

FANUC Robot M-1iA

MECHANICAL UNIT

OPERATOR'S MANUAL

MAROCM1IA08091E REV. E

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**FANUC Robotics America Corporation
3900 W. Hamlin Road
Rochester Hills, Michigan 48309-3253**

B-83084EN/05

This manual can be used with controllers labeled R-30iA or R-J3iC. If you have a controller labeled R-J3iC, you should read R-30iA as R-J3iC throughout this manual.

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This equipment generates, uses, and can radiate radiofrequency energy and if not installed and used in accordance with the instruction manual, may cause interference to radio communications. As temporarily permitted by regulation, it has not been tested for compliance with the limits for Class A computing devices pursuant to subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference. Operation of the equipment in a residential area is likely to cause interference, in which case the user, at his own expense, will be required to take whatever measure may be required to correct the interference.

FANUC Robotics 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

FANUC Robotics America Corporation
Training Department
3900 W. Hamlin Road
Rochester Hills, Michigan 48309-3253
www.fanucrobotics.com

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:

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Patents

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

FANUC Robotics America Corporation Patent List

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Conventions

WARNING

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

CAUTION

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

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

- **Original Instructions**

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

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Should you wish to export or re-export these products, please contact FANUC for advice.

In this manual we have tried as much as possible to describe all the various matters.

However, we cannot describe all the matters which must not be done, or which cannot be done, because there are so many possibilities.

Therefore, matters which are not especially described as possible in this manual should be regarded as "impossible".

PREFACE

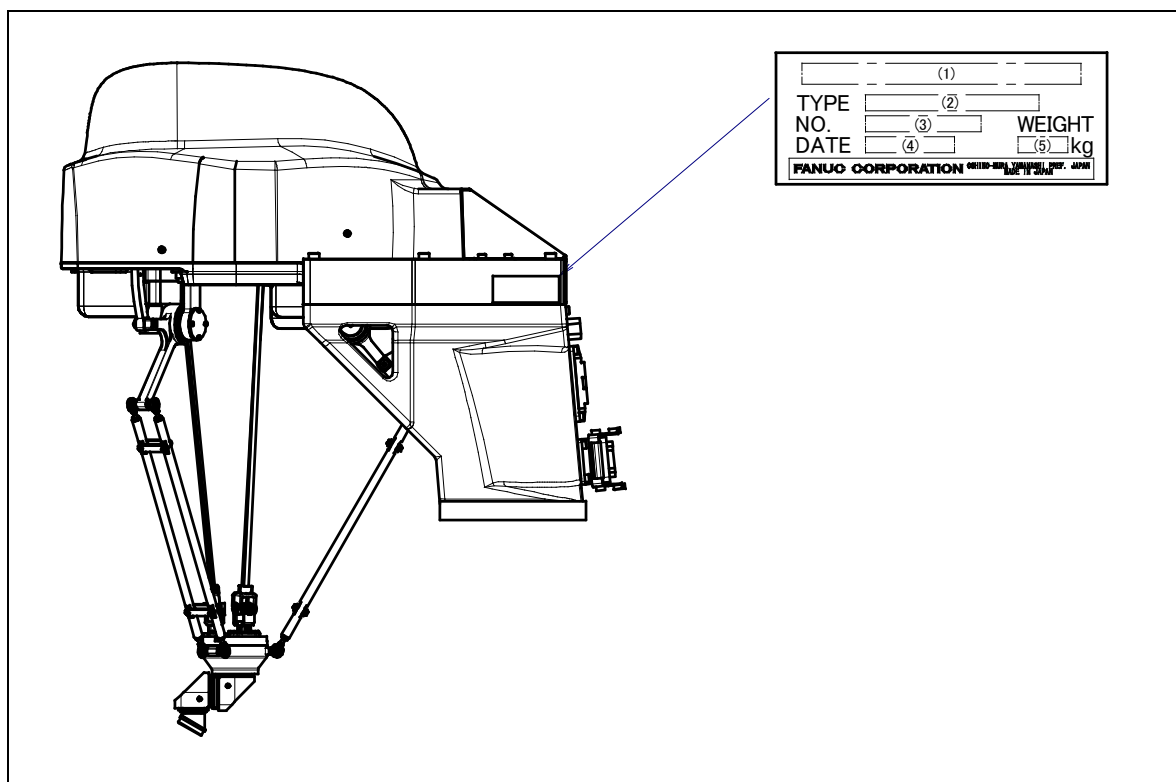
This manual explains operation procedures for the mechanical units of the following robots:

Model name	Mechanical unit specification No.	Maximum load
FANUC Robot M-1iA/0.5S	A05B-1522-B201	0.5kg
FANUC Robot M-1iA/0.5A	A05B-1522-B202	1kg (Note)

NOTE

When 1kg payload option is specified.

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



Position of label indicating mechanical unit specification number

TABLE 1)

	(1)	(2)	(3)	(4)	(5)
CONTENTS	MODEL NAME	TYPE	No.	DATE	WEIGHT kg (without controller)
LETTERS	FANUC Robot M-1iA/0.5S	A05B-1522-B201	PRINT SERIAL NO	PRINT PRODUCTION YEAR AND MONTH	14
	FANUC Robot M-1iA/0.5A	A05B-1522-B202			17

RELATED MANUALS

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

Safety handbook B-80687EN All persons who use the FANUC Robot and system designer must read and understand thoroughly this handbook		Intended readers: All persons who use FANUC Robot, system designer Topics: Safety items for robot system design, operation, maintenance
R-30iA Mate controller	Operations manual LR HANDLING TOOL B-83134EN-1 ALARM CODE LIST B-83124EN-6	Intended readers: Operator, programmer, maintenance person, system designer Topics: Robot functions, operations, programming, setup, interfaces, alarms Use: Robot operation, teaching, system design
	Maintenance manual Standard: B-82725EN B-82725EN-1 (For Europe) B-82725EN-2 (For RIA) Open air type: B-82965EN-1	Intended readers: Maintenance person, system designer Topics: Installation, connection to peripheral equipment, maintenance Use: Installation, start-up, connection, maintenance

SAFETY

Safety

FANUC Robotics 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 Robotics 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 Robotics 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 Robotics therefore, recommends that all personnel who intend to operate, program, repair, or otherwise use the robotics system be trained in an approved FANUC Robotics 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 Robotics 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 Robotics 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 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. 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

For the safety of the operator and the system, follow all safety precautions when operating a robot and its peripheral devices installed in a work cell.

In addition, refer to the “FANUC Robot SAFETY HANDBOOK (B-80687EN)”.

1 WORKING PERSON

The personnel can be classified as follows.

Operator:

- Power ON/OFF for robot controller
- Start of robot program with operator's panel

Programmer or teaching operator:

- Operate for Robot
- Teaching inside safety fence

Maintenance engineer:

- Operate for Robot
- Teaching inside safety fence
- Maintenance (adjustment, replacement)

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

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

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

2 WORKING PERSON SAFETY

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

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

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

- (2) Even when the robot is stationary, it is possible that the robot is still in a ready to move state, and is waiting for a signal. In this state, the robot is regarded as still in motion. To ensure working

person safety, provide the system with an alarm to indicate visually or aurally that the robot is in motion.

- (3) Install a safety fence with a gate so that no working person can enter the work area without passing through the gate. Install an interlocking device, a safety plug, and so forth in the safety gate so that the robot is stopped as the safety gate is opened.

The controller is designed to receive this interlock signal of the door switch. When the gate is opened and this signal received, the controller stops the robot in an emergency. For connection, see Fig.2 (a), (b).

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

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

- (9) When adjusting each peripheral device independently, be sure to turn off the power of the robot.

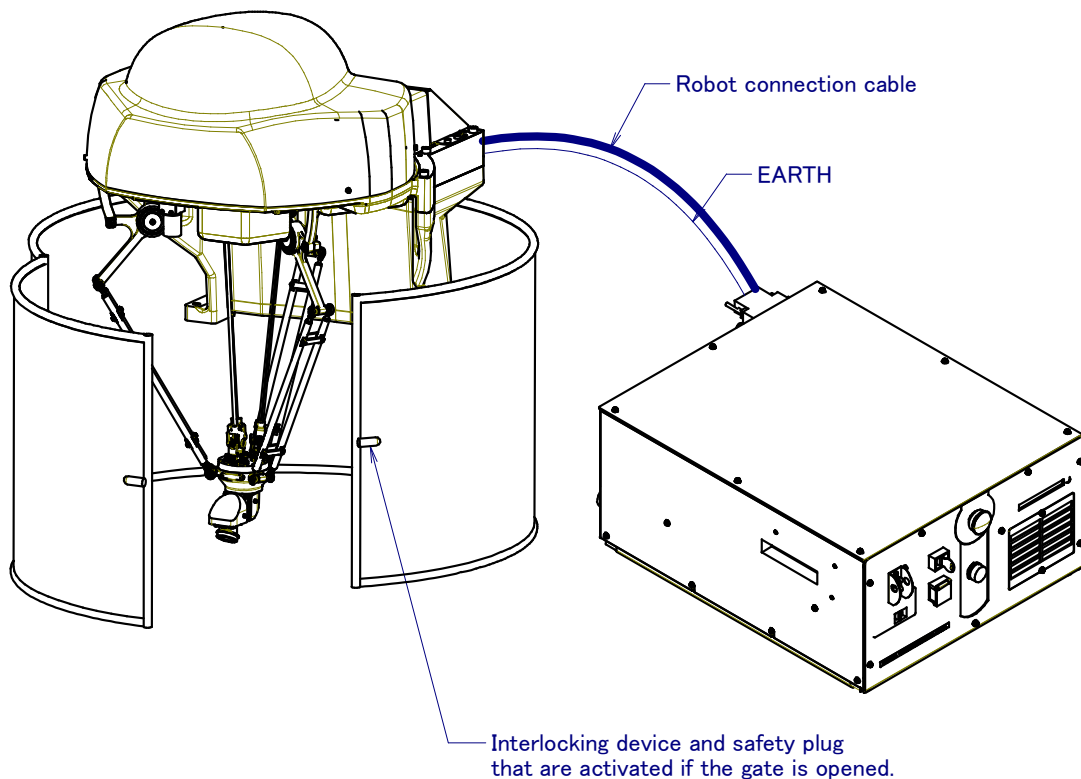


Fig.2 (a) Safety fence and safety gate

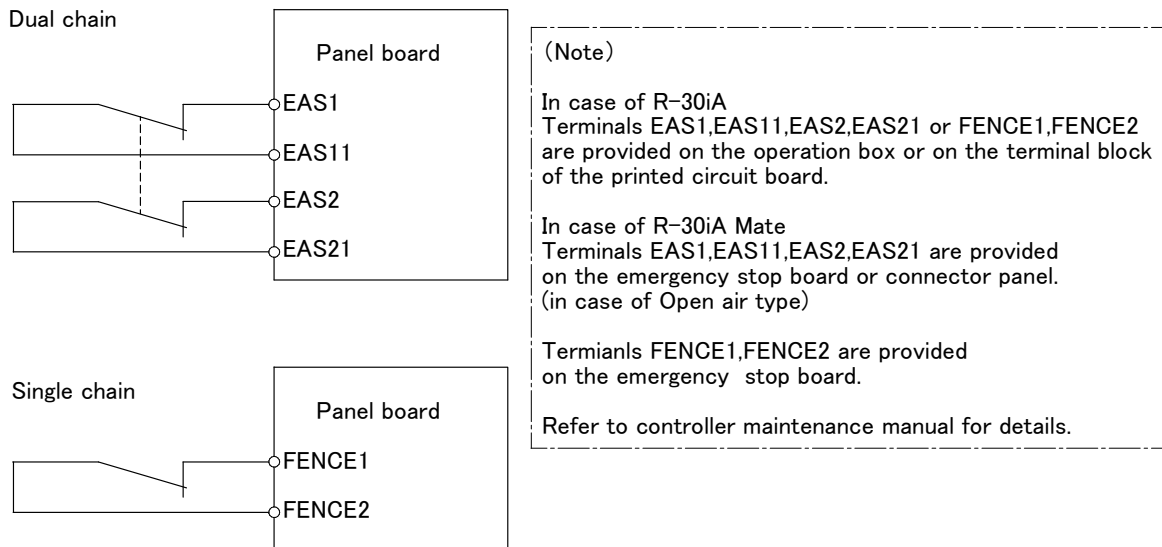


Fig.2 (b) Connection Diagram for Safety Fence

2.1 OPERATOR SAFETY

The operator is a person who operates the robot system. In this sense, a worker who operates power on/off of the robot system or the teach pendant is also operator.

The operator can't operate inside a safety fence.

- (1) Operate the robot system at a location outside of the safety fence.
- (2) If you do not have to operate the robot, turn off the controller power of the robot controller or press the EMERGENCY STOP button, and then proceed with necessary work.
- (3) Install an EMERGENCY STOP button within the general person's reach.

The robot controller is designed to be able to connect to an external EMERGENCY STOP button. With this connection, the controller stops the robot operation when the external EMERGENCY STOP button is pressed. See the diagram below for connection.

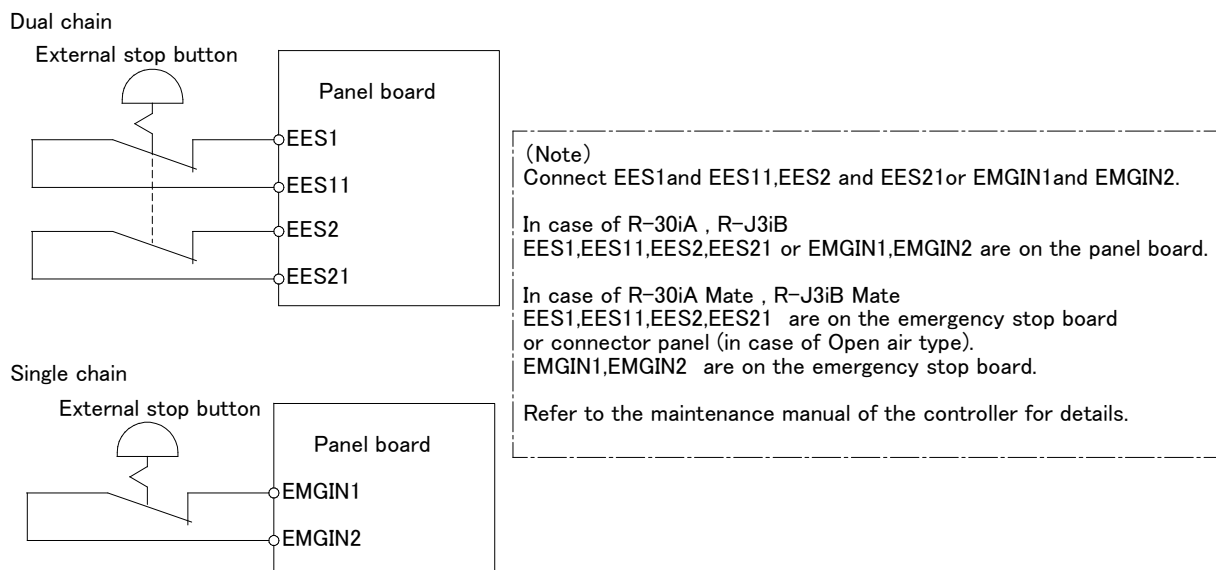


Fig.2.1 Circuit diagram for external emergency stop button

2.2 SAFETY OF THE PROGRAMMER

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

- (1) Unless it is specifically necessary to enter the robot work area, carry out all tasks outside the area.
- (2) Before teaching the robot, check that the robot and its peripheral devices are all in the normal operating condition.
- (3) If it is inevitable to enter the robot work area to teach the robot, check the locations, settings, and other conditions of the safety devices (such as the EMERGENCY STOP button, the DEADMAN switch on the teach pendant) before entering the area.
- (4) The programmer must be extremely careful not to let anyone else enter the robot work area.

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 enters the emergency stop state. 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-30iA Mate Controller standard specification, there is no mode switch. The automatic operation mode and the teach mode is selected by teach pendant enable switch.)

Our teach pendant is provided with a DEADMAN switch as well as an emergency stop button. These button and switch function as follows:

- (1) Emergency stop button: Causes an emergency stop when pressed.
- (2) DEADMAN switch: Functions differently depending on the mode switch setting status.
 - (a) Automatic operation mode: The DEADMAN switch is disabled.
 - (b) Teach mode: Causes an emergency stop when the operator releases the DEADMAN switch or when the operator presses the switch strongly.

Note) The DEADMAN switch is provided to place the robot in the emergency stop state when the operator releases the teach pendant or presses the pendant strongly in case of emergency. The R-30iA/ R-30iA 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 enters the emergency stop state.

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

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

In case of R-30iA Controller or CE or RIA specification of R-30iA Mate Controller

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

T1,T2 mode:DEADMAN switch is effective.

In case of standard specification of R-30iA 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

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

2.3 SAFETY OF THE MAINTENANCE ENGINEER

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

- (1) During operation, never enter the robot work area.
- (2) Except when specifically necessary, turn off the power of the controller while carrying out maintenance. Lock the power switch, if necessary, so that no other person can turn it on.
- (3) If it becomes necessary to enter the robot operation range while the power is on, press the emergency stop button on the operator panel, or the teach pendant before entering the range. The maintenance personnel must indicate that maintenance work is in progress and be careful not to allow other people to operate the robot carelessly.
- (4) When disconnecting the pneumatic system, be sure to reduce the supply pressure.
- (5) Before the start of teaching, check that the robot and its peripheral devices are all in the normal operating condition.
- (6) Do not operate the robot in the automatic mode while anybody is in the robot work area.
- (7) When you maintain the robot alongside a wall or instrument, or when multiple workers are working nearby, make certain that their escape path is not obstructed.

- (8) When a tool is mounted on the robot, or when any moving device other than the robot is installed, such as belt conveyor, pay careful attention to its motion.
- (9) If necessary, have a worker who is familiar with the robot system stand beside the operator panel and observe the work being performed. If any danger arises, the worker should be ready to press the EMERGENCY STOP button at any time.
- (10) When replacing or reinstalling components, take care to prevent foreign matter from entering the system.
- (11) 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.
- (12) When replacing parts, be sure to use those specified by FANUC.
In particular, never use fuses or other parts of non-specified ratings. They may cause a fire or result in damage to the components in the controller.
- (13) When restarting the robot system after completing maintenance work, make sure in advance that there is no person in the work area and that the robot and the peripheral devices are not abnormal.

3 SAFETY OF THE TOOLS AND PERIPHERAL DEVICES

3.1 PRECAUTIONS IN PROGRAMMING

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

3.2 PRECAUTIONS FOR MECHANISM

- (1) Keep the component cells of the robot system clean, and operate the robot in an environment free of grease, water, and dust.
- (2) Don't use unconfirmed liquid for cutting fluid and cleaning fluid.
- (3) Employ a limit switch or mechanical stopper to limit the robot motion so that the robot or cable does not strike against its peripheral devices or tools.
- (4) Observe the following precautions about the mechanical unit cables. When these attentions are not kept, unexpected troubles might occur.
 - Use mechanical unit cable that have required user interface.
 - Don't add user cable or hose to inside of mechanical unit.
 - Please do not obstruct the movement of the mechanical unit cable when cables are added to outside of mechanical unit.
 - In the case of the model that a cable is exposed, Please do not perform remodeling (Adding a protective cover and fix an outside cable more) obstructing the behavior of the outcrop of the cable.
 - Please do not interfere with the other parts of mechanical unit when install equipments in the robot.
- (5) The frequent power-off stop for the robot during operation causes the trouble of the robot. Please avoid the system construction that power-off stop would be operated routinely. (Refer to bad case

example.) Please execute power-off stop after reducing the speed of the robot and stopping it by hold stop or cycle stop when it is not urgent. (Please refer to "STOP TYPE OF ROBOT" in SAFETY for detail of stop type.)

(Bad case example)

- Whenever poor product is generated, a line stops by emergency stop.
 - When alteration was necessary, safety switch is operated by opening safety fence and power-off stop is executed for the robot during operation.
 - An operator pushes the emergency stop button frequently, and a line stops.
 - An area sensor or a mat switch connected to safety signal operate routinely and power-off stop is executed for the robot.
- (6) Robot stops urgently when collision detection alarm (SV050) etc. occurs. The frequent urgent stop by alarm causes the trouble of the robot, too. So remove the causes of the alarm.

4 SAFETY OF THE ROBOT MECHANISM

4.1 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.

4.2 PRECAUTIONS IN PROGRAMMING

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

4.3 PRECAUTIONS FOR MECHANISMS

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

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

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

Name	Specification
Brake release unit	A05B-2450-J350 (Input voltage AC100-115V single phase) A05B-2450-J351 (Input voltage AC200-240V single phase)
Robot connection cable	A05B-2525-J035 (5m) A05B-2525-J036 (10m)

Name	Specification
Power cable	A05B-2525-J010 (5m) (AC100-115V Power plug) (*) A05B-2525-J011 (10m) (AC100-115V Power plug) (*) A05B-2450-J364 (5m) (No power plug) A05B-2450-J365 (10m) (No power plug)

(*) These do not support CE marking.

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



CAUTION

Robot systems installed without adequate number of brake release units or similar means are neither in compliance with EN ISO 10218-1 nor with 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 supporting Robot arm by a block etc. before releasing a brake.

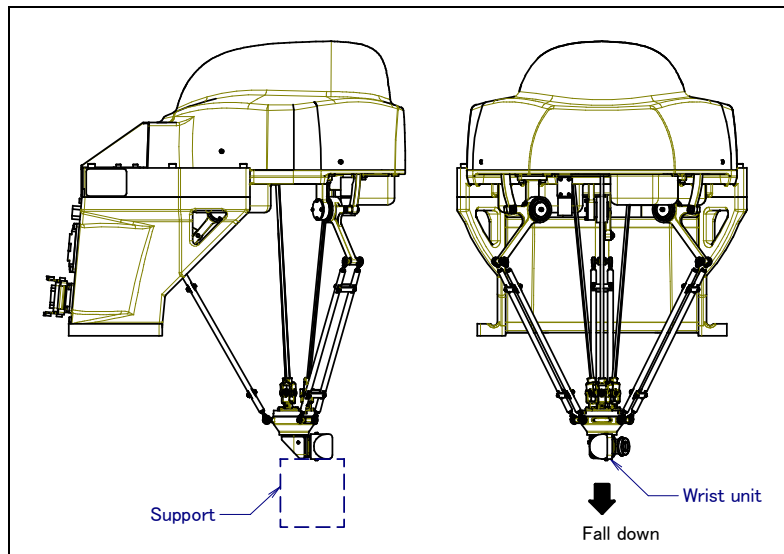


Fig. 4.4 Releasing motor brake and measures

5

SAFETY OF THE END EFFECTOR

5.1

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.

6 STOP TYPE OF ROBOT

The following three robot stop types exist:

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

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

The following processing is performed at Power-Off stop.

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

Controlled stop (Category 1 following IEC 60204-1)

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

The following processing is performed at Controlled stop.

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

Hold (Category 2 following IEC 60204-1)

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

The following processing is performed at Hold.

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



WARNING

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

When the E-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	E-Stop button	External E-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

-: Not stop

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

Option	R-30iA				R-30iA 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-30iA standard (single) does not have servo disconnect.

(**) R-30iA 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.

"Stop type set (Stop pattern C)" option

"Stop type set (Stop pattern C)"(A05B-2500-J570) is an optional function. When this option is loaded, 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 E-stop is pressed.
SRVO-002 Teach pendant E-stop	Teach pendant E-stop is pressed.
SRVO-007 External emergency stops	External emergency stop input (EES1-EES11, EES2-EES21) is open. (R-30iA controller)
SRVO-194 Servo disconnect	Servo disconnect input (SD4-SD41, SD5-SD51) is open. (R-30iA controller)
SRVO-218 Ext.E-stop/Servo Disconnect	External emergency stop input (EES1-EES11, EES2-EES21) is open. (R-30iA 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.

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.

7

WARNING LABEL

(1) Transportation attention label 1

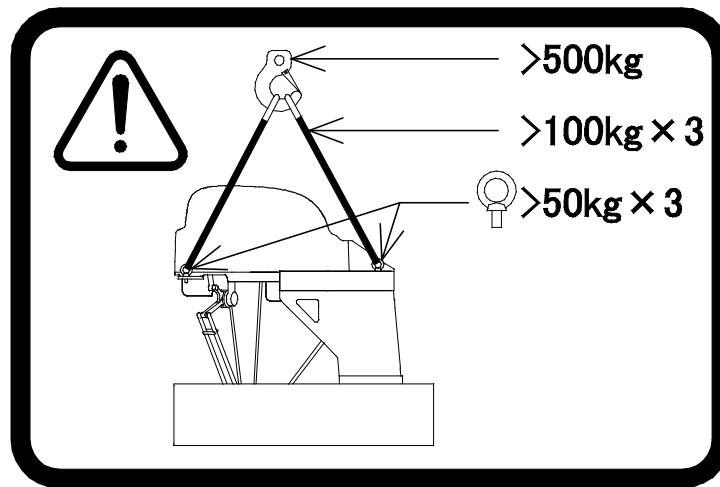


Fig. 7 (a) Transportation attention label 1

Description

- 1) Use a crane having a load capacity of 500 kg or greater.
- 2) Use at least four slings each having a withstand load of 980 N (100 kgf) or greater.
- 3) Use at least four eyebolts each having a withstand load of 490 N (50 kgf) or greater.

(2) Range of motion and payload mark label

Below label is added when CE specification is specified.

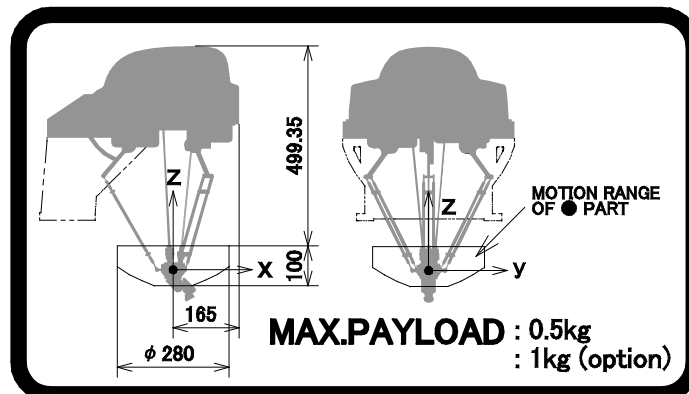


Fig.7 (b) Range of motion and payload mark label

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APPENDIX

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1 TRANSPORTATION AND INSTALLATION

1.1 TRANSPORTATION

The robot can be transported by a crane. When transporting the robot, be sure to change the posture of the robot to that shown Fig.1.1 (a), (b), (c) and lift by using the eyebolts and the transport equipment at their points.

Transportation using a crane (Fig. 1.1 (a), (b), (c))

Fasten the M12 eyebolts at the four points of special transport equipment and lift the robot by the four slings.

NOTE

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



CAUTION

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

NOTE

Be sure to remove end effector before transporting robot.



WARNING

Use the transport equipment only to transport the robot. Do not use the transport equipment to secure the robot. Before moving the robot by using transport equipment, check and tighten any loose bolts on the transport equipment.

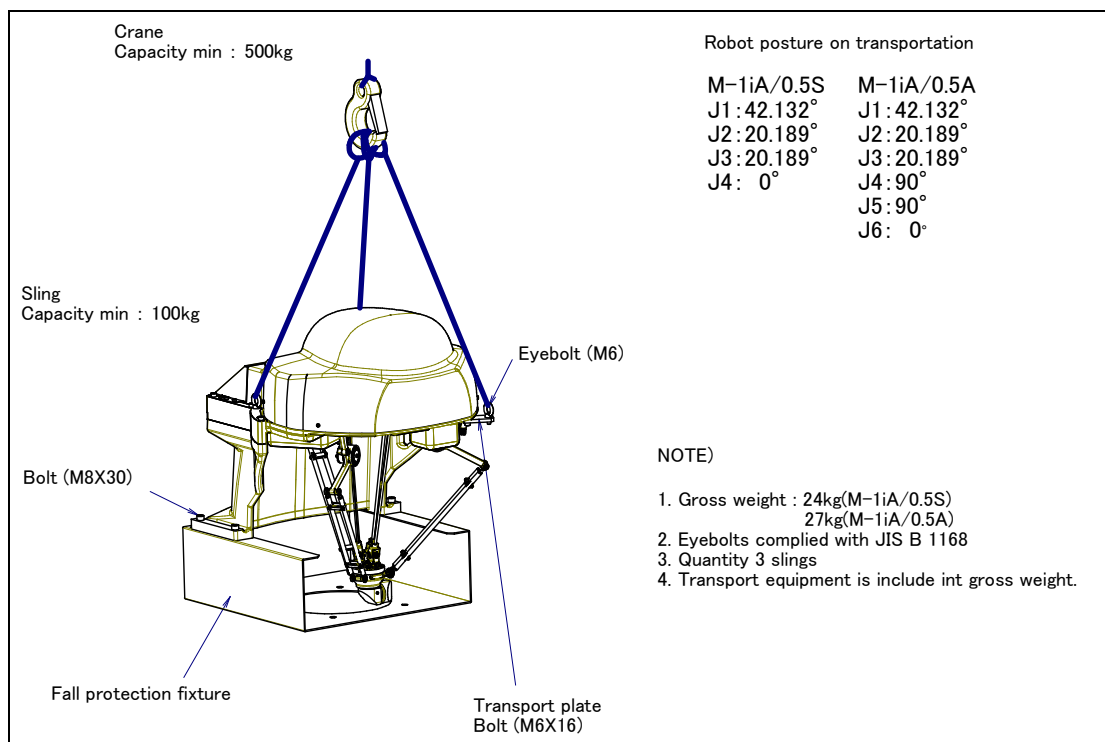


Fig. 1.1 (a) Transportation using a crane (with stand)

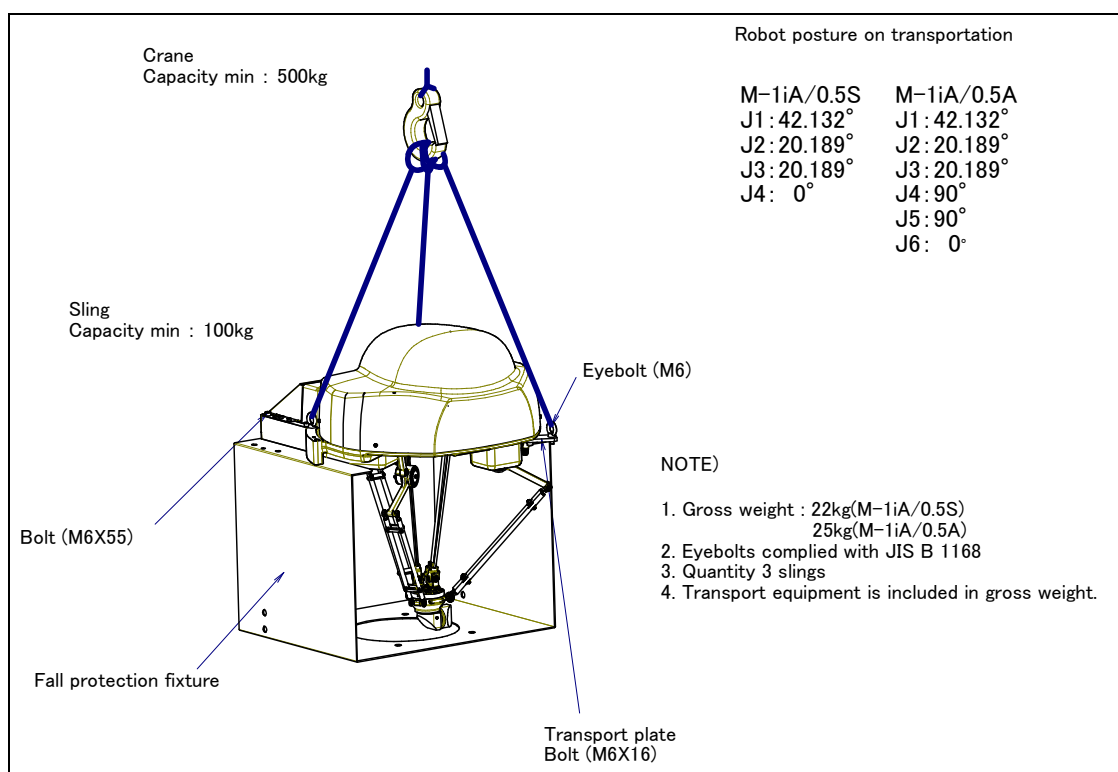


Fig. 1.1 (b) Transportation using a crane (no stand A and no stand B)

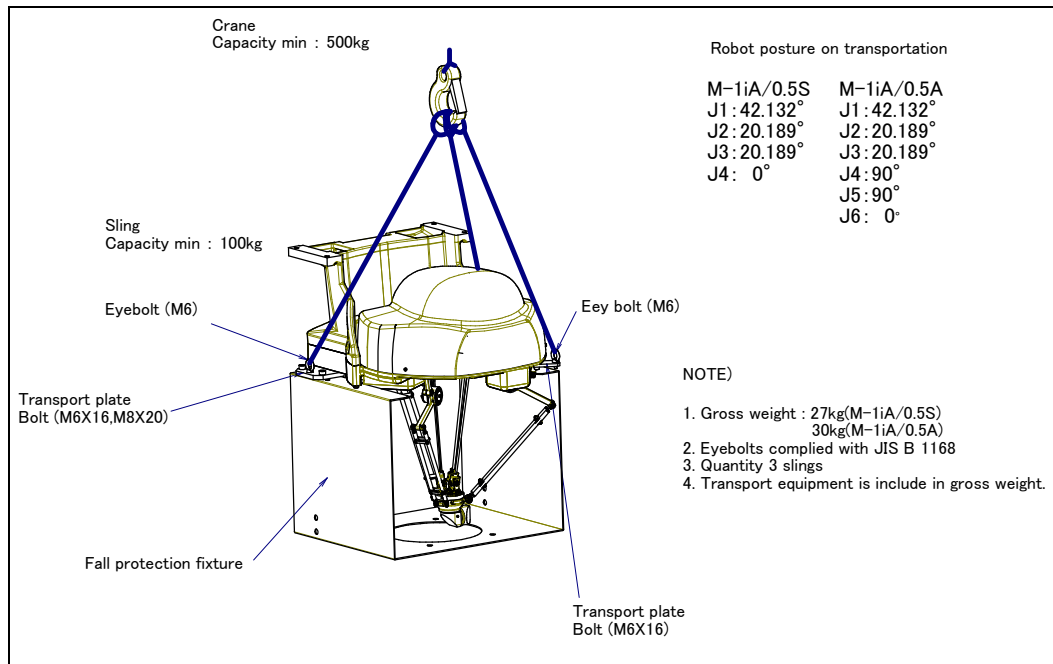


Fig. 1.1 (c) Transportation using a crane (top mount)

1.2 INSTALLATION

Fig. 1.2 (a) to (c) show the robot base dimensions.

Meet the following requirements about the character frequency of robot pedestal.

Character frequency > 50Hz

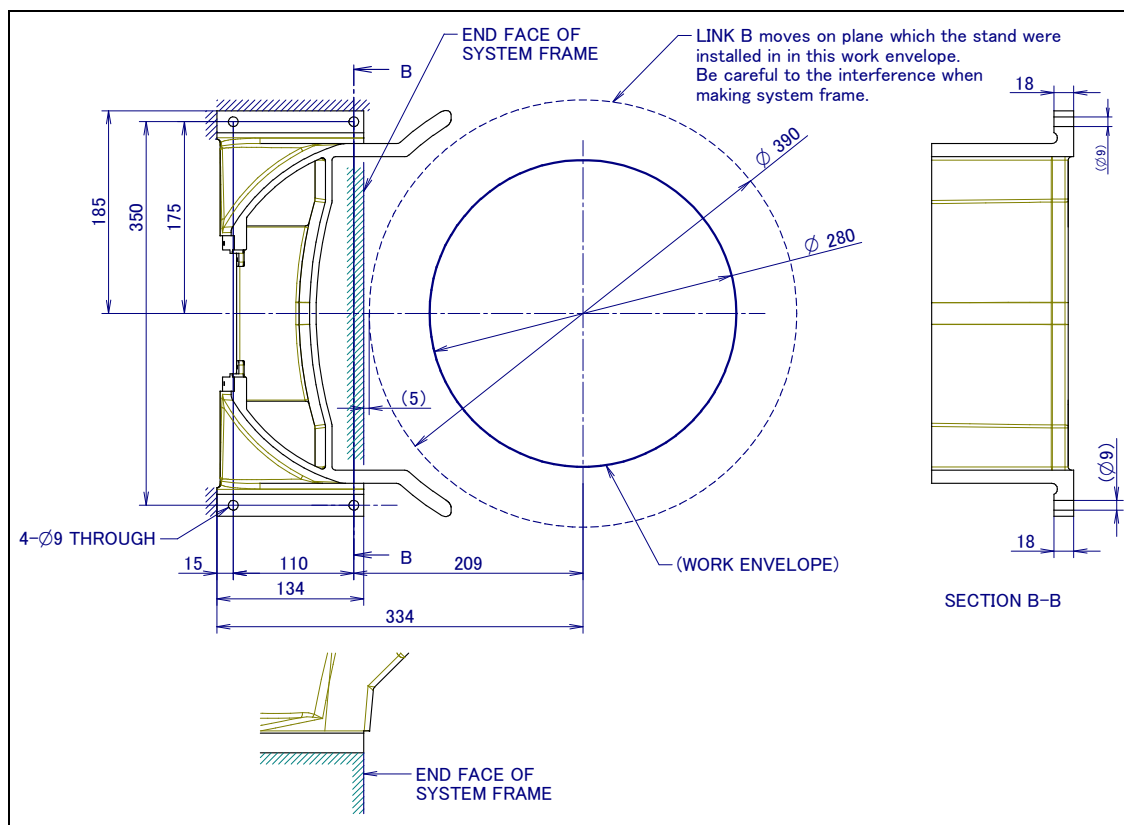


Fig. 1.2 (a) Dimension of robot base (with stand)

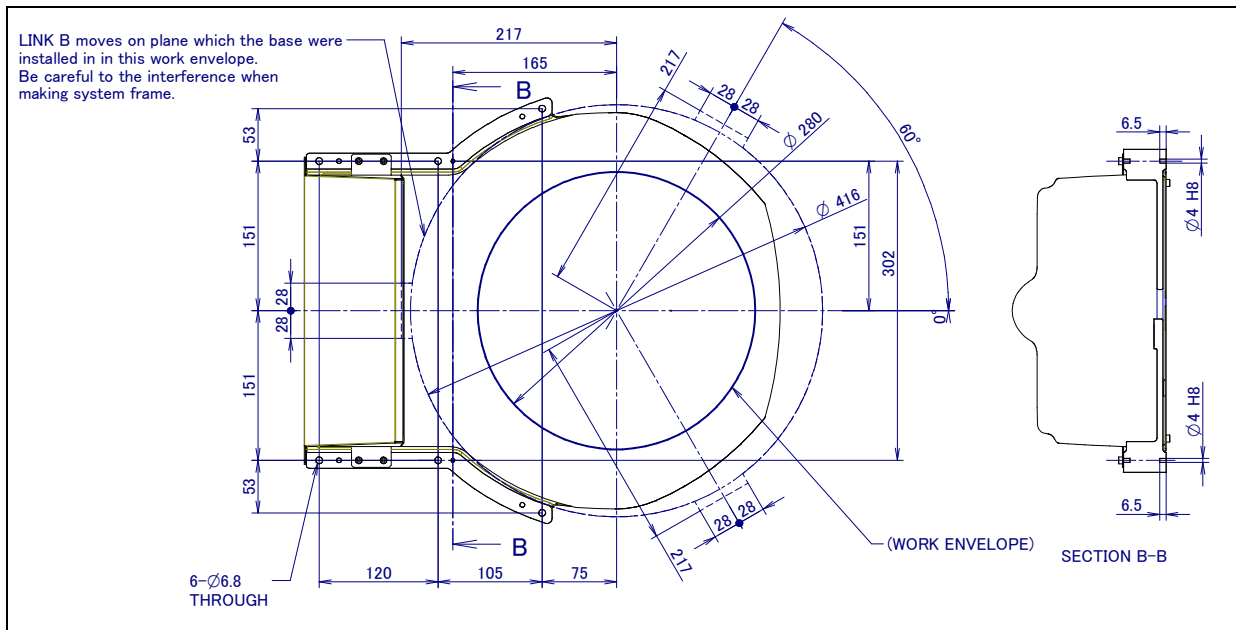


Fig. 1.2 (b) Dimension of robot base (no stand A and no stand B)

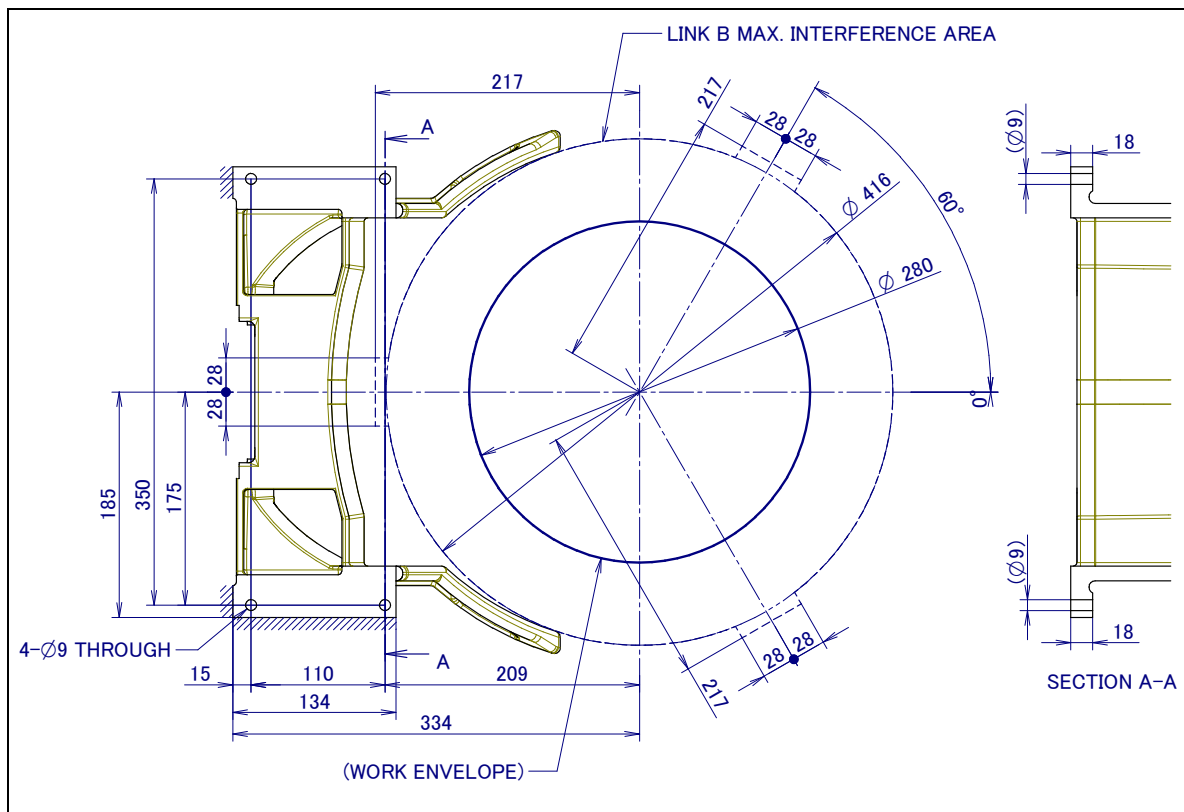


Fig. 1.2 (c) Dimension of robot base (top mount)

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

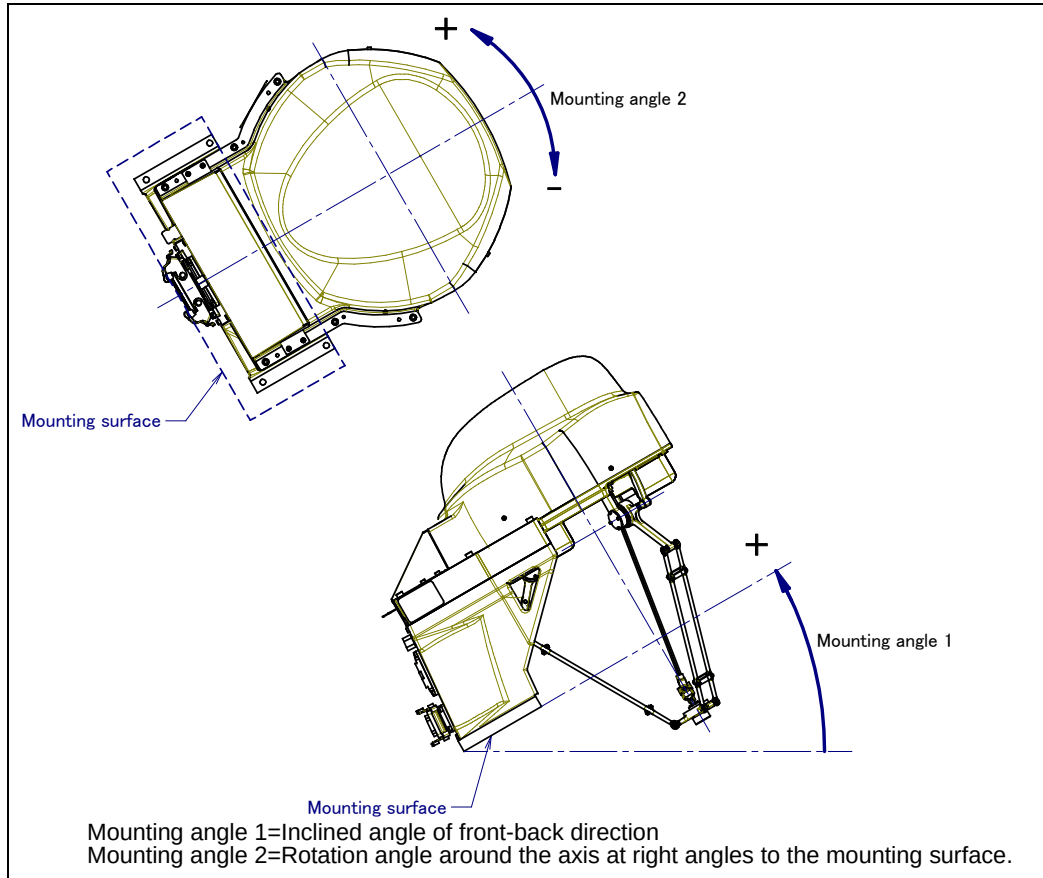


Fig. 1.2 (d) Robot mounting angle

Fig. 1.2 (a) indicate the force and moment applied to the robot base.

Table 1.2 (b),(c) indicate the stopping distance and time until the robot stopping by Power-Off stop or by Controlled stop after input of the stop signal.

Refer to the data when considering the strength of the installation face.

Table 1.2 (a) Force and moment that acts on robot base

	Bending moment Mv (Nm)	Force in vertical condition Fv (N)	Twisting moment Mh (Nm)	Force in horizontal direction Fh (N)
Static	58.2	220.5	0	0
Acceleration/ Deceleration	77.7	269.0	11.0	44.8
Power-Off stop	119.7	450.7	42.8	208.6

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

Model		X	Y	Z
M-1iA/0.5S	Stopping time [msec]	31	31	22
M-1iA/0.5A	Stopping distance [mm]	48	48	21

※ override : 100%

※ Max. payload, and max. inertia posture

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

Model		X	Y	Z
M-1iA/0.5S	Stopping time [msec]	95	95	60
M-1iA/0.5A	Stopping distance [mm]	171	171	61

※ override : 100%

※ Max. payload, and max. inertia posture

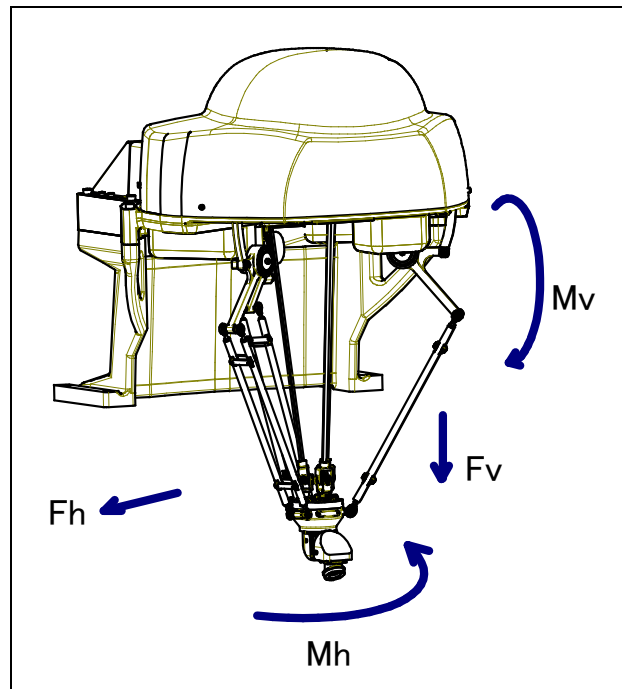


Fig. 1.2 (e) Force and moment that acts on robot base

1.3 MAINTENANCE AREA

Fig. 1.3 shows the maintenance area of the mechanical unit. See Chapter 8 for the mastering.

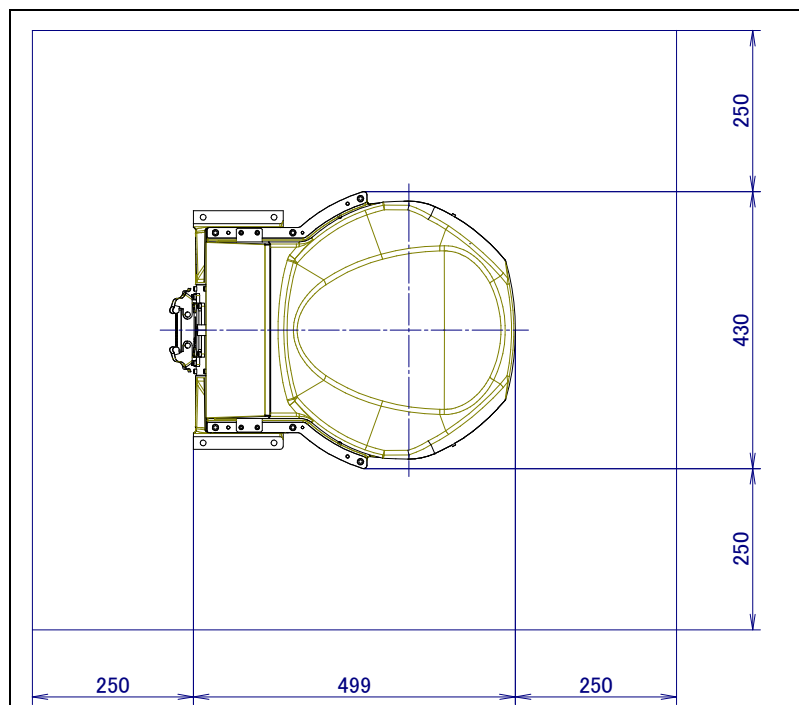


Fig. 1.3 Maintenance area

1.4 INSTALLATION SPECIFICATIONS

Refer to specification of Section 3.1 about installation specifications.

2 CONNECTION WITH THE CONTROLLER

2.1 CONNECTION WITH THE CONTROLLER

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

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



CAUTION

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



WARNING

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

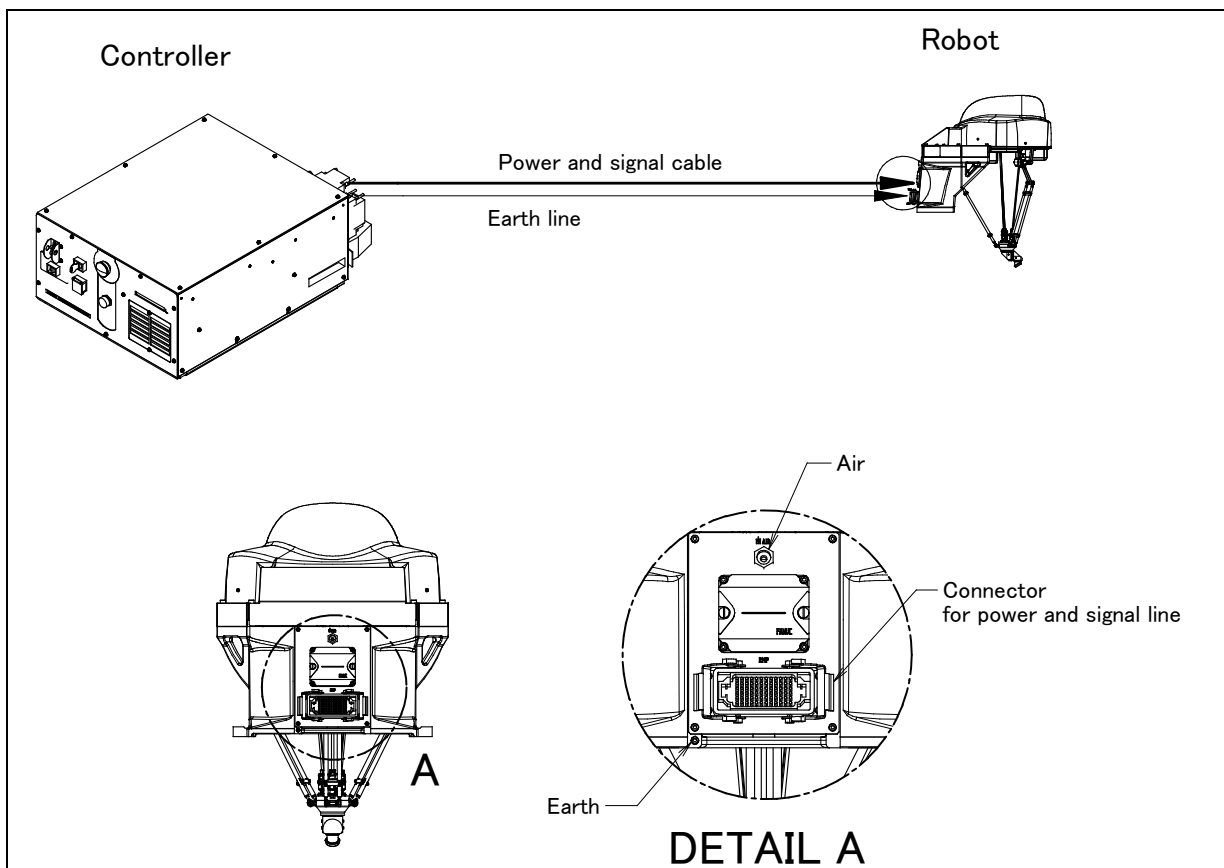


Fig. 2.1 (a) Cable connection (with stand)

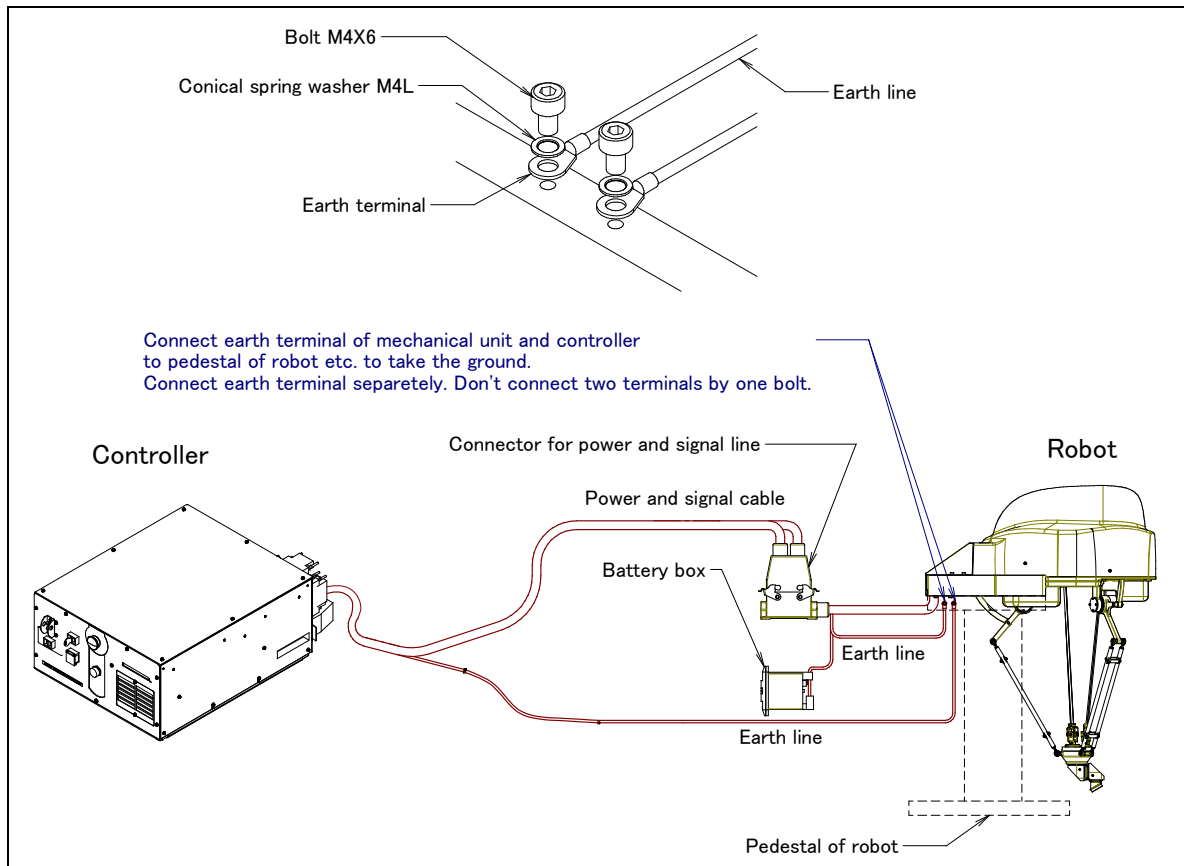


Fig. 2.1 (b) Cable connection (no stand A)

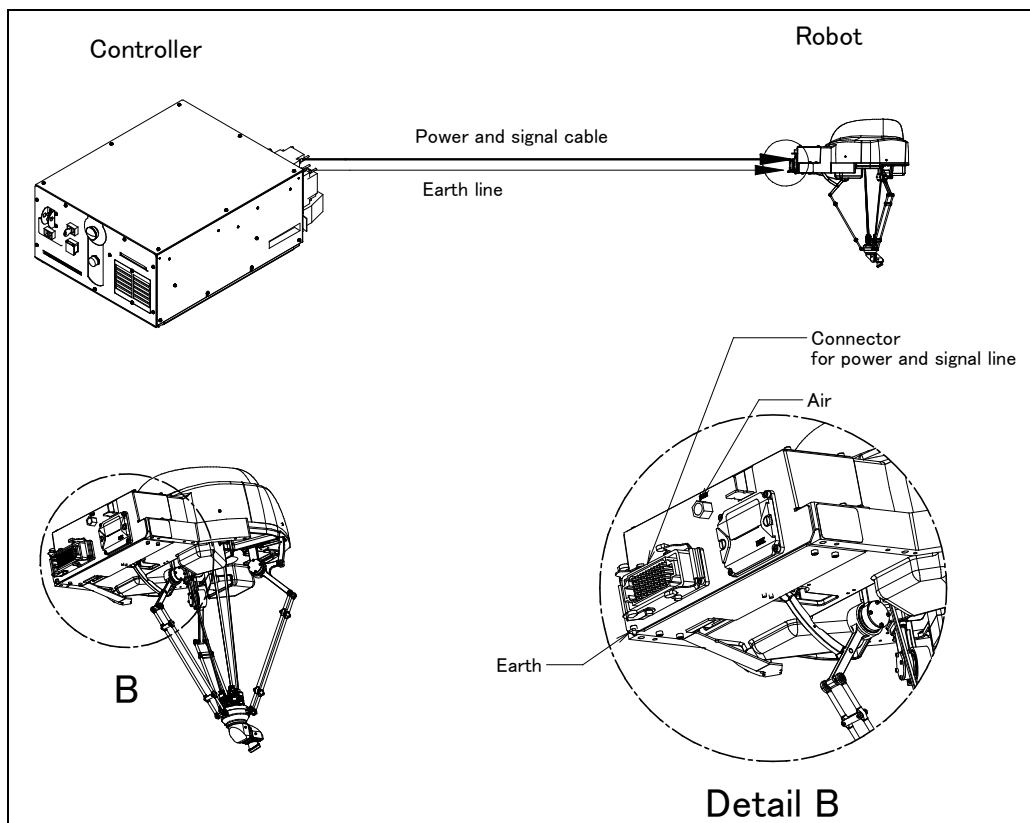


Fig. 2.1 (c) Cable connection (no stand B)

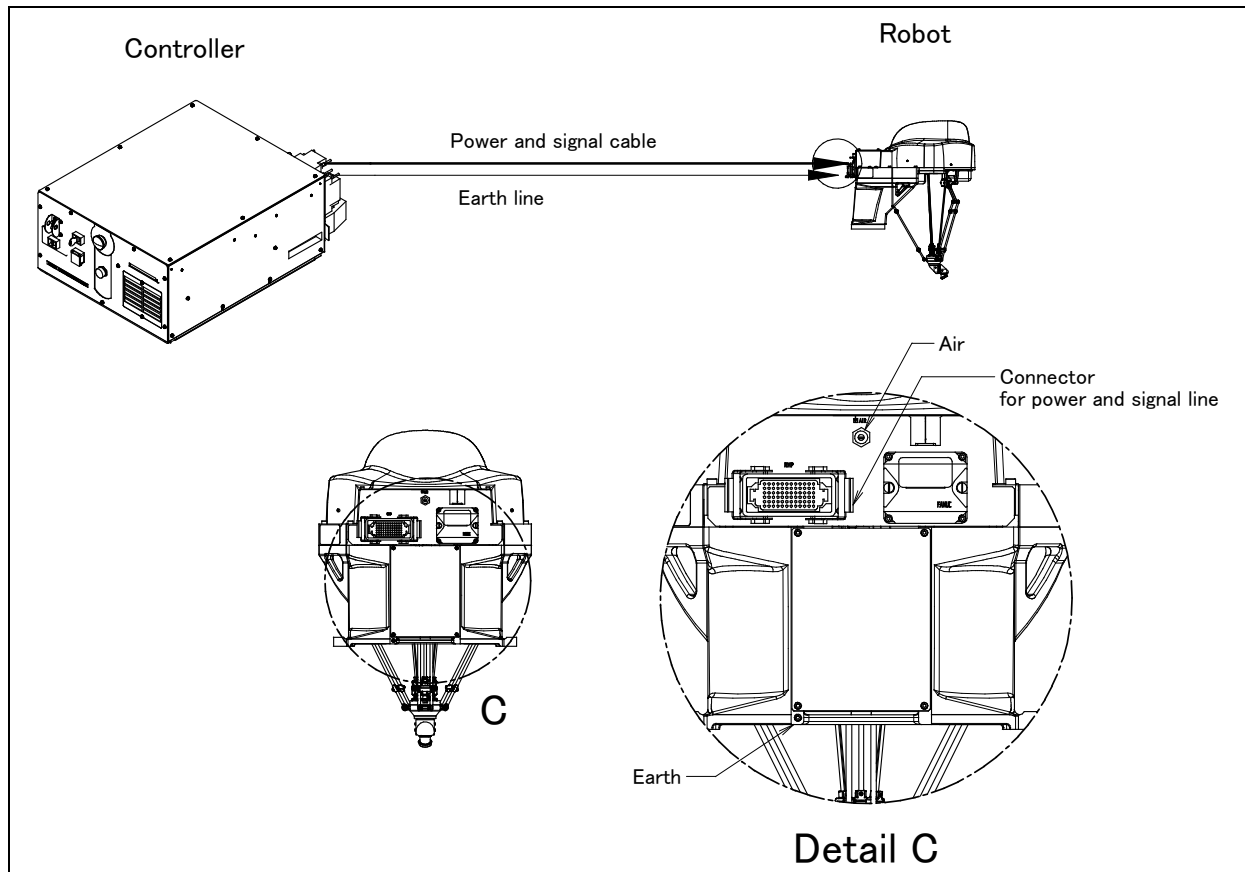


Fig. 2.1 (d) Cable connection (no stand A) (additional stand)

3 BASIC SPECIFICATIONS

3.1 ROBOT CONFIGURATION

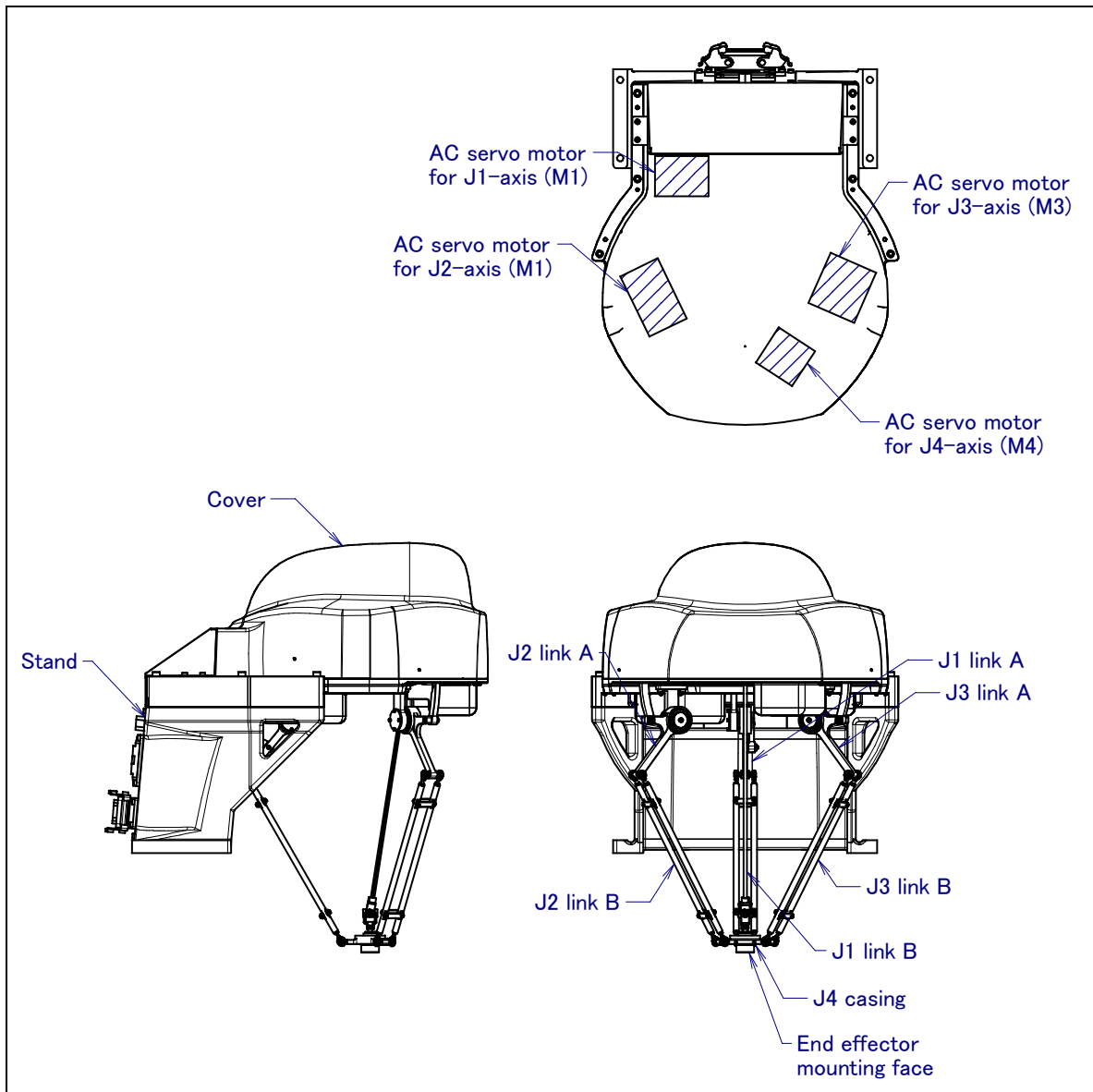


Fig. 3.1 (a) Mechanical unit configuration (M-1iA/0.5S)

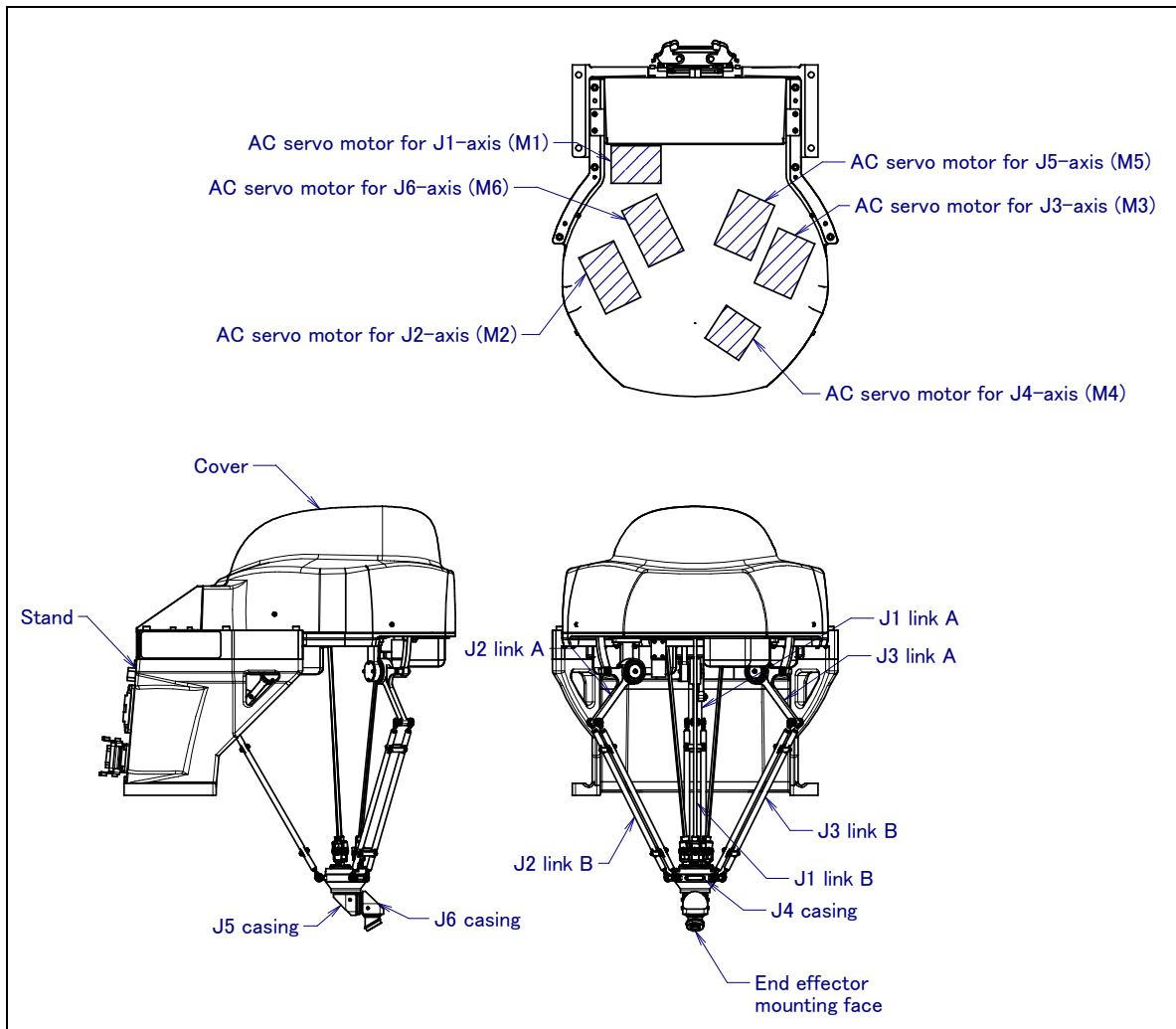


Fig. 3.1 (b) Mechanical unit configuration (M-1iA/0.5A)

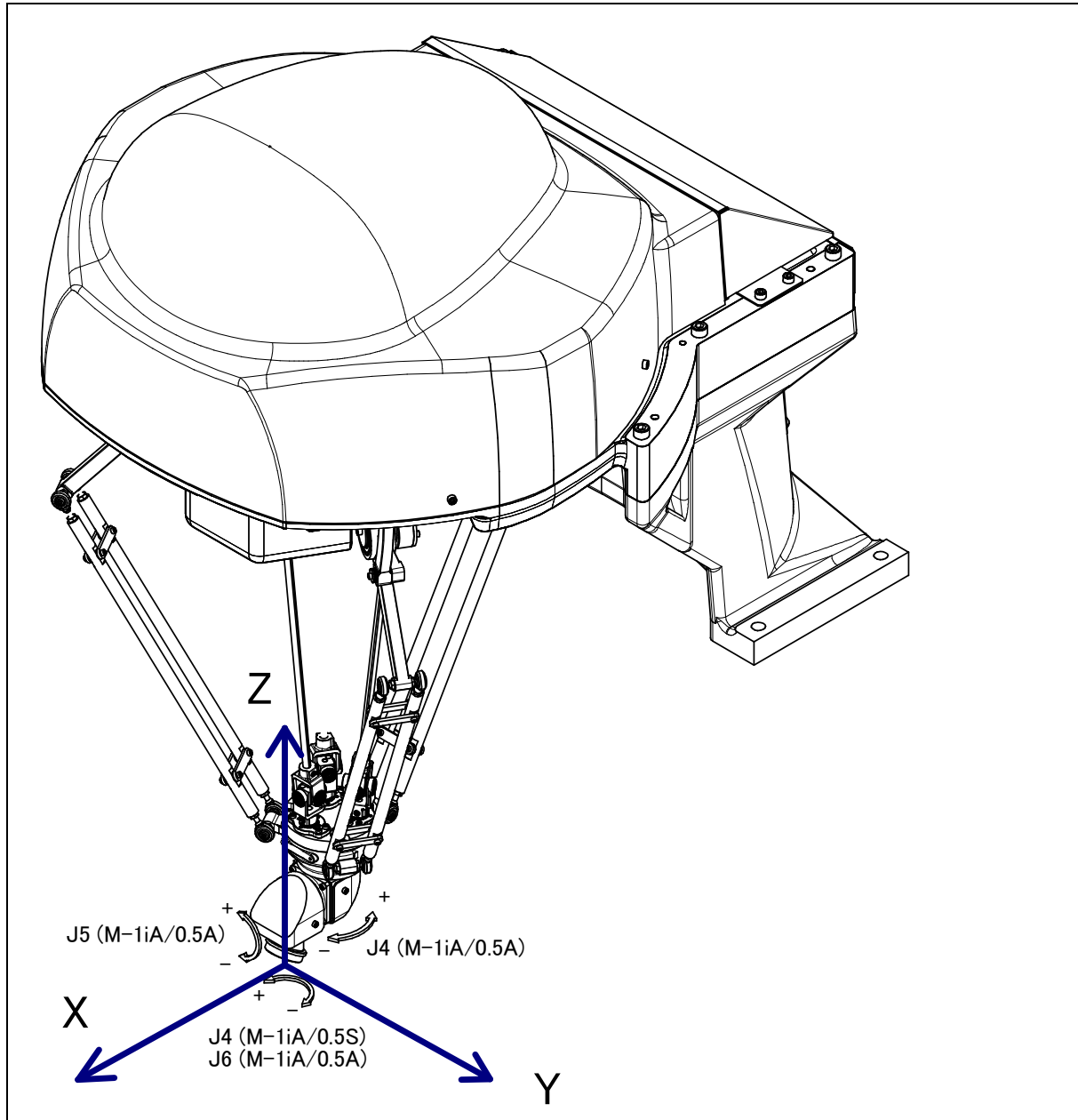


Fig. 3.1 (c) Each axes coordinates

Table 3.1 Specifications

	M-1iA/0.5S	M-1iA/0.5A
Type	Parallel link mechanism robot	
Controlled axes	4-axes (J1, J2, J3, J4)	6-axes (J1, J2, J3, J4, J5, J6)
Installation	Floor, Upside-down	Floor, Upside-down (Angle mount)
Work envelope	Diameter 280 mm, Height 100 mm	
Max.payload	0.5kg	
Drive method	Electric servo drive by AC servo motor	
Wrist maximum speed (Note 1)	3000 deg/sec (J4)	1440 deg/sec (J4,J5,J6)
Repeatability	±0.02mm	
Dust.proof and drip.proof mechanism	Conform to IP20	
Weight of mechanical unit	20kg (with stand)	23kg (with stand)
	14kg (without stand)	17kg (without stand)
Acoustic noise level	Less than 70dB This value is equivalent continuous A-weighted sound pressure level that applied with ISO11201 (EN31201). This value is measured with the following conditions. - Maximum load and speed - Operating mode is AUTO	
Installation environment	Ambient temperature: 0 to 45°C (Note 2) Ambient humidity: Normally 75%RH or less (No dew or frost allowed) Short time 95%Rh or less (Within 1 month) Permissible altitude: Above the sea 1000m or less Vibration: 0.5G or less Free of corrosive gases (Note 3)	

NOTE

- 1 It does not arrive at each axial maximum speed at the short movement distance.
- 2 When robot is used in low temperature environment that is near to 0°C, or robot is not operated for a long time in the environment that is less than 0°C in a holiday or the night, because viscous resistance of the drive train is so big that may cause occurrence of collision detect alarm (SRVO -050) etc. In this case, we recommend performing the warm up operation for several minutes.
- 3 Contact the service representative, if the robot is to be used in an environment or a place subjected to severe vibrations, heavy dust, cutting oil splash and or other foreign substances.

**CAUTION**

They should be installed in the environment of "Pollution degree 2" regulated in IEC 60664-1 (JIS C 0664). "Pollution degree 2" means cleanly environment like an office.

3.2 MECHANICAL UNIT OPERATION AREA AND INTERFERENCE AREA

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

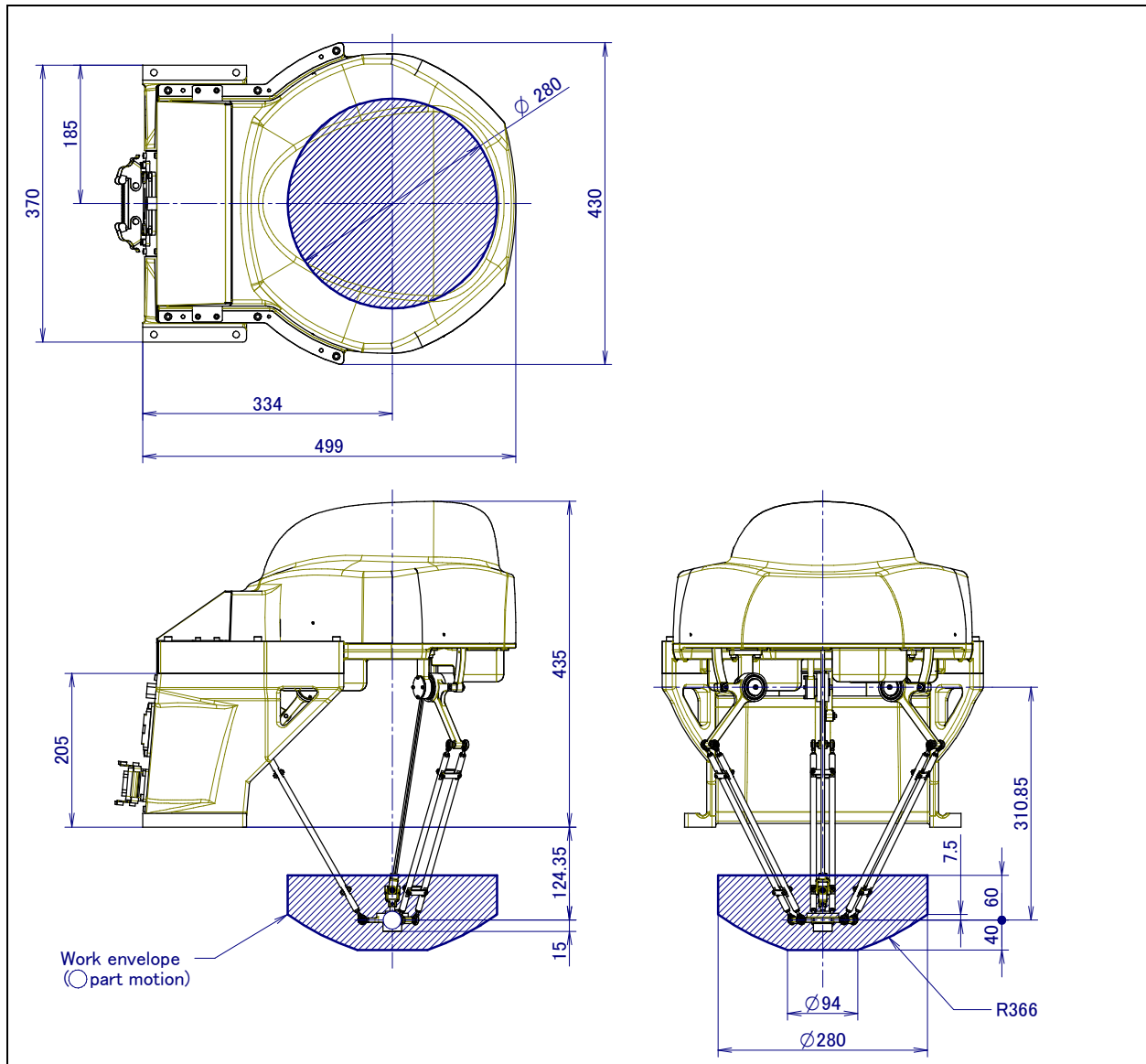


Fig. 3.2 (a) Interference area (M-1iA/0.5S) (with stand)

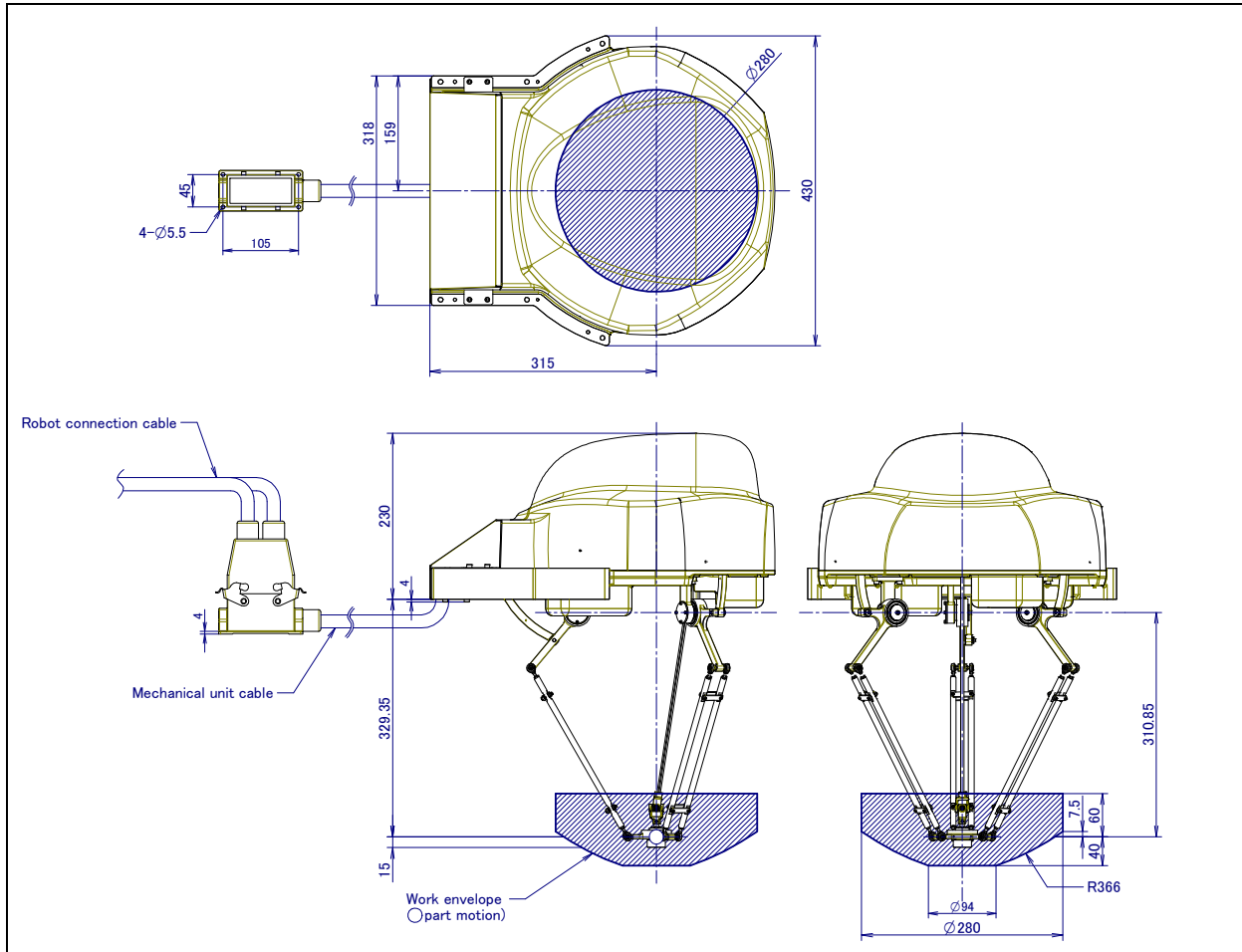


Fig. 3.2 (b) Interference area (M-1iA/0.5S) (no stand A)

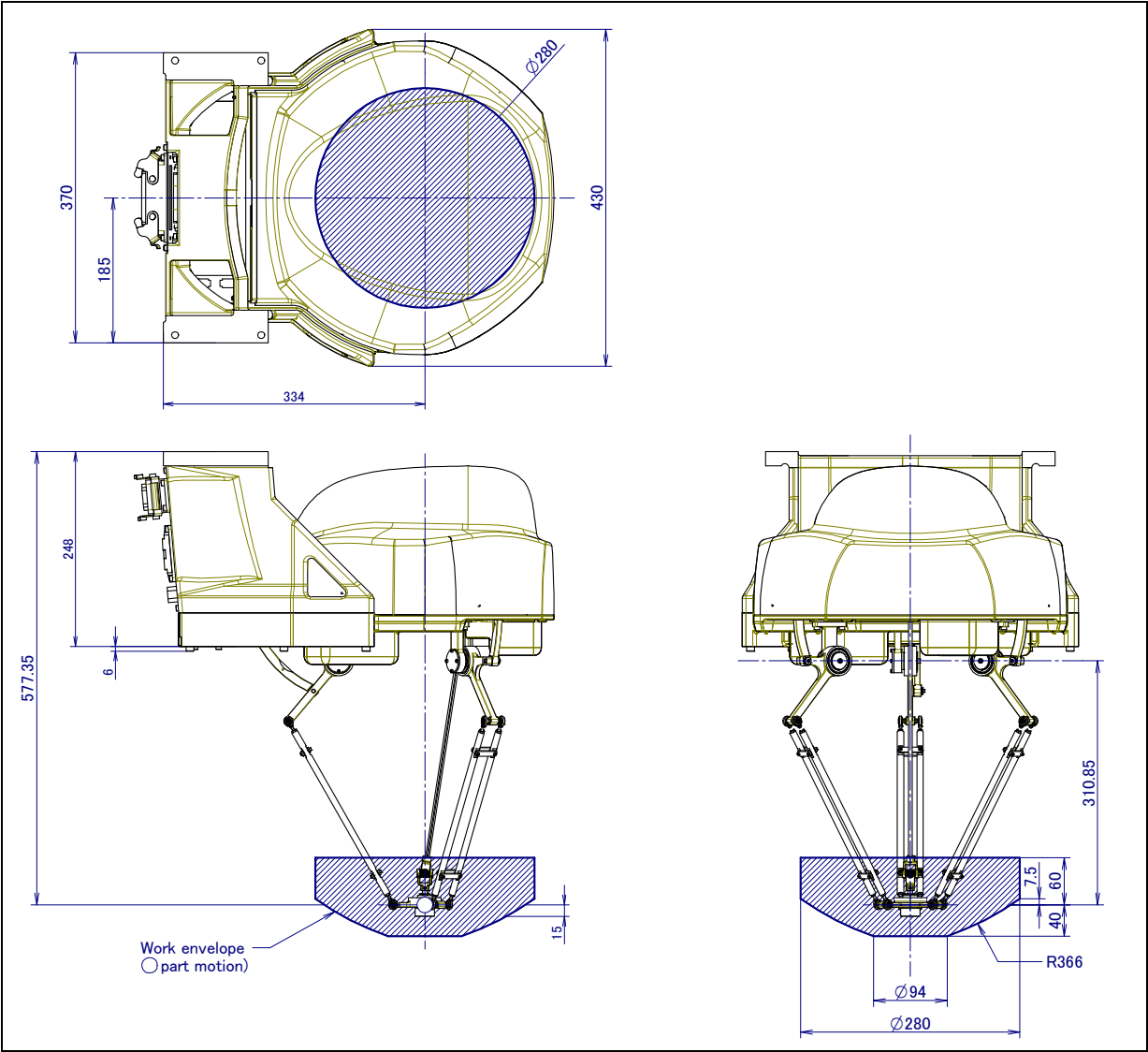


Fig. 3.2 (c) Interference area (M-1iA/0.5S) (upside-down mount)

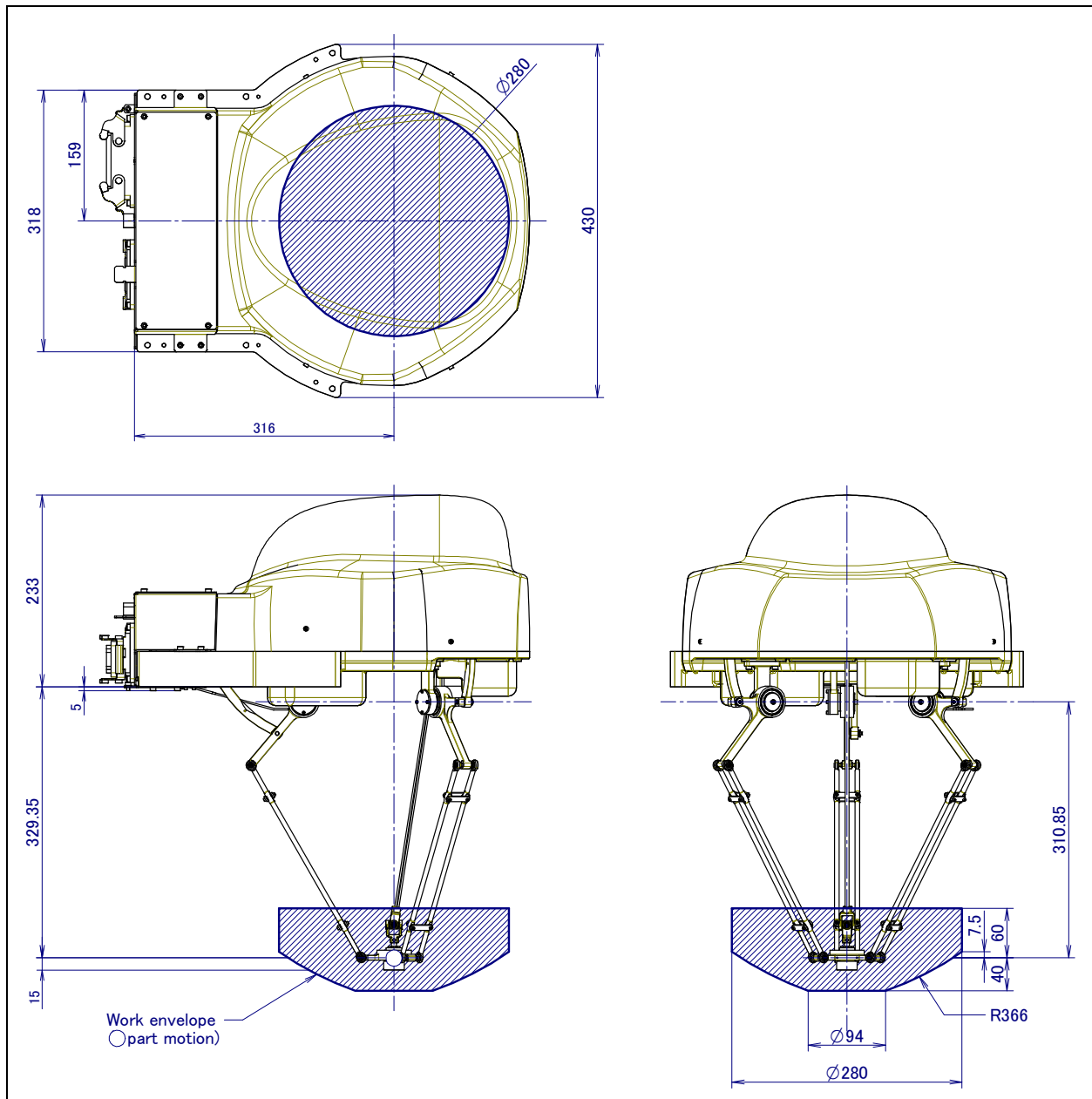


Fig. 3.2 (d) Interference area (M-1iA/0.5S) (no stand B)

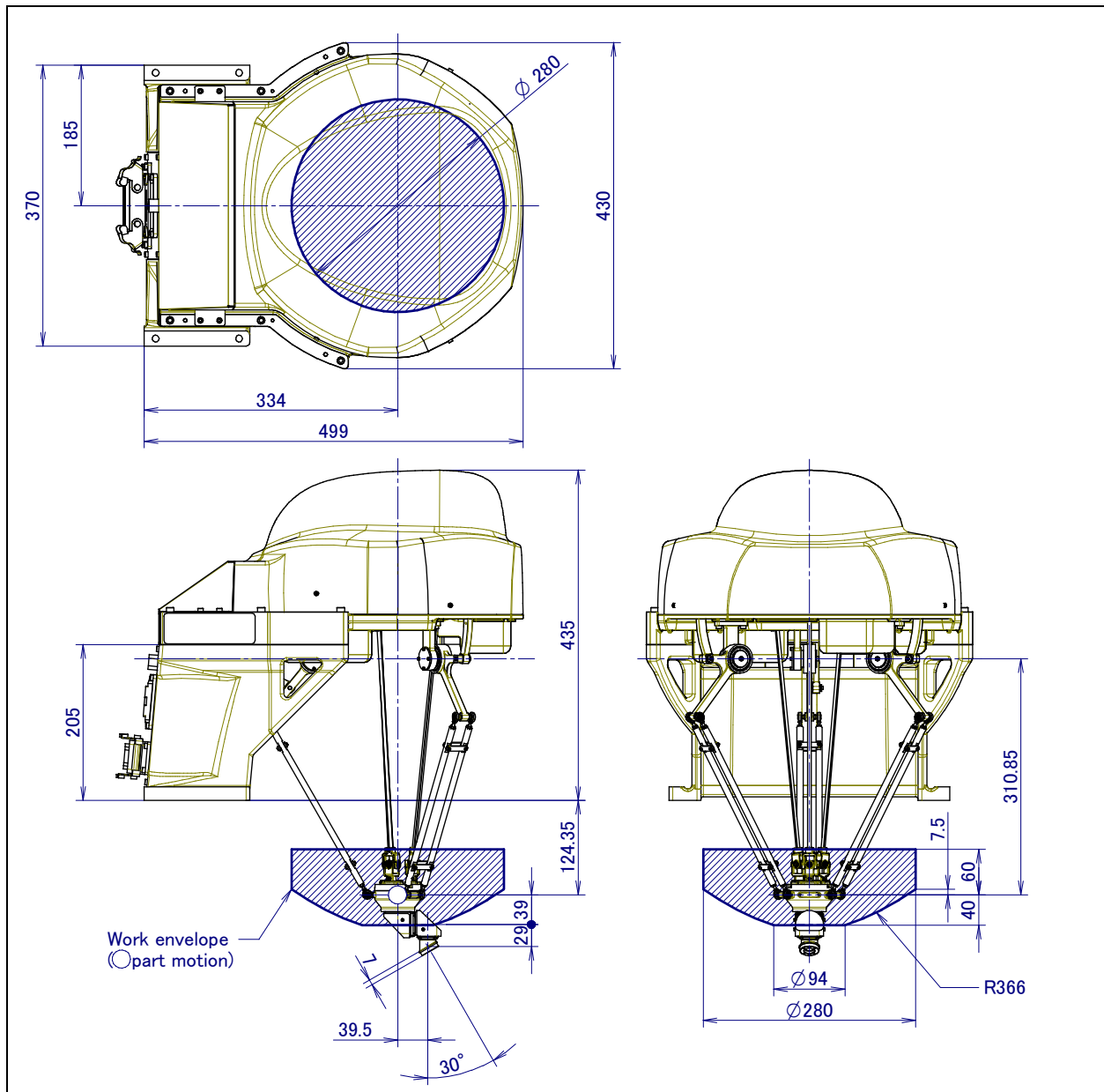


Fig. 3.2 (e) Interference area (M-1iA/0.5A) (with stand)

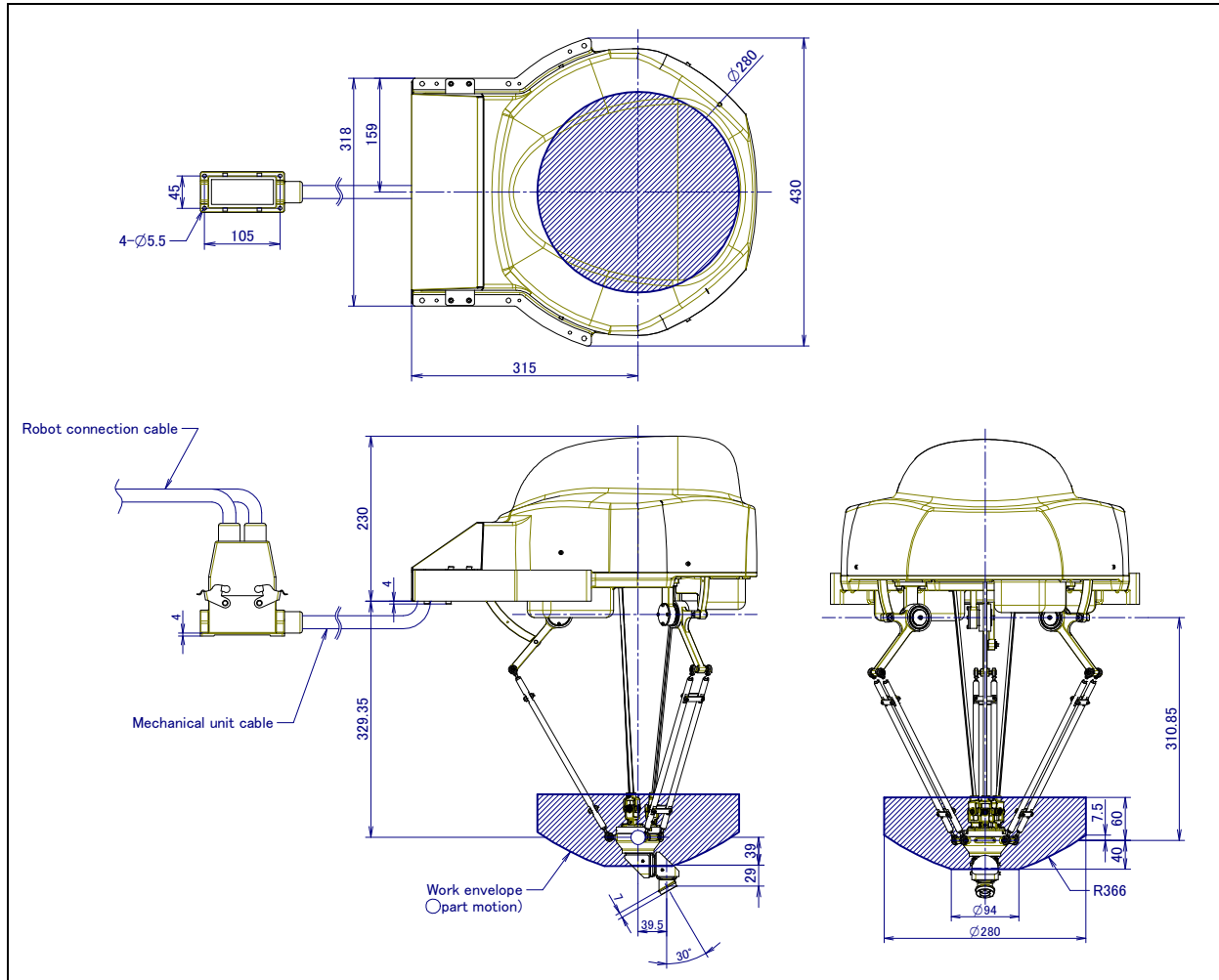


Fig. 3.2 (f) Interference area (M-1iA/0.5A) (no stand A)

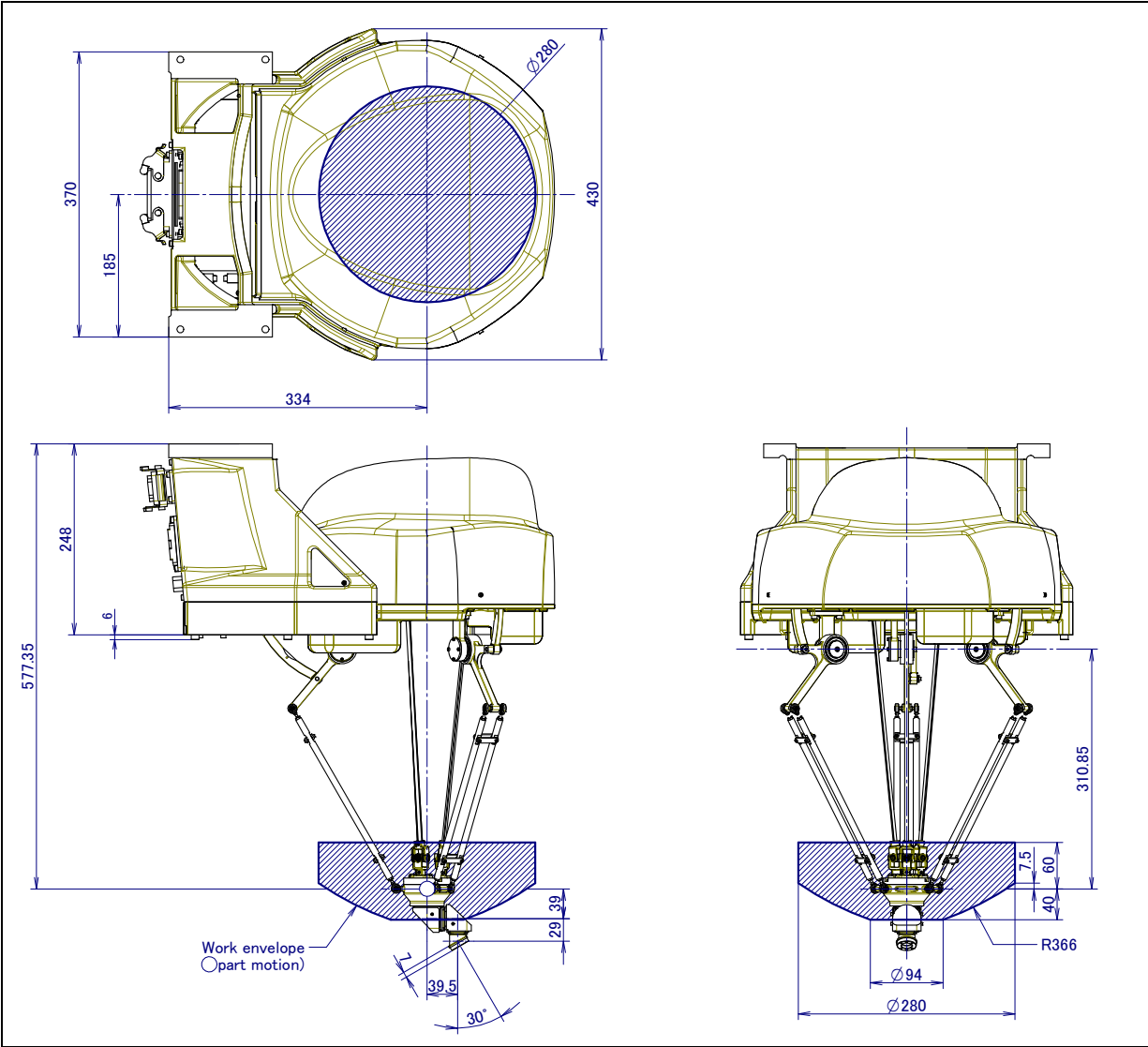


Fig. 3.2 (g) Interference area (M-1iA/0.5A) (upside-down mount)

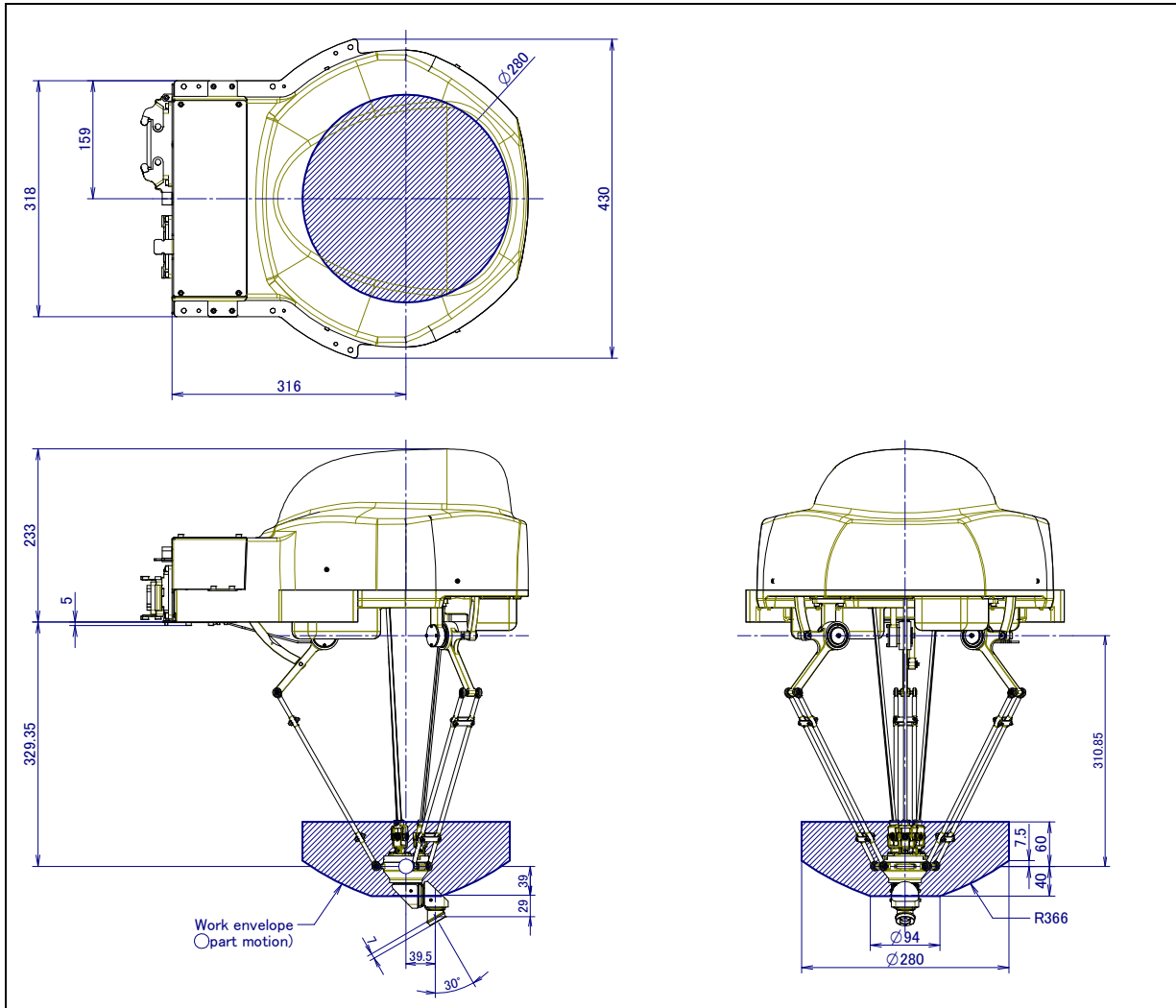


Fig. 3.2 (h) Interference area (M-1iA/0.5A) (no stand B)

3.3 WRIST LOAD CONDITIONS

Fig. 3.3 (a), (b) are diagrams to limit loads applied to the wrist.

- Apply a load within the region indicated in the graph.
- See Section 4.1 about mounting of end effector.

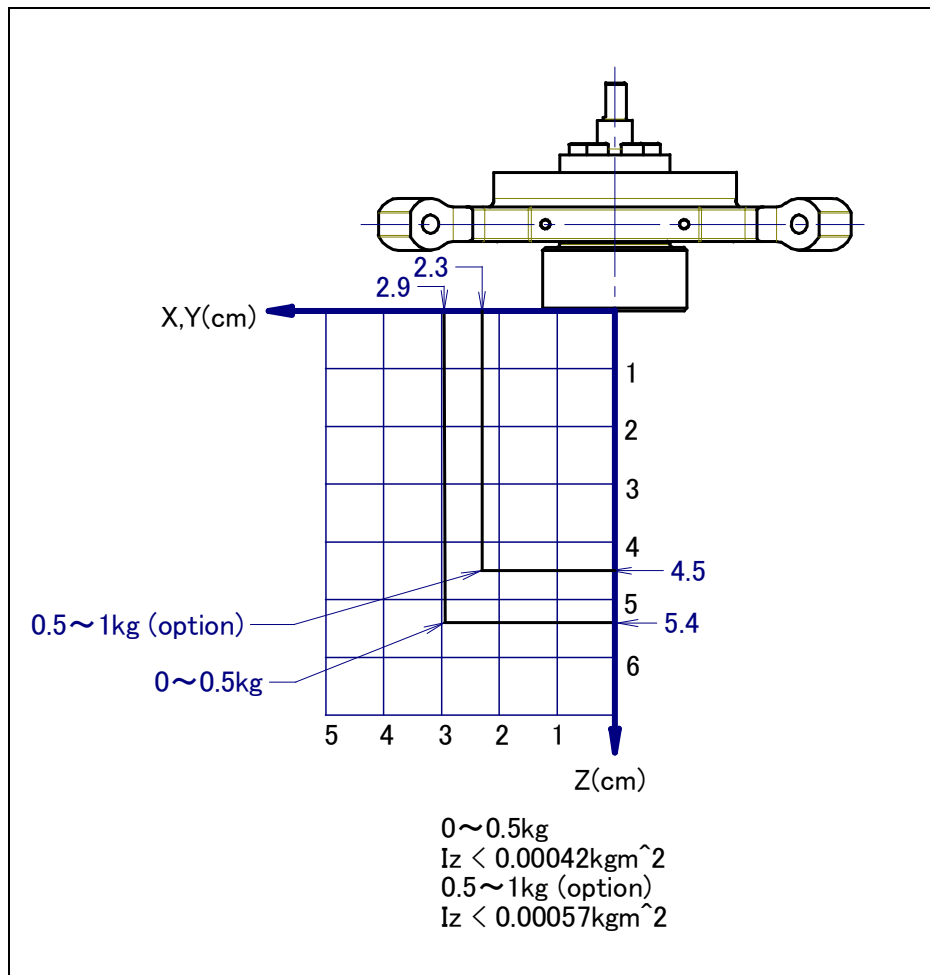


Fig. 3.3 (a) Wrist load diagram (M-1iA/0.5S)

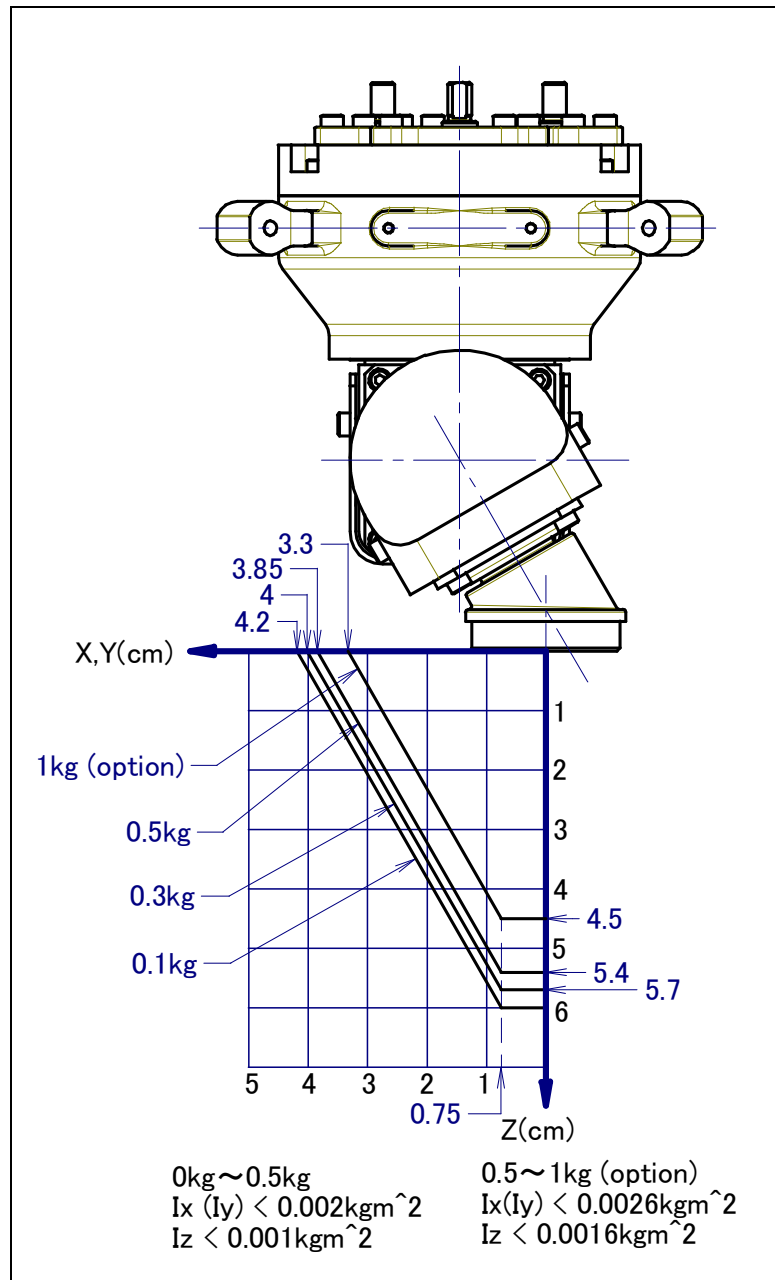


Fig. 3.3 (b) Wrist load diagram (M-1iA/0.5A)

4 MECHANICAL COUPLING TO THE ROBOT

4.1 MECHANICAL COUPLING OF END EFFECTOR TO WRIST

Fig. 4.1 (a), (b) are the diagrams for installing end effectors on the wrist. Select screws and positioning pins of a length that matches the depth of the tapped and pin holes. See Appendix B “Bolt tightening torque” about tightening torque.

⚠ CAUTION

Notice the tooling coupling depth to wrist flange should be shorter than the flange coupling length.

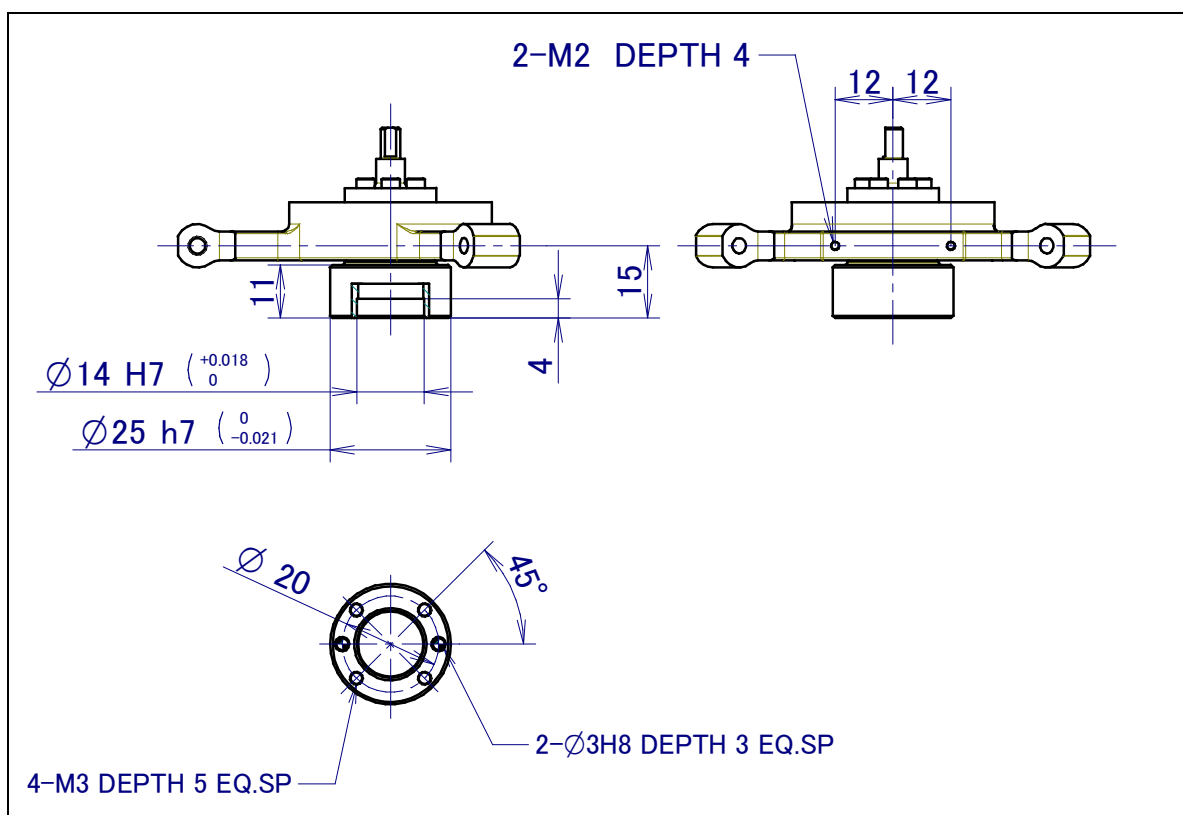


Fig. 4.1 (a) End effector interface dimension (M-1iA/0.5S)

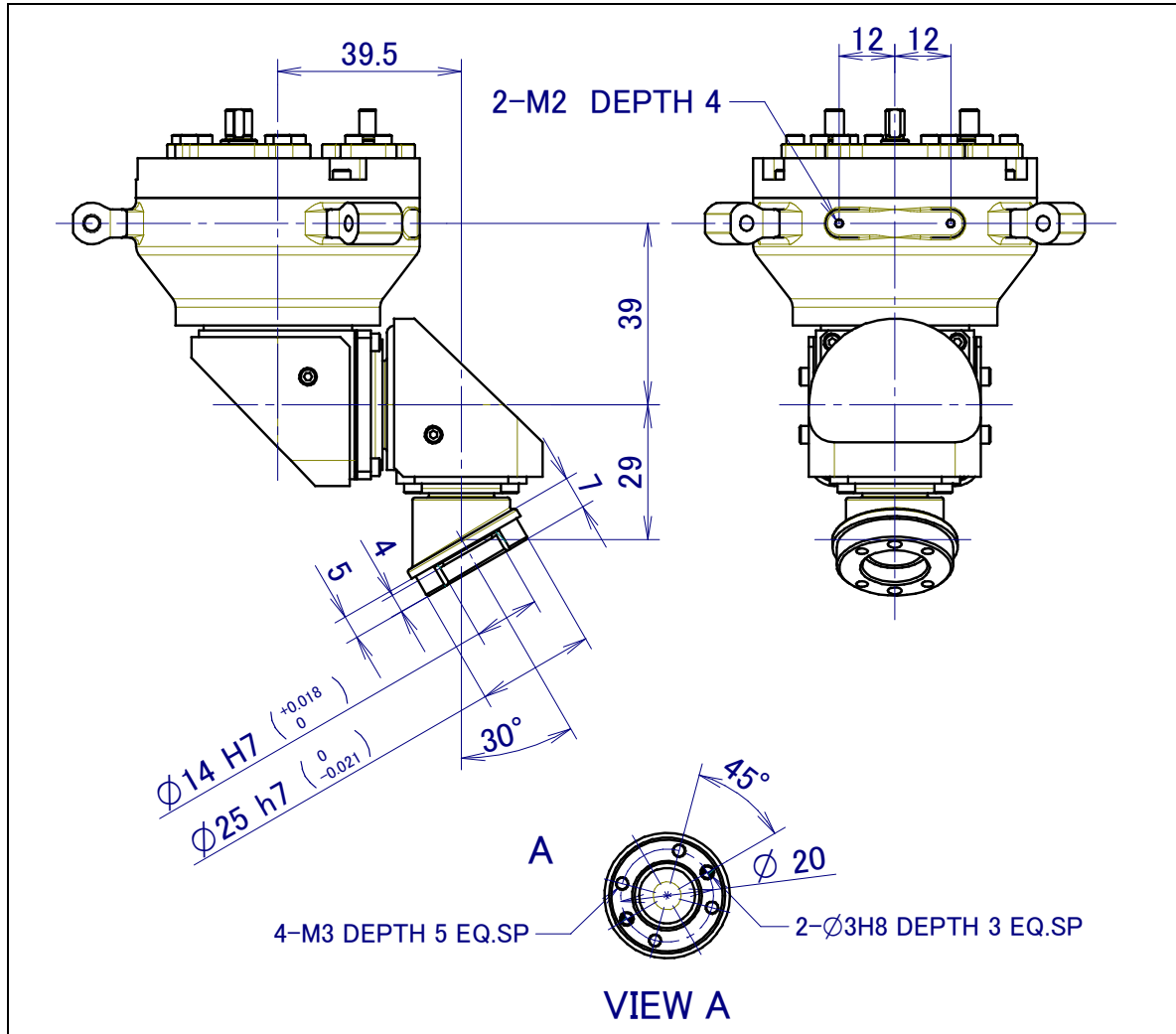


Fig. 4.1 (b) End effector interface dimension (M-1iA/0.5A)

4.2 LOAD SETTING

NOTE

Remember to set load condition parameter. Otherwise, there is a possibility that trouble occurs such as reducer life reduction. Don't exceed allowable payload including connection cables and its swing.

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

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

MOTION PERFORMANCE		JOINT	10 %
Group1			
No.	PAYLOAD[kg]	Comment	
1	0.50	[	]
2	0.00	[	]
3	0.00	[	]
4	0.00	[	]
5	0.00	[	]
6	0.00	[	]
7	0.00	[	]
8	0.00	[	]
9	0.00	[	]
10	0.00	[	]
Active PAYLOAD number = 0			
[TYPE]	GROUP	DETIAL	ARMLOAD SETTND>
	IDENT		>

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

MOTION PAYLOAD SET		JOINT	100 %
Group1			
1	Schedule No [1]:	[Comment	]
2	PAYLOAD	[kg]	0.50
3	PAYLOAD CENTER X	[cm]	0.7654
4	PAYLOAD CENTER Y	[cm]	0.00
5	PAYLOAD CENTER Z	[cm]	5.4484
6	PAYLOAD INERTIA X	[kgfcms ²]	2.0972
7	PAYLOAD INERTIA Y	[kgfcms ²]	2.3716
8	PAYLOAD INERTIA Z	[kgfcms ²]	1.421
[TYPE] GROUP NUMBER DEFAULT HELP			

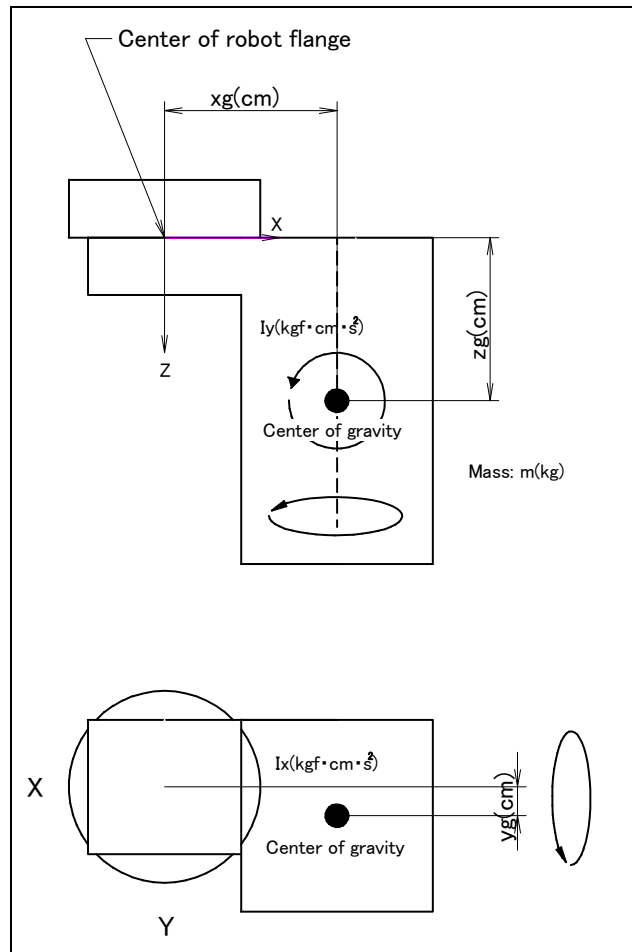


Fig. 4.2 Standard tool coordinate

- 6 Set the payload, gravity center position, and inertia around the gravity center on the MOTION PAYLOAD SET screen. The X, Y, and Z directions displayed on this screen correspond to the respective standard tool coordinates (with no tool coordinate system set up). When values are entered, the following message appears: "Path and Cycletime will change. Set it?" Respond to the message with F4 ([YES]) or F5 ([NO]).
- 7 Clicking F3 ([NUMBER]) will bring you to the MOTION PAYLOAD SET screen for another condition
- 8 Press the previous page key to return to the list screen. Press F5 SETIND, and enter a desired load setting condition number.

5 PIPING AND WIRING TO THE END EFFECTOR

⚠ WARNING

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

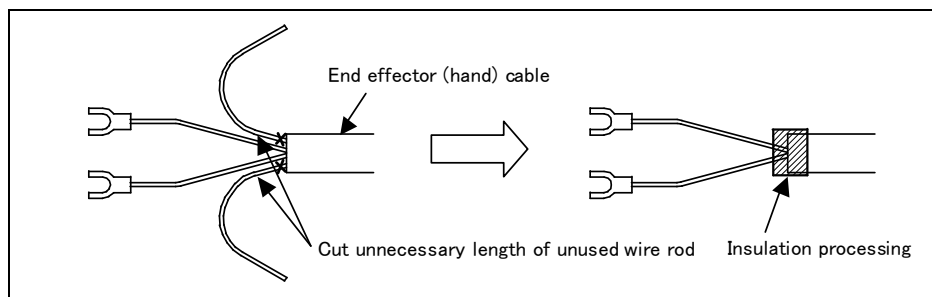


Fig.5 Treatment method of end effector (hand) cable

5.1 AIR SUPPLY AND EE(RI) INTERFACE (OPTION)

Fig.5.1 shows the position of air supply and EE interface position and pin layout.

Optional solenoid valves can be mounted as shown in Tables 5.1. Plugs are inserted in all the ports used for supplying air before the robot is shipped. To use the air circuit, you must remove the plugs and connect the couplings with the ports.

When the solenoid valve is to be replaced, the entire manifold should be replaced.

Table 5.1(a) Optional solenoid valves

Option spec.	Description	Solenoid (Manifold) spec	Remarks	RO
A05B-1522-J001	Double solenoids X1	A97L-0218-0121#D1 (manufactured by SMC)	2 positionX1	RO1 to 2
A05B-1522-J002	Double solenoids X2	A97L-0218-0121#D2 (manufactured by SMC)	2 positionX2	RO1 to 4
A05B-1522-J003	Double solenoids X3	A97L-0218-0121#D3 (manufactured by SMC)	2 positionX3	RO1 to 6

Available section area of the solenoid valve : 1.98mm²(CV value : 0.11)

NOTE

- 1 The connector to be plugged into the interface and the cable attached to that connector should be prepared by the customer.
- 2 When the robot is shipped, a cap is mounted on the end effector interface. When the interface is not used, mount the cap on the interface.

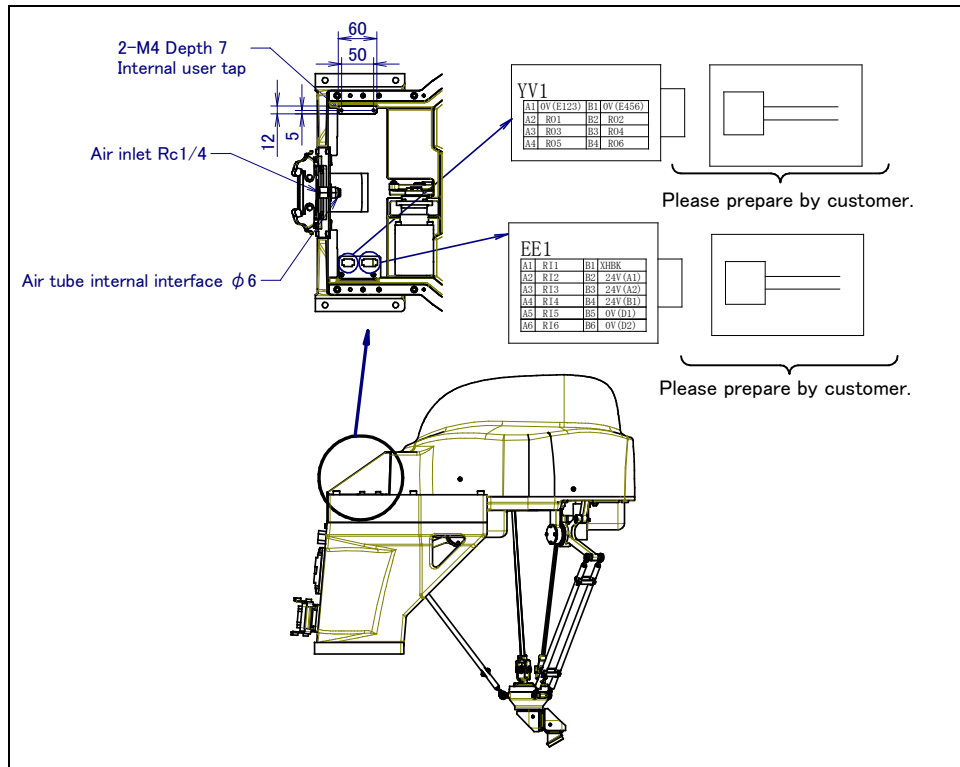


Fig. 5.1 (a) Air supply and end effector interface (RI/RO signal)

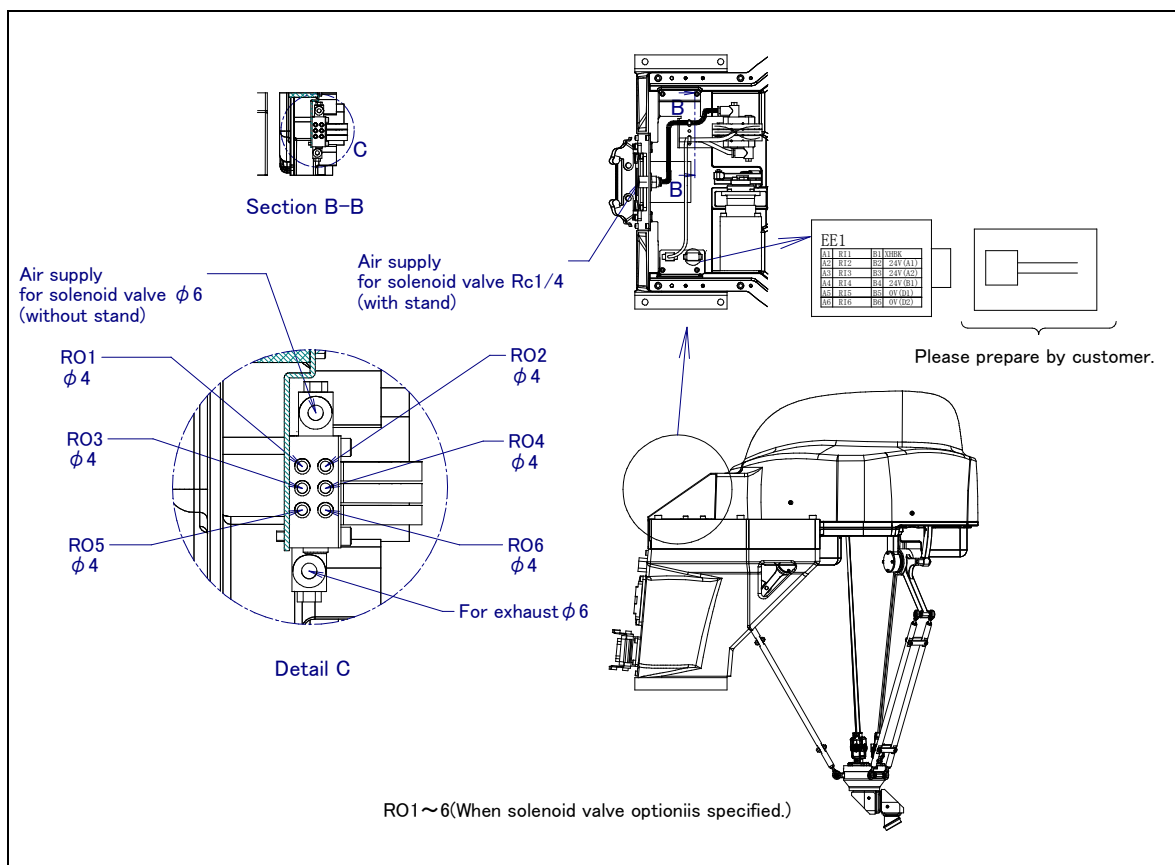


Fig. 5.1 (b) Air supply and end effector interface (RI/RO signal) (When solenoid valve option is specified.)

**CAUTION**

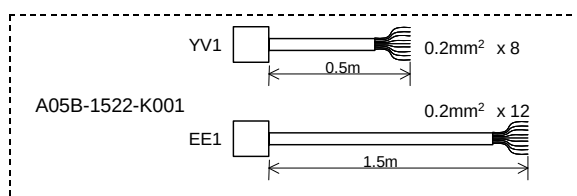
For wiring of the peripheral device to the EE interface, refer to the CONTROLLER MAINTENANCE MANUAL or contact FANUC.

Connector specifications

Table 5.1(b) Supported connectors (user side)

Maker/Dealer	MAKER SPEC		FANUC SPEC	Q'tt	
TYCO ELETORONICS AMP CO. Ltd	YV1	CONNECTOR	1-1827864-4	A63L-0002-0066#R08DX	1
		CONTACT	1827587-2	A63L-0002-0066#CRMB	8
	EE1	CONNECTOR	1-1827864-6	A63L-0002-0066#R12DX	1
		CONTACT	1827587-2	A63L-0002-0066#CRMB	12

Below is prepared as option cable kit.

**NOTE**

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

Fig.5.1 (c) shows window for user free cabling.

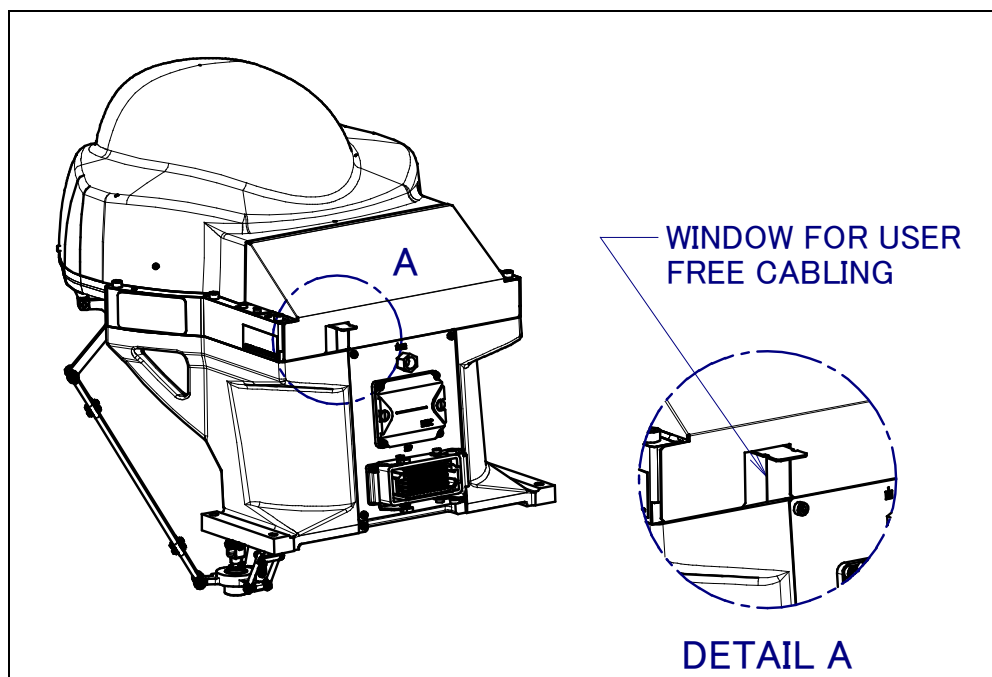


Fig.5.1 (c) Window for user free cabling

Fig.5.1 (d) shows wiring method of wiring along user piping and wiring tag.

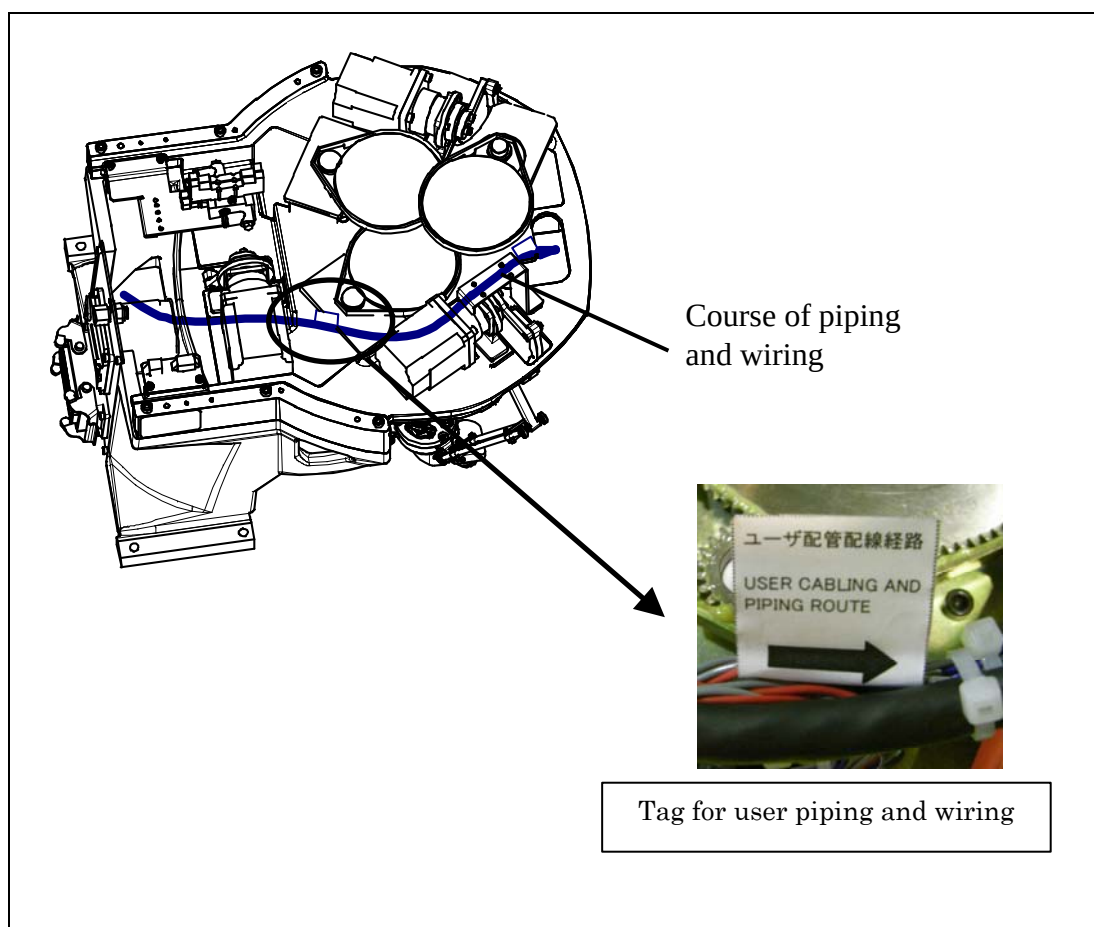


Fig.5.1 (d) wiring method of wiring along user piping and wiring tag

Fig.5.1 (e) shows method of using cable clamp option.

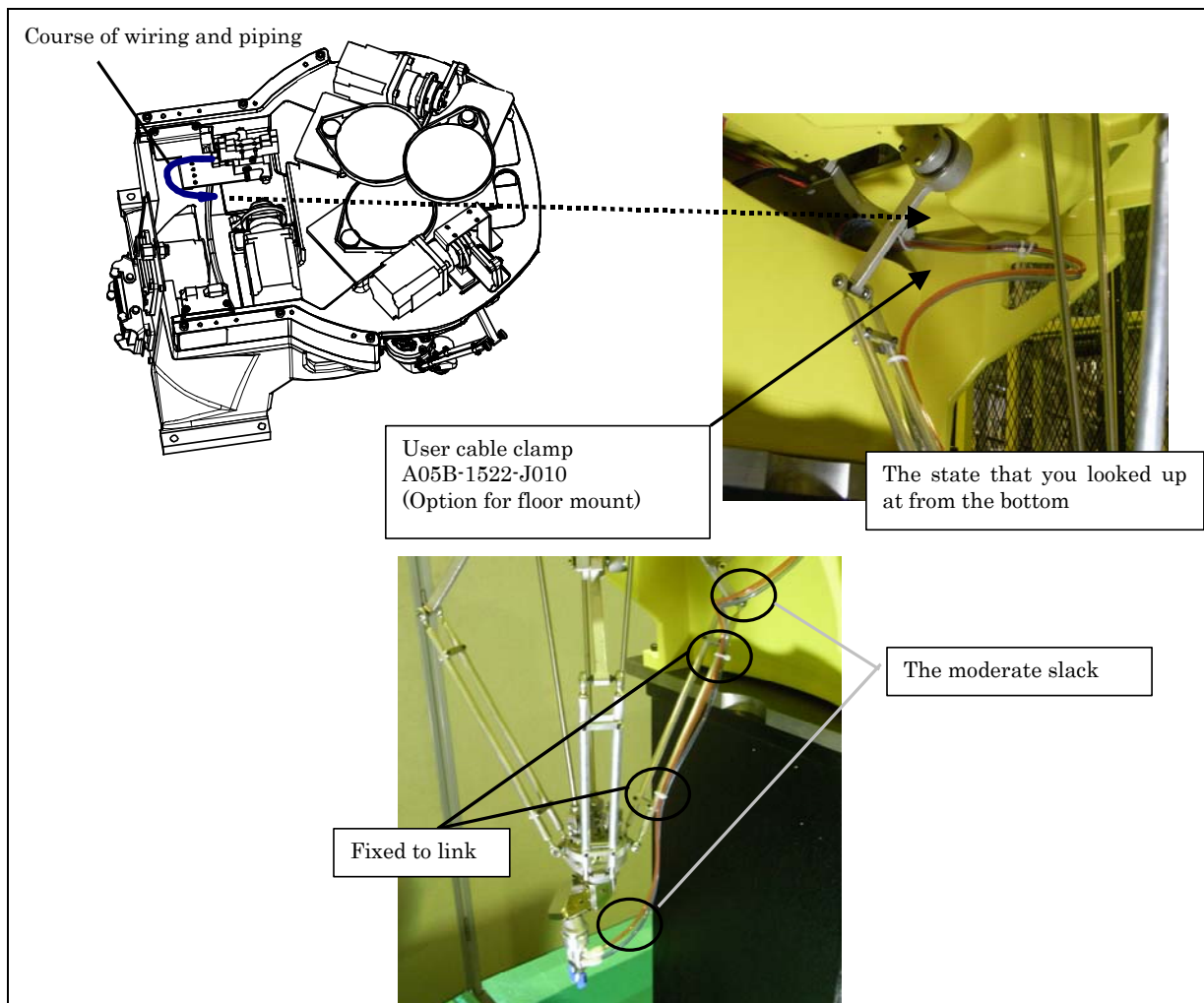


Fig.5.1 (e) method of using cable clamp option

6 CHECKS AND MAINTENANCE

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

NOTE

The periodic maintenance procedures described in this chapter assume that the FANUC robot is used for up to 3,840 hours a year. When using the robot beyond this total operating time, correct the maintenance frequencies shown in this chapter by calculation in proportion to the difference between the actual operating time and 3,840 hours/year.

6.1 PERIODIC MAINTENANCE

6.1.1 Daily Checks

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

(1) Before turning on power

Item	Check items	Check points
1	Oil exudation	Check there is oil exudation on sealed part of each joint parts, spring mounting part and bush part. If there is oil exudation, clean it.

NOTE

Oil content is exposed on the bearing part. In that case wipe them off.

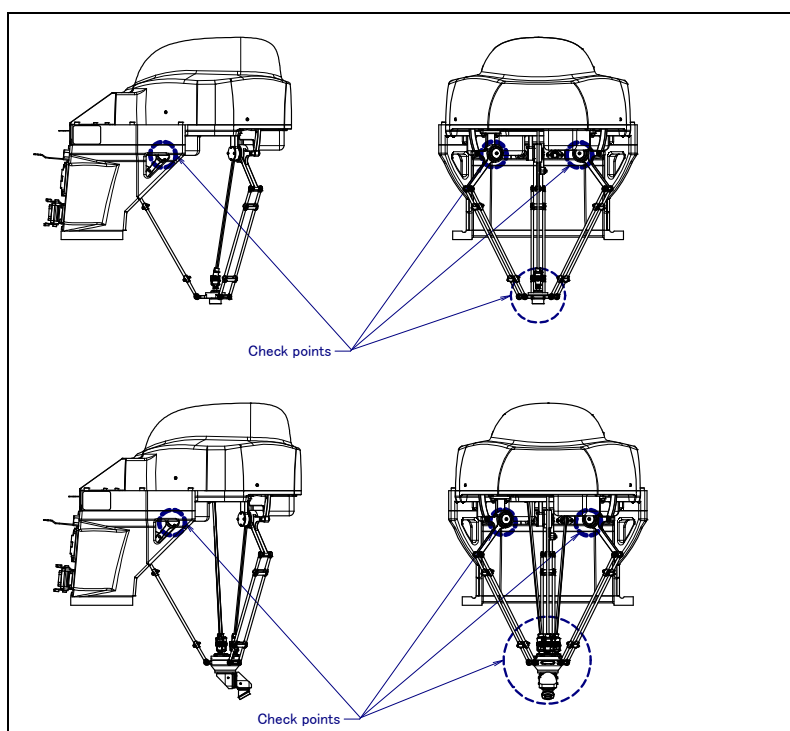


Fig.6.1.1 (a) check points

When air control set is combined

Item	Check items	Check points
1	When air control set is provided.	Air pressure Check air pressure using the pressure gauge on the air regulator as shown in Fig.6.1.1 (b). If it does not meet the specified pressure of 0.49MPa (5 kg/cm ²), adjust it using the regulator pressure setting handle.
2		Leakage from hose Check the joints, tubes, etc. for leaks. Repair leaks, or replace parts, as required.
3		Drain Check drain and release it. When quantity of the drain is remarkable, examine the setting of the air dryer to the air supply side.

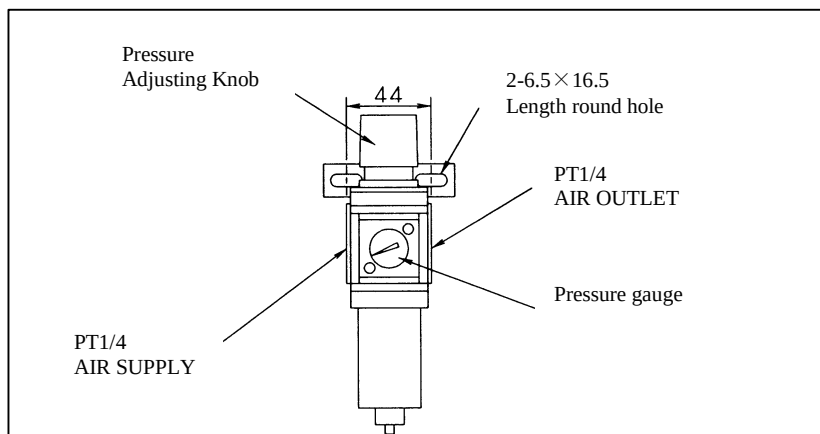


Fig.6.1.1 (b) Air control set (option)

(2) After automatic operation

Item	Check items	Check points
1	Vibration, abnormal noises, and motor heating	Check whether the robot moves along and about the axes smoothly without unusual vibration or sounds. Also, check whether the temperatures of the motors are excessively high.
2	Changing repeatability	Check to see that the stop positions of the robot have not deviated from the previous stop positions.
3	Peripheral devices for proper operation	Check whether the peripheral devices operate properly according to commands from the robot.
4	Brakes for each axis	Check that the end effector drops within 0.2 mm when the power is off.

6.1.2 First 1-month (320 Hours) Checks

Check the following items in the cycle that is shorter between first one month and 320 hours, then every 3 months thereafter. (See the Sub section 6.1.4.)

Item	Check items	Check points
1	Retightening LINK B mounting part	Check the looseness of LINK B part (12 places), if they are loosened, retighten them. (See Fig.6.1.2)
2	Cleaning the ventilator	If the ventilation portion of the controller is dusty, turn off power and clean the unit.

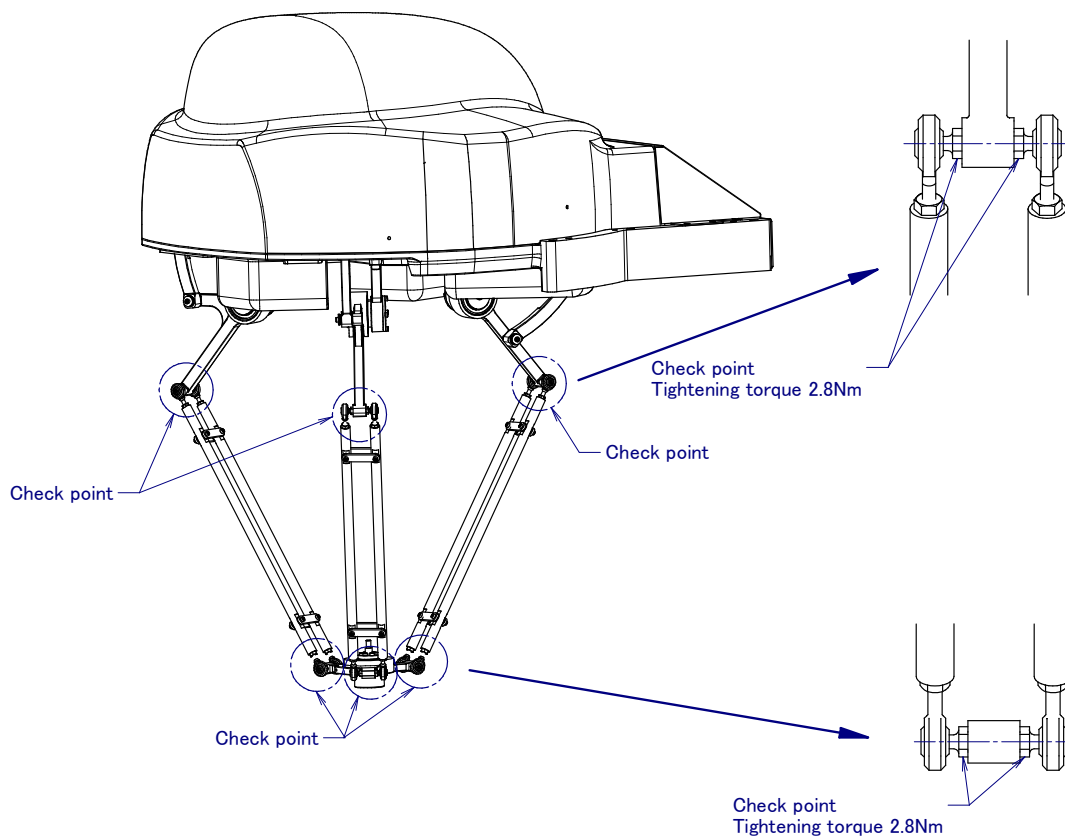


Fig.6.1.2 Checking points of LINK B

6.1.3 First 3-months (960 Hours) Checks

Check the following items at the first quarterly inspection, then every year thereafter. (See the Sub section 6.1.6.) In case of cleaning the grease around the wrist input gear, then every 6 months. (See the Sub section 6.1.5.)

Item	Check items	Check points
1	Connector used in mechanical unit	Check that the connectors of the connector panels are securely engaged. (NOTE 1)
2	Retightening external main bolts	Further, tighten the end-effector mounting bolts and external main bolts. (NOTE 2)
3	Cleaning and checking each part	Clean each part (remove chips, etc.) and check component parts for cracks and flaws. (NOTE 3)
4	Check the end effector (hand) cable	Confirm whether there is wound in the cable.
5	Cleaning the grease around the wrist input gear	Clean the grease of the around of wrist input gear after removing cover. (NOTE 3)
6	Check the robot cable, teach pendant cable and robot connecting cable	Check whether the cable connected to the teach pendant and robot is unevenly twisted.

NOTE 1) Inspection points and checks items of the connectors

Inspection points of the connectors

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

Check items

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

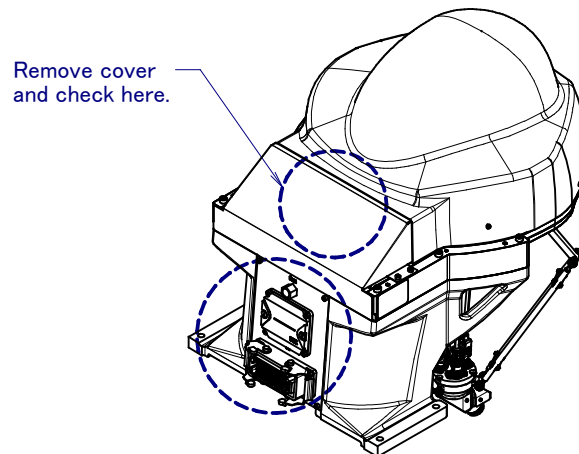


Fig. 6.1.3 (a) Check items of connector

NOTE 2) Points to be retightened

- The end effector mounting bolts, robot installation bolts, and bolts to be removed for inspection need to be retightened.

NOTE 3) Cleaning

- Necessary cleaning points, dust on the flat part, sedimentation of spatters
Clean sediments periodically.
In particular, clean the following points carefully.

Vicinity of the wrist axis and oil seal

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

Vicinity of the wrist input gear

→ Clean up the dirty splattered grease around the gear and gear cover.

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

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

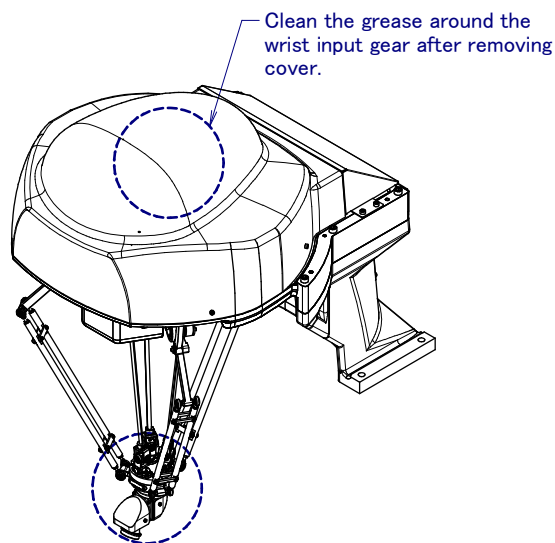


Fig. 6.1.3 (b) Cleaning part

6.1.4 3-months (960 Hours) Checks

Check the following items in the cycle that is shorter between every 3-months and every 960 hours.

Item	Check items	Check points
1	Retightening LINK B mounting part	(See Subsection 6.1.2)
2	Cleaning the ventilator	(See Subsection 6.1.2)

6.1.5 6-months (1,920 Hours) Checks

Check the following items in the cycle that is shorter between every 6-months and every 1,920 hours.

Item	Check items	Check points
1	Supply grease to wrist input gear	(See Subsection 6.2.2)
2	Cleaning the grease around the wrist input gear	(See Subsection 6.1.3)

6.1.6 1-year (3,840 Hours) Checks

Check the following items in the cycle that is shorter between every year and every 3,840 hours.

Item	Check items	Check points
1	Connector used in mechanical unit	(See Subsection 6.1.3.)
2	Retightening external main bolts	(See Subsection 6.1.3.)
3	Cleaning and checking each part	(See Subsection 6.1.3.)
4	Check the end effector (hand) cable	(See Subsection 6.1.3.)
5	Replacing battery (with stand / no stand B)	(See Subsection 6.2.1.)
6	Check the robot cable, teach pendant cable and robot connecting cable	(See Subsection 6.1.3.)

6.1.7 1.5-year (5,760 Hours) Checks

Check the following item in the cycle that is shorter between every 1.5 year and 5,760 hours.

Item	Check items	Check points
1	Replacing battery (no stand A)	Replace battery in the mechanical unit. (See Subsection 6.2.1)

6.2 MAINTENANCE

6.2.1 REPLACING THE BATTERIES (1-YEAR (3,840 Hours) CHECKS (with stand/no stand B)) (1.5-YEAR (5,760 Hours) CHECKS (no stand A))

The position data of each axis is preserved by the backup batteries. The batteries need to be replaced every 1 year in case of with stand/no stand B 1.5 years in case of no stand A. Also, use the following procedure to replace when the backup battery voltage drop alarm occurs.

Procedure of replacing the battery (with stand /no stand B)

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



CAUTION

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

- 2 Remove the battery case cap. (Fig.6.2.1 (a))
- 3 Take out the old batteries from the battery case.
- 4 Insert new batteries into the battery case. Pay attention to the direction of batteries.
- 5 Close the battery case cap.

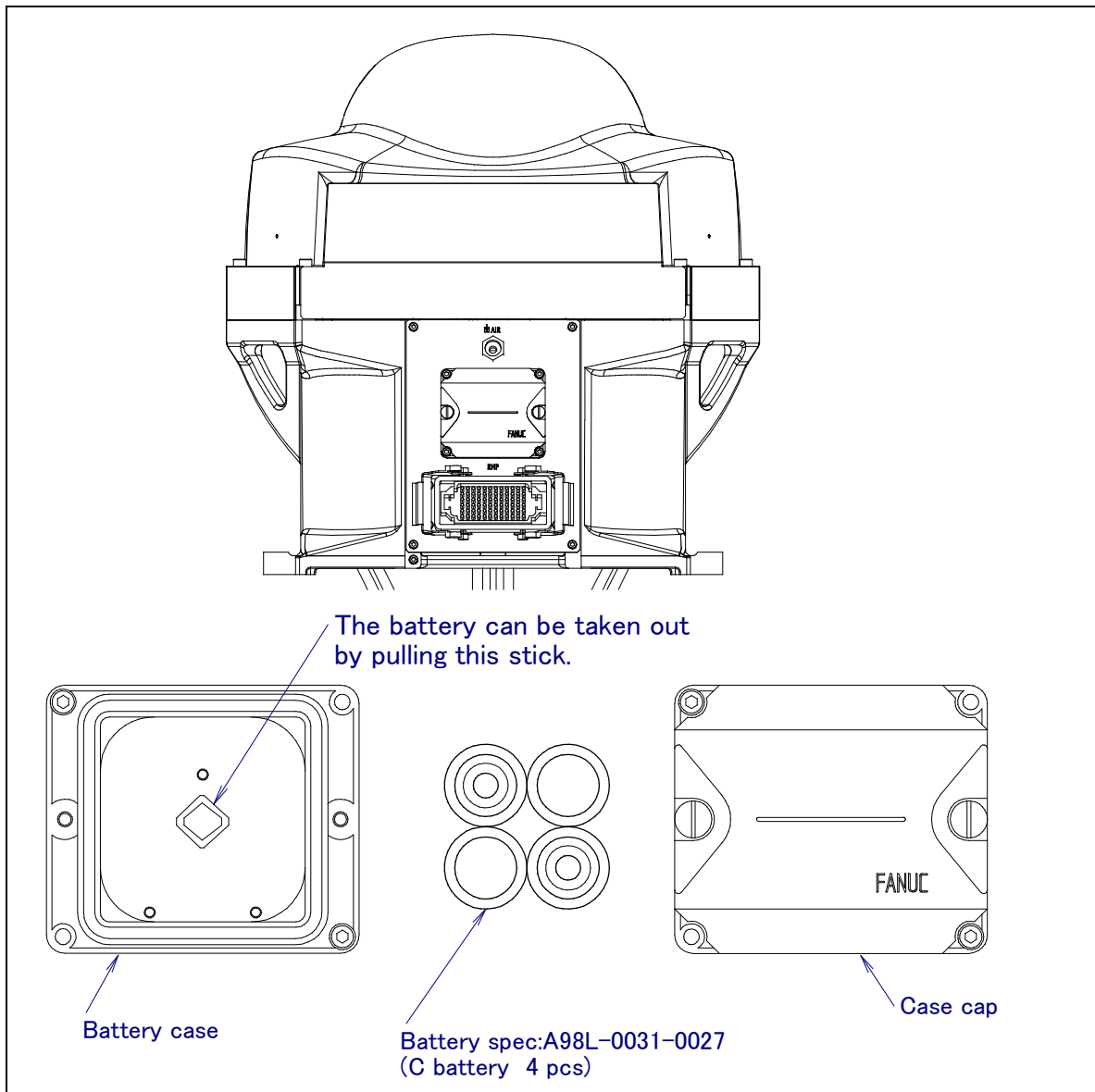


Fig. 6.2.1 (a) Replacing Batteries (with stand/no stand B)

Procedure of replacing the battery (no stand A)

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



CAUTION

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

- 2 Remove the battery case cap. (Fig. 6.2.1 (b))
- 3 Take out the old batteries from the battery case.
- 3 Insert new batteries into the battery case. Pay attention to the direction of batteries.
- 4 Close the battery case cap.

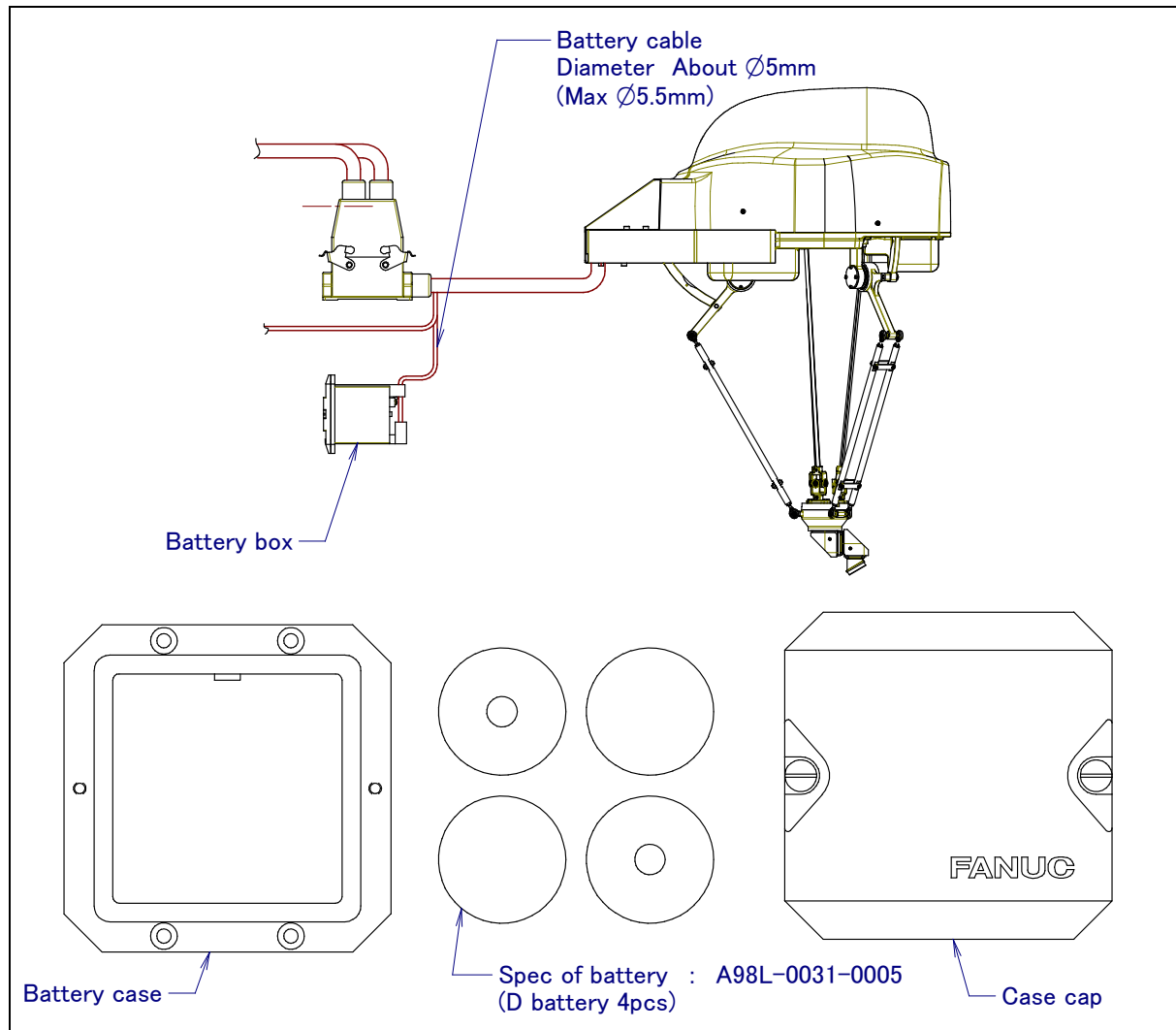


Fig. 6.2.1 (b) Replacing Batteries (no stand A)

Fig 6.2.1 (c) shows the external size of external battery box.

When the battery box needs to be built into the controller or other internal units, refer to the outer dimensions shown in Fig.6.2.1 (c)

The battery box can be fixed by using M4 flat-head screws. (The bolts do not come with the system.)

A maximum of six terminals can be attached to the backplane of the battery box.

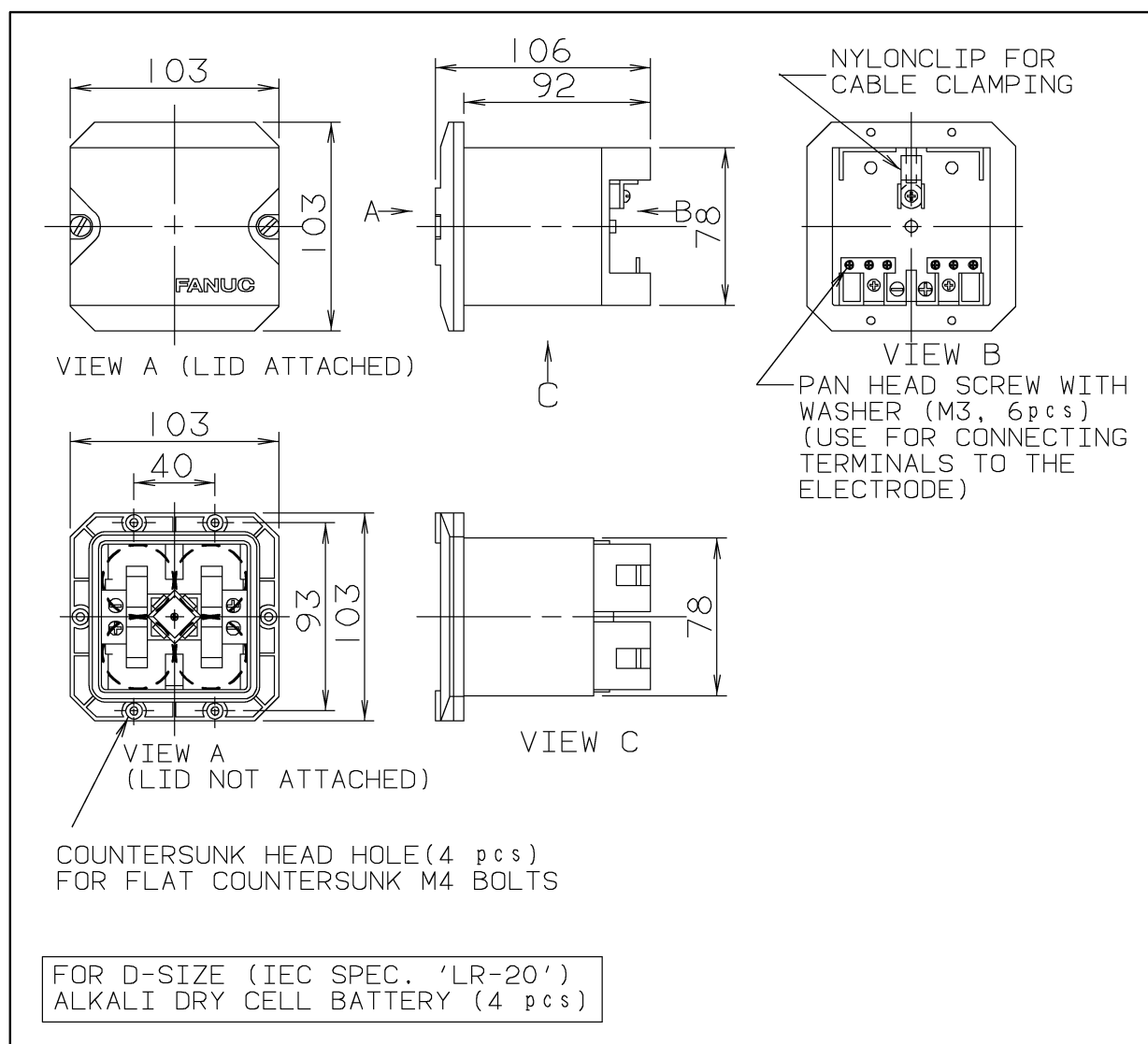


Fig. 6.2.1 (c) Outer dimensions of the battery box

6.2.2 Replacing the Grease of the Drive Mechanism (6 months (1,920 Hours) Checks)

Supply grease to wrist input gear in the cycle that is shorter among every 6 months 1,920 hours by using the following procedures. See table 6.2.2 for the grease name and the quantity.

Table 6.2.2 Grease for 6-months (1,920 hours) periodical replacement

Supply position	Quantity	Grease name
Wrist input gear	Proper quantity	JX Nippon Oil & Energy Corporation TOUGHLIX GREASE RB2 (old name: CG335) Spec: A98L-0040-0252#0.4kg

For grease replacement or replenishment, use the arbitrary posture.

**CAUTION**

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

- 1 Use grease only of the specified type. Grease of a type other than that specified may damage the reducer or lead to other problems.
- 2 To prevent accidents caused by slipping, completely remove any excess grease from the floor or robot.

- 1 Turn off the controller power.
- 2 Remove the cover.
- 3 Supply new grease to the gear of J4 to J6-axes referring to Fig.6.2.2.
In case of M-1iA/0.5S, there are two places for J4-axis.
In case of M-1iA/0.5A, there are six places for J4 to J6-axes.
- 4 Clean up the dirty splattered grease around the gear and gear cover.
- 5 Attach cover.

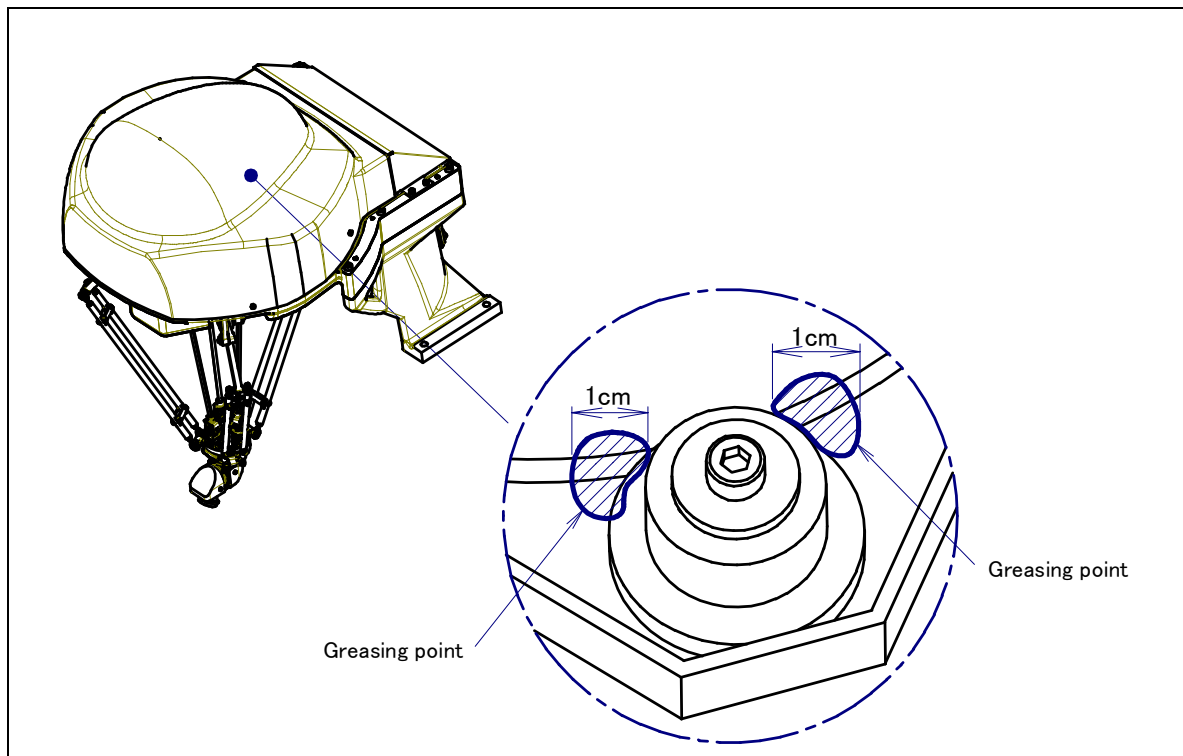


Fig.6.2.2 Supply grease to J4 to J6 gears

6.3 STORAGE

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

7 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.

7.1 GENERAL

The current position of the robot is determined according to the pulse count value supplied from the Pulsecoder on each axis.

Mastering is factory-performed. It is unnecessary to perform mastering in daily operations. However, mastering becomes necessary after:

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



CAUTION

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

Types of Mastering

There are five methods of the following mastering.

Table 7.1 Type of mastering

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

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

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

**CAUTION**

- 1 If mastering is performed incorrectly, the robot may behave unexpectedly. This is very dangerous. Therefore, the positioning screen is designed to appear only when the \$MASTER_ENB system variable is 1 or 2. After performing positioning, press F5 [DONE] on the positioning screen. The \$MASTER_ENB system variable is reset to 0 automatically, thus hiding the positioning screen.
- 2 It is recommended that the current mastering data be backed up before mastering is performed.

7.2 RESETTING ALARMS AND PREPARING FOR MASTERING

Before performing mastering because a motor is replaced, you must release the relevant alarm and display the positioning menu.

Alarm displayed

“Servo –062 BZAL” or “Servo 075 Pulse not established”

Procedure

Step

- 1 Display the positioning menu by following steps 1 to 6.
 - 1 Press the screen selection key.
 - 2 Press [0 NEXT] and Select [6 SYSTEM].
 - 3 Press F1 [TYPE], and select [SYSTEM Variable] from the menu.
 - 4 Place the cursor on \$MASTER_ENB, then key in “1” and press [ENTER].
 - 5 Press F1 [TYPE] again, and select [Mater/Cal] from the menu.
 - 6 Select the desired mastering type from the [Master/Cal] menu.
- 2 To reset the “Servo 062 BZAL” alarm, follow steps 1 to 5.
 - 1 Press the screen selection key.
 - 2 Press [0 NEXT] and select [6 SYSTEM].
 - 3 Press F1 [TYPE], and select [Master/Cal] from the menu.
 - 4 Press the F3 [RES_PCA], then press F4 [TRUE].
 - 5 Turn the controller power off and on again.
- 3 To reset the “Servo 075 Pulse not established” alarm, follow steps 1 to 3.
 - 1 When the controller power is turned on again, the message “Servo 075 Pulse not established” appears again.
 - 2 Move the axis for which the message mentioned above has appeared till alarm disappears when press [FAULT RESET] in either direction.

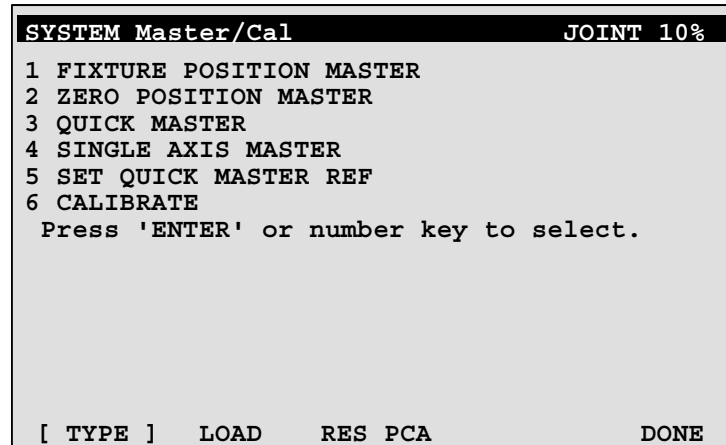
7.3 ZERO POSITION MASTERING

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

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

Procedure of Zero-position Mastering

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



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

NOTE

Brake control can be released by setting the system variables as follows:

\$PARAM_GROUP.SV_OFF_ALL: FALSE

\$PARAM_GROUP.SV_OFF_ENB[*]: FALSE (for all axes)

After changing the system variables, turn the controller power off and on again.

- 6 Select Zero Position Master.
- 7 Press F4, YES. Mastering will be performed automatically. Alternatively, turn the power off and on again. Turning the power on always causes positioning to be performed.
- 8 After completing the calibration, press F5 Done.
- 9 Return brake control to original setting, and turn the controller power off and on again.

Table 7.3 Posture with zero-position marks (witness mark) aligned

Axis	Position
J1-axis	0 deg
J2-axis	0 deg
J3-axis	0 deg
J4-axis	0 deg
J5-axis	0 deg
J6-axis	0 deg



CAUTION

There is no J5, J6-axis for M-1iA/0.5S

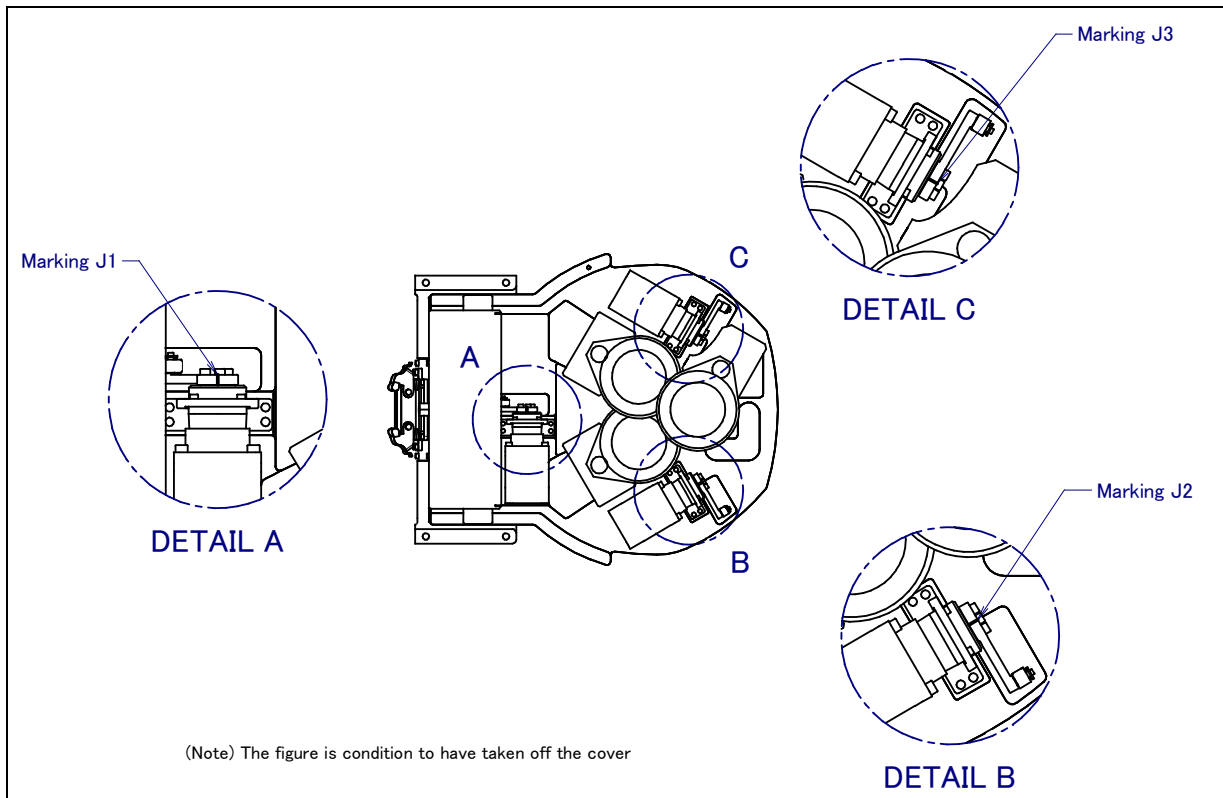


Fig. 7.3 (a) Zero-position mark (witness mark) for each axis (1/3)

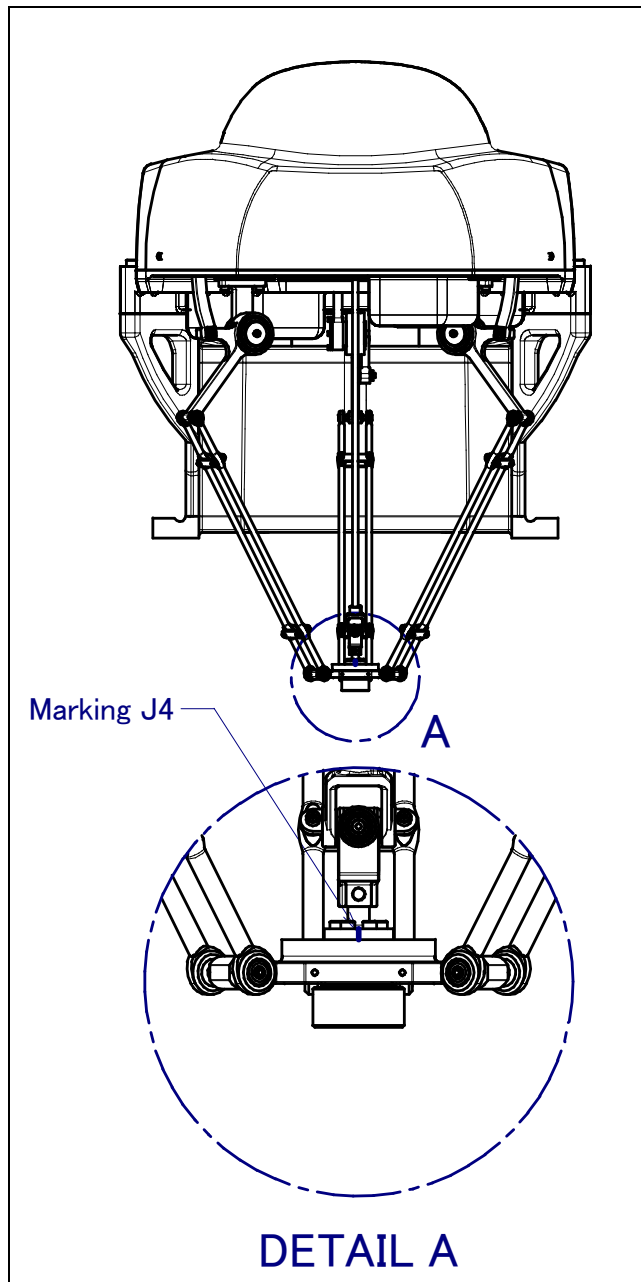


Fig. 7.3 (b) Zero-position mark (witness mark) for each axis (M-1iA/0.5S) (2/3)

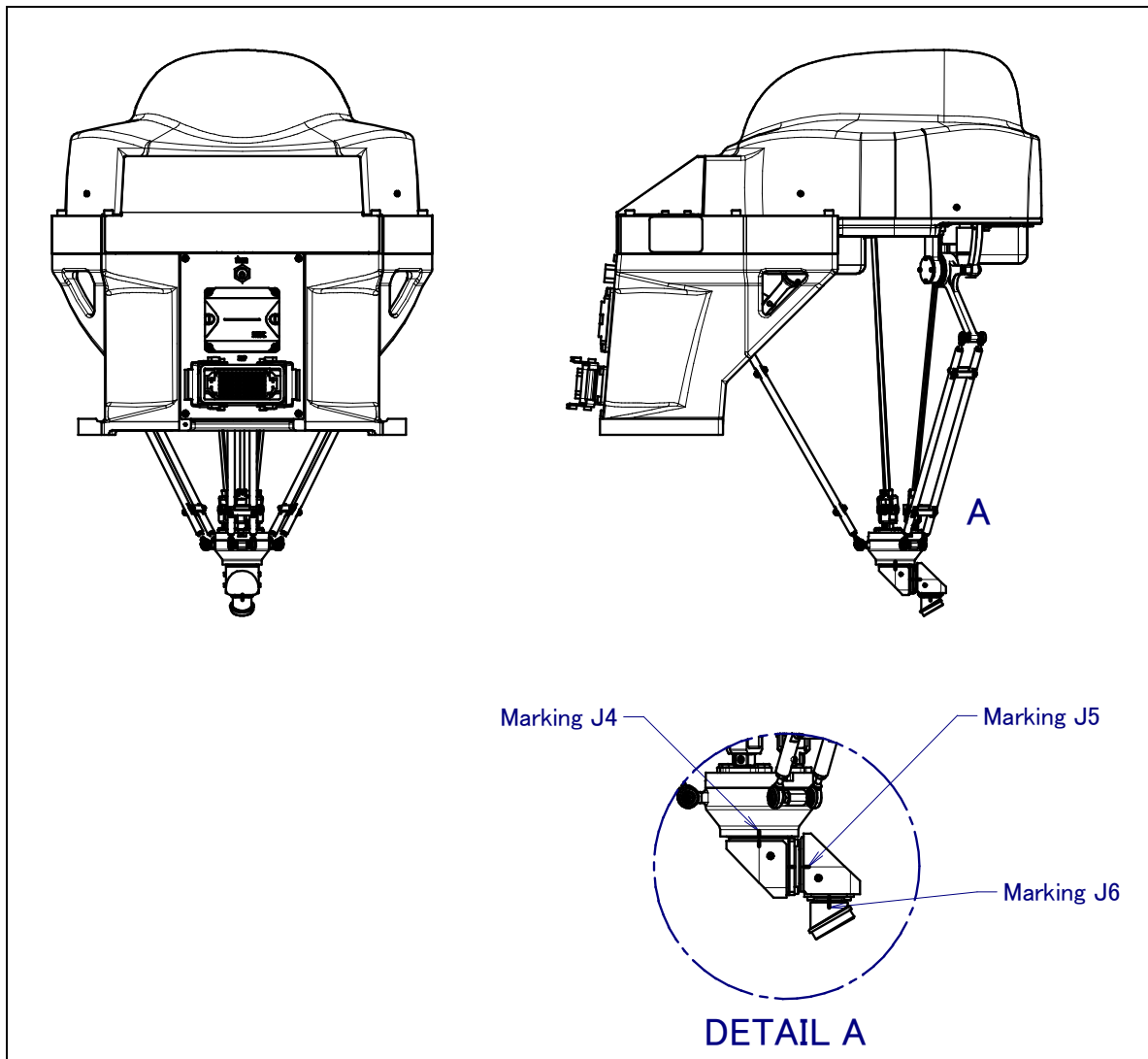


Fig. 7.3 (c) Zero-position mark (witness mark) for each axis (M-1iA/0.5A) (3/3)

7.4 QUICK MASTERING

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

Quick mastering is factory-performed at the position indicated in Table 7.3. Do not change the setting unless there is any problem.

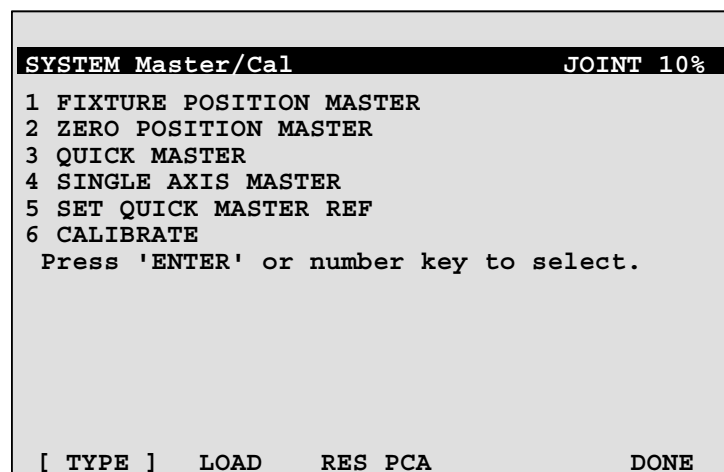
If setting the robot at the position mentioned above is impossible, you must re-set the quick mastering reference position using the following method. (It would be convenient to set up a marker that can work in place of the witness mark.)

CAUTION

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

Procedure Recording the Quick Mastering Reference Position

- 1 Select SYSTEM.
- 2 Select Master/Cal.



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

CAUTION

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

Procedure of Quick Mastering

- 1 Display the Master/Cal screen.

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

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

Quick master? [NO]

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

7.5 SINGLE AXIS MASTERING

Single axis mastering is performed for one axis at a time. The mastering position for each axis can be specified by the user.

Single axis mastering can be used, if mastering data for a specific axis is lost, for example, because a low voltage has been detected on the pulse counter backup battery or because the Pulsecoder has been replaced.

SINGLE AXIS MASTER			JOINT 33%	
	ACTUAL AXIS	(MSTR POS)	(SEL)	[ST]
J1	25.255	(0.000)	(0)	[2]
J2	25.550	(0.000)	(0)	[2]
J3	-50.000	(0.000)	(0)	[2]
J4	12.500	(0.000)	(0)	[2]
J5	31.250	(0.000)	(0)	[2]
J6	43.382	(0.000)	(0)	[2]
E1	0.000	(0.000)	(0)	[2]
E2	0.000	(0.000)	(0)	[2]
E3	0.000	(0.000)	(0)	[2]
			GROUP	EXE

Table 7.5 Items set in single axis mastering

Item	Description
Current position (ACTUAL AXIS)	The current position of the robot is displayed for each axis in degree units.
Mastering position (MSTR POS)	A mastering position is specified for an axis to be subjected to single axis mastering. It would be convenient to set to it to the 0 position.

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

Procedure of Single axis mastering

- 1 Select SYSTEM.
- 2 Select Master/Cal.

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

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

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

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

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

SINGLE AXIS MASTER		JOINT 30%	
			6/9
J5	31.250	(0.000)	(0) [2]
J6	43.382	(90.000)	(0) [2]
GROUP		EXEC	

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

GROUP	EXEC
-------	------

F5

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

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

BACK

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

- 9 Select [6 CALIBRATE], then press F4 [YES]. Positioning is performed. Alternatively, turn the power off and on again. Positioning is performed.
- 10 After completing the calibration, press F5 Done.
- 11 Return brake control to original setting, and turn the controller power off and on again.

DONE

F5

7.6 MASTERING DATA ENTRY

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

Mastering data entry method

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

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

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

SYSTEM Variables		JOINT 10%
13	\$DMR GRP	DMR GRPT
14	\$ENC STAT	[2] of ENC STATT
[TYPE]		

- 4 Select \$DMR_GRP.

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

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

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

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

JOINT 30%

FALSE
[9] of Boolean
[9] of Boolean
[9] of Integer

ENTER

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

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

TRUE FALSE

F4

SYSTEM Variables		JOINT 10%
\$DMR GRP [1]		1/8
1	\$MASTER DONE	TRUE
2	\$OT MINUS	[9] of Boolean
[TYPE]		TRUE FALSE

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

DONE

F5

7.7 CHECKING THE MASTERING

- 1 Checking whether mastering has been made correctly
Usually, positioning is performed automatically at power-on. To check whether mastering has been made correctly, note whether the displayed current position agrees with the actual robot position. Use the procedure described below:
 - (1) Reproduce a particular point in a program. Check whether the point agrees with the specified position.
 - (2) Set all axes of the robot to their 0-degree (0rad) positions. Check that the zero-degree position marks indicated in Section 7.3 are aligned. There is no need to use any visual aid.
 - (3) Using fixtures, set the robot to the mastering position in the same way as when performing mastering. Check that the displayed current position agrees with the actual mastering position.

If the displayed and actual positions do not match, the counter value for a Pulsecoder may have been invalidated as a result of an alarm described in 7.2. Alternatively, the mastering data in system variable \$DMR_GRP.\$MASTER_COUN may have been overwritten as a result of an operation error or some other reason.

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

2 Alarms that may be output during mastering

This section describes those alarms related to Pulsecoders, as well as the actions required to clear them.

(1) BZAL alarm

This alarm is output if the voltage of the Pulsecoder's backup battery falls to 0 V while the power to the controller is disconnected. Also, if Pulsecoder connector is removed for replacing cables etc. this alarm is output because voltage becomes to 0. To clear the alarm, fit a new battery, execute the pulse reset (See section 7.2.), then turn the power off then on again and confirm alarm is not output.

Battery might be weak if you can't reset alarm, then replace battery to new one, perform pulse reset, turn off and on the controller power.

Note that, if this alarm occurs, all data originally held by the Pulsecoder will have been lost. Mastering must be performed again.

(2) BLAL alarm

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

(3) CKAL, RCAL, PHAL, CSAL, DTERR, CRCERR, STBERR, and SPHAL, alarms

Contact the FANUC because the Pulsecoder may be defective.

8 TROUBLESHOOTING

8.1 OVERVIEW

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

8.2 FAILURES, CAUSES AND MEASURES

Table 8.2 lists the major failures that may occur in the mechanical unit and their probable causes. If you cannot pinpoint a failure cause or which measures to apply, contact FANUC.

Table 8.2 Failures, causes and measures

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

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	-Vibration or noise was first noticed after the robot collided with an object or the robot was overloaded for a long period. -The grease of the vibrating or noise occurring axis has not been exchanged for a long period.	[Broken gear, bearing, or reducer] - It is likely that 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. - It is likely that prolonged use of the robot while overloaded caused fretting of the gear tooth surface or rolling surface of a bearing, or reducer due to resulting metal fatigue. - It is likely that foreign matter caught in a gear, bearing, or within a reducer caused damage on the gear tooth surface or rolling surface of the bearing, or reducer. - It is likely that foreign matter caught in a gear, bearing, or within a reducer cause vibration. - It is likely that, because the grease has not been changed for a long period, fretting occurred on the gear tooth surface or rolling surface of a bearing, or reducer due to metal fatigue. These factors all generate cyclic vibration and noise.	-Operate one axis at a time to determine which axis is vibrating. -Remove the motor, and replace the gear, the bearing, and the reducer. For the spec. of parts and the method of replacement, contact FANUC. -Using the robot within its maximum rating prevents problems with the drive mechanism. -Regularly changing the grease with a specified type can help prevent problems.

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

Symptom	Description	Cause	Measure
Vibration Noise (Continued)	-There is some relationship between the vibration of the robot and the operation of a machine near the robot.	[Noise from a nearby machine] -If the robot is not grounded properly, electrical noise is induced on the grounding wire, preventing commands from being transferred accurately, thus leading to vibration. -If the robot is grounded at an unsuitable point, its grounding potential becomes unstable, and noise is likely to be induced on the grounding line, thus leading to vibration.	-Connect the grounding wire firmly to ensure a reliable ground potential and prevent extraneous electrical noise.
Rattling	-While the robot is not supplied with power, pushing it with the hand causes part of the mechanical unit to wobble. -There is a gap on the mounting face of the mechanical unit.	[Mechanical section coupling bolt] -It is likely that overloading or a collision has loosened a mounting bolt in the robot mechanical section.	-Check that the following bolts for each axis are tight. If any of these bolts is loose, apply Loctite and tighten it to the appropriate torque. -Motor retaining bolt -Reducer retaining bolt -Base retaining bolt -Arm retaining bolt -Casting retaining bolt -End effector retaining bolt
	- There is lost motion in the bearing of a joint	[Damage to the bearing, release of the pre-load] - A probable cause is that excessive force was applied to the bearing of the joint due to impact or overload, damaging the bearing or releasing the pre-load.	- Check the movement of the joints during operation to identify the faulty joint. - Remove each leg, move the top and bottom joints manually to check whether the bearings are damaged and whether there is lost motion. If a bearing is damaged or the pre-load is released, replace the unit containing the joint. - This problem can be avoided by avoiding use at overload.

Symptom	Description	Cause	Measure
Motor over-heating	-The ambient temperature of the installation location increases, causing the motor to overheat. -After the robot control program or the load was changed, the motor overheated.	[Ambient temperature] -It is likely that a rise in the ambient temperature prevented the motor from releasing heat efficiently, thus leading to overheating. [Operating condition] -It is likely that the robot was operated with the maximum average current exceeded.	-The teach pendant can be used to monitor the average current. Check the average current when the robot control program is running. The allowable average current is specified for the robot according to its ambient temperature. Contact FANUC for further information. -Relaxing the robot control program and conditions can reduce the average current, thus preventing overheating. -Reducing the ambient temperature is the most effective means of preventing overheating. -Having the surroundings of the robot well ventilated enables the robot to release heat efficiently, thus preventing overheating. Using a fan to direct air at the motor is also effective. -If there is a source of heat near the motor, it is advisable to install shielding to protect the motor from heat radiation.
	-After a control parameter was changed, the motor overheated.	[Parameter] -If data input for a workpiece is invalid, the robot cannot be accelerated or decelerated normally, so the average current increases, leading to overheating.	-Input an appropriate parameter as described in CONTROLLER OPERATOR'S MANUAL.
	-Symptom other than stated above	[Mechanical section problems] -It is likely that problems occurred in the mechanical unit drive mechanism, thus placing an excessive load on the motor. [Motor problems] -It is likely that a failure of the motor brake resulted in the motor running with the brake applied, thus placing an excessive load on the motor. -It is likely that a failure of the motor prevented it from delivering its rated performance, thus causing an excessive current to flow through the motor.	-Repair the mechanical unit while referring to the above descriptions of vibration, noise, and rattling. -Check that, when the servo system is energized, the brake is released. If the brake remains applied to the motor all the time, replace the motor. -If the average current falls after the motor is replaced, it indicates that the first motor was faulty.

Symptom	Description	Cause	Measure
Grease leakage	-Grease is leaking from the mechanical unit.	[Poor sealing] -Probable causes are a crack in the casting, a broken O-ring, a damaged oil seal, or a loose seal bolt. -A crack in a casting can occur due to excessive force that might be caused in collision. -An O-ring can be damaged if it is trapped or cut during disassembling or re-assembling. -An oil seal might be damaged if extraneous dust scratches the lip of the oil seal. -A loose seal bolt might allow grease to leak along the threads.	-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 coupling section -Wrist coupling section -J3 arm coupling section -Inside the wrist -Oil seals are used in the locations stated below. -Inside the reducer -Inside the wrist -Seal bolts are used in the locations stated below. -Grease drain inlet and outlet
Dropping axis	-An axis drops because the brake does not function. -An axis drops gradually when it should be at rest.	[Brake drive relay and motor] -It is likely that brake drive relay contacts are stuck to each other to keep the brake current flowing, thus preventing the brake from operating when the motor is deenergized. -It is likely that the brake shoe has worn out or the brake main body is damaged, preventing the brake from operating efficiently. -It is likely that oil or grease has entered the motor, causing the brake to slip.	-Check whether the brake drive relay contacts are stuck to each other. If they are found to be stuck, replace the relay. -If the brake shoe is worn out, if the brake main body is damaged, or if oil or grease has entered the motor, replace the motor.
Displacement	-The robot operates at a point other than the taught position. -The repeatability is not within the tolerance.	[Mechanical section problems] -If the repeatability is unstable, probable causes are a failure in the drive mechanism or a loose bolt. -If the repeatability becomes stable it is likely that a collision imposed an excessive load, leading to slipping on the base surface or the mating surface of an arm or reducer. -It is likely that the pulse coder 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 pulse coder is abnormal, replace the motor or the pulse coder.
	-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.

Symptom	Description	Cause	Measure
Displacement (Continued)	-Displacement occurred after a parameter was changed.	[Parameter] -It is likely that the mastering data was rewritten in such a way that the robot origin was shifted.	-Re-enter the previous mastering data, which is known to be correct. -If correct mastering data is unavailable, perform mastering again.
BZAL alarm occurred	-BZAL is displayed on the controller screen	- It is likely that the voltage of the memory backup battery is low. - It is likely that the pulse coder cable is defected.	-Replace the battery. -Replace the cable.

APPENDIX

A

PERIODIC MAINTENANCE TABLE

FANUC Robot M-1iA

Periodic Maintenance Table

Working time (H)			Check time	Grease amount	First check 320	3 months 960	6 months 1920	9 months 2880	1 year 3840	4800	5760	6720	2 years 7680	8640	9600	10560
Items																
Mechanical unit	1	Check the exposed connector. (Loosening)	0.2H	—		○			○				○			
	2	Check the motor connector. (Loosening)	0.2H	—		○			○				○			
	3	Tighten the end effector bolt.	0.2H	—		○			○				○			
	4	Tighten the cover and main bolt.	2.0H	—		○			○				○			
	5	Retighten the LINK B mounting part	0.2H	—	○	○	○	○	○	○	○	○	○	○	○	○
	6	Remove spatter and dust etc	1.0H	—		○			○				○			
	7	Check the end effector (hand) cable	0.1H	—		○			○				○			
	8	Replacing battery. (With stand/no stand B)	0.1H	—					●				●			
		Replacing battery. (No stand A)	0.1H	—							●					
	9	Supply grease to wrist input gear	0.5H	Proper quantity			●		●		●		●		●	
Controller	10	Clean the around of wrist input gear	0.1H	—		○	○		○		○		○		○	
	11	Check the robot cable, teach pendant cable and robot connecting cable	0.2H	—		○			○				○			
	12	Cleaning the ventilator	0.2H	—	○	○	○	○	○	○	○	○	○	○	○	○
	13	Replacing battery (*1)	0.1H	—												

*1 Refer to manual of controller

*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
○				○				○				○				○				Overhaul	1
○				○				○				○				○					2
○				○				○				○				○					3
○				○				○				○				○					4
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		5
○				○				○				○				○					6
○				○				○				○				○					7
●				●				●				●				●					8
●						●						●						●			9
●		●		●		●		●		●		●		●		●		●			10
○		○		○		○		○		○		○		○		○		○			11
○				○				○				○				○					12
○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○		13
				●																	13

B MOUNTING BOLT TORQUE LIST

NOTE

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

Use bolt which strengths are below.

But if it is specified in text, obey it.

Hexagon socket head bolt made by steel

Size is M22 or less : Tensile strength 1200N/mm² or more

Size is M24 or more : Tensile strength 1000N/mm² or more

All size of bolt of the plating : Tensile strength 1000N/mm² or more

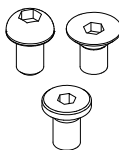
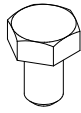
Hexagon bolt, stainless bolt, special shape bolt (button bolt, low-head bolt, flush bolt .etc)

Tensile strength 400N/mm² or more

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

Recommended bolt tightening torques

Unit: Nm

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

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REVISION RECORD

Edition	Date	Contents
05	Jan., 2012	• Addition of stand B • Addition of check of oil exudation • Correction of errors
04	Nov., 2010	• Addition of stop type of robot • Addition of stopping time and distance when controlled stop is executed • Addition of method of piping and wiring • Correction of errors
03	Mar., 2010	• Addition of 1kg payload option • Addition of solenoid valve option
02	Dec., 2009	• Addition of check of LINK B • Correction of errors
01	Aug., 2009	

B-83084EN/05



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