DENSO ROBOT

Vertical articulated

VM-G 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-G (Medium-sized, vertical articulated)	VM-6083G VM-60B1G	Same as left. Same as left.	(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-6083G, for example, the robot unit model is VM-6083D/GM.

Important

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

NOTE:

Robots and controllers that will be exported to South Korea after March 1st 2013 need to have KCs mark for each equipment.

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.

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.

Contents

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, "Installation Precautions". 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 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.

1.1.2 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.

1.1.3 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: The robot unit and robot controller in a set are given the same serial number.

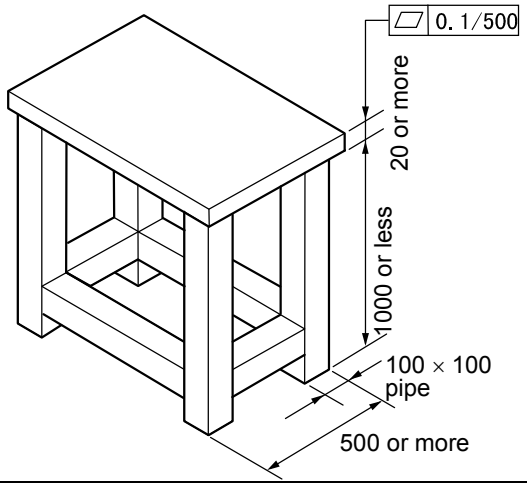
1.1.4 Installation Environment of the Robot Unit

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

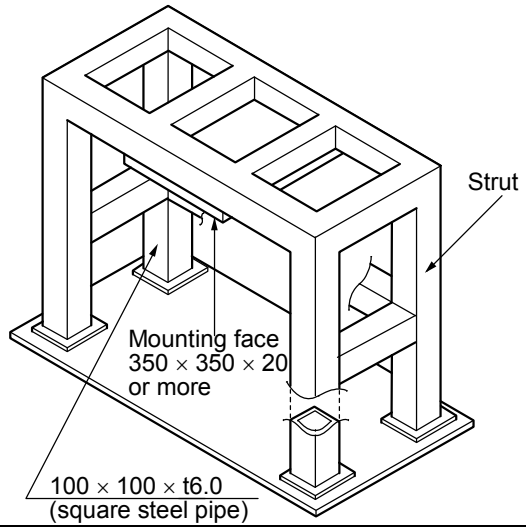
Item	Environments and Conditions
Flatness of the mount	0.1/500 mm (See the upper figure on the next page.)
Rigidity of the mount	Use steel materials. (See the figure on the next page.)
Installation type	Floor-mount or Overhead-mount
Ambient temperature	During operation : 0 to 40°C During storage and transportation : -10 to 60°C
Humidity	During operation : 90% or less (No dew condensation allowed.) During storage and transportation : 75% or less (No dew condensation allowed.)
Vibration	During operation : 4.9 m/s^2 (0.5G) or less During storage and transportation : 29.4 m/s^2 (3G) or less
Altitude	During operation: 1,000 m or less
Safe installation environment	Refer to the SAFETY PRECAUTIONS, 3.1 "Insuring the proper installation environment"
Working space, etc.	• 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.
Grounding conditions	Functional ground See the figure on page 21.



⚠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 Mounting the Robot Unit

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

1.2.1 Transporting the Robot Unit

(1) Precautions in transporting the robot

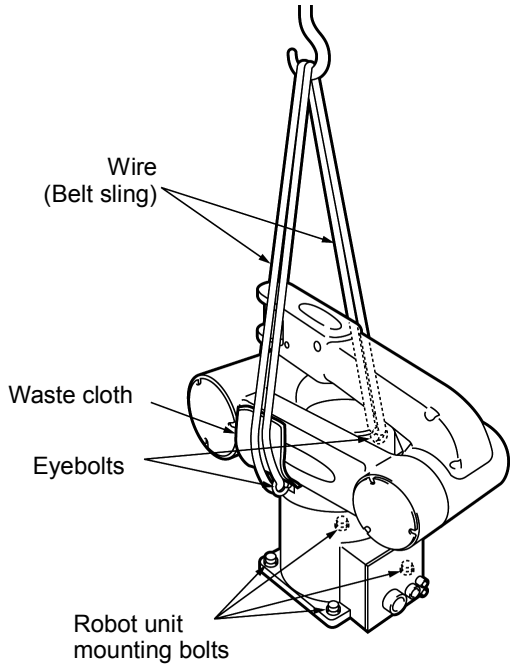
The VM-G series weighs approximately 88 kg (193 lbs). Use a crane suitable for the robot weight.

Have at least two workers handle this job.

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

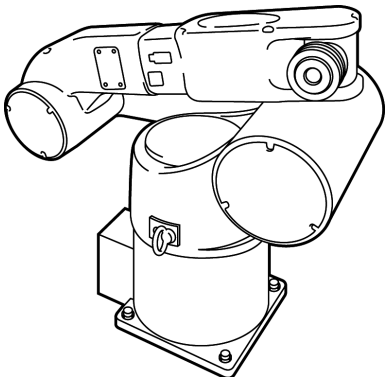
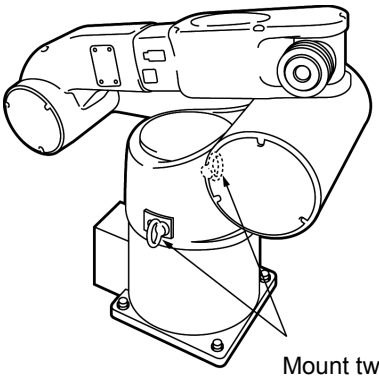
> ⚠**Caution** **Pass the hoisting wires through the specified eyebolts as illustrated below. Passing them through other sections may drop the robot unit, resulting in a broken robot or bodily injuries.**
>
> **Do not hold the first arm, elbow, either side of the 2nd arm, 2nd-axis cover, or 3rd-axis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

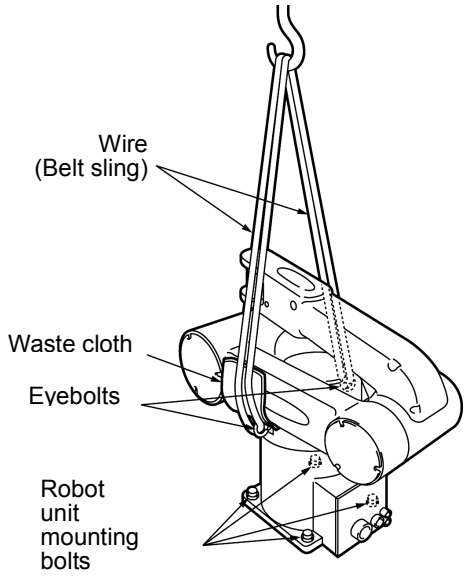
VM-6083G/VM-60B1G



Hoisting Points for Transportation (VM-G series)

(2) Transporting the robot unit

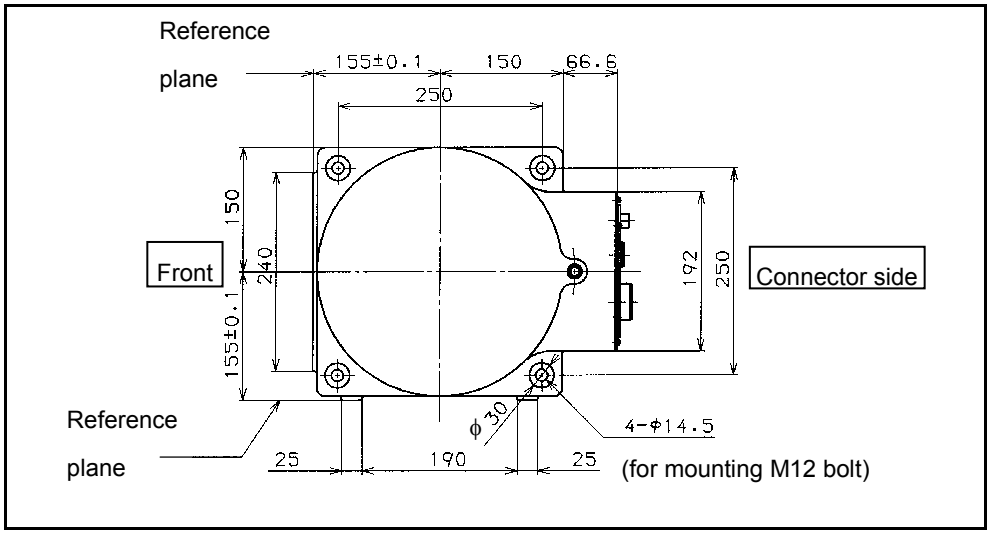
<table>
<tr><th>No.</th><th>Procedure</th><th>Explanatory Illustration</th></tr>
<tr><td>1</td><td>Before transportation, set the robot in a transport position as shown at right by manually moving the second, third and fourth axes.
When unpacked first, the robot is in the transport position, so this job is not required.</td><td>VM6083G/VM60B1G
 
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>VM6083G/VM60B1G
 
Mount two eyebolts perpendicular to the line of the robot unit.
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.	VM6083G/VM60B1G  **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 Section 1.2.2 "Securing 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.

1.2.2 Securing 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-6083G/VM-60B1G

(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 Section 1.2.1 "Transporting the Robot Unit."

(4) Secure the robot to the mount with four bolts and plain washers.
- Bolt: M12 x 40 mm (strength class: 12.9, tightening torque: 128 ±26 Nm)
- Plain washer: JIS B 1256 (polished round)

1.2.3 Overhead-mounting the Robot

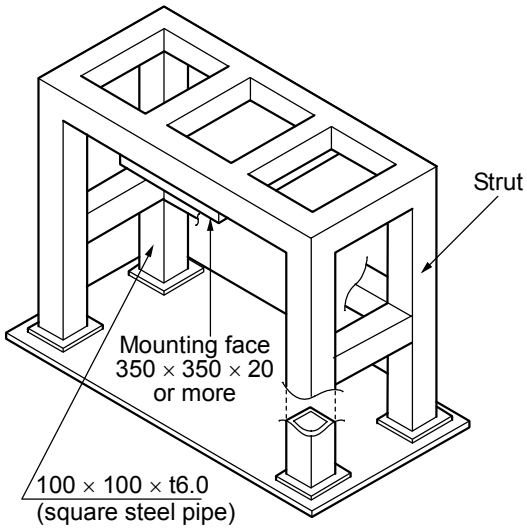
To overhead-mount the robot, an overhead-mount frame and suspension jig are required. Set up those items, referring to the overhead-mount frame shown below and the suspension jigs specified on the following pages.

Caution (1) Install the robot according to Section 1.2.2 "Securing 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.



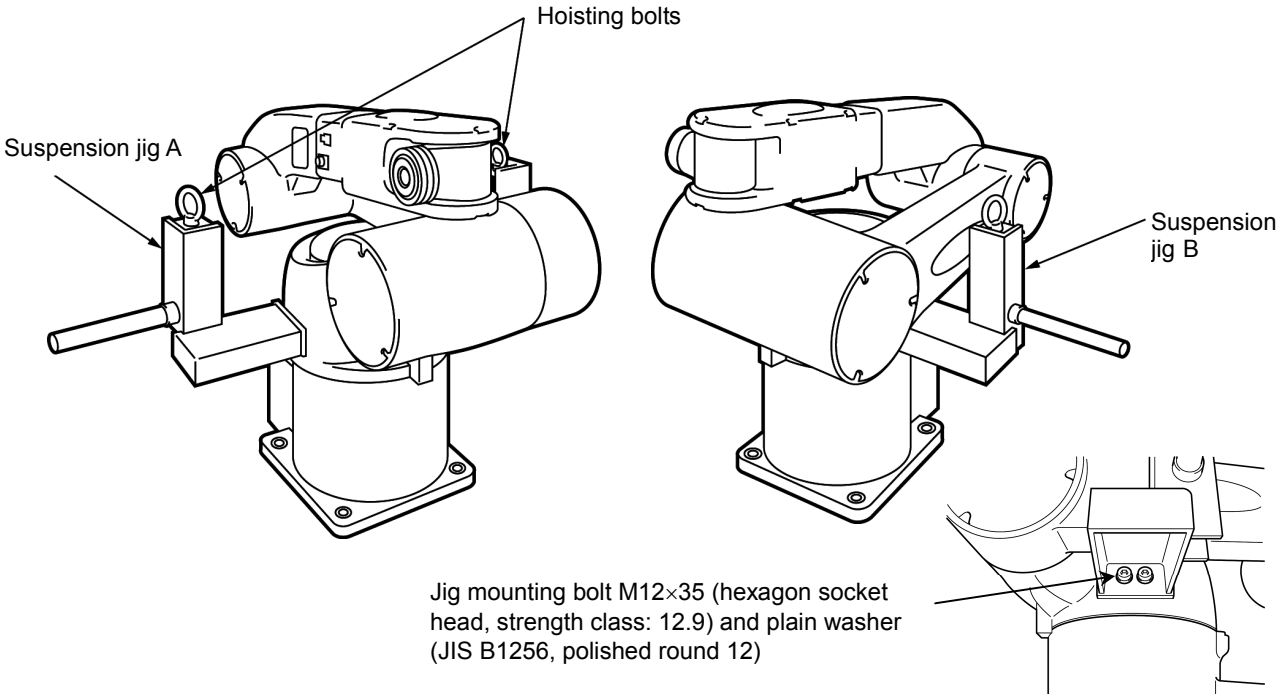
Example of Overhead-mount Frame (VM-G series)

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.

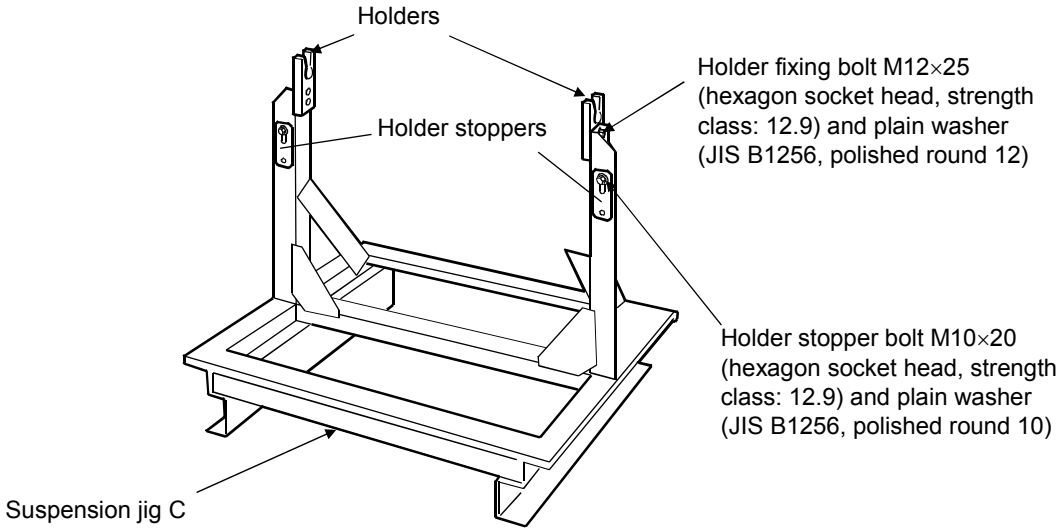
VM-6083G/VM-60B1G

(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 plate--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.

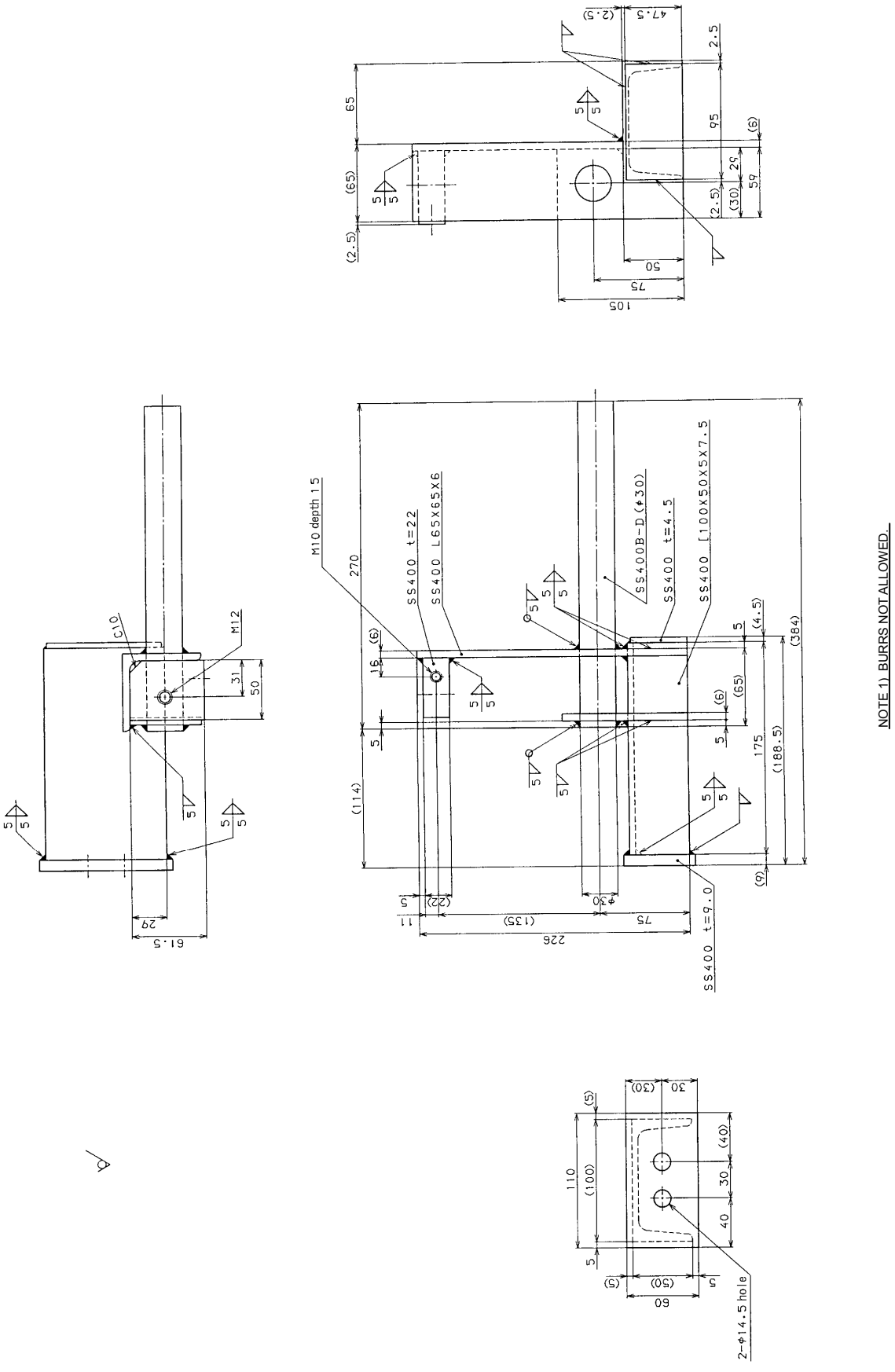


Example of Suspension Jigs A and B

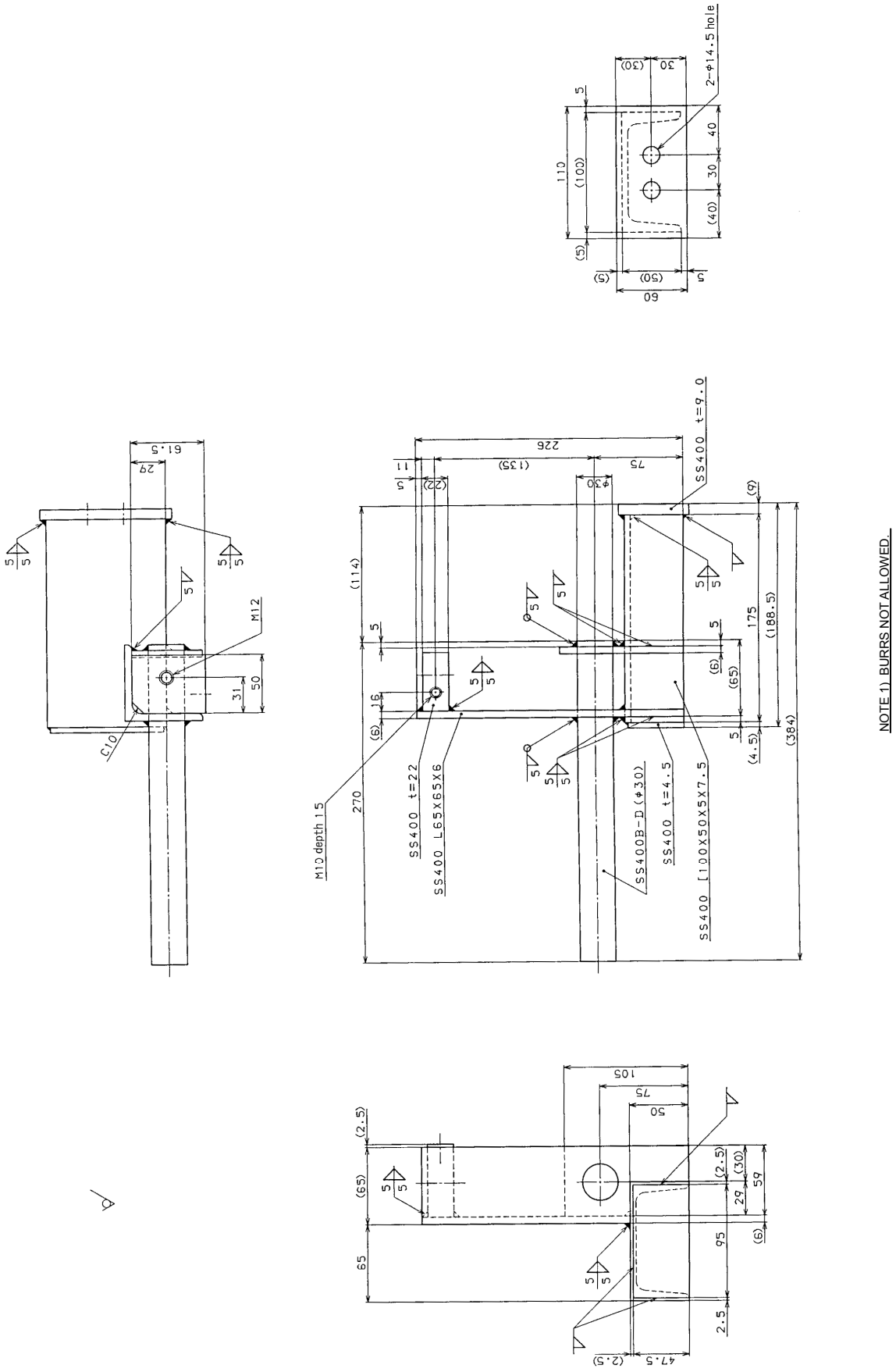


Example of Suspension Jig C

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

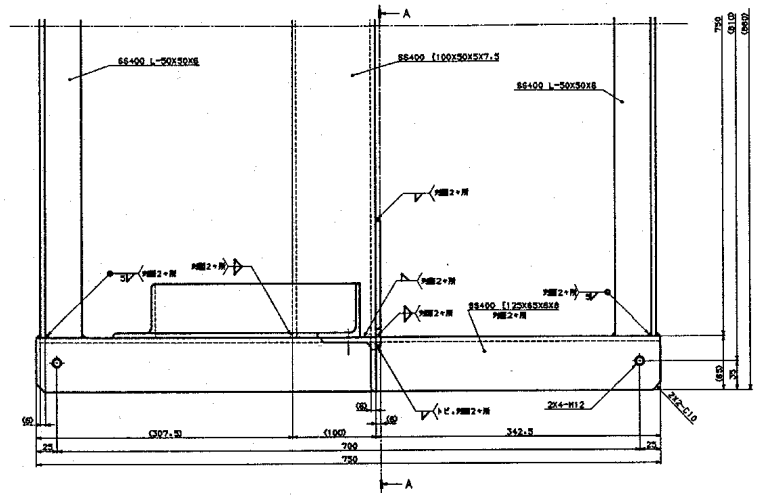


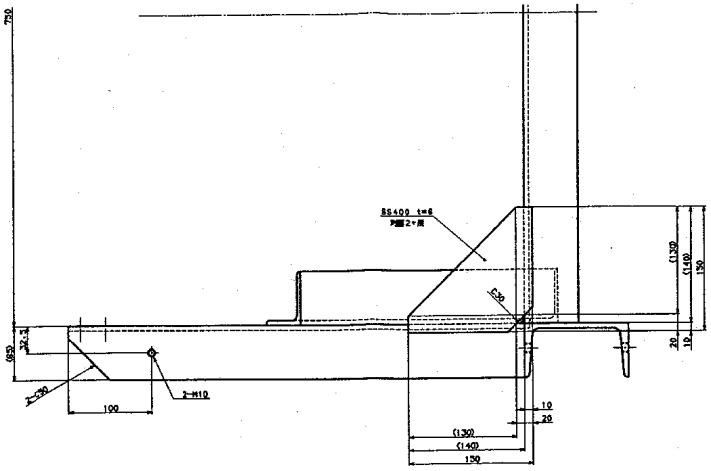
Suspension Jig A

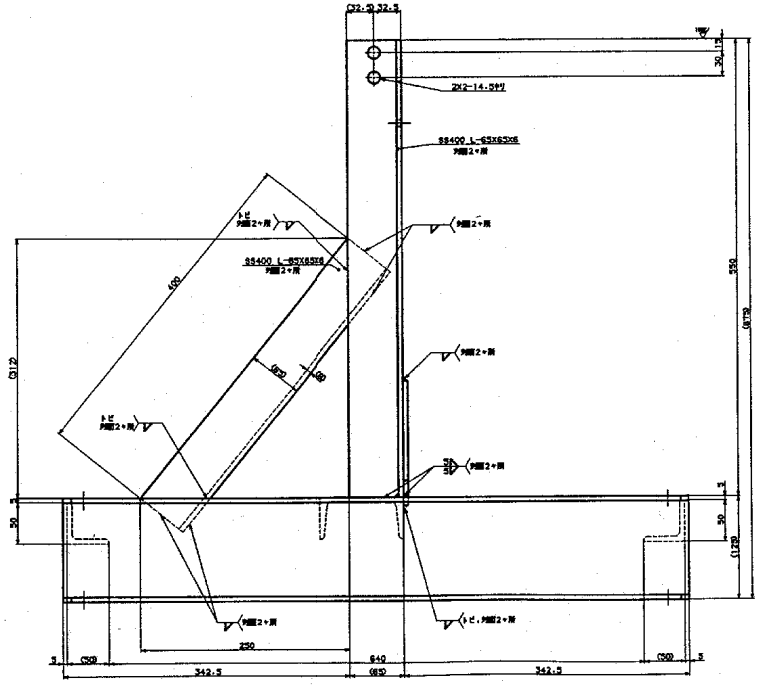


Suspension Jig B

Suspension Jig C

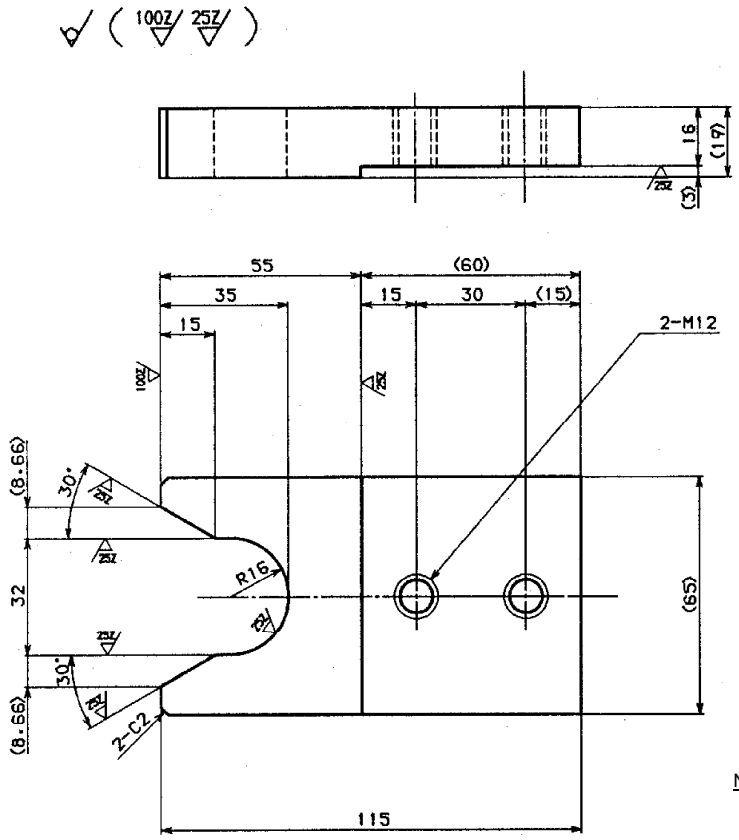






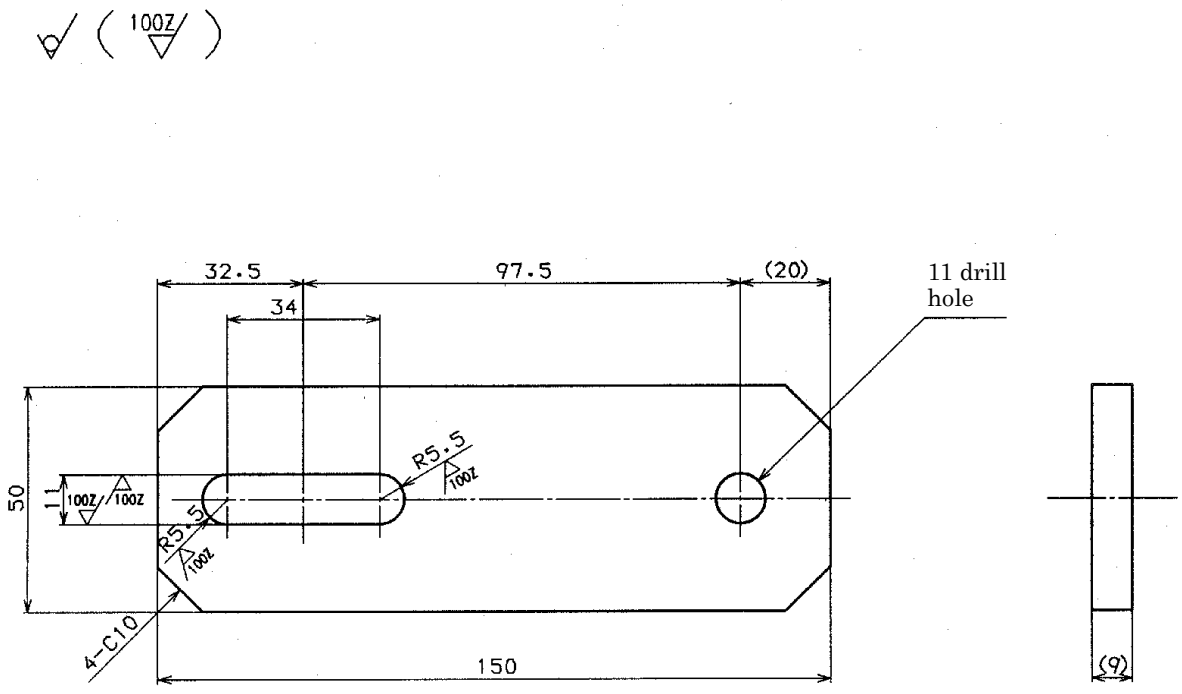
NOTE 1) BURRS NOT ALLOWED.

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.

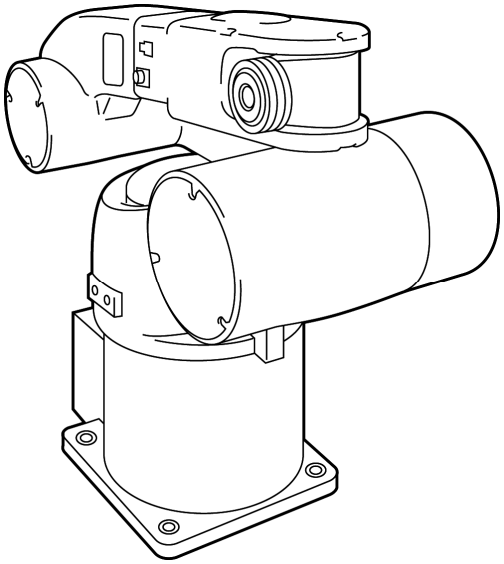
Caution (1) Since the robot unit weighs approximately 88 kg (193 lbs), prepare a crane and a forklift with a lifting load of 0.5 ton or more.

(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.

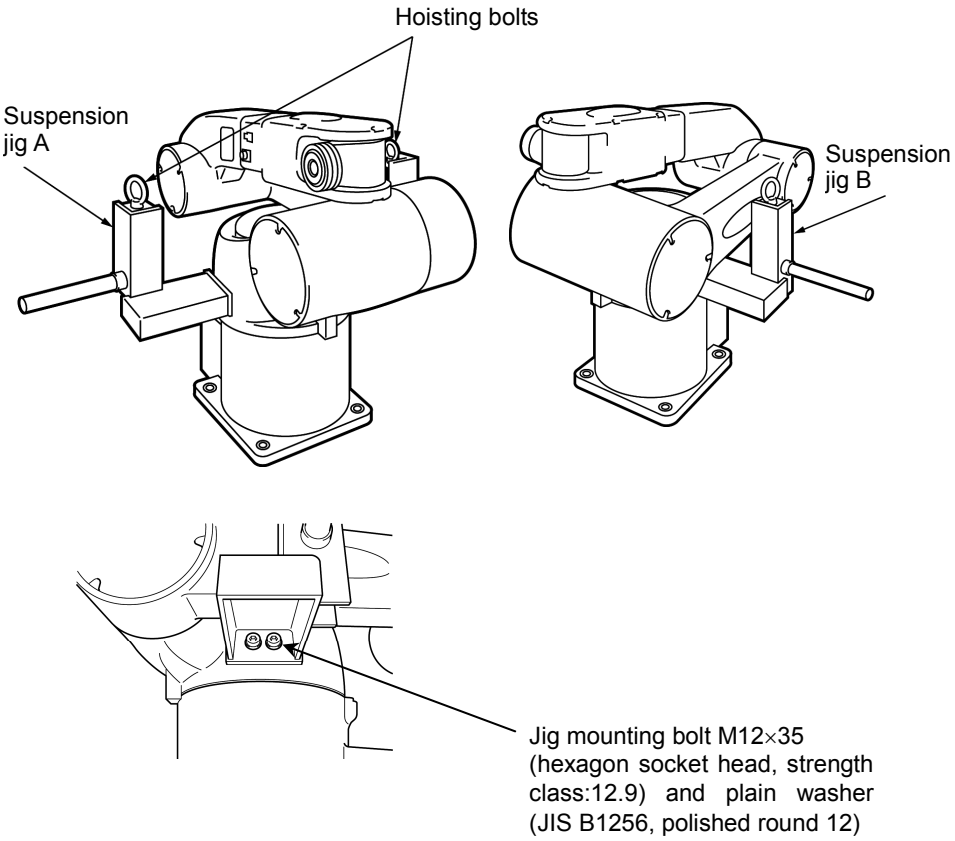
STEP 1

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.



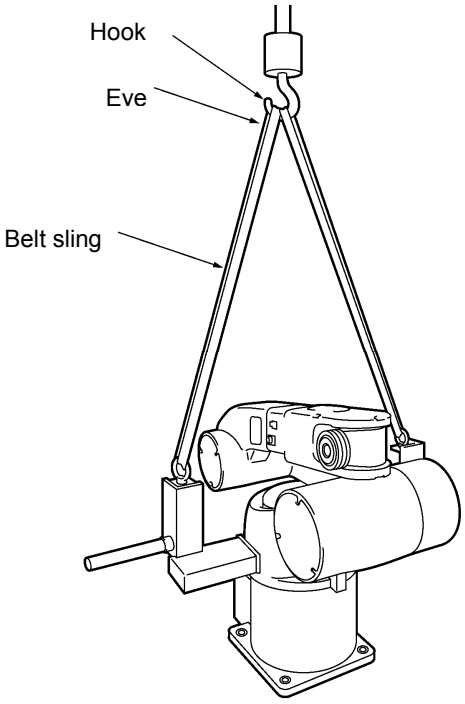
Bolt tightening torque : 130 ±26 Nm

STEP 3

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

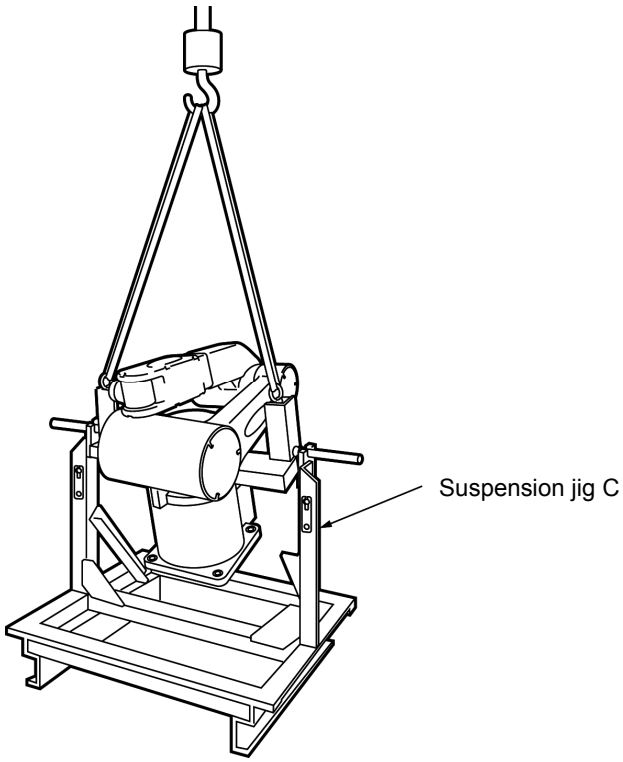
STEP 4

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



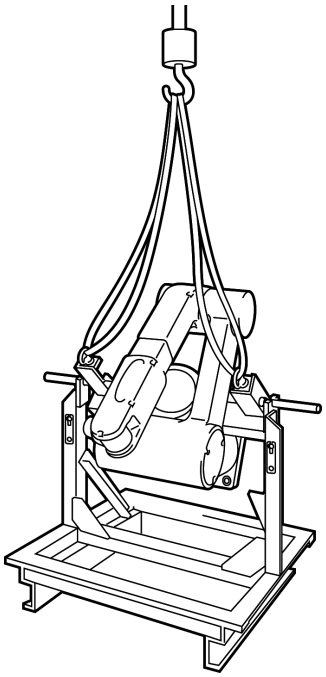
STEP 5

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



STEP 6

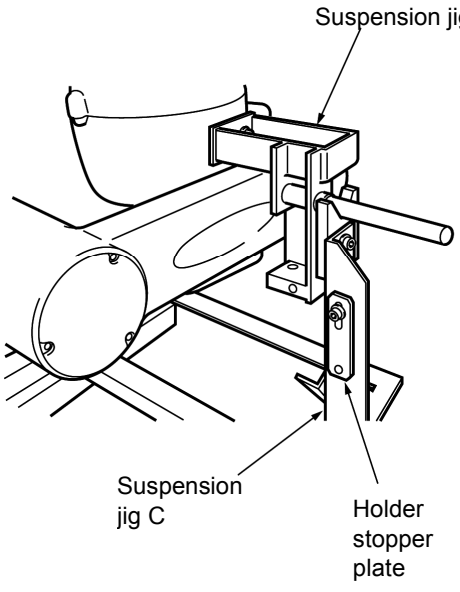
Slowly lower the hook of the crane until the robot unit turns upside down.

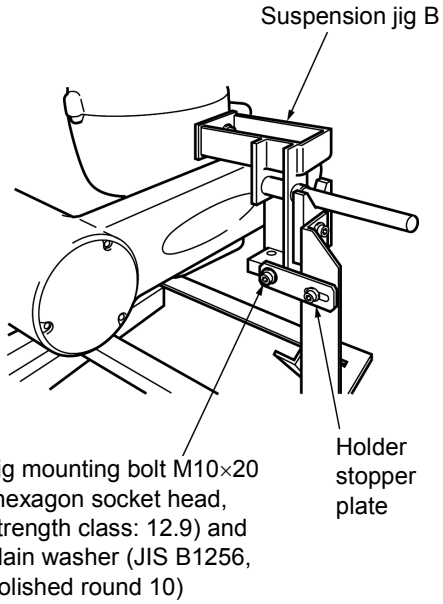


⚠Caution **The robot unit will turn by its own weight as you lower the crane hook. This is not trouble, so do not touch the robot unit itself.**

STEP 7

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

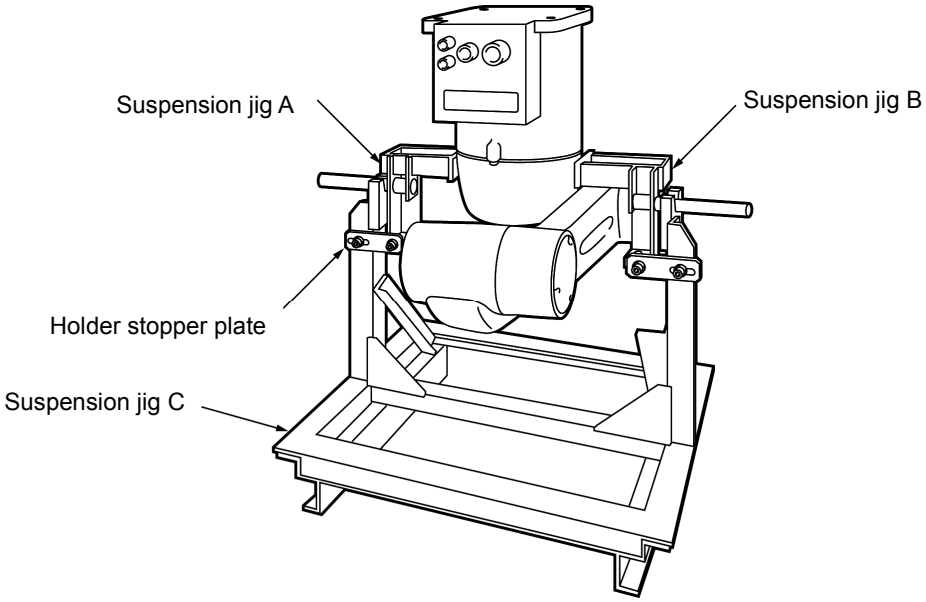




Bolt tightening torque : 71 ±14.2 Nm

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.

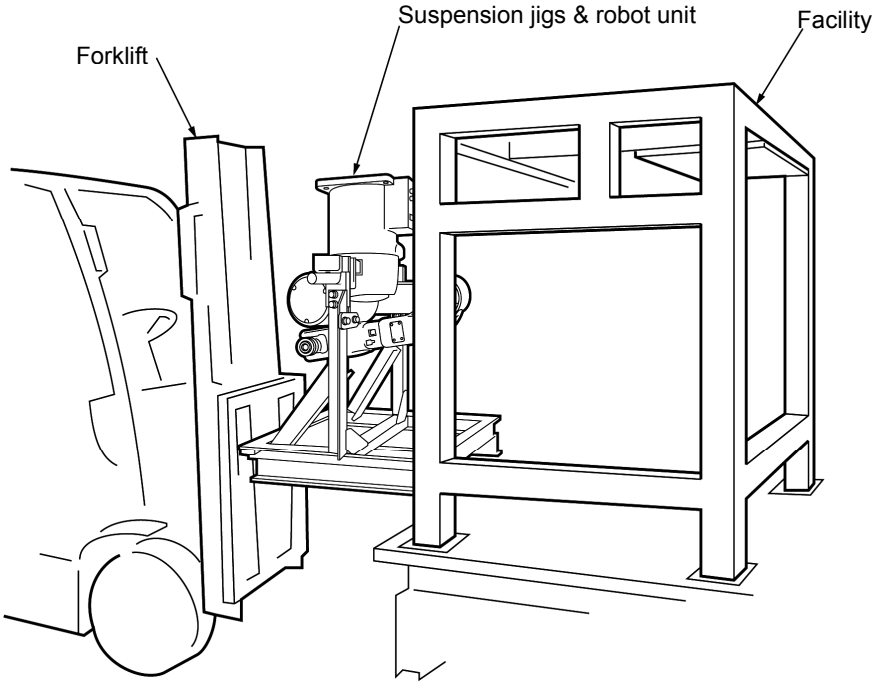


STEP 9

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

STEP 10

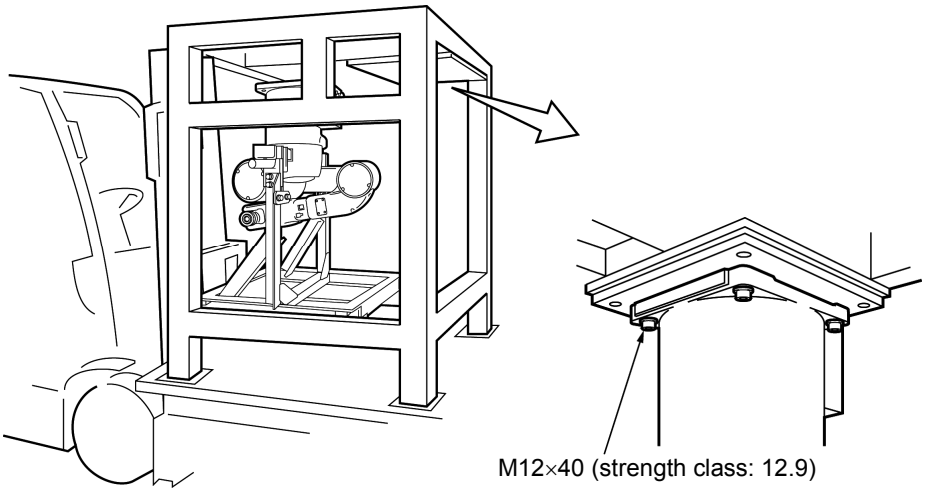
Using a forklift, transport the robot unit fixed to suspension jigs to the robot mount.



STEP 11

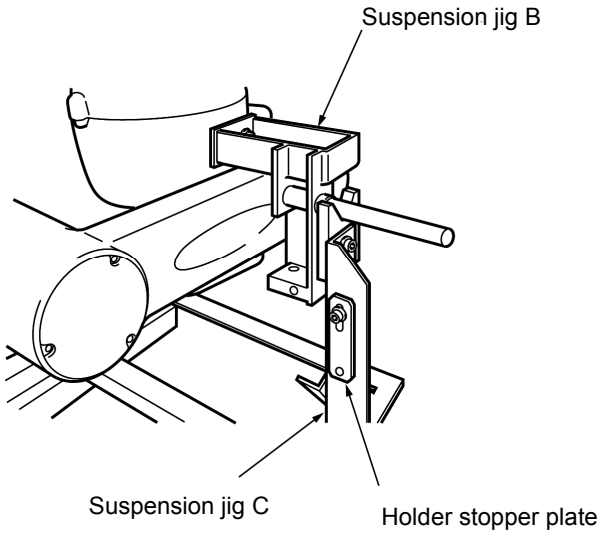
Using the forklift, set the robot unit fixed to suspension jigs in the specified position on the robot mount, then secure it to the robot mount with M12×40 bolts (strength class: 12.9).

Bolt tightening torque : 128 ±26 Nm



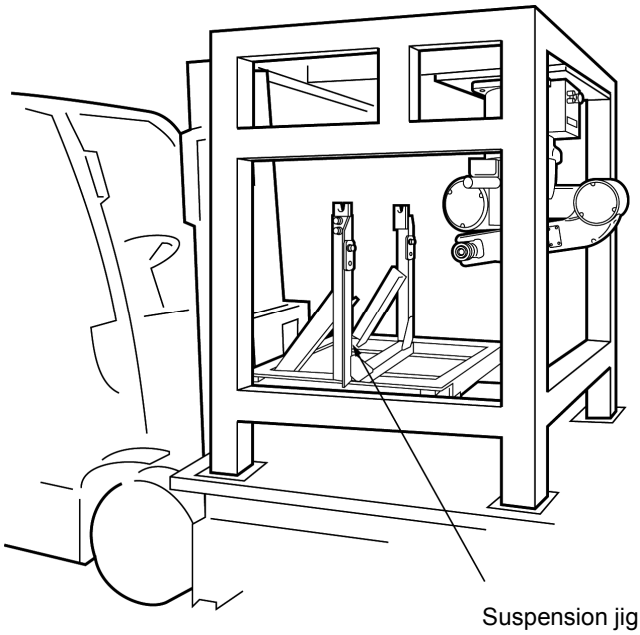
STEP 12

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



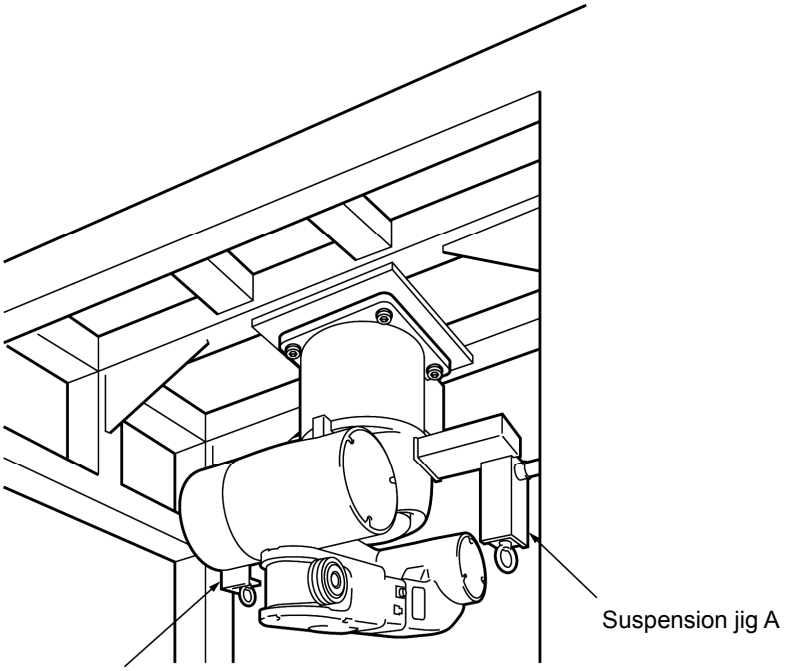
STEP 13

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



STEP 14

Remove suspension jigs A and B from the robot unit.



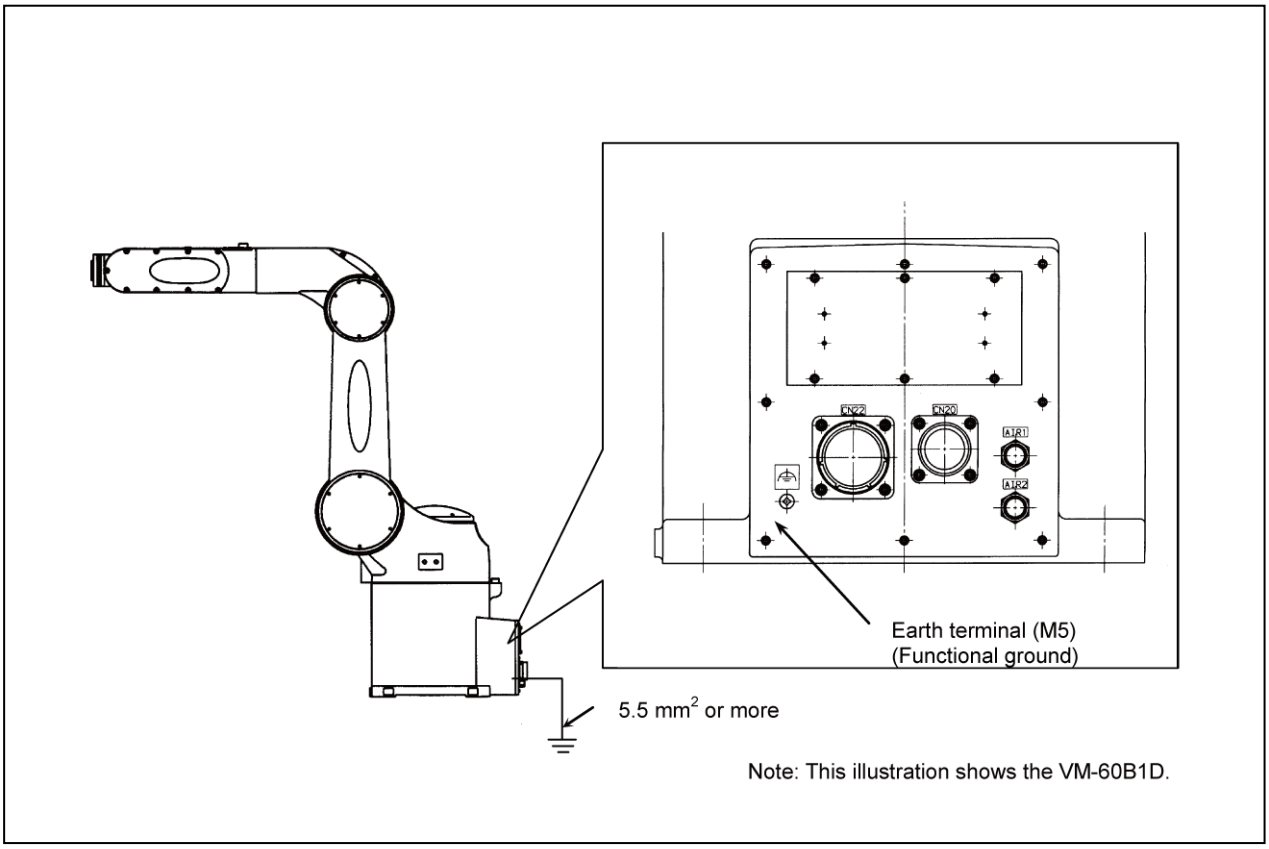
STEP 15

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

1.2.4 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-6083G/VM-60B1G]

1.3 Installing the Robot Controller

For the installing procedures of the robot controller, refer to the RC7M CONTROLLER MANUAL, Section 6.2 "Installing the Robot Controller."

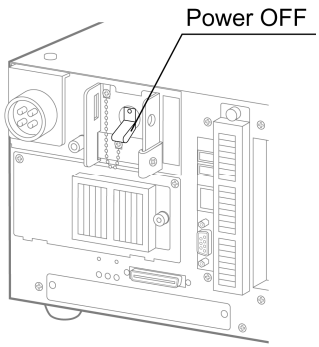
1.4 Precautions When Designing the End-effectors

Refer to the GENERAL INFORMATION ABOUT ROBOT for VM-G SERIES, Chapter 3, Section 3.5 "Precautions When Designing the End-effectors."

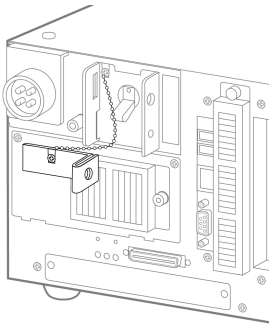
1.5 Locking Out the Power Switch

Lock out the power switch during maintenance and inspection jobs using a commercially available padlock, according to the following procedure.

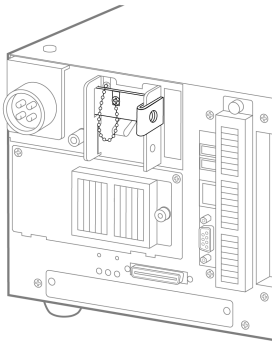
Step 1 **Check that the power switch of the robot controller is turned OFF.**



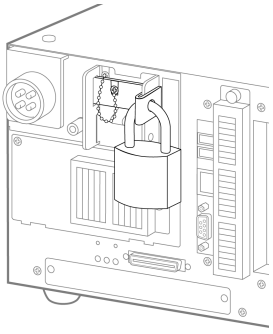
Step 2 **Remove the lockout bar provided on the robot controller.**



Step 3 **Put the lockout bar on the upper side of the power switch.**



Step 4 **Padlock the lockout bar.**



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.

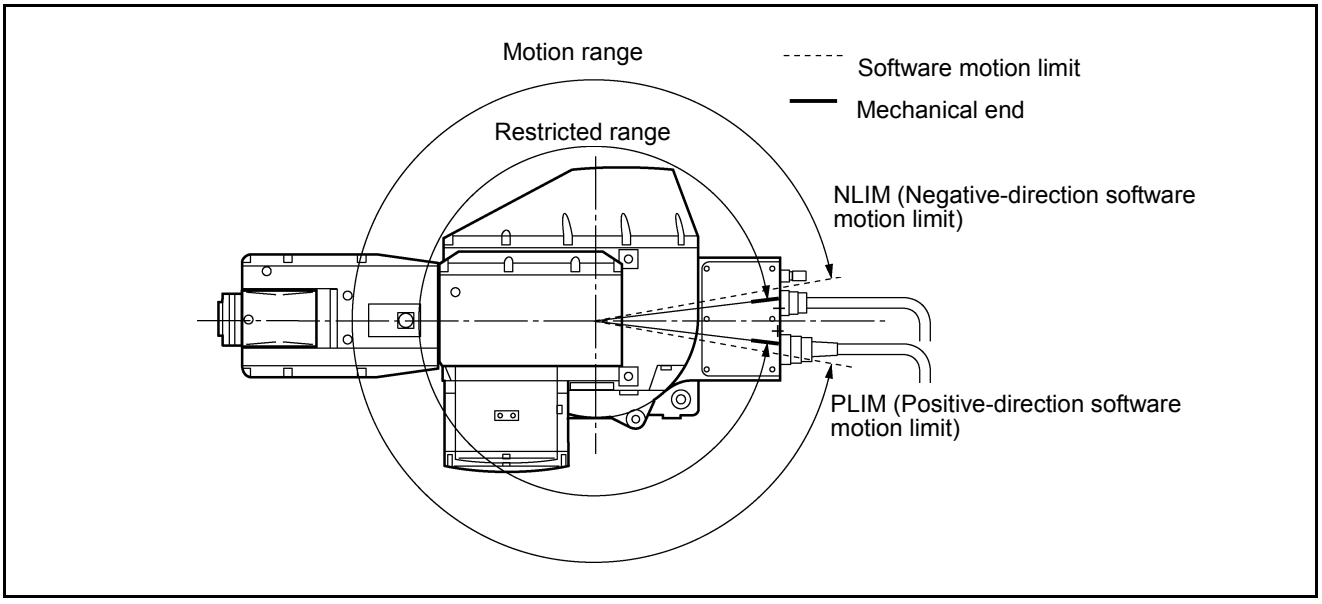
2.2 Modifying Software Motion Limits to Define New Motion Space

2.2.1 What Is a Software Motion Limit?

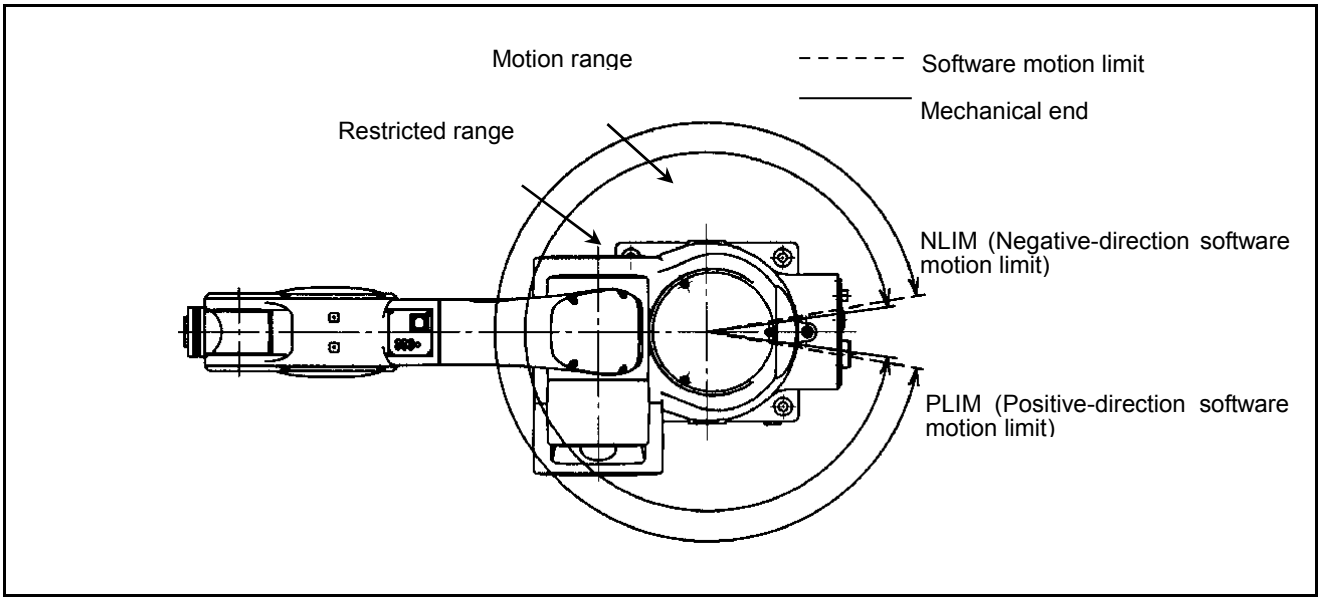
A limit to the operation range of the robot defined by the software is called a software motion limit. Software motion limits become valid after CAL of the robot has been completed and the robot has entered the range set by the limits.
A mechanical operation limit is called a mechanical end and set by 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 below. 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.

> ⚠**Note: Software motion limits are not functions in accordance with safety standards.**



Software Motion Limits and Mechanical Ends



Software Motion Limits and Mechanical Ends

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-G series)

Robot model		1st axis	2nd axis	3rd axis	4th axis	5th axis	6th axis
VM-6083G (See NOTE.)	Positive direction	170°	135°	165°	185°	120°	360°
	Negative direction	-170°	-90° max.	-80° max.	-185°	-120°	-360°
VM-60B1G	Positive direction	170°	135°	168°	185°	120°	360°
	Negative direction	-170°	-90°	-80°	-185°	-120°	-360°

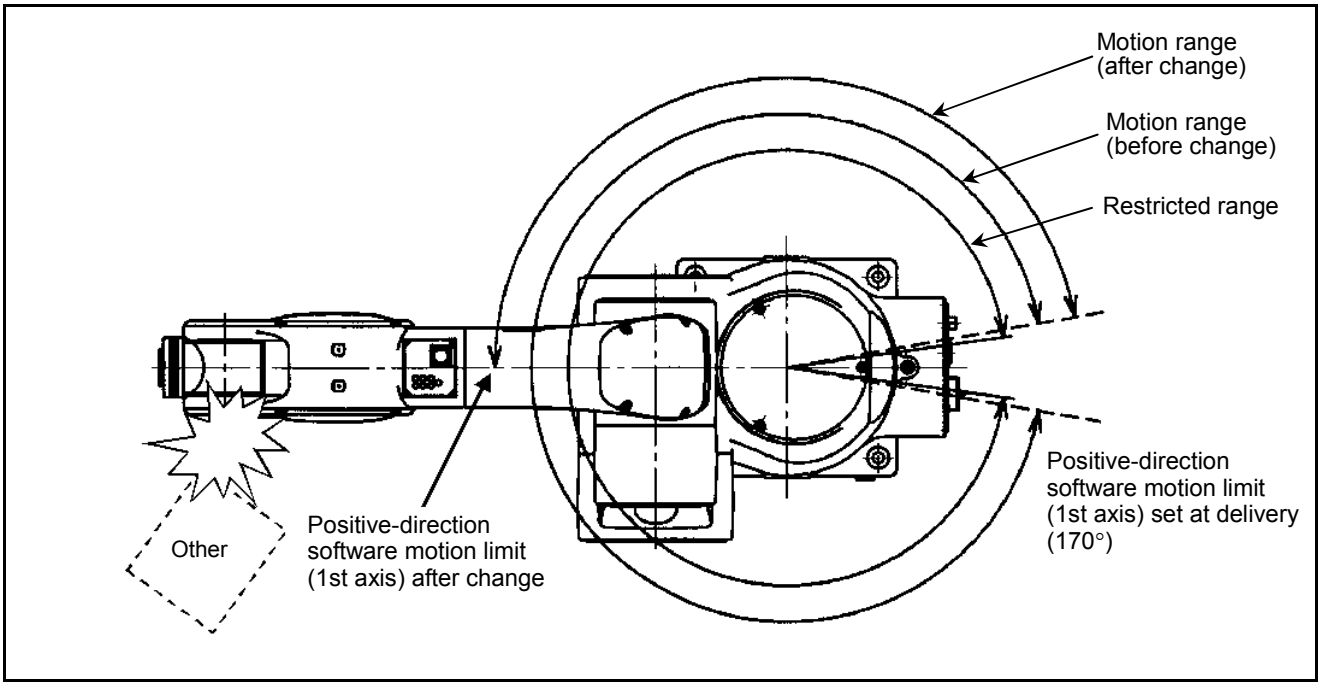
NOTE: The 2nd and 3rd axes of the VM-6083G are restricted in workable spaces according to the robot posture.

2.2.3 Changing Software Motion Limits

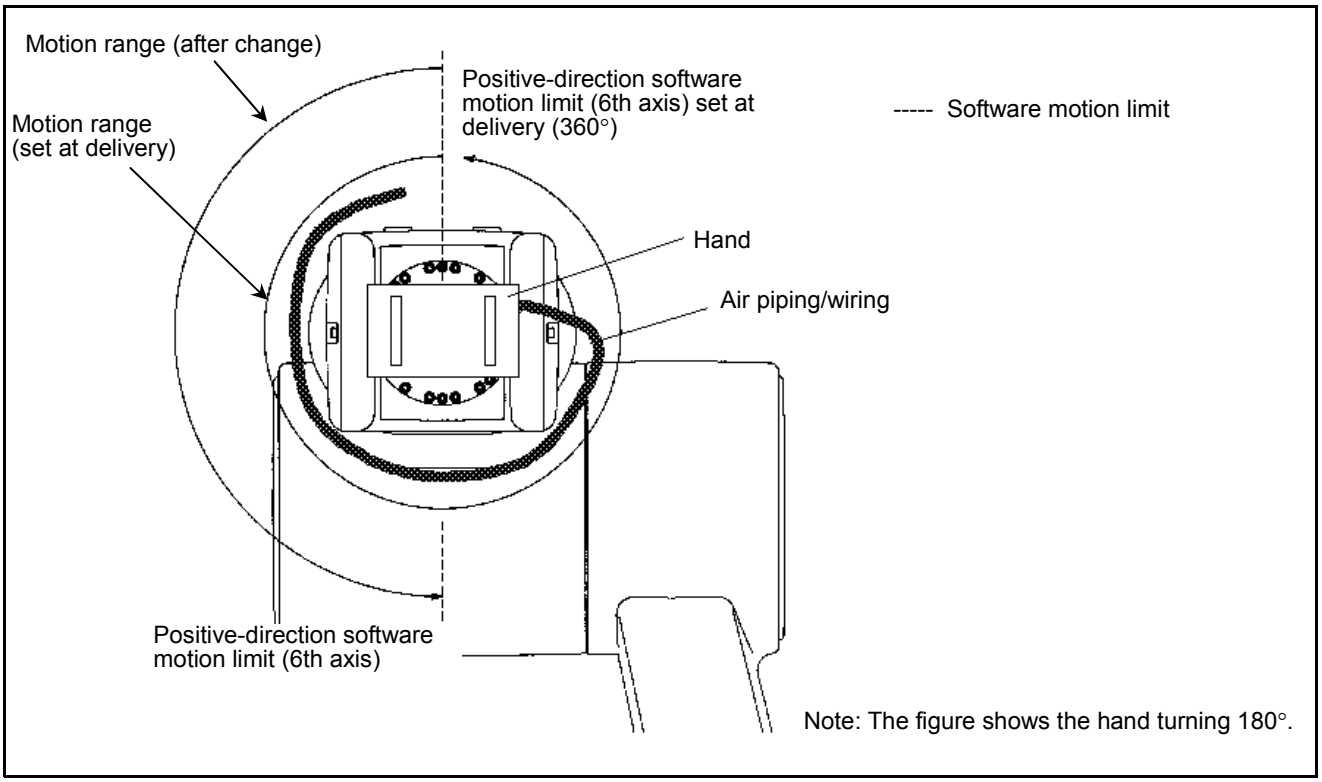
If the robot interferes with any other device, change the software motion limits to make the motion space smaller as shown by the upper figure on this page. If the air piping or wiring of the end-effector becomes taut as the robot runs, change the software motion limits to make the motion space smaller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

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

[VM-6083G/VM-60B1G]



Example 1: Changing Software Motion Limits [VM-6083G/VM-60B1G]



Example 2: Changing Software Motion Limits [VM-6083G/VM-60B1G]

2.3 Changing the Mechanical End

This section describes the procedures of changing the mechanical ends from the 1st-axis to 3rd-axis on the VM-6083G/VM-60B1G series.

CAUTIONS IN 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. **When the robot has collided with a mechanical stopper, contact us for inspection and repairs before using the robot because the robot may be damaged.**
   Also because the mechanical stopper designed and made by the customer may be damaged, do not reuse the mechanical stopper, but replace it before using the robot.
4. **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.**
5. **The failures caused by the mechanical stoppers shall not be covered by the warranty even if the robot is under warranty.**

2.3.1 1st-axis Mechanical End Change

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

At the time of delivery from the factory, mechanical ends are set in the VM-6083G/VM-60B1G series so that the stroke of the 1st axis will be ±170°.

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

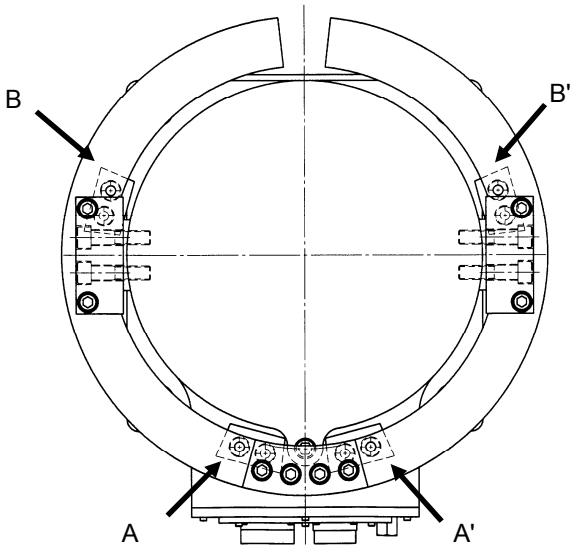
The figure below shows the mechanical stop positions for mechanical end change.

Given below is an example when the mechanical stops are positioned as specified in the table below.

To change the mechanical ends, the following four types of mechanical stop parts are required.

- Mechanical stop (4 pieces)
- Fixture block A (2 pieces)
- Fixture block B (1 piece)
- Plate (2 pieces)

The figures on the following pages show the reference drawings of those mechanical stop parts. Referring to those drawings, you should prepare mechanical stop parts as necessary so that your desired motion space may be set.



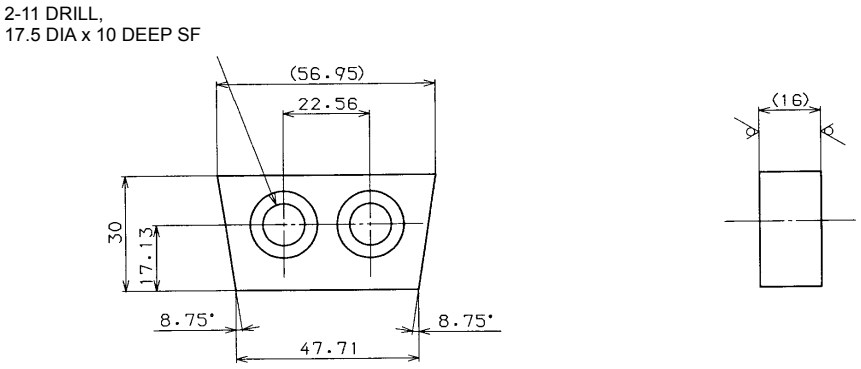
Location of the Mechanical Stops on the VM-6083G/VM-60B1G Series

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 1st axis is different between the positive and negative directions. 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-6083G/VM-60B1G (For 1st-axis)

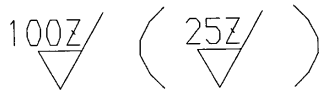


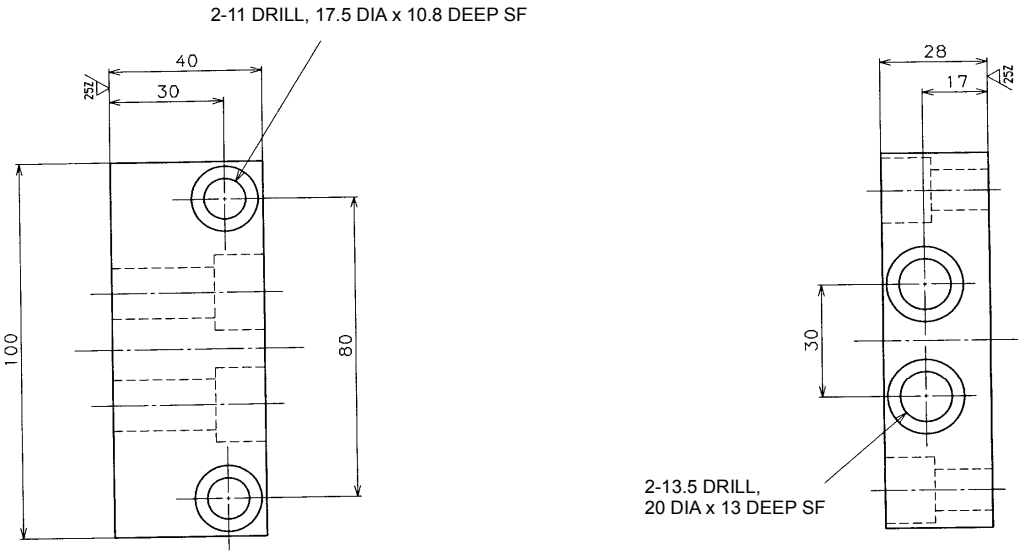
Material: A2017

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

Mechanical Stop

VM-6083G/VM-60B1G (For 1st-axis)



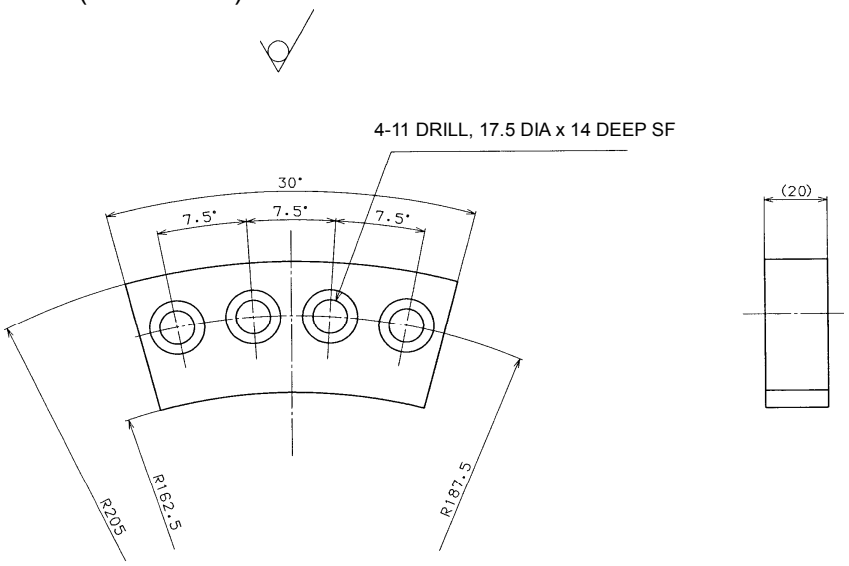


Material: S45C

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

Fixture Block A

VM-6083G/VM-60B1G (For 1st-axis)

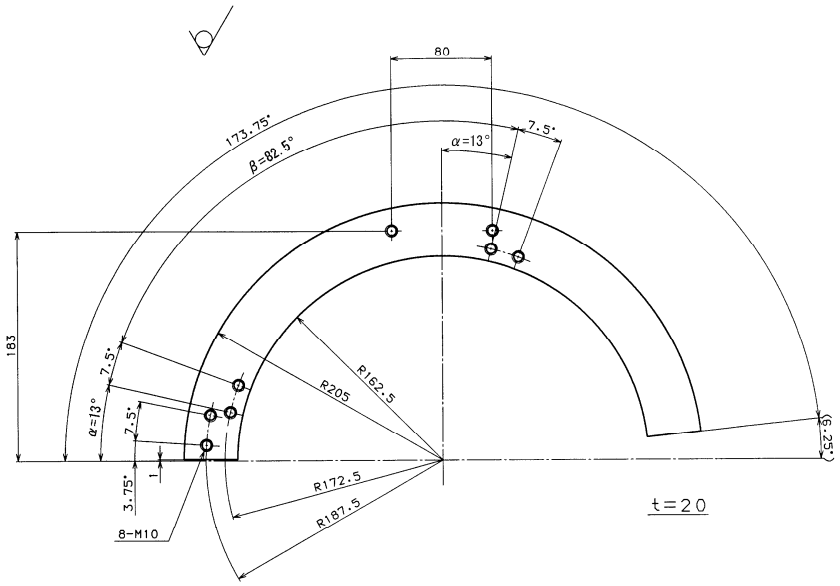


Material: S45C

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

Fixture Block B

VM-6083G/VM-60B1G (For 1st-axis)



Material: S45C

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

(Note 2) α and β are arbitrary angles.

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 required after a mechanical end change, the CALSET must also be performed.

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

(1) When CALSET is necessary (e.g., at the time of motor replacement), if you perform CALSET after removing the mechanical stop parts (prepared by the customer), a mechanical end change requires no RANG value change or CALSET.

(2) If you perform CALSET with the mechanical stop parts (prepared by the customer) being mounted, a mechanical end change requires RANG value change and CALSET. In this case, the position repeatability depends on the mechanical stop parts prepared by the customer.

The customer needs to manage the RANG values and CALSET values after modification, referring to "Backing up Projects."

The following example for the 1st-axis mechanical end change contains RANG value change and CALSET.

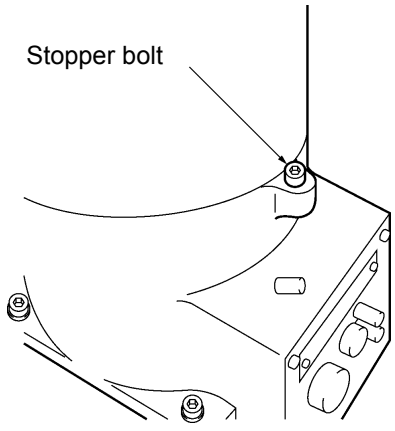
[2] Changing the Mechanical Ends

The mechanical ends can be changed by mounting four types of mechanical stop parts (i.e., mechanical stops, fixture blocks A, fixture block 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

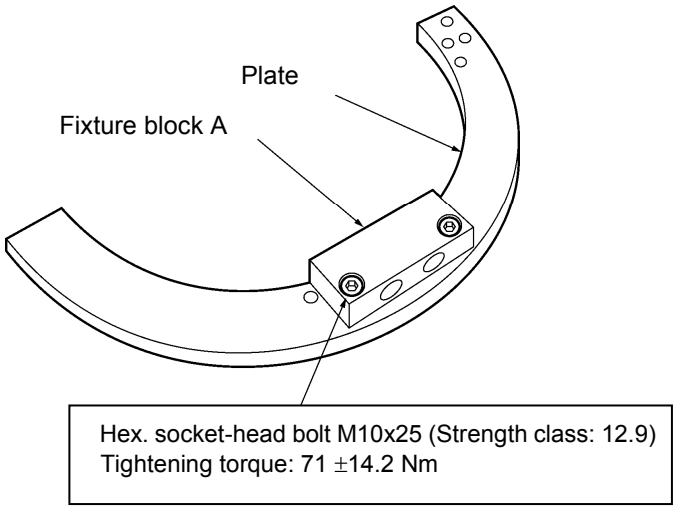
STEP 1

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



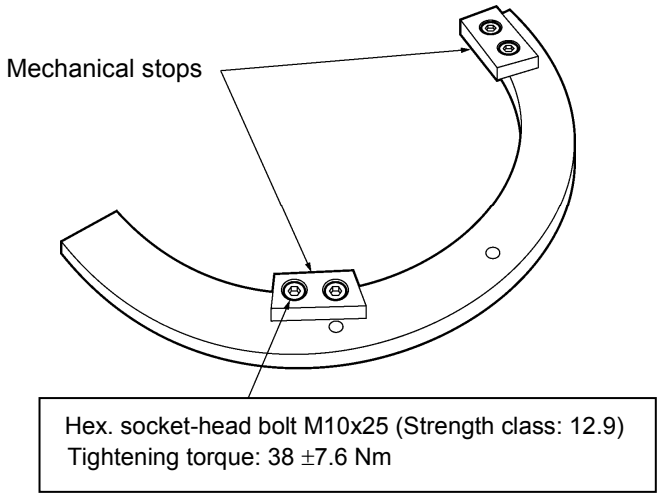
STEP 2

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



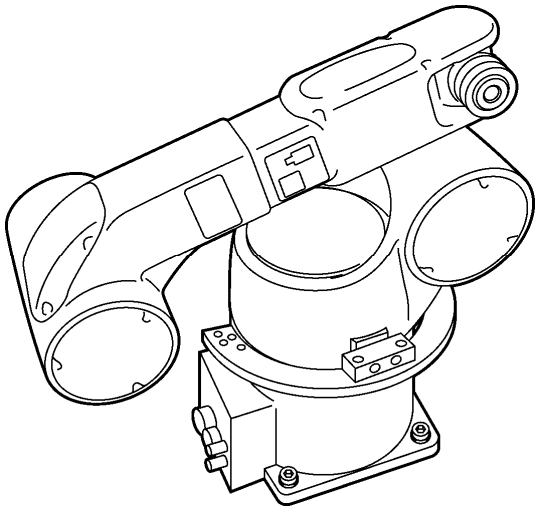
STEP 3

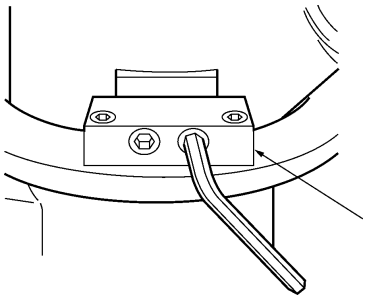
Turn the assemblies made in Step 2 upside down. Secure two mechanical stops to each of those assemblies with two hexagonal socket-head bolts each for determining the desired motion space.



STEP 4

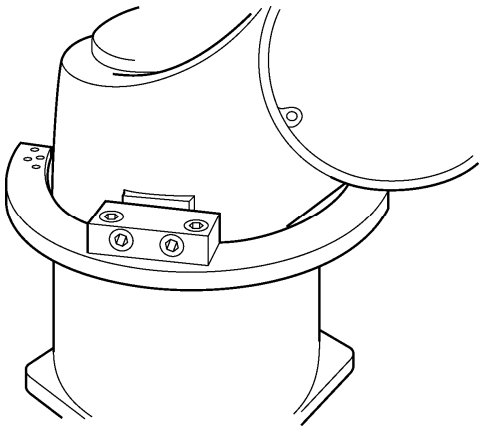
Temporarily secure one of the assemblies made in Step 3 to the side of the 1st axis with hexagonal socket-head bolts.





STEP 5

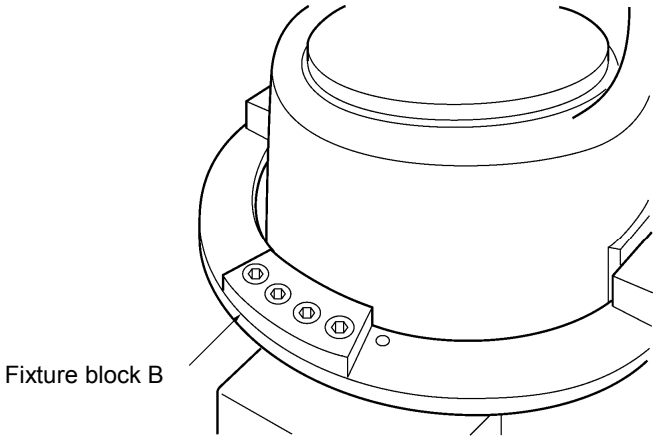
In the same way as in Step 4, temporarily secure the other one of the assemblies to the opposite side.



STEP 6

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

After that, firmly tighten the hexagonal socket-head bolts (on fixture blocks A) that have been temporarily tightened in Steps 4 and 5.



Hexagonal socket-head bolts M10×25 (strength class 12.9)
Bolt tightening torque: 71±14.2Nm
Hexagonal socket-head bolts M12×50 (strength class 12.9)
Bolt tightening torque: 110±22Nm

(2) Software motion limits and Set RANG values

Note: If you perform CALSET with the mechanical stop parts (prepared by the customer) being mounted, a mechanical end change requires RANG value change and CALSET. In this case, the position repeatability depends on the mechanical stop parts prepared by the customer.

The customer needs to manage the RANG values and CALSET values after modification, referring to "Backing up Projects."

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 page 38.

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

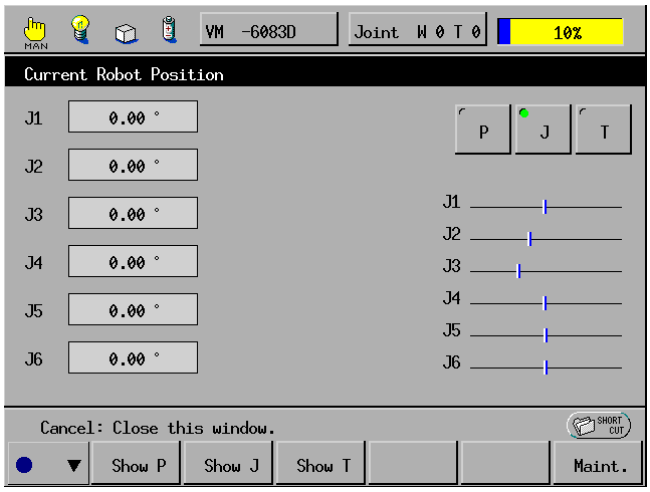
Turn the power switch of the robot controller to ON.

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.

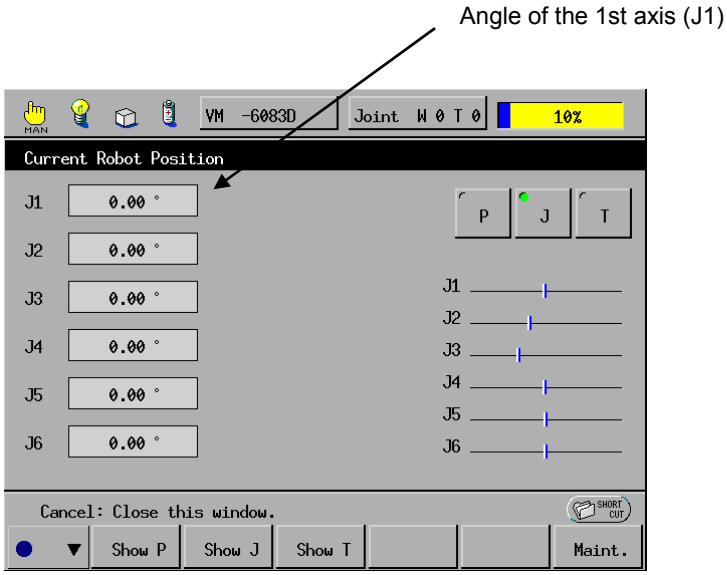


STEP 4

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

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 23 described below.

Changing Positive-Direction Software Motion Limits (PLIMs)

STEP 1

Turn the power switch of the robot controller to ON.

STEP 2

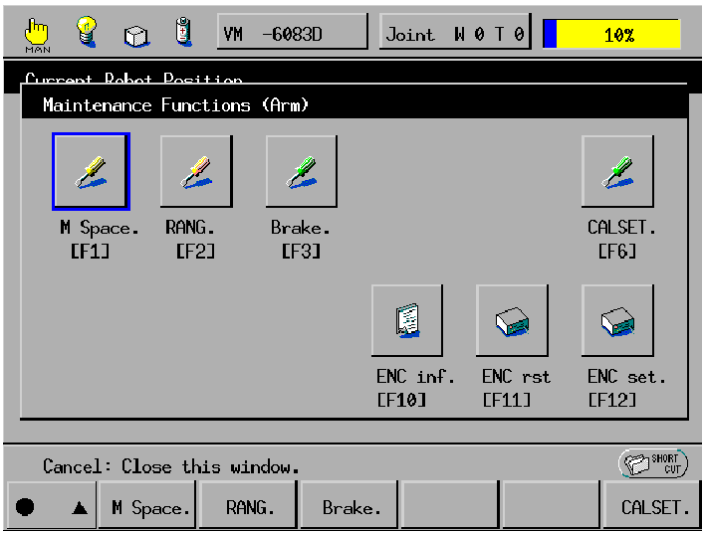
Set the mode selector switch of the teach pendant to MANUAL.

STEP 3

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

STEP 4

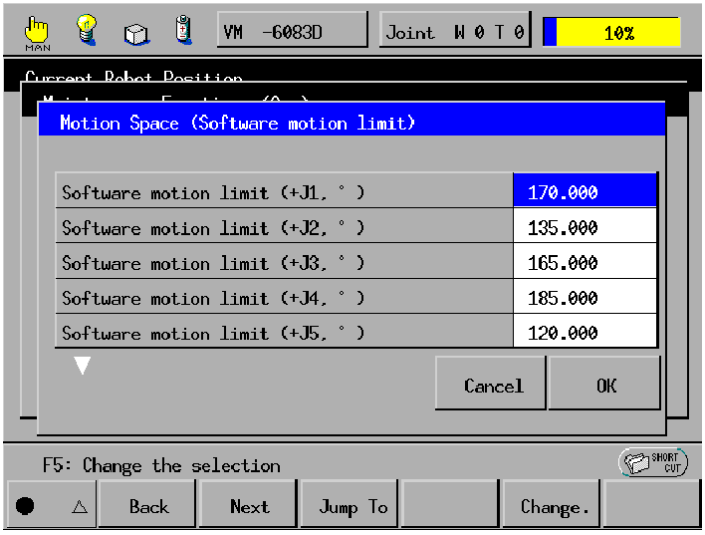
Press [F12 Aux.].
The Maintenance Functions (Arm) window appears.



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.

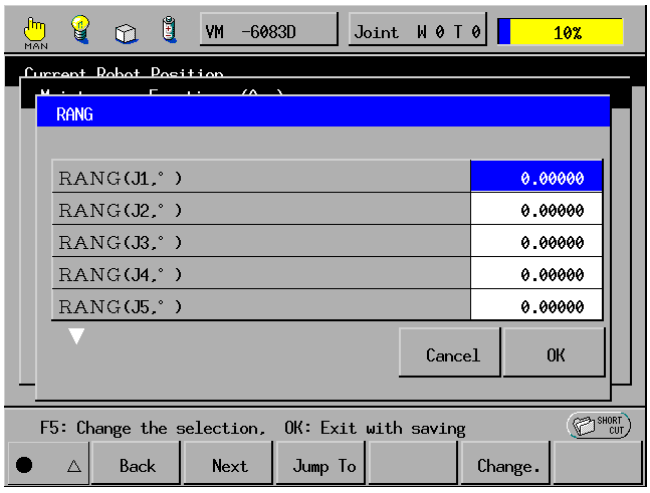
STEP 9

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

Changing Set RANG Values

STEP 10

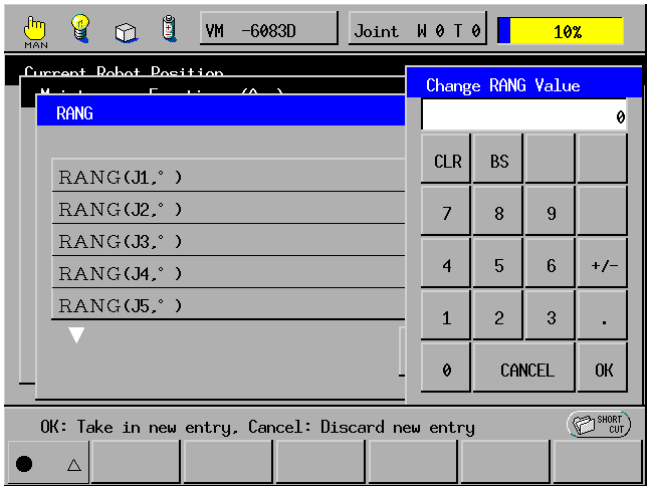
Press [F2 RANG.].
The RANG window appears as shown below.



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

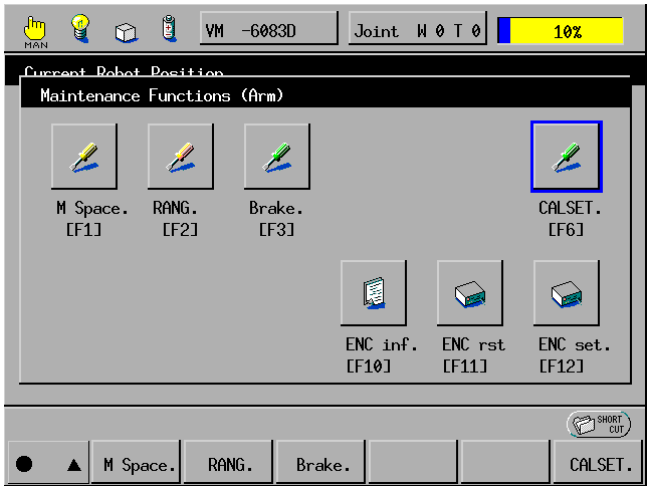
Press [F2 Arm] on the top screen.

CALSET of the 1st Axis

STEP 17

Press SHIFT.

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



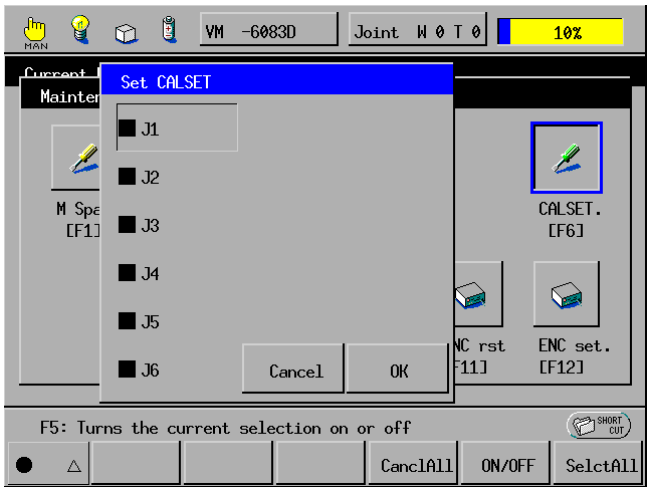
F6

STEP 18

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

STEP 19

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

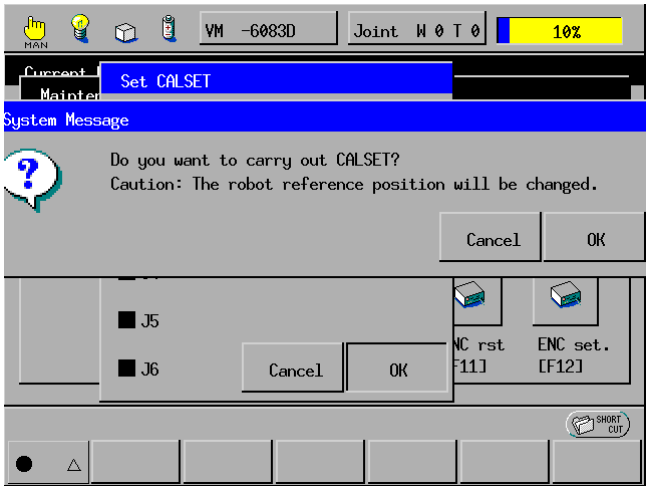


STEP 20

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

STEP 21

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



STEP 22

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

STEP 23

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.**

Note: If you perform CALSET with the mechanical stop parts (prepared by the customer) being mounted, a mechanical end change requires RANG value change and CALSET. In this case, the position repeatability depends on the mechanical stop parts prepared by the customer.

The customer needs to manage the RANG values and CALSET values after modification, referring to "Backing up Projects."

(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

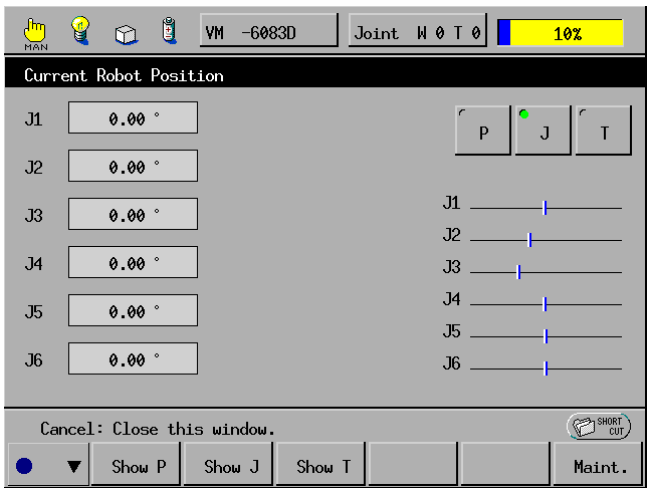
Turn the power switch of the robot controller to ON.

STEP 2

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

STEP 3

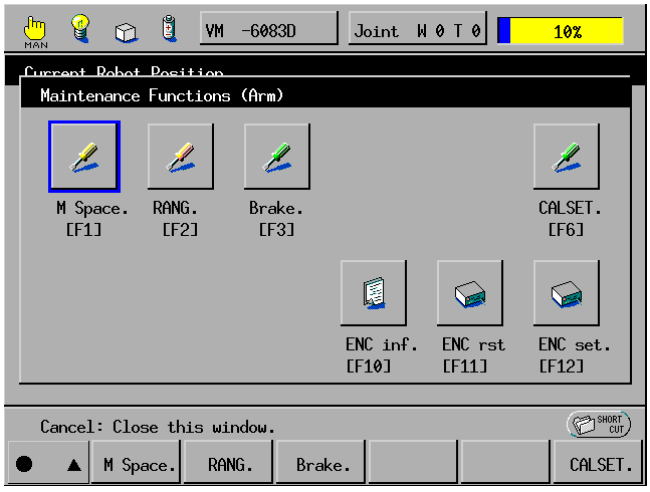
Press [F2 Arm] on the top screen.
The Current Robot Position window appears.



F12

STEP 4

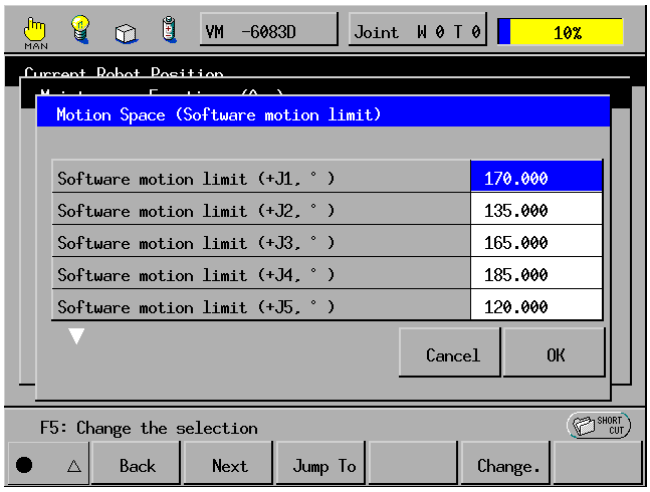
Press [F12 Maint.].
The Maintenance Functions (Arm) window appears.



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 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 preset in the VM-6083G and VM-60B1G series so that the workable angle of the 2nd-axis and 3rd-axis will be as listed 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-G series

Model	Workable angle for the 2nd-axis	Workable angle for the 3rd-axis
VM-6083G series VM-6083G-W series	+135°, -90°	+165°, -80°
VM-60B1G series VM-60B1G-W series	+135°, -90°	+168°, -80°

Changing the mechanical ends of the 2nd-axis and 3rd-axis by adding mechanical stops 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: After changing the mechanical ends, change the software motion limits to the positions inside the mechanical end positions.

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

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

(1) When CALSET is necessary (e.g., at the time of motor replacement), if you perform CALSET after removing the mechanical stop parts (prepared by the customer), a mechanical end change requires no RANG value change or CALSET.

(2) If you perform CALSET with the mechanical stop parts (prepared by the customer) being mounted, a mechanical end change requires RANG value change and CALSET. In this case, the position repeatability depends on the mechanical stop parts prepared by the customer.

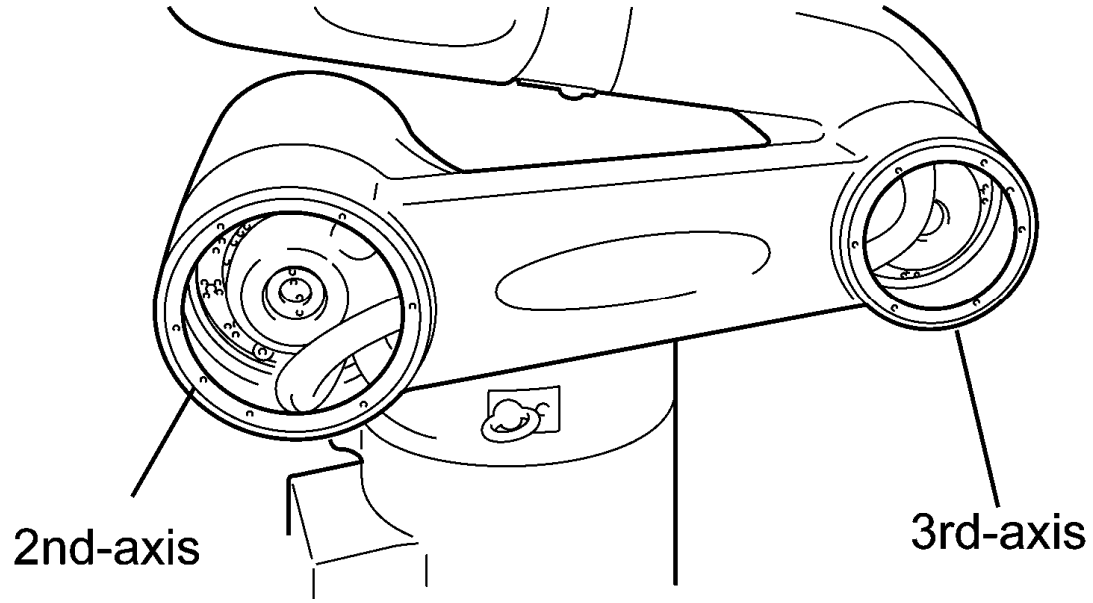
The customer needs to manage the RANG values and CALSET values after modification, referring to "Backing up Projects."

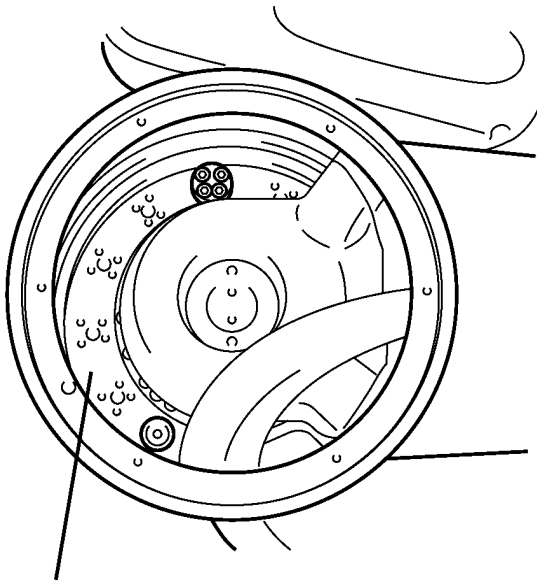
The following examples for the 2nd- and 3rd-axis mechanical end changes do not involve the RANG value change or CALSET.

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

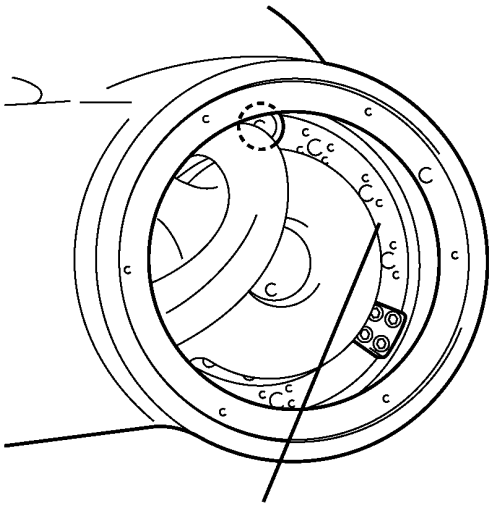
[2.1] Fixing plates for the 2nd-axis and 3rd-axis mechanical stoppers

The VM-6083G/VM-60B1G series of robots has fixing plates to mount the 2nd- and 3rd-axis mechanical stoppers at the time of delivery from the factory.





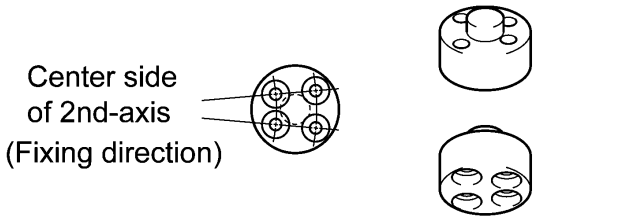
Fixing plate for the 2nd-axis mechanical stopper

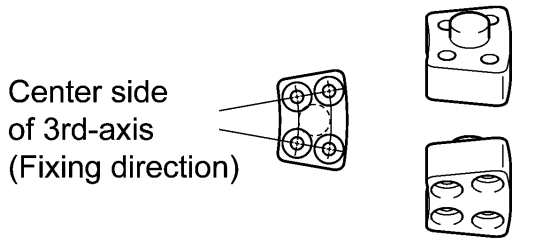


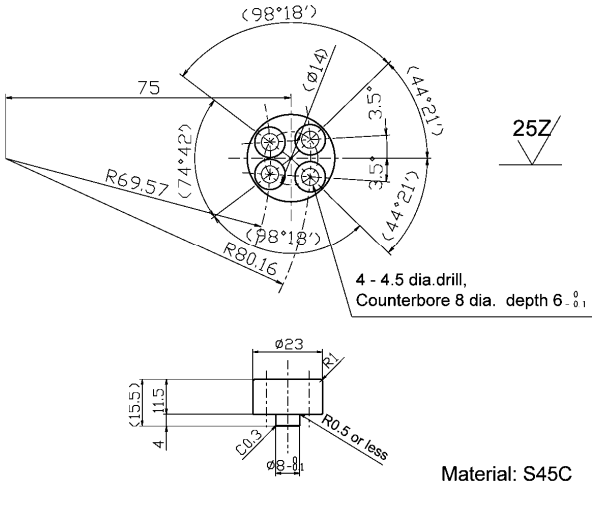
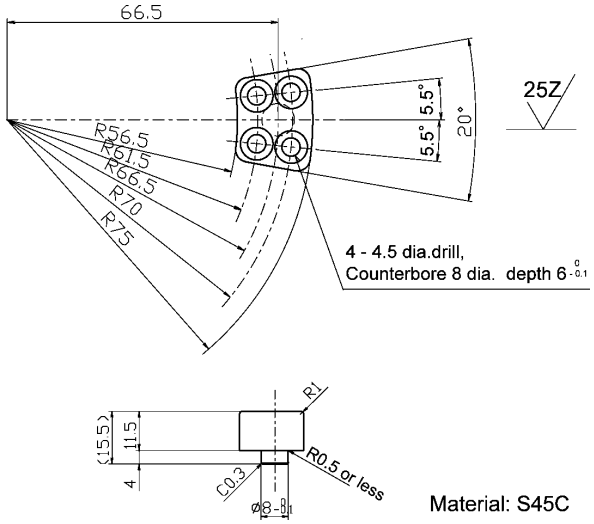
Fixing plate for the 3rd-axis mechanical stopper

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

The reference drawings of the 2nd- 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
 

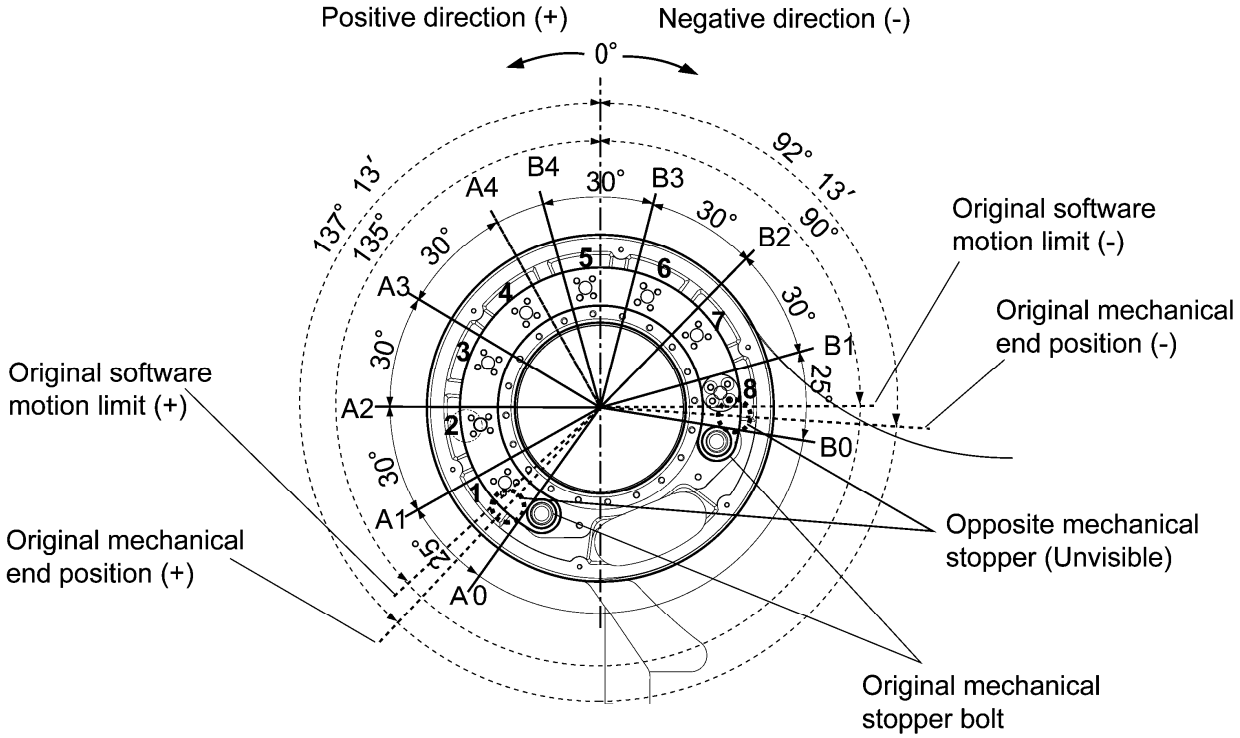
3rd-axis mechanical stopper</td></tr>
<tr><td>Reference drawing
 
(98°18')
75
(ø14)
3.5°
(44°21')
25Z
(74°42')
R69.57
3.5°
(44°21')
(98°18')
R80.16
4 - 4.5 dia.drill,
Counterbore 8 dia. depth 6
ø23
R1
(15.5)
11.5
4
C0.3
R0.5 or less
ø8
Material: S45C</td><td>Reference drawing
 
66.5
25Z
R56.5
R61.5
R66.5
R70
R75
5.5°
5.5°
20°
4 - 4.5 dia.drill,
Counterbore 8 dia. depth 6
R1
(15.5)
11.5
4
C0.3
R0.5 or less
ø8
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

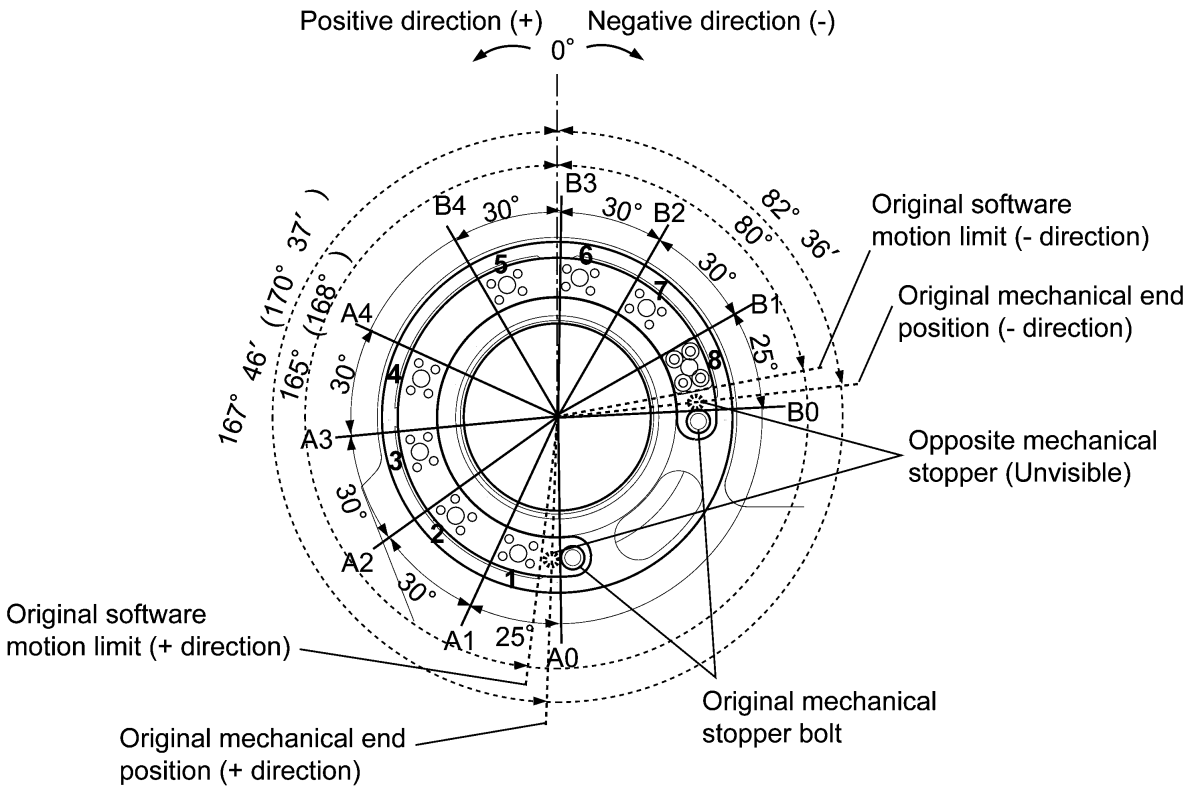


Fixing position of mechanical stopper	Mechanical end positions	
	Positive direction (+)	Negative direction (-)
Original	A0 <Original mechanical end position> +137° 13' <Original software motion limit> +135°	B0 <Original mechanical end position> -92° 13' <Original software motion limit> -90°
1	A1 (25° 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

Explanation of changing the 3rd-axis mechanical ends



Note: Values in parentheses apply to the VM-60B1G.

Fixing position of mechanical stopper	Mechanical end positions	
	Positive direction (+)	Negative direction (-)
Original	A0 <Original mechanical end position> VM-6083G: +167° 46' VM-60B1G: +170° 37' <Original software motion limit> VM-6083G: +165° VM-6083G: +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.

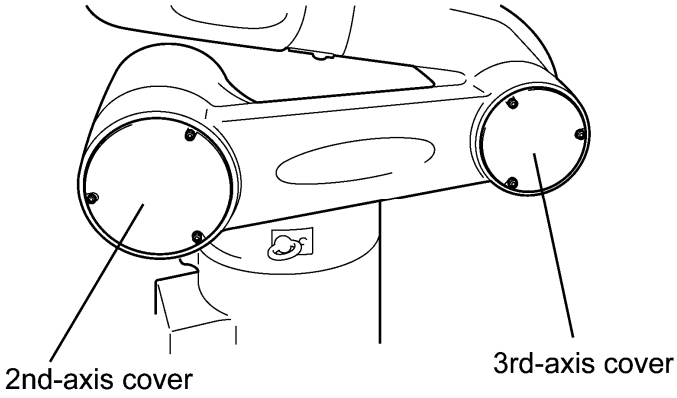
[3] Changing the Mechanical Ends

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

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

(Manufactured by the customer).

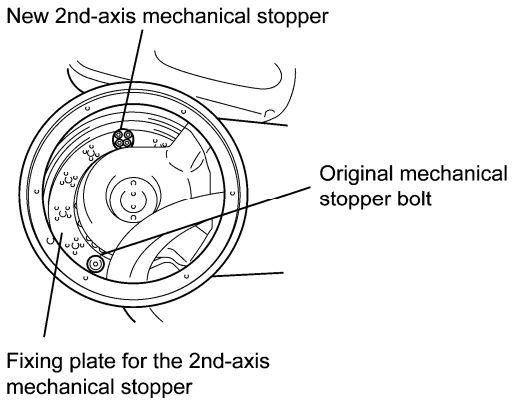
Step 2 Remove the 2nd-axis and 3rd-axis cover.

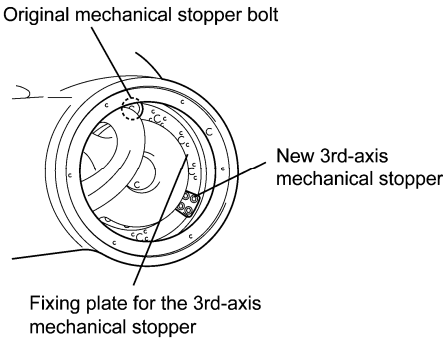


Step 3 Install the mechanical stopper to the fixing position of the robot using four bolts according to [2.3].

Tightening torque: 3.9 Nm±20%

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





Step 4 Reinstall the 2nd-axis and 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.

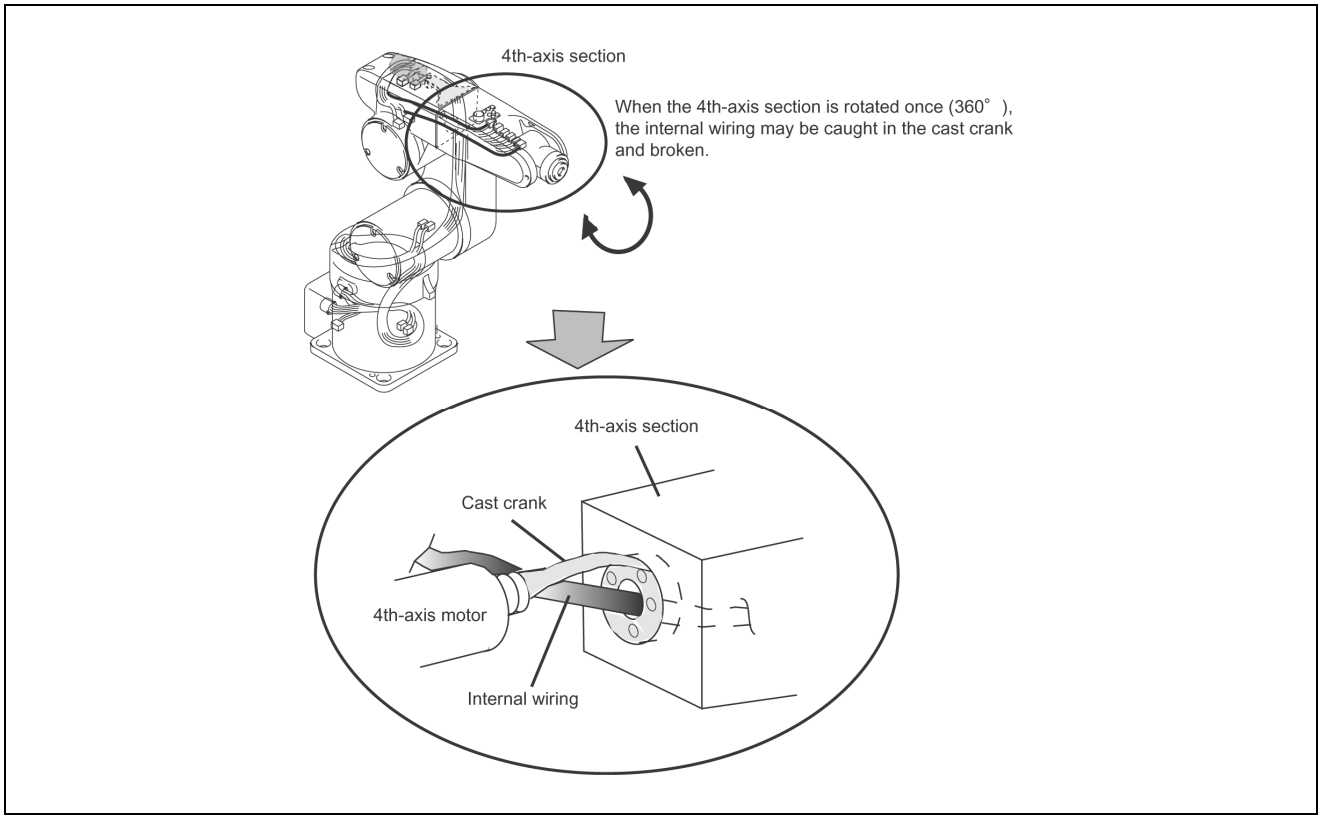
Back up the CALSET data periodically, referring to "Backing Up Projects."

2.4.2 Precautions about CALSET for the VM-G Series

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

Robots in the VM-6083G/VM-60B1G series launched 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.



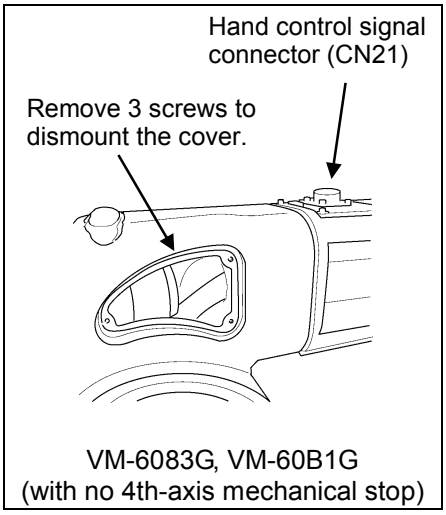
Note that turning the 4th-axis section by more than 360° may break the internal wiring

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:

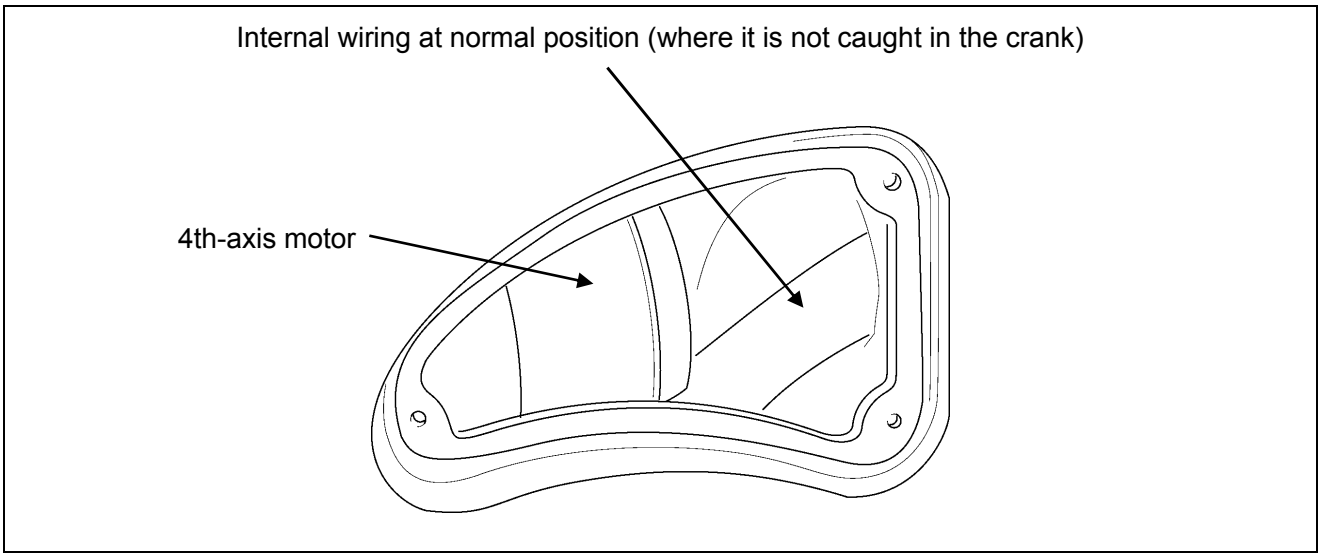


VM-6083G, VM-60B1G
(with no 4th-axis mechanical stop)

(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 the 4th-axis position for VM-6083G/VM-60B1G



(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

All models of the VM-G series have no mechanical stop on the 6th axis.

The VM-6083D/VM-60B1D manufactured after the middle of March in 2001 has no mechanical stop on the 4th axis.

The CALSET procedure differs depending upon whether or not the 4th axis is equipped with a mechanical stop. The models having no mechanical stop on the 4th axis requires mounting a CALSET jig before the start of CALSET as described in Section 2.4.4.

(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 (VM-G series)

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 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-G series can release the brake of the specified axis.**
- **On the VM-G series, the 2nd to 6th axes have brakes.**

(2) When performing CALSET, be careful about the robot motion. Executing the CALSET command releases motor brakes so that the robot arm 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.

(7) If the RANG values have not been changed after a mechanical end change, remove the changed mechanical end(s) before performing CALSET.

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).

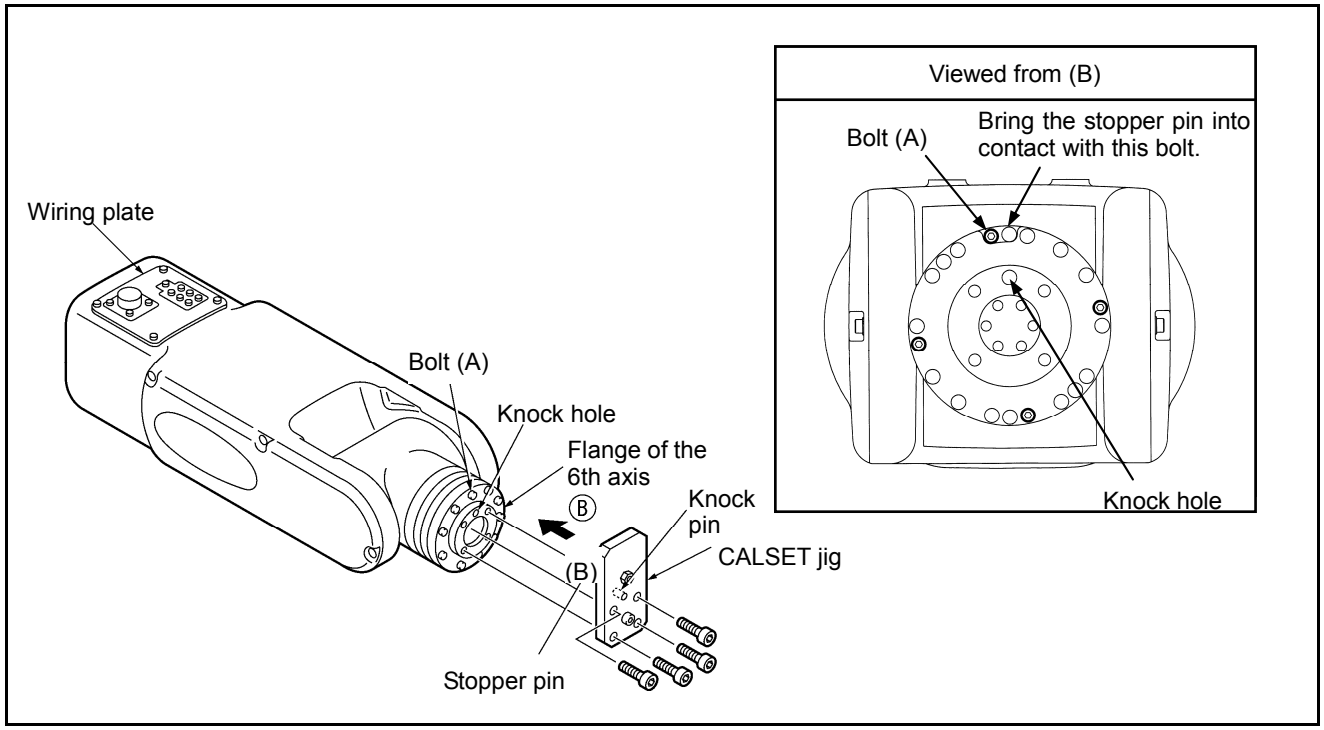
(1) Mounting the CALSET jig on the 6th axis

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 below) comes into contact with bolt (A) when the flange of the 6th axis is turned.



Mounting a CALSET Jig [VM-6083G/VM-60B1G]

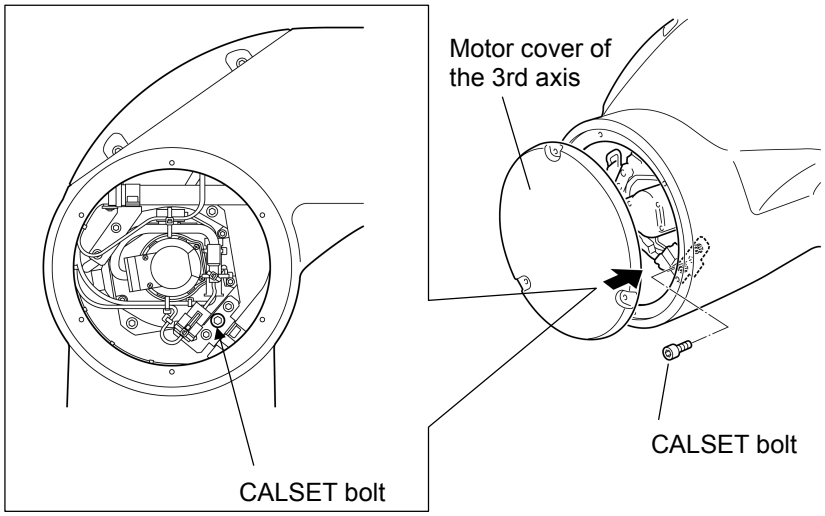
(2) Mounting the CALSET jig on the 4th axis (which has no mechanical stop)

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-6083G/VM-60B1G)

STEP 2

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

STEP 3

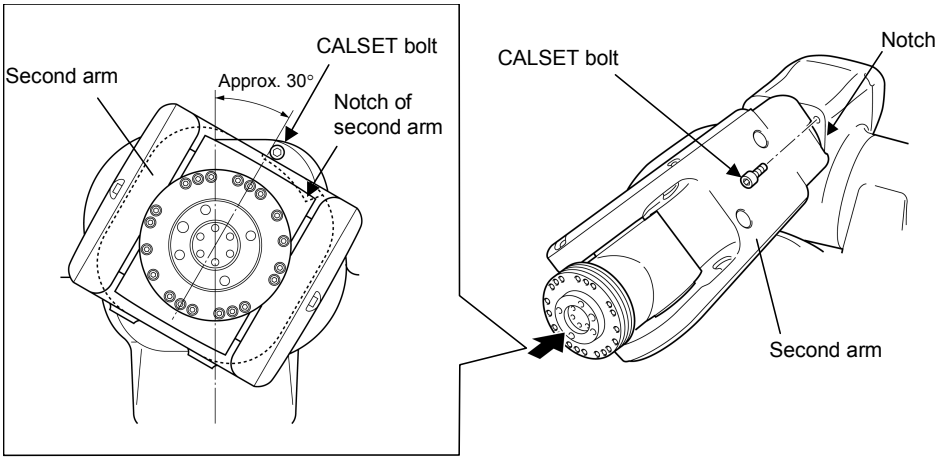
Release the brake of the 4th axis.

STEP 4

Set the CALSET bolt to the end of the 3rd axis housing as shown below.
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-6083G/VM-60B1G)

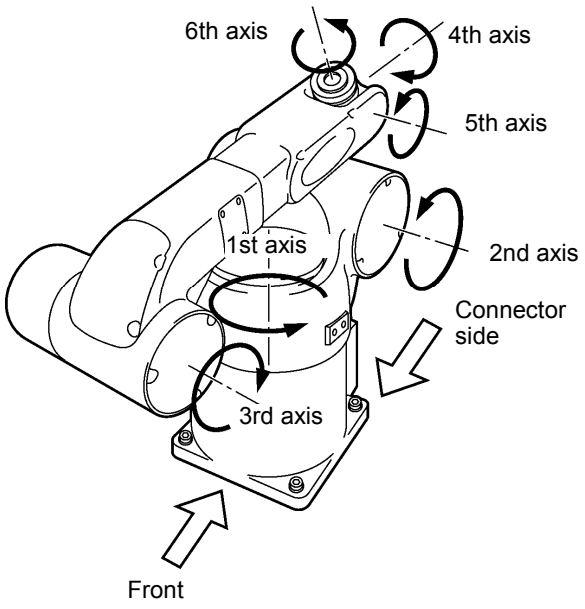
2.4.5 What Is a CALSET Position?

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	Models having no mechanical stop on the 4th axis 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-6083G/VM-60B1G



CALSET Positions (VM-G series)

Caution for using customized mechanical ends:

If the RANG values have not been changed after a mechanical end change, remove the changed mechanical end(s) before performing CALSET. (Refer to the "Precautions When Changing the Mechanical Ends" on page 32.)

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.

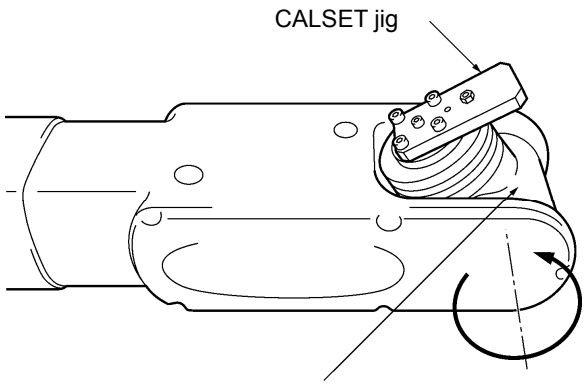
NOTE: Step 1 is required for CALSETing the 4th and 6th axes and Step 2 is for CALSETing the 6th axis. When CALSETing any other axes, skip to Step 3.

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

Mount the CALSET jig according to Section 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.



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

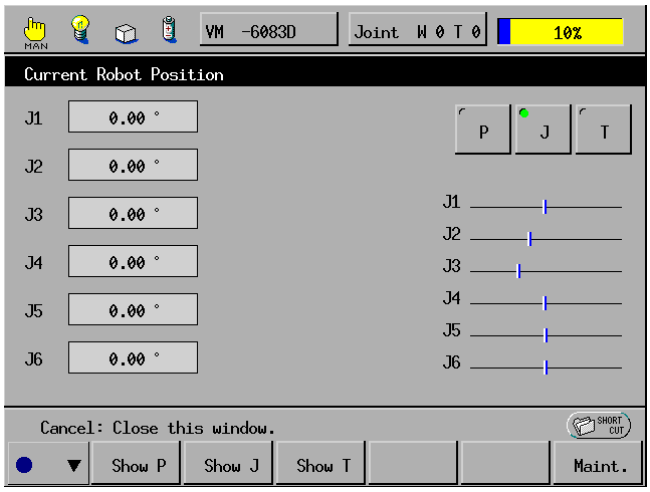
Press the MOTOR key on the teach pendant to turn OFF the power to the motor.

STEP 8

Press [F2 Arm] on the teach pendant.

STEP 9

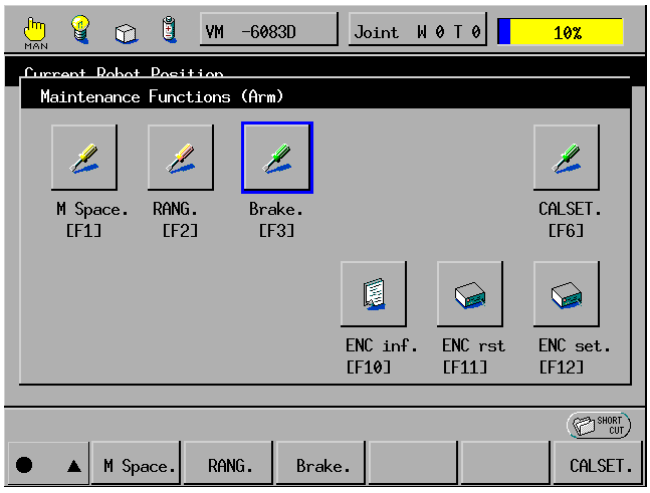
Press the SHIFT key and [F12 Maint.].



F12

STEP 10

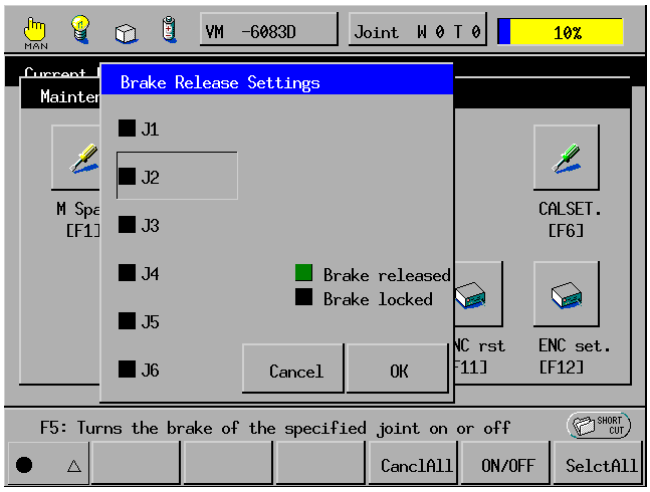
Press [F3 Brake.].



F3

STEP 11

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



STEP 12

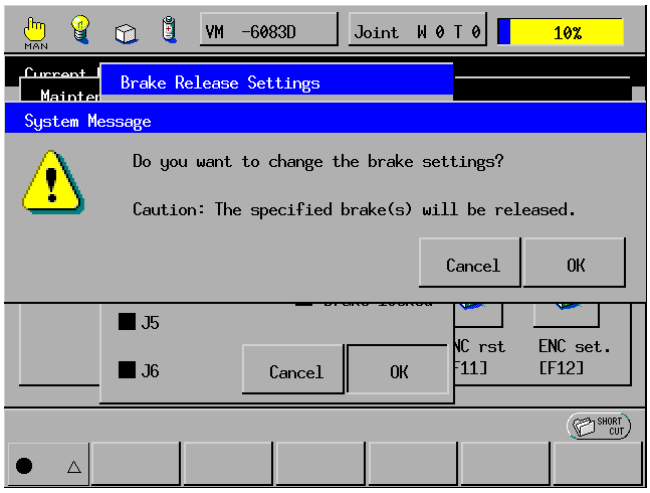
Confirm that there is no danger even if the arm falls as a result of released brakes.

CAUTION: The brake of the specified axis has been released.

STEP 13

Press OK.

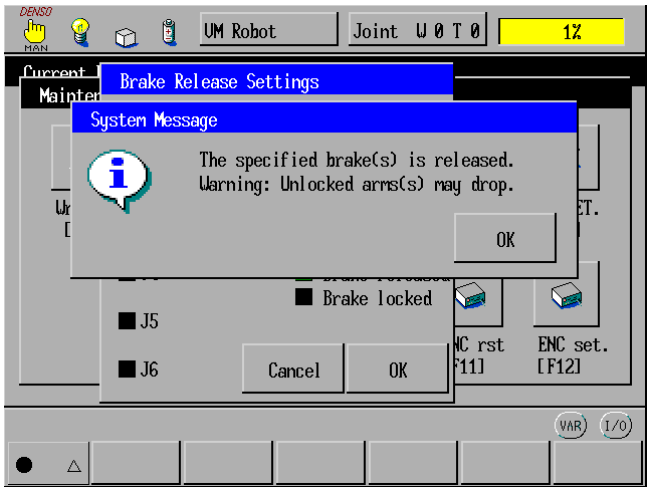
The system message appears asking you whether you want to change the brake settings.



STEP 14

Press OK.

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



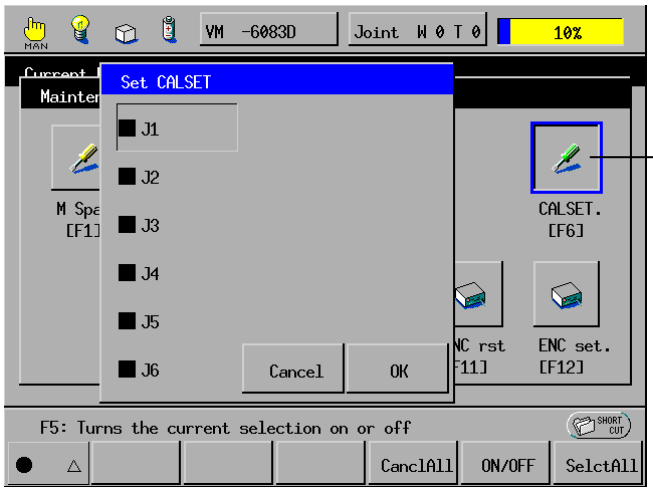
STEP 15

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

STEP 16

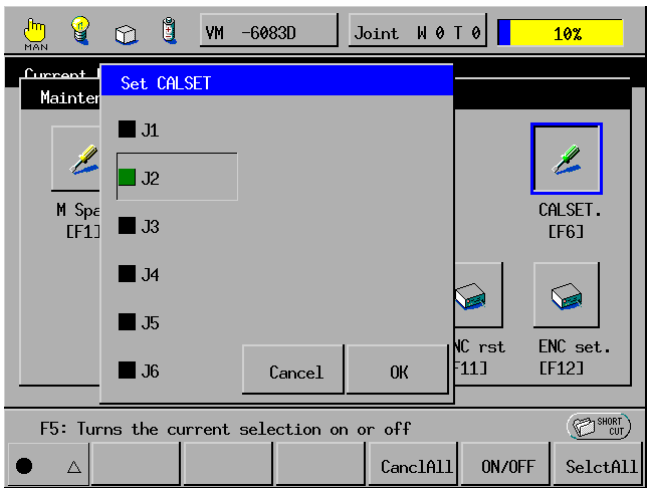
Press [F6 CALSET.].

The Set CALSET window appears.



STEP 17

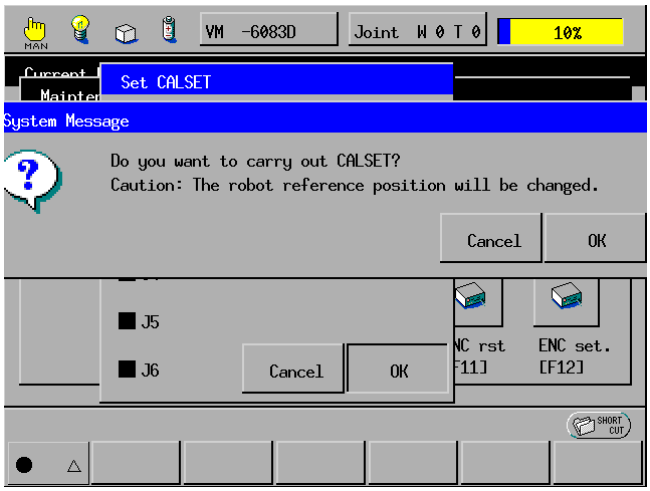
Press the axis number to be CALSET to select CALSET (green display). Deselect CALSET (black display) for the other axes that are not required to be CALSET.



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 when releasing brakes and performing CALSET. For details of the procedure, see Section 2.4.6.1 "CALSETing a Single Axis."

2.5 Setting Control Set of Motion Optimization

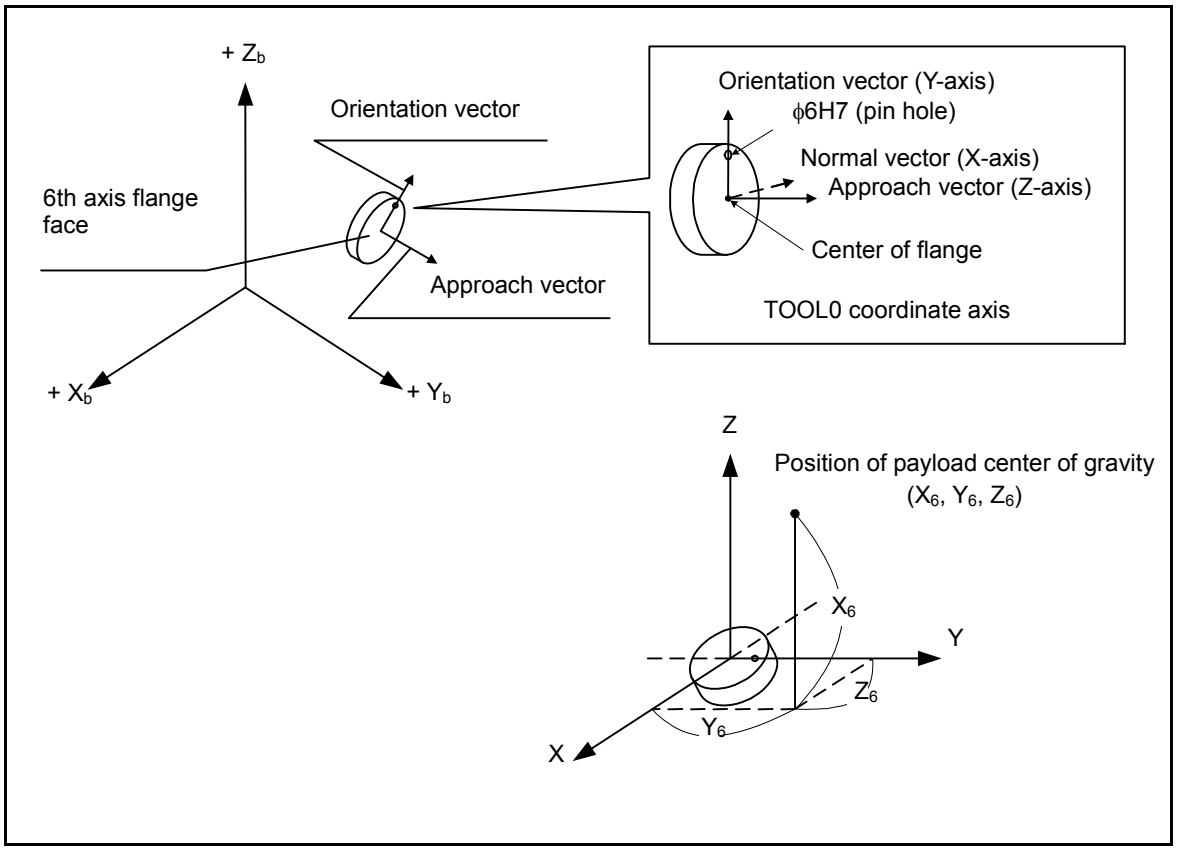
The optimum speed or acceleration will vary depending upon the payload and center of gravity of an end-effector or workpiece that is to be set at the end of the robot flange. Set the payload and center of gravity position of the end-effector or workpiece and the control set of motion optimization according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

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

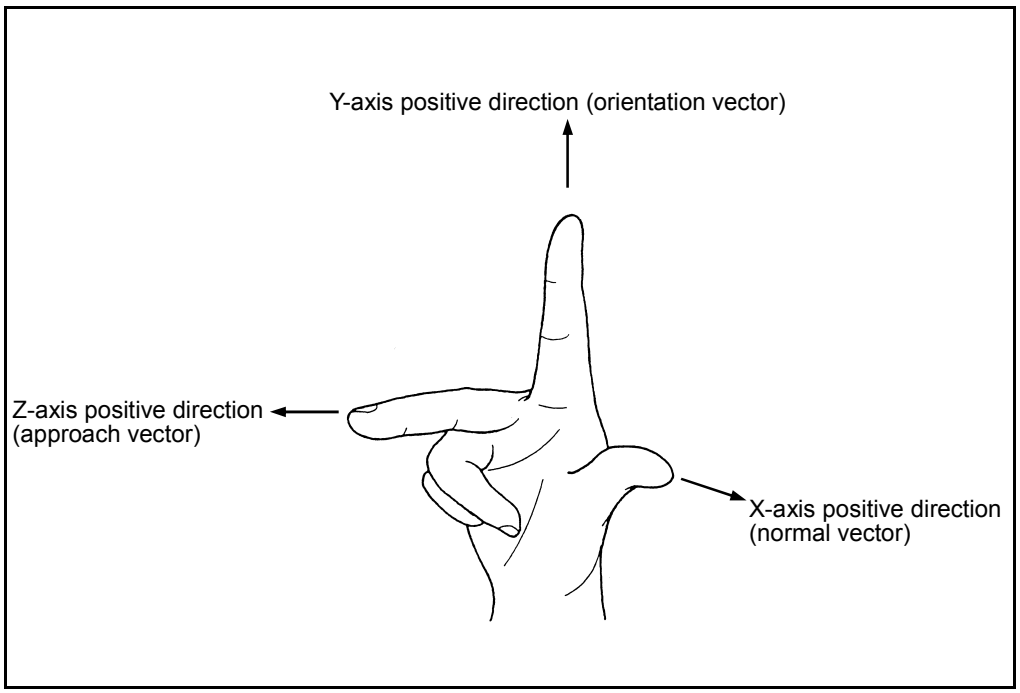
For further information, see the PROGRAMMER'S MANUAL, Section 4.7 "Setting the Master Control Parameters in User Preferences." For the setting procedure, refer to the SETTING-UP MANUAL, Section 2.8 "Setting the Master Control Parameters of the Payload, Center of Gravity, and Control Set of Motion Optimization."

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 2.9 "Setting the Robot Installation Condition" and the PROGRAMMER'S MANUAL, Section 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: Maintenance and inspection must be carried out by a trained worker who possesses the ability to perform these tasks safely.**
>
> **Before performing maintenance and inspection jobs, read the SAFETY PRECAUTIONS, "4. Precautions while Robot is Running" and "5. Daily and Periodical Inspections."**

Maintenance & Inspection Intervals and Purposes

■ VM-6083G/VM-60B1G

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.

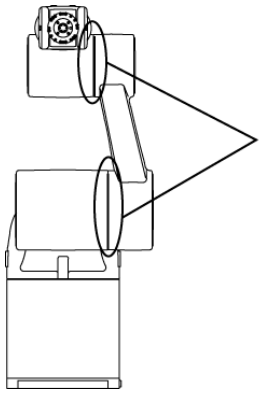
3.1.1 Precautions for installation and maintenance of robots for cleanroom use

When carrying out installation, maintenance or inspection jobs of the cleanroom type in your cleanroom, be sure to follow your dust-proof job rules. If you remove the covers from the robot controller or robot unit, even the cleanroom type may scatter worn belt dust, piping grease, dust or dirt accumulating inside.

Jobs requiring special care

- CALSET
- Cleaning of cooling fan filters in the robot controller
- Replacement of encoder backup batteries
- Replacement of controller memory backup batteries
- Replacement of controller fuses
- Replacement of controller output ICs

CAUTION **When transporting or maintaining the cleanroom type of robot units, take care not to apply an impact or shock to the cover section specified below. An impact or shock applied to the cover section or the resulting deformed cover section may deteriorate the cleanliness performance.**



3.2 Daily Inspections

3.2.1 Check Items

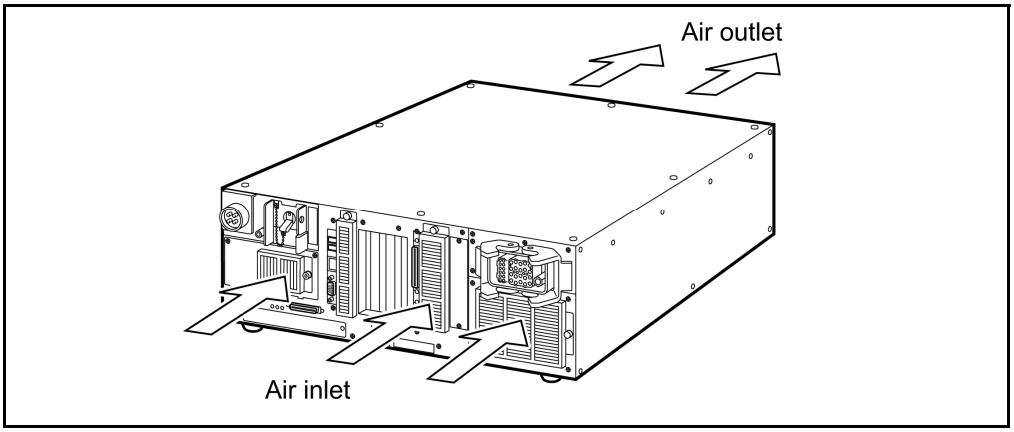
Before starting operations, check the items listed in the table below every day.

Daily Inspections Table

No.	Check:	Controller Power	How to check:	Criterion	What to do: (Note 1)
1	Connectors (CN1 to CN10 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 CN10 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	EMERGENCY STOP button on the teach pendant or the mini pendant	ON	Press the EMERGENCY STOP button.	The robot should come to an emergency stop.	Repair or replace.
7	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.
8	Robot unit	OFF	Visually	No grease leak	Wipe off grease

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 the next figure.



Normal Operation of Cooling Fan (VM-G)

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: 128 ±26 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 Section 3.3.2.)

3.3.2 Cleaning the Cooling Fan Filters in the Robot Controller

For the cleaning procedures of the air intake filter, refer to the RC7M CONTROLLER MANUAL, Section 6.4 "Cleaning the Air Intake Filter."

3.4 Biennial Inspections

3.4.1 Battery Replacement and Belt Inspection

Replace the two types of backup batteries listed below and inspect the timing belts every two years.

Please contact your DENSO representative to inspect timing belts and to adjust them.

> ⚠ **Caution (1)The battery used in this device may present a risk of fire or chemical burn if mistreated. Do not recharge, disassemble, heat above 100°C (212°F), or incinerate.**
>
> **(2)Dispose of used battery promptly. Keep away from children. Do not disassemble and do not dispose of in fire.**

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	Section 3.4.2
2	Memory backup battery	Back up programs, parameters, and CAL data.	In the robot controller	Section 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.**

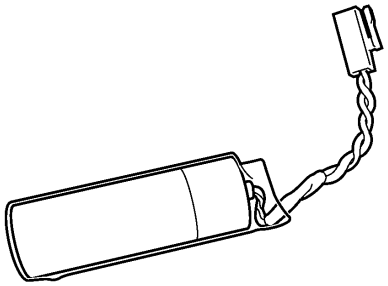
3.4.2 Replacing the Encoder Backup Battery

Replace the encoder backup battery according to the procedure below.

<Replacing procedure >

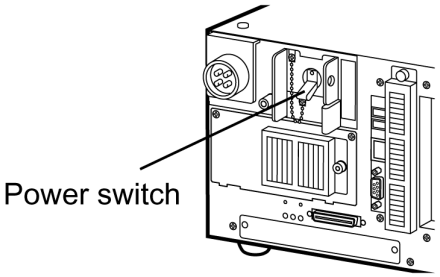
STEP 1

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.



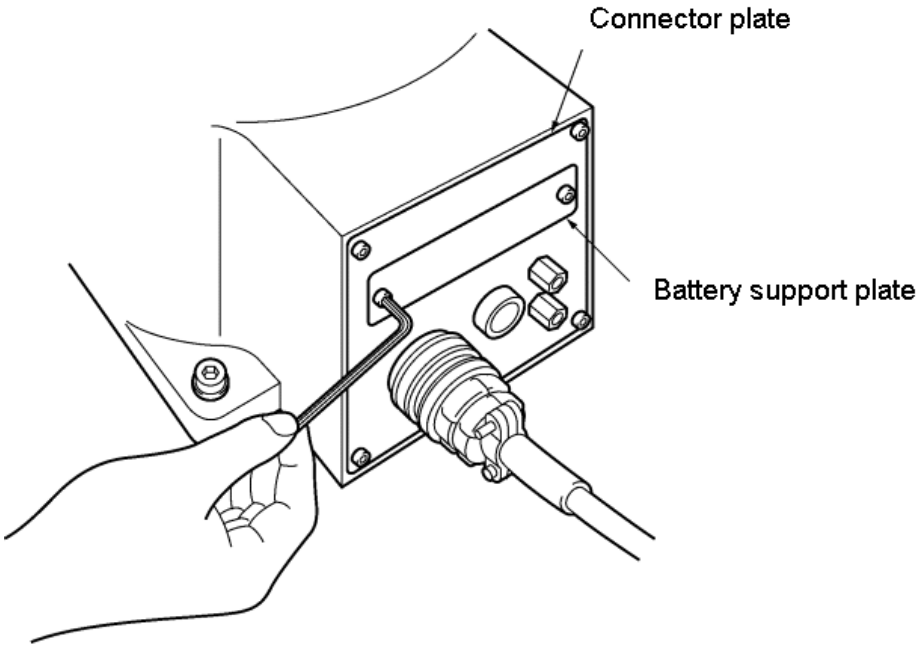
STEP 2

Turn the controller power OFF.

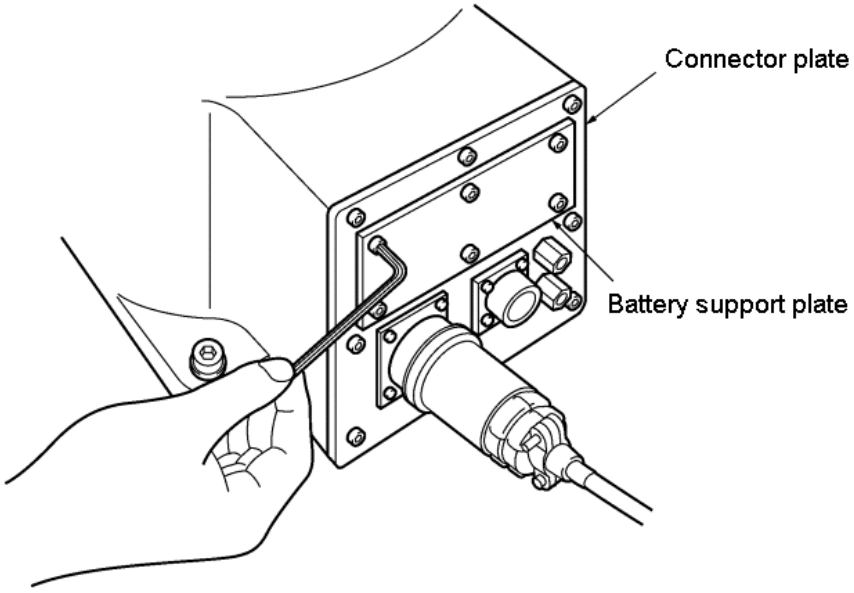


STEP 3

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



<Standard type (VM-6083G, VM-60B1G)>

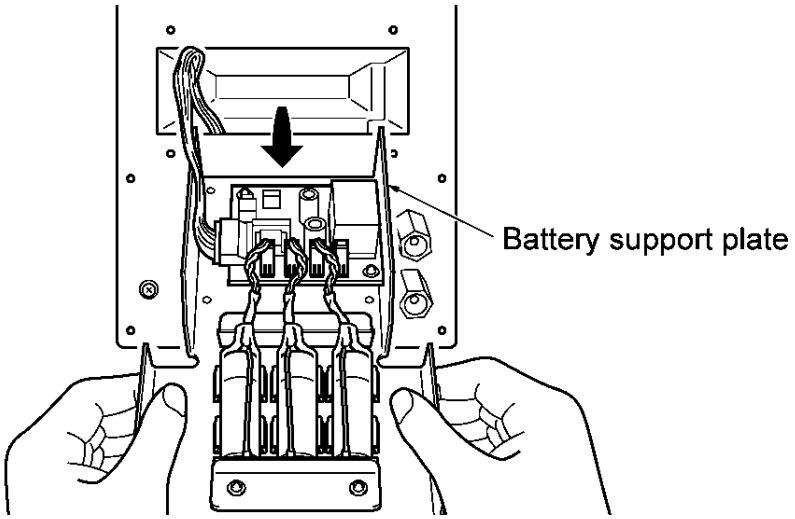


<Dust- & splash-proof type (VM-6083G-W, VM-60B1G-W)>

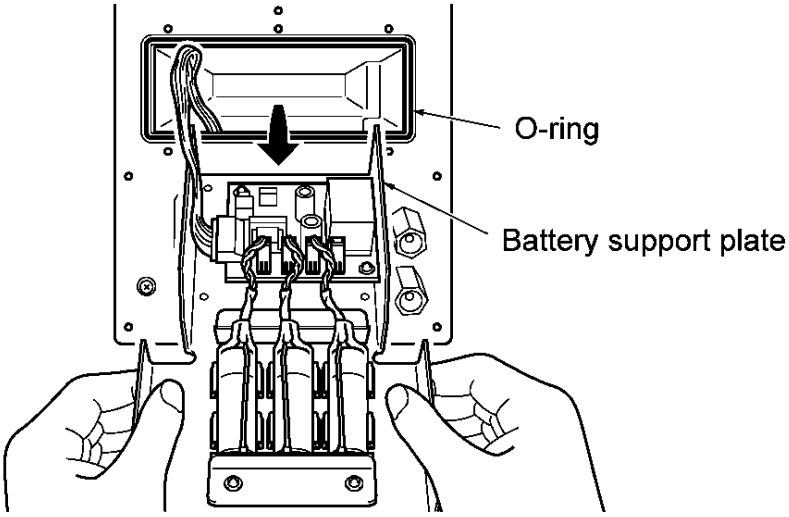
STEP 4

Pull out the battery support plate from the robot unit.

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



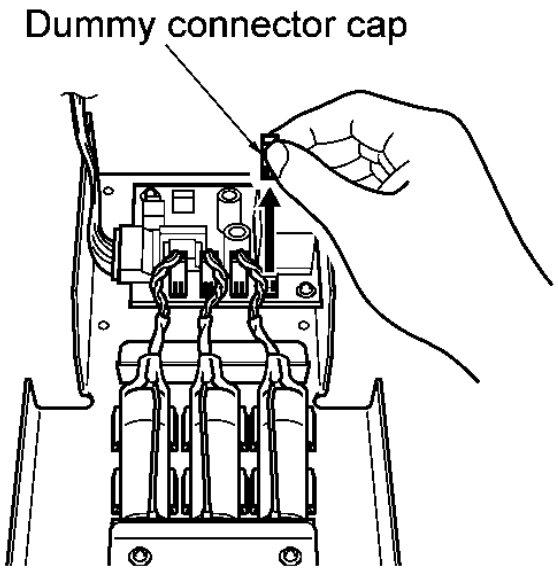
<Standard type (VM-6083G ,VM-60B1G)>



< Dust- & splash-proof type (VM-6083G-W, VM-60B1G-W) >

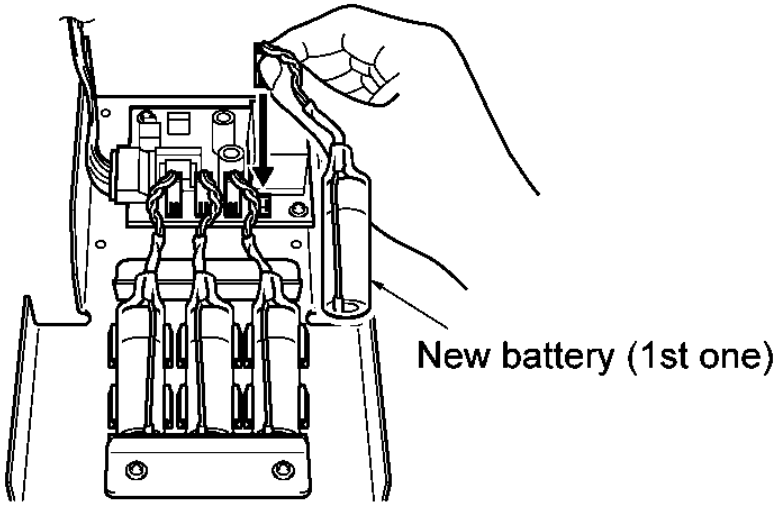
STEP 5

Remove the dummy connector cap from the battery board.



STEP 6

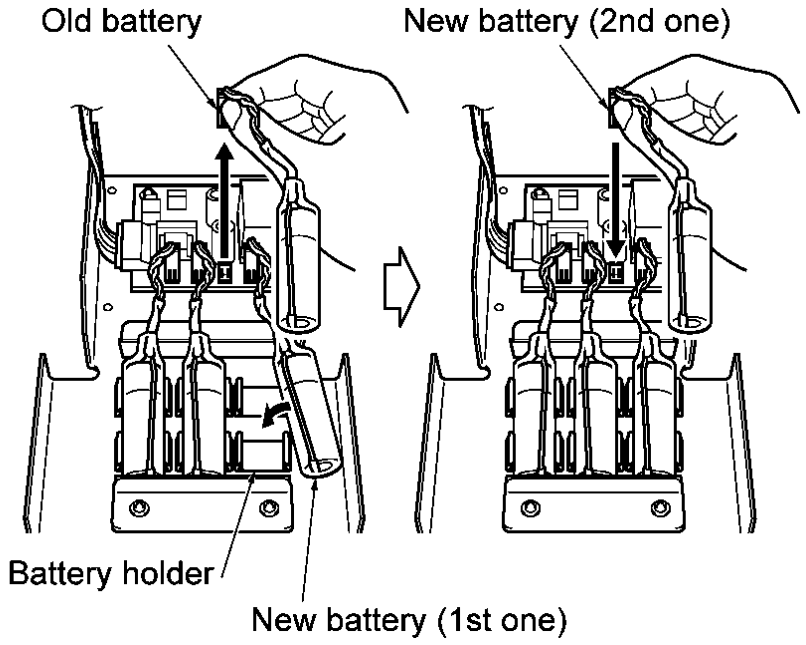
Connect a new battery (1st one) to the pin from which you have disconnected the dummy connector cap in Step 5.



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.

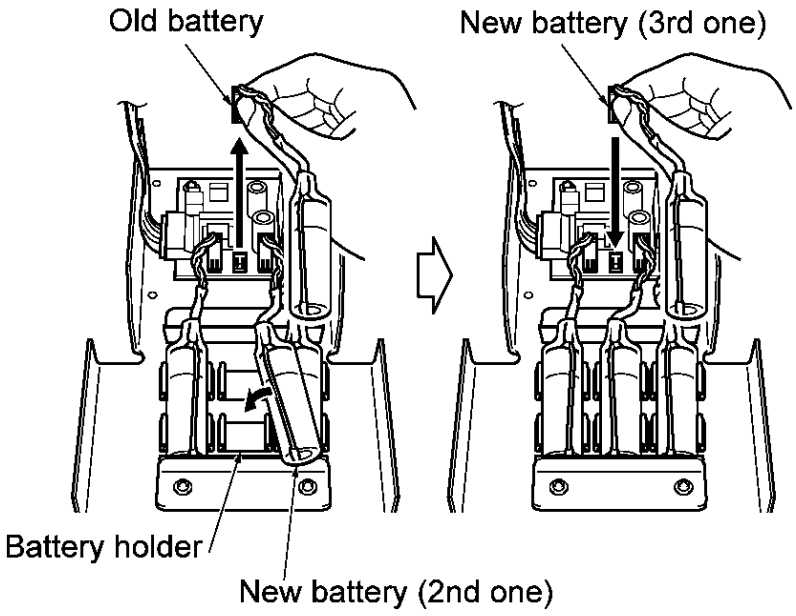
STEP 7

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

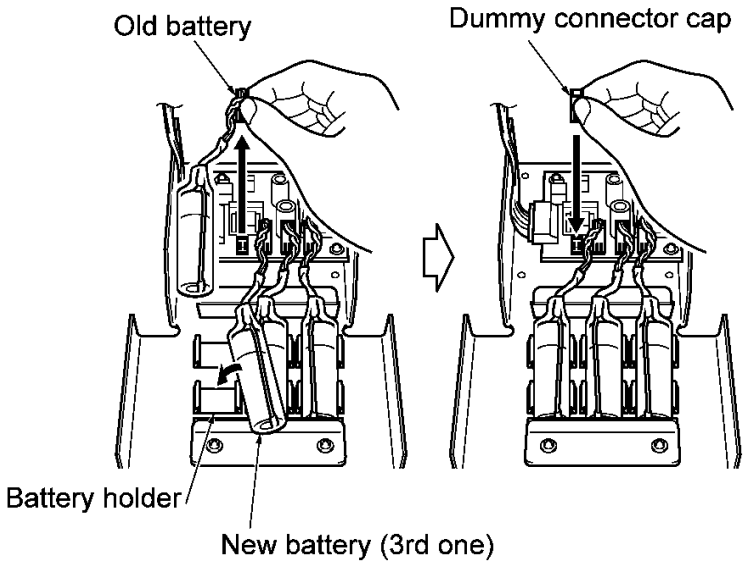
Disconnect the old backup battery that is left next to the new battery connected in Step 7, and then connect a new battery (3rd one).



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

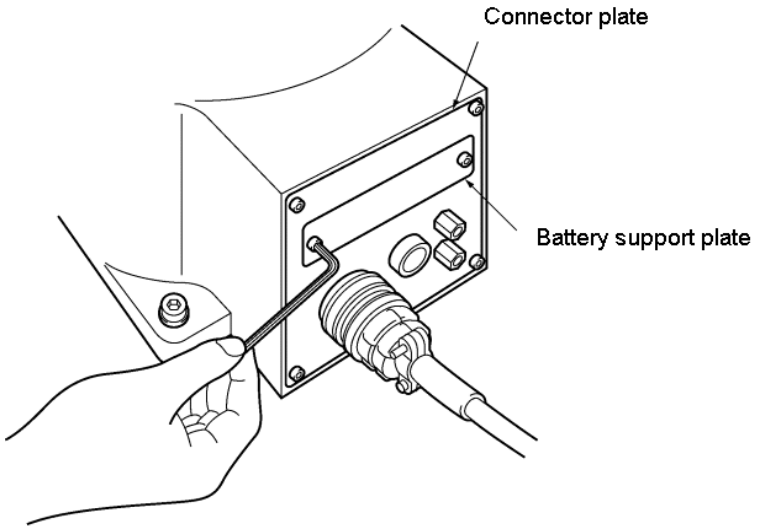
STEP 9

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

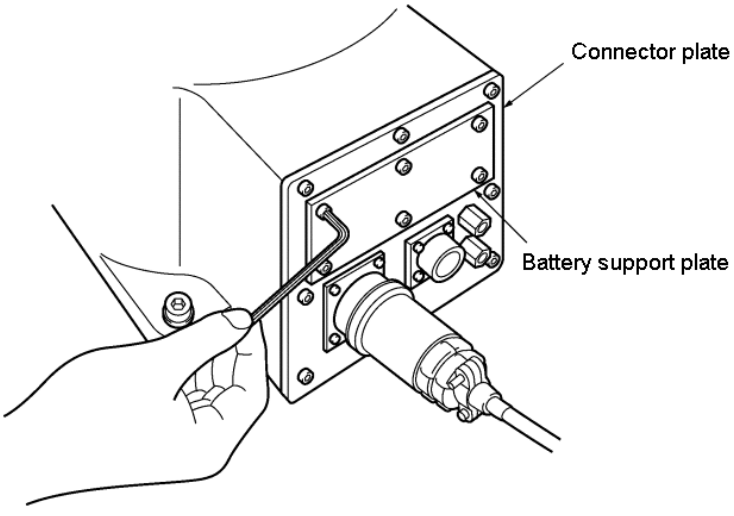


STEP 10

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



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



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

3.4.3 Replacing the Memory Backup Battery

For the replacing procedures of the memory backup battery, refer to the RC7M CONTROLLER MANUAL, Section 6.5 "Replacing the Memory Backup battery."

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: 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 Supplies and Tools for Maintenance

The table lists the supplies and tools for maintenance.

Supplies and Tools for Maintenance

No	Name	Part No.	Remarks
1	Air filter set	410053-0100	For standard type of controllers (FS-1705W)
		410053-0110	For global type of controllers (FS-1705)
2	Memory backup battery	410076-0261	For RC7M controller
3	Fuse (1.3A)	410054-0230	For LM13 for controller I/O
4	Fuse (3.2A)	410054-0270	For LM32 for controller I/O
5	IC for output (NPN)	410077-0010	IC (M54522P) for controller output
6	IC for output (PNP)	410077-0020	IC (M54564P) for controller output
7	Encoder backup battery set	410611-0070	3-battery set
8	CALSET jig	410192-0030	For VM series CALSET

3.6 Replacing Fuses and Output ICs

For the replacing procedures of the fuses and output ICs, refer to the RC7M CONTROLLER MANUAL, Section 6.6 "Replacing Fuses and Output ICs."

3.7 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.

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. You can reset the trip meter by pressing [F6 Reset] in the Odometer window and following the guidance shown on the screen.

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

STEP 1

Turn the controller power ON.

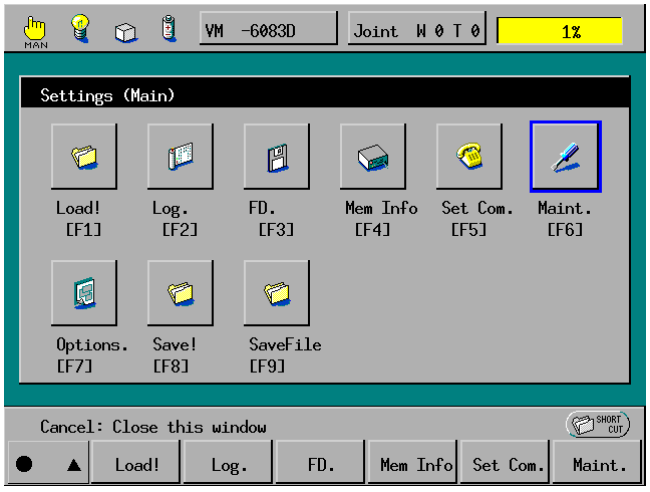
STEP 2

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.

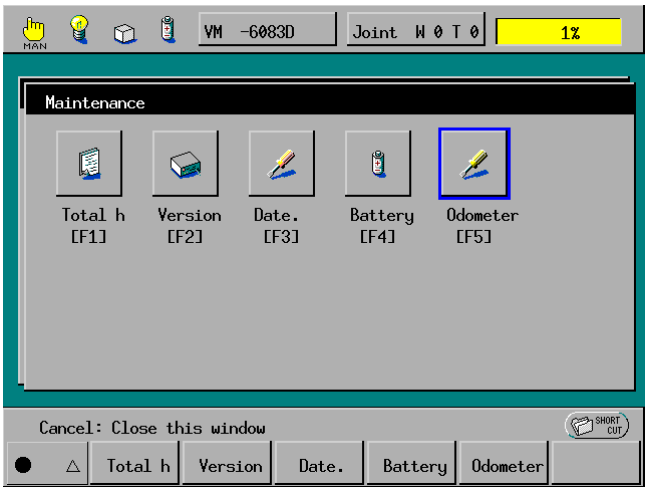


F6

Press [F6 Maint.].

STEP 4

The Maintenance menu appears as shown below.

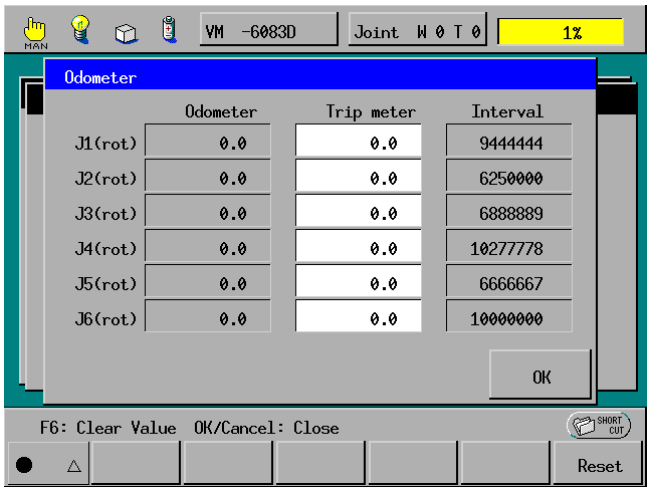


F5

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.

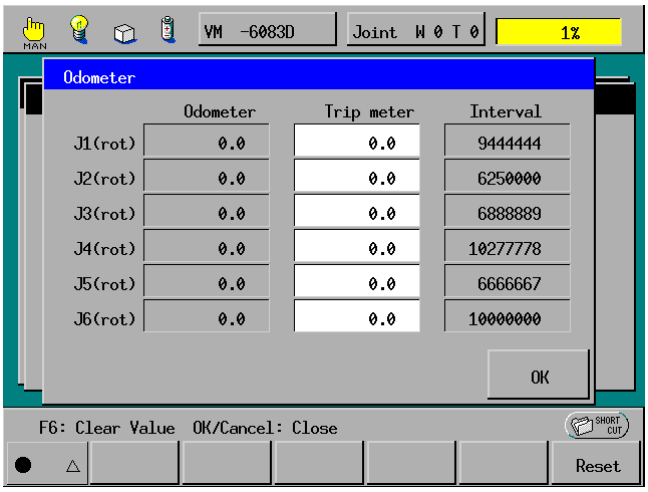
If the Trip meter count exceeds the Interval value, the oil change prompt message will appear.

3.7.2 Resetting the Trip Meter to Zero

STEP 1

Display the Odometer window as shown below.

Access: [F6 Set]—[F6 Maint.]—[F5 Odometer] from the top screen.

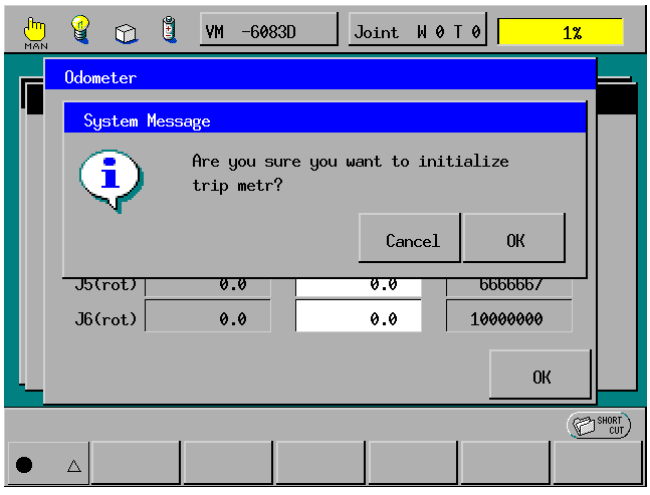


F6

Press [F6 Reset].

STEP 2

The following message appears.



Press the OK button.

The trip meter has been reset to zero.

3.8 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:

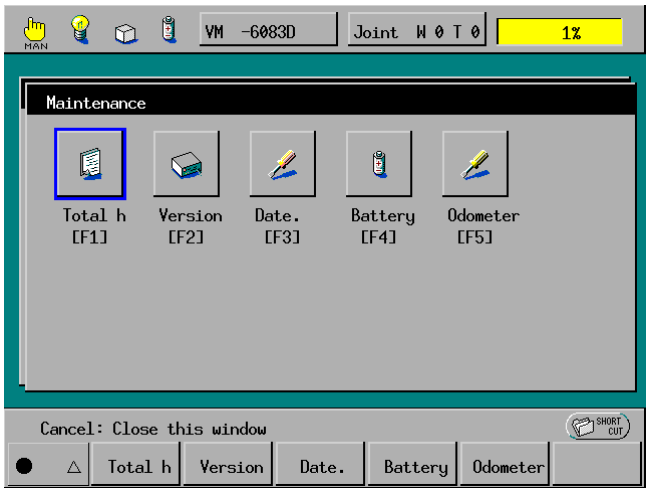
[Total operation]	Shows the grand total of the robot controller ON-time counted after the controller leaves the factory.
[Total running]	Shows the grand total of the robot running time counted after the robot leaves the factory.
[Cumu. operation]	Shows the total of the robot controller ON-time counted 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.

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

STEP 1

Display the Maintenance window as shown below.

Access: [F6 Set]—[F6 Maint.] from the top screen

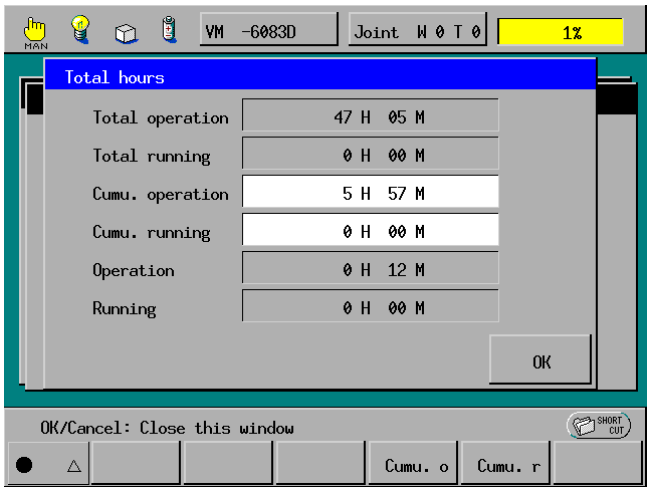


F1

Press [F1 Total h].

STEP 2

The Total hours window appears as shown below.



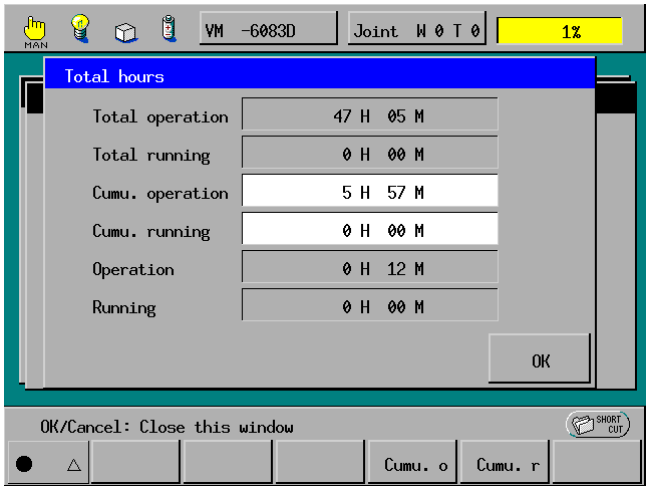
[Total operation]	Shows the grand total of the robot controller ON-time counted after the controller leaves the factory.
[Total running]	Shows the grand total of the robot running time counted after the robot leaves the factory.
[Cumu. operation]	Shows the total of the robot controller ON-time counted 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.

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

STEP 1

Display the Total hours window as shown below.

Access: [F6 Set]—[F6 Maint.]—[F1 Total h] from the top screen

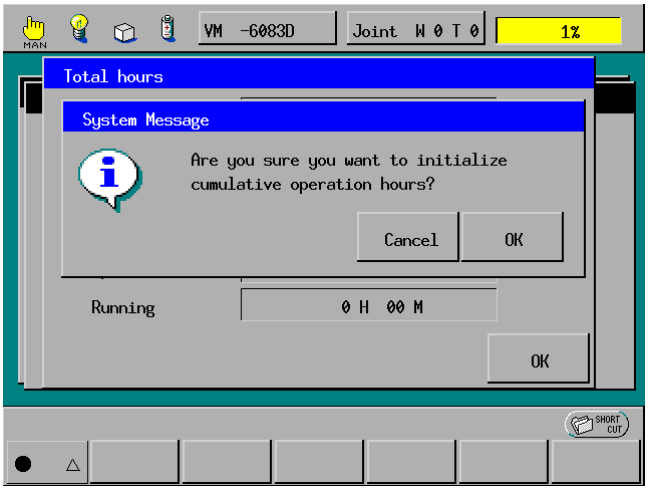


F4

To reset the user counter of the controller ON-time (Cumu.operation), for example, press [F4 Cumu. o].

STEP 2

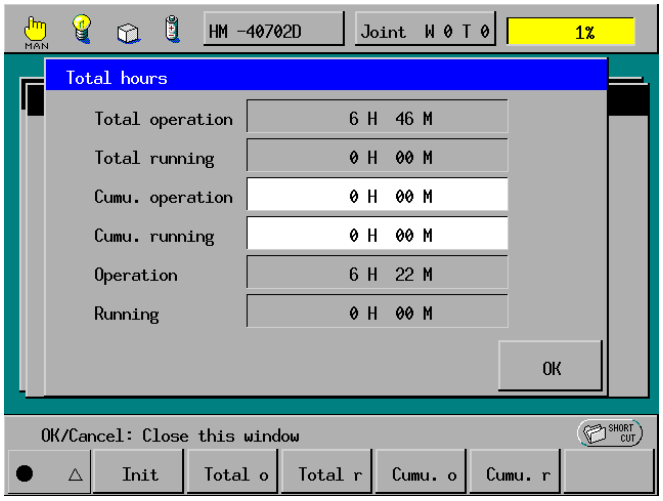
The following system message appears.



Press the OK button.

STEP 3

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



3.9 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]."

3.10 Backing up Projects

You should back up project data periodically in WINCAPSIII in order to recover the robot controller smoothly after loss of project data due to unexpected accidents such as expired service life of memory backup batteries.

Be sure to back up project data and preserve it, in particular:

- at the time of purchase
- after performing CALSET
- after changing RANG values
- after replacement of a motor

DENSO preserves arm data configured at the time of shipment for 10 years. If your arm data is lost, contact your DENSO representative.

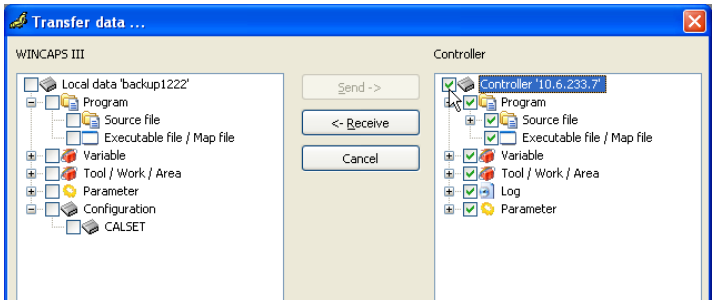
Note	Arm data refers to CALSET and RANG values in project data, which is unique to individual robots and determines the position of each joint.

3.10.1 Back up project data

Use WINCAPSIII to back up project data.

When a project has been created in WINCAPSIII

Receive all data from the controller and preserve it.

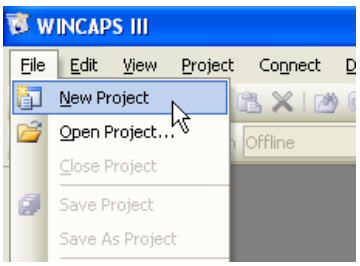


When creating a new project to preserve backup data

Follow the procedure given below.

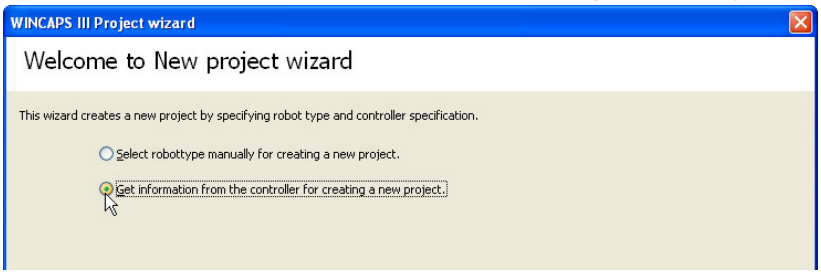
STEP 1

Create a new project in WINCAPSIII.



STEP 2

Choose "Get information from the controller for creating a new project."

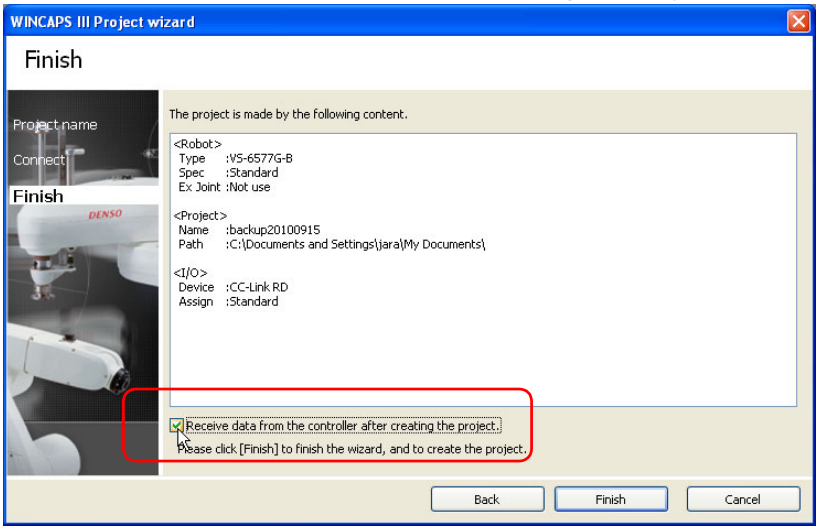


STEP 3

Following the project wizard, enter the IP address and the desired backup file name.

STEP 4

Select "Receive data from the controller after creating the project."



STEP 5

Close the project.

3.10.2 Transfer arm data

When WINCAPSIII exchanges project data with the robot controller, arm data unique to individual robots can be transferred only from the robot controller to WINCAPSIII, but it cannot from WINCAPSIII to the robot controller. This is to protect arm data in the robot controller from being overwritten accidentally.

To transfer arm data from WINCAPSIII to the robot controller, use the following procedure.

STEP 1

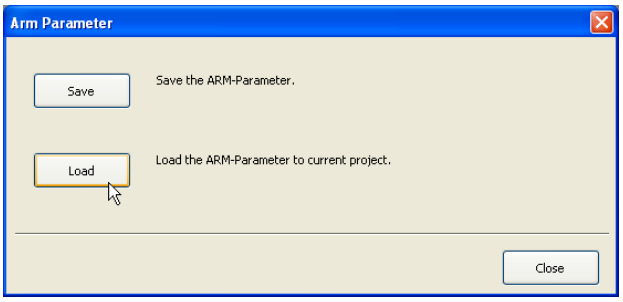
Loading the arm data (***.wam) into the WINCAPSIII project

This step is necessary when only arm data is supplied by DENSO. When project data has been backed up, open the project data in WINCAPSIII and proceed to STEP 2.

Start WINCAPSIII, log on as a Programmer, and create a project suitable for your robot model.

Choose Tool | Arm parameters to display the Arm Parameter window.

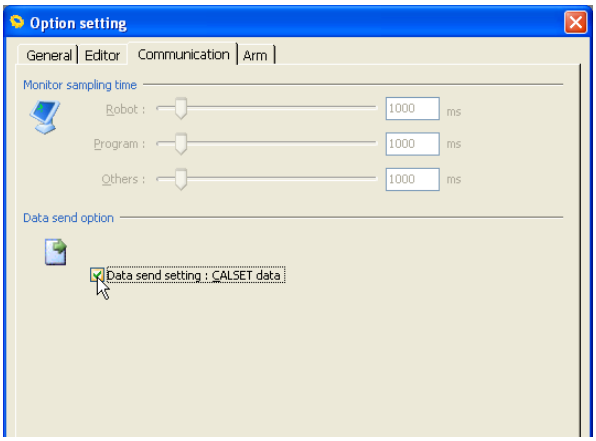
Press Load and select the arm data (***.wam) to load.



STEP 2

Configuring communication options for transfer of arm data from WINCAPSIII to the robot controller

Choose Tool | Option | Communication tab. Select "Data send setting: CALSET data" and press OK.



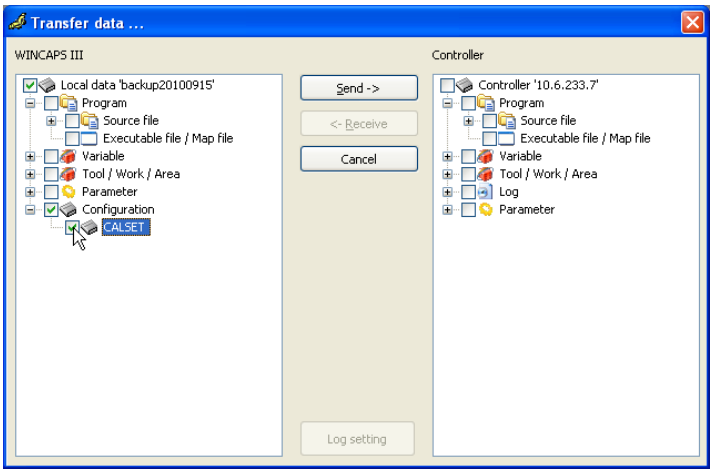
ATTENTION:	During ordinary operations, the "Data send setting: CALSET data" should be deselected. If it is selected, creating a new project and transferring arm parameters overwrites the CALSET-related data in the robot controller with the transferred data, causing errors in teaching positions.

STEP 3

Transferring arm data to the robot controller

Choose Connect | Transfer data to display the Transfer data window.

Select Parameters | Arm parameters and Configuration | CALSET, then press Send.



Upon completion of transfer of the CALSET-related arm data, restart the robot controller.

Vertical Articulated Robot
VM-G SERIES

INSTALLATION & MAINTENANCE GUIDE

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DENSO WAVE INCORPORATED 2Q**C

The purpose of this manual is to provide accurate information in the handling and operating of the robot. Please feel 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.

In no event will DENSO WAVE INCORPORATED be liable for any direct or indirect damages resulting from the application of the information in this manual.