DENSO ROBOT

Vertical articulated

VM-D SERIES

INSTALLATION & MAINTENANCE GUIDE

Preface

Thank you for purchasing this high-speed, high-accuracy assembly robot.

Before operating your robot, read this manual carefully to safely get the maximum benefit from your robot in your assembling operations.

Robot series and/or models covered by this manual

Series	Model		Remarks (Max. reach nickname)
	Floor-mount	Overhead-mount	
VM-D (Medium-sized, vertical articulated)	VM-6070D VM-6083D VM-60B1D	Same as left. Same as left. Same as left.	(VM900) (VM1000) (VM1300)

NOTE 1: Model names listed above apply to the models of robot systems. The model names of robot units are followed by M. If the robot system model is VM-6083D, for example, the robot unit model is VM-6083DM.

Important

To ensure operator safety, be sure to read the precautions and instructions in "SAFETY PRECAUTIONS".

How the documentation set is organized

The documentation set consists of the following books. If you are unfamiliar with this robot and option(s), please read all books and understand them fully before operating your robot and option(s).

GENERAL INFORMATION ABOUT ROBOT

Provides the packing list of the robot and outlines of the robot system, robot unit, and robot controller.

INSTALLATION & MAINTENANCE GUIDE - this book -

Provides instructions for installing the robot components and customizing your robot, and maintenance & inspection procedures.

BEGINNER'S GUIDE

Introduces you to the DENSO robot. Taking an equipment setup example, this book guides you through running your robot with the teach pendant, making a program in WINCAPSII, and running your robot automatically.

SETTING-UP MANUAL

Describes how to set-up or teach your robot with the teach pendant, operating panel, or mini-pendant.

WINCAPSII GUIDE

Provides instructions on how to use the teaching system WINCAPSII which runs on the PC connected to the robot controller for developing and managing programs.

PROGRAMMER'S MANUAL (I), (II)

Describes the PAC programming language, program development, and command specifications in PAC.

RC5 CONTROLLER INTERFACE MANUAL

Describes the RC5 controller, interfacing with external devices, system- and user-input/output signals, and I/O circuits.

ERROR CODE TABLES

List error codes that will appear on the teach pendant, operating panel, or PC screen if an error occurs in the robot series or WINCAPSII. These tables provide detailed description and recovery ways.

OPTIONS MANUAL

Describes the specifications, installation, and use of optional devices.

How this book is organized

This book is just one part of the robot documentation set. This book consists of SAFETY PRECAUTIONS, chapters one through three.

SAFETY PRECAUTIONS

Defines safety terms and related symbols and provides precautions that should be observed. Be sure to read this section before operating your robot.

Chapter 1 Installing Robot Components

Provides information about physical site planning, installation procedures, and engineering-design notes for hands.

Chapter 2 Customizing Your Robot

Describes how to customize your robot--defining the software motion space and restricted space, CALSETing, and setting control set of motion optimization.

Chapter 3 Maintenance and Inspection

Describes the regular maintenance and inspections necessary for maintaining the performance and functions of your robot.

SAFETY PRECAUTIONS

Be sure to observe all of the following safety precautions.

Strict observance of these warning and caution indications are a MUST for preventing accidents, which could result in bodily injury and substantial property damage. Make sure you fully understand all definitions of these terms and related symbols given below, before you proceed to the text itself.

⚠ **WARNING**	Alerts you to those conditions, which could result in serious bodily injury or death if the instructions are not followed correctly.
⚠ **CAUTION**	Alerts you to those conditions, which could result in minor bodily injury or substantial property damage if the instructions are not followed correctly.

Terminology and Definitions

Maximum space: Refers to the volume of space encompassing the maximum designed movements of all robot parts including the end-effector, workpiece and attachments. (Quoted from the RIA* Committee Draft.)

Restricted space: Refers to the portion of the maximum space to which a robot is restricted by limiting devices (i.e., mechanical stops). The maximum distance that the robot, end-effector, and workpiece can travel after the limiting device is actuated defines the boundaries of the restricted space of the robot. (Quoted from the RIA Committee Draft.)

Motion space: Refers to the portion of the restricted space to which a robot is restricted by software motion limits. The maximum distance that the robot, end-effector, and workpiece can travel after the software motion limits are set defines the boundaries of the motion space of the robot. (The "motion space" is DENSO WAVE-proprietary terminology.)

Operating space: Refers to the portion of the restricted space (or motion space in Denso robot) that is actually used by the robot while performing its task program. (Quoted from the RIA Committee Draft.)

Task program: Refers to a set of instructions for motion and auxiliary functions that define the specific intended task of the robot system. (Quoted from the RIA Committee Draft.)

(*RIA: Robotic Industries Association)

1. Introduction

This section provides safety precautions to be observed during installation, teaching, inspection, adjustment, and maintenance of the robot.

2. Installation Precautions

2.1 Insuring the proper installation environment

2.1.1 For standard type

The standard type has not been designed to withstand explosions, dust-proof, nor is it splash-proof. Therefore, it should not be installed in any environment where:

(1) there are flammable gases or liquids,

(2) there are any shavings from metal processing or other conductive material flying about,

(3) there are any acidic, alkaline or other corrosive gases,

(4) there is cutting or grinding oil mist,

(5) it may likely be submerged in fluid,

(6) there is sulfuric cutting or grinding oil mist, or

(7) there are any large-sized inverters, high output/high frequency transmitters, large contactors, welders, or other sources of electrical noise.

2.1.2 For dust-proof, splash-proof type

The dust-proof, splash-proof type is an IP54-equivalent structure, but it has not been designed to withstand explosions. (The HM/HS-E-W and the wrist of the VM-D-W/VS-E-W are an IP65-equivalent dust-proof and splash-proof structure.)

Note that the robot controller is not a dust- or splash-proof structure. Therefore, when using the robot controller in an environment exposed to mist, put it in an optional protective box.

The dust-proof, splash-proof type should not be installed in any environment where:

(1) there are any flammable gases or liquids,

(2) there are any acidic, alkaline or other corrosive gases,

(3) there are any large-sized inverters, high output/high frequency transmitters, large contactors, welders, or other sources of electrical noise,

(4) it may likely be submerged in fluid,

(5) there are any grinding or machining chips or shavings,

(6) any machining oil not specified in this manual is in use, or

Note: Yushiron Oil No. 4C (non-soluble) is specified.

(7) there is sulfuric cutting or grinding oil mist.

2.2 Service space

The robot and peripheral equipment should be installed so that sufficient service space is maintained for safe teaching, maintenance, and inspection.

2.3 Control devices outside the robot's restricted space

The robot controller, teach pendant, and operating panel should be installed outside the robot's restricted space and in a place where you can observe all of the robot’s movements when operating the robot controller, teach pendant, or operating panel.

2.4 Positioning of gauges

Pressure gauges, oil pressure gauges and other gauges should be installed in an easy-to-check location.

2.5 Protection of electrical wiring and hydraulic/pneumatic piping

If there is any possibility of the electrical wiring or hydraulic/pneumatic piping being damaged, protect them with a cover or similar item.

2.6 Positioning of emergency stop switches

Emergency stop switches should be provided in a position where they can be reached easily should it be necessary to stop the robot immediately.

(1) The emergency stop switches should be red.

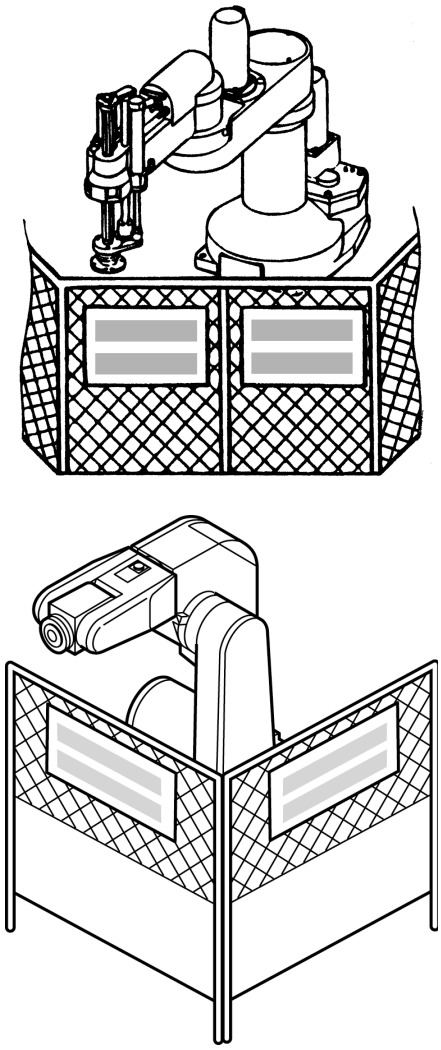
(2) Emergency stop switches should be designed so that they will not be released after pressed, automatically or mistakenly by any other person.

(3) Emergency stop switches should be separate from the power switch.

2.7 Positioning of operating status indicators

Operating status indicators should be positioned in such a way where workers can easily see whether the robot is on temporary halt or on an emergency or abnormal stop.

2.8 Setting-up the safety fence or enclosure



A safety fence or enclosure should be set up so that no one can easily enter the robot's restricted space. If it is impossible, utilize other protectors as described in Section 2.9.

(1) The fence or enclosure should be constructed so that it cannot be easily moved or removed.

(2) The fence or enclosure should be constructed so that it cannot be easily damaged or deformed through external force.

(3) Establish the exit/entrance to the fence or enclosure. Construct the fence or enclosure so that no one can easily get past it by climbing over the fence or enclosure.

(4) The fence or enclosure should be constructed to ensure that it is not possible for hands or any other parts of the body to get through it.

(5) Take any one of the following protections for the entrance/ exit of the fence or enclosure:

1) Place a door, rope or chain across the entrance/exit of the fence or enclosure, and fit it with an interlock that ensures the emergency stop device operates automatically if it is opened or removed.

2) Post a warning notice at the entrance/exit of the fence or enclosure stating "In operation--Entry forbidden" or "Work in progress--Do not operate" and ensure that workers follow these instructions at all times.

When making a test run, before setting up the fence or enclosure, place an overseer in a position outside the robot’s restricted space and one in which he/she can see all of the robot’s movements. The overseer should prevent workers from entering the robot's restricted space and be devoted solely to that task.

2.9 Positioning of rope or chain

If it is not possible to set up the safety fence or enclosure described in Section 2.8, hang a rope or chain around the perimeter of the robot’s restricted space to ensure that no one can enter the restricted space.

(1) Ensure the support posts cannot be moved easily.

(2) Ensure that the rope or chain’s color or material can easily be discerned from the surrounds.

(3) Post a warning notice in a position where it is easy to see stating "In operation--Entry forbidden" or "Work in progress --Do not operate" and ensure that workers follow these instructions at all times.

(4) Set the exit/entrance, and follow the instructions given in Section 2.8, (3) through (5).

2.10 Setting the robot's motion space

The area required for the robot to work is called the robot's operating space.

If the robot's motion space is greater than the operating space, it is recommended that you set a smaller motion space to prevent the robot from interfering or disrupting other equipment.

Refer to the "INSTALLATION & MAINTENANCE GUIDE."

2.11 No robot modification allowed

Never modify the robot unit, robot controller, teach pendant or other devices.

2.12 Cleaning of tools

If your robot uses welding guns, paint spray nozzles, or other end-effectors requiring cleaning, it is recommended that the cleaning process be carried out automatically.

2.13 Lighting

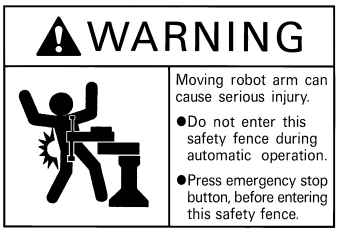
Sufficient illumination should be assured for safe robot operation.

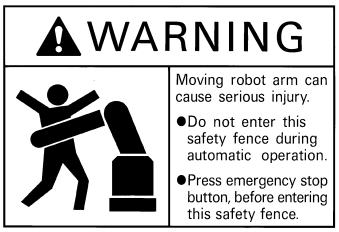
2.14 Protection from objects thrown by the end-effector

If there is any risk of workers being injured in the event that the object being held by the end-effector is dropped or thrown by the end-effector, consider the size, weight, temperature and chemical nature of the object and take appropriate safeguards to ensure safety.

2.15 Affixing the warning label

Place the warning label packaged with the robot on the exit/entrance of the safety fence or in a position where it is easy to see.

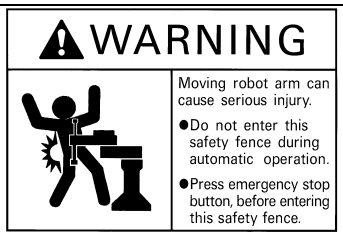


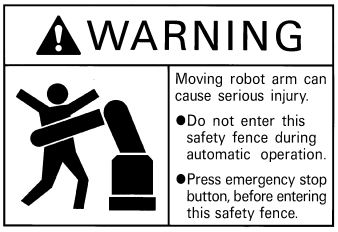


3. Precautions while robot is running

⚠ Warning

Touching the robot while it is in operation can lead to serious injury. Please ensure the following conditions are maintained and that the cautions listed from Section 3.1 onwards are followed when any work is being performed.





1) Do not enter the robot's restricted space when the robot is in operation or when the motor power is on.
2) As a precaution against malfunction, ensure that an emergency stop device is activated to cut the power to the robot motor upon entry into the robot's restricted space.
3) When it is necessary to enter the robot's restricted space to perform teaching or maintenance work while the robot is running, ensure that the steps described in Section 3.3 "Ensuring safety of workers performing jobs within the robot's restricted space" are taken.

3.1 Creation of working regulations and assuring worker adherence

When entering the robot’s restricted space to perform teaching or maintenance inspections, set "working regulations" for the following items and ensure workers adhere to them.

(1) Operating procedures required to run the robot.

(2) Robot speed when performing teaching.

(3) Signaling methods to be used when more than one worker is to perform work.

(4) Steps that must be taken by the worker in the event of a malfunction, according to the contents of the malfunction.

(5) The necessary steps for checking release and safety of the malfunction status, in order to restart the robot after robot movement has been stopped due to activation of the emergency stop device

(6) Apart from the above, any steps below necessary to prevent danger from unexpected robot movement or malfunction of the robot.

1) Display of the control panel (See Section 3.2 on the following page)
2) Assuring the safety of workers performing jobs within the robot's restricted space (See Section 3.3 on the following page)

3) Maintaining worker position and stance

   Position and stance that enables the worker to confirm normal robot operation and to take immediate refuge if a malfunction occurs.

4) Implementation of measures for noise prevention

5) Signaling methods for workers of related equipment

6) Types of malfunctions and how to distinguish them

Please ensure "working regulations" are appropriate to the robot type, the place of installation and to the content of the work.

Be sure to consult the opinions of related workers, engineers at the equipment manufacturer and that of a labor safety consultant when creating these "working regulations".

3.2 Display of operation panel

To prevent anyone other than the worker from accessing the start switch or the changeover switch by accident during operation, display something to indicate it is in operation on the operating panel or teach pendant. Take any other steps as appropriate, such as locking the cover.

3.3 Ensuring safety of workers performing jobs within the robot's restricted space

When performing jobs within the robot's restricted space, take any of the following steps to ensure that robot operation can be stopped immediately upon a malfunction.

(1) Ensure an overseer is placed in a position outside the robot's restricted space and one in which he/she can see all robot movements, and that he/she is devoted solely to that task.

   ① An emergency stop device should be activated immediately upon a malfunction.

   ② Do not permit anyone other than the worker engaged for that job to enter the robot's restricted space.

(2) Ensure a worker within the robot's restricted space carries the portable emergency stop switch so he/she can press it (the robot stop button on the teach pendant) immediately if it should be necessary to do so.

3.4 Inspections before commencing work such as teaching

Before starting work such as teaching, inspect the following items, carry out any repairs immediately upon detection of a malfunction and perform any other necessary measures.

(1) Check for any damage to the sheath or cover of the external wiring or to the external devices.

(2) Check that the robot is functioning normally or not (any unusual noise or vibration during operation).

(3) Check the functioning of the emergency stop device.

(4) Check there is no leakage of air or oil from any pipes.

(5) Check there are no obstructive objects in or near the robot’s restricted space.

3.5 Release of residual air pressure

Before disassembling or replacing pneumatic parts, first release any residual air pressure in the drive cylinder.

3.6 Precautions for test runs

Whenever possible, have the worker stay outside of the robot's restricted space when performing test runs.

3.7 Precautions for automatic operation

(1) At start-up

Before the robot is to be started up, first check the following items as well as setting the signals to be used and perform signaling practice with all related workers.

1) Check that there is no one inside the robot’s restricted space.

2) Check that the teach pendant and tools are in their designated places.

3) Check that no lamps indicating a malfunction on the robot or related equipment are lit.

(2) Check that the display lamp indicating automatic operation is lit during automatic operation.

(3) Steps to be taken when a malfunction occurs

Should a malfunction occur with the robot or related equipment and it is necessary to enter the robot's restricted space to perform emergency maintenance, stop the robot’s operation by activating the emergency stop device. Take any necessary steps such as placing a display on the starter switch to indicate work is in progress to prevent anyone from accessing the robot.

3.8 Precautions in repairs

(1) Do not perform repairs outside of the designated range.

(2) Under no circumstances should the interlock mechanism be removed.

(3) When opening the robot controller's cover for battery replacement or any other reasons, always turn the robot controller power off and disconnect the power cable.

(4) Use only spare tools specified in this manual.

4. Daily and periodical inspections

(1) Be sure to perform daily and periodical inspections. Before starting jobs, always check that there is no problem with the robot and related equipment. If any problems are found, take any necessary measures to correct them.

(2) When carrying out periodical inspections or any repairs, maintain records and keep them for at least 3 years.

5. Management of floppy disks

(1) Carefully handle and store the "Initial settings" floppy disks packaged with the robot, which store special data exclusively prepared for your robot.

(2) After finishing teaching or making any changes, always save the programs and data onto floppy disks.

Making back-ups will help you recover if data stored in the robot controller is lost due to the expired life of the back-up battery.

(3) Write the names of each of the floppy disks used for storing task programs to prevent incorrect disks from loading into the robot controller.

(4) Store the floppy disks where they will not be exposed to dust, humidity and magnetic field, which could corrupt the disks or data stored on them.

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Chapter 1 Installing Robot Components

1.1 Preparing a Proper Environment for Installation

Before installing the robot unit and robot controller, confirm that the operating environment is in conformity with each item of "SAFETY PRECAUTIONS, 2. Installation Precautions," and that the surrounding environment of the location where the robot is to be used meets the specifications as described below. Also, take proper measures to protect the components from vibration.

In an inappropriate environment, the robot will not operate to its full capacity or performance, components may not last long, and unexpected failure may result.

1.1.1 Installation Environments

■ Standard Type

The robot is not explosion-proof, dust-proof or splash-proof, so it should not be installed in any environment where:

(1) there are flammable gases or liquids,

(2) there are any shavings from metal processing or other conductive material flying about,

(3) there are any acidic, alkaline or other corrosive gases,

(4) there is cutting or grinding oil mist,

(5) there is sulfuric cutting or grinding oil mist, or

(6) there are any large-sized inverters, high output/high frequency transmitters, large contactors, welders, or other sources of electrical noise.

■ Dust-proof, Splash-proof Type

The robot is IP54-equivalent dust-proof and splash-proof, but it is not designed to withstand explosions. (The wrist of the VM-D-W/VS-E-W is an IP65-equivalent dust-proof and splash-proof structure.)

Note that the robot controller is not a dust- or splash-proof structure. Therefore, when using the robot controller in an environment exposed to mist, put it in an optional protective box.

The dust-proof, splash-proof type should not be installed in any environment where:

(1) there are flammable gases or liquids,

(2) there are any acidic, alkaline or other corrosive gases,

(3) there are any large-sized inverters, high output/high frequency transmitters, large contactors, welders, or other sources of electrical noise,

(4) it may likely be submerged in fluid,

(5) there are any grinding or machining chips or shavings,

(6) any machining oil other than DENSO authorized oil is in use, or

NOTE: DENSO authorized oil: Yushiron Oil No. 4C (non-soluble)

(7) there is sulfuric cutting or grinding oil mist.

1.1.2 Ambient Temperature and Humidity

Keep the ambient temperature between 0°C and 40°C during operation.

Keep the ambient humidity at 90% or below to prevent dew condensation.

1.1.3 Vibration

Do not install the robot in an environment where it will be exposed to excessive vibration or impact.

Caution: When the excessive vibration is added to the robot unit at power-off during transportation, ERROR 2AF1 (Encoder reference position error) may occur.
If the ERROR 2AF1 occurs when turning the robot controller ON at first after purchasing the robot, refer to the "ERROR CODE TABLES" or contact our Robot Service Section.

1.1.4 Connecting the Robot Unit and Robot Controller

Before delivery, the robot unit and the robot controller are configured as a set. If you purchase two or more robot systems, take care not to mistake each set when connecting robot units and controllers.

⚠**Caution For the position of the serial number, see "1.3 [2] Outer Dimensions and Operating Range" for the robot unit and "1.4 [2] Outer Dimensions" for the robot controller.**

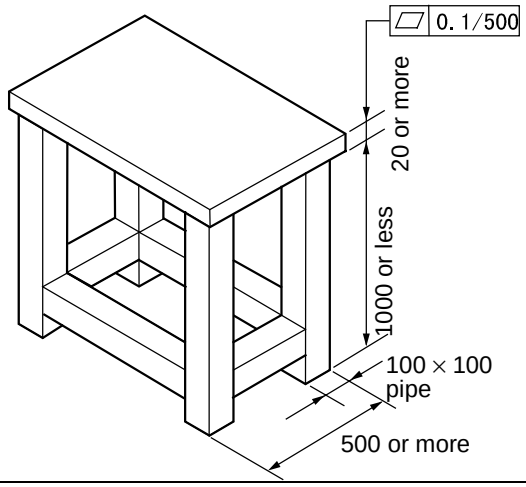
1.1.5 Installation Environment of the Robot Unit

The installation requirements for the robot unit are shown on the next page. Prepare a highly rigid mount by referring to the figure on page 4.

⚠**Caution Do not electric-weld the equipment including the robot. A large current may flow through the motor encoder or robot controller resulting in a failure. If electric welding is required, remove the robot unit and the robot controller from the equipment beforehand.**

Installation Requirements for the Robot Unit

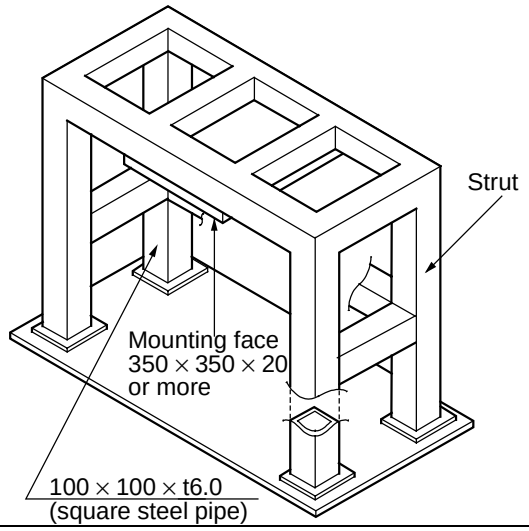
<table>
<tr><th>Item</th><th colspan="2">Environments and Conditions</th></tr>
<tr><td>Flatness of the mount</td><td colspan="2">0.1/500 mm (See the upper figure on the next page.)</td></tr>
<tr><td>Rigidity of the mount</td><td colspan="2">Use steel materials. (See the figure on the next page.)</td></tr>
<tr><td>Installation type</td><td colspan="2">Floor-mount or Overhead-mount</td></tr>
<tr><td>Ambient temperature</td><td colspan="2">During operation : 0 to 40°C
During storage and transportation : -10 to 60°C</td></tr>
<tr><td>Humidity</td><td colspan="2">During operation : 90% or less (No dew condensation allowed.)
During storage and transportation : 75% or less (No dew condensation allowed.)</td></tr>
<tr><td>Vibration</td><td colspan="2">During operation : 4.9 m/s^2 (0.5G) or less
During storage and transportation : 29.4 m/s^2 (3G) or less</td></tr>
<tr><td rowspan="3">Safe installation environment</td><td colspan="2">The robot should not be installed in an environment where:
• there are flammable gases or liquids,
• there are any acidic, alkaline or other corrosive gases,
• there is sulfuric cutting or grinding oil mist, or
• there are any large-sized inverters, high output/high frequency transmitters, large contactors, welders, or other sources of electrical noise.</td></tr>
<tr><td>Standard type
(IP40 – equivalent dust-proof and splash-proof structure)</td><td>The robot should not be installed in an environment where:
• there are any shavings from metal processing or other conductive material flying about,
• there is cutting or grinding oil mist, or
• it may be directly exposed to water, oil or cutting chips.</td></tr>
<tr><td>Dust-proof, splash-proof type
(IP54-equivalent dust-proof and splash-proof structure. The wrist of the VM-D-W/VS-E-W is IP65-equivalent.)</td><td>The robot should not be installed in an environment where:
• it may likely be submerged in fluid,
• there are any grinding or machining chips or shavings, or
• any machining oil other than DENSO authorized Yushiron Oil No. 4C (non-soluble) is in use.</td></tr>
<tr><td>Working space, etc.</td><td colspan="2">• Sufficient service space must be available for inspection and disassembly.
• Keep wiring space (230 mm or more) behind the robot, and fasten the wiring to the mounting face or beam so that the weight of the cables will not be directly applied to the connectors.</td></tr>
<tr><td>Installation conditions</td><td colspan="2">Grounding resistance: 100 Ω or less
See the figure on page 34.</td></tr>
</table>



⚠Caution (1) When the robot operates at high speed, the robot mount undergoes large reaction forces. The mount must be rigid enough so that it will not vibrate or be displaced due to reaction forces. It is also advisable to mechanically join the robot mount with heavy equipment.

(2) Some mounts may produce a resonance sound (howling). If this sound is loud, increase the rigidity of the mount or slightly modify the robot speed.

Robot Mount Example for Floor-mount



⚠Caution (1) When the robot operates at high speed, the top plate structure undergoes large reaction forces. Design the vibration-proof mount so that the top plate will not vibrate due to reaction forces. Also design the top plate structure so that it separates from other top plate structures in the equipment.

(2) Some mounts may produce a resonance sound (howling). If this sound is loud, increase the rigidity of the mount or slightly modify the robot speed.

Robot Mount Example for Overhead-mount

1.2 Installing the Robot Unit

> **⚠Caution** **Before handling or installing the robot unit, be sure to read "SAFETY PRECAUTIONS, 2. Installation Precautions."**

[1] Transporting the Robot Unit

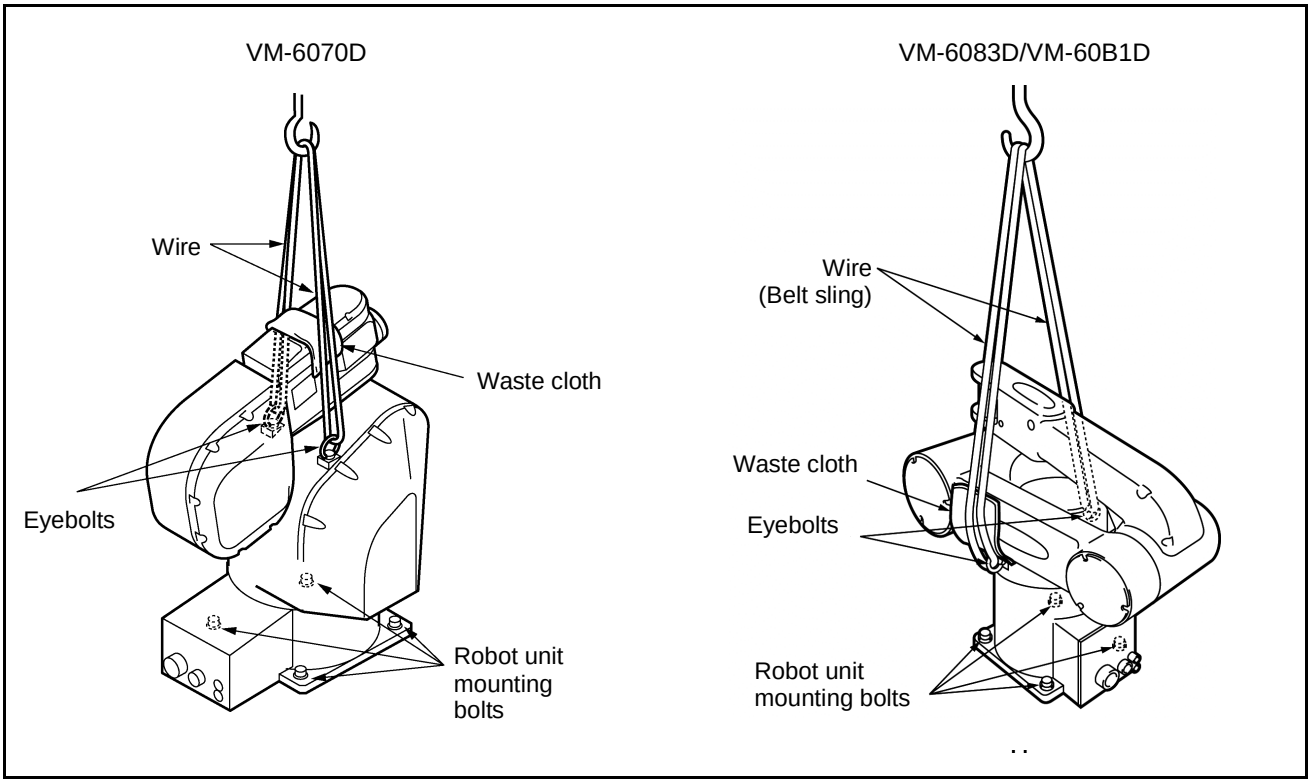
(1) Precautions in transporting the robot

The VM-D series weighs approximately 76 to 95 kg. Use a crane suitable for the robot weight.

Have at least two workers handle this job.

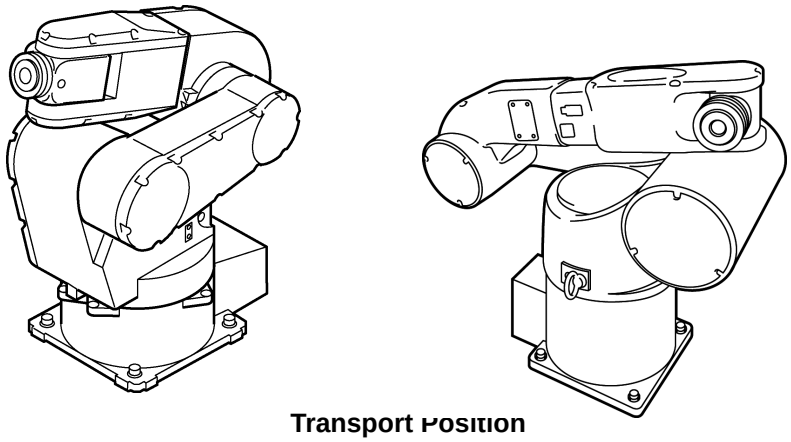
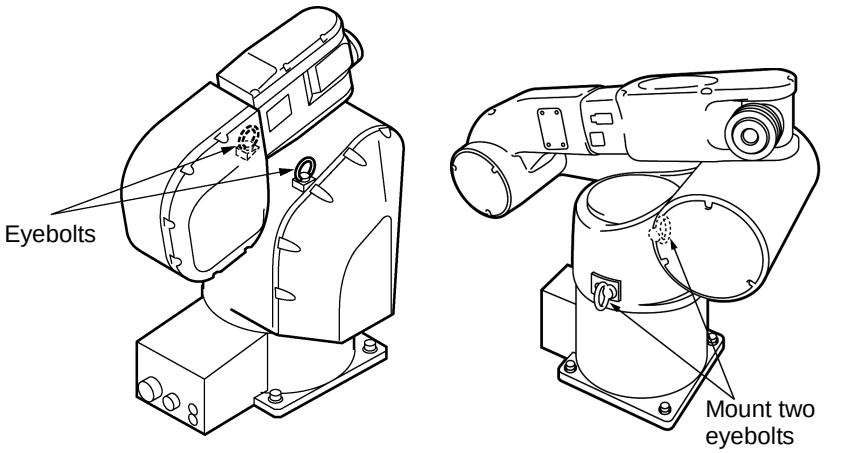
Workers should wear helmets, safety shoes, and gloves during transport.

> **⚠Caution** **Pass the hoisting wires through the specified eyebolts as illustrated below. Passing them through other sections may drop the robot unit, resulting in a broken robot or bodily injuries.**
>
> **Do not hold the first arm, elbow, either side of the 2nd arm, 2nd-axis cover, or 3rd-axis cover, or apply force to any of them.**

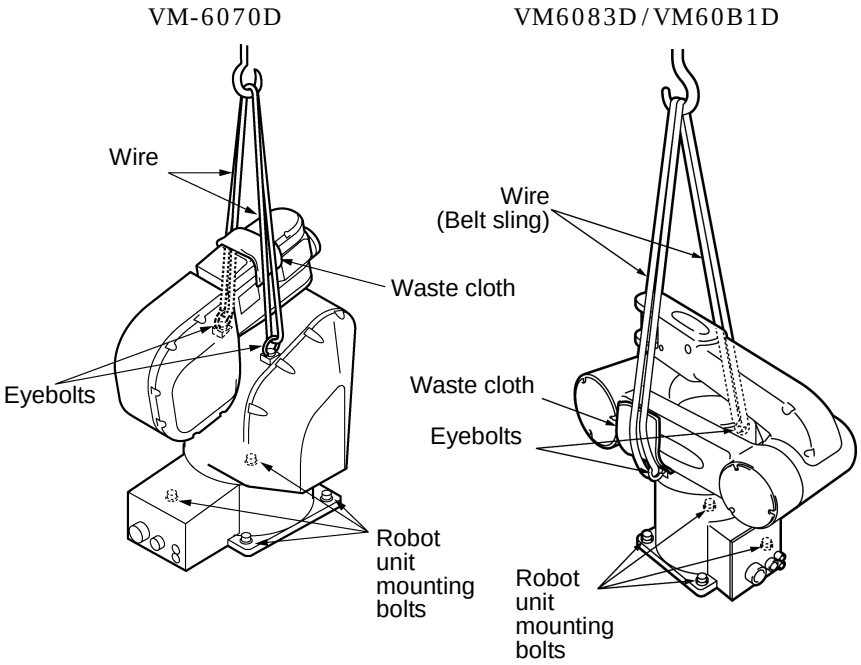


Hoisting Points for Transportation (VM-D series)

(2) Transporting the robot unit

<table>
<tr><th>No.</th><th>Procedure</th><th>Explanatory Illustration</th></tr>
<tr><td>1</td><td>Before transportation, set the robot in a transport position as shown at right by manually moving the second, third and fourth axes.
When unpacked first, the robot is in the transport position, so this job is not required.</td><td>VM-6070D VM6083D/VM60B1D
 
Transport Position
<table>
<tr><th>Axis</th><th>Angle</th></tr>
<tr><td>First axis (J1)</td><td>0°</td></tr>
<tr><td>Second axis (J2)</td><td>-90°</td></tr>
<tr><td>Third axis (J3)</td><td>+165°</td></tr>
<tr><td>Fourth axis (J4)</td><td>+90° or -90°</td></tr>
<tr><td>Fifth axis (J5)</td><td>+90° or -90°</td></tr>
</table></td></tr>
<tr><td>2</td><td>Disconnect the robot control cable, air piping and user signal cables from the robot unit.
When the robot unit is first unpacked, this job is not required.</td><td></td></tr>
<tr><td>3</td><td>As shown at right, mount the eyebolts.
When delivered, the robot unit is packed with eyebolts attached, so this job is not required.</td><td>VM-6070D VM6083D/VM60B1D
 

Mounting Eyebolts</td></tr>
</table>

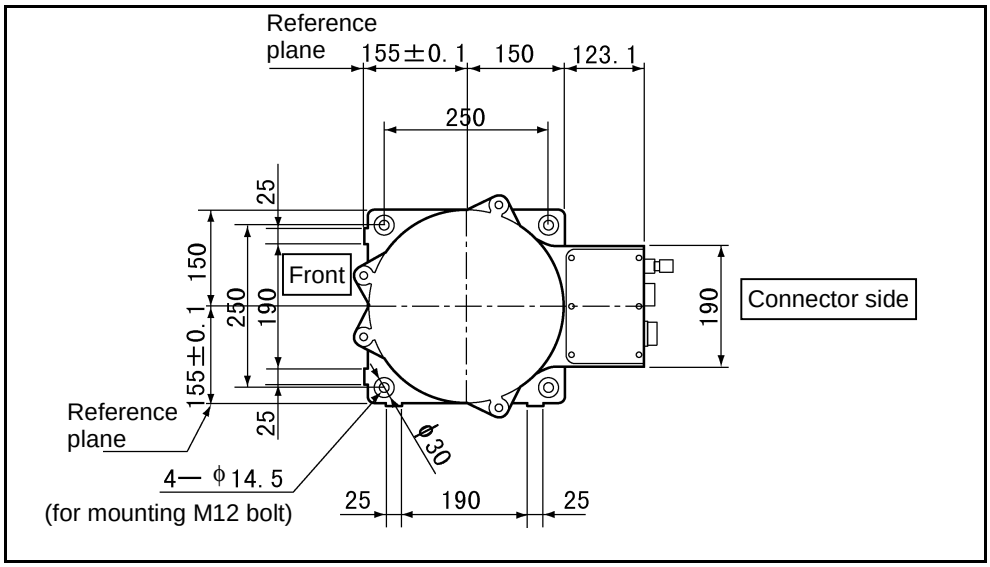
No.	Procedure	Explanatory Illustration
4	As shown at right, place a waste cloth on the second arm and pass the wire through the two eyebolts.	 **Hoisting the Robot Unit**
5	Worker A: Remove the four bolts while supporting the robot unit to prevent it from getting overturned.	
6	Worker B: Operate the crane and move the robot unit to the target site.	
7	Worker B: Put the robot unit down in the target position. Worker A: Temporarily secure the robot unit with four bolts.	
8	Secure the robot unit according to the instructions in "[2] Installing the Robot Unit" on the next page.	
9	Remove the eyebolts from the robot unit.	

⚠Caution (1) Before transporting the robot, check that the path to the target position is free of obstacles.

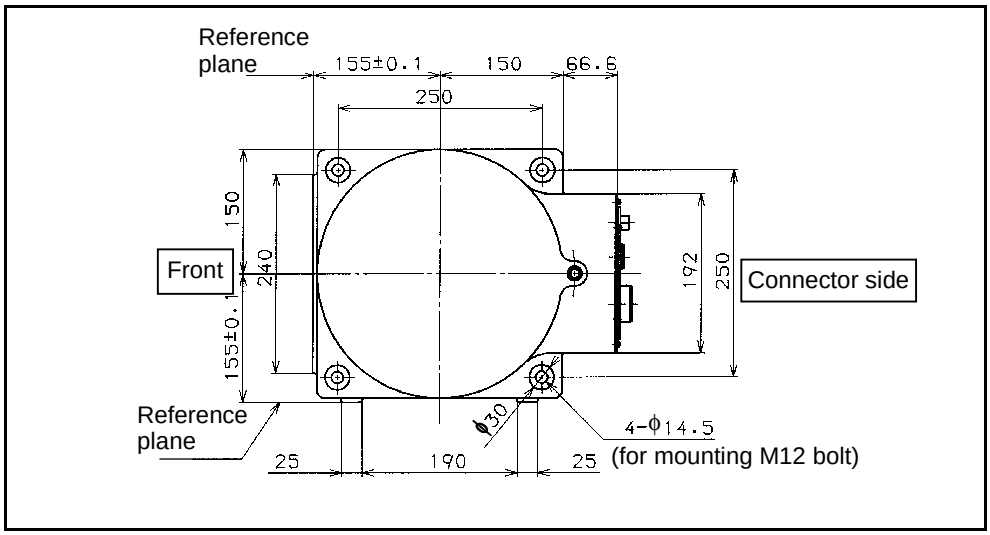
(2) Before running the robot unit, be sure to remove the eyebolts. Otherwise, the robot arm will strike against those eyebolts.

[2] Installing the Robot Unit

(1) Drill four bolt holes (M12) 15-mm deep or more in the robot mount where the robot unit is to be secured, according to the dimensions shown below.



Bolt Positions for Securing the VM-6070D



Bolt Positions for Securing the VM-6083D/VM-60B1D

(2) Secure keys or pins to the reference planes.

NOTE: Be sure to secure keys or pins. They can minimize positional deviations when you remove and reinstall the robot unit for maintenance.

(3) Set the robot unit into place on the robot mount.

NOTE: When transporting the robot unit, follow the instructions given in "[1] Transporting the Robot Unit."

(4) Secure the robot to the mount with four bolts and plain washers.

· Bolt: M12 × 40 mm (strength class: 12.9, tightening torque: 110 ±22 Nm)

· Plain washer: JIS B 1256 (polished round)

[3] Overhead-mounting the Robot

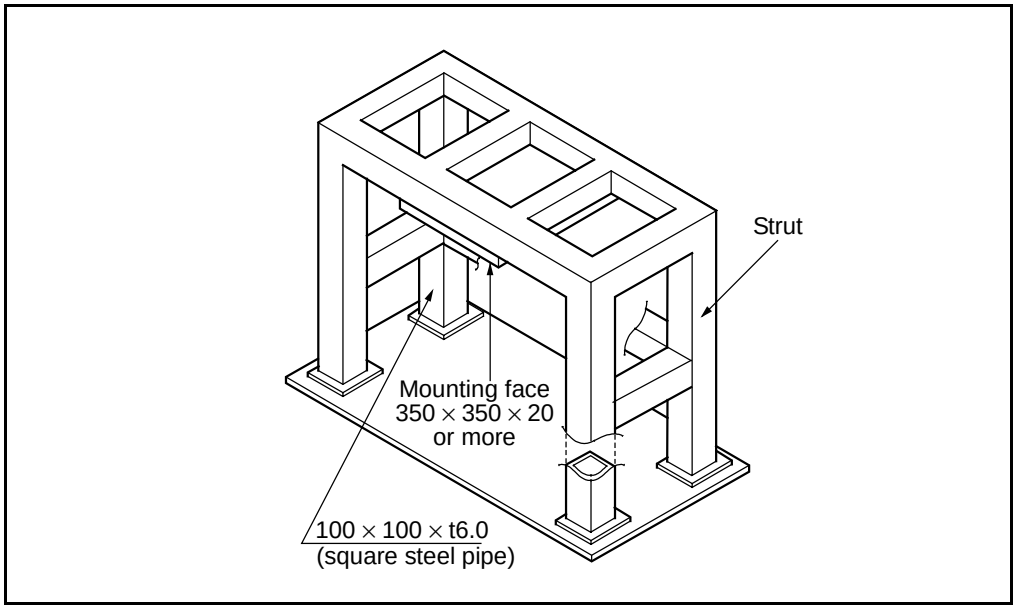
To overhead-mount the robot, an overhead-mount frame and suspension jig are required. Set up those items, referring to Figure 2-8 and suspension jigs specified on the following pages.

Caution (1) Install the robot according to "[2] Installing the Robot Unit" on the previous page. Use bolts of strength class 12.9.

(2) Keep a space of 250 mm or larger for wiring behind the robot. Fasten the wiring to the mounting face or beam so that the weight of the cables will not be directly applied to the connectors.

Overhead-mount Frame

The figure below shows an example of overhead-mount frame.



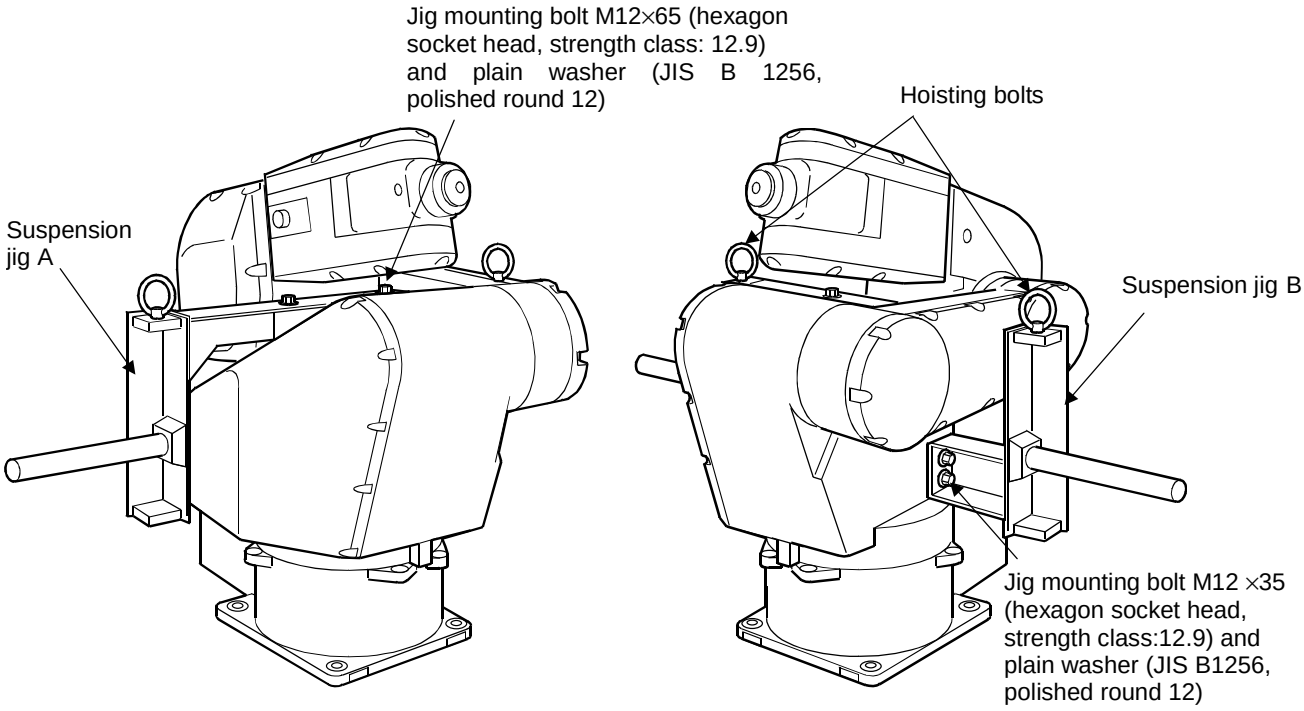
Example of Overhead-mount Frame (VM-D series)

Caution: When the robot is running at high speed, large reaction forces are exerted on the top plate structure. Take proper measures to protect the top plate from vibration caused by reaction forces. Separate the robot installation top plate structure from other top plate structures within the equipment.

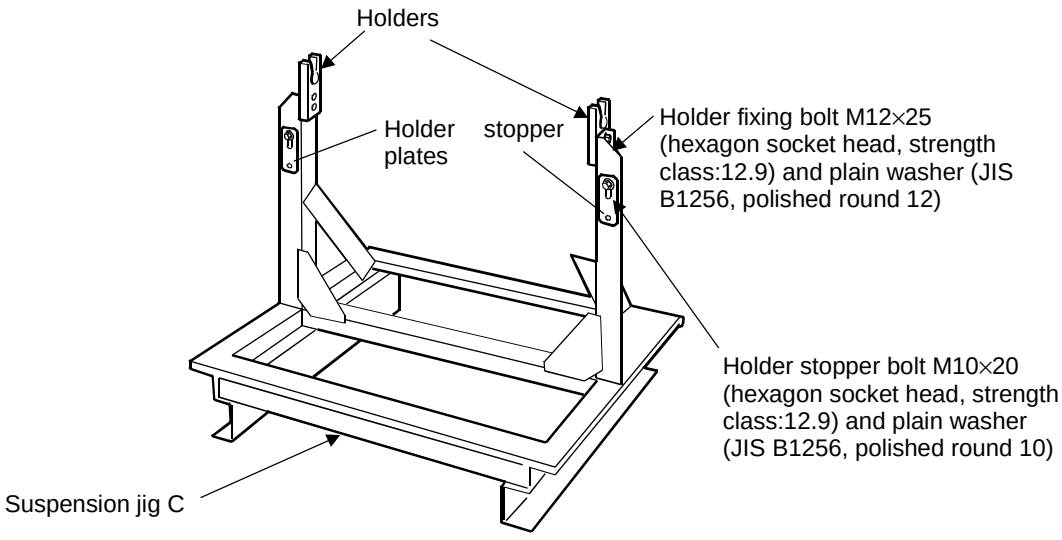
VM-6070D

(1) Overhead-mount Suspension Jigs

To mount the robot overhead, five types of jigs -- suspension jigs A, B and C, two holders and two holder stopper plates -- are required. The upper figures on this page show how to mount suspension jigs A and B, and the lower figure shows how to mount suspension jig C, holder and holder stopper plates. The reference drawings for mounting suspension jigs A, B and C, holders and holder stopper plates are shown on pages 11 through 14. The customer should prepare them as required.

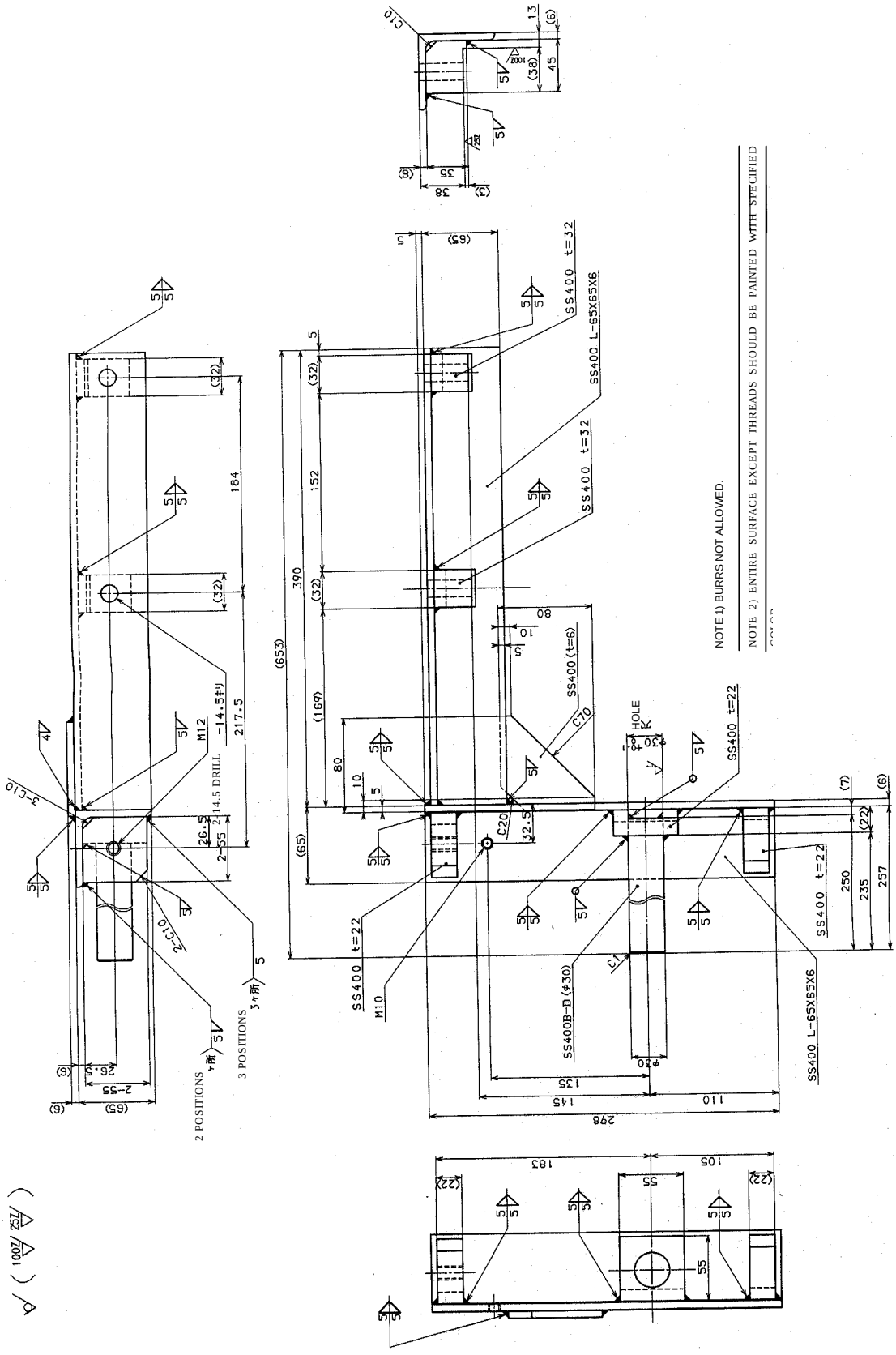


Examples of Suspension Jigs A and B

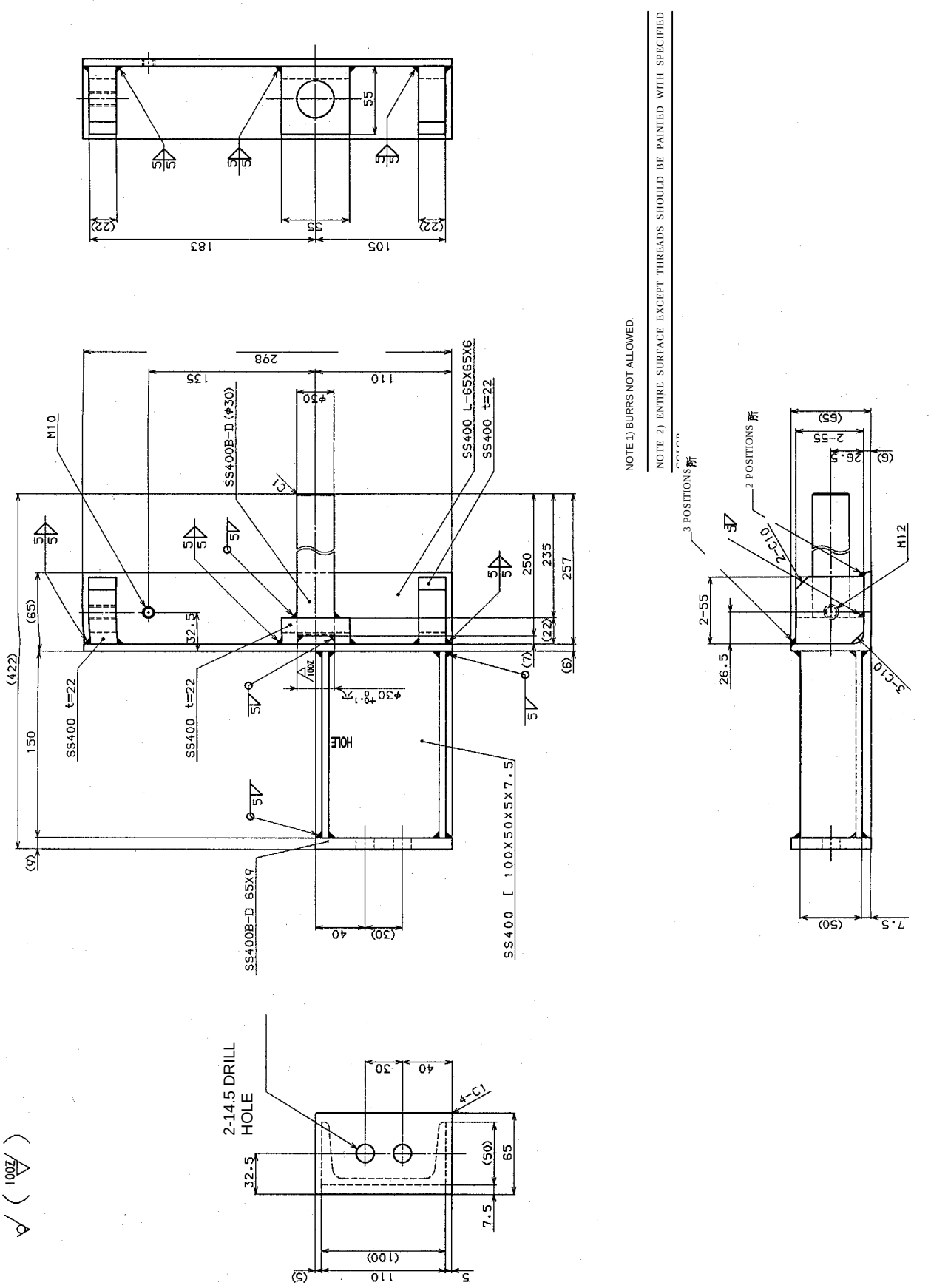


Example of Suspension Jig C

Caution: Bolt tightening torque for M12: 130 ± 26 Nm
Bolt tightening torque for M10: 71 ± 14.2 Nm

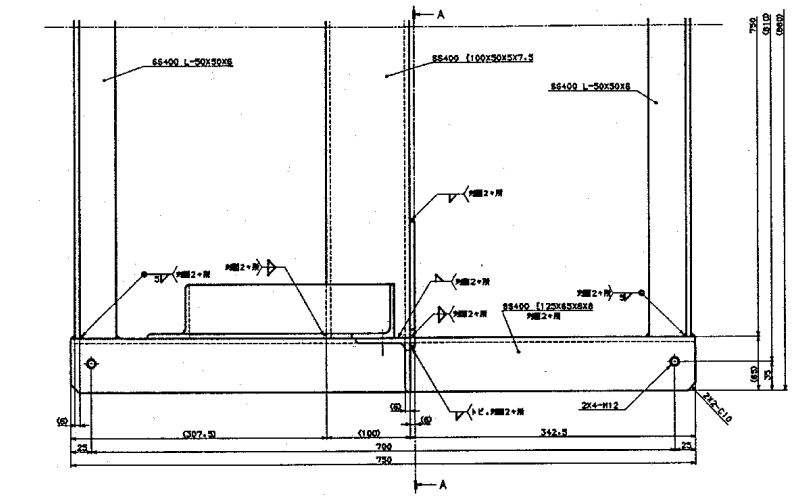


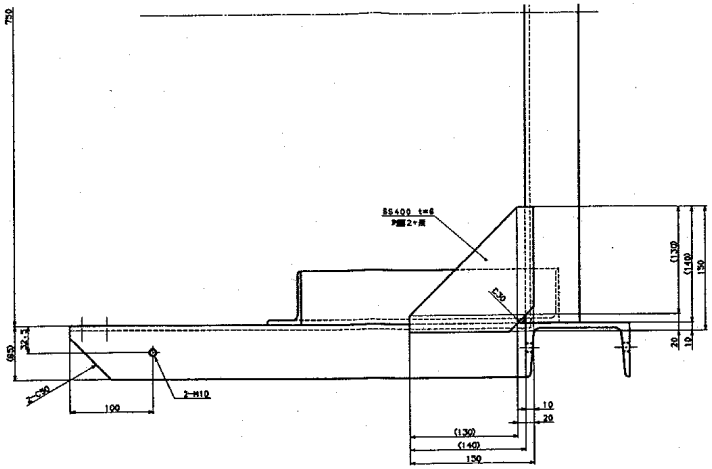
Suspension Jig A



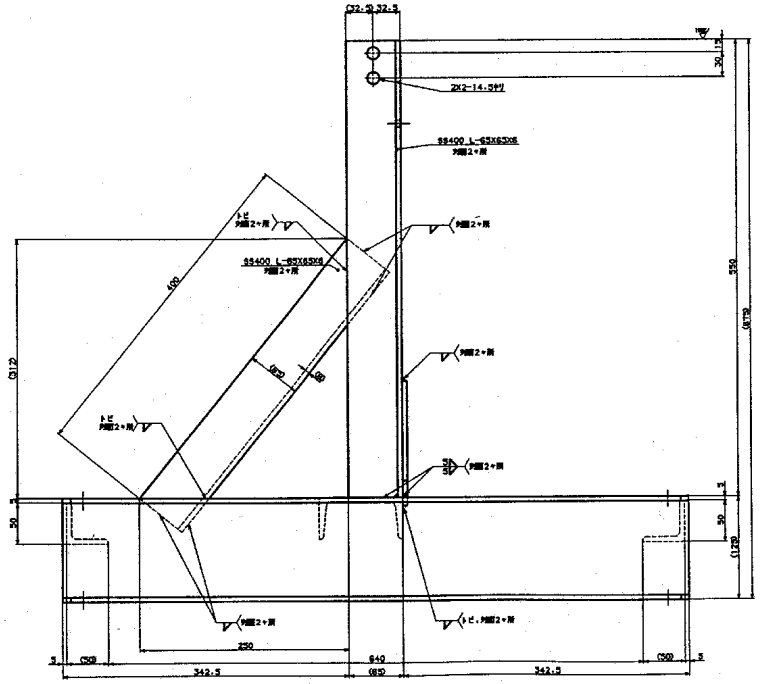
Suspension Jig B

Suspension Jig C



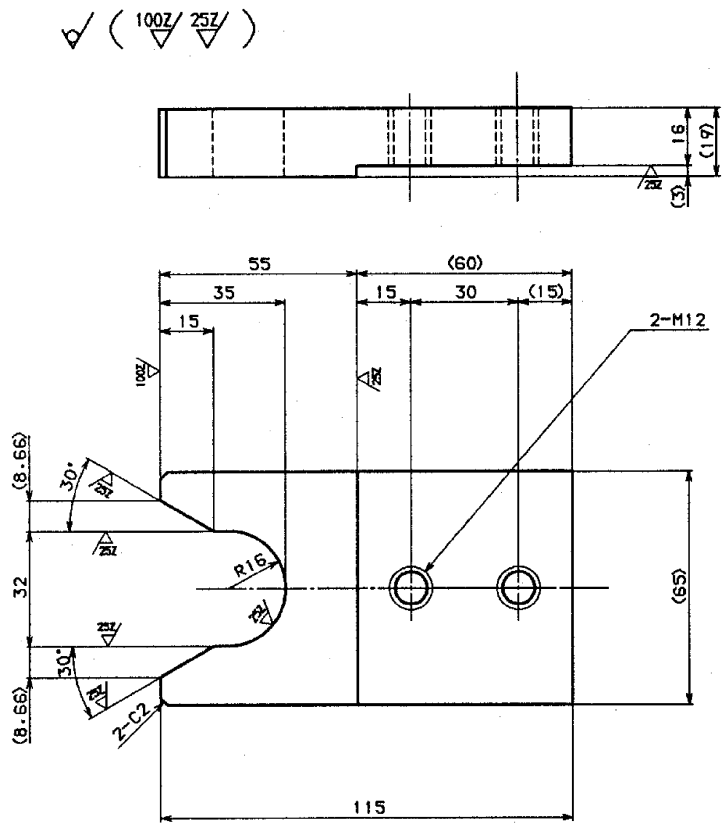


A – A



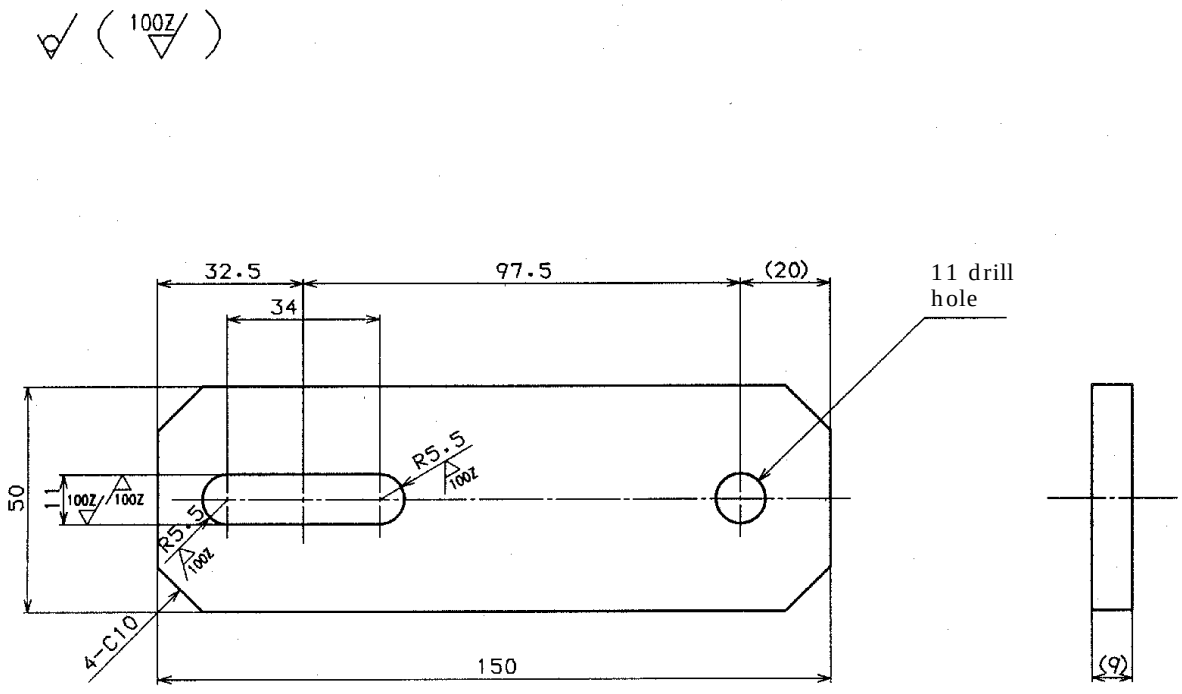
NOTE 1) BURRS NOT ALLOWED.

NOTE 2) ENTIRE SURFACE EXCEPT THREADS SHOULD BE PAINTED WITH SPECIFIED COLOR



NOTE 1) ALL CORNERS SHOULD BE FINE-CHAMFERED UNLESS OTHERWISE SPECIFIED.

Holder



Holder Stopper Plate

NOTE 1) ALL CORNERS SHOULD BE FINE-CHAMFERED UNLESS OTHERWISE SPECIFIED.

(2) Overhead-mounting Example

The basic procedure of overhead-mounting is given on the following pages. Follow the procedure to install the robot unit.

Caution

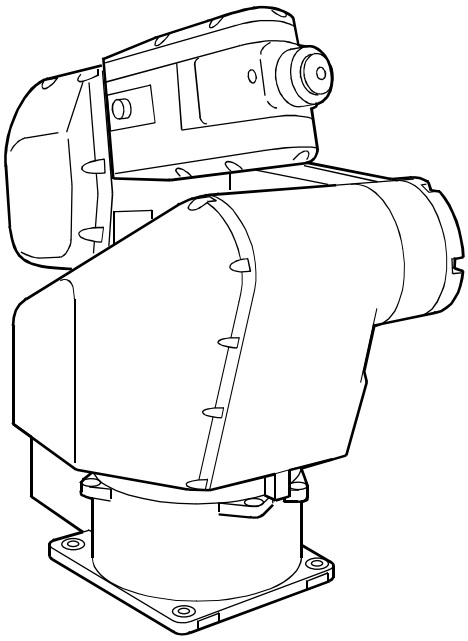
(1) Since the robot unit weighs approximately 95 kg, prepare a crane and a forklift with a lifting load of 0.5 ton or more.

(2) The overhead-mounting job must be performed under the supervision of a qualified operator for sling, crane and forklift operation.

(3) Wear safety shoes and a helmet.

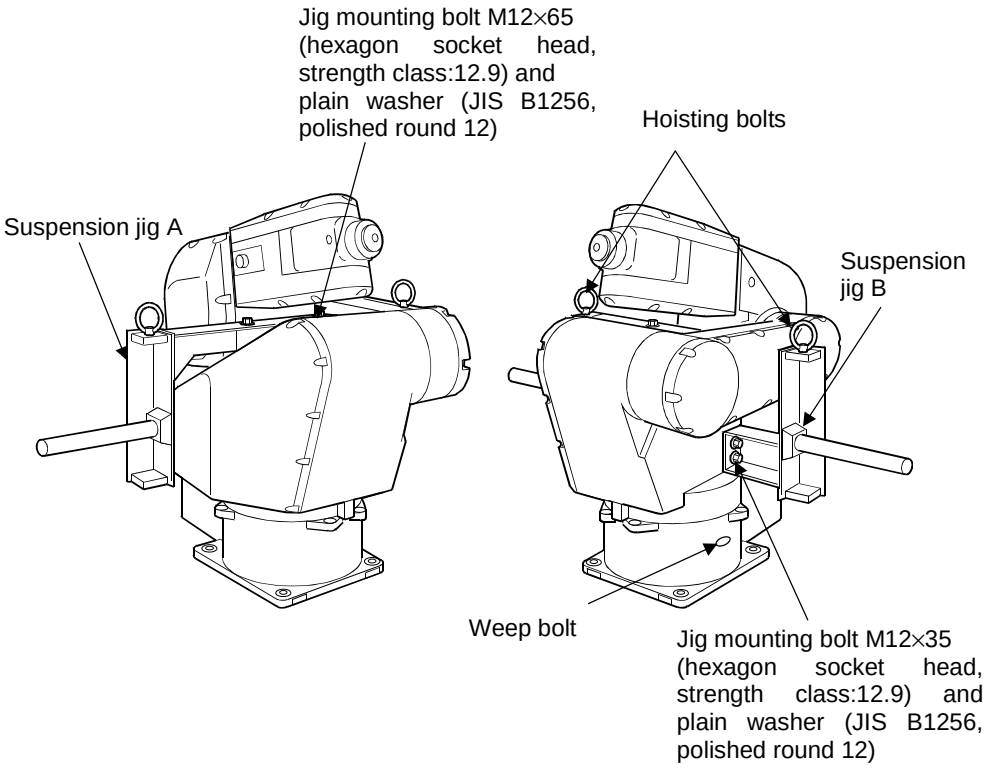
STEP 1

When unpacked, the robot unit is as shown below.



STEP 2

Mount suspension jigs A and B using hexagon socket head bolts and plain washers.
(For the VM-W, remove the weep bolt.)

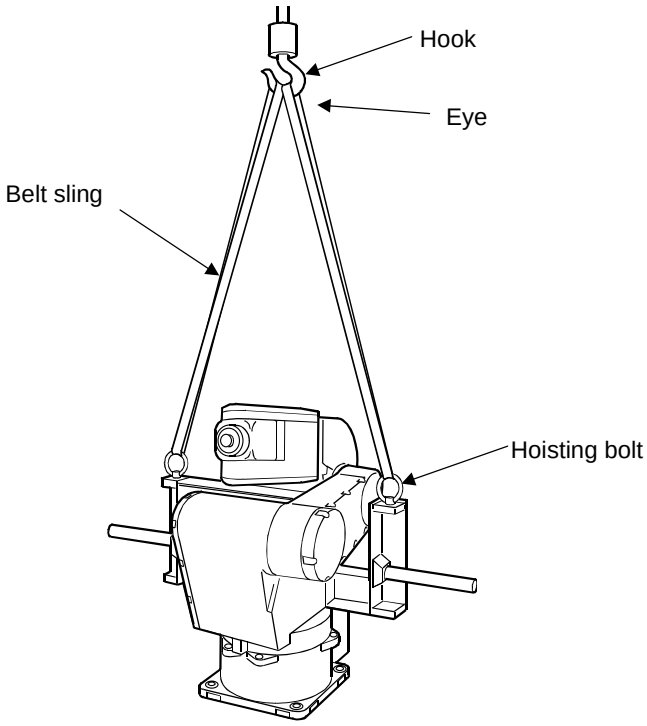


STEP 3

Drive the hoisting bolts (that come with the robot unit) into the suspension jigs.

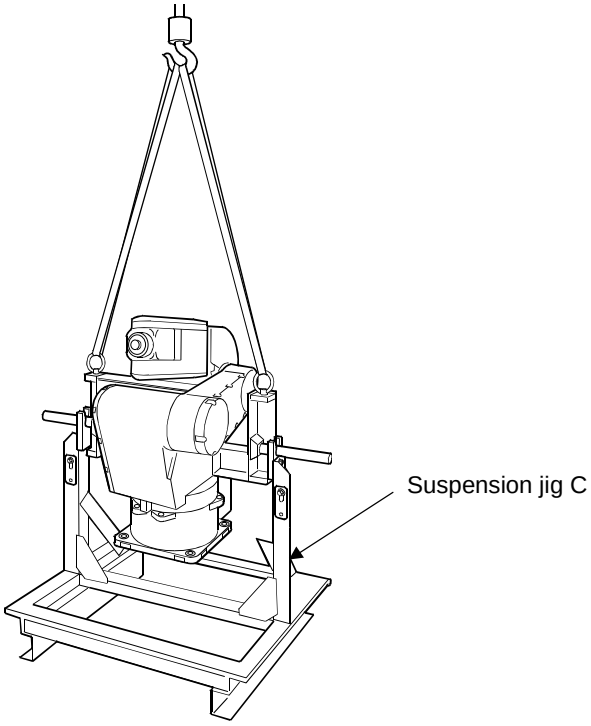
STEP 4

Pass a belt sling through each hoisting bolt, and put their eyes on the hook.



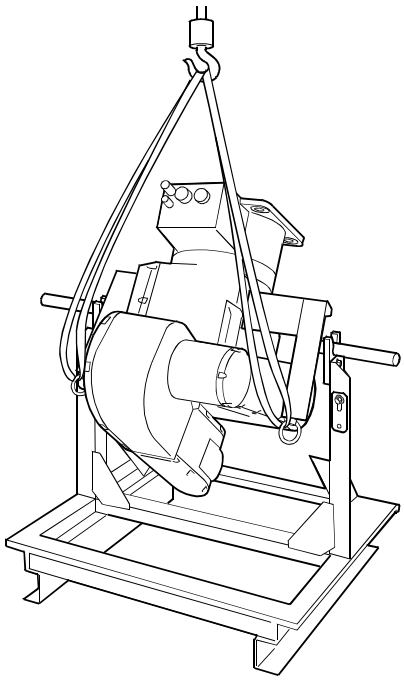
STEP 5

Hoist the robot unit using a crane and move it to the position right above suspension jig C.



▶ STEP 6

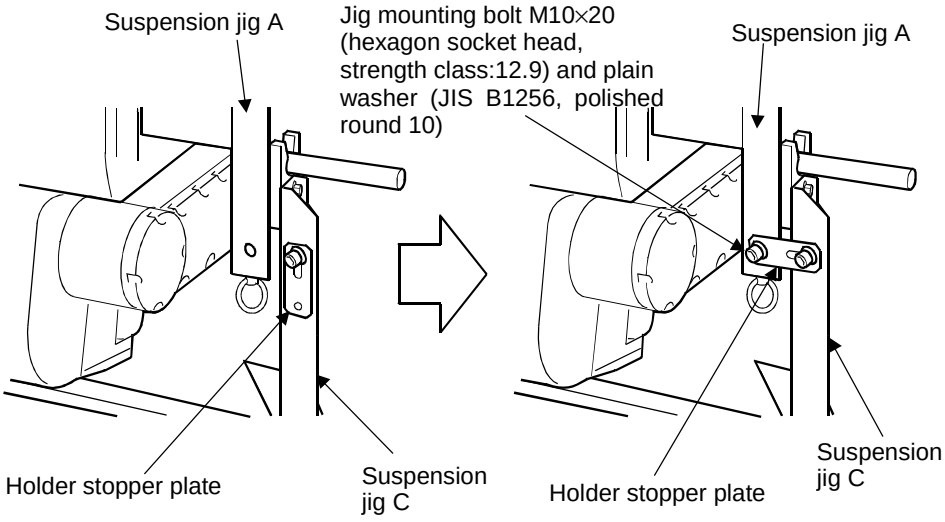
Slowly lower the hook of the crane until the robot unit turns upside down.



⚠Caution: The robot unit will turn by its own weight as you lower the crane hook. This is not trouble, so do not touch the robot unit itself.

▶ STEP 7

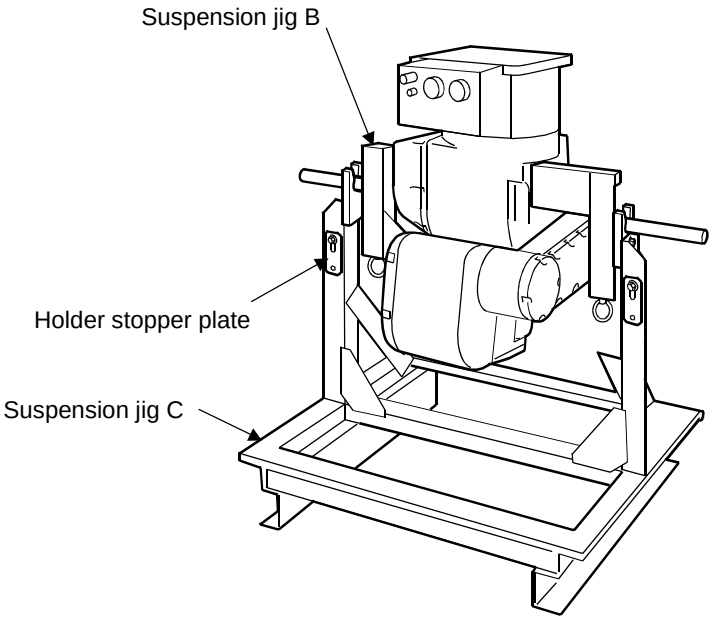
Using the holder stopper plates attached to suspension jig C, join suspension jigs A and C together.



Bolt tightening torque : 71 ±14.2 Nm

STEP 8

On the other side, join suspension jigs B and C together using the other holder stopper plate in the same way as in STEP 7.

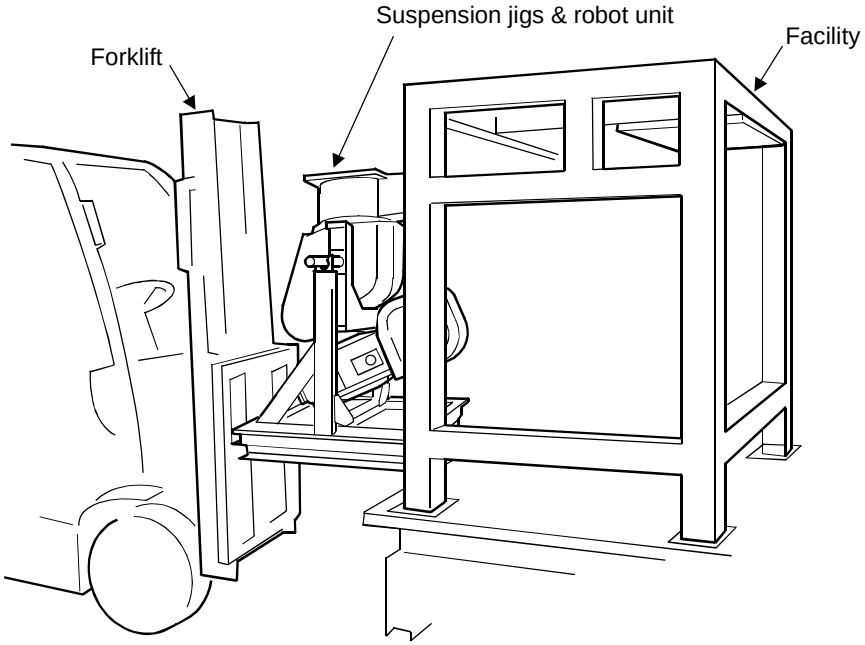


STEP 9

Confirm that the robot unit is secured to the suspension jigs.

STEP 10

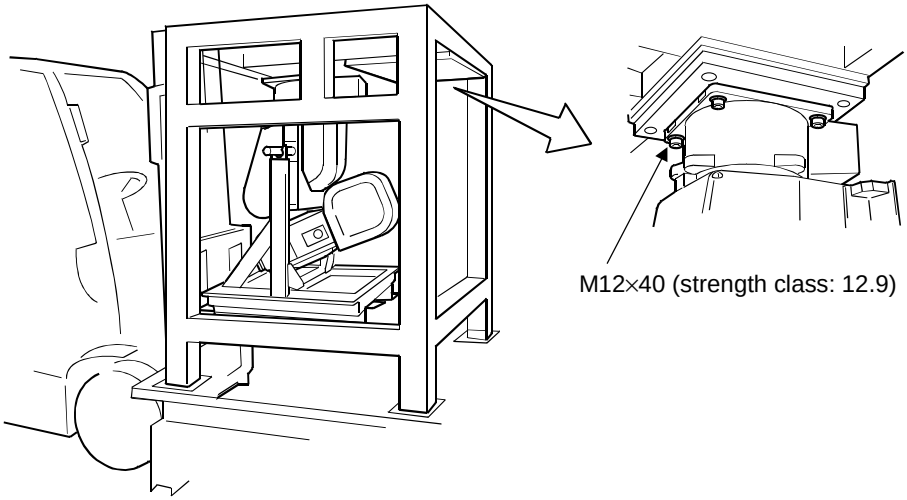
Using a forklift, transport the robot unit fixed to suspension jigs to the robot mount.



STEP 11

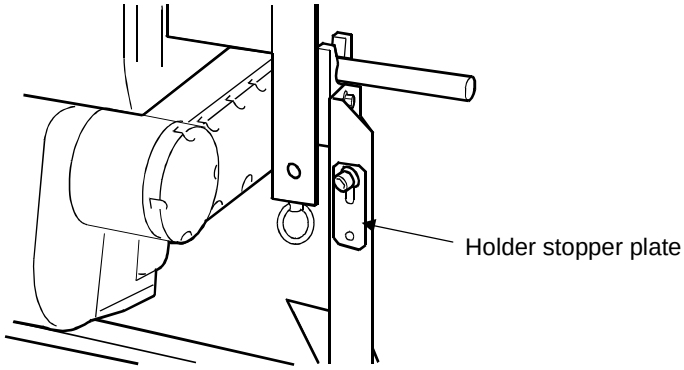
Using the forklift, set the robot unit fixed to suspension jigs in the specified position on the robot mount, then secure it to the robot mount with M12×40 bolts (strength class: 12.9).

Bolt tightening torque : 130 ±26 Nm



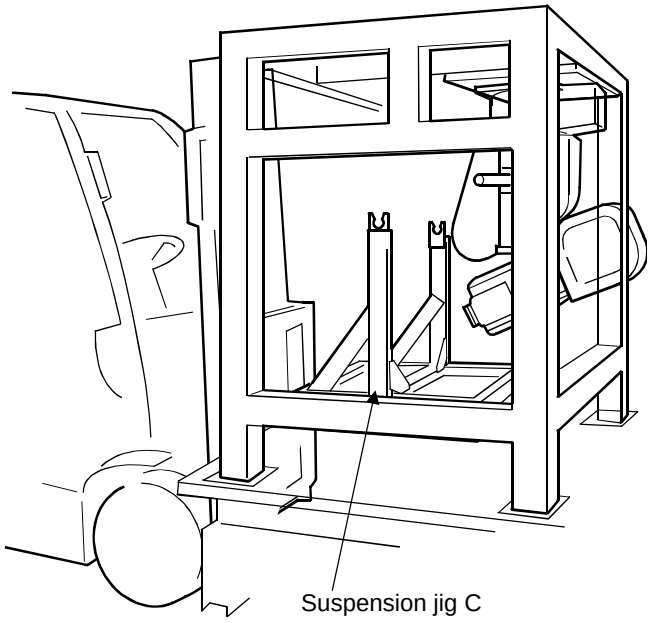
STEP 12

While supporting the robot unit with the forklift, remove the bolts fastening the holder stopper plates.



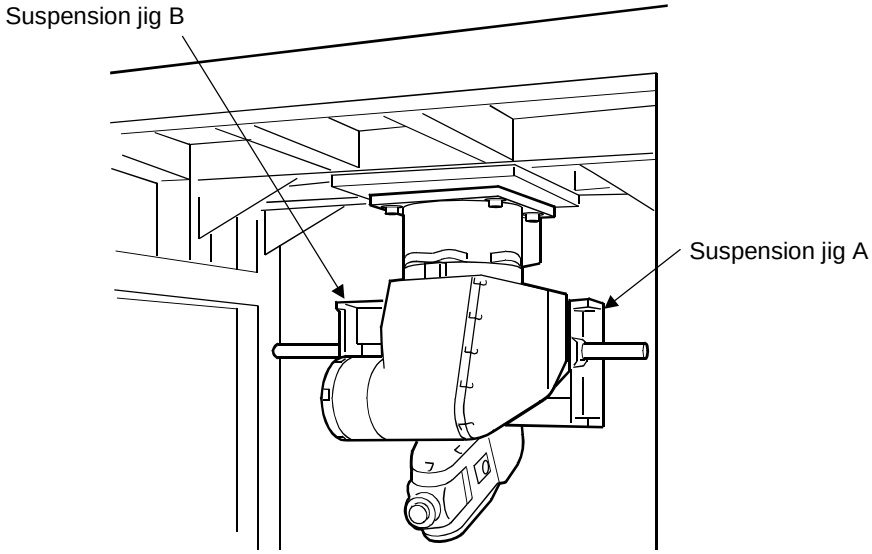
STEP 13

Using the forklift, remove suspension jig C only from the robot unit.



STEP 14

Remove suspension jigs A and B from the robot unit.



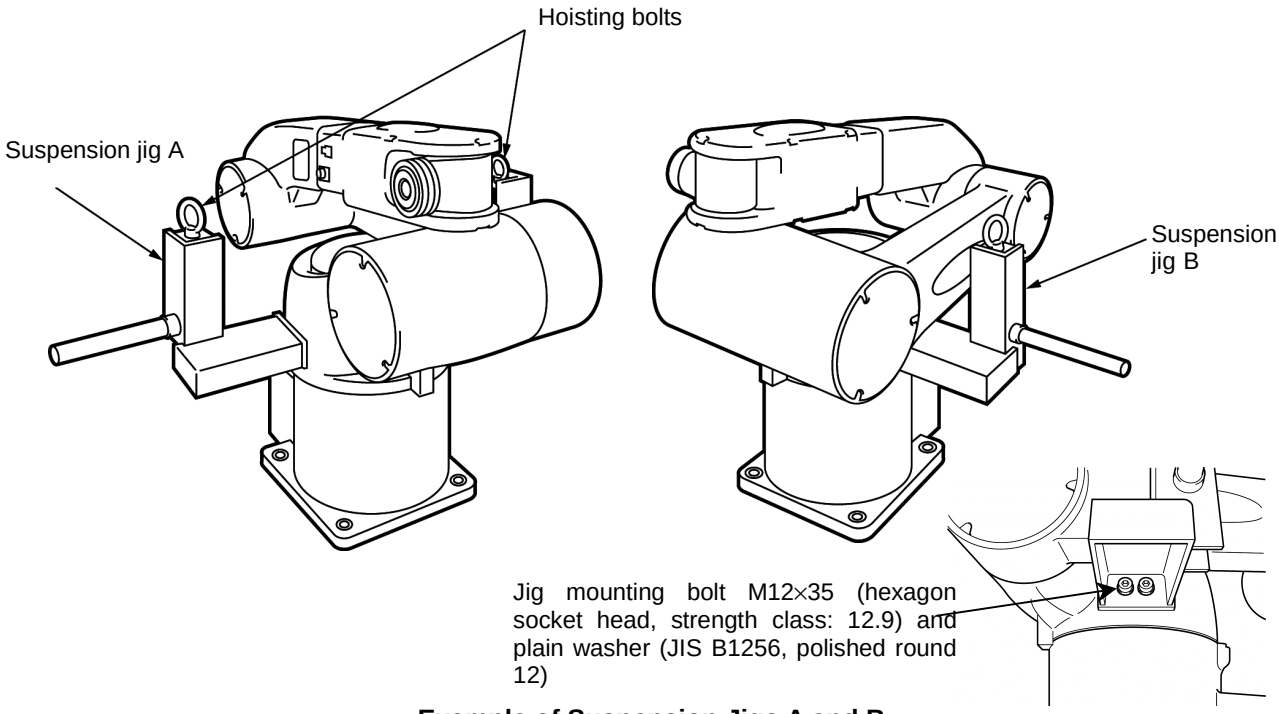
STEP 15

Check that the robot unit is secured to the robot mount. Then, the installation procedure is complete.

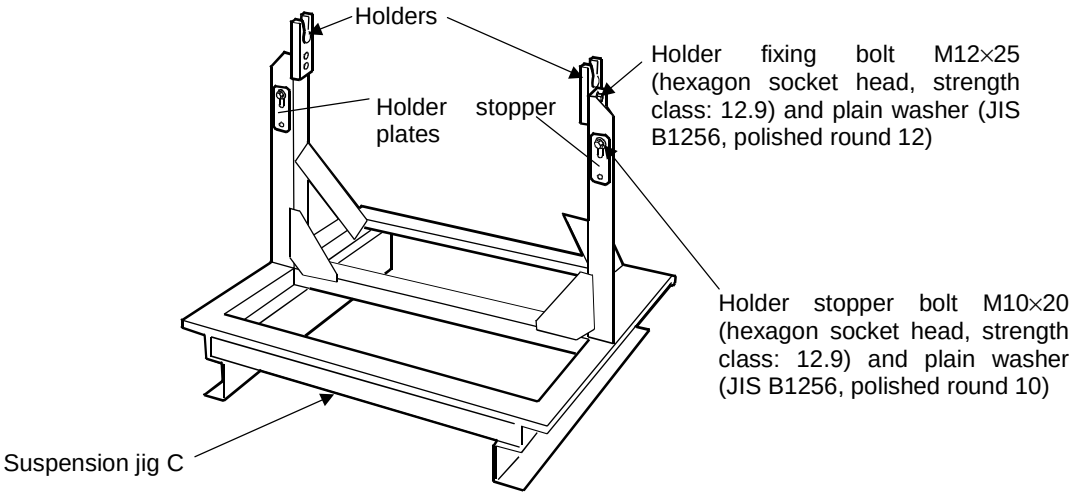
VM-6083D/VM-60B1D

(1) Overhead-mount Suspension Jigs

To mount the robot overhead, five types of jigs -- suspension jigs A, B and C, two holders and two holder stopper plates -- are required. The upper figures on this page show how to mount suspension jigs A and B, and the lower figure shows how to mount suspension jig C, holder and holder stopper plates. The reference drawings for mounting suspension jigs A, B and C, holders and holder stopper plates are shown on pages 23 through 26. The customer should prepare them as required.

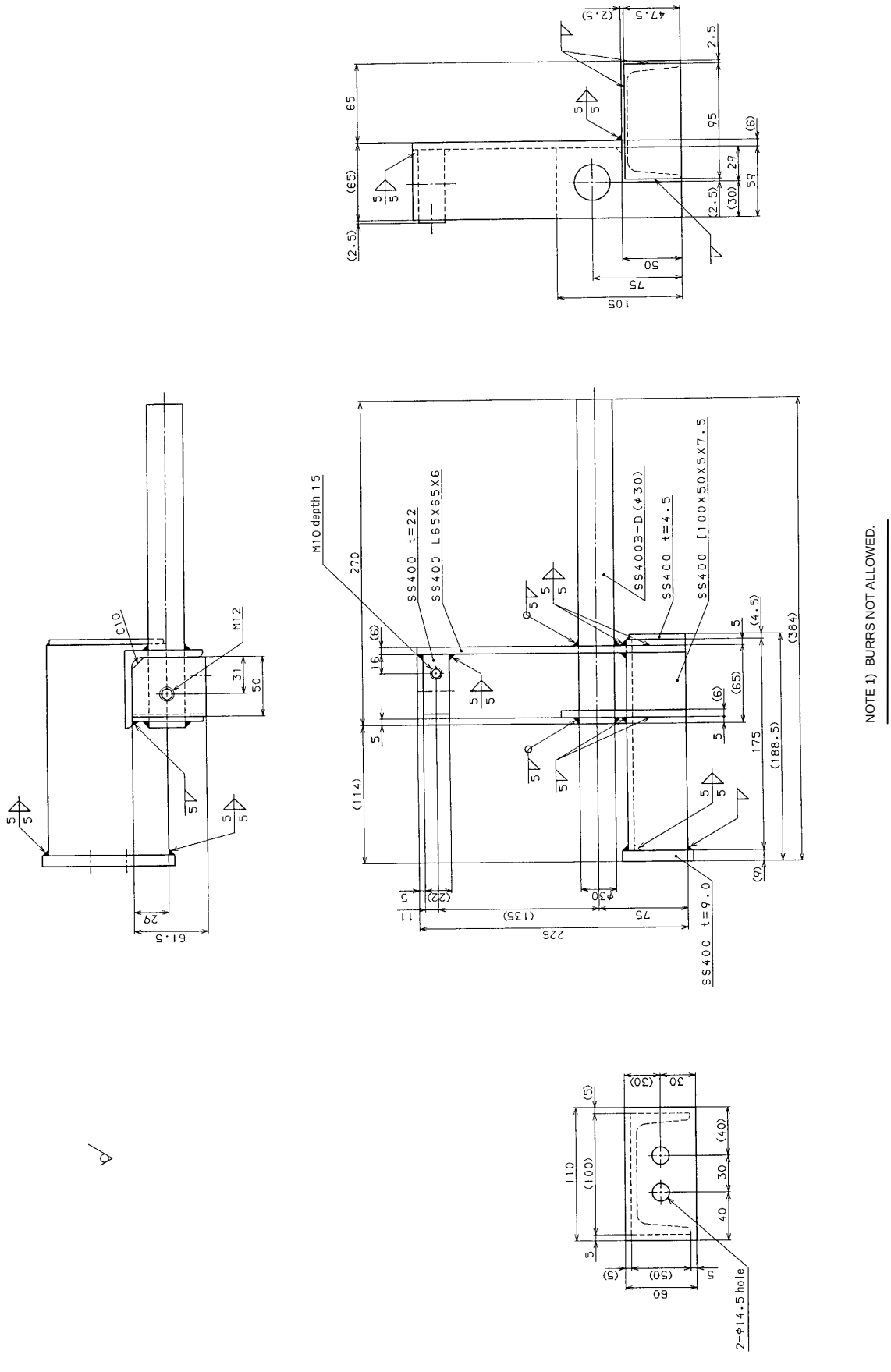


Example of Suspension Jigs A and B

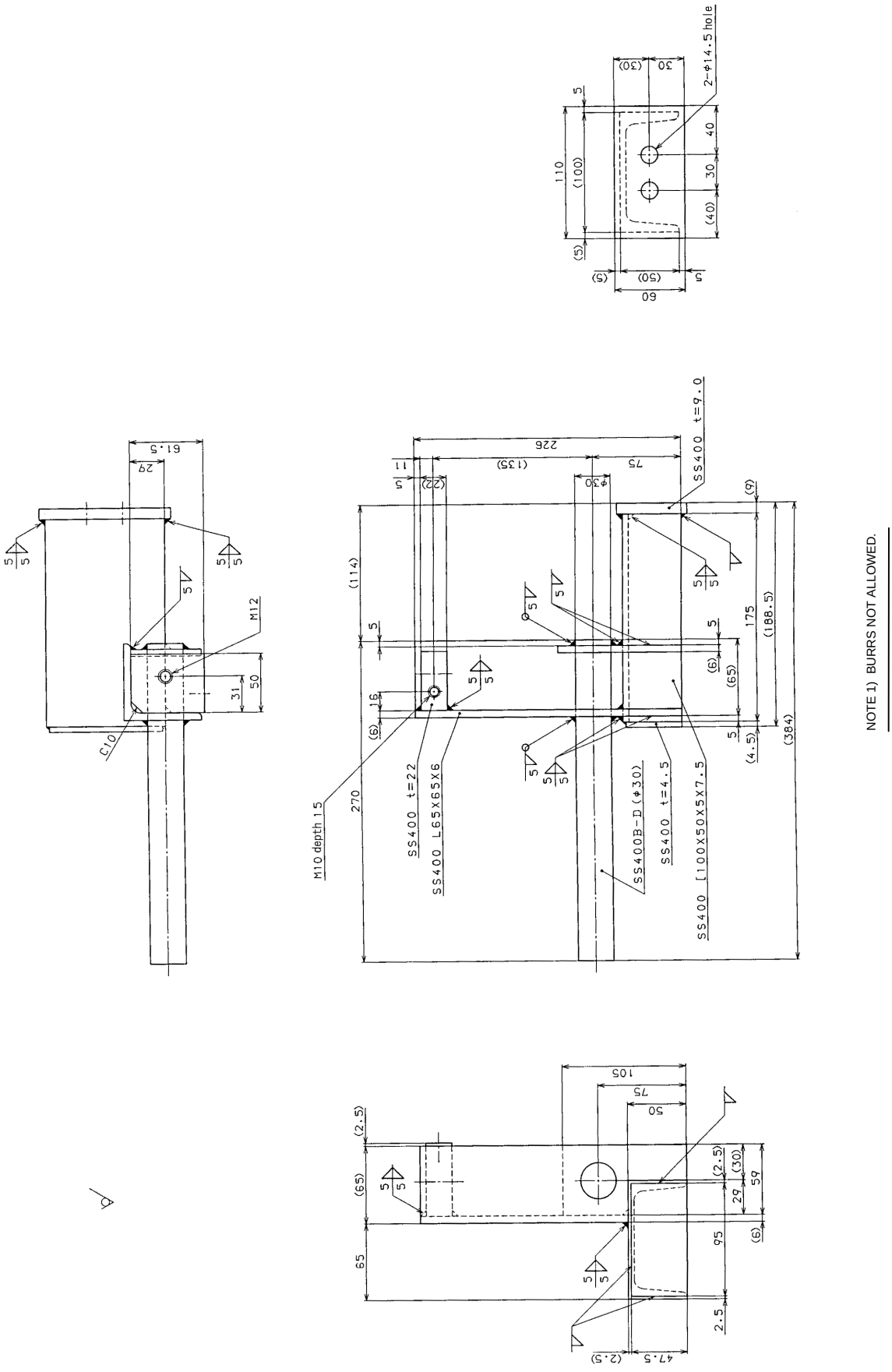


Example of Suspension Jig C

Bolt tightening torque for M12: 130 ±26 Nm
Bolt tightening torque for M10: 71 ±14.2 Nm

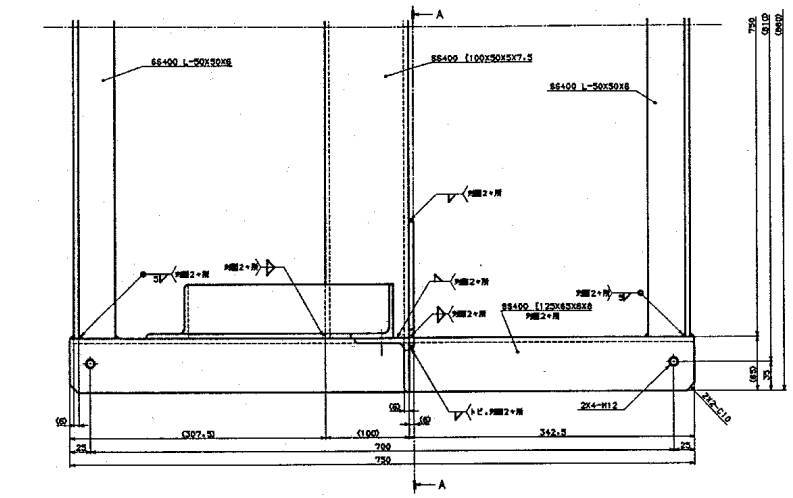


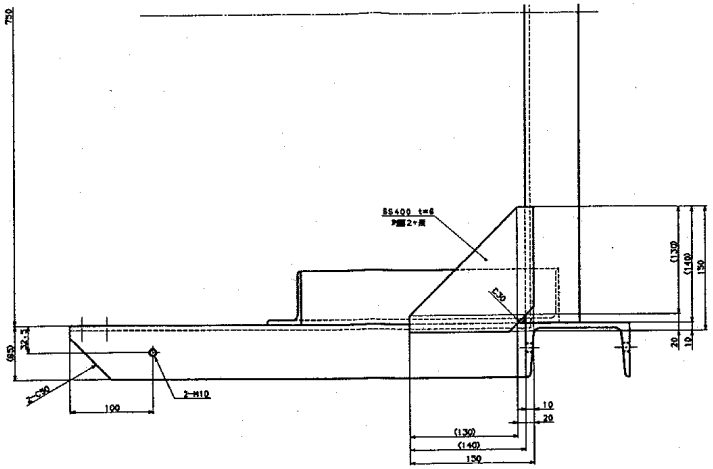
Suspension Jig A



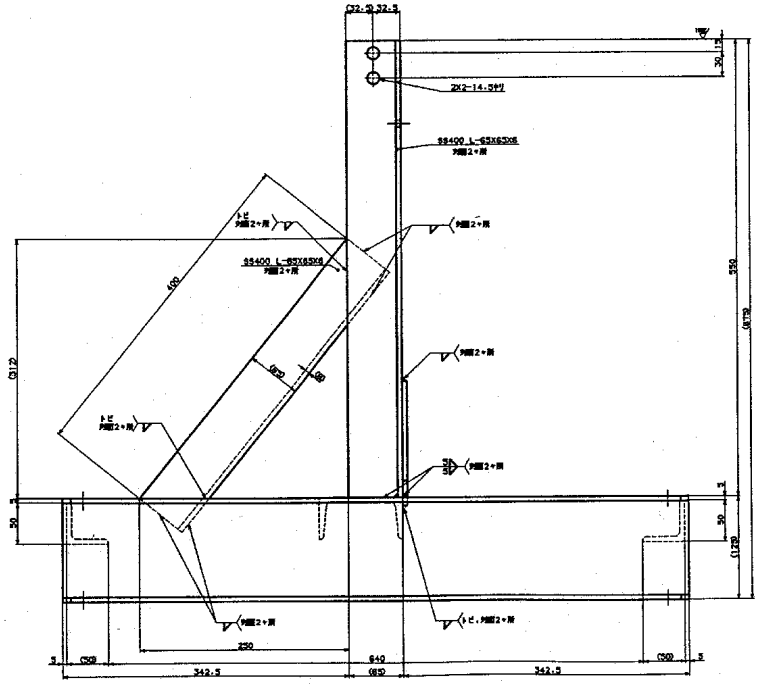
Suspension Jig B

Suspension Jig C



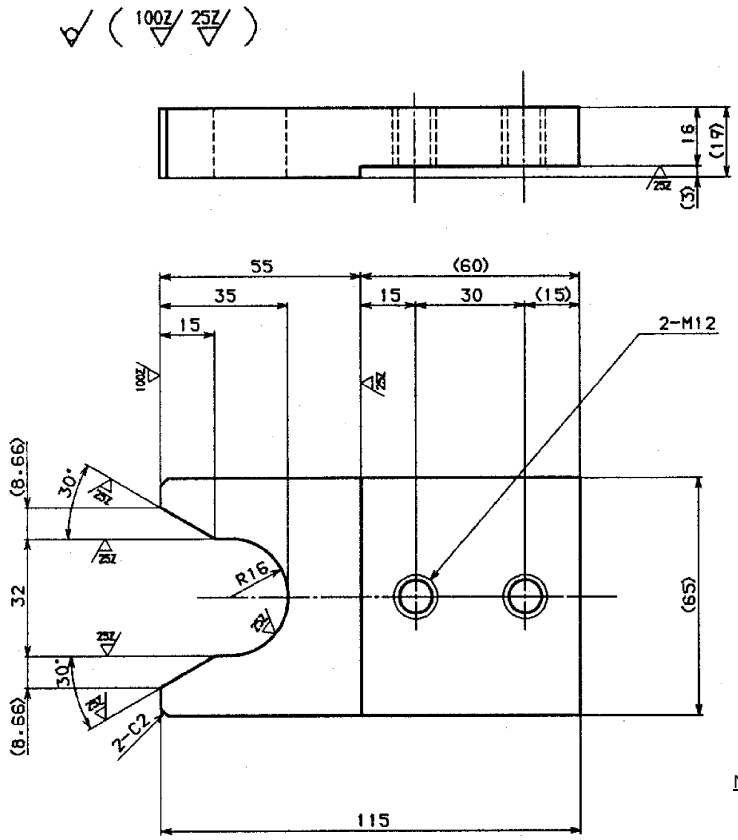


A – A



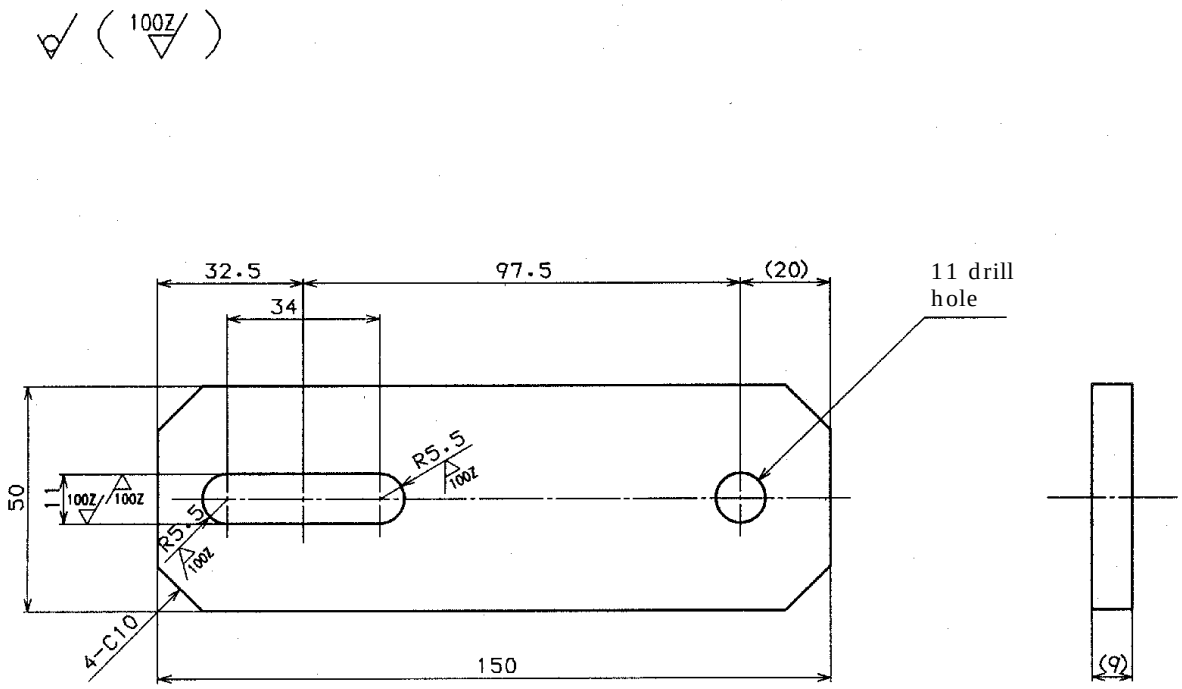
NOTE 1) BURRS NOT ALLOWED.

NOTE 2) ENTIRE SURFACE EXCEPT THREADS SHOULD BE PAINTED WITH SPECIFIED COLOR



NOTE 1) ALL CORNERS SHOULD BE FINE-CHAMFERED UNLESS OTHERWISE SPECIFIED.

Holder



Holder Stopper Plate

NOTE 1) ALL CORNERS SHOULD BE FINE-CHAMFERED UNLESS OTHERWISE SPECIFIED.

(2) Overhead-mounting Example

The basic procedure of overhead-mounting is given on the following pages. Follow the procedure to install the robot unit.

Caution

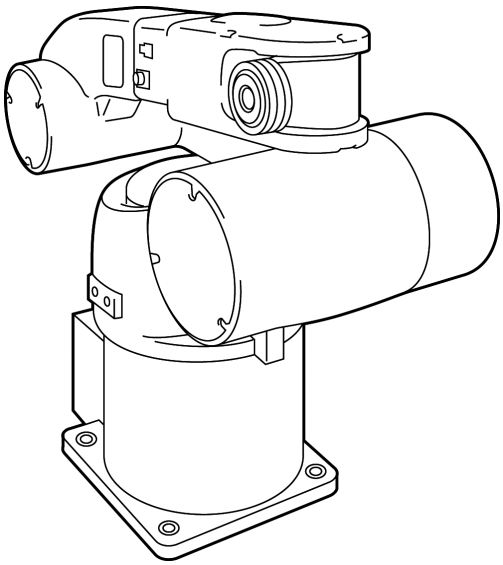
(1) Since the robot unit weighs approximately 80 kg, prepare a crane and a forklift with a lifting load of 0.5 ton or more.

(2) The overhead-mounting job must be performed under the supervision of a qualified operator for sling, crane and forklift operation.

(3) Wear safety shoes and a helmet.

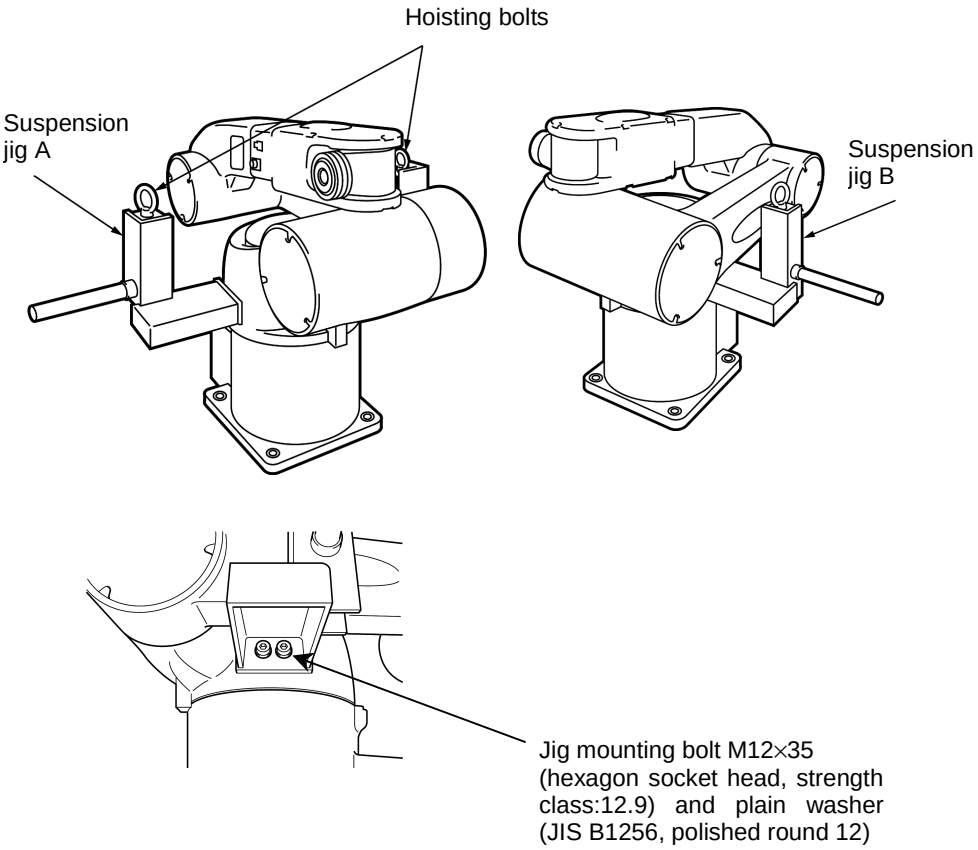
STEP 1

When unpacked, the robot unit is as shown below:



STEP 2

Mount suspension jigs A and B using hexagon socket head bolts and plain washers.



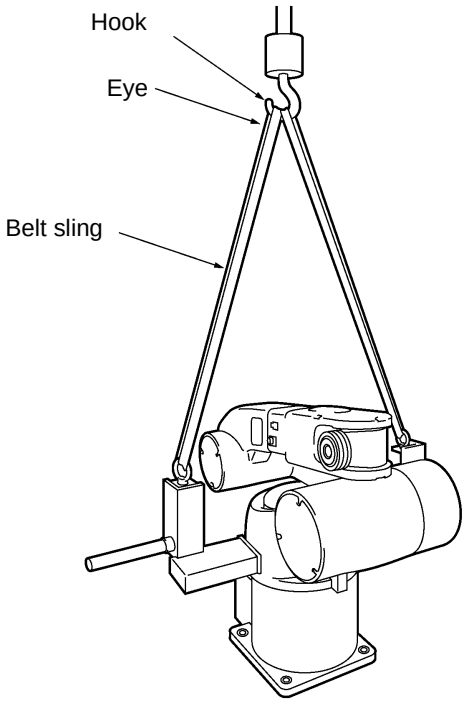
Bolt tightening torque : 130 ±26 Nm

STEP 3

Drive the hoisting (that come with the robot unit) into the suspension jigs.

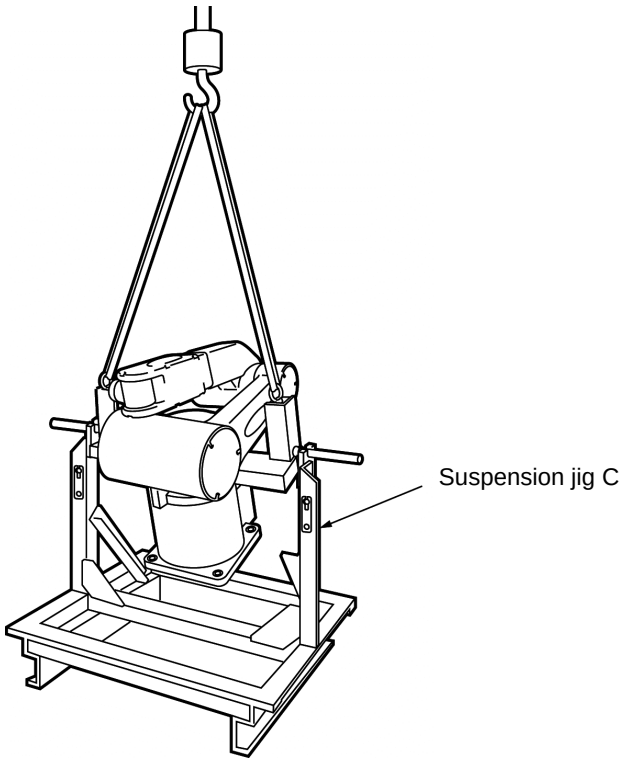
STEP 4

Pass a belt sling through each hoisting bolt, and put their eyes on the hook.



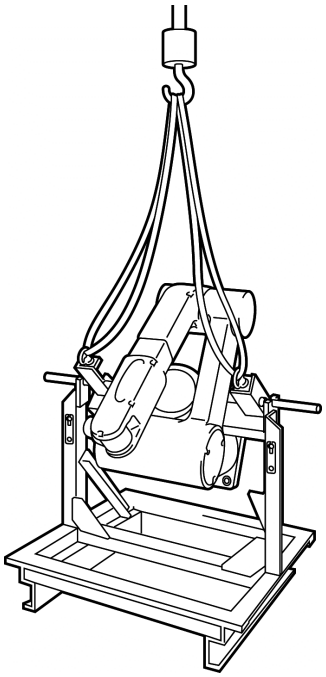
STEP 5

Hoist the robot unit using a crane and move it to the position right above the suspension jig C.



▸ STEP 6

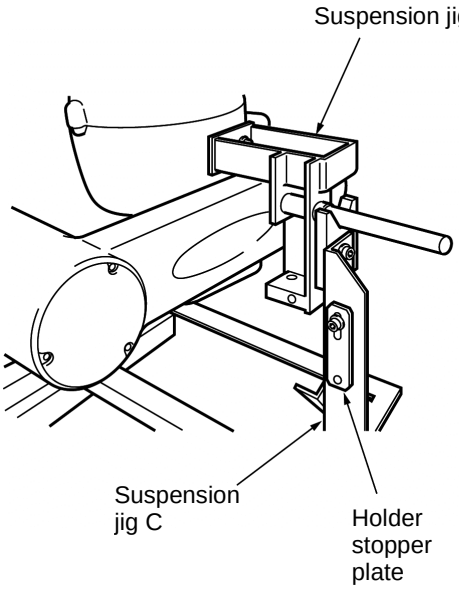
Slowly lower the hook of the crane until the robot unit turns upside down.

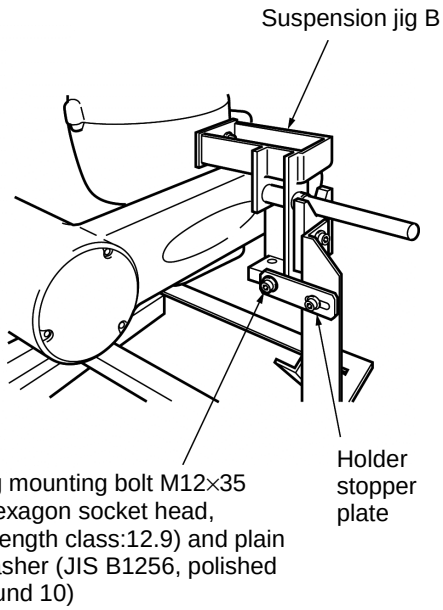


⚠Caution **The robot unit will turn by its own weight as you lower the crane hook. This is not trouble, so do not touch the robot unit itself.**

▸ STEP 7

Using the holder stopper plates attached to suspension jig C, join suspension jigs B and C together.

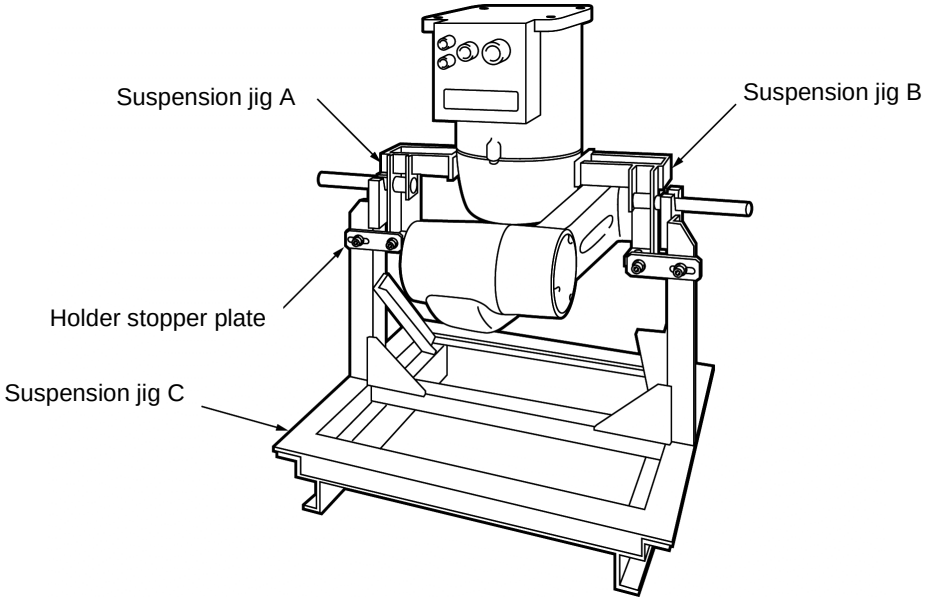




Bolt tightening torque : 71 ±14.2 Nm

STEP 8

On the other side, join suspension jigs B and C together using the other holder stopper plate in the same way as in STEP 7.

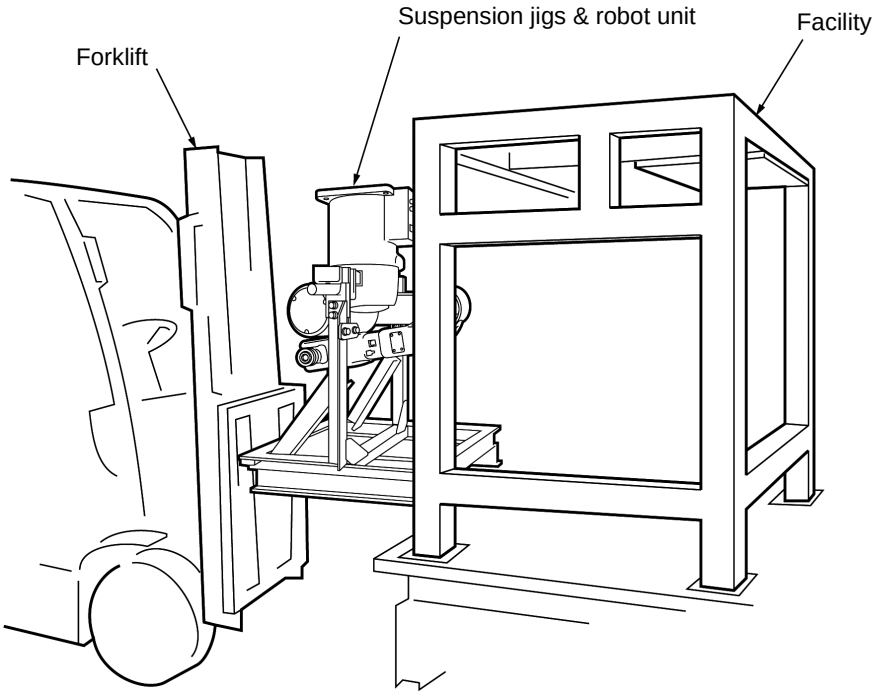


STEP 9

Confirm that the robot unit is secured to the suspension jigs.

STEP 10

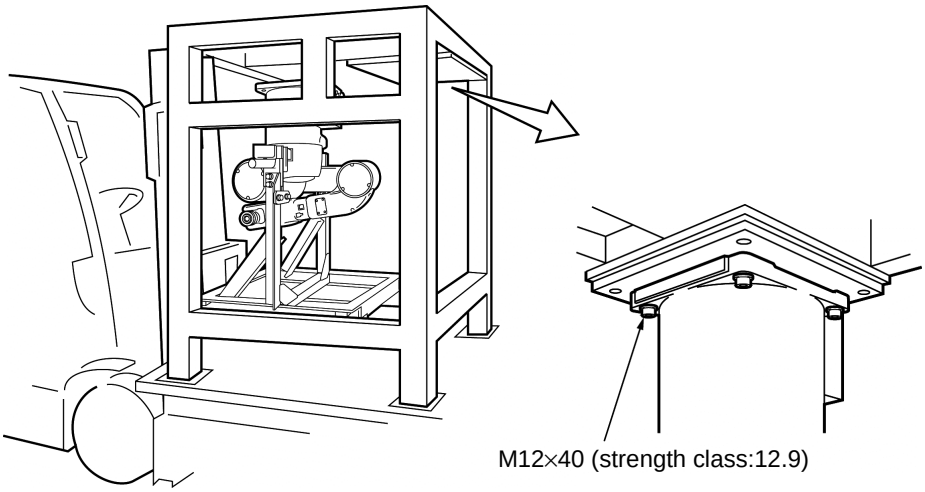
Using a forklift, transport the robot unit fixed to suspension jigs to the robot mount.



STEP 11

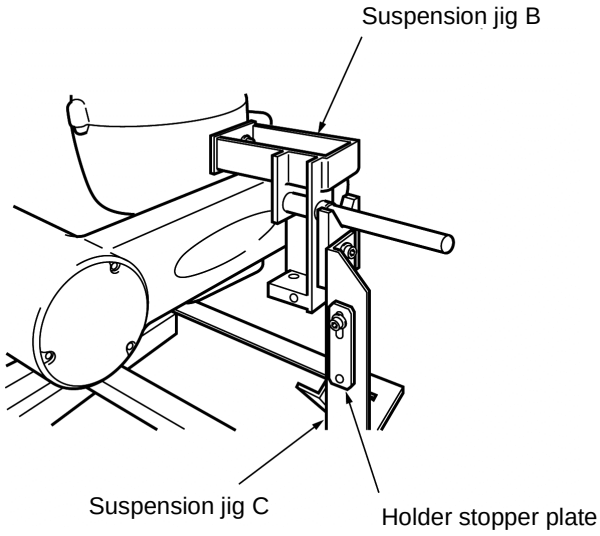
Using the forklift, set the robot unit fixed to suspension jigs in the specified position on the robot mount, then secure it to the robot mount with M12×40 bolts (strength class: 12.9).

Bolt tightening torque : 130 ±26 Nm



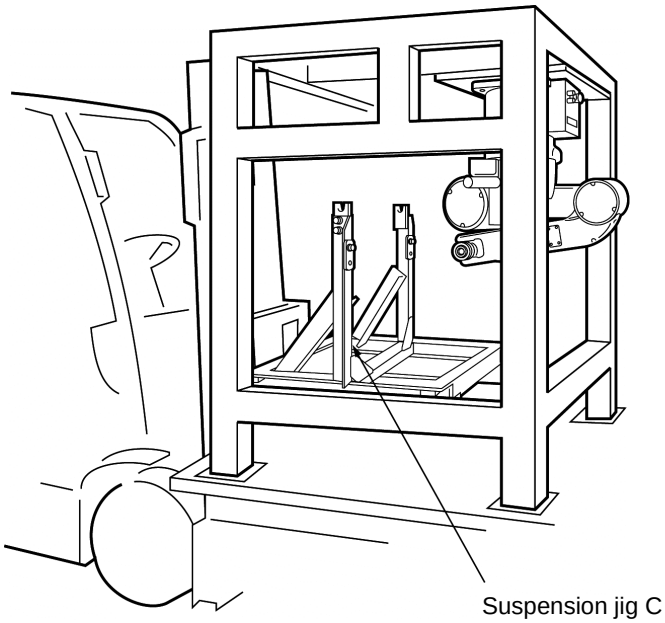
STEP 12

While supporting the robot unit with the forklift, remove the bolts fastening the holder stopper plates.



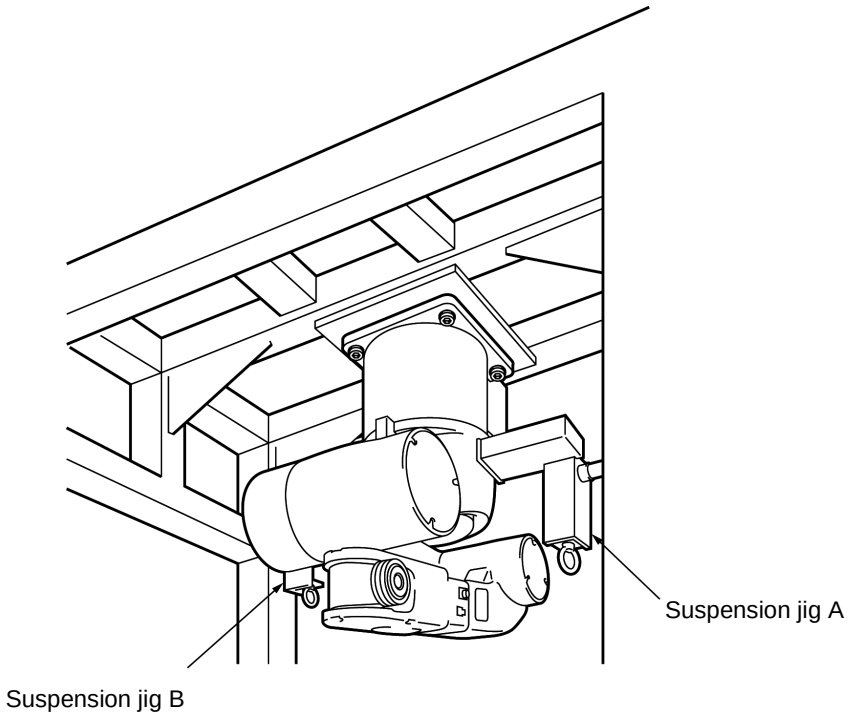
STEP 13

Using the forklift, remove suspension jig C only from the robot unit.



STEP 14

Remove suspension jigs A and B from the robot unit.



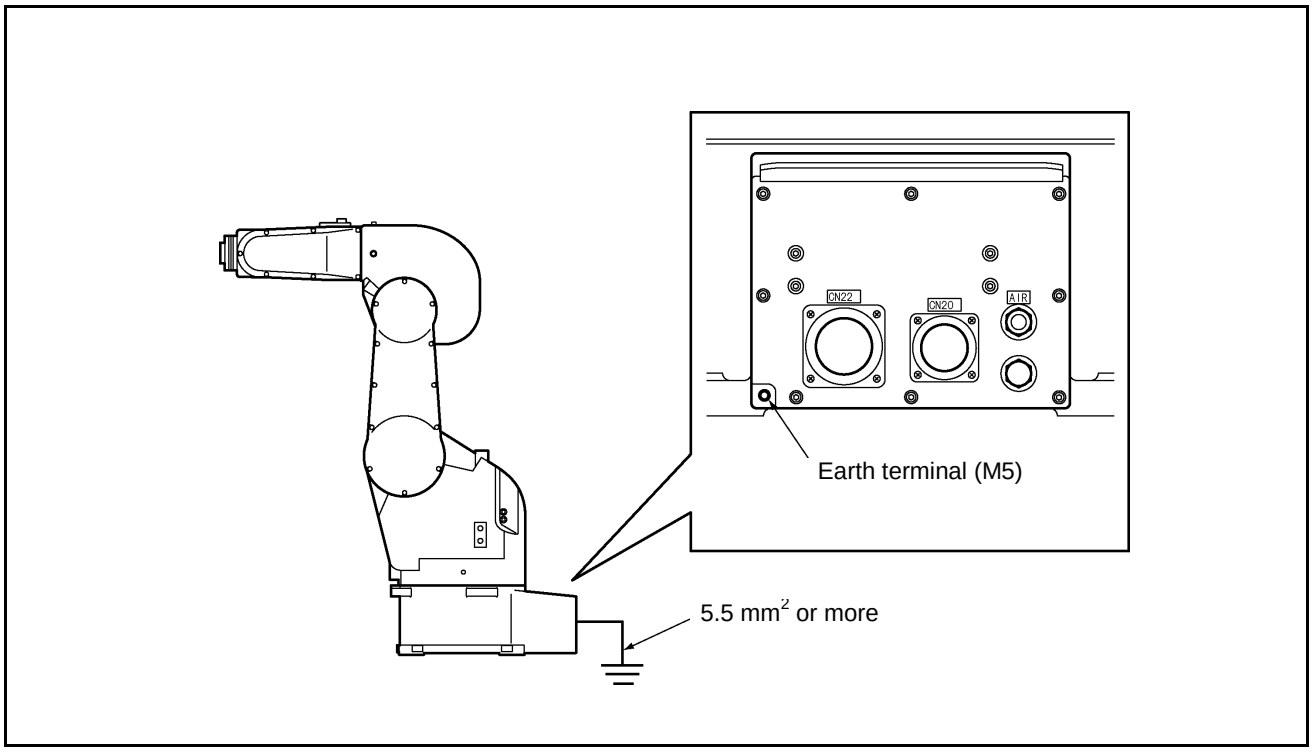
STEP 15

Confirm that the robot unit is secured to the robot mount. Then, the installation procedure is complete.

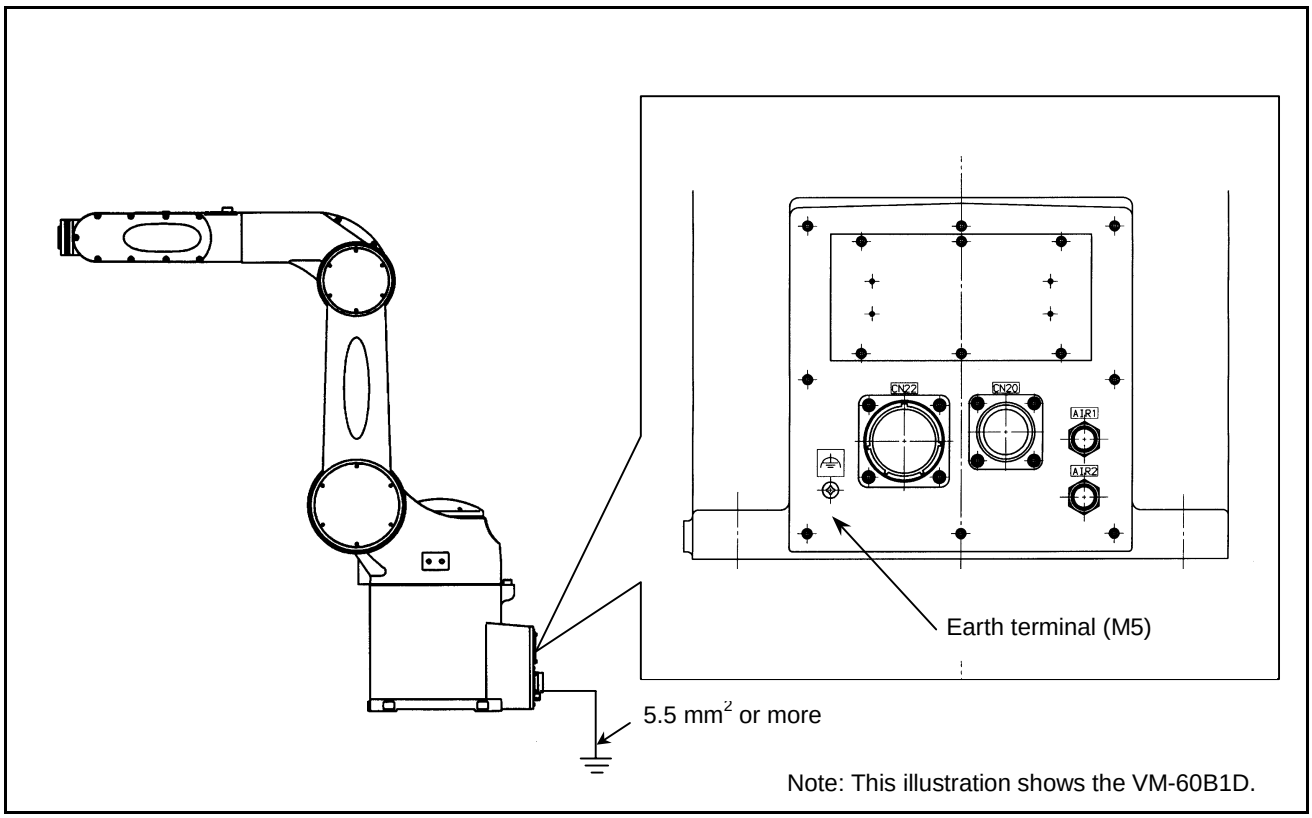
[4] Grounding the Robot Unit

Ground the earth terminal of the robot unit using a wire of 5.5 mm^2 or more.

NOTE: Use a dedicated grounding wire and grounding electrode. Do not share them with any other electric power or power equipment such as a welder.



Grounding the Robot Unit [VM-6070D]



Grounding the Robot Unit [VM-6083D/VM-60B1D]

1.3 Installing the Robot Controller

Before installing the robot controller to the target position, you need to secure the robot controller to the controller mounting panel as described in Subsection 1.3.1.

The robot controller supported by the mounting panel may be either stand-alone or wall-mounted.

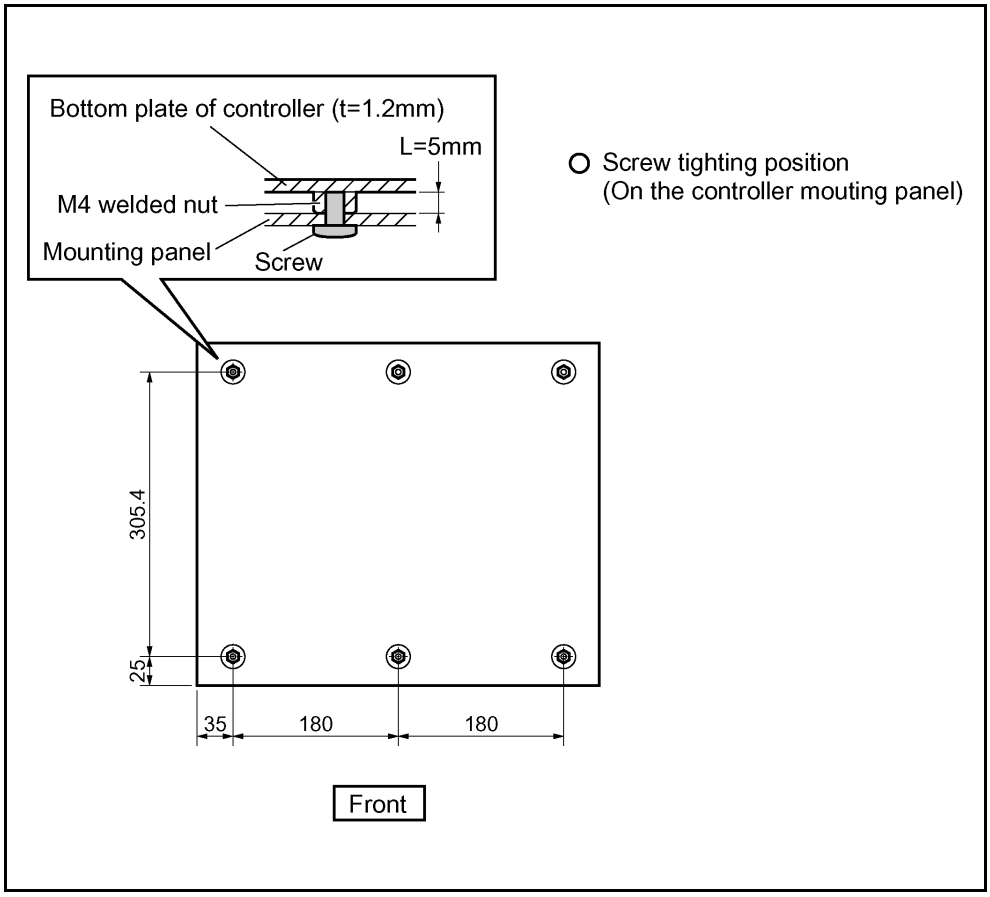
> ⚠**Caution** **When using the robot controller in any environment where there is mist, put the controller in an optional robot controller protective box. The robot controller is not dust-proof, splash-proof, or explosion-proof.**

1.3.1 Securing the Robot Controller to the Controller Mounting Panel

(1) Figure 2-36 shows the bottom view of the robot controller. Marked with "○," the M4-nut welded holes may be used for securing the robot controller to the mounting panel.

(2) Prepare a mounting panel large enough to mount the robot controller. Secure the robot controller to the mounting panel at six nut-welded holes marked with "○" in Figure 2-36, using six M4 screws.

> ⚠**Caution (1)** **The controller mounting screws must not be more than the thickness of the mounting panel plus 5 mm in length. If they exceed 5 mm, the nut welded holes may be damaged.**
>
> **(2)** **Fix the robot controller at all of the six nut-welded holes.**



Location of Mounting Screw Holes
(on the bottom of the robot controller)

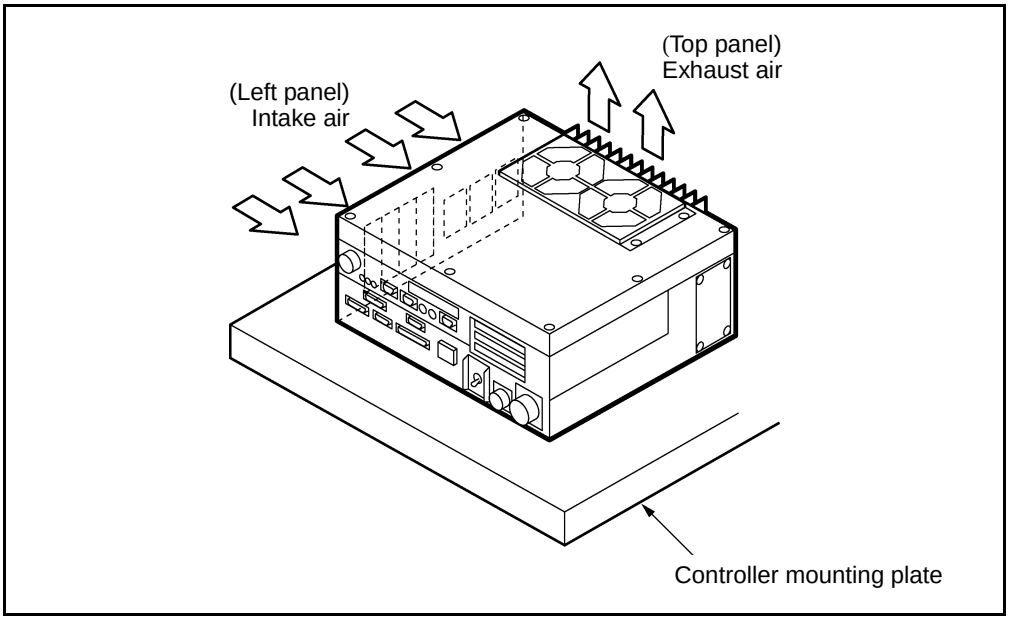
1.3.2 Installing the Robot Controller

The robot controller may be installed stand-alone or on the wall.

[1] Stand-alone

Install the robot controller as shown in Figure 2-37.

> ⚠**Caution** **Do not place anything within 200 mm from the air inlet and air outlet of the robot controller.**

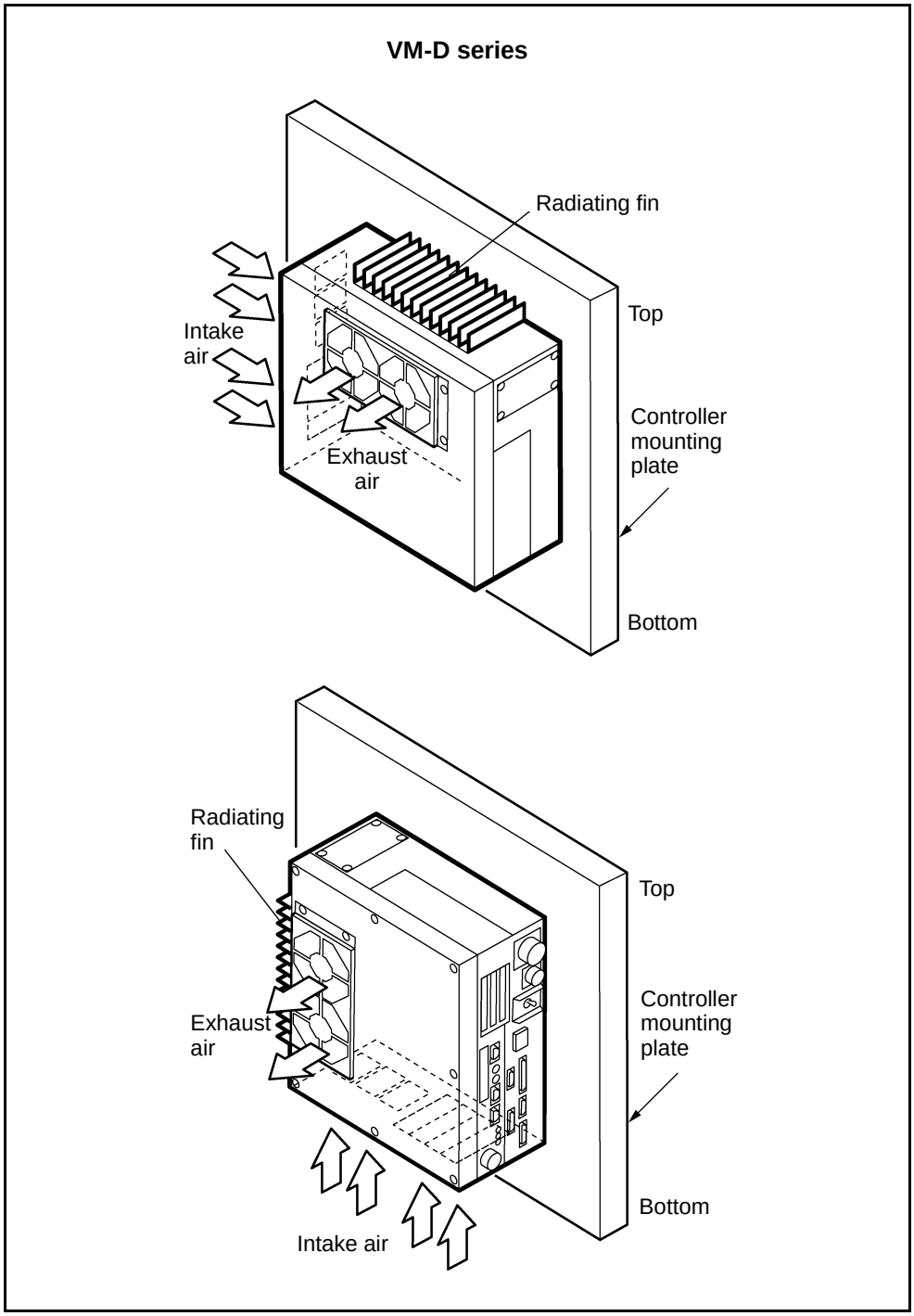


Stand-alone Installation (VM-D series)

[2] Wall-mounted

Install the robot controller as shown in Figure 2-38.

> ⚠ **Caution** **Do not place anything within 200 mm from the air inlet and air outlet on the robot controller.**



Wall-mounted Installation

1.4 Precautions When Designing the End-effectors

Design an end-effector such that it is in compliance with items (1) to (3) described below.

> **⚠CAUTION** **If the end-effector design precautions are not observed, the clamped parts of the robot unit may become loose, rattle or be out of position. In the worst case, the mechanical parts of the robot and robot controller may become damaged.**

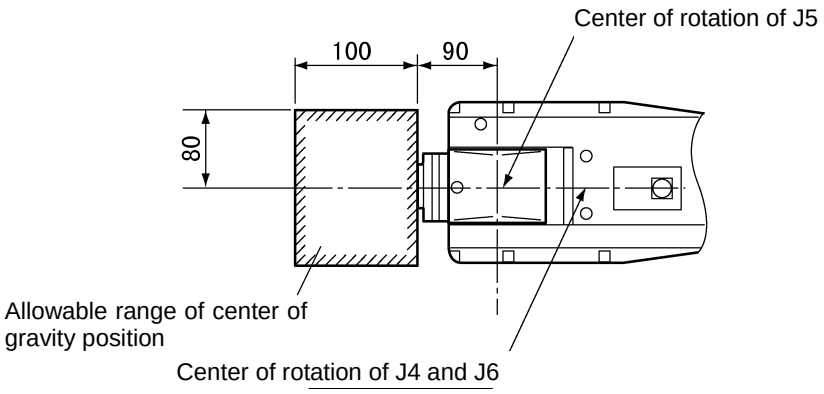
(1) Mass of end-effector

Design the end-effector so that the total mass of the end-effector (including workpiece) will be less than the maximum payload capacity of the robot. The total mass includes the wiring, piping, etc.

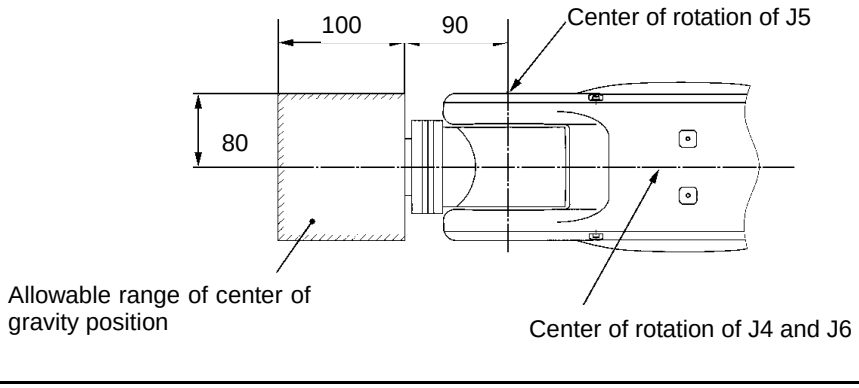
Maximum total mass of end-effector (including workpiece) ≤ Maximum payload capacity (10 kg)

(2) Center of gravity position of end-effector

Design an end-effector so that the position of the center of gravity of the end-effector (including workpiece) is within the range shown in Figure 2-39.



Allowable Range of Center of Gravity Position [VM-6070D]



Allowable Range of Center of Gravity Position [VM-6083D/VM-60B1D]

(3) Moment of inertia around J4, J5 and J6

Design an end-effector so that its moments of inertia around J4, J5 and J6 (including workpiece) do not exceed the maximum allowable moment of inertia of the robot.

Moment of inertia around J4, J5 and J6 of end-effector (incl. mass of workpiece) ≤ Max. allowable moment of inertia (Note)

Note (1) Max. allowable moment of inertia around J4 and J5

VM-6070D	0.25 kgm^2
VM-6083D/VM-60B1D	0.36 kgm^2

(2) Max. allowable moment of inertia around J6

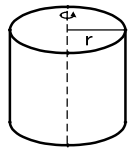
VM-6070D	0.055 kgm^2
VM-6083D/VM-60B1D	0.064 kgm^2

When calculating the moment of inertia around J4, J5 and J6 of the end-effector, use the formulas given in Table 2-2 and Figure 2-40.

Moment-of-Inertia Formulas (VM-D series)

1. Cylinder (1)

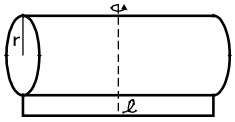
(Axis of rotation = Center axis)



$$I = \frac{mr^2}{2}$$

2. Cylinder (2)

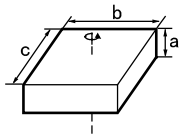
(The axis of rotation passes through the center of gravity.)



$$I = \frac{m}{4}\left(r^2 + \frac{\ell^2}{3}\right)$$

3. Rectangular parallelepiped

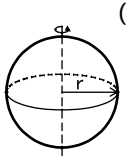
(The axis of rotation passes through the center of gravity.)



$$I = \frac{m}{12}(b^2 + c^2)$$

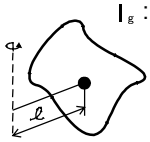
4. Sphere

(Axis of rotation = Center axis)



$$I = \frac{2mr^2}{5}$$

5. Center of gravity not on the axis of rotation



I_g : Inertia moment around center of gravity 〔kgm^2〕

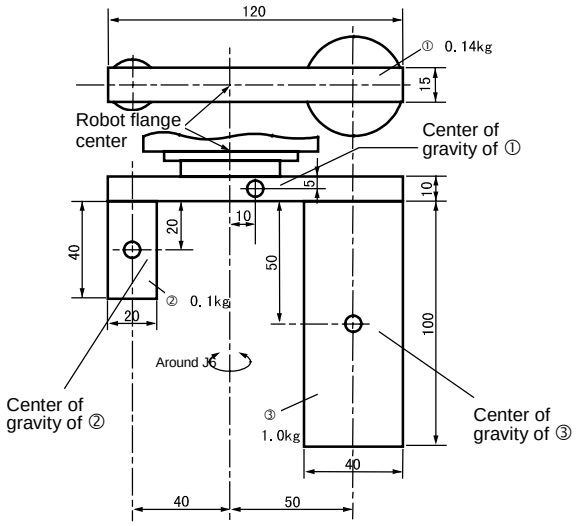
$$I = I_g + m\ell^2$$

I: Moment of inertia 〔kgm^2〕
m: Mass 〔kg〕
r: Radius 〔m〕
b, c, ℓ: Length 〔m〕

Calculation example : When calculating the moment of inertia of a complicated shape, divide it into simple parts as much as possible for easier calculations.

As shown in the figure below, divide the end-effector into three parts (①, ②, ③).

(1) Moment of inertia around J6



Unit: mm

Moment of inertia around J6 of ① : I_1 (from 3 and 5 in Table 2-2)

$$I_1 = \frac{0.14}{12}(0.12^2 + 0.015^2) + 0.14 \times 0.01^2$$
$$= 1.85 \times 10^{-4} \ [\mathrm{kgm^2}]$$

Moment of inertia around J6 of ② : I_2 (from 1 and 5 in Table 2-2)

$$I_2 = \frac{0.1 \times 0.01^2}{2} + 0.1 \times 0.04^2$$
$$= 1.65 \times 10^{-4} \ [\mathrm{kgm^2}]$$

Moment of inertia around J6 of ③ : I_3 (from 1 and 5 in Table 2-2)

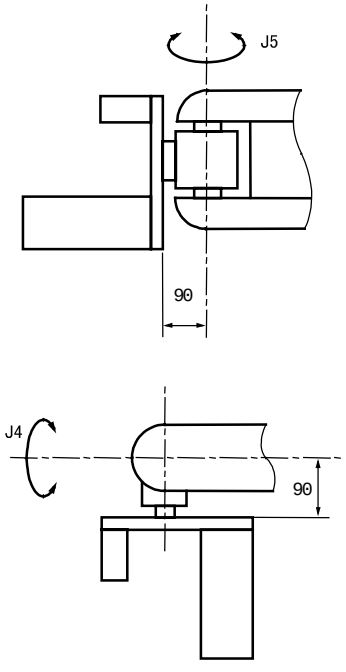
$$I_3 = \frac{1.0 \times 0.02^2}{2} + 1.0 \times 0.05^2$$
$$= 2.7 \times 10^{-3} \ [\mathrm{kgm^2}]$$

Moment of inertia around J6 of entire end-effector: I_{J6}

$$I_{J6} = I_1 + I_2 + I_3 = 0.003 \ [\mathrm{kgm^2}]$$

2 Moment of inertia around J4 and J5

For the following figure, the moment of inertia around J4 and J5 can be calculated according to the same formula.



Moment of inertia around J4 and J5 of ① : I_1 (from 3 and 5 in Table 2-2)

$$I_1 = \frac{0.14}{12}(0.015^2 + 0.01^2) + 0.14 \times (0.09 + 0.005)^2$$
$$= 1.3 \times 10^{-3} \ [\mathrm{kgm^2}]$$

Moment of inertia around J4 and J5 of ② : I_2 (from 2 and 5 in Table 2-2)

$$I_2 = \frac{0.1}{4}\left(0.01^2 + \frac{0.04^2}{3}\right) + 0.1 \times (0.09 + 0.01 + 0.02)^2$$
$$= 1.46 \times 10^{-3} \ [\mathrm{kgm^2}]$$

Moment of inertia around J4 and J5 of ③ : I_3 (from 2 and 5 in Table 2-2)

$$I_3 = \frac{1.0}{4}\left(0.02^2 + \frac{0.1^2}{3}\right) + 1.0 \times (0.09 + 0.01 + 0.05)^2$$
$$= 2.3 \times 10^{-3} \ [\mathrm{kgm^2}]$$

Moment of inertia around J4 and J5 of entire end-effector: I_{J4}, I_{J5}

$$I_{J4} = I_{J5} = I_1 + I_2 + I_3 = 2.6 \times 10^{-2} \ [\mathrm{kgm^2}]$$

End-effector Moment of Inertia Calculation Example (VM-D series)

Chapter 2 Customizing Your Robot

2.1 What Is Customization?

You may customize your robot by modifying or setting the following:

- Software motion limits for defining motion space
- Mechanical ends for defining restricted space
- Control set of motion optimization
- Robot installation conditions

You are recommended to define new motion space and restricted space in order to prevent interference with other devices or entanglement of the end-effector wiring and piping.

WARNING:

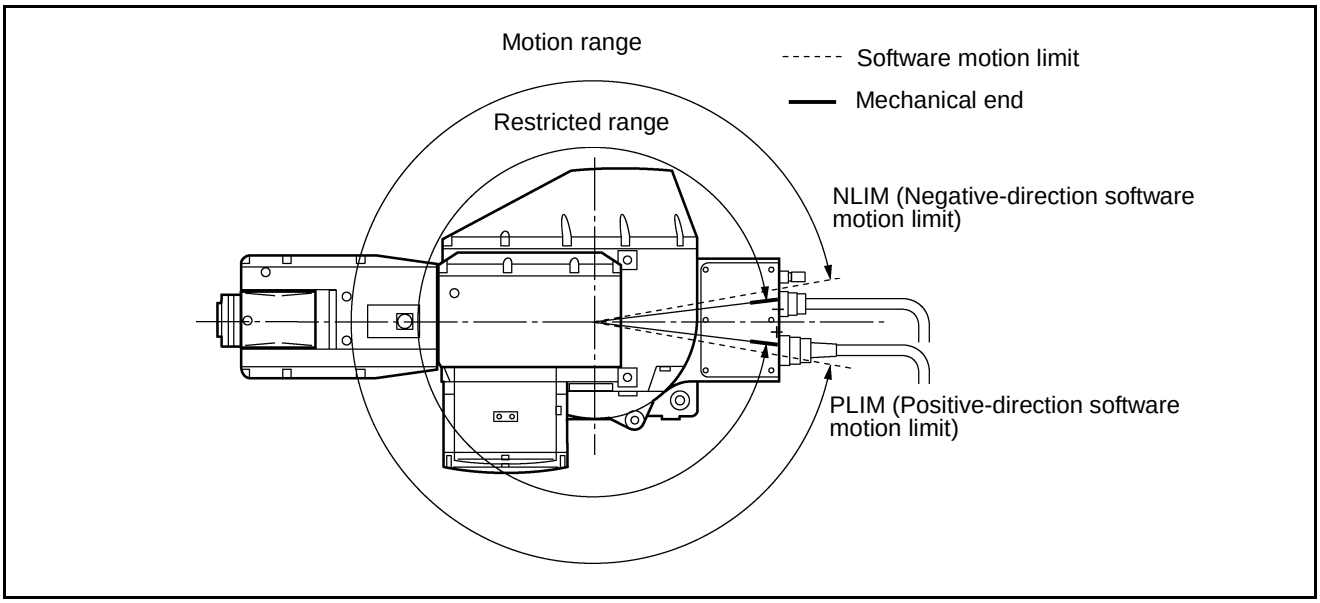
Always set the software motion limits and mechanical ends so that the motion space will be within the restricted space. Otherwise, the robot will bump the mechanical stops, causing serious accidents.

2.2 Modifying Software Motion Limits to Define New Motion Space

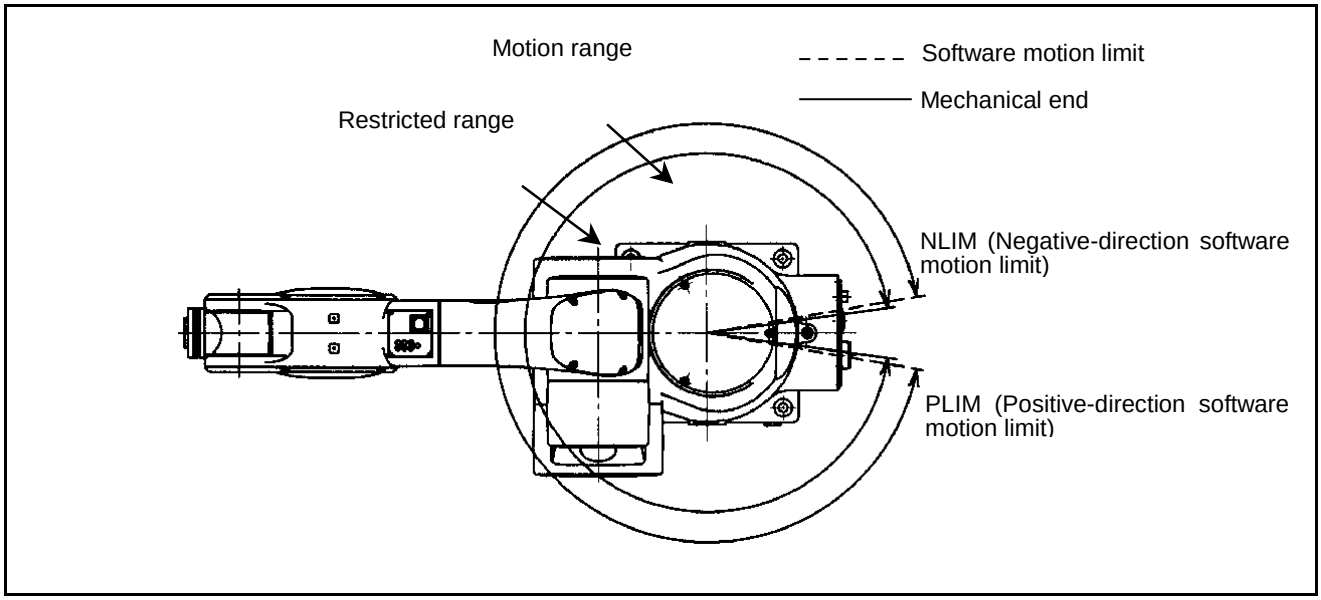
2.2.1 What Is a Software Motion Limit?

A limit to the operation range of the robot defined by the software is called a software motion limit. Software motion limits become valid after CAL of the robot has been completed and the robot has entered the range set by the limits.
A mechanical operation limit is called a mechanical end and set by a mechanical stop. To prevent the robot from striking against a mechanical stop, each software motion limit is set slightly in front of the mechanical end as shown in Figure 4-1. Although there is no mechanical stop for the 6th axis, a software motion limit is set.
If the robot reaches a software motion limit during manual or automatic operation, an error message will be displayed (error code starting from 6070; the first digit represents the axis number) and the robot will come to a stop. The power to the motor is also turned OFF in such a case during automatic operation.

All axes are assigned a software motion limit in both the positive and negative direction of the operation range. The software motion limit in the positive direction is called the positive-direction software motion limit and that in the negative direction is called the negative-direction software motion limit.



Software Motion Limits and Mechanical Ends [VM-6070D]



Software Motion Limits and Mechanical Ends [VM-6083D/VM-60B1D]

2.2.2 Factory Defaults of Software Motion Limits

Table 4-1 lists the software motion limits that are set at the time of delivery.

Factory Defaults of Software Motion Limits (VM-D series)

Robot model		1st axis	2nd axis	3rd axis	4th axis	5th axis	6th axis
VM-6070D	Positive direction	170°	135°	165°	185°	120°	360°
	Negative direction	-170°	-90°	-100°	-185°	-120°	-360°
VM-6083D (See NOTE.)	Positive direction	170°	135°	165°	185°	120°	360°
	Negative direction	-170°	-90° max.	-80° max.	-185°	-120°	-360°
VM-60B1D	Positive direction	170°	135°	168°	185°	120°	360°
	Negative direction	-170°	-90°	-80°	-185°	-120°	-360°

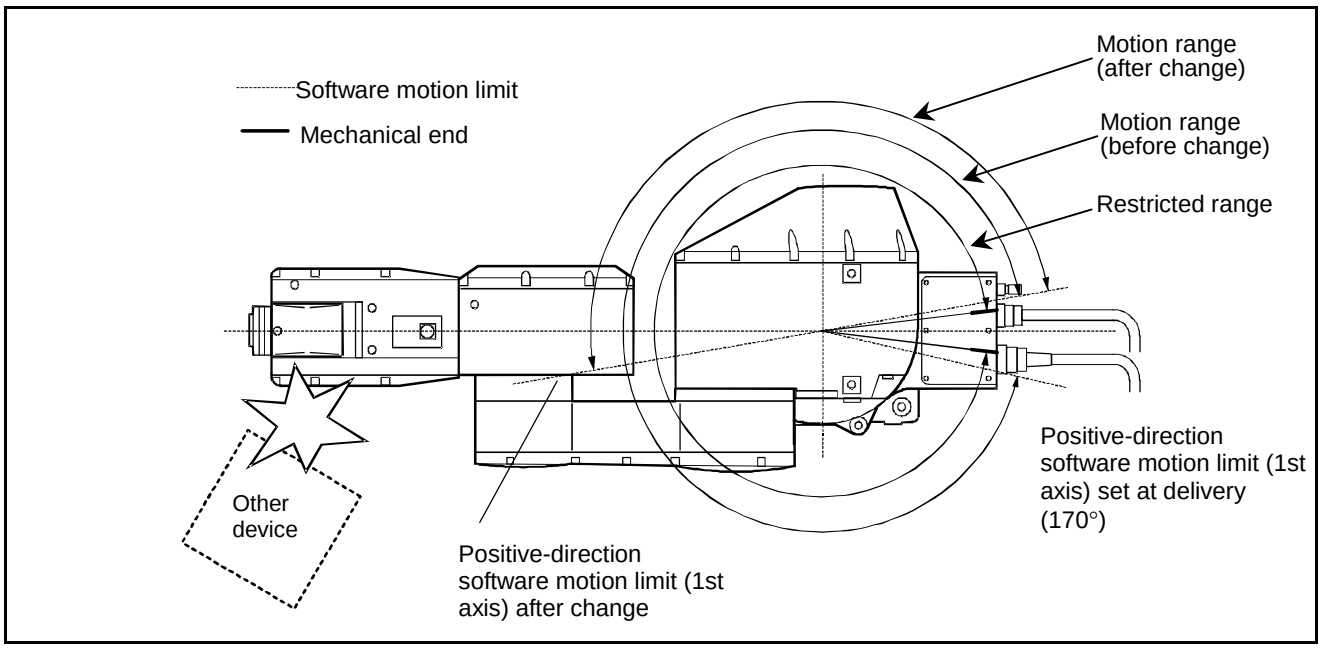
NOTE: The 2nd and 3rd axes of the VM-6083D are restricted in workable spaces according to the robot posture.

2.2.3 Changing Software Motion Limits

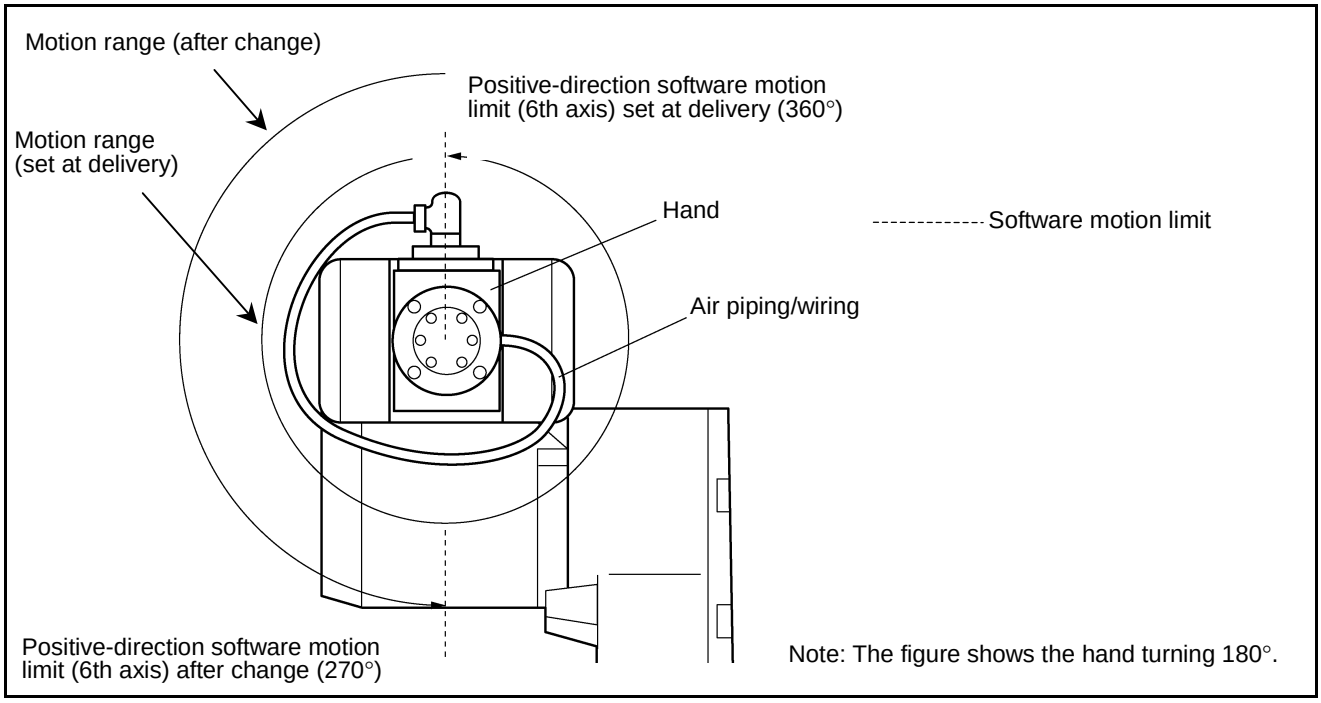
If the robot interferes with any other device, change the software motion limits to make the motion space smaller as shown by the upper figure on this page and the upper figure on the next page. If the air piping or wiring of the end-effector becomes taut as the robot runs, change the software motion limits to make the motion space smaller as shown by the lower figure on this page and the lower figure on the next page.

NOTE: When changing software motion limits, always make the new motion space smaller than the motion space defined by initial settings.

[VM-6070D]

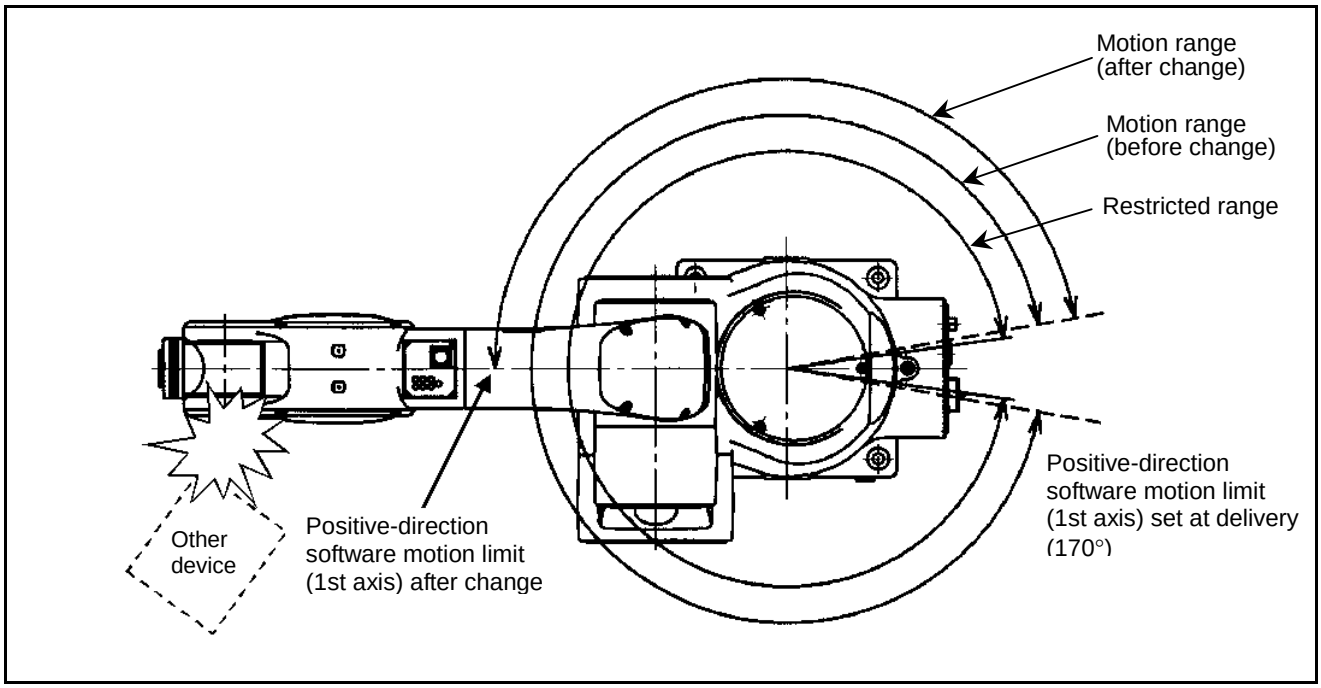


Example 1: Changing Software Motion Limits [VM-6070D]

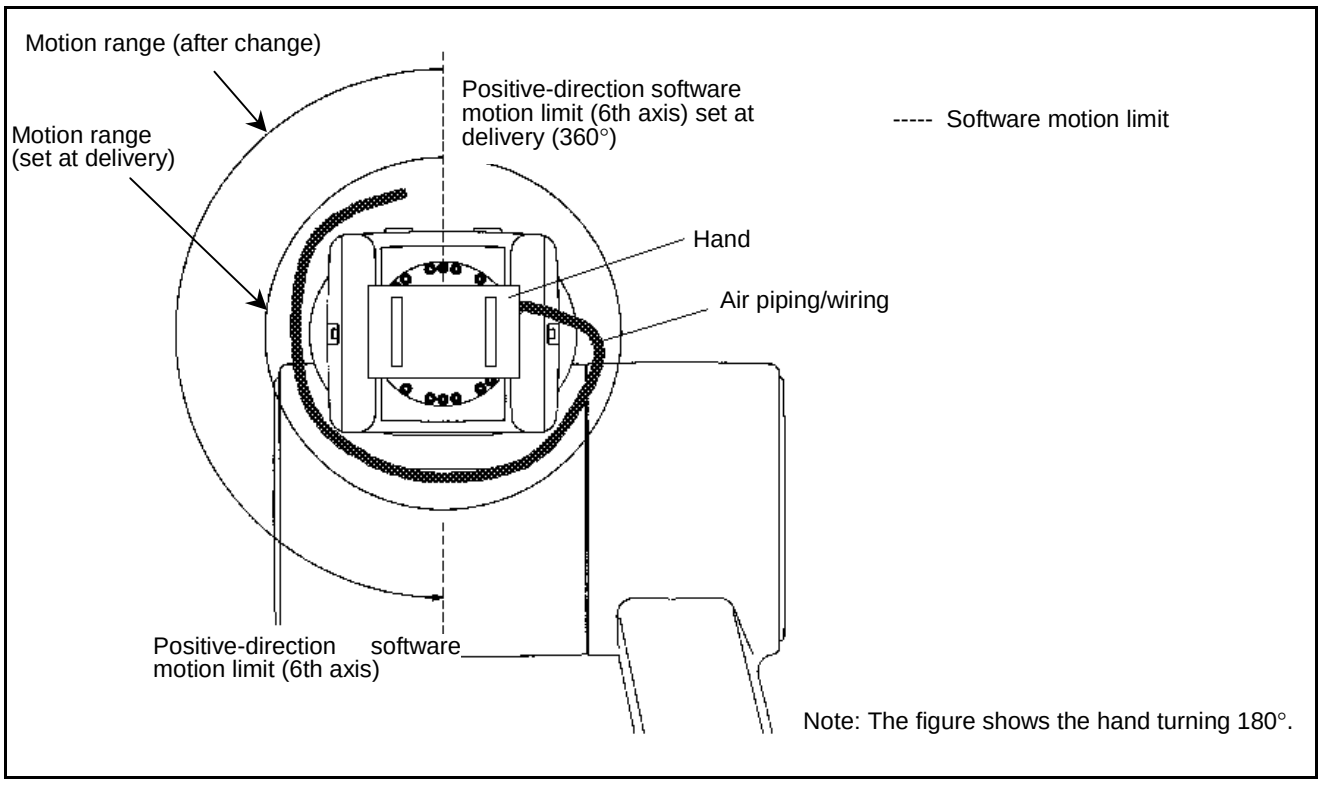


Example 2: Changing Software Motion Limits [VM-6070D]

[VM-6083D/VM-60B1D]



Example 1: Changing Software Motion Limits [VM-6083D/VM-60B1D]



Example 2: Changing Software Motion Limits [VM-6083D/VM-60B1D]

2.2.4 Precautions When Changing the Software Motion Limits

(1) The software motion limits are invalid until CAL is completed.

(2) Confirm the operating space of the robot in the actual working environment. Set the software motion limits using the correct unit of measurement.

If the operating space is too small, the robot may seem to become inoperable.

2.2.5 Procedure for Changing the Software Motion Limits

Described below is the procedure for changing the software motion limits.

STEP 1

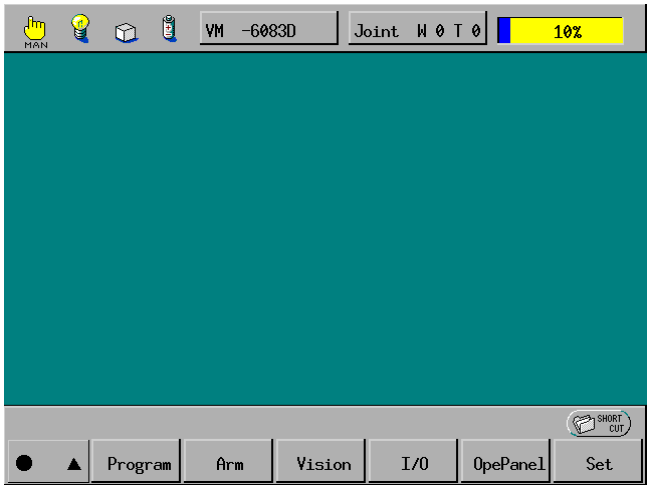
Turn the power switch of the robot controller to ON.

STEP 2

Set the mode selector switch of the teach pendant to MANUAL.

STEP 3

Press [F2 Arm] on the top screen of the teach pendant.

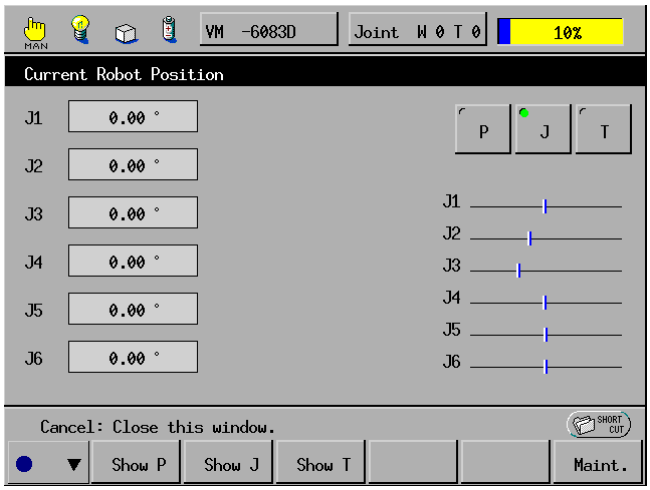


F2

The Current Robot Position window appears as shown in Step 4.

STEP 4

Press the SHIFT key and then press [F12 Maint.].

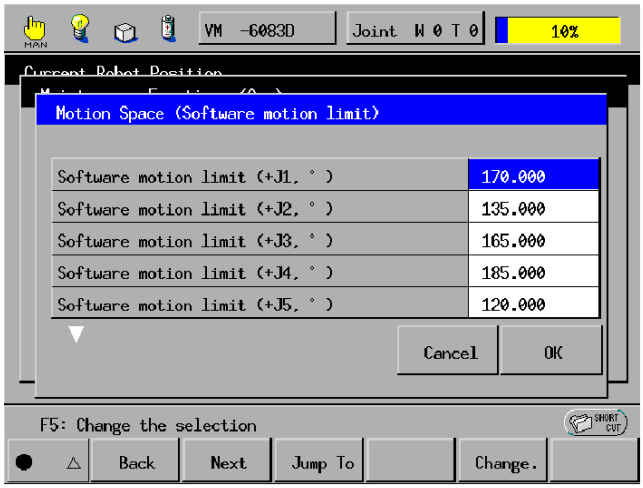


F12

The Maintenance Functions (Arm) window will appear.

STEP 5

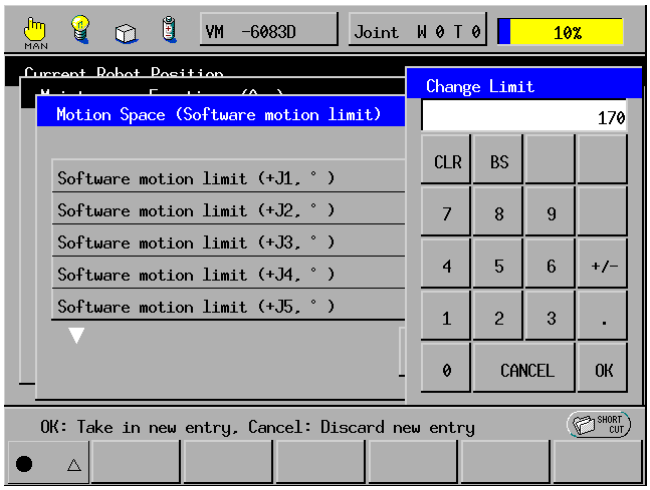
Press [F1 M Space] on the Maintenance Functions (Arm) window.
The Motion Space window will appear as shown below.



F5

STEP 6

Select the item to be modified, then press [F5 Change].
The numeric keypad will appear as shown below.



Enter a desired value using the numeric keys, then press OK.
The new value will be set on the line of the item selected in the Motion Space window.
If two or more items must be changed, repeat Steps 4 and 5.

STEP 7

Press OK in the Motion Space (Software motion limit) window.

STEP 8

Turn OFF the power to the robot controller.

Caution: The new software motion limit(s) specified for the motion space will take effect after the robot controller restarts and CAL is completed.

2.3 Modifying Mechanical Ends to Define New Restricted Space

2.3.1 VM-6070D

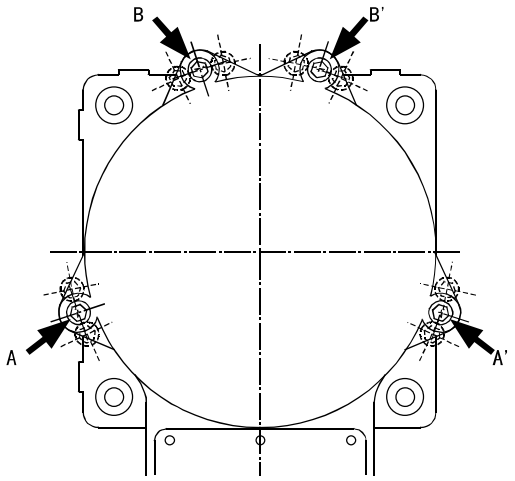
[1] What Is a Mechanical End Change?

At the time of delivery from the plant, mechanical ends are set inside the VM-6070D so that the stroke of the 1st axis will be ±170° (factory default).

Changing the mechanical ends of the 1st axis by adding mechanical stops (bolts) is called a mechanical end change.

To change the mechanical ends, a maximum of three hexagon socket head bolts M12×25 (strength class: 12.9) are required.

The figure below shows the positions of the mechanical stop bolts.



Location of the Mechanical Stop Bolts on the VM-6070D

If the 1st axis comes into contact with any mechanical stop because of the width of the projection of the housing, the angle of the 1st axis is different between the positive direction and the negative direction. Table 4-2 shows the angles of the 1st axis in the positive and negative directions when it is in contact with each mechanical stop.

Stroke of 1st Axis to Mechanical Ends

Mechanical stop position	Positive direction	Negative direction
A'	101°15'	113°45'
A'	-113°45'	-101°15'
B'	11°15'	23°45'
B'	-23°45'	-11°15'
Internal mechanical end	170°	-170°

Precautions When Changing the Mechanical Ends

After a mechanical end change, the software motion limits (PLIMs, NLIMs) and the RANG values must be changed, and CALSET must also be performed.

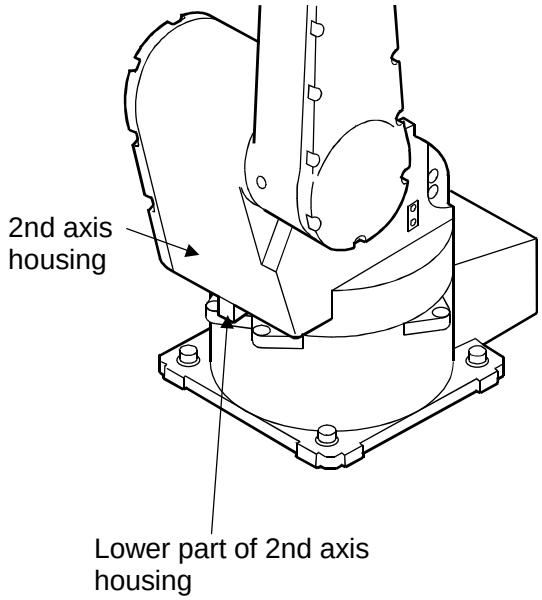
[2] Changing the Mechanical Ends

The mechanical ends can be changed by mounting bolts and then changing the set software motion limits and the RANG values. The procedures for doing this are described in the following sections.

(1) Mounting bolts

▶ STEP 1

Move the 1st axis of the robot, and place the projection in the lower part of the 2nd axis housing in the restricted range that is to be set.



▶ STEP 2

Mount a hexagon socket head bolt (M12×25) in the desired negative-direction mechanical end position. Tighten the bolt to 43 ± 8.6 N·m.
When using the internal mechanical ends as negative-direction mechanical ends, skip this step and proceed to step 3.

▶ STEP 3

Mount a hexagon socket head bolt (M12×25) in the desired positive-direction mechanical end position. Tighten the bolt to 43 ±8.6 N·m.
When using the internal mechanical ends as positive-direction mechanical ends, skip this step.

(2) Software motion limits and Set RANG values

The set software motion limits and RANG values must be changed whenever the mechanical end positions are changed. A RANG is the angle that determines the relationship between the reference position of the robot and the mechanical ends, and is also called a reference angle or ready angle.

The set RANG and software motion limit for each mechanical end position are shown in the table below.

Change the software motion limits (PLIMs) and RANG values according to the procedures given in "(3) Changing positive-direction software motion limits (PLIMs) and RANG values" on the next page and (4) Changing the negative-direction software motion limits (NLIMs) on page 60.

Mechanical End Positions and Set Software Motion Limits and RANG Values

	Positive-direction mechanical end				**Negative-direction mechanical end**			
	A	**B**	**A'**	**B'**	**A**	**B**	**A'**	**B'**
Positive direction software motion limit	99	9	-116	-26				
RANG	101.25	11.25	-113.75	-23.75				
Negative-direction software motion limit					116	26	-99	-9

Examples (1) When the positive-direction mechanical end is A and the negative-direction mechanical ends are the internal mechanical ends, change:

Positive-direction software motion limit = 99
RANG = 101.25

(2) When the positive-direction mechanical ends are the internal mechanical ends and the negative-direction mechanical end is B', change:

Negative-direction software motion limit = -9

(3) When the positive-direction mechanical end is B and the negative-direction mechanical end is A', change:

Positive-direction software motion limit = 9
RANG = 11.25
Negative-direction software motion limit = -99

(4) When the positive-direction mechanical end is A' and the negative-direction mechanical ends are the internal mechanical ends, change:

Positive-direction software motion limit = -116
RANG = -113.75

(5) When the positive-direction mechanical ends are the internal mechanical ends and the negative-direction mechanical end is B, change:

Negative-direction software motion limit = 26

(3) Changing positive-direction software motion limits (PLIMs) and RANG values

The set positive-direction software motion limits (PLIMs) and RANG values must be changed whenever the positive-direction mechanical ends are changed.

Change the set positive-direction software motion limits (PLIMs) and RANG values according to steps 1 through 24 described below.

Changing Positive-Direction Software Motion Limits (PLIMs)

▶ STEP 1

Turn the power switch of the robot controller to ON.

▶ STEP 2

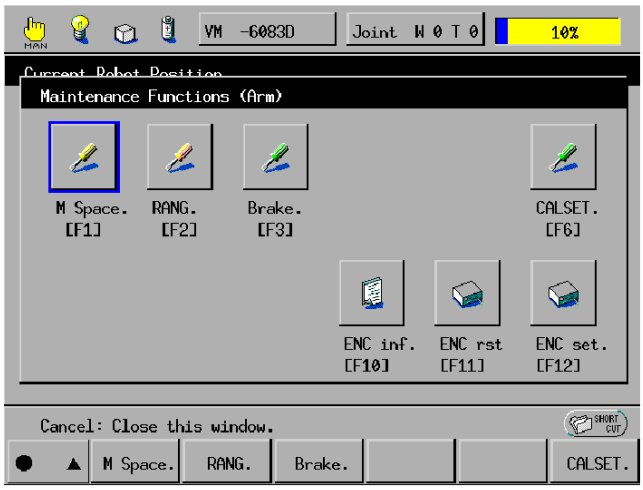
Set the mode selector switch of the teach pendant to MANUAL.

▶ STEP 3

Press [F2 Arm] on the top screen.
The Current Robot Position window appears.

▶ STEP 4

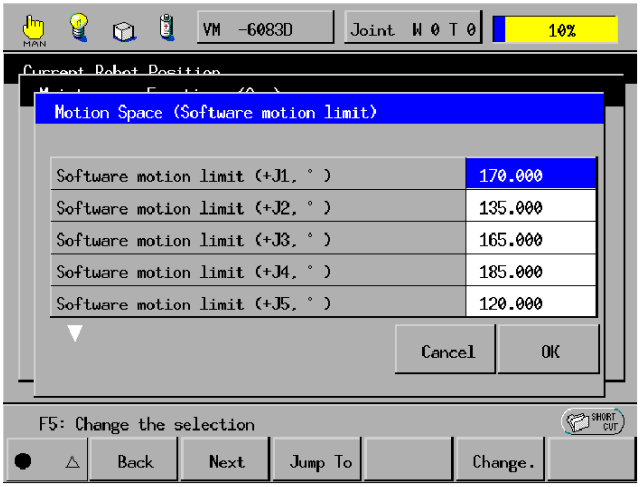
Press [F12 Aux.].
The Maintenance Functions (Arm) window appears.



F1

STEP 5

Press [F1 M Space.].
The Motion Space (Software motion limit) window appears as shown below.



STEP 6

Using the jog dial or cursor keys, select the Software motion limit (+J1, deg) field.

STEP 7

Press [F5 Change.].
The numeric keypad appears.

STEP 8

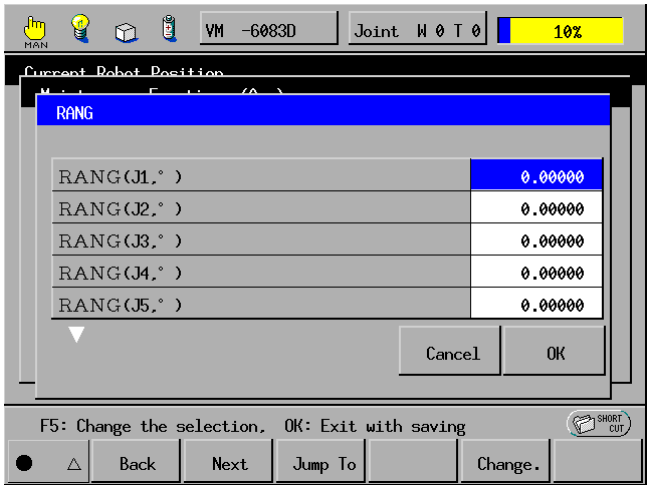
Using the numeric keys, enter the positive-direction software motion limit value, then press OK.
The screen returns to the Motion Space (Software motion limit) window.

STEP 9

Press OK.
The screen returns to the Maintenance Functions (Arm) window.

STEP 10

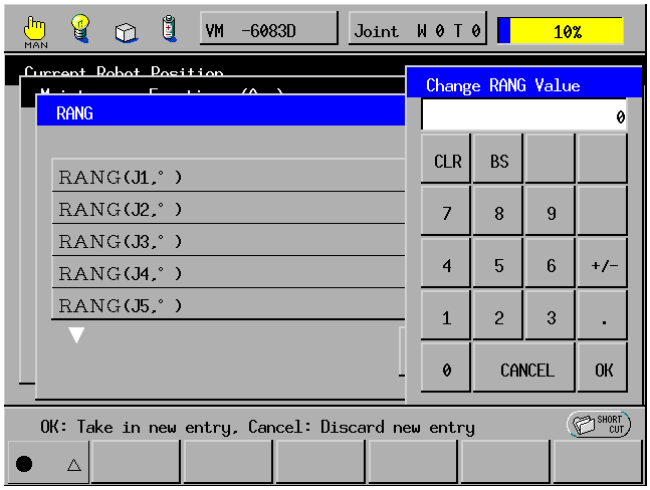
Press [F2 RANG.].
The RANG window appears as shown below.



F5

STEP 11

Press [F5 Change.].
The numeric keypad appears.



STEP 12

Using the numeric keys, enter RANG values, then press OK.
The screen returns to the RANG window.

STEP 13

Press OK.
The screen returns to the Maintenance Functions (Arm) window.

STEP 14

Turn the power switch of the robot controller to OFF.

STEP 15

Turn the power switch of the robot controller to ON.

STEP 16

Press [F2 Arm] on the top screen.

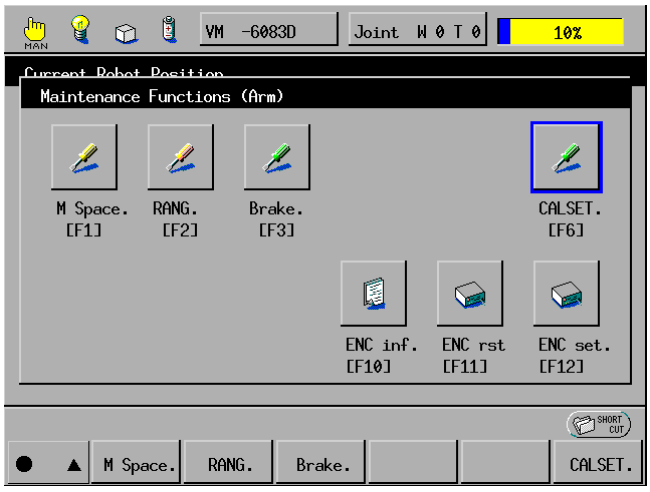
CALSET of the 1st Axis

STEP 17

Press SHIFT.

STEP 18

Press [F12 Maint.]
The Maintenance Functions (Arm) window appears.



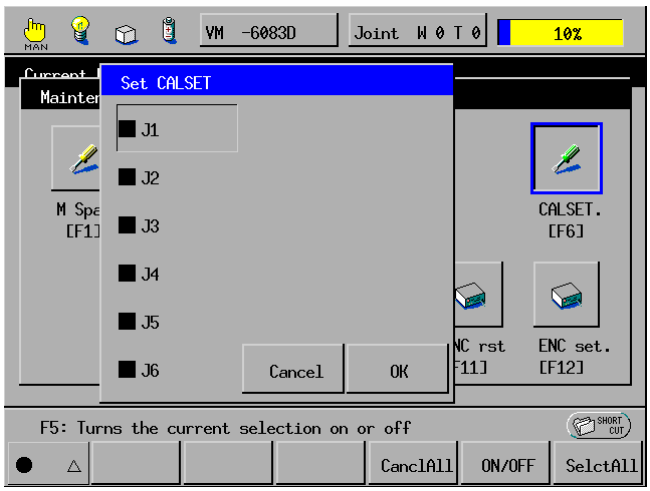
F6

STEP 19

Bring the 1st axis into contact with the positive-direction mechanical end by hand.

STEP 20

Press [F6 CALSET.] on the window in Step 18.
The Set CALSET window appears.

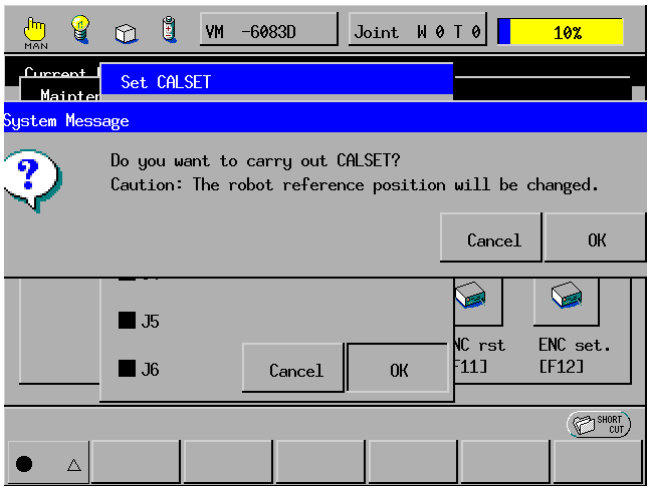


STEP 21

Touch the J1 field and confirm that the mark turns green.

STEP 22

Press OK.
The message window appears asking you whether you want to execute CALSET.



STEP 23

Press OK.
The message window appears informing you that CALSET is completed.

STEP 24

Press OK.

Caution: After CALSET is completed, move the 1st axis over the full stroke in the manual mode (speed = 10% or less) to confirm that the positive-direction and negative-direction software motion limits function properly. If they are valid, the axis stops just before the mechanical end, and ERROR6071 appears.

In the following cases, reset the bolt positions, the positive-direction software motion limits, the RANG values and the negative-direction software motion limits to the original settings, and repeat the procedure from the beginning:

1) **The software motion limits do not function when the axis is near a mechanical end, and another error (6111, 6121 or 6171) occurs.**
2) **A software motion limit error (ERROR6071) occurs although the axis is not near a mechanical end.**

(4) Changing set negative-direction software motion limits (NLIMs)

The set negative-direction software motion limits (NLIMs) must be changed whenever the negative-direction mechanical ends are changed. Change the set negative-direction software motion limits (PLIMs) according to steps 1 through 10 described below.

STEP 1

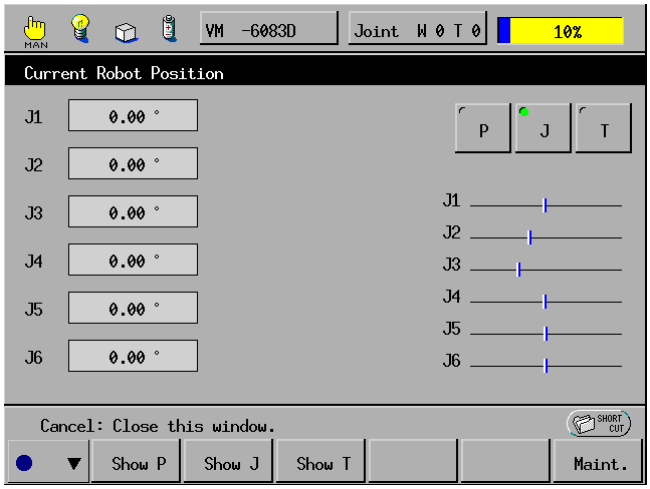
Turn the power switch of the robot controller to ON.

STEP 2

Set the mode selector switch of the teach pendant to MANUAL.

STEP 3

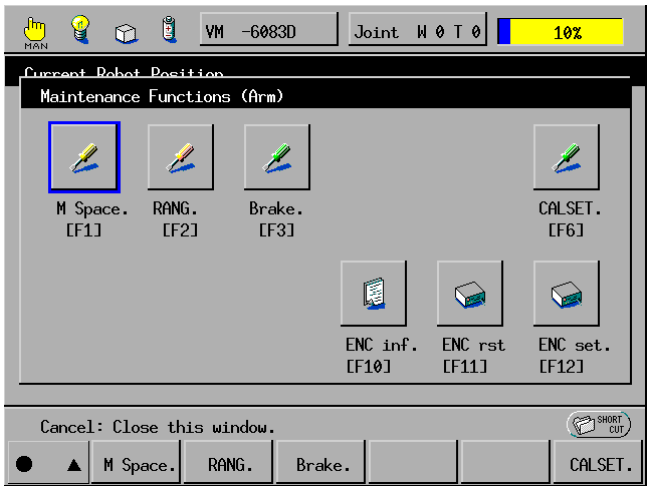
Press [F2 Arm] on the top screen.
The Current Robot Position window appears.



F12

STEP 4

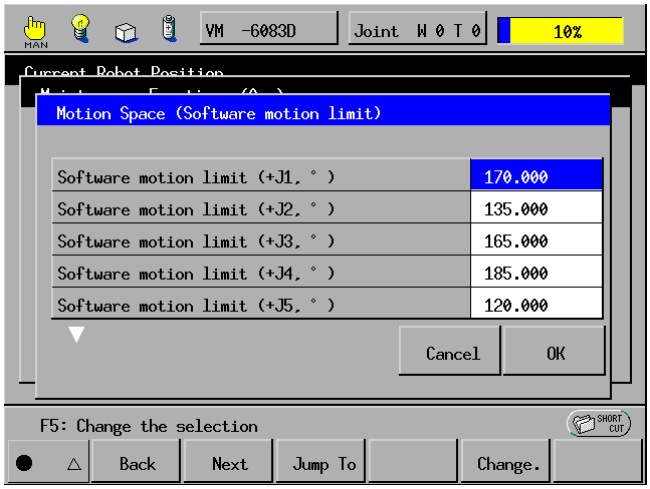
Press [F12 Maint.].
The Maintenance Functions (Arm) window appears.



F1

STEP 5

Press [F1 M Space.].
The Motion Space (Software motion limit) window appears.



STEP 6

Using the jog dial or cursor keys, select the Software motion limit (-J1, deg) field.

STEP 7

Press [F5 Change.].
The numeric keypad appears.

STEP 8

Using the numeric keys, enter a negative-direction software motion limit value, then press OK.
The screen returns to the Motion Space (Software motion limit) window.

STEP 9

Press OK.

STEP 10

Turn the power switch of the robot controller to OFF.

Caution: After changing the software motion limit(s), move the 1st axis over the full stroke in the manual mode (speed = 10% or less) to confirm that the positive- and negative-direction software motion limits function properly. If they are valid, the axis stops just before the mechanical end, and ERROR6071 appears.

In the following cases, reset the bolt positions, the positive-direction software motion limits, the RANG values and the negative-direction software motion limits to the original settings, and repeat the procedure from the beginning:

1) **The software motion limits do not function when the axis is near a mechanical end, and another error (6111, 6121 or 6171) occurs.**
2) **A software motion limit error (ERROR6071) occurs although the axis is not near a mechanical end.**

2.3.2 VM-6083D/VM-60B1D series

This section describes the procedures of changing the mechanical ends from the 1st-axis to 3rd-axis.

CAUTIONS AT CHANGING THE MECHANICAL ENDS

1. **When changing the mechanical ends, design the mechanical stoppers according to your usage and manufacture them.**
2. **After changing the mechanical end, the software motion limits (PLIMs, NLIMs) should be changed not to interfere the mechanical end at the robot operation.**
3. **The mechanical stoppers may not limit the workable area of the robot. Therefore, do not enter the robot's restricted space when the robot power is turned ON.**
4. **If the robot is collided with the mechanical stopper, the robot will stop by detecting the collision but the mechanical stopper may be broken.**
   When the robot is collided with the mechanical stopper, remove the mechanical stopper. And inspect the robot and surrounding devices, and repair them. Do not re-use the mechanical stoppers and re-manufacture them.
5. **The reference drawings described on this manual cannot be covered on the customer's usage conditions sufficiently. Design, manufacture and install the mechanical stoppers according to your usage conditions.**
6. **The failures caused by the mechanical stoppers shall not be covered by the warranty even if the robot is under warranty.**

■ 1st-AXIS

[1] What Is the 1st-axis Mechanical End Change?

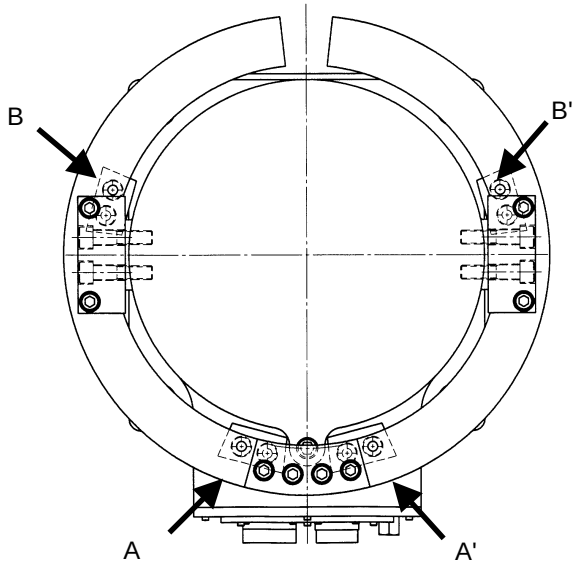
At the time of delivery from the plant, mechanical ends are set inside the VM-6083D/VM-60B1D series so that the stroke of the 1st axis will be ±170° (factory default).

Changing the mechanical ends of the 1st axis by adding mechanical stops is called a mechanical end change.

The figure below shows the positions of mechanical stops in mechanical end change.

The explanation below is for the case where the stop positions are specified in the table below.

To change the mechanical ends, four types of mechanical stop parts (mechanical stop, fixture blocks A (2 pieces) fixture block B and plates (2 pieces)) are necessary. Reference drawings of the mechanical stop, fixture block A, fixture block B and plate) are shown on the next pages. You should prepare mechanical stop parts as required by setting the desired motion space by referring to these drawings.



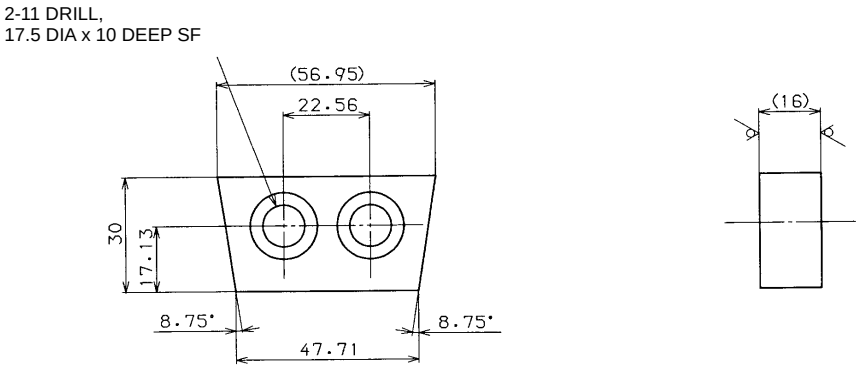
Location of the Mechanical Stops on the VM-6083D/VM-60B1D/VS-E series

If the 1st axis comes into contact with any mechanical stop because of the width of the stopper and its bolt, the angle of the mechanical stop is different between the positive and negative direction. The table below shows the angles of the 1st axis in the positive and negative directions when it is in contact with each mechanical stop.

Stroke of the 1st Axis to Mechanical Ends

Mechanical stop position	Positive direction	Negative direction
A’	5°	28°45’
A’	-28°45’	-5°
B’	95°	118°45’
B’	-118°45’	-95°
Permanent mechanical end	170°	-170°

VM-6083D/VM-60B1D (For 1st-axis)

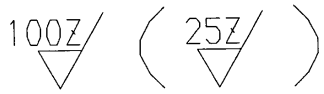


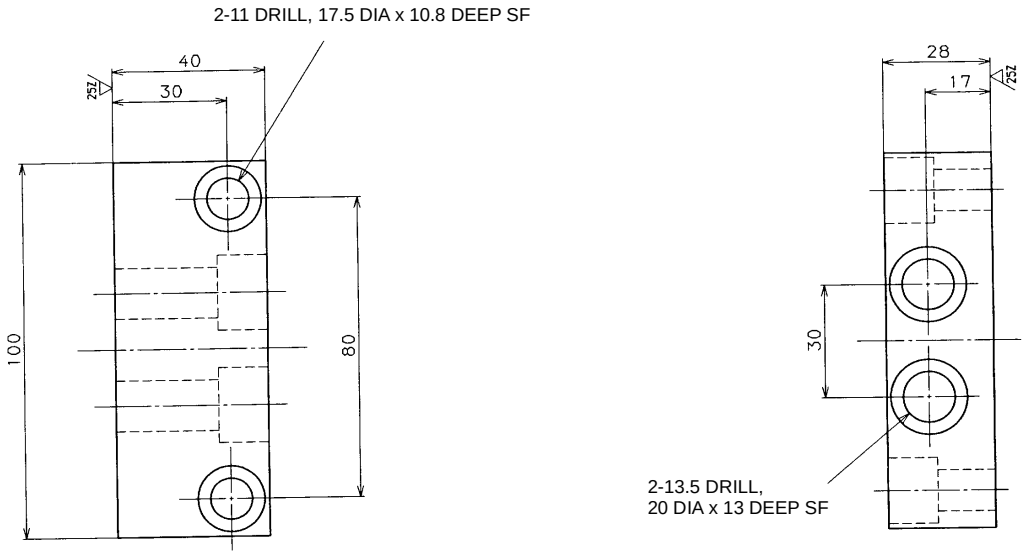
Material: S45C

(Note 1) Unless otherwise specified, corners should be C0.1 to C0.5.

Mechanical Stop

VM-6083D/VM-60B1D (For 1st-axis)



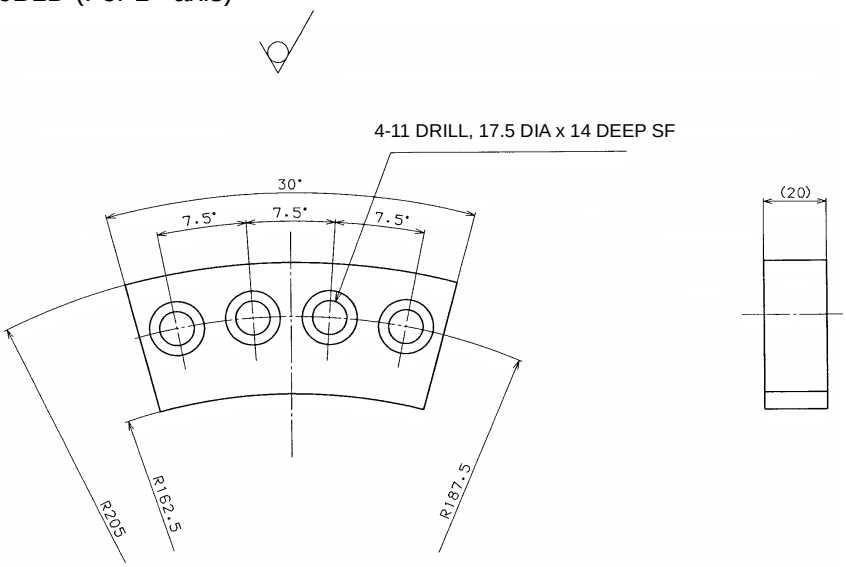


Material: S45C

(Note 1) Unless otherwise specified, corners should be C0.1 to C0.5.

Fixture Block A

VM-6083D/VM-60B1D (For 1st-axis)

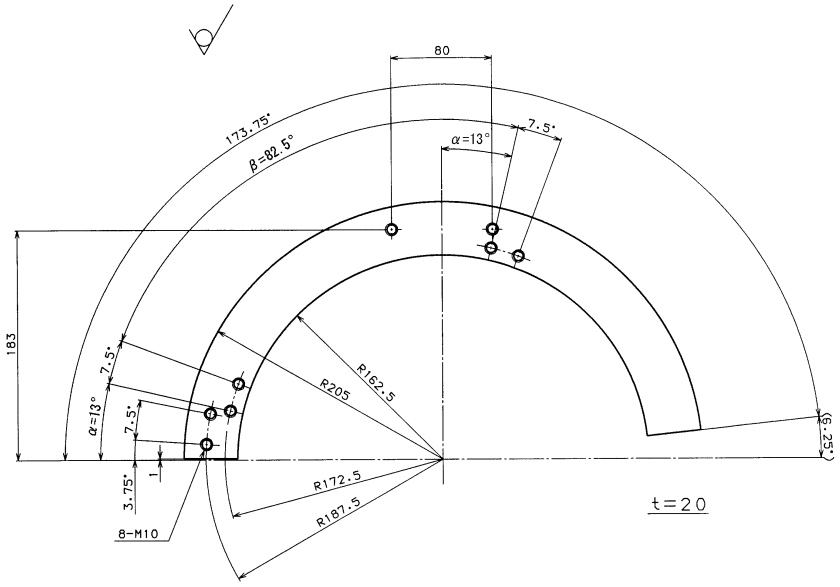


Material: S45C

(Note 1) Unless otherwise specified, corners should be C0.1 to C0.5.

Fixture Block B

VM-6083D/VM-60B1D (For 1st-axis)



Material: S45C

(Note 1) Unless otherwise specified, corners should be C0.1 to C0.5.

For α and β in the above drawing, enter your desired values.

Plate

Precautions When Changing the Mechanical Ends

After a mechanical end change, the software motion limits (PLIMs, NLIMs) must be changed.

And also, if you change the RANG values after a mechanical end change, the CALSET must also be performed.

Note: A RANG is the angle that determines the relationship between the reference position of the robot and the mechanical ends, and is also called a reference angle or ready angle.

(1) If the following case, the RANG values change and the CALSET are not necessary after a mechanical end change.

If you can perform the CALSET after removing the mechanical stop parts prepared by you from the robot when the CALSET becomes necessary (Example: Exchanging the motor).

(2) If the following case, the RANG values change and the CALSET are necessary after a mechanical end change.

If you perform the CALSET for the robot with the mechanical stop parts prepared by you when the CALSET becomes necessary (Example: Exchanging the motor).

In this case, the position repeatability is depended on the mechanical stop parts prepared by you.
And also you need to note down the new RANG values and CALSET values.
The initial RANG values and CALSET values at the time of delivery from the plant are saved in the initialization floppy disk.

In this example, after a mechanical end change, the RANG values must be changed, and CALSET must also be performed.

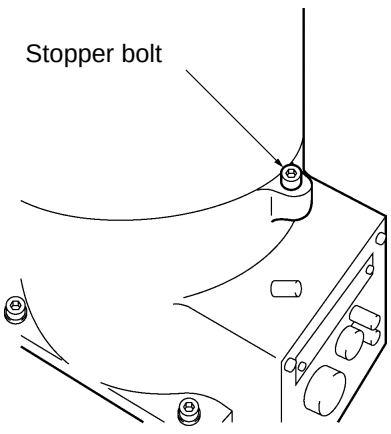
[2] Changing the Mechanical Ends

The mechanical ends can be changed by mounting four types of mechanical stop parts (i.e., mechanical stop, fixture blocks A, fixture blocks B, and plates) and then changing the set software motion limits and the RANG values. The procedures for doing this are described in the following sections.

(1) Mounting mechanical stop parts

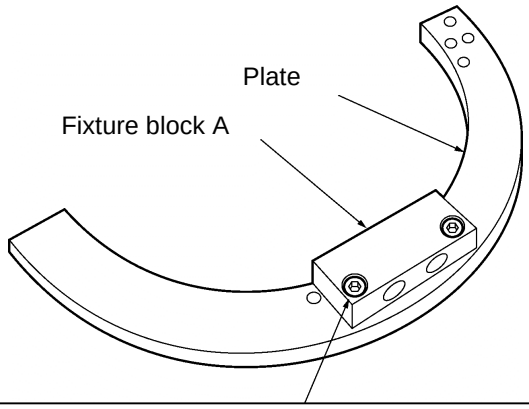
▶ STEP 1

Move the 1st axis of the robot until the stopper bolt comes into the inside of the motion space that you want to set.



STEP 2

Secure fixture block A to the plate with two hexagonal socket-head bolts. (Make a pair of assemblies.)

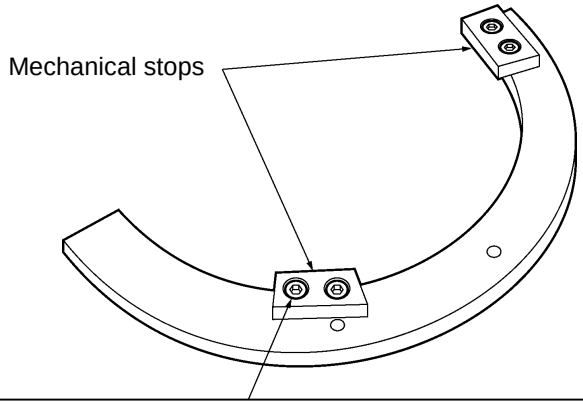


VM-D series: Hex. socket-head bolt M10x25 (Strength class: 12.9)
Tightening torque: 71 ±14.2 Nm

VS-E series: Hex. socket-head bolt M8x16 (Strength class: 12.9)
Tightening torque: 36 ±7.2 Nm

STEP 3

Turn each of the assemblies made in Step 2 upside down. Secure two mechanical stops to it with two hexagonal socket-head bolts each for determining the desired motion space.

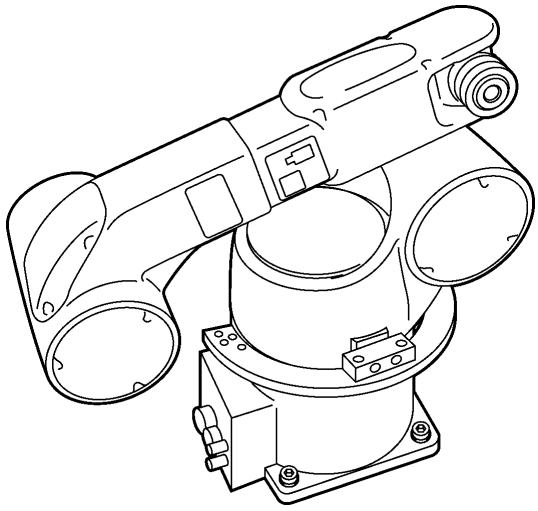


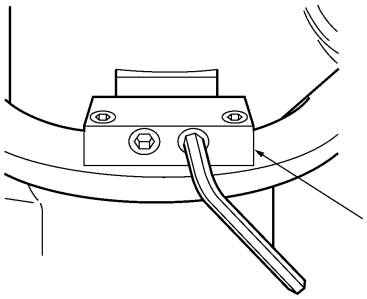
VM-D series: Hex. socket-head bolt M10x25 (Strength class: 12.9)
Tightening torque: 71 ±14.2 Nm

VS-E series: Hex. socket-head bolt M8x16 (Strength class: 12.9)
Tightening torque: 36 ±7.2 Nm

STEP 4

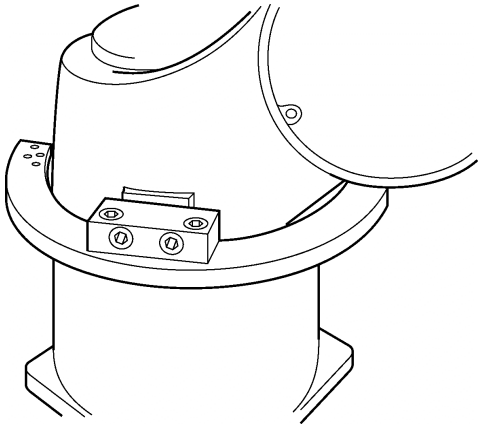
Temporarily secure one of the assemblies made in Step 3 to the side of the 1st axis with hexagonal socket-head bolts.





STEP 5

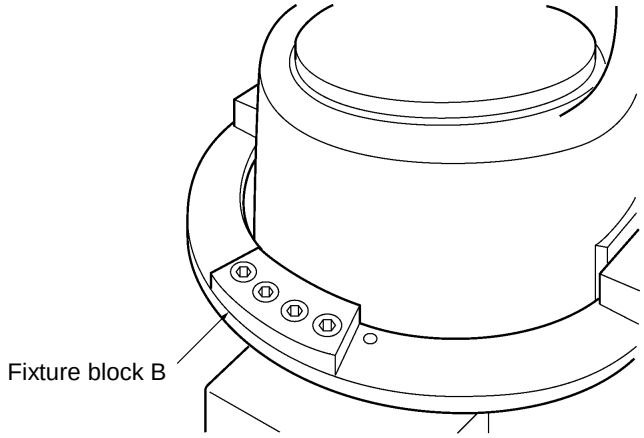
In the same way as in Step 4, temporarily secure the other assembly made in Step 4 to the other side of the 1st axis.



STEP 6

Link the assemblies together that you have temporarily secured in Steps 4 and 5, using fixture block B and hexagonal socket-head bolts.

Then firmly tighten the hexagonal socket-head bolts tightened temporarily in Steps 4 and 5.



VM-D series:	Hex. socket-head bolt M12x50 (Strength class: 12.9)
	Tightening torque: 110 ±22 Nm
	Hex. socket-head bolt M10x25 (Strength class: 12.9)
	Tightening torque: 71 ±14.2 Nm
VS-E series:	Hex. socket-head bolt M8x16 (Strength class: 12.9)
	Tightening torque: 36 ±7.2 Nm

(2) Software motion limits and Set RANG values

Note:	If the following case, the RANG values change and the CALSET are necessary after a mechanical end change. **If you perform the CALSET for the robot with the mechanical stop parts prepared by you when the CALSET becomes necessary (Example: Exchanging the motor).** In this case, the position repeatability is depended on the mechanical stop parts prepared by you. And also you need to note down the new RANG values and CALSET values. The initial RANG values and CALSET values at the time of delivery from the plant are saved in the initialization floppy disk.

The set software motion limits and RANG values must be changed whenever the mechanical end positions are changed. A RANG is the angle that determines the relationship between the reference position of the robot and the mechanical ends, and is also called a reference angle or ready angle. The RANG value checking procedure is given below.

The relationship between each mechanical end position and software motion limits is shown in the table on the next page.

Change the set software motion limits (PLIMs) and RANG values according to the procedures given in "(3) Changing positive-direction software motion limits (PLIMs) and RANG values" and "(4) Changing the negative-direction software motion limits (NLIMs)".

Checking the set RANG values

After mounting the mechanical stop parts, check the RANG values according to the procedure below.

The RANG values that you check here should be entered in the procedure of "(3) Changing positive-direction software motion limits (PLIMs) and RANG values" and "(4) Changing the negative-direction software motion limits (NLIMs)."

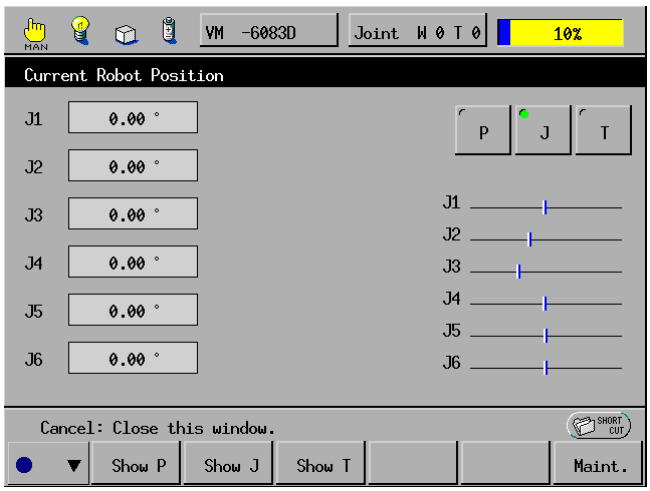
When you use the permanent mechanical end, this checking job is not required.

▶ STEP 1 **Turn the power switch of the robot controller to ON.**

▶ STEP 2 **Set the mode selector switch of the teach pendant to MANUAL.**

STEP 3

Press [F2 Arm] on the top screen.
The Current Robot Position window appears.

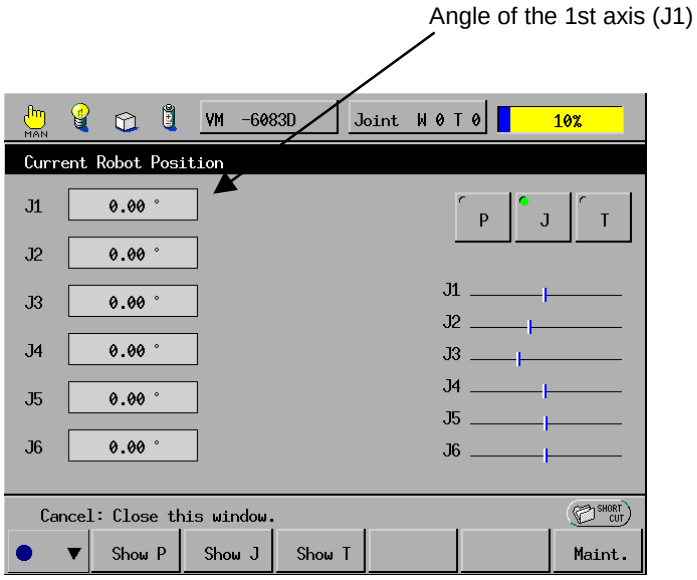


STEP 4

Gently bring the 1st axis of the robot into contact with the newly set positive-direction mechanical end.

STEP 5

Check the value in J1 box that appears when the 1st axis is in contact with the mechanical end in Step 4. The value is RANG value to be newly set.



Mechanical End Positions and Set Software Motion Limits

	Positive-direction mechanical end				Negative-direction mechanical end			
	A	**B**	**A'**	**B'**	**A**	**B**	**A'**	**B'**
Positive-direction software motion limit	0	90	-33.75	-123.75				
Negative-direction software motion limit					33.75	123.75	0	-90

Caution: If you set mechanical ends (in addition to the permanent mechanical end), set the software motion limits 5° inside from the mechanical ends (RANG value). If the software motion limits are set merely less than 5° inside from the mechanical ends, the robot may bump against the mechanical stops before it stops by software.

Examples (1) When the positive-direction mechanical ends are A and the negative-direction ones are the permanent mechanical ends, change:

Positive-direction software motion limit = 0
RANG = value obtained in "Checking the set RANG value"

(2) When the positive-direction mechanical ends are the permanent mechanical ends and the negative-direction mechanical ones are B', change:

Positive-direction software motion limit = -90

(3) When the positive-direction mechanical ends are B and the negative-direction mechanical ends are A', change:

Positive-direction software motion limit = 90
RANG = value obtained in "Checking the set RANG value"
Negative-direction software motion limit = 0

(4) When the positive-direction mechanical ends are A' and the negative-direction mechanical ends are the permanent mechanical ends, change:

Positive-direction software motion limit = -33.75
RANG = value obtained in "Checking the set RANG value"

(5) When the positive-direction mechanical ends are the permanent mechanical ends and the negative-direction mechanical ends are B, change:

Positive-direction software motion limit = 123.75

(3) Changing positive-direction software motion limits (PLIMs) and RANG values

Common to the VM-6070D series. (See page 54.)

Note: If the following case, the RANG values change and the CALSET are necessary after a mechanical end change.

If you perform the CALSET for the robot with the mechanical stop parts prepared by you when the CALSET becomes necessary (Example: Exchanging the motor).

In this case, the position repeatability is depended on the mechanical stop parts prepared by you.
And also you need to note down the new RANG values and CALSET values.
The initial RANG values and CALSET values at the time of delivery from the plant are saved in the initialization floppy disk.

(4) Changing set negative-direction software motion limits (NLIMs)

Common to the VM-6070D series. (See page 60.)

■ The 2nd-axis and 3rd-axis Mechanical Ends Change

[1] What is the 2nd-axis and 3rd-axis Mechanical Ends Change?

At the time of delivery from the factory, mechanical ends are set inside the VM-6083D and VM-60B1D series so that the workable angle of the 2nd-axis and 3rd-axis will be shown in the table below (factory default).

Note: The limit to the workable angle of the robot is defined by the software motion limits. The software motion limits are set inside the mechanical end positions.

Workable angle at shipping for VM-D series

Model	Workable angle for the 2nd-axis	Workable angle for the 3rd-axis
VM-6083D series VM-6083D-W series	+135°, -90°	+165°, -80°
VM-60B1D series VM-60B1D-W series	+135°, -90°	+168°, -80°

Changing the mechanical ends of the 2nd-axis and 3rd-axis by adding mechanical stoppers is called a mechanical end change.

To change the mechanical ends of the 2nd-axis and 3rd-axis, the mechanical stoppers should be prepared by the customer.

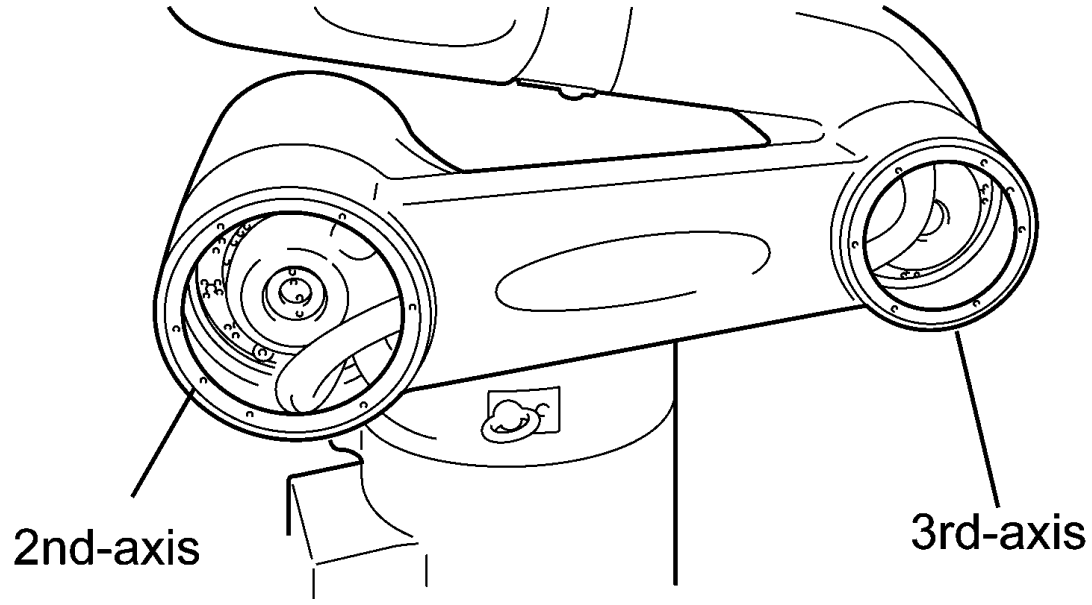
Caution: If changing the mechanical ends, the software motion limits should be changed to the positions inside the mechanical end positions.

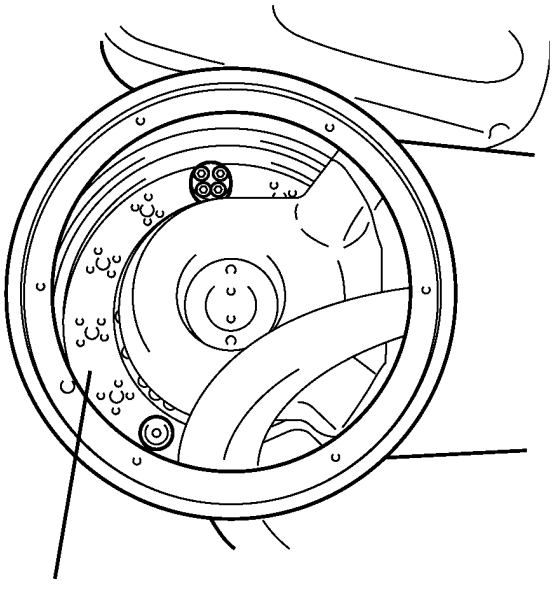
[2] Reference Drawings of the 2nd-axis and 3rd-axis Mechanical Stoppers

[Serial No.: 12D-* or later]**

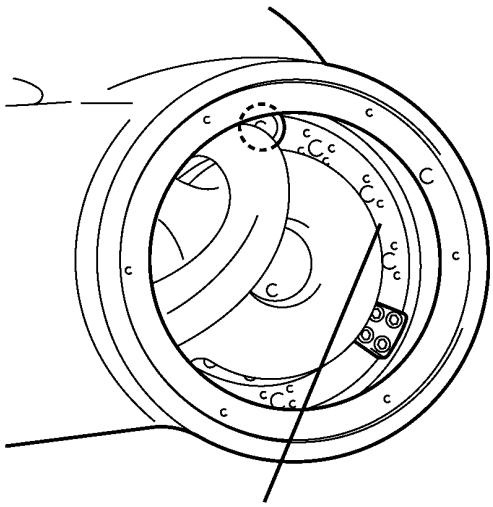
[2.1] Fixing plates for the 2nd-axis and 3rd-axis mechanical stoppers

For the VM-6083D and VM-60B1D series robots (**Only Serial No.: 12D-*** or later**), the fixing plates for the 2nd-axis and 3rd-axis mechanical stoppers are pre-installed at the time of delivery from the factory.





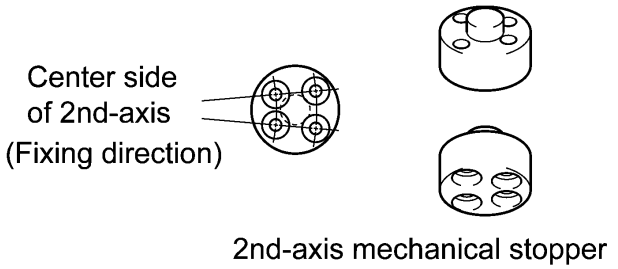
Fixing plate for the 2nd-axis mechanical stopper

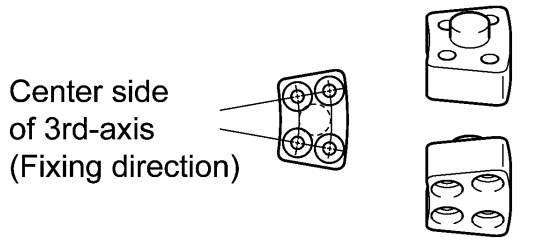


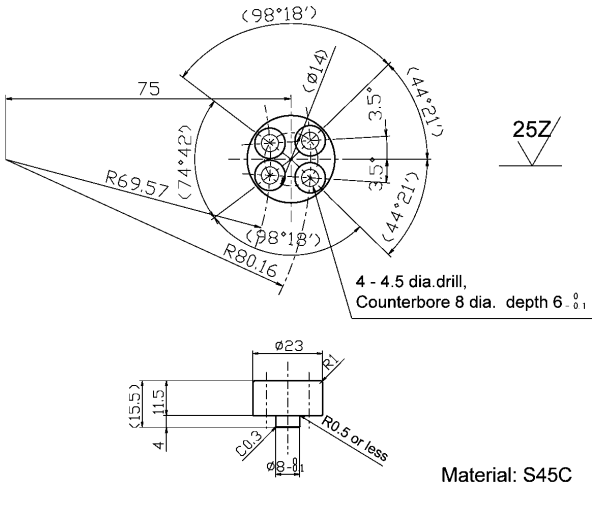
Fixing plate for the 3rd-axis mechanical stopper

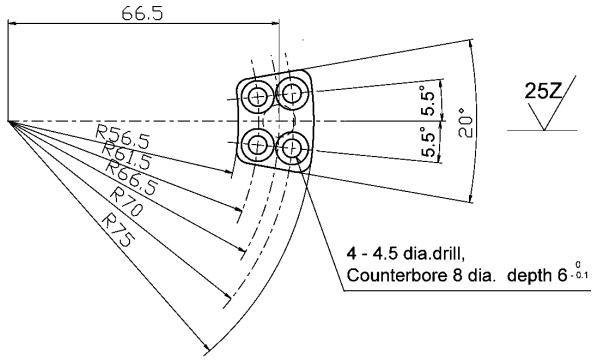
[2.2] Reference drawings of the 2nd-axis and 3rd-axis mechanical stoppers

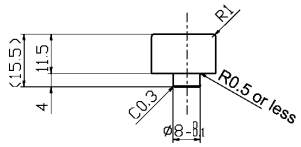
Reference drawings of the 2nd-axis and 3rd-axis mechanical stoppers for changing the mechanical ends are shown in the figure below.

<table>
<tr><th>2nd-axis mechanical stopper</th><th>3rd-axis mechanical stopper</th></tr>
<tr><td>External appearance
 

2nd-axis mechanical stopper</td><td>External appearance
 

3rd-axis mechanical stopper</td></tr>
<tr><td>Reference drawing
 

Material: S45C</td><td>Reference drawing
 



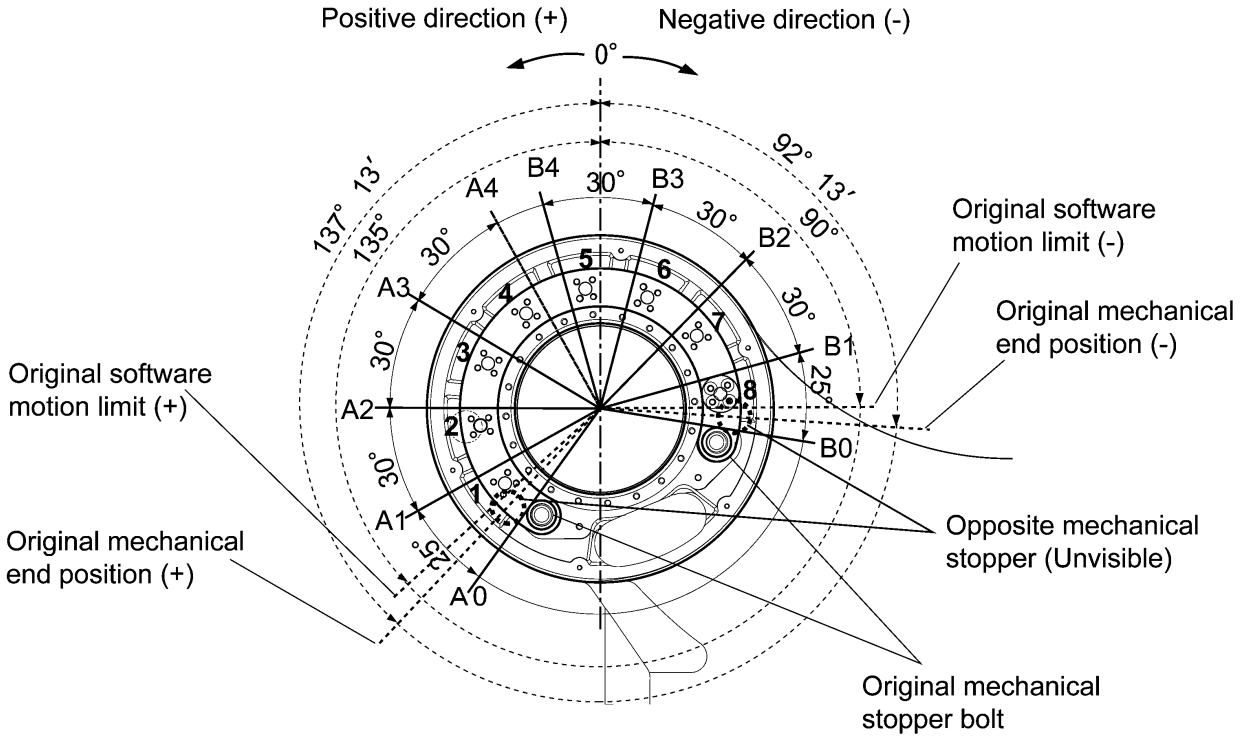
Material: S45C</td></tr>
<tr><td>Fixing Bolt: Hex. Socket head, 4pcs.
Specifications of those bolts:
(JIS B1176) M4×10, SCM435 (JIS G4105),HRC34 to 44</td><td>Fixing Bolt: Hex. Socket head, 4pcs.
Specifications of those bolts:
(JIS B1176) M4×10, SCM435 (JIS G4105),HRC34 to 44</td></tr>
</table>

[2.3] Examples of changing the mechanical ends by mechanical stoppers

Using the mechanical stoppers prepared by the customer, the mechanical ends can be changed as follows.

(1) Example of changing the 2nd-axis mechanical ends

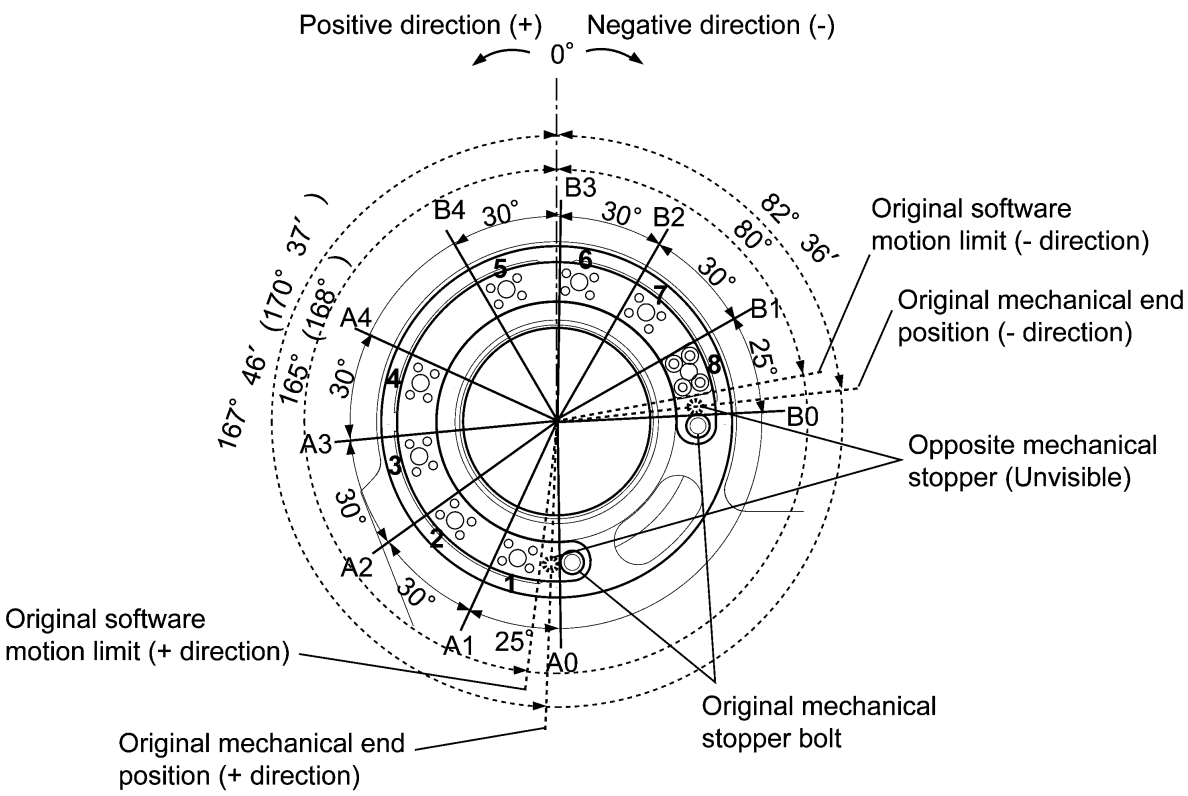
Explanation of changing the 2nd-axis mechanical ends



Fixing position of mechanical stopper	Mechanical end positions	
	Positive direction (+)	Negative direction (-)
Original	A0 <Original mechanical end position> +137° 13′ <Original software motion limit> +135°	B0 <Original mechanical end position> -92° 13′ <Original software motion limit> -90°
1	A1 (25° inside from A0)	-
2	A2 (55° inside from A0)	-
3	A3 (85° inside from A0)	-
4	A4 (115° inside from A0)	-
5	-	B4 (115° inside from B0)
6	-	B3 (85° inside from B0)
7	-	B2 (55° inside from B0)
8	-	B1 (25° inside from B0)

Note: The software motion limits should be 2° to 3° inside the new mechanical end positions.

(2) Example of changing the 3rd-axis mechanical ends



Note: Values in parentheses apply to the VM-60B1D.

Fixing position of mechanical stopper	Mechanical end positions	
	Positive direction (+)	Negative direction (-)
Original	A0 <Original mechanical end position> VM-6083D: +167° 46′ VM-60B1D: +170° 37′ <Original software motion limit> VM-6083D: +165° VM-6083D: +168°	B0 <Original mechanical end position> -82° 36′ <Original software motion limit> -80°
1	A1 (25°inside from A0)	-
2	A2 (55°inside from A0)	-
3	A3 (85°inside from A0)	-
4	A4 (115°inside from A0)	-
5	-	B4 (115°inside from B0)
6	-	B3 (85°inside from B0)
7	-	B2 (55°inside from B0)
8	-	B1 (25°inside from B0)

Note: The software motion limits should be 2° to 3° inside the new mechanical end positions.

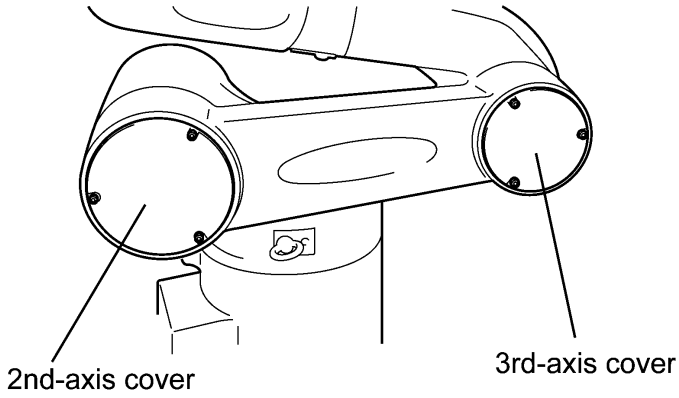
[3] Procedure of Changing the Mechanical Ends

The procedure of changing the mechanical ends is as follows by using the mechanical stoppers described on the Section [2.2].

Step 1 Prepare the mechanical stopper and fixing bolts described on the Section [2.2].

(Manufactured by the customer).

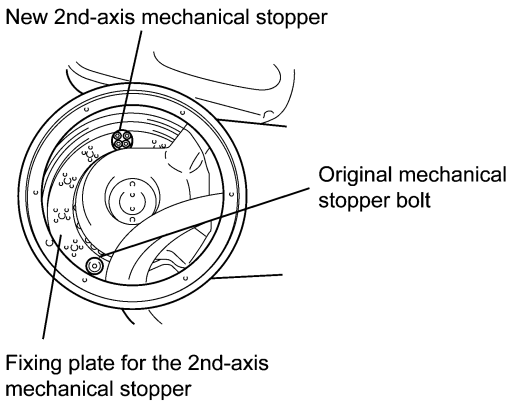
Step 2 Remove the 2nd-axis or 3rd-axis cover.

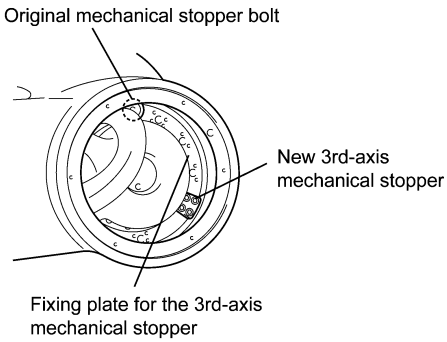


Step 3 Install the mechanical stopper to the fixing position of the robot using four bolts according to the Section [2.3].

Tightening torque: 3.9 Nm±20%

Note: Pay attention to the direction of the mechanical stopper.
(Refer to the reference drawing described on the Section [2.3].)





Step 4 Reinstall the 2nd-axis or 3rd-axis cover.

Tightening torque: 0.59 Nm±20%

Step 5 Change the software motion limits so as to be inside the mechanical end positions.

2.4 CALSET

2.4.1 What Is CALSET?

Calibrating the relationship between position-related information recognized by the robot controller and the actual position of the robot unit is called CALSET.

CALSET must be performed when the motor is replaced or when the encoder backup battery goes dead and the position-related data retained in the encoder is lost as a result.

After CALSET is completed, the calibrated data of the robot unit will be stored in the robot controller. This data is called CALSET data which is different on each robot.

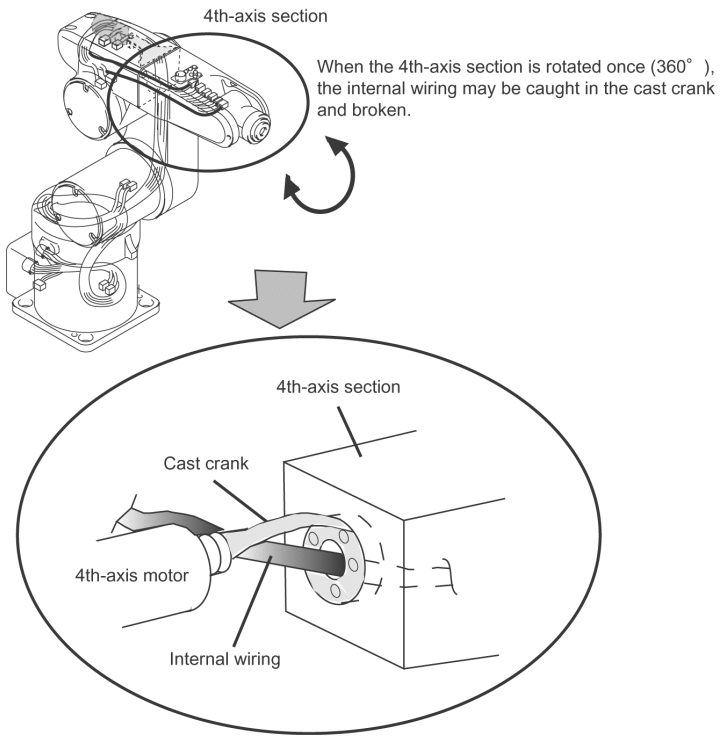
This robot has been CALSET before delivery and the CALSET data is stored in the floppy disks that come with the robot unit. Therefore, even if the memory backup battery in the robot controller dies so that the CALSET data is lost, you do not need to CALSET the robot. Just reload the CALSET data from the floppy disks.

2.4.2 Precautions about CALSET for the VM-D Series

(For models having no mechanical stop on the 4th-axis)

Robots in the VM-6083D/VM-60B1D series launched after March, 2001 have **no mechanical stop on the 4th-axis**.

If the 4th-axis CALSET position is wrongly set by one rotation (360°) while CALSET is being carried out, the internal wiring may be caught in the crank and broken. To carry out CALSET with a robot with no 4th-axis mechanical stop, check the normal 4th-axis position first as described below.



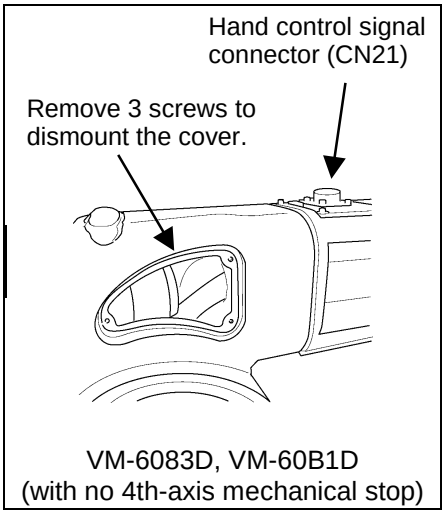
Note that turning the 4th-axis section by more than 360° may break the internal wiring

Checking of 4th-axis Position before Carrying Out CALSET

(1) Manually move the 4th-axis section until the hand control signal connector comes to the upper side.

(2) Dismount the cover from the second arm so that the internal wiring can be checked.

The cover to dismount for each model is shown below:

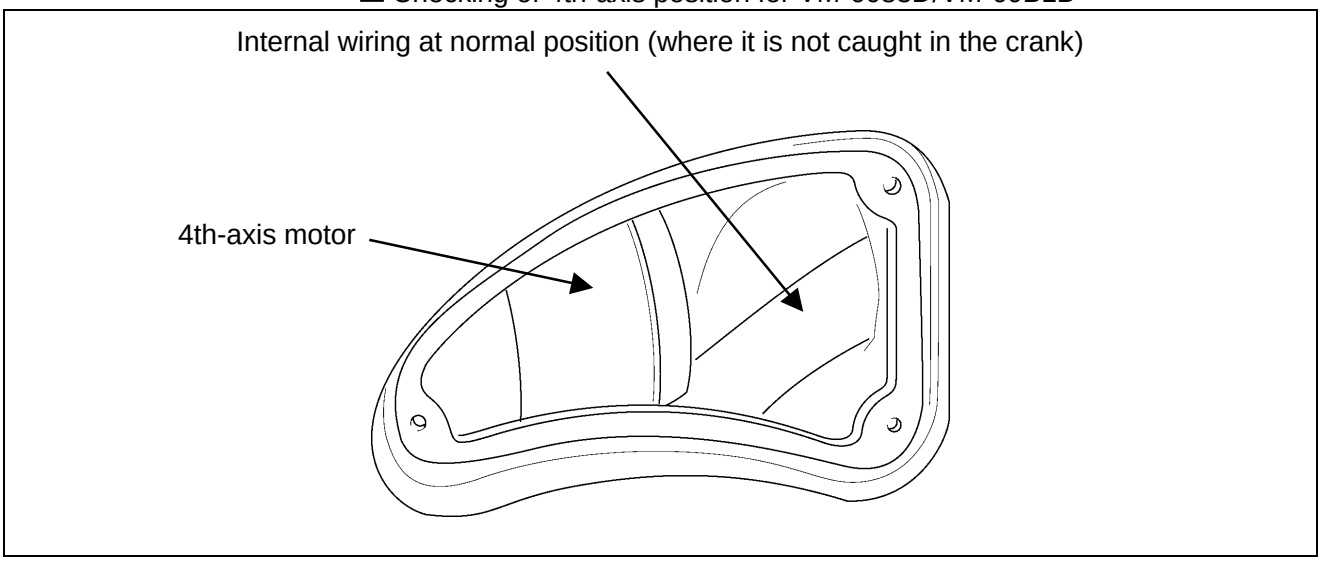


VM-6083D, VM-60B1D
(with no 4th-axis mechanical stop)

(3) Check that the 4th-axis section is at a designated position.

(The hand control signal connector (CN21) of the second arm comes to the upper side and the internal wiring is not caught in the crank at this time.)

■ Checking of 4th-axis position for VM-6083D/VM-60B1D



(4) When the 4th-axis section is not at the normal position, manually move it to a designated position.

Preparation before carrying out CALSET is finished now.

NOTE: If the step [2.4.2] is omitted, the 4th-axis CALSET position may be mistaken by one rotation (360°). The internal wiring may be caught in the crank and broken in such a case.

2.4.3 Preparation for CALSET

In all models, the 1st, 2nd, 3rd, and 5th axes are equipped with mechanical stops but the 6th axis is not.

As for the 4th axis, whether it is equipped with a mechanical stop or not depends upon the model and manufacturing date as listed below. That is, the VM-6083D/VM-60B1D manufactured after the middle of March in 2001 **(Note 1)** and the VS-E series have no mechanical stop on the 4th axis.

To CALSET those axes having no mechanical stop, you need to mount a CALSET jig before starting CALSET as described on the following pages.

Mechanical Stops on Axes

Model	On the 1st, 2nd, 3rd, 5th axes	On the 4th axis	On the 6th axis
VM-6070D	Mechanical stops provided	Mechanical stop provided	No mechanical stops
VM-6083D/VM-60B1D manufactured before the middle of March in 2001		Mechanical stop provided **(Note 1)**	
VM-6083D/VM-60B1D manufactured after the middle of March in 2001		No mechanical stop **(Note 1)**	

(Note 1) To distinguish between the VM-6083D/VM-60B1D having a mechanical stop on the 4th axis and that having no mechanical stop, check the presence of a notch in the figure on page 77. If there is a notch, the model has no mechanical stop ion the 4th axis.

(1) If your model has a mechanical stop on the 4th axis

Press each of the 1st to 5th axes manually against the associated mechanical stop and get the actual position.

Since the 6th axis has no mechanical stop, you need to mount a CALSET jig to set a temporary mechanical end for CALSET. Then press the 6th axis against this mechanical end and get the position. When CALSETing the 6th axis, you need to press also the 5th axis against the mechanical stop since CALSET requires the positional relationship between the 5th and 6th axes.

(2) If your model has no mechanical stop on the 4th axis

Press each of the 1st, 2nd, 3rd, and 5th axes manually against the associated mechanical stop and get the actual position.

Since the 4th and 6th axes have no mechanical stop, you need to mount a CALSET jig to set a temporary mechanical end for CALSET. Then press the 4th and 6th axes against those mechanical ends and get the those positions. When CALSETing the 6th axis, you need to press also the 5th axis against the mechanical stop since CALSETing requires the positional relationship between the 5th and 6th axes.

(3) Cautions at CALSET

CALSET requires some space for bringing each axis into contact with the mechanical end.

Caution (1) When CALSETing, move the axis to be CALSET in the vicinity of the mechanical stop, release the brake, and bring the axis into contact with the mechanical stop.

- **The VM-D/VS-E series may release the brake of the specified axis, but the VS-D series will release brakes of all axes.**
- **VM-D series and the brake-equipped version of the VS-D/-E series: Each of the 2nd through 6th axes has a brake.**
- **None-brake version of the VS-D series: Only the 2nd and 3rd axes have brakes.**
- **None-brake version of the VS-E series: Only the 2nd to 4th axes have brakes.**

(2) When performing CALSET, be careful with the robot motion. The execution of the CALSET command releases motor brakes so that the robot arms will move by its own weight.

(3) After CALSET, confirm in the manual mode that each axis stops at the software motion limit before coming into contact with the mechanical end.

(4) In automatic operation, start to run the robot at low speed. Ensuring safety, gradually increase the speed. It makes adjustment easy.

(5) Position-related data in some programs made before CALSET may vary somewhat after CALSET.

(6) For models having no mechanical stop on the 4th axis:

When rotating the 4th axis with the brake released, take care not to let the 4th axis override the motion limit (initial setting of the software motion limit). Rotating it beyond the motion limit will cause the brake (even released) to be locked, turning the motor off.

Be careful with arms that may rotate by gravity after brakes are released depending upon the robot posture and hand position.

2.4.4 Mounting the CALSET Jig

To CALSET the 6th axis on all models or the 4th axis on models having no mechanical stop, you need to mount the CALSET jig on the axis beforehand according to the procedure given in (1) below or (2) given later, respectively.

To CALSET all axes including the above axes., follow those procedures (1) and (2).

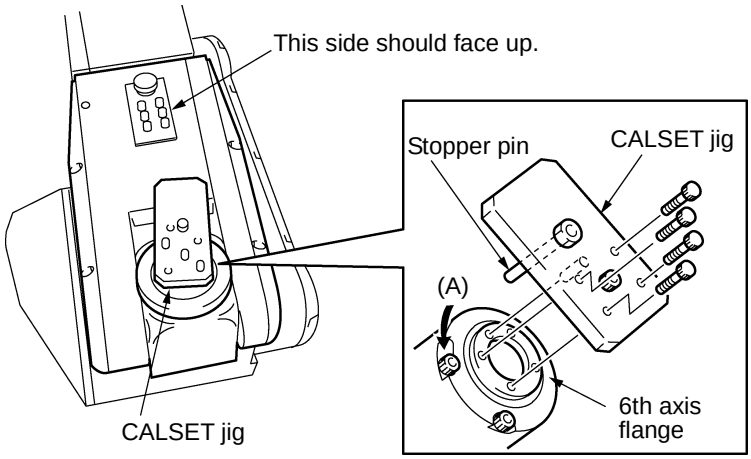
(1) Mounting the CALSET jig on the 6th axis

STEP 1 Fit a stopper pin in the CALSET jig.

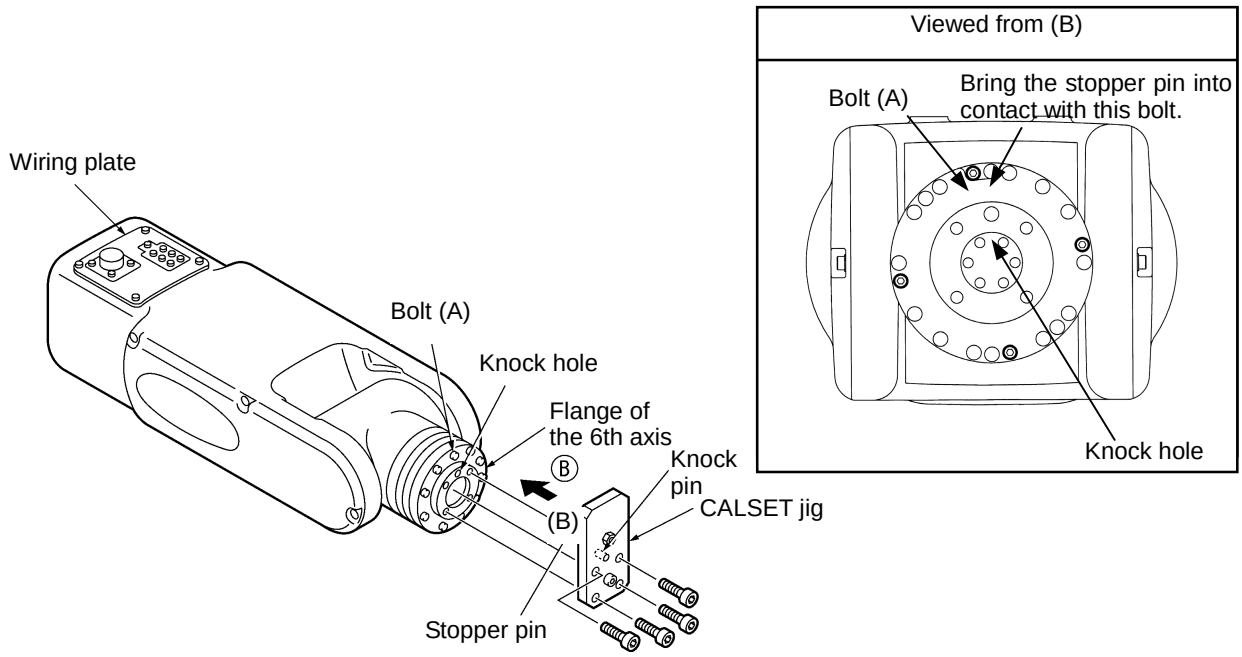
STEP 2 Release the brake of the 6th axis.

STEP 3 Install the CALSET jig on the flange of the 6th axis as shown in the figure below and the figure on the next page.

TIP: The CALSET position of the 6th axis refers to the point where the stopper pin (shown in the lower figures and the figure on the next page) comes into contact with bolt (A) when the flange of the 6th axis is turned.



Mounting a CALSET Jig [VM-6070D]



Mounting a CALSET Jig [VM-6083D/VM-60B1D]

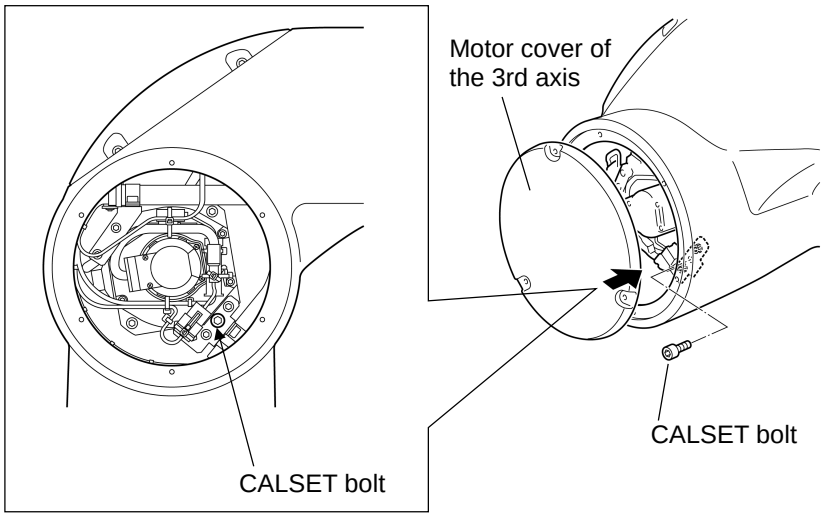
(2) Mounting the CALSET jig on the 4th axis

As a CALSET jig, a special bolt (CALSET bolt) is provided inside the 3rd-axis motor cover in the robot unit.

STEP 1

Remove the 3rd-axis motor cover and unscrew the CALSET bolt.

NOTE: After CALSETing, be sure to set the bolt back into place and torque it to 1.0 Nm ±20%.



Removing the CALSET Bolt (VM-6083D/VM-60B1D)

STEP 2

Rotate the second arm to the position specified in STEP 4.

STEP 3

Release the brake of the 4th axis.

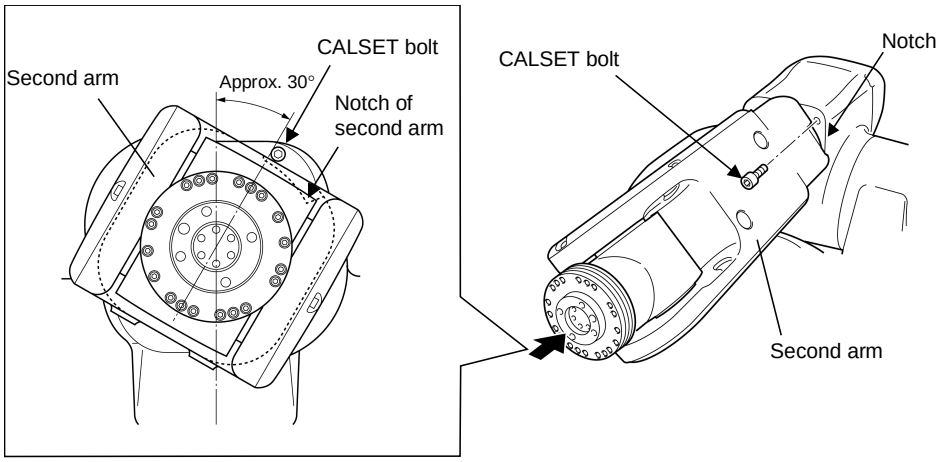
STEP 4

Set the CALSET bolt to the end of the 3rd axis housing as shown in Figure 4-16.

Tightening torque of the CALSET bolt: 2.9 Nm ±20%

NOTE: Be sure to use the CALSET bolt as a CALSET jig. Using any other bolt will result in a positional error in CALSET.

TIP: The CALSET position of the 4th axis refers to the point where the notch of the second arm comes into contact with the head of the CALSET bolt by turning the second arm.



Mounting the CALSET Bolt (VM-6083D/VM-60B1D)

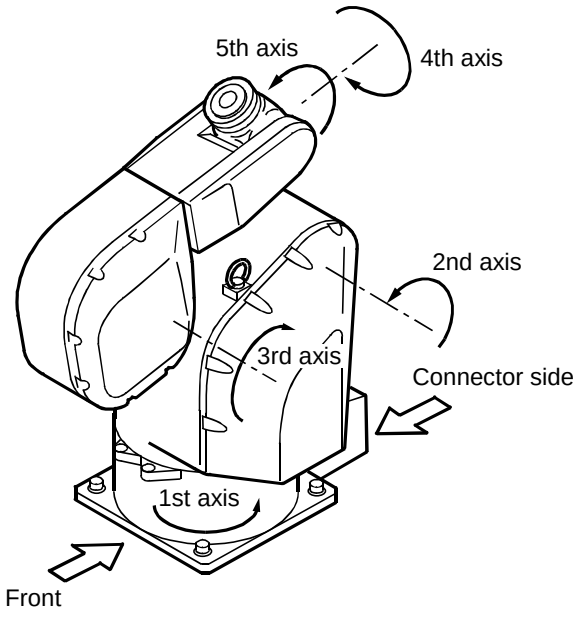
2.4.5 What Is a CALSET Position?

The limit position of an arm to be CALSET is called a CALSET position.

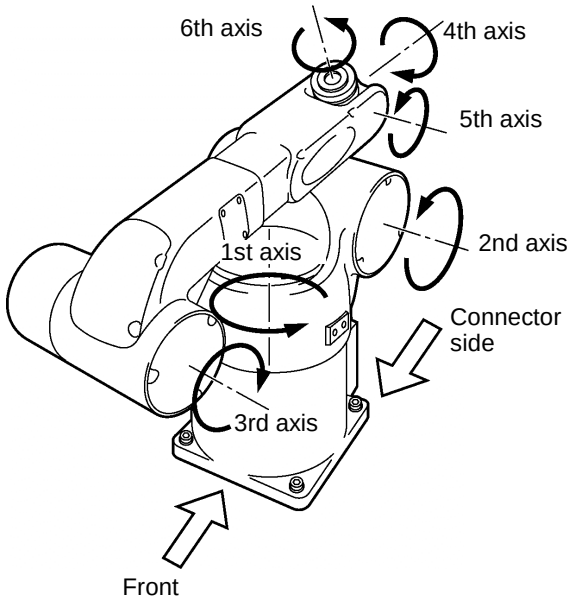
Each axis has a mechanical end in each of the positive and negative directions. The mechanical ends shown in the figure below are the CALSET positions.

Axis		CALSET positions
Position	1st axis	Turning end in the positive direction (counterclockwise end when viewed from top)
	2nd axis	Turning end in the negative direction
	3rd axis	Turning end in the positive direction
	4th axis	<u>Models having a mechanical stop on the 4th axis</u> Turning end in the positive direction (counterclockwise end when viewed from the arm end) <u>Models having no mechanical stop on the 4th axis</u> Turning end in the positive direction, which is set by a CALSET jig. (See Section 2.4.4) (counterclockwise end when viewed from the arm end)
	5th axis	Turning end in the positive direction (upward end of the 5th-axis arm)
	6th axis	Turning end in the positive direction, which is set by a CALSET jig. (See Section 2.4.4)

VM-6070D



VM-6083D/VM-60B1D



CALSET Positions (VM-D series)

2.4.6 CALSET Procedure

2.4.6.1 CALSETing a Single Axis

CALSETing a specified single axis only is called single-axis CALSET.

Perform single-axis CALSET if the motor of an axis is replaced so that the axis must be CALSET, or if some axes cannot be moved to the CALSET positions (mechanical stop positions) at any given time because of interference between the robot unit and its surrounding facilities.

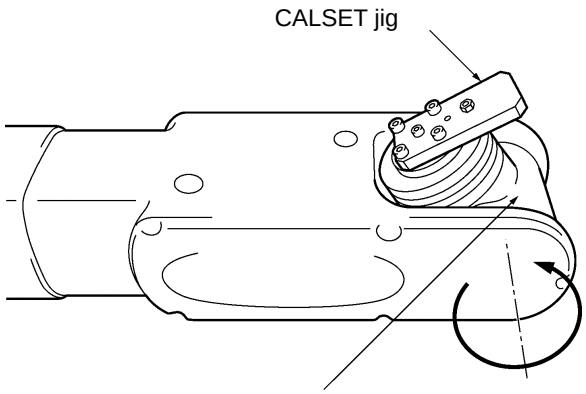
NOTE: Step 1 is required for CALSETing the 4th and 6th axes and Step 2 is for CALSETing the 6th axis. When CALSETing any other axes, skip to Step 3.

STEP 1
(Required for CALSETing the 4th and 6th axes)

Mount the CALSET jig according to Subsection 2.4.2.1 "Mounting the CALSET Jig."

STEP 2
(Required for CALSETing the 6th axis)

Fully turn the 5th axis to its turning end in the positive direction.



STEP 3

Turn the power switch of the robot controller to ON.

STEP 4

Set the mode selector switch of the teach pendant to MANUAL.

STEP 5

Press MOTOR to turn ON the power to the motor.

STEP 6

Move the axis to be CALSET in the vicinity of the mechanical stop via the manual operation from the teach pendant.

STEP 7

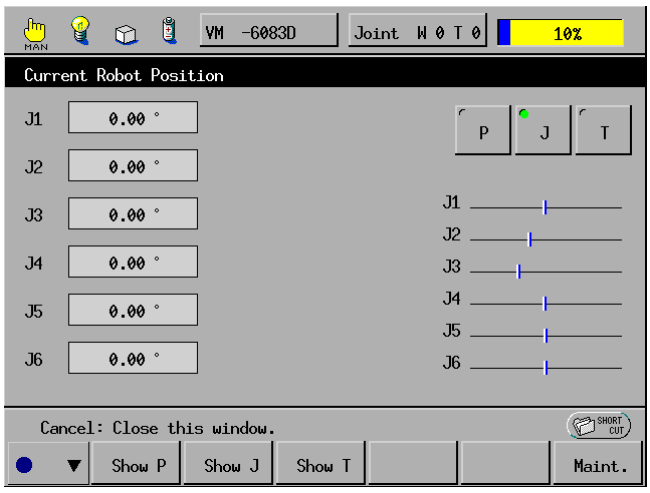
Press the MOTOR key on the teach pendant to turn OFF the power to the motor.

STEP 8

Press [F2 Arm] on the teach pendant.

STEP 9

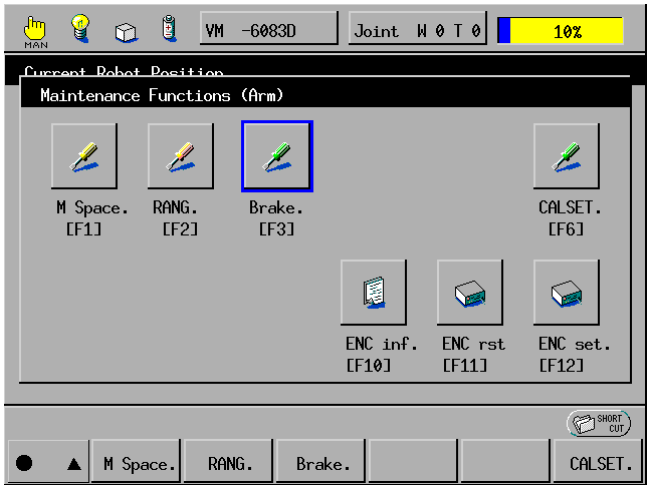
Press the SHIFT key and [F12 Maint.].



F12

STEP 10

Press [F3 Brake.].

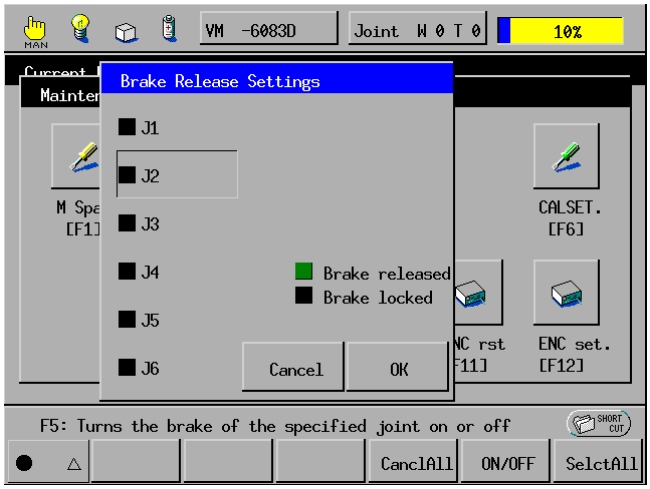


F3

STEP 11

■ **VM-D/VS-E Series**

Touch the axis number to be CALSET to select "Brake released" (green display).



STEP 12

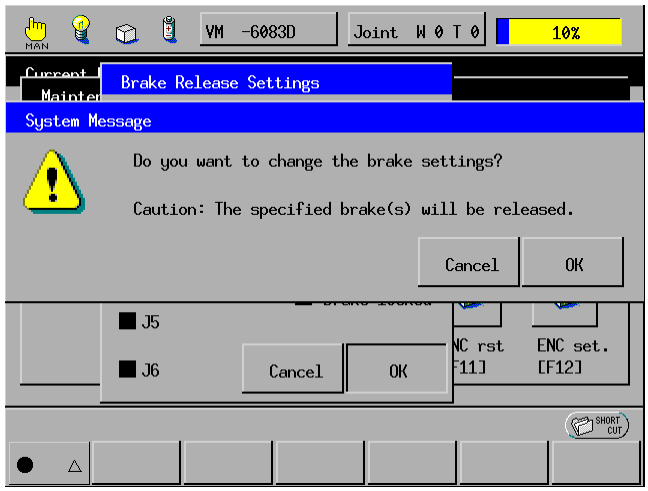
Confirm that there is no danger even if the arms fall as a result of released brakes.

CAUTION: The brake of the specified axis is released in the VM-D/VS-E series.

STEP 13

Press OK.

The system message appears asking you whether you want to change the brake settings.

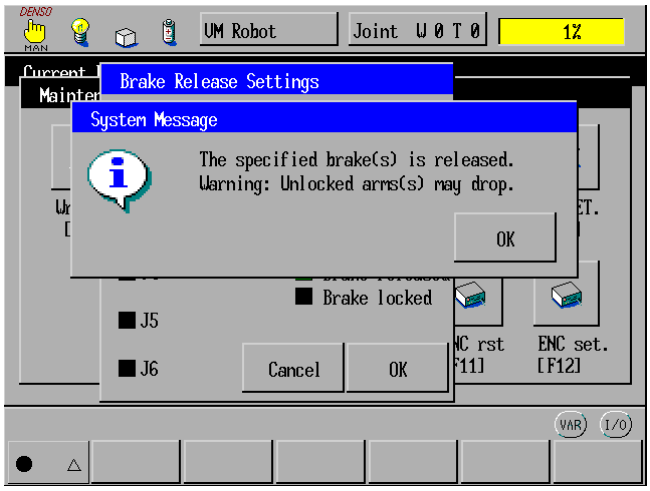


STEP 14

■ **VM-D/VS-E Series**

Press OK.

The system message appears informing that the brake is released and warning against drop of arms.



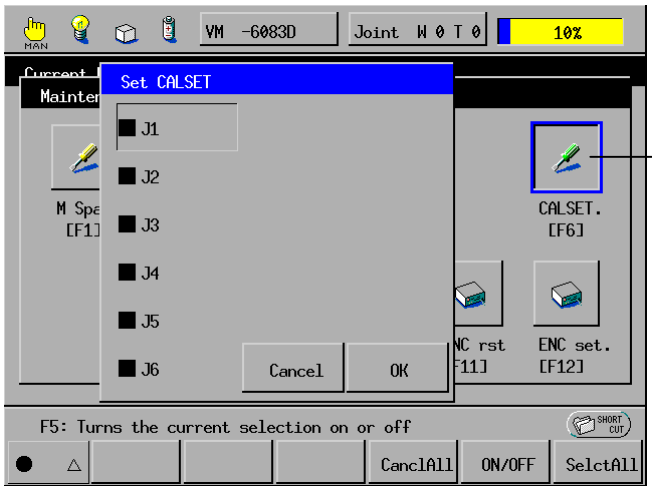
STEP 15

Press the axis to be CALSET against the mechanical stop by hand.

STEP 16

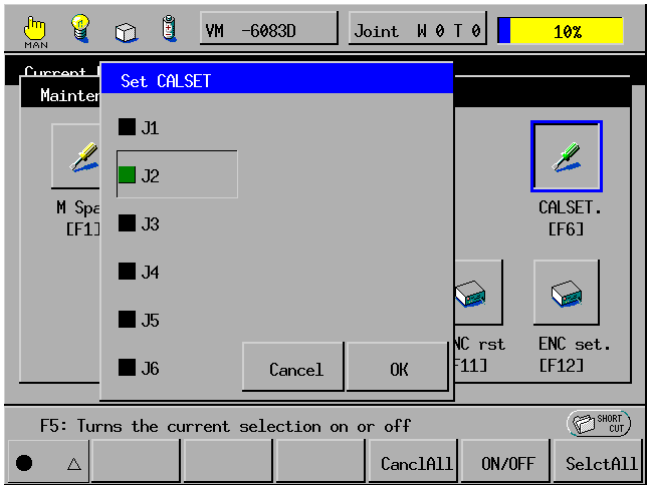
Press [F6 CALSET.].

The Set CALSET window appears.



STEP 17

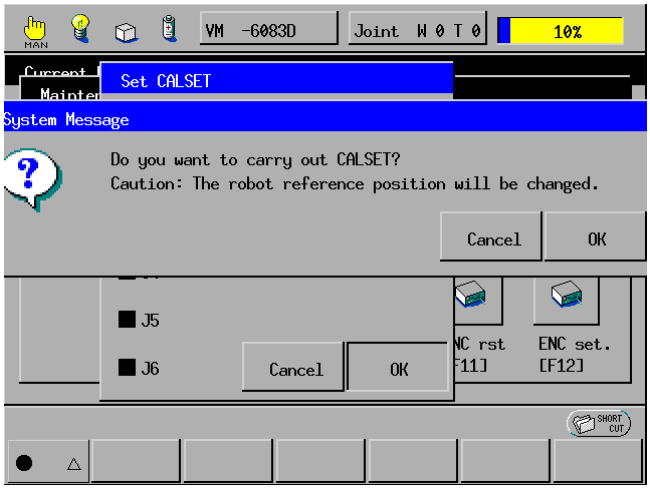
Press the axis number to be CALSET to select CALSET (green display). Deselect CALSET (black display) for the other axes that are not required to be CALSET.



STEP 18

Press OK.

The system message appears asking whether you want to carry out CALSET and showing a caution that the robot reference position will be changed.



STEP 19

Press OK.

The system message appears informing that CALSET is completed.

STEP 20

Press the ROBOT STOP button.

The robot brake becomes activated.

STEP 21

Turn the ROBOT STOP button to cancel robot stop.

STEP 22

Press the MOTOR to turn ON the power to the motor.

Caution: A "motor lock overload" error may occur just after the power to the motor is turned ON. In this case, try to turn ON the power several times, or release the brake, move the axis a little in the opposite direction of the mechanical end, and turn ON the power again.

STEP 23

Move the CALSETed axis in the opposite direction from the mechanical end by the manual operation of the teach pendant.

STEP 24

Perform CAL. The single-axis CALSET of the specified axis is completed.

2.4.6.2 CALSETing All Axes

The CALSET of all axes is called all-axis CALSET.

The procedure is the same as that for single-axis CALSET except that you should select all axes for brake release and CALSET in Steps 9, 13 and 15. For details of the procedure, see Subsection 2.4.6.1 "CALSETing a Single Axis."

2.5 Setting Control Set of Motion Optimization

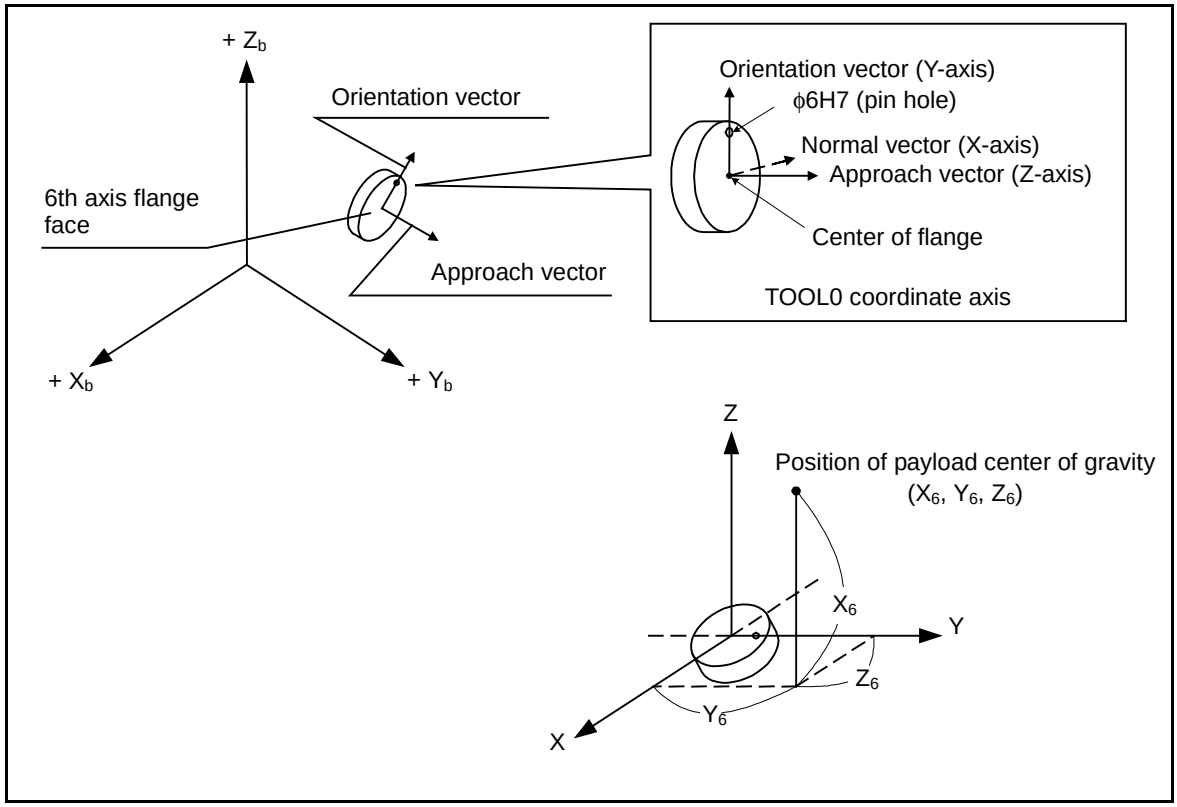
The optimum speed or acceleration will vary depending upon the payload and center of gravity of an end-effector or workpiece that is to be set at the end of the robot flange. Set the payload and center of gravity position of the end-effector or workpiece and the control set of motion optimization according to the payload and robot posture.

The mass of payload is a total mass of an end-effector and workpiece, expressed in grams.

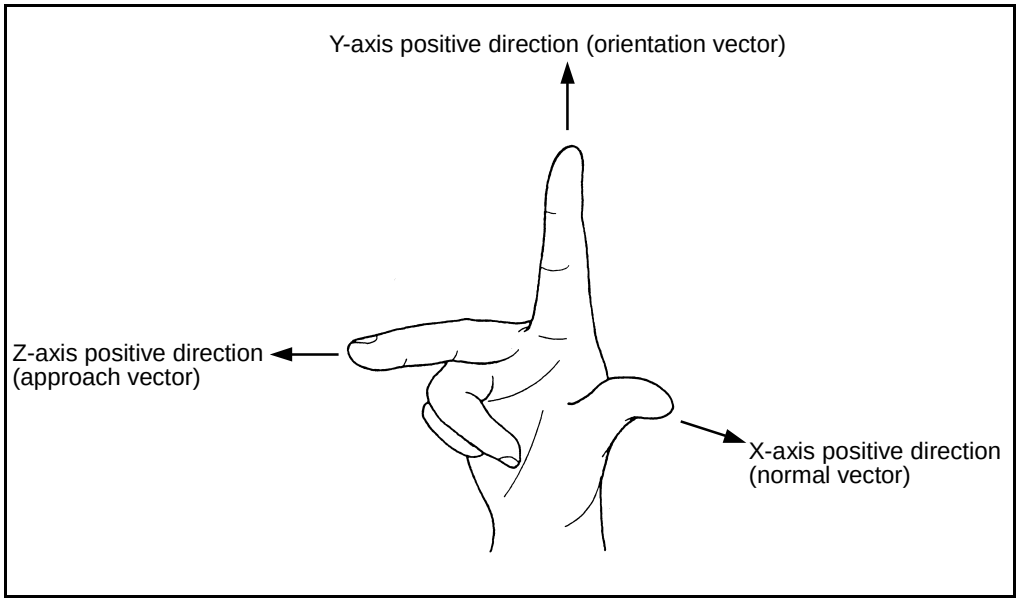
For further information, see the PROGRAMMER'S MANUAL, Section 4.7 "Setting the Master Control Parameters in User Preferences." For the setting procedure, refer to the SETTING-UP MANUAL, Section 2.9, "Setting the Master Control Parameters of the Payload, Center of Gravity, and Control Set of Motion Optimization."

The payload center of gravity is represented by the TOOL0 coordinate system (see this figure below) in the unit of mm.

The origin of the TOOL0 coordinate system is the center of the 6th axis flange. Its Y-component is in the direction from the flange center to the ϕ6H7 pin hole (orientation vector direction). The Z-component is in the vertical direction to the flange face across the flange center (approach vector direction). The X-component is in the X-axis direction of the right hand coordinate system (normal vector direction) with the orientation vector as the Y-axis and the approach vector as the Z-axis. (See the figure on the next page.)



Payload Center of Gravity



Right Hand Coordinate System

2.6 Setting Robot Installation Conditions

The optimum operating conditions will differ depending on whether the robot is floor-mounted or overhead-mounted.

When the robot leaves the factory, it is set for floor-mount. If you overhead-mount your robot, you need to change the installation settings.

For the setting procedure, refer to the SETTING-UP MANUAL, Section 2.10, "Setting the Robot Installation Condition" and the PROGRAMMER'S MANUAL, Subsection 4.7.3 "Setting Robot Installation Conditions."

Chapter 3 Maintenance and Inspection

3.1 Maintenance & Inspection Intervals and Purposes

The table below lists the intervals and purposes of maintenance & inspection.

> ⚠**Caution: Before performing maintenance and inspection jobs, read the SAFETY PRECAUTIONS, "3 Precautions while robot is running" and "4 Daily and periodical inspections."**

Maintenance & Inspection Intervals and Purposes

■ VM-6070D

No.	Intervals		Purposes
1	Daily	Perform inspection jobs specified in Section 3.2 every day before starting operations.	To use your robot safely.
2	Quarterly	Perform inspection jobs specified in Section 3.3 every three months.	To maintain the precision of the robot and to prevent failures caused by overheat of the robot controller.
3	Biennial	Replace backup batteries as specified in Section 3.4 every two years.	To retain the robot-specific data (programs, parameters, etc.) stored in the internal memory of the robot controller and the position data stored in the electronic absolute encoder build in the robot unit.
4	Every 2.5 years (VM-6070D only)	Perform inspection jobs specified in Section 3.5 every 2.5 years.	To check the rotary sections and slideways of the robot for wear, preventing seizure, breakage, and other serious failures that could result from wear.

■ VM-6083D/VM-60B1D

No.	Intervals		Purposes
1	Daily	Perform inspection jobs specified in Section 3.2 every day before starting operations.	To use your robot safely.
2	Quarterly	Perform inspection jobs specified in Section 3.3 every three months.	To maintain the precision of the robot and to prevent failures caused by overheat of the robot controller.
3	Biennial	Replace backup batteries as specified in Section 3.4 every two years.	To retain the robot-specific data (programs, parameters, etc.) stored in the internal memory of the robot controller and the position data stored in the electronic absolute encoder build in the robot unit.

3.2 Daily Inspections

3.2.1 Check Items

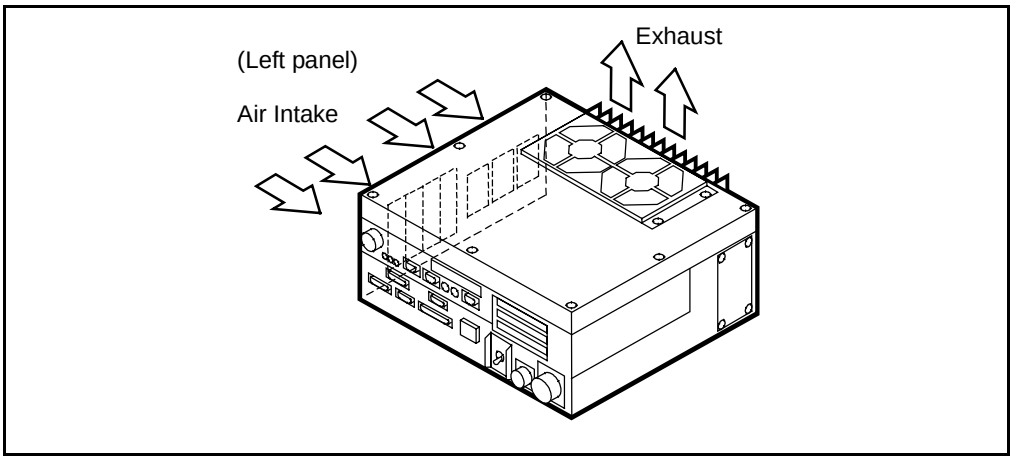
Before starting operations, check the items listed in the table below every day.

Daily Inspections Table

No.	Check:	Controller Power	How to check:	Criterion	What to do: (Note 1)
1	Connectors (CN1 to CN12 on the robot controller) and their mating parts	OFF	Visually	No looseness, disengagement or dirt.	Engage the parts properly and clean them.
2	Cables (connected to CN1 to CN12 on the robot controller) and robot's external cables	OFF	Visually	Free of damage or gouges.	Repair or replace.
3	LCD on the teach pendant	ON	Visually	Properly displayed	Repair or replace.
4	Pilot lamps on the robot controller	ON	Visually	Should light.	Repair or replace.
5	Cooling fan in the robot controller	ON	Visually **(Note 2)**	Should work properly.	Repair or replace.
6	Calibration	ON	Visually	No error or unusual noise.	Repair or replace.
7	ROBOT STOP button on the operating panel or the teach pendant	ON	Press the ROBOT STOP button.	The robot should come to an emergency stop.	Repair or replace.
8	Safety door	ON	Operate the safety door switch and open the switch-wiring door.	The robot should come to an emergency stop.	Repair or replace.

Note 1 Some repair and replacement operations, shown in "What to do:" column, may involve special work. Contact the Robot Service Section.

Note 2 The normal operation of the cooling fan is as shown in next Figure.



Normal Operation of Cooling Fan (VM-D)

3.3 Quarterly Inspections

3.3.1 Check Items

Check the items listed in the table below every three months.

Quarterly Inspections Table

No.	Check:	Controller Power	How to check:	Criterion	What to do:
1	Robot base mounting bolts	OFF	Measure the tightening torque with a torque wrench.	No looseness. Specified torque: 110 ±22 Nm	Tighten the bolts to the specified torque.
2	Cooling fan filters in the robot controller	OFF	Visually	No dust or dirt.	Clean the cooling fan filters. (Refer to Subsect. 3.3.2.)

3.3.2 Cleaning the Cooling Fan Filters in the Robot Controller

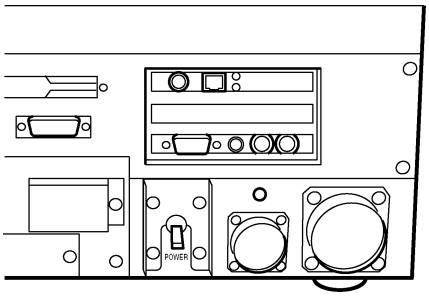
The robot controller has two cooling fan filters—inlet port filter and exhaust port filter.

If either of the filters is clogged, the robot controller becomes badly ventilated to overheat so that the internal electronic devices may fail due to heat.

If a power module error appears, it may be caused by clogged filters, so clean those filters.

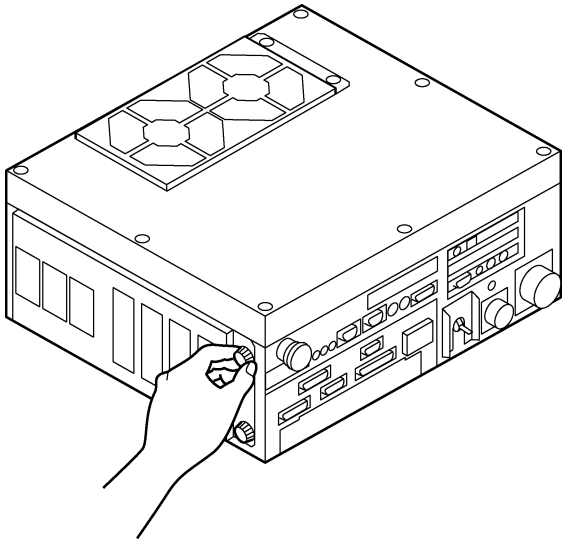
STEP 1

Turn the POWER switch of the Robot Controller OFF.



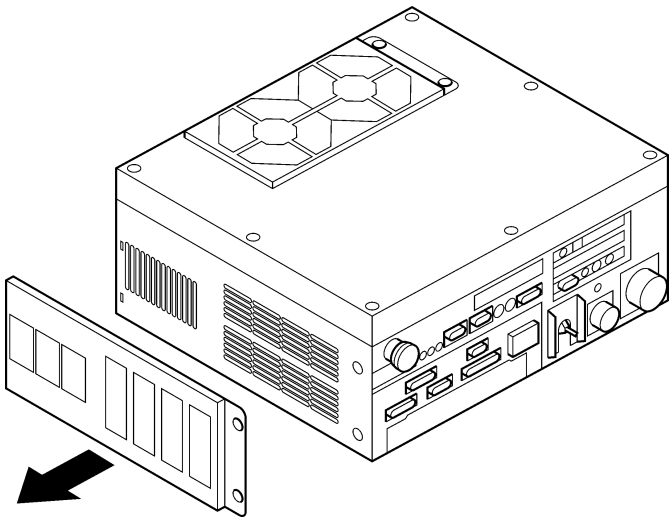
STEP 2

Remove the screws with your fingers to release the inlet port filter.



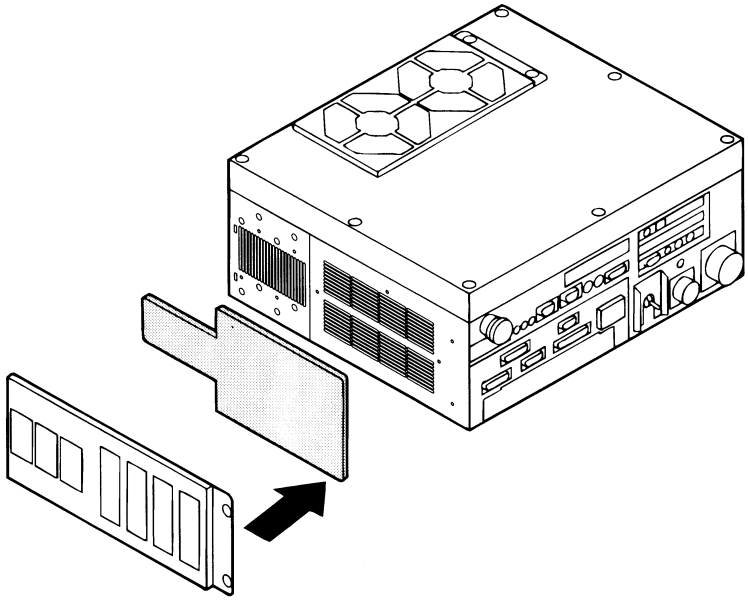
STEP 3

Remove the support frame of the inlet port filter.



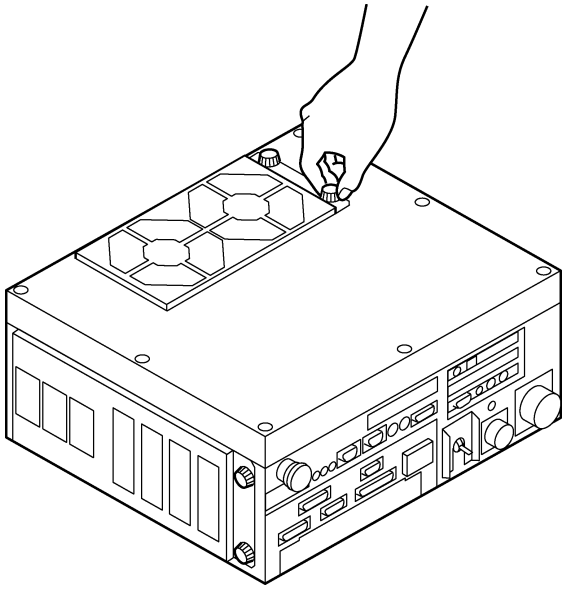
STEP 4

Remove the filter element from the support frame.



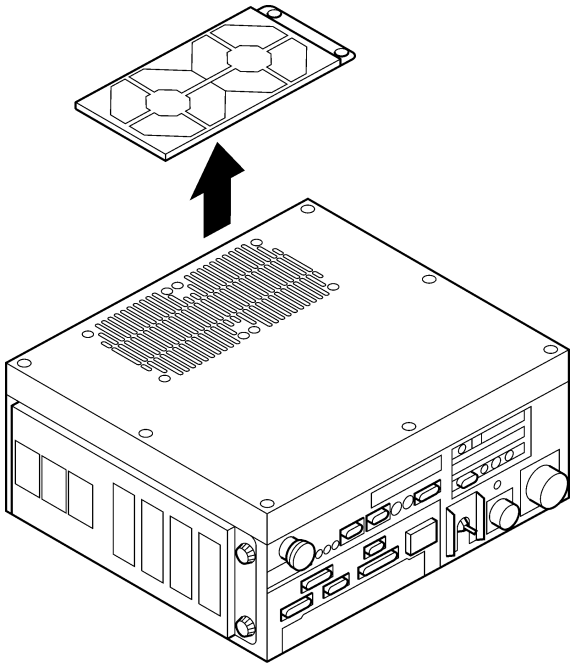
STEP 5

Remove the screws with your fingers to release the exhaust port filter.



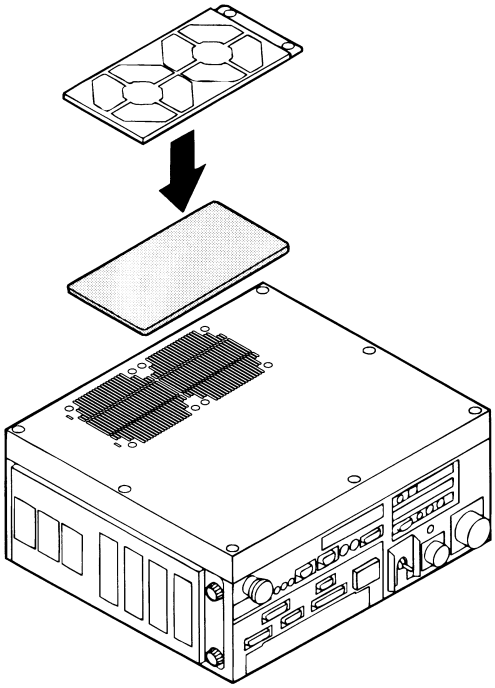
STEP 6

Remove the support frame of the exhaust port filter.



STEP 7

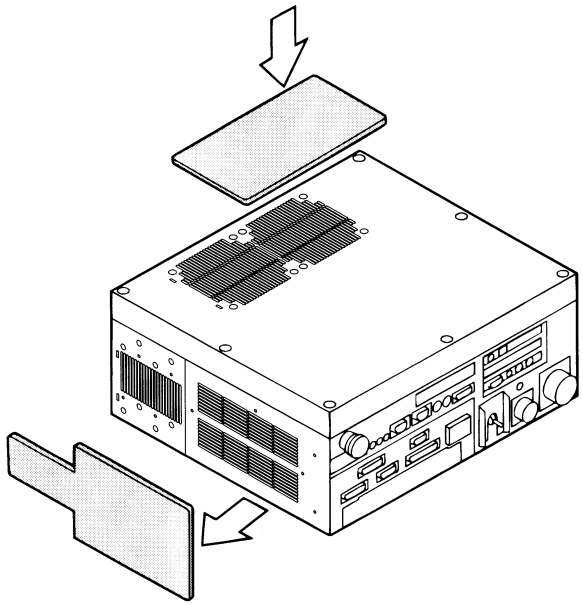
Remove the filter element from the support frame.



▸ STEP 8

Blow compressed air to the filter elements in the direction opposite to the regular air flow.

NOTE: Use dehumidified, oil-free, pure compressed air for cleaning.



If the filters are excessively dirty, wash them with water or warm water (40°C or lower). A neutral detergent is most effective.

Notes (1) Dry the washed filters completely before replacing them.

(2) If the filters are still dirty after air blowing or washing, replace them with new ones.

▸ STEP 9

Reinstall the filters in the reverse order of removal.

3.4 Biennial Inspections

3.4.1 Battery Replacement and Check Items

Replace the two types of backup batteries listed in the upper table on this page and inspect the timing belts on the 5th and 6th axes listed in the lower table on this page in biannual inspections.

Backup Battery Types

	Battery type	Used to:	Located:	Refer to:
1	Encoder backup battery	Back up the position data of the servomotor encoder.	In the robot unit	Subsect. 3.4.2
2	Memory backup battery	Back up programs, parameters, and CAL data.	In the robot controller	Subsect. 3.4.3

The position data of the encoder built in the servomotor is stored in the internal memory of the encoder.

Programs, parameters, CAL data, etc. are stored in the internal memory of the robot controller.

The backup battery for each memory retains the above data while the power to the robot controller is turned OFF. However, these batteries have a limited lifetime and must, therefore, be replaced regularly.

NOTE: If two years elapse from replacement of either backup battery, the "Time to change controller backup battery" message will appear on the teach pendant.

⚠Caution: Without replacing the backup batteries, important robot-specific data stored in each memory will be lost.

Biennial Inspection Table (VM-6083D/VM-60B1D)

No.	Check:	Controller Power	How to check:	Criterion	What to do:
1	Timing belts on the 5th and 6th axes	OFF	Visually	No lack of teeth or excessive wear.	Contact DENSO, Industrial Systems Product Division.

3.4.2 Replacing the Encoder Backup Battery

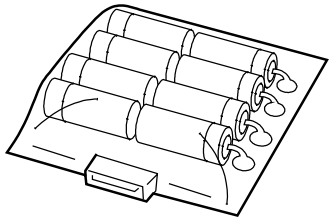
Replace the encoder backup battery according to the procedure below.

[1] VM-6070D

<Replacing procedure >

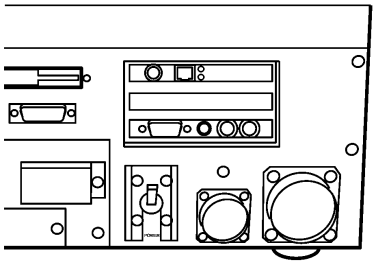
STEP 1

Prepare a new backup battery for replacement.



STEP 2

Turn the controller power ON.



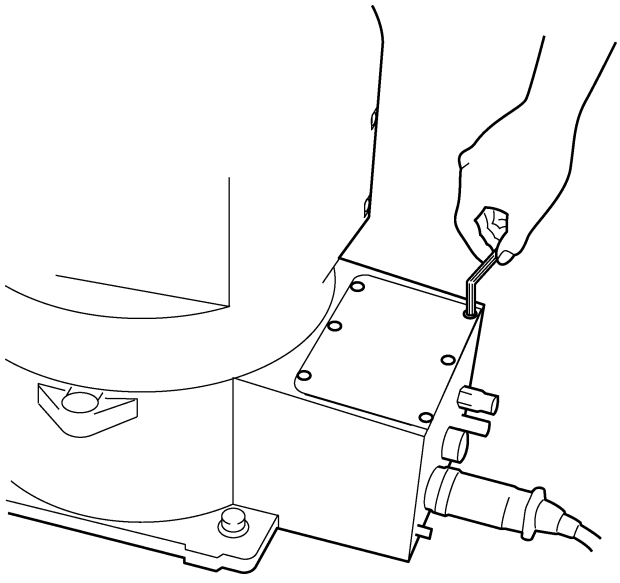
STEP 3

Press and lock the robot stop button on the controller (or on the teach pendant or operating panel) in order to prevent the motor power from becoming turned on accidentally.

Note: To unlock the robot stop button, slightly turn it clockwise.

STEP 4

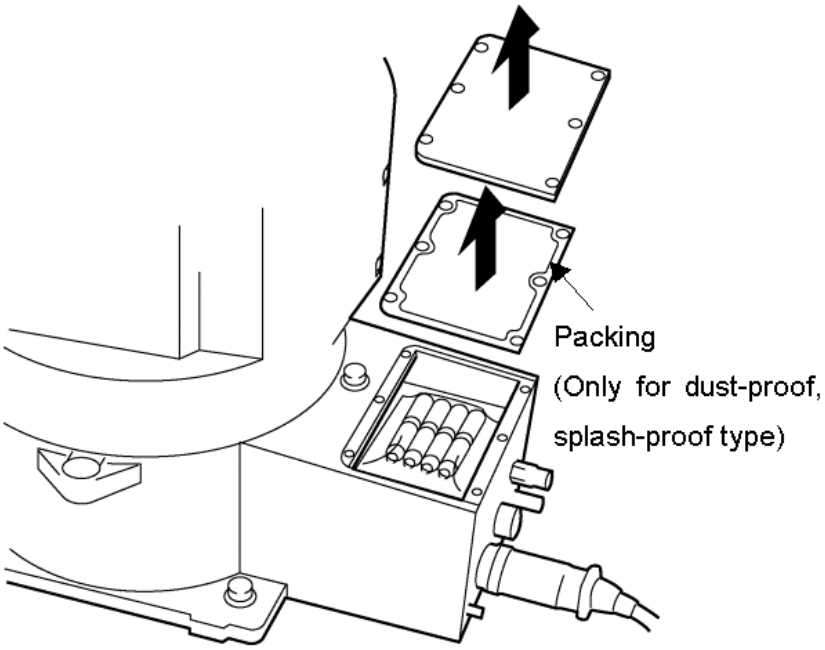
Remove the screws fastening the battery cover to the robot unit with a hexagon wrench.



STEP 5

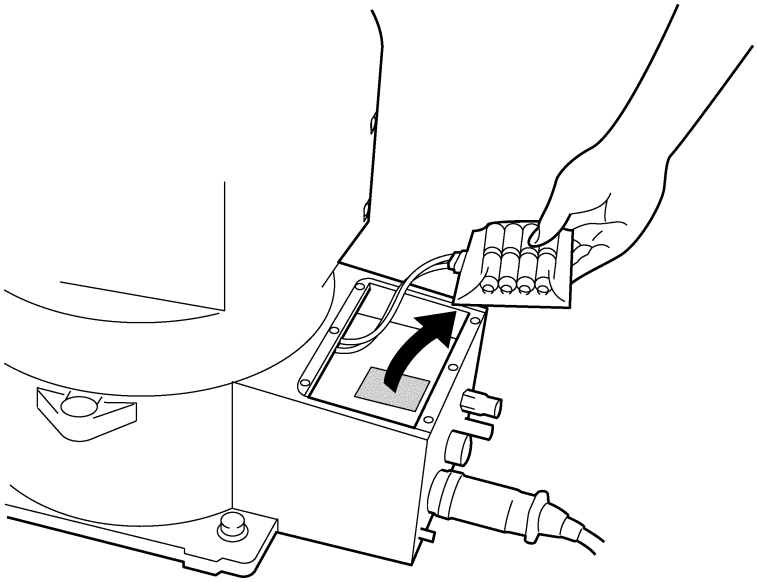
Remove the battery cover from the robot unit.

Note: For the dust-proof & splash-proof type (VM-6070D-W), remove the packing from the robot unit.



STEP 6

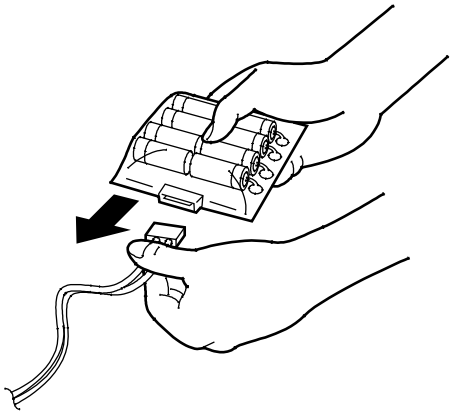
Remove the backup battery from the connector plate.



The backup battery is fastened to the connector plate with Velcro.

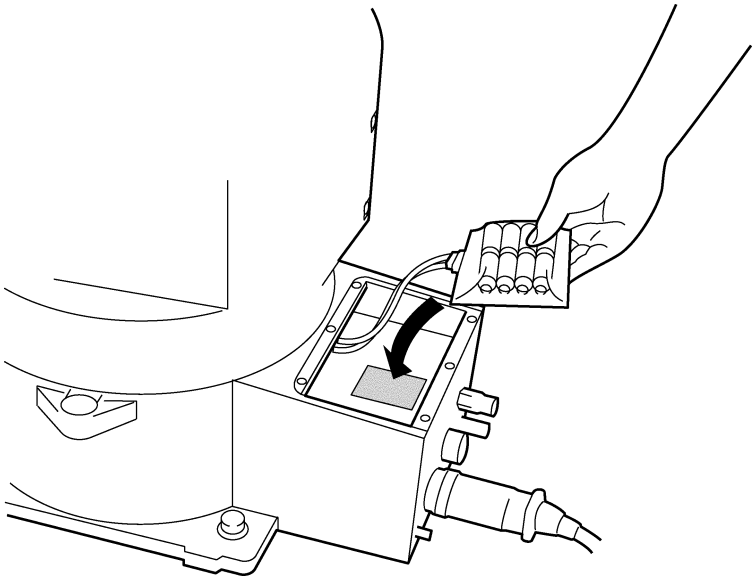
STEP 7

Disconnect the connector from the backup battery and connect a new battery prepared in Step 1.



STEP 8

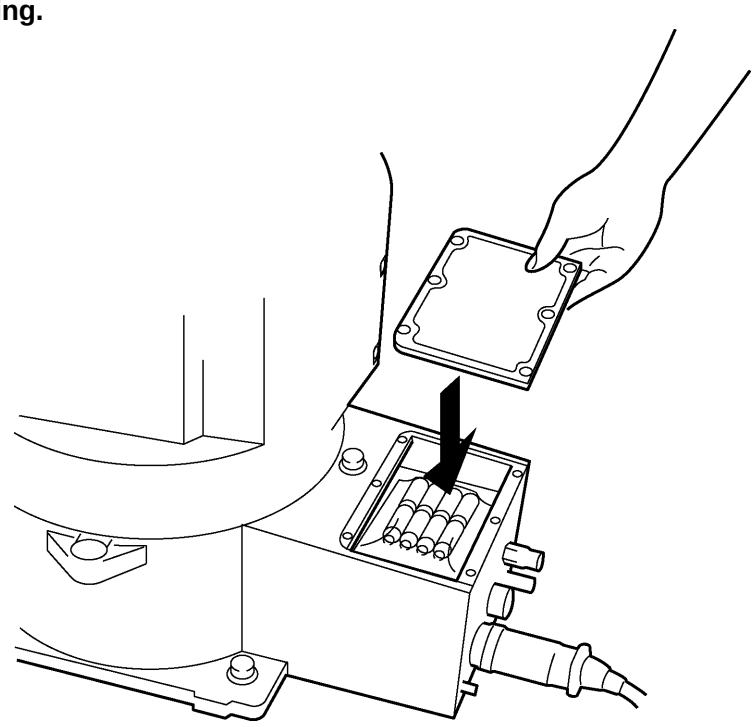
Fitting Velcro on the backup battery and that on the connector plate together, install the backup battery to the connector plate.



▸ STEP 9

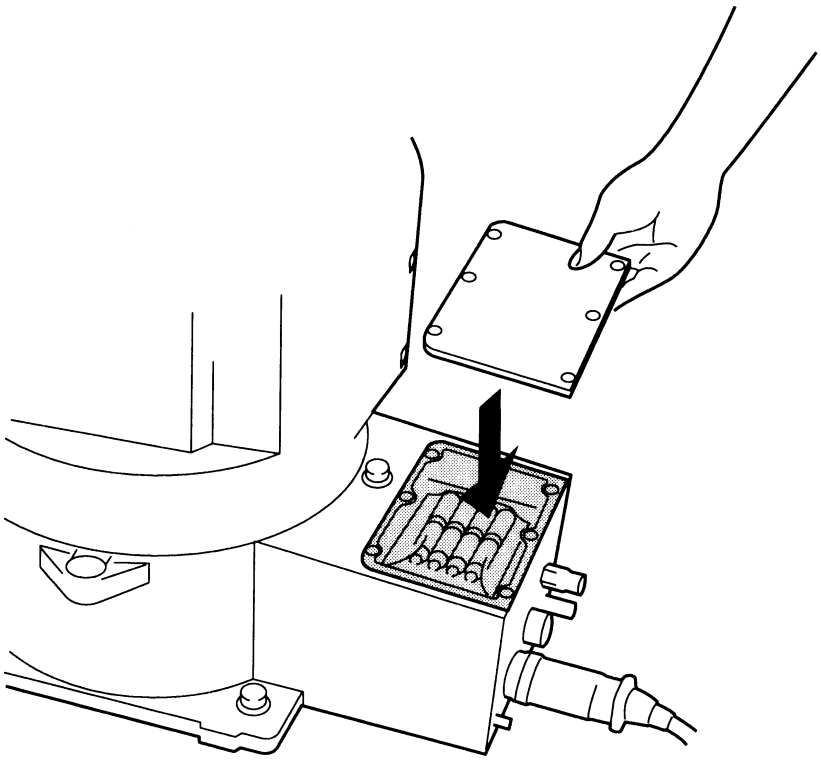
(Only for VM-6070D-W)

For the dust-proof & splash-proof type (VM-6070D-W), put a new packing.



▸ STEP 10

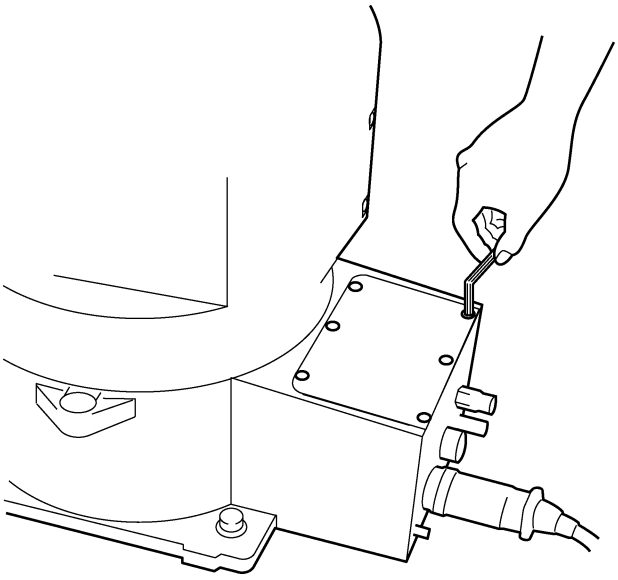
Set the battery cover back into place.



STEP 11

Secure the battery cover with screws, using a hexagon wrench.

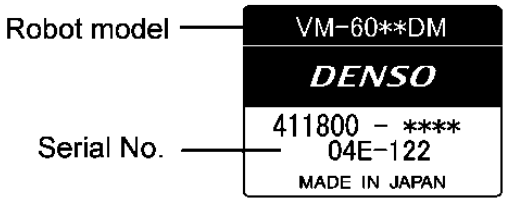
Tightening torque: 1.6 ±0.3 Nm



[2] VM-6083D/VM-60B1D (Serial number: “04E-121 or before”)

Caution: The encoder backup battery had been modified from the robot that serial number is **“04E-122 or after”** in the VM-6083D and VM-60B1D series. This modification has no interchangeability between the new backup battery and the old ones. Please confirm the serial number of the robot when replacing the encoder backup battery. Refer to “ Item [3] VM-6083D/VM-60B1D (Serial number: **“04E-122 or after”**.

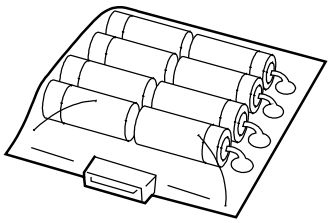
Example of nameplate



<Replacing procedure >

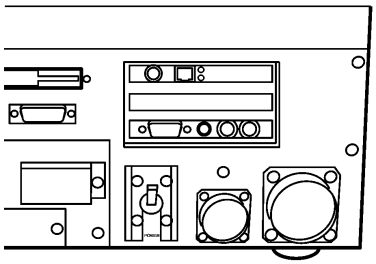
▶ STEP 1

Prepare a new backup battery for replacement.



▶ STEP 2

Turn the controller power ON.



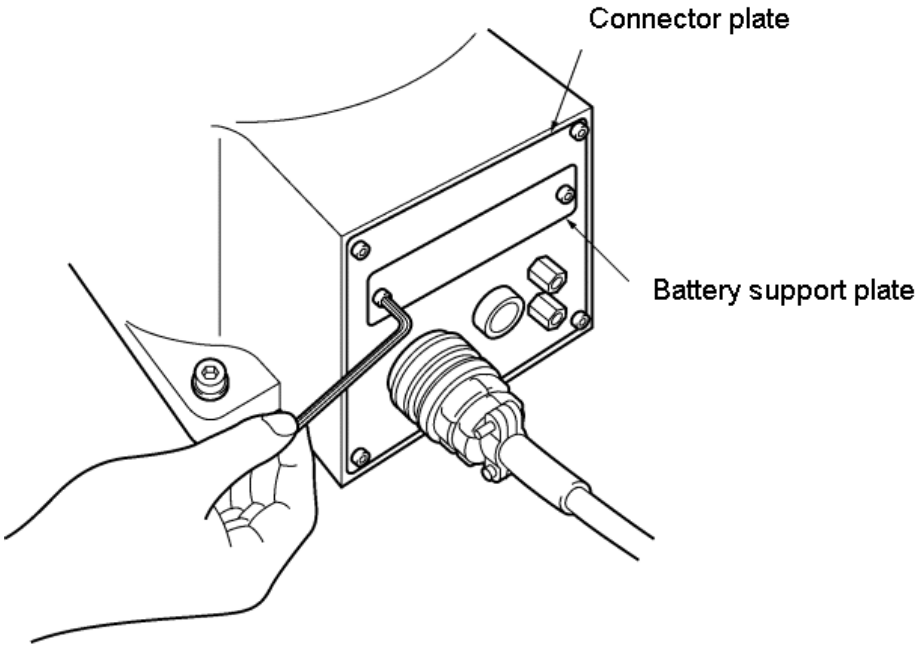
▶ STEP 3

Press and lock the robot stop button on the controller (or on the teach pendant or operating panel) in order to prevent the motor power from becoming turned on accidentally.

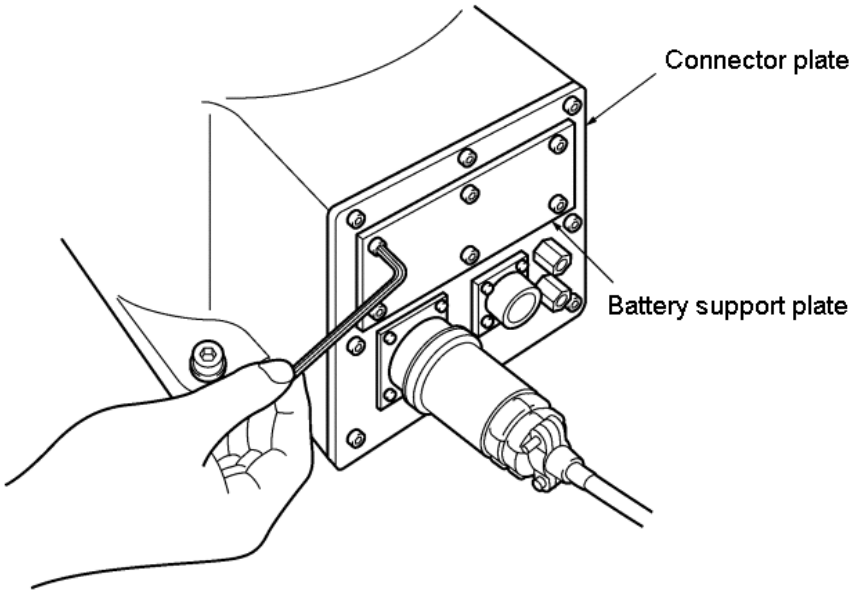
Note: To unlock the robot stop button, slightly turn it clockwise.

STEP 4

Remove the battery support plate from the rear.



<Standard type (VM-6083D, VM-60B1D)>



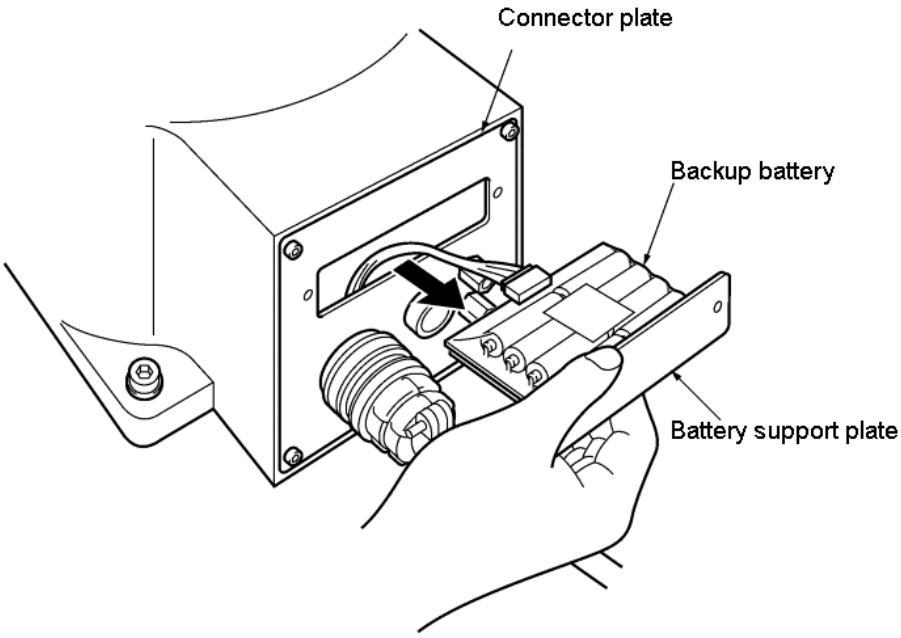
<Dust-proof, splash-proof type (VM-6083D-W, VM-60B1D-W)>

Secured to the connector plate, the battery support plate holds the backup battery.

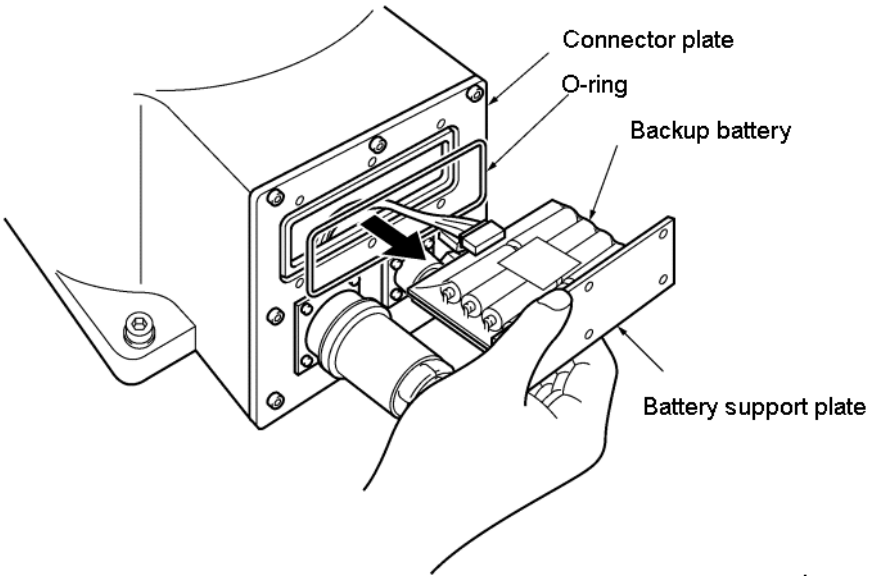
STEP 5

Pull out the battery support plate.

Note: If the robot is the dust-proof, splash-proof type, remove the O-ring from the connector plate.



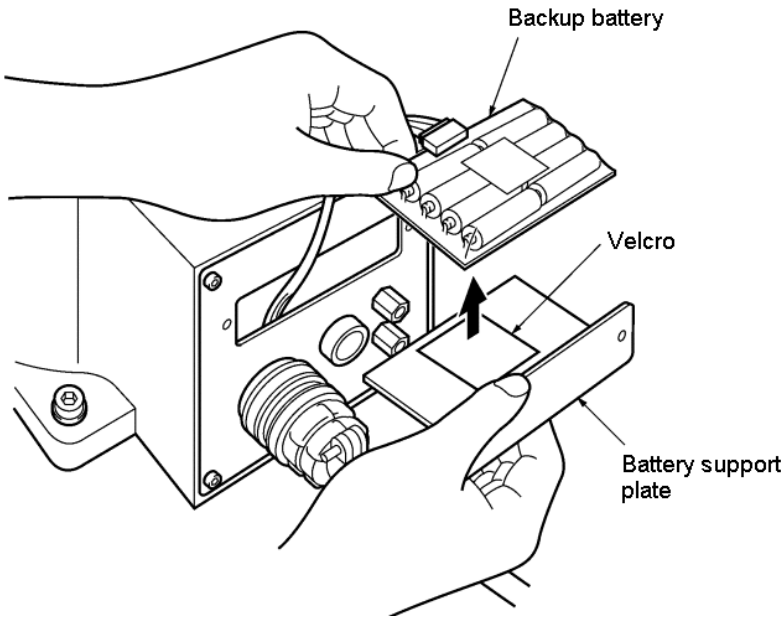
<Standard type (VM-6083D, VM-60B1D)>



<Dust-proof, splash-proof type (VM-6083D-W, VM-60B1D-W)>

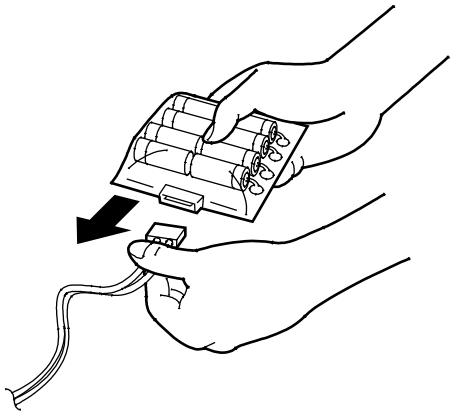
STEP 6

Remove the backup battery which is fastened to the battery support plate with Velcro.



STEP 7

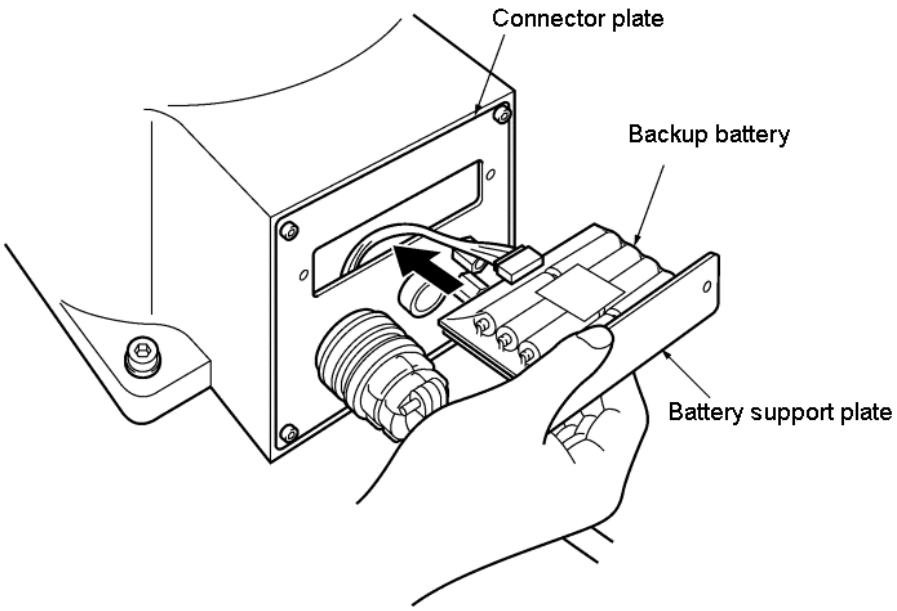
Disconnect the connector from the backup battery and connect a new battery prepared in Step 1.



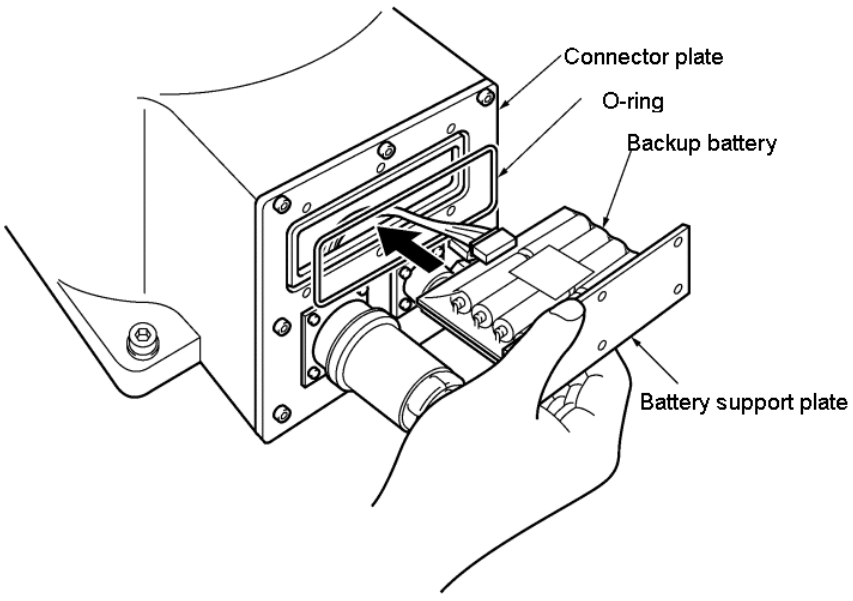
STEP 8

Fit Velcro on the new backup battery and that on the battery support plate together, then set the battery support plate into the connector plate.

Note: If the robot is the dust-proof, splash-proof type, set the new O-ring onto the connector plate.



<Standard type (VM-6083D, VM-60B1D)>

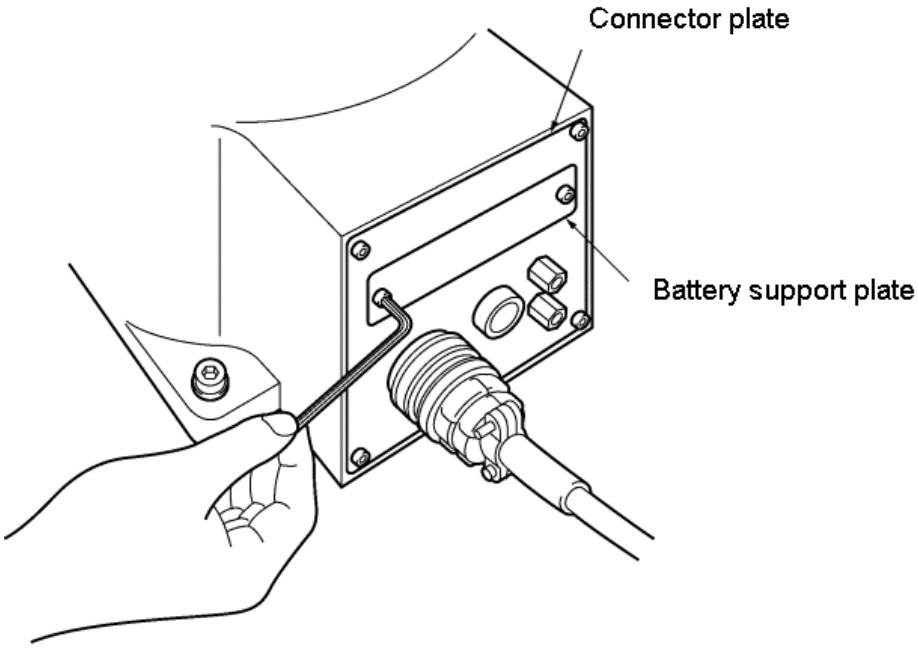


<Dust-proof, splash-proof type (VM-6083D-W, VM-60B1D-W)>

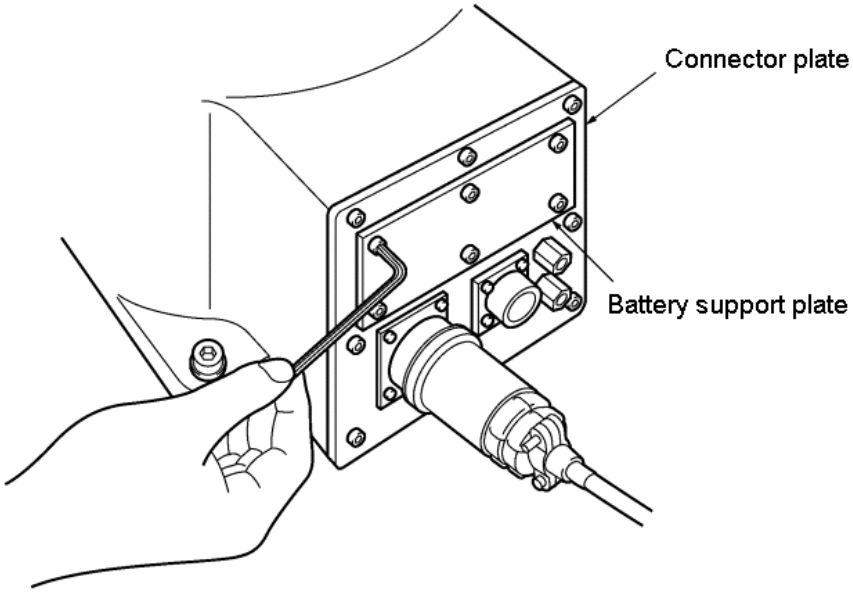
STEP 9

Secure the battery support plate to the connector plate.

Tightening torque: 1.6 ±0.3 Nm



<Standard type (VM-6083D, VM-60B1D)>

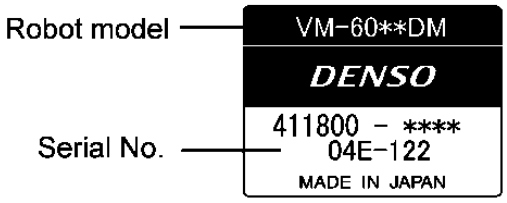


<Dust-proof, splash-proof type (VM-6083D-W, VM-60B1D-W)>

[3] VM-6083D/VM-60B1D (Serial number: “04E-122 or after”)

Caution: The encoder backup battery had been modified from the robot that serial number is **“04E-122 or after”** in the VM-6083D and VM-60B1D series. This modification has no interchangeability between the new backup battery and the old ones. Please confirm the serial number of the robot when replacing the encoder backup battery. Refer to “ Item [2] VM-6083D/VM-60B1D (Serial number: **“04E-121 or before”**.

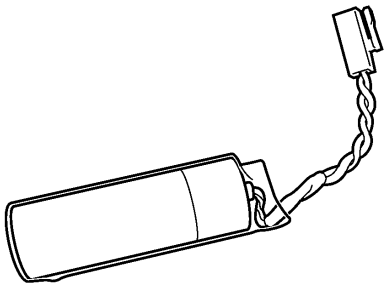
Example of nameplate



<Replacing procedure >

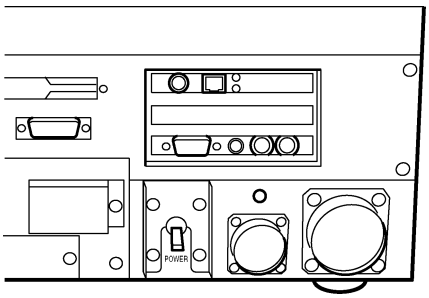
STEP 1

Prepare a new set of 3 backup batteries for replacement.
Note: Be sure to replace all of three batteries with new ones at one time.



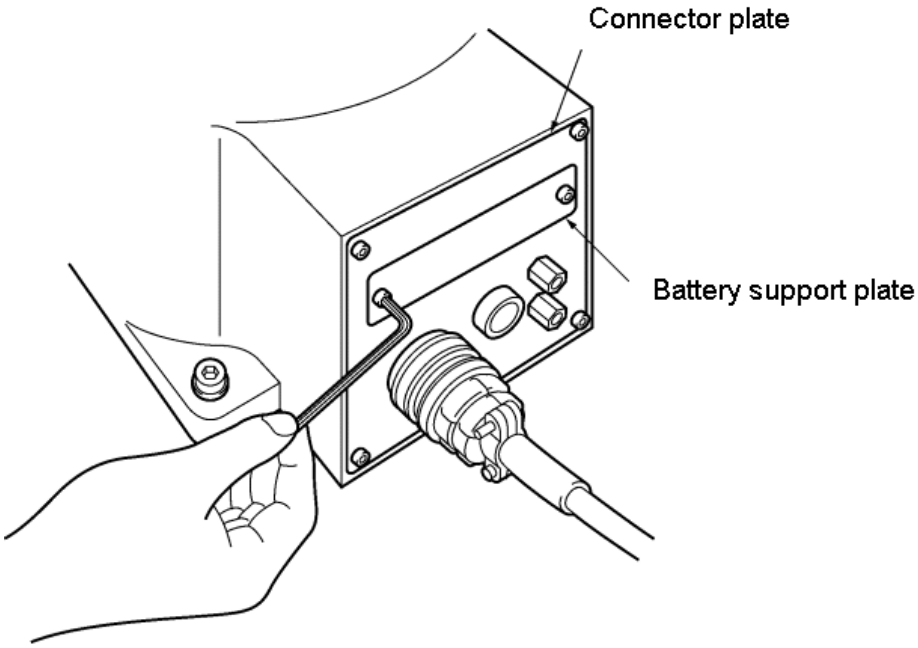
STEP 2

Turn the controller power OFF.

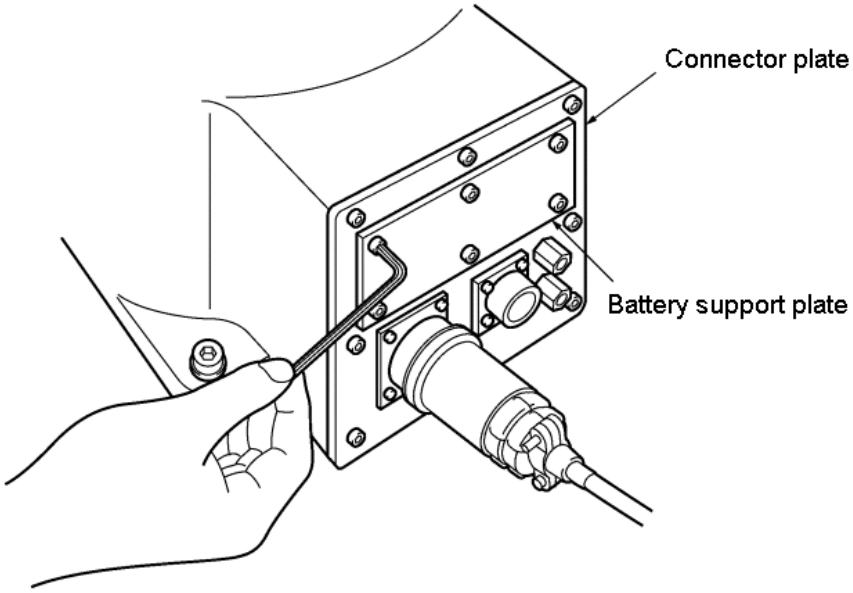


STEP 3

Remove the hexagon socket-head bolts from the battery support plate.



<Standard type (VM-6083D, VM-60B1D)>

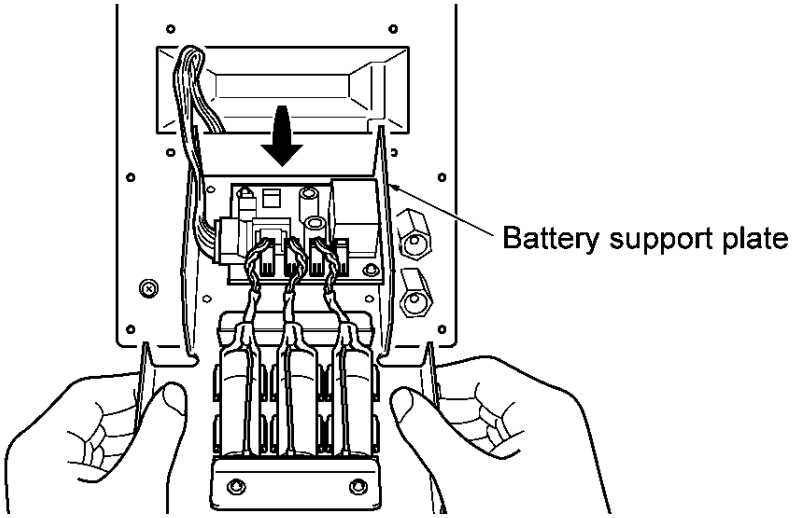


<Dust-proof, splash-proof type (VM-6083D-W, VM-60B1D-W)>

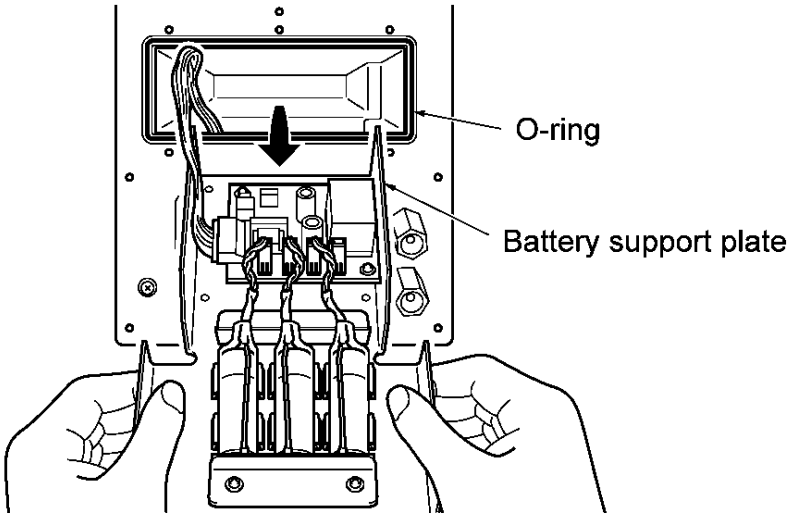
STEP 4

Pull out the battery support plate from the robot unit.

Note: If the robot is the dust-proof, splash-proof type, replace the O-ring to the new ones.



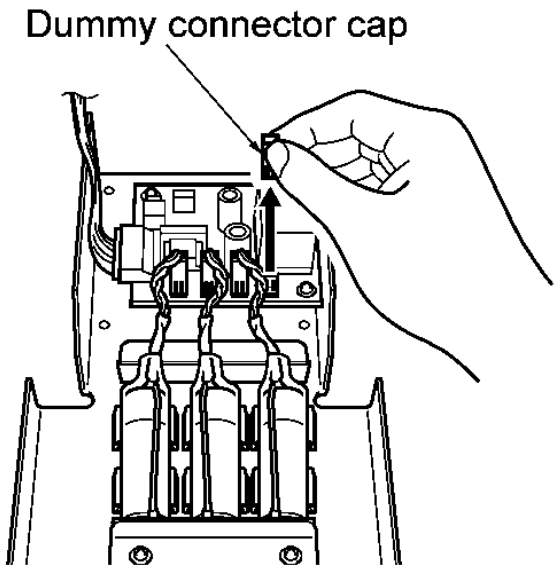
<Standard type (VM-6083D ,VM-60B1D)>



< Dust-proof, splash-proof type (VM-6083D-W, VM-60B1D-W) >

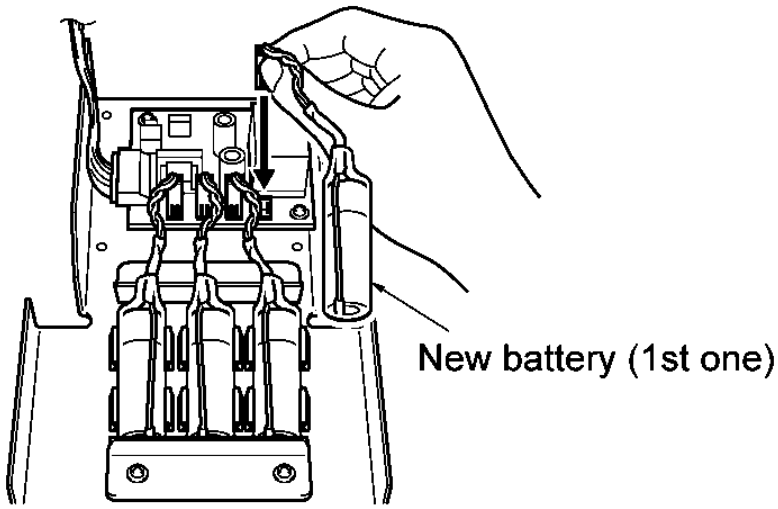
STEP 5

Remove the dummy connector cap from the battery board.



STEP 6

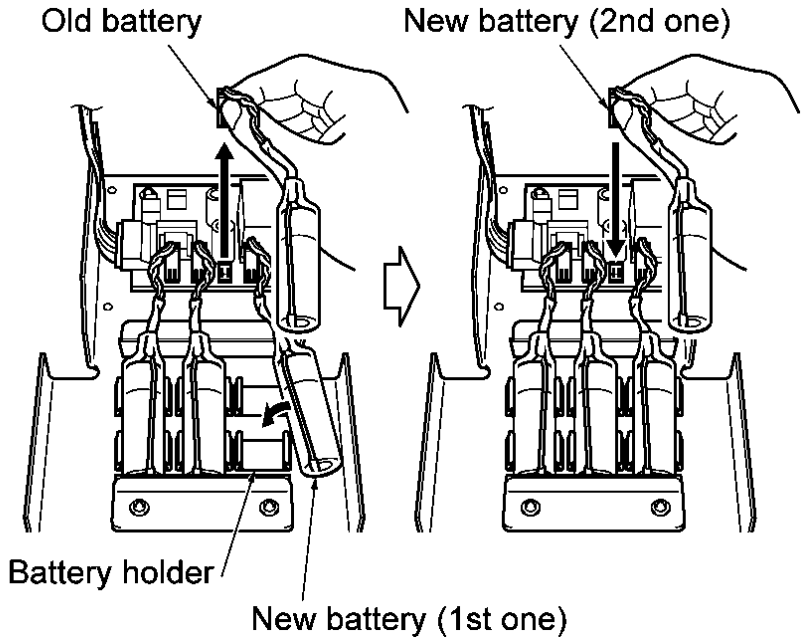
Connect a new battery (1st one) to the pin from which you have disconnected the dummy connector cap in Step 5.



Note: Do not disconnect old backup batteries before connecting a new one to the pin from which the dummy connector cap is removed. If you do so, the encoder positional data may be lost.

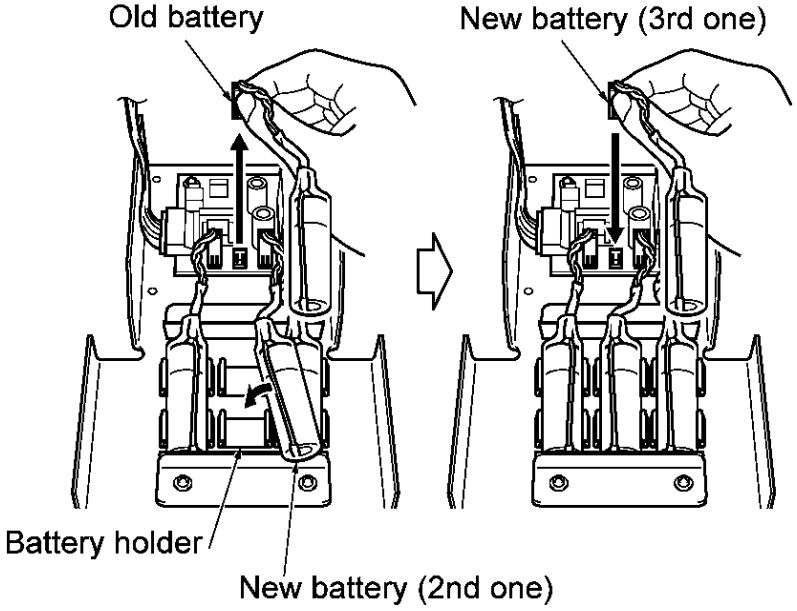
STEP 7

Disconnect the old backup battery that is left next to the new battery connected in Step 6, and then connect a new battery (2nd one).



STEP 8

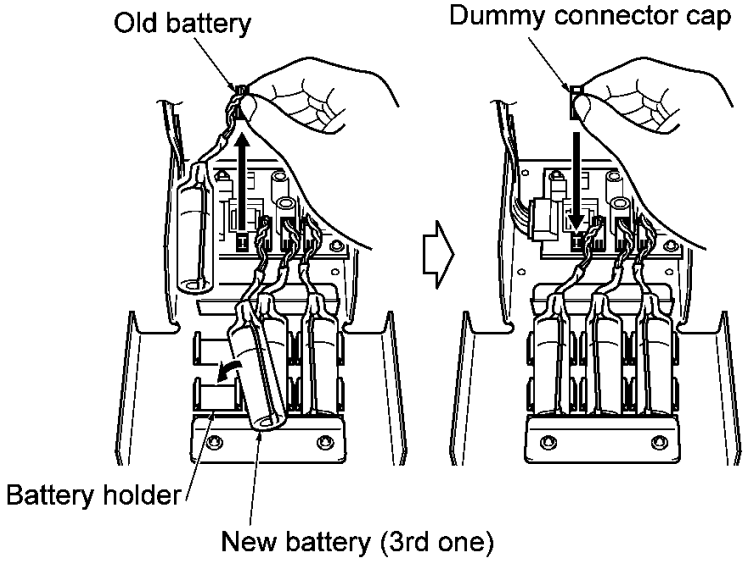
Disconnect the old backup battery that is left next to the new battery connected in Step 7, and then connect a new battery (3rd one).



Note: Be sure to replace all of three batteries with new ones at one time. Otherwise, the battery service life will become short.

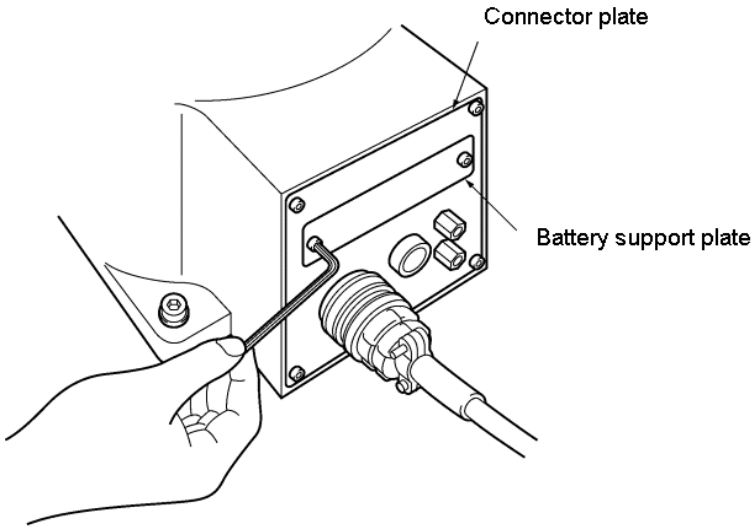
STEP 9

Remove the last old battery and connect the dummy connector cap disconnected in Step 5.

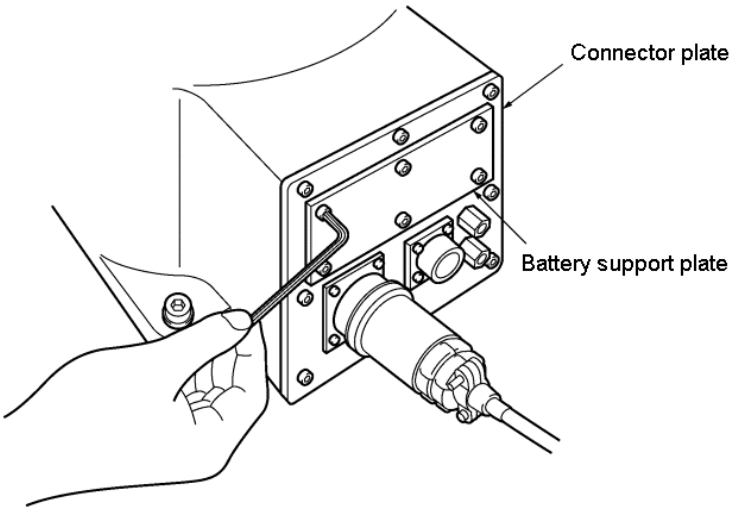


STEP 10

Secure the battery support plate to the connector plate.
Tightening torque: 1.6 ±0.3 Nm



<Standard type (VM-6083D, VM-60B1D)>



< Dust-proof, splash-proof type (VM-6083D-W, VM-60B1D-W) >

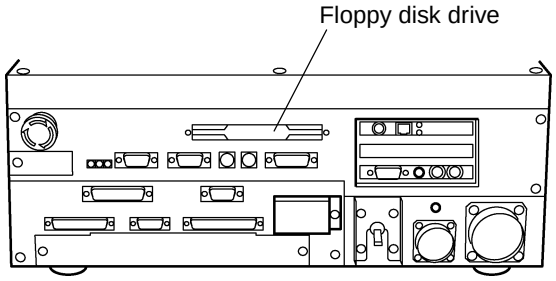
3.4.3 Replacing the Memory Backup Battery

This section gives an example of replacing the memory backup battery. This procedure requires a floppy disk.

Caution: Before replacing the memory backup battery, be sure to save (write) the memory data of the robot controller onto a floppy disk. The built-in floppy disk drive is an option.

▶ STEP 1

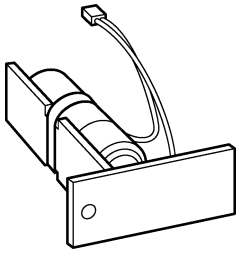
Save (write) the controller memory data onto a floppy disk.



For the data saving procedure, refer to the SETTING-UP MANUAL, Section 5.7 "Displaying the FDD Access Menu, [F6 Set]-[F3 FD.]-[F2 Write.].

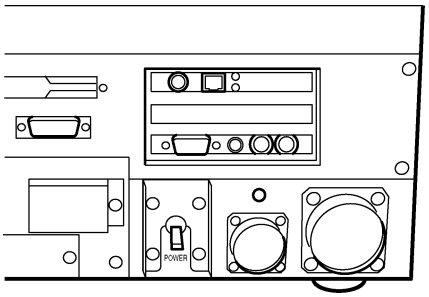
▶ STEP 2

Prepare a new memory backup battery.



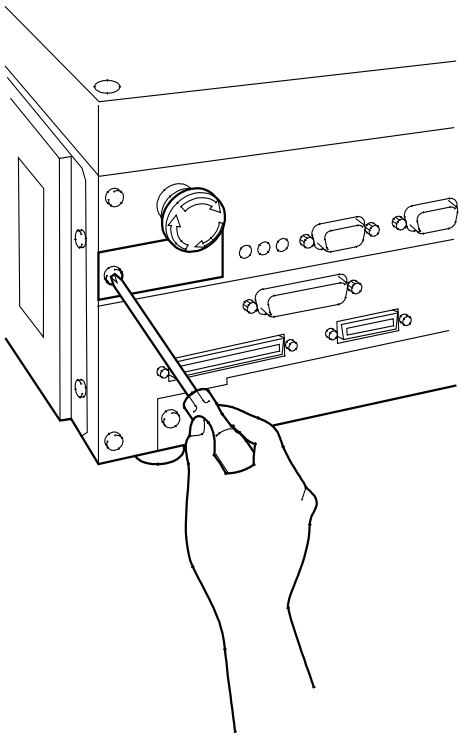
▶ STEP 3

Turn the controller power ON, wait at least one minute, and then turn it OFF again.



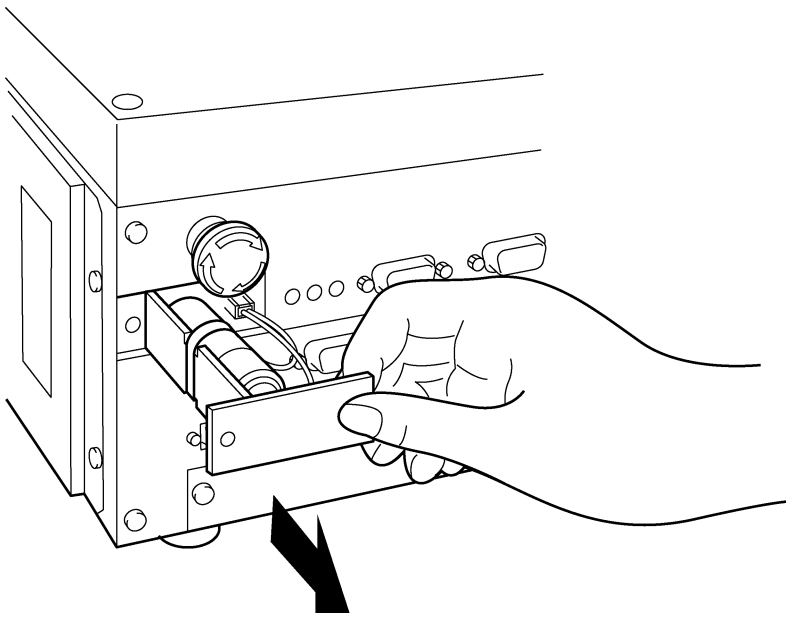
STEP 4

Remove the screw to release the backup battery support.



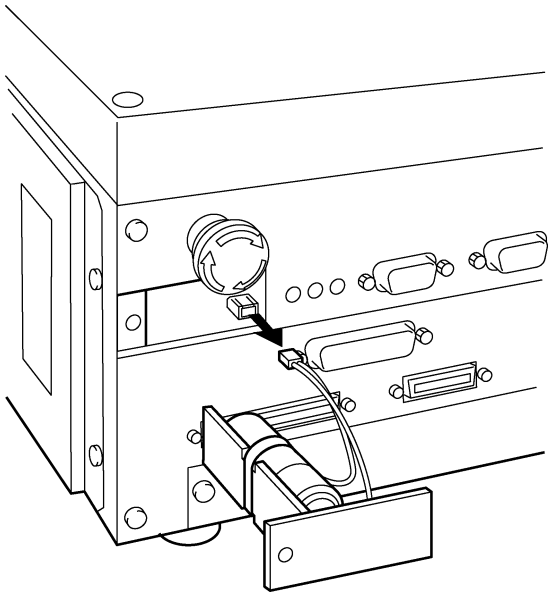
STEP 5

Pull out the backup battery support.



▶ STEP 6

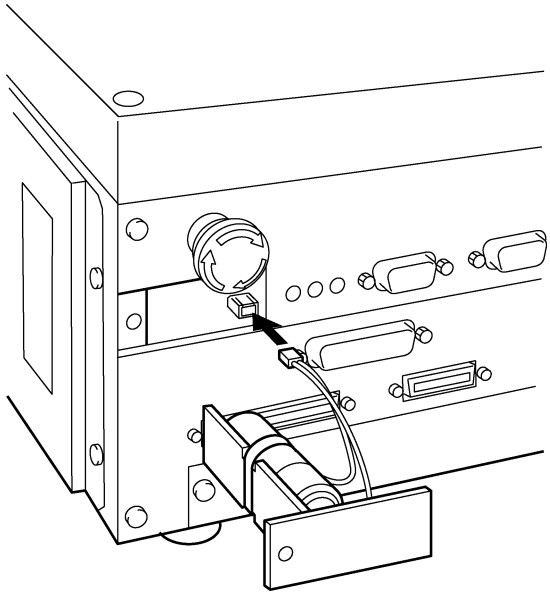
Disconnect the backup battery connector.



⚠Caution: Complete the operations in Steps 6 and 7 within three minutes. If the battery is disconnected for over three minutes, the memory data will be lost.

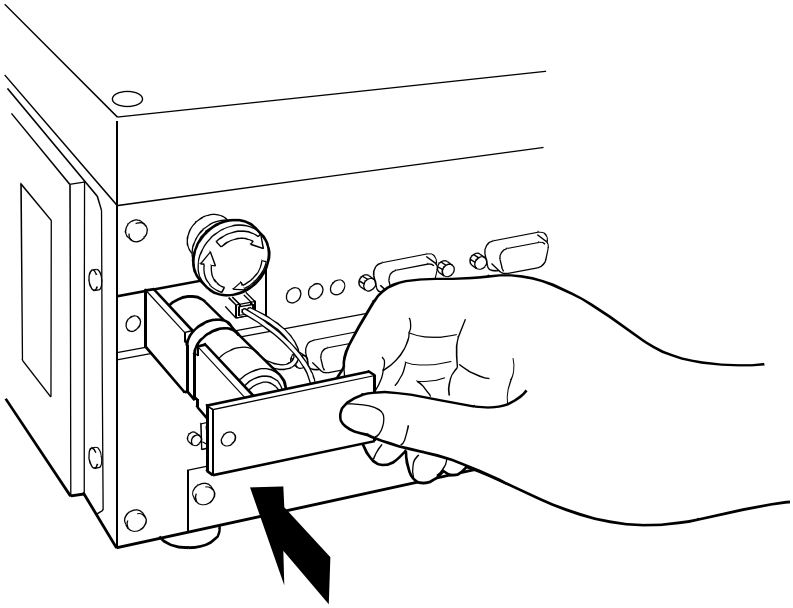
▶ STEP 7

Connect the new memory backup battery prepared in Step 2, to the robot controller.



STEP 8

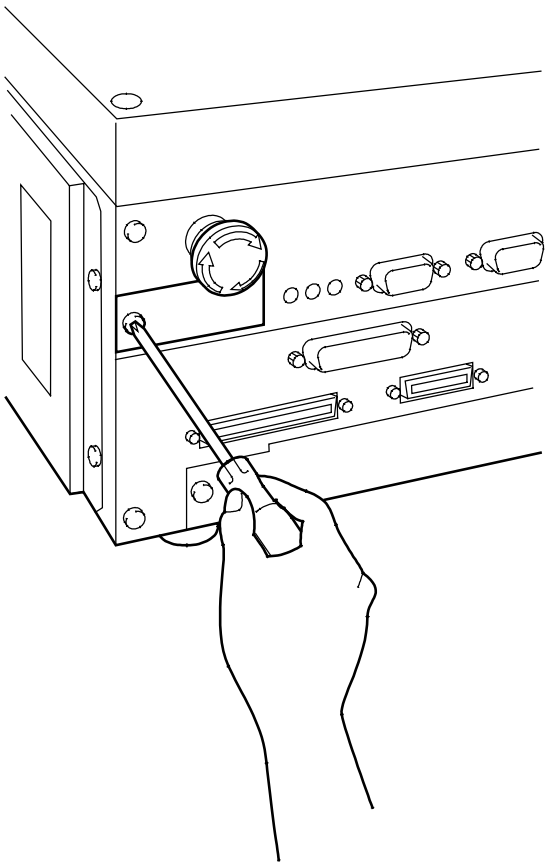
Push the backup battery support into the robot controller.



⚠Caution: Take care not to pinch the battery lead wires between covers or internal parts. Shorting many occur, resulting in an unexpected failure.

STEP 9

Secure the backup battery support with a screwdriver.



3.4.4 Setting the Next Battery Replacement Date

After replacing the memory backup battery, set the next battery replacement date from the teach pendant, according to the following procedure.

NOTE: This procedure cannot be performed with the operating panel.

NOTE: Check that the system clock of the robot controller shows the correct date beforehand. If it is incorrect, the next replacement date will also become incorrect.

STEP 1

On the top screen of the teach pendant, press [F6 Set].
The Settings (Main) window appears.

STEP 2

Press [F6 Maint.] in the Settings (Main) window.
The Maintenance menu appears.

STEP 3

Press [F4 Battery] in the Maintenance menu.
The Next Battery Replacement Date window appears.

In the top of the window, the current setting is displayed.

The date entry areas show the default replacement date that is two years later the current data at which you open this window, assuming that the battery service life is two years.

STEP 4

Press OK.

NOTE: If you do not want to change the replacement date, press Cancel.

The message "Are you sure you want to set the next battery replacement date?" appears.

STEP 5

Press OK.
The screen returns to the Settings (Main) window.

3.5 2.5-year Inspections (VM-6070D only)

3.5.1 Check Items

Check the items listed in the table below every 2.5 years (30 months).

2.5-year Inspection Table (VM-6070D)

No.	Check:	Controller Power	How to check:	Criterion	What to do:
1	Rotary sections and slideways of the robot	OFF	Lubricate the specified points, referring to Subsection 3.5.2. (See NOTE.)		
2	Timing belts on the 1st to 5th axes	OFF	Visually	No lack of teeth or excessive wear.	Contact DENSO, Industrial Systems Product Division.

NOTE: As a guide, lubrication should be at 10,000-hour intervals. You need to change the lubrication intervals according to your operation conditions.

3.5.2 Lubrication Jobs

Apply the specified lubricants to the rotary sections and slideways of the robot unit according to the procedure given in this section.

The lubrication procedure is common to the VM-6070D and VM-6070D-W.

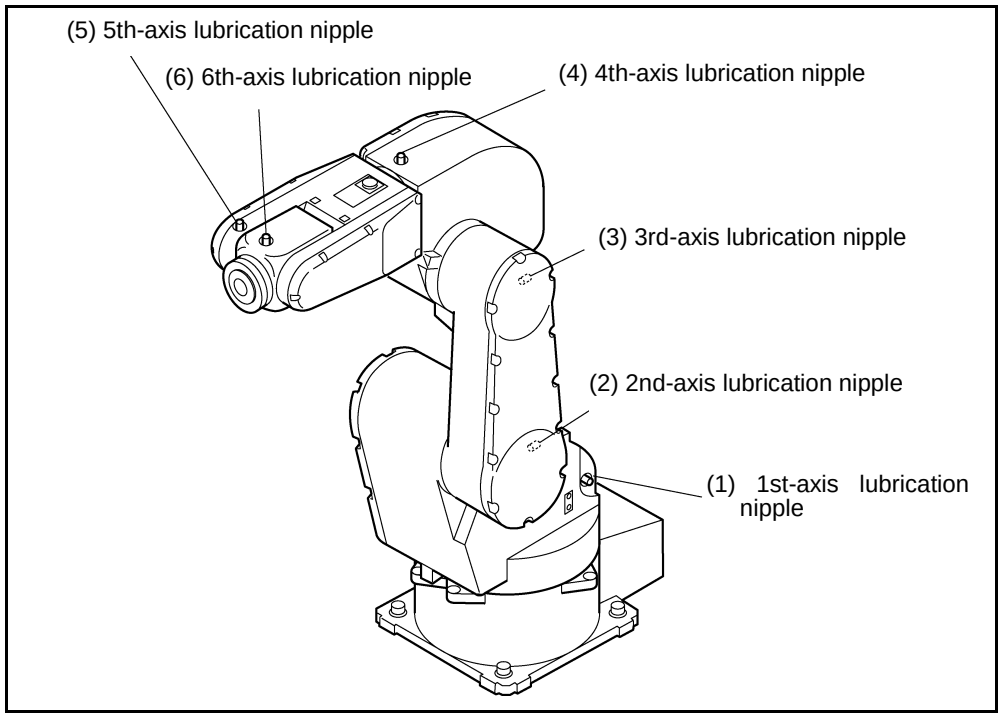
3.5.2.1 Lubrication points and lubricants

The table and figure below show the lubrication points, lubricant types and lubricant amounts for the VM-6070D robot. Use a grease gun for lubrication.

Lubrication Points and Lubricants (VM-6070D/VM-6070D-W)

No.	Lubricating Position	Lubricant type	Lubricant amount
(1)	1st-axis lubrication nipple	4B No.2	4 pushes
(2)	2nd-axis lubrication nipple	4B No.2	4 pushes
(3)	3rd-axis lubrication nipple	4B No.2	4 pushes
(4)	4th-axis lubrication nipple	4B No.2	3 pushes
(5)	5th-axis lubrication nipple	4B No.2	2 pushes
(6)	6th-axis lubrication nipple	4B No.2	2 pushes

NOTE: The lubrication amount is expressed in the number of pushes when you use a recommended grease gun which discharges 1.4 cc of grease each time it is pushed. (Refer to Section 3.6, "Supplies and Tools for Maintenance.")



Lubrication Points on the VM-6070D/VM-6070D-W

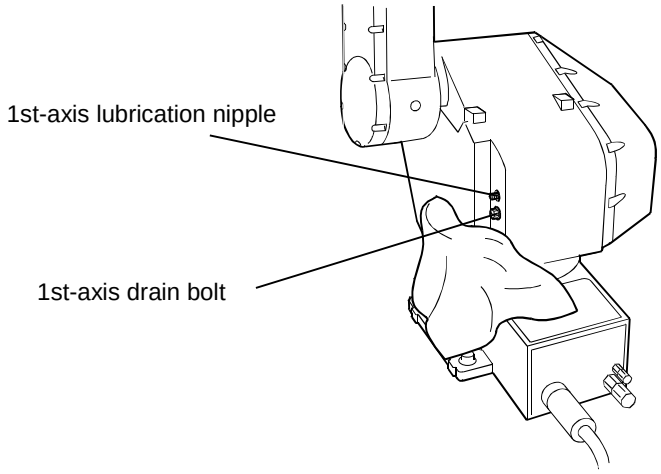
3.5.2.2 Lubricating procedure

Lubricate each axis according to the procedure given below.

(1) Lubricating the 1st axis

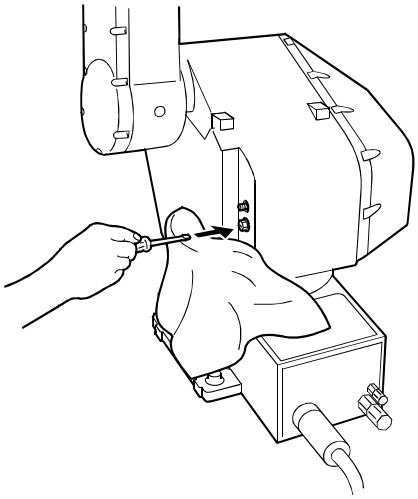
▶ STEP 1

Cover the area around the 1st-axis drain bolt with a waste cloth. This is to prevent the wiring, connectors, and belts from getting dirtied by discharging grease.



▶ STEP 2

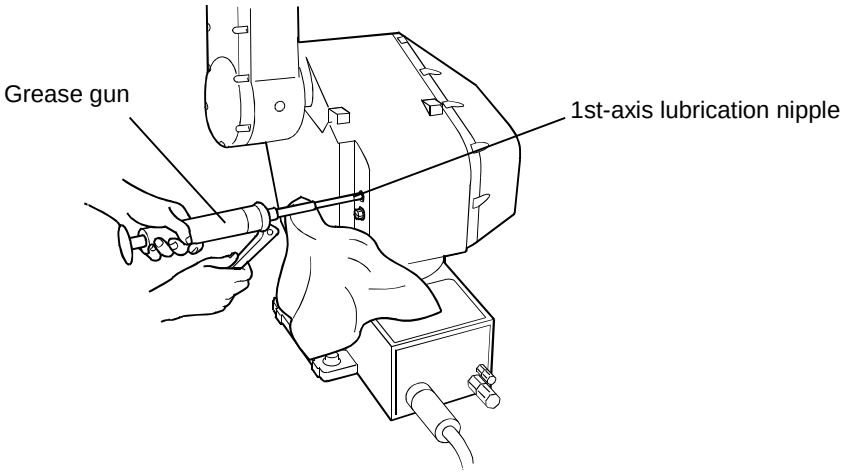
Remove the 1st-axis drain bolt with a screwdriver.



STEP 3

Supply grease through the 1st-axis lubrication nipple, using a grease gun.

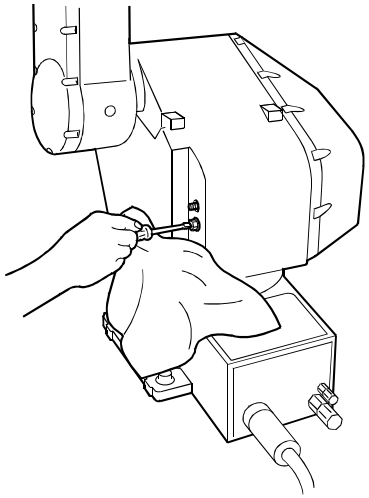
Lubricant amount: 4 pushes or 5.6 cc (with a recommended grease gun)



STEP 4

Reinstall the 1st-axis drain bolt with a screwdriver .

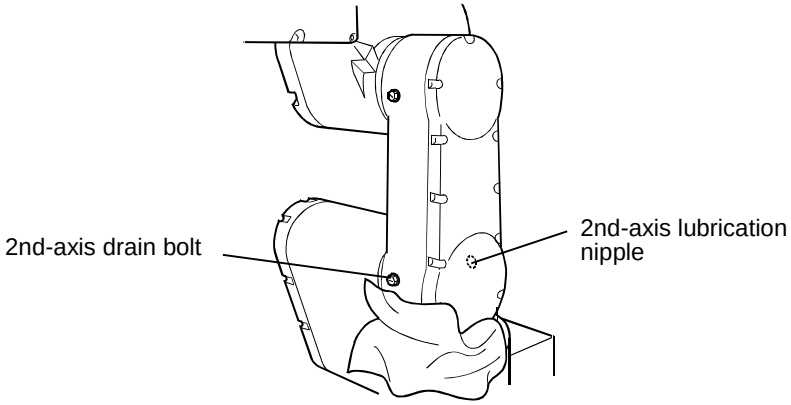
Tightening torque: 1.5 ±0.3 Nm



(2) Lubricating the 2nd axis

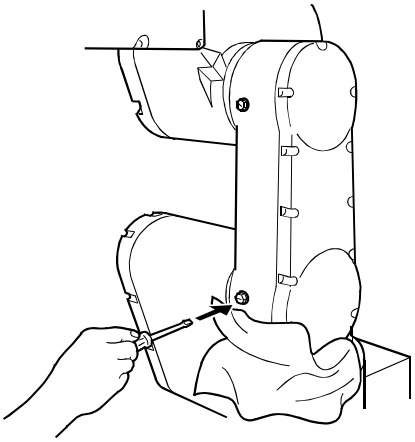
STEP 1

Cover the area around the 2nd-axis drain bolt with a waste cloth. This is to prevent the wiring, connectors, and belts from getting dirtied by discharging grease.



STEP 2

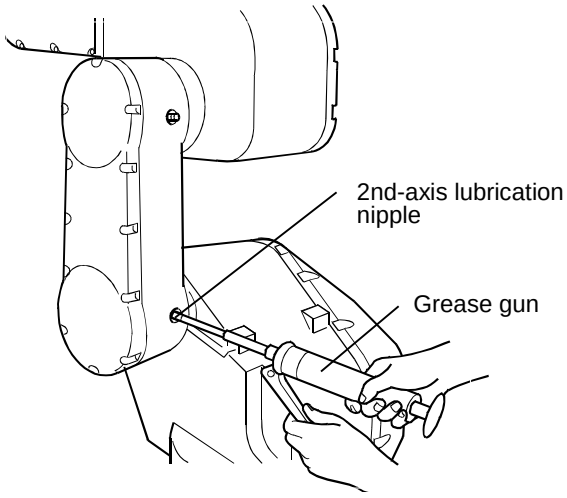
Remove the 2nd-axis drain bolt with a screwdriver.



STEP 3

Supply grease through the 2nd-axis lubrication nipple, using a grease gun.

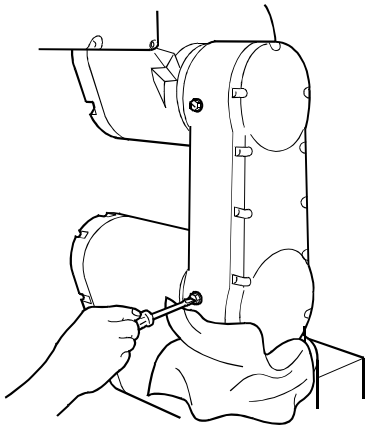
Lubricant amount: 4 pushes or 5.6 cc (with a recommended grease gun)



STEP 4

Reinstall the 2nd-axis drain bolt with a screwdriver.

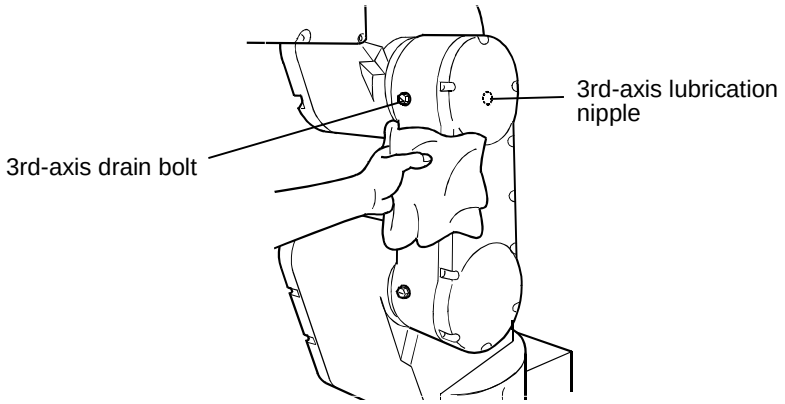
Tightening torque: 1.5 ±0.3 Nm



(3) Lubricating the 3rd axis

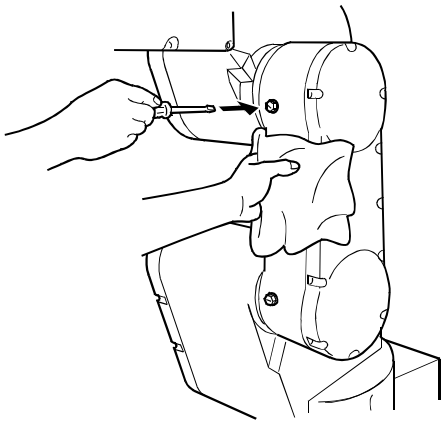
STEP 1

Cover the area around the 3rd-axis drain bolt with a waste cloth. This is to prevent the wiring, connectors, and belts from getting dirtied by discharging grease.



STEP 2

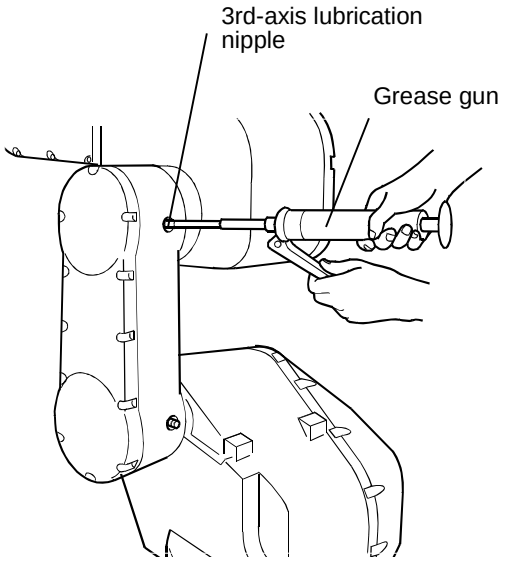
Remove the 3rd-axis drain bolt with a screwdriver.



STEP 3

Supply grease through the 3rd-axis lubrication nipple, using a grease gun.

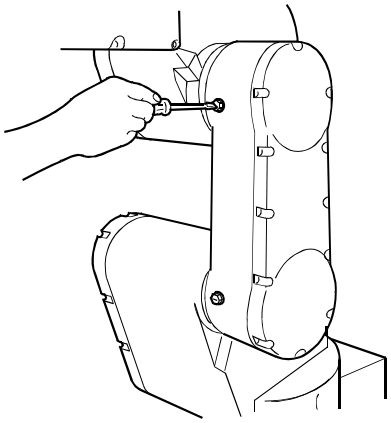
Lubricant amount: 4 pushes or 5.6 cc (with a recommended grease gun)



STEP 4

Reinstall the 3rd-axis drain bolt with a screwdriver.

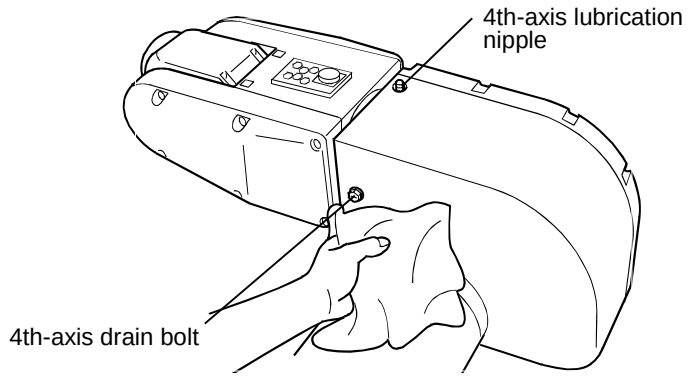
Tightening torque: 1.5 ±0.3 Nm



(4) Lubricating the 4th axis

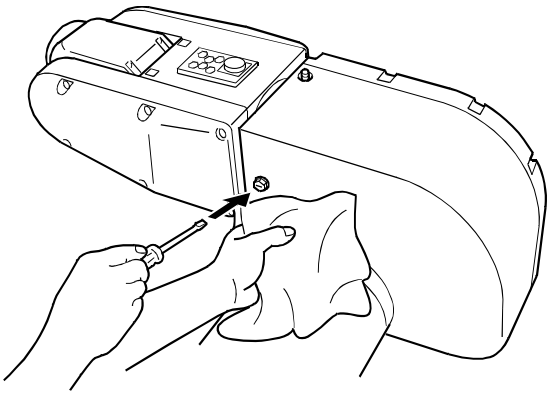
STEP 1

Cover the area around the 4th-axis drain bolt with a waste cloth. This is to prevent the wiring, connectors, and belts from getting dirtied by discharging grease.



STEP 2

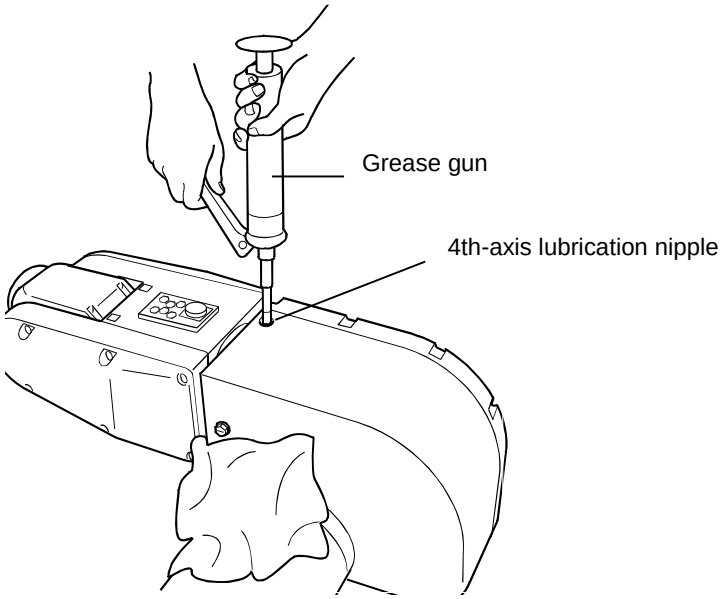
Remove the 4th-axis drain bolt with a screwdriver.



STEP 3

Supply grease through the 4th-axis lubrication nipple, using a grease gun.

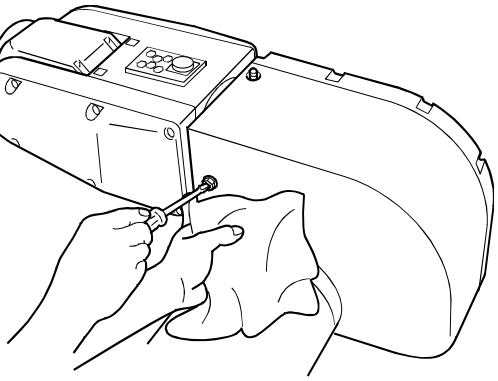
Lubricant amount: 3 pushes or 4.2 cc (with a recommended grease gun)



STEP 4

Reinstall the 4th-axis drain bolt with a screwdriver.

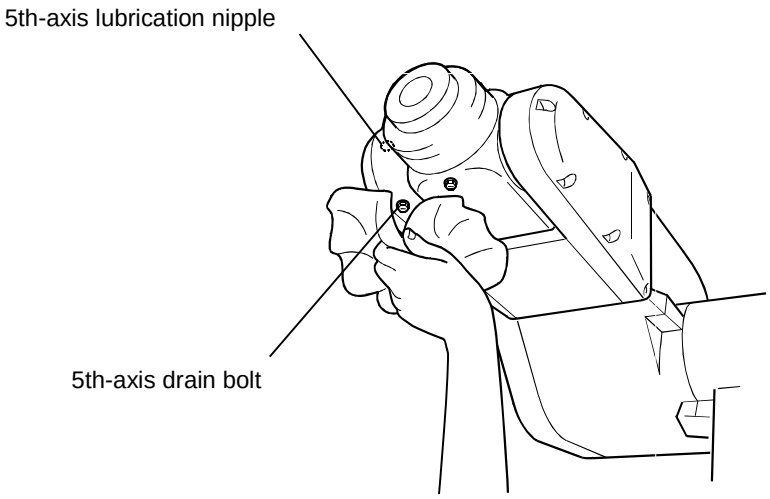
Tightening torque: 1.5 ±0.3 Nm



(5) Lubricating the 5th axis

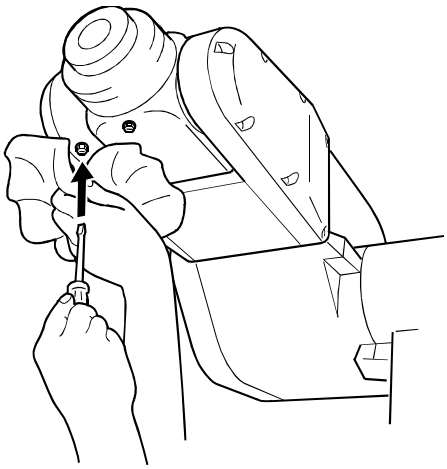
STEP 1

Cover the area around the 5th-axis drain bolt with a waste cloth. This is to prevent the wiring, connectors, and belts from getting dirtied by discharging grease.



STEP 2

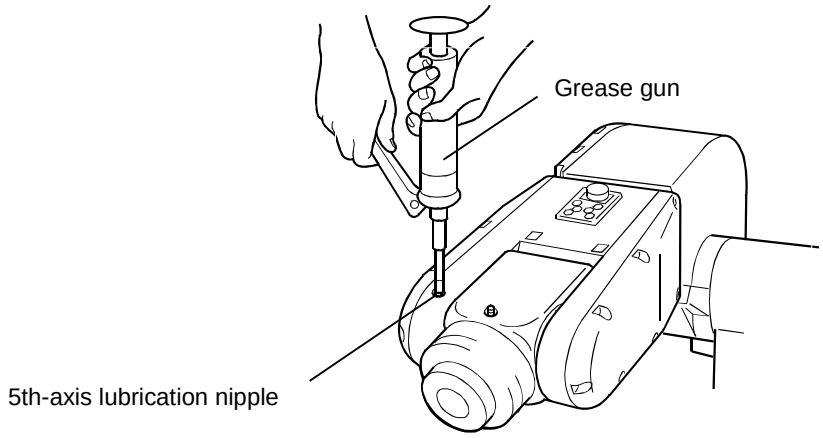
Remove the 5th-axis drain bolt with a screwdriver.



STEP 3

Supply grease through the 5th-axis lubrication nipple, using a grease gun.

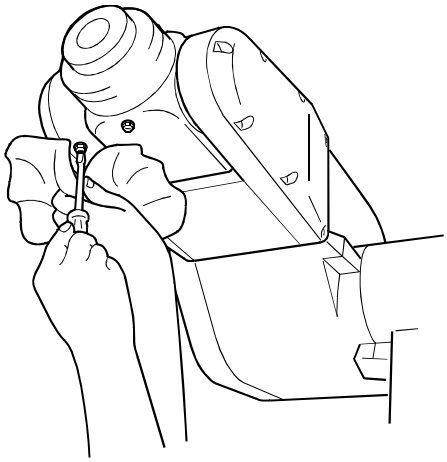
Lubricant amount: 2 pushes or 2.8 cc (with a recommended grease gun)



STEP 4

Reinstall the 5th-axis drain bolt with a screwdriver.

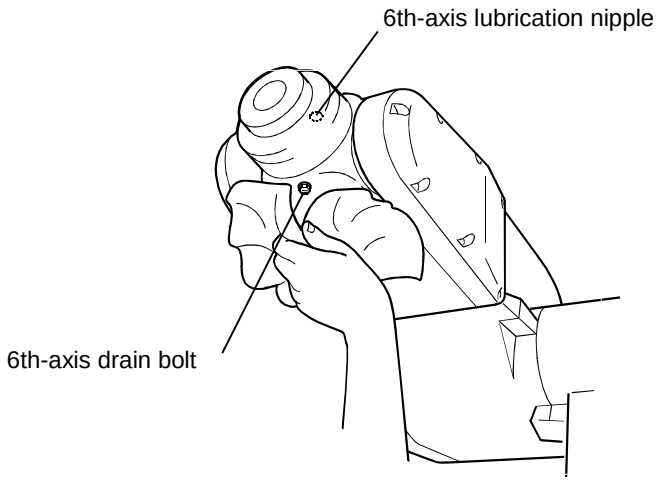
Tightening torque: 1.5 ±0.3 Nm



(6) Lubricating the 6th axis

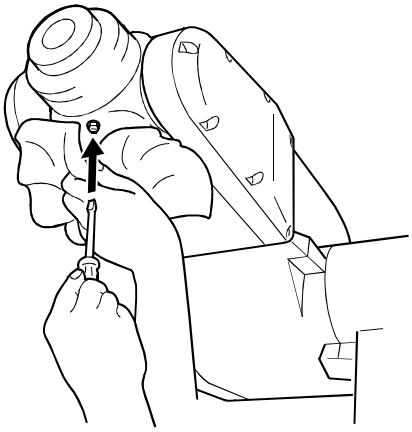
STEP 1

Cover the area around the 6th-axis drain bolt with a waste cloth. This is to prevent the wiring, connectors, and belts from getting dirtied by discharging grease.



STEP 2

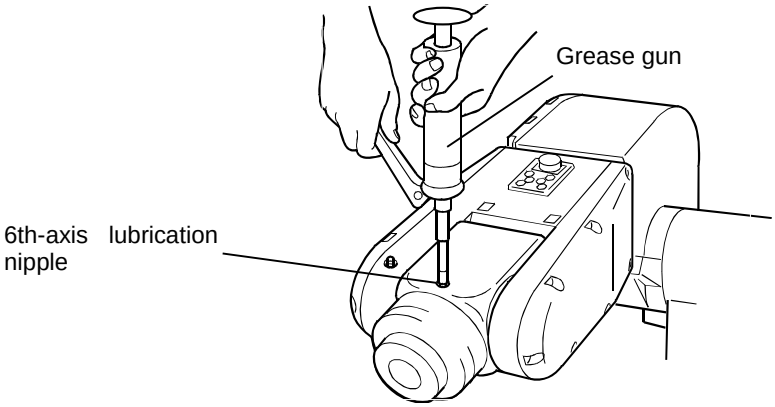
Remove the 6th-axis drain bolt with a screwdriver.



STEP 3

Supply grease through the 6th-axis lubrication nipple, using a grease gun.

Lubricant amount: 2 pushes or 2.8 cc (with a recommended grease gun)



STEP 4

Reinstall the 6th-axis drain bolt with a screwdriver.

Tightening torque: 1.5 ±0.3 Nm

3.6 Supplies and Tools for Maintenance

Tables 6-10 lists the supplies to be replaced regularly and required tools, out of components used in Denso robots. Table 6-11 lists the recommended tools for maintenance and inspection.

3.6.1 Supplies and Tools Required

List of Supplies and Tools Required

No	Name	Part No.	Remarks	
1	Grease (VM-6070D only)	410971-0120	2 kg can	Harmonic grease 4B-No. 2
2	Grease (VM-6070D only)	410971-0110	16 kg can	
3	Filter (left)	410041-0760	Cooling fan filter (inlet port filter) in the robot controller	
4	Filter (top plate)	410041-0750	Cooling fan filter (exhaust port filter) in the robot controller	
5	Memory backup unit	410076-0090	Memory backup battery for controller (with metal plate)	
6	Bus line power unit	410076-0080	Encoder backup battery	
7	Fuse (1.3A)	410054-0230	Fuse LM13 (1.3A) for controller I/O	
8	Fuse (0.3A)	410054-0240	Fuse LM03 (0.3A) for controller I/O	
9	IC for output (NPN)	410077-0010	IC (M54522P) for controller output	
10	IC for output (PNP)	410077-0020	IC (M54564P) for controller output	
11	CALSET jig	410192-0030	For 6th-axis CALSET	

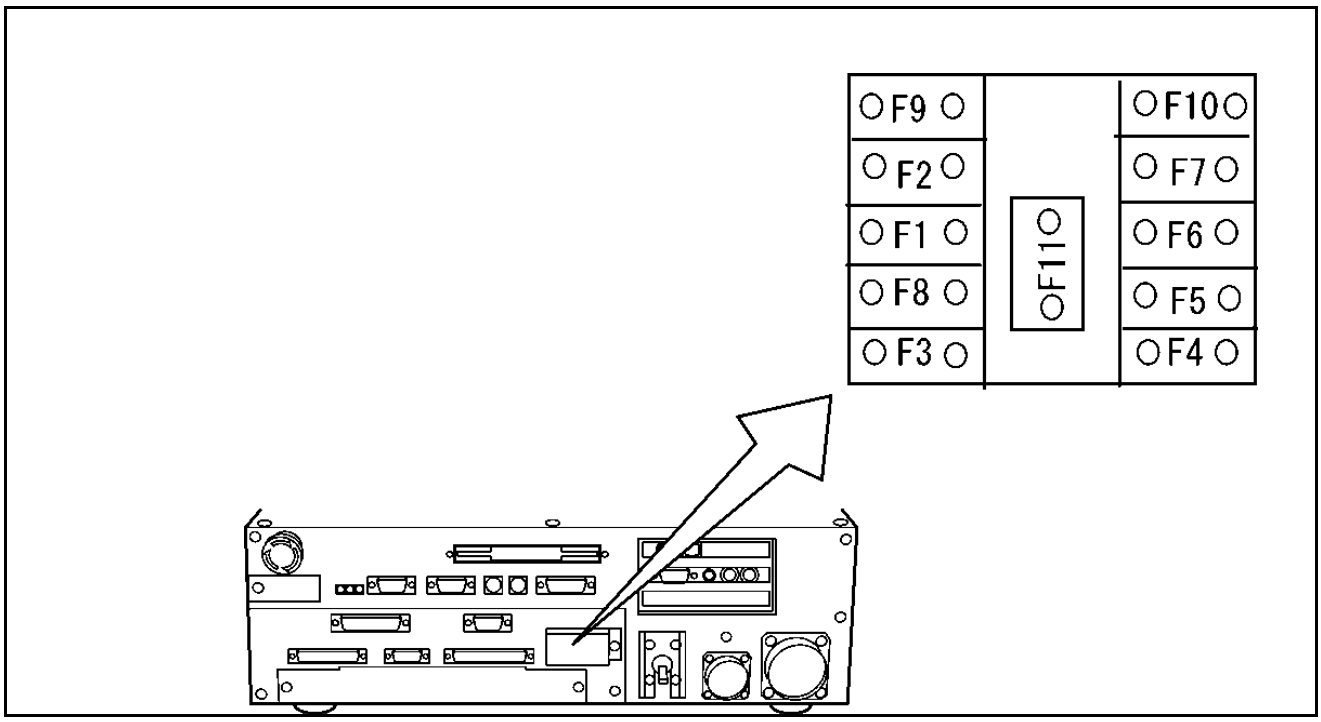
3.6.2 Recommended Tools

List of Recommended Tools

No.	Tool name	Recommended tool (manufacturer)	Application
1	Grease gun	(Yamada Corporation) ·Body: KH-32 ·Standard nozzle: HSP-1	Greasing

3.7 Replacing Fuses

The robot controller is equipped with fuses to protect it from external wiring shorted.
If any fuse is blown, replace it according to the following procedure
The fuse box containing fuses is mounted on the panel of the robot controller.



Locations and Names of Fuses

The table below lists connectors corresponding to the fuses. If an output signal error occurs, check the corresponding fuse.

Output Connectors and Fuses

Connector No.	Connector pin No.	Output IC No.	Fuse No.
I/O POWER CN7	1	—	F1 (1.3A)
	2	—	
	3	—	F2 (1.3A)
	4	—	
HAND I/O CN9	17	—	F3 (1.3A)
	1	IC 1	F4 (1.3A)
	2		
	3		
	4		
	5		
	6		
	7		
	8		
OUTPUT CN10	1	IC 2	
	2		
	3		
	4		
	5		
	6		
	7		
	8		
	9	IC 3	F5 (1.3A)
	10		
	11		
	12		
	13		
	14		
	15		
	16		
	17	IC 4	
	18		
	19		
	20		
	21		
	22		
	23		
	24		
	25	IC 5	F6 (1.3A)
	26		
	27		
	28		
	29		
	30		
	31		
	32		
	33	IC 6	
	34		
	35		
	36		
	37		
	38		
	39		
	40		
	41	IC 7	F7 (1.3A)
	42		
	43		
	44		
	45		
	46		
	47		
	48		
	49	IC 8	
	50		
	51		
	52		
	53		
	54		
	55		
	56		
	65	—	F9 (0.3A)
INPUT CN8	1	—	F8 (1.3A)
	3	—	

Note: In case of the global type (: dual emergency stop type) controller, the list below shows CN10 corresponding to the fuses.

Connector No.	Connector pin No.	Fuse No.
CN10	59	F8 (1.3 A)
	61	
	63	F11 (0.3 A)
	65	F9 (0.3 A)
	67	F10 (0.3 A)

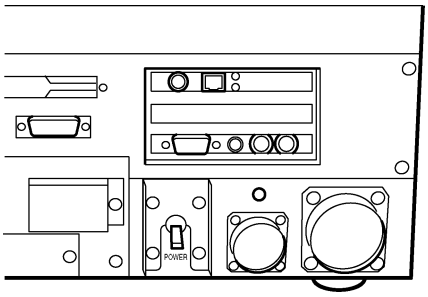
Note: For the connector pin layout, refer to Chapter 5, Subsection 5.6.1 "RC5 CONTROLLER INTERFACE MANUAL".

3.7.1 Replacing Fuses

Replace fuses according to the following procedure:

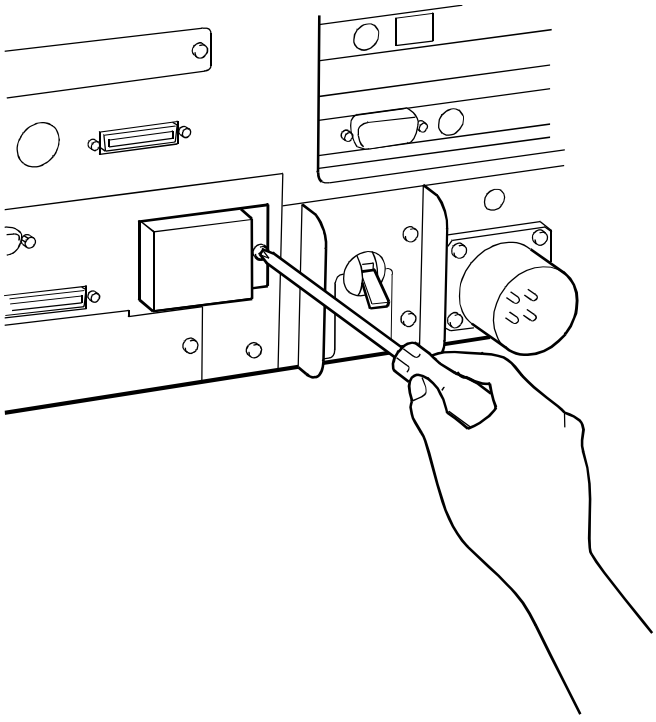
▶ STEP 1

Turn the controller power OFF.



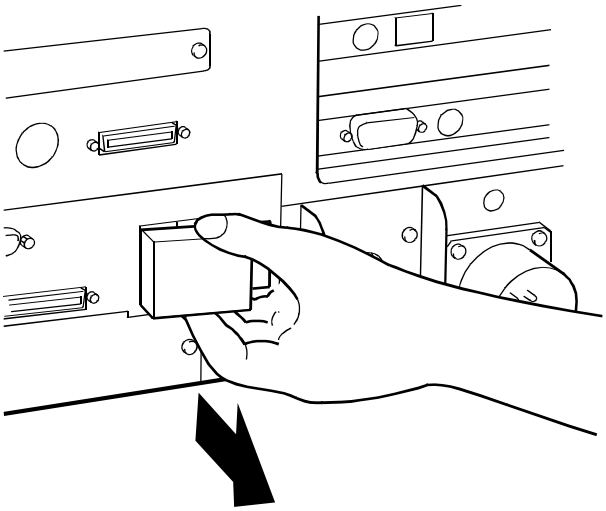
▶ STEP 2

Remove the fuse cover mounting screw with a screwdriver.



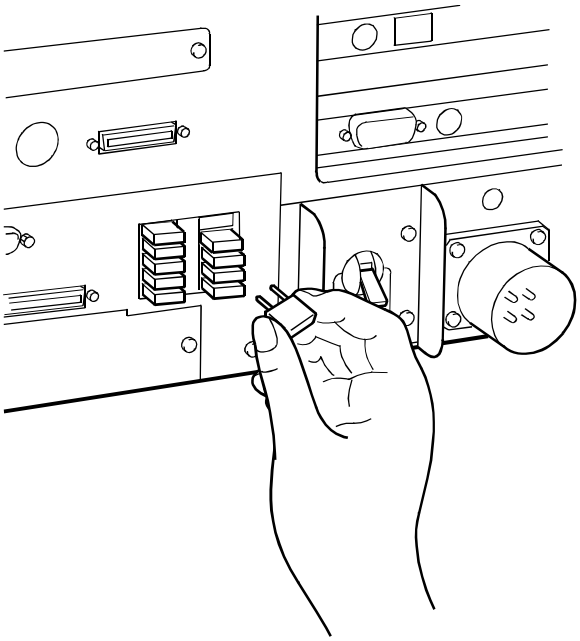
STEP 3

Remove the fuse cover.



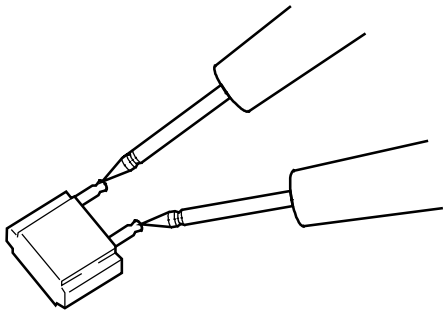
STEP 4

Pull out the fuse to be checked.



STEP 5

Using a circuit tester, check the removed fuse for continuity.

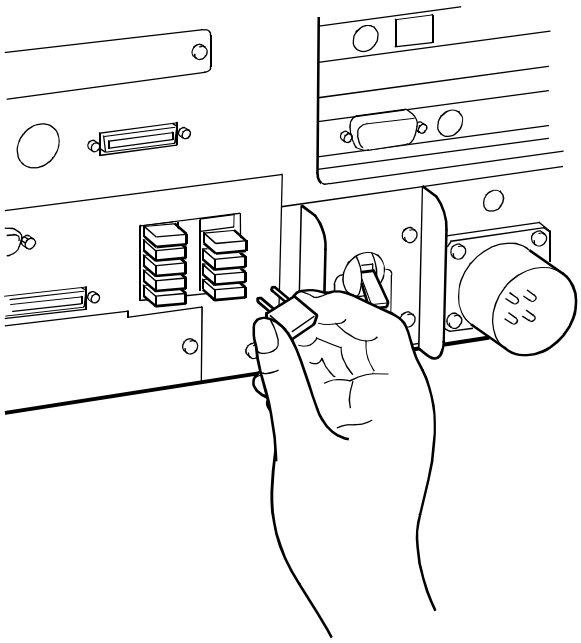


STEP 6

If no continuity is observed with the fuse in Step 5:

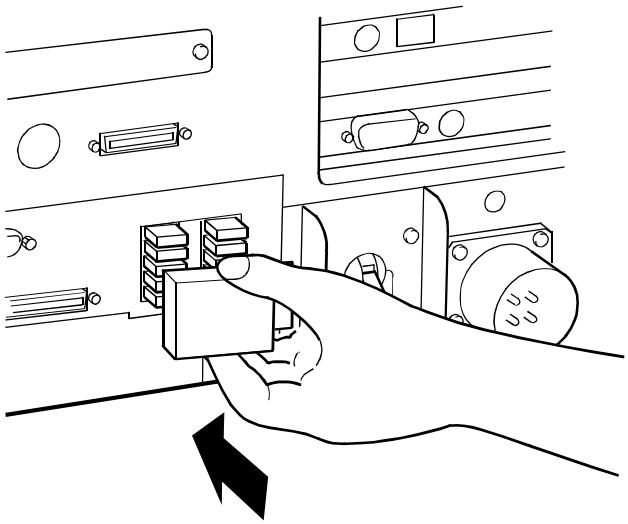
(1) Check the wiring of the corresponding output connector and remove the cause of the blown fuse.
(2) Insert a new fuse into place in the fuse box.

If continuity is observed with the fuse in Step 5, set the removed fuse back into place in the fuse box.



STEP 7

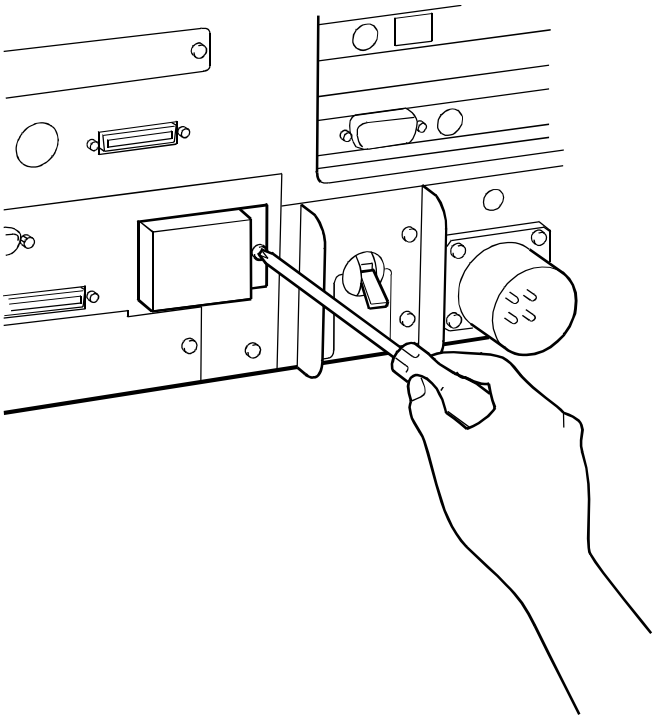
Set the fuse cover to the robot controller.



STEP 8

Replace the fuse cover mounting screw with a screwdriver.

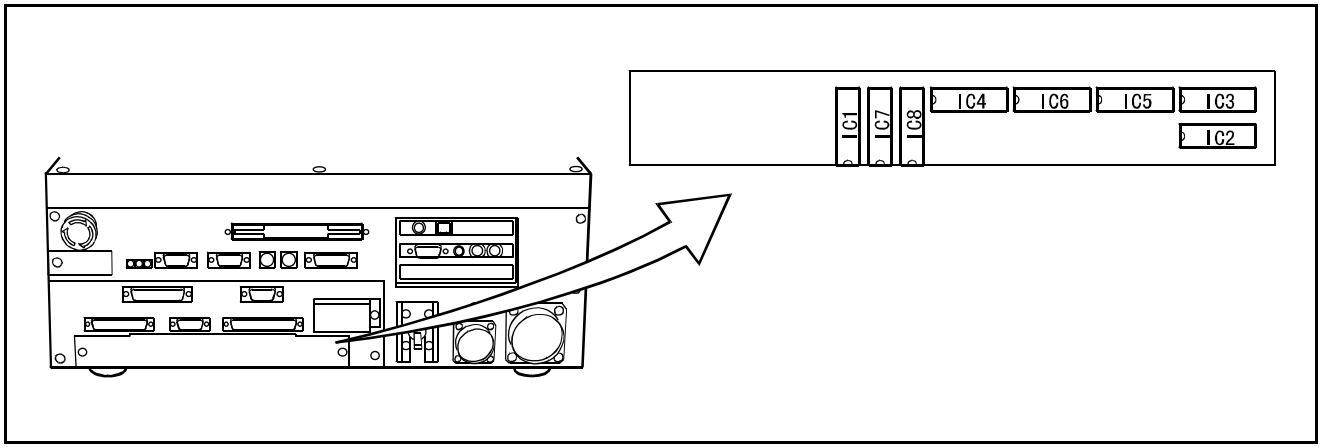
Tightening torque: 0.6 ±0.2 Nm



3.8 Replacing the Output ICs

If an output signal error persists even after replacement of the output fuse, the related output IC needs to be replaced.

Output ICs are located in the panel of the robot controller as shown below.



Location and Names of Output ICs

The table on the next page lists output signals and related IC numbers and fuses.

Output ICs and Fuses

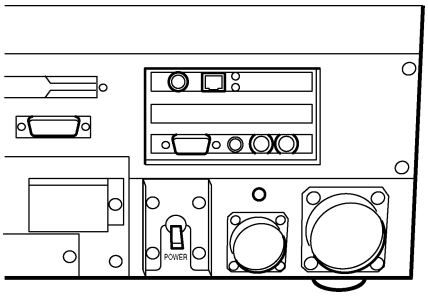
Connector No.	Connector terminal No.	I/O Port No.	Output IC No.	Fuse No.
HAND I/O CN9	1	64	IC 1	F4 (1.3A)
	2	65		
	3	66		
	4	67		
	5	68		
	6	69		
	7	70		
	8	71		
OUTPUT CN10	1	72	IC 2	
	2	73		
	3	74		
	4	75		
	5	76		
	6	77		
	7	78		
	8	79		
	9	80	IC 3	F5 (1.3A)
	10	81		
	11	82		
	12	83		
	13	84		
	14	85		
	15	86		
	16	87		
	17	88	IC 4	
	18	89		
	19	90		
	20	91		
	21	92		
	22	93		
	23	94		
	24	95		
	25	96	IC 5	F6 (1.3A)
	26	97		
	27	98		
	28	99		
	29	100		
	30	101		
	31	102		
	32	103		
	33	104	IC 6	
	34	105		
	35	106		
	36	107		
	37	108		
	38	109		
	39	110		
	40	111		
	41	112	IC 7	F7 (1.3A)
	42	113		
	43	114		
	44	115		
	45	116		
	46	117		
	47	118		
	48	119		
	49	120	IC 8	
	50	121		
	51	122		
	52	123		
	53	124		
	54	125		
	55	126		
	56	127		

3.8.1 Replacing an Output IC

Replace an output IC according to the procedure given below:

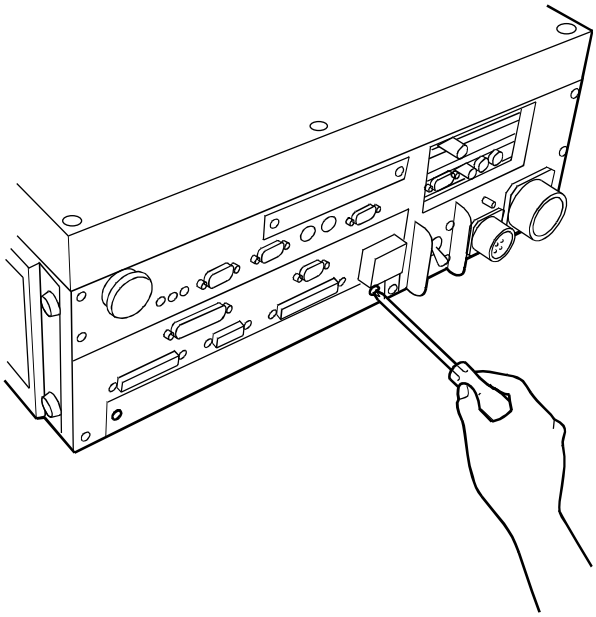
▶ STEP 1

Turn the controller power OFF.



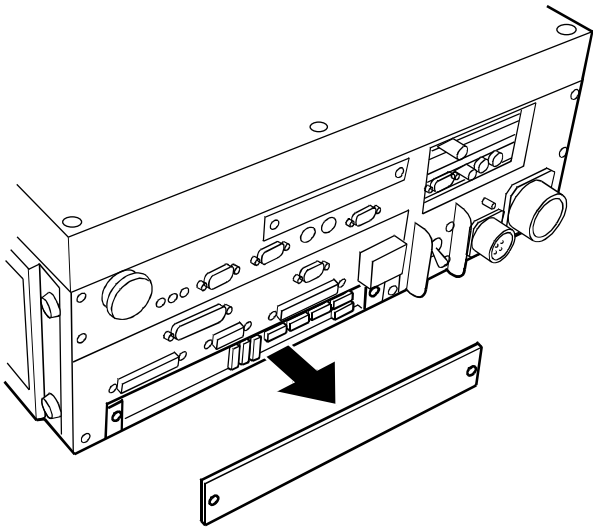
▶ STEP 2

Remove the two screws to release the output IC cover with a screwdriver.



▶ STEP 3

Remove the output IC cover.

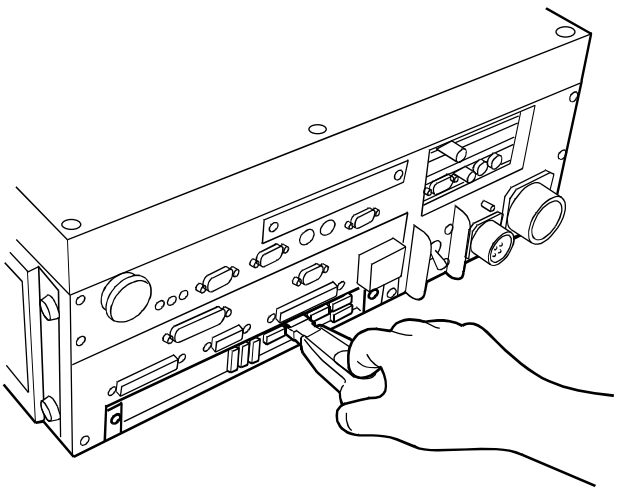


▶ STEP 4

Check the ICs marked with "IC1" to "IC8" on the PC board, and remove the defective output IC with an IC pull-out jig and replace the IC.

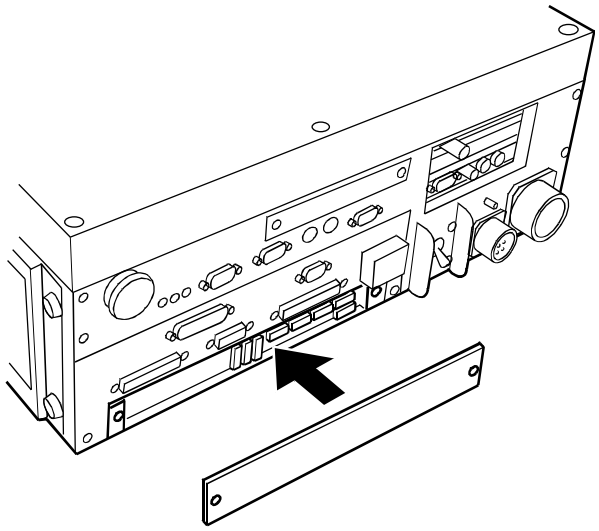
⚠Caution (1) If any output IC is damaged, remove the cause of damage, and replace it with a new output IC.

(2) Do not directly touch the elements and their terminals on each PC board.



STEP 5

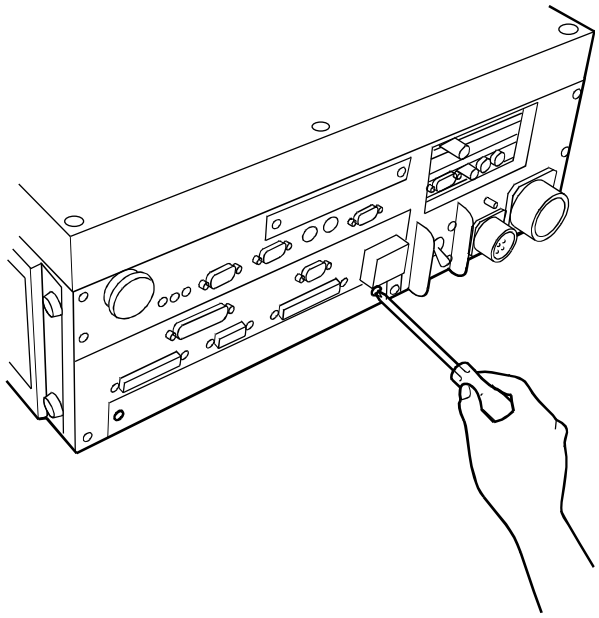
Install the output IC cover to the robot controller.



STEP 6

Secure the output IC cover with two mounting screws.

Tightening torque: 0.6 ±0.2 Nm



3.9 Checking the Odometer and Trip Meter

You may check the odometer and trip meter which count traversed distance of each axis in the Odometer window of the teach pendant. With the trip meter, you may learn when oil change should be made.

The access to the Odometer window is [F6 Set]—[F6 Maint.]—[F5 Odometer].

The Odometer window shows the following items:

[Odometer]	Shows the total distance of each axis traversed after the robot leaves the factory. You cannot reset the odometer.
[Trip meter]	Shows the distance of each axis traversed after you reset the trip meter to zero.
[Interval]	Shows the oil change intervals specified for each axis, as a guide.

3.9.1 Displaying the Odometer, Trip Meter, and Oil Change Intervals

STEP 1

Turn the controller power ON.

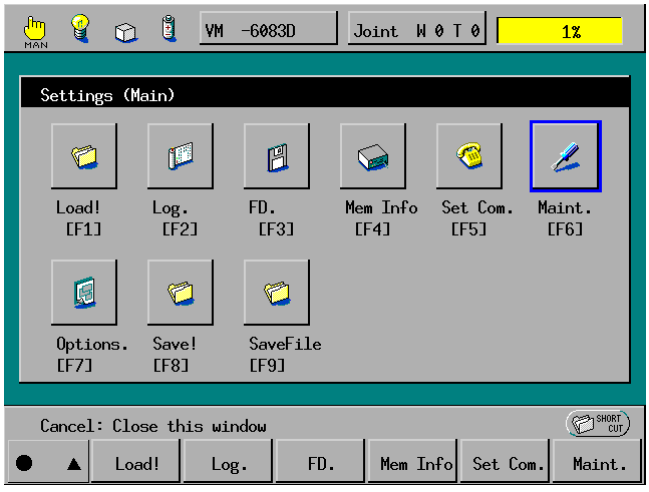
STEP 2

On the teach pendant, set the mode switch to the MANUAL position.

STEP 3

On the top screen, press [F6 Set].

The Settings (Main) window appears as shown below.

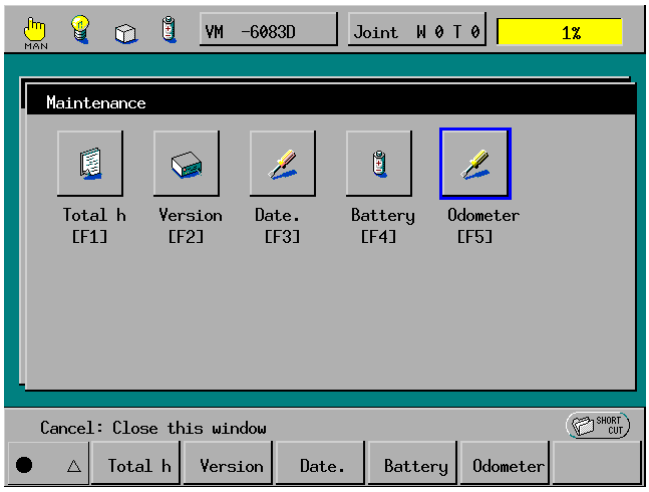


F6

Press [F6 Maint.].

STEP 4

The Maintenance menu appears as shown below.

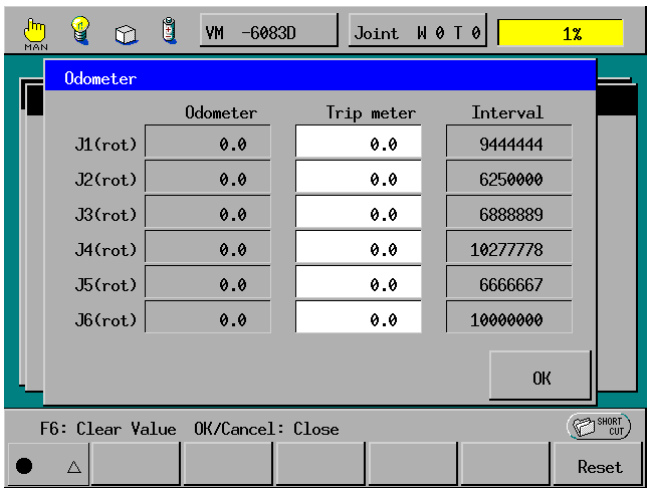


F5

Press [F5 Odometer].

STEP 5

The Odometer window appears as shown below.



F6

In the above Odometer window, the J1 through J6 are expressed in rpm.

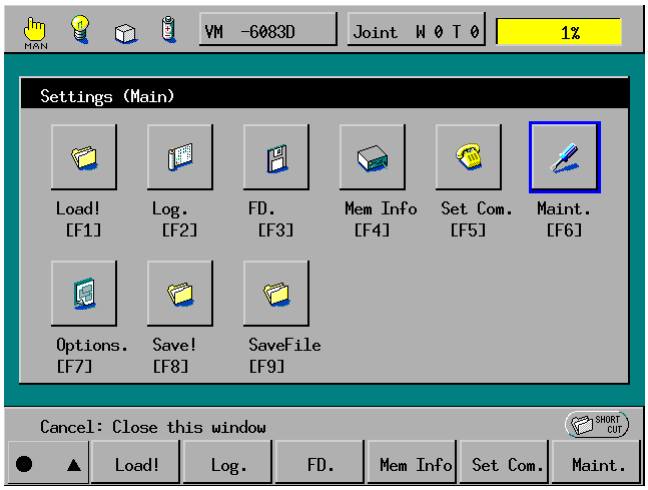
If the Trip meter count exceeds the Interval value, the oil change prompt message will appear.

3.9.2 Resetting the Trip Meter to Zero

STEP 1

On the top screen, press [F6 Set].

The Settings (Main) window appears as shown below.

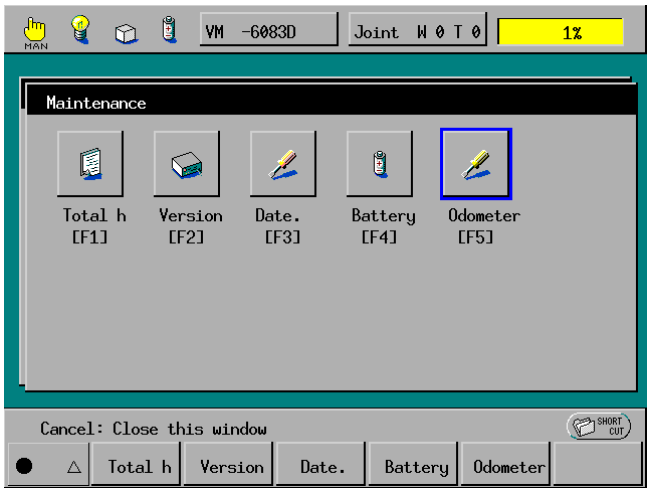


F6

Press [F6 Maint.].

STEP 2

The Maintenance menu appears as shown below.

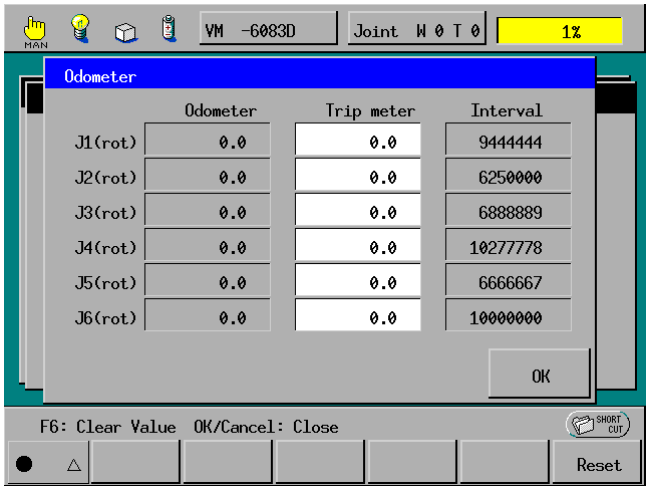


F5

Press [F5 Odometer].

STEP 3

The Odometer window appears as shown below.

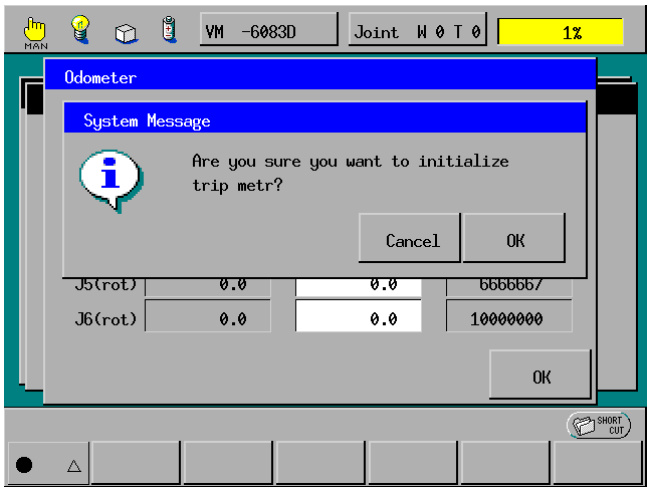


F6

Press [F6 Reset].

STEP 4

The following message appears.



Press the OK button.

The trip meter has been reset to zero.

3.10 Checking the Controller ON-Time and the Robot Running Time and Resetting Their User Counters

You may check the robot controller ON-time and the robot running time in the Total hours window of the teach pendant.

The Total hours window shows the following items:

[Total operation]	Shows the grand total of the robot controller ON-time counted after the controller leaves the factory.
[Total running]	Shows the grand total of the robot running time counted after the robot leaves the factory.
[Cumu. operation]	Shows the total of the robot controller ON-time counted after you reset the user counter to zero.
[Cumu. running]	Shows the total of the robot running time counted after you reset the user counter to zero.
[Operation]	Shows the ON-time of the robot controller counted after it is turned ON this time.
[Running]	Shows the running time of the robot counted after the robot controller is turned ON this time.

3.10.1 Displaying the Controller ON-time and the Robot Running Time

STEP 1

Turn the robot controller power ON.

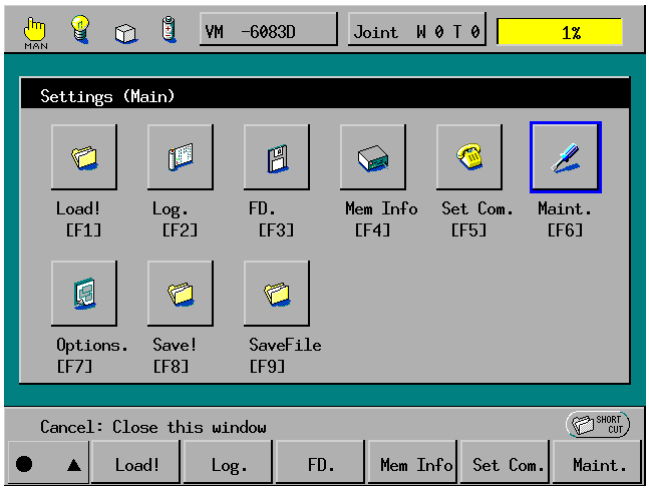
STEP 2

On the teach pendant, set the mode switch to the MANUAL position.

STEP 3

On the top screen, press [F6 Set].

The Settings (Main) window appears as shown below.

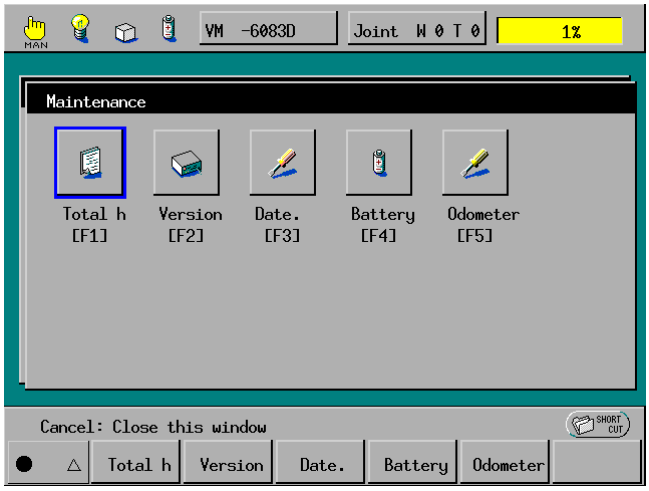


F6

Press [F6 Maint.].

STEP 4

The Maintenance menu appears as shown below.

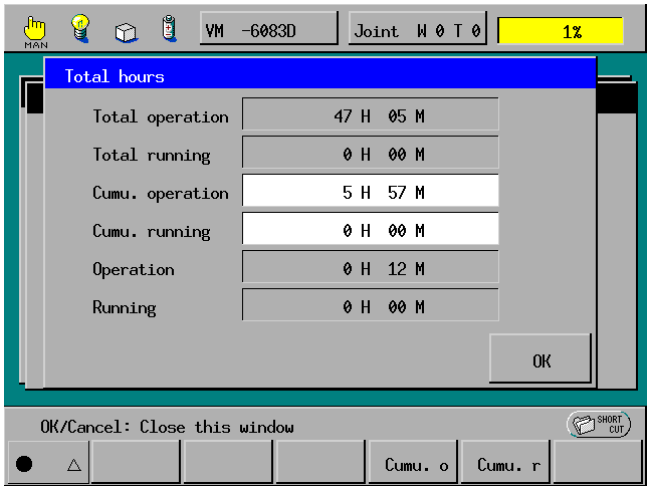


F1

Press [F1 Total h].

STEP 5

The Total hours window appears as shown below.

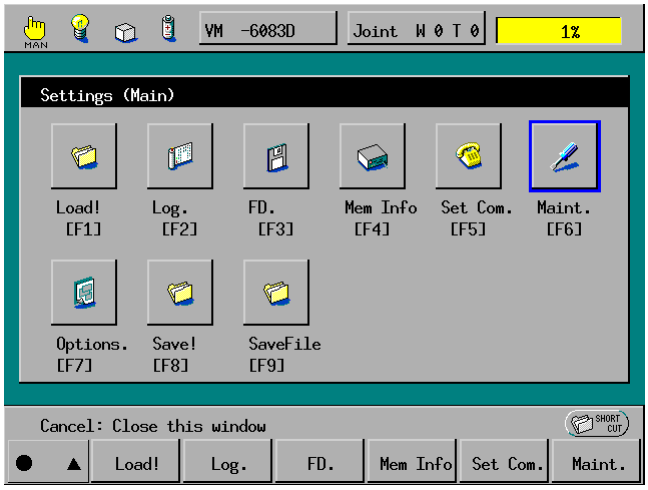


3.10.2 Resetting the User Counters of the Controller ON-Time and the Robot Running Time

STEP 1

On the teach pendant, press [F6 Set].

The Settings (Main) window appears as shown below.

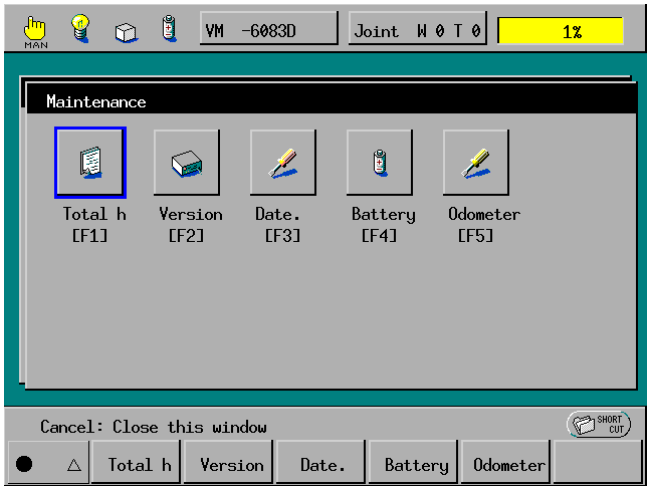


F6

Press [F6 Maint.].

STEP 2

The Maintenance menu appears as shown below.

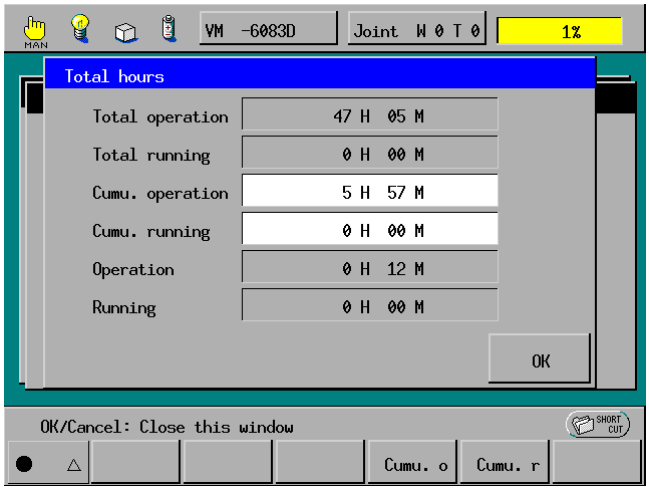


F1

Press [F1 Total h].

STEP 3

The Total hours window appears as shown below.

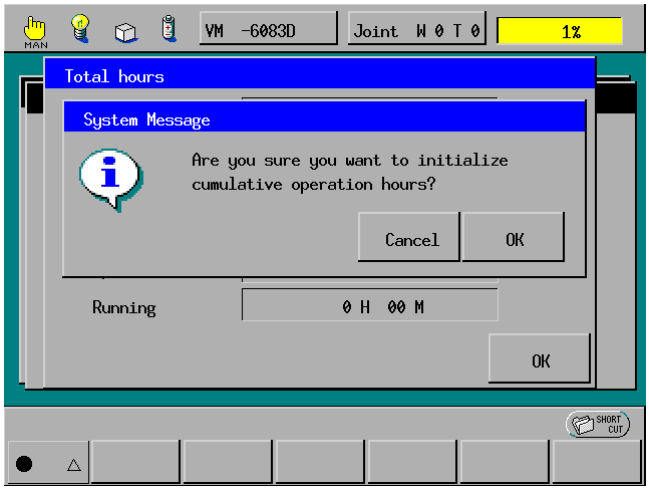


F4

To reset the user counter of the controller ON-time to zero, press [F4 Cumu. o].

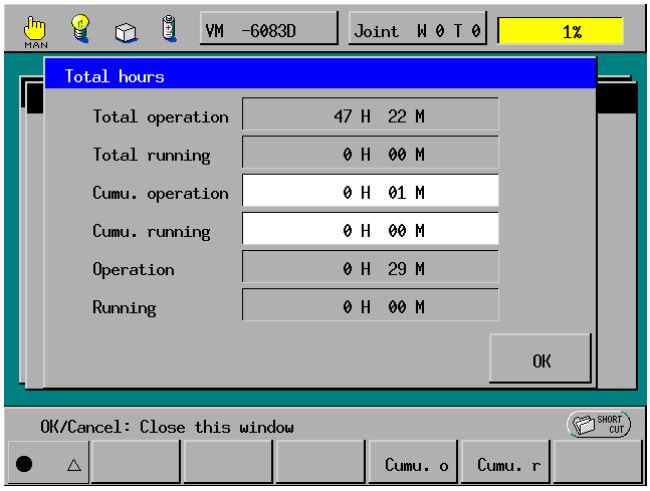
STEP 4

The following system message appears.



Press the OK button.

The user counter of the controller ON-time has been reset to zero.



3.11 Resetting Encoders

You need to reset encoders and perform CALSET if:

- Error 641* occurs due to run-down encoder backup batteries, or
- Error 677* occurs due to a great impact applied to the robot when the power is off.

(* is any of 1 to 6 denoting the object axis.)

This section describes how to reset encoders.

For the encoder resetting procedure, refer to the SETTING-UP MANUAL, Section 5.3, [F2 Arm]—[F12 Maint.]—[M11 ENC rst].

3.12 Using the Initialization Floppy Disk

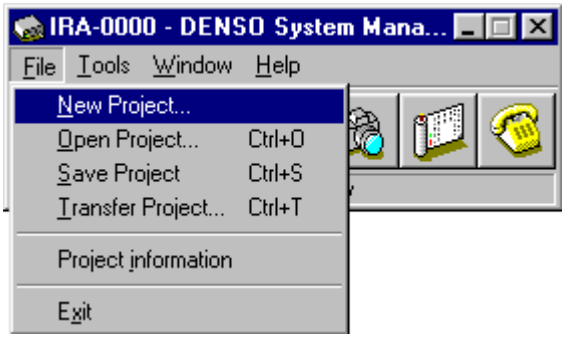
The initialization floppy disk (*.arm) stores arm data in WINCAPSII format.
You transfer the stored arm data to the robot controller in these two steps:
(1) Create a project by using the data stored in the floppy disk.
(2) Transfer the trajectory generation file in the project to the robot controller.

Creating a project to be transferred

▸ STEP 1

Create a new project.

Start WINCAPSII. From the File menu of System Manager, click the New Project.

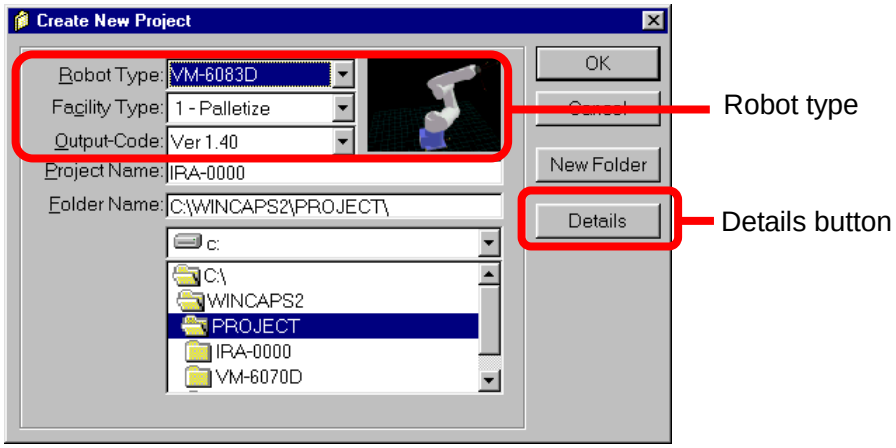


[File menu: Creating a new project]

▸ STEP 2

Select your robot type.

Select the robot type of the controller to which you want to transfer data.

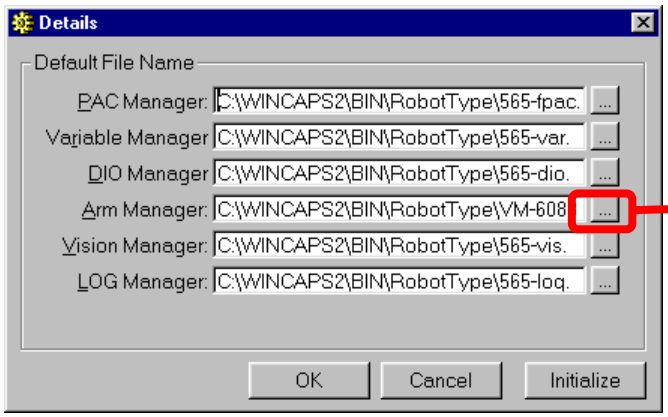


[Create New Project window]

STEP 3

Select arm data.

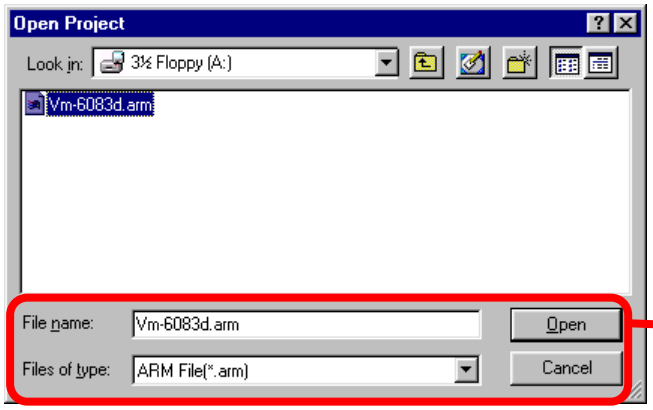
(1) Press the Details button to call up the window below.



[Details window]

(2) Press the Browse button in Arm Manager to call up the Open Project window.

Select desired file in the floppy disk, then press the Open button.



[Selecting a file]

(3) The screen will return to the Details window where you press OK button.

STEP 4

Create a project.

On the Create New Project window, press OK button. Now, a project to be transferred has been created.

Transferring the trajectory generation file

STEP 1

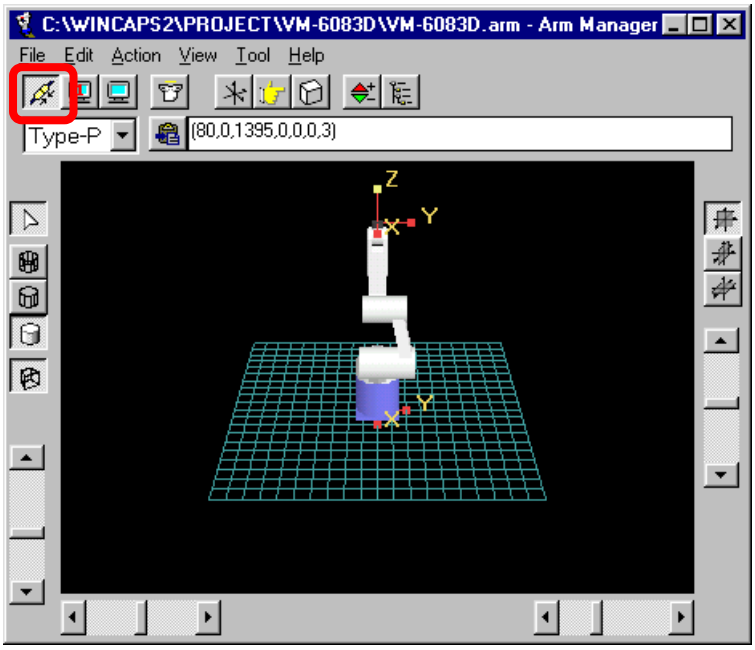
Start of Arm Manager

From System Manager, run Arm Manager.

STEP 2

Connection with the robot controller

Press the Connect button to connect with the robot controller.

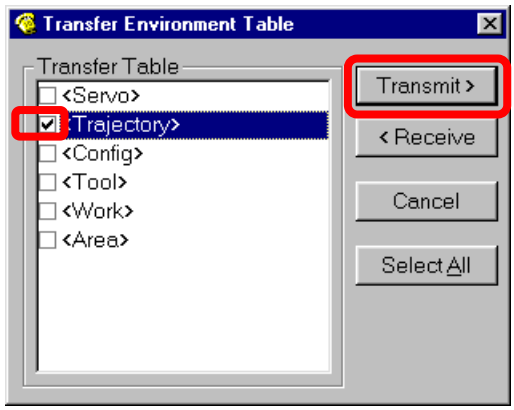


[Arm Manager window]

STEP 3

Data transmission

(1) From the File menu of Arm Manager window, click Transfer command. The Transfer Environment Table appears as shown below.

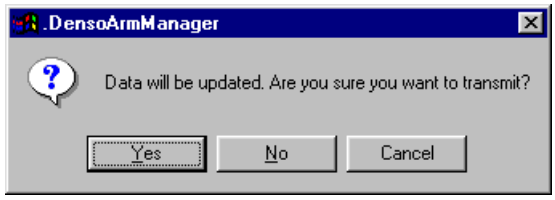


[Transfer Environment Table]

(2) On the table shown above, select the Trajectory and press the Transmit> button.

(3) The following message appears.

Press Yes.



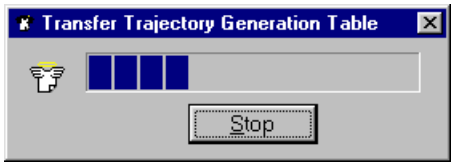
[Confirmation dialog]

The following message appears.

Press OK.

[Configuration transfer dialog]

During data transfer, the following dialog is displayed.



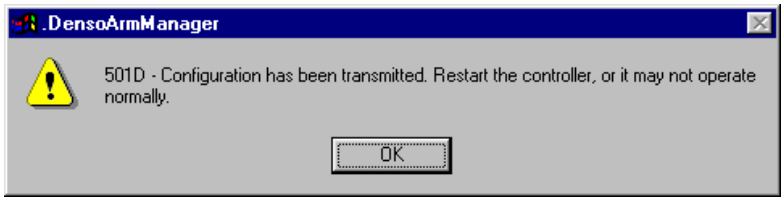
[Transfer Trajectory Generation Table]

(4) Upon completion of transfer, the following message appears.

Press OK.

The arm data stored in the initialization floppy disk has been transferred to the robot controller.

Turn the controller power off and then on.



[Transfer completion message]

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Factory Automation Division

5E**C

The purpose of this manual is to provide accurate information in the handling and operating of the robot. Please feed free to send your comments regarding any errors or omissions you may have found, or any suggestions you may have for generally improving the manual.

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