FANUC Robot M-410*i*B/700

MECHANICAL UNIT

OPERATOR'S MANUAL

B-82334EN/05

- **Original Instructions**

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

SAFETY PRECAUTIONS

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

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

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

1 DEFINITION OF USER

The user can be defined as follows.

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

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

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

- Operator is not allowed to work in the safety fence.
- Programmers and maintenance engineers are allowed to work in the safety fence. The work inside the safety fence includes lifting, setting, teaching, adjustment, maintenance, etc.
- To work inside the safety fence, the person must receive a professional training for the robot.

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

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

2 DEFINITION OF SAFETY NOTATIONS

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

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

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

3 SAFETY OF THE USER

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

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

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

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

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

(4) Provide the peripheral equipment with appropriate earth (Class A, Class B, Class C, and Class D).
(5) Try to install the peripheral equipment outside the robot operating space.
(6) Draw an outline on the floor, clearly indicating the range of the robot operating space, including the tools such as a hand.
(7) Install a mat switch or photoelectric switch on the floor with an interlock to a visual or aural alarm that stops the robot when a user enters the work area.
(8) If necessary, install a safety lock so that no one except the user in charge can turn on the power of the robot.

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

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

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

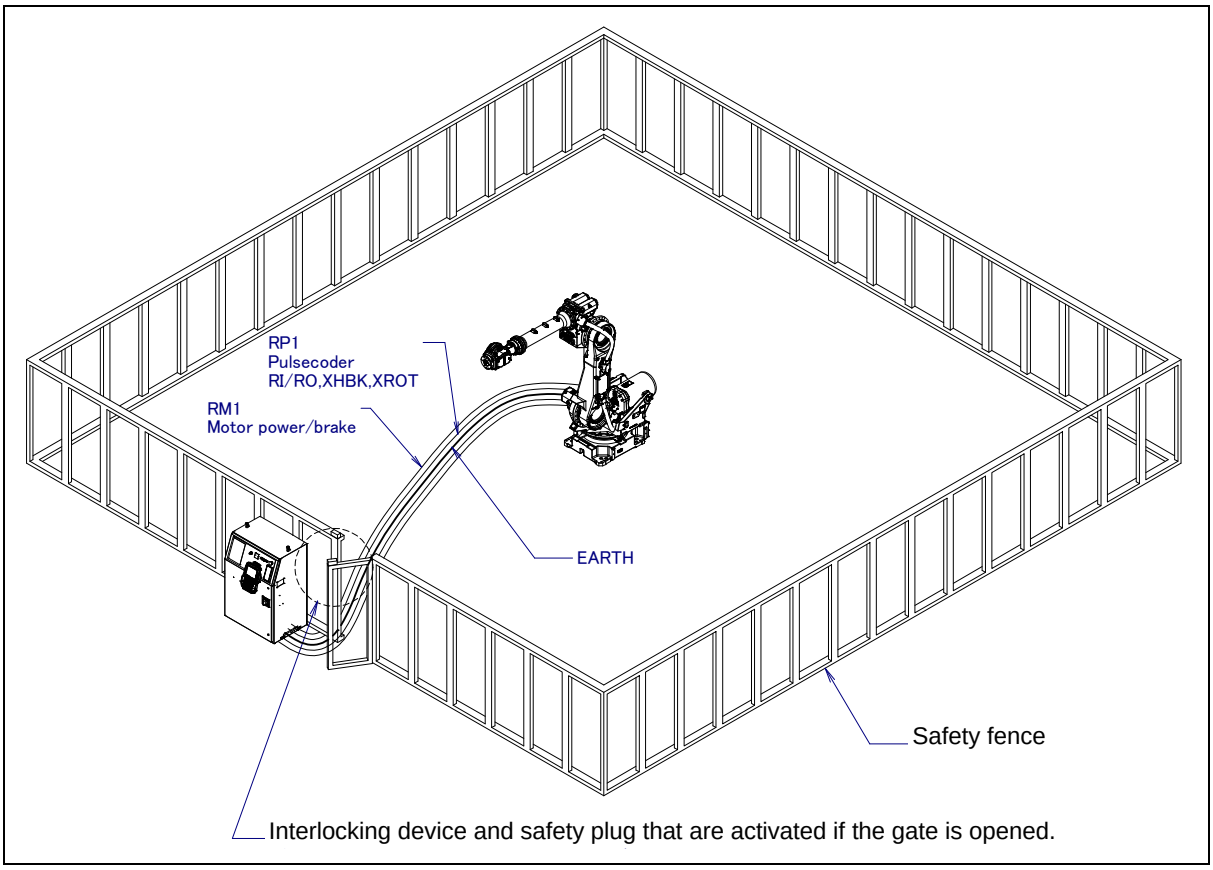


Fig. 3 (a) Safety fence and safety gate

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

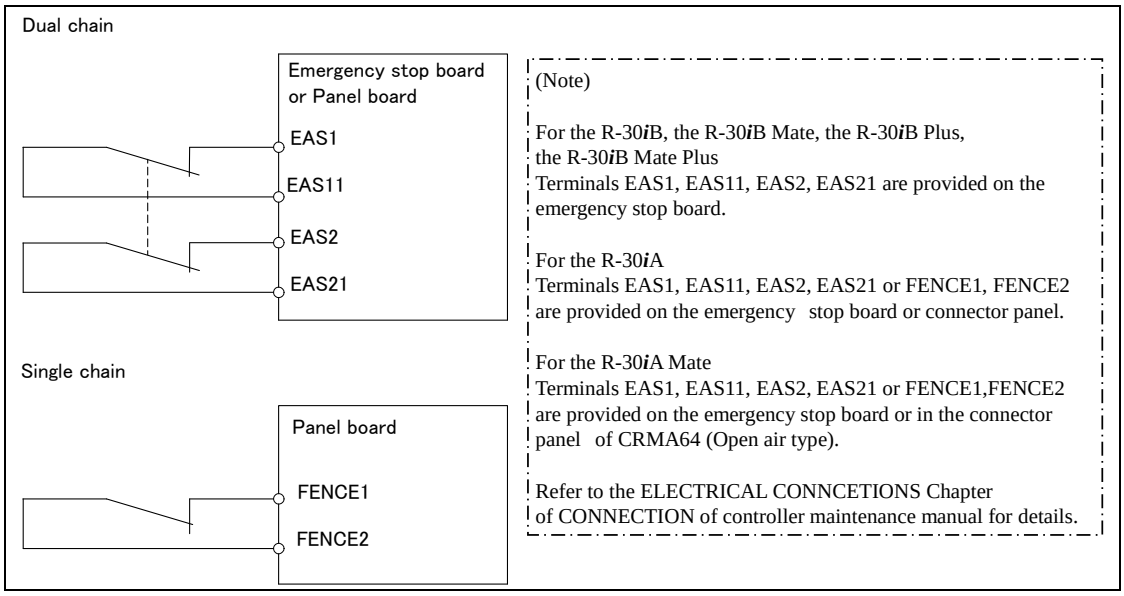


Fig. 3 (b) Connection diagram for the signal of safety fence

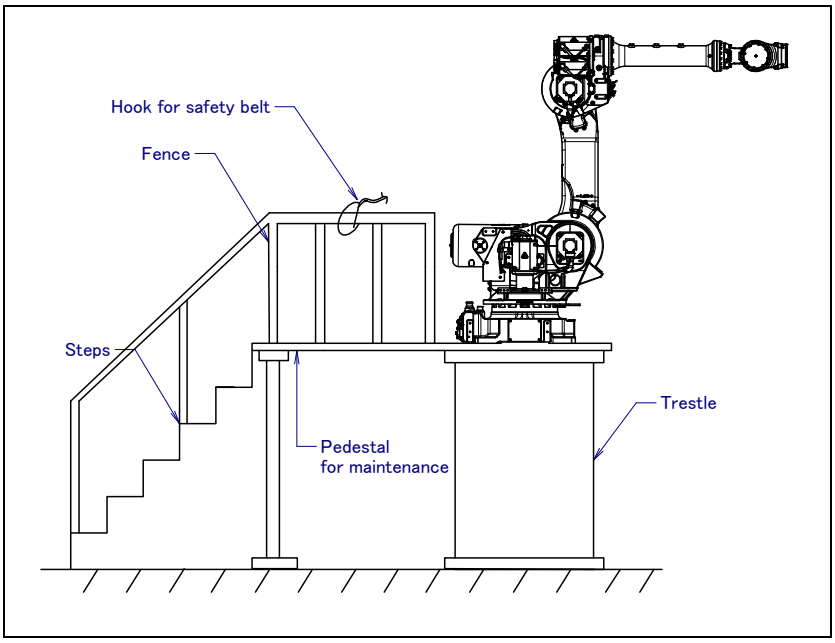


Fig. 3 (c) Pedestal for maintenance

3.1 SAFETY OF THE OPERATOR

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

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

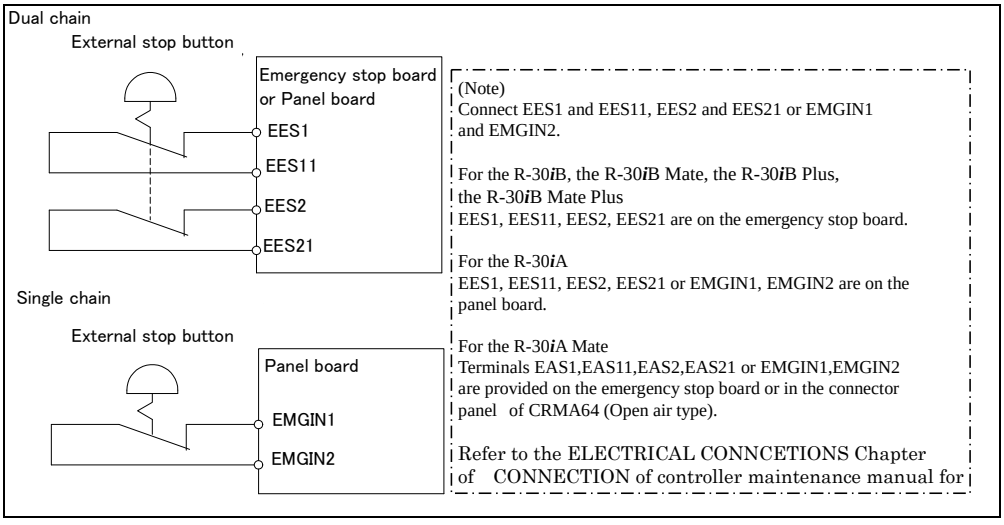


Fig. 3.1 Connection diagram for external emergency stop button

3.2 SAFETY OF THE PROGRAMMER

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

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

Our operator panel is provided with an emergency stop button and a key switch (mode switch) for selecting the automatic operation 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.)

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

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

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

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

For the R-30*i*B Plus/R-30*i*B Mate Plus/R-30*i*B/R-30*i*B Mate/R-30*i*A Controller or CE or RIA specification of the 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.

For the 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 Plus/R-30*i*B Mate Plus/R-30***i***B/R-30*i*B Mate /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 panel, make certain that nobody is in the robot operating space and that there are no abnormal conditions in the robot operating space.

(7) When a program is completed, be sure to carry out the test operation according to the following procedure.
   (a) Run the program for at least one operation cycle in the single step mode at low speed.
   (b) Run the program for at least one operation cycle in 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 must leave the safety fence.

3.3 SAFETY OF THE MAINTENANCE ENGINEER

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

(1) During operation, never enter the robot operating space.
(2) A hazardous situation may arise when the robot or the system, are kept with their power-on during maintenance operations. Therefore, for any maintenance operation, the robot and the system should be put into the power-off state. If necessary, a lock should be in place in order to prevent any other person from turning on the robot and/or the system. In case maintenance needs to be executed in the power-on state, the emergency stop button must be pressed.
(3) If it becomes necessary to enter the robot operating space while the power is on, press the emergency stop button on the operator box or operator panel, or the teach pendant before entering the range. The maintenance worker must indicate that maintenance work is in progress and be careful not to allow other people to operate the robot carelessly.
(4) When entering the area enclosed by the safety fence, the worker must check the whole robot system in order to make sure no dangerous situations exist. In case the worker needs to enter the safety area whilst a dangerous situation exists, extreme care must be taken, and whole robot system status must be carefully monitored.
(5) Before the maintenance of the pneumatic system is started, the supply pressure should be shut off and the pressure in the piping should be reduced to zero.
(6) Before the start of maintenance work, check that the robot and its peripheral equipment are all in the normal operating condition.
(7) Do not operate the robot in the automatic operation while anybody is in the robot operating space.
(8) When you maintain the robot alongside a wall or instrument, or when multiple users are working nearby, make certain that their escape path is not obstructed.
(9) When a tool is mounted on the robot, or when any movable device other than the robot is installed, such as belt conveyor, pay careful attention to its motion.
(10) If necessary, have a user who is familiar with the robot system stand beside the operator panel and observe the work being performed. If any danger arises, the user should be ready to press the EMERGENCY STOP button at any time.
(11) When replacing a part, please contact your local FANUC representative. If a wrong procedure is followed, an accident may occur, causing damage to the robot and injury to the user.
(12) When replacing or reinstalling components, take care to prevent foreign material from entering the system.
(13) When handling each unit or printed circuit board in the controller during inspection, turn off the circuit breaker to protect against electric shock.
If there are two cabinets, turn off the both circuit breaker.
(14) A part should be replaced with a part recommended by FANUC. If other parts are used, malfunction or damage would occur. Especially, a fuse that is not recommended by FANUC should not be used. Such a fuse may cause a fire.
(15) When restarting the robot system after completing maintenance work, make sure in advance that there is no person in the operating space and that the robot and the peripheral equipment are not abnormal.
(16) When a motor or brake is removed, the robot arm should be supported with a crane or other equipment beforehand so that the arm would not fall during the removal.
(17) Whenever grease is spilled on the floor, it should be removed as quickly as possible to prevent dangerous falls.
(18) The following parts are heated. If a maintenance user needs to touch such a part in the heated state, the user should wear heat-resistant gloves or use other protective tools.
- Servo motor
- Inside the controller
- Reducer
- Gearbox
- Wrist unit

(19) Maintenance should be done under suitable light. Care must be taken that the light would not cause any danger.
(20) When a motor, reducer, or other heavy load is handled, a crane or other 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 robot system so that your escape route will not become blocked by the robot, or by peripheral equipment.
- Always pay attention to potentially dangerous situations, and be prepared to press the emergency stop button whenever necessary.

(26) The robot should be periodically inspected. (Refer to the robot mechanical manual and controller maintenance manual.) A failure to do the periodical inspection can adversely affect the performance or service life of the robot and may cause an accident
(27) After a part is replaced, a test execution should be given for the robot according to a predetermined method. (See TESTING section of “Controller operator’s manual”.) During the test execution, the maintenance worker should work outside the safety fence.

4 SAFETY OF THE TOOLS AND PERIPHERAL EQUIPMENT

4.1 PRECAUTIONS IN PROGRAMMING

(1) Use a limit switch or other sensor to detect a dangerous condition and, if necessary, design the program to stop the robot when the sensor signal is received.
(2) Design the program to stop the robot when an abnormality occurs in any other robots or peripheral equipment, even though the robot itself is normal.
(3) For a system in which the robot and its peripheral equipment are in synchronous motion, particular care must be taken in programming so that they do not interfere with each other.
(4) Provide a suitable interface between the robot and its peripheral equipment so that the robot can detect the states of all devices in the system and can be stopped according to the states.

4.2 PRECAUTIONS FOR MECHANISM

(1) Keep the component cells of the robot system clean, operate the robot where insulated from the influence of oil, water, and dust.
(2) Don't use unconfirmed liquid for cutting fluid and cleaning fluid.
(3) Adopt limit switches or mechanical stoppers to limit the robot motion, and avoid the robot from collisions against peripheral equipment or tools.
(4) Observe the following precautions about the mechanical unit cables. Failure to follow precautions may cause problems.
- Use mechanical unit cable that have required user interface.
- Do not add user cable or hose to inside of the mechanical unit.
- Please do not obstruct the movement of the mechanical unit when cables are added to outside of mechanical unit.
- In the case of the model that a cable is exposed, please do not perform remodeling (Adding a protective cover and fix an outside cable more) obstructing the behavior of the outcrop of the cable.
- When installing user peripheral equipment on the robot mechanical unit, please pay attention that the device does not interfere with the robot itself.

(5) The frequent power-off stop for the robot during operation causes the trouble of the robot. Please avoid the system construction that power-off stop would be operated routinely. (Refer to bad case example.) Please perform power-off stop after reducing the speed of the robot and stopping it by hold stop or cycle stop when it is not urgent. (Please refer to "STOP TYPE OF ROBOT" in "SAFETY PRECAUTIONS" for detail of stop type.)
(Bad case example)
- Whenever poor product is generated, a line stops by emergency stop and power-off of the robot is incurred.
- When alteration is necessary, safety switch is operated by opening safety fence and power-off stop is incurred for the robot during operation.
- An operator pushes the emergency stop button frequently, and a line stops.
- An area sensor or a mat switch connected to safety signal operates routinely and power-off stop is incurred for the robot.
- Power-off stop is regularly incurred due to an inappropriate setting for Dual Check Safety (DCS).

(6) Power-off stop of Robot is executed when collision detection alarm (SRVO-050) etc. occurs. Please try to avoid unnecessary power-off stops. It may cause the trouble of the robot, too. So remove the causes of the alarm.

5 SAFETY OF THE ROBOT MECHANICAL UNIT

5.1 PRECAUTIONS IN OPERATION

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

5.2 PRECAUTIONS IN PROGRAMMING

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

5.3 PRECAUTIONS FOR MECHANISMS

Keep the robot operation area clean, and operate the robot in an environment free of grease, water, and dust.

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

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

Name	Specification
Brake release unit	A05B-2450-J350 (Input voltage AC100-115V single phase) A05B-2450-J351 (Input voltage AC200-240V single phase)
Robot connection cable	A05B-2450-J360 (5m) (except A cabinet integrated type controller) A05B-2450-J361(10m) (except A cabinet integrated type controller) A05B-2525-J045 (5m) (A cabinet integrated type controller) A05B-2525-J046(10m) (A cabinet integrated type controller)
Power cable	A05B-2525-J010 (5m) (AC100-115V Power plug) (*) A05B-2525-J011(10m) (AC100-115V Power plug) (*) A05B-2450-J364 (5m) (AC100-115V or AC200-240V No power plug) A05B-2450-J365(10m) (AC100-115V or AC200-240V No power plug)

(*) These do not support CE marking.

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

⚠ CAUTION

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

⚠ WARNING

Robot arm would fall down by releasing its brake because of gravity. Especially because spring balancer and counter balancer are used for J2-axis, it is hard to predict J2-arm and J3-arm movement by the condition of Robot posture and end effecter. Therefore it is strongly recommended to take adequate measures such as hanging Robot arm by a crane before releasing a brake.

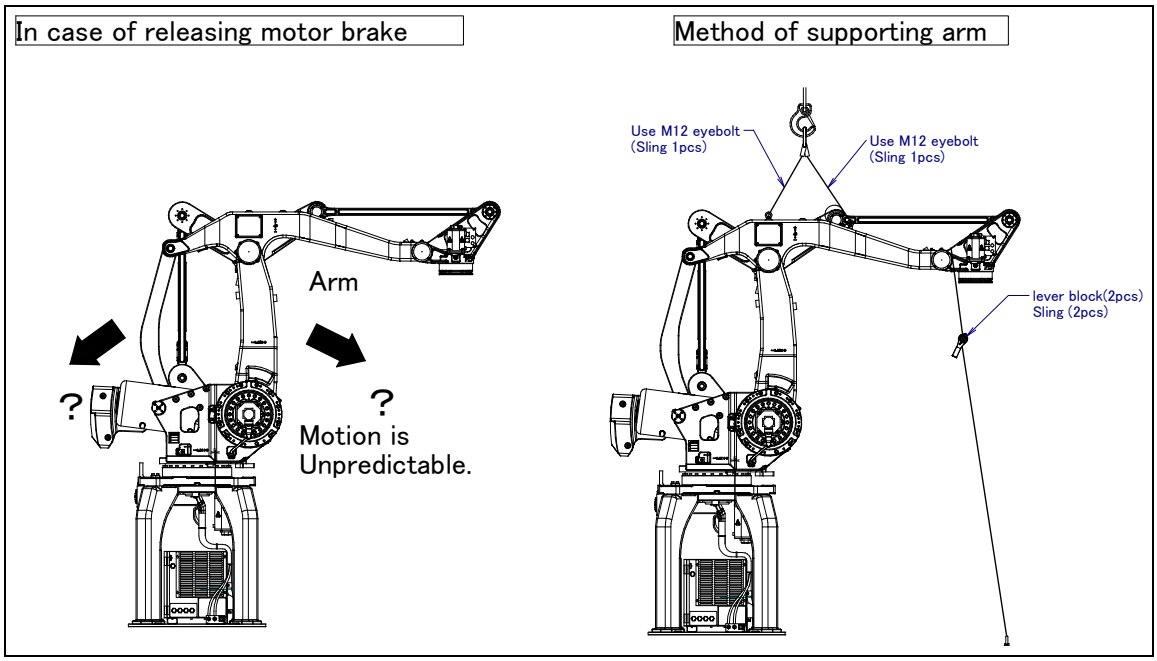


Fig. 5.4 (a) Releasing J2 motor brake and measures

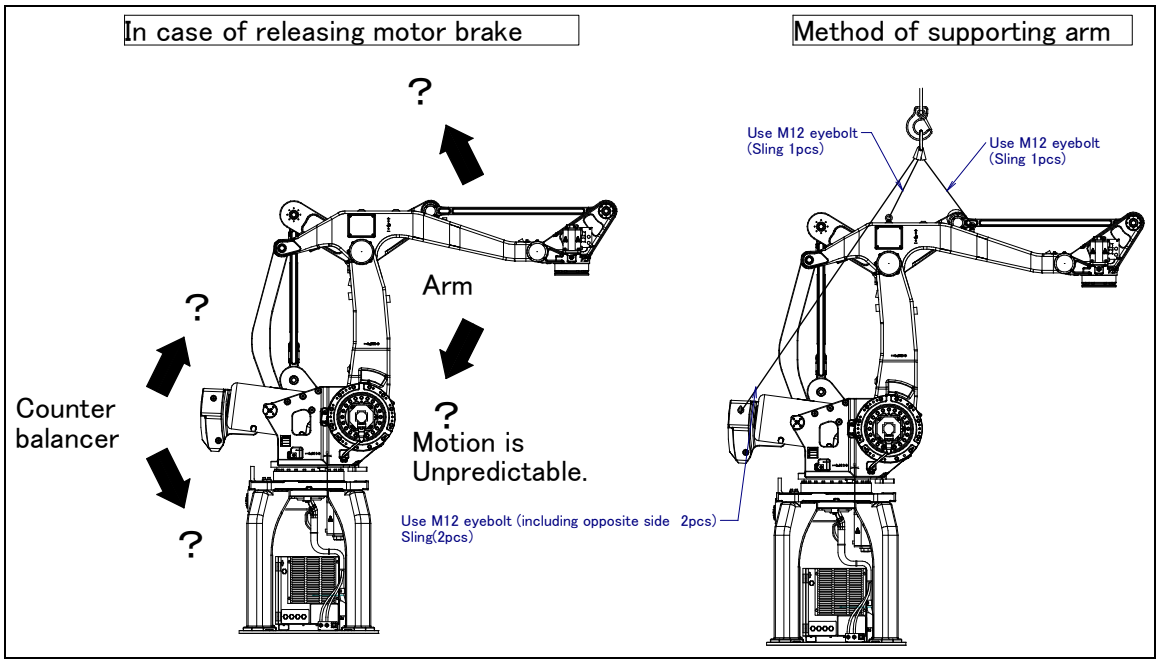


Fig. 5.4 (b) Releasing J3 motor brake and measures

6 SAFETY OF THE END EFFECTOR

6.1 PRECAUTIONS IN PROGRAMMING

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

7 STOP TYPE OF ROBOT

The following three robot stop types exist:

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

Servo power is turned off and the robot stops immediately. Servo power is turned off when the robot is moving, and the path of the deceleration is uncontrolled.
The following processing is performed at Power-Off stop.
- An alarm is generated and servo power is turned off. The robot operation is stopped immediately.
- Execution of the program is paused.

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

Controlled stop (Category 1 following IEC 60204-1)

The robot is decelerated until it stops, and servo power is turned off.
The following processing is performed at Controlled stop.
- The alarm "SRVO-199 Controlled stop" occurs along with a decelerated stop of the robot. Execution of the program is paused.
- After the decelerated stop, 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 patterns differ according to the controller type or option configuration.

There are the following 3 stop patterns.

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

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

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

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

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

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)	Cannot be selected	Cannot be selected	C	C	Cannot be selected	C	C

(*) R-30***i***A standard specification (single) does not have servo disconnect.
(**) R-30***i***A Mate standard specification does not have servo disconnect. The stop type for SVOFF input is Power-Off stop.

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

"Controlled stop by E-Stop" option

When "Controlled stop by E-Stop" (A05B-2600-J570) option (For the 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 is Controlled stop in AUTO mode. In T1 or T2 mode, the stop type is Power-Off stop.

Alarm	Condition
SRVO-001 Operator panel E-stop	Operator's panel E-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/R-30*i*B Mate/R-30*i*B Plus/R-30*i*B Mate Plus 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 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 peripheral equipment or other devices if it deviates from the program path.
- Controlled stop has less physical impact than Power-Off stop. This function is effective for systems where the physical impact on tools is required to be reduced.
- The stopping distance and stopping time of Controlled stop is longer than the stopping distance and stopping time of Power-Off stop. 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/R-30*i*A Mate, this option is available only in the CE or RIA type controller.

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. The stop type set on the DCS screen is used.

> ⚠ **WARNING**
> The stopping distance and stopping time of Controlled stop is 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 stopping distance and stopping time increased in AUTO mode on the above alarms, is necessary when this option is loaded.

8 WARNING & CAUTION LABEL

(1) Greasing and degreasing label

Fig. 8 (a) Greasing and degreasing label

Description

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

1) 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 section 7.3 ″ MAINTENANCE” for explanations about specified grease, the grease amount, and the locations of grease and degrease outlets for individual models.

(2) Disassembly prohibitive label

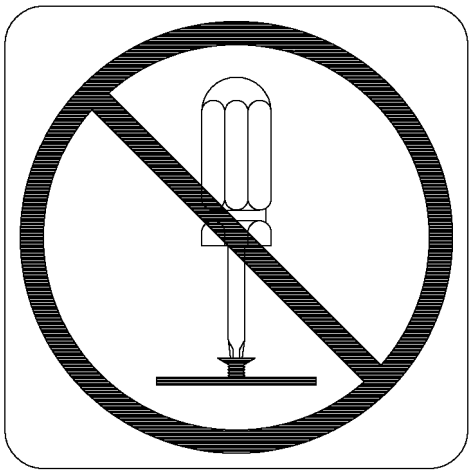


Fig. 8 (b) Disassembly prohibitive label

Description

Do not disassemble the balance unit. It is very dangerous because a spring is loaded in it.

(3) Step-on prohibitive label

Fig. 8 (c) 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.

(4) High-temperature warning label

Fig. 8 (d) High-temperature warning label

Description

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

(5) Transportation label

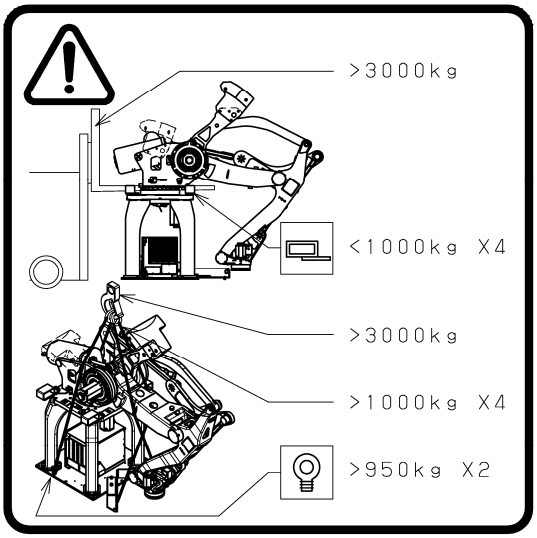


Fig. 8 (e) Transportation label

Description

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

1) Using a forklift
   - Use a forklift having a load capacity of 3000 kg or greater.
   - Keep the total weight of the robot to be transported to within 4000 kg, because the withstand load of the forklift bracket (option) is 9800 N (1000 kgf).

2) Using a crane
   - Use a crane having a load capacity of 3000 kg or greater.
   - Use at least four slings each having a load capacity of 9800 N (1000 kgf) or greater.
   - Use at least two eyebolts each having a load capacity of 9310 N (950 kgf) or greater.

> ⚠ **CAUTION**
> See section II.1.1 TRANSPORTATION for explanations about the posture a specific model should take when it is transported.

(6) Putting weight label

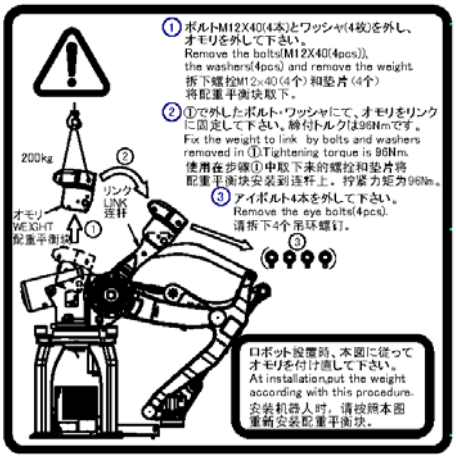


Fig. 8 (f) Putting weight label

Description

After installation of robot, observe the instructions indicated on this label.

1) Remove the bolts (M12 x 40 (4pcs)), the washers (4pcs), and remove the weight.
2) Fix the weight to link by bolts and washers removed in tightening torque in 96Nm
3) Remove eye bolts (4pcs).

(7) Balancer replacement label

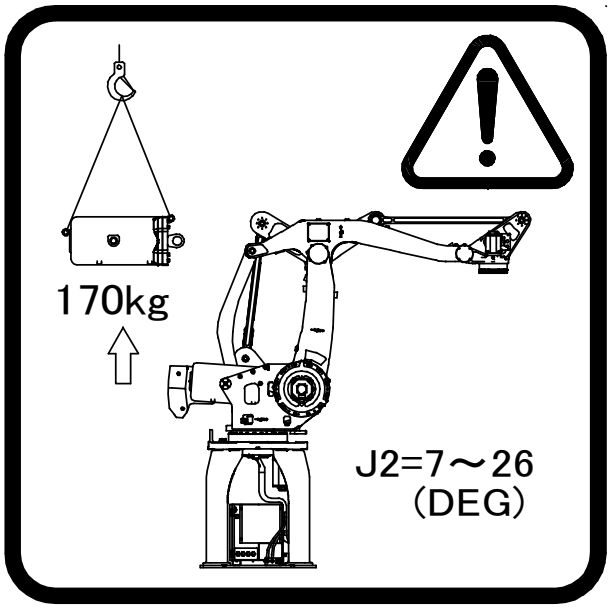


Fig. 8 (g) Balancer replacement label

Description

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

- When replacing the balancer, keep the J2 axis at between 7° and 26°.
- Weight of balancer is 170kg.

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

(8) Transportation prohibitive label

Fig. 8 (h) Transportation prohibitive label

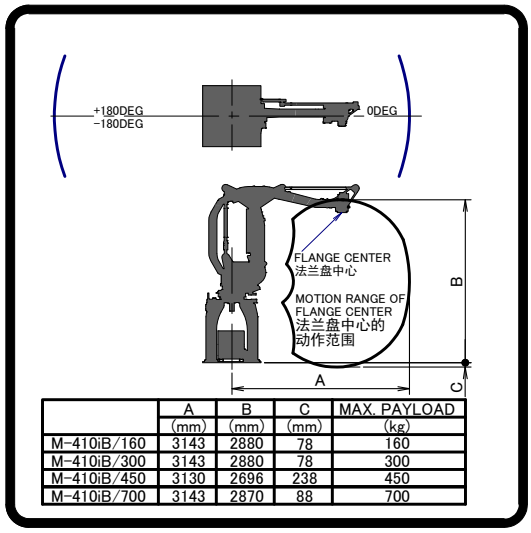
Description

Keep the following in mind when transporting the robot.

- Do not pull eyebolts sideways

(9) Operating space and payload label

Below label is added when CE specification is specified.



	A (mm)	B (mm)	C (mm)	MAX. PAYLOAD (kg)
M-410iB/160	3143	2880	78	160
M-410iB/300	3143	2880	78	300
M-410iB/450	3130	2696	238	450
M-410iB/700	3143	2870	88	700

Fig. 8 (i) Operating space and payload label

160802

PREFACE

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

Model name	Mechanical unit specification No.	Maximum load
FANUC Robot M-410*i*B/700	A05B-1042-B201	700kg

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

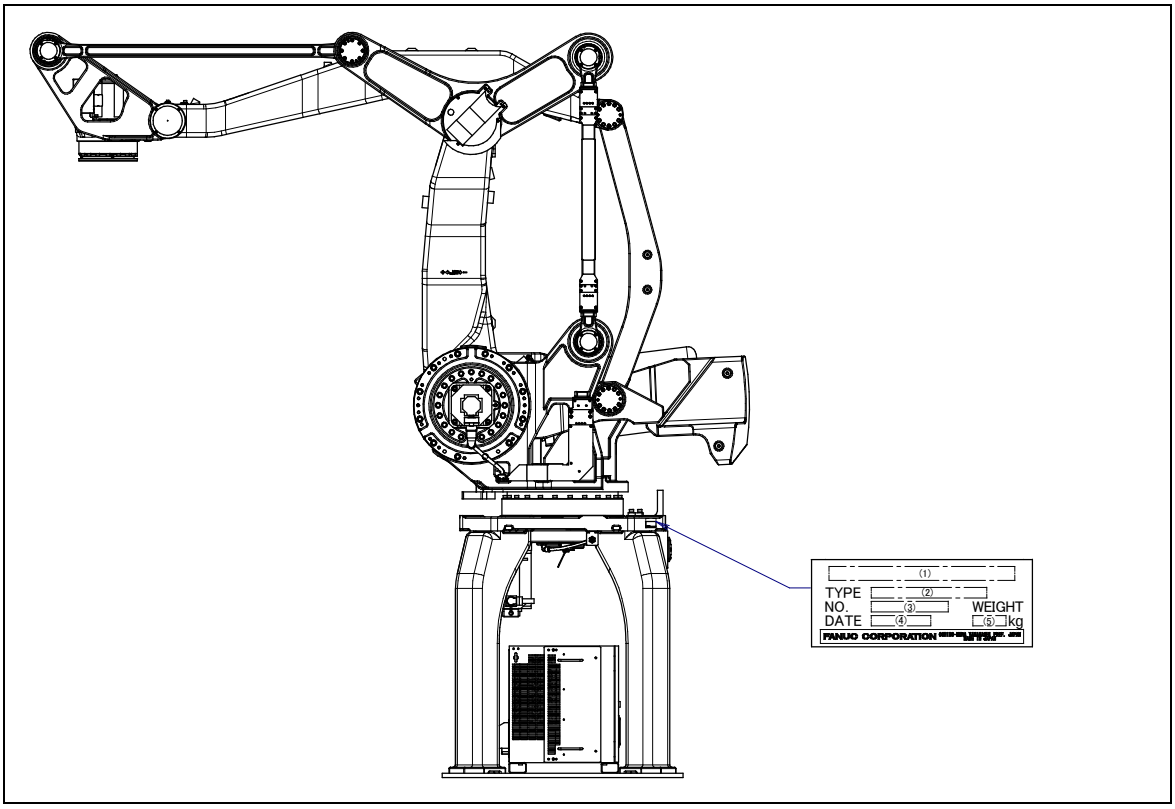


TABLE 1)

	(1)	(2)	(3)	(4)	(5)	(6)
CONTENTS	**MODEL NAME**	**TYPE**	**No.**	**DATE**	**WEIGHT (Including controller)**	**WEIGHT kg (Not including controller)**
LETTERS	FANUC Robot M-410*i*B/700	A05B-1042-B201	SERIAL NO IS PRINTED	PRODUCTION YEAR AND MONTH ARE PRINTED	2700kg	2580

RELATED MANUALS

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

SAFETY HANDBOOK **B-80687EN** All persons who use the FANUC Robot and system designer must read and understand thoroughly this handbook		Intended readers: Operator, system designer Topics: Safety items for robot system design, operation, maintenance
R-30*i*A controller	Setup and Operations manual HANDLING TOOL **B-83124EN-2** ALARM CODE LIST **B-83124EN-6**	Intended readers: Operator, programmer, maintenance engineer, 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 engineer, system designer Topics: Installation, connection to peripheral equipment, maintenance Use: Installation, start-up, connection, maintenance
R-30*i*B, R-30*i*B Plus controller	Operations manual (Basic Operation) **B-83284EN** (Alarm Code List) **B-83284EN-1** OPTIONAL FUNCTION **B-83284EN-2**	Intended readers: Operator, programmer, maintenance engineer, system designer Topics: Robot functions, operations, programming, setup, interfaces, alarms Use: Robot operation, teaching, system design
	Maintenance manual **B-83195EN**	Intended readers: Maintenance engineer, system designer Topics: Installation, connection to peripheral equipment, maintenance Use: Installation, start-up, connection, maintenance

This manual uses following terms.

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

TABLE OF CONTENTS

1 TRANSPORTATION AND INSTALLATION

1.1 TRANSPORTATION

Use a crane or a forklift to transport the robot. Fig.1.1 (a), (b) show the transport posture.

⚠ CAUTION

- When peripherals are installed on a robot, the center of gravity of the robot changes and the robot might become unstable while being transported. If the robot becomes unstable, remove the tooling and place the positioner into the transportation position. This will position the unit center of gravity correctly. It is recommended to transport the end effector and peripherals separately from the robot.
- Robot becomes unstable when it is transported with the end effector applied to wrist, and it is dangerous. Please be sure to remove end effector when robot is transported.
- Use the forklift pockets only to transport the robot with a forklift. Do not use the forklift pockets to secure the robot.
- Before moving the robot by using forklift pockets, check and tighten any loose bolts on the forklift pockets.
- Do not pull eyebolts sideways.
- Prevent the forks of the forklift from having impact on transport equipment.
- Do not thread a chain or the like through transport equipment.

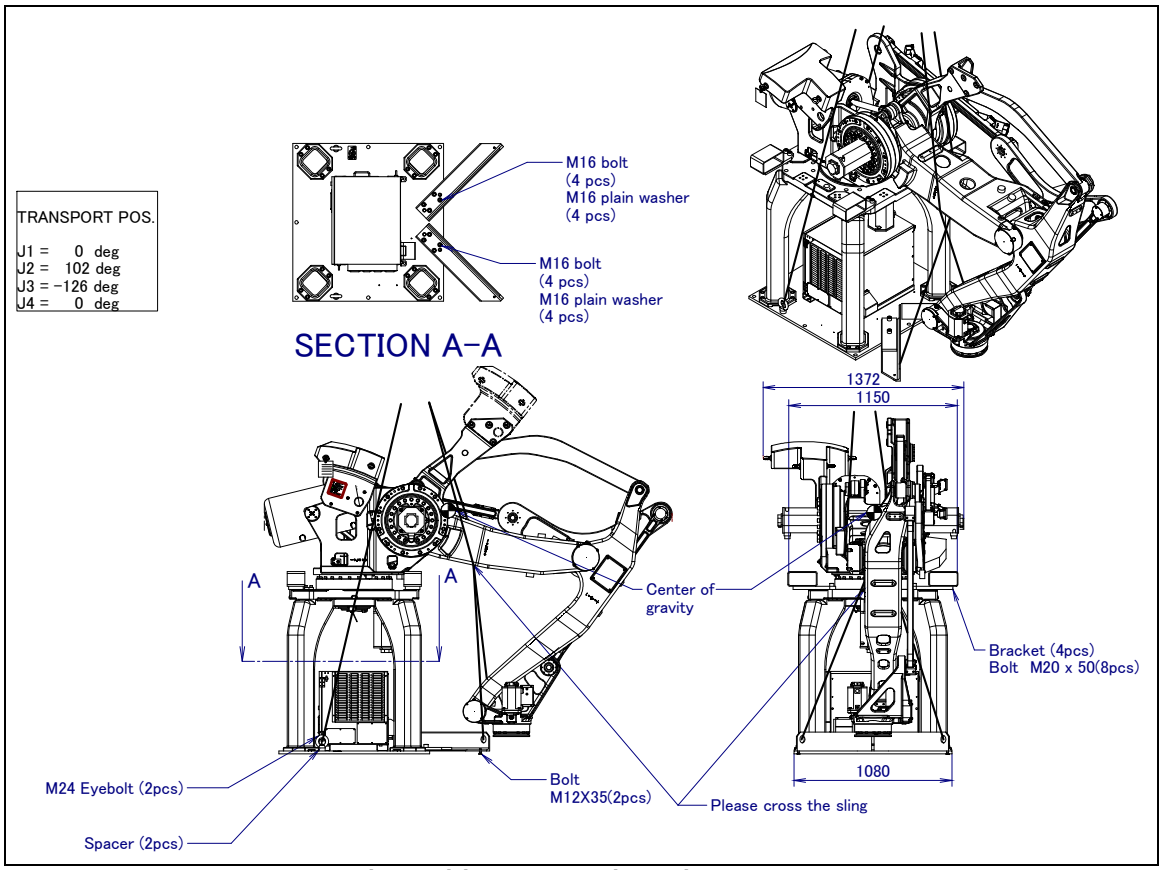


Fig. 1.1 (a) Transportation using a crane

NOTE
Regardless of weight mounting position, the transportation posture of the robot and the method of transportation are common.

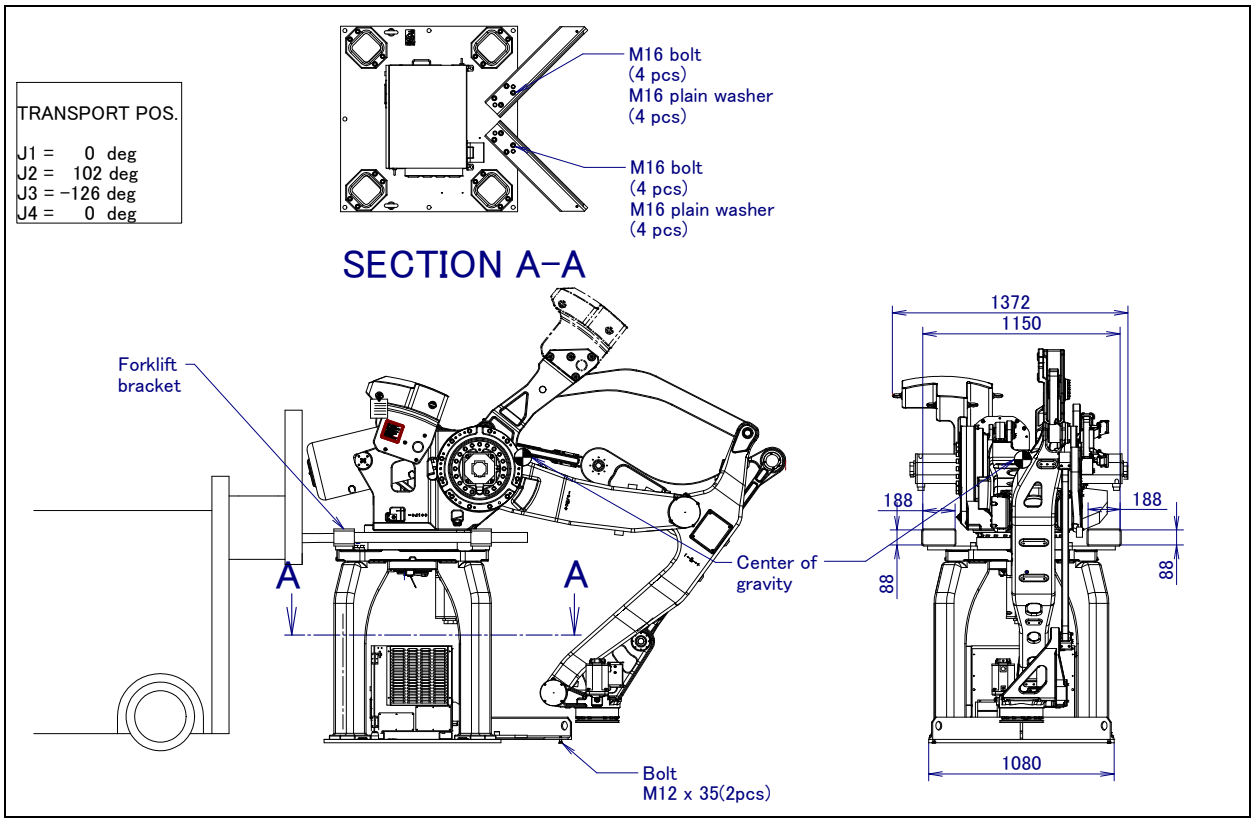


Fig. 1.1 (b) Transportation using a forklift

⚠ CAUTION
1 Regardless of weight mounting position, the transportation posture of the robot and the method of transportation are common.
2 Be careful not to strike the transport equipment strongly with the forklift forks.
3 Mechanical unit weight : 2.7 tons (including the controller)
Crane permissible load : 3.0 tons or more
Rope permissible load : 1.0 ton or more
Number of ropes used : Four
Forklift permissible load : 3.0 ton or more
Eyebolt complied with JIS B 1168

After installation of robot, put the weight J2 base to J2 link by procedure below.

1) Remove the bolts (M12 x 40 (4pcs)), the washers (4 pcs), and remove the weight.
2) Fix the weight to link by bolts and washers removed in tightening torque in 96Nm
3) Remove eye bolts (4pcs).

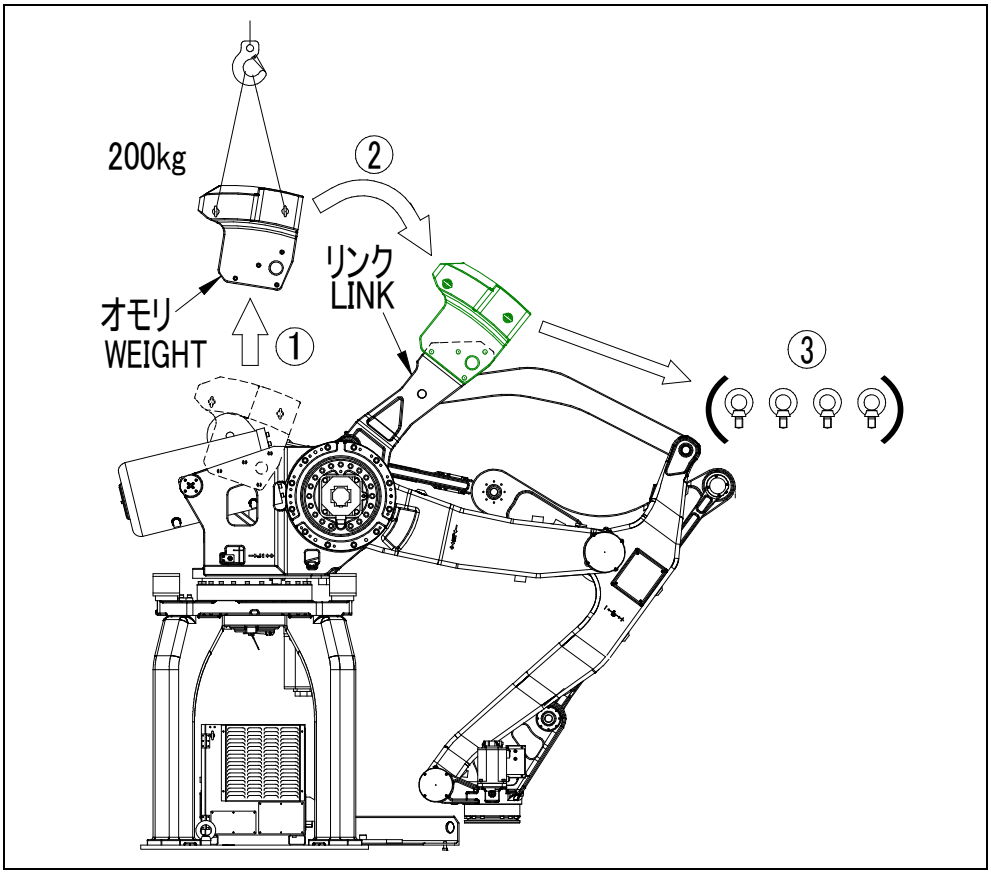


Fig. 1.1 (c) Putting the weight

> ⚠ **CAUTION**
> Please be sure to putting the weight or there is a possibility that the robot cannot demonstrate enough ability.

1.2 INSTALLATION

(1) Installing the robot using the standard pedestal

Described below is how to install the robot using the standard pedestal, which is factory-assembled with the robot.

Fig. 1.2 (a) shows the robot base dimensions. Fig. 1.2 (b) shows an actual example of robot installation. Secure the floor plate (iron plate) to the floor using 16 M20 chemical anchors (Tensile strength 400N/mm^2 or more). Then, secure the robot to the floor plate with eight M20 x 40 bolts (Tensile strength 1200N/mm^2 or more), which are M20 size and at least 40 mm in length.

- Those bolts for which no tightening torque is specified must be tightened according to the APPENDIX B STRENGTH OF BOLT AND BOLT TORQUE LIST.

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

⚠ CAUTION

1 If the robot base is secured directly to the floor with chemical anchors, the anchors may fail due to fluctuating load during robot operation.

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

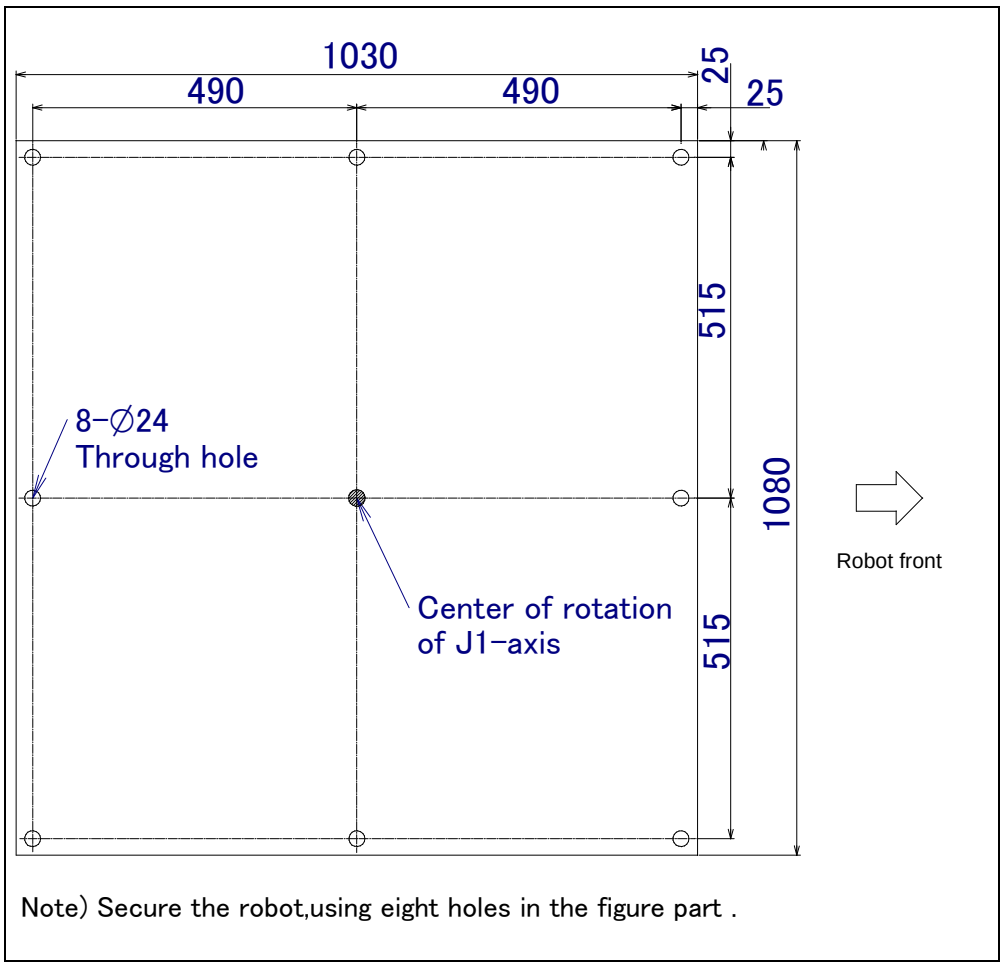


Fig. 1.2 (a) Installation hole dimensions of the robot base

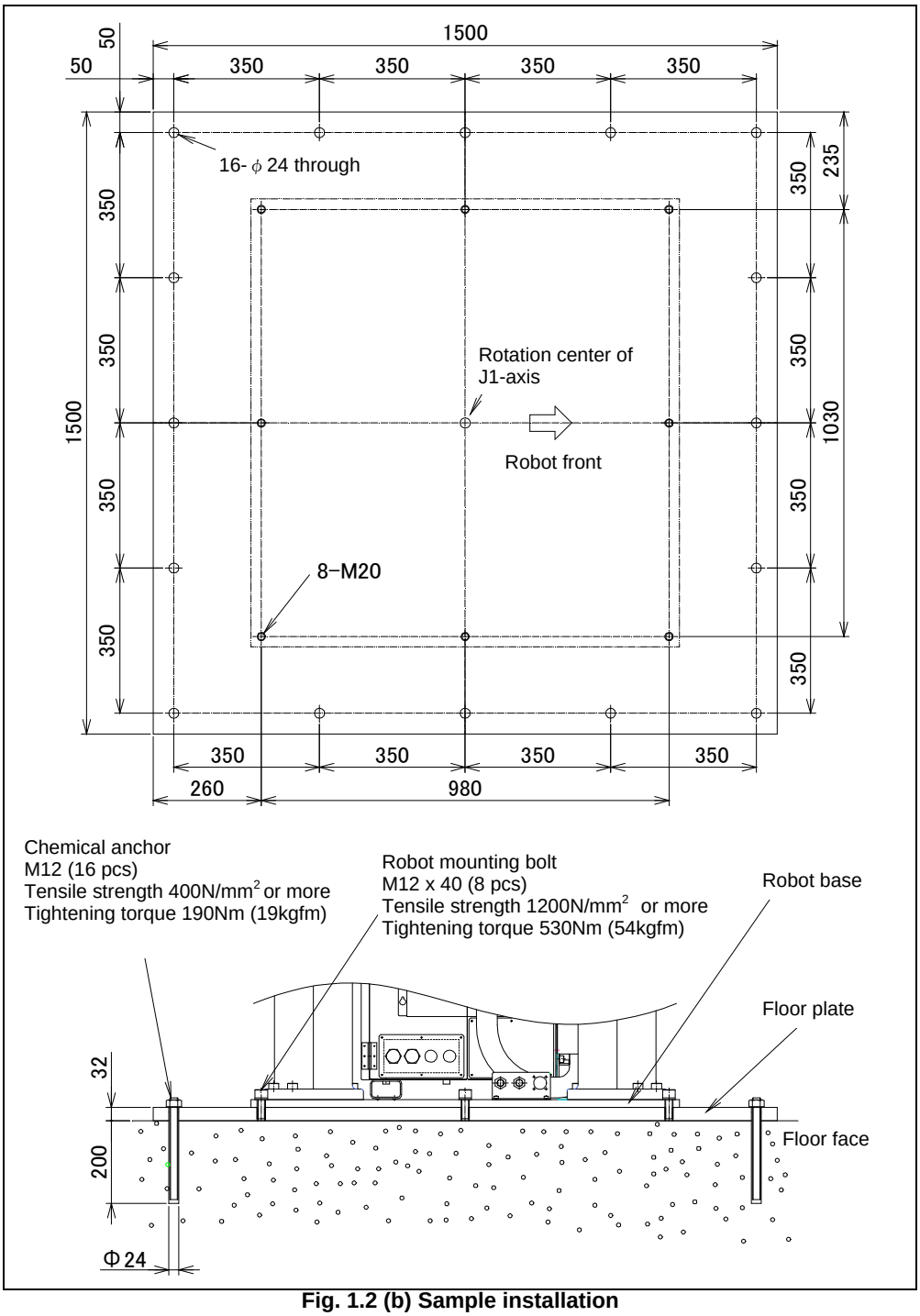


Fig. 1.2 (b) Sample installation

NOTE

1 The customer should prepare the following parts:
- Eight robot securing bolts : M20 x 40 (Tensile strength 1200N/mm^2 or more)
- Sixteen chemical anchors : M20 (Tensile strength 400N/mm^2 or more)
- One floor plate : 32t in thickness

2 The customer is responsible for preparation prior to installation (mounting of anchors, for example)

3 Flatness of robot installation surface must be less than or equal to 0.5mm. Inclination of robot installation surface must be less than or equal to 0.5º. If robot base is placed on uneven ground, it may result in the base breakage or low performance of the robot.

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

Table 1.2 (a) Force and moment that act on base

	Static	Dynamic Acceleration/Deceleration	Power-off stop
Vertical moment :M_V	32,600Nm (3,323gfm)	55,800Nm (5,691kgfm)	87,500Nm (8,932kgfm)
Force in vertical direction :F_V	33,300N (3,400kgf)	36,900N (3,762kgf)	46,300N (4,729kgf)
Horizontal moment :M_H	0 Nm (0 kgfm)	12,600Nm (1,283kgfm)	22,700Nm (2,319kgfm)
Force in horizontal direction :F_H	0 N (0 kgf)	7,200N (712kgf)	8,500N (871kgf)

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

Model		J1-axis	J2-axis	J3-axis
M-410*i*B/700	Stopping time [msec]	576	224	170
	Stopping distance [deg] (rad)	17.3 (0.30)	6.7 (0.12)	5.1 (0.09)

* Max payload and max speed

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

Model		J1-axis	J2-axis	J3-axis
M-410*i*B/700	Stopping time [msec]	940	940	932
	Stopping distance [deg] (rad)	29.9 (0.52)	29.6 (0.52)	29.9 (0.52)

* Max payload and max speed

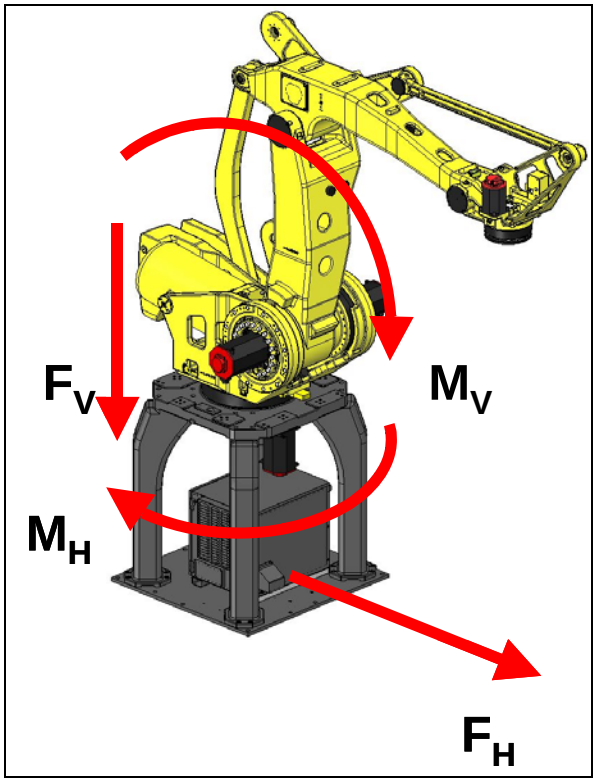


Fig. 1.2 (c) Force and moment that acts on base

(2) Installing the robot without using the standard pedestal

A robot of remote controller type can be installed on a customer-prepared pedestal, without using the standard pedestal, which is factory-assembled with the robot.

Fig. 1.2 (d) shows how to remove the standard pedestal from the robot. First put the robot in the posture of J1-axis = 0°, J2-axis = -44°, J3-axis = -25°, and J4-axis = 0°, then prepare to sling up the robot portion above the J1 base with rope. Remove the J1-axis mounting bolts (sixteen M16 x 65 bolts), and separate the J1 base from the pedestal.

Fig. 1.2 (e) shows the installation interface for the robot. Design a pedestal while taking care of the following points:

- Provide space required when replacing the J1-axis motor.
- Provide space required when mounting and dismounting the mastering fixture.
- Provide space for periodic maintenance (such as battery exchange and degreasing)
- Avoid interference of the robot with the cables and connector box.
- Make sure that the setup is strong enough to withstand the force and moment listed in Table 1.2 (a). To fasten the J1 base to the pedestal, use sixteen bolts having a size of M16 (Tensile strength 1200N/mm^2 or more) and a length of at least 65 mm.

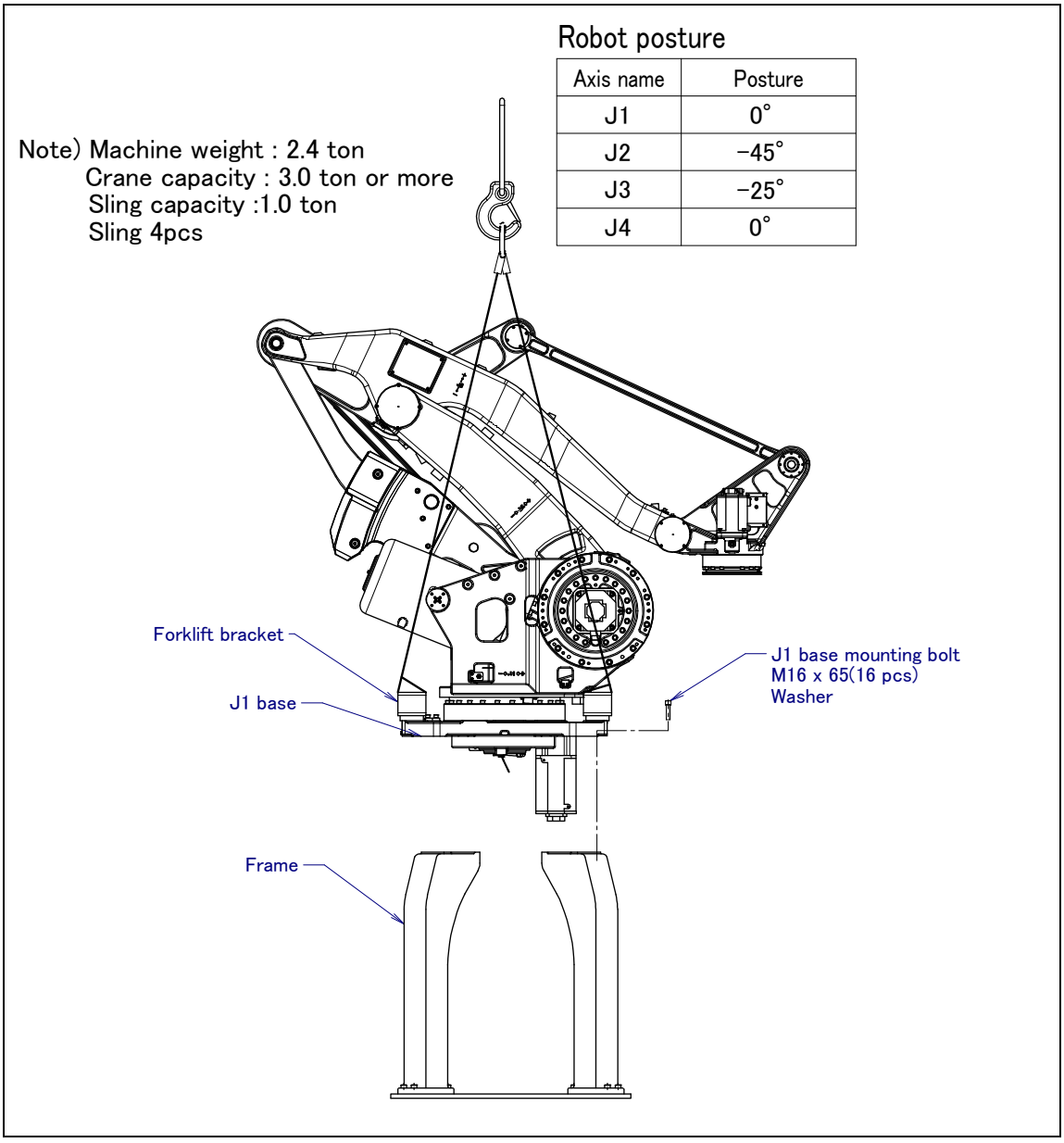


Fig. 1.2 (d) How to remove the pedestal (Remote type controller)

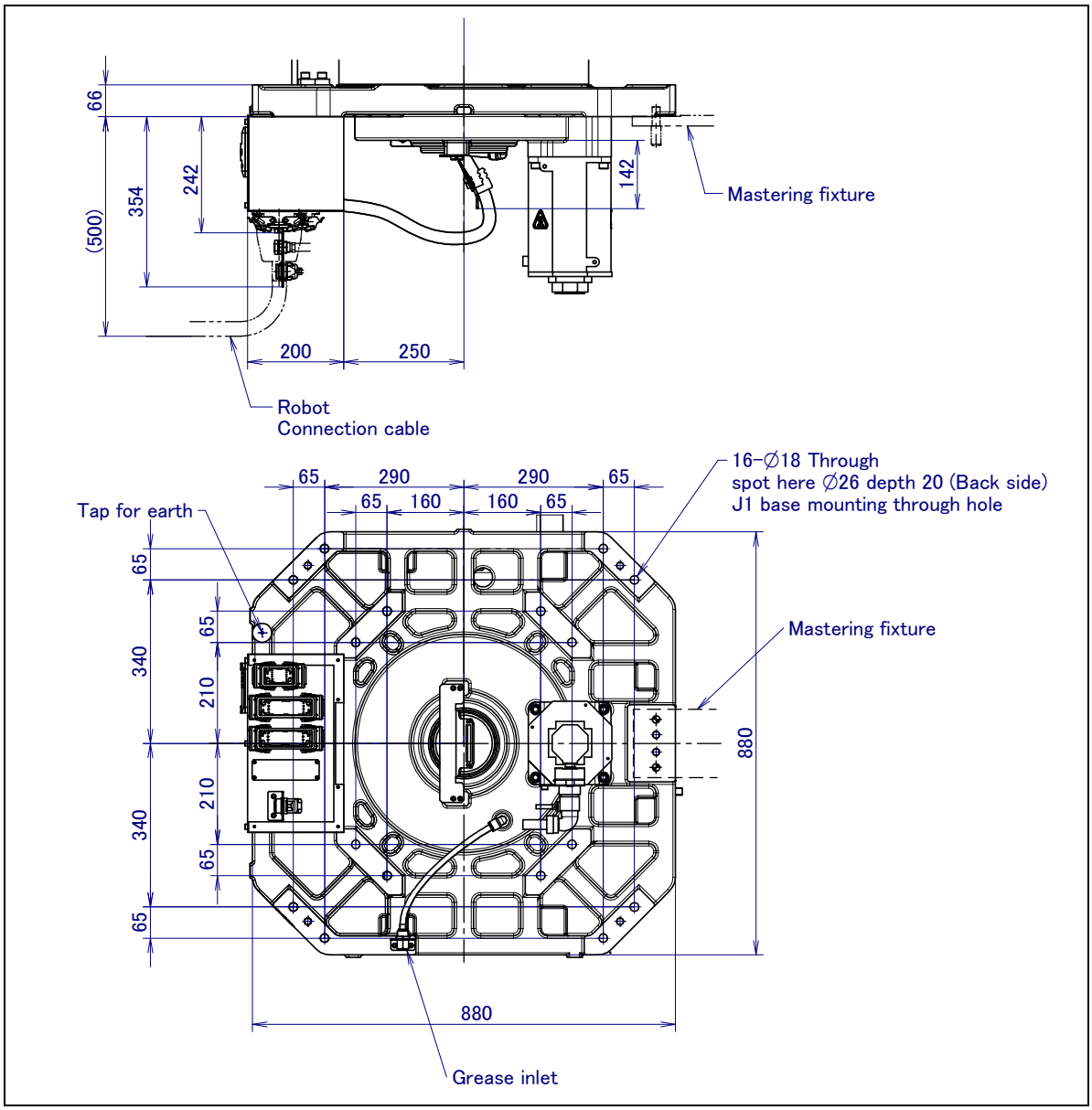


Fig. 1.2 (e) Installation interface for the robot without a standard pedestal (Remote controller type)

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 mastering information.

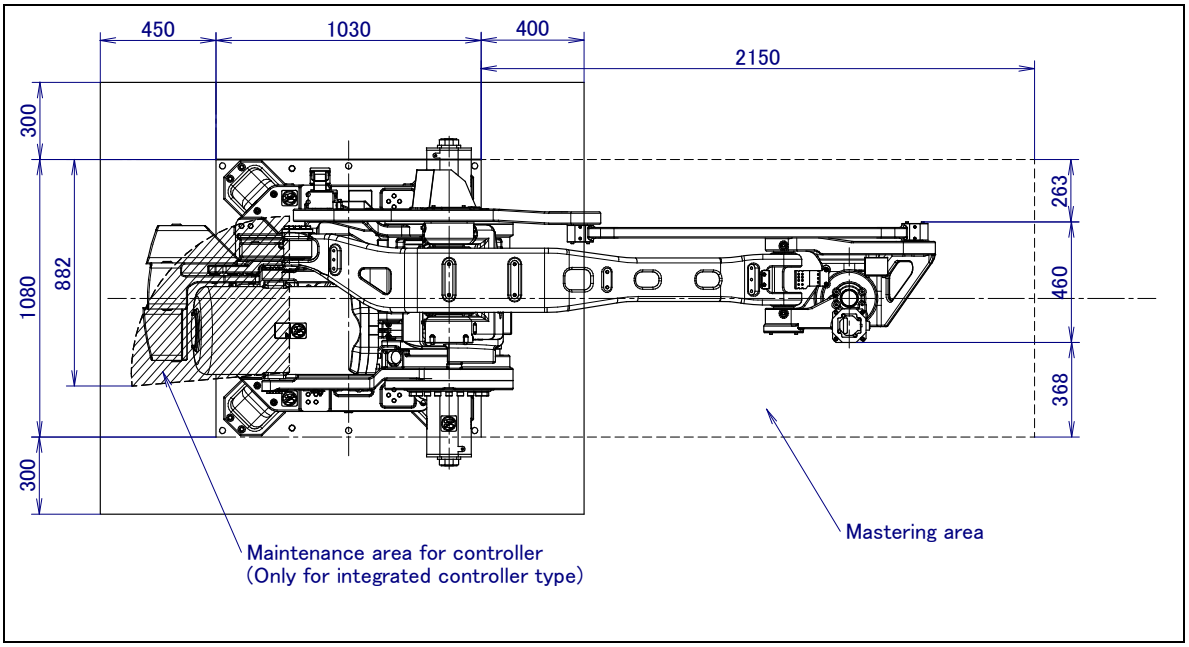


Fig. 1.3 Maintenance area

1.4 INSTALLATION CONDITIONS

Refer to specification of Section 3.1 about installation conditions.

2 CONNECTION WITH THE CONTROLLER

2.1 CONNECTION WITH THE CONTROLLER

In case of integrated controller type, cable of controller is connected to motor of robot directly.

In case of remote controller type, the robot is connected with the controller via the power cable, signal cable, and the earth cable. Connect these cables to the connectors on the back of the base.
For details on air and option cables, see Chapter 5.

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

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

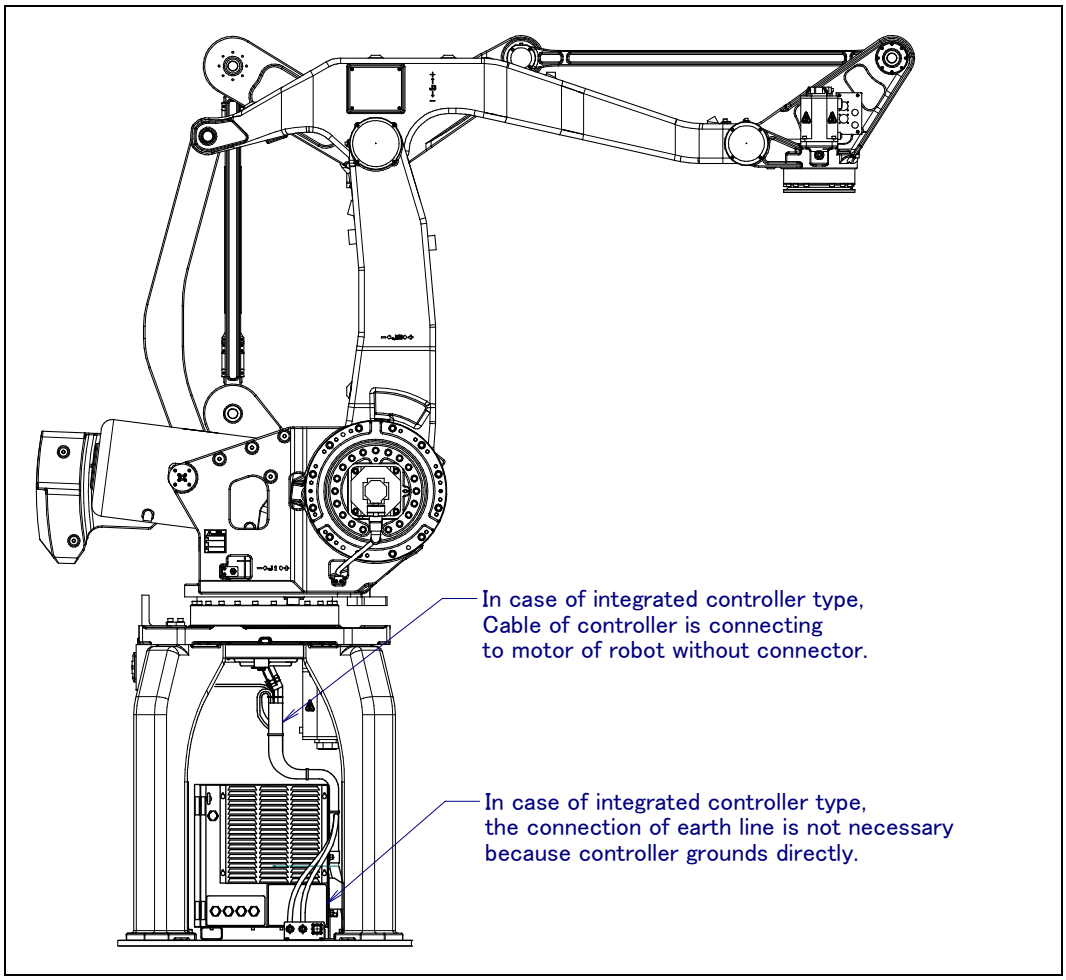


Fig. 2.1 (a) Cable connection (integrated type controller)

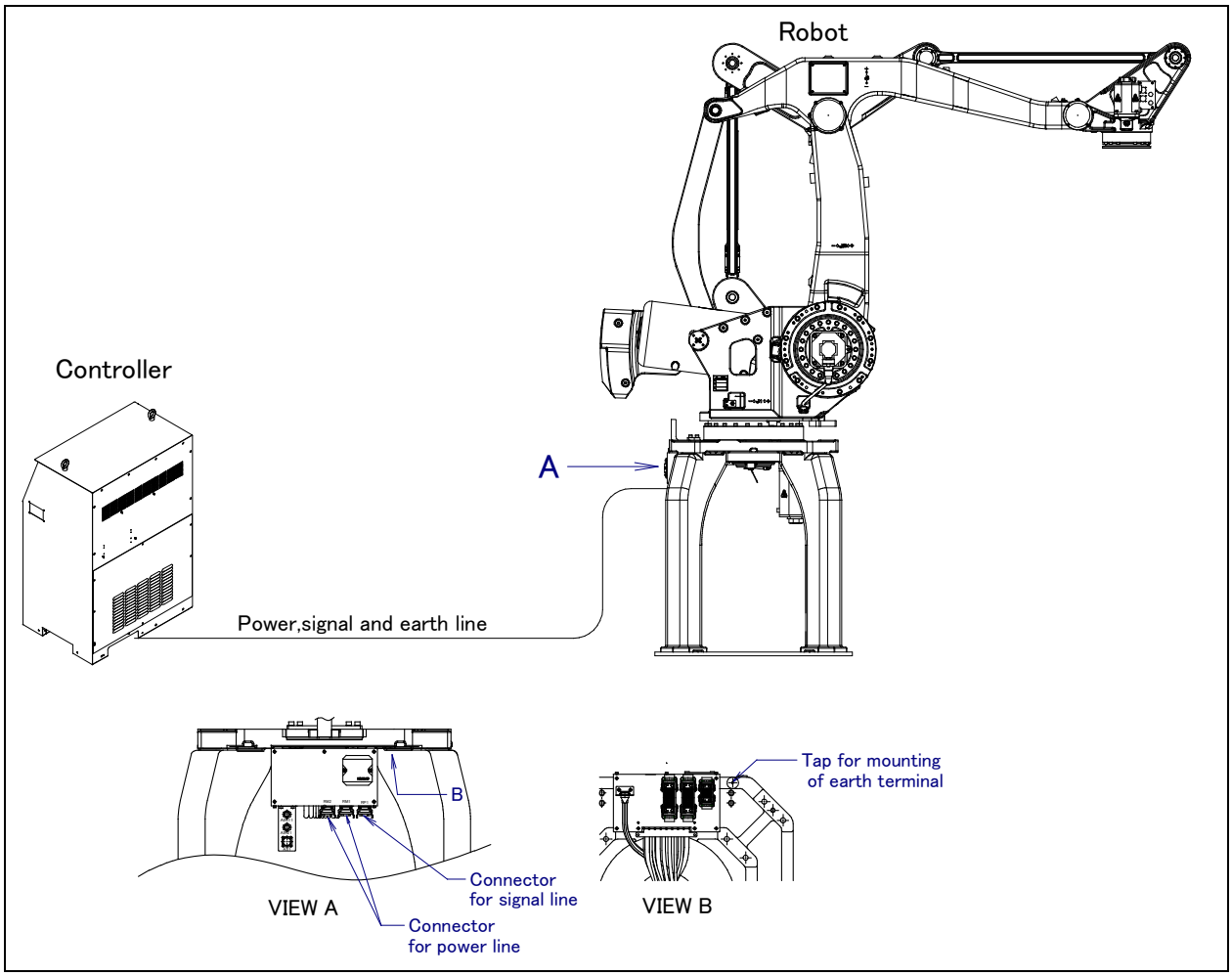


Fig. 2.1 (b) Cable connection (remote type controller)

3 BASIC SPECIFICATIONS

3.1 ROBOT CONFIGURATION

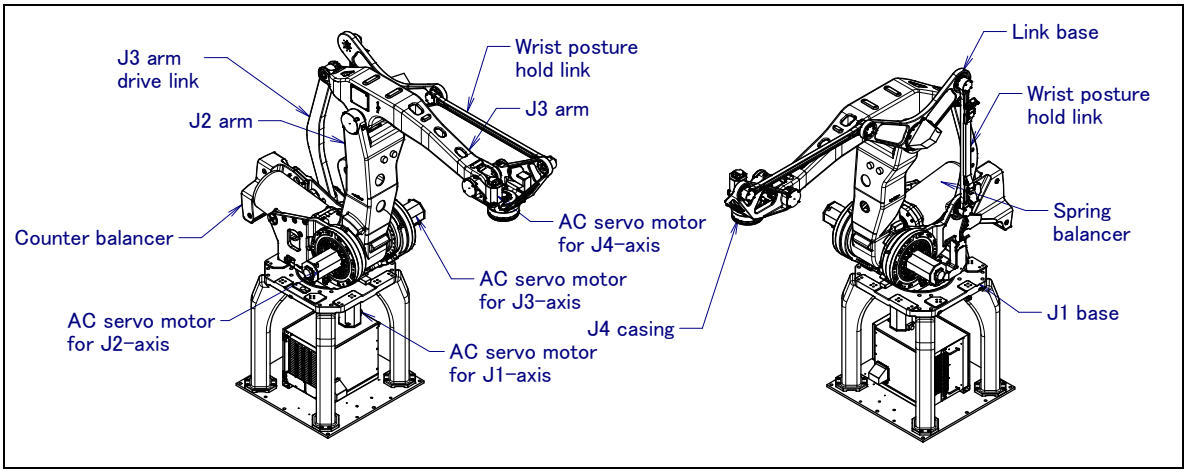


Fig. 3.1 (a) Mechanical unit configuration

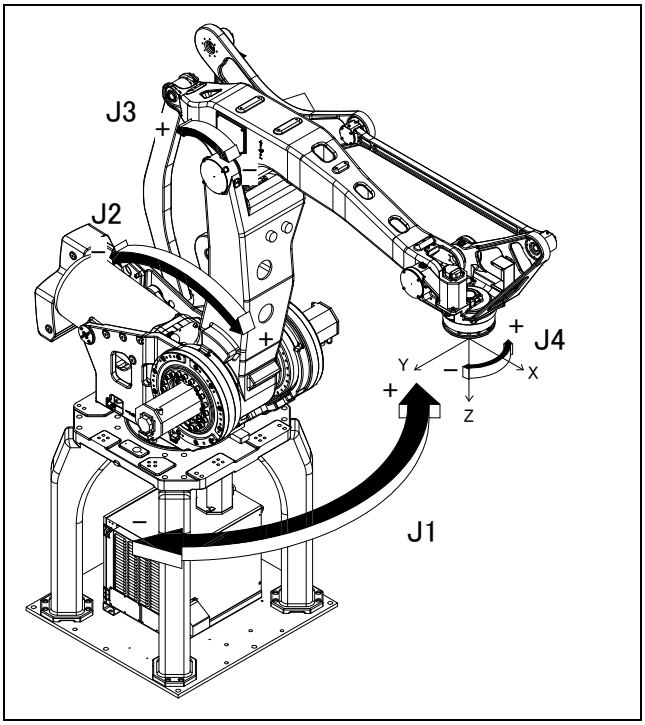


Fig. 3.1(b) Each axes coordinates and mechanical interface coordinates

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

Table 3.1 Specifications

Item		M-410*i*B/700
Controlled axes		4-axes (J1, J2, J3, J4)
Installation		Floor mount
Motion range (Note 1)	J1-axis	360° (60°/sec) 6.28rad(1.05rad/sec)
	J2-axis	144° (60°/sec) 2.51rad(1.05rad/sec)
	J3-axis	136° (60°/sec) 2.37rad(1.05rad/sec)
	J4-axis	540° (120°/sec) 9.42rad(2.09rad/sec)
Max. payload	At wrist (Note 2)	700kg
	On J3 arm (Note 2)	50kg
Allowable load inertia at wrist		490kg-m^2 (5000kgf-cm-sec^2)
Drive method		Electric servo drive by AC servo motor
Repeatability		±0.5mm
Mass		2700kg (with controller of integrated controller type) 2580kg (without controller)
Acoustic noise level		Less than 70dB (Note 3)
Installation environment		Ambient temperature: 0 to 45℃ (Note 4) Ambient humidity: Normally 75%RH or less (No dew or frost allowed) Short time 95%Rh or less (Within 1 month) Permissible altitude: Above the sea 1000m or less Vibration acceleration : 4.9m/s^2 (0.5G) or less Free of corrosive gases (Note 5)

NOTE

1 During short distance motions, the axis speed may not reach the maximum value stated.
2 Prevent the total of the load at wrist and on J3 arm from exceeding 700kg.
In case of M-410*i*B, avoid keeping J3 arm horizontally with max payload for a long time to prevent occurrence of the overheat alarm.
3 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
4 When robot is used in low temperature environment that is near to 0ºC,or robot is not operated for a long time in the environment that is less than 0ºC in a holiday or the night, because viscous resistance of the drive train is so big that may cause occurrence of collision detect alarm (SRVO –050) etc. In this case, we recommend performing the warm up operation for several minutes.
5 Contact the service representative, if the robot is to be used in an environment or a place subjected to hot/cold temperatures, severe vibrations, heavy dust, cutting oil splash and or other foreign substances.

3.2 MECHANICAL UNIT EXTERNAL DIMENSIONS AND OPERATING SPACE

Fig. 3.2 shows the robot operating space. When installing peripheral devices, be careful not to interfere with the robot and its operating space.

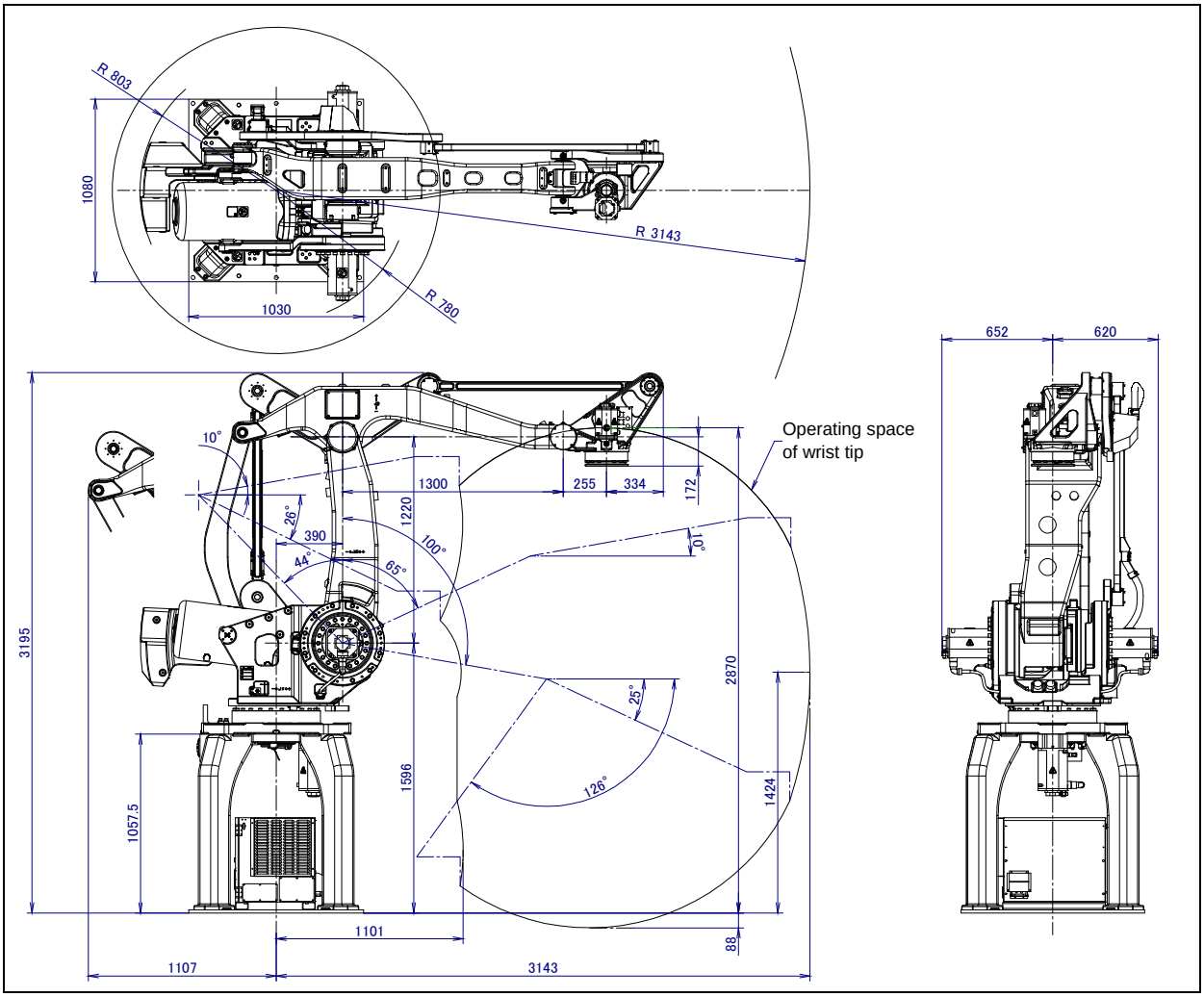


Fig. 3.2 Operating space

3.3 ZERO POINT POSITION AND MOTION LIMIT

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

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

Fig.3.3(a) shows the position of mechanical stopper.

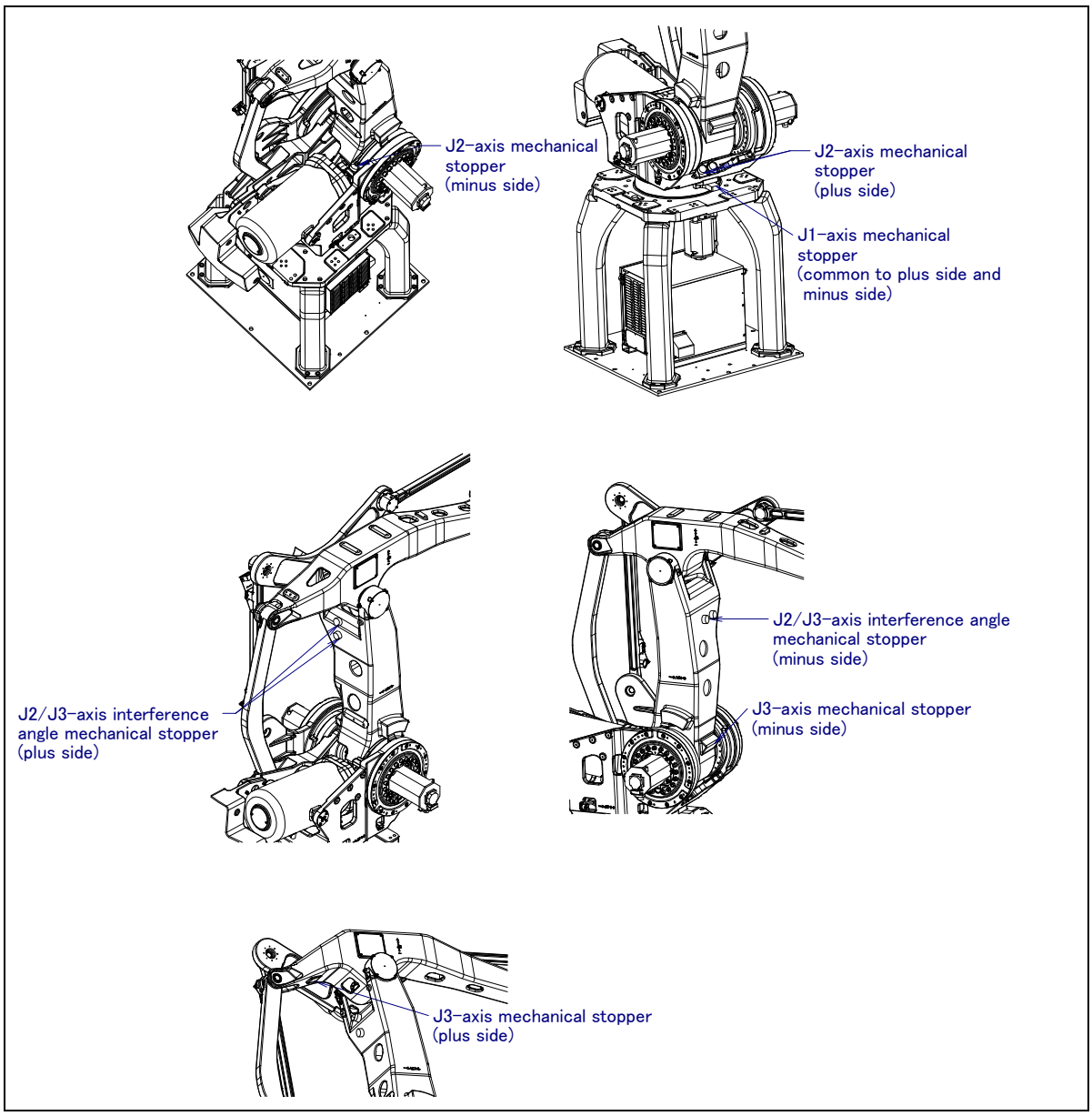


Fig. 3.3 (a) position of mechanical stopper

Fig.3.3 (b) to (g) show the zero point, motion limit (stroke end), limit switch detection position, and maximum stopping distance (stopping distance in condition of max.speed and max.load) of each axis.

Only in case of J1-axis, robot stops by transforming mechanical stopper. There is no mechanical stopper for J4-axis. Only in case of J1 axis, robot stops by transforming mechanical stopper. Be sure to exchange transformed stopper to new one. Tight the bolts according to Appendix B. Replace mechanical stopper of J1-axis referring to Fig.3.3 (a). 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".

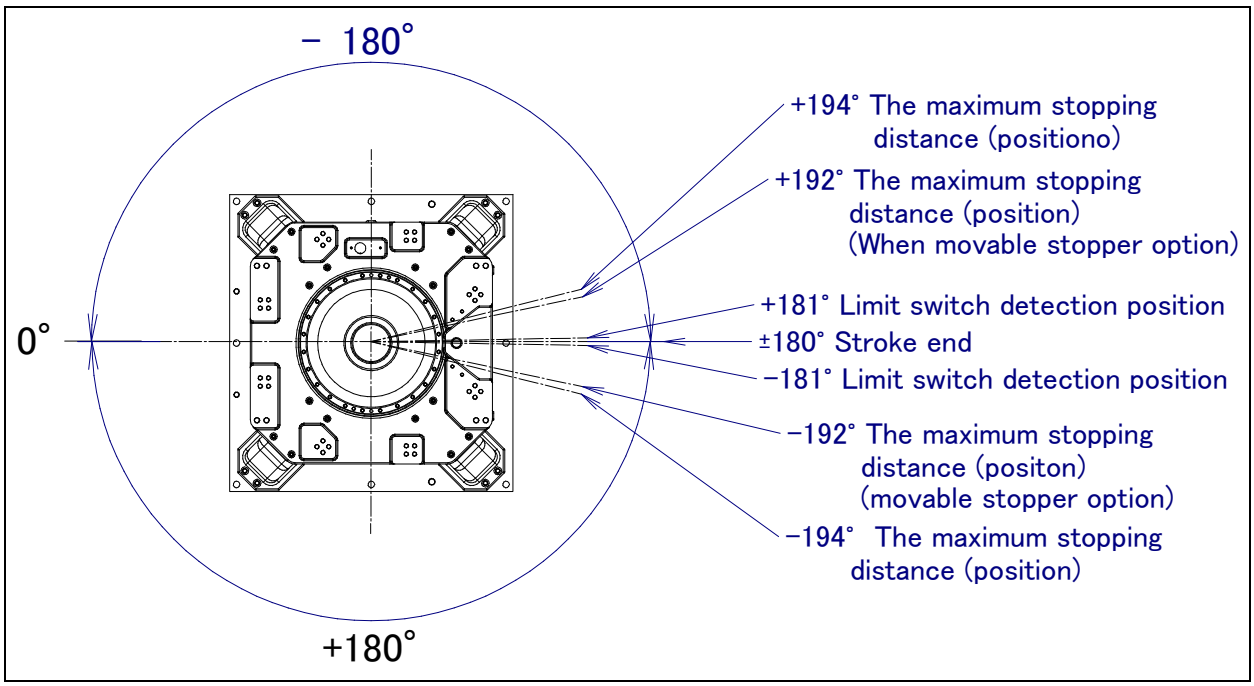


Fig. 3.3 (b) J1-axis motion limit

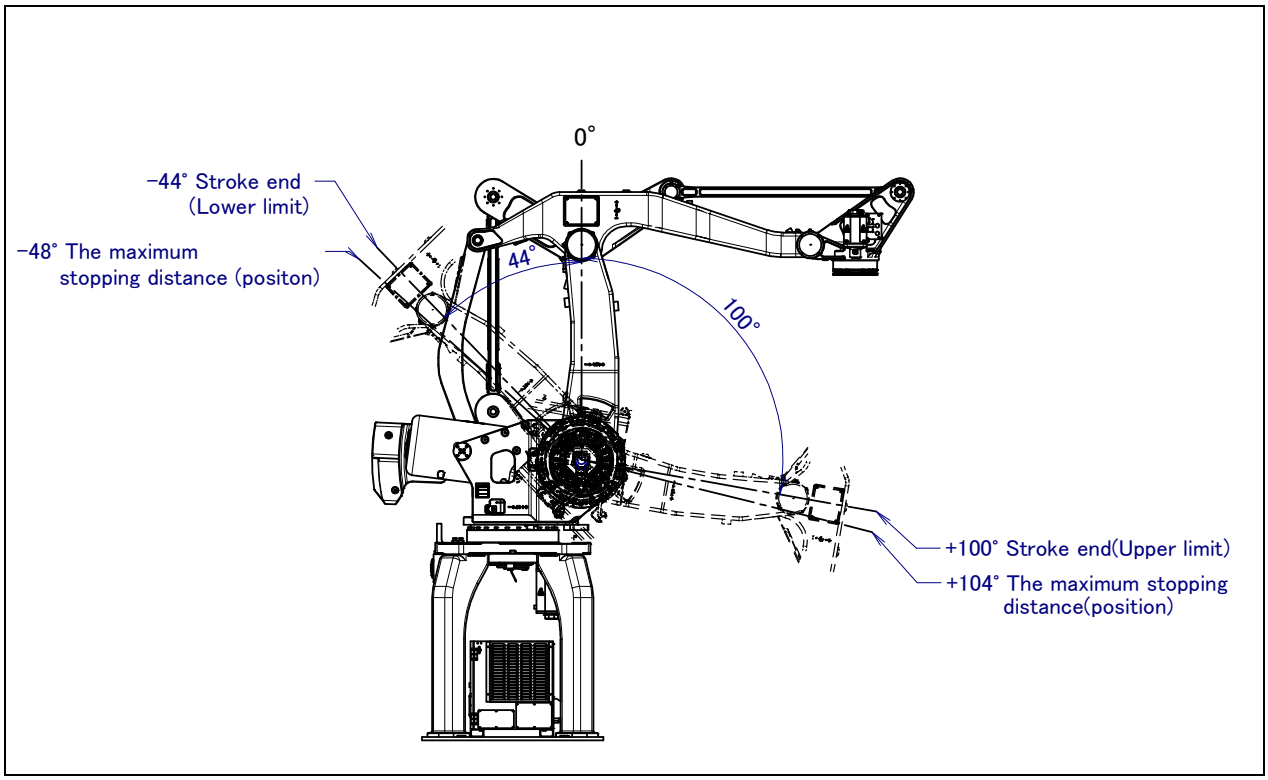


Fig. 3.3 (c) J2-axis motion limit

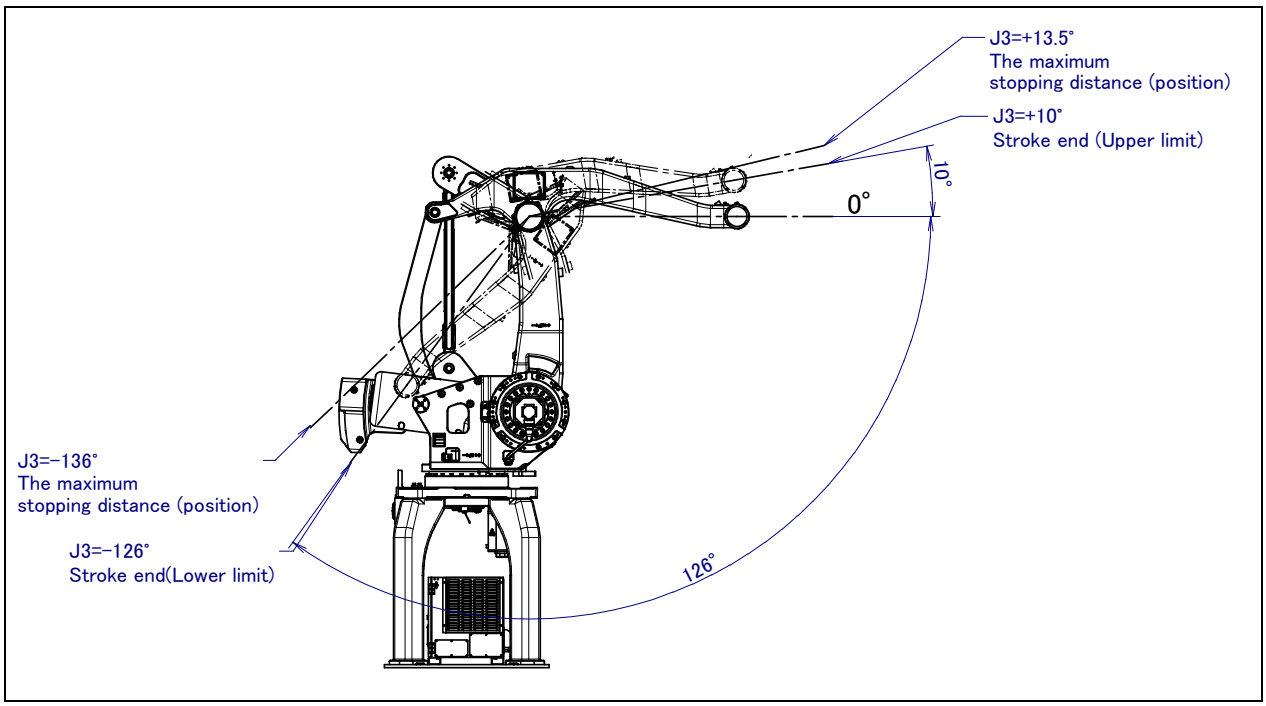


Fig. 3.3 (d) J3-axis motion limit

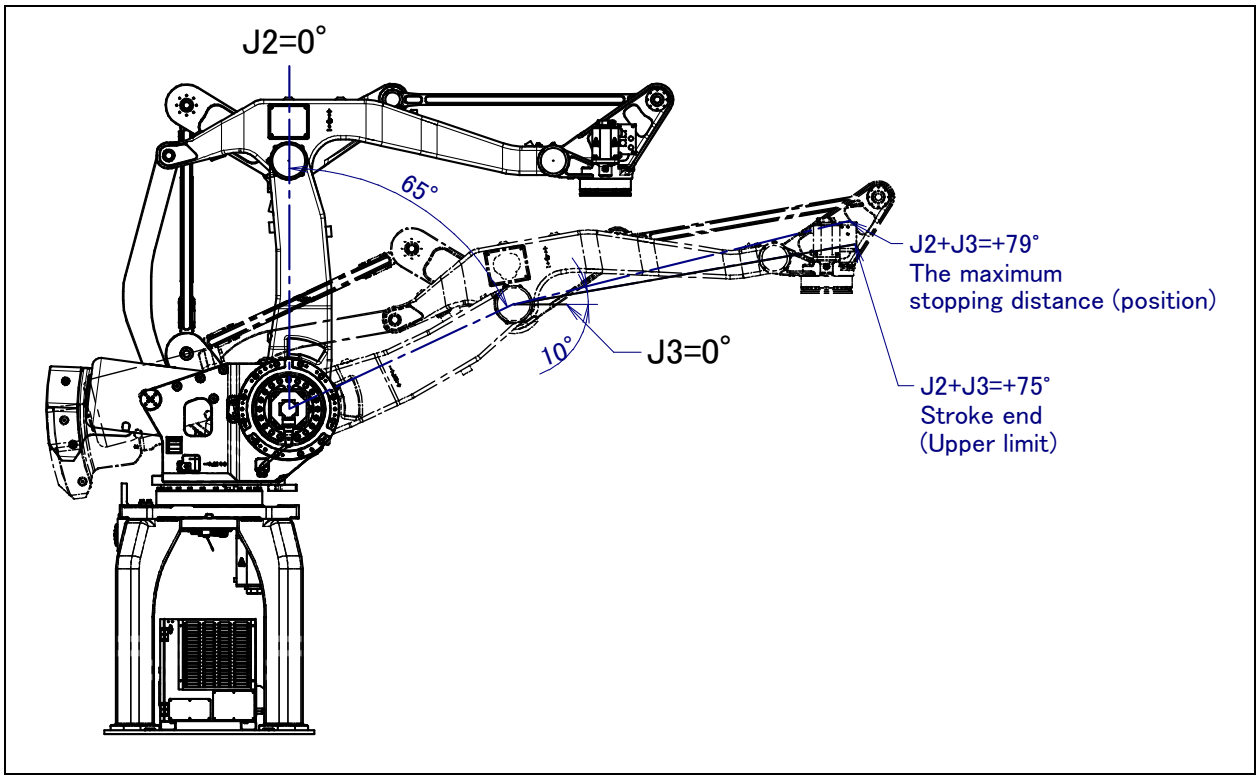


Fig. 3.3 (e) J2/J3-axis interference angle (plus side)

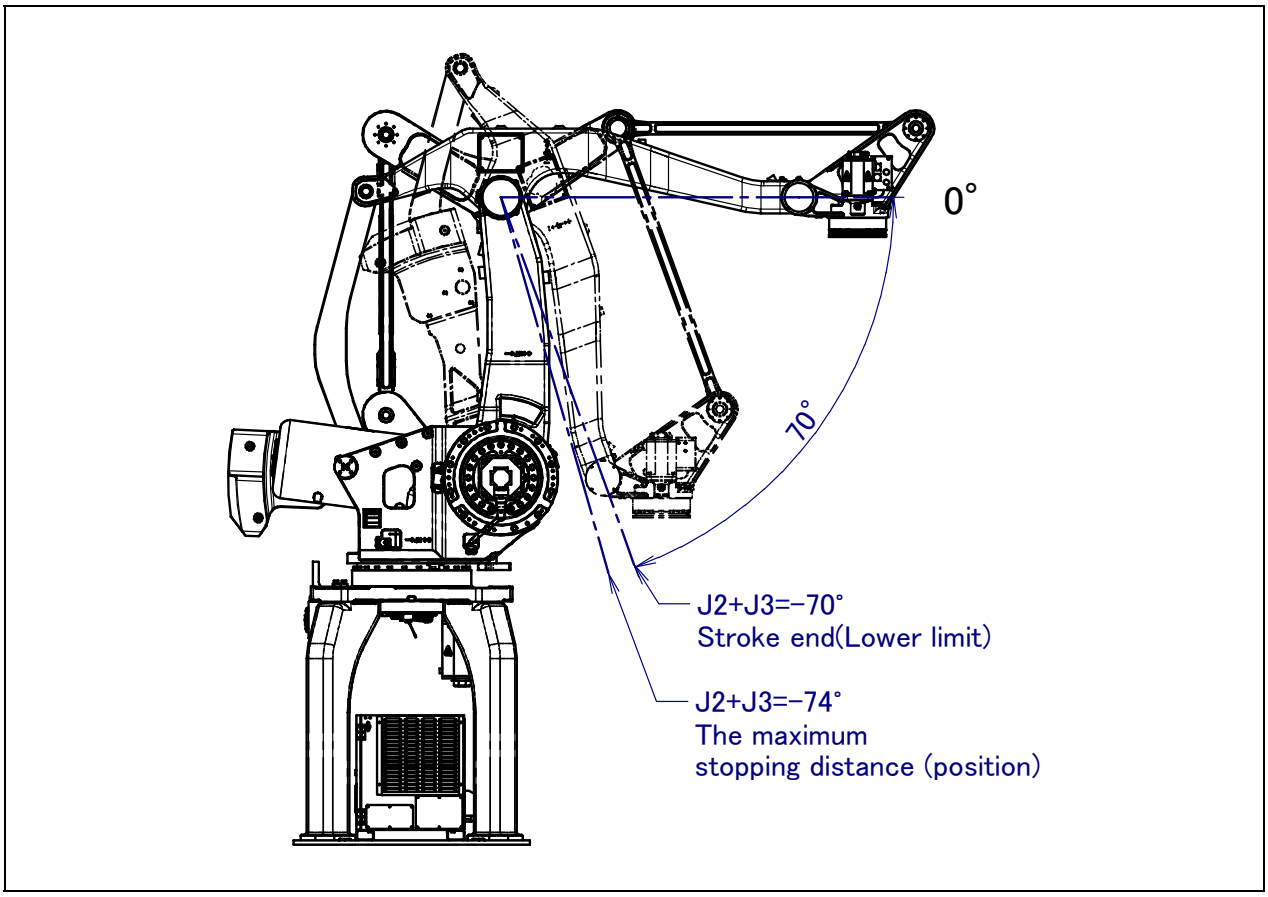


Fig. 3.3 (f) J2/J3-axis interference angle (minus side)

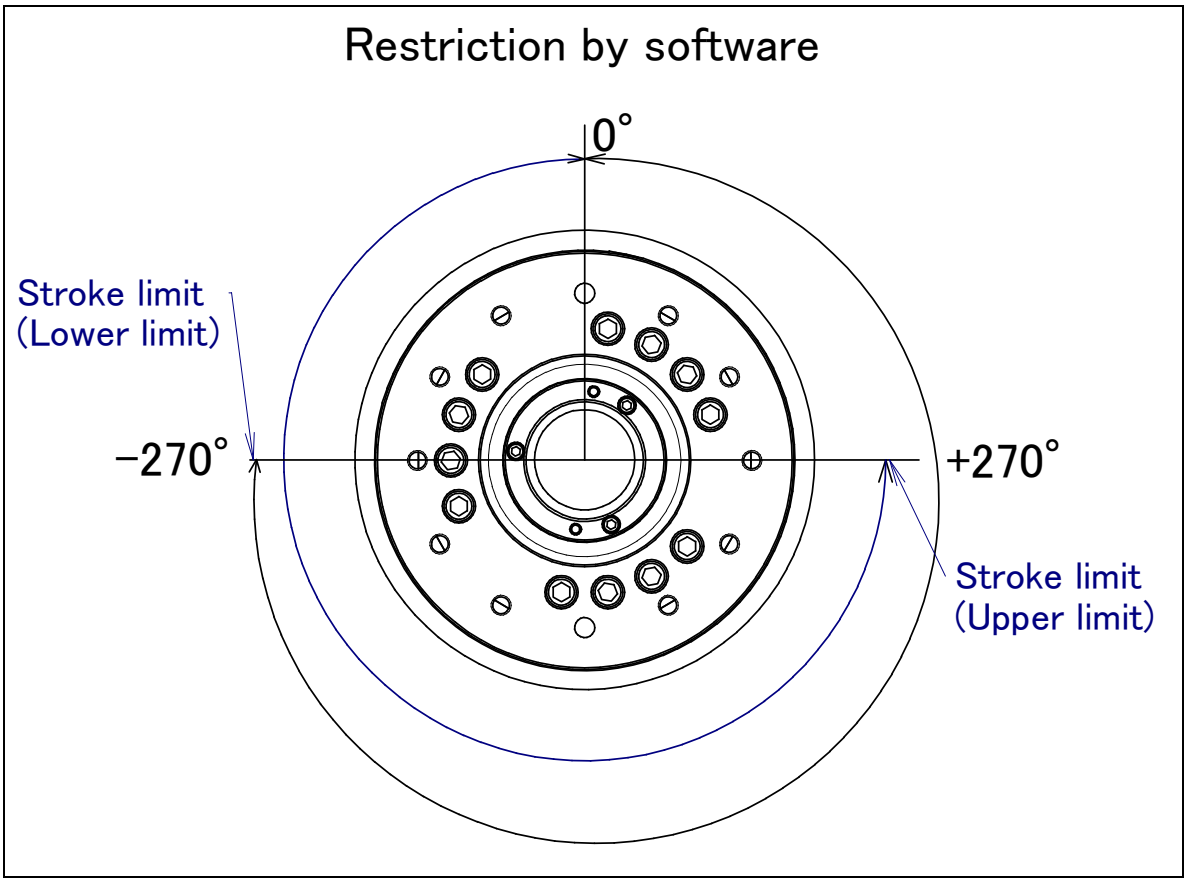


Fig. 3.3 (g) J4-axis motion limit

3.4 WRIST LOAD CONDITIONS

Fig. 3.4 (a) shows the relationships between the horizontal offset of the center of gravity of the wrist load and the permissible load inertia. See the 3.1 about allowable load moment and inertia at wrist.

See Fig. 3.4 (b) for explanations about the vertical offset of the center of gravity of the wrist load.

Keep the wrist load within a range graphically shown in Fig. 3.4 (a).

See Fig. 3.4 (c) for explanations about how to calculate the load inertial.

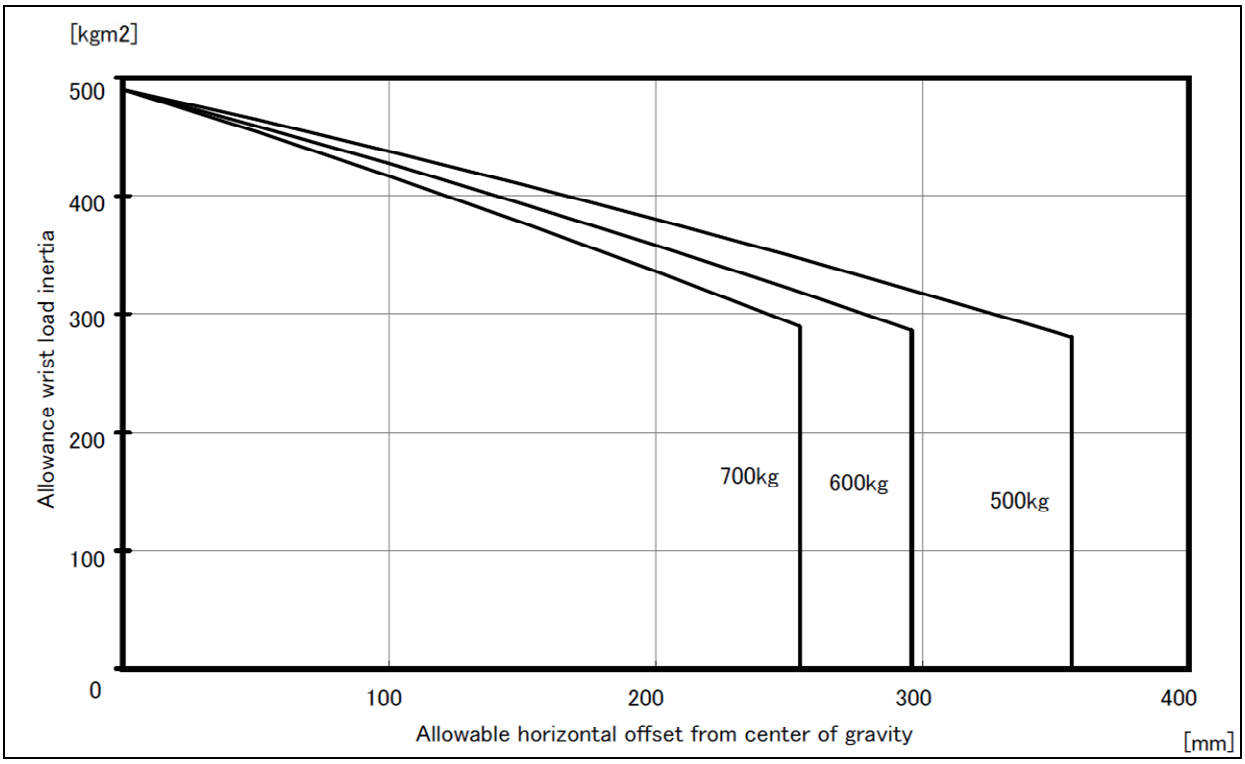


Fig. 3.4 (a) Diagram of the permissible load for the wrist section (horizontal offset)

NOTE
Allowable vertical offset is 1000mm from wrist flange.

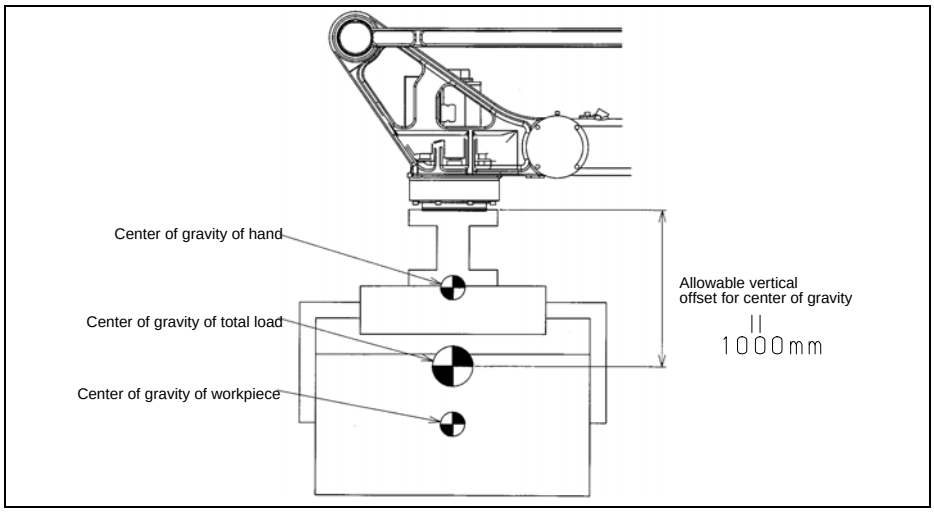


Fig. 3.4 (b) Allowable wrist load condition

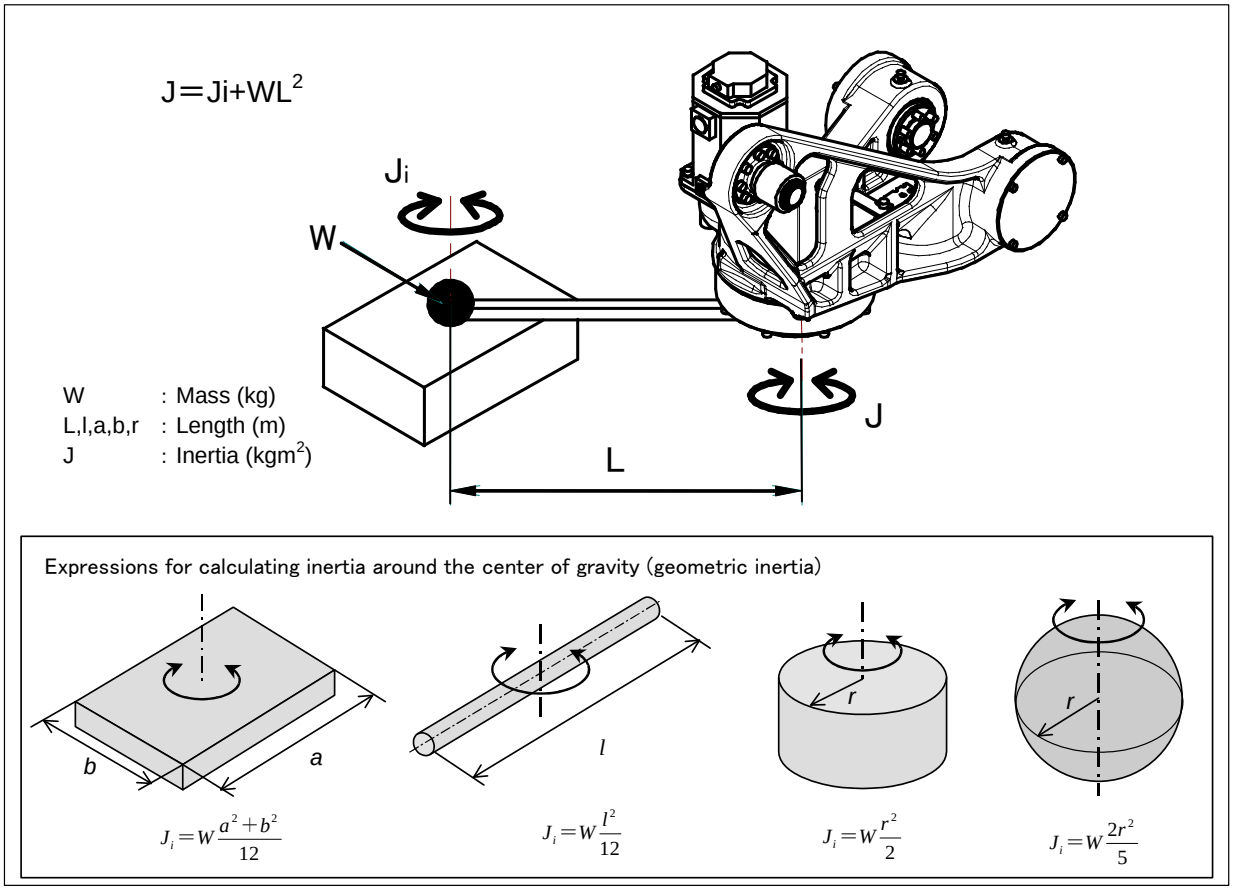


Fig. 3.4 (c) Calculating inertia

The total inertia around the wrist (J4) axis is the sum of the horizontal offset inertia of a workpiece and the geometric inertia around the center of the gravity of the workpiece. It ca be calculated as shown above.

NOTE
If a hand or workpiece has a complicated shape, divide it into simple shapes as shown above. Calculate the geometric inertia and offset inertia of each shape, then obtain their sum.

4 MECHANICAL COUPLING TO THE ROBOT

4.1 MECHANICAL COUPLING OF END EFFECTOR TO WRIST

Fig. 4.1 is the diagram for installing end effectors on the wrist. Select screws and positioning pins of a length that matches the depth of the tapped holes and pin holes. See Appendix B for tightening torque.

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

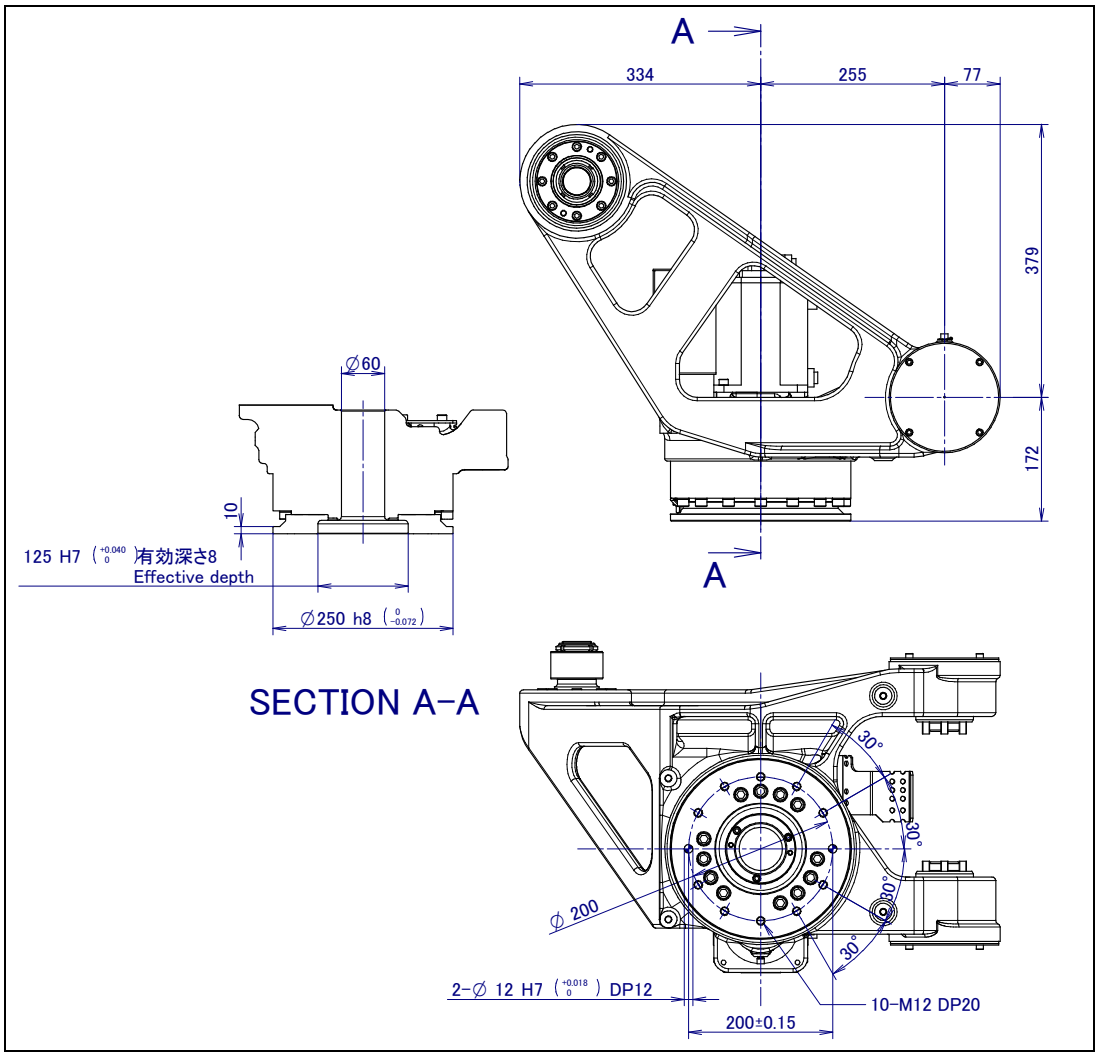


Fig. 4.1 End effector interface

4.2 EQUIPMENT MOUNTING FACE

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

⚠ CAUTION

1 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.
2 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.
3 Equipment should be installed so that mechanical unit cable does not interfere. If equipment interfere, the mechanical unit cable might be disconnected, and unexpected troubles might occur.

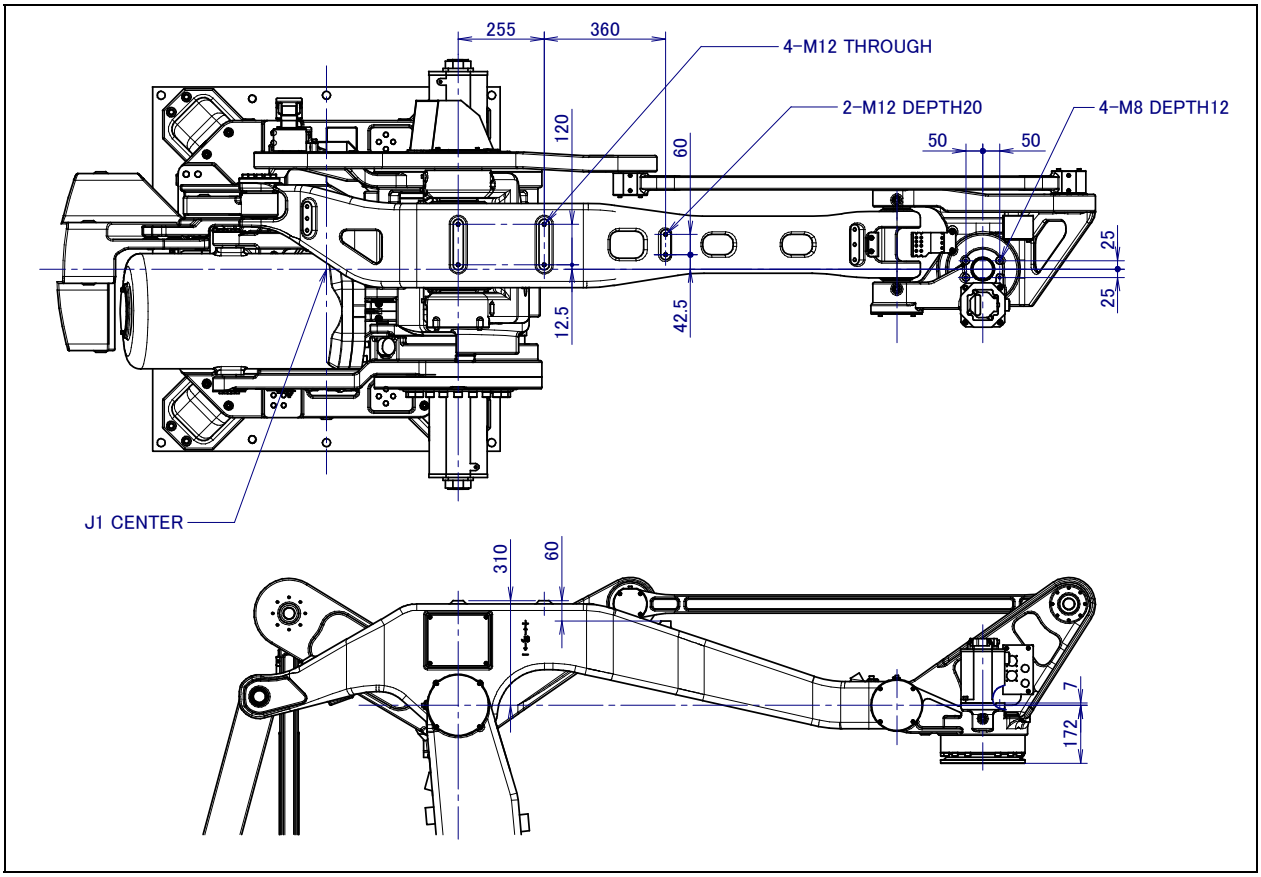


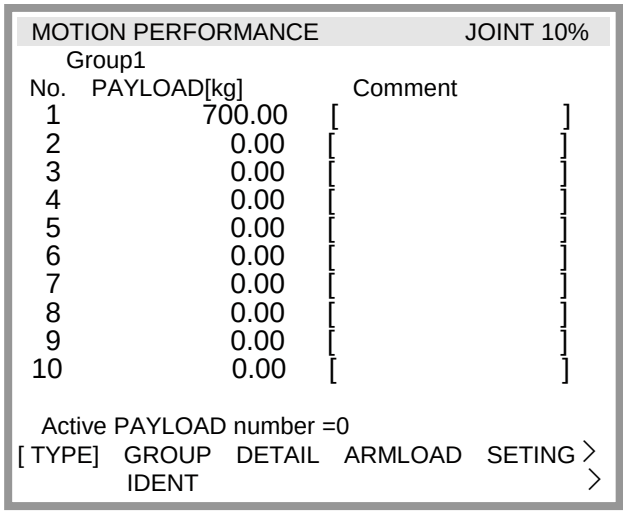
Fig. 4.2 Equipment mounting faces

4.3 LOAD SETTING

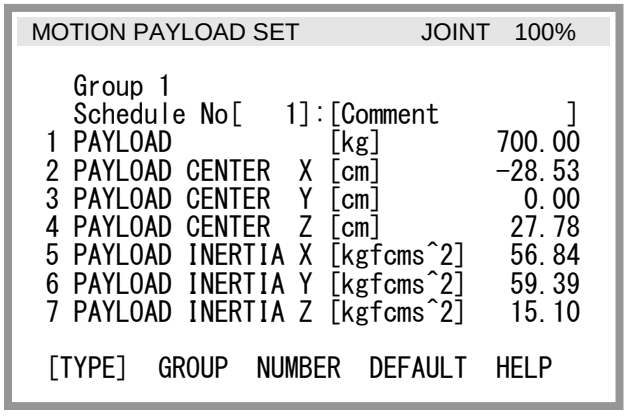
> ⚠ **CAUTION**
> Set load condition parameter before robot runs. Do not operate the robot in over payload. Don't exceed allowable payload including connection cables and its swing. Operation in over payload may occur troubles such as reducer life reduction.

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

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



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



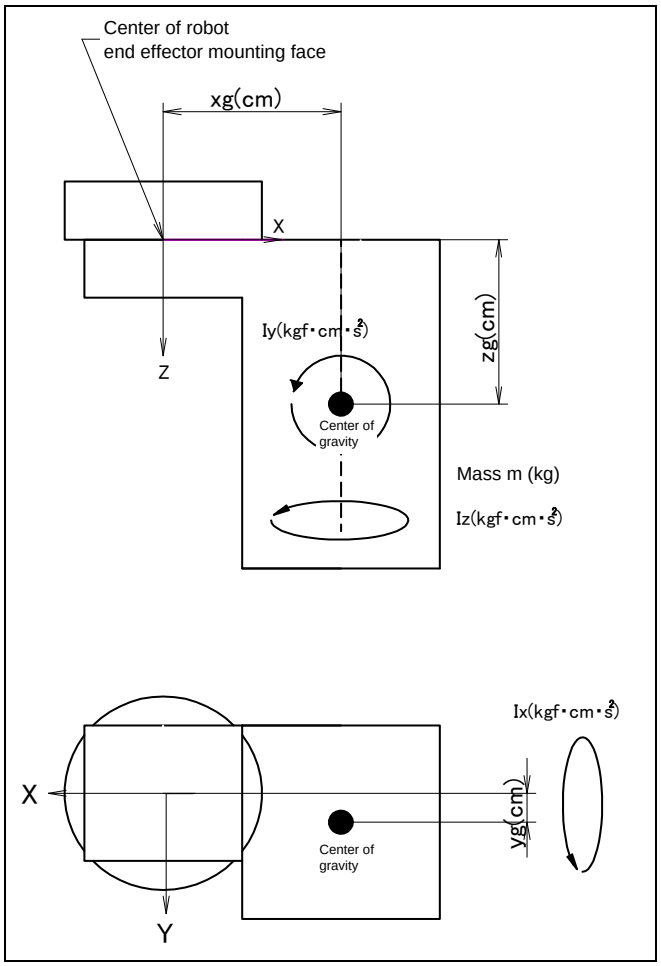


Fig. 4.3 Standard tool coordinate

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

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

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

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

```
MOTION ARMLOAD SET              JOINT   100%

  Group 1
1 ARM LOAD AXIS #1 [kg]             0.00
2 ARM LOAD AXIS #3 [kg]            30.00

[ TYPE ]    GROUP          DEFAULT   HELP
```

10 Specify the weight of the load on the J2 base and J3 arm/J3 casing as follows:
ARMLOAD AXIS #1[kg]: Weight of the load on the J2 base (The load can’t be put for M-410*i*B/700.)
ARMLOAD AXIS #3[kg]: Weight of the load on the J3 arm
The following message appears: “Path and Cycletime will change. Set it?” Select F4 ([YES]) or F5 ([NO]). Once the arm payload is set up, the settings are completed by switching the power off and on again.

5 PIPING AND WIRING TO THE END EFFECTOR

⚠ WARNING

- Only use appropriately-specified mechanical unit cables.
- Do not add user cables or hoses inside of the mechanical unit.
- Please do not obstruct the movement of the mechanical unit cable when cables are added to outside of mechanical unit.
- Please do not perform remodeling (adding a protective cover, or secure an additional outside cable) that obstructs the behavior of the outcrop of the cable.
- When external equipment is installed in the robot, make sure that it does not interfere with other parts of the robot.
- Cut and discard any unnecessary length of wire strand of the end effector (hand) cable. Insulate the cable with seal tape. (See Fig. 5)
- If you have end effector wiring and a process that develops static electricity, keep the end effector wiring as far away from the process as possible. If the end effector and process must remain close, be sure to insulate the cable.
- Be sure to seal the connectors of the user cable and terminal parts of all cables to prevent water from entering the mechanical unit. Also, attach the cover to the unused connector.
- Frequently check that connectors are tight and cable jackets are not damaged.
- When precautions are not followed, damage to cables might occur. Cable failure may result in incorrect function of end effector, robot faults, or damage to robot electrical hardware. In addition, electric shock could occur when touching the power cables.

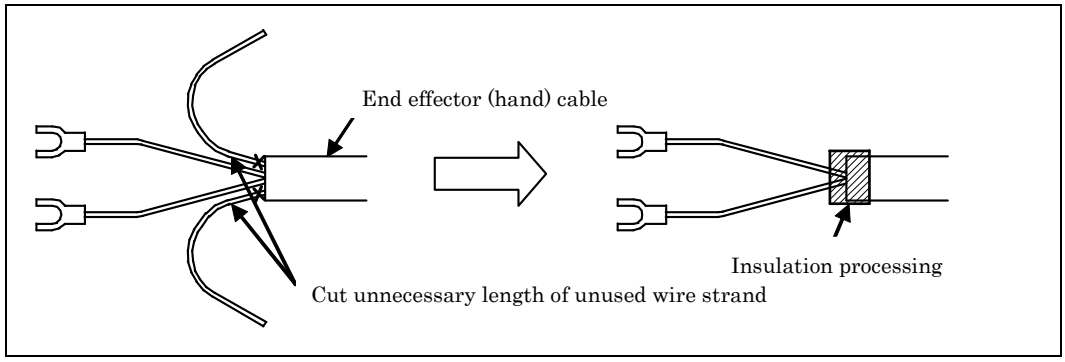


Fig. 5 Treatment method of end effector (hand) cable

5.1 AIR SUPPLY (OPTION)

Robot has two air-pressure supply openings on the robot base or back of the J1 base and the wrist axis unit used to supply air pressure to the end effector. The connector is an Rc3/8 female (ISO).
As couplings are not supplied, it will be necessary to prepare couplings which suit to the hose size.

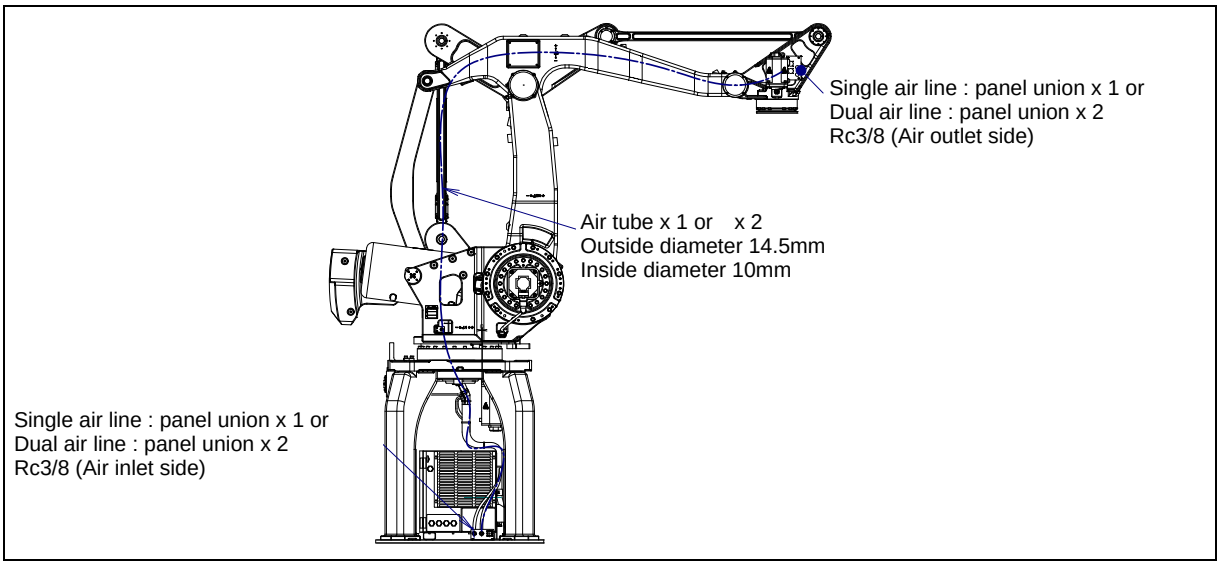


Fig. 5.1 (a) Air supply (integrated type controller)

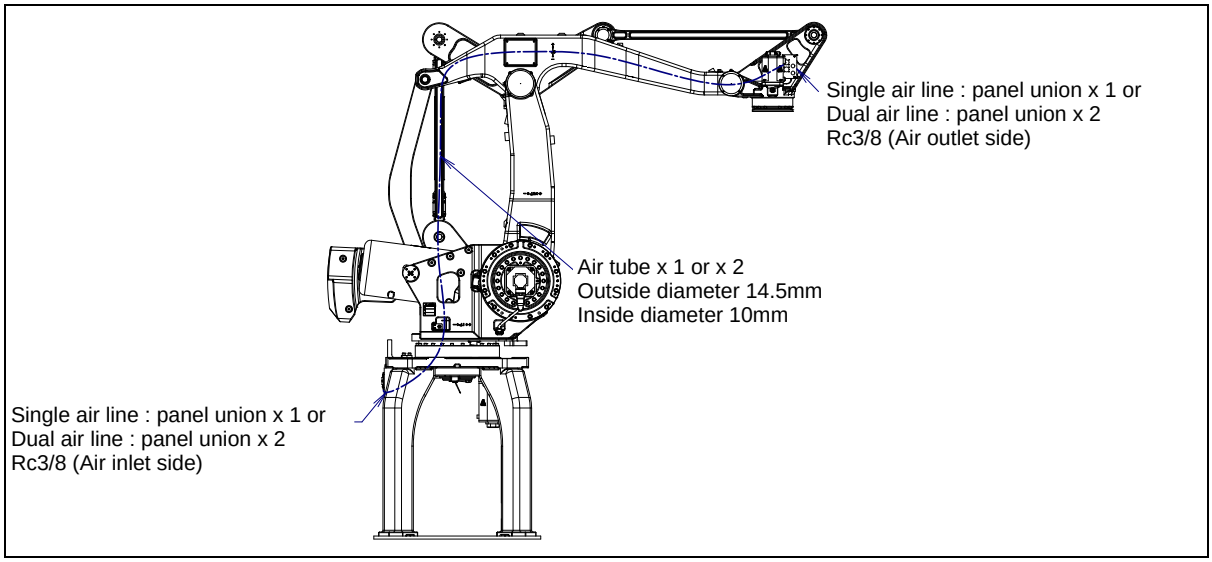


Fig. 5.1 (b) Air supply (remote type controller)

5.2 AIR PIPING (OPTION)

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

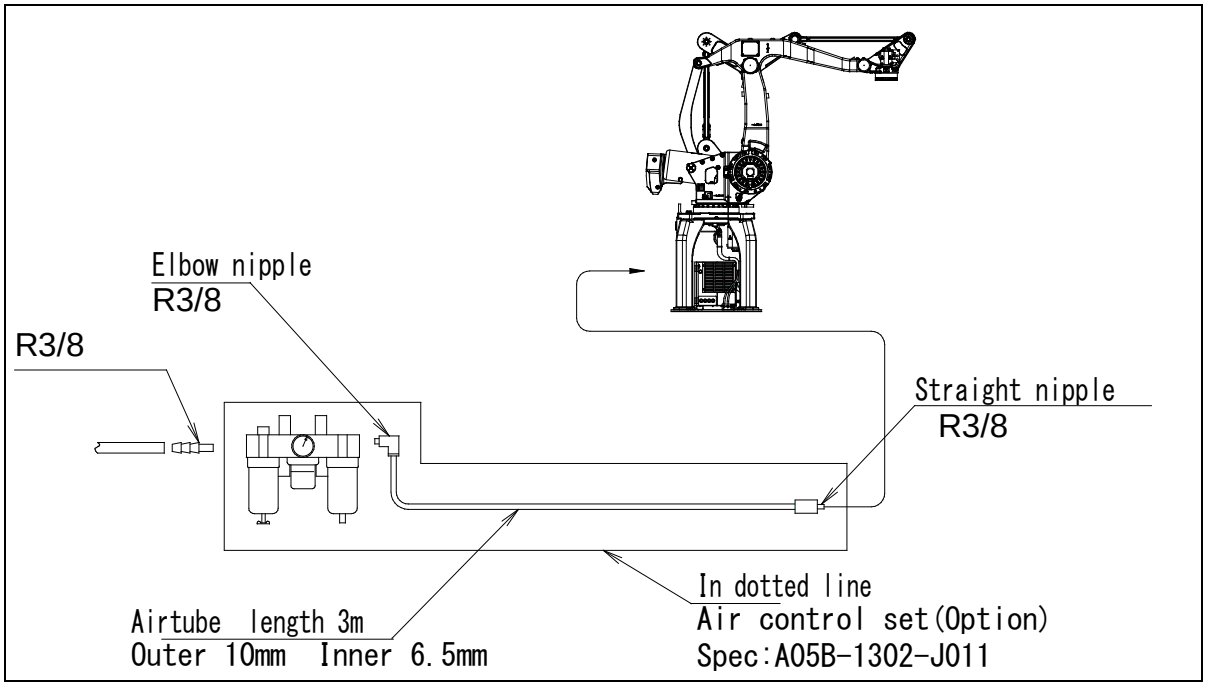


Fig. 5.2 (a) Air piping (option)

Air control set

For the lubricator of air control set, fill in turbine oil #90 to #140 to the specified level. The machine tool builder is required to prepare mounting bolts.

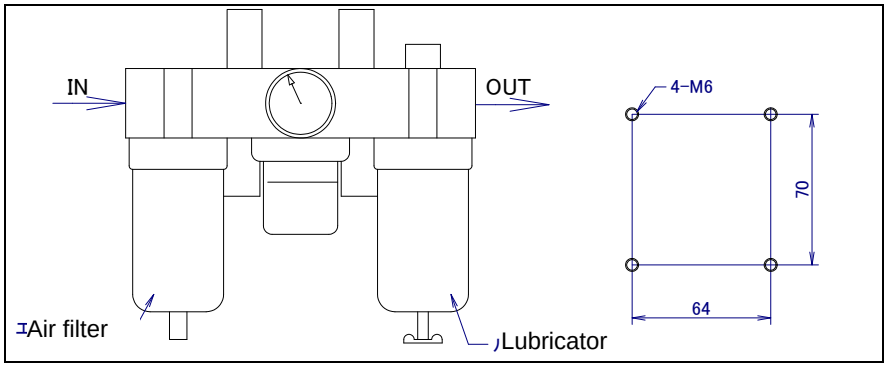


Fig. 5.2 (b) Air control set option (option)

NOTE
The capacity of the air control set is as follows.
These values must not be exceeded.

Air pressure	Supply air pressure	0.49 to 0.69MPa(5 to7kgf/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), (b) show the position of the option cable interface. Fig 5.3 (c) shows the option cable interface. EE interface (RI/RO), user cable (signal lines) and servo hand cable (M5P, M5M) as options.

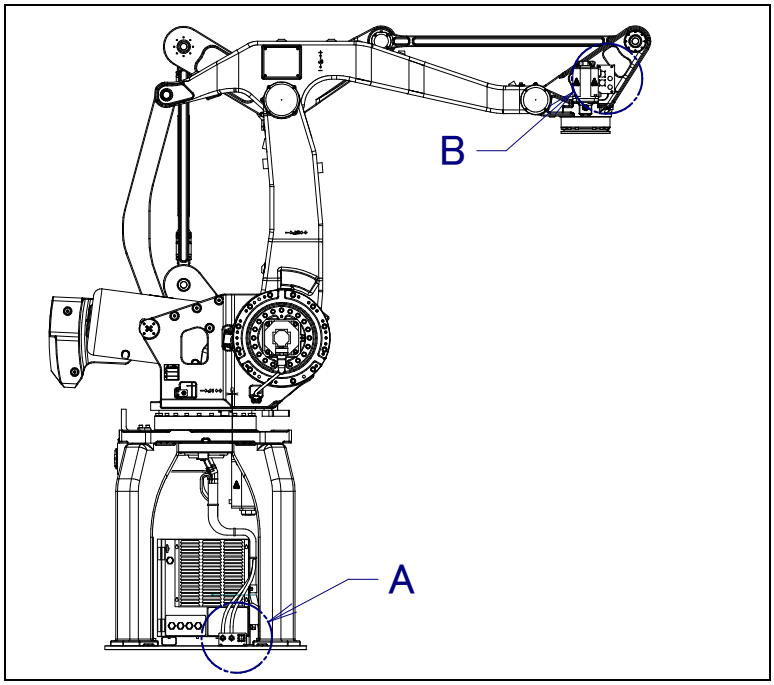


Fig. 5.3 (a) Interface for optional cable (OPTION for integrated type controller)

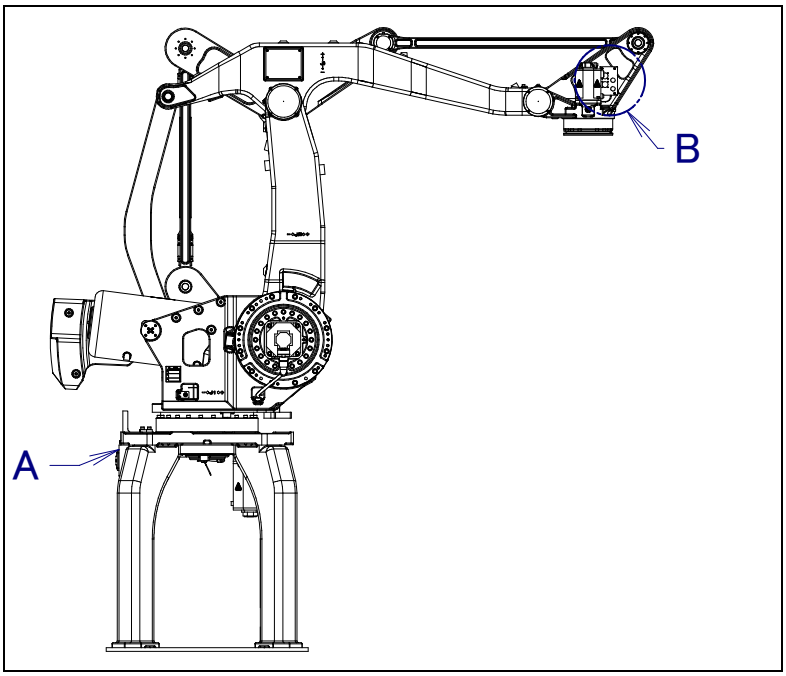


Fig. 5.3 (b) Interface for optional cable (OPTION for remote type controller)

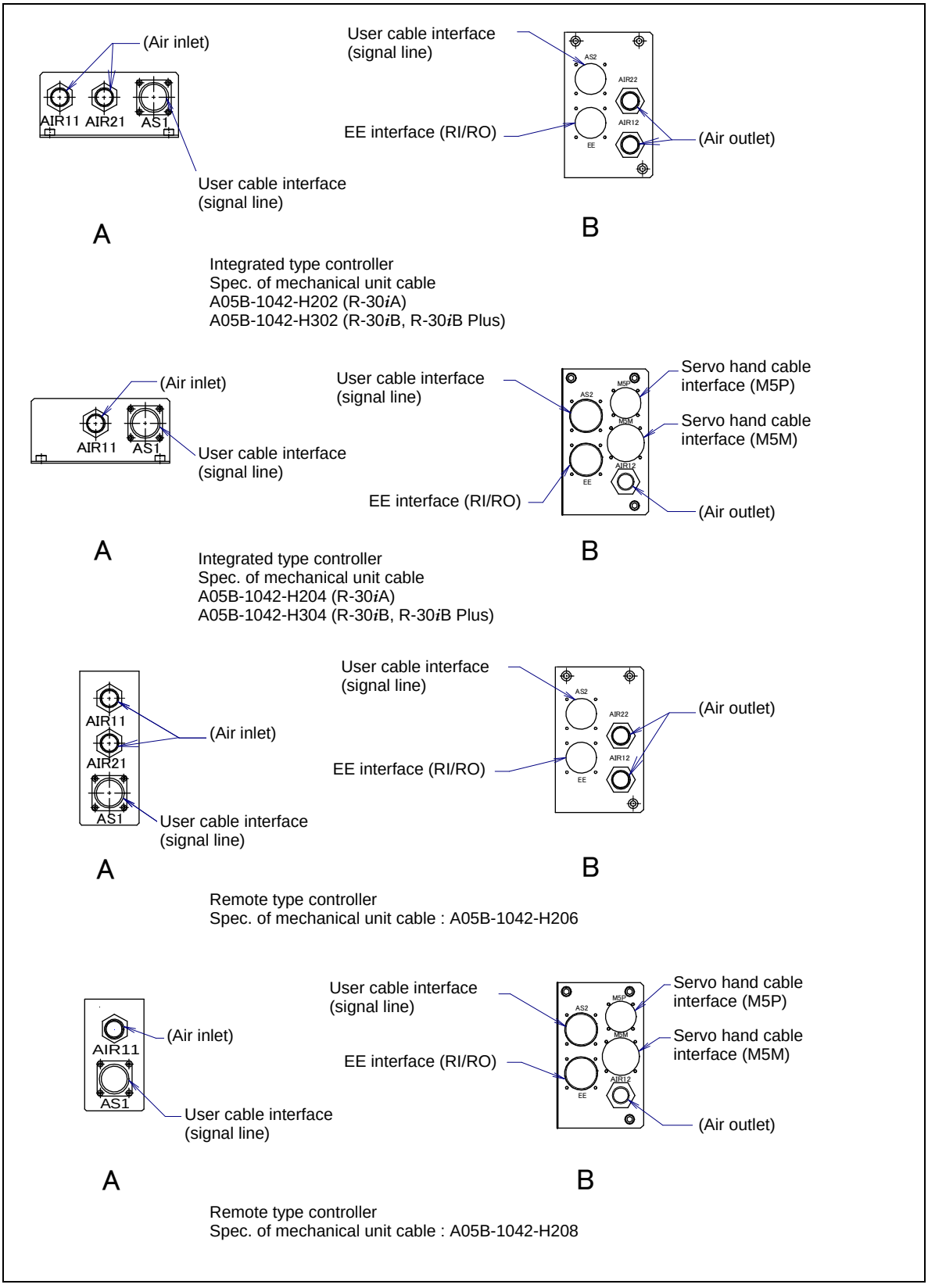


Fig. 5.3 (c) option cable interface

1 EE interface (RI/RO) (Option)
Fig. 5.3 (d) shows pin layout for EE interface (RI/RO).

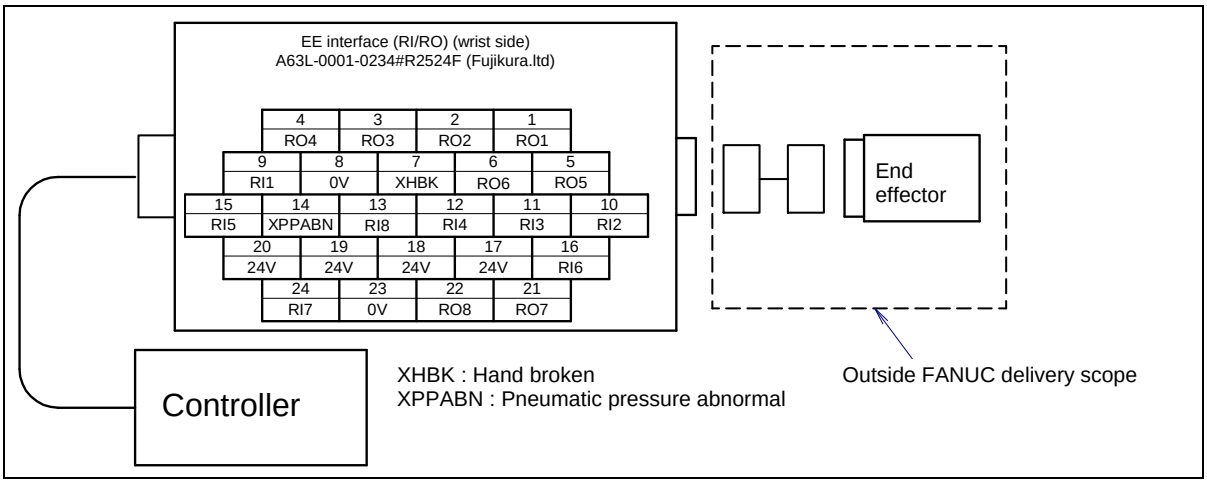


Fig. 5.3 (d) Pin layout for EE interface (RI/RO) (Option)

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

2 User cable (signal line) (AS) Interface (Option)
Fig. 5.3 (e) shows pin layout for user cable (signal line) interface.

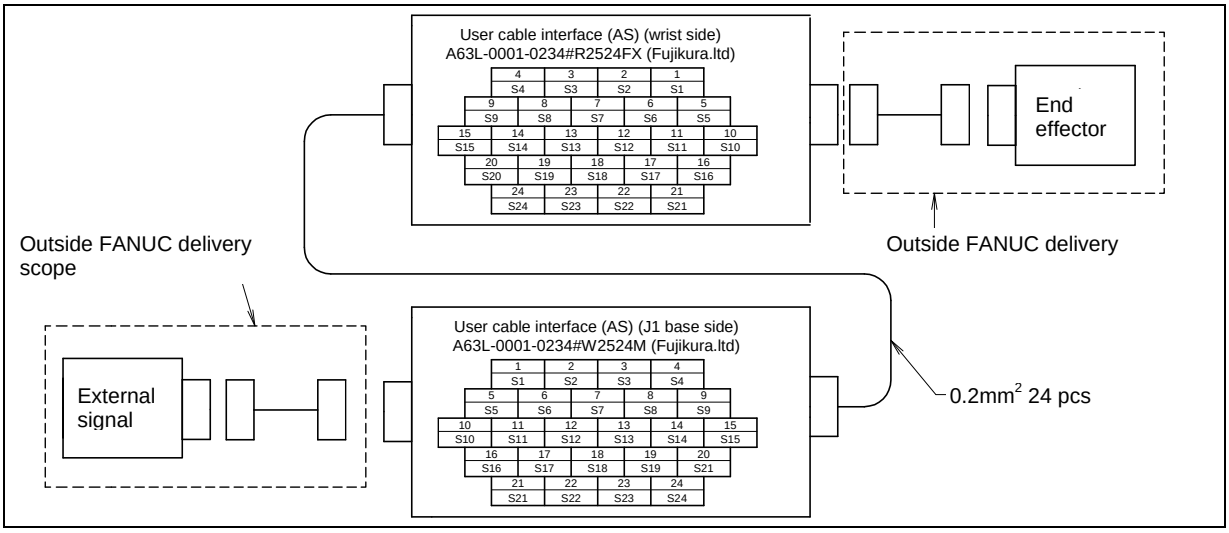


Fig. 5.3 (e) Pin layout for user cable (signal line) (AS) interface (option)

3 Servo hand cable Interface (Option)
Fig. 5.3 (f) shows pin layout for servo hand cable interface.

NOTE
A connector prepared by the customer for the servo cable interface (option) must be a straight type; (an elbow type cannot pass through the hole in the J4 axis.)

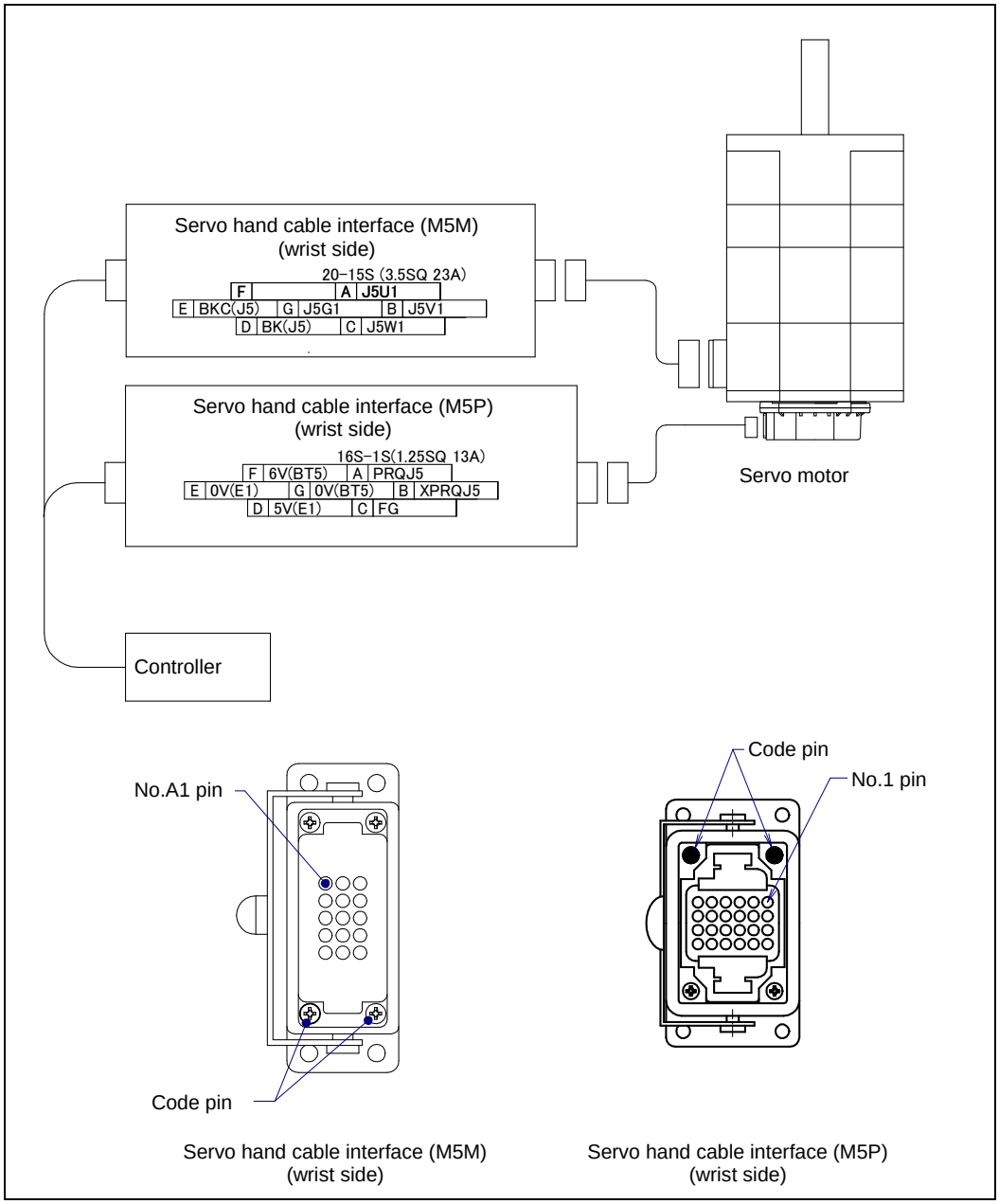


Fig. 5.3 (f) Pin layout for the servo hand cable interface

Table 5.3 (a) Comparative table of signal name according to the motor

ARP	α motor, β motor	α*i*, α*i* –B motor, β*i*, β*i*-B motor
SPD	SD	-
XSPD	*SD	-
PRQ	REQ	RD
XPRQ	*REQ	*RD

Connector specifications

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

Cable	Input side (J1 base)	Output side (wrist side)		Maker /dealer
EE(RI/RO)	———	FANUC spec.:A63L-0001-0234#R2524F		Fujikura Ltd.
AS	FANUC spec:A63L-0001-0234#W2524M	FANUC spec.:A63L-0001-0234#R2524FX		
M5P	———	Housing	09 30 006 0301 (1 pc /1 robot)	HARTING K.K.
		Insert	09 16 024 3101 (1 pc /1 robot)	
		Contact	09 15 000 6204 (8 pcs/1 robot)	
		Code pin	09 30 000 9901 (2 pcs/1 robot)	
M5M	———	Hosing	09 20 010 0301 (1 pc /1 robot)	
		Insert	09 21 015 3101 (1 pc /1 robot)	
		Contact	09 15 000 6201 (2 pcs/1 robot)	
		Contact	09 15 000 6206 (4 pcs/1 robot)	
		Contact	09 30 000 9901 (2 pcs/1 robot)	

Table 5.3 (c) Connector specifications (User side)

Cable	Input side (J1 base)	Output side (wrist side)	Maker /dealer
EE(RI/RO)	———	JMSP2524M (*1) Straight JMLP2524M Angle	Fujikura Ltd.
AS	JMSP2524F (*2) Straight plug	JMSP2524MX (*3) Straight plug	

NOTE

1 Underlined parts are attached. Below shows spec. to order in our company.
(*1)A63L-0001-0234#S2524M
(*2)A63L-0001-0234#S2524F
(*3)A63L-0001-0234#S2524MX

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

6 AXIS LIMIT SETUP

By setting the motion range of each axes, you can change the robot's motion range from the standard values. Changing the motion range of robot is effective under following circumstances:

- Used motion range of robot is limited.
- There's an area where tool and peripheral devices interfere with robot.
- The length of cables and hoses attached for application is limited.

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

- Axis limit software settings (All axes)
- Axis limit adjustable mechanical stopper ((J1-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 J1 axis, do not count merely on software-based limits to the movable range when changing the movable range of the robot. Use mechanical stoppers together so that damage to peripheral equipment and injuries to human bodies can be avoided. In this case, make the software-specified limits match the limits based on the mechanical stoppers.
3 Mechanical stoppers are physical obstacles. The robot cannot move beyond them. For the J1 axis, it is possible to re-position the mechanical stoppers. For J2, J3 axis, the mechanical stoppers are fixed. For the J4 axis only software-specified limits are available.
4 For changing J2 andJ3 axes interference angles, only mechanical stoppers are available; a software-specified motion range cannot be changed.
5 Adjustable mechanical stoppers (J1 axis) are deformed in a collision to stop the robot. Once a stopper is subject to a collision, it can no longer assure its original strength and, therefore, may not stop the robot. When this happens, replace it with a new one.

6.1 SOFTWARE SETTING

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

Setting procedure

1 Press the [MENU] key to display the screen menu.
2 Press [0 NEXT] and press [6 SYSTEM].
3 Press the F1 (]TYPE]).
4 Select [Axis Limits]. The following screen will be displayed.

```
                                   AUTO
SYSTEM Axis Limits                  JOINT 1%
                                   TORQUE= [ON]
AXIS  GROUP   LOWER   UPPER
1         1   -180.00  180.00   deg
2         1    -44.00  100.00   deg
3         1   -126.00   10.00   deg
4         1   -270.00  270.00   deg
5         1      0.00    0.00   deg
6         1      0.00    0.00   deg
7         1      0.00    0.00   deg
8         1      0.00    0.00   deg
9         1      0.00    0.00   deg
 [TYPE] LOAD RES_PCA          DONE
```

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

5 Move the cursor to the desired axis range and type the new value using the numeric keys on the teach pendant.

```
System Axis Limits
                                        2/16
 AXIS      GROUP   LOWER      UPPER
  2          1     -44.00     100.00    deg


 [ TYPE]
```

6 Perform the setting for all axes.
7 Cycle the power of the controller in the cold start mode so the new settings are enabled.

⚠ WARNING
You must cycle the power of the controller to enable the new setting. If you fail to do so, the robot does not work normally and it may injure personnel or damage the equipment.

6.2 J1-AXIS STROKE MODIFICATION (OPTION)

The J1-axis stroke can be limited depending on the operating environment of the robot. The stroke can be changed by changing the locations of the dog and mechanical stopper and the settings of the parameters using the following procedure. (See Fig. 6.2 (a) to (b) and Table 6.2)
The stroke can be changed every 45 degrees in the upper limit of +45 degrees to + 180 degrees and the lower limit of -180 degrees to -45 degrees.

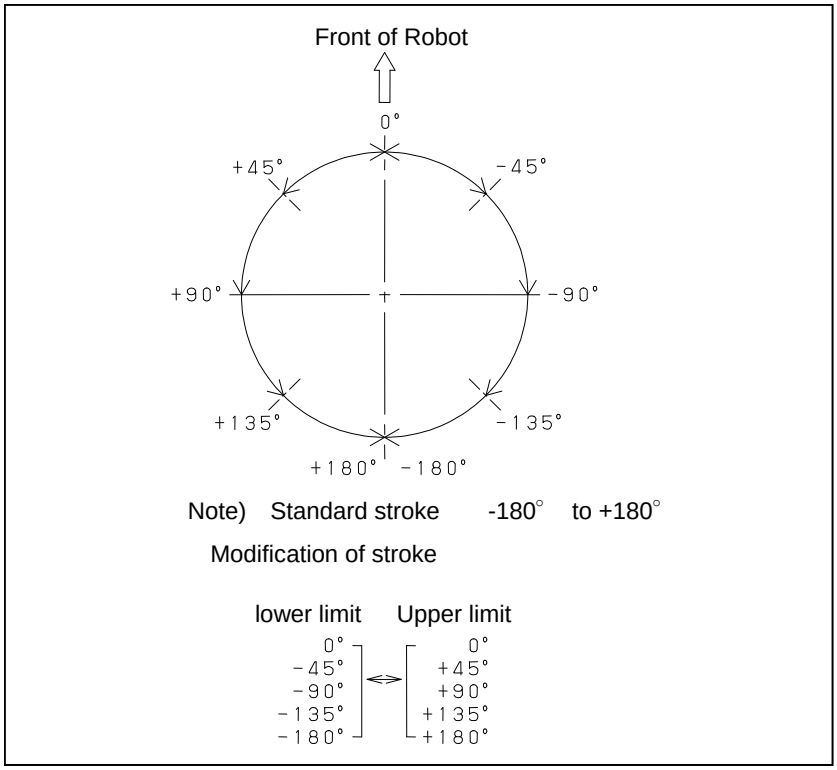
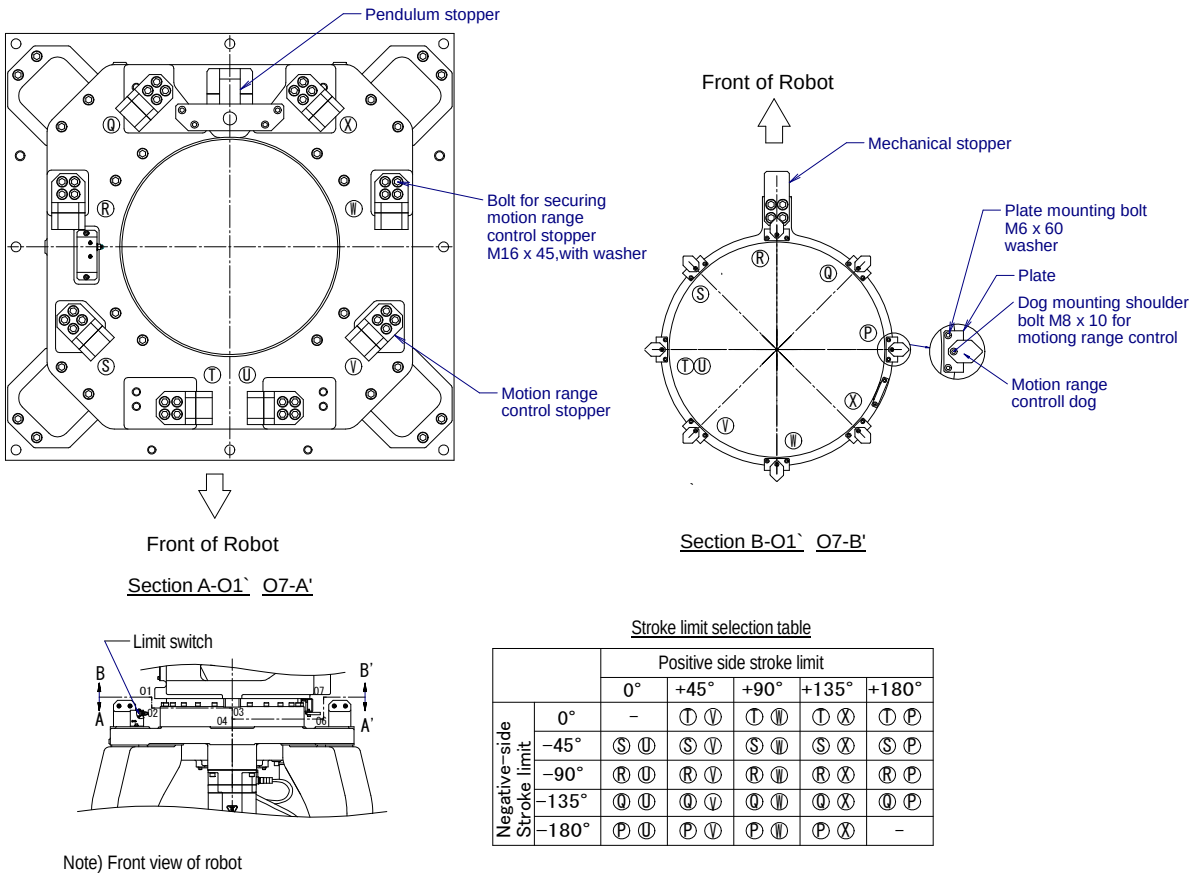


Fig. 6.2 (a) Modifying J1-axis stroke (option)

(a) Changing the mechanical stopper and the dog (option) position.
Change the mechanical position and the dog position as shown in Fig. 6.2 (b).



Stroke limit selection table

		Positive side stroke limit				
		0°	+45°	+90°	+135°	+180°
Negative-side Stroke limit	0°	–	ⓉⓋ	ⓉⓌ	ⓉⓍ	ⓉⓅ
	−45°	ⓈⓊ	ⓈⓋ	ⓈⓌ	ⓈⓍ	ⓈⓅ
	−90°	ⓇⓊ	ⓇⓋ	ⓇⓌ	ⓇⓍ	ⓇⓅ
	−135°	ⓆⓊ	ⓆⓋ	ⓆⓌ	ⓆⓍ	ⓆⓅ
	−180°	ⓅⓊ	ⓅⓋ	ⓅⓌ	ⓅⓍ	–

Fig. 6.2 (b) Modification of J1-axis stroke (option)

(b) Changing system variables
When changing the dog and mechanical stopper, also be sure to change the following system variables according to the required strokes.
After changing system variables, turn the power off then back on again. (The stroke setting described above can be made also by selecting "SYSTEM" using the "MENUS" key, then selecting "Axis limit" menu using F1 (TYPE). Refer to the Controller Operator's Manual for details.

⚠ WARNING
After changing system variables, be sure to run the robot at a low speed and make sure that the robot stops at the ends of the stroke.

Table 6.2 Modification of system variable

Positions	System variable	
	Lower stroke limit $PARAM_GROUP$LOWERLIMS[1]	Upper stroke limit $PARAM_GROUP.$UPPERLIMS[1]
-180°	-180	-
-135°	-135	-
-90°	-90	-
-45°	-45	-
0°	0	0
+45°	-	45
+90°	-	90
+135°	-	135
+180°	-	180

⚠ WARNING
1 If a collision should occur, the J1 axis stopper becomes deformed to absorb energy, so that the robot can stop safely. If the stopper is deformed by mistake, replace it.
2 Do not add threaded holes to the frame, or do not use a self-made stopper to control the J1 stroke at any angle other than the one specified; otherwise, robot operation may be dangerous.

6.3 ADJUSTING LIMIT SWITCHES OF J1-AXIS (OPTION)

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

1 Set the $MOR_GRP.$CAL_DONE system parameter to FALSE. This disables the stroke end specified by the software. As a result, the operator can rotate the robot around the J1-axis by a jog feed which goes beyond the stroke end.
2 Loosen the two M6 x 10 bolts and two M4 x 25 bolts that secure the J1-axis limit switch.
3 Adjust the switch position so that the robot activates the limit switch when approximately 1.0 degree from each stroke end. When the dog is pressed, only one side of the pushing width indication lines on the end of the switch must be 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, release the J1 axis from the limit by JOG feed.
5 Check that the robot also activates the limit switch when the robot is approx. 1.0 degree 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.

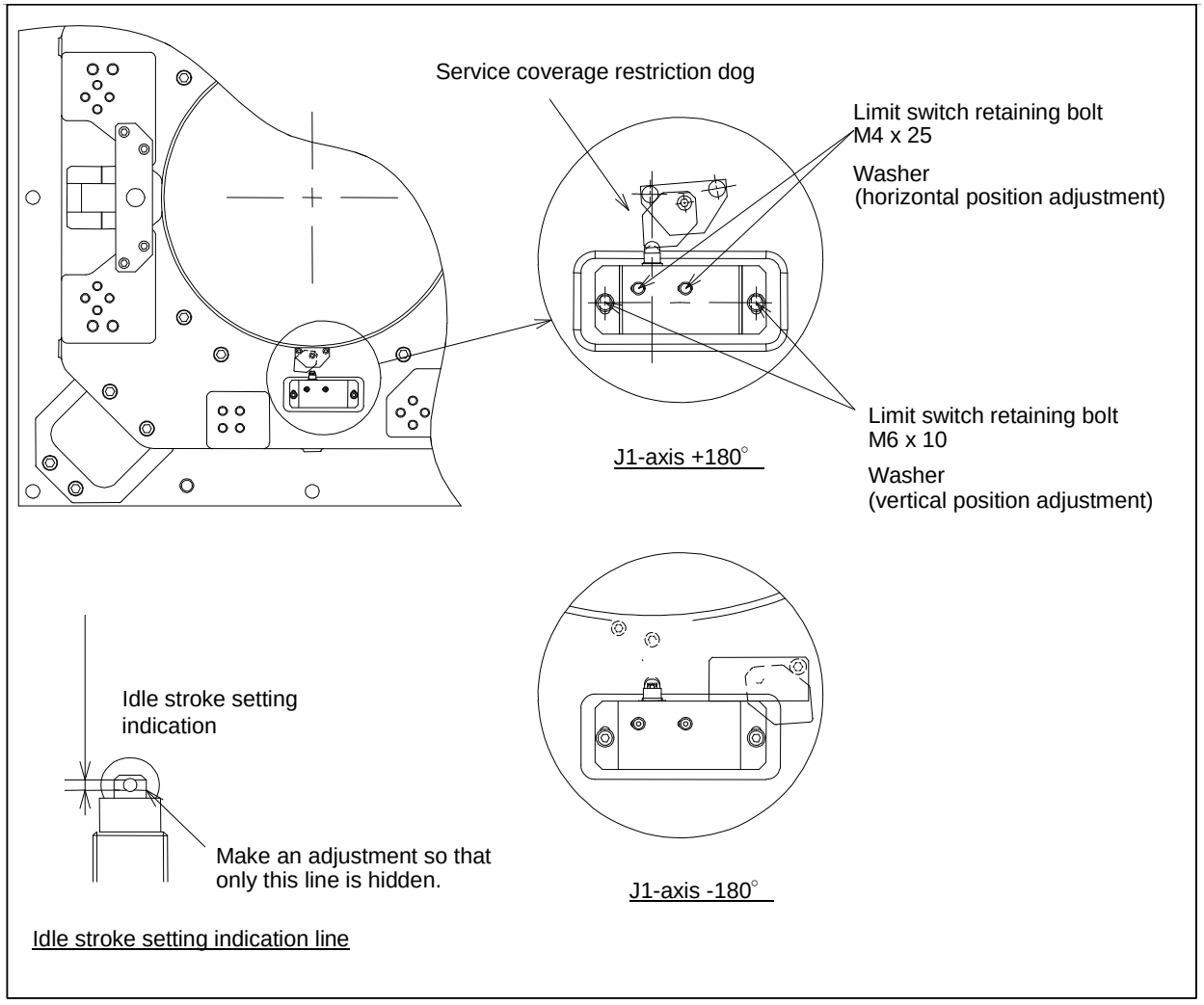


Fig. 6.3 Adjusting J1-axis OT (option)

7 CHECKS AND MAINTENANCE

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

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

7.1 CHECKS AND MAINTENANCE

7.1.1 Daily Checks

Check the following items when necessary before daily system operation.

Check items	Check points and management
Oil seepage	Check whether there is oil on the sealed part of each joint. If there is oil seepage, clean them. **⇒"7.2.1 Confirmation of Oil Seepage"**
Air control set	(When air control set is used) **⇒"7.2.2 Confirmation of the Air Control Set"**
Vibration, abnormal noises	Check whether vibration or abnormal noises occur. When vibration or abnormal noises occur, perform measures referring to the following section: **⇒"9.1 TROUBLESHOOTING"(symptom: Vibration, Noise)**
Positioning accuracy	Check whether the taught positions of the robot have not deviated from the previous taught positions. When displacement occurs, perform the measures as described in the following section: **⇒"9.1 TROUBLESHOOTING"(Symptom: Displacement)**
Peripheral equipment for proper operation	Check whether the peripheral equipment operate properly according to commands from the robot and the peripheral equipment.
Brakes for each axis	Check that the end effector drops 0.2 mm or less when the servo power is turned off. If the end effector (hand) drops more than the prescribed amount, perform the measures as described in the following section: **⇒"9.1 TROUBLESHOOTING"(symptom: Dropping axis)**
Warnings	Check whether unexpected warnings occur in the alarm screen on the teach pendant. If unexpected warnings occur, perform the measures as described in the following manual: **⇒"R-30*i*B/R-30*i*B Mate/R-30*i*B Plus /R-30*i*B Mate Plus CONTROLLER OPERATOR'S MANUAL (Alarm Code List)(B-83284EN-1) or R-30*i*A/R-30*i*A Mate CONTROLLER OPERATOR'S MANUAL (Alarm Code List)(B-83124EN-6)"**

7.1.2 Periodic Checks and Maintenance

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

Check and maintenance intervals (Period, Accumulated operating time)						Check and maintenance items	Check points, management and maintenance methods	Periodic maintenance table No.
1 month 320h	3 months 960h	1 year 3840h	1.5 years 5760h	3 years 11520h	4 years 15360h			
○ Only 1st check	○					Cleaning the controller ventilation system	Confirm the controller ventilation system is not dusty. If dust has accumulated, remove it.	22
	○					Check the external damage or peeling paint	Check whether the robot has external damage or peeling paint due to the interference with the peripheral devices. If an interference occurs, eliminate the cause. Also, if the external damage is serious, and causes a problem in which the robot will not operate, replace the damaged parts.	1
	○					Check for damage of the cable protective sleeve	Check the mechanical unit cable protective sleeves for holes or tears. If damage is found, replace the cable protective sleeve. If the cable protective sleeve is damaged due to the interference with peripheral devices, eliminate the cause, **⇒"7.2.3 Check the Mechanical Unit Cables and Connectors"**	2
	○					Check the wear debris of the J1-axis swing stopper	Check whether wear debris is generated on the J1-axis swing stopper rotation part. If serious wear occurs on the part that generated the wear debris, replace the part.	3
	○					Check for water	Check whether the robot is subjected to water or cutting oils. If liquid was found, remove the cause, and wipe off the liquid.	4
	○ Only 1st check	○				Check for damages to the teach pendant cable, the operation box connection cable or the robot connection cable	Check whether the cable connected to the teach pendant, operation box and robot are unevenly twisted or damaged. If damage is found, replace the damaged cables.	23
	○ Only 1st check	○				Check for damage to the mechanical unit cable (movable part)	Observe the movable part of the mechanical unit cable, and check for damage. Also, check whether the cables are excessively bent or unevenly twisted. **⇒"7.2.3 Check the Mechanical Unit Cables and Connectors"**	5
	○ Only 1st check	○				Check for damage to the end effector (hand) cable	Check whether the end effector cables are unevenly twisted or damaged. If damage is found, replace the damaged cables.	11

Check and maintenance intervals (Period, Accumulated operating time)						Check and maintenance items	Check points, management and maintenance methods	Periodic maintenance table No.
1 month 320h	3 months 960h	1 year 3840h	1.5 years 5760h	3 years 11520h	4 years 15360h			
	○ Only 1st check	○				Check the connection of each axis motor and other exposed connectors	Check the connection of each axis motor and other exposed connectors. **⇒"7.2.3 Check the Mechanical Unit Cables and Connectors"**	6
	○ Only 1st check	○				Retightening the end effector mounting bolts	Retighten the end effector mounting bolts. Refer to the following section for tightening torque information: **⇒"4.1 MECHANICAL COUPLING OF END EFFECTOR TO WRIST"**	7
	○ Only 1st check	○				Retightening the external main bolts	Retighten the bolts which are installed, removed in the inspection, and exposed. Refer to the recommended bolt tightening torque guidelines at the end of the manual. Some bolts are attached with adhesive. If the bolts are tightened with greater than the recommended torque, the adhesive might be removed. Therefore, follow the recommended bolt tightening torque guidelines when retightening the bolts.	8
	○ Only 1st check	○				Check the mechanical stopper and the adjustable mechanical stopper	Check that there is no evidence of a collision on the mechanical stopper, the adjustable mechanical stopper, and check the looseness of the stopper mounting bolts. Check that the J1-axis swing stopper rotates smoothly. **⇒"7.2.4 Check of Fixed Mechanical Stopper and Adjustable Mechanical Stopper"**	9
	○ Only 1st check	○				Clean spatters, sawdust and dust	Check that spatters, sawdust, or dust does not exist on the robot main body. If dust has accumulated, remove it. Especially, clean the robot movable parts well (each joint, and the cable protective sleeve).	10
			○			Replacing the mechanical unit batteries	Replace the mechanical unit batteries **⇒"7.3.2 Replacing the Batteries"**	12
		○				Supply grease to balancer bushing	Supply grease to balancer bushing **⇒"7.3.1 Greasing to Balancer Bushing, Greasing to Bearing"**	17
				○		Supply grease to J3 arm connection part bearing	Supply grease to J3 arm connection part bearing **⇒"7.3.1 Greasing to Balancer Bushing, Greasing to Bearing"**	18
				○		Supply grease to J3 base connection part bearing	Supply grease to J3 base connection part bearing **⇒"7.3.1 Greasing to Balancer Bushing, Greasing to Bearing**	19
				○		Supply grease to wrist connection part bearing	Supply grease to wrist connection part bearing **⇒"7.3.1 Greasing to Balancer Bushing, Greasing to Bearing"**	20

Check and maintenance intervals (Period, Accumulated operating time)						Check and maintenance items	Check points, management and maintenance methods	Periodic maintenance table No.
1 month 320h	3 months 960h	1 year 3840h	1.5 years 5760h	3 years 11520h	4 years 15360h			
				○		Replacing the grease of drive mechanism	Replace the grease of each axis reducer and gearbox **⇒"7.3.3 Replacing the Grease of the Drive Mechanism"**	13 to 16
					○	Replacing the mechanical unit cable	Replace the mechanical unit cable Contact your local FANUC representative for information regarding replacing the cable.	21
					○	Replacing the controller batteries	Replace the controller batteries **⇒Chapter 7 Replacing batteries of R-30*i*B/R-30*i*B Plus CONTROLLER MAINTENANCE MANUAL(B-83195EN) or R-30*i*A CONTROLLER MAINTENANCE MANUAL (B-82595EN) or R-30*i*A CONTROLLER MAINTENANCE MANUAL(For Europe) (B-82595EN-1) or R-30*i*A CONTROLLER MAINTENANCE MANUAL(For RIA) (B-82595EN-2)"**	24

7.2 CHECK POINTS

7.2.1 Confirmation of Oil Seepage

Check items

Confirm whether there is oil seepage on the rotating parts of each joint axis.

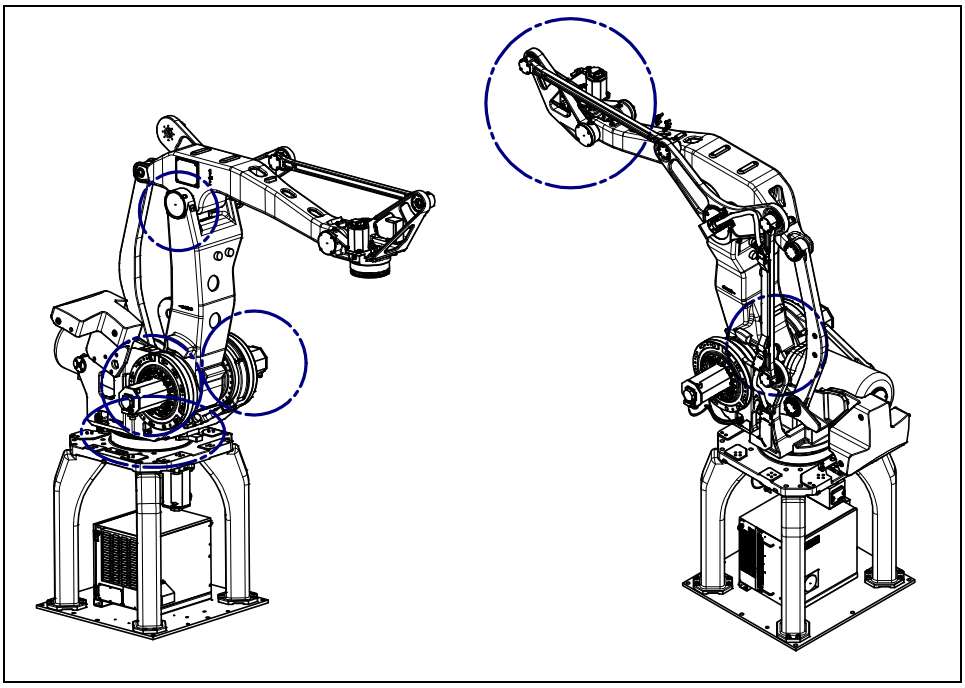


Fig. 7.2.1 Check parts of oil seepage

Management

- Oil might accumulate on the outside of the seal lip depending on the movement condition or environment of the axis. If the oil viscosity changes, the oil might drip depending on the axis movement. To prevent oil spots, be sure to wipe away any accumulated oil under the axis components in Fig. 7.2.1 before you operate the robot.
- Also, drive mechanisms might become hot and the internal pressure of the grease bath might rise by frequent repetitive movement and use in high temperature environments. In these cases, normal internal pressure can be restored by venting the grease outlet. (When opening the grease outlet, refer to Subsection 7.3.3 and ensure that grease is not expelled onto the machine or tooling.)

> ⚠ **WARNING**
> Hot grease might eject suddenly when you open the grease outlet. Attach bags for collecting grease, and use appropriate protective equipment such as heat-resistant gloves, protective glasses, a face shield, or a body suit if necessary.

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

7.2.2 Confirmation of the Air Control Set (option)

When an air control set is used, check the items below.

Item	Check items	Check points
1	Air pressure	Check the air pressure using the pressure gauge on the air control set as shown in Fig. 7.2.2. 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 number of oil drops during operation. 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 will be empty in about 10 to 20 days.
3	Lubricator oil level	Check to see that the air control set oil level is within the specified level.
4	Leakage from hose	Check the joints, tubes, etc. for leaks. Retighten the joints or replace parts, as required.
5	Drain	Check the drain and release it. If the quantity of the drained liquid is significant, examine the setting of the air dryer on the air supply side.

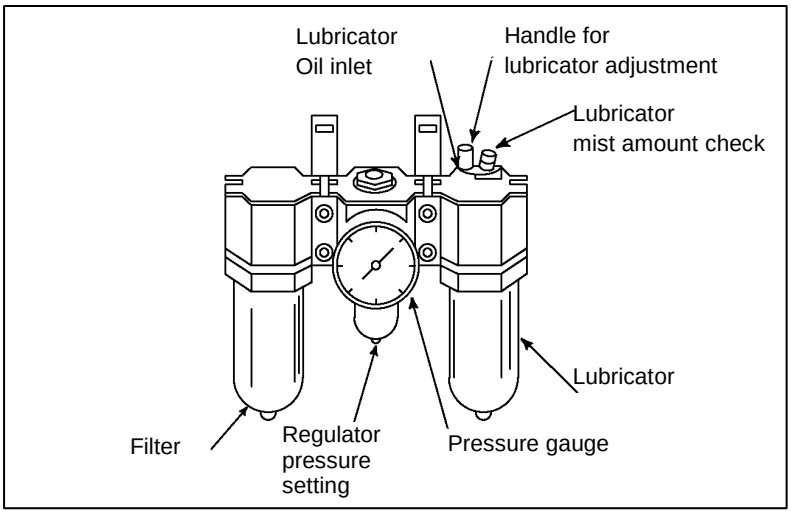


Fig. 7.2.2 Air control set (option)

7.2.3 Check the Mechanical Unit Cables and Connectors

Check points of the mechanical unit cables

J1 movable section, the upper and lower ends of wrist posture retention link at J2 arm back side, J2/J3 connection section, J3/J4 connection section

For J2/J3 connection section, remove the side cover and check those from side.

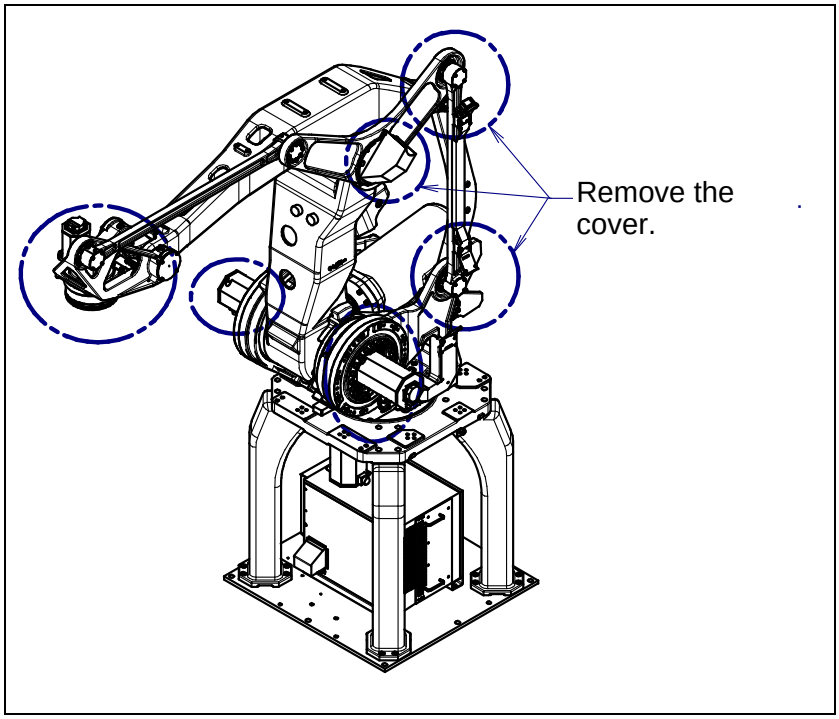


Fig. 7.2.3 (a) Inspection points of the mechanical unit cables

Check items

＜Cable protective sleeve＞

- Check that no holes or tears exist on the cable protective sleeves.
- If there is damage as shown in Fig. 7.2.3 (b), replace the cable protective sleeves.

Fig. 7.2.3 (b) Damage on the cable protective sleeve

＜Cables＞

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

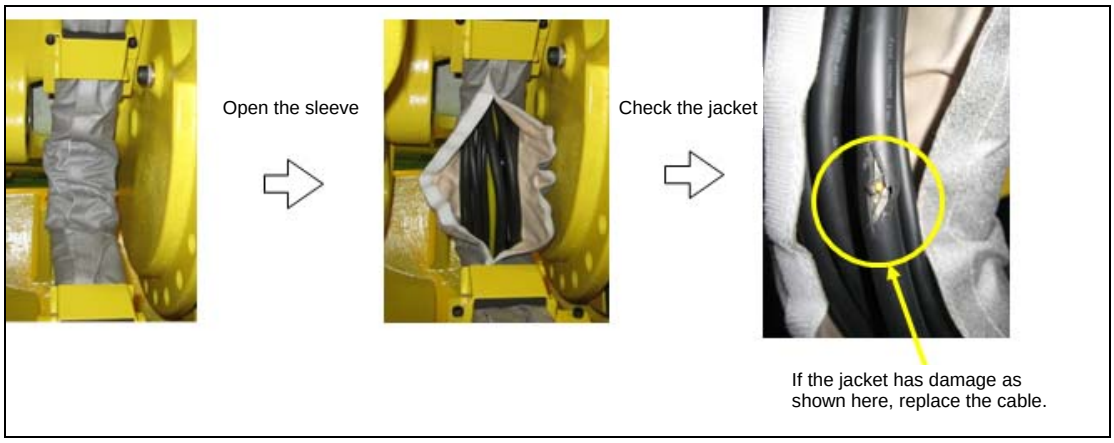


Fig. 7.2.3 (c) Cable check method

Inspection points of the connectors

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

Check items

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

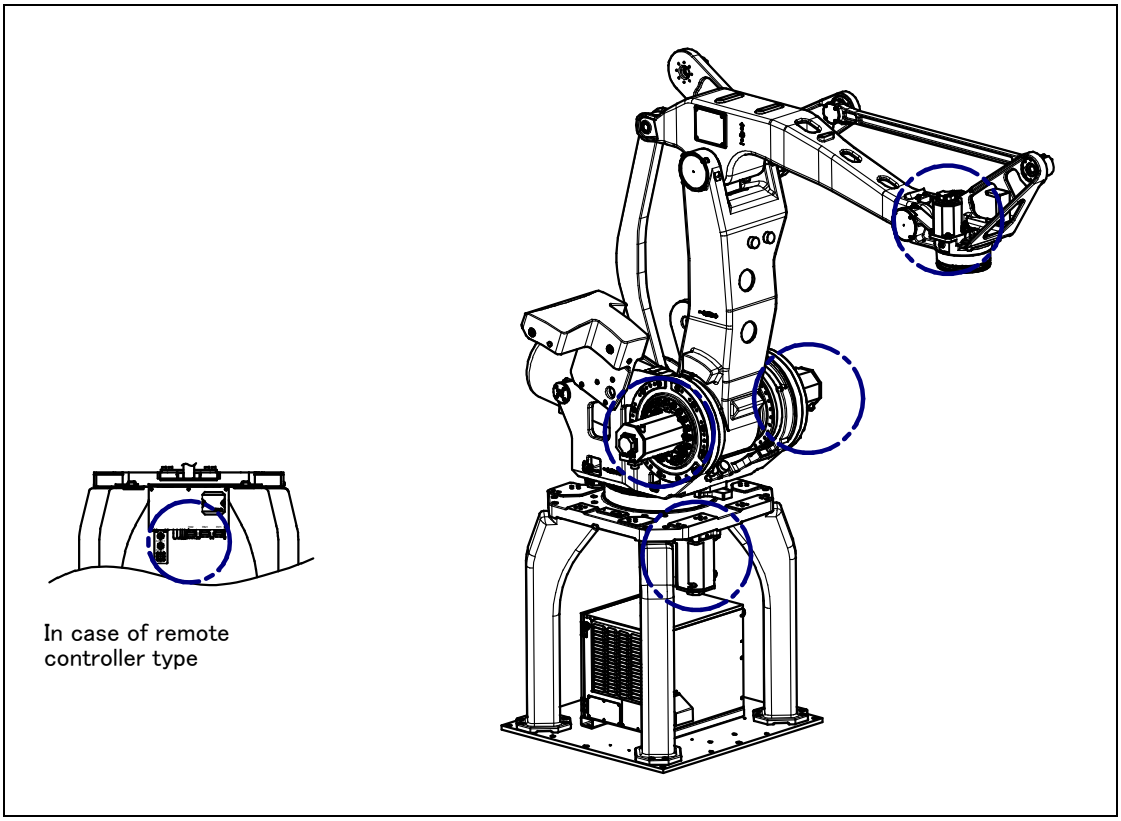


Fig. 7.2.3 (d) Connector Inspection points

7.2.4 Check of Fixed Mechanical Stopper and Adjustable Mechanical Stopper

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

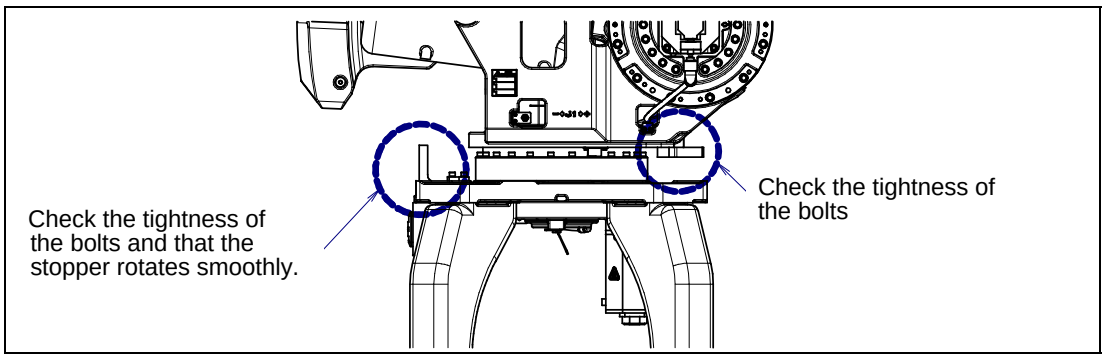


Fig. 7.2.4 Check of fixed mechanical stopper and adjustable mechanical stopper

7.3 MAINTENANCE

7.3.1 Greasing to Balancer Bushing (1.5-year Checks (3840 Hours)) Greasing to Bearing (3-year Checks (11520 Hours))

Be sure to supply grease to the machine at the timing (cumulative operating time or period whichever earlier) specified in Table 7.3.1 (a), (b). Adjust the greasing timing if your robot is installed in an adverse environment. Supply grease immediately if water is splashed to the robot.
Fig 7.3.1 (a) indicates the greasing point of balancer bush. In this time, move robot posture to J3=-16° to -126°.
Fig.7.3.1 (b) to (d) indicate the greasing point of bearing part.
When greasing to bearing of J3 arm connection part, remove seal bolt in Fig.7.3.1 (b) before greasing. When the seal bolt is reused, be sure to seal it with seal tape.

Table 7.3.1 (a) Greasing the Balancer Bushing

Recommended grease	Amount of grease	Greasing interval
Showa Shell Sekiyu K. K. SHELL ALVANIA GREASE S2 (Spec.: A98L-0004-0602#CTG)	10 ml for each (Two points)	1 year or every 3840 hours of accumulated operation

Table 7.3.1 (b) Greasing of the bearing part

Supply position	Recommended grease	Amount of grease	Cumulative operating time (duration)
J3 arm connecting position bearing greasing point	Showa Shell Sekiyu K. K. SHELL ALVANIA GREASE S2 (Spec.: A98L-0004-0602#CTG)	20ml (Two points)	3 years or every 11520 hours of accumulated operation
J3 base cross roller bearing connecting position		20ml	
Wrist connecting position bearing		10ml (Two points)	

NOTE
1 After grease is supplied, old grease is pushed out from the bearing's rotating section. Wipe off the old grease immediately after greasing and, as required, after operations of 50 to 100 hours.
2 If the robot is high-duty, requiring a cooling unit (fan), shorten the standard greasing cycle to half.

Table 7.3.1 (c) Substitutes for ALVANIA GREASE S2

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

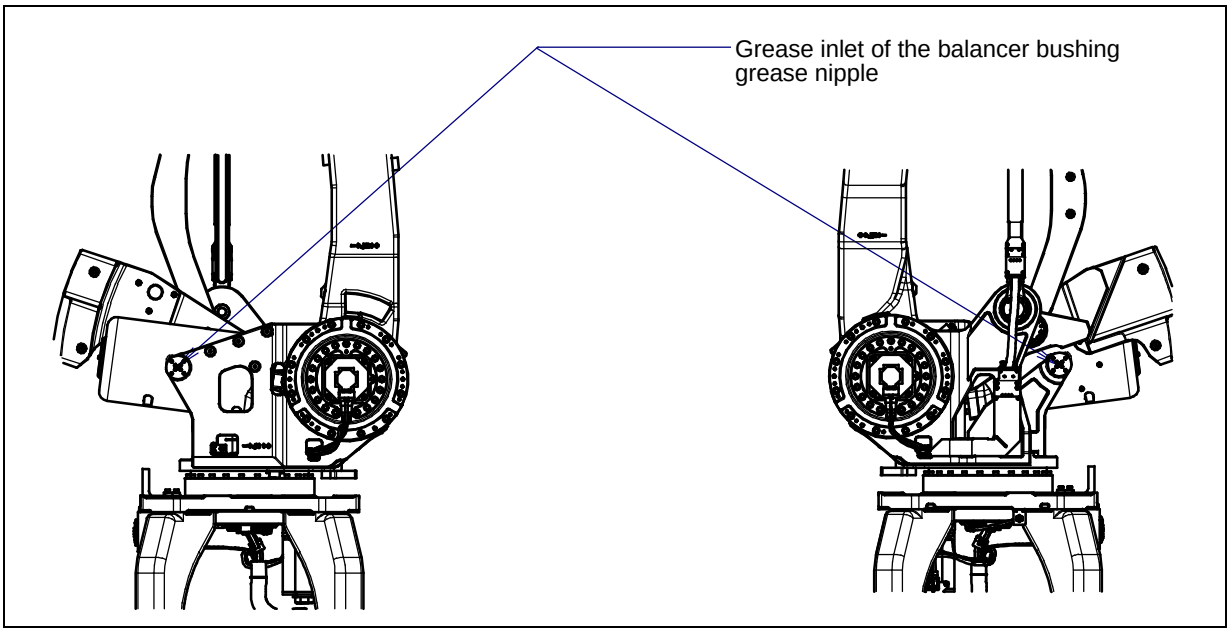


Fig. 7.3.1 (a) Greasing for balancer bushing (2 points)

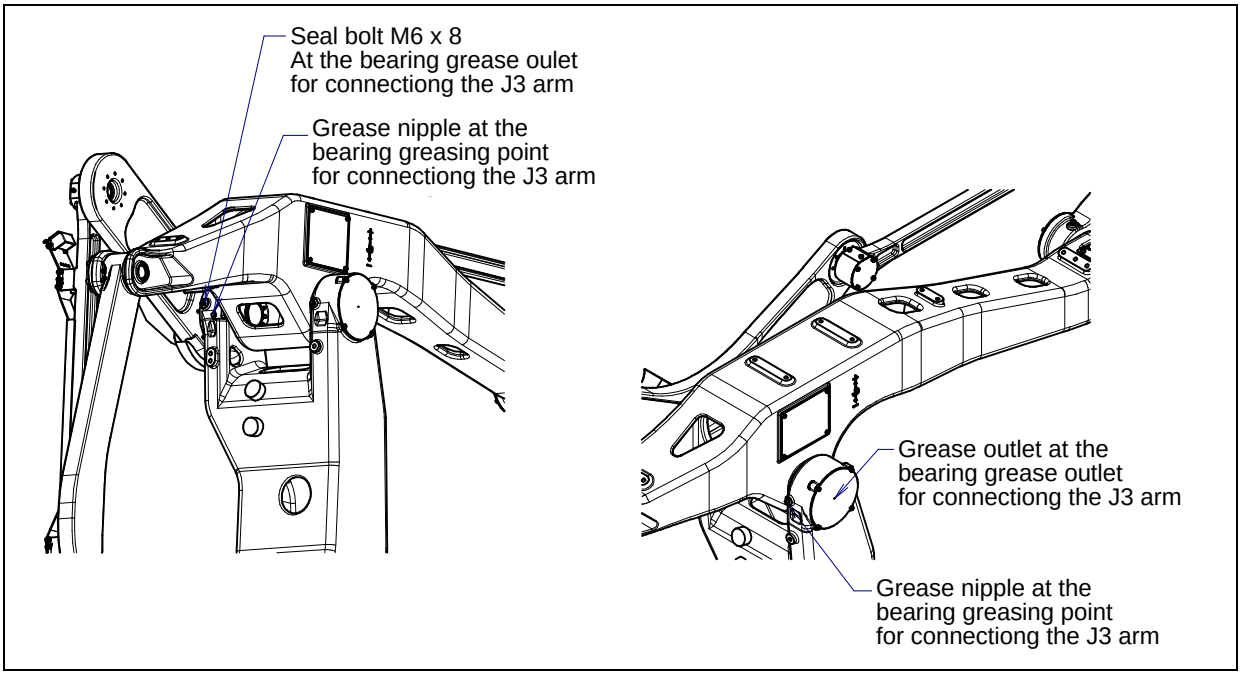


Fig. 7.3.1 (b) Greasing for the bearing of the J3 arm connection (2 points)

⚠ CAUTION
1 Before greasing, remove the stopper or seal bolt at the grease outlet.
2 Apply grease slowly with a manual pump.

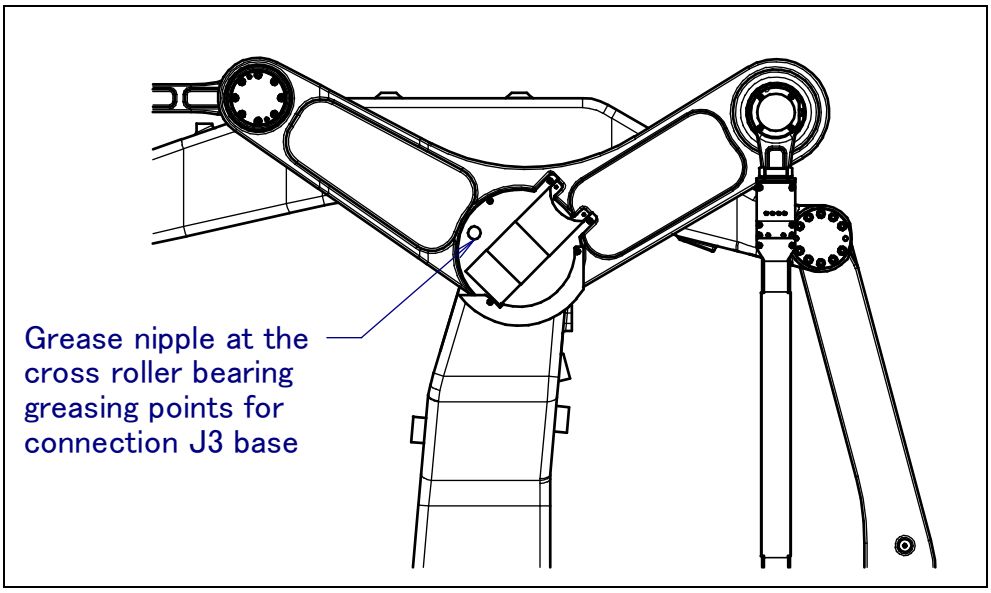


Fig. 7.3.1 (c) Greasing for cross roller bearing J3 base

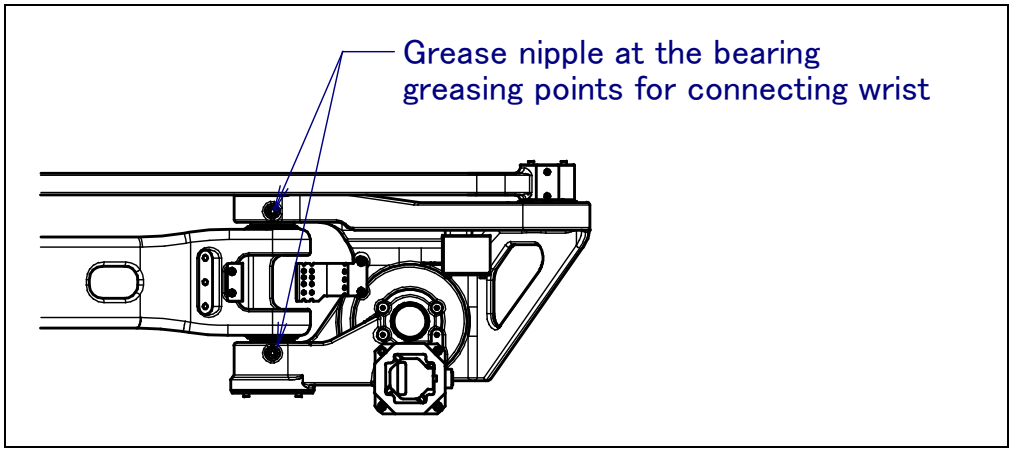


Fig. 7.3.1 (d) Greasing for bearing wrist connection (2 points)

Table 7.3.1 (b) Spec. of the seal bolts and the grease nipple

Parts name	Specifications
Seal bolt (M6 x 8)	A97L-0218-0417#060808
Grease nipple	A97L-0218-0013#A610

7.3.2 Replacing the Batteries (1.5-year Checks)

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

1 Press the EMERGENCY STOP button to prohibit robot motion.

> ⚠ **CAUTION**
> 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.7.3.2)
3 Take out the old batteries from the battery case.
4 Insert new batteries into the battery case. Pay attention to the direction of batteries.
5 Close the battery case cap.

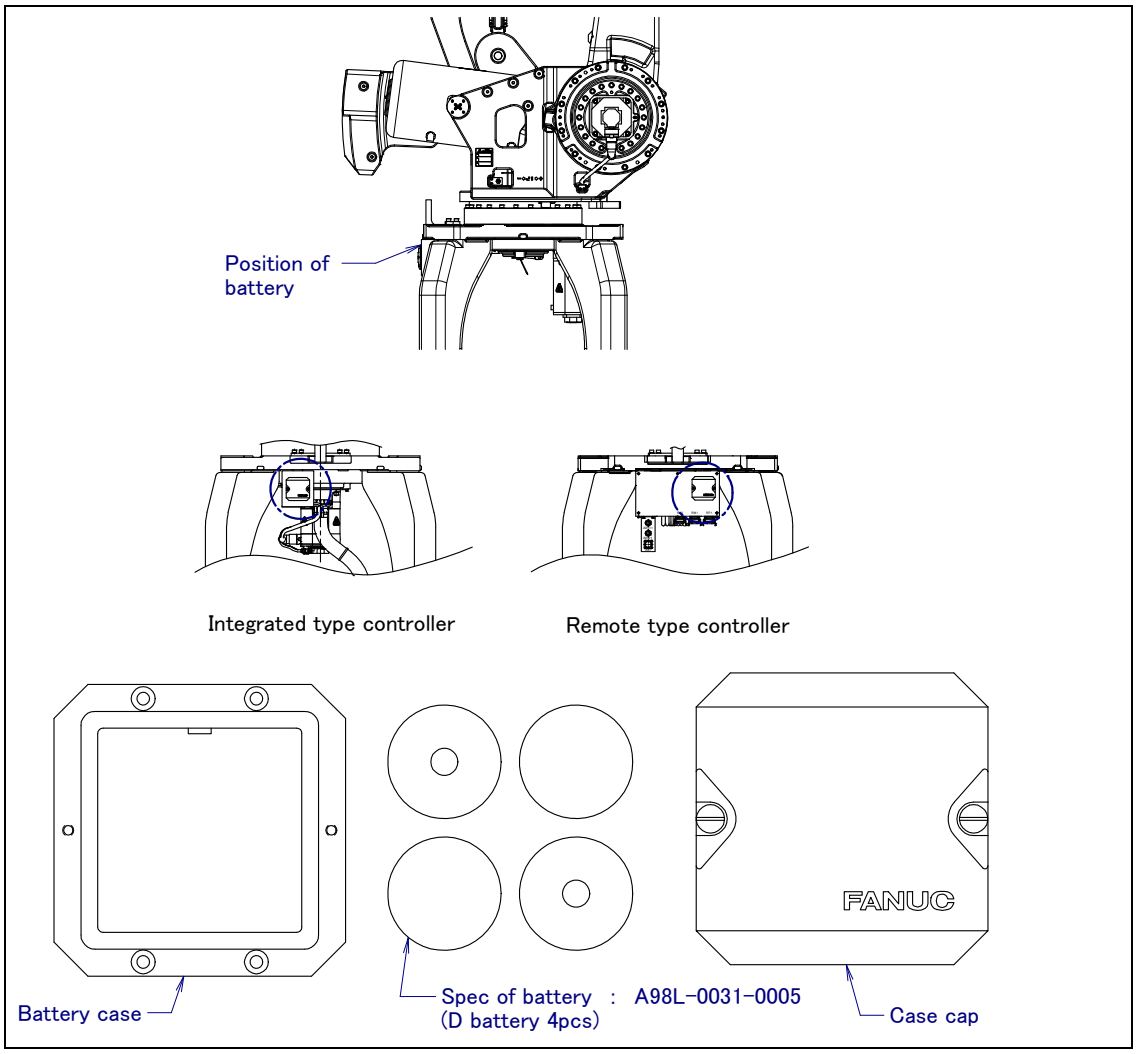


Fig.7.3.2 Replacing batteries

7.3.3 Replacing the Grease of the Drive Mechanism (3-year (11520 Hours) Checks)

According to below, replace the grease of the reducers of J1/J2/J3/J4 at the intervals based on every 3 years or 11520 hours, whichever comes first. See Table 7.3.3 (a) for the grease name and the quantity.

Table 7.3.3 (a) Grease for 3-year (11520 hours) periodical replacement

Models	Grease supplying position	Grease name	Quantity	Gun tip pressure
M-410*i*B/700	J1-axis reducer	Kyodo yushi VIGOGREASE RE0 Spec.: A98L-0040-0174	7400g (8370ml)	0.15 MPa or less (NOTE)
	J2-axis reducer		2800g (3170ml)	
	J3-axis reducer		2600g (2940ml)	
	J4-axis reducer		950g (1080ml)	

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

⚠ WARNING
Hot grease might eject suddenly when you open the grease outlet. Attach bags for collecting grease, and use appropriate protective equipment such as heat-resistant gloves, protective glasses, a face shield, or a body suit if necessary.

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

Table 7.3.3 (b) Postures for greasing

Robot	Supply position	Posture			
		J1	J2	J3	J4
M-410*i*B/700	J1-axis reducer	0°	Arbitrary	Arbitrary	Arbitrary
	J2-axis reducer	Arbitrary	0°	Arbitrary	
	J3-axis reducer		-44 to 40°	-16°	
	J4-axis reducer		Arbitrary	Arbitrary	0°

NOTE
In a high-duty environment where, for example, a cooling unit (fan) is used, grease must be replaced every half the specified standard period.

⚠ CAUTION

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

1 Before starting to grease, remove the seal bolt or the taper plug to allow the grease to come out.
2 Supply grease slowly without applying excessive force, using a manual pump.
3 Whenever possible, avoid using a compressed-air pump, powered by the factory air supply.
Even when using a compressed-air pump is unavoidable, set the gun tip pressure (see Table 7.3.3 (a).) to 0.15MPa or less during application of the grease.
4 Use grease only of the specified type. Grease of a type other than that specified may damage the reducer or lead to other problems.
5 After applying grease, release the remaining pressure within the grease bath as described in the procedure in Subsection 7.3.4.
6 To prevent the accident like fall, fire, remove all the excess grease from the floor and robot.
7 If no old grease is pushed out from the grease outlet or if only an extremely small amount of old grease is pushed out when new grease is supplied into the grease inlet, it is likely that grease is leaking because of a damaged seal or a similar break.

Grease replacement procedure for the J1-axis, J2-axis, J3-axis, and J4-axis reducers

⚠ CAUTION

Be careful not to confuse the grease inlet of the J4-axis reducer with the grease inlet of the wrist link bearing in Fig. 7.3.1 (d) of Section 7.3.1 because they are close to each other.

1 Move the robot to the greasing posture described in Table 7.3.3 (a).
2 Turn off controller power.
3 Remove the seal bolt shown the Fig. 7.3.3 (a) to (d) from the grease outlet.
4 Supply new grease until new grease is output from the grease outlet.
5 After applying grease, release the remaining pressure within the grease bath as described in the procedure in Section 7.3.4.

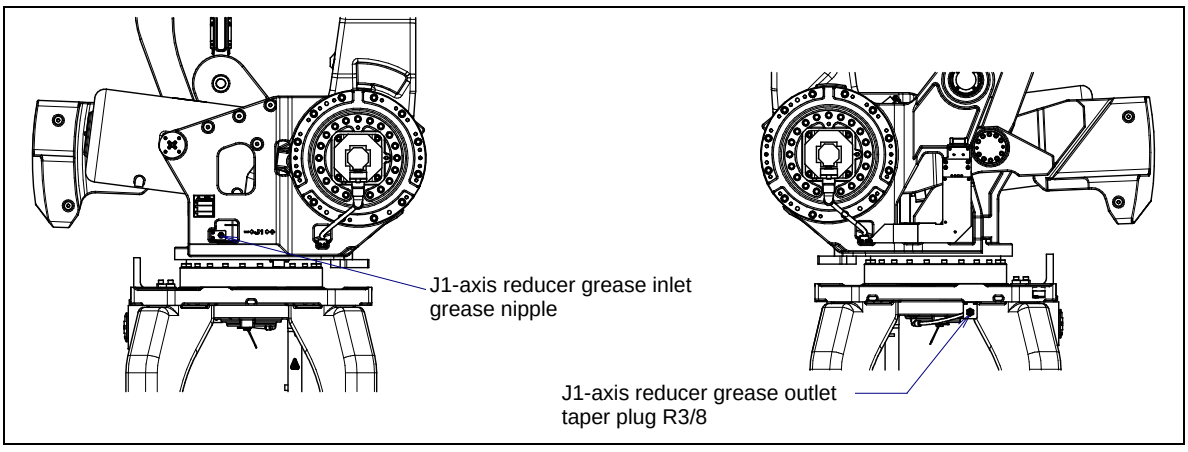


Fig. 7.3.3 (a) Replacing grease of J1-axis reducer

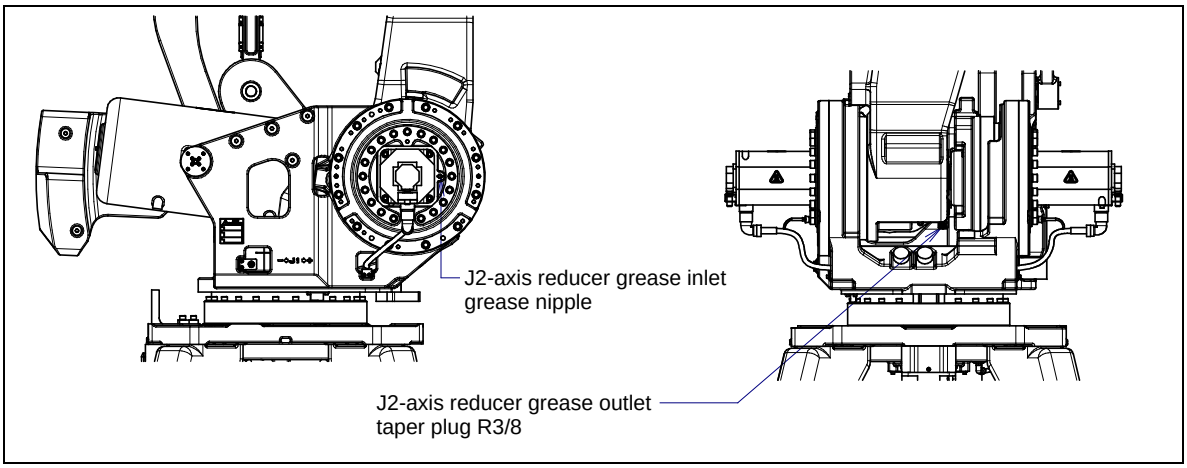


Fig. 7.3.3 (b) Replacing grease of J2-axis reducer

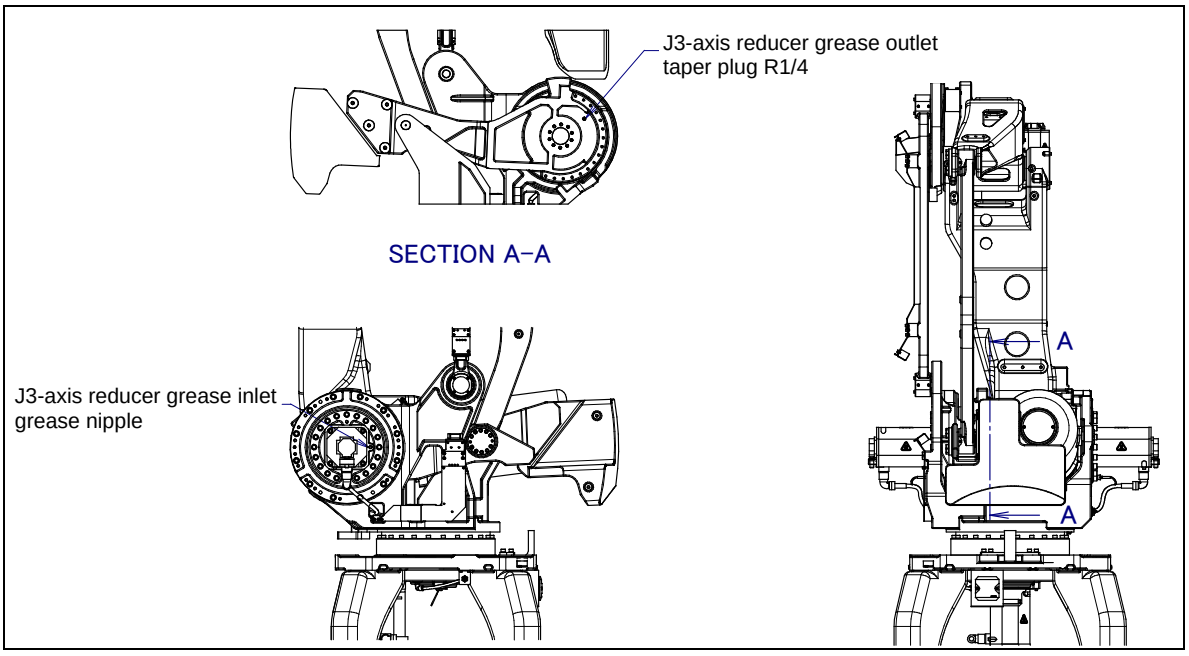


Fig. 7.3.3 (c) Replacing grease of J3-axis reducer

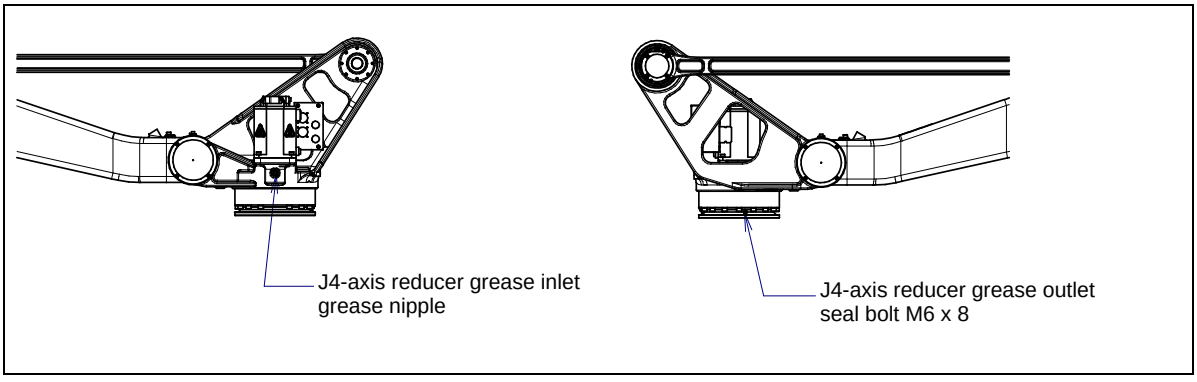


Fig.7.3.3 (d) Replacing grease of J4-axis reducer

Table 7.3.3 (d) Spec. of the seal bolts, taper plugs and the grease nipple

Parts name	Specifications
Seal bolt (M6 x 8)	A97L-0218-0417#060808
Taper plug (R1/4)	A97L-0001-0436#2-2D
Taper plug (R3/8)	A97L-0001-0436#2-3D
Grease nipple	A97L-0218-0013#A610

7.3.4 Procedure for Releasing Remaining Pressure from the Grease Bath

To release the remaining pressure in the grease bath after applying grease, operate the robot for 20 minutes or more as described in the table below with the grease nipple of the grease inlet and the taper plug or seal bolt of the grease outlet left open for the J1-axis reducer and J4-axis reducer, and the taper plug of the grease outlet left open for the J2-axis reducer and J3-axis reducer.
Attach the reclaim bags under the grease inlet and grease outlet to prevent spilled grease from splattering.

<table>
<tr><th>Operating axis / Grease replacement part</th><th>J1-axis</th><th>J2-axis</th><th>J3-axis</th><th>J4-axis</th></tr>
<tr><td>J1-axis reducer</td><td>Axis angle of 80° or more
OVR 50%</td><td colspan="3">Arbitrary</td></tr>
<tr><td>J2-axis reducer</td><td>Arbitrary</td><td>Axis angle of 90° or more
OVR 50%</td><td colspan="2">Arbitrary</td></tr>
<tr><td>J3-axis reducer</td><td colspan="2">Arbitrary</td><td>Axis angle of 60° or more
OVR 100%</td><td>Arbitrary</td></tr>
<tr><td>J4-axis reducer</td><td colspan="3">Arbitrary</td><td>Axis angle of 60° or more
OVR 100%</td></tr>
</table>

If the above operations cannot be performed because of workcell constraints, prolong the operating time so that an equivalent operation can be performed. (For example, when only an axis angle of 30° can be achieved instead of 60°, perform the operation for 40 minutes, which is double the specified time of 20 minutes.) If you grease multiple axes, you can exercise multiple axes 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, taper plug or grease nipple is reused, be sure to seal it with seal tape.

7.4 STORAGE

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

8 MASTERING

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

8.1 OVERVIEW

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

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

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

Types of Mastering

Table 8.1 describes the following mastering methods. Note that "Quick Mastering for Single Axis" is not supported in software version 7DC2 (V8.20P) or earlier.

Table 8.1 Type of mastering

Fixture position mastering	Mastering performed with the mastering fixture before shipping.
Zero-position mastering (witness mark mastering)	Mastering which 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 count of the Pulsecoder connected to the relevant motor and the rotation angle within one rotation. Quick mastering uses the fact that the absolute value of a rotation angle within one rotation will not be lost. (All axes at the same time)
Quick mastering for single axis	This is performed at a user-specified position for one axis. The corresponding count value is obtained from the rotation count of the Pulsecoder connected to the relevant motor and the rotation angle within one rotation. Quick mastering uses the fact that the absolute value of a rotation angle within one rotation will not be lost.
Single axis mastering	Mastering which performed for one axis at a time. The mastering position for each axis can be specified by the user. Useful in performing mastering on a specific axis.
Mastering data entry	Enter the Mastering data directly.

Once mastering is performed, you must carry out positioning (calibration). Positioning is an operation in which the controller reads the pulse count value to sense the current position of the robot.

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

> **⚠ CAUTION**
> 1 If mastering is performed incorrectly, the robot may behave unexpectedly. This is very dangerous. For the reason the Master/Cal screen is designed to appear only when the $MASTER_ENB system variable is 1 or 2. After performing positioning, press F5 [DONE] on the Master/Cal screen. The $MASTER_ENB system variable is reset to 0 automatically, thus hiding the Master/Cal screen will disappear.
> 2 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 has been replaced, it is necessary to release the relevant alarm and display the positioning menu.

Alarm displayed

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

Procedure

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

2 To reset the "SRVO-062 BZAL" alarm, follow steps 1 to 5.
   1 Press the [MENU] key.
   2 Press [0 NEXT] and select [6 SYSTEM].
   3 Press F1 ([TYPE]), and select [Master/Cal] from the menu.
   4 Press F3 ([RES_PCA]), then press F4 ([YES]).
   5 Cycle power of the controller.

3 To reset the "SRVO-075 Pulse not established" alarm, follow the steps 1 to 2.
   1 After cycling controller power, the message "SRVO-075 Pulse not established" appears again.
   2 Move the axis for which the message mentioned above has appeared in either direction till the alarm disappears when you press the [RESET] key.

8.3 ZERO POSITION MASTERING

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

Zero-position mastering involves a visual check, and might not be highly accurate. It should be used only as a quick-fix method.

Zero-position Mastering Procedure

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

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

 [ TYPE ]   LOAD   RES_PCA                DONE
```

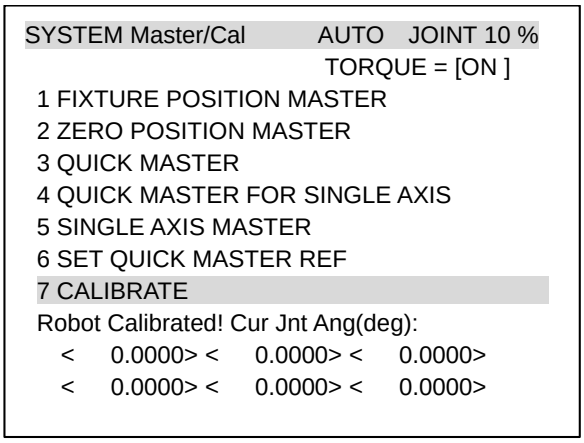
5 Release brake control, and jog the robot into a posture for mastering.

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

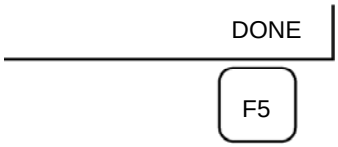
6 Select [2 Zero Position Master]. Press F4 [YES].

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

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



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



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

Table 8.3 Posture with position marks 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

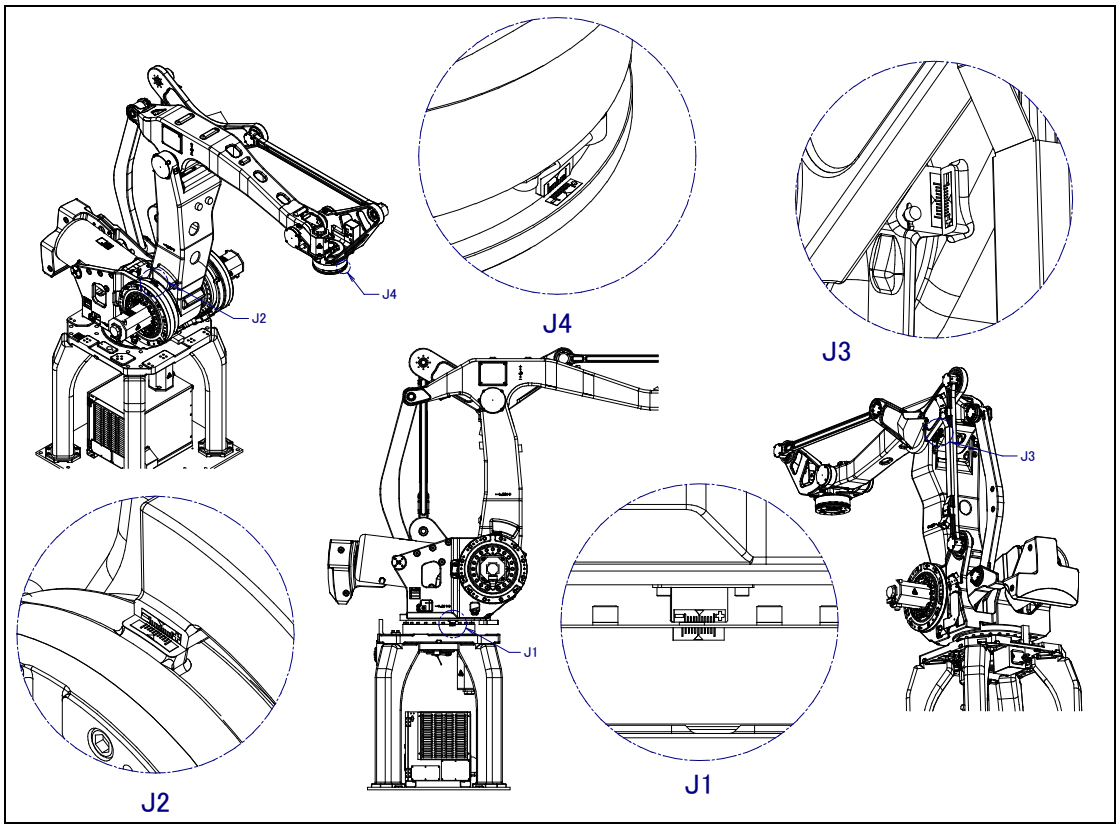


Fig. 8.3 Witness mark for each axis

8.4 QUICK MASTERING

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

Quick mastering is factory-performed at the position indicated in Table 8.3. If possible, do not change the setting.

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

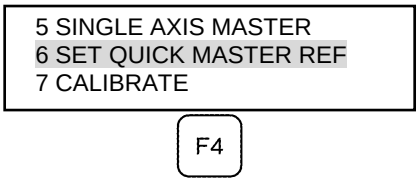
> ⚠ **CAUTION**
> 1 Quick mastering can be used, if the pulse count value is lost, for example, because a low voltage has been detected on the backup battery for the pulse counter.
> 2 Quick mastering cannot be used, after the Pulsecoder is replaced or after the mastering data is lost from the robot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

Procedure Recording the Quick Mastering Reference Position

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

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

 [ TYPE ]   LOAD   RES_PCA                DONE
```

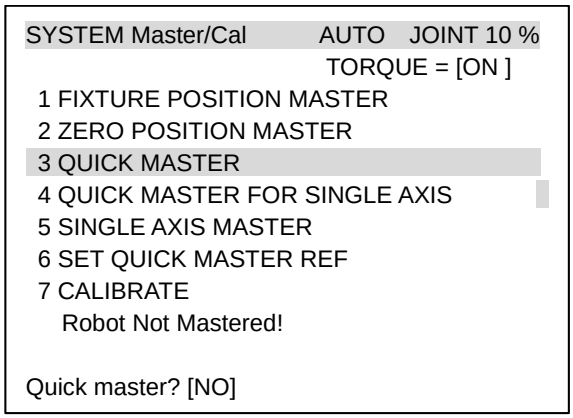
3 Release brake control, and jog the robot to the quick mastering reference position.
4 Select [6 SET QUICK MASTER REF] and press F4 [YES]. Quick mastering reference position will be set.



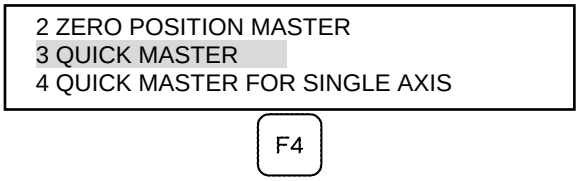
> ⚠ **CAUTION**
> If the robot has lost mastering data due to mechanical disassembly or repair, you cannot perform this procedure. In this case, perform Fixture position mastering or Zero position mastering to restore mastering data.

Procedure of Quick Mastering

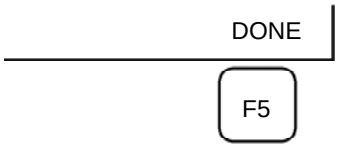
1 Display the Master/Cal screen.



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



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



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

8.5 QUICK MASTERING FOR SINGLE AXIS

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

Quick mastering is factory-performed at the position indicated in Table 8.3. If possible, do not change the setting.

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

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

Procedure Recording the Quick Mastering Reference Position

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

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

 [ TYPE ]   LOAD   RES_PCA                DONE
```

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

```
 5 SINGLE AXIS MASTER
 6 SET QUICK MASTER REF
 7 CALIBRATE
```

F4

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

Procedure of Quick Mastering for single axis

1 Display the Master/Cal screen.

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

Quick master? [NO]
```

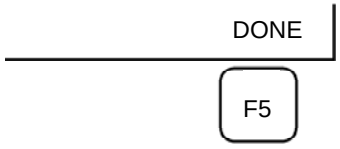
2 Select [4 QUICK MASTER FOR SINGLE AXIS]. The quick master for single axis screen will be displayed.

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

                                                EXEC
```

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

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

                                              EXEC
```

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



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

8.6 SINGLE AXIS MASTERING

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

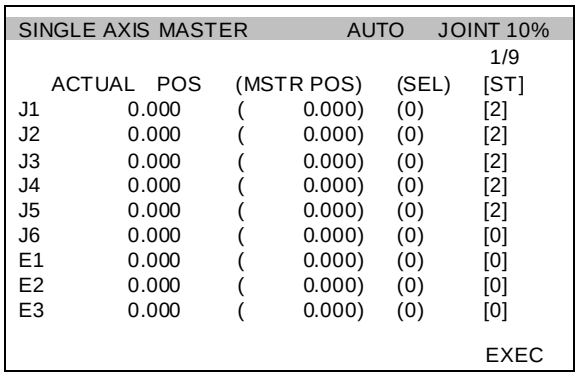


Table 8.6 Items set in single axis mastering

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

Procedure of Single axis mastering

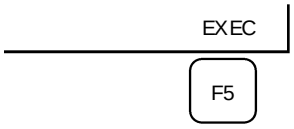
1 Select [6 SYSTEM].
2 Select [Master/Cal].

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

 [ TYPE ]  LOAD  RES_PCA              DONE
```

3 Select [5 SINGLE AXIS MASTER]. The following screen will be displayed.

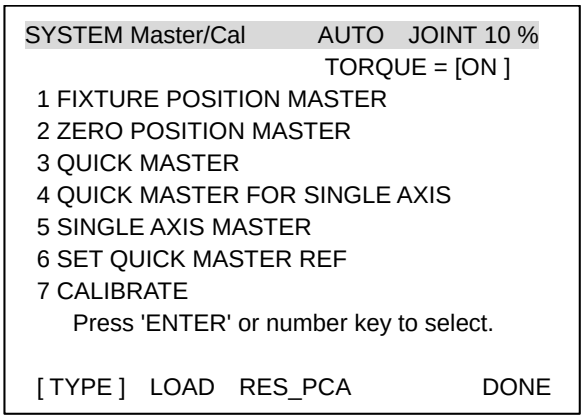
```
SINGLE AXIS MASTER          AUTO    JOINT 10%
                                          1/9
   ACTUAL  POS    (MSTR POS)    (SEL)   [ST]
J1        0.000   (     0.000)   (0)     [2]
J2        0.000   (     0.000)   (0)     [2]
J3        0.000   (     0.000)   (0)     [2]
J4        0.000   (     0.000)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

                                          EXEC
```

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



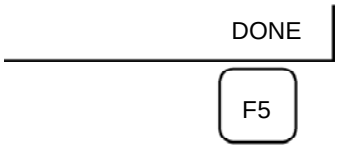

```
SINGLE AXIS MASTER          AUTO    JOINT 10%
                                          6/9
   ACTUAL  POS    (MSTR POS)    (SEL)   [ST]
J1        0.000   (     0.000)   (0)     [2]
J2        0.000   (     0.000)   (0)     [2]
J3        0.000   (     0.000)   (0)     [2]
J4        0.000   (     0.000)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

                                          EXEC
```

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



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

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



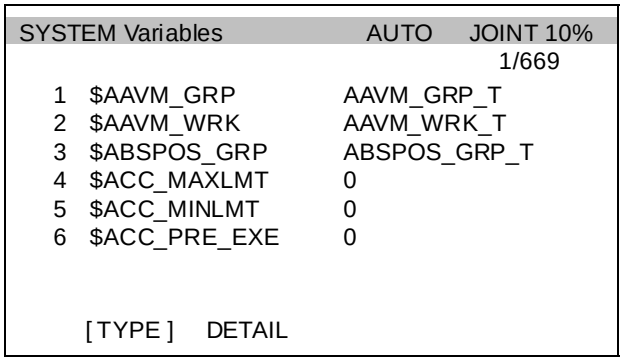
11 Return brake control to original setting, and cycle power of the controller.

8.7 MASTERING DATA ENTRY

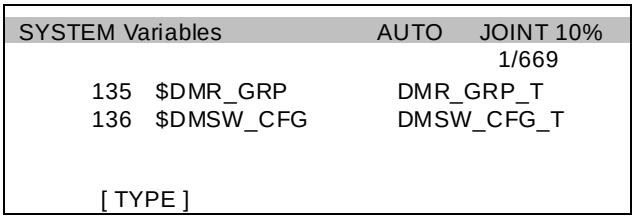
This function enables mastering data values to be assigned directly to a system variable. It can be used if mastering data has been lost but the pulse count is preserved.

Mastering data entry method

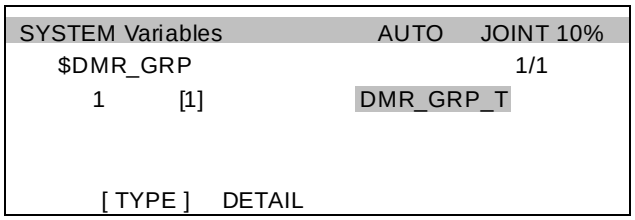
1 Press the [MENU] key, then press [0 NEXT] and select [6 SYSTEM].
2 Press F1 [TYPE]. Select [Variables]. The system variable screen appears.

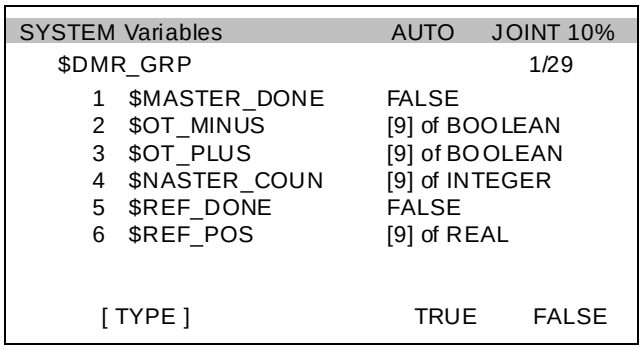


3 Change the mastering data. The mastering data is saved to the $DMR_GRP.$MASTER_COUN system variable.

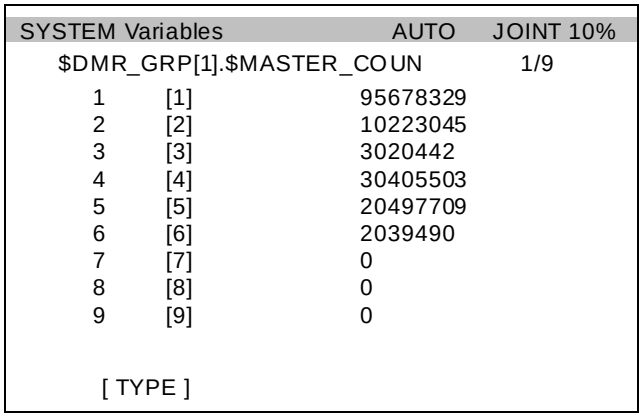


4 Select $DMR_GRP.

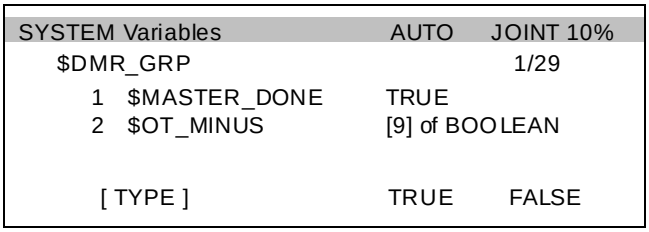




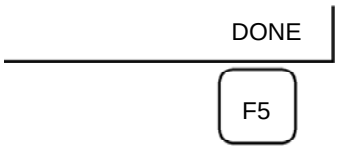
5 Select $MASTER_COUN, and enter the mastering data you have recorded.



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



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



8.8 CHECKING THE MASTERING

1 How to check the robot mastered properly
Usually, positioning is performed automatically when the power is turned on. To check whether mastering has been performed correctly, examine if the current displayed position matches the actual robot position by using one or more of the procedures described below:

(1) Reproduce a particular point in a program. Check whether the point agrees with the specified position.
(2) Set all axes of the robot to their 0-degree (0 rad) positions. Check that the zero-degree position marks indicated in Section 8.3 of the OPERATOR'S MANUAL are aligned. No need of any visual aid.

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

2 Alarm types displayed during mastering and their solution method:
(1) BZAL alarm
This alarm is displayed if the Pulsecoder's backup battery voltage decreases to 0 V while the power to the controller is disconnected. Furthermore, if the Pulsecoder connector is removed for cable replacement, etc. this alarm is displayed as the voltage decreases to 0. Check to see if the alarm will disappear by performing a pulse reset (See Section 8.2.). Then, cycle controller power and check if the alarm disappears or not.
The battery may be drained if the alarm is still displayed. Perform a pulse reset, and turn off and on the controller power after replacing the battery. Note that, if this alarm is displayed, all the original data held by the Pulsecoder will be lost. Mastering is required.
(2) BLAL alarm
Warn 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) Alarm notification like CKAL, RCAL, PHAL, CSAL, DTERR, CRCERR, STBERR, and SPHAL may have trouble with Pulsecoder, contact your local FANUC representative.

9 TROUBLESHOOTING

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

9.1 TROUBLESHOOTING

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

Table 9.1 Troubleshooting

Symptom	Description	Cause	Measure
Vibration Noise	- The J1 base lifts off the floor plate as the robot operates. - There is a gap between the J1 base and floor plate. - A J1 base retaining bolt is loose.	[J1 base fastening] - It is likely that the robot J1 base is not securely fastened to the floor plate. - Probable causes are a loose bolt, an insufficient degree of surface flatness, or foreign material caught between the J1-base plate and floor plate. - If the robot is not securely fastened to the floor plate, the J1 base lifts the floor plate as the robot operates, allowing the base and floor plates to strike each other that, in turn, lead to vibration.	- If a bolt is loose, apply LOCTITE and tighten it to the appropriate torque. - Adjust the floor plate surface flatness to within the specified tolerance. - If there is any foreign matter between the J1 base and floor plate, remove it.
	- The rack or floor plate vibrates during operation of the robot.	[Rack or floor] - It is likely that the rack or floor is not sufficiently rigid. - If the rack or floor is not sufficiently rigid, reaction from the robot deforms the rack or floor, leading to vibration.	- Reinforce the rack or floor to make it more rigid. - If it is impossible to reinforce the rack or floor, modify the robot control program; doing so might reduce the amount of vibration.
	- Vibration becomes more serious when the robot adopts a specific posture. - If the operating speed of the robot is reduced, vibration stops. - Vibration is most noticeable when the robot is accelerating. - Vibration occurs when two or more axes operate at the same time.	[Overload] - It is likely that the load on the robot is greater than the maximum rating. - It is likely that the robot control program is too demanding for the robot hardware. - It is likely that the ACCELERATION value is excessive.	- Check the maximum load that the robot can handle once more. If the robot is found to be overloaded, reduce the load, or modify the robot control program. - Vibration in a specific portion can be reduced by modifying the robot control program while slowing the robot and reducing its acceleration (to minimize the influence on the entire cycle time).

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- Vibration or noise was first noticed after the robot collided with an object or the robot was overloaded for a long period. - The grease of the vibrating or noise occurring axis has not been exchanged for a long period.	[Broken gear, bearing, or reducer] - It is likely that the collision or overload applied an excessive force to 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 is causing vibration. - It is likely that, because the grease has not been changed for a long period, fretting occurred on the gear tooth surface or rolling surface of a bearing, or reducer due to metal fatigue. 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 your local FANUC representative. - Using the robot within its maximum rating prevents problems with the drive mechanism. - Regularly greasing with the specified grease can help prevent problems.

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

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- There is some relationship between the vibration of the robot and the operation of a machine near the robot.	[Noise from a nearby machine] - If the robot is not grounded properly, electrical noise is induced on the grounding wire, preventing commands from being transferred accurately, thus leading to vibration. - If the robot is grounded at an unsuitable point, its grounding potential becomes unstable, and noise is likely to be induced on the grounding line, thus leading to vibration.	- Connect the grounding wire firmly to ensure a reliable ground potential and prevent extraneous electrical noise.
	- There is an unusual sound after replacement of grease. - There is an unusual sound after a long period. - There is an unusual sound during operation at low speed.	- There may be an unusual sound when using other than the specified grease. - Even for the specified grease, there may be an unusual sound during operation at low speed immediately after replacement or after a long period.	- Use the specified grease. - When there is an unusual sound even for specified grease, perform operation for one or two days on an experiment. Generally, a usual sound will disappear.
Rattling	- While the robot is not supplied with power, pushing it with the hand causes part of the mechanical unit to wobble. - There is a gap on the mounting 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 effector retaining bolt

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

Symptom	Description	Cause	Measure
Grease leakage	- Grease is leaking from the mechanical unit.	[Poor sealing] - Probable causes are a crack in the casting, a broken O-ring, a damaged oil seal, or a loose seal bolt. - A crack in a casting can occur due to excessive force that might be caused in collision. - An O-ring can be damaged if it is trapped or cut during disassembling or re-assembling. - An oil seal might be damaged if extraneous dust scratches the lip of the oil seal. - A loose seal bolt 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 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 stuck each other or not. If they are found to be stuck, replace the relay. - Replace the motor confirmed following symptoms. - Brake shoe is worn out - Brake main body is damaged - Oil soak through the motor

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

APPENDIX

A PERIODIC MAINTENANCE TABLE

FANUC Robot M-410*i*B/700 Periodic Maintenance Table

Items		Working time (H)	Check time	Grease amount	First check 320	3 months 960	6 months 1920	9 months 2880	1 year 3840	4800	5760	6720	2 years 7680	8640	9600	10560
Mechanical unit	1	Check for external damage or peeling paint	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	2	Check damages of the cable protective sleeves	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	3	Check wear debris of J1-axis swing stopper	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	4	Check for water	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	5	Check the mechanical cable. (damaged or twisted)	0.2H	—		○			○				○			
	6	Check the motor connector. and exposed connector (loosening)	0.2H	—		○			○				○			
	7	Tighten the end effector bolt.	0.2H	—		○			○				○			
	8	Tighten the cover and main bolt.	2.0H	—		○			○				○			
	9	Check the fixed mechanical stopper and the adjustable mechanical stopper	0.1H	—		○			○				○			
	10	Clean spatters, sawdust and dust	1.0H	—		○			○				○			
	11	Check the end effector (hand) cable	0.1H	—		○			○				○			
	12	Replacing battery.	0.1H	—							●					
	13	Replacing grease of J1 axis reducer *1	1.2H	8370ml												
	14	Replacing grease of J2 axis reducer *1	0.6H	3170ml												
	15	Replacing grease of J3 axis reducer *1	0.6H	2940ml												
	16	Replacing grease of J4 axis reducer *1	0.4H	1080ml												
	17	Greasing to balancer bushing*1 (2 location)	0.5H	10ml each					●				●			
	18	Apply greasing to bearing of J3 arm connection*1 (2 location)	0.1H	20ml each												
	19	Apply greasing to the J3-axis cross roller bearing*1	0.1H	20ml												
	20	Apply greasing to connection parts of wrist *1 (2 locations)	0.1H	10ml each												
	21	Replacing mechanical unit cable*	4.0H	—												
Controller	22	Cleaning the controller ventilation system	0.2H	—	○	○	○	○	○	○	○	○	○	○	○	○
	23	Check damages of the teach pendant cable, the operation box connection cable and the robot connection cable	0.2H	—		○			○				○			
	24	Replacing battery *2	0.1H	—												

*1 Refer to this manual about greasing points.

*2 Refer to “REPLACING UNITS Chapter of MAINTENANCE ” of the following manuals.
R-30*i*A CONTROLLER MAINTENANCE MANUAL (Standard) (B-82595EN),
R-30*i*A CONTROLLER MAINTENANCE MANUAL (For Europe) (B-82595EN-1),
R-30*i*A CONTROLLER MAINTENANCE MANUAL (For RIA) (B-82595EN-2),
R-30*i*B/R-30*i*B Plus CONTROLLER MAINTENANCE MANUAL (B-83195EN),

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

3 years 11520	12480	13440	14400	4 years 15360	16320	17280	18240	5 years 19200	20160	21120	22080	6 years 23040	24000	24960	25920	7 years 26880	27840	28800	29760	8 years 30720	Item
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		1
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		2
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		3
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		4
○				○				○				○				○					5
○				○				○				○				○					6
○				○				○				○				○					7
○				○				○				○				○					8
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○				○				○				○				○					23
				●																	24

Overhaul

B STRENGTH OF BOLT AND BOLT TORQUE LIST

NOTE

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

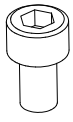
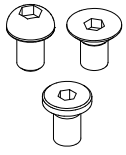
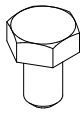
Use the following strength bolts. Comply with any bolt specification instructions.

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

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

Refer to the following tables if the bolts tightening torque are not specified.

Recommended bolt tightening torques **Unit: Nm**

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

INDEX

REVISION RECORD

Edition	Date	Contents
05	Mar.,2017	• Addition of R-30*i*B Plus Controller • Corrections of errors
04	Apr.,2012	• Addition of R-30*i*B Controller • Addition of note for payload • Addition of note for low temperature • Addition of check of oil seepage • Corrections of errors
03	Jul.,2010	• Addition of stop type of robot • Addition of stopping time and distance when controlled stop is executed • Corrections of errors
02	Dec., 2008	• Addition of option cable • Corrections of errors
01	Apr., 2008	

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