FANUC Robot ARC Mate 120*i*C/20T
FANUC Robot M-20*i*A/20T/20MT/35MT

MECHANICAL UNIT

OPERATOR'S MANUAL

B-83034EN/08

- **Original Instructions**

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

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

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

SAFETY PRECAUTIONS

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

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

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

1 DEFINITION OF USER

The 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.

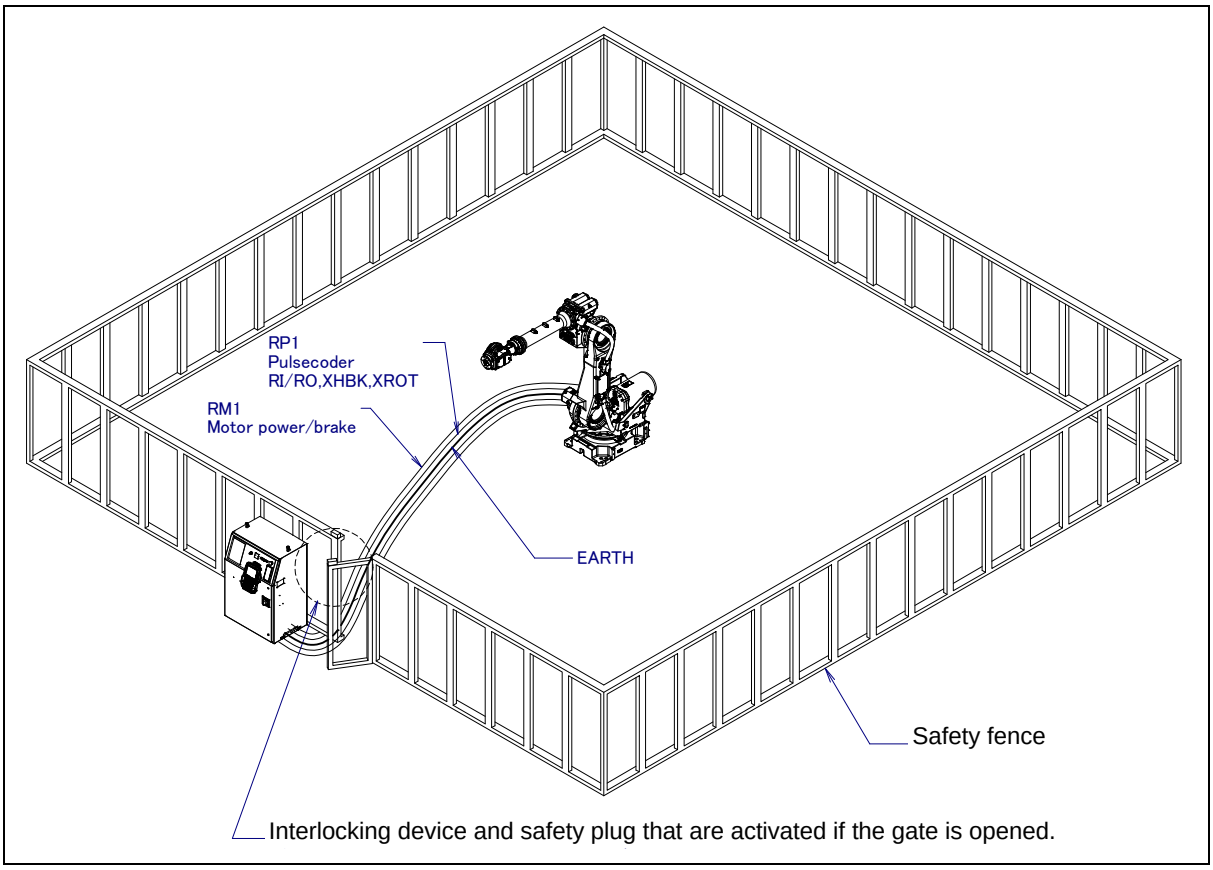


Fig. 3 (a) Safety fence and safety gate

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

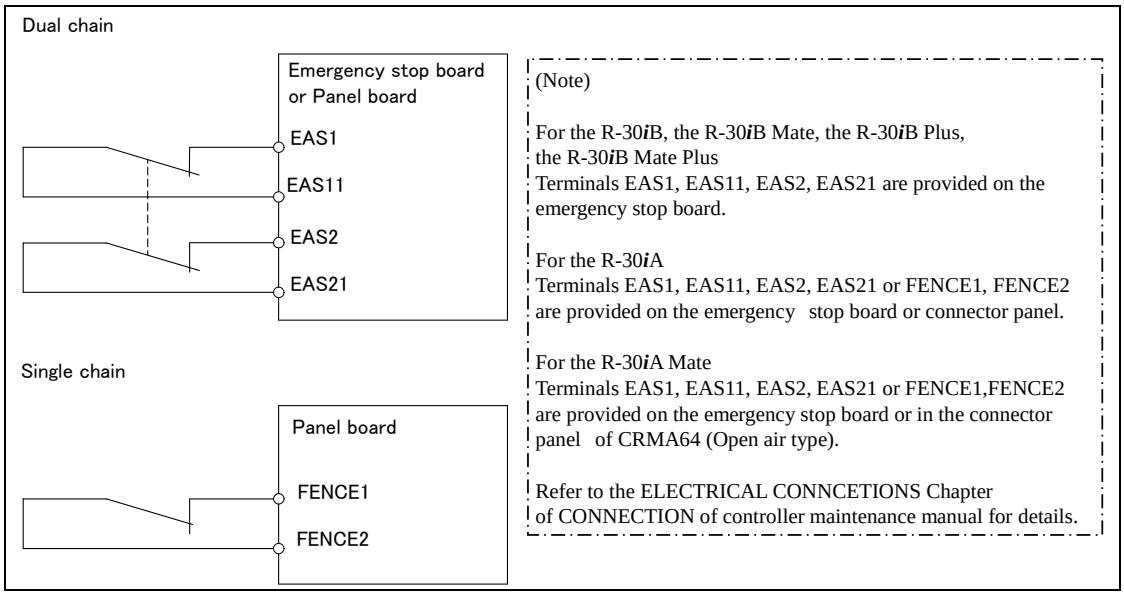


Fig. 3 (b) Connection diagram for the signal of safety fence

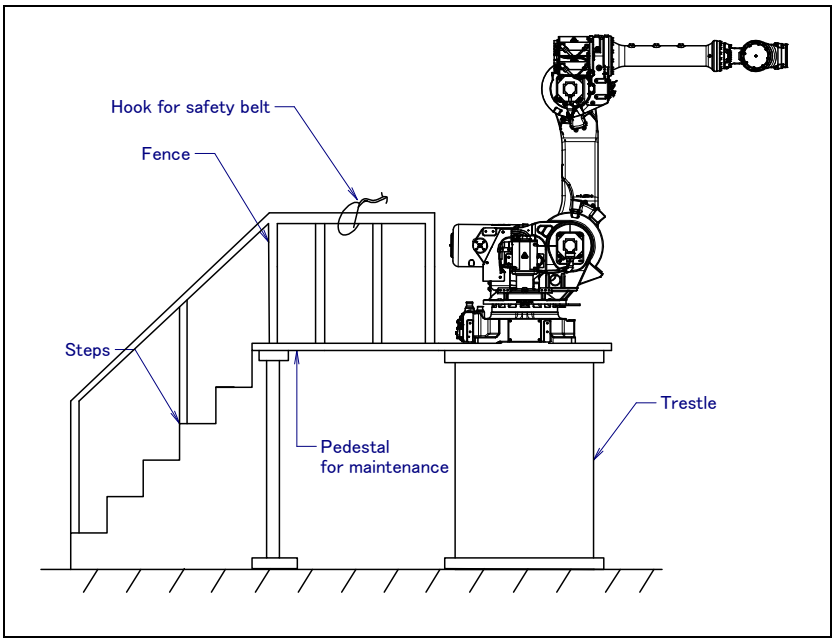


Fig. 3 (c) Pedestal for maintenance

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.

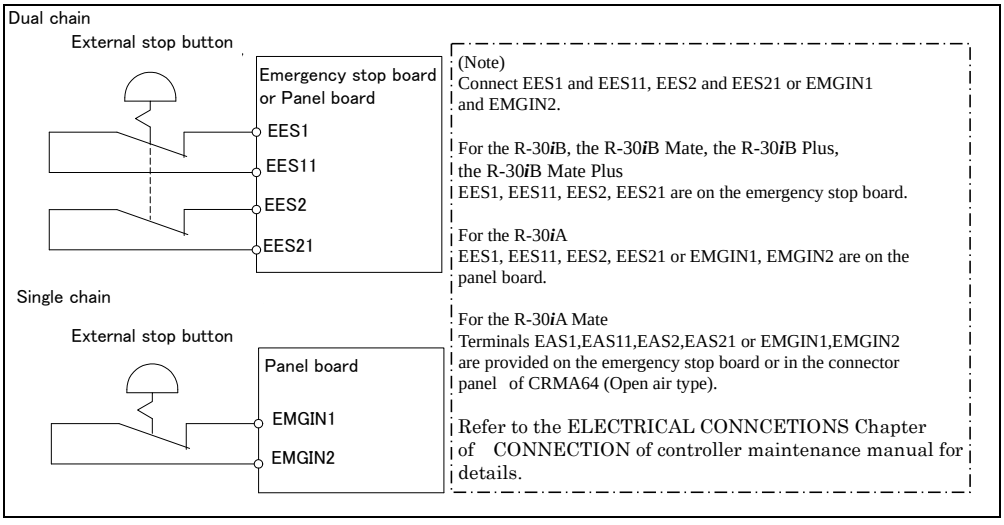


Fig. 3.1 Connection diagram for external emergency stop button

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-2525-J047 (5m) A05B-2525-J048(10m)
Power cable	A05B-2525-J010 (5m) (AC100-115V Power plug) (*) A05B-2525-J011(10m) (AC100-115V Power plug) (*) A05B-2450-J364 (5m) (AC100-115V or AC200-240V No power plug) A05B-2450-J365(10m) (AC100-115V or AC200-240V No power plug)

(*) Not supporting CE Marking.

(2) Prepare and store adequate numbers of brake release units which are ready 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 the gravity. Therefore, it is strongly recommended to take adequate measures such as hanging Robot arm by a crane before releasing a brake.

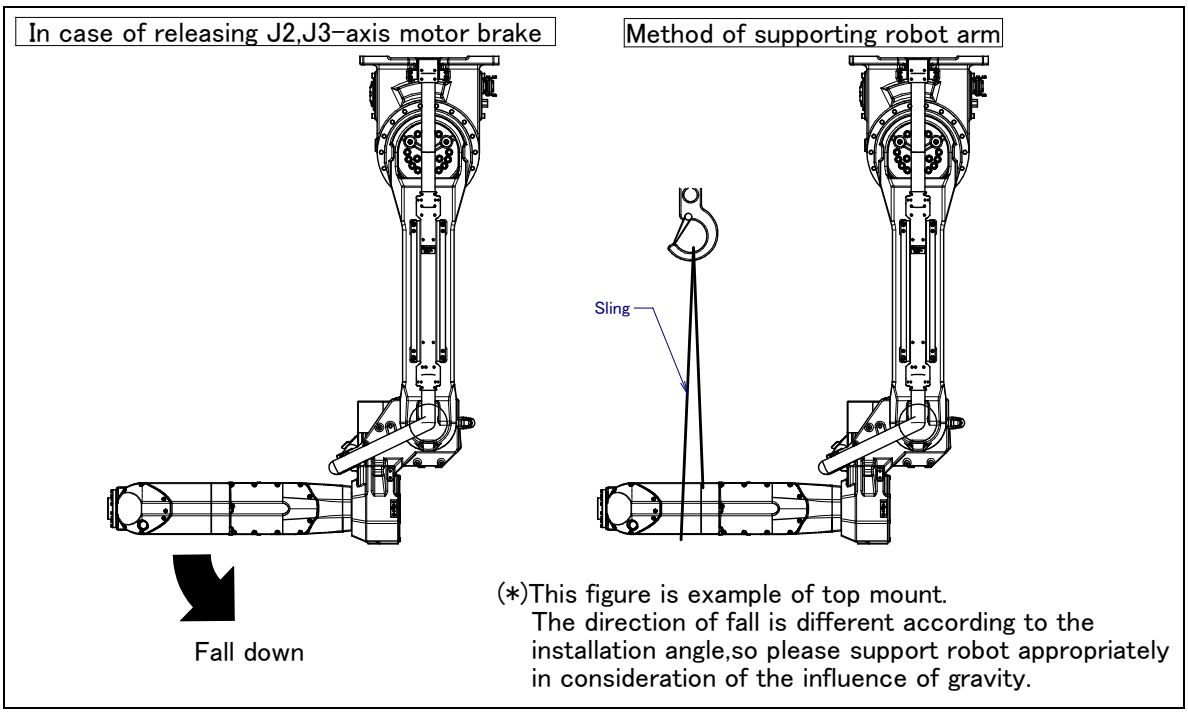


Fig. 5.4 Arm operation by the release of J2/J3-axis motor brake and measures

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 (R-30*i*A, R-30*i*A Mate)

The following three robot stop types exist:

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

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

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

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

Controlled stop (Category 1 following IEC 60204-1)

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

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

Hold (Category 2 following IEC 60204-1)

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

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

⚠ WARNING

1 The stopping distance and time of Controlled stop is longer than those 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. Please refer to the operator's manual of a particular robot model for the data of stopping distance and time.
2 In multi arm system, the longest stopping distance and time of Controlled Stop among each robot are adopted as those for the system. A risk assessment for the whole robot system which takes into consideration a possibility that the stopping distance and time increase, is necessary on the multi arm system.
3 In the system which has extended axis, the longer stopping distance and time of Controlled Stop among robot and extended axis are adopted as those for the system. A risk assessment for the whole robot system which takes into consideration a possibility that the stopping distance and time increase, is necessary on the system which has extended axis. Please refer to the extended axis setup procedure of the controller operator’s manual for considering the stopping distance and time of the extended axis.
4 In case of Controlled stop, motor power shutdown is delayed for a maximum of 2 seconds. In this case, a risk assessment for the whole robot system is necessary, including the 2 seconds delay.

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

There are the following 3 Stop patterns.

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

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

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

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

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

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

"Controlled stop by E-Stop" option

When "Stop type set (Stop pattern C) (A05B-2500-J570) option is specified, the stop type of the following alarms becomes Controlled stop but only in AUTO mode. In T1 or T2 mode, the stop type is Power-Off stop which is the normal operation of the system.

Alarm	Condition
SRVO-001 Operator panel E-stop	Operator panel emergency stop is pressed.
SRVO-002 Teach pendant E-stop	Teach pendant emergency stop is pressed.
SRVO-007 External emergency stops	External emergency stop input (EES1-EES11, EES2-EES21) is open. (R-30*i*A 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 other devices if it deviates from the program path.
- In Controlled stop, physical impact is less than Power-Off stop. This function is effective for systems where the physical impact to the mechanical unit or EOAT (End Of Arm Tool) should be minimized.
- The stopping distance and stopping time of Controlled stop is longer than the stopping distance and stopping time of Power-Off stop, depending on the robot model and axis. Please refer to the operator's manual of a particular robot model for the data of stopping distance and stopping time.

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

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

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

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

8 STOP TYPE OF ROBOT (R-30*i*B, R-30*i*B Mate)

There are following four types of Stopping Robot.

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

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

- An alarm is generated, and then the servo power turns off. Instantly the robot stops.
- Execution of the program is paused.

Frequent Power-Off stop of the robot during operation can cause mechanical problems 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.
"**Controlled stop**" performs following processing.

- The alarm "**SRVO-199 Controlled stop**" occurs along with a decelerated stop. The program execution is paused.
- An alarm is generated, and then the servo power turns off.

Smooth stop (Category 1 following IEC 60204-1)

The robot is decelerated until it stops, and servo power is turned off.
"**Smooth stop**" performs following processing.

- The alarm "**SRVO-289 Smooth Stop**" occurs along with a decelerated stop. The program execution is paused.
- An alarm is generated, and then the servo power turns off.
- In Smooth stop, the robot decelerates until it stops with the deceleration time shorter than Controlled stop.

Hold (Category 2 following IEC 60204-1)

The robot is decelerated until it stops, and servo power remains on.
"**Hold**" performs following processing.

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

⚠ WARNING

1 The stopping distance and time of Controlled stop and Smooth stop are longer than those 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 or Smooth Stop is used. Please refer to the operator's manual of a particular robot model for the data of stopping distance and time.
2 In multi arm system, the longest stopping distance and time of Controlled Stop or Smooth Stop among each robot are adopted as those for the system. A risk assessment for the whole robot system which takes into consideration a possibility that the stopping distance and time increase, is necessary on the multi arm system.
3 In the system which has extended axis, the longer stopping distance and time of Controlled Stop or Smooth Stop among robot and extended axis are adopted as those for the system. A risk assessment for the whole robot system which takes into consideration a possibility that the stopping distance and time increase, is necessary on the system which has extended axis. Please refer to the extended axis setup procedure of the controller operator's manual for considering the stopping distance and time of the extended axis.
4 When Smooth stop occurs during deceleration by Controlled stop, the stop type of robot is changed to Power-Off Stop.
When Smooth stop occurs during deceleration by Hold, the stop type of robot is changed to Power-Off Stop.
5 In case of Controlled stop or Smooth Stop, motor power shutdown is delayed for a maximum of 2 seconds. In this case, a risk assessment for the whole robot system is necessary, including the 2 seconds delay.

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

There are the following 3 Stop patterns.

Stop pattern	Mode	Emergency stop button	External Emergency stop	FENCE open	SVOFF input	Deadman switch (*)
A	AUTO	P-Stop	P-Stop	C-Stop	C-Stop	-
	T1	P-Stop	P-Stop	-	C-Stop	P-Stop
	T2	P-Stop	P-Stop	-	C-Stop	P-Stop
C	AUTO	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
D	AUTO	S-Stop	S-Stop	C-Stop	C-Stop	-
	T1	S-Stop	S-Stop	-	C-Stop	S-Stop
	T2	S-Stop	S-Stop	-	C-Stop	S-Stop

P-Stop: Power-Off stop
C-Stop: Controlled stop
S-Stop: Smooth stop
-: Disable
(*) The stop pattern of NTED input is same as Deadman switch.

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

Option	R-30*i*B/ R-30*i*B Mate
Standard	A(**)
Controlled stop by E-Stop (A05B-2600-J570)	C(**)
Smooth E-Stop (A05B-2600-J651)	D(**)

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

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

"Controlled stop by E-Stop" option

When "**Controlled stop by E-Stop**" (A05B-2600-J570) option is specified, the stop type of the following alarms become Controlled stop but only in AUTO mode. In T1 or T2 mode, the stop type is Power-Off stop which is the normal operation of the system.

Alarm	Condition
SRVO-001 Operator panel E-stop	Operator panel emergency stop is pressed.
SRVO-002 Teach pendant E-stop	Teach pendant emergency stop is pressed.
SRVO-007 External emergency stops	External emergency stop input (EES1-EES11, EES2-EES21) is open.
SRVO-408 DCS SSO Ext Emergency Stop	In DCS Safe I/O connect function, SSO[3] is OFF.
SRVO-409 DCS SSO Servo Disconnect	In DCS Safe I/O connect function, SSO[4] is OFF.

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

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

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

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

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

"Smooth E-Stop Function" option

When "**Smooth E-Stop Function**" (A05B-2600-J651) option is specified, the stop type of the following alarms becomes Smooth stop in all operation modes (AUTO, T1 and T2 mode).

Alarm	Condition
SRVO-001 Operator panel E-stop	Operator panel emergency stop is pressed.
SRVO-002 Teach pendant E-stop	Teach pendant emergency stop is pressed.
SRVO-003 Deadman switch released	Both deadman switches on Teach pendant are released.
SRVO-007 External emergency stops	External emergency stop input (EES1-EES11, EES2-EES21) is open.
SRVO-037 IMSTP input (Group: %d)	IMSTP input (*IMSTP signal for a peripheral device interface) is OFF.
SRVO-232 NTED input	NTED input (NTED1-NTED11, NTED2-NTED21) is open.
SRVO-408 DCS SSO Ext Emergency Stop	In DCS Safe I/O connect function, SSO[3] is OFF.
SRVO-409 DCS SSO Servo Disconnect	In DCS Safe I/O connect function, SSO[4] is OFF.
SRVO-410 DCS SSO NTED input	In DCS Safe I/O connect function, SSO[5] is OFF.
SRVO-419 DCS PROFIsafe comm. error	PROFINET Safety communication error occurs.

Smooth stop is different from **Power-Off stop** as follows:

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

Smooth stop is different from **Controlled stop** as follows:

- The stopping distance and time of Smooth stop is normally shorter than those of Controlled stop, depending on the robot model and axis.

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

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

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

9 STOP TYPE OF ROBOT (R-30*i*B Plus, R-30*i*B Mate Plus)

There are following three types of Stop Category.

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

Servo power is turned off, and the robot stops immediately. Servo power is turned off when the robot is moving, and the motion path of the deceleration is uncontrolled.

"**Stop Category 0**" performs following processing.

- An alarm is generated, and then the servo power turns off. Instantly the robot stops.
- Execution of the program is paused.

Frequent Category 0 Stop of the robot during operation can cause mechanical problems of the robot. Avoid system designs that require routine or frequent Category 0 Stop conditions.

Stop Category 1 following IEC 60204-1 (Controlled Stop, Smooth Stop)

The robot is decelerated until it stops, and servo power is turned off.

"**Stop Category 1**" performs following processing.

- The alarm "**SRVO-199 Controlled stop**" or "**SRVO-289 Smooth Stop**" occurs along with a decelerated stop. The program execution is paused.
- An alarm is generated, and then the servo power turns off.

In Smooth stop, the robot decelerates until it stops with the deceleration time shorter than Controlled stop. The stop type of Stop Category 1 is different according to the robot model or option configuration. Please refer to the operator's manual of a particular robot model.

Stop Category 2 following IEC 60204-1 (Hold)

The robot is decelerated until it stops, and servo power remains on.

"**Stop Category 2**" performs following processing.

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

⚠ WARNING

1 The stopping distance and time of Stop Category 1 are longer than those of Stop Category 0. A risk assessment for the whole robot system which takes into consideration the increased stopping distance and stopping time is necessary when Stop Category 1 is used. Please refer to the operator's manual of a particular robot model for the data of stopping distance and time.
2 In multi arm system, the longest stopping distance and time of Stop Category 1 among each robot are adopted as those for the system. A risk assessment for the whole robot system which takes into consideration a possibility that the stopping distance and time increase, is necessary on the multi arm system.
3 In the system which has extended axis, the longer stopping distance and time of Stop Category 1 among robot and extended axis are adopted as those for the system. A risk assessment for the whole robot system which takes into consideration a possibility that the stopping distance and time increase, is necessary on the system which has extended axis. Please refer to the extended axis setup procedure of the controller operator's manual for considering the stopping distance and time of the extended axis.
4 When Stop Category 1 occurs during deceleration by Stop Category 2, the stop type of robot is changed to Stop Category 0.
5 In case of Stop Category 1, motor power shutdown is delayed for a maximum of 2 seconds. In this case, a risk assessment for the whole robot system is necessary, including the 2 seconds delay.

When the emergency stop button is pressed or the FENCE is open, the stop type of robot is Stop Category 0 or Stop Category 1. The configuration of stop type for each situation is called *stop pattern*. The stop pattern is different according to the option configuration.

There are the following 3 Stop patterns.

Stop pattern	Mode	Emergency stop button	External Emergency stop	FENCE open	SVOFF input	Deadman switch (*)
A	AUTO	Category 0	Category 0	Category 1	Category 1	-
	T1	Category 0	Category 0	-	Category 1	Category 0
	T2	Category 0	Category 0	-	Category 1	Category 0
C	AUTO	Category 1	Category 1	Category 1	Category 1	-
	T1	Category 0	Category 0	-	Category 1	Category 0
	T2	Category 0	Category 0	-	Category 1	Category 0
D	AUTO	Category 1	Category 1	Category 1	Category 1	-
	T1	Category 1	Category 1	-	Category 1	Category 1
	T2	Category 1	Category 1	-	Category 1	Category 1

Category 0: Stop Category 0
Category 1: Stop Category 1
-: Disable
(*) The stop pattern of NTED input is same as Deadman switch.

The following table indicates the Stop pattern according to the controller type or option configuration.
The case R651 is specified.

Option	R-30*i*B Plus/ R-30*i*B Mate Plus
Standard	C(**)
Old Stop Function (A05B-2670-J680)	A(**)
All Smooth Stop Function (A05B-2670-J651)	D(**)

The case R650 is specified.

Option	R-30*i*B Plus/ R-30*i*B Mate Plus
Standard	A(**)
Stop Category 1 by E-Stop (A05B-2670-J521)	C(**)
All Smooth Stop Function (A05B-2670-J651)	D(**)

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

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

"Old Stop Function" option

When "**Old Stop Function**" (A05B-2670-J680) option is specified, the stop type of the following alarms becomes Stop Category 0 in AUTO mode.

Alarm	Condition
SRVO-001 Operator panel E-stop	Operator panel emergency stop is pressed.
SRVO-002 Teach pendant E-stop	Teach pendant emergency stop is pressed.
SRVO-007 External emergency stops	External emergency stop input (EES1-EES11, EES2-EES21) is open.
SRVO-408 DCS SSO Ext Emergency Stop	In DCS Safe I/O connect function, SSO[3] is OFF.
SRVO-409 DCS SSO Servo Disconnect	In DCS Safe I/O connect function, SSO[4] is OFF.

Stop Category 0 is different from **Stop Category 1** as follows:

- In Stop Category 0, servo power is turned off, and the robot stops immediately. Servo power is turned off when the robot is moving, and the motion path of the deceleration is uncontrolled.
- The stopping distance and time of Stop Category 0 is shorter than those of Stop Category 1, depending on the robot model and axis.

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.

"All Smooth Stop Function" option

When "**All Smooth Stop Function**" (A05B-2670-J651) option is specified, the stop type of the following alarms becomes Stop Category 1 in all operation modes (AUTO, T1 and T2 mode).

Alarm	Condition
SRVO-001 Operator panel E-stop	Operator panel emergency stop is pressed.
SRVO-002 Teach pendant E-stop	Teach pendant emergency stop is pressed.
SRVO-003 Deadman switch released	Both deadman switches on Teach pendant are released.
SRVO-007 External emergency stops	External emergency stop input (EES1-EES11, EES2-EES21) is open.
SRVO-037 IMSTP input (Group: %d)	IMSTP input (*IMSTP signal for a peripheral device interface) is ON.
SRVO-232 NTED input	NTED input (NTED1-NTED11, NTED2-NTED21) is open.
SRVO-408 DCS SSO Ext Emergency Stop	In DCS Safe I/O connect function, SSO[3] is OFF.
SRVO-409 DCS SSO Servo Disconnect	In DCS Safe I/O connect function, SSO[4] is OFF.
SRVO-410 DCS SSO Ext Emergency Stop	In DCS Safe I/O connect function, SSO[5] is OFF.
SRVO-419 DCS PROFIsafe comm. error	PROFINET Safety communication error occurs.

Stop Category 1 is different from **Stop Category 0** as follows:

- In Stop Category 1, the robot is stopped along the program path. This function is effective for a system where the robot can interfere with other devices if it deviates from the program path.
- In Stop Category 1, physical impact is less than Stop Category 0. This function is effective for systems where the physical impact to the mechanical unit or EOAT (End of Arm Tool) should be minimized.
- The stopping distance and time of Stop Category 1 is longer than those of Stop Category 0, depending on the robot model and axis.

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

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

> ⚠ **WARNING**
> The stopping distance and time of Stop Category 1 are longer than those of Stop Category 0. A risk assessment for the whole robot system which takes into consideration the increased stopping distance and stopping time, is necessary when this option is loaded.

"Stop Category 1 by E-Stop" option

When "**Stop Category 1 by E-Stop**" (A05B-2670-J521) option is specified, the stop type of the following alarms become Category 1 Stop but only in AUTO mode. In T1 or T2 mode, the stop type is Category 0 Stop which is the normal operation of the system.

Alarm	Condition
SRVO-001 Operator panel E-stop	Operator panel emergency stop is pressed.
SRVO-002 Teach pendant E-stop	Teach pendant emergency stop is pressed.
SRVO-007 External emergency stops	External emergency stop input (EES1-EES11, EES2-EES21) is open.
SRVO-408 DCS SSO Ext Emergency Stop	In DCS Safe I/O connect function, SSO[3] is OFF.
SRVO-409 DCS SSO Servo Disconnect	In DCS Safe I/O connect function, SSO[4] is OFF.

Stop Category 1 is different from **Stop Category 0** as follows:

- In Stop Category 1, the robot is stopped along the program path. This function is effective for a system where the robot can interfere with other devices if it deviates from the program path.
- In Stop Category 1, physical impact is less than Stop Category 0. This function is effective for systems where the physical impact to the mechanical unit or EOAT (End of Arm Tool) should be minimized.
- The stopping distance and time of Stop Category 1 is longer than those of Stop Category 0, depending on the robot model and axis.

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

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

> ⚠ **WARNING**
> The stopping distance and time of Stop Category 1 are longer than those of Stop Category 0. A risk assessment for the whole robot system which takes into consideration the increased stopping distance and stopping time, is necessary when this option is loaded.

10 WARNING & CAUTION LABEL

(1) Greasing and degreasing label

Fig. 10 (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 a specified grease.

> ⚠ **CAUTION**
> See Chapter 7 and 8 “PERIODIC MAINTENANCE” for explanations about specified grease, grease amount, and the locations of grease and degrease outlets for individual models.

(2) Step-on prohibitive label

Fig. 10 (b) Step-on prohibitive label

Description

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

(3) High-temperature warning label

Fig. 10 (c) High-temperature warning label

Description

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

(4) Transportation label

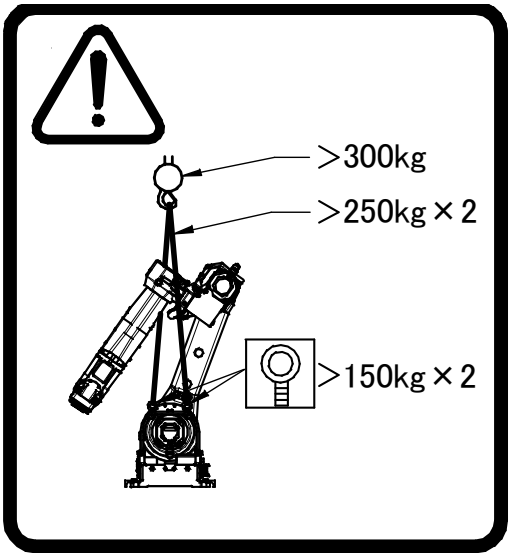


Fig. 10 (d) Transportation label

Description

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

- Use a crane with a load capacity of 300kg or greater.
- Use two slings with each load capacity of 250 kg or greater, sling the robot as shown Chapter 1 of operator's manual.
- Use two M12 eyebolts with each allowable load of 1470 N (150 kgf) or greater.

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

(5) High current attention label

Fig. 10 (e) High current attention label

Description

Do not access during energized high current inside.

(6) Operating space and payload mark label

Below label is added when CE specification is specified.

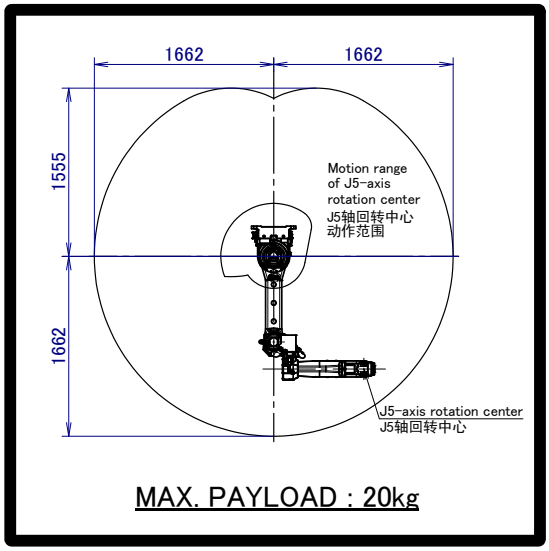


Fig. 10 (f) Operating space and payload mark label (Example of ARC Mate 120*i*C/20T, M-20*i*A/20T)

170616

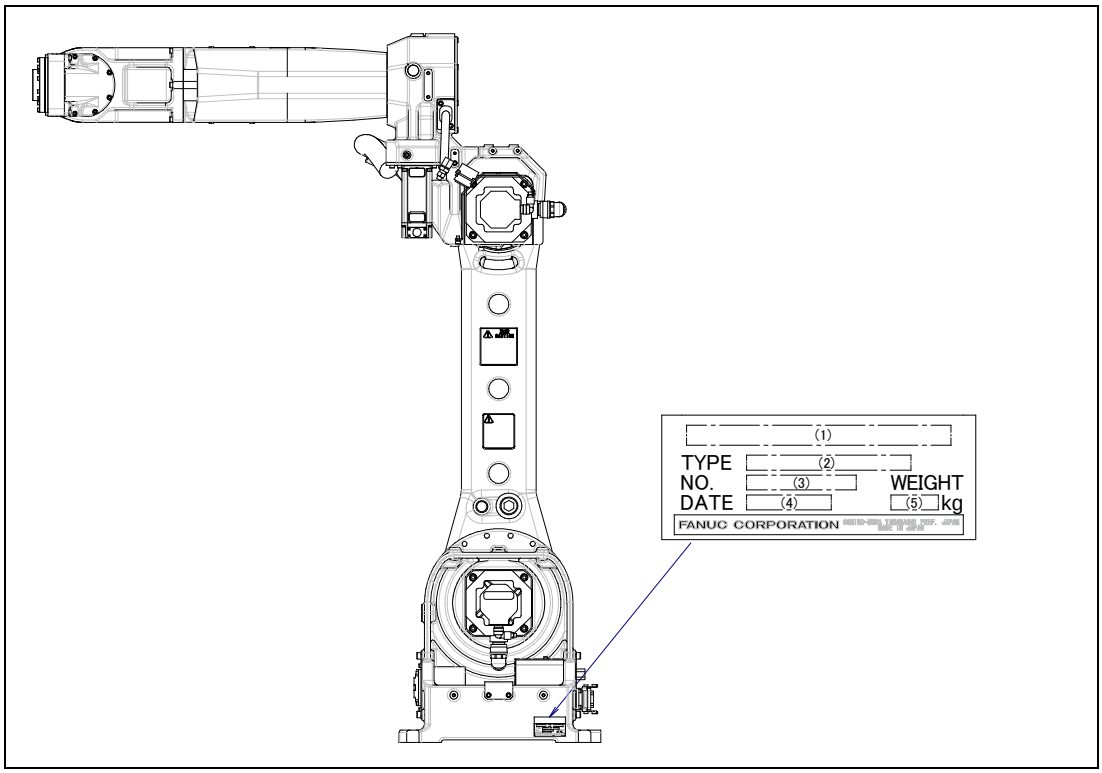
PREFACE

This manual explains that operation procedures for the following mechanical unit:

Model name	Mechanical unit specification No.	Maximum load	Remarks
FANUC Robot ARC Mate 120*i*C/20T	A05B-1222-B221 (*1)	3kg or 20kg	J1-axis motor is attached (Taper shaft)
	A05B-1225-B221 (*2)		
	A05B-1225-B271 (*2)		
FANUC Robot M-20*i*A/20T	A05B-1222-B222 (*1)	3kg or 20kg	J1-axis motor is attached (Taper shaft)
	A05B-1225-B222 (*2)		
	A05B-1225-B272 (*2)		
FANUC Robot ARC Mate 120*i*C/20T	A05B-1222-B231 (*1)	3kg or 20kg	J1-axis motor is attached (Straight shaft)
	A05B-1225-B231 (*2)		
	A05B-1225-B281 (*2)		
FANUC Robot M-20*i*A/20T	A05B-1222-B232 (*1)	3kg or 20kg	J1-axis motor is attached (Straight shaft)
	A05B-1225-B232 (*2)		
	A05B-1225-B282 (*2)		
FANUC Robot M-20*i*A/20MT	A05B-1222-B722	20kg	J1-axis motor is attached (Taper shaft)
	A05B-1225-B722		
FANUC Robot M-20*i*A/20MT	A05B-1222-B732	20kg	J1-axis motor is attached (Straight shaft)
	A05B-1225-B732		
FANUC Robot M-20*i*A/35MT	A05B-1225-B725	35kg	J1-axis motor is attached (Taper shaft)
FANUC Robot M-20*i*A/35MT	A05B-1225-B735	35kg	J1-axis motor is attached (Straight shaft)

NOTE
Motor specifications of (*1) differs from (*2).

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.



Position of label indicating mechanical unit specification number

TABLE 1

	(1)	(2)	(3)	(4)	(5)
CONTENTS	**Model name**	**TYPE**	**No.**	**DATE**	**WEIGHT kg (Without controller)**
LETTERS	FANUC Robot ARC Mate 120*i*C/20T	A05B-1222-B221	SERIAL NO. IS PRINTED	PRODUCTION YEAR AND MONTH ARE PRINTED	185
		A05B-1225-B221			
		A05B-1225-B271			
	FANUC Robot M-20*i*A/20T	A05B-1222-B222			
		A05B-1225-B222			
		A05B-1225-B272			
	FANUC Robot ARC Mate 120*i*C/20T	A05B-1222-B231			
		A05B-1225-B231			
		A05B-1225-B281			
	FANUC Robot M-20*i*A/20T	A05B-1222-B232			
		A05B-1225-B232			
		A05B-1225-B282			
	FANUC Robot M-20*i*A/20MT	A05B-1222-B722			
		A05B-1225-B722			
	FANUC Robot M-20*i*A/20MT	A05B-1222-B732			
		A05B-1225-B732			
	FANUC Robot M-20*i*A/35MT	A05B-1225-B725			187

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	Operator's Manual HANDLING TOOL **B-83124EN-2** ARC TOOL **B-83124EN-3** DISPENSE TOOL **B-83124EN-4** ALARM CODE LIST **B-83124EN-6**	Intended readers : Operator, programmer, Teaching operator, 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, Start-up, Connection, Maintenance Use : Installation, Start-up, Connection, Maintenance
R-30*i*B, R-30*i*B Plus controller	Operator's manual (Basic Operation) **B-83284EN** Operator's manual (Alarm Code List) **B-83284EN-1** Operator's manual (Optional Function) **B-83284EN-2** Arc Welding Function Operator's manual **B-83284EN-3** Spot Welding Function Operator's manual **B-83284EN-4** Dispense Function Operator's manual **B-83284EN-5**	Intended readers : Operator, programmer, Teaching operator, 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, Start-up, Connection, Maintenance Use : Installation, Start-up, Connection, Maintenance

AC servo motor (For J1-axis motor)	AC SERVO MOTOR αis,αi series DESCRIPTION **B-65262EN**	Intended readers: Maintenance engineer, System designer Topics: Specification, Usage Use: Confirmation of specification and usage
	FANUC AC SERVO MOTOR αis series FANUC AC SERVO MOTOR αi series FANUC AC SPINDLE MOTOR αi series FANUC SERVO AMPLIFIER αi series Maintenance Manual **B-65285EN**	Intended readers: Maintenance engineer, System designer Topics: Setup, Troubleshooting, Maintenance Use: Setup, Troubleshooting, Maintenance

⚠ CAUTION
The servo motor for the J1-axis is appended to this robot. “AC SERVO MOTOR αis, αi series DESCRIPTION” describe points of concern to use our servo motor safely. Read it before use the servo motor, and use the servo motor correctly after the each function is understood enough.

Following words is used in this manual.

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

TABLE OF CONTENTS

SAFETY PRECAUTIONS s-1

PREFACE p-1

1 TRANSPORTATION AND INSTALLATION 1
1.1 TRANSPORTATION 1
1.2 INSTALLATION 4
1.2.1 Angle of Mounting Surface Setting 7
1.3 MAINTENANCE AREA 9
1.4 INSTALLATION CONDITIONS 9

2 CONNECTION WITH THE CONTROLLER 10
2.1 CONNECTION WITH THE CONTROLLER 10

3 BASIC SPECIFICATIONS 11
3.1 ROBOT CONFIGURATION 11
3.2 MECHANICAL UNIT EXTERNAL DIMENSIONS AND OPERATING SPACE 15
3.3 ZERO POINT POSITION AND MOTION LIMIT 17
3.4 MOTION RANGE SETTING FOR INTEGRATED HAND CABLE 22
3.5 WRIST LOAD CONDITIONS 23

4 EQUIPMENT INSTALLATION TO THE ROBOT 27
4.1 END EFFECTOR INSTALLATION TO WRIST 27
4.2 EQUIPMENT MOUNTING FACE 31
4.3 LOAD SETTING 34
4.4 CHANGING METHOD OF WRIST PAYLOAD SPECIFICATION FOR ARC Mate120*i*C/20T, M-20*i*A/20T 36
4.4.1 Method of Executing KAREL Program by Using “Call Program” 37
4.4.2 Method of Executing KAREL Program Directly 40
4.5 SETUP OF J1-AXIS 42
4.5.1 Enable and Adjustment of Collision Detection of J1-Axis 47

5 PIPING AND WIRING TO THE END EFFECTOR 49
5.1 AIR SUPPLY (OPTION) 50
5.2 AIR PIPING (OPTION) 51
5.3 INTERFACE FOR OPTION CABLE (OPTION) 52

6 AXIS LIMIT SETUP 59
6.1 CHANGE AXIS LIMIT BY DCS (OPTION) 60

7 CHECKS AND MAINTENANCE (ARC Mate 120*i*C/20T M-20*i*A/20T) 63
7.1 CHECKS AND MAINTENANCE 63
7.1.1 Daily Checks 63
7.1.2 Periodic Checks and Maintenance 64
7.2 CHECK POINTS 67
7.2.1 Confirmation of Oil Seepage 67
7.2.2 Confirmation of the Air Control Set (option) 68

7.2.3 Check the Oil Sight Glasses 68
7.2.4 Check the Failure of the Wrist Part Fluoric Resin Ring....69
7.2.5 Check the Mechanical Unit Cables and Connectors 70
7.2.6 Check of Fixed Mechanical Stopper and Adjustable Mechanical Stopper 72
7.3 MAINTENANCE....73
7.3.1 Replacing the Batteries (1-year (3840 hours) checks)....73
7.3.2 Replacing the Grease and Oil of the Drive Mechanism (3-year (11520 hours) checks)....74
7.3.2.1 Grease replacement procedure for J2/J3-axis reducer 75
7.3.2.2 Procedure for releasing remaining pressure from the grease bath (J2/J3-axis)....77
7.3.2.3 Oil replacement procedure for J4-axis gearbox....78
7.3.2.4 Oil replacement procedure for J5/J6-axis gearbox 81
7.3.2.5 Procedure for releasing remaining pressure from oil bath (J4 to J6-axis)....87
7.4 STORAGE 87

8 CHECKS AND MAINTENANCE (M-20*i*A/20MT/35MT)....88
8.1 CHECKS AND MAINTENANCE 88
8.1.1 Daily Checks 88
8.1.2 Periodic Checks and Maintenance....89
8.2 CHECK POINTS....91
8.2.1 Confirmation of Oil Seepage....91
8.2.2 Confirmation of the Air Control Set (option)....92
8.2.3 Check the Mechanical Unit Cables and Connectors 92
8.2.4 Check of Fixed Mechanical Stopper and Adjustable Mechanical Stopper 94
8.3 MAINTENANCE....95
8.3.1 Replacing the Batteries (1-year (3840 hours) checks)....95
8.3.2 Greasing (1-year (3840 hours) checks) 96
8.3.3 Replacing the Grease of the Drive Mechanism (3-year (11520 hours) checks)....97
8.3.3.1 Grease replacement procedure for J2/J3-axis reducer 98
8.3.3.2 Grease replacement procedure for J4/J5-axis gearbox 100
8.3.3.3 Procedure for releasing remaining pressure from the grease bath (J2/J3-axis)....102
8.3.3.4 Procedure for releasing remaining pressure from the grease bath (J4 to J6-axis)....103
8.4 STORAGE 103

9 MASTERING 104
9.1 OVERVIEW 104
9.2 RESETTING ALARMS AND PREPARING FOR MASTERING 106
9.3 ZERO POSITION MASTERING 107
9.4 QUICK MASTERING....111
9.5 QUICK MASTERING FOR SINGLE AXIS 113
9.6 SINGLE AXIS MASTERING 115
9.7 MASTERING DATA ENTRY....118
9.8 VERIFYING MASTERING 120

10 TROUBLESHOOTING 121
10.1 TROUBLESHOOTING....121
10.2 CHANGE THE COLLISION DETECTION PARAMETER 128

11 M/H CONDUIT (ARC Mate 120*i*C/20T, M-20*i*A/20T OPTION).....129

11.1 NOTES FOR ASSEMBLING CABLE TO M/H CONDUIT 129
11.2 OTHER NOTES 130

APPENDIX

A PERIODIC MAINTENANCE TABLE 133

B STRENGTH OF BOLT AND BOLT TORQUE LIST 138

C INSULATION ABOUT ARC WELDING ROBOT 139
C.1 INSULATION AT THE WRIST 139

D ABOUT MULTIPLE ROBOT CONTROL 140

1 TRANSPORTATION AND INSTALLATION

1.1 TRANSPORTATION

Use a crane to transport the robot. When transporting the robot, be sure to change the posture of the robot to that shown below. The eyebolts and the transport equipment are sure to attach to prescribed place.

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

> ⚠ **WARNING**
> 1 Robot becomes unstable when it is transported with the end effector or equipment is installed, and it is dangerous. Please be sure to remove end effector when robot is transported.
> (Except light thins such as welding torch or wire feeder)
> 2 Before moving the robot by using crane, check and tighten any loose bolts on the transport equipment.
> 3 Do not pull eyebolts sideways.
> 4 This robot cannot stand-alone. Robot may topple without transport bracket. Transport bracket must not be removed before fixing the robot.

When transportation ends, remove the two M12 eyebolts from the J2 base.

> ⚠ **CAUTION**
> Before moving the J2-axis section, be sure to remove the eyebolt from the J2 base so that the J2-axis stopper does not interfere with the eyebolt.

Transportation using a crane (Fig. 1.1 (a) to (c))
Fasten the M10 eyebolts to the two points of the robot base and lift the robot by the two slings. In this case, please intersect and hang two Slings as shown in figure.

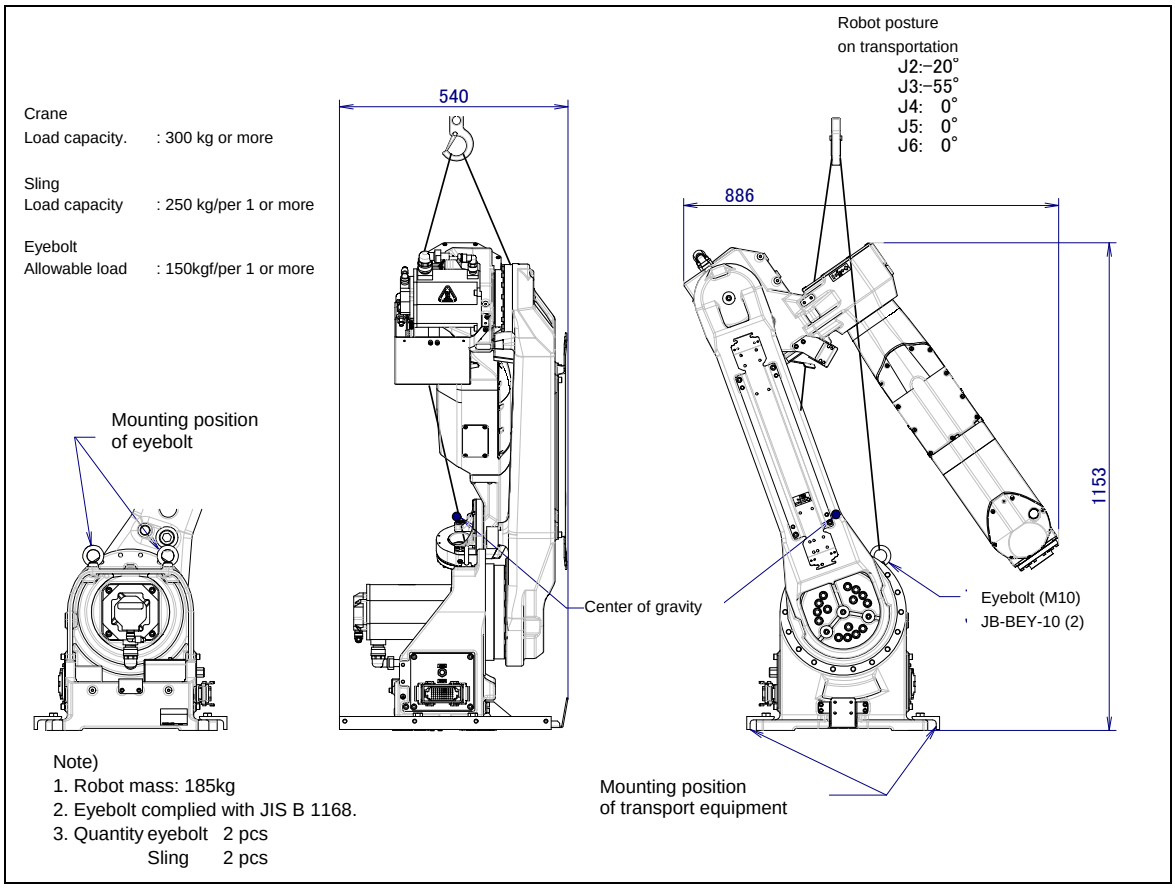


Fig. 1.1 (a) Transportation using a crane

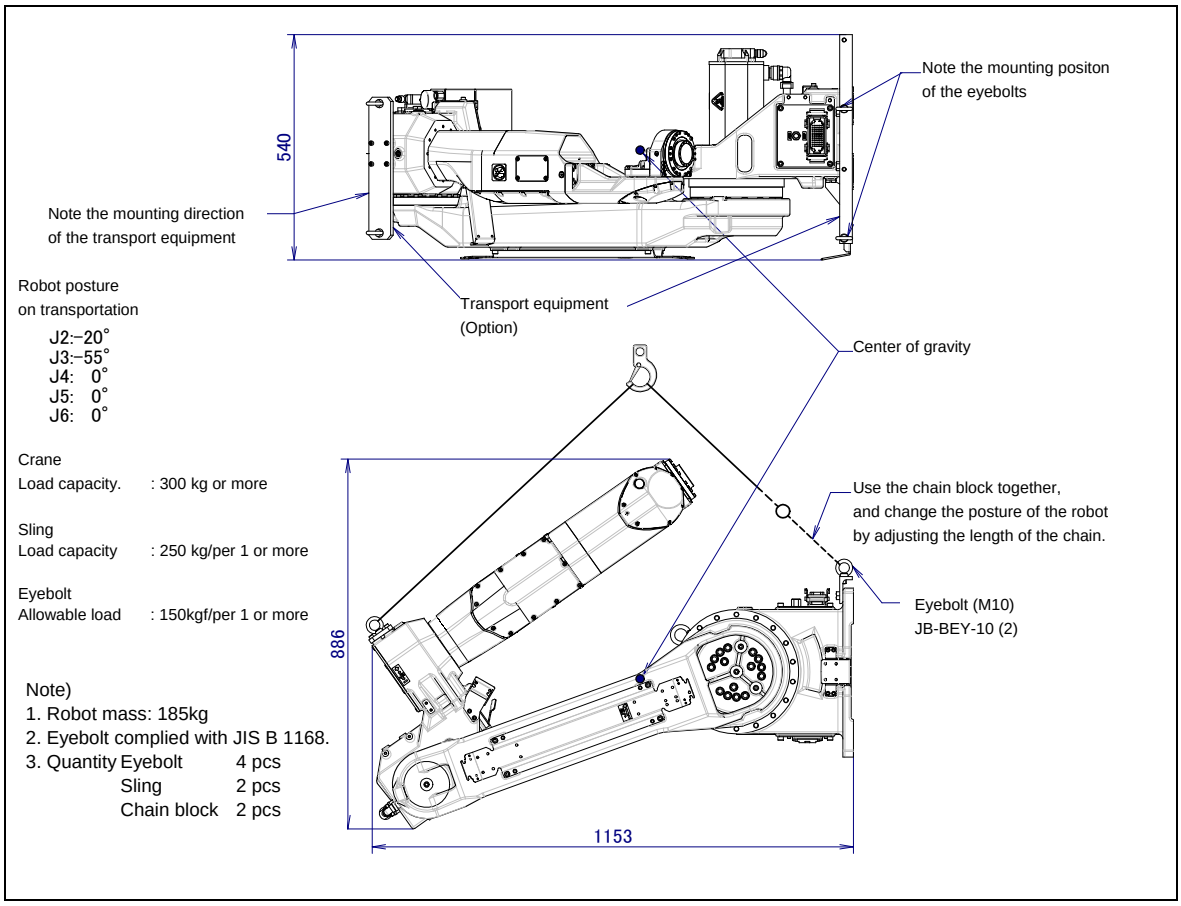


Fig. 1.1 (b) Method of the install on the inclined (wall mount -90°)

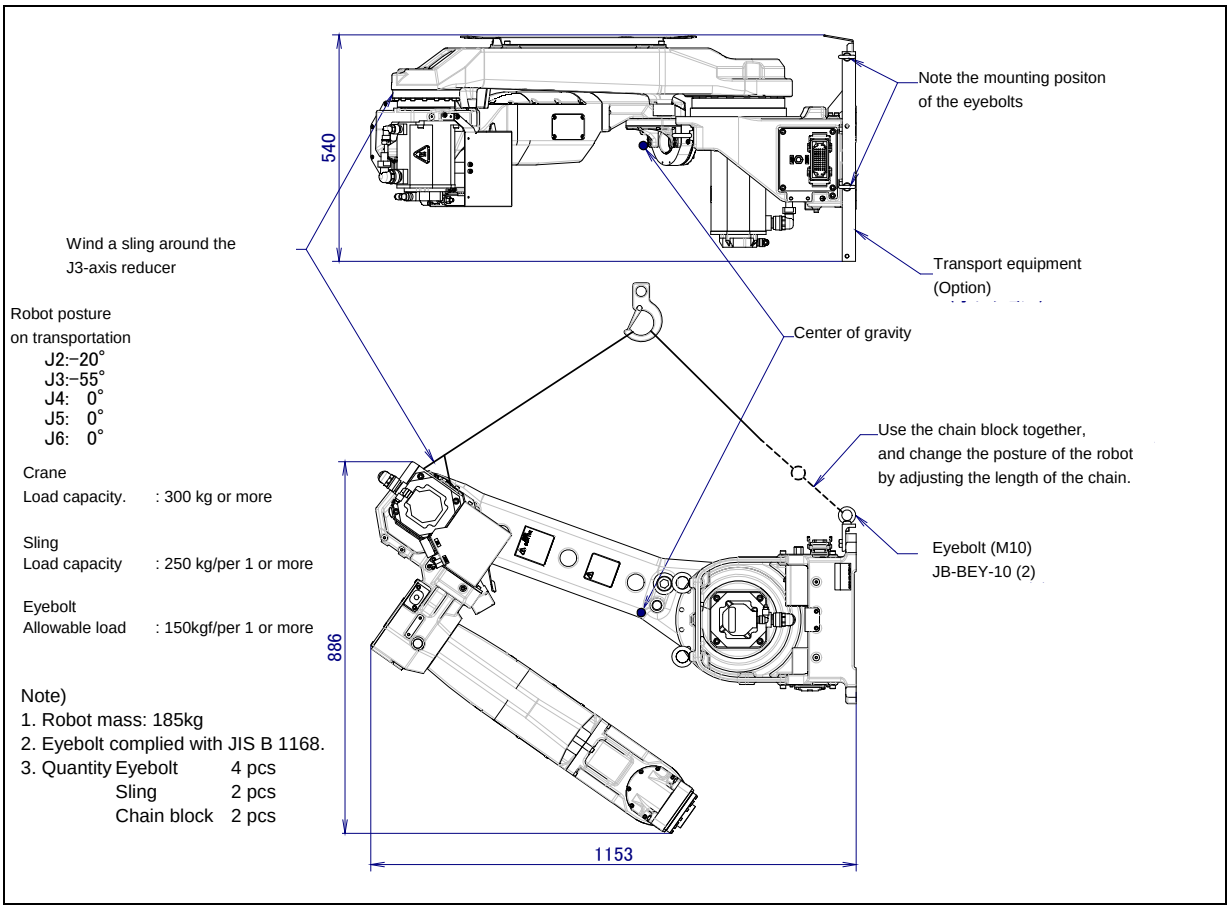


Fig. 1.1 (c) Method of the install on the inclined (wall mount +90°)

1.2 INSTALLATION

Fig. 1.2 (a) shows the robot base dimensions.

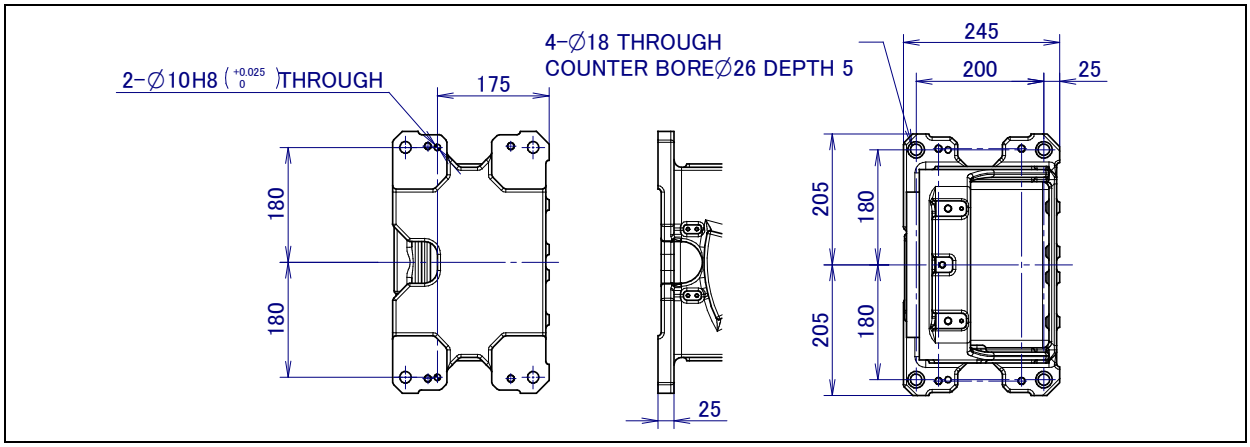


Fig. 1.2 (a) Dimensions of the robot J2 base

NOTE

Use four M16 hexagon holes bolts (Tensile strength 1200N/mm^2 or more) and tighten it with torque of 318Nm for mounting of robot base.
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.

Table 1.2 (a), (b) 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.

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

Model		J2-axis	J3-axis
ARC Mate 120*i*C/20T, M-20*i*A/20T	Stopping time [ms]	246	125
	Stopping distance [deg] (rad)	21.2 (0.37)	11.5 (0.20)
M-20*i*A/20MT	Stopping time [ms]	252	132
	Stopping distance [deg] (rad)	21.2 (0.37)	11.7 (0.20)
M-20*i*A/35MT	Stopping time [ms]	188	124
	Stopping distance [deg] (rad)	5.7 (0.10)	7.2 (0.13)

* Max payload and max speed

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

Model		J2-axis	J3-axis
ARC Mate 120*i*C/20T, M-20*i*A/20T	Stopping time [ms]	429	444
	Stopping distance [deg] (rad)	44.3 (0.77)	47.3 (0.83)
M-20*i*A/20MT	Stopping time [ms]	468	468
	Stopping distance [deg] (rad)	44.3 (0.77)	47.3 (0.83)
M-20*i*A/35MT	Stopping time [ms]	596	596
	Stopping distance [deg] (rad)	21.0 (0.37)	35.9 (0.63)

* Max payload and max speed

Fig. 1.2 (b), (c) and Table (c) to (h) show the force and moment applied to the J2 base. Refer to the data when considering the strength of the installation face.

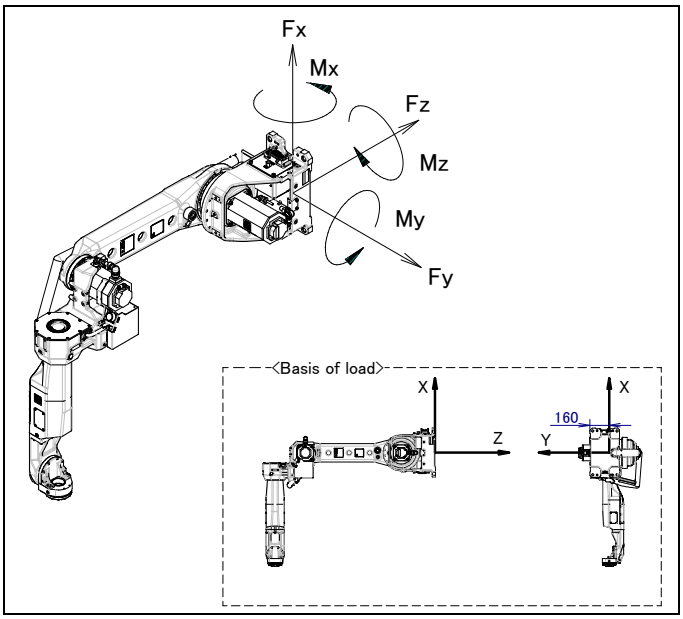


Fig. 1.2 (b) Force and moment that acts on J2 base (wall mount)

Table 1.2 (c) Force and moment that act on J2 base (wall mount) (ARC Mate 120*i*C/20T, M-20*i*A/20T)

	Load along the X-axis Fx N (kgf)	Load along the Y-axis Fy N (kgf)	Load along the Z-axis Fz N (kgf)	Moment around the X-axis Mx Nm (kgfm)	Moment around the Y-axis My Nm (kgfm)	Moment around the Z-axis Mz Nm (kgfm)
During stillness	2823 (288)	0 (0)	0 (0)	0 (0)	1897 (194)	0 (0)
During acceleration or deceleration	4574 (467)	1801 (184)	1751 (179)	1210 (123)	4847 (495)	1210 (123)
During Power-Off stop	9897 (1010)	3841 (392)	7073 (722)	2581 (263)	13959 (1424)	2581 (263)

Table 1.2 (d) Force and moment that act on J2 base (wall mount) (M-20*i*A/20MT)

	Load along the X-axis Fx N (kgf)	Load along the Y-axis Fy N (kgf)	Load along the Z-axis Fz N (kgf)	Moment around the X-axis Mx Nm (kgfm)	Moment around the Y-axis My Nm (kgfm)	Moment around the Z-axis Mz Nm (kgfm)
During stillness	2842 (290)	0 (0)	0 (0)	0 (0)	1917 (196)	0 (0)
During acceleration or deceleration	4574 (433)	1813 (185)	1405 (143)	1223 (125)	4293 (438)	1223 (125)
During Power-Off stop	9970 (1017)	3867 (395)	7128 (727)	2609 (266)	14119 (1441)	2609 (266)

Table 1.2 (e) Force and moment that act on J2 base (wall mount) (M-20*i*A/35MT)

	Load along the X-axis Fx N (kgf)	Load along the Y-axis Fy N (kgf)	Load along the Z-axis Fz N (kgf)	Moment around the X-axis Mx Nm (kgfm)	Moment around the Y-axis My Nm (kgfm)	Moment around the Z-axis Mz Nm (kgfm)
During stillness	2910 (297)	0 (0)	0 (0)	0 (0)	2192 (224)	0 (0)
During acceleration or deceleration	3832 (391)	1856 (189)	923 (94)	1398 (143)	3928 (401)	1398 (143)
During Power-Off stop	7276 (742)	3959 (404)	4367 (446)	3531 (360)	10945 (1117)	3531 (360)

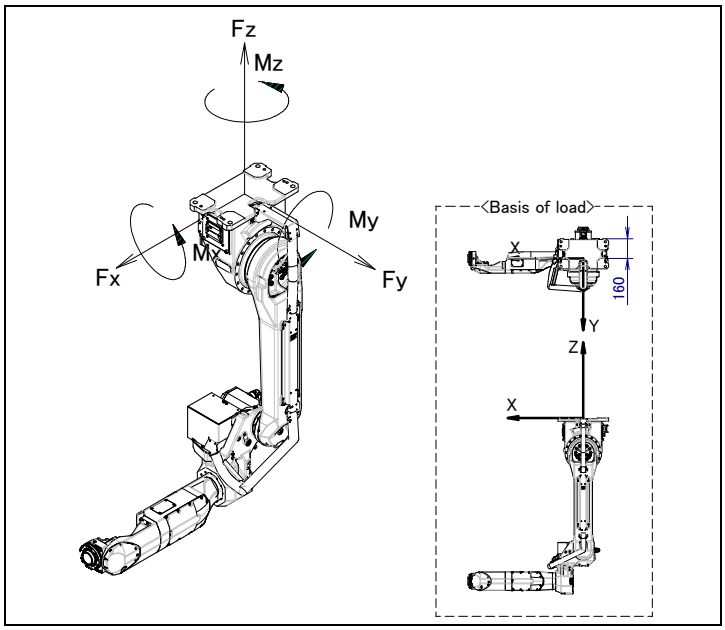


Fig. 1.2 (c) Force and moment that acts on J2 base (upside-down mount)

Table 1.2 (f) Force and moment that act on J2 base (upside-down mount) (ARC Mate 120*i*C/20T, M-20*i*A/20T)

	Load along the X-axis Fx N (kgf)	Load along the Y-axis Fy N (kgf)	Load along the Z-axis Fz N (kgf)	Moment around the X-axis Mx Nm (kgfm)	Moment around the Y-axis My Nm (kgfm)	Moment around the Z-axis Mz Nm (kgfm)
During stillness	0 (0)	0 (0)	2823 (288)	0 (0)	990 (101)	0(0)
During acceleration or deceleration	1751 (179)	1801 (184)	4574 (467)	1210 (123)	3940 (402)	1210 (123)
During Power-Off stop	7073 (722)	3841 (392)	9897 (1010)	2581(263)	13044(1331)	2581(263)

Table 1.2 (g) Force and moment that act on J2 base (upside-down mount) (M-20*i*A/20MT)

	Load along the X-axis Fx N (kgf)	Load along the Y-axis Fy N (kgf)	Load along the Z-axis Fz N (kgf)	Moment around the X-axis Mx Nm (kgfm)	Moment around the Y-axis My Nm (kgfm)	Moment around the Z-axis Mz Nm (kgfm)
During stillness	0 (0)	0 (0)	2842 (290)	0 (0)	990 (103)	0 (0)
During acceleration or deceleration	1405 (143)	1813 (185)	4247 (433)	1223 (125)	3383 (345)	1223 (125)
During Power-Off stop	7128 (727)	3867 (395)	9970 (1017)	2609 (266)	13209 (1348)	2609 (266)

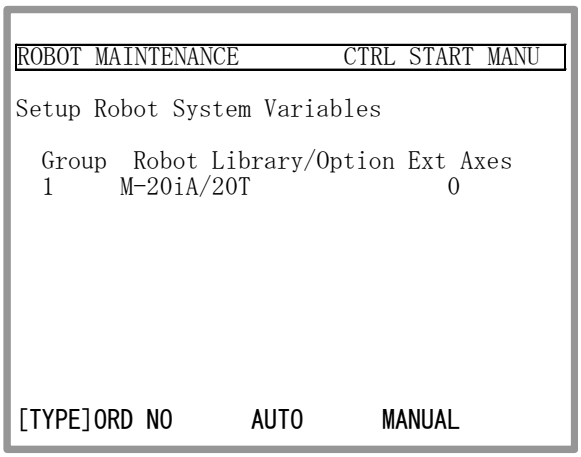
Table 1.2 (h) Force and moment that act on J2 base (upside-down mount) (M-20*i*A/35MT)

	Load along the X-axis Fx N (kgf)	Load along the Y-axis Fy N (kgf)	Load along the Z-axis Fz N (kgf)	Moment around the X-axis Mx Nm (kgfm)	Moment around the Y-axis My Nm (kgfm)	Moment around the Z-axis Mz Nm (kgfm)
During stillness	0 (0)	0 (0)	2910 (297)	0 (0)	1261 (129)	0 (0)
During acceleration or deceleration	923 (94)	1856 (189)	3832 (391)	1398 (143)	2996 (306)	1398 (143)
During Power-Off stop	4367 (446)	3959 (404)	7276 (742)	3531 (360)	10014 (1022)	3531 (360)

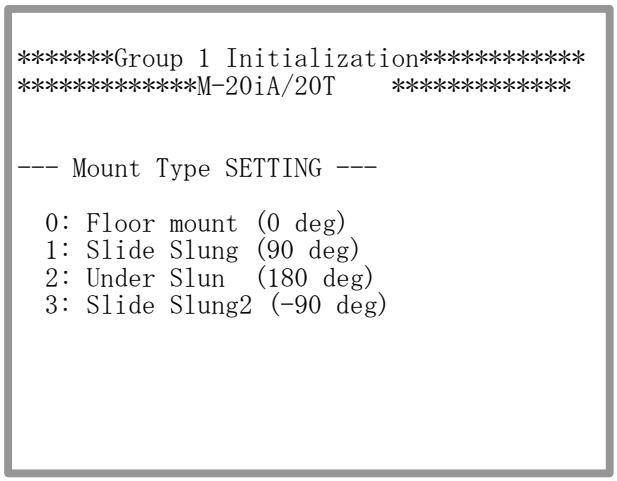
1.2.1 Angle of Mounting Surface Setting

To change the installation type of the robot, be sure to set the mounting angle referring to the procedure below.
Refer to specification of Section 3.1 about installation specifications.

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



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



6 Input mount angle referring to Fig.1.2.1.

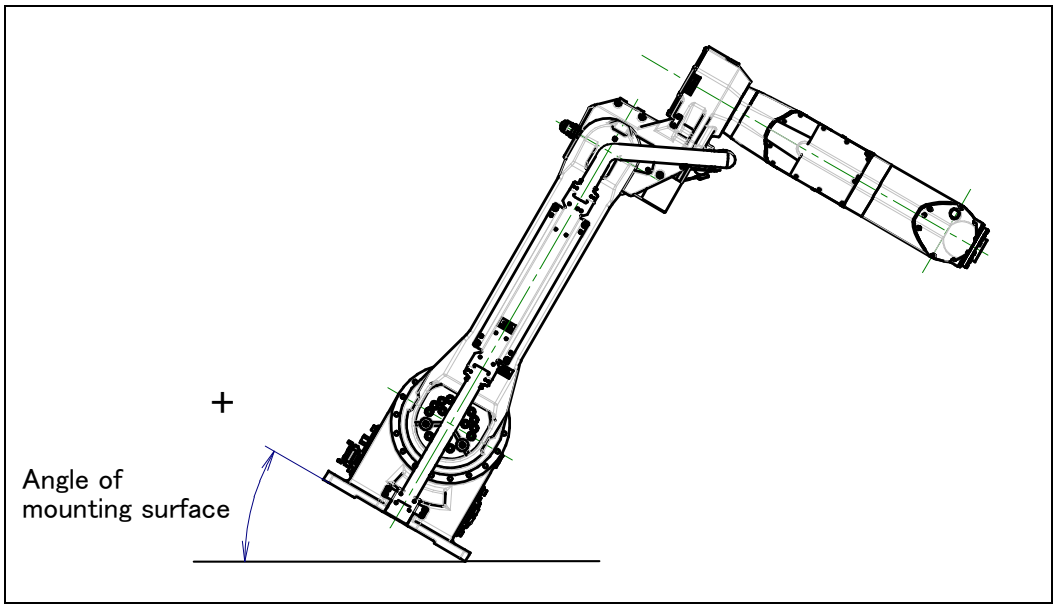
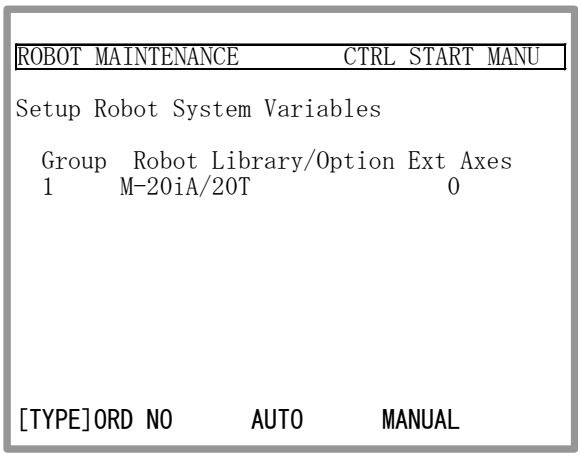


Fig.1.2.1 Mounting angle

7 Input the angle of mounting surface referring to Fig.1.2.1.



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

1.3 MAINTENANCE AREA

Fig. 1.3 shows the maintenance area of the mechanical unit. Be sure to leave enough room for the robot to be mastered. See Chapter 9 for mastering.

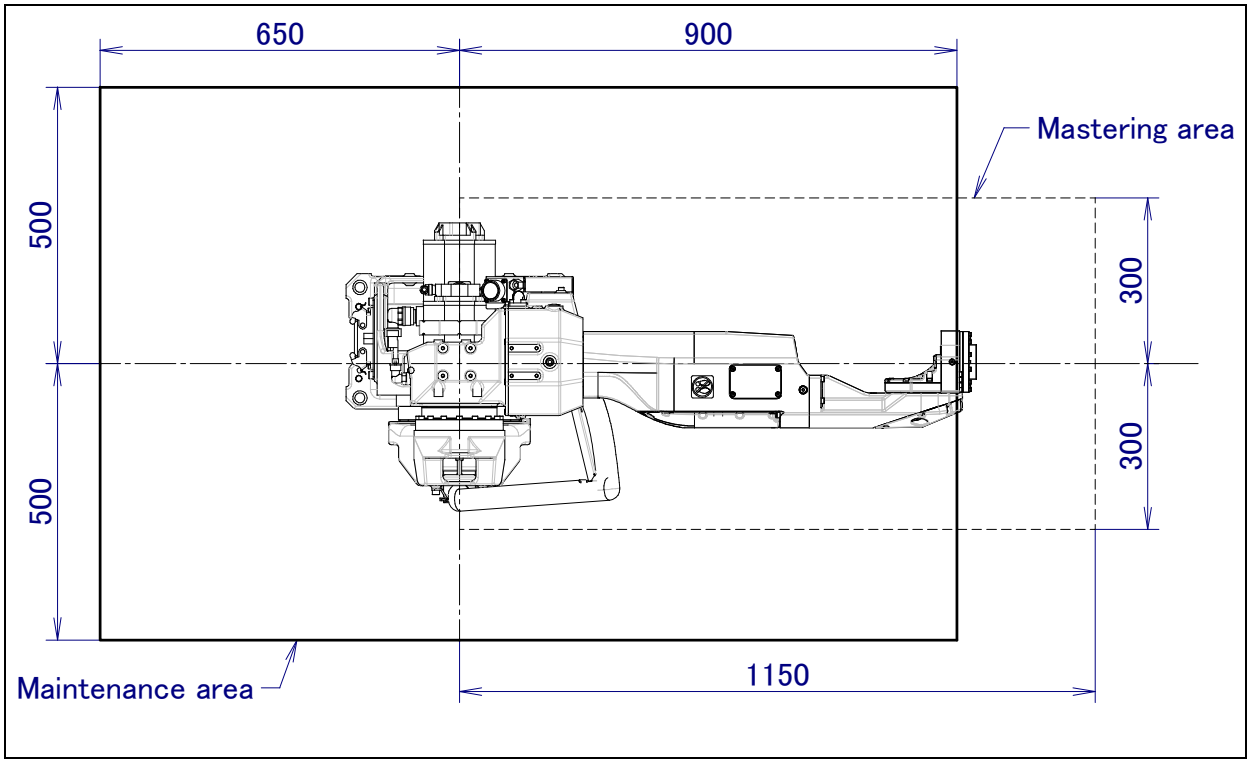


Fig. 1.3 Maintenance area

1.4 INSTALLATION CONDITIONS

Refer to the specifications found in Section 3.1.

2 CONNECTION WITH THE CONTROLLER

2.1 CONNECTION WITH THE CONTROLLER

The robot is connected with the controller via the power and signal cable and earth cable. Connect these cables to the connectors on the back of the robot 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 will heat up and become damaged.

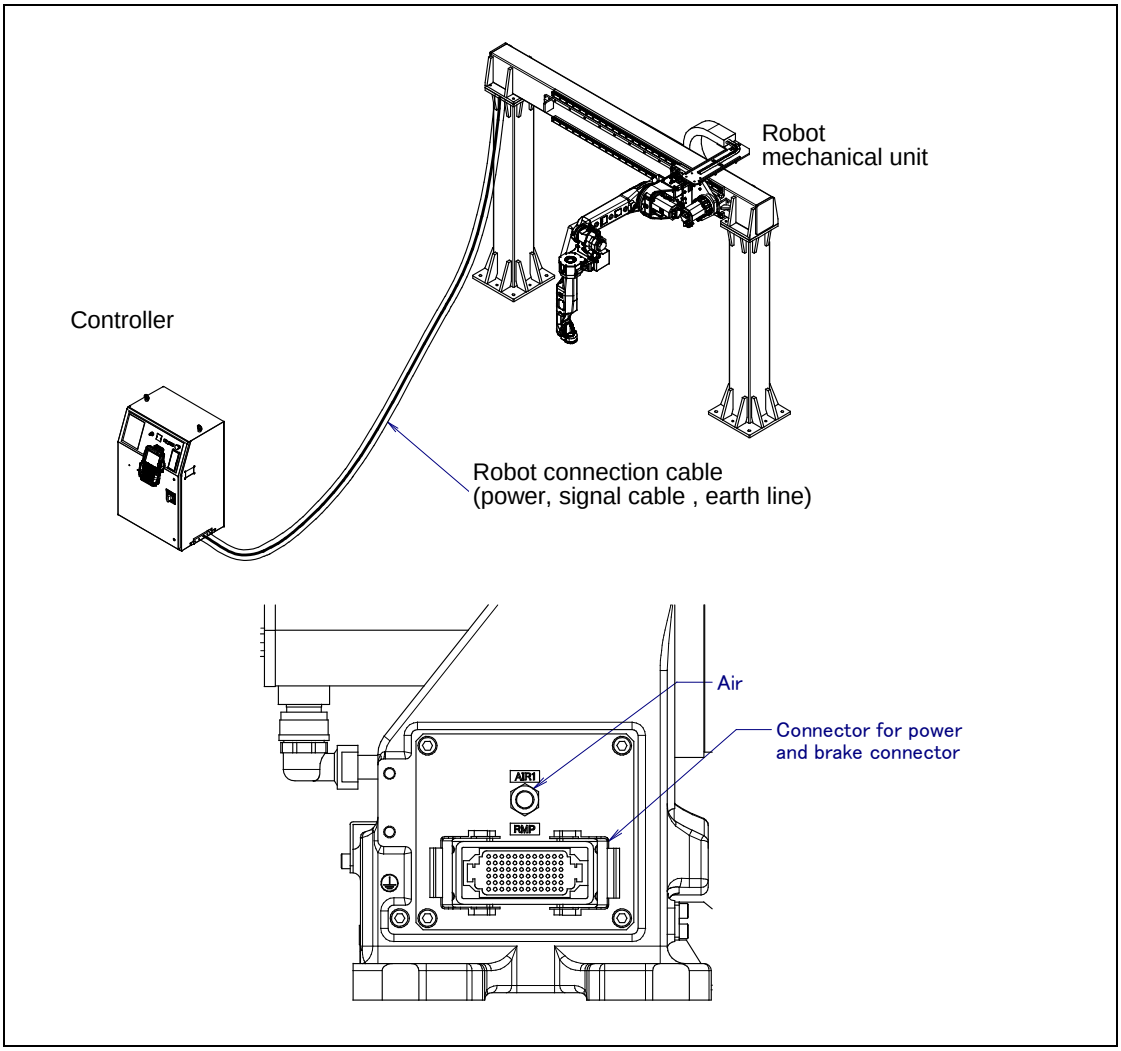


Fig. 2.1 Cable connection

3 BASIC SPECIFICATIONS

3.1 ROBOT CONFIGURATION

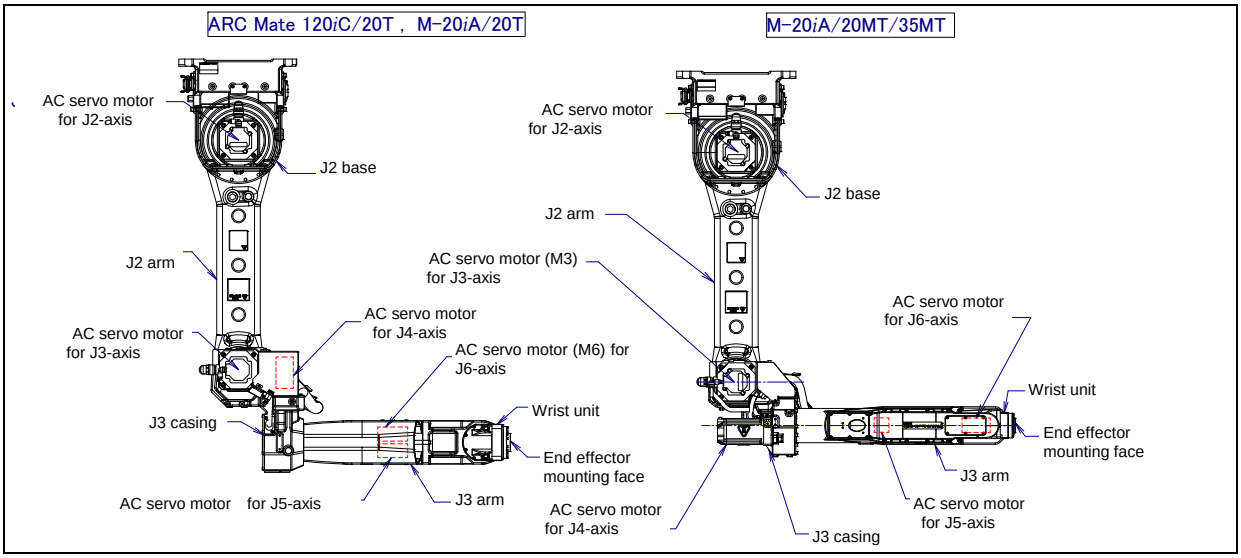


Fig. 3.1 (a) Mechanical unit configuration

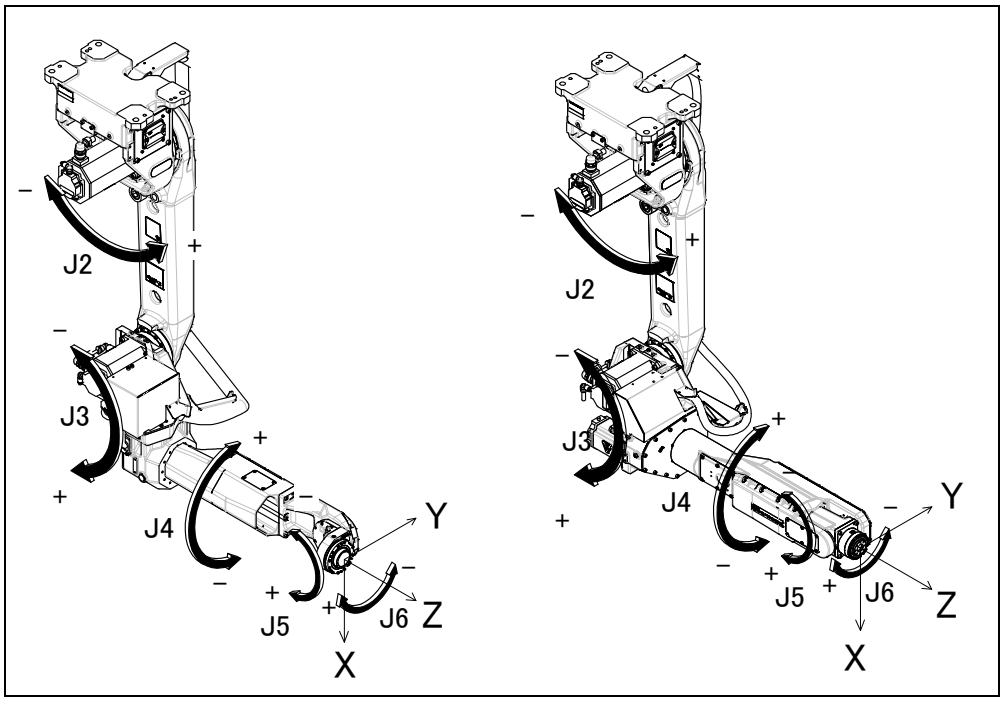


Fig. 3.1 (b) Each axes coordinates and mechanical interface coordinates

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

Specifications (1/2)

Item			Specification	
Model			ARC Mate 120*i*C/20T, M-20*i*A/20T	
Type			Articulated type	
Controlled axes			6axes (J1, J2, J3, J4, J5, J6)	
Installation			Upside-down, Wall mount	
Load setting			3 kg (Standard welding torch) mode	20 kg (High inertia) mode
Motion range Upper limit /Lower limit	J1-axis		(NOTE 1)	
	J2-axis		150° (2.62rad) / -150° (-2.62rad)	
	J3-axis		363° (6.34rad) / -223° (-3.89rad)	
	J4-axis		200° (3.49rad) / -200° (-3.49rad)	
	J5-axis	(NOTE 2)	140° (2.44rad) / -140° (-2.44rad)	
		(NOTE 3)	180° (3.14rad) / -180° (-3.14rad)	
	J6-axis	(NOTE 2)	270° (4.71rad) / -270° (-4.71rad)	
		(NOTE 3)	450° (7.85rad) / -450° (-7.85rad)	
Maximum speed (NOTE 4)	J1-axis		(NOTE 1)	
	J2-axis		175°/s (3.05rad/s)	
	J3-axis		180°/s (3.14rad/s)	
	J4-axis		360°/s (6.28rad/s)	
	J5-axis		360°/s (6.28rad/s)	
	J6-axis		550°/s (9.60rad/s)	
Maximum load	At wrist		3kg	20kg
	On J3 arm (NOTE 5)		12kg	
Allowable load moment at wrist	J4-axis		7.7N·m (0.79kgf·m)	44N·m (4.5kgf·m)
	J5-axis		7.7N·m (0.79kgf·m)	44N·m (4.5kgf·m)
	J6-axis		0.22N·m (0.022kgf·m)	22N·m (2.2kgf·m)
Allowable load inertia at wrist	J4-axis		0.24kg·m^2 (2.5kgf·cm·s^2)	1.04kg·m^2 (11.0kgf·cm·s^2)
	J5-axis		0.24kg·m^2 (2.5kgf·cm·s^2)	1.04kg·m^2 (11.0kgf·cm·s^2)
	J6-axis		0.0027kg·m^2 (0.028kgf·cm·s^2)	0.28kg·m^2 (2.9kgf·cm·s^2)
Drive method			Electric servo drive by AC servo motor	
Repeatability			±0.08mm (NOTE 6)	
Mass			185kg (NOTE 7)	
Acoustic noise level			Less than 70dB (NOTE 8)	
Installation environment			Ambient temperature: 0 to 45℃ (NOTE 9) 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 10)	

NOTE

1 Drive motor αiS12/4000 for J1 axis is attached. (Refer to Table 3.1 (a)) J1-axis motor cable length from the J2 base is about 1m.
2 The specification of “Cable integrated J3 Arm”.
3 The specification of "Conventional dress-out".
4 During short distance motions, the axis speed may not reach the maximum value stated.
5 Maximum load on J3 arm depends on load of wrist. See section 4.2 in detail.
6 Repeatability of the arm unit (J2 to J6-axes).
7 The mass exclude the J1-axis motor and gantry traveling section. Refer to specification manual of AC servo motor about J1-axis motor.
8 The acoustic noise exclude the sound generated from the J1 axis.
When robot is used This value is equivalent continuous A-weighted sound pressure level, which applied with ISO11201 (EN31201) This value is measured with the following conditions.
- Maximum load and speed
- Operating mode is AUTO
9 When the robot is used in a low temperature environment that is near to 0ºC, or not operated for a long time in the environment that is less than 0ºC (during a holiday or during the night), a collision detection alarm (SRVO-050) etc. may occur since the resistance of the drive mechanism could be high immediately after starting the operation. In this case, we recommend performing the warm up operation for several minutes.
10 Contact your local FANUC 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.

Specifications (2/2)

Item		Specification	
Model		M-20*i*A/20MT	M-20*i*A/35MT
Type		Articulated type	
Controlled axes		6-axis (J1, J2, J3, J4, J5, J6)	
Installation		Upside-down, Wall mount	
Load setting		20kg mode	35kg mode
Motion range Upper limit /Lower limit	J1-axis	(NOTE 1)	
	J2-axis	160° (2.79rad) / -100° (-1.75rad)	
	J3-axis	275.6° (4.81rad) / -185° (-3.23rad)	
	J4-axis	200° (3.49rad) / -200° (-3.49rad)	
	J5-axis	140° (2.44rad) / -140° (-2.44rad)	
	J6-axis	450° (7.85rad) / -450° (-7.85rad)	
Maximum speed (NOTE 2)	J1-axis	(NOTE 1)	
	J2-axis	175°/s (3.05rad/s)	180°/s (3.14rad/s)
	J3-axis	180°/s (3.14rad/s)	200°/s (3.49rad/s)
	J4-axis	405°/s (7.07rad/s)	350°/s (6.11rad/s)
	J5-axis	405°/s (7.07rad/s)	350°/s (6.11rad/s)
	J6-axis	615°/s(10.73rad/s)	400°/s (6.98rad/s)
Maximum load	At wrist	20kg	35kg
	On J3 arm (NOTE 3)	12kg	
Allowable load moment at wrist	J4-axis	45.1Nm(kgf·m) (4.6kgf·m)	110.0Nm(kgf·m) (11.2kgf·m)
	J5-axis	45.1Nm(kgf·m) (4.6kgf·m)	110.0Nm(kgf·m) (11.2kgf·m)
	J6-axis	30.0Nm(kgf·m) (3.1kgf·m)	60.0Nm(kgf·m) (6.12kgf·m)
Allowable load inertia at wrist	J4-axis	2.01kg.m^2 (20.42 kgf·cm·s^2)	4.00kg.m^2 (40.82 kgf·cm·s^2)
	J5-axis	2.01kg.m^2 (20.42 kgf·cm·s^2)	4.00kg.m^2 (40.82 kgf·cm·s^2)
	J6-axis	1.01kg.m^2 (10.26 kgf·cm·s^2)	1.50kg.m^2 (15.31 kgfvcm·s^2)
Repeatability		±0.08mm (NOTE 4)	
Robot mass		185kg (Note 5)	187kg (NOTE 5)
Acoustic noise level		Less than 70dB (NOTE 6)	
Installation environment		Ambient temperature: 0 to 45℃ (NOTE 7) Ambient humidity: Normally 75% RH or less (No dew or frost allowed) Short time 95% Rhor less (Within 1 month) Permissible altitude: Above the sea 1000m or less Vibration acceleration: 4.9m/s^2 (0.5G) or less Free of corrosive gases (NOTE 8)	

NOTE

1 Drive motor αiS12/4000 for J1 axis is attached. (Refer to Table 3.1 (a)) J1-axis motor cable length from the J2 base is about 1m.
2 During short distance motions, the axis speed may not reach the maximum value stated.
3 Maximum load on J3 arm depends on load of wrist. See Section 4.2 in detail.
4 Repeatability of the arm unit (J2 to J6-axes).
5 The mass exclude the J1 motor and gantry traveling section. Refer to specification manual of AC servo motor about J1-axis motor.
6 This value is the equivalent continuous A-weighted sound pressure level, which applied with ISO11201 (EN31201). This value is measured with the following conditions.
   - Maximum load and speed
   - Operating mode is AUTO
7 When the robot is used in a low temperature environment that is near to 0ºC, or the robot is not operated for a long time in an environment that is less than 0ºC, for example during a holiday or overnight, viscous resistance of the drive train may cause occurrence of collision detect alarm (SRVO –050) etc. In this case, we recommend performing a warm up operation for several minutes.
8 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.

Table 3.1 (a) Specification of J1-axis motor (appendix)

Model name	Mechanical unit specification No.	Specification of J1-axis motor
FANUC Robot ARC Mate 120*i*C/20T	A05B-1222-B221	A06B-0238-B605#S000
	A05B-1225-B221	A06B-2238-B605
	A05B-1225-B271	A06B-2238-B605
FANUC Robot M-20*i*A/20T	A05B-1222-B222	A06B-0238-B605#S000
	A05B-1225-B222	A06B-2238-B605
	A05B-1225-B272	A06B-2238-B605
FANUC Robot ARC Mate 120*i*C/20T	A05B-1222-B231	A06B-0238-B705#S000
	A05B-1225-B231	A06B-2238-B705
	A05B-1225-B281	A06B-2238-B705
FANUC Robot M-20*i*A/20T	A05B-1222-B232	A06B-0238-B705#S000
	A05B-1225-B232	A06B-2238-B705
	A05B-1225-B282	A06B-2238-B705
FANUC Robot M-20*i*A/20MT	A05B-1222-B722	A06B-2238-B605
	A05B-1225-B722	
FANUC Robot M-20*i*A/20MT	A05B-1222-B732	A06B-2238-B705
	A05B-1225-B732	
FANUC Robot M-20*i*A/35MT	A05B-1225-B725	A06B-2238-B605
FANUC Robot M-20*i*A/35MT	A05B-1225-B735	A06B-2238-B705

Table 3.1(b) The dustproof and waterproof characteristics of ARC Mate 120*i*C/20T

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

Table 3.1(c) The dustproof and waterproof characteristics of M-20iA/20T/20MT/35MT

	Normal specification
Wrist (*) +J3 arm	IP67
Other part	IP54

(*) It does not include conduit part. M/H conduit does not have dustproof and waterproof characteristic. Refer to Chapter 11 for details.

NOTE

Definition of IP code

Definition of IP 67

6=Dust-tight: Complete protection against contact

7=Protection from water immersion: Ingress of water in harmful quantity shall not be possible when the enclosure is immersed in water under defined conditions of pressure and time.

Definition of IP 54

5=Dust-tight: Ingress of dust is not entirely prevented, but it must not enter in sufficient quantity to interfere with the satisfactory of the equipment.

4=Protection from water immersion : Water splashing against the enclosure from any direction shall have no harmful effect.

Performance of resistant chemicals and resistant solvents

(1) The robot cannot be used with the following liquids. Potentially these liquids will cause irreversible damage to the rubber parts (such as: gaskets, oil seals, O-rings etc.). (As exception to this only liquids tested and approved by FANUC can be used with the robot.)
   (a) Organic solvents
   (b) Cutting fluid including chlorine / gasoline
   (c) Amine type detergent
   (d) Acid, alkali and liquid causing rust
   (e) Other liquids or solutions, that will harm NBR or CR rubber
(2) When the robots work in a water or liquid environment, completely drain the J1 base. Incomplete draining of the J2 base will make the robot break down.
(3) Do not use unconfirmed cutting fluid and cleaning fluid.
(4) Do not use the robot immersed in water, neither temporary nor permanent. The robot must not be wet permanently.
   *Example: in case motor surface is exposed to water for a long time, liquid may invade inside the motor and cause failure.

3.2 MECHANICAL UNIT EXTERNAL DIMENSIONS AND OPERATING SPACE

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

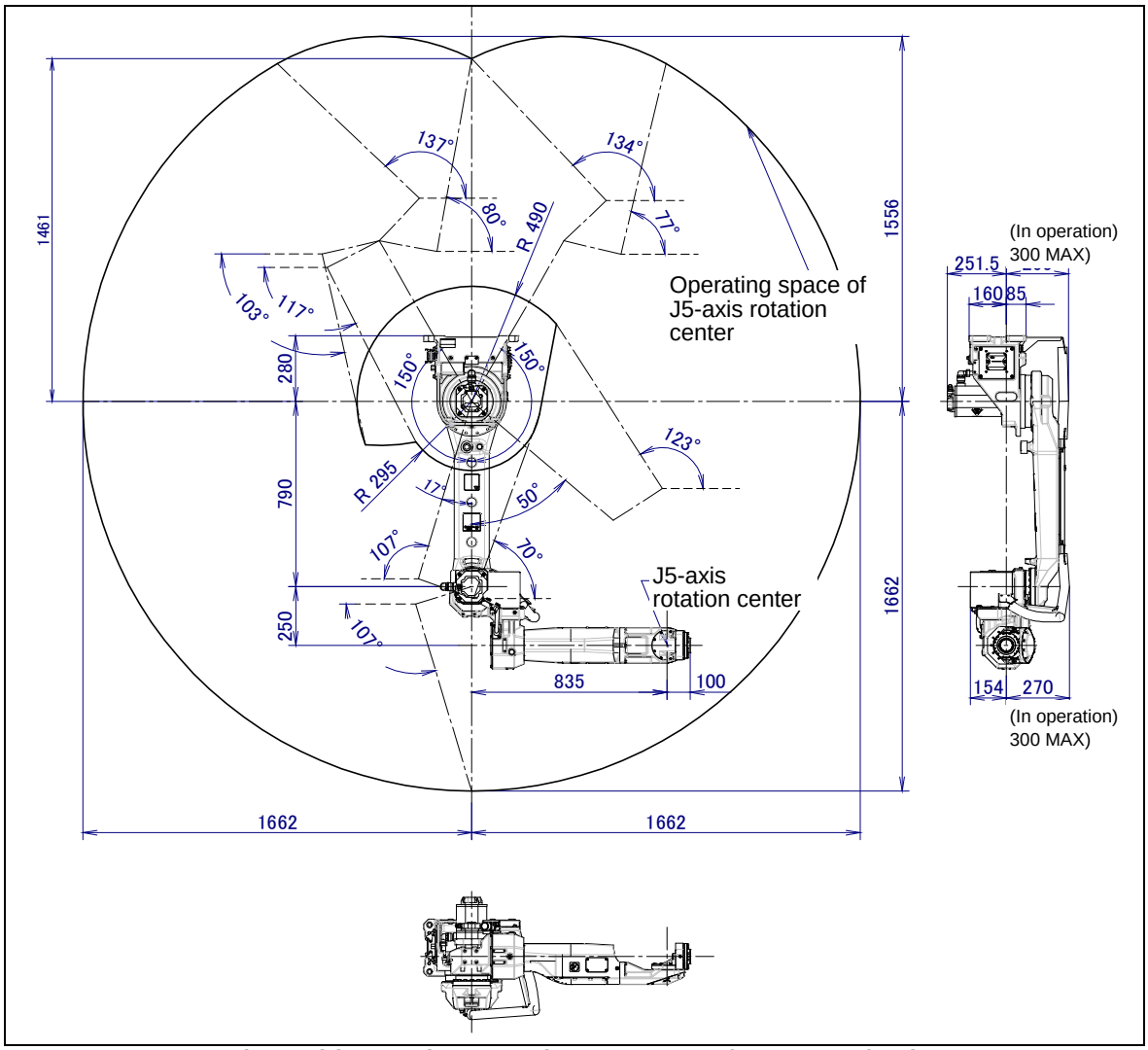


Fig. 3.2 (a) Operating space (ARC Mate 120*i*C/20T, M-20*i*A/20T)

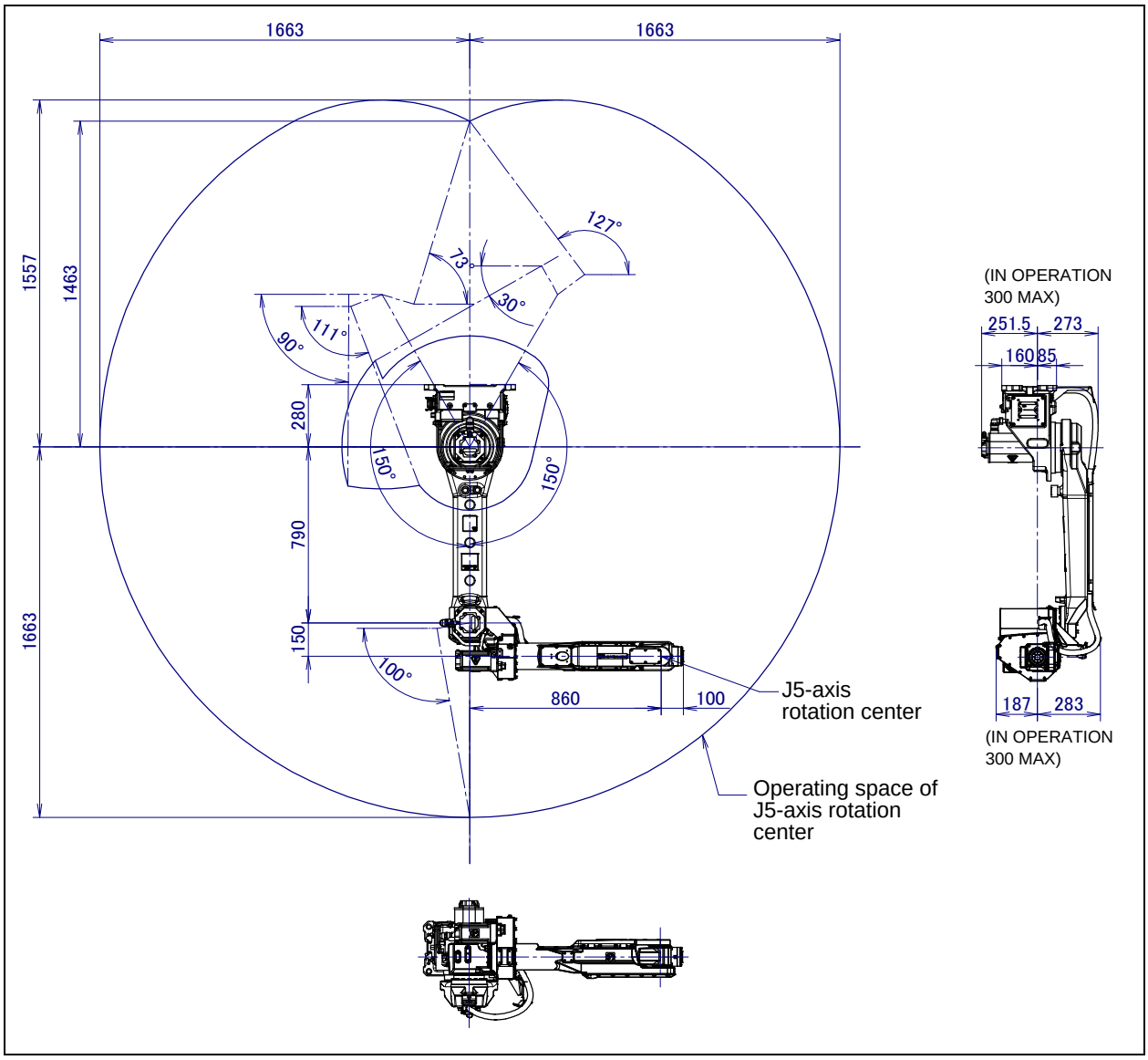


Fig. 3.2 (b) Operating space (M-20*i*A/20MT/35MT)

3.3 ZERO POINT POSITION AND MOTION LIMIT

Each controlled axis has zero point and software motion limit. The robot is controlled so as not to exceed the software motion limit unless zero point position is lost by a failure of the system and a system error, etc.

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. Tighten the bolts according to Fig. 3.3 (a). Be sure to exchange transformed stopper to new one. Don't reconstruct the mechanical stopper. There is a possibility that the robot doesn't stop normally.

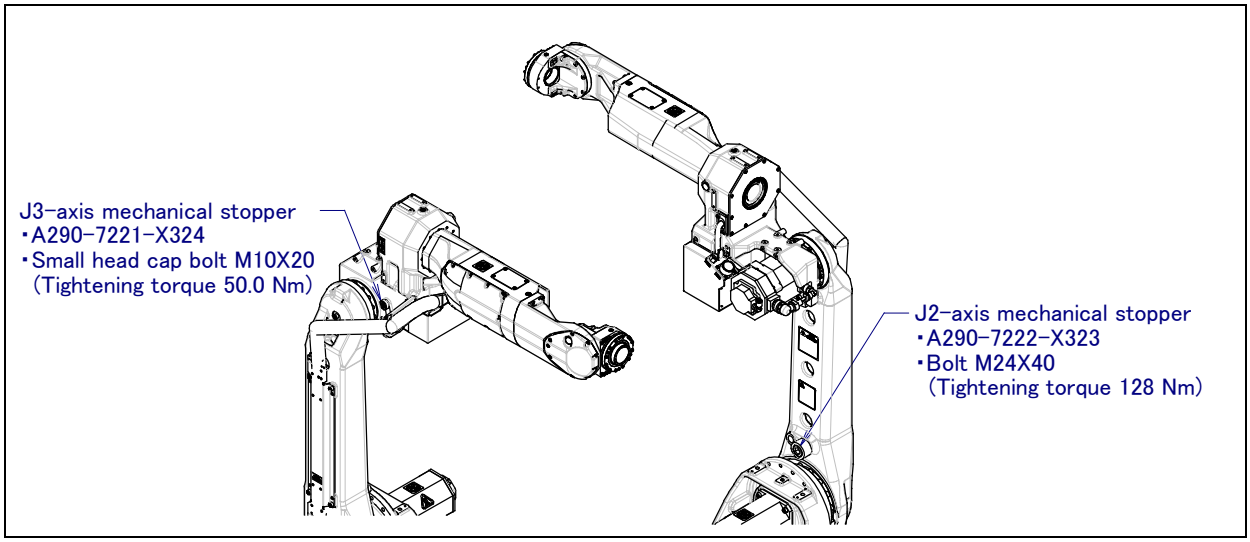


Fig. 3.3 (a) Position of mechanical stopper

Fig 3.3 (b) to (i) show the zero point, the motion limit, and the mechanical stopper position of each axis.

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

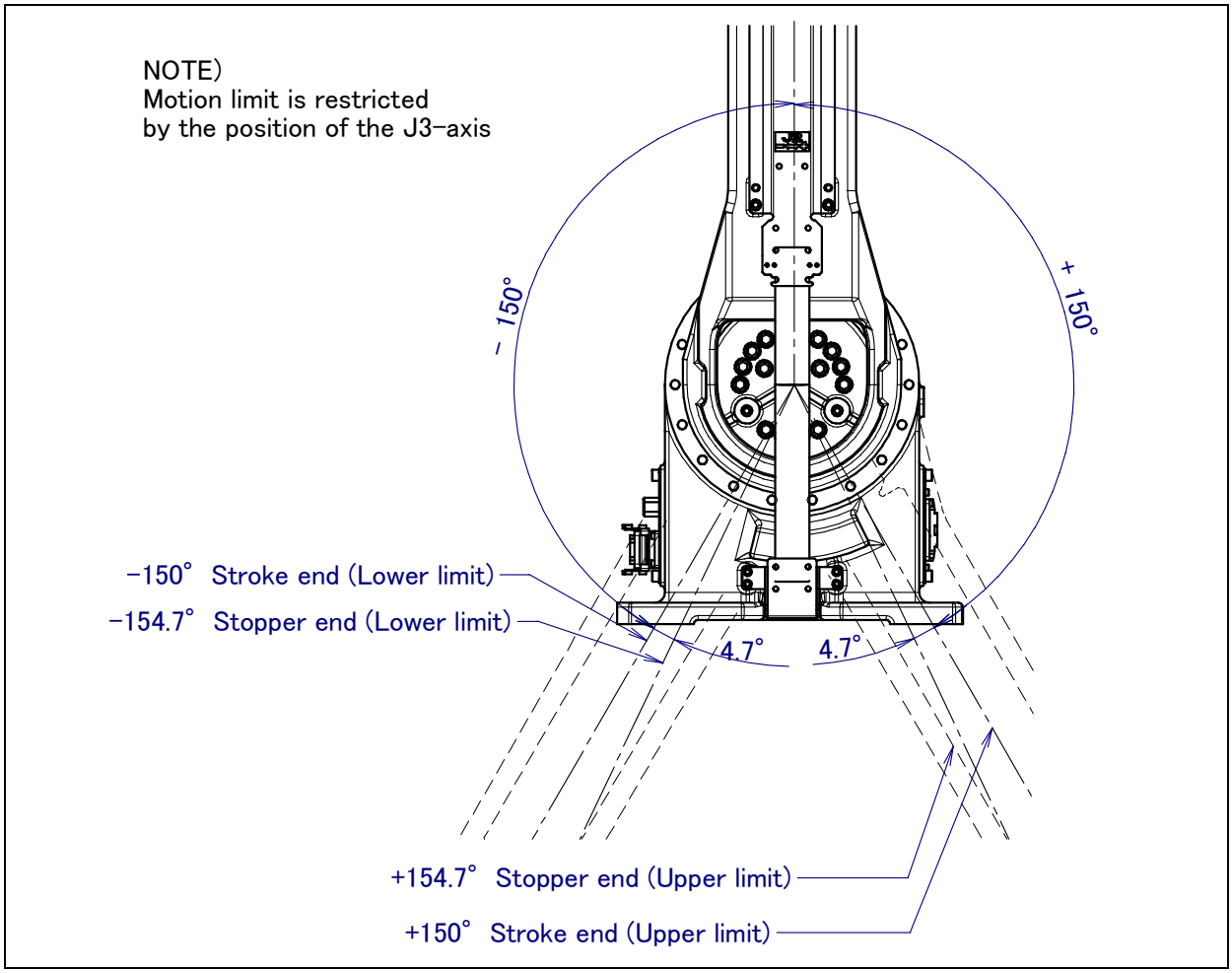


Fig. 3.3 (b) J2-axis motion limit

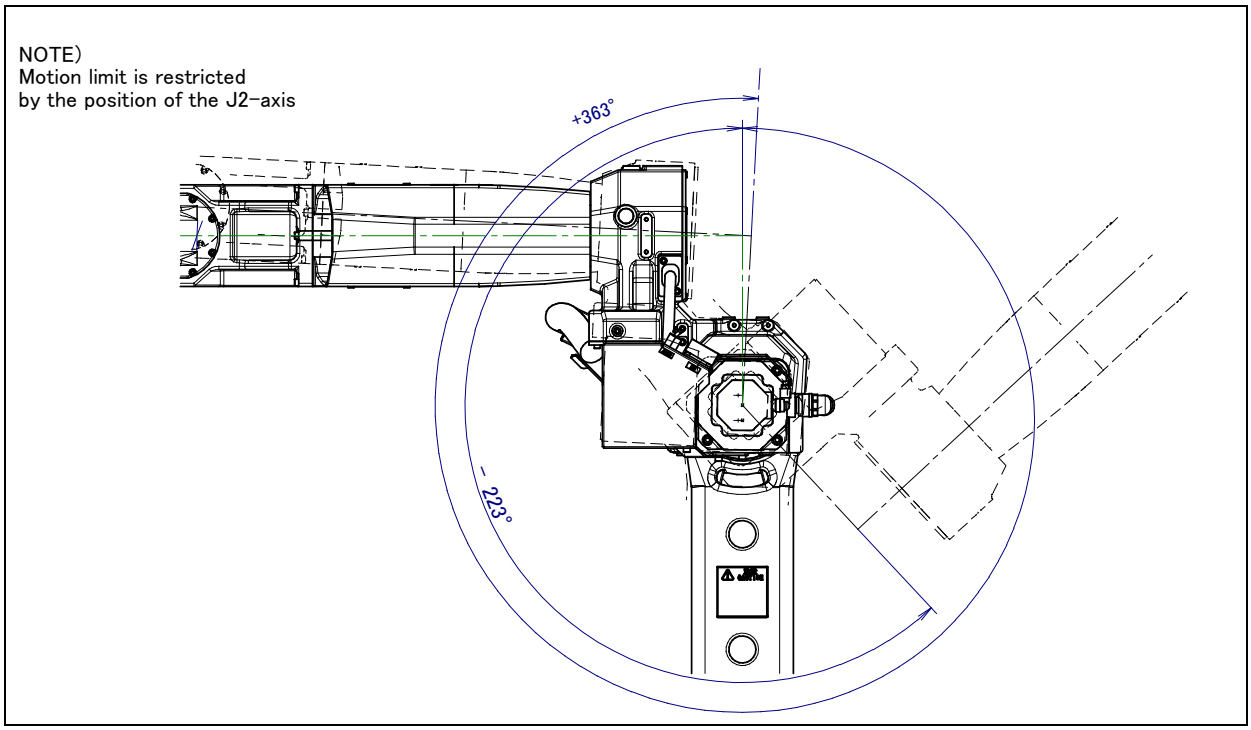


Fig. 3.3 (c) J3-axis motion limit

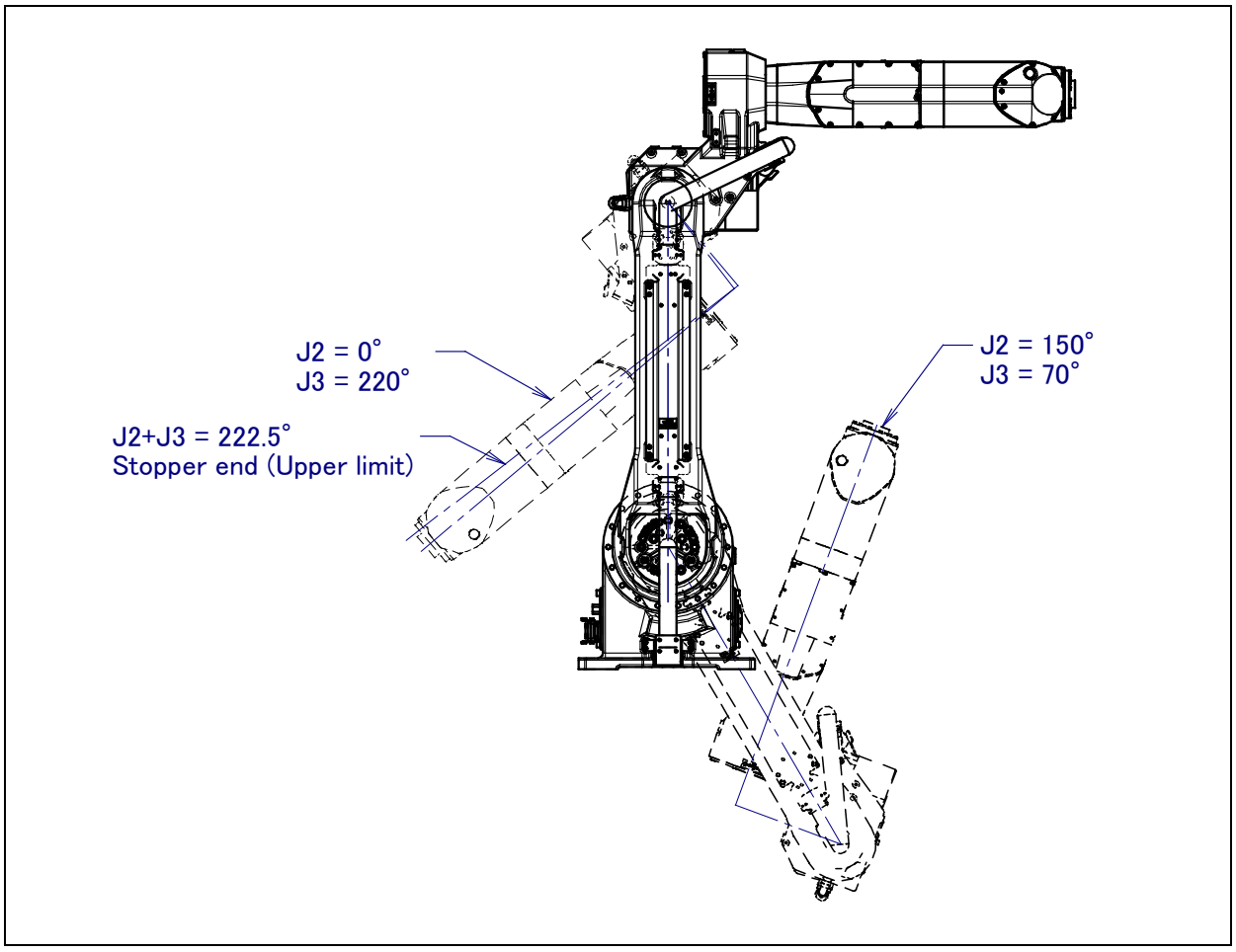


Fig. 3.3 (d) J2/J3-axis motion limit (Upper limit)

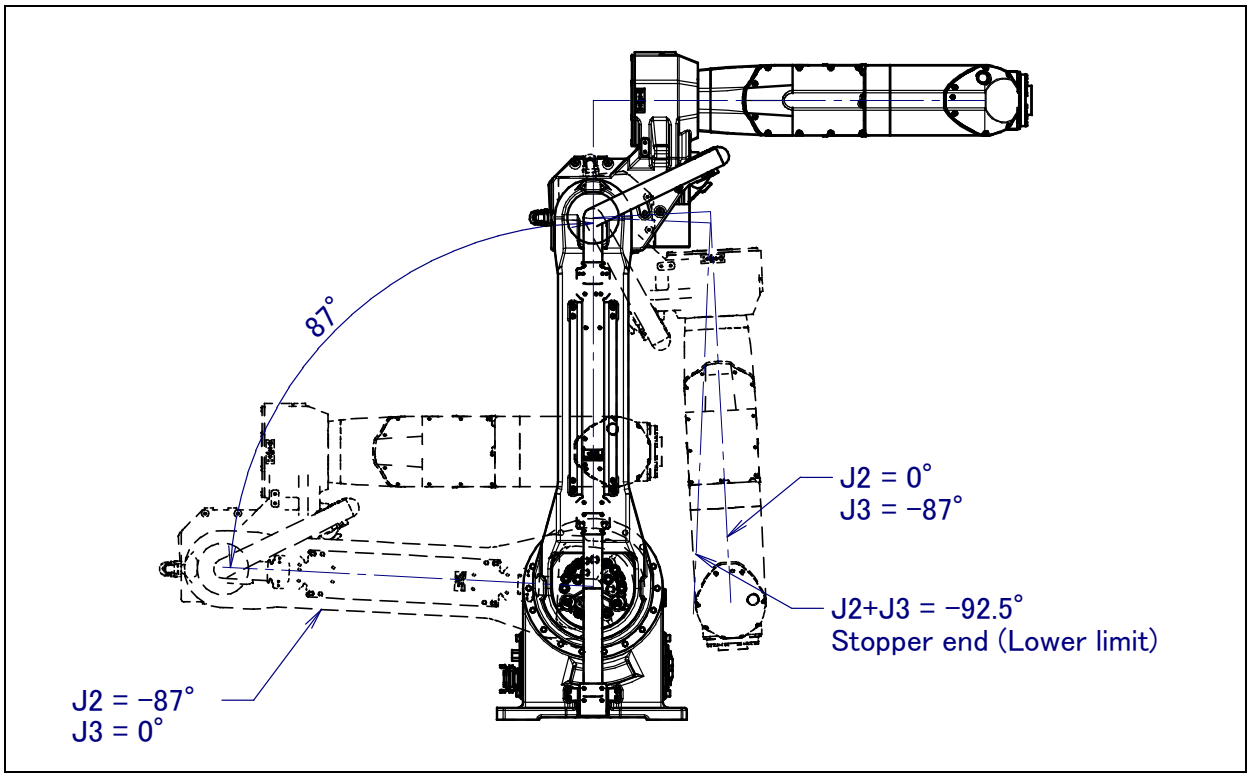


Fig. 3.3 (e) J2/J3-axis motion limit (Lower limit)

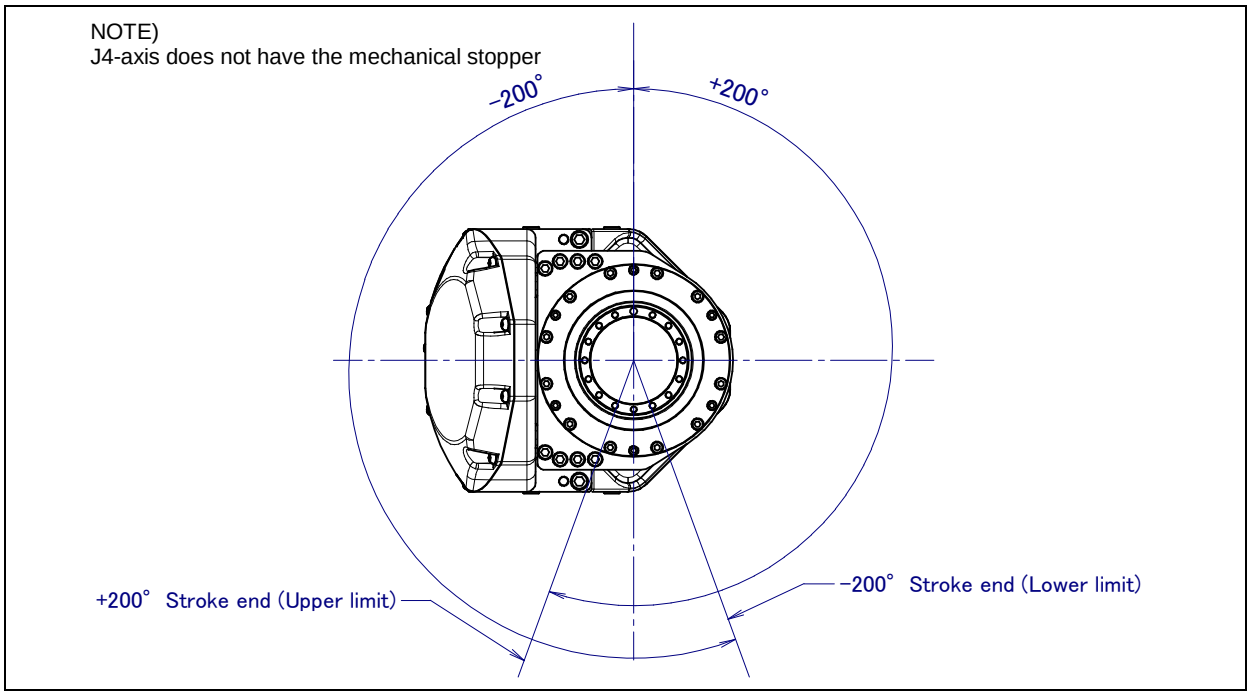


Fig. 3.3 (f) J4-axis motion limit

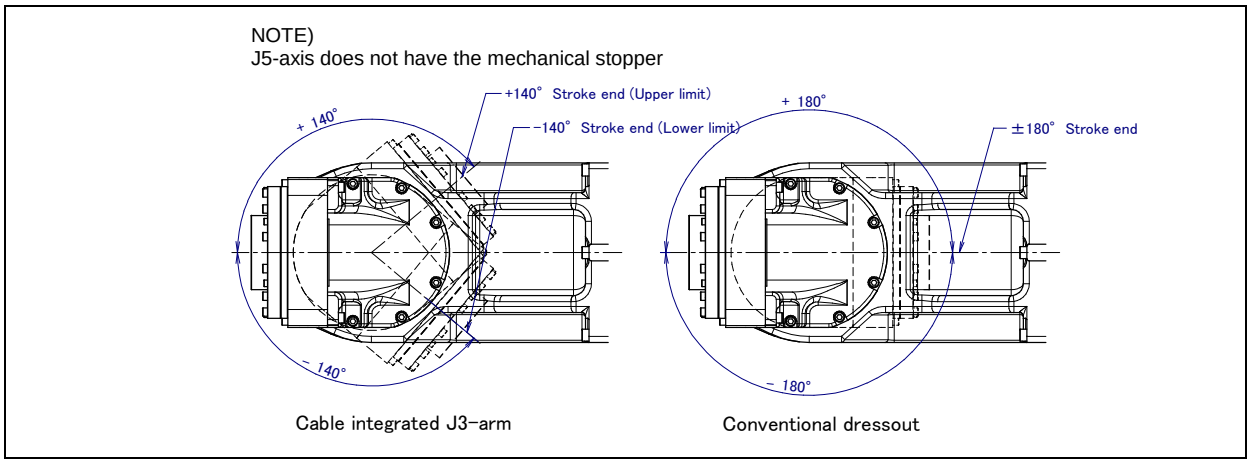


Fig. 3.3 (g) J5-axis motion limit (ARC Mate 120*i*C/20T, M-20*i*A/20T)

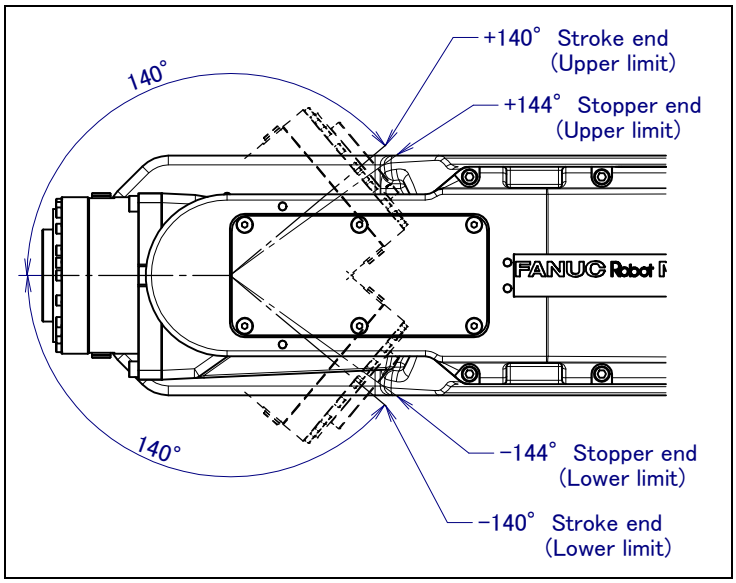


Fig. 3.3 (h) J5-axis motion limit (M-20*i*A/20MT/35MT)

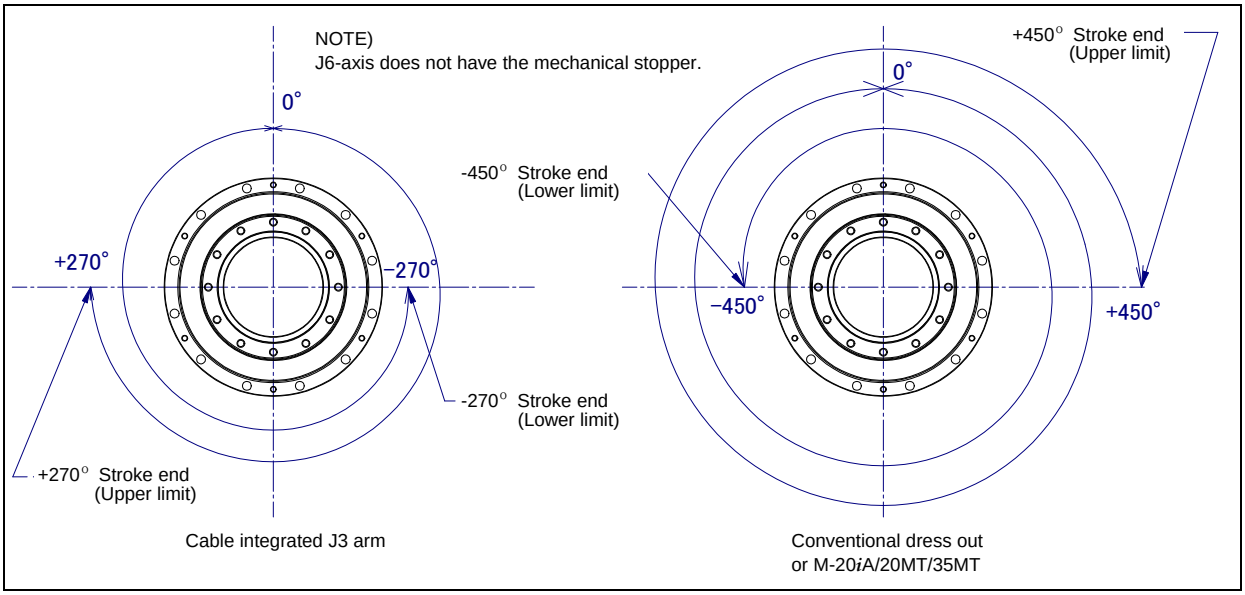


Fig. 3.3 (i) J6-axis motion limit

3.4 MOTION RANGE SETTING FOR INTEGRATED HAND CABLE

In ARC Mate 120*i*C/20T (M-20*i*A/20T), Cable is integrated hollow part of J3 arm is standard. (It is “Cable integrated J3 Arm type” in the following). When the robot is shipped, is set to the range of motion of “Cable integrated J3 arm type”.
The case where conduit is inserted in the J3 arm hollow part, and the cable is passed as shown in Fig. 3.4 is defined as "Cable integrated J3 arm".
Other than the above-mentioned, the case where the cable is passed outside of the J3 arm is defined as "Conventional dress-out” and the case of where the option of no dust M/H conduit is defined as "No dust M/H conduit”.

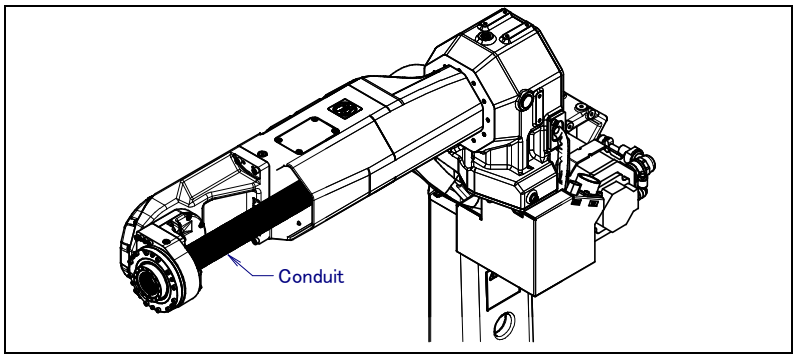


Fig. 3.4 Example of “Cable integrated J3 arm”

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

1 Turn on the controller with [PREV] and [NEXT] key pressed. Then select [3 Controlled start].
2 Set “Conventional dress-out” or "No dust M/H conduit” on the robot initialization screen
3 Perform a Cold Start.

```
1. Cable integrated J3 arm
   (J5:-140 ..140, J6:-270 .. 270[deg])
2: Conventional dress-out
   (J5:-180 .. 180, J6;-450 .. 450[deg])

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

1) Note about “Cable integrate J3 arm” type
   The range of motion of “1” is a set value when the hand (torch and tool) cable which FANUC recommends is integrated in J3 arm. (Handling specification. M/H conduit option [A05B-1222-J701] is needed. Refer to Section 11.2 about exchange cycle.) Other cases, please set range of motion and the regular exchange cycle of the wrist axis besides as well as the dress out according to the specification of installing hand (torch and tool) cable so far.
2) Note about “Conventional dress out” type
   The range of motion of “2” is the one of the dress out type so far, and set the motion range and the regular exchange cycle of the wrist axis according to as usual installing hand (torch and tool) cable.

3.5 WRIST LOAD CONDITIONS

Fig. 3.5 (a) to (d) are diagrams showing the allowable load that can be applied to the wrist section. Apply a load within the region indicated in the graph. In addition, meet the requirements of the allowable load moment / inertia at wrist. Refer to section 3.1 about the allowable load moment / inertia at wrist. Refer to Section 4.1 about the attachment end effector.

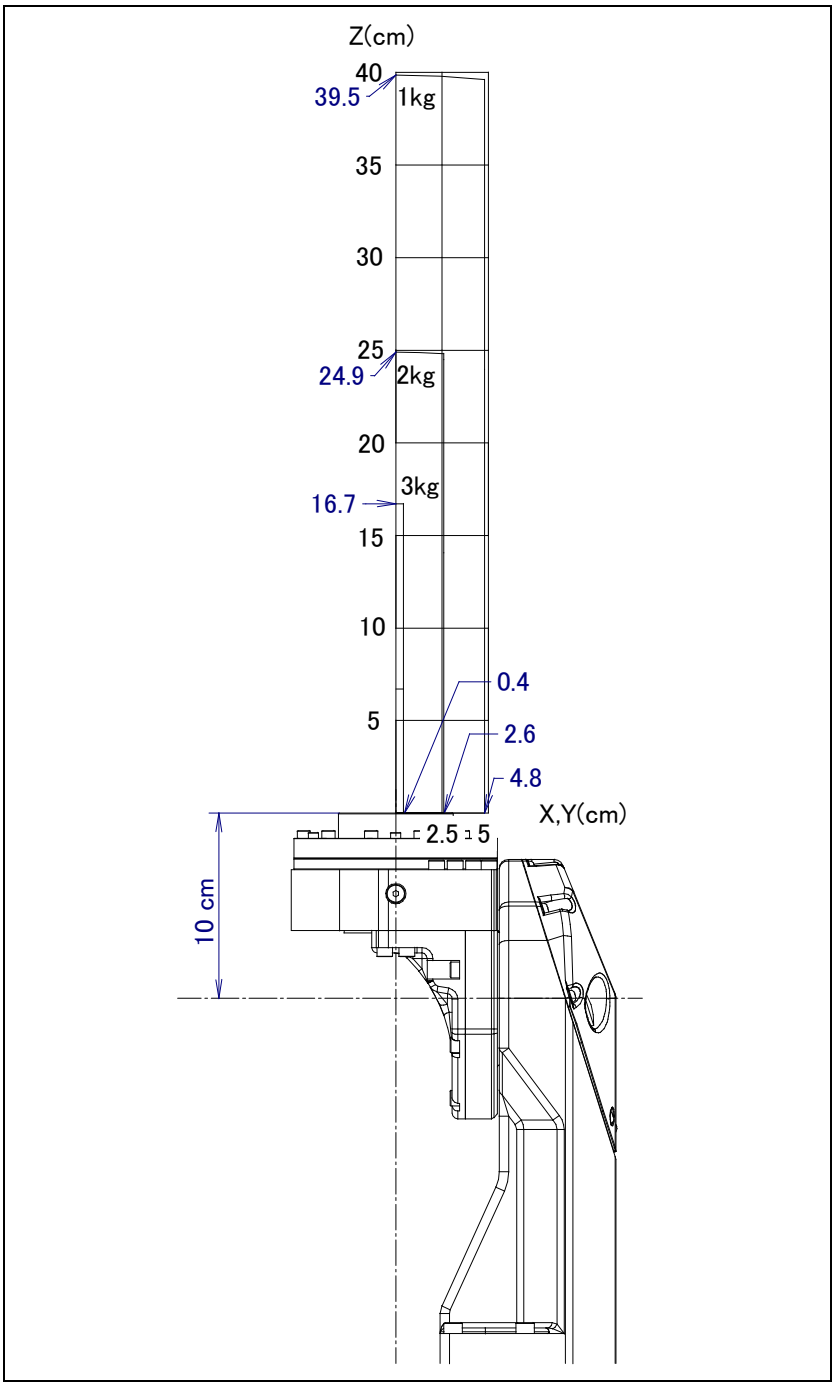


Fig. 3.5 (a) Wrist load diagram (3kg mode)
(ARC Mate 120*i*C/20T, M-20*i*A/20T)

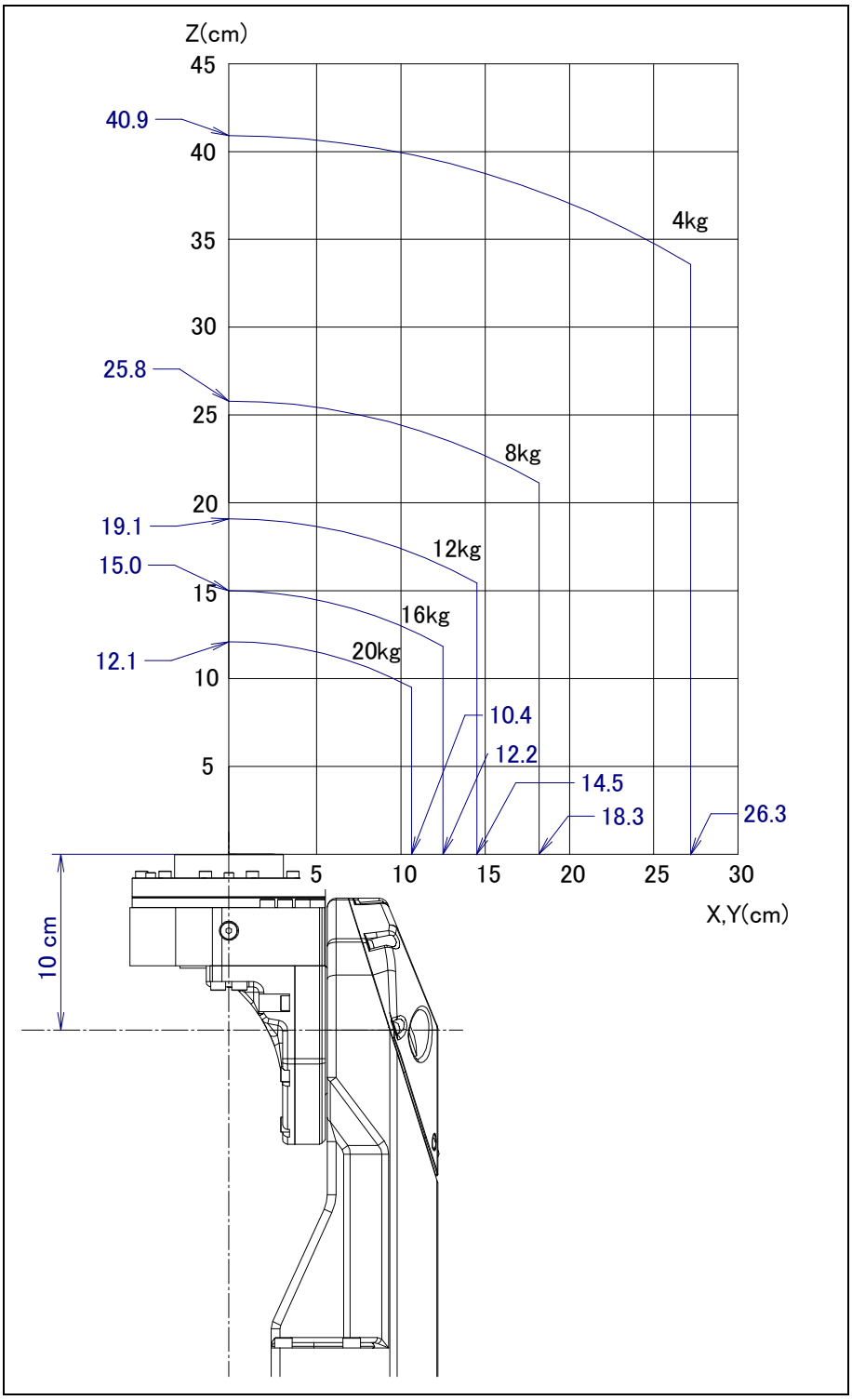


Fig. 3.5 (b) Wrist load diagram (20kg mode)
(ARC Mate 120*i*C/20T, M-20*i*A/20T)

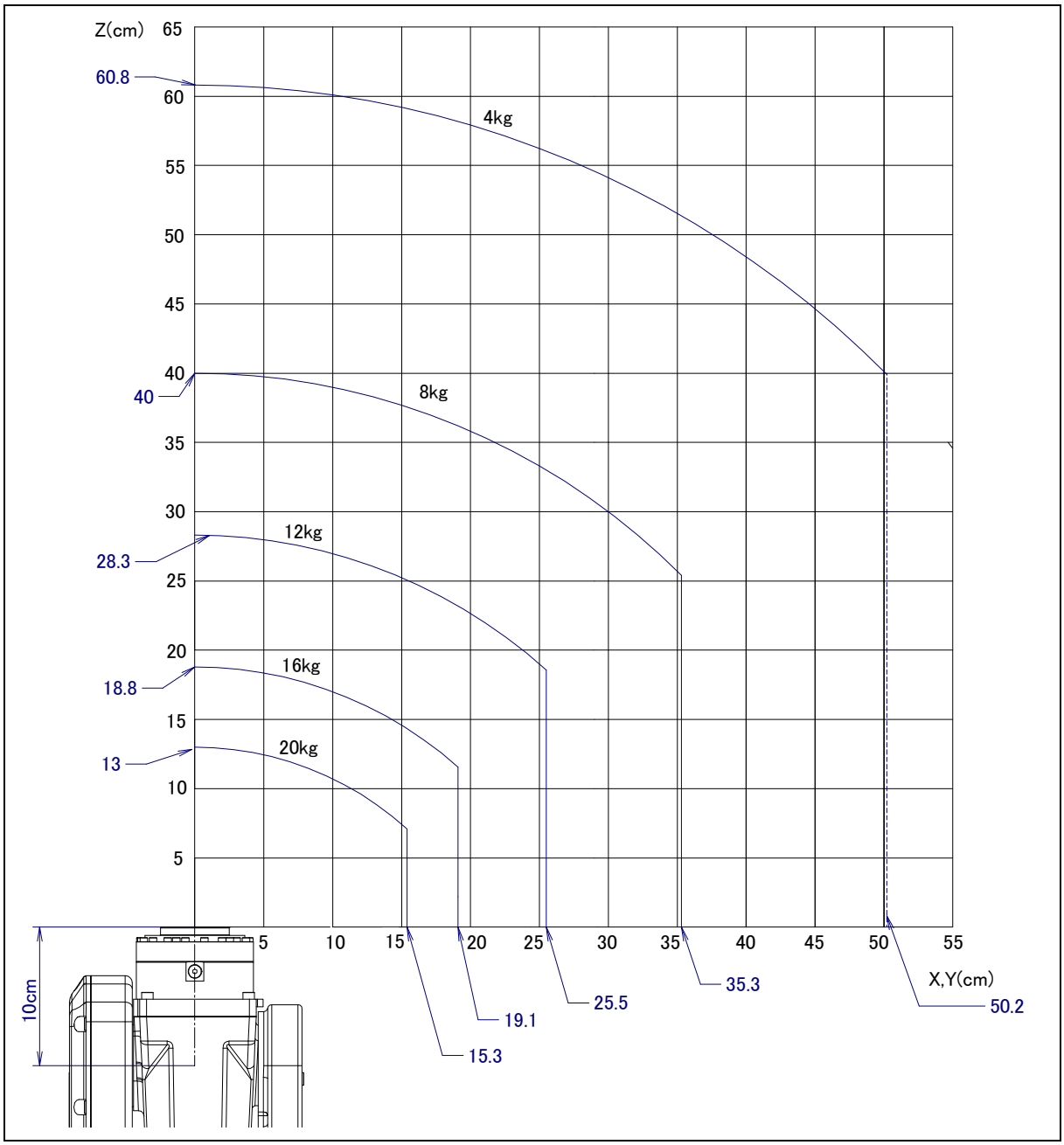


Fig. 3.5 (c) Wrist load diagram
(M-20*i*A/20MT)

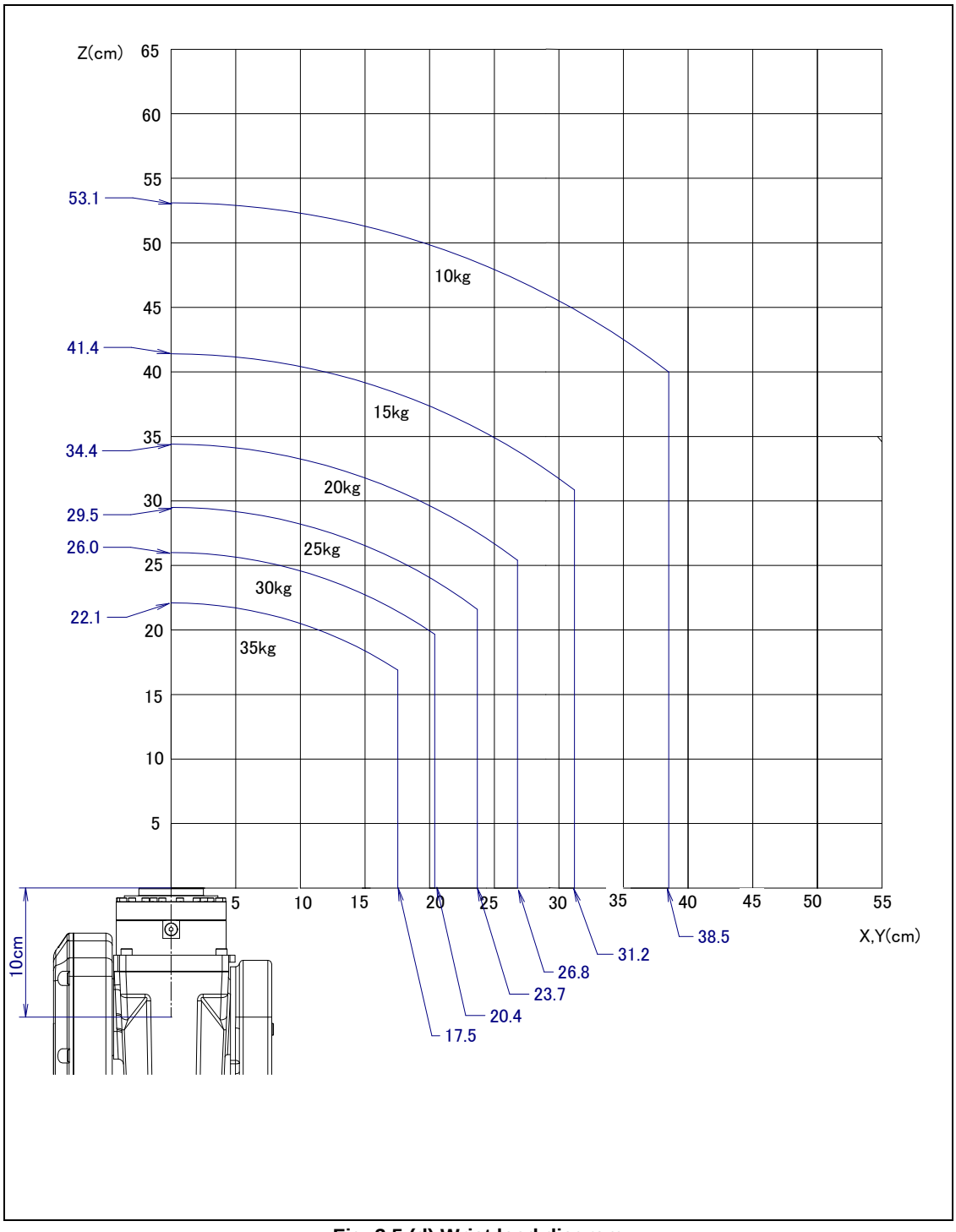


Fig. 3.5 (d) Wrist load diagram
(M-20*i*A/35MT)

4 EQUIPMENT INSTALLATION TO THE ROBOT

4.1 END EFFECTOR INSTALLATION TO WRIST

Fig. 4.1 (a) to (d) show the figures 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 “Bolt tightening torque” for tightening torque specifications.

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

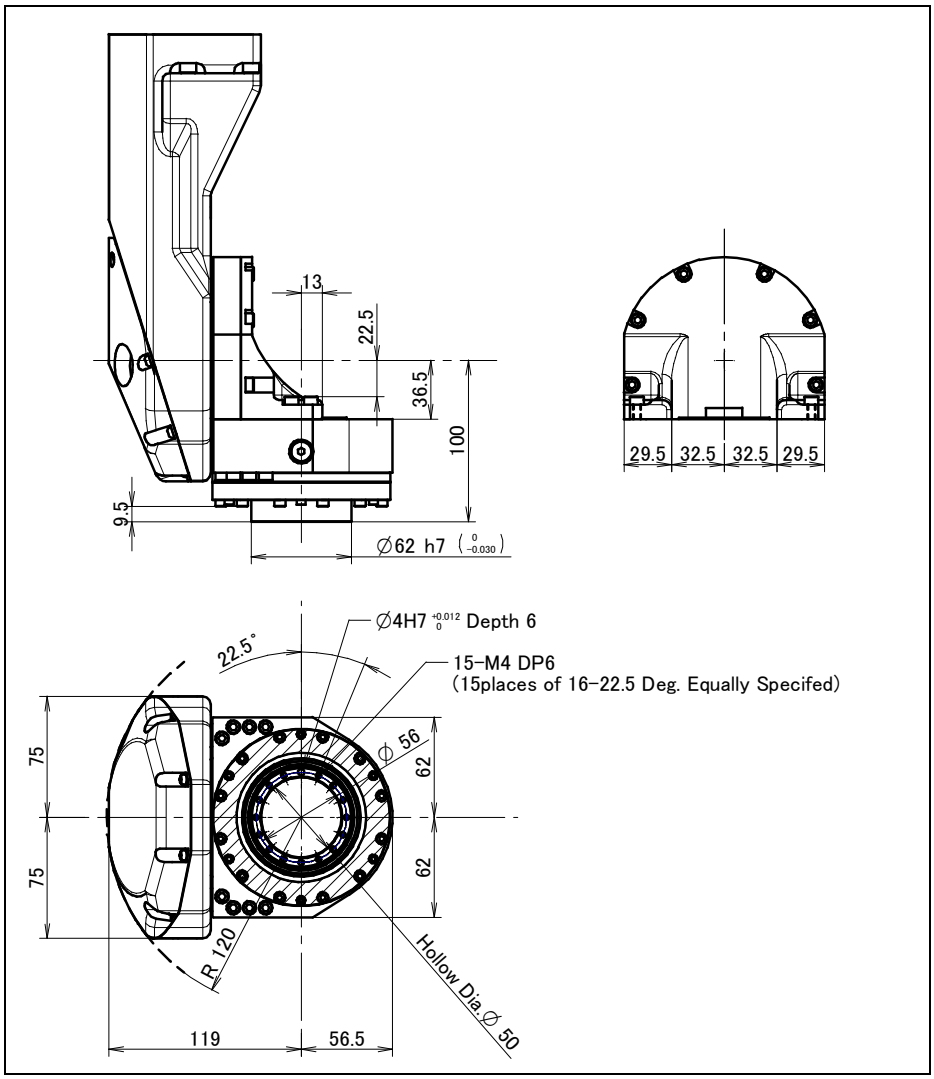


Fig. 4.1 (a) End effector interface (ARC Mate 120*i*C/20T, M-20*i*A/20T) (except A05B-1225-B271, B272, B281, B282)

> ⚠ **CAUTION**
> Do not remove the M3, M4 bolts of shaped area. If they are removed, the robot does not return to the original state.

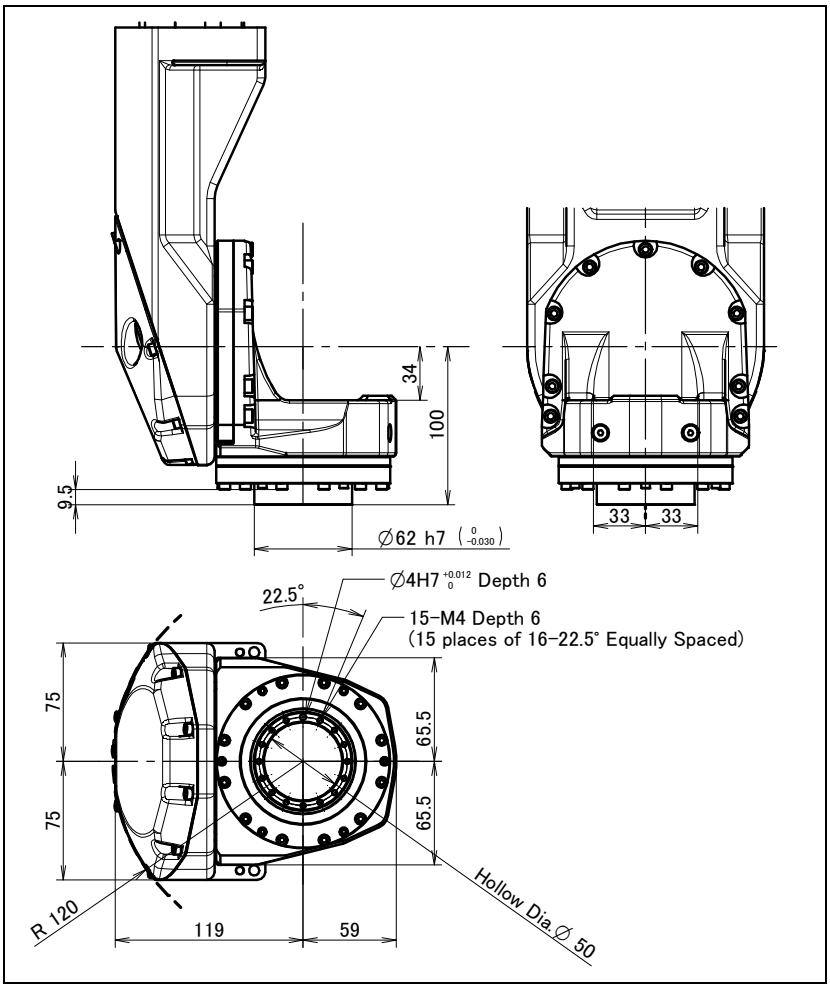


Fig. 4.1 (b) End effector interface (ARC Mate 120*i*C/20T, M-20*i*A/20T) (A05B-1225-B271, B272, B281, B282)

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

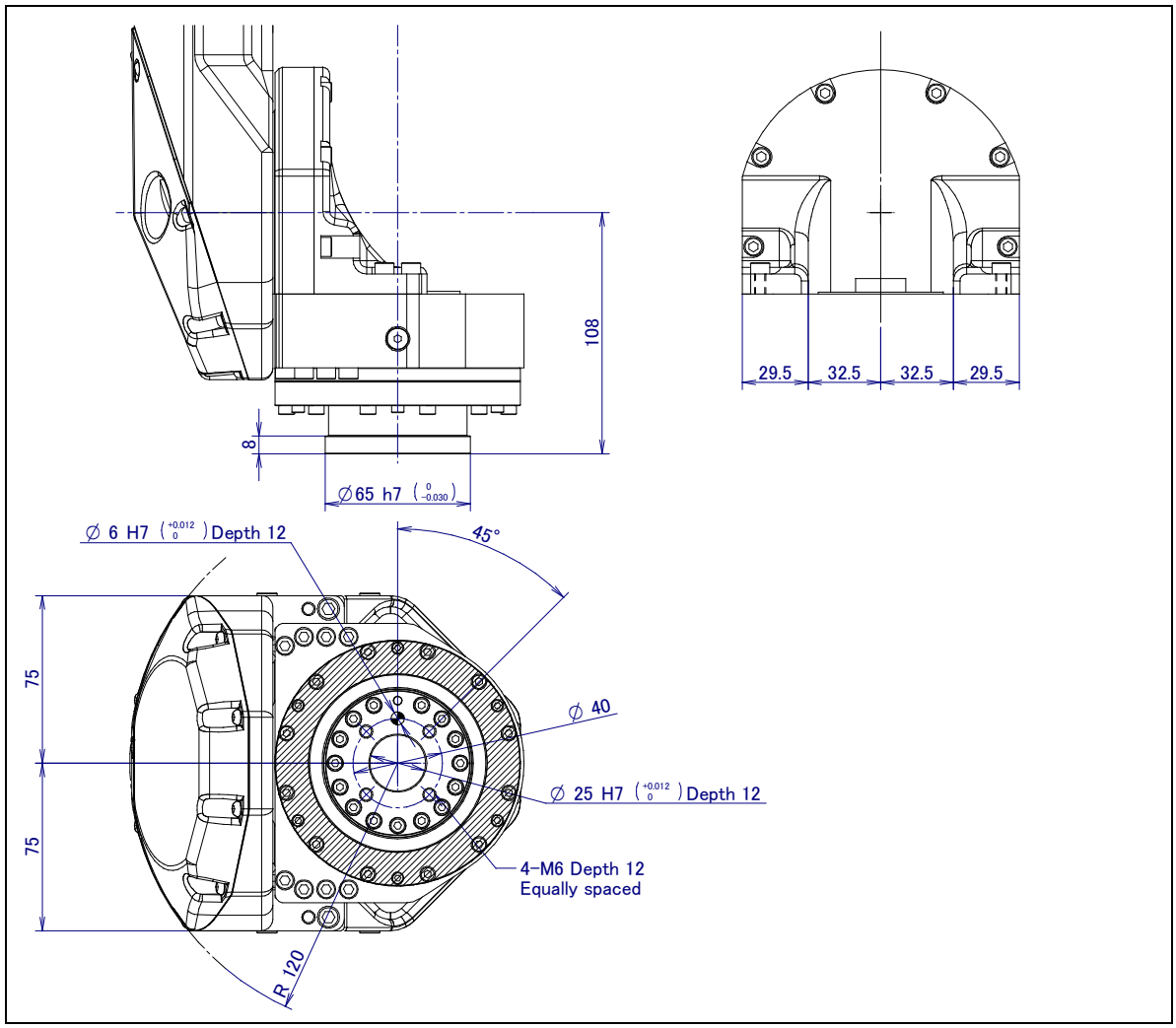


Fig. 4.1 (c) End effector interface (When ISO flange adapter is installed) (ARC Mate 120*i*C/20T, M-20*i*A/20T)

> ⚠ **CAUTION**
> Do not remove the M3, M4 bolts of shaped area. If they are removed, the robot does not return to the original state.

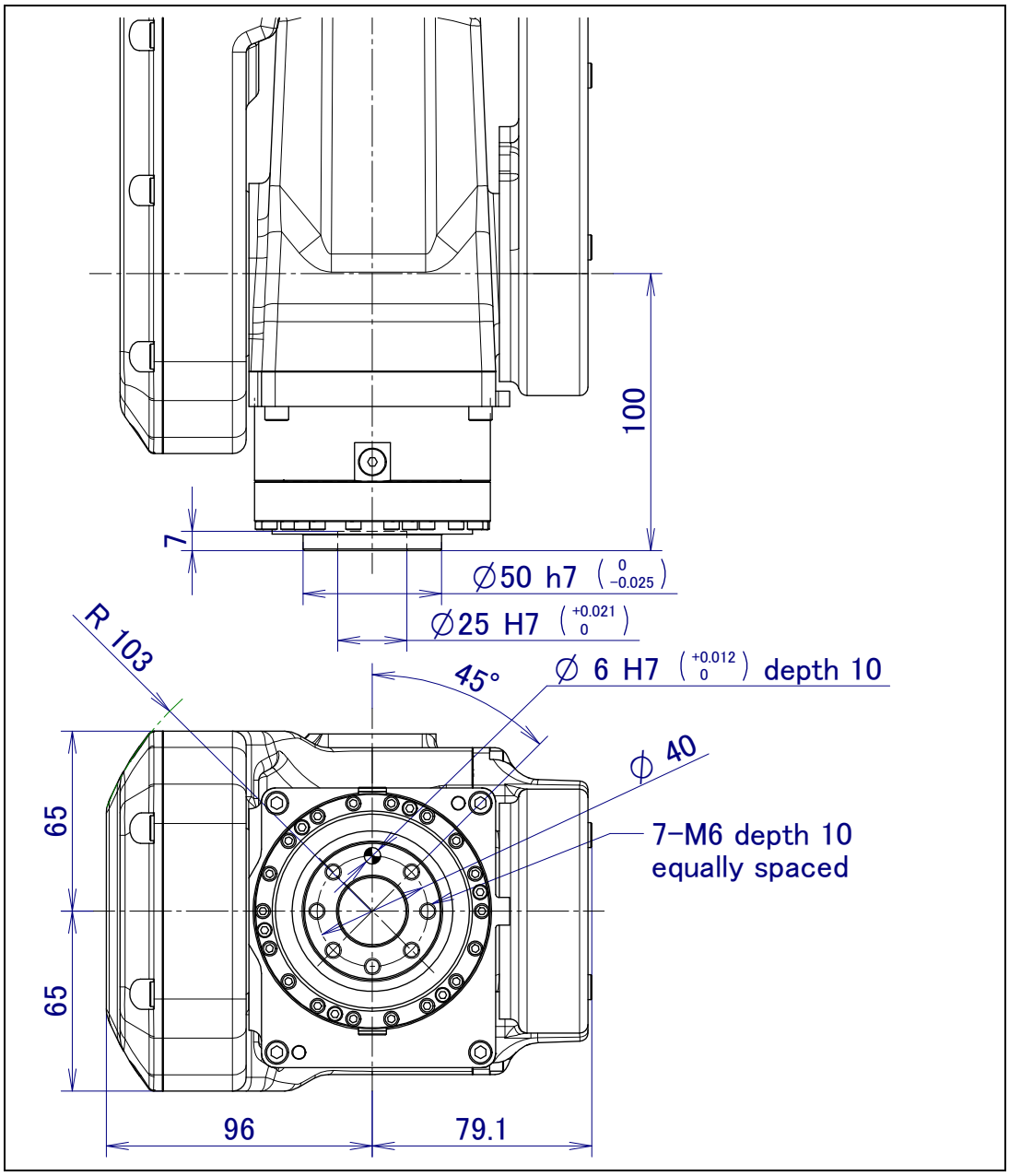


Fig. 4.1 (d) End effector interface (M-20*i*A/20MT/35MT)

4.2 EQUIPMENT MOUNTING FACE

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

⚠ CAUTION

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 is not pinched or damaged. If equipment installation restricts or damages the mechanical unit cable, it might become disconnected, and unexpected conditions might occur.

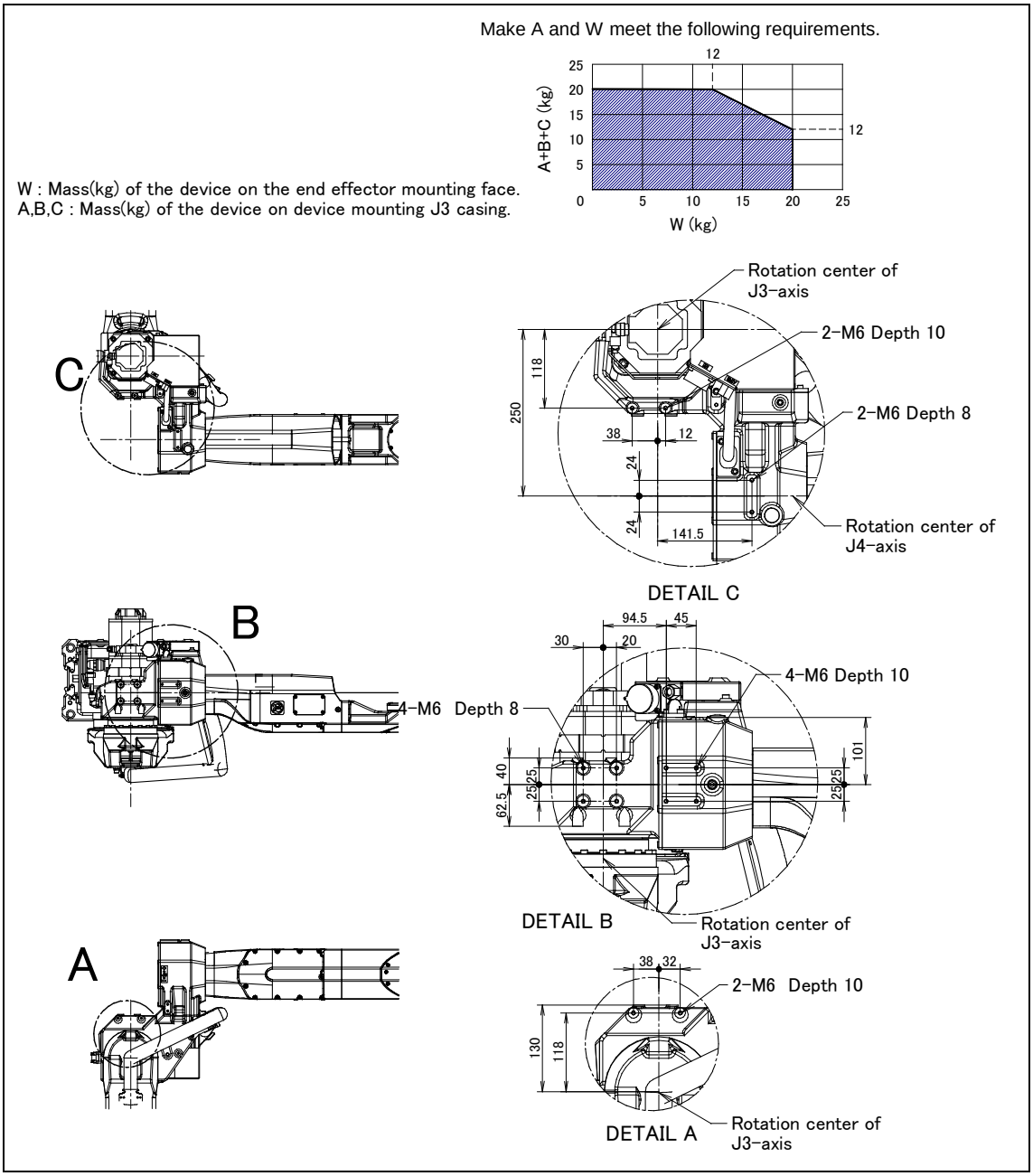


Fig. 4.2 (a) Equipment mounting faces (ARC Mate 120*i*C/20T, M-20*i*A/20T)

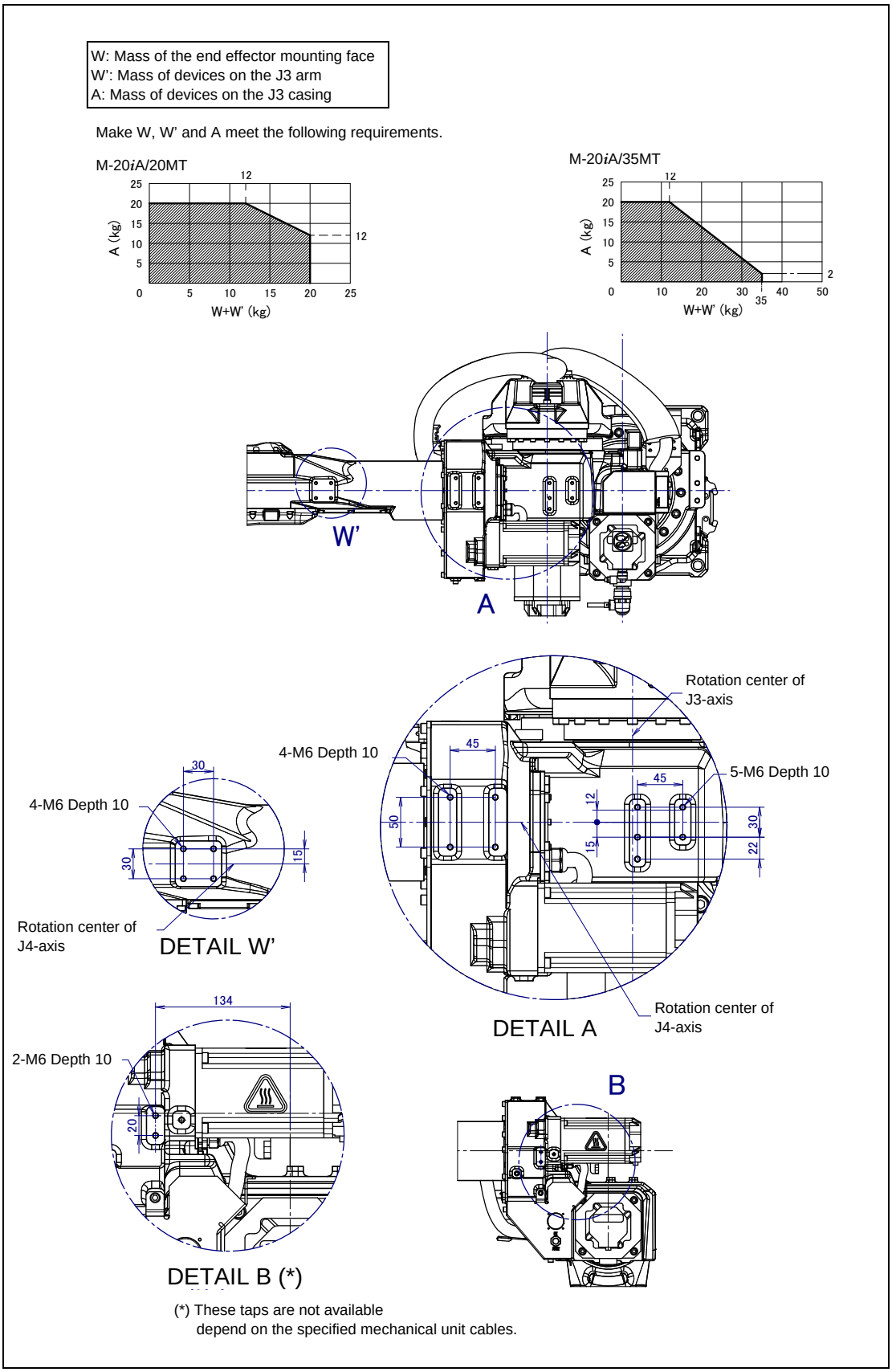


Fig. 4.2 (b) Equipment mounting faces and load limitation (M-20*i*A/20MT/35MT)

Fig. 4.2 (c) shows taps for the cable clamp of M-20*i*A/20MT/35MT.

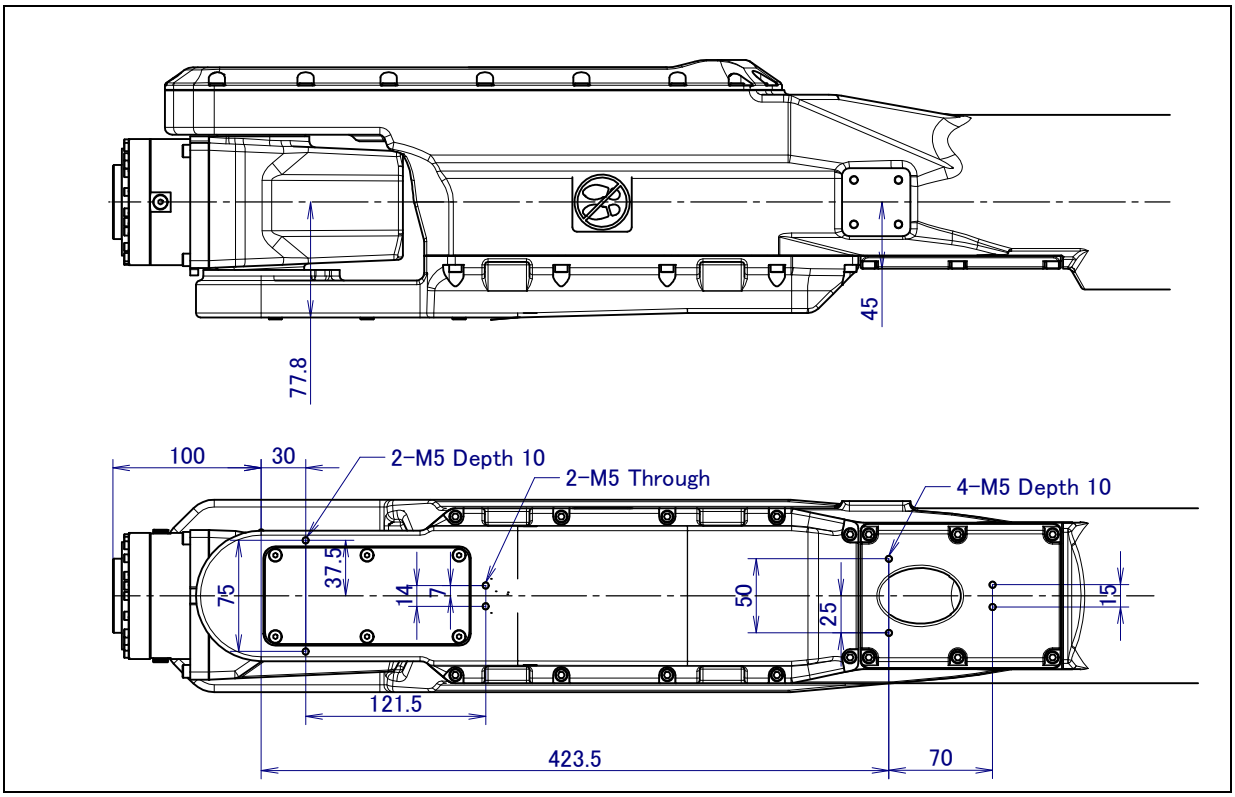


Fig. 4.2 (c) Equipment mounting faces (for the cable clamp) (M-20*i*A/20MT/35MT)

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

4.3 LOAD SETTING

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

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

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

```
MOTION PERFORMANCE                    JOINT 10%
   Group1
No.   PAYLOAD[kg]          Comment
 1          20.00   [                ]
 2           0.00   [                ]
 3           0.00   [                ]
 4           0.00   [                ]
 5           0.00   [                ]
 6           0.00   [                ]
 7           0.00   [                ]
 8           0.00   [                ]
 9           0.00   [                ]
10           0.00   [                ]

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

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

```
MOTION PAYLOAD SET              JOINT  100%

   Group 1
   Schedule No[   1]:[Comment          ]
 1 PAYLOAD             [kg]         20.00
 2 PAYLOAD CENTER  X   [cm]         -7.99
 3 PAYLOAD CENTER  Y   [cm]          0.00
 4 PAYLOAD CENTER  Z   [cm]          6.44
 5 PAYLOAD INERTIA X   [kgfcms^2]    0.13
 6 PAYLOAD INERTIA Y   [kgfcms^2]    0.14
 7 PAYLOAD INERTIA Z   [kgfcms^2]    0.07

 [TYPE]  GROUP  NUMBER  DEFAULT  HELP
```

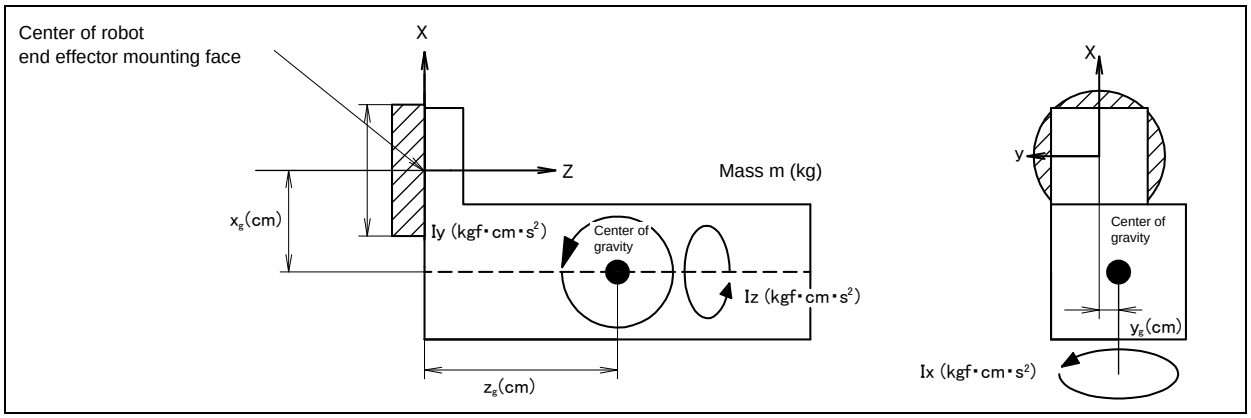


Fig. 4.3 Standard tool coordinate

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

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

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

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

```
MOTION ARMLOAD SET              JOINT   100%

   Group 1
 1 ARM LOAD AXIS #1 [kg]              0.00
 2 ARM LOAD AXIS #3 [kg]             12.00

[  TYPE  ]    GROUP          DEFAULT   HELP
```

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

4.4 CHANGING METHOD OF WRIST PAYLOAD SPECIFICATION FOR ARC Mate120*i*C/20T, M-20*i*A/20T

About Max payload shift function

In ARC Mate 120*i*C/20T, M-20*i*A/20T, the best two servo motion parameters are prepared respectively when the wrist payload specification is 3kg and 20kg. The best acceleration and deceleration operation can be achieved by setting the parameter matched to the wrist payload specification. The parameter is changed by executing the following KAREL programs (It is abbreviated as KAREL for Changing method of wrist payload specification thereafter.)

ARC Mate120*i*C/20T, M-20*i*A/20T

- M2TSET03.PC: 3kg wrist payload specification
- M2TSET20.PC: 20kg wrist payload specification

M-20*i*A/20T is set in 20kg wrist payload specification; ARC Mate 120*i*C/20T is set to 3kg wrist payload specification when robot is shipped.

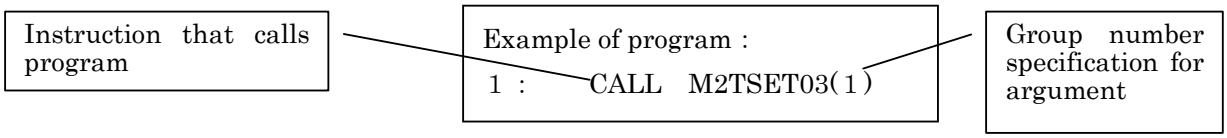
> ⚠ **CAUTION**
> When the robot over the payload in 3kg wrist payload specification (Refer to specification table in Section 3.1 and Section 3.4.), set in 20kg wrist payload specification. If the robot is operated with wrong setting, the function and the lifetime of the robot would deteriorate.
> In case of M-20*i*A/20MT and 35MT, it is impossible to change payload.

Method of shifting

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

(1) Method of executing KAREL program by using "Call program" →Subsection 4.4.1

- The KAREL program is set in the program call instruction of the TP program and the parameter is set by specifying with the argument that shows the group number, and executing it. The parameter of M-20*i*A/20T of a specific group can be switched in this method.



(2) Method of executing KAREL program directly→Subsection 4.4.2

- Select and execute the KAREL program in program select screen.
- Two or more M-20*i*A/20T exists in the multi group system, and it is possible to change in this method bringing the parameter of two or more M-20*i*A/20T together to set the parameter for the same load as them.

> ⚠ **CAUTION**
> Execute KAREL for Changing method of wrist payload specification in the state of cold start mode.
> Be careful that the paths and the cycle time of an existing teach program change if KAREL for changing method of wrist payload specification is executed.

Below section explains the method of executing KAREL for changing wrist payload specification.

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

It is assumed that selecting M-20*i*A/20T of the first group to the 3kg wrist payload specification in the following procedures.

Execution procedure

1 Call the system variable screen.

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

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

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

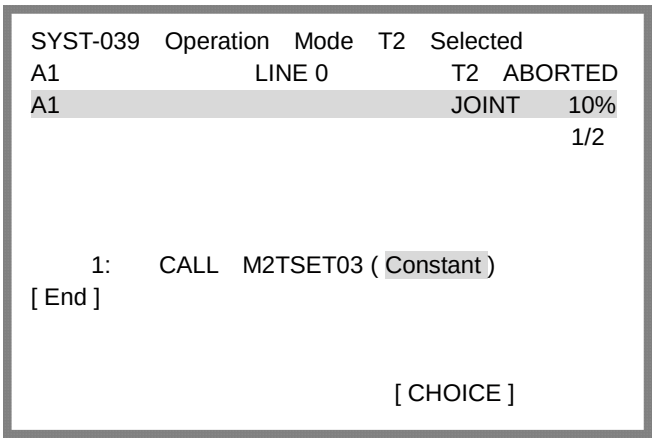
Then, the following screens will be displayed.

```
SYST-039  Operation  Mode  T2  Selected
  PROGRAM list                    JOINT  10 %
1  A1                  5
2  HOME_IO             6
3  M2TSET03            7
4  M2TSET20            8
A1
                                        1/2
      1:    CALL . . .
[ End ]

Select  item
PROGRAM   MACRO    KAREL          STRINGS
```

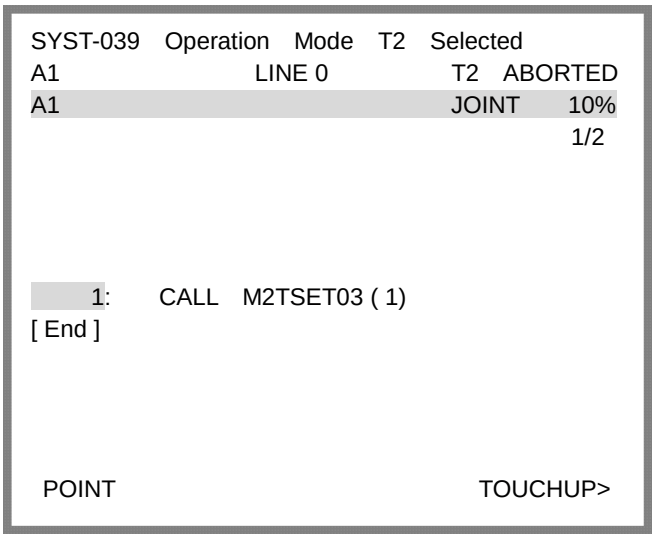
5 Press F3 key (COLLECT), select “KAREL PROG”. Then, select KAREL M2TSET03 of 3kg wrist payload specification from among that because it becomes the following screens.

```
SYST-039  Operation  Mode  T2  Selected
  KAREL list                      JOINT  10 %
1  GEMDATA             5  MEM_PORT
2  GET_HOME            6  PSCOLD
3  M2TSET03            7
4  M2TSET20            8
A1
                                        1/2
      1:    CALL . . .
[ End ]

Select  item
PROGRAM   MACRO    KAREL          STRINGS
```

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



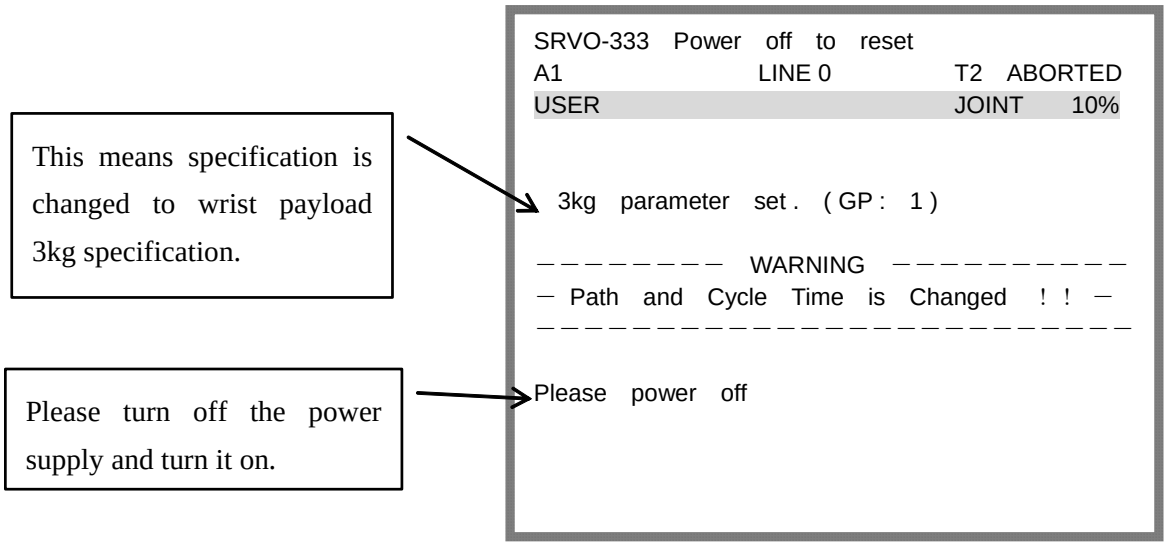
7 The group number (It is 1 here) is put with the cursor in “Constant”.



8 Execute this program.

Push FWD key while pushing SHIFT key

Then, the following screens are displayed. This shows the thing that KAREL M2TSET03.PC of 3kg wrist payload specification is executed.



9 Turn on the power supply again.

The change of the parameter ends above.

4.4.2 Method of Executing KAREL Program Directly

Use scene

For instance, it is assumed that the following multi group systems exist.
1st group: M-20*i*A/20T
2nd group: M-20*i*A/20T
3rd group: positioner A
When the method of the explanation in this chapter is used to do M-20*i*A/20T of the 1st group and 2nd group here to 3kg wrist payload specification, it is possible to set the 1st group and 2nd group to the parameter of an acceptable 3kg wrist payload specification at the same time.

> ⚠ **CAUTION**
> If you want to M-20*i*A/20T of 1st group to 3kg wrist payload specification and M-20*i*A/20T of 2nd group to 20kg wrist payload specification, Method of this chapter cannot be used.
> In that case, please make two programs as follows, and do the parameter change by the method of Chapter 1.

1 Turn on the power supply again after executing the program 1.
2 Turn on the power supply again after executing the program 2.

```
Example of program
Program 1:
1:    call  M2TSET03(1)
Program 2:
1:    call  M2TSET20(2)
```

1st group is Max payload 3kg specification

2nd group is Max payload 20kg specification

Execution procedure

1 Call the system variable screen.

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

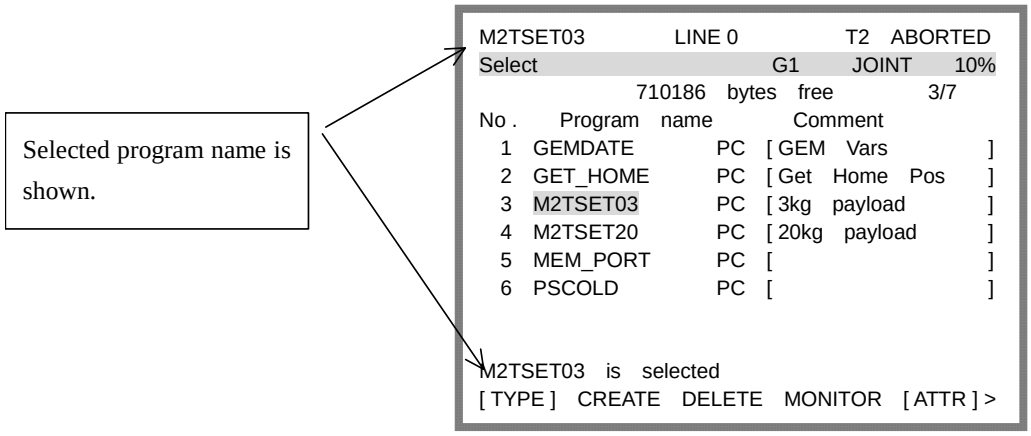
2 Set system variables $KAREL_ENB to 1.
3 Call program select screen and select “.

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

Then, three KAREL programs are displayed as follows.

```
A1                    LINE 0          T2   ABORTED
Select                              G1    JOINT    10%
                  710186  bytes  free          1/7
No .    Program  name          Comment
  1   GEMDATE          PC  [ GEM  Vars          ]
  2   GET_HOME         PC  [ Get  Home  Pos     ]
  3   M2TSET03         PC  [ 3kg  payload       ]
  4   M2TSET20         PC  [ 20kg  payload      ]
  5   MEM_PORT         PC  [                    ]
  6   PSCOLD           PC  [                    ]


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

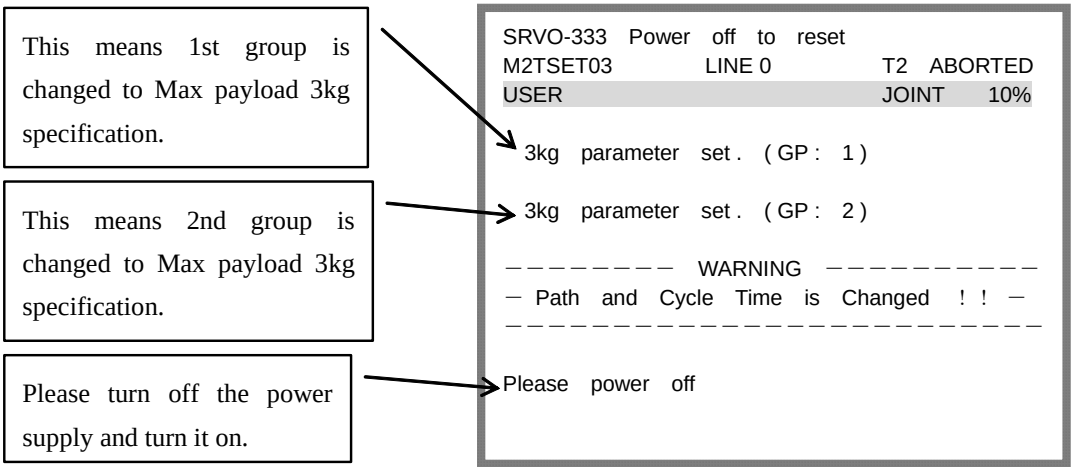
4 Match the cursor to the KAREL program of the load that wants to be set, and push the ENTER key. It is time when it selected M2TSET03.PC that is KAREL of 3kg wrist payload specification as follows. The selected program name is displayed to two places as follows.



5 Execute the program.

Push FWD key while pushing SHIFT key

Then, the following screens are displayed. This is case of executing KAREL M2TSET03.PC of Max payload 3kg specification.



6 Turn on the power supply again.

The change of the parameter ends above.

4.5 SETUP OF J1-AXIS

Once the robot mechanical unit has been installed on the gantry and the controller is hooked up, setup the software according to the specification of the gantry. Set it according to the following procedures.

1 Turn the controller ON while pushing the [PREV] key and the [NEXT] on the teach pendant.
Select "3. Controlled start", controlled start the controller.
Press the [MENU] key and select "9. MAINTENANCE".
2 Move cursor to "M-20*i*A/20T" and press the [F4] key (MANUAL).
3 Select CARTESIAN motion option

```
-- Install CARTESIAN motion option --
1: Cycle Time Priority
2: Path priority
select motion option?
```

Select Cartesian motion option. Default is 1:Cycle Time Priority.

4 Selecting flange type

```
-- FLANGE TYPE SELECT --
1: Normal Flange
2: ISO Flange
select flange type?
```

Select flange type of mechanical unit.

5 Payload setting

```
-- Payload setting --
Current value = *** [kg]
enter Payload ( 0..20 [kg] ) ?
```

Input wrist payload according to the actual work piece (Unit: kg).

6 Mounting type

```
-- Mount Type Setting --
0: Floor Mount (0deg)
1: Side Slung (90deg)
2: Under Slung (180deg)
3: Side Slung 2 (-90deg)
```

Select from "1: Side Slung" or "2: Under Slung" or "3: Side Slung 2" (Normally, "0: Floor mount" should not be selected.) See also Fig. 4.5.

7 J1 carriage set up

```
-- J1 Carriage Setup --
1: North American Carriage
2: Japanese Carriage (Custom)
```

Select "2: Custom Carriage".

8 J1 upper limit

```
-- J1 UPPER LIMIT--
Enter Upper Limit (mm) =
Default value =    ***
```

Input J1 upper limit. (unit : mm)

9 J1 lower limit

```
-- J1 LOWER LIMIT--
Enter Lower Limit (mm) =
Default value =    ***
```

Input J1 lower limit. (unit: mm)

10 J1 mastering position

```
-- J1 MASTER POS--
Enter Master Position (mm) =
Default value =    ***
```

Input J1 mastering position. (unit: mm)

If North American Carriage is selected, go to procedure 18.

11 J1 gear ratio

```
-- J1 Gear Ratio Setting --
Please enter J1 gear ratio.
(Units = mm/rev):
```

Input the gear ratio for the J1-axis. (Significant figures: 6 digits)
The definition for gear ratio is the travel distance per revolution of the motor. (Unit: mm / rev)

12 J1 maximum speed

```
-- J1 Max Speed Setting --
Suggested Speed = **(mm / s)
(Calculated with Max motor speed)
Enter (1:Change, 2:No Change)?
```

Input the maximum speed for the J1-axis. The suggested speed shown here is calculated from the maximum motor speed and gear ratio input in procedure (11).
If you wish to change the value, select “1: Change”. If you wish to use the recommended value, select “2: No Change”.
When “1: Change” is selected, the screen will show the following. Input the desired value. (Unit: mm / sec)

```
-- J1 Max Speed Setting --
Suggested Speed = **(mm / s)
(Calculated with Max motor speed)
Enter (1:Change, 2:No Change)? 1
Enter Max Speed (mm/sec) _>
```

13 J1 motor direction setting

```
-- J1 Motor Direction Setting
Default Motion Sign = TRUE
Enter (1:TRUE, 2:FALSE) ?
```

Set the traveling direction of the slider to the motor rotation.
If the slider travels in the +Y direction with the positive rotation of the motor, select “1: TRUE”.
If the slider travels in the -Y direction with the positive rotation of the motor, select “2: FALSE”. (Fig. 4.5)

14 Time constant of the first joint setup

```
-- ACC/DEC TIME --

Default acc_time1 = 424 (ms)
Enter (1:Change, 2:No Change)?
```

Set the acceleration / deceleration time of the first joint. This is the time used to reach the maximum speed. The default value is 360msec but the value should be set according to the maximum speed and duty.
If you wish to change the value, select “1: Change”. If you wish to use the default value, select “2: No Change”.
When “1: Change” is selected, the screen will show the following. Input the desired value. (Unit: msec)

```
-- ACC/DEC TIME --

Default acc_time1 = 424 (ms)
Enter (1:Change, 2:No Change)? 1
Enter Accel Time1 (ms)?
```

15 Time constant of the second joint setup

```
-- ACC/DEC TIME --

Default acc_time1 = 424 (ms)
Enter (1:Change, 2:No Change)? 1
Enter Accel Time1 (ms)? 320

Default acc_time2 = 212 (ms)
Enter (1:Change, 2:No Change)?
```

Set the constant of the acceleration / deceleration time of the second joint. This is the time used to reach the maximum acceleration / deceleration. Normally, this value is 1/2 of the time constant of the first joint. The default value is 212msec.
If you wish to change the value, select “1: Change”. If you wish to use the default value, select “2: No Change”. When “1: Change” is selected, the screen will show the following. Input the desired value. (Unit: msec)

```
-- ACC/DEC TIME --

Default acc_time2 = 212 (ms)
Enter (1:Change, 2:No Change)? 1
Enter Accel Time2 (ms)?
```

16 Inertia ratio

```
-- LOAD RATIO --
                LoadInertia + MotorInertia
LoadRatio = ---------------------------------------
                        MotorInertia
Enter Load ratio? (0;None 1~6:Valid)
```

Set the inertia ratio of total load inertia converted to motor axis to the motor axis inertia. If you do not wish to set the value, select "0: None".

17 Warning on J1 collision detection

```
**********************************
  Note: Collision Detection
    will be disabled for
    Axis 1.
**********************************
```

The above screen will be shown and will warn you that the collision detection for the J1-axis is disabled. The collision detection for the J1-axis must be optimized according to the gantry that the customer has provided. After the J1-axis has been setup, optimize and activate the collision detection referring to Subsection 4.5.1.
Press Enter key to continue.

18 electing robot type

```
-- ROBOT TYPE SETTING --
1: ARC Mate 120iC/20T (3kg mode)
2: M-20iA/20T (20kg mode)
  Select Robot Type (1 or 2)->
```

Select maximum payload setting from 3kg mode or 20kg mode.

19 Select cable dress-out

```
-- CABLE DRESS-OUT TYPE SETTING
1. Cable integrated J3 arm
  （J5:-140 ..140, J6:-270 .. 270[deg]）
2: Conventional dress-out
  (J5:-180 .. 180, J6;-450 .. 450[deg])
Select cable dress-out type (1 or 2) ->
```

Select cable dress-out type. If cable is integrated into J3 arm, select "1.Cable integrated J3 arm."

20 Setting incline angle

```
-- Mount angle 2 Setting --
Enter mount angle2?(-70deg - +70deg)
```

Enter incline angle α, between J1 rail axis (equal to Y axis at world coordinates) and robot base. The value is $-70\text{deg} \leqq \alpha \leqq +70\text{deg}$. See also Fig. 4.5 regarding orientation of angle α.
This step is skipped and automatically sets 0 deg if mount type setting is "Floor mount" or "Under slung."

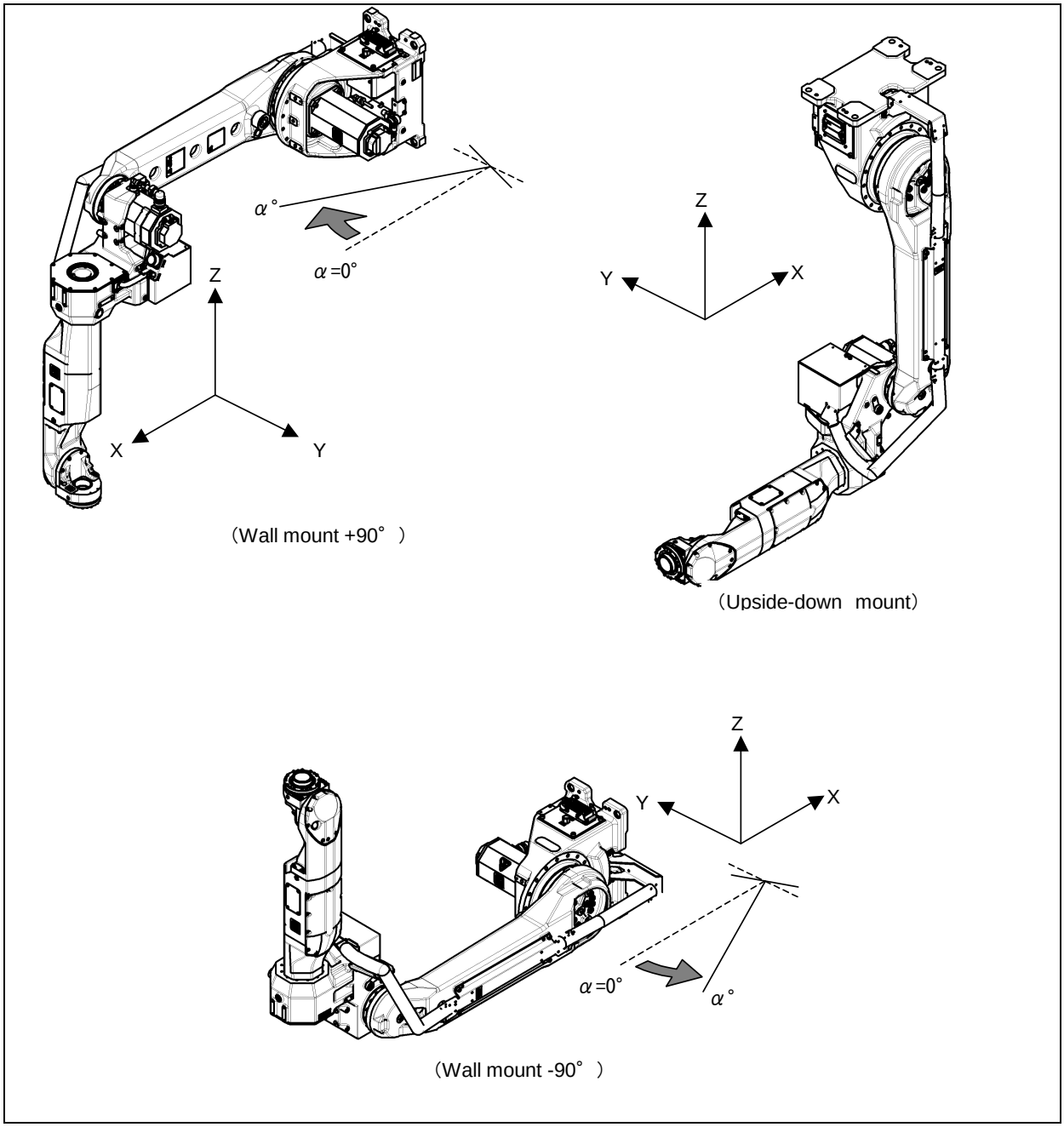


Fig. 4.5 Robot installation type and world coordinates

4.5.1 Enable and Adjustment of Collision Detection of J1-Axis

Enable of collision detection of J1-axis

Collision detection function at J1-axis is disabled in default. Enable collision detect function by following procedure.

1 Display system variables by pressing the [MENU] key and selecting “0:Next” > “6:System”>“F1 Screen > “2:System variables”.
2 Select “$SBR” and press the [ENTER] key.
3 Select [1] and press the [ENTER] key.
4 Select “$PARAM” and press the [ENTER] key.
5 Input “8344 / inertia ratio” into [47]. (Input 1545 if inertia ratio is 5.4.)
6 Input “2097152 / value calculated in (5)” into [112]. (Input 1357 if 1545 is input in (5).)
7 Turn off and on the controller.

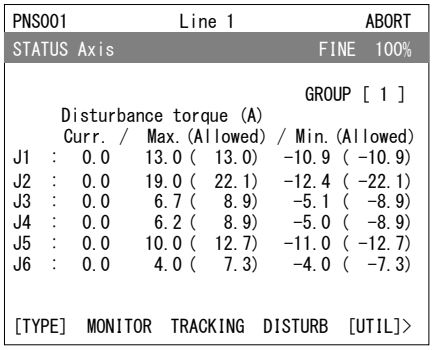
Adjustment of collision detection of J1-axis

> ⚠ **CAUTION**
> Don’t turn off and on the controller power when adjusting collision detection of J1-axis.

1 First input temporary limit for collision detection
  1-1 Display system variables by pressing the [MENU] key and selecting “0:Next” > “6:System”>“F1 Screen > “2:System variables”.
  1-2 Input “1” to variable 「$SVPRM_ENB」.
  1-3 Display servo parameter screen by pressing the [MENU] key and selecting “0:Next” > “6:System”>“F1 Screen > “3:Servo parameter”.
  1-4 Enter F2 key (axis#) and input “1”.
  1-5 Input “7282” into servo parameter [1] [119].
  1-6 Input “-7282” into servo parameter [1] [120].
  1-7 Input “1456” into servo parameter [1] [125].
  1-8 Display system variables by pressing the [MENU] key and selecting “0:Next” > “6:System”>“F1 Screen > “2:System variables”.
  1-9 Input “0” to variable 「$SVPRM_ENB」.

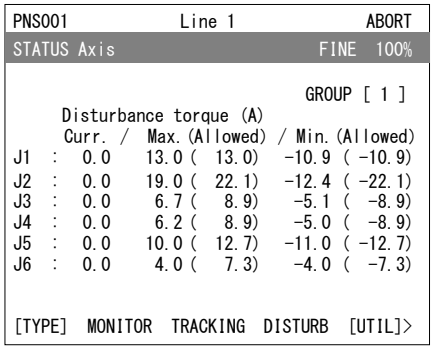
2 Follow the procedure below and set the limits so that no misdetections occur when executing normal programs.
  2-1 Create a program that includes severe motions such as an inverse motion with CNT100.
  If the program for production already exists, the program can be used to optimize the limits for better sensitivity. However, if the program used is modified or changed, misdetections may occur and re-tuning might be required.
  2-2 Run the above program.
  When doing so, do not pause in mid-program.
  Pausing will cause the disturbance torque (shown below) to be cleared at the re-start of the program. The maximum / minimum disturbance torque during the whole program is needed to set the proper limits.

2-3 Measure the max. / min. disturbance torque on STATUS / AXIS / DISTURB screen after executing the program.



As noted above, the disturbance torque will reset at the start of each program. If plural programs exist, create and run a main program that calls all necessary programs or record the max. / min. disturbance torque for each necessary program and use the max. / min. value of all the recorded values.

2-4 Move the cursor to the allowed value in parentheses. Set the allowed value to the same as the measured max. or min. value.



⚠ CAUTION

The actual limit for the servo to power off will occur when the disturbance torque exceeds the below alarm level.

Alarm level (+) = Allowed value (+) + 16 A
Alarm level (–) = Allowed value (–) – 16 A
The 16A will be the margin to prevent misdetections.

2-5 Run the programs with the above settings and confirm that no misdetections occur.

2-6 Set allowed value which is called when turning on the controller power.
Display system variables by pressing the [MENU] key and selecting “0:Next” > “6:System”>“F1 Screen > “2:System variables”.
Select 「$HSCDMNGRP」 and press the [ENTER] key.
Select [1] and press the [ENTER] key.
Input “1456” into $HSCDMNGRP[1].$PARAM125[1].

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 the outside of the mechanical unit.
- Please do not perform remodeling (adding a protective cover, or secure an additional outside cable) that obstructs the behavior of the cable.
- When external equipment is installed on 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 the end effector, robot faults, or damage to robot electrical hardware. In addition, electric shock could occur when touching the power cables.

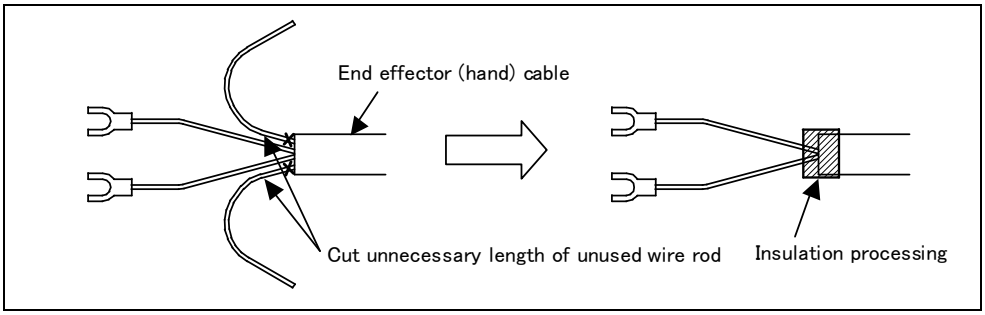


Fig. 5 Treatment method of end effector (hand) cable

5.1 AIR SUPPLY (OPTION)

Air inlet and air outlet are prepared on the back (the front when CONNECTOR PLATE OPPOSITE SIDE ASS'Y is specified) of the J2 base and the J3 casing used to supply air pressure to the end effector. Prepare couplings that suit to the hose size.

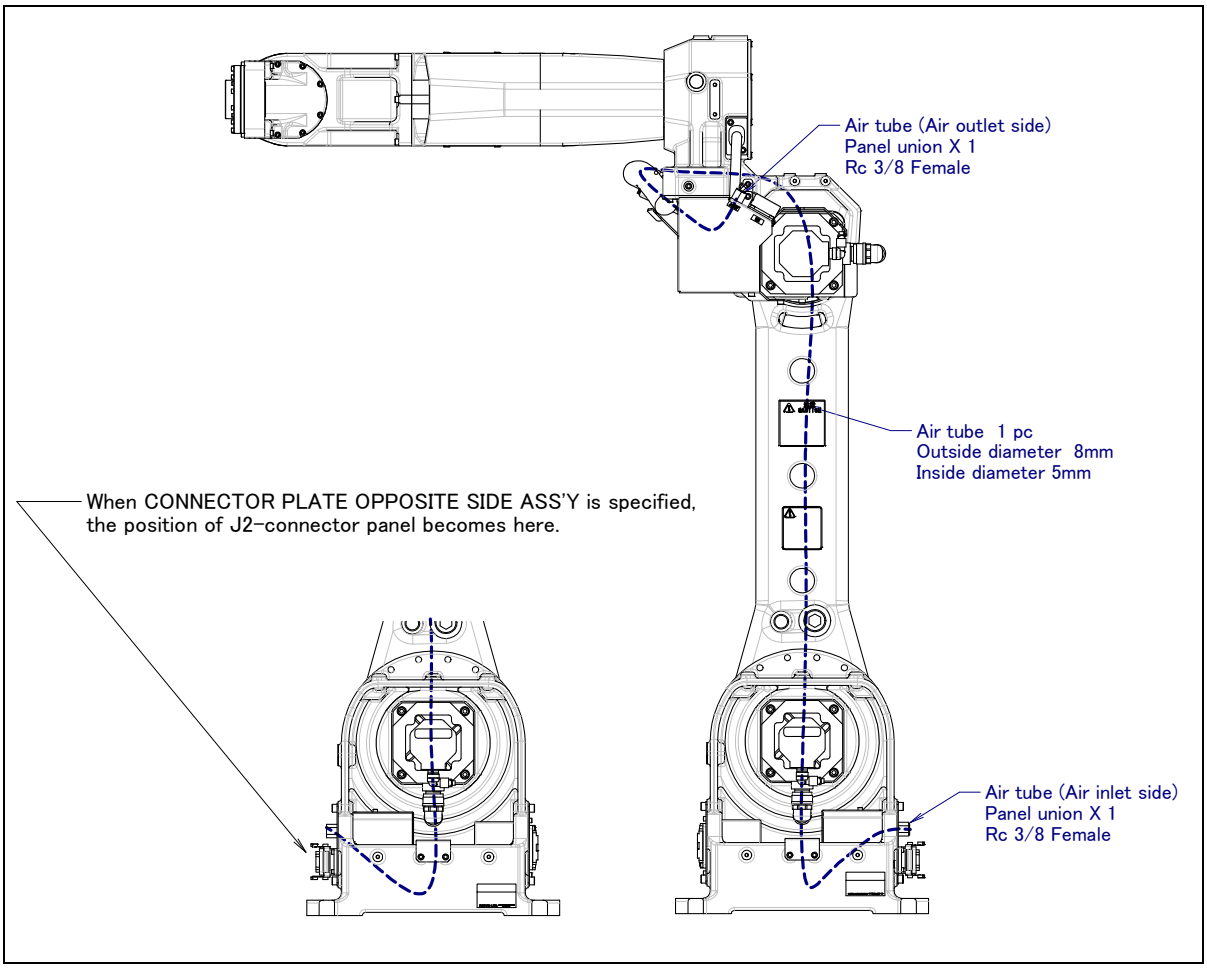


Fig. 5.1 Air supply (option)

5.2 AIR PIPING (OPTION)

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

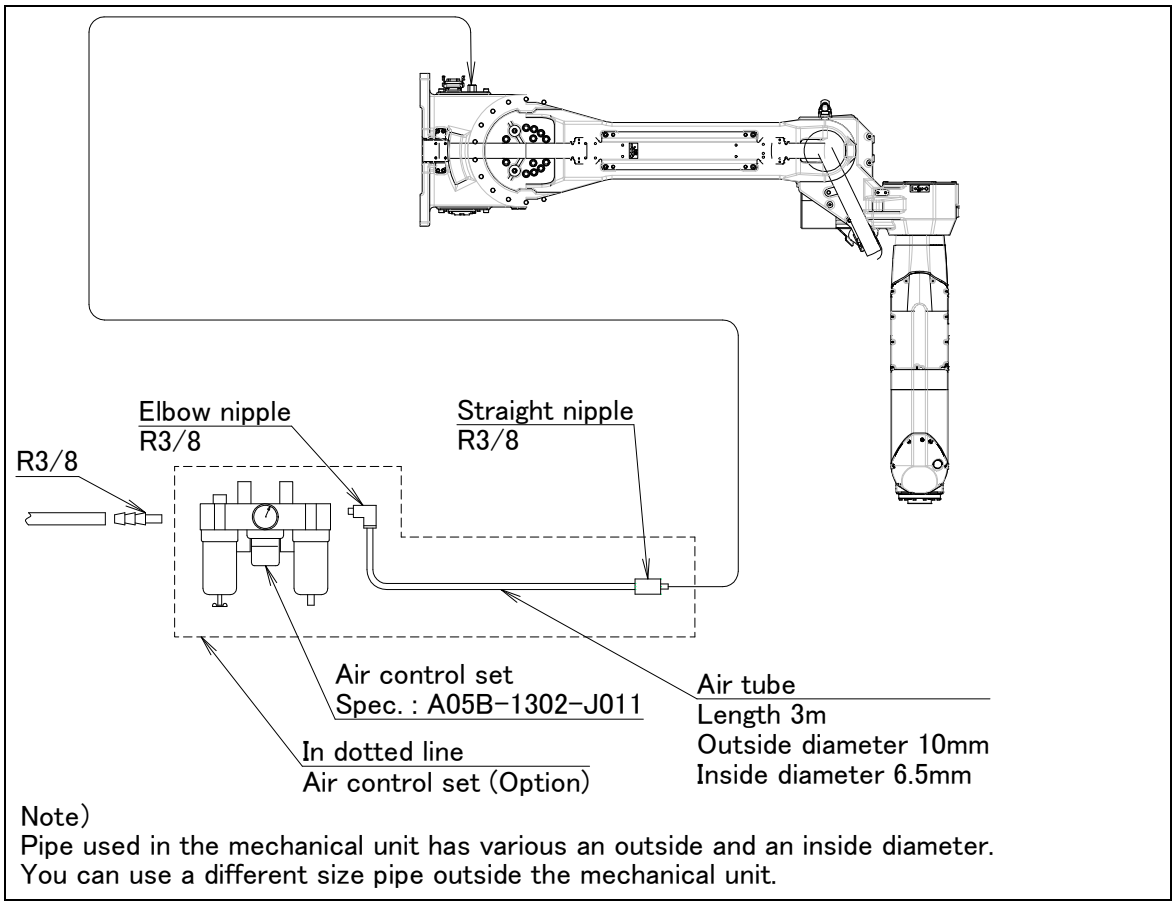


Fig. 5.2 (a) Air piping (option)

Air control set

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.

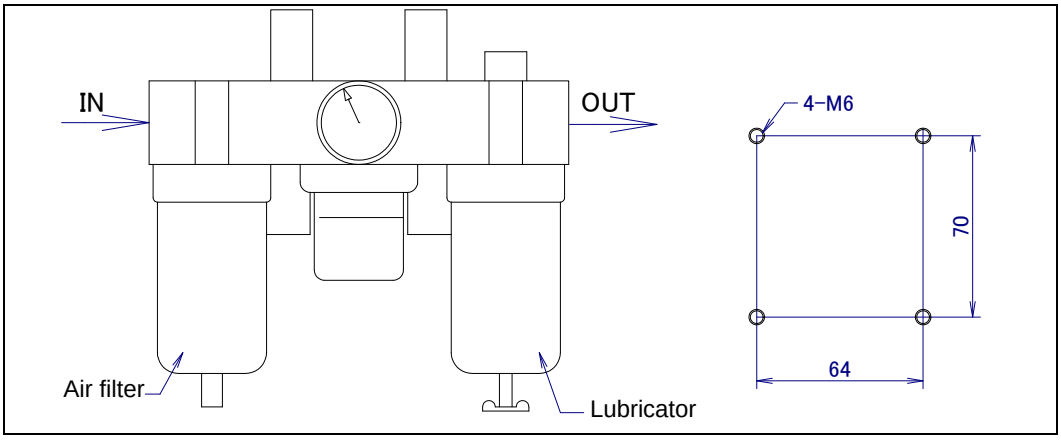


Fig. 5.2 (b) Air control set option (option)

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

5.3 INTERFACE FOR OPTION CABLE (OPTION)

Fig. 5.3 (a) to (e) show the position of the option cable interface. When CONNECTOR PLATE OPPOSITE SIDE ASS'Y is specified, the position of J2 base panel is opposite side. EE interface (RI/RO), User cable (signal), camera cable and 3DL sensor, force sensor cable are prepared as options.

NOTE
Each option cable is written as shown below on the connector panel.
EE interface : EE
User cable (signal) : AS
User cable usable to 3D Laser Vision Sensor and Force Sensor : ASi
Camera cable : CAM
3D Laser Vision Sensor cable : SEN

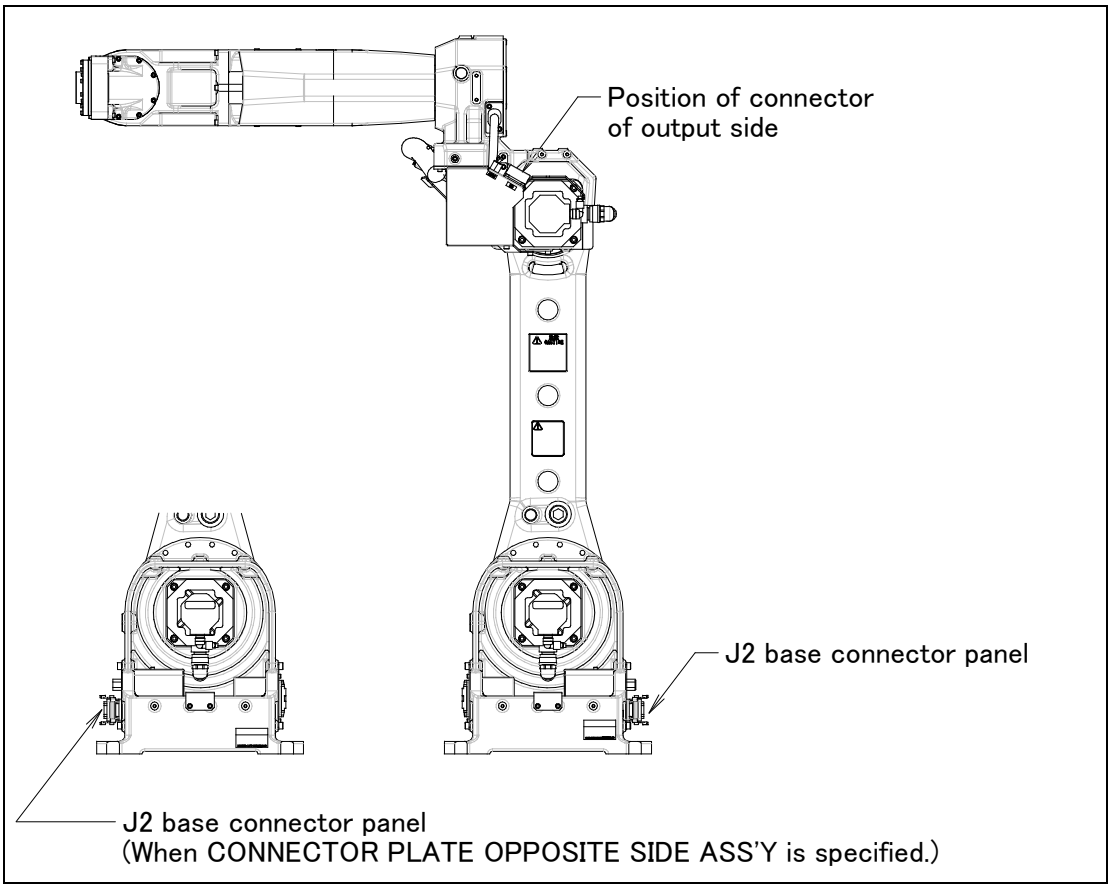


Fig. 5.3 (a) Interface for option cable (OPTION)

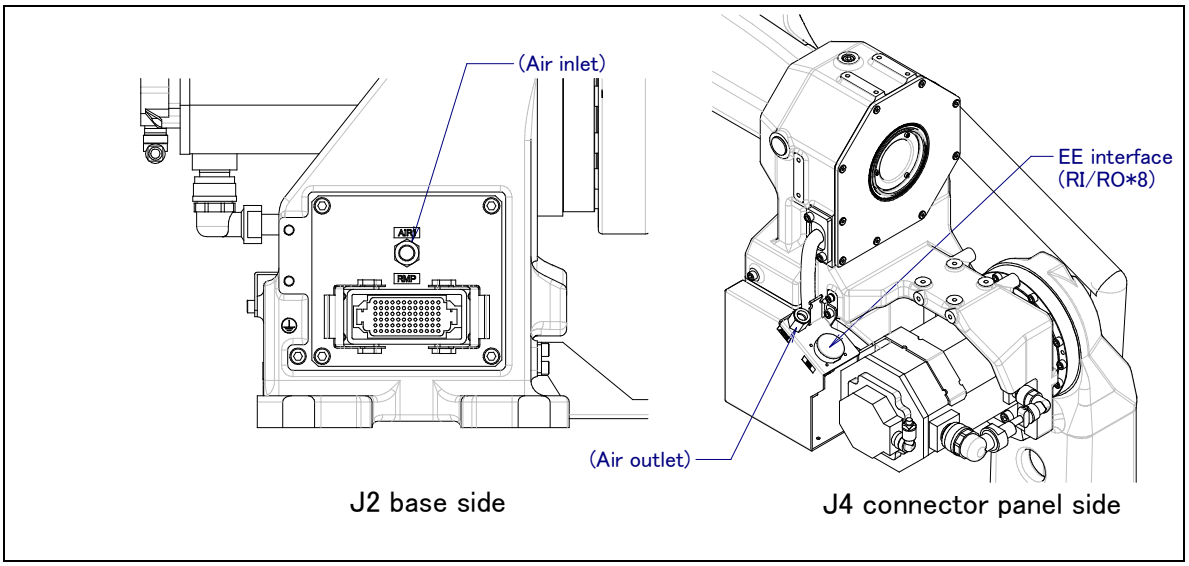


Fig. 5.3 (b) Interface for option cable (A05B-1222-H208, H608 is specified)

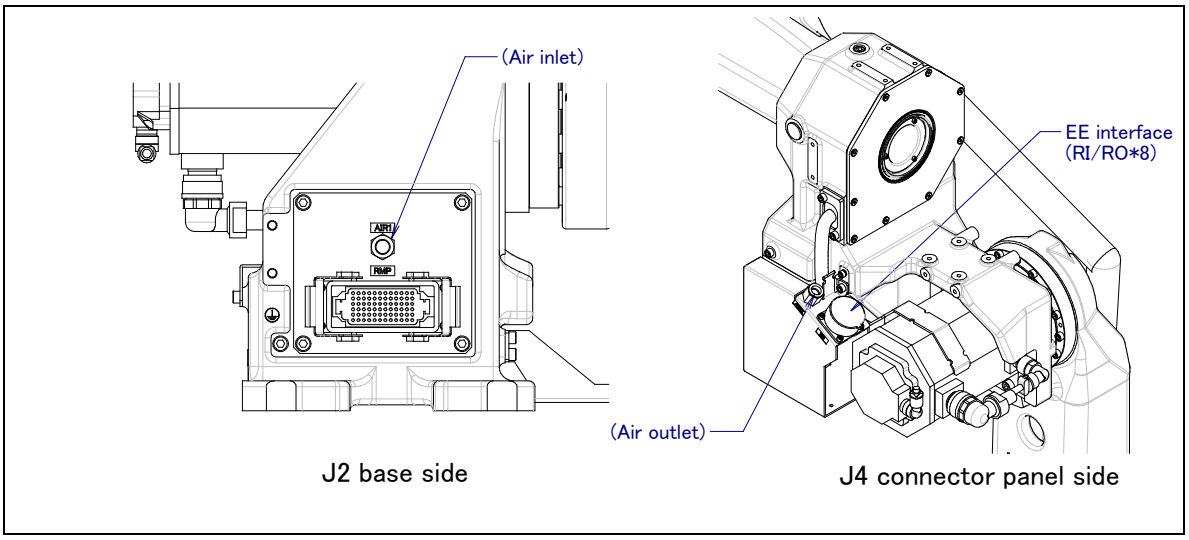


Fig. 5.3 (c) Interface for option cable (A05B-1222-H209 is specified)

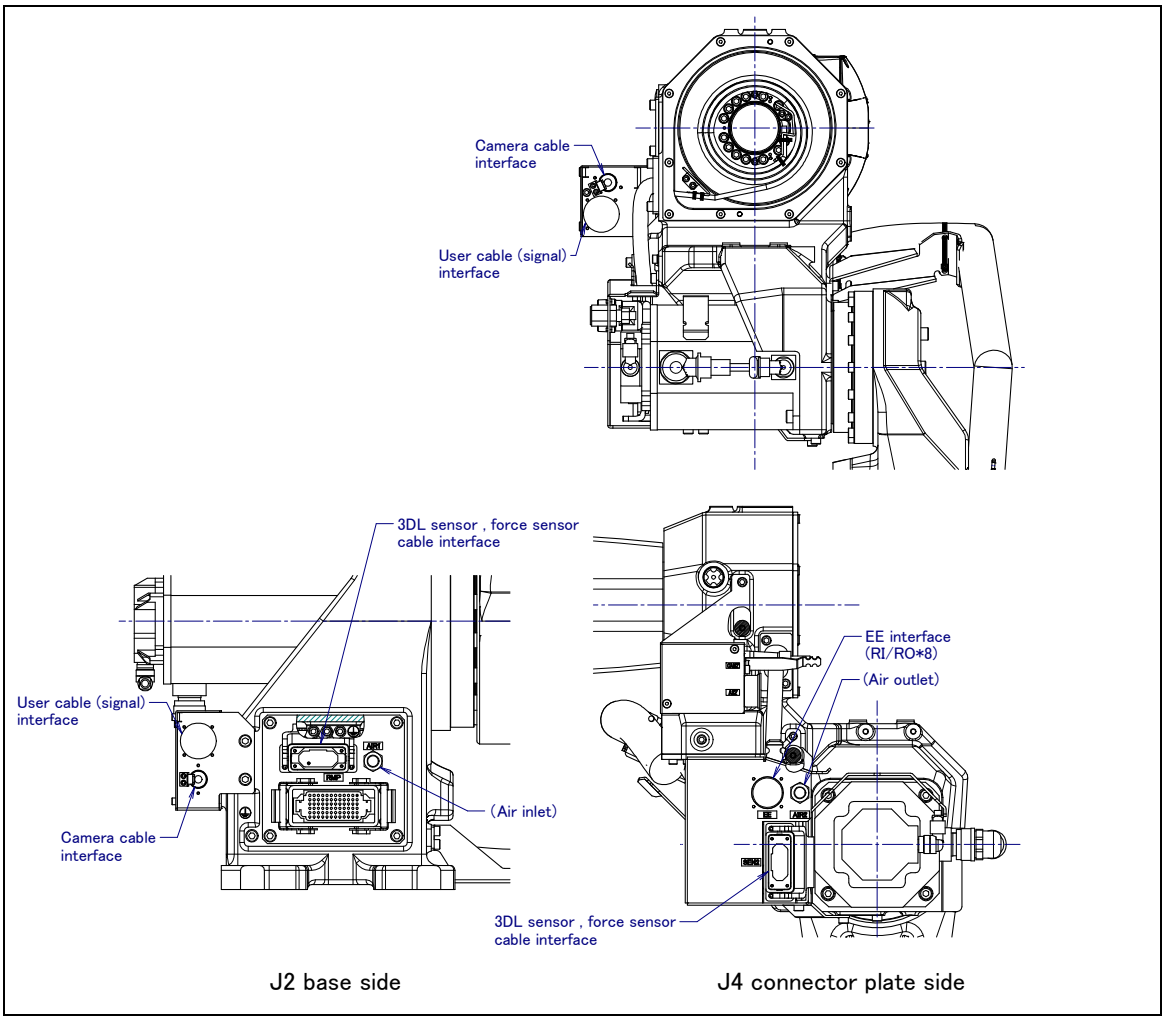


Fig. 5.3 (d) Interface for option cable (A05B-1222-H527 is specified)

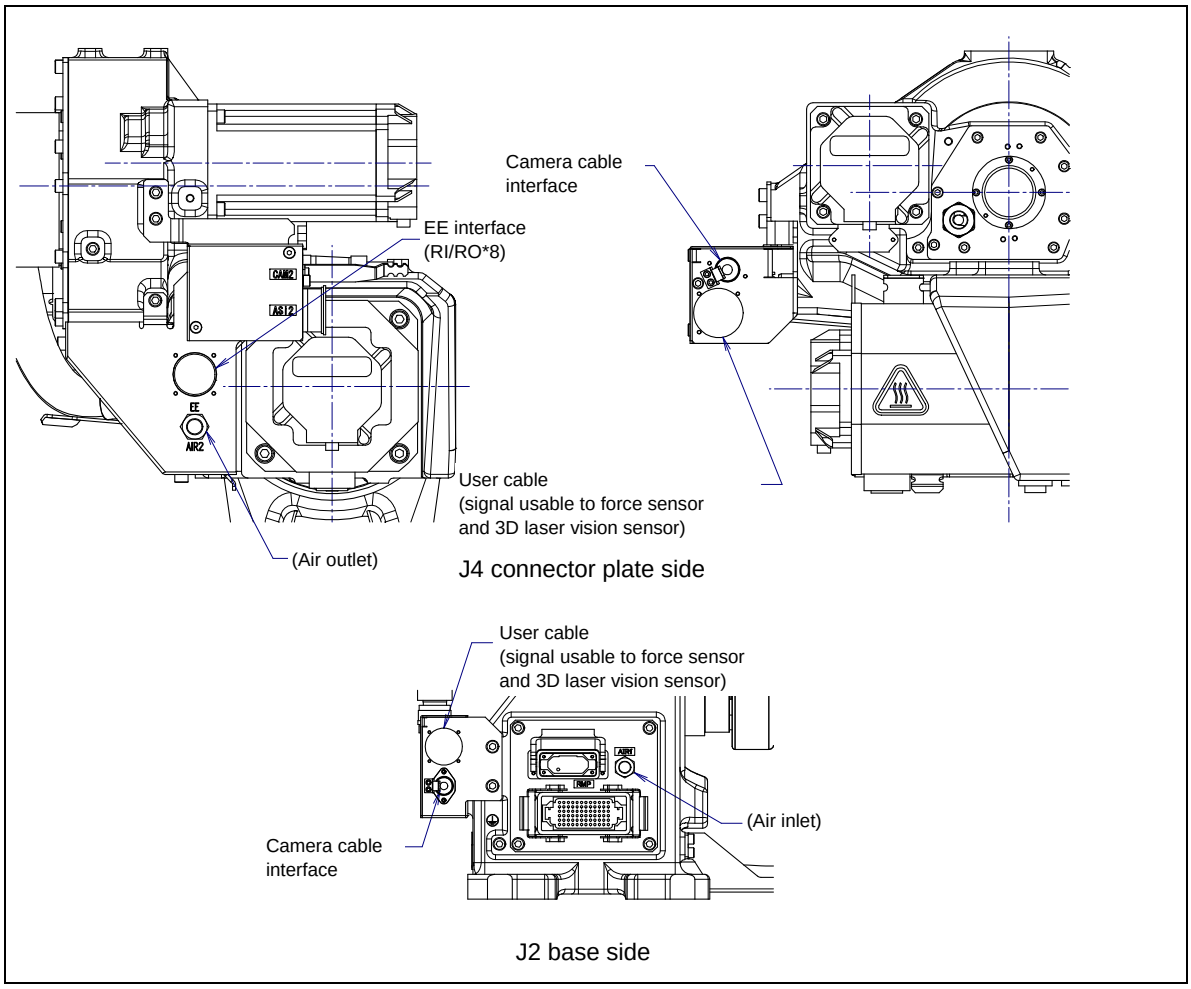


Fig. 5.3 (e) Interface for option cable (A05B-1222-H627 is specified)

1 EE interface (RI/RO) (Option)
Fig. 5.3 (f), (g) show pin layout for EE interface (RI/RO).

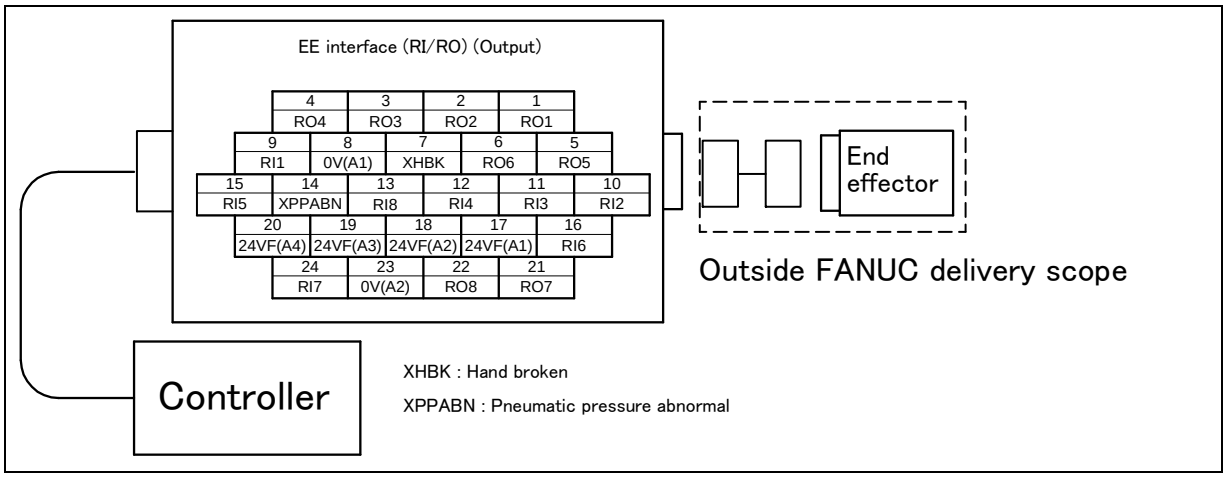


Fig. 5.3 (f) Pin layout for EE interface RI/ROX8 (A05B-1222-H208,H527,H608,H627 is specified)

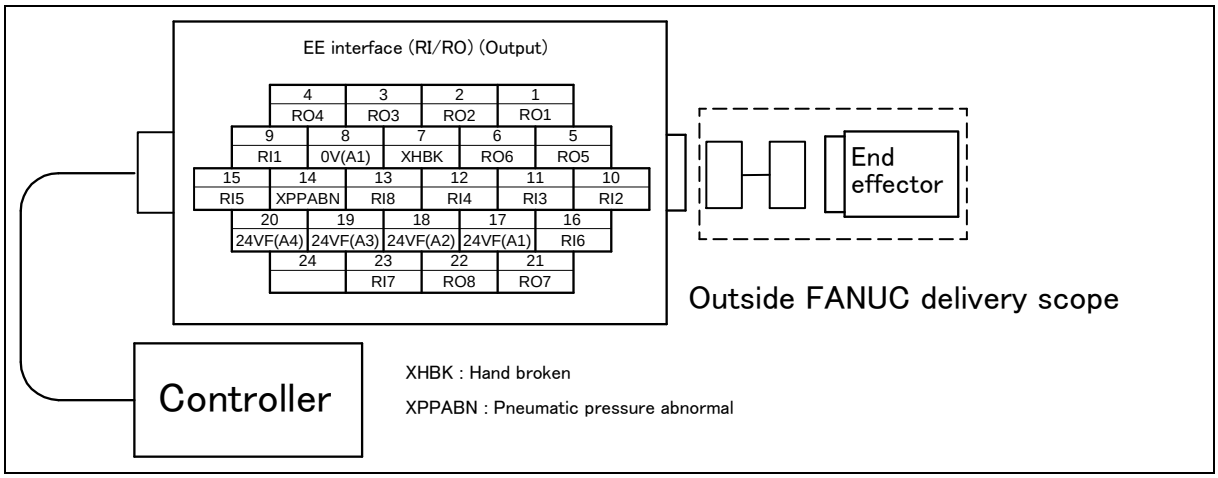


Fig. 5.3 (g) Pin layout for EE interface RI/ROX8 (A05B-1222-H209 is specified)

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

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

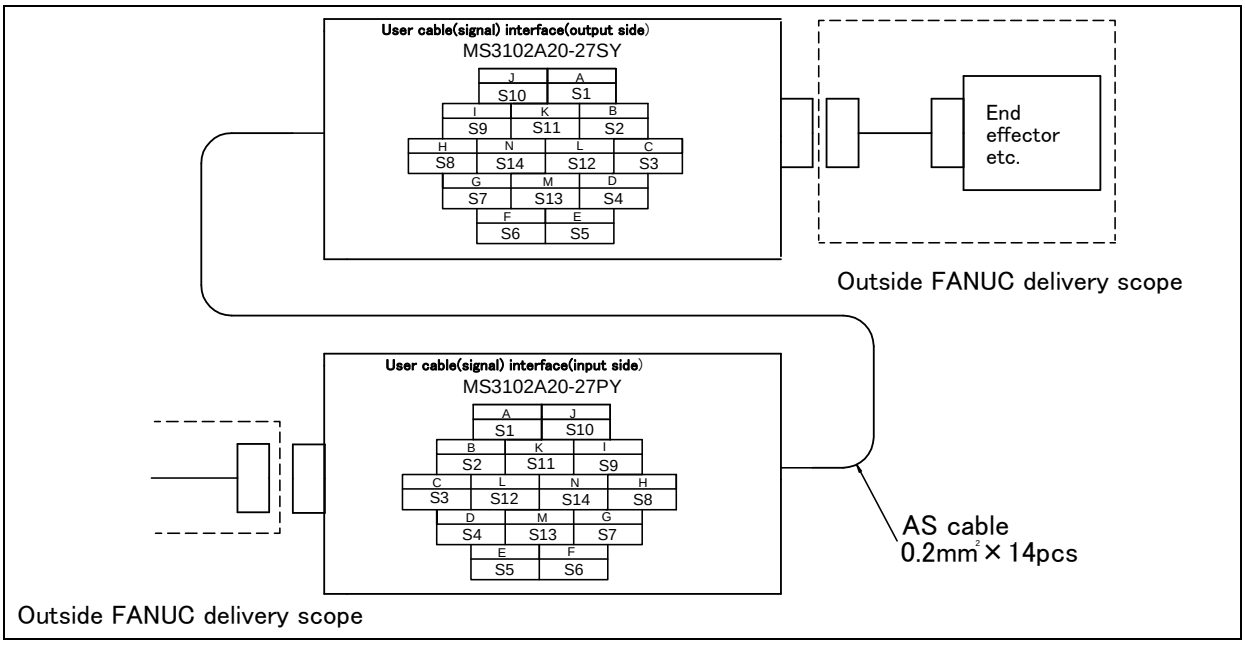


Fig. 5.3 (h) Pin layout for user cable (signal line) (AS) interface (Option)
(A05B-1222-H527 is specified.)

Connector specifications

Table 5.3 (a) Connector specifications (User side) (A05B-1222-H208, H527, H608, H627 is specified)

Cable name	Input side (J2 base)	Output side (J3 casing)	Maker/dealer
EE (RI/RO x 8)	————	JMSP2524M Straight plug (Attached) (FANUC Spec: A63L-0001-0234#S2524M) JMLP2524M Angle plug	Fujikura.Ltd

Table 5.3 (b) Connector specifications (User side) (A05B-1222-H527, H627 is specified)

Cable name	Input side (J2 base)	Output side (J3 casing)	Maker/dealer
AS	Maker specification	Maker specification	Japan Aviation Electronics Industry, Ltd. .etc
	Connector Straight plug : MS3106B20-27SY(*1) Elbow plug : MS3108B20-27SY Or, interchangeable goods. Clamp MS3057-12A (*1)	Connector Straight plug : MS3106B20-27PY (*2) Elbow plug : MS3108B20-27PY Or, interchangeable goods. Clamp MS3057-12A (*2)	
	FANUC specification	FANUC specification	
	A05B-1221-K843 (Straight plug (*1) and clamp (*1) are included)	A05B-1221-K841 (Straight plug (*2) and clamp (*2) are included)	

Table 5.3 (c) Connector specifications (User side) (A05B-1222-H209 is specified)

Cable name	Input side (J2 base)	Output side (J3 casing)	Maker/dealer
EE (RI/RO x 8)	————	JL05-6A24-28P-R Plug (Attached) (FANUC Spec: A63L-0001-0463#D2424P)	Japan Aviation Electronics Industry, Ltd.
	————	JL04-24EBH-R End bell (angle) (Attached) (FANUC Spec: A63L-0001-0463#24EBL)	
	————	JL04-2428CK (20)-R Clamp (Attached) (FANUC Spec: A63L-0001-0463#2428CK20)	

Table 5.3 (d) Connector specifications (Mechanical unit side·reference) (A05B-1222-H208, H527, H608, H627 is specified)

Cable name	Input side (J2 base)	Output side (J3 casing)	Maker/dealer
EE (RI/RO x 8)	————	JMWR2524F	Fujikura.Ltd

Table 5.3 (e) Connector specifications (Mechanical unit side·reference) (A05B-1222-H527, H627 is specified)

Cable name	Input side (J2 base)	Output side (J3 casing)	Maker/dealer
AS, ASi	MS3102A20-27PY	MS3102A20-27SY	Japan Aviation Electronics Industry, Ltd.

Table 5.3 (f) Connector specifications (Mechanical unit side·reference) (A05B-1222-H209 is specified)

Cable name	Input side (J2 base)	Output side (J3 casing)	Maker/dealer
EE (RI/RO x 8)	————	JL05-2A24-28SC-F0-R Receptacle	Japan Aviation Electronics Industry, Ltd.
	————	ST-JL05-16S-C3-100 Socket contact	

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

6 AXIS LIMIT SETUP

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 the robot is effective under following circumstances:

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

The software method used to prevent the robot from going beyond the necessary motion range.

- Axis limit by DCS (All axes)

⚠ WARNING

1 Changing the motion range of any axis affects the operating range of the robot. To avoid trouble, carefully consider the possible effect of the change to the movable range of each axis in advance. Otherwise, it is likely that an unexpected condition will occur; for example, an alarm may occur when the robot tries to reach a previously taught position.
2 For J2/J3-axis, use the DCS function so that damage to peripheral equipment and injuries to human bodies can be avoided.
3 Mechanical stoppers are physical obstacles. But the robot cannot move beyond them. For J2, J3-axis, the mechanical stoppers are fixed. For the J4, J5 and J6-axis, only DCS-specified limits are available.

6.1 CHANGE AXIS LIMIT BY DCS (OPTION)

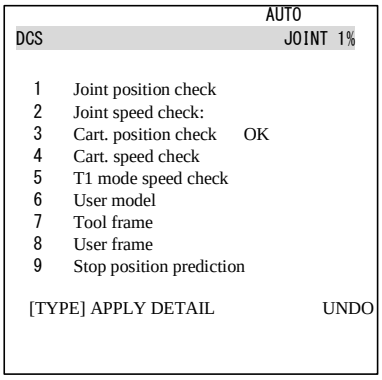
The robot motion can be restricted with DCS (Dual check safety) function by using the following software. For J2/J3-axis, the same effect as adjustable mechanical stopper can be obtained.
The robot motion can be restricted at any angle and position if it is in robot motion area. DCS functions are certified to meet the requirements of International Standard ISO13849-1 and IEC61508 approved by certificate authority. If only the operating space is set using Joint Position Check, the robot stops after it goes beyond the workspace. When the motor power is shut down, the robot's momentum causes it to move some distance before it completely stops. The actual "Robot Stop Position" will be beyond the workspace. To stop the robot within the robot workspace, use the DCS Stop Position Prediction function. The stop position prediction is disabled by default.

- DCS position/speed check function (J567)

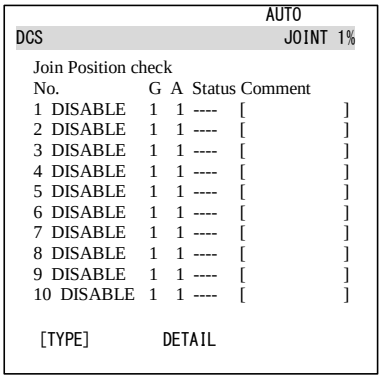
As an example, we shows the procedure to set ±30° for J2-axis in here. Refer to R-30*i*B/ R-30*i*B Mate Controller Dual check safety function Operator's Manual (B-83184EN) for details of other setting, function and DCS stop position prediction.

Setting procedure

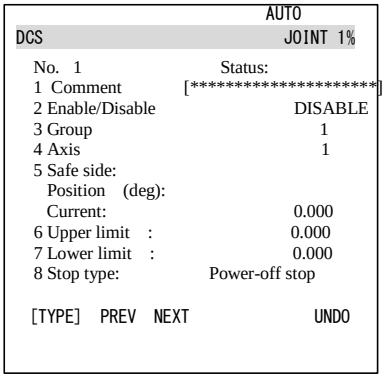
1 Press the [MENU] key to display the screen menu.
2 Press [0 NEXT] and press [6 SYSTEM].
3 Press the F1 (]TYPE]).
4 Select [DCS]. The following screen will be displayed.



5 Move the cursor to [1 Joint position check], then press the [DETAIL].

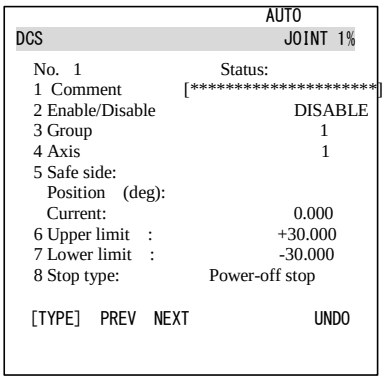


6 Move the cursor to [1], then press the [DETAIL].

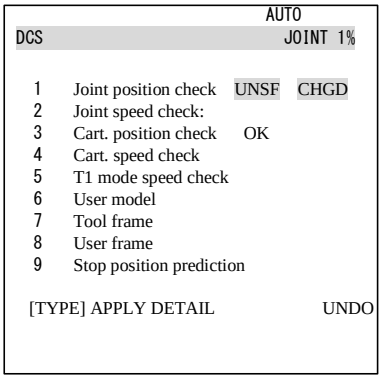


7 Move the cursor to [DISABLE], then press [CHOICE], set the status to [ENABLE].
8 Move the cursor to [Group], then input the robot group number, then press the [ENTER] key.
9 Move the cursor to [Axis], then input “2”, then press the [ENTER] key.
10 Move the cursor to [Upper limit] right side, then input “30”, then press the [ENTER] key.
11 Move the cursor to [Lower limit] right side, then input “-30”, then press the [ENTER] key.

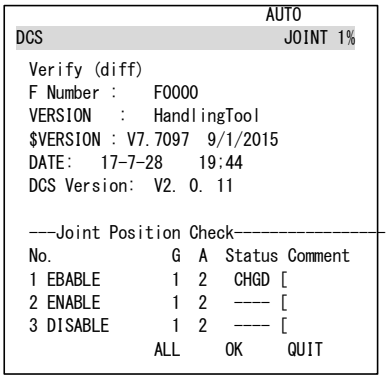
> ⚠ **WARNING**
> If only the operating space is set using Joint Position Check, the robot stops after it goes beyond the workspace. When the motor power is shut down, the robot’s momentum causes it to move some distance before it completely stops. The actual "Robot Stop Position" will be beyond the workspace. To stop the robot within the robot workspace, use the DCS Stop Position Prediction function. The stop position prediction is disabled by default.



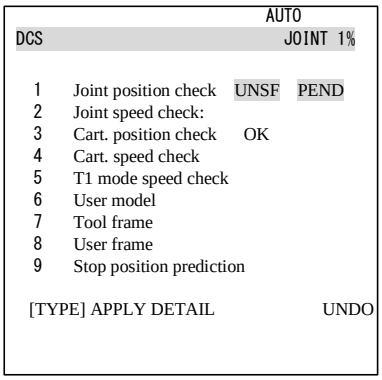
12 Press the [PREV] key two times, back to the first screen.



13 Press the [APPLY].
14 Input 4-digit password, then press the [ENTER] key. (Password default setting is “1111”.)
15 The following screen will be displayed, then press the [OK].



16 [CHGD] on the right side of [1 Joint position check] will change to [PEND].



17 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.

7 CHECKS AND MAINTENANCE (ARC Mate 120*i*C/20T M-20*i*A/20T)

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

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

7.1 CHECKS AND MAINTENANCE

7.1.1 Daily Checks

Check the following items when necessary before daily system operation.

Check items	Check points and management
Oil seepage	Check 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: **⇒"10.1 TROUBLESHOOTING"(symptom: Vibration, Noise)**
Positioning accuracy	Check whether the taught positions of the robot have not deviated from the previously taught positions. When displacement occurs, perform the measures as described in the following section: **⇒"10.1 TROUBLESHOOTING"(symptom: Displacement)**
Peripheral equipment for proper operation	Check whether the peripheral devices operate properly according to commands from the robot and the peripheral devices.
Brakes for each axis	Check that the end effector drops 5 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: **⇒"10.1 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, Operating accumulated time)						Check and Maintenance item	Check points, Management and Maintenance method	Periodic maintenance table No.
1 month 320h	3 months 960h	1 year 3840h	2 years 7680h	3 years 11520h	4 years 15360h			
○ Only 1st check	○					Check the oil sight glasses of J4/J5/J6-axes gearboxes	Please confirm whether the amount of oil of the oil sight glass of J4/J5/J6-axes gearboxes has come above the 3/4 of total height. **⇒"7.2.3 Check the Oil Sight Glasses"**	11
○ Only 1st check	○					Check the failure of the wrist part fluoric resin ring	Check to see whether there is failure on the wrist part fluoric resin ring. If is broken, replace it by new one. **⇒"7.2.4 Check the Failure of the Wrist Part Fluoric Resin Ring"**	21
○ Only 1st check	○					Cleaning the controller ventilation system	If the controller ventilation system is dusty, turn the power off, and clean the unit.	23
	○					Check the external damage or peeling paint	Check whether the robot has external damage due to the interference with the peripheral devices or peeling paint. 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 the damages of the cable protective sleeve	Check whether 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. **⇒"7.2.5 Check the Mechanical Unit Cables and Connectors"**	2
	○					Check for water	Check whether the robot is subjected to water or cutting oils. If liquid was found, remove the cause, and wipe the liquid off.	3
	○ Only 1st check	○				Check for damages to the teach pendant cable, the operation box connection cable or the robot connection cable	Check whether the cable connected to the teach pendant, operation box and robot are unevenly twisted or damaged. If damage is found, replace the damaged cables.	22
	○ Only 1st check	○				Check for damage to the mechanical unit cable (movable part) and welding cable	Observe the movable part of the mechanical unit cable and welding cable, and check for damage. Also, check whether the cables are excessively bent or unevenly twisted. **⇒"7.2.5 Check the Mechanical Unit Cables and Connectors"**	4

Check and maintenance intervals (Period, Operating accumulated time)						Check and Maintenance item	Check points, Management and Maintenance method	Periodic maintenance table No.
1 month 320h	3 months 960h	1 year 3840h	2 years 7680h	3 years 11520h	4 years 15360h			
	○ Only 1st Check	○				Check for damage to the end effector (hand) connection cable	Check whether the end effector connection cables are unevenly twisted or damaged. If damage is found, replace the damaged cables.	5
	○ 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. **⇒"7.2.5 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 END EFFECTOR INSTALLATION 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. **⇒"7.2.6 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, around the welding torch, conduit part, wrist axis hollow part and the cable protective sleeve). The insulation failure occurs when the spatter has collected around the wrist flange or welding torch, and there is a possibility of damaging the robot mechanism by the welding current. (See Appendix C)	10
		○				Replacing the mechanical unit batteries	Replace the mechanical unit batteries **⇒"7.3.1 Replacing the Batteries"**	12

Check and maintenance intervals (Period, Operating accumulated time)						Check and Maintenance item	Check points, Management and Maintenance method	Periodic maintenance table No.
1 month 320h	3 months 960h	1 year 3840h	2 years 7680h	3 years 11520h	4 years 15360h			
			○			Replace the wrist part fluoric resin ring	Replace the wrist part fluoric resin ring Contact your local FANUC representative for information regarding replacing the fluoric resin ring. **⇒"7.2.4 Check the Failure of the Wrist Part Fluoric Resin Ring"**	21
			○			Replacing cable of Mechanical unit welding power	Replace the cable of Mechanical unit welding Contact your local FANUC representative for information regarding replacing the cable.	19
			○			Replacing the Material handling (M/H) conduit or No dust material handling conduit	Replace the Material handling (M/H) conduit Contact your local FANUC representative for information regarding replacing the Material handling (M/H) conduit or No dust material handling conduit	20
				○		Replacing the grease and oil of J2/J3-axis reducer and J4 to J6-axis gearbox	Replace the grease and oil of each axis reducer and gearbox **⇒"7.3.2 Replacing the Grease and Oil of the Drive Mechanism"**	13 to 17
					○	Replacing the mechanical unit cable	Replace the mechanical unit cable Contact your local FANUC representative for information regarding replacing the cable.	18
					○	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) R-30*i*A CONTROLLER MAINTENANCE MANUAL(For Europe) (B-82595EN-1) 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

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

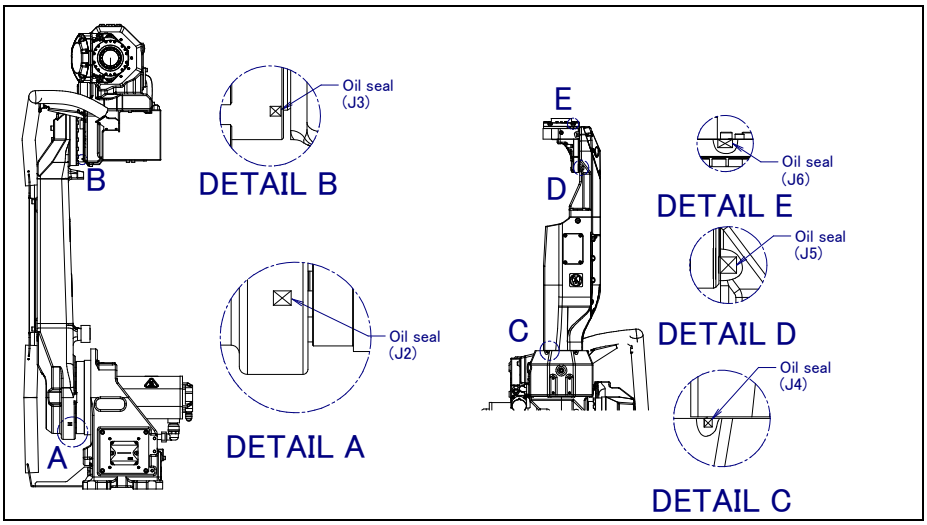


Fig. 7.2.1 Check parts of oil seepage

Management

- O 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.
- In case of oil seepage, please consider replacing the grease and the oil altogether. This replacement potentially can help improve the seepage situation.
- Also, motors might become hot and the internal pressure of the grease bath or oil bath may increase 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 7.3.2 and ensure that grease is not expelled onto the machine or tooling. When opening the oil outlet, refer to Subsection 7.3.2, put a oil pan under the oil outlet or place the oil outlet at the upper side.)

> ⚠ **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.

  ⇒"10.1 TROUBLESHOOTING"(symptom : Grease leakage , Oil leakage)

7.2.2 Confirmation of the Air Control Set (option)

When adopting an air control set, 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. The lubricator becomes empty in about 10 to 20 days under normal operation.
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.

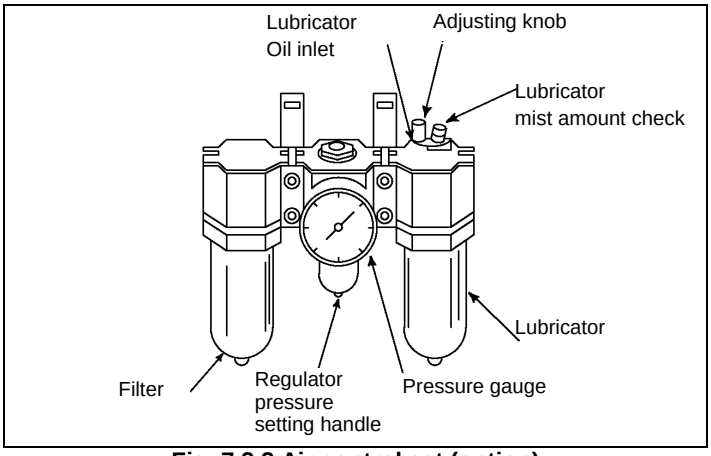


Fig. 7.2.2 Air control set (option)

7.2.3 Check the Oil Sight Glasses

Please confirm whether the amount of oil of the oil sight glass of J4/J5/J6-axes gearboxes has come above the 3/4 of total height, and replenish it if there is a shortage. Though the oil sight glass might not show the air bubble, this does not necessarily mean that there is a problem. When there is not enough oil, the red index of the oil sight glass shows the reflected heat of the light, and the outline of the index is seen clearly. When there is enough oil, it does not show this reflected heat, and the outline of the index is not clear. When the oil sight glass cannot be read at all because of the oil discoloration due to deterioration, as illustrated to the right in Fig. 7.2.3, refer to Subsection 7.3.2 to exchange the oil.

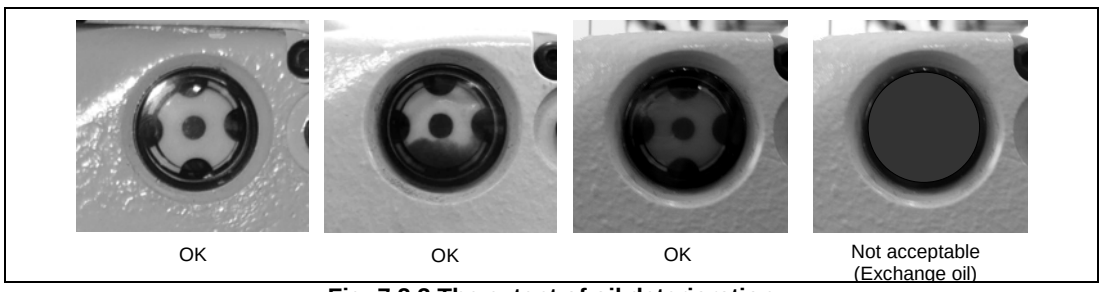


Fig. 7.2.3 The extent of oil deterioration

> ⚠ **CAUTION**
> If you continue using oil that is dirty, it will reduce the seal performance of the oil seal, cause a sludge outbreak, and cause vibration of the robot.
> If the operation condition is severe, oil life is reduced; in that case, we recommend early oil exchange.

7.2.4 Check the Failure of the Wrist Part Fluoric Resin Ring

Check to see whether there is failure on the wrist part fluoric resin ring. If it is broken, replace it with a new one. This part should be changed every two years. If you operate the robot in a dusty environment, you might have to replace this part more often.
(Spec. of fluoric resin ring : A290-7222-X571)

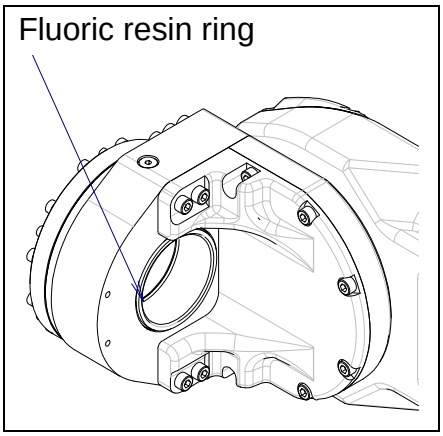


Fig. 7.2.4 (a) Fluoric resin ring

If the fluoric resin rig is broken as shown in Fig. 7.2.4 (b), replace it.

Fig. 7.2.4 (b) Failure of the fluoric resin ring

7.2.5 Check the Mechanical Unit Cables and Connectors

Inspection points of the mechanical unit cables and welding cables

Check the cables for visible damage. Closely inspect movable parts.
Clean any spatter that might be found.

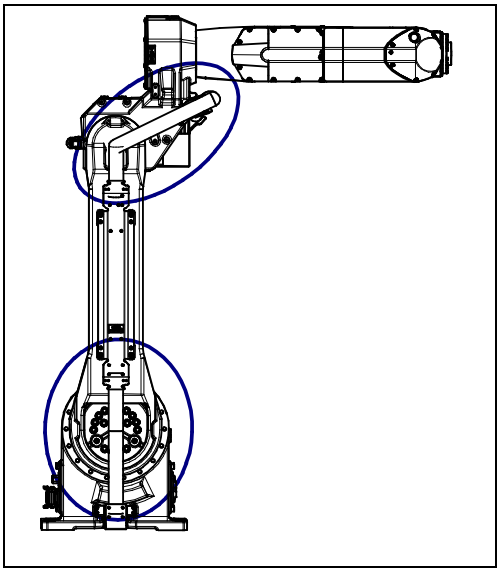


Fig. 7.2.5 (a) Inspection points of the mechanical unit cables

Check points

＜Cable protective sleeve＞

- Check that no holes or tears exist on the cable protective sleeves.
- If there is damage as shown in Fig. 7.2.5 (b), replace the cable protective sleeves.

Fig. 7.2.5 (b) Damage on the cable protective sleeve

＜Cables＞

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

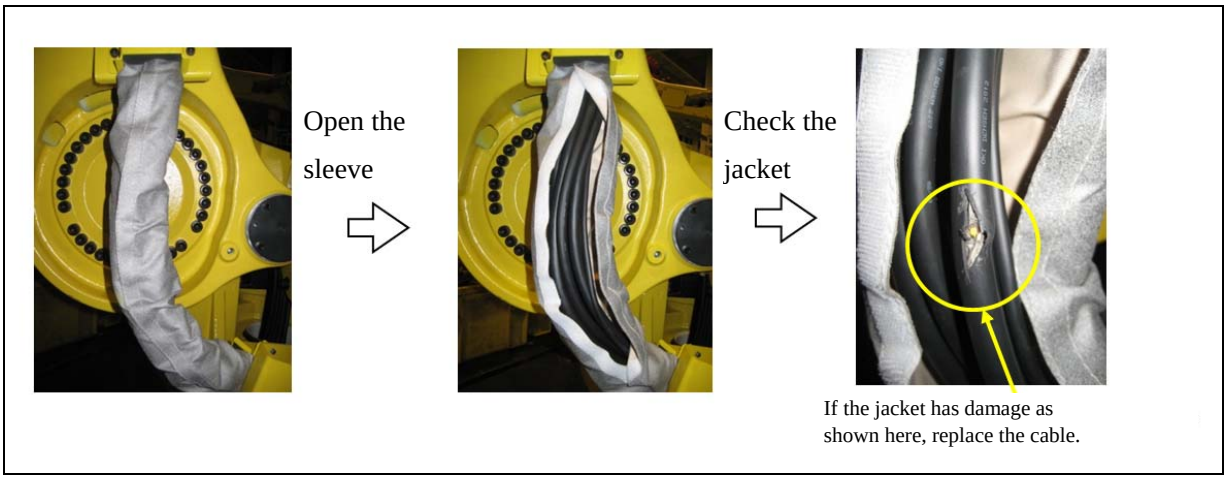


Fig. 7.2.5 (c) Cable check method

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 terminal for tightness.

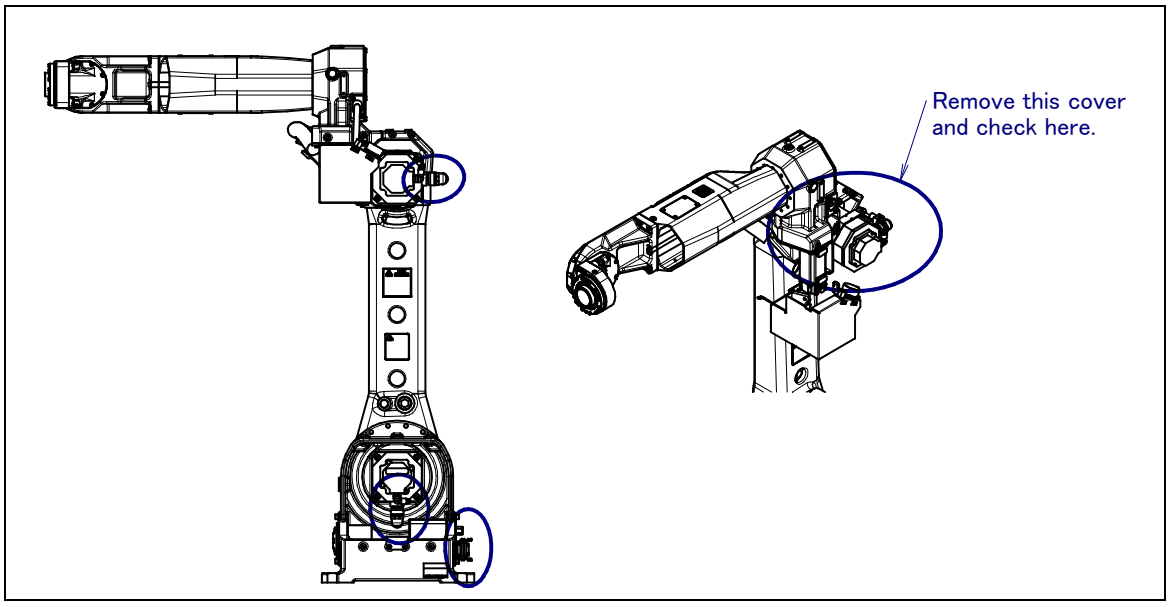


Fig. 7.2.5 (d) Connector Inspection points

7.2.6 Check of Fixed Mechanical Stopper and Adjustable Mechanical Stopper

- Check that there is no evidence of a collision on the 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.

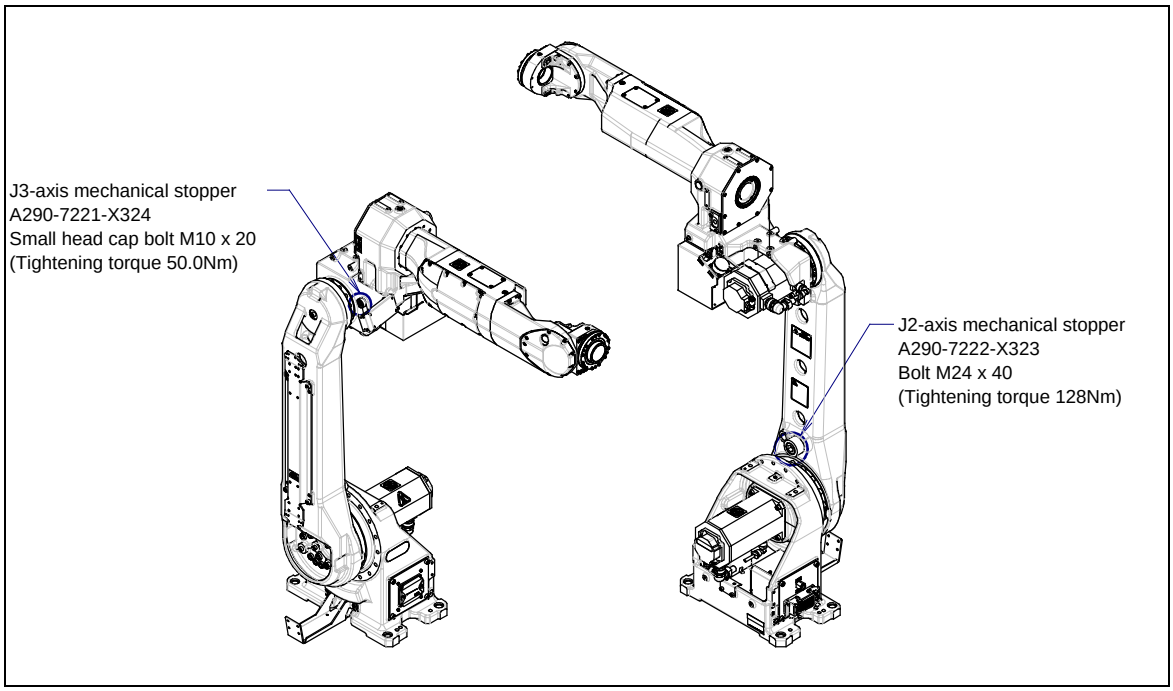


Fig. 7.2.6 Check of mechanical stopper and adjustable mechanical stopper

7.3 MAINTENANCE

7.3.1 Replacing the Batteries (1-year(3840 hours) checks)

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

1 Press the EMERGENCY STOP button to stop the robot motion.

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

2 Remove the battery case cap. (Fig. 7.3.1) If it cannot be removed, tap it on its side with a plastic hammer to loosen the cap before you remove it.
3 Take out the old batteries from the battery case. At this time, the battery can be taken out by pulling the stick in the center of the battery box.
4 Insert new batteries into the battery case. Pay attention to the direction of the batteries.
5 Close the battery case cap.

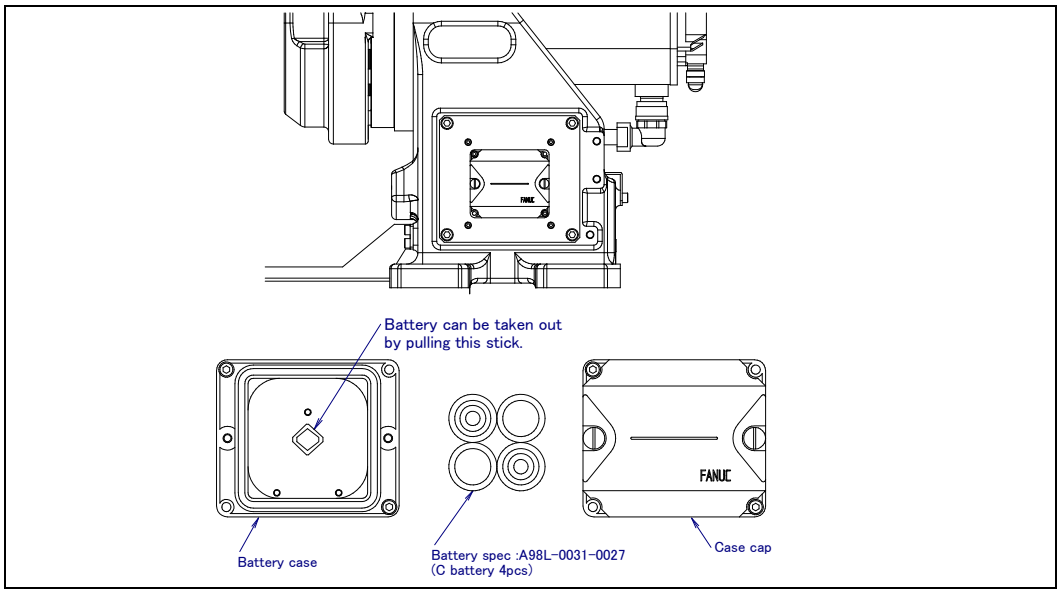


Fig. 7.3.1 Replacing the battery

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

According to the procedures below, replace the grease or the oil of the reducers of J2 and J3-axes and J4/J5/J6-axis gearbox every 3 years or 11520 hours, whichever comes first.

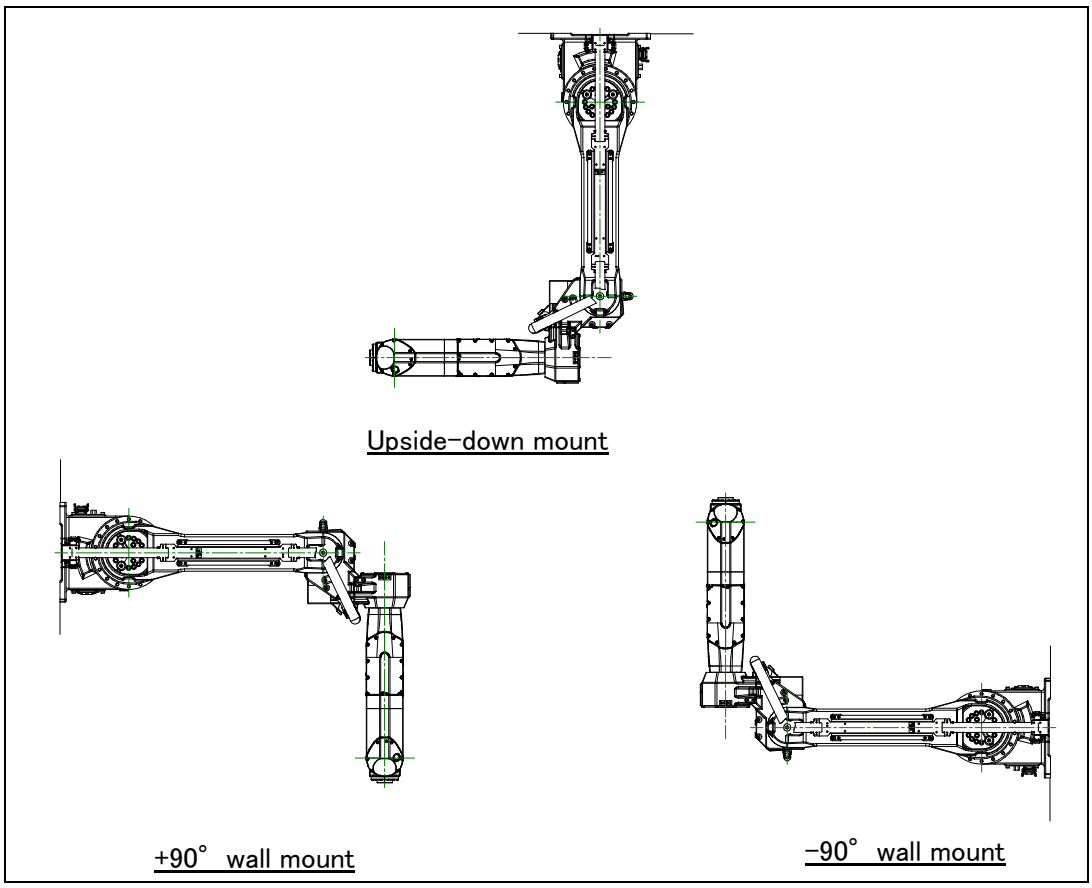


Fig 7.3.2 Installation method

7.3.2.1 Grease replacement procedure for J2/J3-axis reducer

⚠ CAUTION

Failure to supply grease correctly may cause an increase of the internal pressure of the grease bath. Such pressure increase will then damage the seal, which in turn leads to grease leakage and abnormal robot operation.
When performing greasing, therefore, observe the following precautions.

1 Before starting to grease, remove the seal bolt or the taper plug to allow the grease to come out.
2 Supply grease slowly, using a manual pump. (once per two seconds)
3 Whenever possible, avoid using an air pump, which is powered by the factory air supply. If the use of an air pump is unavoidable, supply grease with the pump at a pressure lower than or equal to the gun tip pressure (see Table 7.3.2.1 (a)).
4 Use grease only of the specified type. Grease of a type other than that specified may damage the reducer or lead to other problems.
5 After greasing, release the remaining pressure from the grease bath using the procedure given in Subsection 7.3.2.2, and then close the grease outlet.
6 To prevent slipping accidents and catching fire, completely remove any excess grease from the floor or robot.

Table 7.3.2.1 (a) Grease name and amount (J2/J3-axis reducer)

Greasing points	Amount of grease to be applied	Gun tip pressure	Specified grease
J2-axis reducer	850g(940ml)	0.1MPa or less (NOTE)	Kyodo Yushi VIGOGREASE RE0 (Specification: A98L-0040-0174
J3-axis reducer	340g(380ml)		

NOTE

When using a hand pump, apply grease approximately once per two 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 7.3.2.1 (b) Postures for greasing (J2/J3-axis reducer)

Grease supplying position		Posture				
		J2	J3	J4	J5	J6
J2-axis reducer grease supplying posture	Upside-down mount	-90°	Arbitrary	Arbitrary	Arbitrary	Arbitrary
	Wall mount -90°	90°				
	Wall mount +90°	-90°				
J3-axis reducer grease supplying posture	Upside-down mount	0°	180°			
	Wall mount -90°	0°	0°			
	Wall mount +90°	0°	0°			

1 Move the robot to the greasing posture described in Table 7.3.2.1 (b).
2 Turn off controller power.
3 Remove the seal bolt or taper plug from grease outlet. (Fig.7.3.2.1)
J2-axis : 3 locations (seal bolt M8 x 10)
J3-axis : 1 location (J3-axis reducer first grease outlet, seal bolt M8 x 10)
*When robot is shipped after June, 2011, robot has 2 grease outlet. Remove only first grease outlet.
4 Remove the seal bolt or taper plug from grease inlet and attach a grease nipple.
5 Keep greasing until the new grease pushes the old grease out from each grease outlet.
6 Release the remaining pressure using the procedure given in Subsection 7.3.2.2.

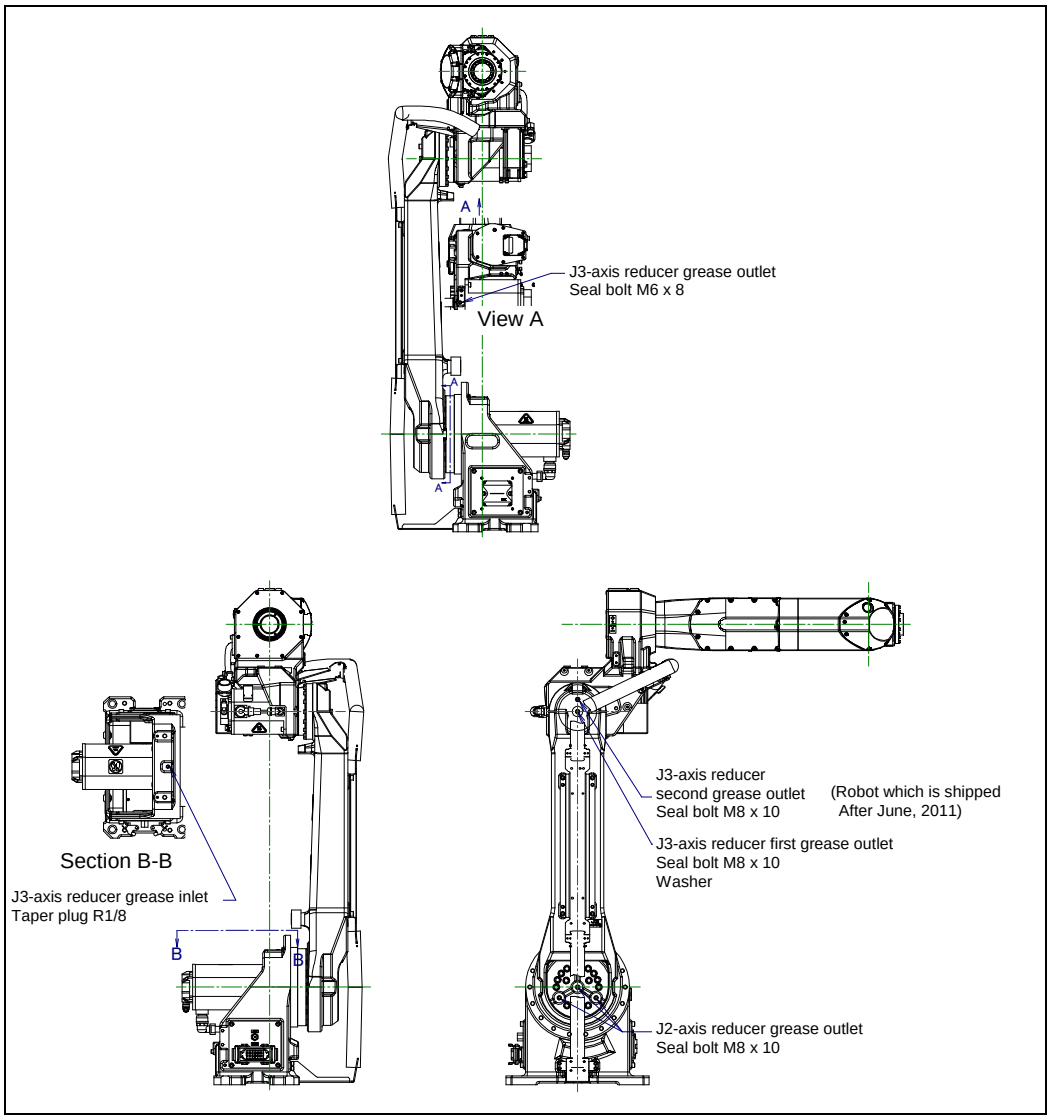


Fig. 7.3.2.1 Greasing points of J2/J3-axis reducer

Table 7.3.2.1 (c) Specification of the seal bolts and the taper plug

Parts name	Specification
Seal bolt (M6 x 8)	A97L-0218-0417#060808
Seal bolt (M8 x 10)	A97L-0218-0417#081010
taper plug (R1/8)	A97L-0001-0436#1-1D

7.3.2.2 Procedure for releasing remaining pressure from the grease bath (J2/J3-axis)

After applying grease, operate the robot as instructed below more than 10 minutes with the plug and seal bolt of the grease inlet and outlet uncapped to release the remaining pressure within the grease bath. In case of J2-axis, there are three seal bolts for grease outlet. In case of J3-axis, robot which shipped before May, 2011 has one grease outlet, robot which shipped June, 2011 or later has two grease outlet. So uncap all of them. Attach a recovery bag below the grease inlet and outlet to prevent output grease from splattering.

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

If the above operation cannot be performed due to the environment of the robot, prolong the operating time so that an equivalent operation can be performed. (When the maximum allowable axis angle is 30°, perform the operation twice for 20 minutes or more.) If you grease or supply oil to multiple axes, you can exercise multiple axes at the same time. After completion of the operation, attach the plug and seal bolts to the grease inlets and outlets.
When two or more axes are supplied at the same time, it is possible to release grease or oil at the same time in two or more axes.

After replacing grease or oil, the internal pressure of the grease bath or oil bath may rise if the robot is operated again under frequent inversion movement or a high temperature environment. In these cases, you can return to normal internal pressure by releasing the grease outlet or oil outlet just after robot operation. (When opening grease outlet or oil outlet, be sure that grease or oil does not spatter.)

7.3.2.3 Oil replacement procedure for J4-axis gearbox

⚠ CAUTION

1 There is a severe risk of gear damage if the robot is operated with insufficient oil. Please make sure the gearbox is always filled with the correct amount of oil.
2 Failure to supply oil correctly may cause damage to the seal, which would in turn lead to oil leakage and abnormal operation. When performing oiling, therefore, observe the following precautions.
(1) Use specified oil. Use of non-approved oil may damage the reducer or lead to other problems.
(2) After oiling, release remaining pressure from the oil bath using the procedure given in Subsection 7.3.2.5, and then close the oil outlet.
(3) To prevent an accident such as a fall or fire, remove all the excess oil from the floor and robot.

Table 7.3.2.3 (a) Oil name and amount (J4-axis gearbox)

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

NOTE 1) It is not a regulated amount injection. Please confirm height of oil sight glass oil surface is 3/4 or more of all heights. Refer to Fig.7.3.2.3 (e).

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

Table 7.3.2.3 (b) Postures for oiling (J4-axis gearbox)

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

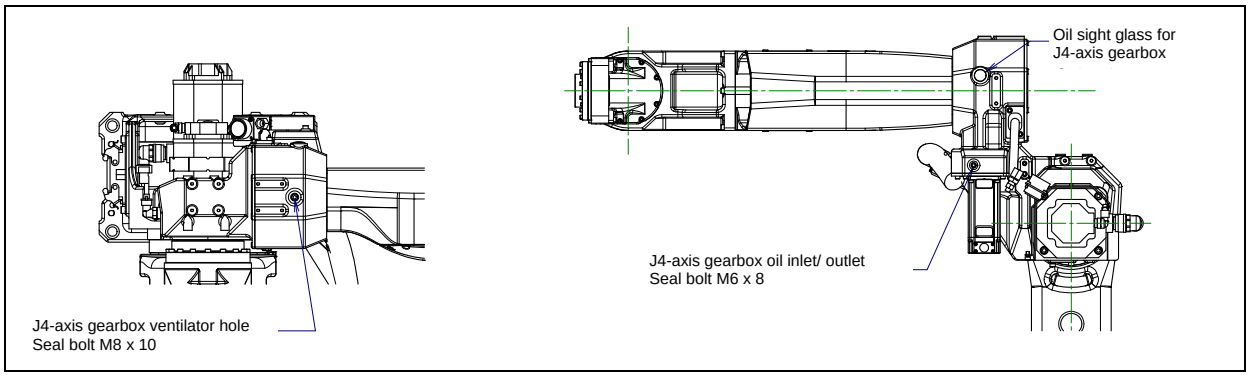


Fig. 7.3.2.3 (a) Oiling point of J4-axis gearbox

Table 7.3.3 (c) Specification of the seal bolts

Parts name	Specification
Seal bolt (M6 x 8)	A97L-0218-0417#060808
Seal bolt (M8 x 10)	A97L-0218-0417#081010

Exhausting oil method

1 Move the robot to the posture described in Table 7.3.2.3 (b).
2 Turn off controller power.
3 Remove any peripheral equipment, if it was mounted over the ventilator hole.

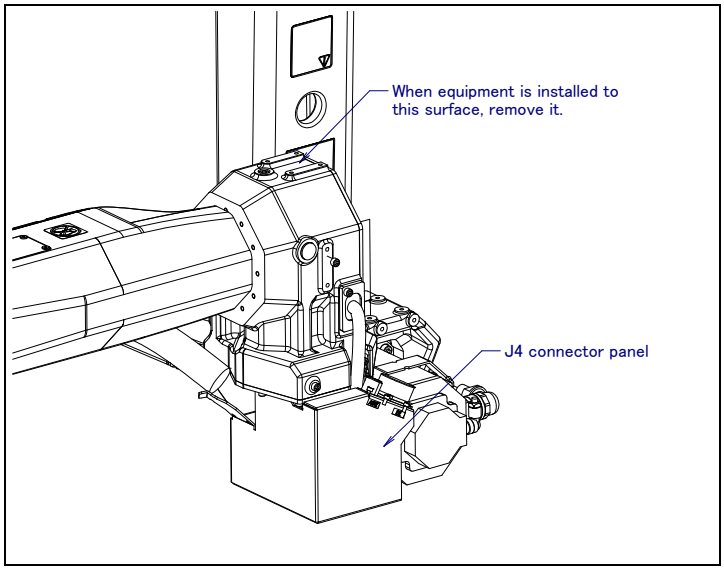


Fig. 7.3.2.3 (b) Removing equipment of the ventilator hole

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

Injecting oil method

7 According to the description below, inject oil.

(1) Install the oil injection nipple with valve (A05B-1221-K006) to the oil inlet.

(2) Confirm that the valve is open, and perform oiling using the oil gun (A05B-1221-K005). If the oil sight glass is filled with oil, push the oil gun about 4cm (about 80ml).

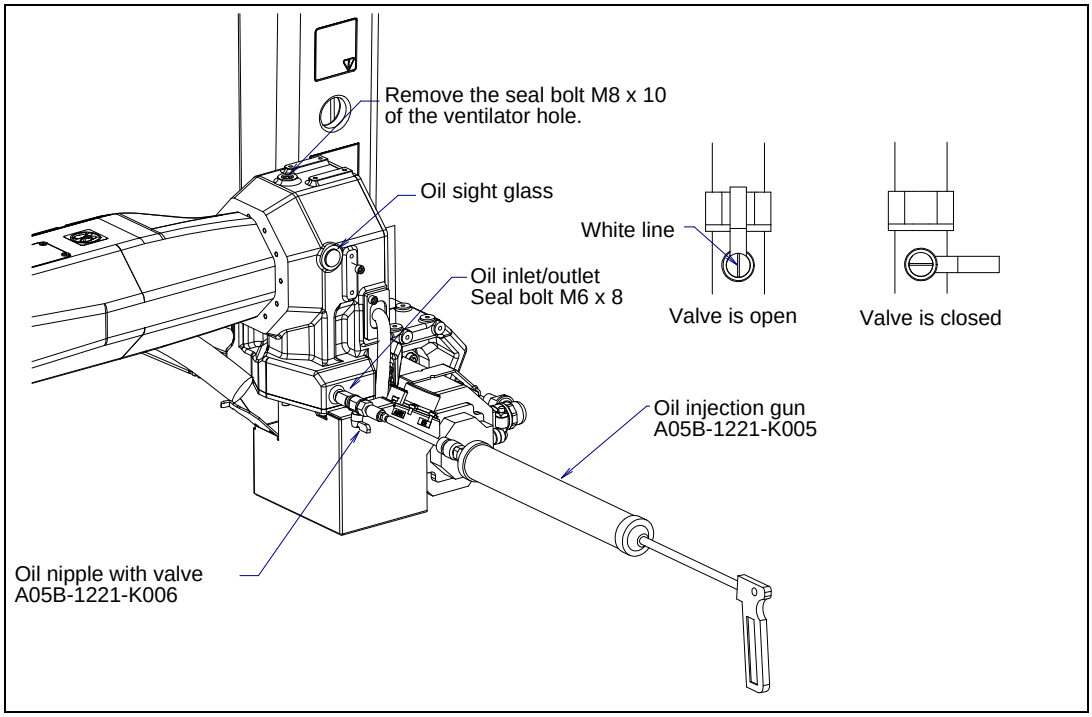


Fig. 7.3.2.3 (c) Oiling by oil gun

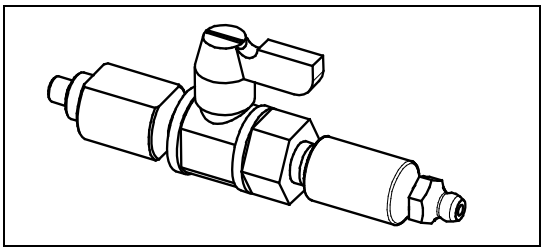


Fig. 7.3.2.3 (d) Oil injection nipple with valve (A05B-1221-K006)

(3) Close the valve of the oil injection nipple, then remove the oil gun.
(4) Attach the seal bolt to the ventilator hole. Replace the seal bolt with a new one. When reusing it, be sure to wind it with seal tape.
(5) Remove the oil injection nipple, and attach seal bolt to the oil inlet. Replace the seal bolt with a new one. When reusing it, be sure to wind it with seal tape.
(6) Release the remaining pressure of oil bath referring to Subsection 7.3.2.5 and confirm oil quantity with oil sight glass.

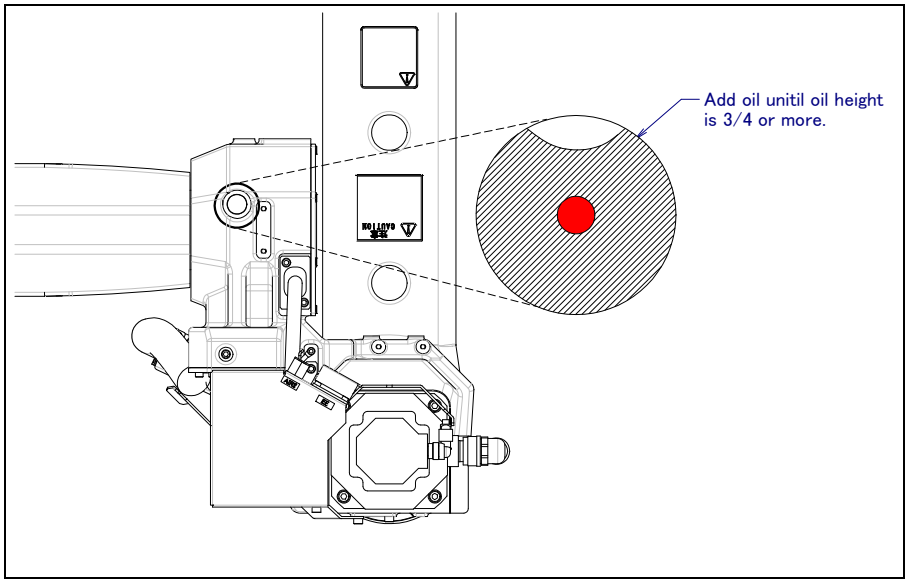


Fig. 7.3.2.3 (e) Aim of oil sight glass (Oiling of J4-axis gearbox)

7.3.2.4 Oil replacement procedure for J5/J6-axis gearbox

⚠ CAUTION
1 There is a severe risk of gear damage if the robot is operated with insufficient oil. Please make sure the gearbox is always filled with the correct amount of oil.
2 Failure to supply oil correctly may cause damage to the seal, which would in turn lead to oil leakage and abnormal operation. When performing oiling, therefore, observe the following precautions.
(1) Use specified oil. Use of non-approved oil may damage the reducer or lead to other problems.
(2) After oiling, release remaining pressure from the oil bath using the procedure given in Subsection 7.3.2.5, and then close the oil outlet.
(3) To prevent an accident such as a fall or fire, remove all the excess oil from the floor and robot.

Table 7.3.2.4 (a) Oil name and amount (J5/J6-axis gearbox)

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

NOTE 1) The amount is not automatically regulated. Be sure to confirm the amount of oil with the oil sight glass.

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

**Table 7.3.2.4 (b) Postures for oiling (J5/J6-axis gearbox)
(except A05B-1225-B271, B272, B281, B282)**

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

**Table 7.3.2.4 (c) Postures for oiling (J5/J6-axis gearbox)
(A05B-1225-B271, B272, B281, B282)**

Supply position		Posture					
		J1	J2	J3	J4	J5	J6
J5/J6-axis gearbox (Supplying posture) (Confirm oiling posture)	Upside-down mount	Arbitrary	Arbitrary	180°	0°	50°	Arbitrary
	-90°wall mount			-90°	0°		
	+90°wall mount			90°	0°		
J5/J6-axis gearbox (Discharging posture)	Upside-down mount			150°	-45°	0°	
	-90°wall mount			120°	-135°		
	+90°wall mount			60°	-45°		

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

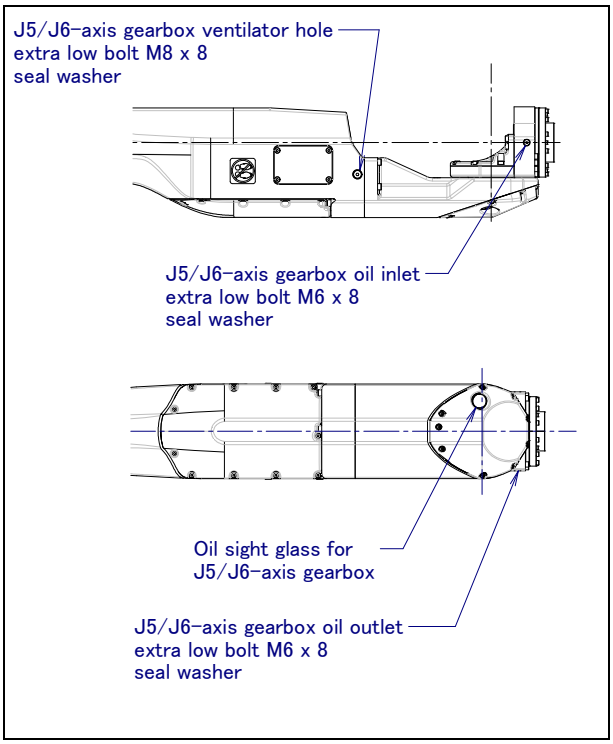


**Fig. 7.3.2.4 (a) Oiling point of J5/J6-axis gearbox
(except A05B-1225-B271, B272, B281, B282)**

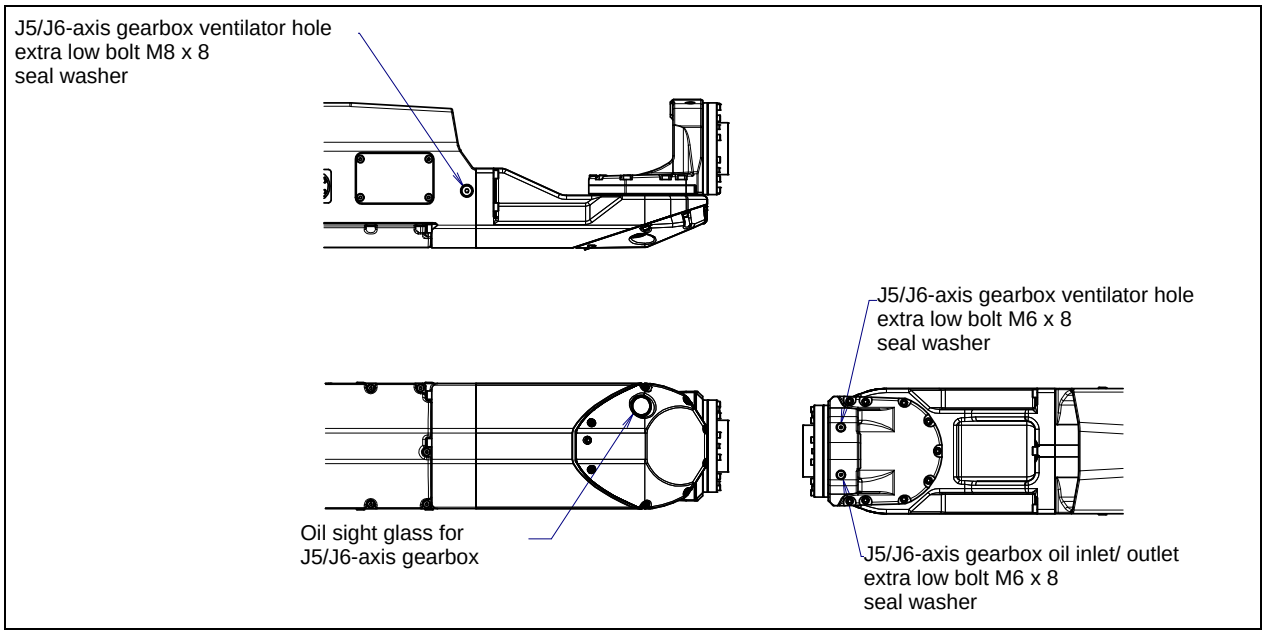


Fig. 7.3.2.4 (b) Oiling point of J5/J6-axis gearbox
(A05B-1225-B271, B272, B281, B282)

Table 7.3.2.4 (d) Specification of the seal washer

Parts name	Specification
Seal washer (M6)	A30L-0001-0048#6M

Exhausting oil method

1 Move the robot to the posture that facilitates oiling and discharging oil as described in Table 7.3.2.4 (b) and (c).
2 Turn off controller power.
3 Put the oil pan under the oil outlet. Remove the extra low bolt and seal washers from the oil outlet, then remove oil inlet and ventilator hole. (See Fig. 7.3.2.4 (a) and (b)) (At this time, if you remove the bolt of the oil outlet first, you can prevent spilling oil.)

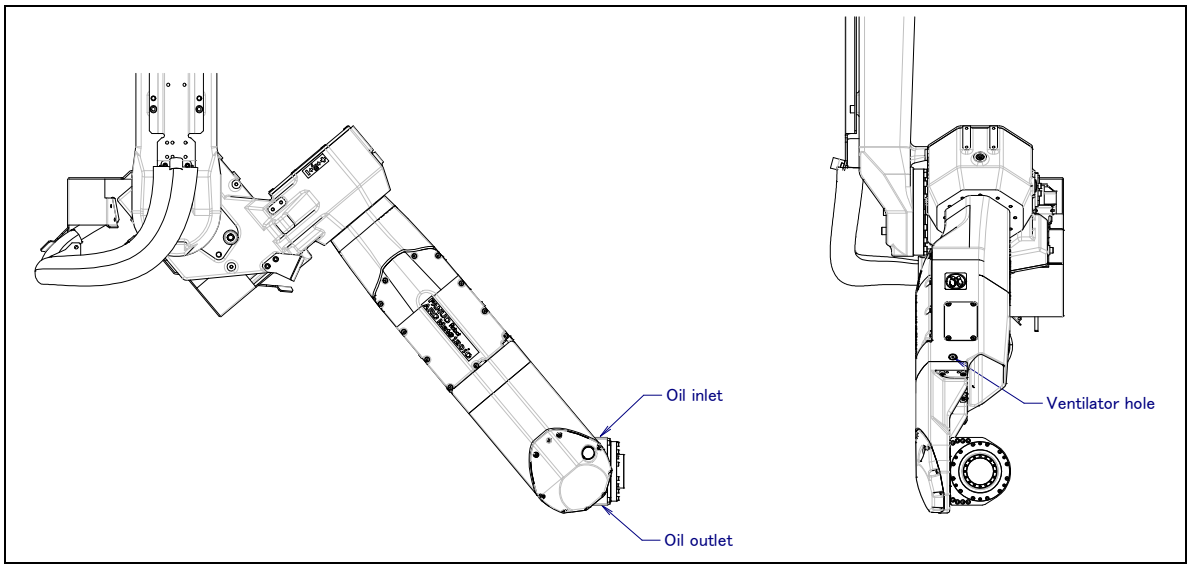


Fig. 7.3.2.4 (c) Oil inlet/outlet and ventilator hole
(except A05B-1225-B271, B272, B281, B282)

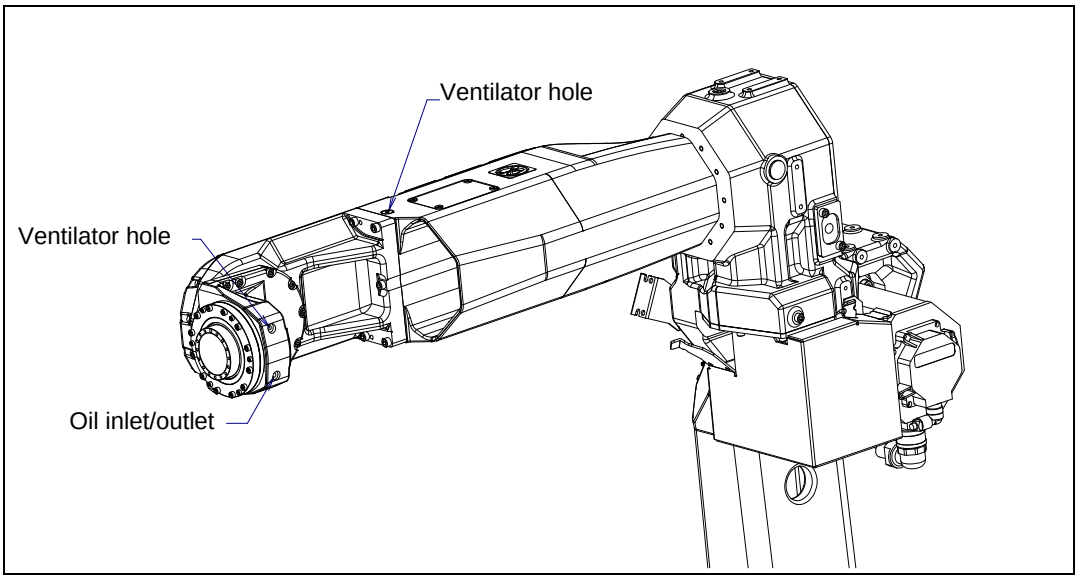


Fig. 7.3.2.4 (d) Oil inlet/outlet and ventilator hole (A05B-1225-B271, B272, B281, B282)

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

Injecting oil method

5 Confirm that the robot posture for J5/J6-axis is as described in) Table 7.3.2.4 (b), (c) and the oil outlet is closed, then supply oil according to description below.

A When oil gun is used

(1) Attach oil injection nipple with valve (A05B-1221-K006) to oil inlet referring to Fig.7.3.2.4 (e) and (f).
(2) Attach oil tray with valve (A05B-1221-K007) to ventilator hole.
(3) Confirm valve of oil inlet and oil outlet are open. Supply oil to J5/J6-axis gearbox by oil injection gun (A05B-1221-K005). If oil comes out in oil tray from oil outlet, Stop supplying oil, close the valve oil injection nipple, and remove oil gun.
(4) Close the valve of oil tray, remove tray and close the oil outlet.
(5) Remove the oil injection nipple, then attach extra low bolt and seal washer to first oil inlet.
(6) Turn on the controller power, move the robot to the posture (J5/J6-axis gearbox (confirm oiling)) of Table 7.3.2.4 (b) and (c).
Confirm the amount of oil. (See Fig.7.3.2.4 (g).) If oil is insufficient, add oil using syringe etc. from ventilator hole.
(7) According to Subsection 7.3.2.5, release the remaining pressure of oil bath and confirm the oil sight glass again.

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

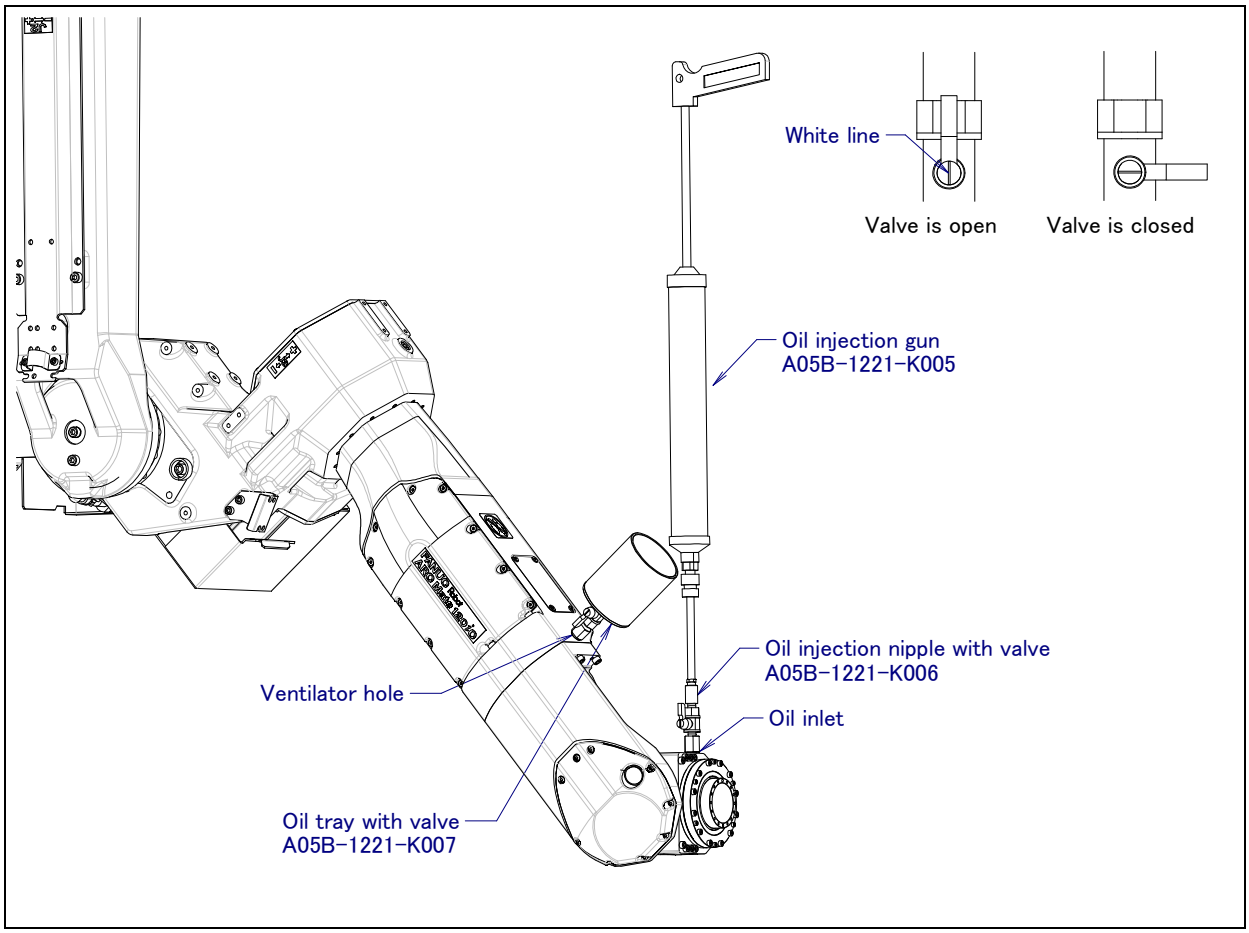


Fig. 7.3.2.4 (e) Oiling by oil gun
(except A05B-1225-B271, B272, B281, B282)

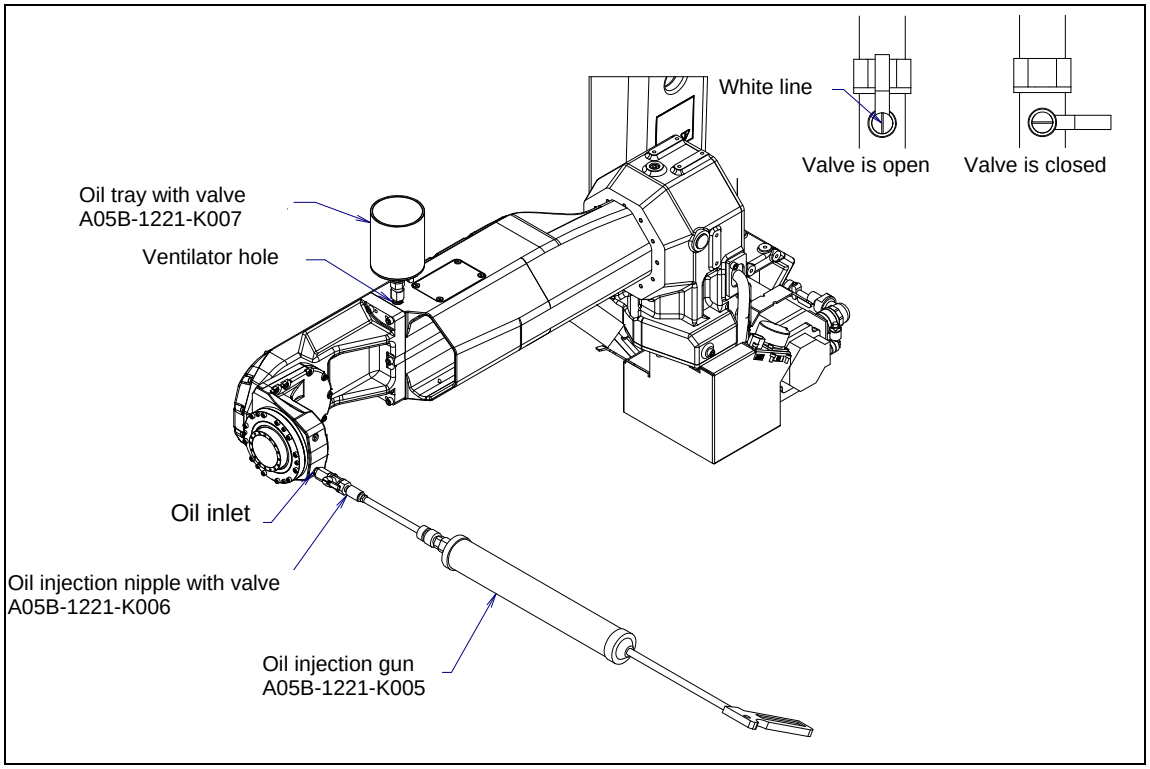


Fig. 7.3.2.4 (f) Oiling by oil gun (A05B-1225-B271, B272, B281, B282)

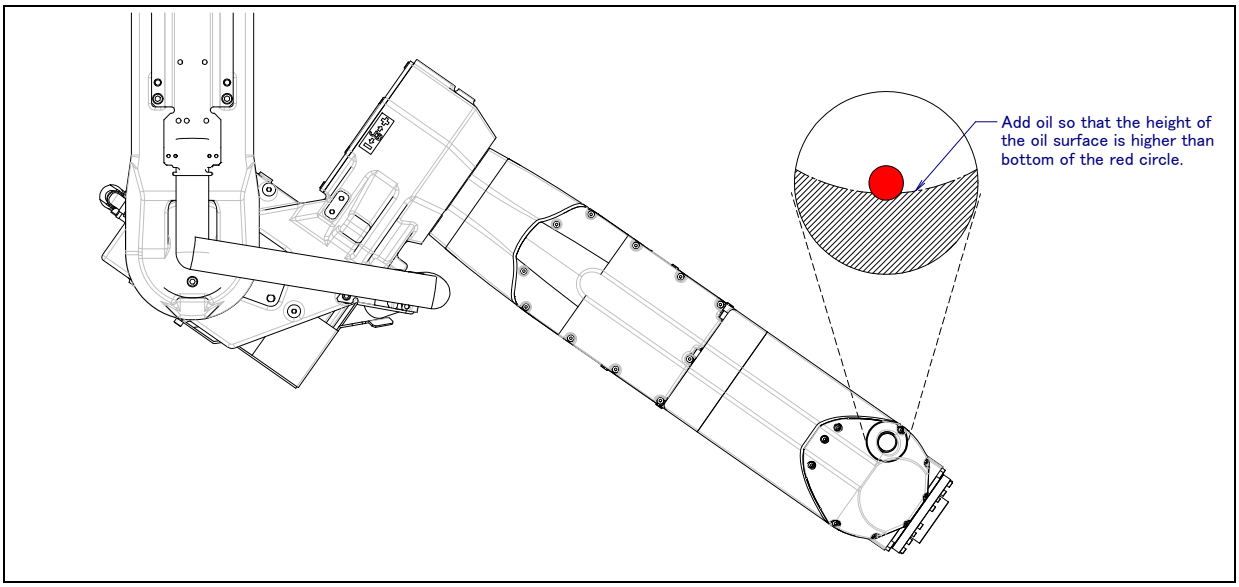


Fig. 7.3.2.4 (g) Standard of oil sight glass ((supply oil J5/J6-axis gearbox)

B When oil gun is not used

(1) Supply oil by means of the oil inlet. If oil overflows from the ventilator hole, stop supplying oil and close the ventilator hole. When oil adapter (A290-7222-X591) is used, attach it referring to the example of Fig. 7.3.2.4 (h). The amounts of oiling are about as many as 60% of adapters. It takes about 25 minutes. Oil adaptor cannot be used for A05B-1225-B271, B272, B281, B282.

(2) Attach extra low bolt and seal washers to the oil inlet.

(3) Turn on the controller power, and move the robot to the posture (J5/J6-axis gearbox (confirm oiling)) of table 7.3.2.4 (b) and (c). Then confirm the amount of oil using the sight glass. (See Fig. 7.3.2.4 (h)). If the amount of oil is insufficient, add oil using a syringe etc. from ventilator hole.

(4) According to Subsection 7.3.2.5, release the remaining pressure of oil bath and confirm the oil sight glass again.

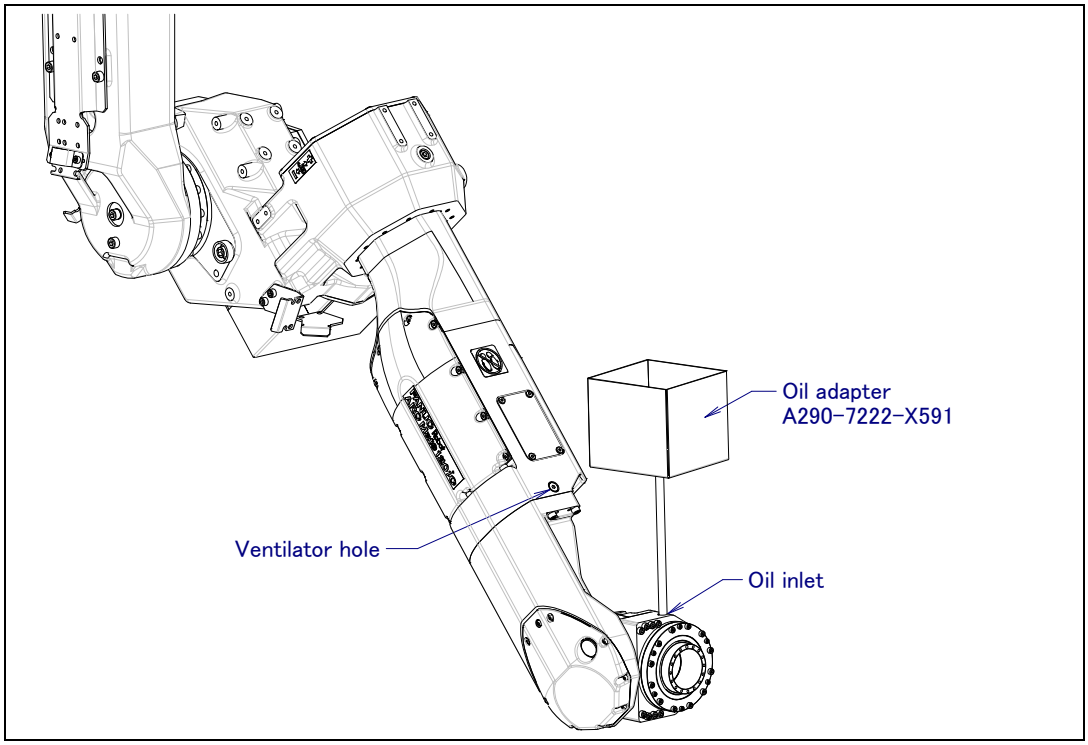


Fig. 7.3.2.4 (h) Oil adapter (for J5/J6-axis gearbox oil inlet)

7.3.2.5 Procedure for releasing remaining pressure from oil bath (J4 to J6-axis)

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

In case of J4-axis gearbox

Confirm that the oil level seen in the oil sight glass is as per Fig. 7.3.2.3 (e). If confirmed then please operate robot J4-axis for 10 minutes, at 100% override, making 90° motion (or more). Keep oil inlet and oil outlet closed during this operation. When completed, move the robot to the posture outlet comes to right above position (In case of floor mount, J3=0°.) and remove seal bolt of J4-axis gearbox oil outlet. Remaining pressure is released at once if it is removed. After operation, confirm whether the oil side of the oil sight glass has come above 3/4, and attach plug of the oil inlet. In case oil level is insufficient, please add oil from the oil outlet with the syringe etc. Wipe off oil that adhered to the surface of the robot and attach the taper plug on the oil inlet, the seal bolt on the oil outlet completely then attach seal bolt of oil outlet.

In case of J5/J6-axis gearbox

Confirm that oil level seen in oil sight glass is as per Fig. 7.3.2.3 (g). If it is confirmed, then move robot to the confirming posture described in Table 7.3.2.3 (b) and (c). Attach extra low bolt and seal washer of the oil inlet but keep it loose. Operate robot J5 and J6-axis for 10 minutes, at 100% override, making 90° motion (or more) on both axes. At this time, make a program that moves both J5 and J6-axis.
When completed, move the robot to the confirming posture. Remaining pressure releases at once if the ventilator hole is opened. Confirm that the oil level seen in the oil sight glass is as per Fig. 7.3.2.3 (g). At this time, please rotate the J4-axis in the direction of +/-, move robot to the confirming posture, and confirm that the amount of oil doesn't decrease. Move the robot to the confirming posture again and add oil from the oil inlet or the ventilator hole with the syringe etc. if necessary. Wipe off the oil that adhered to the surface of the robot and attach the extra low bolt and seal washer on the oil inlet/outlet completely.

If the above operation cannot be performed due to the environment of the robot, extend the operating time so that an equivalent result is achieved. (For example, when the maximum allowable axis angle is 45 degrees, perform the operation for 20 minutes or more.)
When two or more axes are supplied at the same time, it is possible to release grease or oil at the same time in two or more axes.

After replacing grease or oil, the internal pressure of the grease bath or oil bath may rise if the robot is operated again under frequent inversion movement or a high temperature environment. In these cases, you can return to normal internal pressure by releasing the grease outlet or oil outlet just after robot operation. (When opening grease outlet or oil outlet, be sure that grease or oil does not spatter.)

> ⚠ **CAUTION**
> When reusing the seal bolt and taper plug, be sure to seal the threads with seal tape. As for the seal washer, the rubber side sticks to the entire and the other side, rubber sticks to only around hole and rubber sticks is incomplete state, Attach later face to bolt side. Confirm the seal washer is in good condition. If it is damaged, replace it with a new one.
> See Table 7.3.2.3 (c) and Table 7.3.2.4 (d) about for seal bolt and seal washer specifications.

7.4 STORAGE

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

8 CHECKS AND MAINTENANCE (M-20*i*A/20MT/35MT)

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

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

8.1 CHECKS AND MAINTENANCE

8.1.1 Daily Checks

Check the following items when necessary before daily system operation.

Check items	Check points and management
Oil seepage	Check there is oil on the sealed part of each joint. If there is oil seepage, clean them. **⇒"8.2.1 Confirmation of Oil Seepage"**
Air control set	(When air control set is used) **⇒"8.2.2 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: **⇒"10.1 TROUBLESHOOTING"(symptom: Vibration, Noise)**
Positioning accuracy	Check whether the taught positions of the robot have not deviated from the previously taught positions. When displacement occurs, perform the measures as described in the following section: **⇒"10.1 TROUBLESHOOTING"(symptom: Displacement)**
Peripheral equipment for proper operation	Check whether the peripheral devices operate properly according to commands from the robot and the peripheral devices.
Brakes for each axis	Check that the end effector drops 5 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: **⇒"10.1 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)"**

8.1.2 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, Operating accumulated time)						Check and Maintenance item	Check points, Management and Maintenance method	Periodic maintenance table No.
1 month 320h	**3 months 960h**	**1 year 3840h**	2 years 7680h	3 years 11520h	4 years 15360h			
○ Only 1st check	○					Cleaning the controller ventilation system	If the controller ventilation system is dusty, turn the power off, and clean the unit.	20
	○					Check the external damage or peeling paint	Check whether the robot has external damage due to the interference with the peripheral devices or peeling paint. 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 the damages of the cable protective sleeve	Check whether 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. **⇒"8.2.3 Check the Mechanical Unit Cables and Connectors"**	2
	○					Check for water	Check whether the robot is subjected to water or cutting oils. If liquid was found, remove the cause, and wipe the liquid off.	3
	○ Only 1st check	○				Check for damages to the teach pendant cable, the operation box connection cable or the robot connection cable	Check whether the cable connected to the teach pendant, operation box and robot are unevenly twisted or damaged. If damage is found, replace the damaged cables.	19
	○ Only 1st check	○				Check for damage to the mechanical unit cable (movable part) and welding cable	Observe the movable part of the mechanical unit cable and welding cable, and check for damage. Also, check whether the cables are excessively bent or unevenly twisted. **⇒"8.2.3 Check the Mechanical Unit Cables and Connectors"**	4
	○ Only 1st check	○				Check for damage to the end effector (hand) connection cable	Check whether the end effector connection cables are unevenly twisted or damaged. If damage is found, replace the damaged cables.	5

Check and maintenance intervals (Period, Operating accumulated time)						Check and Maintenance item	Check points, Management and Maintenance method	Periodic maintenance table No.
1 month 320h	**3 months 960h**	**1 year 3840h**	2 years 7680h	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. **⇒"8.2.3 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 END EFFECTOR INSTALLATION 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. **⇒"8.2.4 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 **⇒"8.3.1 Replacing the Batteries"**	11
		○				Apply grease	Apply grease to the J6-axis reducer **⇒"8.3.2 Greasing"**	17
				○		Replacing the grease of J2/J3-axis reducer and J4 to J5-axis gearbox	Replace the grease of each axis reducer and gearbox **⇒"8.3.3 Replacing the Grease of the Drive Mechanism"**	12 to 16
					○	Replacing the mechanical unit cable	Replace the mechanical unit cable Contact your local FANUC representative for information regarding replacing the cable.	18
					○	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)"**	21

8.2 CHECK POINTS

8.2.1 Confirmation of Oil Seepage

Check items

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

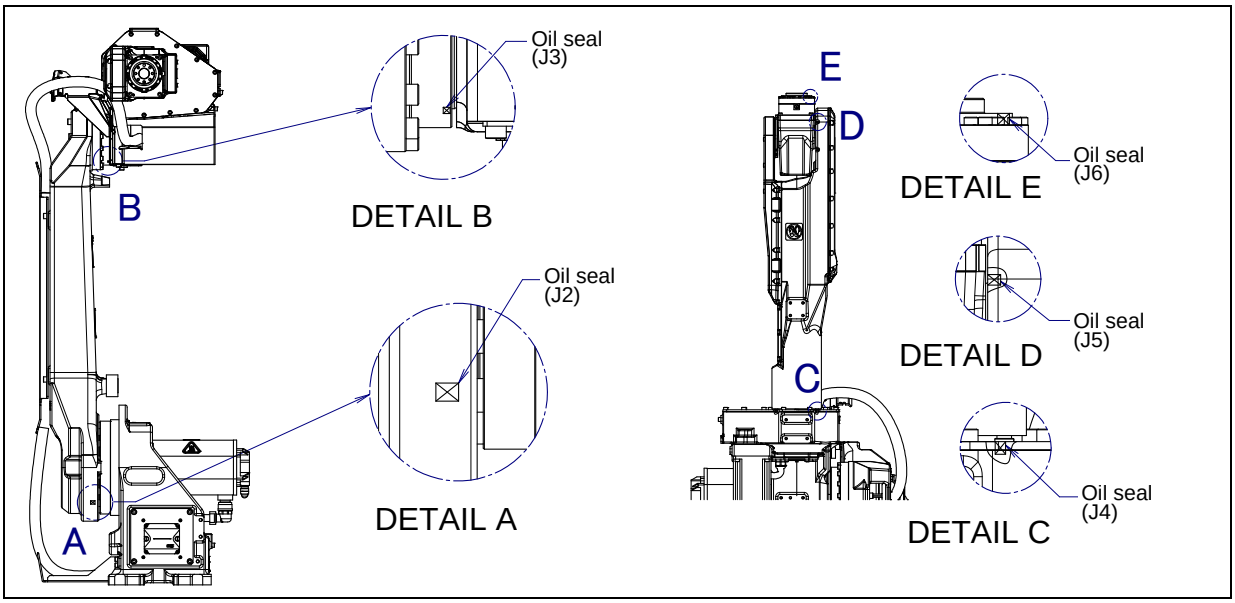


Fig.8.2.1 Check parts of oil seepage

Management

- O 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. 8.2.1 before you operate the robot.
- In case of oil seepage, please consider replacing the grease. This replacement potentially can help improve the seepage situation.
- Also, motors might become hot and the internal pressure of the grease bath may increase 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 8.3.3 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.
  ⇒**"10.1 TROUBLESHOOTING"(symptom: Grease leakage, Oil leakage)**

8.2.2 Confirmation of the Air Control Set (option)

When adopting an air control set, 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. 8.2.2. 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 to 20 sec), adjust it using the lubricator control knob. The lubricator becomes empty in about 10 to 20 days under normal operation.
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. When quantity of the drain is remarkable, examine the setting of the air dryer to the air supply side.

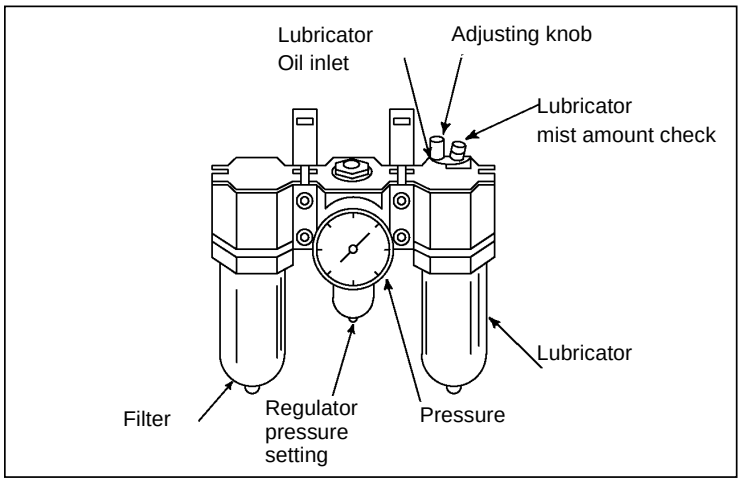


Fig. 8.2.2 Air control set (option)

8.2.3 Check the Mechanical Unit Cables and Connectors

Inspection points of the mechanical unit cables and welding cables

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

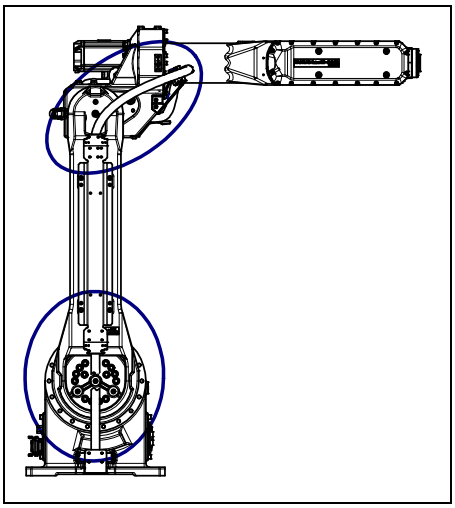


Fig. 8.2.3 (a) Inspection points of the mechanical unit cables

Check points

＜Cable protective sleeve＞

- Check that no holes or tears exist on the cable protective sleeves.
- If there is damage as shown in Fig. 8.2.3 (b), replace the cable protective sleeves.

Fig. 8.2.3 (b) Damages on the cable protective sleeve

＜Cables＞

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

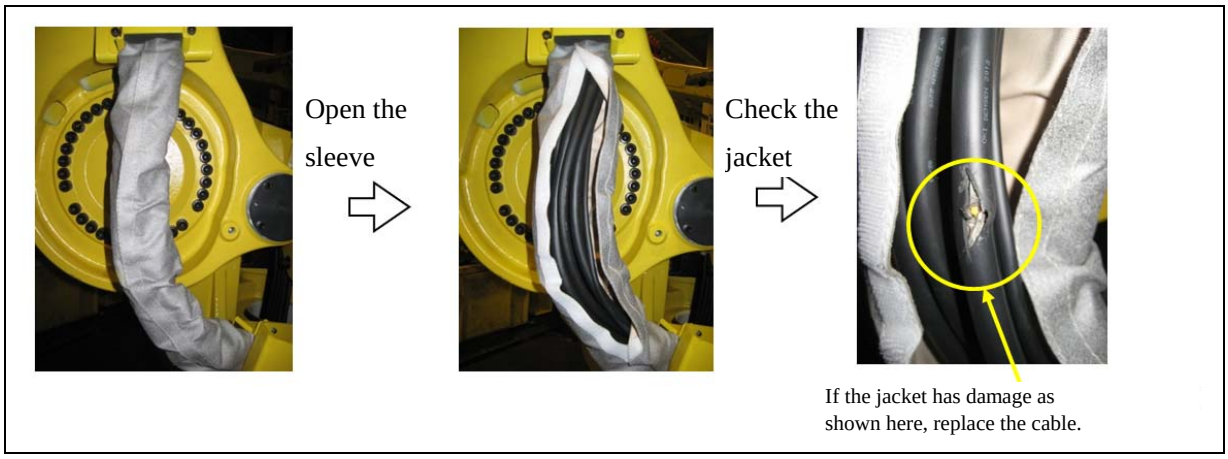


Fig. 8.2.3 (c) Cable check method

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 terminal for tightness.

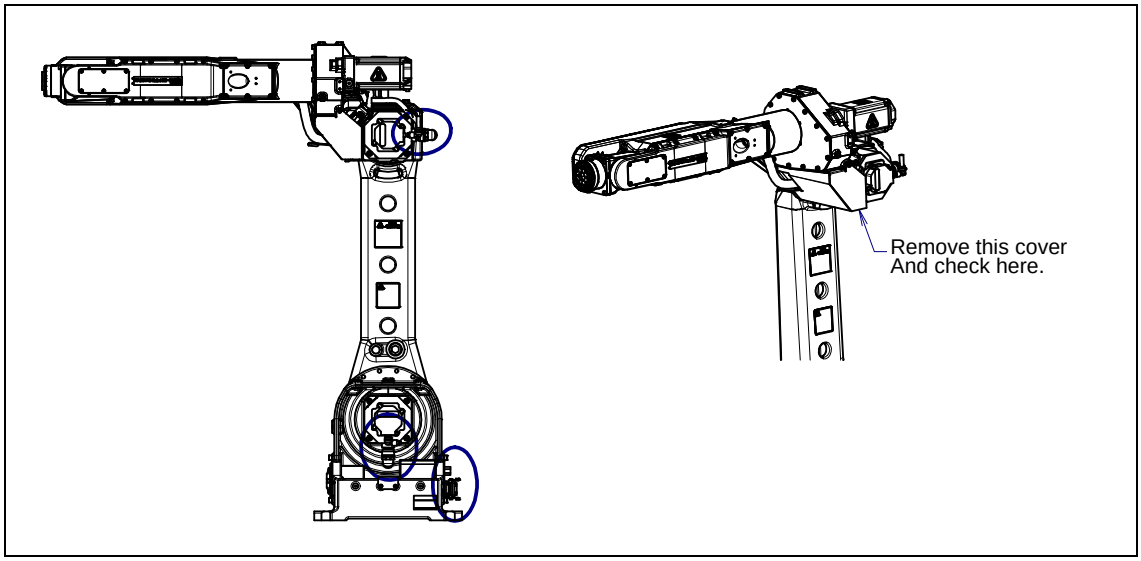


Fig. 8.2.3 (d) Connector Inspection points

8.2.4 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.

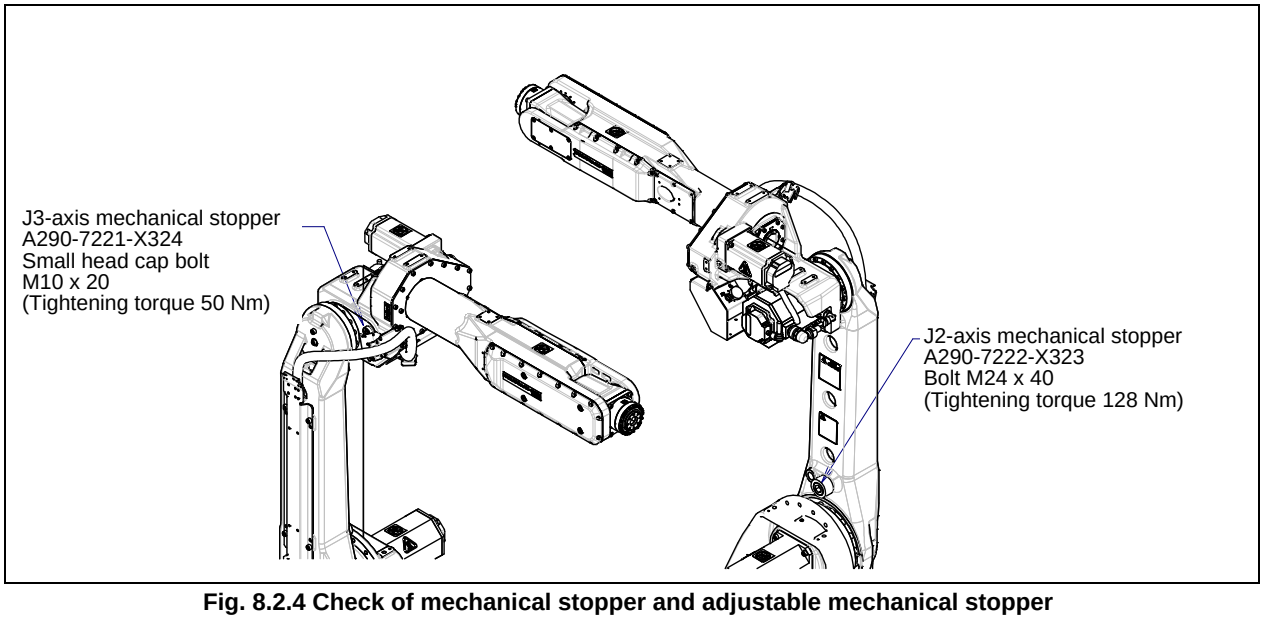


Fig. 8.2.4 Check of mechanical stopper and adjustable mechanical stopper

8.3 MAINTENANCE

8.3.1 Replacing the Batteries (1-year (3840 hours) checks)

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

1 Press the EMERGENCY STOP button to stop the robot motion.

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

2 Remove the battery case cap. (Fig. 8.3.1) If it cannot be removed, tap it on its side with a plastic hammer to loosen the cap before you remove it.
3 Take out the old batteries from the battery case. At this time, the battery can be taken out by pulling the stick at the center of the battery box.
4 Insert new batteries into the battery case. Pay attention to the direction of the batteries.
5 Close the battery case cap.

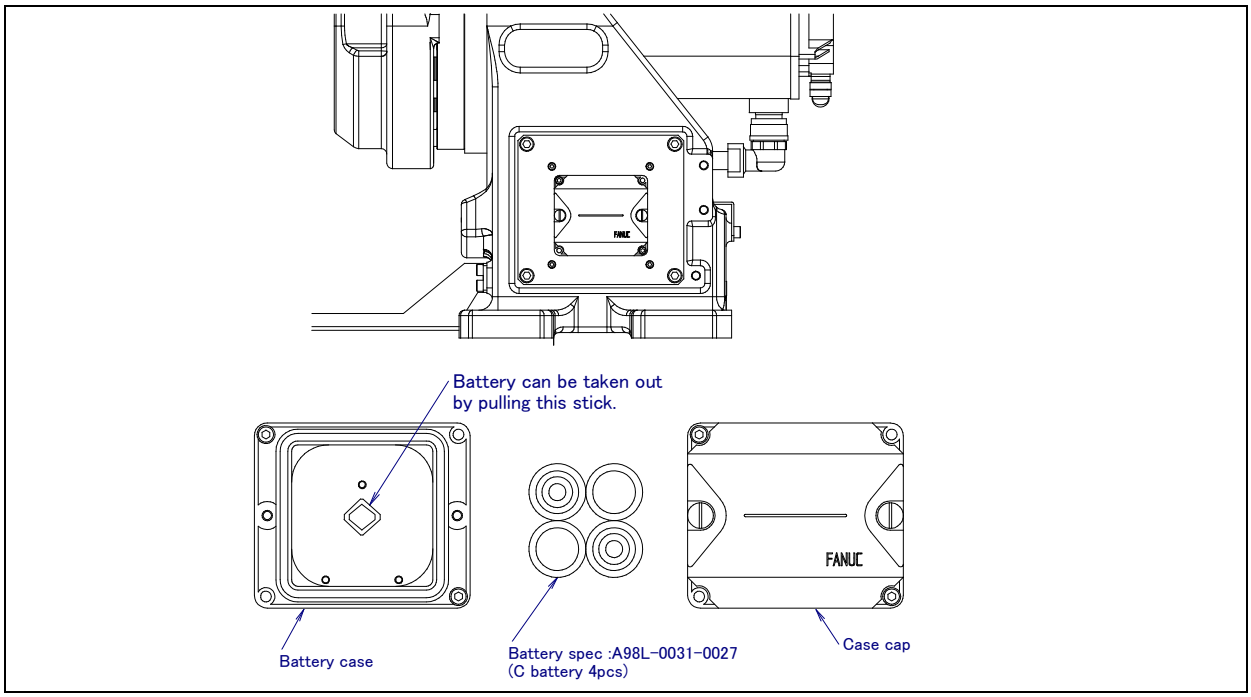


Fig. 8.3.1 Replacing the battery

8.3.2 Greasing (1-year (3840 hours) checks)

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

1 Replenish the J6-axis reducer with grease about every 12 months or after 3840 hours of operation.
2 See Fig.8.3.2 and Table 8.3.2 for greasing points and the method.
3 After applying grease, release the remaining pressure within the grease bath as described in the procedure in Subsection 8.3.3.4.

Table 8.3.2 Greasing points

Greasing point	Specified grease	Amount of grease	Gun tip pressure	Greasing method
J6-axis reducer	Harmonic grease 4BNo.2 Specification: A98L-0040-0230	44ml (39g)	0.1 MPa or less (NOTE)	Remove the extra low bolts and sealing washers of the J6-axis grease inlet and outlet, and attach the supplied grease nipple of the J6-axis to the grease inlet of the J6-axis. After greasing, remove the grease nipple, and attach the extra low bolts and sealing washers to the grease inlet and outlet.

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

⚠ CAUTION
If you grease incorrectly, the pressure in the grease bath may increase steeply, leading to a broken seal, which will eventually cause grease leakage or malfunction. When greasing, be sure to follow the cautions stated in Subsection 8.3.3.1.

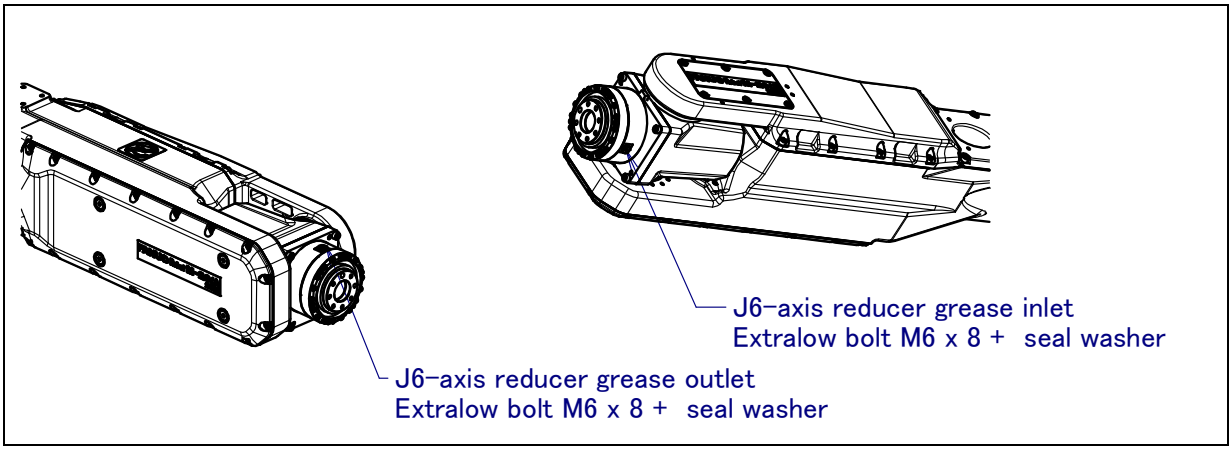


Fig. 8.3.2 J6-axis grease supply position

8.3.3 Replacing the Grease of the Drive Mechanism (3-year (11520 hours) checks)

According to the procedures below, replace the grease of the reducers of J2 and J3-axes and J4/J5-axis gearbox every 3 years or 11520 hours, whichever comes first.

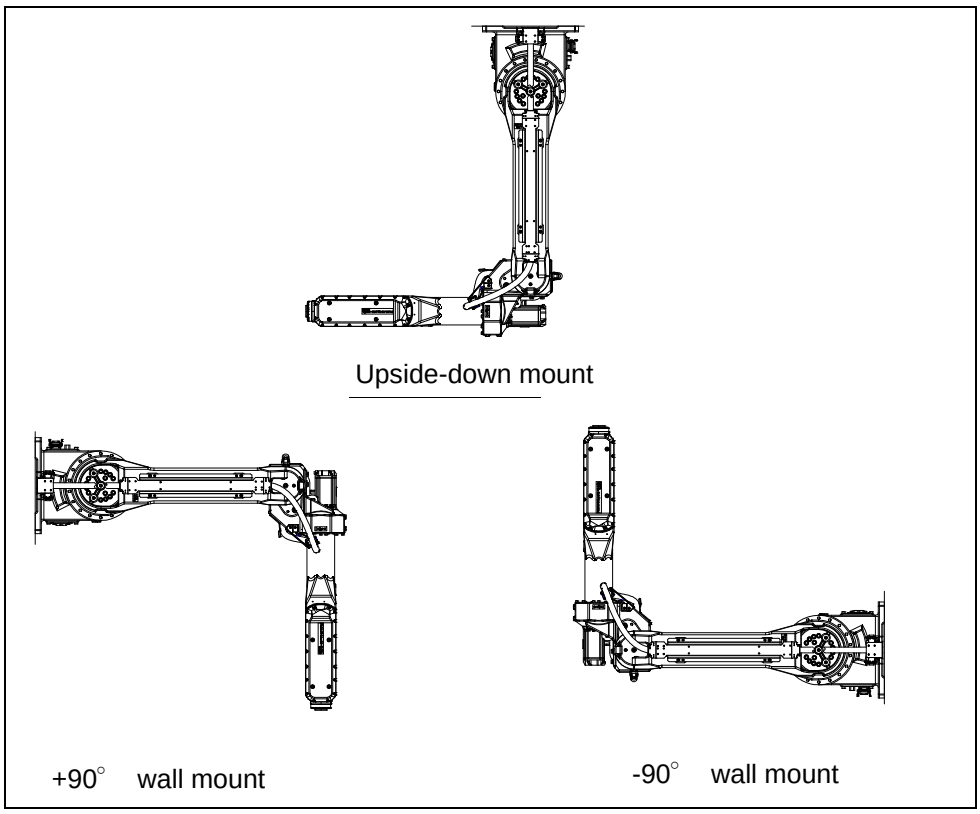


Fig 8.3.3 Installation method

8.3.3.1 Grease replacement procedure for J2/J3-axis reducer

⚠ CAUTION

Failure to supply grease correctly may cause an increase of the internal pressure of the grease bath. Such pressure increase will then damage the seal, which in turn leads to grease leakage and abnormal robot operation.
When performing greasing, therefore, observe the following precautions.

1 Before starting to grease, remove the seal bolt to allow the grease to come out.
2 Supply grease slowly, using a manual pump. (once per two seconds)
3 Whenever possible, avoid using an air pump, which is powered by the factory air supply. If the use of an air pump is unavoidable, supply grease with the pump at a pressure lower than or equal to the gun tip pressure (see Table 8.3.3.1 (a)).
4 Use grease only of the specified type. Grease of a type other than that specified may damage the reducer or lead to other problems.
5 After greasing, release the remaining pressure from the grease bath using the procedure given in Subsection 8.3.3.3, and then close the grease outlet.
6 To prevent slipping accidents and catching fire, completely remove any excess grease from the floor or robot.

Table 8.3.3.1 (a) Grease name and amount (J2/J3-axis reducer)

Greasing points	Amount of grease to be applied	Gun tip pressure	Specified grease
J2-axis reducer	850g(940ml)	0.1MPa or less (NOTE)	Kyodo Yushi VIGOGREASE RE0 (Specification: A98L-0040-0174)
J3-axis reducer	340g(380ml)		

NOTE

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

⚠ WARNING

Hot grease may come out suddenly when opening the grease outlet. Attach bags for collecting grease and use appropriate protective equipment such as a gloves or protective glasses.

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

Table 8.3.3.1 (b) Postures for greasing (J2/J3-axis reducer)

Grease supplying position		Posture				
		J2	J3	J4	J5	J6
J2-axis reducer grease supplying posture	Upside-down mount	-90°	Arbitrary	Arbitrary	Arbitrary	Arbitrary
	Wall mount -90°	90°				
	Wall mount +90°	-90°				
J3-axis reducer grease supplying posture	Upside-down mount	0°	180°			
	Wall mount -90°	0°	0°			
	Wall mount +90°	0°	0°			

1 Move the robot to the greasing posture described in Table 8.3.3.1 (b).
2 Turn off controller power.
3 Remove the seal bolt or taper plug from grease outlet. (Fig. 8.3.3.1)
J2-axis : 3 locations (seal bolt M8 x 10)
J3-axis : 1 location (J3-axis reducer first grease outlet, seal bolt M8 x 10)
* Robot has 2 grease outlets. Remove the only first grease outlet.
4 Remove the seal bolt or taper plug from grease inlet and attach grease nipple.
5 Keep greasing until the new grease pushes out the old grease and comes out from each grease outlet.
6 Release the remaining pressure using the procedure given in Subsection 8.3.3.3.

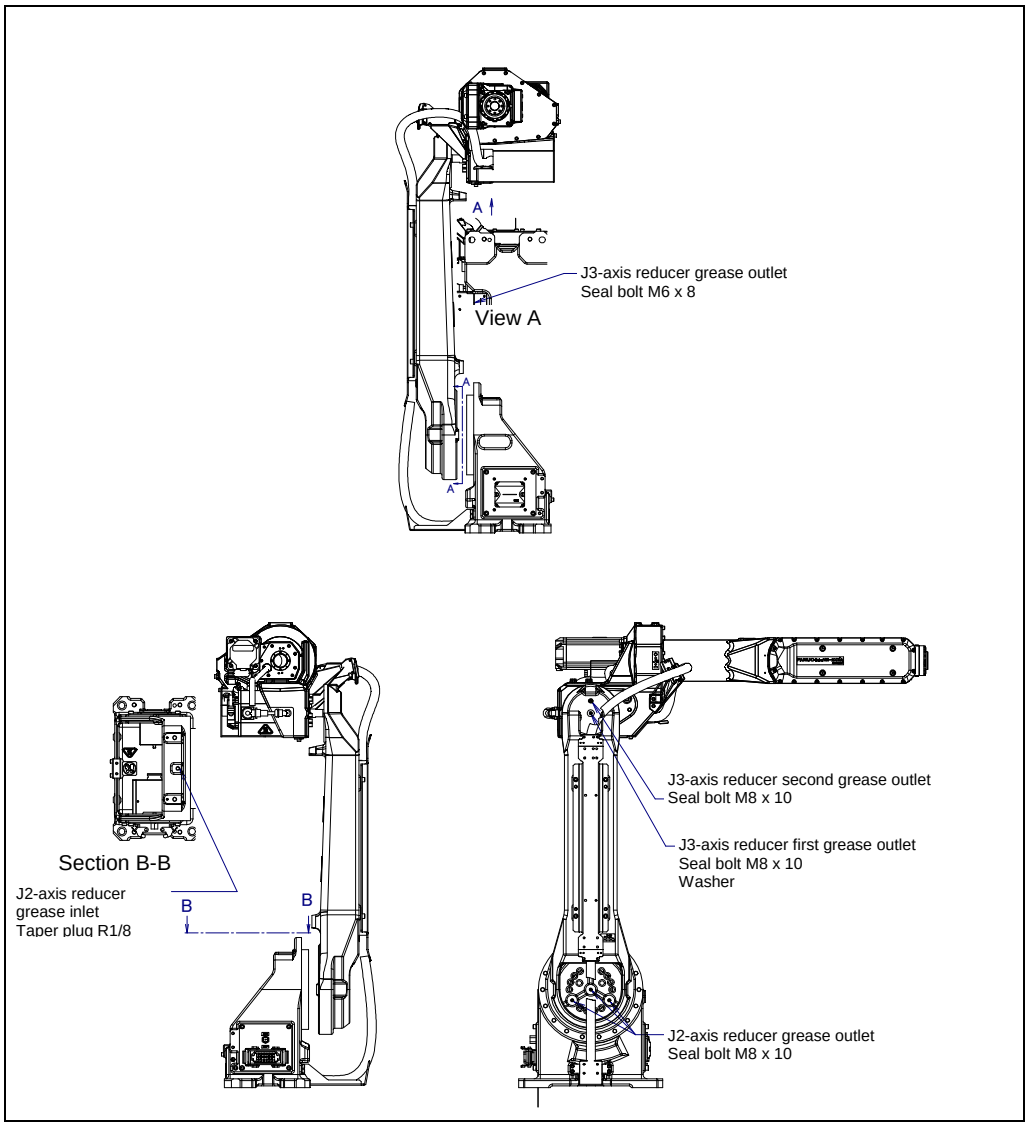


Fig. 8.3.3.1 Greasing points of J2/J3-axis reducer

Table 8.3.3.1 (c) Specification of the seal bolts and the taper plug

Parts name	Specification
Seal bolt (M6 x 8)	A97L-0218-0417#060808
Seal bolt (M8 x 10)	A97L-0218-0417#081010
taper plug (R1/8)	A97L-0001-0436#1-1D

8.3.3.2 Grease replacement procedure for J4/J5-axis gearbox

⚠ CAUTION

Failure to supply grease correctly may cause an increase of the internal pressure of the grease bath. Such pressure increase will then damage the seal, which in turn leads to grease leakage and abnormal robot operation.
When performing greasing, therefore, observe the following precautions.

1 Before starting to grease, remove the seal bolt or the taper plug to allow the grease to come out.
2 Supply grease slowly, using a manual pump. (once per two seconds)
3 Whenever possible, avoid using an air pump, which is powered by the factory air supply.
If the use of an air pump is unavoidable, supply grease with the pump at a pressure lower than or equal to the gun tip pressure (see Table 8.3.3.2 (a)).
4 Use grease only of the specified type. Grease of a type other than that specified may damage the reducer or lead to other problems.
5 After greasing, release the remaining pressure from the grease bath using the procedure given in Subsection 8.3.3.4, and then close the grease outlet.
6 To prevent slipping accidents and catching fire, completely remove any excess grease from the floor or robot.

Table 8.3.3.2 (a) Grease name and amount (J4/J5-axis gearbox)

Greasing points	Amount of grease to be applied	Gun tip pressure	Specified grease
J4-axis gearbox	1100g (1220ml)	0.1MPa or less (NOTE)	Kyodo Yushi VIGOGREASE RE0 (Specification: A98L-0040-0174)
J5-axis gearbox	1000g (1110ml)		

NOTE

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

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

Table 8.3.3.2 (b) Grease supplying posture (J4/J5-axis gearbox)

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

1 Move the robot to the greasing posture described in Table 8.3.3.2 (b).
2 Turn off the controller power.
3 Remove the seal bolt. (Fig. 8.3.3.2)
  J4-axis: 1 location (seal bolt M6 x 8)
  J5-axis: 1 location (bolt M8 x 12 + seal washer)
4 Remove the seal bolt or taper plug from grease inlet and attach grease nipple.
5 Keep greasing until the new grease pushes out the old grease and comes out from each grease outlet.
6 Release the remaining pressure using the procedure given in Subsection 8.3.3.4.

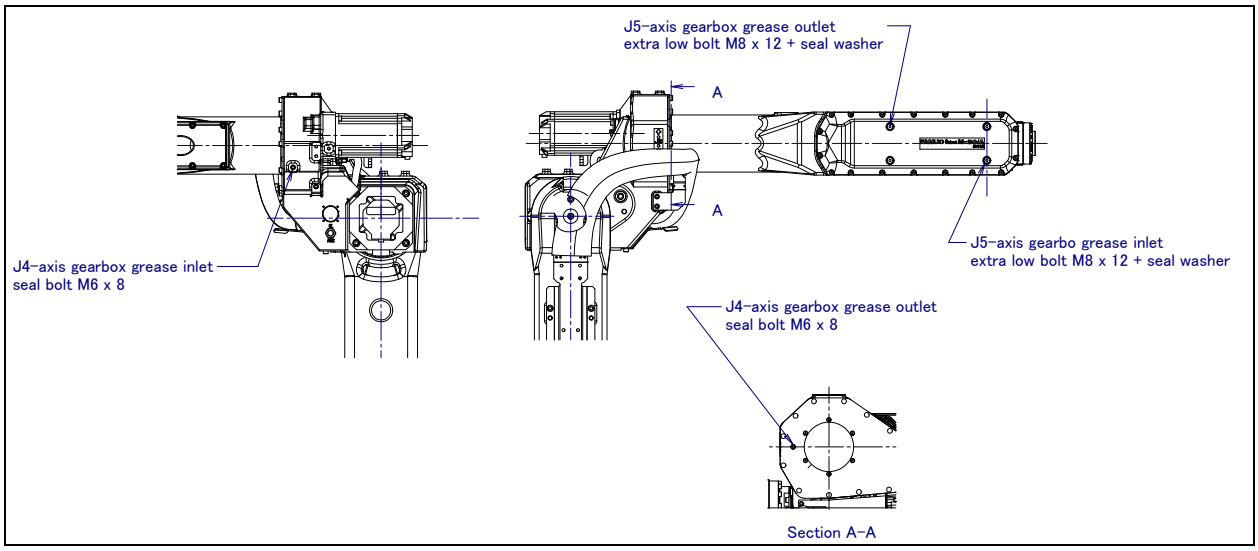


Fig. 8.3.3.2 Greasing point of J4/J5-axis gearbox

Table 8.3.3.2 (c) Spec. of the seal bolt and the seal washer

Parts name	Specification
Seal bolt (M6 x 8)	A97L-0218-0417#060808
Seal washer (M8)	A30L-0001-0048#8M

8.3.3.3 Procedure for releasing remaining pressure from the grease bath (J2/J3-axis)

After applying grease, operate the robot as instructed below more than 10 minutes with the plug and seal bolt of the grease inlet and outlet uncapped to release the remaining pressure within the grease bath. In case of J2-axis, there are three seal bolts for grease outlet. In case of J3-axis, robot has two grease outlets. So uncap all of them.
Attach a recovery bag below the grease inlet and outlet to prevent output grease from splattering.

<table>
<tr><th>Operating axis
Grease
replacement part</th><th>J2-axis</th><th>J3-axis</th><th>J4-axis</th><th>J5-axis</th><th>J6-axis</th></tr>
<tr><td>J2-axis reducer</td><td>Axis angle of 60° or more OVR 100%</td><td colspan="4">Arbitrary</td></tr>
<tr><td>J3-axis reducer</td><td>Arbitrary</td><td>Axis angle of 60° or more OVR 100%</td><td colspan="3">Arbitrary</td></tr>
</table>

If the above operation cannot be performed due to the environment of the robot, prolong the operating time so that an equivalent operation can be performed. (When the maximum allowable axis angle is 30°, perform the twice operation for 20 minutes or more.) If you grease multiple axes, you can exercise multiple axes at the same time. After completion of the operation, attach the plug and seal bolts to the grease inlets and outlets.
When two or more axes are supplied at the same time, it is possible to release grease at the same time in two or more axes.

After replacing grease, the internal pressure of the grease bath may rise if the robot is operated again under frequent inversion movement or a high temperature environment. In these cases, you can return to normal internal pressure by releasing the grease outlet just after robot operation. (When opening the grease outlet, be sure that grease does not spatter.)

8.3.3.4 Procedure for releasing remaining pressure from the grease bath (J4 to J6-axis)

To release the remaining pressure, perform the procedure below.

(For the J4-axis)

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

(For the J5-axis gearbox)

- After greasing, remove the grease nipple from the grease inlet.
- Move the robot to J3= -90°, perform ±90° repeating operation for 5 minutes for only J5-axis. Make the wait time between the two points 0, and perform the continuous operation with position pass is fine.
- After 5 minutes, confirm that grease has been expelled. In normal, grease amount is about 50ml (which is a volume of approximately two golf balls.).
- Attach the bolts and seal washers of the grease inlet and outlet.

(For the J6-axis)

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

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

<table>
<tr><th>Operating axis / Grease replacement part</th><th>J2-axis</th><th>J3-axis</th><th>J4-axis</th><th>J5-axis</th><th>J6-axis</th></tr>
<tr><td>J4-axis gearbox</td><td colspan="2">Arbitrary</td><td>Axis angle of 60° or more OVR 100%</td><td colspan="2">Arbitrary</td></tr>
<tr><td>J5-axis gearbox</td><td colspan="3">Arbitrary</td><td>Axis angle of 180° or more OVR 100%</td><td>Arbitrary</td></tr>
<tr><td>J6-axis reducer</td><td colspan="4">Arbitrary</td><td>Axis angle of 60° or more OVR 100%</td></tr>
</table>

If the above operation cannot be performed due to the environment of the robot, prolong the operating time so that an equivalent operation can be performed. (When the maximum allowable axis angle is 30 degrees, perform the operation again for 20 minutes or more.) When you supply grease to multiple axes, you can run the axes at the same time. After completion of the operation, attach the taper plug, seal bolts or bolts and seal washers to the grease inlets and outlets. When reusing the seal bolts or the taper plug, be sure to seal them with seal tape.

After replacing the grease, the internal pressure of the grease bath may rise if the robot is operated again under frequent inversion movement or a high temperature environment. In these cases, you can return to normal internal pressure by releasing the grease outlet just after robot operation. (When opening the grease outlet, be sure that grease does not spatter.)

8.4 STORAGE

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

9 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.

9.1 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 becomes necessary after:

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

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

Mastering method

Table 9.1 describes the following mastering methods. Note that "Quick Mastering for Single Axis" is not supported in software version 7DC2 (V8.20P) or earlier.

Table 9.1 Type of mastering

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

Once mastering has been performed, positioning (calibration) is necessary. Positioning is an operation which recognizes the current robot position based on the newly mastered robot pulse counts.

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

⚠ CAUTION

1 The J1-axis motor is shipped as an accessory. Therefore, after installing the motor in the J1-axis traveling unit, be sure to perform single axis mastering for the J1-axis.
2 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 the F5 ([DONE]) on the Master/Cal screen. The $MASTER_ENB system variable is reset to 0 automatically. And the Master/Cal screen will disappear.
3 Before performing mastering, it is recommended that you back up the current mastering data.
4 When the motion range is mechanically 360 degrees or more, if any of the axes (J1-axis and J4-axis) to which the cables are connected is turned one turn beyond the correct mastering position when mastering occurs, the cables in the mechanical unit may be damaged. If the correct rotation position is not clear because the axis is moved too much during mastering, remove the connector panel or cover, check the states of the internal cables, and perform mastering in the correct position. For the checking procedure, see Fig. 9.1 (a) and 9.1 (b).

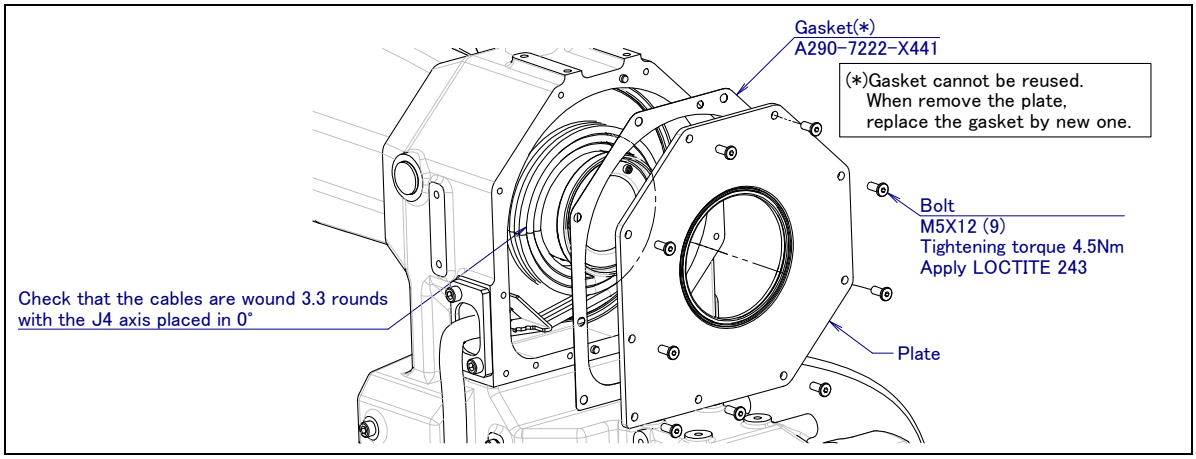


Fig. 9.1 (a) Check the cables (J4-axis)
(ARC Mate 120*i*C/20T, M-20*i*A/20T)

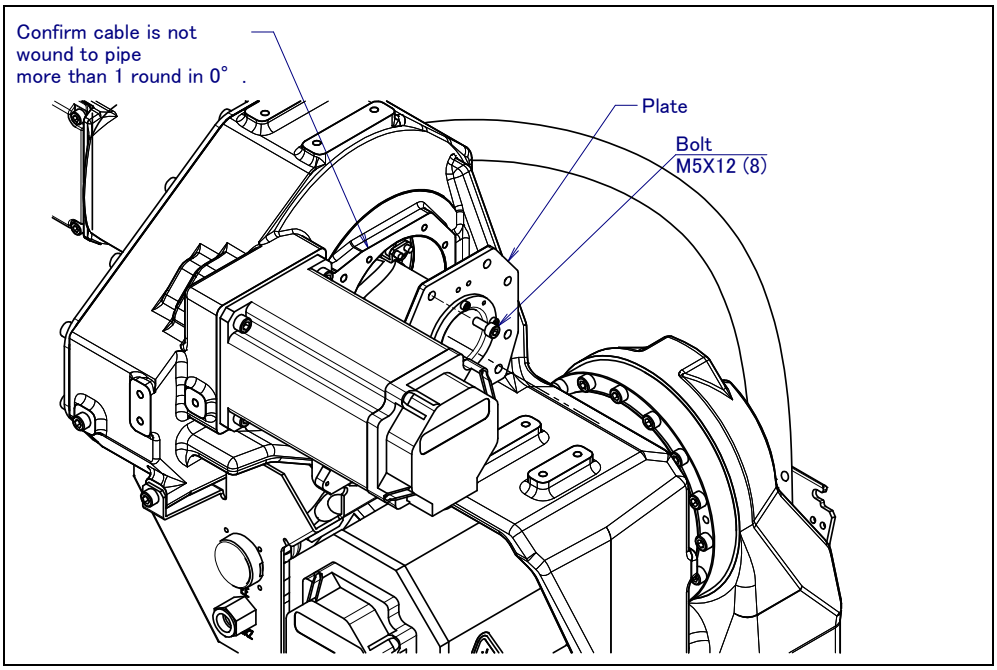


Fig. 9.1 (b) Check the cables (J4-axis)
(M-20*i*A/20MT/35MT)

9.2 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.

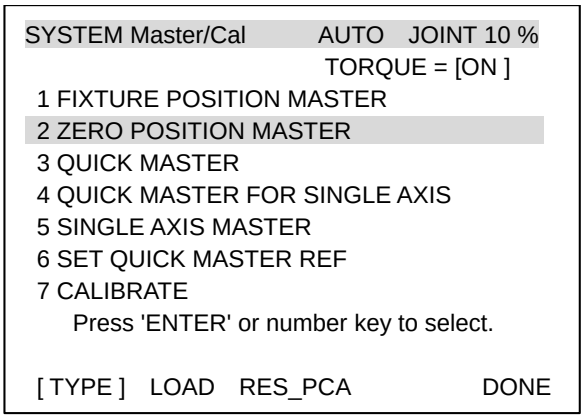
9.3 ZERO POSITION MASTERING

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

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

Zero-position Mastering Procedure

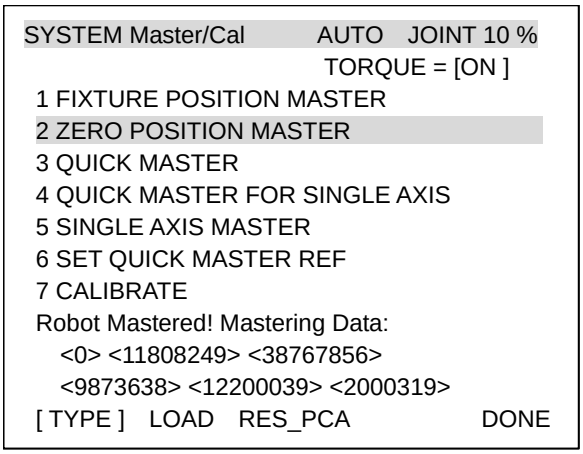
1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM].
3 Press F1 [TYPE], display the screen change menu.
4 Select [Master/Cal]. The positioning screen appears.



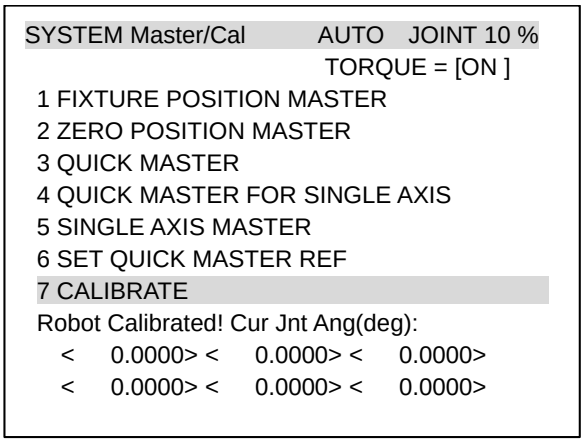
5 Release brake control, and jog the robot into a posture for mastering.

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.

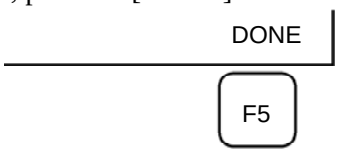
6 Select [2 Zero Position Master]. Press F4 [YES].



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



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



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

Table 9.3 Posture with position marks (witness mark) aligned

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

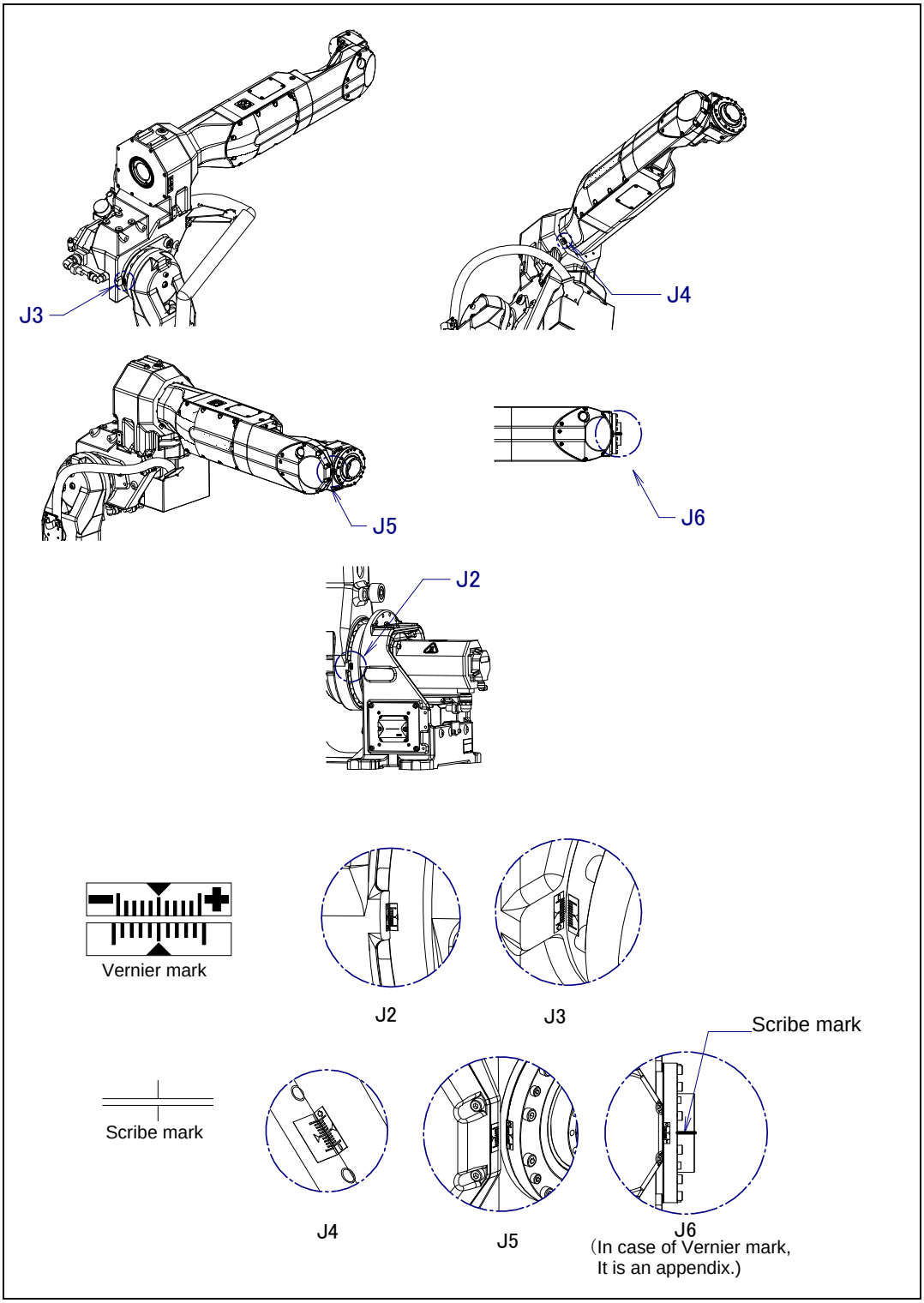


Fig. 9.3 (a) Marking position (ARC Mate 120*i*C/20T, M-20*i*A/20T)

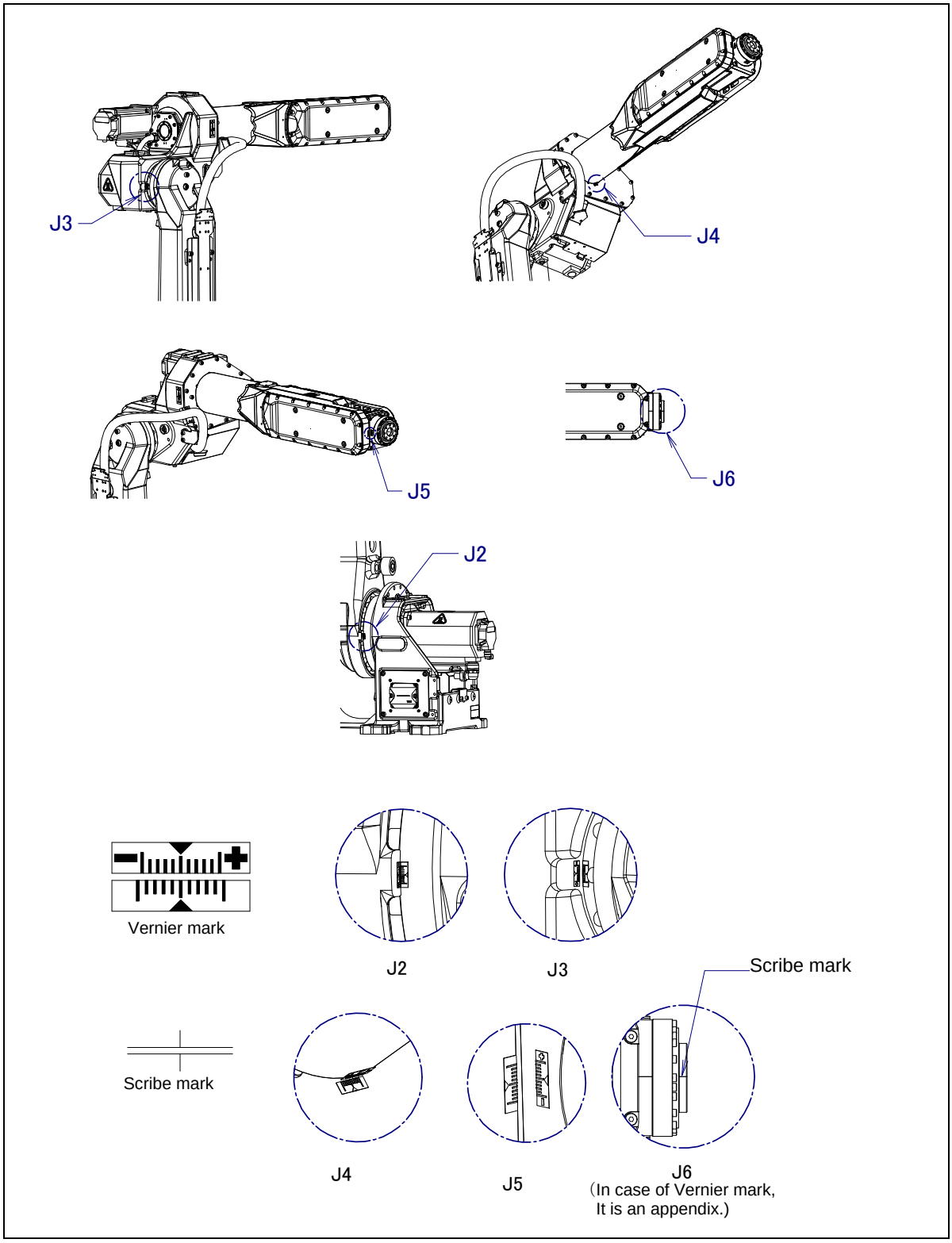


Fig. 9.3 (b) Marking position (M-20*i*A/20MT/30MT)

9.4 QUICK MASTERING

Quick mastering is performed at a user-specified position for each 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 fact that the absolute value of a rotation angle within one rotation will not be lost.

Quick mastering is factory-performed at the position indicated in Table 9.3. Do not change the setting unless there is any problem.

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

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

Procedure for Recording the Quick Mastering Reference Position

1 Select [6 SYSTEM].
2 Select [Master/Cal]. The positioning screen appears.

```
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 is saved.

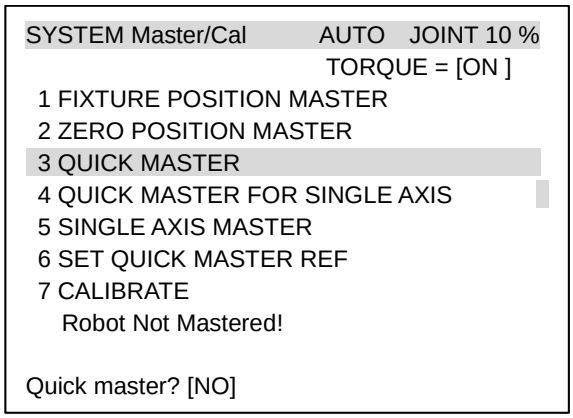
```
 5 SINGLE AXIS MASTER
 6 SET QUICK MASTER REF
 7 CALIBRATE
```

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 is required to restore mastering data.

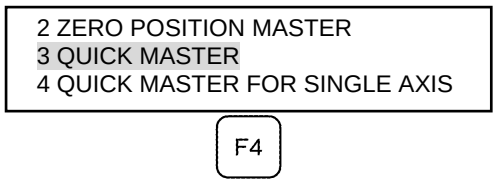
Procedure Quick Mastering

1 Display the Master/Cal screen.



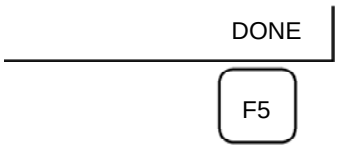
2 Release brake control, and jog the robot to the quick mastering reference position.

3 Move the cursor to [3 QUICK MASTER] and press [ENTER]. Press F4 [YES]. Quick mastering data is saved.



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.

9.5 QUICK MASTERING FOR SINGLE AXIS

Quick mastering for a single axis 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 fact that the absolute value of a rotation angle within one rotation will not be lost.

Quick mastering is factory-performed at the position indicated in Table 9.3. Do not change the setting unless there is any problem.

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

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

Procedure for Recording the Quick Mastering Reference Position

1 Select [6 SYSTEM].
2 Select [Master/Cal]. The positioning screen appears.

```
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 is saved.

```
 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 is required to restore mastering data.

Procedure of Quick Mastering for single axis

1 Display the Master/Cal screen.

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

Quick master? [NO]
```

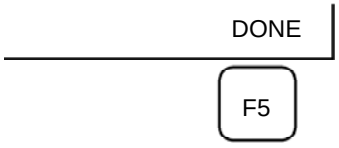
2 Select [4 QUICK MASTER FOR SINGLE AXIS]. You will see the quick master for single axis screen.

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

                                                EXEC
```

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

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

                                                EXEC
```

4 Turn off brake control, then jog the robot to the quick mastering reference position.
5 Press F5 [EXEC]. Mastering is performed. So, [SEL] is reset to 0, and [ST] is re-set to 2 or 1.
6 Move the cursor to CALIBRATE and press ENTER. Calibration is executed. Calibration is executed by power on again.
7 After completing the calibration, press F5 Done.



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

9.6 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.

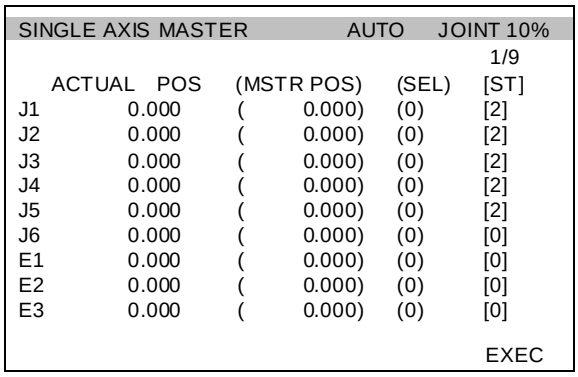


Table 9.6 Items set in single axis mastering

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 to set to it to the 0 degree position.
SEL	This item is set to 1 for an axis to be subjected to single axis mastering. Usually, it is 0.
ST	This item indicates whether single axis mastering has been completed for the corresponding axis. It cannot be changed directly by the user. The value of the item is reflected in $EACHMST_DON (1 to 9). 0: Mastering data has been lost. Single axis mastering is necessary. 1: Mastering data has been lost. (Mastering has been performed only for the other interactive axes.) Single axis mastering is necessary. 2: Mastering has been completed.

Procedure of Single axis mastering

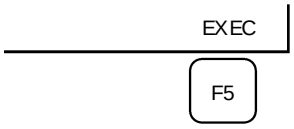
1 Select [6 SYSTEM].
2 Select [Master/Cal]. The positioning screen will be displayed.

```
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 Select [5 SINGLE AXIS MASTER]. You will see a screen similar to the following.

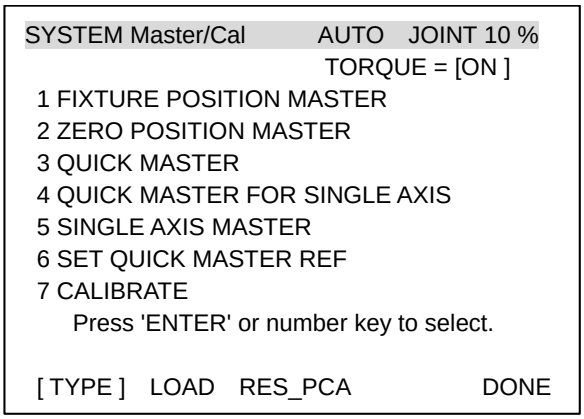
```
SINGLE AXIS MASTER          AUTO    JOINT 10%
                                          1/9
   ACTUAL  POS    (MSTR POS)     (SEL)   [ST]
J1        0.000   (     0.000)   (0)     [2]
J2        0.000   (     0.000)   (0)     [2]
J3        0.000   (     0.000)   (0)     [2]
J4        0.000   (    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

                                          EXEC
```

4 Move the cursor to the [SEL] column for the unmastered axis and press the numeric key [1]. Setting of [SEL] is available for one or more axes.
5 Turn off brake control, 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.



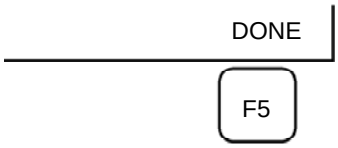

```
SINGLE AXIS MASTER          AUTO    JOINT 10%
                                          6/9
   ACTUAL  POS    (MSTR POS)     (SEL)   [ST]
J1        0.000   (     0.000)   (0)     [2]
J2        0.000   (     0.000)   (0)     [2]
J3        0.000   (     0.000)   (0)     [2]
J4        0.000   (     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].



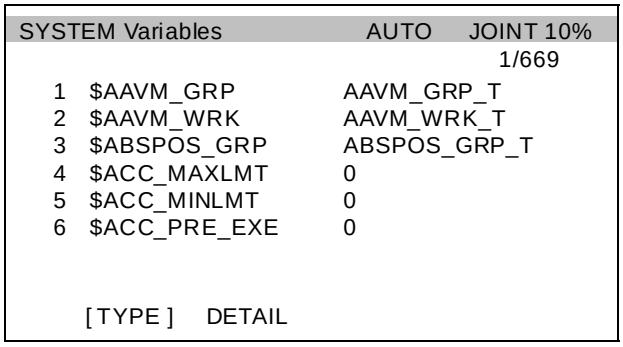
11 Return brake control to original setting, and turn off the controller power and on again.

9.7 MASTERING DATA ENTRY

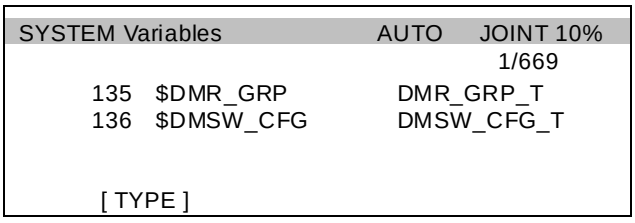
This function enables mastering data values to be assigned directly to a system variable. It can be used if mastering data has been lost but the pulse count is preserved.

Mastering data entry method

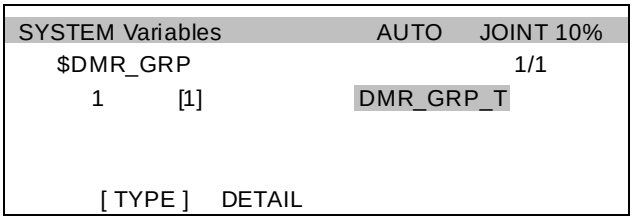
1 Press the [MENU] key, then press [0 NEXT] and select [6 SYSTEM].
2 Press F1 [TYPE]. Select [Variables]. The system variable screen appears.

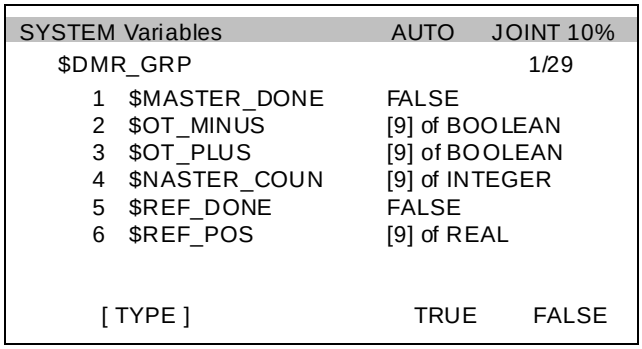


3 Change the mastering data.
The mastering data is saved to the $DMR_GRP.$MASTER_COUN system variable.

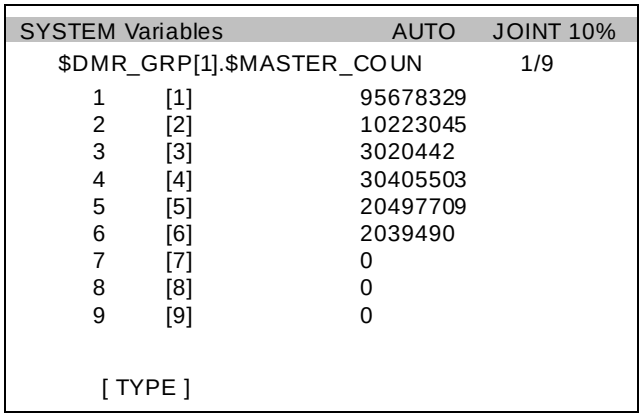


4 Select $DMR_GRP.

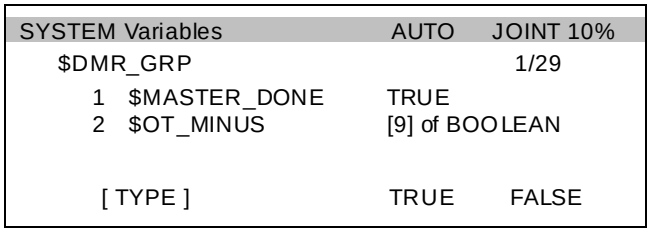




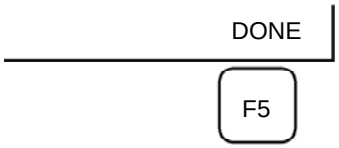
5 Select $MASTER_COUN, and enter the mastering data you have recorded.



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



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



9.8 VERIFYING MASTERING

1 How to verify that the robot is mastered properly:
Usually, positioning is performed automatically when the power is turned on. To check whether mastering has been performed correctly, examine if the current displayed position matches the actual robot position by using the procedure described below:
(1) Reproduce a particular point in a program. Check whether the point agrees with the specified position.
(2) Set all axes of the robot to their 0-degree (0 rad) positions. Check that the zero-degree position marks indicated in Section 9.3 of OPERATOR'S MANUAL are aligned. There is no need to use a visual aid.

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

2 Alarm type displayed during mastering and their solution method:
(1) BZAL alarm
This alarm is displayed if the Pulsecoder's backup battery voltage decreases to 0 V while the power to the controller is disconnected. Furthermore, if the Pulsecoder connector is removed for cable replacement, etc. this alarm is displayed as the voltage decreases to 0. Check to see if the alarm will disappear by performing a pulse reset (See Section 9.2.). Then, cycle power of the controller to check if the alarm disappears or not.
The battery may be drained if the alarm is still displayed. Perform a pulse reset, and turn off and on the controller power after replacing the battery. Note that, if this alarm is displayed, all the original data held by the Pulsecoder will be lost. Mastering is required.
(2) BLAL alarm
This alarm is displayed if the voltage of the Pulsecoder's backup battery has fallen to a level where backup is no longer possible. If this alarm is displayed, replace the battery with a new one immediately while keeping the power turned on. Check whether the current position data is valid, using the procedure described in 1.
(3) Alarm notifications like CKAL, RCAL, PHAL, CSAL, DTERR, CRCERR, STBERR, and SPHAL may indicate trouble with Pulsecoder, contact your local FANUC representative.

10 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.

10.1 TROUBLESHOOTING

Table 10.1 (a) shows the major troubleshooting symptoms that may occur in the mechanical unit and their probable causes. If you cannot pinpoint the cause of a failure or which measures to take, contact your local FANUC representative.

Table 10.1 (a) Troubleshooting

Symptoms	Descriptions	Causes	Measures
Vibration Noise	- As the robot operates, the J2 base lifts off the J1-axis traveling unit. - There is a gap between the J2 base and J1-axis traveling unit. - A bolt for fastening the J2 base is loose.	[J2 base and J1-axis traveling unit fastening] - If the J2 base is not securely fastened to the J1-axis traveling unit, it lifts as the robot operates, allowing the J2-axis base and J1-axis traveling unit to strike each other which, in turn, leads to vibration.	- Check the fastening of the J2 base and J1-axis traveling unit. If it is unstable, reinforce the fastening.
	- As the robot operates, the J1-axis traveling unit or rail vibrates.	[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).

Symptoms	Descriptions	Causes	Measures
Vibration Noise (Continued)	- Vibration was first noticed after the robot collided with an object or the robot was overloaded for a long period. - The grease of the vibrating axis has not been exchanged for a long period. - There is vibration or unusual sound just after replacing grease or oil or parts. - Cyclical vibration and noise occur.	[Broken gear, bearing, or reducer] - It is likely that the collision or overload applied an excessive force on the drive mechanism, thus damaging the tooth surface or rolling contact surface of a bearing, or reducer. - Prolonged overloaded use may cause fretting fatigue on gear tooth surface or rolling surface of bearing and reducer. - It is likely that foreign material which was caught in a gear, bearing, or within a reducer has caused damage on the gear tooth surface or rolling surface of the bearing, or reducer. - It is likely that foreign material which was 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 tooth surface or rolling contact surface of a bearing, or reducer due to metal fatigue. - There is a possibility of Grease or oil has not been exchanged accurately. The amount of grease or oil may be insufficient.	- Operate each axis at individually to judge which axis has been vibrating. - Confirm the oil side of the oil sight glass of J4 to J6-axis. Replenish oil when the oil side has not reached above the half. - Remove the motor, and replace the gear, the bearing, and the reducer. For the specification of parts and the procedure of replacement, contact your local FANUC representative. - Using the robot within its maximum rating prevents problems with the drive mechanism. - Specific type and period of grease and oil change will prevent troubles. - If vibration cannot be removed by replacing grease or oil, Perform continuous operation before replacing grease or oil, then it may be improved.

Symptoms	Descriptions	Causes	Measures
Vibration Noise (Continued)	- The cause of problem cannot be identified from examination of the floor, rack, or mechanical unit.	[Controller, cable, and motor] - If a failure occurs in a controller circuit, preventing control commands from being supplied to the motor normally, or preventing motor information from being sent to the controller normally, vibration might occur. - Pulsecoder defect may be the cause of the vibration as the motor cannot propagate the accurate position to the controller. - If the motor becomes defective, vibration might occur because the motor cannot deliver its rated performance. - If a power line in a movable cable of the mechanical unit has an intermittent break, vibration might occur because the motor cannot accurately respond to commands. - If a Pulsecoder wire in a movable part of the mechanical unit has an intermittent break, vibration might occur because commands cannot be sent to the motor accurately. - If a 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. - The robot 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 there is a mechanical problem. - 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 it. Contact your local FANUC representative for further information if necessary.
	- 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 can be 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 thereby preventing extraneous electrical noise.

Symptoms	Descriptions	Causes	Measures
Vibration Noise (Continued)	- 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, the usual sound will disappear.
	- There is an unusual sound when operating right immediately the replacing part, grease or oil.	- There is a possibility of Grease or oil has not been exchanged accurately. The amount of oiling may be insufficient.	- Stop the robot, and confirm the damage situation at once. -Replenish grease or oil when they are insufficient.
	- The movement speed of robot is not constant	- Sludge may be generated by the deterioration of the oil, and it may be attached to bearing etc.	- Perform continuous operation and destroy the sludge. Then replace oil.
Rattling	- While the robot is not supplied with power, pushing it with the hand causes part of the mechanical unit to wobble. - There is a gap on the mounting face of the mechanical unit.	[Mechanical section coupling bolt] - It is likely that overloading or a collision has loosened a mounting bolt in the robot mechanical section.	- Check that the following bolts for each axis are tight. If any of these bolts is loose, apply LOCTITE and tighten it to the appropriate torque. - Motor retaining bolt - Reducer retaining bolt - Reducer shaft retaining bolt - Base retaining bolt - Arm retaining bolt - Casting retaining bolt - End effector retaining bolt

Symptoms	Descriptions	Causes	Measures
Motor overheating	- The ambient temperature of the installation location increases, causing the motor to overheat. - After a cover was attached to the motor, the motor overheated. - After the robot control program or the load was changed, the motor overheated.	[Ambient temperature] - It is likely that a rise in the ambient temperature or attaching the motor cover prevented the motor from releasing heat efficiently, thus leading to overheating. [Operating condition] - It is likely that the robot was operated with the maximum average current exceeded.	- Reducing the ambient temperature is the most effective means of preventing overheating. - Having the surroundings of the motor well ventilated enables the motor to release heat efficiently, thus preventing overheating. - If there is a source of heat near the motor, it is advisable to install shielding to protect the motor from heat radiation. - Relaxing the robot control program and conditions can reduce the average current, thus preventing overheating. - The teach pendant can be used to monitor the average current. Check the average current when the robot control program is executed.
	- 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 of the operator's manual.
	- Symptom other than stated above	[Mechanical section problems] - It is likely that problems occurred in the mechanical unit drive mechanism, thus placing an excessive load on the motor. [Motor problems] - It is likely that a failure of the motor brake resulted in the motor operating 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.

Symptoms	Descriptions	Causes	Measures
Grease leakage Oil leakage	- Grease or oil is leaking from the mechanical unit.	[Poor sealing] - Probable causes are a crack in the casting, a broken O-ring, a damaged oil seal, or a loose seal bolt. - A crack in a casting can occur due to excessive force that might be caused in a collision. - An O-ring can be damaged if it is pinched or cut during disassembling or re-assembling. - An oil seal might be damaged if extraneous dust scratches the lip of the oil seal. - A loose seal bolt or a taper plug might allow grease to leak along the threads.	- If a crack develops in the casting, sealant can be used as a quick-fix to prevent further grease or oil 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 connection section - J3 arm coupling section - Inside the wrist - Oil seals are used in the locations stated below. - Inside the reducer - Inside the wrist - Seal bolts and taper plugs are used in the locations stated below. - Grease inlet or outlet - Oil inlet or outlet
Dropping axis	- An axis drops because the brake does not function. - An axis drops gradually when it should be at rest.	[Brake drive relay and motor] - It is likely that brake drive relay contacts are stuck to each other to keep the brake current flowing, thus preventing the brake from operating when the motor is reenergized. - It is likely that the brake shoe has worn out or the brake main body is damaged, preventing the brake from operating efficiently. - It is likely that oil or grease has entered the motor, causing the brake to slip.	- Check whether the brake drive relay contacts are stuck to each other. If they are found to be stuck, replace the relay. - If the brake shoe is worn out, if the brake main body is damaged, or if oil or grease has entered the motor, replace the motor.

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

Table 10.1 (b) Allowable drops

At power off	5mm
At emergency stop	5mm

10.2 CHANGE THE COLLISION DETECTION PARAMETER

The collision detection parameter is coordinated beforehand for every robot. You can usually use it in the sate at the time of shipment if load setting is right. We recommend the use in the state of the standard setting as much as possible. When it is necessary to lower the sensitivity of the collision detection, you can change it to be hard to false detection a collision detection parameter by carrying out the following KAREL programs. It is recommended to change a program so that the power does not depend on a robot before carrying out the program. There is no parameter for change M-20*i*A/20MT/30MT.

ARC Mate 120*i*C/20T 3kg payload specification
· hi03m22t.pc
M-20*i*A/20T 20kg payload specification
· highm22t.pc

To return it to an original parameter, execute KAREL program below.

ARC Mate 120*i*C/20T 3kg payload specification
· no03m22t.pc
M-20*i*A/20T 20kg payload specification
· normm22t.pc

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

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

In case of ARC Mate 120*i*C/20T
7DA3/36(V7.30P/36) or later, 7DA4/20(V7.40P/20) or later, 7DA5/13(V7.50P/13) or later, 7DA7/05(V7.70P/05) or later, from first version of 7DC1 (V8.10P) and later software

In case of M-20*i*A/20T
7DA3/36(V7.30P/36) or later, 7DA4/20(V7.40P/20) or later, 7DA5/12(V7.50P/12) or later, 7DA7/05(V7.70P/05) or later, from first version of 7DC1 (V8.10P) and later software

11 M/H CONDUIT (ARC Mate 120*i*C/20T, M-20*i*A/20T OPTION)

11.1 NOTES FOR ASSEMBLING CABLE TO M/H CONDUIT

(1) M/H conduit is the option to protect hand cable etc. You can prevent cables interference with arm directly by installing this and can postpone life of cables. Instead conduit is expendable supplies, so replace it regularly.

(2) The cable is recommended to be clamped at a position 70mm or more away for the wrist side. A position 30mm or more away is recommended for the J4 back side. Adjust the length of the cable between clamping to 970±5mm. Please absorb extra length to Conduit. If cables are not clamped, it cause broken of cable and conduit, be sure to clamp cables.

(3) The longevity of the cable improves by spreading grease on the surface of the cable in Conduit. Shell Alvania grease S2 is recommended. In this case, use the cable with performance that can endure oil. If grease is not applied, it causes early damage of cables and conduit.

Table 11.1 Recommended cables and air tube

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

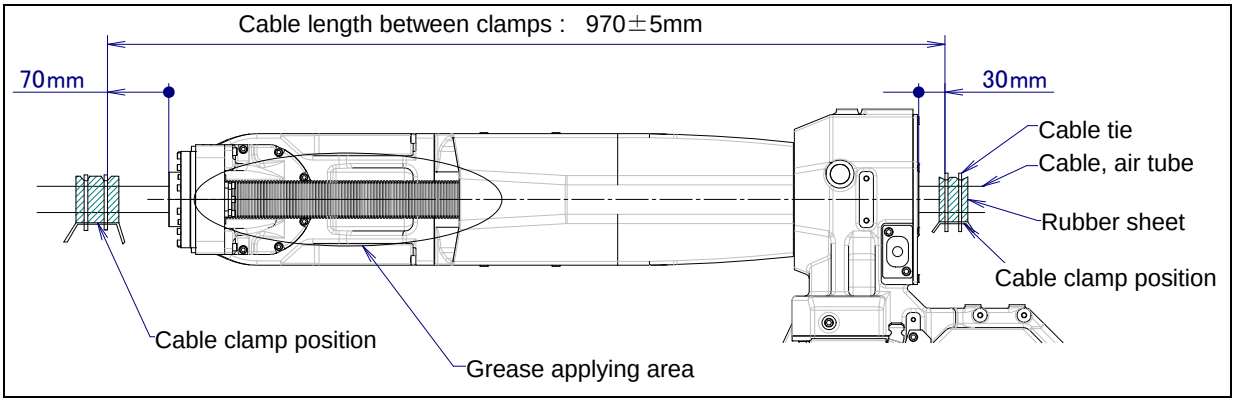


Fig. 11.1 (a) Cable length between clamps

(4) Please make sure that all cables form a bunch 30mm or less in diameter as shown in the figure so that the cables do not rub at the edge of the J6 hollow flange.

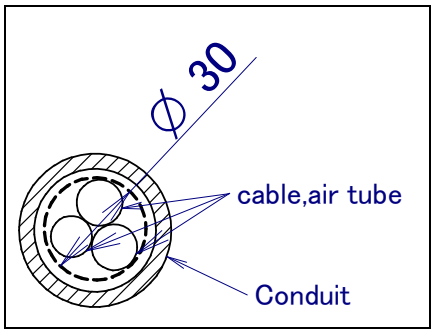


Fig. 11.1 (b) Diameter of cable and air tube in conduit

(5) It is recommended to install a protect ring, if necessary, so that neither cables nor the bolt attached to the J6 midair flange may interfere.
(6) Please roll cables in the rubber seat etc. so as not to damage the surfaces of the cables by the edge of the cable tie, and bind them with a cable tie.

11.2 OTHER NOTES

(1) When M/H conduit is installed, limiting J6 axis range of motion to ±190° is recommended. Cable life shortens when the range exceeds ±190° though it is possible to use a range of motion more than this (maximum ±270°).

Table 11.2 Regular exchange cycle

	Exchange cycle
J5-axis:±140°	Cycle that is shorter among 1.2 million cycles (As one cycle every 30 seconds) and 2 years
J6-axis:±190°	

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

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

APPENDIX

A PERIODIC MAINTENANCE TABLE

FANUC Robot ARC Mate 120*i*C/20T, M-20*i*A/20T
Periodic Maintenance Table

Items			Accumulated operating time (H) / Check time	Oil Grease amount	First check 320	3 months 960	6 months 1920	9 months 2880	1 year 3840	4800	5760	6720	2 years 7680	8640	9600	10560
Mechanical unit	1	Check for external damage or peeling paint	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	2	Check damages of the cable protective	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	3	Check for water	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	4	Check the mechanical cable. (Damaged or twisted)	0.2H	—		○			○				○			
	5	Check the motor connector. (Loosening)	0.2H	—		○			○				○			
	6	Tighten the end effector bolt.	0.2H	—		○			○				○			
	7	Tighten the cover and main bolt.	1.0H	—		○			○				○			
	8	Check the mechanical stopper	0.1H	—		○			○				○			
	9	Clean spatters, sawdust and dust	1.0H	—		○			○				○			
	10	Check the end effector (hand) cable	0.1H	—		○			○				○			
	11	Check the oil sight glass of J4 to J6	0.1H	—	○	○	○	○	○	○	○	○	○	○	○	○
	12	Replacing battery.	0.1H	—					●				●			
	13	Replacing grease of J2-axis reducer	0.5H	940ml												
	14	Replacing grease of J3-axis reducer	0.5H	380ml												
	15	Replacing oil of J4-axis gearbox	0.5H	822ml												
	16	Replacing oil of J5 and J6-axis	0.5H	822ml												
	17	Replacing cable of mechanical unit	4.0H	—												
	18	Replacing M/H conduit	1.0H	—									●			
	19	Check broken of fluoric resin ring.	0.1H	—	○	○	○	○	○	○	○	○	●	○	○	○
Controller	20	Check the robot cable and teach pendant cable	0.2H	—		○			○				○			
	21	Cleaning the ventilator	0.2H	—	○	○	○	○	○	○	○	○	○	○	○	○
	22	Replacing battery *1	0.1H	—												

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

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

3 years 11520	12480	13440	14400	4 years 15360	16320	17280	18240	5 years 19200	20160	21120	22080	6 years 23040	24000	24960	25920	7 years 26880	27840	28800	29760	8 years 30720	Item
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		1
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		2
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		3
○				○				○				○				○					4
○				○				○				○				○					5
○				○				○				○				○					6
○				○				○				○				○					7
○				○				○				○				○					8
○				○				○				○				○					9
○				○				○				○				○					10
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		11
●				●				●				●				●				Overhaul	12
●												●									13
●												●									14
●												●									15
●												●									16
				●																	17
				●								●									18
○	○	○	○	●	○	○	○	○	○	○	○	●	○	○	○	○	○	○	○		19
○				○				○				○				○					20
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		21
				●																	22

FANUC Robot M-20*i*A/20MT/35MT Periodic Maintenance Table

		Items \ Accumulated operating 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 for water	0.1H	—		○	○	○	○	○	○	○	○	○	○	○
	4	Check the mechanical cable. (Damaged or twisted)	0.2H	—		○			○				○			
	5	Check the end effector (hand) cable	0.2H	—		○			○				○			
	6	Check the motor connector. and exposed connector (Loosening)	0.2H	—		○			○				○			
	7	Tighten the end effector bolt.	0.2H	—		○			○				○			
	8	Retightening external main bolts	1.0H	—		○			○				○			
	9	Check the mechanical stopper and adjustable mechanical stopper.	0.1H	—		○			○				○			
	10	Clean spatters, sawdust and dust	1.0H	—		○			○				○			
	11	Replacing battery	0.1H	—					●				●			
	12	Replacing grease of J2-axis reducer	0.5H	940ml												
	13	Replacing grease of J3-axis reducer	0.5H	380ml												
	14	Replacing grease of J4-axis gearbox	0.5H	1220ml												
	15	Replacing grease of J5-axis gearbox	0.5H	1110ml												
	16	Supply grease of J6-axis reducer	0.5H	44ml					●				●			
	17	Replacing cable of mechanical unit	4.0H	—												
Controller	18	Check the robot cable, teach pendant cable and robot connecting cable	0.2H	—		○			○				○			
	19	Cleaning the ventilator	0.2H	—	○	○	○	○	○	○	○	○	○	○	○	○
	20	Replacing battery *1	0.1H	—												

*1 Refer to the “REPLACING UNITS Chapter of MAINTENANCE ” in the following manuals .
R-30*i*B/R-30*i*B Plus CONTROLLER MAINTENANCE MANUAL (B-83195EN),

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

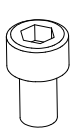
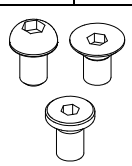
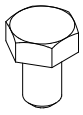
3 years 11520	12480	13440	14400	4 years 15360	16320	17280	18240	5 years 19200	20160	21120	22080	6 years 23040	24000	24960	25920	7 years 26880	27840	28800	29760	8 years 30720	Item
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		1
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		2
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		3
○				○				○				○				○					4
○				○				○				○				○					5
○				○				○				○				○					6
○				○				○				○				○					7
○				○				○				○				○					8
○				○				○				○				○					9
○				○				○				○				○					10
●				●				●				●				●				Overhaul	11
●												●									12
●												●									13
●												●									14
●												●									15
●				●				●				●				●					16
				●																	17
○				○				○				○				○					18
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		19
				●																	20

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 is not specified.

Recommended bolt tightening torques **Unit: Nm**

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

C INSULATION ABOUT ARC WELDING ROBOT

The arc welding robot performs welding, using a welding torch attached to its end effector mounting face via a bracket. Because a high welding current flows through the welding torch, the insulating material must not permit bolting directly from the welding torch bracket to mounting face plate.

If no due consideration is taken, a poor insulation caused by a pileup of spatter can allow the welding current to leak into robot mechanical units, possibly damaging the motor or melting the mechanical unit cable jackets.

C.1 INSULATION AT THE WRIST

- Insulate the end effector mounting surface. Insulation material which is inserted between the end effector mounting surface and the welding torch bracket must be different, and bolt them separately referring to Fig. C.1.
- Insert the insulating material between the torch bracket and faceplate to ensure the two are electrically isolated. When installing the insulating material, be sure to set the crack in the torch holder away from that of the insulating material to prevent spatter from getting in the cracks.
- Allow a sufficient distance (at least 5 mm) at the insulating materials in case a pileup of spatter should occur.

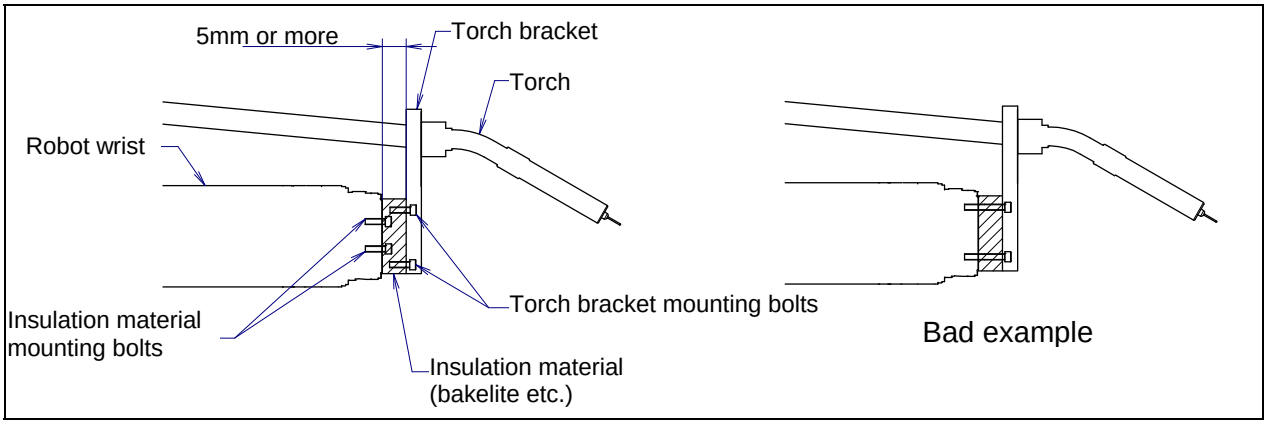


Fig. C.1 Insulation at the wrist

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

D ABOUT MULTIPLE ROBOT CONTROL

Four robots can be controlled by one controller at the maximum. In addition, 6 groups (40 axes) can be controlled by one controller.

NOTE
"The group" means the axial meeting that movement is possible independently.

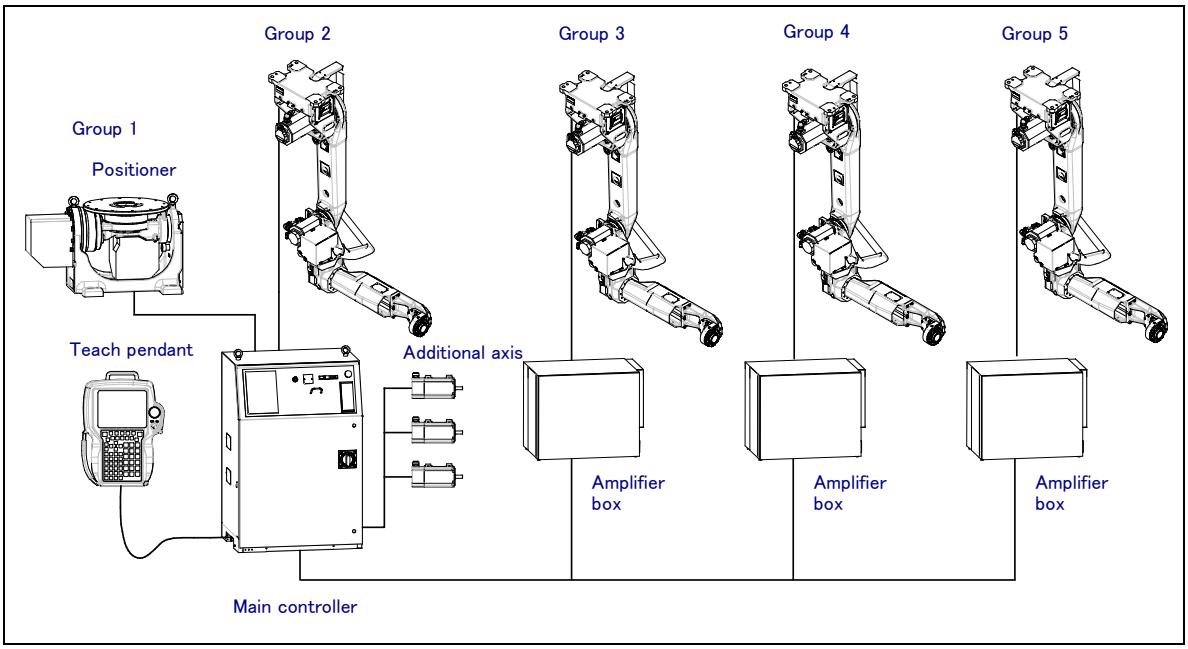


Fig. D MULTIPLE ROBOT CONTROL

When multiple robots are controlled with one controller, select the appropriate servo card of controller from Table D (a) to (c).

Table D (a) Servo card when multiple robots are controlled (R-30*i*A)

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

Table D (b) Servo card when multiple robots are controlled (R-30*i*B)

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

Table D (c) Servo card when multiple robots are controlled (R-30*i*B Plus)

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

(NOTE 1) One robot is needed to assign in 8 axes of servo card in case of Model to which high–sensitivity collision detection is supported as default like ARC Mate *i*C series etc. Therefore, A05B-2500-H040 (8 axes) cannot be used in case of two robots. Similarly, A05B-2500-H044 (24 axes) cannot be used in case of four robots.

(NOTE 2) It can be used only when auxiliary axes are not specified.

INDEX

<A>

ABOUT MULTIPLE ROBOT CONTROL 140
AIR PIPING (OPTION).....51
AIR SUPPLY (OPTION).....50
Angle of Mounting Surface Setting.....7
AXIS LIMIT SETUP 59

<B>

BASIC SPECIFICATIONS 11

<C>

CHANGE AXIS LIMIT BY DCS (OPTION).....60
CHANGE THE COLLISION DETECTION PARAMETER.....128
CHANGING METHOD OF WRIST PAYLOAD SPECIFICATION FOR ARC Mate120*i*C/20T, M-20*i*A/20T.....36
Check of Fixed Mechanical Stopper and Adjustable Mechanical Stopper.....72,94
CHECK POINTS 67,91
Check the Failure of the Wrist Part Fluoric Resin Ring.69
Check the Mechanical Unit Cables and Connectors .70,92
Check the Oil Sight Glasses.....68
CHECKS AND MAINTENANCE 63,88
CHECKS AND MAINTENANCE (ARC Mate 120*i*C/20T M-20*i*A/20T).....63
CHECKS AND MAINTENANCE (M-20*i*A/20MT/35MT) 88
Confirmation of Oil Seepage.....67,91
Confirmation of the Air Control Set (option).....68,92
CONNECTION WITH THE CONTROLLER.....10

<D>

Daily Checks.....63,88

<E>

Enable and Adjustment of Collision Detection of J1-Axis 47
END EFFECTOR INSTALLATION TO WRIST 27
EQUIPMENT INSTALLATION TO THE ROBOT.....27
EQUIPMENT MOUNTING FACE.....31

<G>

Grease replacement procedure for J2/J3-axis reducer75,98
Grease replacement procedure for J4/J5-axis gearbox .100
Greasing (1-year (3840 hours) checks) 96

<I>

INSTALLATION.....4
INSTALLATION CONDITIONS.....9
INSULATION ABOUT ARC WELDING ROBOT 139
INSULATION AT THE WRIST 139
INTERFACE FOR OPTION CABLE (OPTION).....52

<L>

LOAD SETTING.....34

<M>

M/H CONDUIT (ARC Mate 120*i*C/20T, M-20*i*A/20T OPTION).....129
MAINTENANCE 73,95
MAINTENANCE AREA.....9
MASTERING 104
MASTERING DATA ENTRY 118
MECHANICAL UNIT EXTERNAL DIMENSIONS AND OPERATING SPACE 15
Method of Executing KAREL Program by Using “Call Program” 37
Method of Executing KAREL Program Directly.....40
MOTION RANGE SETTING FOR INTEGRATED HAND CABLE 22

<N>

NOTES FOR ASSEMBLING CABLE TO M/H CONDUIT.....129

<O>

Oil replacement procedure for J4-axis gearbox.....78
Oil replacement procedure for J5/J6-axis gearbox.....81
OTHER NOTES 130
OVERVIEW 104

<P>

Periodic Checks and Maintenance 64,89
PERIODIC MAINTENANCE TABLE 133
PIPING AND WIRING TO THE END EFFECTOR.....49
PREFACE..... p-1
Procedure for releasing remaining pressure from oil bath (J4 to J6-axis) 87
Procedure for releasing remaining pressure from the grease bath (J2/J3-axis) 77,102
Procedure for releasing remaining pressure from the grease bath (J4 to J6-axis) 103

<Q>

QUICK MASTERING.....111
QUICK MASTERING FOR SINGLE AXIS.....113

<R>

Replacing the Batteries (1-year (3840 hours) checks)73,95
Replacing the Grease and Oil of the Drive Mechanism (3-year (11520 hours) checks).....74
Replacing the Grease of the Drive Mechanism (3-year (11520 hours) checks) 97
RESETTING ALARMS AND PREPARING FOR MASTERING.....106
ROBOT CONFIGURATION.....11

<S>

SAFETY PRECAUTIONS s-1
SETUP OF J1-AXIS 42
SINGLE AXIS MASTERING 115
STORAGE 87,103
STRENGTH OF BOLT AND BOLT TORQUE LIST 138

<T>

TRANSPORTATION 1
TRANSPORTATION AND INSTALLATION 1
TROUBLESHOOTING 121

<V>

VERIFYING MASTERING 120

<W>

WRIST LOAD CONDITIONS 23

<Z>

ZERO POINT POSITION AND MOTION LIMIT 17
ZERO POSITION MASTERING 107

REVISION RECORD

Edition	Date	Contents
08	Sep.,2017	• Addition of R-30*i*B Plus Controller • Addition of new specification (A05B-1225-B271,B272,B281,B282) for ARC Mate 120*i*C/20T, M-20*i*A/20T • Correction of errors
07	Sep.,2016	• Addition of new specification (A05B-1225-) for ARC Mate 120*i*C/20T, M-20*i*A/20T/20MT • Correction of errors
06	Apr.,2015	• Addition of M-20*i*A/20MT/35MT • Addition of QUICK MASTER for single axis • Correction of errors
05	Aug.,2012	• Addition of R-30*i*B Controller • Addition of mechanical unit cable • Correction of errors
04	Nov.,2011	• Change of oiling method of J4, J5/J6-axis gearbox • Addition of oil seepage • Addition of external dimension of ISO flange adapter • Addition of note about M/H conduit • Correction of errors
03	Oct., 2010	• Addition of stop type of robot • Addition of stopping time and distance when controlled stop is executed • Addition note about end effector (hand) cable • Correction of errors
02	Nov., 2009	• Addition of multiple robot control • Addition of check of the mechanical stopper • Correction of errors
01	May, 2009	

B-83034EN/08

* B - 8 3 0 3 4 E N / 0 8 *