FANUC Robot M-710*i*C

MECHANICAL UNIT

OPERATOR'S MANUAL

B-82274EN/09

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

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

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

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

SAFETY PRECAUTIONS

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

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

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

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

1 WORKING PERSON

The personnel can be classified as follows.

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

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

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

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

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

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

2 DEFINITION OF WARNING, CAUTION AND NOTE

To ensure the safety of user and prevent damage to the machine, this manual indicates each precaution on safety with "Warning" or "Caution" according to its severity. Supplementary information is indicated by "Note". Read the contents of each "Warning", "Caution" and "Note" before attempting to use the oscillator.

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

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

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

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

3 WORKING PERSON SAFETY

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

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

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

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

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

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

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

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

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

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

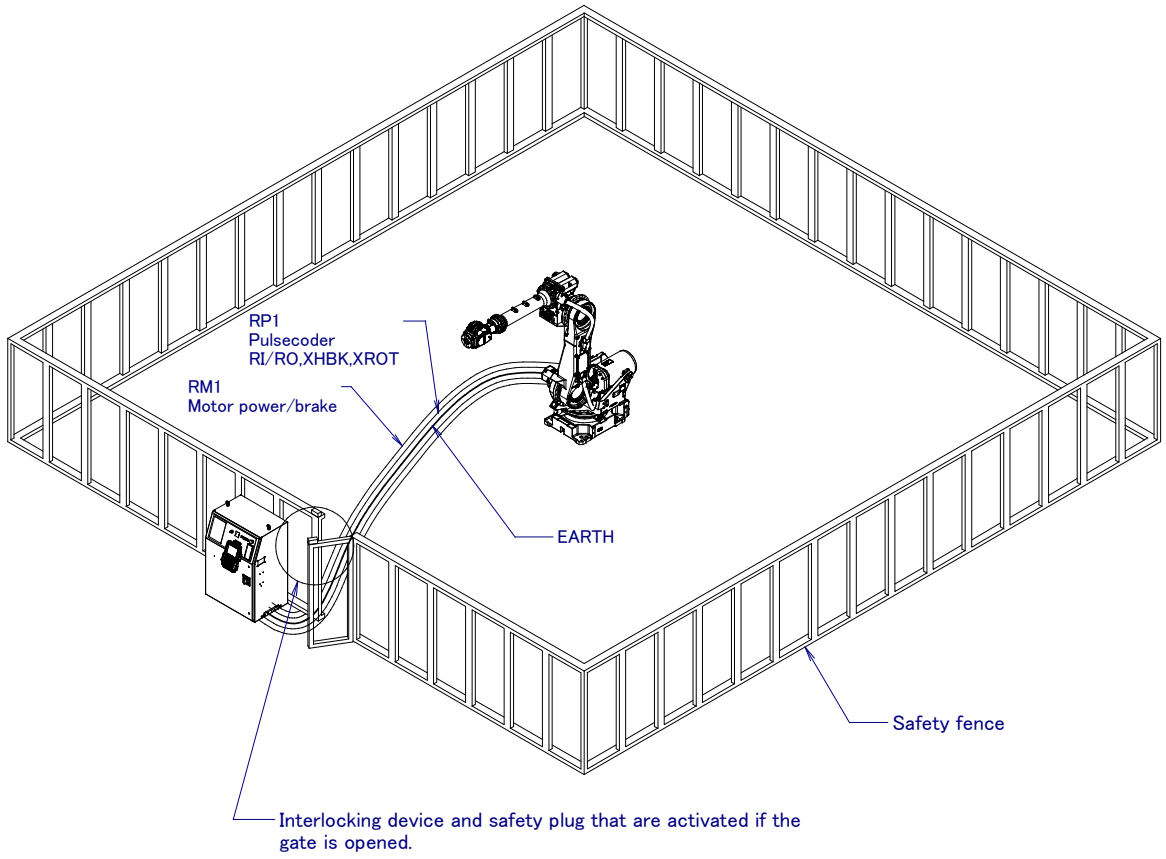


Fig. 3 (a) Safety fence and safety gate

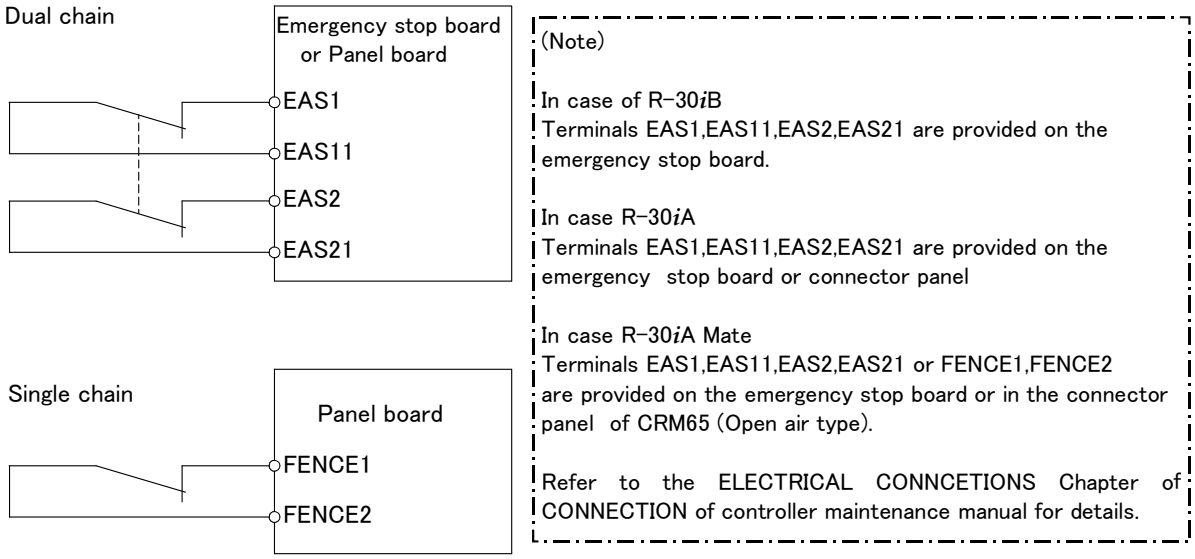


Fig. 3 (b) Limit switch circuit diagram of the safety fence

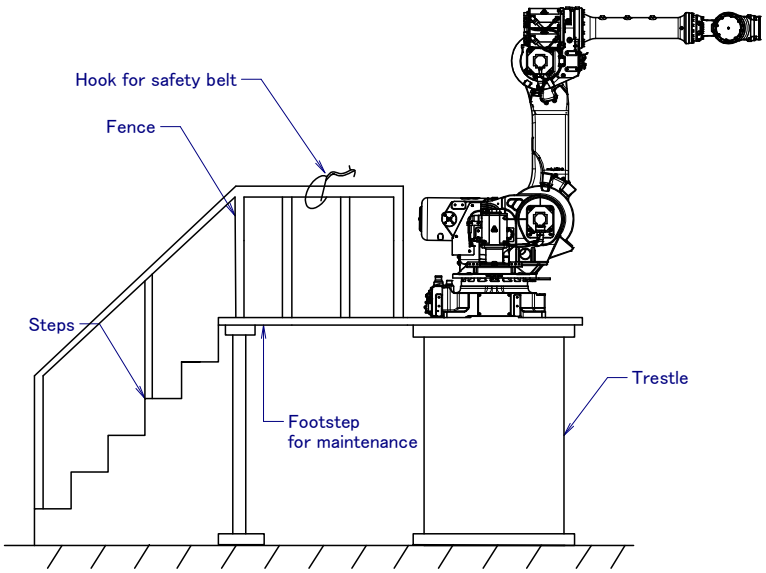


Fig.3 (c) Footstep for maintenance

3.1 OPERATOR SAFETY

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

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

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

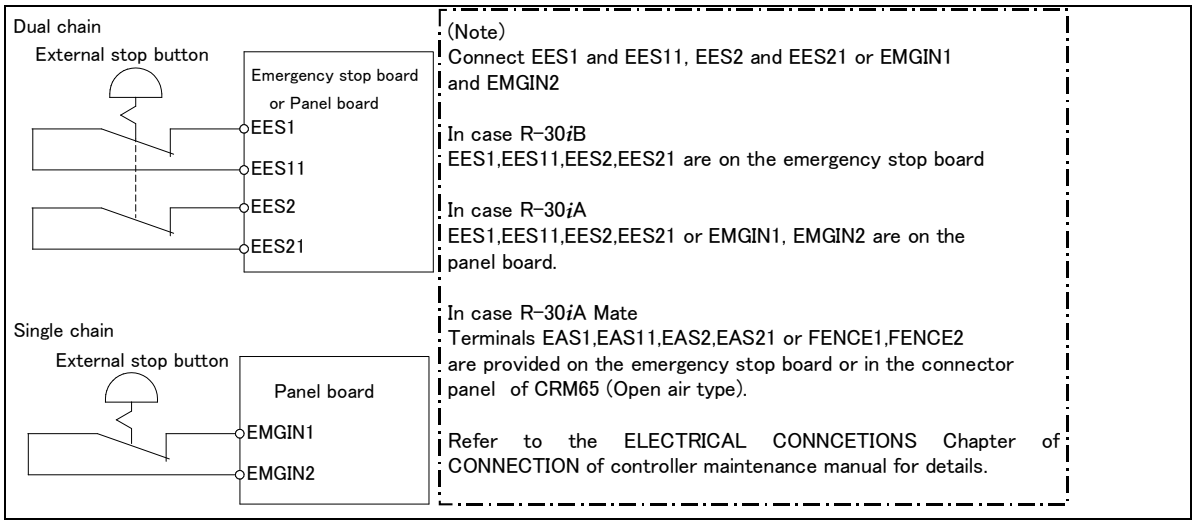


Fig.3.1 Connection diagram for external emergency stop button

3.2 SAFETY OF THE PROGRAMMER

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

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

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

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

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

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

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

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

T1,T2 mode: DEADMAN switch is effective.

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

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

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

3.3 SAFETY OF THE MAINTENANCE ENGINEER

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

(1) During operation, never enter the robot work area.
(2) A hazardous situation may arise when the robot or the system, are kept with their power-on during maintenance operations. Therefore, for any maintenance operation, the robot and the system should be put into the power-off state. If necessary, a lock should be in place in order to prevent any other person from turning on the robot and/or the system. In case maintenance needs to be executed in the power-on state, the emergency stop button must be pressed.
(3) If it becomes necessary to enter the robot operation range while the power is on, press the emergency stop button on the operator panel, or the teach pendant before entering the range. The maintenance personnel must indicate that maintenance work is in progress and be careful not to allow other people to operate the robot carelessly.
(4) When entering the area enclosed by the safety fence, the maintenance worker must check the entire system in order to make sure no dangerous situations exist. In case the worker needs to enter the

safety area whilst a dangerous situation exists, extreme care must be taken, and entire system status must be carefully monitored.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

(25) In case robot motion is required during maintenance, the following precautions should be taken :
- Foresee an escape route. And during the maintenance motion itself, monitor continuously the whole system so that your escape route will not become blocked by the robot, or by peripheral equipment.
- Always pay attention to potentially dangerous situations, and be prepared to press the emergency

stop button whenever necessary.

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

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

4 SAFETY OF THE TOOLS AND PERIPHERAL DEVICES

4.1 PRECAUTIONS IN PROGRAMMING

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

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

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

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

4.2 PRECAUTIONS FOR MECHANISM

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

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

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

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

(5) The frequent power-off stop for the robot during operation causes the trouble of the robot. Please avoid the system construction that power-off stop would be operated routinely. (Refer to bad case example.) Please execute power-off stop after reducing the speed of the robot and stopping it by hold stop or cycle stop when it is not urgent. (Please refer to "STOP TYPE OF ROBOT" in SAFETY PRECAUTIONS for detail of stop type.)
(Bad case example)
- Whenever poor product is generated, a line stops by emergency stop.
- When alteration was necessary, safety switch is operated by opening safety fence and power-off stop is executed for the robot during operation.
- An operator pushes the emergency stop button frequently, and a line stops.

- An area sensor or a mat switch connected to safety signal operate routinely and power-off stop is executed for the robot.

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

5 SAFETY OF THE ROBOT MECHANISM

5.1 PRECAUTIONS IN OPERATION

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

5.2 PRECAUTIONS IN PROGRAMMING

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

5.3 PRECAUTIONS FOR MECHANISMS

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

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

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

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

(*) These do not support CE marking.

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

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

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

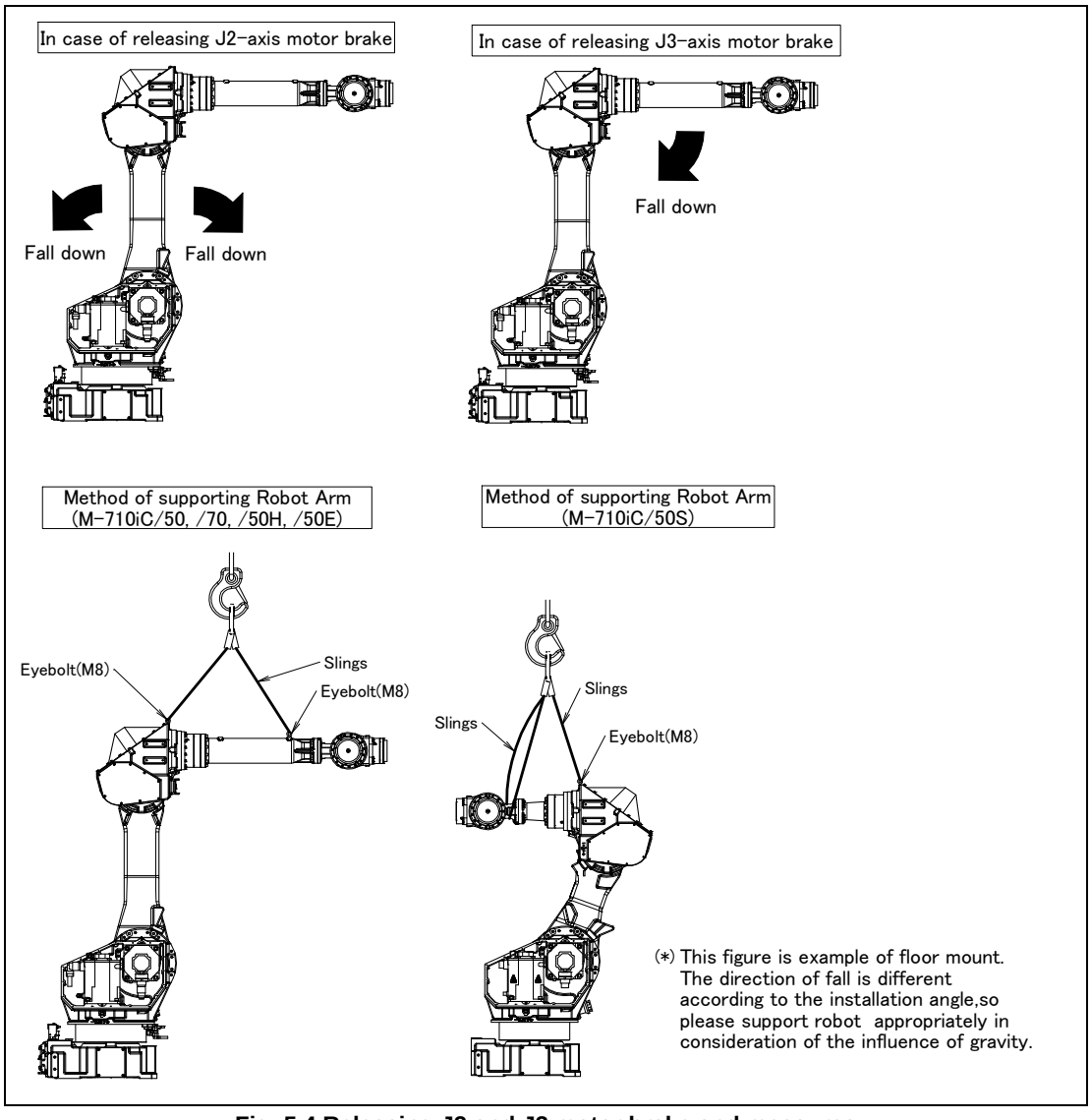


Fig. 5.4 Releasing J2 and J3 motor brake and measures

6 SAFETY OF THE END EFFECTOR

6.1 PRECAUTIONS IN PROGRAMMING

(1) To control the pneumatic, hydraulic and electric actuators, carefully consider the necessary time delay after issuing each control command up to actual motion and ensure safe control.

(2) Provide the end effector with a limit switch, and control the robot system by monitoring the state of the end effector.

7 STOP TYPE OF ROBOT

The following three robot stop types exist:

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

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

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

Controlled stop (Category 1 following IEC 60204-1)

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

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

Hold (Category 2 following IEC 60204-1)

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

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

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

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

There are the following 3 Stop patterns.

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

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

-: Disable

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

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

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

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

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

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

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

"Controlled stop by E-Stop" option

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

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

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

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

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

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

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

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

8 WARNING LABEL

(1) Greasing and degreasing label

Fig. 8 (a) Greasing and degreasing label

Description

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

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

⚠CAUTION
See Chapter 7 CHECKS AND MAINTENANCE for explanations about specified greases, the amount of grease to be supplied, and the locations of grease and degrease outlets for individual models.

(2) Step-on prohibitive label

Fig. 8 (b) Step-on prohibitive label

Description

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

(3) High-temperature warning label

Fig. 8 (c) Step-on prohibitive label

Description

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

(4) Transportation label

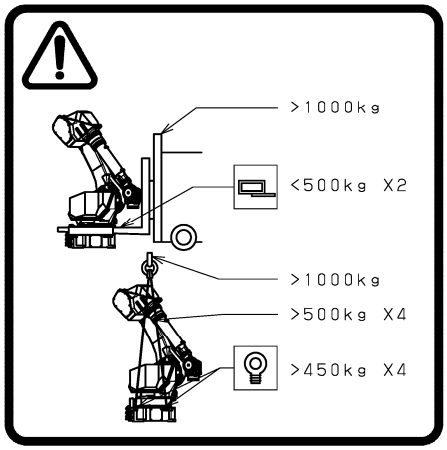


Fig. 8 (d) Step-on prohibitive label

Description

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

1) Using a forklift

- Use a forklift having a load capacity of 1,000 kg or greater.
- Keep the total weight of the robot to be transported to within 1,000 kg, because the withstand load of the forklift bracket (option) is 4,900 N (500 kgf).

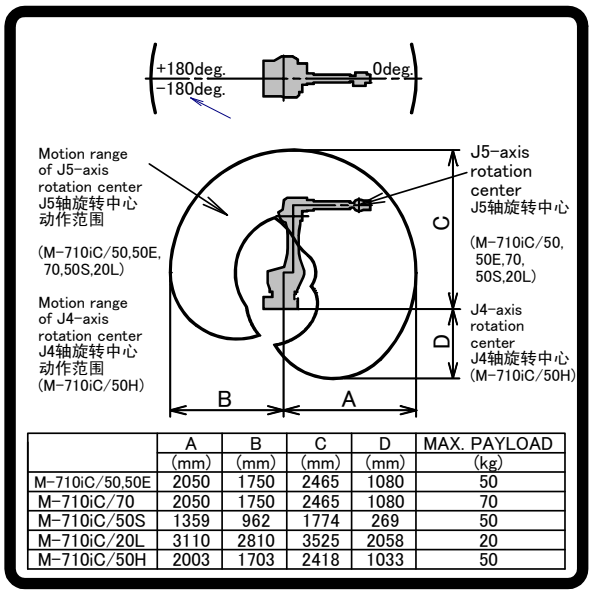
2) Using a crane

- Use a crane having a load capacity of 1,000 kg or greater.
- Use at least four slings each having a withstand load of 4,900 N (500 kgf) or greater.
- Use at least four eyebolts each having a withstand load of 4,410 N (450 kgf) or greater.

⚠CAUTION

Transportation labels are model-specific. Before transporting the robot, see the transportation label affixed to the J2 base side.
See Sub-section 1.1 TRANSPORTATION for explanations about the posture a specific model should take when it is transported.

(5) Range of motion and payload mark label
Below label is added when CE specification is specified.



	A (mm)	B (mm)	C (mm)	D (mm)	MAX. PAYLOAD (kg)
M−710iC/50,50E	2050	1750	2465	1080	50
M−710iC/70	2050	1750	2465	1080	70
M−710iC/50S	1359	962	1774	269	50
M−710iC/20L	3110	2810	3525	2058	20
M−710iC/50H	2003	1703	2418	1033	50

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

(6) Transportation prohibitive label
(When transport equipment option is specified.)

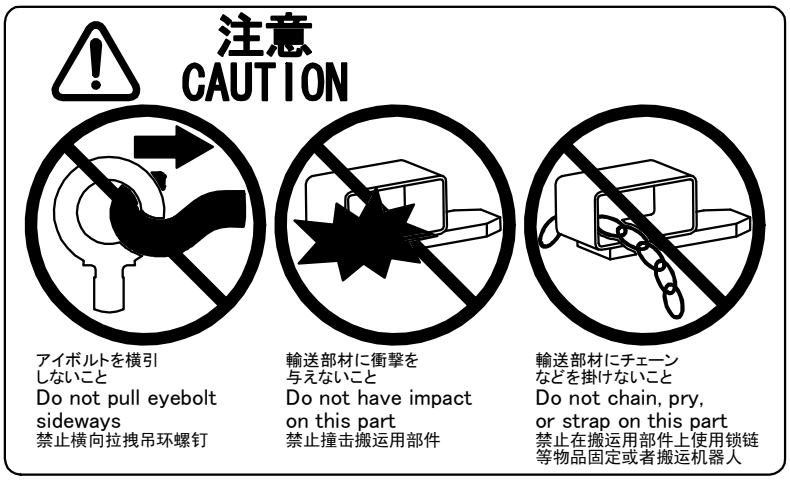


Fig. 8 (f) Transportation prohibitive label

Description

Keep the following in mind when transporting the robot.

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

PREFACE

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

Model name	Mechanical unit specification No.	Maximum load
FANUC Robot M-710*i*C/50	A05B-1125-B201	50kg
FANUC Robot M-710*i*C/70	A05B-1125-B202	70kg
FANUC Robot M-710*i*C/50H	A05B-1125-B204	50kg
FANUC Robot M-710*i*C/50S	A05B-1125-B207	50kg
FANUC Robot M-710*i*C/50E	A05B-1125-B251	50kg

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

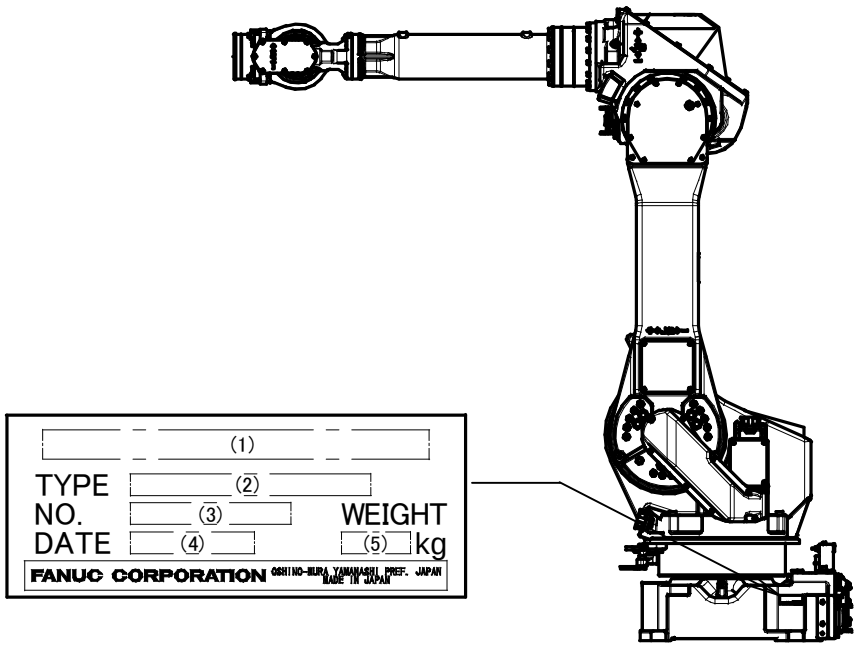


TABLE 1)

	(1)	(2)	(3)	(4)	(5)
CONTENTS	-	TYPE	No.	DATE	WEIGHT kg (Without controller)
LETTERS	FANUC Robot M-710*i*C/50	A05B-1125-B201	PRINT SERIAL NO.	PRINT PRODUCTION YEAR AND MONTH	560
	FANUC Robot M-710*i*C/70	A05B-1125-B202			560
	FANUC Robot M-710*i*C/50H	A05B-1125-B204			540
	FANUC Robot M-710*i*C/50S	A05B-1125-B207			545
	FANUC Robot M-710*i*C/50E	A05B-1125-B251			560

Position of label indicating mechanical unit specification number

RELATED MANUALS

For the FANUC Robot series, the following manuals are available:

Safety handbook B-80687EN All persons who use the FANUC Robot and system designer must read and understand thoroughly this handbook		Intended readers: All persons who use FANUC Robot, system designer Topics: Safety items for robot system design, operation, maintenance
R-30*i*A controller	Setup and Operations manual SPOT TOOL+ B-83124EN-1 HANDLING TOOL B-83124EN-2 ARC TOOL B-83124EN-3 DISPENSE TOOL B-83124EN-4 ALARM CODE LIST B-83124EN-6 SERVO GUN FUNCTION B-82634EN	Intended readers: Operator, programmer, maintenance person, system designer Topics: Robot functions, operations, programming, setup, interfaces, alarms Use: Robot operation, teaching, system design
	Maintenance manual B-82595EN B-82595EN-1 (For Europe) B-82595EN-2 (For RIA)	Intended readers: Maintenance person, system designer Topics: Installation, connection to peripheral equipment, maintenance Use: Installation, start-up, connection, maintenance
R-30*i*B controller	OPERATOR'S MANUAL **(**Basic Function**)** B-83284EN OPERATOR'S MANUAL **(**Alarm Code List**)** B-83284EN-1 Optional Function OPERATOR'S MANUAL B-83284EN-2 Spot Welding Function OPERATOR'S MANUAL B-83284EN-4 Dispense Function OPERATOR'S MANUAL B-83284EN-5	Intended readers : Operator, programmer, maintenance person, system designer Topics : Robot functions, operations, programming, setup, interfaces, alarms Use : Robot operation, teaching, system design
	Maintenance manual B-83195EN	Intended readers : Maintenance person, system designer Topics : Installation, connection to peripheral equipment, maintenance Use : Installation, start-up, connection, maintenance

TABLE OF CONTENTS

1 TRANSPORTATION AND INSTALLATION

1.1 TRANSPORTATION

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

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

⚠WARNING
1 It is recommended to transport robot detaching the end effector and the incidental equipment from the robot because there is the following possibilities when transported with the end effector and the incidental equipment installed.
- It becomes unstable by the change in the position of the center of the gravity of the robot while transporting it.
- The end effector acts by the vibration when transported and an excessive load acts on far movement and the robot.

2 Please firmly fix the end effector referring to clause 1.1.1 when it is difficult to detach the end effector and transport it.
3 Use the forklift pockets only to transport the robot with a forklift. Do not use the forklift pockets for any other transportation method. Do not use the forklift pockets to secure the robot.
4 Before moving the robot by using forklift pockets, check and tighten any loose bolts on the forklift pockets.

(1) Transportation using a crane (Fig. 1.1 (b) ,Fig. 1.1 (d) and Fig. 1.1 (f))
Fasten the M16 eyebolts to the four points of the robot base plate and lift the robot by the four slings.

⚠CAUTION
When lifting the robot, take notice so that the motor, connectors, or cables of the robot are not damaged by slings.

(2) Transportation using a forklift (Fig. 1.1 (c) , Fig. 1.1 (e) and Fig. 1.1 (g))
The specific transport equipment must be attached. Transport equipment is prepared as an option.

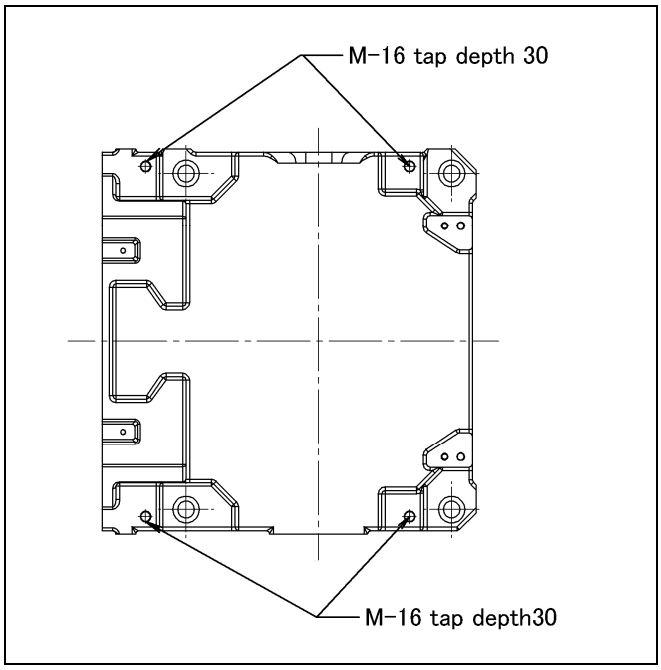


Fig. 1.1 (a) Position of the eyebolts and transportation equipment

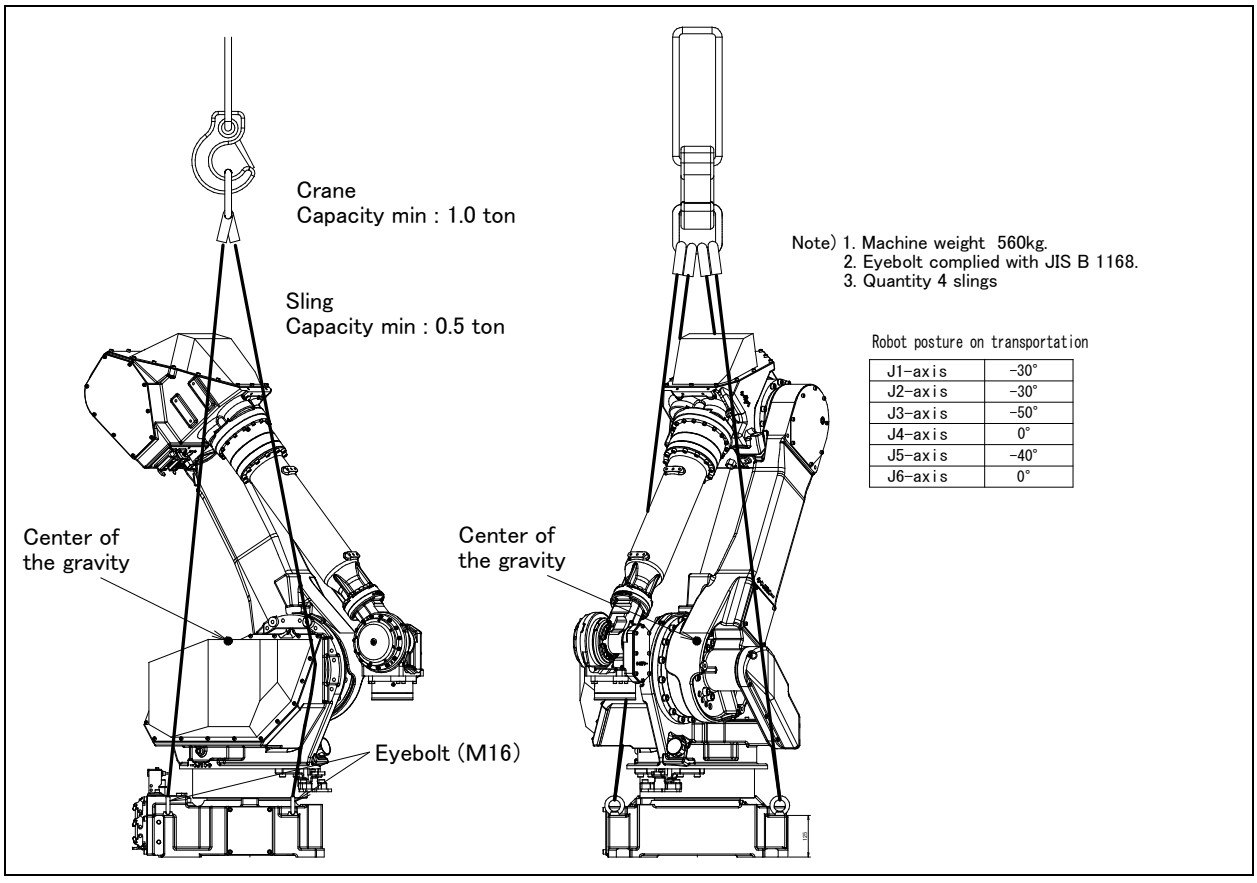


Fig. 1.1 (b) Transportation using a crane (M-710*i*C/50, /70 ,/50E)

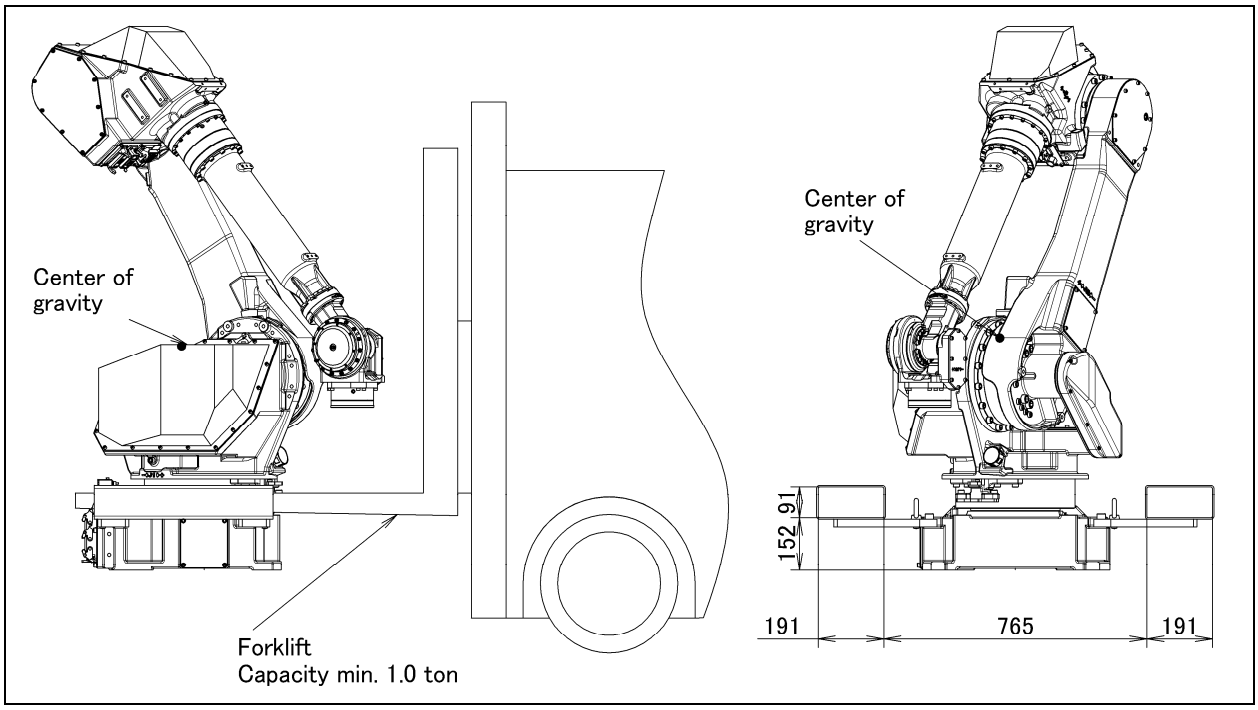


Fig. 1.1 (c) Transportation using a forklift (M-710*i*C/50, /70, /50E)

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

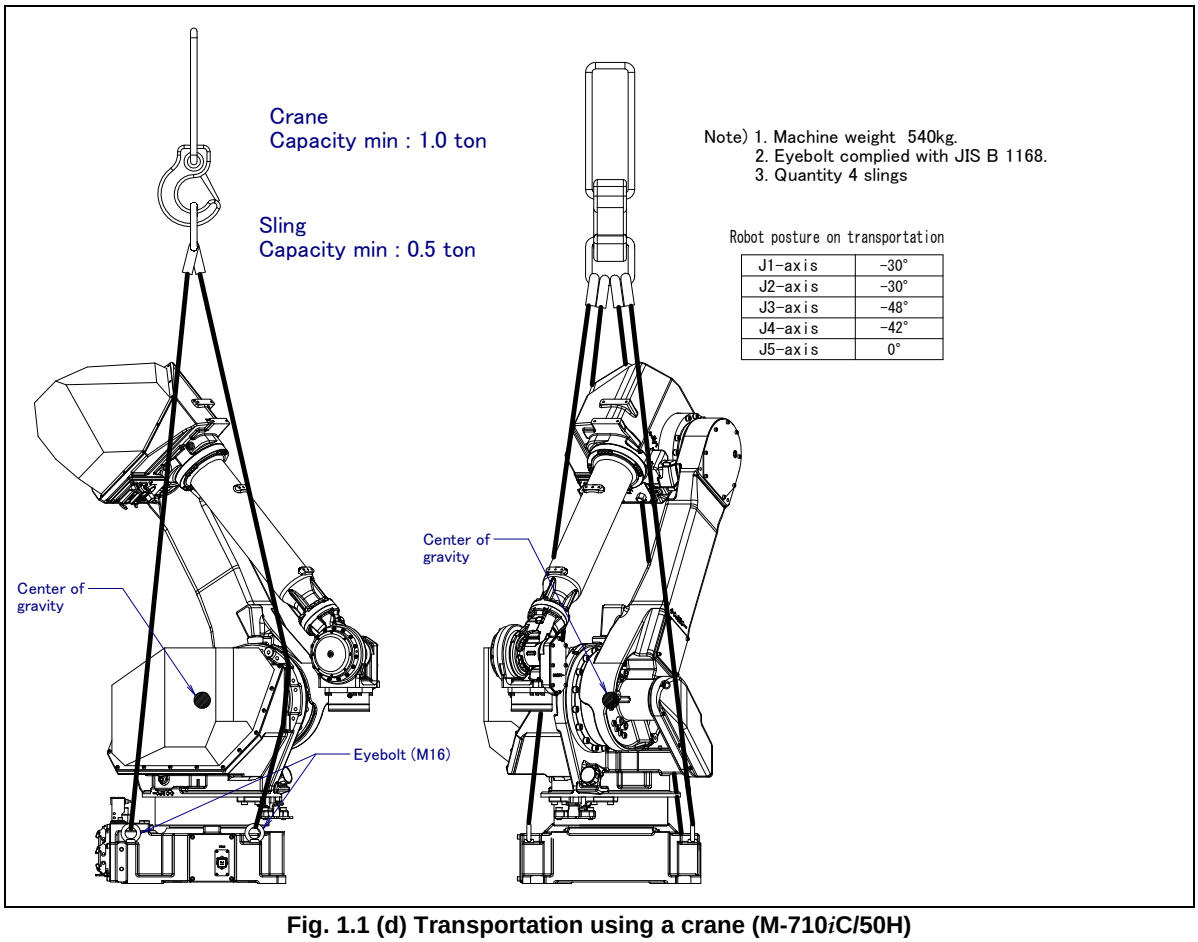


Fig. 1.1 (d) Transportation using a crane (M-710*i*C/50H)

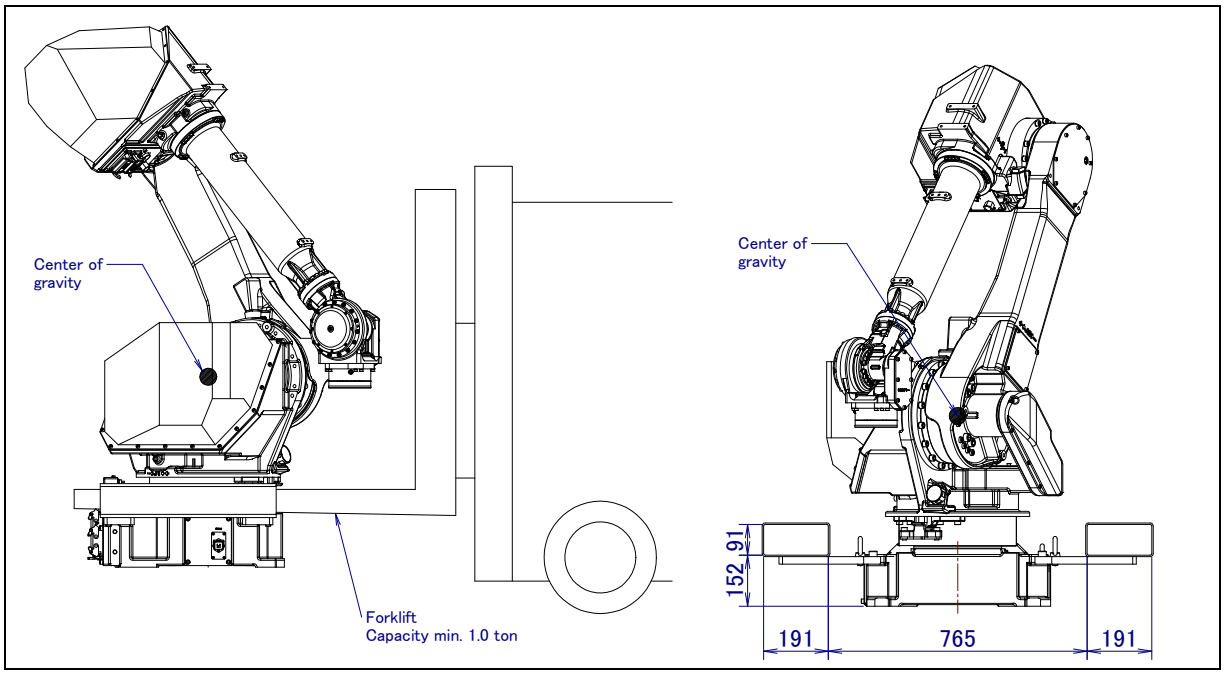


Fig. 1.1 (e) Transportation using a forklift (M-710*i*C/50H)

> **⚠CAUTION**
> Exercise care to prevent the fork of the forklift from striking transport equipments strongly.

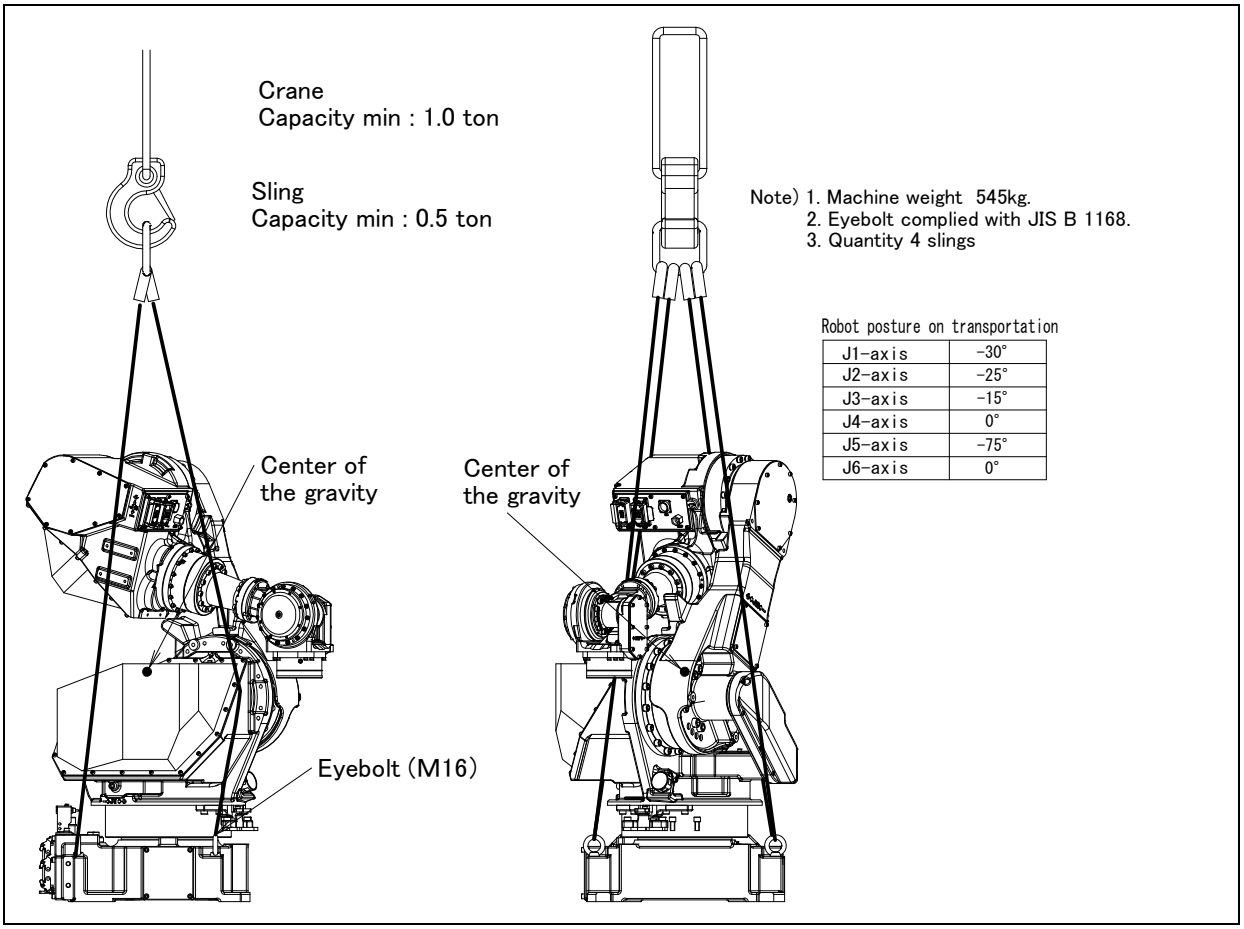


Fig. 1.1 (f) Transportation using a crane (M-710*i*C/50S)

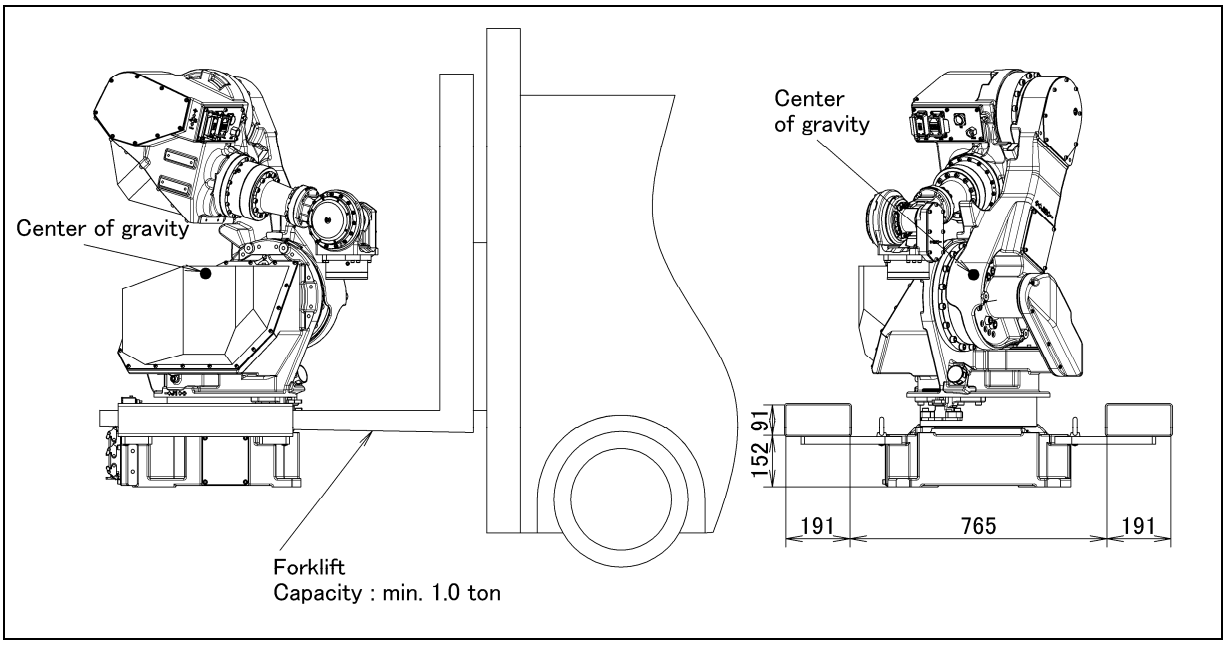


Fig. 1.1 (g) Transportation using a forklift (M-710*i*C/50S)

> **⚠CAUTION**
> Exercise care to prevent the fork of the forklift from striking transport equipments strongly.

1.1.1 Transportation with an End Effector Attached

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

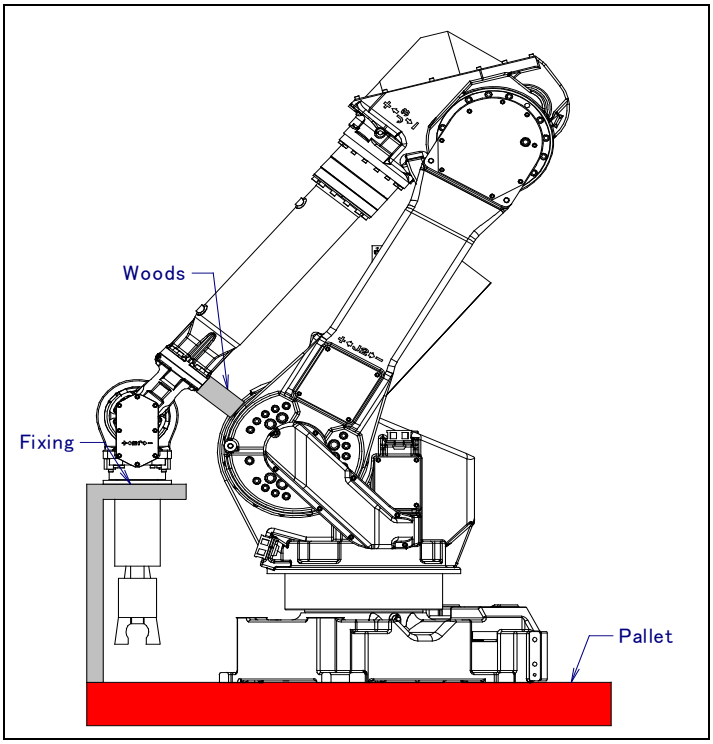


Fig. 1.1.1 Example of securing the arm during transportation when an end effector is attached

1.2 INSTALLATION

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

Following shows the actual example of robot installation.

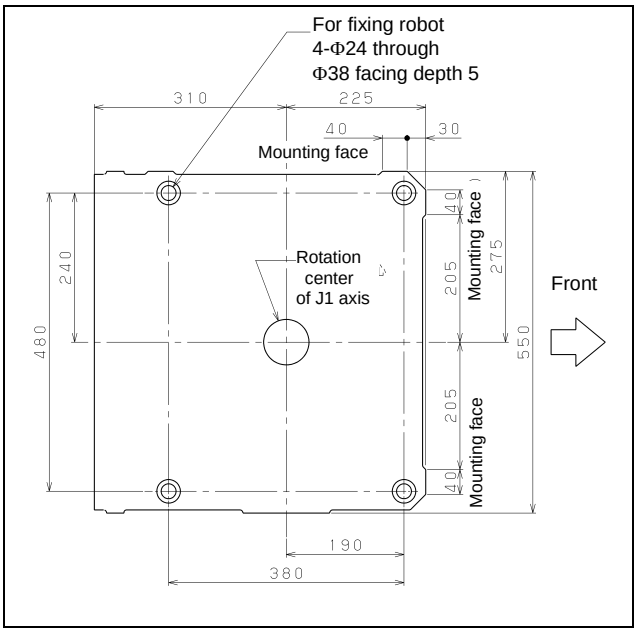


Fig. 1.2 (a) Dimensions of the robot base

Fig.1.2 (b) shows definition of mounting angle. Input angle of mounting surface when you install robot referring to Fig.1.2 (b).

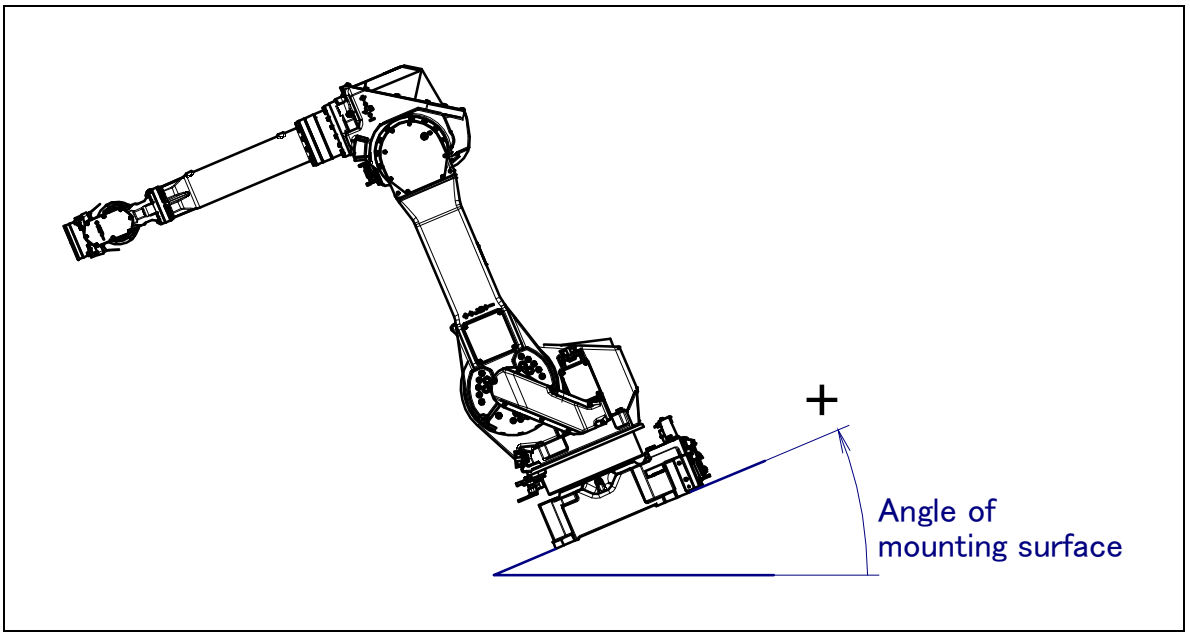


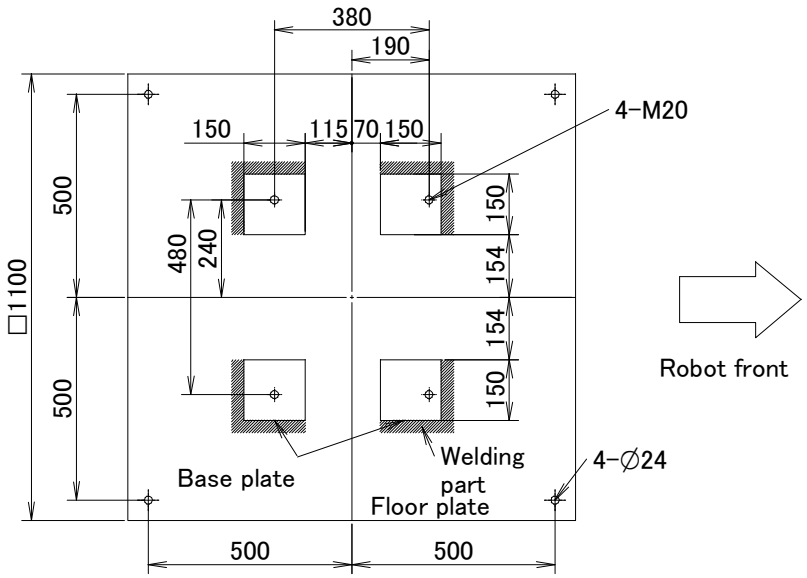
Fig.1.2 (b) Mounting angle

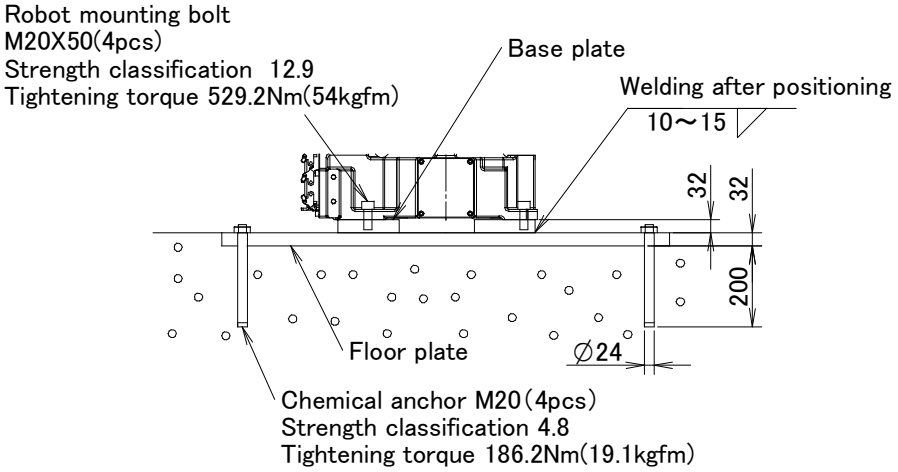
1.2.1 Actual Installation Example

Fig. 1.2.1 (a) shows the actual example of the robot installation.
The floor plate is imbedded in concrete and fastened with four M20 (strength classification 4.8) chemical anchors. Also, fasten the base plate to the robot base using four M20×50 bolts (strength classification 12.9). Next, position the robot, and weld the base plate to the floor plate. (Floor length is 10 to 15mm.)

Parts to be prepared by customer.

Robot mounting bolt	M20X50 (Strength classification 12.9)	4 pcs.
Chemical anchor	M20 (Strength classification 4.8)	4 pcs.
Base plate	Thickness 32t	4 pcs.
Floor plate	Thickness 32t	1 pcs.





(Note 1) Installation work (welding, anchoring.etc) are prepared by customer.
(Note 2) Burry the floor plate in concrete.

Fig. 1.2.1 (a) Actual installation example

Fig. 1.2.1 (b), Table 1.2.1 (a) to Table 1.2.1 (c) indicate the force and moment applied to the base plate at the time of Power off stop of the robot and indicate the stopping distance and time of the J1 through J3 axes until the robot stopping by Power-Off stop or by Controlled stop after input of the stop signal.
Refer to the data when considering the strength of the installation face.

Table1.2.1 (a) Force and moment during Power-Off stop

Model	Vertical moment MV [kNm (kgfm)]	Force in vertical direction FV [kN (kgf)]	Horizontal moment MH [kNm (kgfm)]	Force in horizontal direction FH [kN (kgf)]
M-710*i*C/50, /50E	17.6 (1800)	14.7 (1500)	5.9 (600)	8.0 (820)
M-710*i*C/70	18.6 (1900)	16.0 (1630)	5.9 (600)	8.0 (820)
M-710*i*C/50H	17.6 (1800)	14.7 (1500)	5.9 (600)	8.0 (820)
M-710*i*C/50S	13.2 (1350)	14.7 (1500)	5.9 (600)	7.4 (750)

Table 1.2.1 (b) Stopping time and distance until the robot stopping by Power-Off stop after input of stop signal

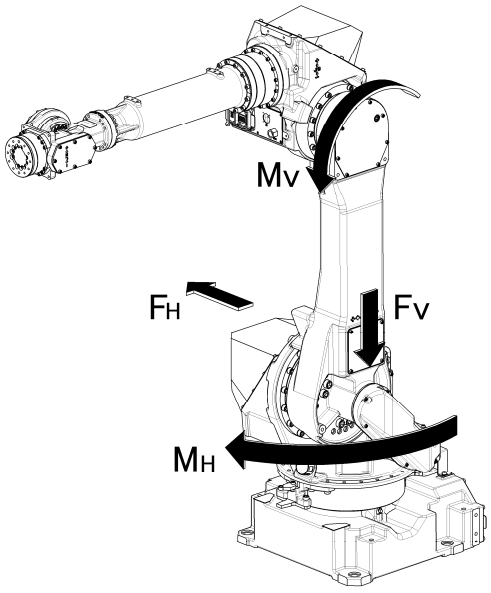
Model		J1-axis	J2-axis	J3-axis
M-710*i*C/50	Stopping time [msec]	310	281	212
	Stopping distance [deg] (rad)	27.1 (0.47)	24.6 (0.43)	18.6 (0.32)
M-710*i*C/50E	Stopping time [msec]	294	286	238
	Stopping distance [deg] (rad)	26.9(0.47)	23.3(0.41)	23.3(0.41)
M-710*i*C/70	Stopping time [msec]	311	205	160
	Stopping distance [deg] (rad)	24.9 (0.43)	12.3 (0.21)	9.6 (0.17)
M-710*i*C/50H	Stopping time [msec]	284	252	220
	Stopping distance [deg] (rad)	28.9(0.50)	22.9(0.40)	21.5(0.38)
M-710*i*C/50S	Stopping time [msec]	166	155	151
	Stopping distance [deg] (rad)	14.5 (0.25)	13.6 (0.24)	13.2 (0.23)

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

Table1.2.1 (c) Stopping time and distance until the robot stopping by Controlled stop after input of stop signal

Model		J1-axis	J2-axis	J3-axis
M-710*i*C/50	Stopping time [msec]	636	644	628
	Stopping distance [deg] (rad)	60.5 (1.06)	62.5 (1.09)	60.4 (1.05)
M-710*i*C/50E	Stopping time [msec]	638	654	630
	Stopping distance [deg] (rad)	60.7(1.06)	61.1(1.07)	60.5(1.06)
M-710*i*C/70	Stopping time [msec]	756	764	708
	Stopping distance [deg] (rad)	63.9 (1.11)	47.5 (0.83)	46.3 (0.81)
M-710*i*C/50H	Stopping time [msec]	652	644	636
	Stopping distance [deg] (rad)	61.2(1.07)	61.2(1.07)	61.6(1.07)
M-710*i*C/50S	Stopping time [msec]	492	492	492
	Stopping distance [deg] (rad)	49.0 (0.85)	47.8 (0.83)	47.8 (0.83)

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



*

Fig. 1.2.1 (b) Force during Power-Off Stop

1.3 MAINTENANCE AREA

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

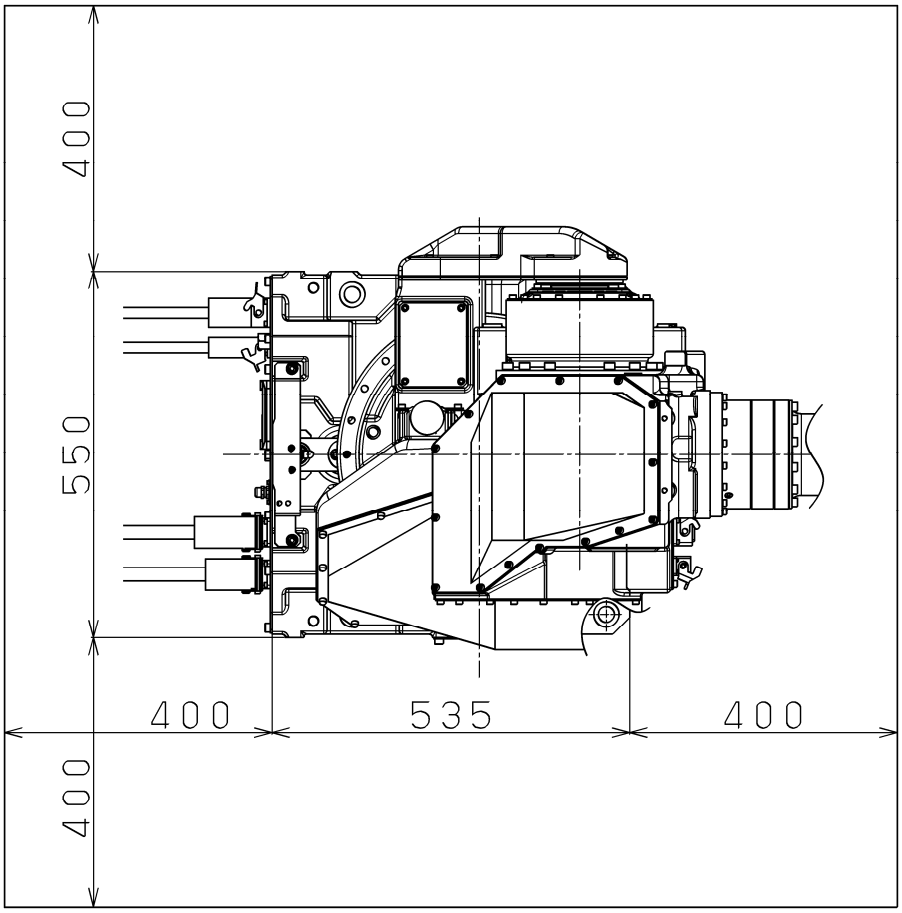


Fig. 1.3 Maintenance area

1.4 INSTALLATION SPECIFICATIONS

See Section 3.1 and caution below about robot installation specifications.

> **⚠CAUTION**
> The wound of coating of robot connection cable causes the flood. Please note handling enough when setting it up, and exchange it when damaging.

2 CONNECTION WITH THE CONTROLLER

2.1 CONNECTION WITH THE CONTROLLER

The robot is connected with the controller (NC) via the power cable and signal cable. Connect these cables to the connectors on the back of the base.

For details on air and option cables, see Chapter 5.

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

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

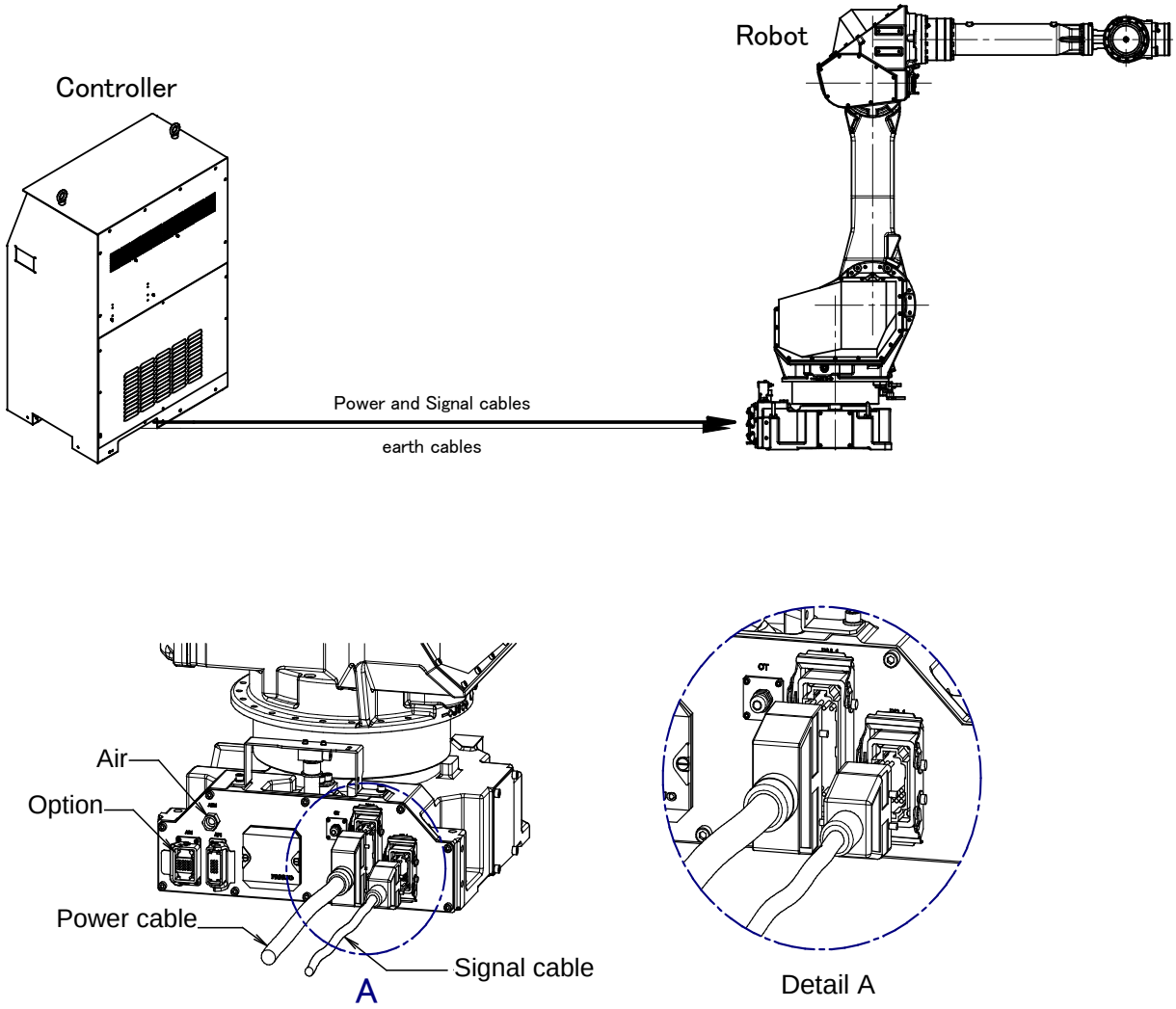


Fig. 2.1 Cable connection

3 BASIC SPECIFICATIONS

3.1 ROBOT CONFIGURATION

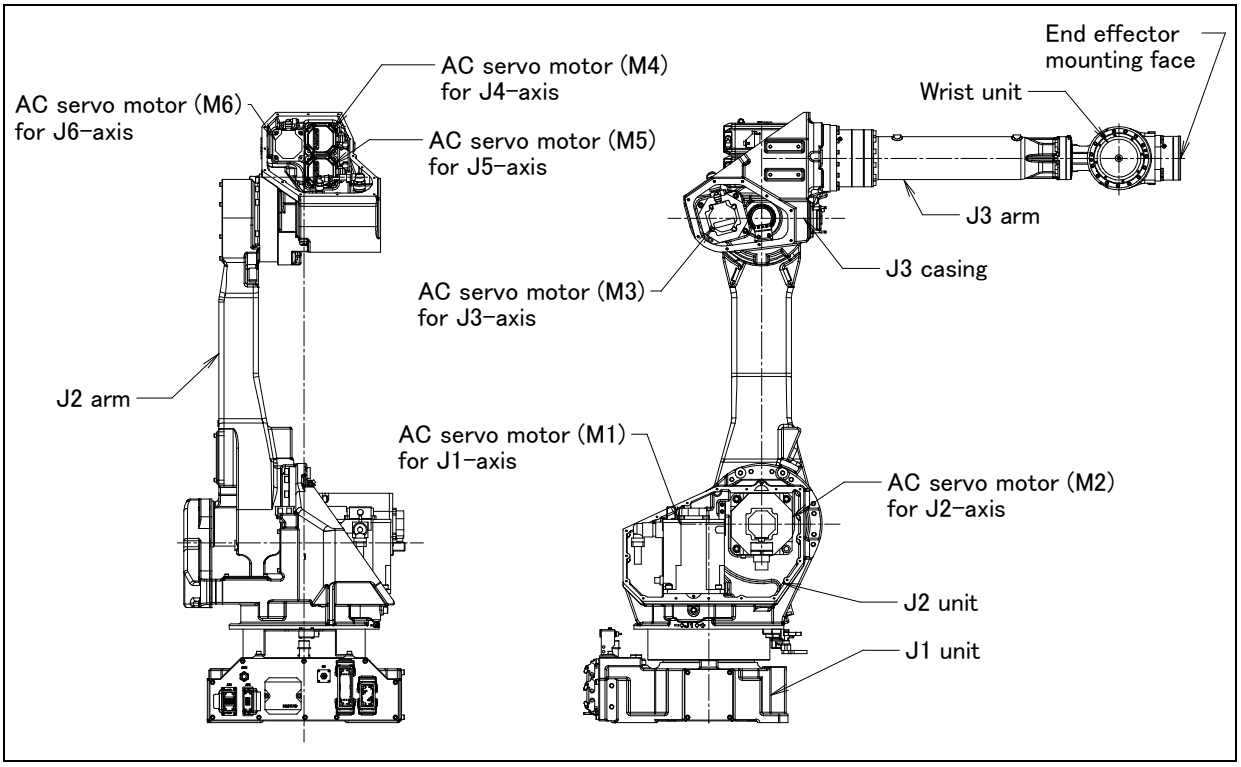


Fig. 3.1 (a) Mechanical unit configuration (M-710*i*C/50, M-710*i*C/70)

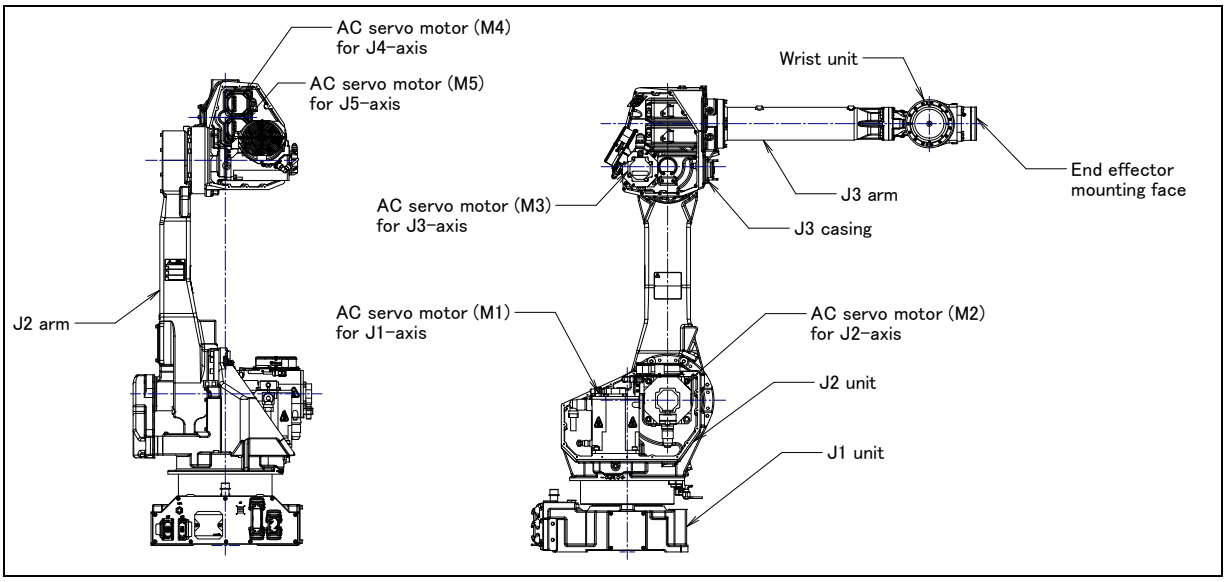


Fig. 3.1 (b) Mechanical unit configuration (M-710*i*C/50H)

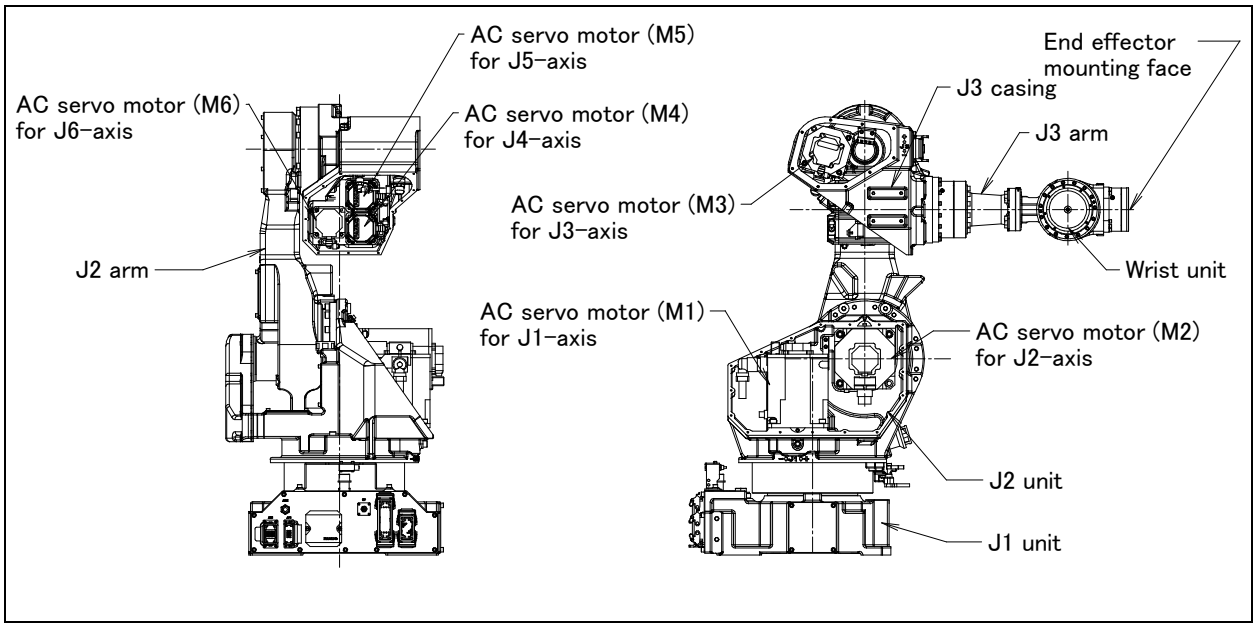


Fig. 3.1 (c) Mechanical unit configuration (M-710*i*C/50S)

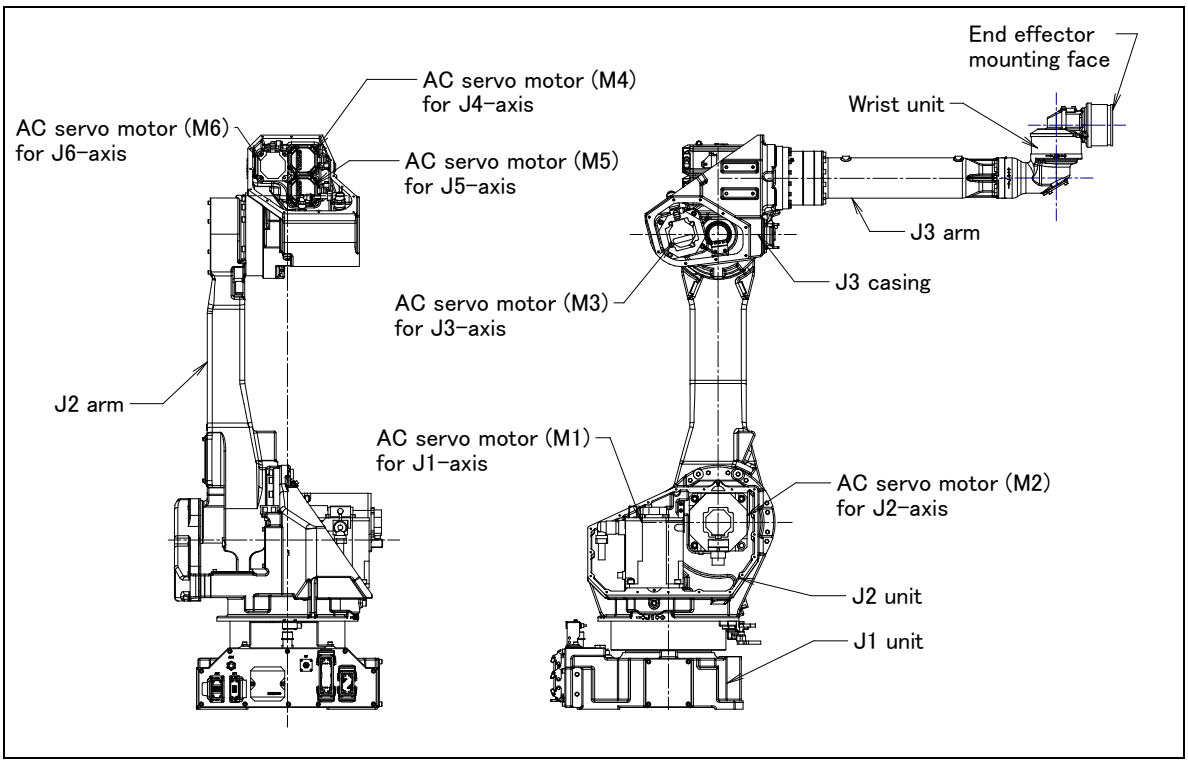


Fig. 3.1 (d) Mechanical unit configuration (M-710*i*C/50E)

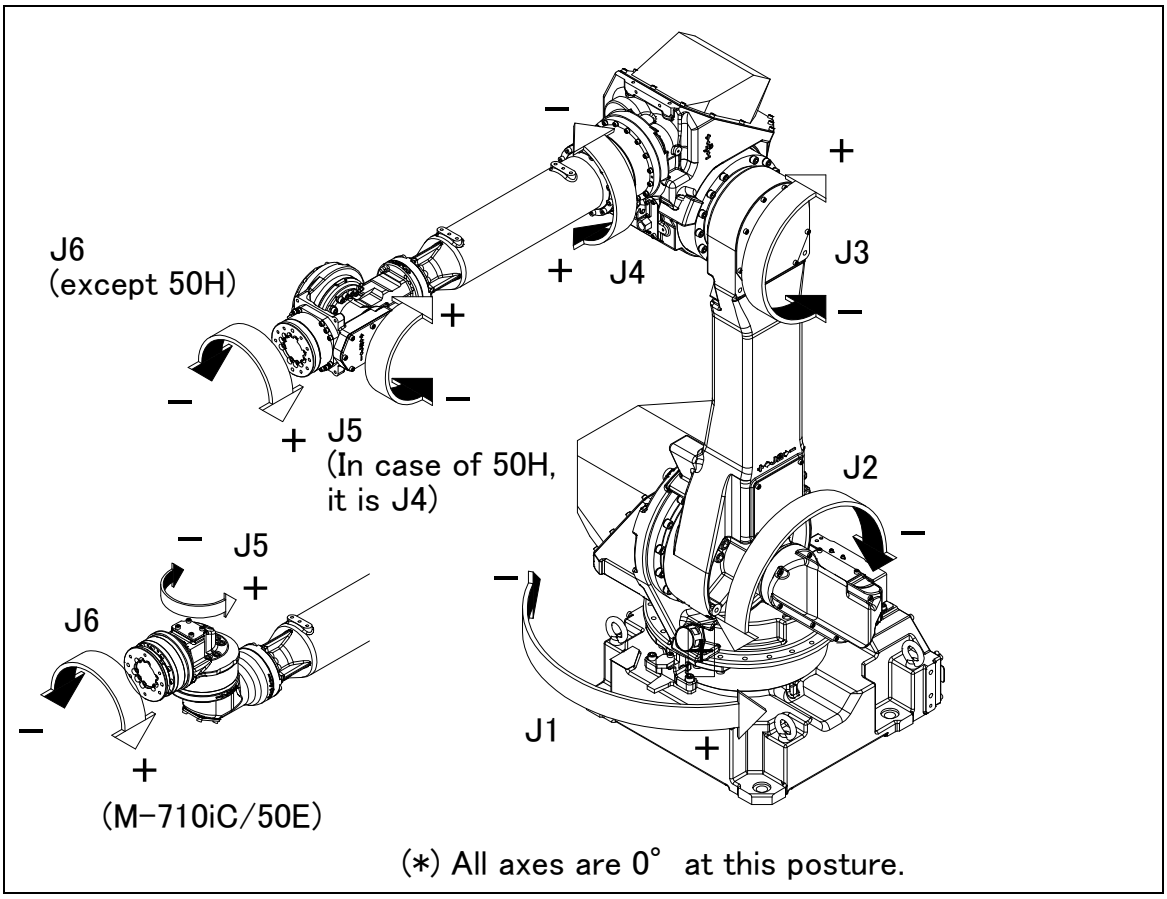


Fig. 3.1 (e) Each axis coordinates

Specifications (1/2)

			M-710*i*C/50	M-710*i*C/70	M-710*i*C/50H
Type			Articulated Type		
Controlled axes			6 axes (J1, J2, J3, J4, J5, J6)		5 axes (J1, J2, J3, J4, J5)
Installation			Floor, upside-down, wall & angle mount		Floor, upside-down
Motion range	J1-axis	Upper limit	180° (3.14rad)	180° (3.14rad)	180°(3.14rad)
		Lower limit	-180° (-3.14rad)	-180° (-3.14rad)	-180° (-3.14rad)
	J2-axis	Upper limit	135° (2.35rad)	135° (2.35rad)	135° (2.35rad)
		Lower limit	-90° (-1.57rad)	-90° (-1.57rad)	-90° (-1.57rad)
	J3-axis	Upper limit	280° (4.88rad)	280° (4.88rad)	280° (4.88rad)
		Lower limit	-160° (-2.79rad)	-160° (-2.79rad)	-160° (-2.79rad)
	J4-axis	Upper limit	360° (6.28rad)	360° (6.28rad)	117° (2.04rad)
		Lower limit	-360° (-6.28rad)	-360° (-6.28rad)	-117° (-2.04rad)
	J5-axis	Upper limit	125° (2.18rad)	125° (2.18rad)	360° (6.28rad)
		Lower limit	-125° (-2.18rad)	-125° (-2.18rad)	-360° (-6.28rad)
	J6-axis	Upper limit	360° (6.28rad)	360° (6.28rad)	
		Lower limit	-360° (-6.28rad)	-360° (-6.28rad)	
Max motion speed (Note 1)	J1-axis		175° /s (3.05rad/s)	160° /s (2.79rad/s)	175°/s (3.05rad/s)
	J2-axis		175° /s (3.05rad/s)	120° /s (2.09rad/s)	175°/s (3.05rad/s)
	J3-axis		175° /s (3.05rad/s)	120° /s (2.09rad/s)	175°/s (3.05rad/s)
	J4-axis		250° /s (4.36rad/s)	225° /s (3.93rad/s)	175°/s (3.05rad/s)
	J5-axis		250° /s (4.36rad/s)	225° /s (3.93rad/s)	720°/s (12.57rad/s)
	J6-axis		355° /s (6.20rad/s)	225° /s (3.93rad/s)	
Max. load capacity	At wrist		50kg	70kg	50kg
	On J3 casing (Note 2)		15kg	15kg	15kg
Allowable load moment at wrist	J4		206N・m (21kgf・m)	294N・m (30kgf・m)	150N・m (15.3kgf・m)
	J5		206N・m (21kgf・m)	294N・m (30kgf・m)	68N・m (6.9kgf・m)
	J6		127N・m (13kgf・m)	147N・m (15kgf・m)	
Allowable load inertia at wrist	J4		28kg・m^2 (286kgf・cm・s^2)	28kg・m^2 (286kgf・cm・s^2)	6.3kg・m^2 (64.3kgf・cm・s^2)
	J5		28kg・m^2 (286kgf・cm・s^2)	28kg・m^2 (286kgf・cm・s^2)	2.5kg・m^2 (25.5kgf・cm・s^2)
	J6		11kg・m^2 (112kgf・cm・s^2)	11kg・m^2 (112kgf・cm・s^2)	
Drive method			Electric servo drive by AC servo motor		
Repeatability			±0.07mm		±0.15mm
Mass			560kg	560kg	540kg
Acoustic noise level (Note 2)			71.3dB NOTE This value is equivalent continuous A-weighted sound pressure level that applied with ISO11201 (EN31201). This value is measured with the following conditions. Maximum load and speed - Operating mode is AUTO		
Installation environment			Ambient temperature: 0 - 45°C (Note 3) Ambient humidity: Normally 75%RH or less No dew, nor frost allowed. Short time (within one month) Max 95%RH Height: Up to 1,000 meters above the sea level required, no particular provision for attitude. Vibration: 0.5G or less Free of corrosive gases (Note 4)		

NOTE

1 In case of short distance motion, the axis speed doesn't reach maximum one.
2 The Max. load capacity at J3 casing is restricted by the load weight at wrist. For details, see Section 3.5.
3 When robot is used in low temperature environment that is near to 0ºC,or robot is not operated for a long time in the environment that is less than 0ºC in a holiday or the night, because viscous resistance of the drive train is so big that may cause occurrence of collision detect alarm (SRVO –050) etc. In this case, we recommend performing the warm up operation for several minutes.
4 Contact the service representative, if the robot is to be used in an environment or a place subjected to severe vibrations, heavy dust, cutting oil splash and or other foreign substances.

Specifications (2/2)

			M-710*i*C/50S	M-710*i*C/50E
Type			Articulated Type	
Controlled axes			6 axes (J1, J2, J3, J4, J5, J6)	
Installation			Floor, upside-down, wall & angle mount	
Motion range	J1-axis	Upper limit	180° (3.14rad)	180° (3.14rad)
		Lower limit	-180° (-3.14rad)	-180° (-3.14rad)
	J2-axis	Upper limit	112° (1.95rad)	135° (2.35rad)
		Lower limit	-57° (-0.99rad)	-90° (-1.57rad)
	J3-axis	Upper limit	279° (4.87rad)	280° (4.88rad)
		Lower limit	-97° (-1.69rad)	-160° (-2.79rad)
	J4-axis	Upper limit	360° (6.28rad)	360° (6.28rad)
		Lower limit	-360° (-6.28rad)	-360° (-6.28rad)
	J5-axis	Upper limit	125° (2.18rad)	190° (3.31rad)
		Lower limit	-125° (-2.18rad)	-190° (-3.31rad)
	J6-axis	Upper limit	360° (6.28rad)	360° (6.28rad)
		Lower limit	-360° (-6.28rad)	-360° (-6.28rad)
Max motion speed (Note 1)	J1-axis		175°/s (3.05rad/s)	175°/s (3.05rad/s)
	J2-axis		175°/s (3.05rad/s)	175°/s (3.05rad/s)
	J3-axis		175°/s (3.05rad/s)	175°/s (3.05rad/s)
	J4-axis		250°/s (4.36rad/s)	250°/s (4.36rad/s)
	J5-axis		250°/s (4.36rad/s)	240°/s (4.19rad/s)
	J6-axis		355°/s (6.20rad/s)	340°/s (5.93rad/s)
Max. load capacity	At wrist		50kg	
	On J3 casing (Note 2)		15kg	
Allowable load moment at wrist	J4-axis		206N·m (21kgf·m)	206N・m (21kgf・m)
	J5-axis		206N·m (21kgf·m)	176N・m (18kgf・m)
	J6-axis		127N·m (13kgf·m)	98N・m (10kgf・m)
Allowable load inertia at wrist	J4-axis		28kg·m^2 (286kgf·cm·s^2)	28kg・m^2 (286kgf・cm・s^2)
	J5-axis		28kg·m^2 (286kgf·cm·s^2)	10.8kg・m^2 (110kgf・cm・s^2)
	J6-axis		11kg·m^2 (112kgf·cm·s^2)	3.3kg・m^2 (34kgf・cm・s^2)
Drive method			Electric servo drive by AC servo motor	
Repeatability			±0.07mm	
Mass			545kg	560kg
Acoustic noise level			71.3dB NOTE This value is equivalent continuous A-weighted sound pressure level that applied with ISO11201 (EN31201). This value is measured with the following conditions. - Maximum load and speed - Operating mode is AUTO	
Installation environment			Ambient temperature: 0 - 45°C (Note 3) Ambient humidity: Normally 75%RH or less No dew, nor frost allowed. Short time (within one month) Max 95%RH Height: Up to 1,000 meters above the sea level required, no particular provision for attitude. Vibration: 0.5G or less Free of corrosive gases (Note 4)	

NOTE

1 In case of short distance motion, the axis speed doesn't reach maximum one.
2 The Max. load capacity at J3 casing is restricted by the load weight at wrist. For details, see Section 3.5.
3 When robot is used in low temperature environment that is near to 0ºC,or robot is not operated for a long time in the environment that is less than 0ºC in a holiday or the night, because viscous resistance of the drive train is so big that may cause occurrence of collision detect alarm (SRVO –050) etc. In this case, we recommend performing the warm up operation for several minutes.

NOTE
4 Contact the service representative, if the robot is to be used in an environment or a place subjected to severe vibrations, heavy dust, cutting oil splash and or other foreign substances.

3.2 MECHANICAL UNIT OPERATION AREA AND INTERFERENCE AREA

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

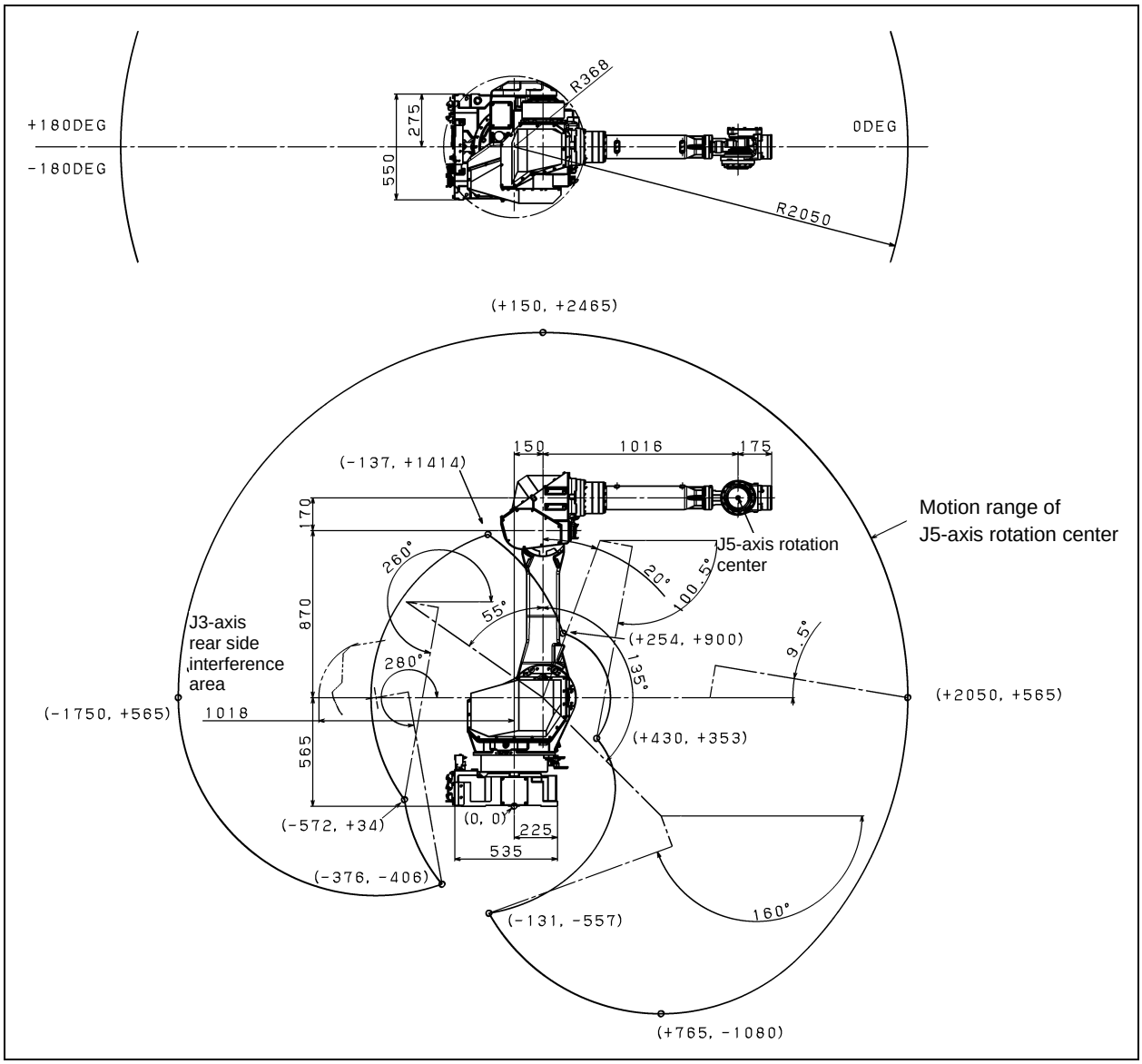


Fig. 3.2 (a) Interference area (M-710*i*C/50, /70)

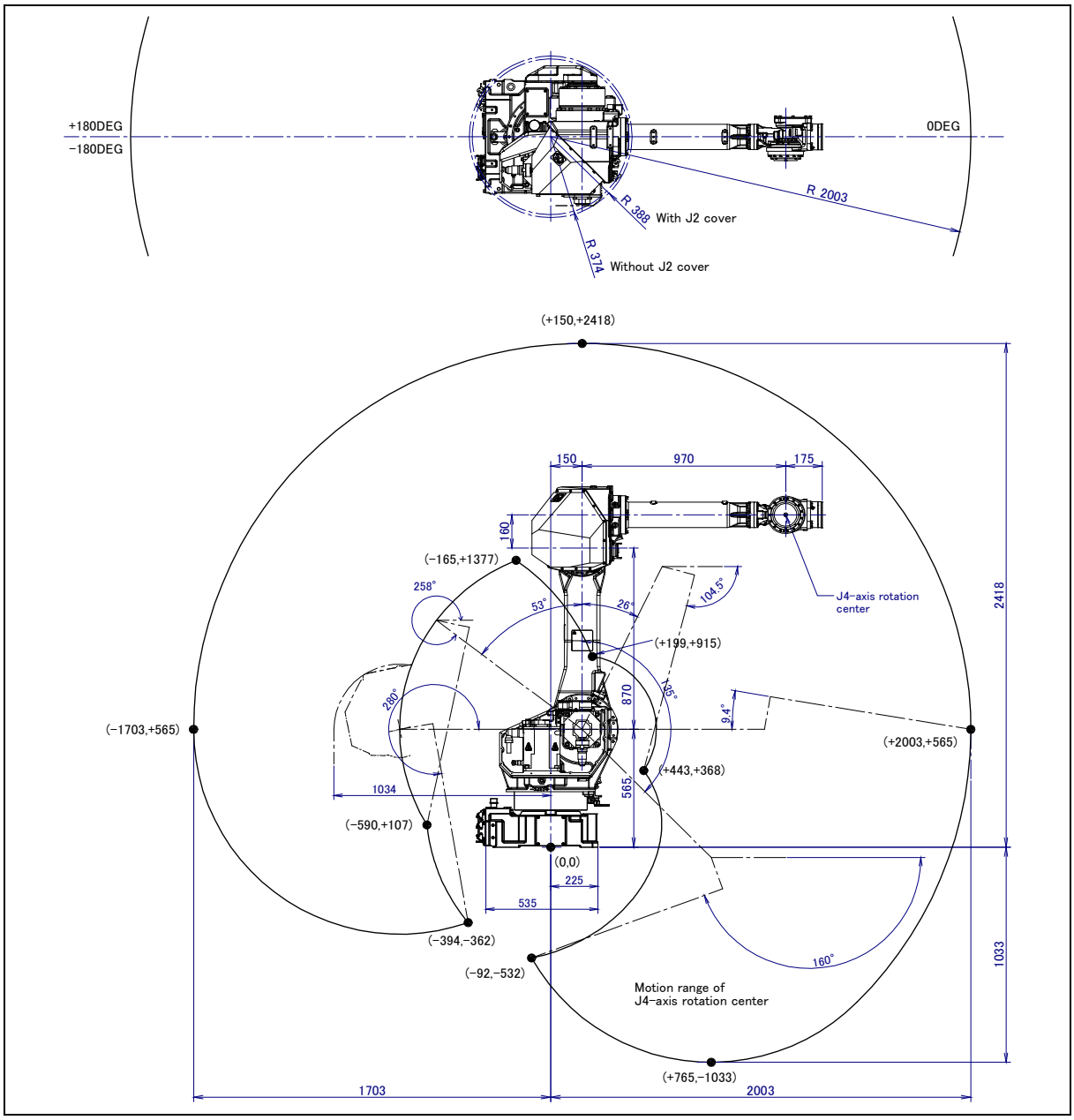


Fig. 3.2 (b) Interference area (M-710*i*C/50H)

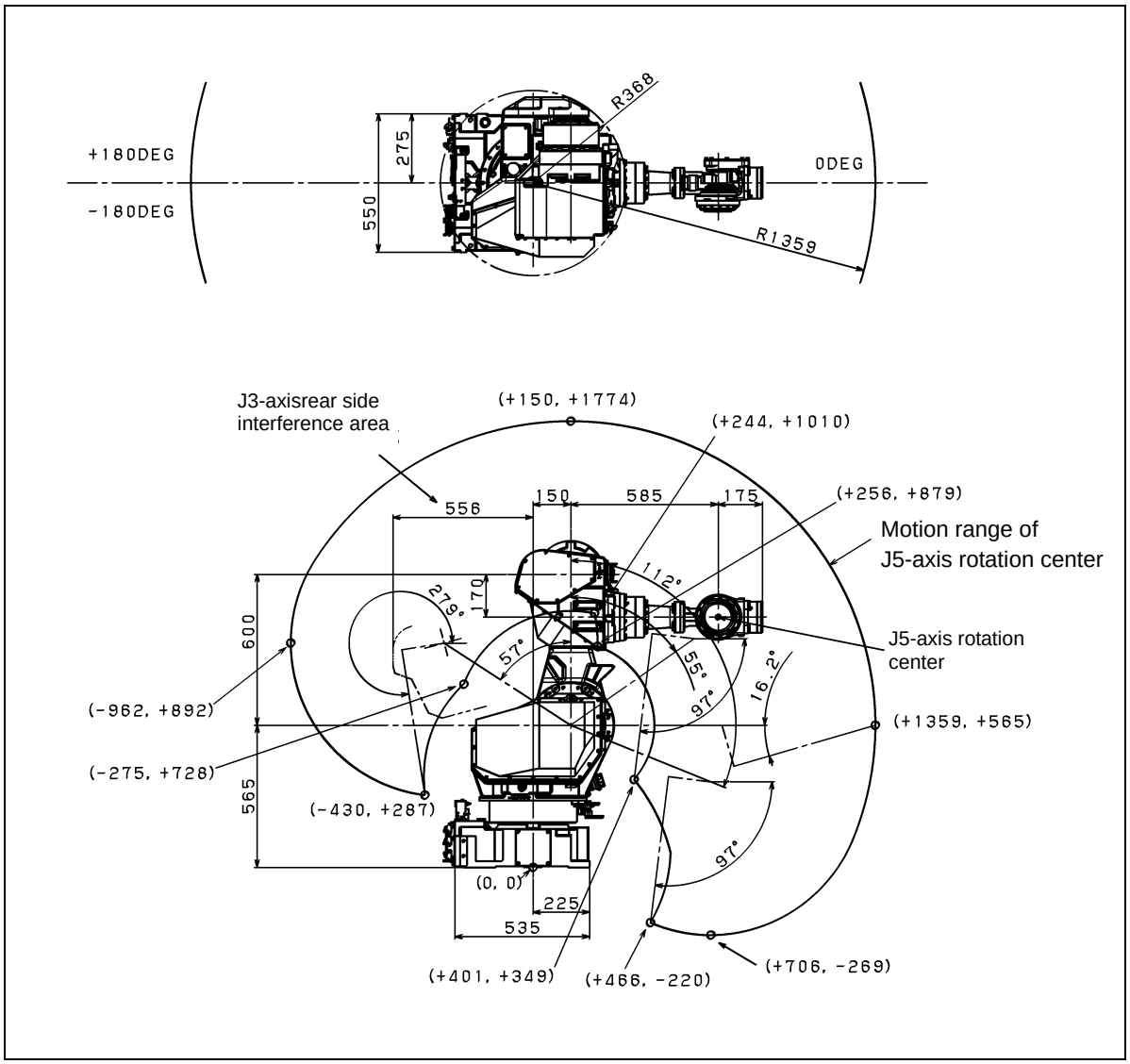


Fig. 3.2 (c) Interference area (M-710*i*C/50S)

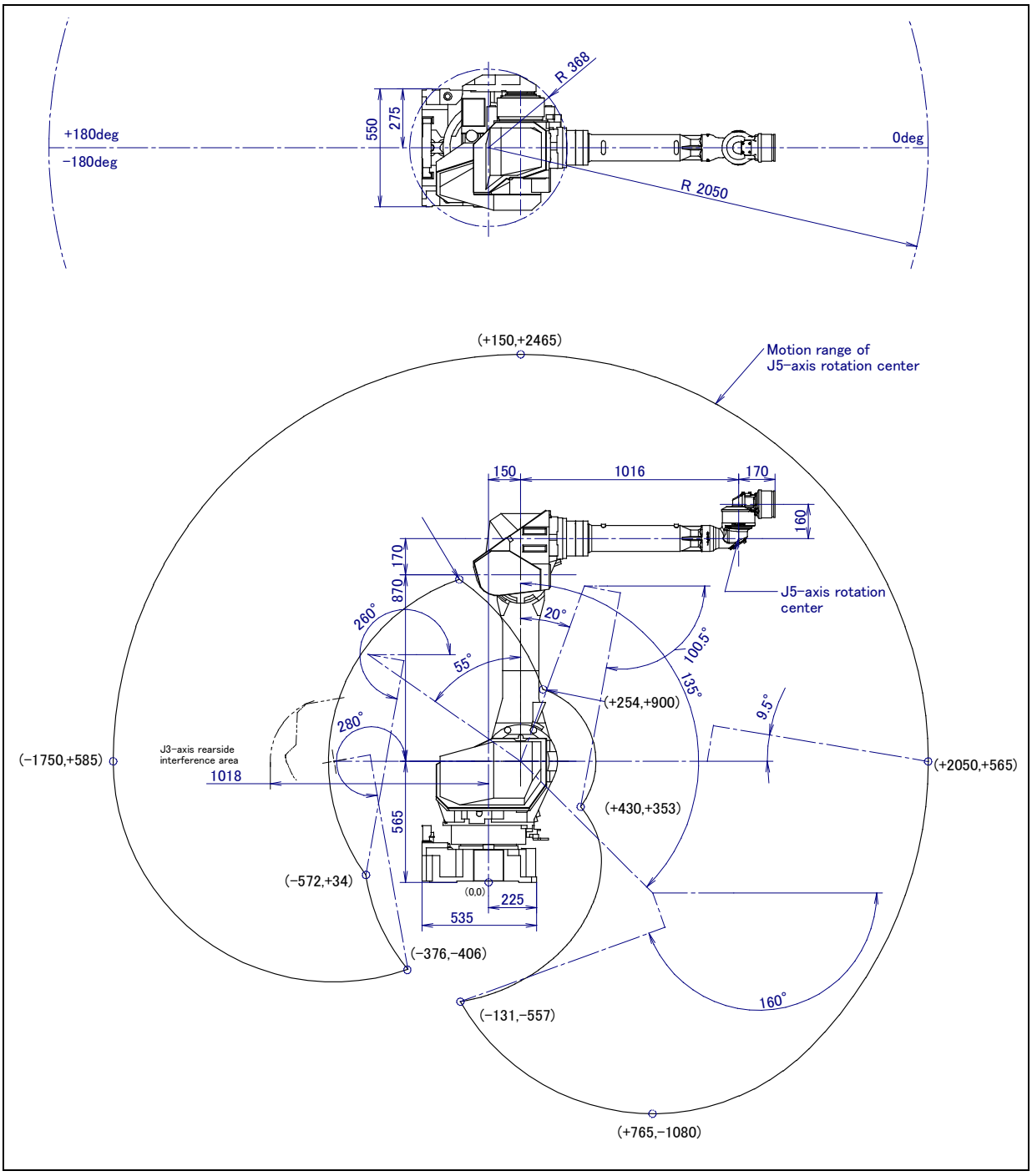


Fig. 3.2 (d) Interference area (M-710*i*C/50E)

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 or limit switch is also prepared to improve safety.

Fig 3.3 (a) shows the position of mechanical stopper. See Section 6.2 about movable mechanical stopper. There is no mechanical stopper for J5-axis of M-710*i*C/50E.

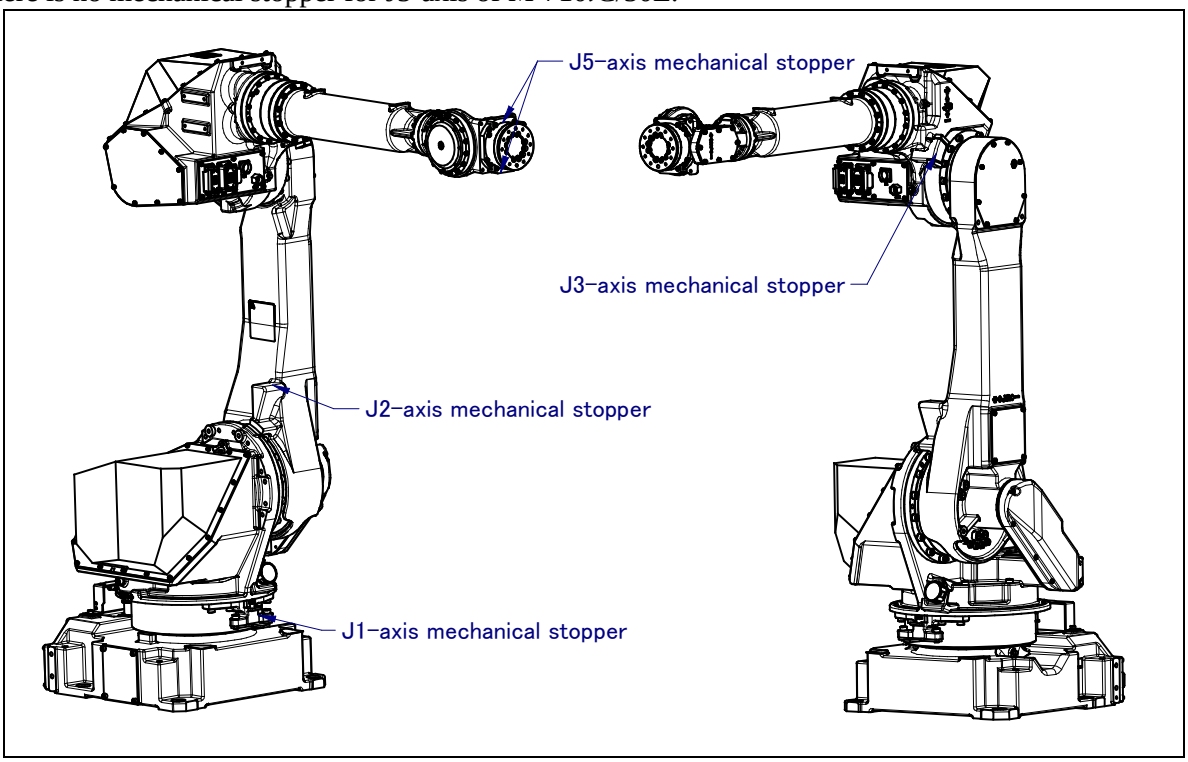


Fig. 3.3 (a) Position of mechanical stopper

Fig.3.3 (b) - (l) show the zero point and motion limit, LS detection position, and maximum stopping distance (stopping distance in condition of max.speed and max.load) of each axis.

Only in case of J1 to J3 axis, robot stops by transforming mechanical stopper. Be sure to exchange transformed stopper to new one. Don’t reconstruct the mechanical stopper. There is a possibility that the robot doesn't stop normally.

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

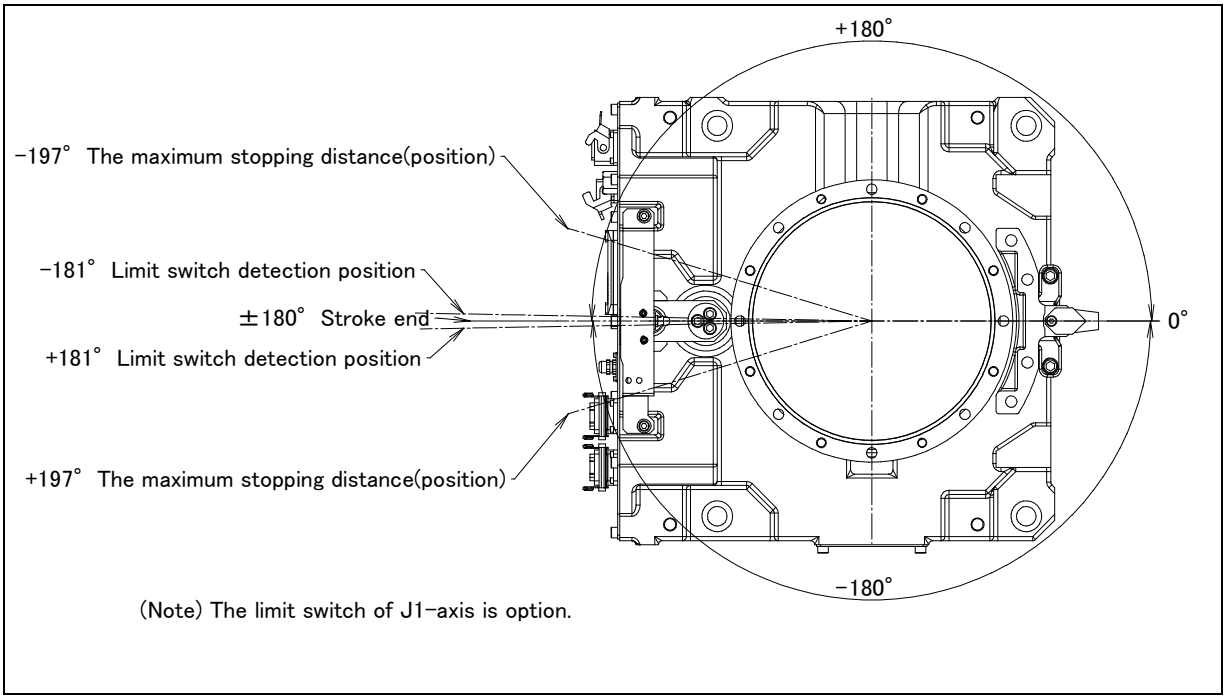


Fig. 3.3 (b) J1-axis motion limit (M-710*i*C/50, 70, 50H,50S, 50E)

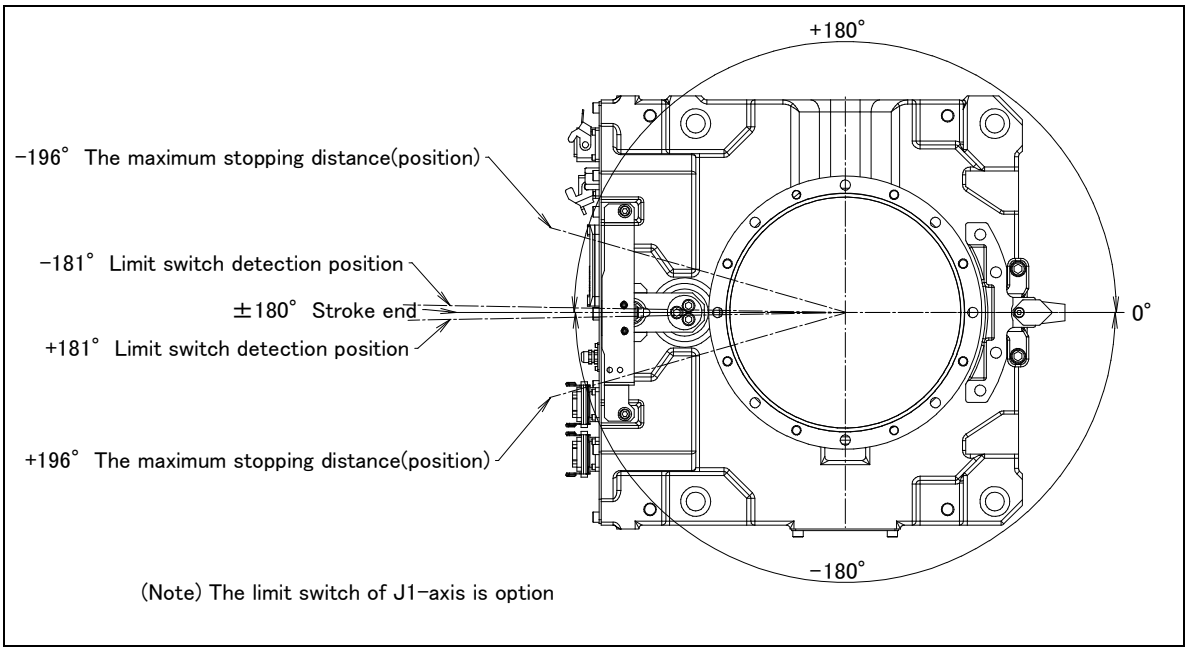


Fig. 3.3 (c) J1-axis motion limit (M-710*i*C/70)

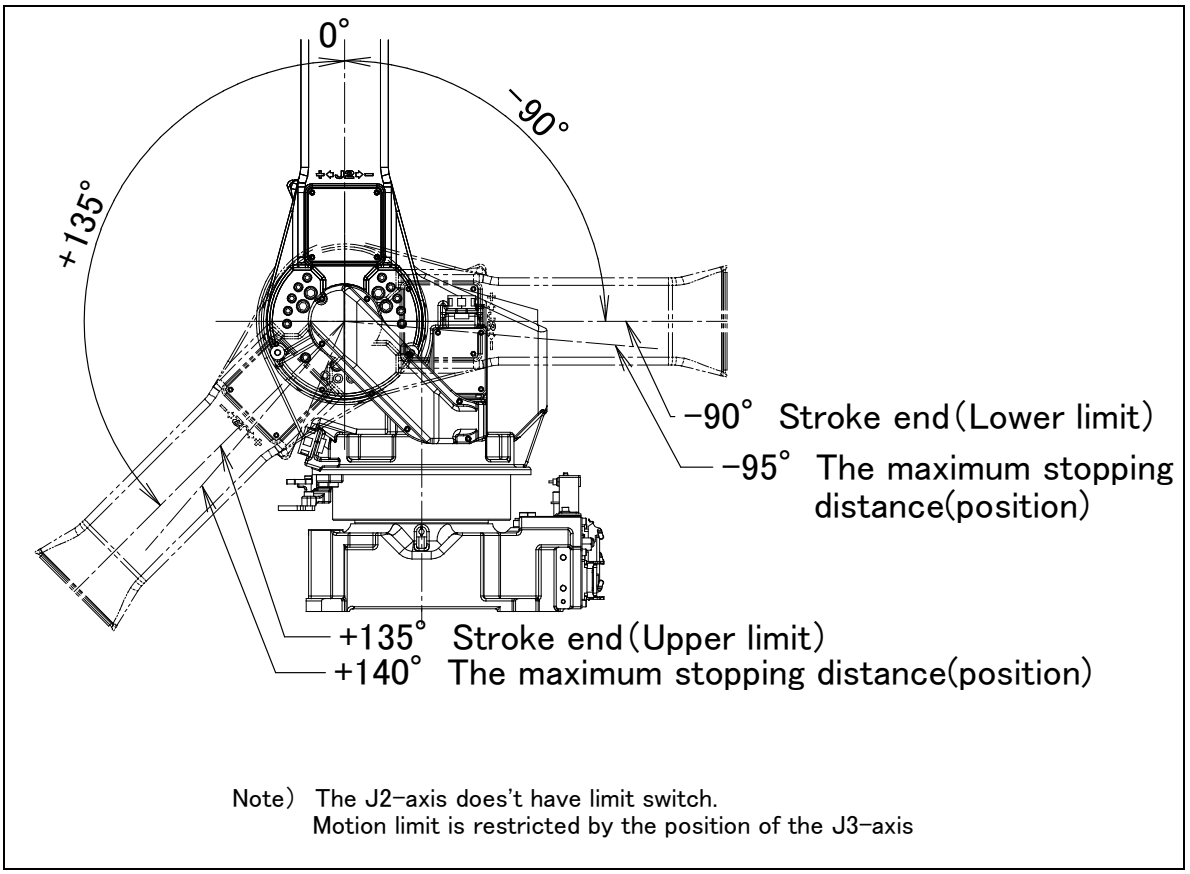


Fig. 3.3 (d) J2-axis motion limit (M-710*i*C/50, 70, 50H, 50E)

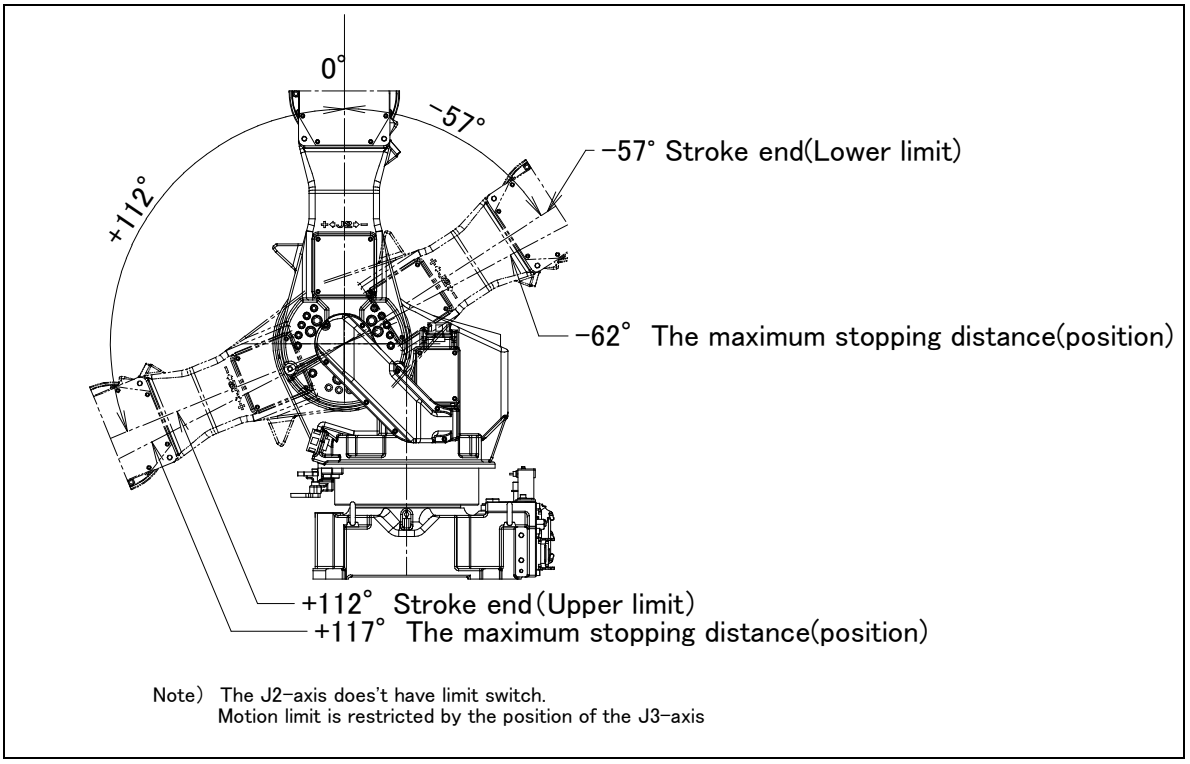


Fig. 3.3 (e) J2-axis motion limit (M-710*i*C/50S)

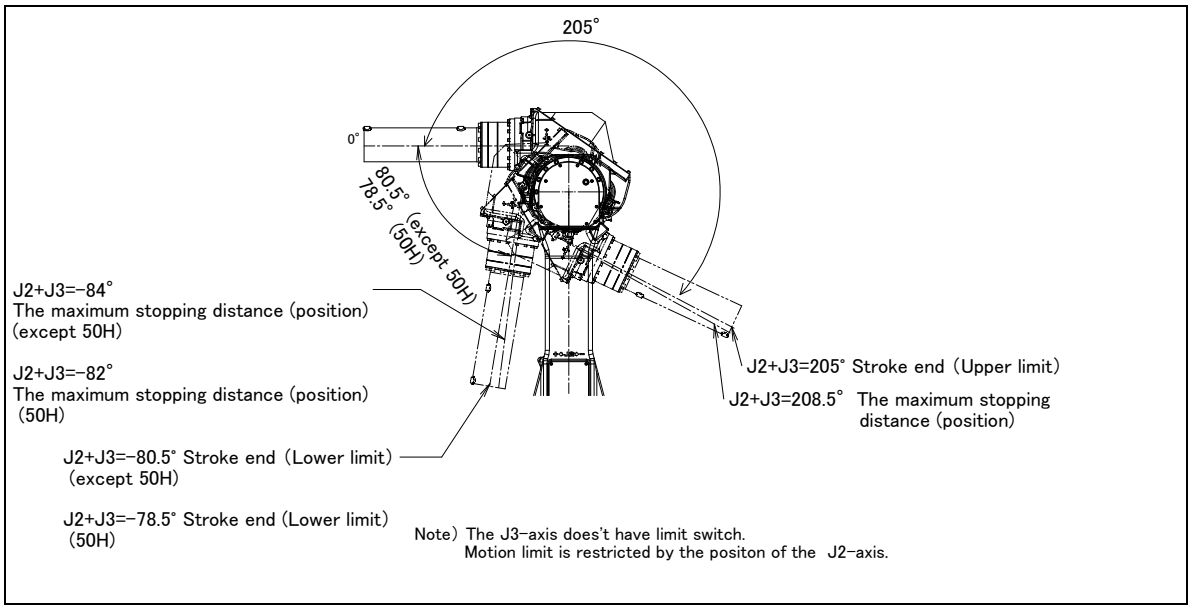


Fig. 3.3 (f) J3-axis motion limit (M-710*i*C/50, 70, 50H, 50E)

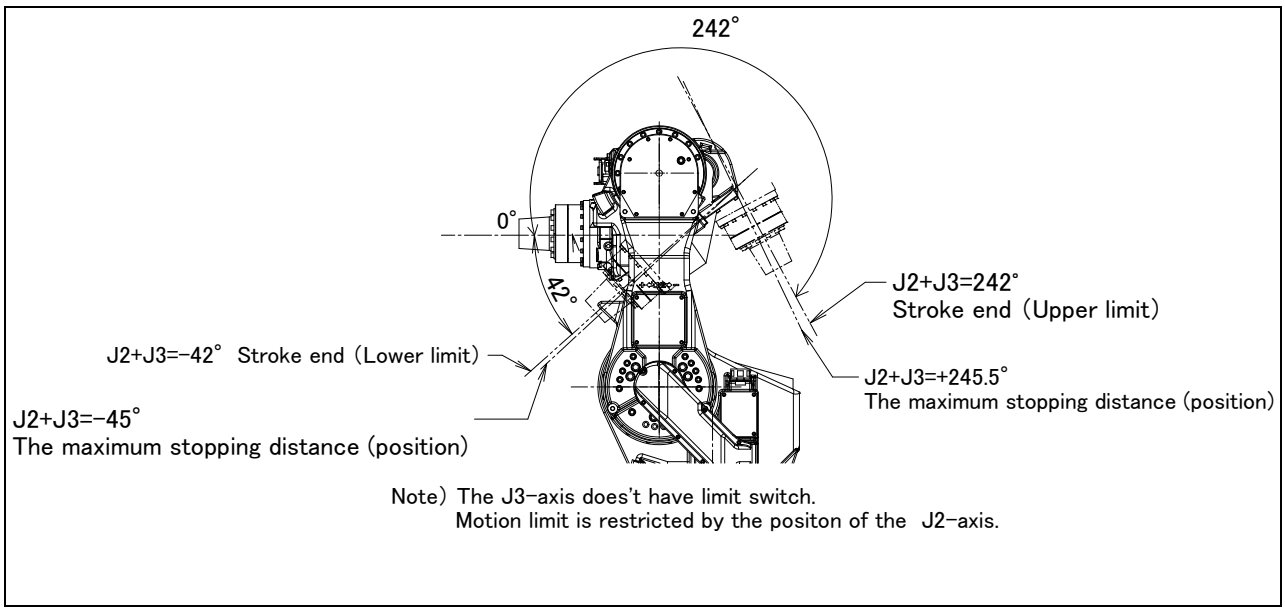


Fig. 3.3 (g) J3-axis motion limit (M-710*i*C/50S)

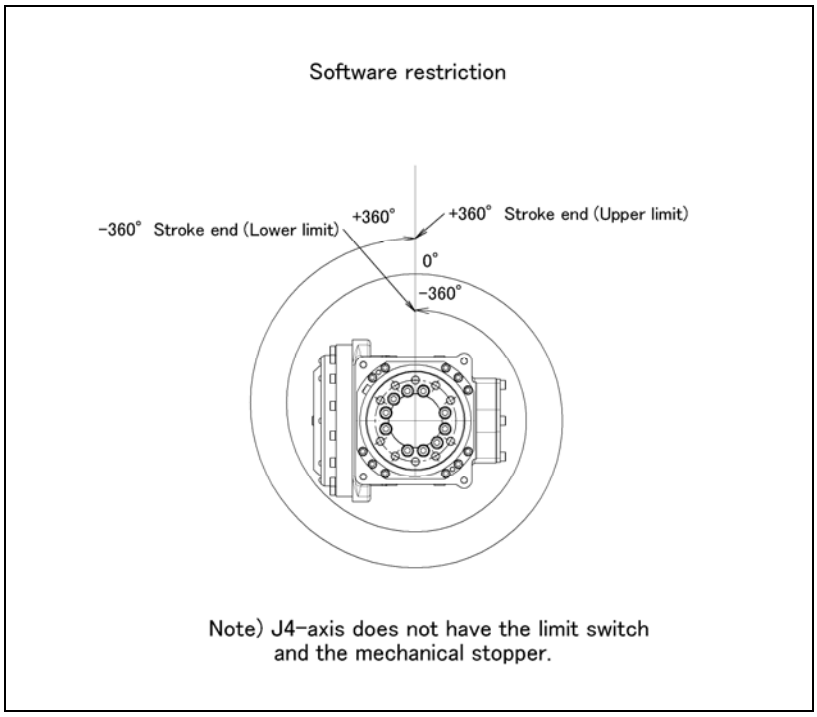


Fig. 3.3 (h) J4-axis motion limit (Except M-710*i*C/50H)

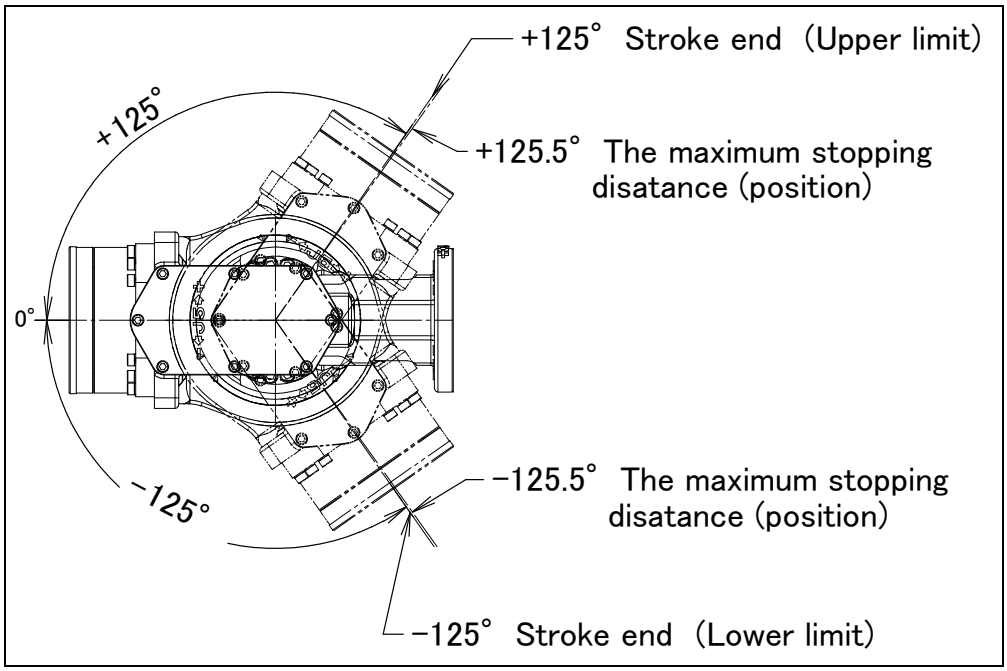


Fig. 3.3 (i) J5-axis motion limit (M-710*i*C/50, 70, 50S)

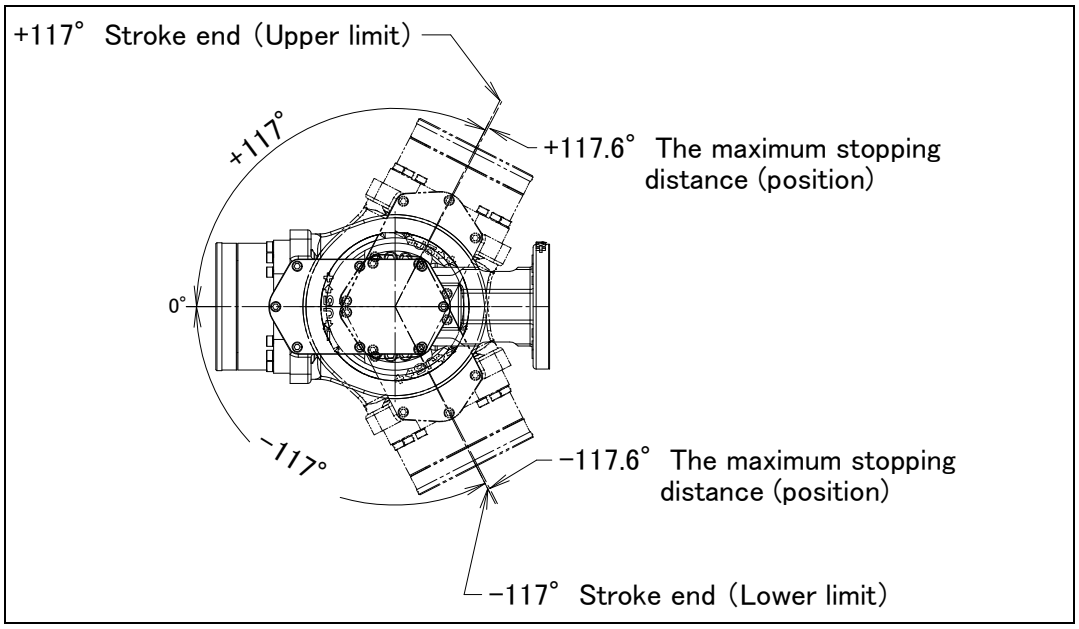


Fig. 3.3 (j) J4-axis motion limit (M-710*i*C/50H)

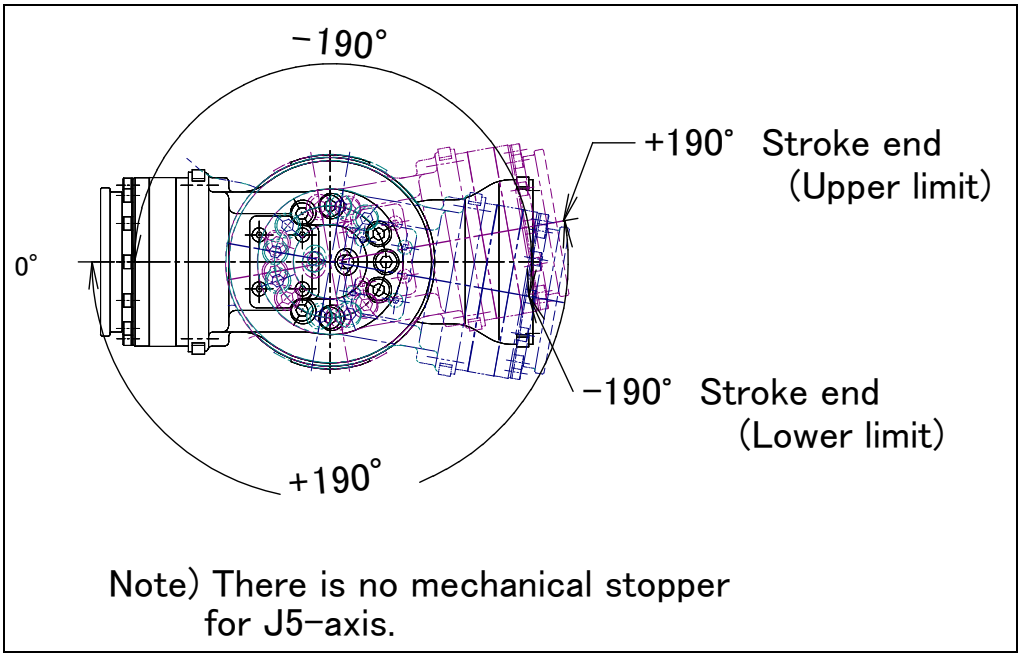


Fig. 3.3 (k) J5-axis motion limit (M-710*i*C/50E)

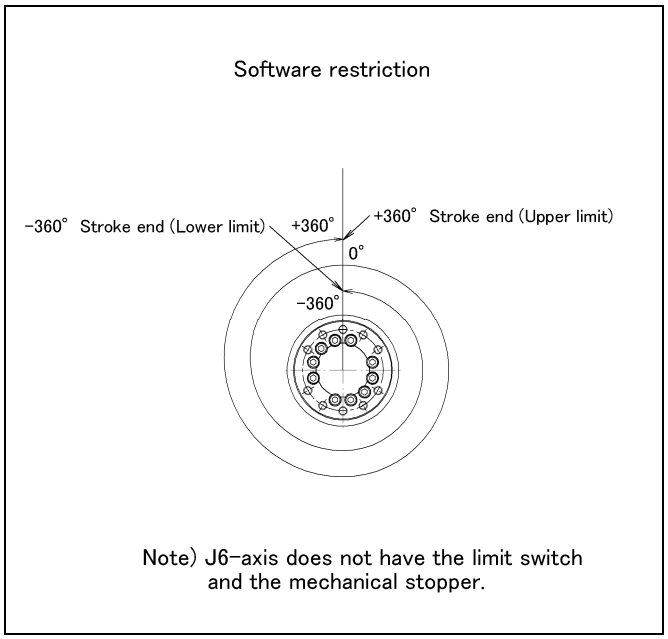


Fig. 3.3 (l) J6-axis motion limit (Except M-710*i*C/50H)
J5-axis motion limit (M-710*i*C/50H)

3.4 WRIST LOAD CONDITIONS

Fig. 3.4 (a) to (d) are diagrams to limit loads applied to the wrist. 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 allowable load moment and the allowable load inertia.

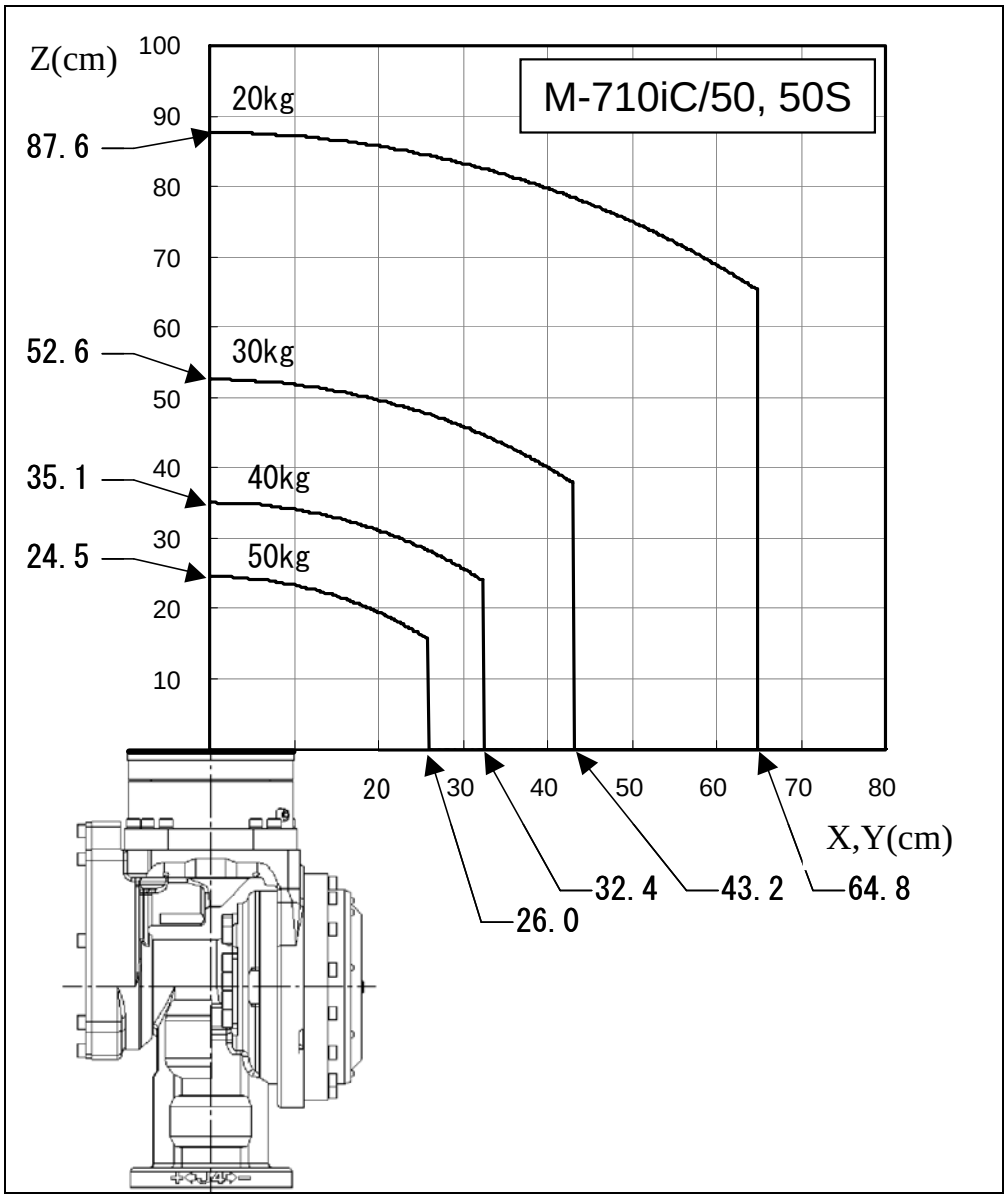


Fig. 3.4 (a) Wrist load diagram (M-710*i*C/50, M-710*i*C/50S)

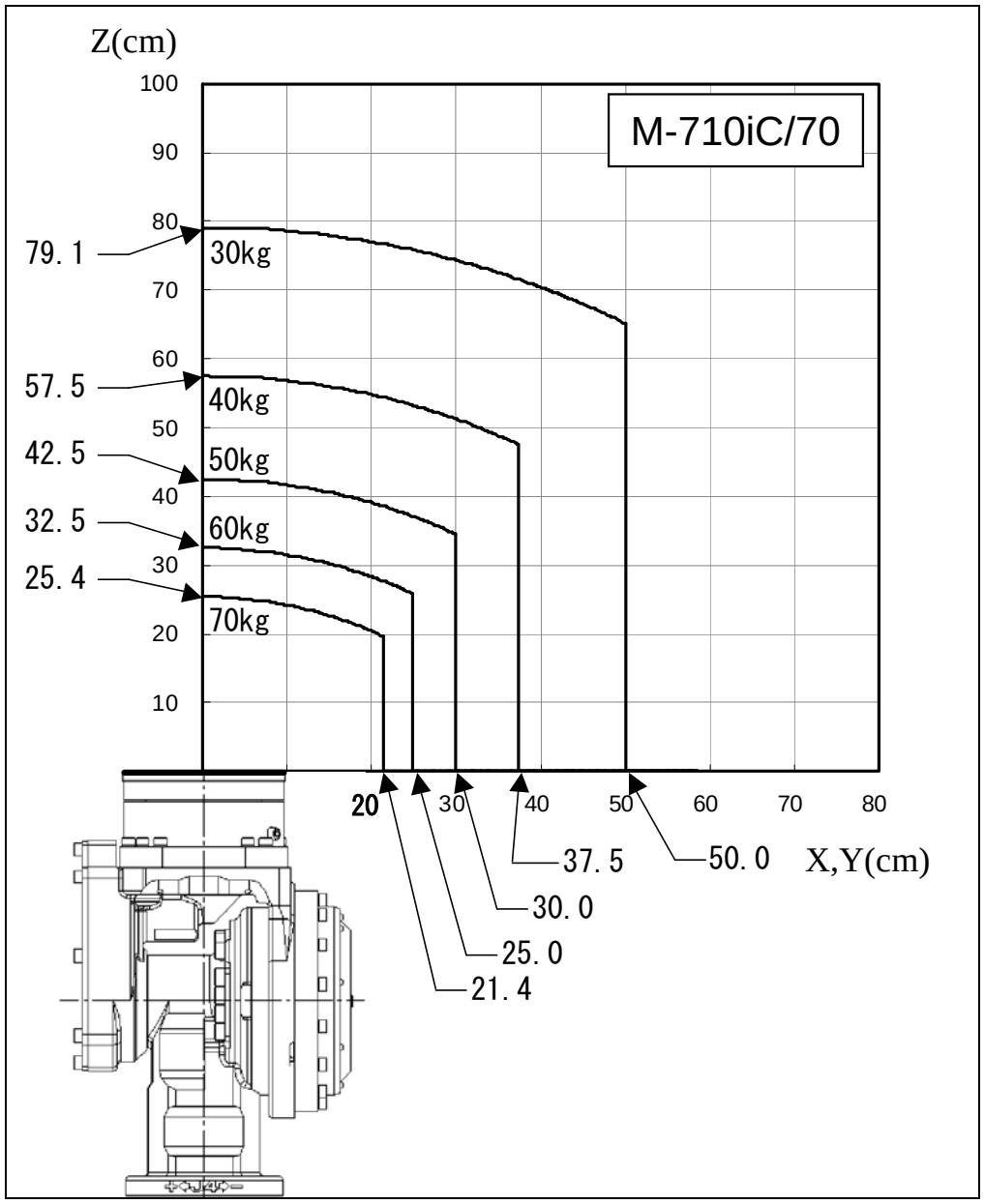


Fig. 3.4 (b) Wrist load diagram (M-710*i*C/70)

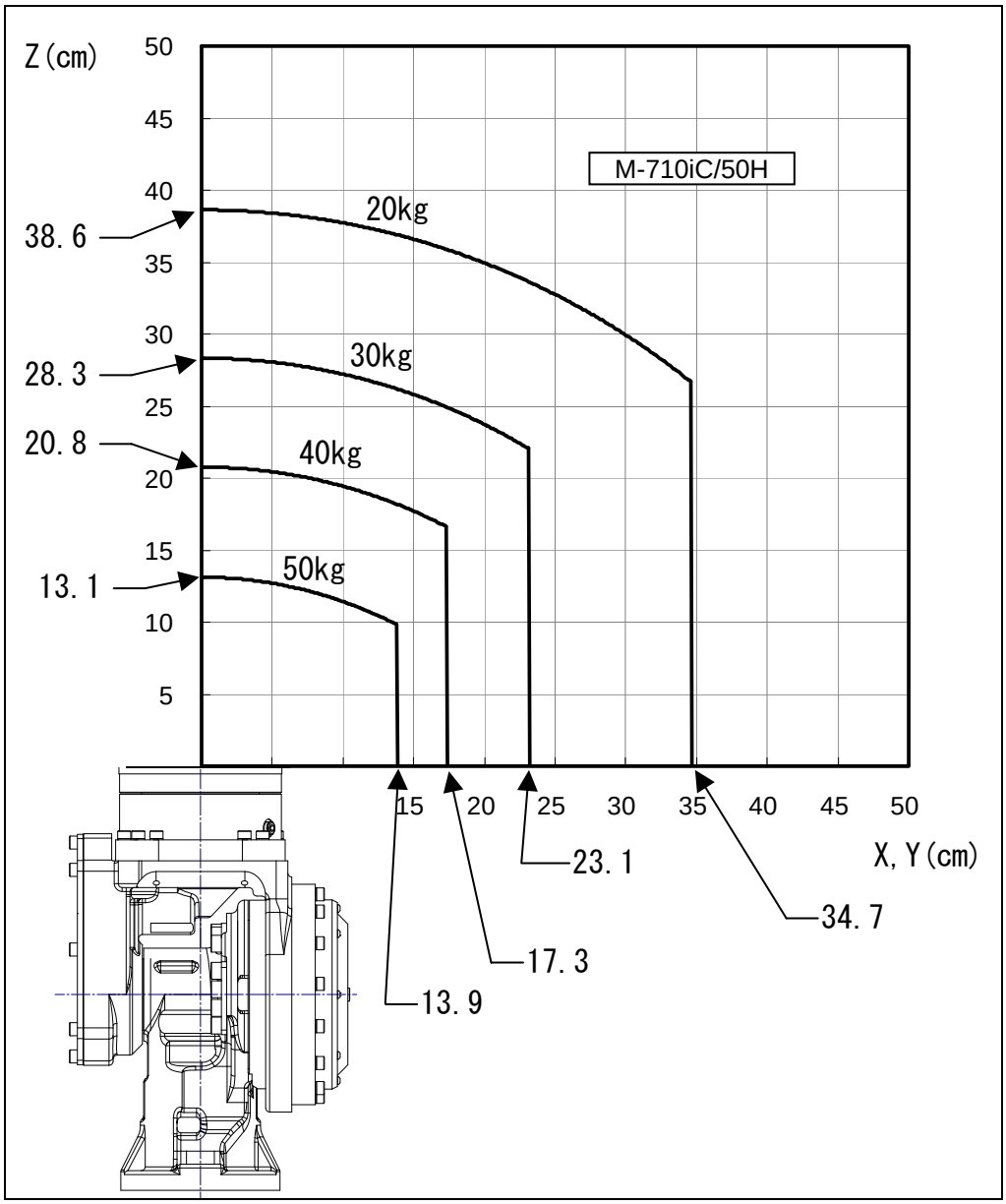


Fig. 3.4 (c) Wrist load diagram (M-710*i*C/50H)

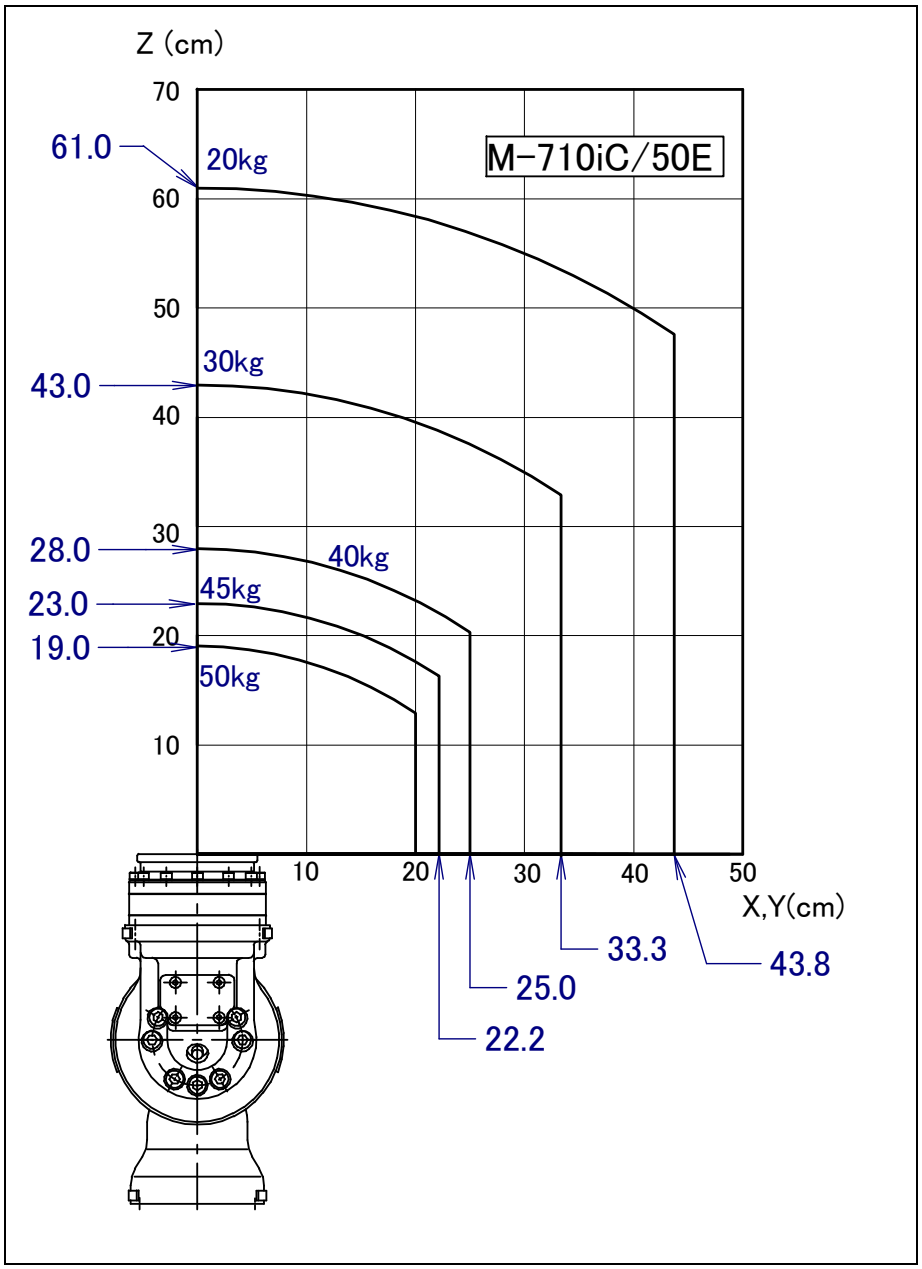


Fig. 3.4 (d) Wrist load diagram (M-710*i*C/50E)

3.5 LOAD CONDITIONS ON J3 CASING

Table 3.5 (a),(b) and Fig. 3.5 show J3 casing load condition.
(The J3 casing load weight is limited according to the wrist load weight.)

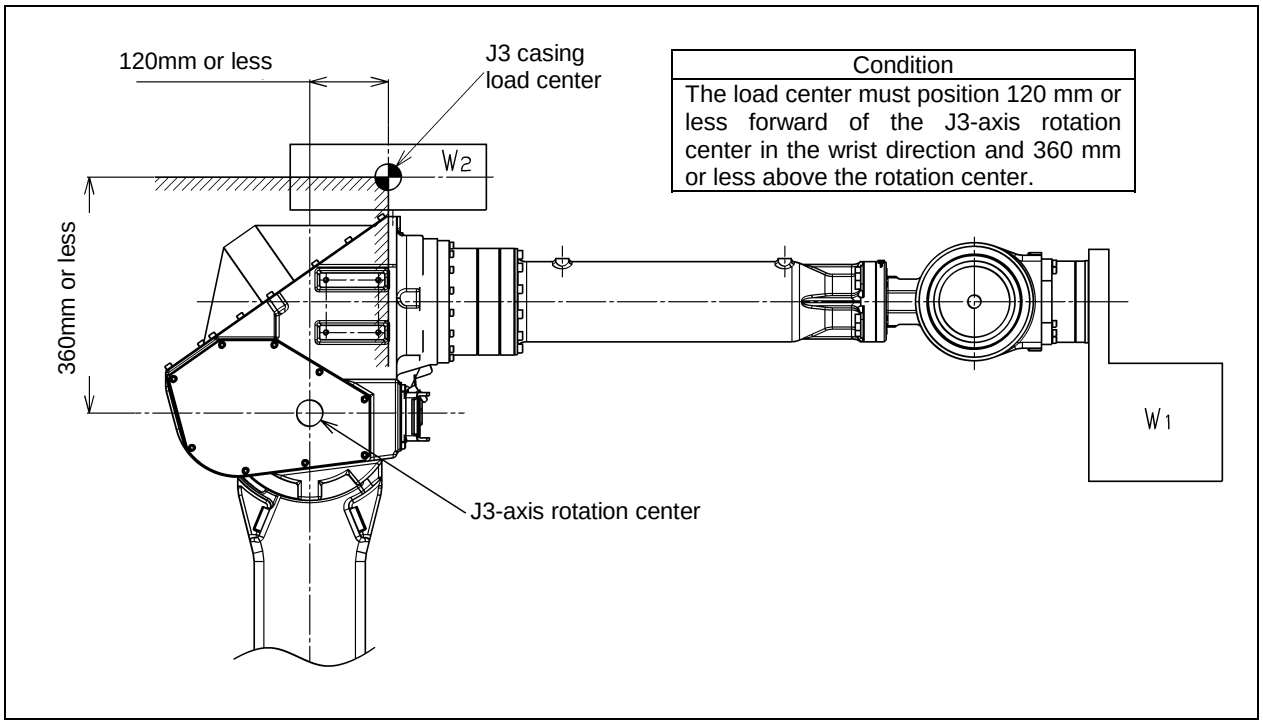


Fig. 3.5 J3 casing load condition

Table 3.5 (a) J3 casing load condition (M-710*i*C/50, /50H, /50S, /50E)

Wrist load weight W_1	**J3 casing load weight** W_2
43 kg or less	15 kg or less
Equal to or more than 43 kg and equal to or less than 50 kg	$W_2 \le -\frac{15}{7} \times (50 - W_1[kg])$

Table 3.5 (b) J3 casing load condition (M-710*i*C/70)

Wrist load weight W_1	**J3 casing load weight** W_2
63 kg or less	15 kg or less
Equal to or more than 63 kg and equal to or less than 70 kg	$W_2 \le \frac{15}{7} \times (70 - W_1[kg])$

⚠CAUTION
- Do not put load on J3 arm. (There is no problem for putting load on J3 casing.)
- If equipment is installed to J3 arm, it is dangerous because it rotate with J3 arm. (except M-710*i*C/50H)
- If you put load on J3 arm, unavoidably, treat it as wrist load.

3.6 MOTION RANGE FOR WALL/INCLINED SURFACE MOUNTED ROBOTS

When robots are mounted on wall or inclined surface, the motion range has restricted range depending on its mounted angle.
Fig.3.6 (a) to (l) show motion range for robots mounted on wall or inclined surface depending on its mounted angle.

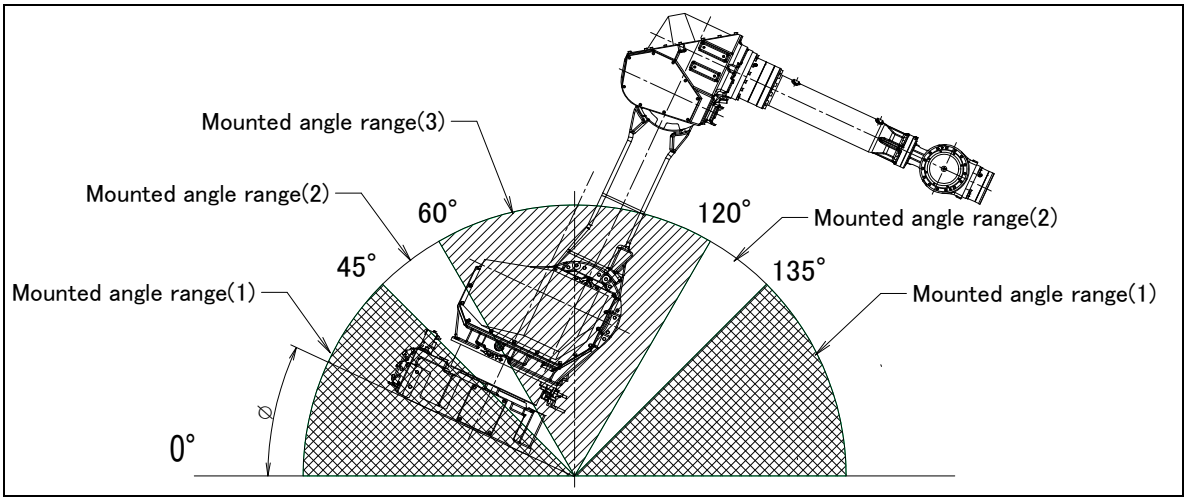


Fig.3.6 (a) Mounted angle (M-710*i*C/50, /50E)

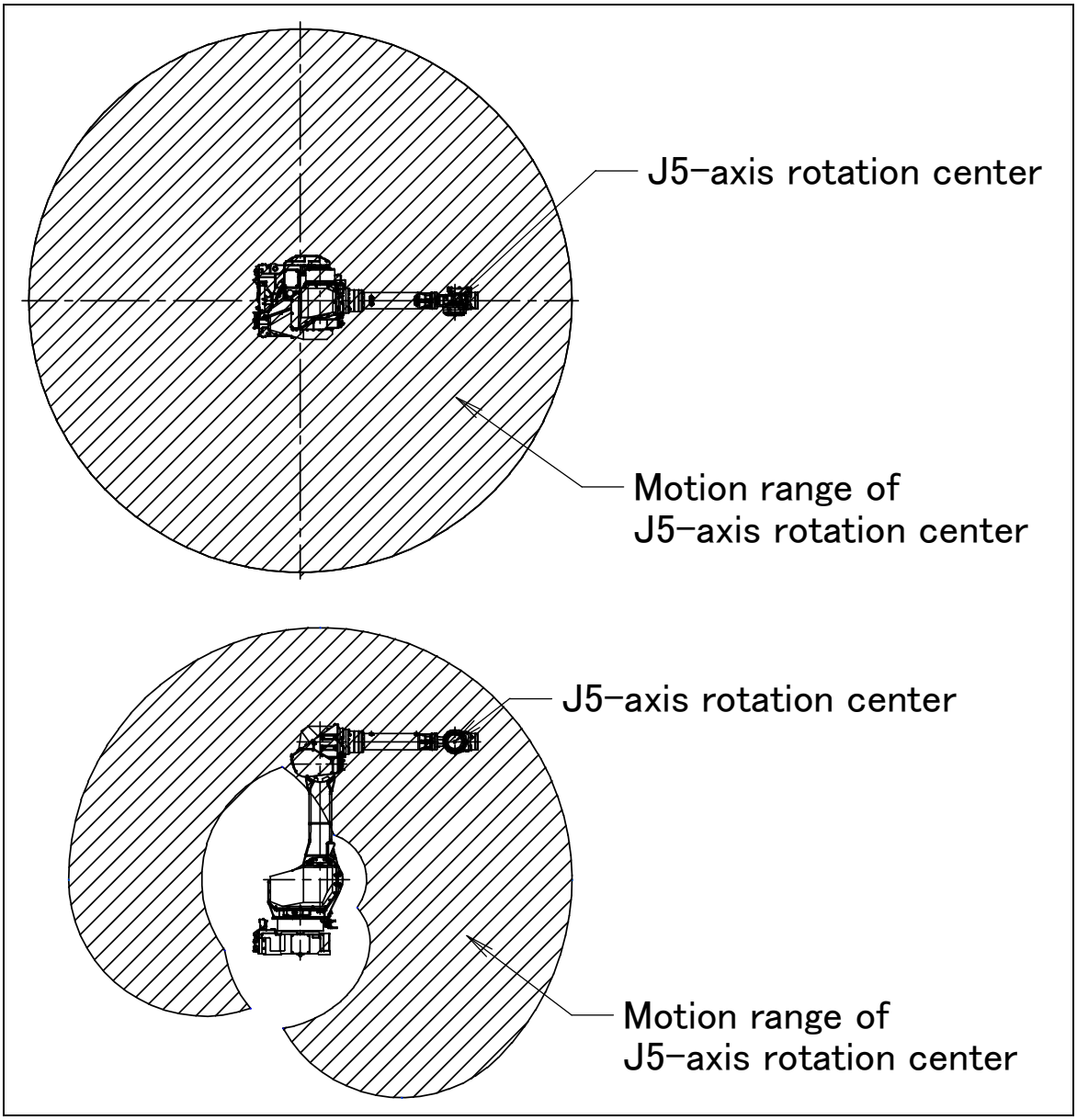


Fig.3.6 (b) Motion range for mounted angle range (1) (M-710*i*C/50, /50E)

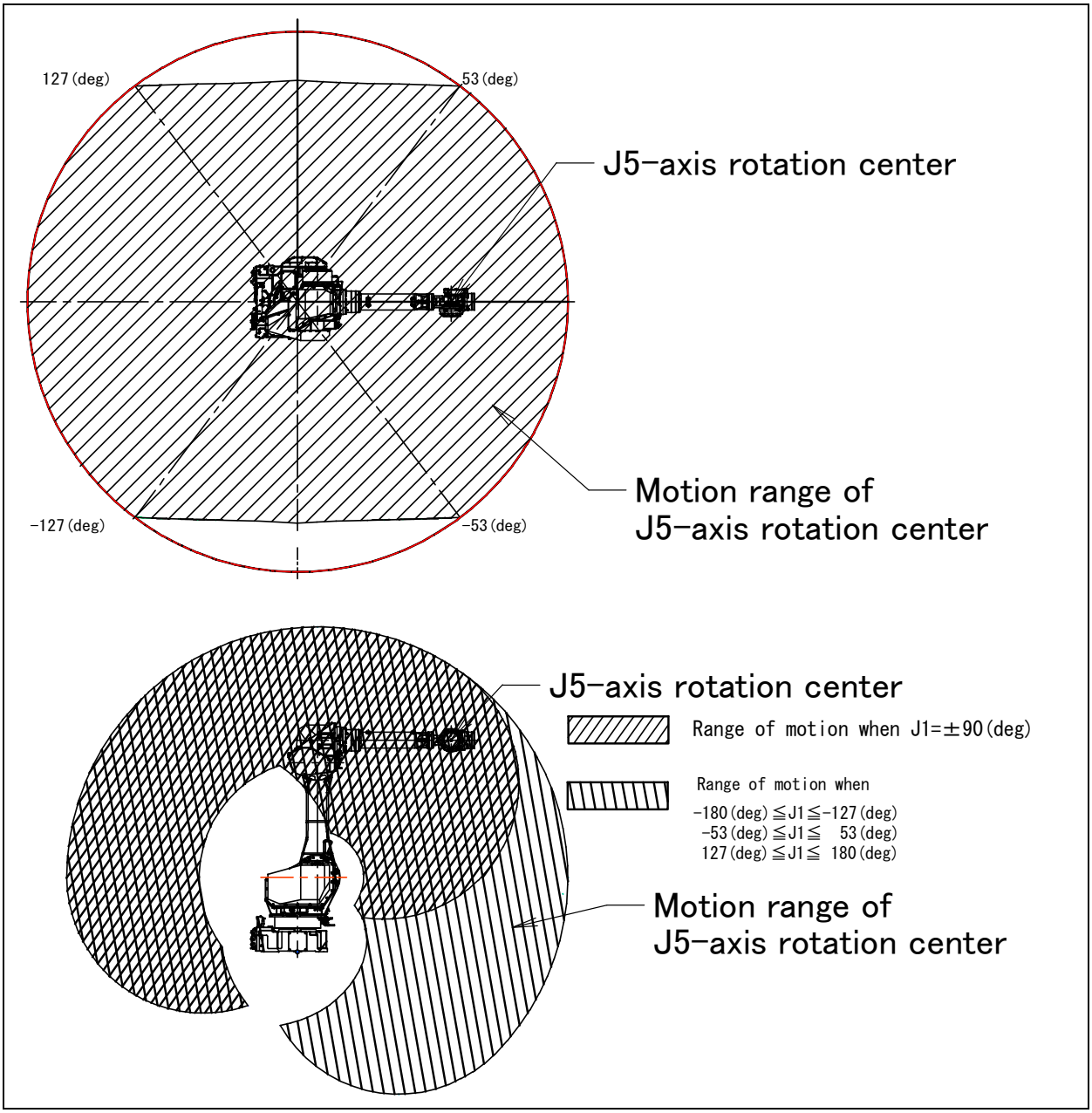


Fig.3.6 (c) Motion range for mounted angle range (2) (M-710*i*C/50, /50E)

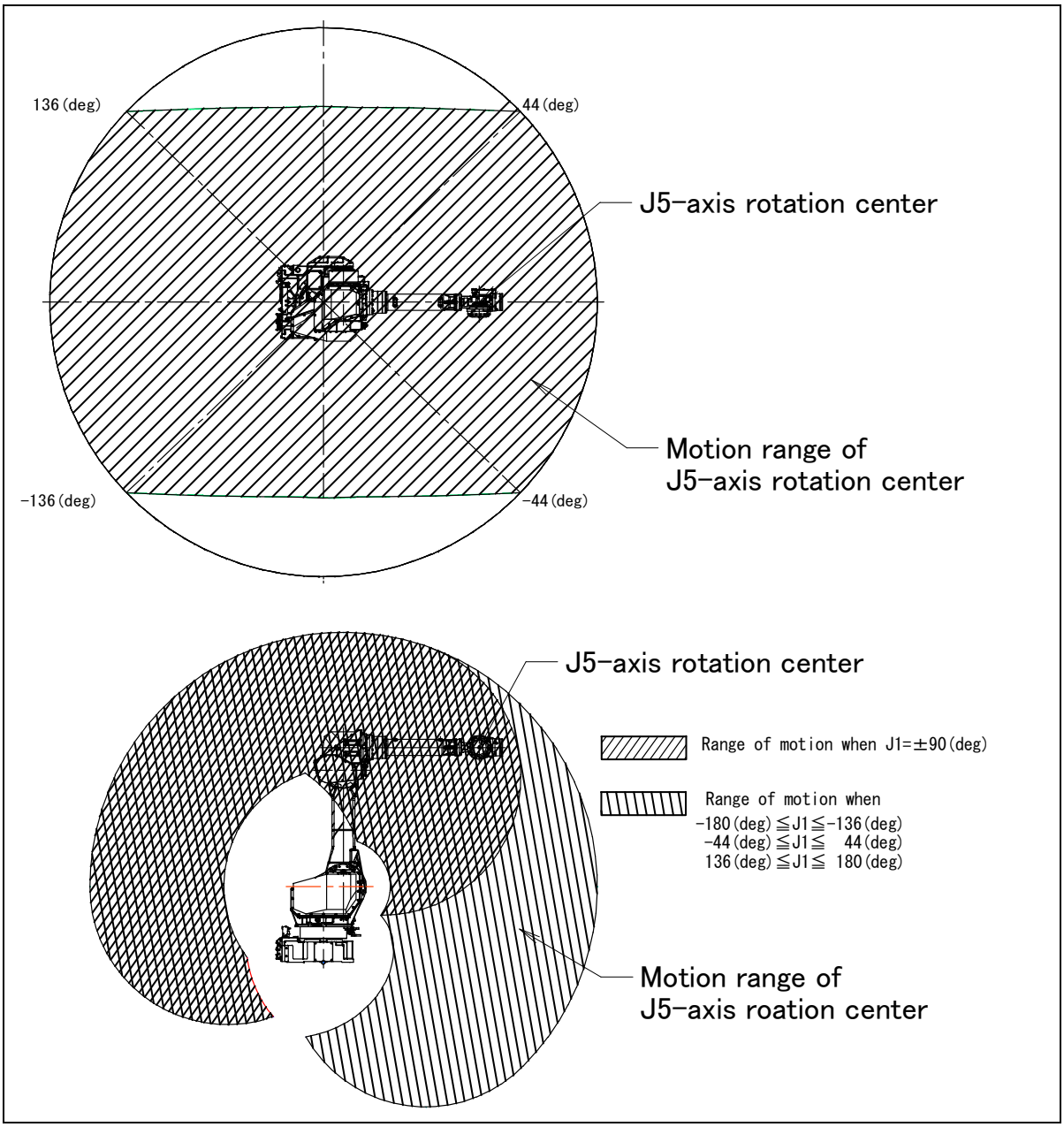


Fig.3.6 (d) Motion range for mounted angle range (3) (M-710*i*C/50, 50E)

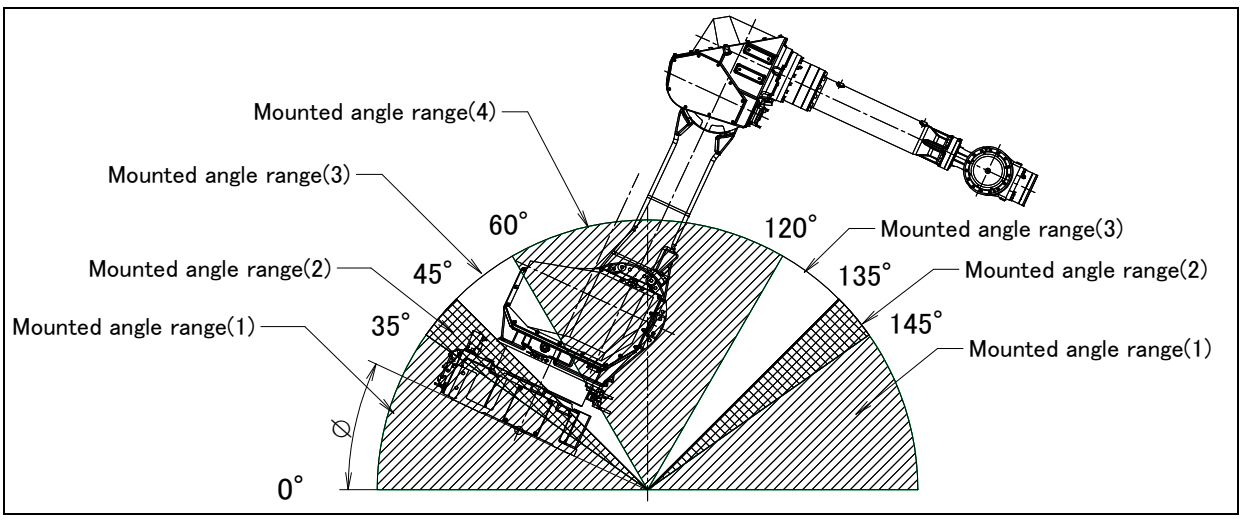


Fig.3.6 (e) Mounted angle (M-710*i*C/70)

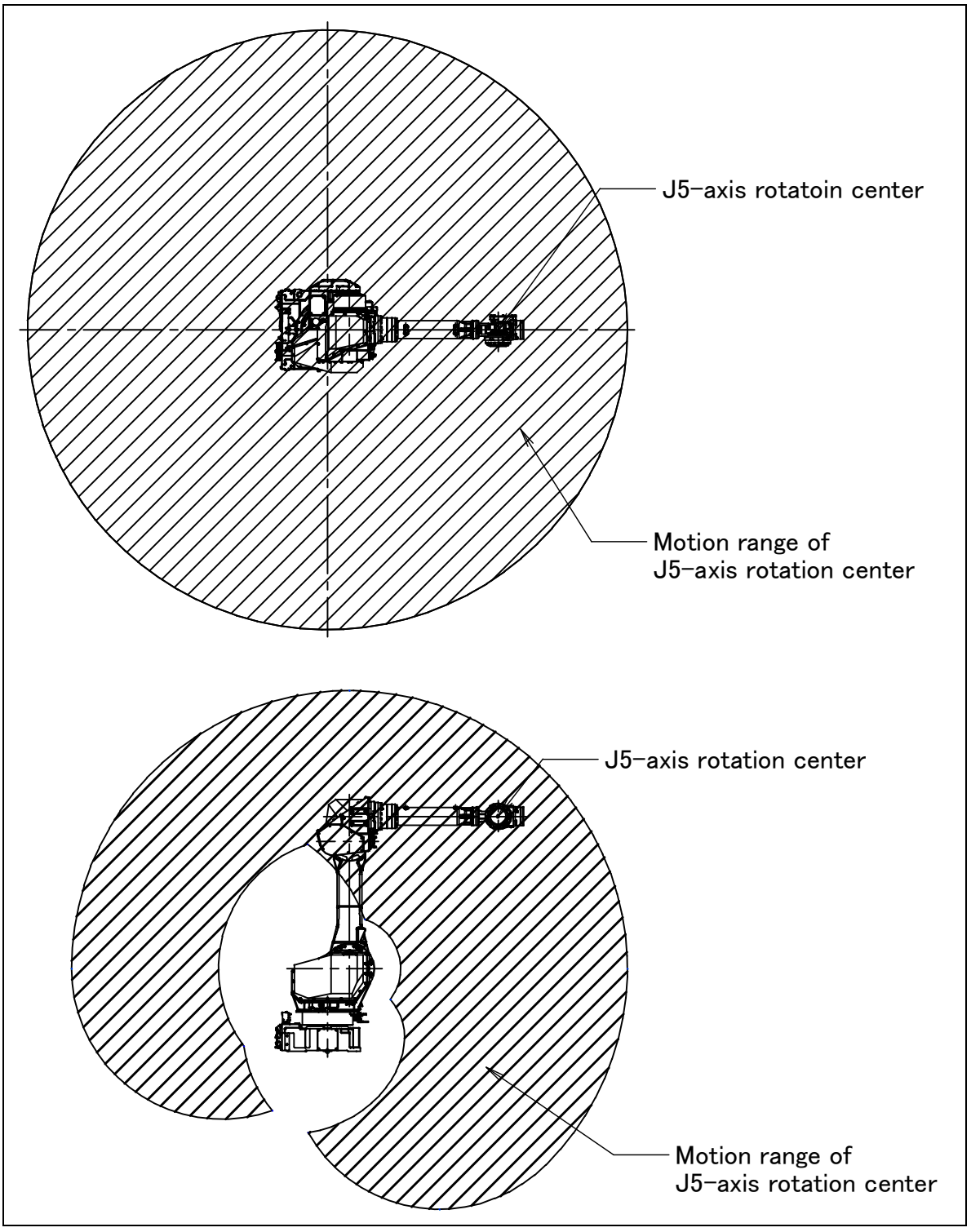


Fig.3.6 (f) Motion range for mounted angle range (1) (M-710*i*C/70)

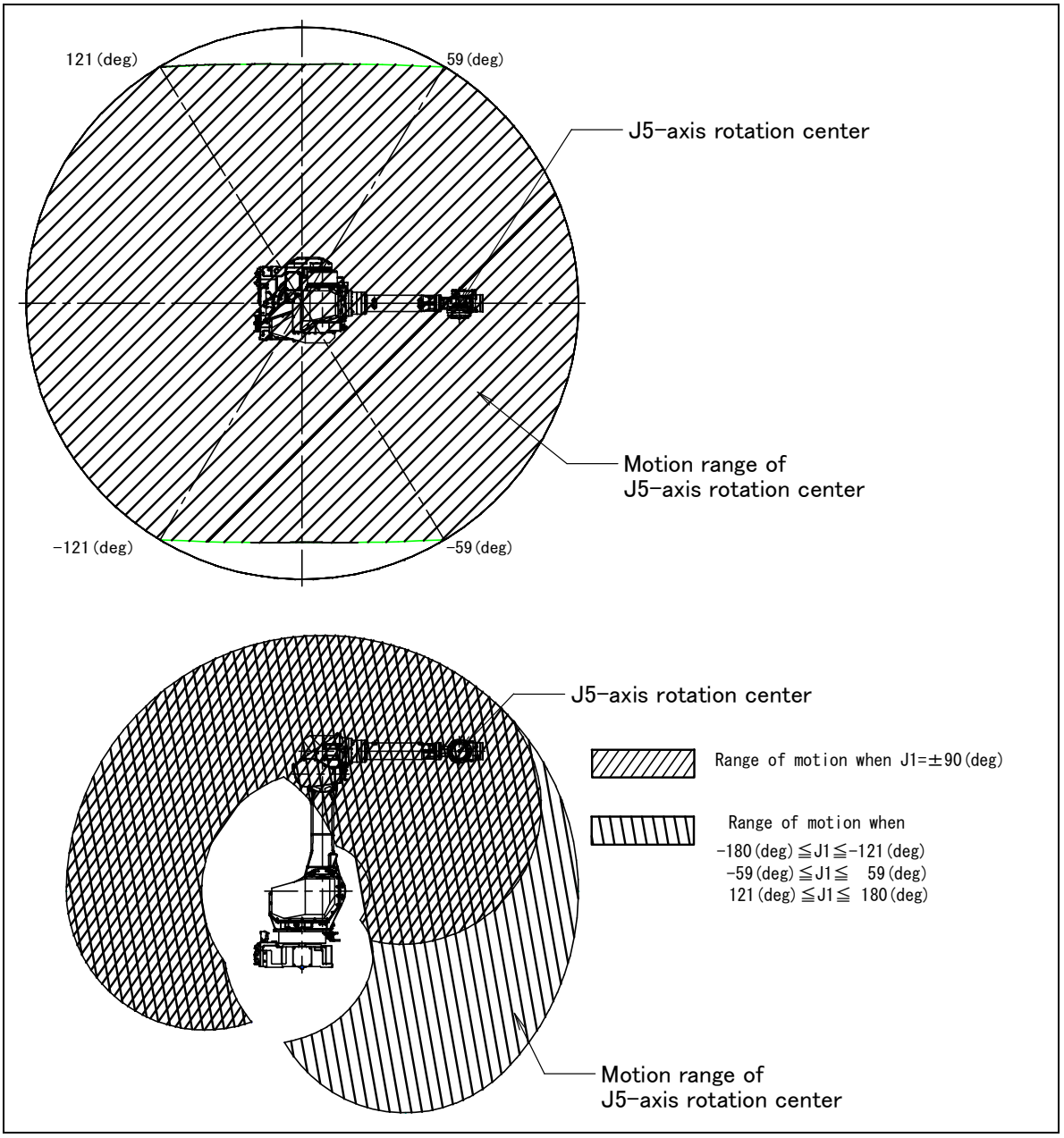


Fig.3.6 (g) Motion range for mounted angle range (2) (M-710*i*C/70)

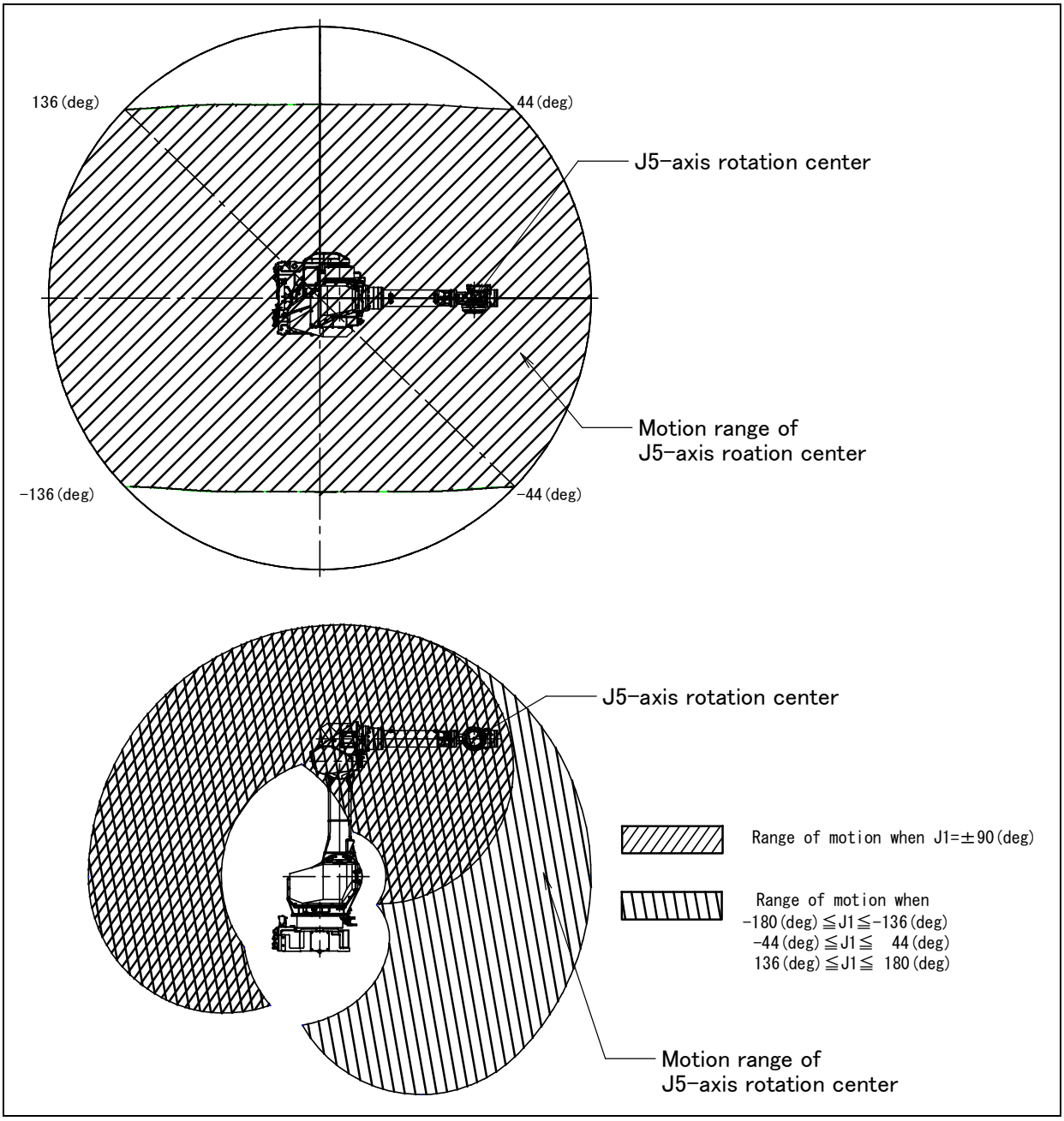


Fig.3.6 (h) Motion range for mounted angle range (3) (M-710*i*C/70)

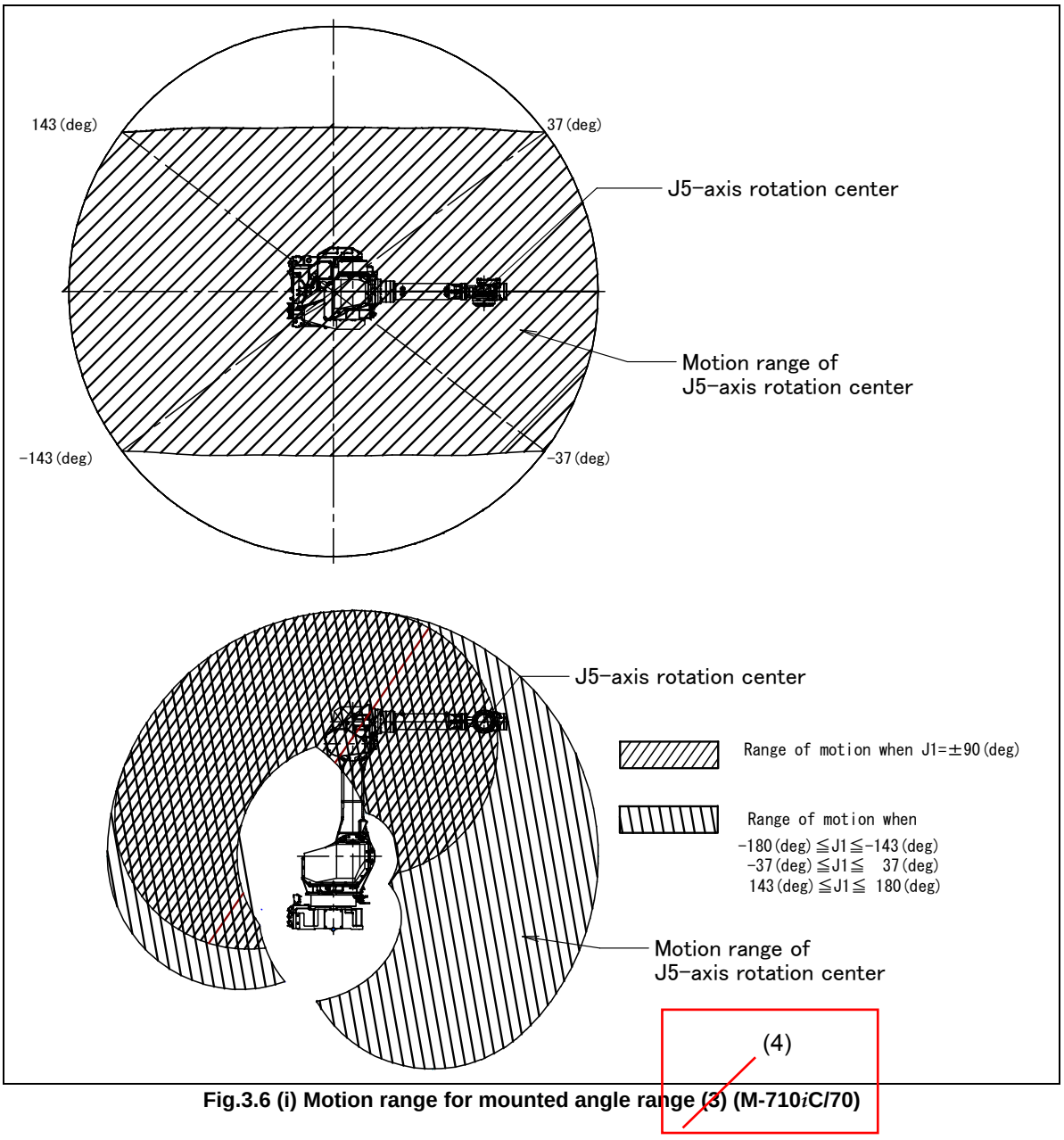


Fig.3.6 (i) Motion range for mounted angle range (3) (M-710*i*C/70)

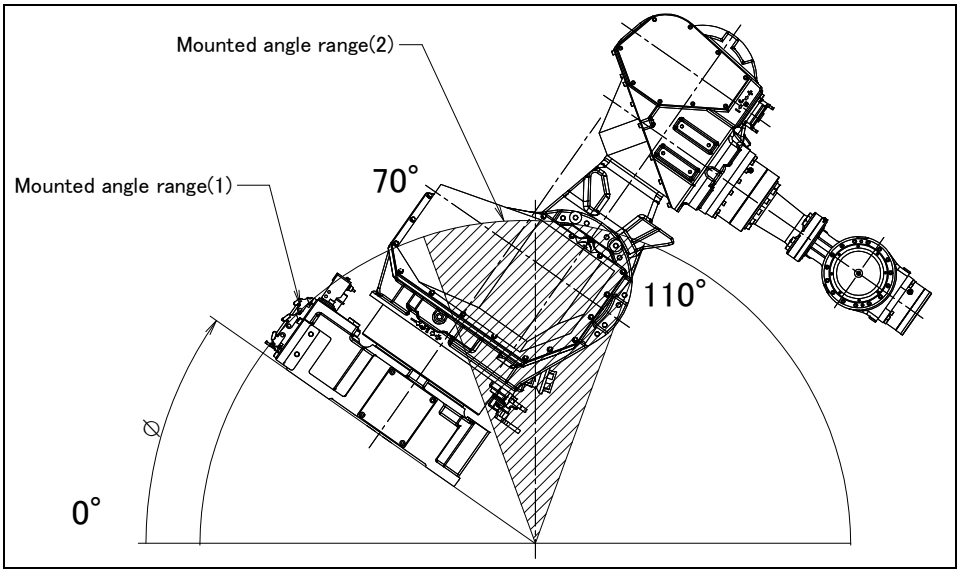


Fig.3.6 (j) Mounted angle (M-710*i*C/50S)

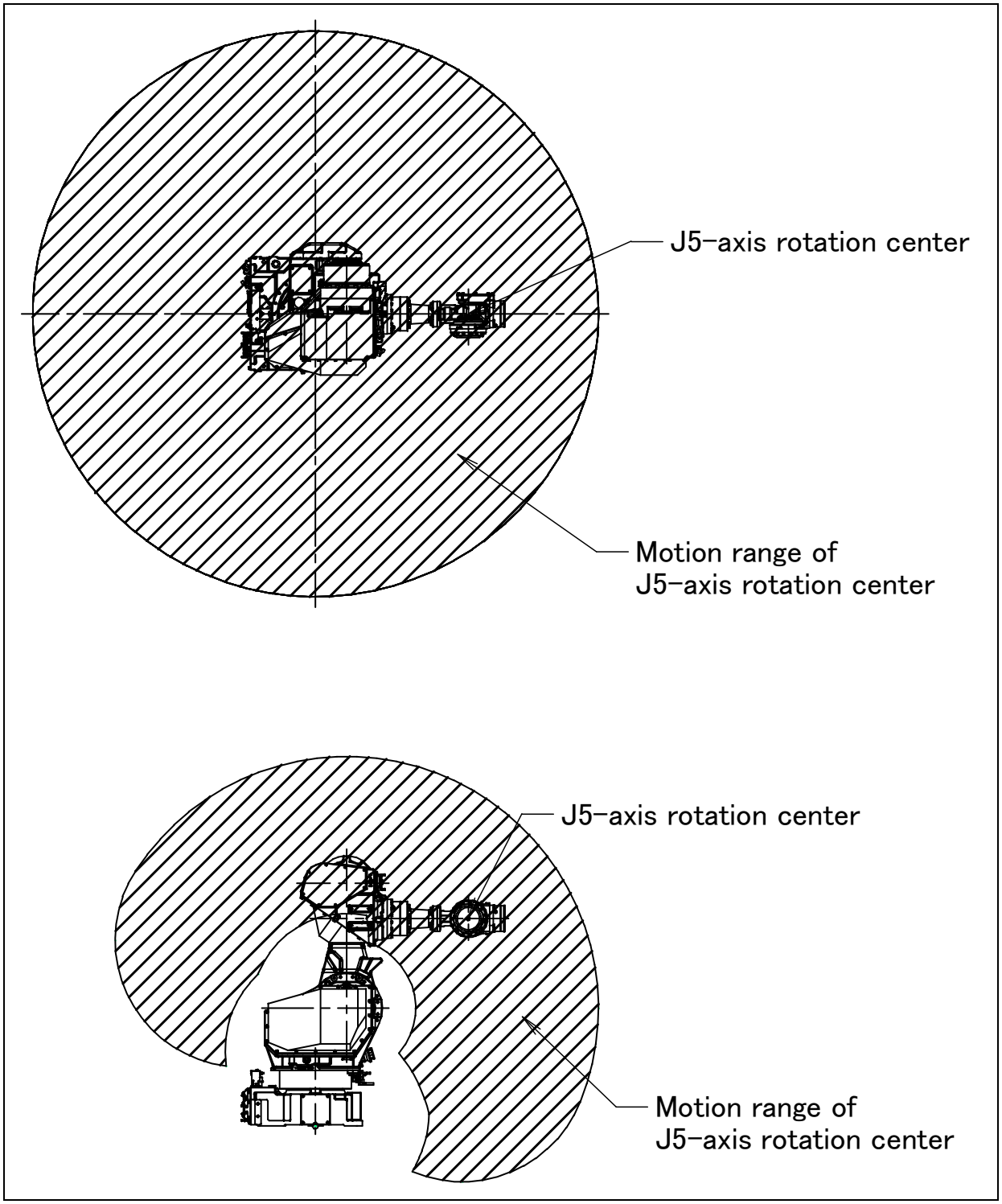


Fig.3.6 (k) Motion range for mounted angle range (1) (M-710*i*C/50S)

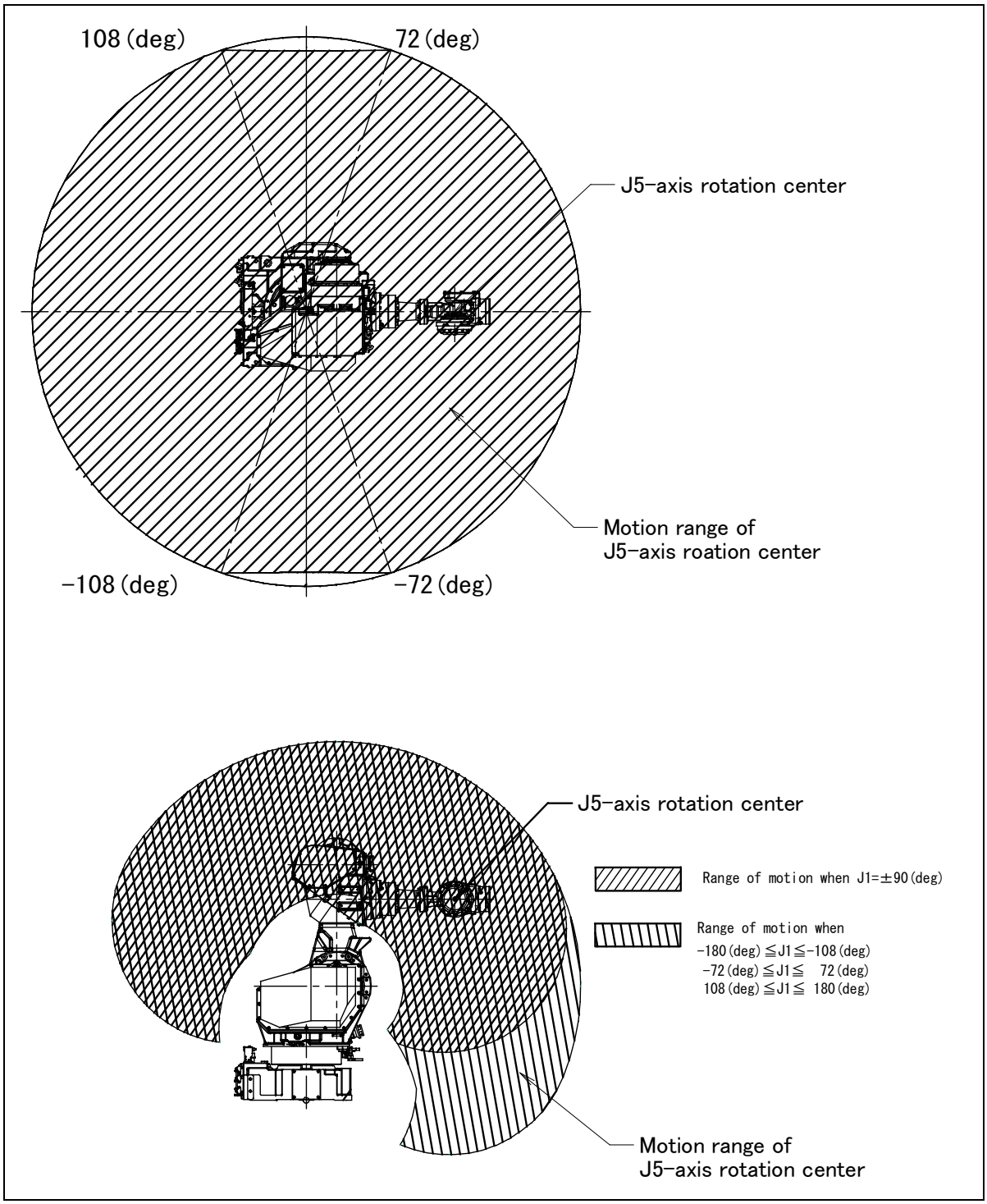


Fig.3.6 (l) Motion range for mounted angle range (2) (M-710*i*C/50S)

4 MECHANICAL COUPLING TO THE ROBOT

4.1 MECHANICAL COUPLING OF END EFFECTOR TO WRIST

Fig. 4.1 (a) to (f) are the diagrams for installing end effectors on the wrist. Select screws and positioning pins of a length that matches the depth of the tapped and pin holes. Fasten the bolt for fixing the end effector with following torque.

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

Table 4.1 Hexagon socket head bolt (Steel: strength rating of 12.9)

Nominal diameter	Tightening torque N·m (kgf·cm)	
	Upper limit	Lower limit
M8	32 (330)	23 (230)
M10	66 (670)	46 (470)

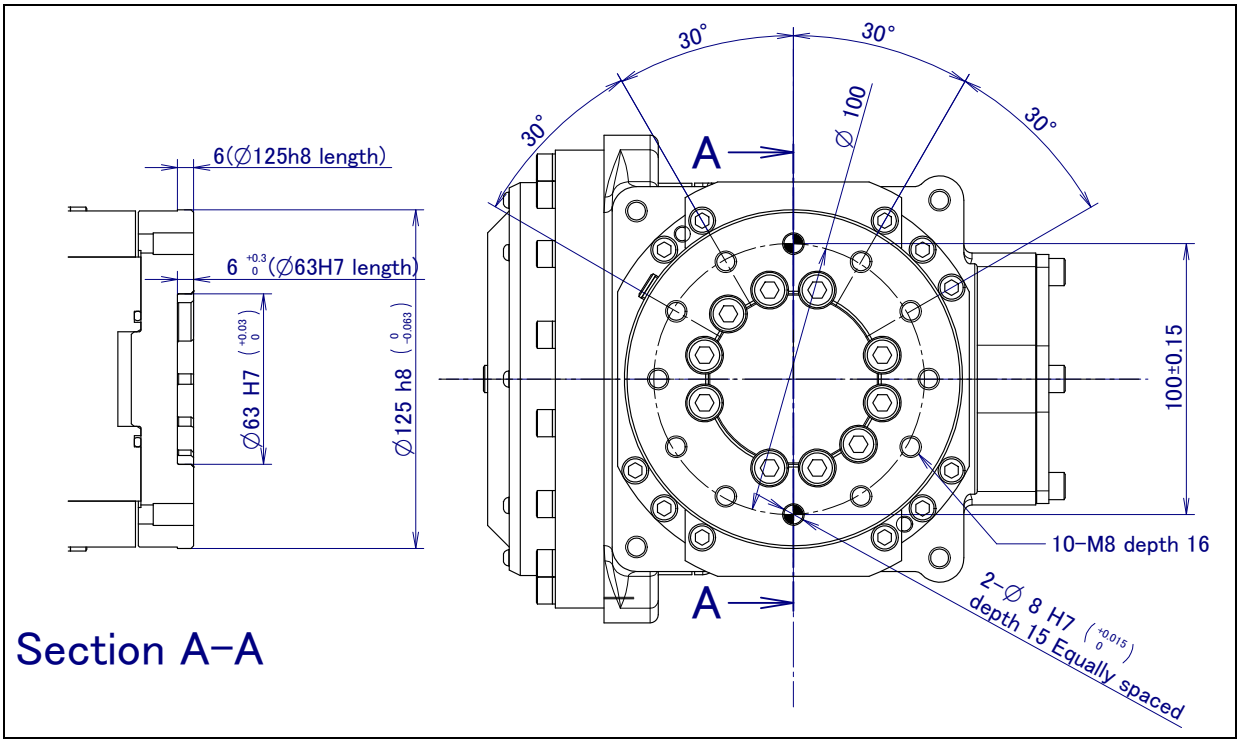


Fig. 4.1 (a) ISO flange, ISO rust protection flange (M-710*i*C/50, /70,/50H,/50S)

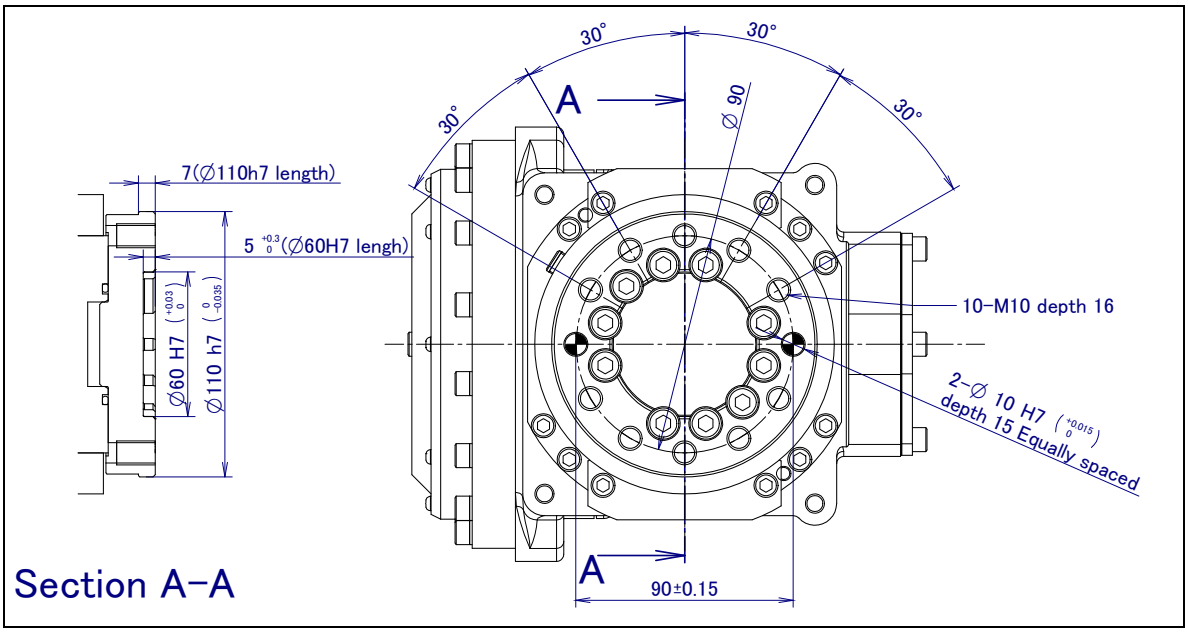


Fig. 4.1 (b) FANUC flange (M-710*i*C/50, /70, /50H ,/50S)

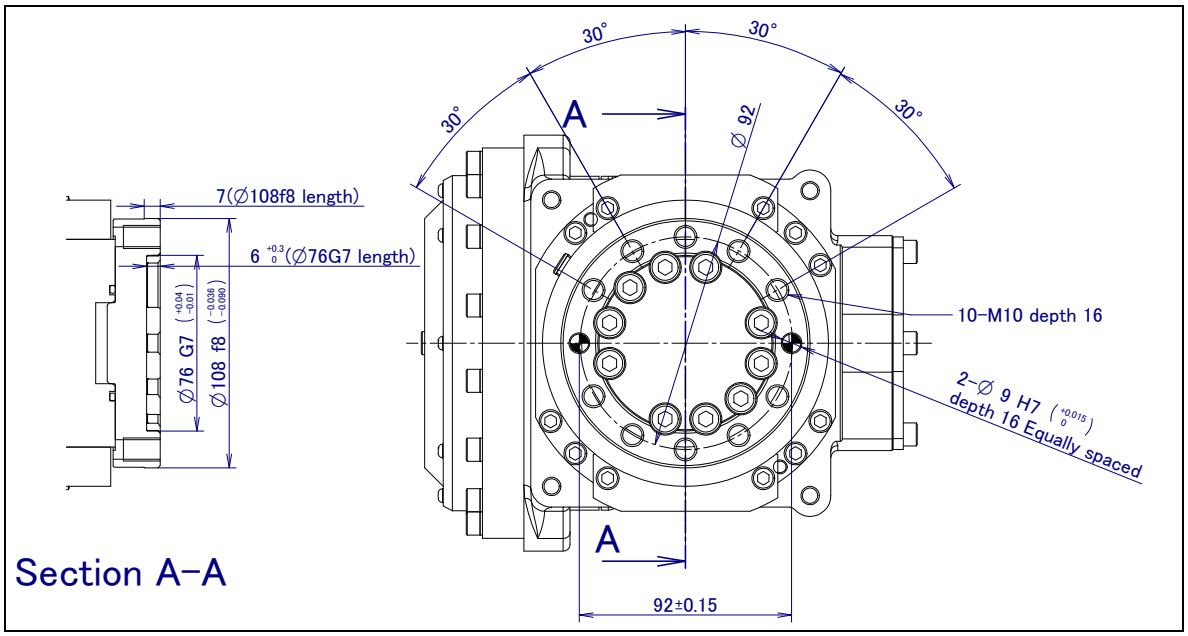


Fig. 4.1 (c) Special flange (M-710*i*C/50, /70, /50H, /50S)

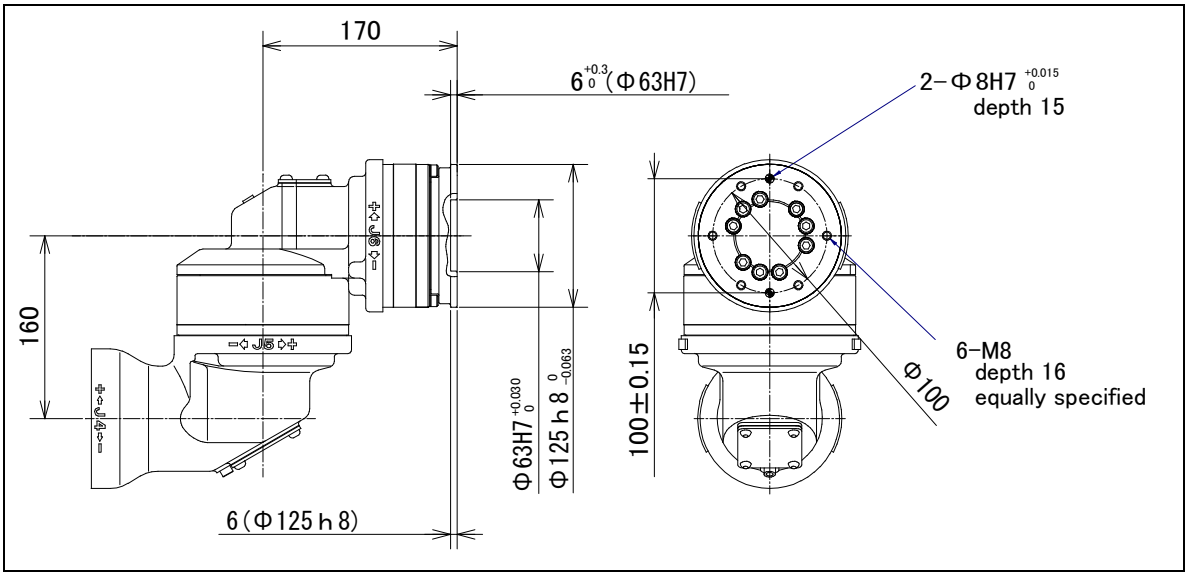


Fig. 4.1 (d) ISO flange (M-710*i*C/50E)

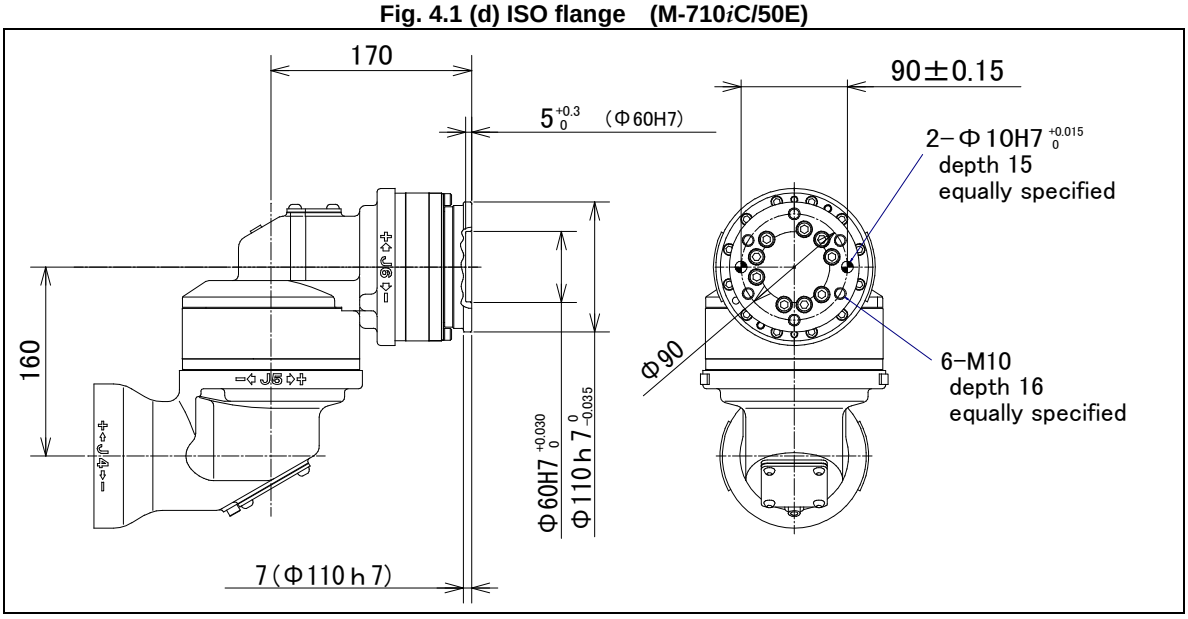


Fig. 4.1 (e) FANUC flange (M-710*i*C/50E)

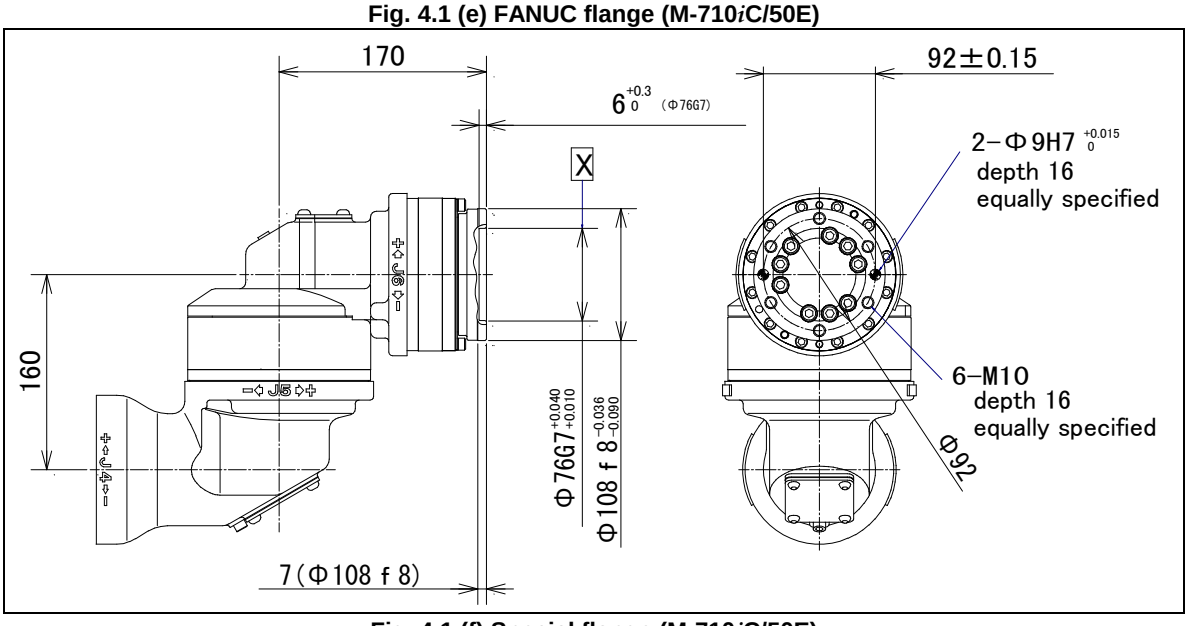


Fig. 4.1 (f) Special flange (M-710*i*C/50E)

4.2 EQUIPMENT MOUNTING FACE

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

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

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

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

⚠CAUTION
- Do not put load on J3 arm. (There is no problem for putting load on J3 casing.)
- If equipment is installed to J3 arm, it is dangerous because it rotate with J3 arm. (except M-710*i*C/50H)
- If you put load on J3 arm, unavoidably, treat it as wrist load.

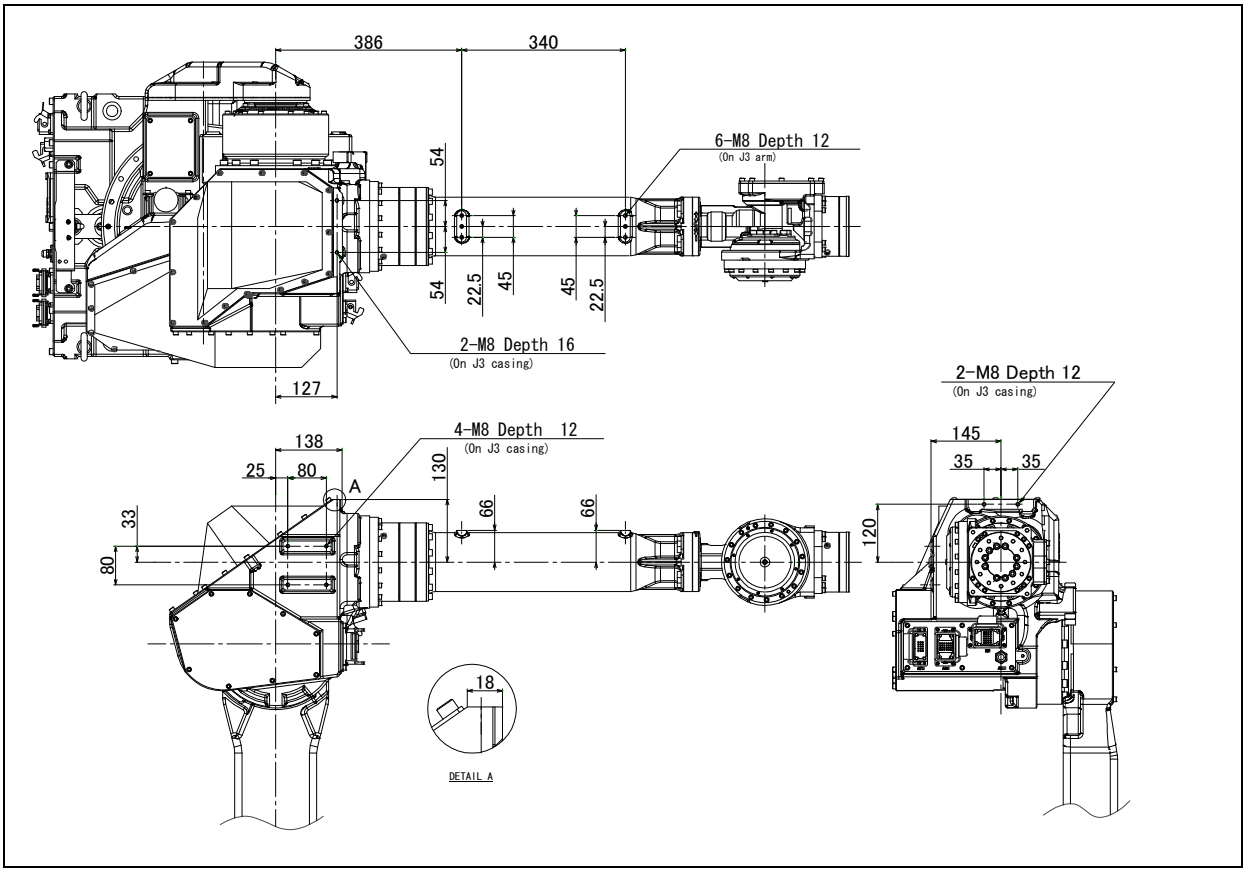


Fig. 4.2 (a) Equipment mounting surfaces (M-710*i*C/50, /70, /50E)

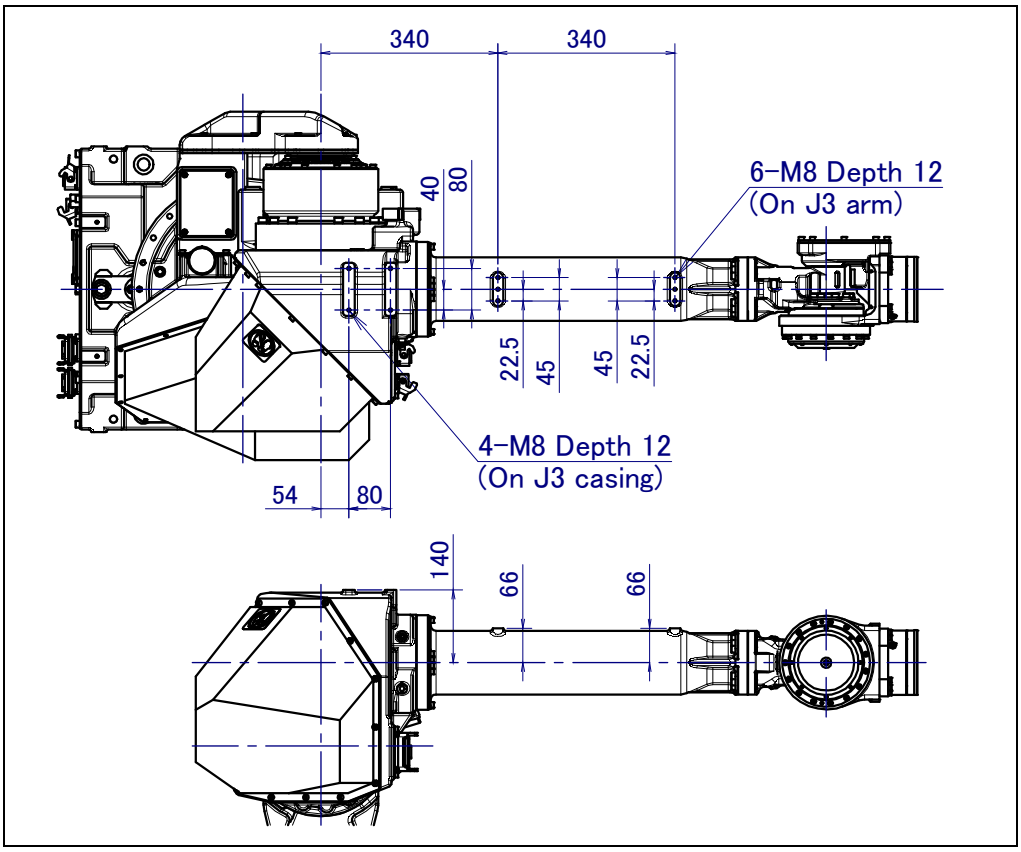


Fig. 4.2 (b) Equipment mounting surfaces (M-710*i*C/50H)

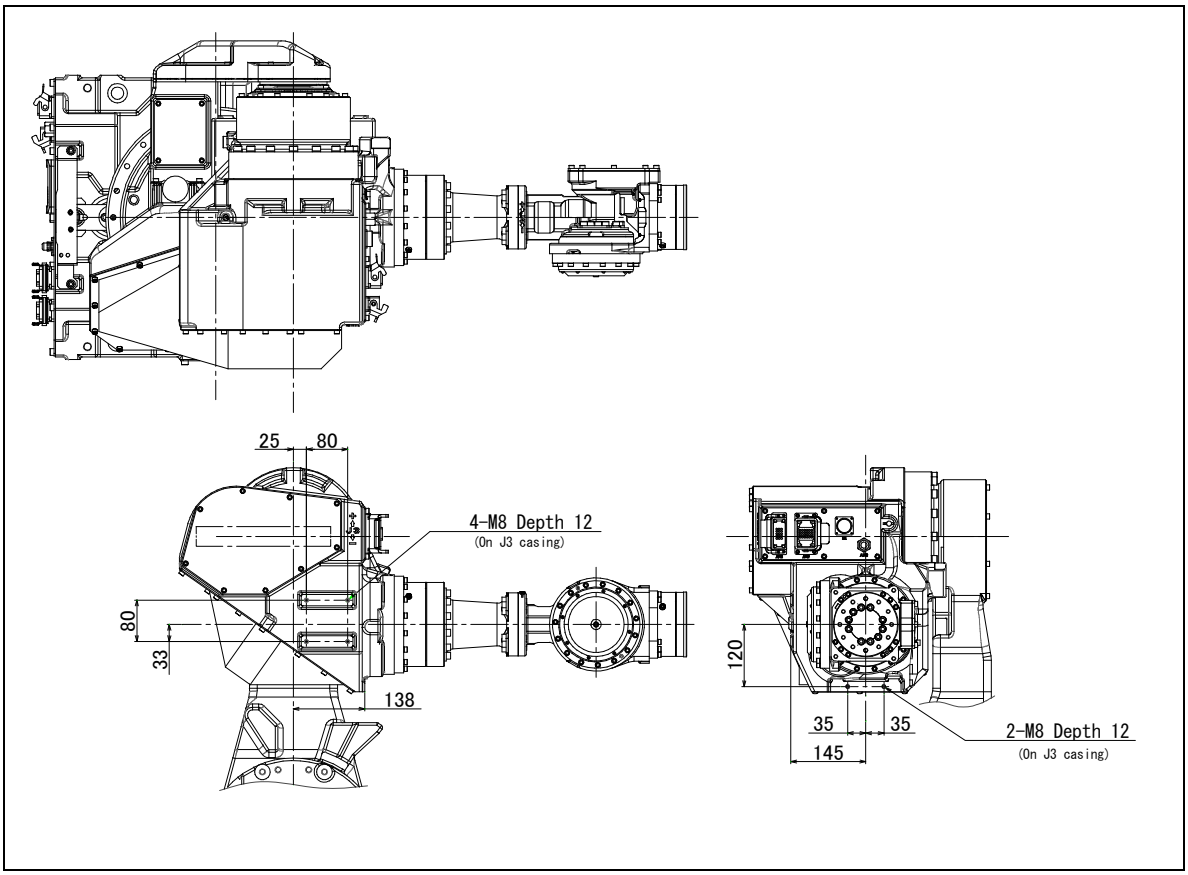


Fig. 4.2 (c) Equipment mounting surfaces (M-710*i*C/50S)

4.3 LOAD SETTING

NOTE
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 motion performance screens include the MOTION PERFORMANCE screen, MOTION PAYLOAD SET screen, and MOTION ARMLOAD SET screen. These screens are used to specify payload information and equipment information on the robot.

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

```
 MOTION PERFORMANCE        JOINT   10 %
      Group1
 No.    PAYLOAD[kg]          Comment
  1              50.00      [                ]
  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  DETIAL  ARMLOAD  SETTND>
          IDENT                        >
```

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

```
 MOTION PAYLOAD SET        JOINT        100 %

      Group1
 1   Schedule No [     1]:   [ Comment          ]
 2   PAYLOAD                 [ kg ]          50.00
 3   PAYLOAD  CENTER  X      [ cm ]         -26.00
 4   PAYLOAD  CENTER  Y      [ cm ]          0.00
 5   PAYLOAD  CENTER  Z      [ cm ]         15.00
 6   PAYLOAD  INERTIA  X     [kgfcmsˆ2]      4.307
 7   PAYLOAD  INERTIA  Y     [kgfcmsˆ2]      6.699
 8   PAYLOAD  INERTIA  Z     [kgfcmsˆ2]      4.318

  [ TYPE ]  GROUP  NUMBER  DEFAULT  HELP
```

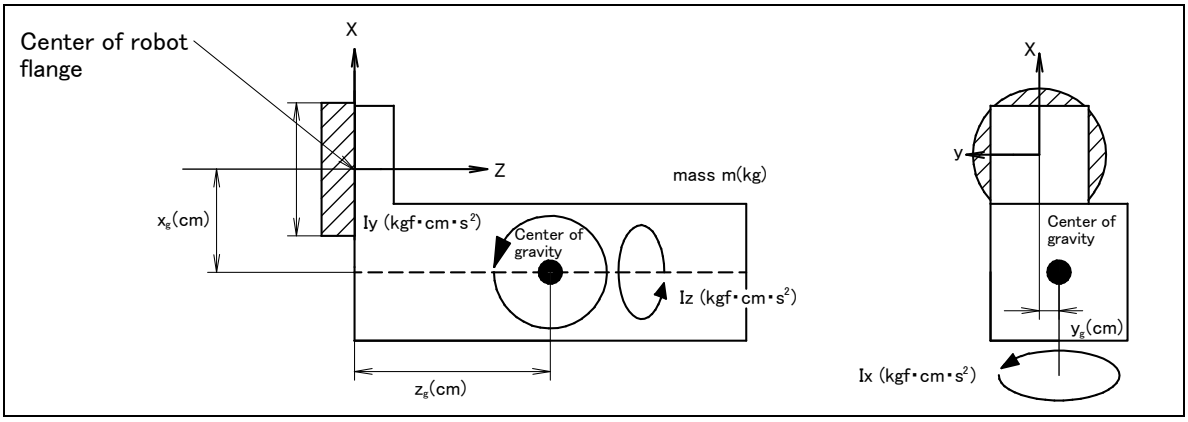


Fig. 4.3 Standard tool coordinate

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 Cycletime will change. Set it?" Respond to the message with F4 ([YES]) or F5 ([NO]).

7 Clicking F3 ([NUMBER]) will bring you to the MOTION PAYLOAD SET screen for another condition

8 Press the previous page key to return to the list screen. Press F5 SETIND, and enter a desired load setting condition number.

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

```
MOTION ARMLOAD SET       JOINT          100 %

      Group1
1     ARM LOAD AXIS #1 [ kg ]          0.00
2     ARM LOAD AXIS #3 [ kg ]         15.00

 [ TYPE ]  GROUP              DEFAULT  HELP
```

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

5 PIPING AND WIRING TO THE END EFFECTOR

⚠ WARNING

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

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

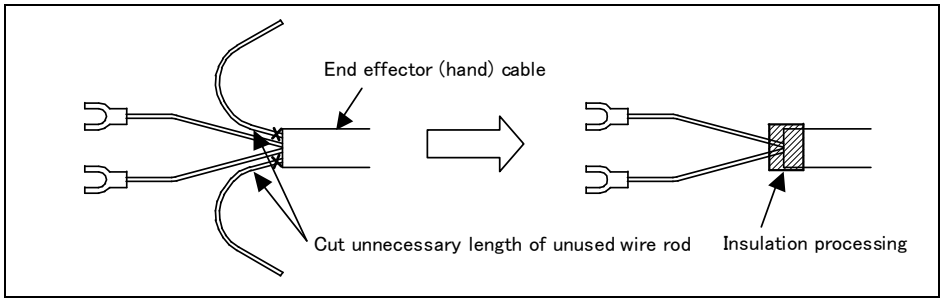


Fig.5 Treatment method of end effector (hand) cable

5.1 AIR SUPPLY (OPTION)

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

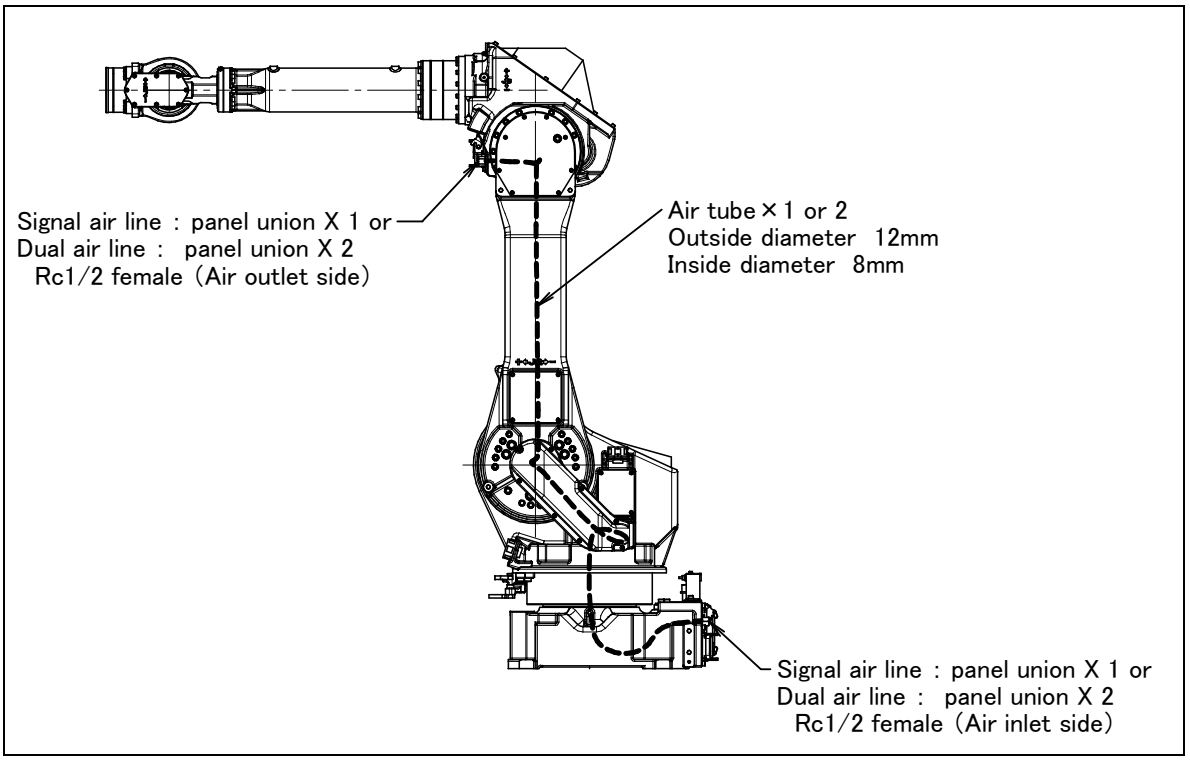


Fig. 5.1 Air supply (option)

5.2 AIR PIPING (OPTION)

Fig. 5.2 (a) shows how to connect air hose to the robot. If the air control set is specified as an option, the air hose between the mechanical unit and the air control set is provided. A tap holes shown in 5.3 figure (b) are necessary for the installation of three points of air sets. Please prepare by customer.

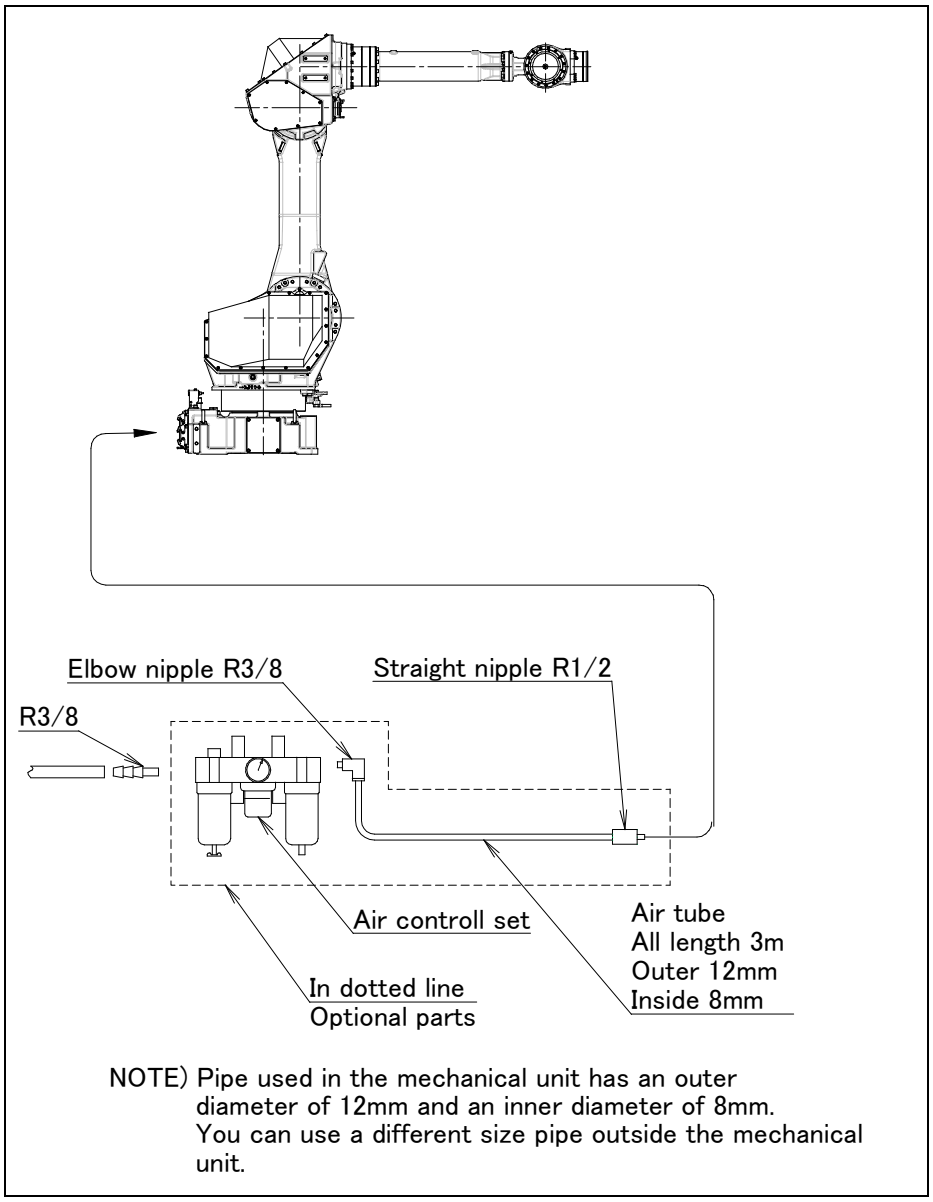


Fig. 5.2 (a) Air piping (option)

Air control set

Fill the lubricator having three air components to the specified level with turbine oil#90 to # 140. The machine tool builder is required to prepare mounting bolts.

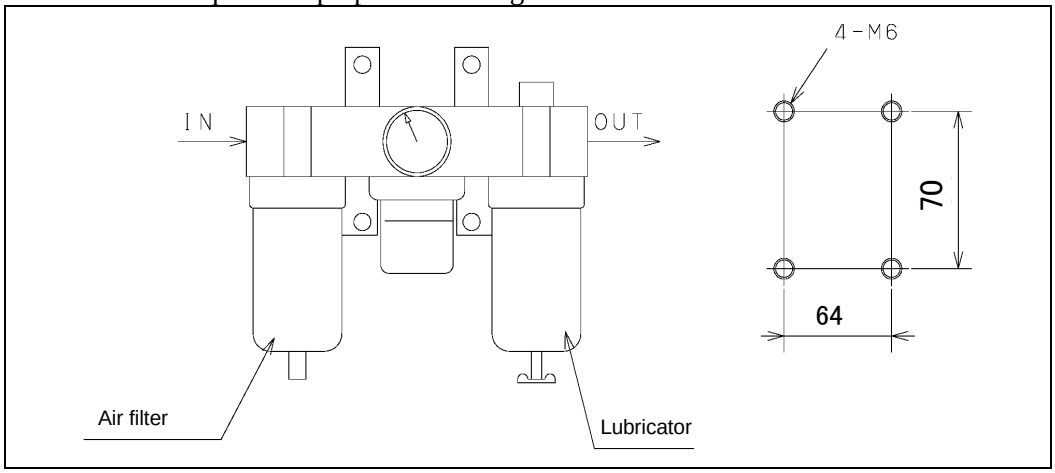


Fig. 5.2 (b) Air control set (option)

NOTE
The capacity values of the robot is determined as follows.
These values must not be exceeded.

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

5.3 INTERFACE FOR OPTION CABLE (OPTION)

Fig. 5.3 (a) to (f) show the position of the option cable interface.
EE interface (RI/RO), user cable (signal line and power line), DeviceNet cable (signal and power line), Additional axis motor cable, (Pulsecoder/power, brake), camera cable, 3DL sensor, force sensor are prepared as options.

NOTE
Each option cable is written like below on connector panel
EE interface : EE
User cable (signal) : AS
User cable (power) : AP
Devicenet cable (signal) : DS
Devicenet cable (power) : DP
Additional axis motor cable (Pulsecoder) : ARP
Additional axis motor cable (power,brake) : ARM
Camera cable : CAM
3DL sensor cable : SEN

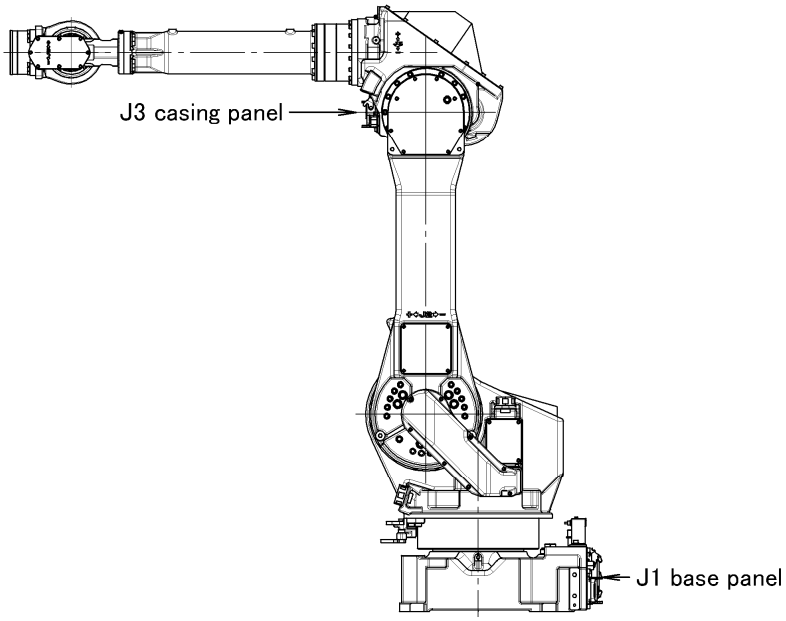
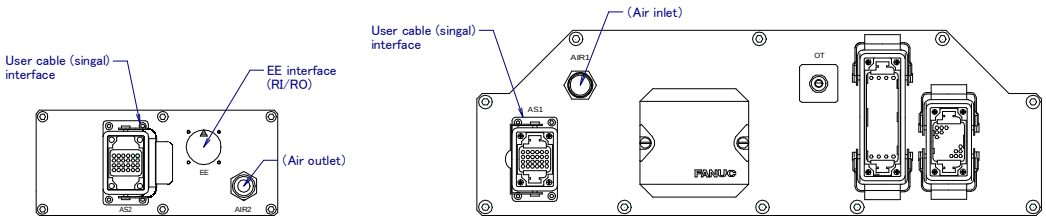
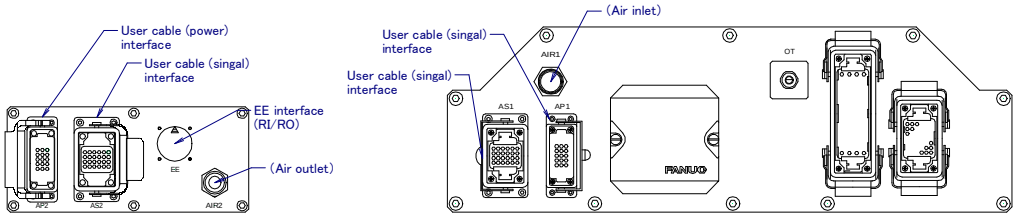


Fig. 5.3 (a) Position of the option cable interface (option)



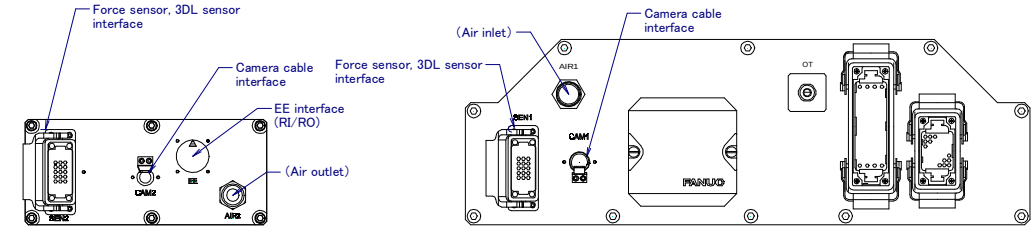
J3 casing connector plate (output side)　　J1 base connector plate (input side)

With user cable (signal) and air ×1
Spec. of mechanical unit cable
A05B-1125-H202 (M-710iC/50, /70, /50E)
A05B-1125-H502 (M-710iC/50H)
A05B-1125-H222 (M-710iC/50S)



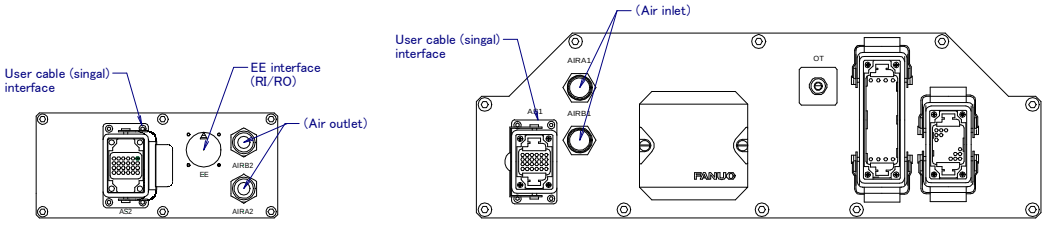
J3 casing connector plate (output side)　　J1 base connector plate (input side)

With user cable (signal/power)
Spec. of mechanical unit cable
A05B-1125-H204 (M-710iC/50, /70, 50E)
A05B-1125-H504 (M-710iC/50H)
A05B-1125-H224 (M-710iC/50S)



J3 casing connector plate (output side)　　J1 base connector plate (input side)

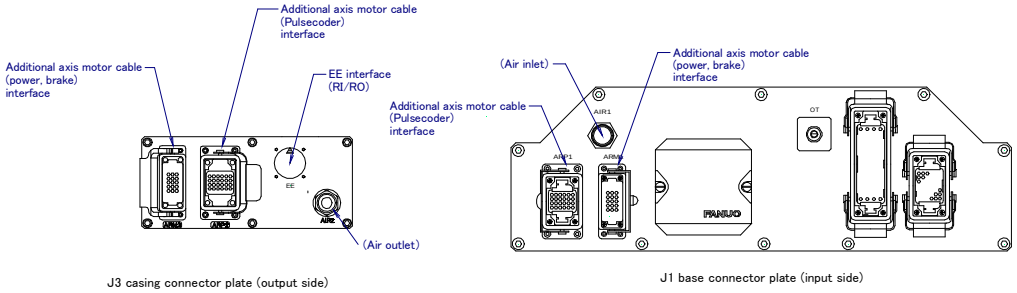
With force sensor , 3DL sensor and camera cable
Spec. of mechanical unit cable
A05B-1125-H404 (M-710iC/50, /70, /50E)
A05B-1125-H422 (M-710iC/50S)



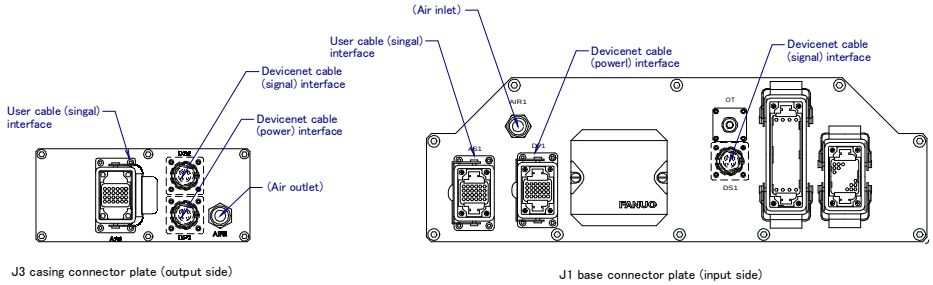
J3 casing connector plate (output side)　　J1 base connector plate (input side)

With user cable (signal) and air ×2
Spec. of mechanical unit cable
A05B-1125-H208 (M-710iC/50, /70, /50E)

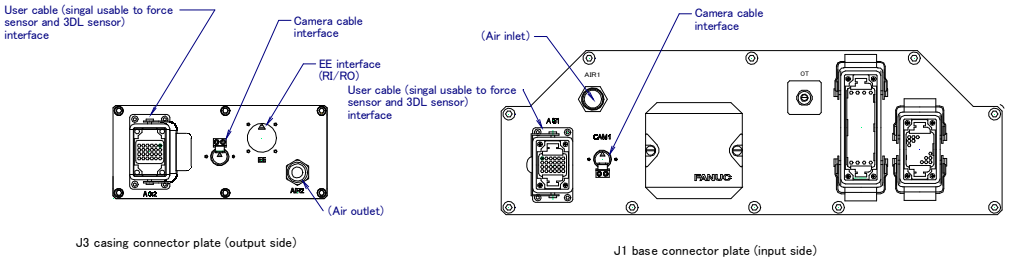
Fig. 5.3 (b) Interface for option cable 1/2



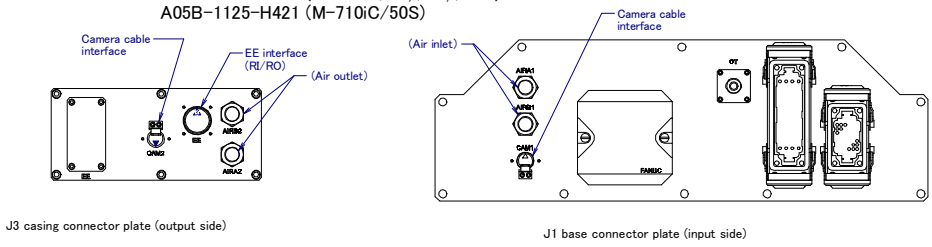
With additional axis motor cable (Pulsecoder/power)
Spec. of mechanical unit cable
A05B-1125-H209 (M-710iC/50, /70, /50E)
A05B-1125-H229 (M-710iC/50S)



With user cable(signal) ,devicenet cable (signal/power)
Spec. of mechanical unit cable
A05B-1125-H210 (M-710iC/50, /70, /50E)

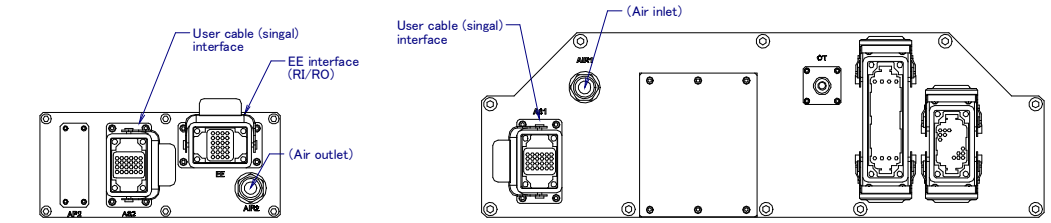


With user cable(signal usable to force sensor and 3DL sensor) and camera cable
Spec. of mechanical unit cable
A05B-1125-H403 (M-710iC/50, /70, /50E)
A05B-1125-H421 (M-710iC/50S)



With camera cable and AIRX2
Spec. of mechanical unit cable
A05B-1125-H405 (M-710iC/50, /70, /50E)

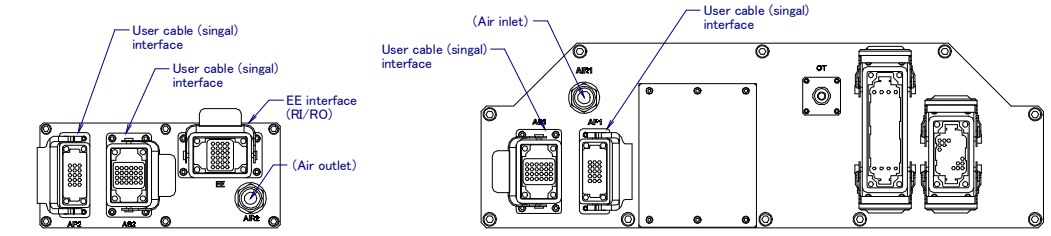
Fig. 5.3 (c) Interface for option cable 2/2



J3 casing connector plate (output side)

J1 base connector plate (input side)

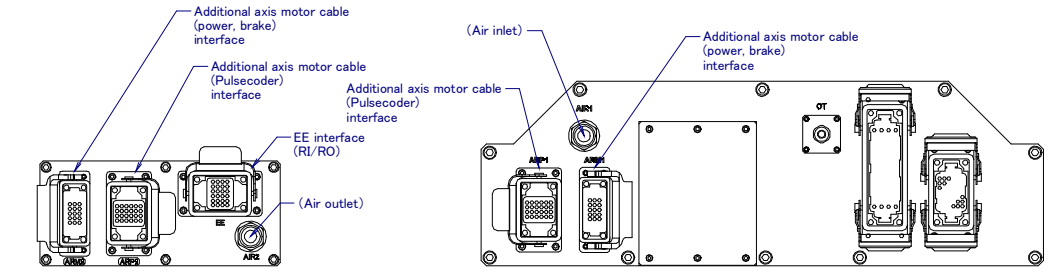
With user cable (signal) and air ×1
Spec of mechanical unit cable
A05B-1125-H202 (M-710iC/50, /70)
A05B-1125-H222 (M-710iC/50S)



J3 casing connector plate (output side)

J1 base connector plate (input side)

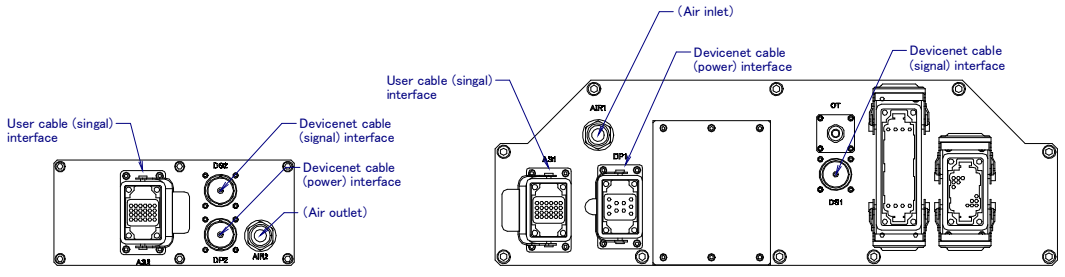
With user cable (signal/power)
Spec. of mechanical unit cable
A05B-1125-H204 (M-710iC/50, /70)
A05B-1125-H224 (M-710iC/50S)



J3 casing connector plate (output side)

J1 base connector plate (input side)

With additional axis motor cable (Pulsecoder/power)
Spec. of mechanical unit cable
A05B-1125-H209 (M-710iC/50, /70)
A05B-1125-H229 (M-710iC/50S)

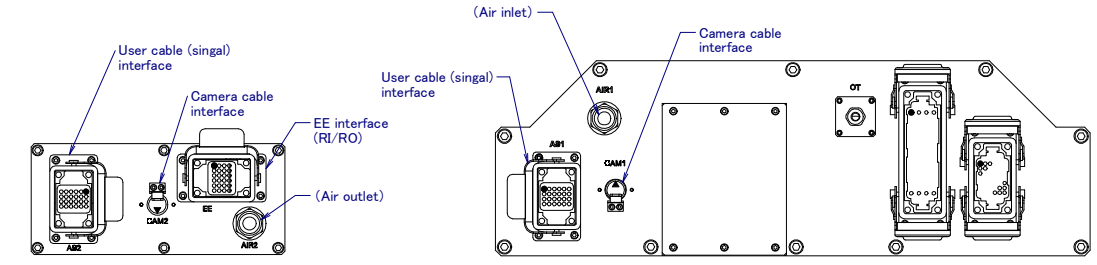


J3 casing connector plate (output side)

J1 base connector plate (input side)

With user cable(signal) ,devicenet cable (signal/power)
Spec. of mechanical unit cable
A05B-1125-H210 (M-710iC/50, /70)

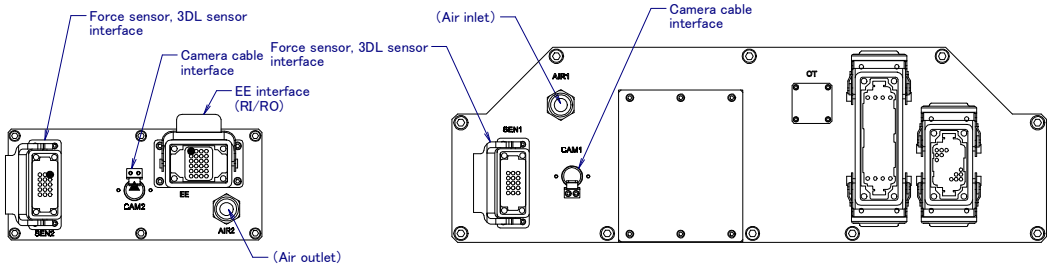
Fig. 5.3 (d) Interface for option cable
(When Severe dust/liquid protection package is specified) 1/2



J3 casing connector plate (output side)

J1 base connector plate (input side)

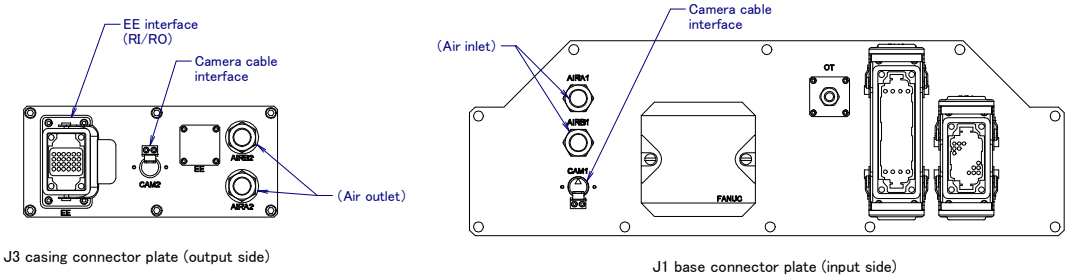
With user cable(signal) and camera cable
Spec. of mechanical unit cable
A05B-1125-H403 (M-710iC/50, /70)
A05B-1125-H421 (M-710iC/50S)



J3 casing connector plate (output side)

J1 base connector plate (input side)

With force sensor , 3DL sensor and camera cable
Spec. of mechanical unit cable
A05B-1125-H404 (M-710iC/50, /70)
A05B-1125-H422 (M-710iC/50S)

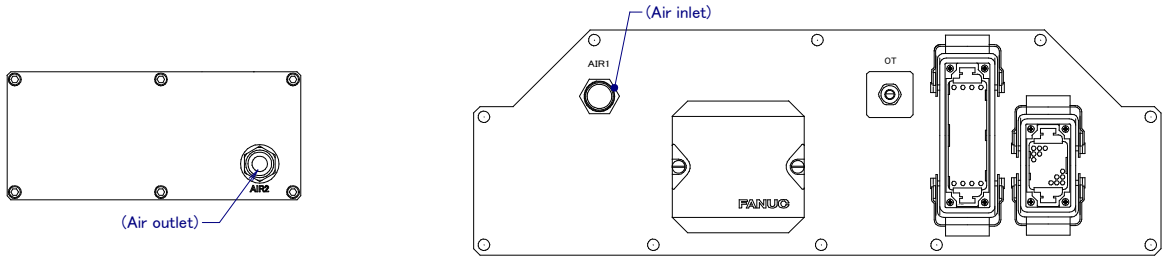


J3 casing connector plate (output side)

J1 base connector plate (input side)

With camera cable and AIRX2
Spec. of mechanical unit cable
A05B-1125-H405 (M-710iC/50, /70, /50E)

Fig. 5.3 (e) Interface for option cable
(When Severe dust/liquid protection package is specified) 2/2



J3 casing connector plate (output side)

J1 base connector plate (input side)

Without EE(RI/RO)
Spec. of mechanical unit cable
A05B-1125-H213 (M-710iC/50, /70)

Fig. 5.3 (f) Interface for option cable (WASHING APPLICATION is specified)

(1) EE interface (RI/RO)(Option)
Fig. 5.3 (g) and (h) show the pin layout for the EE interface (RI/RO).

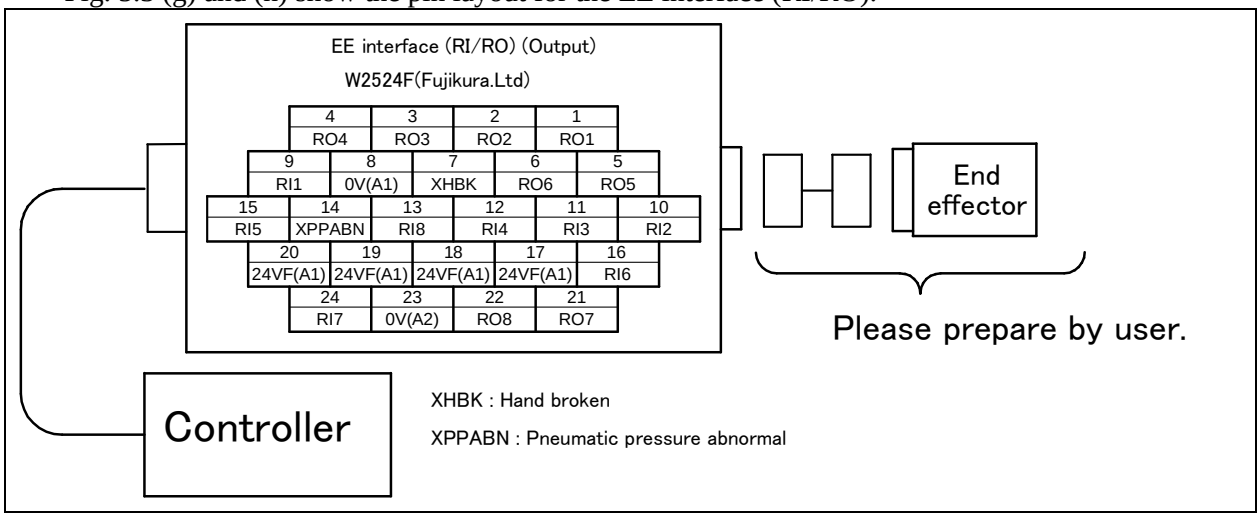


Fig. 5.3 (g) Pin layout for EE interface (RI/RO) (option)

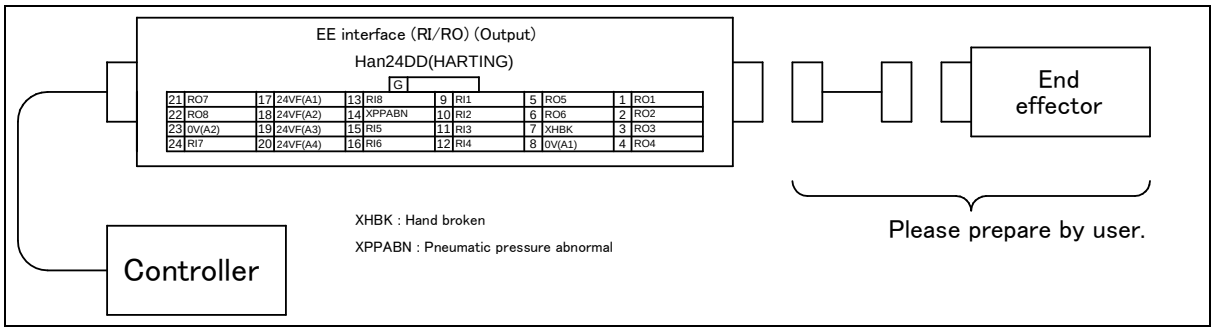


Fig. 5.3 (h) Pin layout for EE interface (RI/RO) (Severe dust/liquid protection package)

> **⚠CAUTION**
> For wiring of the peripheral device to the EE interface, refer to the Chapter 4 of CONNECTION section of CONTROLLER MAINTENANCE MANUAL, too.

(2) User cable (signal line) ,user cable (signal line usable to the 3DL sensor and force sensor) Interface (option)
Fig. 5.3 (i) shows pin layout for user cable (signal line) and user cable (signal line usable to the 3DL sensor and force sensor) interface

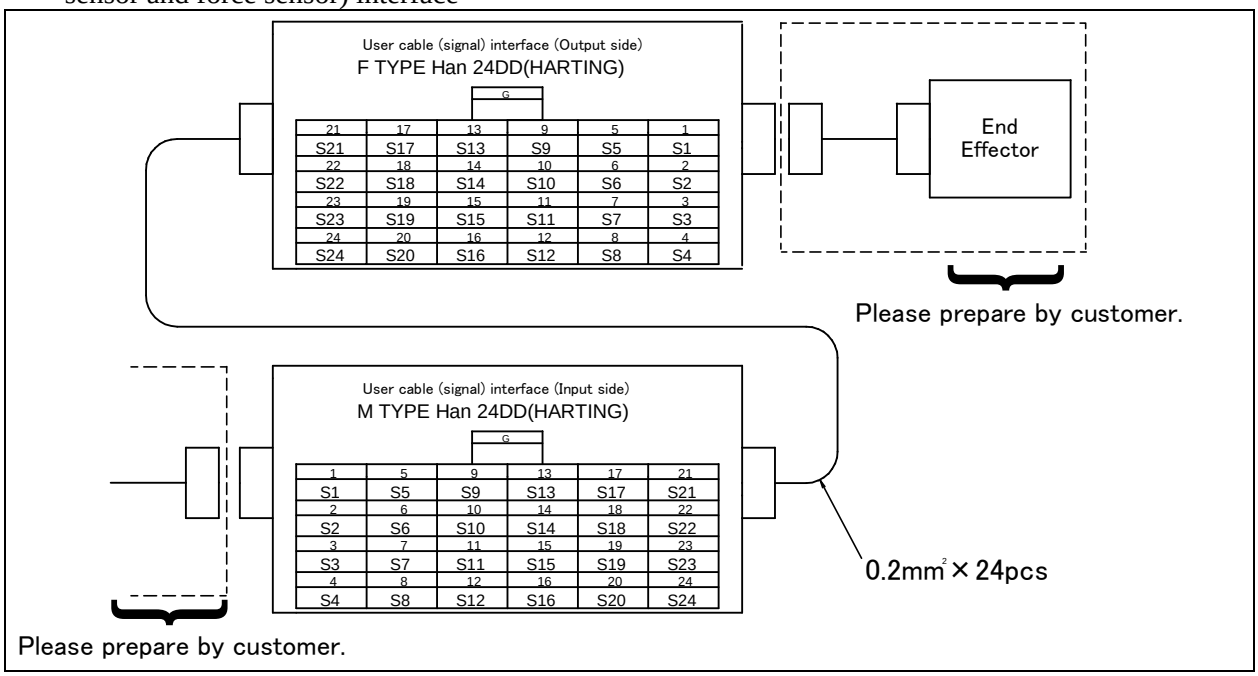


Fig. 5.3 (i) Pin layout for user cable (signal line) user cable (signal line usable to the 3DL sensor and force sensor) interface (option)

(3) User cable (power line) Interface (option)
Fig. 5.3 (j) shows pin layout for user cable (power line) interface.

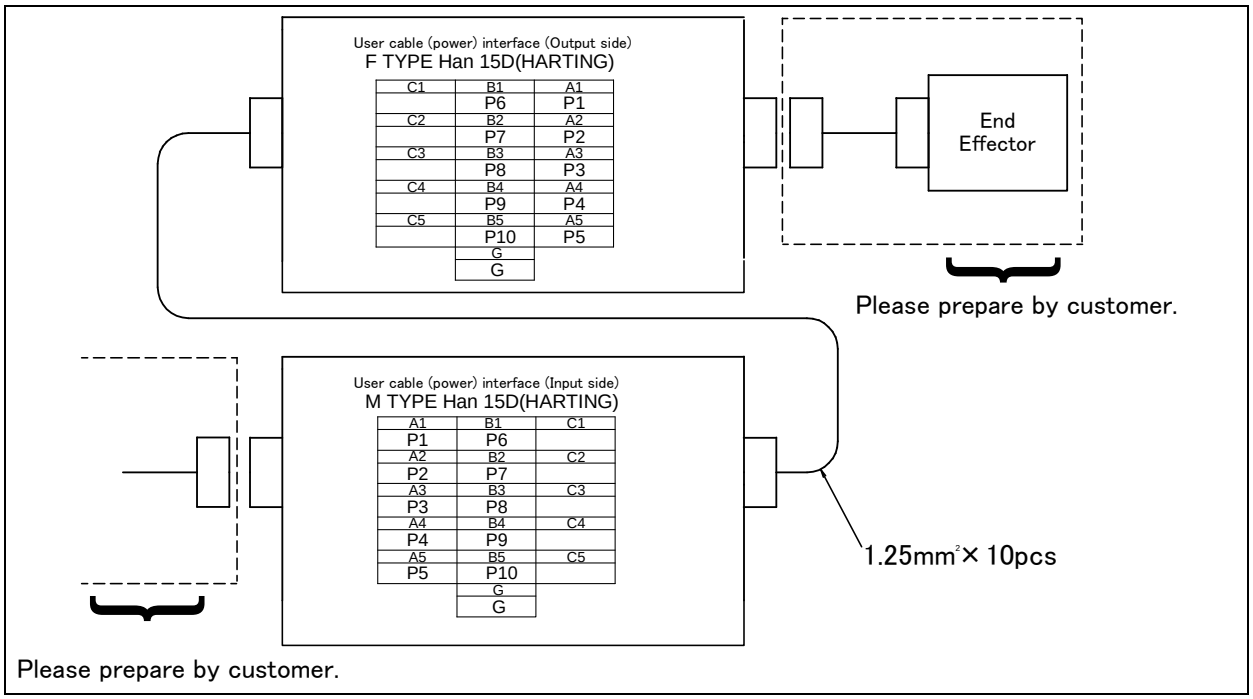


Fig. 5.3 (j) Pin layout for user cable (power line) interface (option)

(4) DeviceNet cable (power line) Interface (option)
Fig. 5.3 (k) shows pin layout for DeviceNet cable (signal line) interface.

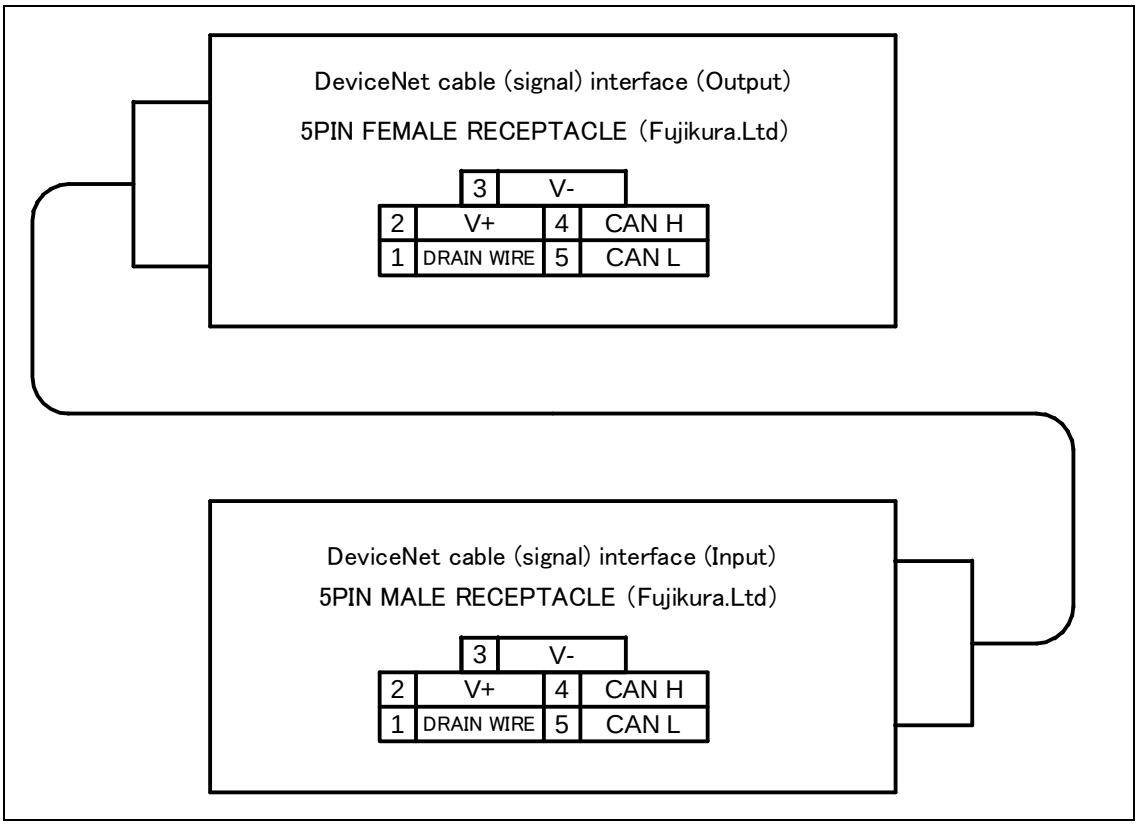


Fig. 5.3 (k) Pin layout for DeviceNet cable (signal line) interface (option)

(5) DeviceNet cable (power line) Interface (option)
Fig. 5.3 (l) shows pin layout for DeviceNet cable (power line) interface.

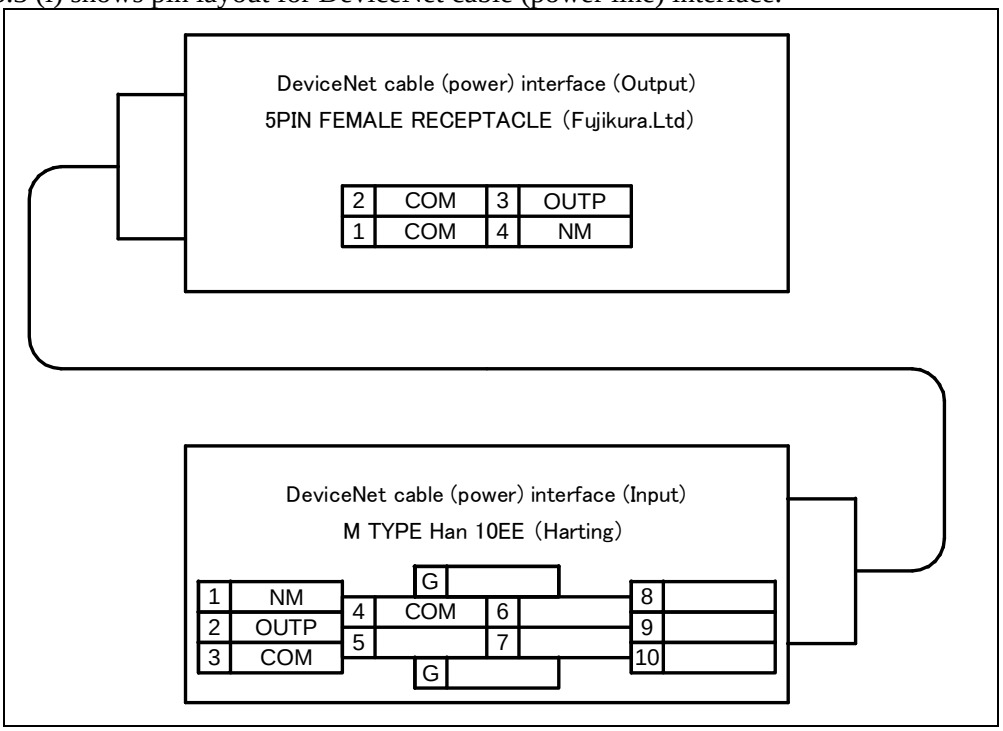


Fig. 5.3 (l) Pin layout for DeviceNet cable (power line) interface (option)

(6) Additional axis motor cable (Pulsecoder line) Interface (option)
Fig. 5.3 (m) shows pin layout for Additional axis motor cable (Pulsecoder line) interface.
The connector has a code pin for preventing improper insertion.

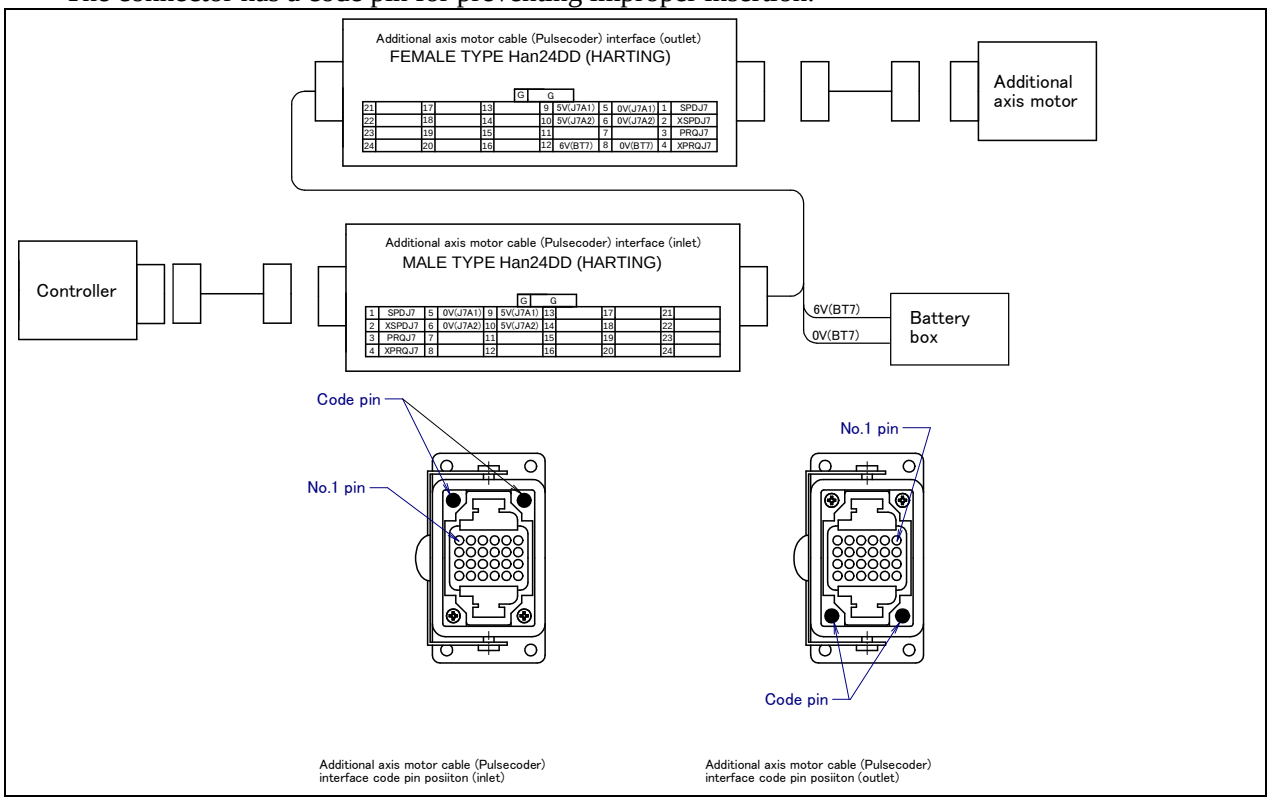


Fig. 5.3 (m) Pin layout for additional axis motor cable (Pulsecoder line) interface (option)

(7) Additional axis motor cable (power and brake cables) Interface (option) Fig. 5.3 (n) shows pin layout for Additional axis motor cable (power and brake cables) interface.
The connector has a code pin for preventing improper insertion.

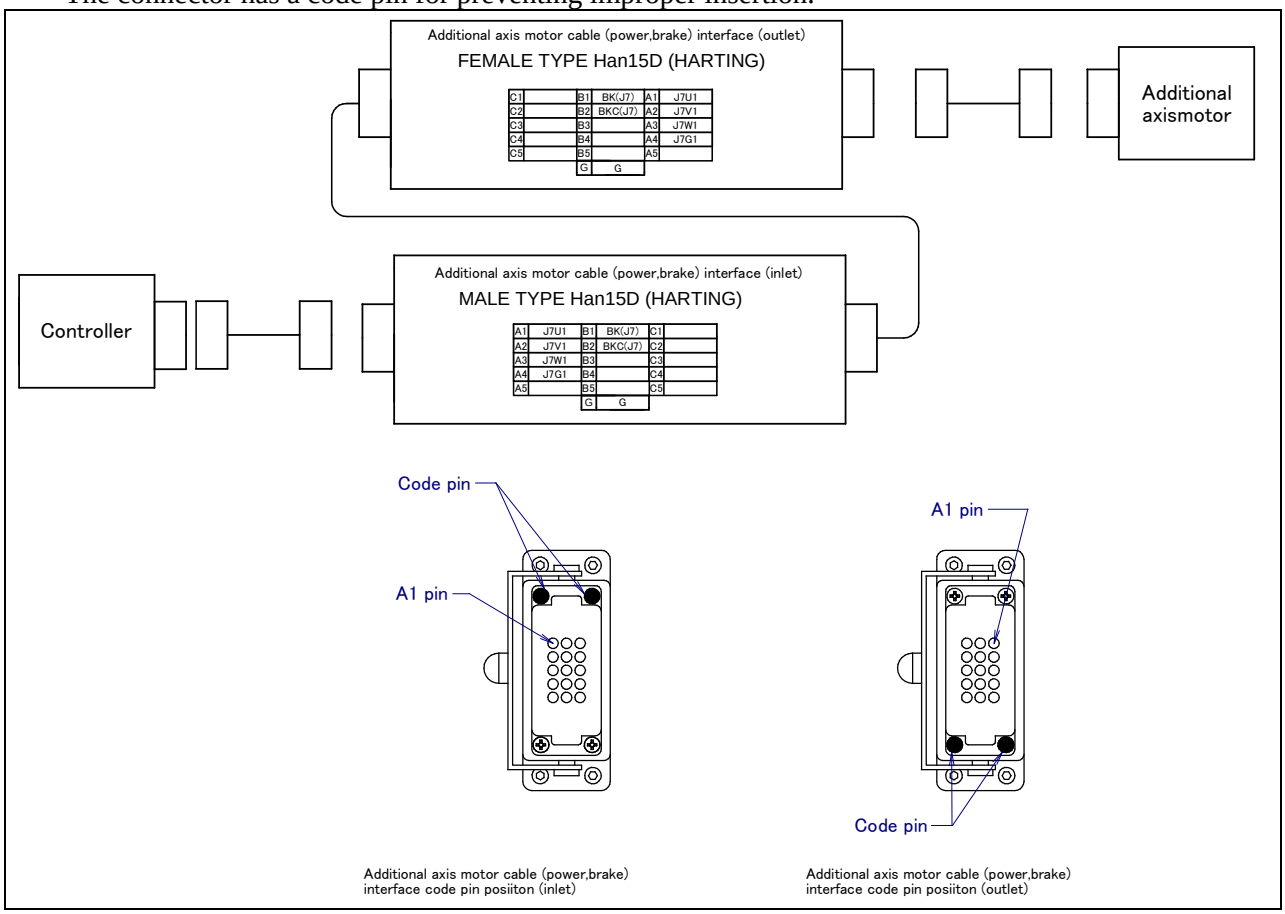


Fig. 5.3 (n) Pin layout for additional axis motor cable (power and brake cables)) interface (option)

Connector specifications

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

Cable	Input side (J1 base)		Output side (J3 casing)		Maker /Dealer
EE (RI/RO)	———		JMWR25.34F		Fujikura .Ltd
AS	Housing Insert Contact	09 30 006 0301 09 16 024 3001 (Han 24DD M) 09 15 000 6103	Housing Insert Contact	09 30 006 0301 09 16 024 3101 (Han 24DD F) 09 15 000 6203	HARTING K.K
AP	Housing Insert Contact	09 20 010 0301 09 21 015 3001 (Han 15D M) 09 15 000 6103	Housing Insert Contact	09 20 010 0301 09 21 015 3101 (Han 15D F) 09 15 000 6203	
EE(RI/RO) (Cable corresponds to the severe dust/liquid protection)	Housing Insert Contact Guide pin	———	Housing Insert Contact Guide pin	09 30 006 0301 09 16 024 3101 (Han 24DD F) 09 15 000 6204 09 30 000 9908	

Table 5.3 (b) Connector specifications (User side)

Cable	Input side (J1 base)		Output side (J3 casing)		Maker /Dealer
EE (RI/RO)	———		JMSP25.34M Straight (Appendix) (FANUC specification: A63L-0001-0234#S25.34M) JMLP25.34M Angle		Fujikura .Ltd
AS	Hood Select one	09 30 006 1540 Side entry 1541 ↓ 0542 0543 1440 Top entry 1441 ↓ 0442 0443	Hood	←The same	HARTING K.K
	Insert	09 16 024 3101 (Han 24DD F)	Insert	09 16 024 3001 (Han 24DD M)	
	Contact Select one	09 15 000 6204 AWG 26-22 6203 AWG 20 6205 AWG 18 6202 AWG 18 6201 AWG 16 6206 AWG 14	Contact	09 15 000 6104 AWG 26-22 6103 AWG 20 6105 AWG 18 6102 AWG 18 6101 AWG 16 6106 AWG 14	
	Clamp Select one	09 00 000 5083 5086 5090 5094 etc.	Clamp	←The same	
AP	Hood Select one	09 30 006 1541 Side entry 0540 ↓ 0541 1440 Top entry 0440 ↓ 0441	Hood	←The same	
	Insert	09 21 015 3101 (Han 15D F)	Insert	09 21 015 3001 (Han 15D M)	
	Contact Select one	09 15 000 6204 AWG 26-22 6203 AWG 20 6205 AWG 18 6202 AWG 18 6201 AWG 16 6206 AWG 14	Contact	09 15 000 6104 AWG 26-22 6103 AWG 20 6105 AWG 18 6102 AWG 18 6101 AWG 16 6106 AWG 14	
	Clamp Select one	09 00 000 5083 5086 5090 5094 etc.	Clamp	←The same	

Cable	Input side (J1 base)	Output side (J3 casing)		Maker /Dealer
EE (RI/RO) (These are attached to the cables which are correspon ded to the sever dust/liquid protection.)	———	Hood	09 30 006 1440 (FANUC specification : A63L-0001-0453#06B1440)	HARTING K.K
		Insert	09 16 024 3001 (Han 24DD M) (FANUC specification : A63L-0001-0453#24DDM)	
		Contact	09 15 000 6104 AWG 26-22 (FANUC specification : A63L-0001-0453#CA6140) 6103 AWG 20 6105 AWG 18 6102 AWG 18 6101 AWG 16 6106 AWG 14	
		Clamp	15.3D (FANUC specification : A63L-0001-0453#A-15.3D)	
		Bush	09 30 000 9909 (FANUC specification : A63L-0001-0453#A-9909)	

Table 5.3 (c) Connector specifications (DeviceNet cable, on the Mechanical unit side)

Cable	Input side (J1 base)		Manu.	Output side (J3 casing)	Maker /Dealer
DS	CM03A-R5P-S-2		Fujikura . Ltd	CM03A-R5P-S-2	Fujikura . Ltd
DP	Housing Insert Contact	09 30 006 0301 09 32 010 3001 09 33 000 6105	HARTING K.K.	84854-9102	MOLEX JAPAN CO.LTD

Table 5.3 (d) Connector specifications (DeviceNet cable, on the user equipment side)

Cable	Input side (J1 base)		Manu.	Output side (J3 casing)	Maker /Dealer
DS	MINI connector for use on the device net 5-pin, female 1 CM03-P5S		Fujikura .Ltd	CM03-J5P	Fujikura . Ltd
DP	Hood Select just one	09 30 006 1540 Side entry 1541 0542 0543 1440 Top entry 1441 0442 0443	HARTING K.K.	CM03-J4P	Fujikura . Ltd
	Insert	09 32 010 3101			
	Contact Select just one	09 15 000 6204 AWG 26-22 6203 AWG 20 6205 AWG 18 6202 AWG 18 6201 AWG 16 6206 AWG 14			
	Clamp Select just one	09 00 000 5083 5086 5090 5094 Many other types are available			

Table 5.3 (e) Connector specifications (Additional axis motor cable, on the Mechanical unit side)

Cable	Input side (J1 base)		Output side (J3 casing)		Maker /Dealer
ARP	Housing	09 30 006 0301	Housing	09 30 006 0301	HARTING K.K.
	Insert	09 16 024 3001 (Han 24DD M)	Insert	09 16 024 3101 (Han 24DD F)	
	Contact	09 15 000 6103	Contact	09 15 000 6203	
	Code pin	09 30 000 9901	Code pin	09 30 000 9901	
ARM	Housing	09 20 010 0301	Housing	09 20 010 0301	
	Insert	09 21 015 3001 (Han 15D M)	Insert	09 21 015 3101 (Han 15D F)	
	Contact	09 15 000 6101	Contact	09 15 000 6201	
	Code pin	09 30 000 9901	Code pin	09 30 000 9901	

NOTE
For details, such as the dimensions, refer to the related catalogs offered by the respective manufacturers, or contact FANUC.

6 AXIS LIMIT SETUP

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

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

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

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

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

⚠CAUTION

1 Changing the motion range of any axis affects the operation range of the robot. To avoid trouble, carefully consider a possible effect of the change to the movable range of each axis in advance. Otherwise, it is likely that an unexpected condition occurs; for example, an alarm may occur in a previous taught position.
2 For the J1axis, do not count merely on software-based limits to the movable range when changing the movable range of the robot. Use mechanical stoppers together so that damage to peripheral equipment and injuries to human bodies can be avoided. In this case, make the software-specified limits match the limits based on the mechanical stoppers.
3 Mechanical stoppers are physical obstacles. The robot cannot move beyond them. For the J1 to J3 axis(except J2 and J3 of M-710*i*C/50S), it is possible to re-position the mechanical stoppers. For J5 axes, the mechanical stoppers are fixed. For the J4 and J6 axes, only software-specified limits are available.
4 Adjustable mechanical stoppers 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.

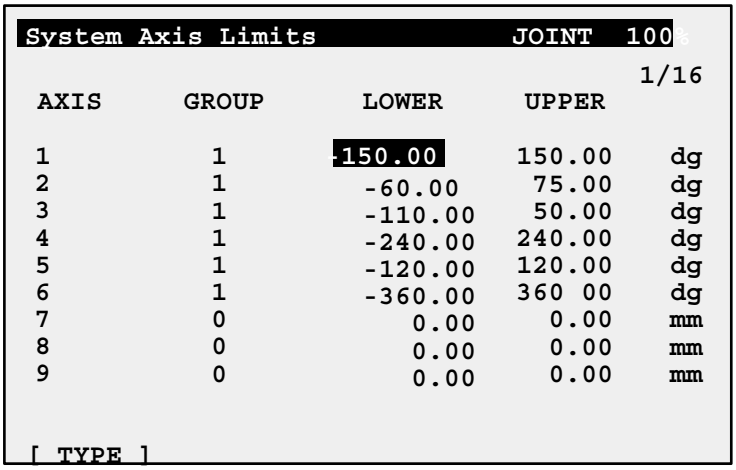
6.1 SOFTWARE SETTING

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



NOTE
0 indicates the robot does not have these axes.

5 Move the cursor to the axis limit you want to set.

⚠WARNING
Do not depend on J1, J2, and J3 axis (except J2 and J3 of M-710*i*C/50S)limit software settings to control the motion range of your robot. Use the axis limit switches or Mechanical stopper also; otherwise, injury to personnel or damage to equipment could occur.

6 Type the new value using the numeric keys on the teach pendant.
7 Repeat Steps 5 through 6 until you are finished setting the axis limits.

⚠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.

8 Turn off the controller and then turn it back on again in the cold start mode so the new information can be used.

6.2 ADJUSTABLE MECHANICAL STOPPER AND LIMIT SWITCH SETTING (OPTION)

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

Change the position of the mechanical stoppers according to the desired movable range.

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

Item		Movable range
J1 axis adjustable mechanical stopper, limit switch	Upper limit	Settable in steps of 15° degrees in a range of -105° to +180° degrees
	Lower limit	Settable in steps of 15° degrees in the range of -180° to +150° degrees
	Space between the upper and lower limits	A space of 75° degrees or more is required.
J2 axis adjustable mechanical stopper (M-710*i*C/50,/70, /50H ,/50E)	Upper limit	Settable in steps of 10° in the range of -50° to +80°. A mechanical stopper is also provided at the upper limit +140° of the standard movable range.
	Lower limit	Settable in steps of 10° in the range of -60° to +80°. A mechanical stopper is also provided at the lower limit -95°of the standard movable range.
	Space between the upper and lower limits	A space of 50° degrees or more is required.
J3 axis adjustable mechanical stopper (M-710*i*C/50,70, /50H,/50E)	Upper limit	Settable in steps of 20° in the range of -20° to +160° and –30˚ and +170˚. A mechanical stopper is also provided at the upper limit +283.5° of the standard movable range.
	Lower limit	Settable in steps of 20° in the range of -40° to +140° and –50˚ and +150˚. A mechanical stopper is also provided at the lower limit -163.5° of the standard movable range.
	Space between the upper and lower limits	A space of 60° degrees or more is required.

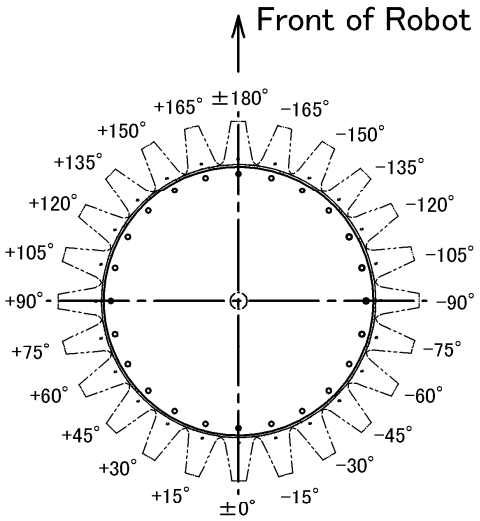
NOTE
If the newly set operation range does not include 0°, it is necessary to change it by zero position mastering so that 0° is included.

NOTE
When adjustable mechanical stopper is ordered, mounting bolt is attached.

NOTE
When motion range is changed by movable mechanical stopper, be sure to set the motion range of soft same refer to Section 6.1

Notes on attaching the J1-axis mechanical stopper

The motion range limited by the J1-axis mechanical stopper can be changed in steps of 15 degrees by changing the installation hole. Select the appropriate installation hole corresponding to the desired limit angle with reference to the following figure.



Note) J1−axis top view
A minimum space of 75° is required between the plus side stopper and minimum side stopper.

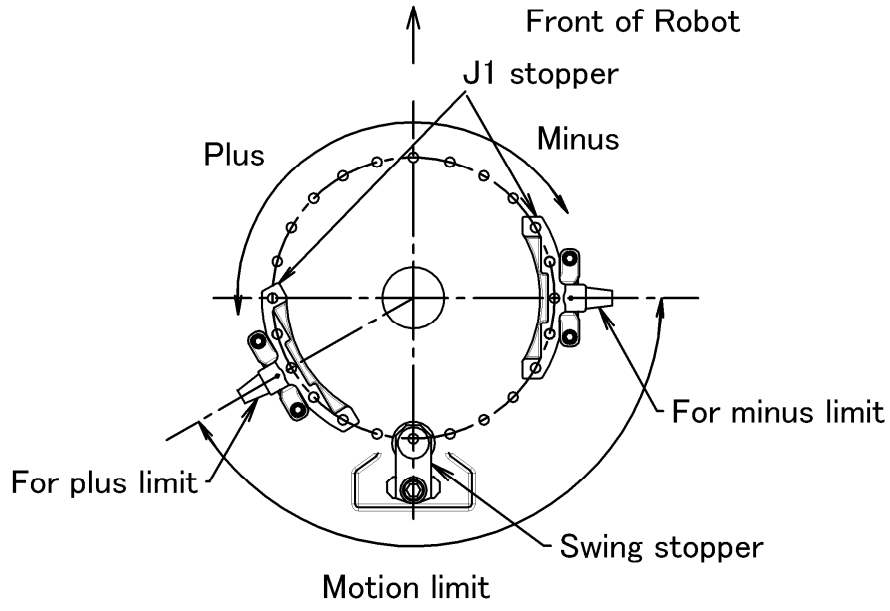


Fig. 6.2(a) Mechanical stopper and motion limit of J1-axis (Option)

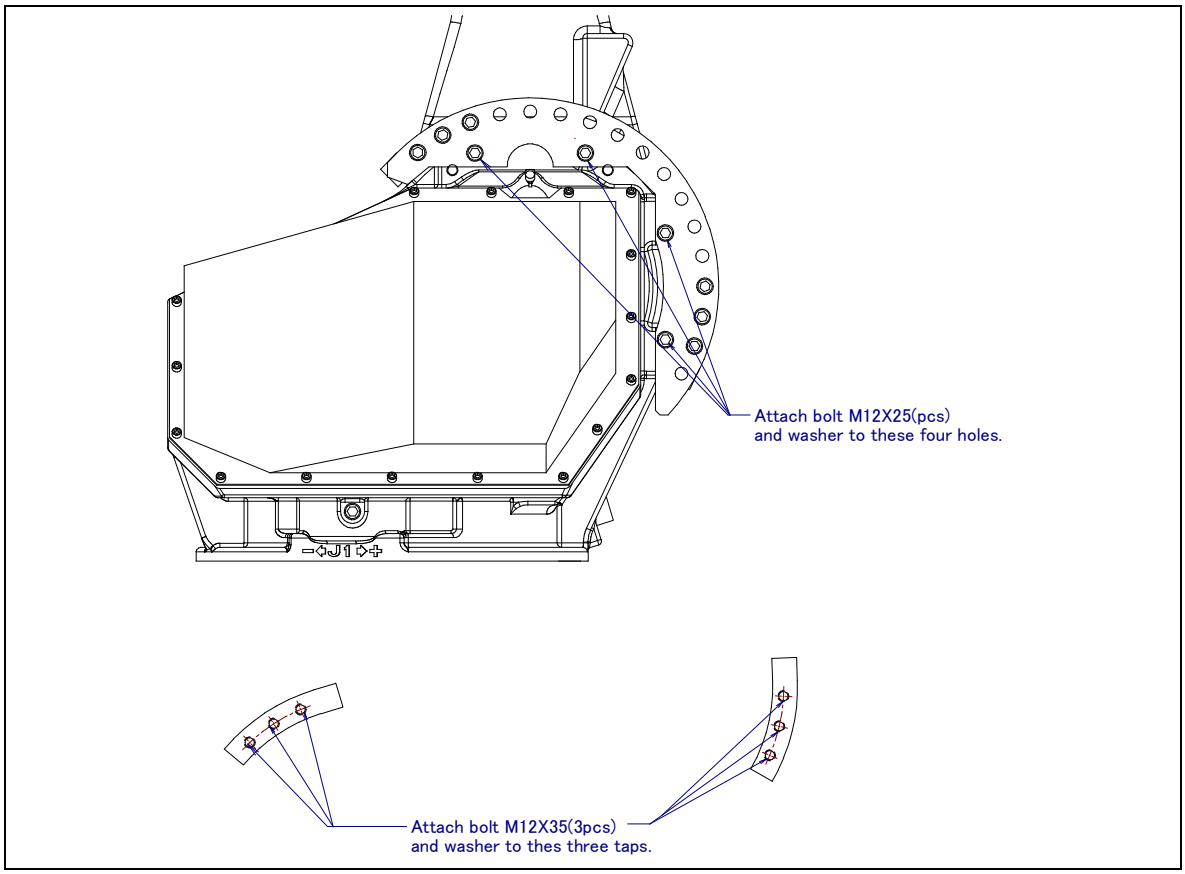


Fig. 6.2(b) J2-Axis movable mechanical stopper (M-710*i*C/50, /70, /50H ,/50E)

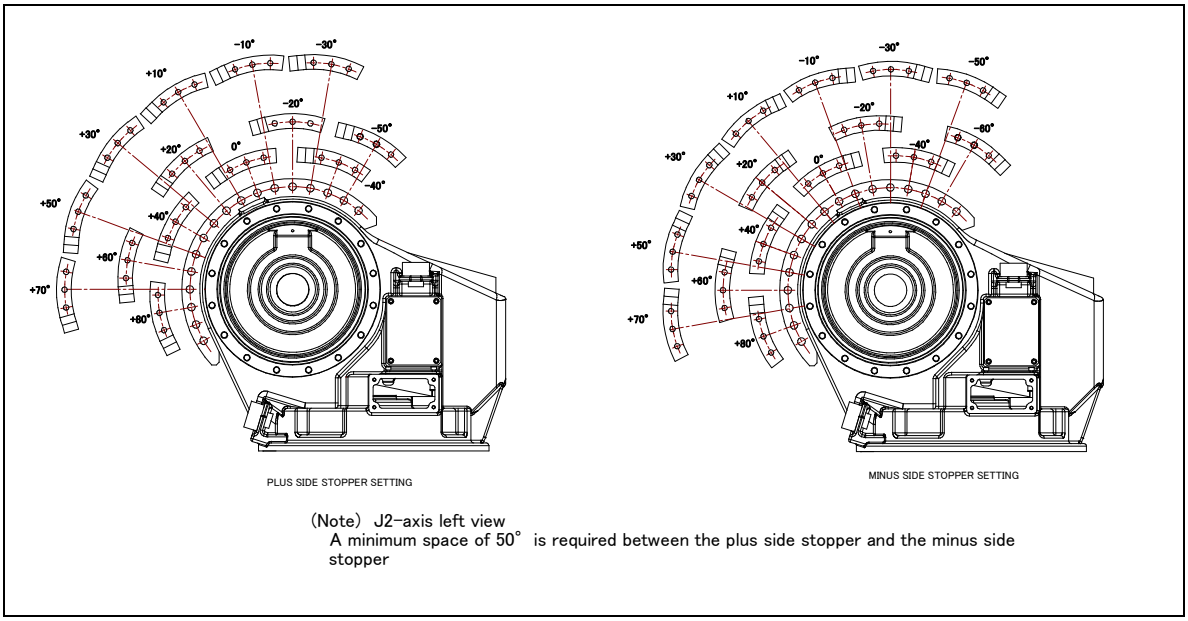


Fig. 6.2(c) Attachment of J2-Axis movable mechanical stopper (M-710*i*C/50, /70, /50H ,/50E)

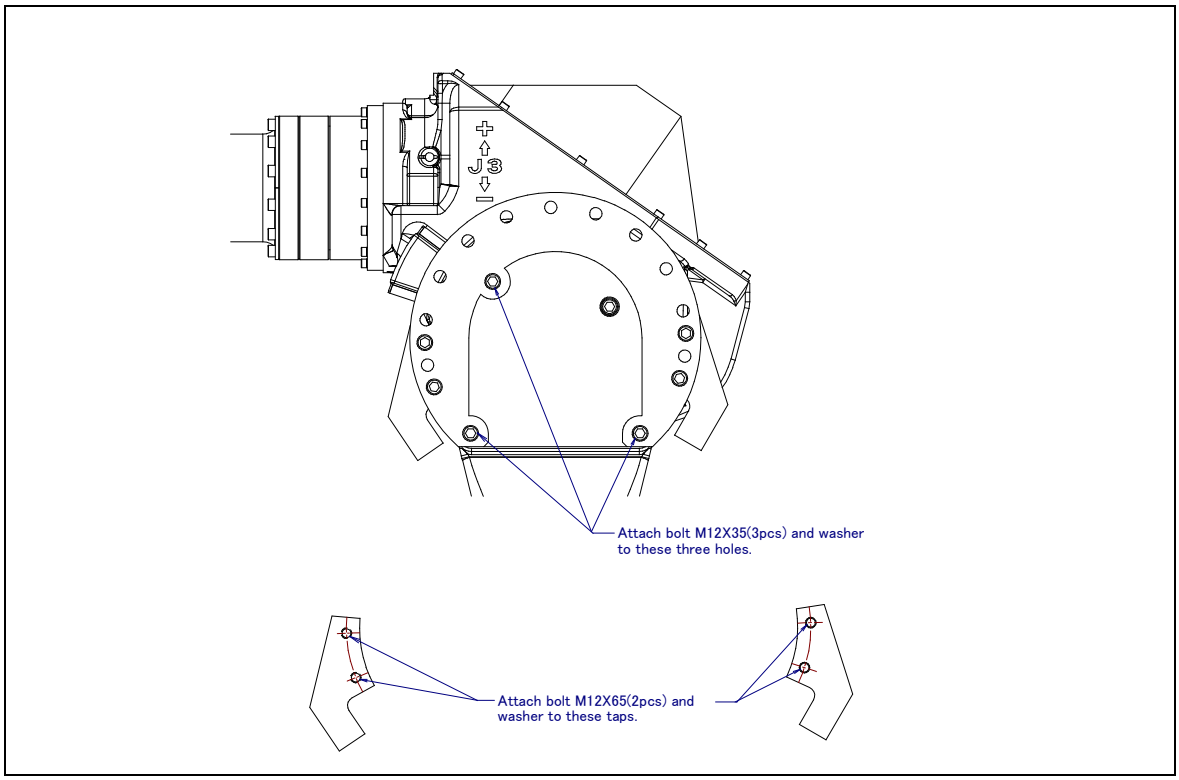


Fig. 6.2(d) J3-Axis movable mechanical stopper (M-710*i*C/50, /70, /50H ,/50E)

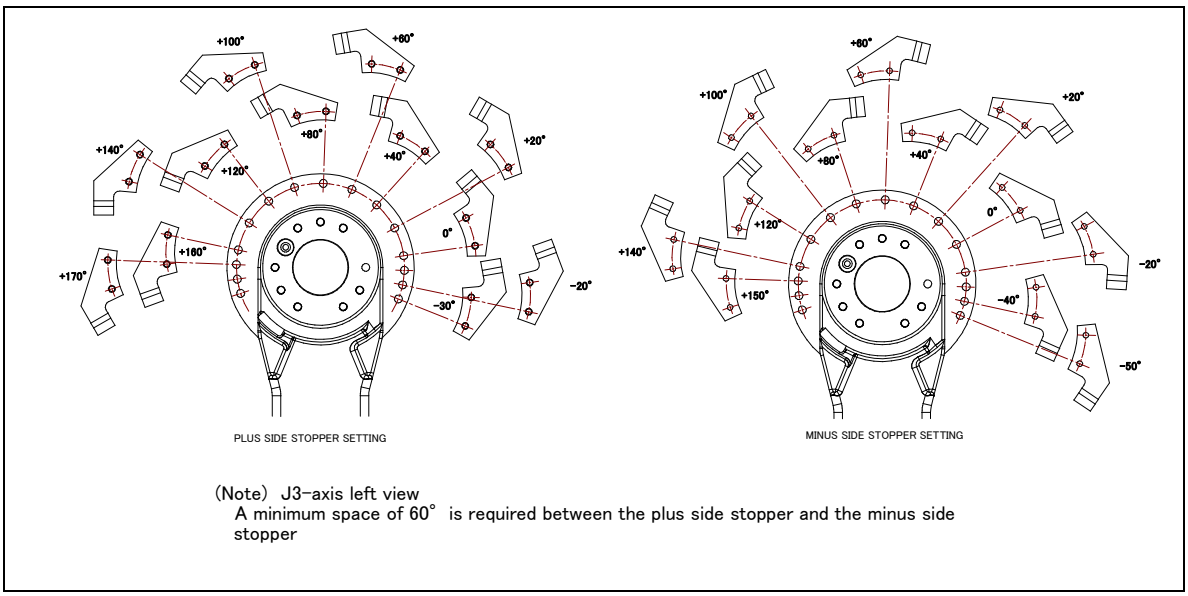


Fig. 6.2(e) Attachment of J3-Axis movable mechanical stopper (M-710*i*C/50, /70, /50H ,/50E)

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)
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

Item		Plus side	Minus side
M-710*i*C/50, /50H, /50E	J1	+17°	-17°
	J2	+19°	-18°
	J3	+11°	-10°
M-710*i*C/70	J1	+16°	+16°
	J2	+12°	-11°
	J3	+11°	-10°
M-710*i*C/50S	J1	+17°	-17°
	J2	There is no movable mechanical stopper.	
	J3		

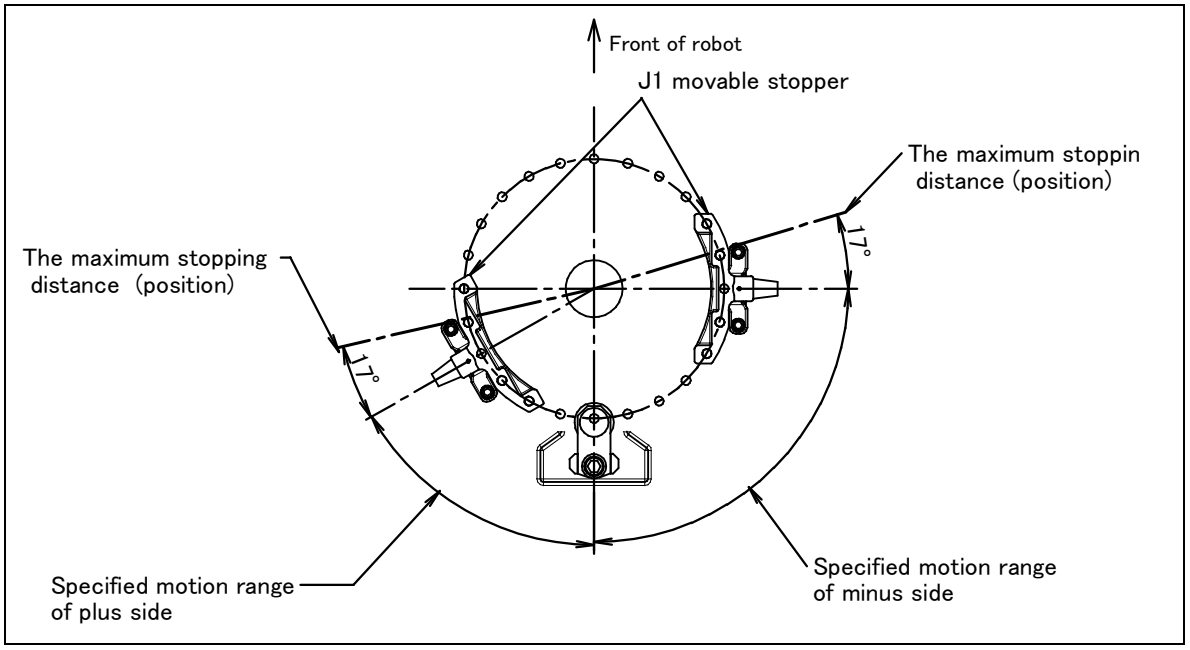


Fig. 6.2(f) The maximum stopping distance of movable mechanical stopper (J1-axis of M-710*i*C/50, /50H , /50S, /50E)

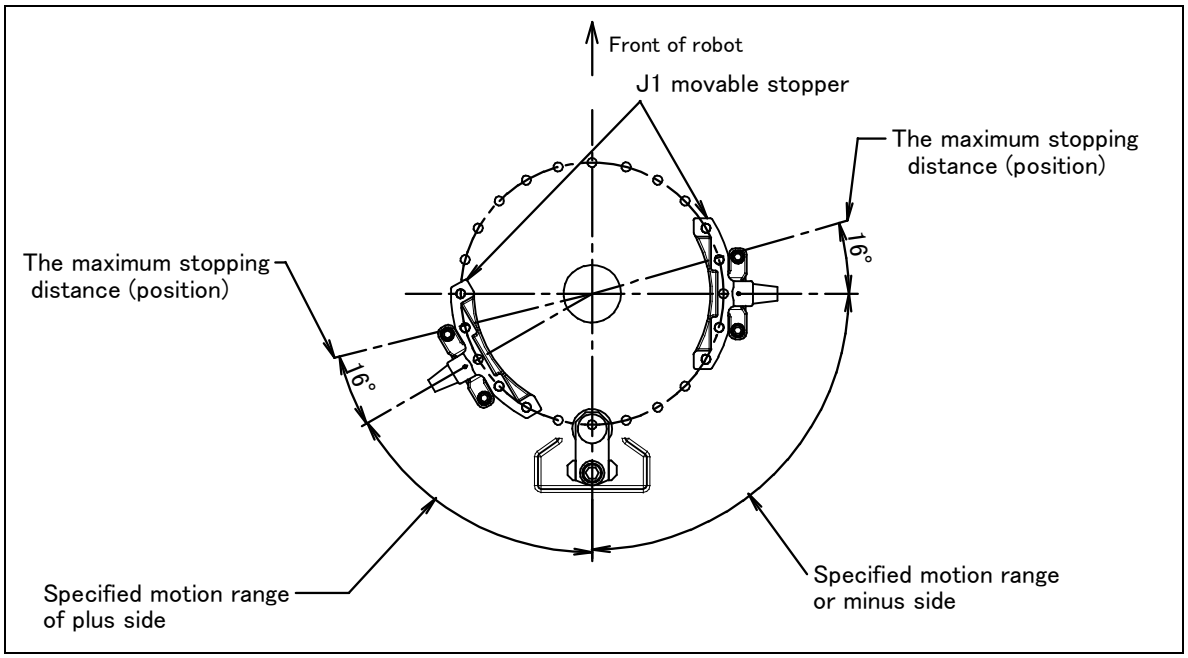


Fig. 6.2(g) The maximum stopping distance of movable mechanical stopper(J1-axis of M-710*i*C/70)

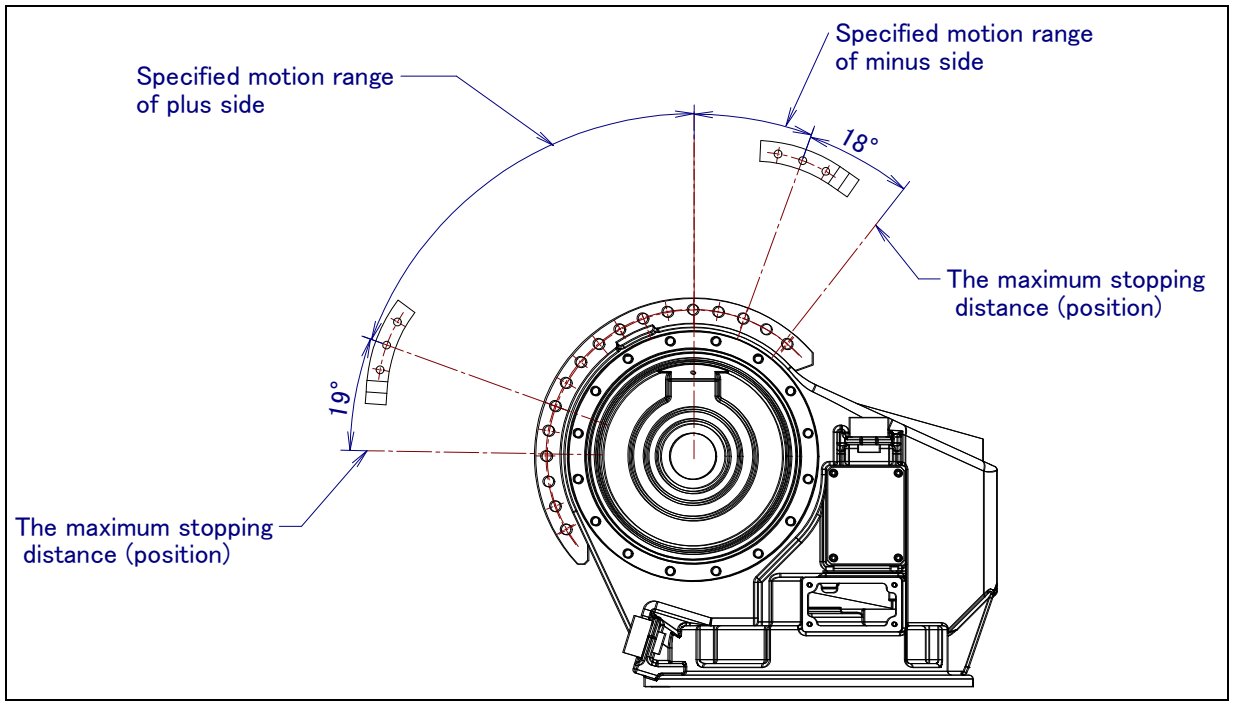


Fig. 6.2(h) The maximum stopping distance of movable mechanical stopper (J2-axis of M-710*i*C/50, /50H, /50E)

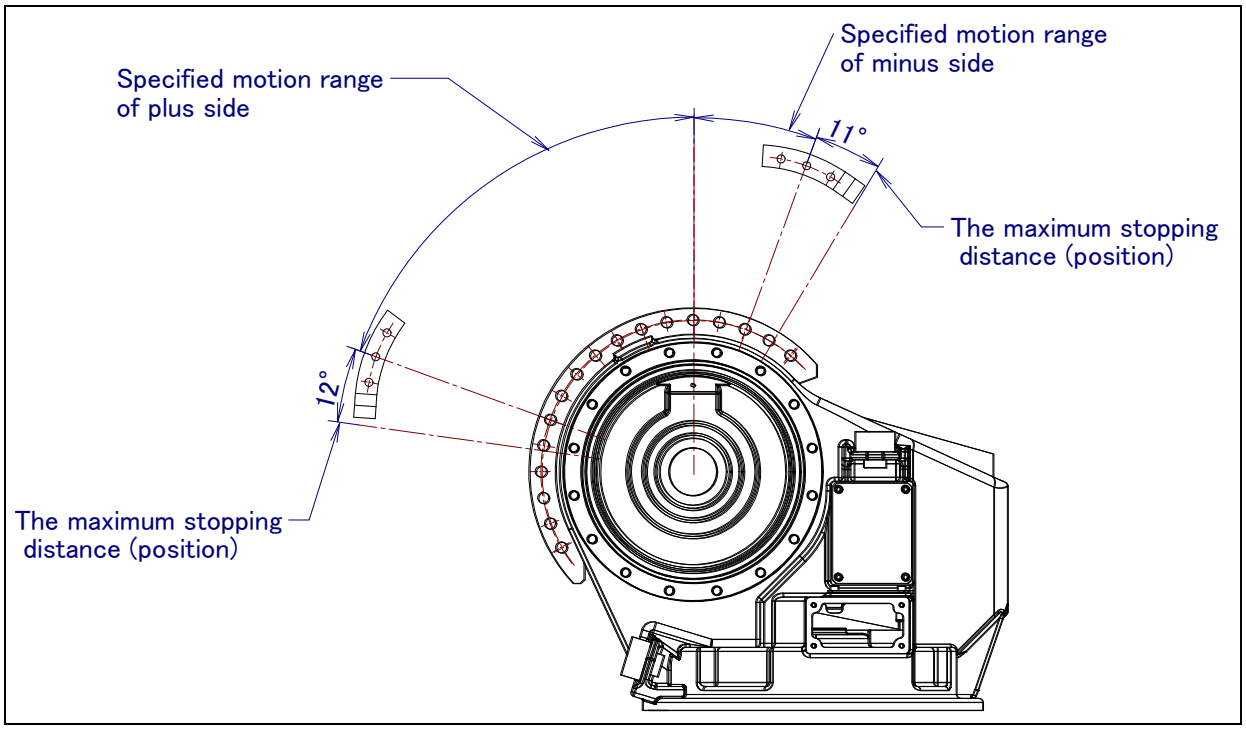


Fig. 6.2(i) The maximum stopping distance of movable mechanical stopper(J2-axis of M-710*i*C/70)

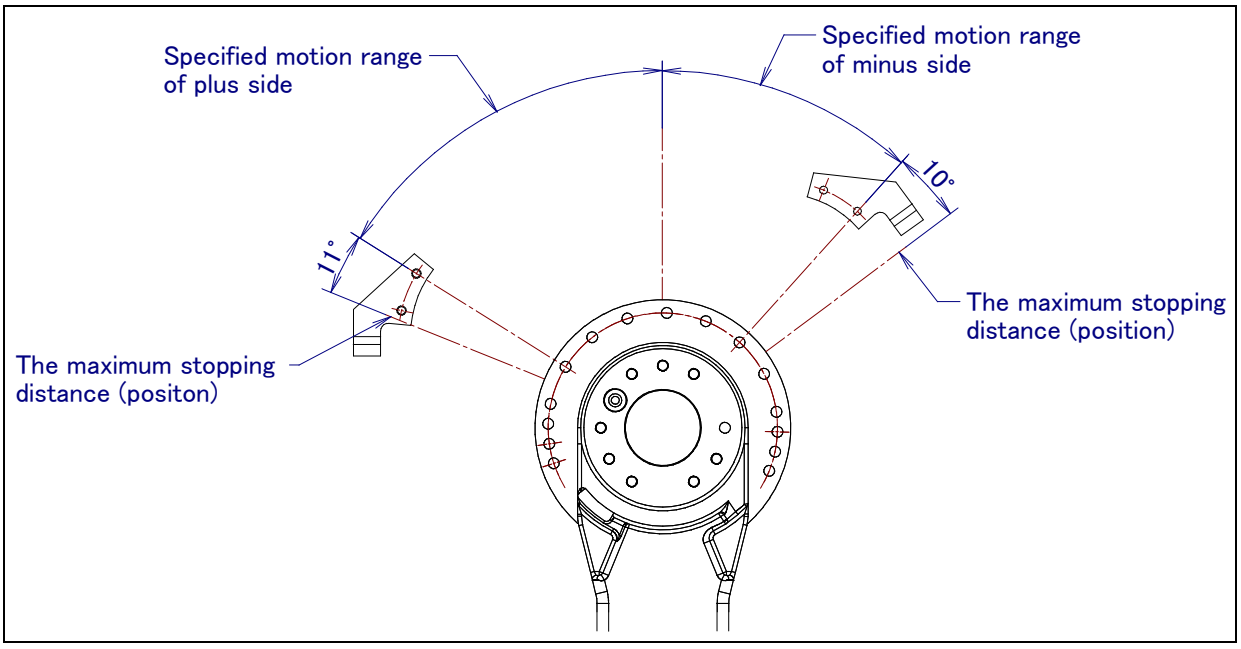
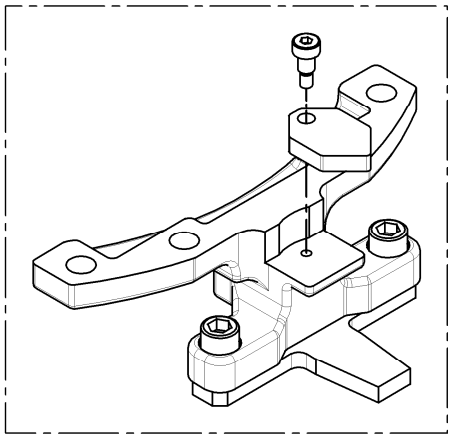


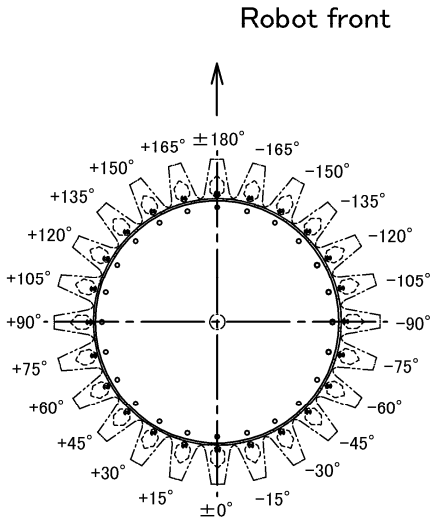
Fig. 6.2(j) The maximum stopping distance of movable mechanical stopper (J3-axis of M-710*i*C/50, /70, /50H ,/50E)

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

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



The dog of the J1−axis is attached to the mechanical stopper.
At this time, use the screw hole of the mechanical stopper.



(Note) This figure is drawn with the J1−axis viewed from above.
The dog of the J1−axis is placed in the same position as with the mechanical stopper.

Fig. 6.3 J1-Axis Dog Position and Motion Range (Option)

6.4 ADJUSTING LIMIT SWITCH (OPTION)

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

ADJUSTING PROCEDURE

1 Set the $MOR_GRP.$CAL_DONE system parameter to FALSE. This disables the motion limit specified by the software. As a result, the operator can rotate the robot by a jog feed which goes beyond the motion limit.
2 Loosen the following bolts.
M8×12 2 pcs M4×25 2 pcs
3 Move the limit switch so that the robot activates it at about 1.0° degree before the stroke end. Step on the dog, and position the limit switch in such a place that only one of the step-on allowance indication lines at the tip of the switch is hidden.
4 When the limit switch operates and detects overtravel (OT), the robot stops, and an error message, “OVERTRAVEL”, is displayed. To restart the robot, hold on the SHIFT key and press the RESET key. Then, while holding on the SHIFT key, move the adjusting axis off the OT limit switch by jogging in joint mode.
5 Check that the robot also activates the limit switch when the robot is approx. 1.0° degrees from the opposite stroke end in the same way as above. If the limit switch does not operate at the position, adjust the position of the switch again.
6 Set the $MOR_GRP.$CAL_DONE system parameter to TRUE.
7 Turn off the power, then turn it on again to restart the controller.

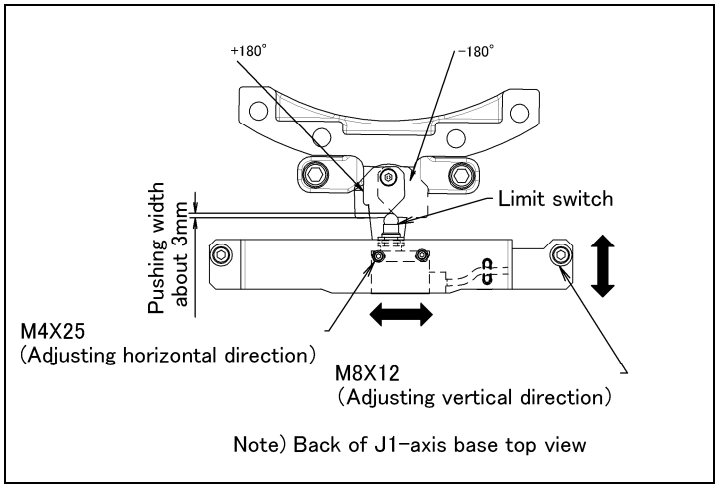


Fig. 6.4 Adjusting J1-axis limit switch (option)

7 CHECKS AND MAINTENANCE

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

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

7.1 PERIODIC MAINTENANCE

7.1.1 Daily Checks

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

(1) Before turning on power

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

NOTE
1 Oil exudation may be attached (Slightly a loot oil stick) to outside of lip depend on the movement condition or environment of the circumference. If this oil contents change to a state of dew, it may fail depend on the movement.
You can prevent oil spot from falling down by wiping the oil contents which is accumulated to under part of oil seal before operation.
2 Also, motors may become the high temperature and the internal pressure of grease bath may rise by frequent repetition movement and use in the high temperature environment.
In these cases, you can return internal pressure by releasing grease out let just after operation of robot. (When opening grease outlet, pay attention grease is not scattered referring to Subsection 7.2.2.)

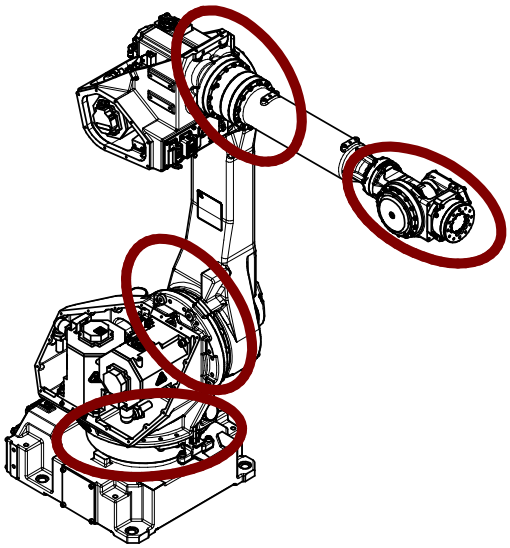


Fig.7.1.1 (a) Check parts of oil exudation

Check items

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

When air control set is combined

Item	Check items		Check points
1	In case of air control set	Air pressure	Check air pressure using the pressure gauge on the air regulator as shown in Fig.7.1.1 (a). If it does not meet the specified pressure of 0.49 to 0.69 MPa (5-7 kgf/cm^2), adjust it using the regulator pressure-setting handle.
2		Lubricator oil mist quantity	Check the drop quantity during wrist or hand motion. If it does not meet the specified value (1 drop/10-20 sec), adjust it using the lubricator control knob. Under normal usage, the lubricator becomes empty in about 10 to 20 days under normal operation.
3		Lubricator oil level	Check to see that the lubricator level is within the specified level shown meet the specified pressure of 10 KPa (0.1kgf/cm^2), adjust it using the regulator pressure-setting handle.
4		Leakage from hose	Check the joints, tubes, etc. for leaks. Repair leaks, or replace parts, as required.
5		Drain	Check drain and release it. When quantity of the drain is remarkable, examine the setting of the air dryer to the air supply side.
6	In case of air purge kit	Supply pressure	Check the supply pressure using the air purge kit shown in Fig.7.1.1 (b). If it does not meet the specified pressure of 10 KPa (0.1 kgf/cm^2), adjust it using the regulator pressure setting handle.
7		Dryer	Check whether the color of the dew point checker is blue. When it is not blue, identify the cause and replace the dryer. Maintenance for air purge kit, refer to the operator's manual attached kit.
8		Drain	Check drain, When quantity of the drain is remarkable, examine the setting of the air dryer to the air supply side.

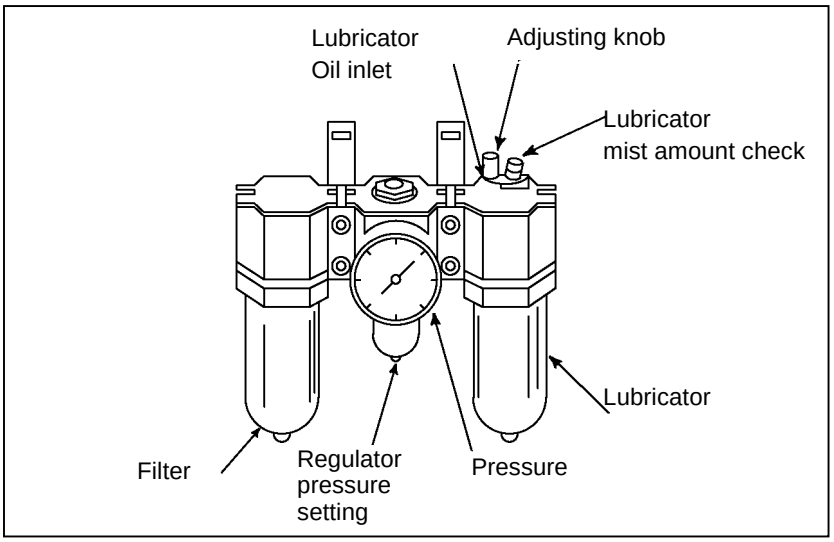


Fig.7.1.1 (b) Air control set

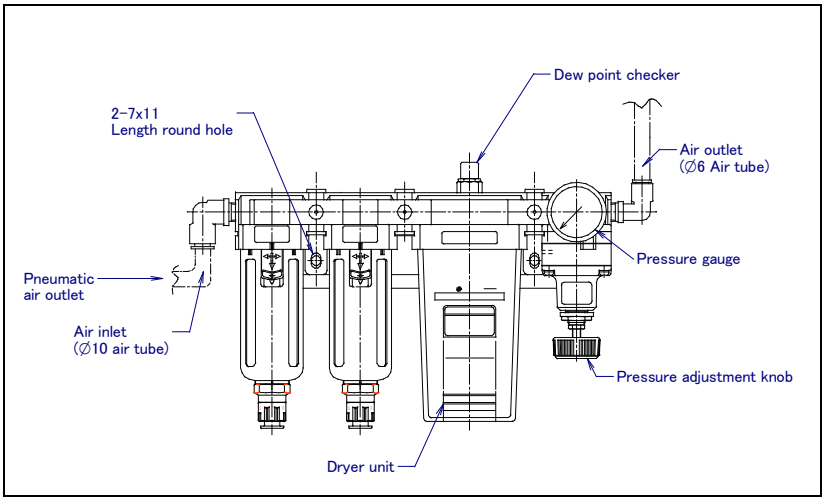


Fig.7.1.1 (c) Air purge kit (option)

(2) After automatic operation

Item	Check items	Check points
1	Vibration, abnormal noises, and motor heating	Check whether the robot moves along and about the axes smoothly without unusual vibration or sounds. Also, check whether the temperatures of the motors are excessively high.
2	Changing repeatability	Check to see that the stop positions of the robot have not deviated from the previous stop positions.
3	Peripheral devices for proper operation	Check whether the peripheral devices operate properly according to commands from the robot.
4	Brakes for each axis	Check that the end effector drops within 0.5 mm when the power is cut.

7.1.2 First 1-Month (320 hours operating) Check

Check the following items after the first one-month operation (or 320 hours operating)

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

7.1.3 First 3-month (960 hours) Checks

Check the following items at the first quarterly inspection, then every year thereafter.(See the Subsection 7.1.5.)

Item	Check items	Check points
1	Retightening external main bolts	Further, tighten the end-effecter mounting bolts and external main bolts. (Note 1)
2	Check the mechanical stopper and adjustable mechanical stopper	Check the looseness of mounting bolts of mechanical stopper and adjustable mechanical stopper. Particular, check swing stopper of J1-axis rotates smoothly (Note 2)
3	Cleaning and checking each part	Clean each part (remove chips, etc.) and check component parts for cracks and flaws.(Note 3)
4	Check the end effector (hand) cable	Confirm whether there is wound in the coating of cable
5	Check the fan.	Confirm whether the fan operates normally when fan is attached,
6	Check the teach pendant cable, operation box connecting cable and robot connecting cable	Check whether the cable connected to the teach pendant and robot is unevenly twisted.

Note 1) Points to be retightened

- The end effecter mounting bolts, robot installation bolts, and bolts to be removed for inspection need to be retightened.
- The bolts exposed to the outside of the robot need to be retightened.

For the tightening torque, see the recommended bolt tightening torque shown in the Appendix.
A loose prevention agent (adhesive) is applied to some bolts. If the bolts are tightened with greater than the recommended torque, the loose prevention agent may be removed. So, follow the recommended tightening torque when retightening them.

Note 2) Check of mechanical stopper and adjustable mechanical stopper.

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

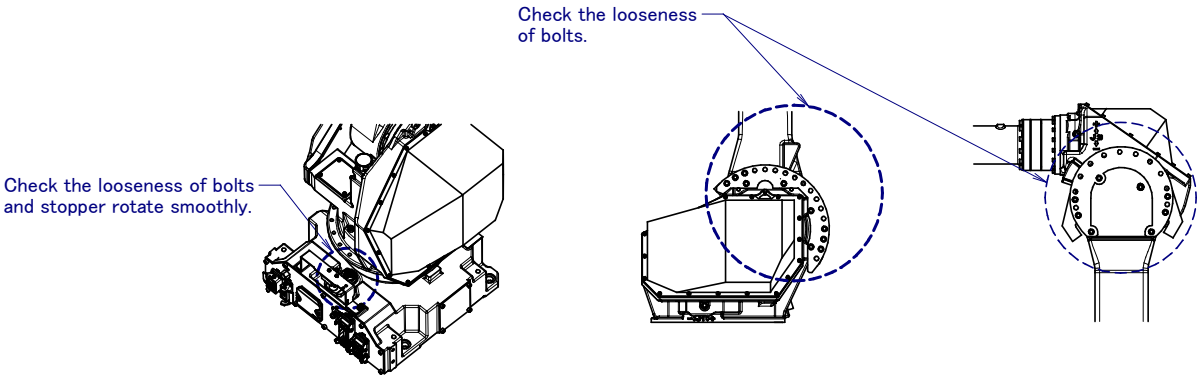


Fig.7.1.3 (a) Check of mechanical stopper and adjustable mechanical stopper.

Note 3) Cleaning

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

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

Vicinity of the wrist axis and oil seal

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

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

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

Vicinity of the welding torch and wrist flange (When ARC welding application is specified.)

→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)

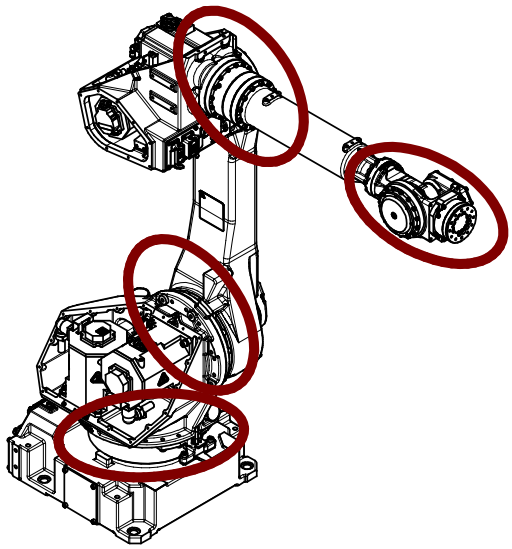


Fig.7.1.3 (b) Cleaning part

7.1.4 3-month (960 hours) Checks

Check the following item at the first one-months (320 hours), then every 3-month thereafter. (See the Subsection 7.1.3.)

Item	Check items	Check points
1	Ventilation portion of controller	(See Section 7.1.2.)

7.1.5 1-year (3,840 hours) Checks

Check the following items about once every year (3,840 hours).

Item	Check items	Check points
1	Cables used in mechanical unit	Check whether the jackets of the mechanical unit cables are damaged. Also, check whether the cables are excessively bent or unevenly twisted. Check that the connectors of the motors and connector panels are securely engaged.(Note 4)
2	Retightening external main bolts	(See Section 7.1.3.)
3	Check the mechanical stopper and adjustable mechanical stopper	(See Section 7.1.3.)

Item	Check items	Check points
4	Cleaning each parts and inspection	(See Section 7.1.3.)
5	Check the end effector (hand) cable	(See Section 7.1.3.)
6	Check the fan	(See Section 7.1.3.)
7	Check the teach pendant cable, operation box connecting cable and robot connecting cable	(See Section 7.1.3.)

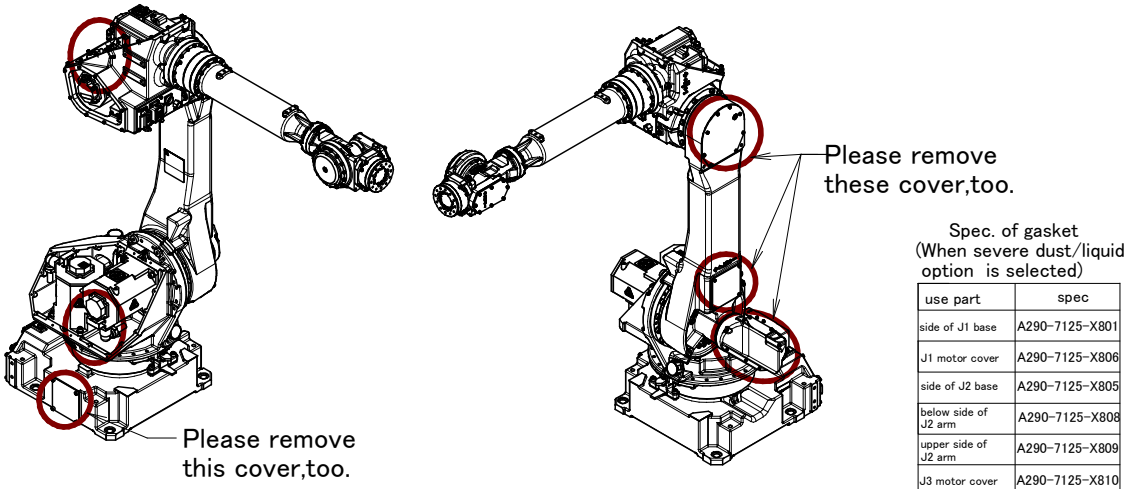
Note 1) Inspection points and check items of the mechanical unit cables and connectors

Inspection points of the mechanical unit cables

For the J1-axis and J2-axis,check cables after remove J2 motor cover.
For the J3-axis,check cables after remove cover of J3 casing.
When severe dust/liquid protection option is selected, packing is attached to the cover. If you remove covers, exchange packing for the new article absolutely.

Check items

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



Spec. of gasket
(When severe dust/liquid option is selected)

use part	spec
side of J1 base	A290-7125-X801
J1 motor cover	A290-7125-X806
side of J2 base	A290-7125-X805
below side of J2 arm	A290-7125-X808
upper side of J2 arm	A290-7125-X809
J3 motor cover	A290-7125-X810
side of J3 casing	A290-7125-X815

Fig 7.1.5 (a) Check items of Mechanical unit cable

Inspection points of the connectors

- Power/brake connectors of the motor
- Robot connection cables and user cables

Check items

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

When severe dust/liquid protection option is selected, packing is attached to the cover. If you remove covers, exchange packing for the new article absolutely.

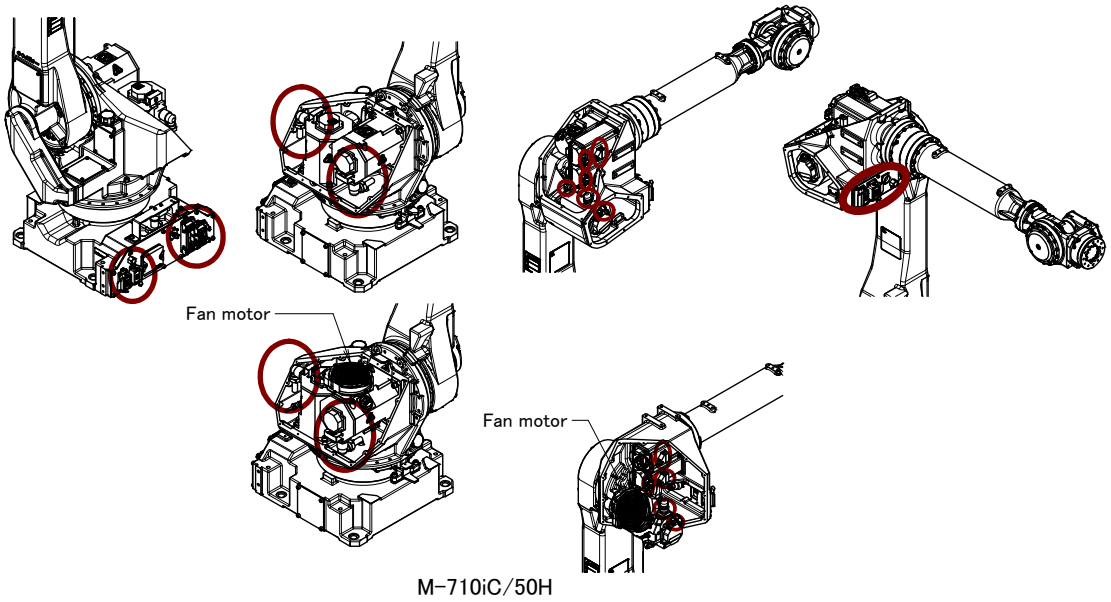


Fig 7.1.5 (b) Check items of connector

7.1.6 1.5-year (5,760 hours) Checks

Check the following item once every 1.5-year (5,760 hours).

Item	Check items	Check points
1	Battery	Replace battery in the mechanical unit. (See Section 7.2)

7.1.7 3-year (11,520 hours) Checks

Check the following items about once every 3 years (11,520 hours).

Item	Check items	Check points
1	Replacing grease of each axis reducer and gearbox	(See Section 7.2)

7.1.8 4-year (15,360 hours) Checks

Check the following items once every 4 years (15,360 hours).

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

7.2 MAINTENANCE

7.2.1 Replacing the Batteries (1.5 Years checks)

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

Procedure of replacing the battery

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

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

2 Remove the battery case cap.(Fig. 7.2.1 (a))
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.

> **⚠ CAUTION**
> When using a robot with the severe dust/liquid protection option, remove the cover from the battery case as shown in Fig. 7.2.1 (b) to replace the battery. After replacing the battery, reinstall the cover. In this time, please be sure to replace packing to new one for effects of severe dust/liquid protection.

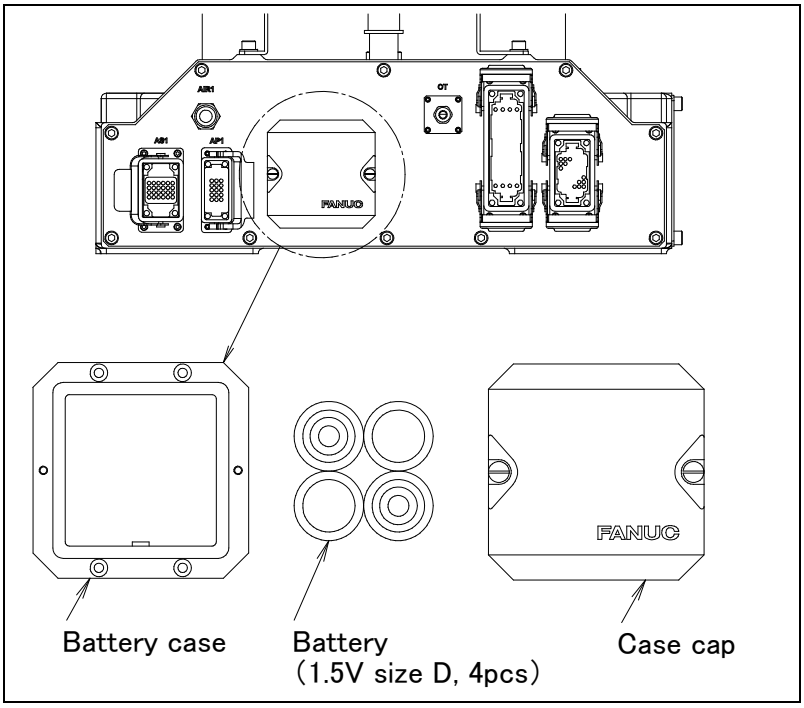


Fig. 7.2.1 (a) Replacing the battery

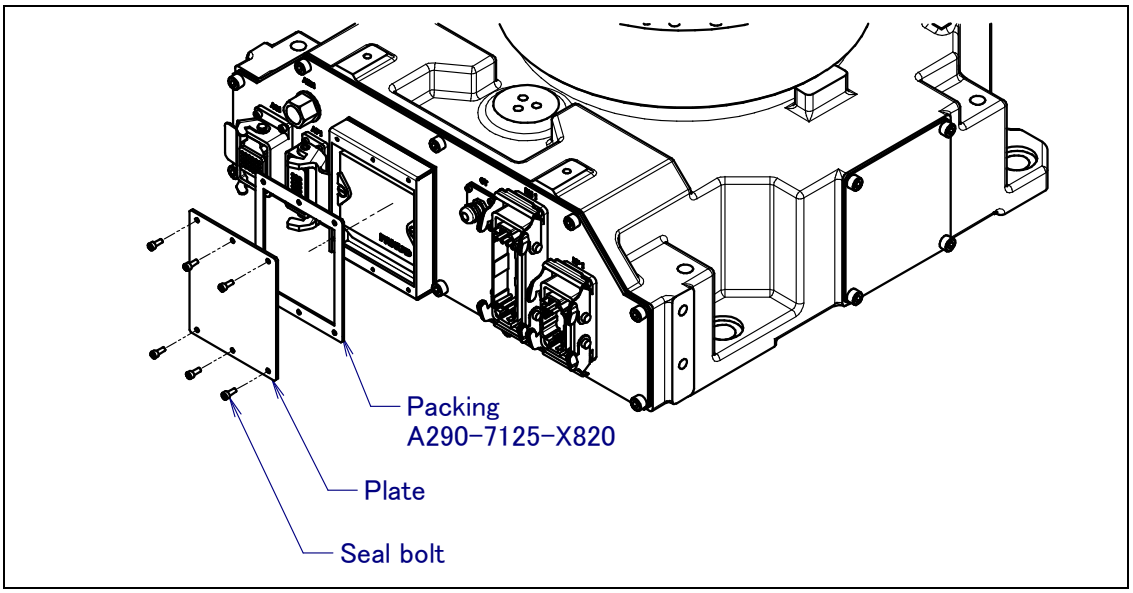


Fig. 7.2.1 (b) Removing the plate

7.2.2 Replacing the Grease of the Drive Mechanism (3 years (11,520 hours) checks)

Replace the grease of the reducers of J1, J2, and J3 axes, the J4-axis gearbox and the wrist every three years or 11,520 hours by using the following procedures.

Table 7.2.2 (a) Grease for 3-year periodical replacement

Supply position	Quantity	Gun tip pressure	Grease name
J1-axis reducer	2950g (3300ml)	0.1MPa or less (NOTE)	Kyodo Yushi VIGOGREASE RE0 Spec.:A98L-0040-0174
J2-axis reducer (M-710*i*C/50, /70, /50S, /50E)	1500g (1660ml)		
J2-axis reducer (M-710*i*C/50H)	1260g (1400ml)		
J3-axis reducer	950g(1060ml)		
J4/J5/J6-axis gearbox (M-710*i*C/50, /70, /50S, /50E)	810g (920ml)		
J4/J5-axis gearbox (M-710*i*C/50H)	580g (650ml)		
Wrist (M-710*i*C/50, /70 ,/50H, 50S)	580g (650ml)		
Wrist (M-710*i*C/50E)	510g (580ml)		

NOTE
When using a hand pump, apply grease approximately once per two seconds. For grease replacement or replenishment, use the postures indicated below.

Table 7.2.2 (b) Postures for greasing

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

⚠CAUTION

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

1 Before starting to grease, open the grease outlet (remove the plug or bolt from the grease outlet).
2 A grease inlet may optionally have a plug. Replace the plug with the attached grease nipple and then start greasing.
3 A grease inlet may optionally have a plug. Replace the plug with the attached grease nipple and then start greasing.
4 Whenever possible, avoid using an air pump, which is powered by the factory air supply.
  If the use of an air pump is unavoidable, supply grease with the pump at a pressure lower than or equal to the gun tip pressure (see Table 7.2.3 (a)).
5 Use grease only of the specified type. Grease of a type other than that specified may damage the reducer or lead to other problems.
6 After greasing, release remaining pressure from the grease bath using the procedure given in Section 7.2.6, and then close the grease outlet.
7 To prevent accidents caused by slipping, completely remove any excess grease from the floor or robot.

7.2.3 Grease Replacement Procedure of the J1, J2, J3-Axis Reducer

1 Move the robot to the greasing posture described in Table 7.2.2 (b).
2 Turn off the controller power.
3 Remove the seal bolt from grease outlet.(Fig.7.2.3 (a)～7.2.3 (d))
4 Supply new grease through the grease inlet until new grease is output from grease outlet.
5 After greasing, release remaining pressure as the Subsection 7.2.6.

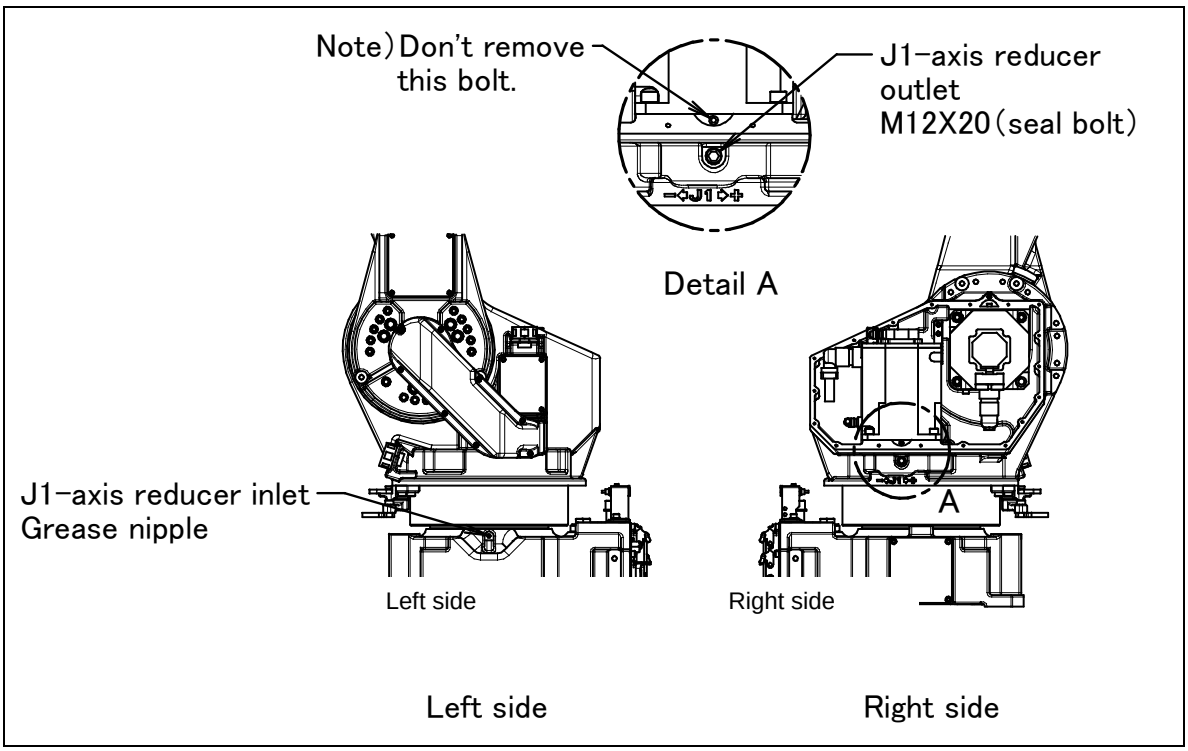


Fig. 7.2.3 (a) Replacing grease of the J1-axis reducer

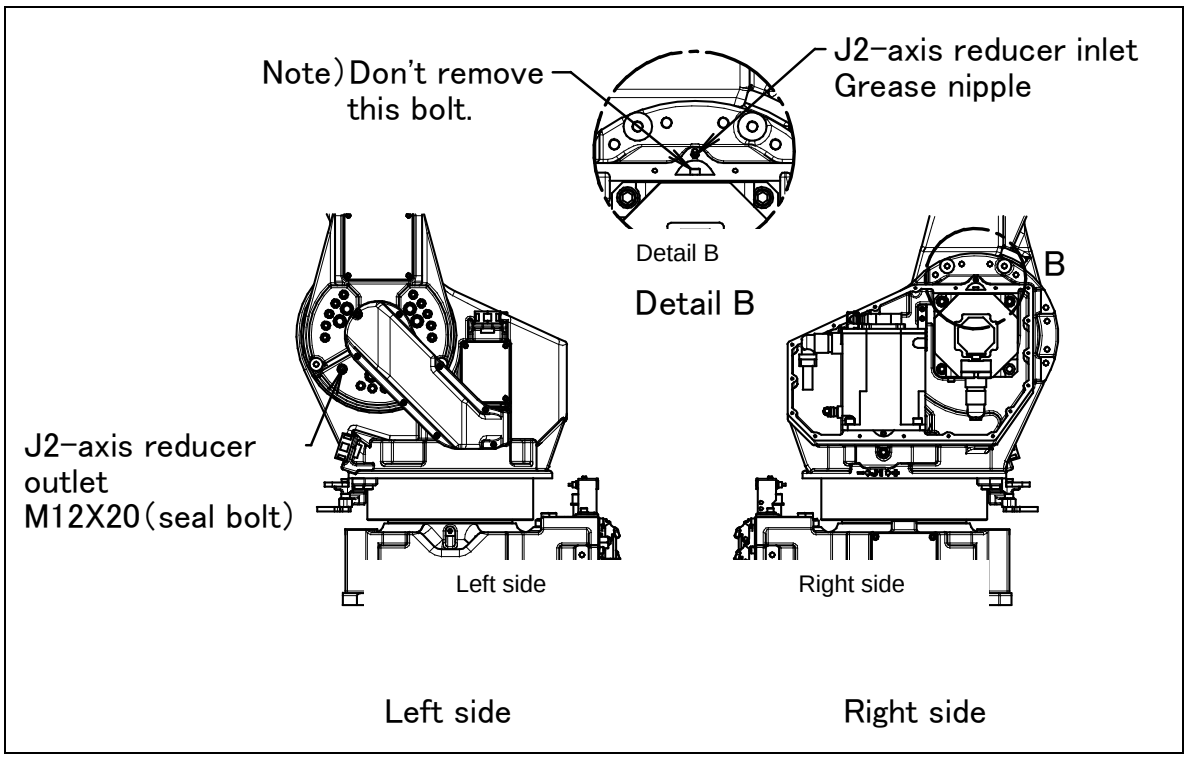


Fig. 7.2.3 (b) Replacing grease of the J2-axis reducer

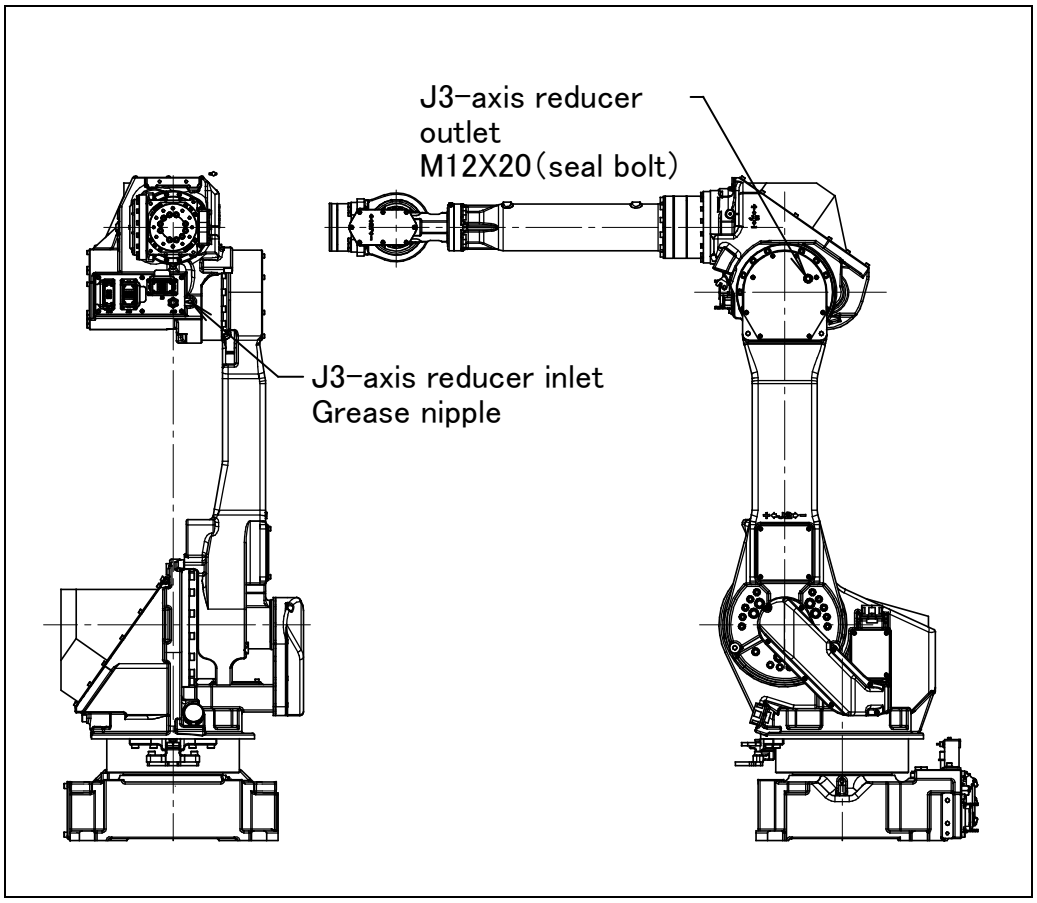


Fig. 7.2.3 (c) Replacing grease of the J3-axis reducer(M-710*i*C/50, /70, /50H, /50E)

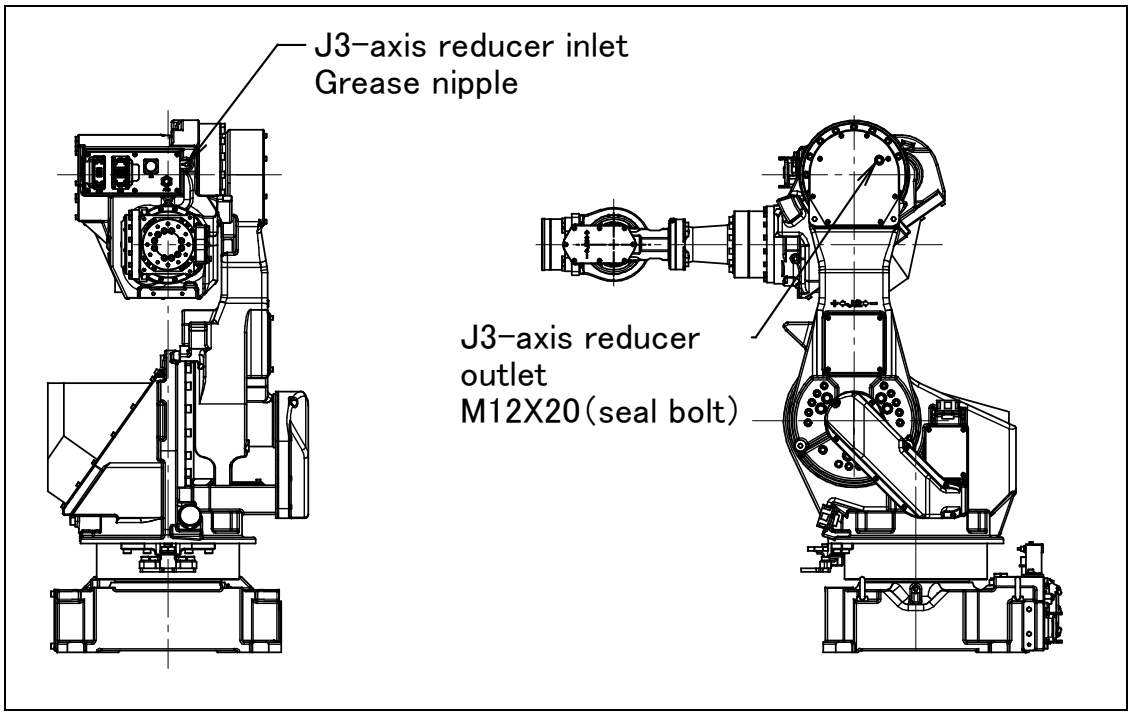


Fig. 7.2.3 (d) Replacing grease of the J3-axis reducer(M-710*i*C/50S)

7.2.4 Grease Replacement Procedure for the J4/J5/J6-Axis Gearbox (J4/J5-axis gearbox)

1 Move the robot to the greasing posture described in Table 7.2.2 (b).
2 Turn off the controller power.
3 Remove the seal bolt from the grease outlet.(Fig. 7.2.4 (a), 7.2.4 (b))
4 Supply new grease until new grease is output from the grease outlet.
5 After greasing, release remaining pressure as the Subsection 7.2.6.

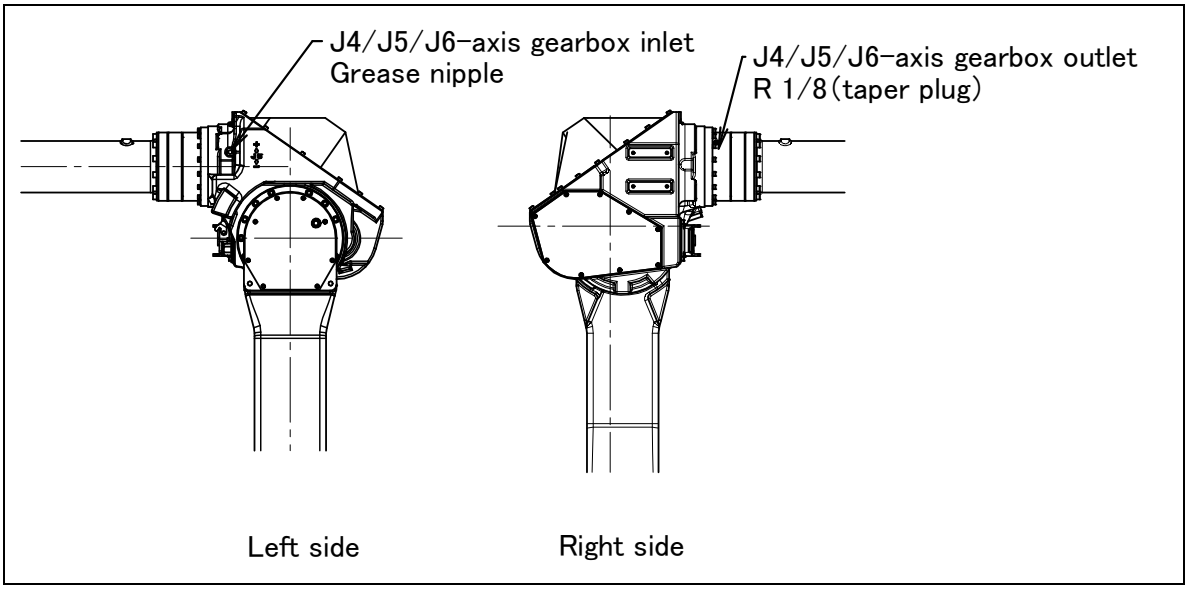


Fig. 7.2.4 (a) Replacing grease of the J4/J5/J6-axis gearbox (M-710*i*C/50, /70, /50E)

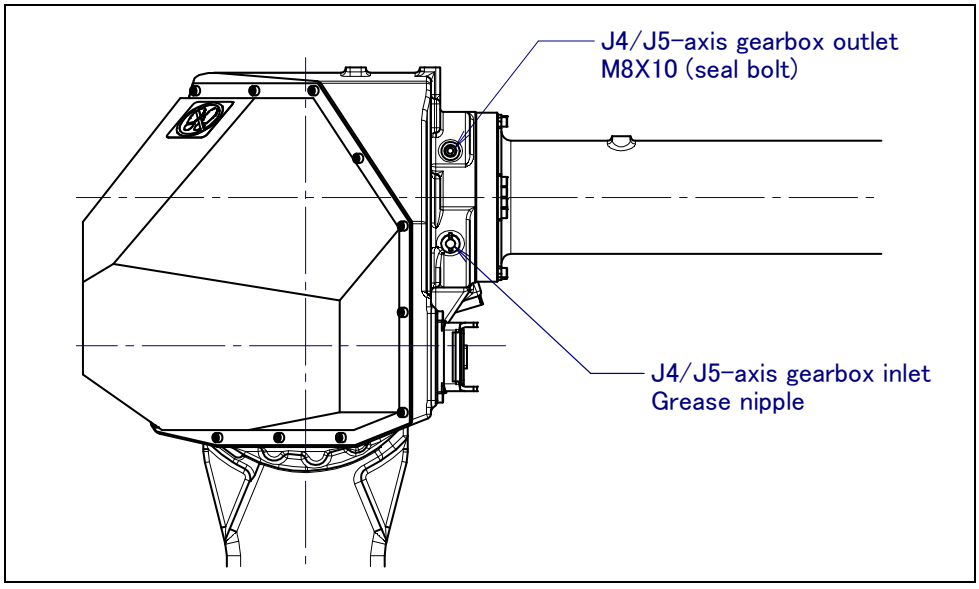


Fig. 7.2.4 (b) Replacing grease of the J4/J5-axis gearbox(M-710*i*C/50H)

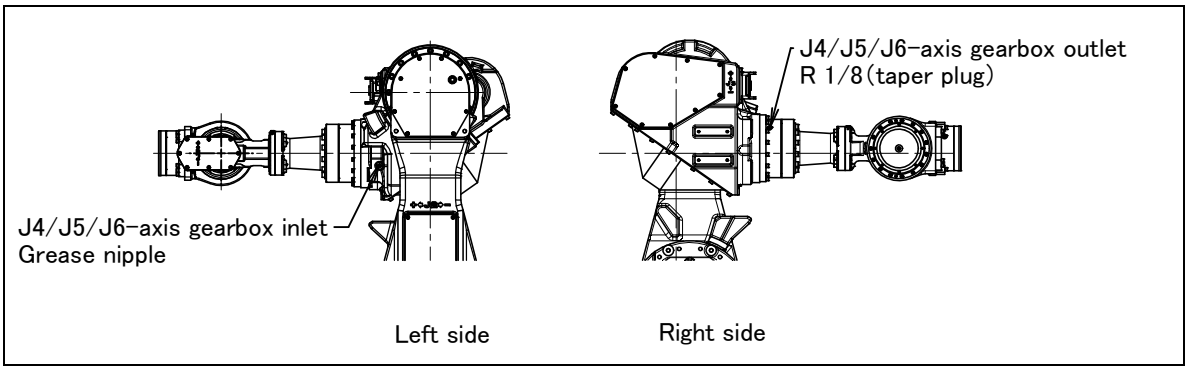


Fig. 7.2.4 (c) Replacing grease of the J4/J5/J6-axis gearbox(M-710*i*C/50S)

7.2.5 Grease Replacement Procedure for the Wrist

Grease Replacement Procedure for the Wrist (M-710*i*C/50, /70, /50H, /50S)

1 Move the robot to the greasing posture described in Table 7.2.2 (b).
2 Turn off the controller power.
3 Remove the plug with a sealant from the wrist grease outlet and attach the grease nipple that comes with the robot (Fig. 7.2.5 (a)).
4 Supply new grease through the wrist grease inlet until new grease is output from wrist grease outlet.
5 After greasing, release remaining pressure as the Subsection 7.2.6.

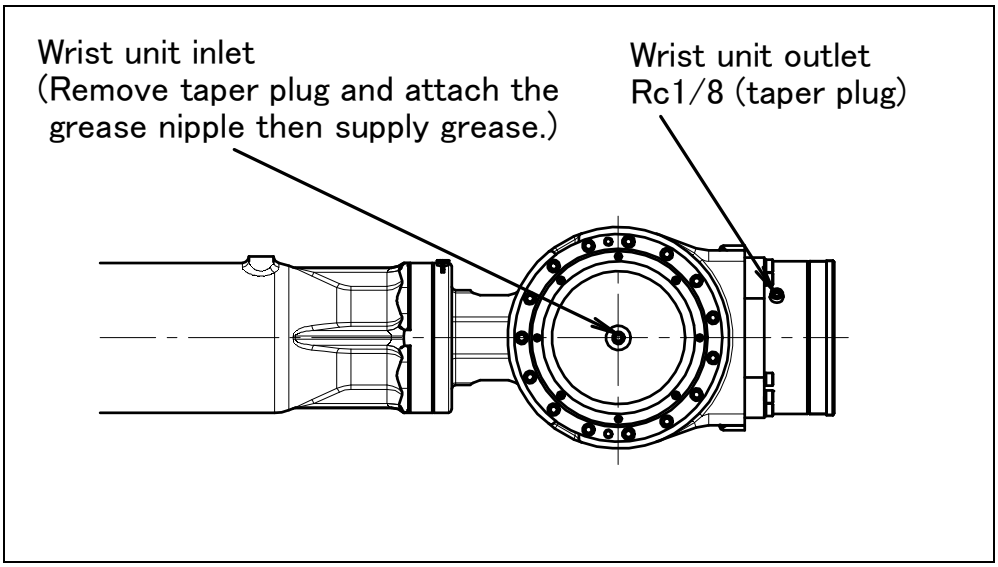


Fig. 7.2.5 (a) Replacing grease of the wrist (M-710*i*C/50, /70, /50H, /50S)

Grease Replacement Procedure for the Wrist (M-710*i*C/50E)

1 Move the robot to the greasing posture described in table 7.2.2 (b).
2 Turn off the controller power.
3 Remove the seal bolt of wrist grease outlet 1 (Fig. 7.2.5 (b)).
4 Supply grease to the wrist grease inlet until new grease outputs from wrist grease outlet 1.
5 Attach the seal bolt to wrist grease outlet 1.
6 Next, remove the seal bolt of wrist grease outlet 2.
7 Supply new grease through the wrist grease inlet until new grease is output from wrist grease outlet 2
8 Release remaining pressure using the procedure given in Section 7.2.6.

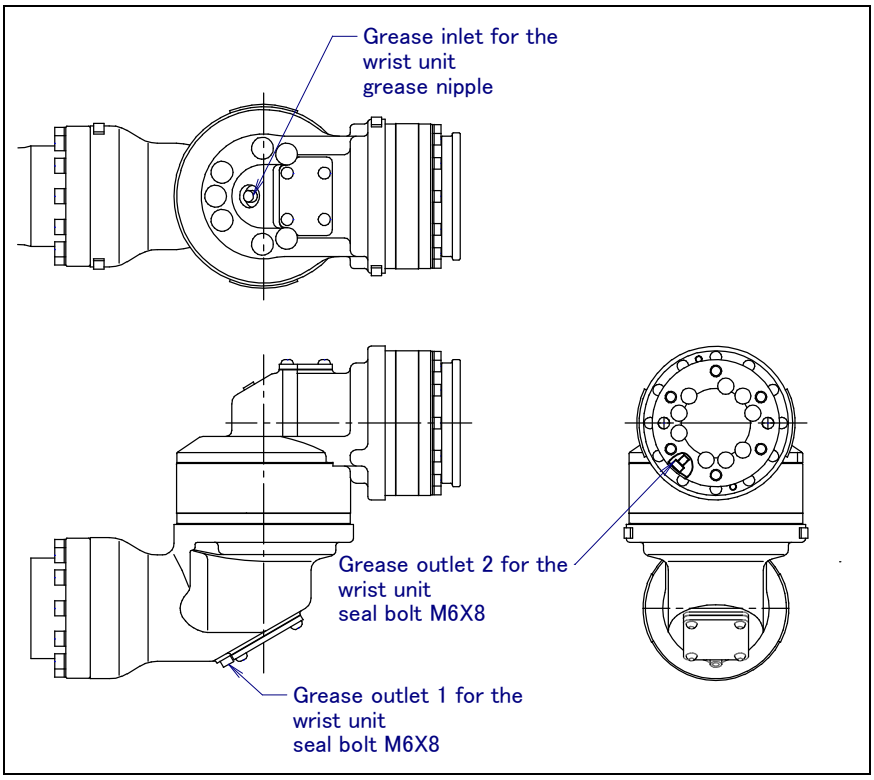


Fig. 7.2.5 (b) Replacing grease of the wrist (M-710*i*C/50E)

7.2.6 Procedure for Releasing Remaining Pressure within the Grease Bath

After greasing, operate the robot for 20 minutes or more with the grease nipple of the grease inlet and the seal bolt of the grease outlet uncapped to release remaining pressure within the grease bath.
Attach the reclaim bags under the grease inlet and grease outlet to prevent spilled grease from splattering.

Operating axis / Grease replacement part	J1-axis	J2-axis	J3-axis	J4-axis	J5-axis	J6-axis
J1-axis reducer	Axis angle of 60° or more OVR 80%	Arbitrary				
J2-axis reducer	Arbitrary	Axis angle of 60° or more OVR 100%	Arbitrary			
J3-axis reducer	Arbitrary		Axis angle of 60° or more OVR 100%	Arbitrary		
J4-axis gearbox	Arbitrary			Axis angle of 60° or more OVR 100%		
Wrist axis	Arbitrary			Axis angle of 60° or more OVR 100%		

If the above operations cannot be performed due to local circumstances, the same count operation is necessary. (When the maximum allowable axis angle is 30°, perform twice the operation for 40 minutes or more.)
When multiple axes are greased at the same time, the axes can be run at the same time.

After the above operation is performed, attach the grease nipple to the grease inlet and the seal bolt to the grease outlet. When the seal bolt or grease nipple is reused, be sure to seal it with seal tape.

7.3 STORAGE

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

8 MASTERING

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

8.1 GENERAL

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

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

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

Types of Mastering

There are five methods of the following mastering.

Table 8.1 Type of mastering

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

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

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

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

⚠CAUTION
It is recommended that the current mastering data be backed up before mastering is performed.

8.2 RESETTING ALARMS AND PREPARING FOR MASTERING

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

Alarm displayed

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

Procedure

Step

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

2 To reset the "Servo 062 BZAL" alarm, follow steps 1 to 5.
   1 Press the screen selection key.
   2 Press [0 NEXT] and select [6 SYSTEM].
   3 Press F1 [TYPE], and select [Master/Cal] from the menu.
   4 Press the F3 [RES_PCA], then press F4 [TRUE].
   5 Turn off the controller power and on again.

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

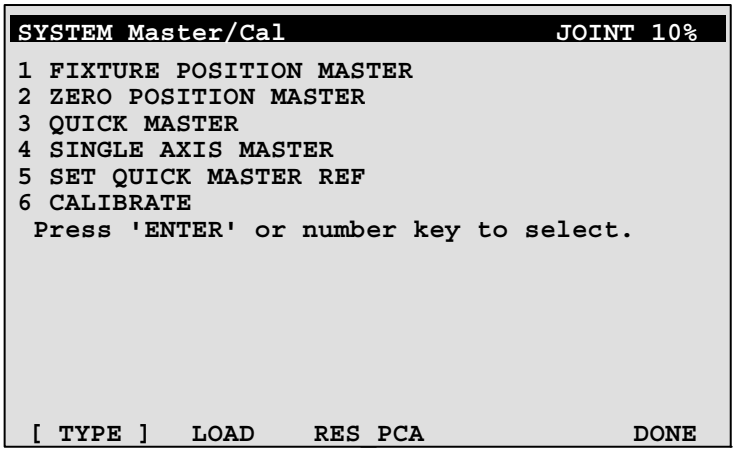
8.3 ZERO POSITION MASTERING

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

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

Procedure of Zero-position Mastering

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



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

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

6. Select Zero Position Master.
7. Press F4, YES. Mastering will be performed automatically. Alternatively, turn off the controller power and on again. Turning on the controller power always causes positioning to be performed.
8. Return brake control to original setting, and turn off the controller power and on again.

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

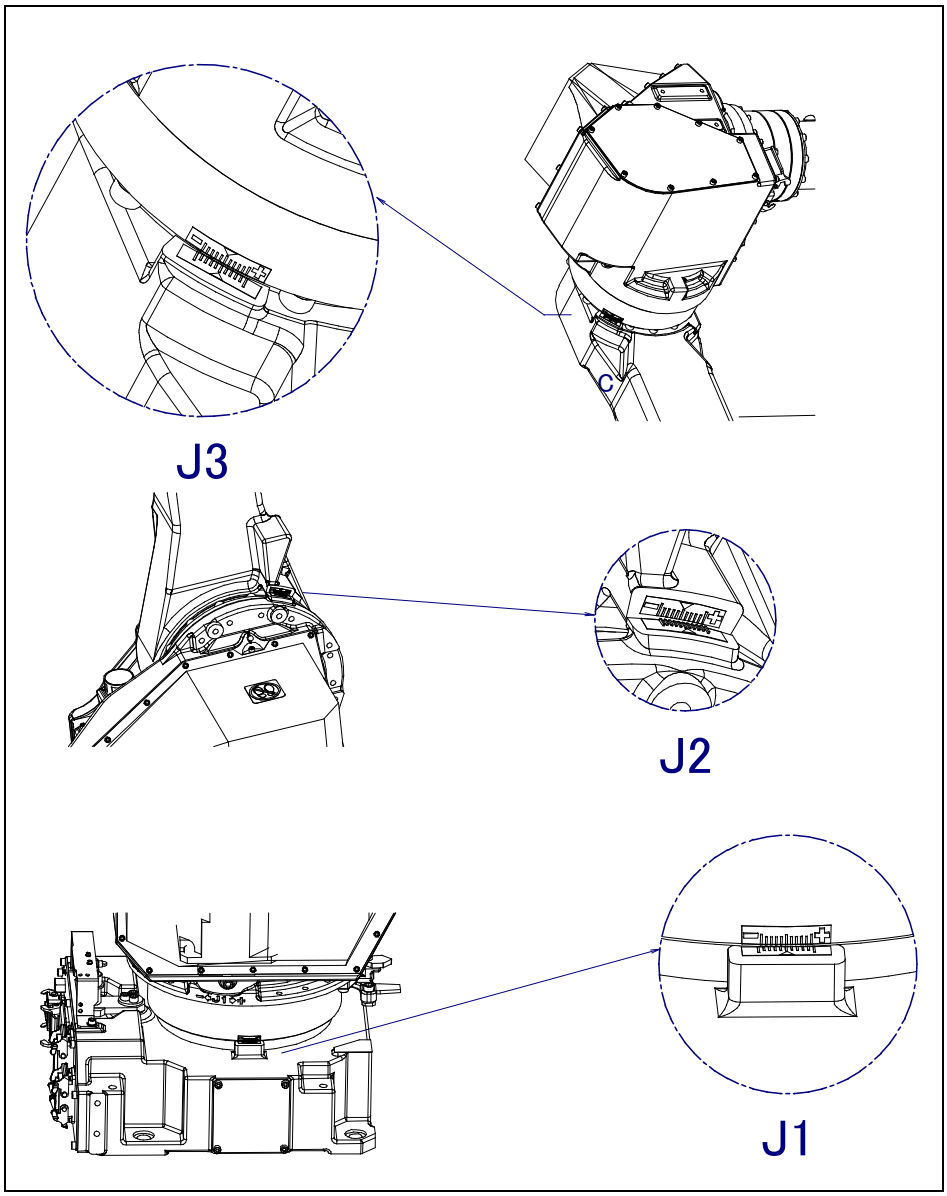


Fig. 8.3 (a) zero-position mark (witness mark) for each axis

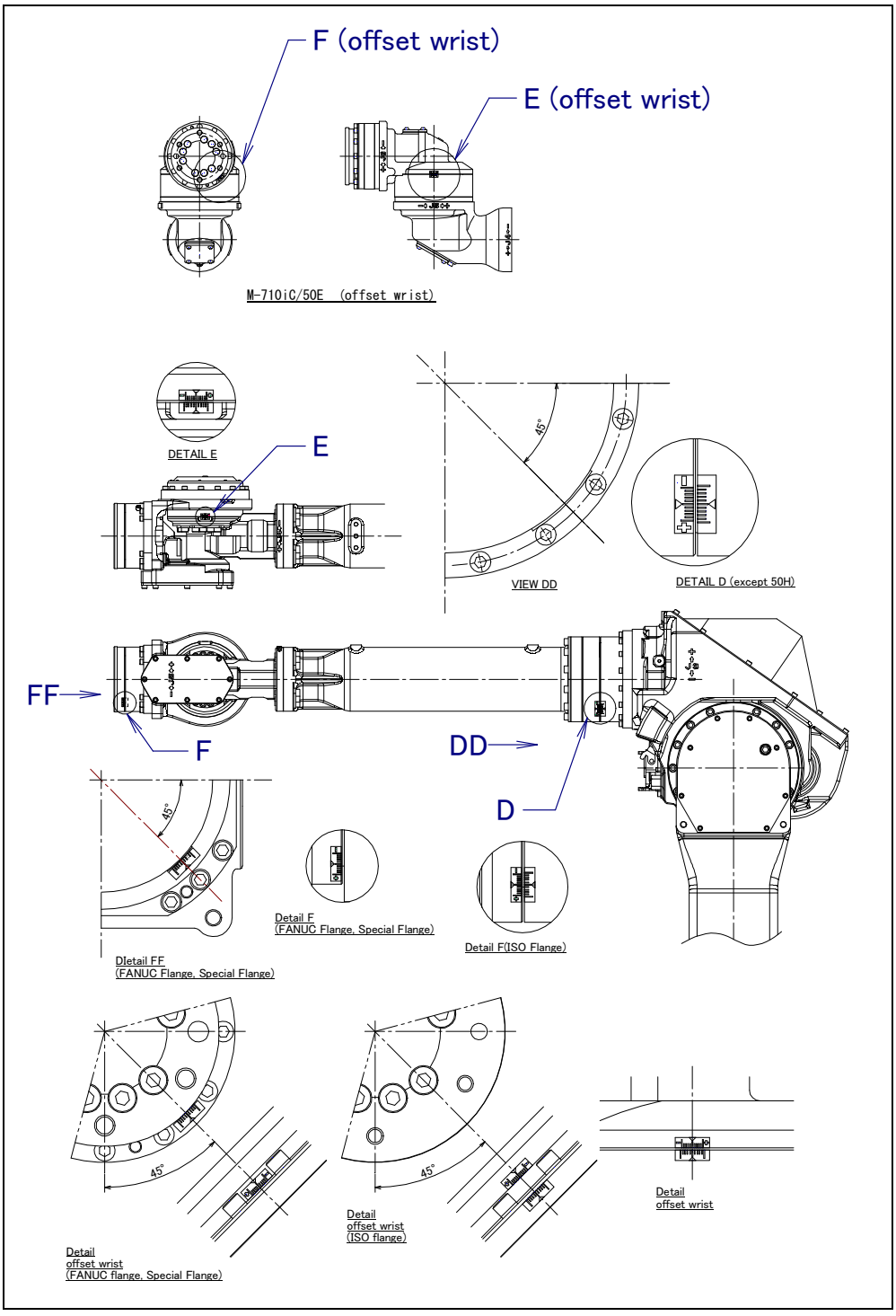


Fig. 8.3 (b) zero-position mark (witness mark) for each axis

8.4 QUICK MASTERING

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

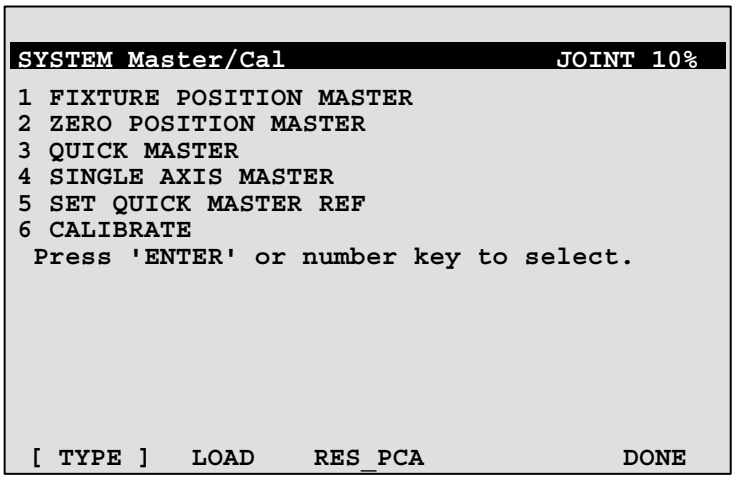
Quick mastering is factory-performed at the position indicated in Table 8.3. Do not change the setting unless there is any problem.

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

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

Procedure Recording the Quick Mastering Reference Position

1 Select SYSTEM.
2 Select Master/Cal.

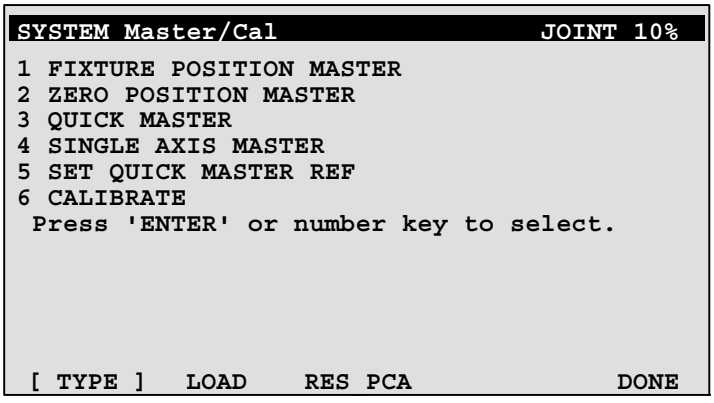


3 Release brake control, and jog the robot to the quick mastering reference position.
4 Set quick master ref? [NO] Move the cursor to SET QUICK MASTER REF and press ENTER. Press F4, YES.

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

Procedure of Quick Mastering

1 Display the Master/Cal screen.



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

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

4 Move the cursor to CALIBRATE and press ENTER. Calibration is executed. Calibration is executed by power on again.
5 After completing the calibration, press F5 Done.
6 Return brake control to original setting, and turn off the controller power and on again.

8.5 SINGLE AXIS MASTERING

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

```
SINGLE AXIS MASTER                    JOINT 33%
   ACTUAL AXIS   (MSTR POS)   (SEL)   [ST]

J1   25.255        (0.000)      (0)    [2]
J2   25.550        (0.000)      (0)    [2]
J3  -50.000        (0.000)      (0)    [2]
J4   12.500        (0.000)      (0)    [2]
J5   31.250        (0.000)      (0)    [2]
J6   43.382        (0.000)      (0)    [2]
E1    0.000        (0.000)      (0)    [2]
E2    0.000        (0.000)      (0)    [2]
E3    0.000        (0.000)      (0)    [2]

                                GROUP  EXE
```

Table 8.5 Items set in single axis mastering

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

Procedure of Single axis mastering

1 Select SYSTEM.
2 Select Master/Cal.

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




 [ TYPE ]   LOAD    RES_PCA
```

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

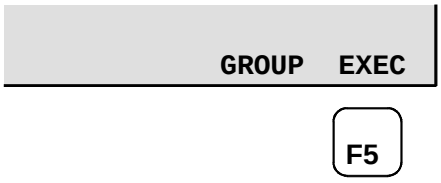
```
SINGLE AXIS MASTER                   JOINT 10%

                                              1/9
  ACTUAL POS      (MSTR POS)   (SEL)    [ST]
J1   25.255      (   0.000)    (0)     [2]
J2   25.550      (   0.000)    (0)     [2]
J3  -50.000      (   0.000)    (0)     [2]
J4   12.500      (   0.000)    (0)     [2]
J5   31.250      (   0.000)    (0)     [0]
J6   43.382      (   0.000)    (0)     [0]
E1    0.000      (   0.000)    (0)     [2]
E2    0.000      (   0.000)    (0)     [2]
E3    0.000      (   0.000)    (0)     [2]

  [ TYPE ]                              GROUP   EXEC
```

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

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

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

                                        GROUP  EXEC
```

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

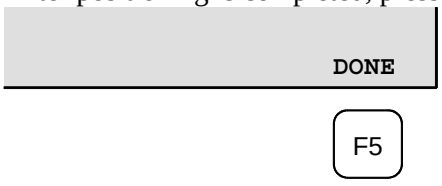



```
SINGLE AXIS MASTER                    JOINT 30%
                                              1/9
   ACTUAL AXIS   (MSTR POS)   (SEL)   [ST]
J1   25.255       (0.000)      (0)     [2]
J2   25.550       (0.000)      (0)     [2]
J3  -50.000       (0.000)      (0)     [2]
J4   12.500       (0.000)      (0)     [2]
J5    0.000       (0.000)      (0)     [2]
J6    0.000       (0.000)      (0)     [2]
E1    0.000       (0.000)      (0)     [2]
E2    0.000       (0.000)      (0)     [2]
E3    0.000       (0.000)      (0)     [2]

                                   GROUP  EXEC
```

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


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




 [ TYPE ]                                DONE
```

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

8.6 MASTERING DATA ENTRY

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

Mastering data entry method

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

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


[ TYPE ]
```

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

```
SYSTEM Variables                    JOINT 10%

  13   $DMR GRP   DMR GRPT
  14   $ENC STAT   [2] of ENC STATT


[ TYPE ]
```

4 Select $DMR_GRP.

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

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

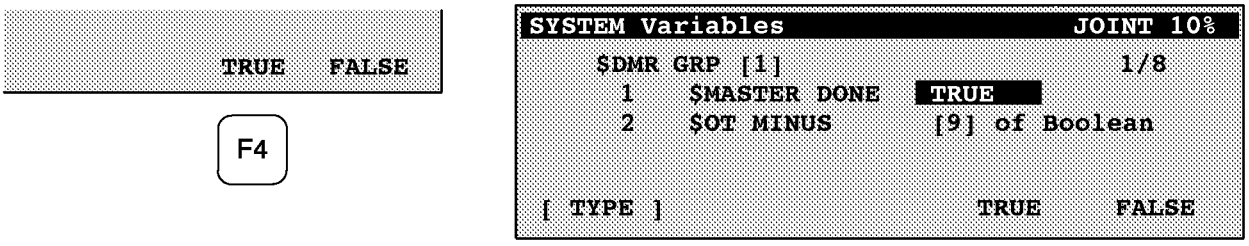
```
SYSTEM Variables                    JOINT 10%
    $DMR GRP [1]                        1/8
      1   $MASTER DONE   FALSE
      2   $OT MINUS      [9] of Boolean
      3   $OT PLUS       [9] of Boolean
      4   $MASTER COUN   [9] of Integer
      5   $REF DONE      FALSE
      6   $REF POS      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

[ TYPE ]                    TRUE    FALSE
```

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

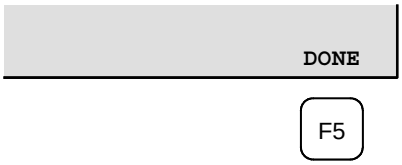
```
                    JOINT 30%
 FALSE
 [9] of Boolean
 [9] of Boolean
 [9] of Integer
                          ENTER
```

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

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



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



8.7 CHECKING THE MASTERING

1 Checking whether mastering has been made correctly

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

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

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

2 Alarms that may be output during mastering and remedy for it
(1) BZAL alarm
This alarm is output if the voltage of the Pulsecoder's backup battery falls to 0 V while the power to the controller is disconnected. Also, if Pulsecoder connector is removed for replacing cables etc. this alarm is output because voltage becomes to 0. To clear the alarm, fit a new battery, execute the pulse reset (See Section 8.2.), then turn the power off then on again and confirm alarm is not output.
Battery might be weak if you can’t reset alarm, then replace battery to new one , perform pulse reset , turn off and on the controller power. Note that, if this alarm occurs, all data originally held by the Pulsecoder will have been lost. Mastering must be performed again.

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

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

9 TROUBLESHOOTING

9.1 OVERVIEW

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

9.2 FAILURES, CAUSES AND MEASURES

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

Table 9.2 Failures, causes and measures

Symptom	Description	Cause	Measure
Vibration noise	-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 base plate. -Probable causes are a loose bolt, an insufficient degree of surface flatness, or foreign material caught between the base plate and floor plate. -If the robot is not securely fastened to the base plate, the J1 base lifts the base plate as the robot operates, allowing the base and floor plates to strike each other, which, in turn, leads to vibration.	-If a bolt is loose, apply LOCTITE and tighten it to the appropriate torque. -Adjust the base plate surface flatness to within the specified tolerance. -If there is any foreign material between the J1 base and base plate, remove it. -As the robot operates, the rack or floor on which the robot is mounted vibrates.
	-Apply epoxy to the floor surface and re-install the plate.	[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 or noise was first noticed after the robot collided with an object or the robot was overloaded for a long period. -The grease of the vibrating or noise occurring axis has not been exchanged for a long period. -There is vibration or unusual sound just after replacing grease or oil or parts.	[Broken gear, bearing, or reducer] - It is likely that collision or overload applied an excessive force on the drive mechanism, thus damaging the geartooth surface or rolling surface of a bearing, or reducer. - It is likely that prolonged use of the robot while overloaded caused fretting of the gear tooth surface or rolling surface of a bearing, or reducer due to resulting metal fatigue. - It is likely that foreign material caught in a gear, bearing, or within a reducer caused damage on the gear tooth surface or rolling surface of the bearing, or reducer. - It is likely that foreign material caught in a gear, bearing, or within a reducer cause vibration. - It is likely that, because the grease has not been changed for a long period, fretting occurred on the gear tooth surface or rolling surface of a bearing, or reducer due to metal fatigue. These factors all generate cyclic vibration and noise.	-Operate one axis at a time to determine which axis is vibrating. -Remove the motor, and replace the gear , the bearing, and the reducer. For the spec. of parts and the method of replacement, contact FANUC. -Using the robot within its maximum rating prevents problems with the drive mechanism. -Regularly changing the grease with a specified type can help prevent problems.

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

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	-There is some relationship between the vibration of the robot and the operation of a machine near the robot.	[Noise from a nearby machine] -If the robot is not grounded properly, electrical noise is induced on the grounding wire, preventing commands from being transferred accurately, thus leading to vibration. -If the robot is grounded at an unsuitable point, its grounding potential becomes unstable, and noise is likely to be induced on the grounding line, thus leading to vibration.	-Connect the grounding wire firmly to ensure a reliable ground potential and prevent extraneous electrical noise.
	- There is an unusual sound after replacement of grease. - There is an unusual sound after a long period. - 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 surface of the mechanical unit.	[Mechanical section coupling bolt] -It is likely that overloading or a collision has loosened a mounting bolt in the robot mechanical section.	-Check that the following bolts for each axis are tight. If any of these bolts is loose, apply LOCTITE and tighten it to the appropriate torque. -Motor retaining bolt -Reducer retaining bolt -Reducer shaft retaining bolt -Base retaining bolt -Arm retaining bolt -Casting retaining bolt -End effecter retaining bolt

Symptom	Description	Cause	Measure
Motor overheating	-The ambient temperature of the installation location increases, causing the motor to overheat. -After a cover was attached to the motor, the motor overheated. -After the robot control program or the load was changed, the motor overheated.	[Ambient temperature] -It is likely that a rise in the ambient temperature or attaching the motor cover prevented the motor from releasing heat efficiently, thus leading to overheating. [Operating condition] -It is likely that the robot was operated with the maximum average current exceeded.	The teach pendant can be used to monitor the average current. Check the average current when the robot control program is running. The allowable average current is specified for the robot according to its ambient temperature. Contact FANUC for further information. -Relaxing the robot control program and conditions can reduce the average current, thus preventing overheating. -Reducing the ambient temperature is the most effective means of preventing overheating. -Having the surroundings of the motor well ventilated enables the motor to release heat efficiently, thus preventing overheating. Using a fan to direct air at the motor is also effective. -If there is a source of heat near the motor, it is advisable to install shielding to protect the motor from heat radiation.
	-After a control parameter was changed, the motor overheated.	[Parameter] -If data input for a workpiece is invalid, the robot cannot be accelerated or decelerated normally, so the average current increases, leading to overheating.	-Input an appropriate parameter as described in CONTROLLER OPERATOR'S MANUAL.
	-Symptom other than stated above	[Mechanical section problems] -It is likely that problems occurred in the mechanical unit drive mechanism, thus placing an excessive load on the motor. [Motor problems] -It is likely that a failure of the motor brake resulted in the motor running with the brake applied, thus placing an excessive load on the motor. -It is likely that a failure of the motor prevented it from delivering its rated performance, thus causing an excessive current to flow through the motor.	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 might allow grease to leak along the threads. -Problems with the grease nipple or threads.	-If a crack develops in the casting, sealant can be used as a quick-fix to prevent further grease leakage. However, the component should be replaced as soon as possible, because the crack might extend. -O-rings are used in the locations listed below. -Motor coupling section -Reducer (case and shaft) coupling section -Wrist coupling section -J3 arm coupling section -Inside the wrist -Oil seals are used in the locations stated below. -Inside the reducer -Inside the wrist -Seal bolts are used in the locations stated below. -Grease drain outlet -Replace the grease nipple.
Dropping axis	-An axis drops because the brake does not function. -An axis drops gradually when it should be at rest.	[Brake drive relay and motor] -It is likely that brake drive relay contacts are stuck to each other to keep the brake current flowing, thus preventing the brake from operating when the motor is deenergized. -It is likely that the brake shoe has worn out or the brake main body is damaged, preventing the brake from operating efficiently. -It is likely that oil or grease has entered the motor, causing the brake to slip.	-Check whether the brake drive relay contacts are stuck to each other. If they are found to be stuck, replace the relay. -If the brake shoe is worn out, if the brake main body is damaged, or if oil or grease has entered the motor, replace the motor.

Symptom	Description	Cause	Measure
Displace-ment	-The robot operates at a point other than the taught position. -The repeatability is not within the tolerance.	[Mechanical section problems] -If the repeatability is unstable, probable causes are a failure in the drive mechanism or a loose bolt. -If the repeatability becomes stable, it is likely that a collision imposed an excessive load, leading to slipping on the base surface or the mating surface of an arm or reducer. -It is likely that the Pulsecoder is abnormal.	-If the repeatability is unstable, repair the mechanical section by referring to the above descriptions of vibration, noise, and rattling. -If the repeatability is stable, correct the taught program. Variation will not occur unless another collision occurs. -If the Pulsecoder is abnormal, replace the motor or the Pulsecoder.
	-Displacement occurs only in a specific peripheral unit.	[Peripheral unit displacement] -It is likely that an external force was applied to the peripheral unit, thus shifting its position relative to the robot.	-Correct the setting of the peripheral unit position. -Correct the taught program.
	-Displacement occurred after a parameter was changed.	[Parameter] -It is likely that the mastering data was rewritten in such a way that the robot origin was shifted.	-Re-enter the previous mastering data, which is known to be correct. -If correct mastering data is unavailable, perform mastering again.
BZAL alarm occurred	-BZAL is displayed on the controller screen	-It is likely that the voltage of the memory backup battery is low. -It is likely that the Pulsecoder cable is defected.	-Replace the battery. -Replace the cable.

10 SEVERE DUST/LIQUID PROTECTION PACKAGE (OPTION)

10.1 OVERVIEW

The package is intended to improve the Severe dust/liquid protection characteristics of the robot so that it can be used in a severe environment.

Model	Severe dust/liquid protection specification
M-710*i*C/50, M-710*i*C/70	A05B-1125-J801 (*1)
	A05B-1125-J811 (*2)
	A05B-1125-J823 (*3)
	A05B-1125-J829 (*4)
M-710*i*C/50S	A05B-1125-J802 (*1)
	A05B-1125-J812 (*4)
	A05B-1125-J824 (*5)

(*1) When mechanical unit cable for camera is not selected.
(*2) When mechanical unit cable for camera A05B-1125-H403 is selected.
(*3) When mechanical unit cable for camera A05B-1125-H404 is selected.
(*4) When mechanical unit cable for camera A05B-1125-H405 is selected.
(*5) When mechanical unit cable for camera A05B-1125-H421 is selected.
(*6) When mechanical unit cable for camera A05B-1125-H422 is selected.

10.2 SEVERE DUST/LIQUID PROTECTION CHARACTERISTICS

The following table lists the IEC529-based Severe dust/liquid protection characteristics of the M-710*i*C.

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

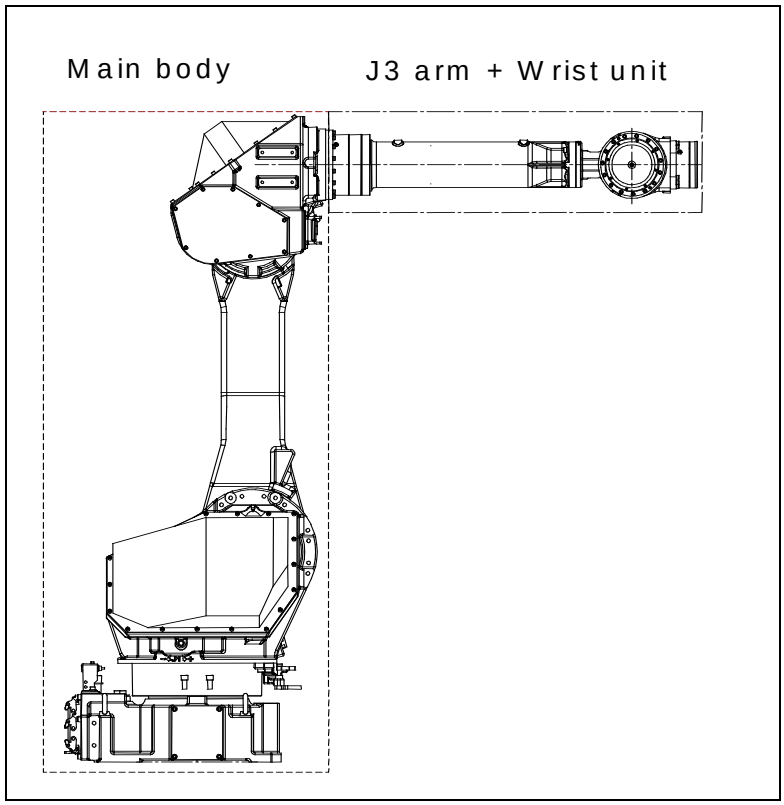


Fig. 10.2 Severe dust/liquid protection characteristics of the M-710*i*C

10.3 CONFIGURATION OF THE SEVERE DUST/LIQUID PROTECTION PACKAGE

The following table lists the major differences between the M-710*i*C standard specification and Severe dust/liquid protection package.

	Standard specification	Severe dust/liquid protection option
Bolts	Dyed black steel bolt	FR coating bolt Stainless bolt
Washer	Dyed black washer	Black chrome washer
Cover		J2 cover Battery box cover
EE(RI/RO) connector	Non-waterproof connector	Waterproof connector
Others		Gasket Packing is added.

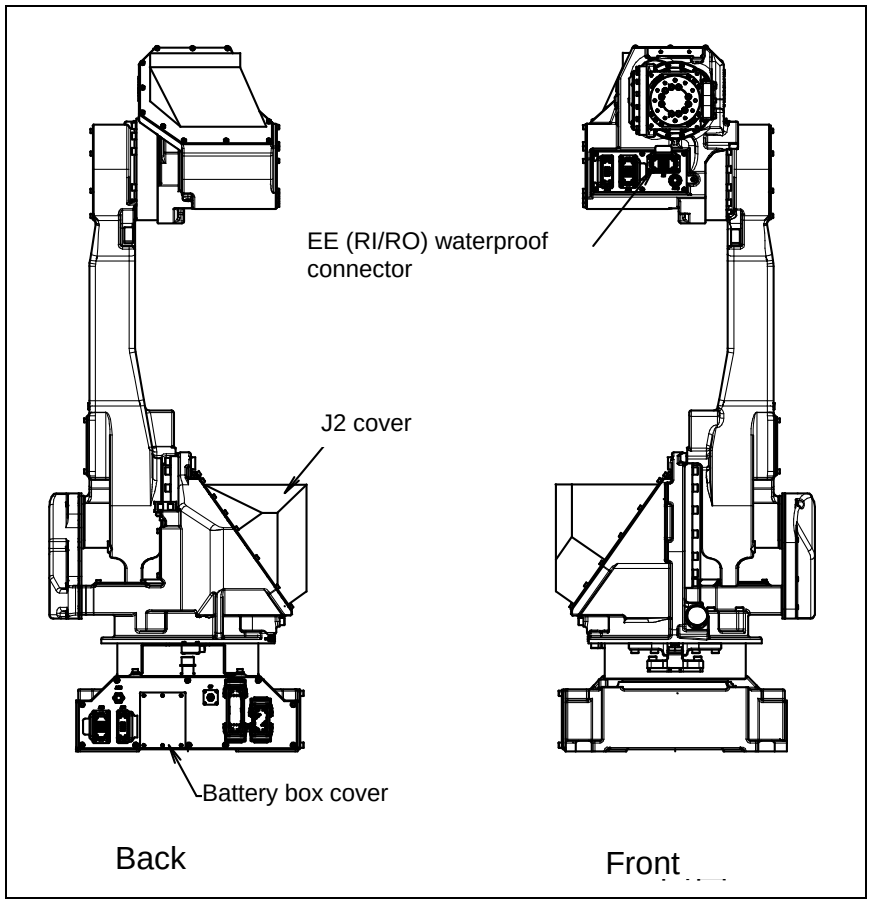


Fig. 10.3 Configuration of the severe dust/liquid protection package of M-710*i*C

10.4 NOTES ON SPECIFYING SEVERE DUST/LIQUID PROTECTION PACKAGE

1 The liquids below cannot be applied because they may cause deterioration or corrosion of the rubber parts (such as packings, oil seals, and O-rings) used in the robot.
   (a) Organic solvent
   (b) Chlorine- or gasoline-based cutting fluid
   (c) Amine-based cleaning fluid
   (d) Liquid or solution that includes a corrosive such as an acid or alkali or causes rust
   (e) Some other liquid or solution to which nitrile rubber (NBR) does not have resistance

2 When the robot is used in an environment where a liquid such as water is dashed over the robot, great attention should be given to drainage under the J1 base.
   A failure may be caused if the J1 base is kept immersed in water due to poor drainage.

3 This option can be used only when the J2 cover is selected.

4 Please be sure to exchange it for the new article when you remove the gasket or packings by the component replacement and the check.

11 CORRESPOND TO WASHING APPLICATION (OPTION)

11.1 ABOUT CORRESPOND TO WASHING APPLICATION

CORRESPOND TO WASHING APPLICATION is intended to improve the Severe dust/liquid protection characteristics of the robot so that it can be used in a severe environment like wet scrubber.
This option includes Severe dust/liquid protection option.

Model	Severe dust/liquid protection specification
M-710*i*C/50, M-710*i*C/70	A05B-1125-J809

11.2 NOTES OF CORRESPOND TO WASHING APPLICATION

1 CORRESPOND TO WASHING APPLICATION specifies cleaning liquids usable with the robot. (Always keep all the liquids at or below 60°C.)

Liquid model name	Manufacturer name	Permissible concentration
CleanMate MS-1	TOHO Chemical Industry Co., LTD.	5.0% Diluted to 20 parts of water
Toyosol ST-91P	Toyoda Chemical Industry Co., Ltd.	2.0% Diluted to 50 parts of water.
Toyosol SE-78P	Toyoda Chemical Industry Co., Ltd.	5.0% Diluted to 20 parts of water.
TOYOKNOCK RE-777P	Toyoda Chemical Industry Co., Ltd.	3.0% Diluted to 33 parts of water.
MP-70	Henkel Japan	3.0% Diluted to 33 parts of water.
Pakuna FD-800	YUKEN Industry CO., LTD.	5.0% Diluted to 20 parts of water.
Yushiro cleaner W51H	YUSHIRO CHEMICAL INDUSTRY CO., LTD.	3.3% Diluted to 30 parts of water.
Yushiro cleaner W80	YUSHIRO CHEMICAL INDUSTRY CO., LTD.	3.3% Diluted to 30 parts of water.
SP-414	PLODUCTOCHEMIHALS	5.0% Diluted to 20 parts of water.
SP-424	PLODUCTOCHEMIHALS	5.0% Diluted to 20 parts of water.
SP-260	PLODUCTOCHEMIHALS	5.0% Diluted to 20 parts of water.

2 Note that applying a cleaning liquid not included in the specification or one beyond its permissible concentration or temperature even if it is included in the specification to the robot may results in serious damage to the robot.
3 The cables connecting the robot, controller, and external battery are not resistant to any cleaning liquid. So, install them in such a way that no cleaning liquid will be splashed to the cables.

11.3 INSTALLING THE AIR PURGE KIT

Use the prepared air purge kit.
Set the air purge pressure to 10 kPa (0.1 kgf/cm^2).

NOTE
1 It is recommended that a dedicated air pressure source be used for an air purge. Do not use the same air pressure source for both the air purge kit and others. Otherwise, the dryer capacity is exceeded and water or oil remains in air, causing serious damage to the robot.
2 After installing the robot, perform an air purge at all times.
Even when the robot is not operating, an air purge is required if it is placed in a bad condition.
3 When removing the air tube from the air inlet of the J1 connector panel, replace the joint together. Be careful to prevent cleaning fluids from entering into the joint. Otherwise, rubbers in the joint are degraded and the robot may be damaged.

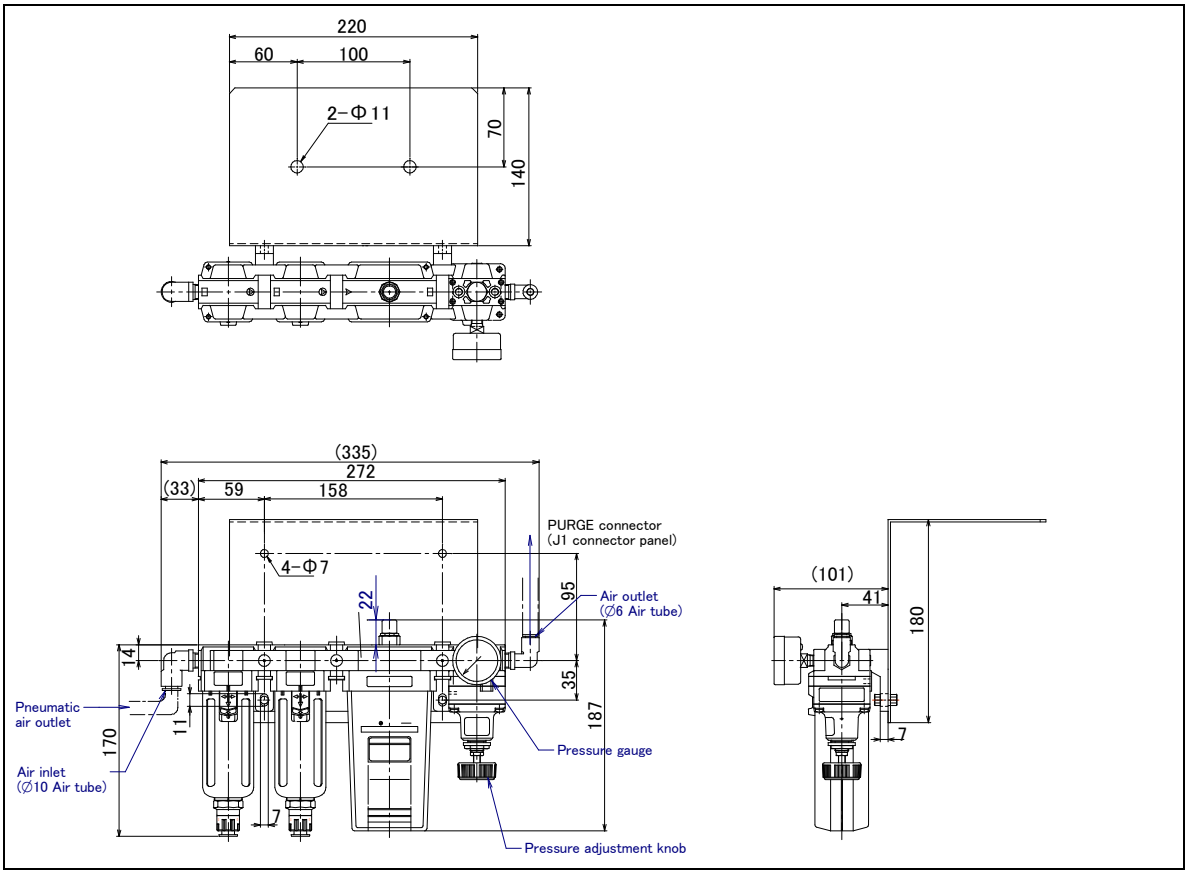


Fig 11.3 (a) Air purge kit outside dimensions

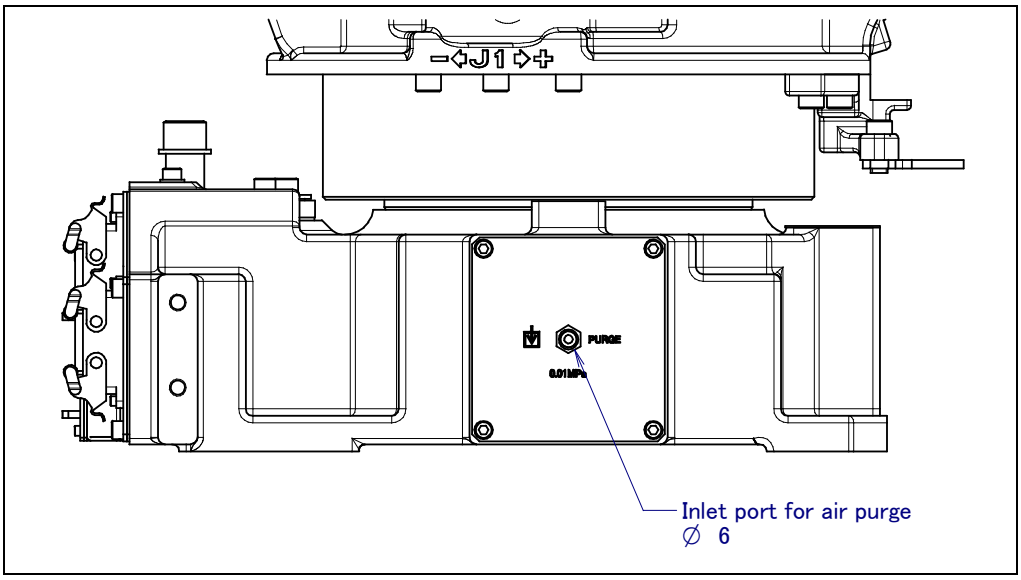


Fig 11.3 (b) Mounting position of air purge to robot

12 MOTOR AIR BLOW OPPTION (OPTION)

When motor air blow option is specified, inlet port is attached to the side of the J1 base.
When severe dust/liquid protection option is specified, exhaust port is attached ,too.
Supply air pressure is 0.49 to 0.69MPa(5 to 7kgf/cm^2).

- Use dry air.
- Do not close the exhaust of J1 side when using both severe dust/liquid protection and air blow.

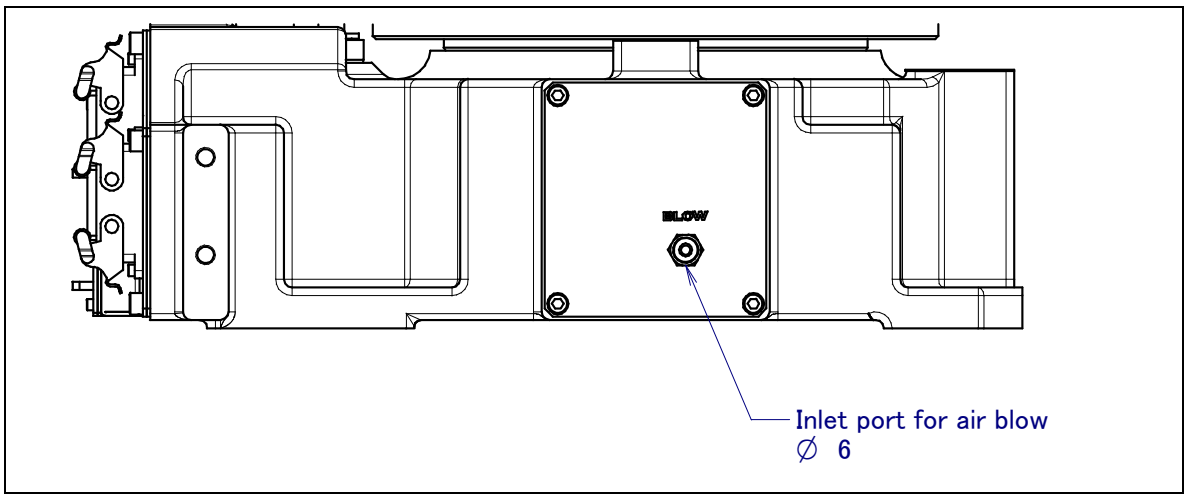


Fig.12(a) Inlet port for air blow

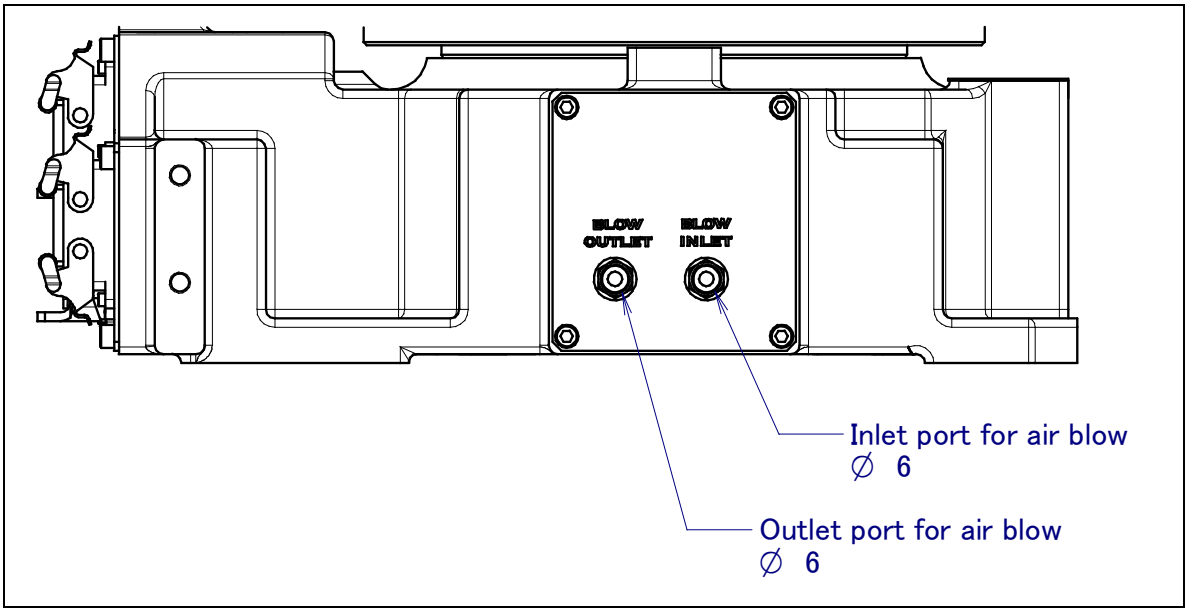


Fig.12(b) Inlet port and outlet port for air blow (When severe dust/liquid protection option is specified)

APPENDIX

A PERIODIC MAINTENANCE TABLE

FANUC Robot M-710*i*C/50,70,50S,50E Periodic Maintenance Table

Items		Working time (H)	Check time	Grease amount	First check 320	3 months 960	6 months 1920	9 months 2880	1 year 3840	4800	5760	6720	2 years 7680	8640	9600	10560
Mechanical unit	1	Check the mechanical cable. (damaged or twisted)	0.2H	-					○				○			
	2	Check the motor connector. (loosening)	0.2H	-					○				○			
	3	Tighten the end effector bolt.	0.2H	-		○			○				○			
	4	Tighten the cover and main bolt.	2.0H	-		○			○				○			
	5	Check the mechanical stopper	0.1H			○			○				○			
	6	Remove spatter and dust etc.	1.0H	-		○			○				○			
	7	Check the end effector (hand) cable	0.1H	-		○			○				○			
	8	Check the fan	0.1H	-		○			○				○			
	9	Replacing battery.	0.1H	-							●					
	10	Replacing grease of J1 axis reducer	0.5H	3300ml												
	11	Replacing grease of J2 axis reducer	0.5H	1660ml												
	12	Replacing grease of J3 axis reducer	0.5H	1060ml												
	13	Replacing grease of J4/J5/J6-axis gearbox	0.5H	920ml												
	14	Replacing grease of wrist axis unit (M-710*i*C/50, /70, /50S)	0.5H	610ml												
		Replacing grease of wrist axis unit (M-710*i*C/50E)	0.5H	580ml												
	15	Replacing cable of mechanical unit	4.0H	-												
Controller	16	Check the robot cable, teach pendant cable and robot connecting cable	0.2H	-		○			○				○			
	17	Cleaning the ventilator	0.2H	-	○	○	○	○	○	○	○	○	○	○	○	○
	18	Replacing battery *1	0.1H	-												

*1 Refer to manual of controller.

*2 ●: requires order of parts
○: 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
○				○				○				○				○				Overhaul	1
○				○				○				○				○					2
○				○				○				○				○					3
○				○				○				○				○					4
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○				○				○				○				○					6
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○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		17
				●																	18

FANUC Robot M-710*i*C/50H Periodic Maintenance Table

Items		Working time (H)	Check time	Grease amount	First check 320	3 months 960	6 months 1920	9 months 2880	1 year 3840	4800	5760	6720	2 years 7680	8640	9600	10560
Mechanical unit	1	Check the mechanical cable. (damaged or twisted)	0.2H	-					○				○			
	2	Check the motor connector. (loosening)	0.2H	-					○				○			
	3	Tighten the end effector bolt.	0.2H	-		○			○				○			
	4	Tighten the cover and main bolt.	2.0H	-		○			○				○			
	5	Check the mechanical stopper	0.1H			○			○				○			
	6	Remove spatter and dust etc.	1.0H	-		○			○				○			
	7	Check the end effector (hand) cable	0.1H	-		○			○				○			
	8	Check the fan	0.1H	-		○			○				○			
	9	Replacing battery.	0.1H	-							●					
	10	Replacing grease of J1 axis reducer	0.5H	3300ml												
	11	Replacing grease of J2 axis reducer	0.5H	1400ml												
	12	Replacing grease of J3 axis reducer	0.5H	1060ml												
	13	Replacing grease of J4/J5-axis gearbox	0.5H	650ml												
	14	Replacing grease of wrist axis unit	0.5H	650ml												
	15	Replacing cable of mechanical unit	4.0H	-												
Controller	16	Check the robot cable, teach pendant cable and robot connecting cable	0.2H	-		○			○				○			
	17	Cleaning the ventilator	0.2H	-	○	○	○	○	○	○	○	○	○	○	○	○
	18	Replacing battery *1	0.1H	-												

*1 Refer to manual of controller.

*2 ●: requires order of parts
○: 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
○				○				○				Overhaul				○					1
○				○				○								○					2
○				○				○								○					3
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○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		17
				●																	18

B STRENGTH OF BOLT AND BOLT TORQUE LIST

NOTE

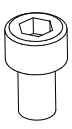
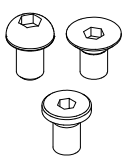
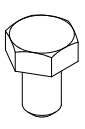
When applying LOCTITE to the important bolt tightening points, make sure that it is applied to the entire longitudinal portion in the engaging section of the female threads. If it is applied to the male threads, the bolts may be loosened because sufficient adhesion cannot be obtained. Remove the dust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

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

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

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

Recommended bolt tightening torques **Unit: Nm**

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

C INSULATION ABOUT ARC WELDING ROBOT

C.1 ABSTRACT

The arc welding robot performs welding, using a welding torch attached to its end effector via a bracket. Because a high welding current flows through the welding torch, the insulation between the end effector and torch is dualized.
If no due consideration is taken, a poor insulation caused by a pileup of spatter can allow the welding current to leak into robot mechanical sections, possibly resulting in the motor being damaged or the sheaths of cables in the mechanical sections melting.

C.2 INSULATION AT THE WRIST

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

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REVISION RECORD

Edition	Date	Contents
09	July, 2012	• Addition of M-710iC/50H • Addition and change of mechanical unit cable with camera • Correction of errors
08	Jan., 2012	• Addition of note for low temperature • Addition of check of oil exudation • Correction of errors
07	Aug.,2010	• Addition of stop type of robot • Addition of stopping time and distance when controlled stop is executed • Corrections of errors
06	Apr.,2009	• Addition of M-710*i*C/50E • Addition of option cable • Addition of motor air blow (option) • Correction of errors
05	May,2008	• Addition data of max stopping distance(position) • Addition movable stopper for J2 and J3 • Addition of severe dust/liquid protection option for mechanical unit cable for camera
04	Jan.,2008	• Addition of procedures to move arm without drive power in emergency or abnormal situations • Addition of notes on transportation with an end effector attached • Addition of sensor cables for Severe dust/liquid protection option • Addition of stopping time and distance when emergency stop • Addition of OPTION FOR WASHING APPLICATION • Correction of errors
03	May, 2007	• Change the name of controller. (from R-J3*i*C to R-30*i*A). • Addition of notes about transportation equipment • Addition of motion range for inclined surface mounted robots
02	Jun., 2006	• Addition of M-710*i*C/70 and Severe dust/liquid protection option • Correction of troubleshooting
01	Dec., 2005	

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