FANUC Robot
M-710*i*C/20L /12L /20M

MECHANICAL UNIT

OPERATOR'S MANUAL

MAROCM71009061E REV. I

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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.

Send your comments and suggestions about this manual to:
product.documentation@fanucamerica.com

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

4,630,567 4,639,878 4,707,647 4,708,175 4,708,580 4,942,539 4,984,745 5,238,029 5,239,739 5,272,805 5,293,107 5,293,911 5,331,264 5,367,944 5,373,221 5,421,218 5,434,489 5,644,898 5,670,202 5,696,687 5,737,218 5,823,389 5,853,027 5,887,800 5,941,679 5,959,425 5,987,726 6,059,092 6,064,168 6,070,109 6,086,294 6,122,062 6,147,323 6,204,620 6,243,621 6,253,799 6,285,920 6,313,595 6,325,302 6,345,818 6,356,807 6,360,143 6,378,190 6,385,508 6,425,177 6,477,913 6,490,369 6,518,980 6,540,104 6,541,757 6,560,513 6,569,258 6,612,449 6,703,079 6,705,361 6,726,773 6,768,078 6,845,295 6,945,483 7,149,606 7,149,606 7,211,978 7,266,422 7,399,363

FANUC CORPORATION Patent List

4,571,694 4,626,756 4,700,118 4,706,001 4,728,872 4,732,526 4,742,207 4,835,362 4,894,596 4,899,095 4,920,248 4,931,617 4,934,504 4,956,594 4,967,125 4,969,109 4,970,370 4,970,448 4,979,127 5,004,968 5,006,035 5,008,834 5,063,281 5,066,847 5,066,902 5,093,552 5,107,716 5,111,019 5,130,515 5,136,223 5,151,608 5,170,109 5,189,351 5,267,483 5,274,360 5,292,066 5,300,868 5,304,906 5,313,563 5,319,443 5,325,467 5,327,057 5,329,469 5,333,242 5,337,148 5,371,452 5,375,480 5,418,441 5,432,316 5,440,213 5,442,155 5,444,612 5,449,875 5,451,850 5,461,478 5,463,297 5,467,003 5,471,312 5,479,078 5,485,389 5,485,552 5,486,679 5,489,758 5,493,192 5,504,766 5,511,007 5,520,062 5,528,013 5,532,924 5,548,194 5,552,687 5,558,196 5,561,742 5,570,187 5,570,190 5,572,103 5,581,167 5,582,750 5,587,635 5,600,759 5,608,299 5,608,618 5,624,588 5,630,955 5,637,969 5,639,204 5,641,415 5,650,078 5,658,121 5,668,628 5,687,295 5,691,615 5,698,121 5,708,342 5,715,375 5,719,479 5,727,132 5,742,138 5,742,144 5,748,854 5,749,058 5,760,560 5,773,950 5,783,922 5,799,135 5,812,408 5,841,257 5,845,053 5,872,894 5,887,122 5,911,892 5,912,540 5,920,678 5,937,143 5,980,082 5,983,744 5,987,591 5,988,850 6,023,044 6,032,086 6,040,554 6,059,169 6,088,628 6,097,169 6,114,824 6,124,693 6,140,788 6,141,863 6,157,155 6,160,324 6,163,124 6,177,650 6,180,898 6,181,096 6,188,194 6,208,105 6,212,444 6,219,583 6,226,181 6,236,011 6,236,896 6,250,174 6,278,902 6,279,413 6,285,921 6,298,283 6,321,139 6,324,443 6,328,523 6,330,493 6,340,875 6,356,671 6,377,869 6,382,012 6,384,371 6,396,030 6,414,711 6,424,883 6,431,018 6,434,448 6,445,979 6,459,958 6,463,358 6,484,067 6,486,629 6,507,165 6,654,666 6,665,588 6,680,461 6,696,810 6,728,417 6,763,284 6,772,493 6,845,296 6,853,881 6,888,089 6,898,486 6,917,837 6,928,337 6,965,091 6,970,802 7,038,165 7,069,808 7,084,900 7,092,791 7,133,747 7,143,100 7,149,602 7,131,848 7,161,321 7,171,041 7,174,234 7,173,213 7,177,722 7,177,439 7,181,294 7,181,313 7,280,687 7,283,661 7,291,806 7,299,713 7,315,650 7,324,873 7,328,083 7,330,777 7,333,879 7,355,725 7,359,817 7,373,220 7,376,488 7,386,367 7,464,623 7,447,615 7,445,260 7,474,939 7,486,816 7,495,192 7,501,778 7,502,504 7,508,155 7,512,459 7,525,273 7,526,121

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.

- **Original Instructions**

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

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

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

In this manual, we 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.

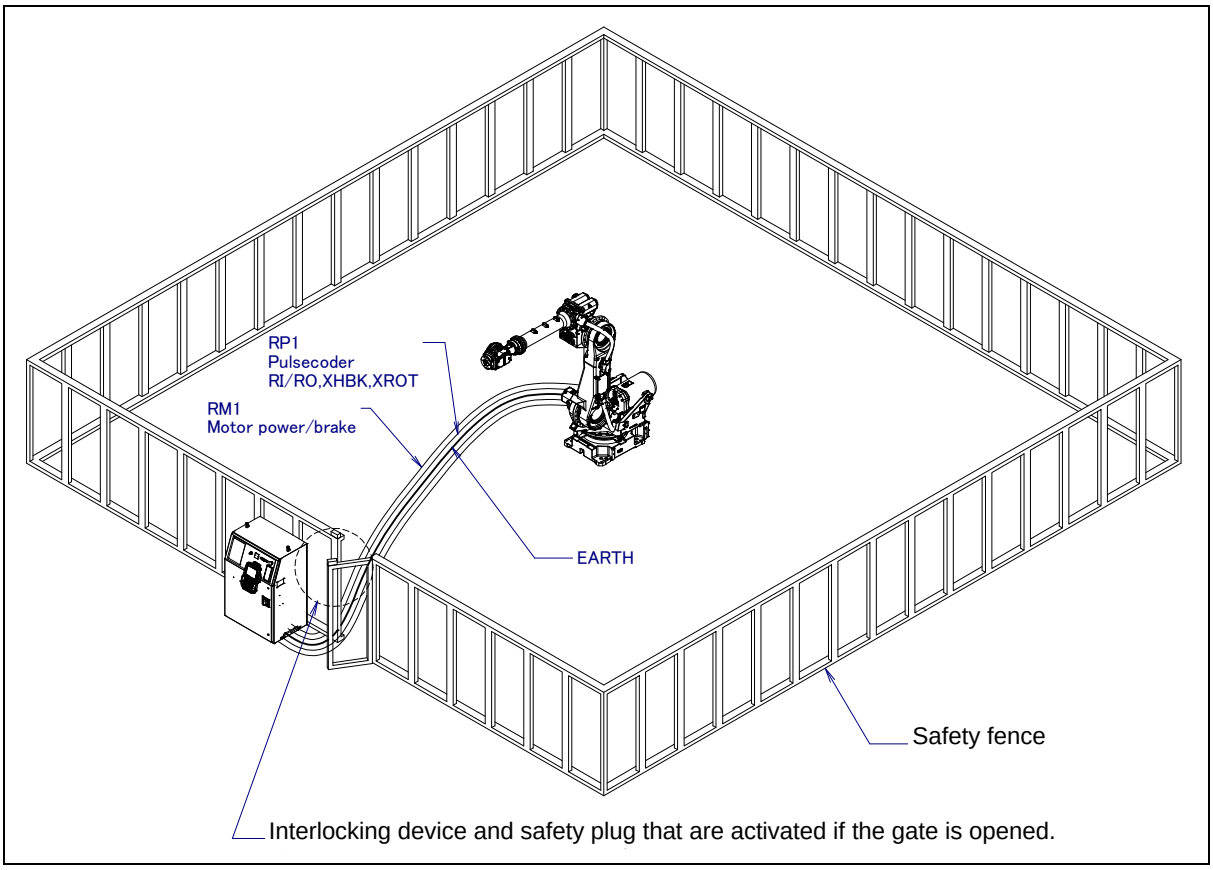


Fig. 3 (a) Safety fence and safety gate

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

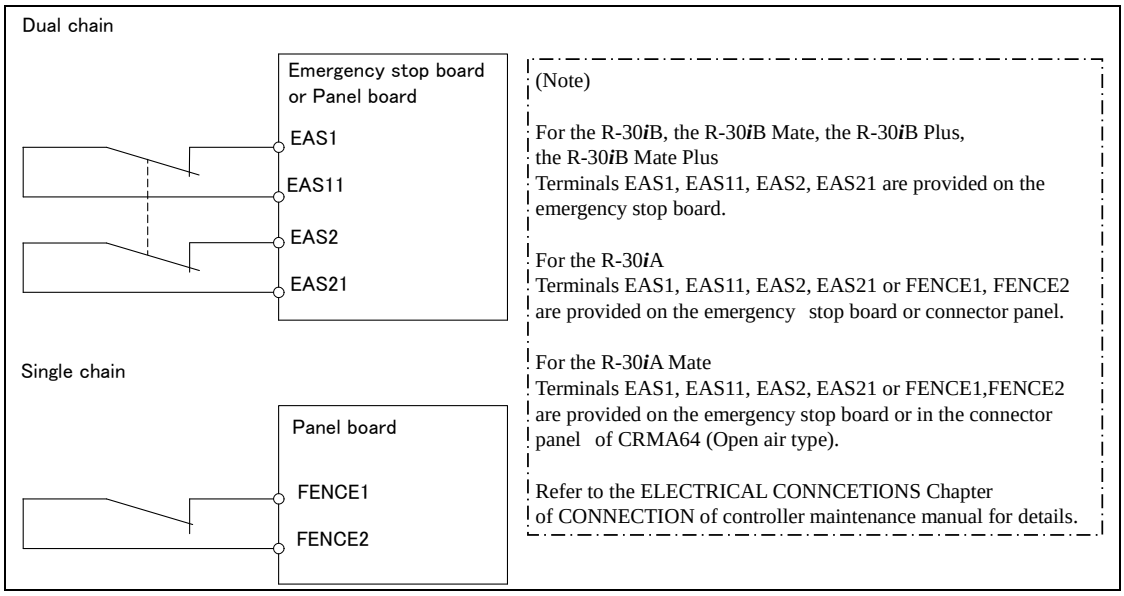


Fig. 3 (b) Connection diagram for the signal of safety fence

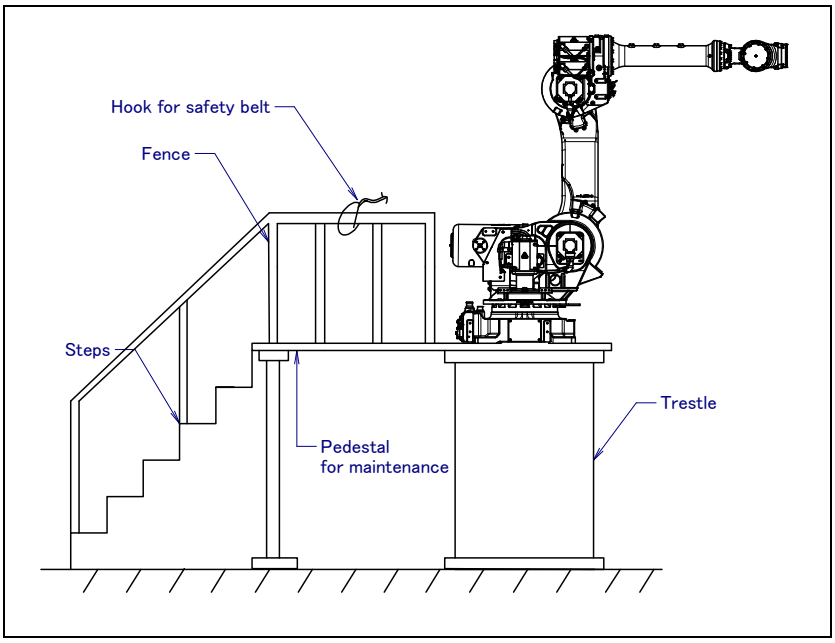


Fig. 3 (c) Pedestal for maintenance

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.

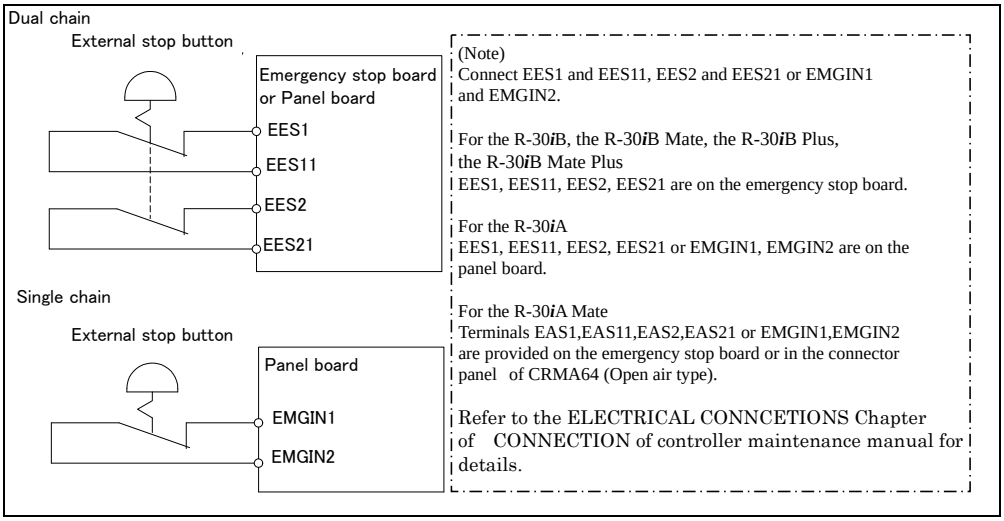


Fig. 3.1 Connection diagram for external emergency stop button

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.

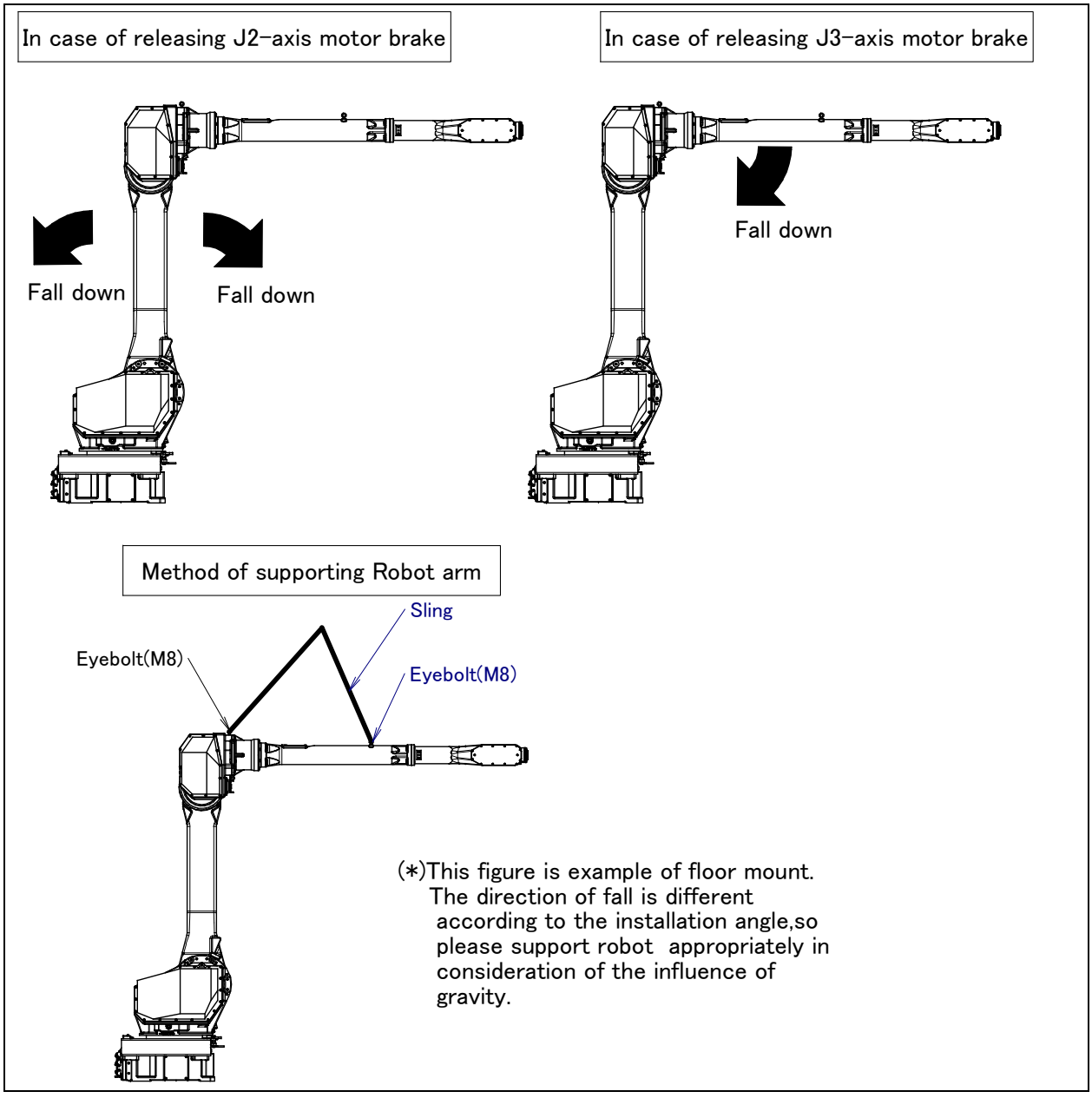


Fig. 5.4 Arm operation by the release of J2, J3-axis motor brake and measures

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 Section 7.3 ″ 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) High-temperature warning label

Description

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

(4) Transportation label

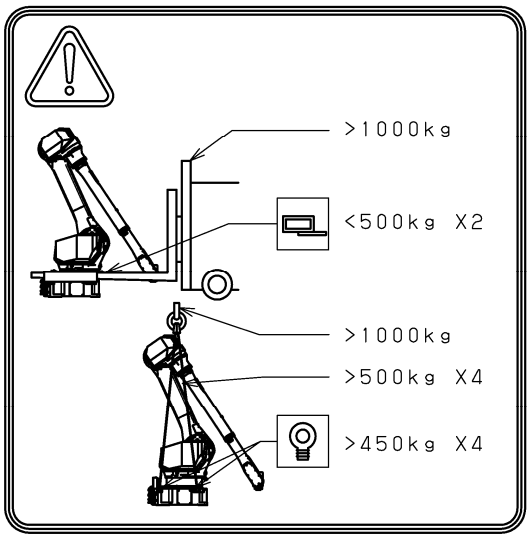


Fig. 10 (d) Transportation label

Description

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

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 allowable load of the forklift bracket (option) is 4900 N (500 kgf).

2) Using a crane
   - Use a crane with a load capacity of 1000 kg or greater.
   - Use four slings with each load capacity of 500 kg or greater.
   - Use four eyebolts with each allowable load 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 arm.
> See Sub-section 1.1 TRANSPORTATION for explanations about the posture a specific model should take when it is transported.

(5) Transportation caution label (When transport equipment option is specified.)

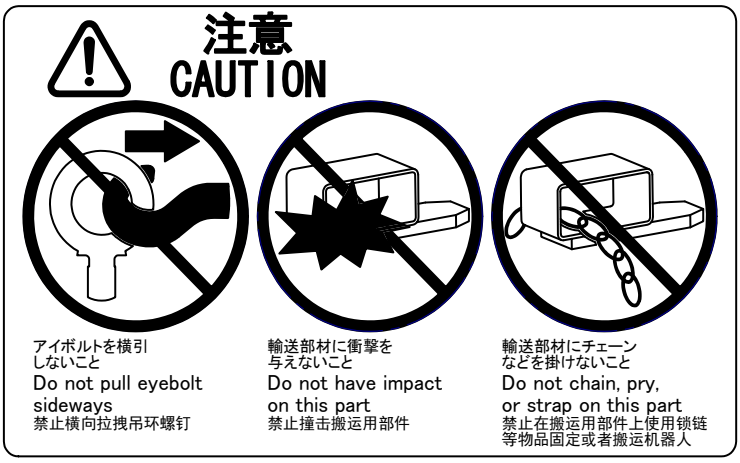


Fig. 10 (e) Transportation caution label

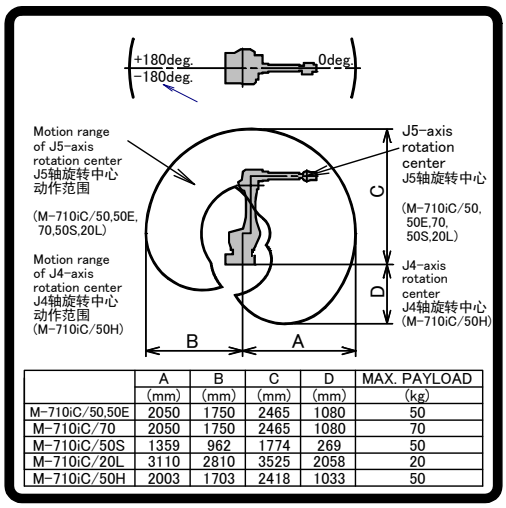
Description

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 transport equipment
3) Do not thread a chain or the like through transport equipment.

(6) Operating space and payload label

In the case of CE specification, the following label is added:



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

Fig. 10 (f) Operating space and payload label (Example of M-710*i*C/20L)

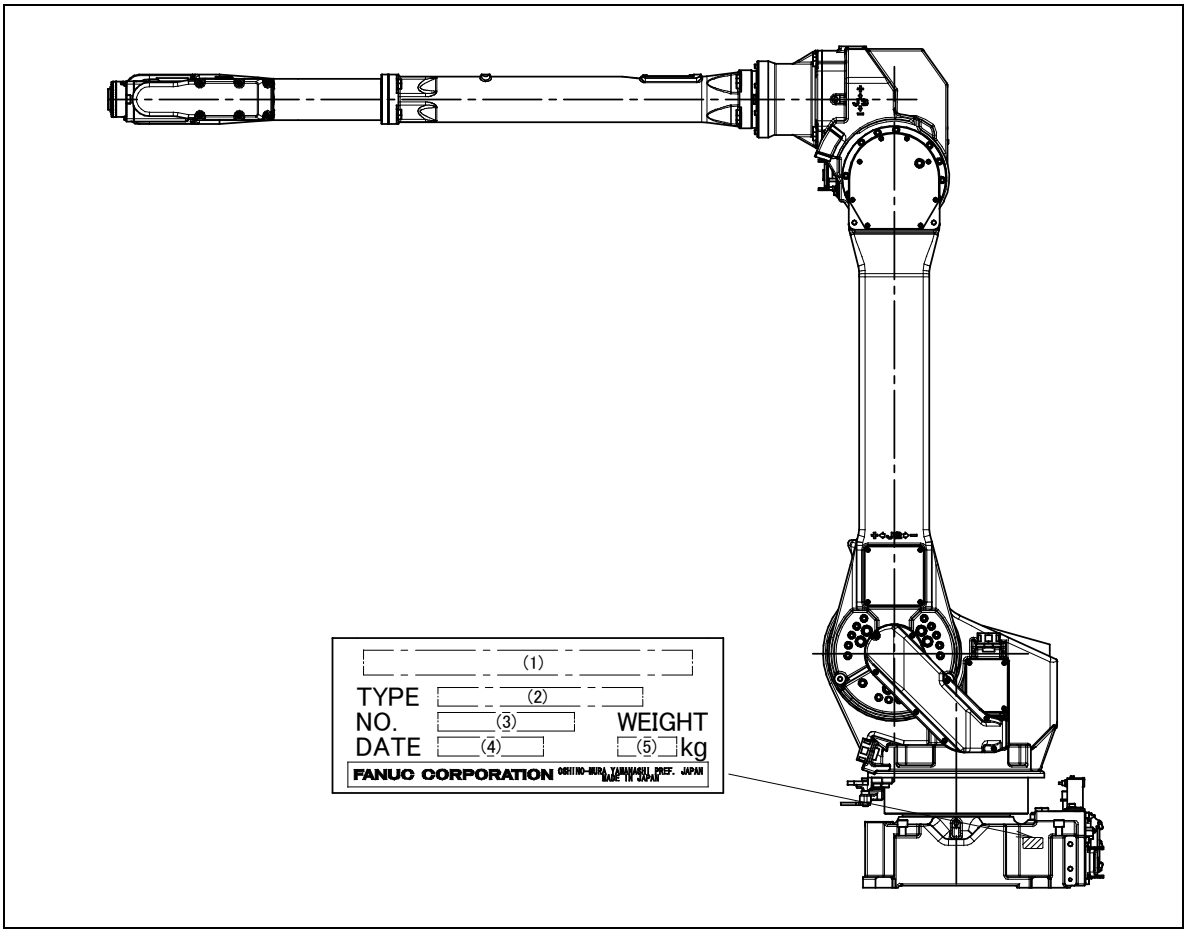
170511

PREFACE

This manual explains maintenance procedures for the following mechanical units:

Model name	Mechanical unit specification No.	Maximum load
FANUC Robot M-710*i*C/20L	A05B-1125-B205	20kg
FANUC Robot M-710*i*C/12L	A05B-1125-B206	12kg
FANUC Robot M-710*i*C/20M	A05B-1125-B209	20kg

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	-	TYPE	No.	DATE	WEIGHT kg (Without controller)
LETTERS	FANUC Robot M-710*i*C/20L	A05B-1125-B205	SERIAL NO. IS PRINTED	PRODUCTION YEAR AND MONTH ARE PRINTED	540
	FANUC Robot M-710*i*C/12L	A05B-1125-B206			540
	FANUC Robot M-710*i*C/20M	A05B-1125-B209			530

RELATED MANUALS

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

SAFETY HANDBOOK **B-80687EN** All persons who use the FANUC Robot and system designer must read and understand thoroughly this handbook		Intended readers: Operator , system designer Topics: Safety items for robot system design, operation, maintenance
R-30*i*A controller	OPERATOR'S MANUAL 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, start-up, connection, 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** (Alarm Code List) **B-83284EN-1** OPTIONAL FUNCTION **B-83284EN-2** ARC WELDING FUNCTION **B-83284EN-3** SPOT WELDING FUNCTION **B-83284EN-4** DISPENSE TOOL **B-83284EN-5** Servo Gun Function **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, start-up, connection, 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

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APPENDIX

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) to (d))
Fasten the M16 eyebolts to the four points of the robot base plate and lift the robot by the four slings.

⚠ CAUTION

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

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

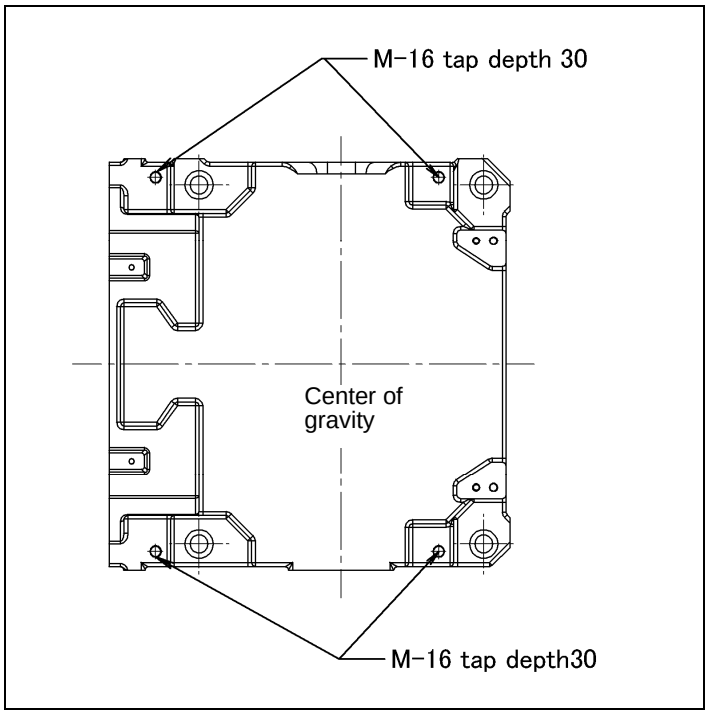


Fig. 1.1 (a) Position of the eyebolts and transportation equipment

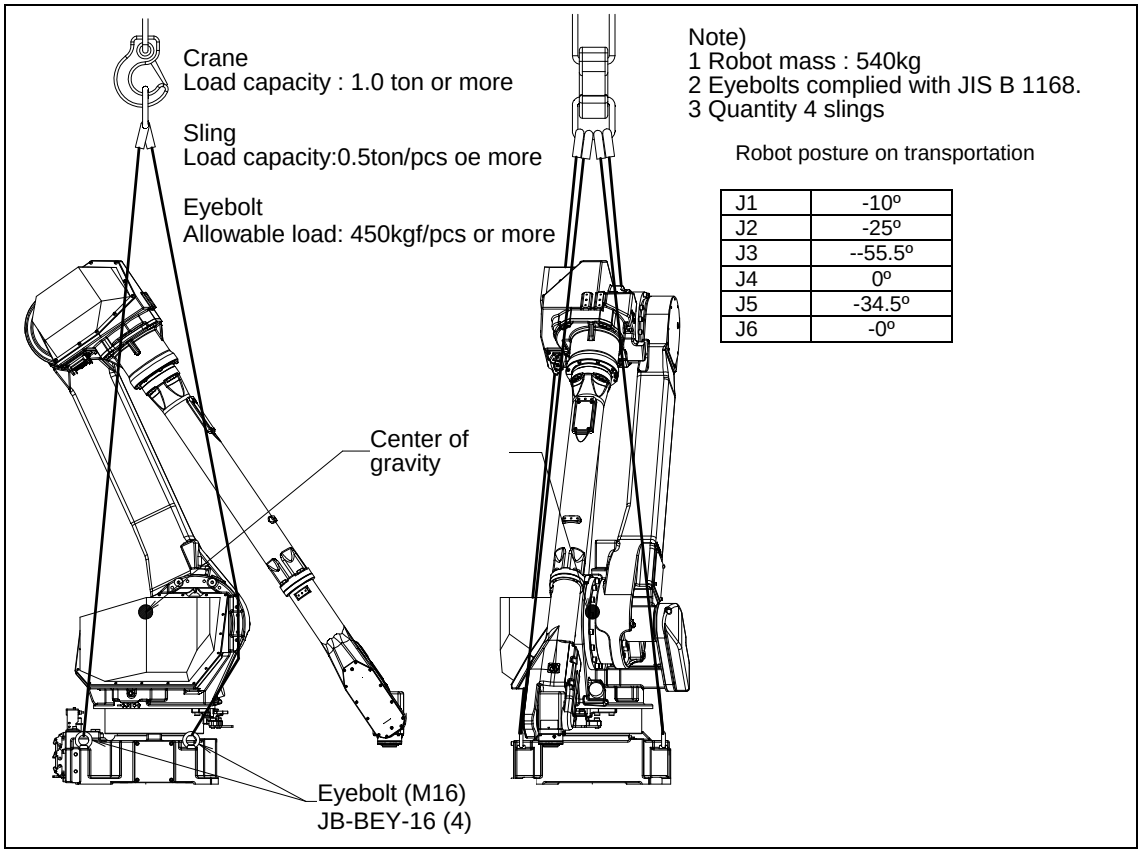


Fig. 1.1 (b) Transportation using a crane (M-710*i*C/20L)

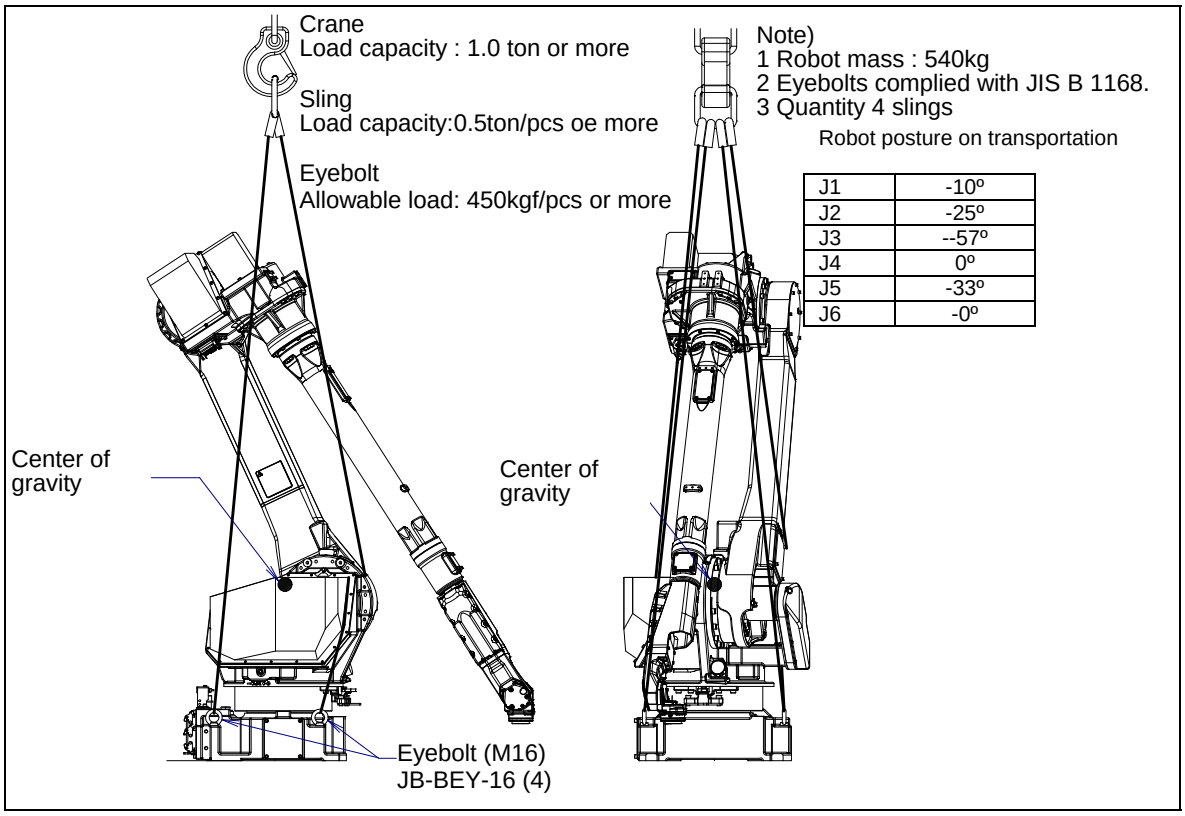


Fig. 1.1 (c) Transportation using a crane (M-710*i*C/12L)

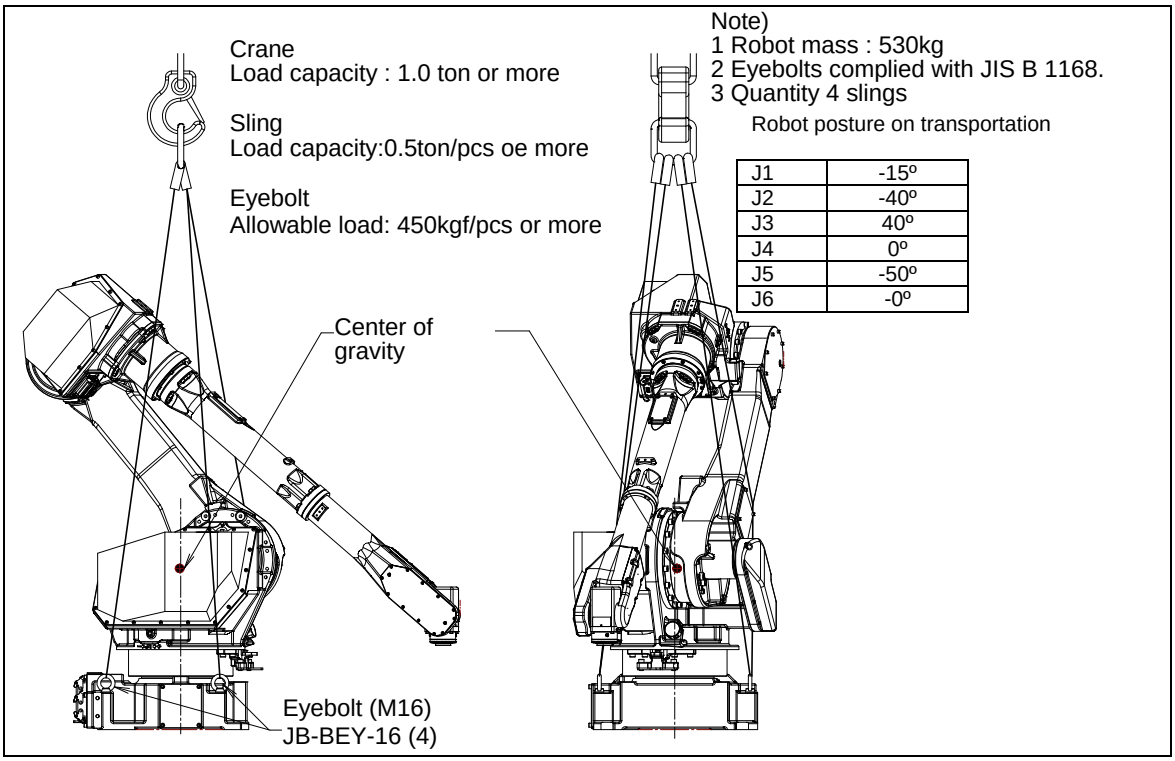


Fig. 1.1 (d) Transportation using a crane (M-710*i*C/20M)

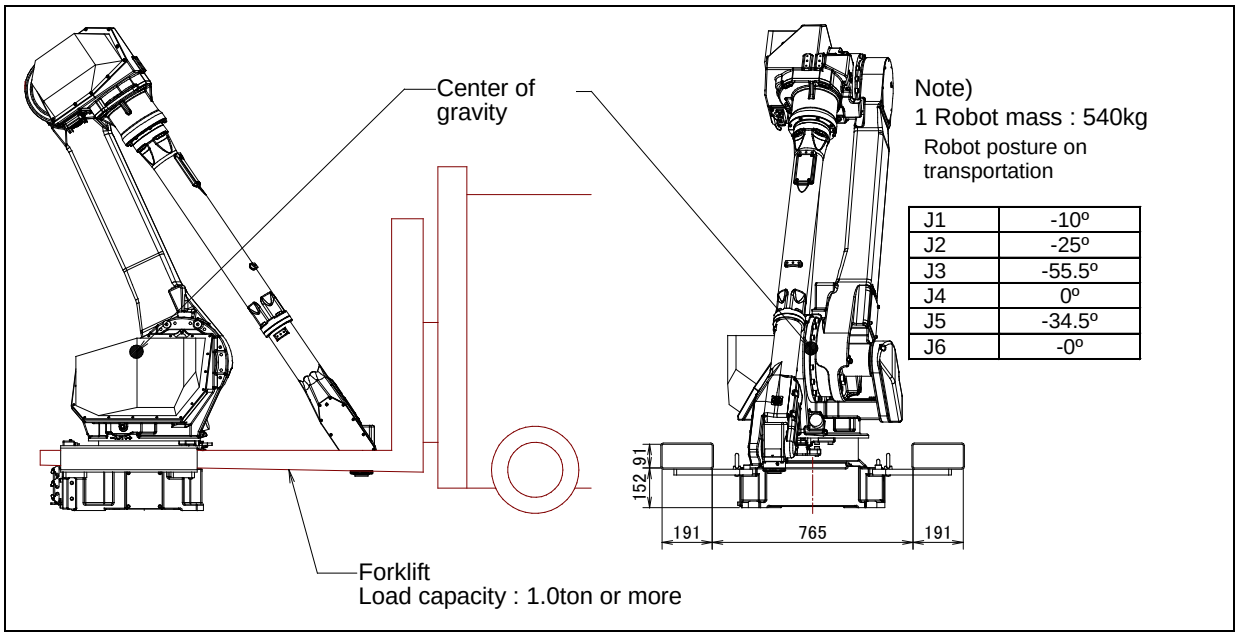


Fig. 1.1 (e) Transportation using a forklift (M-710*i*C/20L)

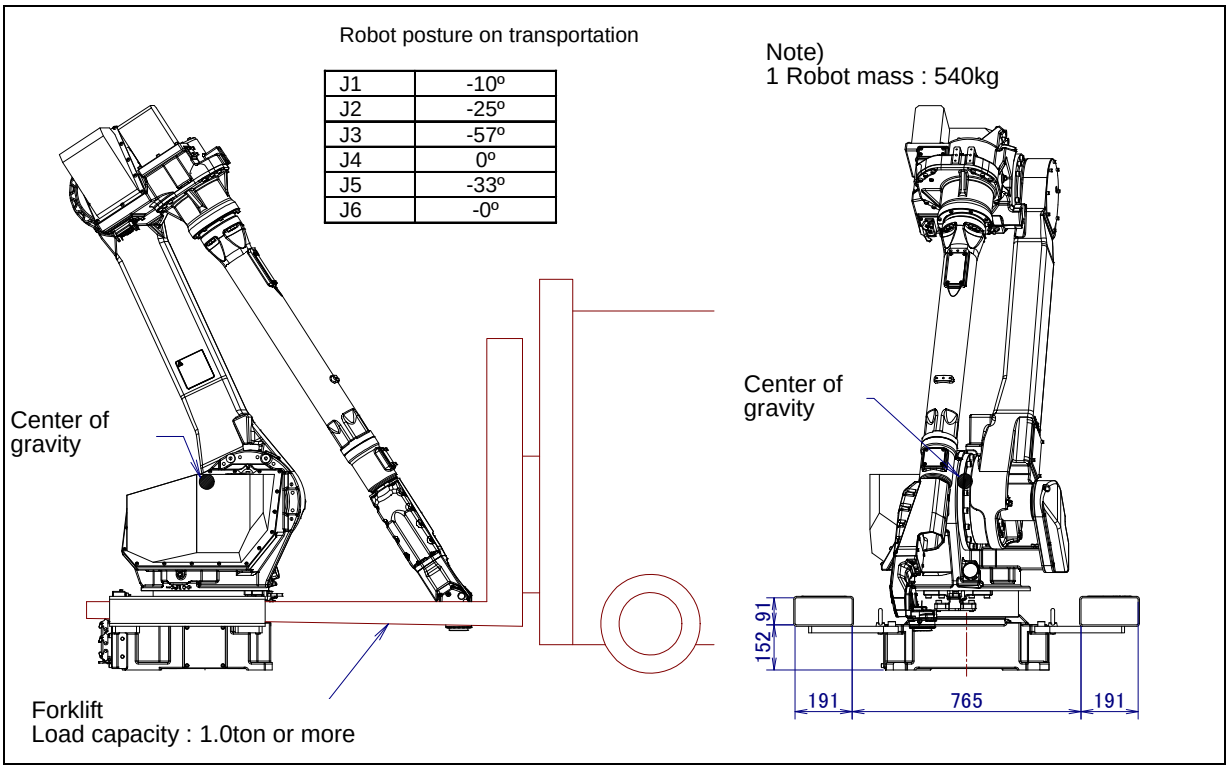


Fig. 1.1 (f) Transportation using a forklift (M-710*i*C/12L)

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

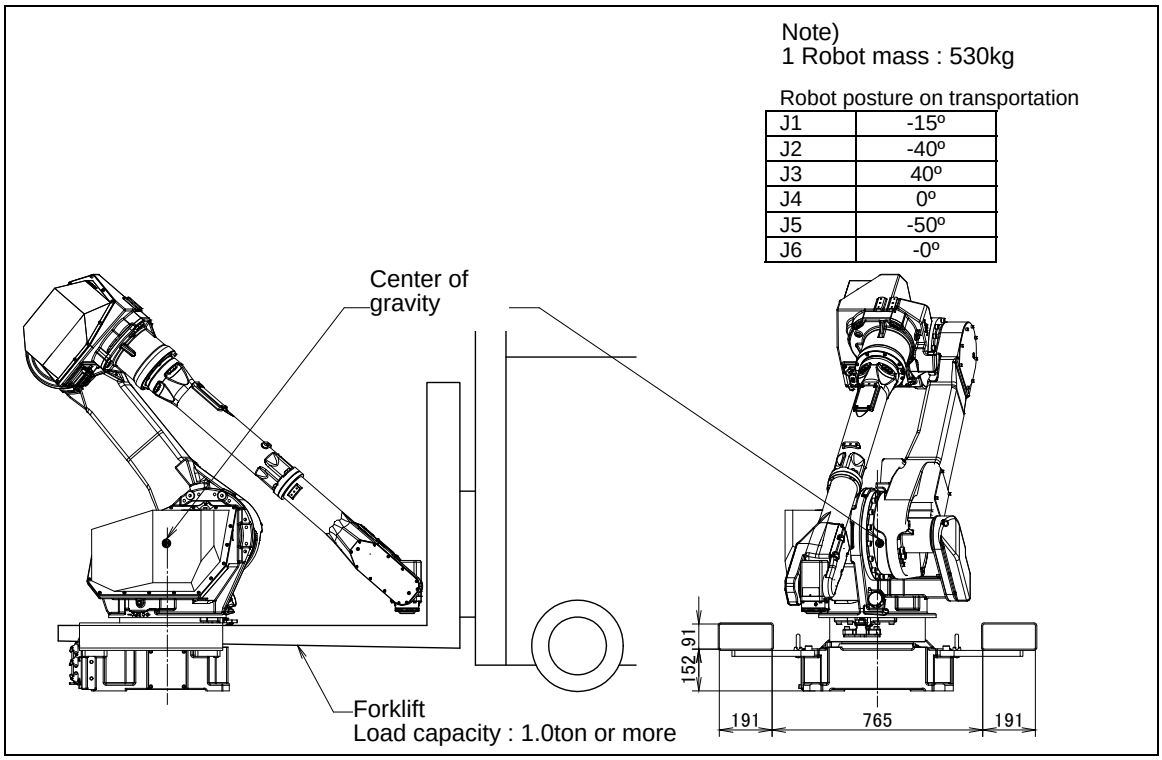


Fig. 1.1 (g) Transportation using a forklift (M-710*i*C/20M)

> ⚠ **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.

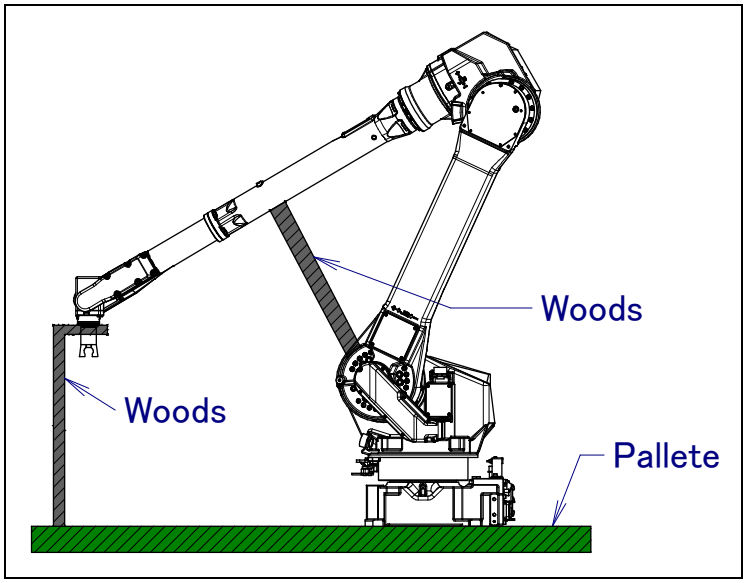


Fig. 1.1.1 Example of securing the arm during transportation when an end effector is attached

1.2 INSTALLATION

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

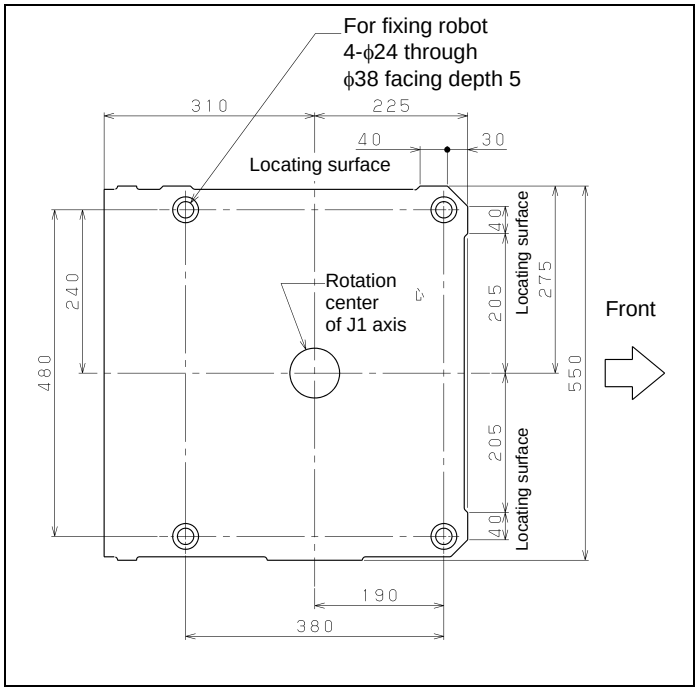


Fig. 1.2 Dimensions of the robot base

1.2.1 Installation Method

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.)

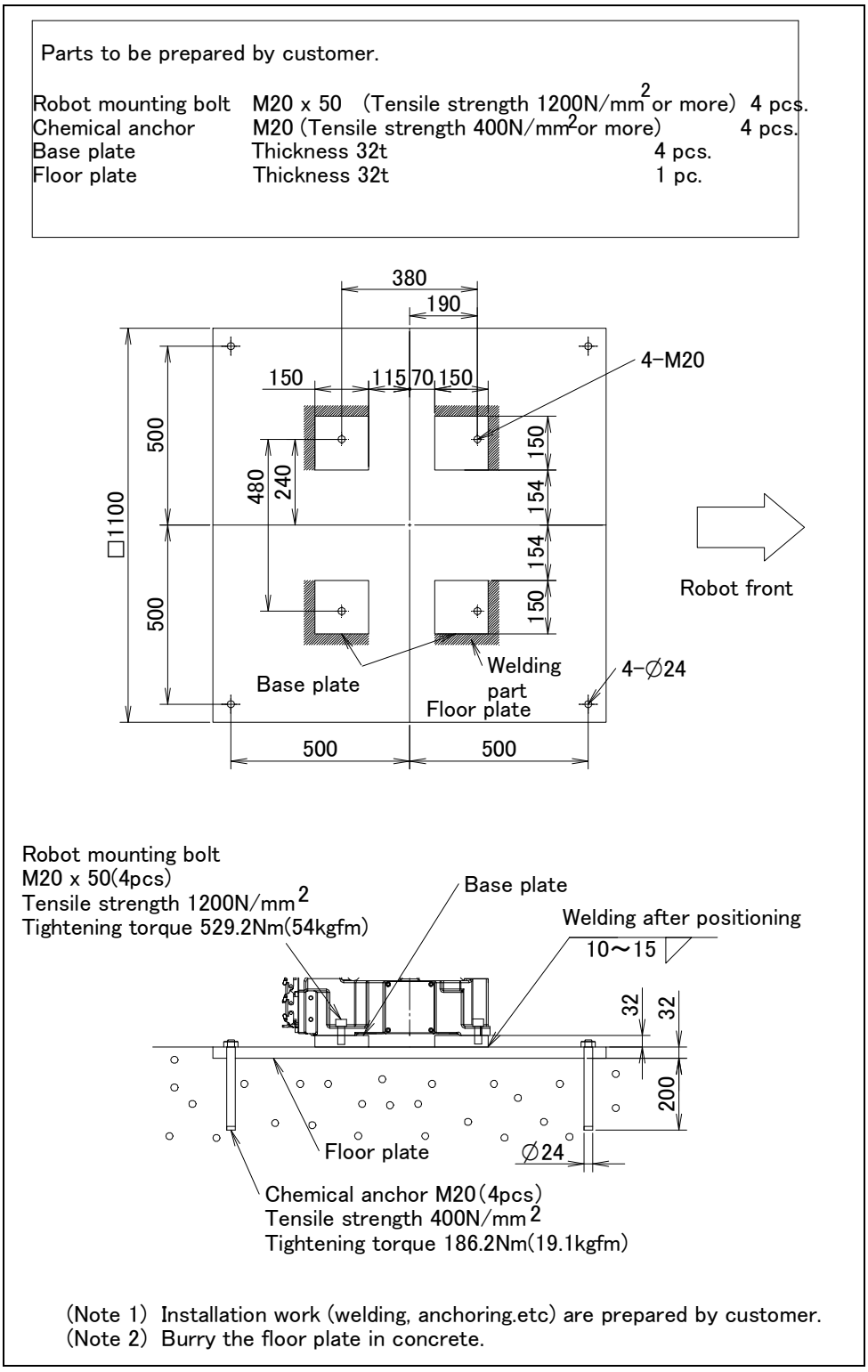


Fig. 1.2.1 (a) Actual installation example

> ⚠ **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 0.5°.
> 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.

Table 1.2.1 (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/20L	16.8 (1714)	9.8 (1003)	6.5 (659)	7.1 (720)
M-710*i*C/12L	12.9 (1320)	9.1 (930)	5.4 (550)	6.8 (690)
M-710iC/20M	13.1 (1335)	9.2 (942)	4.8 (488)	5.9 (599)

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/20L	Stopping time [ms]	276	247	217
	Stopping distance [deg] (rad)	24.0 (0.42)	21.6 (0.38)	19.5 (0.34)
M-710*i*C/12L	Stopping time [ms]	284	284	172
	Stopping distance [deg] (rad)	27.5 (0.48)	25.8 (0.45)	14.5 (0.25)
M-710*i*C/20M	Stopping time [ms]	252	228	188
	Stopping distance [deg] (rad)	24.3 (0.42)	22.6 (0.39)	19.2 (0.33)

*Max payload and max speed

Table 1.2.1 (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/20L	Stopping time [ms]	718	734	710
	Stopping distance [deg] (rad)	65.2 (1.14)	62.4 (1.09)	68.7 (1.20)
M-710*i*C/12L	Stopping time [ms]	772	908	756
	Stopping distance [deg] (rad)	75.1 (1.31)	74.6 (1.30)	71.8 (1.25)
M-710*i*C/20M	Stopping time [ms]	741	708	668
	Stopping distance [deg] (rad)	66.2 (1.15)	66.0 (1.15)	65.4 (1.14)

*Max payload and max speed

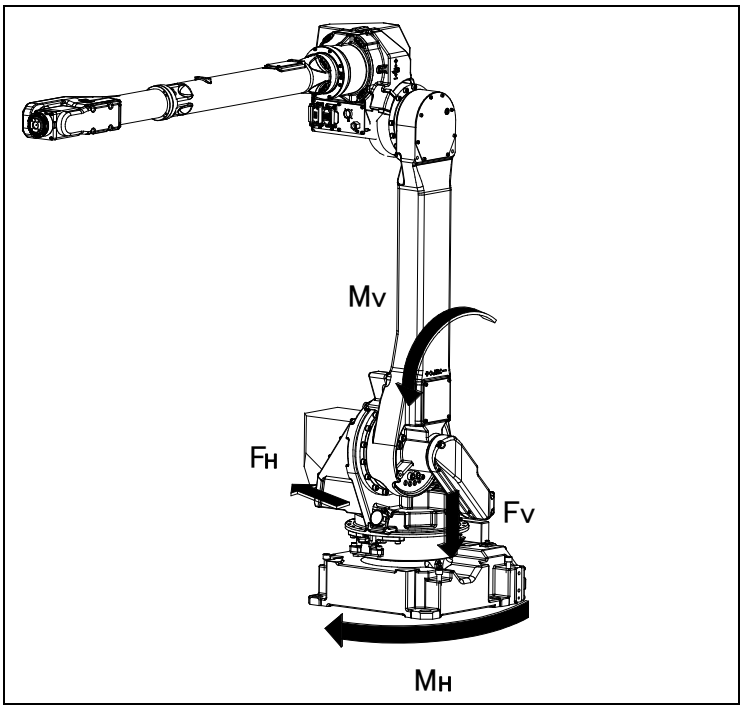
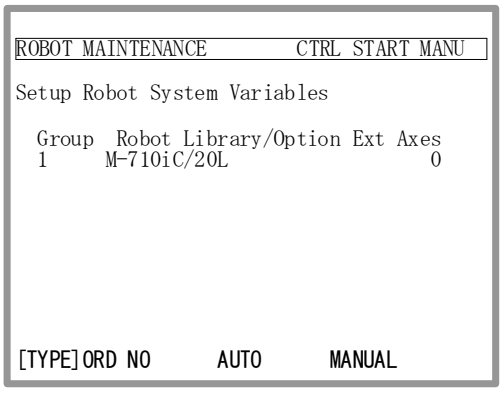


Fig. 1.2.1 (b) Force and moment during Power-Off Stop

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/20L****************


--- 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.

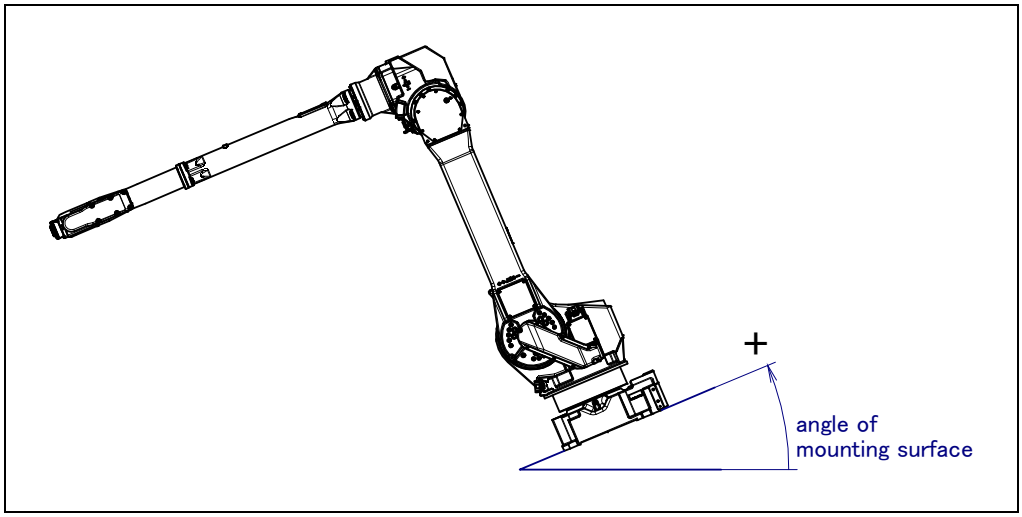


Fig. 1.2.2 Mounting angle

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/20L                  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.

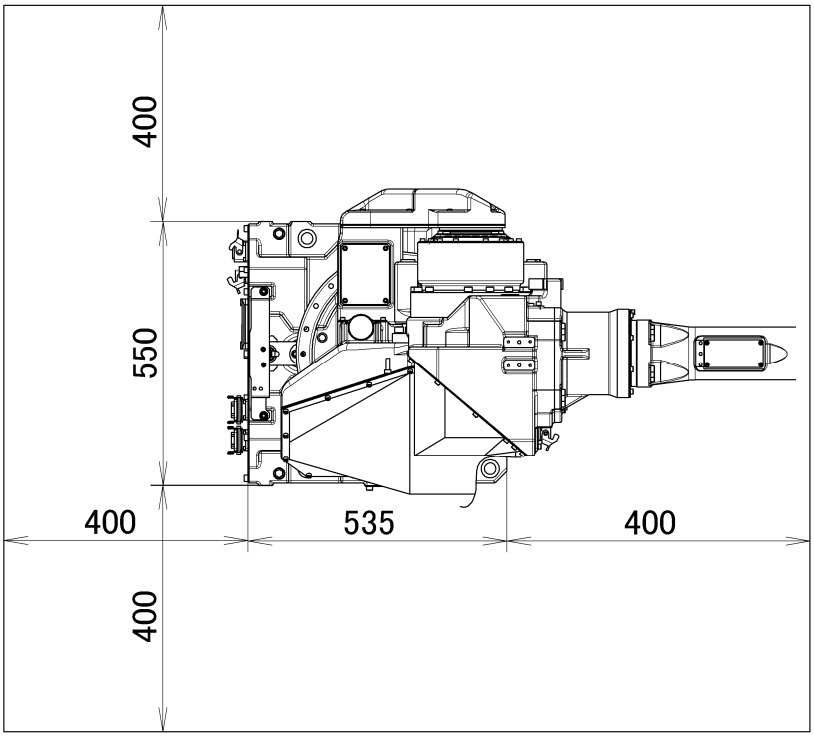


Fig. 1.3 Maintenance area

1.4 INSTALLATION CONDITIONS

Refer to the caution below concerning installation conditions.
Refer to also to the specifications found in Section 3.1.

> ⚠ **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 and signal cable and earth cable. Connect these cables to the connectors on the back of the robot base.

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

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

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

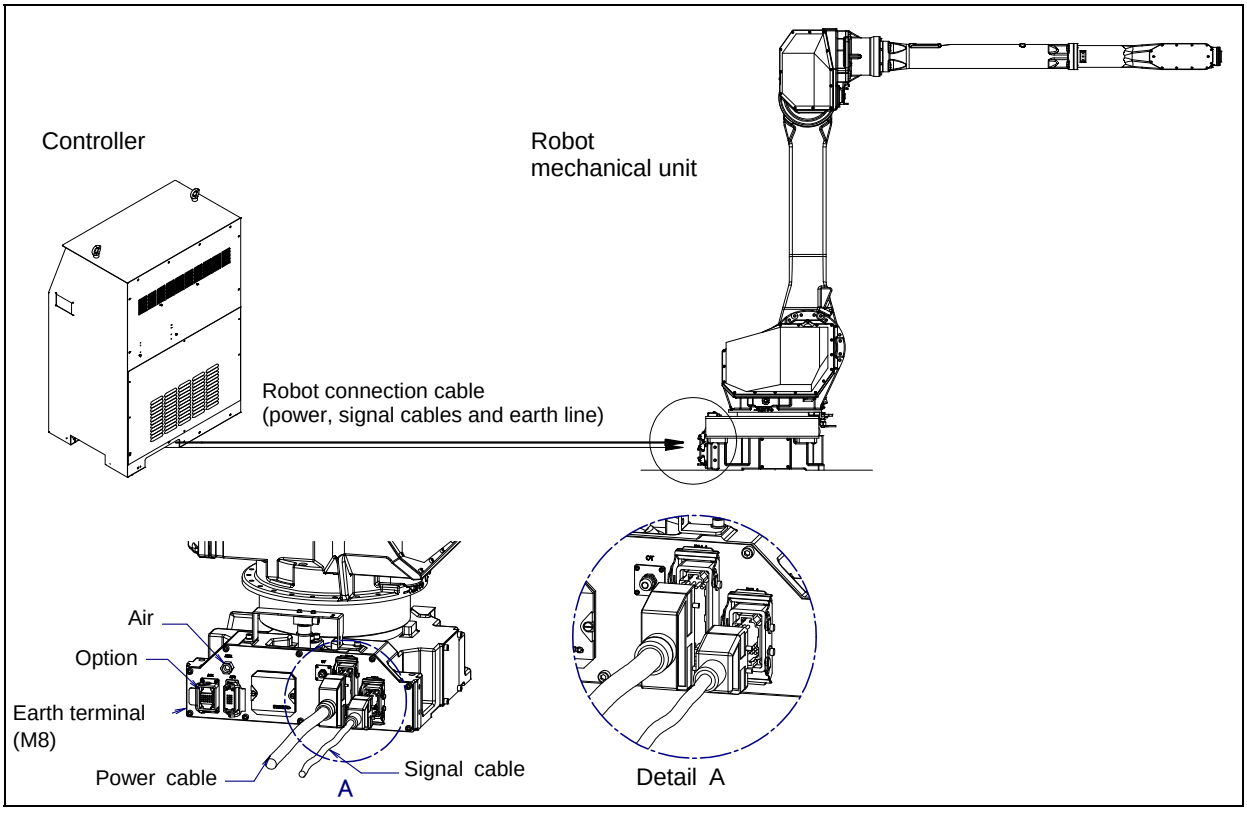


Fig. 2.1 Cable connection

3 BASIC SPECIFICATIONS

3.1 ROBOT CONFIGURATION

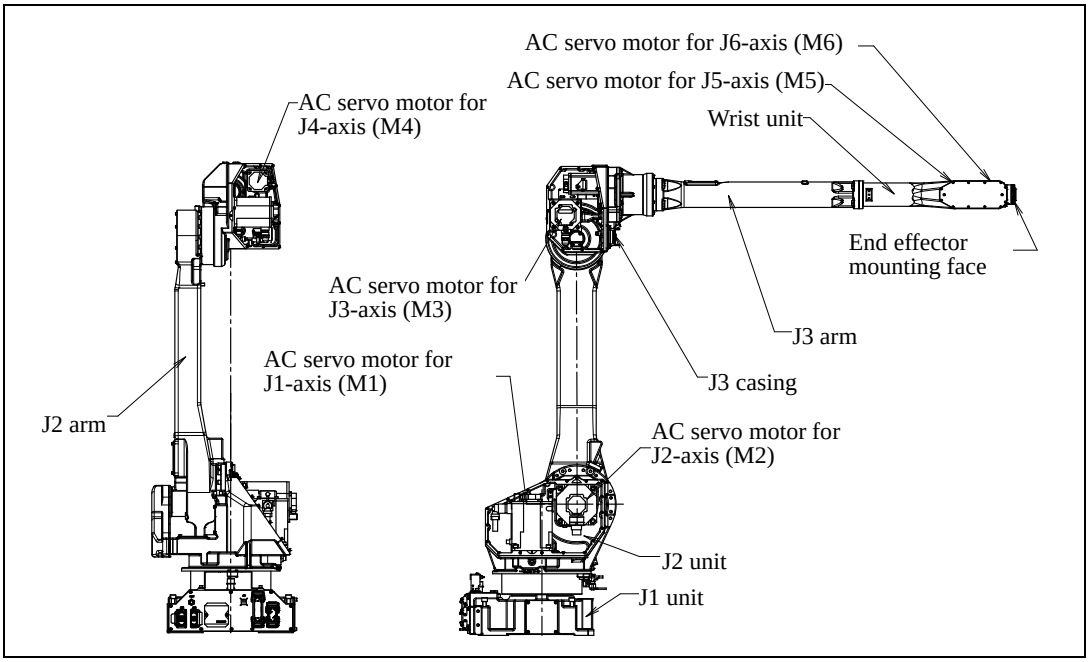


Fig. 3.1 (a) Mechanical unit configuration (M-710*i*C/20L/20M)

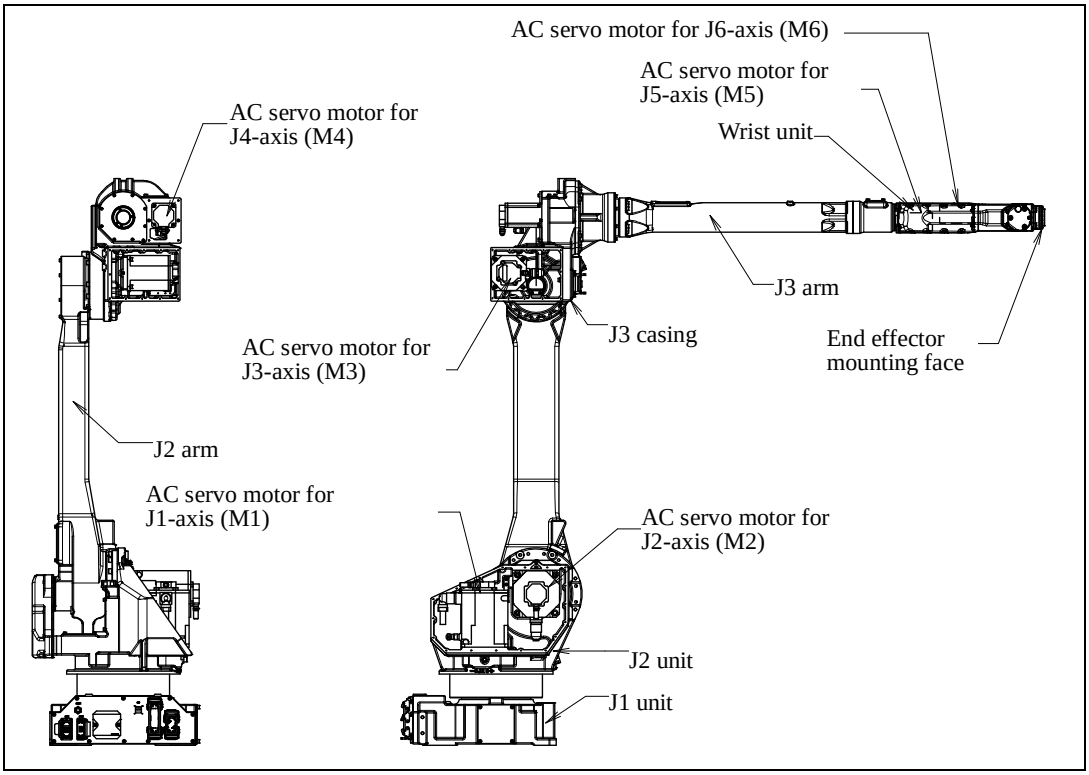


Fig. 3.1 (b) Mechanical unit configuration (M-710*i*C/12L)

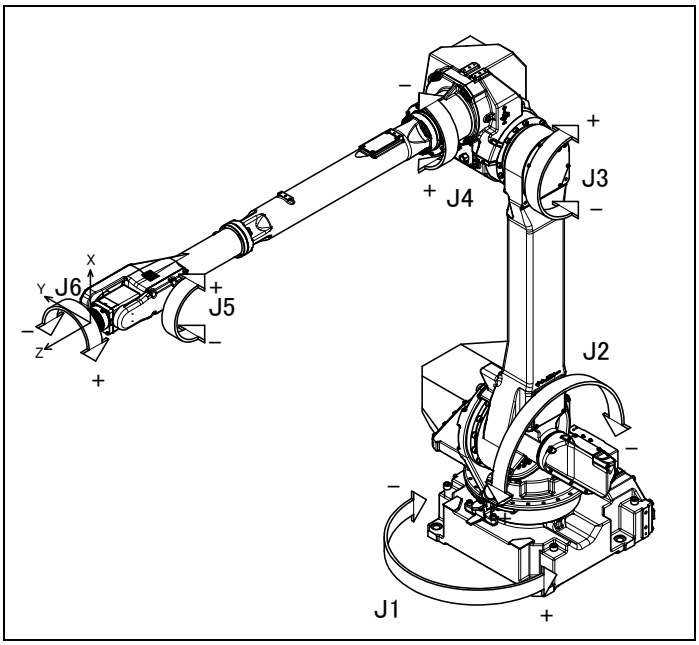


Fig. 3.1 (c) Each axis coordinates and mechanical interface coordinates

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

Specifications

Item			Specification		
Model			M-710*i*C/20L	M-710*i*C/12L	M-710*i*C/20M
Type			Articulated Type		
Controlled axes			6-axis (J1, J2, J3, J4, J5, J6)		
Reach			3110mm	3123mm	2582mm
Installation (NOTE1)			Floor, upside-down mount (angle)		
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° (2.36rad)	135° (2.36rad)	135° (2.36rad)
		Lower limit	-90° (-1.57rad)	-90° (-1.57rad)	-90° (-1.57rad)
	J3-axis	Upper limit	270° (4.71rad)	270° (4.71rad)	275° (4.80rad)
		Lower limit	-162° (-2.83rad)	-164° (-2.86rad)	-160° (-2.79rad)
	J4-axis	Upper limit	200° (3.49rad)	200° (3.49rad)	200° (3.49rad)
		Lower limit	-200° (-3.49rad)	-200° (-3.49rad)	-200° (-3.49rad)
	J5-axis	Upper limit	140° (2.44rad)	190° (3.31rad)	140° (2.44rad)
		Lower limit	-140° (-2.44rad)	-190° (-3.31rad)	-140° (-2.44rad)
	J6-axis	Upper limit	450° (7.85rad)	360° (6.28rad)	450° (7.85rad)
		Lower limit	-450° (-7.85rad)	-360° (-6.28rad)	-450° (-7.85rad)
Max motion speed (NOTE 2)	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		180°/s (3.14rad/s)	180°/s (3.14rad/s)	180°/s (3.14rad/s)
	J4-axis		350°/s (6.11rad/s)	400°/s (6.98rad/s)	350°/s (6.11rad/s)
	J5-axis		360°/s (6.28rad/s)	430°/s (7.50rad/s)	360°/s (6.28rad/s)
	J6-axis		600°/s (10.47rad/s)	630°/s (11.0rad/s)	600°/s (10.47rad/s)
Max. load capacity	At wrist		20kg	12kg	20kg
	At J3 casing (NOTE 3)		24kg		
Allowable load moment at wrist	J4-axis		39.2N·m (4.0kgf·m)	22.0N·m (2.24kgf·m)	39.2N·m (4.0kgf·m)
	J5-axis		39.2N·m (4.0kgf·m)	22.0N·m (2.24kgf·m)	39.2N·m (4.0kgf·m)
	J6-axis		19.6N·m (2.0kgf·m)	9.8N·m (1.0kgf·m)	19.6N·m (2.0kgf·m)
Allowable load inertia at wrist	J4-axis		0.88kg·m^2 (9.0kgf·cm·s^2)	0.65kg·m^2 (6.6kgf·cm·s^2)	0.88kg·m^2 (9.0kgf·cm·s^2)
	J5-axis		0.88kg·m^2 (9.0kgf·cm·s^2)	0.65kg·m^2 (6.6kgf·cm·s^2)	0.88kg·m^2 (9.0kgf·cm·s^2)
	J6-axis		0.25kg·m^2 (2.5kgf·cm·s^2)	0.17kg·m^2 (1.7kgf·cm·s^2)	0.25kg·m^2 (2.5kgf·cm·s^2)
Drive method			Electric servo drive by AC servo motor		
Repeatability(NOTE 4)			±0.11mm	±0.09mm	±0.06mm
Mass (NOTE 5)			540kg		530kg
Acoustic noise level			71.3dB (NOTE 6)		
Installation environment			Ambient temperature: 0 - 45°C (NOTE 7) 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 posture. Vibration acceleration : 4.9m/s^2 (0.5G) or less Free of corrosive gases (NOTE 8)		

NOTE

1 There are restrictions on the J1- and J2-axis motion ranges under the installation condition indicated in parentheses. However, there is no restriction for M-710*i*C/20M. Refer to Section 3.7 for details.
2 During short distance motions, the axis speed may not reach the maximum value stated.
3 The Max. load capacity at J3 casing is restricted by the load weight at wrist. For details, see Section 3.5.
4 Compliant with ISO 9283.
5 The weight of the controller is not included.
6 This value is the 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

7 When the robot is used in a low temperature environment that is near to 0ºC, or the robot is not operated for a long time in the an environment that is less than 0ºC, for example in during a holiday or the overnight, because viscous resistance of the drive train is so big that may cause occurrence of collision detect alarm (SRVO–050) etc. In this case, we recommend performing the a warm up operation for several minutes.
8 Contact the service representative, if the robot is to be used in an environment or a place subjected to hot/cold temperatures, severe vibrations, heavy dust, cutting oil splash and or other foreign substances.

The following table lists the IEC60529-based severe dust/liquid protection characteristics of the M-710*i*C.

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

(*) Except some connectors

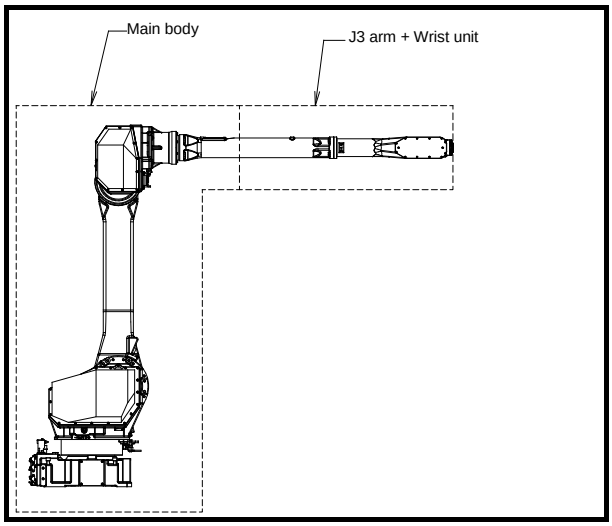


Fig. 3.1 (d) Characteristics of the M-710*i*C

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) Coolant including chlorine / gasoline
   (c) Amine type detergent
   (d) Acid, alkali and liquid causing rust
   (e) Other liquids or solutions, that will harm NBR
(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 liquid.
(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 OPERATING SPACE AND INTERFERENCE AREA

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

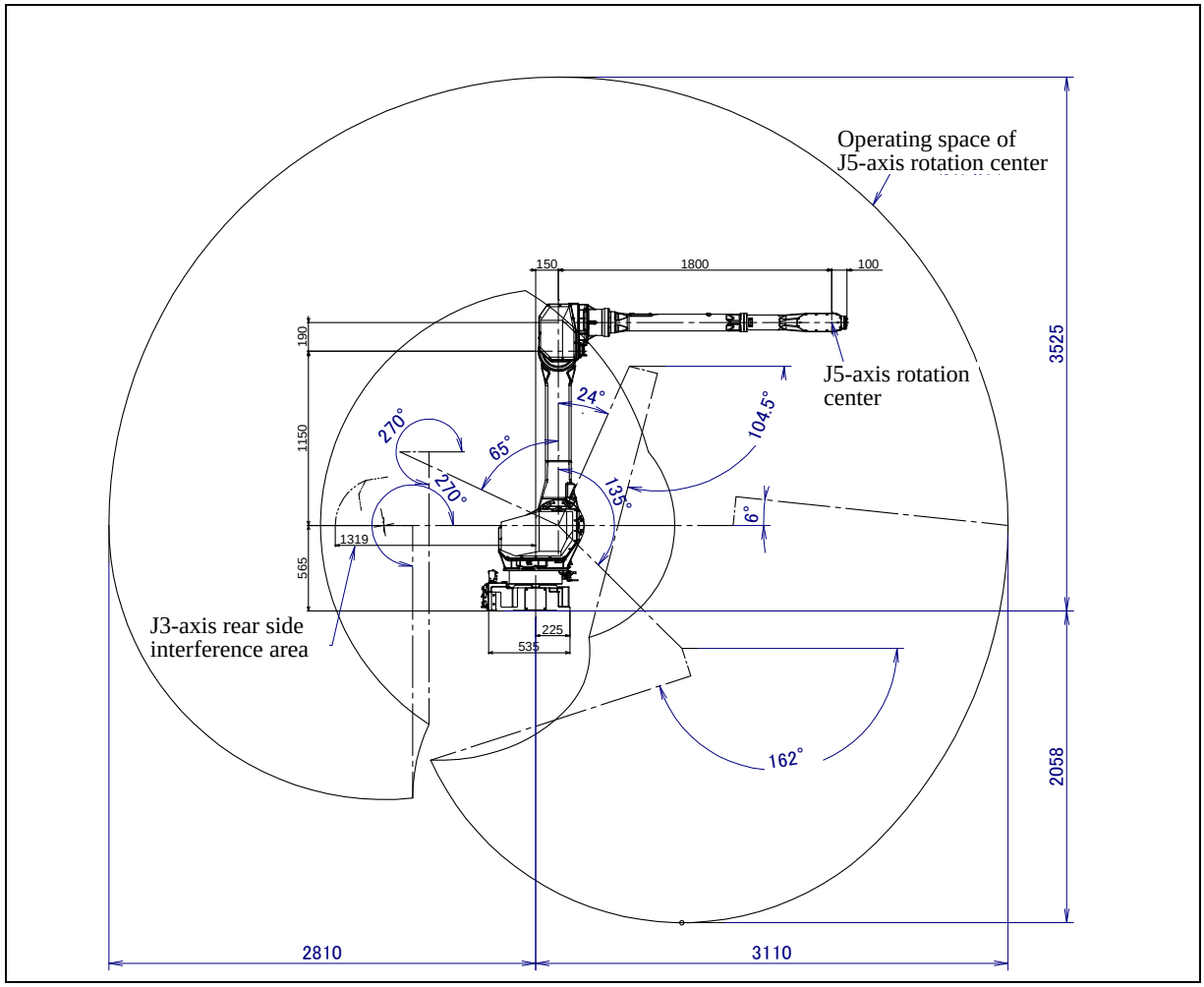


Fig. 3.2 (a) Operating space (M-710*i*C/20L)

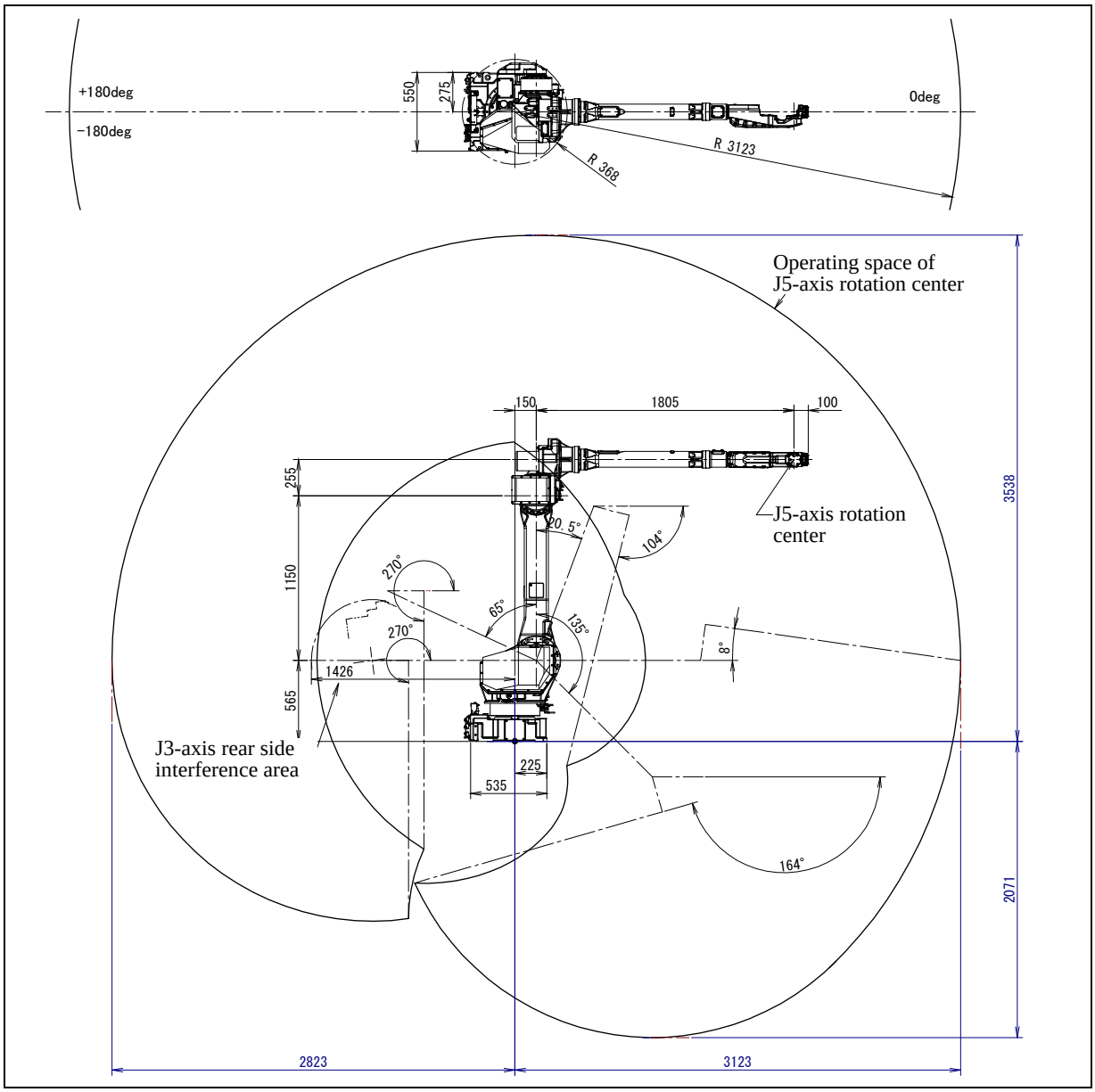


Fig. 3.2 (b) Operating space (M-710*i*C/12L)

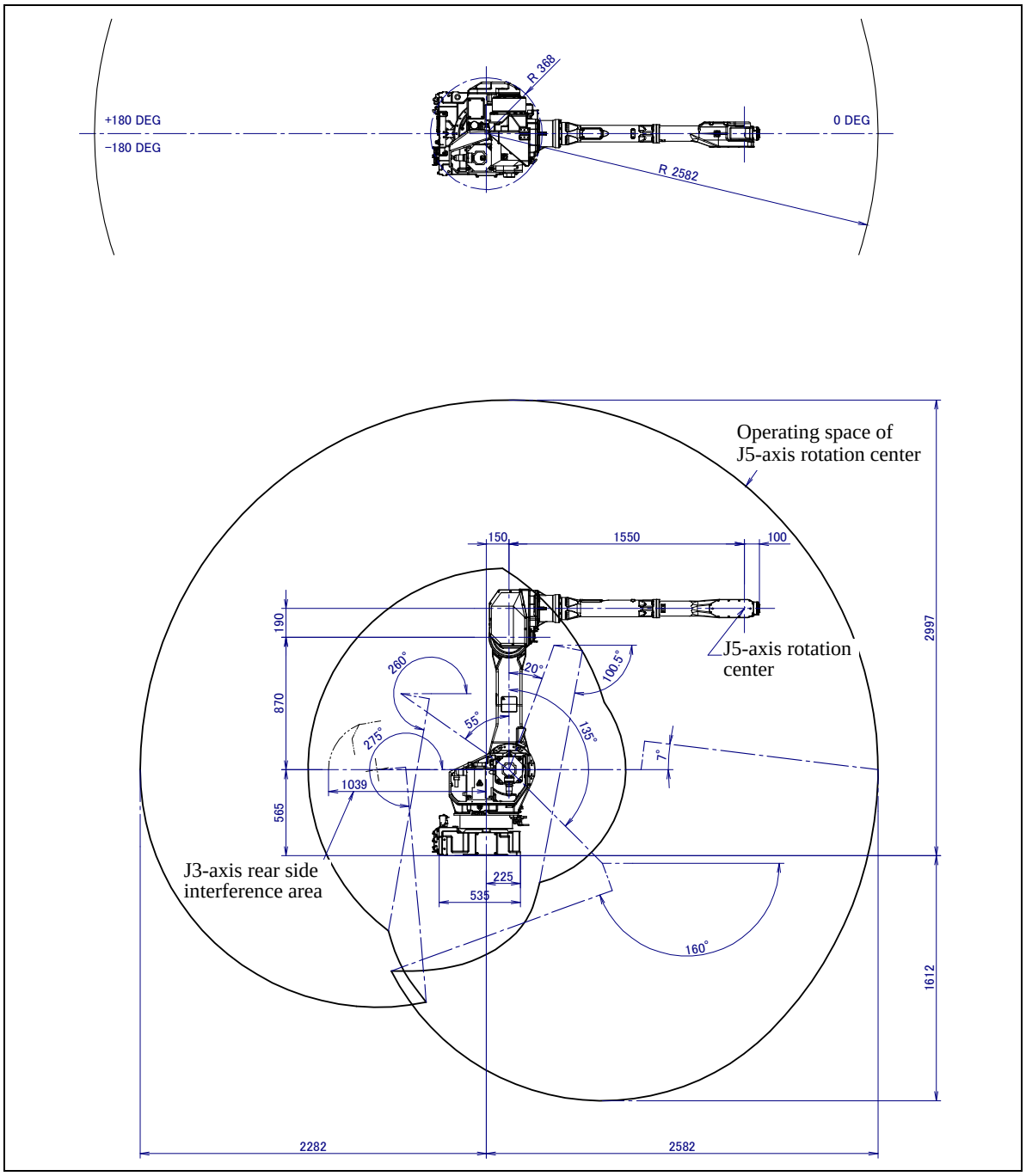


Fig. 3.2 (c) Operating space (M-710*i*C/20M)

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. Only in case of J1 axis, robot stops by transforming mechanical stopper. Be sure to exchange transformed stopper to new one. Tight the bolts according to Appendix B. Replace mechanical stopper of J1- axis referring to Fig. 3.3 (a). Don't reconstruct the mechanical stopper. There is a possibility that the robot doesn't stop normally.

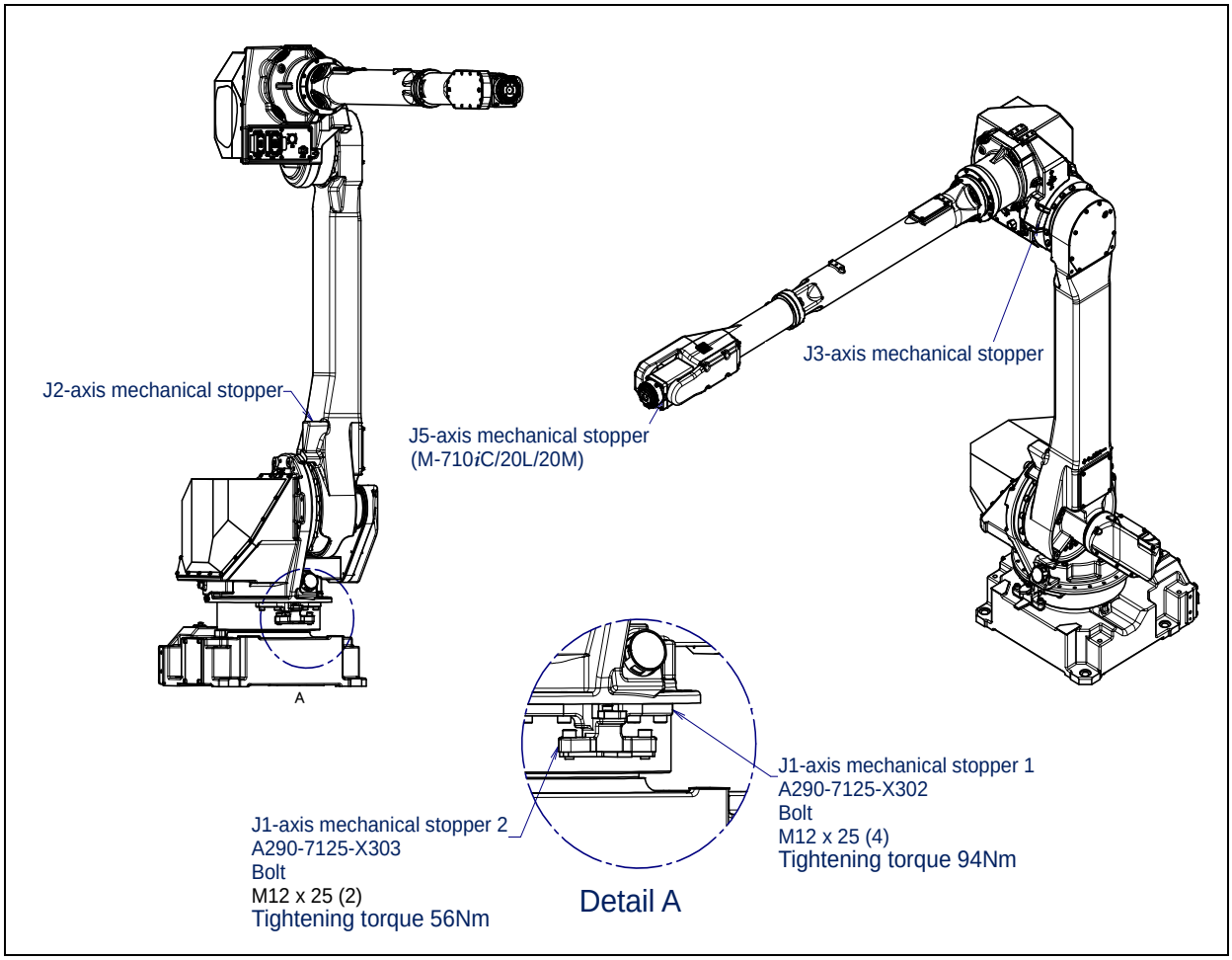


Fig. 3.3 (a) Position of mechanical stopper

Fig. 3.3 (b) to (i) 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.

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

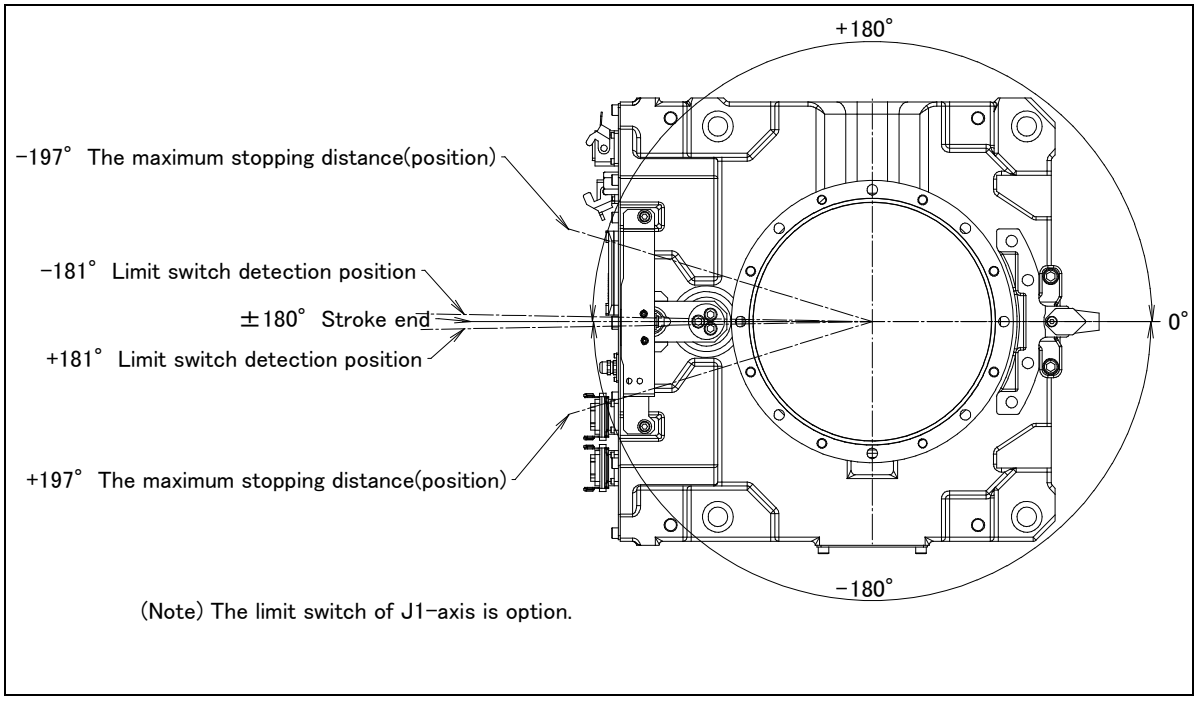


Fig. 3.3 (b) J1-axis motion limit

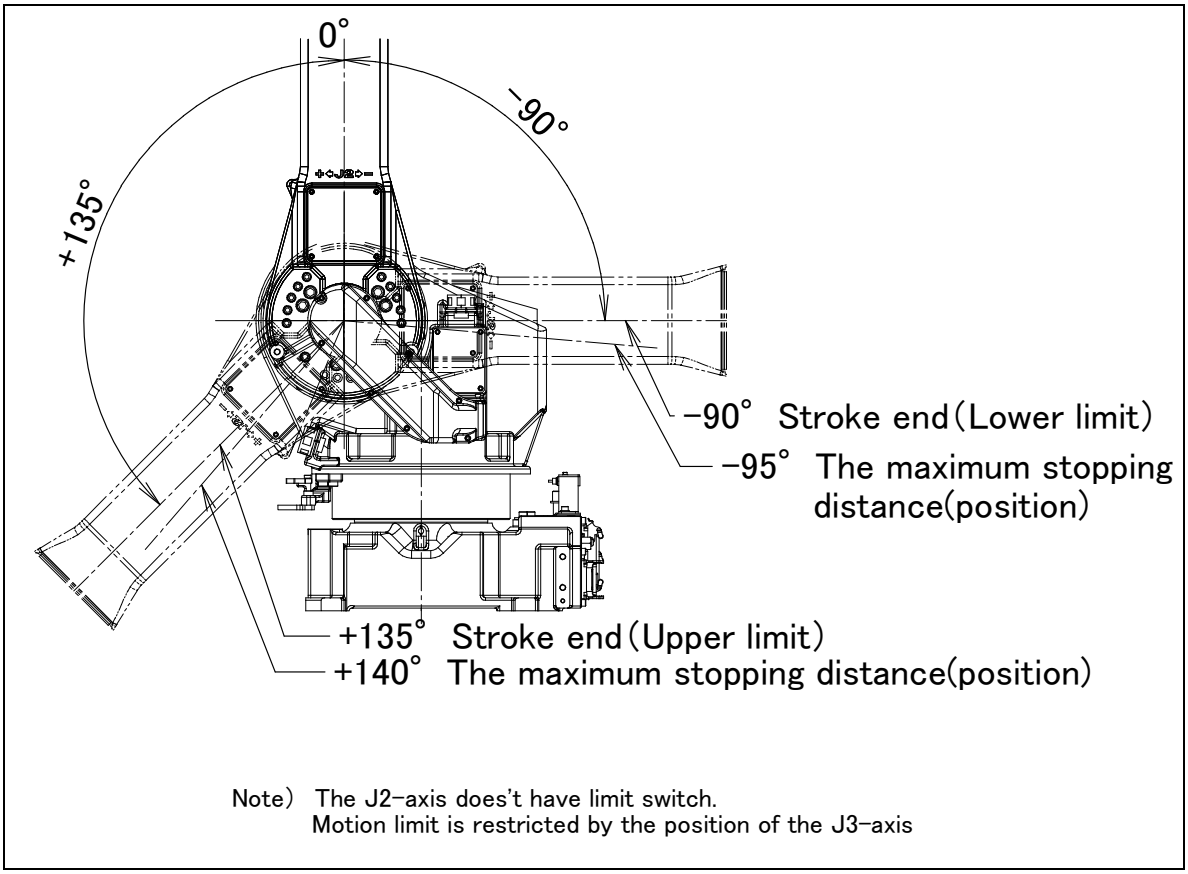
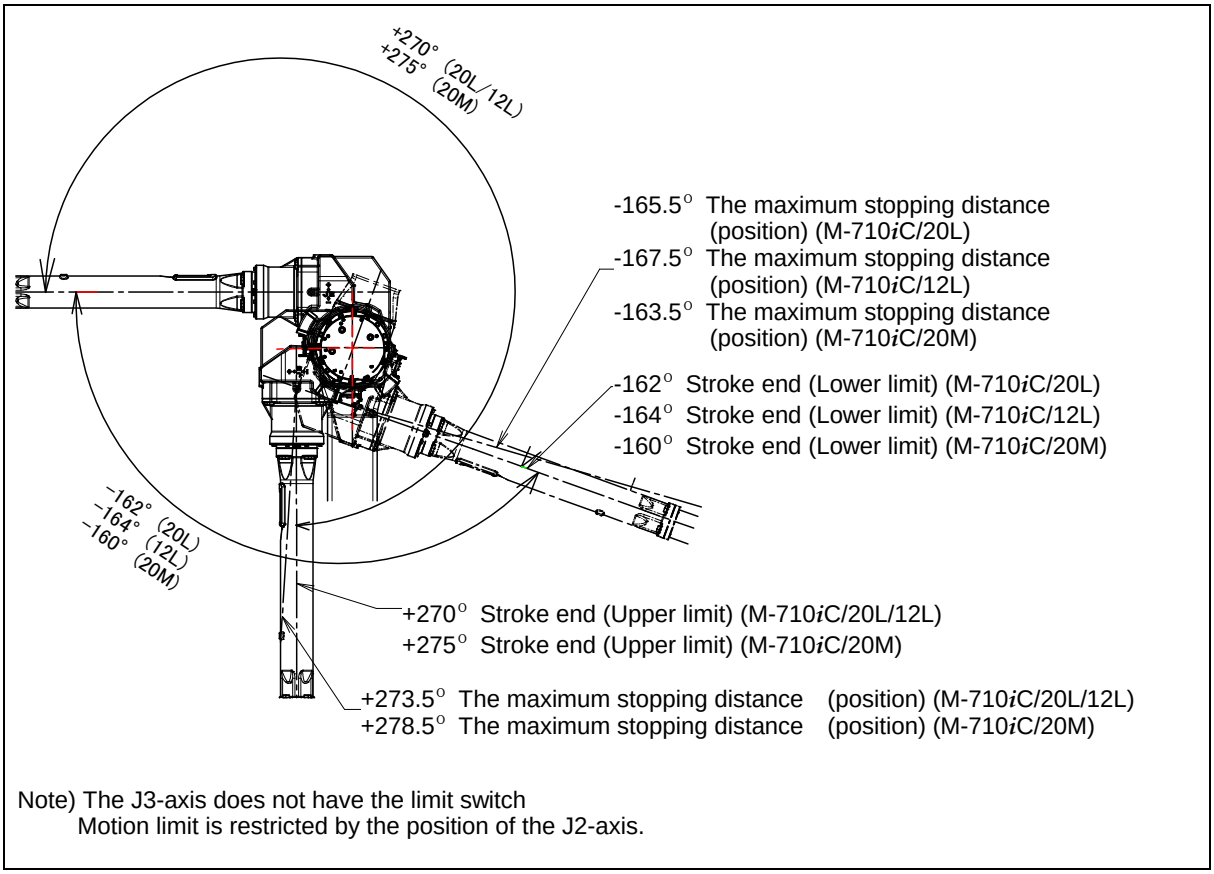
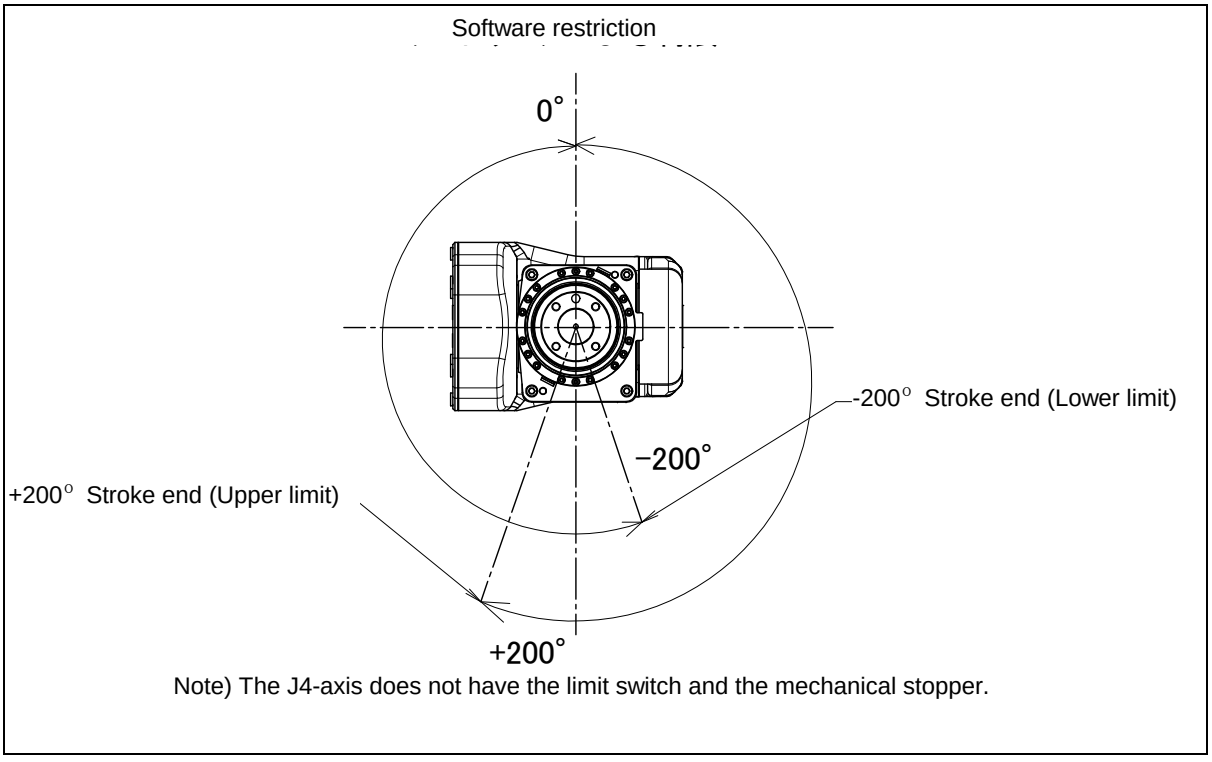


Fig. 3.3 (c) J2-axis motion limit



Note) The J3-axis does not have the limit switch
Motion limit is restricted by the position of the J2-axis.

Fig. 3.3 (d) J3-axis motion limit



Note) The J4-axis does not have the limit switch and the mechanical stopper.

Fig. 3.3 (e) J4-axis motion limit

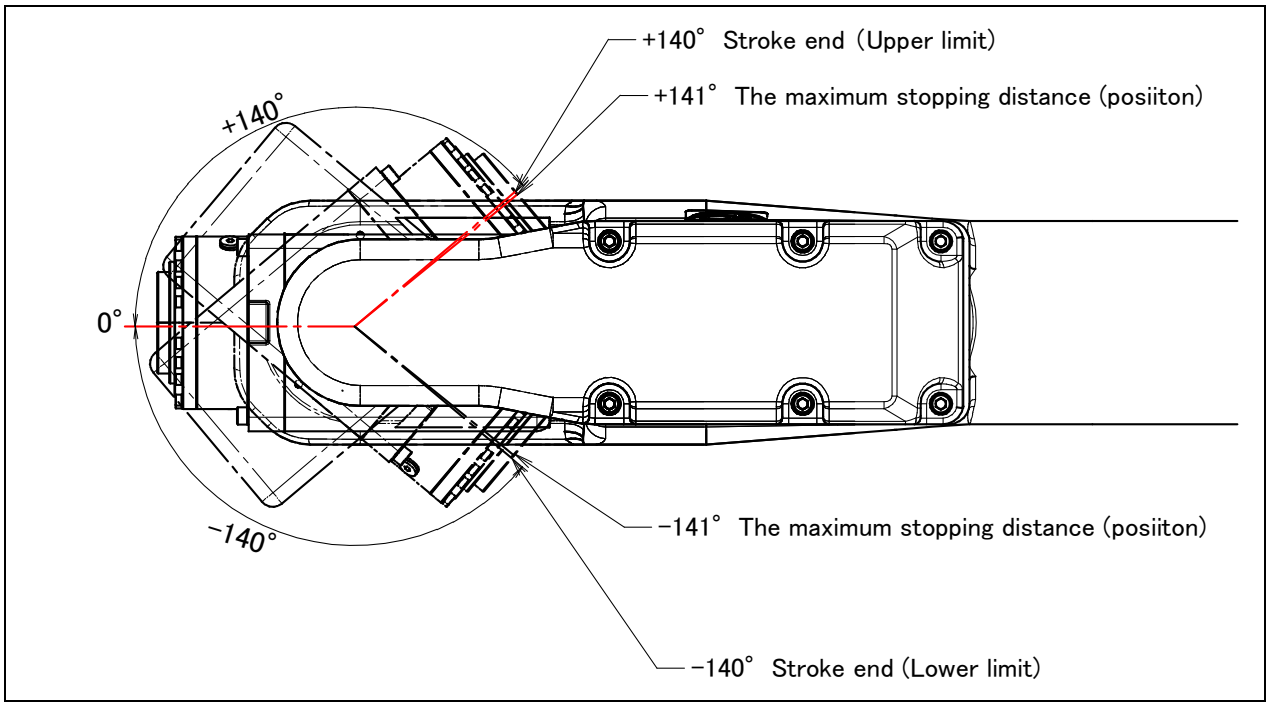


Fig. 3.3 (f) J5-axis motion limit (M-710*i*C/20L/20M)

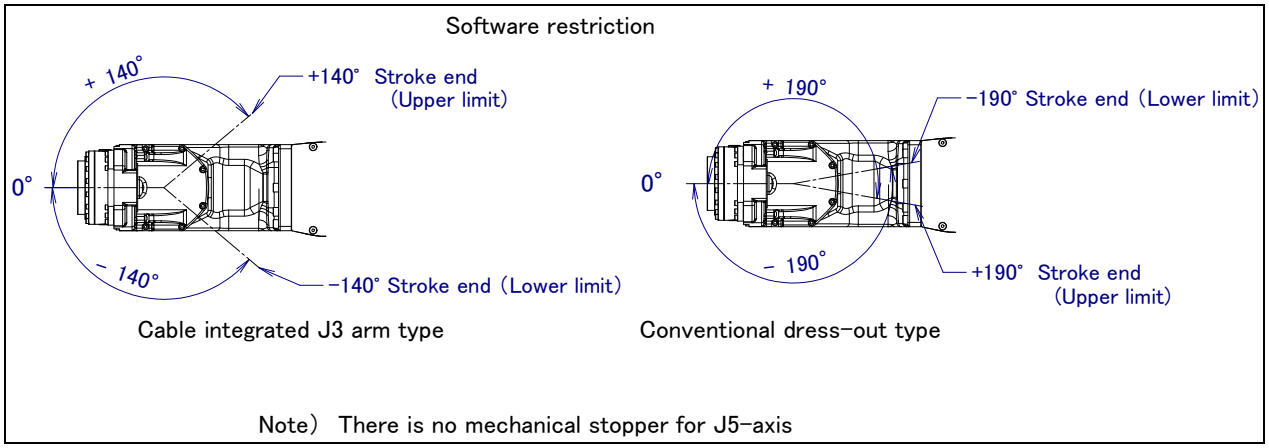


Fig. 3.3 (g) J5-axis motion limit (M-710*i*C/12L)

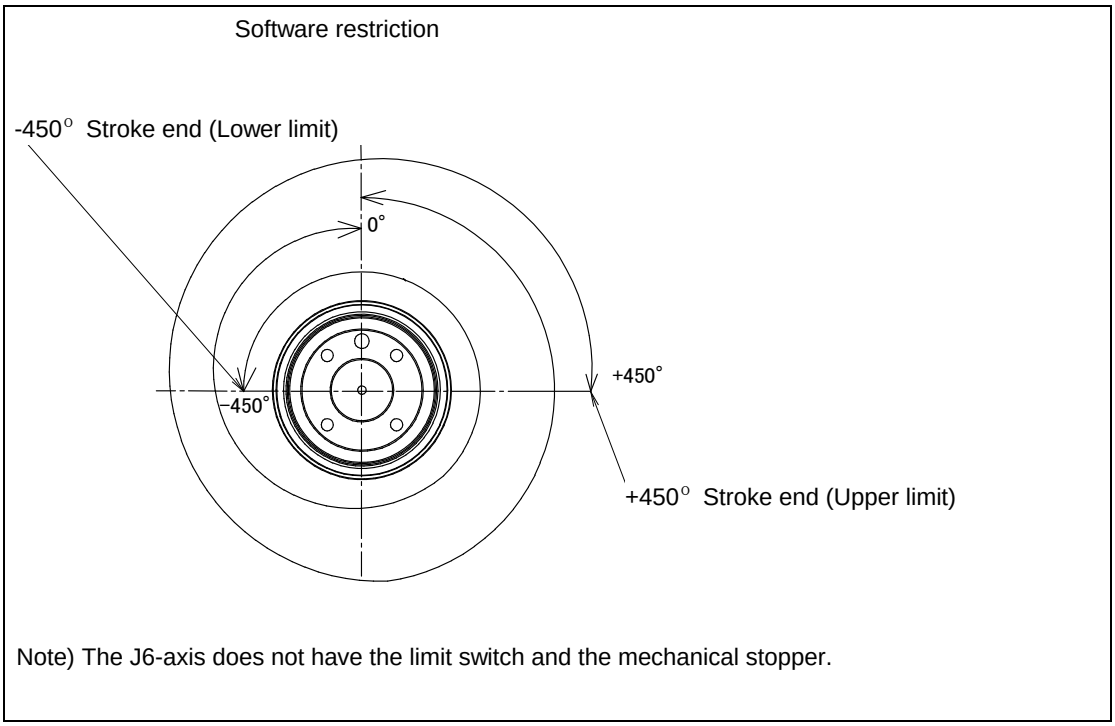


Fig. 3.3 (h) J6-axis motion limit (M-710*i*C/20L/20M)

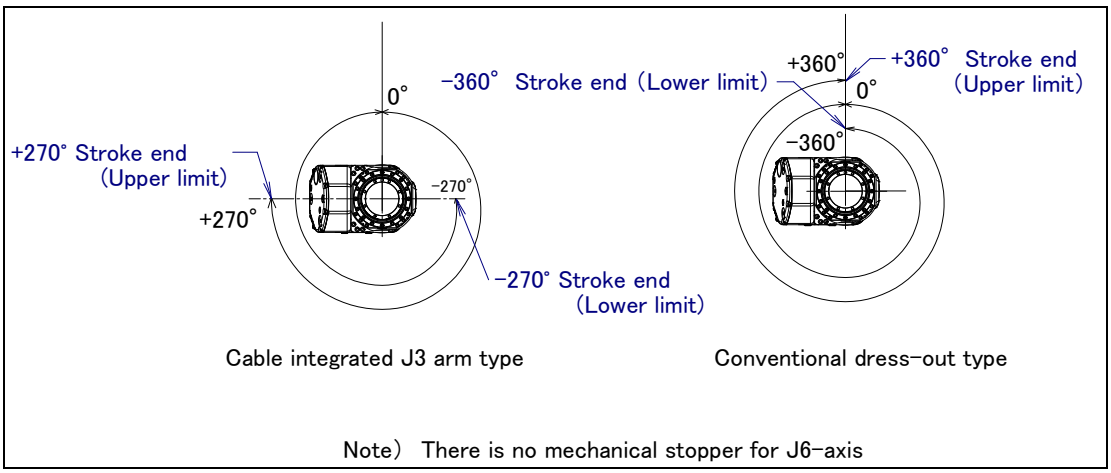


Fig. 3.3 (i) J6-axis motion limit (M-710*i*C/12L)

3.4 WRIST LOAD CONDITIONS

Fig. 3.4 (a) and (b) 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 4.1 about allowable load moment and the allowable load inertia.

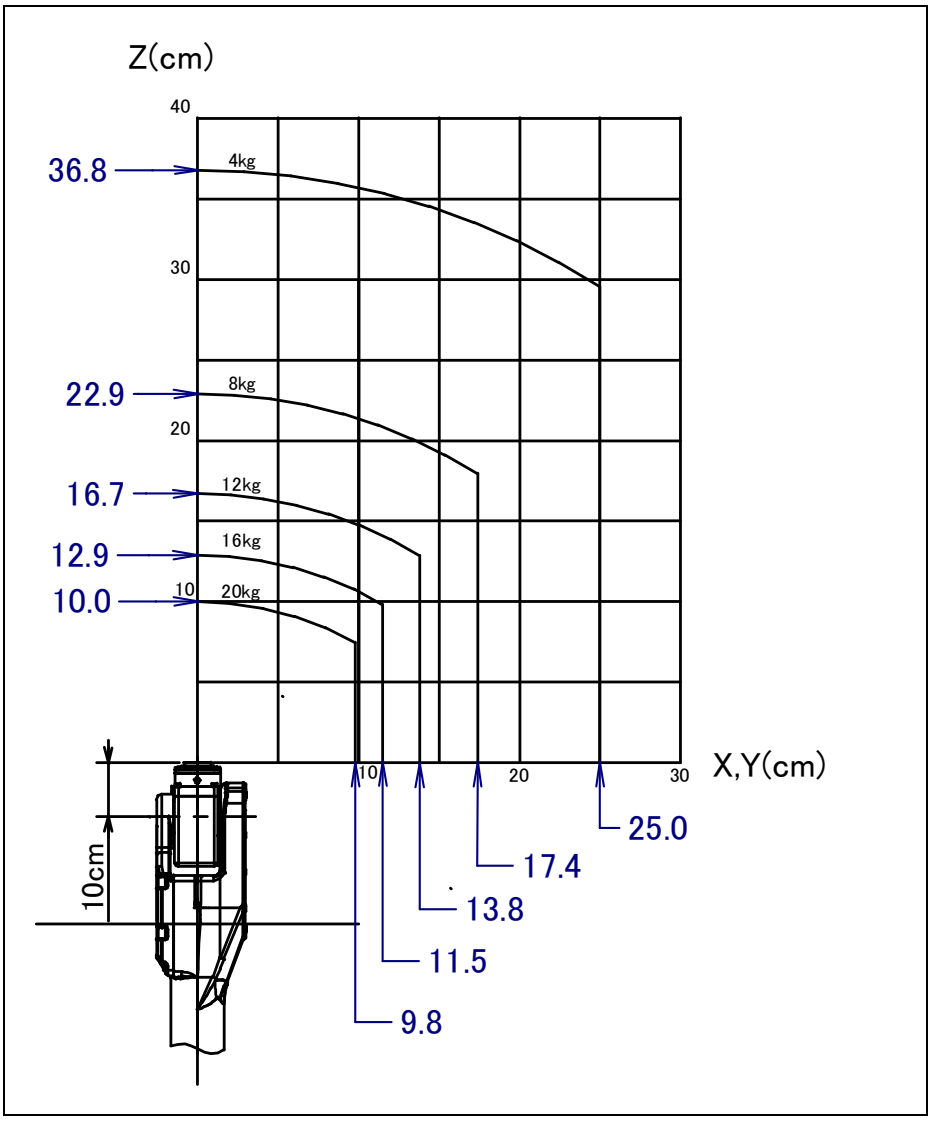


Fig. 3.4 (a) Wrist load diagram (M-710*i*C/20L/20M)

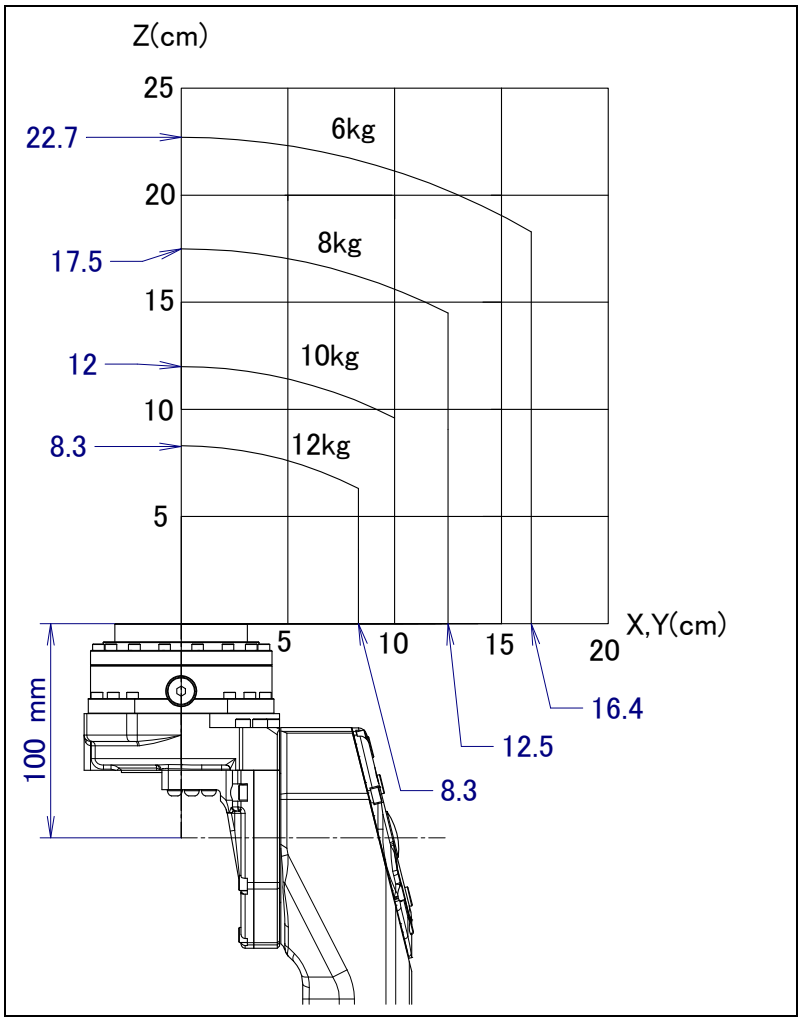


Fig. 3.4 (b) Wrist load diagram (M-710*i*C/12L)

3.5 LOAD CONDITIONS ON J3 CASING

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

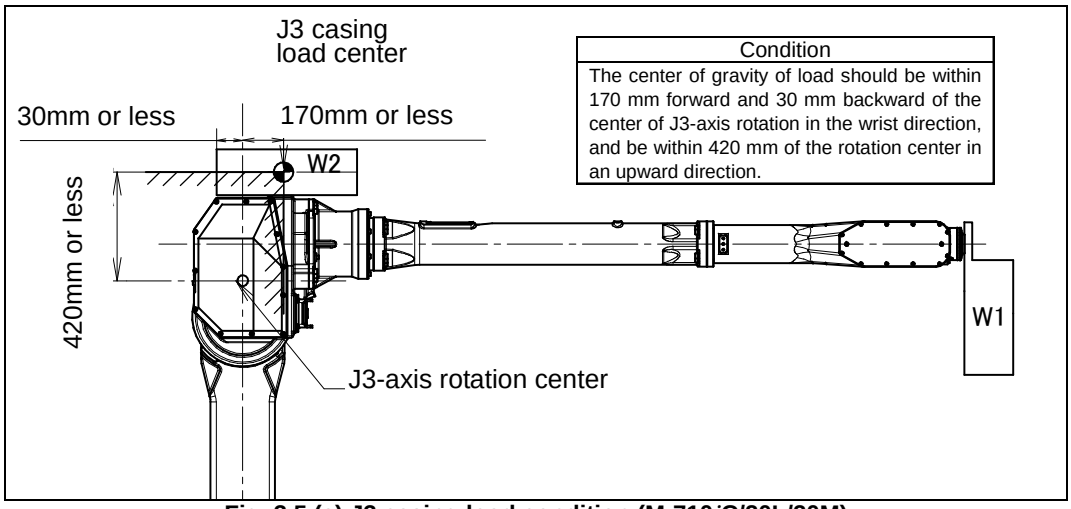


Fig. 3.5 (a) J3 casing load condition (M-710*i*C/20L/20M)

Table 3.5 J3 casing load condition (M-710*i*C/20L/20M)

Wrist load weight W_1	J3 casing load weight W_2
15kg or less	24 kg or less
More than15kg and less than 20kg	$W_2 \le \frac{14}{5} \times (20 - W_1[kg]) + 10$

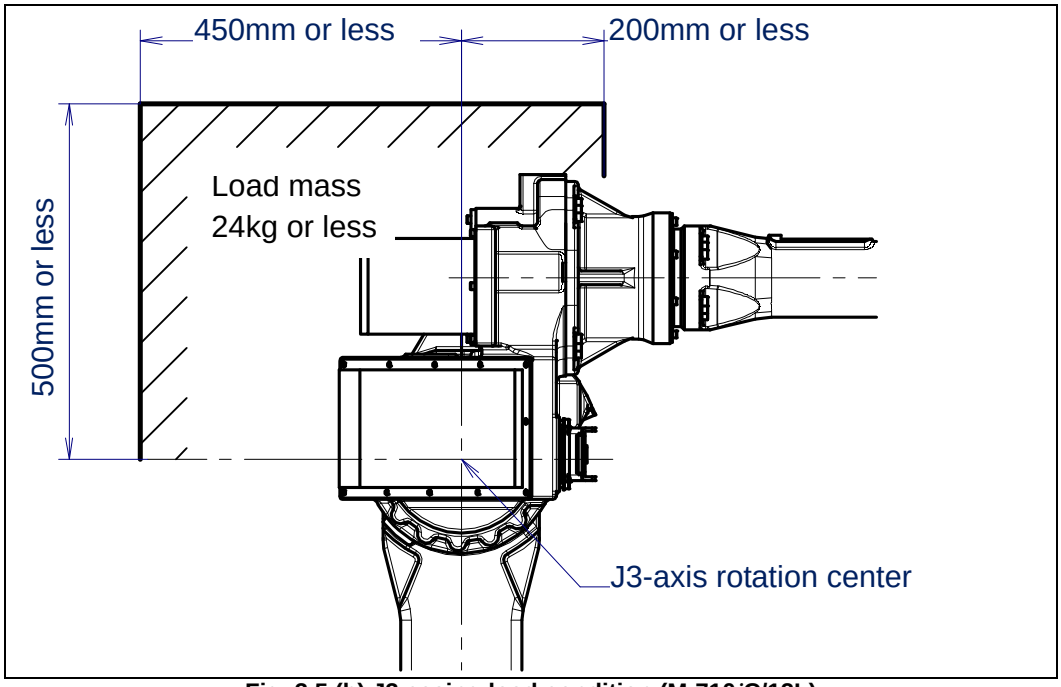


Fig. 3.5 (b) J3 casing load condition (M-710*i*C/12L)

⚠ 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 rotates with J3 arm.
- If you put load on J3 arm, unavoidably, treat it as wrist load.

3.6 ABOUT SWITCHING BETWEEN MOVEMENT TYPES

The M-710*i*C/20L/12L/20M have two movement types: general setting (Turbomove enabled) and sealing setting (Turbomove disabled).
Switching between the settings is automatically performed when you run a dedicated switching program as described below.

Switching program name

CHNGMOVE.PC (Common to M-710*i*C/20L/12L/20M)

When you run this program, you are asked whether you really want to switch to the other movement type of the Robot.

If the current setting is “General Setting (Minimum Time Control Enabled)”

```
Move type setting for M-710iC/20L
 (Group: 1)

The present movetype is General type.
Do you change to Sealing type?

[Yes: 1, No: Else] ->
```

If the current setting is “Sealing Setting (Minimum Time Control Disabled)”

```
Move type setting for M-710iC/20L
 (Group: 1)

The present movetype is Sealing type.
Do you change to General type?

[Yes: 1, No: Else] ->
```

When you select “Yes” in response to the prompt, switching to the other movement type (parameter change) is performed. A message then appears on the screen, notifying you of the switching.

If switching from “General Setting” to “Sealing Setting” has been performed

```
[Yes: 1, No: Else] -> 1
 Sealing type setting has been set.
 (Group: 1)
```

If switching from “Sealing Setting” to “General Setting” has been performed

```
[Yes: 1, No: Else] -> 1
 General type setting has been set.
 (Group: 1)
```

When you select “No” in response to the prompt, the current movement type is maintained. A message then appears on the screen, indicating that switching has been canceled.

If switching has been canceled

```
[Yes: 1, No: Else] -> 0
 Move type setting has been canceled.
  (Group: 1)
```

If there is more than one M-710*i*C/20L/12L/20M unit in a multi-group system, you are further asked whether you really want to switch to the other movement type of the second M-710*i*C/20L/12L/20M unit.

```
[Yes: 1, No: Else] -> 1
 Sealing type setting has been set.
  (Group: 1)

 Move type setting for M-710iC/20L
  (Group: 2)

 The present movetype is General type.
 Do you change to Sealing type?

 [Yes: 1, No: Else] ->
```

If switching to the other movement type has been performed (if movement type switching has been performed for one or more groups in a multi-group system), you are prompted to turn the power off and then back on when you exit the program. In addition, alarm “SRVO-333 POWER OFF AND ON” is then issued.
The switching completes when the power is turned off and then back on.

If switching to the other movement type has been performed

```
[Yes: 1, No: Else] -> 1
 Sealing type setting has been set.
  (Group: 1)

Please power off
```

⚠ CAUTION
This program can only be used to switch between movement types of the M-710*i*C/20L/12L/20M. Even if a multi-group system includes other robots, a switching prompt does not appear for a group with a robot other than the M-710*i*C/20L/12L/20M.

3.7 OPERATING SPACE FOR WALL/INCLINED SURFACE MOUNTED ROBOTS

In case of M-710*i*C/20L/12L, when robots are mounted on wall or inclined surface, the operating space has restricted range depending on its mounted angle.
Fig.3.7 (a) to (h) show operating space for robots mounted on wall or inclined surface depending on its mounted angle. However, there is no restriction for M-710*i*C/20M.

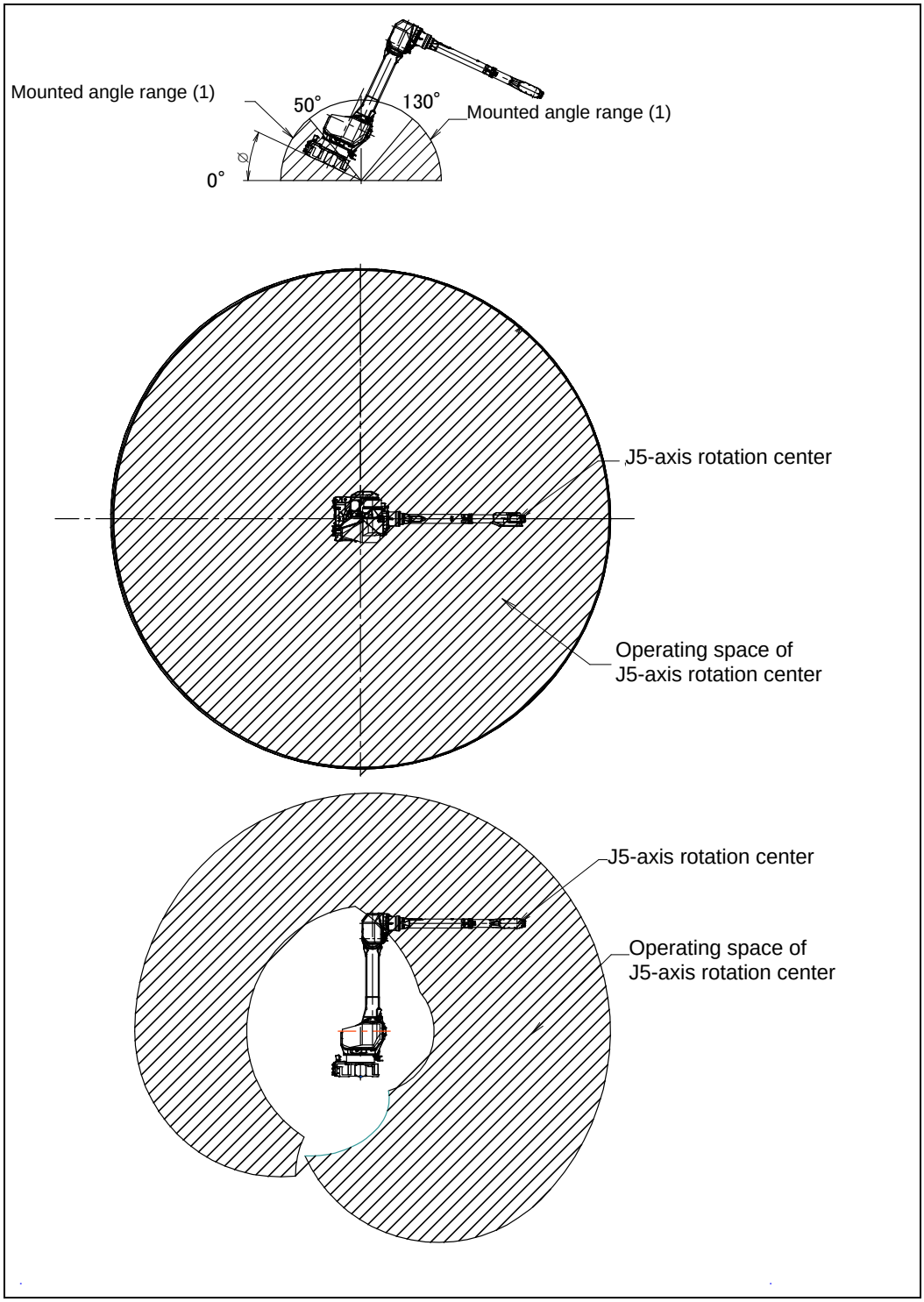


Fig. 3.7 (a) Operating space for mounted angle range (1)
(0°≦ϕ≦50°, 130°≦ϕ≦180°) (M-710*i*C/20L)

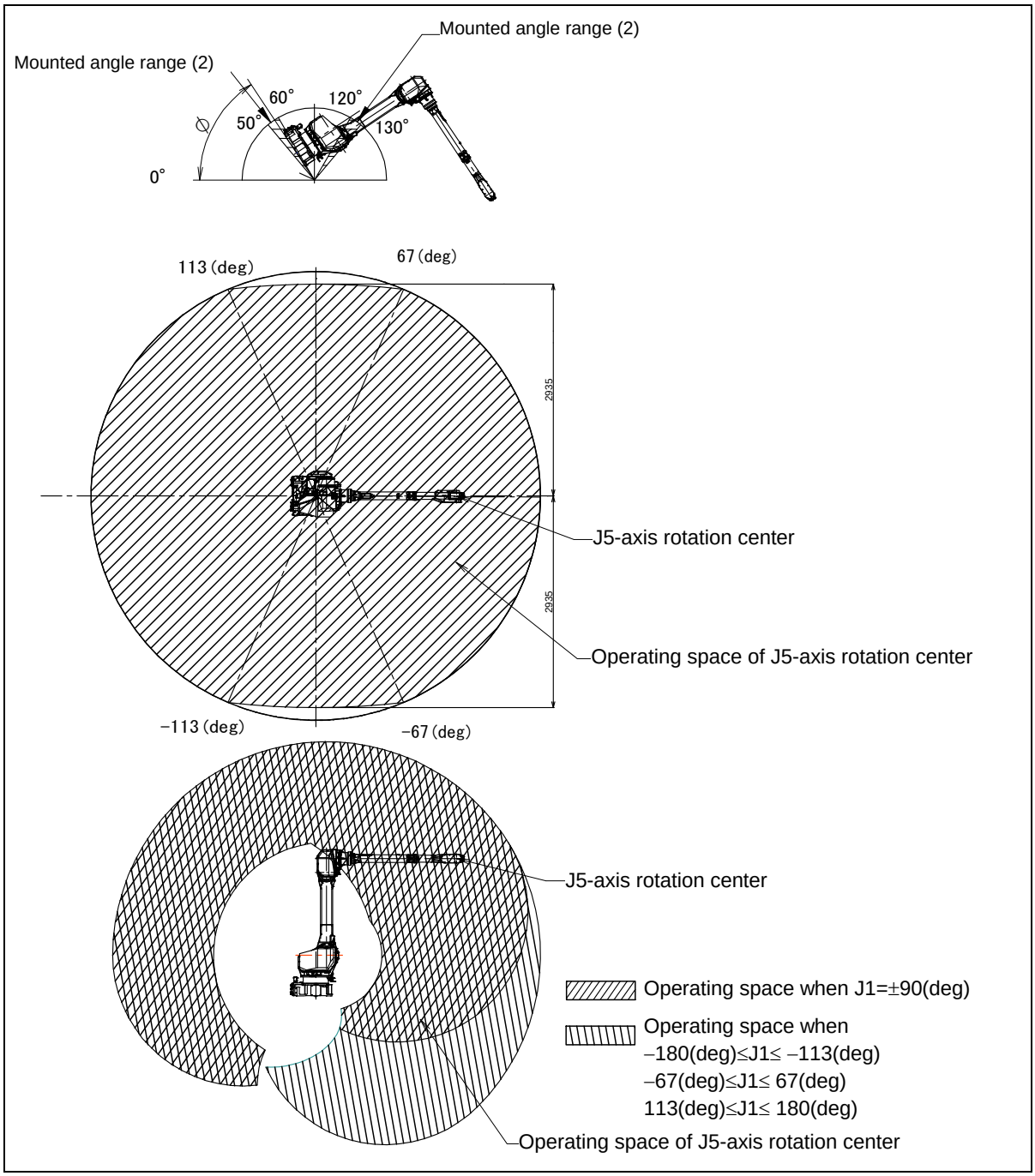


Fig. 3.7 (b) Operating space for mounted angle range (2)
(50°<ϕ≦60°, 120°≦ϕ<130°) (M-710*i*C/20L)

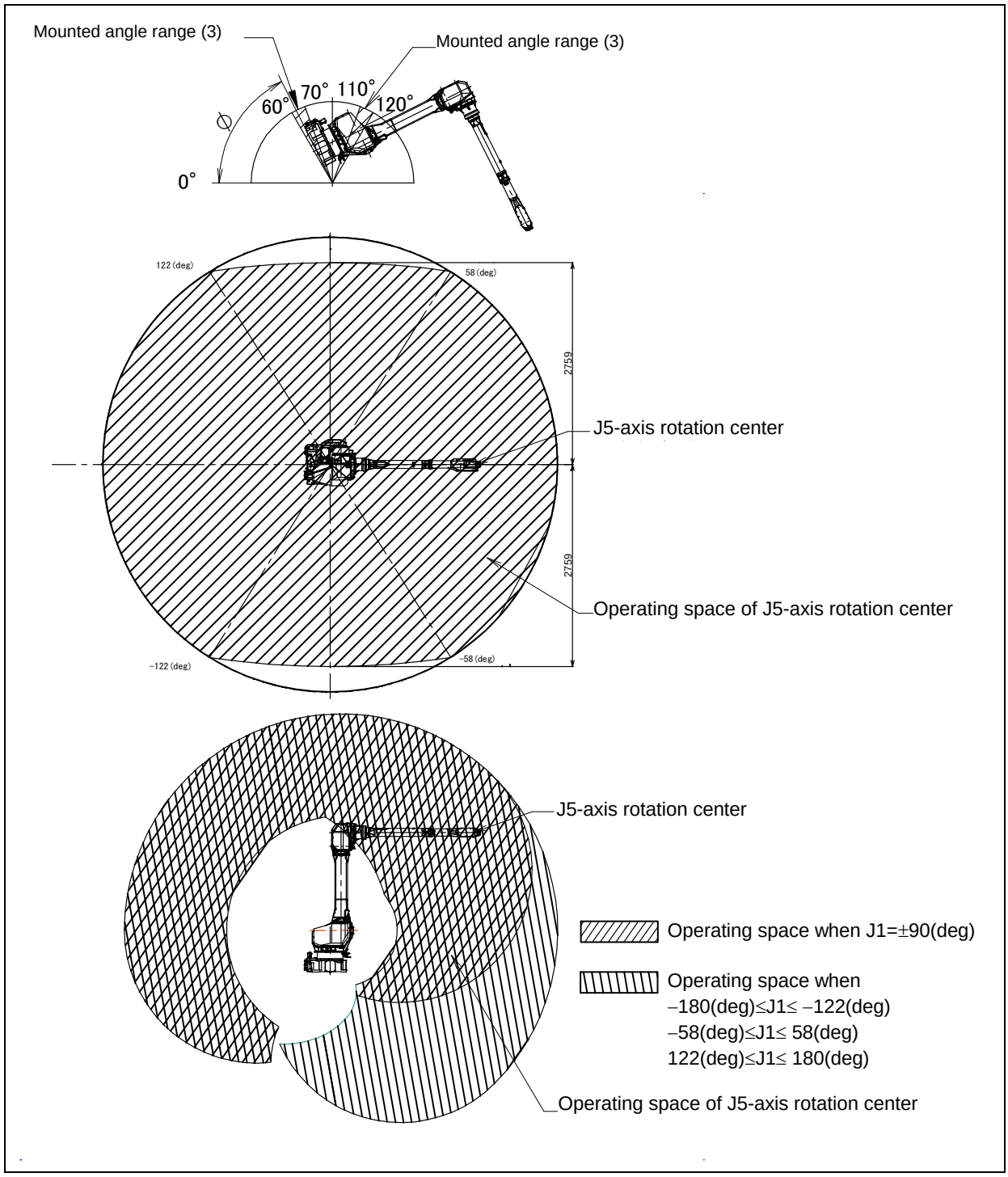


Fig. 3.7 (c) Operating space for mounted angle range (3)
(60°< ϕ ≦70°, 110°≦ ϕ <120°) (M-710*i*C/20L)

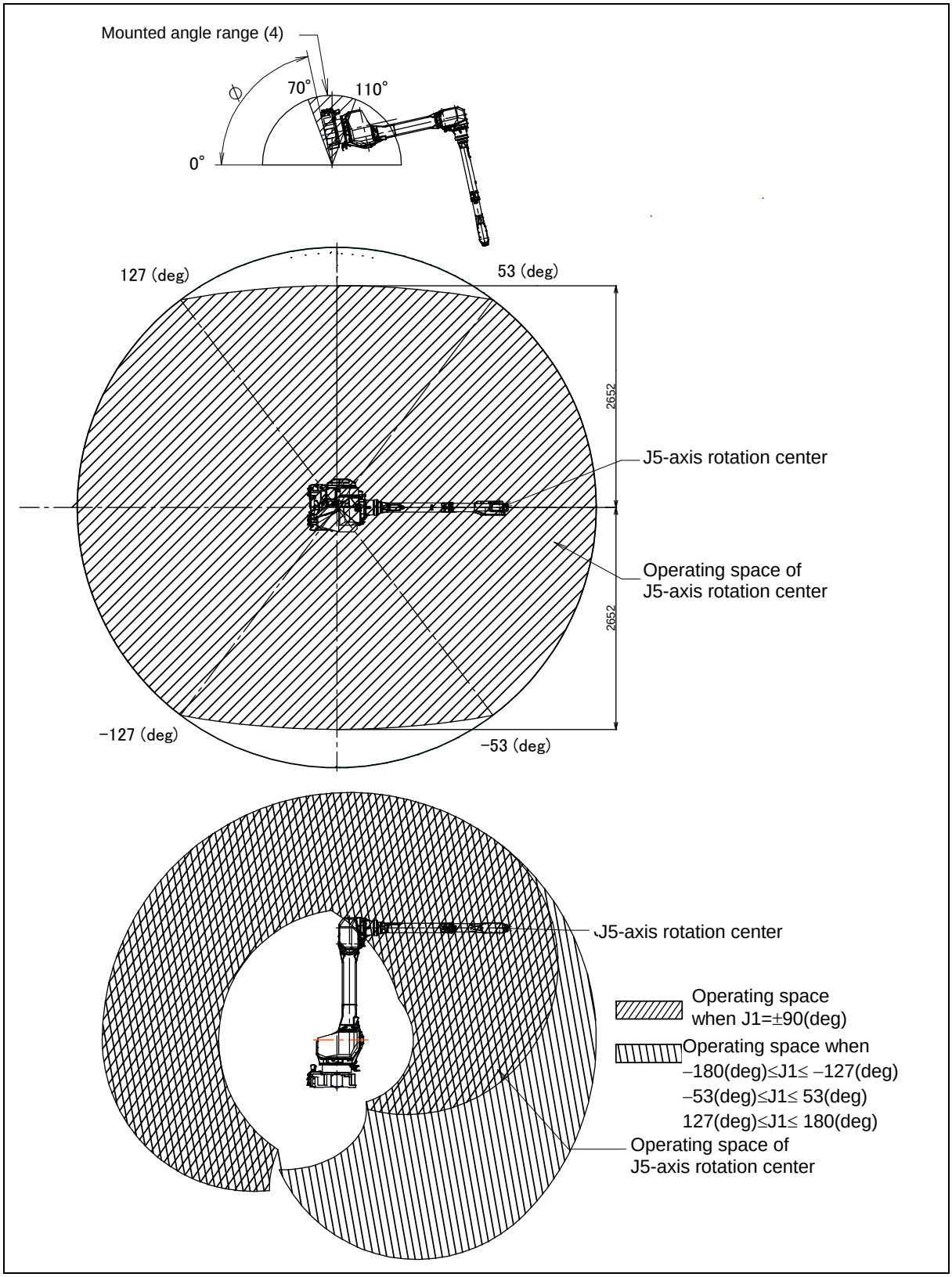


Fig. 3.7 (d) Operating space for mounted angle range (4)
(70°< ϕ <110°) (M-710*i*C/20L)

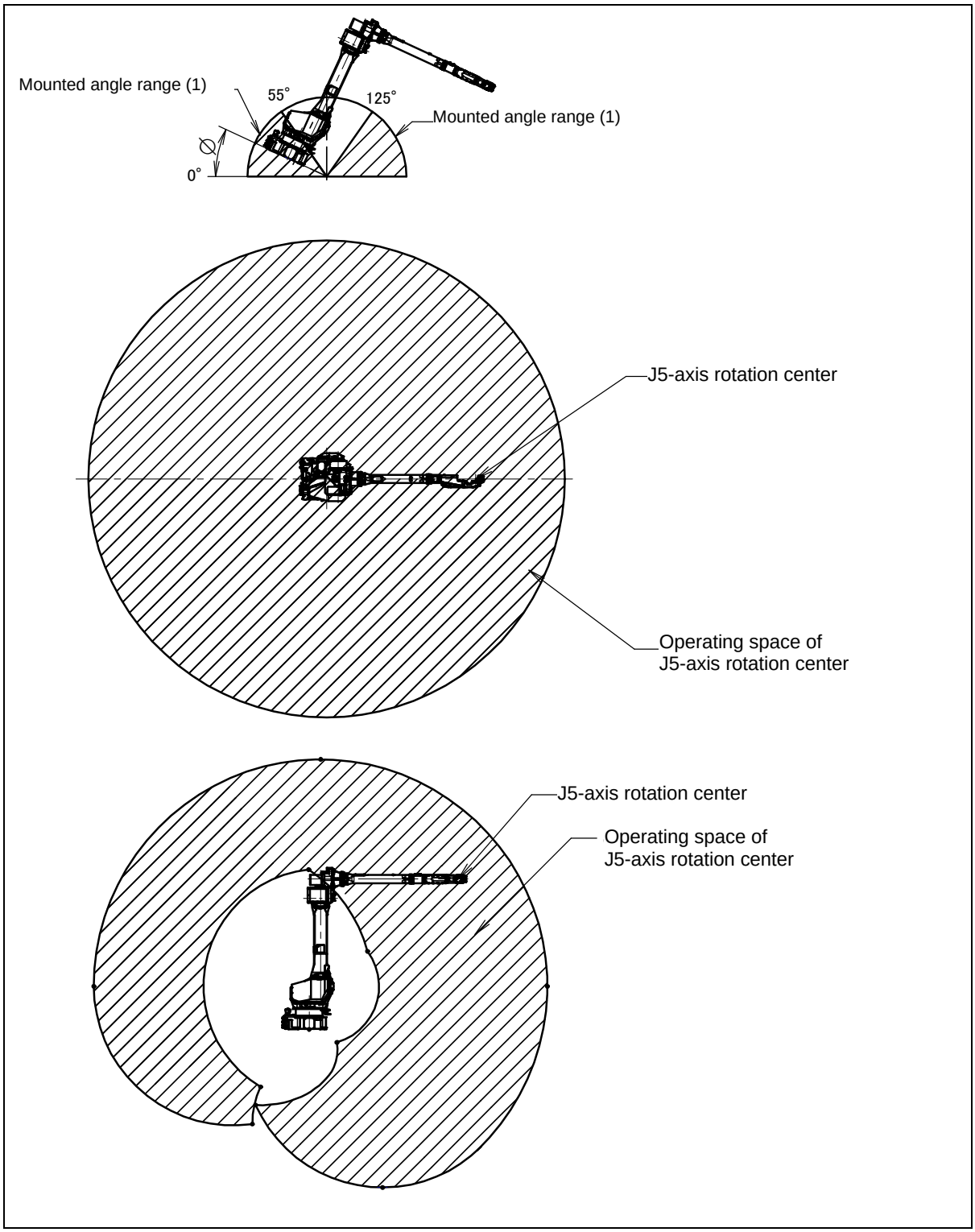


Fig. 3.7 (e) Operating space for mounted angle range (1)
(0°≦ϕ≦55°, 125°≦ϕ≦180°) (M-710*i*C/12L)

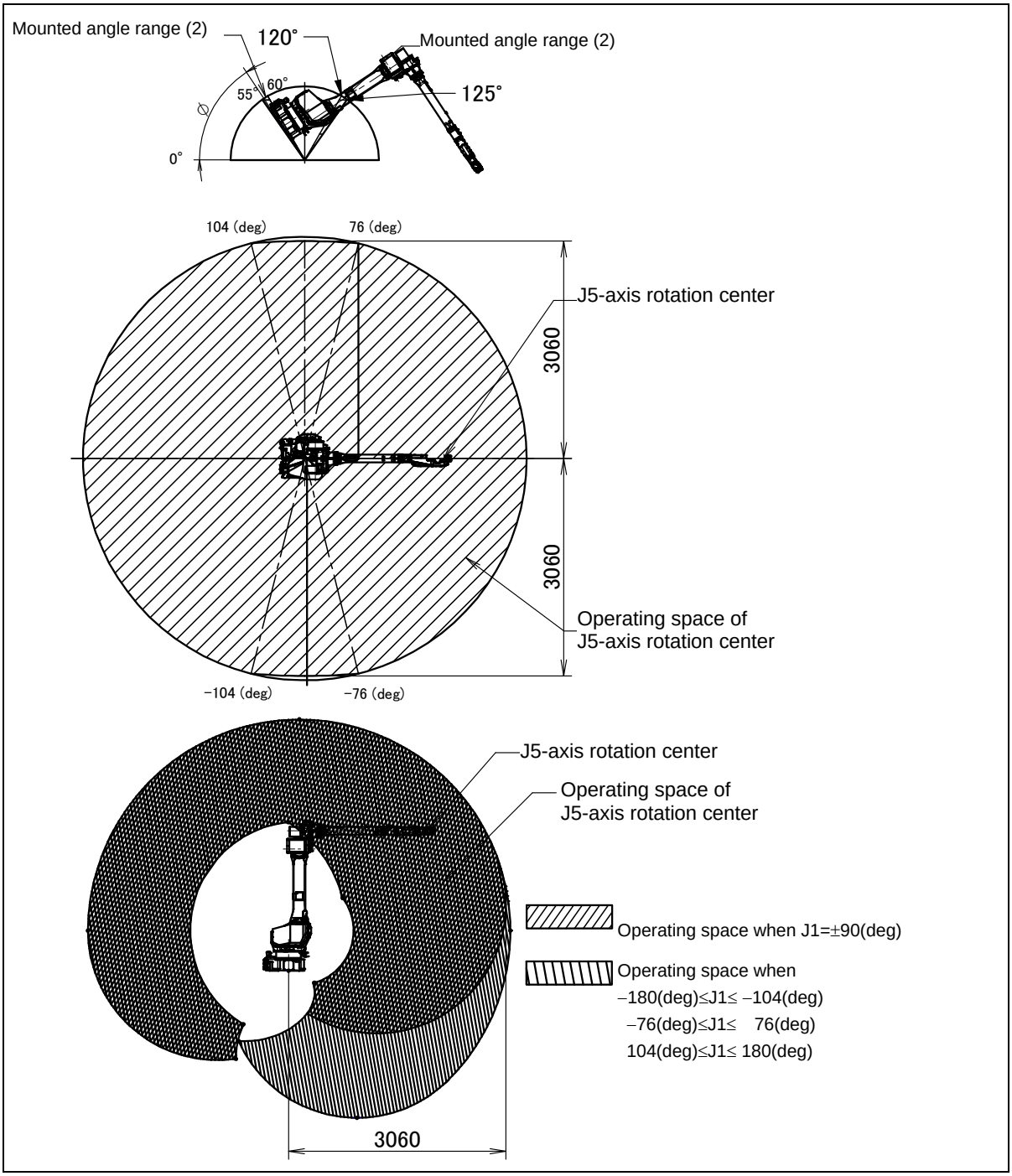


Fig. 3.7 (f) Operating space for mounted angle range (2)
(55°≦ φ ≦60°, 120°≦ φ ≦125°) (M-710*i*C/12L)

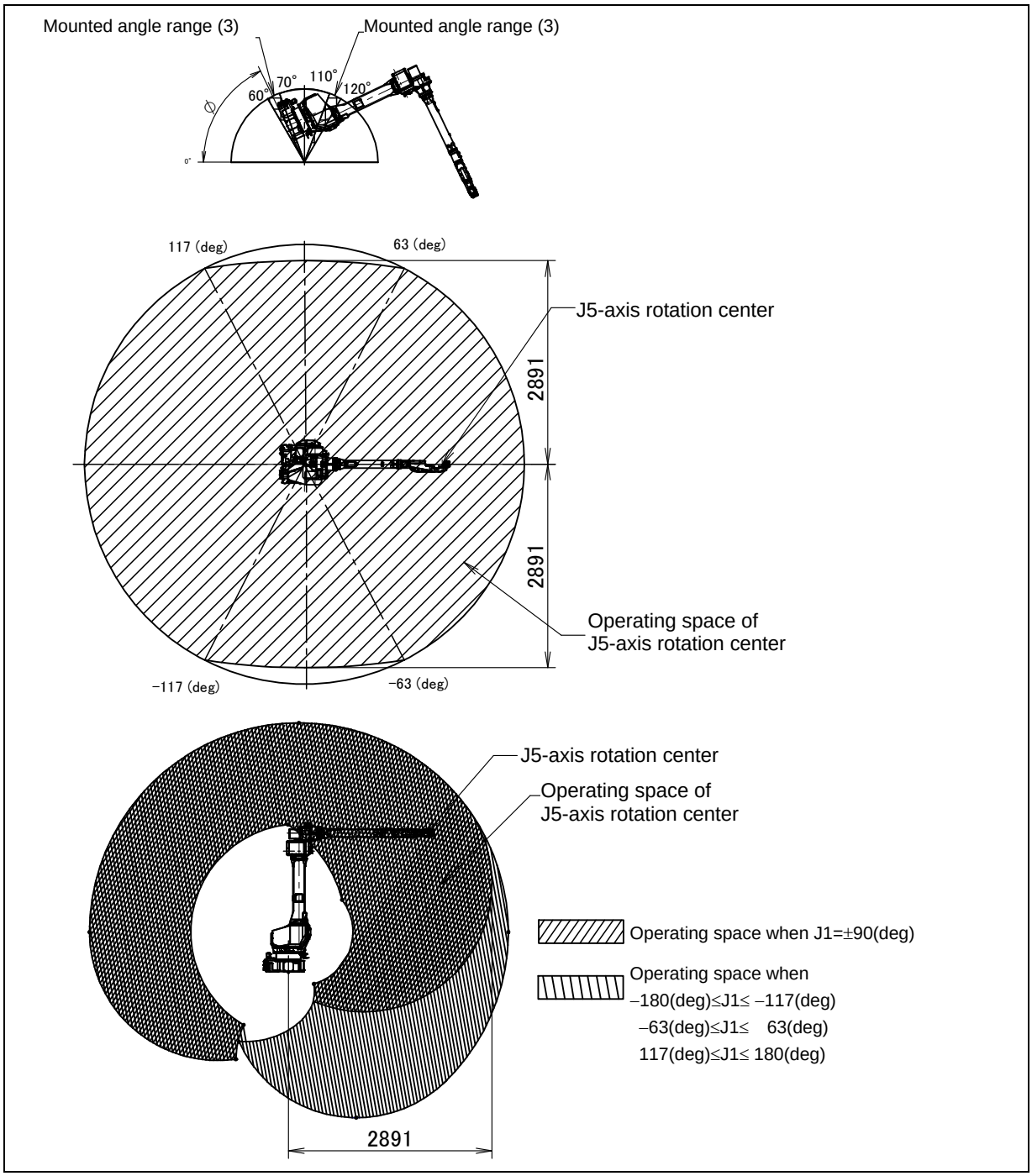


Fig. 3.7 (g) Operating space for mounted angle range (3)
(60°< ϕ ≦70°, 110°≦ ϕ <120°) (M-710*i*C/12L)

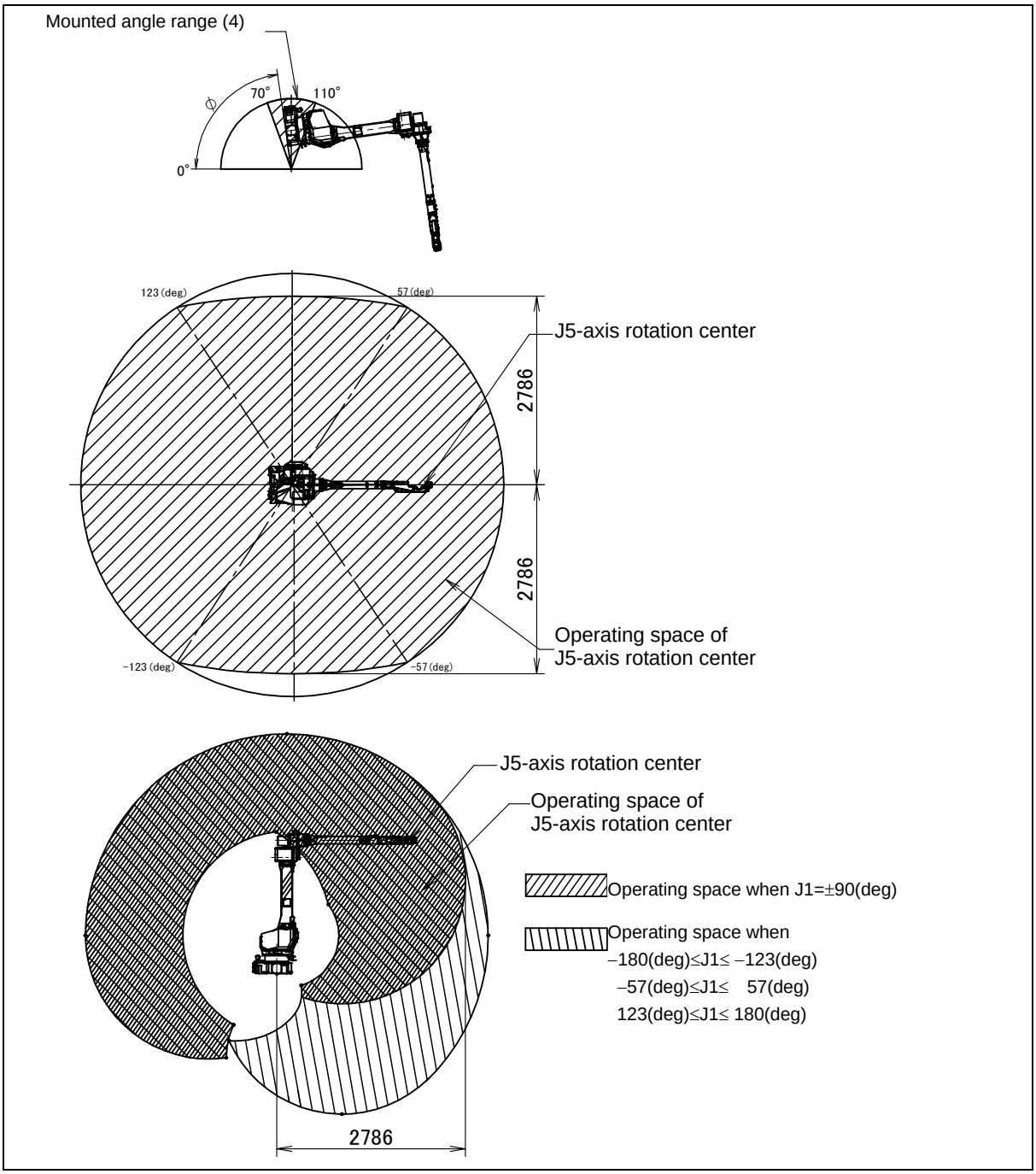


Fig. 3.7 (h) Operating space for mounted angle range (4)
(70°< ϕ <110°) (M-710*i*C/12L)

4 EQUIPMENT INSTALLATION TO THE ROBOT

4.1 END EFFECTOR INSTALLATION TO WRIST

Fig. 4.1 (a) shows the figures for installing end effectors on the wrist of M-710*i*C/20L/20M. The end effector is engaged using a ϕ50h7 spigot or ϕ25H7 socket, positioned using a 1-ϕ6H7 reamed hole, and fastened using four M6 self-tapping screws. As for the M6 self-tapping screws, select those not longer than the tapping depth (10 mm).

Fig. 4.1 (b) show the figures for installing end effectors on the wrist of M-710*i*C/12L. Select screws and positioning pins of a length that matches the depth of the tapped and pinholes.

See Appendix B “Bolt tightening torque” for tightening torque specifications.

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

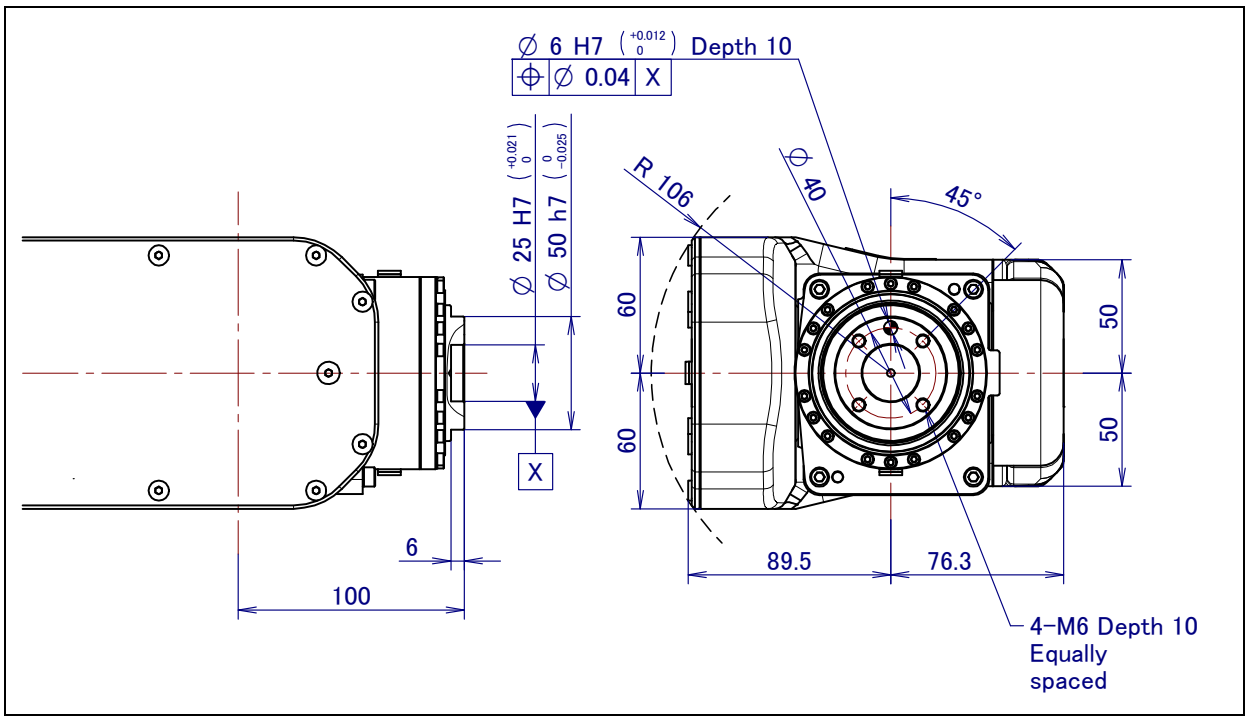


Fig. 4.1 (a) Mounting surface for the end effector (M-710*i*C/20L/20M)

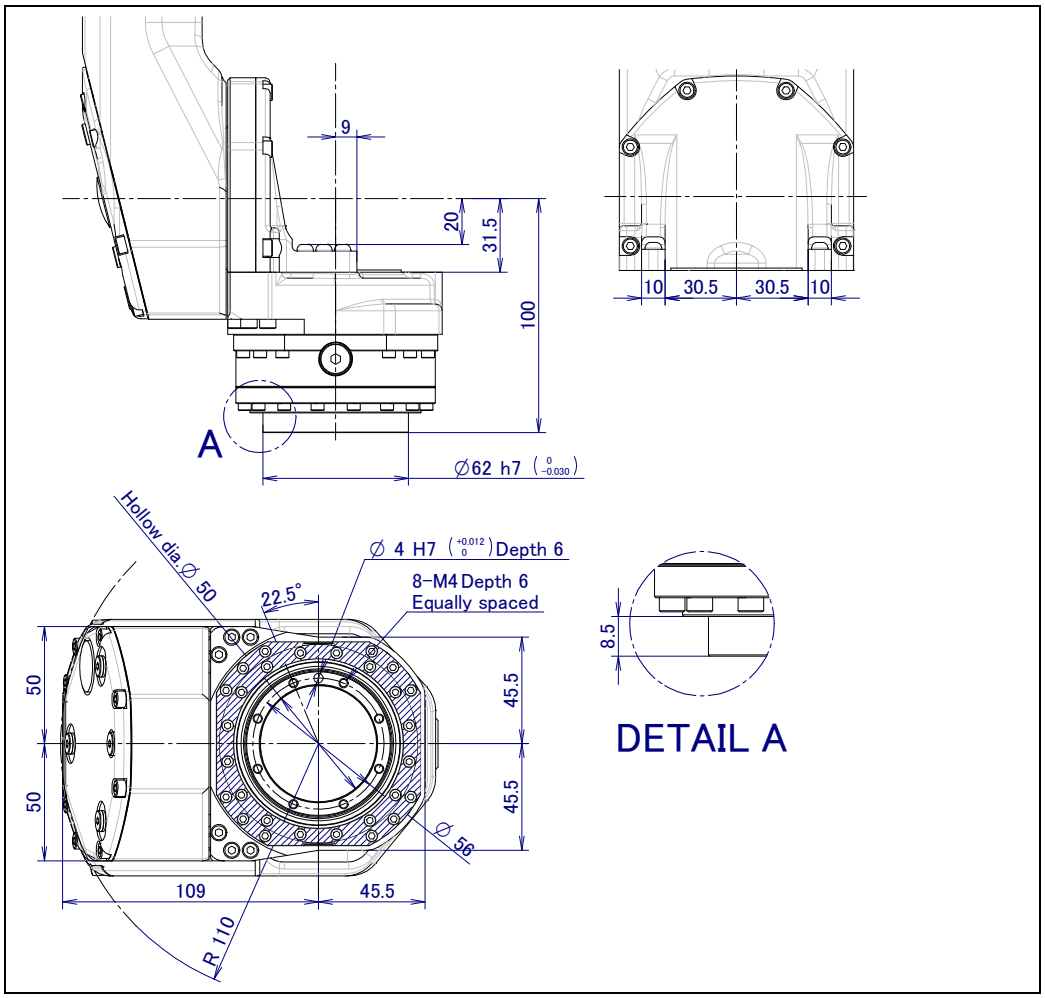


Fig. 4.1 (b) Mounting surface for the end effector (M-710*i*C/12L)

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

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 so that mechanical unit cable is not pinched or damaged. If equipment installation restricts or damages the mechanical unit cable, it might become disconnected, and unexpected conditions might occur.
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.
6 If you put load on J3 arm, unavoidably, treat it as wrist load.

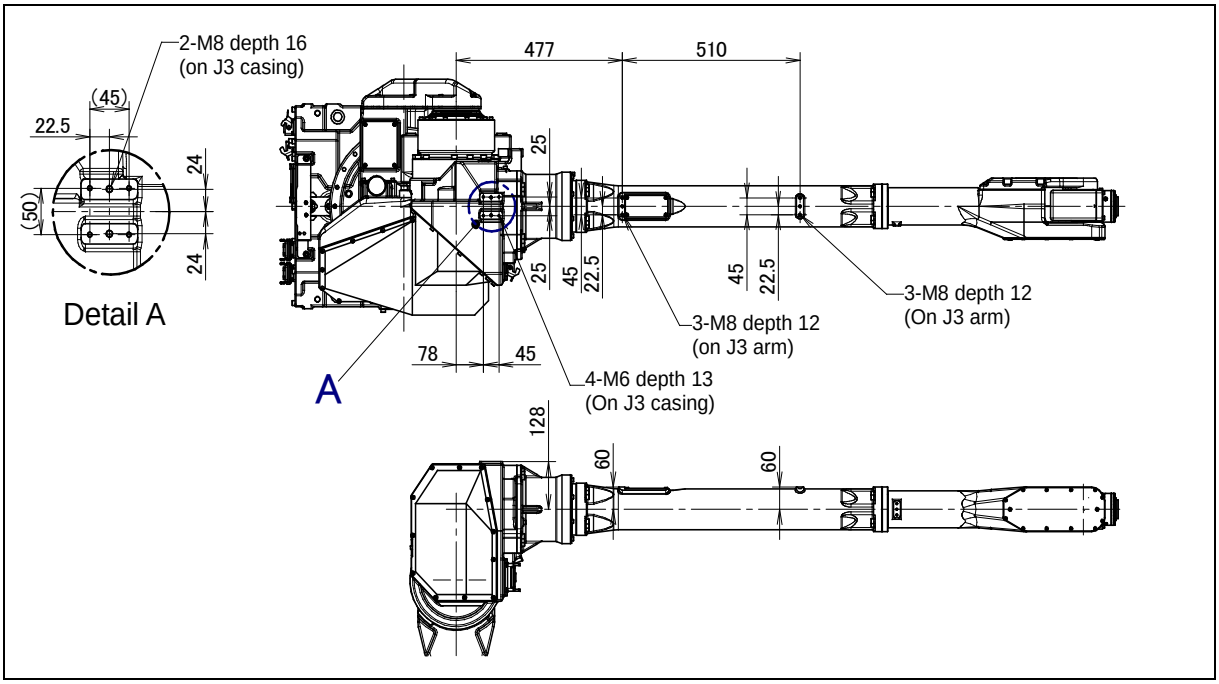


Fig. 4.2 (a) Equipment mounting surfaces (M-710*i*C/20L)

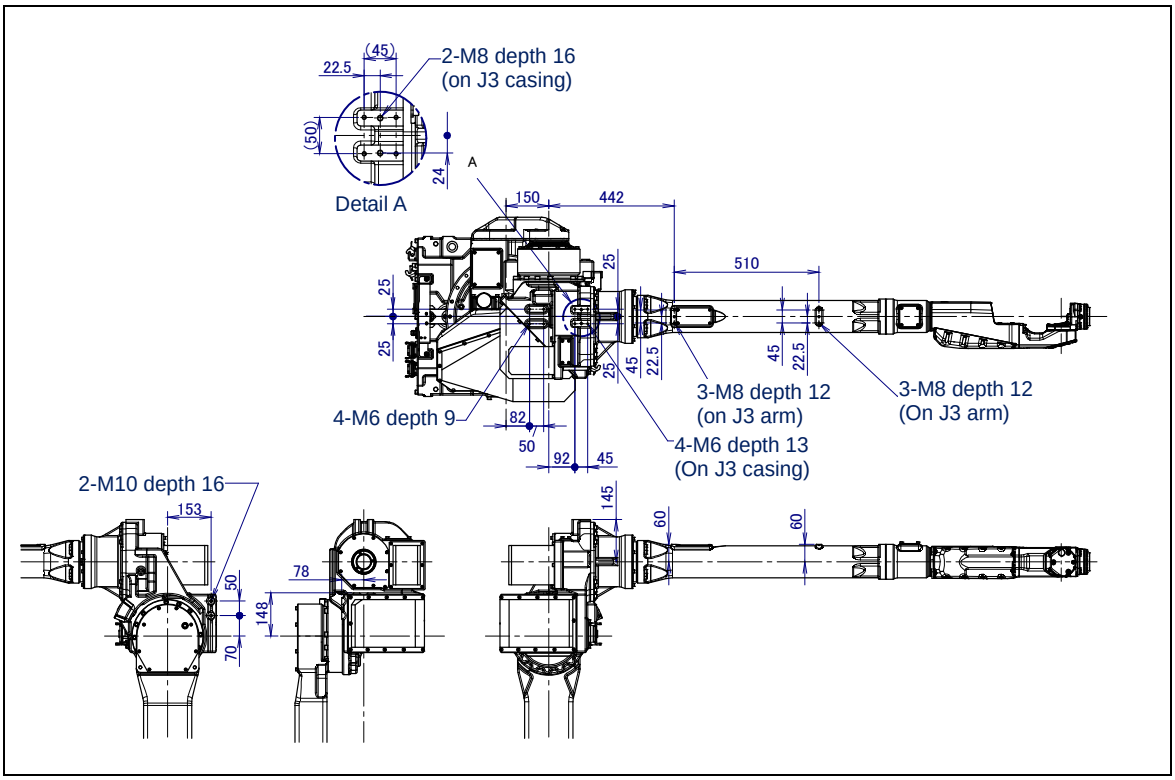


Fig. 4.2 (b) Equipment mounting surfaces (M-710*i*C/12L)

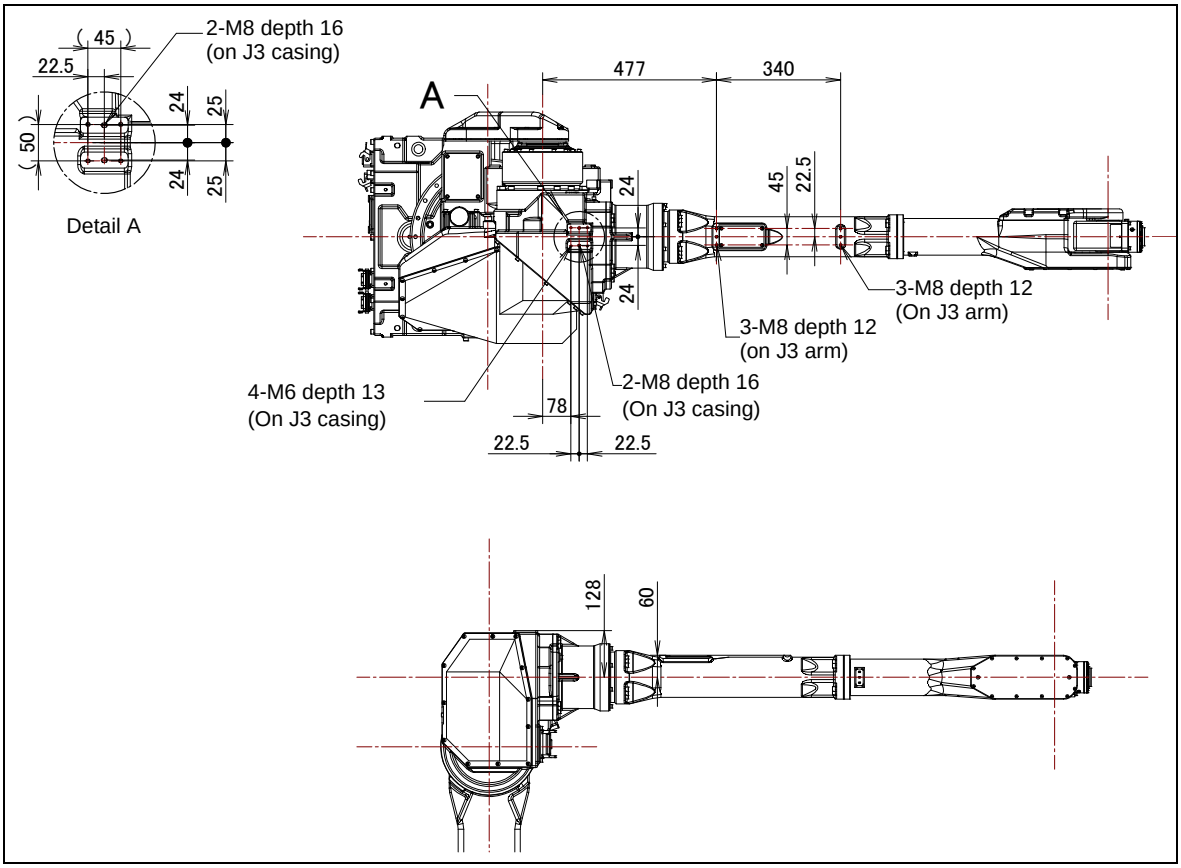


Fig. 4.2 (c) Equipment mounting surfaces (M-710*i*C/20M)

4.3 LOAD SETTING

⚠ CAUTION

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

2 WHEN PERFORMING LOAD ESTIMATION AFTER PARTS REPLACEMENT (for M-710*i*C/12L)
If wrist axis motors (J5/J6-axis) or reducers are replaced, payload estimation accuracy may decrease. Perform calibration of load estimation without the load such as hand before performing load estimation.
Chapter 9 "LOAD ESTIMATION" in the 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          20.00  [                    ]
   2           0.00  [                    ]
   3           0.00  [                    ]
   4           0.00  [                    ]
   5           0.00  [                    ]
   6           0.00  [                    ]
   7           0.00  [                    ]
   8           0.00  [                    ]
   9           0.00  [                    ]
  10           0.00  [                    ]

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

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

```
MOTION PAYLOAD SET                JOINT   100%

  Group 1
  Schedule No[   1]:[Comment          ]
1 PAYLOAD              [kg]          20.00
2 PAYLOAD CENTER  X    [cm]         -10.00
3 PAYLOAD CENTER  Y    [cm]           0.00
4 PAYLOAD CENTER  Z    [cm]           7.50
5 PAYLOAD INERTIA X [kgfcms^2]        0.663
6 PAYLOAD INERTIA Y [kgfcms^2]        0.727
7 PAYLOAD INERTIA Z [kgfcms^2]        0.644

 [TYPE]  GROUP  NUMBER  DEFAULT  HELP
```

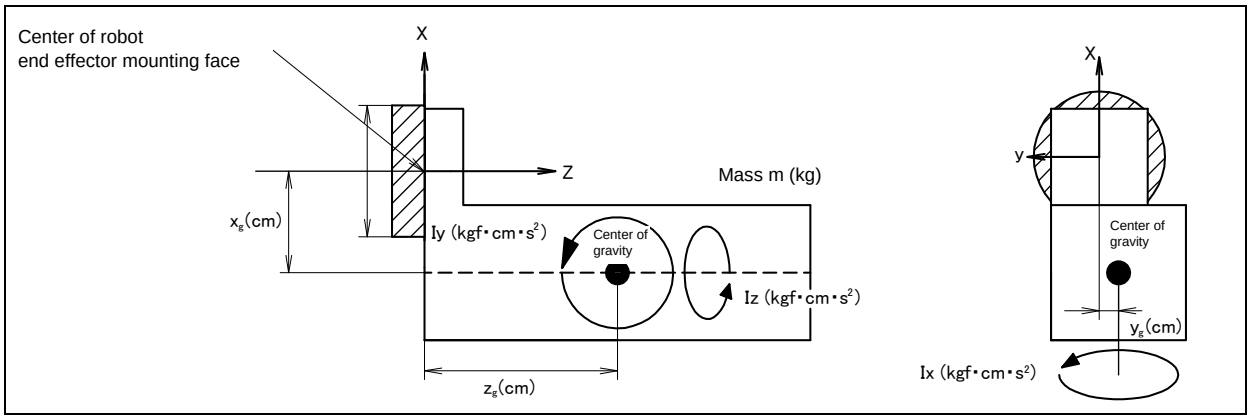


Fig. 4.3 Standard tool coordinate

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 ]         12.00

 [ 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?" will be displayed. Select F4 YES or F5 NO. Once the mass of a device is entered, it is put in effect by cycling power.

5 PIPING AND WIRING TO THE END EFFECTOR

⚠ WARNING

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

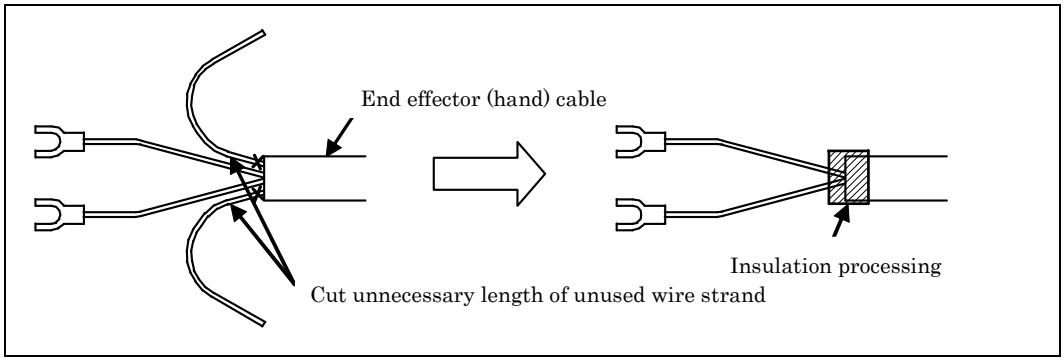


Fig. 5 Treatment method of end effector (hand) cable

5.1 AIR SUPPLY (OPTION)

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 an Rc1/2 female (ISO).
Because couplings are not supplied, it will be necessary to prepare couplings, which suit to the hose size.

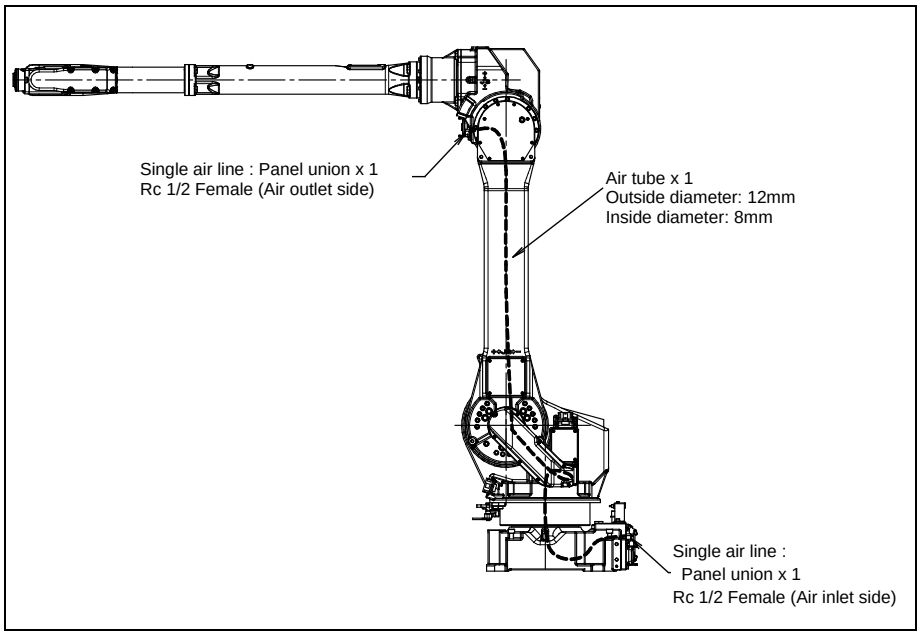


Fig. 5.1 Air supply (option)

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.

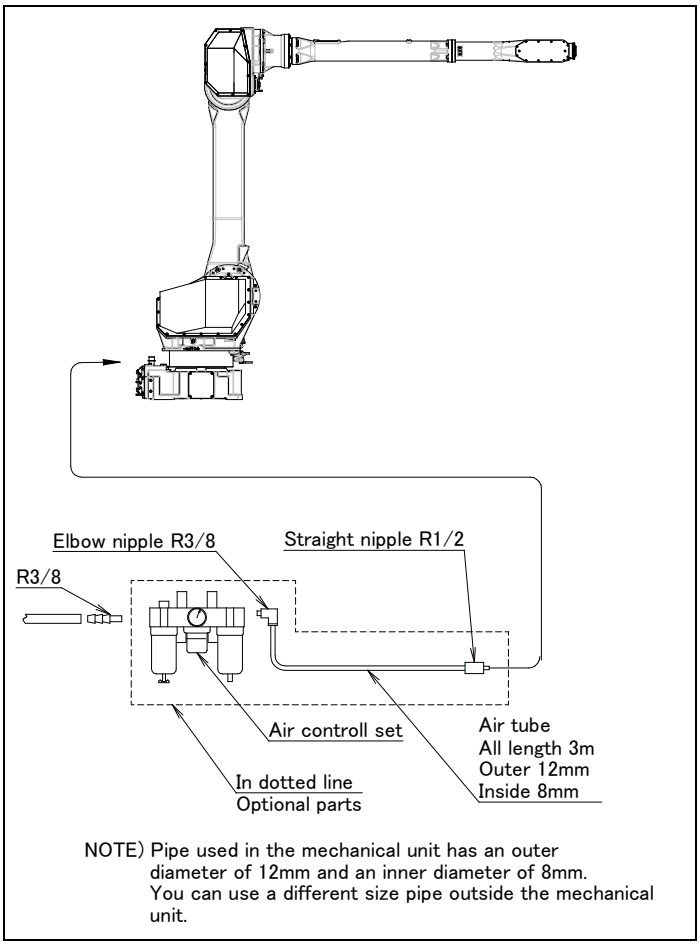


Fig. 5.2 (a) Air piping (option)

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.

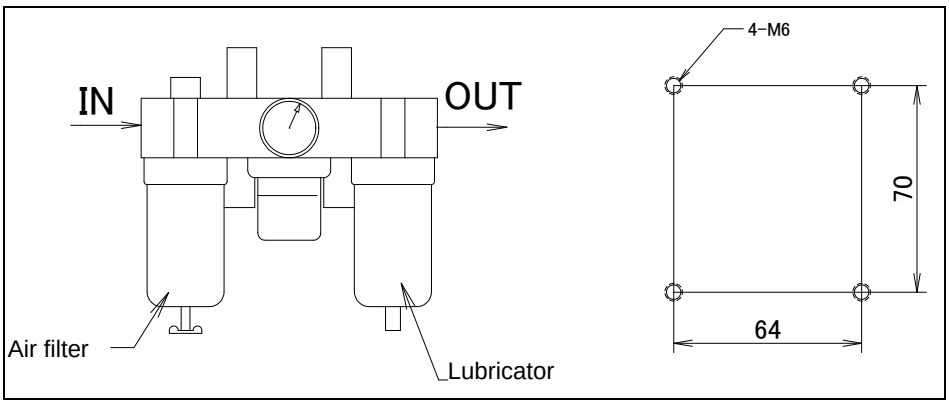


Fig. 5.2 (b) Air control set (option)

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

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

5.3 INTERFACE FOR OPTION CABLE (OPTION)

Fig. 5.3 (a) to (d) show the position of the option cable interface.
End effector interface (RI/RO), user cable (signal line, signal line usable to force sensor and 3D Laser Vision sensor), user cable (power line), Additional axis motor cable (Pulsecoder/power brake), camera cable, 3D Laser Vision sensor cable, wire feeder cable (for LINCOLN welding power supply), Ethernet cable (signal) :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 line usable to force sensor and 3D Laser Vision sensor) : ASi
User cable (power) : AP
Additional axis motor cable (Pulsecoder) : ARP
Additional axis motor cable (power, brake) : ARM
Camera cable : CAM
3D Laser Vision sensor cable : SEN/3DV
Wire feeder cable : W/F
Ethernet cable (signal) : ES

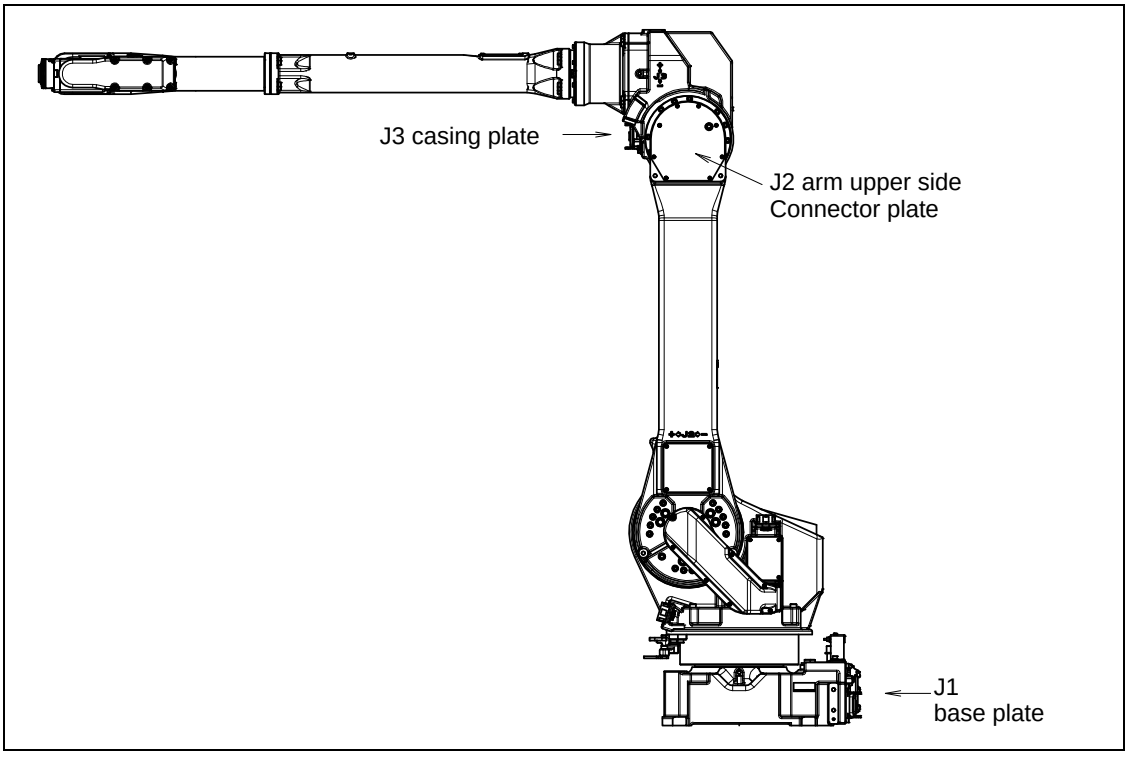


Fig. 5.3 (a) Position of the option cable interface (option)

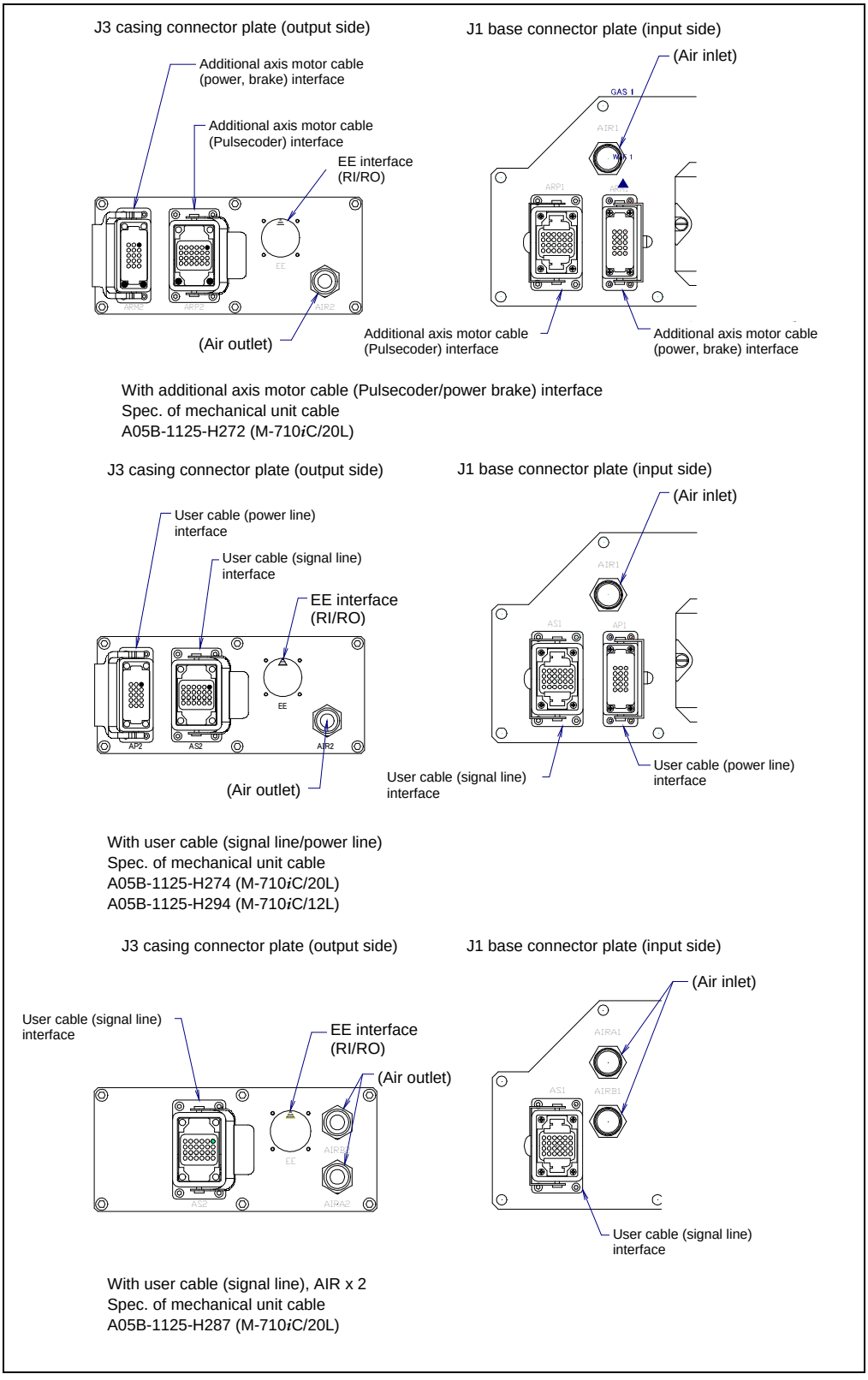


Fig. 5.3 (b) Interface for option cable 1/2

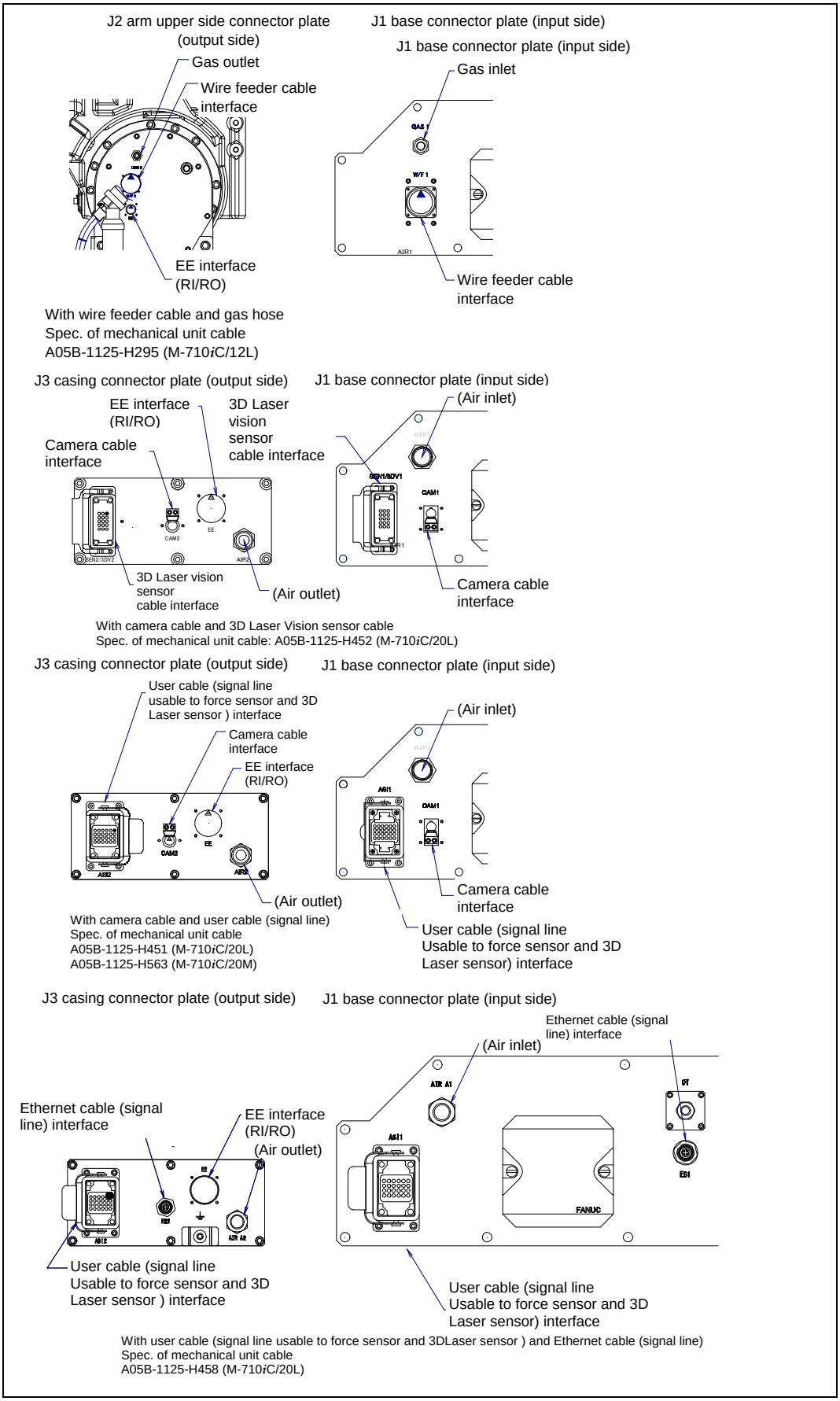


Fig. 5.3 (c) Interface for option cable 2/2

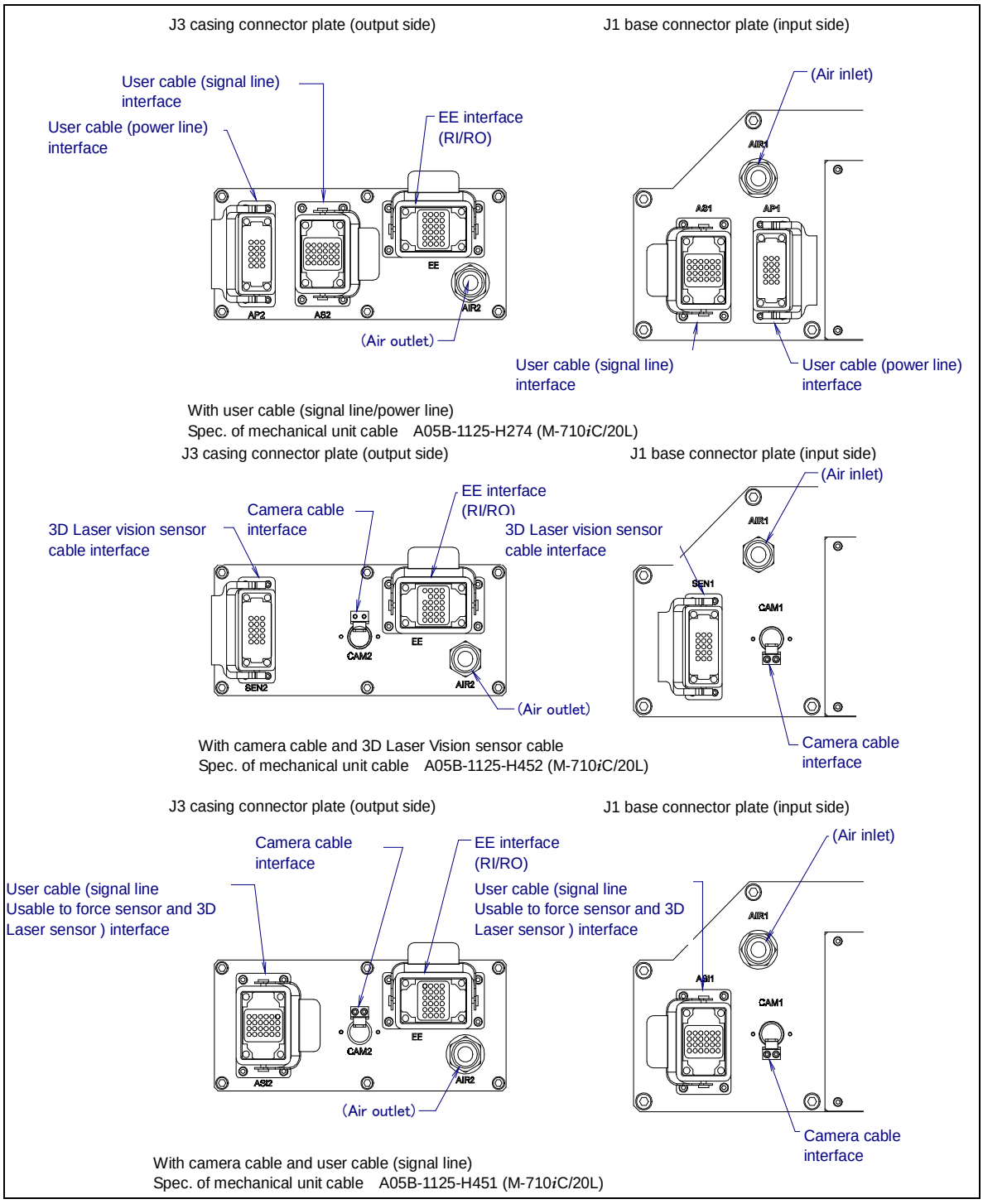


Fig. 5.3 (d) Interface for option cable 2/2 (When severe dust/liquid protection is specified)

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

Fig. 5.3 (e) and (f) 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.

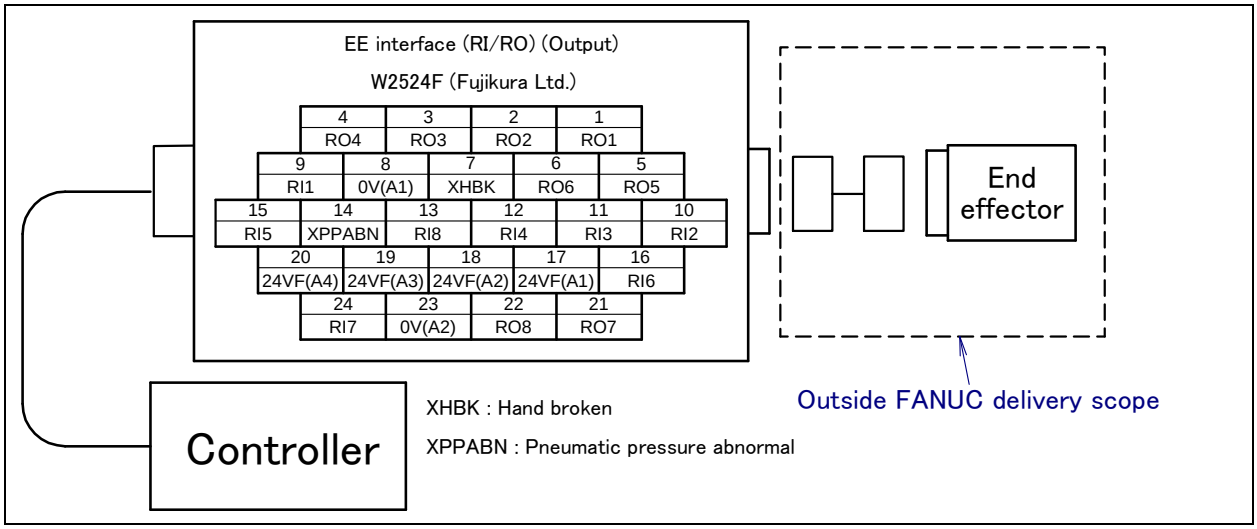


Fig. 5.3 (e) Pin layout for EE interface (RI/RO) (option)

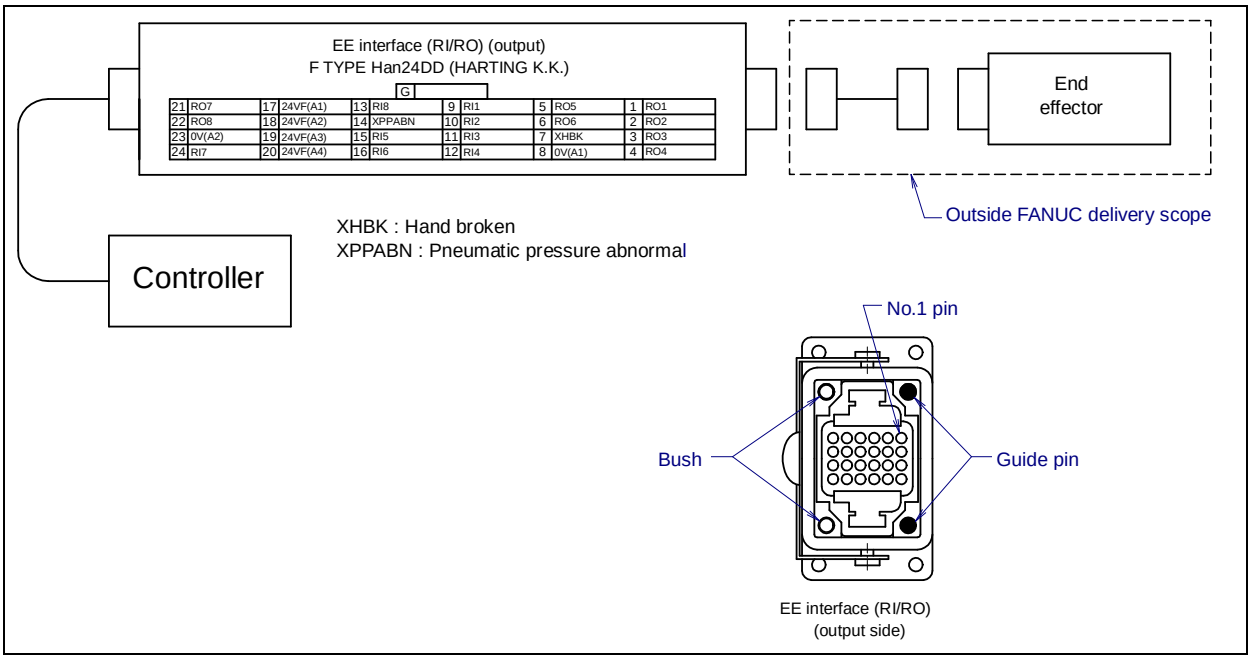


Fig. 5.3 (f) Pin layout for EE interface (RI/RO) (Severe dust/liquid protection package)

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

(2) User cable (signal line) (AS) Interface (option)
Fig. 5.3 (g) 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.

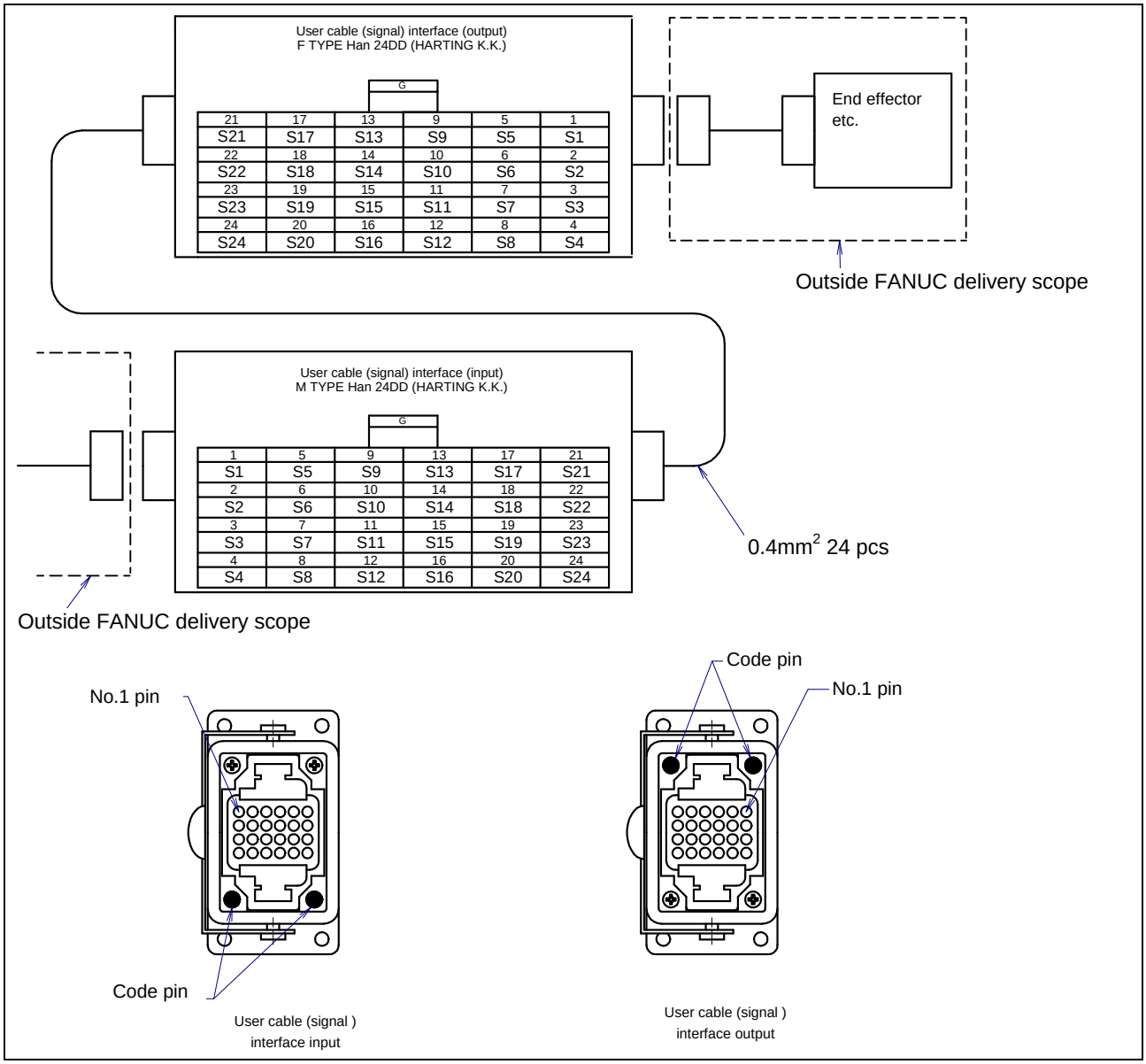


Fig. 5.3 (g) Pin layout for user cable (signal line) (AS) interface and code pin layout (option)

(3) User cable (signal line usable to force sensor and 3D Laser Vision sensor) (ASi) Interface (option)
Fig. 5.3 (h) 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.

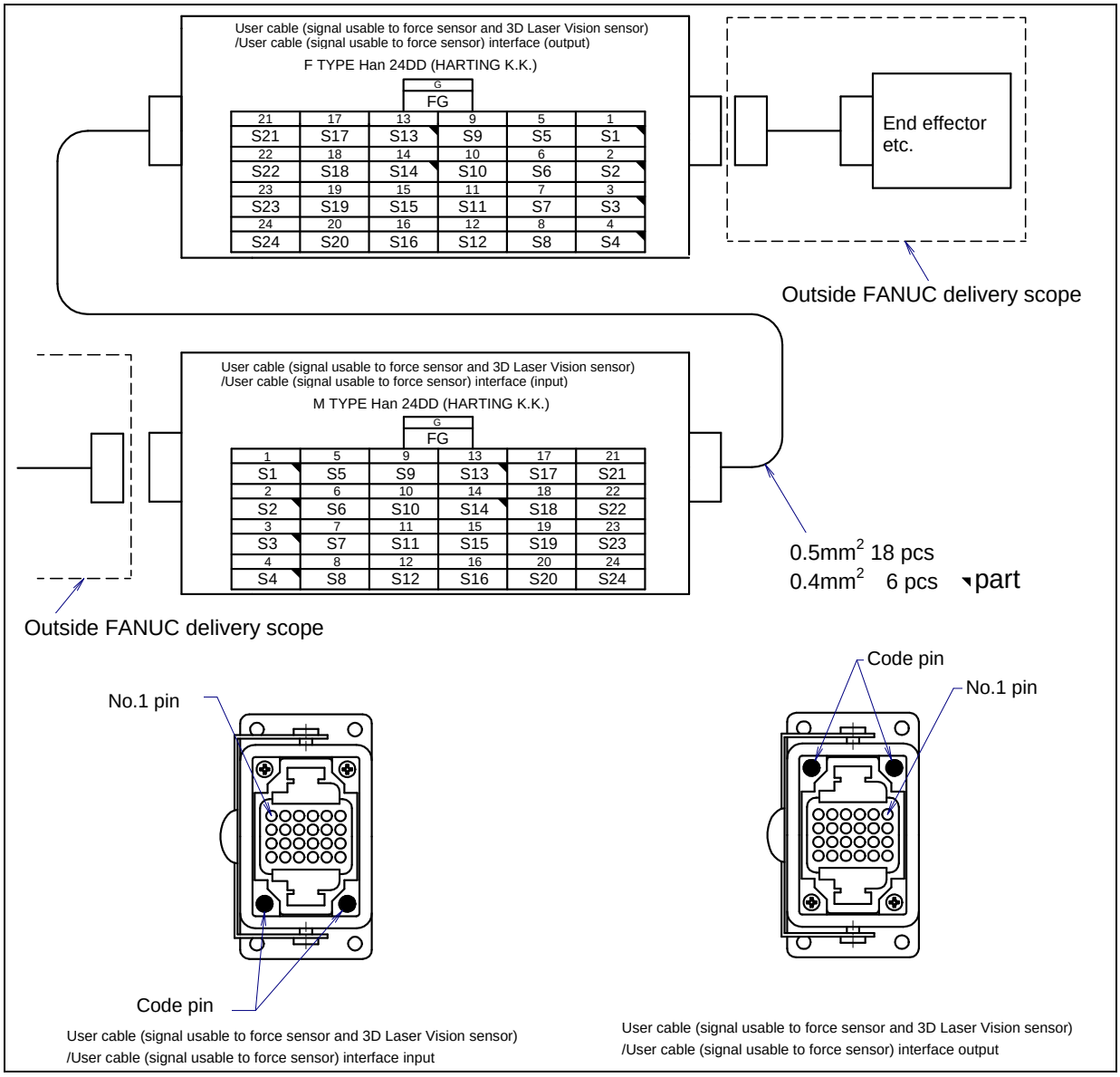


Fig. 5.3 (h) Pin layout for user cable (signal line usable to force sensor and 3D Laser Vision sensor) (ASi) interface and code pin layout (option)

(3) User cable (power line) (AP) Interface (option)
Fig. 5.3 (i) 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.

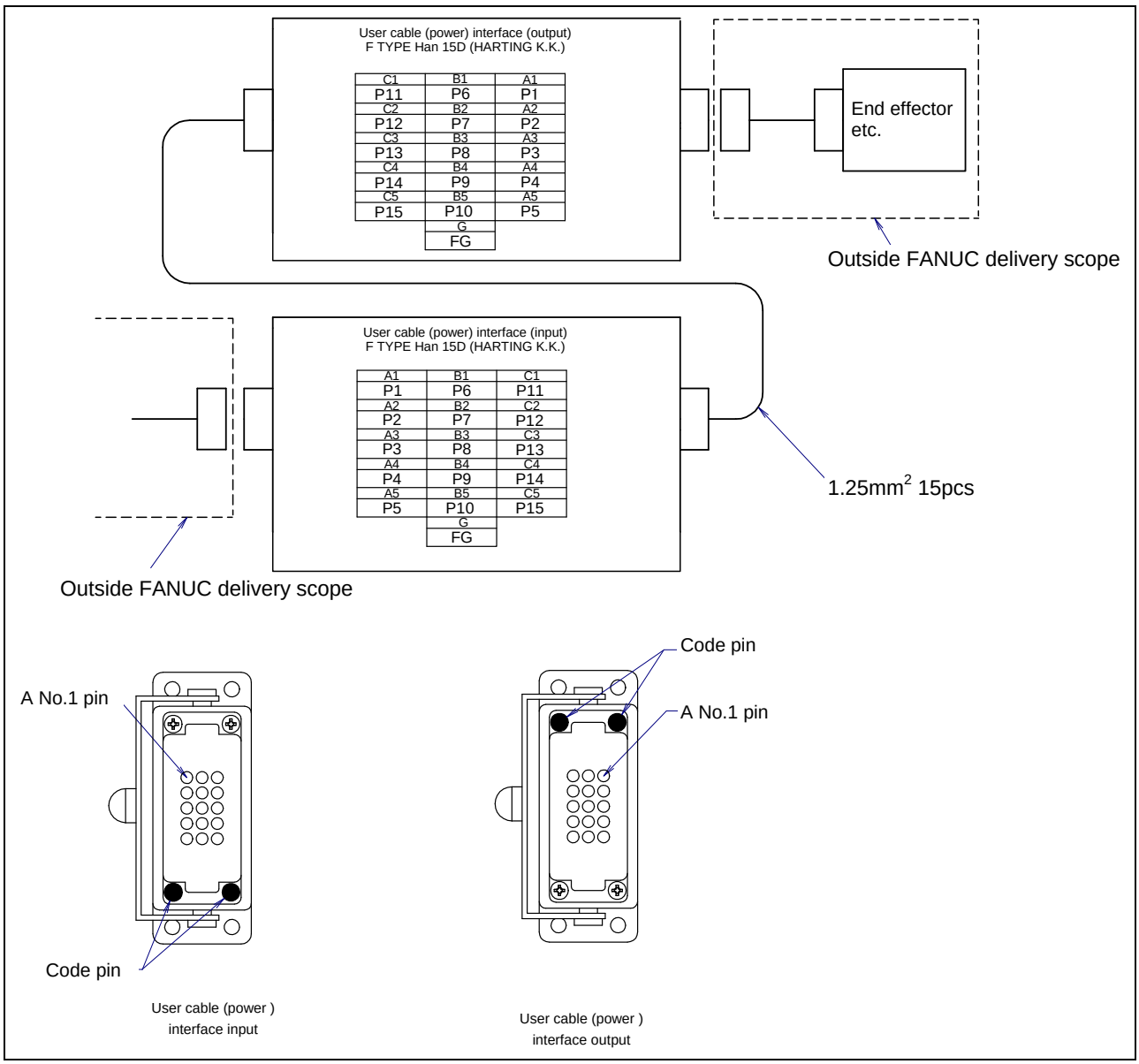


Fig. 5.3 (i) Pin layout for user cable (power line) (AP) interface and code pin layout (option)

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

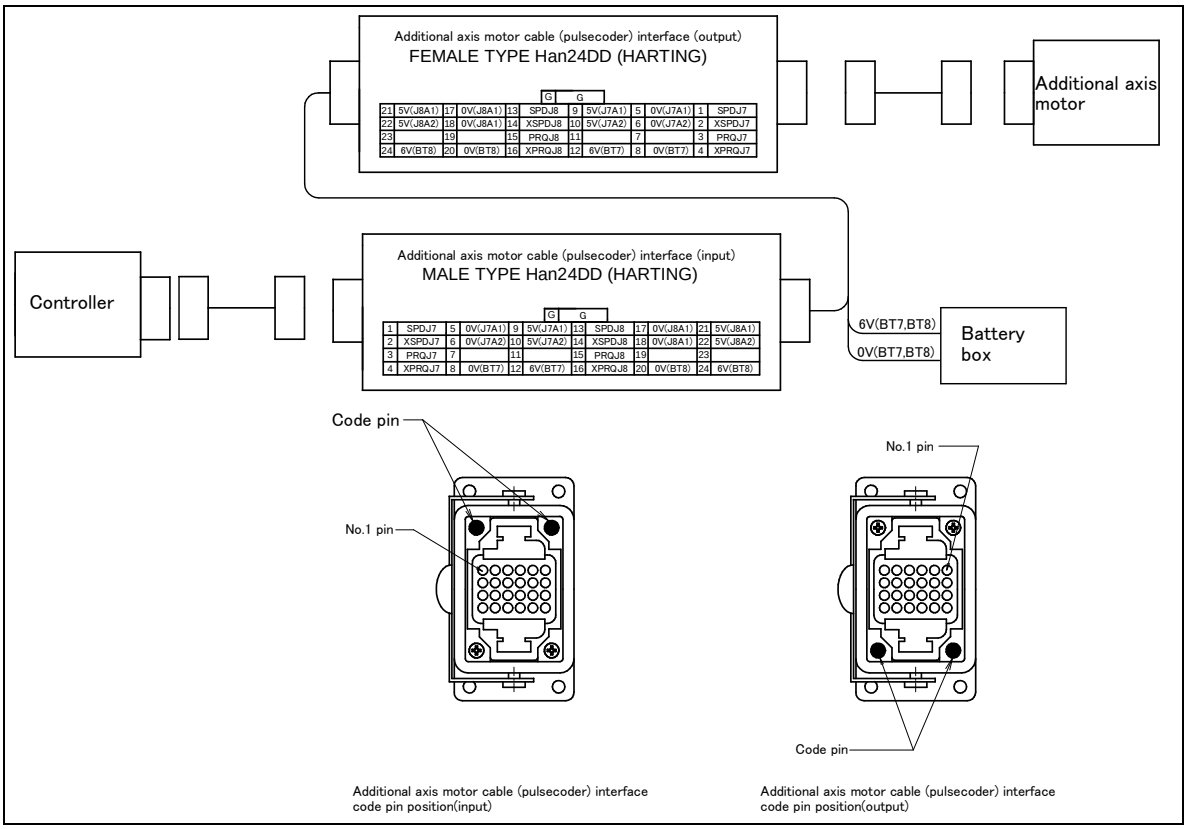


Fig. 5.3 (j) Pin layout and code pin position of the additional axis (2-axes) motor cable (Pulsecoder cable) (ARP) interface and layout position of the code pin (option)

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

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

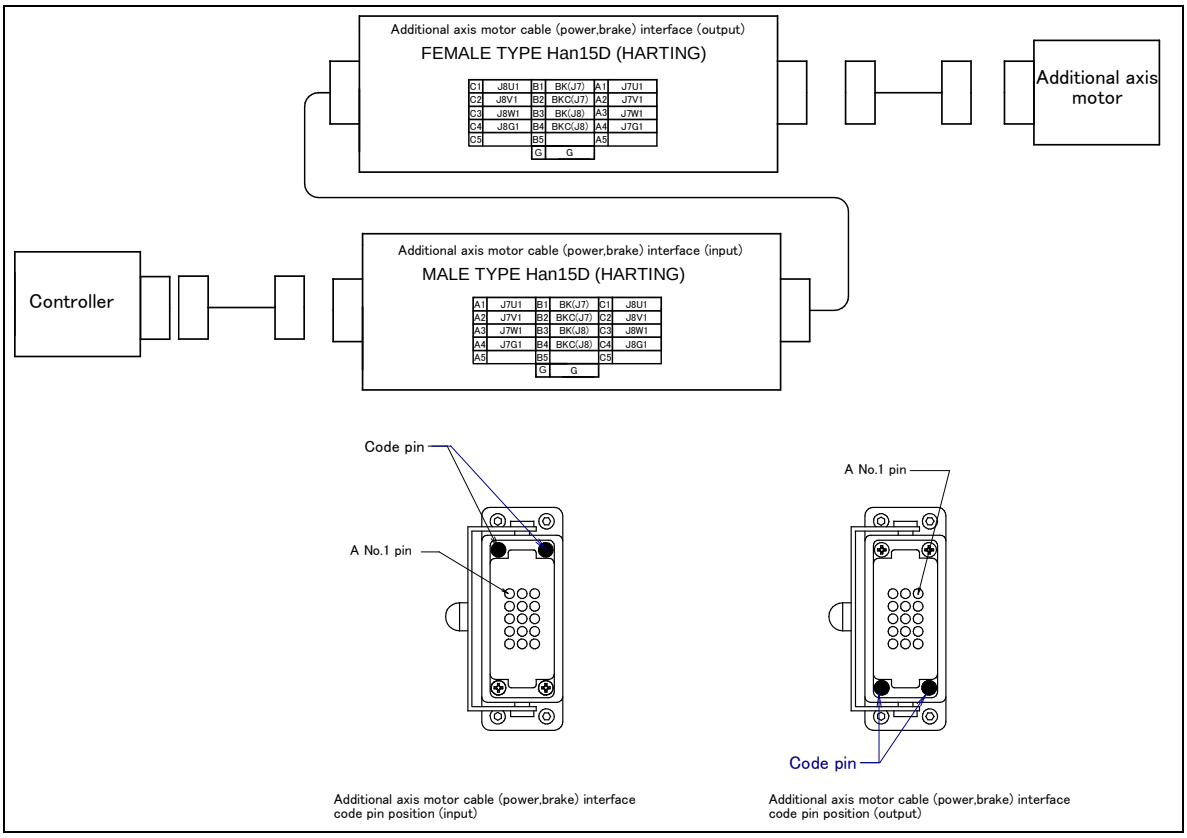


Fig. 5.3 (k) Pin layout and code pin position of the additional axis (2-axis) motor cable (power and brake cables) (ARM) interface and layout position of the code pin (option)

(6) Wire feeder power supply Interface (W/F)(option)
Fig. 5.3 (l) show the pin layout for the wire feeder power supply interface.

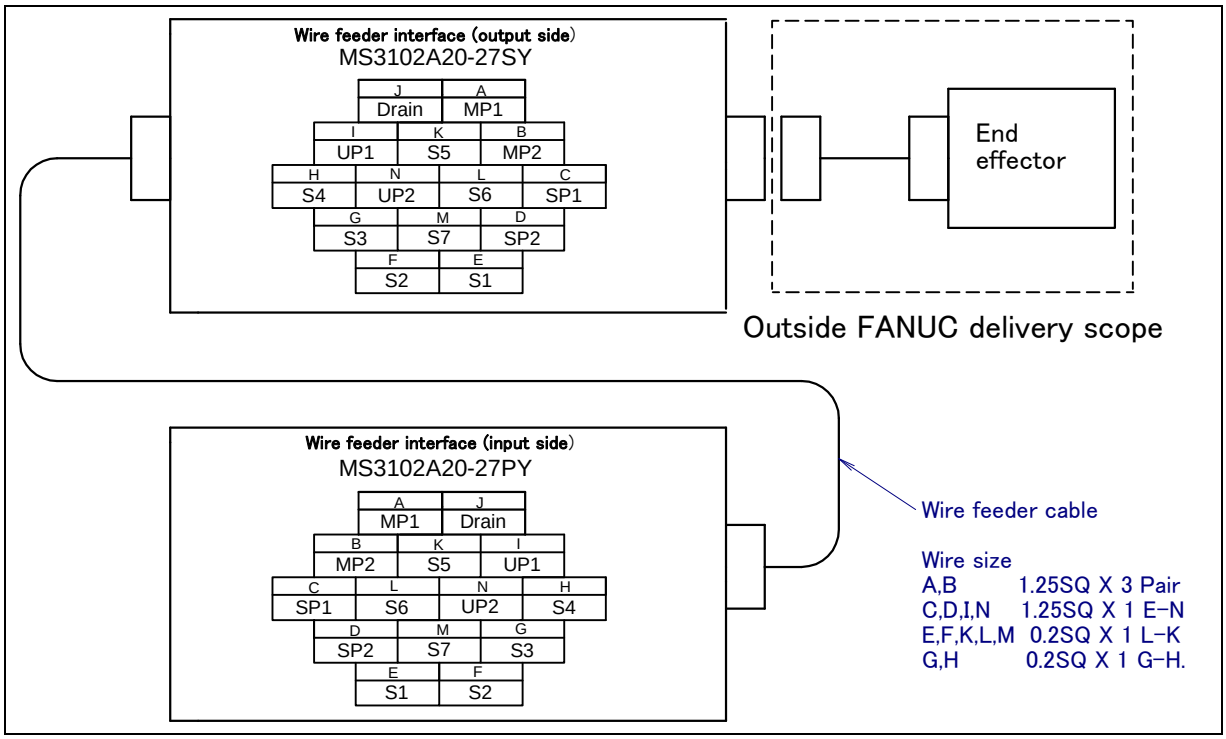


Fig. 5.3 (l) Pin layout for LINCOLN wire feeder power supply (W/F) interface (option)

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

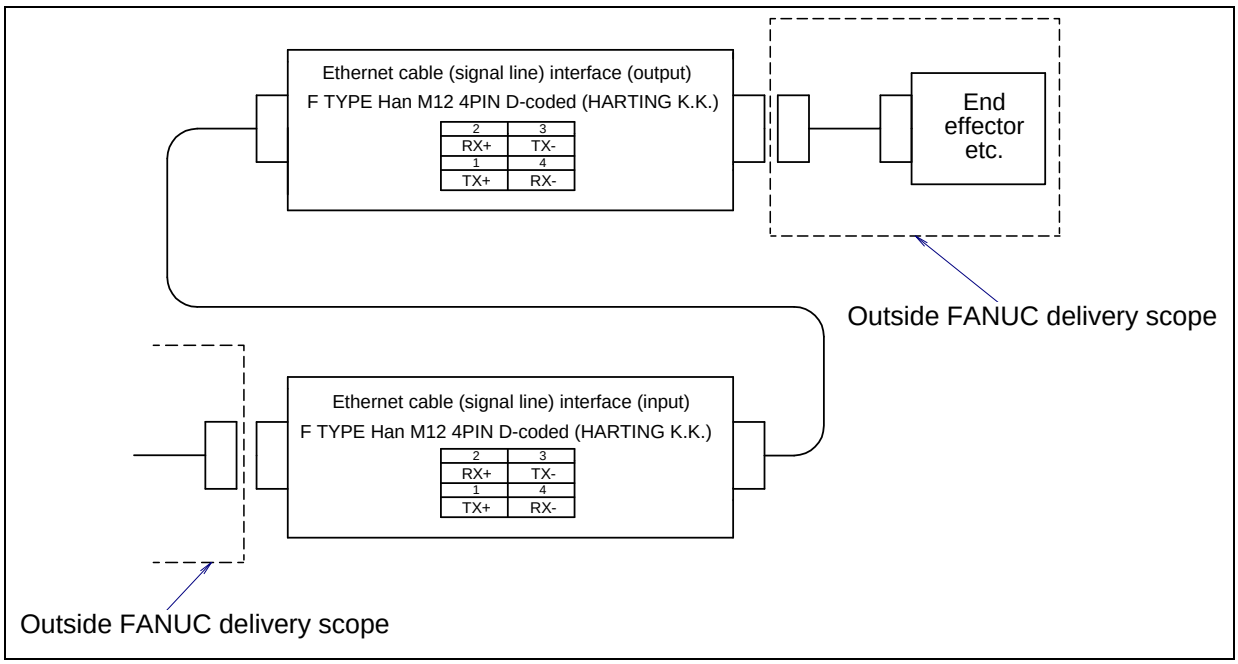


Fig. 5.3 (m) Pin layout for Ethernet cable (signal line) (ES) interface (option)

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	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	
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	
ARP	Housing Insert Contact Code pin	09 30 006 0301 09 16 024 3001 09 15 000 6103 09 30 000 9901	Housing Insert Contact Code pin	09 30 006 0301 09 16 024 3101 09 15 000 6203 09 30 000 9901	
ARM	Housing Insert Contact Code pin	09 20 010 0301 09 21 015 3001 09 15 000 6101 09 30 000 9901	Housing Insert Contact Code pin	09 20 010 0301 09 21 015 3101 09 15 000 6201 09 30 000 9901	
LMP1	JMWR1303M		———		Fujikura . Ltd
W/F	MS3102A20-27PY		MS3102A20-27SY		Fujikura. Ltd Japan Aviation Electronics Industry, Ltd.
ES	Connector Contact	21 03 882 2425 09 67 000 7476	Connector Contact	21 03 882 2425 09 67 000 7476	HARTING K.K.

Table 5.3 (c) Connector specifications (User side)

Cable	Input side (J1 base)		Output side (J3 casing)		Maker /Dealer
EE (RI/RO)	_____		JMSP2524M (*1) Straight JMLP2524M Angle		Fujikura . Ltd
AS	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 30 006 1540 Side entry 0541 ↓ 0541 1440 Top entry 0440 ↓ 0441	Hood	←The same	HARTING K.K.
	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 correspond ed to the sever dust/liquid protection.)	———	Hood (NOTE 2)	09 30 006 1540 Side entry 1541 ↓ 0542 0543 1440(*2) Top entry 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)	
LMP1	JMSP1303F Straight plug (FANUC spec. A63L-0001-0234#S1303F) JMLP1303F Angle plug	———		Fujikura . Ltd
W/F	Straight plug : MS3106B20-27SY (*1) Elbow plug : MS3108B20-27SY or a compatible product Clamp : MS3057-12A (*1) (FANUC spec. : A05B-1221-K843 Straight plug (*1) and clamp (*1) are included)	Straight plug : MS3106B20-27PY (*2) Elbow plug : MS3108B20-27PY or a compatible produce Clamp : MS3057-12A (*2) (FANUC spec. :A05B-1221-K841 Straight plug (*1) and clamp (*1) are included)		Fujikura. Ltd Japan Aviation Electronics Industry, Ltd.
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		

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

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 the robot is effective under following circumstances:

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

Three methods are provided not to exceed the motion range of the robot:

- Axis limit software settings (All axes)
- Axis limit adjustable mechanical stopper (J1, J2, J3 axes (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-based 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, 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-based limits are available.
4 Adjustable mechanical stoppers (J1 to J3 axis) are deformed in a collision to stop the robot. Once a stopper is subject to a collision, it can no longer assure its original strength and, therefore, may not stop the robot. When this happens, replace it with a new one.

6.1 SOFTWARE SETTING

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

Procedure

Setting Up Axis Limits

1 Press the [MENU] key to display the screen menu.
2 Select [0 NEXT] and press [6 SYSTEM]..
3 Press F1, [TYPE], display the screen change menu.
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	-162.00	270.00	deg
4	1	-200.00	200.00	deg
5	1	-140.00	140.00	deg
6	1	-450.00	450.00	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 The setting value 0.00 indicates that the robot does not have the axis.
2 Do not depend on J1, J2, and J3 axes limit software settings to control the motion range of your robot. Use the axis limit switches or adjustable mechanical stopper also; otherwise injury to personnel or damage to equipment could occur.

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

System Axis Limits JOINT 100%
Group1 1/16

AXIS	GROUP	LOWER	UPPER	
2	1	-90.00	135.00	deg

[TYPE]

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

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

6.2 ADJUSTABLE MECHANICAL STOPPER AND LIMIT SWITCH SETTING (OPTION)

For the J1, J2, and J3 axes, the adjustable mechanical stopper (option) can be installed. The position of the adjustable mechanical support can be changed. 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

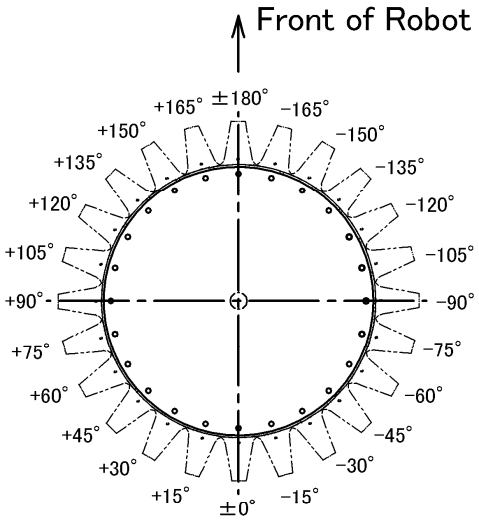
Item		Movable range
J1 axis adjustable mechanical stopper, limit switch	Upper limit	Settable in steps of 15° degrees in a range of -105° to +180° degrees
	Lower limit	Settable in steps of 15° degrees in the range of -180° to +105° degrees
	Space between the upper and lower limits	A space of 75° degrees or more is required.
J2 axis adjustable mechanical stopper	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	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.

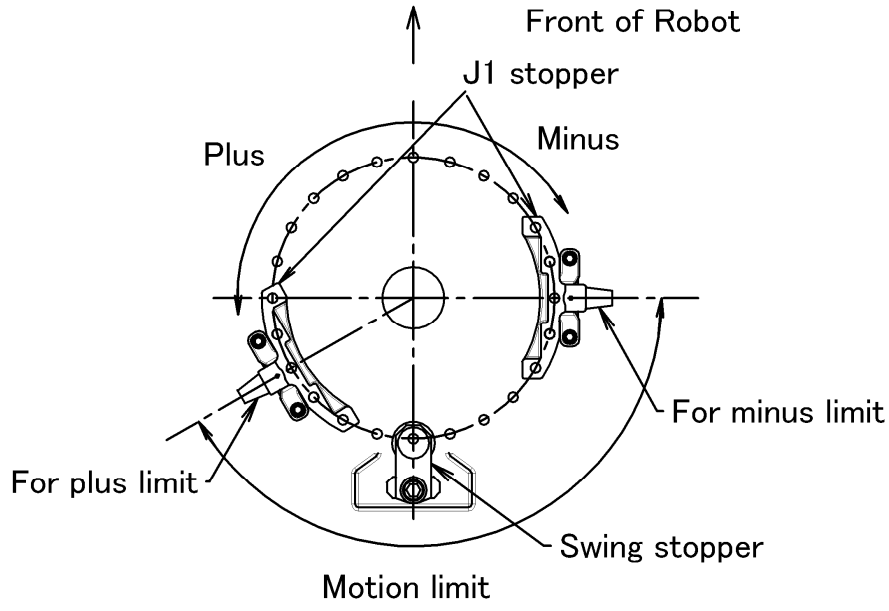


Fig. 6.2 (a) Mechanical stopper and motion limit of J1-axis (Option)

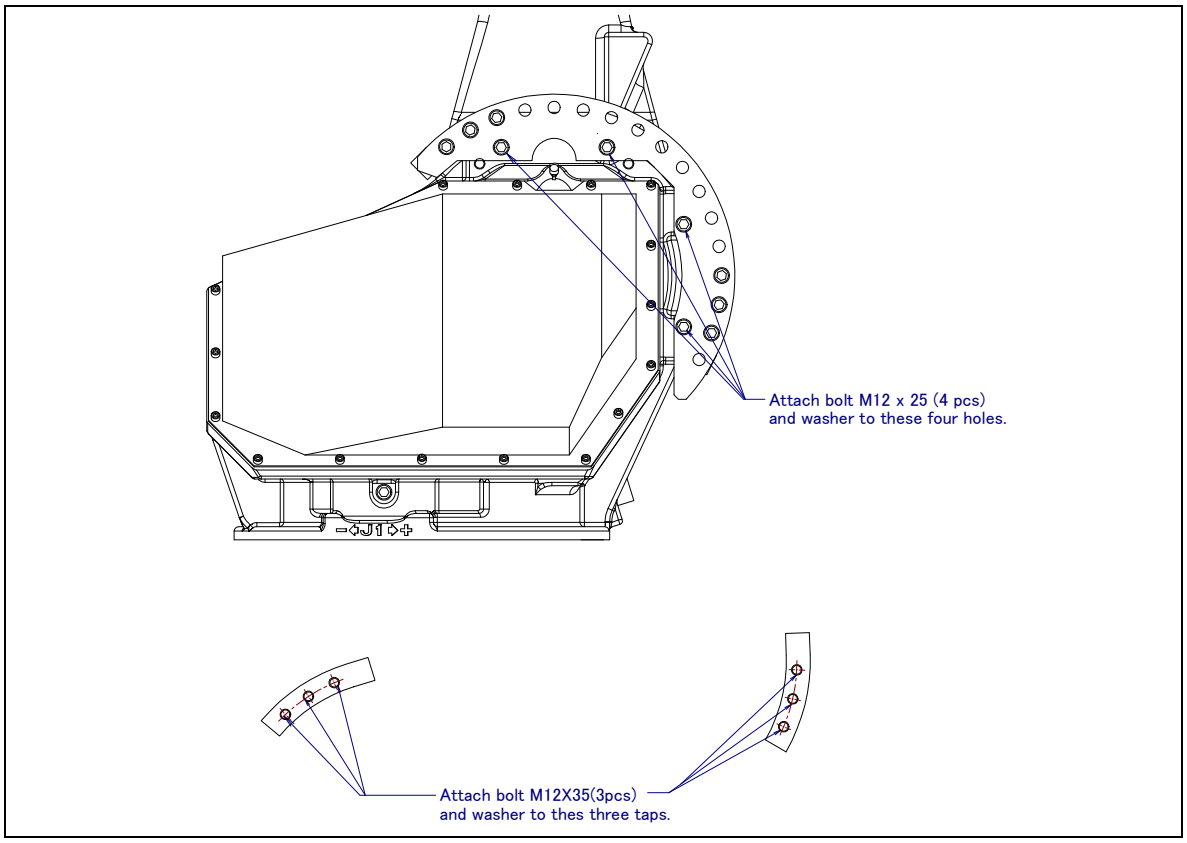


Fig. 6.2 (b) J2-Axis movable mechanical stopper

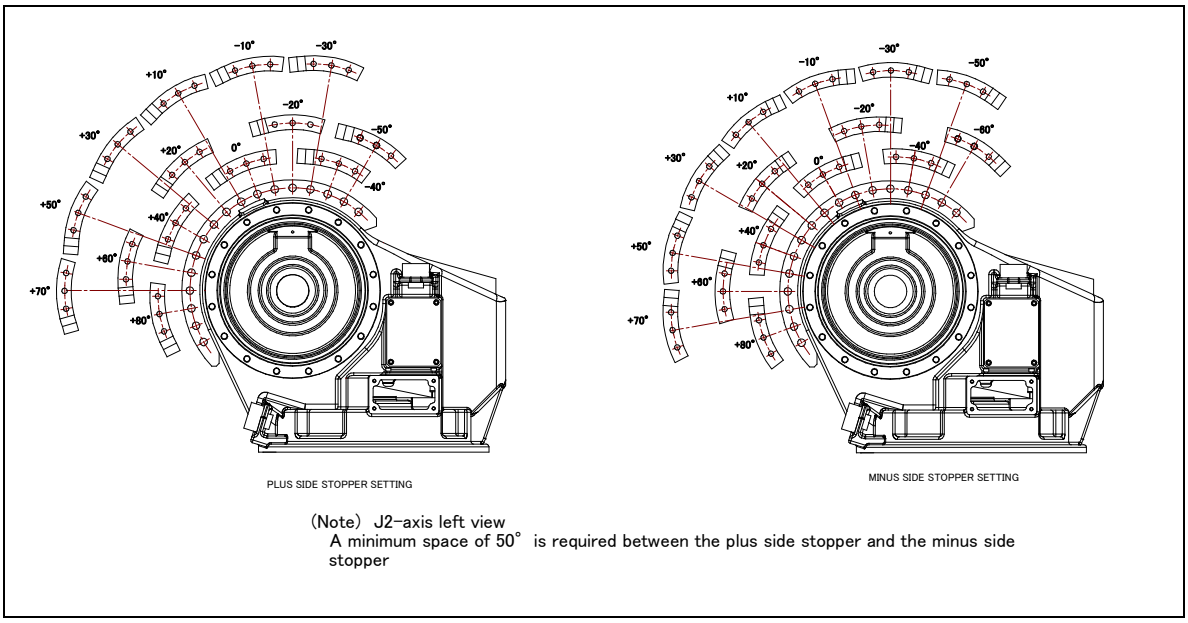


Fig. 6.2 (c) Attachment of J2-Axis movable mechanical stopper

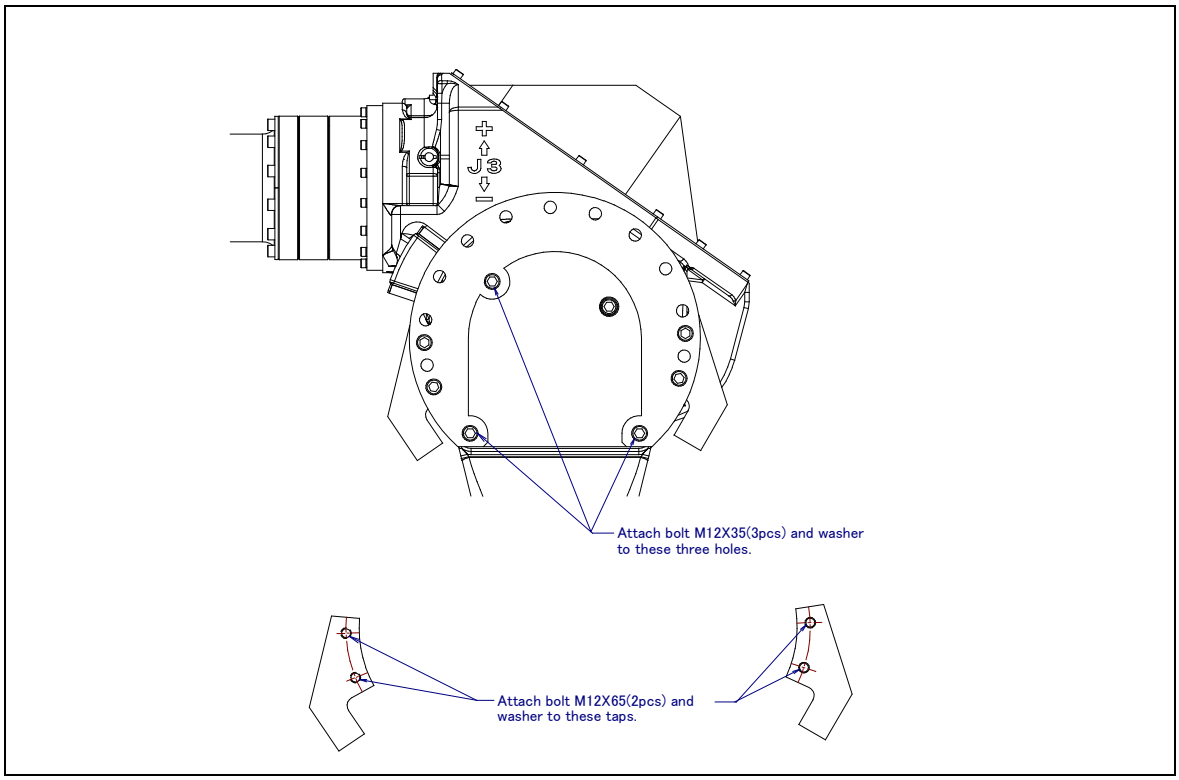


Fig. 6.2 (d) J3-Axis movable mechanical stopper

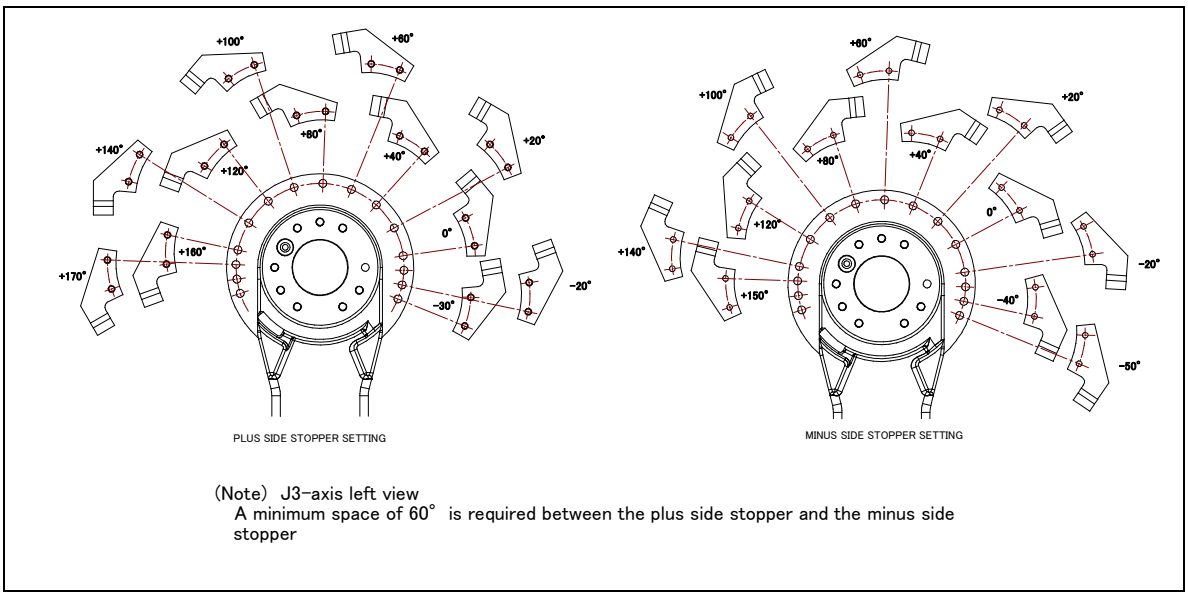


Fig. 6.2 (e) Attachment of J3-Axis movable mechanical stopper

The movable mechanical stopper is a mechanism that can be adjusted in its position. The robot can work safely inside the adjusted motion range, up to the maximum range as shown in Table 6.2 (b)
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/20L M-710*i*C/12L M-710*i*C/20M	J1-axis	+17°	-17°
	J2-axis	+19°	-18°
	J3-axis	+11°	-10°

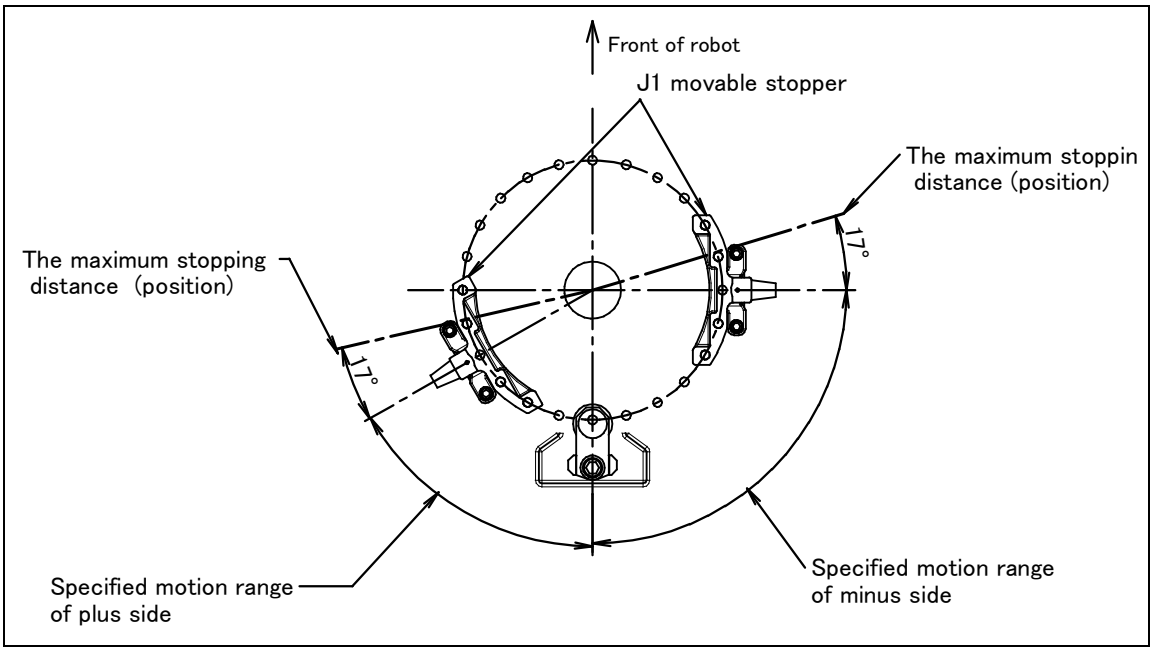


Fig. 6.2 (f) The maximum stopping distance of movable mechanical stopper (J1-axis)

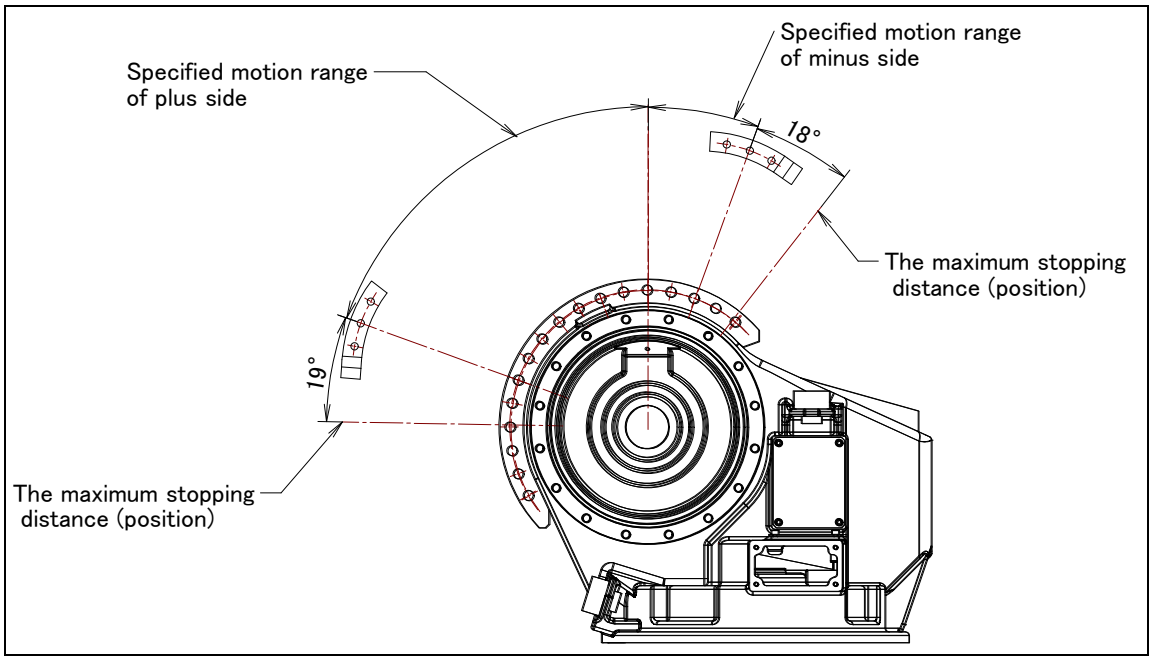


Fig. 6.2 (g) The maximum stopping distance of movable mechanical stopper (J2-axis)

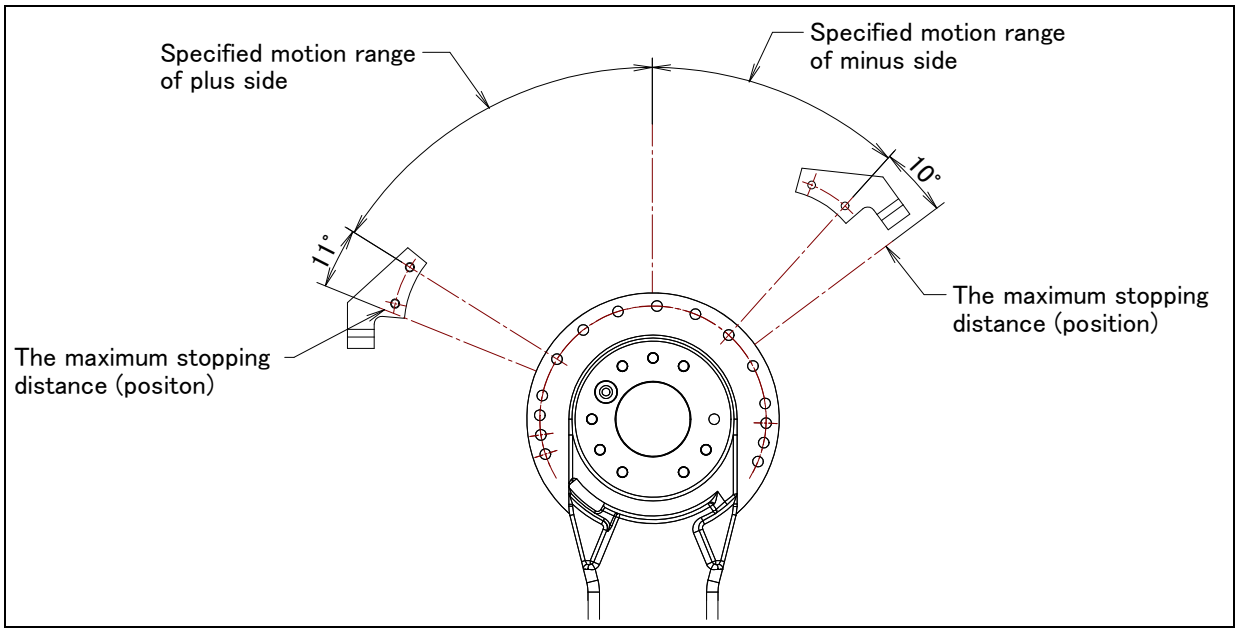
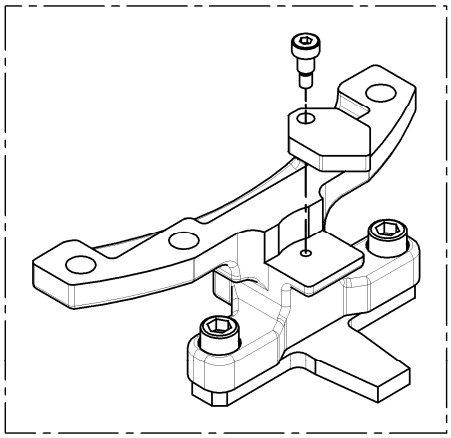


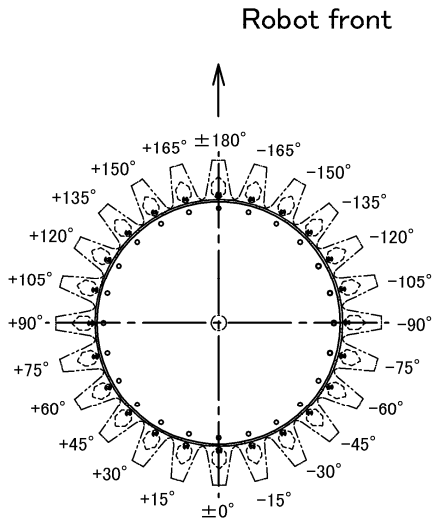
Fig. 6.2 (h) The maximum stopping distance of movable mechanical stopper

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 Cycle power of the controller.

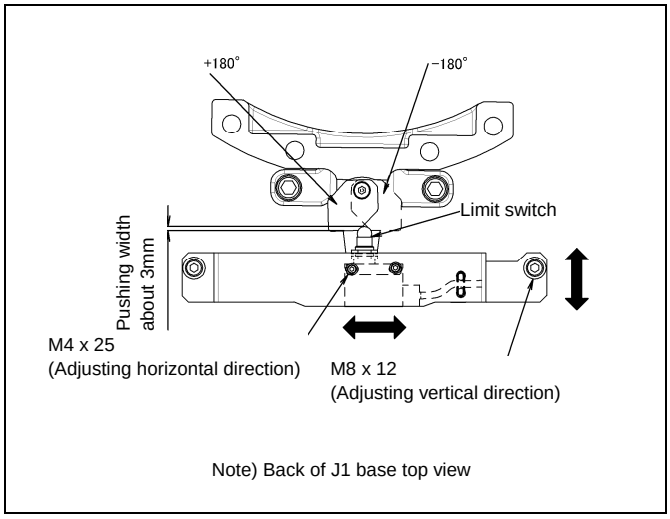


Fig. 6.4 Adjusting J1-axis limit switch (option)

7 CHECKS AND MAINTENANCE (M-710*i*C/20L/20M)

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

NOTE
The periodic maintenance procedures described in this chapter assume that the FANUC robot is used for up to 3840 hours a year. In cases where robot use exceeds 3840 hours/year, adjust the given maintenance frequencies accordingly. The ratio of actual operating time/year vs. the 3840 hours/year should be used to calculate the new (higher) frequencies. For example, when using the robot 7680 hours a year, the maintenance frequency should be doubled – i.e. the time 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	(When air control set is used) **⇒"7.2.2 Confirmation of the Air Control Set"**
Vibration, abnormal noises	Check whether vibration or abnormal noises occur. When vibration or abnormal noises occur, perform measures referring to the following section: **⇒"10.1 TROUBLESHOOTING" (symptom : Vibration, Noise)**
Positioning accuracy	Check that the taught positions of the robot have not deviated from the previously taught positions. When the displacement occurs, perform the measures as described in the following section: **⇒"10.1 TROUBLESHOOTING" (symptom : Displacement)**
Peripheral equipment for proper operation	Check whether the peripheral equipment operate properly according to commands from the robot and the peripheral equipment.
Brakes for each axis	Check that the end effector drops 0.5 mm or less when servo power is turned off. If the end effector (hand) drops, perform the measures as described in the following section: **⇒"10.1 TROUBLESHOOTING" (symptom : Dropping axis)**
Warnings	Check whether unexpected warnings occur in the alarm screen on the teach pendant. If unexpected warnings occur, perform the measures as described in the following manual: **⇒"R-30*i*B/R-30*i*B Mate/R-30*i*B Plus/R-30*i*B Mate Plus CONTROLLER OPERATOR'S MANUAL (Alarm Code List)(B-83284EN-1) or R-30*i*A/R-30*i*A Mate CONTROLLER OPERATOR'S MANUAL (Alarm Code List)(B-83124EN-6)"**

7.1.2 Periodic Check 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 that the controller ventilation system is not dusty. If dust has accumulated, remove it.	19
	○					Check for external damage or peeling paint	Check whether the robot has external damage or peeling paint due to contact with the peripheral equipment. If unintended contact has occurred, 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
	○ Only 1st check	○				Check for damage to the end effector (hand) cable	Check whether the end effector cables are unevenly twisted or damaged. If damage is found, replace the damaged cables.	4
		○				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"**	5
	○ 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"**	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	○				Retightening the cover mounting bolts and external main bolts	Retighten the cover mounting bolts, the robot installation bolts, bolts that have been removed for inspection, and bolts exposed to the outside. Refer to the recommended bolt tightening torque guidelines at the end of the manual. An adhesive to prevent bolts from loosening is applied to some bolts. If the bolts are tightened with greater than the recommended torque, the adhesive might be removed. Therefore, follow the recommended bolt tightening torque guidelines when retightening the bolts.	7
	○ Only 1st check	○				Check the 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"**	8
	○ Only 1st check	○				Clean spatters, sawdust and dust	Check that spatters, sawdust, or dust does not exist on the robot main body. If dust has accumulated, remove it. Especially, clean the robot movable parts well (each joint 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)	9
			○			Replacing the mechanical unit batteries	Replace the mechanical unit batteries **⇒"7.3.1 Replacing the Batteries"**	10
		○				Apply grease	**Apply grease to the J6-axis reducer** **⇒"7.3.2 Greasing**	16
				○		Replacing the grease of drive mechanism	Replace the grease of each axis reducer and gearbox **⇒"7.3.3 Replacing the Grease of the Drive Mechanism"**	11-15
					○	Replacing the mechanical unit cable	Replace the mechanical unit cable Contact your local FANUC representative for information regarding replacing the cable.	17
					○	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)**	20

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.

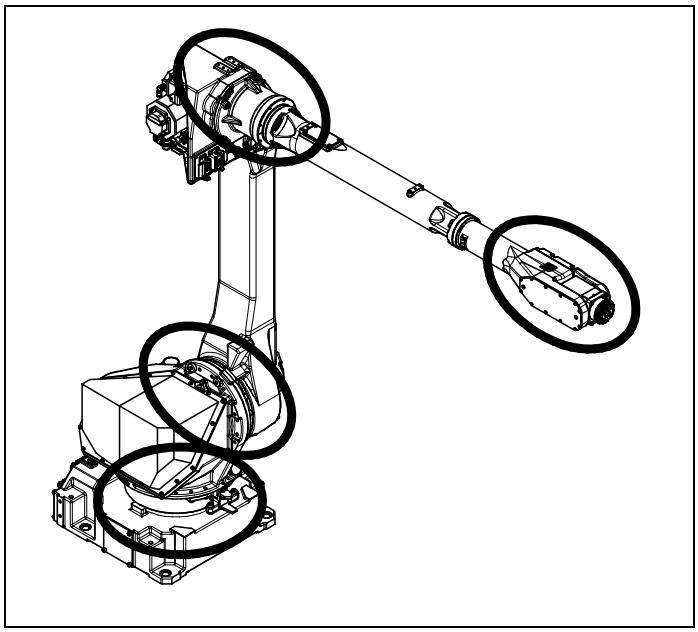


Fig. 7.2.1 Check parts of oil seepage

Management

- Oil might accumulate on the outside of the seal lip depending on the movement condition or environment of the axis. If the oil changes to a state of liquid, the oil might fall depending on the axis movement. To prevent oil spots, be sure to wipe away any accumulated oil under the axis components before you operate the robot.
- In case of oil seepage, please consider replacing the grease. 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 achieved by venting the grease outlet. (When opening the grease outlet, refer to Subsection 7.3.3 and ensure that grease is not expelled onto the machine or tooling.)

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

- If you must wipe oil frequently, and opening the grease outlet does not stop the seepage, perform the measures below.

  ⇒" 10.1 TROUBLESHOOTING" (symptom : Grease leakage)

7.2.2 Confirmation of the Air Control Set (option)

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

Item	Check items	Check points
1	Air pressure	Check the air pressure using the pressure gauge on the air control set as shown in Fig. 7.2.2. If it does not meet the specified pressure of 0.49 to 0.69 MPa (5-7 kgf/cm^2), adjust it using the regulator pressure-setting handle.
2	Lubricator oil mist quantity	Check the number of oil drops during operation. If it does not meet the specified value (1 drop/10-20 sec), adjust it using the 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 empty it. When the quantity of liquid in the drain is excessive, examine the setting of the air dryer on the air supply side.

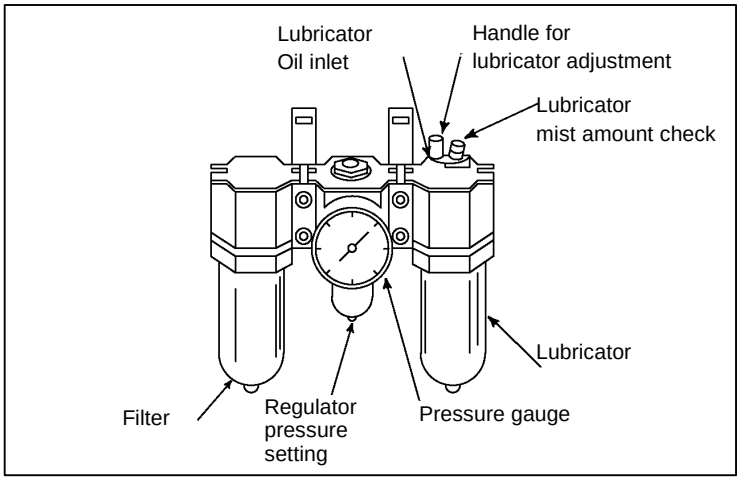


Fig. 7.2.2 Air control set (option)

7.2.3 Check the Mechanical Unit Cables and Connectors

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.

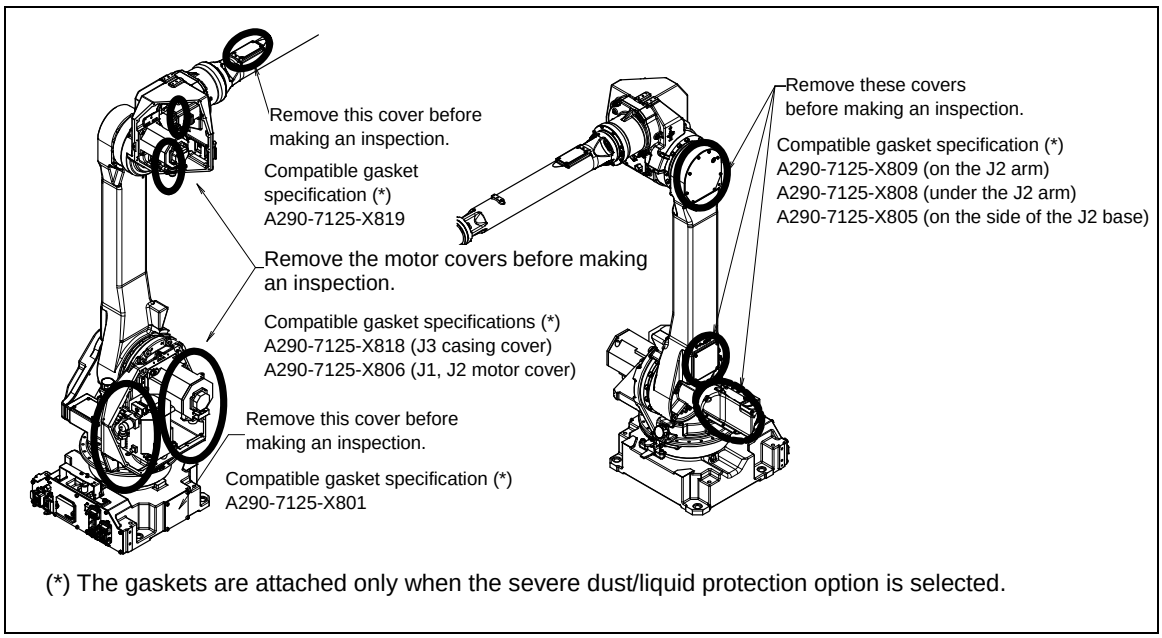


Fig. 7.2.3 (a) Inspection points of the mechanical unit cables

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.

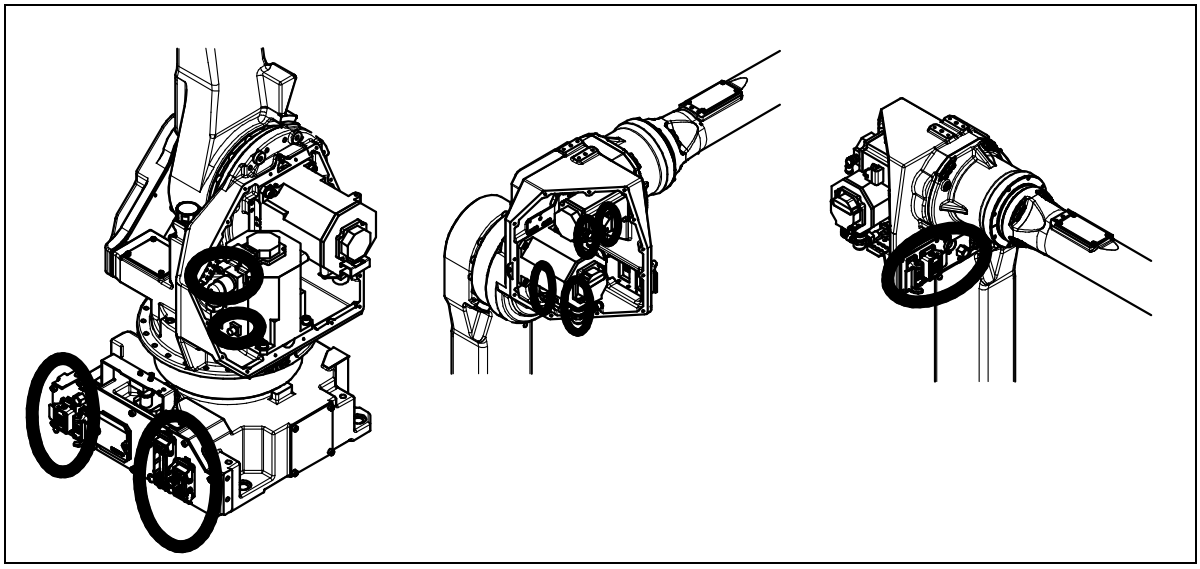


Fig. 7.2.3 (b) Connector Inspection points

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 the J1-axis swing stopper rotates smoothly.
- Refer to Section 6.2 of the operator's manual for details regarding the adjustable mechanical stopper.

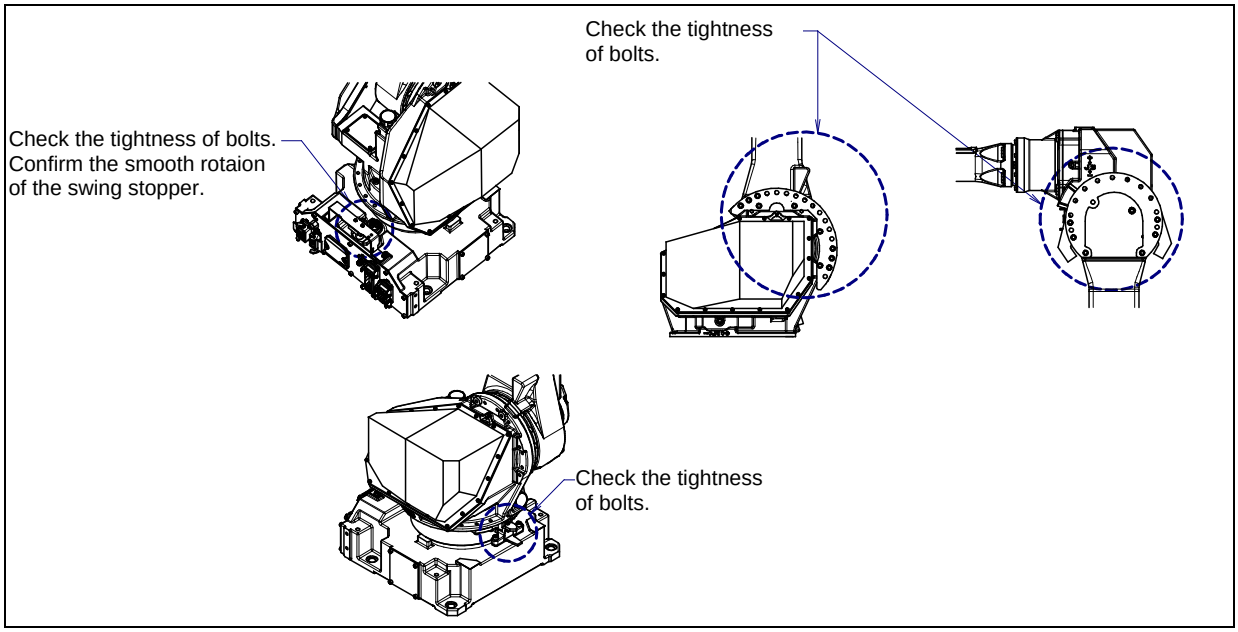


Fig. 7.2.4 Check of fixed mechanical stopper and adjustable mechanical stopper

7.3 MAINTENANCE

7.3.1 Replacing the Batteries (1.5 Year checks)

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

Procedure of replacing the battery

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

> **⚠ CAUTION**
> Be sure to keep the power supply turned on. Replacing the batteries with the power supply turned off causes all current position data to be lost. If this occurs, 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.

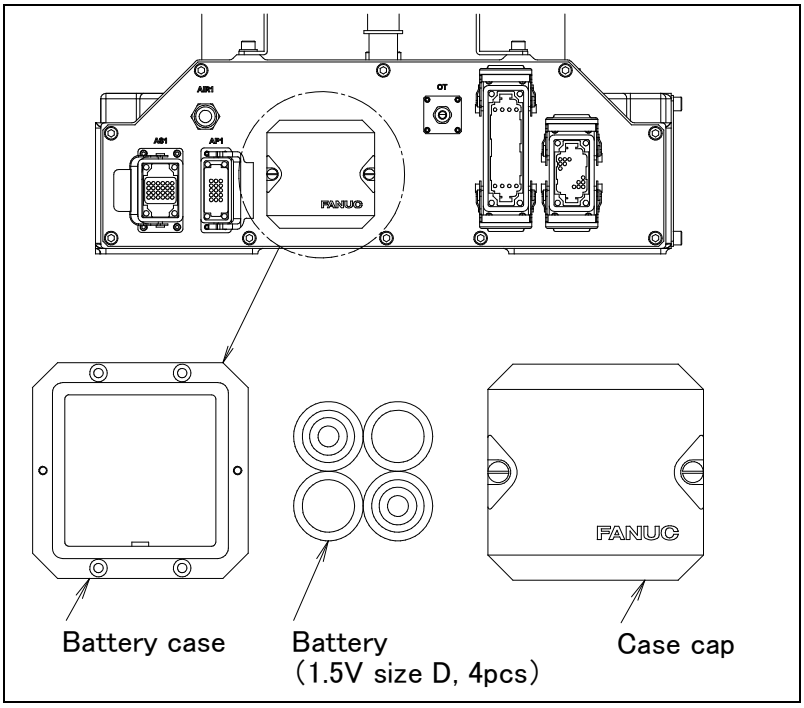


Fig. 7.3.1 (a) Replacing the battery

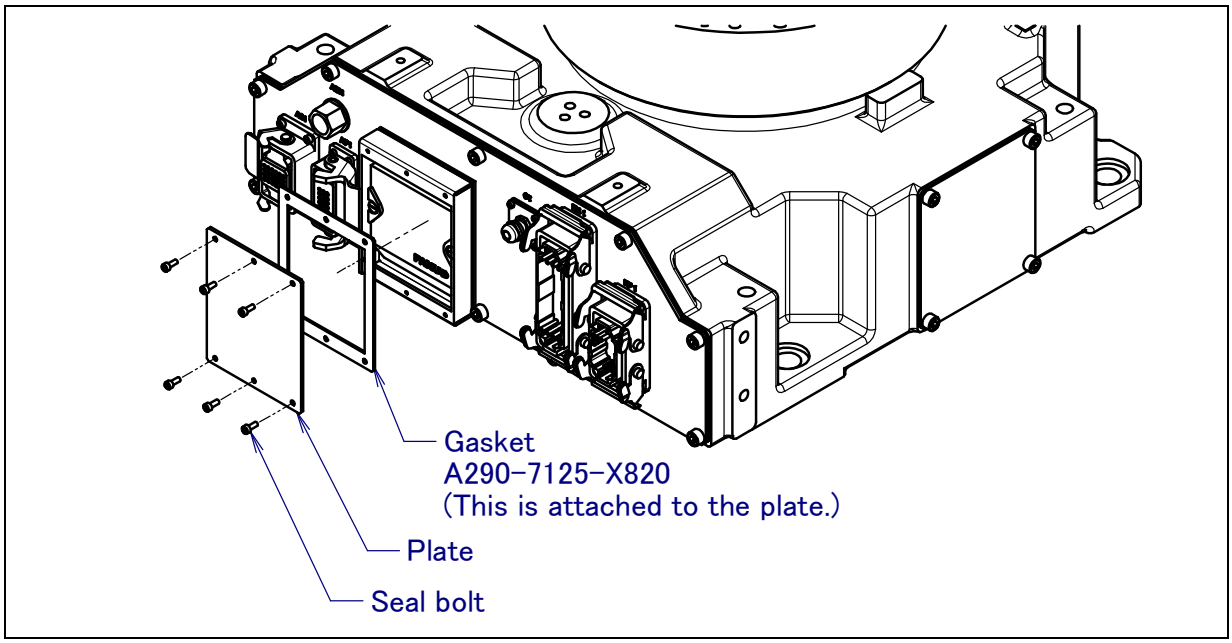


Fig.7.3.1 (b) Removing the battery cover plate (When severe dust/liquid protection is specified)

7.3.2 Greasing

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

i) Replenish the robot with grease at cycle that is shorter between every 12 months and 3840 hours operating.
ii) See Fig. 7.3.2 and Table 7.3.2 (a) for greasing points and the method.
iii) After applying grease, release the remaining pressure within the grease bath as described in the procedure in Subsection 7.3.3.4.

Table 7.3.2 (a) Greasing points

Greasing point	Specified grease	Amount of grease	Gun tip pressure	Greasing method
J6-axis reducer	Harmonic drive systems Harmonic grease SK-3 (Specification: A98L-0040-0110)	40ml	0.1 MPa or less (NOTE)	Replace the flat-head bolts and sealing washers of the J6-axis grease inlet and outlet, and attach the supplied grease nipple to the grease inlet of the J6-axis. After greasing, remove the grease nipple, and attach the flat-head bolts and sealing washers to the grease inlet and outlet.

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

> ⚠ **CAUTION**
> If you grease incorrectly, the pressure in the grease bath may increase steeply, leading to a broken seal, which will eventually cause grease leakage or malfunction.
> When greasing, be sure to follow the cautions stated in Subsection 7.3.3.

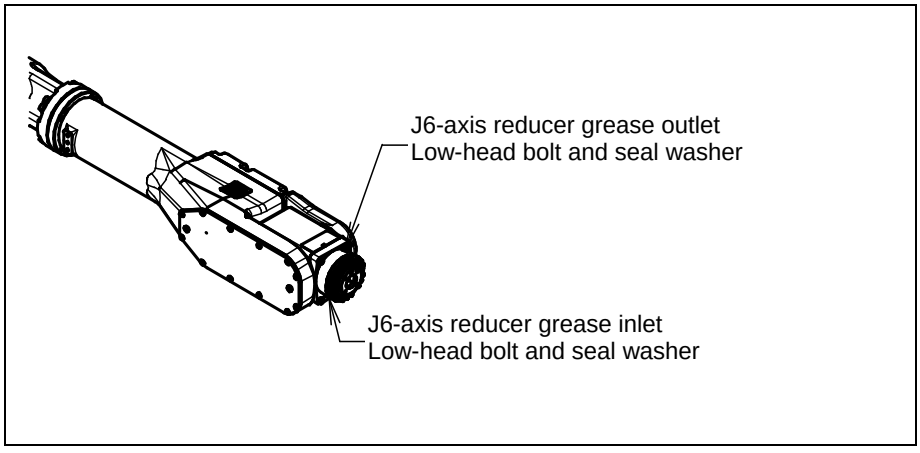


Fig.7.3.2 Greasing the J6-Axis Reducer

Table 7.3.2 (b) Spec. of the seal washer

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

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

According to below, replace the grease of J1 to J3 axes reducer and J4/J5-axes gearbox at the intervals based on every 3 years or 11520 hours, whichever comes first. See Table 7.3.3 (a) for the grease name and the quantity.

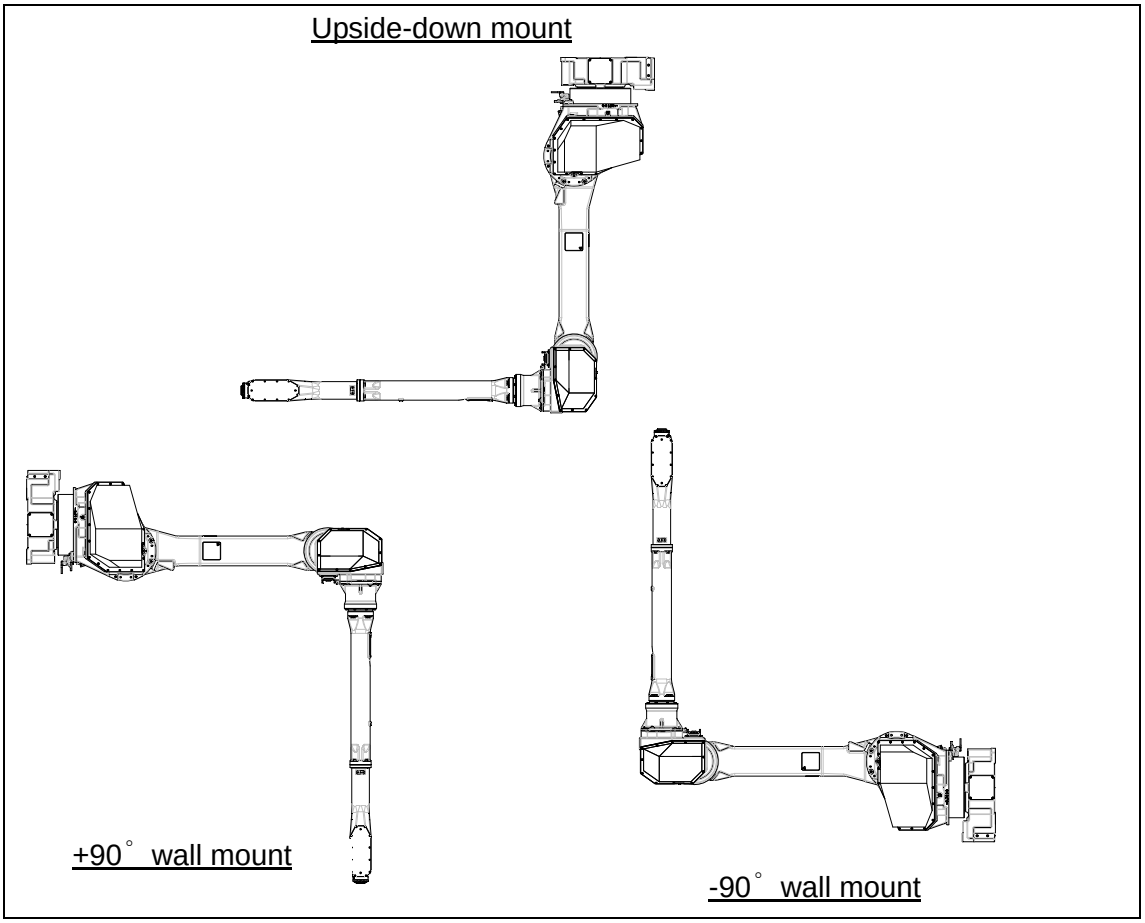


Fig. 7.3.3 Installation method

Table 7.3.3 (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	1500g (1660ml)		
J3-axis reducer	950g (1060ml)		
J4-axis gearbox	880g (1000ml)		
J5-axis gearbox	400g (440ml)		

NOTE
When using a hand pump, apply grease at a rate of approximately once per two seconds.

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

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

Table 7.3.3 (b) Postures for greasing

Supply position		Posture					
		J1	**J2**	**J3**	**J4**	**J5**	**J6**
J1-axis reducer	Floor mount	0°	Arbitrary	Arbitrary	Arbitrary	Arbitrary	Arbitrary
	Upside-down mount						
	-90° wall mount						
	+90° wall mount						
J2-axis reducer	Floor mount	Arbitrary	0°	Arbitrary	Arbitrary	Arbitrary	Arbitrary
	Upside-down mount						
	-90° wall mount						
	+90° wall mount						
J3-axis reducer	Floor mount	Arbitrary	0°	0°	Arbitrary	Arbitrary	Arbitrary
	Upside-down mount						
	-90° wall mount						
	+90° wall mount						
J4-axis gearbox	Floor mount	Arbitrary	Arbitrary	0°	Arbitrary	Arbitrary	Arbitrary
	Upside-down mount			180°			
	-90° wall mount	0°		-90°			
	+90° wall mount			90°			
J5-axis gearbox	Floor mount	Arbitrary	Arbitrary	-90°	Arbitrary	Arbitrary	Arbitrary
	Upside-down mount			90°			
	-90° wall mount	0°		180°			
	+90° wall mount			0°			

⚠ 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. (once per two seconds)
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 7.3.3 (a).
5 Use specified grease. Use of non-approved grease may damage the reducer or lead to other problems.
6 After greasing, confirm that no grease is leaking from the grease outlet and that the grease bath is not pressurized, 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.

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

1 Move the robot to the greasing posture described in Table 7.3.3 (b).
2 Turn off the controller power.
3 Remove the seal bolt from grease outlet. (Fig.7.3.3.1 (a) to (c))
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 7.3.3.4.

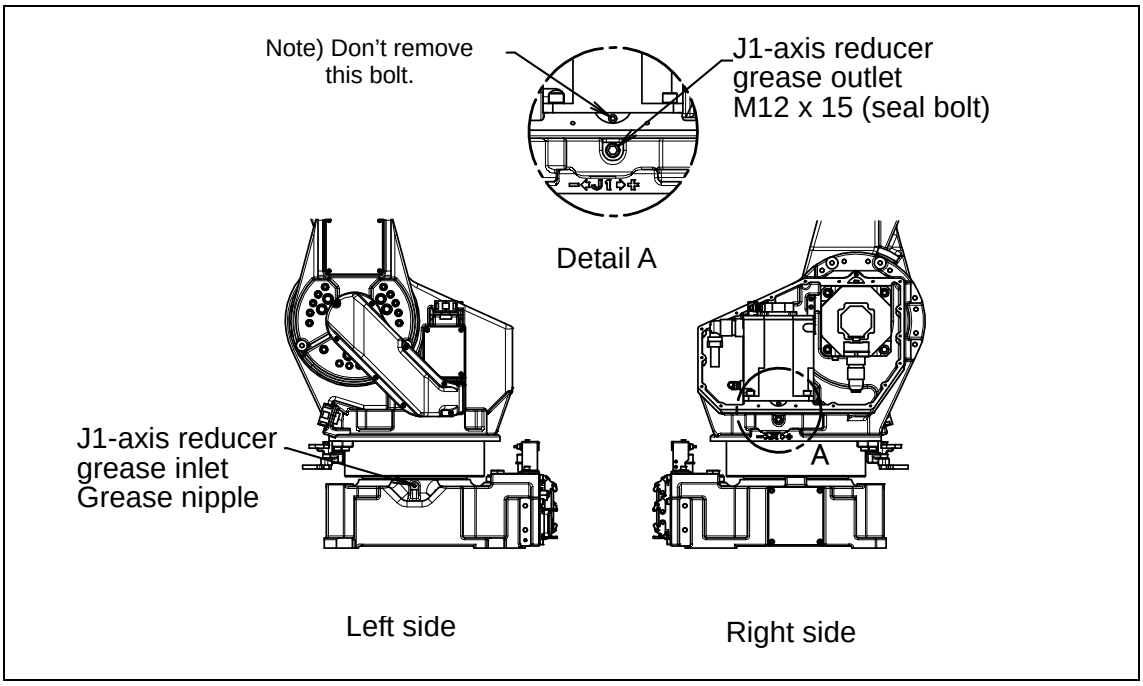


Fig. 7.3.3.1 (a) Replacing grease of the J1-axis reducer

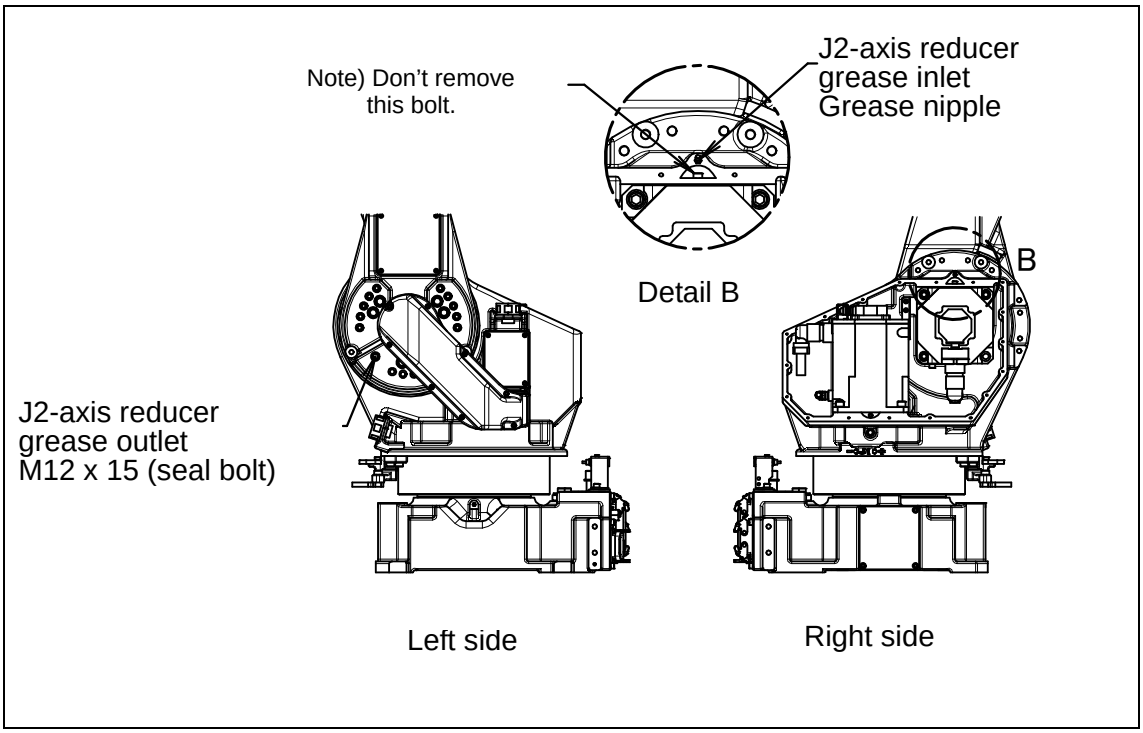


Fig. 7.3.3.1 (b) Replacing grease of the J2-axis reducer

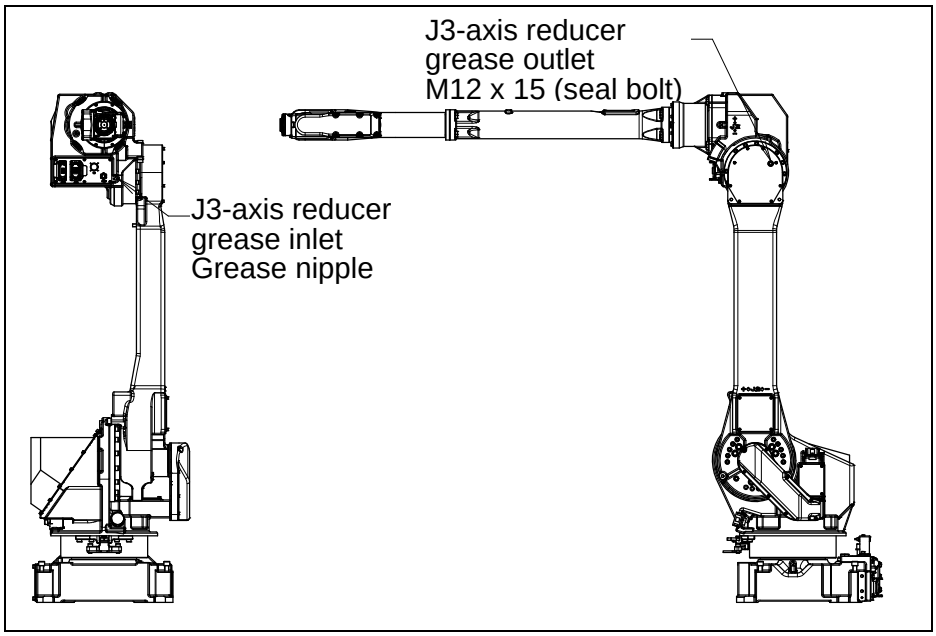


Fig. 7.3.3.1 (c) Replacing grease of the J3-axis reducer

Table 7.3.3.1 Specification of the seal bolt and grease nipple (J1 - J3-axis)

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

7.3.3.2 Grease replacement procedure for the J4-axis gearbox

1 Move the robot to the greasing posture described in Table 7.3.3 (b).
2 Turn off the controller power.
3 Remove the seal bolt from the grease outlet. (Fig. 7.3.3.2)
4 Supply new grease until new grease is output from the grease outlet.
5 After greasing, release remaining pressure as the Subsection 7.3.3.4.

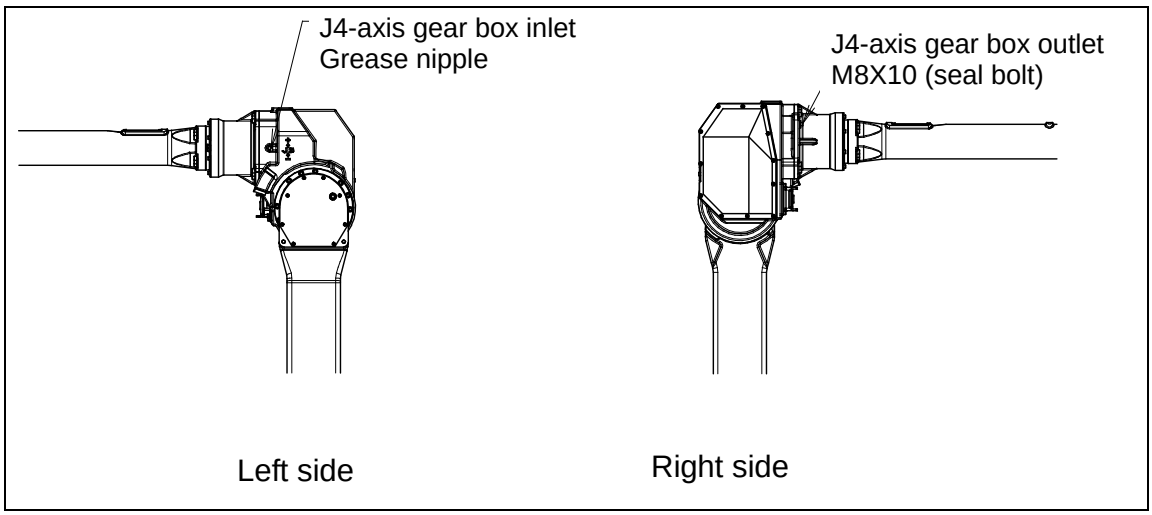


Fig. 7.3.3.2 Replacing grease of the J4-axis gearbox (When the Seal Bolt is M8x10)

Table 7.3.3.2 Specification of the seal bolt and grease nipple (J4-axis)

Parts name	Specifications
Seal bolt (M8)	A97L-0218-0417#081010
Grease nipple	A97L-0218-0013#A610

7.3.3.3 Grease replacement procedure for the J5-axis gearbox

1 Move the robot to the greasing posture described in Table 7.3.3 (b).
2 Turn off the controller power.
3 Remove the low-head bolts and seal washers from the wrist grease inlet and outlet, and attach the grease nipple, which is supplied with the robot, to the grease inlet (Fig. 7.3.3.3).
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 sub-Subsection 7.3.3.4.

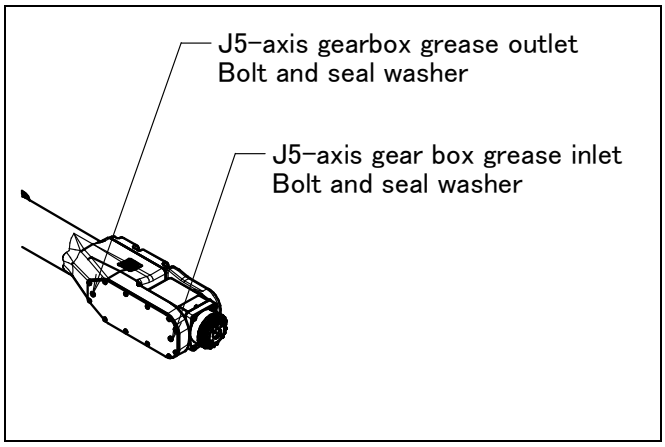


Fig. 7.3.3.3 Grease replacement procedure for the J5-axis gearbox

Table 7.3.3.3 Specification of the seal washer (J5-axis)

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

7.3.3.4 Procedure for releasing remaining pressure within the grease bath

(For the J1-, J2-, J3-, or J4-axis)
After greasing, operate the robot as described in the table below for at least 20 minutes, with the grease nipple removed from the grease inlet and the seal bolt removed from the grease outlet, to release remaining pressure from the grease bath.

(For the J5-axis gearbox)
- After greasing, remove the bolts and seal washers from the grease inlet and outlet.
- Move the robot to J3=-90°, perform ±90° repeating operation during 5 minutes for only J5-axis. Make wait time between 2 points 0, perform the running with position pass is fine.
- After 5 minutes, confirm about 50ml grease is pulled out. (just as volume of 2 golf balls.)
- Attach the bolts and seal washers of grease inlet and outlet.

(For the J6-axis)
After greasing, operate the robot as described in the table below for at least 10 minutes, with the grease nipple removed from the grease inlet and the seal bolt removed from the grease outlet, to release remaining pressure from the grease bath.

Under the grease inlets and outlets, attach bags for collecting grease so that grease does not spatter when it comes out of the inlets or outlets.

Operating axis / Grease replacement part	J1-axis	J2-axis	J3-axis	J4-axis	J5-axis	J6-axis
J1-axis reducer	Axis angle of 60° or more OVR 80%	Arbitrary				
J2-axis reducer	Arbitrary	Axis angle of 60° or more OVR 80%	Arbitrary			
J3-axis reducer	Arbitrary		Axis angle of 60° or more OVR 80%	Arbitrary		
J4-axis gearbox	Arbitrary			Axis angle of 60° or more OVR 80%	Arbitrary	
J5-axis gearbox	Arbitrary				Axis angle of 180° or more OVR 100%	Arbitrary
J6-axis reducer	Arbitrary					Axis angle of 60° or more OVR 100%

If the above operations cannot be performed because of workcell constraints, prolong the operating time so that an equivalent operation can be performed. (For example, 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 replacing grease, grease bath may rise if robot is operated again under frequent inversion movement or high temperature environment. In these cases, you can return internal pressure by releasing grease out let just after operation of robot. (When opening grease outlet, attention grease is not scattered.)

⚠ CAUTION
When reusing seal bolt and taper plug, be sure to seal t thread part with seal tape.
As for the seal washer, In one side, rubber sticks to the entire and the other side, rubber sticks to only around hole and rubber sticks is incomplete state, Attach later face to bolt side. Confirm seal washer by viewing. If it is damaged obviously, replace it by new one.
See Table 7.3.2 (b), Table 7.3.3.1, Table 7.3.3.2 and Table 7.3.3.3 about specification of seal bolts and seal washer.

7.4 STORAGE

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

8 CHECKS AND MAINTENANCE (M-710*i*C/12L)

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

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

8.1 CHECKS AND MAINTENANCE

8.1.1 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 there is oil on the sealed part of each joint. If there is an oil seepage, clean them. **⇒"8.2.1 Confirmation of Oil Seepage"**
Air control set	(When air control set is used) **⇒"8.2.2 Confirmation of the Air Control Set"**
Vibration, abnormal noises	Check whether vibration or abnormal noises occur. When vibration or abnormal noises occur, perform measures referring to the following section: **⇒"10.1 TROUBLESHOOTING"(symptom : Vibration, Noise)**
Positioning accuracy	Check that the taught positions of the robot have not deviated from the previously taught positions. When the displacement occurs, perform the measures as described in the following section **⇒"10.1 TROUBLESHOOTING"(symptom : Displacement)**
Peripheral equipment for proper operation	Check whether the peripheral equipment operate properly according to commands from the robot and the peripheral equipment.
Brakes for each axis	Check that the end effector drops 5 mm or less when servo power is turned off. If the end effector (hand) drops, perform the measures as described in the following section: **⇒"10.1 TROUBLESHOOTING"(symptom : Dropping axis)**
Warnings	Check whether unexpected warnings occur in the alarm screen on the teach pendant. If unexpected warnings occur, perform the measures as described in the following manual: **⇒"R-30*i*B/R-30*i*B Mate/R-30*i*B Plus/R-30*i*B Mate Plus CONTROLLER OPERATOR'S MANUAL (Alarm Code List)(B-83284EN-1)"** **R-30*i*A/R-30*i*A Mate CONTROLLER OPERATOR'S MANUAL (Alarm Code List)(B-83124EN-6)"**

8.1.2 Periodic Check 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 months 320h	3 months 960h	1 year 3840h	1.5 year 5760h	2 years 7680h	3 years 15360h	4 years 15360h			
○ Only 1st check	○						Check the oil sight glasses of J5/J6-axes gearboxes	Please confirm whether the amount of oil of the oil sight glass of J5/J6-axes gearboxes has come above the 1/4 of total height. **⇒"8.2.3 Check the Oil Sight Glasses"**	10
○ Only 1st check	○						Check the failure of the wrist part fluoric resin ring	Check to see whether there is failure on the wrist part fluoric resin ring. If is broken, replace it by new one. **⇒"8.2.4 Check the Failure of the Wrist Part Fluoric Resin Ring"**	19
○ Only 1st check	○						Cleaning the controller ventilation system	Confirm that the controller ventilation system is not dusty. If dust has accumulated, remove it.	21
	○						Check for external damage or peeling paint	Check whether the robot has external damage or peeling paint due to contact with the peripheral equipment. If unintended contact has occurred, 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.	20
	○ Only 1st check	○					Check for damage to the mechanical unit cable (movable part)	Observe the movable part of the mechanical unit cable, and check for damage. Also, check whether the cables are excessively bent or unevenly twisted. **⇒"8.2.5 Check the Mechanical Unit Cables and Connectors"**	3
	○ Only 1st check	○					Check for damage to the end effector (hand) cable	Check whether the end effector connection cables are unevenly twisted or damaged. If damage is found, replace the damaged cables.	4

Check and maintenance intervals (Period, Accumulated operating time)							Check and maintenance item	Check points, management and maintenance method	Periodic maintenance table No.
1 months 320h	3 months 960h	1 year 3840h	1.5 year 5760h	2 years 7680h	3 years 15360h	4 years 15360h			
	○ Only 1st check	○					Check the connection of each axis motor and other exposed connectors	Check the connection of each axis motor and other exposed connectors. **⇒"8.2.5 Check the Mechanical Unit Cables and Connectors"**	5
	○ 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"**	6
	○ Only 1st Check	○					Retightening the cover mounting bolts and external main bolts	Retighten the cover mounting bolts, the robot installation bolts, bolts that have been removed for inspection, and bolts exposed to the outside. Refer to the recommended bolt tightening torque guidelines at the end of the manual. An adhesive to prevent bolts from loosening is applied to some bolts. If the bolts are tightened with greater than the recommended torque, the adhesive might be removed. Therefore, follow the recommended bolt tightening torque guidelines when retightening the bolts.	7
	○ Only 1st Check	○					Check the 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. **⇒"8.2.6 Check of Fixed Mechanical Stopper and Adjustable Mechanical Stopper"**	8
	○ Only 1st check	○					Clean spatters, sawdust and dust	Check that spatters, sawdust, or dust does not exist on the robot main body. If dust has accumulated, remove it. Especially, clean the robot movable parts well (each joint 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)	9
			○				Replacing the mechanical unit batteries	Replace the mechanical unit batteries **⇒"8.3.1 Replacing the Batteries"**	11

Check and maintenance intervals (Period, Accumulated operating time)							Check and maintenance item	Check points, management and maintenance method	Periodic maintenance table No.
1 months 320h	3 months 960h	1 year 3840h	1.5 year 5760h	2 years 7680h	3 years 15360h	4 years 15360h			
				○			Replacing the wrist part fluoric resin ring	Replace the wrist part fluoric resin ring Contact your local FANUC representative for information regarding replacing the fluoric resin ring. **⇒"8.2.4 Check the Failure of the Wrist Part Fluoric Resin Ring"**	19
				○			Replacing the Material handling (M/H) conduit	Replace the Material handling (M/H) conduit. Contact your local FANUC representative for information regarding replacing the Material handling (M/H) conduit	18
					○		Replacing the grease and oil of the J1-J3 axes reducer and J4-J6-axes gear box	Replace the grease and oil of each axis reducer and gearbox **⇒"8.3.2 Replacing the Grease and Oil of the Drive Mechanism"**	12-16
						○	Replacing the mechanical unit cable	Replace the mechanical unit cable Contact your local FANUC representative for information regarding replacing the cable.	17
						○	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)"**	22

8.2 CHECK POINTS

8.2.1 Confirmation of Oil Seepage

Check items

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

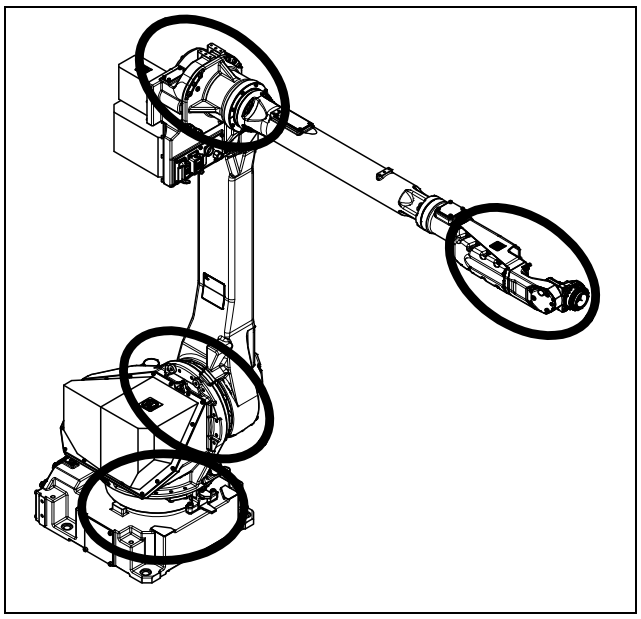


Fig. 8.2.1 Check parts of oil seepage

Management

- Oil might accumulate on the outside of the seal lip depending on the movement condition or environment of the axis. If the oil changes to a state of liquid, the oil might fall depending on the axis movement. To prevent oil spots, be sure to wipe away any accumulated oil under the axis components before you operate the robot.
- In case of oil seepage, please consider replacing the grease. This replacement potentially can help improving the seepage situation.
- Also, motors might become hot and the internal pressure of the grease bath or oil bath might rise by frequent repetitive movement and use in high temperature environments. In these cases, normal internal can be achieved by venting the grease outlet. (When opening the grease outlet of J1 to J4-axis, refer to Subsection 8.3.2 and ensure that grease is not expelled onto the machine or tooling. When opening the oil outlet of J4 to J5-axis, put a oil pan under the oil outlet or place the oil outlet at the upper side.)

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

- If you must wipe oil frequently, and opening the grease outlet does not stop the seepage, perform the measures below.
  ⇒**" 10.1 TROUBLESHOOTING"(symptom : Grease leakage)**

8.2.2 Confirmation of the Air Control Set

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

Item	Check items	Check points
1	Air pressure	Check the air pressure using the pressure gauge on the air control set as shown in Fig. 8.2.2. If it does not meet the specified pressure of 0.49 to 0.69 MPa (5-7 kgf/cm^2), adjust it using the regulator pressure-setting handle.
2	Lubricator oil mist quantity	Check the number of oil drops during operation. If it does not meet the specified value (1 drop/10-20 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 empty it. When the quantity of liquid in the drain is excessive, examine the setting of the air dryer on the air supply side.

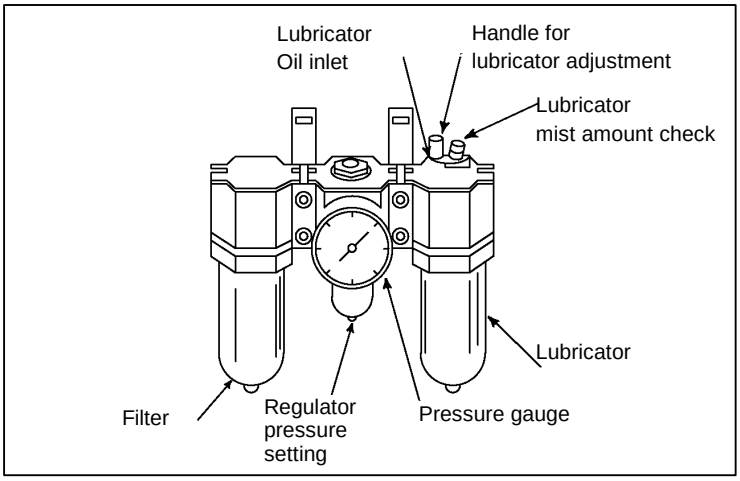


Fig. 8.2.2 Air control set (option)

8.2.3 Check the Oil Sight Glasses

Please confirm whether the amount of oil of the oil sight glass of J5/J6-axes gearboxes has come above the 1/4 of total height. Please replenish it in case of the shortage. Through the oil sight glass might not have air part, but this is not trouble. When oil does not fill enough, the red index of the oil sight glass shows the reflected heat of the light, and the outline of the index is seen clearly. When oil fills enough, it does not show this reflected heat, and the outline of the index is not clear. When the oil sight glass cannot be read at all because of the oil discoloration due to deterioration, like a right edge of Fig. 8.2.3, exchange oil referring to Subsection 8.3.2.

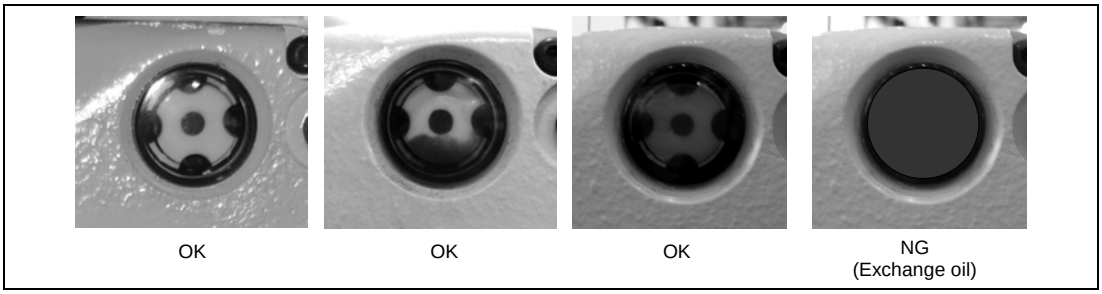


Fig. 8.2.3 The extent of oil deterioration

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

8.2.4 Check the Failure of the Wrist Part Fluoric Resin Ring

Check to see whether there is failure on the wrist part fluoric resin ring. If is broken, replace it by new one.
Two years are aims in an exchange period. If you operate robot with the state that hard mine dust is attached to rotated part, exchange period may shortens. (Spec. of fluoric resin ring : A290-7221-X571)

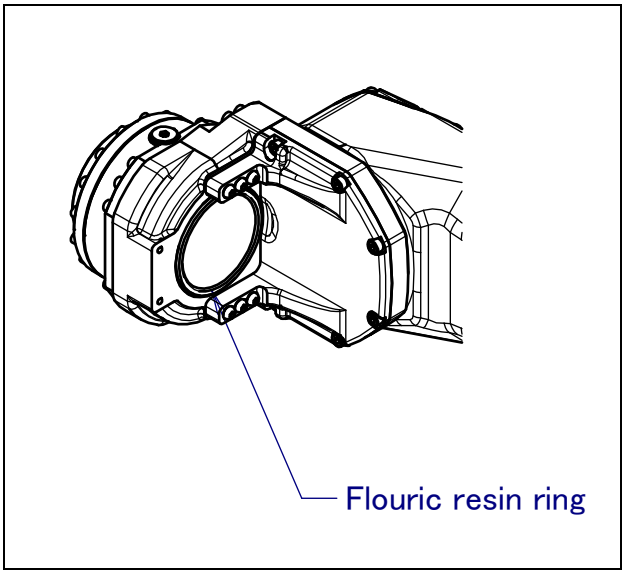


Fig. 8.2.4 (a) Fluoric resin ring

If the fluoric resin rig is broken as shown in Fig. 8.2.4 (b), replace it.

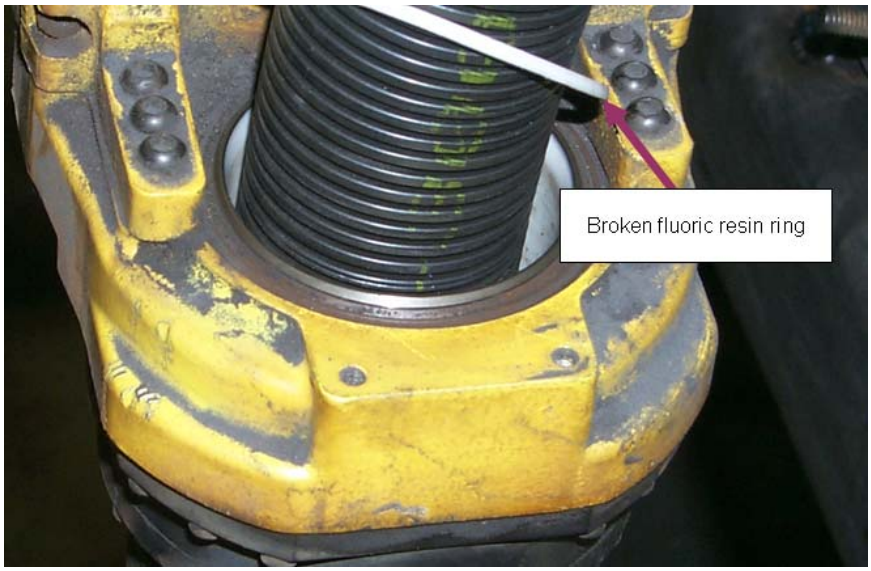


Fig. 8.2.4 (b) Failure of the fluoric resin ring

8.2.5 Check the Mechanical Unit Cables and Connectors

Inspection points of the mechanical unit cables

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

Check items

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

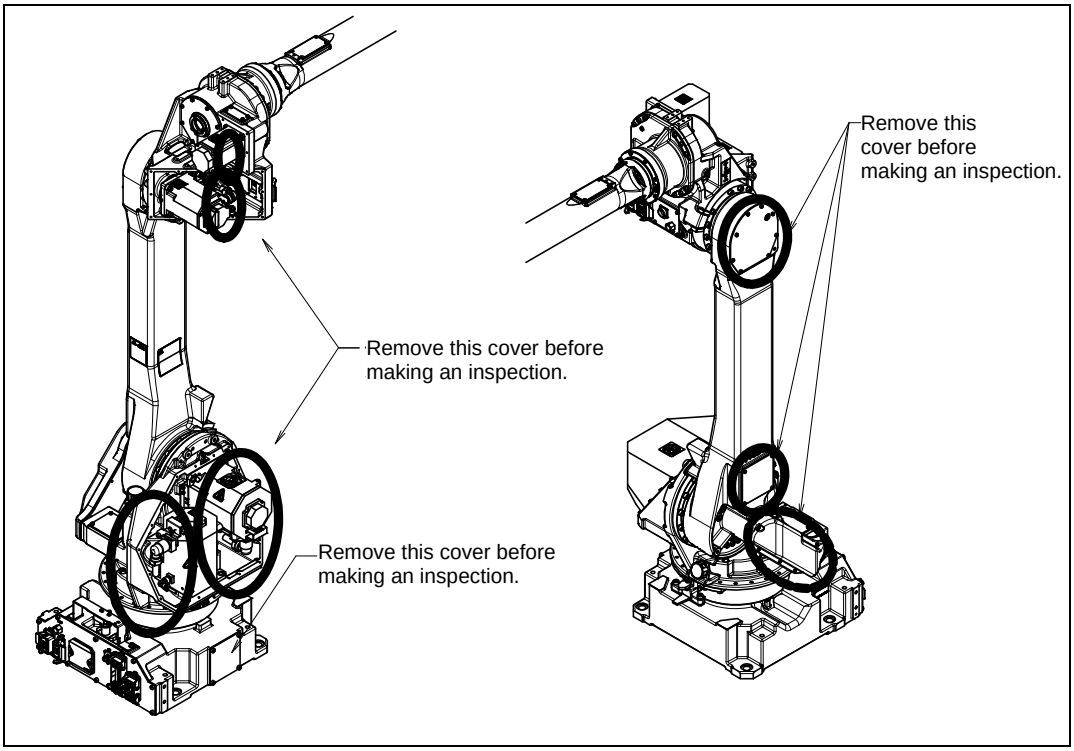


Fig. 8.2.5 (a) Inspection points of the mechanical unit cables

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.

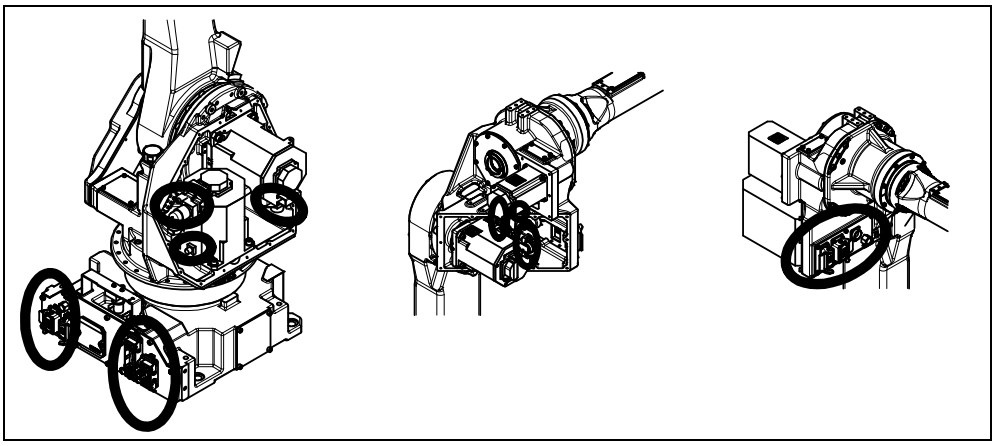


Fig. 8.2.5 (b) Connector Inspection points

8.2.6 Check of Fixed Mechanical Stopper and Adjustable Mechanical Stopper

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

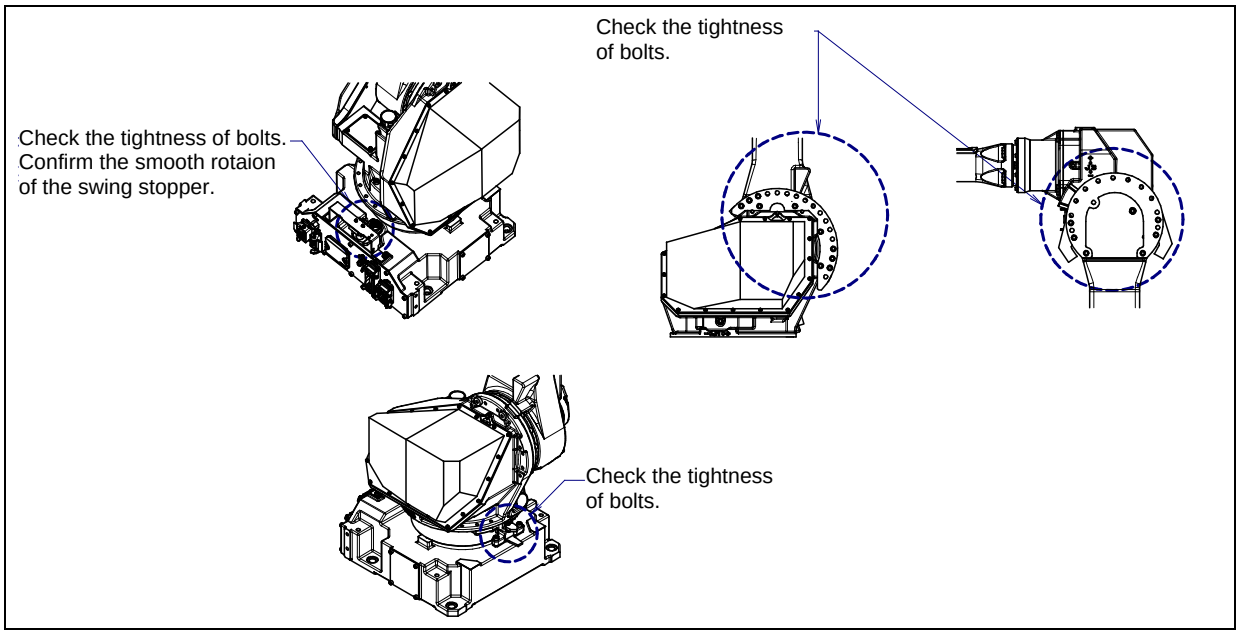


Fig. 8.2.6 Check of fixed mechanical stopper and adjustable mechanical stopper

8.3 MAINTENANCE

8.3.1 Replacing the Batteries (1.5 Year checks)

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

Procedure of replacing the battery

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

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

2 Remove the battery case cap (Fig. 8.3.1).
3 Take out the old batteries from the battery case.
4 Insert new batteries into the battery case. Pay attention to the direction of batteries.
5 Close the battery case cap.

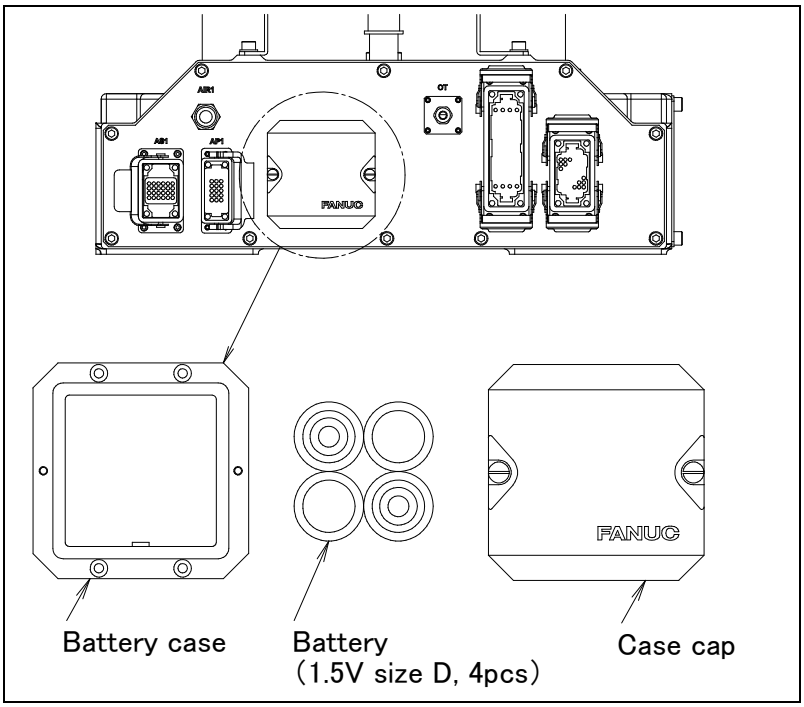


Fig. 8.3.1 Replacing the battery

8.3.2 Replacing the Grease and Oil of the Drive Mechanism (3-years (11520 Hours) Checks)

According to below, replace the grease of J1 to J3 axes reducer and J4/J5/J6-axes gearbox at the intervals based on every 3 years or 11520 hours, whichever comes first.

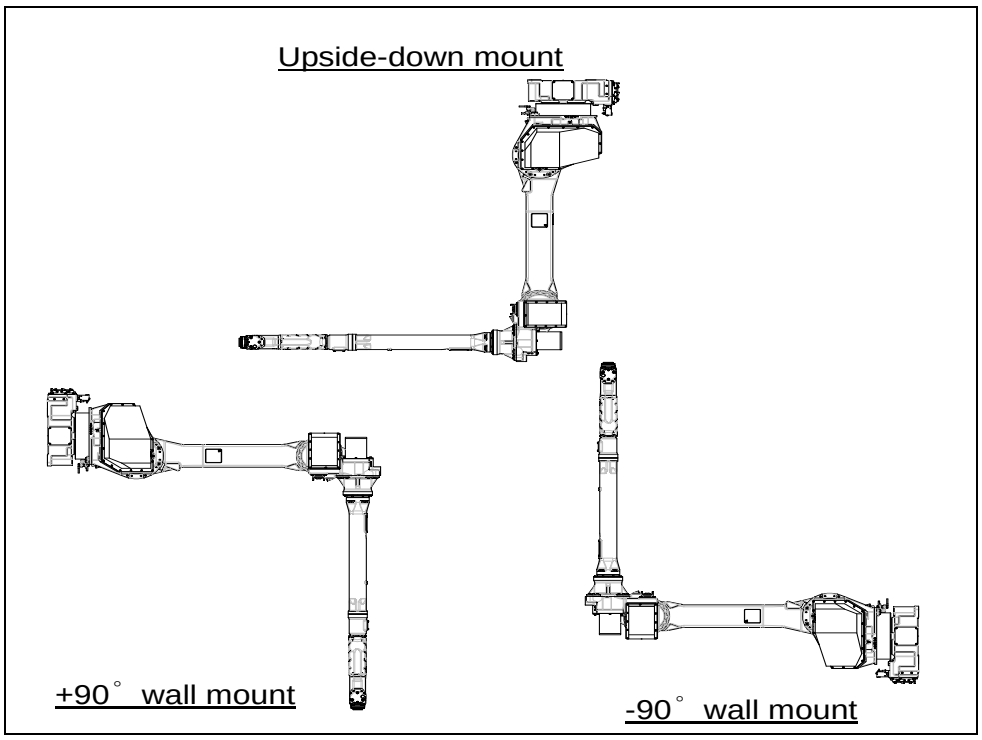


Fig. 8.3.2 Installation method

8.3.2.1 Grease replacement procedure of the J1, J2, J3-axis reducer and J4-axis gearbox

⚠ CAUTION

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

1 Before starting to grease, remove the seal bolt or the taper plug to allow the grease to come out.
2 Supply grease slowly, using a manual pump. (once per two seconds)
3 Whenever possible, avoid using an air pump, which is powered by the factory air supply.
  If the use of an air pump is unavoidable, supply grease with the pump at a pressure lower than or equal to the gun tip pressure (Table 8.3.2.1 (a)).
4 Use specified grease. Use of non-approved grease may damage the reducer or lead to other problems.
5 After greasing, release the remaining pressure from the grease bath using the procedure given in Subsection 8.3.2.2, and then close the grease inlet, the grease outlet and the ventilator hole.
6 To prevent the accident like fall, fire, remove all the excess grease from the floor and robot.

According to below, replace the grease of J1 to J3 axes reducer and J4-axis gearbox at the intervals based on every 3 years or 11520 hours, whichever comes first. See Table 8.3.2.1 (a) for the grease name and the quantity.

Table 8.3.2.1 (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	1500g (1660ml)		
J3-axis reducer	950g (1060ml)		
J4-axis gearbox	1300g (1480ml)		

NOTE
When using a hand pump, apply grease at a rate of approximately once per two seconds.

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

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

Table 8.3.2.1 (b) Postures for greasing

Supply position		Posture					
		J1	J2	J3	J4	J5	J6
J1-axis reducer	Floor mount	0°	Arbitrary	Arbitrary	Arbitrary	Arbitrary	Arbitrary
	Upside-down mount						
	-90° wall mount						
	+90° wall mount						
J2-axis reducer	Floor mount	Arbitrary	0°	Arbitrary	Arbitrary	Arbitrary	Arbitrary
	Upside-down mount						
	-90° wall mount						
	+90° wall mount						
J3-axis reducer	Floor mount	Arbitrary	0°	0°	Arbitrary	Arbitrary	Arbitrary
	Upside-down mount						
	-90° wall mount						
	+90° wall mount						
J4-axis gearbox	Floor mount	Arbitrary	Arbitrary	0°	Arbitrary	Arbitrary	Arbitrary
	Upside-down mount			180°			
	-90° wall mount	0°		-90°			
	+90° wall mount			90°			

1 Move the robot to the greasing posture described in Table 8.3.2.1 (b).
2 Turn off the controller power.
3 Remove the seal bolt from grease outlet. (Fig. 8.3.2.1 (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 8.3.2.2.

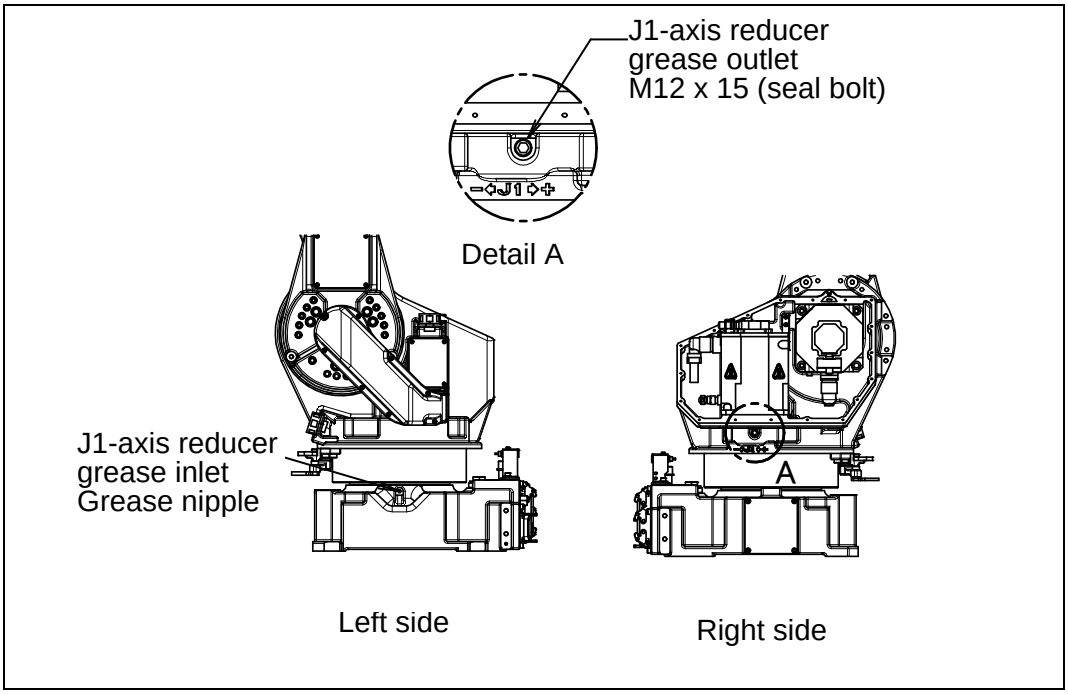


Fig. 8.3.2.1 (a) Replacing grease of the J1-axis reducer

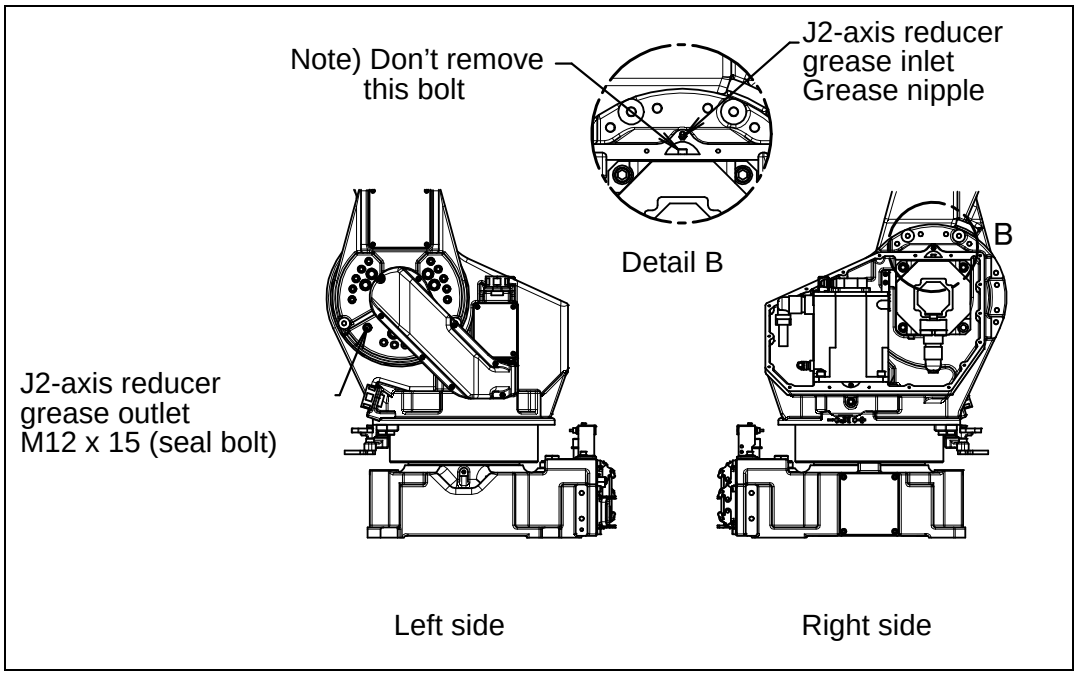


Fig. 8.3.2.1 (b) Replacing grease of the J2-axis reducer

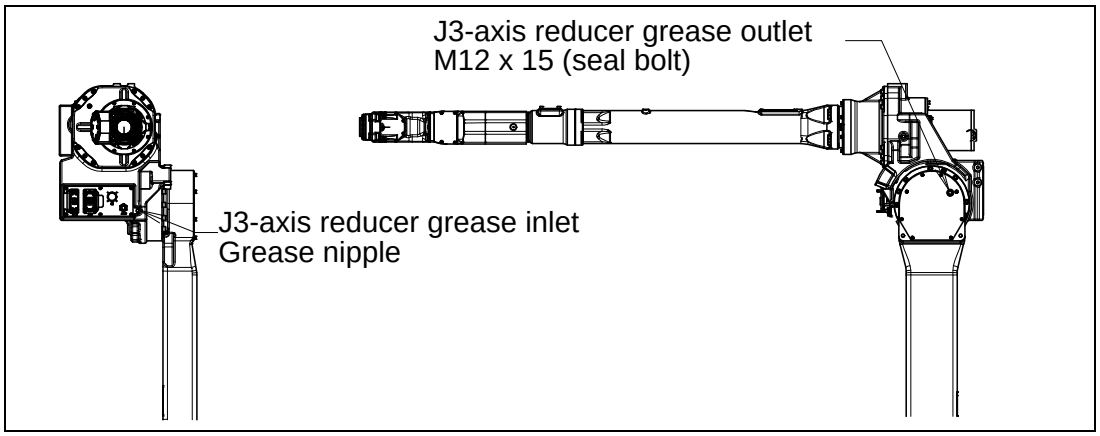


Fig. 8.3.2.1 (c) Replacing grease of the J3-axis reducer

Table 8.3.2.1 (c) Specification of the seal bolt (J1 to J3-axis)

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

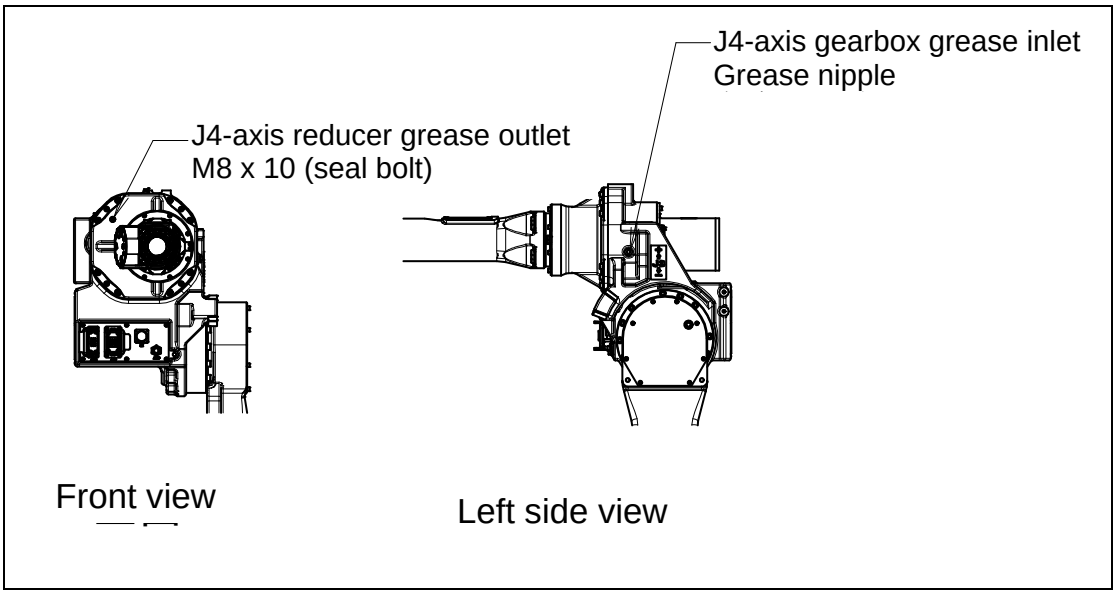


Fig. 8.3.2.1 (d) Replacing grease of the J4-axis gearbox

Table 8.3.2.1 (d) Specification of the seal bolt and grease nipple (J4-axis)

Parts name	Specifications
Seal bolt (M8)	A97L-0218-0417#081010
Grease nipple	A97L-0218-0013#A610

8.3.2.2 Procedure for releasing remaining pressure from the grease bath (J1 to J4-axis)

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

<table>
<tr><th>Operating axis / Grease replacement part</th><th>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 80%</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 80%</td><td colspan="2">Arbitrary</td></tr>
<tr><td>J4-axis gearbox</td><td colspan="3">Arbitrary</td><td>Axis angle of 60° or more OVR 80%</td><td>Arbitrary</td></tr>
</table>

If the above operation cannot be performed due to the environment of the robot, prolong the operating time so that an equivalent operation can be performed. (When the maximum allowable axis angle is 30 degrees, perform the twice operation for 40 minutes or more.) If you grease or supply oil multiple axes, you can exercise multiple axes at the same time. After completion of the operation, attach the taper plug and seal bolts to the grease inlets and outlets. When reusing the seal bolts, be sure to seal them with seal tape.

After replacing grease or oil, grease bath or oil bath may rise if robot is operated again under frequent inversion movement or high temperature environment. In these cases, you can return internal pressure by releasing grease out let or oil outlet just after operation of robot. (When opening grease outlet or oil outlet, attention grease or oil is not scattered.)

8.3.2.3 Oil replacement procedure for the J5/J6- axis gearbox

> **⚠ CAUTION**
> There is severe risk of gear damage in case robot is operated with oil shortage.
> Please make sure the gearbox is always filled with correct amount of oil.

Table 8.3.2.3 (a) Oil name and amount of oiling of standard to be replaced at regular intervals of three years (11520 hours)

Oiling points	Amount of oil to be applied (total capacity of the oil bath) NOTE 1)	Gun tip pressure	Specified oil
J5/J6-axis gearbox	330g(390ml)	0.1MPa or less	JXTG Nippon Oil & Energy Corporation BONNOC AX68 (Specification: A98L-0040-0233)

NOTE 1) It is not a regulated amount injection. Please confirm height of oil sight glass oil surface is 1/4 or more of all heights. Refer to Fig. 8.3.2.3 (a).

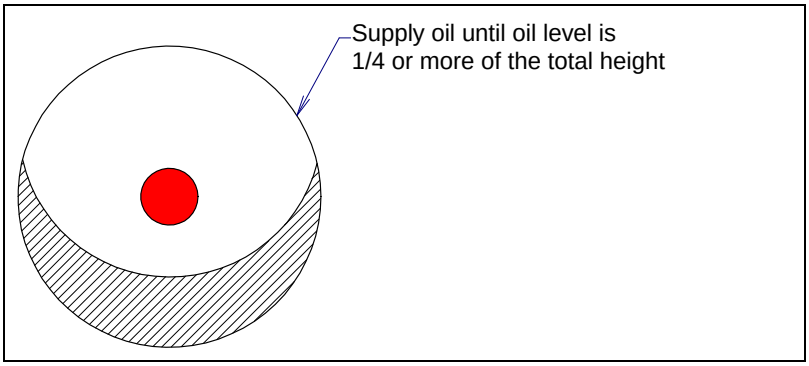


Fig. 8.3.2.3 (a) Oil sight glass

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

Table 8.3.2.3 (b) Oiling posture (J5/J6-axis gearbox)

Oiling points		Posture					
		J1	J2	J3	J4	J5	J6
J5/J6-axis gearbox Oiling posture when using oil gun	Floor mount	Arbitrary	Arbitrary	18°	-40°	0°	Arbitrary
	Upside-down mount			-18°	140°		
	Wall mount -90°	0°		-72°	-40°		
	Wall mount +90°			108°	-40°		
J5/J6-axis gearbox Oiling posture when not using oil gun	Floor mount	Arbitrary		18°	90°		
	Upside-down mount			-18°	-90°		
	Wall mount -90°	0°		-72°	90°		
	Wall mount +90°			108°	90°		
J5/J6-axis gearbox oil replenishment	Floor mount	Arbitrary		90°	0°		
	Upside-down mount			-90°	0°		
	Wall mount -90°	0°		0°	0°		
	Wall mount +90°			180°	0°		
J5/J6-axisgearbolx oil discharge	Floor mount	Arbitrary		-30°	-70°		
	Upside-down mount			30°	110°		
	Wall mount -90°	0°		-210°	-70°		
	Wall mount +90°			150°	-70°		
J5/J6-axis gearbox confirm oiling	Floor mount	Arbitrary		0°	0°		
	Upside-down mount			180°	0°		
	Wall mount -90°	0°		-90°	0°		
	Wall mount +90°			90°	0°		
J5/J6-axis gearbox releasing remaining pressure	Floor mount	Arbitrary		20° - 90°	90°		
	Upside-down mount			-20° - -90°	-90°		
	Wall mount -90°	0°		0° - 70°	-90°		
	Wall mount +90°			110°-180°	90°		

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

Exhausting oil method

1 Move the robot to the posture of J5/J6-axis (oil discharge) described in Table 8.3.2.3 (b).
2 Turn off controller power.
3 Put the oil pan under the oil outlet.
Remove the taper plug, extra low bolt and seal washer of first oil inlet and oil outlet. See Fig. 8.3.2.3 (b) In this time, if you remove bolt of oil outlet firstly, you can prevent spilling oil on surroundings.

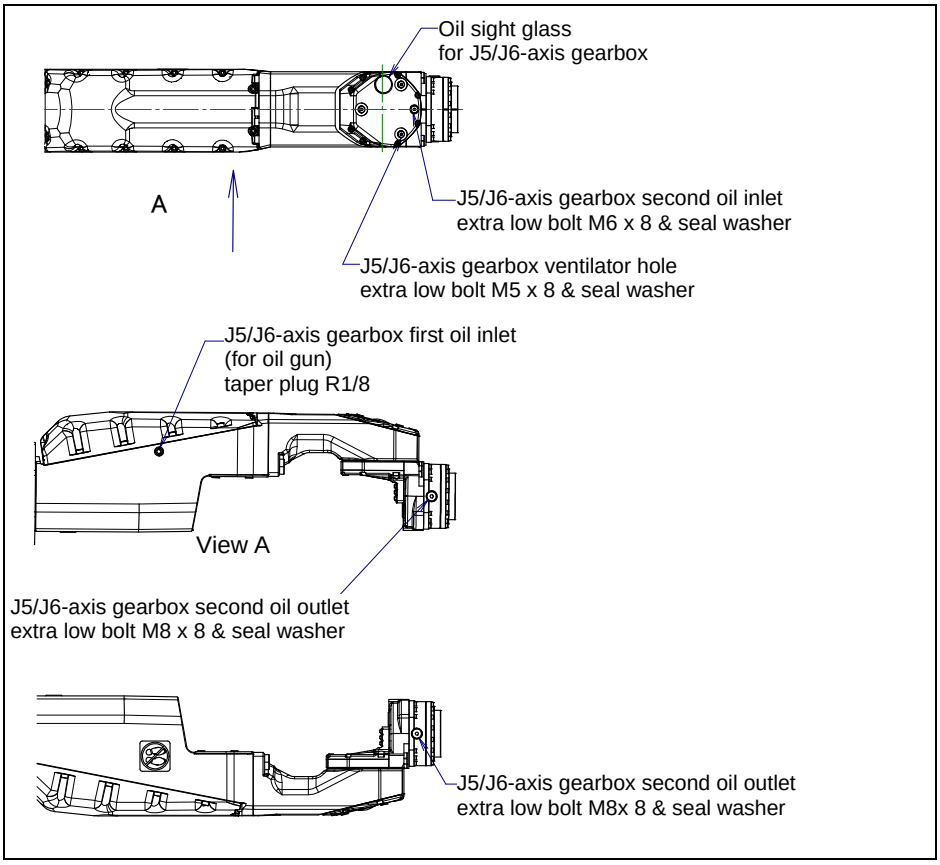


Fig. 8.3.2.3 (b) Oil inlet and outlet

Table 8.3.2.3 (c) Specification of extra low bolt, taper plug and seal washer

Parts name	Specification
Extra low bolt (M6)	A97L-0218-0502#M6X8
Extra low bolt (M8)	A97L-0218-0502#M8X8
Taper plug (R1/8)	A97L-0001-0436#1-1D
Seal washer (M5)	A30L-0001-0048#5M
Seal washer (M6)	A30L-0001-0048#6M
Seal washer (M8)	A30L-0001-0048#8M

4 Install the taper plug or extra low bolt and seal washer to the first oil outlet and oil outlet after all oil is exhausted.
5 Turn on controller power.

Injecting oil method

A When oil gun is used

1 Install oil injection nipple with valve to J5/J6-axis gearbox first oil inlet (A05B-1224-K006) (Fig. 8.3.2.3 (d)) referring to Fig.8.3.2.3 (c).
2 Attach oil tray with valve (A05B-1221-K007) to J5/J6-axis gearbox oil outlet (J6-axis bearing part).
3 Confirm valve of oil inlet and oil outlet are open referring to Fig.8.3.2.3 (c). Supply oil to J5/J6-axis gearbox by oil injection gun (A05B-1221-K005). If oil comes out in oil tray from oil outlet, Stop supplying oil, close the valve oil injection nipple, and remove oil gun
4 Close the valve of oil tray, remove tray and close the oil outlet.
5 Remove the oil injection nipple, then attach extra low bolt and seal washer to first oil inlet.
6 Move robot to the posture for J5/J6-axis gearbox (replenishment) of Table 8.3.2.3 (b) and add oil from second oil inlet (M5) by a syringe fountain pen filler. If about 15ml of oil is added, oil comes out from oil inlet. Then close the oil inlet.
7 Move robot to the posture for J5/J6-axis gearbox (confirm oiling) of Table 8.3.2.3 (b) and confirm the quantity of oil. (See Fig.8.3.2.3 (a).)
8 Turn J4-axis 90 degree by each axis jog, back to the original posture, confirm oil amount height is 1/4 or more. If oil is insufficient, add oil by a syringe fountain pen filler.
9 Release remaining the pressure using the procedure given in Subsection 8.3.2.4 and confirm the oil sight glass again.

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

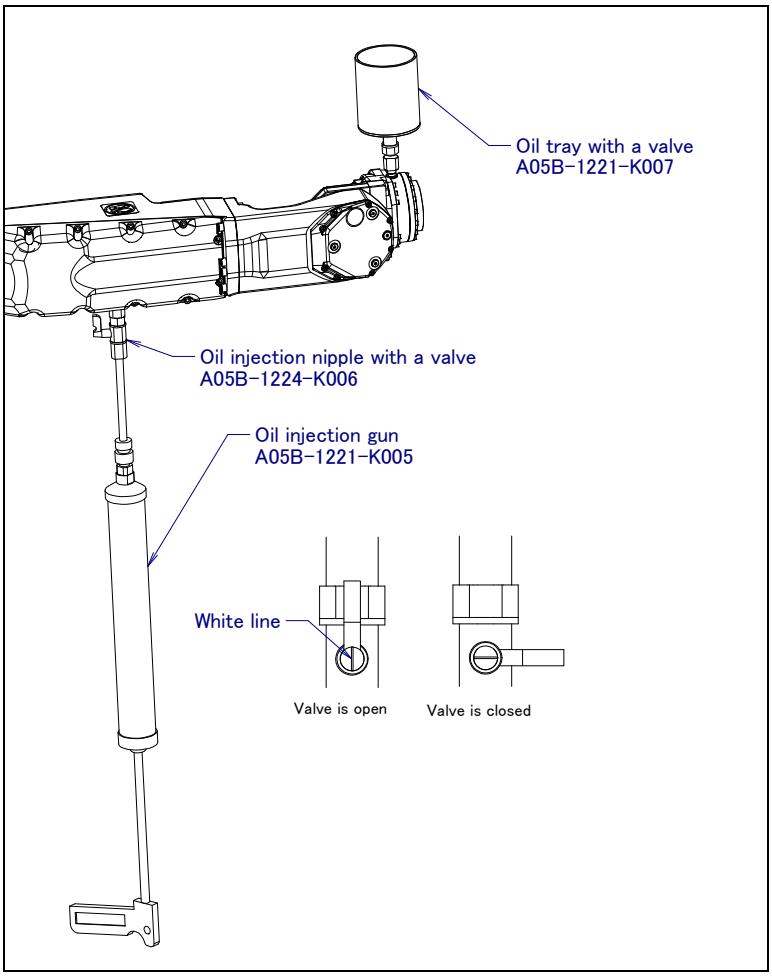


Fig. 8.3.2.3 (c) Oil injection by oil gun

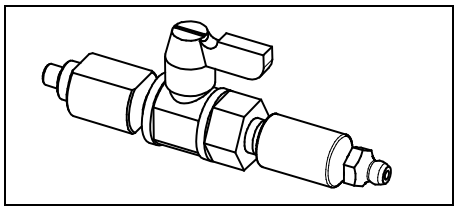


Fig. 8.3.2.3 (d) Oil injection nipple with valve (A05B-1224-K006)

B When oil gun is not used

(1) Remove extra low bolt and seal washer of ventilator hole and second oil inlet of Fig.8.3.2.3 (b) and supply oil. When the adaptor for oiling (A290-7221-X591) is used, oiling is easy. (Fig. 8.3.2.3 (e). In case of using adaptor for oiling, install it to second oil inlet. remove J5/J6-axis gearbox ventilator hole and supply oil. The amounts of oiling are about as many as two adaptors. It takes about five minutes to oil as many as one cup.

(2) When oil comes out from ventilator hole, In case of using adapter for oiling ,remove it, close the ventilator hole, move robot to the posture (confirm oiling) of Table 8.3.2.3 (b) and confirm amount of oil sight glass. (See Fig. 8.3.2.3 (a)) If oil is not sufficient, replenish it by a syringe fountain pen filler.

(3) Move the robot to the posture (replenishment) and add oil from second oil inlet (M6). If about 15ml of oil is added, oil comes out from oil inlet. Then close the oil inlet.

(4) Move robot to the posture for J5/J6-axis gearbox (confirm oiling) of Table 8.3.2.3 (b).In this time, rotate the J4-axis to +/- direction and confirm oil does not decrease. If it decreased, move the robot to the posture for J5/J6-axis gearbox (confirm oiling) of Table 8.3.2.3 (b). and add oil from second oil inlet (M6) by a syringe fountain pen filler.

(5) Release the remaining pressure using the procedure given in Subsection 8.3.2.4.

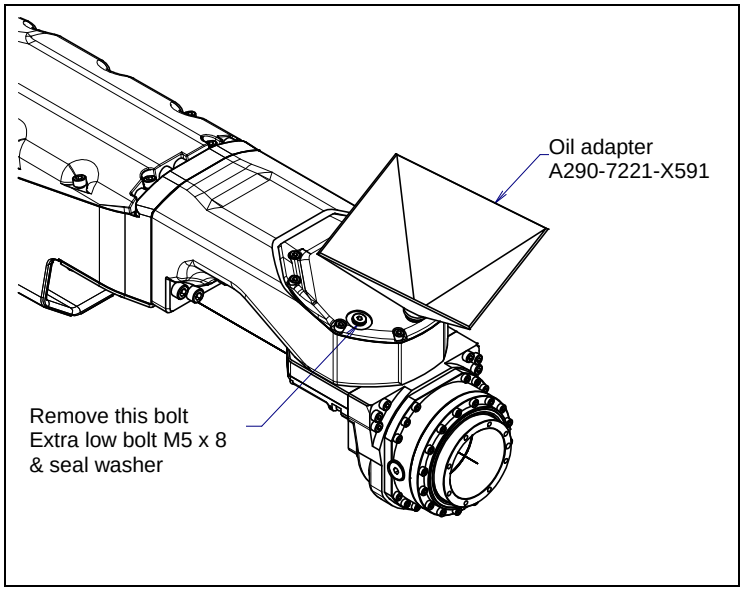


Fig. 8.3.2.3 (e) Oil adapter (supplying oil J5/J6-axis gearbox)

8.3.2.4 Procedure for releasing remaining pressure from the oil bath (J5/J6-axis)

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

In case of J5/J6-axis gearbox

Confirm that oil level seen in oil sight glass is as per Fig. 8.3.2.3 (a). If it was confirmed then please jog robot to the posture of J5/J6 (Release remaining pressure). Attach extra low bolt and seal washer of the second oil inlet (M6) but keep it loose. Operate robot J5 and J6 axis during 10 minutes, at 100% override, making 90 degrees motion (or more) on both axis. When completed, please jog to the posture of J5/J6 (Replenishment). Remaining pressure release at once if second oil inlet is opened.
Temporary close the second oil inlet, move the robot to posture of J5/J6 (confirm oiling), then confirm that oil level seen in oil sight glass is above 1/4 or more of total height. At this time, please rotate the J4 axis in the direction of +/-, and confirm that the amount of oil doesn't decrease. Move robot to the posture of J5/J6 (Replenishment) again and add oil from the second oil inlet with the syringe etc. when decreasing after operation, move the robot to posture of J5/J6 (confirm oiling), confirm the oil amount.
Then wipe off the oil that adhered to the surface of the robot off when confirming it and close the first oil inlet completely.
If the above operation cannot be performed due to the environment of the robot, prolong the operating time so that an equivalent operation can be performed. (When the maximum allowable axis angle is 45 degrees, perform the twice operation for 20 minutes or more.) After completion of the operation, attach the taper plug to the oil inlets. If you grease or supply oil multiple axes, you can exercise multiple axes at the same time.

After replacing grease or oil, grease bath or oil bath may rise if robot is operated again under frequent inversion movement or high temperature environment. In these cases, you can return internal pressure by releasing grease out let or oil outlet just after operation of robot. (When opening grease outlet or oil outlet, attention grease or oil is not scattered.)

> ⚠ **CAUTION**
> When reusing seal bolt and taper plug, be sure to seal t thread part with seal tape.
> As for the seal washer, In one side, rubber sticks to the entire and the other side, rubber sticks to only around hole and rubber sticks is incomplete state, Attach later face to bolt side. Confirm seal washer by viewing. If it is damaged obviously, replace it by new one.
> See Table 8.3.2.3 (c) about specification of seal bolts and seal washer.

8.4 STORAGE

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

9 MASTERING

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

9.1 OVERVIEW

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

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

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

Types of Mastering

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

Table 9.1 Type of mastering

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

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

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

> ⚠ **WARING**
> 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 It is recommended that the current mastering data be backed up before mastering is performed.

9.2 RESETTING ALARMS AND PREPARING FOR MASTERING

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

Alarm displayed

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

Procedure

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

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

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

9.3 ZERO POSITION MASTERING

Zero-position mastering (witness mark mastering) is performed with all axes set at the 0-degree position. A zero-position mark (witness mark) is attached to each robot axis (Fig. 9.3 (a), (b)). This mastering is performed with all axes set at the 0-degree position using their respective witness marks.

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

Zero-position Mastering Procedure

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

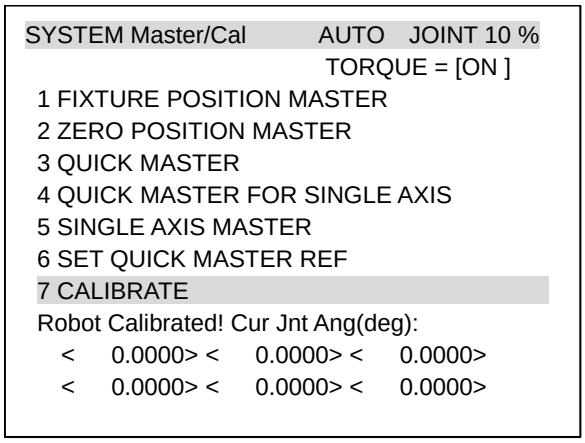
5 Release brake control, and jog the robot into a posture for mastering.

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

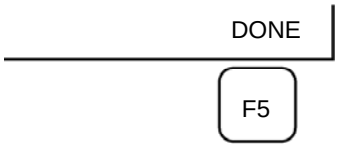
6 Select [2 ZERO POSITION MASTER]. Press F4 [YES].

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

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



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



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

Table 9.3 Posture with position marks (witness mark) aligned

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

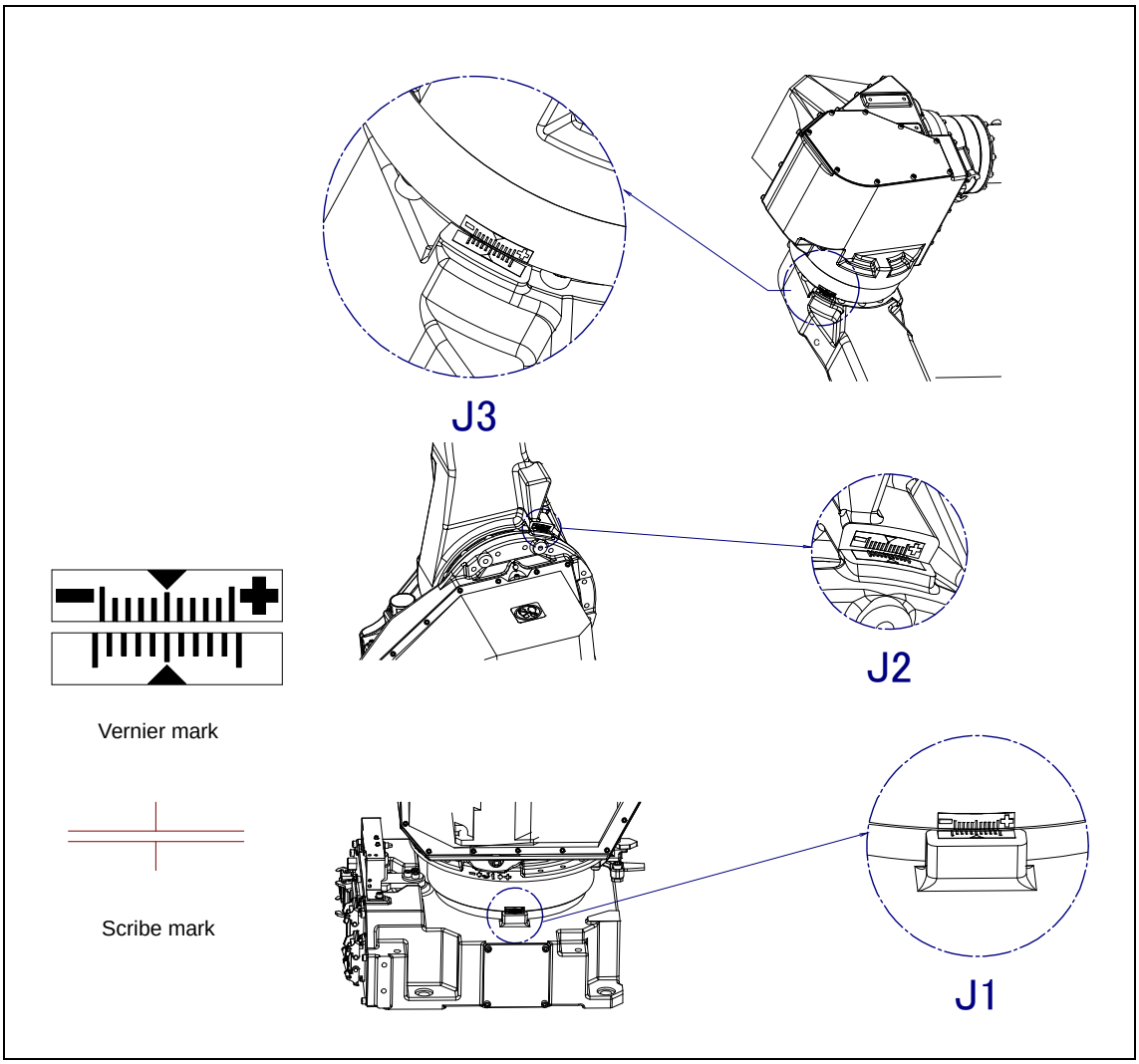


Fig. 9.3 (a) zero-position mark (witness mark) for each axis (J1 to J3 axes)

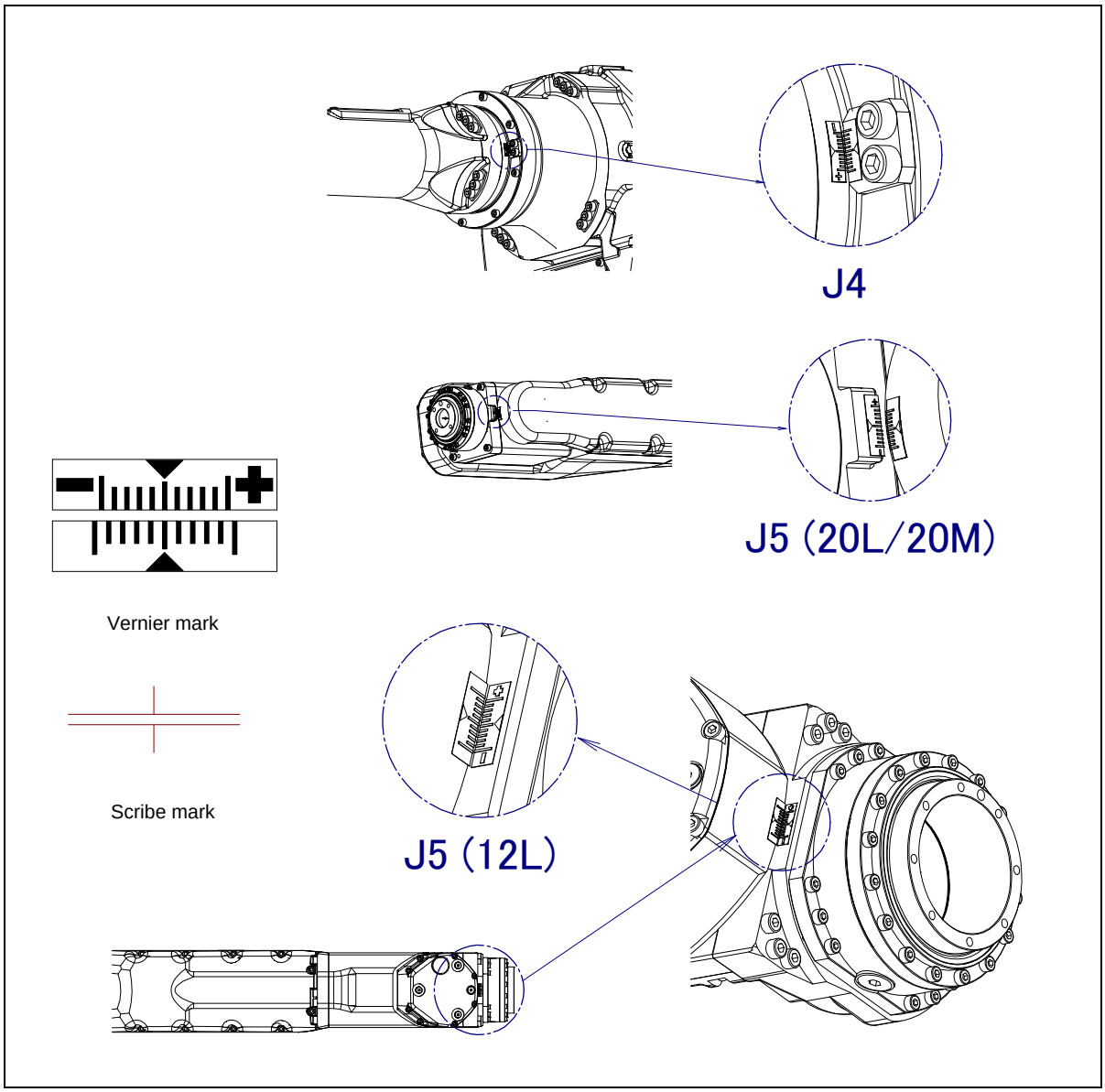


Fig. 9.3 (b) zero-position mark (witness mark) for each axis (J4 to J6 axes)

9.4 QUICK MASTERING

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

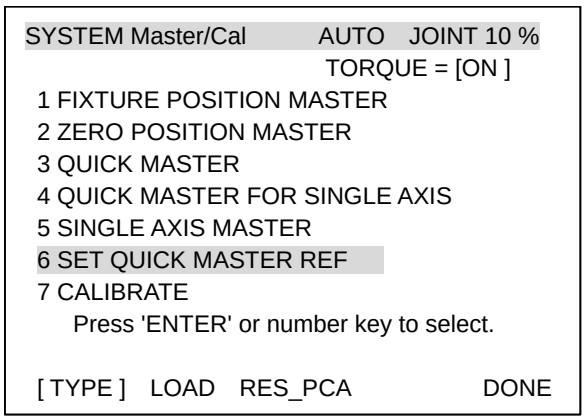
Quick mastering is factory-performed at the position indicated in Table 9.3. Do not change the setting unless there is any problem.

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

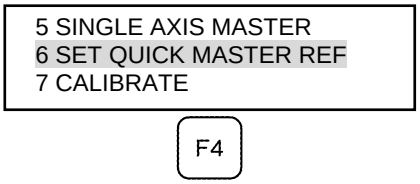
> ⚠ **CAUTION**
> 1 Quick mastering can be used, if the pulse count value is lost, for example, because a low voltage has been detected on the backup battery for the pulse counter.
> 2 Quick mastering cannot be used, after the Pulsecoder is replaced or after the mastering data is lost from the robot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

Procedure for Recording the Quick Mastering Reference Position

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



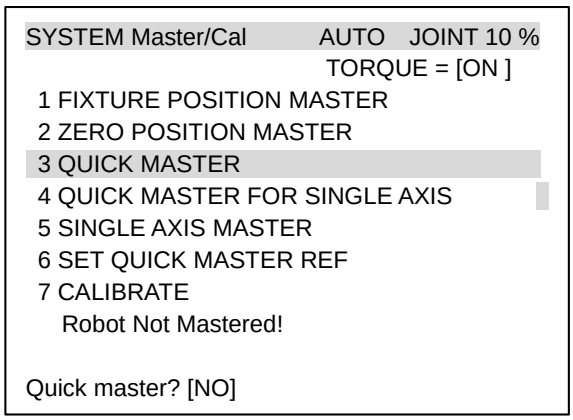
3 Release brake control, and jog the robot to the quick mastering reference position.
4 Select [6 SET QUICK MASTER REF] and press F4 [YES]. Quick mastering reference position will be set.



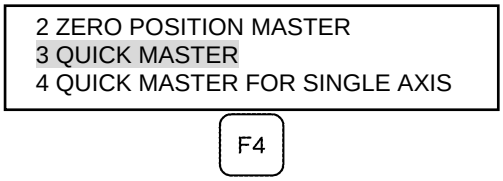
> ⚠ **CAUTION**
> If the robot has lost mastering data due to mechanical disassembly or repair, you cannot perform this procedure. In this case, perform Fixture position mastering or Zero position mastering to restore mastering data.

Procedure of Quick Mastering

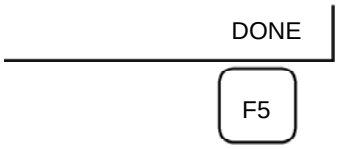
1 Display the Master/Cal screen.



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.

9.5 QUICK MASTERING FOR SINGLE AXIS

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

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

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

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

Procedure for Recording the Quick Mastering Reference Position

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

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

 [ TYPE ]   LOAD   RES_PCA                DONE
```

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

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

F4

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

Procedure of Quick Mastering for single axis

1 Display the Master/Cal screen.

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

Quick master? [NO]
```

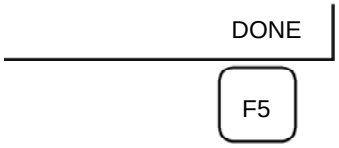
2 Select [4 QUICK MASTER FOR SINGLE AXIS]. The quick master for single axis screen will be displayed.

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

                                                EXEC
```

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

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

                                                EXEC
```

4 Turn off brake control, then jog the robot to the quick mastering reference position.
5 Press F5 [EXEC]. Mastering is performed. So, [SEL] is reset to 0, and [ST] is re-set to 2.
6 Move the cursor to [7 CALIBRATE] and press the [ENTER] key. Calibration is executed. Calibration may also be 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.

9.6 SINGLE AXIS MASTERING

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

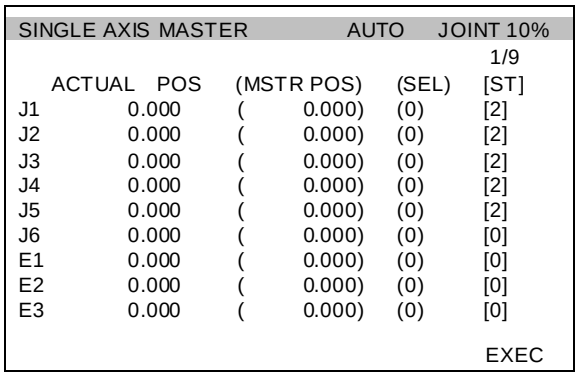


Table 9.6 Items set in single axis mastering

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

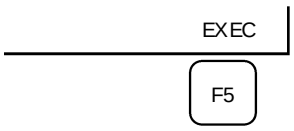
1 Select [6 SYSTEM].
2 Select [Master/Cal].

```
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]. You will see a screen similar to the following.

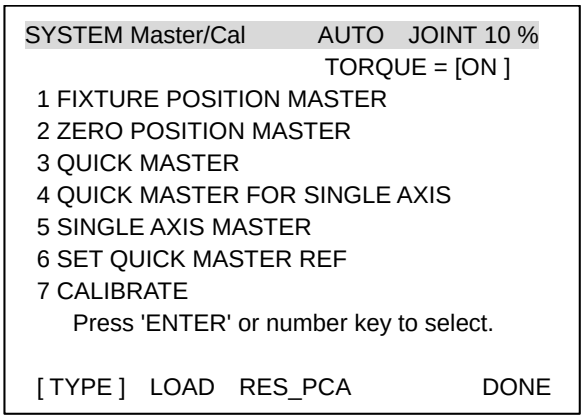
```
SINGLE AXIS MASTER          AUTO    JOINT 10%
                                          1/9
   ACTUAL  POS    (MSTR POS)    (SEL)   [ST]
J1        0.000   (     0.000)   (0)     [2]
J2        0.000   (     0.000)   (0)     [2]
J3        0.000   (     0.000)   (0)     [2]
J4        0.000   (     0.000)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

                                          EXEC
```

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



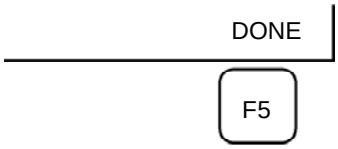

```
SINGLE AXIS MASTER          AUTO    JOINT 10%
                                          6/9
   ACTUAL  POS    (MSTR POS)    (SEL)   [ST]
J1        0.000   (     0.000)   (0)     [2]
J2        0.000   (     0.000)   (0)     [2]
J3        0.000   (     0.000)   (0)     [2]
J4        0.000   (     0.000)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

                                          EXEC
```

8 When single axis mastering is completed, press the [PREV] key ey 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].



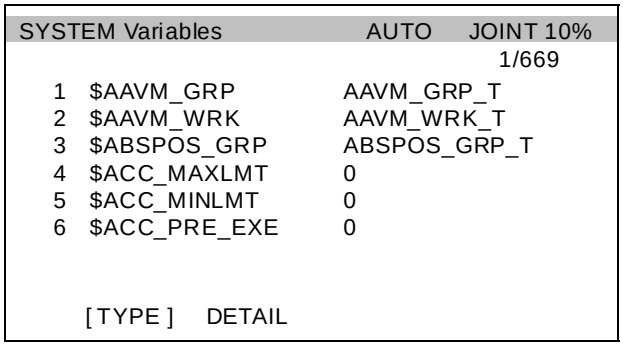
11 Return brake control to original setting, and cycle power of the controller.

9.7 MASTERING DATA ENTRY

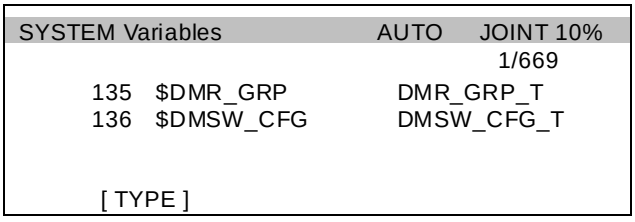
This function enables mastering data values to be assigned directly to a system variable. It can be used if mastering data has been lost but the pulse count is preserved.

Mastering data entry method

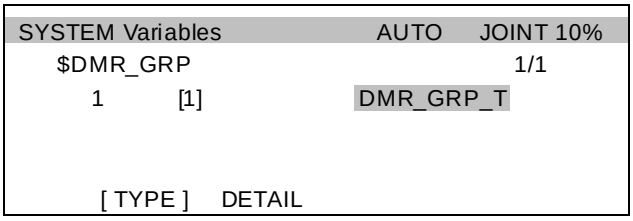
1 Press the [MENU] key, then press [0 NEXT] and select [6 SYSTEM].
2 Press F1 [TYPE]. Select [Variables]. The system variable screen appears.

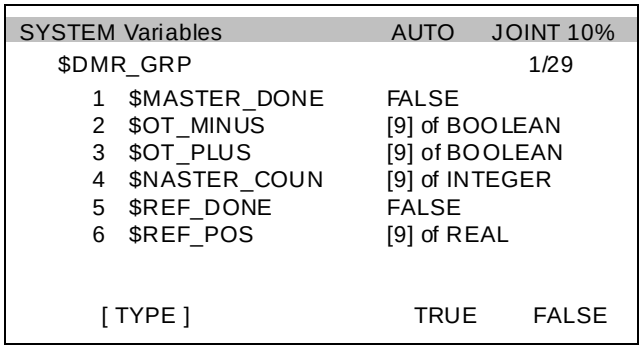


3 Change the mastering data. The mastering data is saved to the $DMR_GRP.$MASTER_COUN system variable.

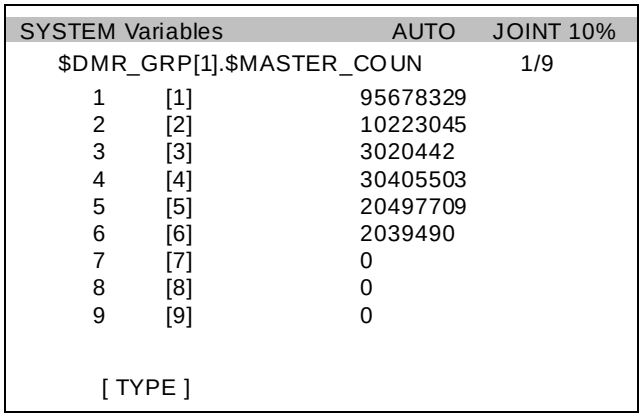


4 Select $DMR_GRP.

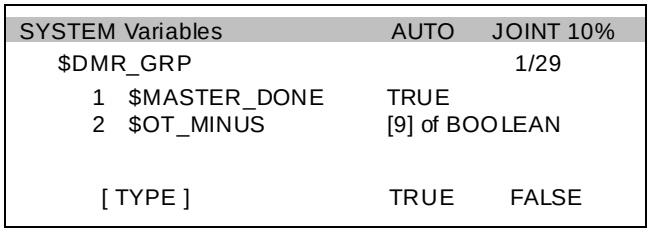




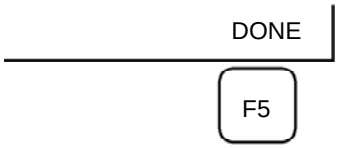
5 Select $MASTER_COUN, and enter the mastering data you have recorded.



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



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



9.8 CHECKING THE MASTERING

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

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

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

10 TROUBLESHOOTING

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

10.1 TROUBLESHOOTING

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

Table 10.1 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, remove it. - As the robot operates, the rack or floor on which the robot is mounted vibrates.
	- 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 deforms the rack or floor, and responsible for the 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 adopts a specific posture. - If the operating speed of the robot is reduced, vibration stops. - Vibration is most noticeable when the robot is accelerating. - Vibration occurs when two or more axes operate at the same time.	[Overload] - It is likely that the load on the robot is greater than the maximum rating. - It is likely that the robot control program is too demanding for the robot hardware. - It is likely that the ACCELERATION value is excessive.	- Check the maximum load that the robot can handle once more. If the robot is found to be overloaded, reduce the load, or modify the robot control program. - Vibration in a specific portion can be reduced by modifying the robot control program while slowing the robot and reducing its acceleration (to minimize the influence on the entire cycle time).

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- Vibration or noise was first noticed after the robot collided with an object or the robot was overloaded for a long period. - The grease of the vibrating or noise occurring axis has not been replaced for a long period.	[Broken gear, bearing, or reducer] - It is likely that collision or overload applied an excessive force on the drive mechanism, thus damaging the gear tooth surface or rolling surface of a bearing, or reducer. - Prolonged use with overloaded may cause the fretting fatigue on gear tooth surface or rolling surface of bearing and reducer. - It is likely that foreign material caught in a gear, bearing, or inside the reducer has 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 or oil 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 by neglect greasing. Above causes will bring to cyclical 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 or oiling with the specified grease can help prevent problems.

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	- The cause of problem cannot be identified from examination of the floor, rack, or mechanical 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. - 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 unusual sound after replacement of grease. - There is an unusual sound after a long period. - There is an unusual sound during operation at low speed.	- There may be an 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 with the hand causes part of the mechanical unit to wobble. - There is a gap on the mounting surface of the mechanical unit.	[Mechanical section coupling bolt] - It is likely that overloading or a collision has loosened a mounting bolt in the robot mechanical section.	- Check that the following bolts for each axis are tight. If any of these bolts is loose, apply LOCTITE and tighten it to the appropriate torque. - Motor retaining bolt - Reducer retaining bolt - Reducer shaft retaining bolt - Base retaining bolt - Arm retaining bolt - Casting retaining bolt - End effector retaining bolt

Symptom	Description	Cause	Measure
Motor overheating	- The motor overheated due to 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 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 the motor, it is advisable to install shielding to protect the motor from heat radiation. - Relaxing the robot control program and load condition is an effective way to reduce the average current. Thus, prevent overheating. - The teach pendant can monitor the average current. Check the average current when the robot control program launched.
	- After a control parameter (load setting etc.) was changed, the motor overheated.	[Parameter] - If data input for a workpiece is invalid, the robot cannot be 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 section problems] - It is likely that problems occurred in the mechanical unit drive mechanism, thus placing an excessive load on the motor. [Motor problems] - It is likely that a failure of the motor brake resulted in the motor running with the brake applied, thus placing an excessive load on the motor. - It is likely that a failure of the motor prevented it from delivering its rated performance, thus causing an excessive current to flow through the motor.	- Repair the mechanical unit while referring to the above descriptions of vibration, noise, and rattling. - Check that, when the servo system is energized, the brake is released. If the brake remains applied to the motor all the time, replace the motor. - If the average current falls after the motor is replaced, it indicates that the first motor was faulty.

Symptom	Description	Cause	Measure
Grease leakage	- Grease is leaking from the mechanical unit.	[Poor sealing] - Probable causes are a crack in the casting, a broken O-ring, a damaged oil seal, or a loose seal bolt. - A crack in a casting can occur due to excessive force that might be caused in collision. - An O-ring can be damaged if it is trapped or cut during disassembling or re-assembling. - An oil seal might be damaged if extraneous dust scratches the lip of the oil seal. - A loose seal bolt might allow grease to leak along the threads. - Problems with the grease nipple or threads.	- If a crack develops in the casting, sealant can be used as a quick-fix to prevent further grease leakage. However, the component should be replaced as soon as possible, because the crack might extend. - O-rings are used in the locations listed below. - Motor coupling section - Reducer (case and shaft) coupling section - Wrist coupling section - J3 arm coupling section - Inside the wrist - Oil seals are used in the locations stated below. - Inside the reducer - Inside the wrist - Seal bolts are used in the locations stated below. - Grease outlet - Replace the grease nipple.
Dropping axis	- An axis 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 moves to a point other than the taught position. - The repeatability is not within the tolerance.	[Mechanical section problems] - If the repeatability is unstable, probable causes are a failure in the drive mechanism or a loose bolt. - If the repeatability becomes stable, it is likely that a collision imposed an excessive load, leading to slipping on the base surface or the mating surface of an arm or reducer. - It is likely that the Pulsecoder is abnormal.	- If the repeatability is unstable, repair the mechanical section by referring to the above descriptions of vibration, noise, and rattling. - If the repeatability is stable, correct the taught program. Variation will not occur unless another collision occurs. - If the Pulsecoder is abnormal, replace the motor.
	- Displacement occurs only in a specific peripheral unit.	[Peripheral unit displacement] - It is likely that an external force was applied to the peripheral unit, thus shifting its position relative to the robot.	- Correct the setting of the peripheral unit position. - Correct the taught program.
	- Displacement occurred after a parameter was changed.	[Parameter] - It is likely that the mastering data was rewritten in such a way that the robot origin was shifted.	- Re-enter the previous mastering data, which is known to be correct. - If correct mastering data is unavailable, perform mastering again.
BZAL alarm occurred	- BZAL is displayed on the teach pendant screen	- It is likely that the voltage of the memory backup battery is low. - It is likely that the Pulsecoder cable is defected.	- Replace the battery. - Replace the cable.

11 SEVERE DUST/LIQUID PROTECTION PACKAGE (OPTION)

11.1 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/20L	A05B-1125-J808 (*1)
	A05B-1125-J818 (*2)
	A05B-1125-J826 (*3)

(*1) When mechanical unit cable for camera is not selected.
(*2) When mechanical unit cable for camera (A05B-1125-H451) is selected.
(*3) When mechanical unit cable for camera (A05B-1125-H452) is selected.

11.2 CONFIGURATION OF THE SEVERE DUST/LIQUID PROTECTION PACKAGE

The following table lists the major differences between the M-710*i*C/20L 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 connector	Non-waterproof connector	Waterproof connector
Others		Gaskets are added.

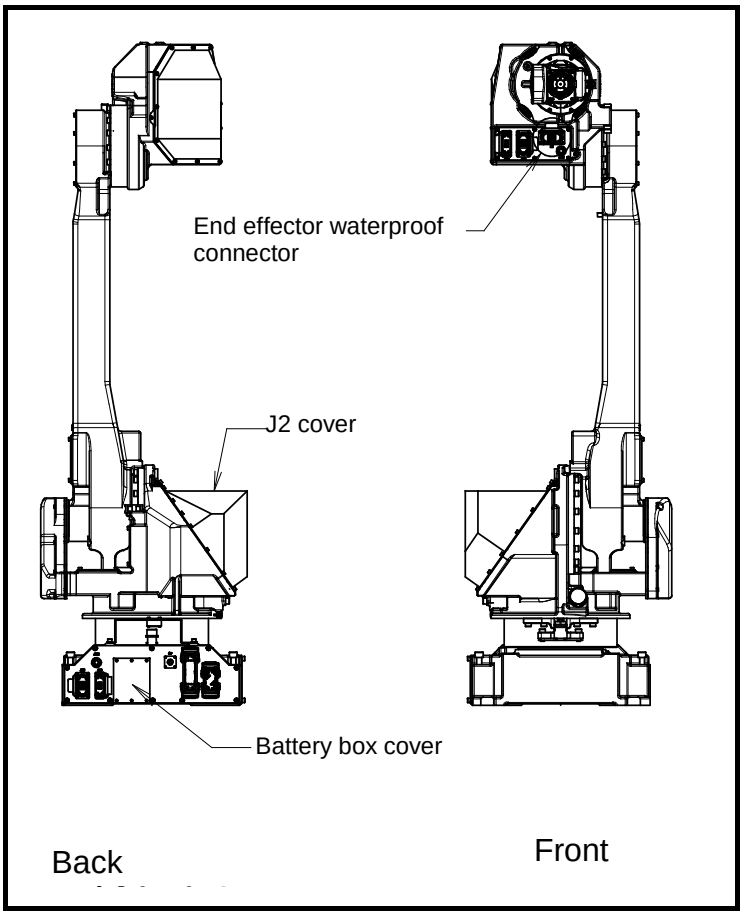


Fig. 11.2 Configuration of the Severe dust/liquid protection package of M-710*i*C/20L

APPENDIX

A PERIODIC MAINTENANCE TABLE

FANUC Robot M-710*i*C/20L/20M **Periodic Maintenance Table**

Items			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 end effector (hand) cable	0.1H	—		○			○				○			
	5	Check the motor connector and exposed connector (loosening)	0.2H	—					○				○			
	6	Tighten the end effector bolt	0.1H	—		○			○				○			
	7	Tighten the cover and main bolt	1.0H	—		○			○				○			
	8	Check the mechanical stopper and adjustable mechanical stopper	0.1H	—		○			○				○			
	9	Clean spatters, sawdust and dust	1.0H	—		○			○				○			
	10	Replacing battery.	0.1H	—							●					
	11	Replacing grease of J1 axis reducer	0.5H	3300ml												
	12	Replacing grease of J2 axis reducer	0.5H	1660ml												
	13	Replacing grease of J3 axis reducer	0.5H	1060ml												
	14	Replacing grease of J4 axis gearbox	0.5H	1000ml												
	15	Replacing grease of J5 axis gearbox	0.5H	440ml												
	16	Greasing of J6 axis reducer	0.2H	40ml					●				●			
	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 the “REPLACING UNITS Chapter of MAINTENANCE” in the following manuals.
R-30*i*A CONTROLLER MAINTENANCE MANUAL (Standard) (B-82595EN),
R-30*i*A CONTROLLER MAINTENANCE MANUAL (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)

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

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

Overhaul

FANUC Robot M-710*i*C/12L **Periodic Maintenance Table**

Items			Check time	Oil Grease amount	First check 320	3 months 960	6 months 1920	9 months 2880	1 year 3840	4800	5760	6720	2 years 7680	8640	9600	10560
Mechanical unit	1	Check for external damage or peeling paint	0.1H	-		○	○	○	○	○	○	○	○	○	○	○
	2	Check for water	0.1H	-		○	○	○	○	○	○	○	○	○	○	○
	3	Check the mechanical cable (Damaged or twisted)	0.2H	-		○			○				○			
	4	Check the end effector (hand) cable	0.1H	-		○			○				○			
	5	Check the motor connector and exposed connector (loosening)	0.2H	-		○			○				○			
	6	Tighten the end effector bolt	0.1H	-		○			○				○			
	7	Tighten the cover and main bolt	1.0H	-		○			○				○			
	8	Check the mechanical stopper and adjustable mechanical stopper	0.1H	-		○			○				○			
	9	Clean spatters, sawdust and dust	1.0H			○			○				○			
	10	Check the oil sight glass of J5/J6 axes	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 oil of J4 axis gearbox	0.5H	1480ml												
	16	Replacing oil of J5 and J6 axis gearbox	0.5H	390ml												
	17	Replacing cable of mechanical unit	4.0H	-												
	18	Replacing M/H(Material Handling) conduit (option)	1.0H	-									●			
	19	Check broken of fluoric resin ring.	0.1H	-	○	○	○	○	○	○	○	○	●	○	○	○
Controller	20	Check the robot cable, teach pendant cable and robot connecting cable	0.2H	-		○			○				○			
	21	Cleaning the controller ventilation system	0.2H	-	○	○	○	○	○	○	○	○	○	○	○	○
	22	Replacing battery *1	0.1H	-												

*1 Refer to the “REPLACING UNITS Chapter of MAINTENANCE” in the following manuals.
R-30*i*B/R-30*i*B Plus CONTROLLER MAINTENANCE MANUAL (B-83195EN),
R-30*i*B Mate/R-30*i*B Mate Plus CONTROLLER MAINTENANCE MANUAL (B-83525EN)

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

3 years 11520	12480	13440	14400	4 years 15360	16320	17280	18240	5 years 19200	20160	21120	22080	6 years 23040	24000	24960	25920	7 years 26880	27840	28800	29760	8 years 30720	Item
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		1
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		2
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○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		21
				●																	22

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.

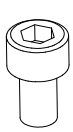
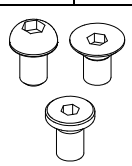
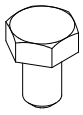
Use the following strength bolts. Comply with any bolt specification instructions.
Hexagon socket head bolt made of steel:

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 is not specified.

Recommended bolt tightening torques **Unit: Nm**

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

C INSULATION ABOUT ARC WELDING ROBOT

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

C.1 INSULATION AT THE WRIST

- Reliably design to insulate at the end effector mounting surface. Insulation material which insert between end effector mounting surface and the welding torch bracket must be different kind, and bolt them separately referring to Fig. C.1.
- Insert the insulating material between the torch and torch bracket so that the insulation is dualized. When installing the insulating material, be sure to set the slit in the torch holder away from that of the insulating material to prevent spatter from getting in the slits.
- Allow a sufficient distance (at least 5 mm) at the insulating materials in case a pileup of spatter should occur.

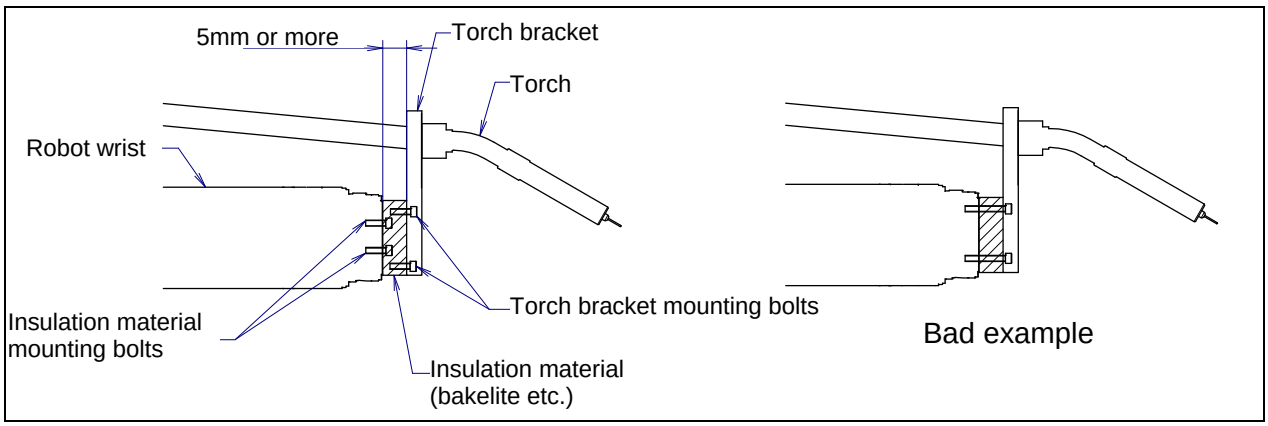


Fig. C.1 Insulation at the wrist

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

INDEX

REVISION RECORD

Edition	Date	Contents
09	Jul, 2017	• Addition of R-30*i*B Plus, R-30*i*B Mate Plus Controller • Correction of errors
08	Jan.,2016	• Addition of M-710*i*C/20M • Addition of quick mastering for single axis • Correction of errors
07	Aug.,2014	• Addition of M-710*i*C/12L • Correction of errors
06	Mar.,2014	• Addition of R-30*i*B Mate • Addition of note for IP ratio • Correction of errors
05	Apr.,2012	• Addition of R-30*i*B • Addition of note for low temperature • Change of specification of mechanical unit cables • Addition of check of oil seepage • Correction of errors
04	Jun.,2010	・• Addition of stop type of robot ・• Addition of stopping time and distance when control stop is executed ・• Addition of stopping distance of stopper. ・• Addition of check of stopper ・• Corrections of errors
03	Jan.,2008	・• Addition of Procedure to move arm without drive power in emergency or abnormal situations ・• Addition of notes on transportation with an end effector attached ・• Addition of cable for sensor and severe dust/liquid protection package ・• Addition of Stopping time and distance when emergency stop
02	Sep., 2007	・• Change the name of controller (from R-J3iC to R-30iA) ・• Addition of severe dust/liquid protection package ・• Corrections of errors
01	Aug., 2006	

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