FANUC Robot ARC Mate 0*i*B

MECHANICAL UNIT

OPERATOR'S MANUAL

B-83614EN/02

- **Original Instructions**

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

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

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

SAFETY PRECAUTIONS

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

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

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

1 DEFINITION OF USER

The personnel can be classified as follows.

Operator:
- Turns the robot controller power on/off
- Starts the robot program from operator panel

Programmer:
- Operates the robot
- Teaches the robot inside the safety fence

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

- Operator is not allowed to work in the safety fence.
- Programmers and maintenance engineers are allowed to work in the safety fence. Works carried out in the safety fence include transportation, installation, teaching, adjustment, and maintenance.
- To work inside the safety fence, the person must be trained on proper robot operation.

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

- Adequate clothes for the operation
- Safety shoes
- A helmet

2 DEFINITION OF SAFETY NOTATIONS

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

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

- Check this manual thoroughly, and keep it handy for the future reference.

3 SAFETY OF THE USER

User 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 user safety.

(1) Have the robot system users 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 user 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 user 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 (b).

(4) Provide the peripheral equipment with appropriate earth (Class A, Class B, Class C, and Class D).
(5) Try to install the peripheral equipment outside the robot operating space.
(6) Draw an outline on the floor, clearly indicating the range of the robot operating space, 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 user enters the work area.
(8) If necessary, install a safety lock so that no one except the user in charge can turn on the power of the robot.

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

(9) When adjusting each peripheral equipment independently, be sure to turn off the power of the robot.
(10) Operators should be ungloved while manipulating the operator 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. (refer to Controller OPERATOR'S MANUAL.)
(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 inside 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.)
- Outdoor

(16) When connecting the peripheral equipment 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 footstep, please consider security for installation and maintenance work in high place according to Fig. 3 (c). Please consider footstep and safety belt mounting position.

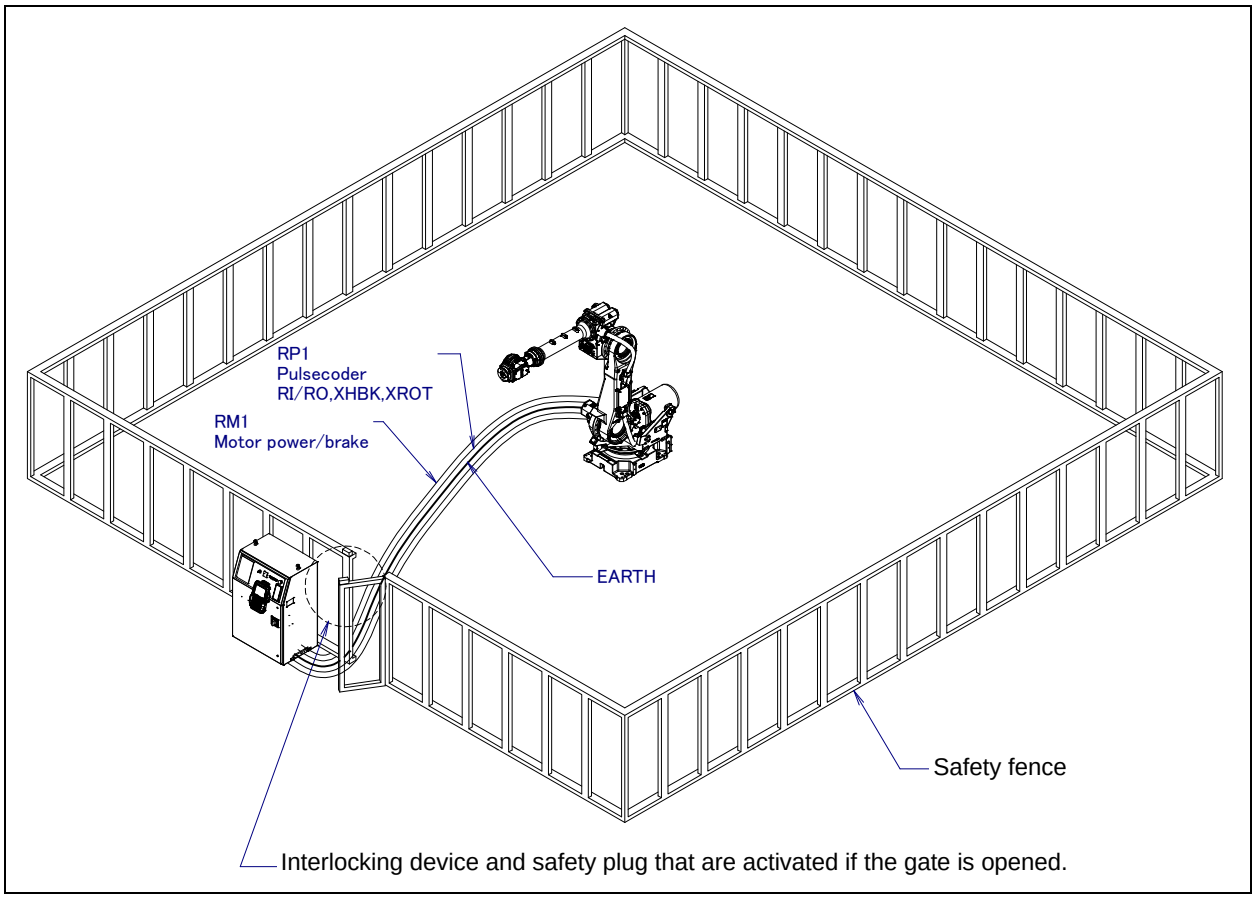


Fig. 3 (a) Safety fence and safety gate

> ⚠ **WARNING**
> When you close a fence, please confirm that there is not a person from all directions of the robot.

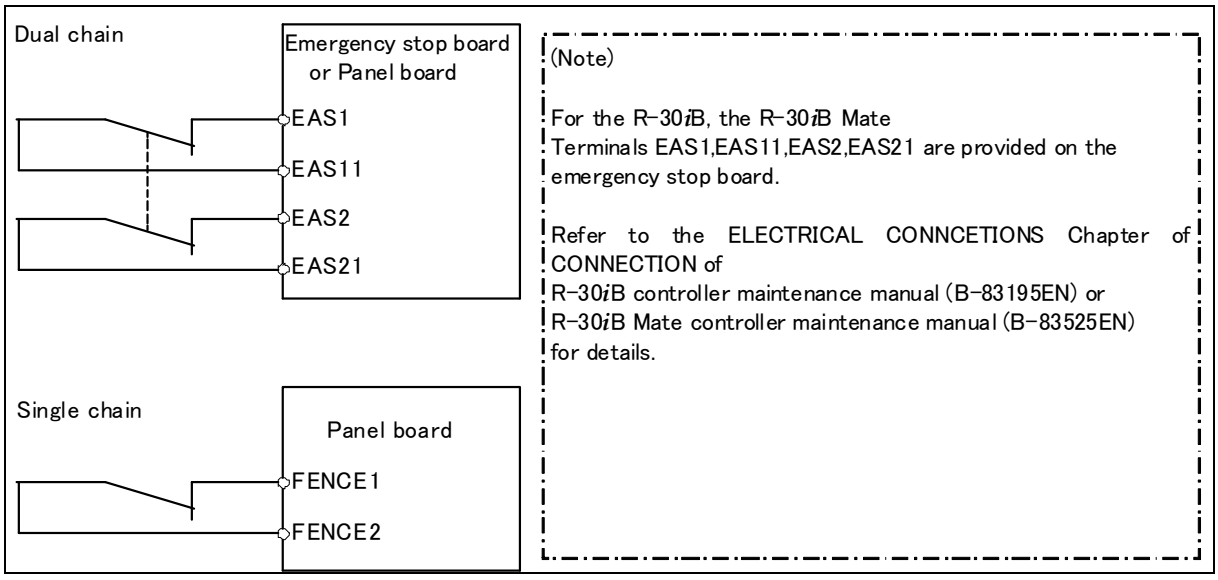


Fig. 3 (b) Connection diagram for the signal of safety fence

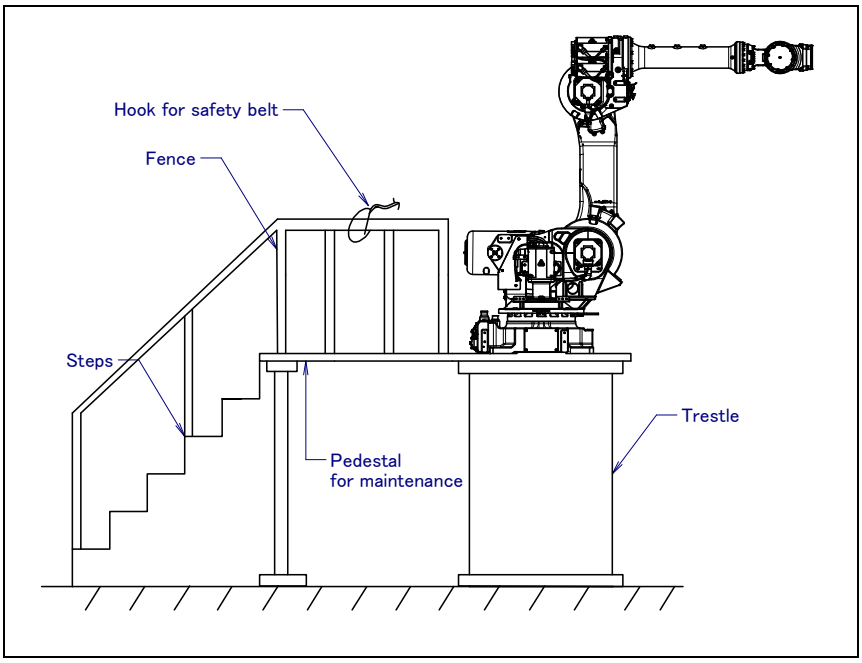


Fig. 3 (c) Pedestal for maintenance

3.1 SAFETY OF THE OPERATOR

An operator refers to a person who turns on and off the robot system and starts a robot program from, for example, the operator panel during daily operation.
Operators cannot work inside of the safety fence.

(1) If the robot does not need to be operated, turn off the robot controller power or press the EMERGENCY STOP button during working.
(2) Operate the robot system outside the operating space of the robot.
(3) Install a safety fence or safety door to avoid the accidental entry of a person other than an operator in charge or keep operator out from the hazardous place.
(4) Install one or more necessary quantity of EMERGENCY STOP button(s) within the operator's reach in appropriate location(s) based on the system layout.

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.

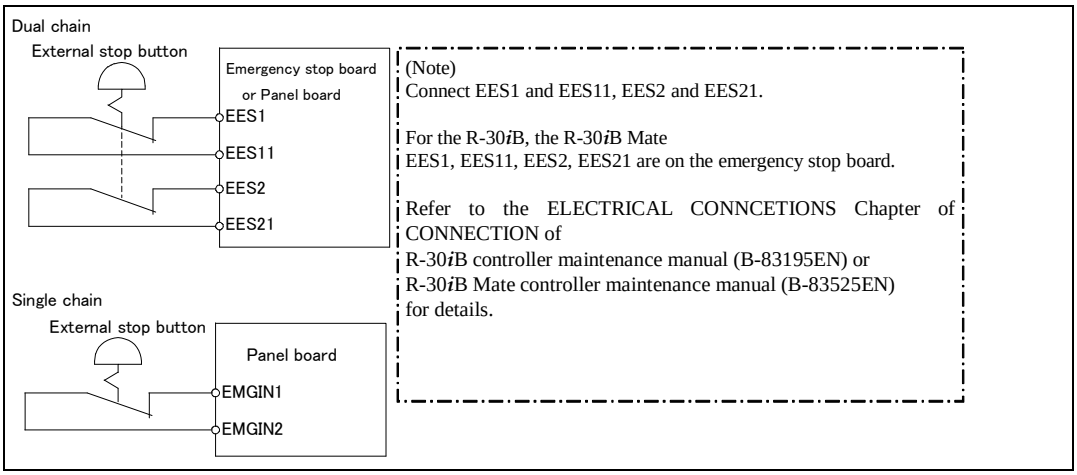


Fig. 3.1 Connection diagram for external emergency stop button

3.2 SAFETY OF THE PROGRAMMER

While teaching the robot, the operator may need to enter the robot operation area. The programmer must ensure the safety especially.

(1) Unless it is specifically necessary to enter the robot operating space, carry out all tasks outside the operating space.
(2) Before teaching the robot, check that the robot and its peripheral equipment are all in the normal operating condition.
(3) If it is inevitable to enter the robot operating space 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 operating space.
(5) Programming should be done outside the area of the safety fence as far as possible. If programming needs to be done inside 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 whole robot 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 (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 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.

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 the stop of the robot (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) Enable: Servo power is turned off when the operator releases the DEADMAN switch or when the operator presses the switch strongly.
   (b) Disable: The DEADMAN switch is disabled.
   (Note) The DEADMAN switch is provided to stop the robot when the operator releases the teach pendant or presses the pendant strongly in case of emergency. The R-30*i*B/R-30*i*B 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 equipment 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.

Mode	Teach pendant enable switch	Software remote condition	Teach pendant	Operator panel	Peripheral equipment
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.

(6) To start the system using the operator box or operator panel, make certain that nobody is the robot operating space area and that there are no abnormalities in the robot operating space.
(7) When a program is completed, be sure to carry out a test operation according to the following procedure.
  (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 continuous operation at low speed.
  (c) Run the program for one operation cycle in continuous operation 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 continuous operation at the normal operating speed and check that the system operates automatically without trouble.
  (e) After checking the completeness of the program through the test operation above, execute it in the automatic operation.
(8) While operating the system in the automatic operation, the programmer should leave the safety fence.

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 operating space.
(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 operating space while the power is on, press the emergency stop button on the operator box or operator panel, or the teach pendant before entering the range. The maintenance worker 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 worker must check the whole robot 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 whole robot 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 maintenance work, check that the robot and its peripheral equipment are all in the normal operating condition.
(7) Do not operate the robot in the automatic operation while anybody is in the robot operating space.

(8) When you maintain the robot alongside a wall or instrument, or when multiple users are working nearby, make certain that their escape path is not obstructed.
(9) When a tool is mounted on the robot, or when any movable device other than the robot is installed, such as belt conveyor, pay careful attention to its motion.
(10) If necessary, have a user who is familiar with the robot system stand beside the operator panel and observe the work being performed. If any danger arises, the user should be ready to press the EMERGENCY STOP button at any time.
(11) When replacing a part, please contact your local FANUC representative. If a wrong procedure is followed, an accident may occur, causing damage to the robot and injury to the user.
(12) When replacing or reinstalling components, take care to prevent foreign material from entering the system.
(13) When handling each unit or printed circuit board in the controller during inspection, turn off the circuit breaker to protect against electric shock.
If there are two cabinets, turn off the both circuit breaker.
(14) A part should be replaced with a part recommended by FANUC. If other parts are used, malfunction or damage would occur. Especially, a fuse that is not recommended by FANUC should not be used. Such a fuse may cause a fire.
(15) When restarting the robot system after completing maintenance work, make sure in advance that there is no person in the operating space and that the robot and the peripheral equipment 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 user needs to touch such a part in the heated state, the user 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 equipmenthould 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 robot 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 worker should work outside the safety fence.

4 SAFETY OF THE TOOLS AND PERIPHERAL EQUIPMENT

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 abnormality occurs in any other robots or peripheral equipment, even though the robot itself is normal.
(3) For a system in which the robot and its peripheral equipment 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 equipment 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, operate the robot where insulated from the influence of oil, water, and dust.
(2) Do not use unconfirmed liquid for cutting fluid and cleaning fluid.
(3) Adopt limit switches or mechanical stoppers to limit the robot motion, and avoid the robot from collisions against peripheral equipment or tools.
(4) Observe the following precautions about the mechanical unit cables. Failure to follow precautions may cause problems.
- Use mechanical unit cable that have required user interface.
- Do not add user cable or hose to inside of the mechanical unit.
- Please do not obstruct the movement of the mechanical unit 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 the device 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 perform 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 and power-off of the robot is incurred.
- When alteration is necessary, safety switch is operated by opening safety fence and power-off stop is incurred 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 operates routinely and power-off stop is incurred for the robot.
- Power-off stop is regularly incurred due to an inappropriate setting for Dual Check Safety (DCS).

(6) Power-off stop of Robot is executed 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 MECHANICAL UNIT

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 operating spaces 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 robot operation area 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 pinched by the robot), brake release unit can be used to move the robot axes without drive power.
Please order following unit and cable.

Name	Specification
Brake release unit	A05B-2450-J350 (Input voltage AC100-115V single phase) A05B-2450-J351 (Input voltage AC200-240V single phase)
Robot connection cable	A05B-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.

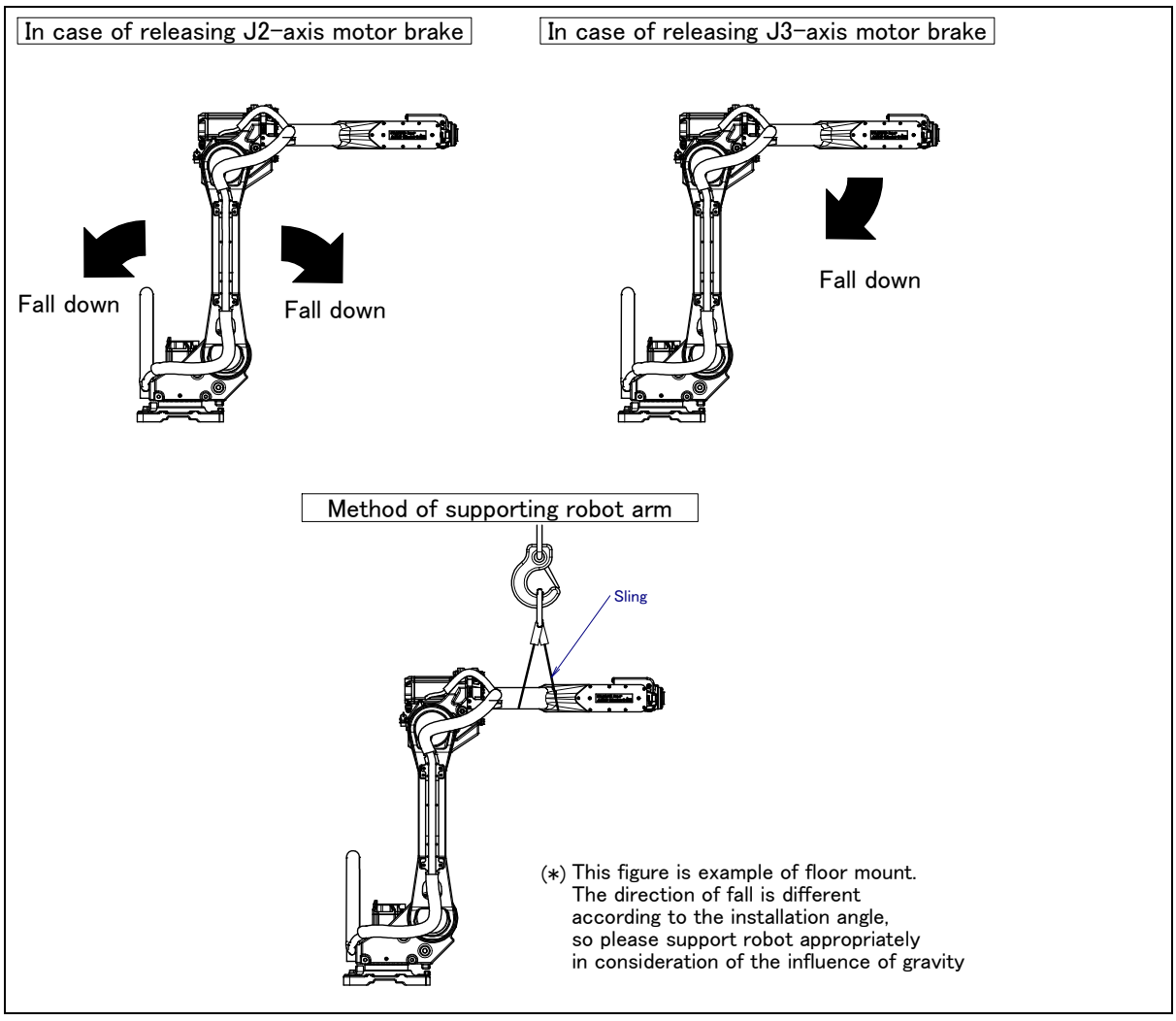


Fig. 5.4 Arm operation by the release of J2/J3-axis motor brakes and measures

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 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.

Frequent Power-Off stop of the robot during operation can cause failures of the robot.
Avoid system designs that require routine or frequent Power-Off stop conditions.

Controlled stop (Category 1 following IEC 60204-1)

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

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

Hold (Category 2 following IEC 60204-1)

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

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

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

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

There are the following 3 Stop patterns.

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

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

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

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

(*) R-30*i*B/R-30*i*B Mate does not have servo disconnect. R-30*i*B Mate does not have SVOFF input.

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 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.
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.

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 & CAUTION 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 Subsection 7.3.2 Replacing the Grease of the Drive Mechanism (3 years (11520 hours) checks) for explanations about specified grease, the grease amount, and the locations of grease and degrease outlets.

(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 tool such as heat-resistant gloves.

(4) Transportation label

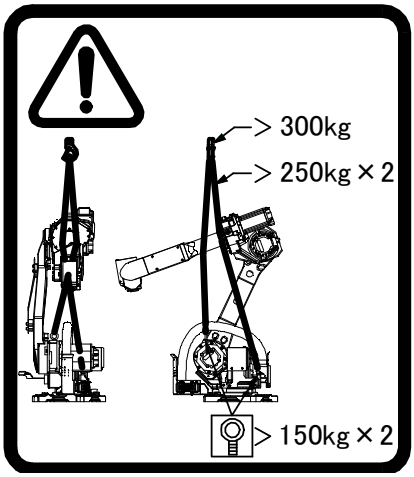


Fig. 8 (d) Transportation label

Description

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

(1) Using a crane

- Use a crane with a load capacity of 2940N(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.

> ⚠ **CAUTION**
> See Section 1.1 TRANSPORTATION of operator's manual for explanations about the posture should take when it is transported.

(5) Disassembly prohibitive label (for robot with pedestal)

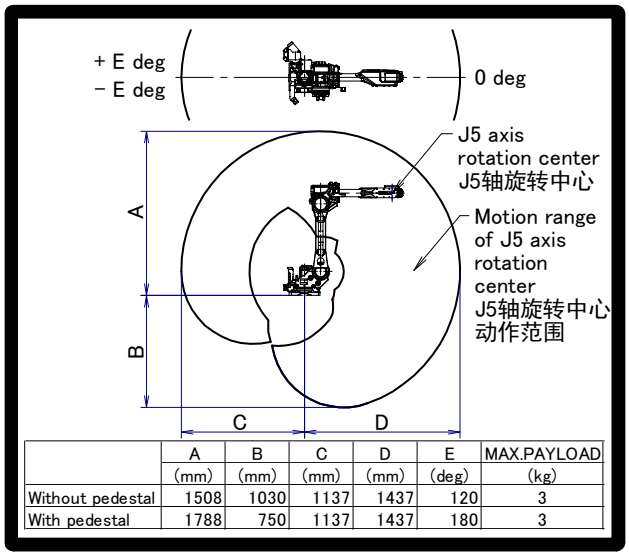
Fig. 8 (e) Disassembly prohibitive label

Descriptions

Do not remove J1 base.

(6) Operating space and payload label

Below label is added when CE specification is specified.



	A (mm)	B (mm)	C (mm)	D (mm)	E (deg)	MAX.PAYLOAD (kg)
Without pedestal	1508	1030	1137	1437	120	3
With pedestal	1788	750	1137	1437	180	3

Fig. 8 (f) Operating space and payload label

160302

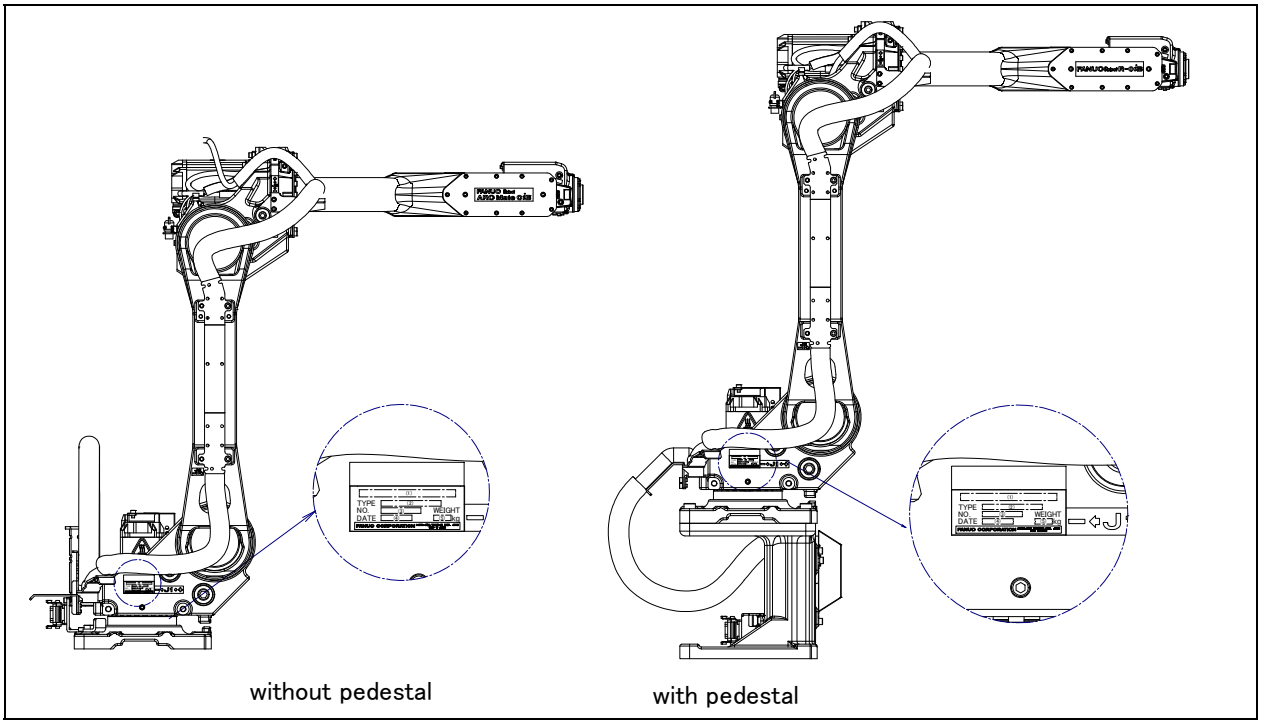
PREFACE

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 0*i*B	A05B-1223-B301	3kg

NOTE
1 Use of this robot is strictly limited to arc welding applications. Any other use is prohibited.
2 This robot cannot be used in environments where it could be subject to water or oil splashing.
3 Wrist load and moment and inertia limits must be strictly observed. Exceeding the allowable values will cause premature mechanical unit breakdown.

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



Position of label indicating mechanical unit specification number

TABLE 1)

	(1)	(2)	(3)	(4)	(5)	(5)
CONTENTS	**Model name**	**TYPE**	**No.**	**DATE**	**WEIGHT kg (WITHOUT PEDESTAL)**	**WEIGHT kg (WITH PEDESTAL)**
LETTERS	FANUC Robot ARC Mate 0*i*B	A05B-1223-B301	SERIAL NO IS PRINTED	PRODUCTION YEAR AND MONTH ARE PRINTED	99	145

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: Topics:	Operator , system designer Safety items for robot system design, operation, maintenance
R-30*i*B Mate controller	Operations manual (Basic Operation) **B-83284EN** Operations manual (Alarm Code List) **B-83284EN-1** Operations manual (Optional Function) **B-83284EN-2** ARC WELDING FUNCTION Operations manual **B-83284EN-3**	Intended readers: Topics: Use:	Operator, programmer, maintenance engineer, system designer Robot functions, operations, programming, setup, interfaces, alarms Robot operation, teaching, system design
	Maintenance manual **B-83525EN**	Intended readers: Topics: Use:	Maintenance engineer, system designer Installation, connection to peripheral equipment, maintenance Installation, start-up, connection, maintenance

This manual uses following terms.

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

TABLE OF CONTENTS

1 TRANSPORTATION AND INSTALLATION

1.1 TRANSPORTATION

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

> ⚠ **WARNING**
> 1 When hoisting or lowering the robot with a crane or forklift, move it slowly with great care. When placing the robot on the floor, exercise care to prevent the installation surface of the robot from striking the floor strongly.
> 2 Robot becomes unstable when it is transported with the tool or equipment is installed, and it is dangerous. Please be sure to remove them when robot is transported.
> (Except light thins such as welding torch or wire feeder)
> 3 Do not pull eyebolts sideways.
> 4 When the robot without pedestal type is specified, be careful not to trip on the J1 movable part cable.

1) Transportation using a crane (Fig. 1.1 (a), (b))
Fasten the M10 eyebolts to the two points of the robot base and lift the robot by the two 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.

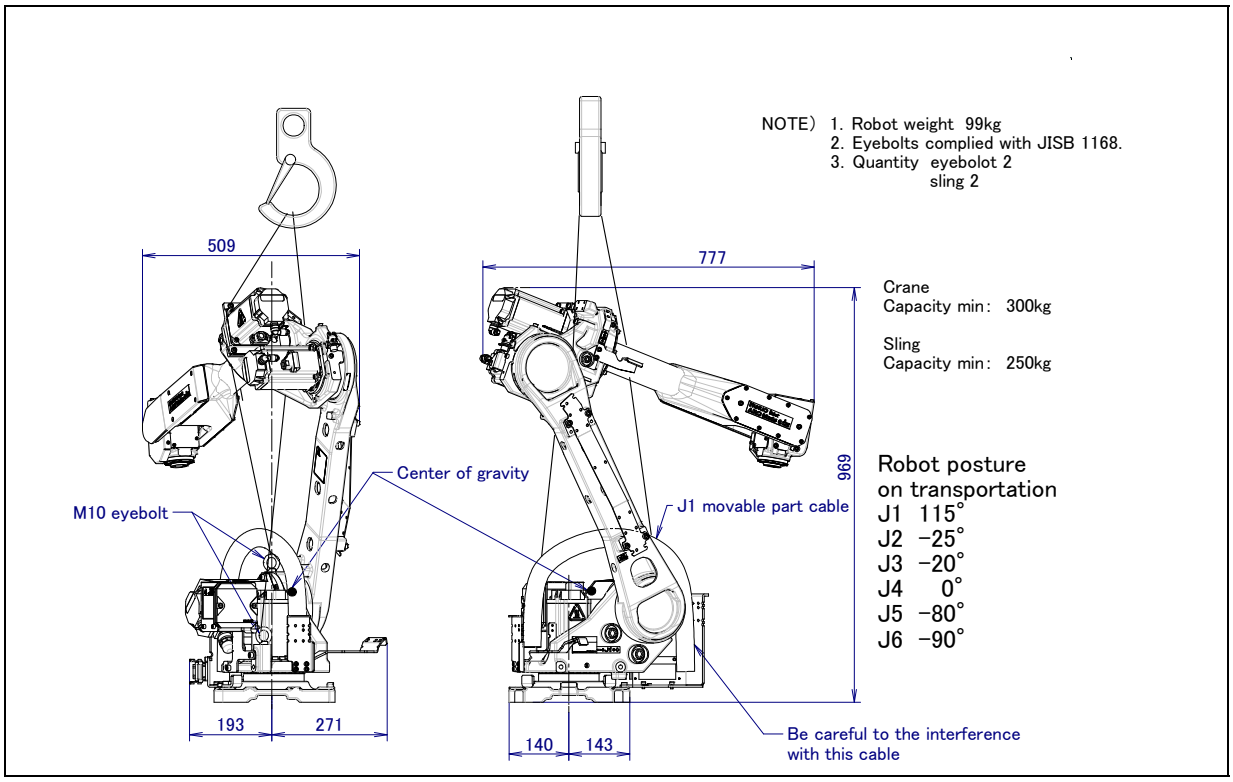


Fig. 1.1 (a) Transportation using a crane (without pedestal)

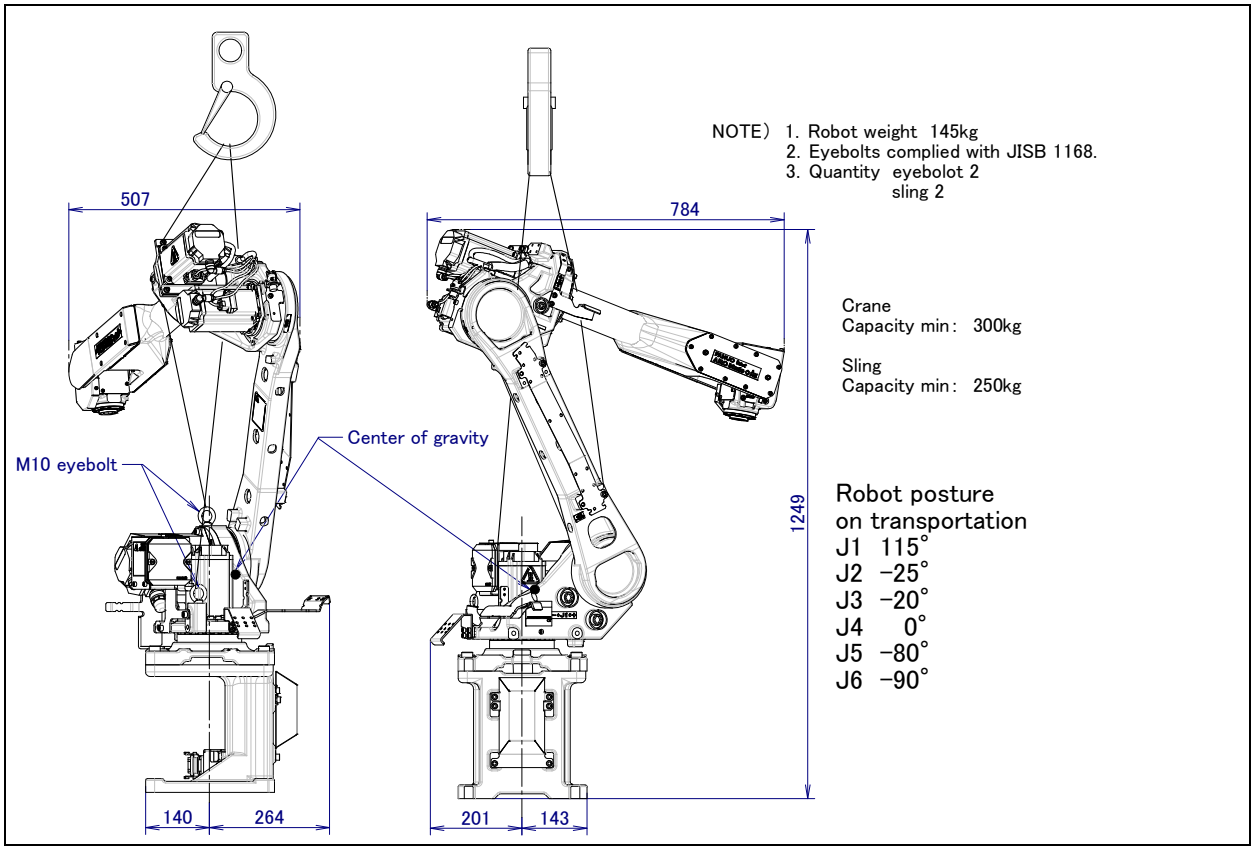


Fig. 1.1 (b) Transportation using a crane (with pedestal)

1.2 INSTALLATION

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

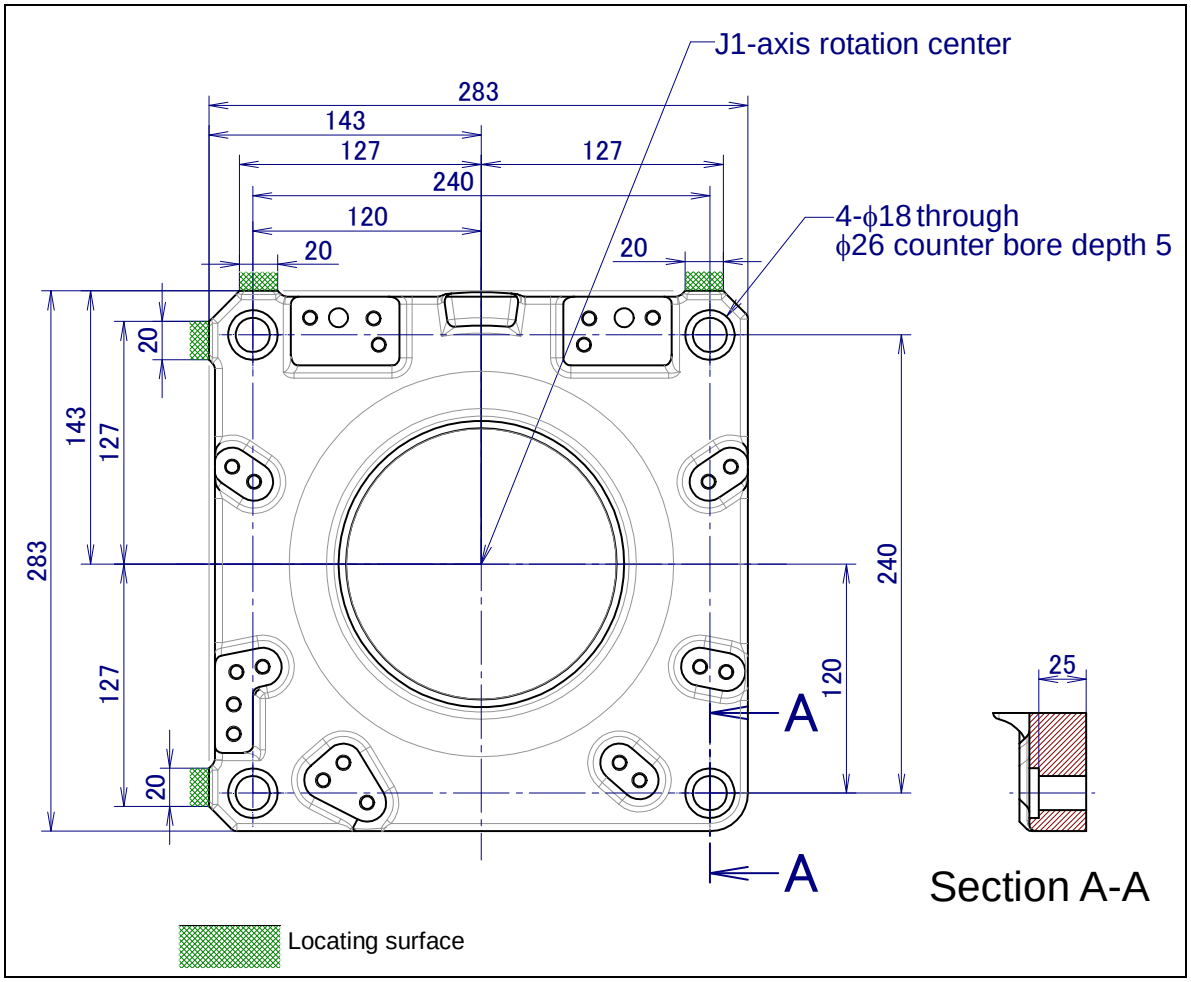


Fig. 1.2 (a) Dimensions of the robot base (without pedestal)

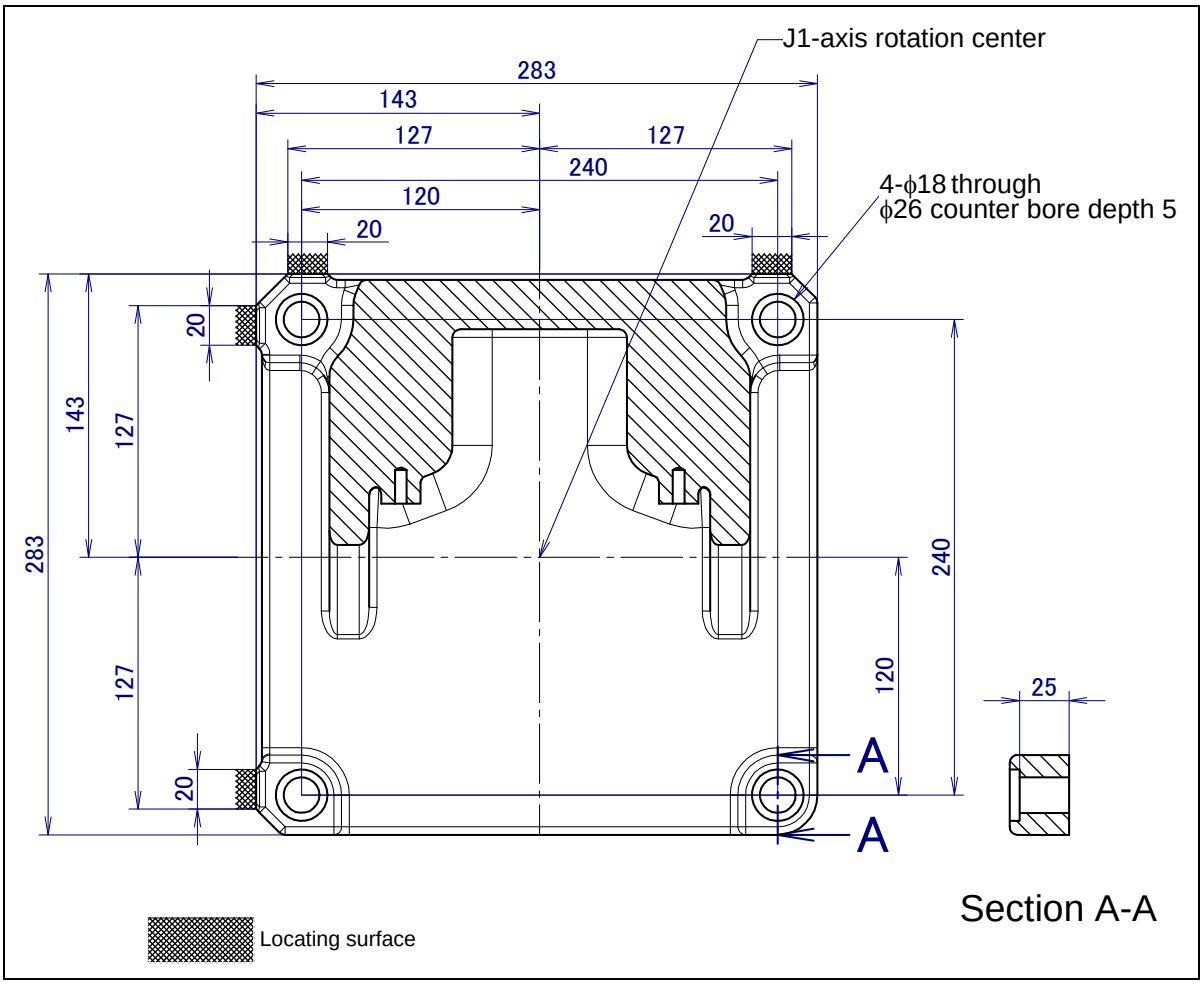


Fig. 1.2 (b) Dimensions of the robot base (with pedestal)

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 M16x50 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 locating surface.

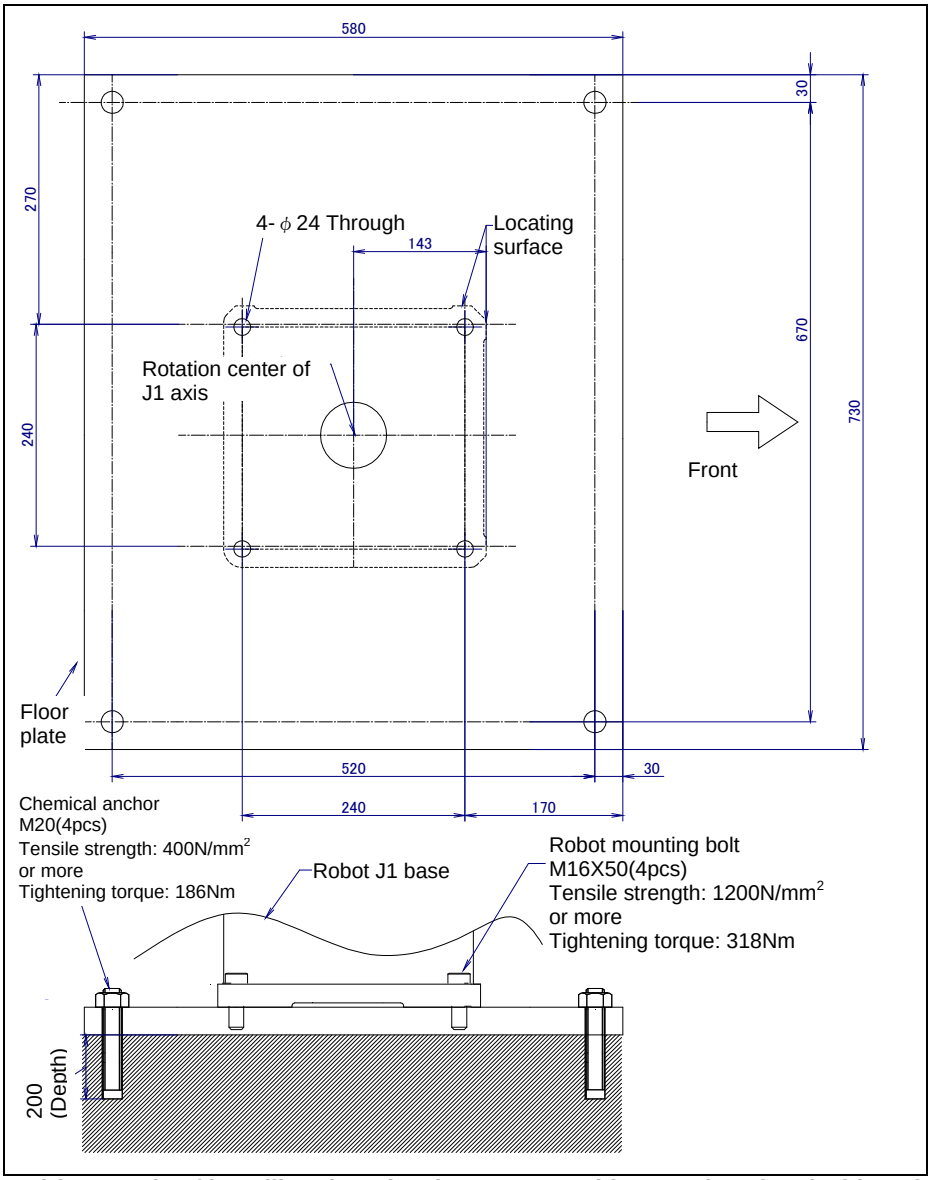


Fig. 1.2 (c) Example of installing the robot (common to without pedestal and with pedestal)

NOTE

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 M16X50 (tensile strength 1200N/mm^2 or more) and tighten bolt with regulated tightening torque 318Nm four robot mounting bolts.
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.
Flatness of robot installation surface must be less than or equal to 0.5mm.
Inclination of robot installation surface must be less than or equal to 0.5º. If robot base is placed on uneven ground, it may result in the base breakage or low performance of the robot.

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

Table 1.2 (a) Force and moment that act on J1 base (without pedestal)

	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	496 (51)	1199 (122)	0(0)	0(0)
During acceleration or deceleration	1390 (142)	1670 (170)	373 (38)	1535 (157)
During Power-Off stop	2239 (228)	2582 (263)	1049 (107)	1867 (190)

Table 1.2 (b) Force and moment that act on J1 base (with pedestal)

	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	496 (51)	1651 (168)	0(0)	0(0)
During acceleration or deceleration	1937 (198)	2122 (217)	373 (38)	1535 (157)
During Power-Off stop	2693 (275)	3034 (310)	1049 (107)	1867 (190)

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 0*i*B	Stopping time [ms]	172	108	92
	Stopping distance [deg] (rad)	19.6(0.34)	10.9(0.19)	9.4(0.16)

*Max payload and max speed

Table 1.2 (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 0*i*B	Stopping time [ms]	364	380	348
	Stopping distance [deg] (rad)	44.5(0.78)	42.8(0.75)	37.9(0.66)

*Max payload and max speed

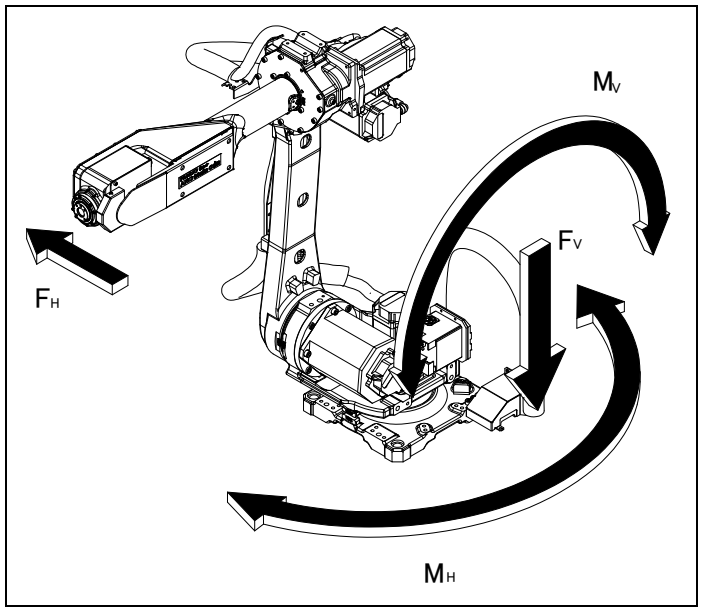
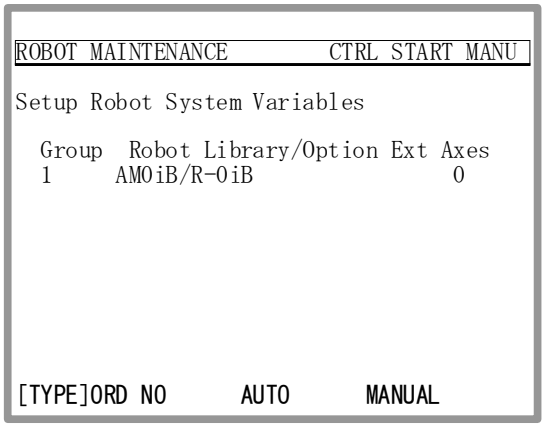


Fig. 1.2 (d) Force and moment that acts on J1 base

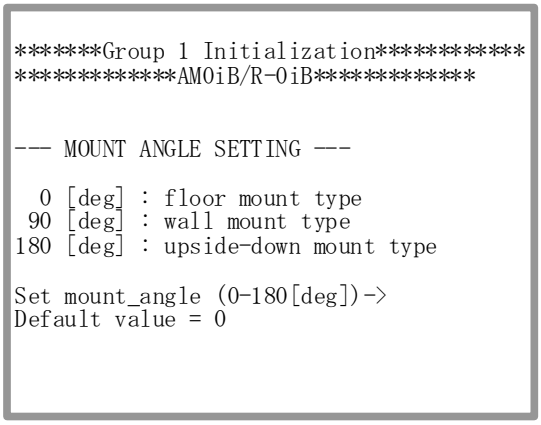
1.2.1 Angle of Mounting Surface Setting

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. In case of robot without pedestal, except floor mount or upside-down mount is impossible.

1 Turn on the controller with the [PREV] and the [NEXT] key pressed. Then select [3 Controlled start].
2 Press the [MENU] key and select [9 MAINTENANCE].
3 Select the robot which you set mount angle and press the [ENTER] key.



4 Press the [F4] key.
5 Press the [ENTER] key until screen below is displayed.



6 Input mount angle referring to Fig.1.2.1.Input mount angle referring to Fig. 1.2.1. Robot without pedestal supports only floor mount and upside-down mount.

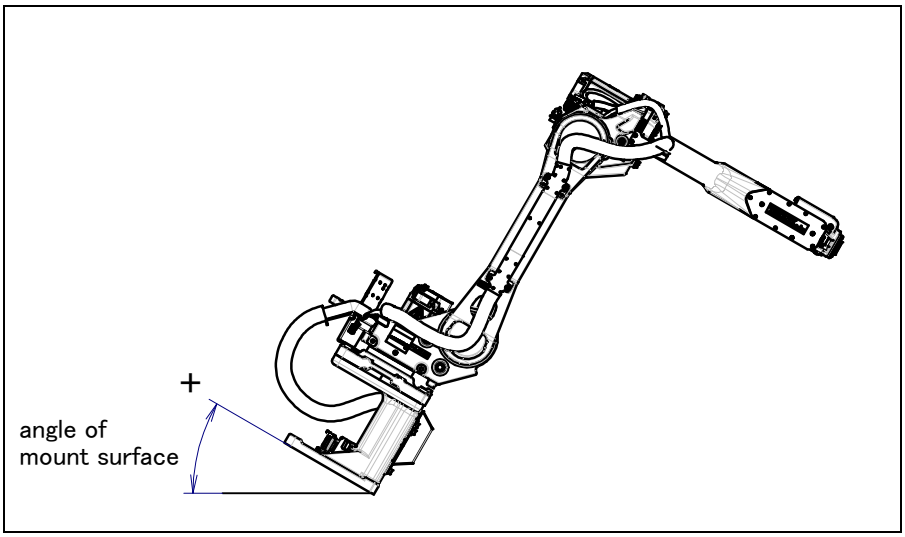
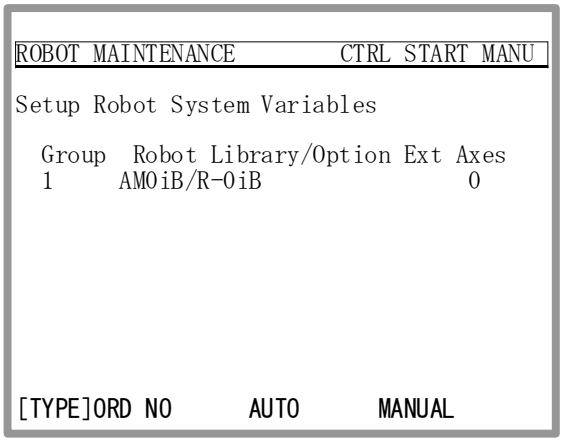


Fig. 1.2.1 Mounting angle

7 Press the [ENTER] key until screen below is displayed again.



8 Press the [FCTN] key and select [1 START (COLD)].

1.3 MAINTENANCE AREA

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

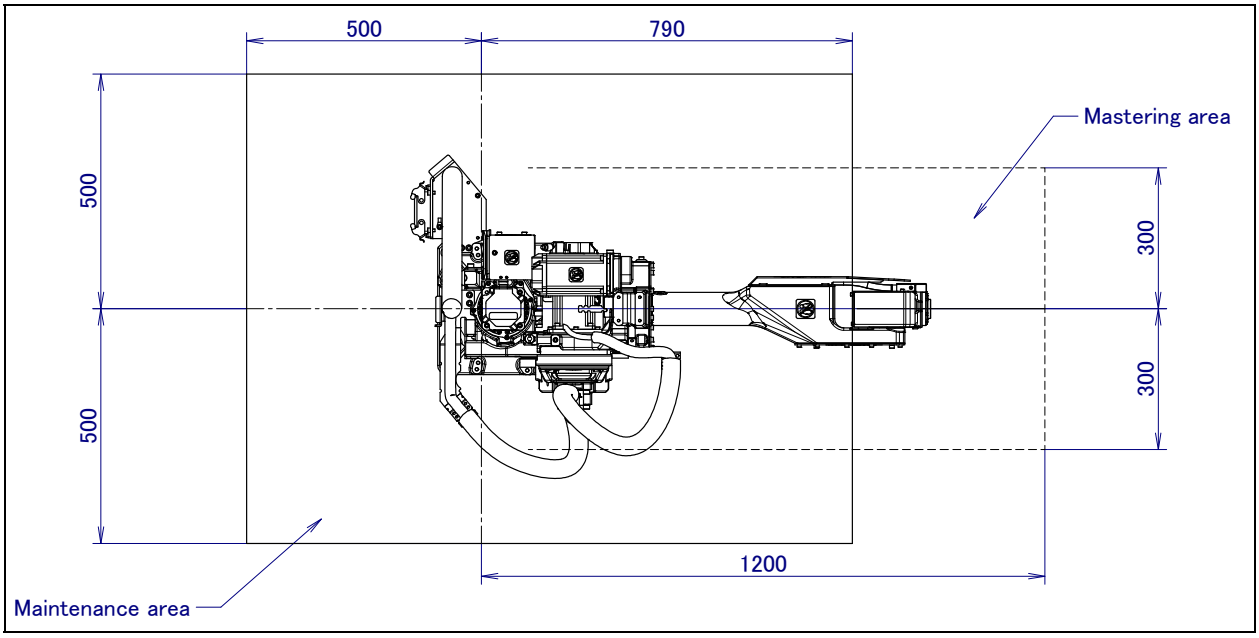


Fig. 1.3 Maintenance area

1.4 INSTALLATION SPECIFICATIONS

Refer to 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 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 the robot and controller with the earth line (ground). Otherwise, there is the risk of electrical shock.

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

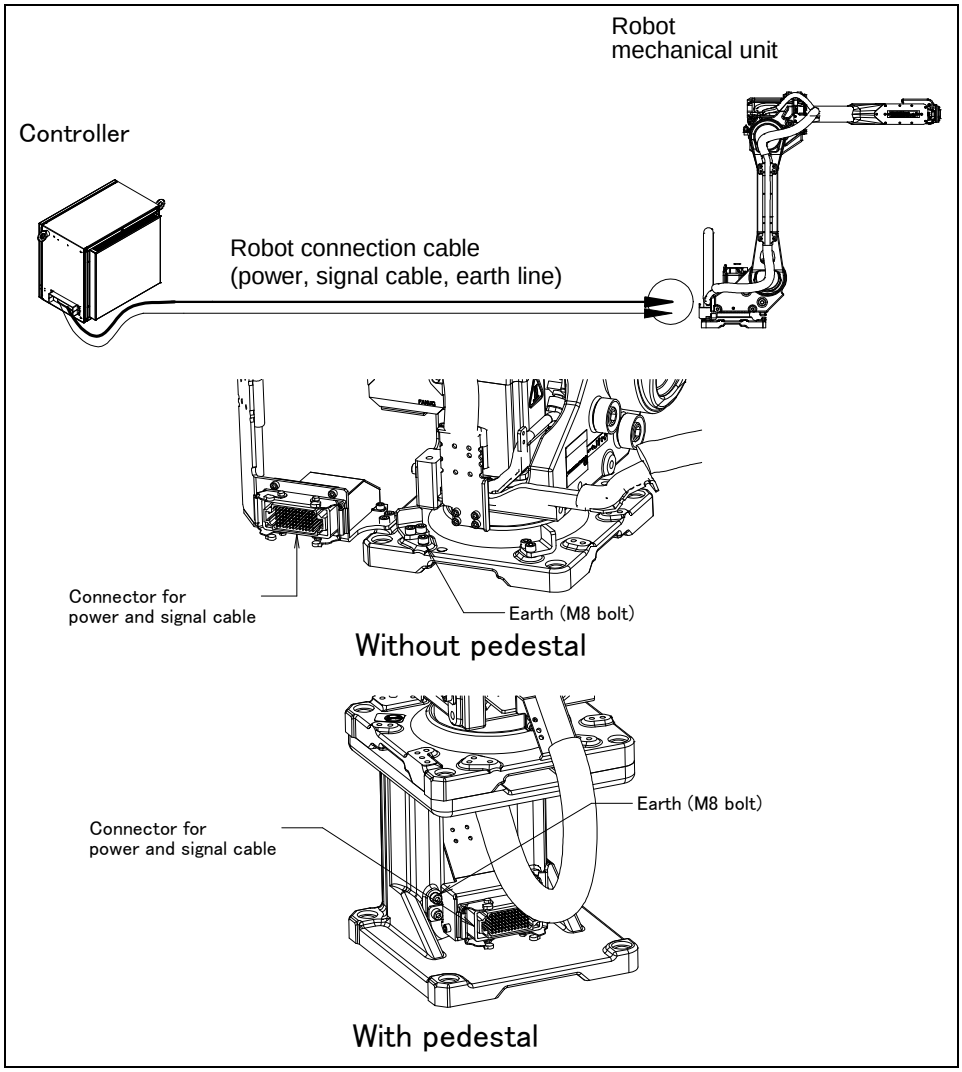


Fig. 2.1 Cable connection

3 BASIC SPECIFICATIONS

3.1 ROBOT CONFIGURATION

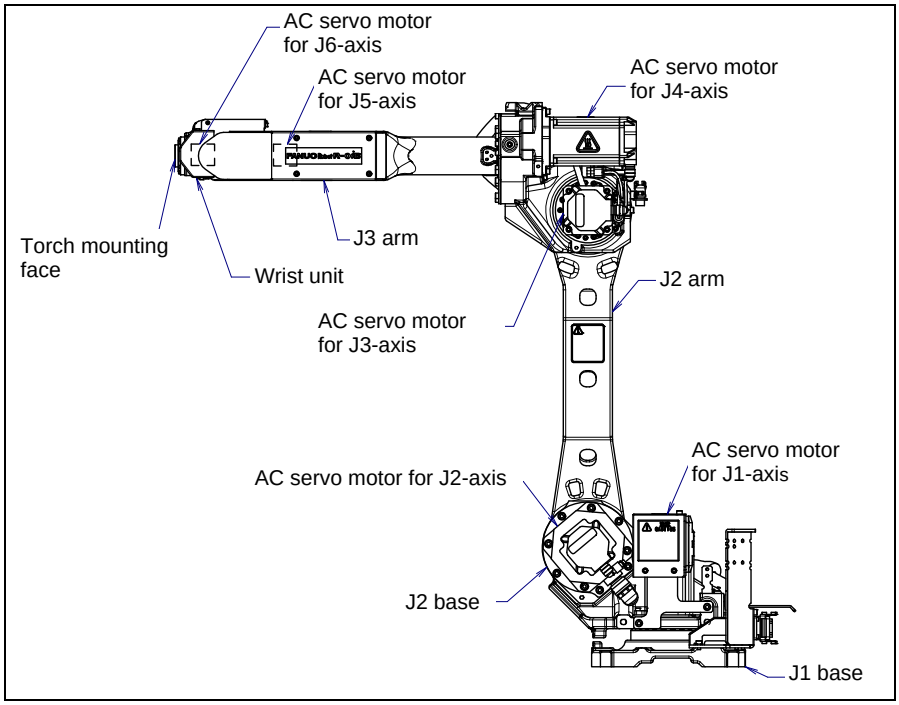


Fig. 3.1 (a) Mechanical unit configuration (without pedestal)

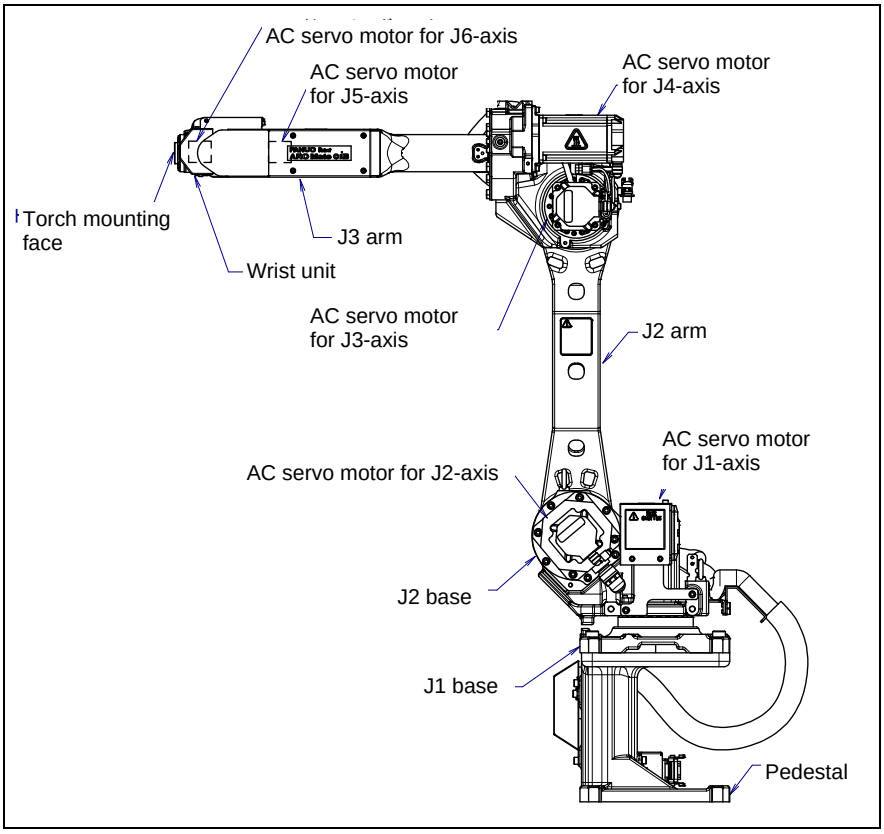


Fig. 3.1 (b) Mechanical unit configuration (with pedestal)

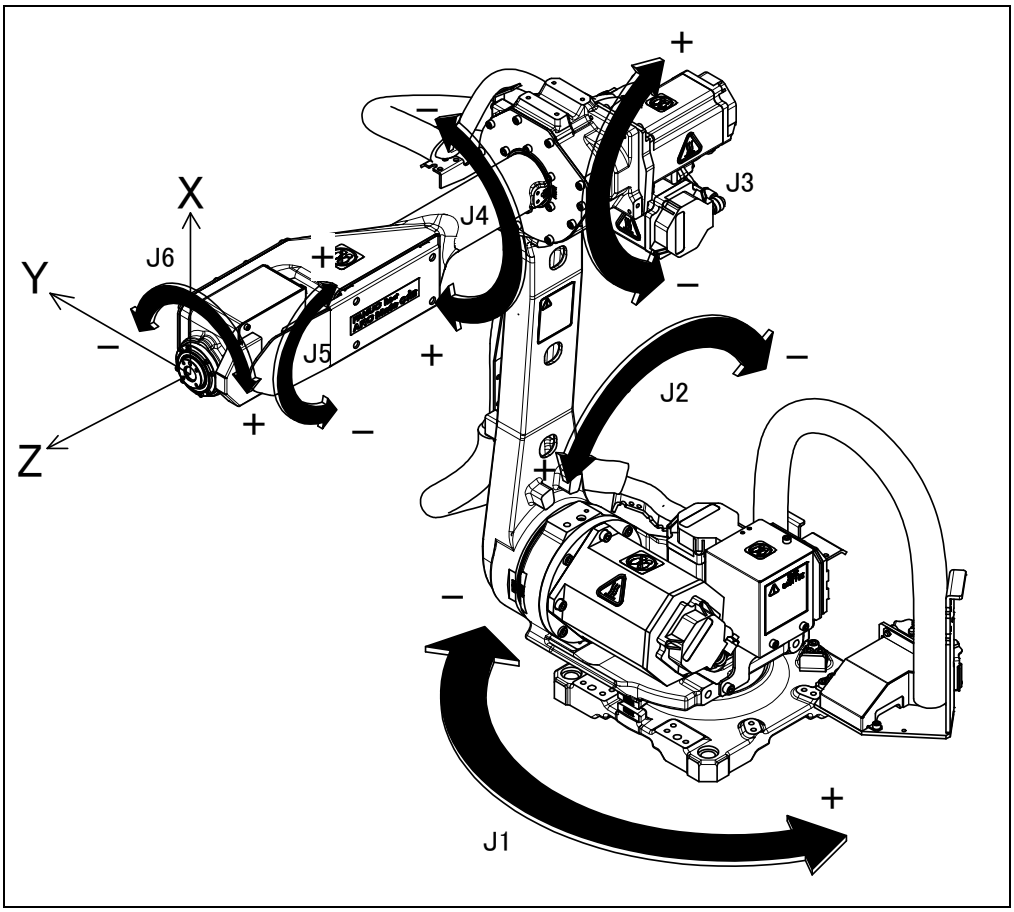


Fig. 3.1 (c) Each axes coordinates and mechanical interface coordinates

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

Specifications

Item		Specification	
Model		ARC Mate 0*i*B	
Type		Articulated type	
Controlled axes (Note 1)		6-axes (J1, J2, J3, J4, J5, J6)	
Installation		Floor, Upside-down, Angle mount (Note 2)	
Motion range	J1-axis	Upper limit/Lower limit	120° (2.09rad)/-120° (-2.09rad) (with stopper) 180° (3.14rad)/-180° (-3.14rad) (without stopper)
	J2-axis	Upper limit/Lower limit	160° (2.79rad)/-90° (-1.57rad)
	J3-axis	Upper limit/Lower limit	275° (4.80rad)/-180° (-3.14rad)
	J4-axis	Upper limit/Lower limit	190° (3.31rad)/-190° (-3.31rad)
	J5-axis	Upper limit/Lower limit	140° (2.44rad)/-140° (-2.44rad)
	J6-axis	Upper limit/Lower limit	360° (6.28rad)/-360° (-6.28rad)
Maximum speed (Note 3)	J1-axis	225°/s (3.93rad/s)	
	J2-axis	215°/s (3.75rad/s)	
	J3-axis	225°/s(3.93rad/s)	
	J4-axis	425°/s (7.42rad/s)	
	J5-axis	425°/s (7.42rad/s)	
	J6-axis	625°/s(10.91rad/s)	
Maximum load	Wrist	3kg	
Allowable load moment at wrist	J4-axis	8.9 N·m	
	J5-axis	8.9 N·m	
	J6-axis	3.0 N·m	
Allowable load inertia at wrist	J4-axis	0.28 kg·m^2	
	J5-axis	0.28 kg·m^2	
	J6-axis	0.035 kg·m^2	
Repeatability		±0.08 mm	
Robot mass		99 kg (without pedestal) 145 kg (with pedestal)	
Acoustic noise level		Less than 70dB (Note 4)	
Installation environment		Ambient temperature: 0 to 45℃ (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)	

⚠ CAUTION

1 In case of using robot combined with aux. axis, please consult with your local FANUC representative.
2 In case of angle mount, motion range is restricted. Refer to Section 3.6.
3 During short distance motions, the axis speed may not reach the maximum value stated.
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 the robot is used in a low temperature environment that is near to 0ºC, or not operated for a long time in the environment that is less than 0ºC (during a holiday or during the night), a collision detection alarm (SRVO-050) etc. may occur since the resistance of the drive mechanism could be high immediately after starting the operation. In this case, we recommend performing the warm up operation for several minutes.
6 Contact the service representative, if the robot is to be used in an environment or a place subjected to severe vibrations, heavy dust splash and or other foreign substances.

⚠ CAUTION

Use of this robot is strictly limited to arc welding applications. Any other use is prohibited. Do not use the robot in environments where it could be subject to water or oil splashing.

3.2 MECHANICAL UNIT OPERATION AREA AND OPERATING SPACE

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

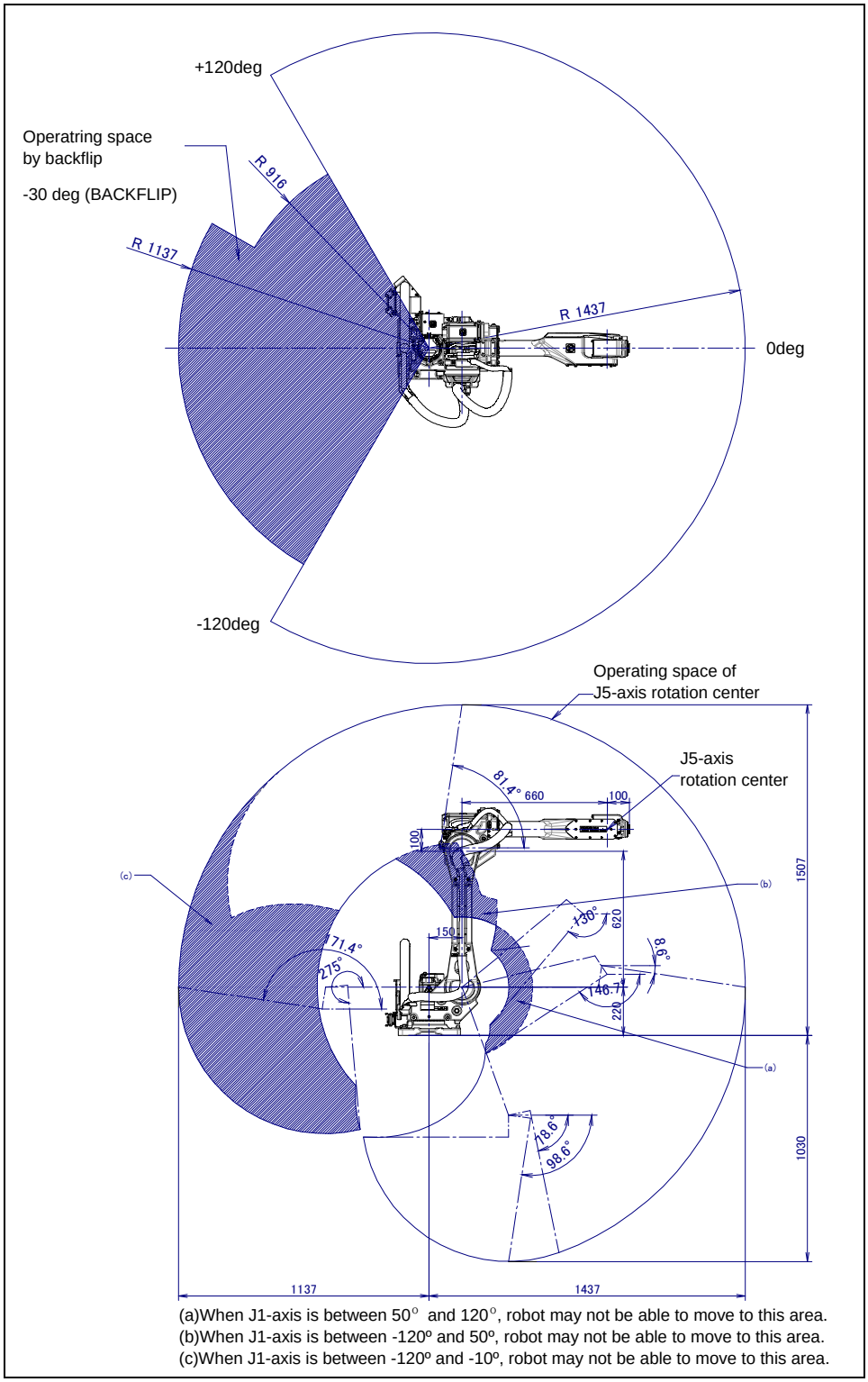


Fig. 3.2 (a) Operating space (without pedestal)

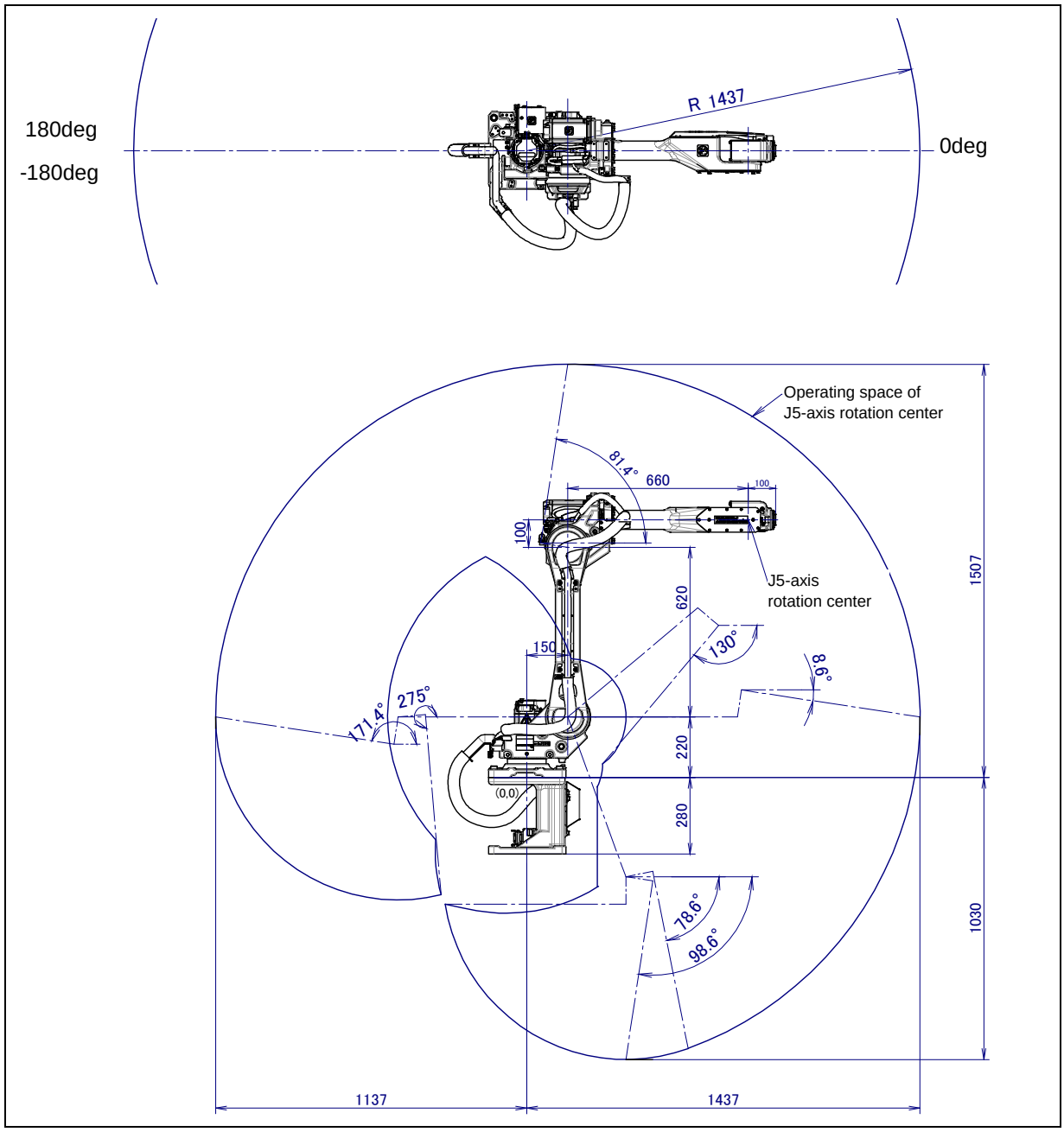


Fig. 3.2 (b) Operating space (with pedestal)

3.3 ZERO POINT POSITION AND MOTION LIMIT

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

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

Fig. 3.3 (a) shows the position of the mechanical stopper. For the J1 to J3-axis, stopping by overtravel damages the mechanical stopper. If this occurs, replace the stopper with a new one. Don't reconstruct the mechanical stopper. There is a possibility that the robot doesn't stop normally.

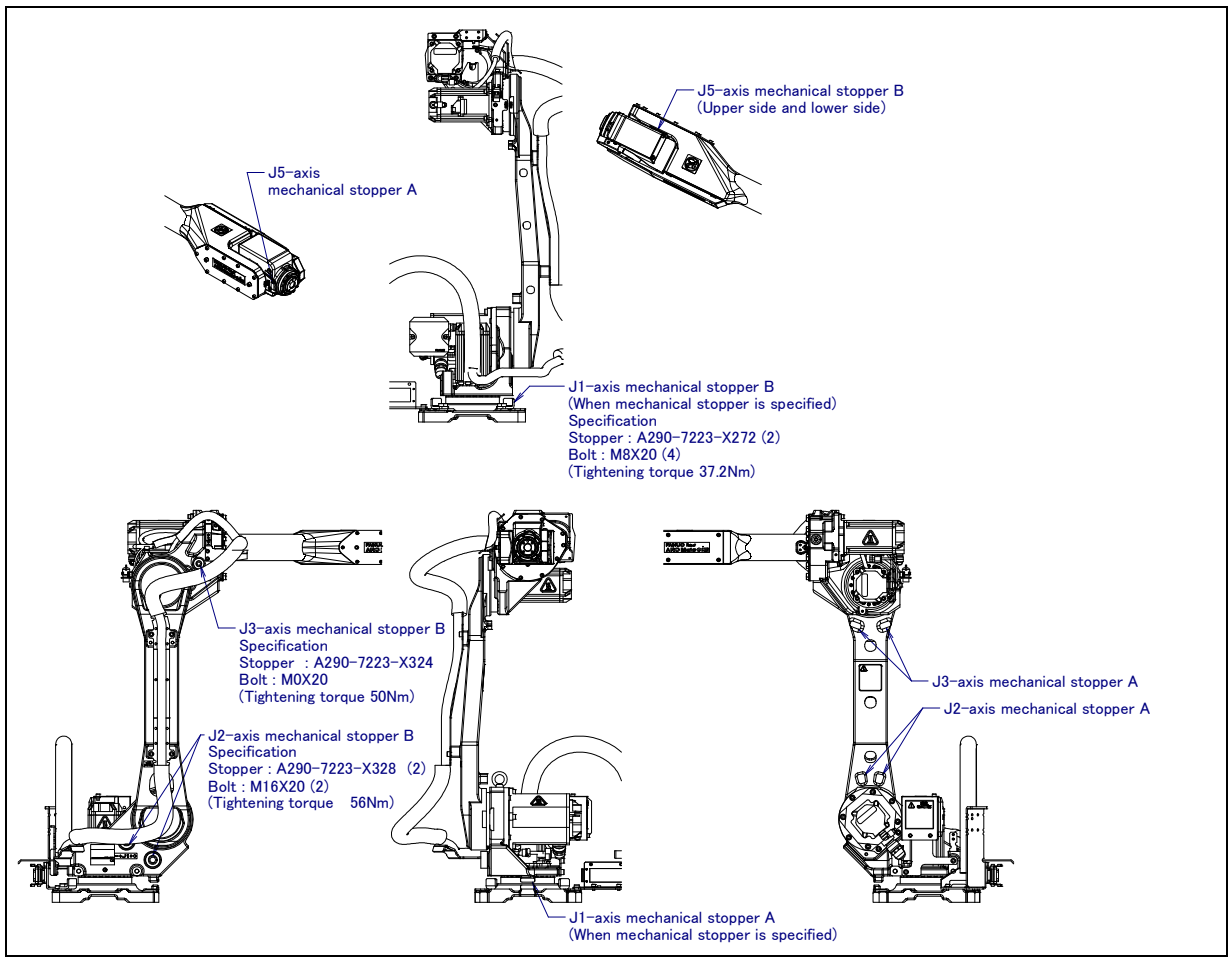


Fig. 3.3 (a) Position of mechanical stopper

Fig.3.3 (b) to (h) show the zero point, motion limit and maximum stopping distance (stopping distance in condition of max speed and max load) of each axis.

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

> ⚠ **CAUTION**
> Depending on the position of the J1/J2/J3-axis, the movable part of the J1 cable may interfere with the robot arm. In normal application this interference will not cause cable failure. However, in case of frequent interference, it is recommended to proceed to a periodical check of the cable condition.

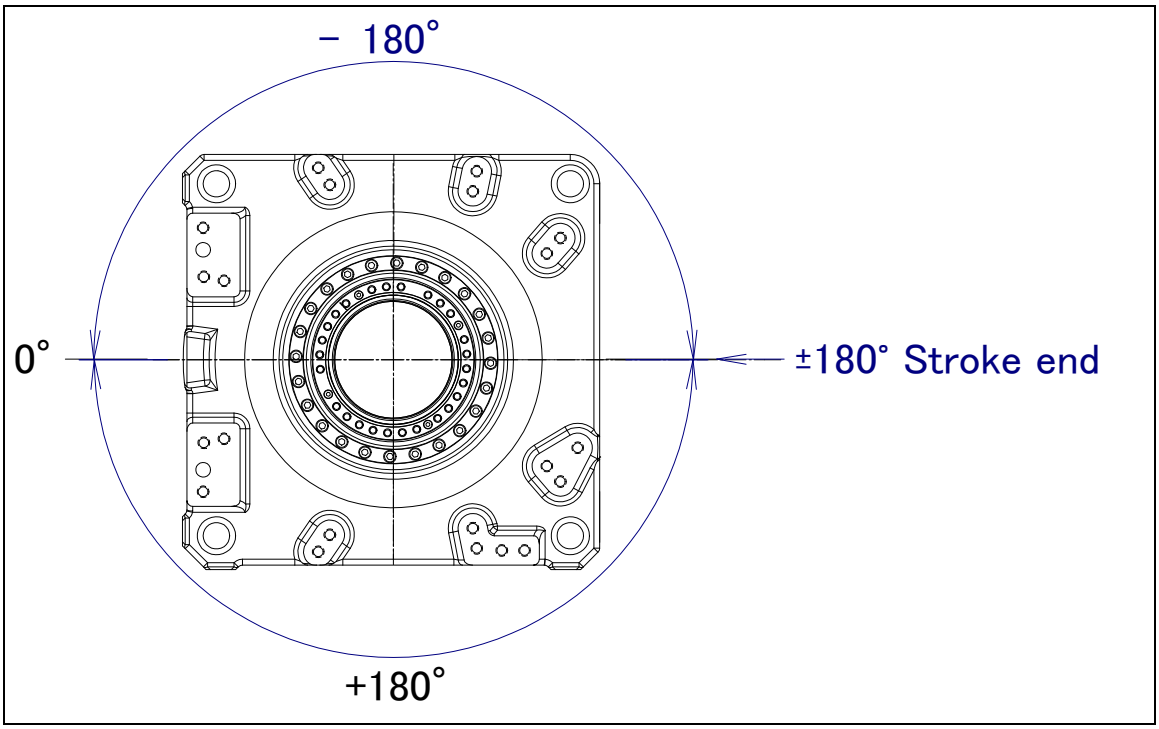


Fig. 3.3 (b) J1-axis motion limit (J1-axis 360°turn specification)

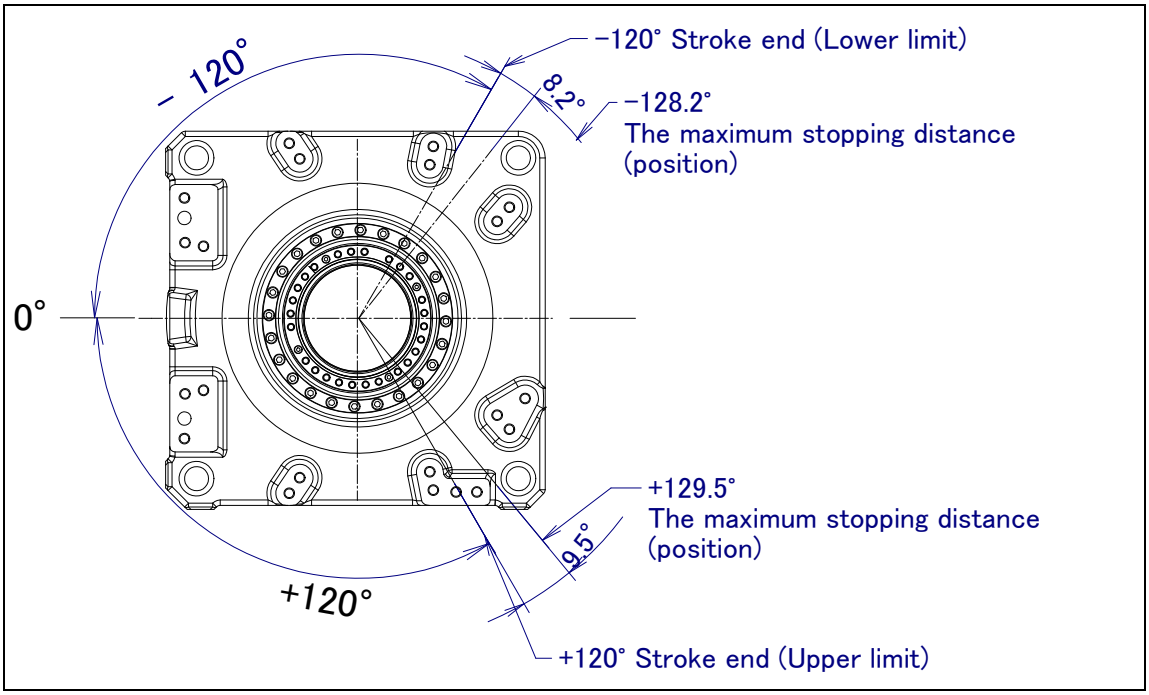


Fig. 3.3 (c) J1-axis motion limit (J1-axis 240°turn specification)

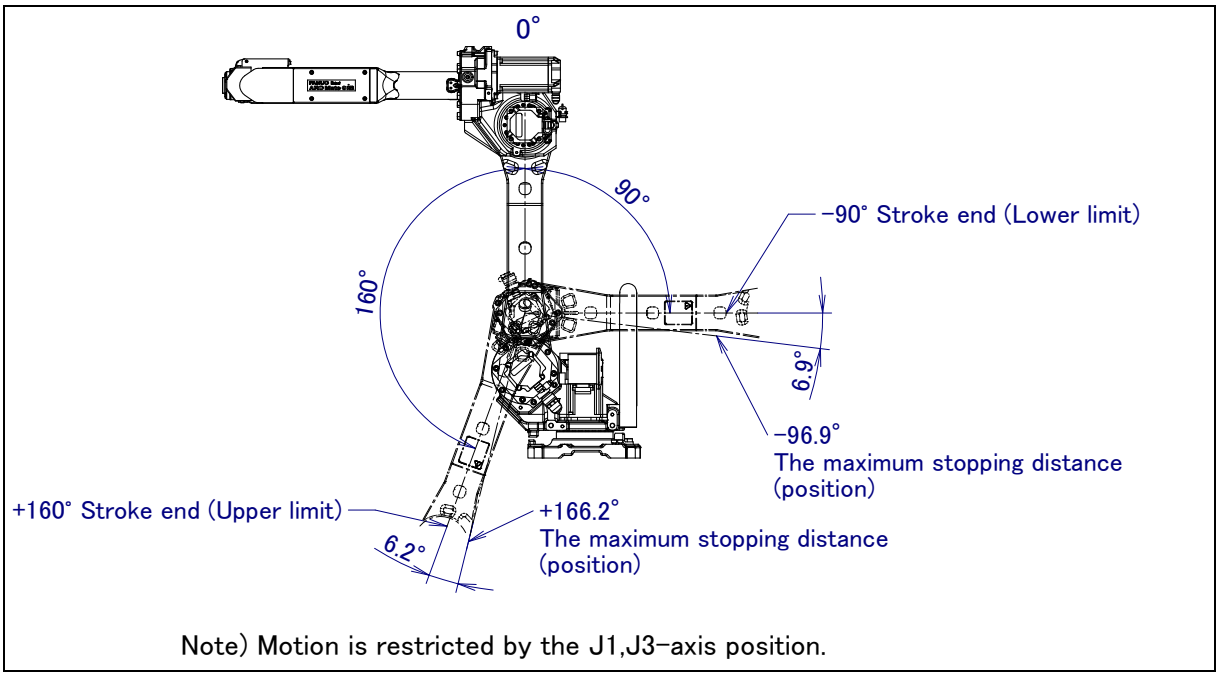


Fig. 3.3 (d) J2-axis motion limit

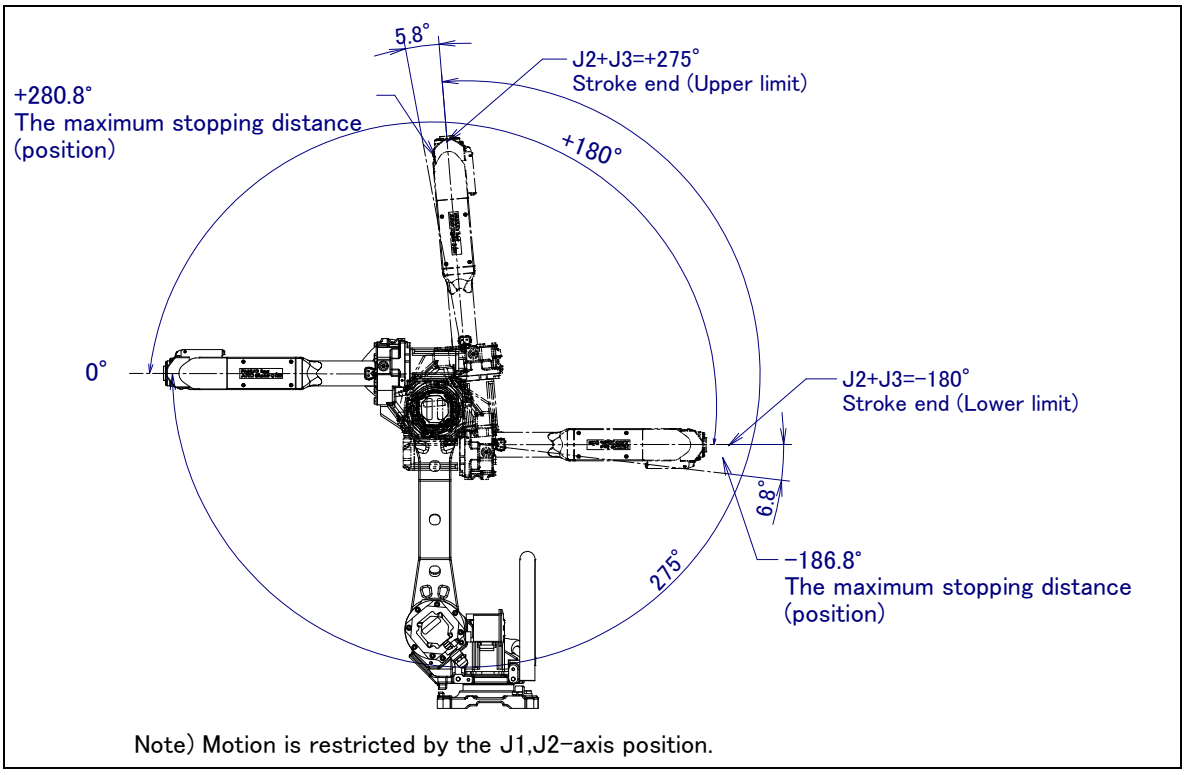


Fig. 3.3 (e) J3-axis motion limit

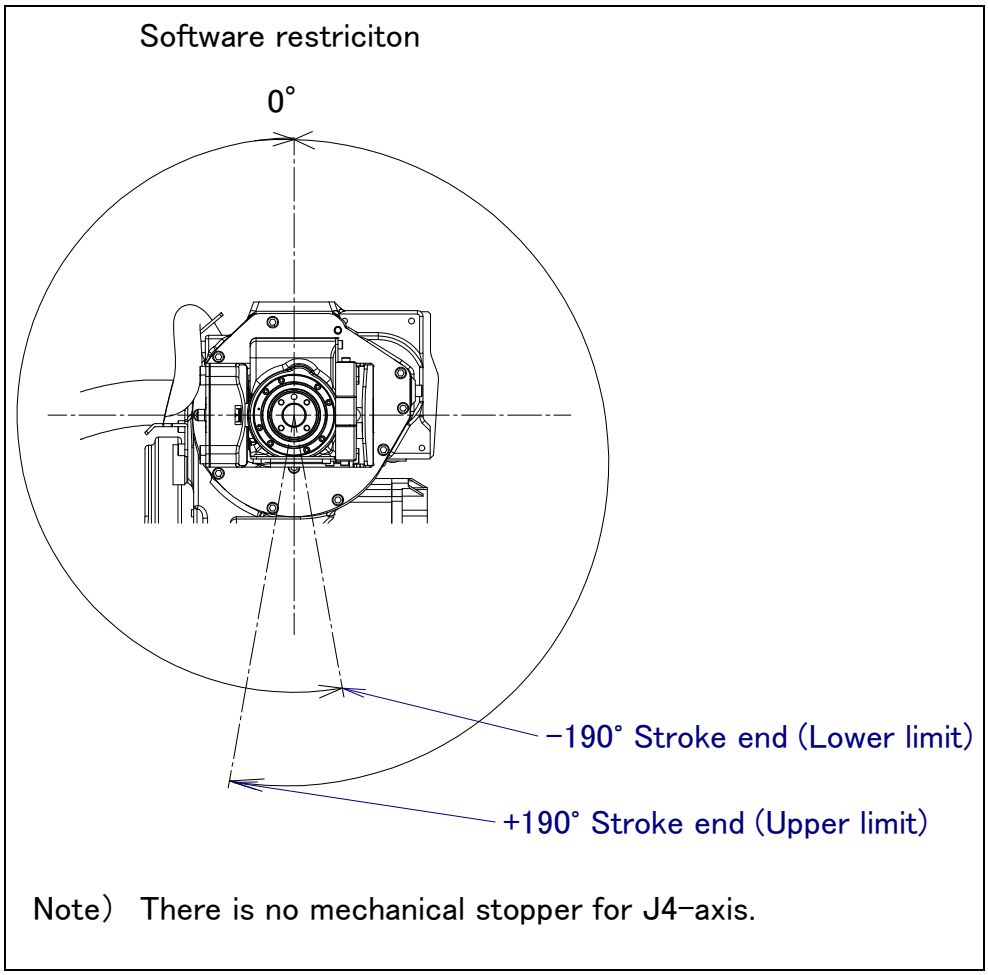


Fig. 3.3 (f) J4-axis motion limit

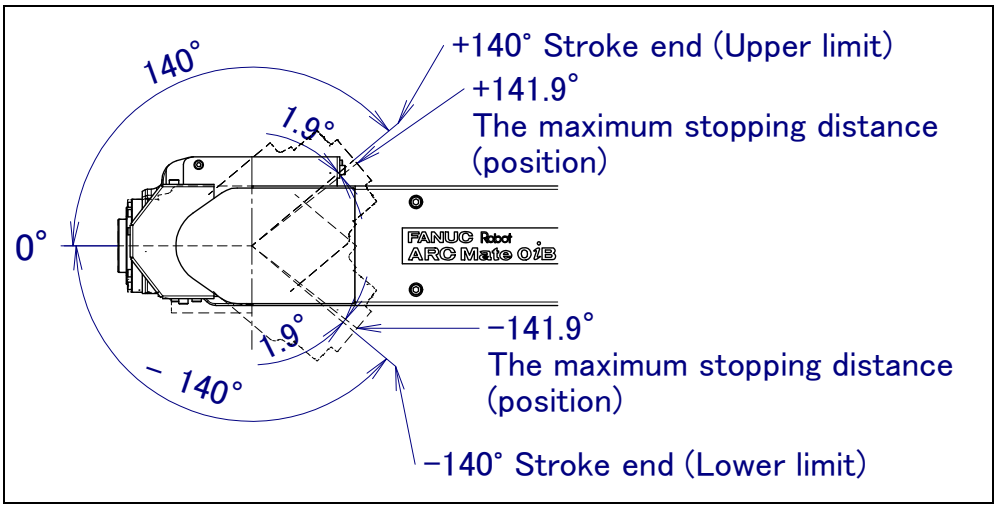


Fig. 3.3 (g) J5-axis motion limit

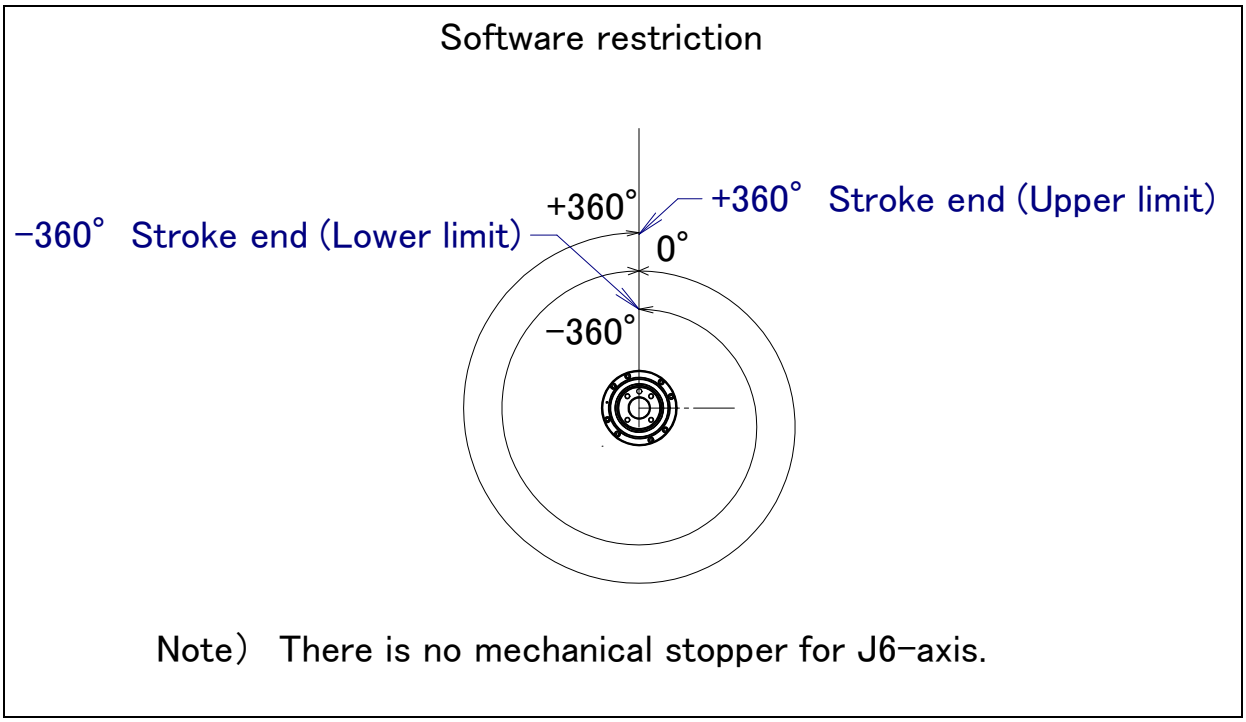


Fig. 3.3 (h) J6-axis motion limit

3.4 WRIST LOAD CONDITIONS

- Fig. 3.4 is a diagram showing the allowable load that can be applied to the wrist section.
- Apply a load within the region indicated in the graph.
- Apply the conditions of the allowable load moment and the allowable load inertia. See Section 3.1 about the allowable load moment and the allowable load inertia.
- See Section 4.1 about mounting of end effector.

> ⚠ **CAUTION**
> If load exceeds allowable load, it may cause early breakage of mechanical unit. Be careful.

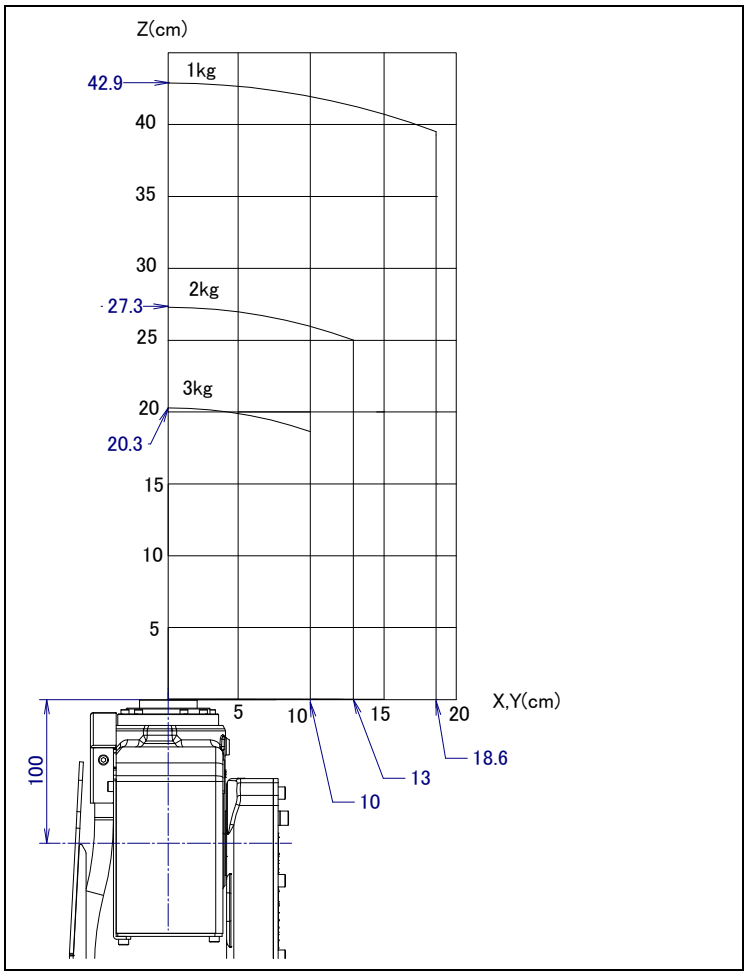


Fig. 3.4 Wrist load diagram

3.5 LOAD CONDITION ON WIRE FEEDER MOUNTING FACE

Install wire feeder to J3 casing so that center of gravity is in the shaped frame of Fig.3.5.
Limit of wire feeder mass: 7kg

> ⚠ **CAUTION**
> If center of gravity of wire feeder is out of the shaped frame, it causes early breakage of mechanical unit. Be careful.

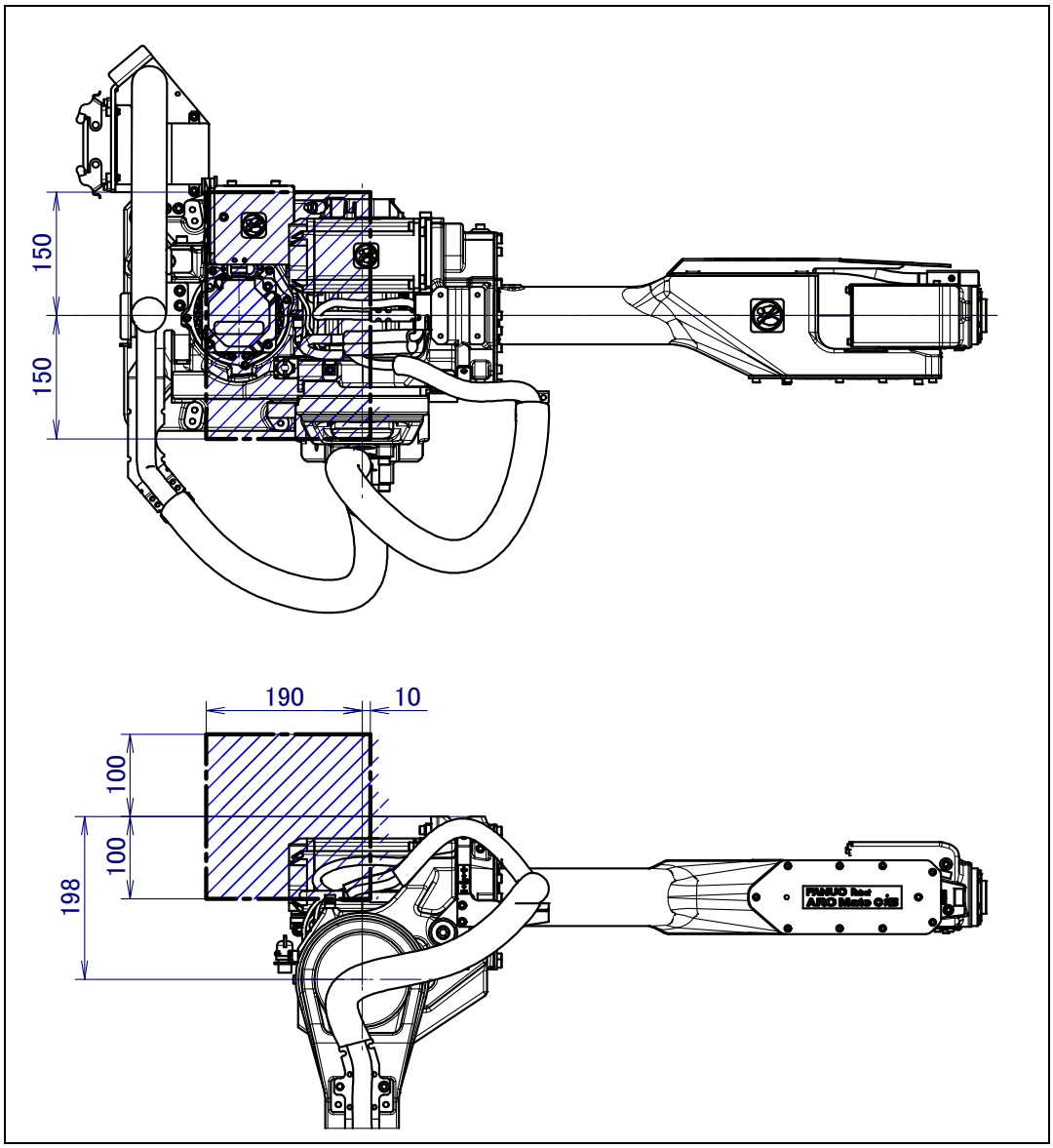


Fig. 3.5 Load condition of wire feeder mounting face

3.6 OPERATING SPACE FOR INCLINATION INSTALLATION

In case of the robot with pedestal, when the robot is installed on an angle, the operating area is limited to that angle. The robot can't rest except for within the ranges that are shown in the Fig. 3.6 (a) to (c).
In case of robot without pedestal, inclination installation is impossible.

Installation area (1) (0º≦ θ ≦9º, 171º≦ θ ≦180º)

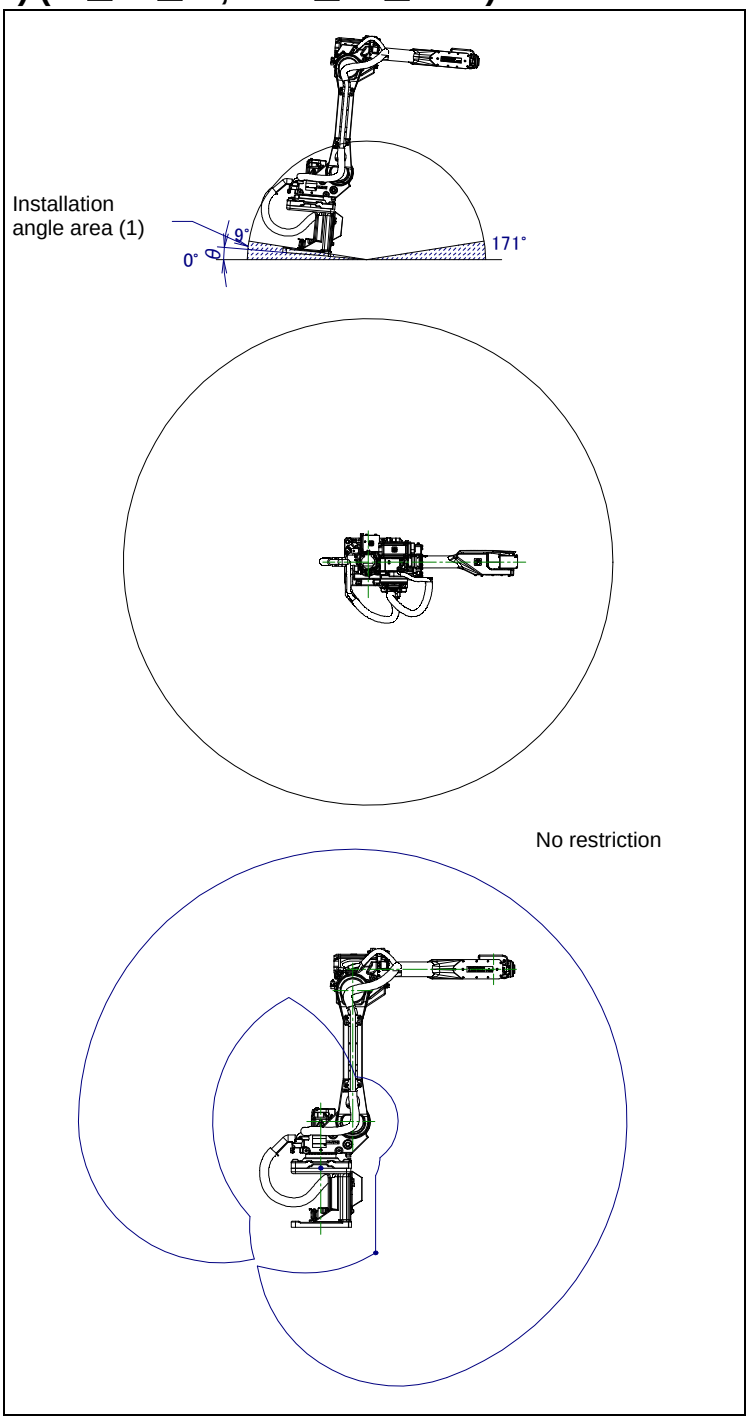


Fig. 3.6 (a) Installation area (1) operating area
(0°≦ θ ≦50°, 130°≦ θ ≦180°)

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

Installation area (2) (9º≦ θ ≦26º, 154º≦ θ ≦171º)

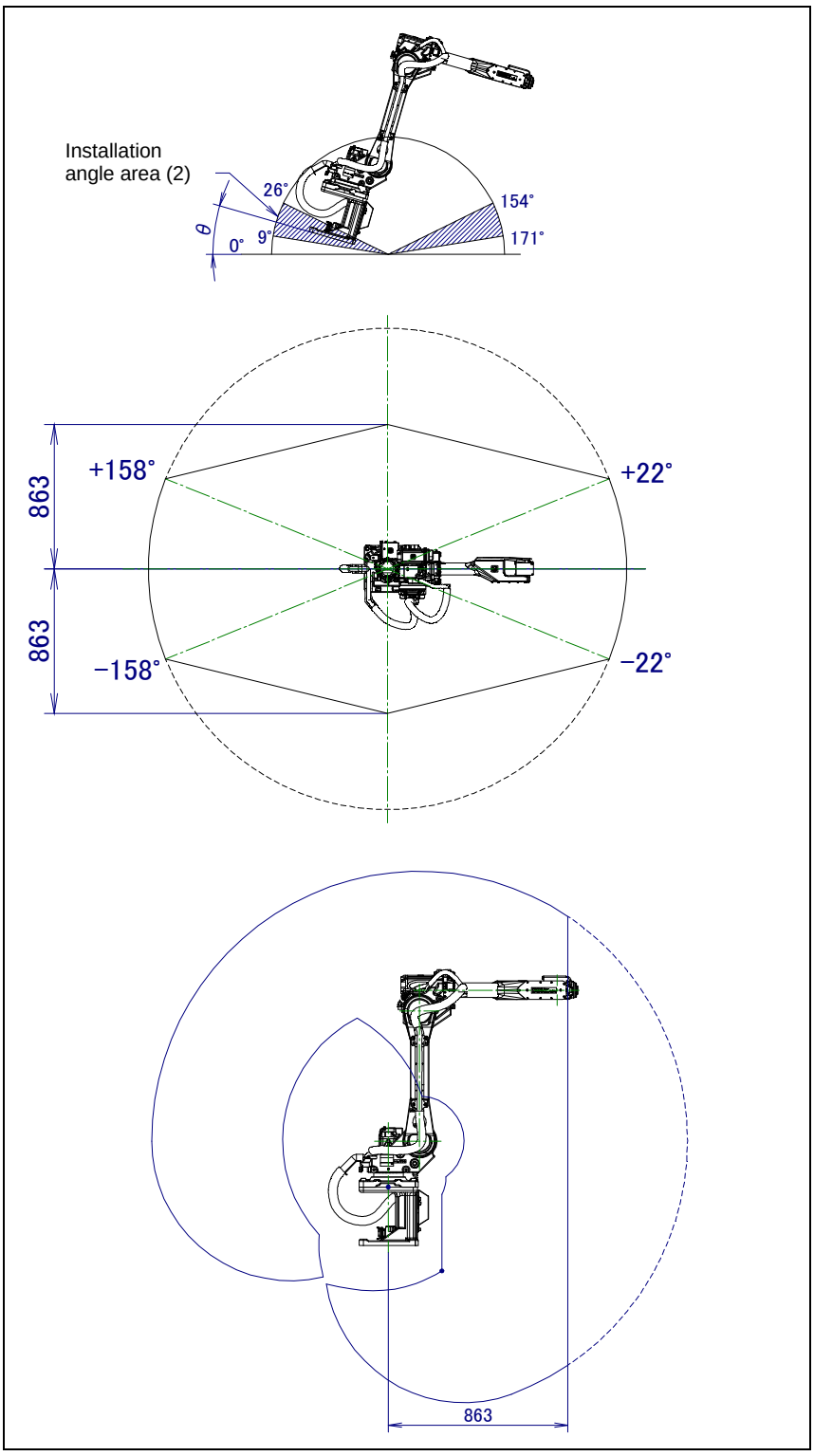


Fig. 3.6 (b) Installation area (2) operating area
(9°＜θ ≦26°, 154°≦ θ <171°)

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

Installation area (3) (26º< θ <154º)

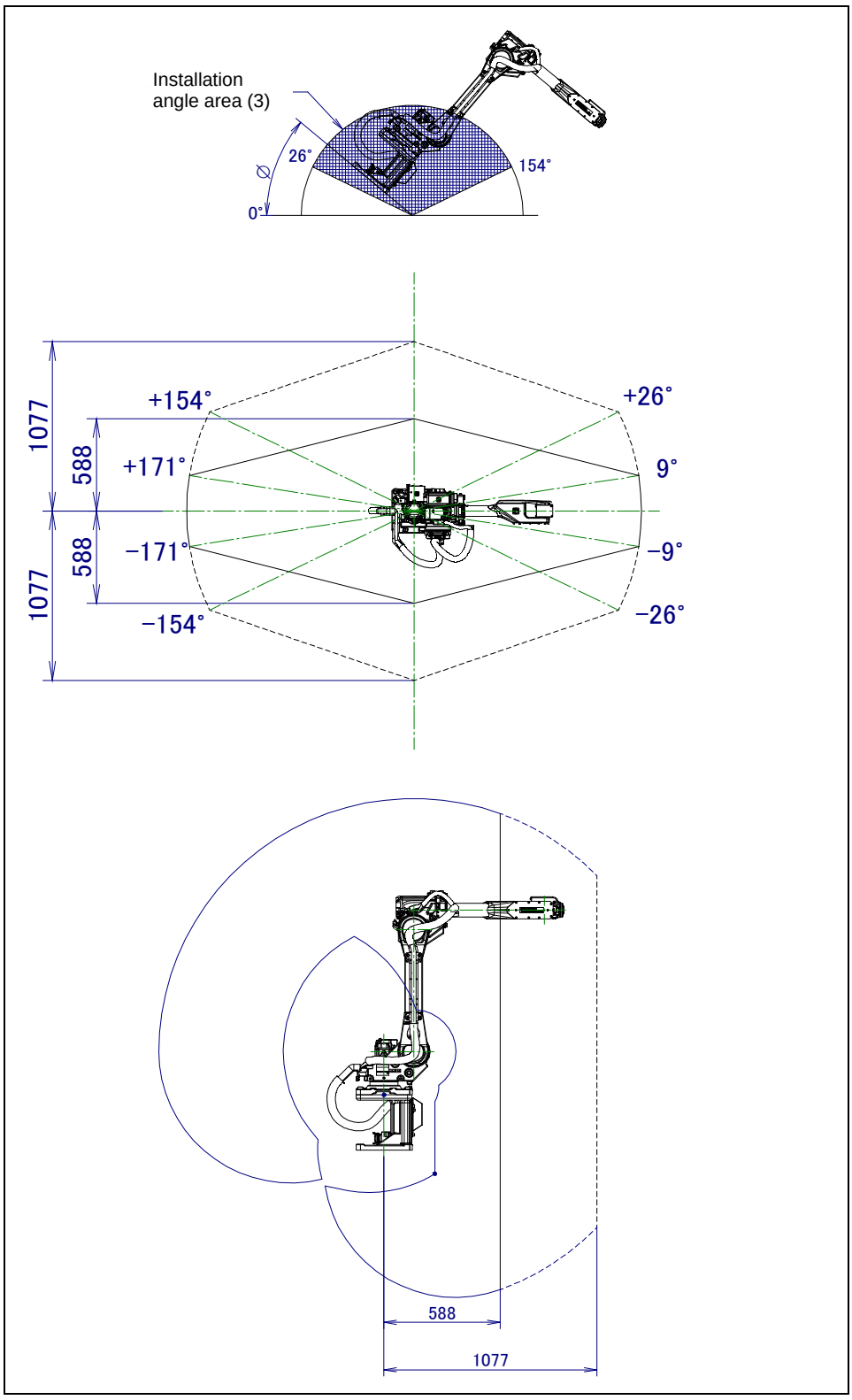


Fig. 3.6 (c) Installation area (3) operating area (26°< θ <154°)

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 WELDING TORCH MOUNTING FACE TO WRIST TIP

Fig. 4.1 is the diagram for installing welding torch on the wrist. Select screws and positioning pins of a length that matches the depth of the tapped holes and pinholes. See Appendix B “STRENGTH OF BOLT AND BOLT TORQUE LIST” for tightening torque specifications.

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

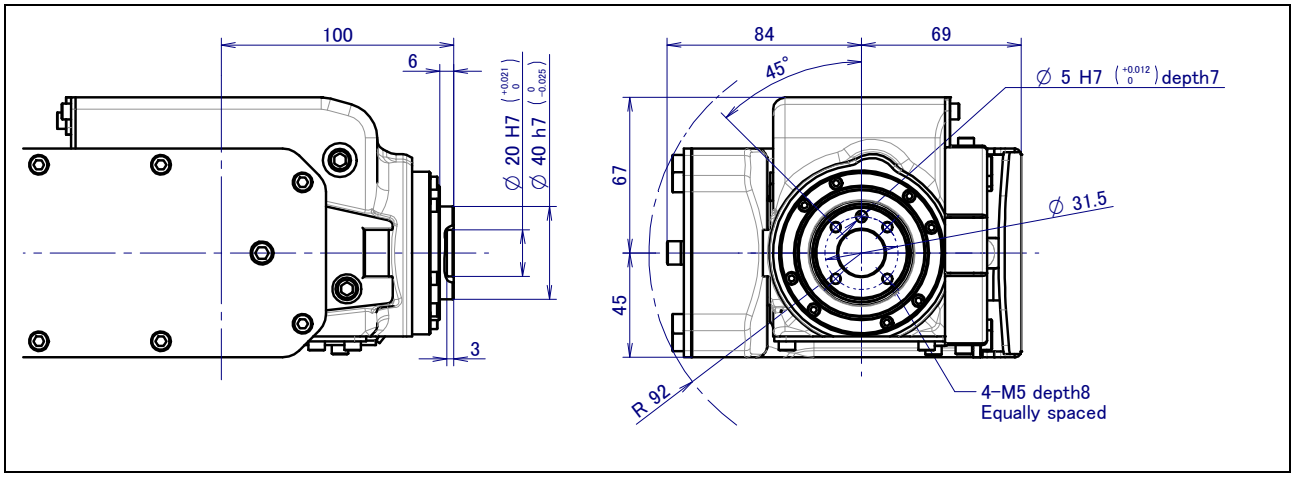


Fig. 4.1 Welding torch mounting face

4.2 WIRE FEEDER,WELD EQUIPIMENT MOUNTING FACE

As shown in Fig. 4.2 (a) and (b), tapped holes are provided to install the wire feeder and the weld equipment to the robot.

> ⚠ **WARNING**
> Wire feeder should be installed on robot in a way it does not interfere with the mechanical unit cables. If equipment interfere, the mechanical unit cable might be disconnected, and unexpected troubles might occur.

> ⚠ **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.

> ⚠ **CAUTION**
> 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.

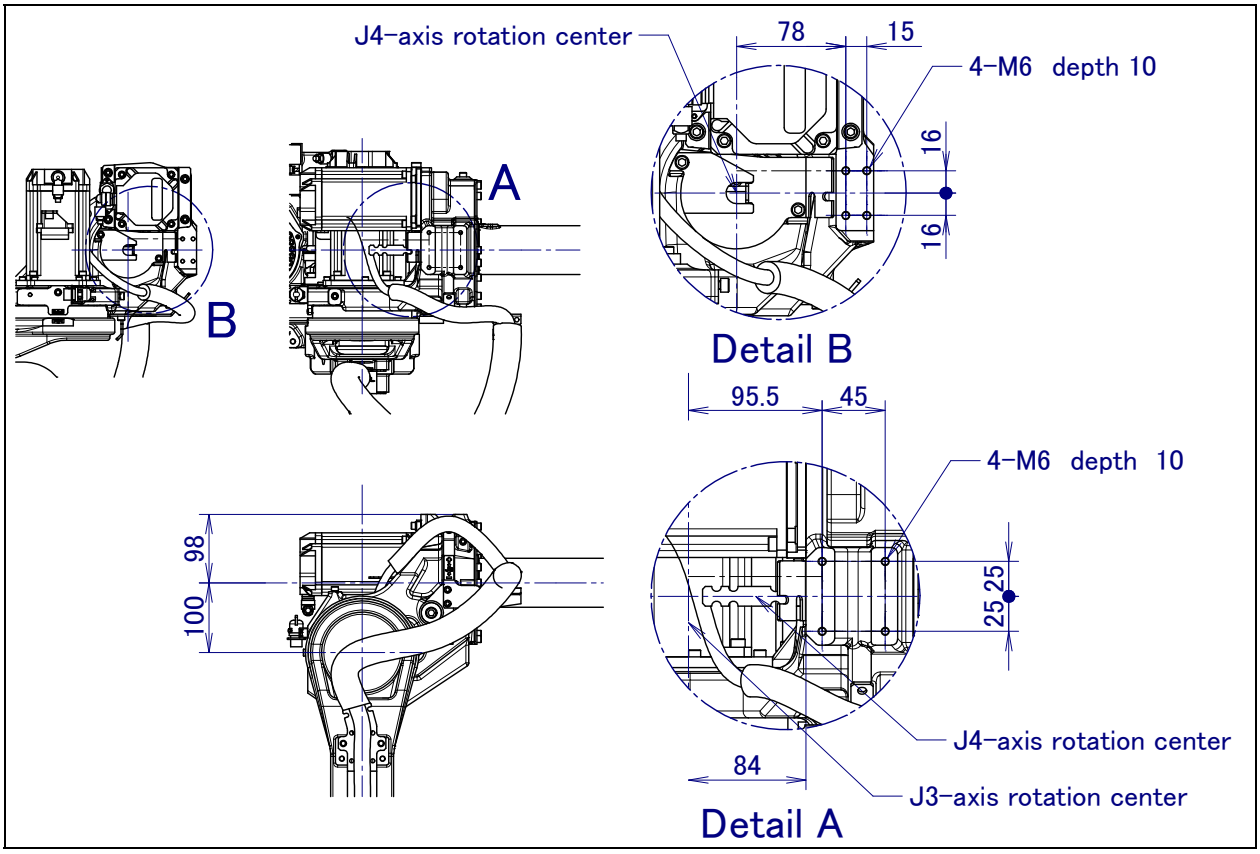


Fig. 4.2 (a) Wire feeder mounting face diameter (J3 casing part)

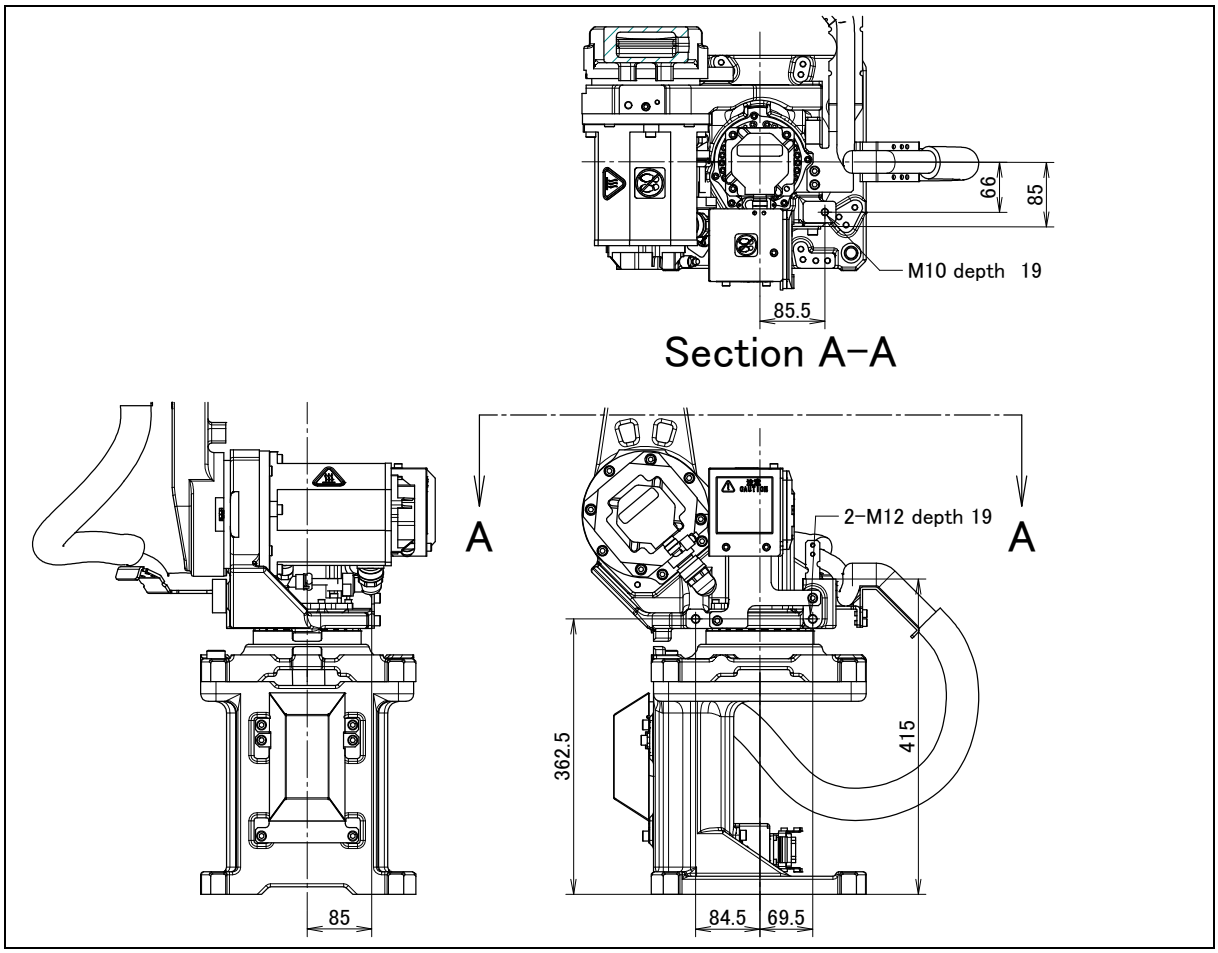


Fig. 4.2 (b) Weld equipment mounting diameter (J2 base) (only for with pedestal)

Limit of weld equipment mass on the J2 base : 30kg

4.3 LOAD SETTING

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

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

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

```
MOTION PERFORMANCE                    JOINT 10%
   Group1
No.   PAYLOAD[kg]          Comment
 1              3.00   [                ]
 2              0.00   [                ]
 3              0.00   [                ]
 4              0.00   [                ]
 5              0.00   [                ]
 6              0.00   [                ]
 7              0.00   [                ]
 8              0.00   [                ]
 9              0.00   [                ]
10              0.00   [                ]

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

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

```
MOTION PAYLOAD SET              JOINT   100%

  Group 1
  Schedule No[   1]:[Comment          ]
1 PAYLOAD             [kg]          3.00
2 PAYLOAD CENTER  X   [cm]         -7.99
3 PAYLOAD CENTER  Y   [cm]          0.00
4 PAYLOAD CENTER  Z   [cm]          6.44
5 PAYLOAD INERTIA X   [kgfcms^2]    0.13
6 PAYLOAD INERTIA Y   [kgfcms^2]    0.14
7 PAYLOAD INERTIA Z   [kgfcms^2]    0.07

[TYPE]  GROUP  NUMBER  DEFAULT  HELP
```

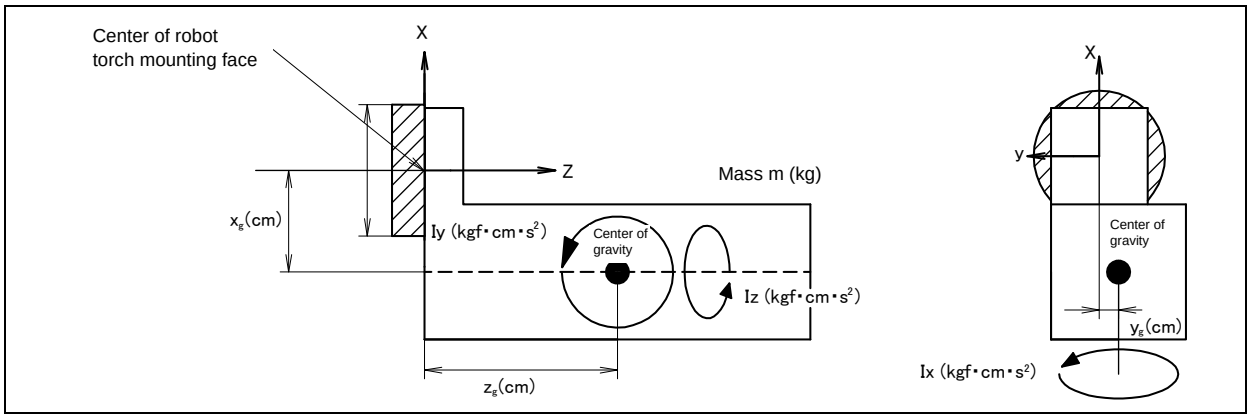


Fig. 4.3 Standard tool coordinate

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

7 Pressing F3 ([NUMBER]) will bring you to the MOTION PAYLOAD SET screen for another condition number. For a multi group 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]              7.00

[ 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 your local FANUC representative 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.

NOTE
In case load setting above the admissible values is set, the message “Load is OVER. Can’t set to this.” will be posted. In such case, the actual load must be reduced in order to return into the admissible range. Re-confirm its validity, and set it.

5 PIPING AND WIRING TO THE END EFFECTOR

⚠ WARNING

- Do not add user cables or hoses inside of the mechanical unit.
- Please do not obstruct the movement of the mechanical unit cable when cables are added to outside of mechanical unit.
- Please do not perform remodeling (Adding a protective cover and fix an outside cable more) obstructing the behavior of the outcrop of the cable.
- When external equipment is installed in the robot, make sure that it does not interfere with other parts of the robot.
- Check that connectors are tight and cable jackets are not damaged routinely.
- When precautions are not followed, damage to cables might occur. Cable failure may result in incorrect function of end effector, robot faults, or damage to robot electrical hardware. In addition, electric shock could occur when touching the power cables.

5.1 AIR SUPPLY (OPTION)

Robot has air and gas inlet and air and gas outlet on the back of the J1 base and on the J3 casing used to supply air pressure to the end effector. As couplings are not supplied, it will be necessary to prepare couplings, which suit to the hose size.

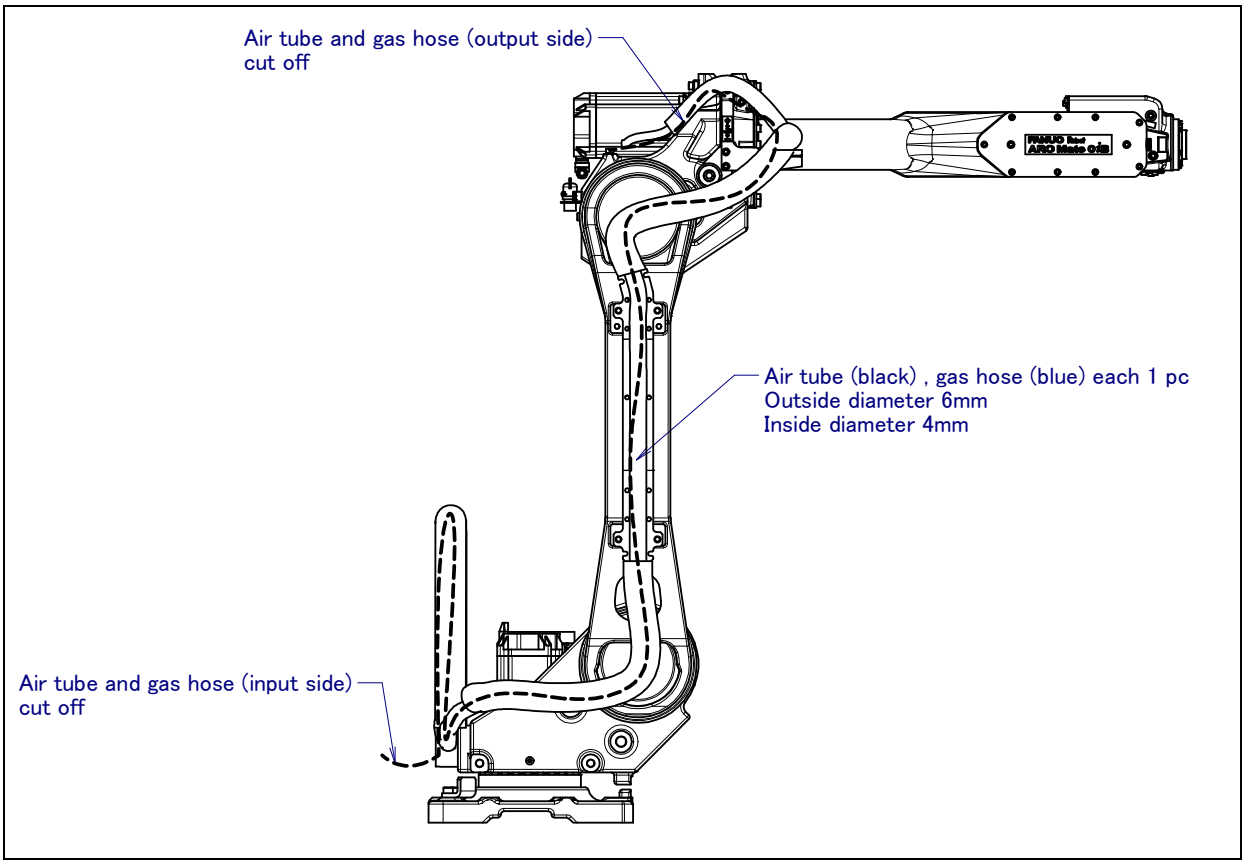


Fig. 5.1 (a) Air supply (option) (without pedestal)

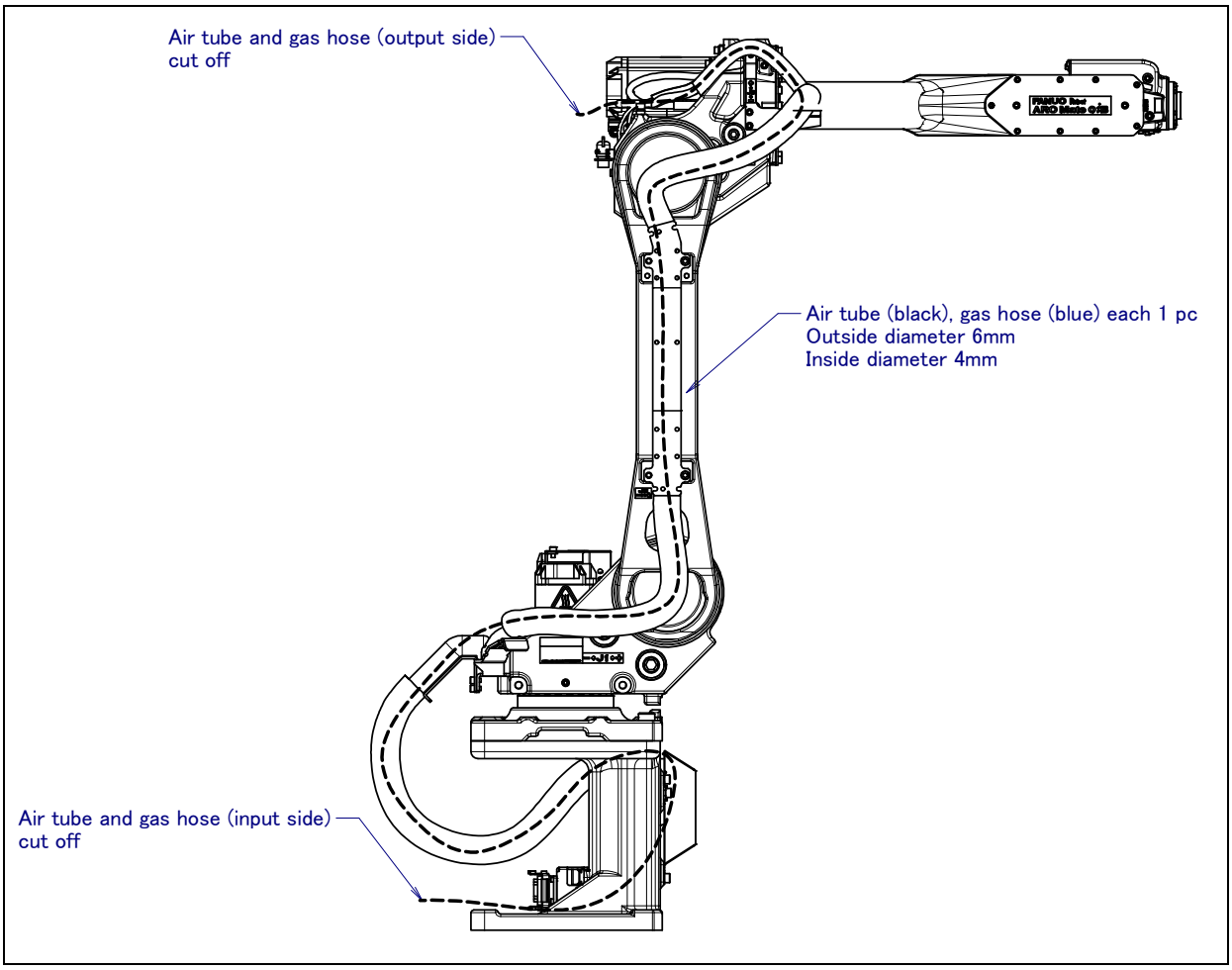


Fig. 5.1 (b) Air supply (option) (with pedestal)

Air pressure	Supply air pressure	0.49 to 0.69MPa(5 to 7kgf/cm^2) Setting: 0.49MPa(5kgf/cm^2)

Attach the joint on the tip of the air tube and gas hose, then use them.

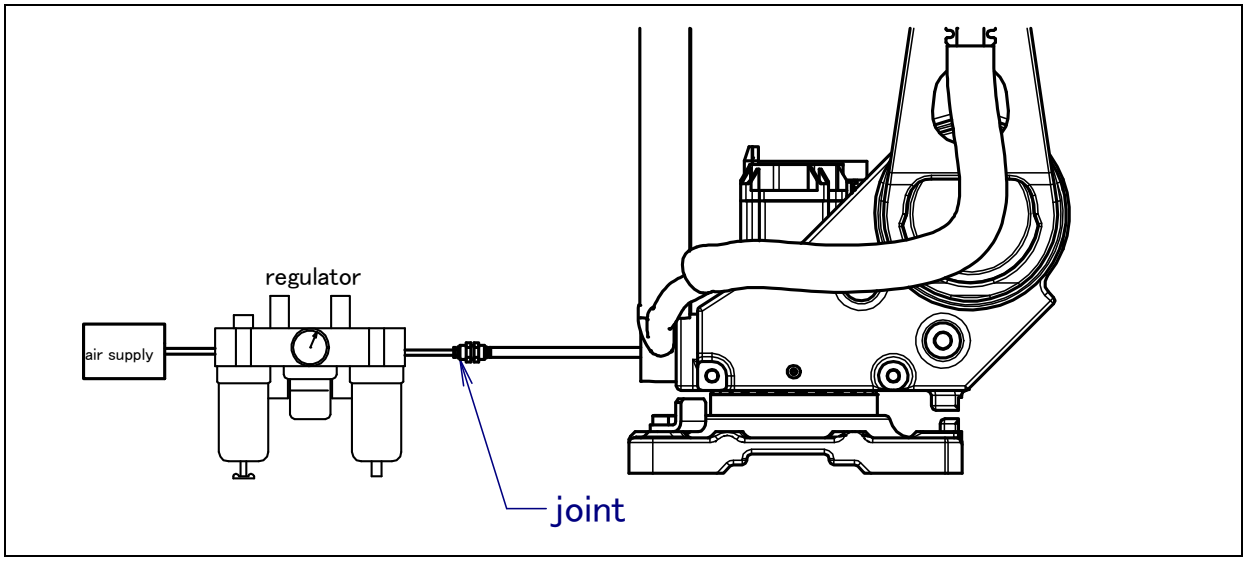


Fig.5.1 (c) Example of air tube piping

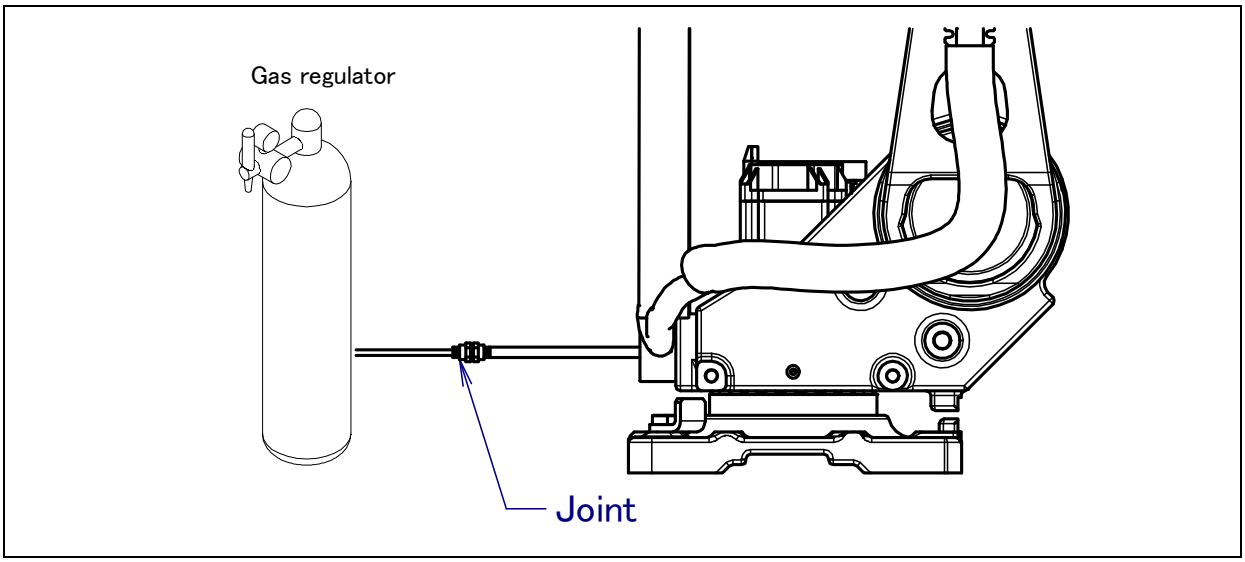


Fig.5.1 (d) Example of gas hose connecting

5.2 INTERFACE FOR OPTION CABLE (OPTION)

Fig. 5.2 (a) shows the position of the option cable face. EE interface (RI/RO) is prepared as options.

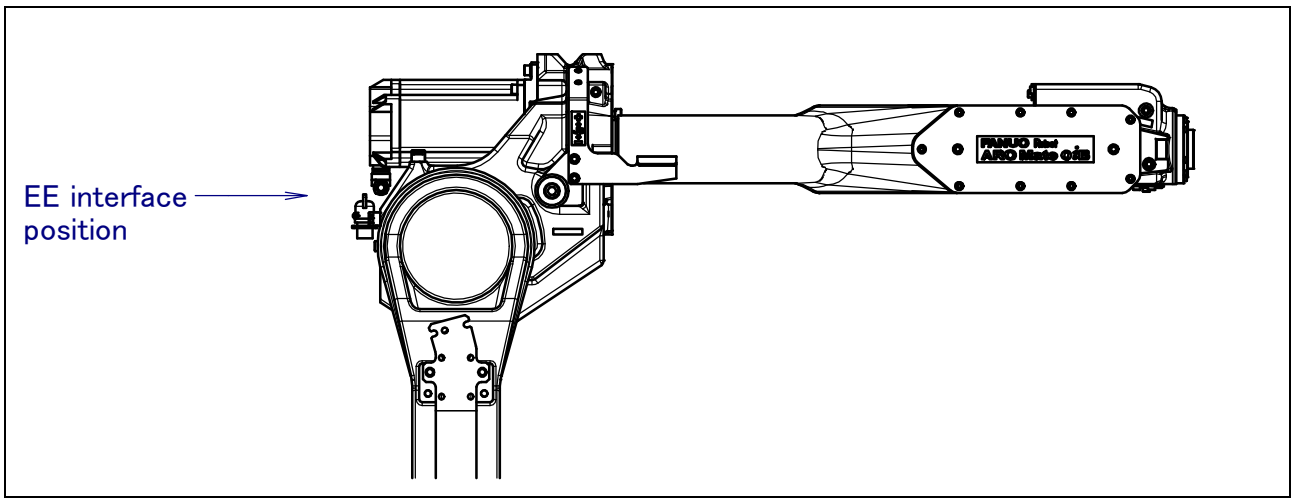


Fig. 5.2 (a) Interface for optional cable (Option)

1 EE interface (RI/RO) (Option)
Fig. 5.2 (b) shows pin layout for EE interface (RI/RO).

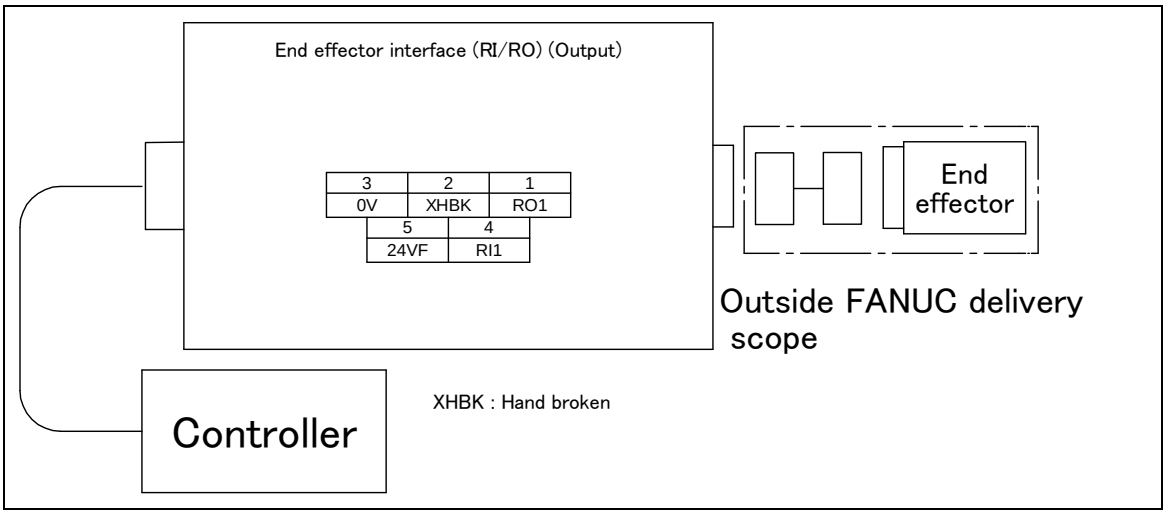


Fig. 5.2 (b) Pin layout for EE interface (RI/RO) RI/RO x 1 (Option)

> ⚠ **CAUTION**
> To wire the peripheral device to the EE interface, refer to the “ELECTRICAL CONNECTIONS Chapter of the CONTROLLER MAINTENANCE MANUAL”.

Connector specifications

Table 5.2 (a) Connector specifications (User side)

Cable name	Input side (J1 base)	Output side (J3 casing)	Maker/dealer
EE (RI/RO x 1)	————	JMSP1305M Straight plug (FANUC Spec: A05B-1221-K845) JMLP1305M Angle plug	Fujikura.Ltd

Table 5.2 (b) Connector specifications (Mechanical unit side・reference)

Cable name	Input side (J1 base)	Output side (J3 casing)	Maker/dealer
EE (RI/RO x 1)	————	JMWR1305F	Fujikura.Ltd

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

6 AXIS LIMIT SETUP

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

- Used motion range limitations
- Tooling and fixture interference points
- Cable and hose lengths

The one 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)

⚠ WARNING

1 Changing the motion range of any axis affects the operation range of the robot. To avoid trouble, carefully consider a possible effect of the change to the movable range of each axis in advance. Otherwise, it is likely that an unexpected condition occurs; for example, an alarm may occur in a previous taught position.
2 For 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 to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE].
4 Select [Axis Limits]. The following screen will be displayed.

System Axis Limits JOINT 100%
Group1 1/16

AXIS	GROUP	LOWER	UPPER	
1	1	-180.00	180.00	deg
2	1	-90.00	160.00	deg
3	1	-180.00	275.00	deg
4	1	-190.00	190.00	deg
5	1	-140.00	140.00	deg
6	1	-360.00	360.00	deg
7	1	0.00	0.00	mm
8	1	0.00	0.00	mm
9	1	0.00	0.00	mm

[TYPE]

⚠ WARNING
1 0.00 indicates the robot does not have these axes.
2 Do not depend on J1-axis limit software settings to control the motion range of your robot. Use the axis limit switches or adjustable mechanical stopper also; otherwise injury to personnel or damage to equipment could occur.

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

System Axis Limits JOINT 100%
Group1 1/16

AXIS	GROUP	LOWER	UPPER	
2	1	-90.0	160.00	deg

[TYPE]

6 Perform the setting for all axes.
7 Turn off the controller and then turn it back on again in the cold start mode so the new information can be used.

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

6.2 J1-AXIS ADJUSTABLE MECHANICAL STOPPER (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.
When adjustable mechanical stopper is transformed by a collision, please change it.

Table 6.2 (a) Adjustable stopper motion range

Item		Movable range
J1-axis adjustable mechanical stopper	Upper limit	Settable in a range of +0°,+45°, +90°, +120°.
	Lower limit	Settable in a range of -0°,-45°, -90°, -120°.

> **⚠ CAUTION**
> If the newly set operation range does not include 0°, you must change it by zero degree mastering so that 0° is included.

When J1-axis mechanical stopper option is specified, attach stopper to robot referring to Fig.6.2 (a).

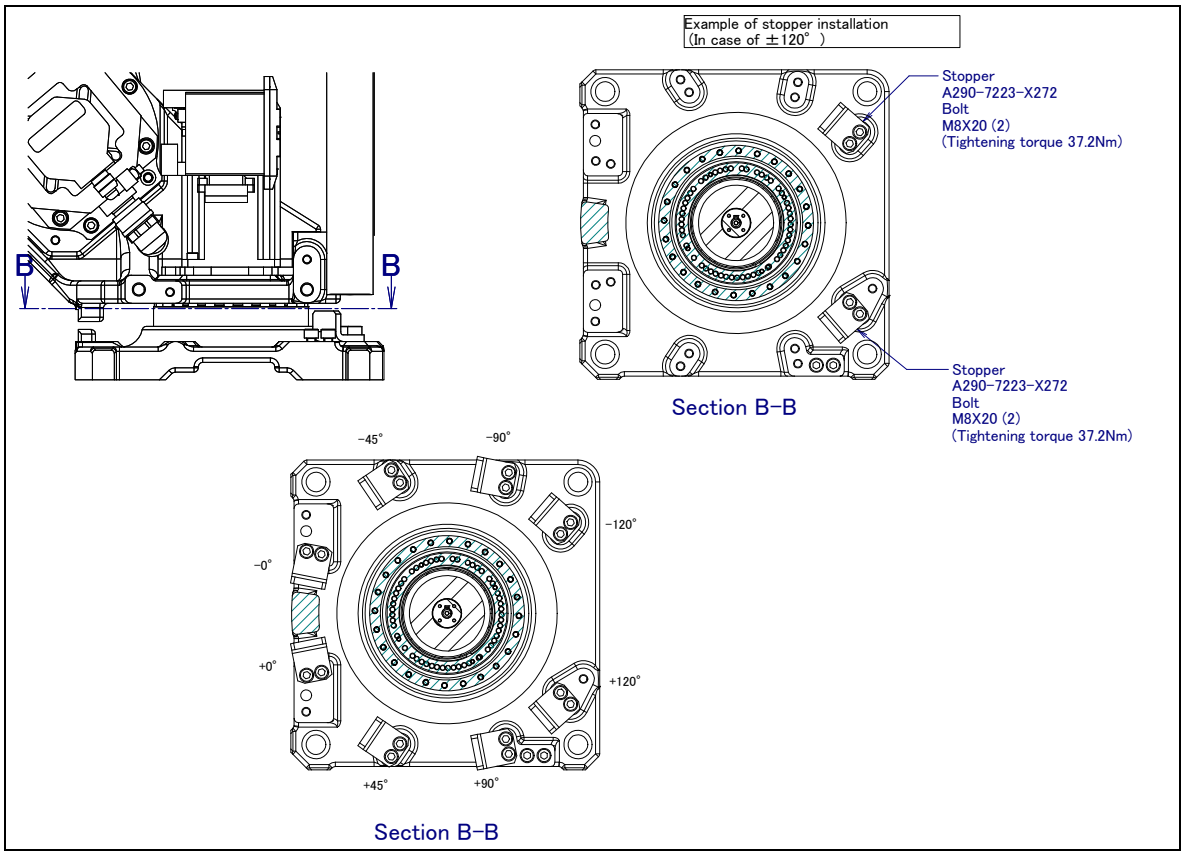


Fig. 6.2 (a) Attachment of J1-axis mechanical adjustable stopper

The movable mechanical stopper is a mechanism that can be adjusted in its position. The robot can work safely inside the adjusted motion range, up to the maximum range as shown in Table 6.2 (b) and Fig. 6.2 (b). A robot attempting to travel beyond this set range of motion, will be stopped by these stoppers, by collision; and therefore the robot will remain contained within the setup range.
Stopping the robot will cause the mechanical stopper to be “transformed” (means : permanently damaged). Be sure to exchange such “transformed” stopper.

Table 6.2 (b) The maximum stopping distance (position) of movable mechanical stopper

	Plus side	Minus side
J1	+9.5°	-8.2°

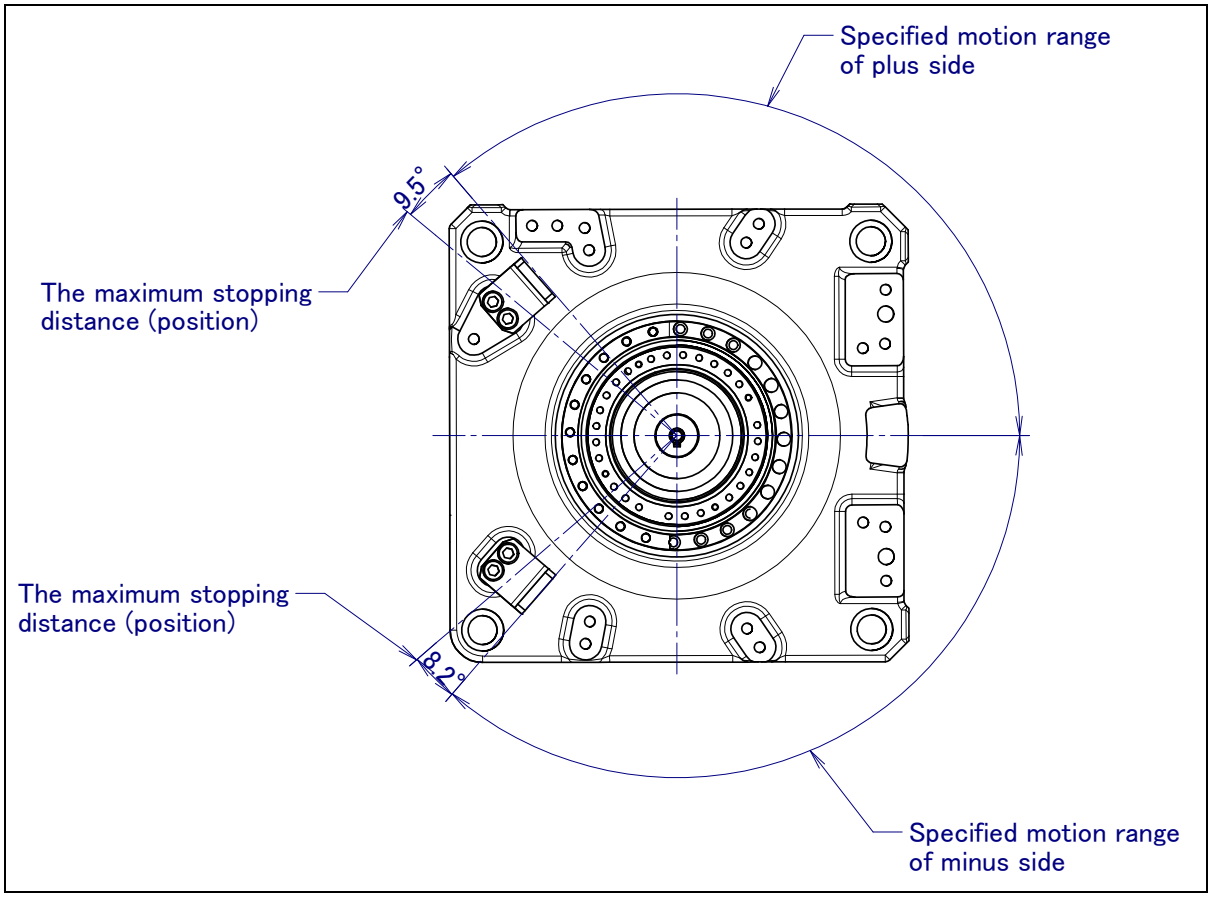


Fig. 6.2 (b) The maximum stopping distance of movable mechanical stopper of J1-axis (position)

7 CHECKS AND MAINTENANCE

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

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

7.1 CHECKS AND MAINTENANCE

7.1.1 Daily Checks

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

Check items	Check points and management
Oil seepage	Check to see if there is oil on the sealed part of each joint. If there is an oil seepage, clean it. **⇒"7.2.1 Confirmation of Oil Seepage"**
Vibration, abnormal noises	Check whether vibration or abnormal noises occur. When vibration or abnormal noises occur, perform measures referring to the following section: **⇒"9.1 TROUBLESHOOTING"(symptom : Vibration, Noise)**
Repeatability	Check to see that the taught positions of the robot have not deviated from the previous taught positions. When displacement occurs, perform the measures as described in the following section: **⇒"9.1 TROUBLESHOOTING"(symptom : Displacement)**
Peripheral devices for proper operation	Check whether the peripheral devices operate properly according to commands from the robot and the peripheral devices.
Brakes for each axis	Check that the end effector drops within 5 mm when servo power is turned off. If the end effector (hand) drops, perform the measures as described in the following section: **⇒"9.1 TROUBLESHOOTING"(symptom : Dropping axis)**
Warnings	Check whether unexpected warnings occur in the alarm screen on the teach pendant. If unexpected warnings occur, perform the measures as described in the following manual: **⇒"R-30*i*B/R-30*i*B Mate CONTROLLER OPERATOR'S MANUAL (Alarm Code List)(B-83284EN-1)"**

7.1.2 Periodic Checks and Maintenance

Check the following items at the intervals recommended below based on the total operating time or the accumulated operating time, whichever comes first. (○ : Item needs to be performed.)

Check and maintenance intervals (Operating time, Accumulated operating time)							Check and maintenance item	Check points, management and maintenance method	Periodic maintenance table No.
1 month 320h	3 months 960h	1 year 3840h	1.5 years 5760h	2 years 7680h	3 years 11520h	4 years 15360h			
○ Only 1st check	○						Cleaning the controller ventilation system	Confirm the controller ventilation system is not dusty. If dust has accumulated, remove it.	18
	○						Check for external damage or peeling paint	Check whether the robot has external damage or peeling paint due to the interference with the peripheral devices. If an interference occurs, eliminate the cause. Also, if the external damage is serious, and causes a problem in which the robot will not operate, replace the damaged parts.	1
	○						Check damages of the cable protection sheaths	Check whether the cable protection sheaths of the mechanical unit cable have holes or tears. If damage is found, replace the cable protection sheath. If the cable protection sheath is damaged due to the interference with peripheral devices, eliminate the cause. **⇒"7.2.2 Check the Mechanical Unit Cables and Connectors"**	2
	○						Check for water	Check whether the robot is subjected to water or cutting oils. If water is found, remove the cause and wipe off the liquid.	3
	○ Only 1st check	○					Check for damages to the teach pendant cable, the operation box connection cable or the robot connection cable	Check whether the cable connected to the teach pendant, operation box and robot are unevenly twisted or damaged. If damage is found, replace the damaged cables.	17
	○ Only 1st check	○					Check for damage to the mechanical unit cable (movable part) and welding cable	Observe the movable part of the mechanical unit cable and welding cable, and check for damage. Also, check whether the cables are excessively bent or unevenly twisted. **⇒"7.2.2 Check the Mechanical Unit Cables and Connectors"**	4
	○ Only 1st check	○					Check the connection of each axis motor and other exposed connectors	Check the connection of each axis motor and other exposed connectors. **⇒"7.2.2 Check the Mechanical Unit Cables and Connectors"**	5
	○ Only 1st check	○					Retightening the end effector mounting bolts	Retighten the welding torch mounting bolts. Refer to the following section for tightening torque information: **⇒"4.1 WELDING TORCH MOUNTING FACE TO WRIST TIP"**	6

Check and maintenance intervals (Operating time, Accumulated operating time)							Check and maintenance item	Check points, management and maintenance method	Periodic maintenance table No.
1 month 320h	3 months 960h	1 year 3840h	1.5 years 5760h	2 years 7680h	3 years 11520h	4 years 15360h			
	○ Only 1st check	○					Retightening the external main bolts	Retighten the robot installation bolts, bolts to be removed for inspection, and bolts exposed to the outside. Refer to the recommended bolt tightening torque guidelines at the end of the manual. An adhesive to prevent bolts from loosening is applied to some bolts. If the bolts are tightened with greater than the recommended torque, the adhesive might be removed. Therefore, follow the recommended bolt tightening torque guidelines when retightening the bolts.	7
	○ Only 1st check	○					Check the fixed mechanical stopper and the adjustable mechanical stopper	Check that there is no evidence of a collision on the fixed mechanical stopper, the adjustable mechanical stopper, and check the tightness of the stopper mounting bolts. **⇒"7.2.3 Check of Fixed Mechanical Stopper and Adjustable Mechanical Stopper"**	8
	○ Only 1st check	○					Clean spatters, sawdust and dust	Check that spatters, sawdust, or dust does not exist on the robot main body. If dust has accumulated, remove it. Especially, clean the robot movable parts well (each joint, around the welding torch, wrist flange). The insulation failure occurs when the spatter has collected around the wrist flange or welding torch, and there is a possibility of damaging the robot mechanism by the welding current. (See Appendix C)	9
	○ Only 1st check	○					Check the cable for equipment	Check whether the cables for equipment are unevenly twisted or damaged. If damage is found, replace the damaged cables.	10
			○				Replacing the mechanical unit batteries	Replace the mechanical unit batteries **⇒"7.3.1 Replacing the Batteries"**	11
					○		Replacing the grease of J4 to J6-axis gearbox	Replace the grease of J4 to J6-axis gearbox. **⇒"7.3.2 Replacing the Grease of the Drive Mechanism"**	12 to 14
						○	Replacing the mechanical unit cable	Replace the mechanical unit cable. Contact your local FANUC representative for information regarding replacing the cable.	15
				○			Replacing the J1-axis cable protection sheath.	Replace the J1-axis cable protection sheath. Contact your local FANUC representative for information regarding replacing the cable.	16
						○	Replacing the controller batteries	Replace the controller batteries **⇒Chapter 7 Replacing batteries of R-30*i*B Mate CONTROLLER MAINTENANCE MANUAL (B-83525EN)"**	19

7.2 CHECK POINTS

7.2.1 Confirmation of Oil Seepage

Check items

Check there is oil on sealed part of each joint parts. If there is oil seepage, clean them.

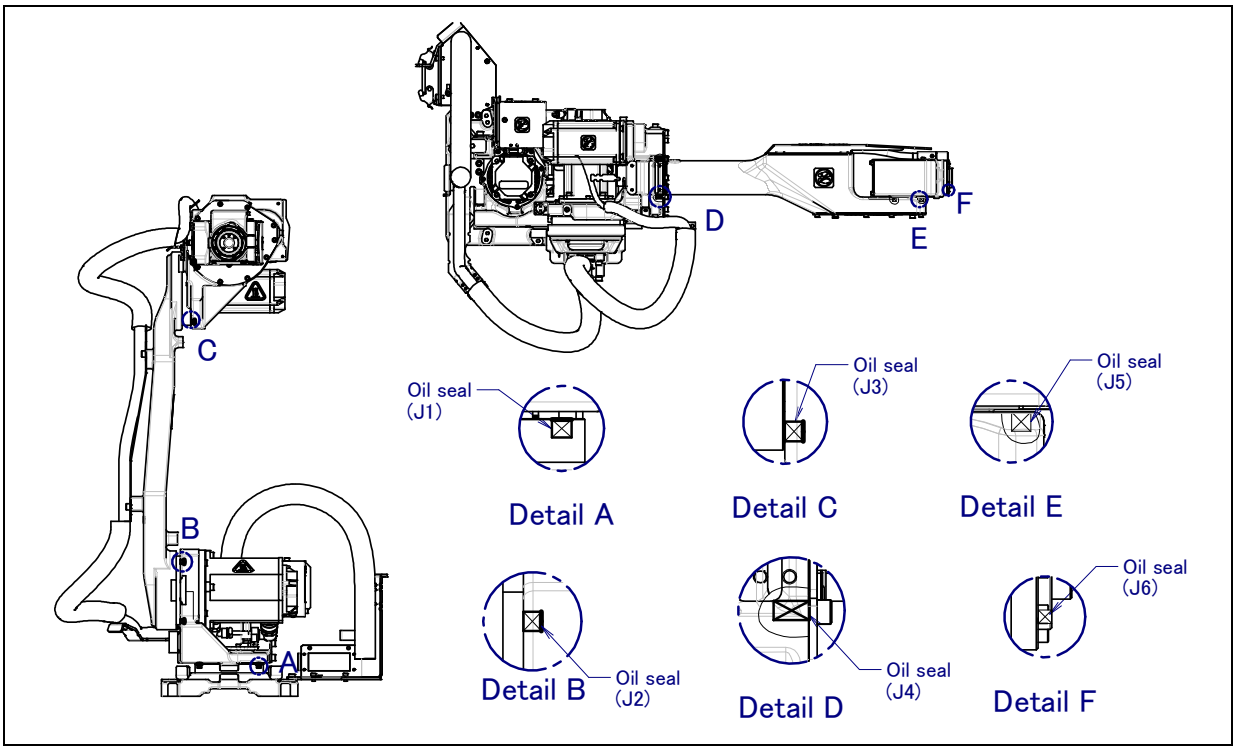


Fig. 7.2.1 Check parts of oil seepage

Management

- Oil might accumulate on the outside of the seal lip depending on the movement condition or environment of the axis. If the oil changes to a state of liquid, the oil might fall depending on the axis movement. To prevent oil spots, be sure to wipe away any accumulated oil under the axis components before you operate the robot.
- In case of oil seepage, please consider replacing the grease and the oil altogether. This replacement potentially can help improving the seepage situation.
- Also, motors might become hot and the internal pressure of the grease bath or oil bath might rise by frequent repetitive movement and use in high temperature environments. In these cases, normal internal can be achieved by venting the grease outlet. (When opening the grease outlet, and ensure that grease is not expelled onto the machine or tooling.)

> ⚠ **WARNING**
> Grease may come out suddenly when opening the grease outlet. Attach bags for collecting grease.

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

7.2.2 Check the Mechanical Unit Cables and Connectors

Inspection points of the mechanical unit cables and welding cables

Check the cable for damage that has been exposed. Take special care for movable parts.
Clean it when the spatter adheres.

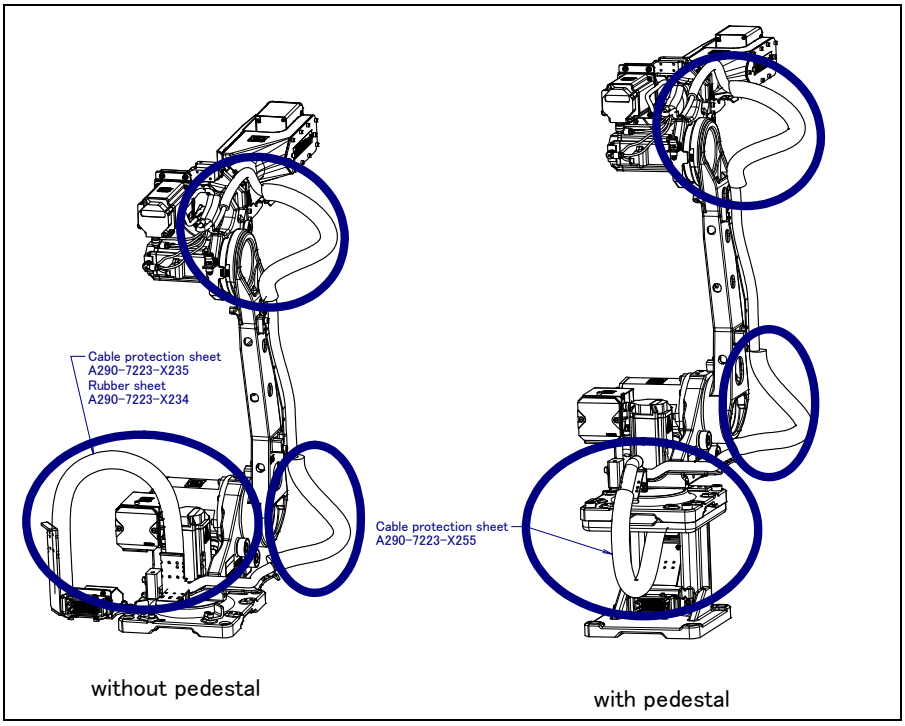


Fig. 7.2.2 (a) Inspection points of the mechanical unit cables

Check points

＜Cable protection sheath＞

- Check that no holes or tears exist on the cable protection sheaths.
- If there is damage as shown in Fig. 7.2.2 (b), replace the cable protection sheaths.

Fig. 7.2.2 (b) Damages on the cable protection sheath

＜Cables＞

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

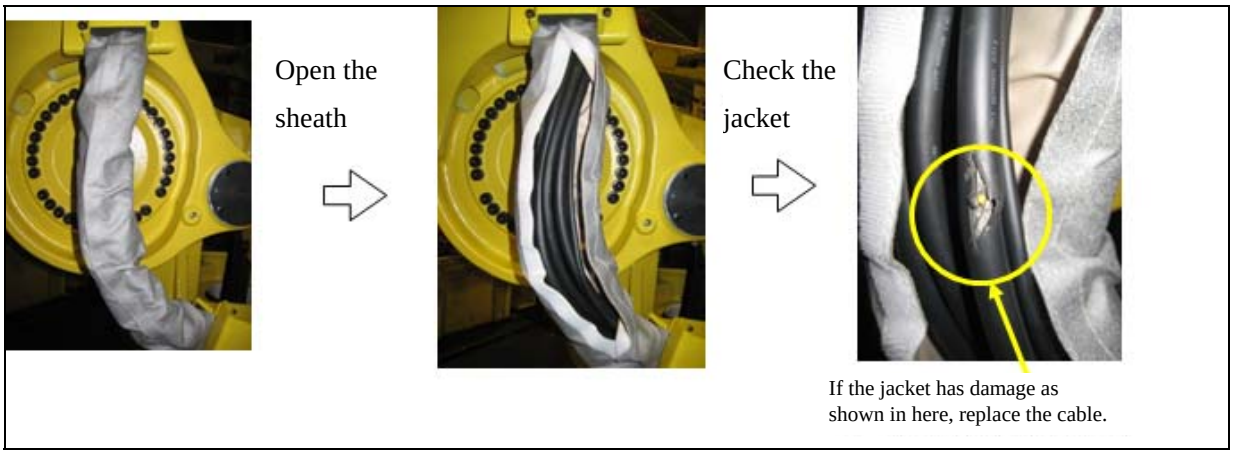


Fig. 7.2.2 (c) Cable check method

Inspection points of the connectors

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

Check items

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

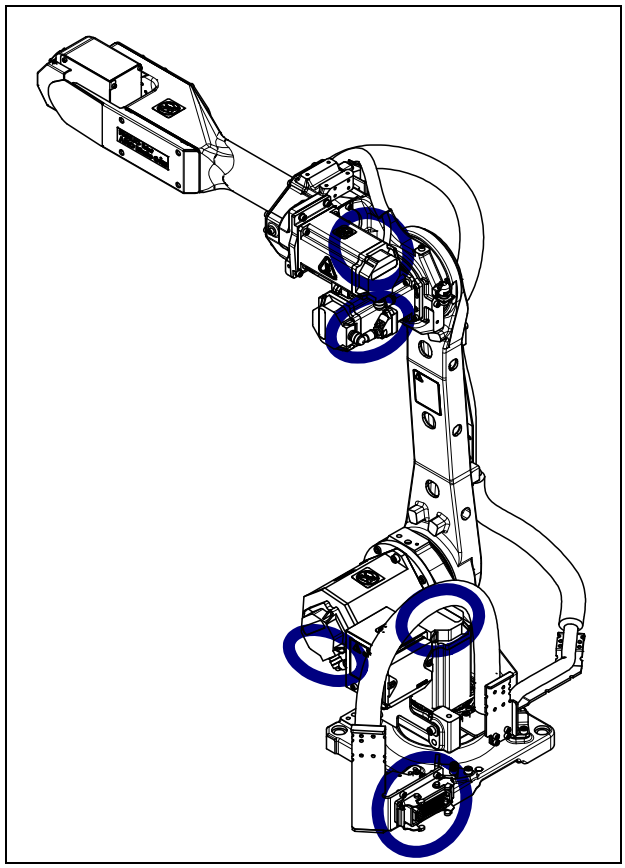


Fig. 7.2.2 (d) Connector Inspection points

7.2.3 Check of Fixed Mechanical Stopper and Adjustable Mechanical Stopper

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

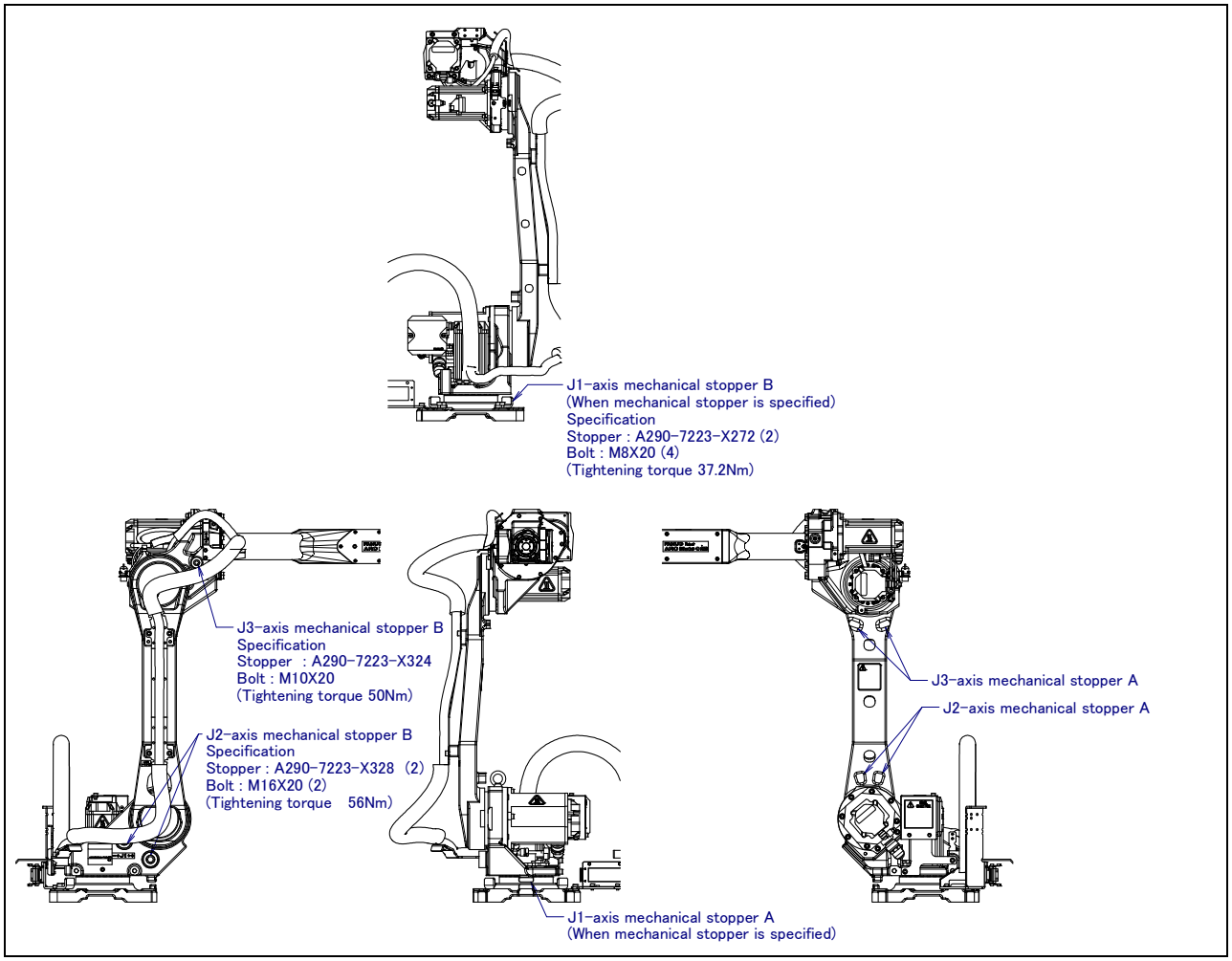


Fig. 7.2.3 Check of fixed mechanical stopper and adjustable mechanical stopper

7.3 MAINTENANCE

7.3.1 Replacing the Batteries (1.5 year (5760 hours) checks)

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

Procedure of replacing the battery

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

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

2 Remove the battery case cap. (Fig. 7.3.1)
3 Take out the old batteries from the battery case.
4 Insert new batteries into the battery case. Pay attention to the direction of batteries.
5 Close the battery case cap.

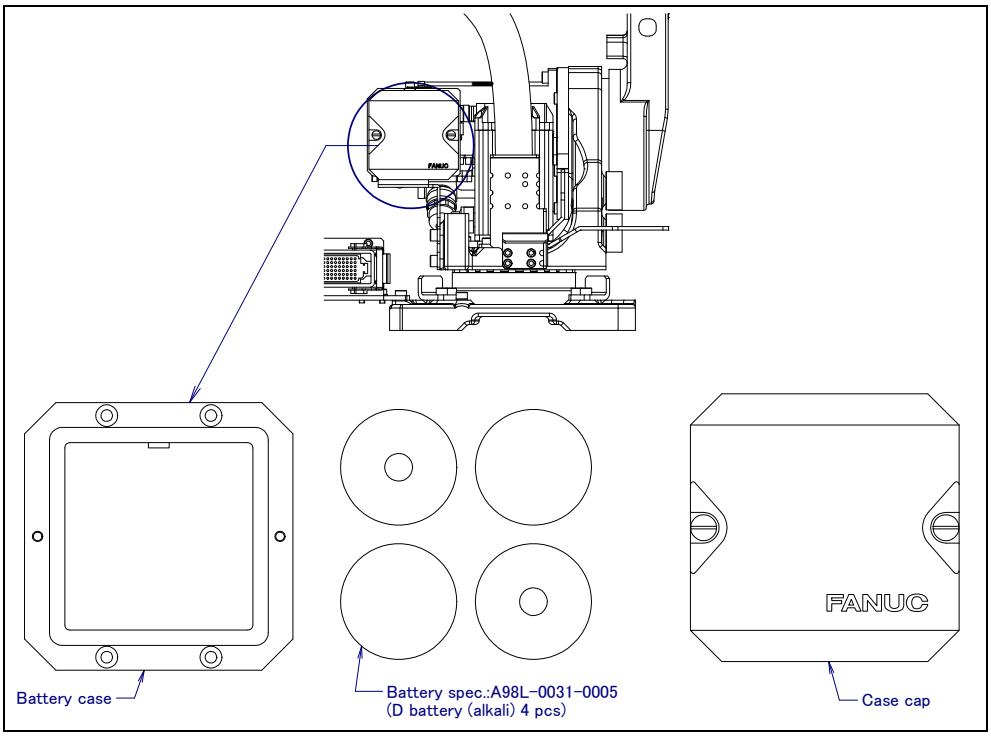


Fig. 7.3.1 Replacing the battery

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

7.3.2.1 Grease replacement procedure for the reducer

Replace the grease of the reducers of J4/J5/J6-axis gearbox at the intervals based on every 3 years or 11520 hours, whichever comes first by using the following procedures. For J1 to J3-axes, greasing may be necessary when robot is overhaul period, so contact your local FANUC representative. (If robot is under environment of the high temperature, shortening the interval is recommended.)

⚠ CAUTION

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

1 Before starting to grease, open the seal bolt of the 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 7.3.2.1 (a)).
4 Use specified grease. Use of non-approved grease may damage the reducer or lead to other problems.
5 After greasing, release remaining pressure from the grease bath using the procedure given in Subsection 7.3.2.2, and then close the grease outlet.
6 To prevent an accident such as a fall or fire, remove all the excess grease from the floor and robot.

Table 7.3.2.1 (a) Grease name and amount to be replaced at regular intervals of three years (11520 hours)

Greasing points	Amount of grease to be applied	Gun tip pressure	Specified grease
J4-axis gearbox	400g(450ml)	0.1MPa or less (NOTE)	Kyodo Yushi VIGOGREASE RE0 (Specification: A98L-0040-0174)
J5-axis gearbox	180g(200ml)		
J6-axis gearbox	75g(85ml)		

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

For grease replacement or replenishment, use the Postures indicated below.
Consider relative angle of from posture of floor mount when robot is angle mount.

Table 7.3.2.1 (b) Grease supplying posture

Supply position		Posture					
		J1	J2	J3	J4	J5	J6
J4-axis gearbox supply posture	Floor mount	Arbitrary	Arbitrary	0°	Arbitrary	Arbitrary	Arbitrary
	Top mount			180°			
	Wall mount -90°	0°		-90°			
	Wall mount +90°			90°			
J5-axis gearbox supply posture	Floor mount	Arbitrary		0°	0°		
	Top mount			180°			
	Wall mount -90°	0°		-90°			
	Wall mount +90°			90°			
J6-axis gearbox supply posture	Floor mount	Arbitrary		0°		0°	
	Top mount			180°			
	Wall mount -90°	0°		-90°			
	Wall mount +90°			0°			

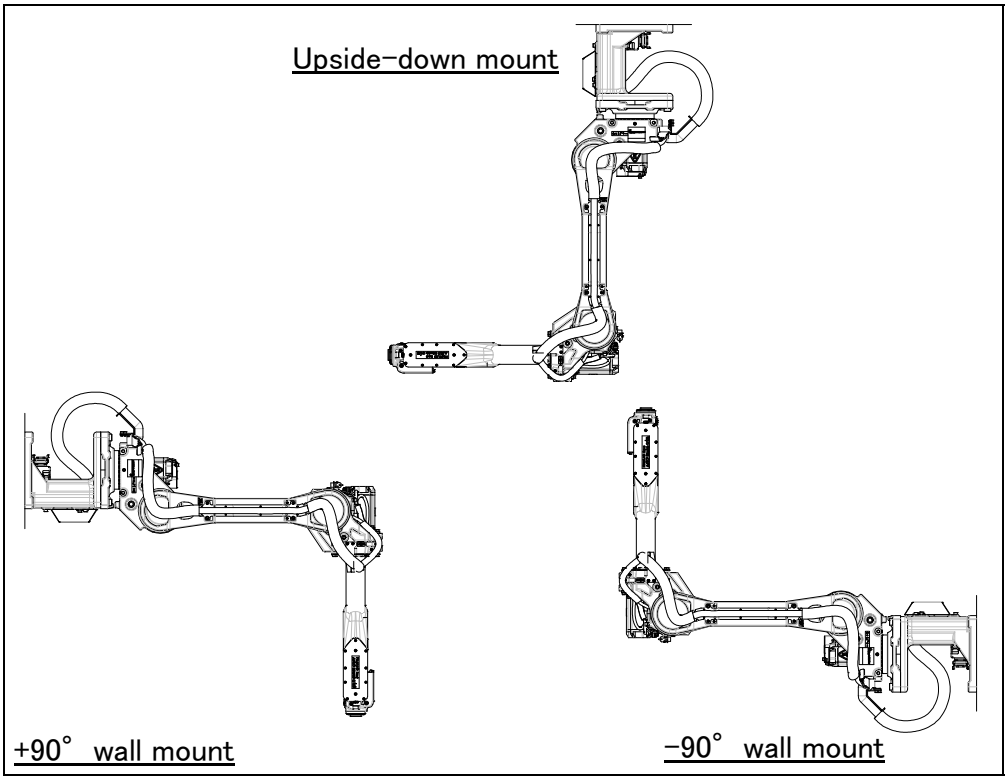


Fig. 7.3.2.1 (a) Installation method

1 Move the robot to the greasing Posture described in Table.7.3.2.1 (b).
2 Turn off the controller power.
3 Remove the taper plug or the seal bolt or the bolt and the seal washer from grease outlet. (Fig. 7.3.2.1 (b))
  J4-axis: seal bolt M6X8
  J5-axis: bolt M6X8 + seal washer
  J6-axis: taper plug R1/8
4 Remove the seal bolt or the 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 7.3.2.2.

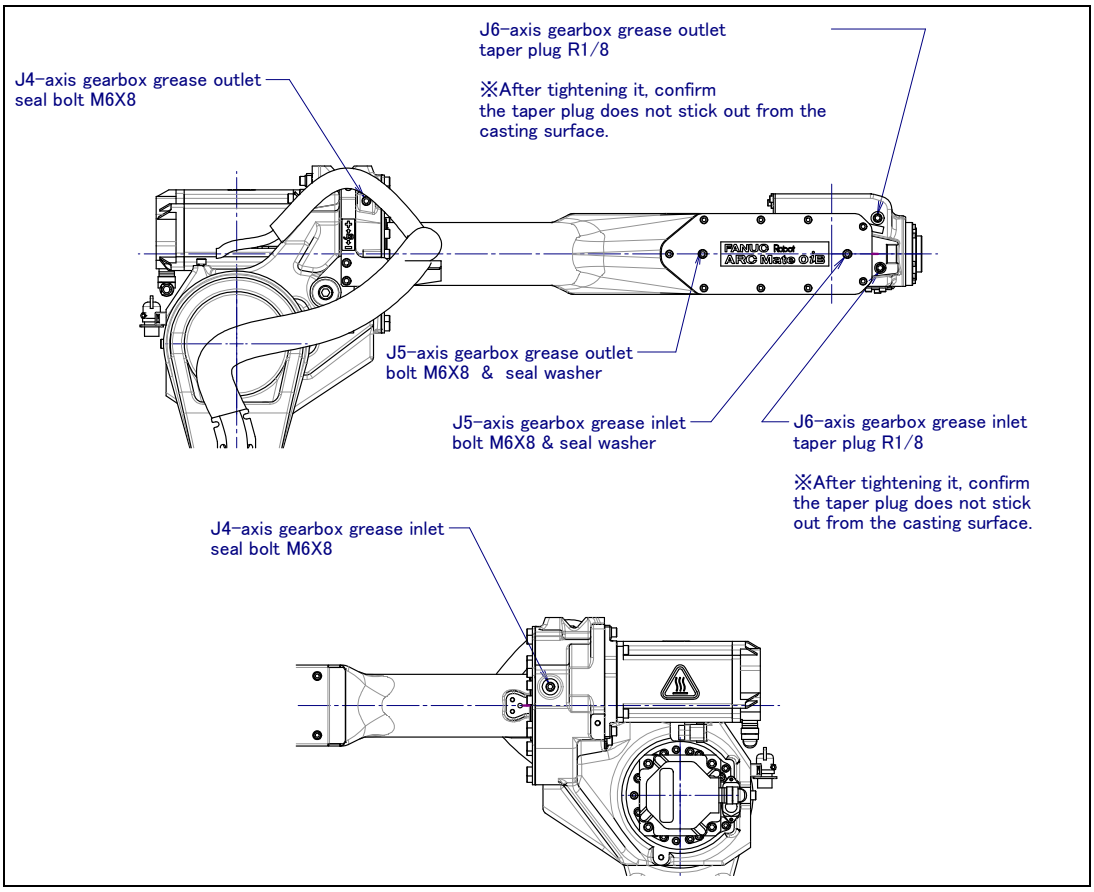


Fig. 7.3.2.1 (b) Greasing points of gearboxes

Table 7.3.2.1 (c) Specification of seal bolt , taper plug and seal washer

Parts name	Specification
Seal bolt (M6X8)	A97L-0218-0417#060808
Taper plug (R1/8)	A97L-0001-0436#1-1D
Seal washer (M6)	A30L-0001-0048#6M

7.3.2.2 Procedure for releasing remaining pressure from the grease bath

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

To release remaining pressure, after remove the tube for applying grease leave the grease inlets and outlets open for three minutes. Install the bolts or seal bolts in the grease inlets and outlets, and perform repetitive operation with an axis angle of at least 60 degrees and OVR100% for 10 minutes or more.
In case of J5-axis, move the robot so that tip of J3 arm face floor.
After the operation is completed, remove the taper plugs or bolts from the grease inlets and outlets, and leave the grease inlets and outlets open for three minutes to release internal pressure.

When the above operation is impossible due to ambient conditions, perform the program operation for a time equivalent to the above. (When the maximum allowable axis angle is 30 degrees, perform the twice operation for 20 minutes or more.) Upon completion of the above operation, attach the taper plug or the seal bolt or bolt and seal washer to each the grease inlet and outlet. When reusing the seal bolt or taper plug, be sure to seal it with seal tape.

7.4 STORAGE

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

8 MASTERING

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

8.1 OVERVIEW

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

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

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

Types of Mastering

Table 8.1 describes the following mastering methods. If 7DC2 (V8.20P) or former software is installed, "Quick Mastering for Single Axis" has not been supported.

Table 8.1 Type of mastering

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

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

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
If mastering is performed incorrectly, the robot may behave unexpectedly. This is very dangerous. For this reason, the Master/Cal screen is designed to appear only when the $MASTER_ENB system variable is 1 or 2. After performing positioning, press F5, ([DONE]) on the Master/Cal screen. The $MASTER_ENB system variable is reset to 0 automatically, and the Master/Cal screen will disappear.

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

⚠ CAUTION
If J4-axis 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 Fig. 8.1.

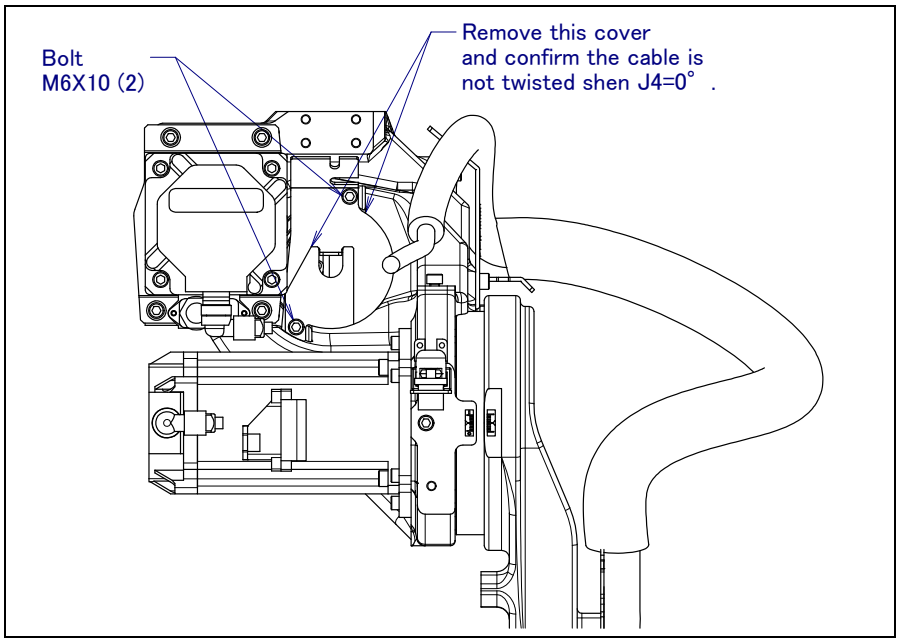


Fig. 8.1 Confirming the state of cable (J4-axis)

> ⚠ **CAUTION**
> When the robot is operated without J4 cover, it may cause serious trouble.
> Be sure to put cover back and operate the robot.

8.2 RESETTING ALARMS AND PREPARING FOR MASTERING

Before performing mastering because a motor is replaced, you must release the relevant alarm and display the positioning menu.

Alarm displayed

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

Procedure

1 Display the positioning menu by following steps 1 to 6.
   1 Press the [MENU] key to display the screen menu.
   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] key.
   5 Press F1 [TYPE], and select[Master/Cal] from the menu. Select the desired mastering type from the [Master/Cal] menu.
2 To reset the "SRVO-062 BZAL" alarm, follow steps 1 to 5.
   1 Press the [MENU] key to display the screen menu.
   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 "SRVO-075 Pulse not established" alarm, follow steps 1 to 2.
   1 When the controller power is turned on again, the message "SRVO-075 Pulse not established" appears again.
   2 Move the axis for which the message mentioned above has appeared in either direction till the alarm disappears when you press [FAULT RESET].

8.3 ZERO POSITION MASTERING

Zero-position mastering (witness mark mastering) is performed with all axes set at the 0-degree position. A zero-position mark (witness mark) is attached to each robot axis (Fig. 8.3). This mastering is performed with all axes set at the 0-degree position using their respective witness marks.

Zero-position mastering involves a visual check. It cannot be so accurate. It should be used only as a quick-fix method.

Procedure of Zero-position Mastering

1 Press [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE].
4 Select [Master/Cal].

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

 [ TYPE ]   LOAD   RES_PCA                DONE
```

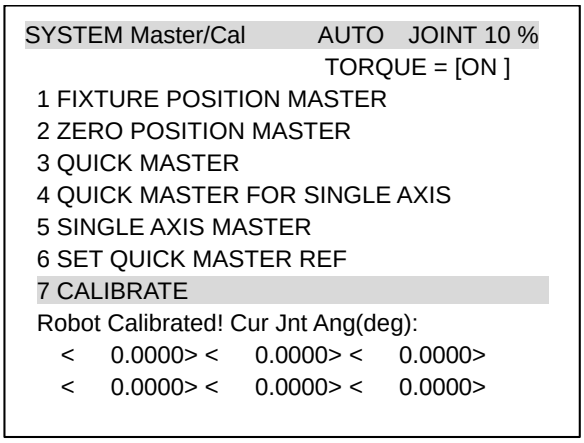
5 Release brake control, and jog the robot into a posture for mastering.

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

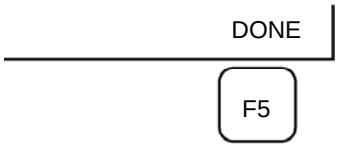
6 Select [Zero Position Master]. Press F4 [YES].

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

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



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



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

Table 8.3 Posture with position marks (witness mark) aligned

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

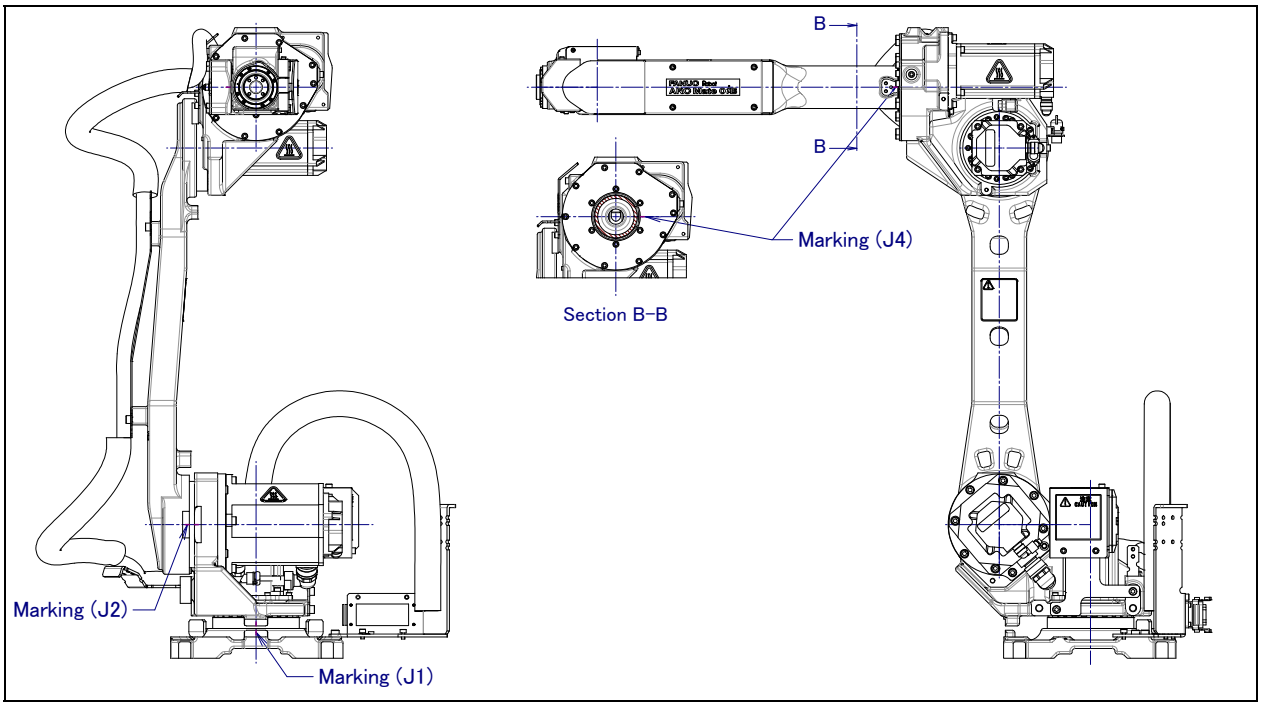


Fig. 8.3 (a) Marking position (witness mark) for each axis

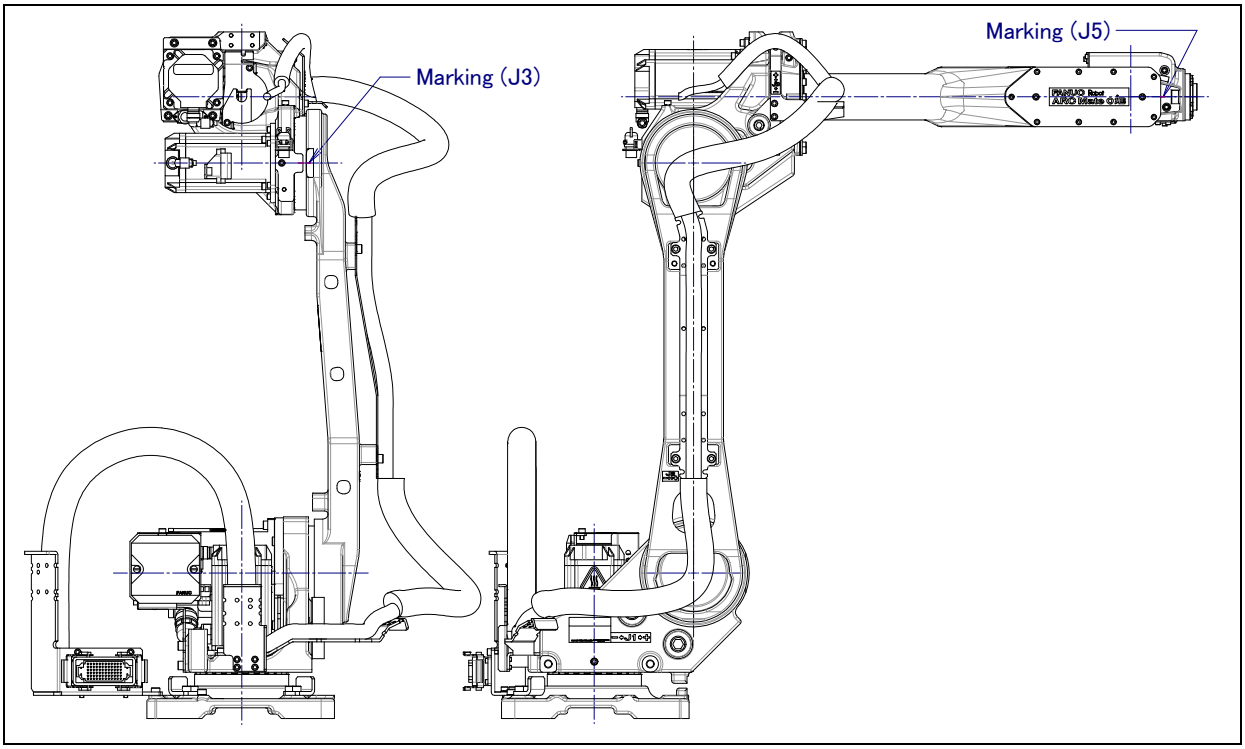


Fig. 8.3 (b) Zero-position mark (witness mark) for each axis

8.4 QUICK MASTERING

Quick mastering is performed at a user-specified position. The pulse 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.

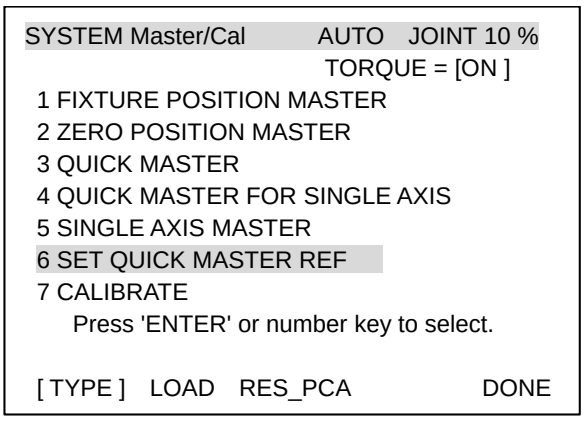
Quick mastering is factory-performed at the position indicated in Table 8.3. Do not change the setting unless there is any problem.

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

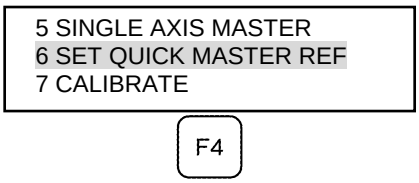
> ⚠ **CAUTION**
> 1 Quick mastering can be used, if the pulse count value is lost, for example, because a low voltage has been detected on the backup battery for the pulse counter.
> 2 Quick mastering cannot be used, after the Pulsecoder is replaced or after the mastering data is lost from the robot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

Procedure Recording the Quick Mastering Reference Position

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



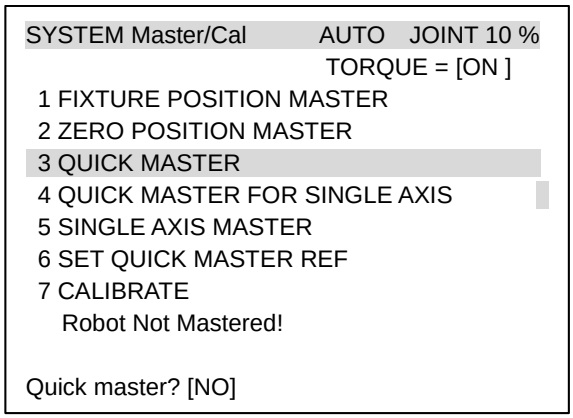
3 Release brake control, and jog the robot to the quick mastering reference position.
4 Select [6 SET QUICK MASTER REF] and press F4 [YES]. Quick mastering reference position will be set.



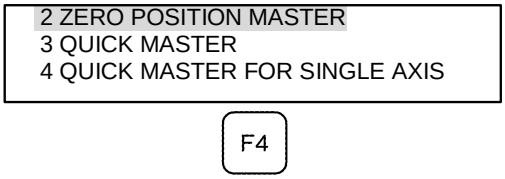
> ⚠ **CAUTION**
> If the robot has lost mastering data due to mechanical disassembly or repair, you cannot perform this procedure. In this case, perform Fixture position mastering or zero –position mastering is required to restore mastering data.

Procedure of Quick Mastering

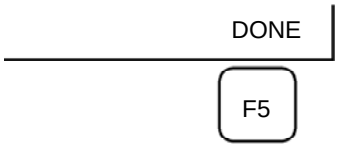
1 Display the Master/Cal screen.



2 Release brake control, and jog the robot to the quick mastering reference position.
3 Select [3 QUICK MASTER] and press F4 [YES]. Quick mastering reference position will be set.



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



6 Return brake control to original setting, and cycle power of the controller.

8.5 QUICK MASTERING FOR SINGLE AXIS

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

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

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

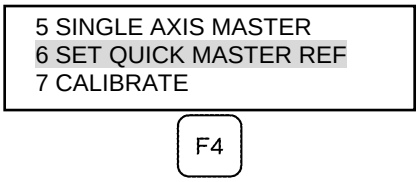
> ⚠ **CAUTION**
> 1 Quick mastering can be used, if the pulse count value is lost, for example, because a low voltage has been detected on the backup battery for the pulse counter.
> 2 Quick mastering cannot be used, after the Pulsecoder is replaced or after the mastering data is lost from the robot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

Procedure Recording the Quick Mastering Reference Position

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

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

 [ TYPE ]   LOAD   RES_PCA                DONE
```

3 Release brake control, and jog the robot to the quick mastering reference position.
4 Select [6 SET QUICK MASTER REF] and press F4 [YES]. Quick mastering reference position will be set.



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

Procedure of Quick Mastering for single axis

1 Display the Master/Cal screen.

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

Quick master? [NO]
```

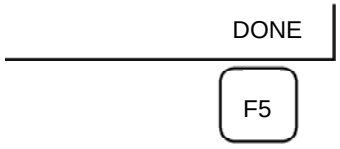
2 Select [4 QUICK MASTER FOR SINGLE AXIS]. You will see the quick master for single axis screen.

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

                                              EXEC
```

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

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

                                              EXEC
```

4 Turn off brake control, then jog the robot to the quick mastering reference position.
5 Press F5 [EXEC]. Mastering is performed. So, [SEL] is reset to 0, and [ST] is re-set to 2.
6 Select [7 CALIBRATE] and press [ENTER] key. Calibration is executed. Calibration is executed by cycling power.
7 After completing the calibration, press F5 Done.



8 Return brake control to original setting, and cycle power of the controller.

8.6 SINGLE AXIS MASTERING

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

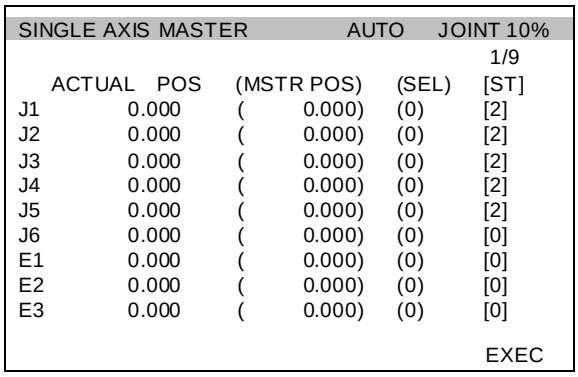
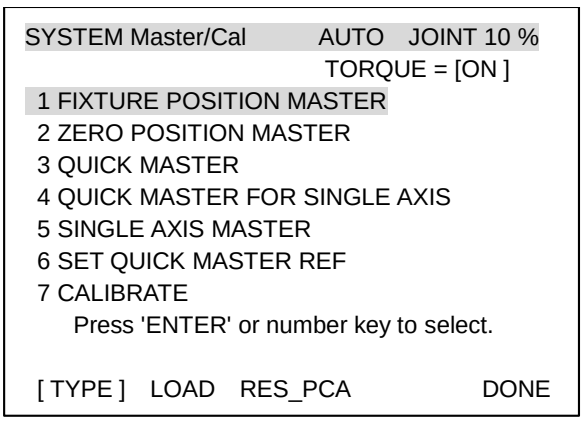


Table 8.6 Items set in single axis mastering

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

Procedure of Single axis mastering

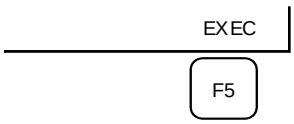
1 Select [6 SYSTEM].
2 Select [Master/Cal].



3 Select [4 SINGLE AXIS MASTER]. You will see a screen similar to the following.

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

                                          EXEC
```

4 For the axis to which to perform single axis mastering, set (SEL) to "1." Setting of [SEL] is available for one or more axes.
5 Turn off brake control, then jog the robot to the mastering position.
6 Enter axis data for the mastering position.
7 Press F5 [EXEC]. Mastering is performed. So, [SEL] is reset to 0, and [ST] is re-set to 2 or 1.

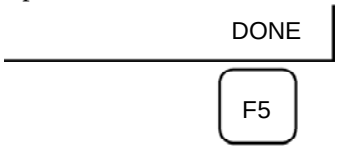



```
SINGLE AXIS MASTER          AUTO    JOINT 10%
                                          6/9
   ACTUAL   POS    (MSTR POS)    (SEL)   [ST]
J1          0.000  (      0.000)  (0)     [2]
J2          0.000  (      0.000)  (0)     [2]
J3          0.000  (      0.000)  (0)     [2]
J4          0.000  (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

                                          EXEC
```

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

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

 [ TYPE ]   LOAD   RES_PCA              DONE
```

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



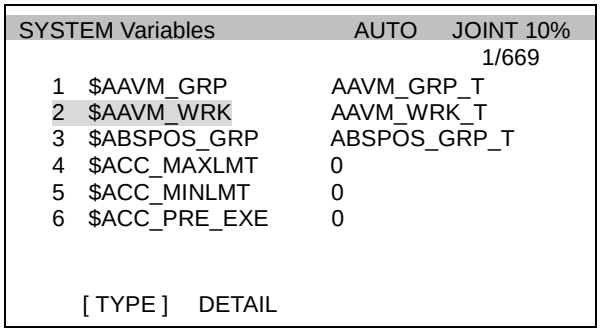
11 Return brake control to original setting, and cycle power of the controller.

8.7 MASTERING DATA ENTRY

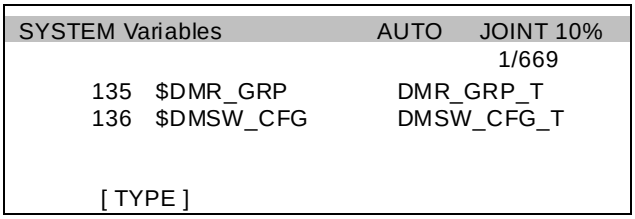
This function enables mastering data values to be assigned directly to a system variable. It can be used if mastering data has been lost but the pulse count is preserved.

Mastering data entry method

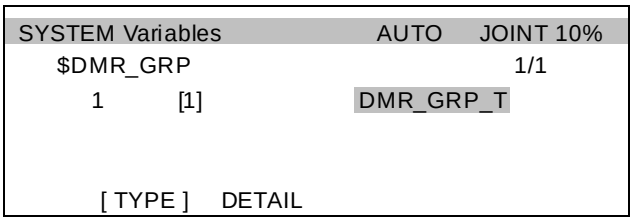
1 Press the [MENU] key, then press [0 NEXT] and select [6 SYSTEM].
2 Press F1 [TYPE]. Select [Variables]. The system variable screen appears.

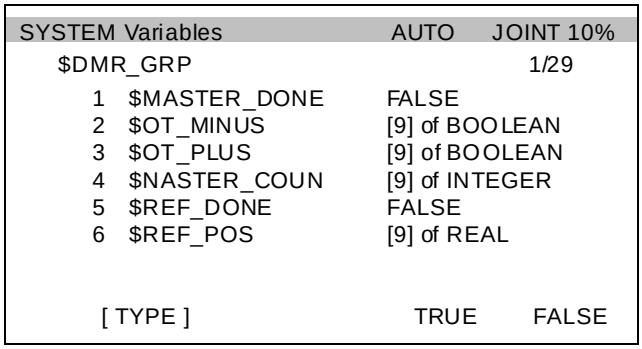


3 Change the mastering data. The mastering data is saved to the $DMR_GRP.$MASTER_COUN system variable.

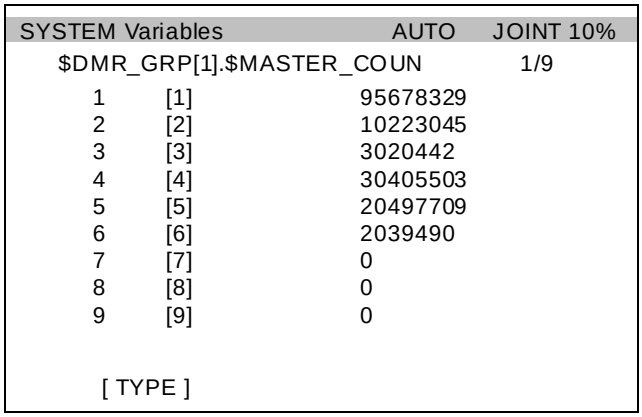


4 Select $DMR_GRP.

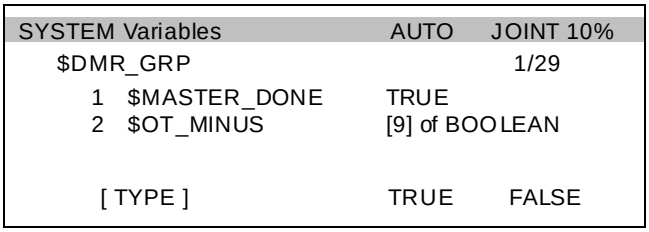




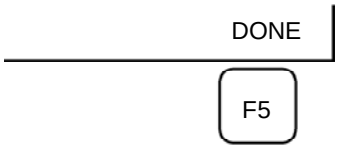
5 Select $MASTER_COUN, and enter the mastering data you have recorded.



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



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



8.8 VERIFYING MASTERING

1 How to verify that the robot is mastered properly:
Usually, positioning is performed automatically when the power is turned on. To check whether mastering has been performed correctly, examine if the current displayed position meets the actual robot position by using the procedure described below:
(1) Reproduce a particular point in a program. Check whether the point agrees with the specified position.
(2) Set all axes of the robot to their 0-degree (0 rad) positions. Check that the zero-degree position marks indicated in Section 8.3 of OPERATOR'S MANUAL are aligned. There is no need to use a visual aid.

If the displayed and actual positions do not match, the counter value for a Pulsecoder may have been invalidated as a result of an alarm described in 8.2. Alternatively, the mastering data in system variable $DMR_GRP.$MASTER_COUN may have been overwritten as a result of an operation error or some other reason.
Compare the data with the values indicated on the supplied data sheet. This system variable is overwritten whenever mastering is performed. Whenever mastering is performed, record the value of the system variable on the data sheet.

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

9 TROUBLESHOOTING

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

9.1 TROUBLESHOOTING

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

Table 9.1 (a) Troubleshooting

Symptom	Description	Cause	Measure
Vibration Noise	- The J1 base lifts off the floor plate as the robot operates. - There is a gap between the J1 base and floor plate. - A J1 base retaining bolt is loose.	[J1 base fastening] - It is likely that the robot J1 base is not securely fastened to the 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 LOCTITE and tighten it to the appropriate torque. - Adjust the floor plate surface flatness to within the specified tolerance. - If there is any foreign material between the J1 base and floor plate, remove it. - Apply adhesive between the J1 base and base plate.
	- The rack or floor plate vibrates during operation of the robot.	[Rack or floor] - It is likely that the rack or floor is not 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)	- 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.	[Broken gear, bearing, or reducer] - 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 material 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 material caught in a gear, bearing, or within a reducer cause vibration. - It is likely that, because the grease has not been changed for a long period, fretting occurred on the tooth surface or rolling contact surface of a bearing, or reducer due to metal fatigue. For J1 to J3–axis, grease replacing is not necessary if robot is used normally. But in case of temperature is very high, or posture is almost constant and Motion angle is very small. It is necessary to add grease. About greasing method of J1 to J3-axes, please contact your local FANUC representative. These factors all generate cyclic vibration and noise.	- Operate one axis at a time to determine which axis is vibrating. - Remove the motor, and replace the gear, the bearing, and the reducer. For the spec. of parts and the method of replacement, contact FANUC. - Using the robot within its maximum rating prevents problems with the drive mechanism. - Regularly changing the grease with a specified type can help prevent problems.

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

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- There is some relationship between the vibration of the robot and the operation of a machine near the robot.	[Noise from a nearby machine] - If the robot is not grounded properly, electrical noise is induced on the grounding wire, preventing commands from being transferred accurately, thus leading to vibration. - If the robot is grounded at an unsuitable point, its grounding potential becomes unstable, and noise is likely to be induced on the grounding line, thus leading to vibration.	- Connect the grounding wire firmly to ensure a reliable ground potential and prevent extraneous electrical noise.
	- There is an unusual sound after replacement of grease. - There is an unusual sound after a long period. - 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 LOCTITE and tighten it to the appropriate torque. -Motor retaining bolt -Reducer retaining bolt -Reducer shaft retaining bolt -Base retaining bolt -Arm retaining bolt -Casting retaining bolt -End effector retaining bolt

Symptom	Description	Cause	Measure
Motor overheating	- The motor overheated due to the temperature in the installation area rose. - After a cover was attached to the motor, the motor overheated. - After changing the Robot control program or the load, the motor overheat.	[Ambient temperature] - It is likely that the motor overheated along with the ambient temperature rose, and could not dissipate the heat. [Operating condition] - It is likely that the overcurrent above the specified permissive average current.	- Reducing the ambient temperature is the most effective means of preventing overheat. - Having the surroundings of the motor well ventilated enables the motor to release heat efficiently, thus preventing overheating. - If there is a source of heat near the motor, it is advisable to install shielding to protect the motor from heat radiation. - Relaxing the robot control program and load condition is effective to reduce the average current. Thus, prevent overheating. - The teach pendant can monitor the average current. Check the average current when the robot control program launched.
	- After a control parameter (load setting etc.) was changed, the motor overheated.	[Parameter] - If data input for a workpiece is invalid, the robot cannot be accelerated or decelerated normally, so the average current increases, leading to overheating.	- As for load setting, Input an appropriate parameter referring to Section 4.3.
	- Symptom other than stated above	[Mechanical section problems] - It is likely that problems occurred in the mechanical unit drive mechanism, thus placing an excessive load on the motor. [Motor problems] - It is likely that a failure of the motor brake resulted in the motor running with the brake applied, thus placing an excessive load on the motor. - It is likely that a failure of the motor prevented it from delivering its rated performance, thus causing an excessive current to flow through the motor.	- Repair the mechanical unit while referring to the above descriptions of vibration, noise, and rattling. - Check that, when the servo system is energized, the brake is released. If the brake remains applied to the motor all the time, replace the motor. - If the average current falls after the motor is replaced, it indicates that the first motor was faulty.

Symptom	Description	Cause	Measure
Grease leakage	- Grease is leaking from the mechanical unit.	[Poor sealing] - Probable causes are a crack in the casting, a broken O-ring, a damaged oil seal, or a loose seal bolt. - A crack in a casting can occur due to excessive force that might be caused in collision. - An O-ring can be damaged if it is trapped or cut during disassembling or re-assembling. - An oil seal might be damaged if extraneous dust scratches the lip of the oil seal. - A loose seal bolt or a taper plug 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 enlarge. - O-rings are used in the locations listed below. -Motor coupling section -Reducer (case and shaft) coupling section -Wrist connection section -J3 arm coupling section -Inside the wrist - Oil seals are used in the locations stated below. -Inside the reducer -Inside the wrist - Seal bolts and taper plugs are used in the locations stated below. -Grease inlet or outlet -Cover fixation
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 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. - Replace the motor confirmed following symptoms. - Brake shoe is worn out - Brake main body is damaged - Oil soak through the motor - J1/J4-axis cable has movable part .So if robot exceeds stroke limit, load depends on cable and it may cause damage of cables. If robot exceeds stroke limit, remove plate of back of J4, return axis to motion range during checking condition of cables. If cable tie is cut, attach new articles. If you operate robot with cable tie is cut, it cause damage of cables. (See Section 8.1).

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.
	- 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 teach pendant 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 9.1 (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.

APPENDIX

A PERIODIC MAINTENANCE TABLE

FANUC Robot ARC Mate 0*i*B Periodic Maintenance Table

		Items \ Working time (H)	Check time	Grease amount	First check 320	3 months 960	6 months 1920	9 months 2880	1 year 3840	4800	5760	6720	2 years 7680	8640	9600	10560
Mechanical unit	1	Check for external damage or peeling paint	0.1H	-		○	○	○	○	○	○	○	○	○	○	○
	2	Check damages of the cable protection sheaths	0.1H	-		○	○	○	○	○	○	○	○	○	○	○
	3	Check for water	0.1H	-		○	○	○	○	○	○	○	○	○	○	○
	4	Check the mechanical cable. (Damaged or twisted)	0.2H	-		○			○				○			
	5	Check the motor connector. (Loosening)	0.2H	-		○			○				○			
	6	Tighten the end effector bolt.	0.2H	-		○			○				○			
	7	Tighten the cover and main bolt.	1.0H	-		○			○				○			
	8	Check the mechanical stopper and adjustable mechanical stopper	0.1H	-		○			○				○			
	9	Clean spatters, sawdust and dust	1.0H	-		○			○				○			
	10	Check the cable for equipment	0.1H			○			○				○			
	11	Replacing batteries	0.1H	-							●					
	12	Replacing grease of J4-axis gearbox	0.5H	450ml												
	13	Replacing grease of J5-axis Gearbox	0.5H	200ml												
	14	Replacing grease of J6-axis gearbox	0.5H	85ml												
	15	Replacing cable of mechanical unit	4.0H	-												
	16	Replace the J1 cable protection sheet	0.2H	-									●			
Controller	17	Check the robot cable, teach pendant cable and robot connecting cable	0.2H	-		○			○				○			
	18	Cleaning the ventilator	0.2H	-	○	○	○	○	○	○	○	○	○	○	○	○
	19	Replacing battery *1	0.1H	-												

*1 Refer to “REPLACING UNITS Chapter of MAINTENANCE of Control Maintenance Manual”.

*2 ●: requires order of parts

○: does not requires 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
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		1
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		2
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		3
○				○				○				○				○					4
○				○				○				○				○					5
○				○				○				○				○					6
○				○				○				○				○					7
○				○				○				○				○					8
○				○				○				○				○					9
○				○				○				○				○					10
●						●						●						●			11
●												●									12
●												●									13
●												●									14
				●																	15
				●								●									16
○				○				○				○				○					17
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		18
				●																	19

Overhaul

B STRENGTH OF BOLT AND BOLT TORQUE LIST

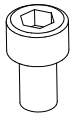
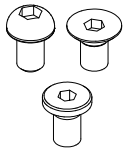
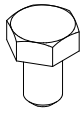
NOTE
When applying LOCTITE to a part, spread the LOCTITE on the entire length of the engaging part of the female thread. If applied to the male threads, poor adhesion can occur potentially loosening the bolt. Clean the bolts and the threaded holes and wipe off the oil on the engaging section. Make sure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

Adopt following strength bolts. Comply with any bolt specification instructions as specified.

Hexagon socket head bolt made by steel:
Size M22 or less: Tensile strength 1200N/mm^2 or more
Size M24 or more: Tensile strength 1000N/mm^2 or more
All size plating bolt: Tensile strength 1000N/mm^2 or more

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

Recommended bolt tightening torques **Unit: Nm**

Nominal diameter	Hexagon socket head bolt (steel)		Hexagon socket head bolt (stainless)		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

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 insulating material must not permit bolting directly from the welding torch bracket to mounting face plate.

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 units, possibly damaging the motor or melting the mechanical unit cable jackets.

C.1 INSULATION AT THE WRIST

- Insulate the end effector mounting surface. Insulation material which is inserted between the end effector mounting surface and the welding torch bracket must be different, and bolt them separately referring to Fig. C.1.
- Insert the insulating material between the torch bracket and faceplate to ensure the two are electrically isolated. 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.

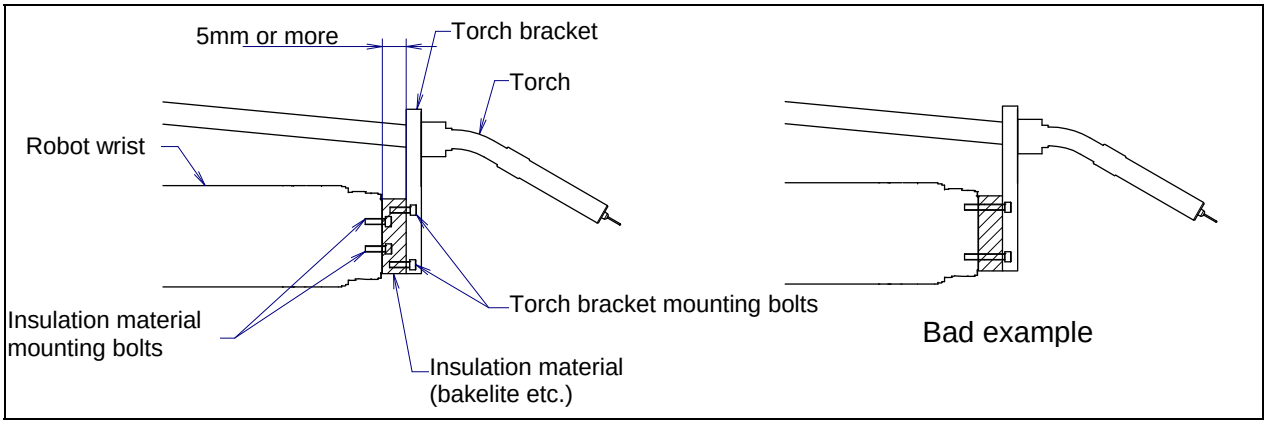


Fig. C.1 Insulation at the wrist

- Even after the insulation is reinforced, it is likely that, if a pileup of spatter grows excessively, current may leak. Periodically remove the spatter.

INDEX

REVISION RECORD

Edition	Date	Contents
02	May, 2016	• Addition of OPERATING SPACE FOR INCLINATION INSTALLATION • Addition of quick mastering for single axis • Correction of errors
01	Dec., 2013	

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