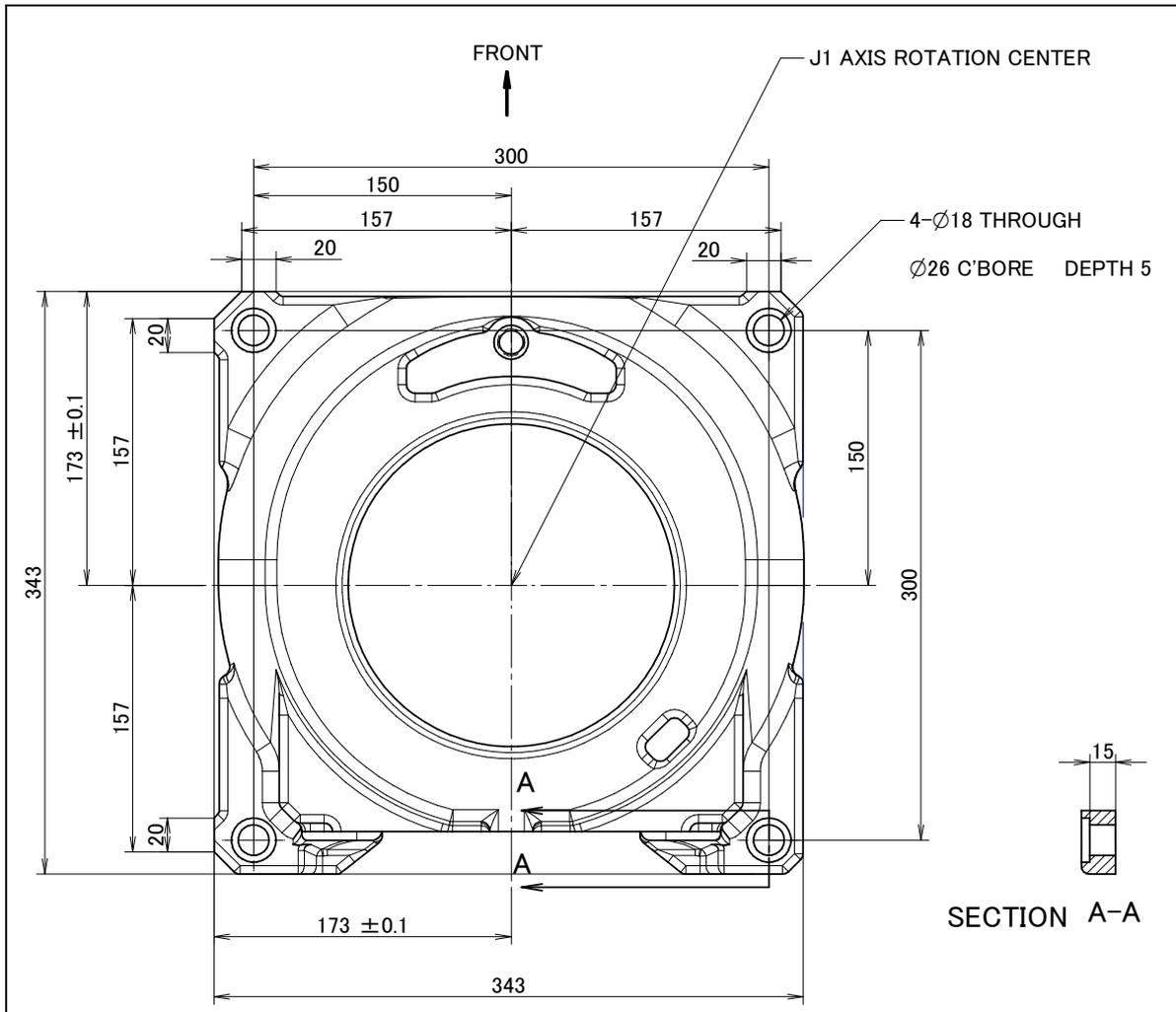


Fig. 1.2 (a) Dimensions of the robot base

If robot is used except floor mount, be sure to set the mounting angle referring to the procedure below. Refer to specification of Section 3.1 about installation specifications.

- 1 Perform a Controlled Start.
- 2 Press [MENU] key and select "9 MAINTENANCE" .
- 3 Select the robot which you want to set mount angle and press INPUT key.

```

ROBOT MAINTENANCE          CTRL START MANU
Setup Robot System Variables

Group  Robot Library/Option Ext Axes
1      M-20iA AMI20iC          0

[TYPE]ORD NO      AUTO      MANUAL

```

- 4 Press F4 key.
- 5 Press INPUT key until screen below is displayed.

```

*****Group 1 Initialization*****
*****ARC Mate 120iC*****

--- MOUNT ANGLE SETTING ---

0 [deg] : floor mount type
90 [deg] : wall mount type
180 [deg] : upside-down mount type

Set mount_angle (0-180[deg])->
Default value = 0

```

- 6 Input mount angle referring to Fig.1.2 (b).

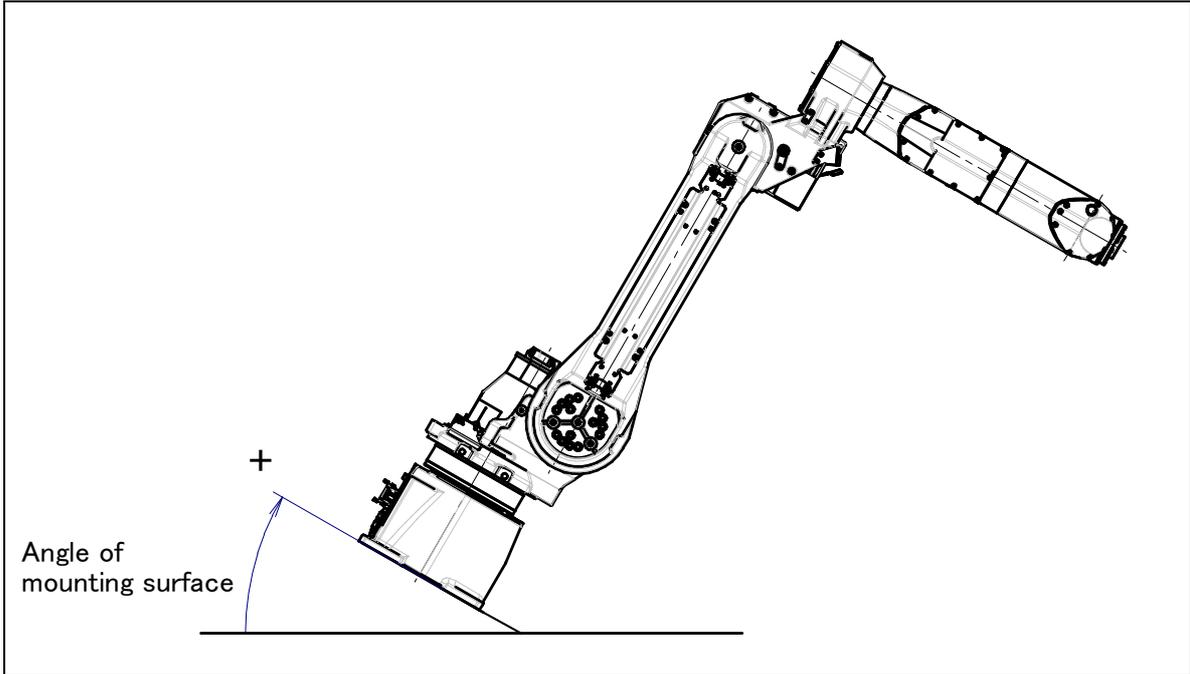
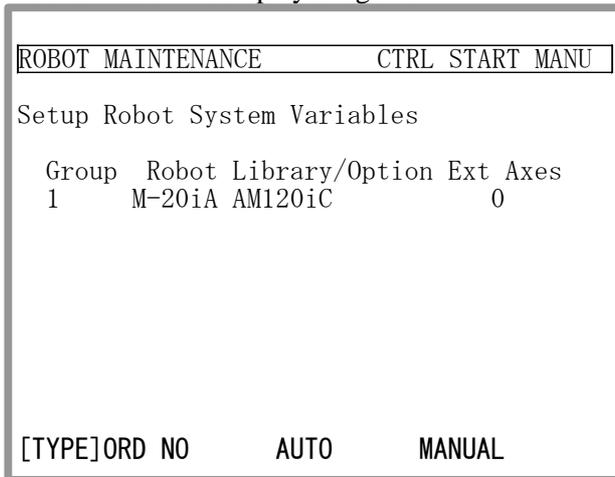


Fig.1.2 (b) Mounting angle

7 Press INPUT key until screen below is displayed again.



8 Press FCTN key and select "1 START (COLD)".

Fig. 1.2 (c) shows an example of installing the robot. In this example, the sole plate is fixed with four M20 chemical anchors (tensile strength 400N/mm^2 or more), and the robot base is fastened to the sole plate with four M16 \times 40 bolts (tensile strength 1200N/mm^2 or more). If compatibility must be maintained in teaching the robot after the robot mechanical unit is replaced, use the mounting face.

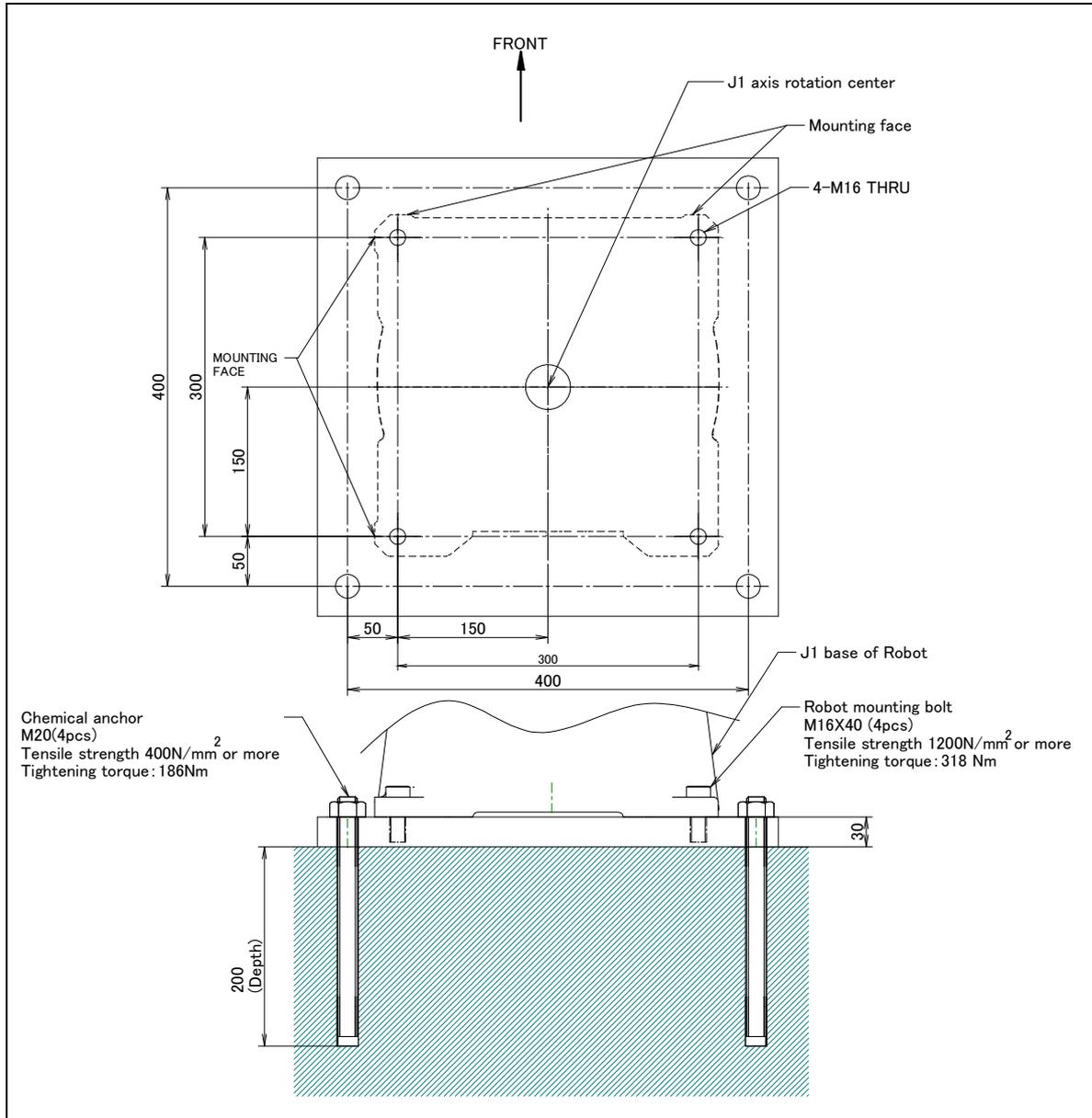


Fig. 1.2 (c) Example of installing the robot



CAUTION

The customer shall arrange for the positioning pin, anchor bolts, and sole plate. Don't perform leveling at the robot base directly using a push bolt or a wedge. Use four hexagon socket head bolt M16 \times 40 (tensile strength 1200N/mm^2 or more) and tighten bolt with regulated tightening torque 318Nm four robot-mounting bolts.

Fig. 1.2 (d), Table 1.2 (a) to Table 1.2 (d) indicate the force and moment applied to the robot base 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.

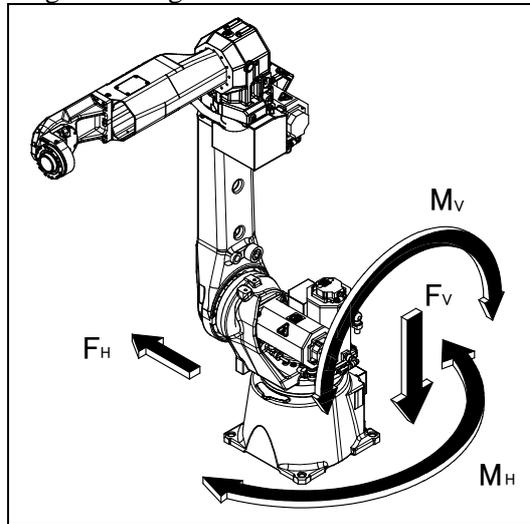


Fig. 1.2 (d) Force and moment that acts on the robot base

Table 1.2 (a) Force and moment that act on J1 base
(ARC Mate 120iC, M-20iA, ARC Mate 120iC/10L, M-20iA/10L)

	Vertical moment MV [Nm](kgfm)	Force in vertical direction FV N (kgf)	Horizontal moment MH Nm (kgfm)	Force in horizontal direction FH N (kgf)
During stillness	1537 (157)	2732 (279)	0(0)	0(0)
During acceleration or deceleration	6233 (636)	4425 (451)	2020(206)	3912 (399)
During Power-Off stop	12802 (1306)	7979 (814)	8315 (848)	7239 (739)

Table 1.2 (b) Force and moment that act on J1 base (M-20iA/20M)

	Vertical moment MV [Nm](kgfm)	Force in vertical direction FV N (kgf)	Horizontal moment MH Nm (kgfm)	Force in horizontal direction FH N (kgf)
During stillness	1554 (159)	2751 (281)	0 (0)	0 (0)
During acceleration or deceleration	6302 (643)	4457 (455)	2045 (209)	3953 (403)
During Power-Off stop	12944 (1321)	8038 (820)	8415 (859)	7318 (747)

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

Model		J1-axis	J2-axis	J3-axis
ARC Mate 120iC, M-20iA	Stopping time [ms]	246	246	125
	Stopping angle [deg] (rad)	25.7 (0.45)	21.2 (0.37)	11.5 (0.20)
ARC Mate 120iC/10L, M-20iA /10L	Stopping time [ms]	199	192	104
	Stopping angle [deg] (rad)	20.8 (0.36)	15.3 (0.27)	10.7 (0.19)
M-20iA/20M	Stopping time [ms]	292	252	132
	Stopping angle [deg] (rad)	30.3 (0.53)	21.2 (0.37)	11.7 (0.20)

*Max payload and max speed

*Max. payload, and max. inertia posture

Table1.2 (d) Stopping time and distance until the robot stopping by Controlled stop after input of stop signal

Model		J1-axis	J2-axis	J3-axis
ARC Mate 120iC, M-20iA	Stopping time [ms]	428	429	444
	Stopping angle [deg] (rad)	45.3 (0.79)	44.3 (0.77)	47.3 (0.83)
ARC Mate 120iC/10L, M-20iA /10L	Stopping time [ms]	437	442	442
	Stopping angle [deg] (rad)	47.6 (0.83)	44.6(0.78)	45.2(0.79)
M-20iA/20M	Stopping time [ms]	476	468	468
	Stopping angle [deg] (rad)	50.1 (0.87)	44.3 (0.77)	47.3 (0.83)

*Max payload and max speed

*Max. payload, and max. inertia posture

1.3 MAINTENANCE AREA

Fig. 1.3 (a) to (c) show the maintenance area of the mechanical unit. Dotted line area is necessary for mastering .Be sure to leave enough room for the robot to be mastered. See Chapter 8 for the mastering.

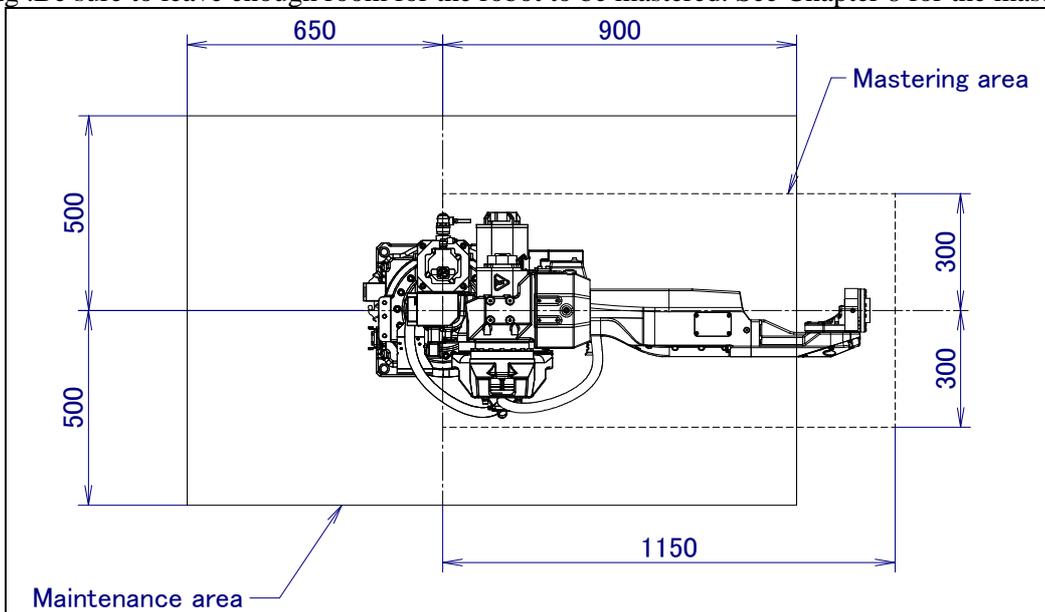


Fig. 1.3 (a) Maintenance area (ARC Mate 120iC,M-20iA)

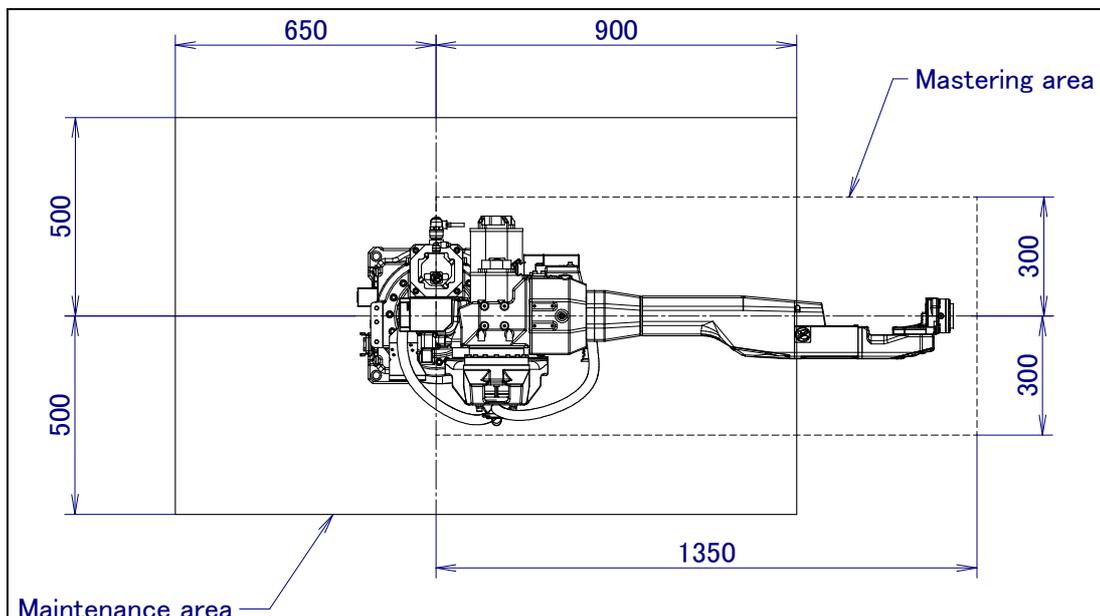


Fig. 1.3 (b) Maintenance area (ARC Mate 120iC/10L,M-20iA/10L)

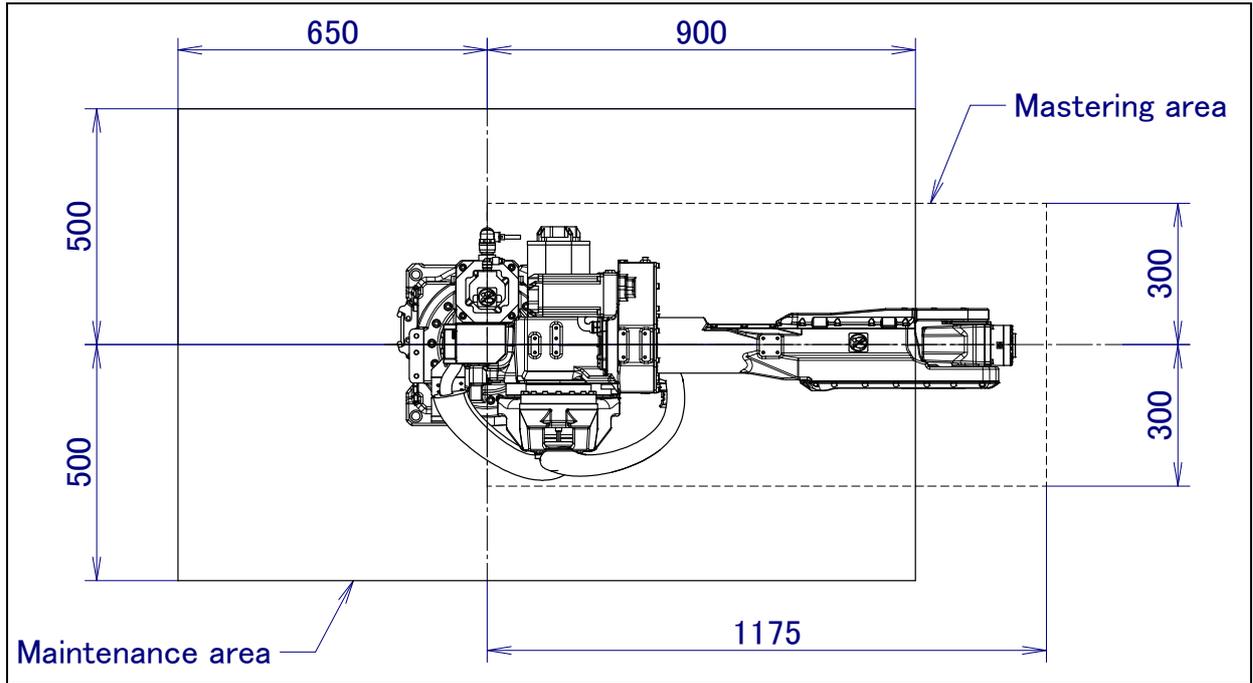


Fig. 1.3 (c) Maintenance area (M-20iA/20M)

1.4 INSTALLATION SPECIFICATIONS

Refer to specification 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.

⚠ WARNING

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

⚠ CAUTION

- 1 Before connecting the cables, be sure to turn off the power.
- 2 Don't use 10m or longer coiled cable without untying. The long coiled cable will heat and damage itself.

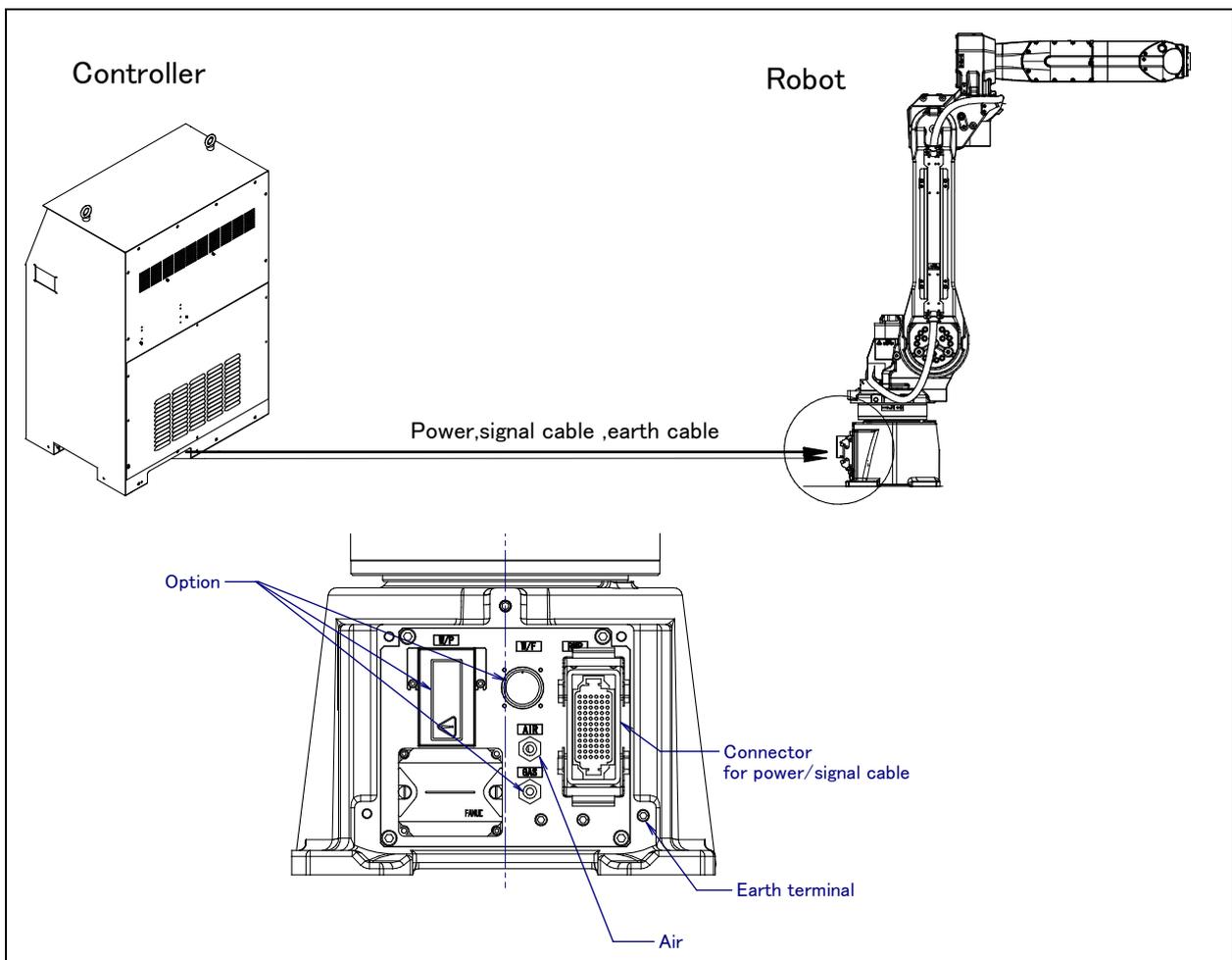


Fig. 2.1 Cable connection

3 BASIC SPECIFICATIONS

3.1 ROBOT CONFIGURATION

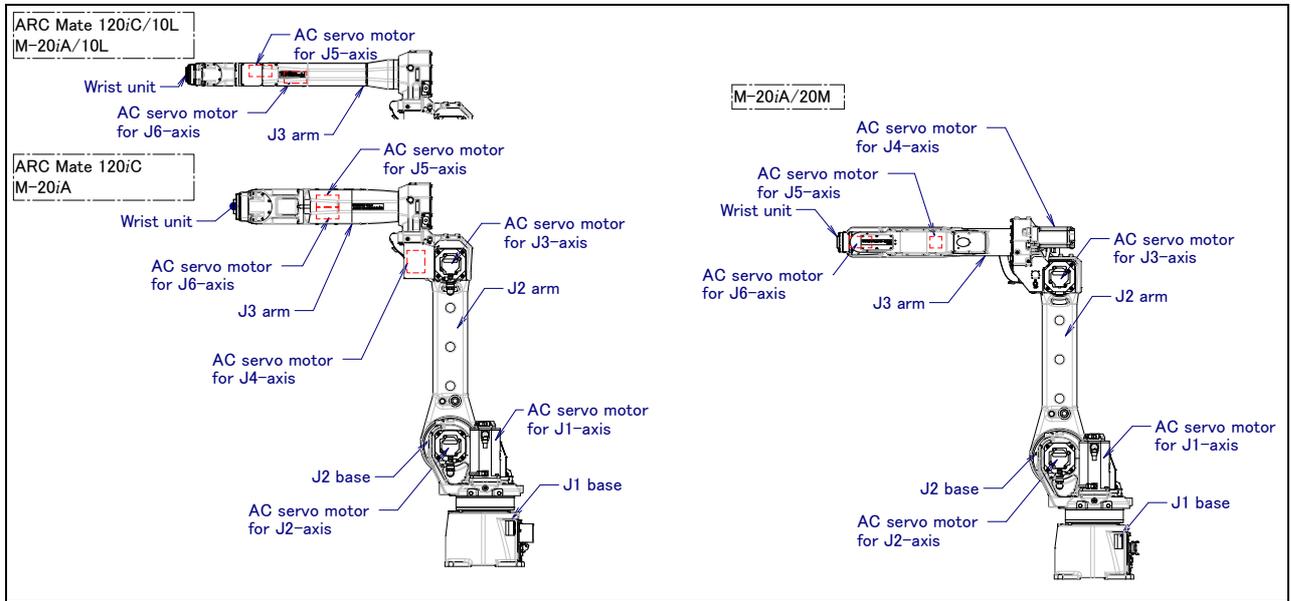


Fig. 3.1 (a) Mechanical unit configuration

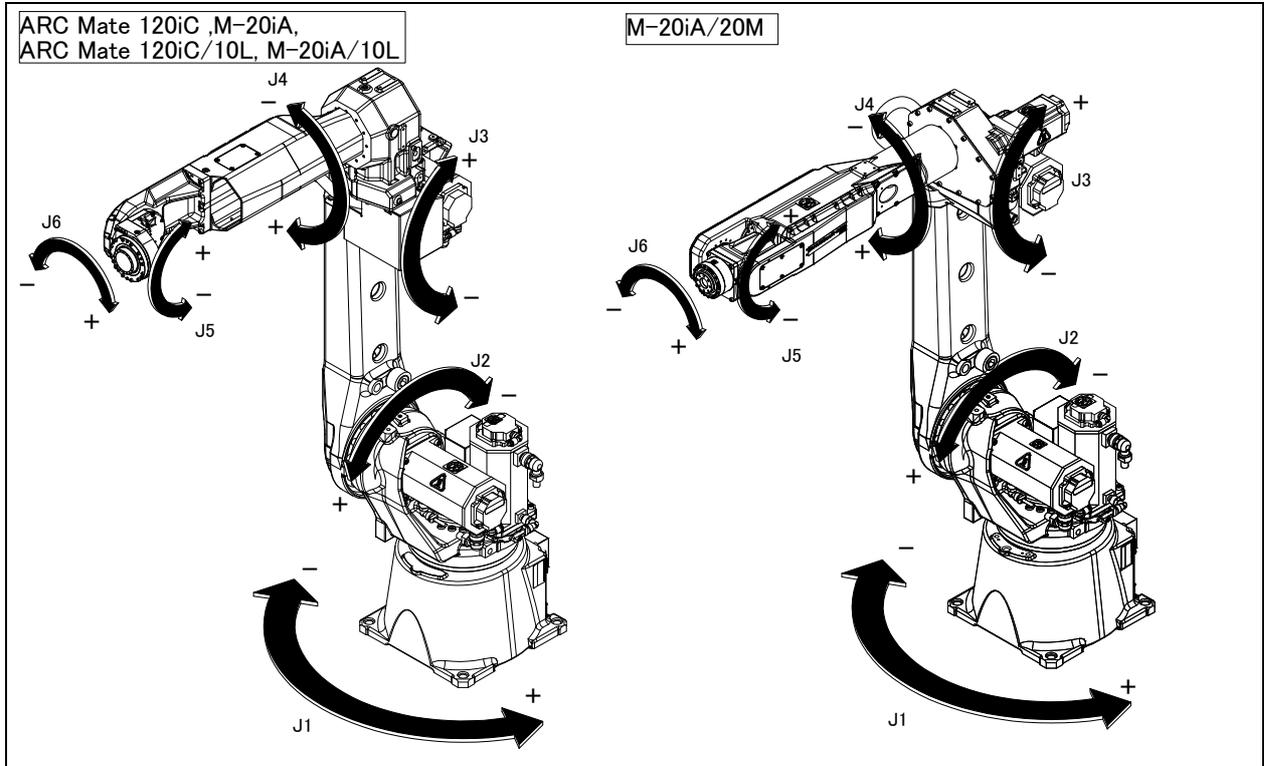


Fig. 3.1 (b) Each axes coordinates

Specifications (3/3)

目		Specification
Model		M-20iA/20M
Type		Articulated type
Controlled axes		6-axis(J1, J2, J3, J4, J5, J6)
Installation		Floor, (Upside-down, Wall & Angle mount) (NOTE 1)
Load setting		20kg mode
Motion range Upper limit /Lower limit	J1-axis	185° (3.23rad) / -185° (-3.23rad)
	J2-axis	160° (2.79rad) / -100° (-1.75rad)
	J3-axis	275.6° (4.81rad) / -185° (-3.23rad)
	J4-axis	200° (3.49rad) / -200° (-3.49rad)
	J5-axis	140° (2.44rad) / -140° (-2.44rad)
	J6-axis	450° (7.85rad) / -450° (-7.85rad)
Maximum speed (Note 2)	J1-axis	195°/sec (3.40rad/s)
	J2-axis	175°/sec (3.05rad/s)
	J3-axis	180°/sec (3.14rad/s)
	J4-axis	405°/sec (7.07rad/s)
	J5-axis	405°/sec (7.07rad/s)
	J6-axis	615°/sec (10.73rad/s)
Maximum load	At wrist	20kg
	On J3 arm (NOTE 3)	12kg
Allowable load moment at wrist	J4-axis	45.1Nm(kgf·m) (4.6kgf·m)
	J5-axis	45.1Nm(kgf·m) (4.6kgf·m)
	J6-axis	30.0Nm(kgf·m) (3.1kgf·m)
Allowable load inertia at wrist	J4-axis	2.01kg·m ² (20.42 kgf·cm·s ²)
	J5-axis	2.01kg·m ² (20.42 kgf·cm·s ²)
	J6-axis	1.01kg·m ² (10.26 kgf·cm·s ²)
Repeatability		±0.08mm
Robot mass		250kg
Acoustic noise level		Less than 70dB (Note 4)
Installation environment		Ambient temperature: 0 to 45°C (Note 5) Ambient humidity: Normally 75%RH or less (No dew or frost allowed) Short time 95%Rhor less (Within 1 month) Permissible altitude: Above the sea 1000m or less Vibration acceleration : 4.9m/s ² (0.5G) or less Free of corrosive gases (Note 6)

NOTE

- 1 Under the installation condition within (), motion range will be limited only when high inertia mode. See Section 3.6.
- 2 In case of short distance motion, the axis speed may not reach the maximum value stated.
- 3 Maximum load on J3 arm depends on load of wrist. See Section 4.2 in detail.
- 4 This value is equivalent continuous A-weighted sound pressure level, which applied with ISO11201 (EN31201). This value is measured with the following conditions.
-Maximum load and speed
-Operating mode is AUTO
- 5 When robot is used in low temperature environment that is near to 0°C, or robot is not operated for a long time in the environment that is less than 0°C 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.
- 6 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.

Table 3.1 (a) The dustproof and waterproof characteristics of ARC Mate 120iC, ARC Mate 120iC/10L

	Normal specification
Wrist (*) + J3 arm	IP54
Other part	IP54

Table 3.1 (b) The dustproof and waterproof characteristics of M-20iA, M-20iA/10L, M-20iA/20M

	Normal specification	Severe dust/liquid protection option
Wrist (*) + J3 arm	IP67	IP67
Other part	IP54	IP55

(*)

It does not include conduit part. M/H conduit and No dust M/H conduit do not have dustproof and waterproof characteristic. Refer to Chapter 10 and 11 for details.

NOTE

Definition of IP code

Definition of IP 67

6 = Dust-tight

7 = Protection from water immersion

Definition of IP 55

5 = Dust-protected

5 = Protection from water jet

Definition of IP 54

5 = Dust-protected

4 = Protection from splashing water

Performance of resistant chemicals and resistant solvents

- (1) The robot (including severe dust/liquid protection model) cannot be used with the following liquids because there is fear that rubber parts (gasket, oil seal, O-ring etc.) will corrode.
 - (a) Organic solvents
 - (b) Coolant including chlorine / gasoline
 - (c) Aminergic detergent
 - (d) Acid, alkali and liquid causing rust
 - (e) Other liquids or solutions, that will harm NBR
- (2) When the robots work in the environment, using water or liquid, complete draining of J1 base must be done. Incomplete draining of J1 base will make the robot break down.
- (3) Don't use unconfirmed liquid.

3.2 MECHANICAL UNIT OPERATION AREA AND INTERFERENCE AREA

Fig. 3.2(a), (b) show 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.

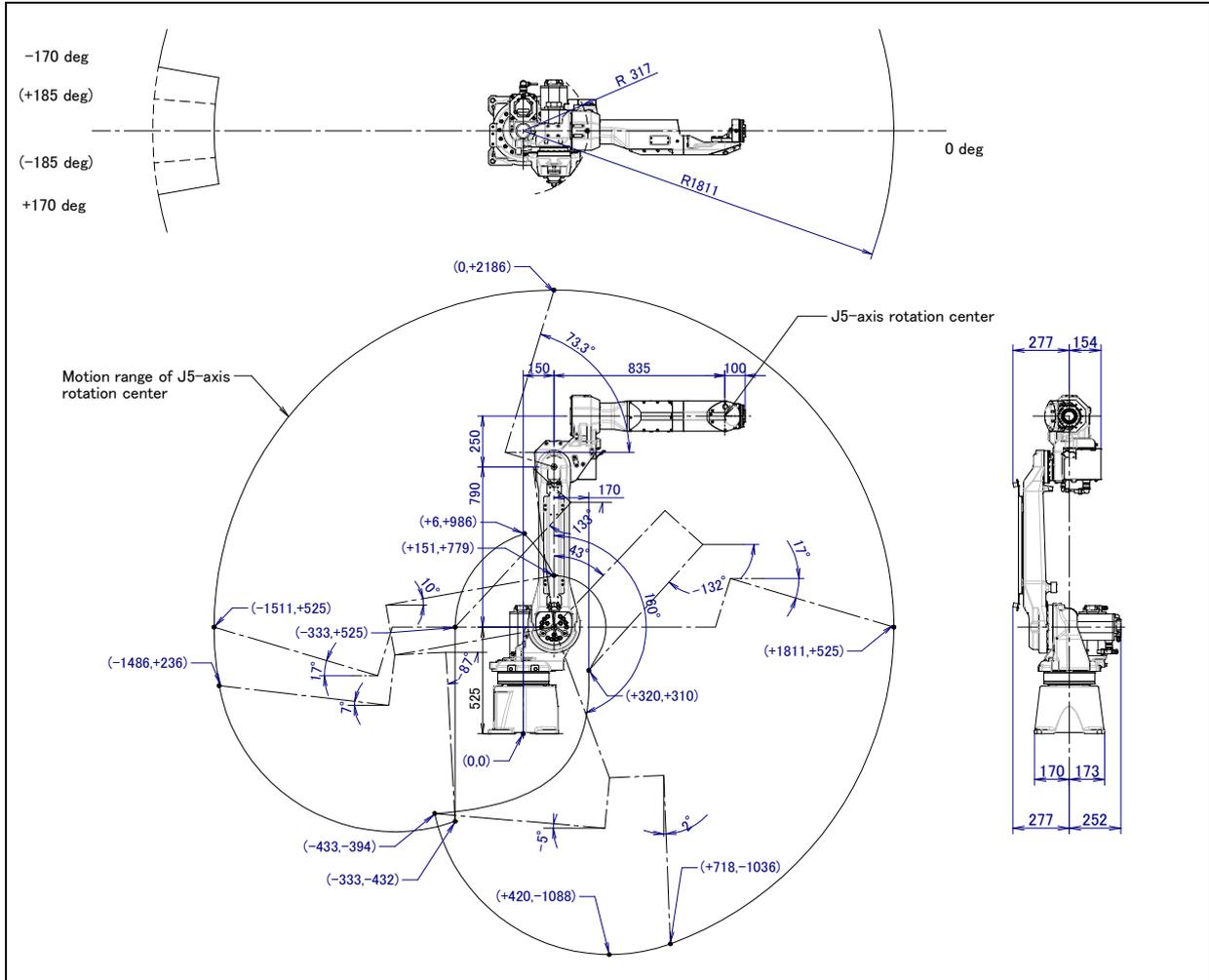


Fig. 3.2 (a) Interference area (ARC Mate 120iC, M-20iA)

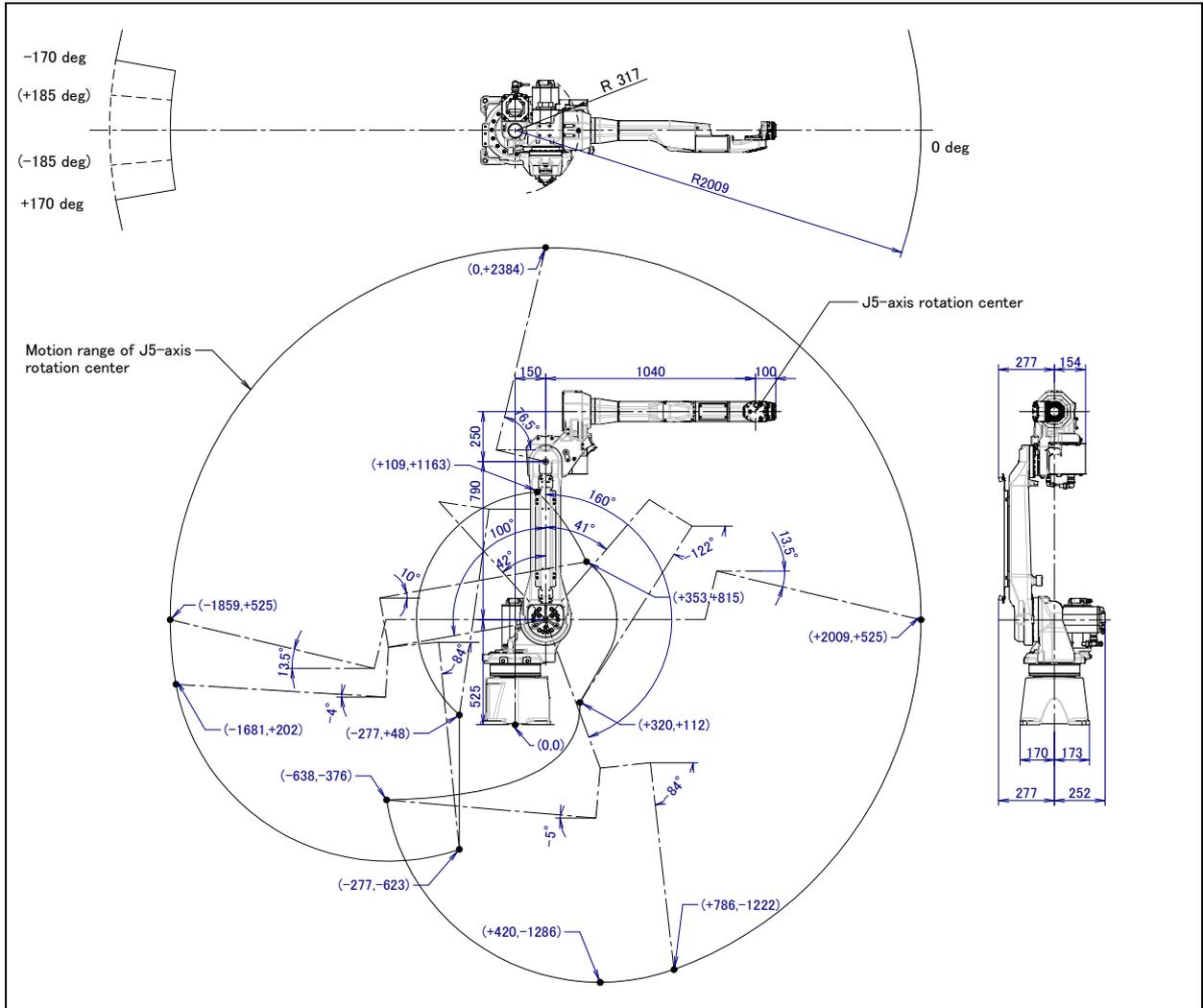


Fig. 3.2 (b) Interference area (ARC Mate 120iC/10L, M-20iA/10L)

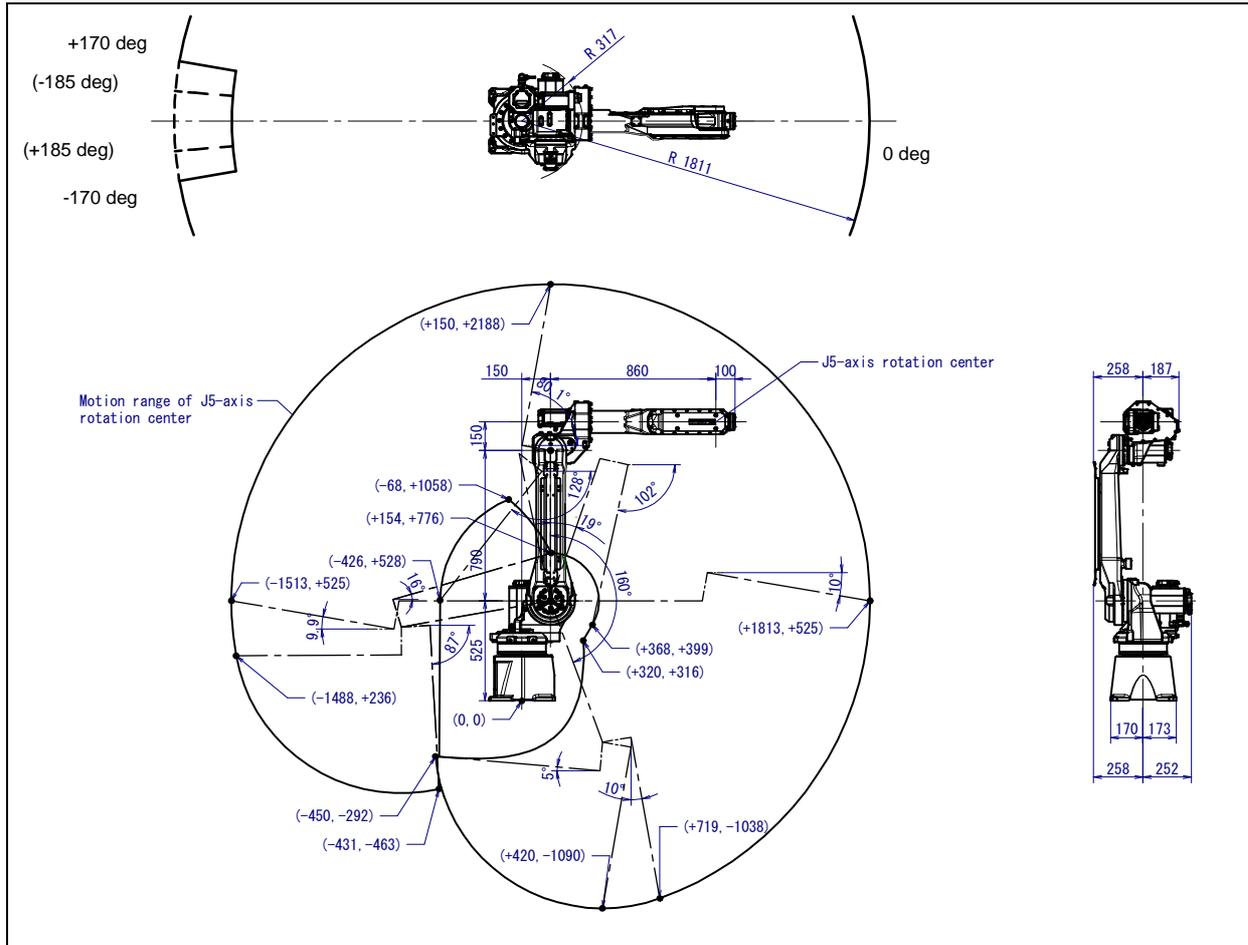


Fig. 3.2 (c) Interference area (M-20iA/20M)

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.

In case of J1 to J3-axis, robot stops by transforming mechanical stopper. Be sure to exchange transformed stopper to new one referring to Fig.3.3 (a). Don't reconstruct the mechanical stopper. There is a possibility that the robot doesn't stop normally.

Fig.3.3 (b) to (k) 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".

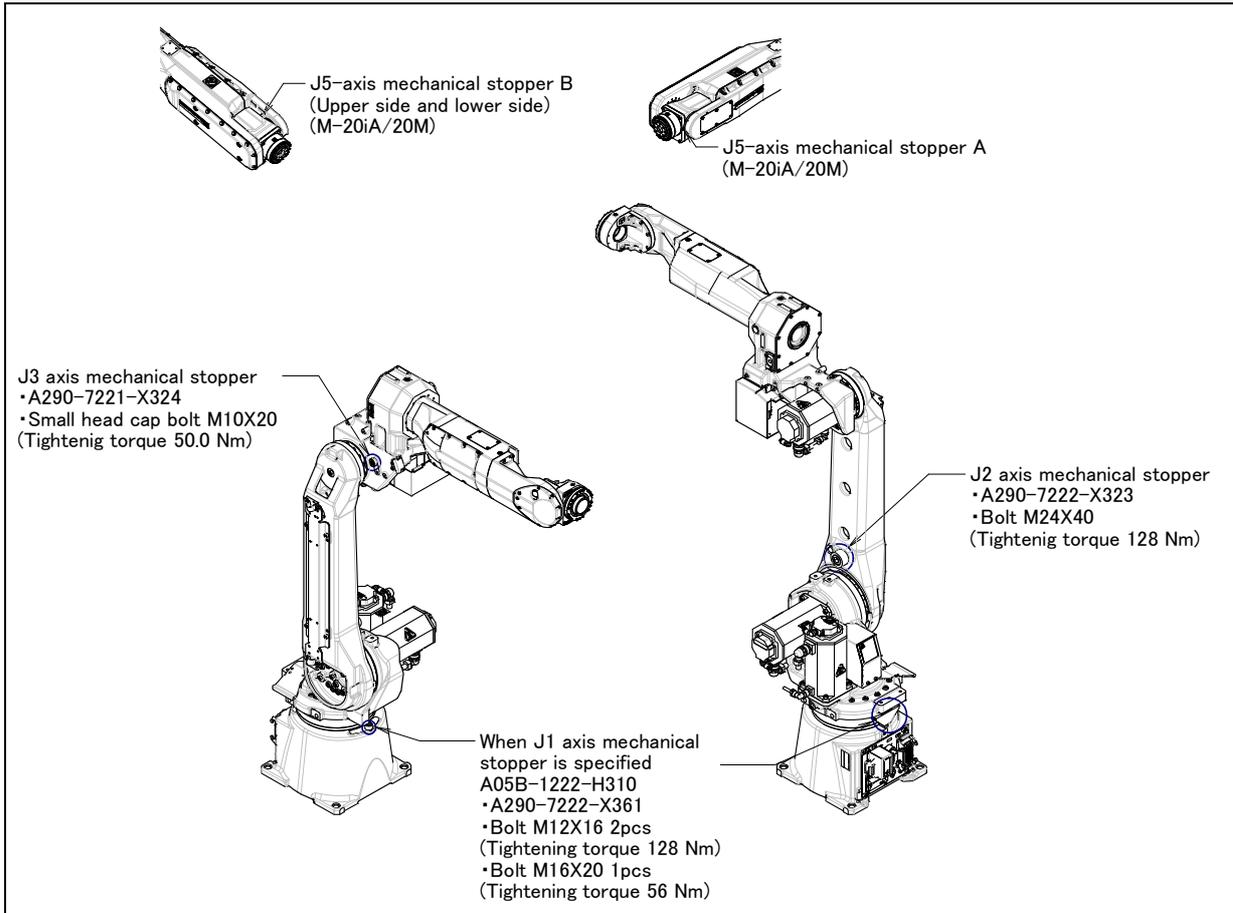


Fig. 3.3 (a) Position of mechanical stopper

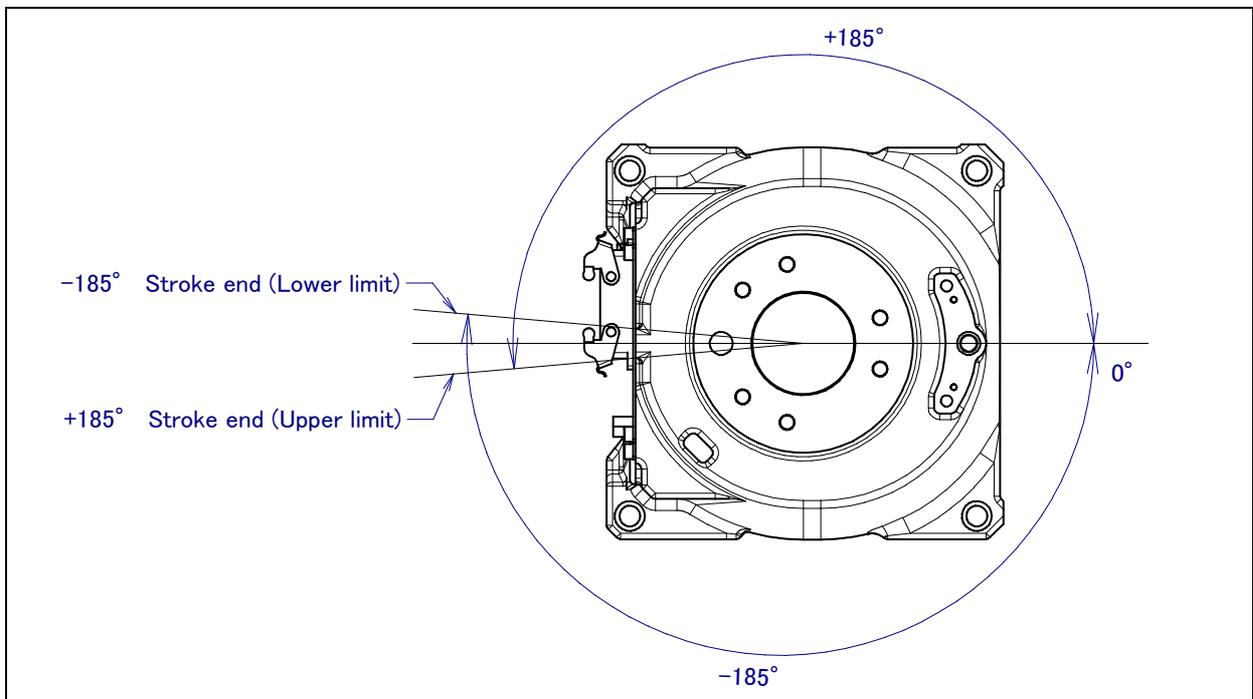


Fig. 3.3 (b) J1-axis motion limit (When mechanical stopper is not selected)

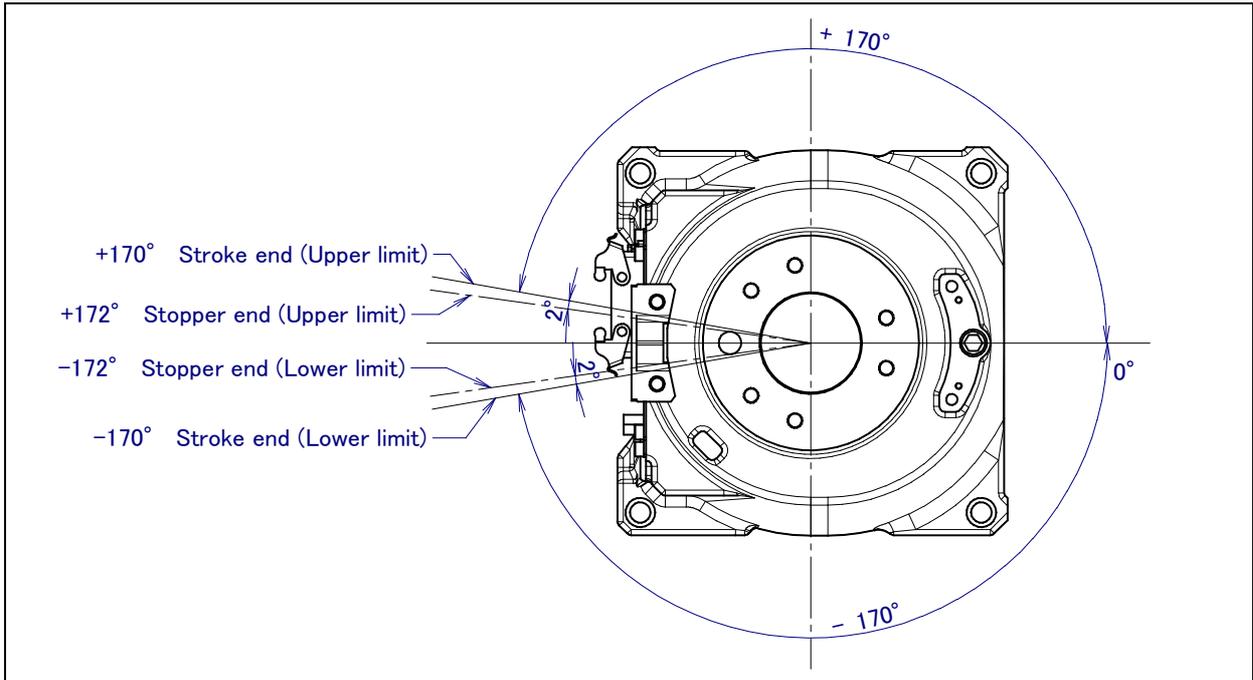


Fig. 3.3 (c) J1-axis motion limit (When mechanical stopper is selected)

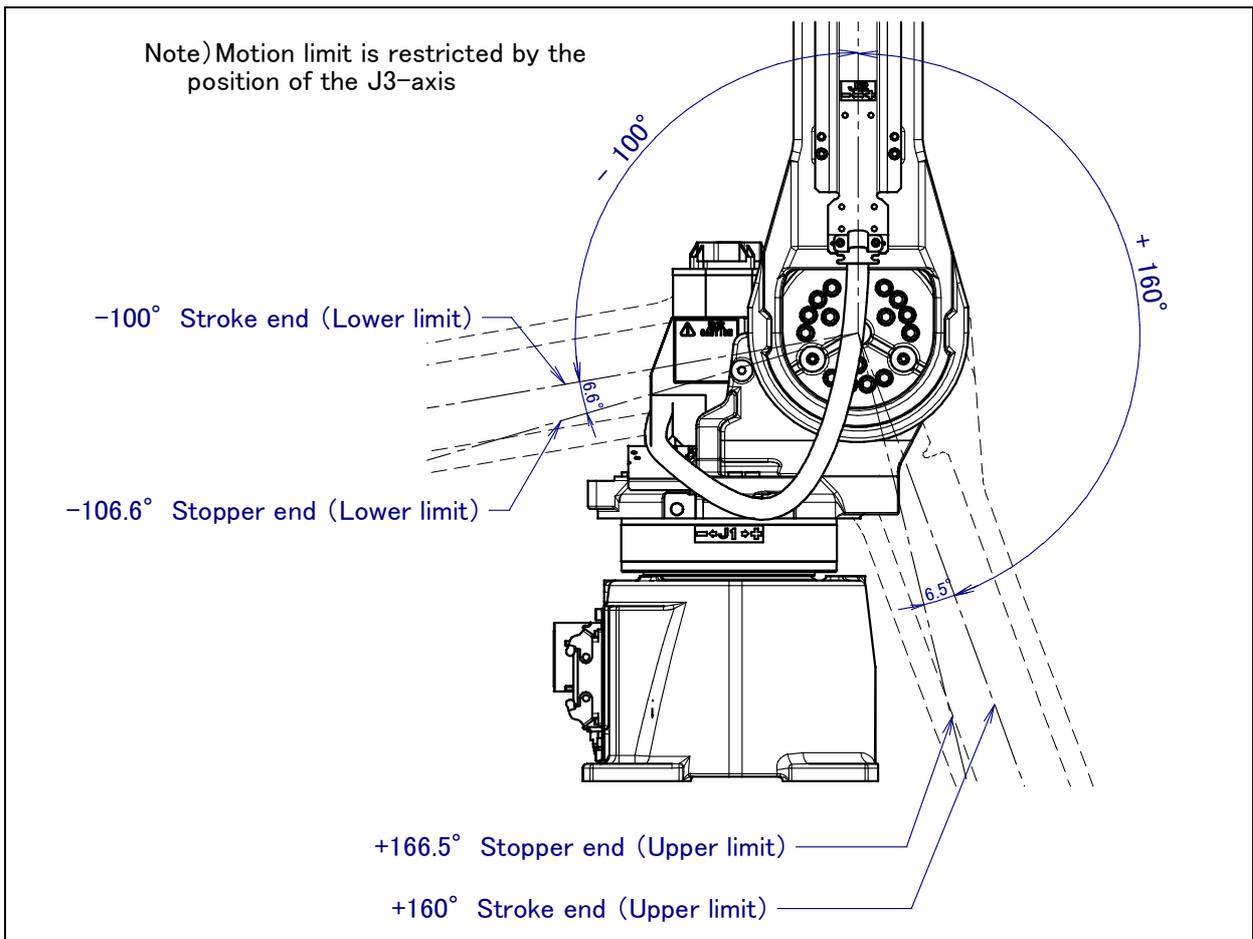


Fig. 3.3 (d) J2-axis motion limit

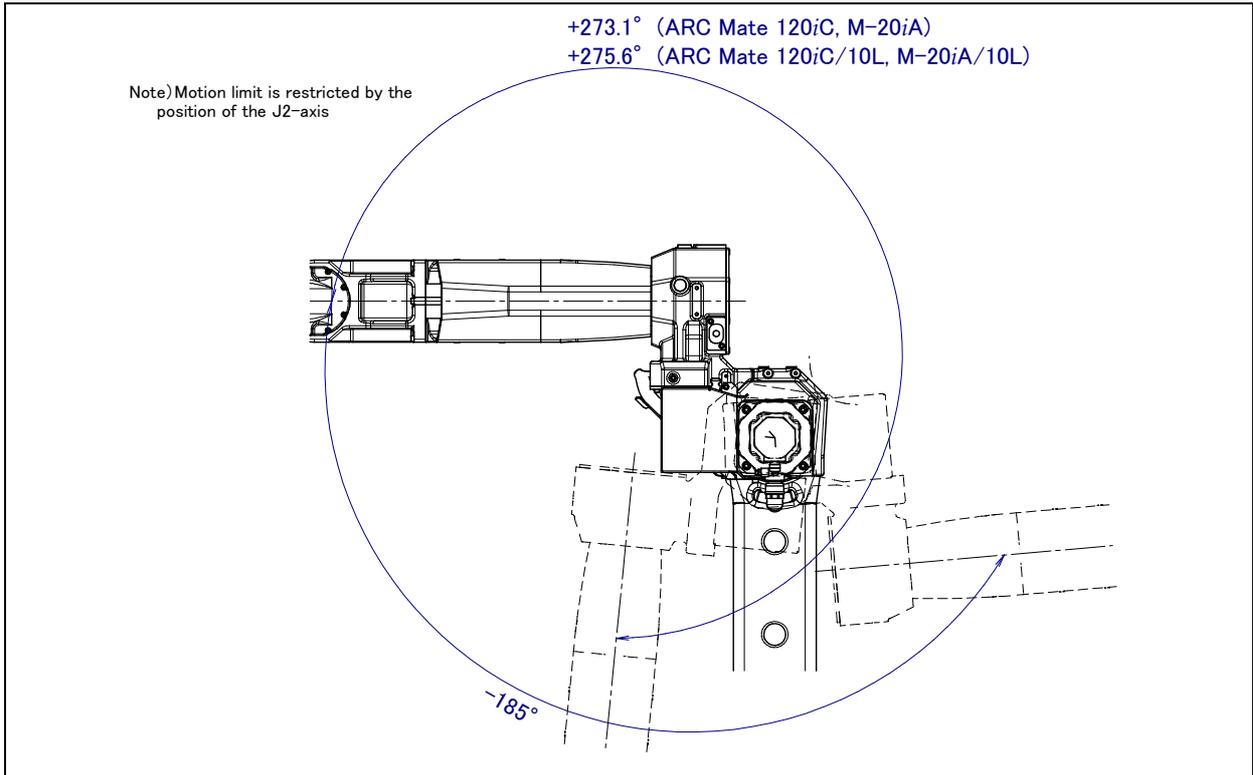


Fig. 3.3 (e) J3-axis motion limit

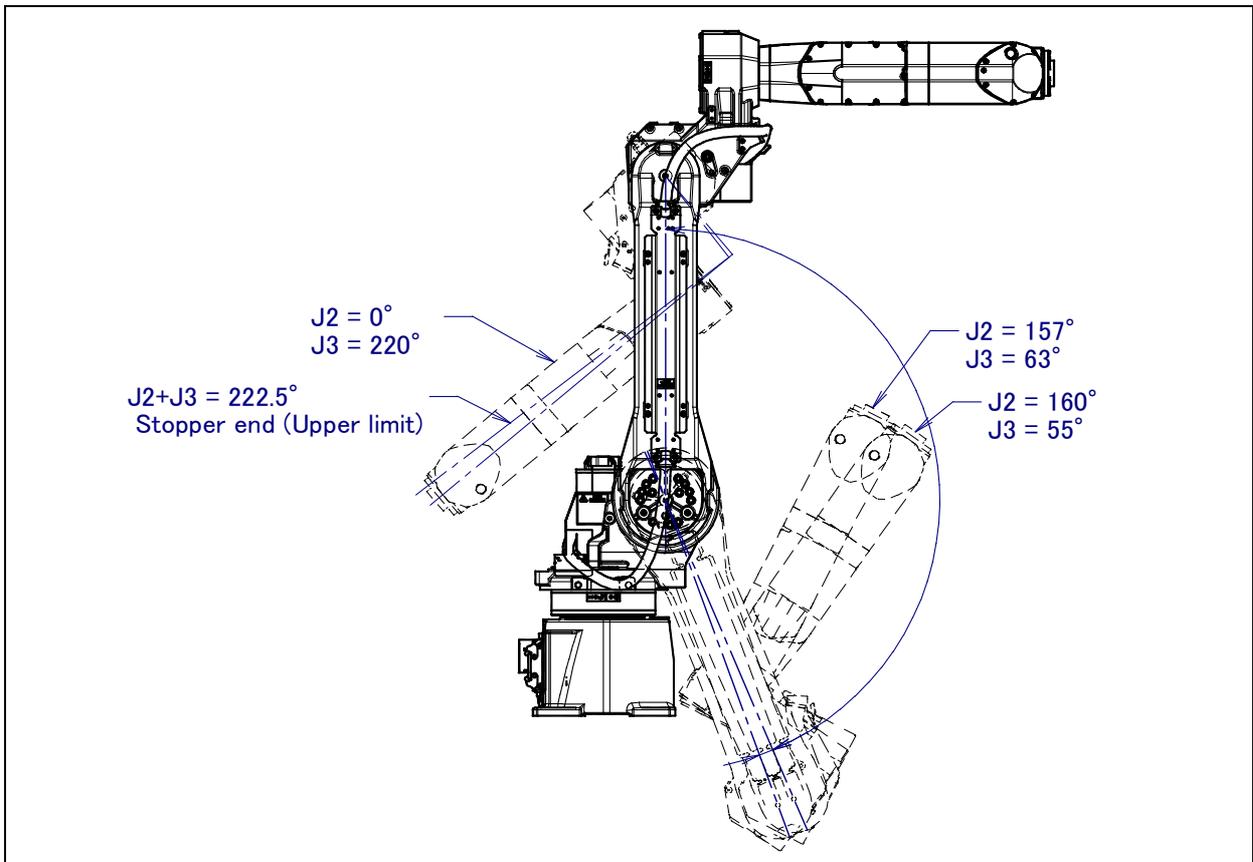


Fig. 3.3 (f) J2, J3-axis motion limit (Upper limit)

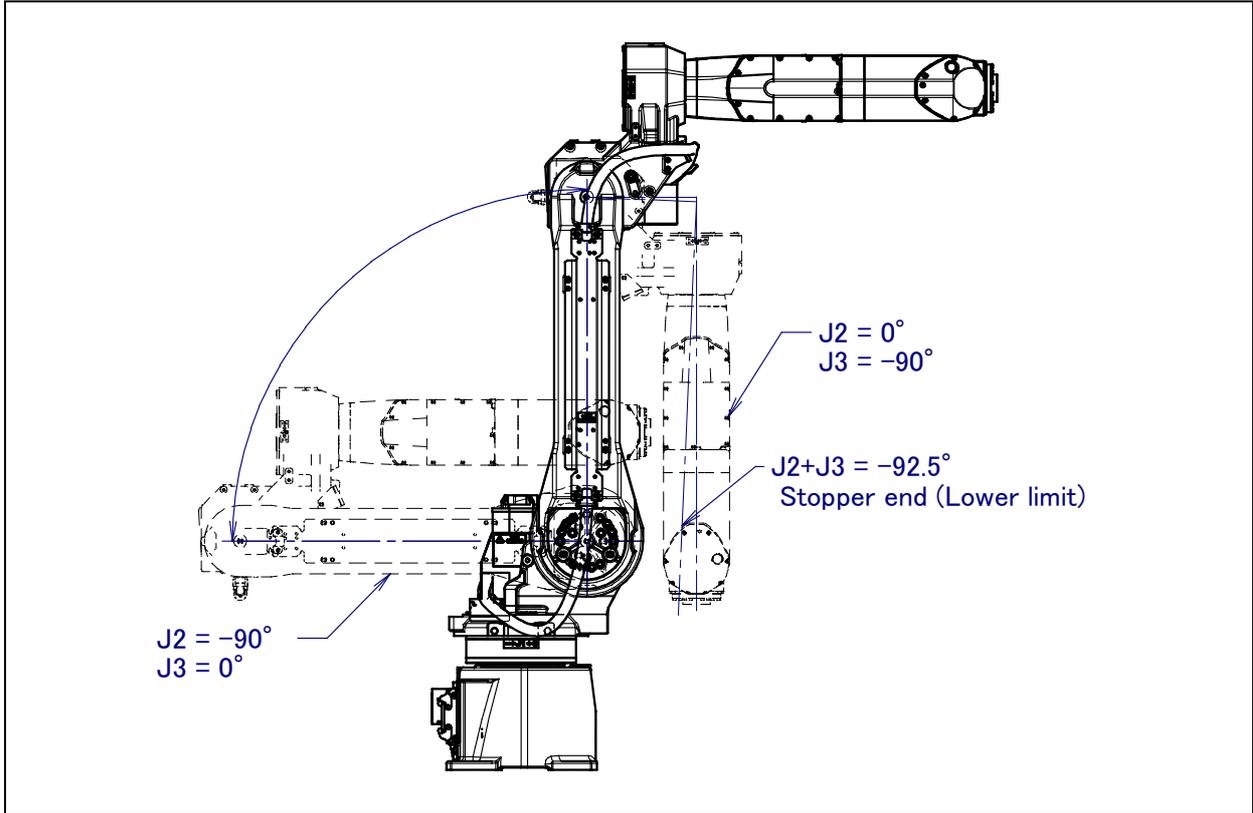


Fig. 3.3 (g) J2, J3-axis motion limit (Lower limit)

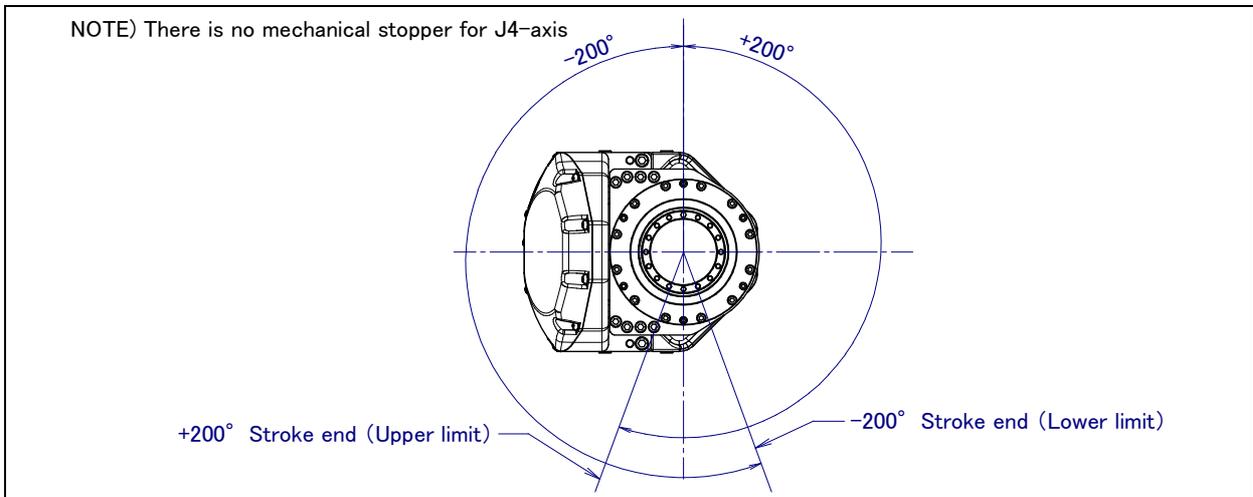
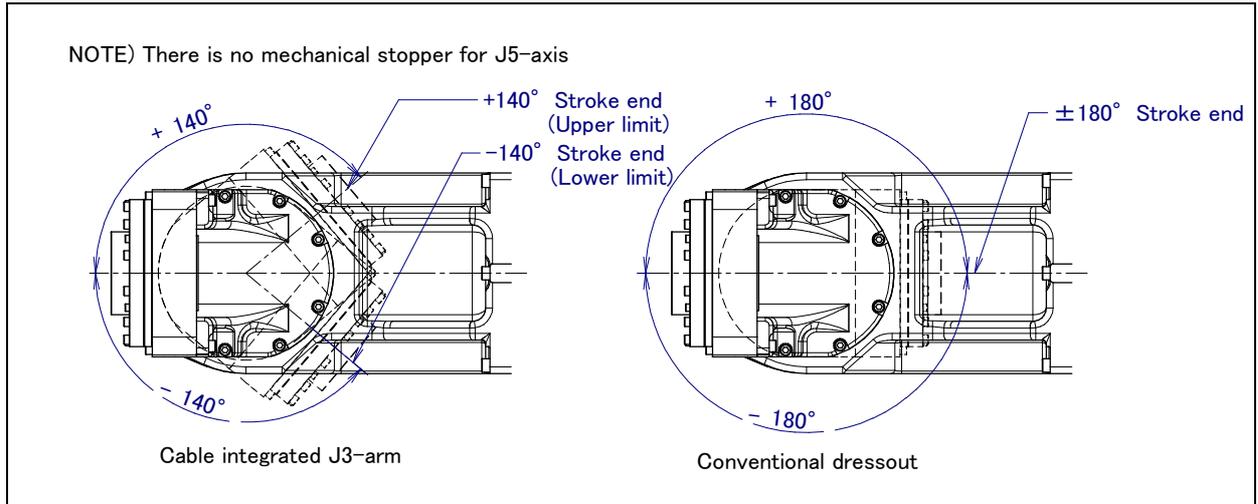
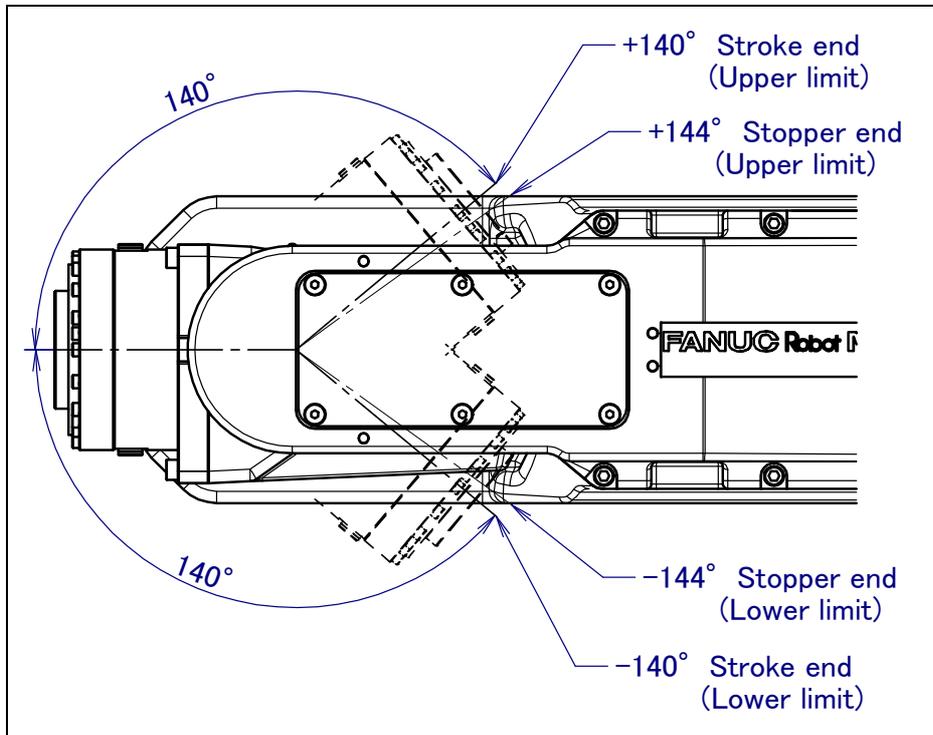


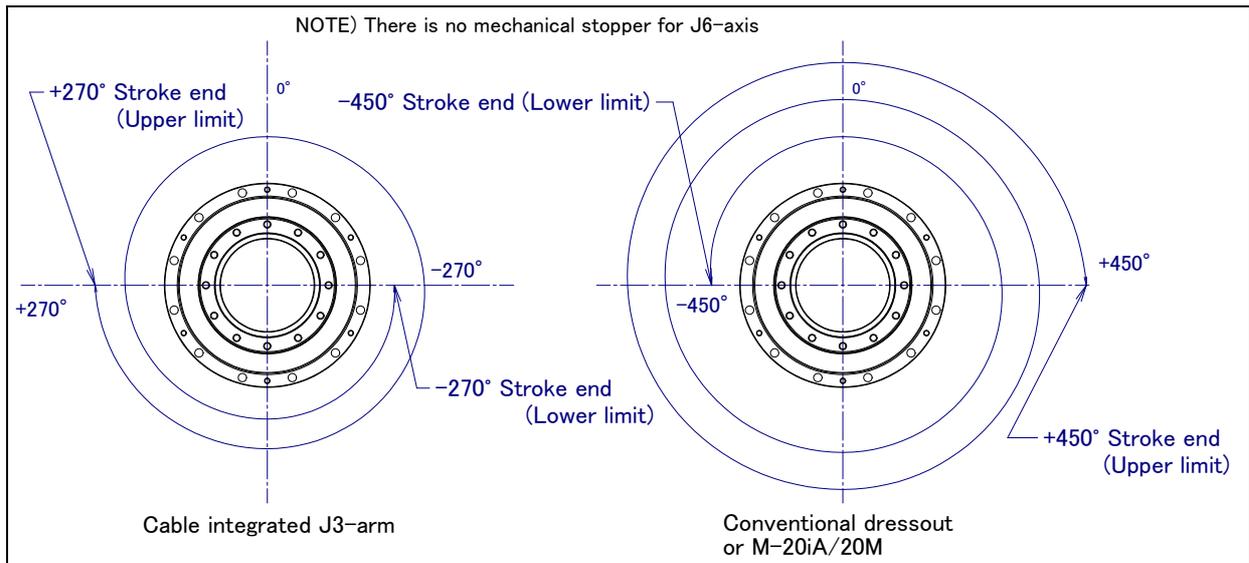
Fig. 3.3 (h) J4-axis motion limit



**Fig. 3.3 (i) J5-axis motion limit
(ARC Mate 120iC, M-20iA, ARC Mate 120iC/10L, M-20iA/10L)**



**Fig. 3.3 (j) J5-axis motion limit
(M-20iA/20M)**



3.4 ABOUT THE SETTING OF THE MOTION RANGE OF THE ROBOT

In ARC Mate 120iC, Cable is integrated hollow part of J3 arm is standard. (It is “Cable integrated J3 Arm type” in the following). When the robot is shipped, is set to the range of motion of “Cable integrated J3 arm type”.

The case where conduit is inserted in the J3 arm hollow part, and the cable is passed as shown in Fig. 3.4 is defined as "Cable integrated J3 arm".

Other than the above-mentioned, the case where the cable is passed outside of the J3 arm is defined as "Conventional dress-out" and the case of where the option of no dust M/H conduit is defined as "No dust M/H conduit".

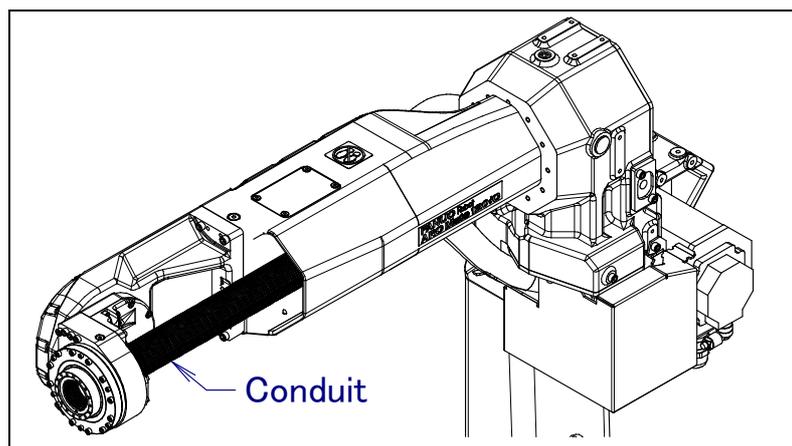


Fig. 3.4 Example of “Cable integrated J3 arm”

When robot is used with “Conventional dress-out” or “No dust M/H conduit”, robot needs to be changed the motion range. Set the motion range by the following methods.

- 1 Perform a Controlled Start.
- 2 Set “Conventional dress-out” or “No dust M/H conduit” on the robot initialization screen
- 3 Perform a Cold Start.

1: Cable integrated J3 arm
(J5:-140 .. 140, J6:-270 .. 270[deg])
 2: Conventional dress-out
(J5:-190 .. 190, J6:-360 .. 360[deg])
 3: No dust M/H conduit
(J5:-120 .. 120, J6:-270 .. 270[deg])

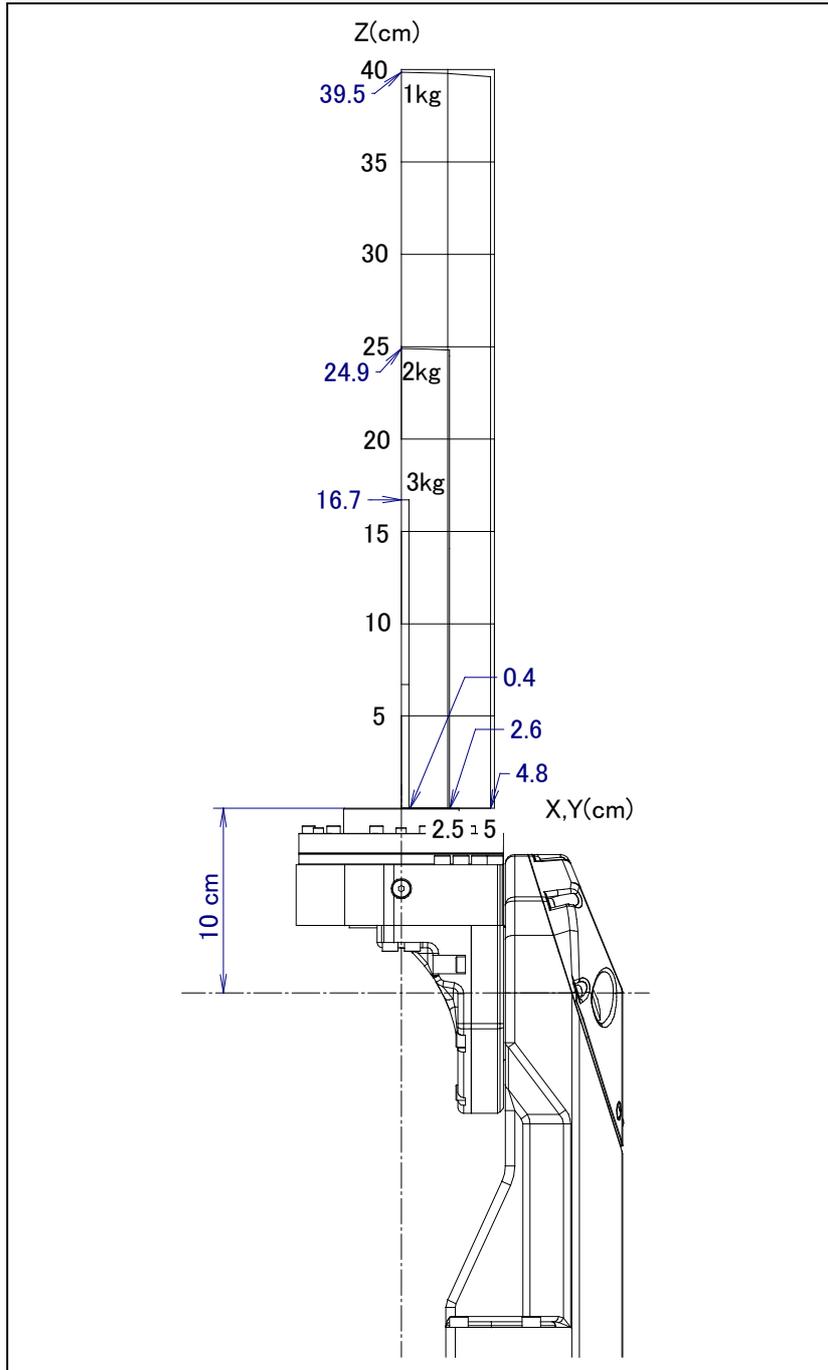
Select cable dress-out type (1 or 2 or 3) ->

- 1) Note about “Cable integrate J3 arm” type
The range of motion of “1” is a set value when the hand (torch and tool) cable which FANUC recommends is integrated in J3 arm. (Handling specification. M/H conduit option [A05B-1222-J701, J702] is needed. Refer to Section 10.3 about exchange cycle.) Other cases, please set range of motion and the regular exchange cycle of the wrist axis besides as well as the dress out according to the specification of installing hand (torch and tool) cable so far.
- 2) Note about “Conventional dress out” type
The range of motion of “2” is the one of the dress out type so far, and set the motion range and the regular exchange cycle of the wrist axis according to as usual installing hand (torch and tool) cable.
- 3) Note about “No dust M/H conduit” type
The range of motion of “3” is the motion range when the option of no dust M/H conduit is specified. Set the motion range and the regular exchange cycle of the wrist axis according to as usual installing hand (tool) cable. (Refer to Chapter 11 about exchange cycle.)

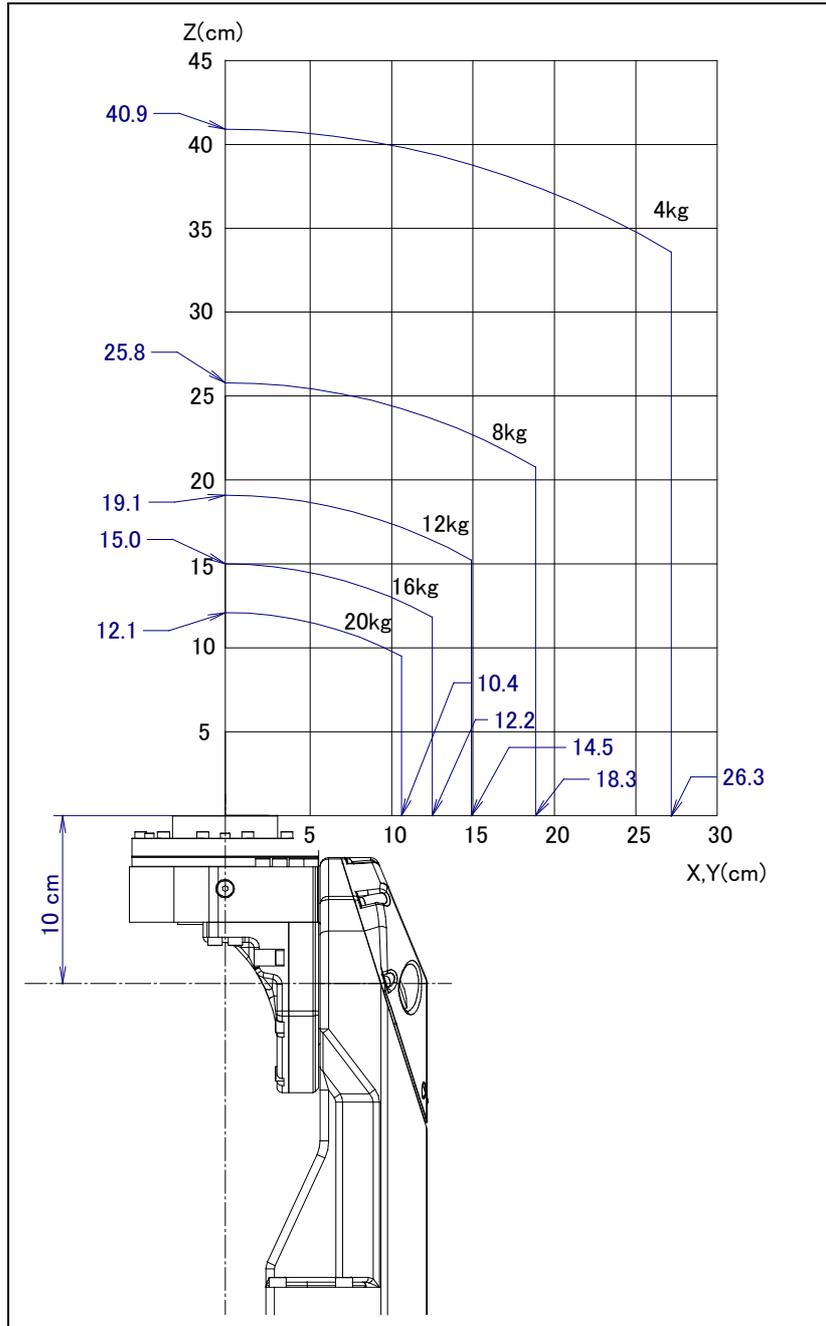
3.5 WRIST LOAD CONDITIONS

Fig. 3.5 (a) to (e) are diagrams to limit loads applied to the wrist.

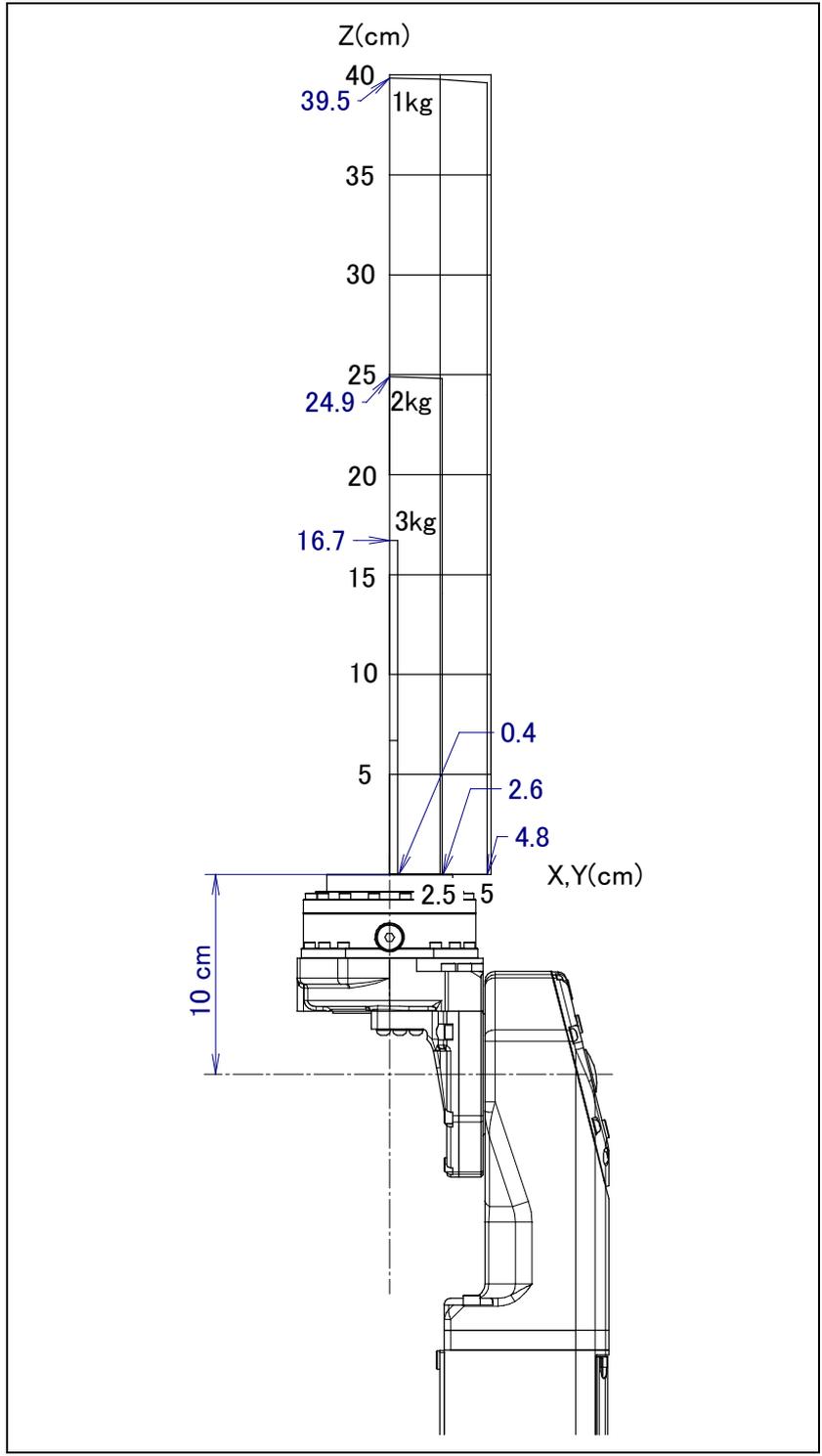
- Apply a load within the region indicated in the graph.
- Please use it to meet the requirement of the allowable load moment and inertia at wrist. See the 3.1 about allowable load moment and inertia at wrist.
- See Section 4.1 about mounting of end effector.



**Fig. 3.5 (a) Wrist load diagram
(ARC Mate 120iC/M-20iA 3kg wrist payload specification)**



**Fig. 3.5 (b) Wrist load diagram
(ARC Mate 120iC/M-20iA 20kg wrist payload specification)**



**Fig. 3.5 (c) Wrist load diagram
(ARC Mate 120iC/10L, M-20iA/10L 3kg wrist payload specification)**

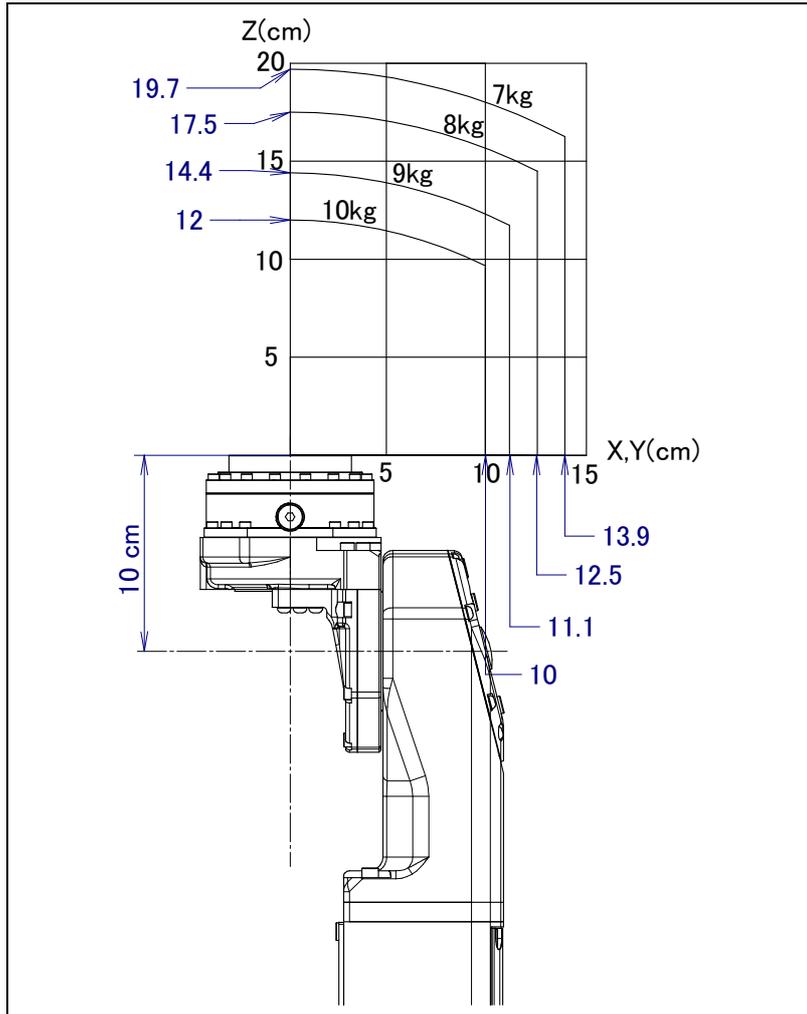


Fig. 3.5 (d) Wrist load diagram (ARC Mate 120iC/10L,M-20iA/10L 10kg wrist payload specification)

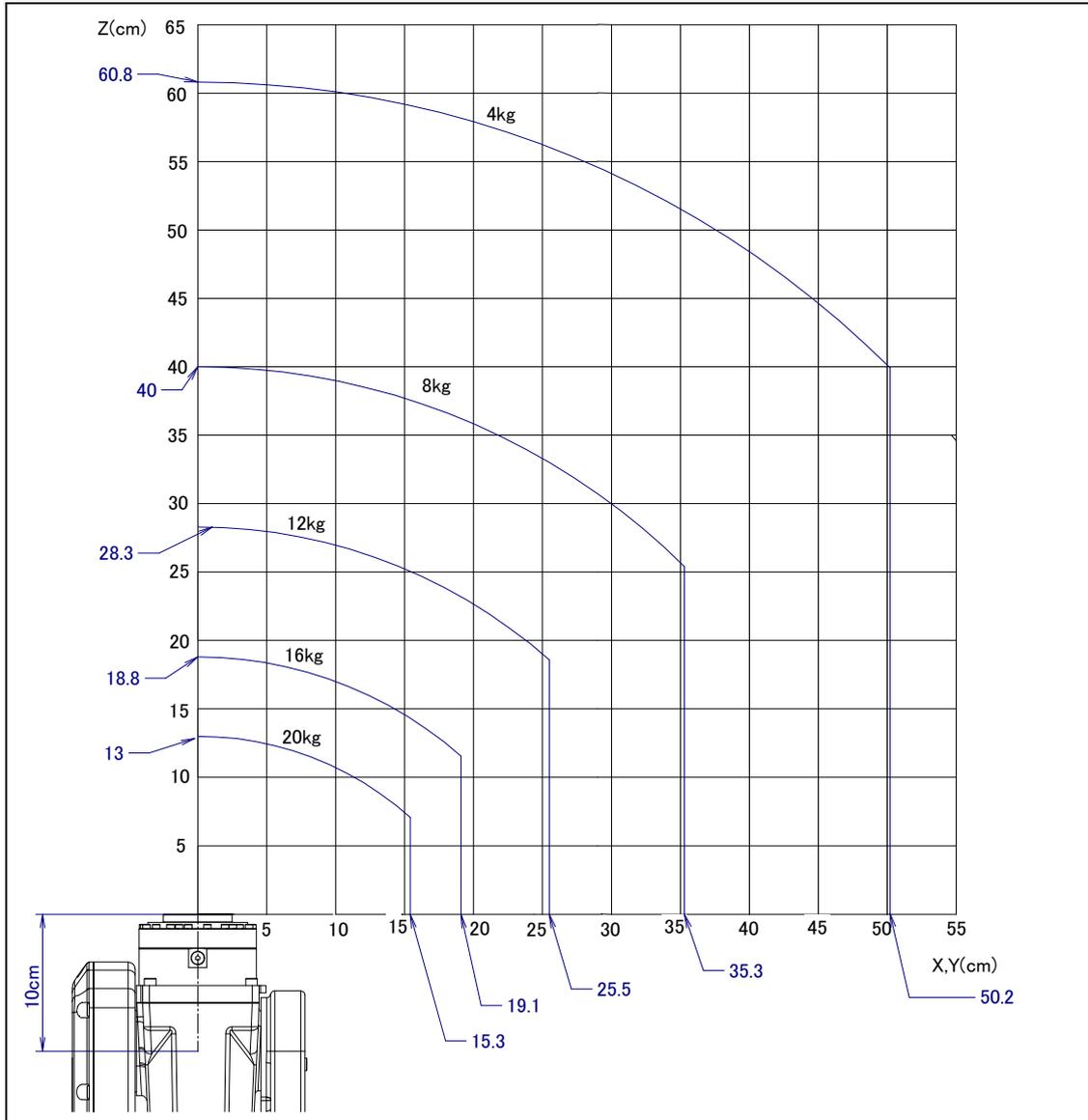


Fig. 3.5 (e) Wrist load diagram (M-20iA/20M)

3.6 OPERATING AREA FOR INCLINATION INSTALLATION

In case of High inertia mode (20 kg payload specification in case of ARC Mate 120iC, M-20iA, 10 kg payload specification in case of ARC Mate 120iC/10L, M-20iA/10L), when the robot is installed on an angle, the operating area is limited as the angle. The robot can't rest except for the ranges that are shown in the Fig. 3.6 (a) to (k).

In case of standard welding mode (3kg payload specification), there is no restriction for operating area.

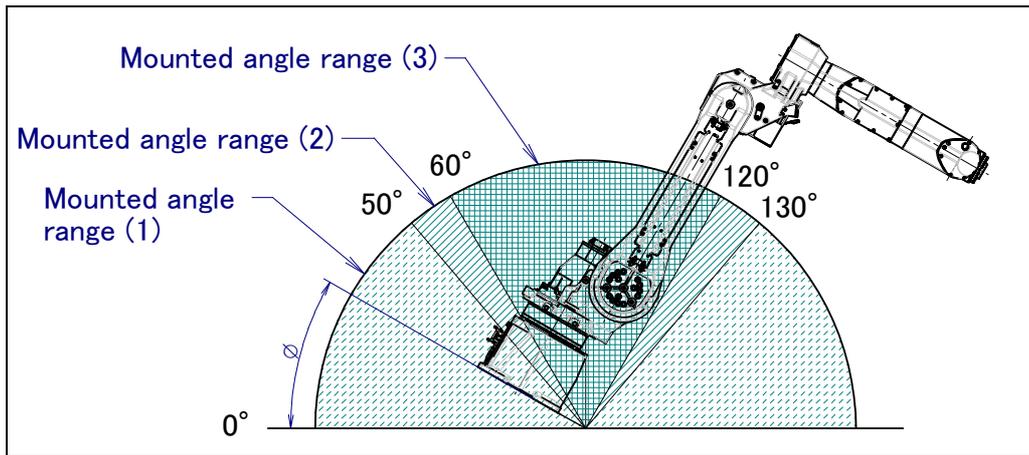


Fig.3.6 (a) Installation angle area (ARC Mate 120iC, M-20iA)

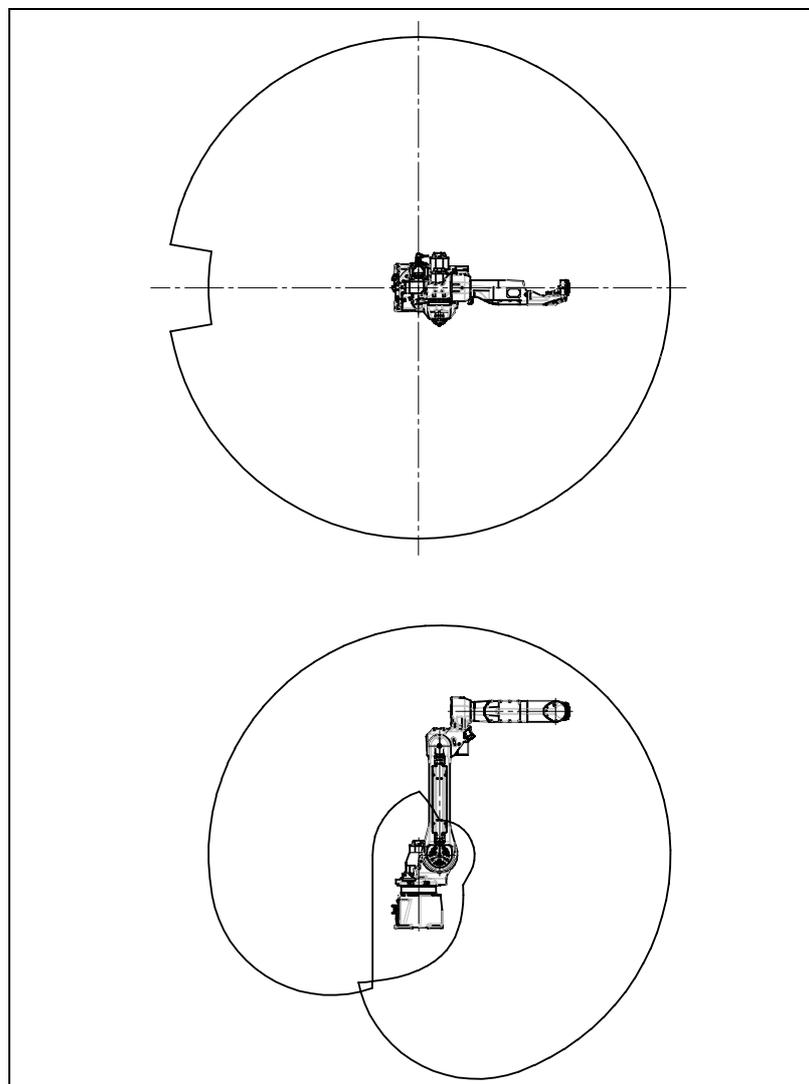


Fig.3.6 (b) Installation area (1) operation area (ARC Mate 120iC, M-20iA)
 $(0^\circ \leq \phi \leq 50^\circ, 130^\circ \leq \phi \leq 180^\circ)$

NOTE

In case of mounted angle (1), there is no operation area restriction.

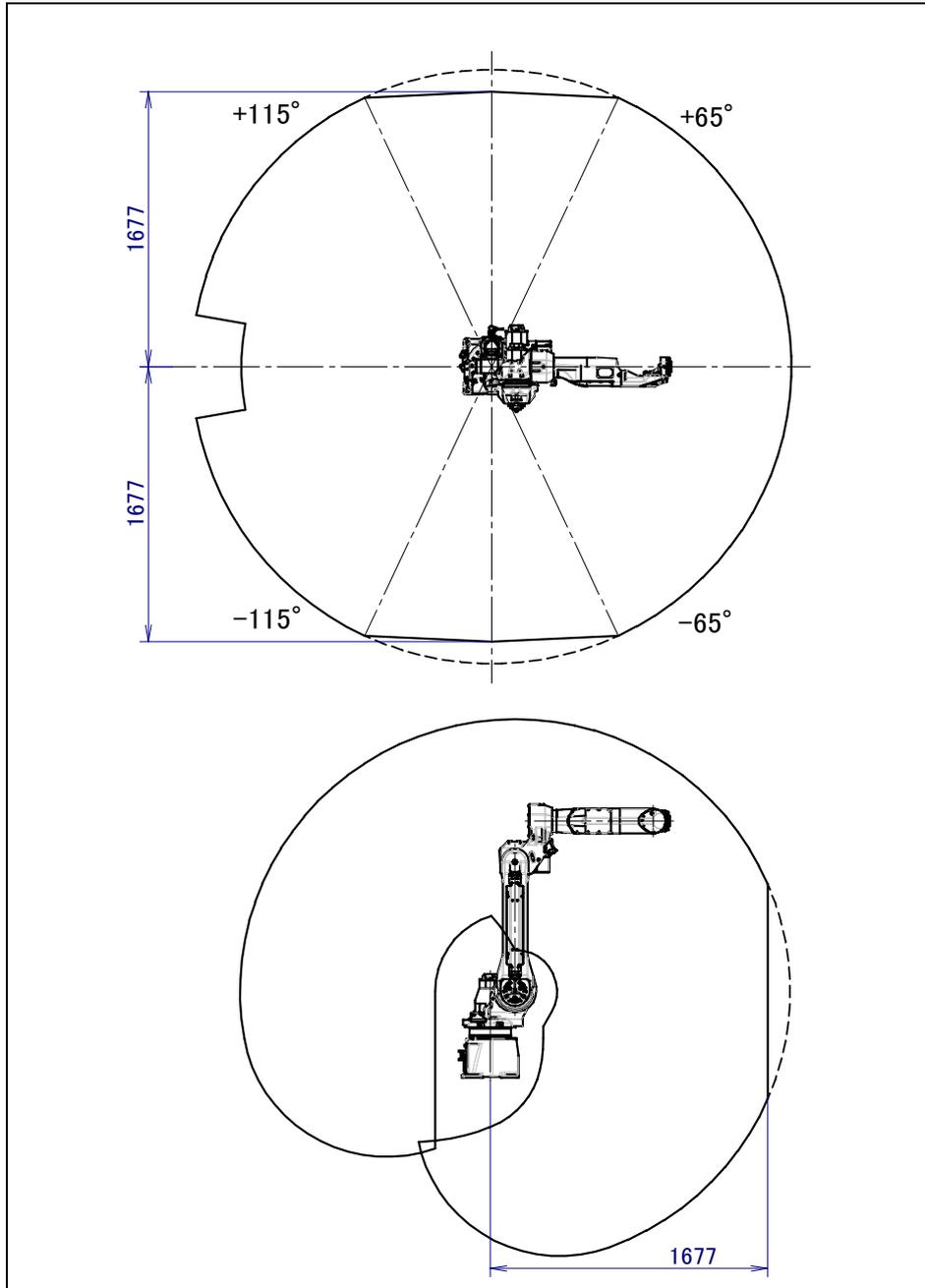


Fig.3.6 (c) Installation area (2) operation area (ARC Mate 120iC, M-20iA)
 ($50^\circ < \phi \leq 60^\circ$, $120^\circ \leq \phi < 130^\circ$)

NOTE

Robot can rest in a solid line range. The operation to a dotted line range becomes possible when not resting.

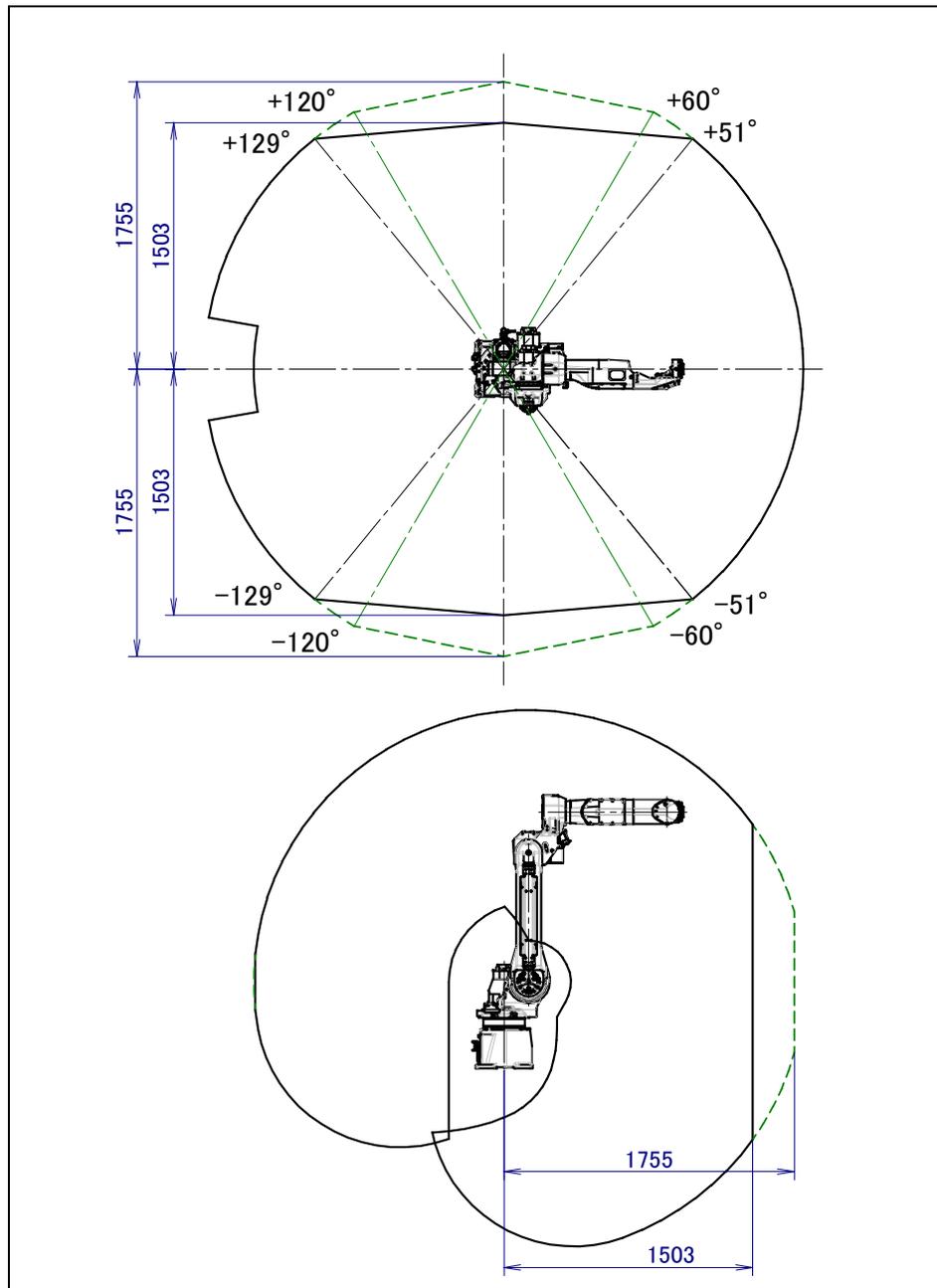


Fig.3.6 (d) Installation area (3) operation area (ARC Mate 120iC, M-20iA)
 $(60^\circ < \phi < 120^\circ)$

NOTE

Robot can rest in a solid line range. The operation to a dotted line range becomes possible when not resting.

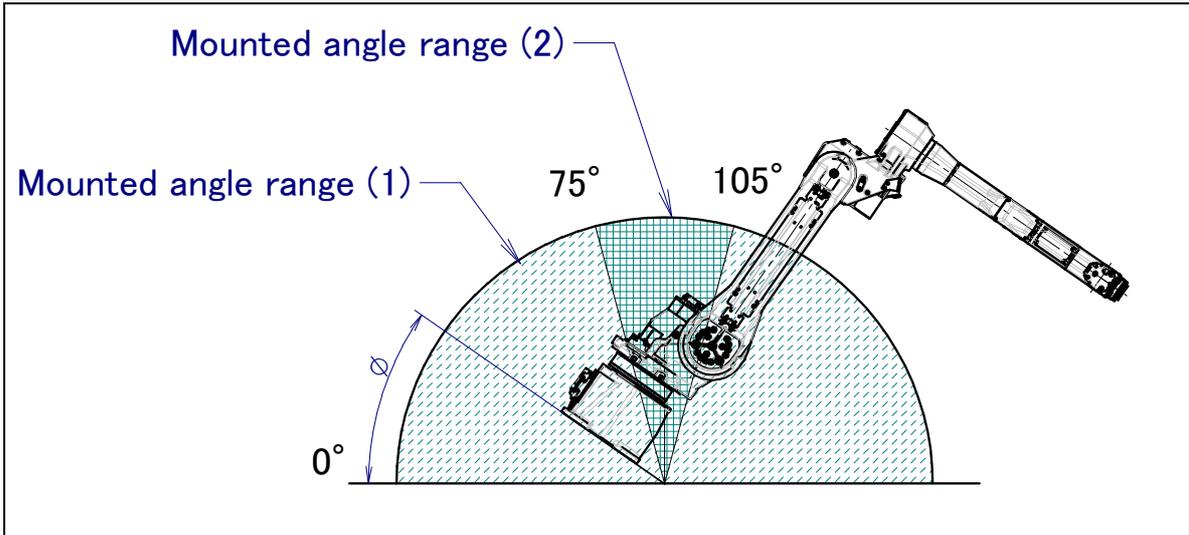


Fig.3.6 (e) Installation angle area (ARC Mate 120iC/10L, M-20iA/10L)

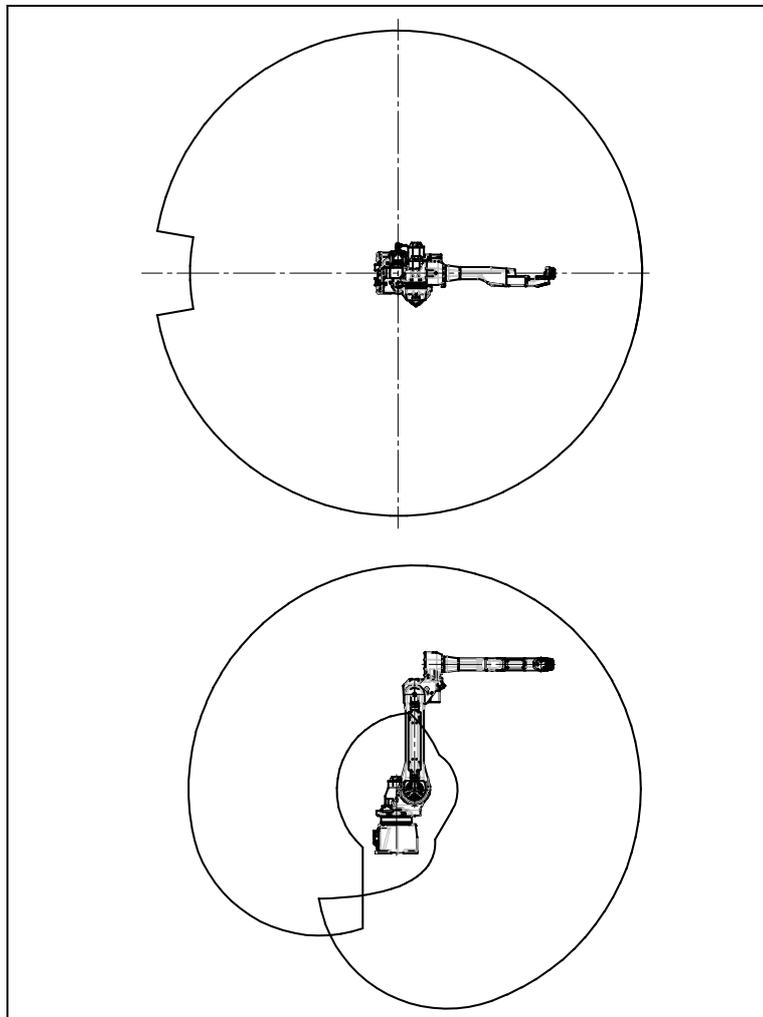


Fig.3.6 (f) Installation area (1) operation area (ARC Mate 120iC/10L, M-20iA/10L)
 $(0^\circ \leq \phi \leq 75^\circ, 105^\circ \leq \phi \leq 180^\circ)$

NOTE

In case of mounted angle (1), there is no operation area restriction.

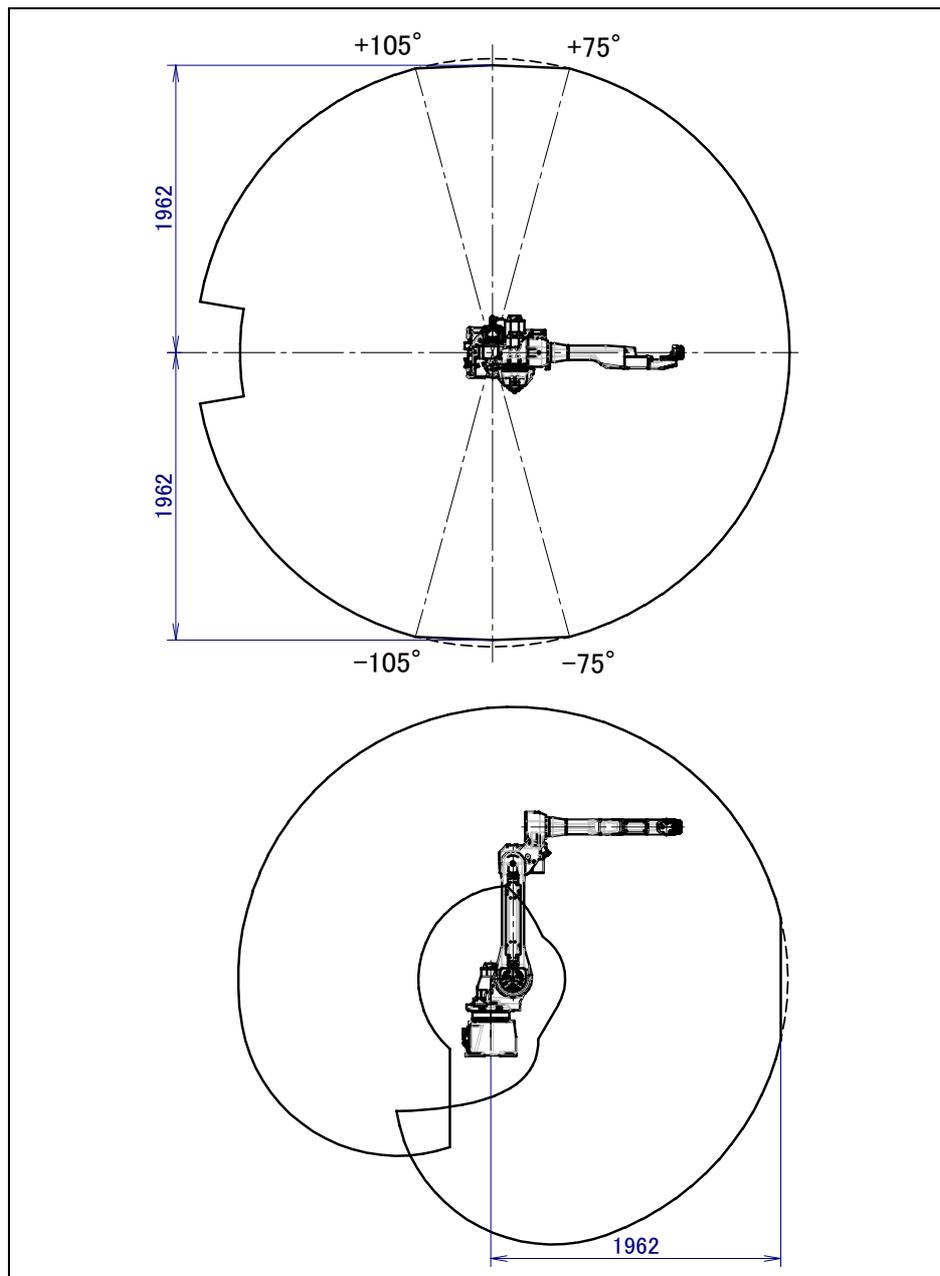


Fig.3.6 (g) Installation area (2) operation area (ARC Mate 120iC/10L, M-20iA/10L)
 $(75^\circ < \phi < 125^\circ)$

NOTE

Robot can rest in a solid line range. The operation to a dotted line range becomes possible when not resting.

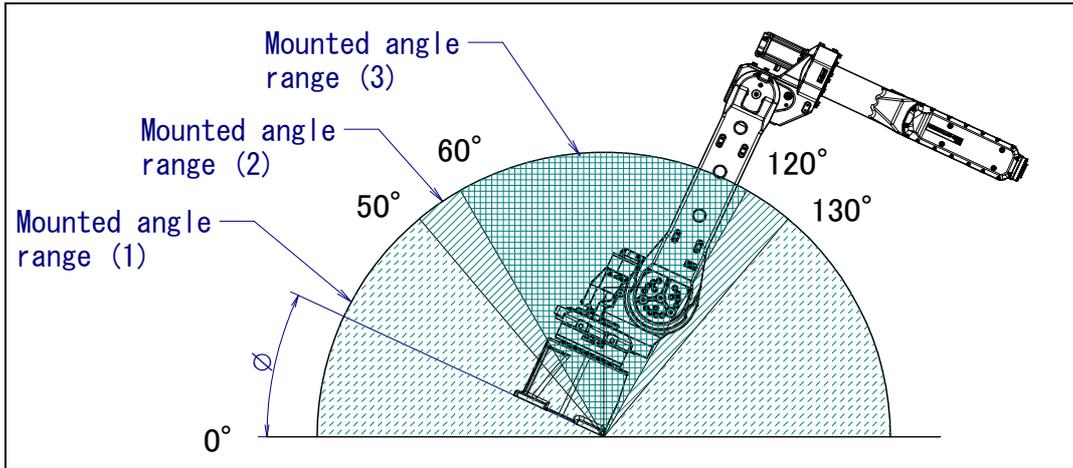


Fig.3.6 (h) Installation angle area (M-20iA/20M)

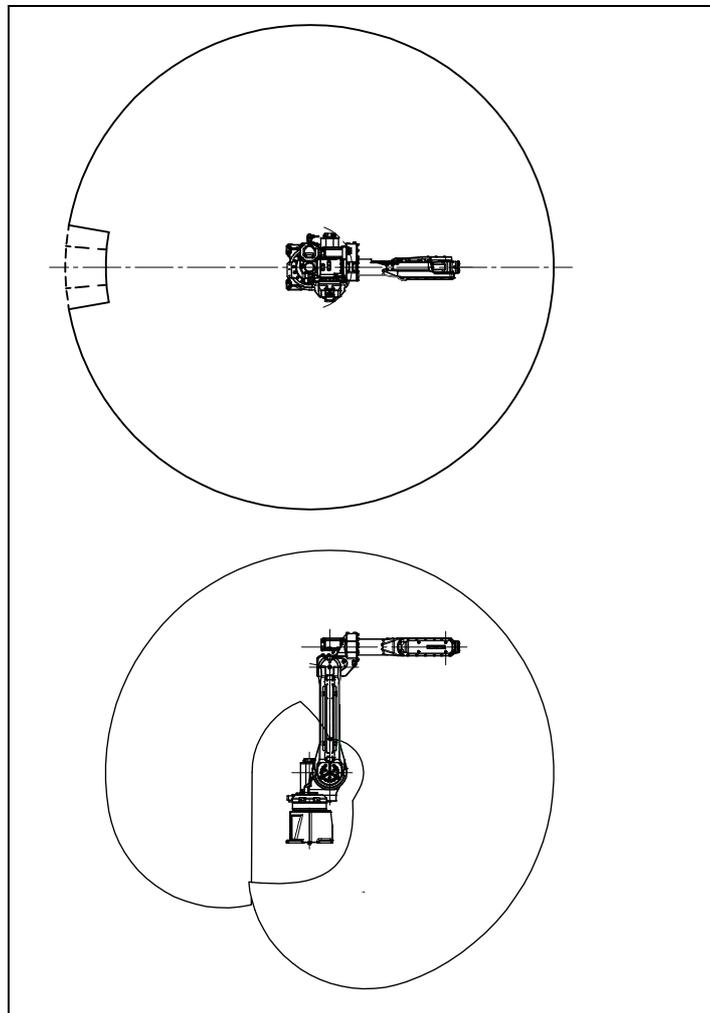


Fig.3.6 (i) Installation area (1) operation area (M-20iA/20M)
 $(0^\circ \leq \phi \leq 50^\circ, 130^\circ \leq \phi \leq 180^\circ)$

NOTE

In case of mounted angle (1), there is no operation area restriction.

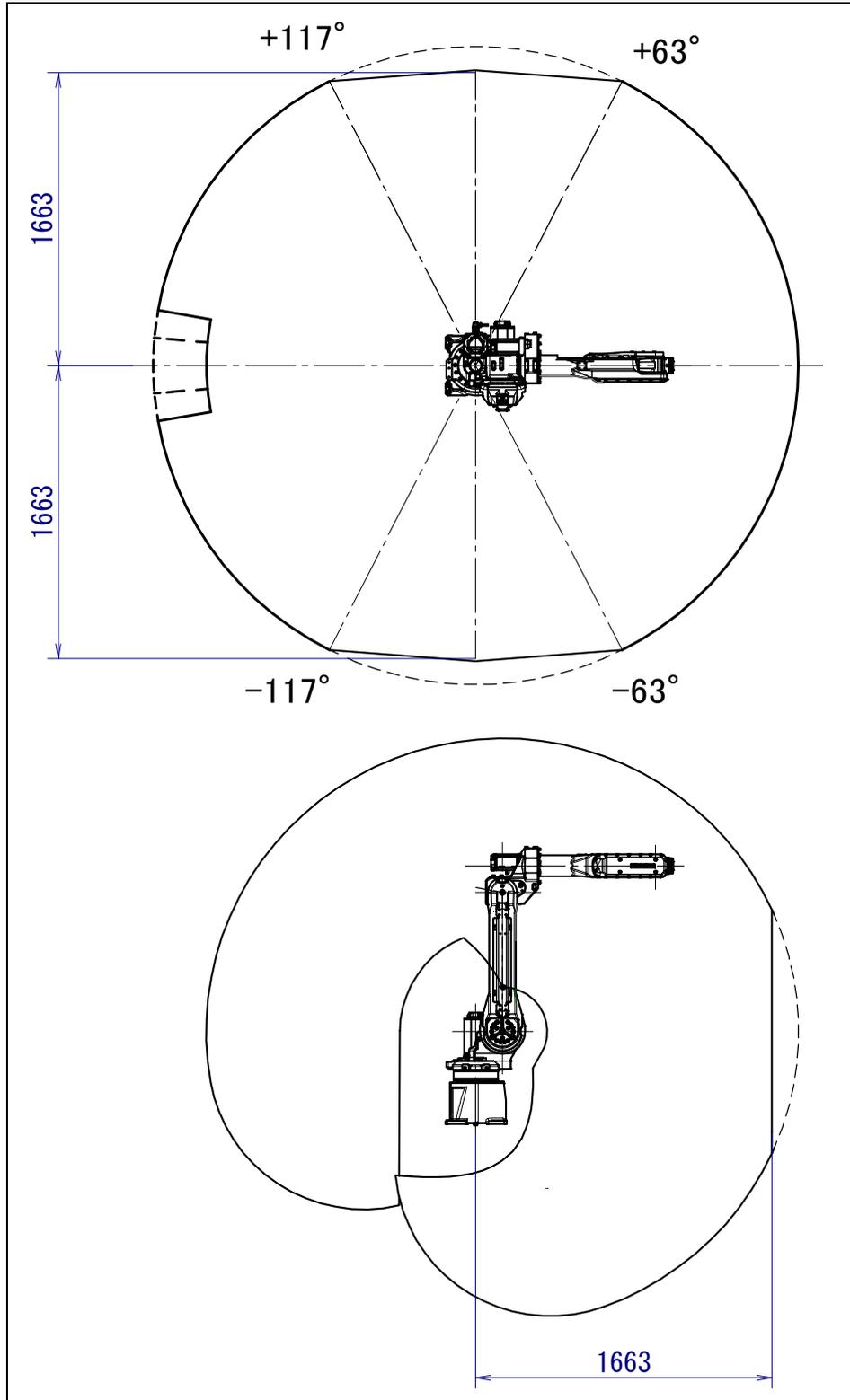


Fig.3.6 (j) Installation area (2) operation area (M-20iA/20M)
 ($50^\circ < \phi \leq 60^\circ$, $120^\circ \leq \phi < 130^\circ$)

NOTE

Robot can rest in a solid line range. The operation to a dotted line range becomes possible when not resting.

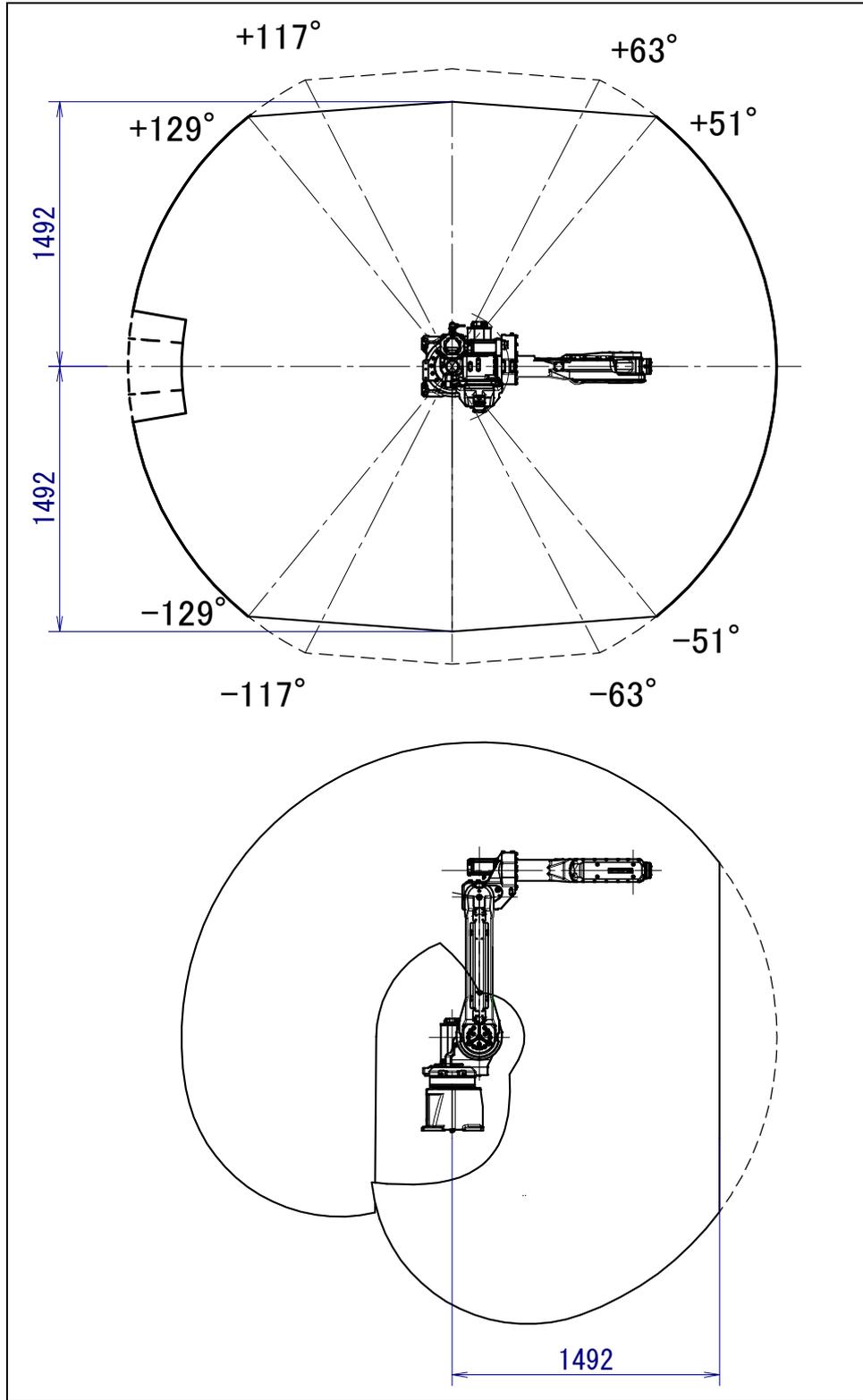


Fig.3.6 (k) Installation area (3) operation area (M-20iA/20M)
 ($60^\circ < \phi < 120^\circ$)

NOTE

Robot can rest in a solid line range. The operation to a dotted line range becomes possible when not resting.

4 MECHANICAL COUPLING TO THE ROBOT

4.1 MECHANICAL COUPLING OF END EFFECTOR TO WRIST

Fig. 4.1 (a) to (e) are the diagram for installing end effectors on the wrist. Select screws and positioning pins of a length that matches the depth of the tapped and pin holes. See Appendix B “Bolt tightening torque” about tightening torque.

**CAUTION**

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

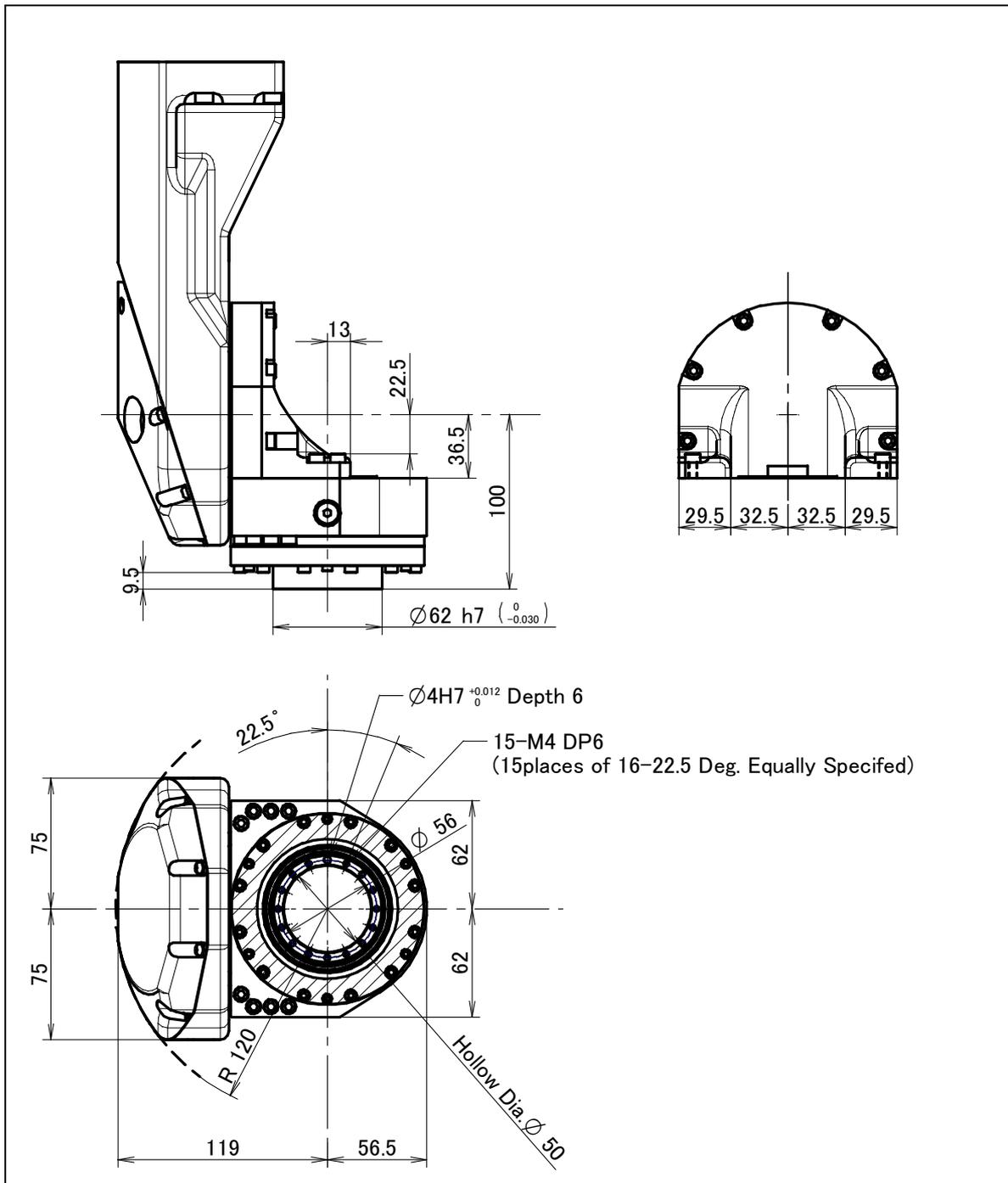


Fig. 4.1 (a) End effector interface (ARC Mate 120iC, M-20iA)

⚠ CAUTION

Do not remove the M3, M4 bolts of shaped area. If they are removed, work of re-assembling robot becomes difficult.

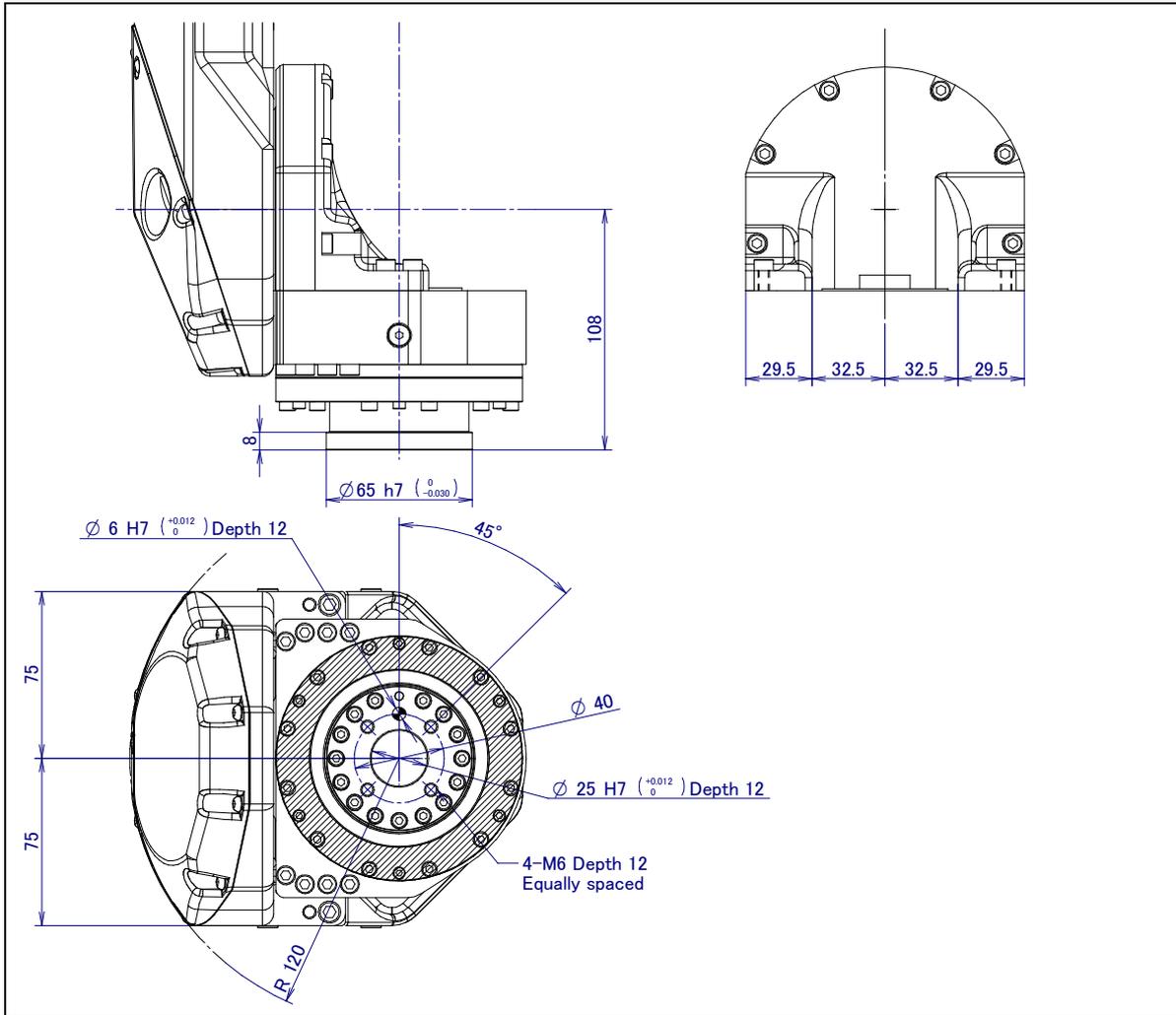


Fig. 4.1 (b) End effector interface (When ISO flange adapter is installed) (ARC Mate 120iC, M-20iA)

⚠ CAUTION

Do not remove the M3,M4 bolts of shaped area. If they are removed, work of re-assembling robot becomes difficult.

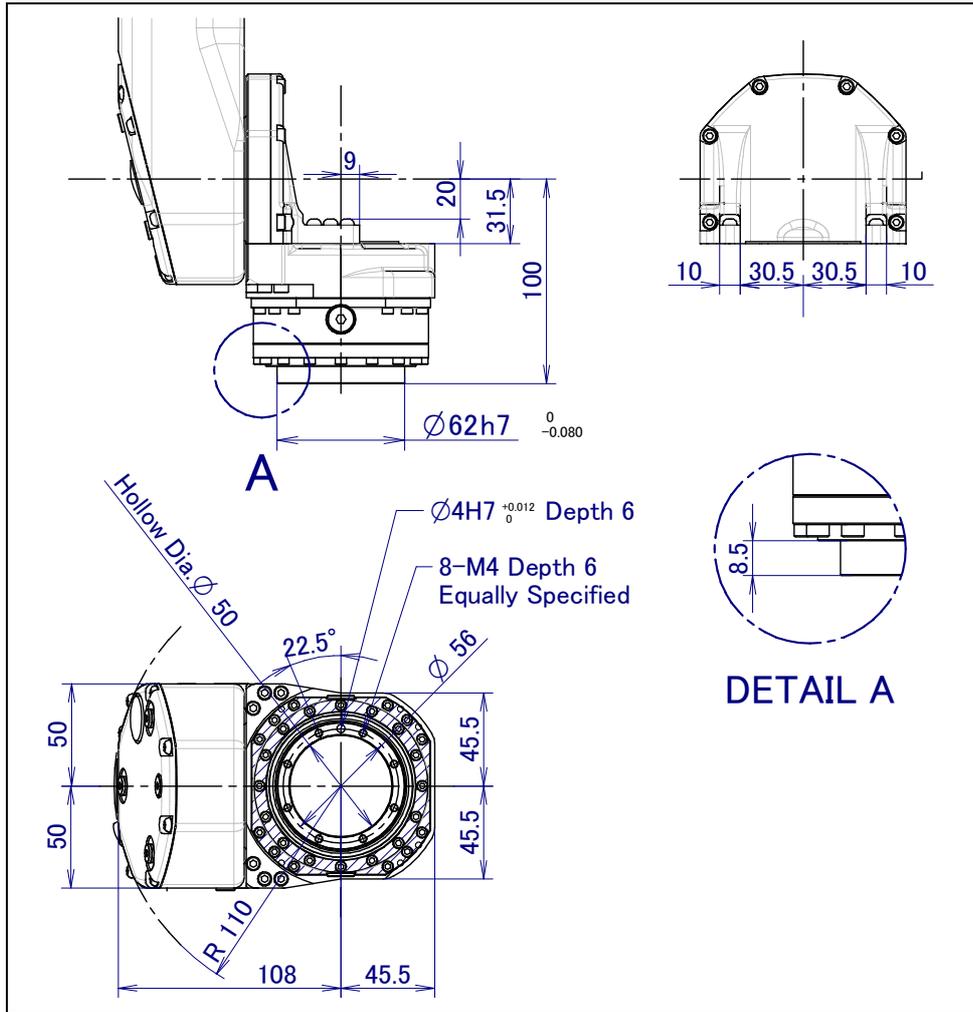


Fig. 4.1 (c) End effector interface (ARC Mate 120iC/10L, M-20iA/10L)

⚠ CAUTION

Do not remove the M3 bolts of shaped area. If they are removed, work of re-assembling robot becomes difficult.

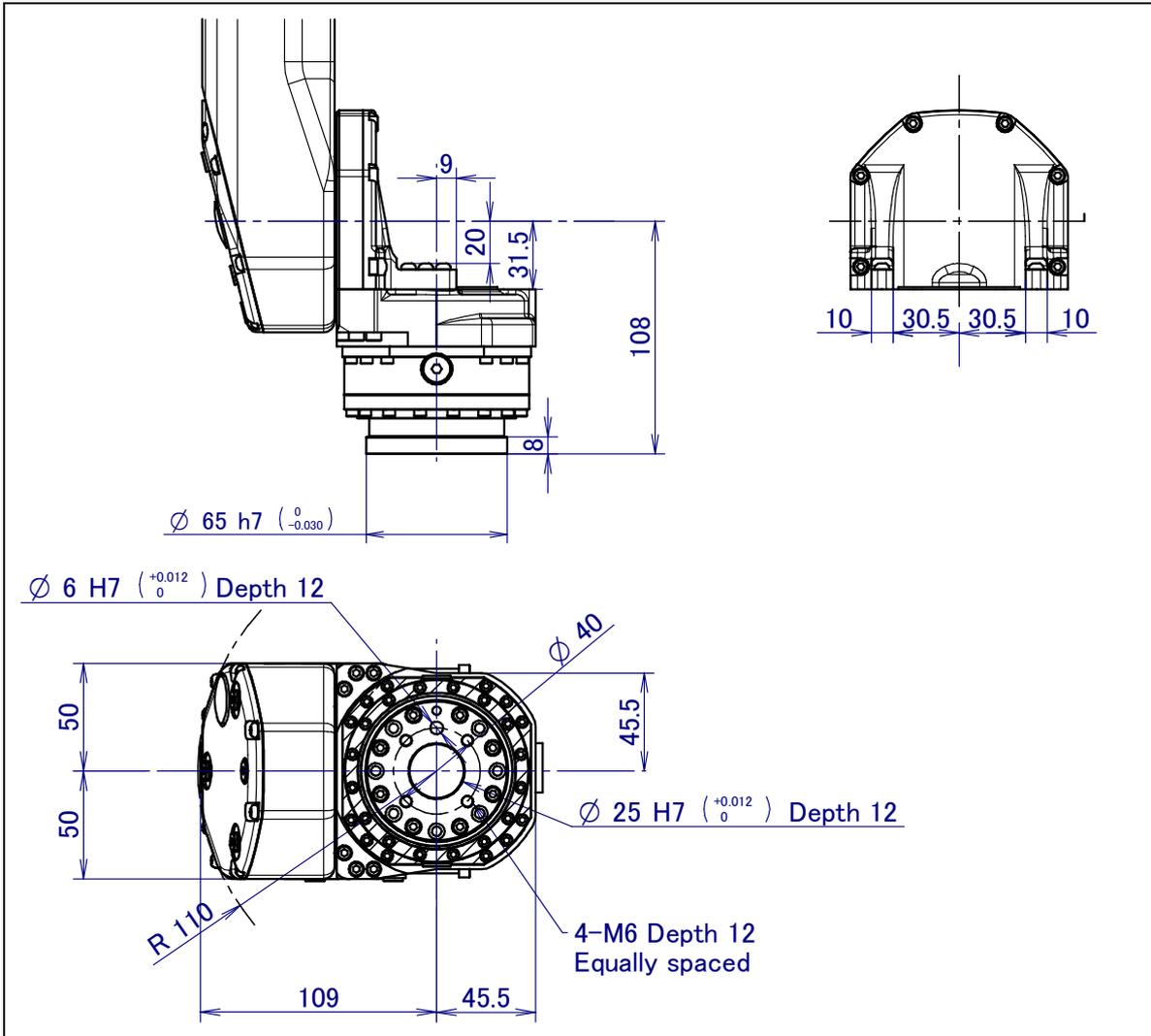


Fig. 4.1 (d) End effector interface (When ISO flange adapter is installed) (ARC Mate 120iC/10L, M-20iA/10L)

⚠ CAUTION

Do not remove the M3 bolts of shaped area. If they are removed, work of re-assembling robot becomes difficult.

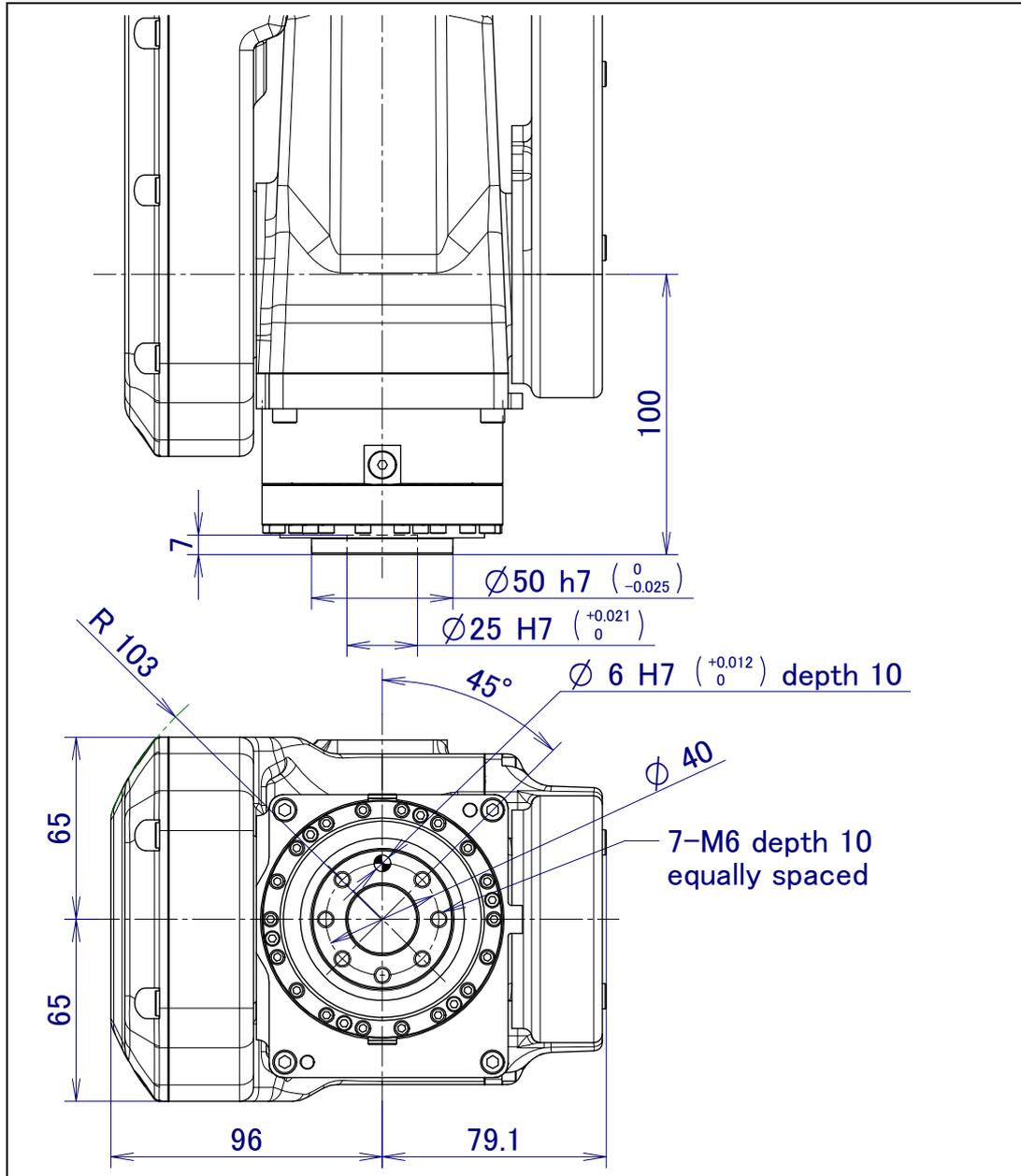


Fig. 4.1 (e) End effector interface (M-20iA/20M)

4.2 EQUIPMENT MOUNTING FACE

Fig. 4.2 (a) and (b) show position of tapped and load condition install equipment 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.

⚠ CAUTION
 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.

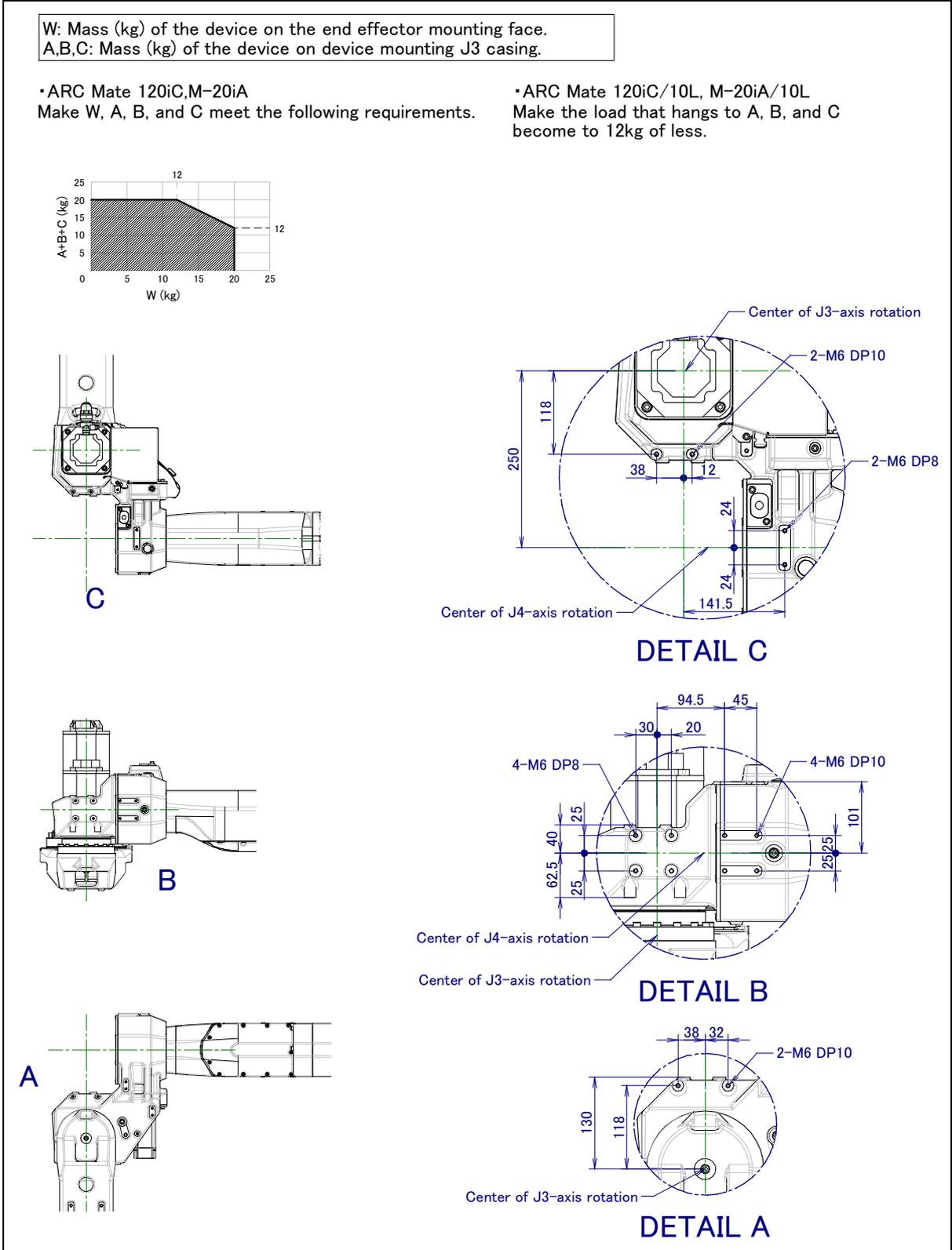
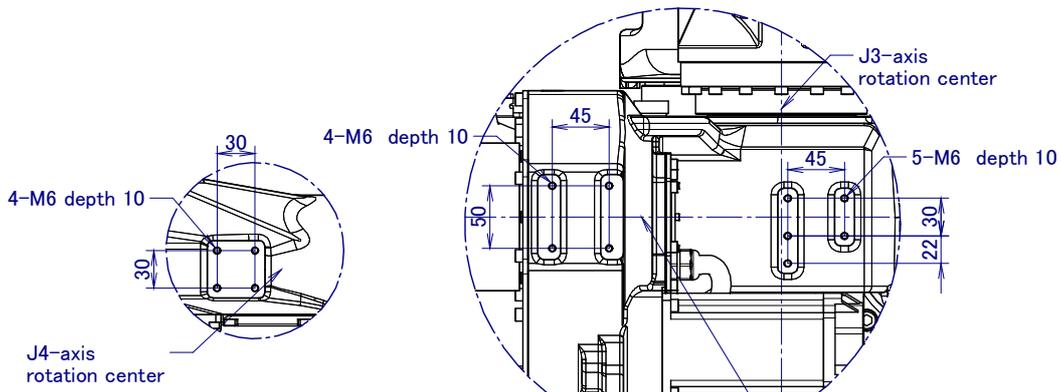
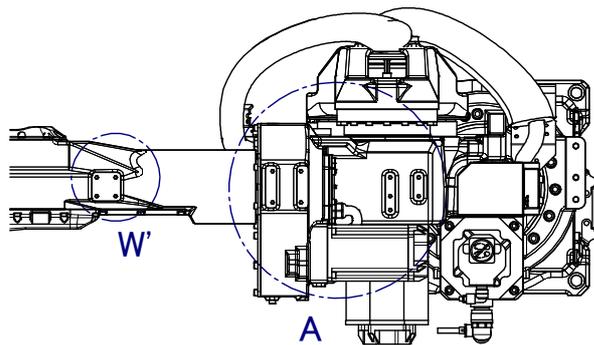
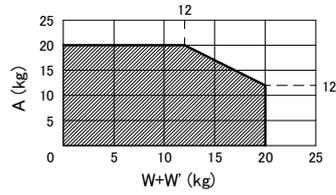


Fig. 4.2 (a) Equipment mounting faces and load condition
 (ARC Mate 120iC, M-20iA, ARC Mate 120iC/10L, M-20iA/10L)

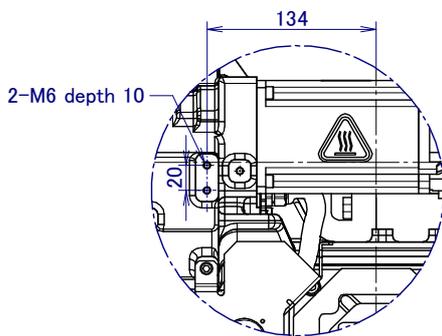
W: Mass (kg) of end effector mounting face
 W': Mass (kg) of J3 arm equipment mounting face
 A: Mass (kg) of J3 casing equipment mounting face

Make W,W',A meet the following requirements.

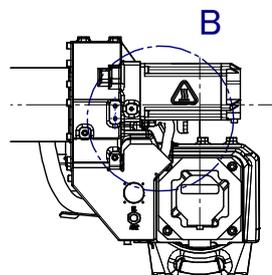


DETAIL W'

DETAIL A



DETAIL B(*)



(*) These taps are not useful depend on the specified mechanical unit cable.

Fig. 4.2 (b) Equipment mounting faces and load condition (M-20iA/20M)

Fig.4.2 (c) shows taps for the cable clamp of M-20iA/20M.

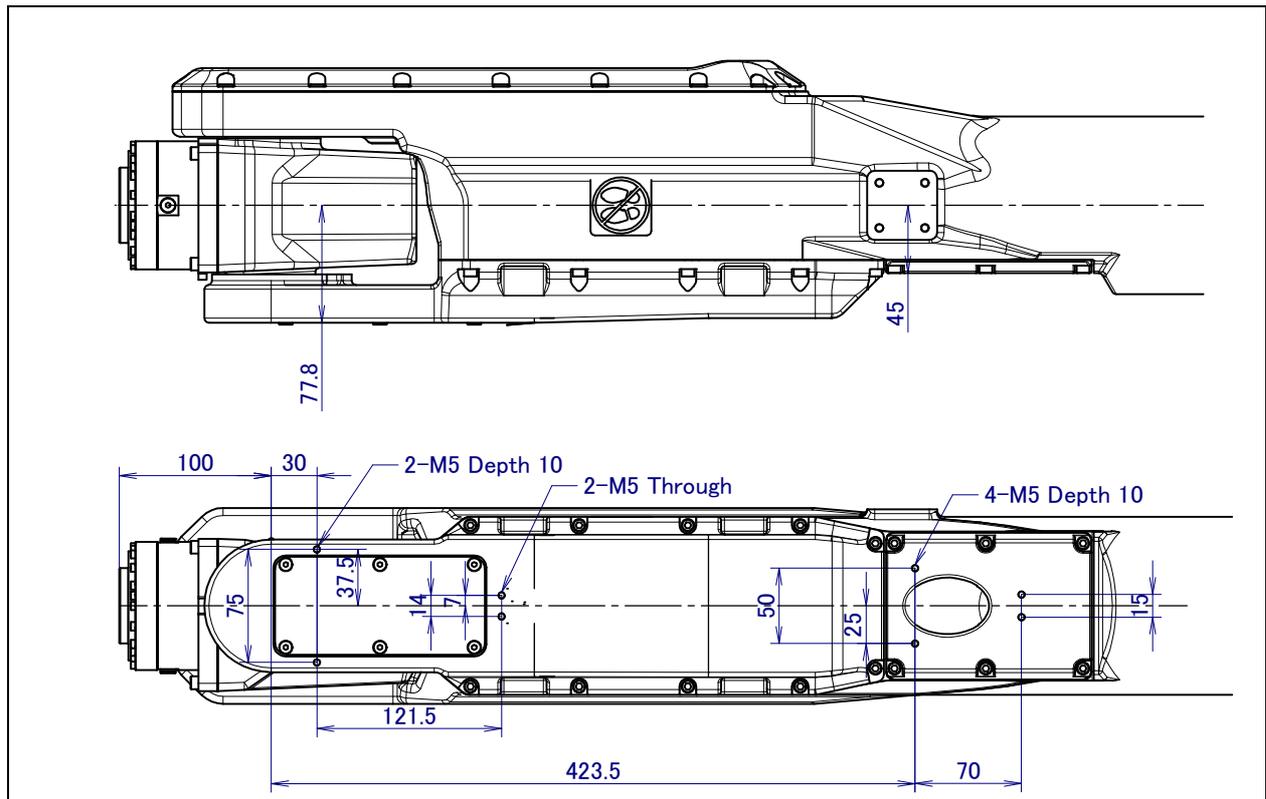


Fig. 4.2 (c) Equipment mounting faces (for the cable clamp) (M-20iA/20M)

NOTE

When the clamp option is specified, the taps of Fig.4.2 (c) are can not be used.

4.3 LOAD SETTING

NOTE

- 1 Set load condition parameter before robot runs. Do not operate the robot in over payload reduction. Don't exceed allowable payload including connection cables and its swing. Operation in over payload may occur troubles such as reducer life
- 2 Wrist payload specification cannot be changed in the setting of this paragraph and refer to Section 4.4.

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

MOTION PERFORMANCE		JOINT 10%	
Group1			
No.	PAYLOAD[kg]	Comment	
1	20.00	[]
2	0.00	[]
3	0.00	[]
4	0.00	[]
5	0.00	[]
6	0.00	[]
7	0.00	[]
8	0.00	[]
9	0.00	[]
10	0.00	[]
Active PAYLOAD number =0			
[TYPE]	GROUP	DETAIL	ARMLoad SETIND >
	IDENT		>

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

MOTION PAYLOAD SET		JOINT 100%	
Group 1			
Schedule No[1]	: [Comment]	
1	PAYLOAD	[kg]	20.00
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	[kgfcm ²]	0.13
6	PAYLOAD INERTIA Y	[kgfcm ²]	0.14
7	PAYLOAD INERTIA Z	[kgfcm ²]	0.07
[TYPE]	GROUP	NUMBER	DEFAULT HELP

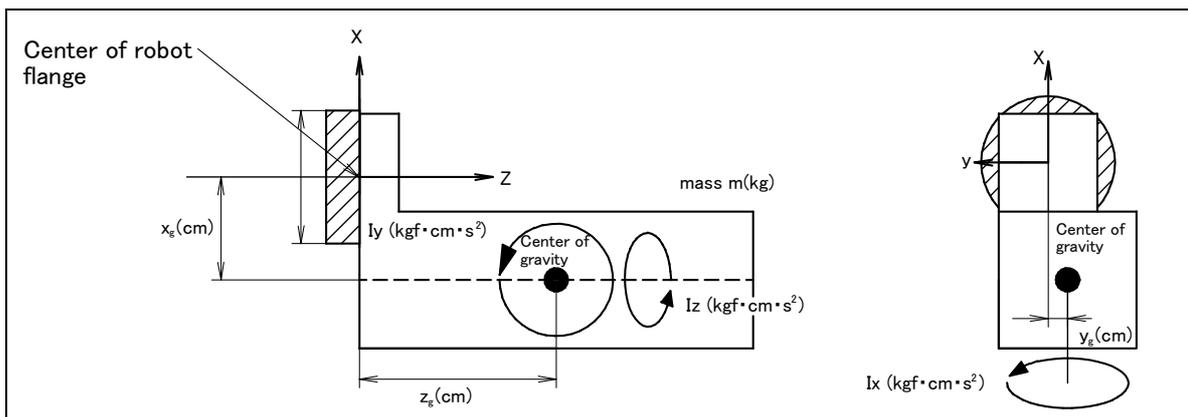


Fig. 4.3 Standard tool coordinate

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

- 8 Press the PREV key to return to the MOTION PERFORMANCE screen. Press F5 ([SETIND]), and enter the desired payload setting condition number.
- 9 On the list screen, pressing F4 ARMLOAD brings you to the device-setting screen.

MOTION ARMLOAD SET		JOINT	100%
Group 1			
1	ARM LOAD AXIS #1 [kg]		0.00
2	ARM LOAD AXIS #3 [kg]		12.00
[TYPE]	GROUP	DEFAULT	HELP

- 10 Specify the mass of the loads on the J2 base and J3 arm. When you enter following parameter, ARMLOAD AXIS #1[kg]: Mass of the load on the J2 base. (Contact FANUC if you install equipments on J2 base.)
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.

4.4 CHANGING METHOD OF WRIST PAYLOAD SPECIFICATION (except M-20iA/20M)

About Max payload shift function

In ARC Mate120iC/M-20iA, the best two servo motion parameters are prepared respectively when the wrist payload specification is 3kg, 6kg, and 10kg. The best addition and subtraction velocity operation can be achieved by setting the parameter matched to the wrist payload specification. The parameter is changed by executing the following KAREL programs (It is abbreviated as KAREL for Changing method of wrist payload specification thereafter.)

ARCMate120iC, M-20iA

- M20SET03.PC: 3kg wrist payload specification
- M20SET20.PC: 20kg wrist payload specification

ARCMate120iC/10L, M-20iA/10L

- M2LSET03.PC: 3kg wrist payload specification
- M2LSET10.PC PC: 10kg wrist payload specification

It explains the procedure as an example of ARCMate120iC, M-20iA at the following.

M-20iA is set in 20kg wrist payload specification, M-20iA/10L is set in 10kg wrist payload specification and ARC Mate 120iC and ARC Mate 120iC/10L is set to an acceptable 3kg wrist payload specification when robot is shipped.

But when the robot is specified Servo Torch, ARC Mate 120iC is set in 20kg wrist payload specification, ARC Mate 120iC/10L is set in 10kg wrist payload specification

CAUTION

When the robot over the payload in 3kg wrist payload specification (Refer to specification table in Section 3.1 and Section 3.5.), set in 20kg wrist payload specification. (In case of ARC Mate 120iC/10L or M-20iA/10L, set in 10kg wrist payload specification.) If the robot is operated with wrong setting, the function and the lifetime of the robot would deteriorate.

In case of M-20iA/20M, it is impossible to change payload.

Method of shifting

There are the following two in the method of executing KAREL for changing method of wrist payload specification. Please use it properly according to the purpose.

- 1) Method of executing KAREL program by using "Call program" → Refer to Subsection 4.4.1
 - The KAREL program is set in the program call instruction of the TP program and the parameter is set by specifying with the argument that shows the group number, and executing it. The parameter of M-20iA of a specific group can be switched in this method.

Instruction that calls program

Example of program :

1 : CALL M20SET03(1)

Group number specification for argument

- 2) Method of executing KAREL program directly → Refer to Subsection 4.4.1
 - Select and execute the KAREL program in program select screen.
 - Two or more M-20iA exists in the multi group system, and it is possible to change in this method bringing the parameter of two or more M-20iA together to set the parameter for the same load as them.

NOTE

- 1 Execute KAREL for Changing method of wrist payload specification in the state of cold start mode.
- 2 Be careful that the tracks and the cycle time of an existing instruction program change if KAREL for changing method of wrist payload specification is executed. It depends as follows, and it explains the method of executing KAREL for Changing method of wrist payload specification.

4.4.1 Method of Executing KAREL Program by Using “Call program”

- * The following procedures assume the thing of changing M-20iA of the first group to the 3kg wrist payload specification.

Execution procedure

- 1 Call the system variable screen.

MENU key → Select “System” and press F1 key(screen) → Select “System variables”

- 2 Set system variables \$KAREL_ENB to 1.
- 3 Open TP program edit screen.
- 4 Select “call program” from among the program instruction

F1 key (INST) → Select “CALL” → Select “CALL program”

Then, the following screens are displayed.

SYST-039	Operation	Mode	T2	Selected
PROGRAM list				JOINT 10 %
1	A1		5	
2	HOME_IO		6	
3	M20SET03		7	
4	M20SET20		8	
A1				1/2
1: CALL ...				
[End]				
Select item				
PROGRAM	MACRO	KAREL	STRINGS	

- 5 Press F3 key (KAREL). Then, select KAREL M20SET03 of 3kg wrist payload specification from among that because it becomes the following screens.

SYST-039	Operation	Mode	T2	Selected
KAREL list				JOINT 10 %
1	GEMDATA		5	MEM_PORT
2	GET_HOME		6	PSCOLD
3	M20SET03		7	
4	M20SET20		8	
A1				1/2
1: CALL ...				
[End]				
Select item				
PROGRAM	MACRO	KAREL	STRINGS	

- 6 Press F4 key (select). Choose “CONSTANT” from there. Then, it becomes the following screens.

```

SYST-039 Operation Mode T2 Selected
A1          LINE 0      T2 ABORTED
A1          JOINT      10%
                                     1/2

      1:  CALL  M20SET03 ( Constant )
[ End ]

                                [ CHOICE ]
    
```

- 7 The group number (It is 1 here) is put with the cursor in “Constant”.

```

SYST-039 Operation Mode T2 Selected
A1          LINE 0      T2 ABORTED
A1          JOINT      10%
                                     1/2

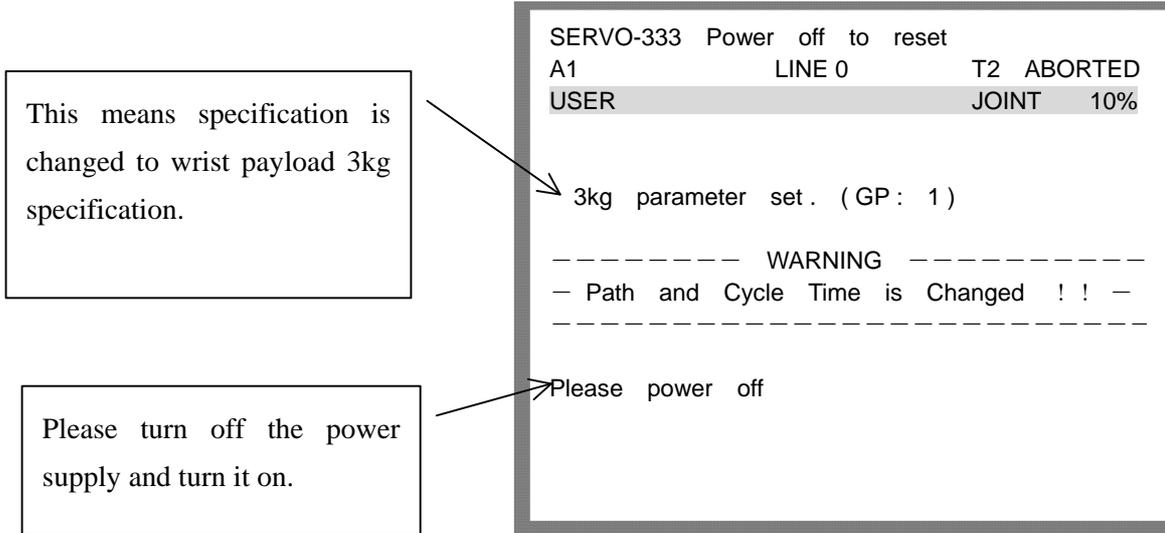
      1:  CALL  M20SET03 ( 1 )
[ End ]

POINT                                TOUCHUP>
    
```

- 8 Execute this program.

Push FWD key while pushing SHIFT key.

Then, the following screens are displayed. This shows the thing that KAREL M20SET03.PC of 3kg wrist payload specification is executed.



9 Turn on the controller power again.

The change of the parameter ends above.

4.4.2 Method of Executing KAREL Program Directly

Use scene

For instance, it is assumed that the following multi group systems exist.

- 1st group: M-20iA
- 2nd group: M-20iA
- 3rd group: Positioner A

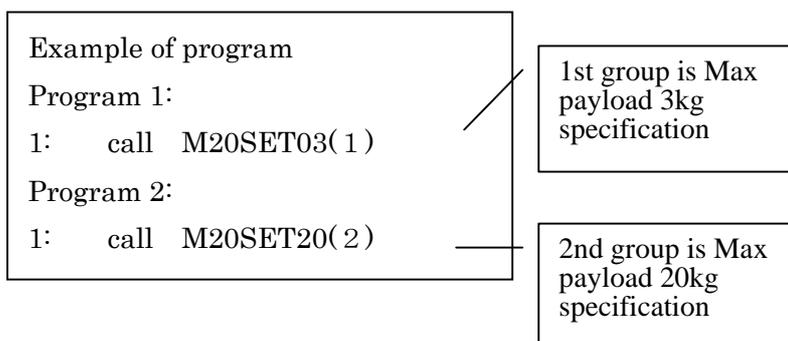
When the method of the explanation in this chapter is used to do M-20iA of the 1st group and 2nd group here to 3kg wrist payload specification, it is possible to set the 1st group and 2nd group to the parameter of an acceptable 3kg wrist payload specification at the same time.

NOTE

If you want to M-20iA of 1st group to 3kg wrist payload specification and M-20iA of 2nd group to 20kg wrist payload specification, Method of this chapter cannot be used.

In that case, please make two programs as follows, and do the parameter change by the method of Chapter 1.

- 1 Turn on the controller power again after executing the program 1.
- 2 Turn on the controller power again after executing the program 2.



Execution procedure

- 1 Call the system variable screen.

MENU key → Press F1 key (screen) after selecting “system” → Select system variables

- 2 Set system variables \$KAREL_ENB to 1.
- 3 Call program select screen and select “

program select key→ select KAREL by F1 key (type)

Then, three KAREL programs are displayed as follows.

```

A1                LINE 0          T2 ABORTED
Select            G1    JOINT    10%
                710186 bytes free    1/7
No.   Program name      Comment
  1   GEMDATE           PC [GEM Vars    ]
  2   GET_HOME          PC [Get Home Pos  ]
  3   M20SET03          PC [3kg payload   ]
  4   M20SET20          PC [20kg payload   ]
  5   MEM_PORT          PC [              ]
  6   PSCOLD            PC [              ]

[TYPE] CREATE DELETE MONITOR [ATTR]>
    
```

- 4 Match the cursor to the KAREL program of the load that wants to be set, and push the ENTER key. It is time when it selected M20SET03.PC that is KAREL of 3kg wrist payload specification as follows. The selected program name is displayed to two places as follows.

Selected program name is shown.

```

M20SET03         LINE 0          T2 ABORTED
Select            G1    JOINT    10%
                710186 bytes free    3/7
No.   Program name      Comment
  1   GEMDATE           PC [GEM Vars    ]
  2   GET_HOME          PC [Get Home Pos  ]
  3   M20SET03          PC [3kg payload   ]
  4   M20SET20          PC [20kg payload   ]
  5   MEM_PORT          PC [              ]
  6   PSCOLD            PC [              ]

M20SET03 is selected
[TYPE] CREATE DELETE MONITOR [ATTR]>
    
```

- 5 Execute the program.

Push FWD key while pushing SHIFT key.

Then, the following screens are displayed. This is case of executing KAREL M20SET03.PC of Max payload 3kg specification.

This means 1st group is changed to Max payload 3kg specification.

This means 2nd group is changed to Max payload 3kg specification.

Please turn off the power supply and turn it on.

```

SERVO-333 Power off to reset
M20SET03      LINE 0      T2 ABORTED
USER          JOINT 10%
3kg parameter set. (GP: 1)
3kg parameter set. (GP: 2)
----- WARNING -----
- Path and Cycle Time is Changed !! -
-----
Please power off
          
```

- 6 Turn on the controller power again.

The change of the parameter ends above.

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.
- 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 damage of coating of cables routinely.
- When these attentions are not kept, unexpected troubles might occur.

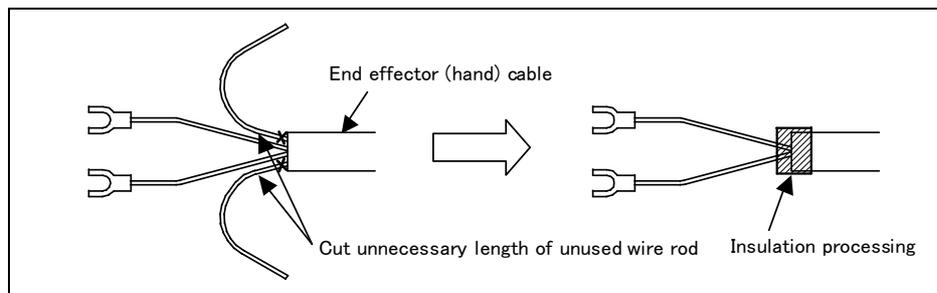


Fig.5 Treatment method of end effector (hand) cable

5.1 AIR SUPPLY (OPTION)

Robot has air inlet and air outlet openings on the J1 base and the J3 casing. As couplings are not supplied, it will be necessary to prepare couplings, which suit to the hose size.

Please refer to the table below about panel union and inside and outside diameter of air tube.

Spec of Mechanical unit cable	Panel union (Input side)	Panel union (Output side)	Outer, inner and number of air tube
A05B-1222-H201 A05B-1222-H221 A05B-1222-H231 A05B-1222-H251 A05B-1222-H505 A05B-1222-H507 A05B-1222-H535 A05B-1222-H537 A05B-1222-H601 A05B-1222-H605	Rc3/8 FemaleX1	Rc3/8 FemaleX1	Outer 8mm Inner 5mm × 1pcs
A05B-1222-H202 A05B-1222-H203 A05B-1222-H206 A05B-1222-H232 A05B-1222-H233 A05B-1222-H236	1/4NPT FemaleX2	None	Outer 6.35mm Inner 4.23mm × 2pcs
A05B-1222-H214	Rc3/8 FemaleX2	Rc3/8 FemaleX2	Outer 10mm Inner 6.5mm × 2pcs

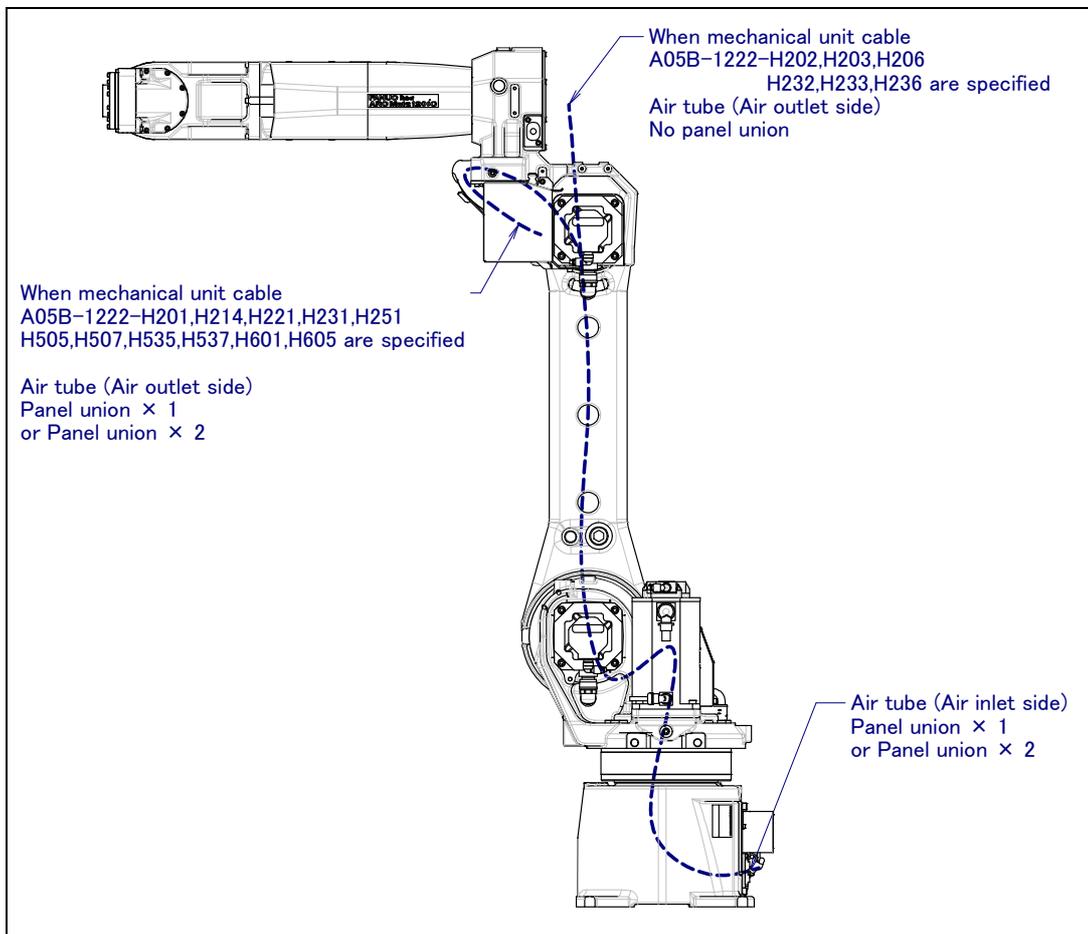


Fig. 5.1 Air supply (option)

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).

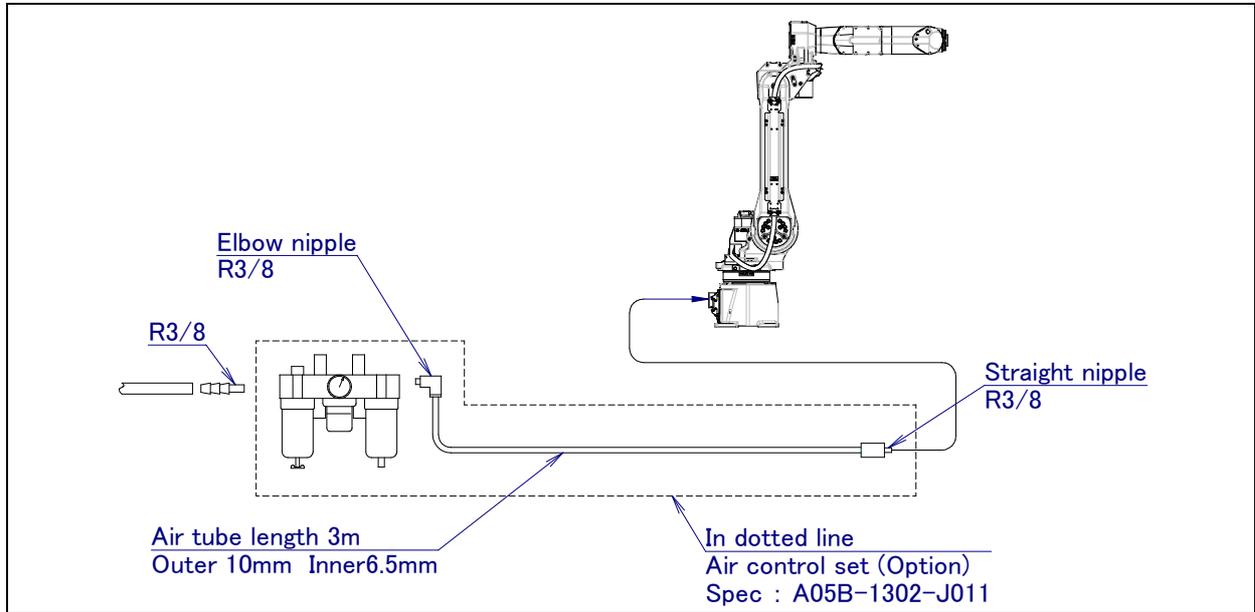


Fig. 5.2 (a) Air piping (Option)

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.

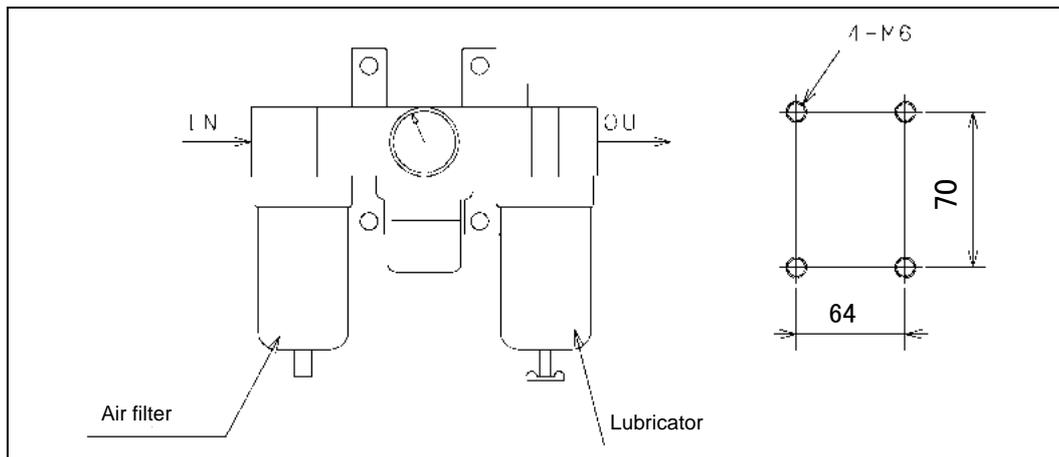


Fig. 5.2 (b) Air control set (Option)

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 150NI/min (0.15Nm ³ /min)

5.3 INTERFACE FOR OPTION CABLE (OPTION)

Fig. 5.3 (b) to (i) show the position of the end effector interface. EE interface (RI/RO), wire feeder power supply interface, welding power supply, user cable (signal lines) and camera cables are prepared as options.

NOTE

Each option cable is written like below on connector panel

EE(RI/RO) interface : EE

I/O Unit Model B : I/O

User cable (signal) : AS

User cable (power) : AP

Wire feeder cable W/F

Welding power cable W/P

User cable usable to 3D Laser Vision Sensor and Force Sensor : ASi

Camera cable : CAM

Sensor cable : SEN

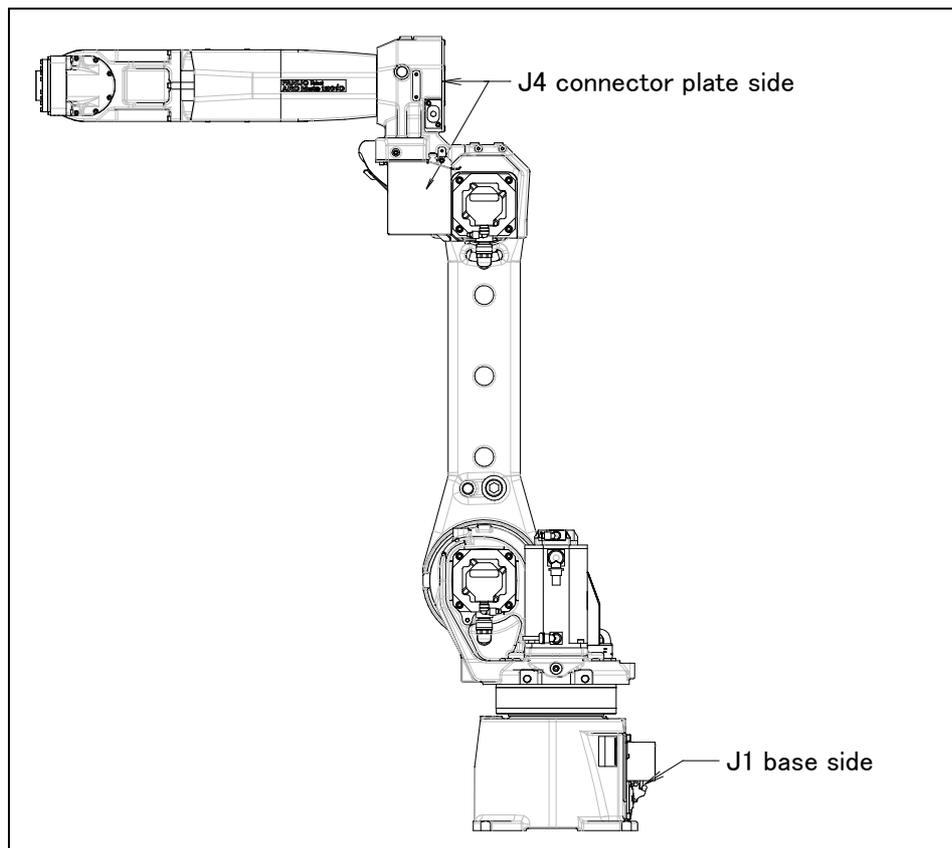


Fig. 5.3 (a) Interface for optional cable (Option)

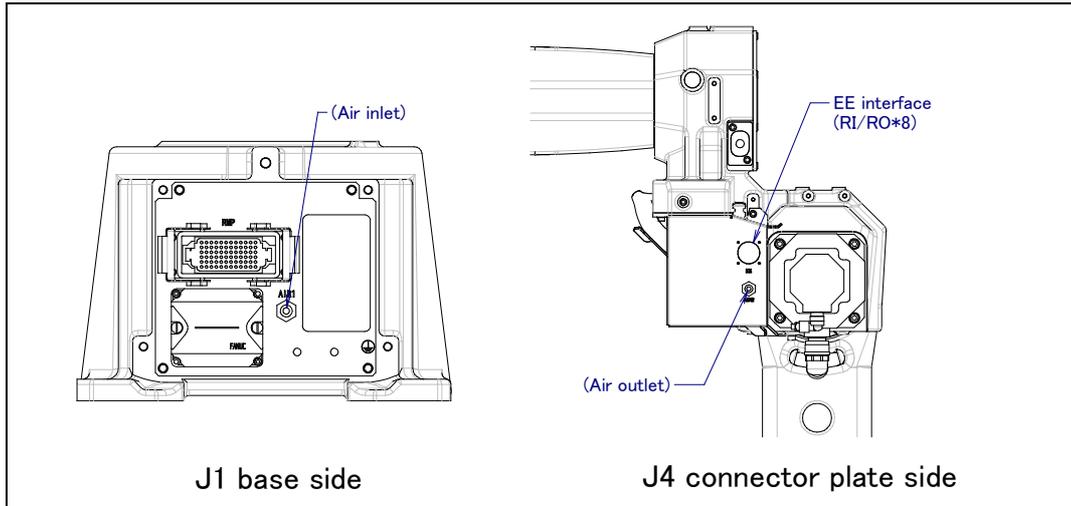


Fig. 5.3 (b) Interface for option cable (A05B-1222-H201, H231 is specified)

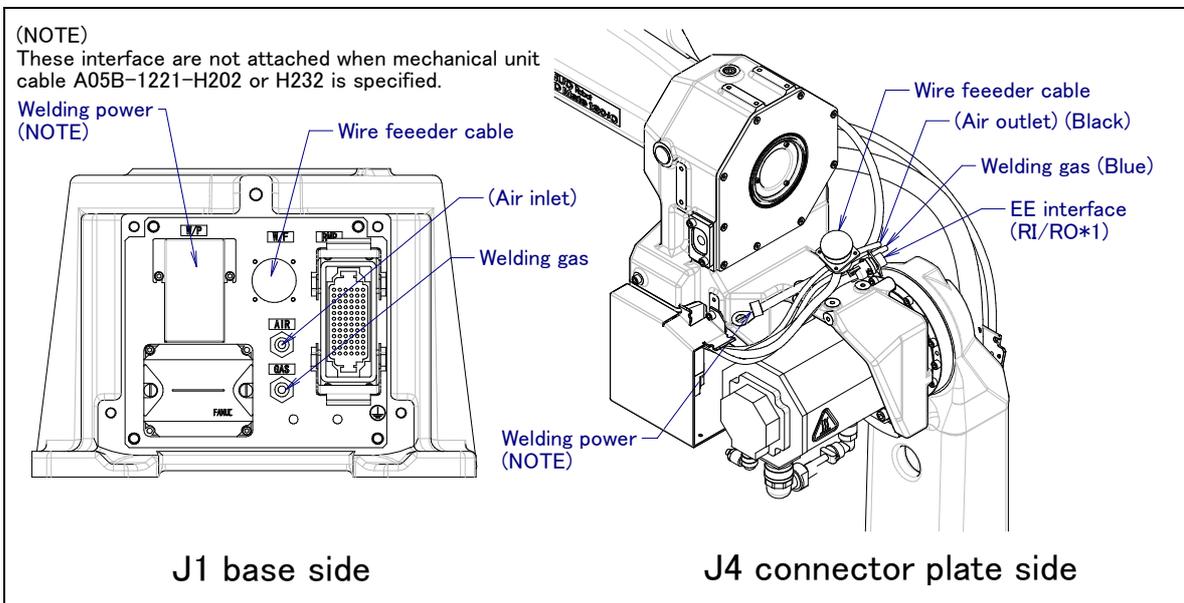


Fig. 5.3 (c) Interface for option cable (A05B-1222-H202, H203, H206, H232, H233, H236 is specified)

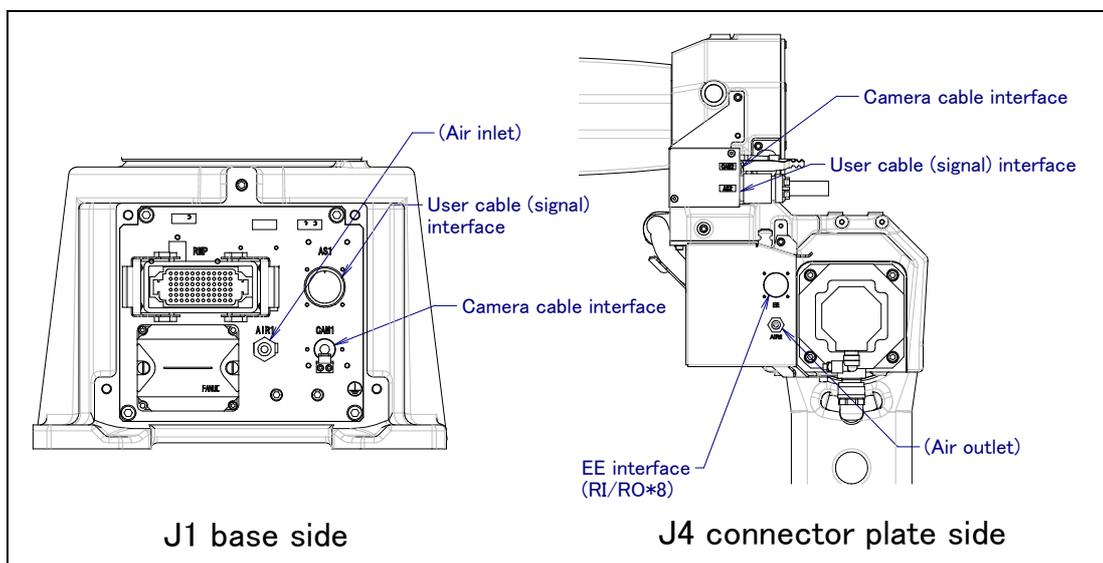


Fig. 5.3 (d) Interface for option cable (A05B-1222-H505, H535 is specified)

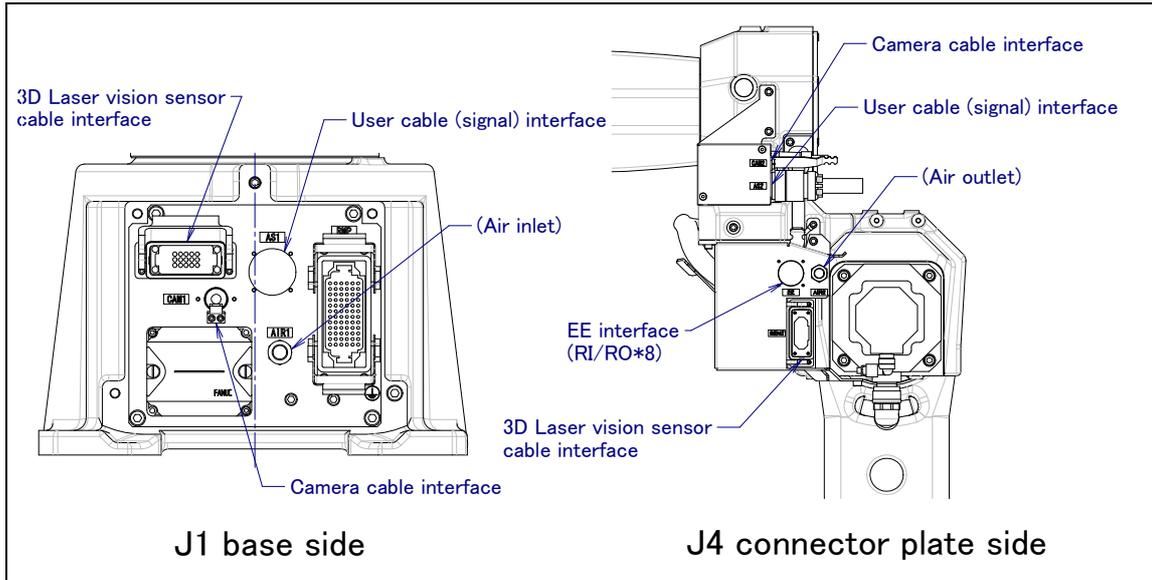


Fig. 5.3 (e) Interface for option cable (A05B-1222-H507, H537 is specified)

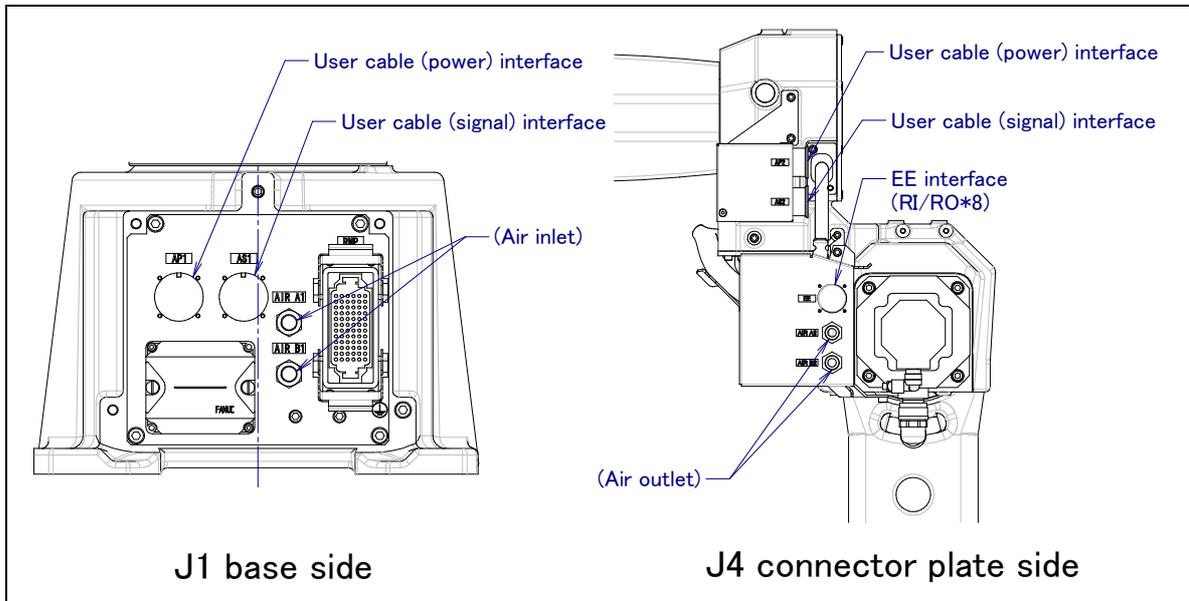


Fig. 5.3 (f) Interface for option cable (A05B-1222-H214 is specified)

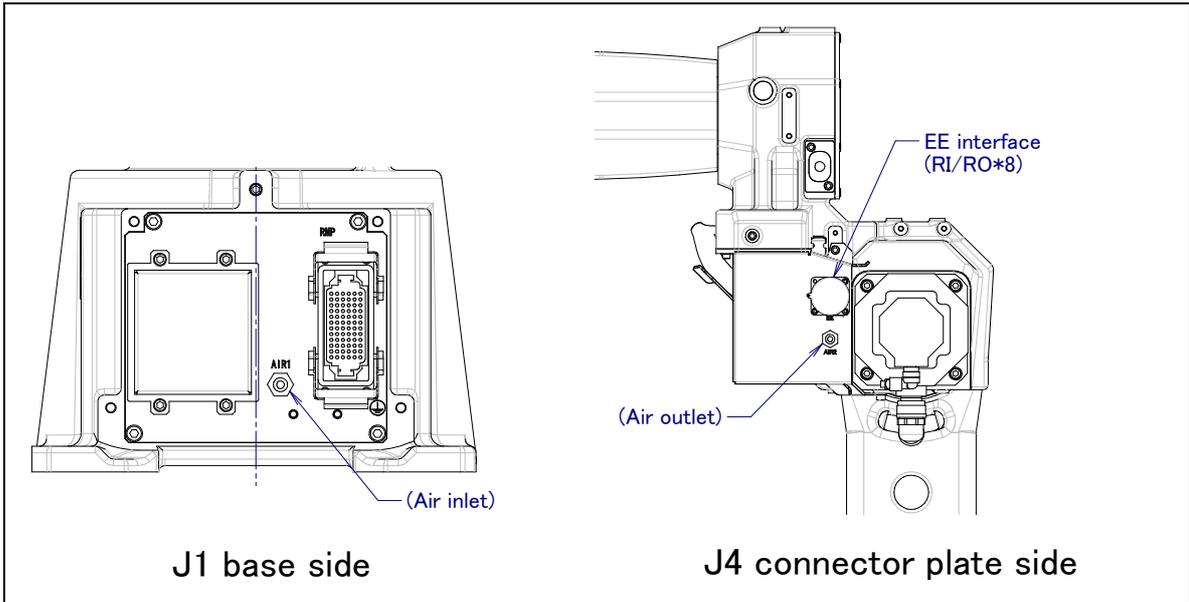


Fig. 5.3 (g) Interface for option cable (A05B-1222-H221, H251 is specified)

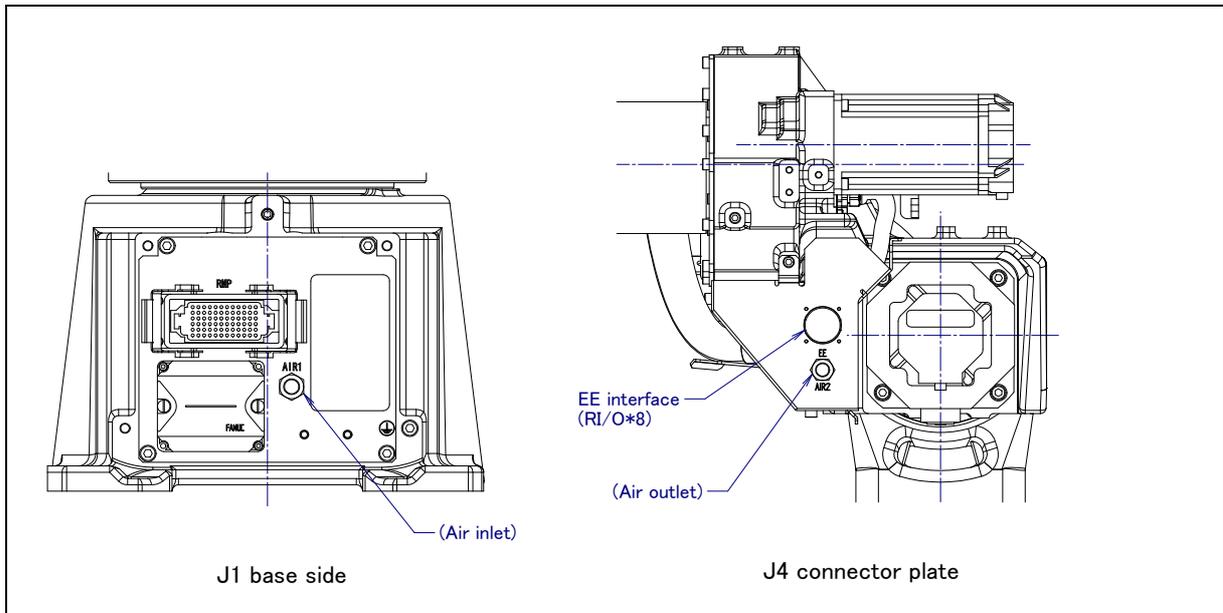


Fig. 5.3 (h) Interface for option cable (A05B-1222-H601 is specified)

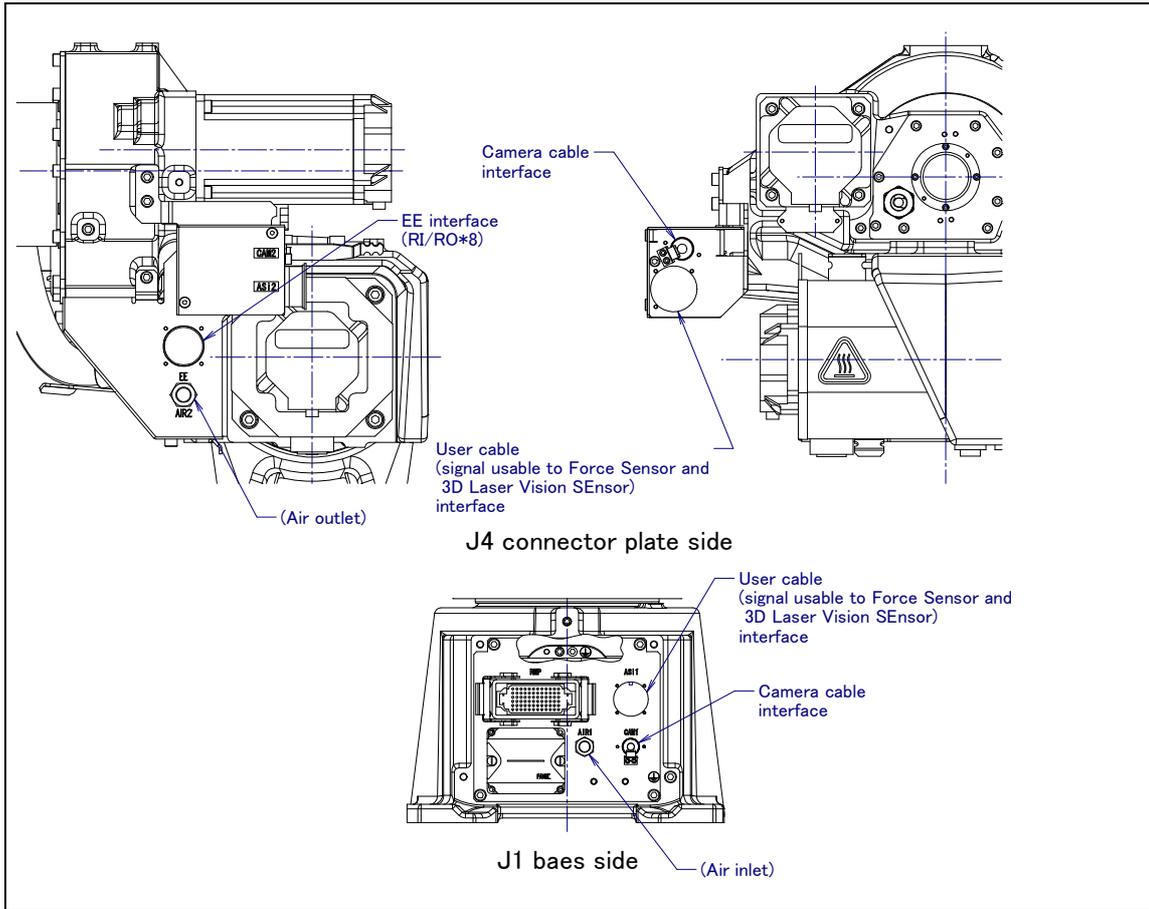


Fig. 5.3 (i) Interface for option cable (A05B-1222-H605 is specified)

1 EE interface (RI/RO) (Option)

Fig. 5.3 (j) to (k) show pin layout for EE interface (RI/RO).

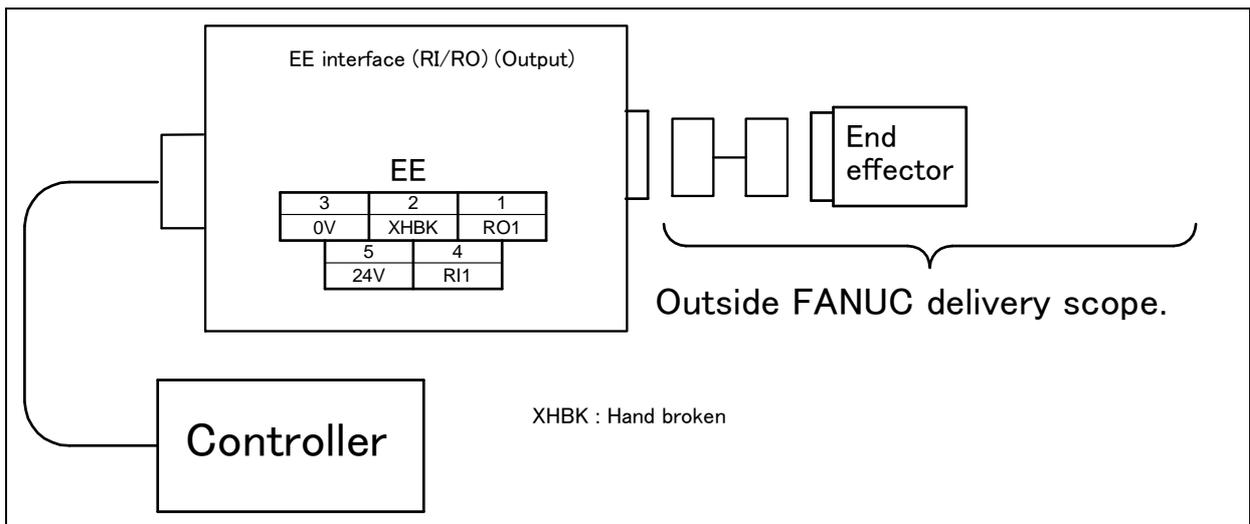


Fig. 5.3 (j) Pin layout for EE interface (RI/RO) RI/ROX1 (Option)

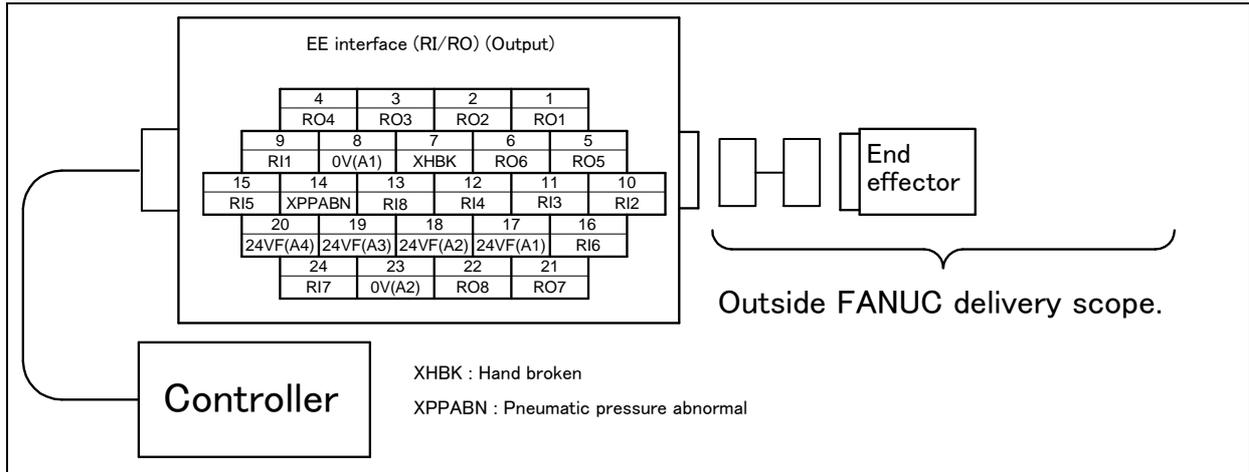


Fig. 5.3 (k) Pin layout for EE interface (RI/RO) RI/ROX8 (Option)

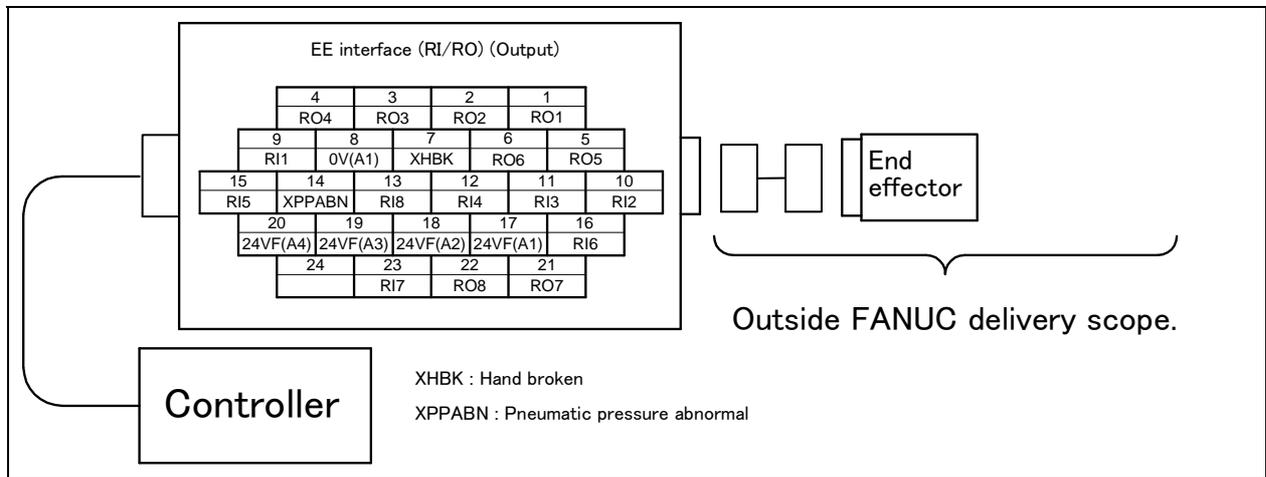


Fig. 5.3 (l) Pin layout for EE interface (When severe dust/liquid protection option is specified) RI/ROX8 (Option)

2 Wire feeder (W/F) power supply Interface (Option)

Fig. 5.3 (m) shows pin layout for wire feeder power supply interface.

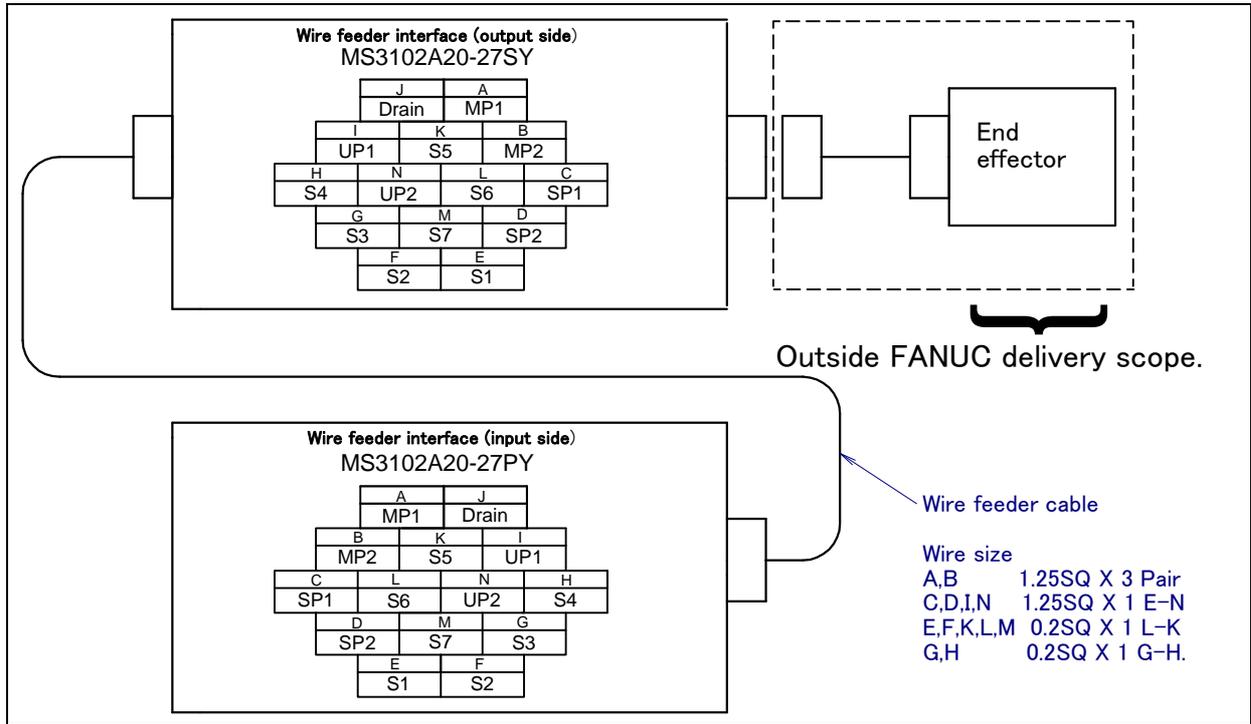


Fig. 5.3 (m) Pin layout for wire feeder (W/F) power supply interface (Option)

3 User cable (signal line) (AS) Interface (Option)

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

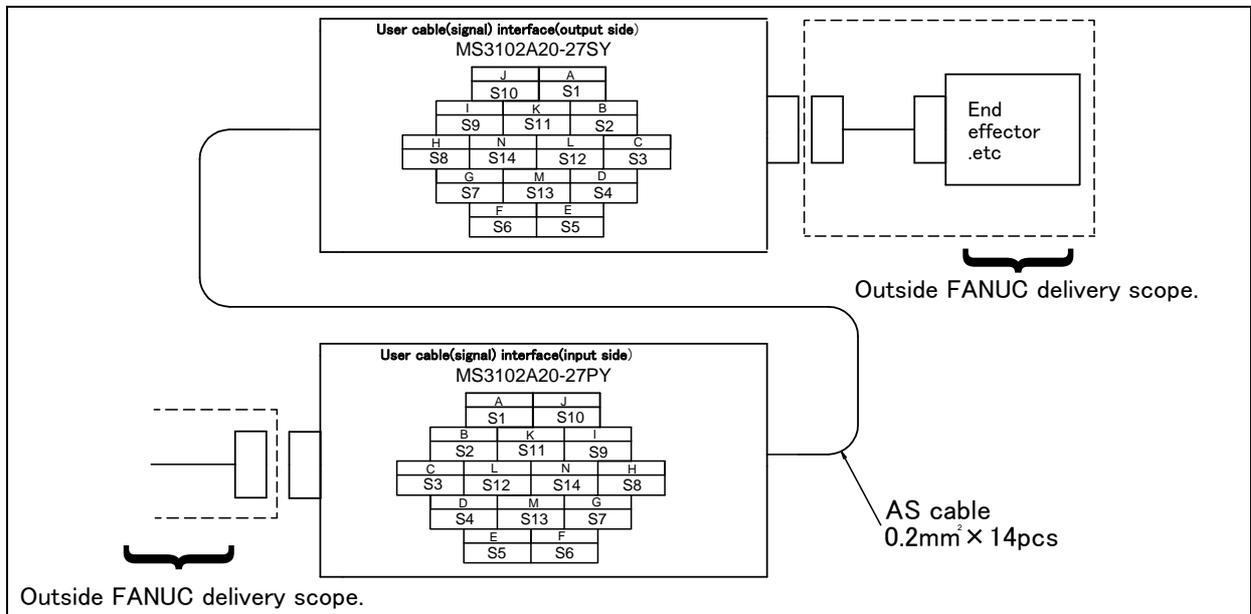


Fig. 5.3 (n) Pin layout for user cable (signal line) (AS) interface (Option)

- 4 User cable (power line) (AP) Interface (Option)
 Fig. 5.3 (o) shows pin layout for user cable (power line) interface.

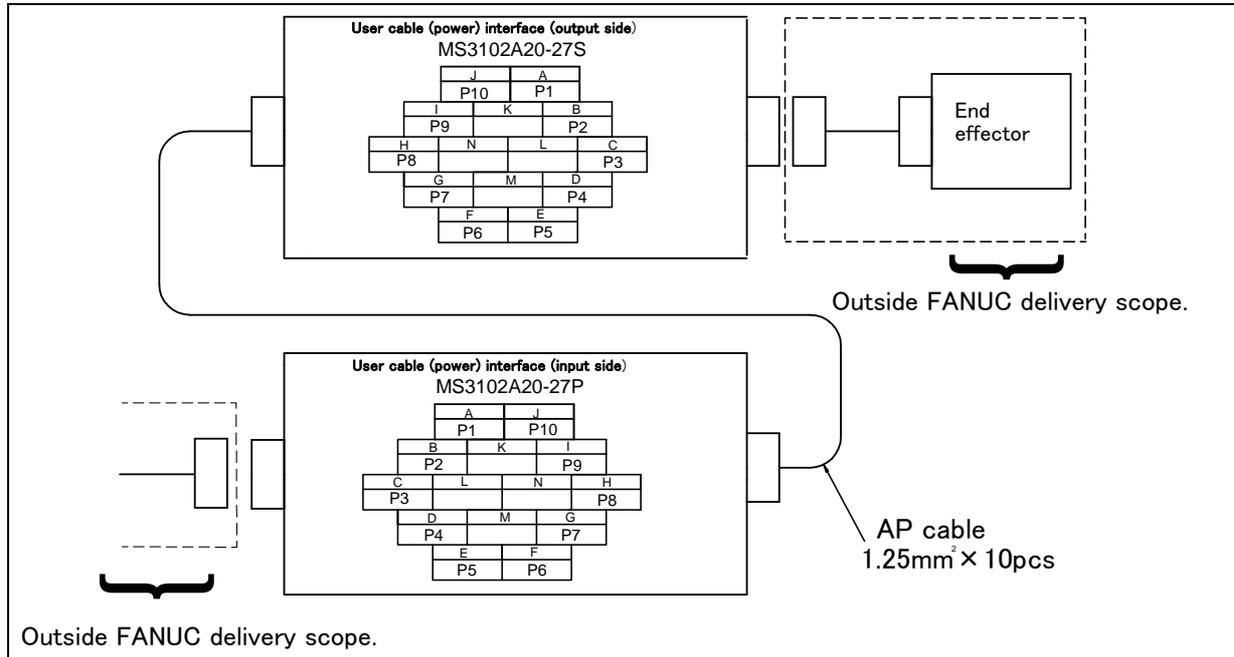


Fig. 5.3 (o) Pin layout for user cable (power line) (AP) interface (Option)

⚠ CAUTION
 For wiring of the peripheral device to the end effector interface, refer to the CONTROLLER MAINTENANCE MANUAL.

Connector specifications

Table 5.3 (a) Connector specifications (User side)

Cable name	Input side (J1 base)	Output side (J3 casing)	Maker/dealer
EE (RI/RO × 1)	—————	JMSP1305M Straight plug (FANUC Spec: A05B-1221-K845) JMLP1305M Angle plug	Fujikura.Ltd
EE (RI/RO × 8)	—————	JMSP2524M Straight plug (Attached) (FANUC Spec: A63L-0001-0234#S2524M) JMLP2524M Angle plug	
Wire feeder & AS	Maker specification	Maker specification	Fujikura.Ltd Japan Aviation Electronics Industry, Ltd.
	Connector Straight plug: MS3106B20-27SY (*1) Elbow plug: MS3108B20-27SY Or a compatible mode Clamp MS3057-12A (*1)	Connector Straight plug: MS3106B20-27PY (*2) Elbow plug: MS3108B20-27PY Or a compatible mode Clamp MS3057-12A (*2)	
	FANUC specification	FANUC specification	
	A05B-1221-K843 (Straight plug (*1) and clamp (*1) are included)	A05B-1221-K841 (Straight plug (*2) and clamp (*2) are included)	
AP	Maker specification	Maker specification	Fujikura.Ltd Japan Aviation Electronics Industry, Ltd.
	Connector Straight plug: MS3106B20-27S (*3) Elbow plug: MS3108B20-27S Or a compatible mode Clamp MS3057-12A (*3)	Connector Straight plug: MS3106B20-27P (*4) Elbow plug: MS3108B20-27P Or a compatible mode Clamp MS3057-12A (*4)	
	FANUC specification	FANUC specification	
	A05B-1221-K844 (Straight plug (*3) and clamp (*3) are included)	A05B-1221-K842 (Straight plug (*4) and clamp (*4) are included)	

Table 5.3 (b) Connector specifications

(On the user side when the M-20iA, M-20iA/10L, M-20iA/20M severe dust/liquid protection option is specified)

Component name	Model	Maker/dealer
Plug	JL05-6A24-28PC-F0-R (FANUC specification: A63L-0001-0463#P2424P)	Japan Aviation Electronics Industry, Ltd.
End bell	JL04-24EBL-R (FANUC specification: A63L-0001-0463#24EBL)	
Clamp	JL04-2428CK (20) –R (FANUC specification: A63L-0001-0463#2428CK20)	
Pin contact	ST-JL05-16P-C3-100 (FANUC specification: A63L-0001-0463#16PC3)	

Table 5.3 (c) Connector specifications (Mechanical unit side · reference)

Cable name	Input side (J1 base)	Output side (J3 casing)	Maker/dealer
EE (RI/RO × 1)	—————	JMWR1305F	Fujikura.Ltd
EE (RI/RO × 8)	—————	JMWR2524F	
Wire feeder & AS	MS3102A20-27PY	MS3102A20-27SY	Fujikura.Ltd, Japan Aviation Electronics Industry, Ltd. etc

Table 5.3 (d) Connector specifications (on the Mechanical unit side when the M-20iA, M-20iA/10LL, M-20iA/20M severe dust/liquid protection option is specified reference)

Component name	Model	Maker/dealer
Receptacle	JL05-2A24-28SC-F0-R	Japan Aviation Electronics Industry, Ltd. etc
Socket contact	ST-JL05-16S-C3-100	

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 LIMIT 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

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

- Axis limit software settings (All axes)
- Axis limit adjustable mechanical stopper ((J1 axis) option)

NOTE

- 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 axis, 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 Adjustable mechanical stoppers (J1 axis) are deformed in a collision to stop the robot. Once a stopper is subject to a collision, it can no longer assure its original strength and, therefore, may not stop the robot. When this happens, replace it with a new one.

6.1 SOFTWARE SETTING

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.

Procedure Setting up Axis Limits

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

SYSTEM Axis limits				JOINT
AXIS	GROUP	LOWER	UPPER	1/16
1	1	-180.00	180.00	deg
2	1	-90.00	135.00	deg
3	1	-160.00	280.00	deg
4	1	-360.00	360.00	deg
5	1	-125.00	125.00	deg
6	1	-360.00	360.00	deg
7	1	0.000	0.00	mm
8	1	0.000	0.00	mm
9	1	0.000	0.00	mm
[TYPE]				

NOTE

- 1 0,00 indicates the robot does not have these axes.
- 2 For the J1 axis, do not count merely on software-based limits to the movable range when changing the movable range of the robot. Use mechanical stoppers together. In this case, make the software-specified limits match the limits based on the mechanical stoppers.

- 5 Move the cursor to the axis limit you would like to set.
- 6 Type the new value using the numeric keys on the teach pendant.
- 7 Repeat Steps 5 through 6 until you are finished setting the axis limits.
- 8 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 (OPTION)

For the J1 axis, it is possible to re-position mechanical stoppers.
Change the position of the mechanical stoppers according to the desired movable range.

Item	Movable range	
J1 axis adjustable mechanical stopper	Upper limit	Settable in steps of 30° degrees in a range of +20° to +170° degrees
	Lower limit	Settable in steps of 30° degrees in the range of -170° to -20° degrees

NOTE

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

J1 AXIS STROKE MODIFICATION

A stroke modification can be performed at an arbitrary position in steps of 30° within the range -170° to $+170^\circ$.

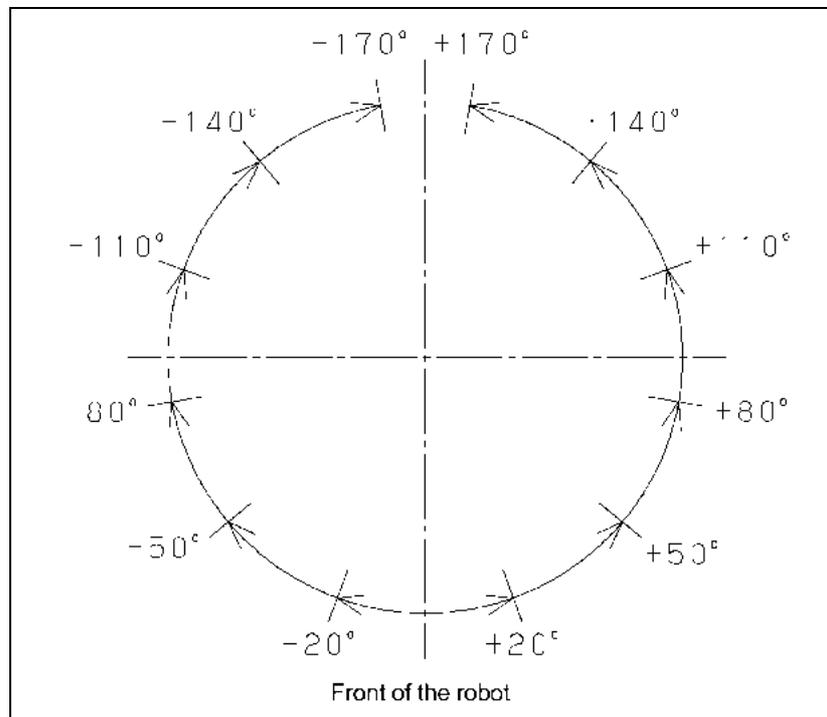


Fig. 6.2 (a) J1 axis stroke modification

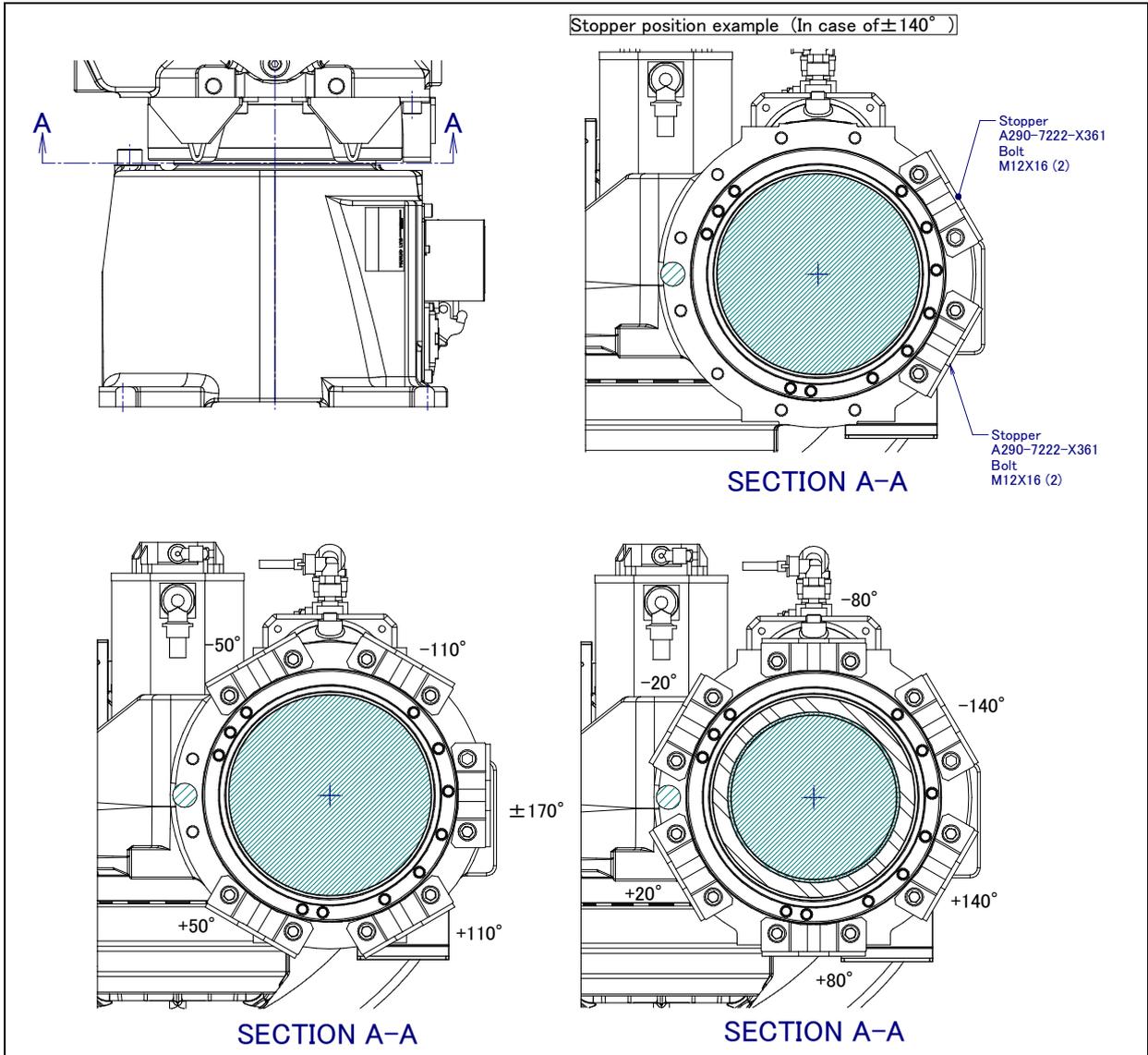


Fig. 6.2 (b) Installing of J1 axis adjustable stopper

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. In case however the use of the robot exceeds these 3840 hours/year, please adjust the given maintenance frequencies accordingly. The ratio of actual operation time/year vs. the 3840 hours/year should be used for calculating the new (higher) frequencies. For example, when using the robot 7680 hours a year, the maintenance frequency should be doubled – i.e. the time interval should be divided by 2.

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 leak	Check there is oil leak on sealed part of each joint parts. If there is oil leak, clean them. (Note)

NOTE

- Depending on robot motion, environment condition, etc. some oil leak may be noticed on the outside of the oil seal lips. Be aware these leak may accumulate and finally form oil drops, which may get spill depending on robot motion. Therefore, before starting operation of robot, please wipe off all oil leak of oil seal of Fig.7.1.1 (a) and (b).
- In case of oil leak, please consider replacing the grease and the oil altogether. This replacement potentially can help improving the leak situation.

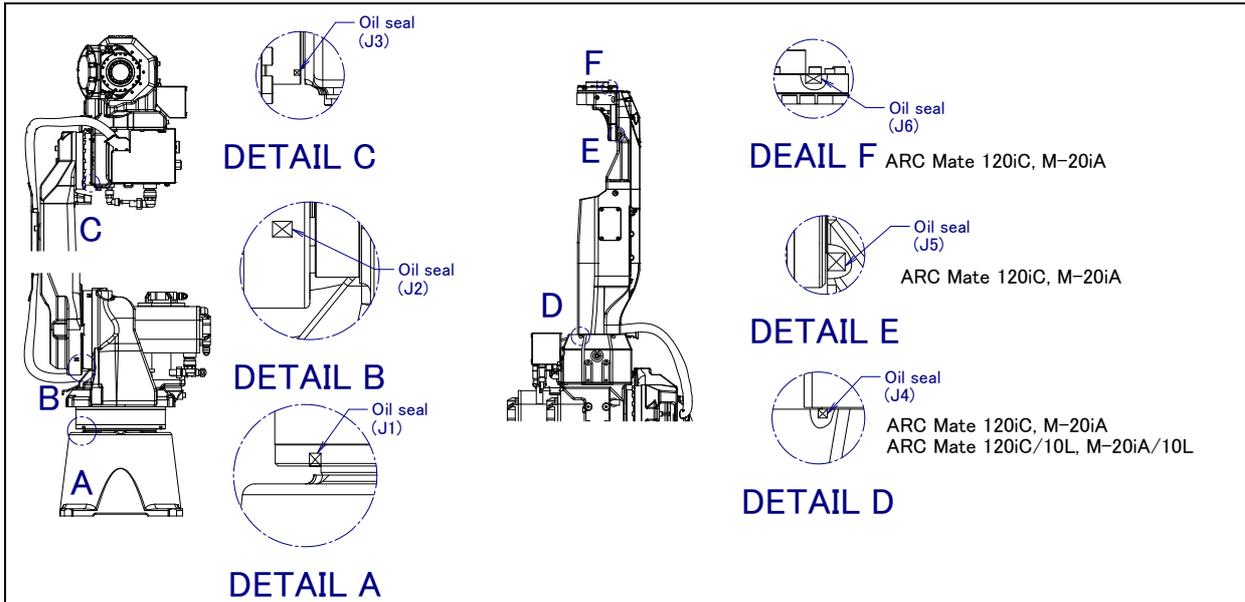


Fig.7.1.1 (a) Check parts of oil seal (1/2)

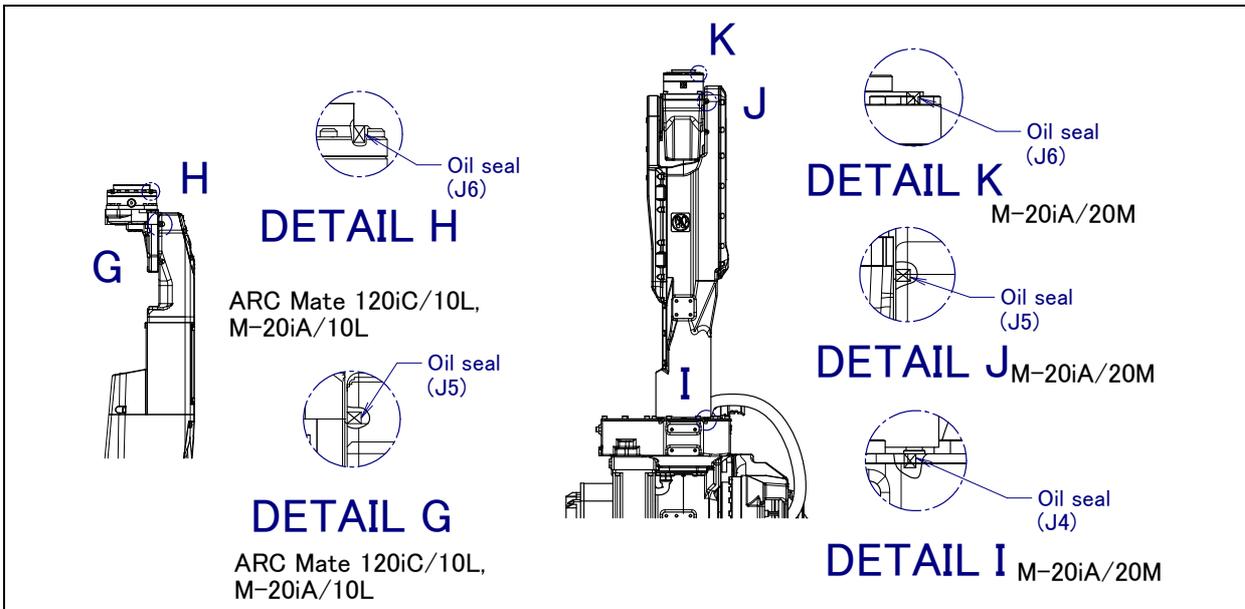


Fig.7.1.1 (b) Check parts of oil seal (2/2)

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 (c). 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 (1drop/10-20 sec), adjust it using the oiler control knob. Under normal usage, the oiler 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.

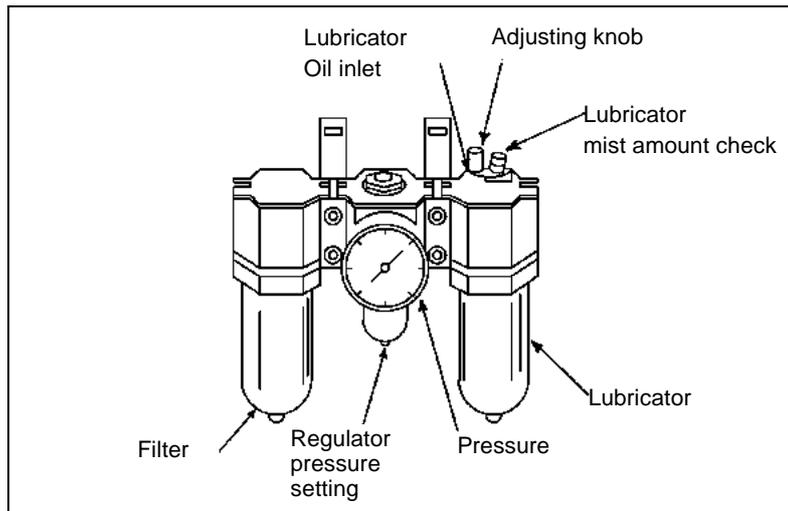


Fig.7.1.1 (c) Air control set

(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 taught positions of the robot have not deviated from the previous taught 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 5 mm when the power is cut.

7.1.2 First 1-month (320 hours operating) Checks

Check the following items after the time that is shorter between first one-month operation and 320 hours operating

Item	Check items	Check points
1	Check the oil sight glass of J4, J5/J6-axis gearbox (except M-20iA/20M)	Please confirm whether the amount of oil of the oil sight glass has come above Fig.7.2.3.2 (d), Fig.7.2.3.3 (c) and Fig. 7.2.3.4 (c) and replenish it if the level is low. When the oil sight glass does not have an air bubble then please check that the oil level is above the sight glass through the vent plug. A flashlight may be useful to see the level in the gearbox. Please consult your local FANUC representative if you have questions or concerns regarding the gearbox oil level. Moreover, please exchange oil when it is discolored due to deterioration or the quality is questionable in the oil sight glass such as right side of Fig.7.1.2. Refer to Subsection 7.2.2 about replacing method of oil.
2	Ventilation portion of controller	Check whether the cable connected to the teach pendant and robot is unevenly twisted.

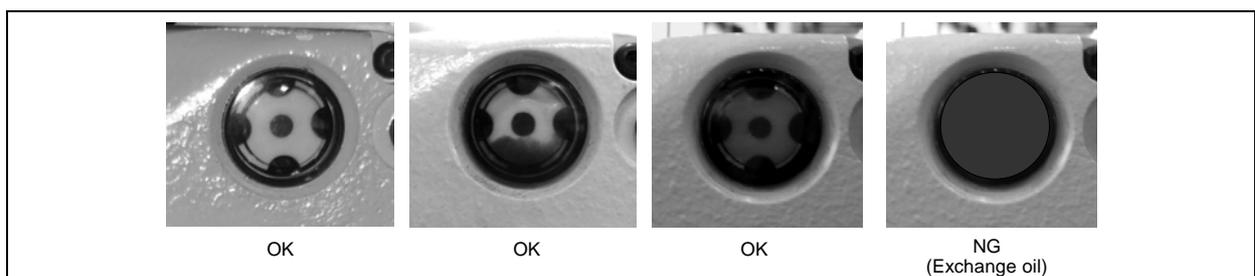


Fig.7.1.2 The extent of oil deterioration

**CAUTION**

Prolonged use of contaminated oil will cause the oil seal performance to decrease, and will lead to subsequent robot malfunction. Therefore, in case of severe robot operation conditions, oil exchange schedule must be shortened in order to keep contamination level low.

7.1.3 First 3-month (960 hours) Checks

Check the following items at the first quarterly inspection, then every year thereafter. (See Subsection 7.1.4.)

Item	Check items	Check points
1	Mechanical unit cable and welding 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	Further, tighten the end-effector mounting bolts and external main bolts. (NOTE2)
3	Check the mechanical stopper and adjustable mechanical stopper	Check the bolts of mechanical stopper and adjustable mechanical stopper are tightened. (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 any damage to the cable.
6	Controller cable and robot connecting cable	Check whether the cable connected to the teach pendant and robot is unevenly twisted.

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

Inspection points of the mechanical unit cables

Check the cable for damage that has been exposed. Clean it when the spatter adheres.

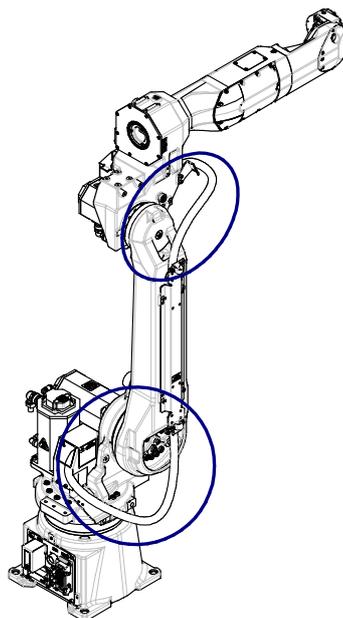


Fig. 7.1.3 (a) Inspection points of the mechanical unit cables

Inspection points of the connectors

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

Check items

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

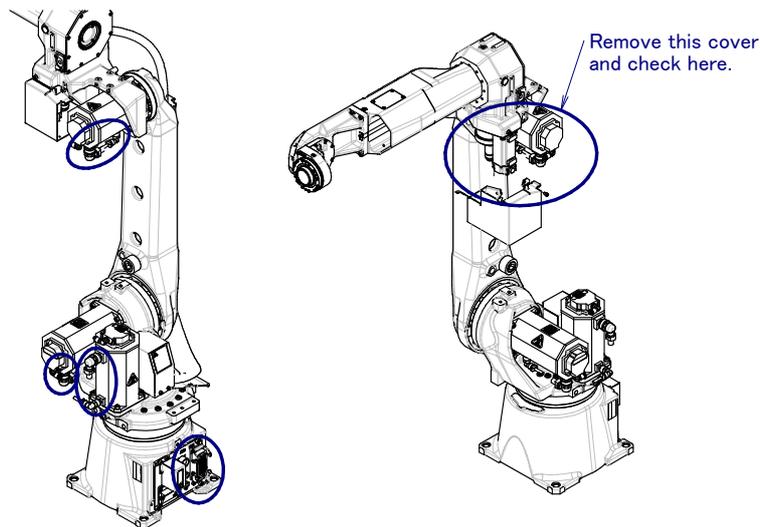


Fig. 7.1.3 (b) Inspection points of connectors

Note 2) Points to be retightened

- The end effector 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 loosen, retighten them.

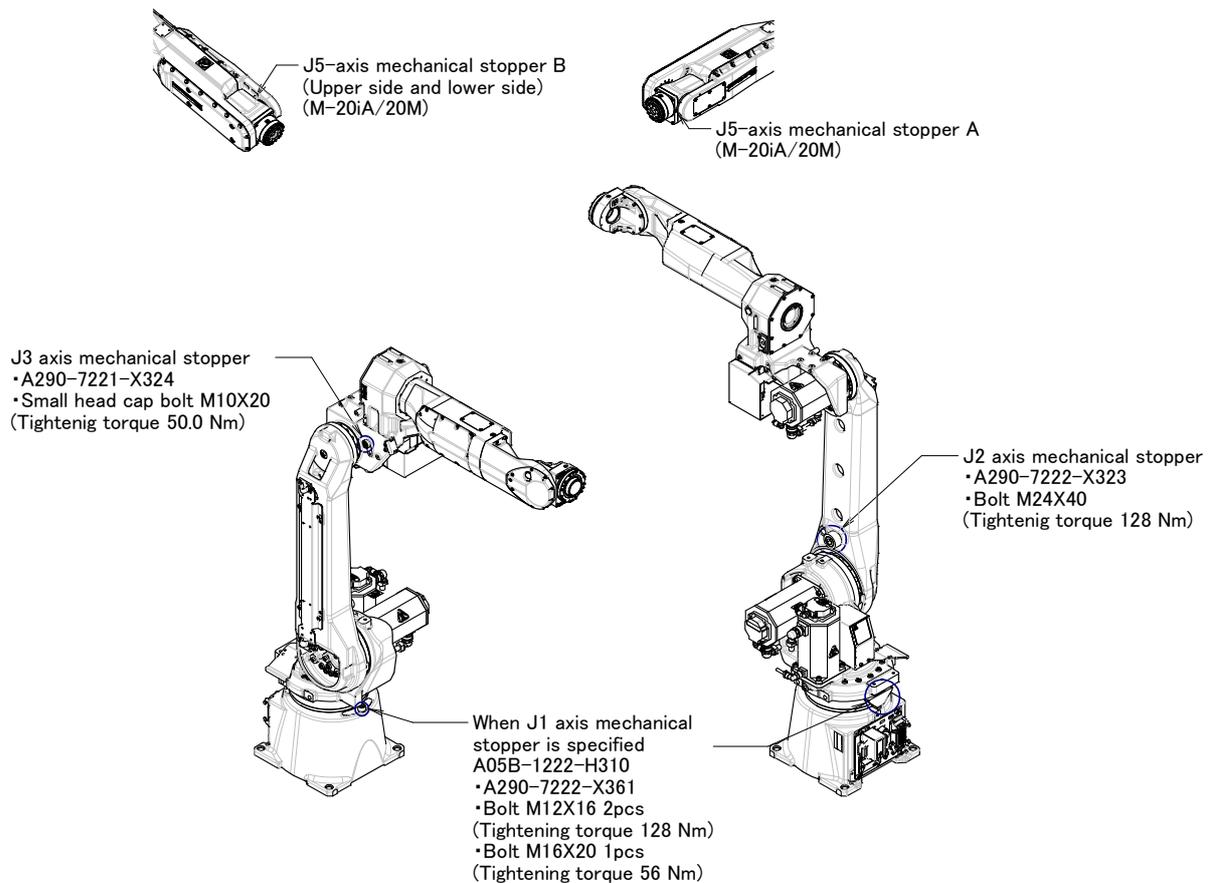


Fig.7.1.3 (c) Check of mechanical stopper and adjustable mechanical stopper

Note 4) Cleaning

- Necessary cleaning points, dust on the flat part, accumulation of weld spatter and oil
Clean sediments periodically.
In particular, clean the following points carefully.
Vicinity of the wrist axis and oil seal
→ Debris that is attached to the oil seal could cause an oil leak.
Vicinity of the welding torch and wrist flange
→ The insulation failure occurs when the spatter has collected around the wrist flange or welding
and there is a possibility of damaging the robot mechanism by the welding current. (See
appendix C)
Vicinity of the conduit and the wrist hollow part.
- Check the vicinity of the inspection points and ensure that the welding cables and the EOAT cables
are not rubbing on the wrist and the J3 arm. (EOAT : end-of-arm-tooling)
- Check if there is a collision at the EOAT.
- Check that the fluoroc resin ring of wrist is damaged. When it is damaged, replace it by new one.
Two years are aims in an exchange period. If you operate robot with the state that hard mine dust is
attached to rotated part, exchange period may shortens.
- Check the reducer or grease bath for an oil leak.
→ If oil can be found a day after wiping oil, an oil leak might be the result of a bad seal.

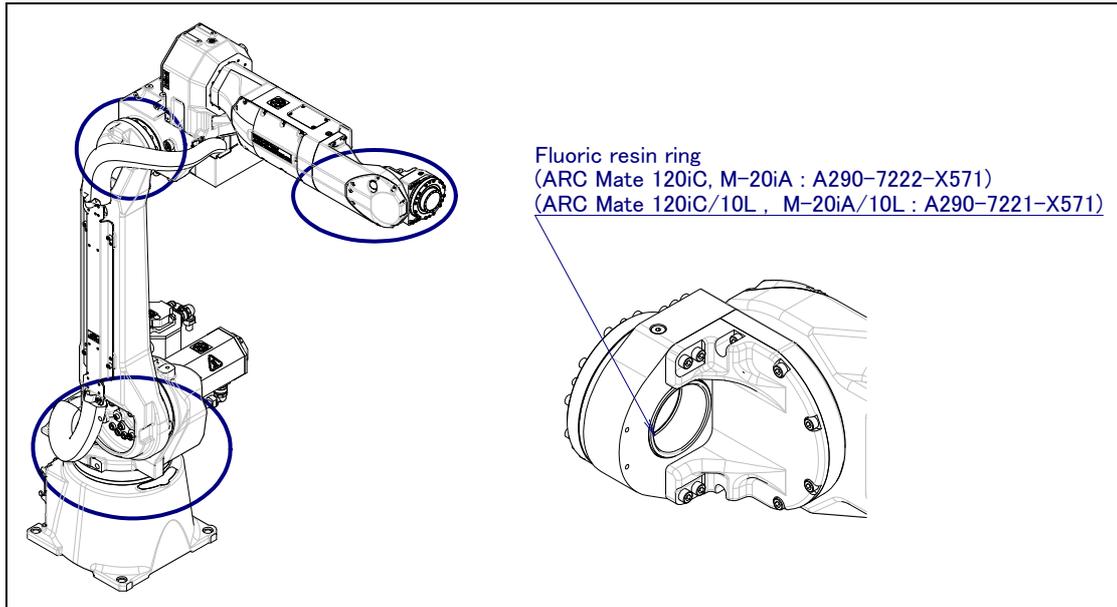


Fig. 7.1.3 (d) Cleaning points

7.1.4 3-month (960 hours operating) Checks

Check the following items after the three-month operation (or 960 hours operating)

Item	Check items	Check points
1	Check the oil sight glass of J4, J5/J6-axis gearbox	(See Subsection 7.1.2.)
2	Fluoric resin ring	Check whether fluorine resin ring is damaged. If it is damaged, replace it by new one. (See NOTE4 of Subsection 7.1.3.)
3	Ventilation portion of controller	(See Subsection 7.1.2.)

7.1.5 1-year (3840 hours) Checks

Check the following items once every year (3840 hours).

Item	Check items	Check points
1	Mechanical unit cable and welding cable	(See Subsection 7.1.3.)
2	Retightening external main bolts	(See Subsection 7.1.3.)
3	Check the mechanical stopper and adjustable mechanical stopper	(See Subsection 7.1.3.)
4	Cleaning each parts and inspection	(See Subsection 7.1.3.)
5	Check the end effector (hand) cable	(See Subsection 7.1.3.)
6	Battery	(See Subsection 7.1.3.)
7	Supply grease to J6-axis reducer (M-20iA/20M)	Supply grease to J6-axis reducer. (See Subsection 7.2.2.)
8	Controller cable and robot connecting cable	Replace battery in the mechanical unit. (See Subsection 7.1.3)

7.1.6 3-year (11520 hours) Checks

Check the following items once every 3 years (11520 hours).

Item	Check items	Check points
1	Replacing grease and oil of each axis reducer and gearbox	Replace grease and oil of reducer and gearbox. (See Subsection 7.2.1.)

7.1.7 4-year (15360 hours) Checks

Check the following items in cycle that is shorter every 4 years and 15360 hours.

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

7.2 MAINTENANCE

7.2.1 Replacing the Batteries (1-year checks)

The position data of each axis is preserved by the backup batteries. The batteries need to be replaced every 1 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. 7.2.1(a), (b)) If it cannot be removed, tap it to side direction with a plastic hammer.
- 3 Take out the old batteries from the battery case. In this time, battery can be taken out by pulling the stick of the center of the battery box.
- 4 Insert new batteries into the battery case. Pay attention to the direction of batteries.
- 5 Close the battery case cap.



CAUTION

When using a robot with the severe dust/liquid protection option, remove the cover from the battery case as shown in Fig. 7.2.1 (b) to replace the battery. After replacing the battery, reinstall the cover. In this time, please be sure to replace gasket by new one for effects of severe dust/liquid protection. When sticking a gasket on a battery cover, please stick it not to have gaps between them.

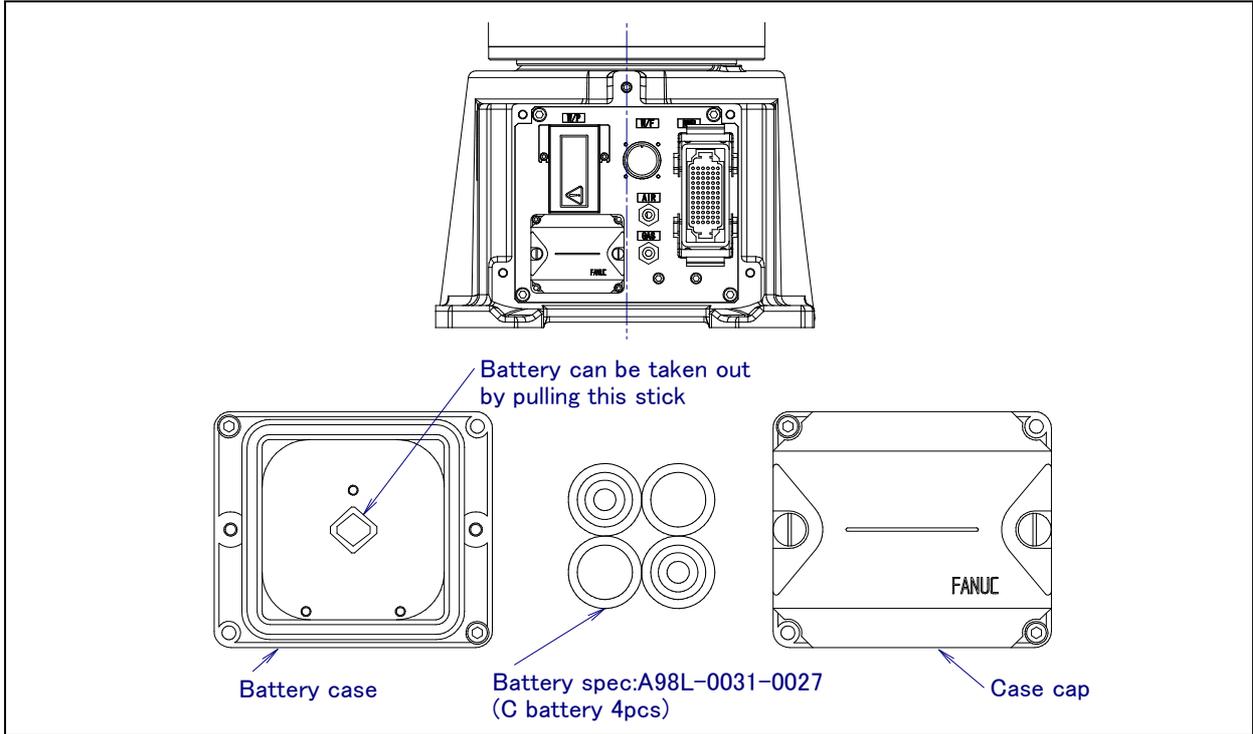


Fig. 7.2.1 (a) Replacing the battery

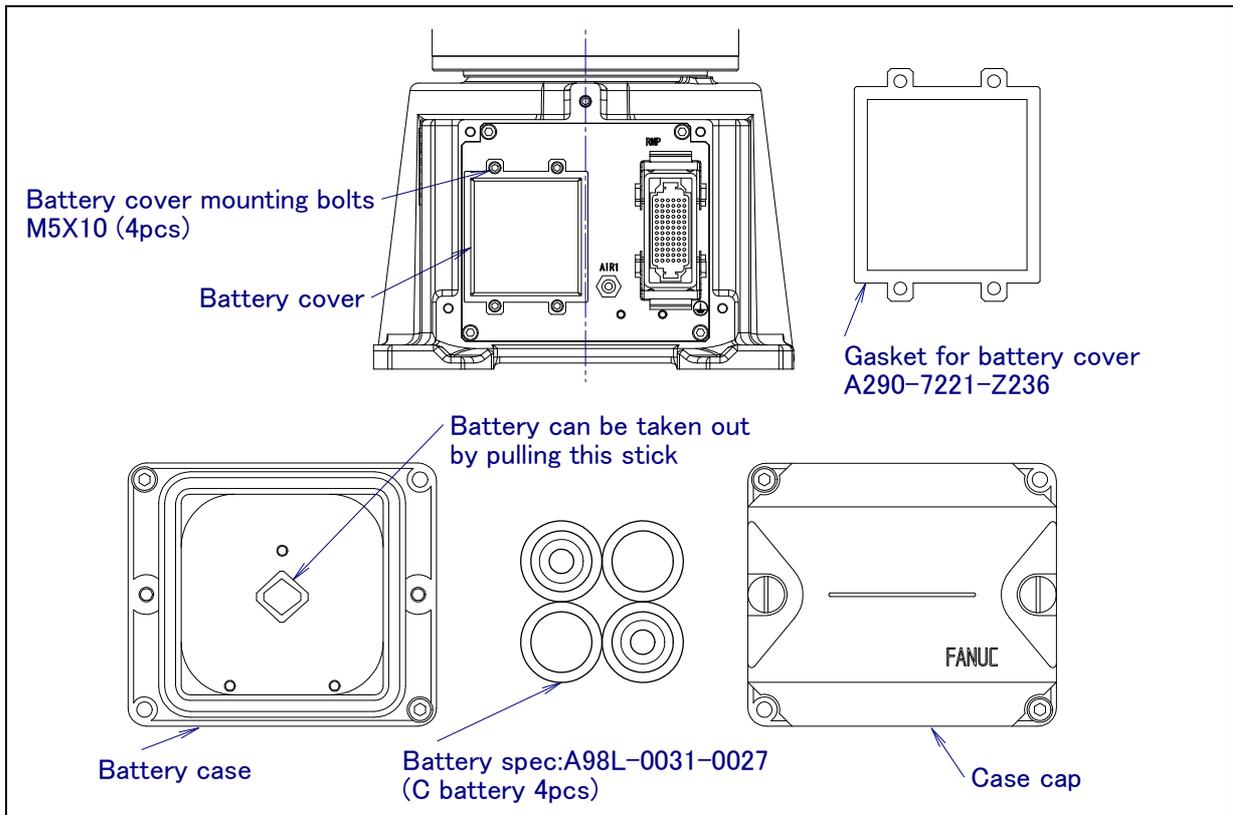


Fig. 7.2.1 (b) Replacing the battery (When severe dust/liquid protection option is specified)

7.2.2 Greasing (M-20iA/20M)

Following is the greasing procedure for J6-axis reducer.
When greasing the robot, keep its power turned off.

- i) Replenish the J6-axis reducer with grease about every 12 months or after 3840 hours of operation.
- ii) See Fig. 3.1 and Table 3.1 for greasing points and the method.
- iii) After applying grease, release the remaining pressure within the grease bath as described in the procedure in Subsection 7.2.3.8.

Table 7.2.2 Greasing points

Greasing point	Specified grease	Amount of grease	Gun tip pressure	Greasing method
J6-axis reducer	Harmonic grease 4BNo.2 Specification : A98L-0040-0230	40ml	0.1 MPa or less (NOTE)	Remove the Extra low bolts and sealing washers of the J6-axis grease inlet and outlet, and attach the supplied grease nipple of the J6-axis to the grease inlet of the J6-axis. After greasing, remove the grease nipple, and attach the extra low bolts and sealing washers to the grease inlet and outlet.

NOTE When using a hand pump, apply grease approximately once per two seconds.

⚠ CAUTION

If you grease incorrectly, the pressure in the grease bath may increase steeply, leading to a broken seal, which will eventually cause grease leakage or malfunction. When greasing, be sure to follow the cautions stated in Subsection 7.2.5.

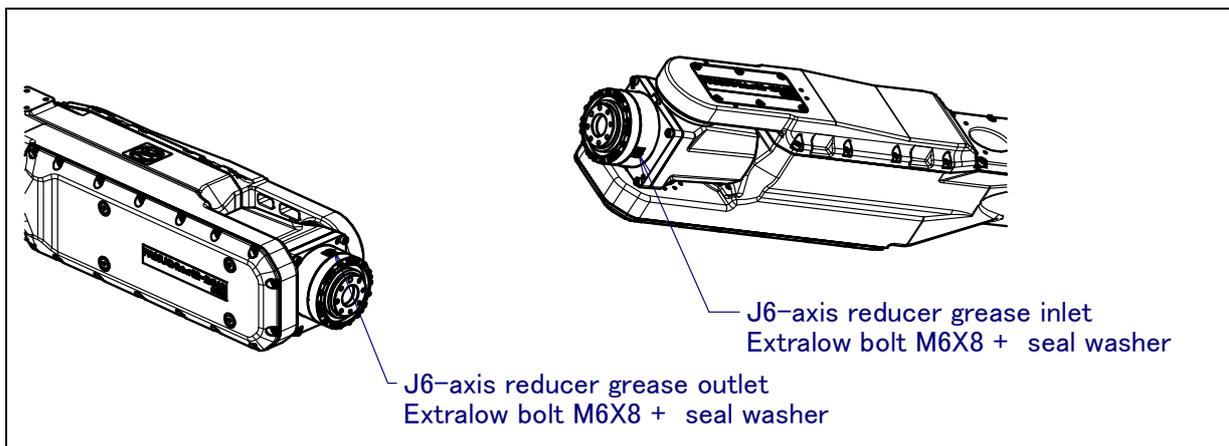


Fig.7.2.2 J6-axis grease supply position (M-20iA/20M)

7.2.3 Replacing the Grease and Oil of the Drive Mechanism (3-year (11520 hours) checks)

Replace the grease and of the reducers of J1, J2, and J3 axes and J4/J5/J6-axis gearbox in cycle that is shorter among every three years and 11520 hours by using the following procedures.

NOTE

When reusing the seal bolts, be sure to seal them with seal tape.

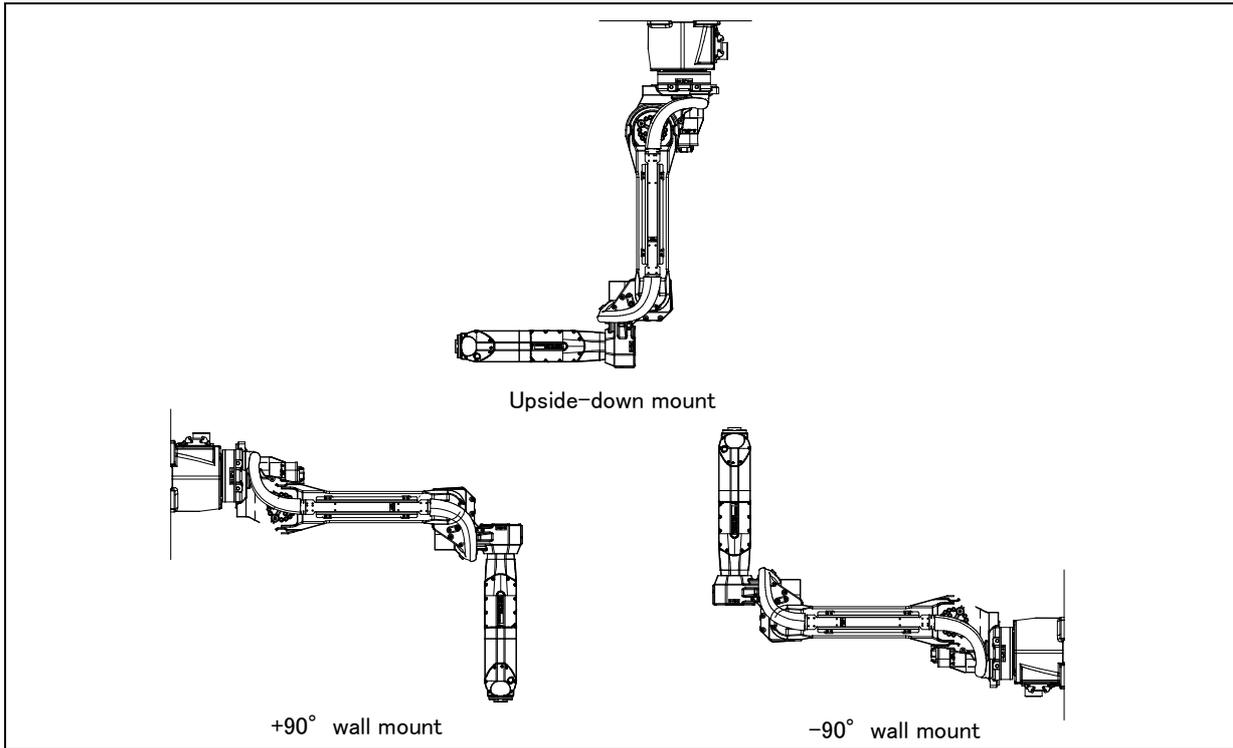


Fig 7.2.3 (a) Installation method

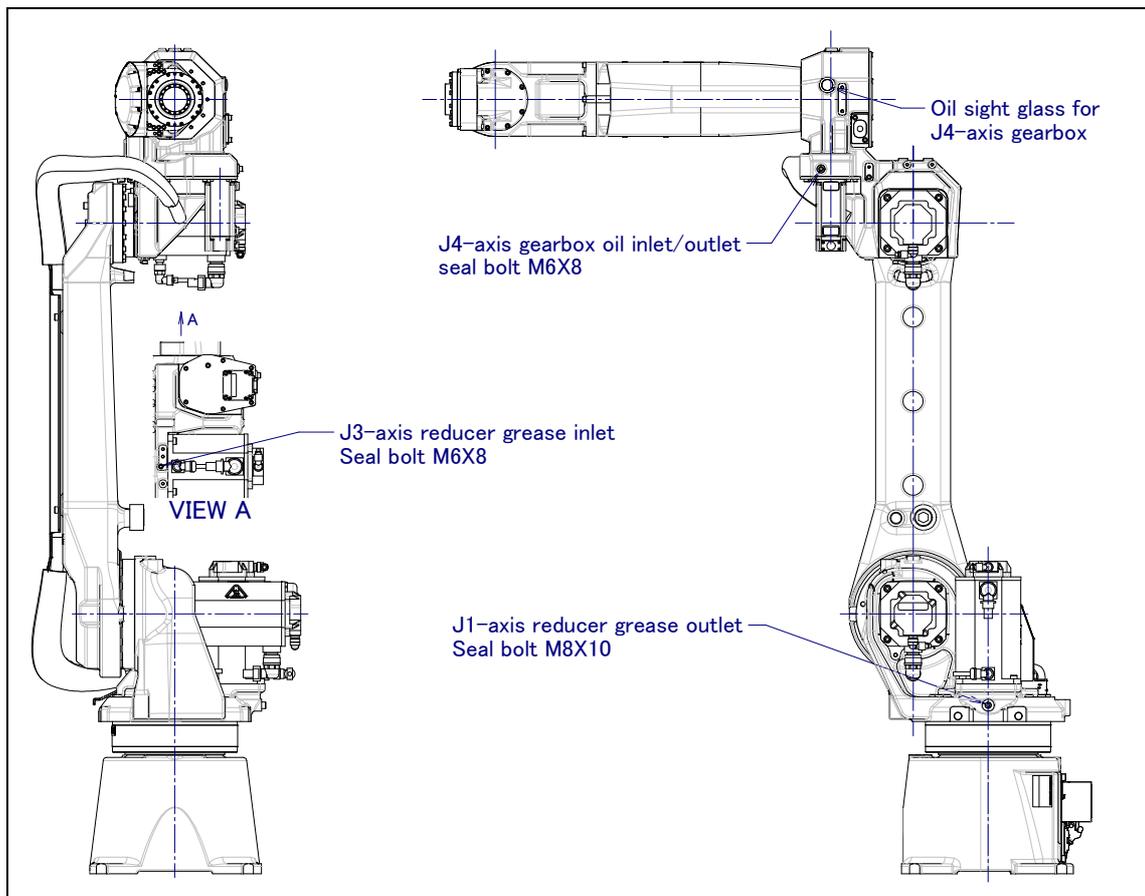


Fig.7.2.3 (b) Greasing point of reducer and oiling points of gearbox
(ARC Mate 120iC,M-20iA,ARC Mate 120iC/10L,M-20iA/10L)

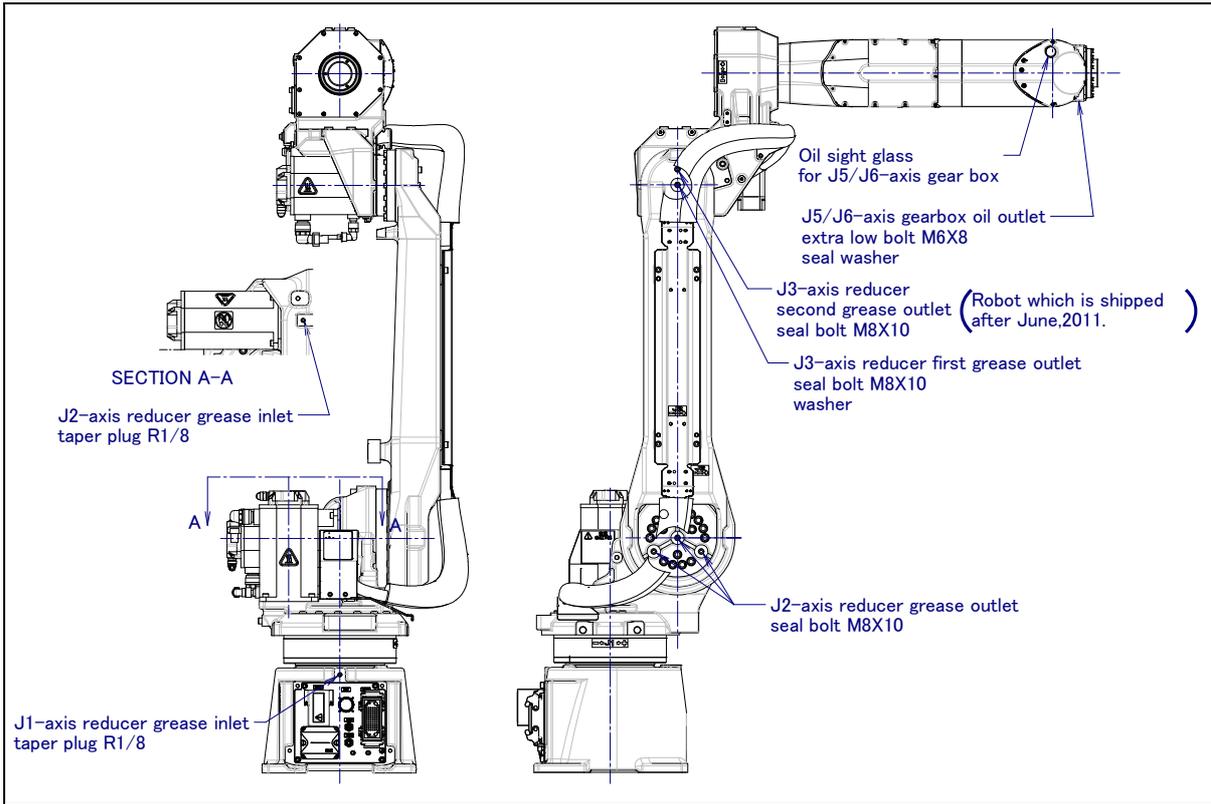


Fig.7.2.3 (c) Greasing point of reducer and oil oiling points of gearbox (ARC Mate 120iC, M-20iA)

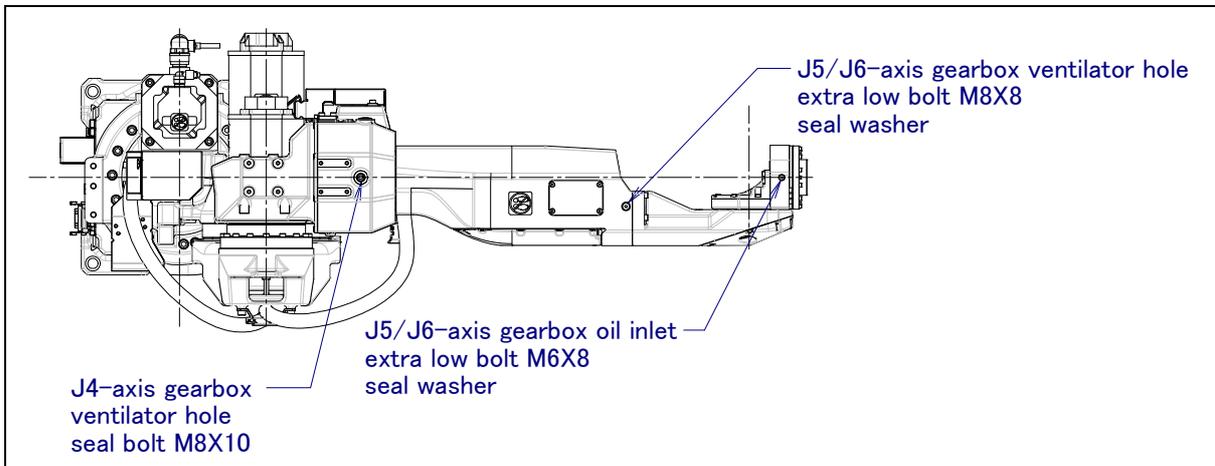
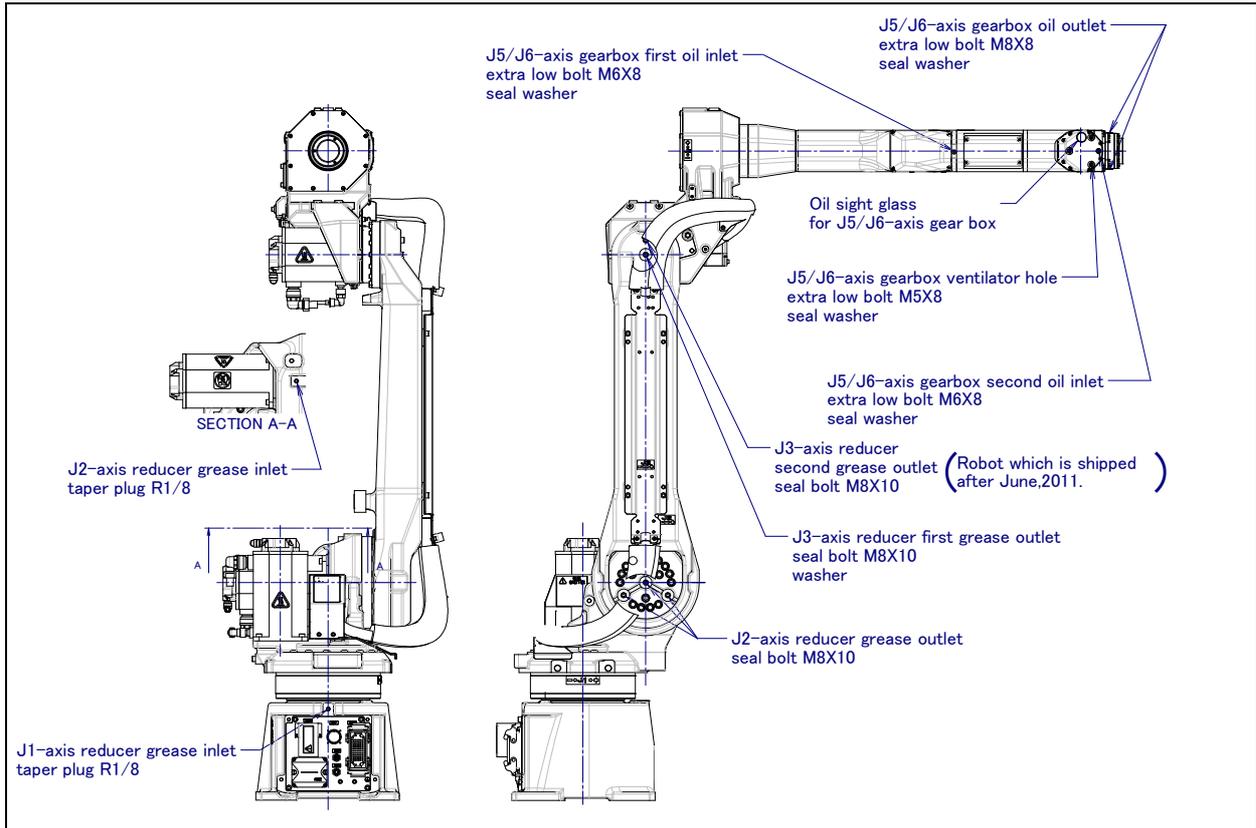
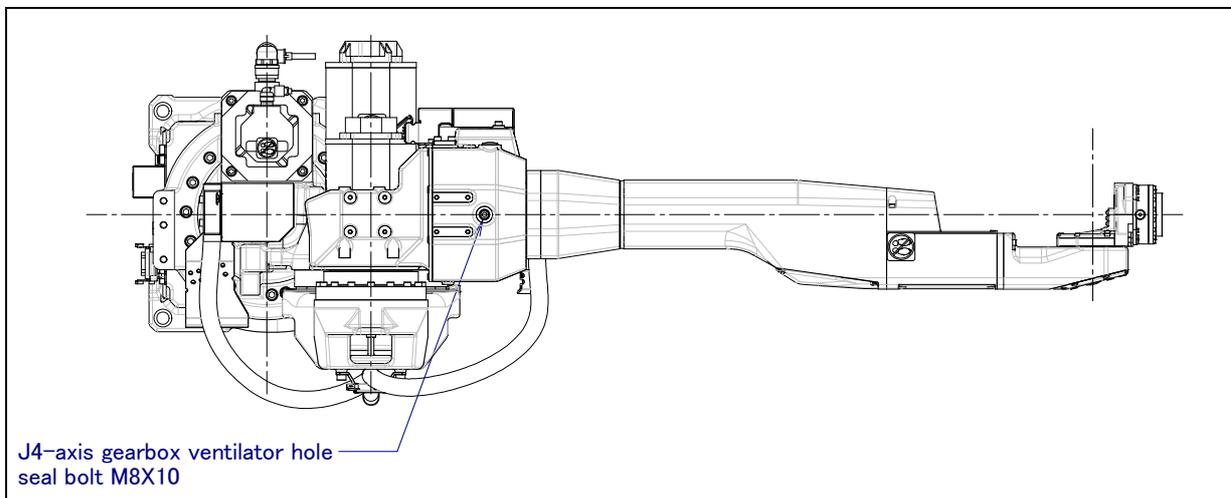


Fig.7. 2.3 (d) Greasing point of reducer and oil oiling points of gearbox (ARC Mate 120iC, M-20iA)



**Fig.7.2.3 (e) Greasing point of reducer and oiling points of gearbox
(ARC Mate 120iC/20L, M-20iA/10L)**



**Fig.7.2.3 (f) Greasing point of reducer and oiling points of gearbox
(ARC Mate 120iC/20L, M-20iA/10L)**

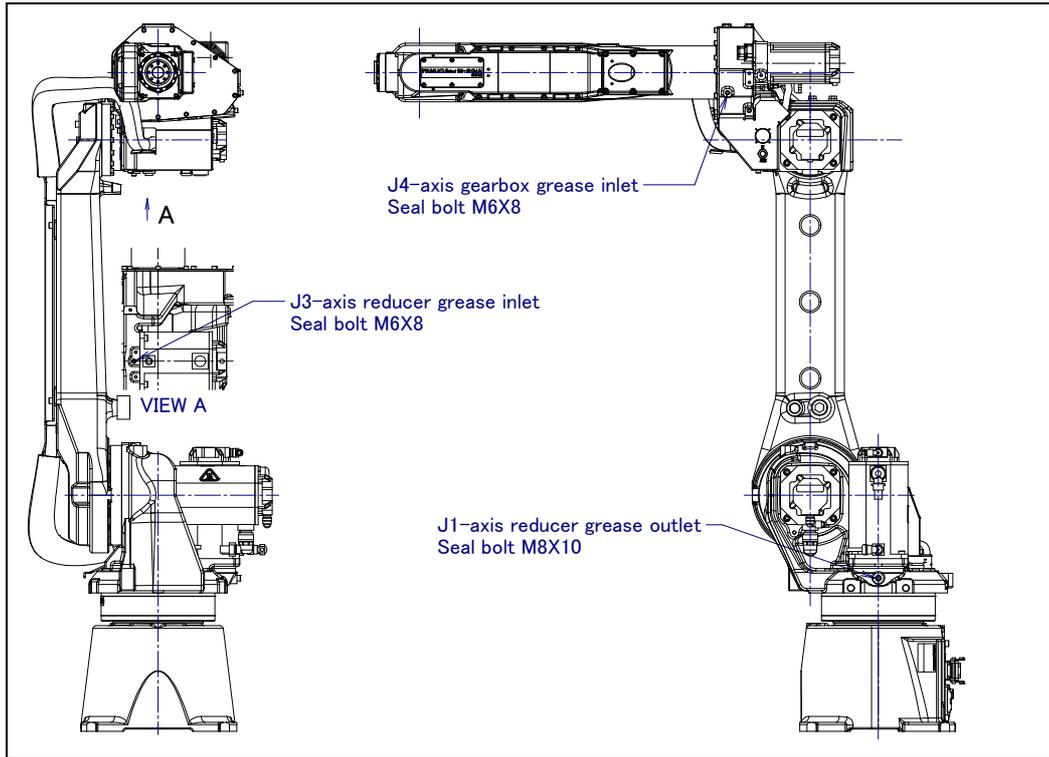


Fig.7.2.3 (g) Greasing point of reducer and gearbox (M-20iA/20M)

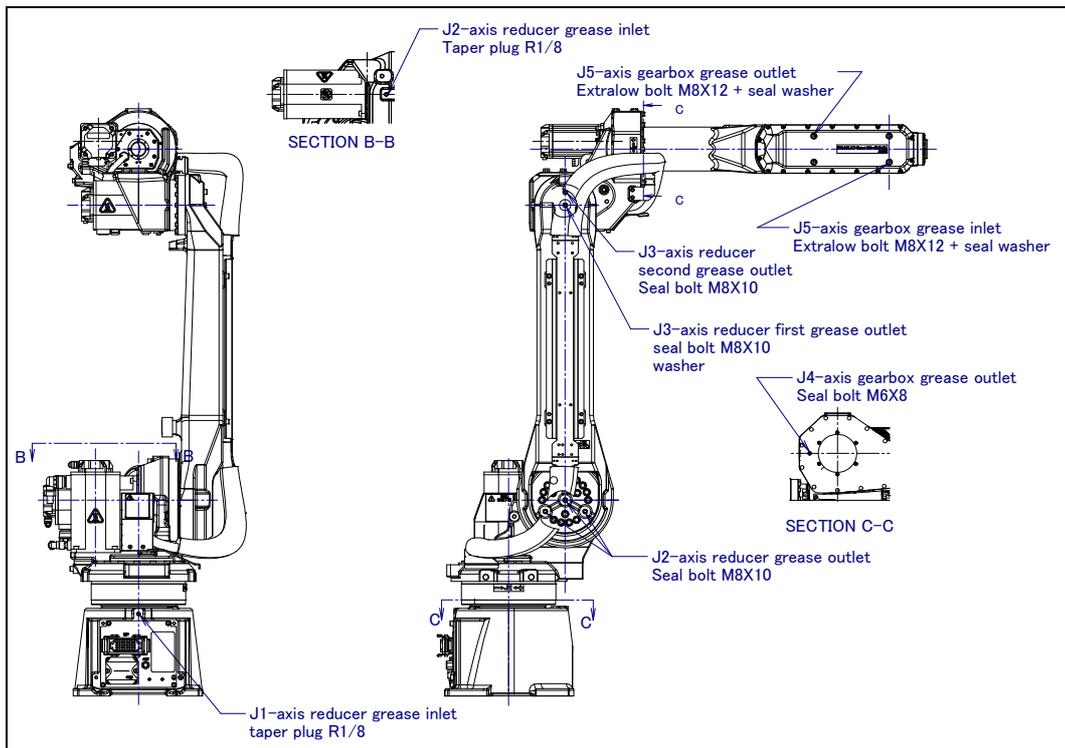


Fig.7.2.3 (h) Greasing point of reducer and gearbox (M-20iA/20M)

Table 7.2.3 Specification of seal bolts, taper plug and seal washer

Parts name	Specification
Seal bolt (M6X8)	A97L-0218-0417#060808
Seal bolt (M8X10)	A97L-0218-0417#081010
taper plug (R1/8)	A97L-0001-0436#1-1D
seal washer (M5)	A30L-0001-0048#5M

Parts name	Specification
seal washer (M6)	A30L-0001-0048#6M
seal washer (M8)	A30L-0001-0048#8M

7.2.3.1 Grease replacement procedure for J1 to J3-axis reducer

⚠ CAUTION
 Failure to supply grease may cause the increase of the internal pressure of the grease bath and may cause damage to the seal performance, 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 seal bolt or taper plug of grease outlet).
- 2 Supply grease slowly, using a manual pump. (once per two seconds)
- 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 2.2.1 (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 Subsection 2.2.5, and then close the grease outlet.
- 6 To prevent accidents caused by slipping, completely remove any excess grease from the floor or robot.

Table 7.2.3.1 (a) Grease name and amount (J1, J2, J3-axis reducer)

Greasing points	Amount of grease to be applied	Gun tip pressure	Specified grease
J1-axis reducer	1000g (1111ml)	0.1MPa or less (NOTE)	Kyodo Yushi VIGOGREASE RE0 (Specification: A98L-0040-0174)
J2-axis reducer	850g(944ml)		
J3-axis reducer	300g(333ml)		

NOTE) When using a hand pump, apply grease approximately once per two seconds.

Table 7.2.3.1 (b) Postures for greasing (J1, J2, J3-axis reducer)

Supply position		Supply position					
		J1	J2	J3	J4	J5	J6
J1-axis reducer	Floor mount	Arbitrary	Arbitrary	Arbitrary	Arbitrary	Arbitrary	Arbitrary
	Upside-down mount						
	-90° wall mount						
	+90° wall mount						
J2-axis reducer	Floor mount	Arbitrary	Arbitrary	Arbitrary	Arbitrary	Arbitrary	Arbitrary
	Upside-down mount						
	-90° wall mount						
	+90° wall mount						
J3-axis reducer	Floor mount	Arbitrary	Arbitrary	0°	Arbitrary	Arbitrary	Arbitrary
	Upside-down mount			180°			
	-90° wall mount	Arbitrary	0°	270° or -90°			
	+90° wall mount			90°			

- 1 Move the robot to the greasing posture described in Table 7.2.3.1 (b).
- 2 Turn off the controller power.

- 3 Remove the seal bolt or taper plug from grease outlet. (Fig.7.2.3 (b), (c), (e))
 J1-axis : 1 location (seal bolt M8x10)
 J2-axis : 3 locations (seal bolt M8x10)
 J3-axis : 1 locations (J3-axis reducer first grease outlet ,seal bolt M8x10) *When robot is shipped after June,2011, robot has 2 grease outlet. Remove only first grease outlet.
- 4 Remove the seal bolt or taper plug from grease inlet and attach grease nipple.
- 5 Keep greasing until the new grease pushes out the old grease and comes out from each grease outlet.
- 6 Release remaining pressure using the procedure given in Subsection 7.2.3.6. In case of upside-down mount, pull out about 130cc grease to make space of grease bath.

7.2.3.2 Oil replacement procedure for J4-axis gearbox (ARC Mate 120iC, M-20iA,ARC Mate 120iC/10L, M-20iA/10L)

NOTE
 There is severe risk of gear damage in case robot is operated with oil shortage. Please make sure the gearbox is always filled with correct amount of oil.

Table 7.2.3.2 (a) Oil name and amount (J4-axis gearbox)

Oiling points	Amount of oil to be applied (NOTE 1)	Gun tip pressure	Specified oil
J4-axis gearbox	700g(822ml)	0.1MPa or less (NOTE 2)	JX Nippon Oil & Energy Corporation BONNOC AX68 (Specification: A98L-0040-0233)

NOTE 1) It is not a regulated amount injection. Please confirm height of oil sight glass oil surface is 3/4 or more of all heights. Refer to Fig.7.2.3.2 (d).

Table 7.2.3.2 (b) Postures for oiling (J4-axis gearbox)

Supply position		Posture					
		J1	J2	J3	J4	J5	J6
J4-axis gearbox	Floor mount	Arbitrary	Arbitrary	0°	Arbitrary	Arbitrary	Arbitrary
	Upside-down mount			180°			
	Upside-down mount			-90°			
	+90°wall mount			90°			

Exhausting oil method

- 1 Move the robot to the greasing posture described in Table 7.2.3.2 (b).
- 2 Turn off the controller power.
- 3 Remove any peripheral equipment, if it was mounted at the ventilator hole.

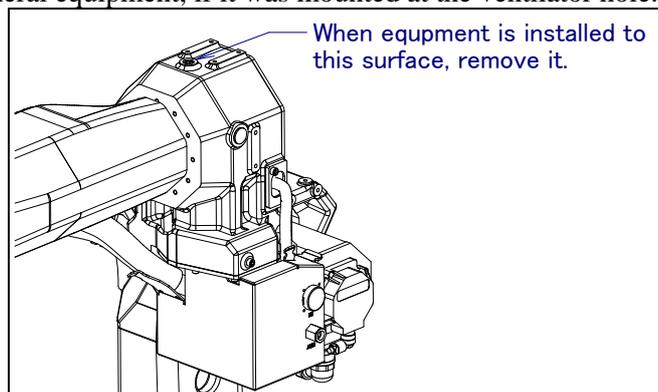


Fig.7.2.3.2 (a) Removing equipment of the ventilator hole

- 4 Put the oil pan under the oil outlet.
- 5 Block the gap using tape etc. to prevent oil from oil outlet intruding into the J4 connector panel.
If robot is shipped before March,2009, remove the J4 connector panel mounting bolts and make plug of oil inlet/outlet can be seen. When moving the connector panel, remove user side or air joint if it is necessary. Then Remove taper plug or seal bolt or oil outlet and ventilator hole and exhaust oil.
- 6 When all oil is discharged, attach the taper plug. Replace the taper plug by new one. When reusing it, wind it with a seal tape.

Injecting oil method

- 7 According to description below, inject oil.
 - (1) Install the oil injection nipple with valve (A05B-1221-K006) to the oil inlet.
 - (2) Confirm the valve is open, Perform oiling using the oil gun (A05B-1221-K005). If the oil sight glass is filled with oil, push the oil gun about 4cm (about 80ml).

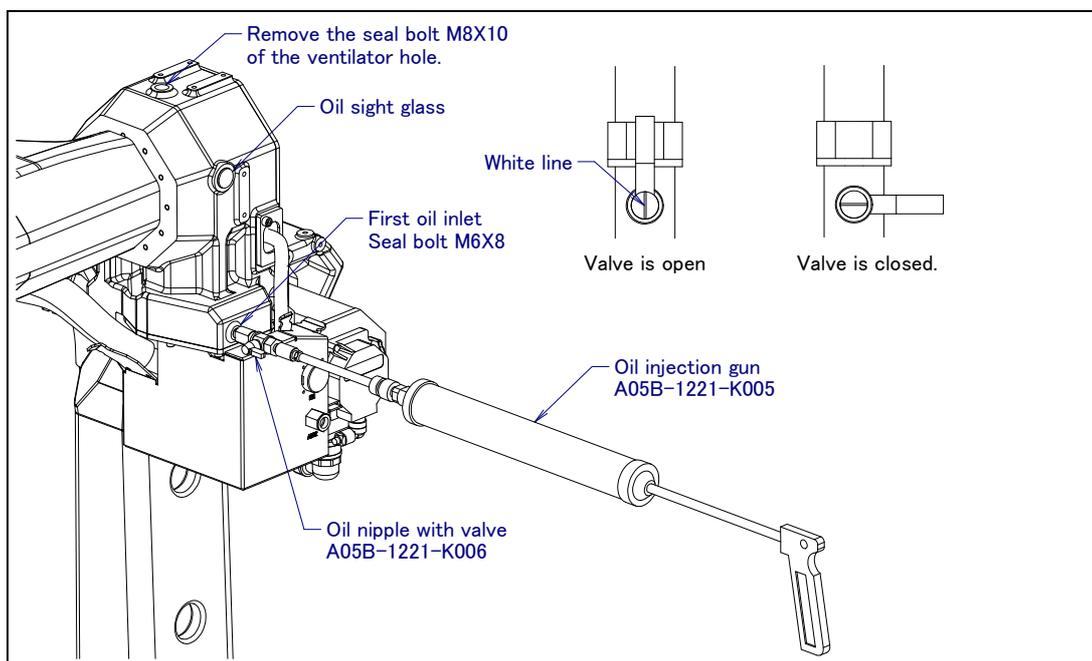


Fig.7.2.3.2 (b) Oiling by oil gun

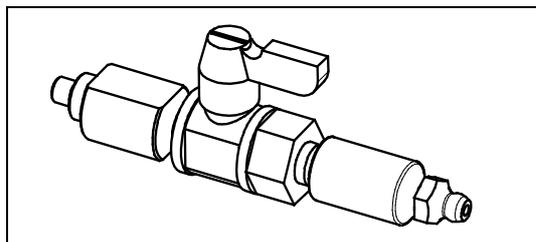


Fig.7.2.3.2 (c) Oil injection nipple with valve (A05B-1221-K006)

- (3) Close the valve of oil injection nipple, then remove the oil gun.
- (4) Attach the seal bolt to the ventilator hole. Replace the seal bolt by new one. When reusing it, be sure to wind it with a seal tape.
- (5) Remove oil injection nipple, and attach seal bolt to oil inlet. Replace seal bolt by new one. When reusing it, be sure to wind it with seal tape.
- (6) Release remaining pressure of oil bath referring to Subsection 7.2.3.7 and confirm oil quantity with oil sight glass.

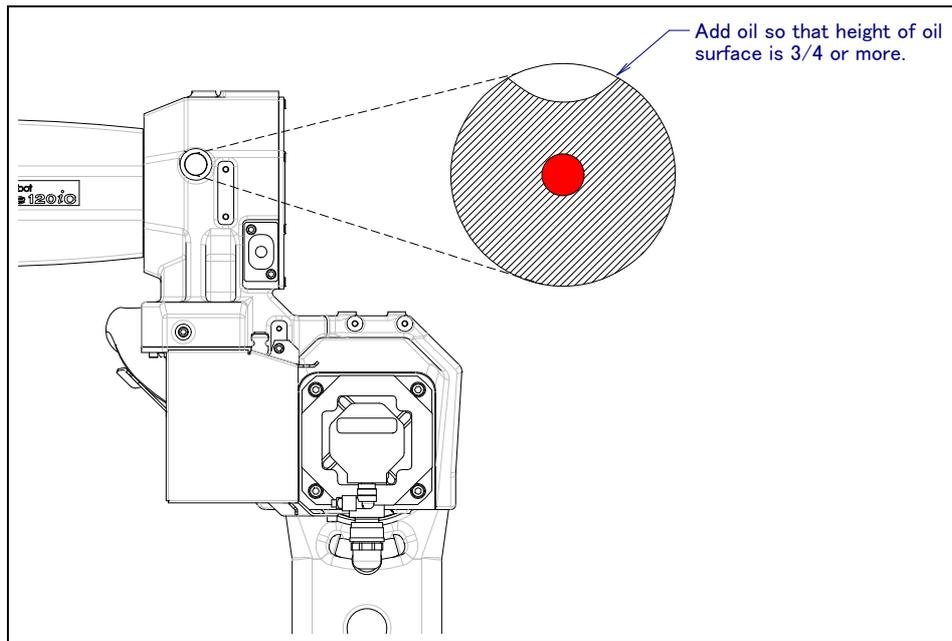


Fig.7.2.3.2 (d) Aim of oil sight glass (Oiling of J4-axis gearbox)

7.2.3.3 Oil replacement procedure for J5/J6-axis gearbox (ARC Mate 120iC, M-20iA)

NOTE
 There is severe risk of gear damage in case robot is operated with oil shortage. Please make sure the gearbox is always filled with correct amount of oil.

Table 7.2.3.3 (a) Oil name and amount (J5/J6-axis gearbox)

Oiling points	Amount of oil to be applied (NOTE 1)	Gun tip pressure	Specified oil
J5/J6-axis gearbox	700g(822ml)	0.1MPa or less	JX Nippon Oil & Energy Corporation BONNOC AX68 (Specification: A98L-0040-0233)

NOTE 1) It is not a regulated amount injection. Be sure to confirm the amount of oil with the oil sight glass.

Table 7.2.3.3 (b) Postures for oiling (J5/J6-axis gearbox)

Supply position		Posture					
		J1	J2	J3	J4	J5	J6
J5/J6-axis gearbox (Supplying posture) (Discharging posture)	Floor mount	Arbitrary	Arbitrary	-50°	0°	50°	Arbitrary
	Upside-down mount			50°	180°		
	-90°wall mount			140°	180°		
	+90°wall mount			40°	0°		
J5/J6-axis gearbox (Confirm oiling posture)	Floor mount			-35°	0°	0°	
	Upside-down mount			35°	180°		
	-90°wall mount			125°	180°		
	+90°wall mount			55°	0°		

NOTE) Choose the one of the posture taken easily when there is two or more posture.

Exhausting oil method

- 1 Move the robot to the posture for oiling and discharging oil described in Table 7.2.3.3 (b).

- 2 Turn off the controller power.
- 3 Put the oil pan under the oil outlet. Remove extra low bolt and seal washer of oil outlet, then remove oil inlet and ventilator hole. (See Fig.7.2.3.3 (a)) (In this time, if you remove bolt of oil outlet firstly, you can prevent spilling oil on surroundings.)

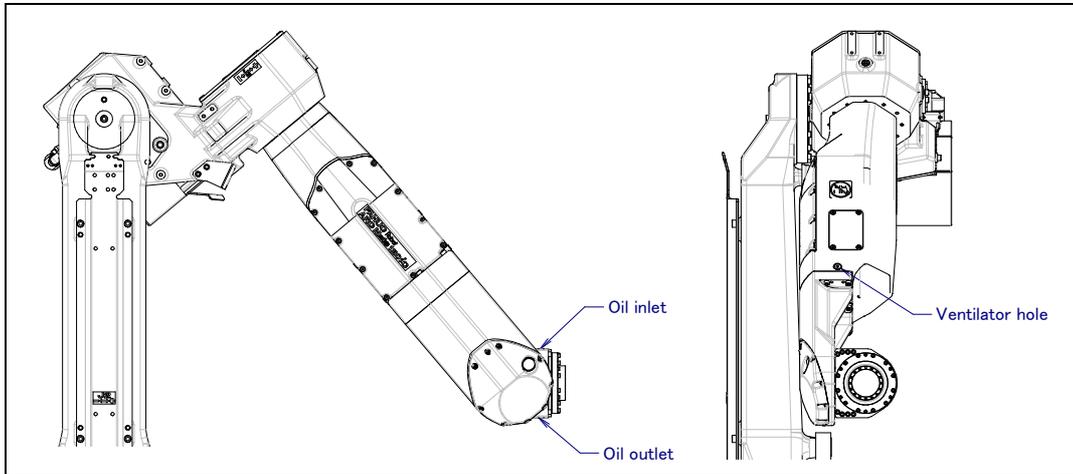


Fig.7.2.3.3 (a) Oil adapter (supply oil J5/J6-axis gearbox) (ARC Mate 120iC, M-20iA)

- 4 When all oil is discharged, attach extra low bolt and seal washer to oil outlet.

Injecting oil method

- 5 Confirm robot posture is J5/J6-axis gearbox (posture for oiling and discharging oil) and oil outlet is closed, then supply oil according to description below.
 - A When oil gun is used
 - (1) Attach oil injection nipple with valve (A05B-1221-K006) to oil inlet (Fig.7.2.3.2 (b)) referring to Fig.7.2.3.3 (b).
 - (2) Attach oil tray with valve (A05B-1221-K007) to ventilator hole.
 - (3) Confirm valve of oil inlet and oil outlet are open. Supply oil to J5/J6-axis gearbox by oil injection gun (A05B-1221-K005). If oil comes out in oil tray from oil outlet, Stop supplying oil, close the valve oil injection nipple, and remove oil gun.
 - (4) Close the valve of oil tray, remove tray and close the oil outlet.
 - (5) Remove the oil injection nipple, then attach extra low bolt and seal washer to first oil inlet.
 - (6) Turn on the controller power, move the robot to the posture (J5/J6-axis gearbox (confirm oiling)). Confirm the amount of oil. (See Fig.7.2.3.3 (c).) If oil is insufficient, add oil using syringe etc. from ventilator hole. If oil is added, stir the oil in oil bath by releasing remaining pressure of Subsection 7.2.3.7, then confirm the amount of oil.
 - (7) According to Subsection 7.2.3.7, release remaining pressure of oil bath and confirm the oil sight glass again.

⚠ CAUTION

If supplying oil forcibly when valve is closed, internal pressure of oil bath rise abnormally and cause oil leak from seal part or oil seal falling out. Be careful.

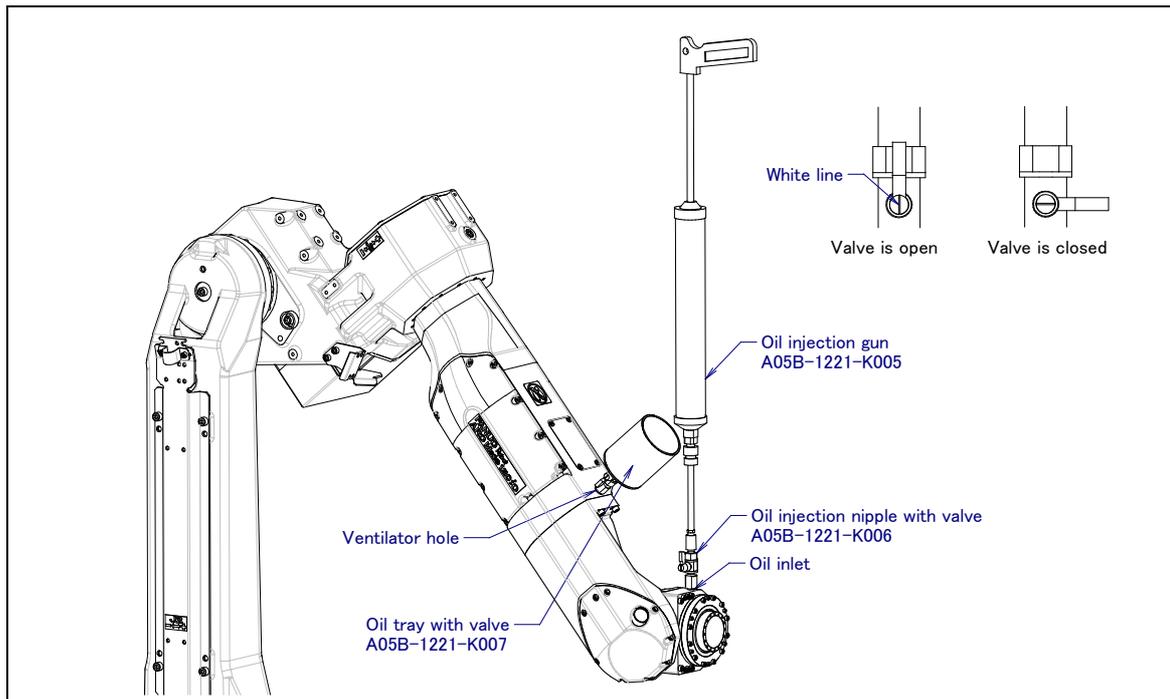


Fig.7.2.3.3 (b) Oiling by oil gun

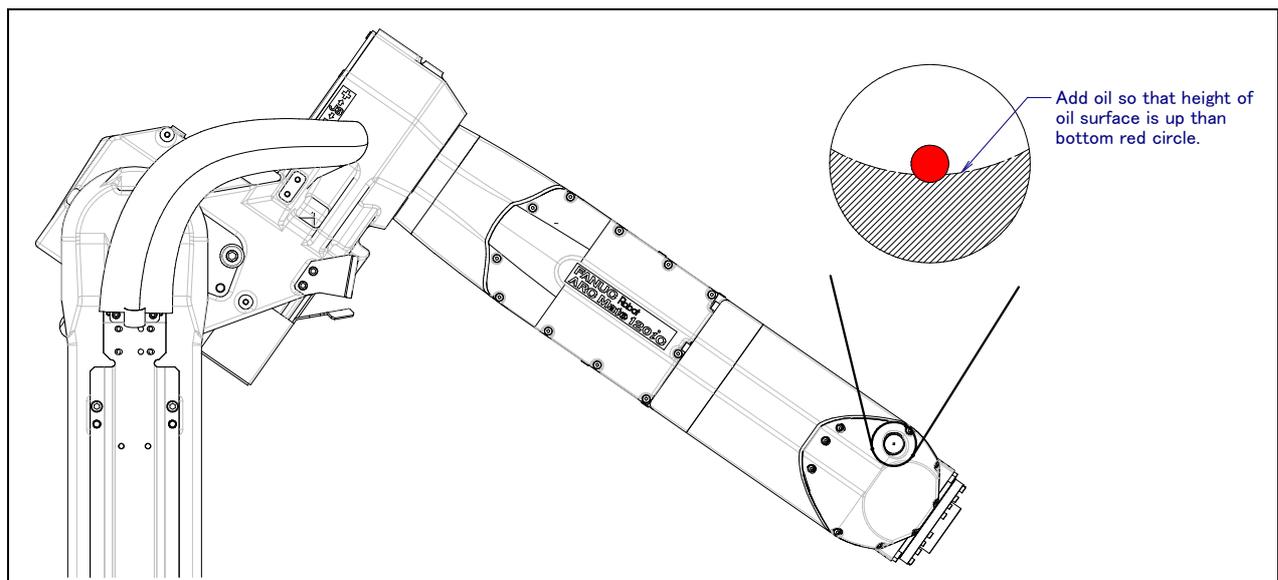


Fig.7.2.3.3 (c) Standard of oil sight glass ((supply oil J5/J6-axis gearbox) (ARC Mate 120iC, M-20iA)

B When oil gun is not used

- (1) Supply oil from oil inlet. If oil overflowed form ventilator hole, stop supplying oil and close the ventilator hole. When oil adapter (A290-7222-X591) is used, attach it referring to example of Fig.7.2.3.3 (d). The amounts of oiling are about as many as 0.6 adapters. It takes about 25 minutes.
- (2) Attach extra low bolt and seal washer to oil inlet.
- (3) Turn on the controller power, Move the robot to the posture (J5/J6-axis gearbox (confirm oiling)) then confirm the amount of oil sight glass. (See Fig.7.2.3.3 (c)). If oil is insufficient, add oil using syringe etc. from ventilator hole. If oil is added, stir the oil in oil bath by releasing remaining pressure of Subsection 7.2.3.7, then confirm the amount of oil.
- (4) According to Subsection 7.2.3.7, release remaining pressure of oil bath and confirm the oil sight glass again.

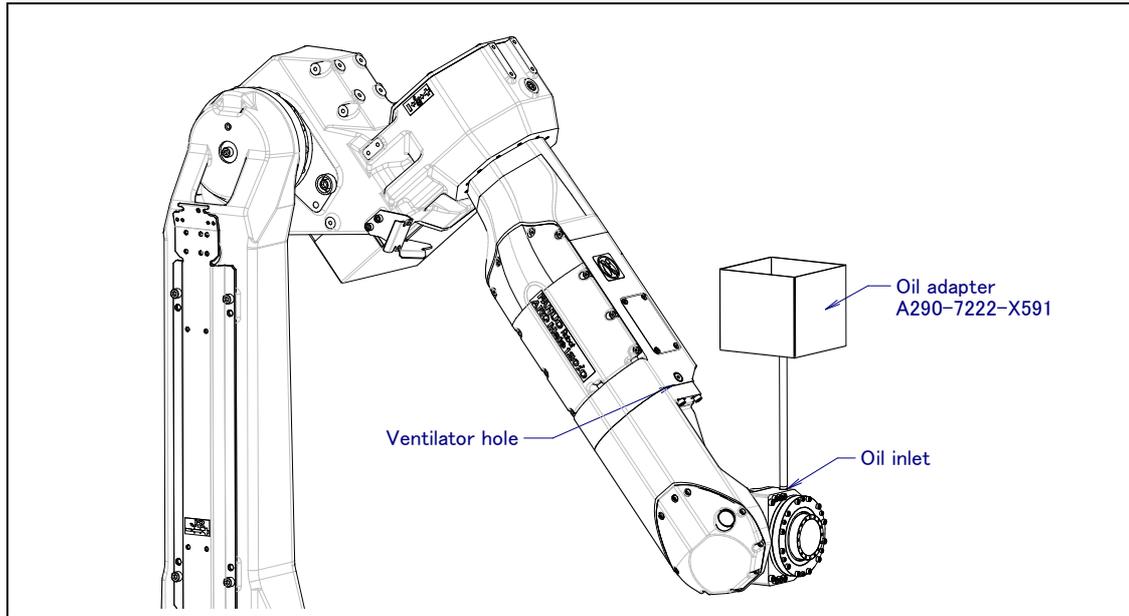


Fig.7.2.3.3 (d) Oil adapter (for J5/J6-axis gearbox oil inlet) (ARC Mate 120iC, M-20iA)

7.2.3.4 Oil replacement procedure for J5/J6-axis gearbox (ARC Mate 120iC/10L, M-20iA/10L)

⚠ NOTE

There is severe risk of gear damage in case robot is operated with oil shortage. Please make sure the gearbox is always filled with correct amount of oil.

Table 7.2.3.4 (a) Oil name and amount (J5/J6-axis gearbox)

Oiling points	Amount of oil to be applied (NOTE 1)	Gun tip pressure	Specified oil
J5/J6-axis gearbox	340g(400ml)	0.1MPa or less	JX Nippon Oil & Energy Corporation BONNOC AX68 (Specification: A98L-0040-0233)

NOTE 1) It is not a regulated amount injection. Be sure to confirm the amount of oil with the oil sight glass.

Table 7.2.3.4 (b) Postures for oiling (J5/J6-axis gearbox)

Supply position		Posture					
		J1	J2	J3	J4	J5	J6
J5/J6-axis gearbox (Oiling posture) (When oil gun is used)	Floor mount	Arbitrary	Arbitrary	18°	-40°	0°	Arbitrary
	Upside-down mount			-18°	140°		
	-90°wall mount	0°		-72°	-40°		
	+90°wall mount			108°	-40°		
J5/J6-axis gearbox (Oiling posture) (When oil gun is not used)	Floor mount	Arbitrary		18°	90°		
	Upside-down mount			-18°	-90°		
	-90°wall mount	0°		-72°	90°		
	+90°wall mount			108°	90°		
J5/J6-axis gearbox (replenishing oil)	Floor mount	Arbitrary		90°	0°		
	Upside-down mount			-90°	0°		
	-90°wall mount	0°		0°	0°		
	+90°wall mount			180°	0°		
J5/J6-axis gearbox (discharging oil)	Floor mount	Arbitrary	-30°	-70°			
	Upside-down mount		30°	110°			
	-90°wall mount	0°	-210°	-70°			
	+90°wall mount		150°	-70°			
J5/J6-axis gearbox (confirm oiling)	Floor mount	Arbitrary	0°	0°			
	Upside-down mount		180°	0°			
	-90°wall mount	0°	-90°	0°			
	+90°wall mount		90°	0°			
J5/J6-axis gearbox (release remaining pressure)	Floor mount	Arbitrary	20° - 90°	90°	Arbitrary		
	Upside-down mount		-20° - -90°	-90°			
	-90°wall mount	0°	0° - 70°	-90°			
	+90°wall mount		110° - 180°	90°			

NOTE) Choose the one of the posture taken easily when there is two or more posture.

Exhausting oil method

- 1 Move the robot to the posture of J5/J6-axis (oil discharge) described in Table 7.2.3.4 (b) .
- 2 Turn off the controller power.
- 3 Put the oil pan under the oil outlet.
Remove the extra low bolt and seal washer of first oil inlet and seal washer. See Fig.7.2.3.4 (a)) (In this time, if you remove bolt of oil outlet firstly, you can prevent spilling oil on surroundings.

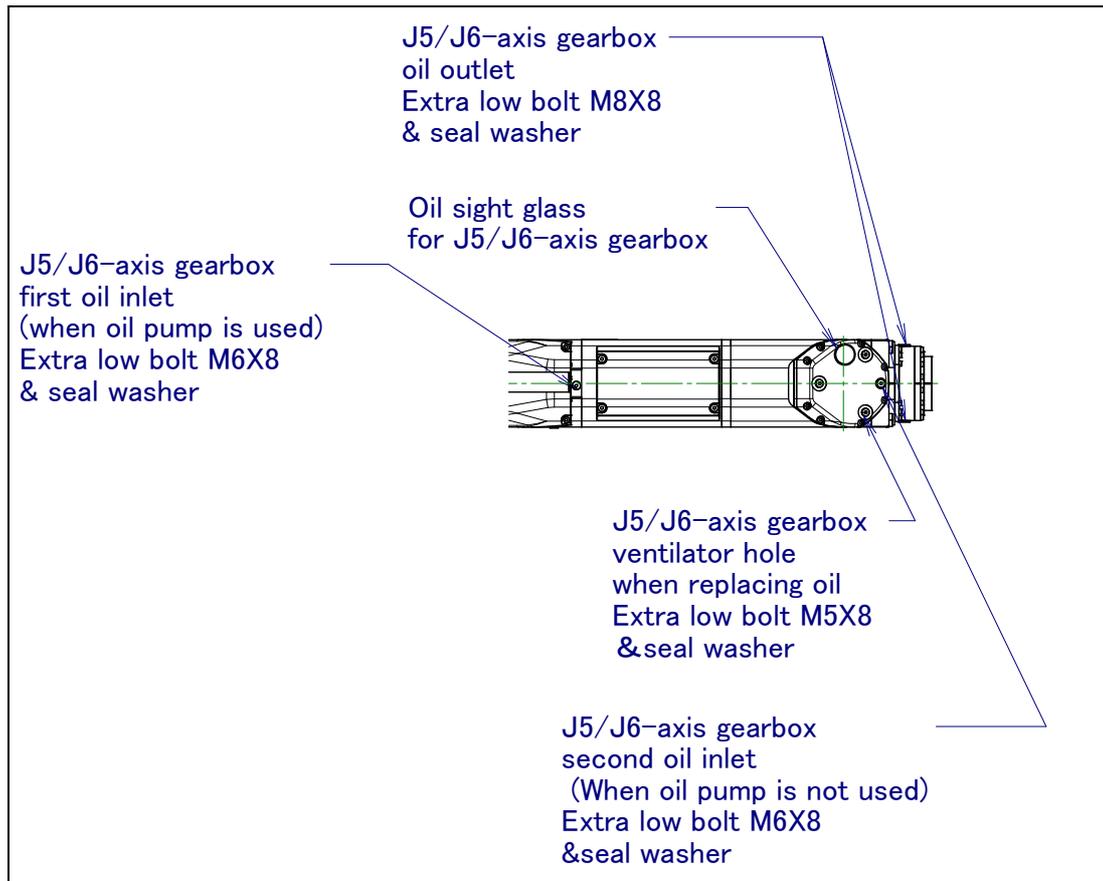


Fig.7.2.3.4 (a) Oil inlet and outlet (ARC Mate 120iC/10L,M-20iA/10L)

- 4 Install the taper plug or extra low bolt and seal washer to the first oil outlet and oil outlet after all oil is exhausted.
- 5 Turn on the controller power.

Injecting oil method

- 6 Move the robot to the J5/J6-axis gearbox oil supplying posture (posture when using oil gun differs from posture when not using oil gun. Please be careful)
- 7 Turn off the controller power.
- 8 Supply oil according to the procedure below/
 - A When oil gun is used
 - (1) Install oil injection nipple with valve to J5/J6-axis gearbox first oil inlet (A05B-1221-K006) (Fig.7.2.3.2 (c)) referring to Fig.7.2.3.4 (b).
 - (2) Attach oil tray with valve (A05B-1221-K007) to J5/J6-axis gearbox oil outlet (J6-axis cross roller part).
 - (3) Confirm valve of oil inlet and oil outlet are open referring to Fig.7.2.3.4 (b). Supply oil to J5/J6-axis gearbox by oil injection gun (A05B-1221-K005). If oil comes out in oil tray from oil outlet, Stop supplying oil, close the valve oil injection nipple, and remove oil gun
 - (4) Close the valve of oil tray, remove tray and close the oil outlet.
 - (5) Remove the oil injection nipple, then attach extra low bolt and seal washer to first oil inlet.
 - (6) Move robot to the posture for J5/J6-axis gearbox (replenishment) of Table 7.2.3.4 (b) and add oil from second oil inlet (M5) by a syringe fountain pen filler. If about 15ml of oil is added, oil comes out from oil inlet. Then close the oil inlet.
 - (7) Move robot to the posture for J5/J6-axis gearbox (confirm oiling) of Table 7.2.3.4 (b) and confirm the quantity of oil. (See Fig.7.2.3.4 (c).)
 - (8) Turn J4-axis 90 degree by each axis jog, back to the original posture, confirm oil amount height is 3/4 or more. If oil is insufficient, add oil by a syringe fountain pen filler.
 - (9) Release remaining pressure using the procedure given in Subsection 7.2.3.7 and confirm the oil sight glass again.

**CAUTION**

If supplying oil forcibly when valve is closed, internal pressure of oil bath rise abnormally and cause oil leak from seal part or oil seal falling out. Be careful

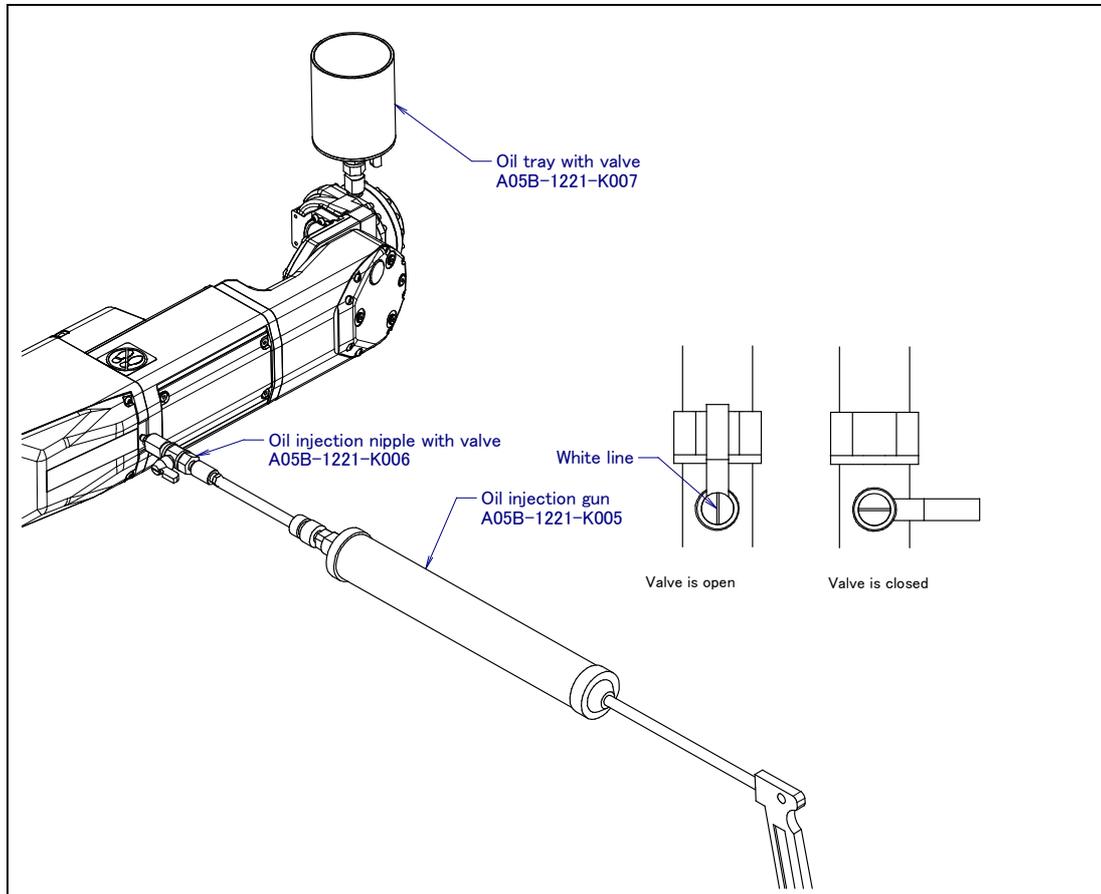
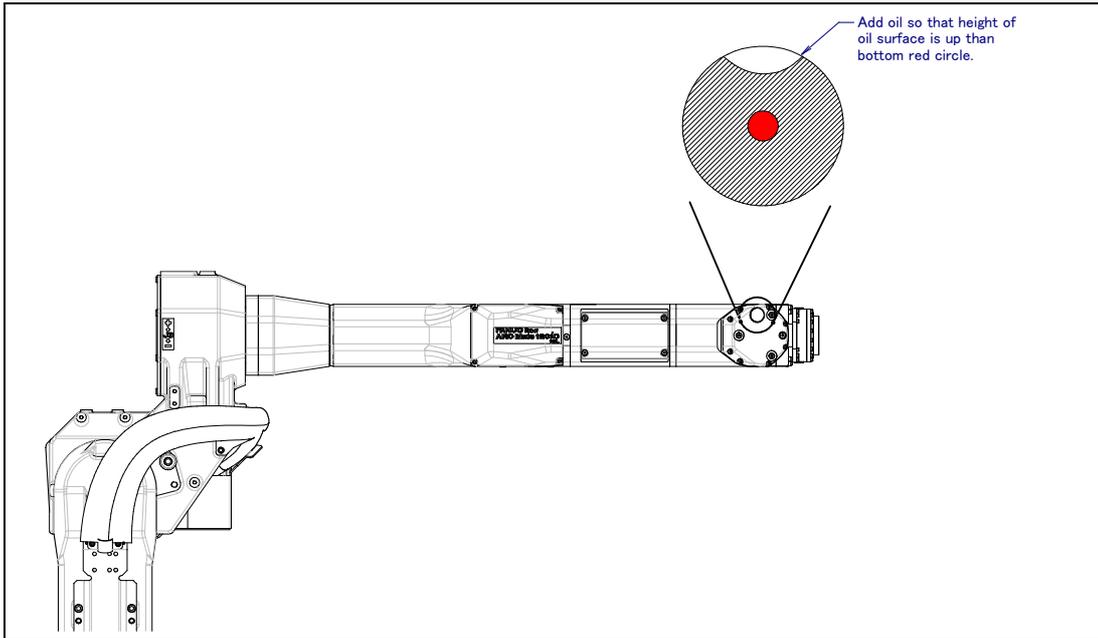


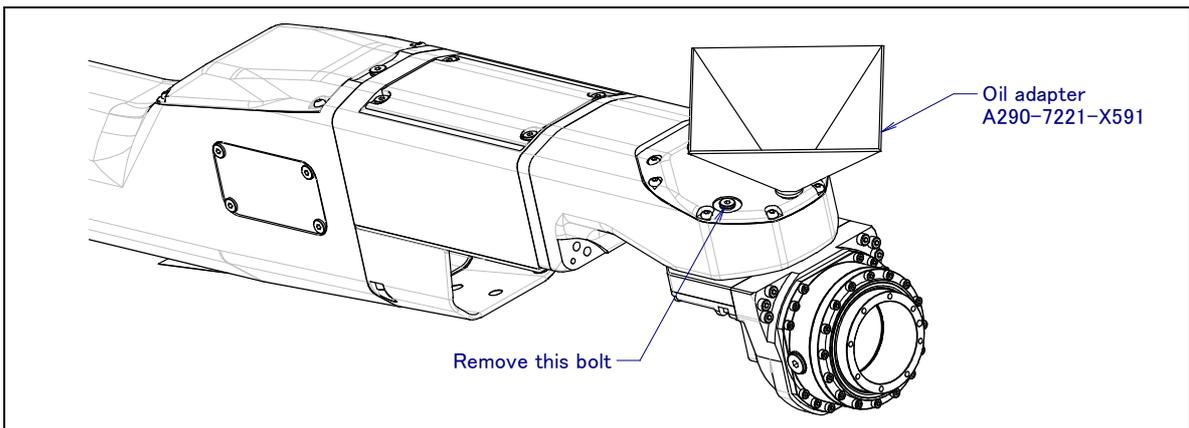
Fig.7.2.3.4 (b) Oil injection by oil gun

B When oil gun is not used

- (1) Remove extra low bolt and seal washer of ventilator hole and second oil inlet of Fig.7.2.3.3 (a) and supply oil. When the adaptor for oiling (A290-7221-X591) is used, oiling is easy. (Fig. 7.2.3.4 (d). In case of using adaptor for oiling, install it to second oil inlet. remove J5/J6-axis gearbox ventilator hole and supply oil. The amounts of oiling are about as many as two adaptors. It takes about five minutes to oil as many as one cup.
- (2) When oil comes out from ventilator hole, In case of using adapter for oiling ,remove it, close the ventilator hole, move robot to the posture (confirm oiling) and confirm amount of oil sight glass. (See Fig.7.2.3.4 (c)) If oil is not sufficient, replenish it by a syringe fountain pen filler.
- (3) Move the robot to the posture (replenishment) and add oil from second oil inlet (M6). If about 15ml of oil is added, oil comes out from oil inlet. Then close the oil inlet.
- (4) Move robot to the posture for J5/J6-axis gearbox (confirm oiling) of Table 7.2.3.4 (b).In this time, rotate the J4-axis to +/- direction and confirm oil does not decrease. If it decreased, move the robot to the posture for J5/J6-axis gearbox (confirm oiling) of Table 7.2.3.4 (b). And add oil from second oil inlet (M6) by a syringe fountain pen filler.
- (5) Release remaining pressure using the procedure given in Subsection 7.2.3.7.



**Fig. 7.2.3.4 (c) Standard of oil sight glass
(ARC Mate 120iC/10L,M-20iA/10L)**



**Fig.7.2.3.4 (d) Oil adapter (supplying oil J5/J6-axis gearbox)
(ARC Mate 120iC/10L,M-20iA/10L)**

7.2.3.5 Grease replacement procedure for J4,J5-axis gearbox (M-20iA/20M)

⚠ 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 seal bolt or taper plug of grease outlet).
- 2 Supply grease slowly, using a manual pump. (once per two seconds)
- 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 7.2.3.5 (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 Subsection 7.2.3.8, and then close the grease outlet.
- 6 To prevent accidents caused by slipping, completely remove any excess grease from the floor or robot.

Table 7.2.3.5 (a) Grease name and amount (J4,J5-axis gearbox)

Greasing points	Amount of grease to be applied	Gun tip pressure	Specified grease
J4-axis gearbox	1100g (1220ml)	0.1MPa or less (NOTE)	Kyodo Yushi VIGOGREASE REO (Specification: A98L-0040-0174)
J5-axis gearbox	1000g(1110ml)		

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

Table 7.2.3.5 (b) Grease supplying posture (J4,J5-axis gearbox)

Greasing points		Posture					
		J1	J2	J3	J4	J5	J6
J4-axis gearbox Greasing posture	Floor mount	Arbitrary	Arbitrary	0°	Arbitrary	Arbitrary	Arbitrary
	Upside-down mount			0°			
	-90° wall mount			90°			
	+90° wall mount			90°			
J5-axis gearbox Greasing posture	Floor mount	Arbitrary	Arbitrary	-90°	Arbitrary	Arbitrary	Arbitrary
	Upside-down mount			90°			
	-90° wall mount			180°			
	+90° wall mount			0°			

- 1 Move the robot to the greasing posture described in Table 7.2.3.5 (b) .
- 2 Turn off the controller power.
- 3 Remove the seal bolt. (Fig.7.2.3 (g), (h))
J4-axis : 1 location (seal bolt M6X8)
J5-axis : 1 location (bolt M8X12 + seal washer)
- 4 Remove the seal bolt or taper plug from grease inlet and attach grease nipple.

- 5 Keep greasing until the new grease pushes out the old grease and comes out from each grease outlet.
- 6 Release remaining pressure using the procedure given in Subsection 7.2.3.8.

7.2.3.6 Procedure for releasing remaining pressure from the grease bath (J1 to J3-axis)

After applying grease, operate the robot as instructed below with the plug and seal bolt of the grease inlet and outlet uncapped to release the remaining pressure within the grease bath. In case of J2-axis, there are three seal bolts for grease outlet. In case of J3-axis, robot which shipped before May,2011 has one grease outlet, robot which shipped June,2011 has two grease outlet. So uncap all of them.

Attach a recovery bag below the grease inlet and outlet to prevent output grease from splattering.

Operating axis Grease replacement part	J1-axis	J2-axis	J3-axis	J4-axis	J5-axis	J6-axis
	J1-axis reducer	Axis angle of 60° or more OVR 100%	Arbitrary			
J2-axis reducer	Arbitrary	Axis angle of 60° or more OVR 100%	Arbitrary			
J3-axis reducer	Arbitrary		Axis angle of 60° or more OVR 100%	Arbitrary		

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. (When the maximum allowable axis angle is 30°, perform the twice operation for 20 minutes or more.) After completion of the operation, attach the plug and seal bolts to the grease inlets and outlets.

When two or more axes are supplied at the same time, it is possible to release grease or oil at the same time in two or more axes.

After replacing grease or oil, grease bath or oil bath may rise if robot is operated again under frequent inversion movement or high temperature environment. In these cases, you can return internal pressure by releasing grease out let or oil outlet just after operation of robot. (When opening grease outlet or oil outlet, pay attention grease or oil is not scattered.)

7.2.3.7 Procedure for releasing oil (J4 to J6-axis) (ARC Mate 120iC, M-20iA,ARC Mate 120iC/10L, M-20iA/10L)

After replacing oil, please do the following operation to adjust the amount of oil properly.

In case of J4-axis gearbox

Confirm that oil level seen in oil sight glass is as per Fig.7.2.3.2 (d). If confirmed then please operate robot J4 axis during 10 minutes, at 100% override, making 90° motion (or more). Keep oil inlet and oil outlet closed during this operation. When completed, move the robot to the posture outlet comes to right above position (In case of floor mount, J3=0°.) and remove seal bolt of J4-axis gearbox oil outlet. Remaining pressure is released at once if it is removed. After operation, confirm whether the oil side of the oil sight glass has come above Fig.7.2.3.2 (b), and attach plug of the oil inlet. In case oil level is insufficient, please add oil from the oil outlet with the syringe etc. Wipe the oil that adheres to the surface of the robot and attach the taper plug on the oil inlet, the seal bolt on the oil outlet completely then attach seal bolt of oil outlet.

In case of J5/J6-axis gearbox

1 In case of ARC Mate 120iC, M-20iA

Confirm that oil level seen in oil sight glass is as per Fig.7.2.3.3 (c). If it is confirmed, then move robot to the confirming posture described in Table 7.2.3.3 (b). Attach extra low bolt and seal washer of the oil inlet but keep it loose. Operate robot J5 and J6 axis during 10 minutes, at 100% override, making 90° motion (or more) on both axes. In this time, make program that move both of J5-axis and J6-axis.

When completed, move the robot to the confirming posture. Remaining pressure release at once if the ventilator hole is opened. Confirm that oil level seen in oil sight glass is as per Fig.2.2.3 (c). At this time, please rotate the J4 axis in the direction of +/-, move robot to the posture of confirming posture, and confirm the thing that the amount of oil doesn't decrease. Move robot to the confirming posture again and add oil from the oil inlet or the ventilator hole with the syringe etc. when decreasing. Wipe the oil that adheres to the surface of the robot and attach the extra low bolt and seal washer on the oil inlet/outlet completely.

2 In case of ARC Mate 120iC/10L, M-20iA/10L

Confirm that oil level seen in oil sight glass is as Fig.7.2.3.4 (c). Then move the robot to the posture J5/J6-axis (release remaining pressure), attach extra low bolt and seal washer to second oil inlet but keep them loose. Operate robot J5 and J6 axis during 10 minutes, at 100% override, making 90° motion (or more) on both axes. In this time, make program that move both of J5-axis and J6-axis.

When completed, move the robot to the J5/J6-axis confirming posture. Remaining pressure is released at once if the second oil inlet (M5) is opened. Confirm that oil level is 3/4 or more. At this time, please rotate the J4 axis in the direction of +/-, and confirm the thing that the amount of oil doesn't decrease. If oil decreases, move robot to the posture J5/J6-axis gearbox (replenish oil) and add oil from the second oil inlet with the syringe etc. After it is confirmed, wipe the oil that adheres to the surface of the robot and attach the extra low bolt on the oil inlet completely.

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. (When the maximum allowable axis angle is 45 degrees, perform the twice operation for 20 minutes or more.)

When two or more axes are supplied at the same time, it is possible to release grease or oil at the same time in two or more axes.

After replacing grease or oil, grease bath or oil bath may rise if robot is operated again under frequent inversion movement or high temperature environment. In these cases, you can return internal pressure by releasing grease out let or oil outlet just after operation of robot. (When opening grease outlet or oil outlet, pay attention grease or oil is not scattered.)

CAUTION

When reusing seal bolt and taper plug, be sure to seal t thread part with seal tape.

As for the seal washer, one side, rubber sticks to the entire and the other side, rubber sticks to only around hole and rubber sticks is incomplete state, Attach later face to bolt side. Confirm seal washer by viewing. If it is damaged obviously, replace it to new one.

See Table 2.2 about specification of seal bolts and seal washer.

7.2.3.8 Procedure for releasing remaining pressure from the grease bath (J4 to J5-axis) (M-20iA/20M)

To release remaining pressure, perform the procedure below.

(For the J4-axis)

Operate the robot as described in the table below for at least 10 minutes, with the seal bolts removed from the grease inlet and outlet.

(For the J5-axis gearbox)

- After greasing, remove the grease nipple from the grease inlet.
- Move the robot to J3=90°, perform $\pm 90^\circ$ repeating operation during 5 minutes for only J5-axis. Make wait time between 2 points 0, perform the running with position pass is fine.
- After 5 minutes, confirm about 50ml grease is pulled out. (just as volume of 2 golf balls.)
- Attach the bolts and seal washers of grease inlet and outlet.

(For the J6-axis)

Operate the robot as described in the table below for at least 10 minutes, with the extra low bolts and seal washers removed from the grease inlet and outlet.

Attach a recovery bag below the grease inlet and outlet to prevent output grease from splattering.

Operating axis Grease replacement part	J1-axis	J2-axis	J3-axis	J4-axis	J5-axis	J6-axis
J4-axis gearbox	Arbitrary			Axis angle of 60° or more OVR 100%	Arbitrary	
J5-axis gearbox	Arbitrary				Axis angle of 180° or more OVR 100%	Arbitrary
J6-axis reducer	Arbitrary					Axis angle of 60° or more OVR 100%

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. (When the maximum allowable axis angle is 30 degrees, perform the twice operation for 20 minutes or more.) When you supply grease or oil to plural axes, you can run the plural axes at the same time. After completion of the operation, attach the taper plug, seal bolts or bolts and seal washers to the grease inlets and outlets. When reusing the seal bolts or the taper plug, be sure to seal them with seal tape.

After replacing grease, grease bath may rise if robot is operated again under frequent inversion movement or high temperature environment. In these cases, you can return internal pressure by releasing grease out let just after operation of robot. (When opening grease outlet or oil outlet, attention grease or oil is not scattered.)

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.

WARNING

In case of R-30iB, when arc tool (3kg payload specification) is specified, mastering is performed with gravity compensation function is enabled in our factory before shipment. Please refer to Chapter 11 of R-30iB/R-30iB Mate controller optional function operator's manual (B-83284EN-2) for details of the gravity compensation function.

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 controller 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 at factory-made settings.
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 single 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 your local FANUC representative.

⚠ CAUTION

- 1 If mastering is performed incorrectly, the robot may behave unexpectedly. This is very dangerous. Therefore, the positioning screen is designed to appear only when the \$MASTER_ENB system variable is 1 or 2. After performing positioning, press F5 [DONE] on the positioning screen. The \$MASTER_ENB system variable is reset to 0 automatically, thus hiding the positioning screen.
- 2 It is recommended that the current mastering data be backed up before mastering is performed.
- 3 When the movable range is mechanically 360 degrees or more, if any of the axes (J1-axis and J4-axis) to which the cables are connected is turned one turn in the correct mastering position, the cables in the mechanical unit are damaged. If the correct rotation position is not clear because the axis is moved too much during mastering, remove the connector panel or cover, check the states of the internal cables, and perform mastering in the correct position. For the checking procedure, see Figs. 8.1 (a) to 8.1 (c).

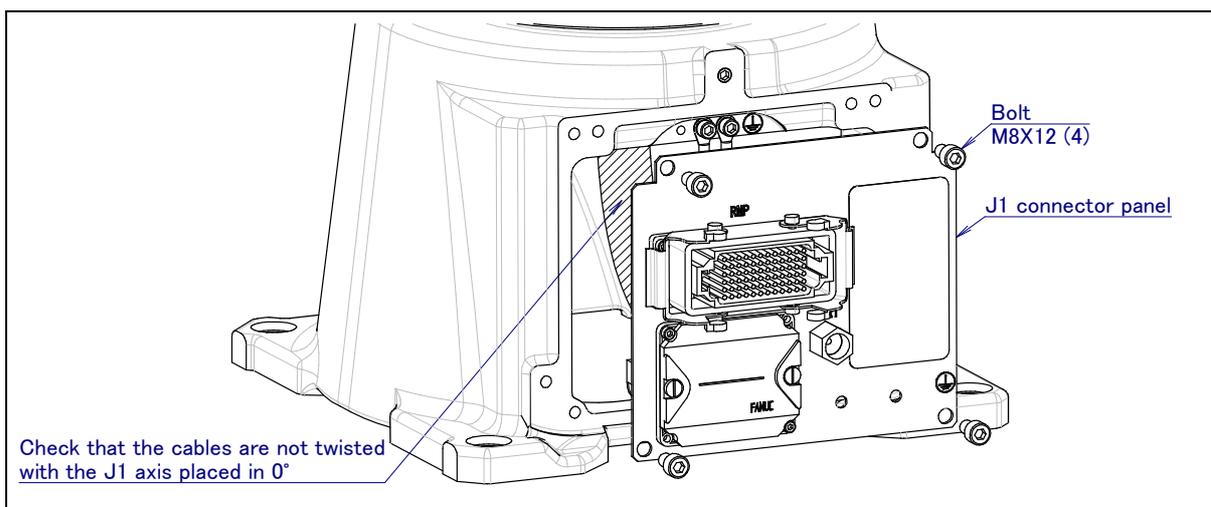


Fig. 8.1 (a) Check the cables statement (J1 axis)

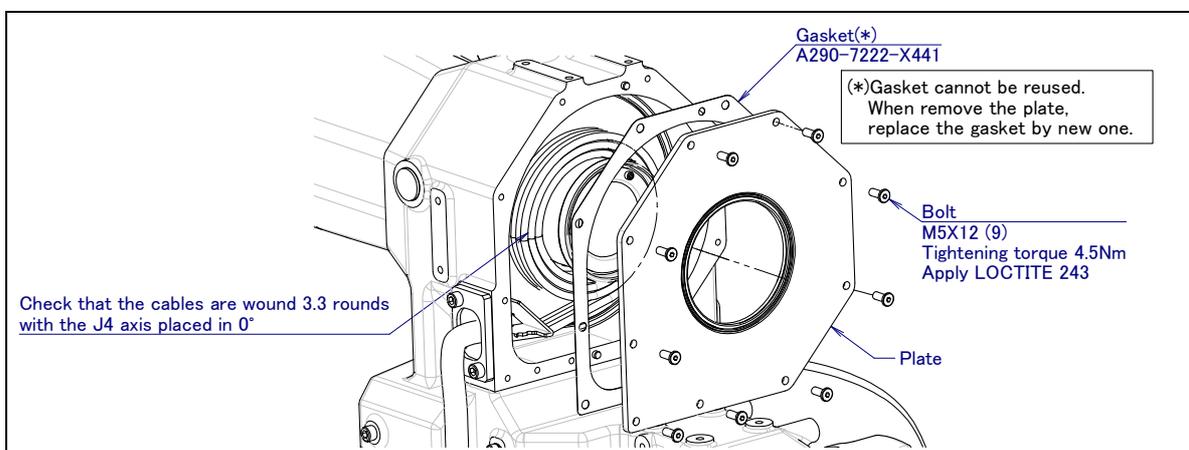


Fig. 8.1 (b) Check the cables statement (J4 axis)
(ARC Mate 120iC,M-20iA,ARC Mate 120iC/10L,M-20iA/10L)

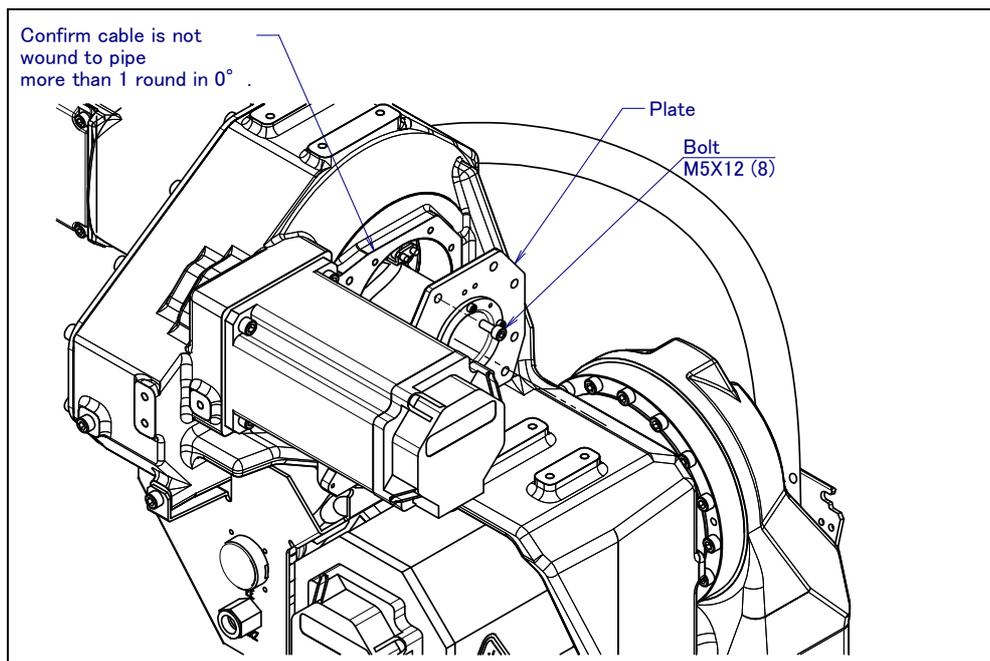


Fig. 8.1 (c) Check the cables statement (J4 axis)
(M-20iA/20M)

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

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

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

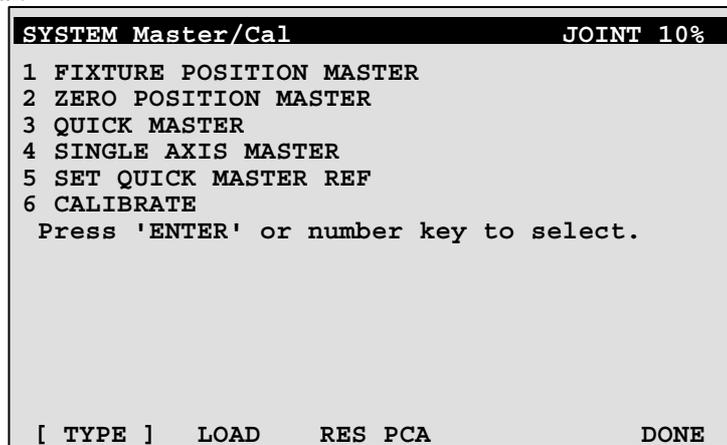
8.3 ZERO POSITION MASTERING

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. 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 [MENU] key.
- 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, switch the controller power off and on again.

- 6 Select Zero Position Master, and Press F4, YES.
- 7 Select Calibrate, and Press F4, YES. Mastering will be performed automatically. Alternatively, switch the power off and on again. Switching the power on always causes positioning to be performed.
- 8 After completing the calibration, press F5 Done.
- 9 Return brake control to original setting, and turn off the controller power and on again.

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

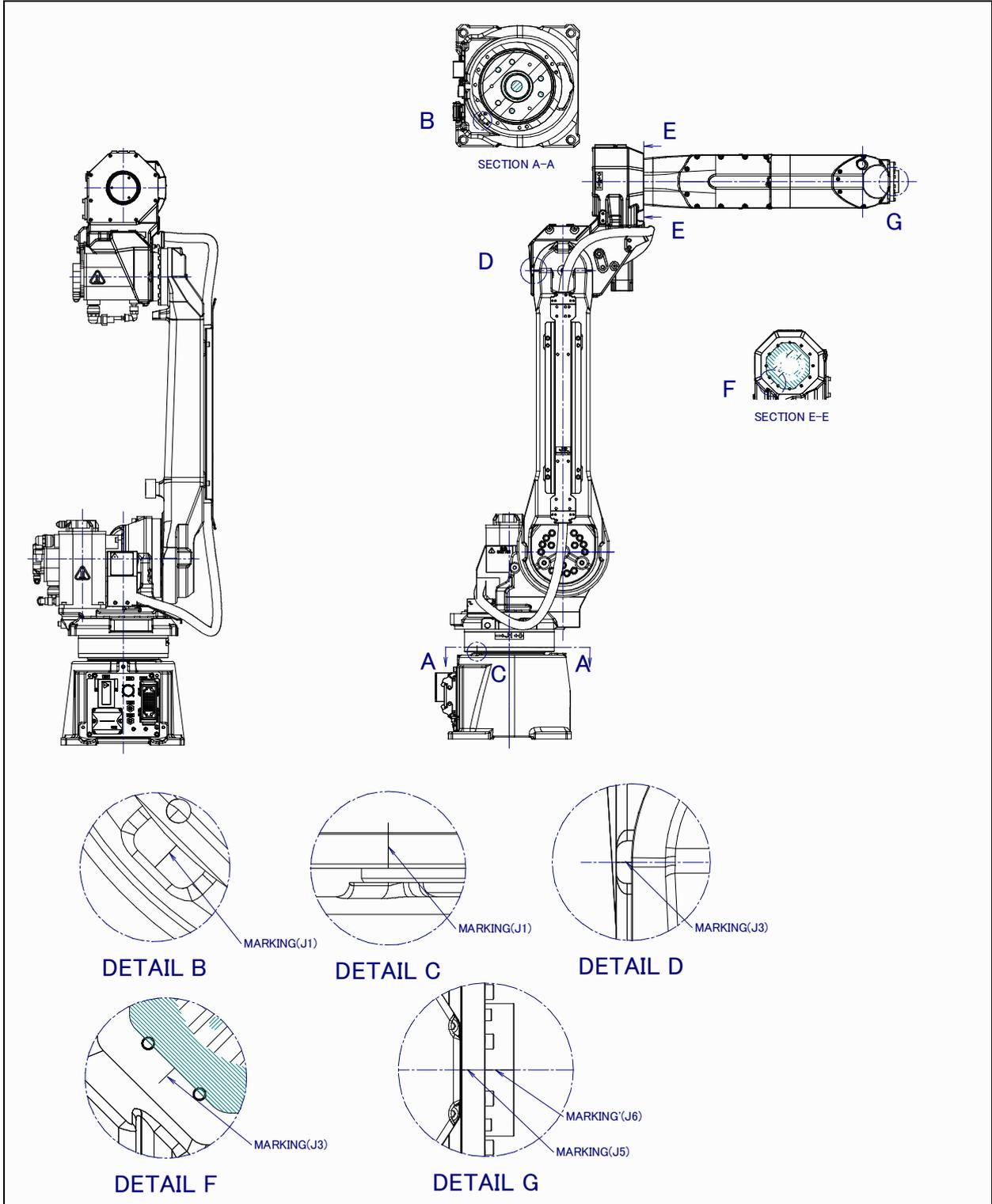


Fig. 8.3 (a) Marking position (ARC Mate 120iC, M-20iA)

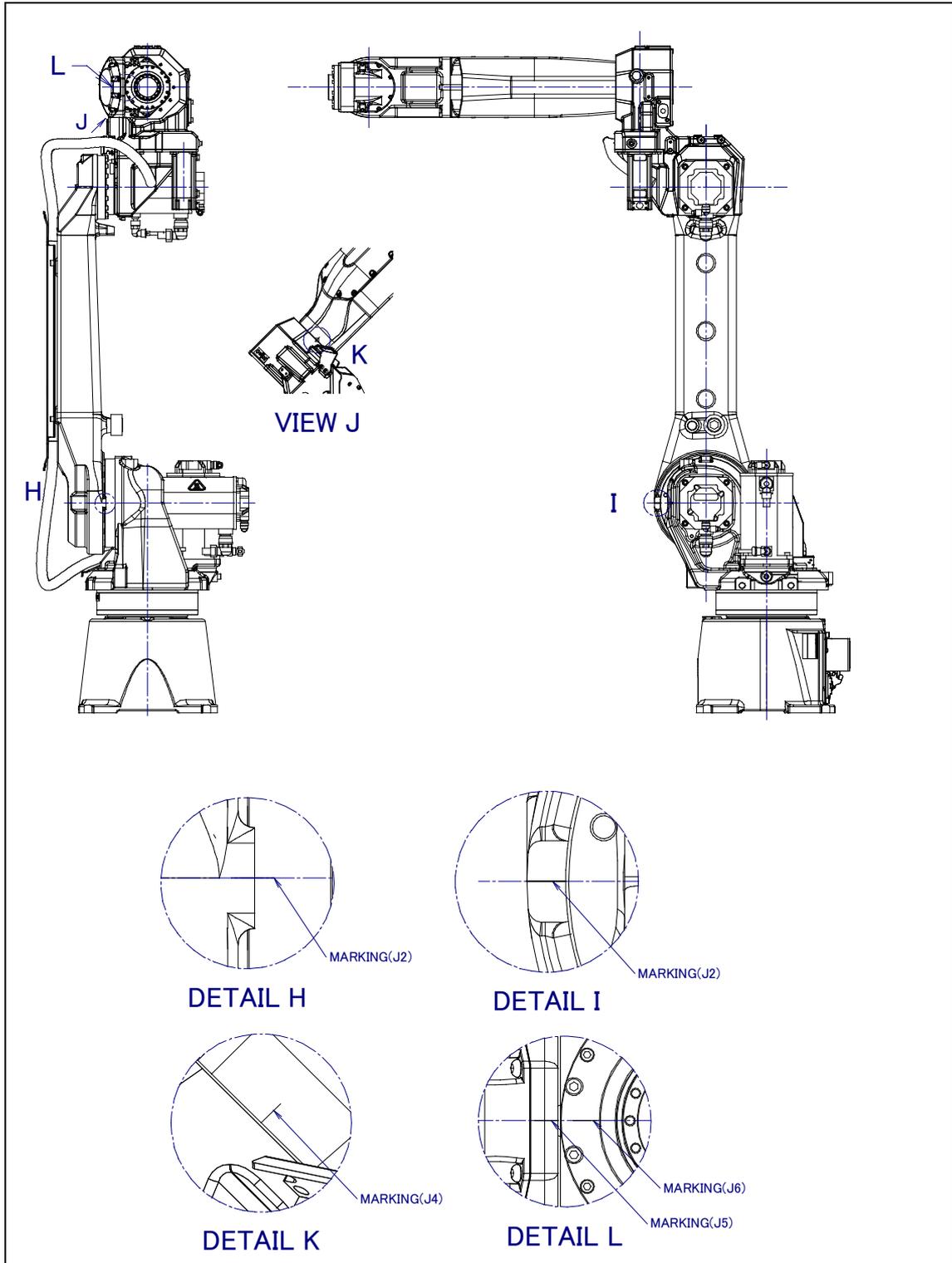


Fig. 8.3 (b) Marking position (ARC Mate 120iC, M-20iA)

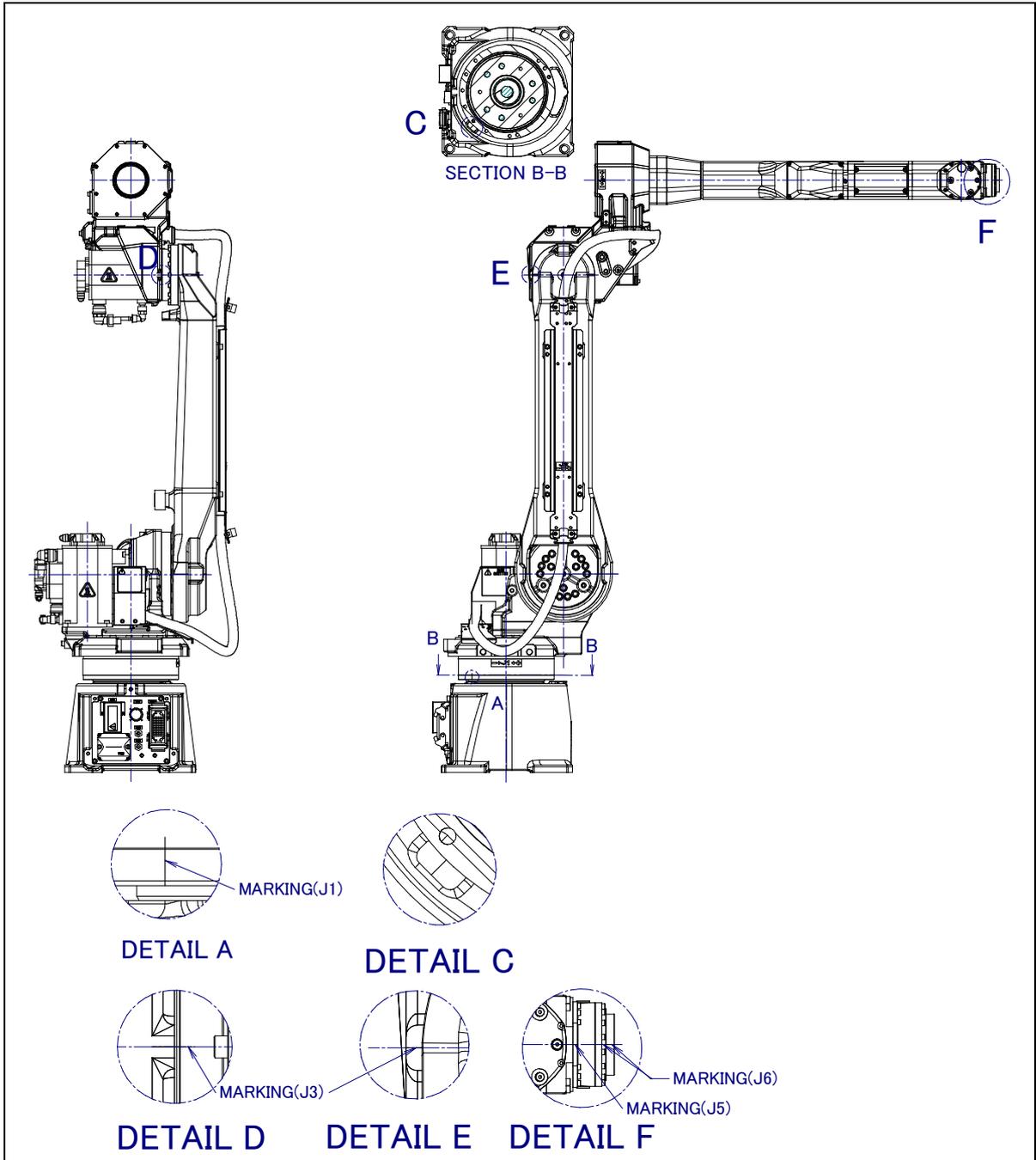


Fig. 8.3 (c) Marking position (ARC Mate 120iC/10L, M-20iA/10L)

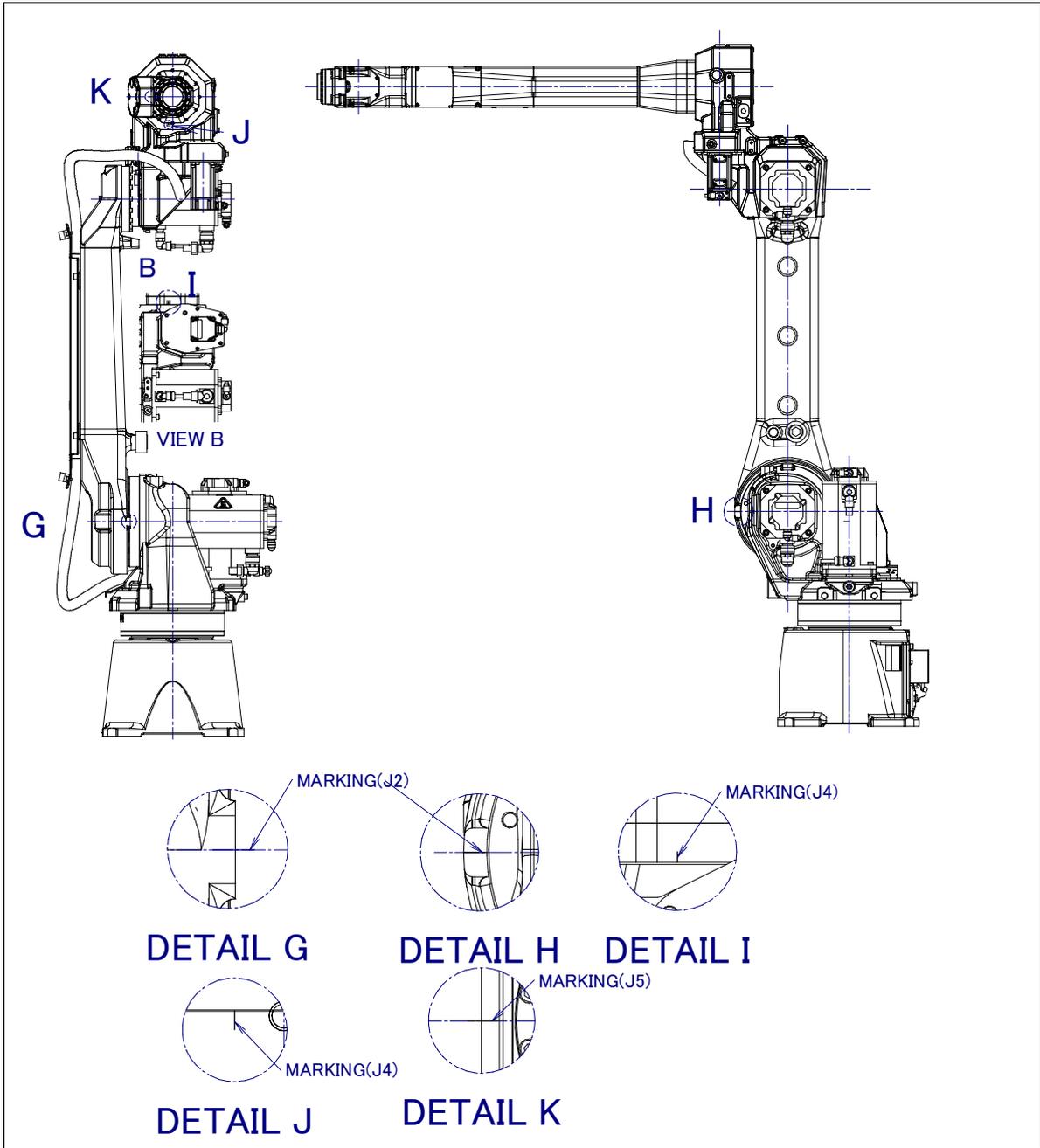


Fig. 8.3 (d) Marking position (ARC Mate 120iC/10L, M-20iA/10L)

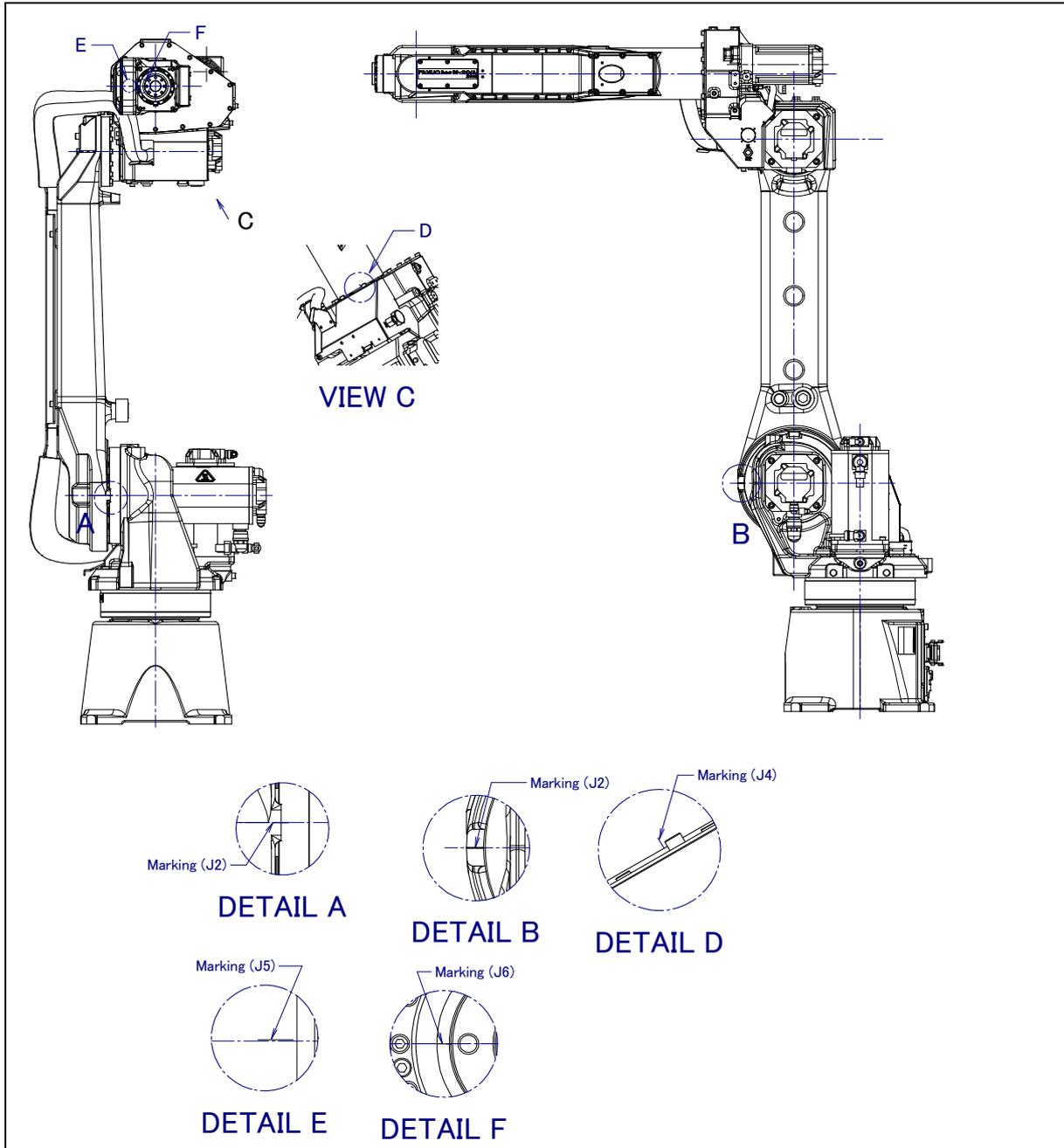


Fig. 8.3 (e) Marking position (M-20iA/20M)

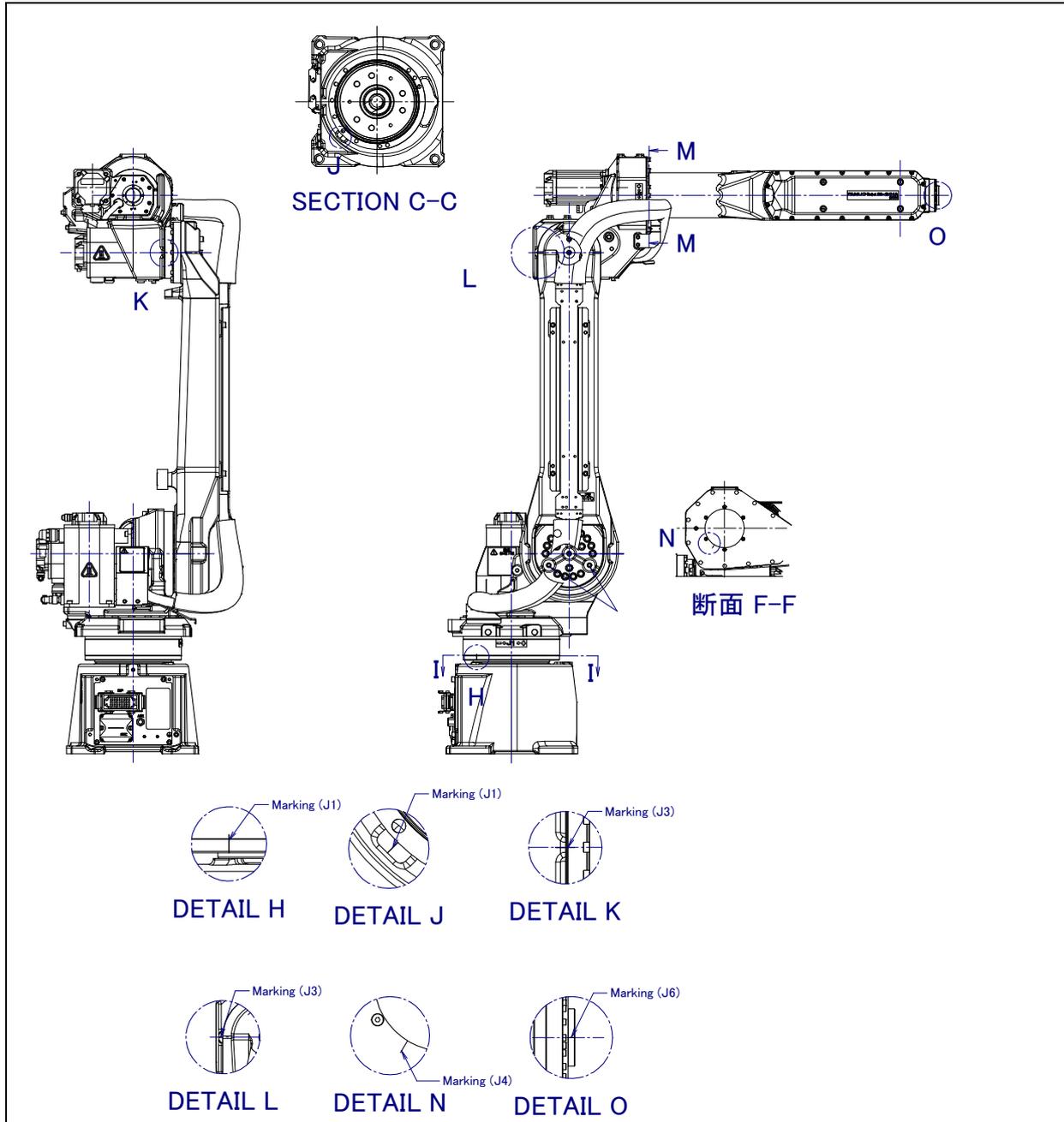


Fig. 8.3 (f) Marking position (M-20iA/20M)

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 Mastering Reference Position

- 1 Select SYSTEM.
- 2 Select Master/Cal.

```

SYSTEM Master/Cal                               JOINT 10%
1 FIXTURE POSITION MASTER
2 ZERO POSITION MASTER
3 QUICK MASTER
4 SINGLE AXIS MASTER
5 SET QUICK MASTER REF
6 CALIBRATE
Press 'ENTER' or number key to select.

[ TYPE ]   LOAD   RES_PCA                       DONE

```

- 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 Quick Mastering

- 1 Display the Master/Cal screen.

```

SYSTEM Master/Cal                               JOINT 10%
1 FIXTURE POSITION MASTER
2 ZERO POSITION MASTER
3 QUICK MASTER
4 SINGLE AXIS MASTER
5 SET QUICK MASTER REF
6 CALIBRATE
Press 'ENTER' or number key to select.

[ TYPE ]   LOAD   RES_PCA                       DONE

```

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

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.

SINGLE AXIS MASTER		JOINT 33%		
	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)	[2]
E3	0.000	(0.000)	(0)	[2]
		GROUP	EXE	

Table 8.5 Items set in single axis mastering

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

Procedure Mastering a Single Axis

- 1 Select SYSTEM.
- 2 Select Master/Cal.

SYSTEM Master/Cal		JOINT 10%
1	FIXTURE POSITION MASTER	
2	ZERO POSITION MASTER	
3	QUICK MASTER	
4	SINGLE AXIS MASTER	
5	SET QUICK MASTER REF	
6	CALIBRATE	
Press 'ENTER' or number key to select.		
[TYPE]	LOAD	RES_PCA

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

SINGLE AXIS MASTER			JOINT 10%
			1/9
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)	[0]
J6 43.382	(0.000)	(0)	[0]
E1 0.000	(0.000)	(0)	[2]
E2 0.000	(0.000)	(0)	[2]
E3 0.000	(0.000)	(0)	[2]
[TYPE]		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.

JOINT 30%		
5/9		
(0.000)	(0)	[2]
(0.000)	(0)	[2]

SINGLE AXIS MASTER		JOINT 30%
		5/9
J5 31.250	(0.000)	(0) [2]
J6 43.382	(90.000)	(0) [2]
		GROUP EXEC

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

GROUP EXEC

F5

SINGLE AXIS MASTER				JOINT 30%
	ACTUAL POS	(MSTR POS)	(SEL)	1/9 [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	0.000	(0.000)	(0)	[2]
J6	90.000	(90.000)	(0)	[2]
E1	0.000	(0.000)	(0)	[2]
E2	0.000	(0.000)	(0)	[2]
E3	0.000	(0.000)	(0)	[2]

GROUP EXEC

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

BACK

SYSTEM Master/Cal		JOINT 30%
1	FIXTURE POSITION MASTER	
2	ZERO POSITION MASTER	
3	QUICK MASTER	
4	SINGLE AXIS MASTER	
5	SET QUICK MASTER REF	
6	CALIBRATE	
Press 'ENTER' or number key to select.		
[TYPE]		DONE

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

DONE

F5

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

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

```

SYSTEM Variables                                JOINT 10%
                                           1/98
1  $AP MAXAX      536870912
2  $AP PLUGGED    4
3  $AP TOTALAX    16777216
4  $AP USENUM     [12] of Byte
5  $AUTOINIT      2
6  $BLT           19920216

[ TYPE ]
    
```

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

```

SYSTEM Variables                                JOINT 10%
13  $DMR GRP      DMR GRPT
14  $ENC STAT     [2] of ENC STATT

[ TYPE ]
    
```

- 4 Select \$DMR_GRP.

```

JOINT 30%
DMR GRPT
[2] of ENC STATT
ENTER
    
```

```

SYSTEM Variables                                JOINT 10%
$DMR GRP 1/1
1  [1] DMR GRPT
    
```

```

SYSTEM Variables                                JOINT 10%
$DMR GRP [1] 1/8
1  $MASTER DONE   FALSE
2  $OT MINUS      [9] of Boolean
3  $OT PLUS       [9] of Boolean
4  $MASTER COUN   [9] of Integer
5  $REF DONE      FALSE
6  $REF POS       [9] of Real
7  $REF COUNT     [9] of Integer
8  $BCKLSH SIGN   [9] of Boolean

[ TYPE ]                                TRUE  FALSE
    
```

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

```

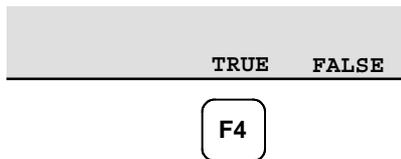
JOINT 30%
FALSE
[9] of Boolean
[9] of Boolean
[9] of Integer
ENTER
    
```

```

SYSTEM Variables                                JOINT 10%
$DMR GRP [1].$MASTER COUN 1/9
1  [1] 95678329
2  [2] 10223045
3  [3] 3020442
4  [4] 304055030
5  [5] 20497709
6  [6] 2039490
7  [7] 0
8  [8] 0
9  [9] 0
    
```

- 6 Press the PREV key.

- 7 Set \$MASTER_DONE to TRUE.



SYSTEM Variables		JOINT 10%	
\$DMR_GRP [1]		1/8	
1	\$MASTER_DONE	TRUE	
2	\$OT_MINUS [9] of Boolean		
[TYPE]		TRUE	FALSE

- 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 because 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, and execute the pulse reset (See Section 8.2.), then turn the power off then on again and confirms 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 GENERAL

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

9.2 PROBLEMS AND CAUSES

Table 9.2 (a) shows the main mechanical unit problems and their causes. If a cause of remedy is unclear, please contact your FANUC service representative.

Table 9.2 (a) Problems and causes and measure

Symptom	Description	Cause	Measure
Vibration Noise	-The J1 base lifts off the floor plate as the robot operates. -There is a gap between the J1 base and floor plate. -A J1 base retaining bolt is loose.	[J1 base fastening] -It is likely that the robot J1 base is not securely fastened to the floor plate. -Probable causes are a loose bolt, an insufficient degree of surface flatness, or foreign material caught between the J1 base and floor plate. -If the robot is not securely fastened to the floor plate, the J1 base lifts the floor plate as the robot operates, allowing the base and floor plates to strike each other, which, in turn, leads to vibration.	-If a bolt is loose, apply LOCITE and tighten it to the appropriate torque. -Adjust the floor plate surface flatness to within the specified tolerance. -If there is any foreign matter between the J1 base and floor plate, remove it.
	-The rack or floor plate vibrates during operation of the robot.	[Rack or floor] -It is likely that the rack or floor is not sufficiently rigid. -If the rack or floor is not sufficiently rigid, reaction from the robot deforms the rack or floor, leading to vibration.	-Reinforce the rack or floor to make it more rigid. -If it is impossible to reinforce the rack or floor, modify the robot control program; doing so might reduce the amount of vibration.
	-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 slowing the robot and reducing its acceleration (to minimize the influence on the entire cycle time).

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	<ul style="list-style-type: none"> -Vibration was first noticed after the robot collided with an object or the robot was overloaded for a long period. -The grease of the vibrating axis has not been exchanged for a long period. -There is vibration or unusual sound just after replacing grease or oil or parts. 	[Broken gear, bearing, or reducer] <ul style="list-style-type: none"> - It is likely that collision or overload applied an excessive force on the drive mechanism, thus damaging the tooth surface or rolling contact surface of a bearing, or reducer. - It is likely that prolonged use of the robot while overloaded caused fretting of the tooth surface or rolling contact surface of a bearing, or reducer due to resulting metal fatigue. - It is likely that foreign matter caught in a gear, bearing, or within a reducer caused damage on the tooth surface or rolling contact surface of the bearing, or reducer. - It is likely that foreign matter 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 tooth surface or rolling contact surface of a bearing, or reducer due to metal fatigue. -There is a possibility of Grease or oil has not been exchanged accurately. The amount of grease or oil may be insufficient. These factors all generate cyclic vibration and noise.	<ul style="list-style-type: none"> -Operate one axis at a time to determine which axis is vibrating. -Confirm the oil side of the oil sight glass of J4-J6 axis. Replenish oil when the oil side has not reached above the half. -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. -If vibration can no be removed by replacing grease or oil, Perform running before replacing grease or oil, then it may be improved.

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	-The cause of problem cannot be identified from examination of the floor, rack, or mechanical section.	<p>[Controller, cable, and motor]</p> <p>-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.</p> <p>-If the Pulsecoder develops a fault, vibration might occur because Information about the motor position cannot be transferred to the controller accurately.</p> <p>-If the motor becomes defective, vibration might occur because the motor cannot deliver its rated performance.</p> <p>-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.</p> <p>-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.</p> <p>-If a connection cable between them has an intermittent break, vibration might occur.</p> <p>-If the power cable has an intermittent break, vibration might occur.</p> <p>-If the power source voltage drops below the rating, vibration might occur.</p> <p>-If a robot control parameter is set to an invalid value, vibration might occur.</p>	<p>-Refer to the controller Maintenance Manual for troubleshooting related to the controller and amplifier.</p> <p>-Replace the Pulsecoder for the motor of the axis that is vibrating and check whether the vibration still occurs.</p> <p>-Also, replace the motor of the axis that is vibrating, and check whether vibration still occurs. For the method of replacement, contact FANUC.</p> <p>-Check that the robot is supplied with the rated voltage.</p> <p>-Check whether the sheath of the power cord is damaged. If so, replace the power cord, and check whether vibration still occurs.</p> <p>-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.</p> <p>-If vibration occurs only when the robot assumes a specific posture, it is likely that a cable in the mechanical unit is broken.</p> <p>-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.</p> <p>-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.</p>

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. -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.	-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, a 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 LOCITE and tighten it to the appropriate torque. -Motor retaining bolt -Reducer retaining bolt -Reducer shaft retaining bolt -Base retaining bolt -Arm retaining bolt -Casting retaining bolt -End effector retaining bolt

Symptom	Description	Cause	Measure
Motor overheating	<p>-The ambient temperature of the installation location increases, causing the motor to overheat.</p> <p>-After a cover was attached to the motor, the motor overheated.</p> <p>-After the robot control program or the load was changed, the motor overheated.</p>	<p>[Ambient temperature]</p> <p>-It is likely that a rise in the ambient temperature or attaching the motor cover prevented the motor from releasing heat efficiently, thus leading to overheating.</p> <p>[Operating condition]</p> <p>-It is likely that the robot was operated with the maximum average current exceeded.</p>	<p>-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.</p> <p>-Relaxing the robot control program and conditions can reduce the average current, thus preventing overheating.</p> <p>-Reducing the ambient temperature is the most effective means of preventing overheating.</p> <p>-Having the surroundings of the motor well ventilated enables the motor to release heat efficiently, thus preventing overheating. Using a fan to direct air at the motor is also effective.</p> <p>-If there is a source of heat near the motor, it is advisable to install shielding to protect the motor from heat radiation.</p>
	<p>-After a control parameter was changed, the motor overheated.</p>	<p>[Parameter]</p> <p>-If data input for a workpiece is invalid, the robot cannot be accelerated or decelerated normally, so the average current increases, leading to overheating.</p>	<p>-Input an appropriate parameter as described in CONTROLLER OPERATOR'S MANUAL.</p>
	<p>-Symptom other than stated above</p>	<p>[Mechanical section problems]</p> <p>-It is likely that problems occurred in the mechanical unit drive mechanism, thus placing an excessive load on the motor.</p> <p>[Motor problems]</p> <p>-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.</p> <p>-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.</p>	<p>-Repair the mechanical unit while referring to the above descriptions of vibration, noise, and rattling.</p> <p>-Check that, when the servo system is energized, the brake is released.</p> <p>If the brake remains applied to the motor all the time, replace the motor.</p> <p>-If the average current falls after the motor is replaced, it indicates that the first motor was faulty.</p>

Symptom	Description	Cause	Measure
Grease leakage Oil leakage	-Grease or oil 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.	-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 connecting part -J3 arm coupling section -Inside the wrist -Oil seals are used in the locations stated below. -J1-axis cable pipe -Inside the reducer -Inside the wrist -Seal bolts are used in the locations stated below. -Grease or oil outlet
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 reenergized. -It is likely that the brake shoe has worn out or the brake main body is damaged, preventing the brake from operating efficiently. -It is likely that oil or grease 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 occurred	-BZAL is displayed on the controller screen	-It is likely that the voltage of the memory backup battery is low. - It is likely that the Pulsecoder cable is defected.	-Replace the battery. -Replace the cable.

Table 9.2 (b) Allowable drops

At power off	5mm
At emergency stop	5mm

NOTE

Each value indicates the amount by which an end effector mounting face may fall.

9.3 CHANGE THE COLLISION DETECTION PARAMETER

The collision detection parameter is coordinated beforehand for every robot. You can usually use it in the state at the time of shipment if load setting is right. We recommend the use in the state of the standard setting as much as possible. When it is necessary to lower the sensitivity of the collision detection, you can change it to be hard to false detection a collision detection parameter by carrying out the following KAREL programs. It is recommended to change a program so that the power does not depend on a robot before carrying out the program.

ARC Mate 120iC 3kg payload specification

- hi03m2ia.pc

ARC Mate 120iC/10L 3kg payload specification

- hi03m22t.pc

M-20iA 20kg payload specification

- highm2ia.pc

M-20iA/1L 10kg payload specification

- highm21l.pc

If you want to return it an original parameter, execute KAREL program below.

ARC Mate 120iC 3kg payload specification

- no03m2ia.pc

ARC Mate 120iC/10L 3kg payload specification

- no03m22t.pc

M-20iA 20kg payload specification

- normm2ia.pc

M-20iA/10L 10kg payload specification

- normm21l.pc

Practice method of KAREL program is same to KAREL for changing wrist payload specification , so refer to Section 4.4.

In the case of a following software version, these are applied.

In case of ARC Mate 120iC, ARC Mate 120iC/10L

V7.30P/36 or later, V7.40P/20 or later, V7.50P/13 or later, V7.70P/05 or later

In case of M-20iA, M-20iA/10L

V7.30P/36 or later, V7.40P/20~, V7.50P/12 or later, V7.70P/05 or later

10 M/H CONDUIT (OPTION)

10.1 NOTES WHEN CABLE IS ATTACHED TO M/H CONDUIT

- (1) M/H conduit is the option to protect hand cable etc. You can prevent cables interference with arm directly by installing this and can postpone life of cables . Instead conduit is expendable supplies, so replace it regularly.
- (2) The cable is recommended to be clamped at a position 70mm or more away for the wrist side. A position 30mm or more away is recommended for the J4 back side. In case of M-20iA, adjust the length of the cable between clamping to 970±5mm. In case of M-20iA/10L, adjust the length of the cable between clamping to 1175±5mm. Please absorb extra length to Conduit. If cables are not clamped, it cause broken of cable and conduit, be sure to clamp cables.
- (3) The longevity of the cable improves by spreading grease on the surface of the cable in Conduit. Shell Alvania grease S2 is recommended. In this case, use the cable with performance that can endure oil. If grease is not applied, it causes early damage of cables and conduit.

Fig.10.1 Recommended cables and air tube

Cable name	Maker	Spec of FANUC	Specifications
End effector cable	Oki cable co. Ltd	A66L-0001-0459	0.2mm ² 24-core Cable for moving part
Signal line 3DV sensor cable	Oki cable co. Ltd	A66L-0001-0464#1	0.2mm ² 2-core 4 pairs (8-core) Cable for moving part
Power line	Oki cable co. Ltd	A66L-0001-0401#10	1.25mm ² 10-core Cable for moving part
Force sensor cable	Okano cable co. Ltd	A66L-0001-0178#03P	0.3mm ² 2-core 3 pairs (6-core) Cable for moving part
3D Laser Vision sensor camera cable	Hitachi cable co. Ltd	A66L-0001-0525	0.26mm ² 4-core 0.13mm ² 2-core 0.08mm ² 2-core Cable for moving part
LED lighting cable	Hitachi cable co. Ltd	A66L-0001-0143	0.2mm ² 6-core Cable for moving part
Air tube	SMC	A97L-0218-0010	TU0604 (Outside diameter=φ6mm, Inside diameter=φ4mm)

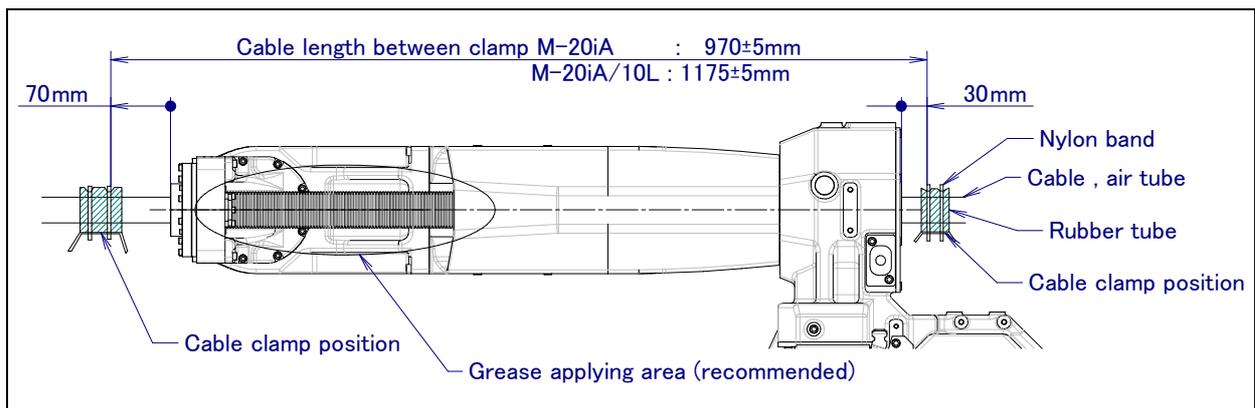


Fig.10.1 (a) Cable length between clamps

- (4) Please install circumscription yen of bunches of cables on 30mm or less as shown in figure so that cables should not rub at the edge of the J6 hollow flange. If filling degree is over , it causes early damage of conduit.

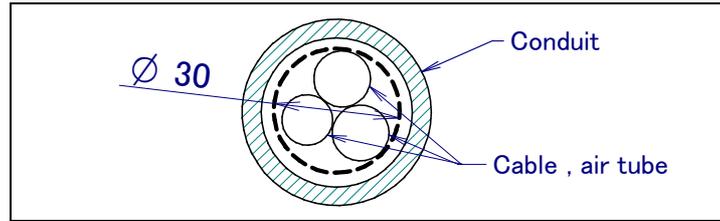


Fig.10.1 (b) Diameter of cable and air tube in conduit

- (5) It is recommended to install protect ring and protect it if necessary so that bolts which are attached to J6 hollow flange does not interfere with cables.
- (6) Please roll cables in the rubber seat etc. so as not to damage surfaces of cables by the edge of the nylon band in the cable clamping part, and bind on that in the nylon band.

10.2 WRIST CABLE KIT

Cable kits that include M/H conduit, cables and air tube between J4 connector panels to hand (recommend by FANUC) are prepared as options. When assembling them, refer to Fig.10.2 (a), (b).

When these options are specified, these wrist cable kits are added to the normal M/H conduit when they are shipped.

Table 10.2 Wrist cable kit (M-20iA)

Model	Name	Specification	Constitution
M-20iA	Force sensor wrist cable kit	A05B-1222-J736	M/H conduit, Force sensor wrist cable End effector wrist cable (RI/RO for each 8 points), Air ϕ 6X4
	3D Laser Vision sensor wrist cable kit	A05B-1222-J752	M/H conduit, 3D Laser Vision sensor wrist cable End effector wrist cable (RI/RO for each 8 points), Air ϕ 6X4
	Force & 3D Laser Vision sensor wrist cable kit	A05B-1222-J757	M/H conduit, Force sensor wrist cable 3D Laser Vision sensor wrist cable End effector wrist cable (RI/RO for each 8 points), Air ϕ 6X4

NOTE

Refer to Section 10.1 about clamp position near J4/J6 holes exist, lengths between cable clamp and notes.

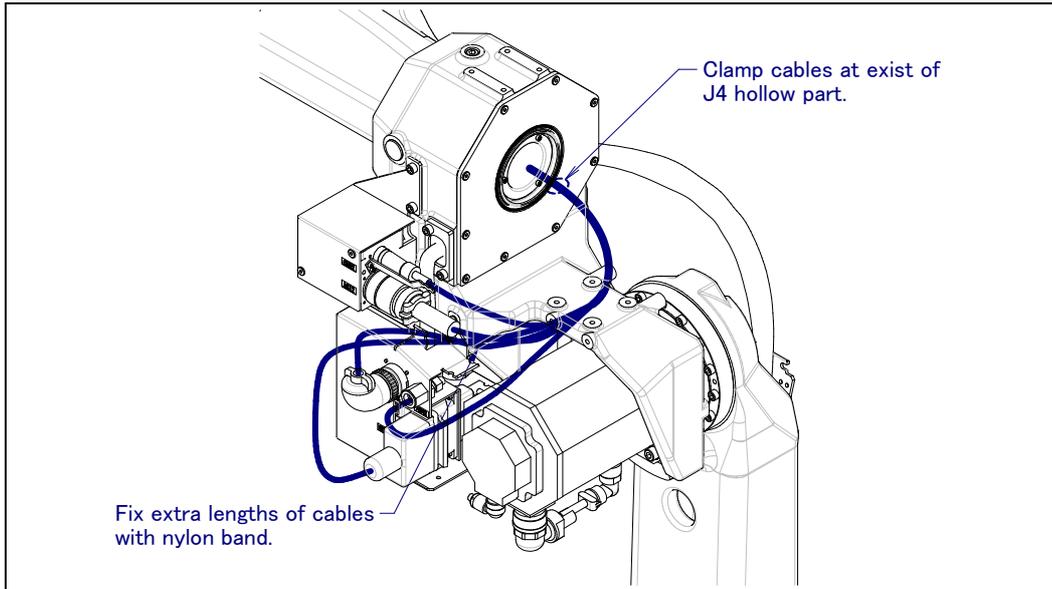


Fig.10.2 (a) Cabling around J3 casing

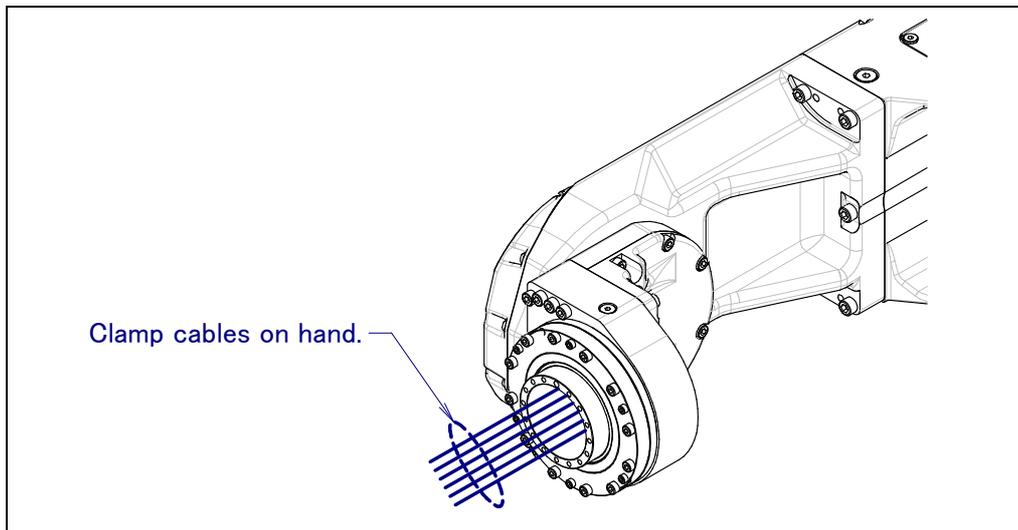


Fig.10.2 (b) Cabling around wrist

When you set solenoid valve to J3 casing, use EE wrist cable relay kit (specification: A05B-1221-J736).

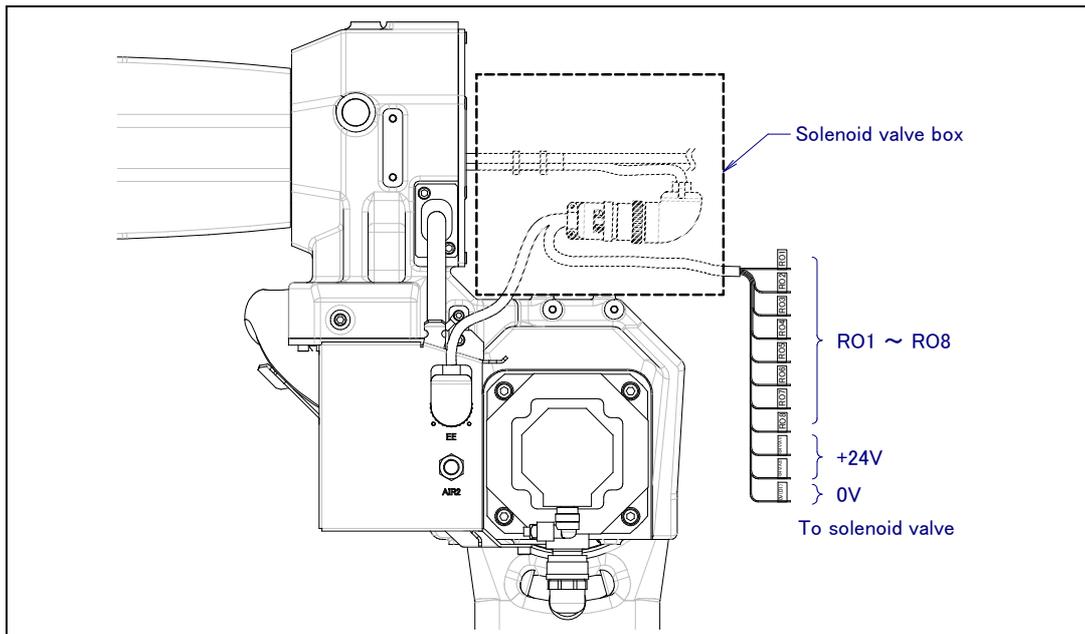


Fig.10.2 (c) End effector wrist cable relay kit

10.3 OTHER NOTES

- (1) When M/H conduit is installed, use by the range limitation of J6 axis range of motion $\pm 190^\circ$ is recommended. The longevities of cables shortens when using it exceeding $\pm 190^\circ$ though it is possible to use even in range of motion more than this (maximum $\pm 270^\circ$).

Fig.10.3 Regular exchange cycle

	Exchange cycle
J5-axis: $\pm 140^\circ$	Cycle that is shorter among 1.2 million cycles (As one cycle every 30 seconds) and 2 years
J6-axis: $\pm 190^\circ$	

NOTE

Please note that it is a standard at the exchange cycle when the cable wire rod and the air tube of the FANUC recommendation are used. If cable is not clamped or grease is not applied or filling degree of cable in conduit is over or robot is operated with fluoroc resin ring is broken, it causes early damage of cables and conduit.

- (2) Please examine the structure that the cutting powder etc. Do not invade in Conduit when you specify M/H conduit and severe dust/liquid protection option simultaneously.
- (3) Fluoroc resin ring is installed to J6 hollow part. White powder is generated to reduce friction of rotation, but this is not trouble. Fluoroc resin ring is expendable supply. Two years are aims in an exchange period. If you operate robot with the state that hard mine dust is attached to rotated part, exchange period may shortens. If robot is operated with fluoroc resin ring is broken, it causes early damage of conduit.

11 NO DUST M/H CONDUIT (OPTION)

- (1) NO DUST M/H conduit is option to protect hand cable etc. You can prevent cables interference with arm directly by installing this and can postpone life of cables. Instead conduit is expendable supplies replace it regularly.
- (2) Please prepare rubber bush as Fig 11 (b). Please make thickness between wrist flange and tip of rubber bush is 9mm, thickness of rubber bush is 6mm. In case of J3 casing side, please make thickness between back of J3 casing and tip of rubber bush is 11.4mm and thickness of rubber bush is 6mm. Make length of cable between rubber bush is $944 \pm 5\text{mm}$ and absorb extra length to Conduit. (3) The longevity of the cable improves by spreading grease on the surface of the cable in Conduit. Alvania grease S2 is recommended. In this case, please use the cable with performance that can endure oil. If grease is not applied, it causes early damage of cables and conduit.
- (3) The longevity of the cable improves by spreading grease on the surface of the cable in Conduit. Alvania grease S2 is recommended. In this case, please use the cable with performance that can endure oil. If grease is not applied, it causes early damage of cables and conduit.
- (4) Confirm there is no gap in slit part of rubber bush. When there is a gap, clean degree turn worse. Please be careful.

Table 11 Recommended cables and air tube

Cable name	Maker	Spec of FANUC	Specifications
End effector cable	Oki cable co. Ltd	A66L-0001-0459	0.2mm ² 24-core Cable for moving part
Signal line 3DV sensor cable	Oki cable co. Ltd	A66L-0001-0464#1	0.2mm ² 2-core 4 pairs (8-core) Cable for moving part
Power line	Oki cable co. Ltd	A66L-0001-0401#10	1.25mm ² 10-core Cable for moving part
Force sensor cable	Okano cable co. Ltd	A66L-0001-0178#03P	0.3mm ² 2-core 3 pairs (6-core) Cable for moving part
3DV sensor camera cable	Hitachi cable co. Ltd	A66L-0001-0525	0.26mm ² 4-core 0.13mm ² 2-core 0.08mm ² 2-core Cable for moving part
LED lighting cable	Hitachi cable co. Ltd	A66L-0001-0143	0.2mm ² 6-core Cable for moving part
Air tube	SMC	A97L-0218-0010	TU0604 (Outside diameter=φ6mm, Inside diameter=φ4mm)

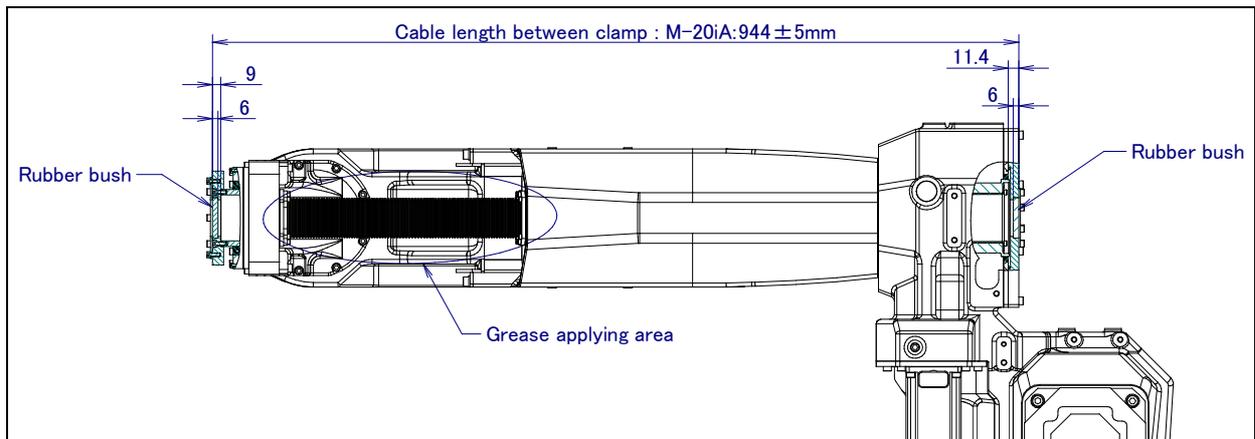


Fig.11 (a) Cable length between clamps

- (5) Please install circumscription yen of bunches of cables on 30mm or less as shown in figure so that cables should not rub at the edge of the J6 hollow flange. If filling degree is over , it causes early damage of cables and conduit.

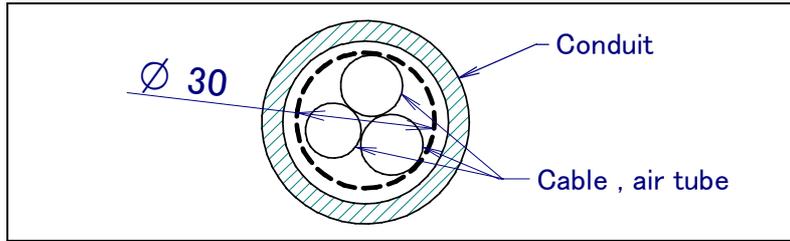


Fig. 11 (b) Diameter of cable and air tube in conduit

(6) Refer to figure below about shape of rubber bush and structure of cables in conduit.

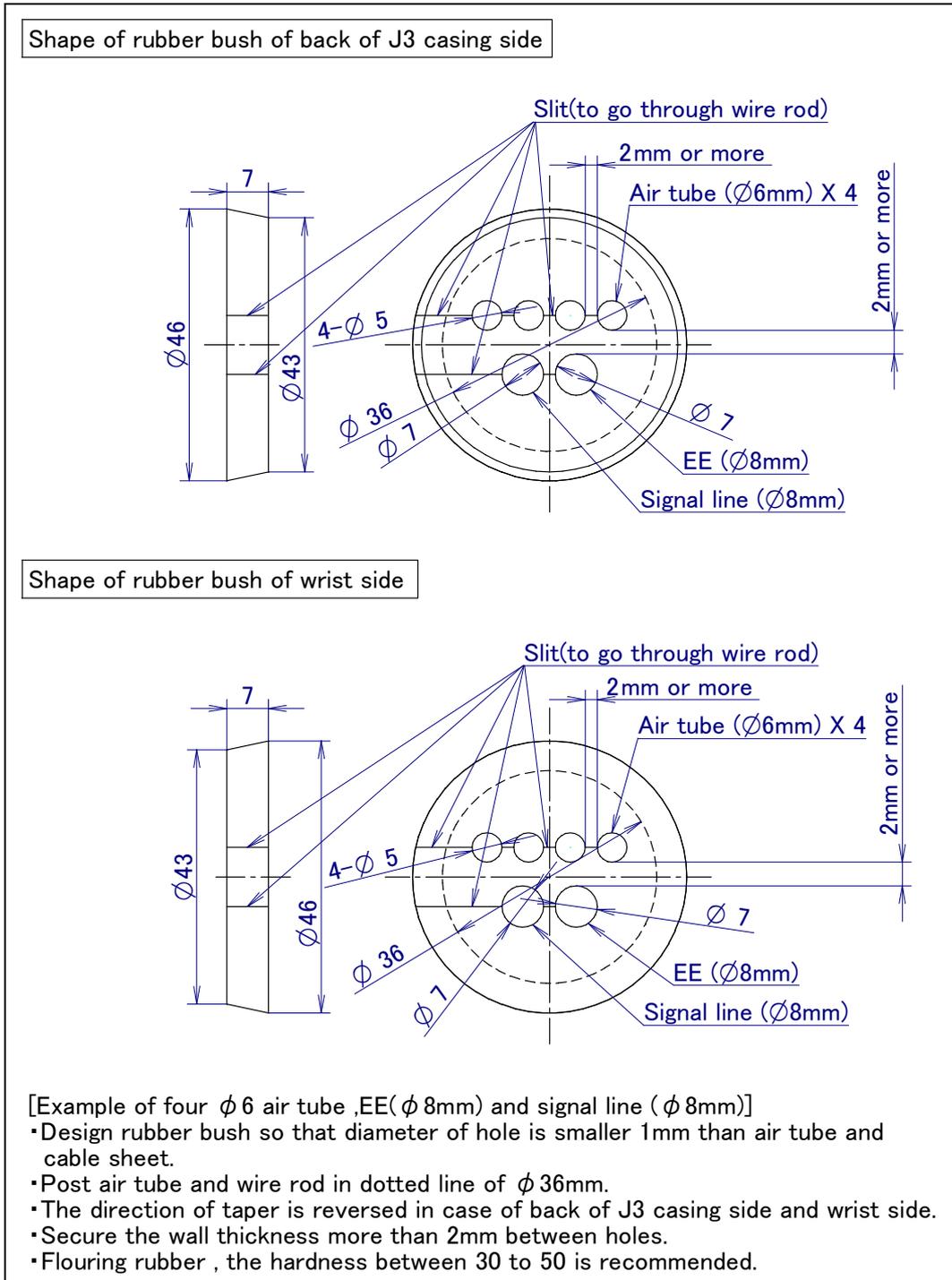


Fig.11.1 (c) Shape of rubber bush (example)

(7) Refer to figure below about structure of seal of back of J3 casing.

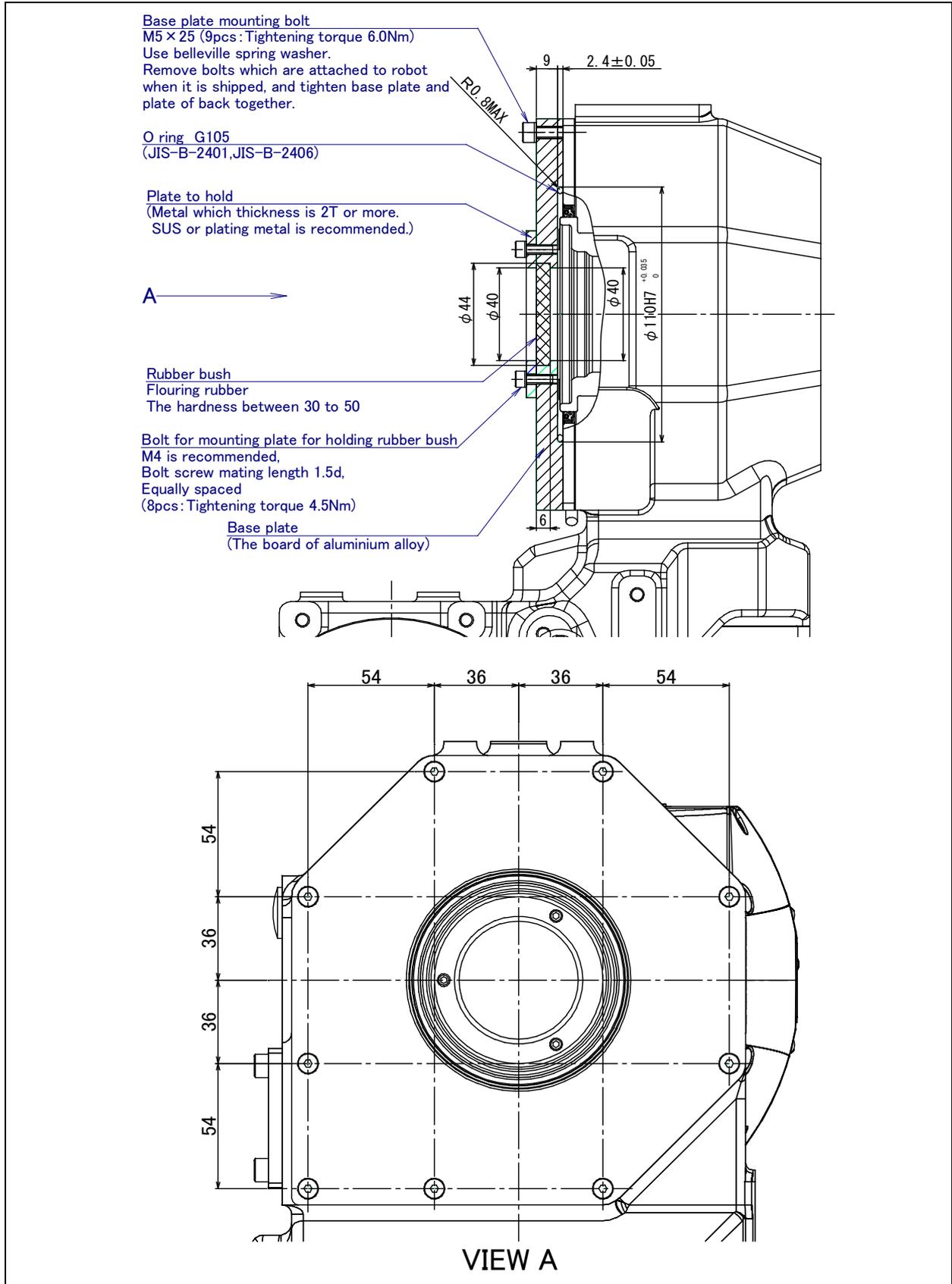


Fig.11.1 (d) Structure of seal of back of J3 casing

- (8) Refer to figure below about structure of seal of wrist. If wrist is not sealed, dust come from hollow hole. Be sure to seal wrist.

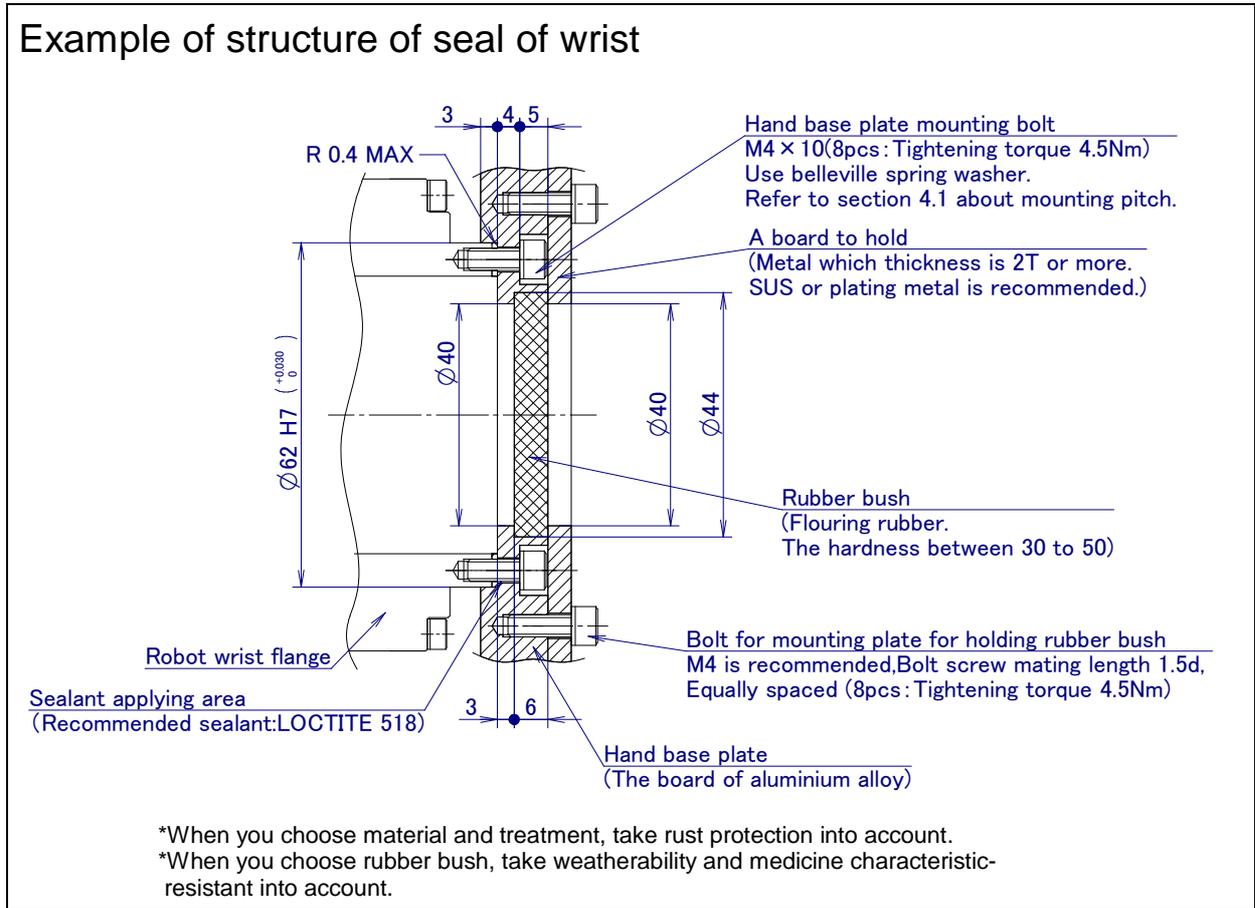


Fig.11.1 (e) Structure of seal of wrist (example)

- (9) When No dust M/H conduit is installed, use by the range limitation of J6 axis range of motion $\pm 190^\circ$ is recommended. The longevities of cables shortens when using it exceeding $\pm 190^\circ$ though it is possible to use even in range of motion more than this (maximum $\pm 270^\circ$). For J5-axis use it motion range in $\pm 120^\circ$. If J5-axis move more than $\pm 120^\circ$, it cause break of conduit, be careful.

NOTE

If cable is not clamped or grease is not applied or filling degree of cable in conduit is over, it causes early damage of cables and conduit.

- (10) Specification is ISO class 5 (equal to clean class 100).

12 TIG WELDING OPTION

When TIG welding option is specified, install Noise shield plate as below. (It is attached when robot is shipped.)

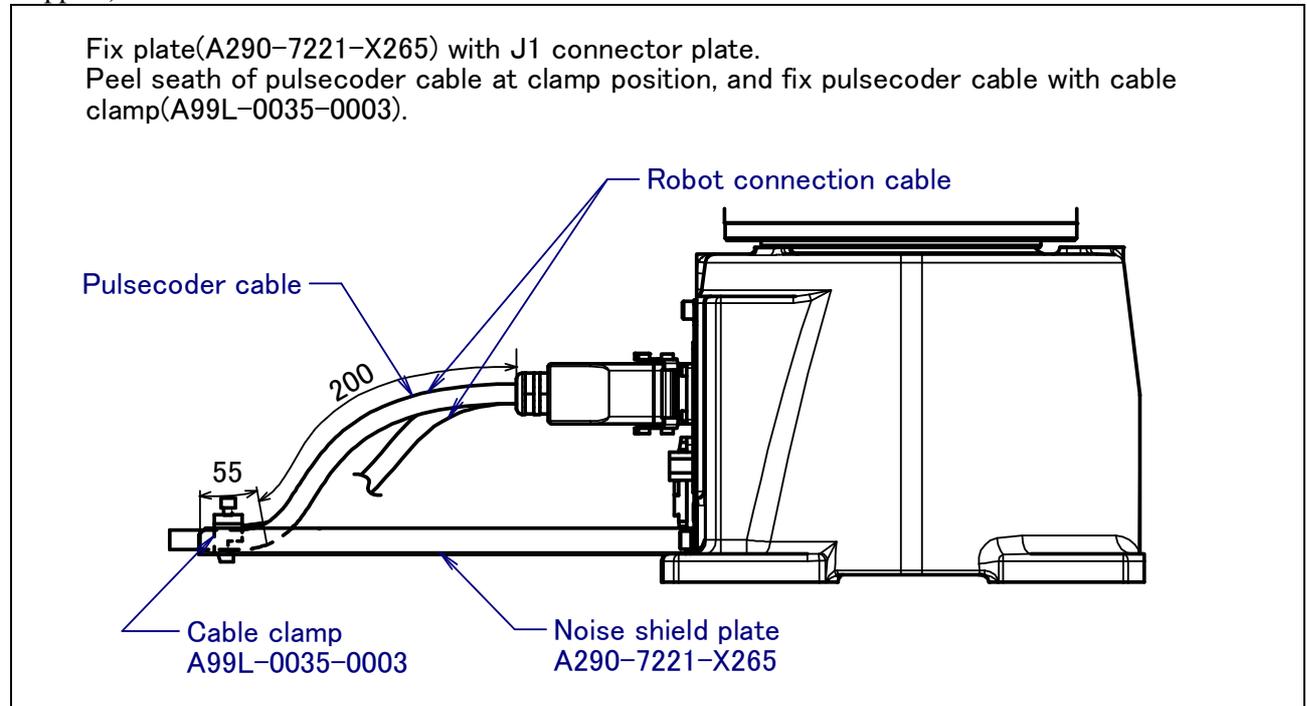


Fig.12 Attaching of noise shield plate

APPENDIX

A PERIODIC MAINTENANCE TABLE

FANUC Robot ARC Mate 120iC, M-20iA	Periodic Maintenance Table
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Items		Working time (H)	Check time	Oil 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	Retightening external main bolts	2.0H	—		○			○				○				
	5	Check the mechanical stopper and adjustable mechanical stopper.	0.1H	—		○			○				○				
	6	Remove spatter and dust etc.	1.0H	—		○			○				○				
	7	Check the end effector (hand) cable	0.1H	—		○			○				○				
	8	Check the oil sight glass of J4 to J6 axis	0.1H	—	○	○	○	○	○	○	○	○	○	○	○	○	○
	9	Replacing battery	0.1H	—					●					●			
	10	Replacing grease of J1 axis reducer	0.5H	1111ml													
	11	Replacing grease of J2 axis reducer	0.5H	944ml													
	12	Replacing grease of J3 axis reducer	0.5H	211ml													
	13	Replacing oil of J4 axis gear box	0.5H	822ml													
	14	Replacing oil of J5 and J6 axis unit	0.5H	822ml													
	15	Replacing cable of mechanical unit	4.0H	—													
	16	Replacing cable of Mechanical unit welding power	4.0H	—										●			
	17	Replacing M/H conduit/No dust M/H conduit	1.0H	—										●			
	18	Fluoric resin ring	0.1H	—	○	○	○	○	○	○	○	○	○	●	○	○	○
Controller	19	Check the robot cable, teach pendant cable and robot connecting cable	0.2H	—		○			○				○				
	20	Cleaning the ventilator	0.2H	—	○	○	○	○	○	○	○	○	○	○	○	○	
	21	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	1	
○				○				○				○				○							2
○				○				○				○				○							3
○				○				○				○				○							4
○				○				○				○				○							5
○				○				○				○				○							6
○				○				○				○				○							7
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○			8
●				●				●				●				●							9
●												●											10
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				●																			21

FANUC Robot ARC Mate 120iC/10L, M-20iA/10L Periodic Maintenance Table

Items		Working time (H)	Check time	Oil 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	Retightening external main bolts	2.0H	—		○			○				○				
	5	Check the mechanical stopper and adjustable mechanical stopper.	0.1H	—		○			○				○				
	6	Remove spatter and dust etc.	1.0H	—		○			○				○				
	7	Check the application cable	0.1H	—		○			○				○				
	8	Check the oil sight glass of J4 to J6 axis	0.1H	—	○	○	○	○	○	○	○	○	○	○	○	○	○
	9	Replacing battery	0.1H	—						●				●			
	10	Replacing grease of J1 axis reducer	0.5H	1111ml													
	11	Replacing grease of J2 axis reducer	0.5H	944ml													
	12	Replacing grease of J3 axis reducer	0.5H	211ml													
	13	Replacing oil of J4 axis gear box	0.5H	822ml													
	14	Replacing oil of J5 and J6 axis unit	0.5H	400ml													
	15	Replacing cable of mechanical unit	4.0H	—													
	16	Replacing cable of Mechanical unit welding power	4.0H	—										●			
	17	Replacing M/H conduit/No dust M/H conduit	1.0H	—										●			
	18	Fluoric resin ring	0.1H	—	○	○	○	○	○	○	○	○	○	●	○	○	○
Controller	19	Check the robot cable, teach pendant cable and robot connecting cable	0.2H	—		○			○				○				
	20	Cleaning the ventilator	0.2H	—	○	○	○	○	○	○	○	○	○	○	○	○	
	21	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	1	
○				○				○				○				○							2
○				○				○				○				○							3
○				○				○				○				○							4
○				○				○				○				○							5
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○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○			8
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○	○	○	○	●	○	○	○	○	○	○	○	●	○	○	○	○	○	○	○	○			18
○				○				○				○				○							19
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○			20
				●																			21

FANUC Robot M-20iA/20M	Periodic Maintenance Table
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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	Retightening external main bolts	2.0H	—		○			○				○			
	5	Check the mechanical stopper and adjustable mechanical stopper.	0.1H	—		○			○				○			
	6	Remove spatter and dust etc.	1.0H	—		○			○				○			
	7	Check the end effector (hand) cable	0.1H	—		○			○				○			
	8	Replacing battery	0.1H	—					●				●			
	9	Replacing grease of J1 axis reducer	0.5H	1111ml												
	10	Replacing grease of J2 axis reducer	0.5H	944ml												
	11	Replacing grease of J3 axis reducer	0.5H	211ml												
	12	Replacing grease of J4 axis gearbox	0.5H	1200ml												
	13	Replacing grease of J5 axis gearbox	0.5H	1110ml												
	14	Supply grease of J6-axis reducer	0.5H	40ml						●				●		
	15	Replacing cable of mechanical unit	4.0H	—												
Controller	16	Check the robot cable, teach pendant cable and robot connecting cable	0.2H	—		○			○				○			
	17	Cleaning the ventilator	0.2H	—	○	○	○	○	○	○	○	○	○	○	○	○
	18	Replacing 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	1	
○				○				○				○				○							2
○				○				○				○				○							3
○				○				○				○				○							4
○				○				○				○				○							5
○				○				○				○				○							6
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				●																			18

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 tapped holes and wipe oil off the engaging section. Make sure that there is no solvent in the tapped holes. 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/mm² or more

Size is M24 or more : Tensile strength 1000N/mm² or more

All size of bolt of the plating : Tensile strength 1000N/mm² or more

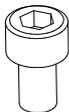
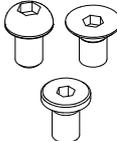
Hexagon bolt, stainless bolt, special shape bolt (button bolt, low-head bolt, flush bolt .etc)

Tensile strength 400N/mm² 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	_____	_____	_____	_____	_____	_____
								

C INSULATION ABOUT ARC WELDING ROBOT

C.1 ABSTRACT

The arc welding robot performs welding, using a welding torch attached to its end effector mounting face via a bracket.

Because a high welding current flows through the welding torch, the insulation between the end effector mounting face and torch is dualized.

If no due consideration is taken, a poor insulation caused by a pileup of spatter can allow the welding current to leak into robot mechanical sections, possibly resulting in the motor being damaged or the sheaths of cables in the mechanical sections melting.

C.2 INSULATION AT THE WRIST

- Design the insulation between the end effector mounting face and welding torch so that no current will leak from the end effector. Concretely, when fastening the insulating material inserted between the end effector mounting face and torch bracket, use different bolts on the insulation material and torch bracket.
- Insert the insulating material between the torch and torch bracket so that the insulation is dualized. When installing the insulating material, be sure to set the crack in the torch holder away from that of the insulating material to prevent spatter from getting in the cracks.
- Allow a sufficient distance (at least 5 mm) at the insulating materials in case a pileup of spatter should occur.
- Even after the insulation is reinforced, it is likely that, if a pileup of spatter grows excessively, current may leak. Periodically remove spatter when the robot is in service.

D CONTROL OF MULTIPLE ROBOTS

In case of R-30iA,R-30iA Mate, one controller can control up to four robots. Moreover, one controller can control up to eight groups, 56 axes.

In case of R-30iB, one controller can control up to four robots. Moreover, one controller can control up to eight groups, 72 axes.

NOTE
 "Group" means the gathering of independent movable axes.

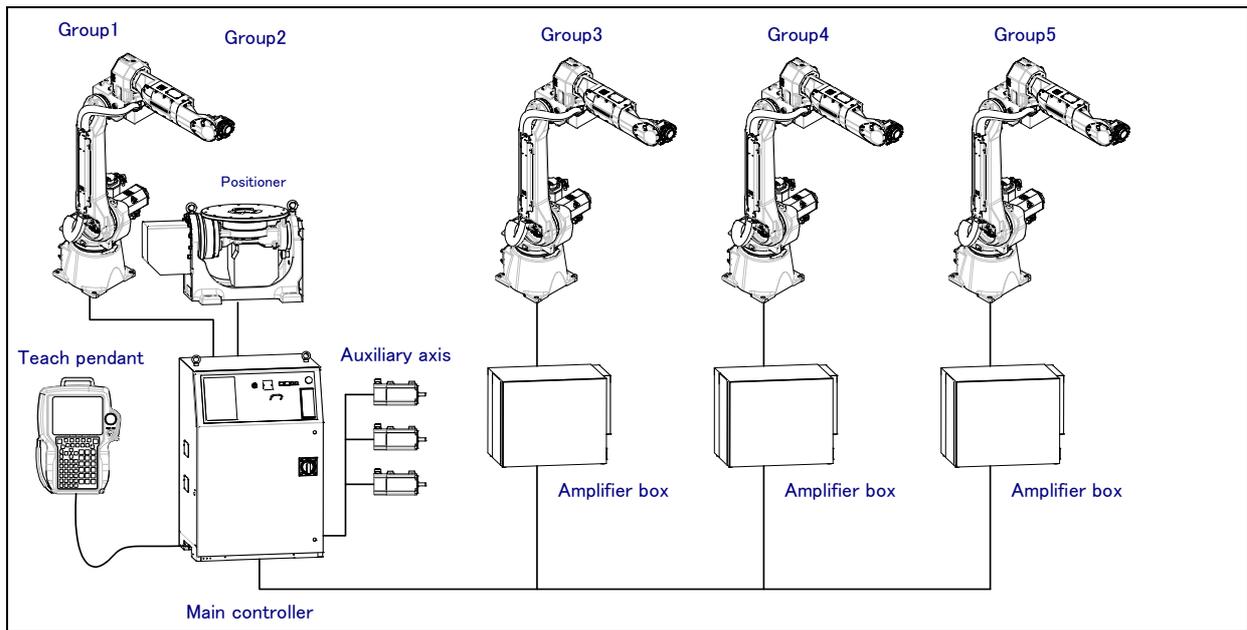


Fig.D Control of multiple robots

When multiple robots are controlled with one controller, select in table D (a),(b) that appropriate servo card and auxiliary axis board of controller

Table D (a) Servo card and auxiliary axis board when multiple robots are controlled (R-30iA, R-30iA Mate)

Number of robots	Servo card and auxiliary axis board	Remarks
2 (NOTE1)	A05B-2500-H042 (16 axes)	Max. 4 auxiliary axes can be used in total of robot 1 st and 2 nd
3	A05B-2500-H044 (24 axes)	Max. 4 auxiliary axes can be used in total of robot 1 st and 2 nd Max. 2 auxiliary axes can be used in robot 3 rd
4 (NOTE1)	A05B-2500-H042 (16 axes) + A05B-2500-J030 (16 axes) (NOTE2) A05B-2550-J020 (16 axes) (NOTE3)	Max. 4 auxiliary axes can be used in total of robot 1 st and 2 nd Max. 4 auxiliary axes can be used in total of robot 3 rd and 4 th

Table D (b) Servo card and auxiliary axis board when multiple robots are controlled (R-30iB)

Number of robots	Servo card and auxiliary axis board	Remarks
2	A05B-2600-H041 (12 axes) (Note 4) A05B-2600-H042 (18 axes)	Max. 6 auxiliary axes can be used in total of robot 1 st and 2 nd
3	A05B-2600-H044 (18 axes) (Note 4) A05B-2600-H043 (24 axes)	Max. 6 auxiliary axes can be used in total of robot 1 st , 2 nd and 3 rd
4	A05B-2600-H043 (24 axes) (Note 4) A05B-2600-H044 (36 axes)	Max. 12 auxiliary axes can be used in total of robot 1 st , 2 nd , 3 rd and 4 th

(NOTE1) One robot is needed to assign in 8 axes of servo card in case of Model to which high-sensitivity collision detection is supported as default like ARC Mate *iC* series etc. Therefore, A05B-2500-H040 (8 axes) cannot be used in case of two robots. Similarly, A05B-2500-H044 (24 axes) cannot be used in case of four robots.

(NOTE2) Select here when the controller is R-30iA.

(NOTE3) Select here when the controller is R-30iA Mate.

(NOTE4) It can be used only when auxiliary axes are not specified.

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REVISION RECORD

Edition	Date	Contents
07	Oct.,2013	<ul style="list-style-type: none"> • Addition of R-30iB Mate • Change of oiling method of J4-axis gearbox • Correction of errors
06	Sep.,2012	<ul style="list-style-type: none"> • Addition of R-30iB • Addition of M-20iA/20M • Correction of errors
05	Sep.,2011	<ul style="list-style-type: none"> • Change of oiling method of J4, J5/J6-axis gearbox • Addition of exudation of oil • Addition of external dimension of ISO flange adapter • Addition of note about M/H conduit and No dust M/H conduit • Correction of errors
04	Jul, 2010	<ul style="list-style-type: none"> • Addition of stop type of robot • Addition of stopping time and distance when controlled stop is executed • Correction of errors
03	Feb, 2010	<ul style="list-style-type: none"> • Addition of no dust M/H conduit • Addition of insulation • Addition of control of multiple robots • Change the oil replacement procedure for J4 and J5/J6 gear box
02	Sep, 2008	<ul style="list-style-type: none"> • Addition of sever dust/liquid protection option • Addition of TIG welding option • Correction of errors
01	Jul, 2008	

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