FANUC Robot M-710*i*C /50/70/50H/50S/45M/50E

MECHANICAL UNIT

OPERATOR'S MANUAL

MARAC710C02061E REV. L

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FANUC conducts courses on its systems and products on a regularly scheduled basis at the company's world headquarters in Rochester Hills, Michigan. For additional information contact

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For customer assistance, including Technical Support, Service, Parts & Part Repair, and Marketing Requests, contact the Customer Resource Center, 24 hours a day, at 1-800-47-ROBOT (1-800-477-6268). International customers should call 011-1-248-377-7159.

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Patents

One or more of the following U.S. patents might be related to the FANUC products described in this manual.

FANUC America Corporation Patent List

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Conventions

WARNING

Information appearing under the "WARNING" caption concerns the protection of personnel. It is boxed and bolded to set it apart from the surrounding text.

CAUTION

Information appearing under the "CAUTION" caption concerns the protection of equipment, software, and data. It is boxed and bolded to set it apart from the surrounding text.

Note Information appearing next to NOTE concerns related information or useful hints.

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.

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

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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

FANUC America Corporation is not and does not represent itself as an expert in safety systems, safety equipment, or the specific safety aspects of your company and/or its work force. It is the responsibility of the owner, employer, or user to take all necessary steps to guarantee the safety of all personnel in the workplace.

The appropriate level of safety for your application and installation can be best determined by safety system professionals. FANUC America Corporation therefore, recommends that each customer consult with such professionals in order to provide a workplace that allows for the safe application, use, and operation of FANUC America Corporation systems.

According to the industry standard ANSI/RIA R15-06, the owner or user is advised to consult the standards to ensure compliance with its requests for Robotics System design, usability, operation, maintenance, and service. Additionally, as the owner, employer, or user of a robotic system, it is your responsibility to arrange for the training of the operator of a robot system to recognize and respond to known hazards associated with your robotic system and to be aware of the recommended operating procedures for your particular application and robot installation.

Ensure that the robot being used is appropriate for the application. Robots used in classified (hazardous) locations must be certified for this use.

FANUC America Corporation therefore, recommends that all personnel who intend to operate, program, repair, or otherwise use the robotics system be trained in an approved FANUC America Corporation training course and become familiar with the proper operation of the system. Persons responsible for programming the system–including the design, implementation, and debugging of application programs–must be familiar with the recommended programming procedures for your application and robot installation.

The following guidelines are provided to emphasize the importance of safety in the workplace.

CONSIDERING SAFETY FOR YOUR ROBOT INSTALLATION

Safety is essential whenever robots are used. Keep in mind the following factors with regard to safety:

- The safety of people and equipment
- Use of safety enhancing devices
- Techniques for safe teaching and manual operation of the robot(s)
- Techniques for safe automatic operation of the robot(s)
- Regular scheduled inspection of the robot and workcell
- Proper maintenance of the robot

Keeping People Safe

The safety of people is always of primary importance in any situation. When applying safety measures to your robotic system, consider the following:

- External devices
- Robot(s)
- Tooling
- Workpiece

Using Safety Enhancing Devices

Always give appropriate attention to the work area that surrounds the robot. The safety of the work area can be enhanced by the installation of some or all of the following devices:

- Safety fences, barriers, or chains
- Light curtains
- Interlocks
- Pressure mats
- Floor markings
- Warning lights
- Mechanical stops
- EMERGENCY STOP buttons
- DEADMAN switches

Setting Up a Safe Workcell

A safe workcell is essential to protect people and equipment. Observe the following guidelines to ensure that the workcell is set up safely. These suggestions are intended to supplement and not replace existing federal, state, and local laws, regulations, and guidelines that pertain to safety.

- Sponsor your personnel for training in approved FANUC America Corporation training course(s) related to your application. Never permit untrained personnel to operate the robots.
- Install a lockout device that uses an access code to prevent unauthorized persons from operating the robot.
- Use anti–tie–down logic to prevent the operator from bypassing safety measures.
- Arrange the workcell so the operator faces the workcell and can see what is going on inside the cell.
- Clearly identify the work envelope of each robot in the system with floor markings, signs, and special barriers. The work envelope is the area defined by the maximum motion range of the robot, including any tooling attached to the wrist flange that extend this range.

- Position all controllers outside the robot work envelope.
- Never rely on software or firmware based controllers as the primary safety element unless they comply with applicable current robot safety standards.
- Mount an adequate number of EMERGENCY STOP buttons or switches within easy reach of the operator and at critical points inside and around the outside of the workcell.
- Install flashing lights and/or audible warning devices that activate whenever the robot is operating, that is, whenever power is applied to the servo drive system. Audible warning devices shall exceed the ambient noise level at the end–use application.
- Wherever possible, install safety fences to protect against unauthorized entry by personnel into the work envelope.
- Install special guarding that prevents the operator from reaching into restricted areas of the work envelope.
- Use interlocks.
- Use presence or proximity sensing devices such as light curtains, mats, and capacitance and vision systems to enhance safety.
- Periodically check the safety joints or safety clutches that can be optionally installed between the robot wrist flange and tooling. If the tooling strikes an object, these devices dislodge, remove power from the system, and help to minimize damage to the tooling and robot.
- Make sure all external devices are properly filtered, grounded, shielded, and suppressed to prevent hazardous motion due to the effects of electro–magnetic interference (EMI), radio frequency interference (RFI), and electro–static discharge (ESD).
- Make provisions for power lockout/tagout at the controller.
- Eliminate *pinch points*. Pinch points are areas where personnel could get trapped between a moving robot and other equipment.
- Provide enough room inside the workcell to permit personnel to teach the robot and perform maintenance safely.
- Program the robot to load and unload material safely.
- If high voltage electrostatics are present, be sure to provide appropriate interlocks, warning, and beacons.
- If materials are being applied at dangerously high pressure, provide electrical interlocks for lockout of material flow and pressure.

Staying Safe While Teaching or Manually Operating the Robot

Advise all personnel who must teach the robot or otherwise manually operate the robot to observe the following rules:

- Never wear watches, rings, neckties, scarves, or loose clothing that could get caught in moving machinery.
- Know whether or not you are using an intrinsically safe teach pendant if you are working in a hazardous environment.

- Before teaching, visually inspect the robot and work envelope to make sure that no potentially hazardous conditions exist. The work envelope is the area defined by the maximum motion range of the robot. These include tooling attached to the wrist flange that extends this range.
- The area near the robot must be clean and free of oil, water, or debris. Immediately report unsafe working conditions to the supervisor or safety department.
- FANUC America Corporation recommends that no one enter the work envelope of a robot that is on, except for robot teaching operations. However, if you must enter the work envelope, be sure all safeguards are in place, check the teach pendant DEADMAN switch for proper operation, and place the robot in teach mode. Take the teach pendant with you, turn it on, and be prepared to release the DEADMAN switch. Only the person with the teach pendant should be in the work envelope.

WARNING

Never bypass, strap, or otherwise deactivate a safety device, such as a limit switch, for any operational convenience. Deactivating a safety device is known to have resulted in serious injury and death.

- Know the path that can be used to escape from a moving robot; make sure the escape path is never blocked.
- Isolate the robot from all remote control signals that can cause motion while data is being taught.
- Test any program being run for the first time in the following manner:

WARNING

Stay outside the robot work envelope whenever a program is being run. Failure to do so can result in injury.

  - Using a low motion speed, single step the program for at least one full cycle.
  - Using a low motion speed, test run the program continuously for at least one full cycle.
  - Using the programmed speed, test run the program continuously for at least one full cycle.
- Make sure all personnel are outside the work envelope before running production.

Staying Safe During Automatic Operation

Advise all personnel who operate the robot during production to observe the following rules:

- Make sure all safety provisions are present and active.

- Know the entire workcell area. The workcell includes the robot and its work envelope, plus the area occupied by all external devices and other equipment with which the robot interacts.
- Understand the complete task the robot is programmed to perform before initiating automatic operation.
- Make sure all personnel are outside the work envelope before operating the robot.
- Never enter or allow others to enter the work envelope during automatic operation of the robot.
- Know the location and status of all switches, sensors, and control signals that could cause the robot to move.
- Know where the EMERGENCY STOP buttons are located on both the robot control and external control devices. Be prepared to press these buttons in an emergency.
- Never assume that a program is complete if the robot is not moving. The robot could be waiting for an input signal that will permit it to continue its activity.
- If the robot is running in a pattern, do not assume it will continue to run in the same pattern.
- Never try to stop the robot, or break its motion, with your body. The only way to stop robot motion immediately is to press an EMERGENCY STOP button located on the controller panel, teach pendant, or emergency stop stations around the workcell.

Staying Safe During Inspection

When inspecting the robot, be sure to

- Turn off power at the controller.
- Lock out and tag out the power source at the controller according to the policies of your plant.
- Turn off the compressed air source and relieve the air pressure.
- If robot motion is not needed for inspecting the electrical circuits, press the EMERGENCY STOP button on the operator panel.
- Never wear watches, rings, neckties, scarves, or loose clothing that could get caught in moving machinery.
- If power is needed to check the robot motion or electrical circuits, be prepared to press the EMERGENCY STOP button, in an emergency.
- Be aware that when you remove a servomotor or brake, the associated robot arm will fall if it is not supported or resting on a hard stop. Support the arm on a solid support before you release the brake.

Staying Safe During Maintenance

When performing maintenance on your robot system, observe the following rules:

- Never enter the work envelope while the robot or a program is in operation.
- Before entering the work envelope, visually inspect the workcell to make sure no potentially hazardous conditions exist.

- Never wear watches, rings, neckties, scarves, or loose clothing that could get caught in moving machinery.
- Consider all or any overlapping work envelopes of adjoining robots when standing in a work envelope.
- Test the teach pendant for proper operation before entering the work envelope.
- If it is necessary for you to enter the robot work envelope while power is turned on, you must be sure that you are in control of the robot. Be sure to take the teach pendant with you, press the DEADMAN switch, and turn the teach pendant on. Be prepared to release the DEADMAN switch to turn off servo power to the robot immediately.
- Whenever possible, perform maintenance with the power turned off. Before you open the controller front panel or enter the work envelope, turn off and lock out the 3–phase power source at the controller.
- Be aware that when you remove a servomotor or brake, the associated robot arm will fall if it is not supported or resting on a hard stop. Support the arm on a solid support before you release the brake.

⚠WARNING

Lethal voltage is present in the controller WHENEVER IT IS CONNECTED to a power source. Be extremely careful to avoid electrical shock. HIGH VOLTAGE IS PRESENT at the input side whenever the controller is connected to a power source. Turning the disconnect or circuit breaker to the OFF position removes power from the output side of the device only.

- Release or block all stored energy. Before working on the pneumatic system, shut off the system air supply and purge the air lines.
- Isolate the robot from all remote control signals. If maintenance must be done when the power is on, make sure the person inside the work envelope has sole control of the robot. The teach pendant must be held by this person.
- Make sure personnel cannot get trapped between the moving robot and other equipment. Know the path that can be used to escape from a moving robot. Make sure the escape route is never blocked.
- Use blocks, mechanical stops, and pins to prevent hazardous movement by the robot. Make sure that such devices do not create pinch points that could trap personnel.

⚠WARNING

Do not try to remove any mechanical component from the robot before thoroughly reading and understanding the procedures in the appropriate manual. Doing so can result in serious personal injury and component destruction.

- Be aware that when you remove a servomotor or brake, the associated robot arm will fall if it is not supported or resting on a hard stop. Support the arm on a solid support before you release the brake.
- When replacing or installing components, make sure dirt and debris do not enter the system.
- Use only specified parts for replacement. To avoid fires and damage to parts in the controller, never use nonspecified fuses.
- Before restarting a robot, make sure no one is inside the work envelope; be sure that the robot and all external devices are operating normally.

KEEPING MACHINE TOOLS AND EXTERNAL DEVICES SAFE

Certain programming and mechanical measures are useful in keeping the machine tools and other external devices safe. Some of these measures are outlined below. Make sure you know all associated measures for safe use of such devices.

Programming Safety Precautions

Implement the following programming safety measures to prevent damage to machine tools and other external devices.

- Back–check limit switches in the workcell to make sure they do not fail.
- Implement ‘‘failure routines” in programs that will provide appropriate robot actions if an external device or another robot in the workcell fails.
- Use *handshaking* protocol to synchronize robot and external device operations.
- Program the robot to check the condition of all external devices during an operating cycle.

Mechanical Safety Precautions

Implement the following mechanical safety measures to prevent damage to machine tools and other external devices.

- Make sure the workcell is clean and free of oil, water, and debris.
- Use DCS (Dual Check Safety), software limits, limit switches, and mechanical hardstops to prevent undesired movement of the robot into the work area of machine tools and external devices.

KEEPING THE ROBOT SAFE

Observe the following operating and programming guidelines to prevent damage to the robot.

Operating Safety Precautions

The following measures are designed to prevent damage to the robot during operation.

- Use a low override speed to increase your control over the robot when jogging the robot.
- Visualize the movement the robot will make before you press the jog keys on the teach pendant.
- Make sure the work envelope is clean and free of oil, water, or debris.
- Use circuit breakers to guard against electrical overload.

Programming Safety Precautions

The following safety measures are designed to prevent damage to the robot during programming:

- Establish *interference zones* to prevent collisions when two or more robots share a work area.
- Make sure that the program ends with the robot near or at the home position.
- Be aware of signals or other operations that could trigger operation of tooling resulting in personal injury or equipment damage.
- In dispensing applications, be aware of all safety guidelines with respect to the dispensing materials.

NOTE: Any deviation from the methods and safety practices described in this manual must conform to the approved standards of your company. If you have questions, see your supervisor.

ADDITIONAL SAFETY CONSIDERATIONS FOR PAINT ROBOT INSTALLATIONS

Process technicians are sometimes required to enter the paint booth, for example, during daily or routine calibration or while teaching new paths to a robot. Maintenance personnel also must work inside the paint booth periodically.

Whenever personnel are working inside the paint booth, ventilation equipment must be used. Instruction on the proper use of ventilating equipment usually is provided by the paint shop supervisor.

Although paint booth hazards have been minimized, potential dangers still exist. Therefore, today's highly automated paint booth requires that process and maintenance personnel have full awareness of the system and its capabilities. They must understand the interaction that occurs between the vehicle moving along the conveyor and the robot(s), hood/deck and door opening devices, and high–voltage electrostatic tools.

CAUTION

Ensure that all ground cables remain connected. Never operate the paint robot with ground provisions disconnected. Otherwise, you could injure personnel or damage equipment.

Paint robots are operated in three modes:

- Teach or manual mode
- Automatic mode, including automatic and exercise operation
- Diagnostic mode

During both teach and automatic modes, the robots in the paint booth will follow a predetermined pattern of movements. In teach mode, the process technician teaches (programs) paint paths using the teach pendant.

In automatic mode, robot operation is initiated at the System Operator Console (SOC) or Manual Control Panel (MCP), if available, and can be monitored from outside the paint booth. All personnel must remain outside of the booth or in a designated safe area within the booth whenever automatic mode is initiated at the SOC or MCP.

In automatic mode, the robots will execute the path movements they were taught during teach mode, but generally at production speeds.

When process and maintenance personnel run diagnostic routines that require them to remain in the paint booth, they must stay in a designated safe area.

Paint System Safety Features

Process technicians and maintenance personnel must become totally familiar with the equipment and its capabilities. To minimize the risk of injury when working near robots and related equipment, personnel must comply strictly with the procedures in the manuals.

This section provides information about the safety features that are included in the paint system and also explains the way the robot interacts with other equipment in the system.

The paint system includes the following safety features:

- Most paint booths have red warning beacons that illuminate when the robots are armed and ready to paint. Your booth might have other kinds of indicators. Learn what these are.

- Some paint booths have a blue beacon that, when illuminated, indicates that the electrostatic devices are enabled. Your booth might have other kinds of indicators. Learn what these are.
- EMERGENCY STOP buttons are located on the robot controller and teach pendant. Become familiar with the locations of all E–STOP buttons.
- An intrinsically safe teach pendant is used when teaching in hazardous paint atmospheres.
- A DEADMAN switch is located on each teach pendant. When this switch is held in, and the teach pendant is on, power is applied to the robot servo system. If the engaged DEADMAN switch is released or pressed harder during robot operation, power is removed from the servo system, all axis brakes are applied, and the robot comes to an EMERGENCY STOP. Safety interlocks within the system might also E–STOP other robots.

WARNING

An EMERGENCY STOP will occur if the DEADMAN switch is released on a bypassed robot.

- Overtravel by robot axes is prevented by software limits. All of the major and minor axes are governed by software limits. DCS (Dual Check Safety), limit switches and hardstops also limit travel by the major axes.
- EMERGENCY STOP limit switches and photoelectric eyes might be part of your system. Limit switches, located on the entrance/exit doors of each booth, will EMERGENCY STOP all equipment in the booth if a door is opened while the system is operating in automatic or manual mode. For some systems, signals to these switches are inactive when the switch on the SOC is in teach mode.
- When present, photoelectric eyes are sometimes used to monitor unauthorized intrusion through the entrance/exit silhouette openings.
- System status is monitored by computer. Severe conditions result in automatic system shutdown.

Staying Safe While Operating the Paint Robot

When you work in or near the paint booth, observe the following rules, in addition to all rules for safe operation that apply to all robot systems.

WARNING

Observe all safety rules and guidelines to avoid injury.

WARNING

Never bypass, strap, or otherwise deactivate a safety device, such as a limit switch, for any operational convenience. Deactivating a safety device is known to have resulted in serious injury and death.

WARNING

Enclosures shall not be opened unless the area is known to be nonhazardous or all power has been removed from devices within the enclosure. Power shall not be restored after the enclosure has been opened until all combustible dusts have been removed from the interior of the enclosure and the enclosure purged. Refer to the Purge chapter for the required purge time.

- Know the work area of the entire paint station (workcell).
- Know the work envelope of the robot and hood/deck and door opening devices.
- Be aware of overlapping work envelopes of adjacent robots.
- Know where all red, mushroom–shaped EMERGENCY STOP buttons are located.
- Know the location and status of all switches, sensors, and/or control signals that might cause the robot, conveyor, and opening devices to move.
- Make sure that the work area near the robot is clean and free of water, oil, and debris. Report unsafe conditions to your supervisor.
- Become familiar with the complete task the robot will perform BEFORE starting automatic mode.
- Make sure all personnel are outside the paint booth before you turn on power to the robot servo system.
- Never enter the work envelope or paint booth before you turn off power to the robot servo system.
- Never enter the work envelope during automatic operation unless a safe area has been designated.
- Never wear watches, rings, neckties, scarves, or loose clothing that could get caught in moving machinery.
- Remove all metallic objects, such as rings, watches, and belts, before entering a booth when the electrostatic devices are enabled.
- Stay out of areas where you might get trapped between a moving robot, conveyor, or opening device and another object.
- Be aware of signals and/or operations that could result in the triggering of guns or bells.
- Be aware of all safety precautions when dispensing of paint is required.
- Follow the procedures described in this manual.

Special Precautions for Combustible Dusts (Powder Paint)

When the robot is used in a location where combustible dusts are found, such as the application of powder paint, the following special precautions are required to insure that there are no combustible dusts inside the robot.

- Purge maintenance air should be maintained at all times, even when the robot power is off. This will insure that dust can not enter the robot.
- A purge cycle will not remove accumulated dusts. Therefore, if the robot is exposed to dust when maintenance air is not present, it will be necessary to remove the covers and clean out any accumulated dust. Do not energize the robot until you have performed the following steps.

1. Before covers are removed, the exterior of the robot should be cleaned to remove accumulated dust.
2. When cleaning and removing accumulated dust, either on the outside or inside of the robot, be sure to use methods appropriate for the type of dust that exists. Usually lint free rags dampened with water are acceptable. Do not use a vacuum cleaner to remove dust as it can generate static electricity and cause an explosion unless special precautions are taken.
3. Thoroughly clean the interior of the robot with a lint free rag to remove any accumulated dust.
4. When the dust has been removed, the covers must be replaced immediately.
5. Immediately after the covers are replaced, run a complete purge cycle. The robot can now be energized.

Staying Safe While Operating Paint Application Equipment

When you work with paint application equipment, observe the following rules, in addition to all rules for safe operation that apply to all robot systems.

⚠ WARNING

When working with electrostatic paint equipment, follow all national and local codes as well as all safety guidelines within your organization. Also reference the following standards: NFPA 33 Standards for Spray Application Using Flammable or Combustible Materials, and NFPA 70 National Electrical Code.

- **Grounding**: All electrically conductive objects in the spray area must be grounded. This includes the spray booth, robots, conveyors, workstations, part carriers, hooks, paint pressure pots, as well as solvent containers. Grounding is defined as the object or objects shall be electrically connected to ground with a resistance of not more than 1 megohms.
- **High Voltage**: High voltage should only be on during actual spray operations. Voltage should be off when the painting process is completed. Never leave high voltage on during a cap cleaning process.
- Avoid any accumulation of combustible vapors or coating matter.
- Follow all manufacturer recommended cleaning procedures.
- Make sure all interlocks are operational.

- No smoking.
- Post all warning signs regarding the electrostatic equipment and operation of electrostatic equipment according to NFPA 33 Standard for Spray Application Using Flammable or Combustible Material.
- Disable all air and paint pressure to bell.
- Verify that the lines are not under pressure.

Staying Safe During Maintenance

When you perform maintenance on the painter system, observe the following rules, and all other maintenance safety rules that apply to all robot installations. Only qualified, trained service or maintenance personnel should perform repair work on a robot.

- Paint robots operate in a potentially explosive environment. Use caution when working with electric tools.
- When a maintenance technician is repairing or adjusting a robot, the work area is under the control of that technician. All personnel not participating in the maintenance must stay out of the area.
- For some maintenance procedures, station a second person at the control panel within reach of the EMERGENCY STOP button. This person must understand the robot and associated potential hazards.
- Be sure all covers and inspection plates are in good repair and in place.
- Always return the robot to the ‘‘home’’ position before you disarm it.
- Never use machine power to aid in removing any component from the robot.
- During robot operations, be aware of the robot’s movements. Excess vibration, unusual sounds, and so forth, can alert you to potential problems.
- Whenever possible, turn off the main electrical disconnect before you clean the robot.
- When using vinyl resin observe the following:
  - Wear eye protection and protective gloves during application and removal.
  - Adequate ventilation is required. Overexposure could cause drowsiness or skin and eye irritation.
  - If there is contact with the skin, wash with water.
  - Follow the Original Equipment Manufacturer’s Material Safety Data Sheets.
- When using paint remover observe the following:
  - Eye protection, protective rubber gloves, boots, and apron are required during booth cleaning.
  - Adequate ventilation is required. Overexposure could cause drowsiness.
  - If there is contact with the skin or eyes, rinse with water for at least 15 minutes. Then seek medical attention as soon as possible.
  - Follow the Original Equipment Manufacturer’s Material Safety Data Sheets.

SAFETY PRECAUTIONS

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

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

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

1 DEFINITION OF USER

The user can be defined as follows.

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

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

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

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

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

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

2 DEFINITION OF SAFETY NOTATIONS

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

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

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

3 SAFETY OF THE USER

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

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

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

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

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

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

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

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

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

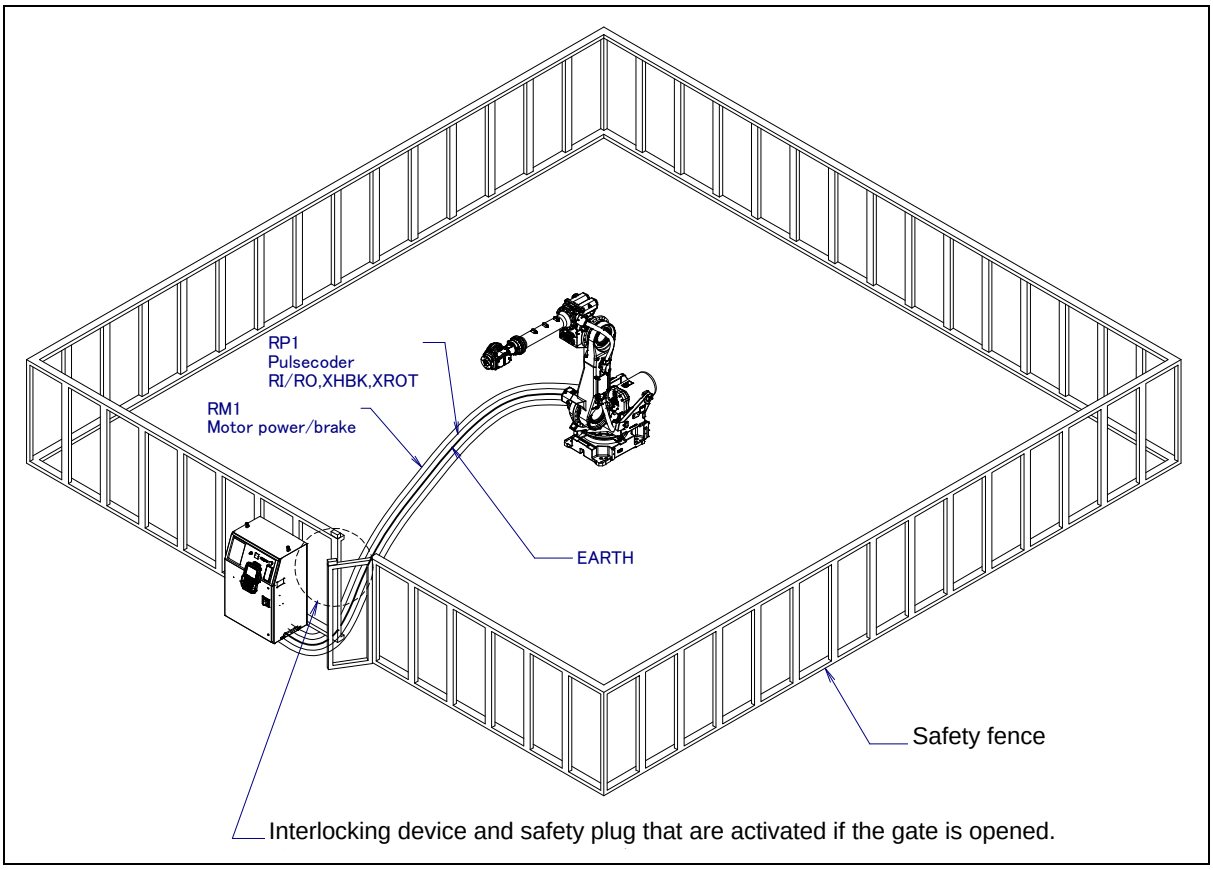


Fig. 3 (a) Safety fence and safety gate

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

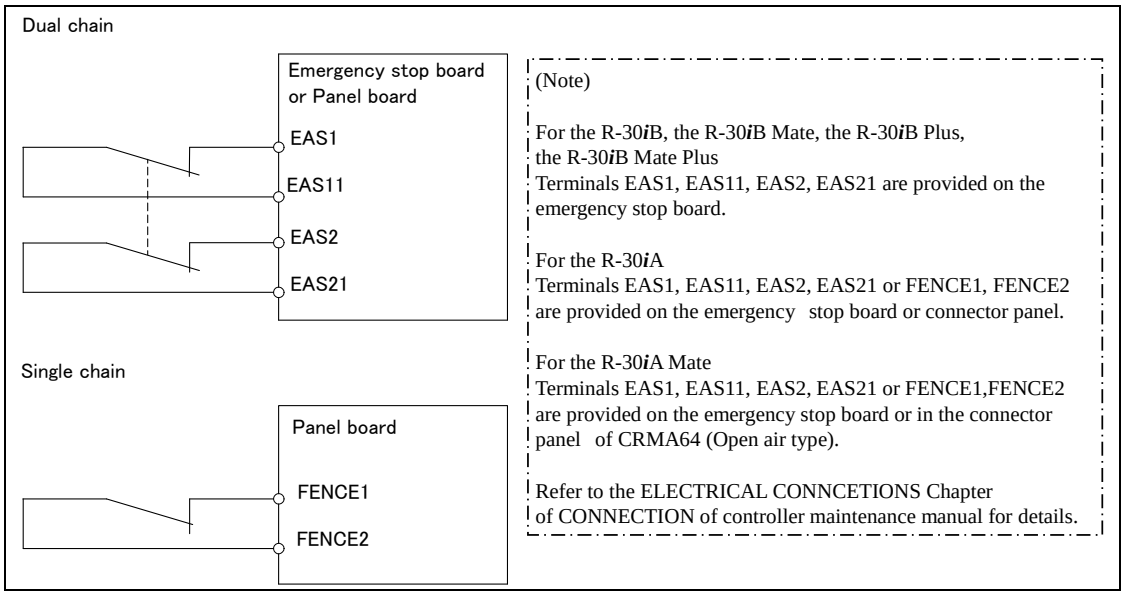


Fig. 3 (b) Connection diagram for the signal of safety fence

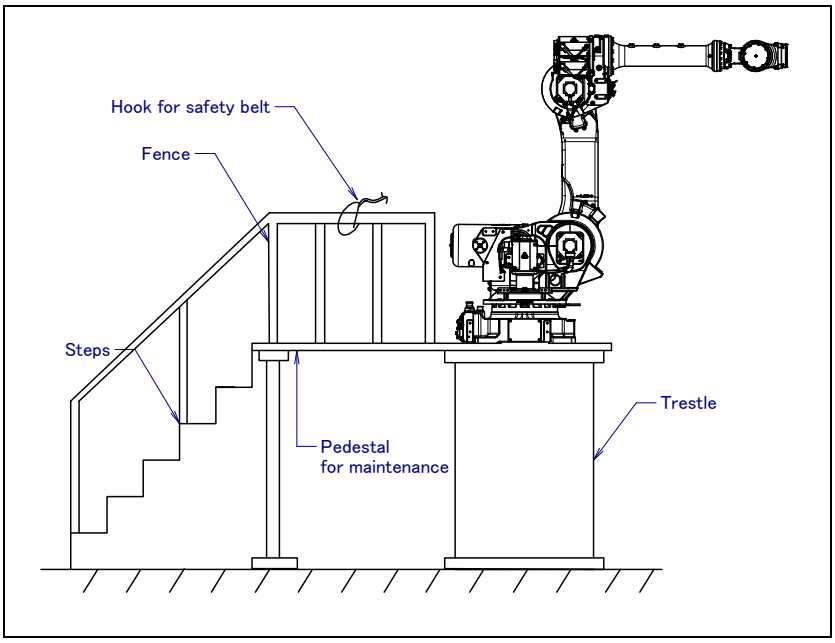


Fig. 3 (c) Pedestal for maintenance

3.1 SAFETY OF THE OPERATOR

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

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

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

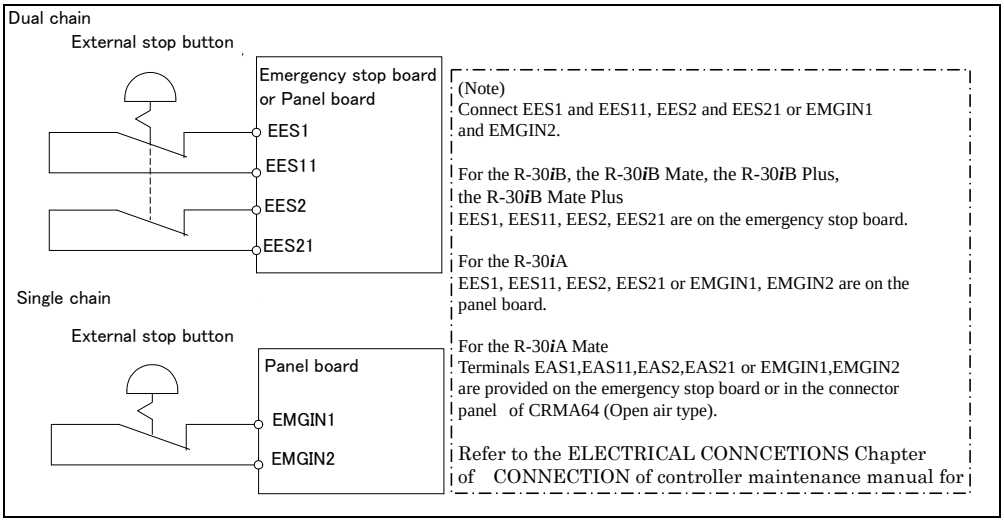


Fig. 3.1 Connection diagram for external emergency stop button

3.2 SAFETY OF THE PROGRAMMER

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

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

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

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

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

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

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

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

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

T1,T2 mode: DEADMAN switch is effective.

For the standard specification of R-30*i*A Mate Controller

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

(6) (Only when R-30*i*B Plus/R-30*i*B Mate Plus/R-30***i***B/R-30*i*B Mate /R-30*i*A Controller or CE or RIA specification of R-30*i*A Mate controller is selected.) To start the system using the operator panel, make certain that nobody is in the robot operating space and that there are no abnormal conditions in the robot operating space.

(7) When a program is completed, be sure to carry out the test operation according to the following procedure.
   (a) Run the program for at least one operation cycle in the single step mode at low speed.
   (b) Run the program for at least one operation cycle in the continuous operation mode at low speed.
   (c) Run the program for one operation cycle in the continuous operation mode at the intermediate speed and check that no abnormalities occur due to a delay in timing.
   (d) Run the program for one operation cycle in the continuous operation mode at the normal operating speed, and check that the system operates automatically without trouble.
   (e) After checking the completeness of the program through the test operation above, execute it in the automatic operation mode.

(8) While operating the system in the automatic operation mode, the teach pendant operator must leave the safety fence.

3.3 SAFETY OF THE MAINTENANCE ENGINEER

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

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

(19) Maintenance should be done under suitable light. Care must be taken that the light would not cause any danger.
(20) When a motor, reducer, or other heavy load is handled, a crane or other equipment should be used to protect maintenance workers from excessive load. Otherwise, the maintenance workers would be severely injured.
(21) The robot should not be stepped on or climbed up during maintenance. If it is attempted, the robot would be adversely affected. In addition, a misstep can cause injury to the worker.
(22) When performing maintenance work in high place, secure a footstep and wear safety belt.
(23) After the maintenance is completed, spilled oil or water and metal chips should be removed from the floor around the robot and within the safety fence.
(24) When a part is replaced, all bolts and other related components should put back into their original places. A careful check must be given to ensure that no components are missing or left not mounted.
(25) In case robot motion is required during maintenance, the following precautions should be taken :
- Foresee an escape route. And during the maintenance motion itself, monitor continuously the whole robot system so that your escape route will not become blocked by the robot, or by peripheral equipment.
- Always pay attention to potentially dangerous situations, and be prepared to press the emergency stop button whenever necessary.

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

4 SAFETY OF THE TOOLS AND PERIPHERAL EQUIPMENT

4.1 PRECAUTIONS IN PROGRAMMING

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

4.2 PRECAUTIONS FOR MECHANISM

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

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

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

5 SAFETY OF THE ROBOT MECHANICAL UNIT

5.1 PRECAUTIONS IN OPERATION

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

5.2 PRECAUTIONS IN PROGRAMMING

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

5.3 PRECAUTIONS FOR MECHANISMS

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

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

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

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

(*) These do not support CE marking.

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

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

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

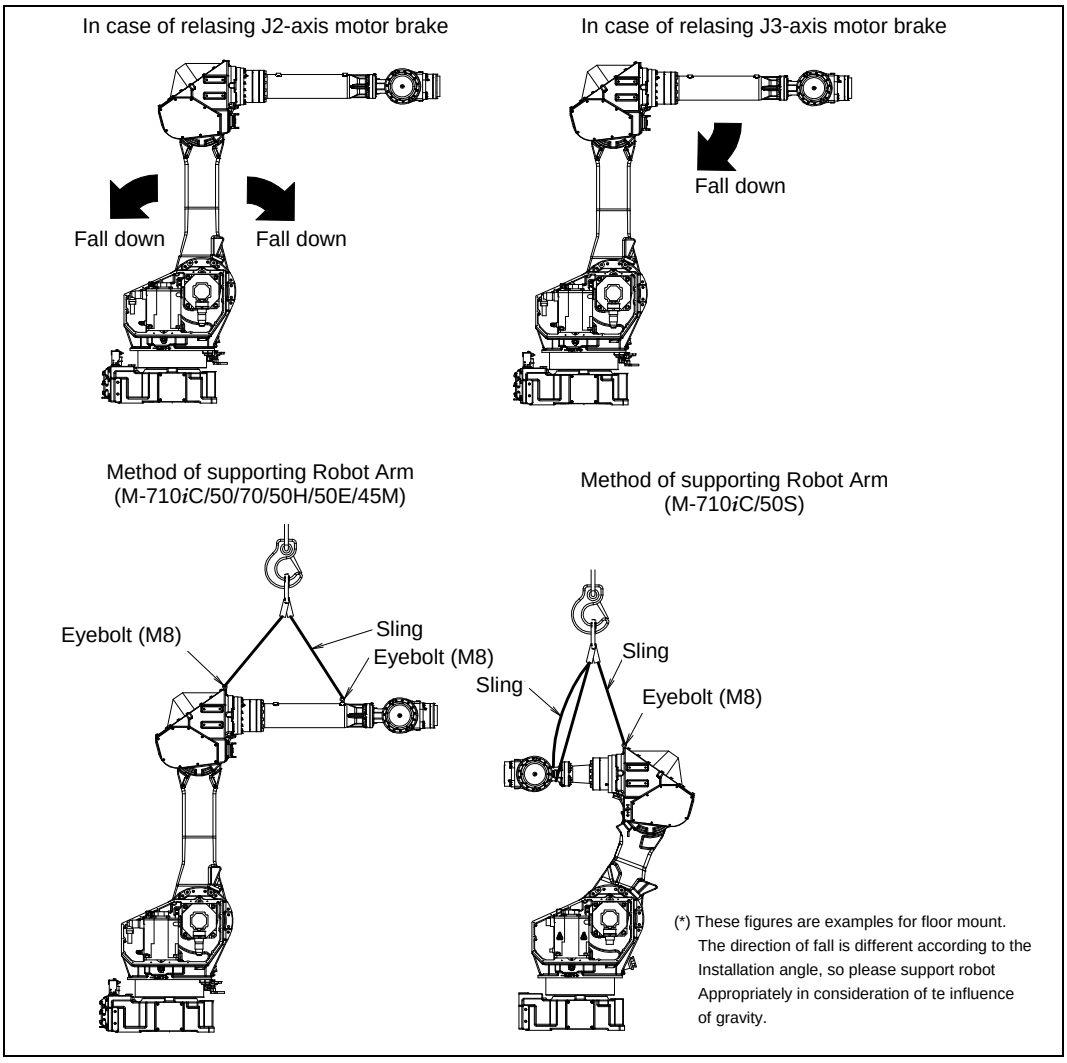


Fig. 5.4 Arm operation by the release of J2, J3-axis motor brake and measures

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 specified grease.

> ⚠ **CAUTION**
> See Chapter 7 CHECKS AND MAINTENANCE for explanations about specified grease, the 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) Step-on prohibitive label

Description

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

(4) Transportation label

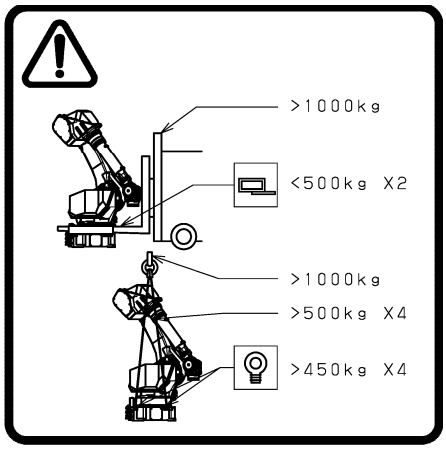


Fig. 10 (d) Step-on prohibitive label

Description

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

1) Using a forklift
- Use a forklift having a load capacity of 1000 kg or greater.
- Keep the total weight of the robot to be transported to within 1000 kg, because the load capacity of the forklift bracket (option) is 4900 N (500 kgf).

2) Using a crane
- Use a crane having a load capacity of 1000 kg or greater.
- Use at least four slings each having a load capacity of 4900 N (500 kgf) or greater.
- Use at least four eyebolts each having a load capacity of 4410 N (450 kgf) or greater.

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

(5) Operation space and payload label

Below label is added when CE specification is specified.

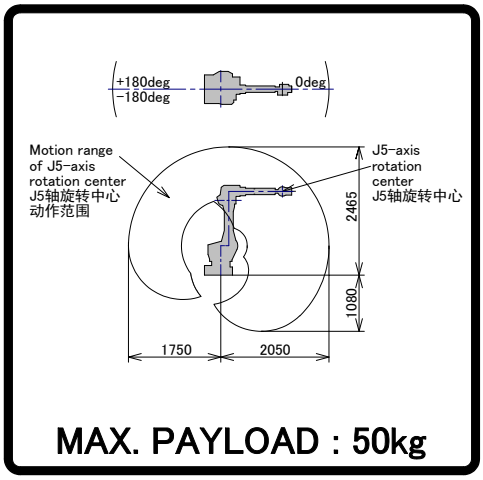


Fig. 10 (e) Operation space and payload label (Example of M-710*i*C/50/50E)

(6) Transportation caution label

(When transport equipment option is specified.)

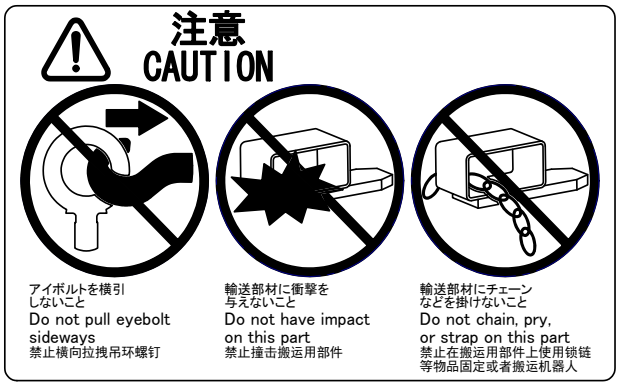


Fig. 10 (f) Transportation caution label

Description

Keep the following in mind when transporting the robot.

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

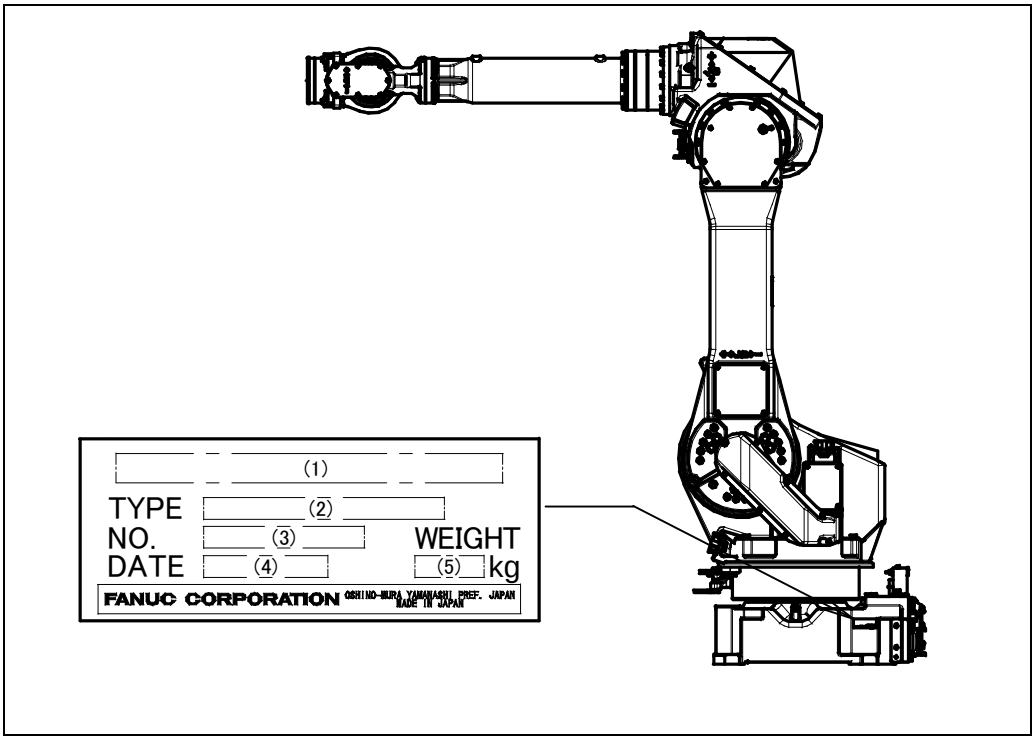
170511

PREFACE

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

Model name	Mechanical unit specification No.	Maximum load
FANUC Robot M-710*i*C/50	A05B-1125-B201	50kg
FANUC Robot M-710*i*C/70	A05B-1125-B202	70kg
FANUC Robot M-710*i*C/50H	A05B-1125-B204	50kg
FANUC Robot M-710*i*C/50S	A05B-1125-B207	50kg
FANUC Robot M-710*i*C/45M	A05B-1125-B208	45kg
FANUC Robot M-710*i*C/50E	A05B-1125-B251	50kg

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 M-710*i*C/50	A05B-1125-B201	SERIAL NO. IS PRINTED	PRODUCTION YEAR AND MONTH ARE PRINTED	560
	FANUC Robot M-710*i*C/70	A05B-1125-B202			560
	FANUC Robot M-710*i*C/50H	A05B-1125-B204			540
	FANUC Robot M-710*i*C/50S	A05B-1125-B207			545
	FANUC Robot M-710*i*C/45M	A05B-1125-B208			570
	FANUC Robot M-710*i*C/50E	A05B-1125-B251			560

RELATED MANUALS

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

Safety handbook B-80687EN All persons who use the FANUC Robot and system designer must read and understand thoroughly this handbook		Intended readers: Operator, system designer Topics: Safety items for robot system design, operation, maintenance
R-30*i*A controller	Setup and Operations manual SPOT TOOL+ **B-83124EN-1** HANDLING TOOL **B-83124EN-2** ARC TOOL **B-83124EN-3** DISPENSE TOOL **B-83124EN-4** ALARM CODE LIST **B-83124EN-6** SERVO GUN FUNCTION **B-82634EN**	Intended readers: Operator, programmer, maintenance engineer, system designer Topics: Robot functions, operations, programming, setup, interfaces, alarms Use: Robot operation, teaching, system design
	Maintenance manual **B-82595EN** **B-82595EN-1** (For Europe) **B-82595EN-2** (For RIA)	Intended readers: Maintenance engineer, system designer Topics: Installation, connection to peripheral equipment, maintenance Use: Installation, start-up, connection, maintenance
R-30*i*B, **R-30*i*B Mate,** **R-30*i*B Plus,** **R-30*i*B Mate Plus** controller	OPERATOR'S MANUAL (Basic Operation) **B-83284EN** OPERATOR'S MANUAL (Alarm Code List) **B-83284EN-1** Optional Function OPERATOR'S MANUAL **B-83284EN-2** Arc Welding Function OPERATOR'S MANUA **B-83284EN-3** Spot Welding Function OPERATOR'S MANUAL **B-83284EN-4** Dispense Function OPERATOR'S MANUAL **B-83284EN-5** Servo gun Function OPERATOR'S MANUAL **B-83264EN**	Intended readers : Operator, programmer, maintenance engineer, system designer Topics : Robot functions, operations, programming, setup, interfaces, alarms Use : Robot operation, teaching, system design
	MAINTENANCE MANUAL R-30*i*B, R-30*i*B Plus : **B-83195EN** R-30*i*B Mate, R-30*i*B Mate Plus : **B-83525EN**	Intended readers : Maintenance engineer, system designer Topics : Installation, connection to peripheral equipment, maintenance Use : Installation, start-up, connection, maintenance

This manual uses following terms.

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

TABLE OF CONTENTS

1 TRANSPORTATION AND INSTALLATION

1.1 TRANSPORTATION

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

⚠ WARNING

1 When hoisting or lowering the robot with a crane or forklift, move it slowly with great care. When placing the robot on the floor, exercise care to prevent the installation surface of the robot from striking the floor.
2 It is recommended to transport robot detaching the end effector and the incidental equipment from the robot because there is the following possibilities when transported with the end effector and the incidental equipment installed.
   - It becomes unstable by the change in the position of the center of the gravity of the robot while transporting it.
   - The end effector acts by the vibration when transported and an excessive load acts on far movement and the robot.
3 Please firmly fix the end effector referring to Subsection 1.1.1 when it is difficult to detach the end effector and transport it.
4 Use the forklift pockets only to transport the robot with a forklift. Do not use the forklift pockets for any other transportation method. Do not use the forklift pockets to secure the robot.
5 Before moving the robot by using transport equipment, check the bolts on the transport equipment and tighten any loose bolts if any.

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

⚠ CAUTION

When lifting the robot, be careful not to damage motors, connectors, or cables of the robot by slings.

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

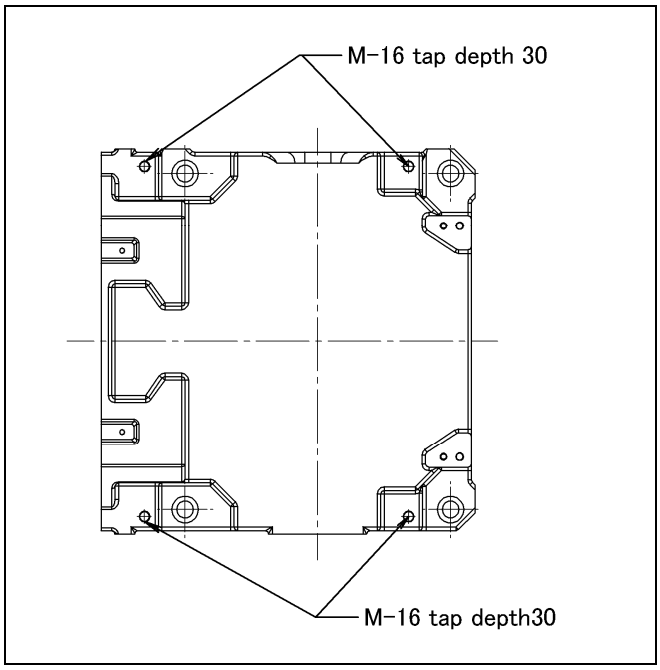


Fig. 1.1 (a) Position of the eyebolts and transportation equipment

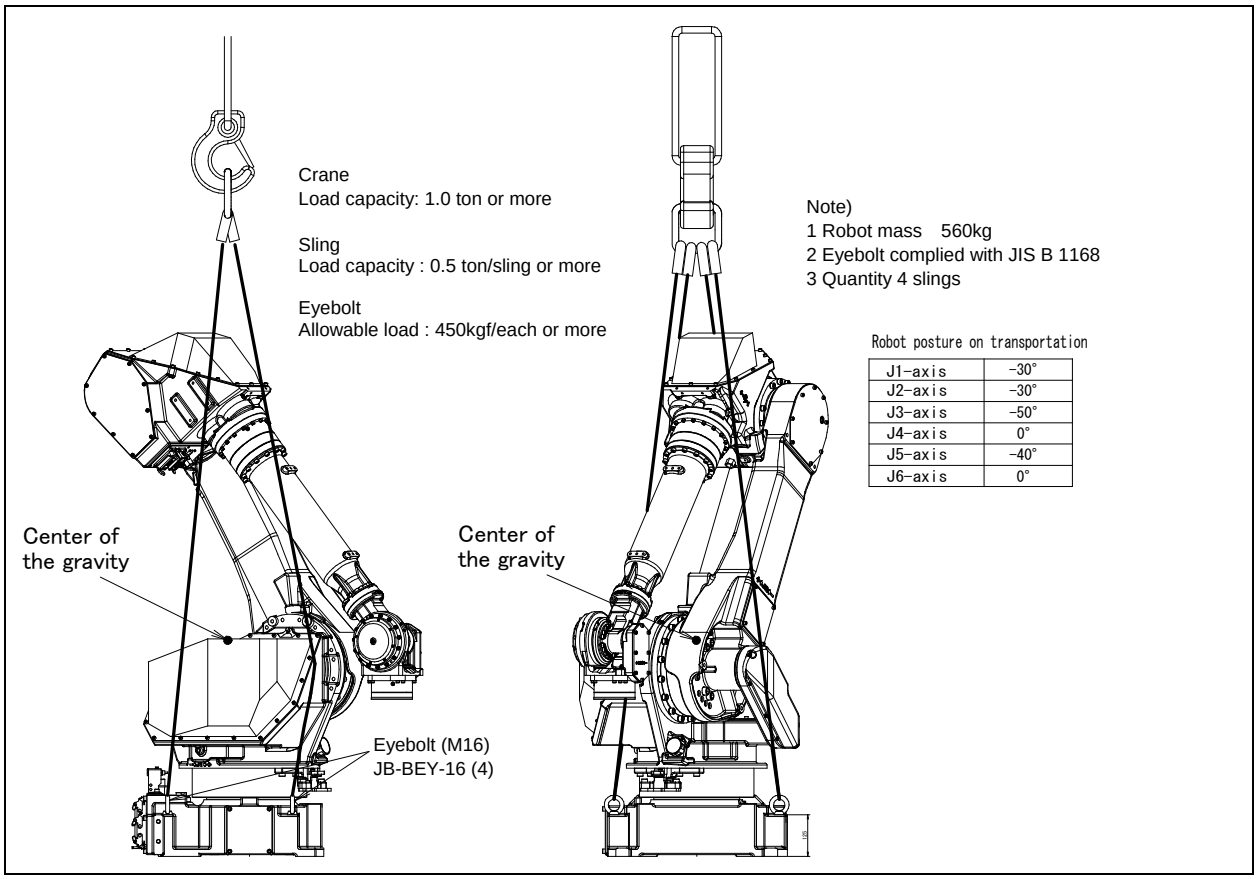


Fig. 1.1 (b) Transportation using a crane (M-710*i*C/50/70/45M/50E)

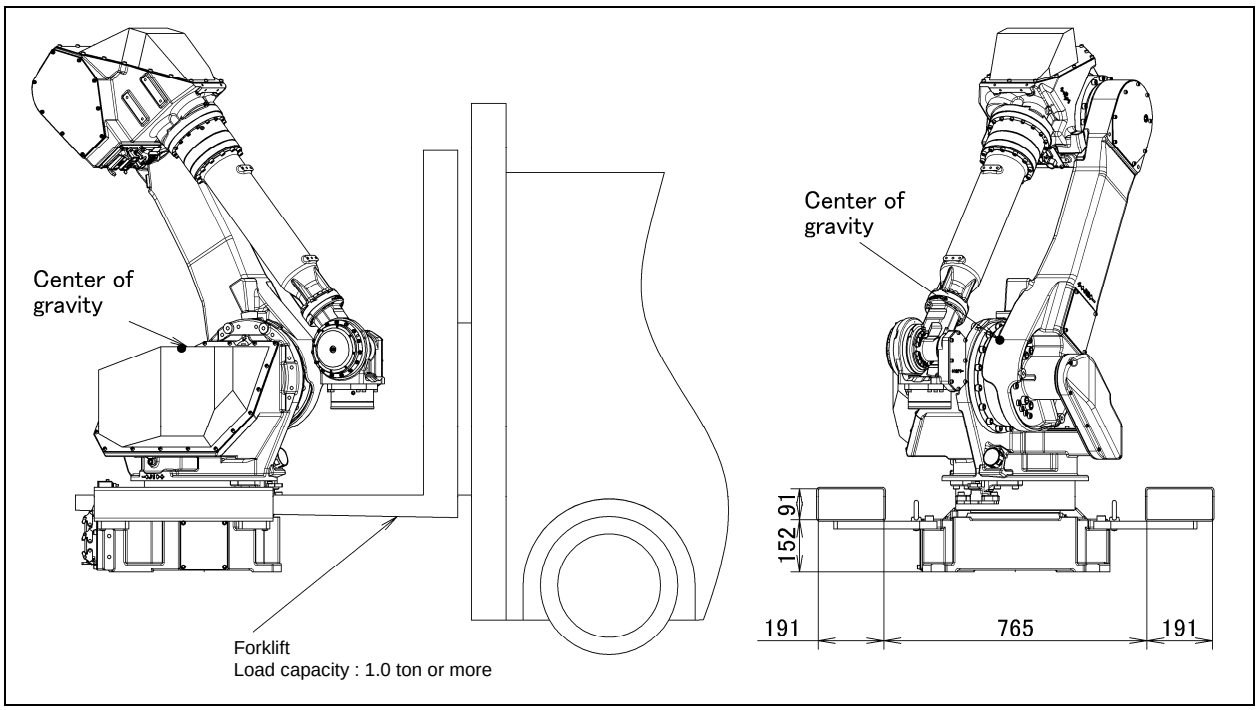


Fig. 1.1 (c) Transportation using a forklift (M-710*i*C/50/70/45M/50E)

> ⚠ **CAUTION**
> Be careful not to strike the transport equipment strongly with the forklift forks.

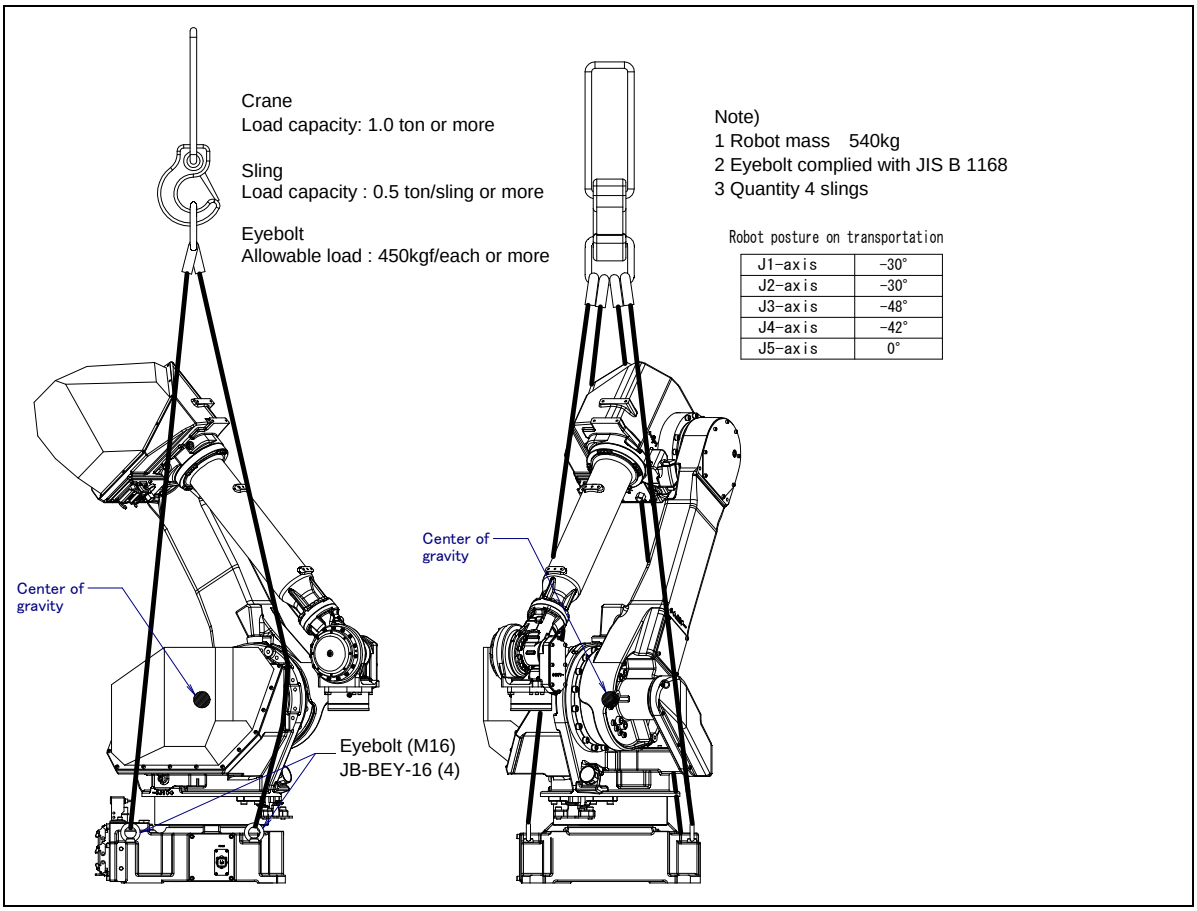


Fig. 1.1 (d) Transportation using a crane (M-710*i*C/50H)

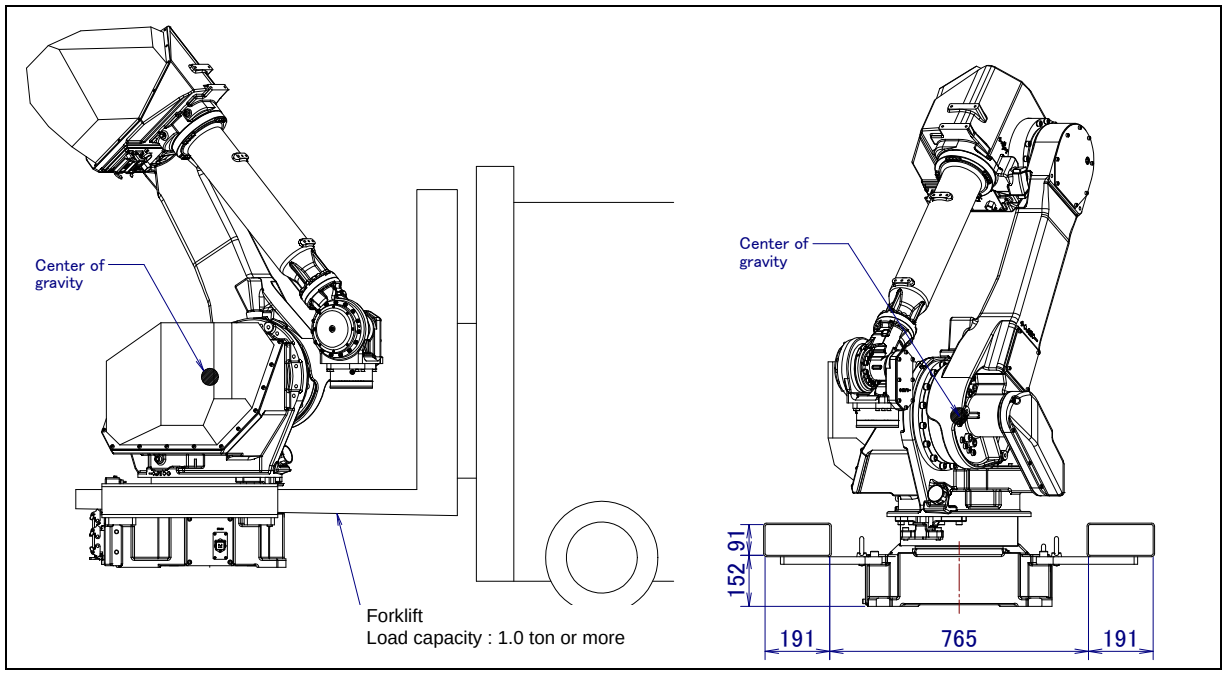


Fig. 1.1 (e) Transportation using a forklift (M-710*i*C/50H)

> ⚠ **CAUTION**
> Be careful not to strike the transport equipment with the forklift forks.

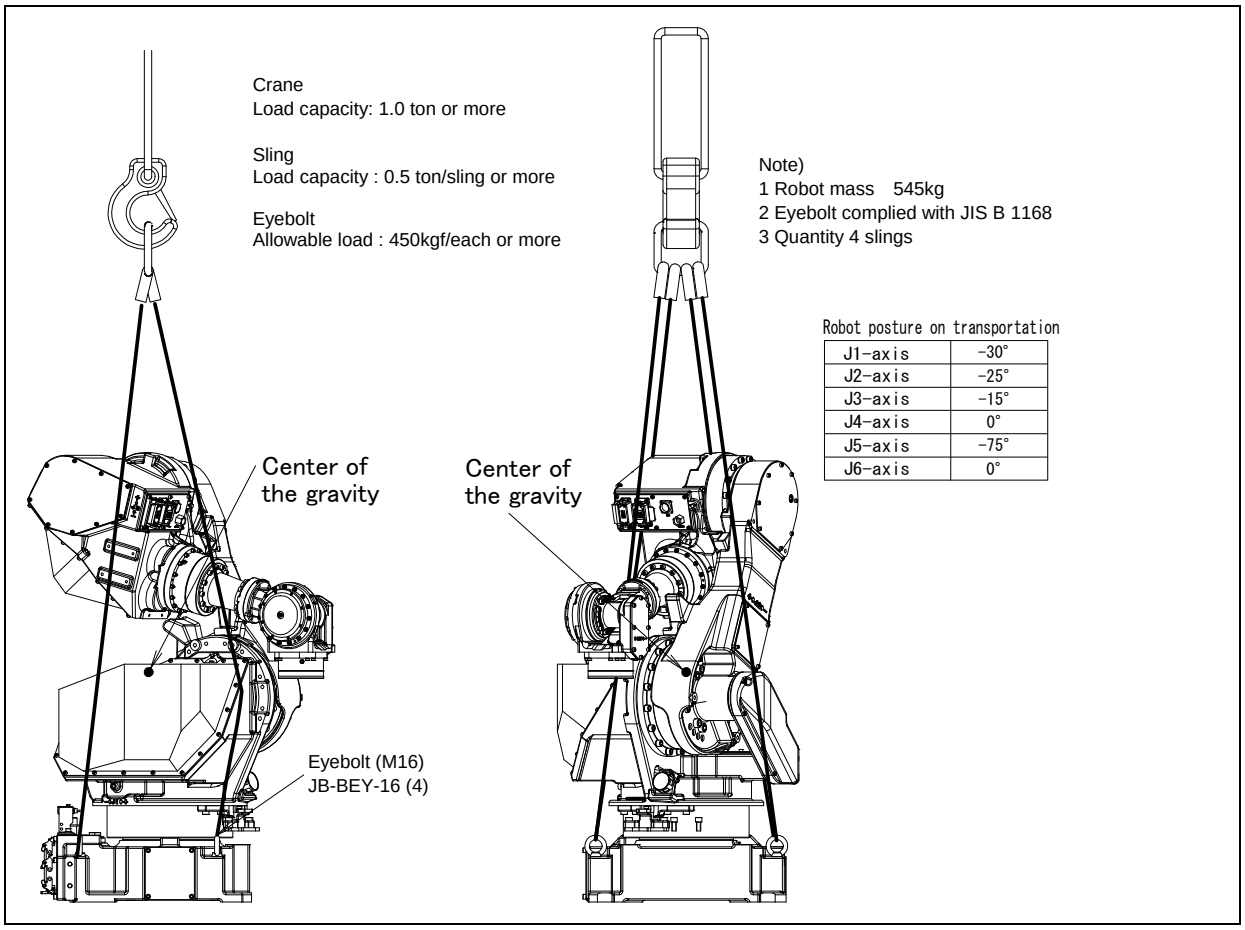


Fig. 1.1 (f) Transportation using a crane (M-710*i*C/50S)

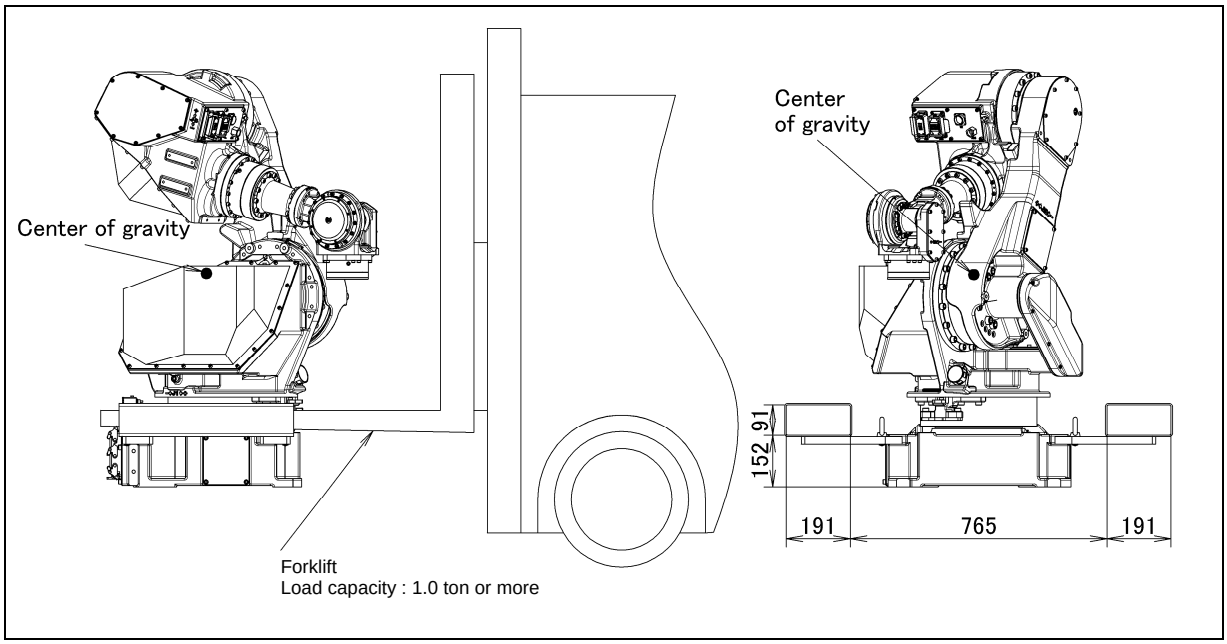


Fig. 1.1 (g) Transportation using a forklift (M-710*i*C/50S)

> ⚠ **CAUTION**
> Be careful not to strike the transport equipment with the forklift forks.

1.1.1 Transportation with an End Effector Attached

When transporting a robot with an end effector such as a welding gun or hand attached, secure the arm with wood. If the arm is not secured, the end effector may oscillate for a cause such as vibration during transportation, as a result, a large impact load, imposes on the reducer of the robot, cause premature failure of the reducer.

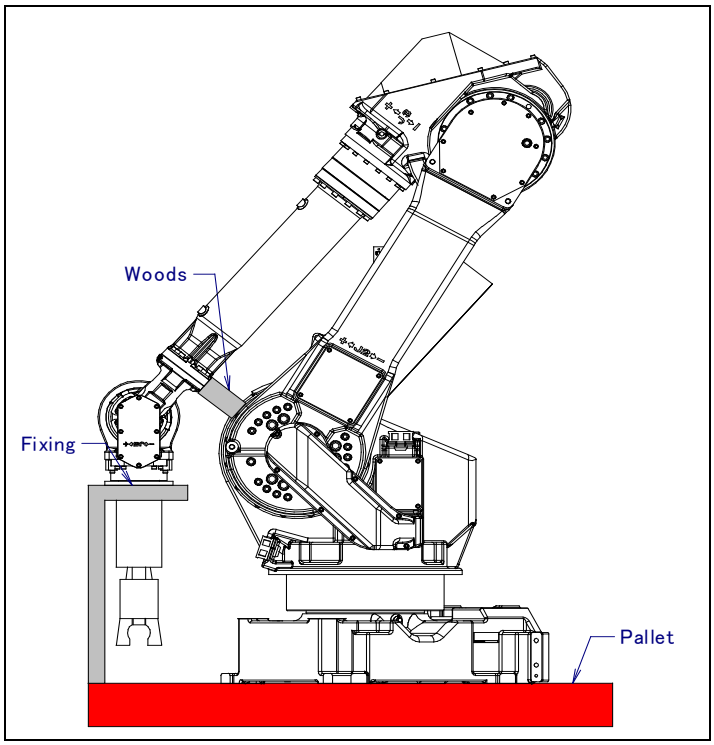


Fig. 1.1.1 Example of securing the arm during transportation when an end effector is attached

1.2 INSTALLATION

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

Following shows the actual example of robot installation.

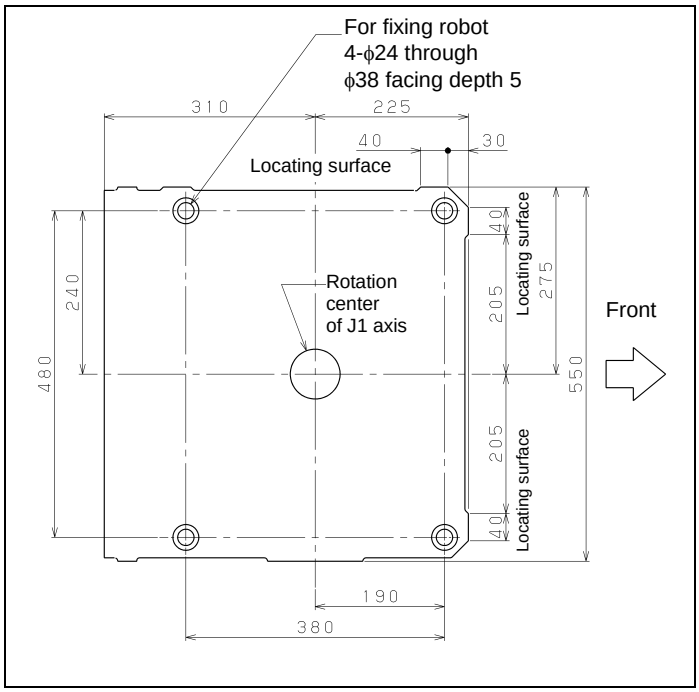


Fig. 1.2 Dimensions of the robot base

1.2.1 Actual Installation Example

Fig. 1.2.1 (a) shows the actual example of the robot installation.
The floor plate is imbedded in concrete and fastened with four M20 (Tensile strength 400N/mm^2 or more) chemical anchors. Also, fasten the base plate to the robot base using four M20 x 50 bolts (Tensile strength 1200N/mm^2 or more). Next, position the robot, and weld the base plate to the floor plate. (Floor length is 10 to 15mm.)

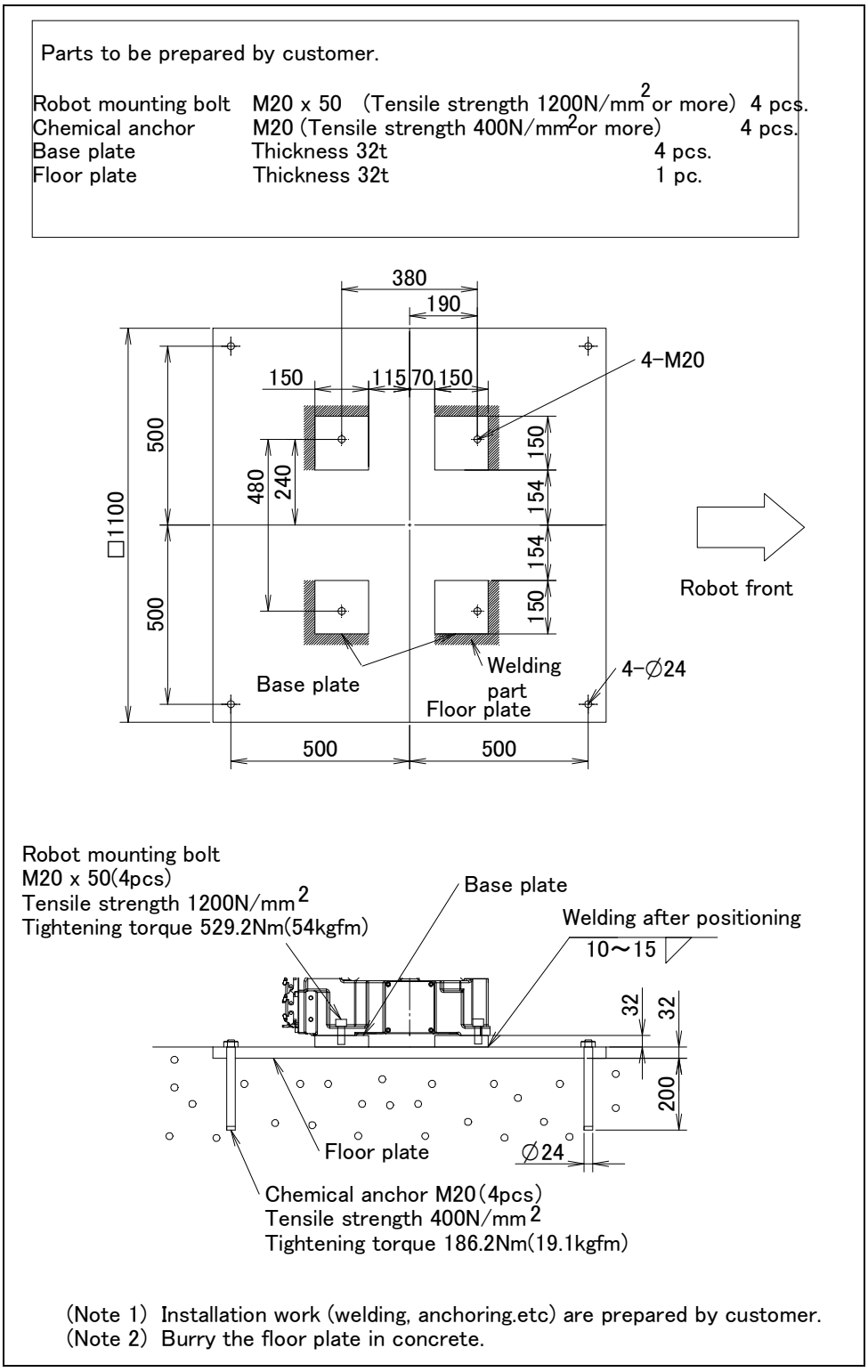


Fig. 1.2.1 (a) Actual installation example

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

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

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

Model	Vertical moment MV [kNm (kgfm)]	Force in vertical direction FV [kN (kgf)]	Horizontal moment MH [kNm (kgfm)]	Force in horizontal direction FH [kN (kgf)]
M-710*i*C/50/50E	17.6 (1800)	14.7 (1500)	5.9 (600)	8.0 (820)
M-710*i*C/70	18.6 (1900)	16.0 (1630)	5.9 (600)	8.0 (820)
M-710*i*C/50H	17.6 (1800)	14.7 (1500)	5.9 (600)	8.0 (820)
M-710*i*C/50S	13.2 (1350)	14.7 (1500)	5.9 (600)	7.4 (750)
M-710*i*C/45M	19.1 (1950)	14.7 (1500)	8.3 (850)	9.8 (1000)

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

Model		J1-axis	J2-axis	J3-axis
M-710*i*C/50	Stopping time [msec]	310	281	212
	Stopping distance [deg] (rad)	27.1 (0.47)	24.6 (0.43)	18.6 (0.32)
M-710*i*C/50E	Stopping time [msec]	294	286	238
	Stopping distance [deg] (rad)	26.9(0.47)	23.3(0.41)	23.3(0.41)
M-710*i*C/70	Stopping time [msec]	311	205	160
	Stopping distance [deg] (rad)	24.9 (0.43)	12.3 (0.21)	9.6 (0.17)
M-710*i*C/50H	Stopping time [msec]	284	252	220
	Stopping distance [deg] (rad)	28.9(0.50)	22.9(0.40)	21.5(0.38)
M-710*i*C/50S	Stopping time [msec]	166	155	151
	Stopping distance [deg] (rad)	14.5 (0.25)	13.6 (0.24)	13.2 (0.23)
M-710*i*C/45M	Stopping time [msec]	308	380	316
	Stopping distance [deg] (rad)	24.5 (0.43)	30.2 (0.53)	27.7 (0.48)

* Max speed and max inertia posture

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

Model		J1-axis	J2-axis	J3-axis
M-710*i*C/50	Stopping time [msec]	636	644	628
	Stopping distance [deg] (rad)	60.5 (1.06)	62.5 (1.09)	60.4 (1.05)
M-710*i*C/50E	Stopping time [msec]	638	654	630
	Stopping distance [deg] (rad)	60.7(1.06)	61.1(1.07)	60.5(1.06)
M-710*i*C/70	Stopping time [msec]	756	764	708
	Stopping distance [deg] (rad)	63.9 (1.11)	47.5 (0.83)	46.3 (0.81)
M-710*i*C/50H	Stopping time [msec]	652	644	636
	Stopping distance [deg] (rad)	61.2(1.07)	61.2(1.07)	61.6(1.07)
M-710*i*C/50S	Stopping time [msec]	492	492	492
	Stopping distance [deg] (rad)	49.0 (0.85)	47.8 (0.83)	47.8 (0.83)
M-710*i*C/45M	Stopping time [msec]	660	708	708
	Stopping distance [deg] (rad)	63.8 (1.11)	65.7 (1.15)	65.5 (1.14)

* Max speed and max inertia posture

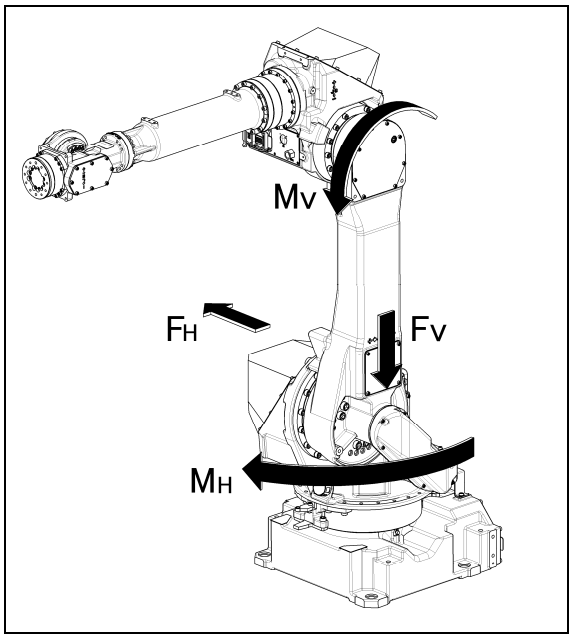
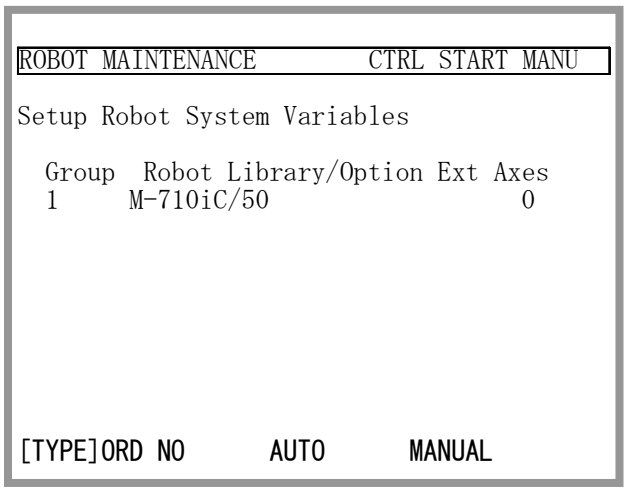


Fig. 1.2.1 (b) Force and moment during Power-Off Stop

1.2.2 Angle of Mounting Surface Setting

For all robot mounts except floor mount, be sure to set the mounting angle referring to the procedure below. Refer to Section 3.1 for installation specifications.

1 Turn on the controller with [PREV] and [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.

```
*******Group 1 Initialization***********
**************M-710iC/50*****************


--- MOUNT ANGLE SETTING ---

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

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

6 Input the mount angle referring to Fig. 1.2.2.

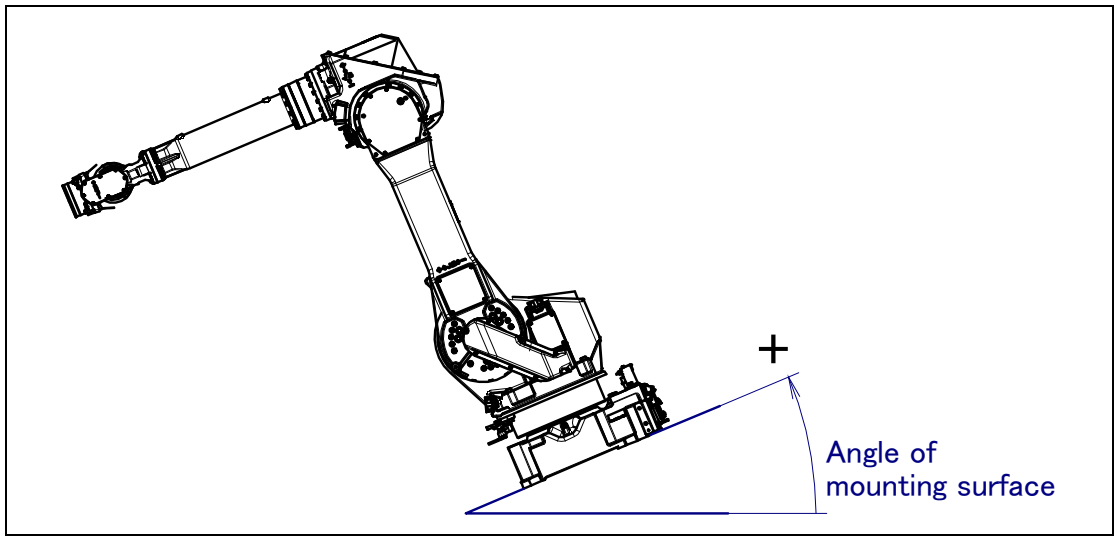


Fig.1.2.2 Mounting angle

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

```
ROBOT MAINTENANCE          CTRL START MANU

Setup Robot System Variables

  Group  Robot Library/Option Ext Axes
  1      M-710iC/50                   0




[TYPE]ORD NO       AUTO       MANUAL
```

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

1.3 MAINTENANCE AREA

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

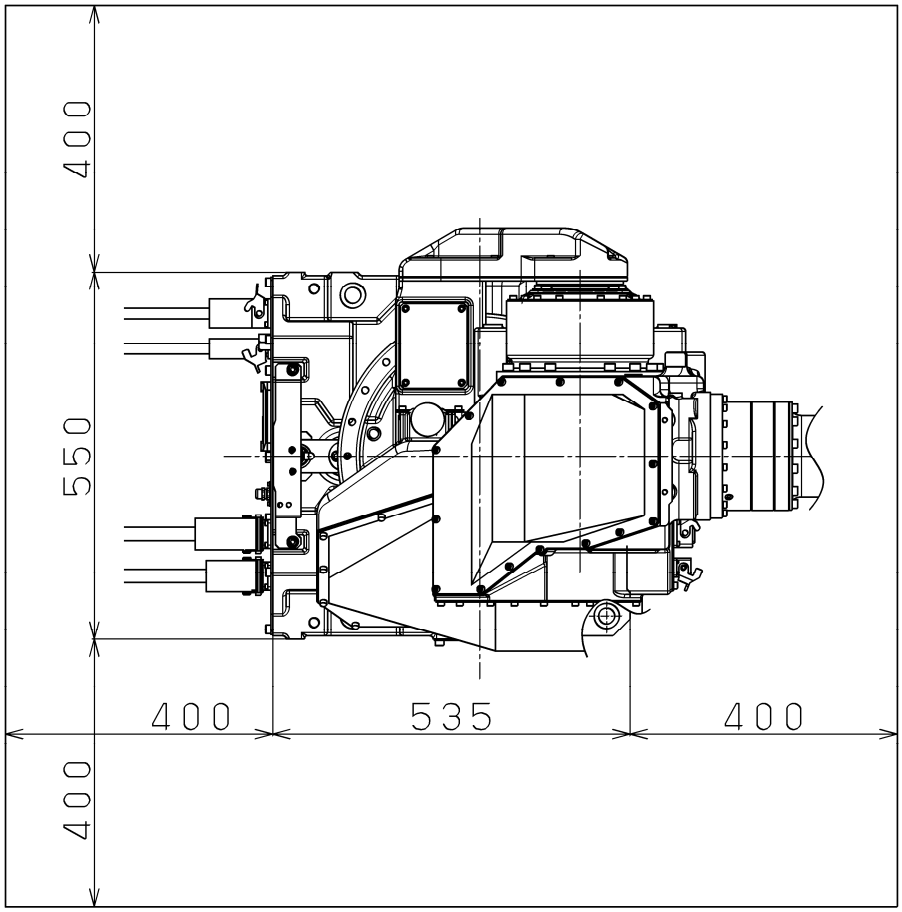


Fig. 1.3 Maintenance area

1.4 INSTALLATION CONDITIONS

See Section 3.1 and caution below about robot installation conditions.

> ⚠ **CAUTION**
> Damage of the cable jacket can cause water intrusion. Take care when installing the cable and exchange it if it is damaged.

2 CONNECTION WITH THE CONTROLLER

2.1 CONNECTION WITH THE CONTROLLER

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

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

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

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

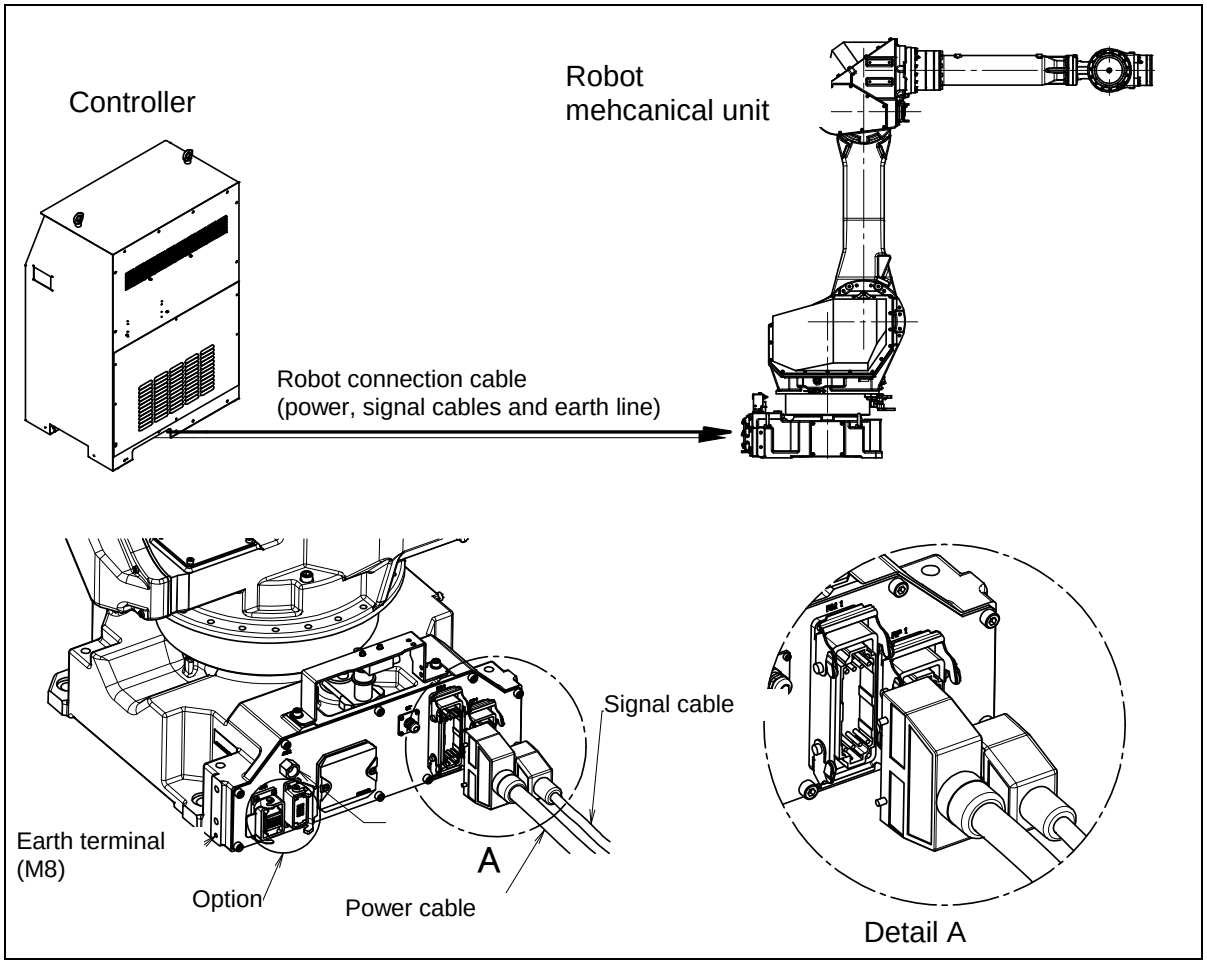


Fig. 2.1 Cable connection

3 BASIC SPECIFICATIONS

3.1 ROBOT CONFIGURATION

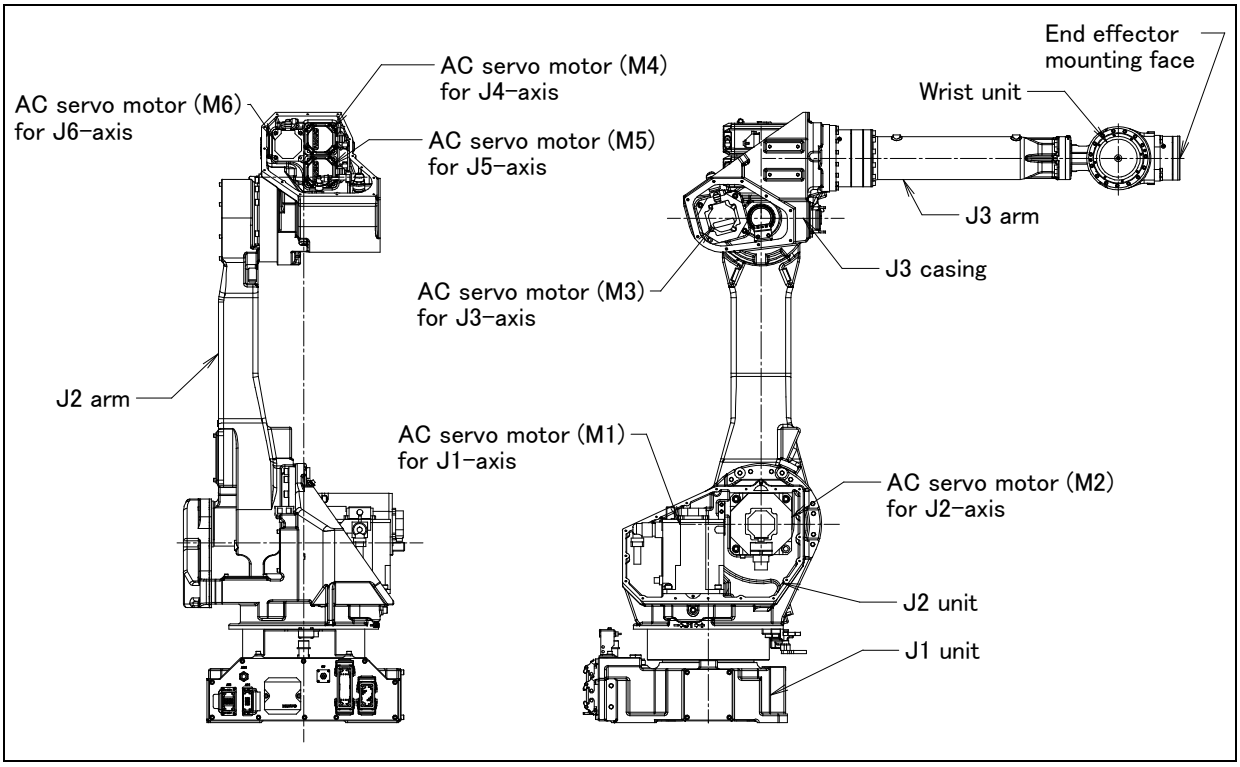


Fig. 3.1 (a) Mechanical unit configuration (M-710*i*C/50/70/45M)

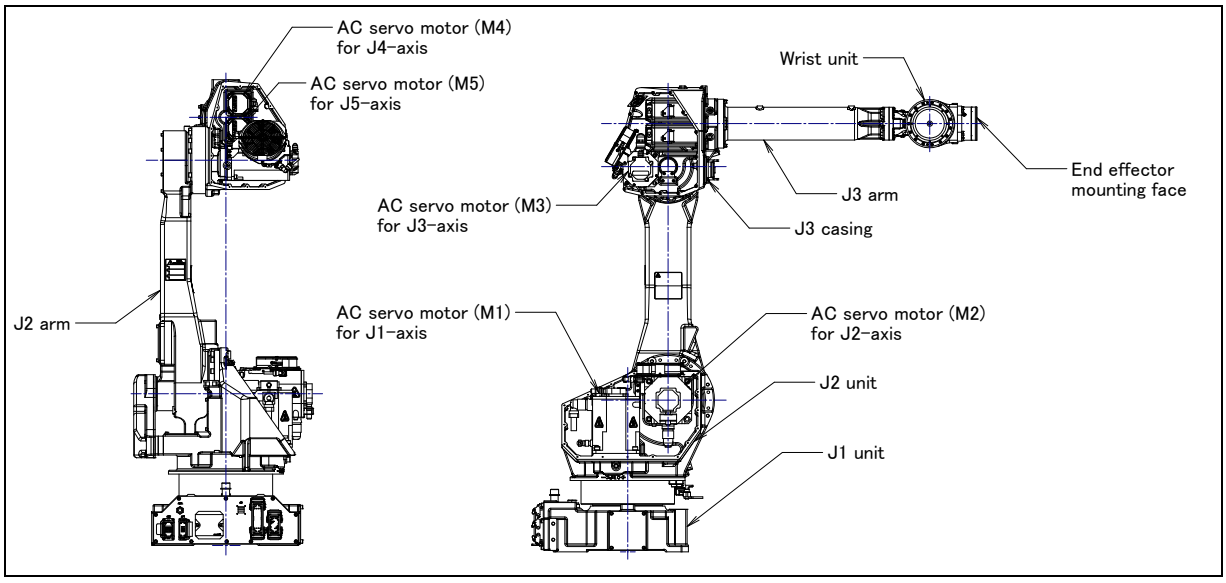


Fig. 3.1 (b) Mechanical unit configuration (M-710*i*C/50H)

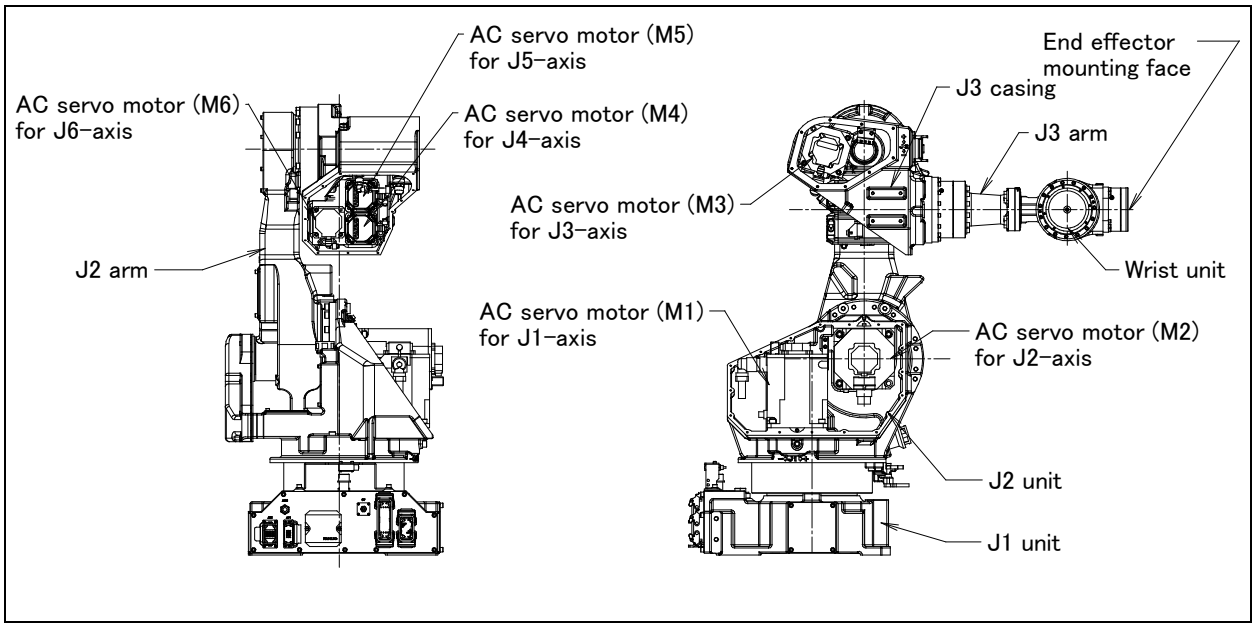


Fig. 3.1 (c) Mechanical unit configuration (M-710*i*C/50S)

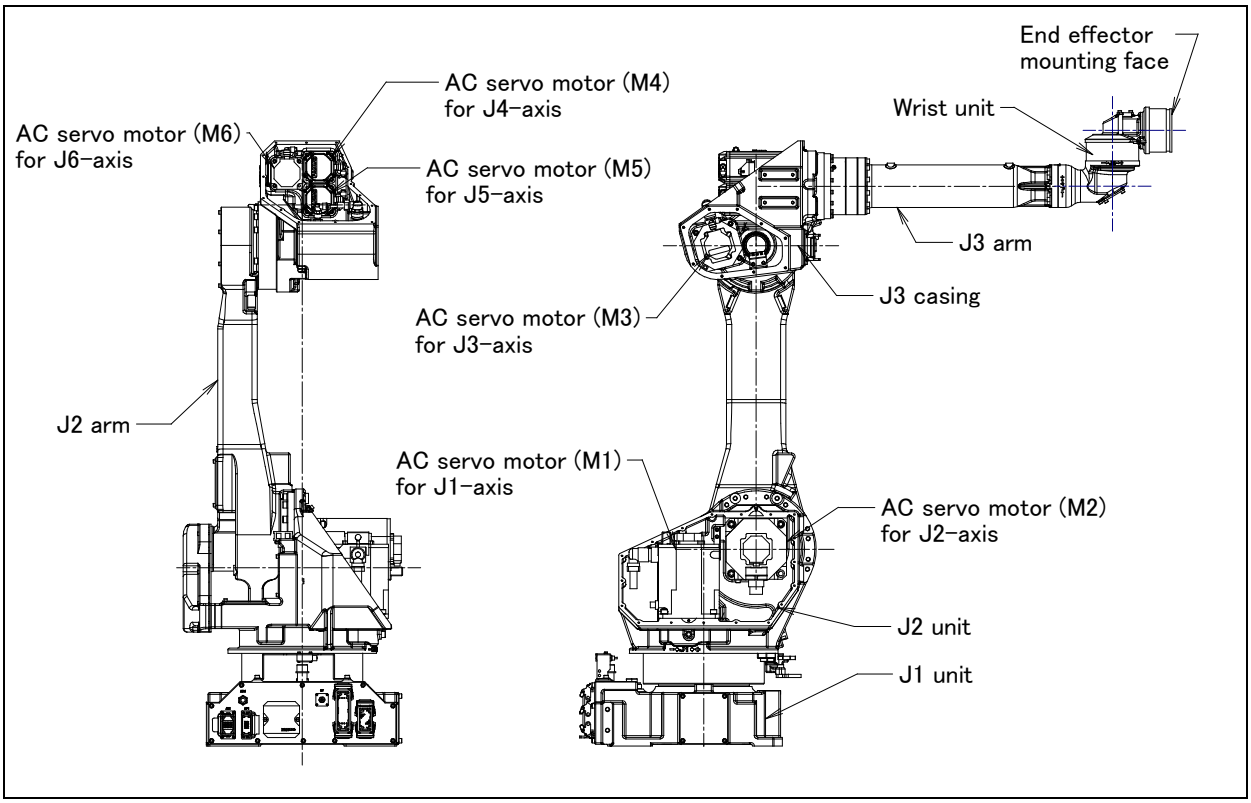


Fig. 3.1 (d) Mechanical unit configuration (M-710*i*C/50E)

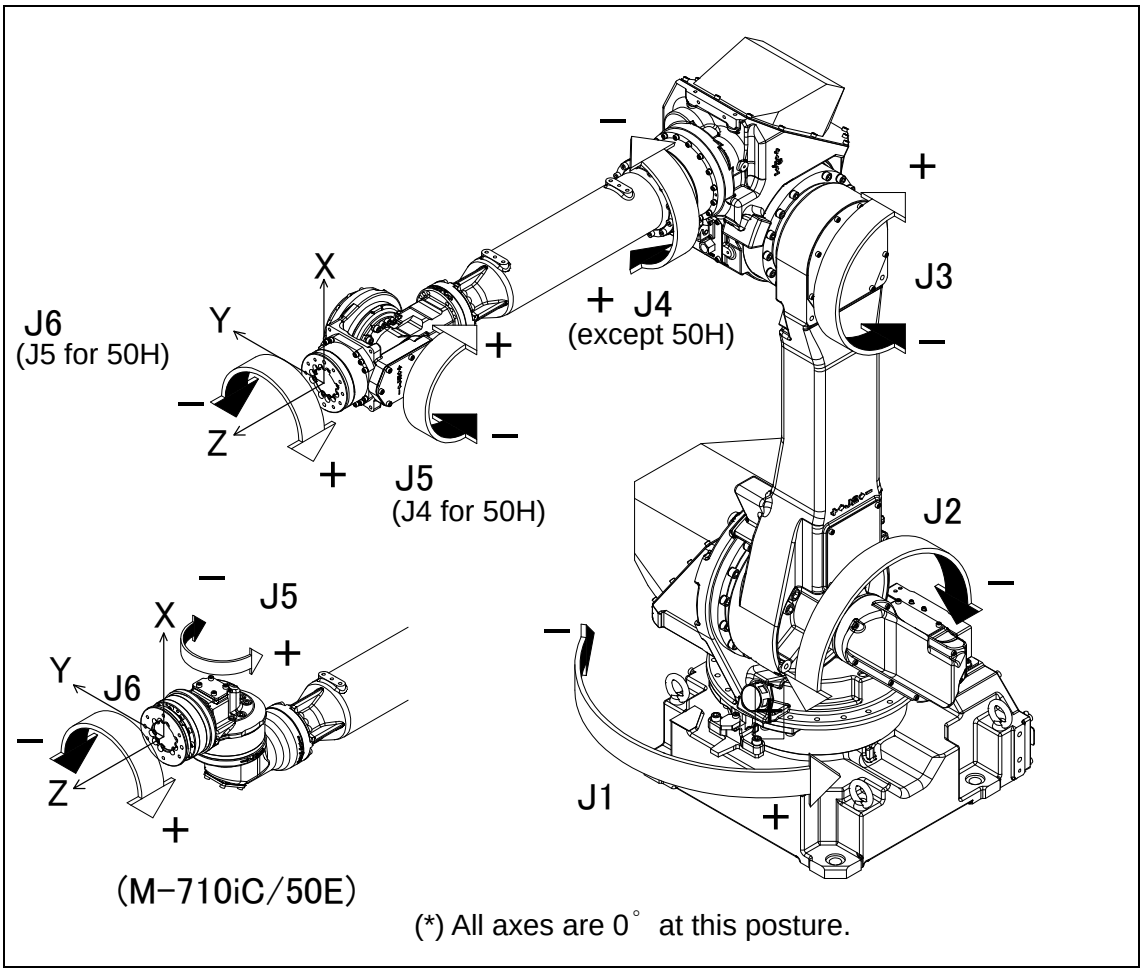


Fig. 3.1 (e) Each axis coordinates and mechanical interface coordinates

NOTE
Zero point of mechanical interface coordinates is the end effector mounting face center.

Specifications (1/2)

			M-710*i*C/50	M-710*i*C/70	M-710*i*C/50H
Type			Articulated Type		
Controlled axes			6 axes (J1, J2, J3, J4, J5, J6)		5 axes (J1, J2, J3, J4, J5)
Installation			Floor, upside-down (angle mount)		Floor, upside-down
Motion range	J1-axis	Upper limit	180° (3.14rad)	180° (3.14rad)	180° (3.14rad)
		Lower limit	-180° (-3.14rad)	-180° (-3.14rad)	-180° (-3.14rad)
	J2-axis	Upper limit	135° (2.35rad)	135° (2.35rad)	135° (2.35rad)
		Lower limit	-90° (-1.57rad)	-90° (-1.57rad)	-90° (-1.57rad)
	J3-axis	Upper limit	280° (4.88rad)	280° (4.88rad)	280° (4.88rad)
		Lower limit	-160° (-2.79rad)	-160° (-2.79rad)	-160° (-2.79rad)
	J4-axis	Upper limit	360° (6.28rad)	360° (6.28rad)	117° (2.04rad)
		Lower limit	-360° (-6.28rad)	-360° (-6.28rad)	-117° (-2.04rad)
	J5-axis	Upper limit	125° (2.18rad)	125° (2.18rad)	360° (6.28rad)
		Lower limit	-125° (-2.18rad)	-125° (-2.18rad)	-360° (-6.28rad)
	J6-axis	Upper limit	360° (6.28rad)	360° (6.28rad)	
		Lower limit	-360° (-6.28rad)	-360° (-6.28rad)	
Max motion speed (NOTE 1)	J1-axis		175° /s (3.05rad/s)	160° /s (2.79rad/s)	175°/s (3.05rad/s)
	J2-axis		175° /s (3.05rad/s)	120° /s (2.09rad/s)	175°/s (3.05rad/s)
	J3-axis		175° /s (3.05rad/s)	120° /s (2.09rad/s)	175°/s (3.05rad/s)
	J4-axis		250° /s (4.36rad/s)	225° /s (3.93rad/s)	175°/s (3.05rad/s)
	J5-axis		250° /s (4.36rad/s)	225° /s (3.93rad/s)	720°/s (12.57rad/s)
	J6-axis		355° /s (6.20rad/s)	225° /s (3.93rad/s)	
Max. load capacity	At wrist		50kg	70kg	50kg
	On J3 casing (NOTE 2)		15kg	15kg	15kg
Allowable load moment at wrist	J4		206N·m (21kgf·m)	294N·m (30kgf·m)	150N·m (15.3kgf·m)
	J5		206N·m (21kgf·m)	294N·m (30kgf·m)	68N·m (6.9kgf·m)
	J6		127N·m (13kgf·m)	147N·m (15kgf·m)	
Allowable load inertia at wrist	J4		28kg·m^2 (286kgf·cm·s^2)	28kg·m^2 (286kgf·cm·s^2)	6.3kg·m^2 (64.3kgf·cm·s^2)
	J5		28kg·m^2 (286kgf·cm·s^2)	28kg·m^2 (286kgf·cm·s^2)	2.5kg·m^2 (25.5kgf·cm·s^2)
	J6		11kg·m^2 (112kgf·cm·s^2)	11kg·m^2 (112kgf·cm·s^2)	
Drive method			Electric servo drive by AC servo motor		
Repeatability			±0.04mm (NOTE 3)		±0.15mm
Mass			560kg	560kg	540kg
Acoustic noise level			71.3dB (NOTE 4)		
Installation environment			Ambient temperature: 0 - 45°C (NOTE 5) Ambient humidity: Normally 75%RH or less No dew, nor frost allowed. Short time (within one month) Max 95%RH Height: Up to 1000 meters above the sea level required, no particular provision for attitude. Vibration acceleration: 4.9m/s^2 (0.5G) or less Free of corrosive gases (NOTE 6)		

NOTE

1 During short distance motions, the axis speed may not reach the maximum value stated.
2 The Max. load capacity at J3 casing is restricted by the load weight at wrist. For details, see Section 3.5.
3 Compliant with ISO 9283.
4 This value is equivalent continuous A-weighted sound pressure level that applied with ISO11201 (EN31201). This value is measured with the following conditions.
- Maximum load and speed
- Operating mode is AUTO

5 When the robot is used in a low temperature environment that is near to 0ºC, or not operated for a long time in the environment that is less than 0ºC (during a holiday or during the night), a collision detection alarm (SRVO-050) etc. may occur since the resistance of the drive mechanism could be high immediately after starting the operation. In this case, we recommend performing the warm up operation for several minutes.
6 Contact the service representative, if the robot is to be used in an environment or a place subjected to hot/cold temperatures, severe vibrations, heavy dust, cutting oil splash and or other foreign substances.

Specifications (2/2)

			M-710*i*C/50S	M-710*i*C/45M	M-710*i*C/50E
Type			Articulated Type		
Controlled axes			6 axes (J1, J2, J3, J4, J5, J6)		
Installation			Floor, upside-down (angle mount)		
Motion range	J1-axis	Upper limit	180° (3.14rad)	180° (3.14rad)	180° (3.14rad)
		Lower limit	-180° (-3.14rad)	-180° (-3.14rad)	-180° (-3.14rad)
	J2-axis	Upper limit	112° (1.95rad)	135° (2.36rad)	135° (2.35rad)
		Lower limit	-57° (-0.99rad)	-90° (-1.57rad)	-90° (-1.57rad)
	J3-axis	Upper limit	279° (4.87rad)	280° (4.88rad)	280° (4.88rad)
		Lower limit	-97° (-1.69rad)	-160° (-2.79rad)	-160° (-2.79rad)
	J4-axis	Upper limit	360° (6.28rad)	400° (6.98rad)	360° (6.28rad)
		Lower limit	-360° (-6.28rad)	-400° (-6.98rad)	-360° (-6.28rad)
	J5-axis	Upper limit	125° (2.18rad)	125° (2.18rad)	190° (3.31rad)
		Lower limit	-125° (-2.18rad)	-125° (-2.18rad)	-190° (-3.31rad)
	J6-axis	Upper limit	360° (6.28rad)	400° (6.98rad)	360° (6.28rad)
		Lower limit	-360° (-6.28rad)	-400° (-6.98rad)	-360° (-6.28rad)
Max motion speed (NOTE 1)	J1-axis		175°/s (3.05rad/s)	180°/s (3.14rad/s)	175°/s (3.05rad/s)
	J2-axis		175°/s (3.05rad/s)	180°/s (3.14rad/s)	175°/s (3.05rad/s)
	J3-axis		175°/s (3.05rad/s)	180°/s (3.14rad/s)	175°/s (3.05rad/s)
	J4-axis		250°/s (4.36rad/s)	250°/s (4.36rad/s)	250°/s (4.36rad/s)
	J5-axis		250°/s (4.36rad/s)	250°/s (4.36rad/s)	240°/s (4.19rad/s)
	J6-axis		355°/s (6.20rad/s)	360°/s (6.28rad/s)	340°/s (5.93rad/s)
Max. load capacity	At wrist		50kg	45kg	50kg
	On J3 casing (NOTE 2)		15kg		
Allowable load moment at wrist	J4-axis		206N·m (21kgf·m)	206N·m (21kgf·m)	206N·m (21kgf·m)
	J5-axis		206N·m (21kgf·m)	206N·m (21kgf·m)	176N·m (18kgf·m)
	J6-axis		127N·m (13kgf·m)	127N·m (13kgf·m)	98N·m (10kgf·m)
Allowable load inertia at wrist	J4-axis		28kg·m^2 (286kgf·cm·s^2)	28kg·m^2 (286kgf·cm·s^2)	28kg·m^2 (286kgf·cm·s^2)
	J5-axis		28kg·m^2 (286kgf·cm·s^2)	28kg·m^2 (286kgf·cm·s^2)	10.8kg·m^2 (110kgf·cm·s^2)
	J6-axis		11kg·m^2 (112kgf·cm·s^2)	20kg·m^2 (204kgf·cm·s^2)	3.3kg·m^2 (34kgf·cm·s^2)
Drive method			Electric servo drive by AC servo motor		
Repeatability			±0.04mm (NOTE 3)	±0.06mm (NOTE 3)	±0.07mm
Mass			545kg	570kg	560kg
Acoustic noise level			71.3dB (NOTE 4)		
Installation environment			Ambient temperature: 0 - 45°C (NOTE 5) Ambient humidity: Normally 75%RH or less No dew, nor frost allowed. Short time (within one month) Max 95%RH Height: Up to 1,000 meters above the sea level required, no particular provision for attitude. Vibration acceleration: 4.9m/s^2 (0.5G) or less Free of corrosive gases (NOTE 6)		

NOTE

1 During short distance motions, the axis speed may not reach the maximum value stated.
2 The Max. load capacity at J3 casing is restricted by the load weight at wrist. For details, see Section 3.5.
3 Compliant with ISO 9283.
4 This value is equivalent continuous A-weighted sound pressure level that applied with ISO11201 (EN31201). This value is measured with the following conditions.
- Maximum load and speed
- Operating mode is AUTO

5 When the robot is used in a low temperature environment that is near to 0ºC, or not operated for a long time in the environment that is less than 0ºC (during a holiday or during the night), a collision detection alarm (SRVO-050) etc. may occur since the resistance of the drive mechanism could be high immediately after starting the operation. In this case, we recommend performing the warm up operation for several minutes.
6 Contact the service representative, if the robot is to be used in an environment or a place subjected to severe vibrations, heavy dust, cutting oil splash and or other foreign substances.

The following table lists the IEC60529-based Severe dust/liquid protection characteristics of the M-710*i*C. Refer to Chapter 10 about severe dust/liquid protection package (option).

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

(*) Except some connectors

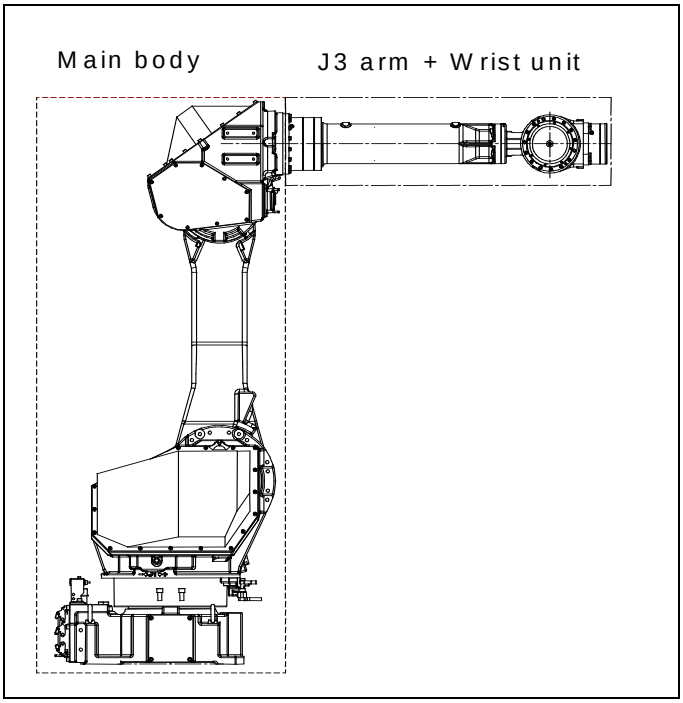


Fig. 3.1 (f) Characteristics of the M-710*i*C

NOTE

Definition of IP code

Definition of IP 67
- 6=Dust-tight
- 7=Protection from water immersion

Definition of IP 66
- 6=Dust-tight
- 6=Protection from powerful water jets.

Definition of IP 54
- 5=Dust-protected
- 4=Protection from splashing water

Performance of resistant chemicals and resistant solvents

(1) The robot (including severe dust/liquid protection model) cannot be used with the following liquids. 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 the environment, using water or liquid, complete draining of J1 base must be done. Incomplete draining of J1 base will make the robot break down.

(3) Don not use unconfirmed cutting fluid and cleaning fluid.

(4) Do not use the robot immersed in water, neither temporary nor permanent. 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) to (e) show the robot operating space. When installing peripheral devices, be careful not to interfere with the robot and its operating space.

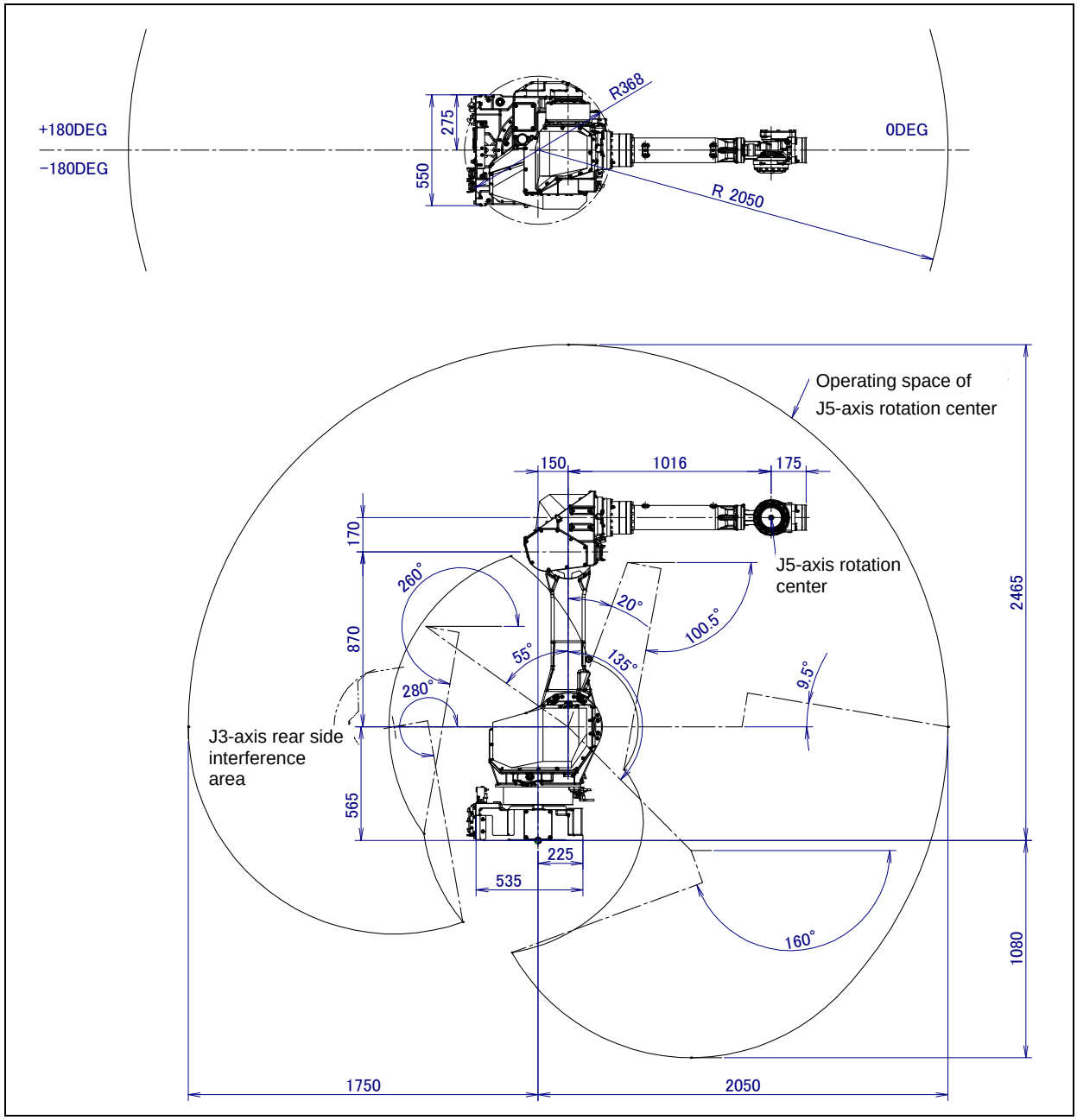


Fig. 3.2 (a) Operating space (M-710*i*C/50/70)

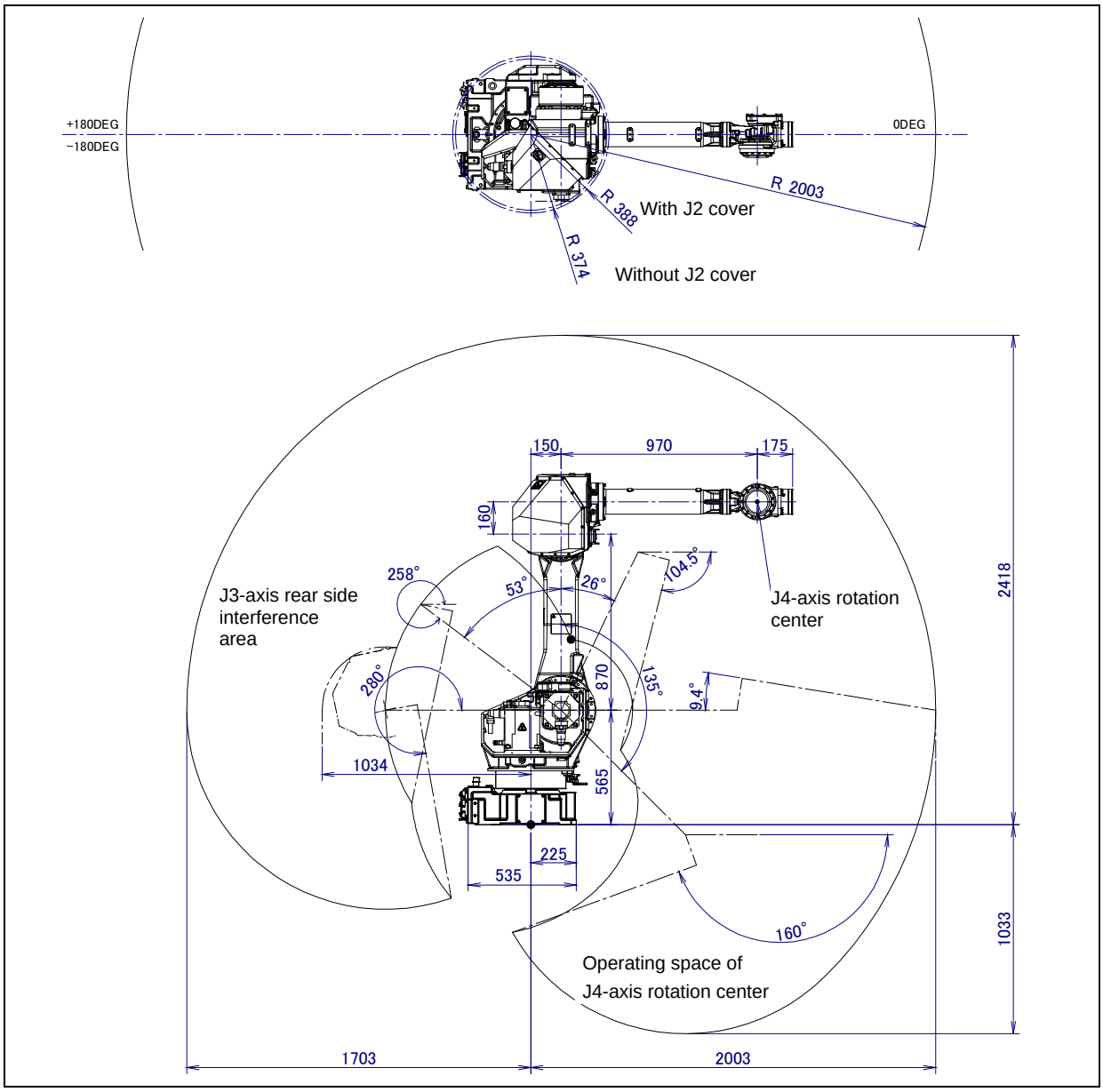


Fig. 3.2 (b) Operating space (M-710*i*C/50H)

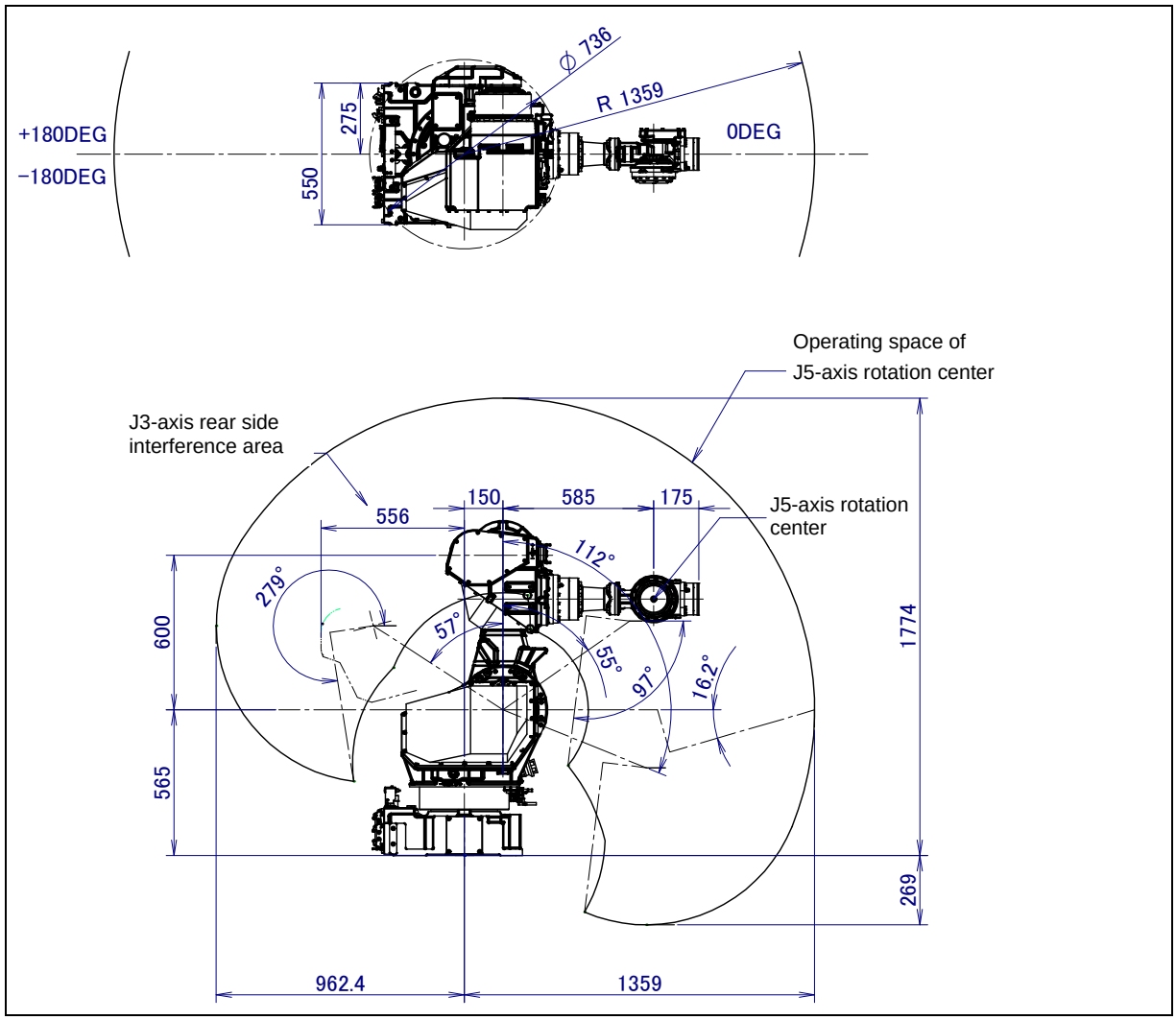


Fig. 3.2 (c) Operating space (M-710*i*C/50S)

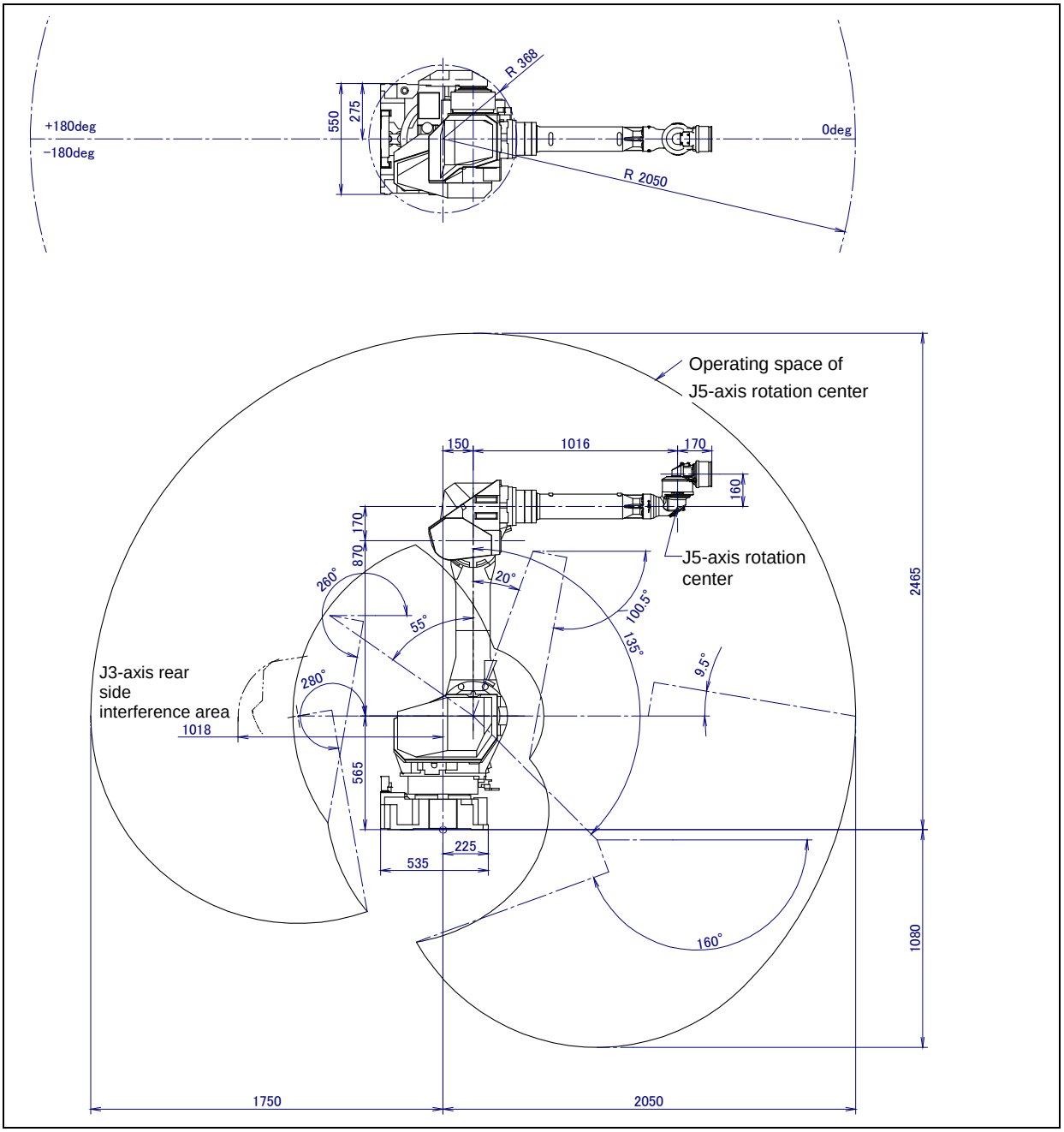


Fig. 3.2 (d) Operating space (M-710*i*C/50E)

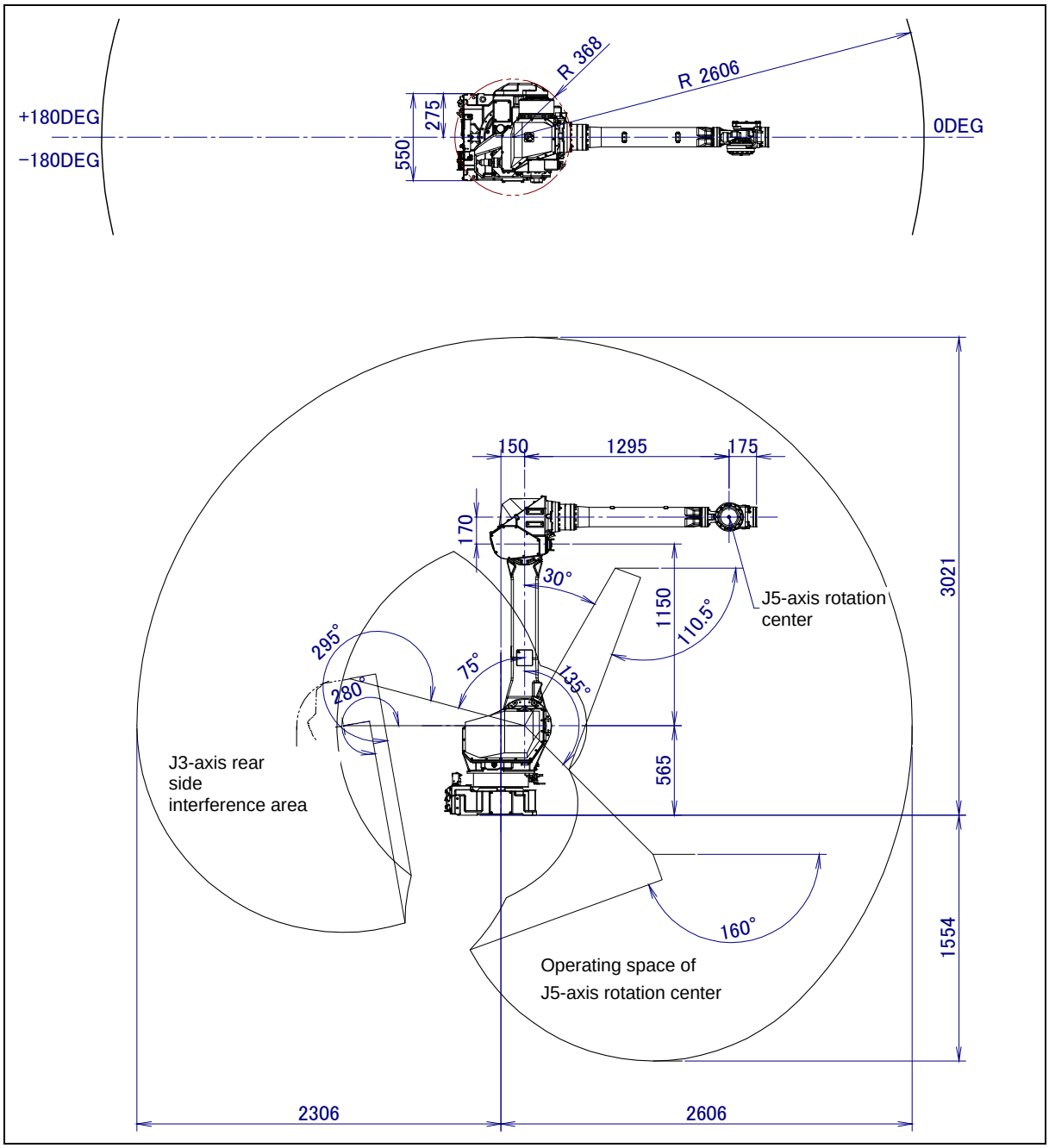


Fig. 3.2 (e) Operating space (M-710*i*C/45M)

3.3 ZERO POINT POSITION AND MOTION LIMIT

Zero point and motion range are provided for each controlled axis. 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. The robot cannot exceed the motion range unless there is a loss of zero point position due to abnormalities in servo system or system error. In addition, the motion range limit by a mechanical stopper or limit switch is also prepared to improve safety.

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

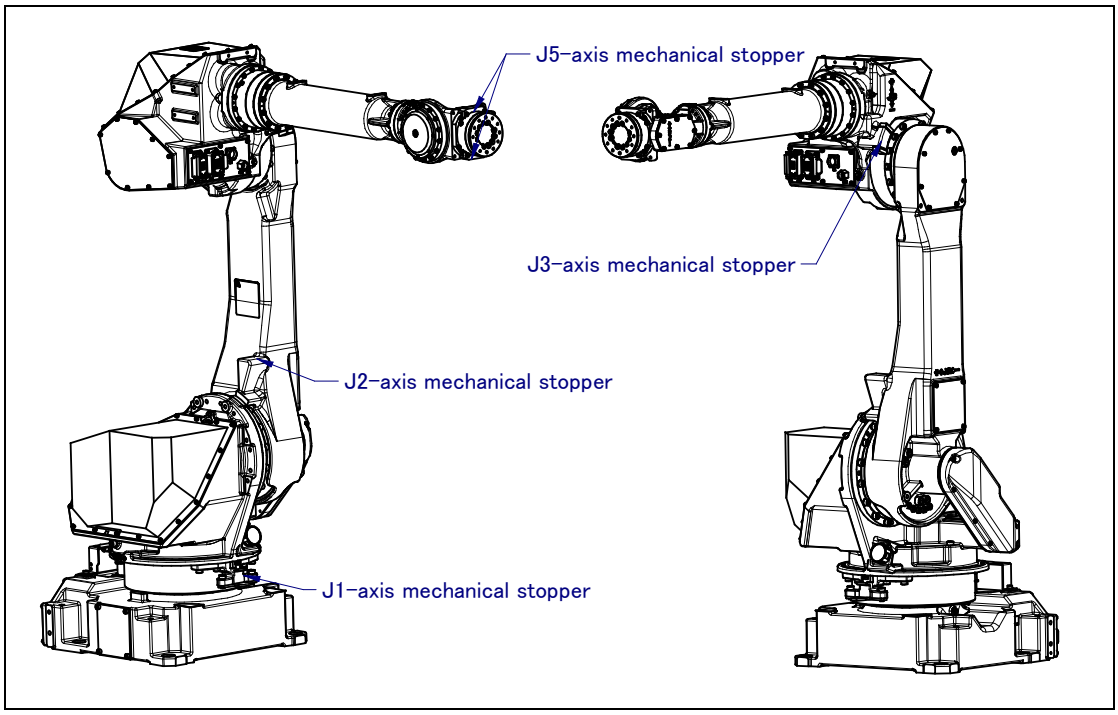


Fig. 3.3 (a) Position of mechanical stopper

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

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

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

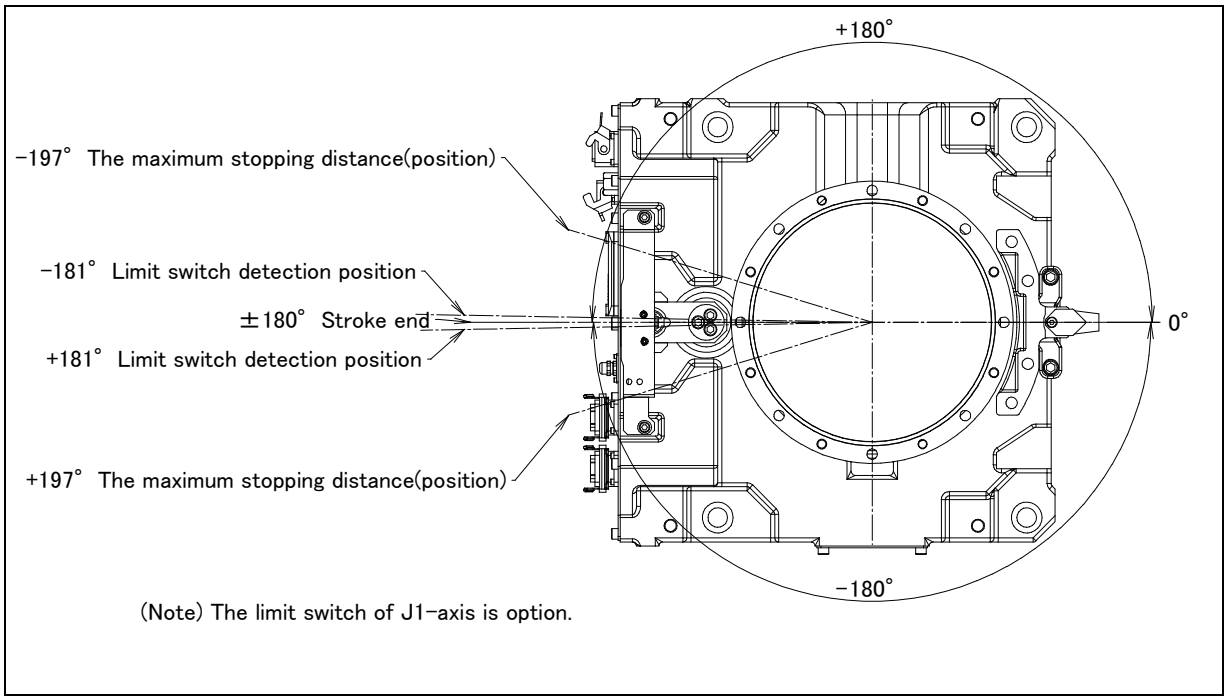


Fig. 3.3 (b) J1-axis motion limit (M-710*i*C/50/50H/50S/50E/45M)

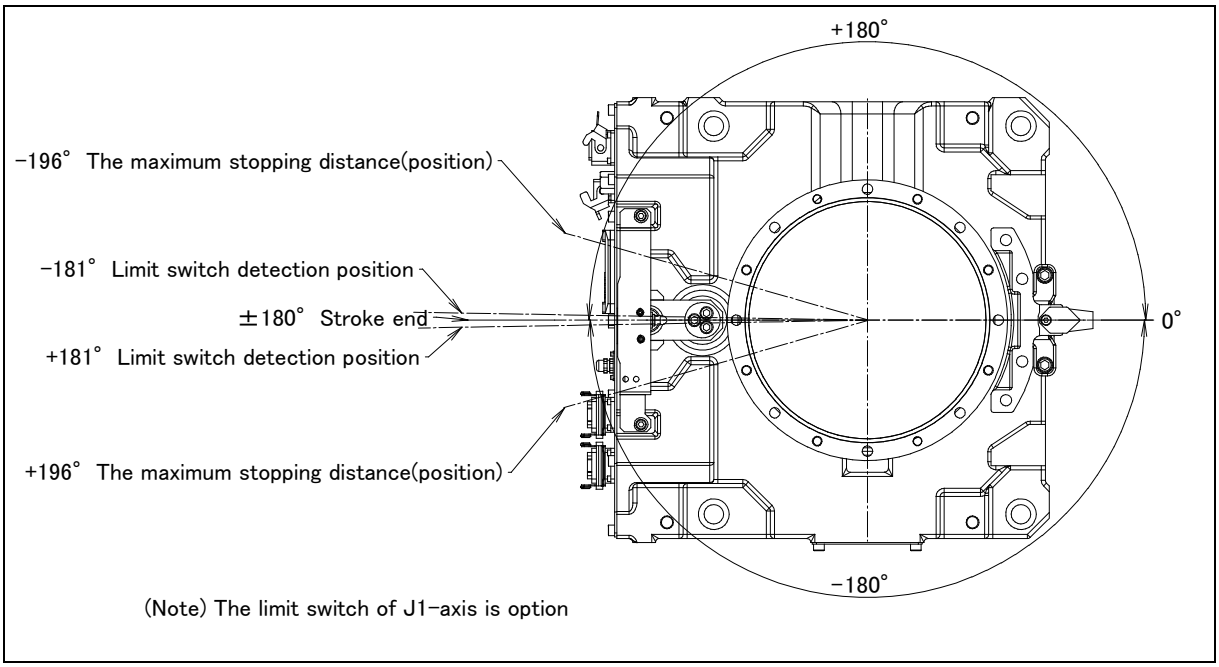


Fig. 3.3 (c) J1-axis motion limit (M-710*i*C/70)

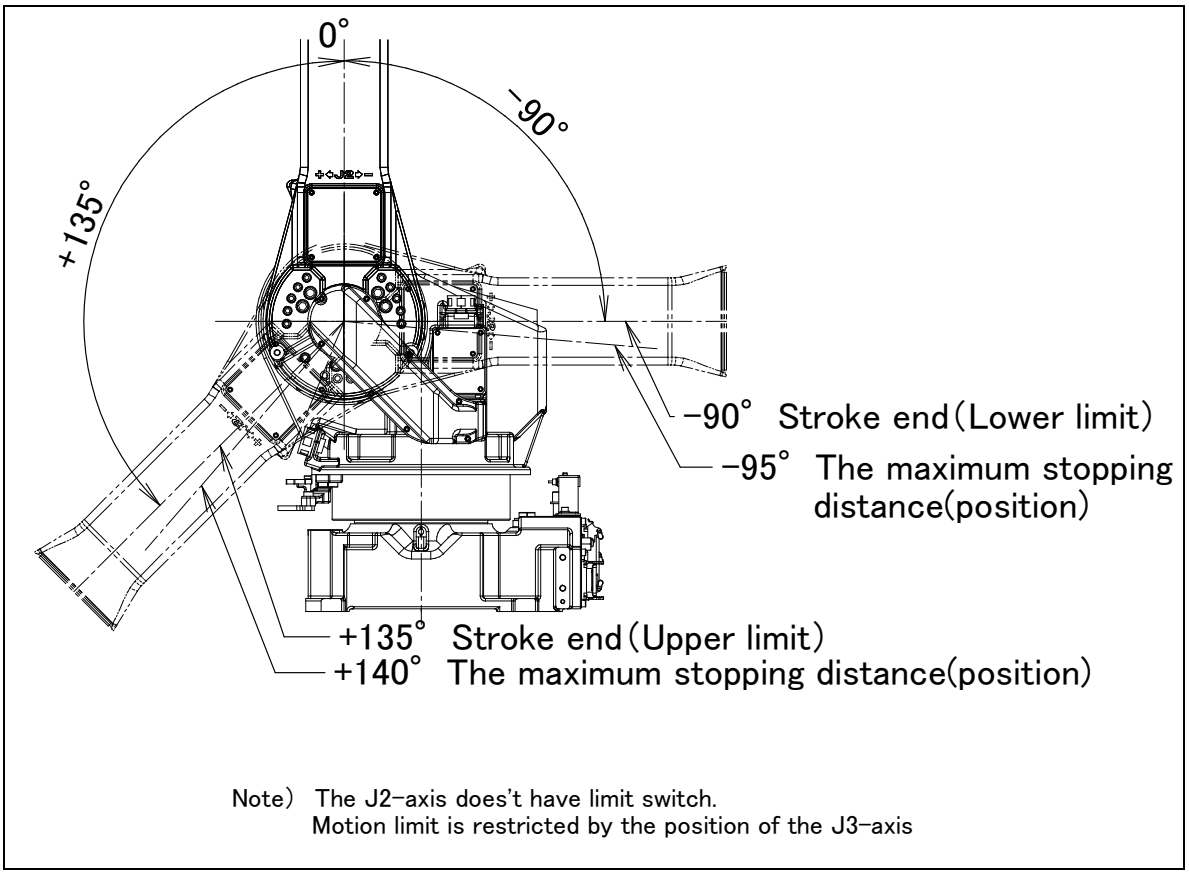


Fig. 3.3 (d) J2-axis motion limit (M-710*i*C/50/70/50H/45M/50E)

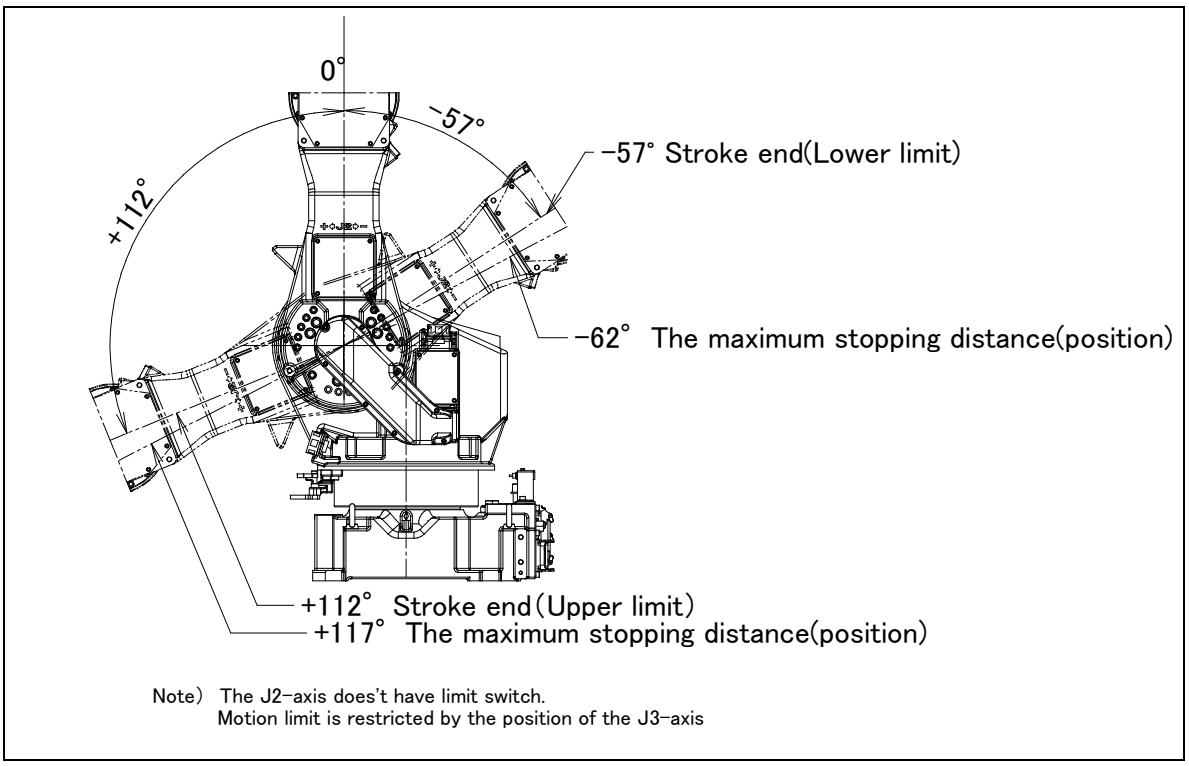


Fig. 3.3 (e) J2-axis motion limit (M-710*i*C/50S)

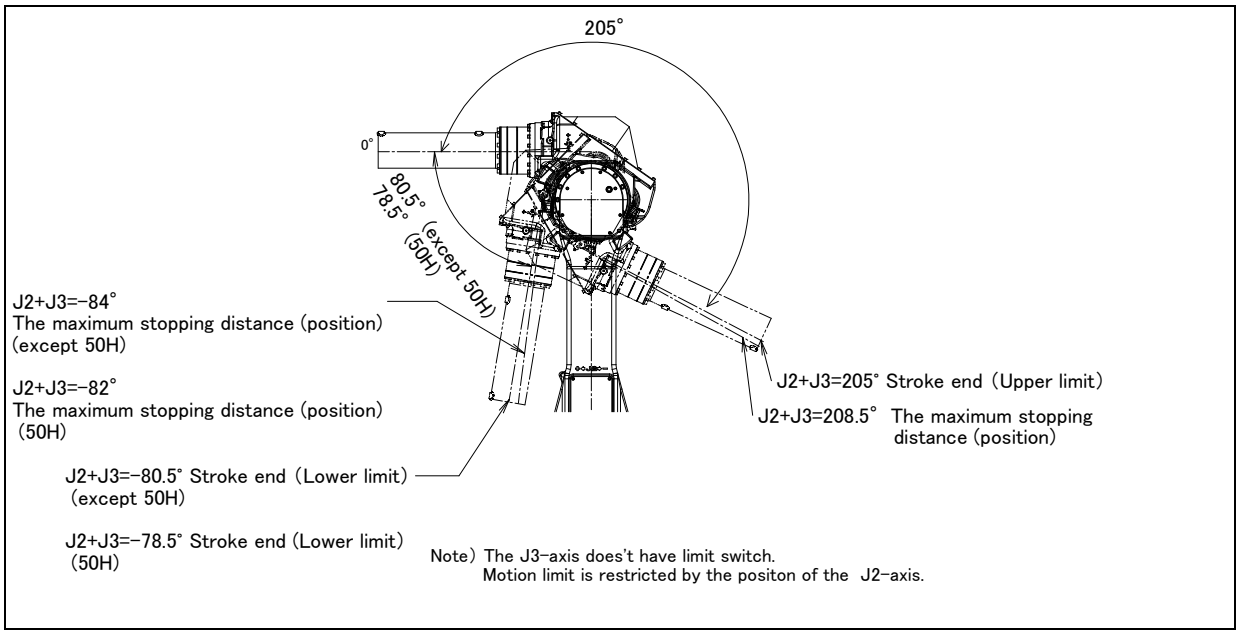


Fig. 3.3 (f) J3-axis motion limit (M-710*i*C/50/70/50H/45M/50E)

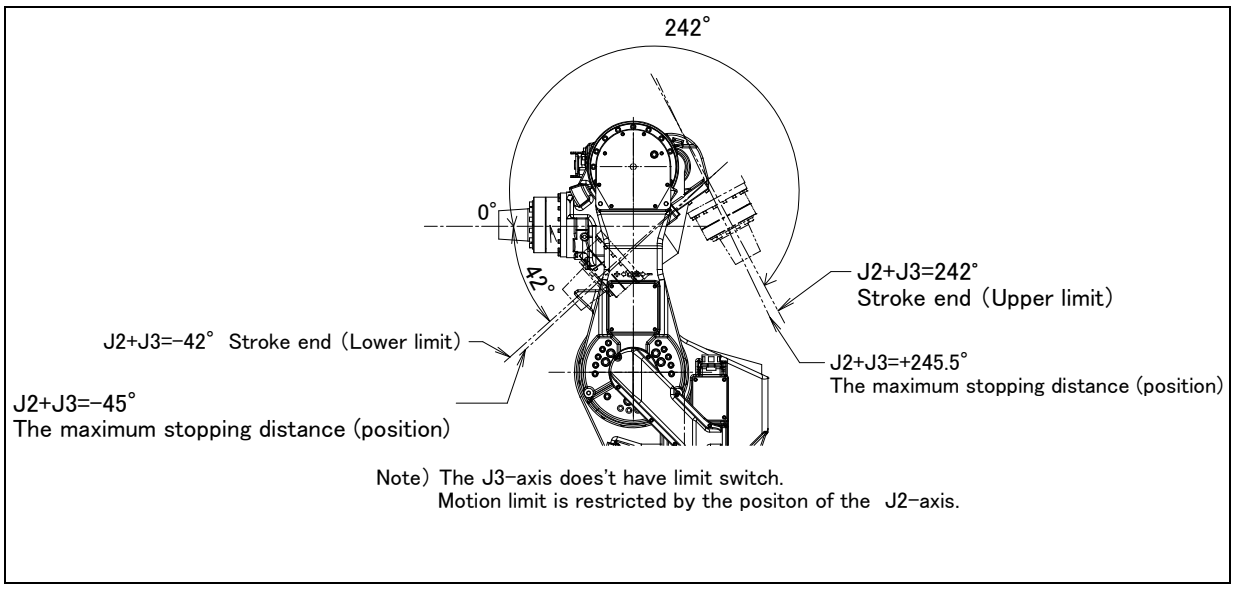


Fig. 3.3 (g) J3-axis motion limit (M-710*i*C/50S)

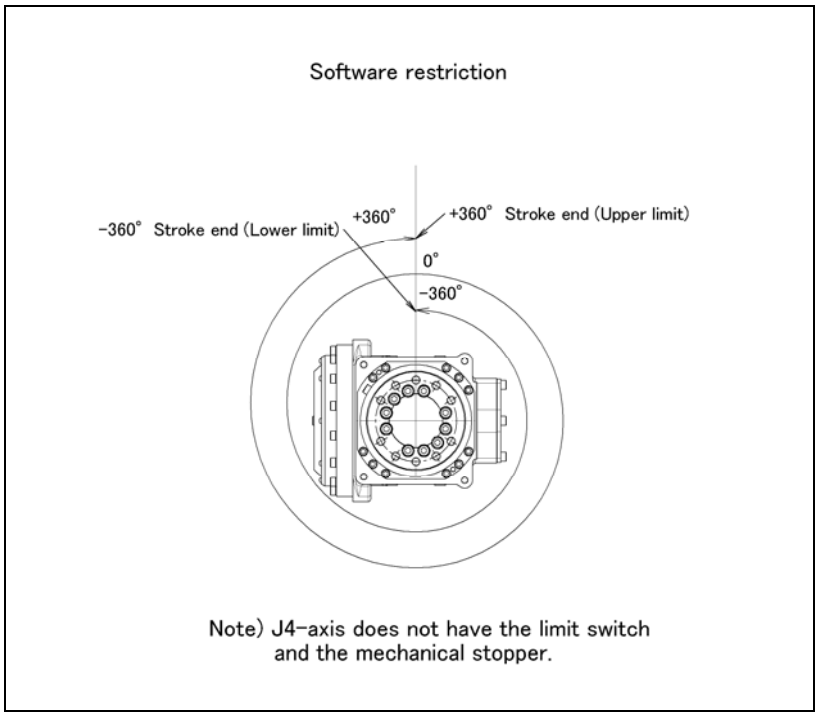


Fig. 3.3 (h) J4-axis motion limit (Except M-710*i*C/50H/45M)

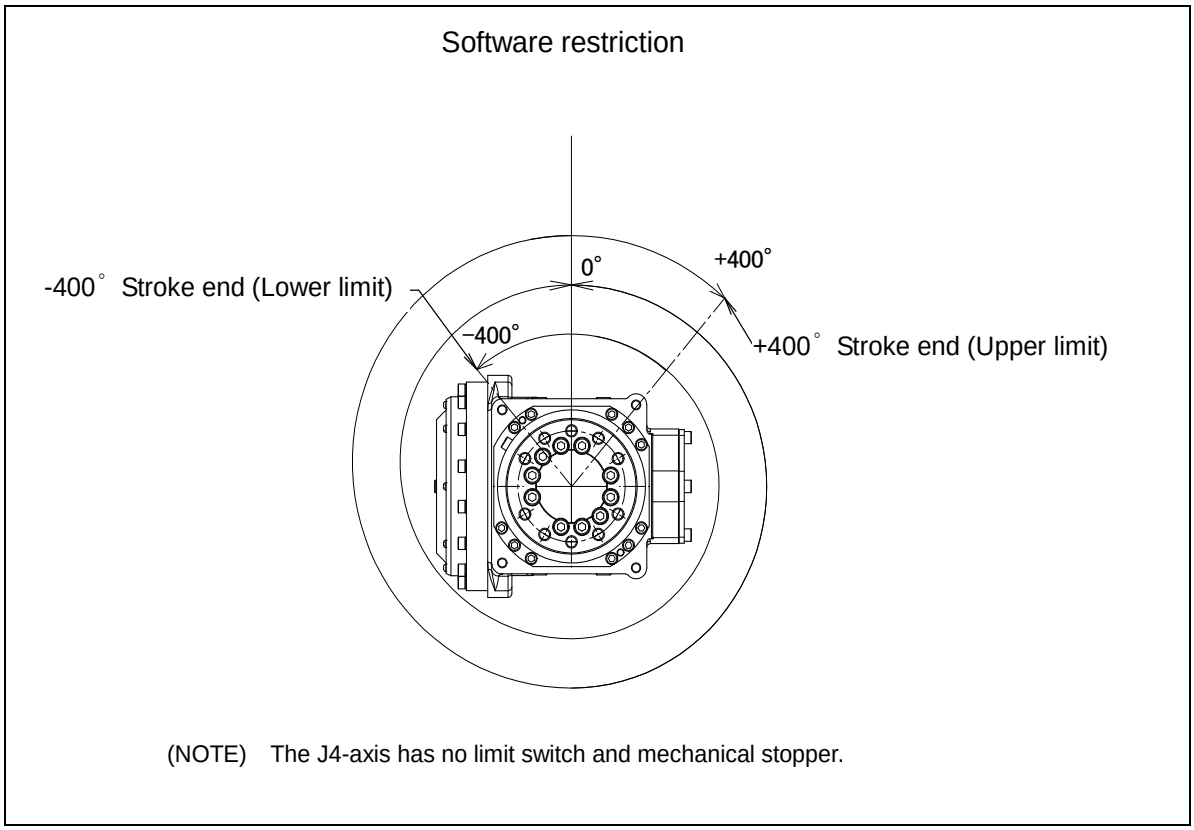


Fig. 3.3 (i) J4-axis motion limit (Except M-710*i*C/45M)

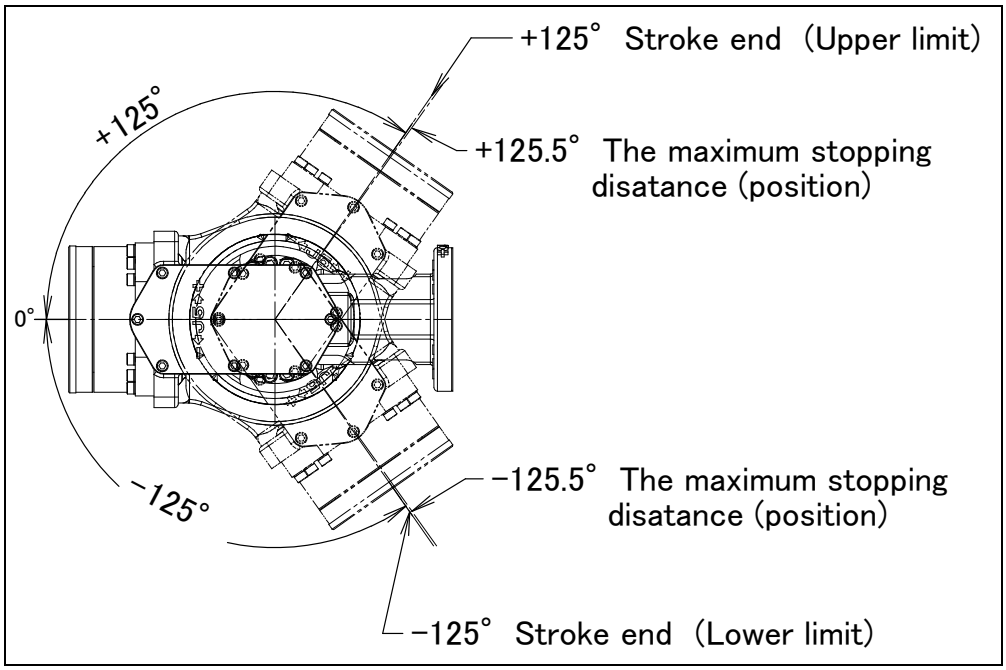


Fig. 3.3 (j) J5-axis motion limit (M-710*i*C/50/70/50S/45M)

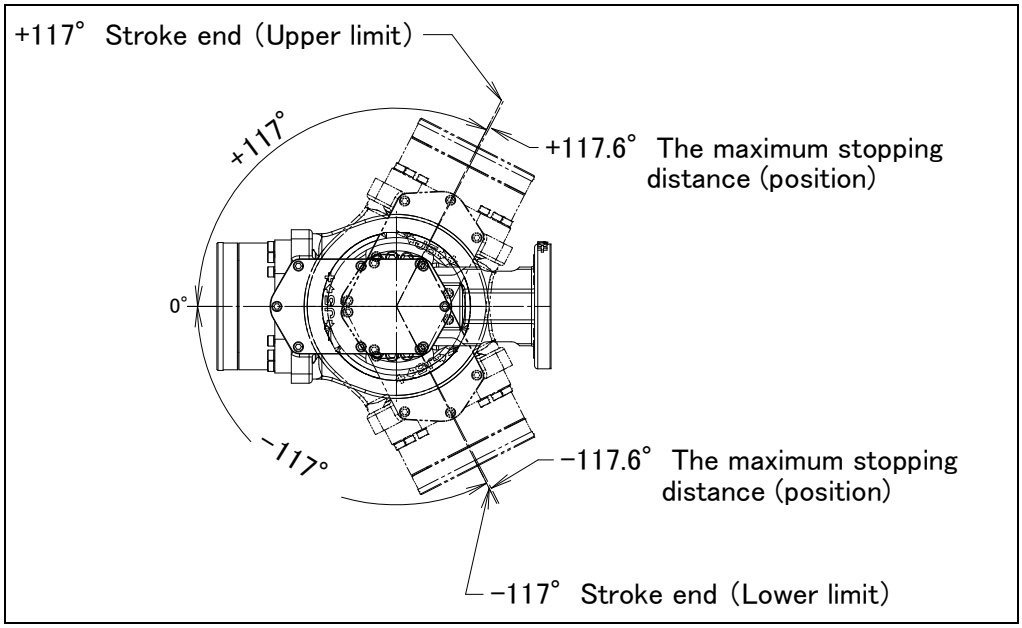


Fig. 3.3 (k) J4-axis motion limit (M-710*i*C/50H)

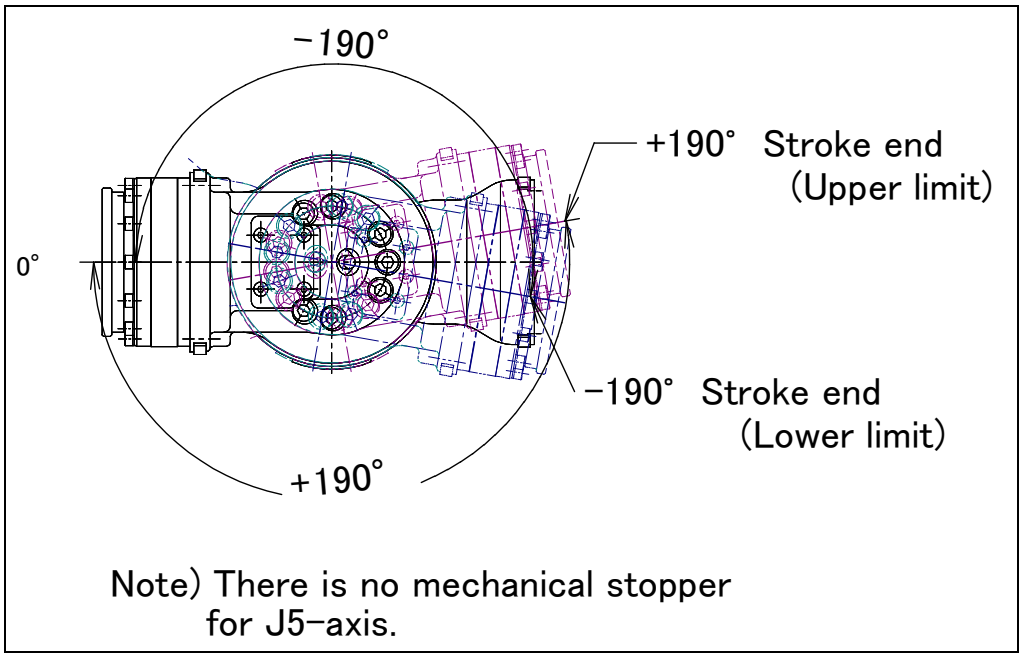


Fig. 3.3 (l) J5-axis motion limit (M-710*i*C/50E)

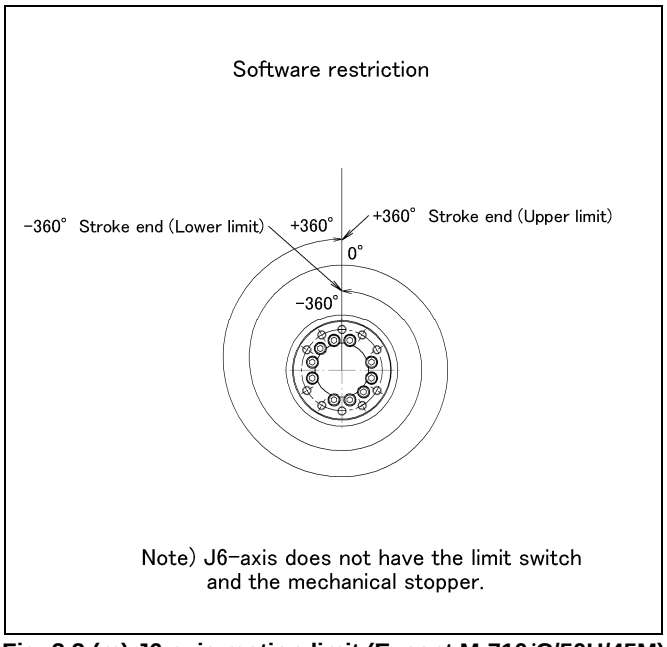
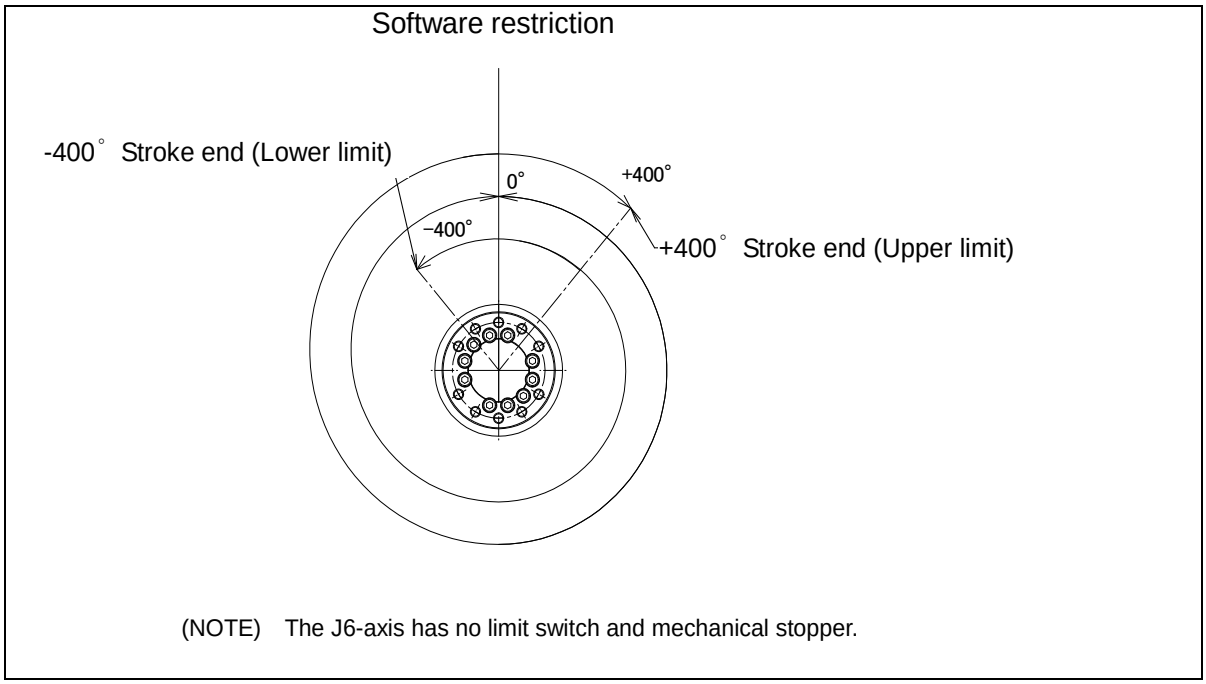


Fig. 3.3 (m) J6-axis motion limit (Except M-710*i*C/50H/45M)
J5-axis motion limit (M-710*i*C/50H)



(NOTE) The J6-axis has no limit switch and mechanical stopper.

Fig. 3.3 (n) J6-axis motion limit (M-710*i*C/45M)

3.4 WRIST LOAD CONDITIONS

Fig. 3.4 (a) to (e) are diagrams showing the allowable load that can be applied to the wrist section. Apply a load within the region indicated in the graph. Apply the conditions of the allowable load moment and the allowable load inertia. See Section 3.1 about allowable load moment and the allowable load inertia.

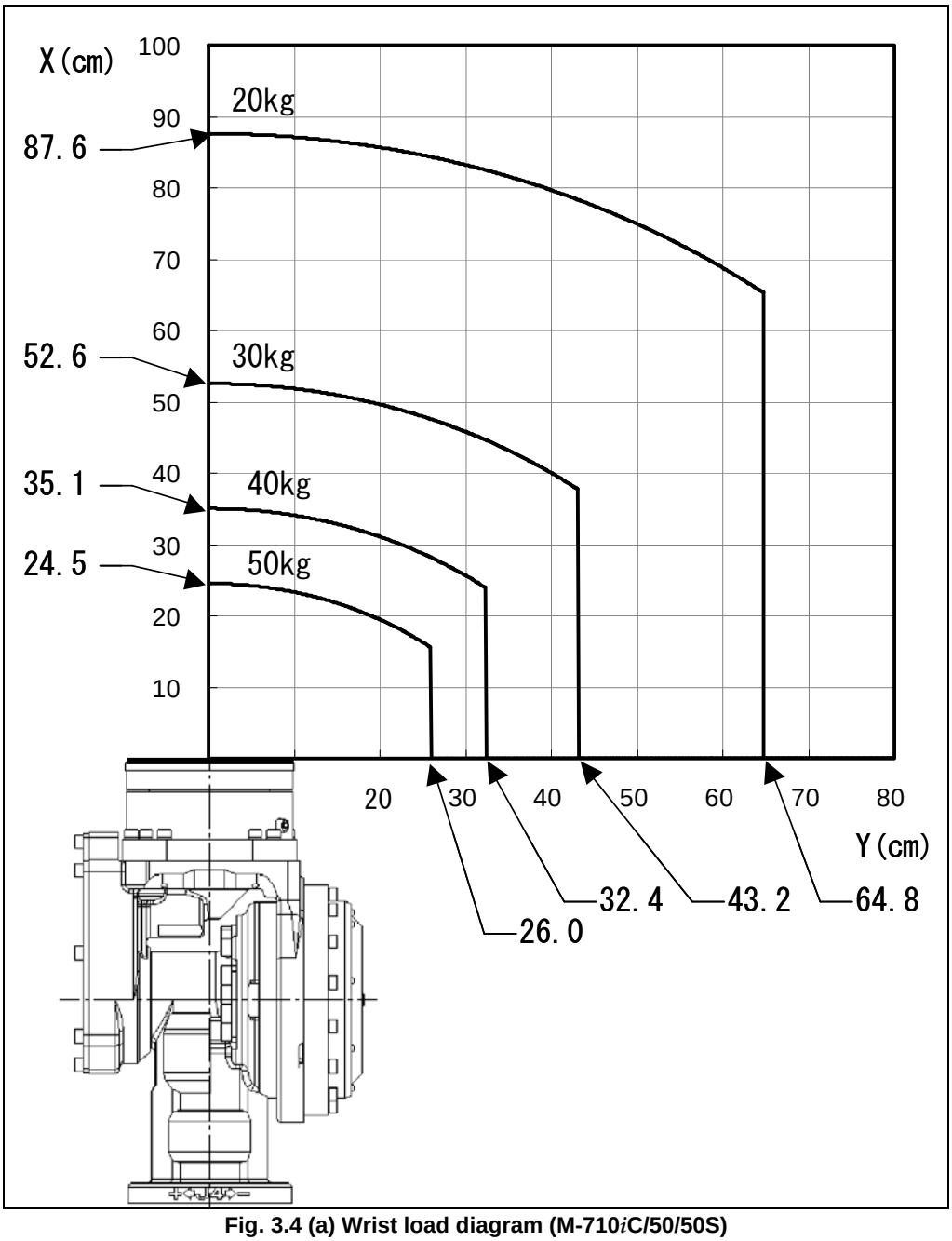


Fig. 3.4 (a) Wrist load diagram (M-710*i*C/50/50S)

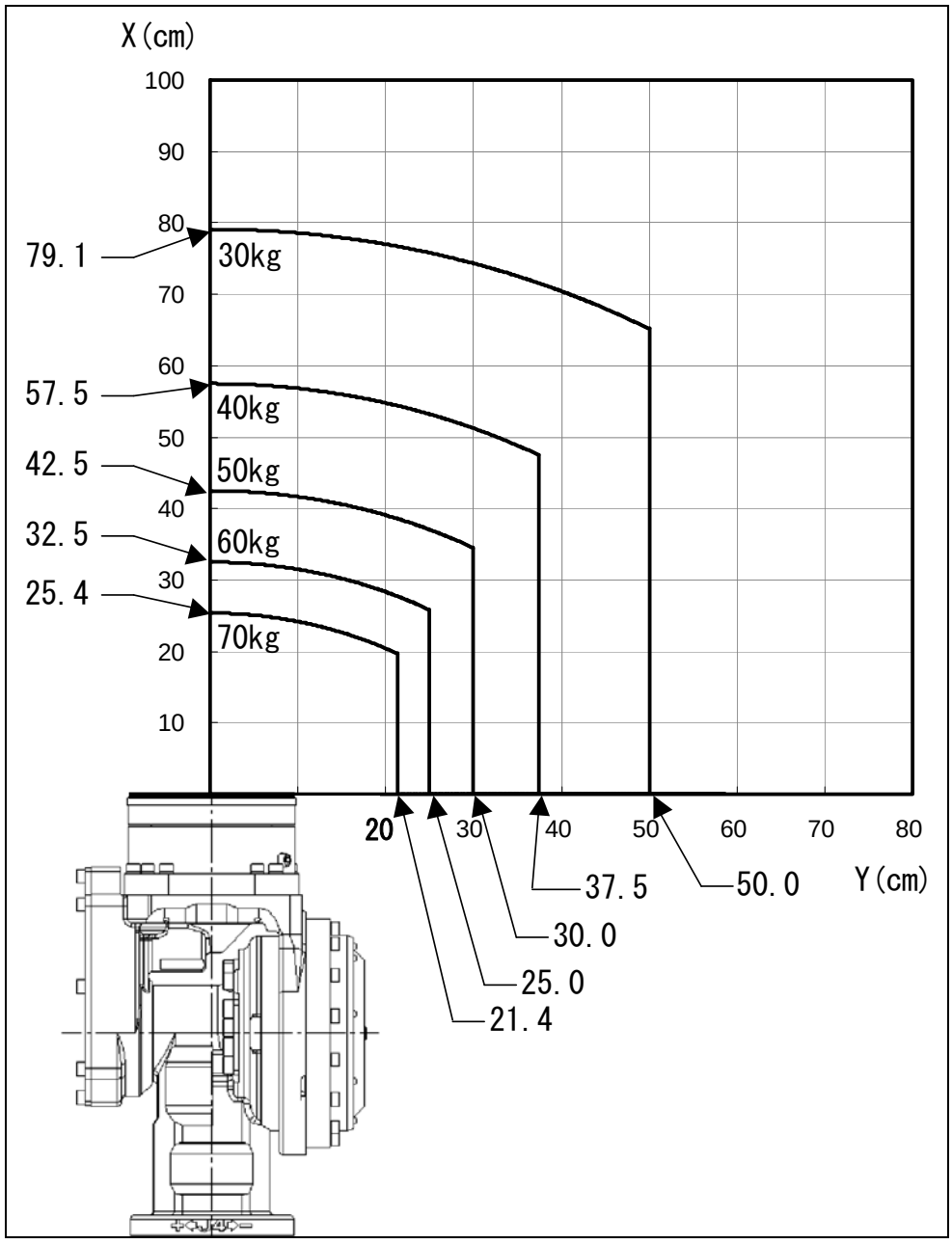


Fig. 3.4 (b) Wrist load diagram (M-710*i*C/70)

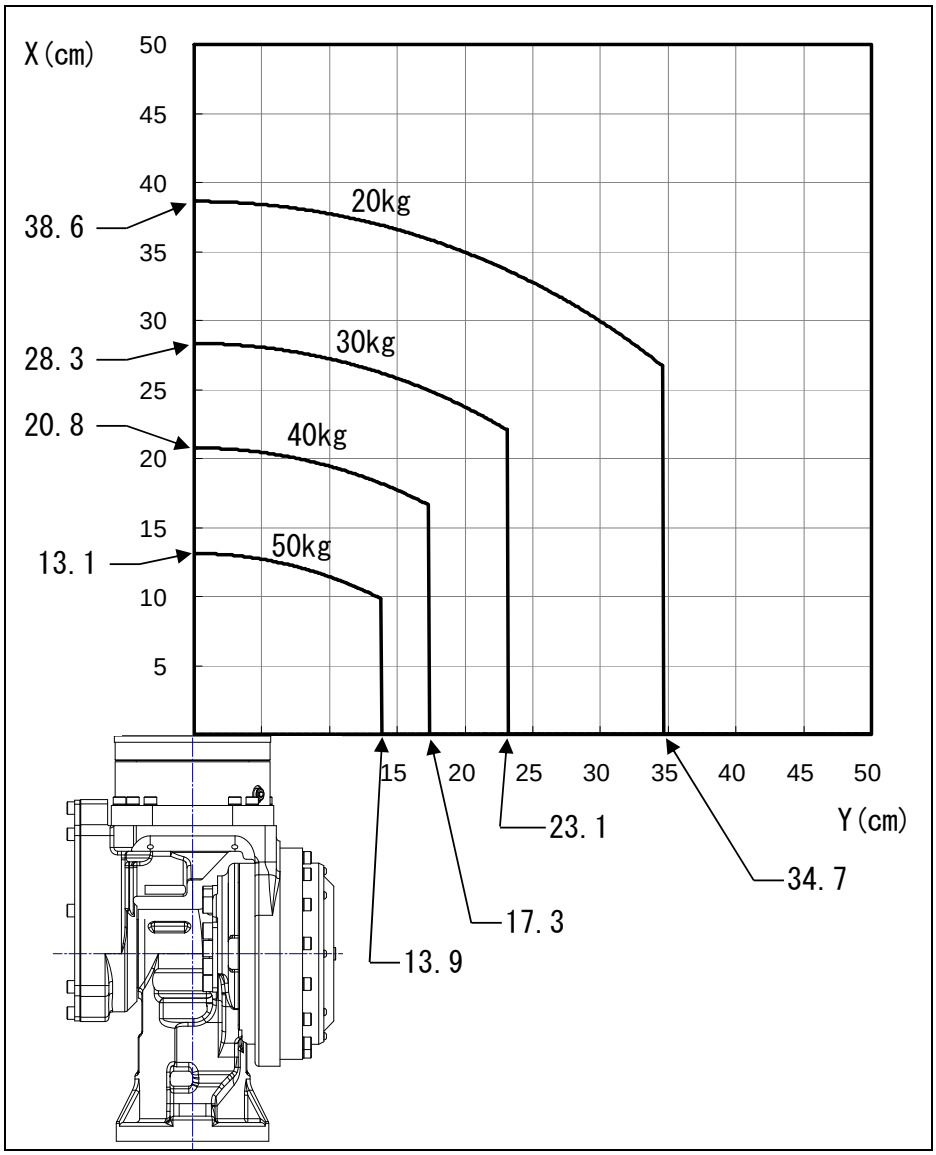


Fig. 3.4 (c) Wrist load diagram (M-710*i*C/50H)

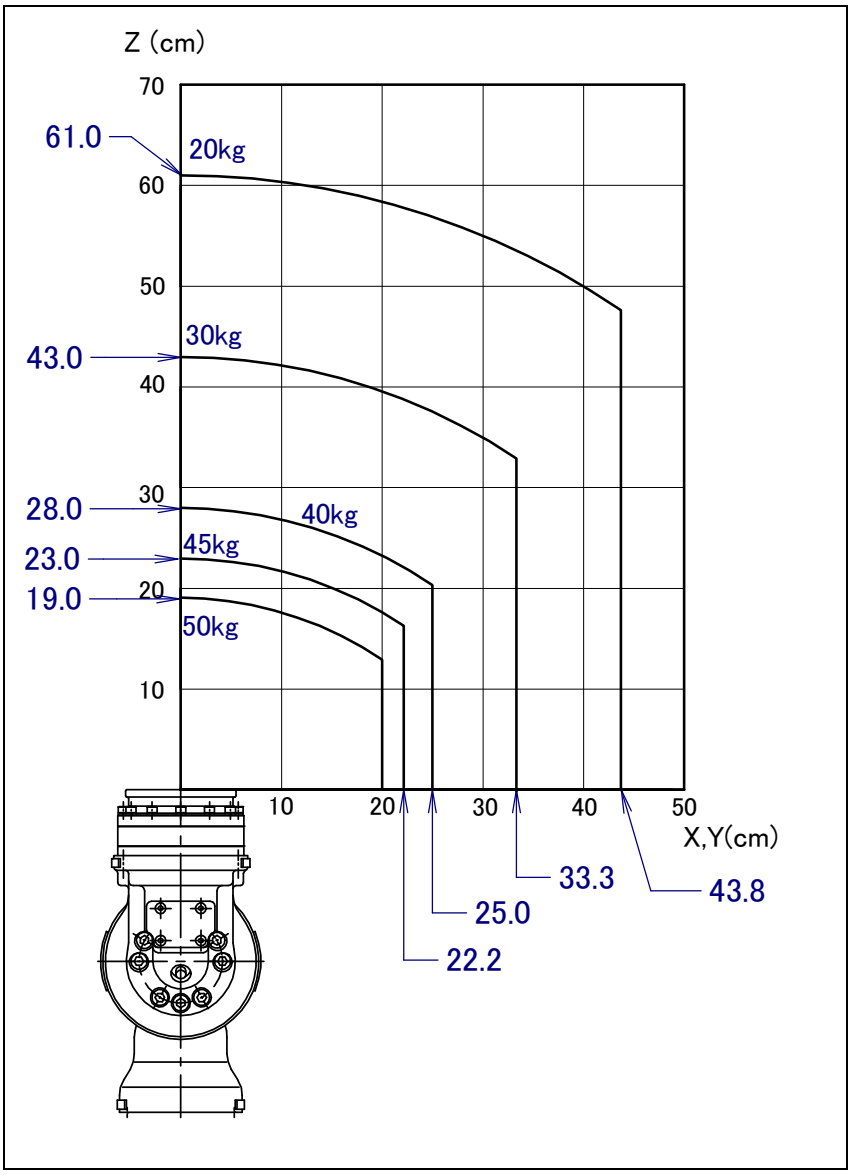


Fig. 3.4 (d) Wrist load diagram (M-710*i*C/50E)

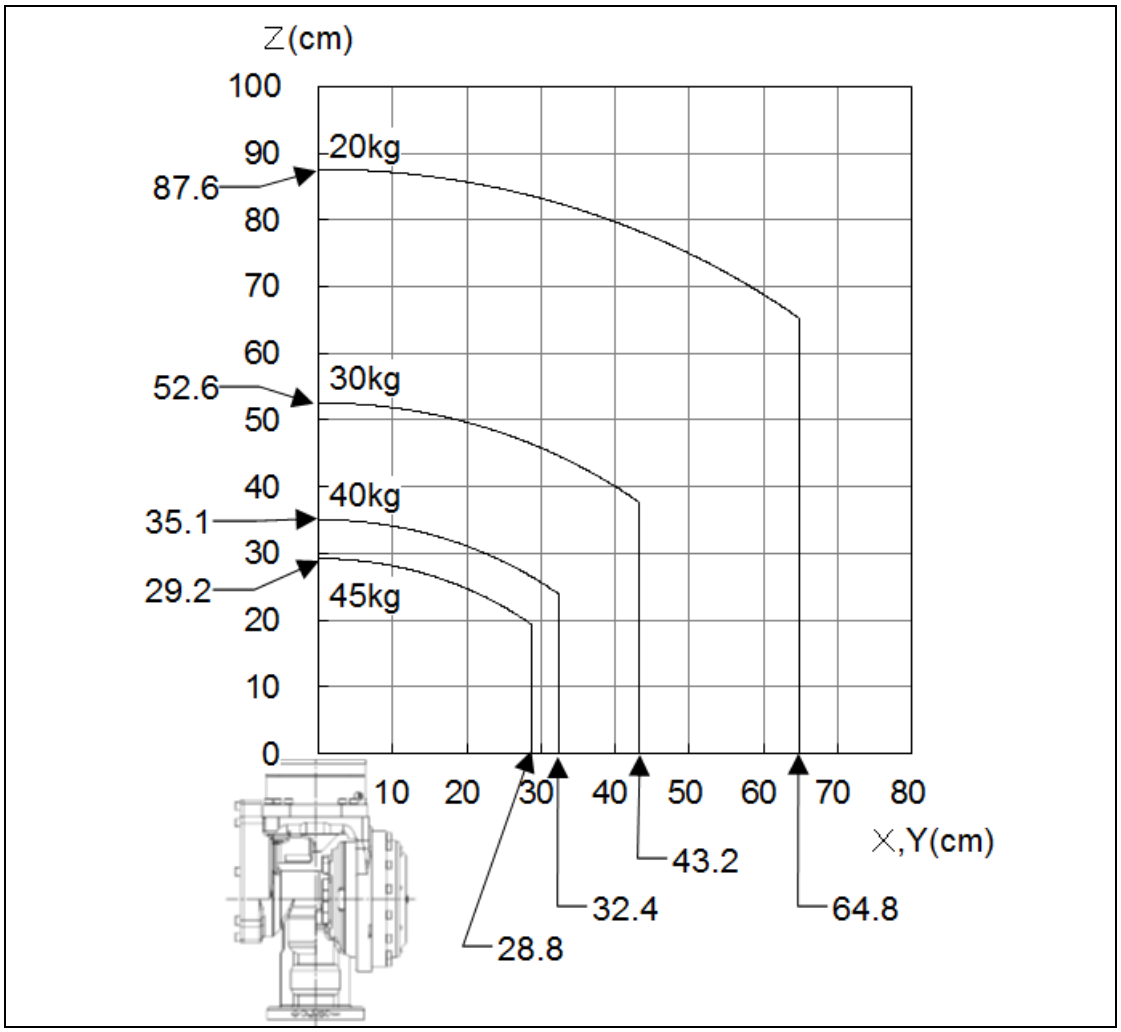


Fig. 3.4 (e) Wrist load diagram (M-710*i*C/45M)

3.5 LOAD CONDITIONS ON J3 CASING

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

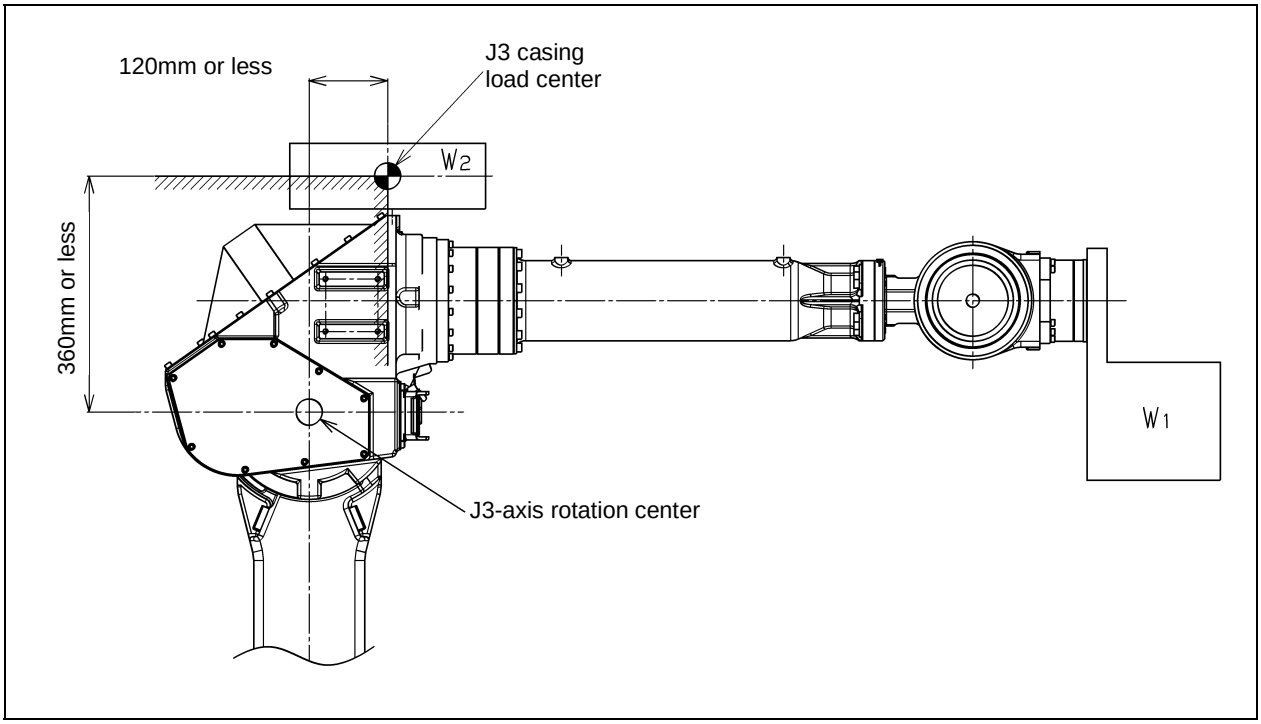


Fig. 3.5 J3 casing load condition

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

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

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

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

Table 3.5 (c) J3 casing load condition (M-710*i*C/45M)

Wrist load weight W_1	J3 casing load weight W_2
38 kg or less	15 kg or less
Equal to or more than 38 kg and equal to or less than 45 kg	$W_2 \le \frac{15}{7} \times (45 - W_1[kg])$

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

3.6 OPERATING SPACE FOR WALL/INCLINED SURFACE MOUNTED ROBOTS

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

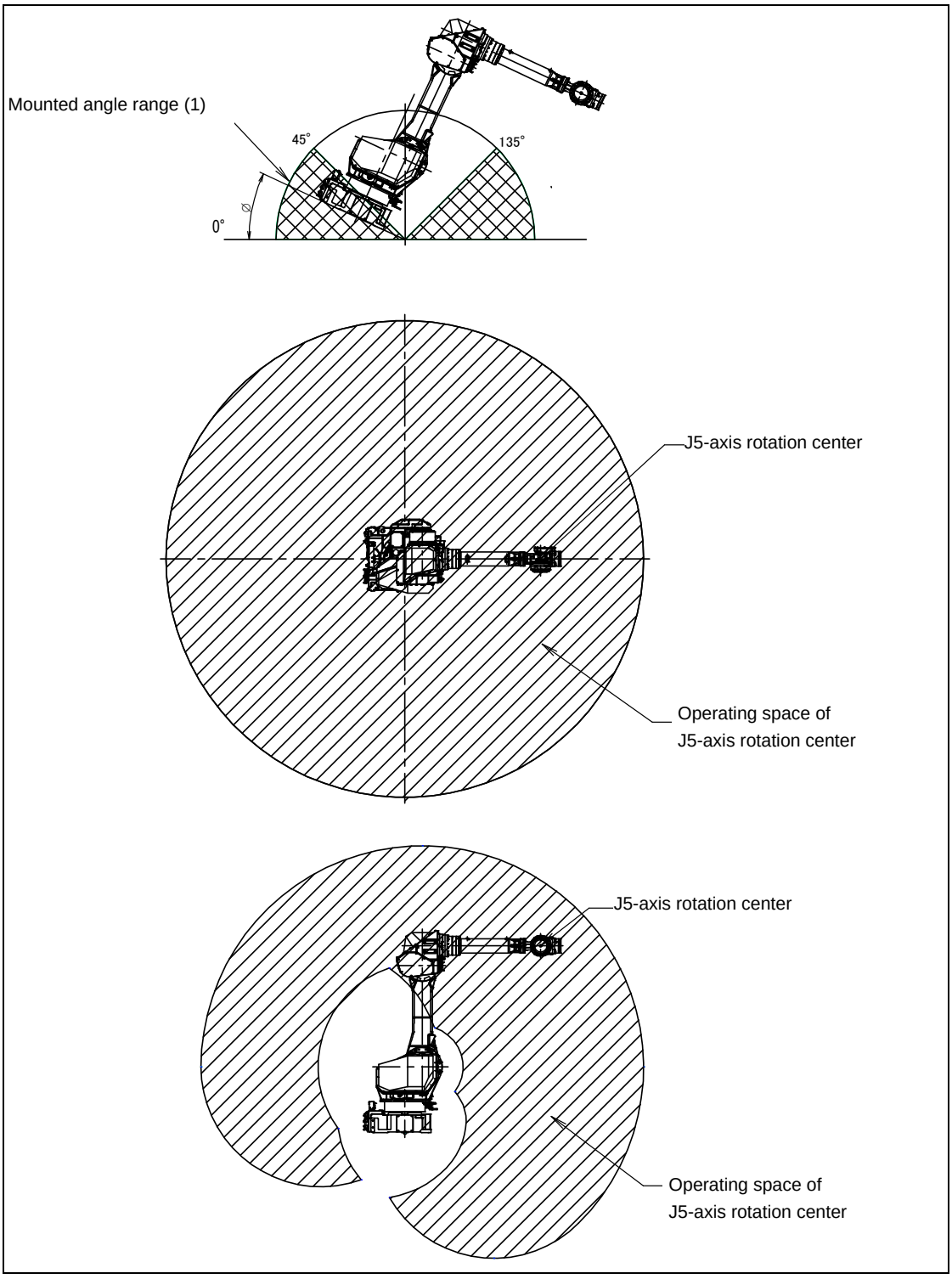


Fig. 3.6 (a) Operating space for mounted angle range (1) (M-710*i*C/50/50E)
(0°≦ϕ≦45°, 135°≦ϕ≦180°)

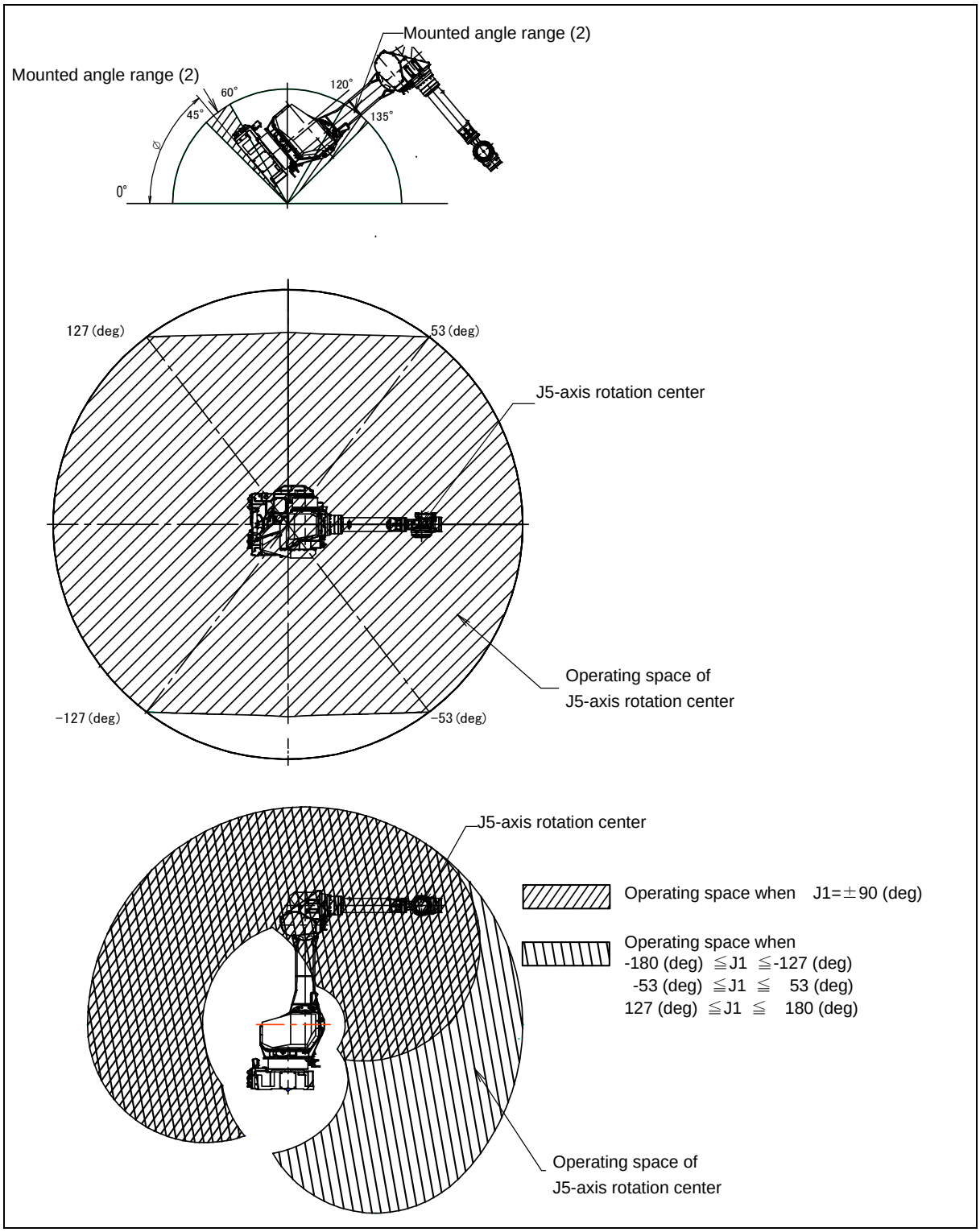


Fig. 3.6 (b) Operating space for mounted angle range (2) (M-710*i*C/50/50E)
(45°<φ≦60°, 120°≦φ<135°)

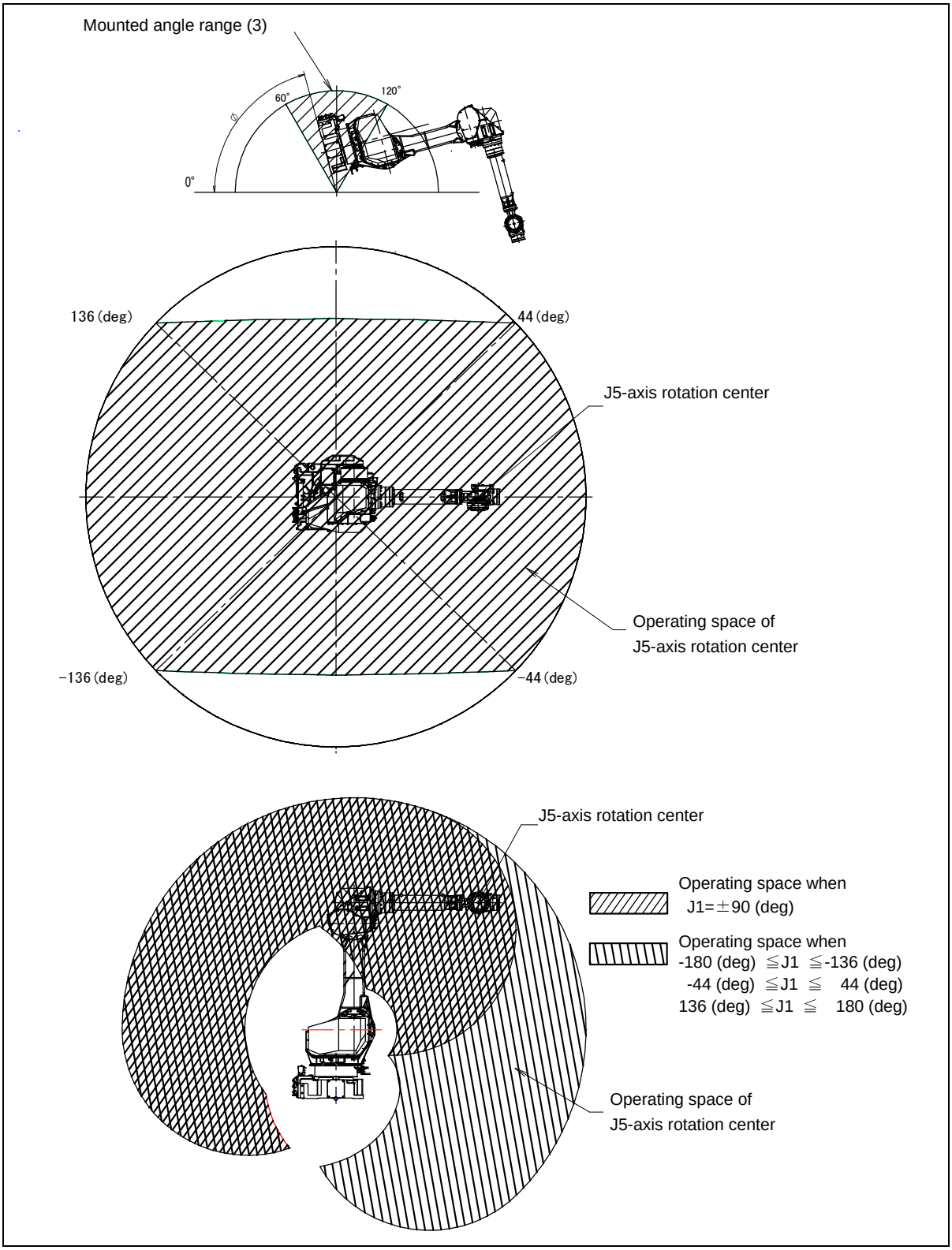


Fig. 3.6 (c) Operating space for mounted angle range (3) (M-710*i*C/50/50E) (60°< ϕ <120°)

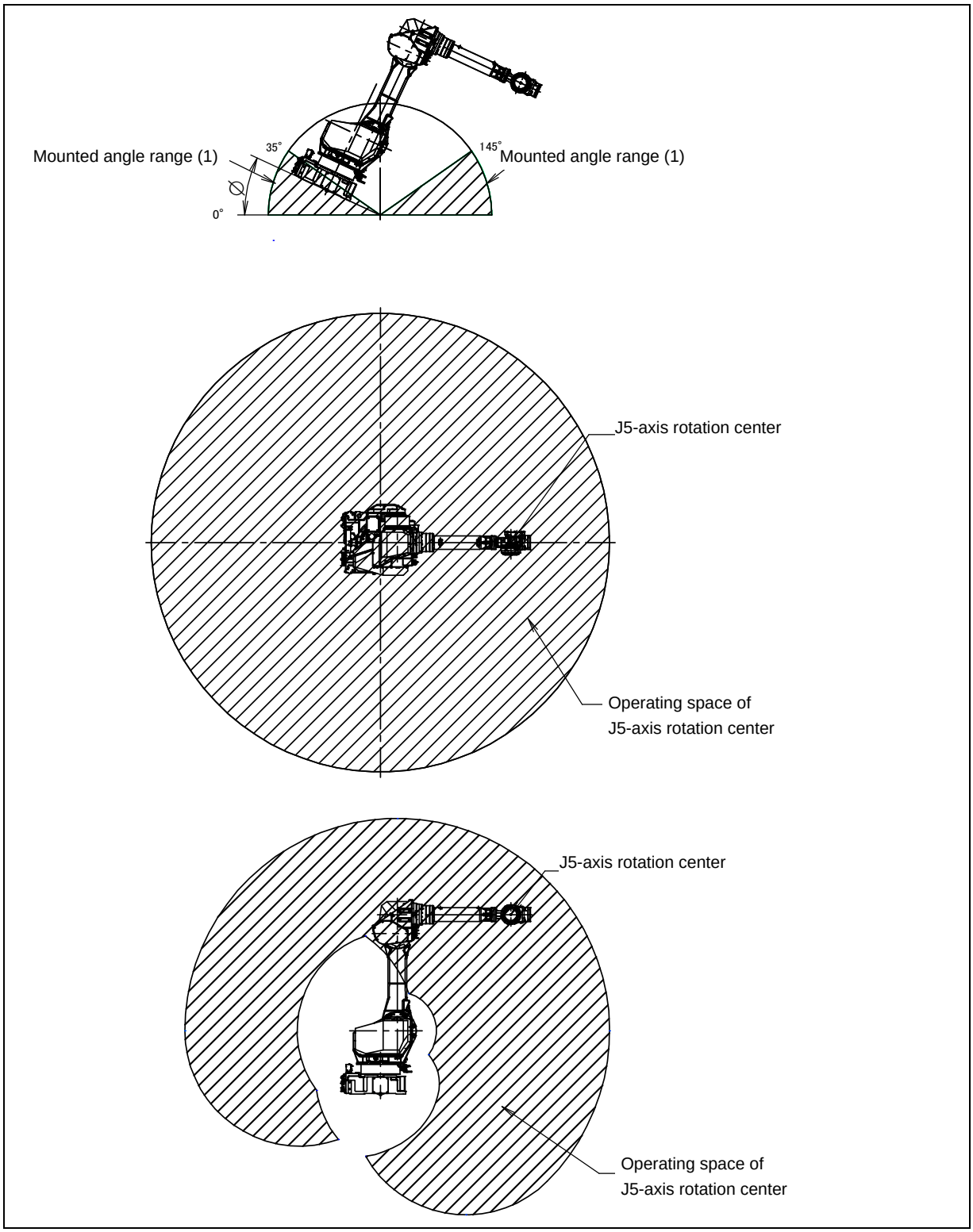


Fig. 3.6 (d) Operating space for mounted angle range (1) (M-710*i*C/70)
(0°≦ϕ≦35°, 145°≦ϕ≦180°)

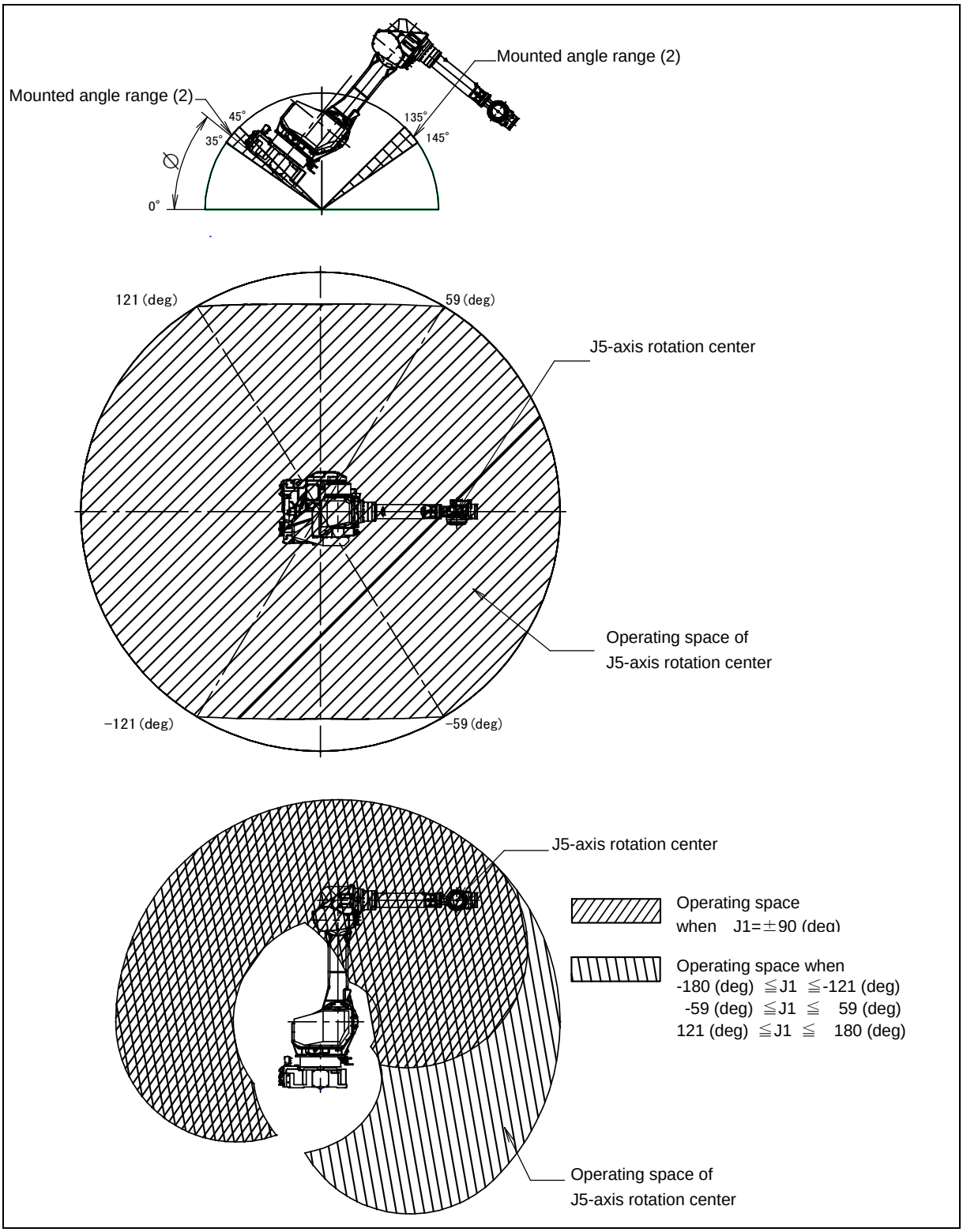


Fig. 3.6 (e) Operating space for mounted angle range (2) (M-710*i*C/70)
(35°< ϕ ≦45°, 135°≦ ϕ <145°)

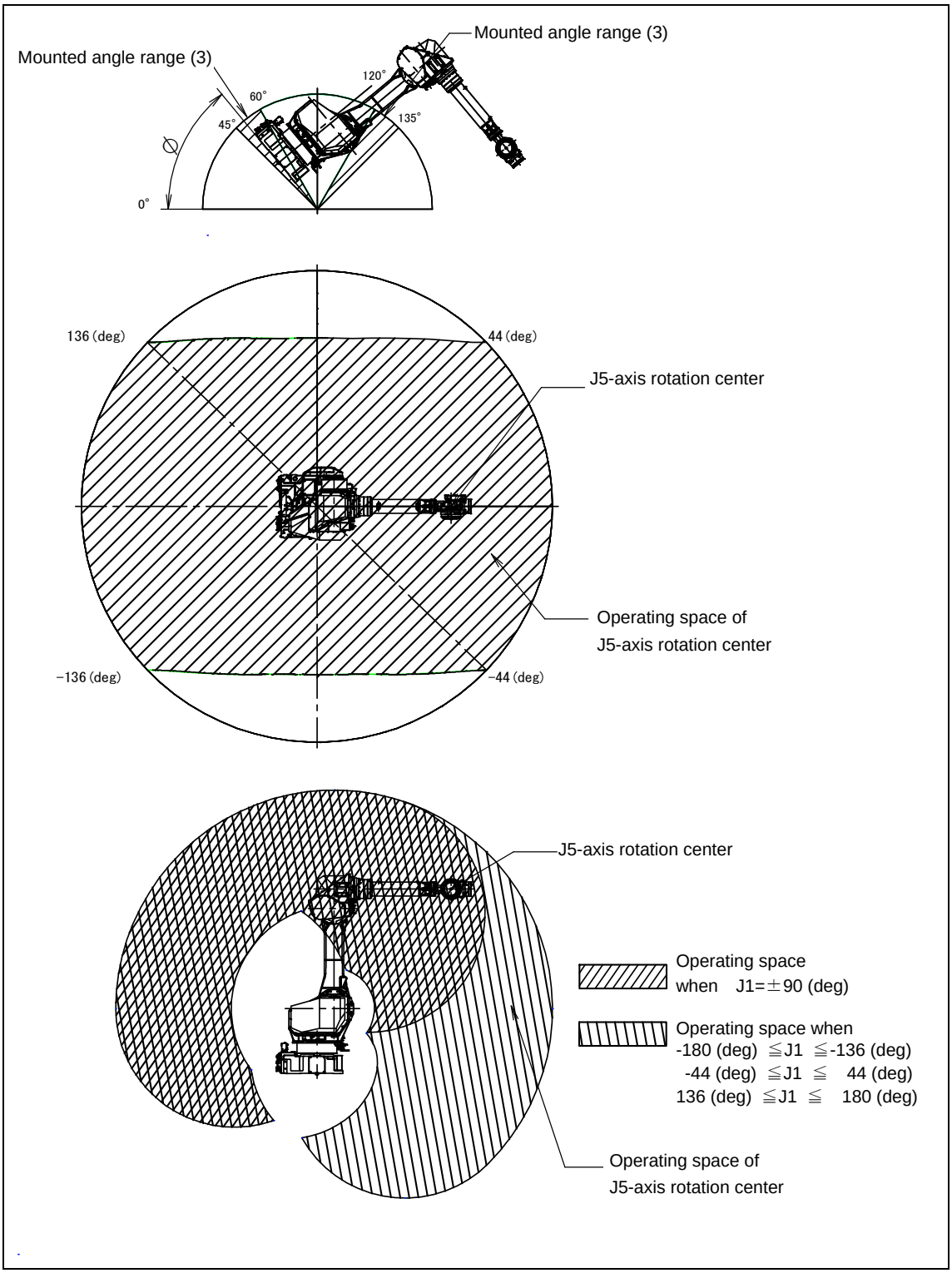


Fig. 3.6 (f) Operating space for mounted angle range (3) (M-710*i*C/70)
(45°<ϕ≦60°, 120°≦ϕ<135°)

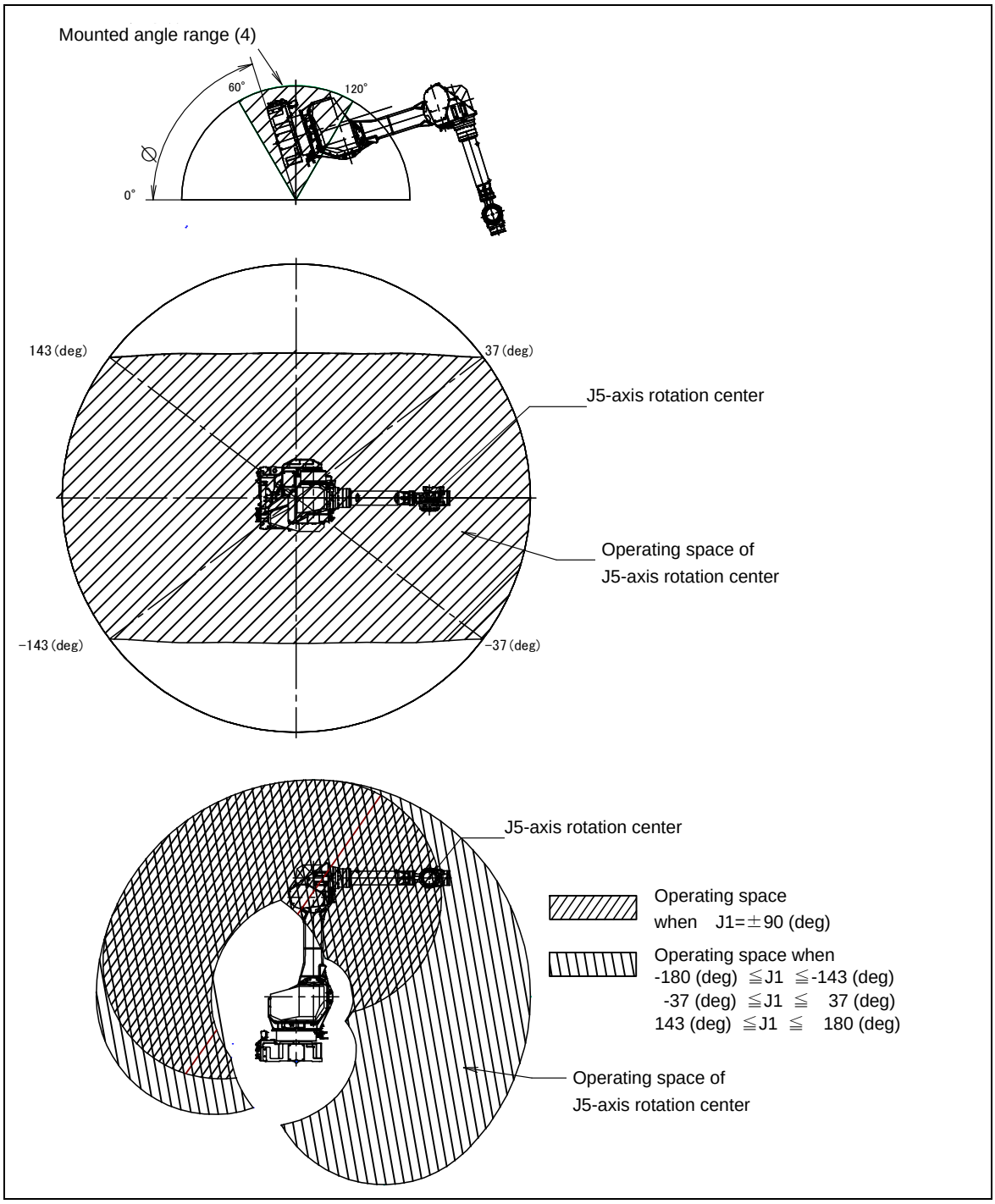


Fig. 3.6 (g) Operating space for mounted angle range (4) (M-710*i*C/70)
(60°< ϕ <120°)

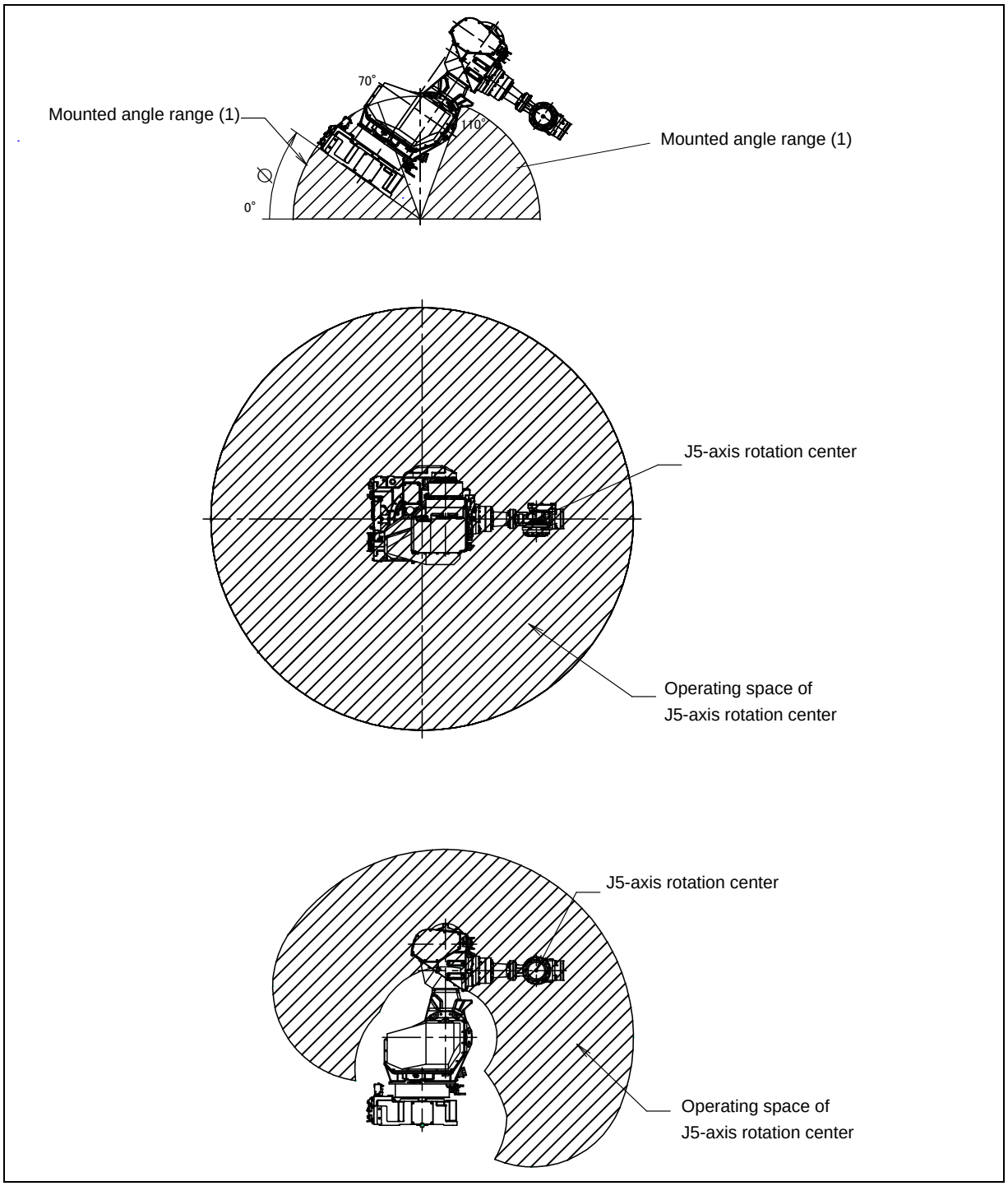


Fig. 3.6 (h) Operating space for mounted angle range (1) (M-710*i*C/50S)
(0°≦ϕ≦70°, 110°≦ϕ≦180°)

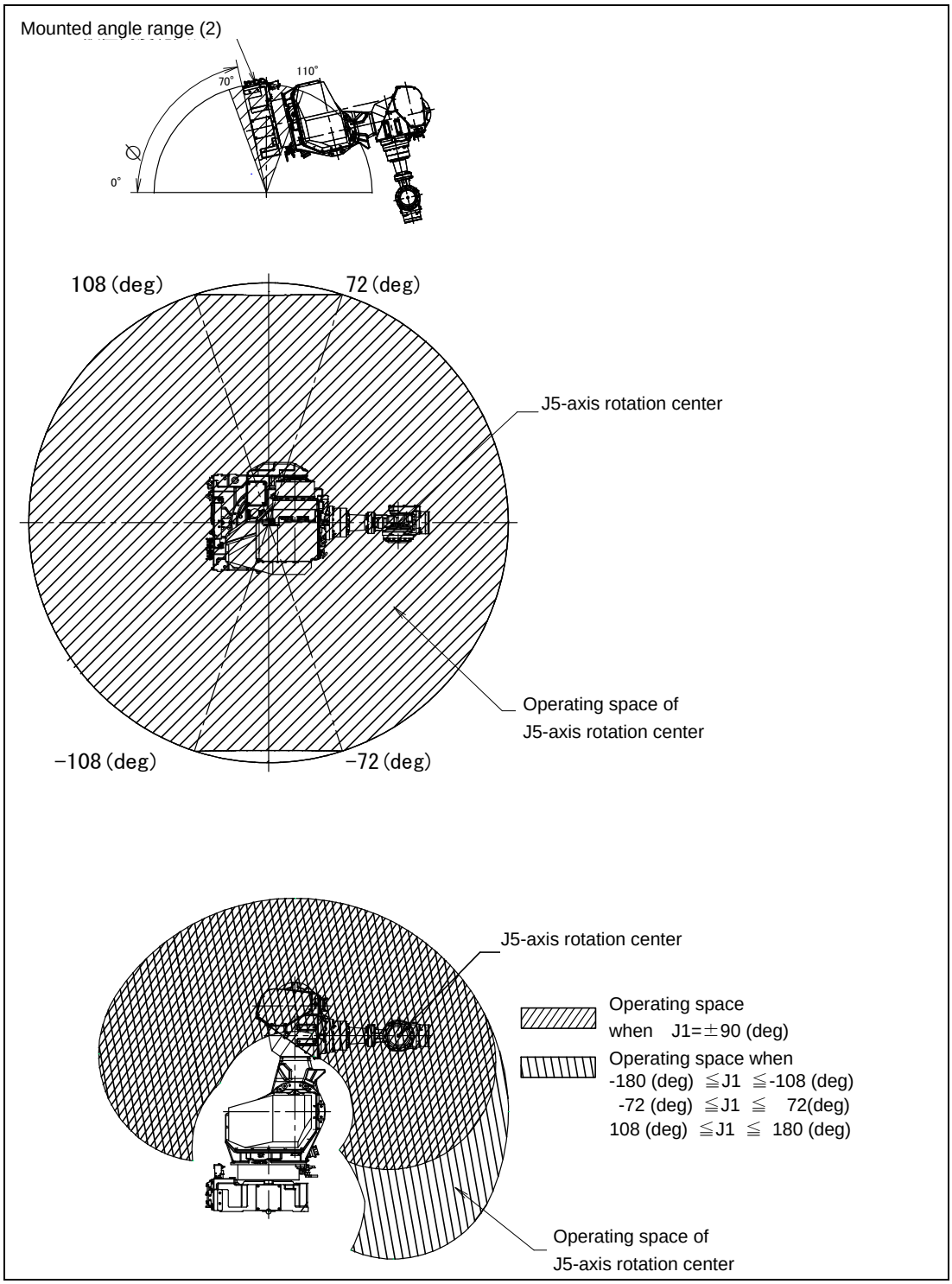


Fig. 3.6 (i) Operating space for mounted angle range (2) (M-710*i*C/50S) (70°< ϕ <110°)

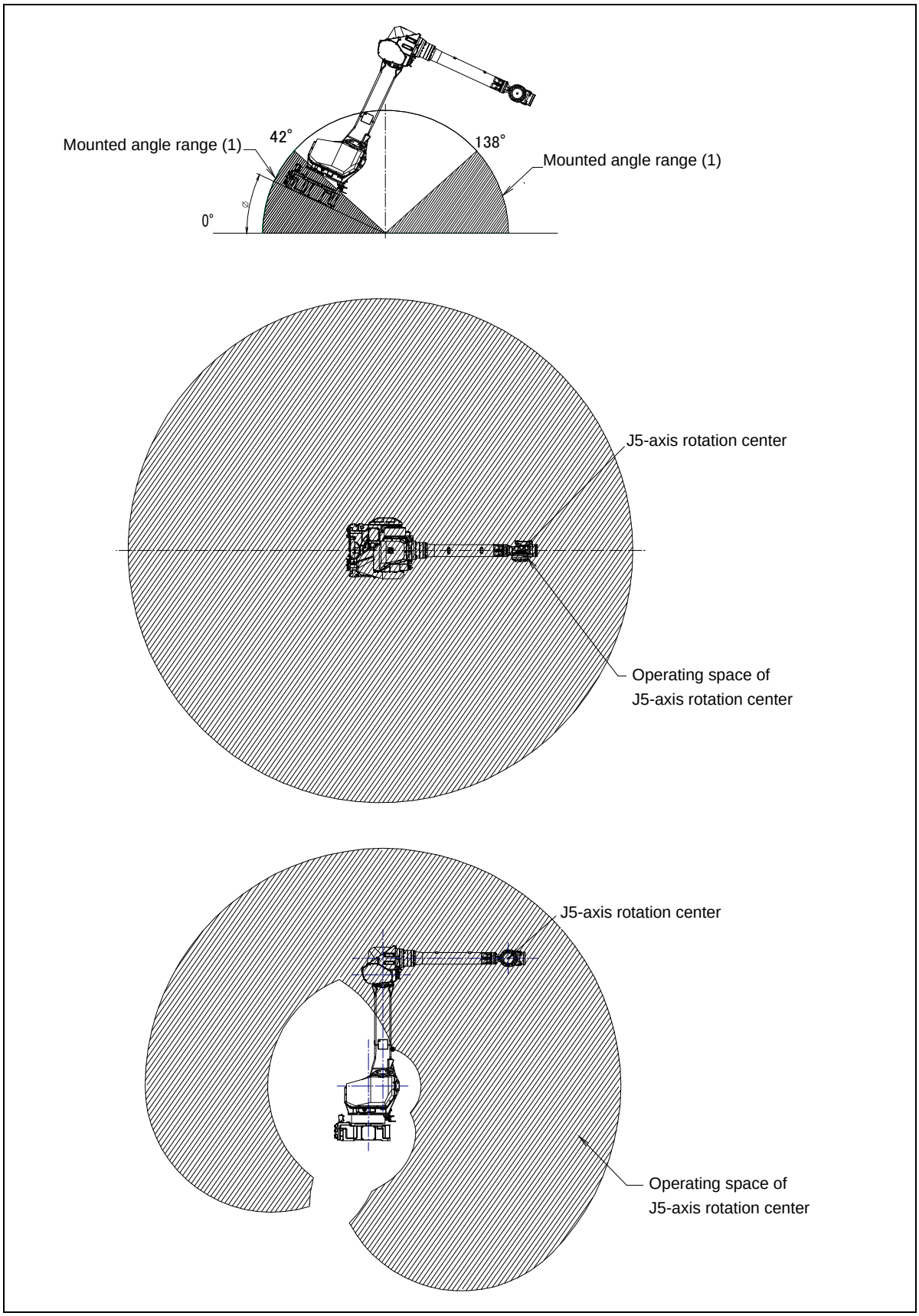


Fig. 3.6 (j) Operating space for mounted angle range (1) (M-710*i*C/45M)
(0°≦ϕ≦42°, 138°≦ϕ≦180°)

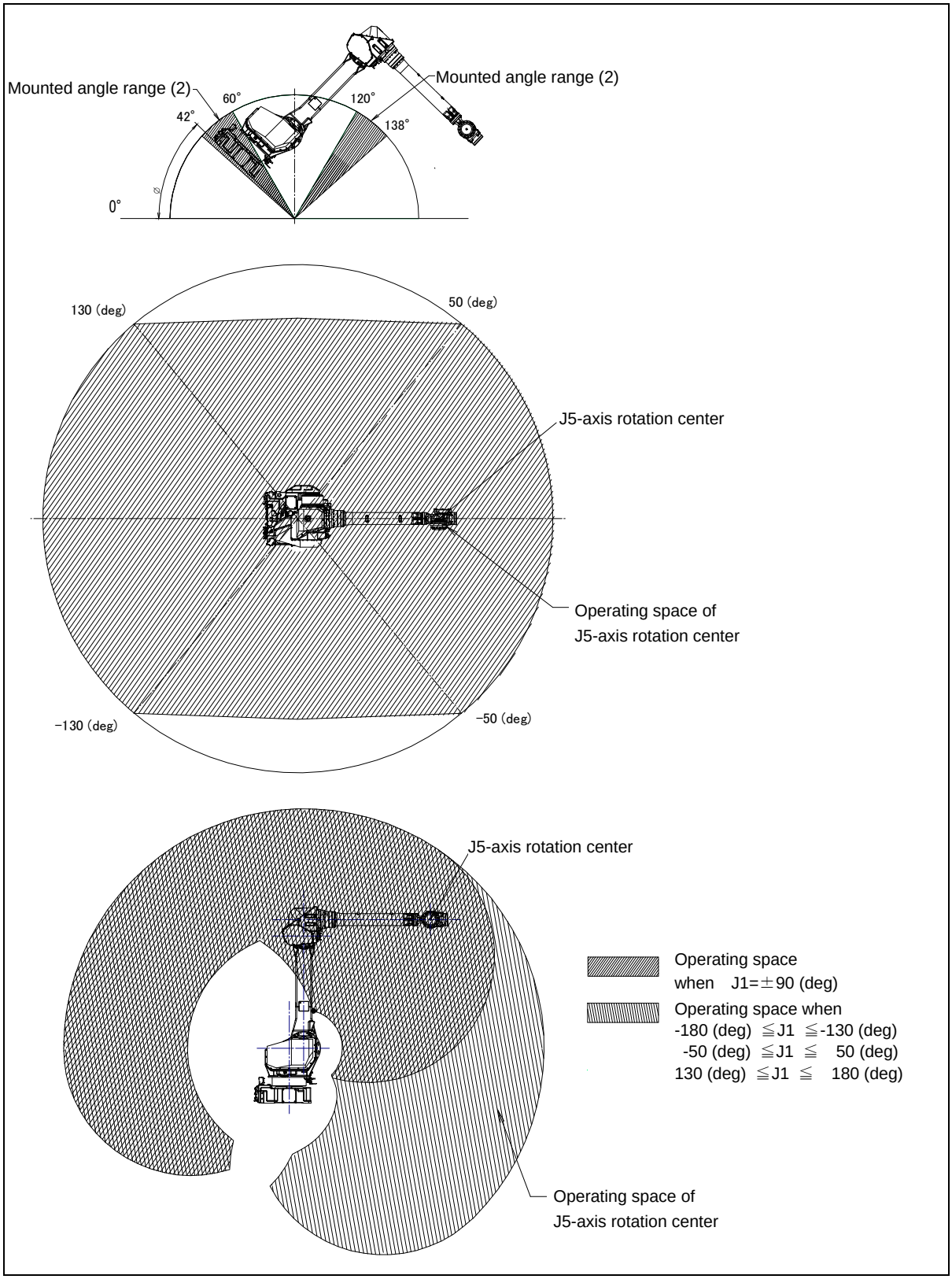


Fig. 3.6 (k) Operating space for mounted angle range (2) (M-710*i*C/45M)
(42°< ϕ ≦60°, 120°≦ ϕ <138°)

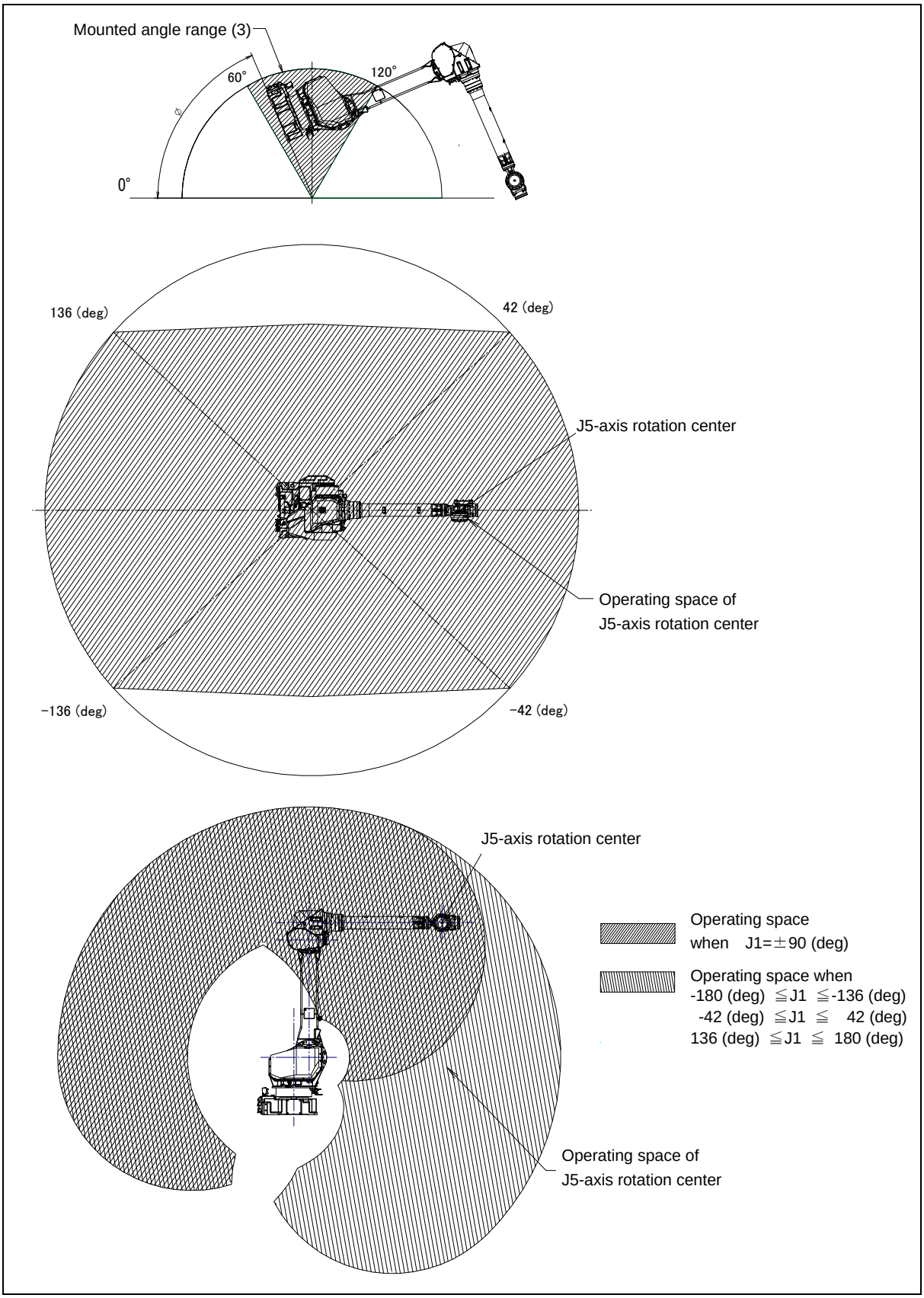


Fig. 3.6 (l) Operating space for mounted angle range (3) (M-710*i*C/45M)
(60°< ϕ <120°)

4 EQUIPMENT INSTALLATION TO THE ROBOT

4.1 END EFFECTOR INSTALLATION TO WRIST

Fig. 4.1 (a) to (f) 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. Fasten the bolt for fixing the end effector with following torque.

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

Table 4.1 Hexagon socket head bolt (Tensile strength 1200N/mm^2 or more)

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

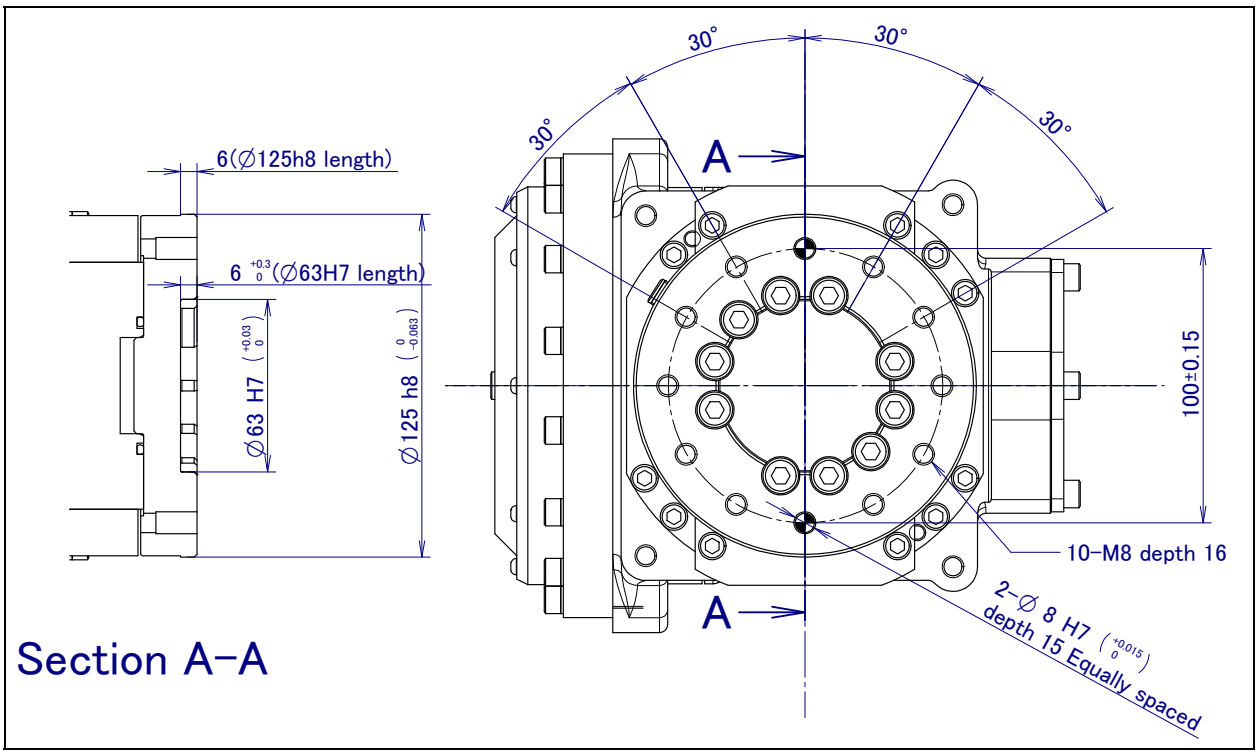


Fig. 4.1 (a) ISO flange, ISO rust protection flange (M-710*i*C/50/70/50H/50S/45M)

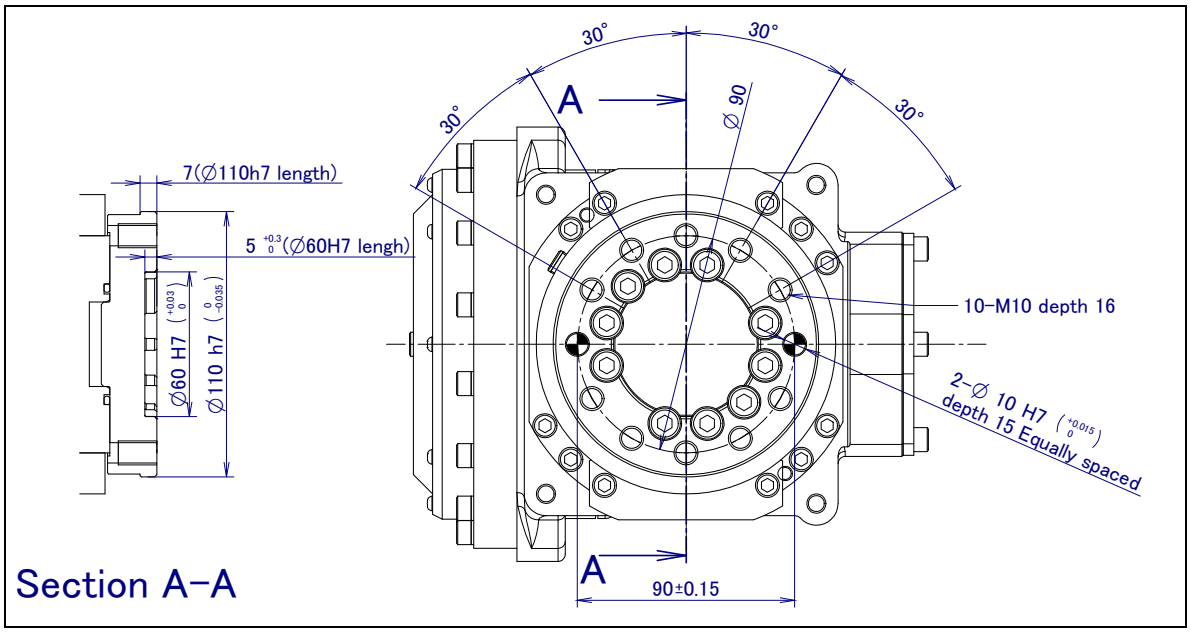


Fig. 4.1 (b) FANUC flange (M-710*i*C/50/70/50H/50S/45M)

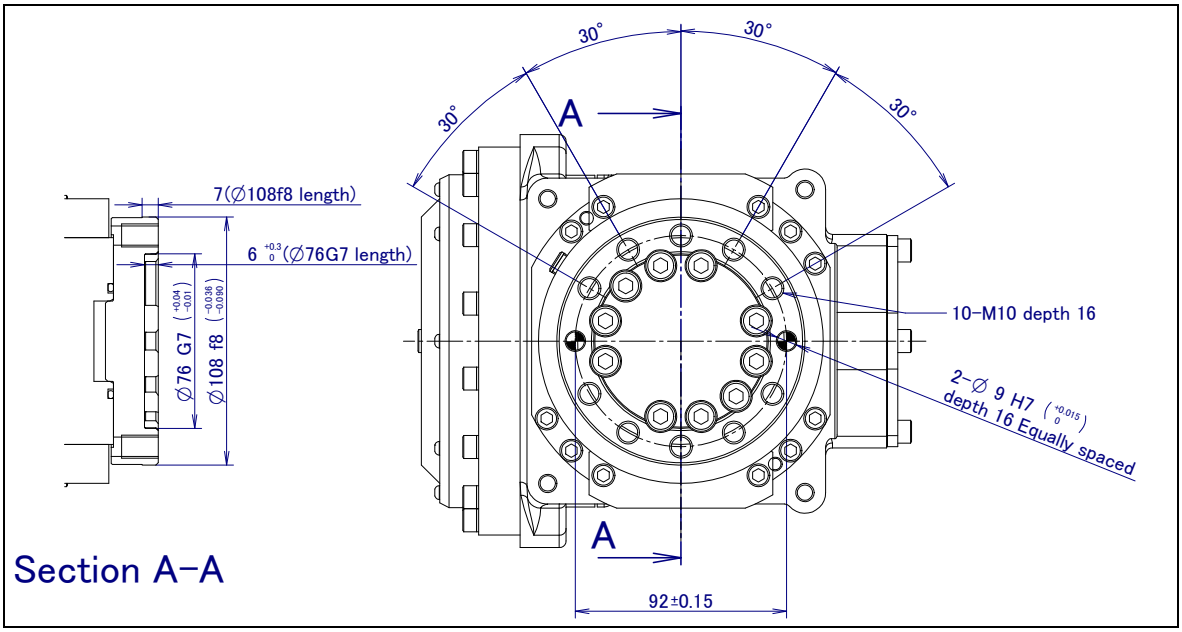


Fig. 4.1 (c) Special flange (M-710*i*C/50/70/50H/50S/45M)

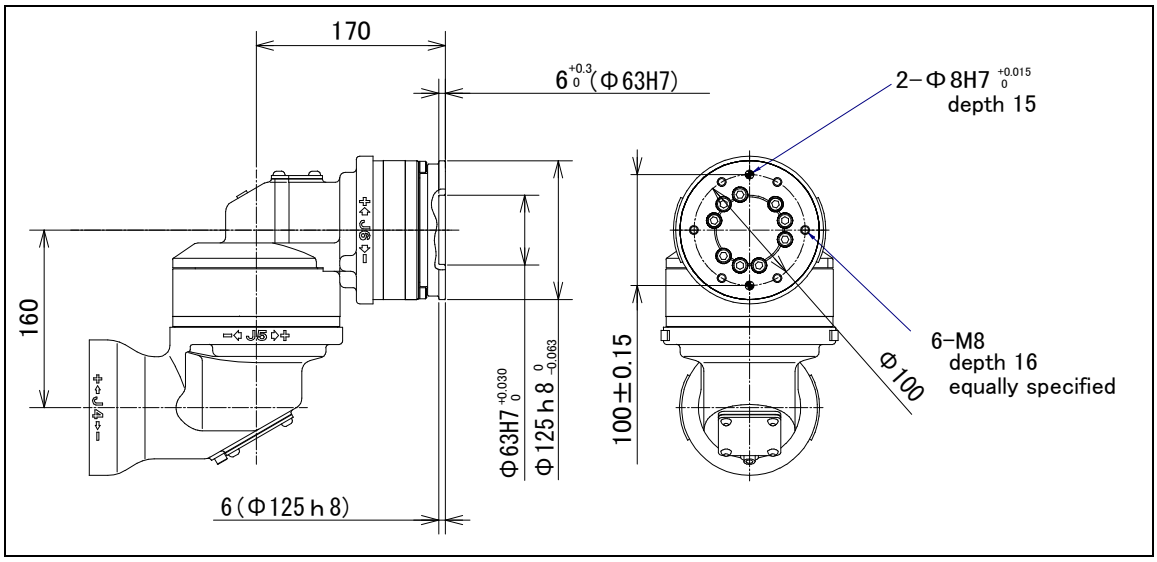


Fig. 4.1 (d) ISO flange, ISO antirust flange (M-710*i*C/50E)

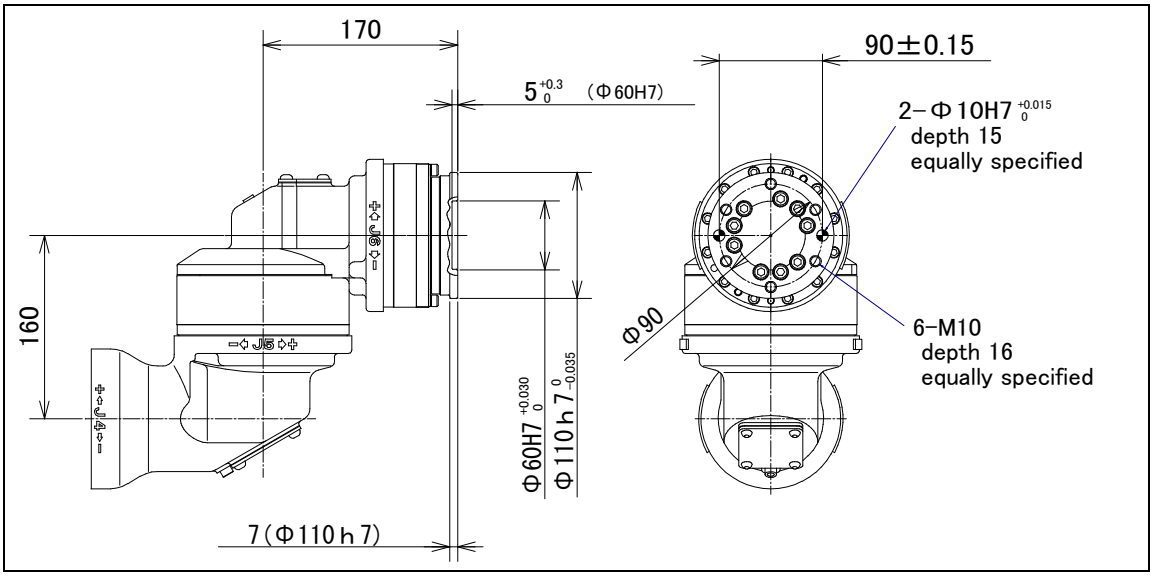


Fig. 4.1 (e) FANUC flange (M-710*i*C/50E)

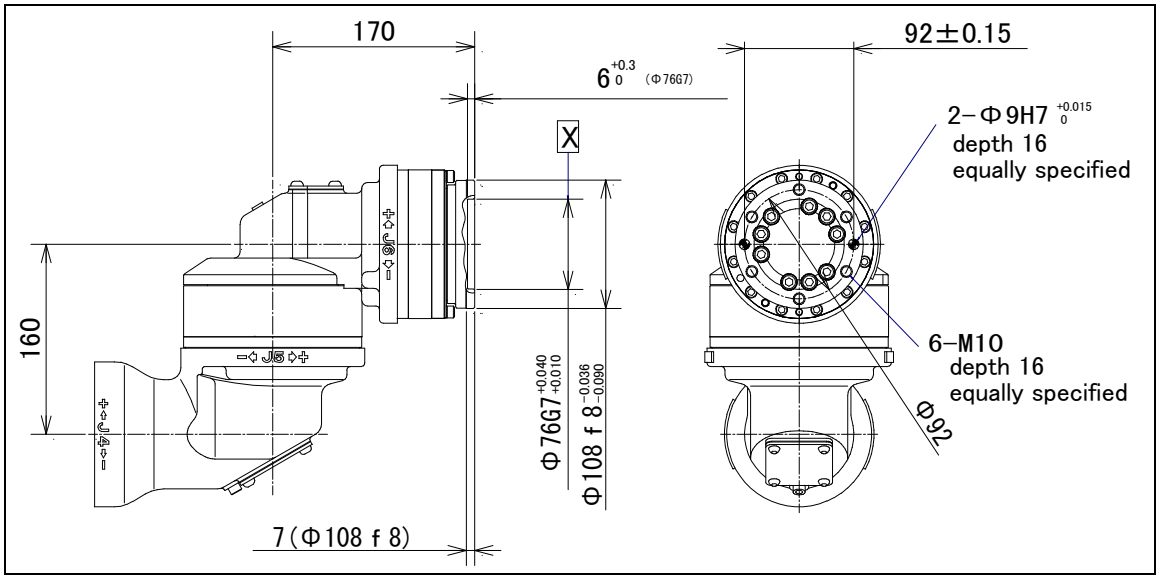


Fig. 4.1 (f) Special flange (M-710*i*C/50E)

4.2 EQUIPMENT MOUNTING FACE

As shown in Fig. 4.2 (a) to (c), 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 on robot in a way it does not interfere with the mechanical unit cables. If equipment interfere, the mechanical unit cable might be disconnected, and unexpected troubles might occur.
4 Do not put load on J3 arm. (There is no problem for putting load on J3 casing.)
5 If equipment is installed to J3 arm, it is dangerous because it rotate with J3 arm. (except M-710*i*C/50H)
6 If you put load on J3 arm, unavoidably, treat it as wrist load.

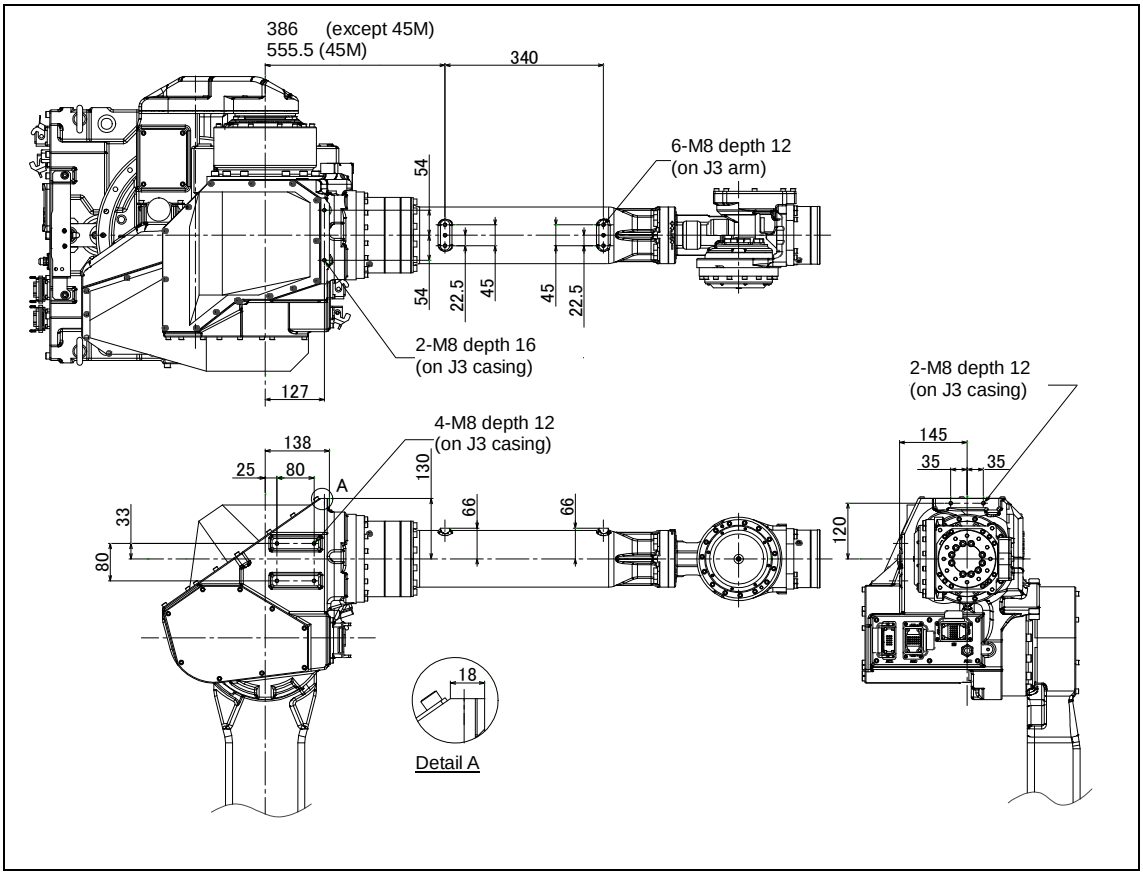


Fig. 4.2 (a) Equipment mounting surfaces (M-710*i*C/50/70/45M/50E)

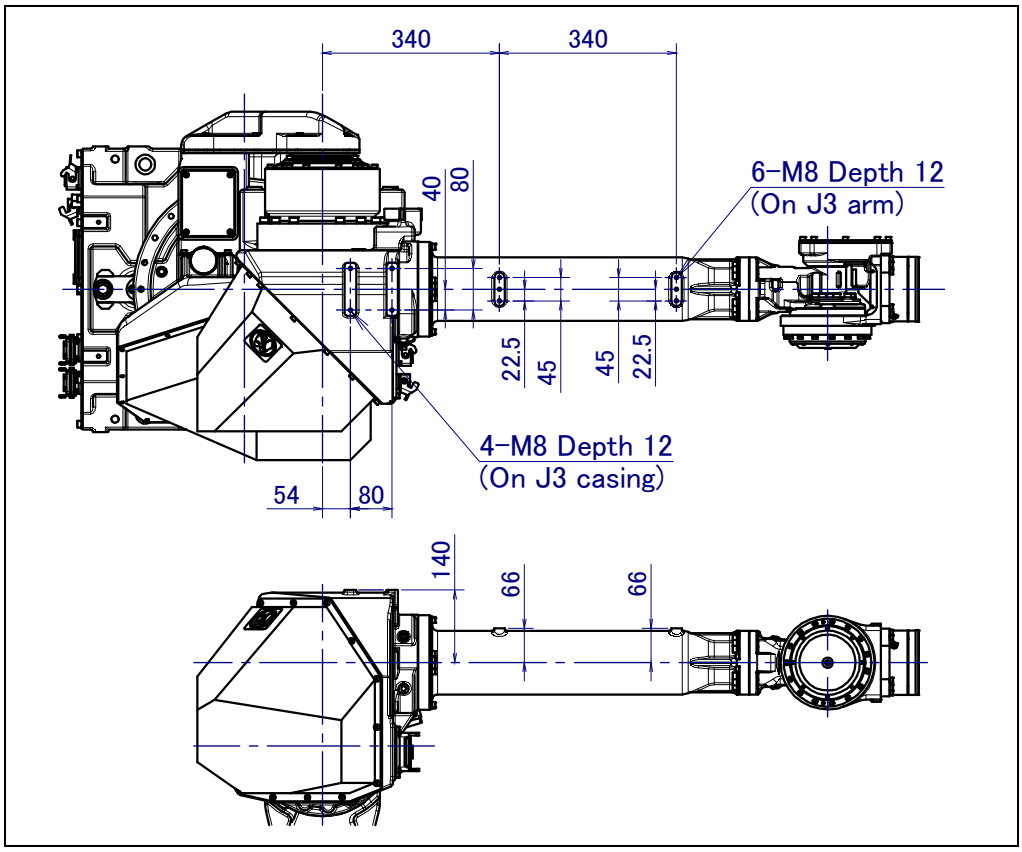


Fig. 4.2 (b) Equipment mounting surfaces (M-710*i*C/50H)

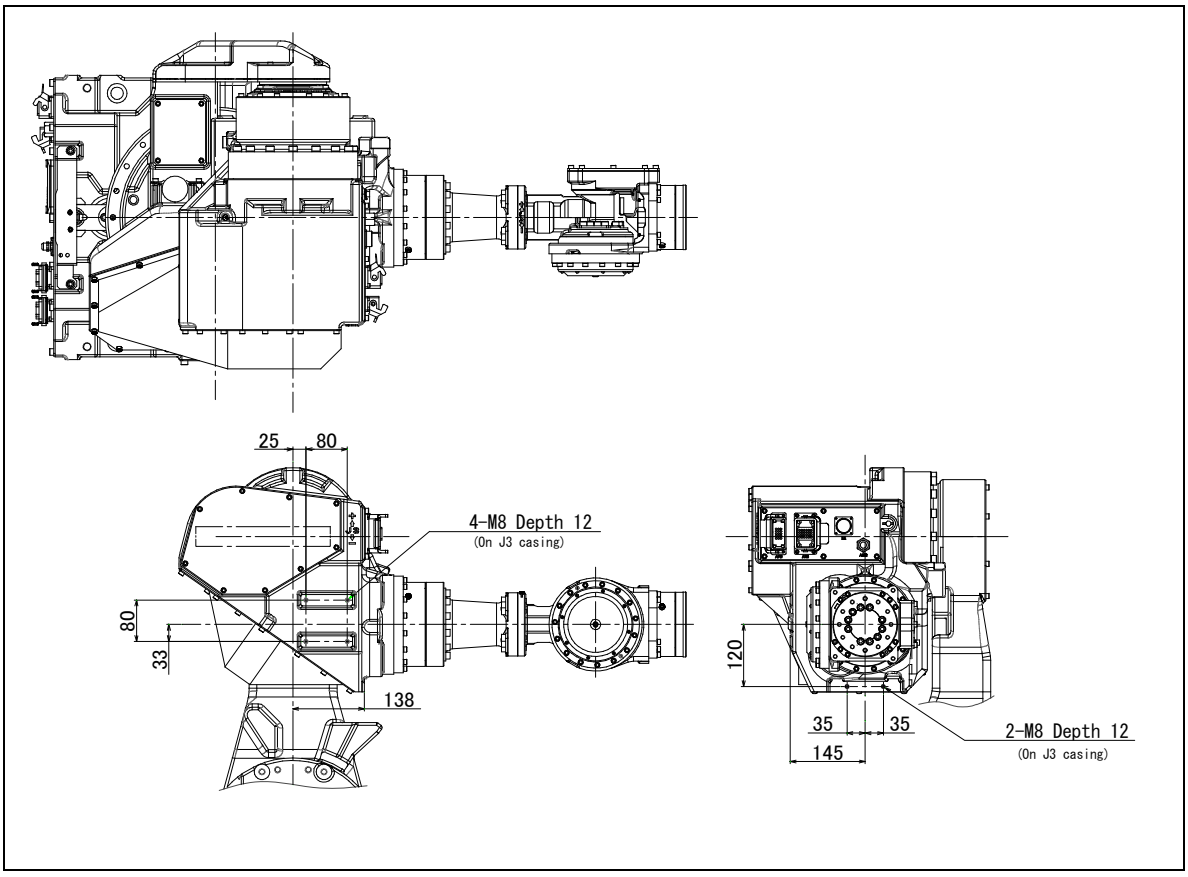


Fig. 4.2 (c) Equipment mounting surfaces (M-710*i*C/50S)

4.3 LOAD SETTING

⚠ CAUTION

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

2 WHEN PERFORMING LOAD ESTIMATION AFTER PARTS REPLACEMENT
If wrist axes (J5/J6-axis) motors or reducers are replaced, estimation accuracy may go down. Perform the calibration for load estimation before performing load estimation. Refer to below.
- Section 9.15 "LOAD ESTIMATION" in R-30*i*A Controller Spot tool+ OPERATOR'S MANUAL (B-83124EN-1).
- Section 9.15 "LOAD ESTIMATION" in R-30*i*A Controller Handling tool OPERATOR'S MANUAL (B-83124EN-2).
- Section 9.15 "LOAD ESTIMATION" in R-30*i*A Controller Arc tool OPERATOR'S MANUAL (B-83124EN-3).
- Section 9.15 "LOAD ESTIMATION" in R-30*i*A Controller Dispense tool OPERATOR'S MANUAL (B-83124EN-4).
- Chapter 9 "LOAD ESTIMATION" in R-30*i*B/R-30*i*B Mate/R-30*i*B Plus/R-30*i*B Mate Plus Controller Optional Function OPERATOR'S MANUAL (B-83284EN-2).

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

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

```
MOTION PERFORMANCE                    JOINT 10%
     Group1
No.   PAYLOAD[kg]          Comment
  1          50.00   [                    ]
  2           0.00   [                    ]
  3           0.00   [                    ]
  4           0.00   [                    ]
  5           0.00   [                    ]
  6           0.00   [                    ]
  7           0.00   [                    ]
  8           0.00   [                    ]
  9           0.00   [                    ]
 10           0.00   [                    ]


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

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

```
MOTION PAYLOAD SET                    JOINT 10%

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

 [TYPE] GROUP NUMBER   DEFAULT   HELP
```

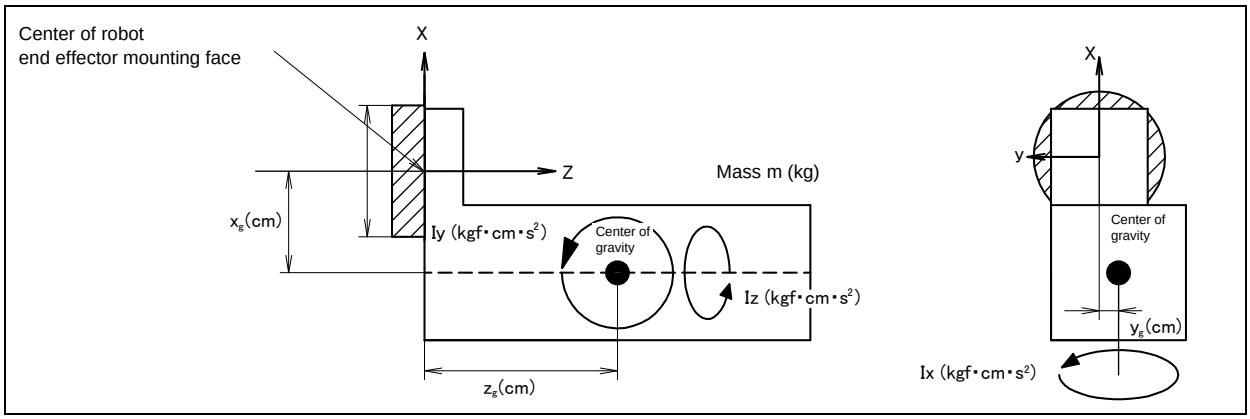


Fig. 4.3 Standard tool coordinate

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

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

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

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

```
MOTION ARMLOAD SET      JOINT        100 %

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

 [ TYPE ]  GROUP            DEFAULT   HELP
```

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

5 PIPING AND WIRING TO THE END EFFECTOR

⚠ WARNING

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

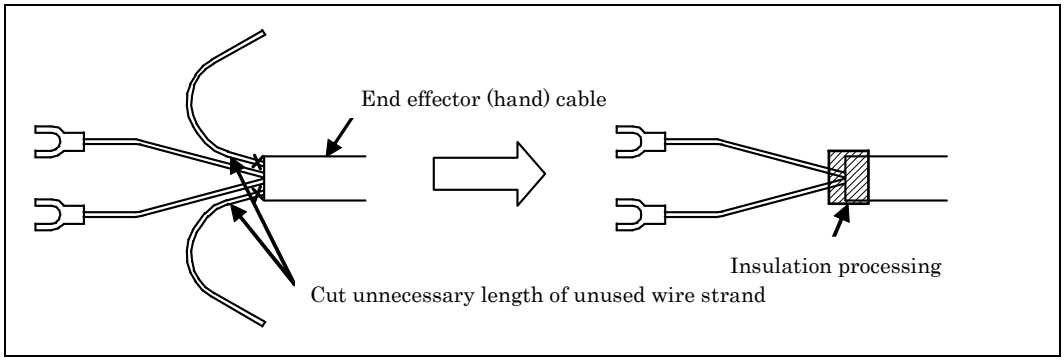


Fig. 5 Treatment method of end effector (hand) cable

5.1 AIR SUPPLY (OPTION)

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

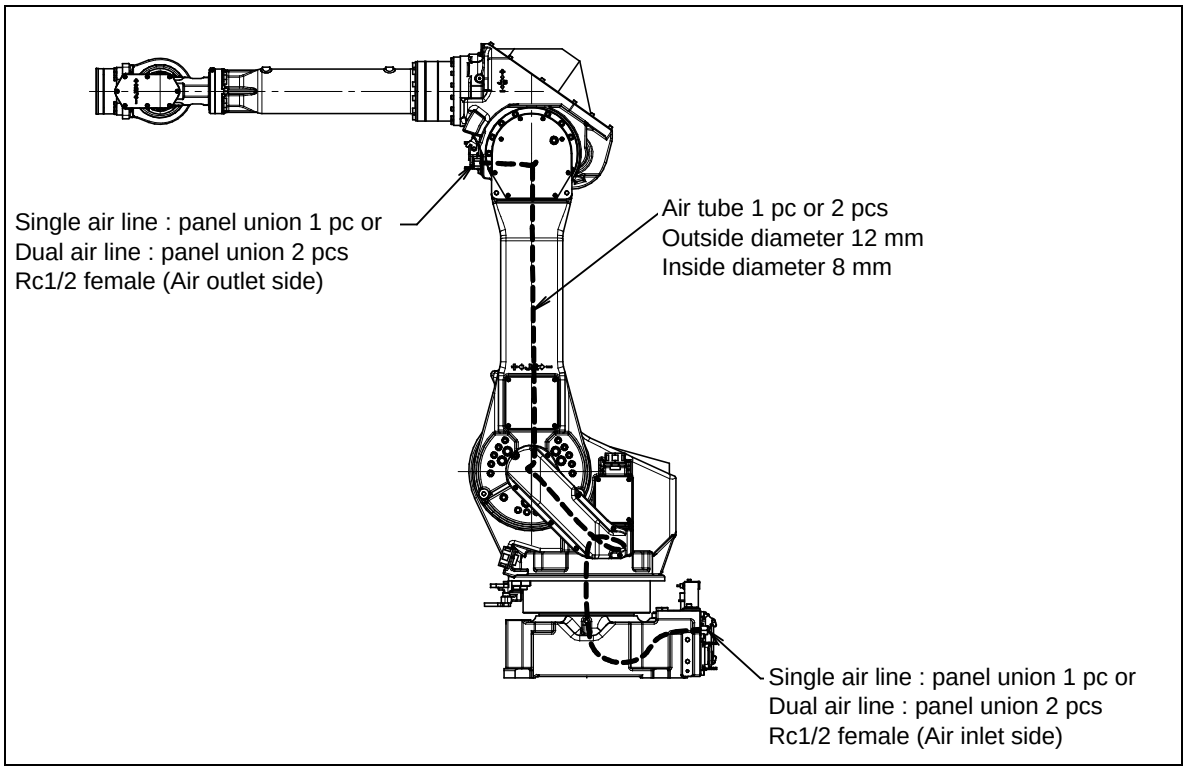


Fig. 5.1 Air supply (option)

5.2 AIR PIPING (OPTION)

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

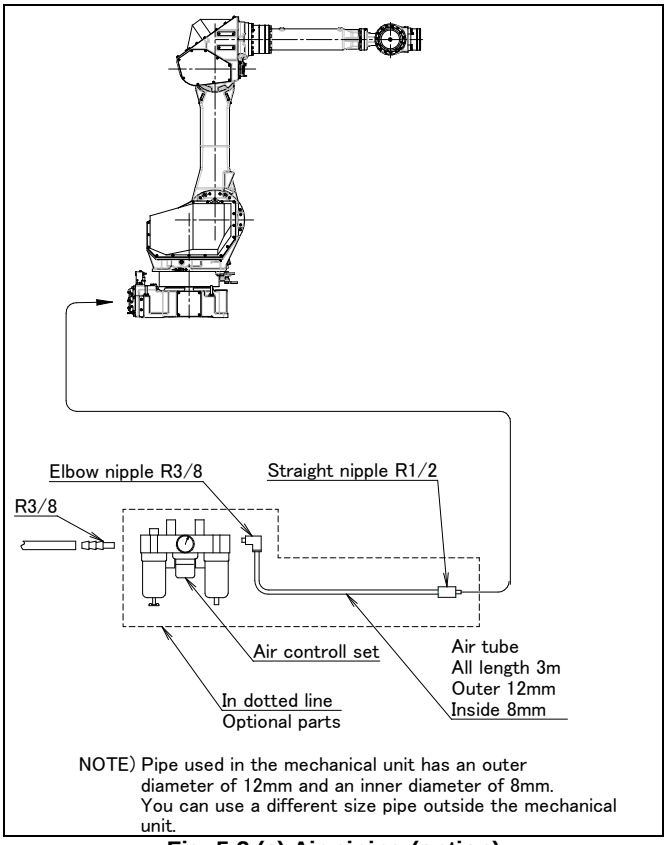


Fig. 5.2 (a) Air piping (option)

Air control set

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.

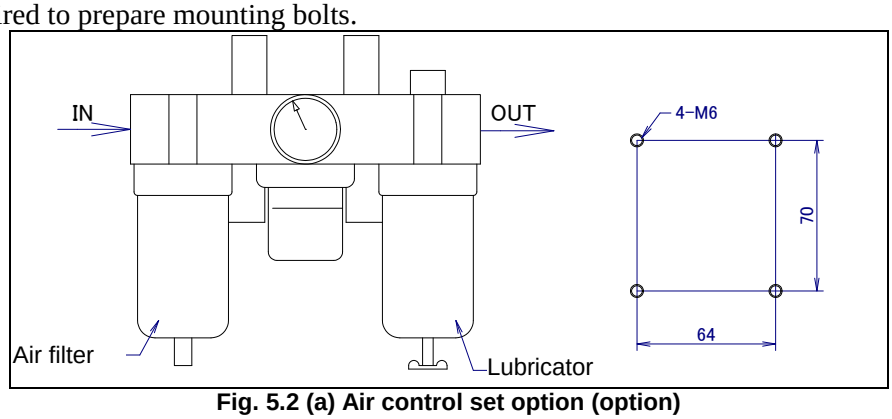


Fig. 5.2 (a) Air control set option (option)

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

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

5.3 INTERFACE FOR OPTION CABLE (OPTION)

Fig. 5.3 (a) to (i) show the position of the option cable interface.
EE interface (RI/RO), user cable (signal line, signal line usable to force sensor and 3D Laser Vision sensor and power line), DeviceNet cable (signal and power line), Additional axis motor cable, (Pulsecoder/power, brake), camera cable, 3D Laser Vision sensor, force sensor, Ethernet cable (signal/power) 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 (signal usable to force sensor and 3D Laser Vision sensor) : ASi
User cable (power) : AP
DeviceNet cable (signal) : DS
DeviceNet cable (power) : DP
Additional axis motor cable (Pulsecoder) : ARP
Additional axis motor cable (power, brake) : ARM
Camera cable : CAM
3D Laser Vision sensor cable : SEN
Ethernet cable (signal) : ES
Ethernet cable (power) : EP

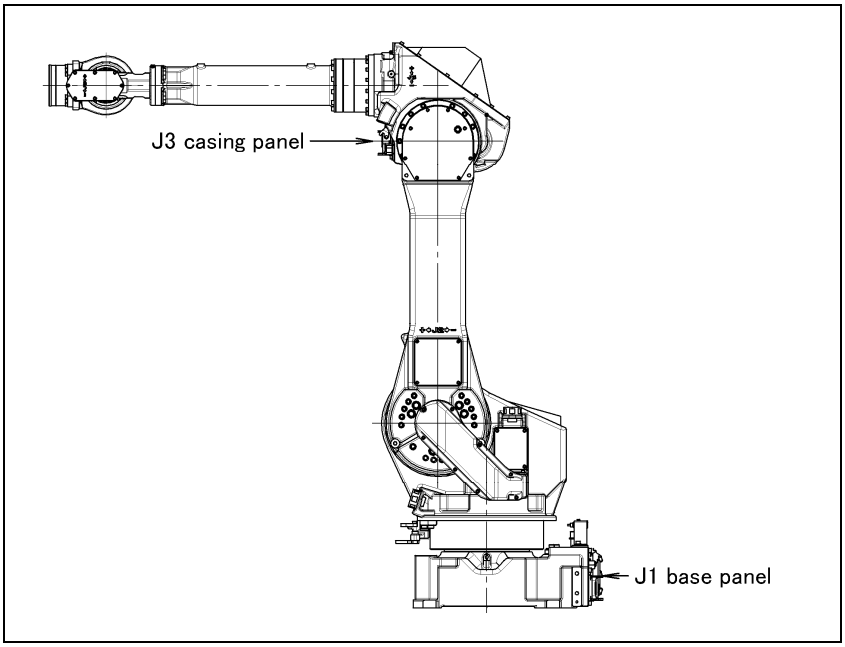
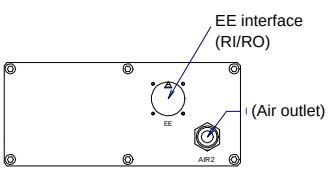
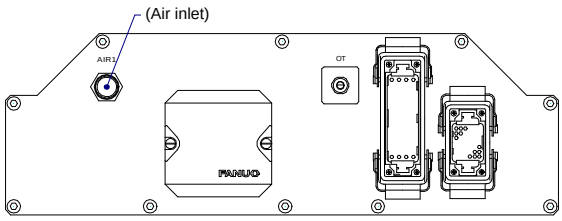


Fig. 5.3 (a) Position of the option cable interface (option)

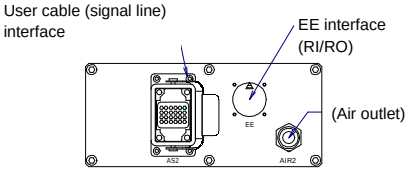


J3 casing connector plate (output side)

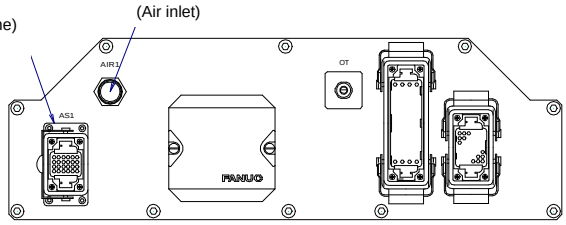


J1 base connector plate (input side)

With air x 1
Spec. of mechanical unit cable
A05B-1125-H201 (M-710*i*C/50/70/50E)
A05B-1125-H501 (M-710*i*C/50H)
A05B-1125-H221 (M-710*i*C/50S)
A05B-1125-H521 (M-710*i*C/45M)

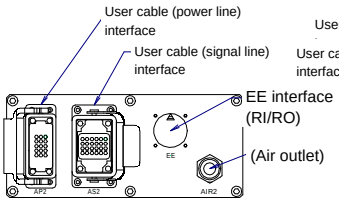


J3 casing connector plate (output side)

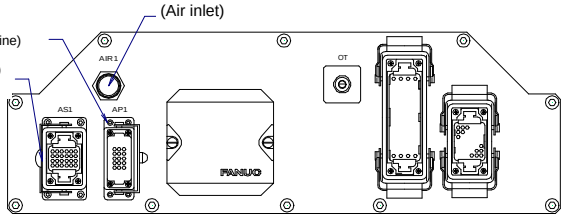


J1 base connector plate (input side)

With user cable (signal line), air x 1
Spec. of mechanical unit cable
A05B-1125-H202 (M-710*i*C/50/70/50E)
A05B-1125-H502 (M-710*i*C/50H)
A05B-1125-H222 (M-710*i*C/50S)
A05B-1125-H522 (M-710*i*C/45M)

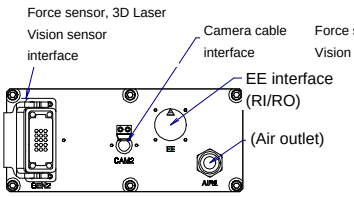


J3 casing connector plate (output side)

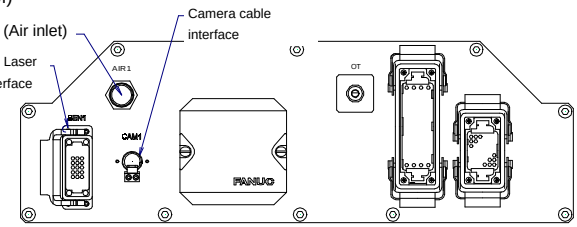


J1 base connector plate (input side)

With user cable (signal line/power line), air x 1
Spec. of mechanical unit cable
A05B-1125-H204 (M-710*i*C/50/70/50E)
A05B-1125-H504 (M-710*i*C/50H)
A05B-1125-H224 (M-710*i*C/50S)
A05B-1125-H524 (M-710*i*C/45M)



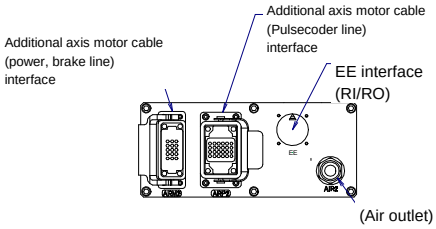
J3 casing connector plate (output side)



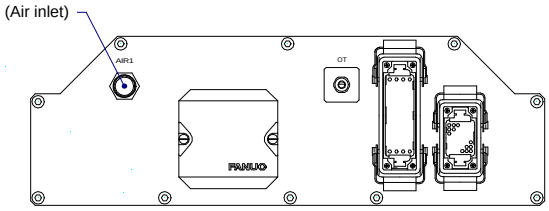
J1 base connector plate (input side)

With force sensor and 3D Laser vision sensor, camera cable and LED light
Spec. of mechanical unit cable
A05B-1125-H404 (M-710*i*C/50/70/50E)
A05B-1125-H422 (M-710*i*C/50H)

Fig. 5.3 (b) Interface for option cable (1/4)

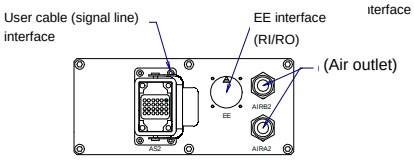


J3 casing connector plate (output side)

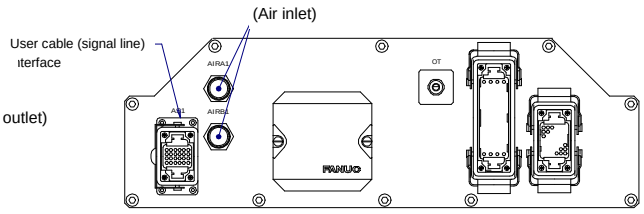


J1 base connector plate (input side)

With additional axis motor cable (Pulsecoder line/power , brake line)
Spec. of mechanical unit cable
A05B-1125-H505 (M-710*i*C/50H) (1-axis)

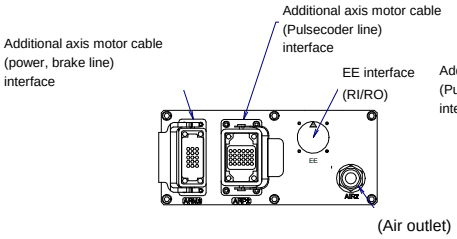


J3 casing connector plate (output side)

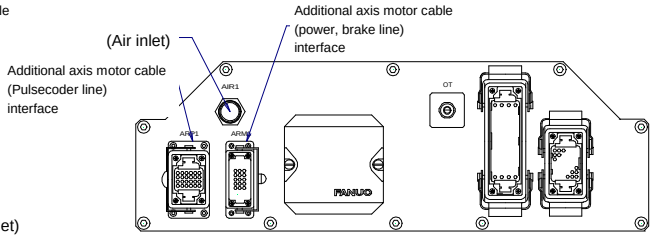


J1 base connector plate (input side)

With user cable (signal line), air x 2
Spec. of mechanical unit cable
A05B-1125-H208 (M-710*i*C/50/70/50E)

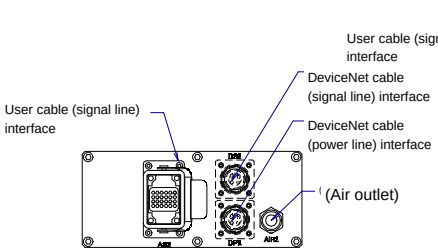


J3 casing connector plate (output side)

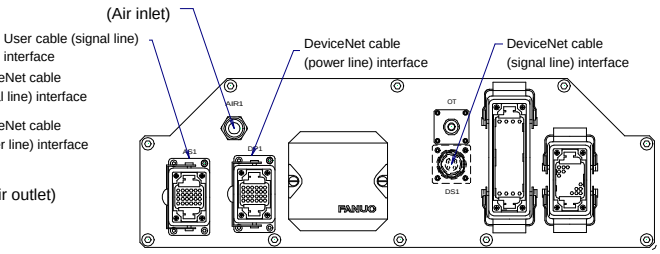


J1 base connector plate (input side)

With additional axis motor cable (Pulsecoder line/power, brake line)
Spec. of mechanical unit cable
A05B-1125-H209 (M-710*i*C/50/70/50E) (1-axis)
A05B-1125-H229 (M-710*i*C/50S) (1-axis)
A05B-1125-H411 (M-710*i*C/50/70/50E) (2-axis)
A05B-1125-H423 (M-710*i*C/50S) (2-axis)



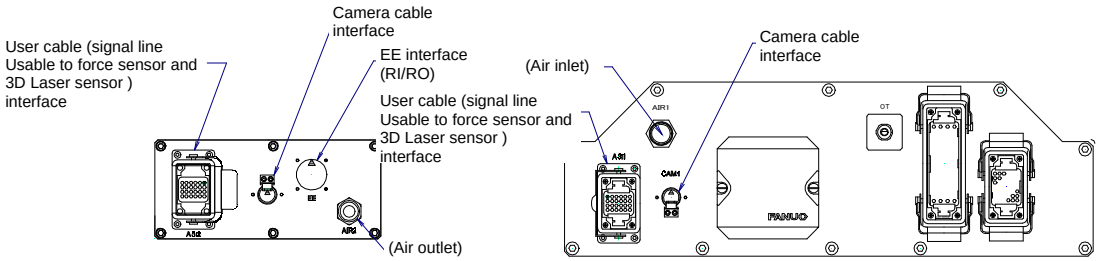
J3 casing connector plate (output side)



J1 base connector plate (input side)

With user cable (signal line), DeviceNet cable (signal line/power line)
Spec. of mechanical unit cable
A05B-1125-H210 (M-710*i*C/50/70/50E)

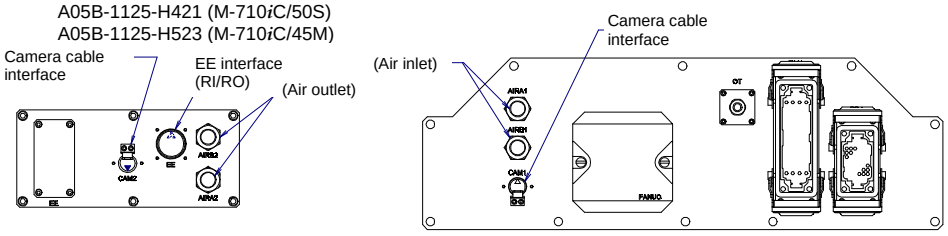
Fig. 5.3 (c) Interface for option cable (2/4)



J3 casing connector plate (output side)

J1 base connector plate (input side)

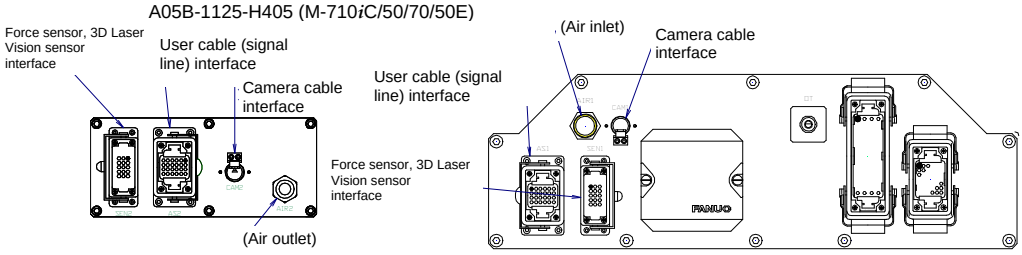
With user cable (signal line usable to force sensor and 3D Laser Vision sensor) and camera cable
Spec. of mechanical unit cable
A05B-1125-H403 (M-710*i*C/50/70/50E)
A05B-1125-H421 (M-710*i*C/50S)
A05B-1125-H523 (M-710*i*C/45M)



J3 casing connector plate (output side)

J1 base connector plate (input side)

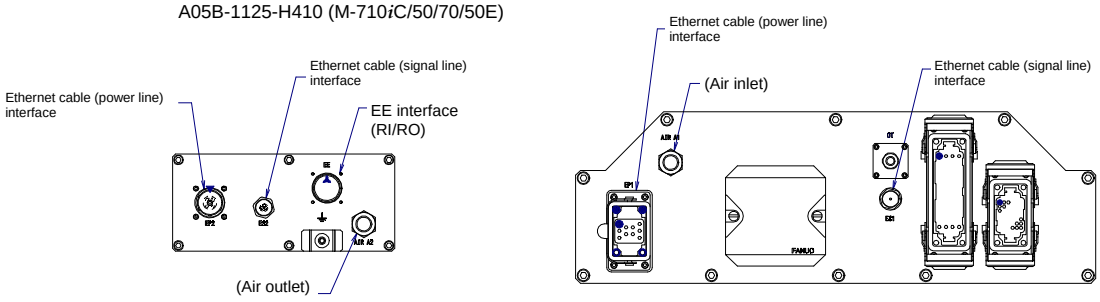
With camera cable, air x 2
Spec. of mechanical unit cable
A05B-1125-H405 (M-710*i*C/50/70/50E)



J3 casing connector plate (output side)

J1 base connector plate (input side)

With user cable (signal line), camera cable, force sensor , 3D Laser Vision sensor , air x 1
Spec. of mechanical unit cable
A05B-1125-H410 (M-710*i*C/50/70/50E)

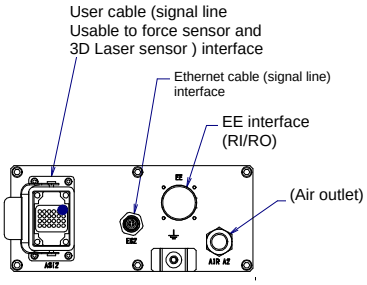


J3 casing connector plate (output side)

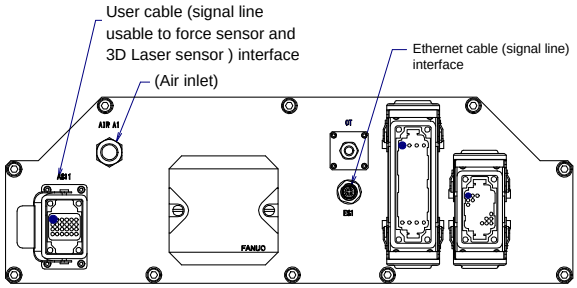
J1 base connector plate (input side)

With user cable (signal line/power line), air x 1
Spec. of mechanical unit cable
A05B-1125-H416 (M-710*i*C/50/70/50E)
A05B-1125-H528 (M-710*i*C/45M)

Fig. 5.3 (d) Interface for option cable (3/4)

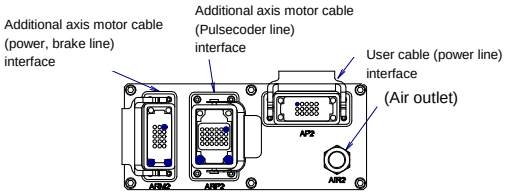


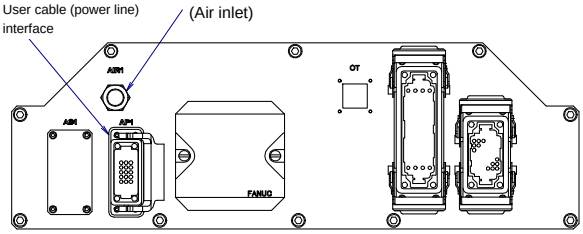
J3 casing connector plate (output side)



J1 base connector plate (input side)

With Ethernet cable (signal) and User cable (signal line usable to force sensor and
3D Laser sensor), air x 1
Spec. of mechanical unit cable
A05B-1125-H417 (M-710*i*C/50/70/50E)

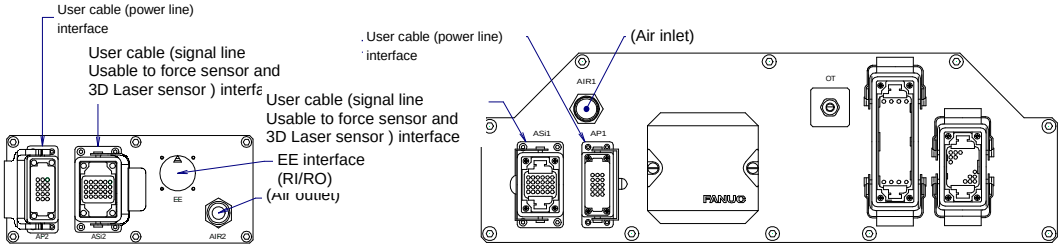




J3 casing connector plate (output side)

J1 base connector plate (input side)

With user cable (power line) and additional axis motor cable (Pulsecoder line/power , brake line)
Spec. of mechanical unit cable
A05B-1125-H506 (M-710*i*C/50H)

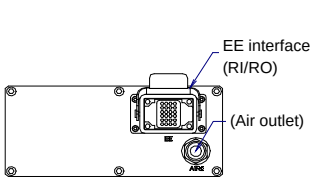


J3 casing connector plate (output side)

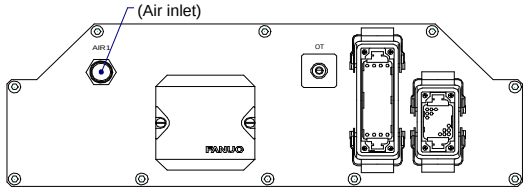
J1 base connector plate (input side)

With user cable (signal usable to force sensor and 3D Laser Vision sensor/power line)
Spec. of mechanical unit cable
A05B-1125-H525 (M-710*i*C/45M)

Fig. 5.3 (e) Interface for option cable (4/4)

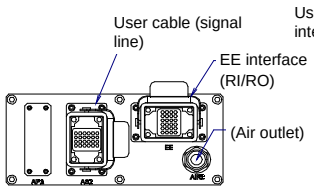


J3 casing connector plate (output side)

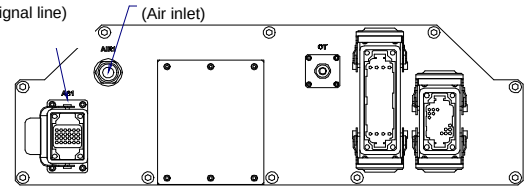


J1 base connector plate (input side)

With air x 1
Spec. of mechanical unit cable
A05B-1125-H201 (M-710*i*C/50/70)
A05B-1125-H221 (M-710*i*C/50S)
A05B-1125-H541 (M-710*i*C/45M)

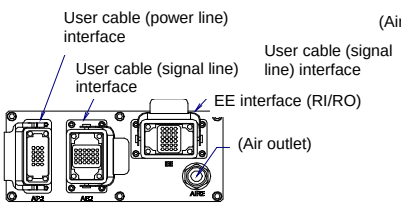


J3 casing connector plate (output side)

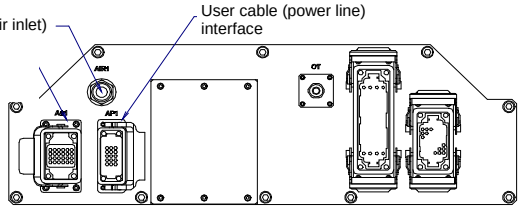


J1 base connector plate (input side)

With user cable (signal line), air x 1
Spec. of mechanical unit cable
A05B-1125-H202 (M-710*i*C/50/70)
A05B-1125-H222 (M-710*i*C/50S)
A05B-1125-H542 (M-710*i*C/45M)

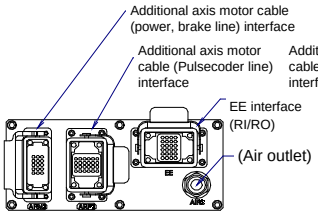


J3 casing connector plate (output side)

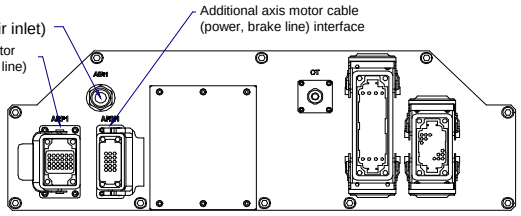


J1 base connector plate (input side)

With user cable (signal line/power line), air x 1
Spec. of mechanical unit cable
A05B-1125-H204 (M-710*i*C/50/70)
A05B-1125-H224 (M-710*i*C/50S)
A05B-1125-H544 (M-710*i*C/45M)

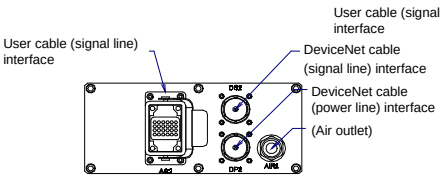


J3 casing connector plate (output side)

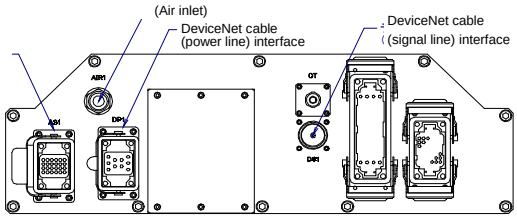


J1 base connector plate (input side)

With additional axis motor cable (Pulsecoder line/power , brake line)
Spec. of mechanical unit cable
A05B-1125-H209 (M-710*i*C/50/70) (1-axis)
A05B-1125-H229 (M-710*i*C/50S) (1-axis)
A05B-1125-H411 (M-710*i*C/50/70/50E) (2-axis)
A05B-1125-H423 (M-710*i*C/50S) (2-axis)



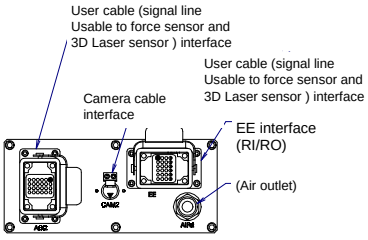
J3 casing connector plate (output side)



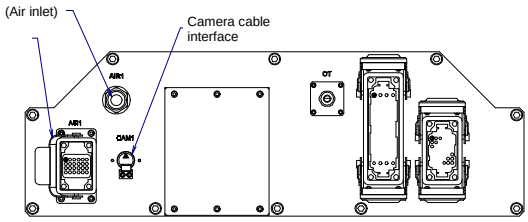
J1 base connector plate (input side)

With user cable (signal line), DeviceNet cable (signal line/power line)
Spec. of mechanical unit cable
A05B-1125-H210 (M-710*i*C/50/70)

Fig. 5.3 (f) Interface for option cable
(When Severe dust/liquid protection package is specified) 1/3

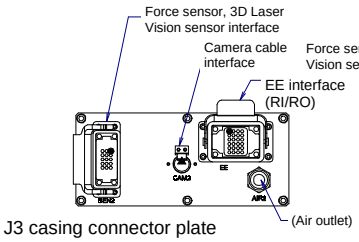


J3 casing connector plate (output side)

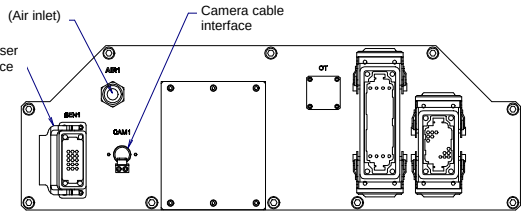


J1 base connector plate (input side)

With user cable (signal line usable to force sensor and 3D Laser Vision sensor) and camera cable
Spec. of mechanical unit cable
A05B-1125-H403 (M-710*i*C/50/70)
A05B-1125-H421 (M-710*i*C/50S)
A05B-1125-H523 (M-710*i*C/45M)

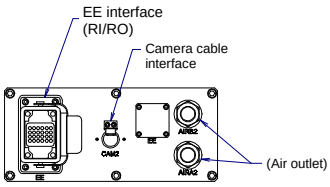


J3 casing connector plate
(output side)

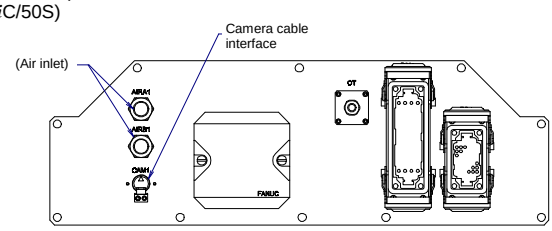


J1 base connector plate (input side)

With force sensor and 3D Laser vision sensor, camera cable and LED light
Spec. of mechanical unit cable
A05B-1125-H404 (M-710*i*C/50/70)
A05B-1125-H422 (M-710*i*C/50S)

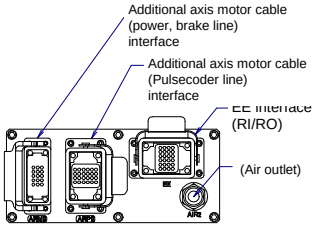


J3 casing connector plate (output side)

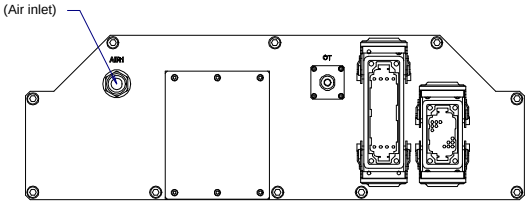


J1 base connector plate (input side)

With camera cable, air x 2
Spec. of mechanical unit cable
A05B-1125-H405 (M-710*i*C/50/70)



J3 casing connector plate (output side)



J1 base connector plate (input side)

With additional axis motor cable (Pulsecoder line/power , brake line)
Spec. of mechanical unit cable
A05B-1125-H515 (M-710*i*C/50H) (1-axis)

Fig. 5.3 (g) Interface for option cable
(When Severe dust/liquid protection package is specified) 2/3

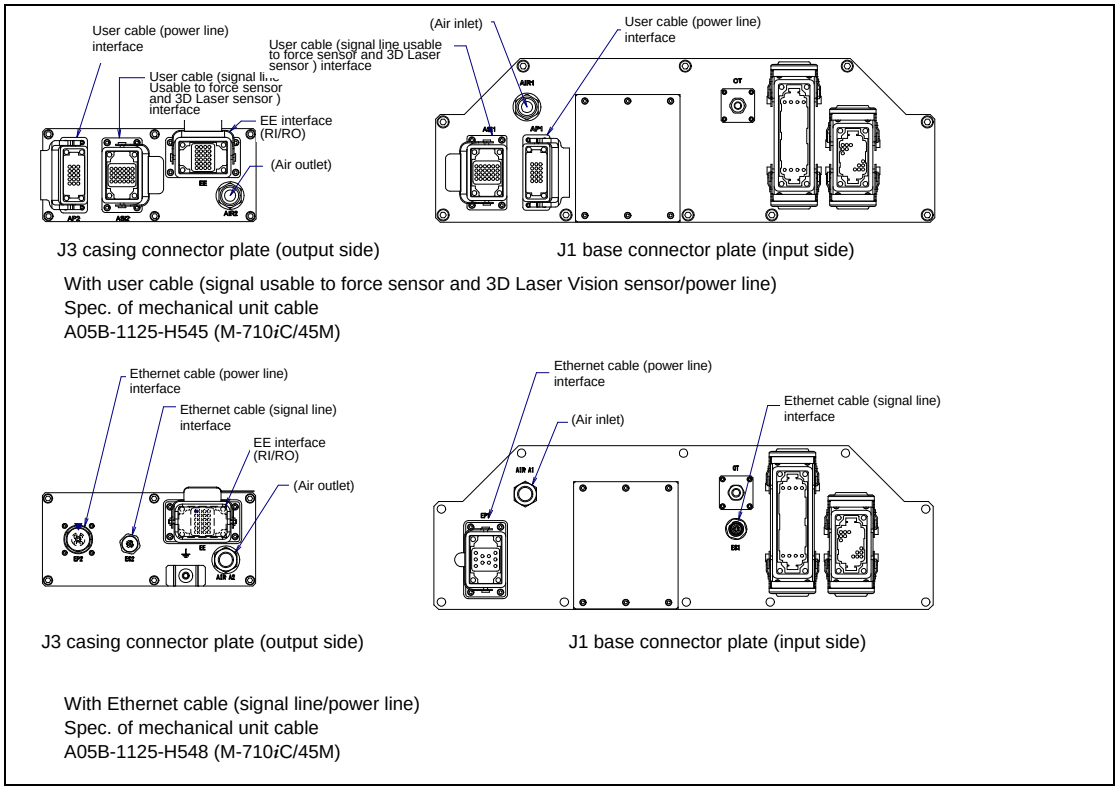


Fig. 5.3 (h) Interface for option cable
(When Severe dust/liquid protection package is specified) 2/2

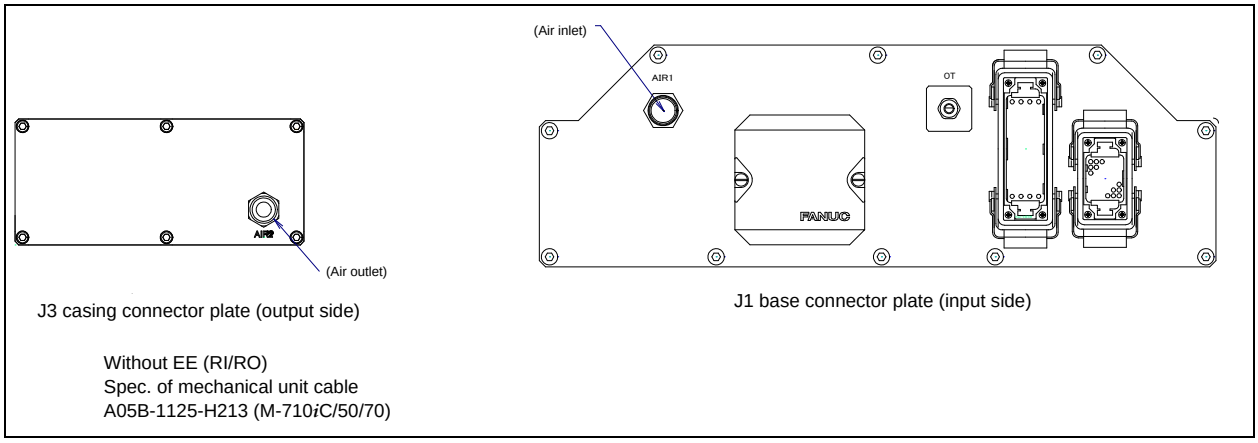


Fig. 5.3 (i) Interface for option cable (WASHING APPLICATION is specified)

(1) EE interface (RI/RO) (Option)

Fig. 5.3 (j) and (k) show the pin layout for the EE interface (RI/RO). When severe dust/liquid protection package is specified, the connector has guide pins and bushes for preventing improper insertion. For cables prepared by the user, use these guide pins and bushes.

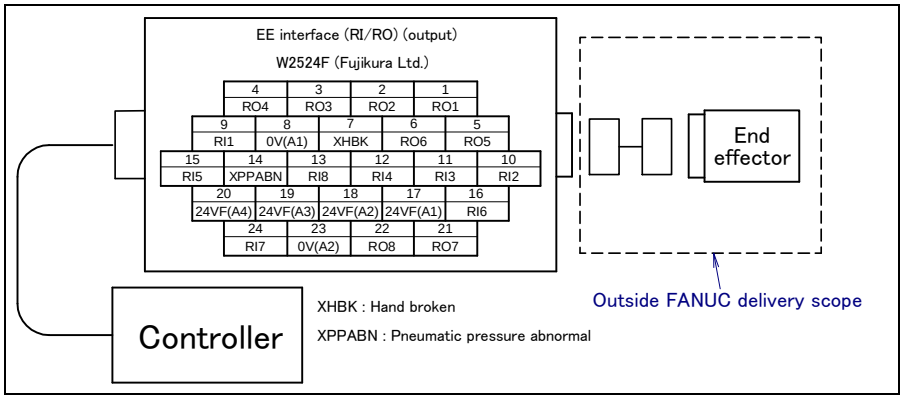


Fig. 5.3 (j) Pin layout for EE interface (RI/RO) (option)

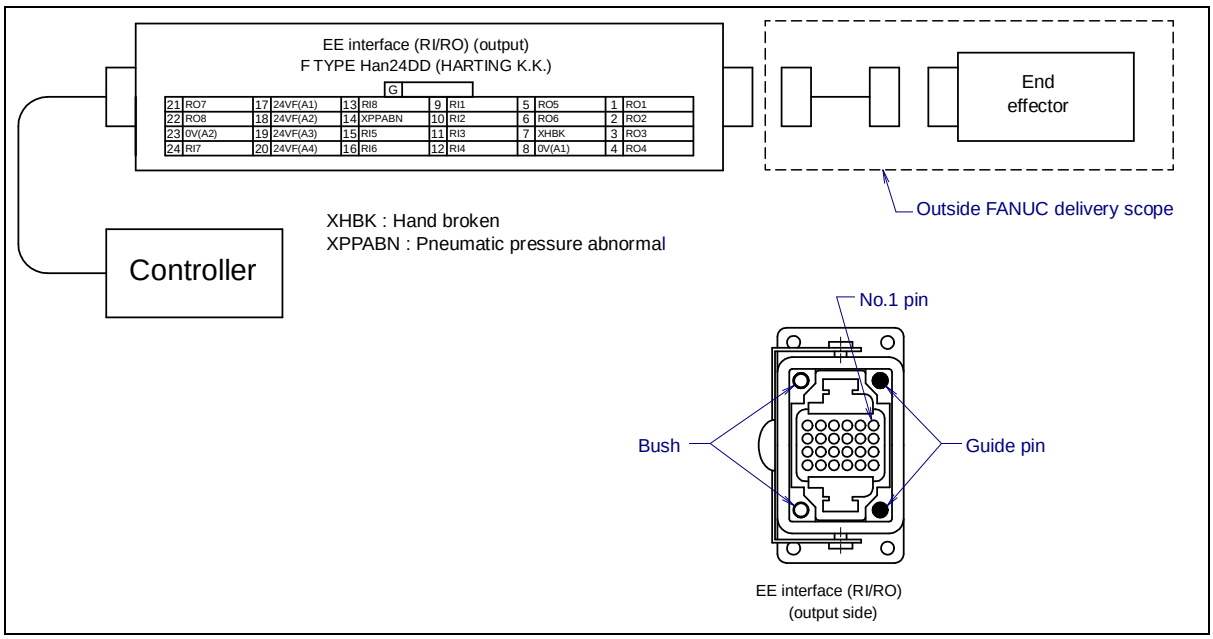


Fig. 5.3 (k) Pin layout for EE interface (RI/RO) (Severe dust/liquid protection package) (option)

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

(2) User cable (signal line) (AS) Interface (option)
Fig. 5.3 (l) shows pin layout for user cable (signal line) interface.
The connector has a code pin for preventing improper insertion. For cables prepared by the user, use this code pin.

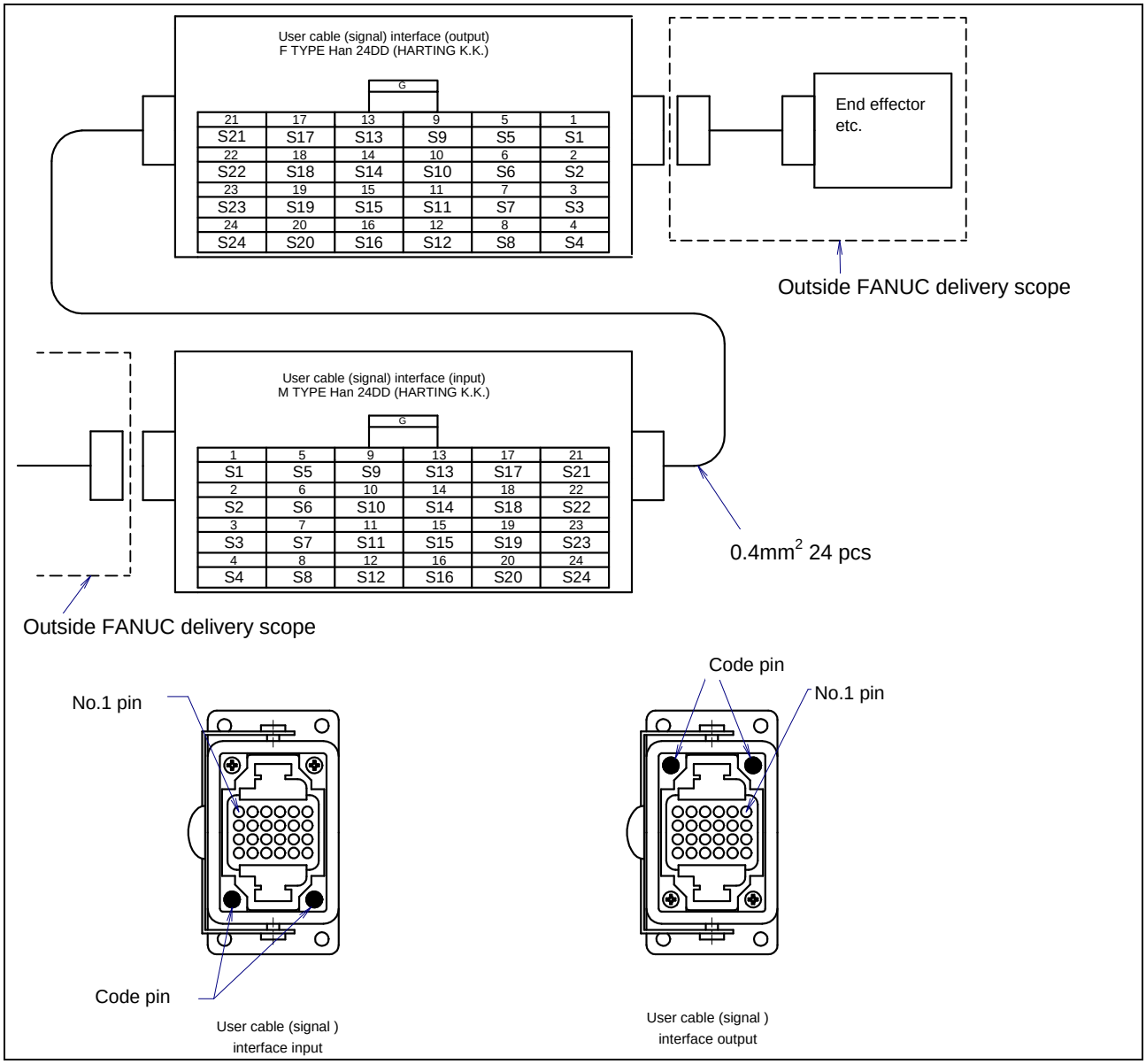


Fig. 5.3 (l) Pin layout for user cable (signal line) (AS) interface and code pin layout (option)

(3) User cable (signal line usable to force sensor and 3D Laser Vision sensor) (ASi) Interface (option)
Fig. 5.3 (m) shows the pin layout for the user cable (signal line usable to force sensor and 3D Laser Vision sensor) interface.
The connector has a code pin for preventing improper insertion. The code pin is required for the cable which is prepared by the user.

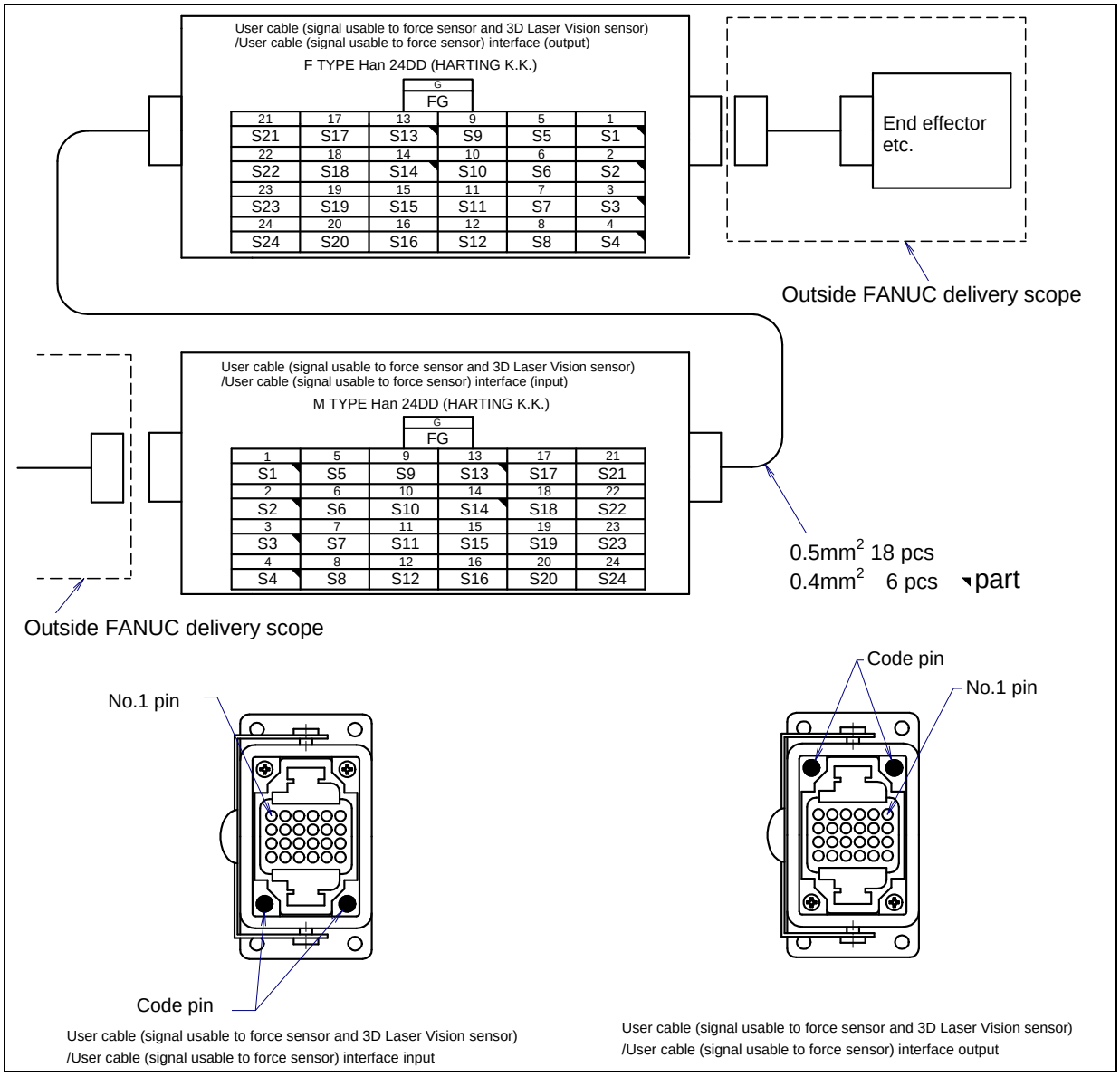


Fig. 5.3 (m) Pin layout for user cable (signal line usable to force sensor and 3D Laser Vision sensor) (ASi) interface and code pin layout (option)

(4) User cable (power line) (AP) Interface (option)
Fig. 5.3 (n) shows the pin layout for the user cable (power line) interface.
The connector has a code pin for preventing improper insertion. The code pin is required for the cable which is prepared by the user.

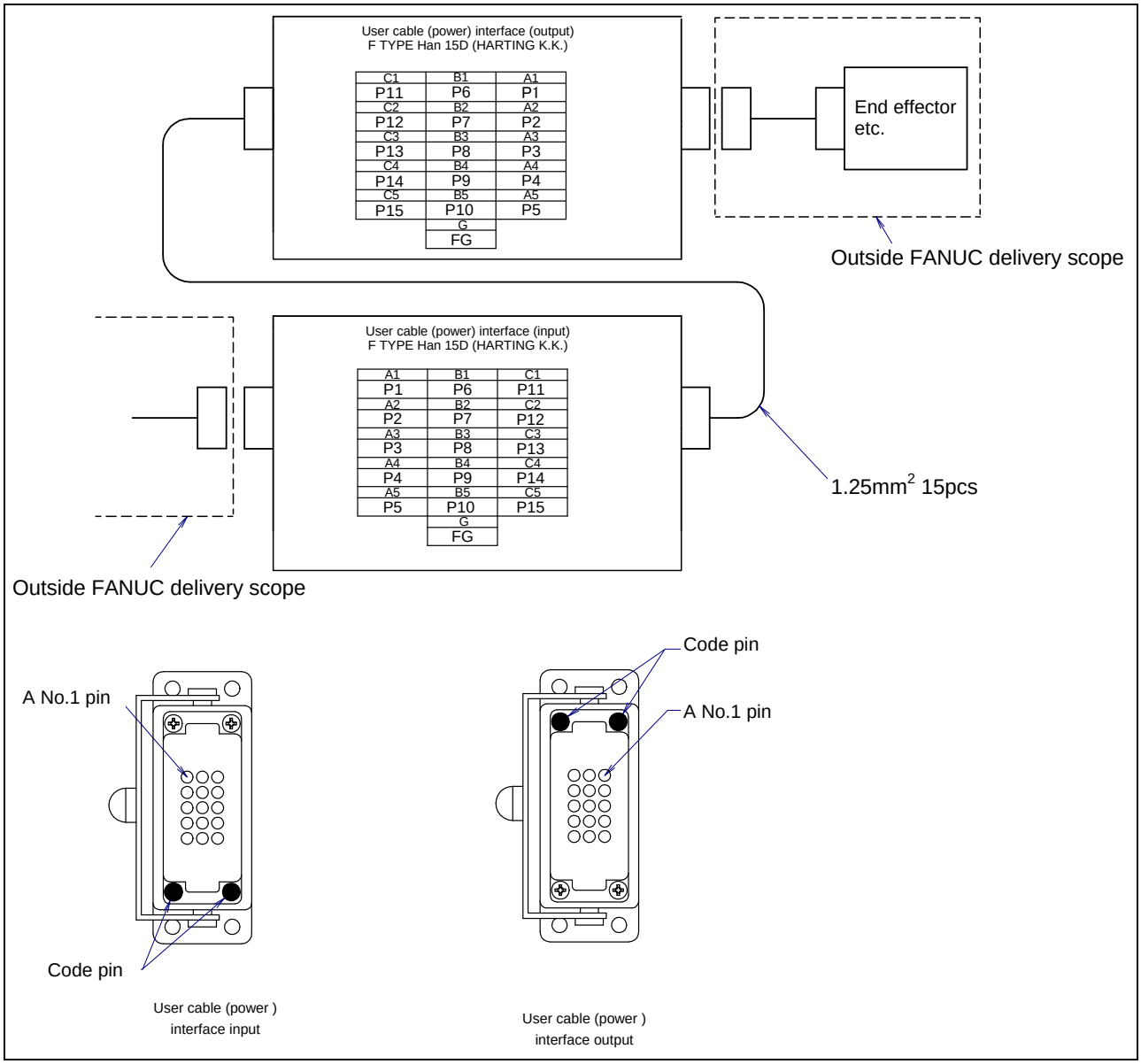


Fig. 5.3 (n) Pin layout for user cable (power line) (AP) interface and code pin layout (option)

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

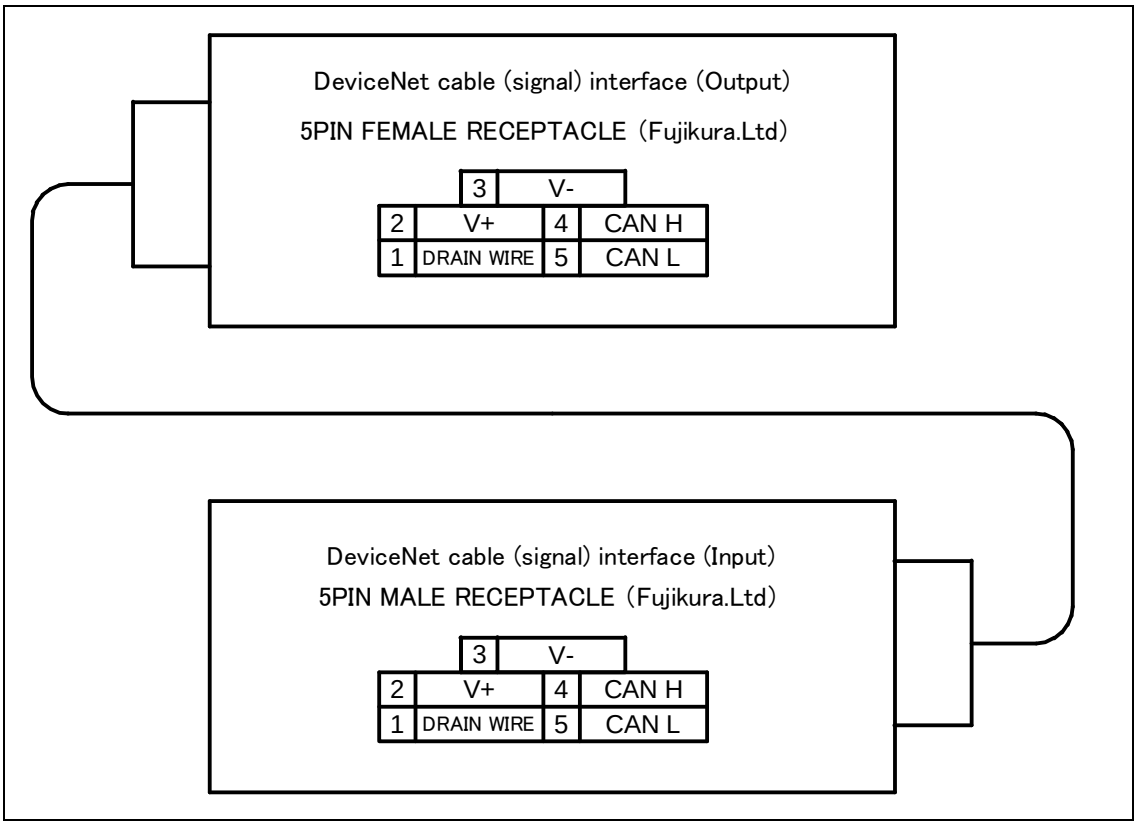


Fig. 5.3 (o) Pin layout for DeviceNet cable (signal line) (DS) interface (option)

(6) DeviceNet cable (power line) (DP) Interface (option)
Fig. 5.3 (p) shows pin layout for DeviceNet cable (power line) interface.

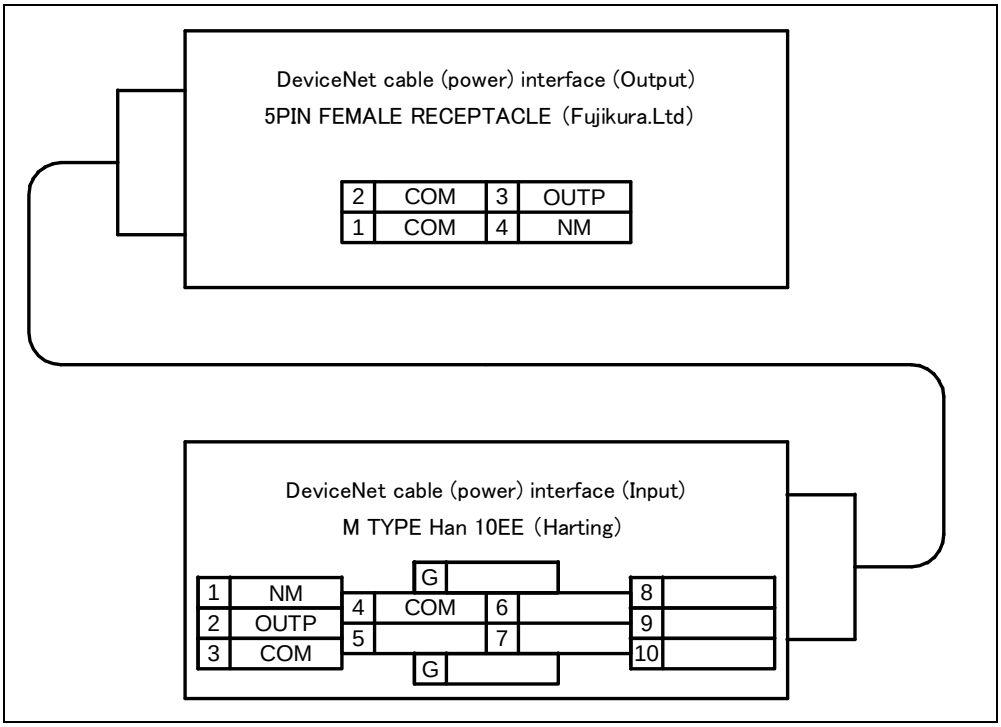


Fig. 5.3 (p) Pin layout for DeviceNet cable (power line) (DP) interface (option)

(7) Additional axis motor cable (Pulsecoder line) (ARP) Interface (option)
Fig. 5.3 (q) to (s) show pin layout for Additional axis motor cable (Pulsecoder line) interface.
The connector has a code pin for preventing improper insertion.

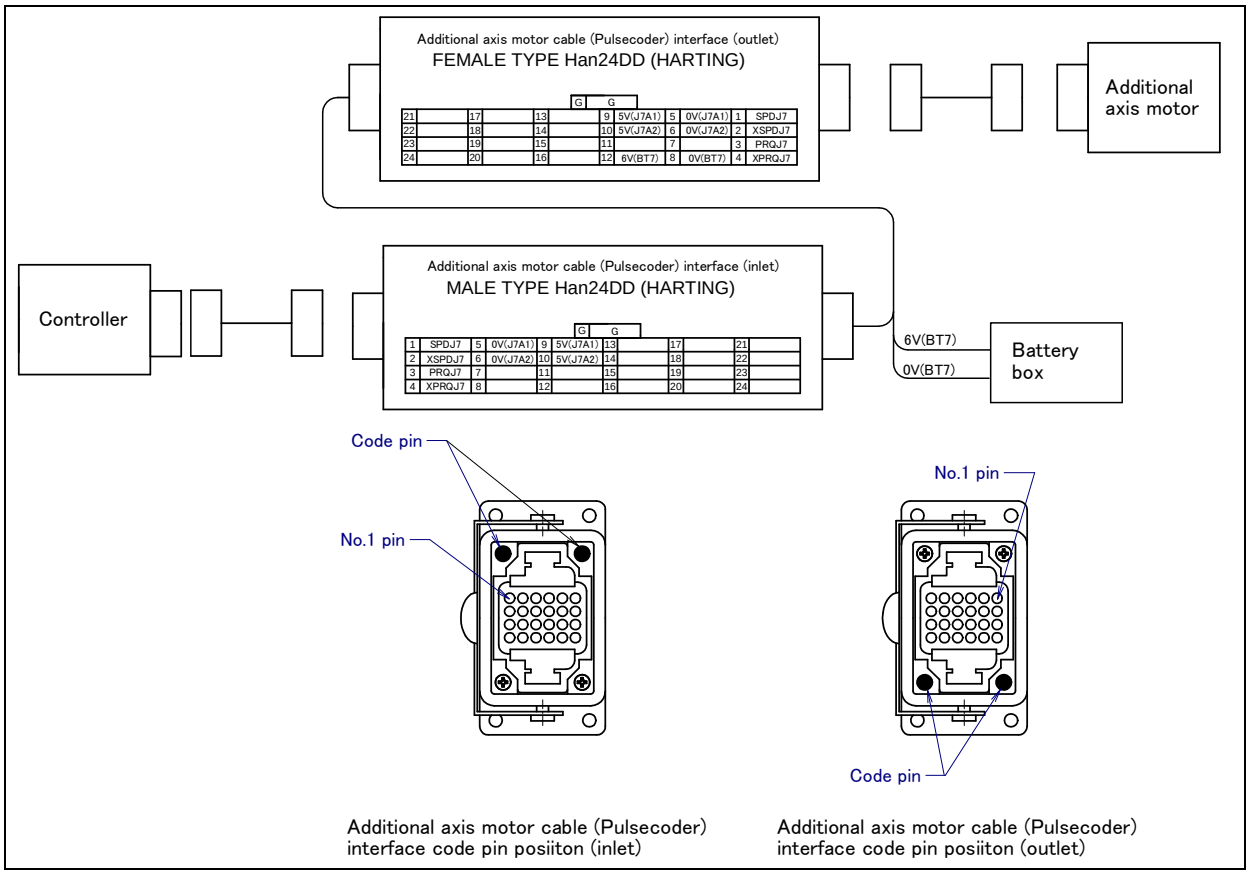


Fig. 5.3 (q) Pin layout for additional axis (1-axis) motor cable (Pulsecoder line) (ARP) interface (option) (Except M-710*i*C/50H)

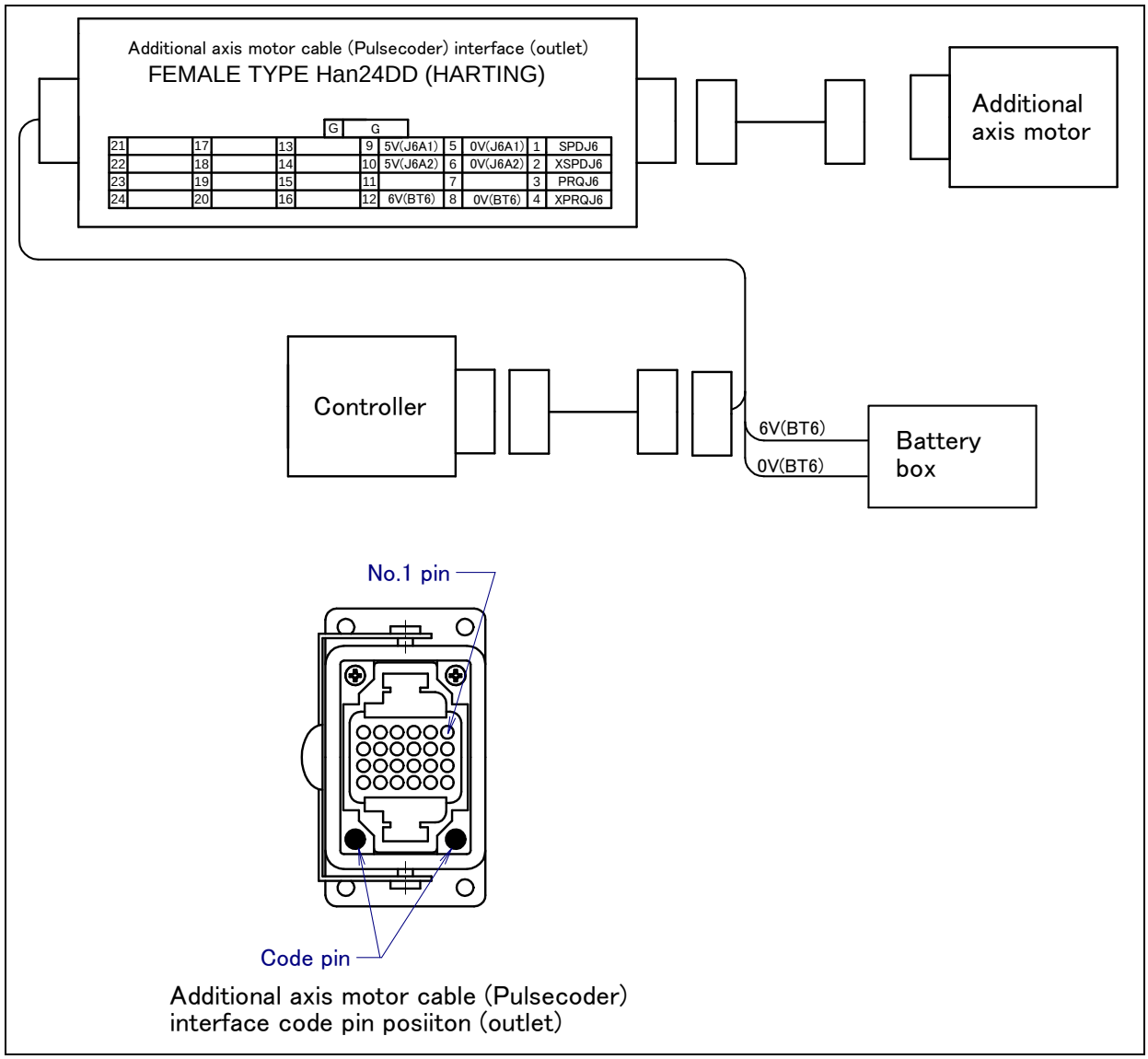


Fig. 5.3 (r) Pin layout for additional axis (1-axis) motor cable (Pulsecoder line) (ARP) interface (option) (M-710*i*C/50H)

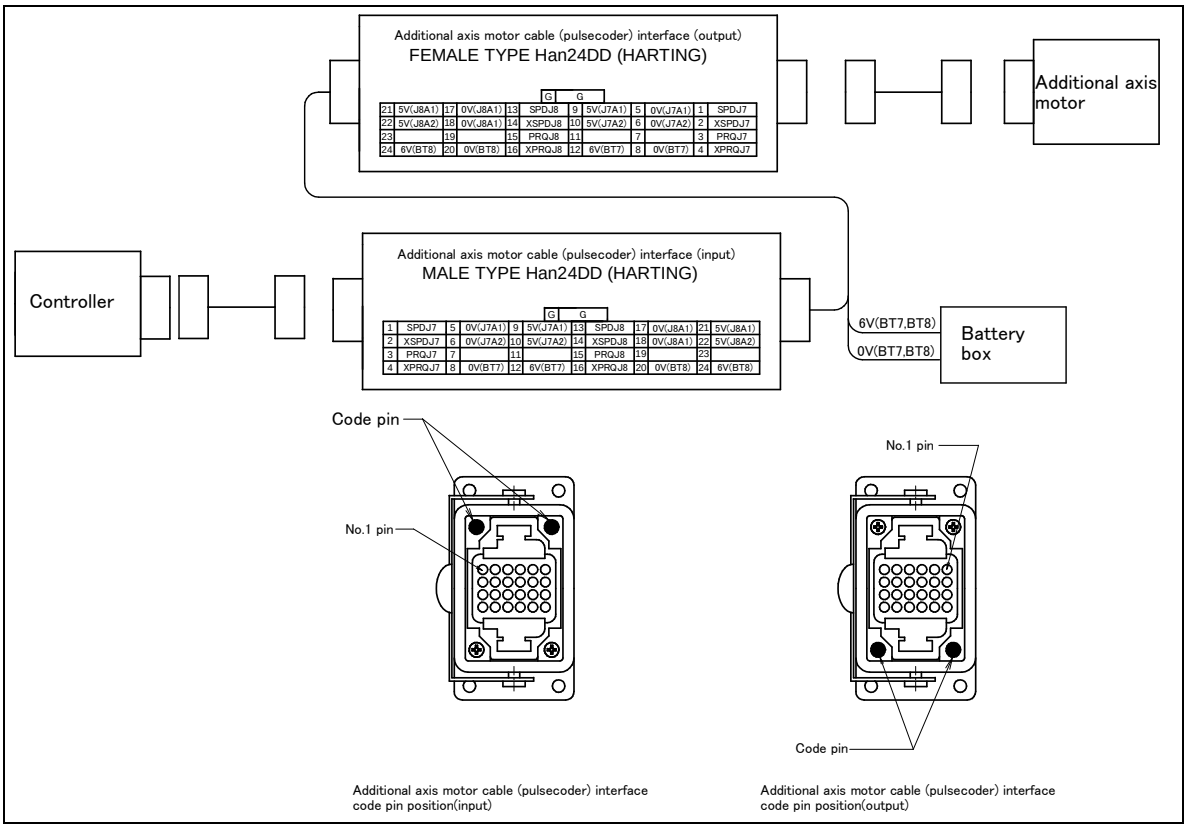


Fig. 5.3 (s) Pin layout and code pin position of the additional axis (2-axes) motor cable (Pulsecoder cable) (ARP) interface and layout position of the code pin (option)

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

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

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

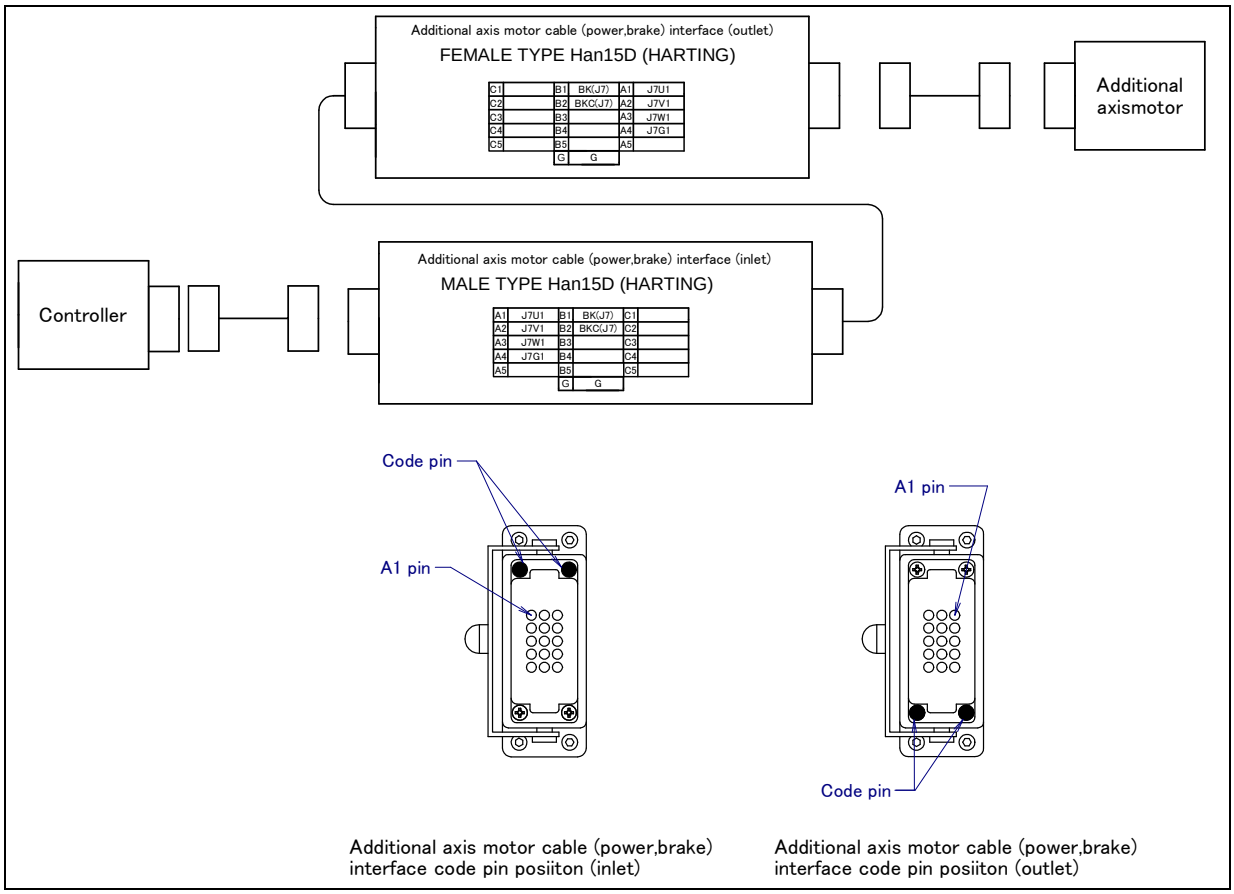


Fig. 5.3 (t) Pin layout for additional axis (1-axis) motor cable (power and brake cables)(ARM) interface (option) (Except M-710*i*C/50H)

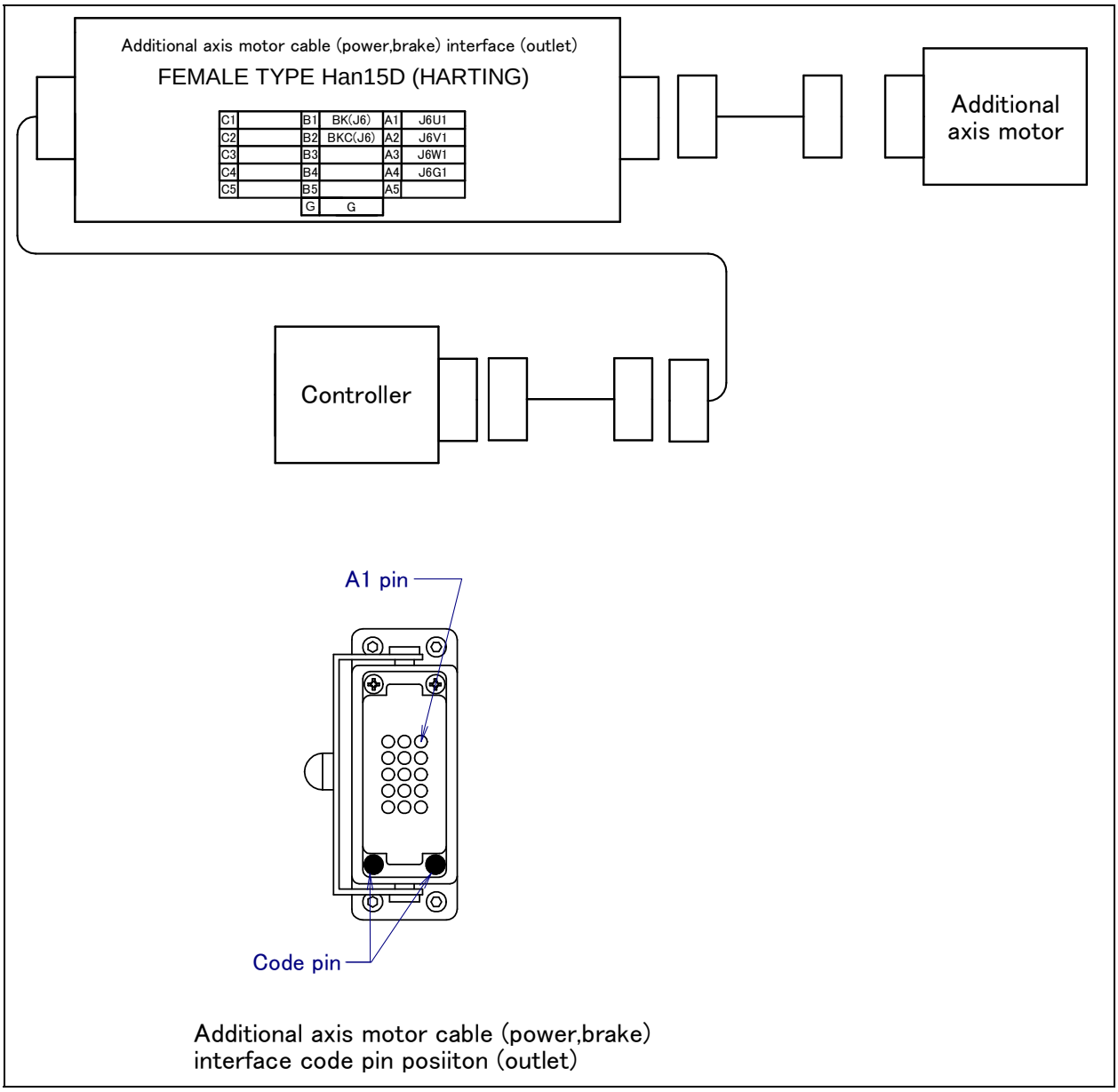


Fig. 5.3 (u) Pin layout for additional axis (1-axis) motor cable (power and brake cables) (ARM) interface (option) (M-710*i*C/50H)

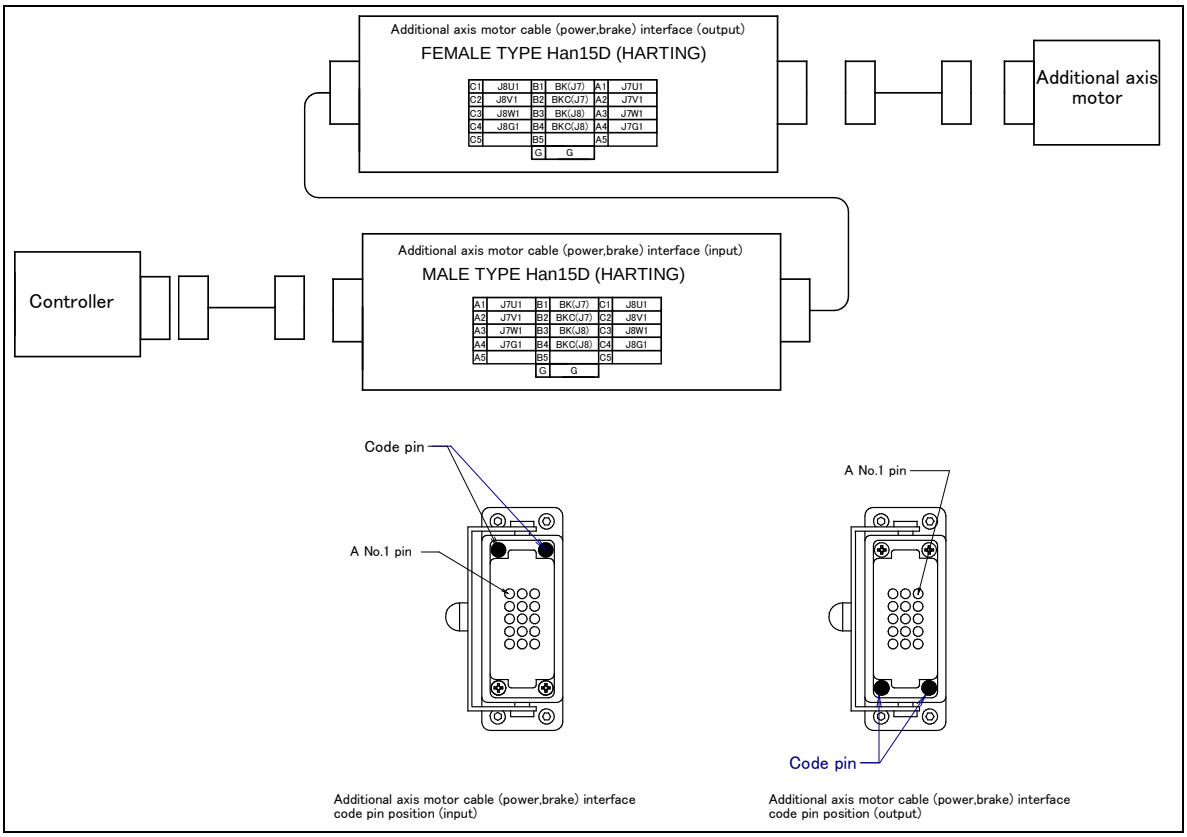


Fig. 5.3 (v) Pin layout and code pin position of the additional axis (2-axis) motor cable (power and brake cables) (ARM) interface and layout position of the code pin (option)

(9) Ethernet cable (signal line) (ES) interface (option)
Fig. 5.3 (w) shows the pin layout of the Ethernet cable (signal line) (ES) interface.

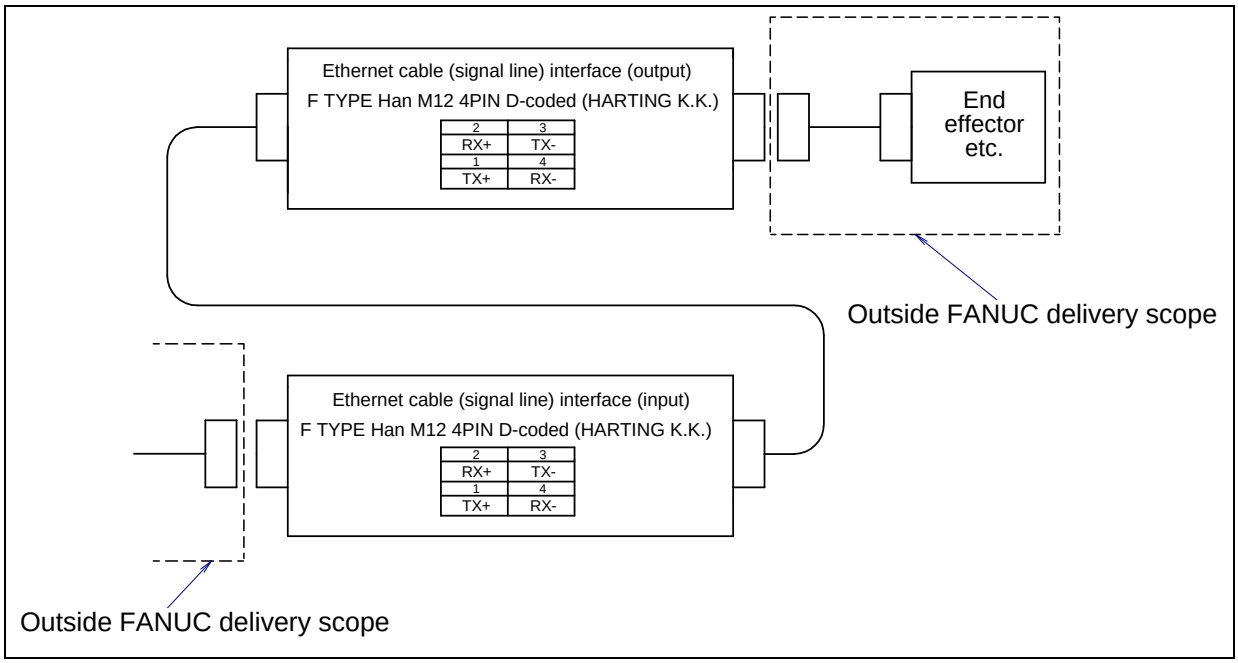


Fig. 5.3 (w) Pin layout for Ethernet cable (signal line) (ES) interface (option)

(10) Ethernet cable (power line) (EP) interface (option)
Fig. 5.3 (x) shows the pin layout of the Ethernet cable (power line) (EP) interface.

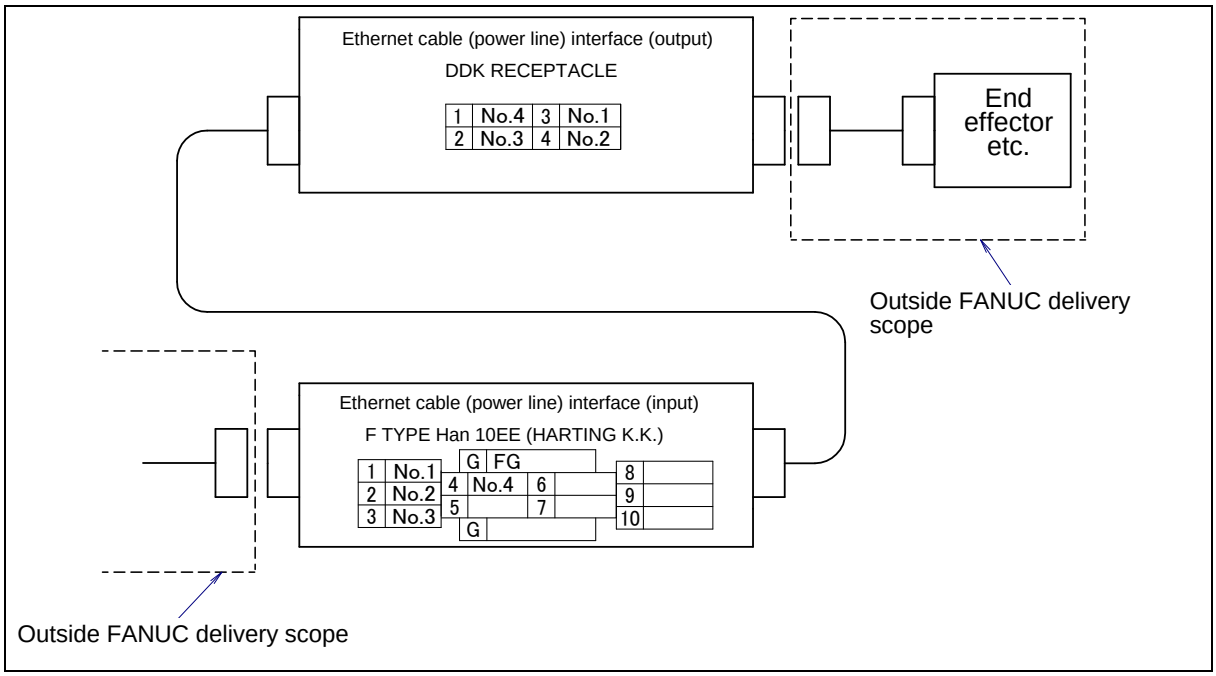


Fig. 5.3 (x) Pin layout for Ethernet cable (power line) (EP) interface (option)

Connector specifications

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

Cable	Input side (J1 base)		Output side (J3 casing)		Maker /Dealer
EE (RI/RO)	———		JMWR2524F		Fujikura. Ltd
AS ASi	Housing Insert Contact	09 30 006 0301 09 16 024 3001 09 15 000 6103	Housing Insert Contact	09 30 006 0301 09 16 024 3101 09 15 000 6203	HARTING K.K.
AP	Housing Insert Contact	09 20 010 0301 09 21 015 3001 09 15 000 6103	Housing Insert Contact	09 20 010 0301 09 21 015 3101 09 15 000 6203	
EE(RI/RO) (Cable corresponds to the severe dust/liquid protection)	Housing Insert Contact Guide pin	———	Housing Insert Contact Guide pin	09 30 006 0301 09 16 024 3101 09 15 000 6204 09 30 000 9908	

Table 5.3 (c) Connector specifications (User side)

Cable	Input side (J1 base)		Output side (J3 casing)		Maker /Dealer
EE (RI/RO)	_____		JMSP2524M (*1) JMLP2524M	Straight Angle	Fujikura .Ltd
AS ASi	Hood (NOTE 2)	09 30 006 1540 Side entry 1541 0542 0543 1440 Top entry 1441 0442 0443	Hood	←The same	HARTING K.K.
	Insert	09 16 024 3101	Insert	09 16 024 3001	
	Contact (NOTE 2)	09 15 000 6204 AWG 26-22 6203 AWG 20 6205 AWG 18 6202 AWG 18 6201 AWG 16 6206 AWG 14	Contact (NOTE 2)	09 15 000 6104 AWG 26-22 6103 AWG 20 6105 AWG 18 6102 AWG 18 6101 AWG 16 6106 AWG 14	
	Clamp (NOTE 2)	09 00 000 5083 5086 5090 5094 etc.	Clamp	←The same	
AP	Hood (NOTE 2)	09 20 010 1541 Side entry 0540 0541 1440 Top entry 0440 0441	Hood	←The same	
	Insert	09 21 015 3101	Insert	09 21 015 3001	
	Contact (NOTE 2)	09 15 000 6204 AWG 26-22 6203 AWG 20 6205 AWG 18 6202 AWG 18 6201 AWG 16 6206 AWG 14	Contact (NOTE 2)	09 15 000 6104 AWG 26-22 6103 AWG 20 6105 AWG 18 6102 AWG 18 6101 AWG 16 6106 AWG 14	
	Clamp (NOTE 2)	09 00 000 5083 5086 5090 5094 etc.	Clamp	←The same	

Cable	Input side (J1 base)	Output side (J3 casing)		Maker /Dealer
EE (RI/RO) (These are attached to the cables which are corresponded to the sever dust/liquid protection.)	———	Hood (NOTE 2)	09 30 006 1540 Side entry 1541 0542 0543 1440(*2) Top entry 1440 1441 0442 0443	HARTING K.K.
		Insert	09 16 024 3001 (*3)	
		Contact (24 pcs)	09 15 000 6104 (*4) AWG 26-22 6103 AWG 20 6105 AWG 18 6102 AWG 18 6101 AWG 16 6106 AWG 14	
		Clamp (NOTE 2)	09 00 000 5085 (*5) 5086 5090 5094 Many other types are available	
		Guide pin (2 pcs)	09 33 000 9908 (*6)	
		Bush (2 pcs)	09 33 000 9909 (*7)	

NOTE 1

Underlined parts are attached. Below shows spec. to order in our company.

(*1) A63L-0001-0234#S2524M
(*2) A63L-0001-0453#06B1440
(*3) A63L-0001-0453#24DDM
(*4) A63L-0001-0453#CA6104
(*5) A63L-0001-0453#A-152D
(*6) A63L-0001-0453#A-9908
(*7) A63L-0001-0453#A-9909

Table 5.3 (d) Connector specifications (DeviceNet cable and Ethernet cable on the Mechanical unit side)

Cable	Input side (J1 base)		Manu.	Output side (J3 casing)		Maker /Dealer
DS	CM03A-R5P-S-2		Fujikura .Ltd	CM03A-PR5S-S-2		Fujikura .Ltd
DP	Housing Insert Contact	09 30 006 0301 09 32 010 3001 09 33 000 6105	HARTING K.K.	84854-9102		MOLEX JAPAN CO.LTD
ES	Connector Contact	21 03 882 2425 09 67 000 7476		Connector Contact	21 03 882 2425 09 67 000 7476	Fujikura .Ltd
EP	Housing Insert Contact Guide pin Bush	09 30 006 0301 09 32 010 3001 09 33 000 6105 09 30 000 9908 09 30 000 9909		CM03A-PR4S-S02		

Table 5.3 (e) Connector specifications (DeviceNet cable and Ethernet cable on the user equipment side)

Cable	Input side (J1 base)		Manu.	Output side (J3 casing)	Maker /Dealer
DS	MINI connector for use on the device net 5-pin, female 1 CM03-P5S		Fujikura .Ltd	CM03-J5P	Fujikura .Ltd
DP	Hood (NOTE 2)	09 30 006 1540 Side entry 1541 0542 0543 1440 Top entry 1441 0442 0443	HARTING K.K.	CM03-J4P	Fujikura .Ltd
	Insert	09 32 010 3101			
	Contact (NOTE 2)	09 15 000 6204 AWG 26-22 6203 AWG 20 6205 AWG 18 6202 AWG 18 6201 AWG 16 6206 AWG 14			
	Clamp (NOTE 2)	09 00 000 5083 5086 5090 5094 Many other types are available			
ES	Connector	21 03 882 1415		←The same	HARTING K.K.
	Contact (NOTE 2)	09 67 000 7576 AWG 28-24 5576 AWG 26-22 8576 AWG 24-20 3576 AWG 22-18		←The same	
EP	Hood (NOTE 2)	09 20 010 1541 Side entry 0540 0541 1440 Top entry 0440 0441		CM03-J4P	Fujikura .Ltd
	Insert	09 21 015 3101			
	Contact (NOTE 2)	09 15 000 6204 AWG 26-22 6203 AWG 20 6205 AWG 18 6202 AWG 18 6201 AWG 16 6206 AWG 14			
	Clamp (NOTE 2)	09 00 000 5083 5086 5090 5094 Many other types are available			
	Code pin	09 30 000 9901			

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

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

NOTE 2
For details, such as the dimensions, refer to the related catalogs offered by the respective manufacturers, or contact your local FANUC representative.

6 AXIS LIMIT SETUP

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

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

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

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

⚠ WARNING

1 Changing the motion range of any axis affects the operation range of the robot. To avoid trouble, carefully consider a possible effect of the change to the movable range of each axis in advance. Otherwise, it is likely that an unexpected condition occurs; for example, an alarm may occur in a previous taught position.
2 For the J1axis, do not count merely on software-based limits to the movable range when changing the movable range of the robot. When changing the movable range, use mechanical stoppers together so that damage to peripheral equipment and injuries to human bodies can be avoided. In this case, make the software-specified limits match the limits based on the mechanical stoppers.
3 Mechanical stoppers are physical obstacles. The robot cannot move beyond them. For the J1 to J3 axis (except J2 and J3 of M-710*i*C/50S), it is possible to re-position the mechanical stoppers. For J5 axes, the mechanical stoppers are fixed. For the J4 and J6 axes, only software-specified limits are available.
4 Adjustable mechanical stoppers are deformed in a collision to stop the robot. Once a stopper is subject to a collision, it can no longer assure its original strength and, therefore, may not stop the robot. When this happens, replace it with a new one.

6.1 SOFTWARE SETTING

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

Procedure Setting Up Axis Limits

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

System Axis Limits JOINT 100%
Group1 1/16

AXIS	GROUP	LOWER	UPPER	
1	1	-180.00	180.00	deg
2	1	-90.00	135.00	deg
3	1	-160.00	280.00	deg
4	1	-360.00	360.00	deg
5	1	-125.00	125.00	deg
6	1	-360.00	360.00	deg
7	1	0.00	0.00	mm
8	1	0.00	0.00	mm
9	1	0.00	0.00	mm

[TYPE]

⚠ WARNING
1 0.00 indicates the robot does not have these axes.
2 Do not depend on J1, J2, and J3 axes (except the J2, J3 axes of M-710*i*C/50S) limit software settings to control the motion range of your robot. Use the axis limit switches or adjustable mechanical stopper also; otherwise injury to personnel or damage to equipment could occur.

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

System Axis Limits JOINT 100%
Group1 1/16

AXIS	GROUP	LOWER	UPPER	
2	1	-90.00	135.00	deg

[TYPE]

6 Repeat Steps 5 through 6 until you are finished setting the axis limits.
7 Turn off the controller and then turn it back on again in the cold start mode so the new information can be used.

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

6.2 ADJUSTABLE MECHANICAL STOPPER AND LIMIT SWITCH SETTING (OPTION)

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

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

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

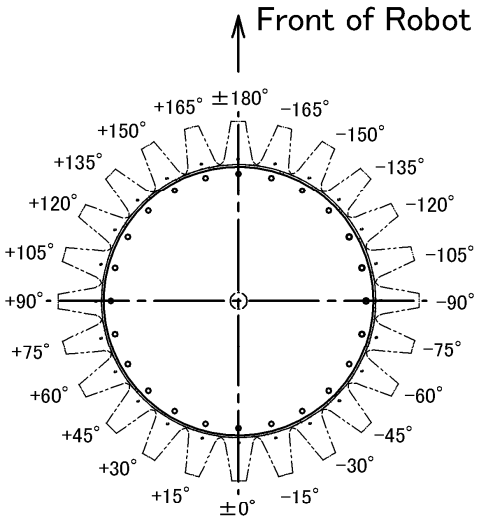
Item		Movable range
J1 axis adjustable mechanical stopper, limit switch	Upper limit	Settable in steps of 15° degrees in a range of -105° to +180° degrees
	Lower limit	Settable in steps of 15° degrees in the range of -180° to +150° degrees
	Space between the upper and lower limits	A space of 75° degrees or more is required.
J2 axis adjustable mechanical stopper (only for M-710*i*C/50/70/50H/50E/45M)	Upper limit	Settable in steps of 10° in the range of -50° to +80°. A mechanical stopper is also provided at the upper limit +140° of the standard movable range.
	Lower limit	Settable in steps of 10° in the range of -60° to +80°. A mechanical stopper is also provided at the lower limit -95° of the standard movable range.
	Space between the upper and lower limits	A space of 50° degrees or more is required.
J3 axis adjustable mechanical stopper (only for M-710*i*C/50/70/50H/50E/45M)	Upper limit	Settable in steps of 20° in the range of -20° to +160° and –30° and +170°. A mechanical stopper is also provided at the upper limit +283.5° of the standard movable range.
	Lower limit	Settable in steps of 20° in the range of -40° to +140° and –50° and +150°. A mechanical stopper is also provided at the lower limit -163.5° of the standard movable range.
	Space between the upper and lower limits	A space of 60° degrees or more is required.

NOTE

1 If the newly set operation range does not include 0°, it is necessary to change it by zero position mastering so that 0° is included.
2 When adjustable mechanical stopper is ordered, mounting bolt is attached.
3 When motion range is changed by movable mechanical stopper, be sure to set the motion range of soft same refer to Section 6.1

Notes on attaching the J1-axis mechanical stopper

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



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

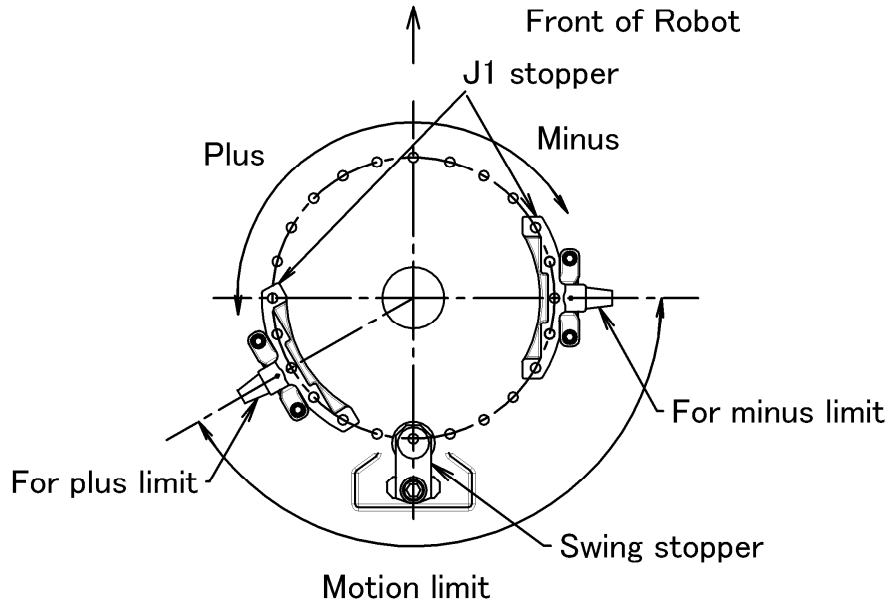


Fig. 6.2 (a) Mechanical stopper and motion limit of J1-axis (Option)

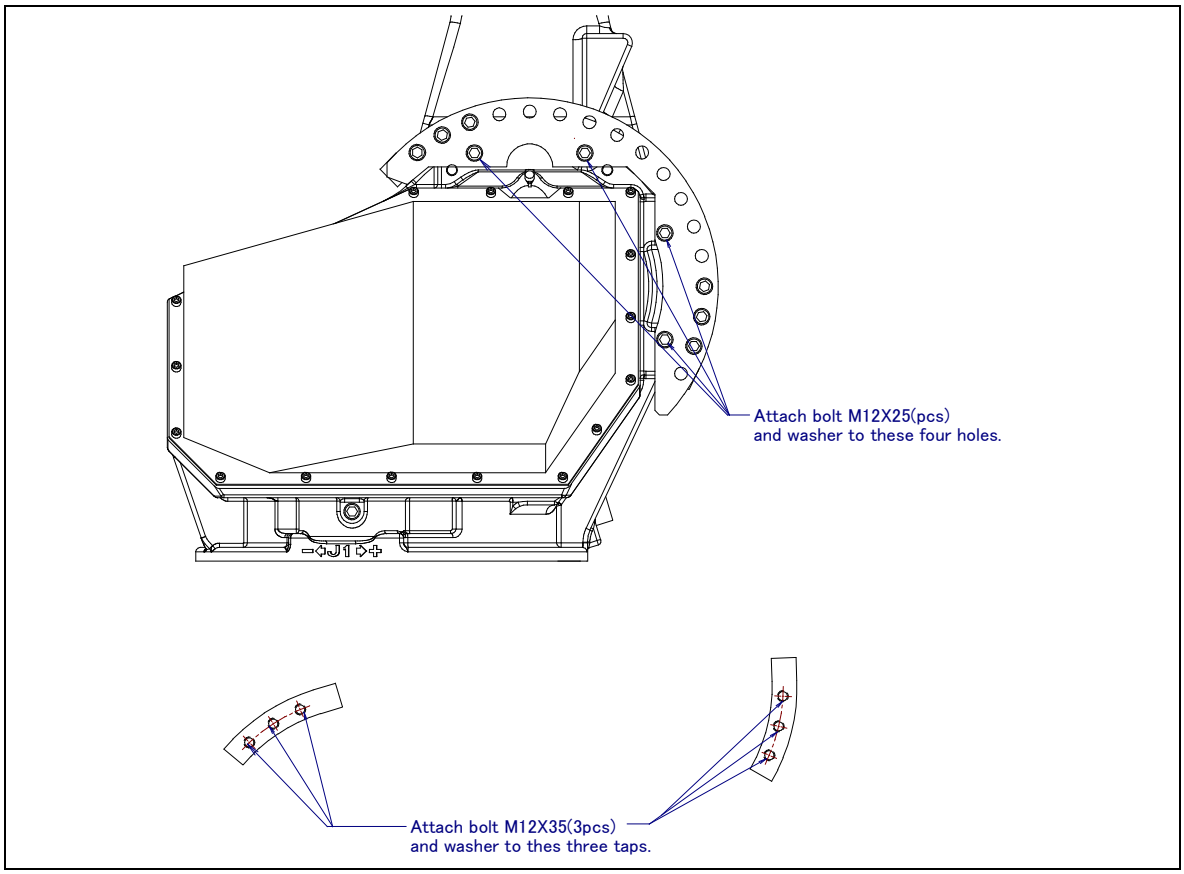


Fig. 6.2 (b) J2-Axis movable mechanical stopper (M-710*i*C/50/70/50H/50E/45M)

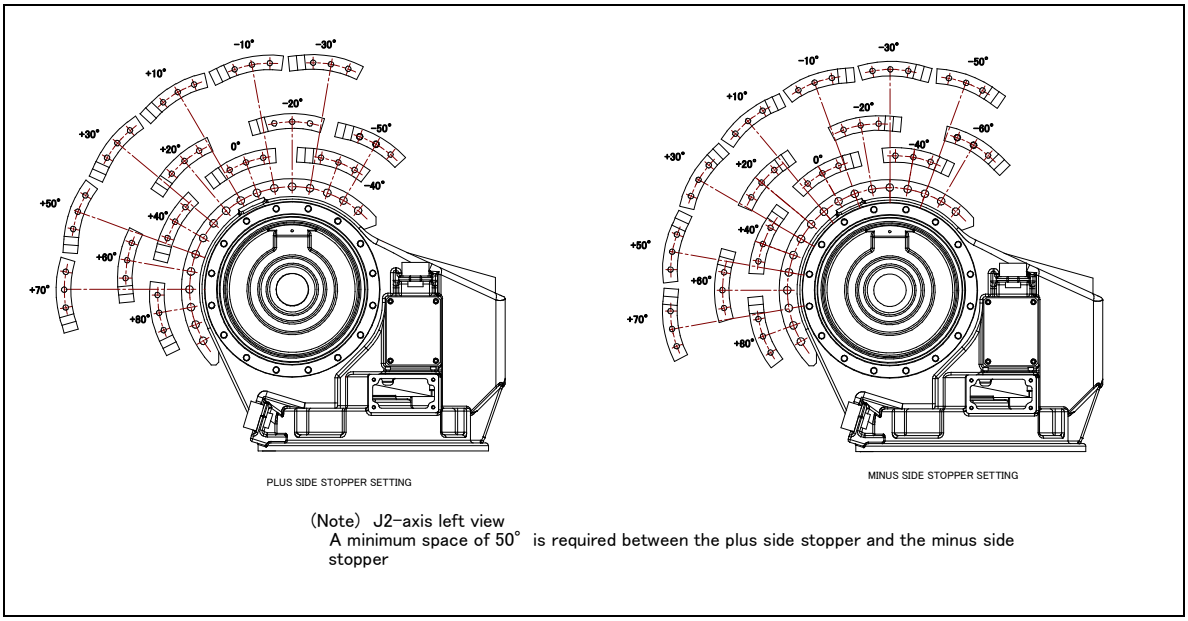


Fig. 6.2 (c) Attachment of J2-Axis movable mechanical stopper (M-710*i*C/50/70/50H/50E/45M)

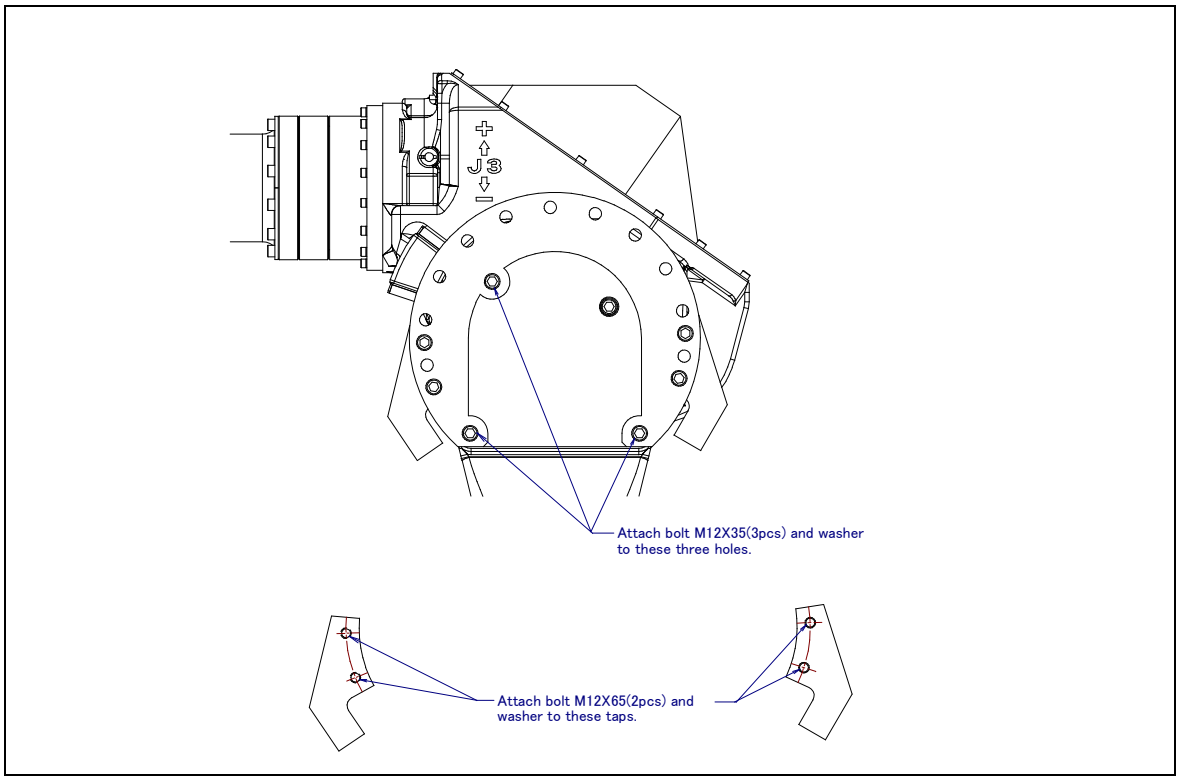


Fig. 6.2 (d) J3-Axis movable mechanical stopper (M-710*i*C/50/70/50H/50E/45M)

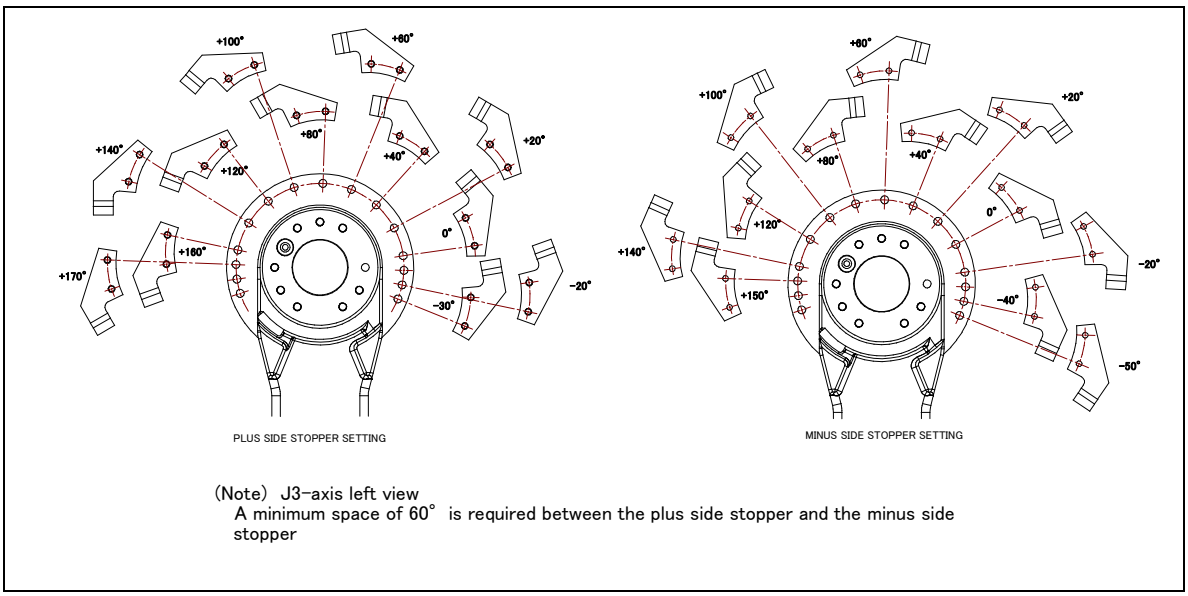


Fig. 6.2 (e) Attachment of J3-Axis movable mechanical stopper (M-710*i*C/50/70/50H/50E/45M)

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

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

Item		Plus side	Minus side
M-710*i*C/50/50H/50E/45M	J1-axis	+17°	-17°
	J2-axis	+19°	-18°
	J3-axis	+11°	-10°
M-710*i*C/70	J1-axis	+16°	+16°
	J2-axis	+12°	-11°
	J3-axis	+11°	-10°
M-710*i*C/50S	J1-axis	+17°	-17°
	J2-axis	There is no movable mechanical stopper.	
	J3-axis		

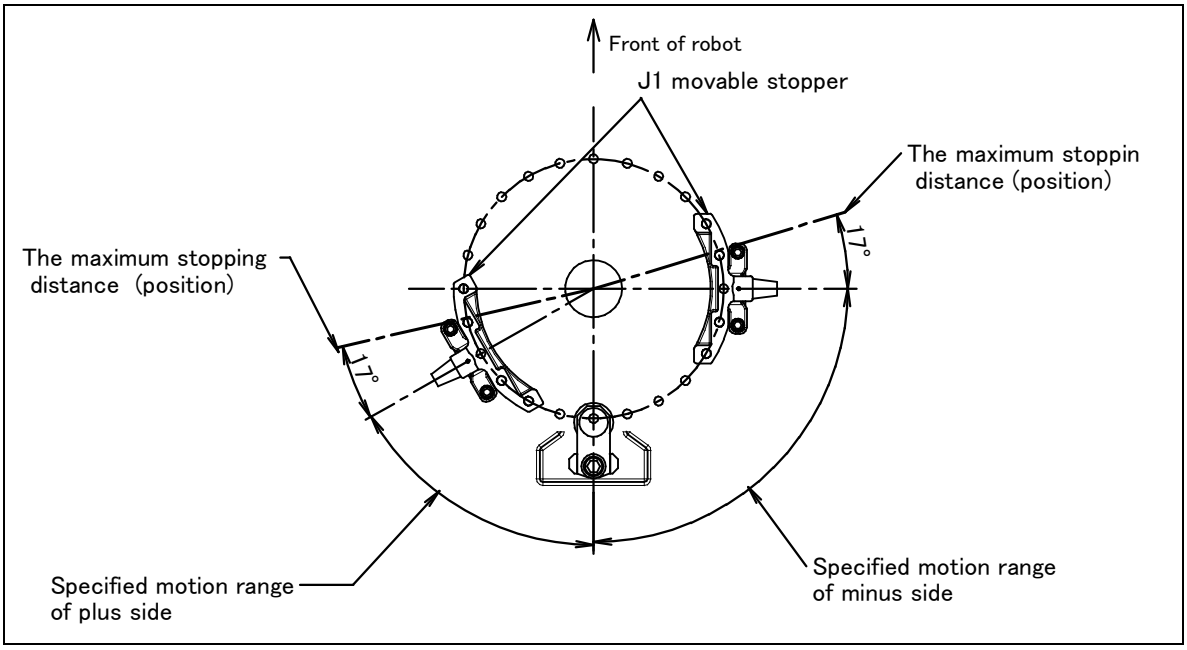


Fig. 6.2 (f) The maximum stopping distance of movable mechanical stopper (J1-axis of M-710*i*C/50/50H/50S/50E/45M)

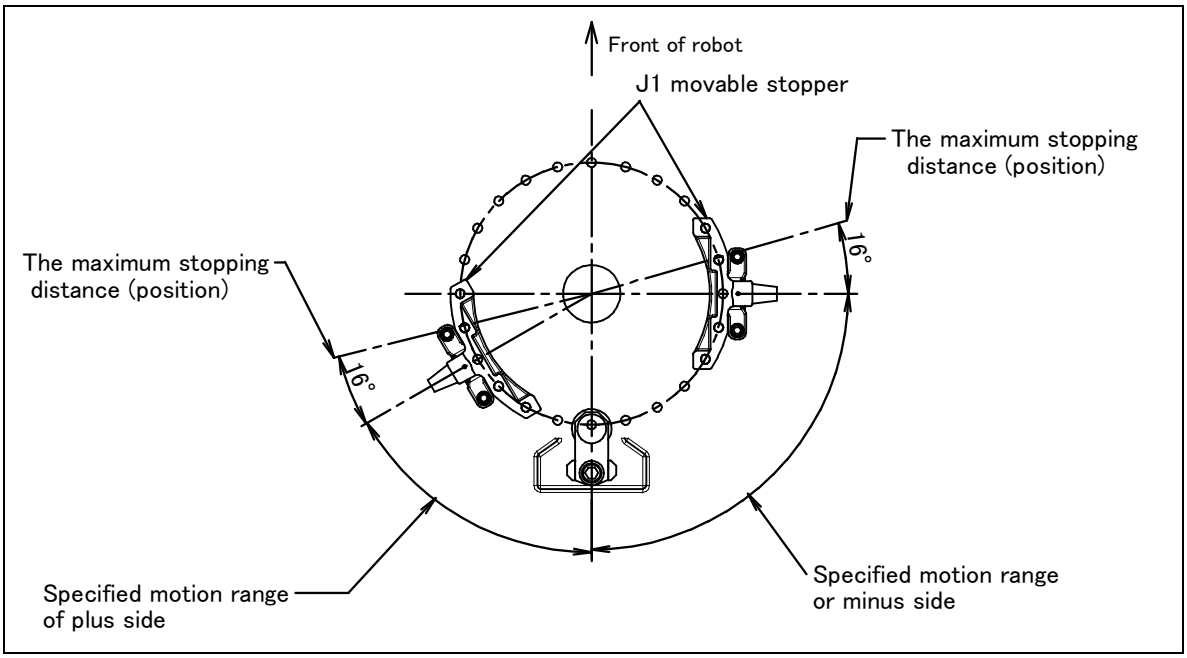


Fig. 6.2 (g) The maximum stopping distance of movable mechanical stopper (J1-axis of M-710*i*C/70)

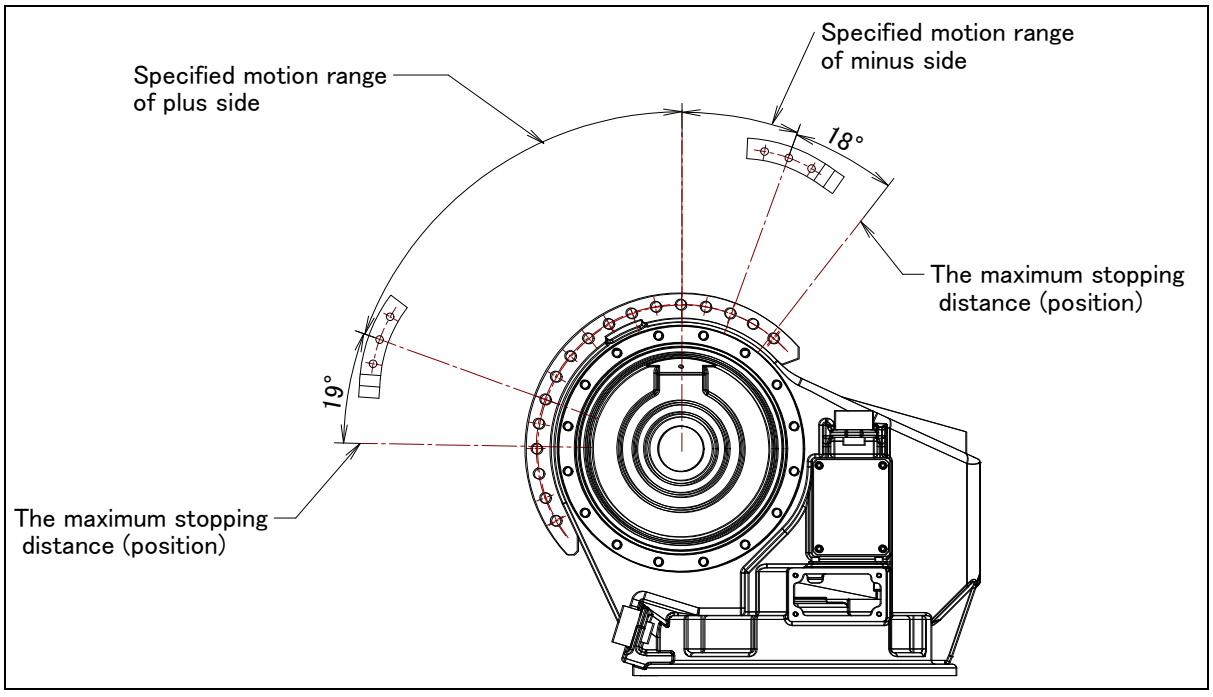


Fig. 6.2 (h) The maximum stopping distance of movable mechanical stopper (J2-axis of M-710*i*C/50/50H/50E/45M)

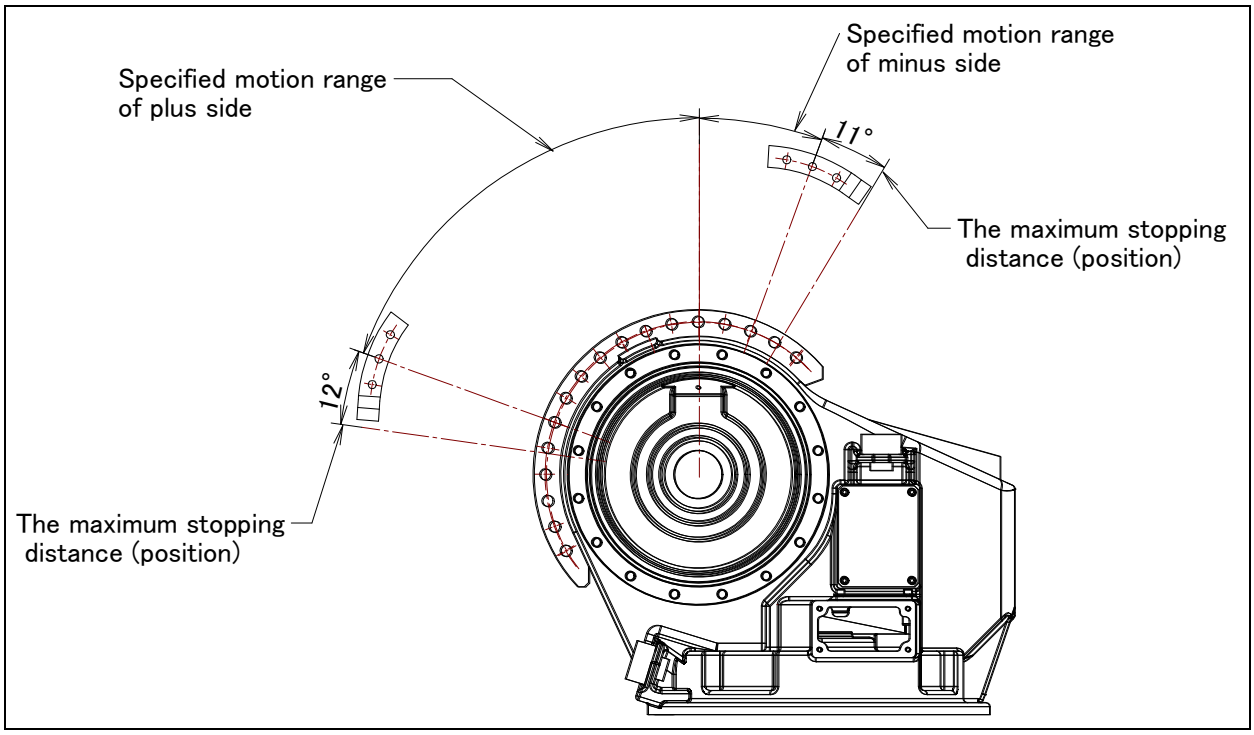


Fig. 6.2 (i) The maximum stopping distance of movable mechanical stopper (J2-axis of M-710*i*C/70)

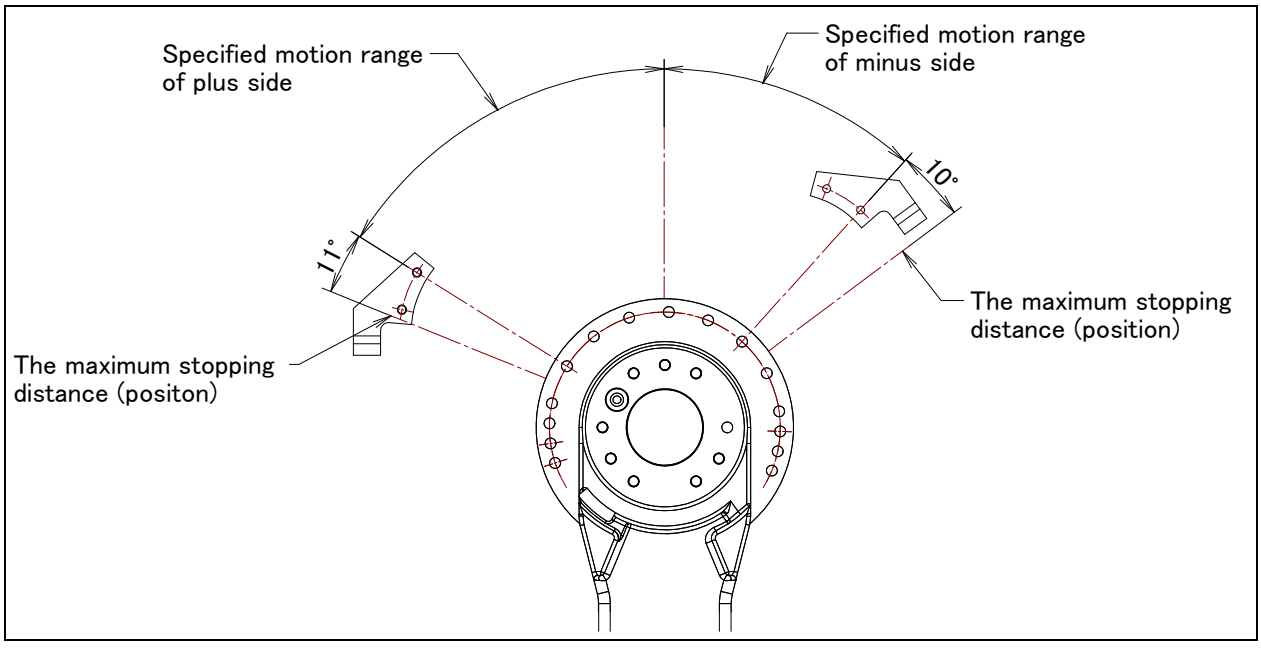
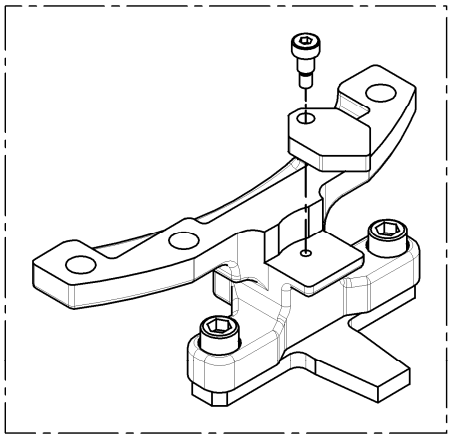


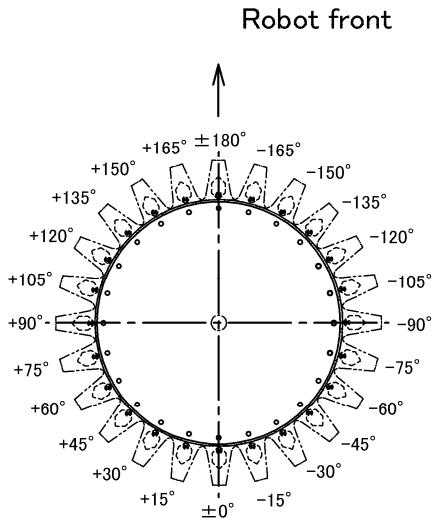
Fig. 6.2 (j) The maximum stopping distance of movable mechanical stopper (J3-axis of M-710*i*C/50/50H/70/50E/45M)

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

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



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



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

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

6.4 ADJUSTING LIMIT SWITCH (OPTION)

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

ADJUSTING PROCEDURE

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

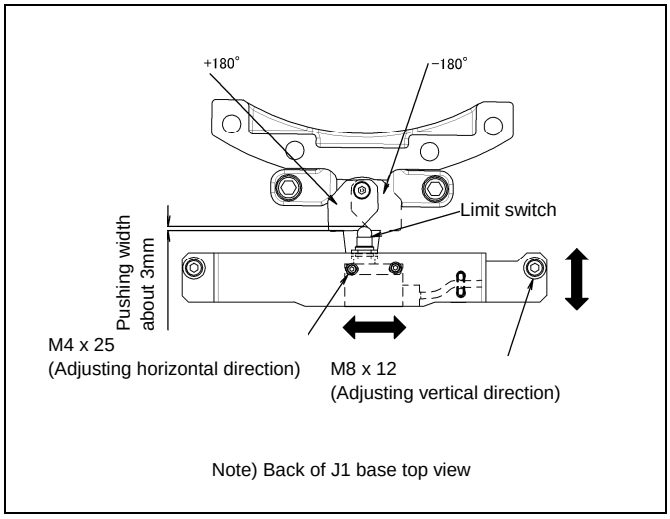


Fig. 6.4 Adjusting J1-axis limit switch (option)

7 CHECKS AND MAINTENANCE

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

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

7.1 CHECKS ANS MAINTENANCE

7.1.1 Daily Checks

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

Check items	Check points and management
Oil seepage	Check to see if there is oil on the sealed part of each joint. If there is an oil seepage, clean it. **⇒"7.2.1 Confirmation of Oil Seepage"**
Air control set Air purge kit	(When air control set or air purge kit is used) **⇒"7.2.2 Confirmation of the Air Control Set and Air Purge Kit"**
Vibration, abnormal noises	Check whether vibration or abnormal noises occur. When vibration or abnormal noises occur, perform measures referring to the following section: **⇒"9.1 TROUBLESHOOTING"(symptom : Vibration, Noise)**
Positioning accuracy	Check to see that the taught positions of the robot have not deviated from the previous taught positions. When displacement occurs, perform the measures as described in the following section: **⇒"9.1 TROUBLESHOOTING"(symptom : Displacement)**
Peripheral equipment for proper operation	Check whether the peripheral equipment operate properly according to commands from the robot and the peripheral equipment.
Brakes for each axis	Check that the end effector drops within 0.5 mm when servo power is turned off. If the end effector (hand) drops, perform the measures as described in the following section: **⇒"9.1 TROUBLESHOOTING"(symptom : Dropping axis)**
Warnings	Check whether unexpected warnings occur in the alarm screen on the teach pendant. If unexpected warnings occur, perform the measures as described in the following manual: **⇒"R-30*i*B/R-30*i*B Mate/R-30*i*B Plus/R-30*i*B Mate Plus CONTROLLER OPERATOR'S MANUAL (Alarm Code List)(B-83284EN-1) or R-30*i*A/R-30*i*A Mate CONTROLLER OPERATOR'S MANUAL (Alarm Code List)(B-83124EN-6)"**

7.1.2 Periodic Checks and Maintenance

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

Check and maintenance intervals (Period, accumulated operating time)						Check and maintenance item	Check points, management and maintenance method	Periodic maintenance table No.
1 month 320h	3 months 960h	1 year 3840h	1.5 years 5760h	3 years 11520h	4 years 15360h			
○ Only 1st check	○					Cleaning the controller ventilation system	Confirm the controller ventilation system is not dusty. If dust has accumulated, remove it.	20
	○					Check the external damage or peeling paint	Check whether the robot has external damage or peeling paint due to the interference with the peripheral devices. If an interference occurs, eliminate the cause. Also, if the external damage is serious, and causes a problem in which the robot will not operate, replace the damaged parts.	1
	○					Check for water	Check whether the robot is subjected to water or cutting oils. If water is found, remove the cause and wipe off the liquid.	2
	○ 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.	18
		○				Check for damage to the mechanical unit cable (movable part)	Observe the movable part of the mechanical unit cable, and check for damage. Also, check whether the cables are excessively bent or unevenly twisted. **⇒"7.2.3 Check the Mechanical Unit Cables and Connectors"**	3
		○				Check the connection of each axis motor and other exposed connectors	Check the connection of each axis motor and other exposed connectors. **⇒"7.2.3 Check the Mechanical Unit Cables and Connectors"**	4
	○ 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"**	5
	○ Only 1st check	○				Retightening the cover mounting bolts and external main bolts	Retighten the cover mounting bolts, the robot installation bolts, bolts to be removed for inspection, and bolts exposed to the outside. Refer to the recommended bolt tightening torque guidelines at the end of the manual. An adhesive to prevent bolts from loosening is applied to some bolts. If the bolts are tightened with greater than the recommended torque, the adhesive might be removed. Therefore, follow the recommended bolt tightening torque guidelines when retightening the bolts.	6

Check and maintenance intervals (Period, accumulated operating time)						Check and maintenance item	Check points, management and maintenance method	Periodic maintenance table No.
1 month 320h	3 months 960h	1 year 3840h	1.5 years 5760h	3 years 11520h	4 years 15360h			
	○ 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 tightness of the stopper mounting bolts. Check that the J1-axis swing stopper rotates smoothly. **⇒"7.2.4 Check of Fixed Mechanical Stopper and Adjustable Mechanical Stopper"**	7
	○ 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 wrist flange). The insulation failure occurs when the spatter has collected around the wrist flange or welding torch, and there is a possibility of damaging the robot mechanism by the welding current. (See Appendix C)	8
	○ 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.	9
	○ Only 1st check	○				Check the operation of the cooling fan	(When cooling fans are installed on the each axis motor) Check whether the cooling fans are operating correctly. If the cooling fans do not operate, replace them.	10
			○			Replacing the mechanical unit batteries	Replace the mechanical unit batteries **⇒"7.3.1 Replacing the Batteries"**	11
				○		Replacing the grease of drive mechanism	Replace the grease of each axis reducer and gearbox **⇒"7.3.2 Replacing the Grease of the Drive Mechanism"**	12 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*B Mate CONTROLLER MAINTENANCE MANUAL (B-83525EN) or R-30*i*A CONTROLLER MAINTENANCE MANUAL (B-82595EN) or R-30*i*A CONTROLLER MAINTENANCE MANUAL(For Europe) (B-82595EN-1) or R-30*i*A CONTROLLER MAINTENANCE MANUAL(For RIA) (B-82595EN-2)"**	21

7.2 CHECK POINTS

7.2.1 Confirmation of Oil Seepage

Check items

Check to see whether there is an oil seepage on the rotating parts of each joint axis.

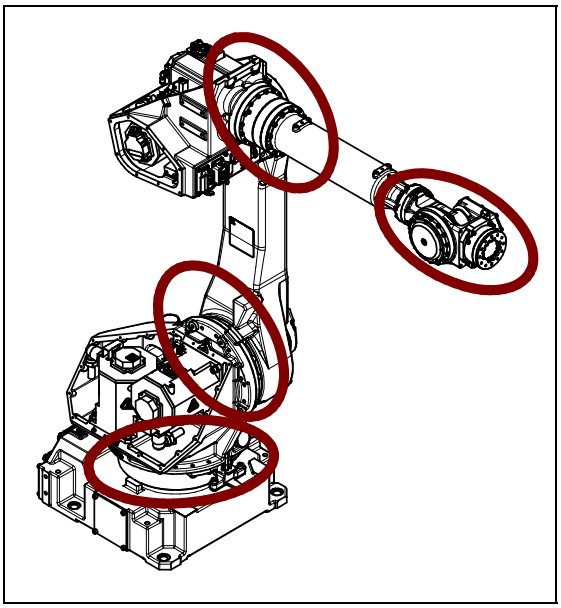


Fig. 7.2.1 Check parts of oil seepage

Management

- Oil might accumulate on the outside of the seal lip depending on the movement condition or environment of the axis. If the oil viscosity changes, the oil might drip depending on the axis movement. To prevent oil spots, be sure to wipe away any accumulated oil under the axis components in Fig. 7.2.1 before you operate the robot.
- In case of oil seepage, please consider replacing the grease. This replacement potentially can help improving the seepage situation.
- Also, motors might become hot and the internal pressure of the grease bath might rise by frequent repetitive movement and use in high temperature environments. In these cases, normal internal 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.)

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

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

7.2.2 Confirmation of the Air Control Set and Air Purge Kit (option)

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

Item	Check items		Check points
1	In case of air control set	Air pressure	Check air pressure using the pressure gauge on the air control set as shown in Fig.7.2.2 (a). If it does not meet the specified pressure of 0.49 to 0.69 MPa (5-7 kgf/cm^2), adjust it using the regulator pressure-setting handle.
2		Lubricator oil mist quantity	Check the number of oil drops during operation. If it does not meet the specified value (1 drop/10-20 sec), adjust it using the handle for lubricator adjustment. 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.
6	In case of air purge kit	Supply pressure	Check the supply pressure using the air purge kit shown in Fig.7.2.2 (b). If it does not meet the specified pressure of 10 KPa (0.1kgf/cm^2), adjust it using the regulator pressure setting handle.
7		Dryer	Check whether the color of the dew point checker is blue. When it is not blue, identify the cause and replace the dryer. Maintenance for air purge kit, refer to the operator's manual attached kit.
8		Drain	Check drain, When quantity of the drain is remarkable, examine the setting of the air dryer to the air supply side.

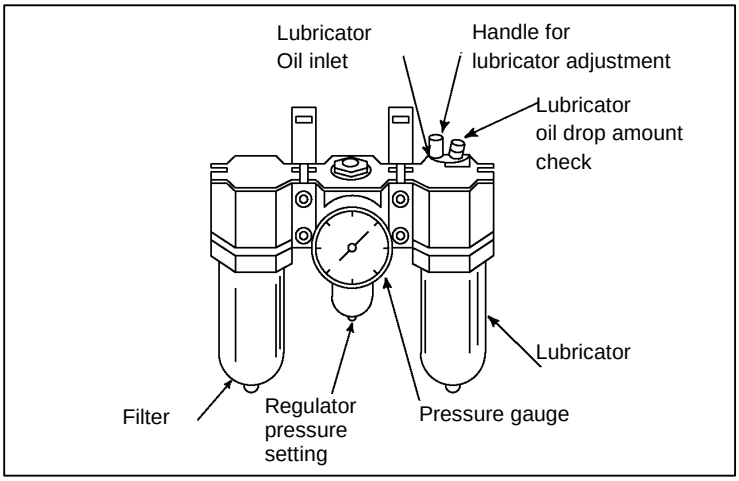


Fig. 7.2.2 (a) Air control set (option)

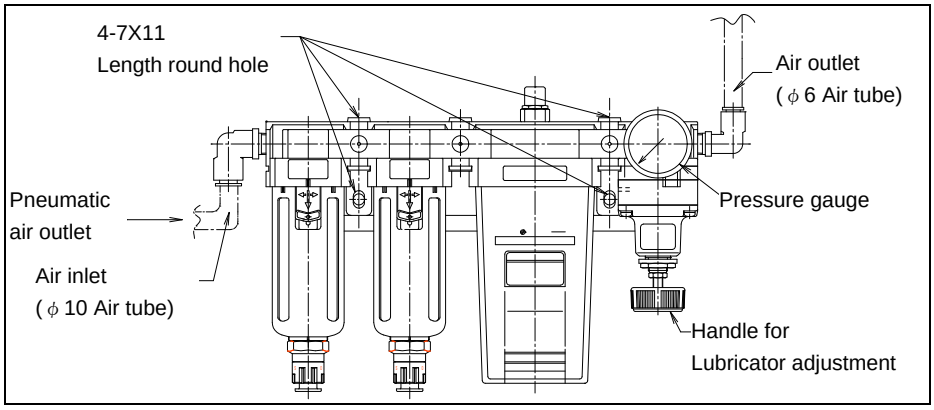


Fig. 7.2.2 (b) Air purge kit (option)

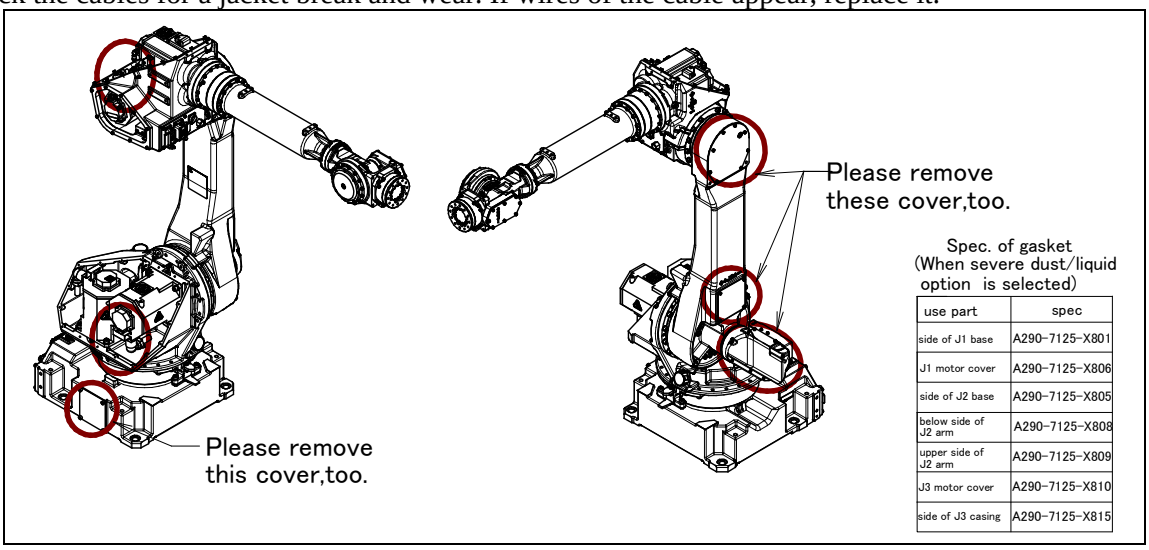
7.2.3 Check the Mechanical Unit Cables and Connectors

Inspection points of the mechanical unit cables

For the J1-axis, inspect the cables from above the J2 base and from the side by removing the metal plate on the side of the J1 base. When the J2 base cover is attached, inspect there after removing the cover. For the J2-axis, inspect there after removing the J2 base side cover. For the J3-axis, check cables after remove cover of J3 casing. When severe dust/liquid protection option is selected, gasket is attached to the cover. If you remove covers, be sure to exchange gasket for the new article.

Check items

Check the cables for a jacket break and wear. If wires of the cable appear, replace it.



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

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

Inspection points of the connectors

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

Check items

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

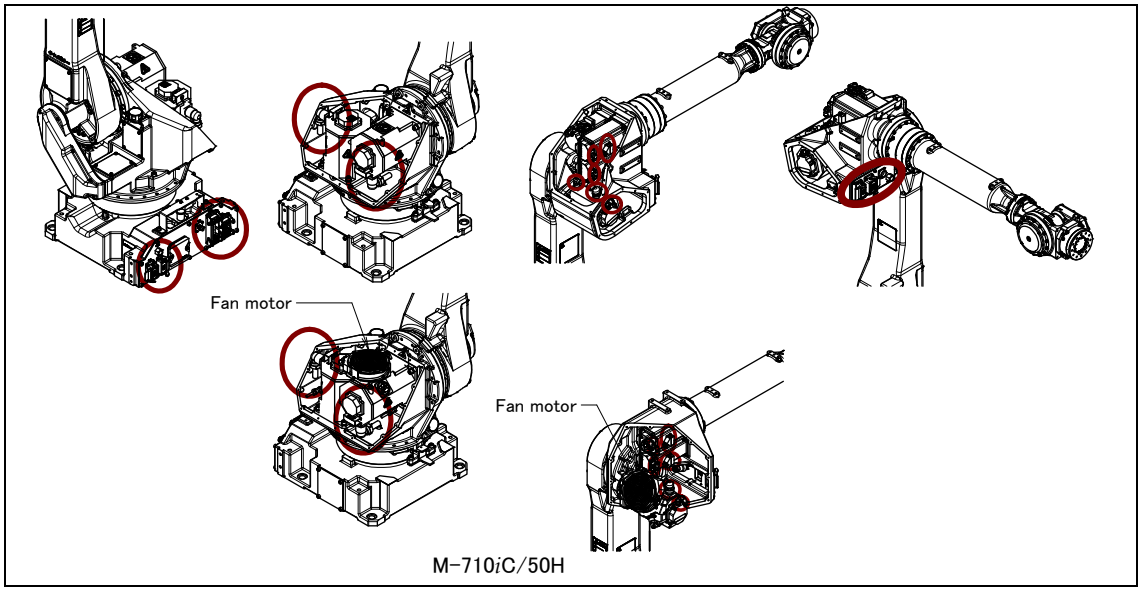


Fig. 7.2.3 (b) Connector Inspection points

7.2.4 Check of Fixed Mechanical Stopper and Adjustable Mechanical Stopper

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

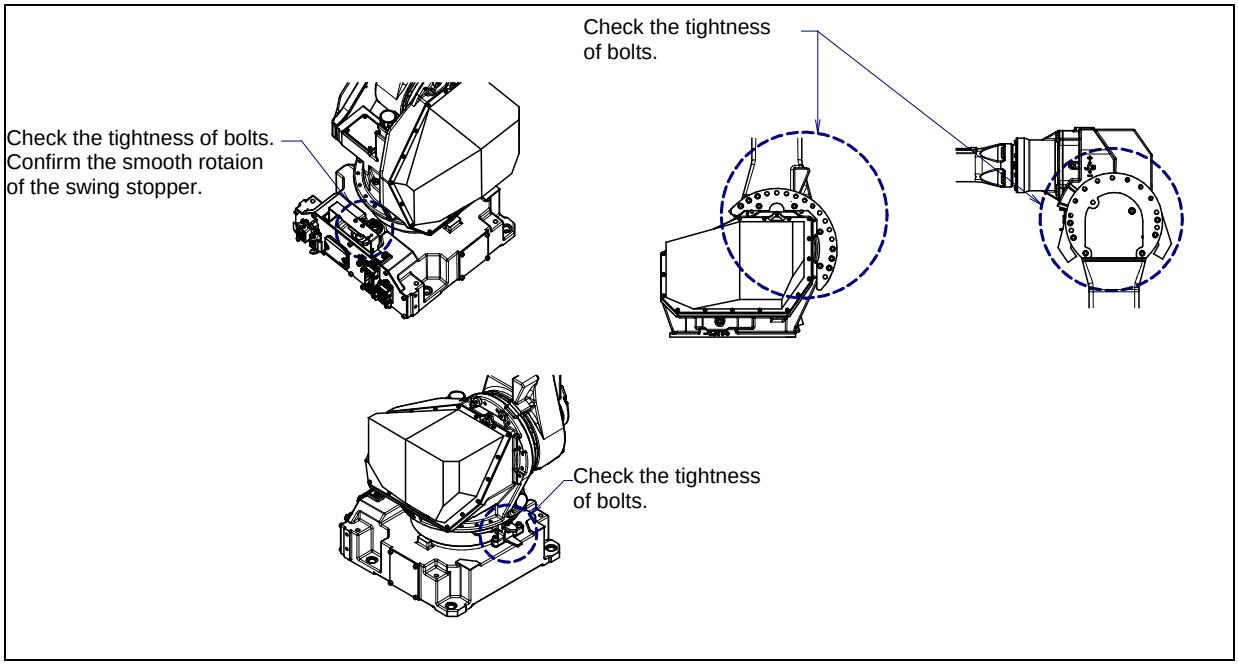


Fig. 7.2.4 Check of fixed mechanical stopper and adjustable mechanical stopper

7.3 MAINTENANCE

7.3.1 Replacing the Batteries (1.5-year (5760 Hours) Periodic Maintenance)

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

Procedure for replacing the battery

1 Press the EMERGENCY STOP button to prohibit 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 (a)).
3 Take out the old batteries from the battery case.
4 Insert new batteries into the battery case. Pay attention to the direction of batteries.
5 Close the battery case cap.

> ⚠ **CAUTION**
> When using a robot with the severe dust/liquid protection option, remove the cover from the battery case as shown in Fig.7.3.1 (b) to replace the battery. After replacing the battery, reinstall the cover. At this time, please be sure to replace gasket with new one for severe dust/liquid protection.

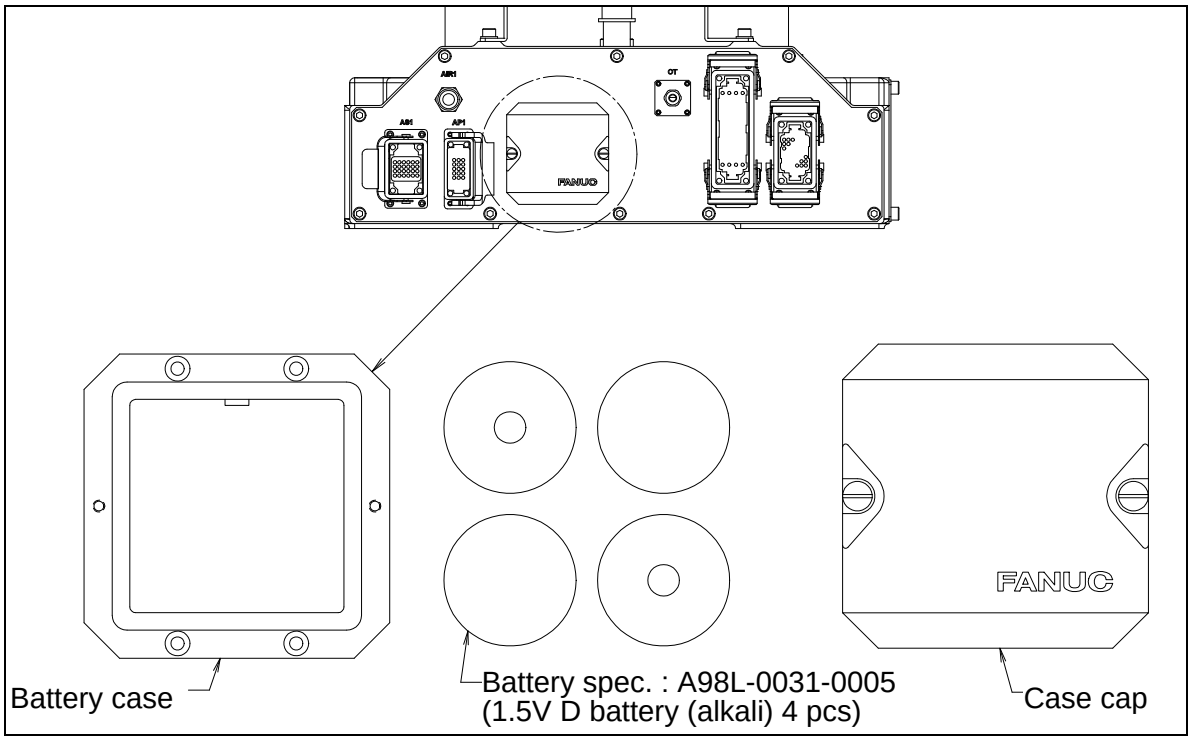


Fig. 7.3.1 (a) Replacing the battery

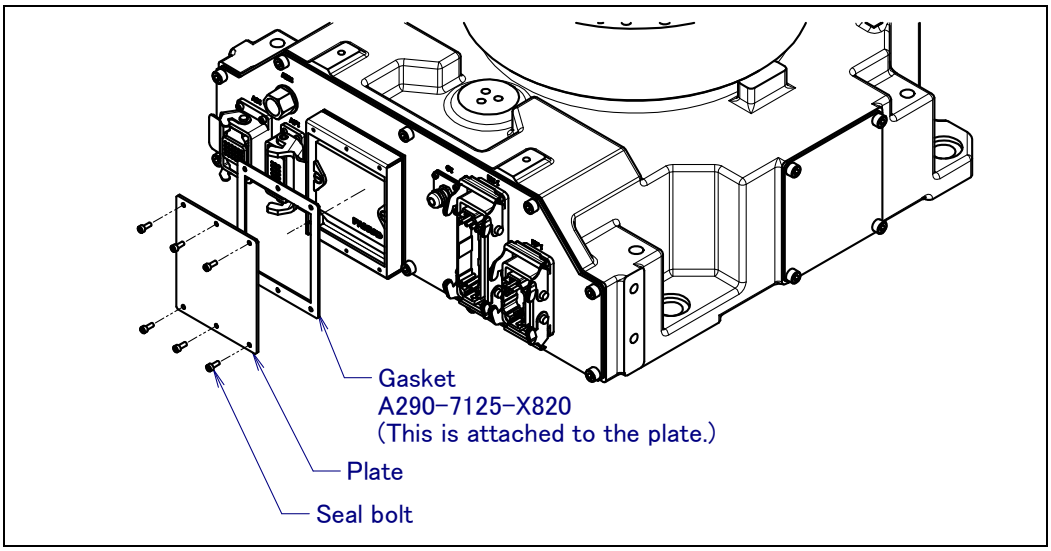


Fig.7.3.1 (b) Removing the battery cover plate (When severe dust/liquid protection is specified)

7.3.2 Replacing the Grease of the Drive Mechanism (3-year (11520 Hours) Periodic Maintenance)

According to below, replace the grease of J1 to J3 axes reducer, J4/J5/J6-axis gearbox (J4/J5-axis gearbox) and wrist at the intervals based on every 3 years or 11520 hours, whichever comes first. See Table 7.3.2 (a) for the grease name and the quantity.

Table 7.3.2 (a) Grease for 3-years (11520 hours) periodical replacement

Grease supplying position	Quantity	Gun tip pressure	Grease name
J1-axis reducer	2950g (3300ml)	0.1MPa or less (NOTE)	Kyodo Yushi VIGOGREASE RE0 Spec.:A98L-0040-0174
J2-axis reducer (M-710*i*C/50/70/50S/50E/45M)	1500g (1660ml)		
J2-axis reducer (M-710*i*C/50H)	1260g (1400ml)		
J3-axis reducer	950g (1060ml)		
J4/J5/J6-axis gearbox (M-710*i*C/50/70/50S/50E/45M)	810g (920ml)		
J4/J5-axis gearbox (M-710*i*C/50H)	580g (650ml)		
Wrist (M-710*i*C/50/70/50H/50S/45M)	580g (650ml)		
Wrist (M-710*i*C/50E)	510g (580ml)		

NOTE
When a manual pump is used for greasing, the standard rate is one pumping cycles 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 (b) Postures for greasing

<table>
<tr><th rowspan="2">Supply position</th><th colspan="6">Posture</th></tr>
<tr><th>J1</th><th>J2</th><th>J3</th><th>J4</th><th>J5</th><th>J6</th></tr>
<tr><td>J1-axis reducer</td><td rowspan="5">Arbitrary</td><td>Arbitrary</td><td rowspan="2">Arbitrary</td><td rowspan="4">Arbitrary</td><td rowspan="4">Arbitrary</td><td rowspan="4">Arbitrary</td></tr>
<tr><td>J2-axis reducer</td><td>0°</td></tr>
<tr><td>J3-axis reducer</td><td>0°</td><td>0°</td></tr>
<tr><td>J4/J5/J6-axis gearbox
(J4/J5-axis gearbox)</td><td rowspan="2">Arbitrary</td><td>0°</td></tr>
<tr><td>Wrist</td><td>0°</td><td>0°</td><td>0°</td><td>0°</td></tr>
</table>

⚠ CAUTION

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

1 Before starting to grease, remove the seal bolt or the taper plug to allow the grease to come out.
2 A grease inlet may optionally have a plug. Replace the plug with the attached grease nipple and then start greasing.
3 Supply grease slowly without applying excessive force, using a manual pump.
4 Whenever possible, avoid using a compressed-air pump, powered by the factory air supply. Even when it is unavoidable to use a compressed-air pump, the gun tip pressure needs to be set the value of the gun tip pressure on Table 7.3.2 (a).
5 Use specified grease. Use of non-approved grease may damage the reducer or lead to other problems.
6 After greasing, release remaining pressure from the grease bath using the procedure given in Subsection 7.3.2.4, and then close the grease outlet.
7 To prevent an accident such as a fall or fire, remove all the excess grease from the floor and robot.

7.3.2.1 Grease replacement procedure of the J1, J2, J3-axis reducer

1 Move the robot to the greasing posture described in Table 7.3.2 (b).
2 Turn off the controller power.
3 Remove the seal bolt from grease outlet. (Fig.7.3.2.1 (a) to (d))
4 Supply new grease through the wrist grease inlet until new grease is output from wrist grease outlet.
5 After greasing, release the remaining pressure as the Subsection 7.3.2.4.

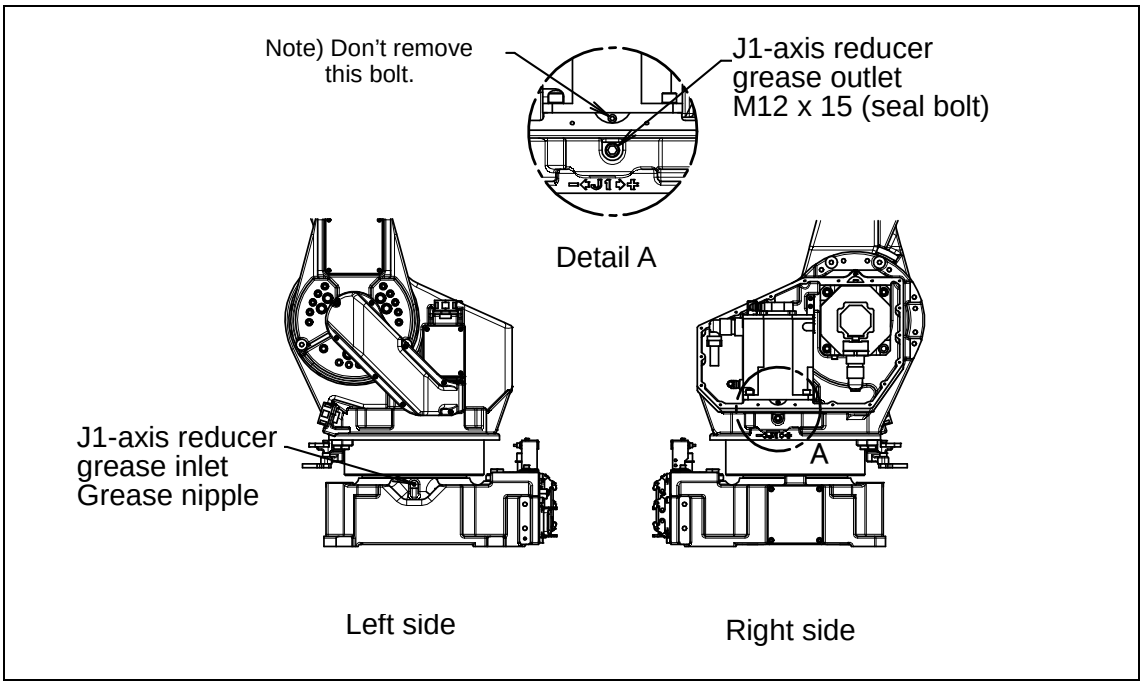


Fig. 7.3.2.1 (a) Replacing grease of the J1-axis reducer

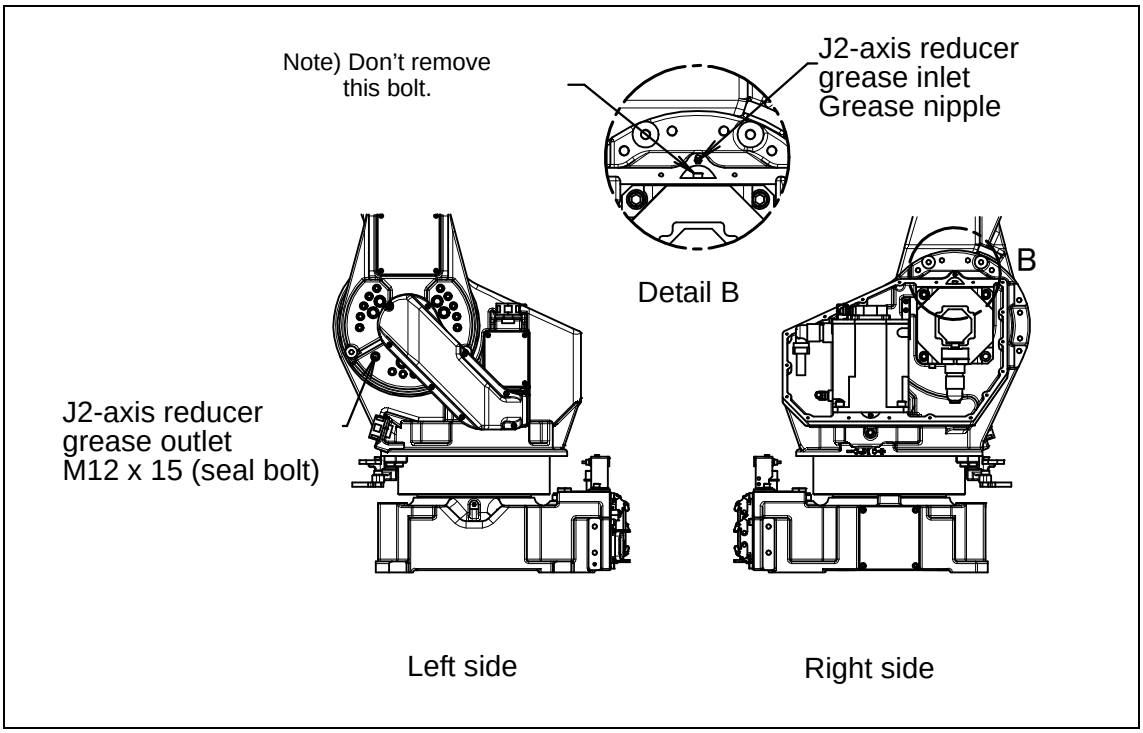


Fig. 7.3.2.1 (b) Replacing grease of the J2-axis reducer

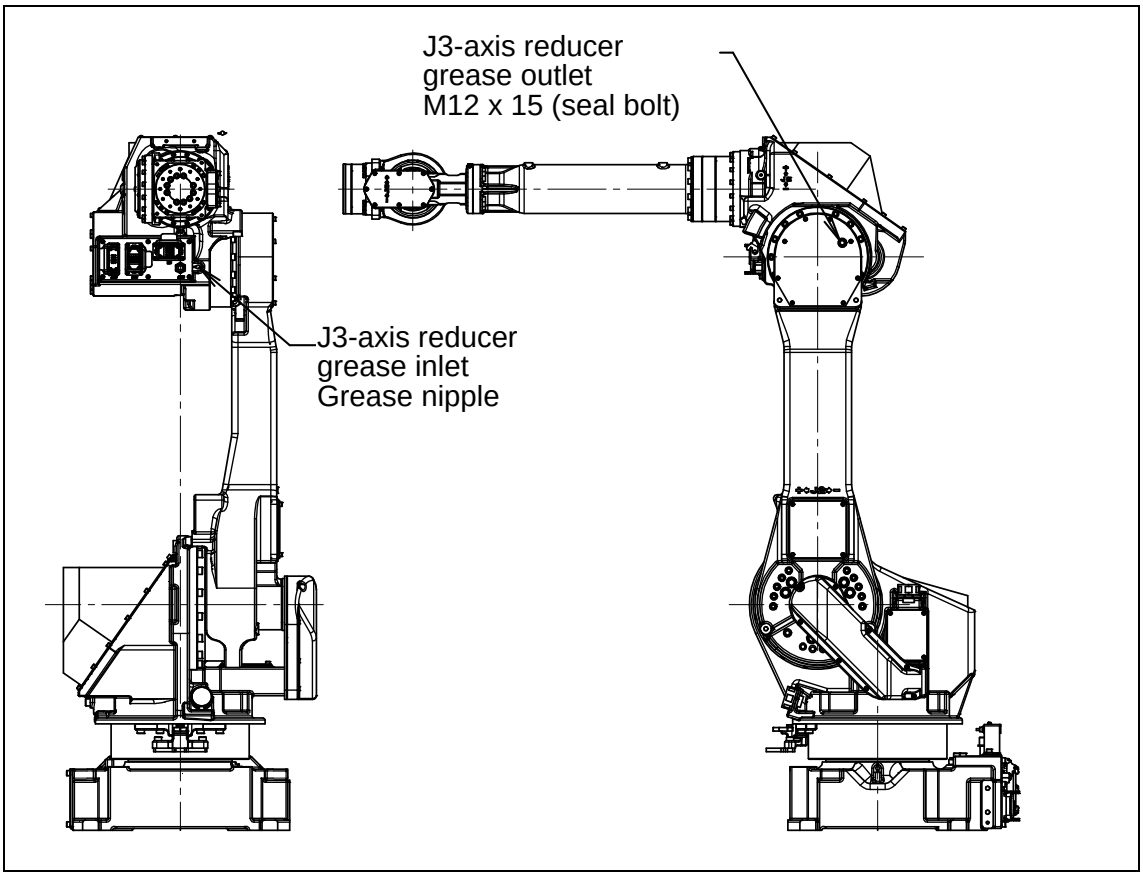


Fig. 7.3.2.1 (c) Replacing grease of the J3-axis reducer (M-710*i*C/50/70/50H/50E/45M)

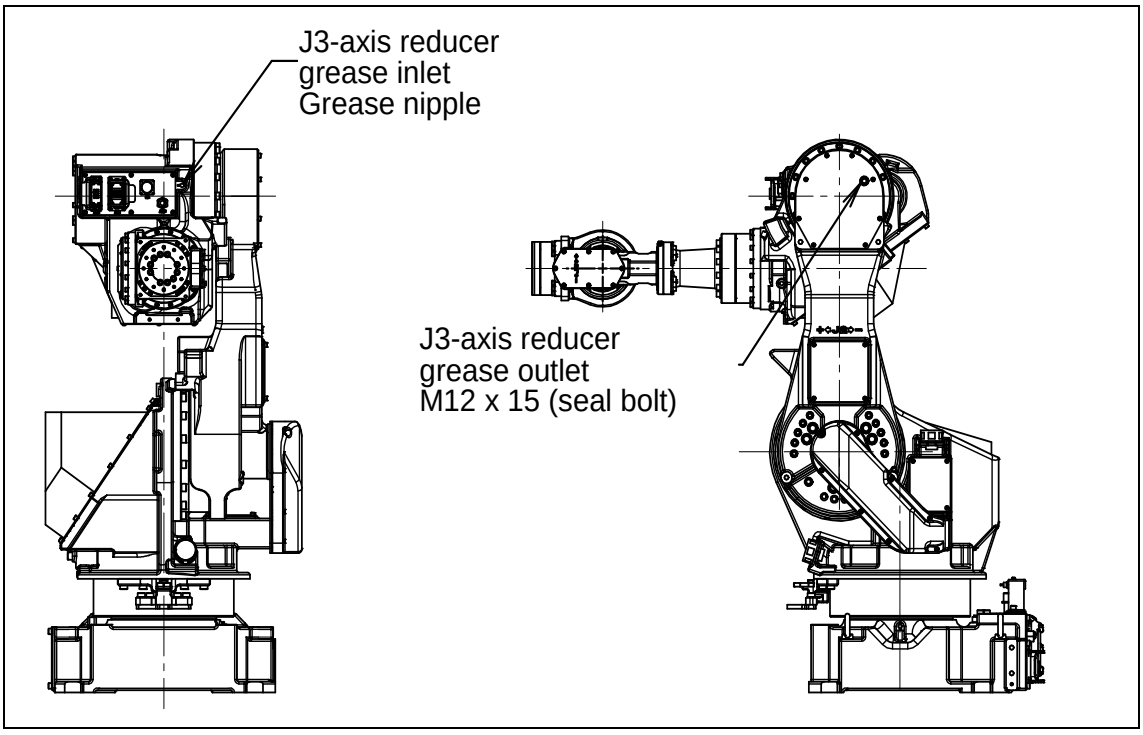


Fig. 7.3.2.1 (d) Replacing grease of the J3-axis reducer (M-710*i*C/50S)

Table 7.3.2.1 Specification of the seal bolt and grease nipple (J1 to J3-axis)

Parts name	Specifications
Seal bolt (M12)	A97L-0218-0417#121515
Grease nipple	A97L-0218-0013#A610

7.3.2.2 Grease replacement procedure for the J4/J5/J6-axis gearbox (J4/J5-axis gearbox)

1 Move the robot to the greasing posture described in Table 7.3.2 (b).
2 Turn off the controller power.
3 Remove the seal bolt from the grease outlet. (Fig. 7.3.2.2(a) to (c))
4 Supply new grease until new grease is output from the grease outlet.
5 After greasing, release the remaining pressure as the sub-Subsection 7.3.2.4.

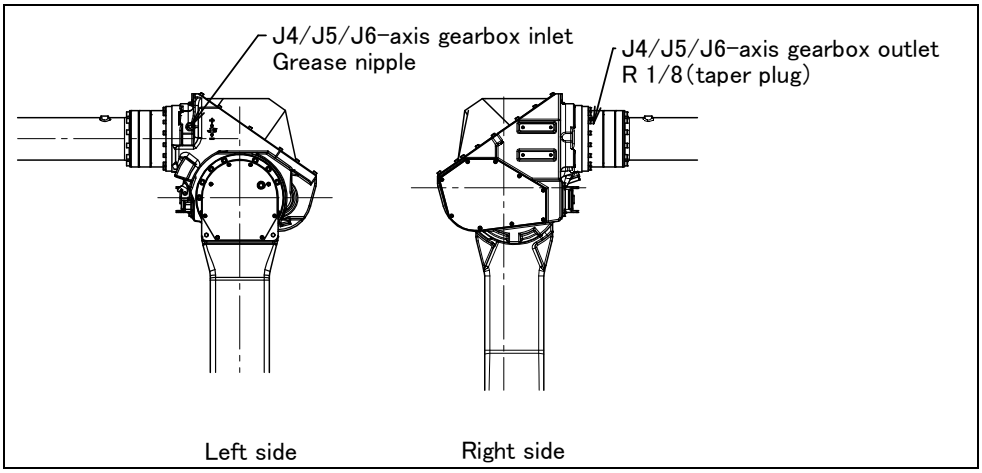


Fig. 7.3.2.2 (a) Replacing grease of the J4/J5/J6-axis gearbox (M-710*i*C/50/70/50E/45M)

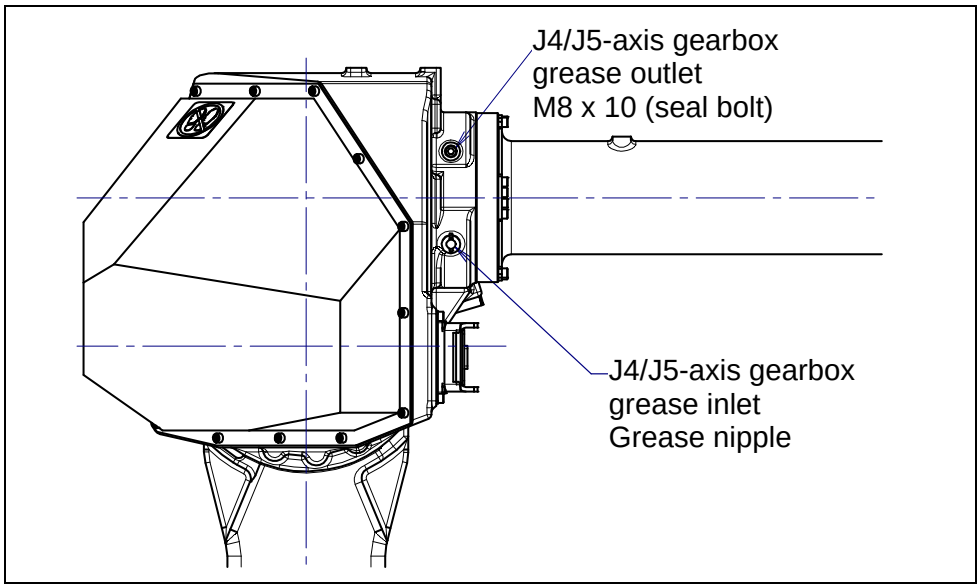


Fig. 7.3.2.2 (b) Replacing grease of the J4/J5-axis gearbox (M-710*i*C/50H)

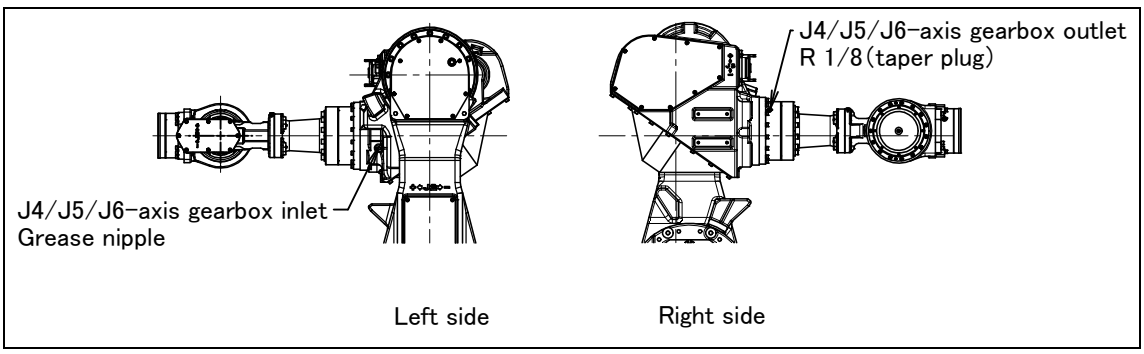


Fig. 7.3.2.2 (c) Replacing grease of the J4/J5/J6-axis gearbox (M-710*i*C/50S)

Table 7.3.2.2 Specification of the seal bolt, taper plug and grease nipple (J4/J5/J6-axis gearbox (J4/J5-axis gearbox))

Parts name	Specifications
Seal bolt (M8)	A97L-0218-0417#081010
Taper plug (R1/8)	A97L-0001-0436#2-1D
Grease nipple	A97L-0218-0013#A610

7.3.2.3 Grease replacement procedure for the wrist

Grease Replacement Procedure for the Wrist (M-710*i*C/50/70/50H/50S/45M)

1 Move the robot to the greasing posture described in Table 7.3.2 (b).
2 Turn off the controller power.
3 Remove the plug with a sealant from the wrist grease outlet and attach the grease nipple that comes with the robot (Fig. 7.3.2.3 (a)).
4 Supply new grease through the wrist grease inlet until new grease is output from wrist grease outlet.
5 After greasing, release remaining pressure as the Subsection 7.3.2.4.

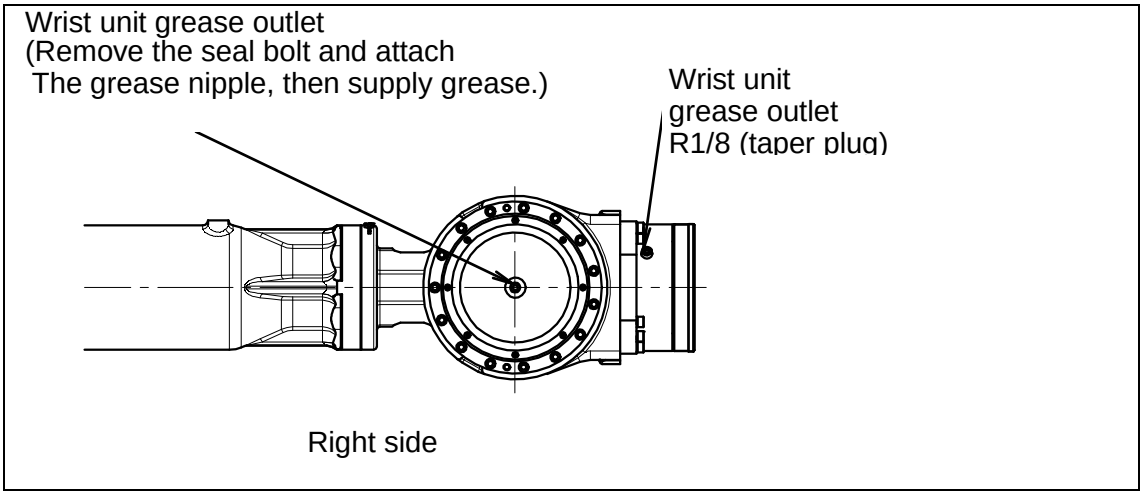


Fig. 7.3.2.3 (a) Replacing grease of the wrist (M-710*i*C/50/70/50H/50S/45M)

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

1 Move the robot to the greasing posture described in table 7.3.2 (b).
2 Turn off the controller power.
3 Remove the seal bolt of wrist grease outlet 1 (Fig. 7.3.2.3 (b)).
4 Supply grease to the wrist grease inlet until new grease outputs from wrist grease outlet 1.
5 Attach the seal bolt to wrist grease outlet 1.
6 Next, remove the seal bolt of wrist grease outlet 2.
7 Supply new grease through the wrist grease inlet until new grease is output from wrist grease outlet 2.
8 Release remaining pressure using the procedure given in Section 7.3.2.4.

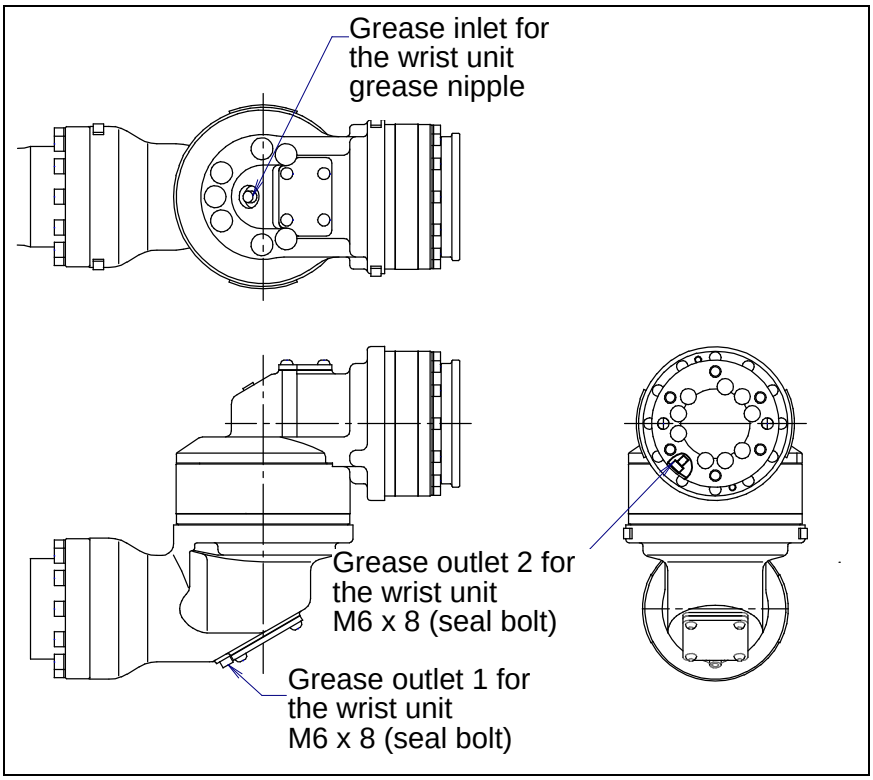


Fig. 7.3.2.3 (b) Replacing grease of the wrist (M-710*i*C/50E)

Table 7.3.2.3 Specification of the seal bolt and taper plug (Wrist)

Parts name	Specifications
Seal bolt (M6)	A97L-0218-0417#060808
Taper plug (R1/8)	A97L-0001-0436#2-1D

7.3.2.4 Procedure for releasing remaining pressure within the grease bath

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

<table>
<tr><th>Operating axis / Grease replacement part</th><th>J1-axis</th><th>J2-axis</th><th>J3-axis</th><th>J4-axis</th><th>J5-axis</th><th>J6-axis</th></tr>
<tr><td>J1-axis reducer</td><td>Axis angle of 60° or more OVR 80%</td><td colspan="5">Arbitrary</td></tr>
<tr><td>J2-axis reducer</td><td>Arbitrary</td><td>Axis angle of 60° or more OVR 100%</td><td colspan="4">Arbitrary</td></tr>
<tr><td>J3-axis reducer</td><td colspan="2">Arbitrary</td><td>Axis angle of 60° or more OVR 100%</td><td colspan="3">Arbitrary</td></tr>
<tr><td>J4/J5/J6-axis gearbox (J4/J5-axis gearbox)</td><td colspan="3">Arbitrary</td><td colspan="3">Axis angle of 60° or more OVR 100%</td></tr>
<tr><td>Wrist axis</td><td colspan="3">Arbitrary</td><td colspan="3">Axis angle of 60° or more OVR 100%</td></tr>
</table>

If the above operations cannot be performed due to local circumstances, the same count operation is necessary. (When the maximum allowable axis angle is 30°, perform twice the operation for 40 minutes or more.) If you grease multiple axes, you can exercise multiple axes at the same time. After the above operation is performed, attach the grease nipple to the grease inlet and the seal bolt to the grease outlet. When the seal bolt or grease nipple is reused, be sure to seal it with seal tape.

7.4 STORAGE

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

8 MASTERING

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

8.1 OVERVIEW

The current position of the robot is determined according to the pulse count value supplied from the Pulsecoder on each axis.
Mastering is factory0-performed. It is unnecessary to perform mastering in daily operations. However, mastering is required under the following conditions:

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

> ⚠ **CAUTION**
> Robot data (including mastering data) and Pulsecoder data are backed up by their respective backup batteries. Data will be lost if the batteries are gone dead. Replace the batteries in the controller and mechanical units periodically. Alarm will alert decreasing the battery voltage.

Types of Mastering

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

Table 8.1 Type of mastering

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

Once performing the mastering, the positioning (calibration) is indispensable. The Positioning is an operation which recognizes the robot current position loading the pulse count value.

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

⚠ CAUTION
1 If mastering is performed incorrectly, the robot may behave unexpectedly. This is very dangerous. For the reason, the Master/Cal screen is designed to appear only when the $MASTER_ENB system variable is 1 or 2. After performing positioning, press 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.
2 Before performing mastering, recommend to back up the current mastering data.

8.2 RESETTING ALARMS AND PREPARING FOR MASTERING

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

Alarm displayed

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

Procedure

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

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

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

8.3 ZERO POSITION MASTERING

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

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

Zero-position Mastering Procedure

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

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

 [ TYPE ]   LOAD   RES_PCA                DONE
```

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

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

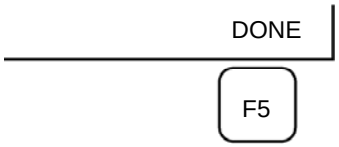
6 Select [2 Zero Position Master]. Press F4 [YES].

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

7 Select [6 CALIBRATE] and press F4 [YES]. Mastering will be performed automatically. Alternatively, turn off the controller power and on again. Turning on the power always causes positioning to be performed.

```
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 Calibrated! Cur Jnt Ang(deg):
   <    0.0000> <    0.0000> <    0.0000>
   <    0.0000> <    0.0000> <    0.0000>
```

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



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

Table 8.3 Posture with position marks (witness mark) aligned

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

⚠ CAUTION
There is no J6-axis for M-710*i*C/50H.

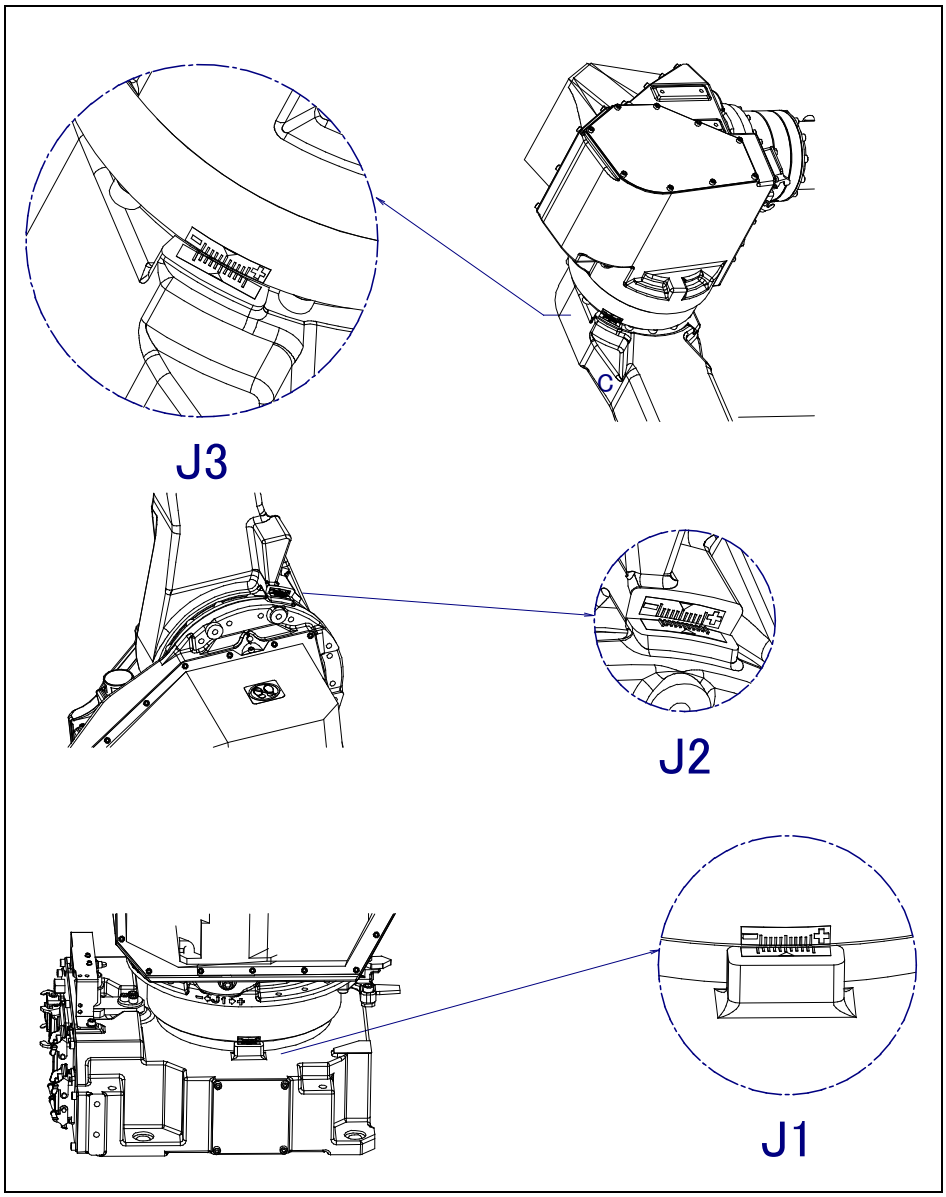


Fig. 8.3 (a) zero-position mark (witness mark) for each axis (1/2)

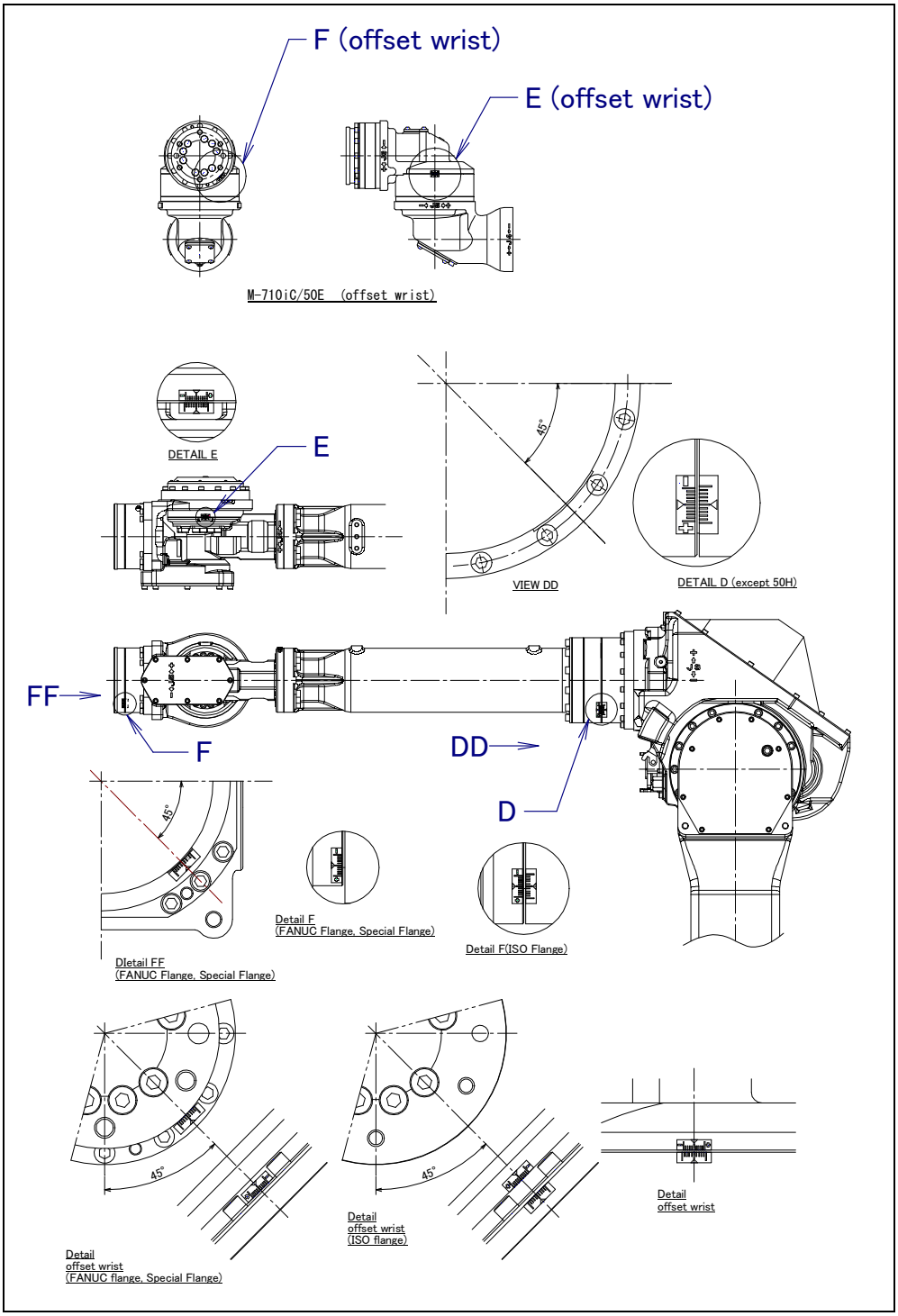


Fig. 8.3 (b) zero-position mark (witness mark) for each axis (2/2)

8.4 QUICK MASTERING

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

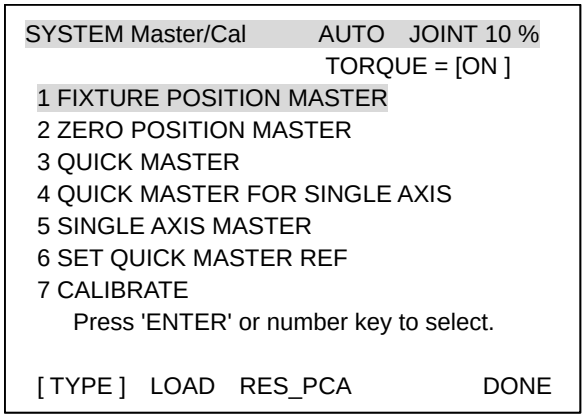
Quick mastering is factory-performed at the position indicated in Table 8.3. Do not change the setting unless there is any problem.

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

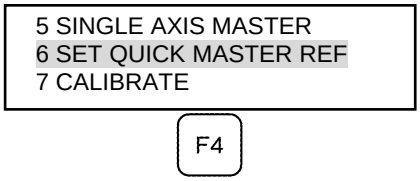
> **⚠ CAUTION**
> 1 Quick mastering can be used, if the pulse count value is lost, for example, because a low voltage has been detected on the backup battery for the pulse counter.
> 2 Quick mastering cannot be used, after the Pulsecoder is replaced or after the mastering data is lost from the robot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

Procedure Recording the Quick Mastering Reference Position

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



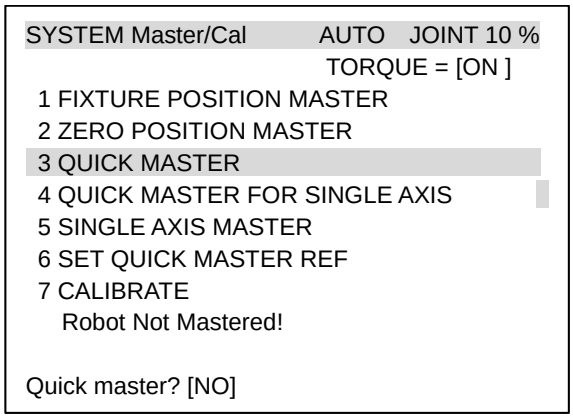
3 Release brake control, and jog the robot to the quick mastering reference position.
4 Select [6 SET QUICK MASTER REF] and press F4 [YES]. Quick mastering reference position is saved.



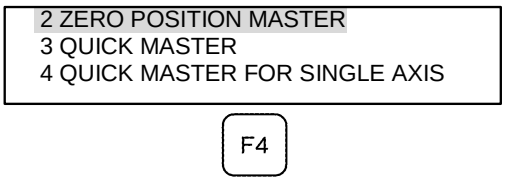
> **⚠ CAUTION**
> If the robot has lost mastering data due to mechanical disassembly or repair, you cannot perform this procedure. In this case, perform Fixture position mastering or Zero position mastering to restore mastering data.

Procedure of Quick Mastering

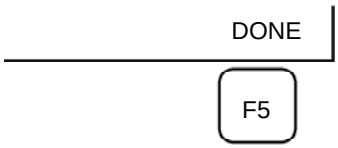
1 Display the Master/Cal screen.



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



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



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

8.5 QUICK MASTERING FOR SINGLE AXIS

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

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

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

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

Procedure Recording the Quick Mastering Reference Position

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

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

 [ TYPE ]   LOAD   RES_PCA                DONE
```

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

Procedure of Quick Mastering for single axis

1 Display the Master/Cal screen.

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

Quick master? [NO]
```

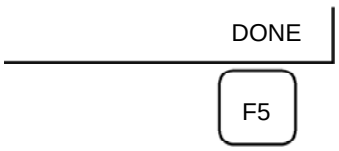
2 Select [4 QUICK MASTER FOR SINGLE AXIS]. The quick master for single axis screen will be displayed.

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

                                                EXEC
```

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

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

                                                EXEC
```

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



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

8.6 SINGLE AXIS MASTERING

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

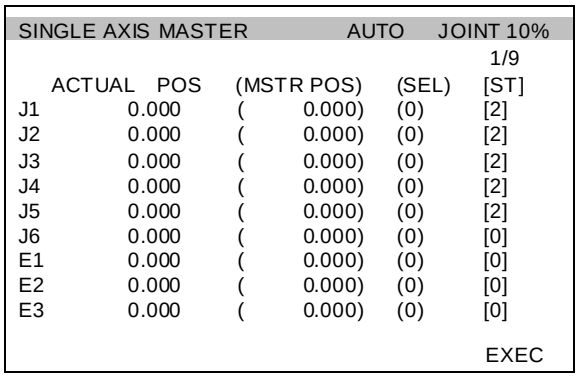


Table 8.6 Items set in single axis mastering

Item	Description
Current position (ACTUAL AXIS)	The current position of the robot is displayed for each axis in degree units.
Mastering position (MSTR POS)	A mastering position is specified for an axis to be subjected to single axis mastering. It would be convenient if it is set to 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].

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

 [ TYPE ]   LOAD   RES_PCA                DONE
```

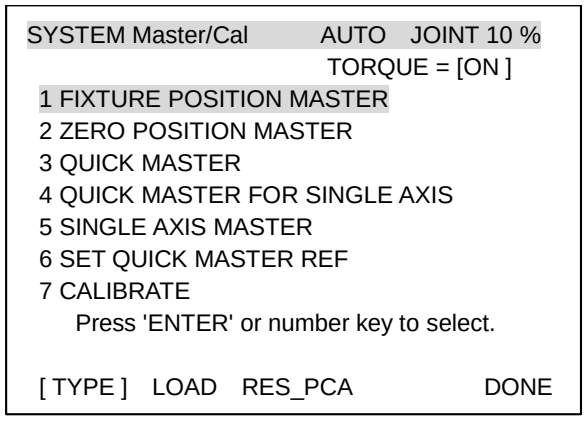
3 Select [5 SINGLE AXIS MASTER]. The following screen will be displayed.

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

                                          EXEC
```

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

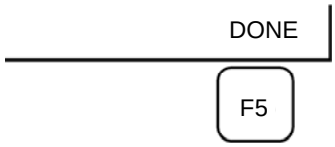
```
SINGLE AXIS MASTER          AUTO    JOINT 10%
                                          6/9
    ACTUAL   POS    (MSTR POS)    (SEL)   [ST]
J1          0.000   (     0.000)  (0)     [2]
J2          0.000   (     0.000)  (0)     [2]
J3          0.000   (     0.000)  (0)     [2]
J4          0.000  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

                                          EXEC
```

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



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

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



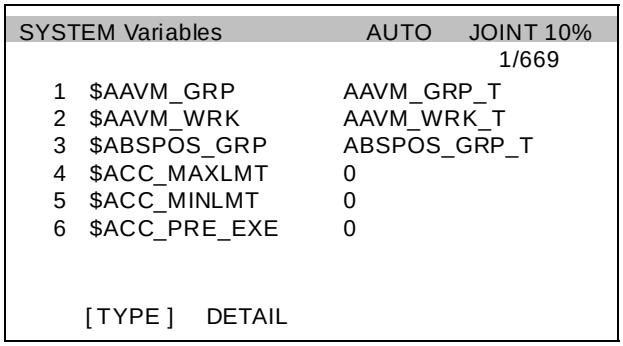
11 Return brake control to original setting, and cycle power of the controller.

8.7 MASTERING DATA ENTRY

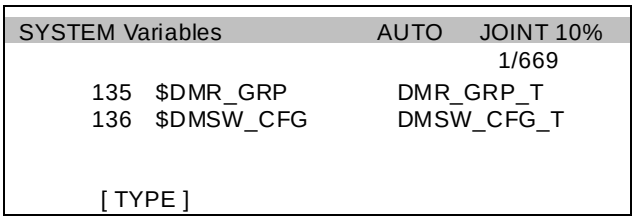
This function enables mastering data values to be assigned directly to a system variable. It can be used if mastering data has been lost but the pulse count is preserved.

Mastering data entry method

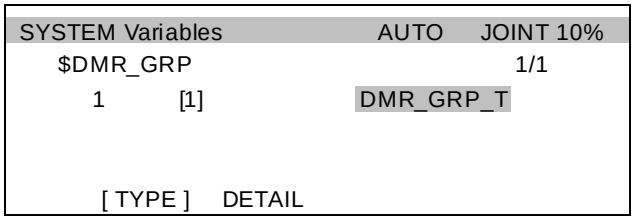
1 Press [MENU] key, then press [0 NEXT] and select [6 SYSTEM].
2 Press F1 [TYPE]. Select [Variables]. The system variable screen will be displayed.

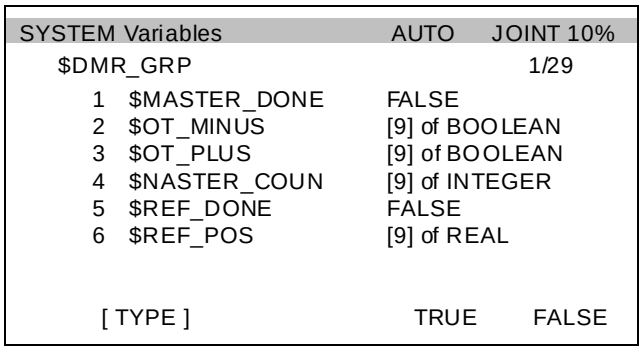


3 Change the mastering data. The mastering data is saved to the $DMR_GRP.$MASTER_COUN system variable.

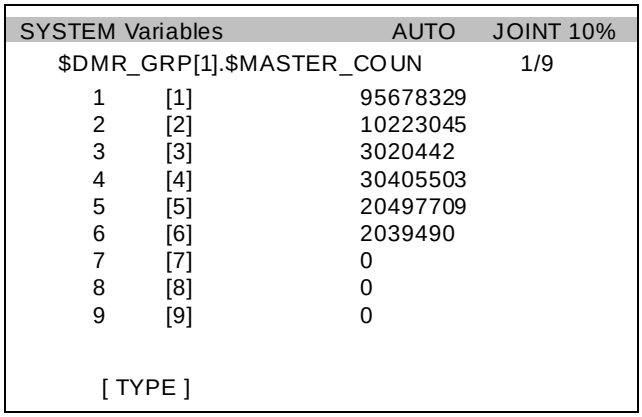


4 Select $DMR_GRP.

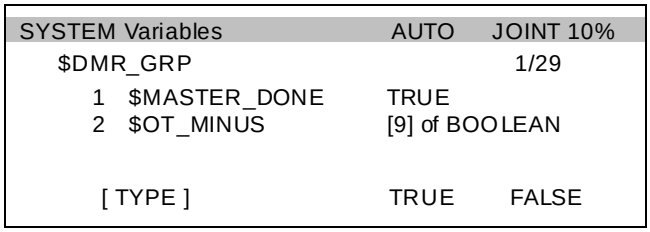




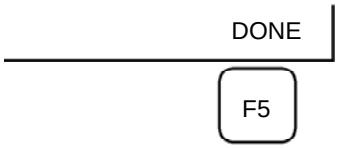
5 Select $MASTER_COUN, and enter the mastering data you have recorded.



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



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



8.8 CHECKING THE MASTERING

1 How to check the robot mastered properly

Usually, positioning is performed automatically at the power on. To check whether mastering has been performed correctly, examine if the current displayed position meets the actual robot position by using the procedure described below:

(1) Reproduce a particular point in a program. Check whether the point agrees with the specified position.

(2) Set all axes of the robot to their 0-degree (0 rad) positions. Check that the zero-degree position marks indicated in Section 8.3 of OPERATOR'S MANUAL are aligned. No need of any visual aid.

If the displayed and actual positions do not match, the counter value for a Pulsecoder may have been invalidated as a result of an alarm described in 2. Alternatively, the mastering data in system variable $DMR_GRP.$MASTER_COUN may have been overwritten as a result of an operation error or some other reason.

Compare the data with the values indicated on the supplied data sheet. This system variable is overwritten whenever mastering is performed. Whenever mastering is performed, record the value of the system variable on the data sheet.

2 Alarm type displayed during mastering and their Solution methodology

(1) BZAL alarm

This alarm is alert if the Pulsecoder's backup battery voltage decreases to 0 V while the power to the controller is disconnected. Furthermore, if Pulsecoder connector is removed for replacing cables etc. this alarm is output as the voltage decreased to 0. Confirm if the alarm will disappear by performing pulse reset (See Section 8.2.). And 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 pulse reset, turn off and on the controller power after replacing the battery. Note that, if this alarm displayed, all the original data held by the Pulsecoder will be lost. Mastering is required.

(2) BLAL alarm

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

(3) Alarm notification like CKAL, RCAL, PHAL, CSAL, DTERR, CRCERR, STBERR, and SPHAL may have trouble with Pulsecoder, contact your local FANUC representative.

9 TROUBLESHOOTING

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

9.1 TROUBLESHOOTING

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

Table 9.1 Troubleshooting

Symptom	Description	Cause	Measure
Vibration noise	- The J1 base lifts off the floor plate as the robot operates. - There is a gap between the J1 base and floor plate. - A J1 base retaining bolt is loose.	[J1 base fastening] - It is likely that the robot J1 base is not securely fastened to the floor plate. - Probable causes are a loose bolt, an insufficient degree of surface flatness, or foreign material caught between the J1 base plate and floor plate. - If the robot is not securely fastened to the floor plate, the J1 base lifts the floor plate as the robot operates, allowing the base and floor plates to strike each other. That, in turn, leads to vibration.	- If a bolt is loose, apply LOCTITE and tighten it to the appropriate torque. - Adjust the base plate surface flatness to within the specified tolerance. - If there is any foreign material between the J1 base and base plate, eliminate them. - Apply adhesive between the J1 base and base plate.
	- The rack or floor plate vibrates during operation of the robot.	[Rack or floor] - It is likely that the rack or floor is not rigid enough. - If they are not rigid enough, counterforce can deform the rack or floor, and cause vibration.	- Reinforce the rack or floor to make it more rigid. - If reinforcing the rack or floor is impossible, modify the robot control program; doing so might reduce the vibration.
	- Vibration becomes more serious when the robot is in 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 heavier 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 or not. If the robot is overloaded, reduce the load, or modify the robot control program. - Vibration can be reduced by re-modifying the robot control program; reducing speed or acceleration with minimizing the influence on the entire cycle time.

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- Vibration or noise was first noticed after the robot collided with an object or the robot was overloaded for a long period. - The grease of the vibrating or noise occurring axis has not been exchanged for a long period.	[Broken gear, bearing, or reducer] - It is likely that the collision or overload applied an excessive force to the drive mechanism, thus damaging the geartooth surface or rolling surface of a bearing, or reducer. - It is likely that prolonged use of the robot while overloaded caused fretting of the gear tooth surface or rolling surface of a bearing, or reducer due to resulting metal fatigue. - It is likely that foreign material caught in a gear, bearing, or within a reducer caused damage on the gear tooth surface or rolling surface of the bearing, or reducer. - It is likely that foreign material caught in a gear, bearing, or within a reducer is causing vibration. - It is likely that, because the grease has not been changed for a long period, fretting occurred on the gear tooth surface or rolling surface of a bearing, or reducer due to metal fatigue. These factors all generate cyclic vibration and noise.	- Operate each axis at individually to judge which axis has been vibrating. - 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. - Regularly greasing with the specified grease can help prevent problems.

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- The cause of problem cannot be identified from examinationof 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. - It may vibrate when an invalid value 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 abnormal condition 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 FANUC for further information if necessary.

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- There is some relationship between the vibration of the robot and the operation of a machine near the robot.	[Noise from a nearby machine] - If the robot is not grounded properly, electrical noise 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.
	- There is an abnormal noise after replacing grease. - There is an abnormal noise after a long time. - There is an abnormal noise during operation at low speed.	- There may be an abnormal noise when using other than the specified grease. - Even for the specified grease, there may be an abnormal noise during operation at low speed immediately after replacement or after a long time.	- Use the specified grease. - When there is an abnormal noise even when using the specified grease, operate for one or two days as an experiment. Generally, the abnormal noise will disappear.
Rattling	- While the robot is not supplied with power, pushing it by hand wobbles part of the mechanical unit. - There is a gap on the mounting face of the mechanical unit.	[Mechanical unit mounting bolt] - It is likely that overloading or a collision has loosened a mounting bolt in the robot mechanical unit.	- Check the following retaining bolts tightness for each axis. If any of these bolts is loose, apply LOCTITE and bolt down with appropriate torque. - Motor retaining bolt - Reducer retaining bolt - Reducer shaft retaining bolt - Base retaining bolt - Arm retaining bolt - Casing retaining bolt - End effector retaining bolt

Symptom	Description	Cause	Measure
Motor overheating	- The motor overheated due to a rise in temperature in the installation area. - After a cover was attached to the motor, the motor overheated. - After changing the Robot control program or the load, the motor overheat.	[Ambient temperature] - It is likely that the motor overheated when the ambient temperature rose, and could not dissipate the heat. [Operating condition] - It is likely that the overcurrent is above the specified permissive average current.	- Reducing the ambient temperature is the most effective means of preventing overheat. - If there is a source of heat near, it is advisable to install shielding to protect the motor from heat radiation. - Relaxing the robot control program and load condition is effective to reduce the average current. Thus, prevent overheat. - The teach pendant can monitor the average current. Check the average current when the robot control program launched.
	- After a control parameter (load setting etc.) was changed, the motor overheated.	[Parameter] - If data input for a workpiece is invalid, the robot cannot be accelerate or decelerate normally, so the average current increases, leading to the motor overheating.	- As for load setting, Input an appropriate parameter referring to Section 4.3.
	- Symptom other than stated above	[Mechanical unit 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 motor brake failure locked on the break, and cause the motor overloaded. - It is likely that a failure of the motor prevented it from delivering its rated performance, thus causing an excessive current to flow into the motor. - It is likely that cooling fan is broken.	- Repair the mechanical unit 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. - Judgment is possible if the average current decreased after replacing the motor, the former motor had been defected. - If the cooling fan is broken, replace it by new one.

Symptom	Description	Cause	Measure
Grease leakage	- Grease leaks from the mechanical unit.	[Poor sealing] - Probable causes are a crack in the casting, a damaged O-ring, a damaged oil seal, or a loose seal bolt. - The casting may crack with excessive force caused in collision. - An O-ring can be damaged if it is trapped or cut during disassembling or re-assembling. - An oil seal may be damaged if dust scratches the lip. - A loose seal bolt may allow grease to leak along the threads. - Problems with the grease nipple.	- If the casting cracks, sealant can be used as a quick-fix to prevent further grease leakage. However, the component must be replaced as soon as possible, as the crack will widen. - O-rings are used in the locations listed below. - Motor coupling section - Reducer (case and shaft) coupling section - Wrist coupling section - J3 arm coupling section - Inside the wrist - Oil seals are used in the locations stated below. - Inside the reducer - Inside the wrist - Seal bolts are used in the locations stated below. - Grease drain outlet - Replace the grease nipple.
Dropping axis	- An axis falls because the brake went out. - An axis falls while standing still.	[Brake drive relay and motor] - It is likely that brake drive relay contacts are stuck to each other and 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 soak through the motor, causing the brake to slip.	- Check whether the brake drive relays are stuck to each other or not. If they are found to be stuck, replace the relays. - Replace the motor after confirming whether the following symptoms have occurred. - Brake shoe is worn out - Brake main body is damaged - Oil soaked through the motor

Symptom	Description	Cause	Measure
Displace-ment	- The robot operates at a point other than the taught position. - The repeatability is not within the tolerance.	[Mechanical unit problems] - If the repeatability is unstable, probable causes are a failure in the drive mechanism or a loose bolt, and so on. - If the repeatability is stable, it is likely that collision by an excessive load caused slip on the mounting face of each axis arm, and reducer. - It is likely that the Pulsecoder is abnormal.	- If the repeatability is unstable, repair the mechanical unit 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 equipment.	[Peripheral equipment displacement] - It is likely that an external force was applied to the peripheral equipment, thus shifting its position relative to the robot.	- Correct the setting of the peripheral equipment position. - Correct the taught program.
	- Displacement occurred after a parameter was changed.	[Parameter] - It is likely that the mastering data was overwritten, and the origin had misaligned.	- Re-enter the previous optimal mastering data. - If optimal mastering data is unavailable, perform mastering again.
BZAL alarm occurred	- BZAL is displayed on the teach pendant screen	- The voltage of the memory backup battery may be low. - The Pulsecoder cable may be broken.	- Replace the battery. - Replace the cable.

10 SEVERE DUST/LIQUID PROTECTION PACKAGE (OPTION)

10.1 OVERVIEW

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

NOTE
Contact your FANUC representative for confirmation that the Severe Dust/liquid protection package is suitable for your environment.

Model	Severe dust/liquid protection specification
M-710*i*C/50/70	A05B-1125-J801 (*1)
	A05B-1125-J811 (*2)
	A05B-1125-J823 (*3)
	A05B-1125-J829 (*4)
M-710*i*C/50S	A05B-1125-J802 (*1)
	A05B-1125-J812 (*5)
	A05B-1125-J824 (*6)
M-710*i*C/50H	A05B-1125-J836
M-710*i*C/45M	A05B-1125-J837

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

10.2 CONFIGURATION OF THE SEVERE DUST/LIQUID PROTECTION PACKAGE

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

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

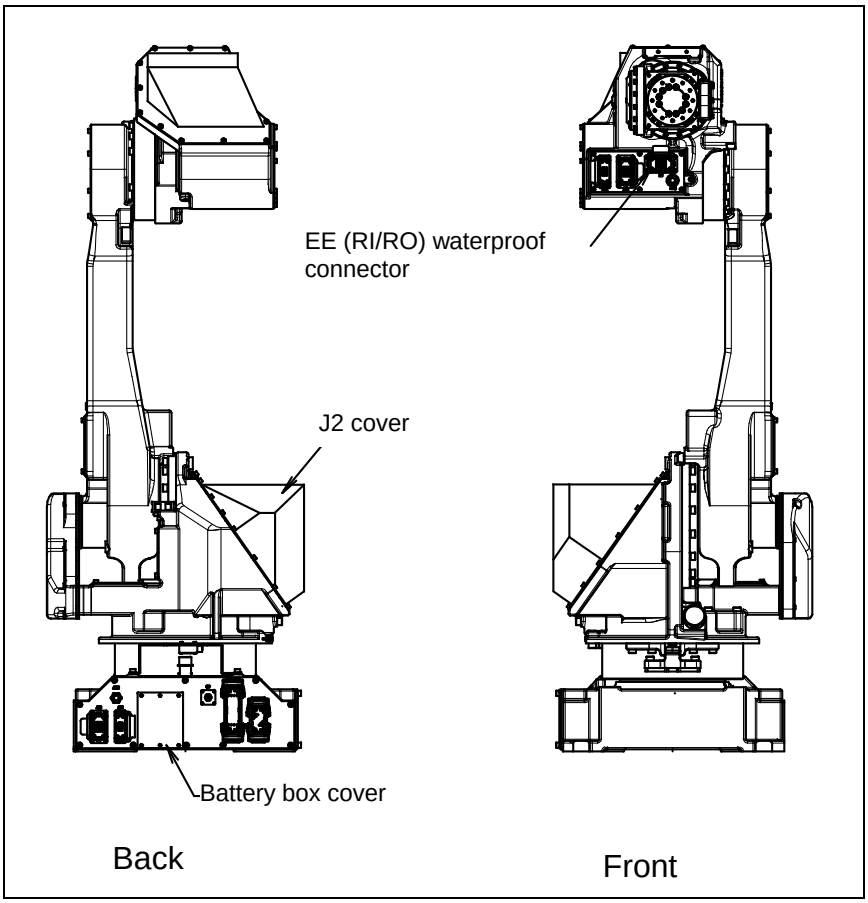


Fig. 10.2 Configuration of the severe dust/liquid protection package of M-710*i*C

11 CORRESPOND TO WASHING APPLICATION (OPTION)

11.1 ABOUT CORRESPOND TO WASHING APPLICATION

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

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

11.2 NOTES OF CORRESPOND TO WASHING APPLICATION

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

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

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

11.3 INSTALLING THE AIR PURGE KIT

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

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

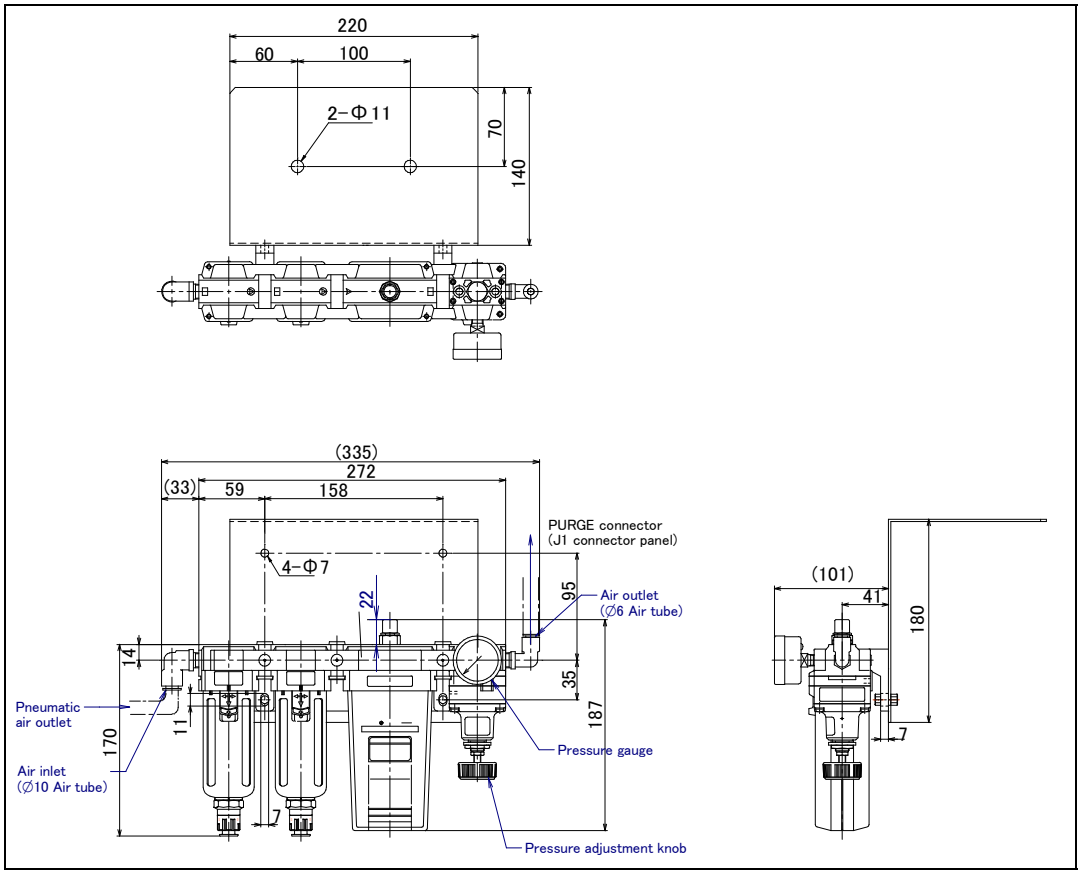


Fig 11.3 (a) Air purge kit outside dimensions

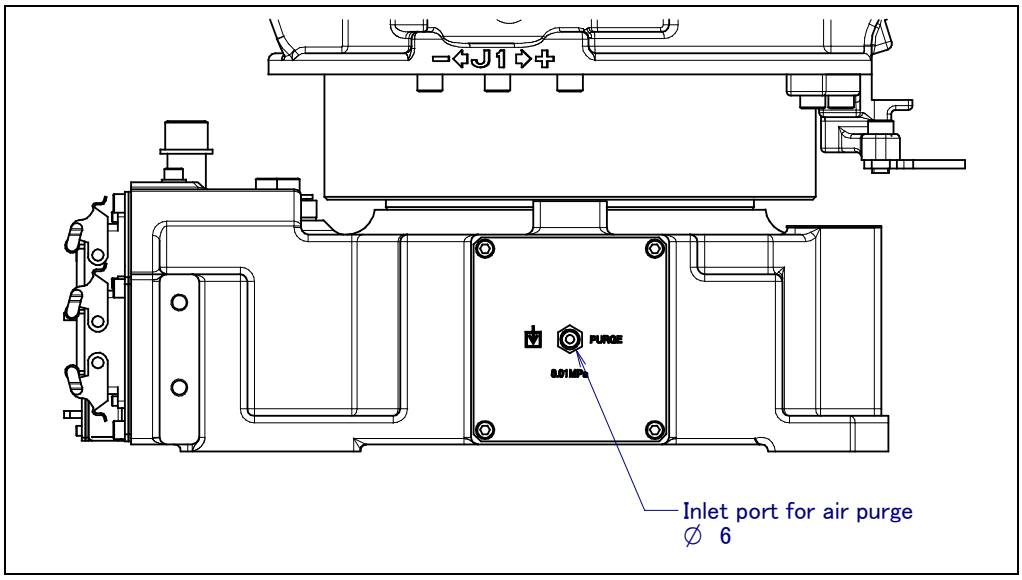


Fig 11.3 (b) Mounting position of air purge to robot

12 MOTOR AIR BLOW OPTION (OPTION)

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

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

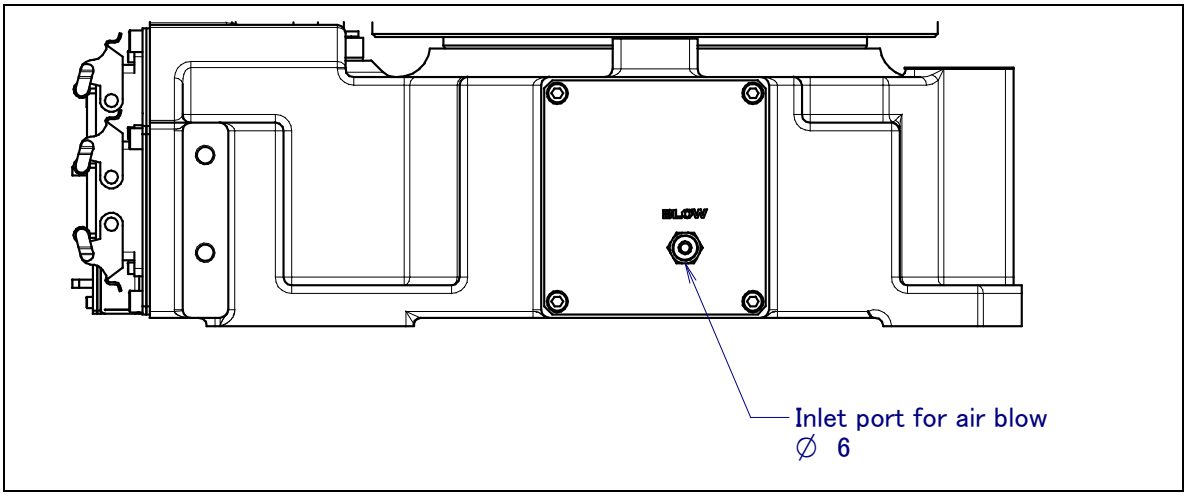


Fig. 12 (a) Inlet port for air blow

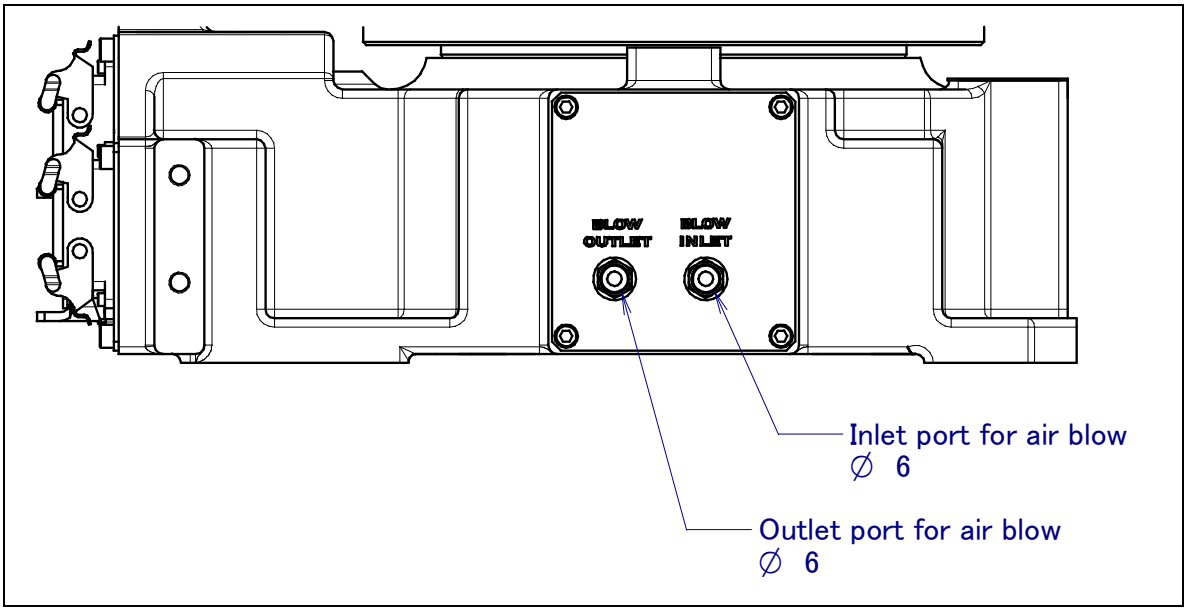


Fig. 12 (b) Inlet port and outlet port for air blow (When severe dust/liquid protection option is specified)

APPENDIX

A PERIODIC MAINTENANCE TABLE

FANUC Robot M-710*i*C/50/70/50S/45M/50E **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 for water	0.1H	-		○	○	○	○	○	○	○	○	○	○	○
	3	Check the mechanical cable. (damaged or twisted)	0.2H	-					○				○			
	4	Check the motor connector and exposed connector (loosening)	0.2H	-					○				○			
	5	Tighten the end effector bolt.	0.2H	-		○			○				○			
	6	Tighten the cover and main bolt.	2.0H	-		○			○				○			
	7	Check the mechanical stopper and adjustable mechanical stopper	0.1H			○			○				○			
	8	Remove spatter and dust etc.	1.0H	-		○			○				○			
	9	Check the end effector (hand) cable	0.1H	-		○			○				○			
	10	Check the operation of the cooling fan	0.1H	-		○			○				○			
	11	Replacing battery	0.1H	-							●					
	12	Replacing grease of J1 axis reducer	0.5H	3300ml												
	13	Replacing grease of J2 axis reducer	0.5H	1660ml												
	14	Replacing grease of J3 axis reducer	0.5H	1060ml												
	15	Replacing grease of J4/J5/J6-axis gearbox	0.5H	920ml												
	16	Replacing grease of wrist axis unit (M-710*i*C/50/70/50S)	0.5H	650ml												
		Replacing grease of wrist axis unit (M-710*i*C/50E)	0.5H	580ml												
	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 controller ventilation system	0.2H	-	○	○	○	○	○	○	○	○	○	○	○	○
	20	Replacing battery *1	0.1H	-												

*1 Refer to “REPLACING UNITS Chapter of MAINTENANCE” of the following manuals.
R-30*i*A CONTROLLER MAINTENANCE MANUAL (Standard) (B-82595EN),
R-30*i*A CONTROLLER MAINTENANCE MANUAL (For Europe) (B-82595EN-1),
R-30*i*A CONTROLLER MAINTENANCE MANUAL (For RIA) (B-82595EN-2),
R-30*i*B/R-30*i*B Plus CONTROLLER MAINTENANCE MANUAL (B-83195EN),
R-30*i*B Mate/R-30*i*B Mate Plus CONTROLLER MAINTENANCE MANUAL (B-83525EN)

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○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		1
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		2
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○				○				○				○				○					4
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○				○				○				○				○					8
○				○				○				○				○					9
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●						●						●						●			11
●												●									12
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				●																	20

Overhaul

FANUC Robot M-710*i*C/50H **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 for water	0.1H	-		○	○	○	○	○	○	○	○	○	○	○
	3	Check the mechanical cable. (damaged or twisted)	0.2H						○				○			
	4	Check the motor connector. (loosening)	0.2H	-					○				○			
	5	Tighten the end effector bolt.	0.2H	-		○			○				○			
	6	Tighten the cover and main bolt.	2.0H	-		○			○				○			
	7	Check the mechanical stopper and adjustable mechanical stopper	0.1H			○			○				○			
	8	Remove spatter and dust etc.	1.0H	-		○			○				○			
	9	Check the end effector (hand) cable	0.1H	-		○			○				○			
	10	Check the operation of the cooling fan	0.1H	-		○			○				○			
	11	Replacing battery	0.1H	-							●					
	12	Replacing grease of J1 axis reducer	0.5H	3300ml												
	13	Replacing grease of J2 axis reducer	0.5H	1400ml												
	14	Replacing grease of J3 axis reducer	0.5H	1060ml												
	15	Replacing grease of J4/J5-axis gearbox	0.5H	650ml												
	16	Replacing grease of wrist axis unit	0.5H	650ml												
	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	-												

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○	○	○	○	○	○	○	○	○	○	○	○		○	○	○	○	○	○	○	○	2
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○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		19
				●																	20

Overhaul

Overhaul

B STRENGTH OF BOLT AND BOLT TORQUE LIST

NOTE

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

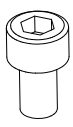
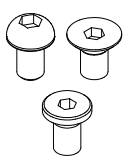
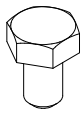
Use the following strength bolts. Comply with any bolt specification instructions.
Hexagon socket head bolt made of steel:

Size M22 or less : Tensile strength 1200N/mm^2 or more
Size M24 or more : Tensile strength 1000N/mm^2 or more
All size plating bolt : Tensile strength 1000N/mm^2 or more

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

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

Recommended bolt tightening torques **Unit: Nm**

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

C INSULATION ABOUT ARC WELDING ROBOT

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

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

C.1 INSULATION AT THE WRIST

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

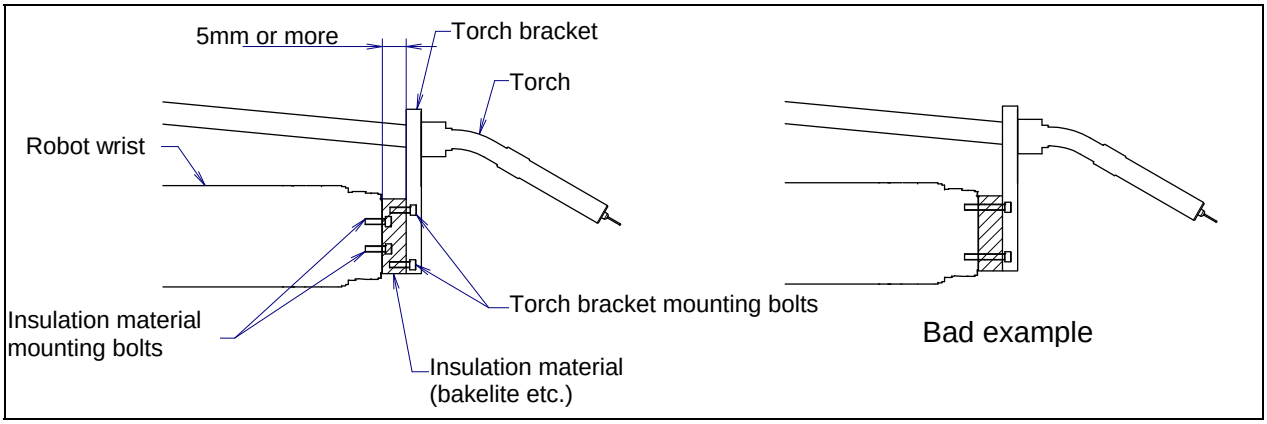


Fig. C.1 Insulation at the wrist

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

INDEX

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<W>

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REVISION RECORD

Edition	Date	Contents
12	Jun, 2017	• Addition of R-30*i*B Plus, R-30*i*B Mate Plus Controller • Correction of errors
11	Sep., 2015	• Addition of Quick mastering for single axis • Correction of errors
10	Sep., 2014	• Addition of R-30*i*B Mate Controller • Addition of M-710*i*C/45M • Correction of errors
09	July, 2012	• Addition of M-710*i*C/50H • Addition and change of mechanical unit cable with camera • Correction of errors
08	Jan., 2012	• Addition of note for low temperature • Addition of check of oil seepage • Correction of errors
07	Aug.,2010	• Addition of stop type of robot • Addition of stopping time and distance when controlled stop is executed • Corrections of errors
06	Apr.,2009	• Addition of M-710*i*C/50E • Addition of option cable • Addition of motor air blow (option) • Correction of errors
05	May,2008	• Addition data of max stopping distance(position) • Addition movable stopper for J2 and J3 • Addition of severe dust/liquid protection option for mechanical unit cable for camera
04	Jan.,2008	• Addition of procedures to move arm without drive power in emergency or abnormal situations • Addition of notes on transportation with an end effector attached • Addition of sensor cables for Severe dust/liquid protection option • Addition of stopping time and distance when emergency stop • Addition of OPTION FOR WASHING APPLICATION • Correction of errors
03	May, 2007	• Change the name of controller. (from R-J3*i*C to R-30*i*A). • The note about transportation equipment label is added • Addition of notes about transportation equipment • Addition of motion range for inclined surface mounted robots • Change the manufacture name of Daiichi Denshi Kogyo K.K to Fujikura Ltd. • Correction of errors
02	Jun., 2006	• Addition of M-710*i*C/70 and Severe dust/liquid protection option • Correction of troubleshooting
01	Dec., 2005	

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