

DENSO ROBOT

Vertical articulated

VS-G-T SERIES

INSTALLATION & MAINTENANCE GUIDE (T03)

Copyright © DENSO WAVE INCORPORATED, 2007 - 2011

All rights reserved. No part of this publication may be reproduced in any form or by any means without permission in writing from the publisher.

Specifications are subject to change without prior notice.

All products and company names mentioned are trademarks or registered trademarks of their respective holders

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	
	Floor-mount	Overhead-mount
VS-G-T (Small-sized, horizontal articulated)	VS-6556G-BW-T03 VS-6577G-BW-T03	Same as left.

Important

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

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
1.1 Preparing a Proper Environment for Installation.....	1
1.1.1 Ambient Temperature and Humidity	1
1.1.2 Vibration.....	1
1.1.3 Connecting the Robot Unit and Robot Controller	1
1.1.4 Installation Environment of the Robot Unit	2
1.2 Mounting the Robot Unit	4
1.2.1 Caution in Floor-mount Installation of the Dust- & Splash-proof Type of Robot Units	4
1.2.2 Transporting the Robot Unit.....	5
1.2.3 Securing the Robot Unit	8
1.2.4 Grounding the Robot Unit	9
1.3 Installing the Robot Controller.....	9
1.4 Installing the Operation Panel	10
1.4.1 Installation Environment of the Operation Panel	10
1.4.2 Securing the Operation Panel	11
1.5 Cautions for Designing the Robot Hand	11
1.6 Moving Each Axis with Motor Power OFF in Emergency Stop	12
1.7 Releasing Brakes.....	13
1.8 Locking Out the Power Switch	14
Chapter 2 Customizing Your Robot	15
2.1 What Is Customization?	15
2.2 Modifying Software Motion Limits to Define New Motion Space.....	16
2.2.1 What Is a Software Motion Limit?	16
2.2.2 Factory Defaults of Software Motion Limits.....	17
2.2.3 Changing Software Motion Limits	18
2.2.4 Precautions When Changing the Software Motion Limits	19
2.2.5 Procedure for Changing the Software Motion Limits	19
2.2.6 Switching to the Extended Screen.....	22
2.3 Changing the Mechanical End	24
2.3.1 1st-axis Mechanical End Change	25
2.3.2 2nd-axis and 3rd-axis Mechanical Ends Change	42
2.4 CALSET.....	49
2.4.1 What Is CALSET?.....	49
2.4.2 Precautions about CALSET for the VS-G-T Series.....	49
2.4.3 Preparation for CALSET	52
2.4.4 Mounting the CALSET Jig.....	53
2.4.5 What Is a CALSET Position?.....	56
2.4.6 CALSET Procedure.....	57
2.5 Setting Control Set of Motion Optimization	63
2.6 Setting Robot Installation Conditions	64
Chapter 3 Maintenance and Inspection	65
3.1 Maintenance & Inspection Intervals and Purposes	65
3.2 Daily Inspections.....	66
3.2.1 Check Items.....	66
3.3 Quarterly Inspections	67

3.3.1	Check Items.....	67
3.3.2	Cleaning the Cooling Fan Filters in the Robot Controller.....	67
3.4	Biennial Inspections.....	68
3.4.1	Battery Replacement.....	68
3.4.2	Replacing the Encoder Backup Battery.....	69
3.4.3	Replacing the Memory Backup Battery.....	73
3.4.4	Setting the Next Battery Replacement Date.....	73
3.5	Five-yearly Inspections.....	74
3.6	Supplies and Tools for Maintenance.....	74
3.7	Replacing Fuses and Output ICs.....	74
3.8	Checking the Odometer and Trip Meter.....	75
3.8.1	Displaying the Odometer, Trip Meter, and Oil Change Intervals.....	75
3.8.2	Resetting the Trip Meter to Zero.....	77
3.9	Checking the Controller ON-Time and the Robot Running Time and Resetting Their User Counters.....	78
3.9.1	Displaying the Controller ON-time and the Robot Running Time.....	78
3.9.2	Resetting the User Counters of the Controller ON-Time and the Robot Running Time.....	79
3.10	Resetting Encoders.....	80
3.11	Backing up Projects.....	81
3.11.1	Back up project data.....	81
3.11.2	Transfer arm data.....	83

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.

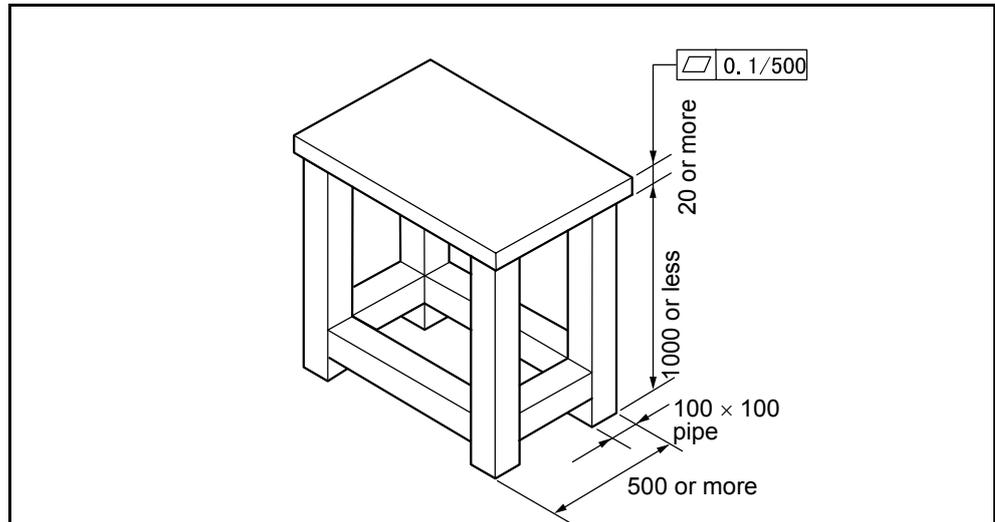
1.1.4 Installation Environment of the Robot Unit

The installation requirements for the robot unit are listed 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.

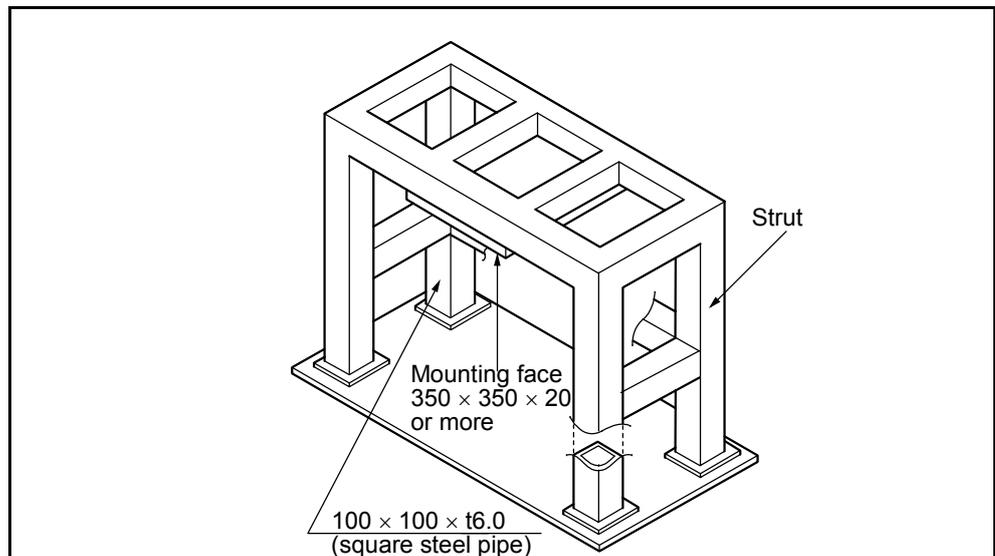
Installation Requirements for the Robot Unit

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.	<ul style="list-style-type: none"> • 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 9.



- ⚠ 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

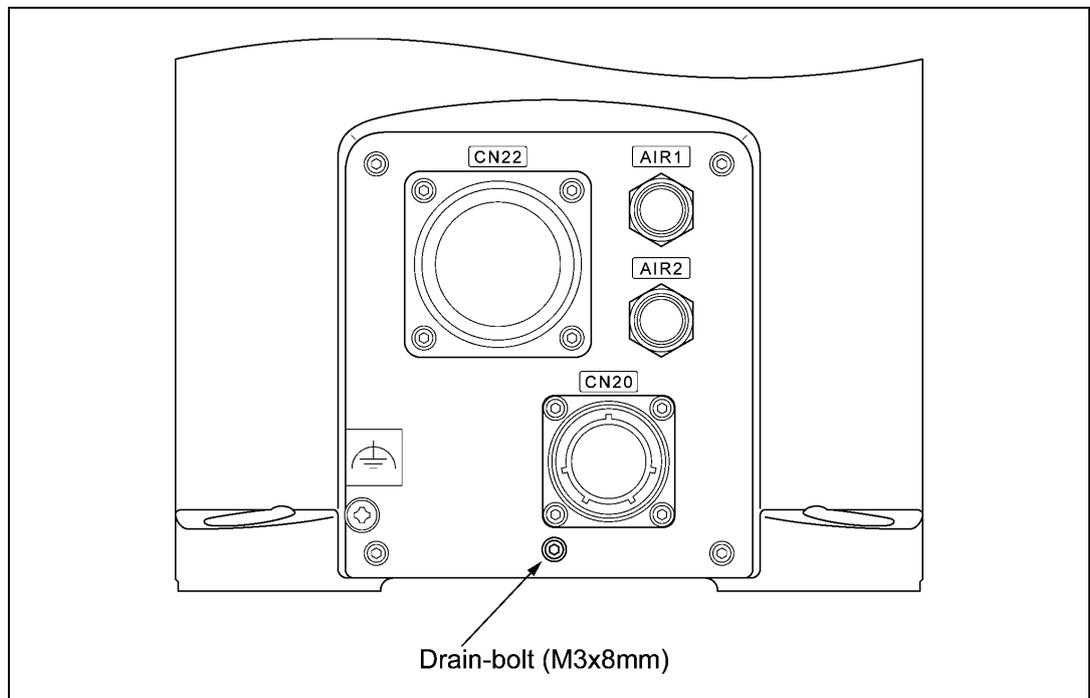
1.2 Mounting the Robot Unit

⚠ Caution Before handling or installing the robot unit, be sure to read **SAFETY PRECAUTIONS, "3. Installation Precautions."**

1.2.1 Caution in Floor-mount Installation of the Dust- & Splash-proof Type of Robot Units

For the dust- & splash-proof type of robot units, the drain-bolt (M3 x 8 mm) is screwed onto the rear side of the robot unit as shown in the figure below. At the floor-mount installation, remove the drain-bolt shown in the figure below, before installing the robot unit. It will become a drain-hole for the liquid.

⚠ Caution: At the overhead-mount installation, do not remove the drain-bolt when installing the robot unit. If you do so, the robot failure may occur.



Drain Bolt on the Dust- & Splash-proof Type of Robot Units

1.2.2 Transporting the Robot Unit

(1) Precautions in transporting the robot

The VS-G-T series weighs approximately 36 kg (80 lbs). Use a crane suitable for the robot weight.

Have at least two workers handle this job.

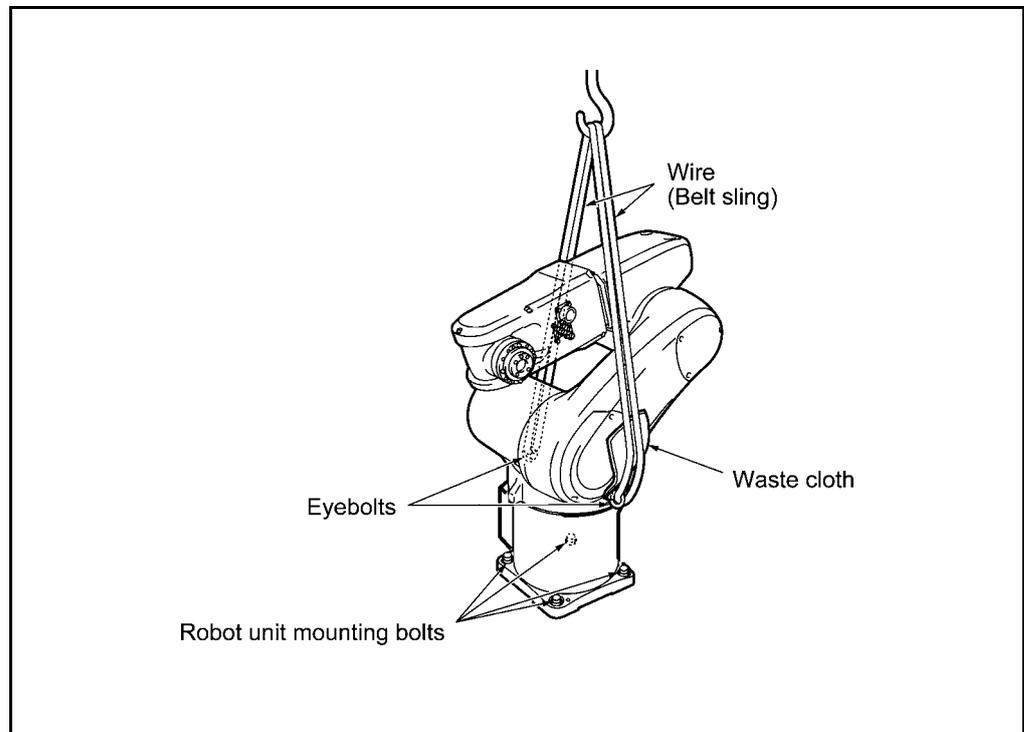
Workers should wear helmets, safety shoes, and gloves during transport.



Caution

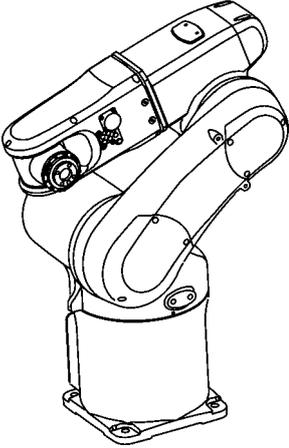
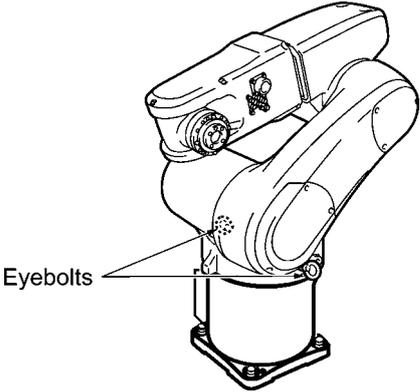
Pass the hoisting wires through the specified eyebolts as illustrated below. Passing them through other sections may drop the robot unit, resulting in a broken robot or bodily injuries.

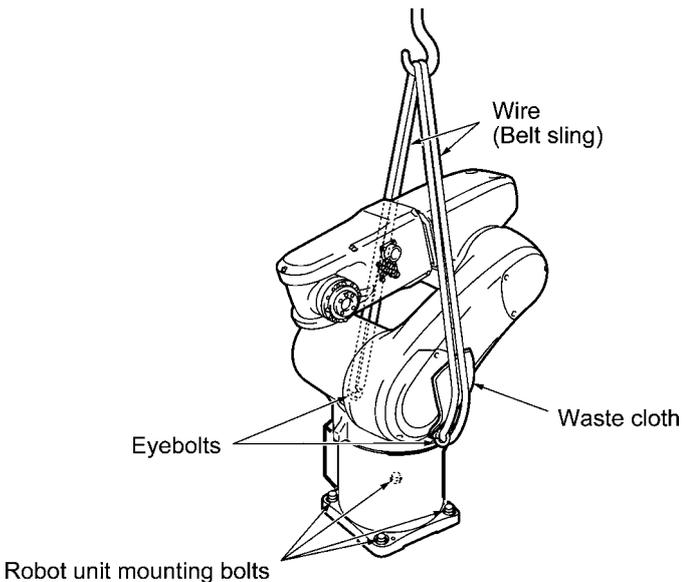
Do not hold the first arm, elbow, either side of the 2nd arm, 2nd-axis cover, or 3rd-axis cover, or apply force to any of them.



Hoisting Points for Transportation (VS-G-T series)

(2) Transporting the robot unit

No.	Procedure	Explanatory Illustration												
1	<p>Before transportation, set the robot in a transport position as shown at right by manually moving the second, third and fourth axes.</p> <p>When unpacked first, the robot is in the transport position, so this job is not required.</p>	<div style="text-align: center;">  <p>Transport Position</p> <table border="1" data-bbox="614 824 1466 1025"> <thead> <tr> <th>Axis</th> <th>Angle</th> </tr> </thead> <tbody> <tr> <td>First axis (J1)</td> <td>-90°</td> </tr> <tr> <td>Second axis (J2)</td> <td>-55°</td> </tr> <tr> <td>Third axis (J3)</td> <td>+163°</td> </tr> <tr> <td>Fourth axis (J4)</td> <td>-90°</td> </tr> <tr> <td>Fifth axis (J5)</td> <td>-90°</td> </tr> </tbody> </table> </div>	Axis	Angle	First axis (J1)	-90°	Second axis (J2)	-55°	Third axis (J3)	+163°	Fourth axis (J4)	-90°	Fifth axis (J5)	-90°
Axis	Angle													
First axis (J1)	-90°													
Second axis (J2)	-55°													
Third axis (J3)	+163°													
Fourth axis (J4)	-90°													
Fifth axis (J5)	-90°													
2	<p>Disconnect the robot control cable, air piping and user signal cables from the robot unit.</p> <p>When the robot unit is first unpacked, this job is not required.</p>													
3	<p>As shown at right, mount the eyebolts.</p> <p>When delivered, the robot unit is packed with eyebolts attached, so this job is not required.</p>	<div style="text-align: center;">  <p>Mounting Eyebolts</p> </div>												

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.	 <p style="text-align: center;">Hoisting the Robot Unit</p>
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 1.2.3 "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.

1.2.3 Securing the Robot Unit

(1) Drill four bolt holes (M10) 20-mm deep or more, and two dowel pin holes ($\phi 4$, H7 for diamond shaped pin, and $\phi 6H7$ for internally threaded positioning pin) 10-mm deep or more in the robot mounting position where the robot unit is to be secured, according to the dimension in the figure below.

(2) Drive the diamond-shaped pin into the $\phi 4H7$ hole so that it orients as shown below.

(3) Drive the internally threaded positioning pin into the $\phi 6H7$ hole.

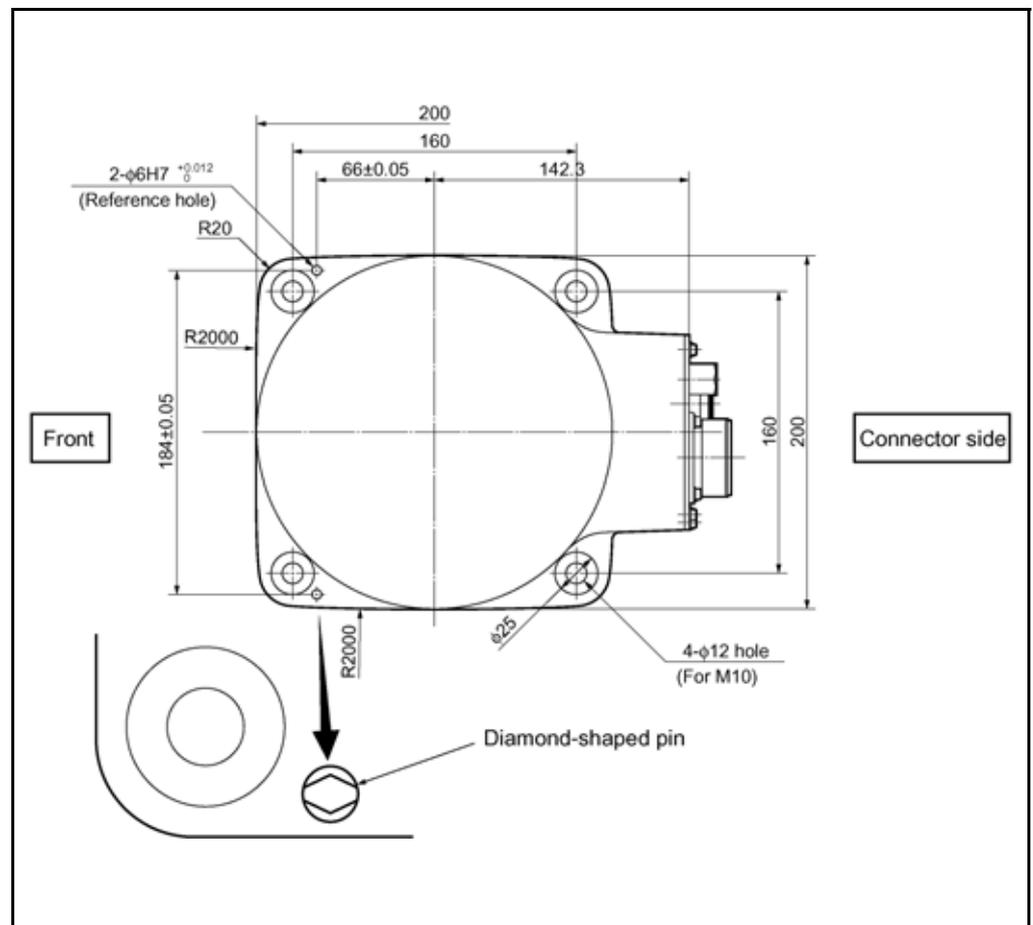
NOTE: Be sure to drive the knock pins. It can minimize positional deviations that may be caused by the removal/installation of the robot unit for maintenance or the vibration during operation.

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

When transporting the robot unit, follow the instructions given in Section 1.2.2 "Transporting the Robot Unit."

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

- Bolt: M10 \times 30 mm (strength class: 12.9)
- Tightening torque: 70 ± 14 Nm

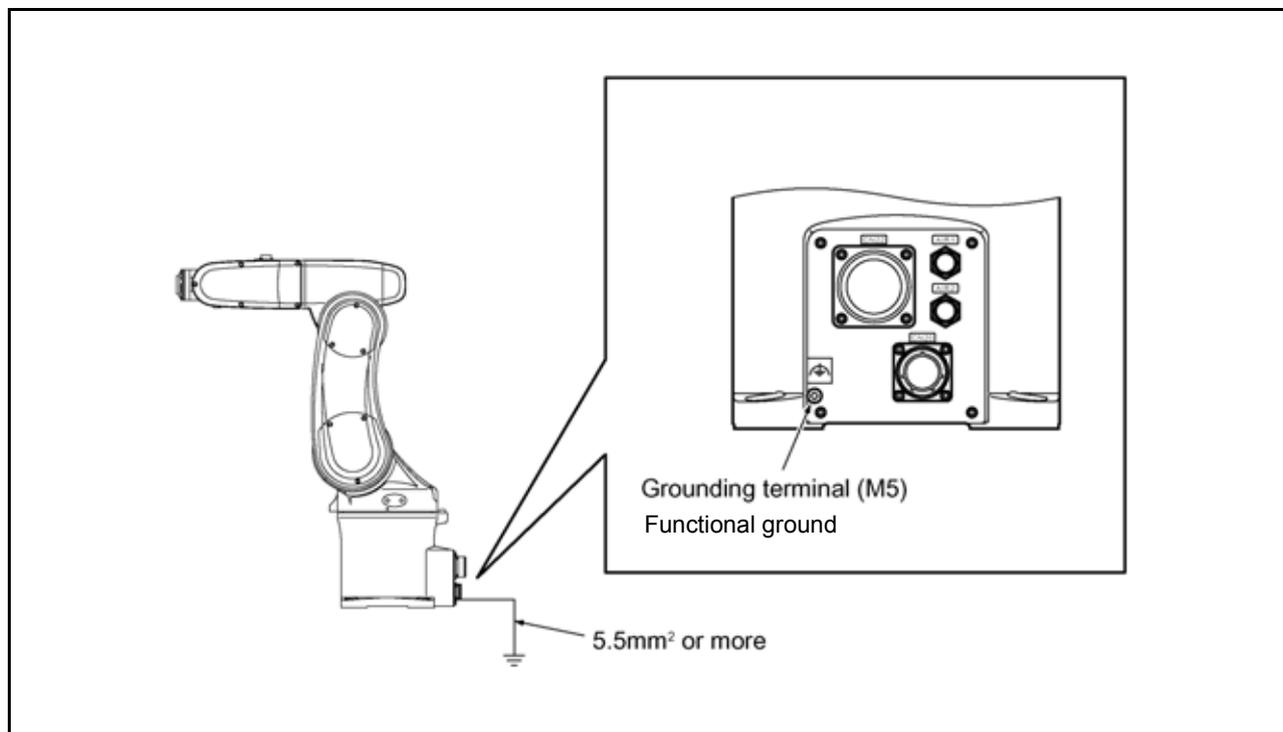


Bolt Positions for Securing the Robot Unit (VS-G-T series)

1.2.4 Grounding the Robot Unit

Ground the grounding terminal of the robot unit with a wire of 5.5 mm² 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 (VS-G-T series)

1.3 Installing the Robot Controller

For the installing procedures of the robot controller, refer to the RC7M CONTROLLER MANUAL (T03), Section 3.2 "Installing the Robot Controller."

1.4 Installing the Operation Panel

1.4.1 Installation Environment of the Operation Panel

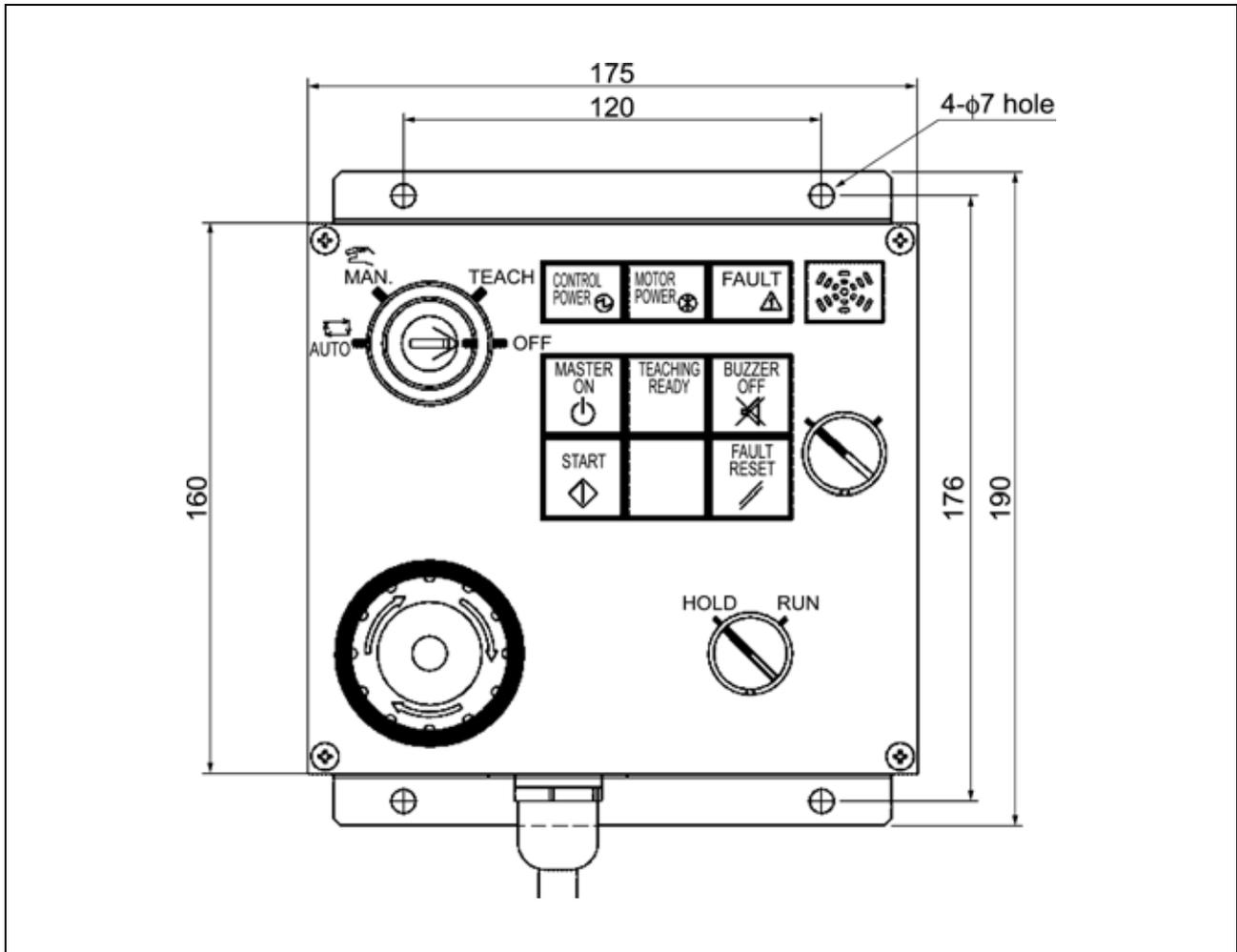
The table below lists the installation requirements for the operation panel.

Installation Requirements for the Operation Panel

Item	Environments and Conditions
Installation type	Wall-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.)
Safe installation environment	The operation panel should not be installed in an environment where: <ul style="list-style-type: none">• there are flammable gases or liquids,• there are any acidic, alkaline or other corrosive gases,• there is sulfuric cutting or grinding oil mist, or• there are any large-sized inverters, high output/high frequency transmitters, large contactors, welders, or other sources of electrical noise.
Working space, etc.	<ul style="list-style-type: none">• The operation panel should be installed at a place where the operator can easily see and operate it, and easily perform maintenance.• Sufficient space must be available for operation and maintenance.
Installation conditions	Grounding resistance: 100Ω or less

1.4.2 Securing the Operation Panel

According to the dimensions specified in the figure below, drill four fixing holes (M6) in the robot mount where the operation panel is to be anchored. Then secure the operation panel with four bolts (M6).



Bolt Positions for Securing the Operation Panel

1.5 Cautions for Designing the Robot Hand

Refer to the GENERAL INFORMATION ABOUT ROBOT (T03) for VS-G-T SERIES, Chapter 3, Section 3.5 "Precautions When Designing the End-effectors."

1.6 Moving Each Axis with Motor Power OFF in Emergency Stop

Every axis has a brake in VS-G-T series of robot units.

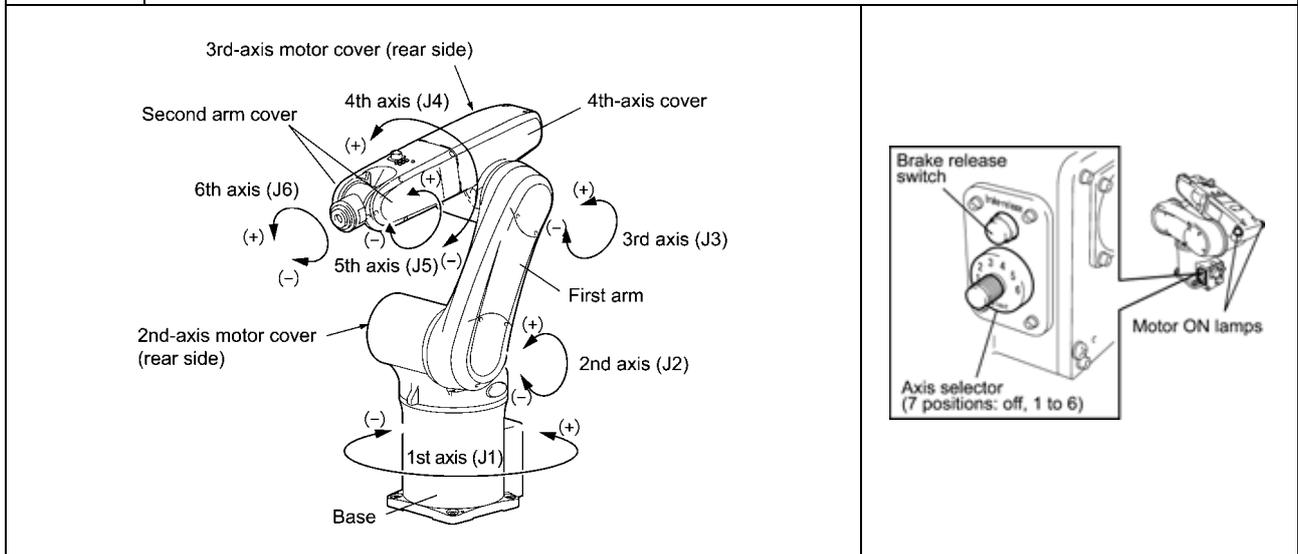
Model	Axes with brake	How to release brake
VS-GW	All axes	Using the teach pendant Access: [ExtScrn]—[Arm]—[Maint.]—[Brake.] Using the brake release switch (For details, refer to Section 1.7 " Releasing Brakes.")

The table below shows how to move each axis with the motor power being OFF when the robot is in an emergency stop.

⚠ Warning: Performing the brake release operation drops the arm. Make sure beforehand that the release operation will not cause bodily injuries or equipment damages.

Moving the axes in an emergency stop

Axis	How to move the axes	
1st axis	<u>Using the teach pendant</u>	
2nd axis	Release the brakes with the teach pendant and then move the target axis by hand.	
3rd axis	<u>Using the brake release switch</u>	
4th axis		
5th axis		Select the target axis to release its brake with the axis selector, and then move the axis by hand while holding down the brake release switch.
6th axis		(For details, refer to Section 1.7 " Releasing Brakes.")



1.7 Releasing Brakes

A brake can be released using the brake release switch and the axis selector on the base of the robot.

NOTE: A brake can also be released using the teach pendant.

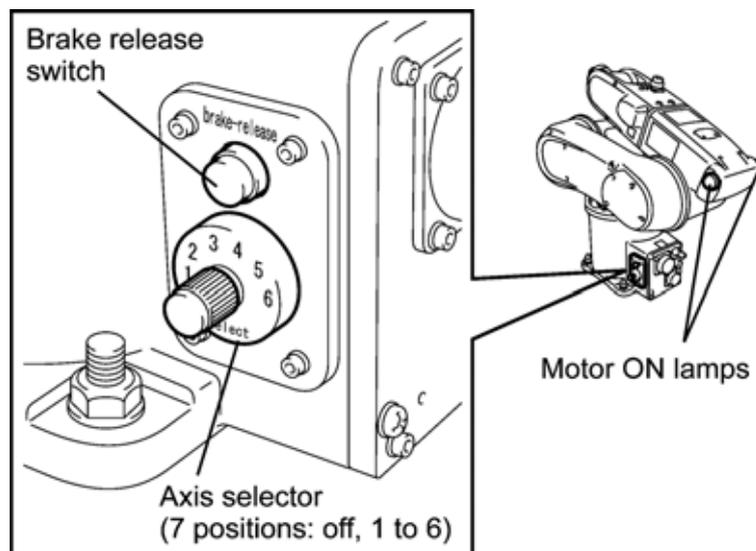
- ⚠ Warning**
- (1) Before pressing the brake release switch, make sure that there is no danger that dropping the arm will cause bodily injuries or equipment damage. Pressing the switch releases the brake of the selected axis, dropping the arm depending upon the axis.
 - (2) Do not turn the axis selector with the brake release switch being pressed.
 - (3) To prevent an unintended brake release, usually set the axis selector to OFF.

Step 1 Turn the power switch of the robot controller to ON.

NOTE: Check that the motor ON lamps are not lit (motor power OFF).

Step 2 Select the target axis to release its brake with the axis selector.

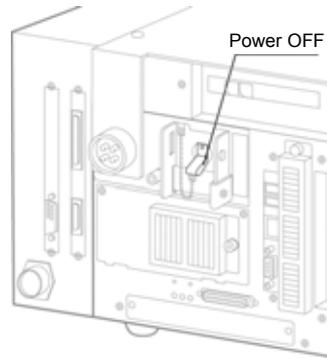
Step 3 Press the brake release switch. Only when the switch is being pressed, the brake of the selected axis is released.



1.8 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.

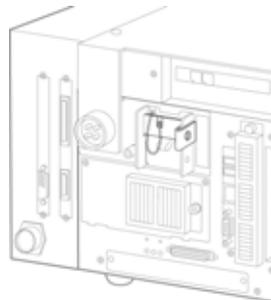
Step 1 Check that the power switch of the robot controller is turned OFF.



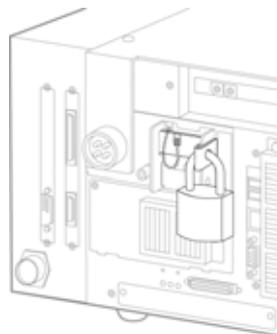
Step 2 Remove the lockout bar provided on the robot controller.



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

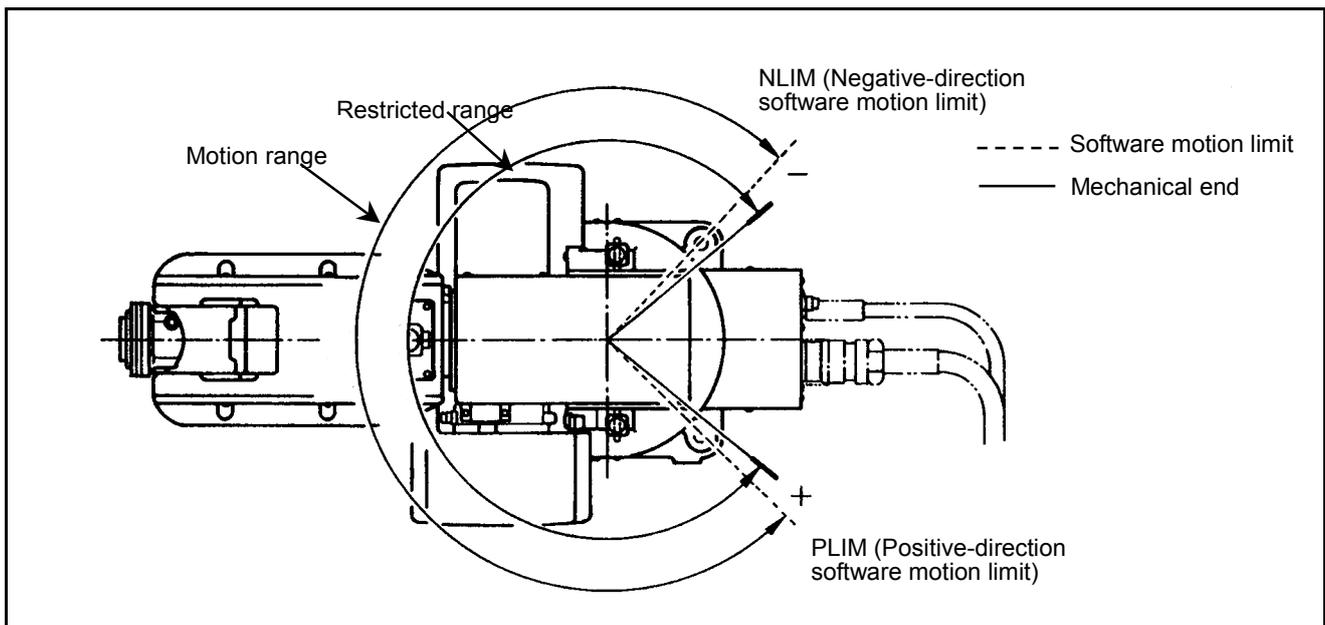
2.2.1 What Is a Software Motion Limit?

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 in the figure 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.



Software Motion Limits and Mechanical Ends

2.2.2 Factory Defaults of Software Motion Limits

The table below lists the software motion limits that are set at the time of delivery.

Factory Defaults of Software Motion Limits (VS-G-T series)

Robot model		1st axis	2nd axis	3rd axis	4th axis	5th axis	6th axis
VS-6556G (See NOTE.)	Positive direction	170°	135°	166°	190°	120°	360°
	Negative direction	-170°	-100° max.	-119° max.	-190°	-120°	-360°
VS-6577G	Positive direction	170°	135°	169°	190°	120°	360°
	Negative direction	-170°	-100°	-119°	-190°	-120°	-360°

NOTE: The 2nd and 3rd axes of the VS-6556G are restricted in workable spaces according to the robot posture.

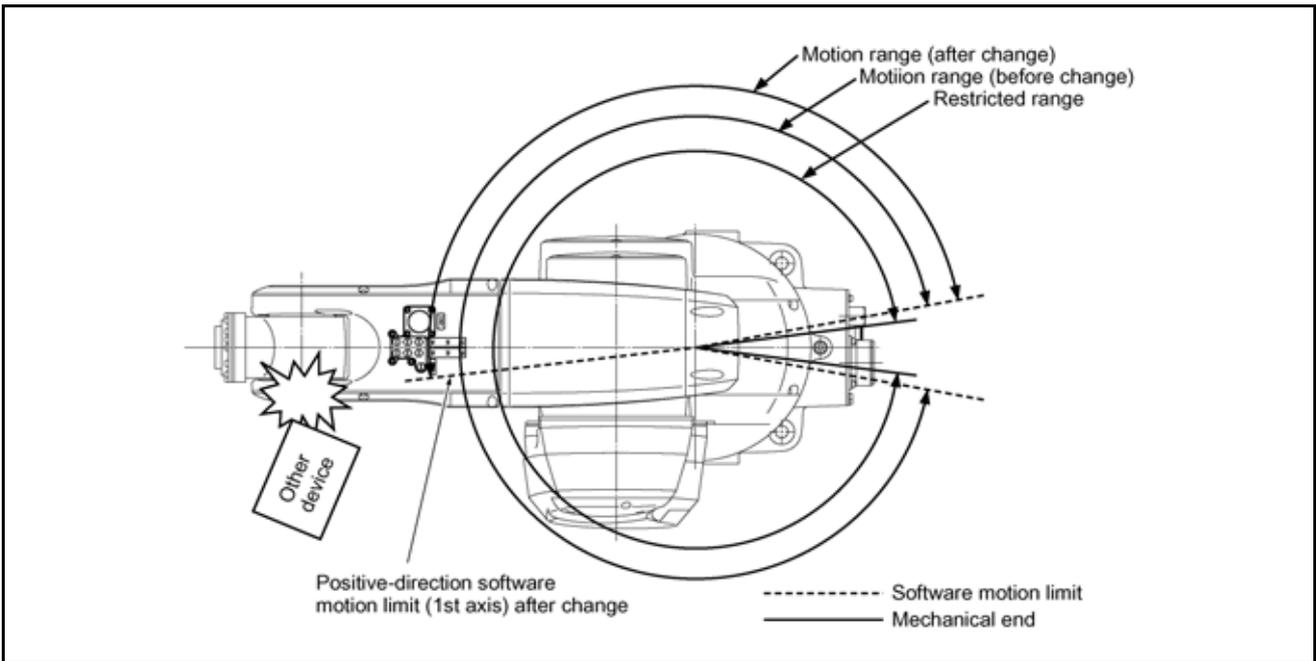
2.2.3 Changing Software Motion Limits

If the robot interferes with any other device, change the software motion limits to make the motion space smaller as shown in the upper figure on this page.

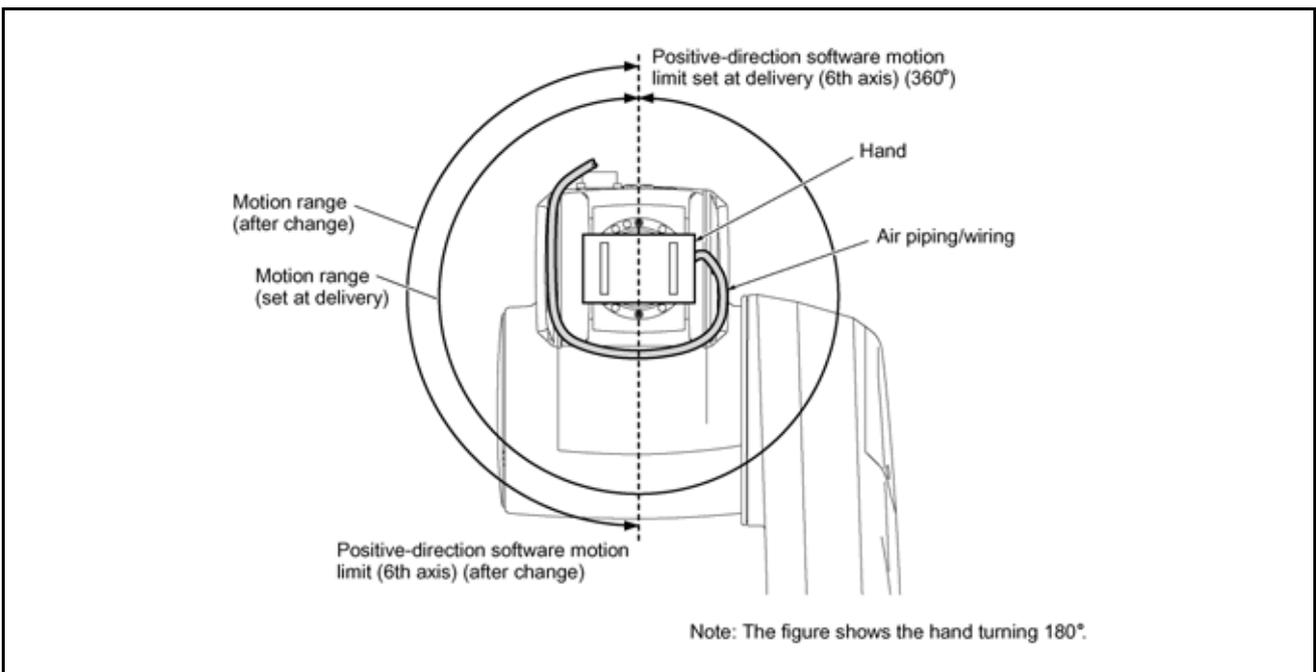
If the air piping or wiring of the end-effector becomes taut as the robot runs, then change the software motion limits to make the motion space smaller as shown in the lower figure on this page.

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

■ VS-G-T Series



Example 1: Changing Software Motion Limits [VS-G-T series]



Example 2: Changing Software Motion Limits [VS-G-T series]

2.2.4 Precautions When Changing the Software Motion Limits

- (1) The software motion limits are invalid until CAL is completed.
- (2) Confirm the operating space of the robot in the actual working environment. Set the software motion limits using the correct unit of measurement.
If the operating space is too small, the robot may seem to become inoperable.

2.2.5 Procedure for Changing the Software Motion Limits

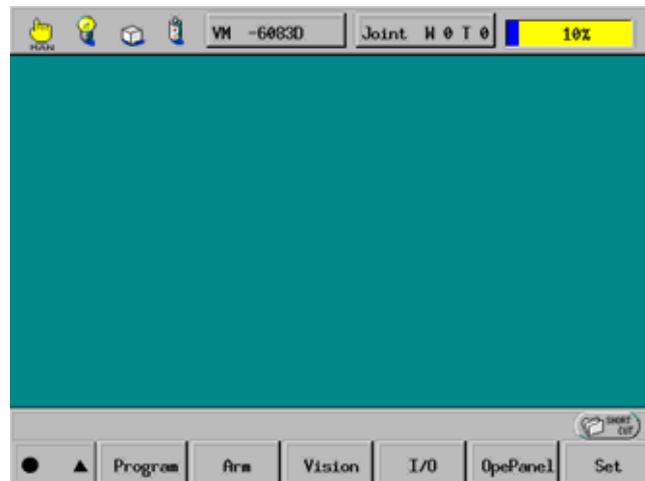
Described below is the procedure for changing the software motion limits.

Step 1 Turn the power switch of the robot controller to ON.

Step 2 On the operation panel, turn the mode selector switch to the TEACH position.
On the teach pendant, turn the manual/auto selector switch to the manual position.

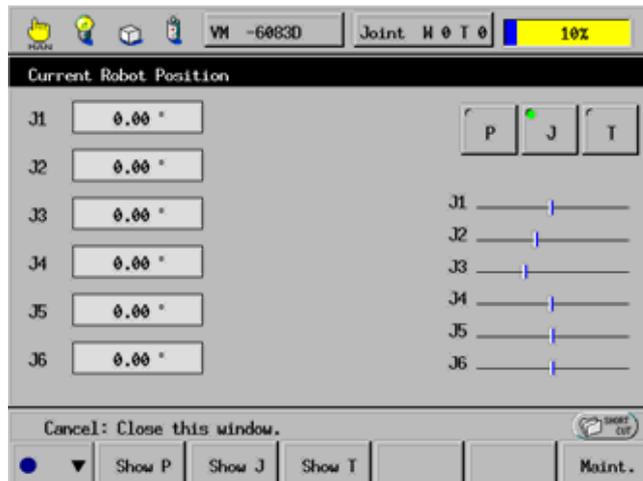
Step 3 Switch the teach pendant to the extended screen.
For the switching procedure, refer to Section 2.2.6 "Switching to the Extended Screen."

Step 4 Press [Arm] on the extended screen.



The Current Robot Position window appears as shown in Step 5.

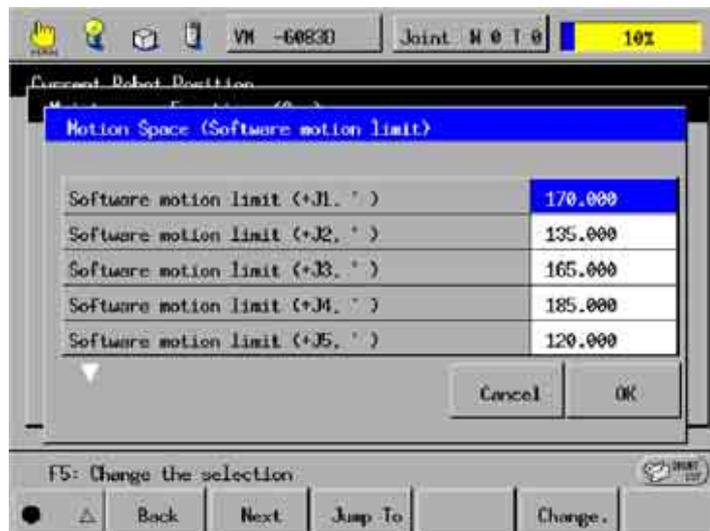
Step 5 Press the SHIFT key and then press [Maint.].



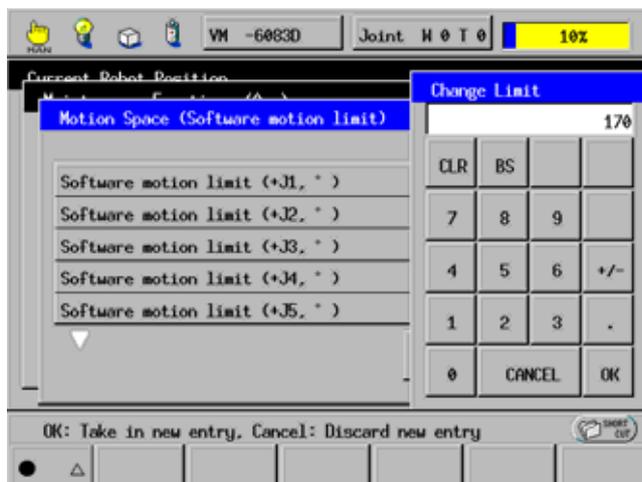
The Maintenance Functions (Arm) window will appear.

Step 6 Press [M Space] on the Maintenance Functions (Arm) window. The Motion Space window will appear as shown below.

Select the item to be modified, then press [Change].



Step 7 The numeric keypad will appear as shown below.



Enter a desired value using the numeric keys, then press OK.

The new value will be set on the line of the item selected in the Motion Space window.

If two or more items must be changed, repeat Steps 6 and 7.

Step 8 Press OK in the Motion Space (Software motion limit) window.

While holding down the ENABLE key, press the CLOSE key to return to the top screen.

Step 9 Turn OFF the power to the robot controller.

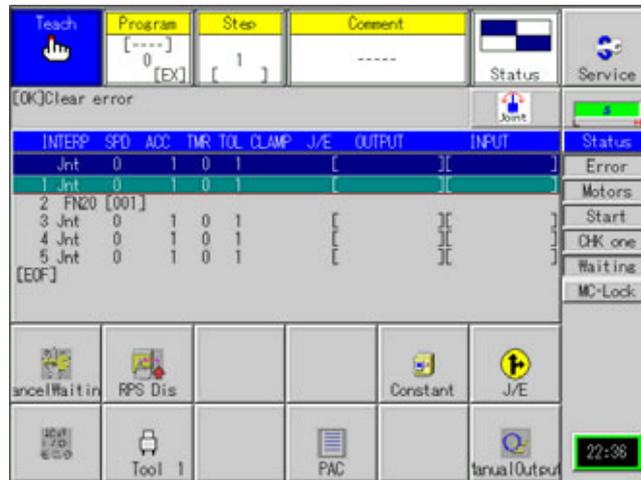
Caution: The new software motion limit(s) specified for the motion space will take effect after the robot controller restarts and CAL is completed.

2.2.6 Switching to the Extended Screen

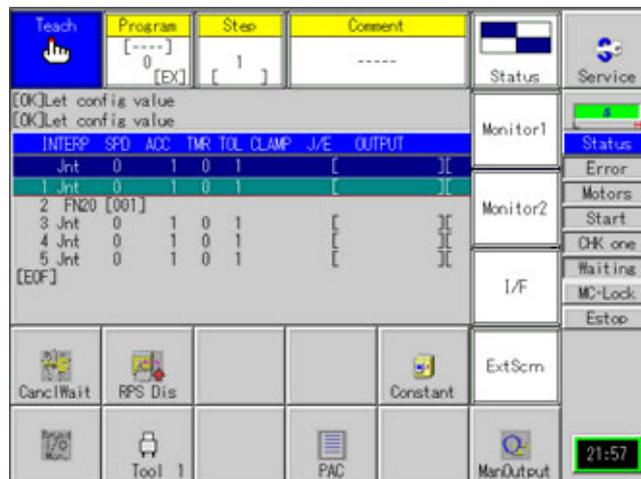
In addition to the top screen, the teach pendant has the extended screen. This section describes the switching procedure from the top screen to the extended one.

Step 1 Press the Status button at the top right on the top screen.

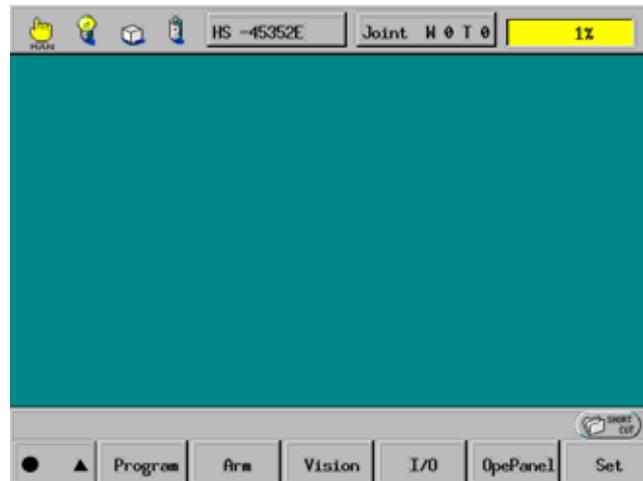
The drop-down menu appears as shown in Step 2.



Step 2 Press the ExtScrn on the drop-down menu.



Step 3 The extended screen appears as shown below.



Step 4 While holding down the **ENABLE** key, press the **CLOSE** key to return to the top screen.

Note that this operation may not close the extended screen in any of the following states.

- During program editing
- During parameter editing
- During program loading
- In error occurrence state

2.3 Changing the Mechanical End

This section describes the procedures of changing the mechanical ends of the 1st-axis to 3rd-axis for the VS-G-T 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. The mechanical stoppers may not limit the workable area of the robot. Therefore, do not enter the robot's restricted space when the robot power is turned ON.
4. If the robot is collided with the mechanical stopper, the robot will stop by detecting the collision but the mechanical stopper may be broken.
When the robot is collided with the mechanical stopper, remove the mechanical stopper. And inspect the robot and surrounding devices, and repair them. Do not re-use the mechanical stoppers and re-manufacture them.
5. The reference drawings described on this manual cannot be covered on the customer's usage conditions sufficiently. Design, manufacture and install the mechanical stoppers according to your usage conditions.
6. The weight addition by the mechanical stoppers may affect the maximum payload.
7. 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 VS-G-T series so that the stroke of the 1st axis will be $\pm 170^\circ$.

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

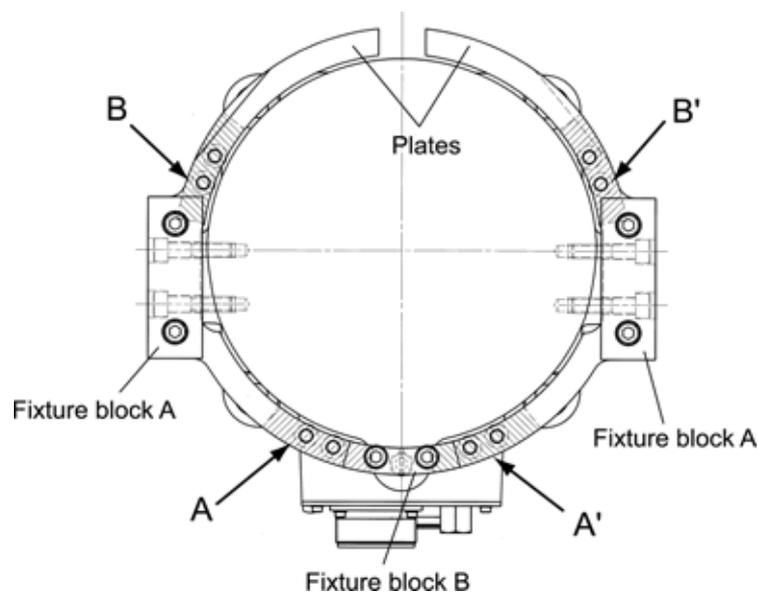
The figure below shows the mechanical stop positions for mechanical end change.

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.



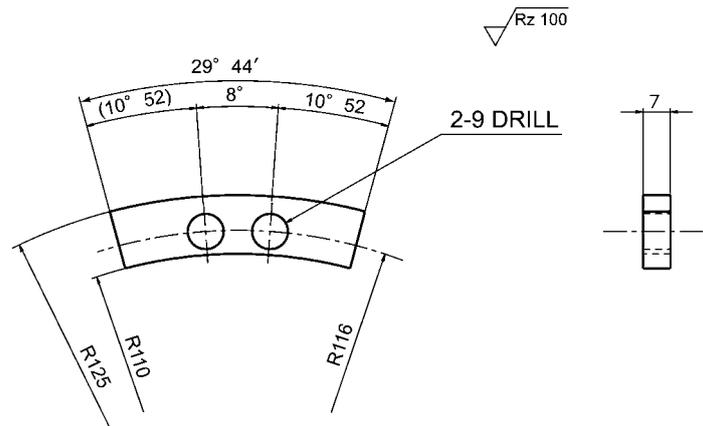
Locations of Mechanical Stops in the VS-G-T Series

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 direction and the negative direction. The table below shows the angles of the 1st axis in the positive and negative directions when it is in contact with each mechanical stop.

Stroke of the 1st Axis to Mechanical Ends

Mechanical stop position	Positive direction	Negative direction
A	5°	41°
A'	-41°	-5°
B	95°	131°
B'	-131°	-95°
Permanent mechanical end	170°	-170°

VS-G-T series (For 1st-axis)

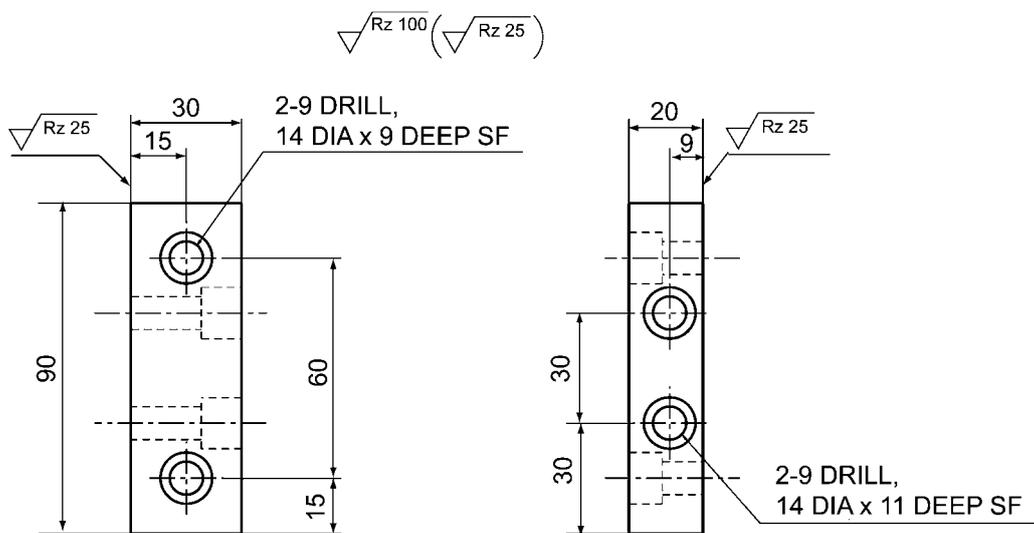


Material: A2017

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

Mechanical Stop

VS-G-T series (For 1st-axis)

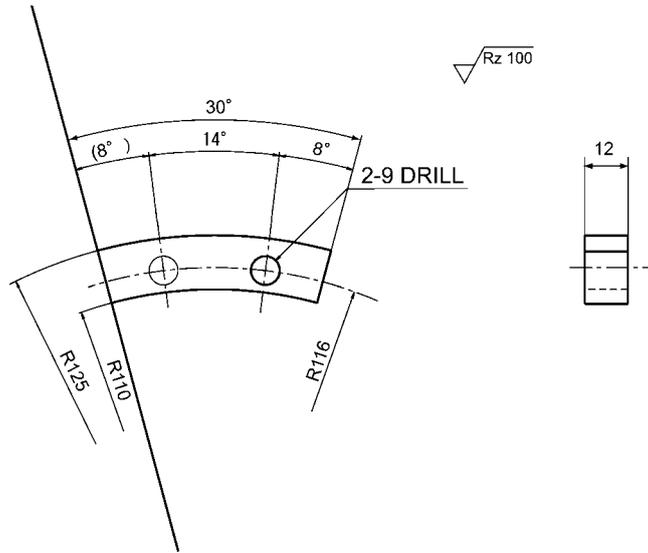


Material: S45C

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

Fixture Block A

VS-G-T series (For 1st-axis)

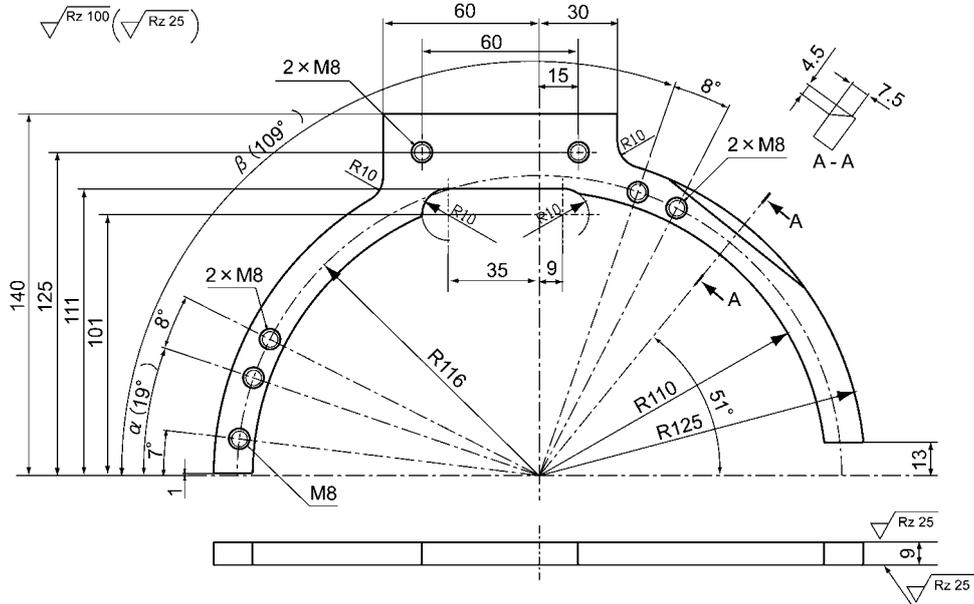


Material: S45C

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

Fixture Block B

VS-G-T series (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. (In the above sample, mechanical stop positions A and B are 5° and 95°, respectively.)

Plate

Precautions When Changing the Mechanical Ends

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

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

Note: 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."

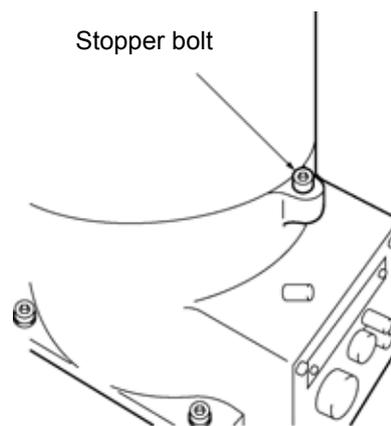
The following example for the 1st-axis mechanical end change contains RANG value change and CALSET.

[2] Changing the Mechanical Ends

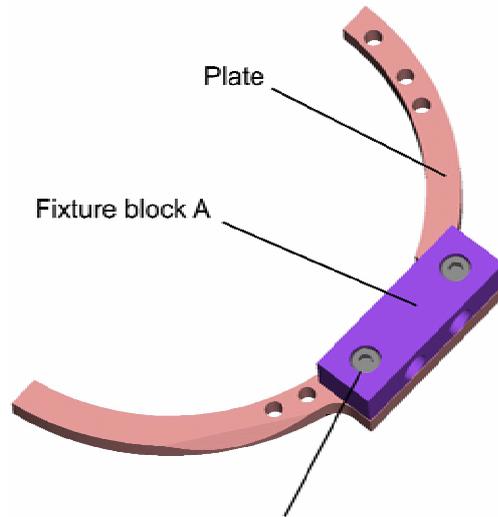
The mechanical ends can be changed by mounting four types of mechanical stop parts (i.e., mechanical stops, fixture blocks A, fixture block B, and plates) and then changing the software motion limits and the RANG values. The procedures for doing this are described in the following sections.

(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.

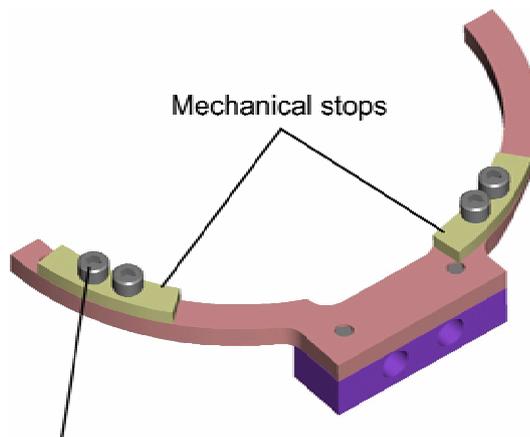


Step 2 Secure fixture block A to the plate with two hexagonal socket-head bolts. (Make a pair of assemblies.)



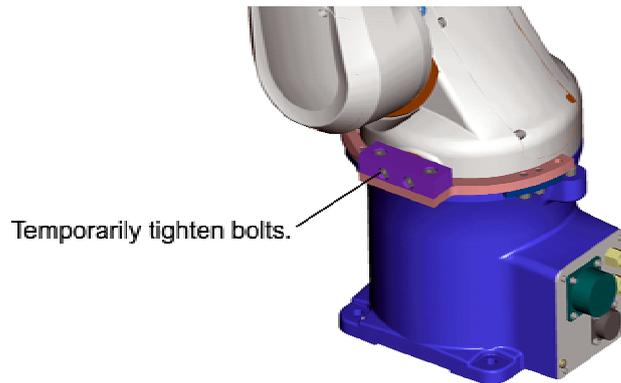
Hex. socket-head bolt M8x16 (Strength class: 12.9)
Tightening torque: 36 ± 7.2 Nm

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 for determining the desired motion space.

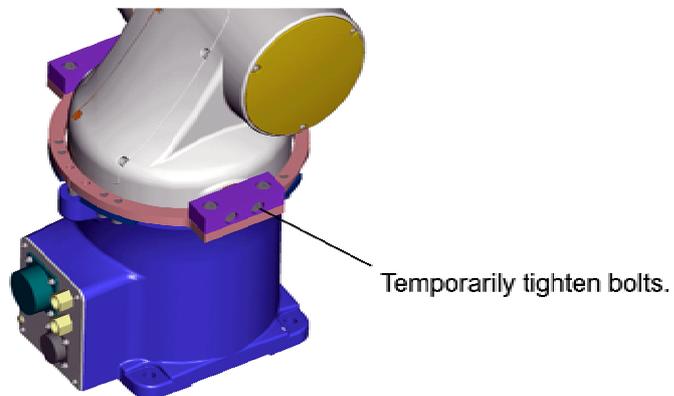


Hex. socket-head bolt M8x16 (Strength class: 12.9)
Tightening torque: 20 ± 4 Nm

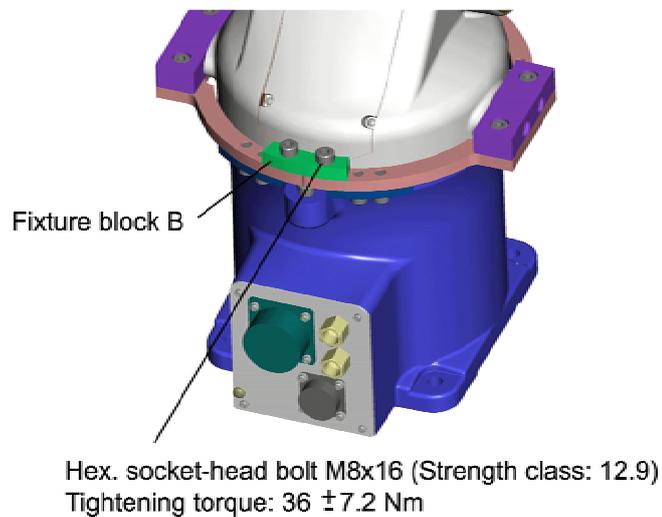
Step 4 Temporarily secure one of the assemblies made in Step 3 to the side of the 1st axis with hexagonal socket-head bolts.



Step 5 In the same way as in Step 4, temporarily secure the other 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 two 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.



(2) Software motion limits and 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 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 33.

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

Checking the 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 negative-direction software motion limits (NLIMs)".

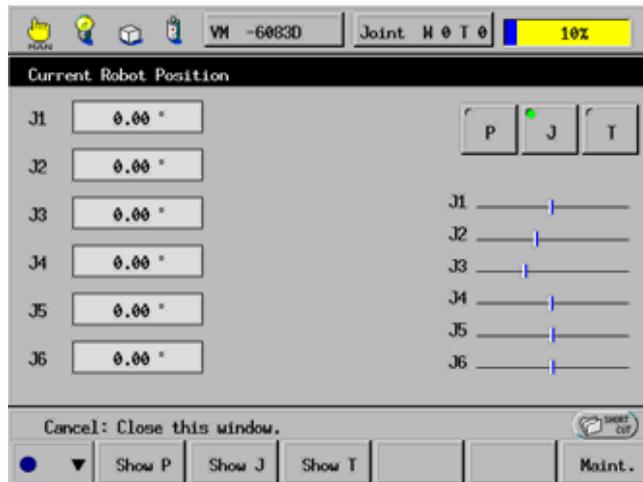
When you use the permanent mechanical end, this checking job is not required.

Step 1 Turn the power switch of the robot controller to ON.

Step 2 On the operation panel, turn the mode selector switch to the TEACH position.
On the teach pendant, turn the manual/auto selector switch to the manual position.

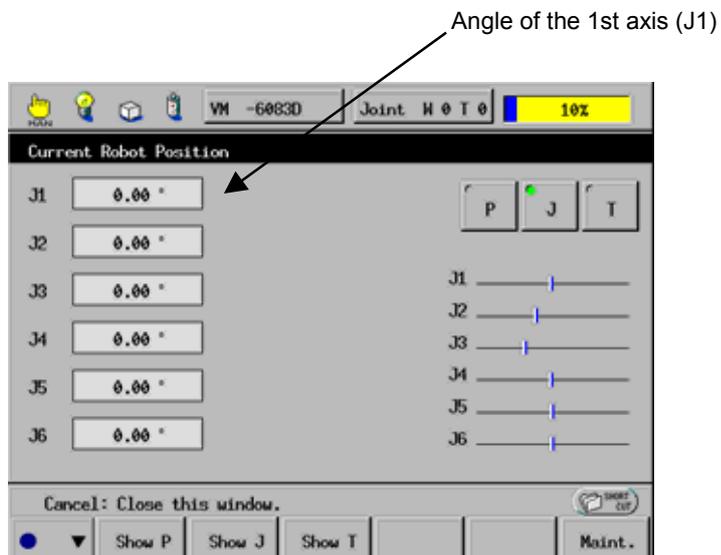
Step 3 Switch the teach pendant to the extended screen.

- Step 4** Press [Arm] on the extended screen.
The Current Robot Position window appears.



- Step 5** Gently bring the 1st axis of the robot into contact with the newly set positive-direction mechanical end.

- Step 6** Check the value in J1 box that appears when the 1st axis is in contact with the mechanical end in Step 5. The value is RANG value to be newly set.



While holding down the ENABLE key, press the CLOSE key to return to the top screen.

Mechanical End Positions and 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	-46	-136	/	/	/	/
Negative-direction software motion limit	/	/	/	/	46	136	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 RANG value"
 - (2) When the positive-direction mechanical ends are the permanent mechanical ends and the negative-direction mechanical ones are B', change:
 Negative-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 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 = -46
 RANG = value obtained in "Checking the RANG value"
 - (5) When the positive-direction mechanical ends are the permanent mechanical ends and the negative-direction mechanical ends are B, change:
 Negative-direction software motion limit = 136

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

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

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."

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

Changing Positive-Direction Software Motion Limits (PLIMs)

- Step 1** Turn the power switch of the robot controller to ON.

- Step 2** On the operation panel, turn the mode selector switch to the TEACH position.
On the teach pendant, turn the manual/auto selector switch to the manual position.

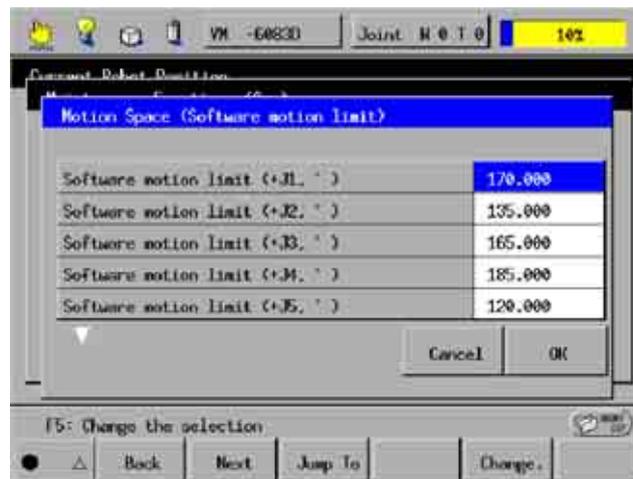
- Step 3** Switch the teach pendant to the extended screen.

- Step 4** Press [Arm] on the extended screen.
The Current Robot Position window appears.

- Step 5** In the Current Robot Position window, press [Maint.].
The Maintenance Functions (Arm) window appears.



Step 6 Press [M Space.] in the window shown in the previous step.
The Motion Space (Software motion limit) window appears as shown below.



Step 7 Using the cursor keys, select the Software motion limit (+J1, deg) field.

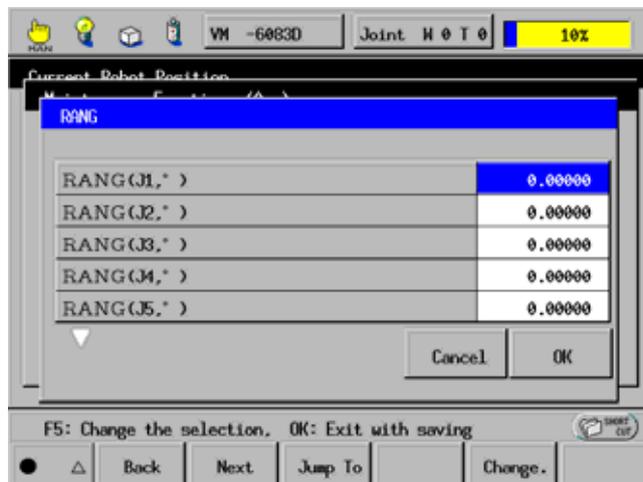
Step 8 Press [Change.].
The numeric keypad appears.

Step 9 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 10 Press OK.
The screen returns to the Maintenance Functions (Arm) window.

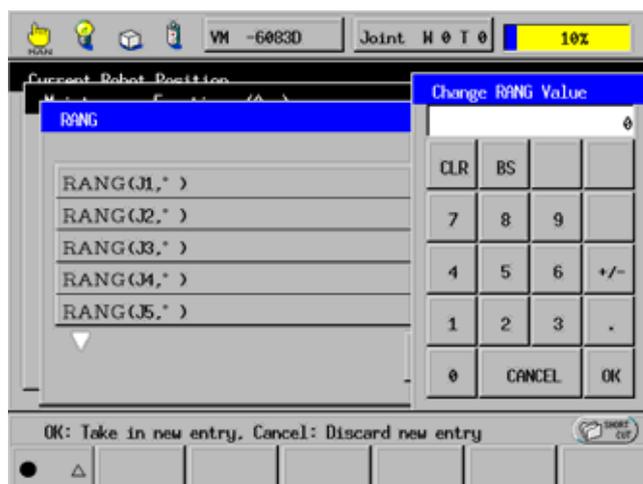
Changing RANG Values

- Step 11** In the Maintenance Functions (Arm) window, press [RANG].
The RANG window appears as shown below.



Press [Change.].

- Step 12** The numeric keypad appears.



- Step 13** Using the numeric keys, enter RANG values, then press OK.
The screen returns to the RANG window.

Step 14 | Press OK.
The screen returns to the Maintenance Functions (Arm) window.

Step 15 | Turn the power switch of the robot controller to OFF.

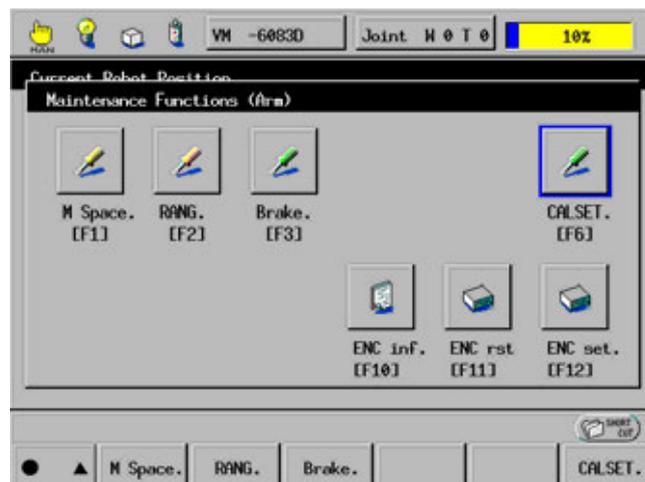
Step 16 | Turn the power switch of the robot controller to ON.

Step 17 | Press [Arm] on the extended screen.

CALSET of the 1st Axis

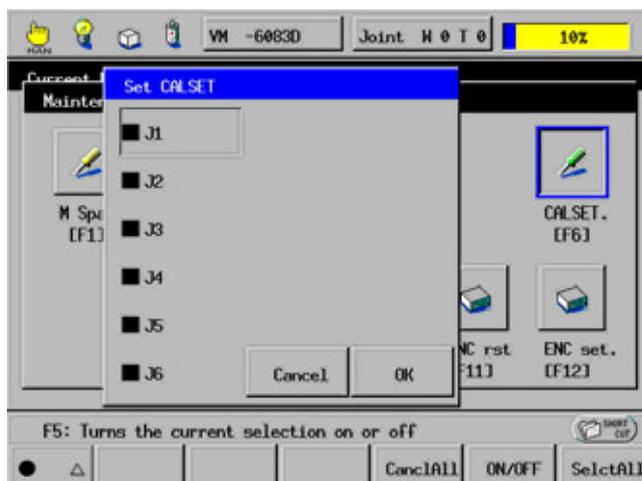
NOTE: Release the brake on the 1st axis before CALSETing.

Step 18 | Press the **SHIFT** key and **[Maint.]**.
The Maintenance Functions (Arm) window appears.



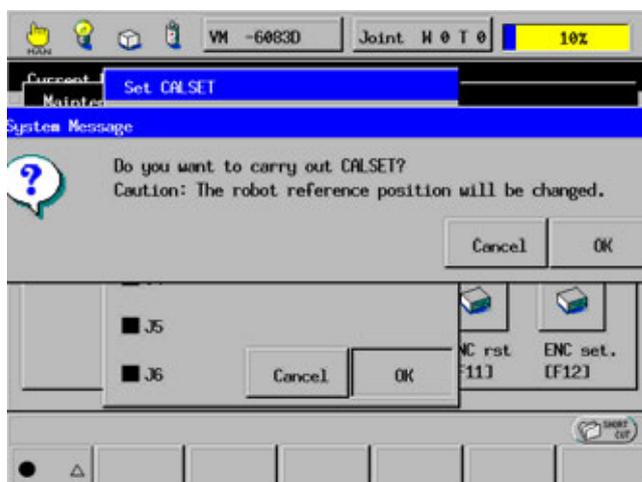
Step 19 | Bring the 1st axis into contact with the positive-direction mechanical end by hand.

Step 20 Press [CALSET.] on the window in Step 18.
The Set CALSET window appears.



Step 21 Touch the J1 field and confirm that the mark turns green.

Step 22 Press OK.
The message window appears asking you whether you want to execute CALSET.



Step 23

Press OK.

The message window appears informing you that CALSET is completed.

Step 24

Press OK.

While holding down the ENABLE key, press the CLOSE key to return to the top screen.

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

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

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

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

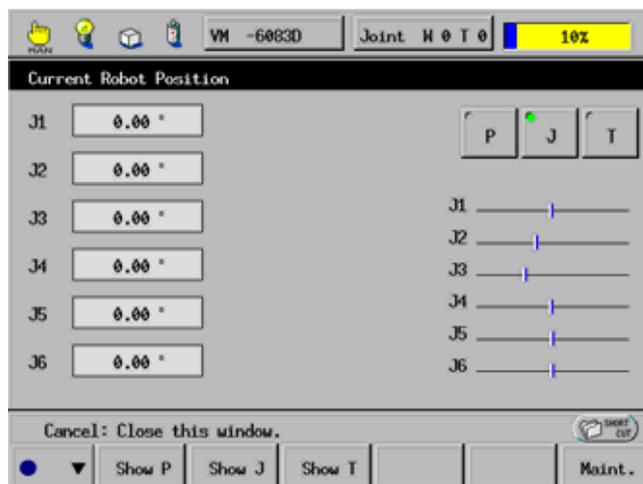
The negative-direction software motion limits (NLIMs) must be changed whenever the negative-direction mechanical ends are changed. Change the negative-direction software motion limits (PLIMs) according to steps 1 through 11 described below.

Step 1 Turn the power switch of the robot controller to ON.

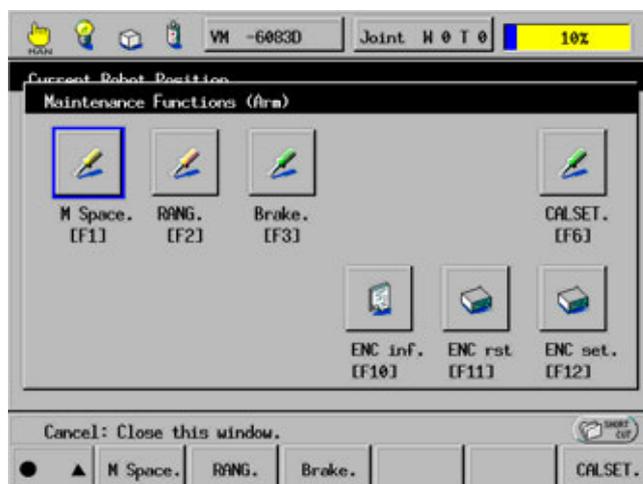
Step 2 On the operation panel, turn the mode selector switch to the TEACH position.
On the teach pendant, turn the manual/auto selector switch to the manual position.

Step 3 Switch the teach pendant to the extended screen.

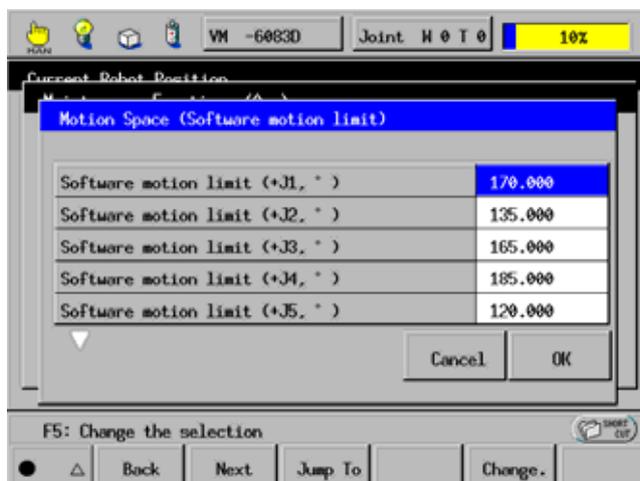
Step 4 Press [Arm] on the extended screen.
The Current Robot Position window appears.



Step 5 Press [Maint.].
The Maintenance Functions (Arm) window appears.



Step 6 Press [M Space.] in the window shown in the previous step. The Motion Space (Software motion limit) window appears.



Step 7 Using the cursor keys, select the Software motion limit (-J1, deg) field.

Step 8 Press [Change.]. The numeric keypad appears.

Step 9 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 10 Press OK.

Step 11 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 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 limit. The software motion limit is set inside the mechanical end positions.

Workable angle at shipping for VS-G-T series

Model	Workable angle for the 2nd-axis	Workable angle for the 3rd-axis
VS-6556G series	+135°, -100°	+166°, -119°
VS-6577G series	↑	+169°, -119°

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

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

Caution: 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.

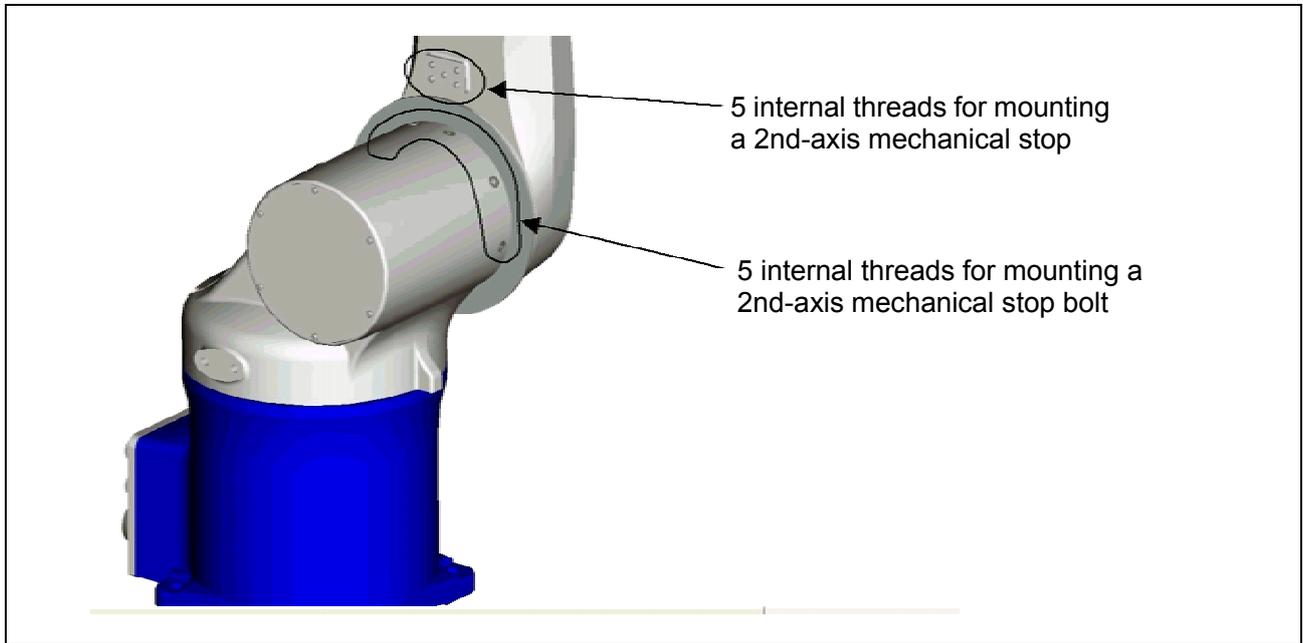
- (1) When CALSET is necessary (e.g., at the time of motor replacement), if you perform CALSET after removing the mechanical stop parts (prepared by the customer), a mechanical end change requires no RANG value change or CALSET.
- (2) If you perform CALSET with the mechanical stop parts (prepared by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

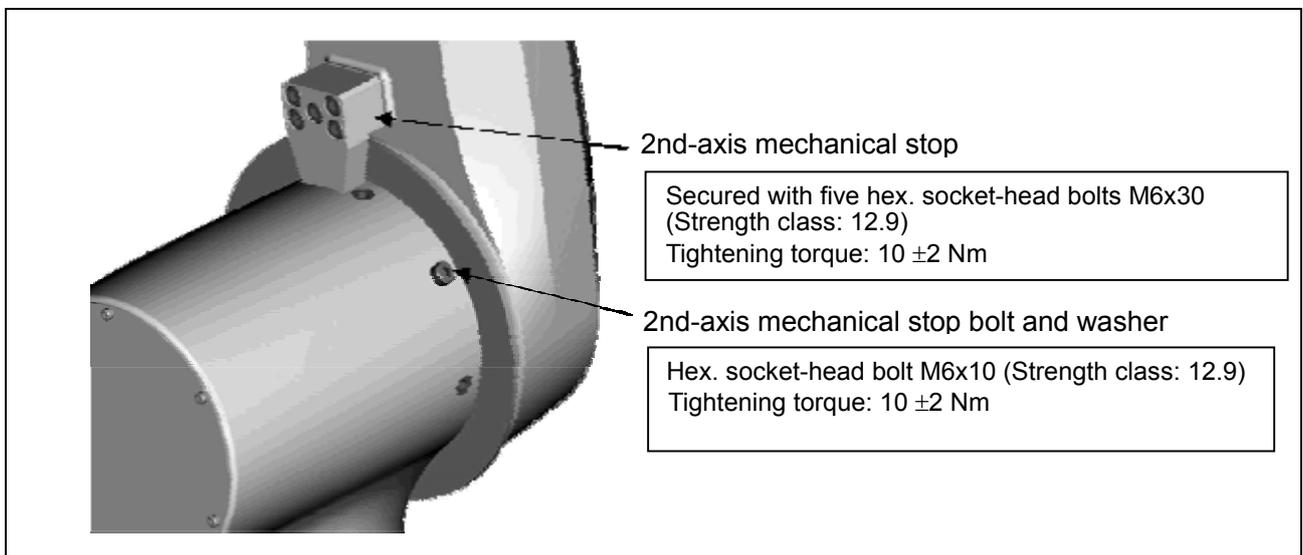
[2] 2nd-axis Mechanical End Change

(1) Outline

The 2nd-axis mechanical end can be changed by mounting a mechanical stop and a total of six mechanical stop bolts (both of which should be prepared by the customer) to the existing internal threads in the robot unit as shown below.



Existing Internal Threads for 2nd-axis Mechanical End Change

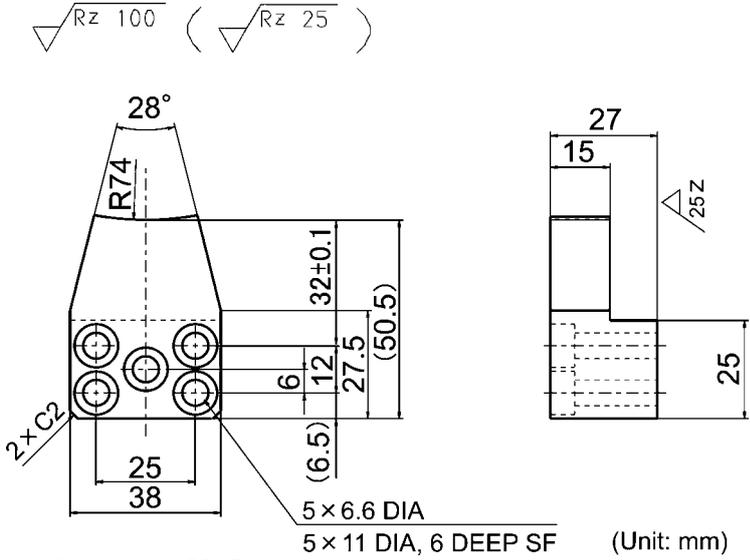
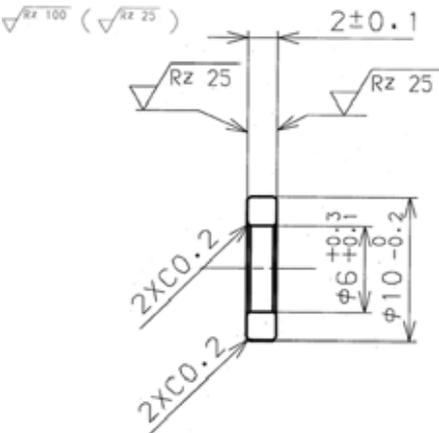


Example of 2nd-axis Mechanical End Configured on the Robot Unit

(2) Items to be Prepared by the Customer for 2nd-axis Mechanical End Change

Shown below are the items to be prepared by the customer for 2nd-axis mechanical end change.

Items for 2nd-axis Mechanical End Change

To be prepared by the customer	Reference Drawings (Specifications)
2nd-axis mechanical stop	 <p>Material: A2017 5 × 6.6 DIA 5 × 11 DIA, 6 DEEP SF (Unit: mm)</p>
Washer	 <p>Material: A2017 (Unit: mm)</p>

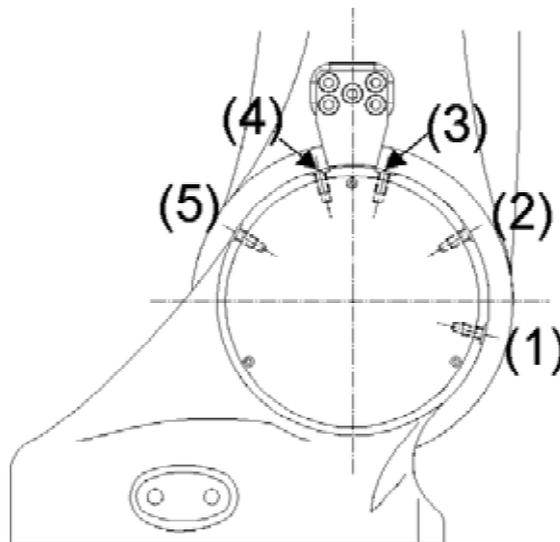
(3) 2nd-axis Mechanical End Positions

The 2nd-axis mechanical end positions available are shown below.

Note: Mounting the 2nd-axis mechanical stop limits the workable angle of the 2nd axis so that the 2nd axis cannot move up to the factory default angle.

Observe the following.

- (1) The 2nd axis cannot move overriding -60° in the negative direction, so set the negative-direction software motion limit for the 2nd axis in the positive side than -60° .
- (2) In the VS-6556 series, mounting the 2nd-axis mechanical stop limits the workable angle of the 3rd axis so that the 3rd axis cannot move overriding -30° in the negative direction. Set the negative-direction software motion limit for the 3rd axis in the positive side than -30° .
- (3) Be careful with the design of the mechanical stop. Depending upon the shape of the mechanical stop prepared by the customer, the axis may hit the mechanical stop before the software motion limit described above is activated.



Motion range (software motion limit value): The table below lists the 2nd-axis motion range when a positive or negative direction mechanical stop is mounted at each of the mechanical end positions available.

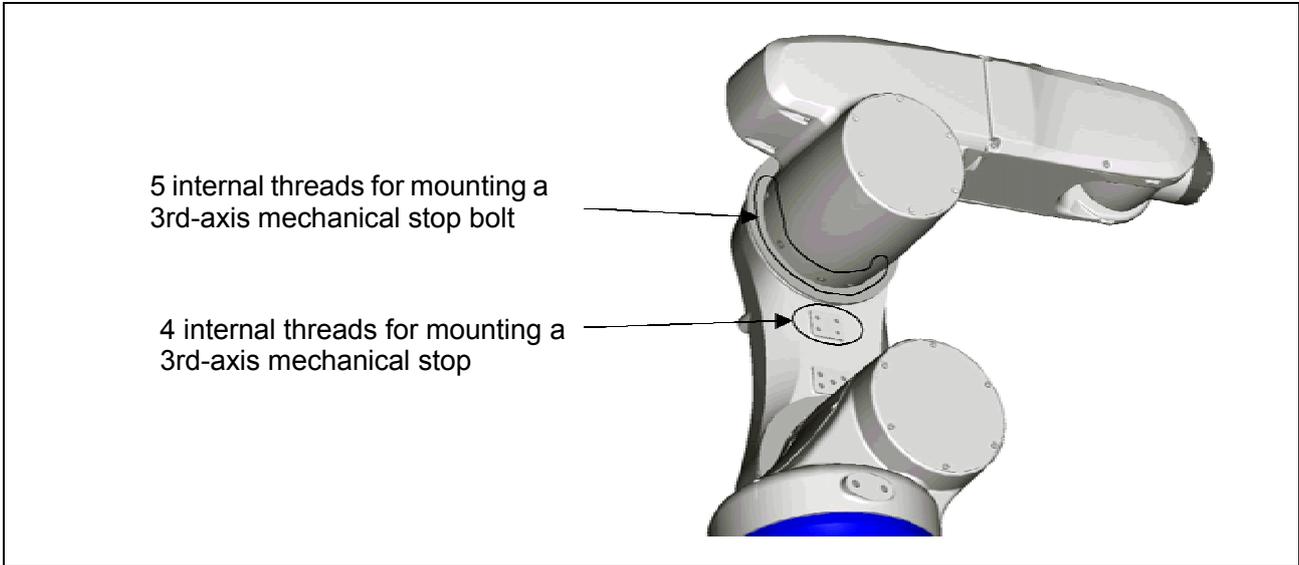
Stop bolt position	Positive direction	Negative direction
(1)	87°	121°
(2)	42°	76°
(3)	-3°	31°
(4)	-31°	3°
(5)	---	-42°

2nd-axis Mechanical End Positions Available

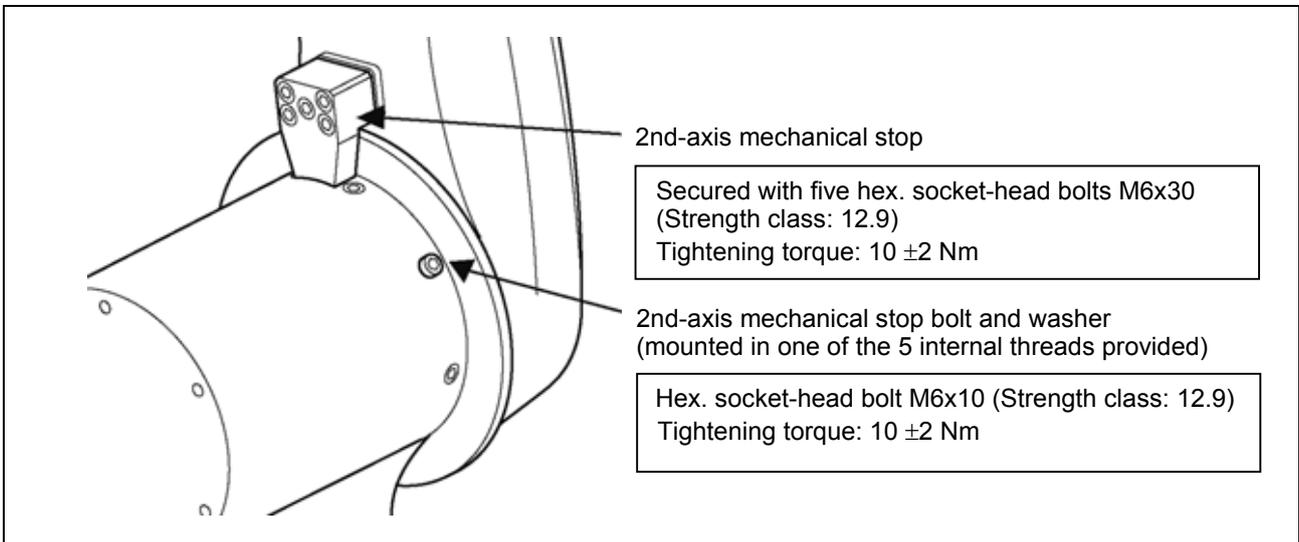
[3] 3rd-axis Mechanical End Change

(1) Outline

The 3rd-axis mechanical end can be changed by mounting a mechanical stop and a total of five mechanical stop bolts (both of which should be prepared by the customer) to the existing internal threads in the robot unit as shown below.



Existing Internal Threads for 3rd-axis Mechanical End Change

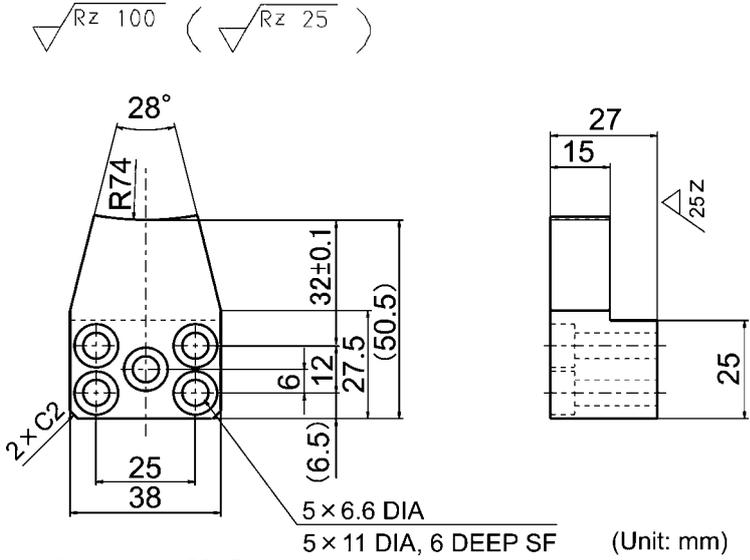
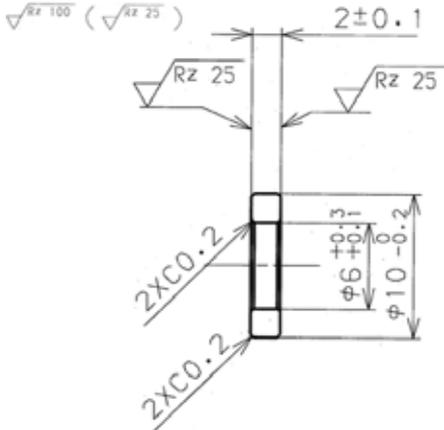


Example of 3rd-axis Mechanical End Configured on the Robot Unit

(2) Items to be Prepared by the Customer for 3rd-axis Mechanical End Change

Shown below are the items to be prepared by the customer for 3rd-axis mechanical end change.

Items for 3rd-axis Mechanical End Change

To be prepared by the customer	Reference Drawings (Specifications)
2nd-axis mechanical stop	 <p>Material: A2017</p> <p>(Unit: mm)</p>
Washer	 <p>Material: A2017</p> <p>(Unit: mm)</p>
Bolts	<ul style="list-style-type: none"> • Five hex. socket-head bolts M6x30 (Strength class: 12.9) for securing a mechanical stop • One hex. socket-head bolt M6x10 (Strength class: 12.9) as a mechanical stop bolt

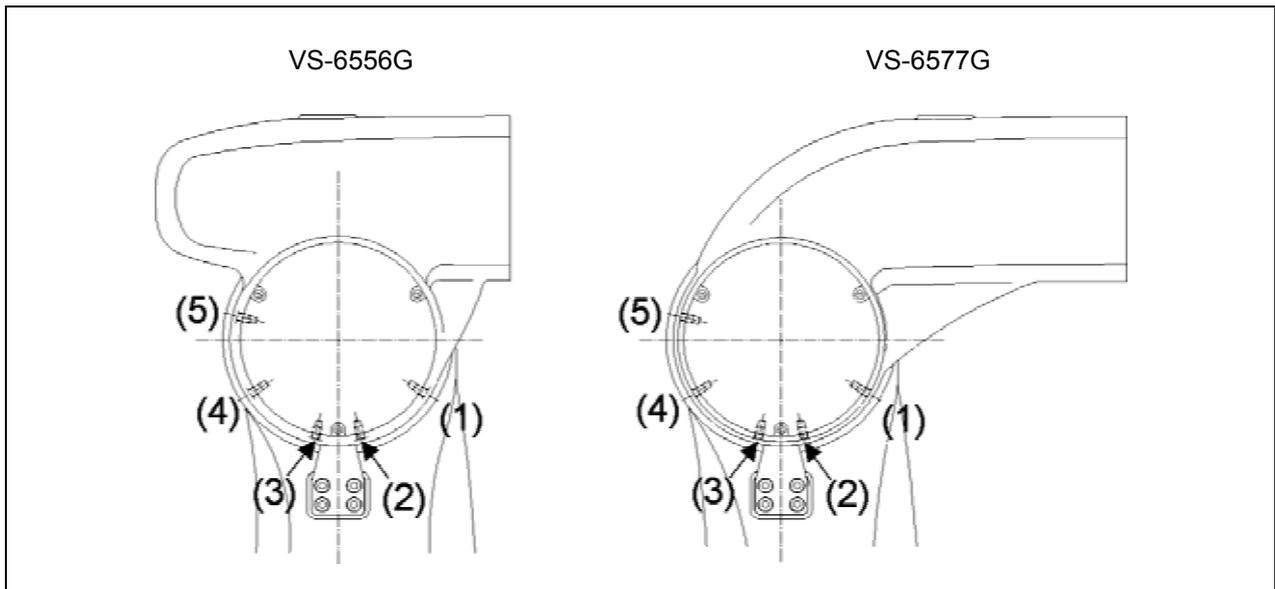
(3) 3rd-axis Mechanical End Positions

The 3rd-axis mechanical end positions available are shown below.

Note: Mounting the 3rd-axis mechanical stop limits the workable angle of the 3rd axis so that the 3rd axis cannot move up to the factory default angle.

Observe the following.

- (1) The 3rd axis cannot move overriding 150° in the positive direction, so set the positive-direction software motion limit for the 3rd axis in the negative side than 150° .
- (2) In the VS-6556G series, mounting the 3rd-axis mechanical stop limits the workable angle of the 3rd axis so that the 3rd axis cannot move overriding -20° in the negative direction. Set the negative-direction software motion limit for the 3rd axis in the positive side than -20° .
- (3) In the VS-6577G series, the 3rd-axis cannot move overriding -65° in the negative direction. Set the negative-direction software motion limit for the 3rd-axis in the positive side than -65° .
- (4) Be careful with the design of the mechanical stop. Depending upon the shape of the mechanical stop prepared by the customer, the axis may hit the mechanical stop before the software motion limit described above is activated.



Motion range (software motion limit value): The table below lists the 3rd-axis motion range when a positive or negative direction mechanical stop is mounted at each of the mechanical end positions available.

Stopper bolt position	Positive direction	Negative direction
(1)	132°	---
(2)	87°	119°
(3)	61°	93°
(4)	16°	48°
(5)	---	3°

3rd-axis Mechanical End Positions Available

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.

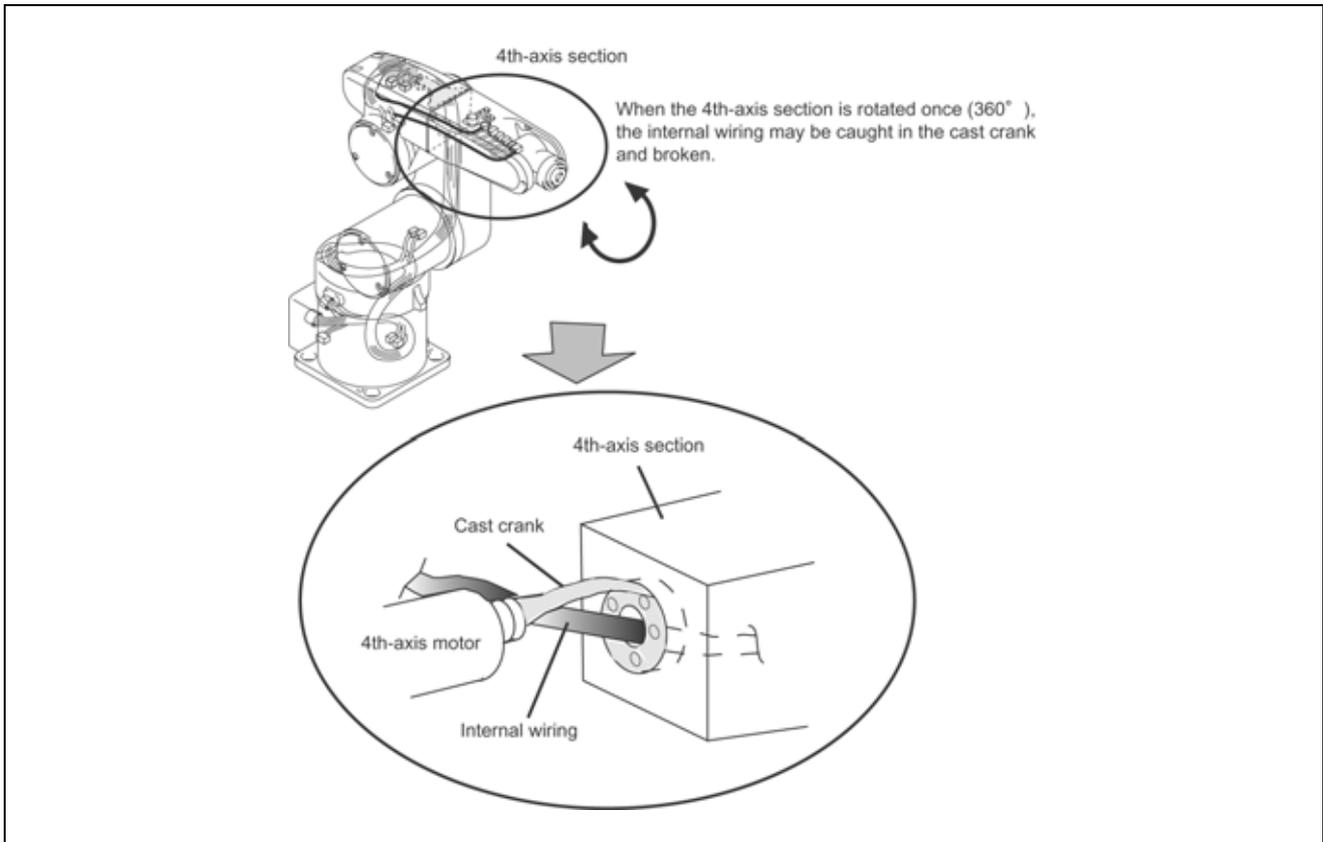
Back up the CALSET data periodically, referring to "Backing Up Projects."

2.4.2 Precautions about CALSET for the VS-G-T Series

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

Robots in the VS-G-T series 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 cast 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.

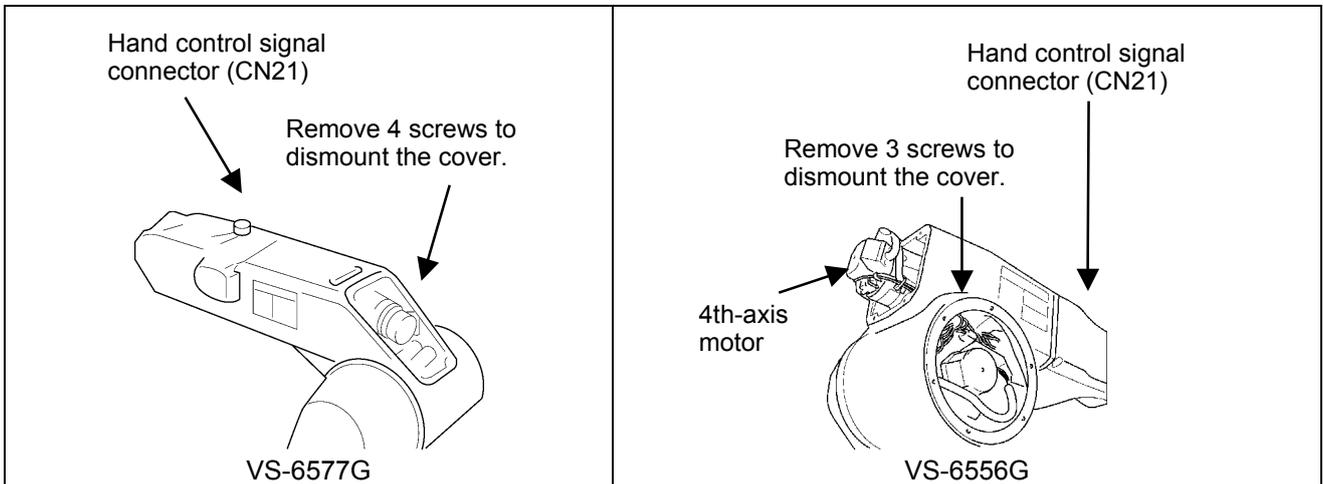


Note that turning the 4th-axis section by more than 360° may break the internal wiring

Checking of 4th-axis Position before Carrying Out CALSET

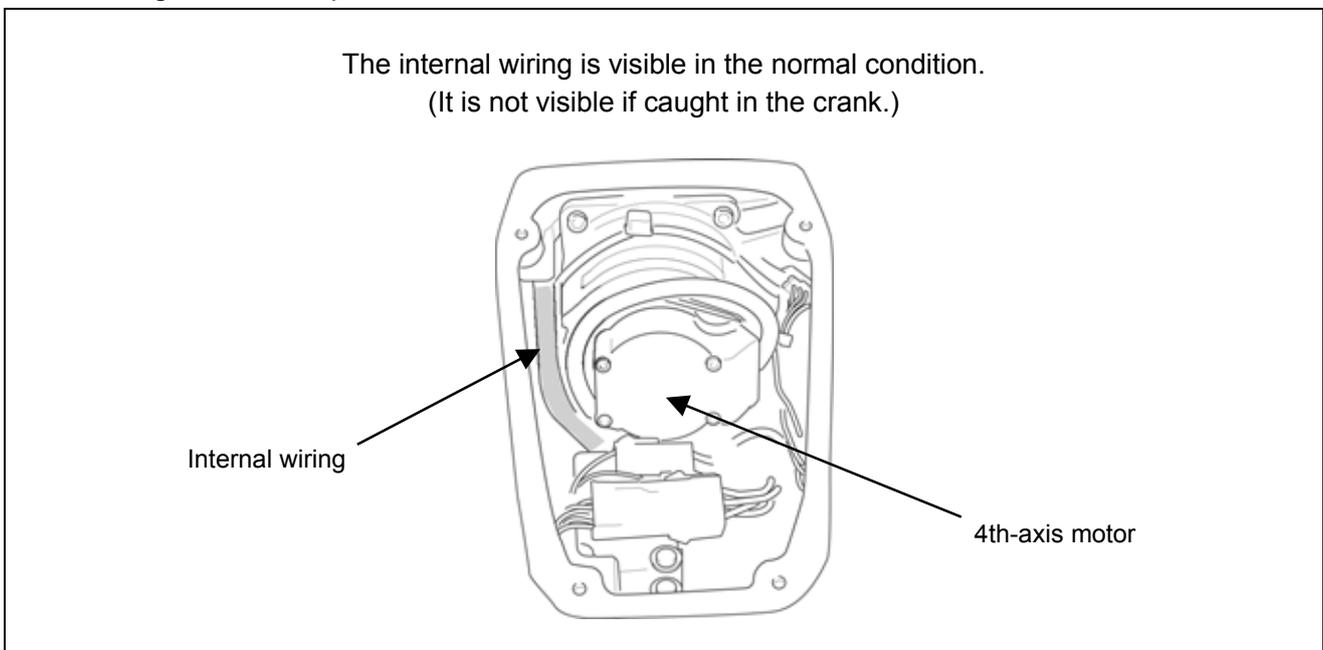
- (1) Manually move the 4th-axis section until the hand control signal connector comes to the upper side.
- (2) Dismount the cover from the second arm so that the internal wiring can be checked.

The cover to dismount for each model is shown below:



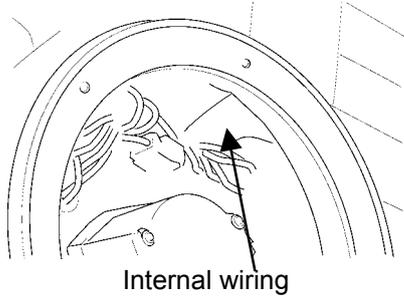
- (3) Check that the 4th-axis section is at a designated position.
(The hand control signal connector (CN21) of the second arm comes to the upper side and the internal wiring is not caught in the crank at this time.)

■ Checking the 4th-axis position for VS-6577G

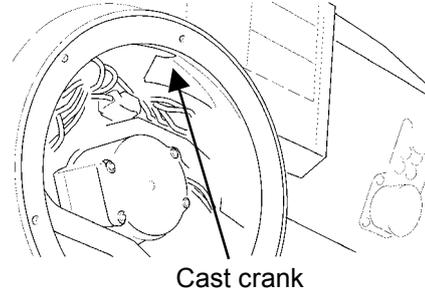


■ Checking the 4th-axis position for VS-6556

The internal wiring is visible in the normal condition as below.



When the 4th-axis section is rotated from where it is as shown on the left, the internal wiring is caught in the crank and becomes invisible in the left figure. (The figure below shows the crank at around 250°.)



- (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

The VS-G-T series has no mechanical stop on the 4th and 6th axes.

Mechanical Stops on Axes (VS-G-T)

On the 1st to 3rd and 5th axes	On the 4th and 6th axes
Mechanical stops provided	No mechanical stops

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.

■ Cautions at CALSET

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

- Caution (1) When CALSETing, move the target axis in the vicinity of the mechanical stop, release the brake, and bring the axis into contact with the mechanical stop.**
- The VS-G-T series can release the brake of the specified axis.
- (2) When releasing brakes, be careful about the robot motion. Releasing brakes causes the robot arm to 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.

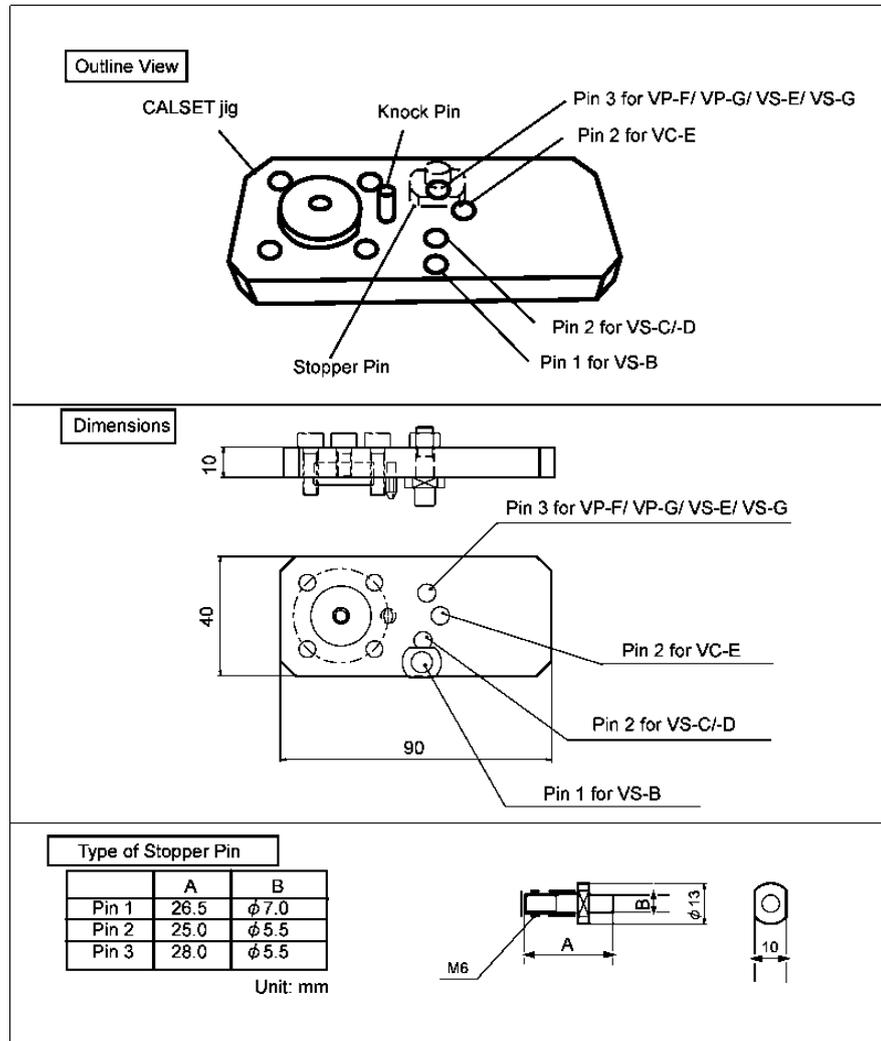
2.4.4 Mounting the CALSET Jig

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

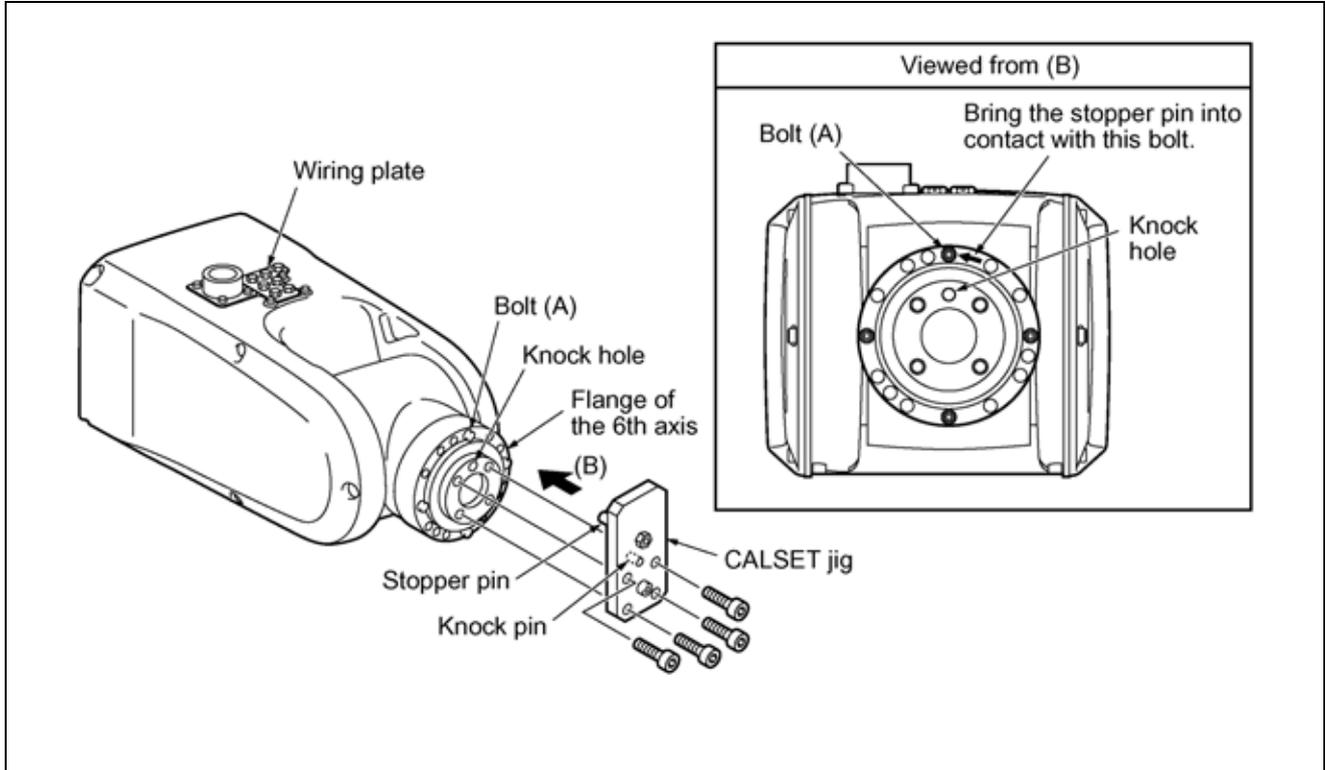
Step 1 Fit a stopper pin in the CALSET jig.



Step 2 Release the brake of the 6th axis.

Step 3 | Install the CALSET jig on the 6th axis flange as shown in the figure below.

TIP: The CALSET position of the 6th axis refers to the point where the stopper pin (shown in the figure below) comes into contact with bolt (A) by turning the flange of the 6th axis.



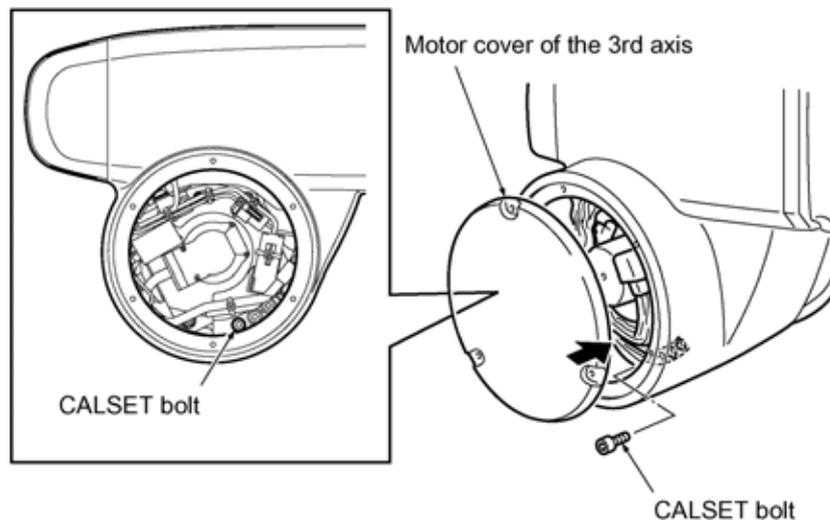
Mounting a CALSET Jig (VS-G-T series)

(2) Mounting the CALSET jig on the 4th axis (For models having no mechanical stop on the 4th axis)

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

Step 1 Remove the 3rd-axis motor cover and unscrew the CALSET bolt.

NOTE: After CALSETing, be sure to set the bolt back into place and torque it to $1.0 \text{ Nm} \pm 20\%$.



Removing the CALSET Bolt (VS-G-T series)

Step 2 Rotate the second arm to the position specified in the Step 4.

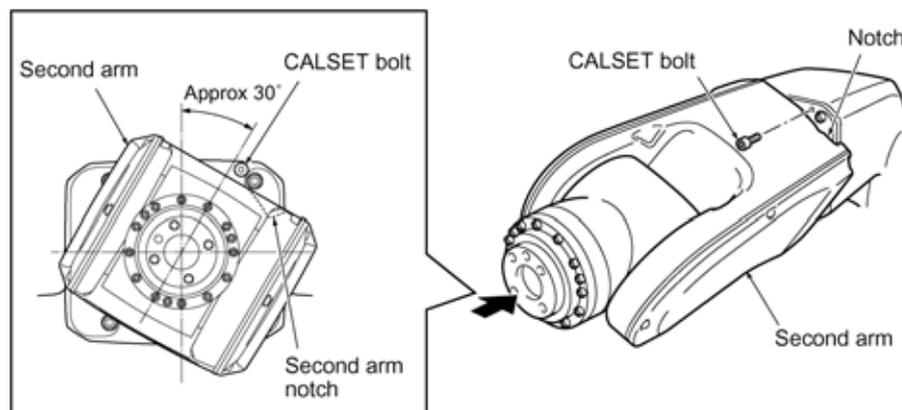
Step 3 Release the brake of the 4th axis.

Step 4 Set the CALSET bolt to the end of the 3rd axis housing as shown in the figure below.

Tightening torque of the CALSET bolt: $2.9 \text{ Nm} \pm 20\%$

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.



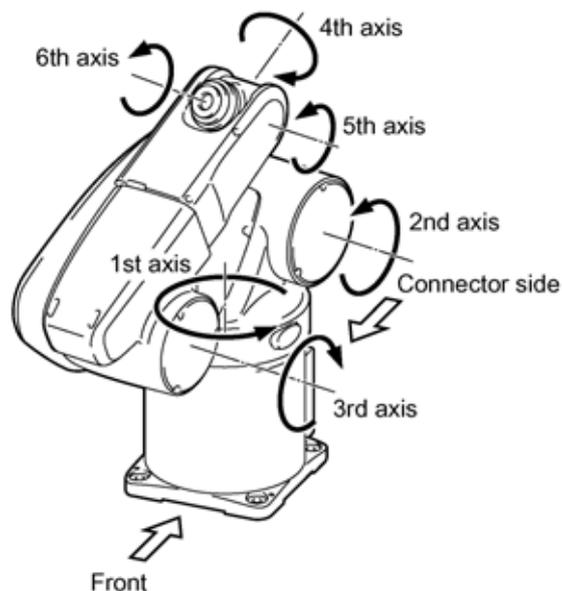
Mounting the CALSET Bolt (VS-G-T series)

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 position
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	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.)



CALSET Positions (VS-G-T 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 "CAUTIONS IN CHANGING THE MECHANICAL ENDS" on page 24.)

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.

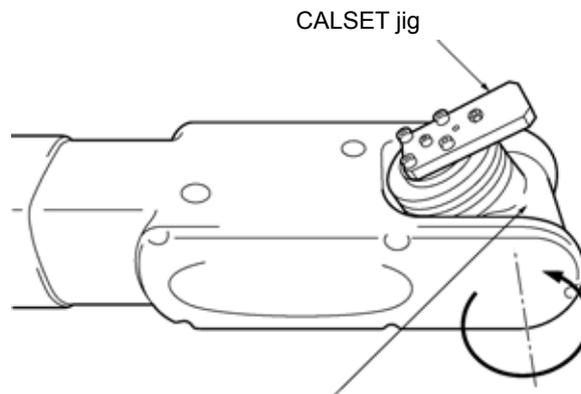
NOTE: Step 1 is required for CALSETing the 4th and 6th axes and Step 2 is for CALSETing the 6th axis. When CALSETing any other axes, skip to Step 3.

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

Mount the CALSET jig according to Section 2.4.4 "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.
Insert the teach plug prepared by the customer.**

Step 4

**On the operation panel, turn the mode selector switch to the TEACH position.
On the teach pendant, turn the manual/auto selector switch to the manual position.**

Step 5

**On the operation panel, press the TEACHING READY button.
On the teach pendant, hold down either one of the deadman switches to turn the motor ON. The robot is ready to run.**

Step 6

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

Releasing brakes (using the brake release switch)

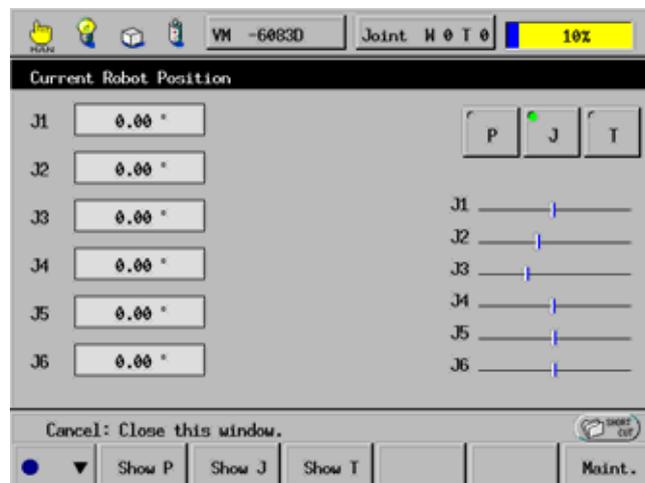
NOTE: Release the brake referring to Section 1.7 "Releasing Brakes" and then proceed to Step 16.

Step 7 Release the deadman switch to turn the motor power OFF.

Step 8 Switch the teach pendant to the extended screen.

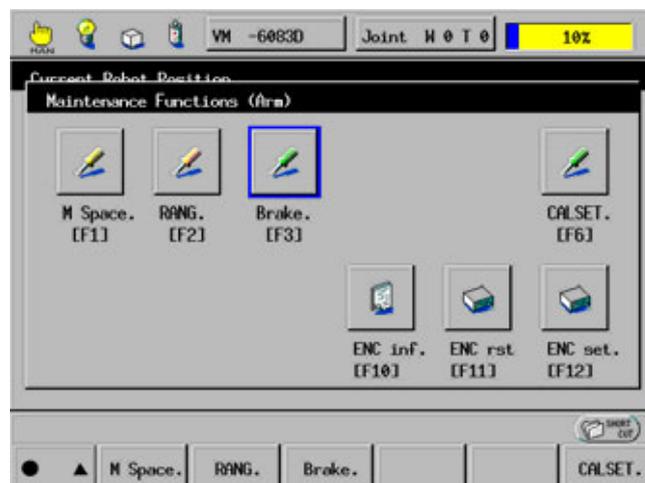
Step 9 Press [Arm] on the extended screen.

Step 10 Press the SHIFT key and [Maint.].



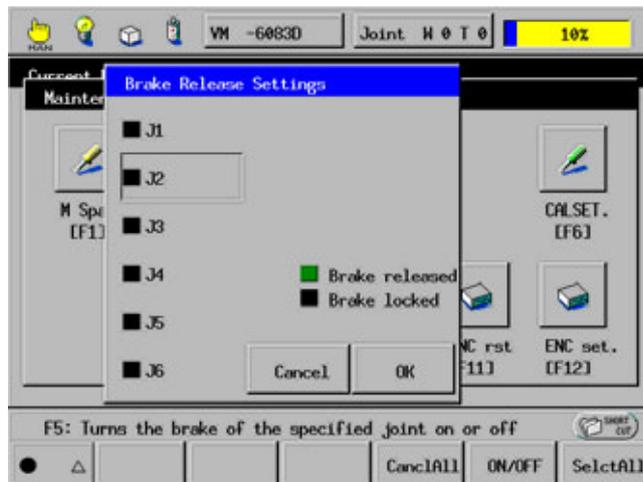
The Maintenance Functions (Arm) window appears.

Step 11 Press [Brake.].



The Brake release setting window appears.

Step 12 Touch the axis number to be CALSET to select "Brake released" (green display).

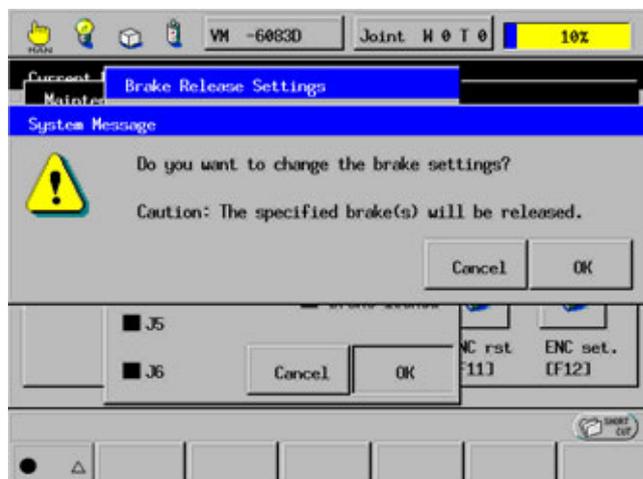


Step 13 Confirm that there is no danger even if the arms fall as a result of released brakes.

CAUTION: In the VS-G-T series, the brake of the specified axis is released.

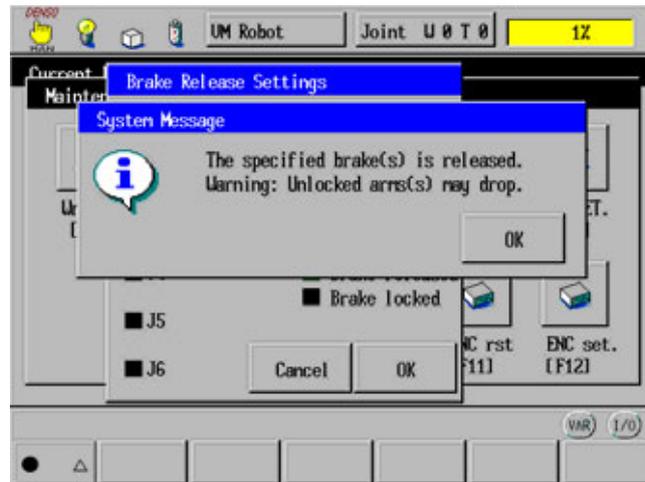
Step 14 Press OK.

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



Step 15 Press OK.

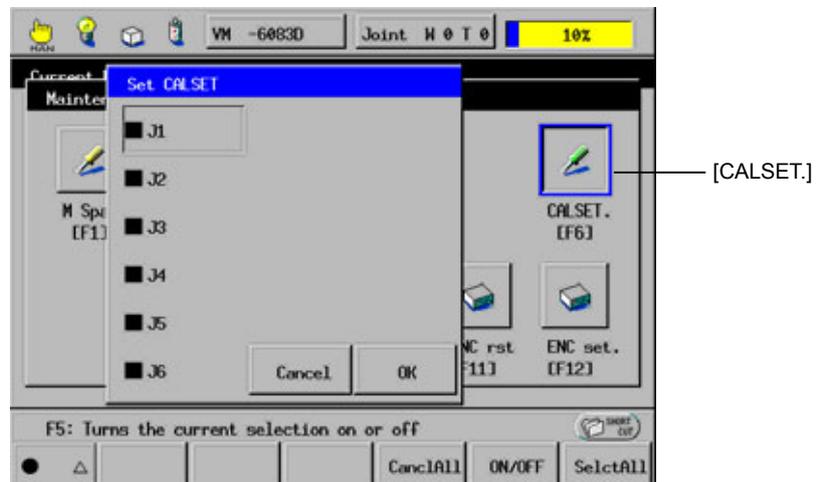
The system message appears informing that the brake is released and warning against drop of arms.



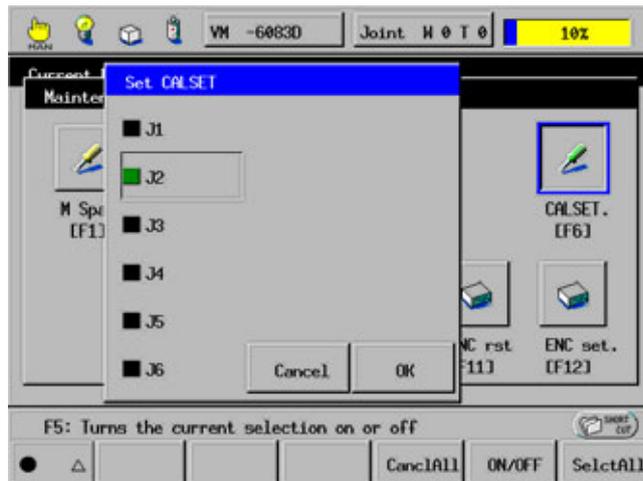
Step 16 Press the axis to be CALSET against the mechanical stop by hand.

Step 17 Press [CALSET].

The Set CALSET window appears.



Step 18 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 19 Press OK.

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



Step 20 Press OK.

The system message appears informing that CALSET is completed.

Step 21 Press the **EMERGENCY STOP** button.

The robot brake becomes activated.

Step 22 Turn the **EMERGENCY STOP** button to cancel robot stop.

Step 23 On the operation panel, press the **TEACHING READY** button.

On the teach pendant, hold down either one of the deadman switches to turn the motor ON. The robot is ready to run.

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

Step 25 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

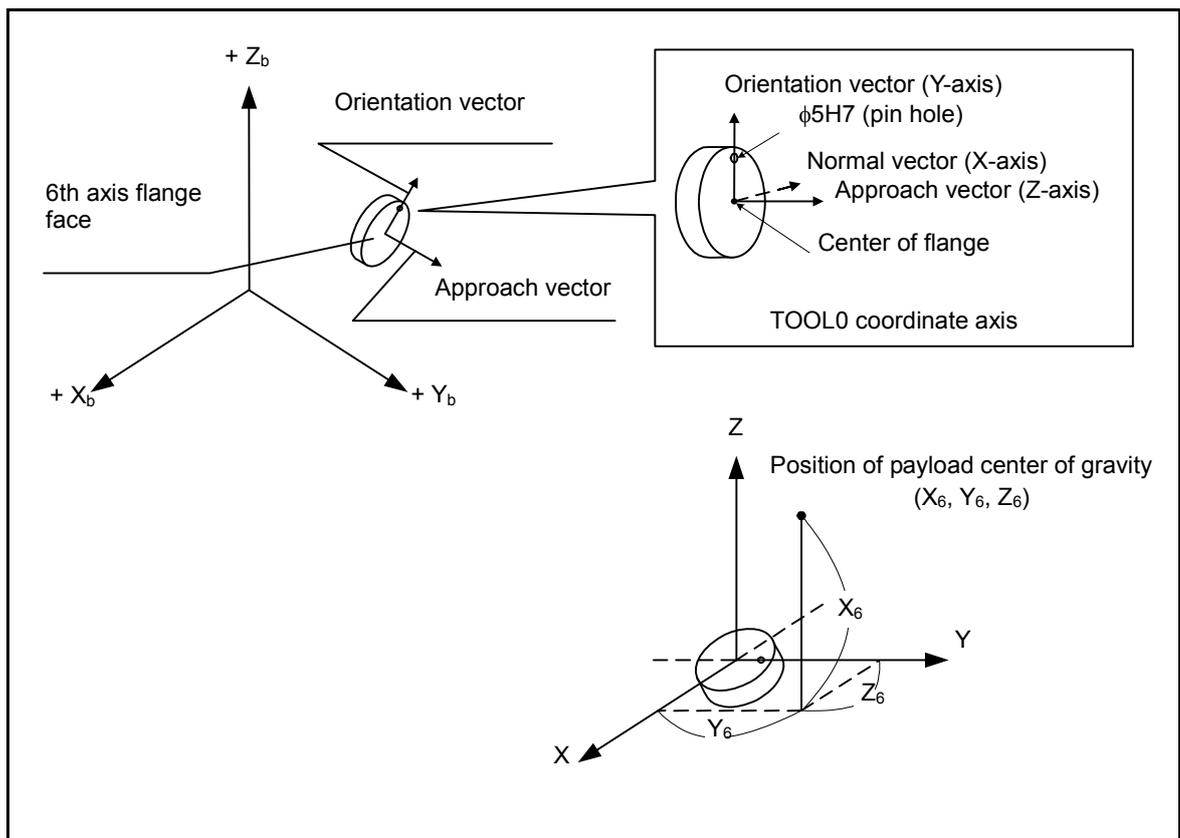
The optimum speed or acceleration will vary depending upon the payload and center of gravity of an end-effector or workpiece that is to be set at the end of the robot flange. Set the payload and center of gravity position of the end-effector or workpiece and the control set of motion optimization according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

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

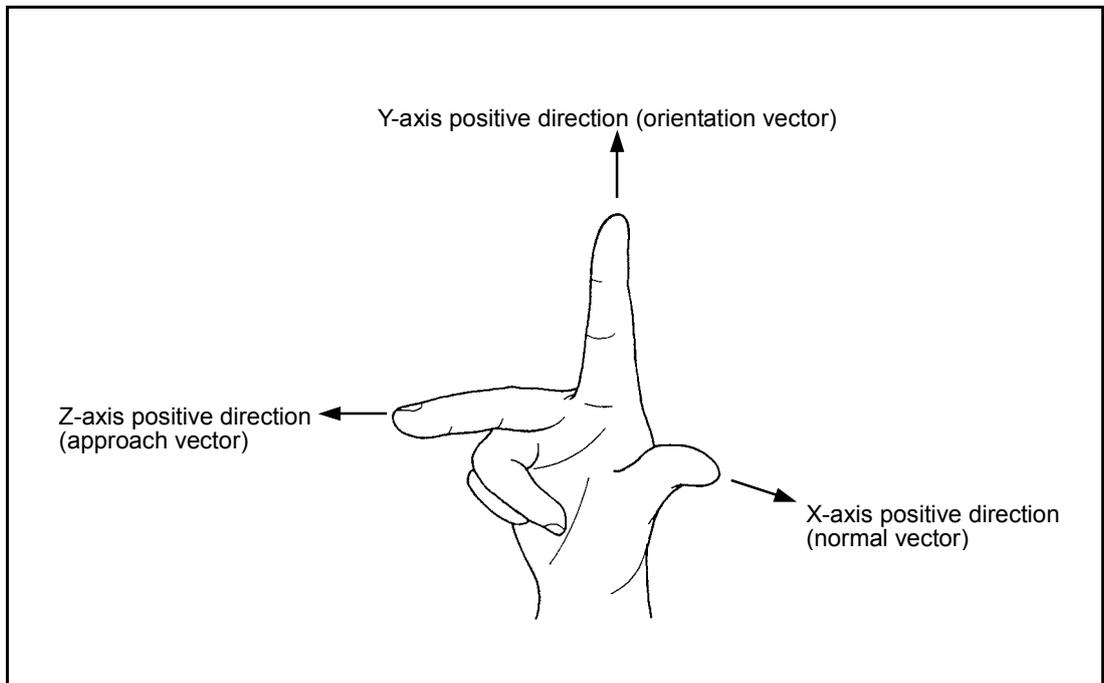
For further information, see the PROGRAMMER'S MANUAL (I) (T03) Section 4.7 "Setting the Master Control Parameters in User Preferences." For the setting procedure, refer to the SETTING-UP MANUAL (T03), Section 2.7 "Setting the Master Control Parameters of the Payload, Center of Gravity, and Control Set of Motion Optimization."

The payload center of gravity is represented by the TOOL0 coordinate system (see the 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 $\phi 5H7$ 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 (T03), Section 2.8, "Setting the Robot Installation Condition" and the PROGRAMMER'S MANUAL (I) (T03), Section 4.7.3 "Setting Robot Installation Conditions."

Chapter 3 Maintenance and Inspection

3.1 Maintenance & Inspection Intervals and Purposes

Carry out the maintenance and inspection jobs show in the table below.

 **Caution: 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

No.	Intervals		Purposes
1	Daily	Perform inspection jobs specified in <u>Section 3.2</u> every day before starting operations.	To use your robot safely.
2	Quarterly	Perform inspection jobs specified in <u>Section 3.3</u> 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 <u>Section 3.4</u> every two years.	To retain the robot-specific data (programs, parameters, etc.) stored in the internal memory of the robot controller and the position data stored in the electronic absolute encoder build in the robot unit.
4	Five-yearly	Perform inspection jobs specified in <u>Section 3.5</u> every five years.	To retain the data stored in the PC10P board.

3.2 Daily Inspections

3.2.1 Check Items

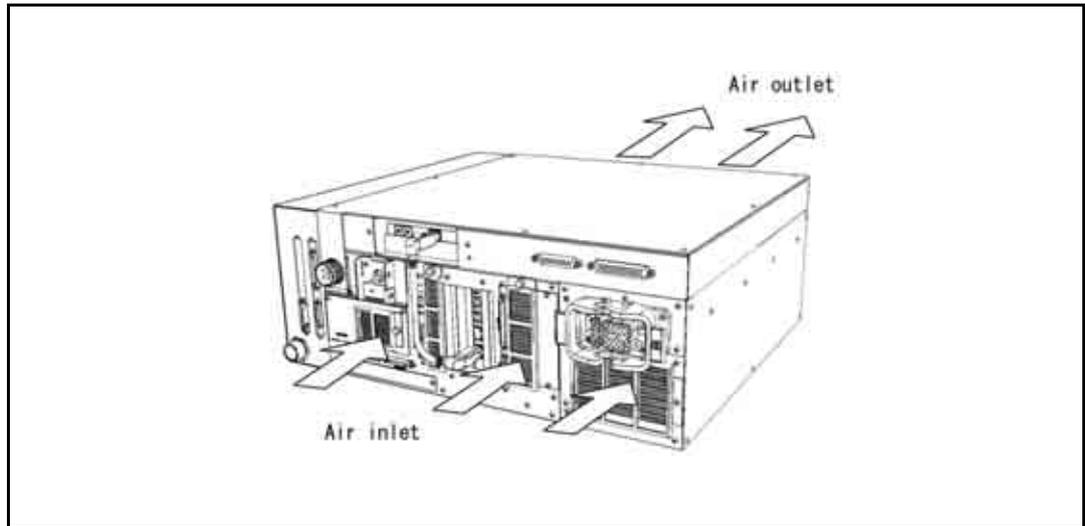
Before starting operation every day, check the items listed in the table below.

Daily Inspections Table

No.	Check:	Controller Power	How to check:	Criterion	What to do: (Note 1)
1	Connectors (CN1 to CN23 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 CN23 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 buttons on the teach pendant and the operation panel	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	Brake release switch	OFF	Check for looseness.	No looseness.	Tighten up.
9	Motor ON lamp on the robot unit	ON	Visually	They should light when the motor is ON.	Inspect and repair.

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 figure on the next page.



Normal Operation of Cooling Fan (VS-G-T series)

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: 70±14 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 (T03), Section 3.4 "Cleaning the Air Intake Filter."

3.4 Biennial Inspections

3.4.1 Battery Replacement

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

⚠ 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.

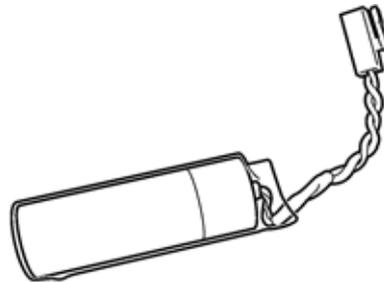
Biennial Inspection Table (VS-G-T series)

No.	Check:	Controller Power	How to check:	Criterion	What to do:
1	Timing belts on the 5th and 6th axes				Please contact your DENSO representative to inspect timing belts and to adjust them.

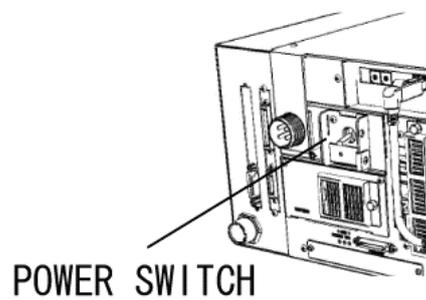
3.4.2 Replacing the Encoder Backup Battery

Replace the encoder backup battery according to the procedure below.

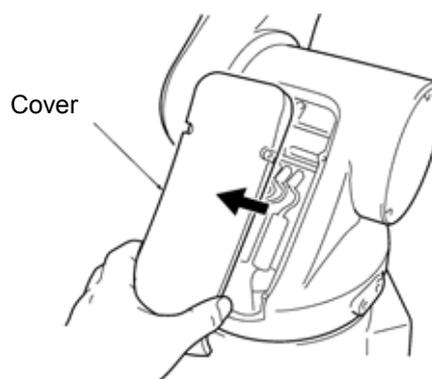
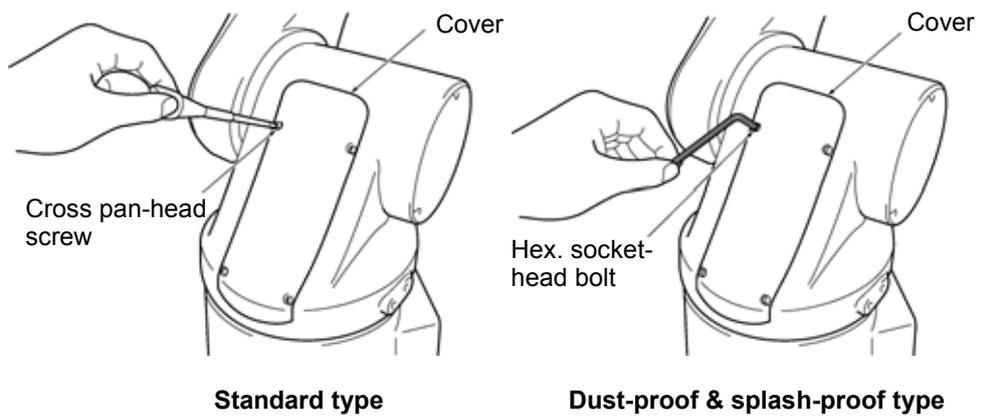
Step 1 Prepare a new set of 3 backup batteries for replacement.



Step 2 Turn the controller power OFF.

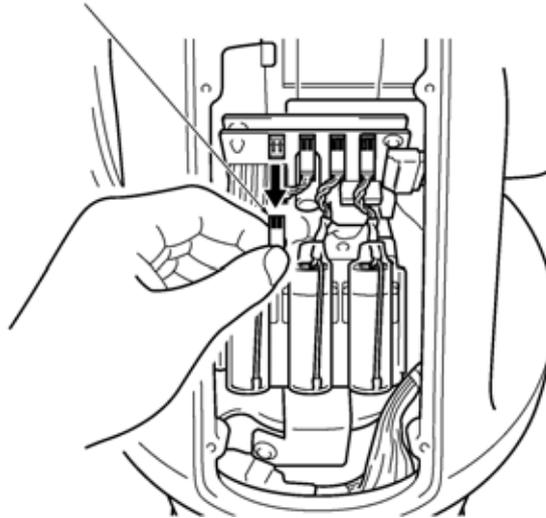


Step 3 Remove the cover from the robot unit.

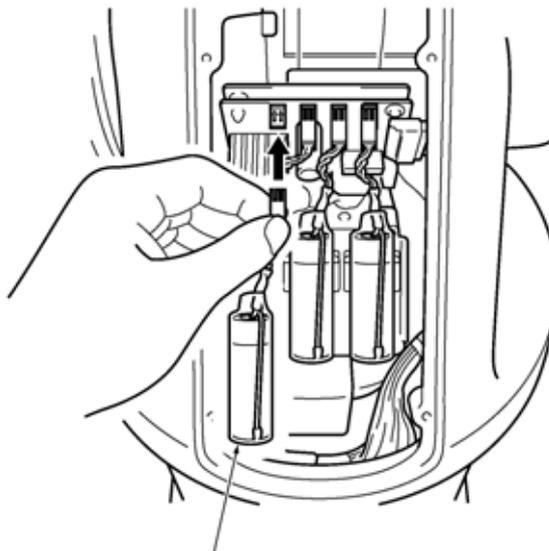


Step 4 Remove the dummy connector cap from the battery board.

Dummy connector cap



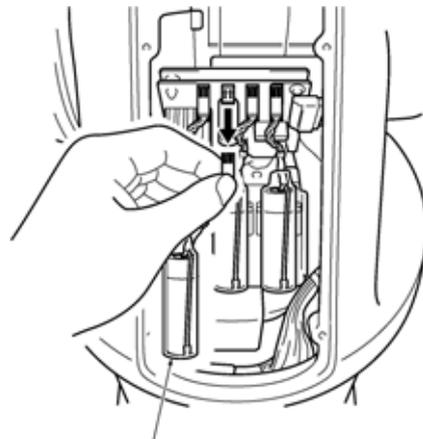
Step 5 Connect a new battery (1st one) to the pin from which you have disconnected the dummy connector cap in Step 4.



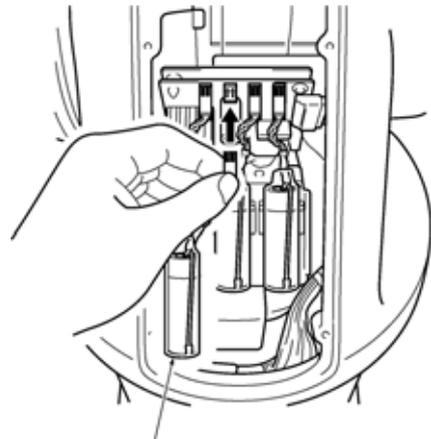
New backup battery

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 6 Disconnect the old backup battery that is right next to the new battery connected in Step 5, and then connect a new battery (2nd one).

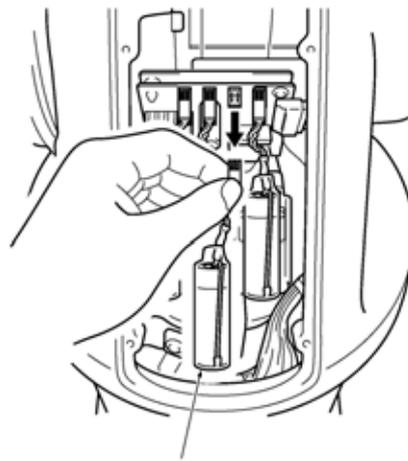


Old backup battery

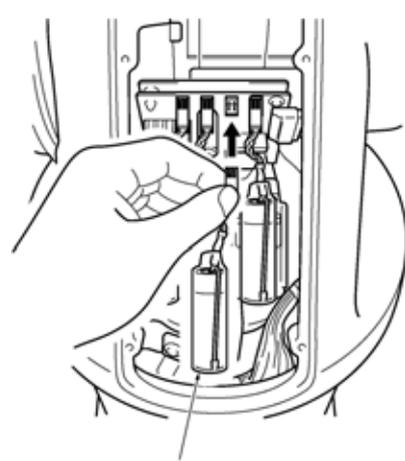


New backup battery

Step 7 Disconnect the old backup battery that is right next to the new battery connected in Step 6, and then connect a new battery (3rd one).



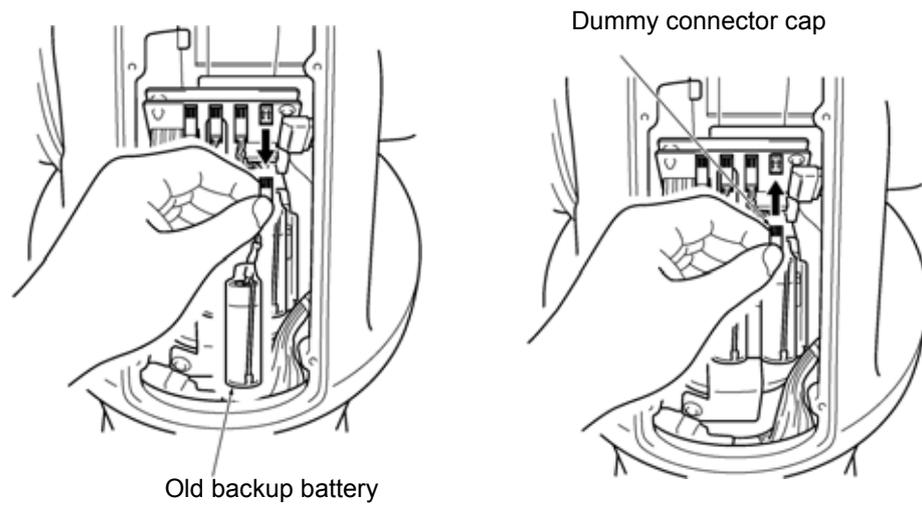
Old backup battery



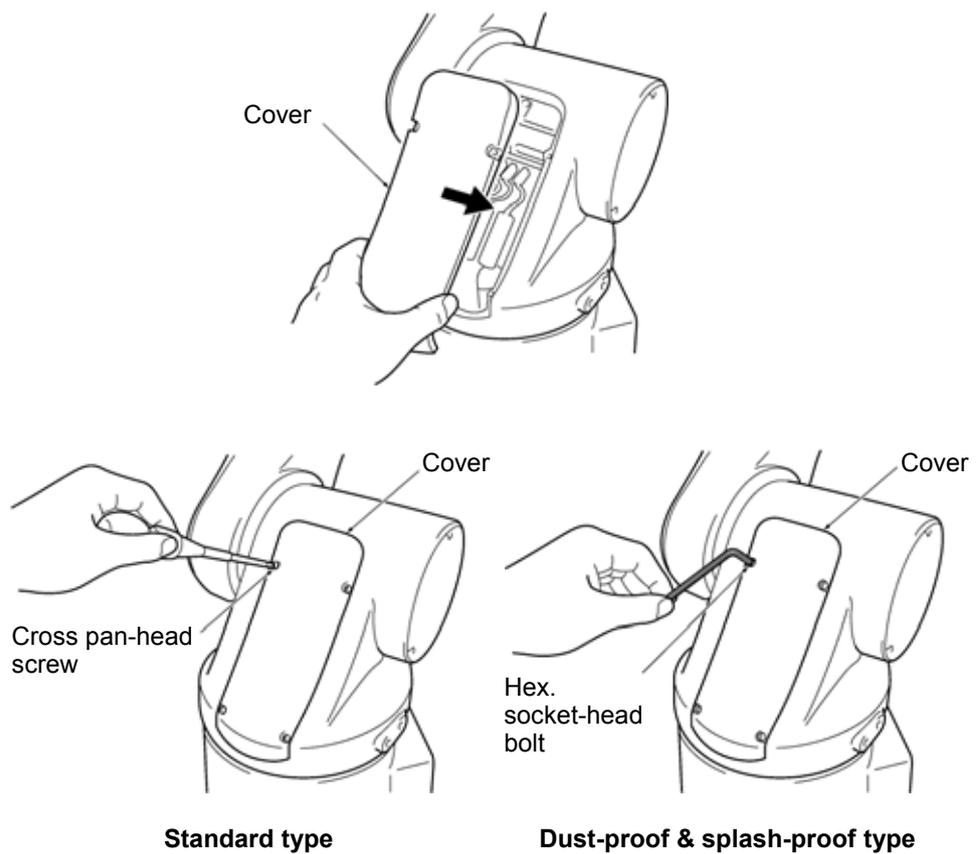
New backup battery

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

Step 8 Remove the last old battery and connect the dummy connector cap disconnected in Step 4.



Step 9 Install the cover to the robot unit.



Tightening torque:

Cross pan-head screw: 0.59 Nm (Standard type)

Hex. socket-head bolt: 2.0 Nm (Dust-proof, splash-proof type)

3.4.3 Replacing the Memory Backup Battery

For the replacing procedures of the memory backup battery, refer to the RC7M CONTROLLER MANUAL (T03), Section 3.5 "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 | **Switch the teach pendant to the extended screen.**

Step 2 | **On the extended screen, press [Set].**
The Settings (Main) window appears.

Step 3 | **Press [Maint.] in the Settings (Main) window.**
The Maintenance menu appears.

Step 4 | **Press [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 5 | **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 6 | **Press OK.**
The screen returns to the Settings (Main) window.

3.5 Five-yearly Inspections

For the replacement procedure of the PC10P backup battery in the controller, refer to the RC7M Controller Manual, "Replacing the PC10P Backup Battery."

3.6 Supplies and Tools for Maintenance

The table below shows the supplies and tools for maintenance.

 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.
--

Supplies and Tools for Maintenance

No	Name	Part No.	Remarks
1	Air filter set	410053-0110	For global type of controllers (FS-1705)
2	Memory backup battery	410076-0260	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 (PNP)	410077-0020	IC (M54564P) for controller output
6	Encoder backup battery set	410611-0070	3-battery set
7	CALSET jig	410192-0010	For 6th-axis CALSET
8	PC10P Backup Battery	Prepared by customer	Lithium rechargeable battery (JTEKT Corporation : TIP-5426)

3.7 Replacing Fuses and Output ICs

For the replacing procedures of the fuses and output ICs, refer to the RC7M CONTROLLER MANUAL (T03), Section 3.7 "Replacing Fuses and Output ICs."

3.8 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.

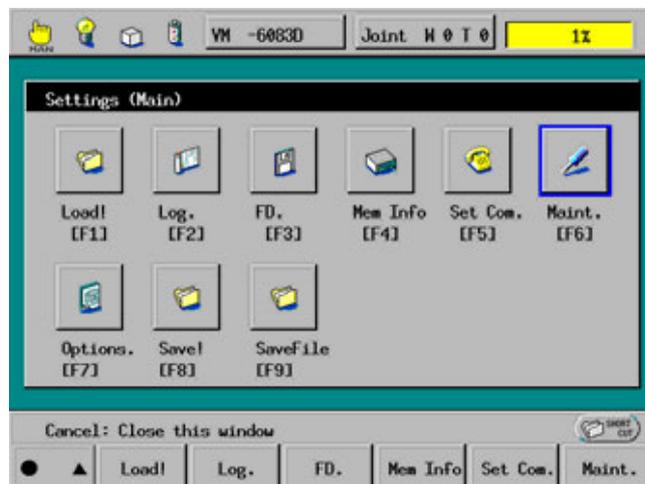
The access to the Odometer window is [ExtScrn]—[Set]—[Maint.]—[Odometer].

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 [Reset] in the Odometer window and following the guidance shown on the screen.
-

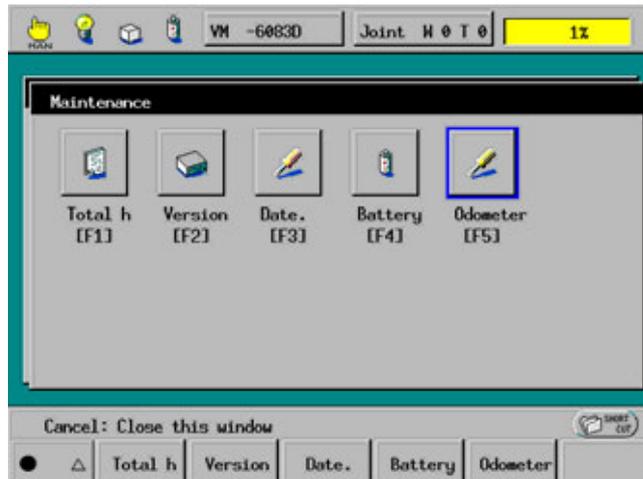
3.8.1 Displaying the Odometer, Trip Meter, and Oil Change Intervals

- Step 1** Turn the controller power ON.
- Step 2** Turn the manual/auto selector switch to the manual position.
- Step 3** Switch the teach pendant to the extended screen.
- Step 4** On the extended screen, press [Set].
The Settings (Main) window appears as shown below.



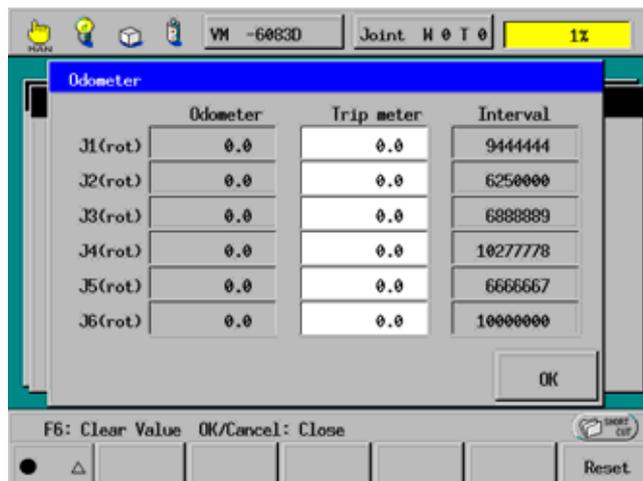
Press [Maint.].

Step 5 The Maintenance menu appears as shown below.



Press [Odometer].

Step 6 The Odometer window appears as shown below.

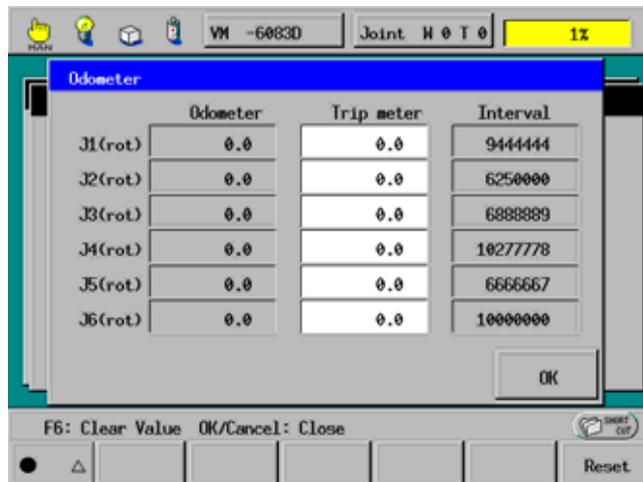


In the above Odometer window, the J1 through J6 are expressed in rpm. If the Trip meter count exceeds the Interval value, the oil change prompt message will appear.

While holding down the ENABLE key, press the CLOSE key to return to the top screen.

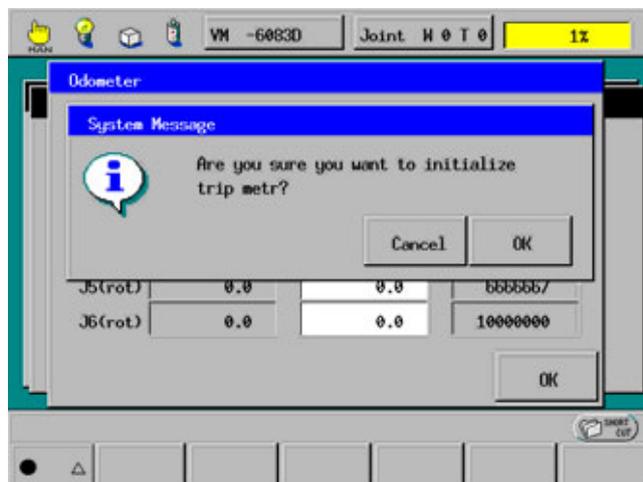
3.8.2 Resetting the Trip Meter to Zero

- Step 1** Display the Odometer window as shown below.
Access: [ExtScrn]—[Set]—[Maint.]—[Odometer] from the top screen.



Press [Reset].

- Step 2** The following message appears.



Press the OK button.

The trip meter has been reset to zero.

While holding down the ENABLE key, press the CLOSE key to return to the top screen.

3.9 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:

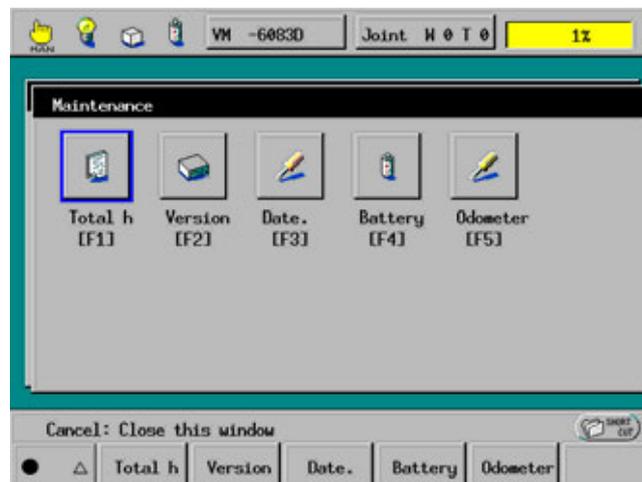
[Total operation]	Shows the grand total of the robot controller ON-time counted after the controller leaves the factory.
[Total running]	Shows the grand total of the robot running time counted after the robot leaves the factory.
[Cumu. operation]	Shows the total of the robot controller ON-time counted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

You can reset the user counters of the robot controller ON-time and the robot running time only.

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

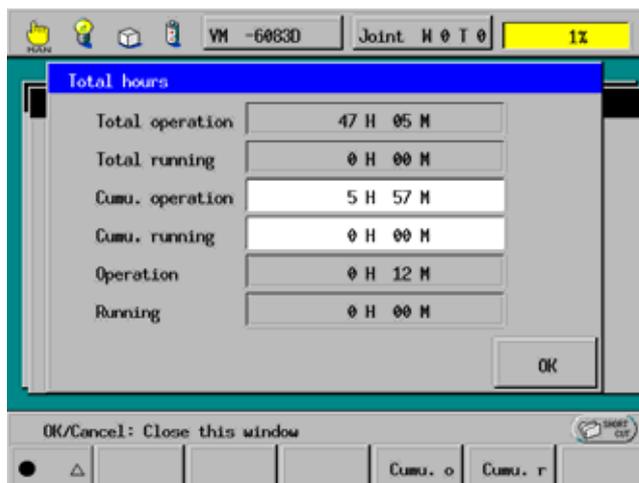
Step 1 Display the Maintenance window as shown below.

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



Press [Total h].

Step 2 The Total hours window appears as shown below.



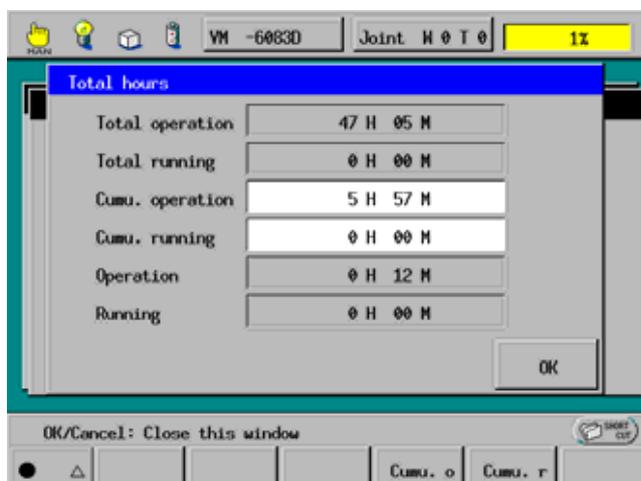
While holding down the **ENABLE** key, press the **CLOSE** key to return to the top screen.

- [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.

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

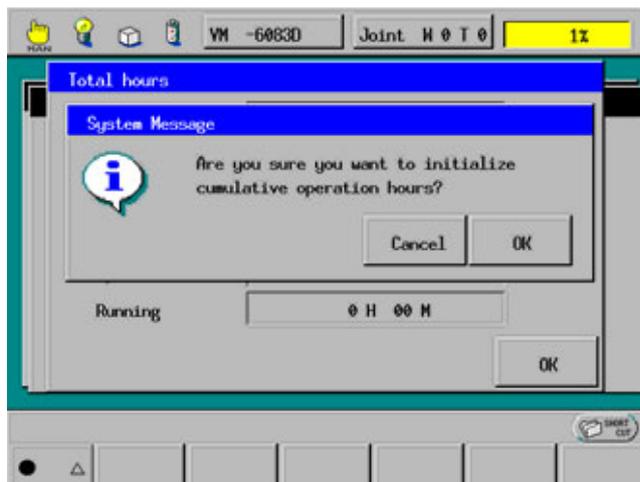
Step 1 Display the Total hours window as shown below.

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



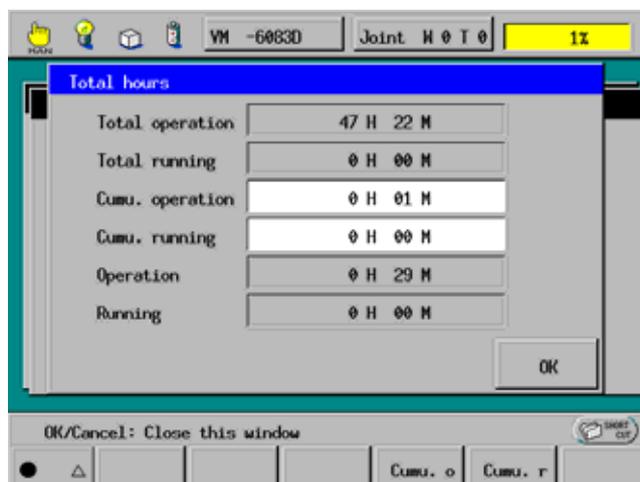
To reset the user counter of the controller ON-time (Cumu.operation), for example, press [Cumu. o].

Step 2 The following system message appears.



Press the OK button.

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



While holding down the ENABLE key, press the CLOSE key to return to the top screen.

3.10 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 (T03), Section 5.3, [ExtScr]-[Arm]-[Maint.]-[ENC rest]".

3.11 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.

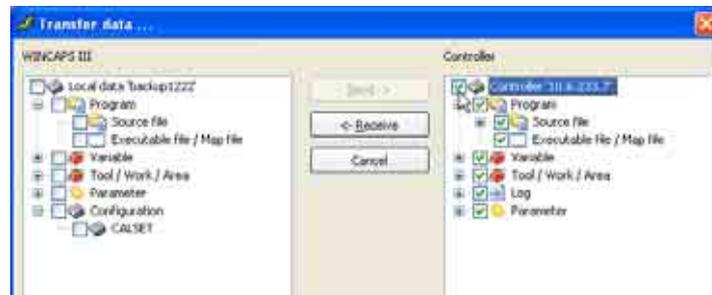
Note **Arm data refers to CALSET and RANG values in project data, which is unique to individual robots and determines the position of each joint.**

3.11.1 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."

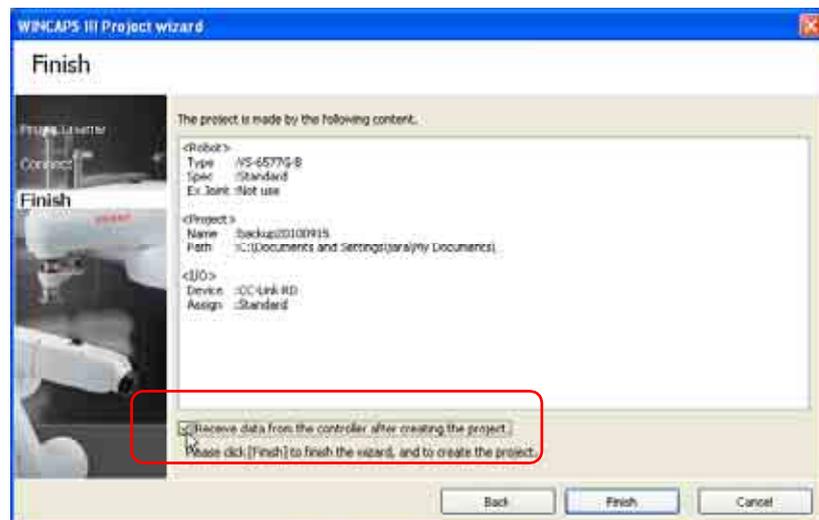


STEP 3

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.

3.11.2 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 VS-G-T SERIES

INSTALLATION & MAINTENANCE GUIDE (T03)

First Edition	May 2007
Third Edition	September 2010
Fourth Edition	August 2011

DENSO WAVE INCORPORATED

8N**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.

