DENSO ROBOT

Vertical articulated

VS-G SERIES

INSTALLATION & MAINTENANCE GUIDE

Preface

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

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

Robot series and/or models covered by this manual

Series	Model
Mini-sized, vertical articulated VS-G (Models configured with RC7M controller)	VS-6556G (6-axis type) VS-6556E/GM (5-axis type)

NOTE 1: Model names listed above apply to the models of robot systems. The model names of robot units are followed by M. If the robot system model is VS-6556G, for example, the robot unit model is VS-6556E/GM.

Important

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

How the documentation set is organized

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

GENERAL INFORMATION ABOUT ROBOT

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

INSTALLATION & MAINTENANCE GUIDE - this book -

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

STARTUP HANDBOOK

Introduces you to the DENSO robot system and guides you through connecting the robot unit and controller with each other, running the robot with the teach pendant, and making and verifying a program. This manual is a comprehensive guide to starting up your robot system.

SETTING-UP MANUAL

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

For the panel designer functions, refer to the Panel Designer User's Manual (SUPPLEMENT).

WINCAPSIII GUIDE

Provides instructions on how to use the programming support tool WINCAPSIII which runs on the PC connected to the robot controller for developing and managing programs.

PROGRAMMER'S MANUAL I, Program Design and Commands

Describes the PAC programming language, program development, and command specifications in PAC. This manual consists of two parts; Part 1 provides the basic programming knowledge, and Part 2, details of individual commands.

PROGRAMMER'S MANUAL II, PAC Library

Describes the program libraries that come with WINCAPSIII as standard.

RC7M CONTROLLER MANUAL

Provides the specifications, installation and maintenance of the RC7M controller. It also describes interfacing with external devices, system- and user-input/output signals, and I/O circuits.

ERROR CODE TABLES

List error codes that will appear on the teach pendant or mini-pendant if an error occurs in the robot system. These tables also provide detailed description and recovery ways.

OPTIONS MANUAL

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

For the extension board "conveyer tracking board," refer to the OPTIONS MANUAL (SUPPLEMENT).

How this book is organized

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

SAFETY PRECAUTIONS

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

Chapter 1 Installing Robot Components

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

Chapter 2 Customizing Your Robot

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

Chapter 3 Maintenance and Inspection

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

SAFETY PRECAUTIONS

Be sure to observe all of the following safety precautions.

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

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

Terminology and Definitions

Maximum space: Refers to the space which can be swept by the moving parts of the robot as defined by the manufacturer, plus the space which can be swept by the end-effector and the workpiece. (Quoted from the ISO 10218-1:2006.)

Restricted space: Refers to the portion of the maximum space restricted by limiting devices (i.e., mechanical stops) that establish limits which will not be exceeded. (Quoted from the ISO 10218-1:2006.)

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

Operating space: Refers to the portion of the restricted space that is actually used while performing all motions commanded by the task program. (Quoted from the ISO 10218-1:2006.)

Task program: Refers to a set of instructions for motion and auxiliary functions that define the specific intended task of the robot system. (Quoted from the ISO 10218-1:2006.)

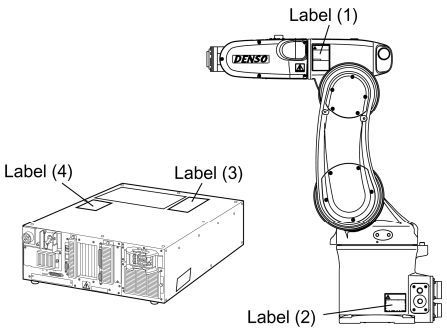
1. Introduction

This section provides safety precautions to be observed for the robot system.

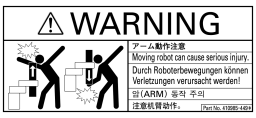
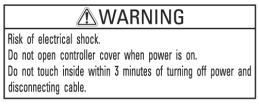
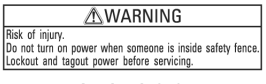
The installation shall be made by qualified personal and should confirm to all national and local codes.

2. Warning Labels

The robot unit and controller have warning labels. These labels alert the user to the danger of the areas on which they are pasted. Be sure to observe the instructions printed on those labels.



(Example: Location of labels)

Warning label	Instructions printed on the label
 Label (1)	Risk of injury. Never enter the restricted space.
<Except HM>  <HM>  Label (2)	<u>For UL-Listed robot units only</u> Risk of injury. This label alerts the user that pressing the brake release switch could drop the arm.
 Label (3)	Risk of electrical shock. Never open the controller cover when the power is on. Never touch the inside of the controller for at least 3 minutes even after turning the power off and disconnecting the power cable.
 Label (4)	Risk of injury. Be sure to perform lockout/tagout before starting servicing. Turning the power ON when a person is inside the safety fence may move the arm, causing injuries.

3. Installation Precautions

3.1 Insuring the proper installation environment

■ **For standard type and cleanroom type**

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

(1) there are flammable gases or liquids,

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

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

(4) there is a mist,

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

■ **For dust- & splash-proof type**

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

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

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

(1) there are any flammable gases or liquids,

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

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

(4) it may likely be submerged in fluid,

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

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

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

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

3.2 Service space

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

3.3 Control devices outside the robot's restricted space

The robot controller, teach pendant and mini-pendant should be installed outside the robot's restricted space and in a place where you can observe all of the robot's movements and operate the robot easily.

3.4 Positioning of gauges

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

3.5 Protection of electrical wiring and hydraulic/pneumatic piping

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

3.6 Grounding resistance

The protective grounding resistance of the robot power supply should not be more than 100Ω.

3.7 Positioning of emergency stop switches

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

(1) The emergency stop switches should be red.

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

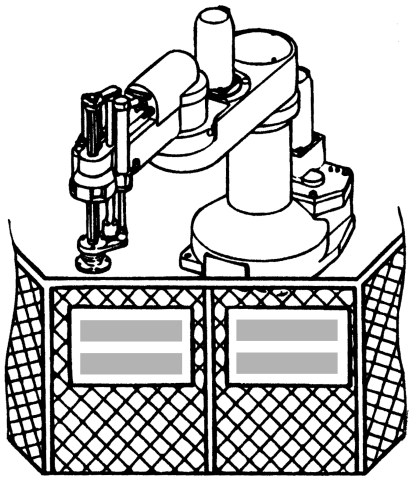
(3) Emergency stop switches should be separate from the power switch.

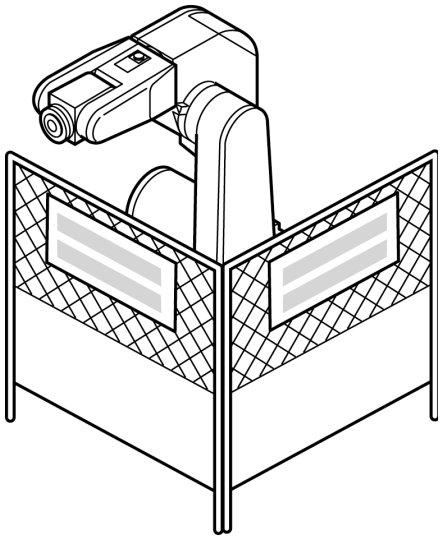
3.8 Positioning of operating status indicators

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

Note: The UL-Listed robot units have motor ON lamps on their robot arms.

3.9 Setting-up a safety fence





A safety fence should be set up so that no one can easily enter the robot's restricted space.

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

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

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

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

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

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

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

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

3.10 Setting the robot's motion space

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

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

Refer to the INSTALLATION & MAINTENANCE GUIDE, Chapter 2.

3.11 No robot modification allowed

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

3.12 Cleaning of tools

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

3.13 Lighting

Sufficient illumination should be assured for safe robot operation.

3.14 Protection from objects thrown by the end-effector

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

3.15 Affixing the warning label

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

3.16 Posting the moving directions of all axes

Post a notice showing axes names and moving directions in a visible location on the robot unit. The posted moving directions should match the actual directions.

No posting or wrong direction posting may result in bodily injuries or property damages due to incorrect operation.

4. Precautions while Robot is Running

⚠ Warning

Touching the robot while it is in operation can lead to serious injury. Please ensure the following conditions are maintained and that the cautions listed from Section 4.1 and onwards are followed when any work is being performed.

1) Do not enter the robot's restricted space when the robot is in operation or when the motor power is on.
2) As a precaution against malfunction, ensure that an emergency stop device is activated to cut the power to the robot motor upon entry into the robot's restricted space.
3) When it is necessary to enter the robot's restricted space to perform teaching or maintenance work while the robot is running, ensure that the steps described in Section 4.3 "Ensuring safety of workers performing jobs within the robot's restricted space" are taken.

4.1 Creation of working regulations and assuring worker adherence

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

(1) Operating procedures required to run the robot.

(2) Robot speed when performing teaching.

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

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

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

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

1) Display of the control panel (See Section 4.2 on the next page.)
2) Assuring the safety of workers performing jobs within the robot's restricted space (See Section 4.3 on the next page.)
3) Maintaining worker position and stance

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

4) Implementation of measures for noise prevention
5) Signaling methods for workers of related equipment
6) Types of malfunctions and how to distinguish them

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

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

4.2 Display of operation panel

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

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

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

(1) Ensure an overseer is placed in a position outside the robot's restricted space and one in which he/she can see all robot movements, and that he/she is devoted solely to that task.
   ① An emergency stop device should be activated immediately upon a malfunction.
   ② Do not permit anyone other than the worker engaged for that job to enter the robot's restricted space.

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

4.4 Inspections before commencing work such as teaching

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

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

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

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

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

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

4.5 Release of residual air pressure

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

4.6 Precautions for test runs

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

4.7 Precautions for automatic operation

(1) At start-up

Stay out of the safeguarded space with a safety fence when starting the robot; in particular, take extra caution in Internal automatic operation.

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

1) Check that there is no one inside the safeguarded space (with a safety fence).
2) Check that the teach pendant and tools are in their designated places.
3) Check that no lamps indicating a malfunction on the robot or related equipment are lit.

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

(3) Steps to be taken when a malfunction occurs

Stop the robot's operation by activating the emergency stop device when it is necessary to enter the safeguarded space with a safety fence to perform emergency maintenance in the case of malfunction of the robots or related equipment.

Take any necessary steps such as posting a notice on the start switch to indicate work is in progress to prevent anyone from accessing the robot.

4.8 Precautions in repairs

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

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

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

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

5. Daily and Periodical Inspections

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

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

6. Management of Floppy Disks

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

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

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

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

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

7. Safety Codes

The safety standards relating to robot systems are listed below.

As well as observing the safety precautions given in this manual, ensure compliance with all local and national safety and electrical codes for the installation and operation of the robot system.

Standards	Title
ANSI/RIA R15.06-1999	Industrial Robots and Robot Systems--Safety Requirements
ANSI/UL1740: 1998	Safety for Robots and Robotic Equipment
CAN/CSA Z434-03	Industrial Robots and Robot Systems--General Safety Requirements
ISO10218-1: 2006	Robots for industrial environments--Safety requirements--Part 1: Robot
NFPA 79: 2002	Electrical Standard for Industrial Machinery

8. Battery Recycling

DENSO Robot uses lithium batteries.

Discard batteries according to your local and national recycling law.

廢電池請回收

EU

Contents

Chapter 1 Installing Robot Components

1.1 Preparing a Proper Environment for Installation

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

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

1.1.1 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.

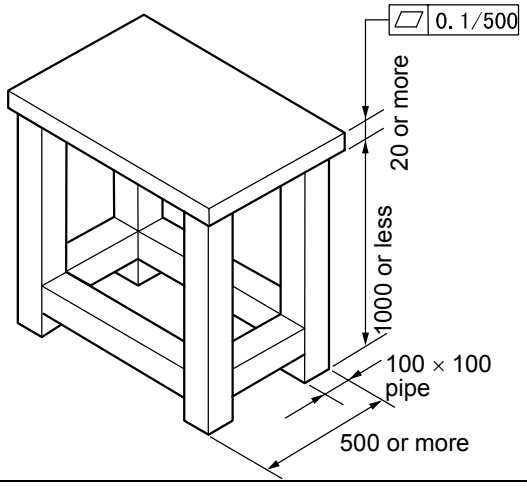
1.1.4 Installation Environment of the Robot Unit

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

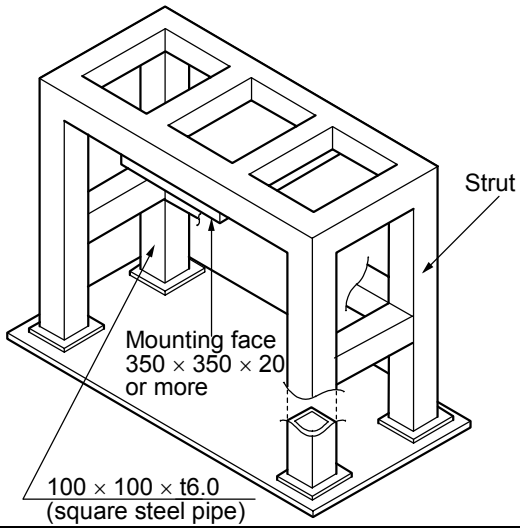
Item	Environments and Conditions
Flatness of the mount	0.1/500 mm (See the upper figure on the next page.)
Rigidity of the mount	Use steel materials. (See the figure on the next page.)
Installation type	Floor-mount or Overhead-mount
Ambient temperature	During operation: 0 to 40°C During storage and transportation: -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.	• 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

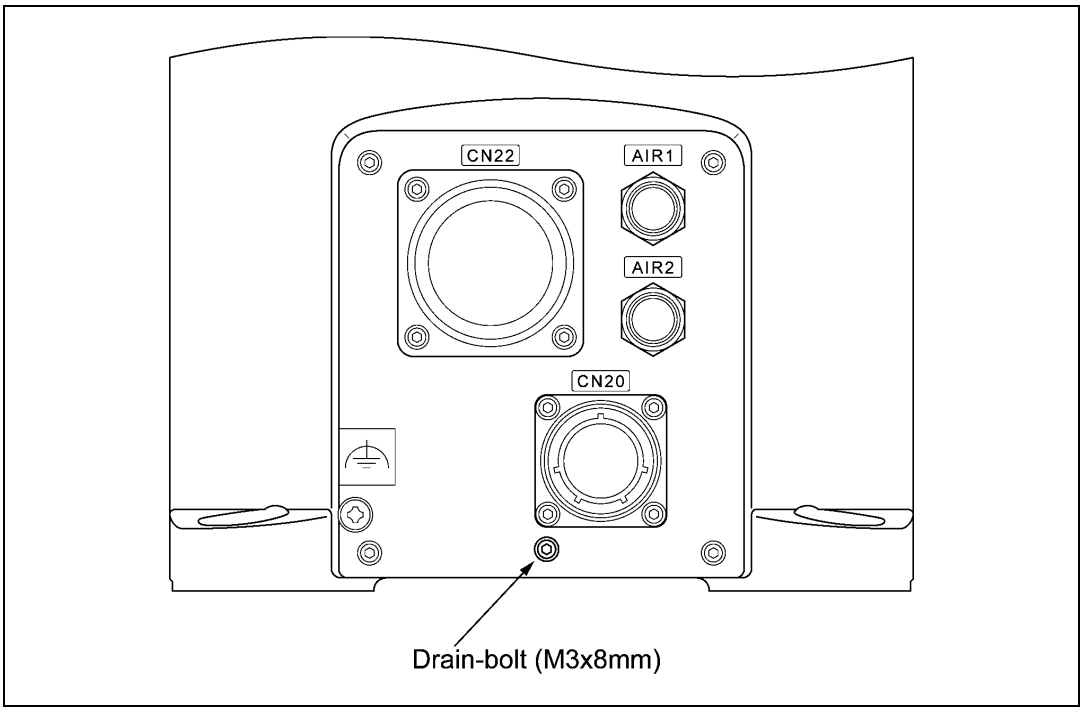
1.2 Mounting the Robot Unit

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

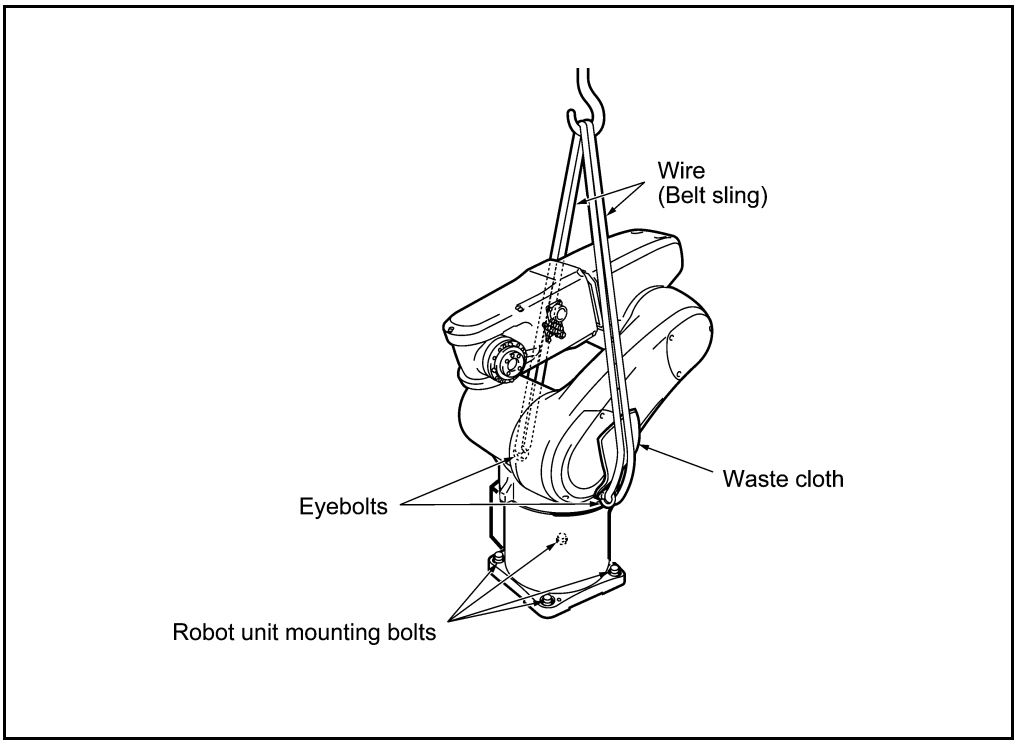
(1) Precautions in transporting the robot

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

Have at least two workers handle this job.

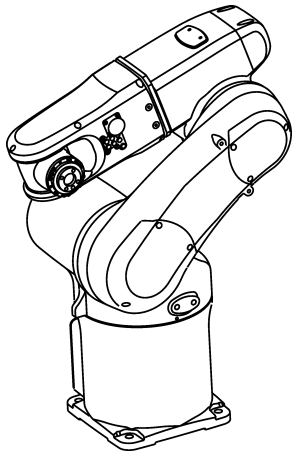
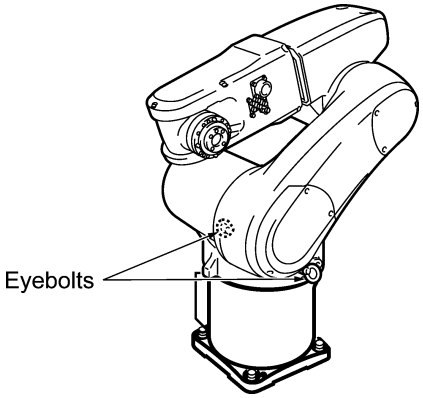
Workers should wear helmets, safety shoes, and gloves during transport.

> **⚠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.**

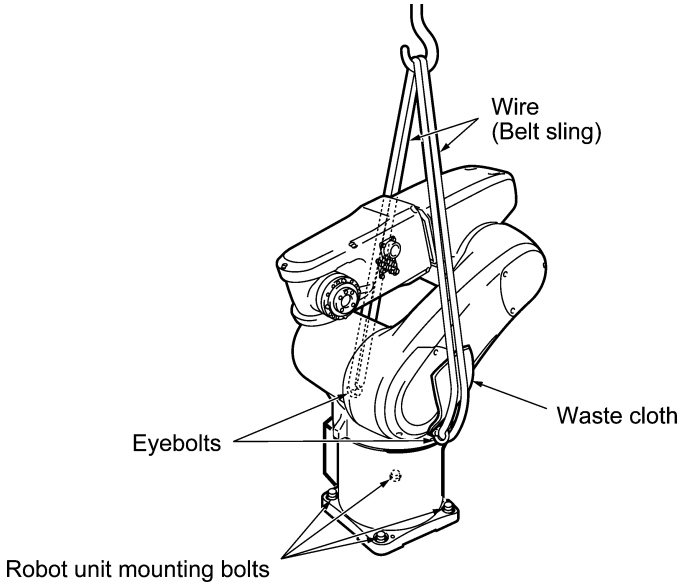


Hoisting Points for Transportation (VS-G series)

(2) Transporting the robot unit

<table>
<tr><th>No.</th><th>Procedure</th><th>Explanatory Illustration</th></tr>
<tr><td>1</td><td>Before transportation, set the robot in a transport position as shown at right by manually moving the second, third and fourth axes.
When unpacked first, the robot is in the transport position, so this job is not required.</td><td> 
Transport Position
<table>
<tr><th>Axis</th><th>Angle</th></tr>
<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>
</table></td></tr>
<tr><td>2</td><td>Disconnect the robot control cable, air piping and user signal cables from the robot unit.
When the robot unit is first unpacked, this job is not required.</td><td></td></tr>
<tr><td>3</td><td>As shown at right, mount the eyebolts.
When delivered, the robot unit is packed with eyebolts attached, so this job is not required.</td><td> 

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

No.	Procedure	Explanatory Illustration
4	As shown at right, place a waste cloth on the second arm and pass the wire through the two eyebolts.	 **Hoisting the Robot Unit**
5	Worker A: Remove the four bolts while supporting the robot unit to prevent it from getting overturned.	
6	Worker B: Operate the crane and move the robot unit to the target site.	
7	Worker B: Put the robot unit down in the target position. Worker A: Temporarily secure the robot unit with four bolts.	
8	Secure the robot unit according to the instructions in 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 (ϕ4, H7 for diamond shaped pin, and ϕ6H7 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.

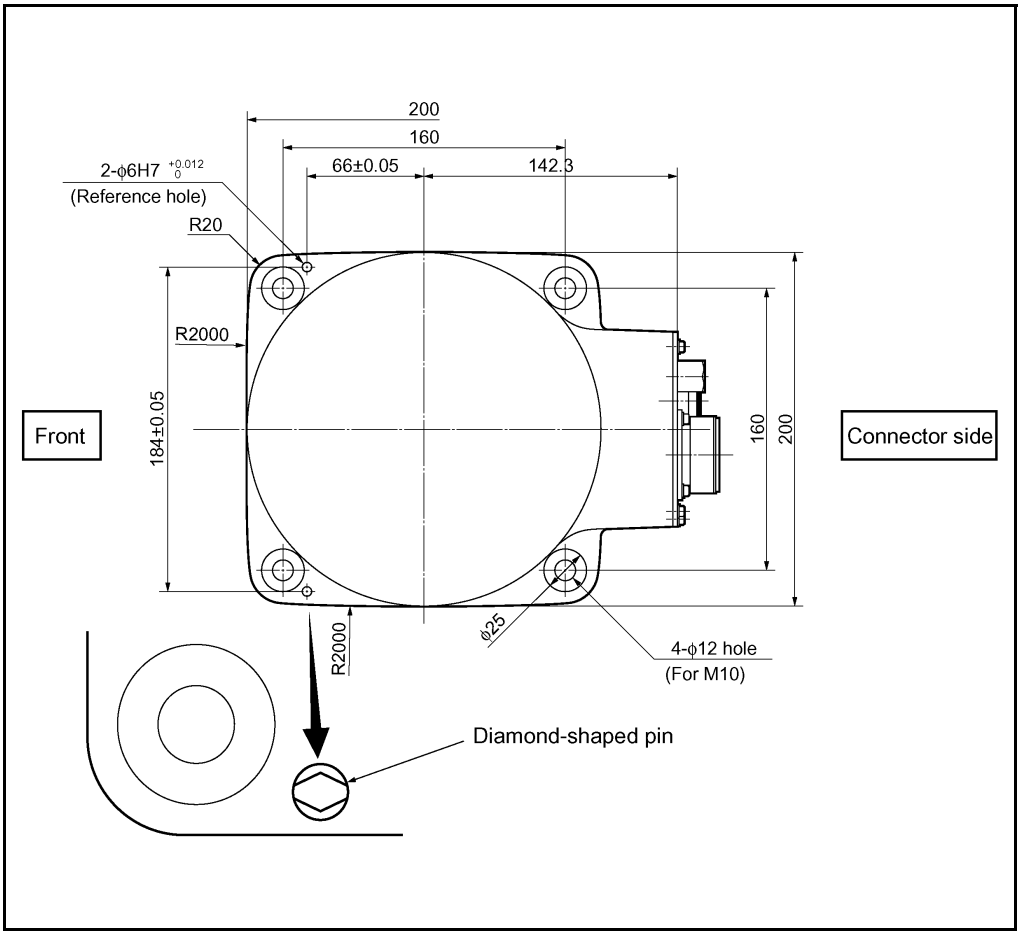
(2) Drive the diamond-shaped pin into the ϕ4H7 hole so that it orients as shown below.

(3) Drive the internally threaded positioning pin into the ϕ6H7 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 × 30 mm (strength class: 12.9)
· Tightening torque: 70 ±14 Nm

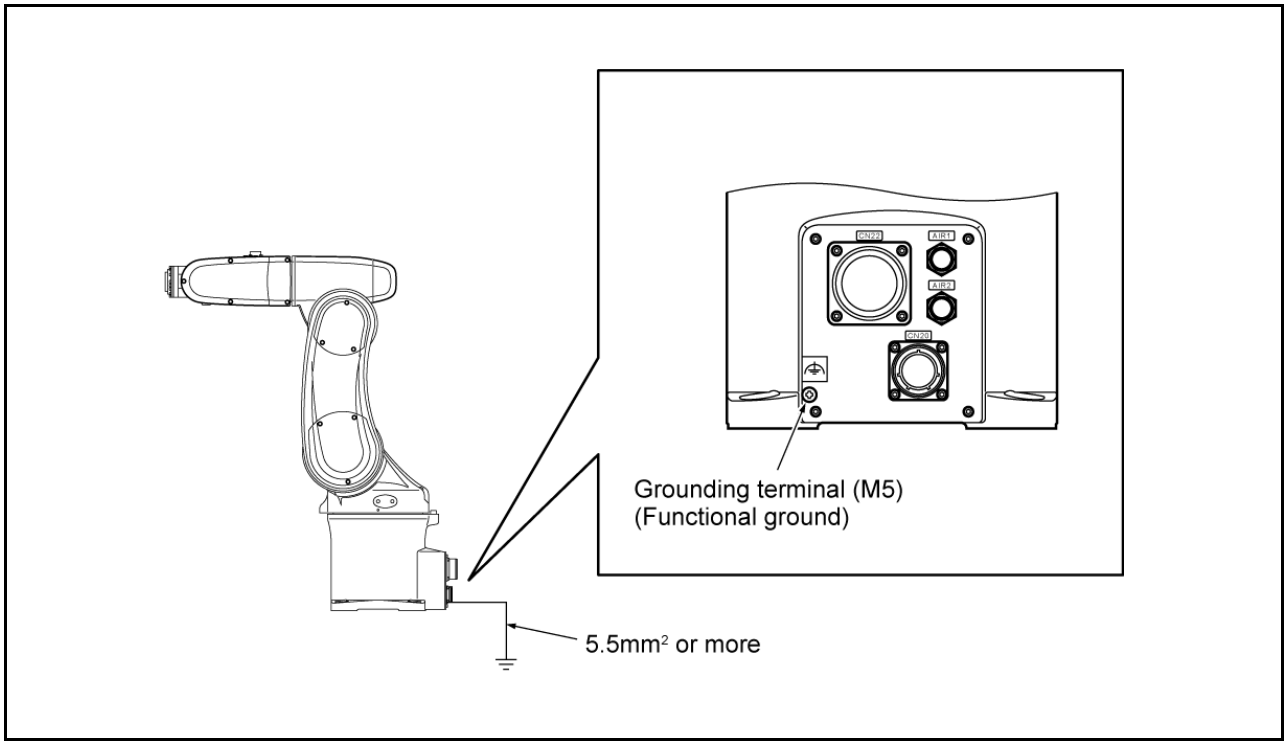


Bolt Positions for Securing the Robot Unit (VS-G series)

1.2.4 Grounding the Robot Unit

Ground the grounding terminal of the robot unit with a wire of 5.5 mm^2 or more.

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



Grounding the Robot Unit (VS-G series)

1.3 Installing the Robot Controller

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

1.4 Cautions for Designing the Robot Hand

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

1.5 Moving Each Axis with Motor Power OFF in Emergency Stop

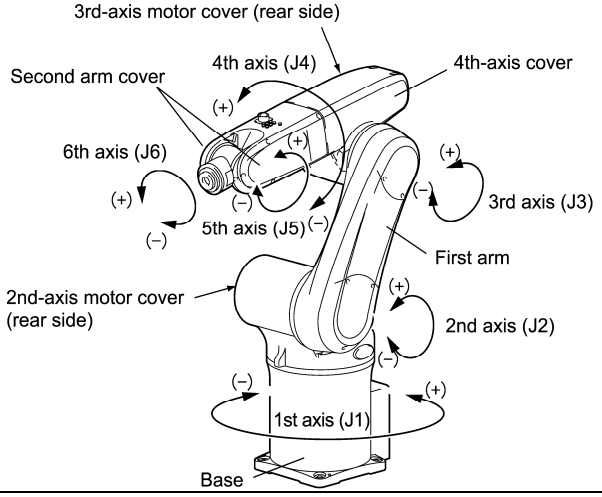
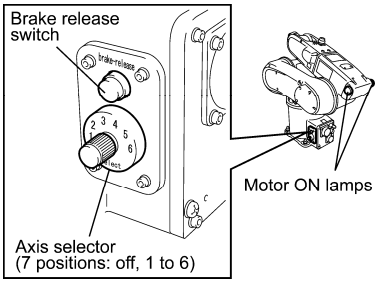
The table below shows which axes have a brake in the VS-G series of robot units. The brake releasing operation on UL-Listed robot units is different from that on other types.

Robot unit	Model	Axes with brake	How to release brake
Without brake	VS-G VS-G-W	2nd to 4th axes	With the teach pendant or mini-pendant Access: [F2 Arm]—[F12 Maint.]—[F3 Brake.] on the teach pendant For details, refer to the SETTING-UP MANUAL, Chapter 5 "Commands Assigned to Function Keys of the Teach Pendant" and Chapter 6 "Using the Mini-Pendant."
With brake	VS-G-B VS-G-BW	2nd to 6th axes	
UL-Listed	VS-GW-UL	All axes	With the brake release switch (For details, refer to Section 1.6 "Releasing Brakes on UL-Listed Robot Units.") Note: The teach pendant or mini-pendant cannot release the 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

<table>
<tr><td rowspan="2">Axis</td><td colspan="3">How to move the axes</td></tr>
<tr><td>VS-G, VS-G-W</td><td>VS-G-B, VS-G-BW</td><td>VS-GW-UL</td></tr>
<tr><td>1st axis</td><td>Move the robot arm by hand.</td><td>Move the robot arm by hand.</td><td rowspan="6">Select the target axis with the axis selector, and then move the axis by hand while holding down the brake release switch.
(For details, refer to Section 1.6 "Releasing Brakes on UL-Listed Robot Units.")</td></tr>
<tr><td>2nd axis</td><td rowspan="3">Release the brake with the teach pendant or mini-pendant, and then move the robot arm by hand.</td><td rowspan="5">Release the brake with the teach pendant or mini-pendant, and then move the robot arm by hand.
(For details, refer to the SETTING-UP MANUAL, Chapter 5 "Commands Assigned to Function Keys of the Teach Pendant" and Chapter 6 "Using the Mini-Pendant.")</td></tr>
<tr><td>3rd axis</td></tr>
<tr><td>4th axis</td></tr>
<tr><td>5th axis</td><td rowspan="2">Move the robot arm by hand.</td></tr>
<tr><td>6th axis</td></tr>
<tr><td colspan="3"> 
</td><td> 

(UL-Listed)</td></tr>
</table>

1.6 Releasing Brakes on UL-Listed Robot Units

The brake release operation on UL-Listed robot units is different from that on other types. The UL-Listed robot units have the axis selector and the brake release switch on the base for brake releasing.

NOTE: On robot units except UL-Listed ones, the teach pendant or mini-pendant is used to release brakes. Refer to the SETTING-UP MANUAL, Chapter 5 "Commands Assigned to Function Keys of the Teach Pendant" and Chapter 6 "Using the Mini-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.

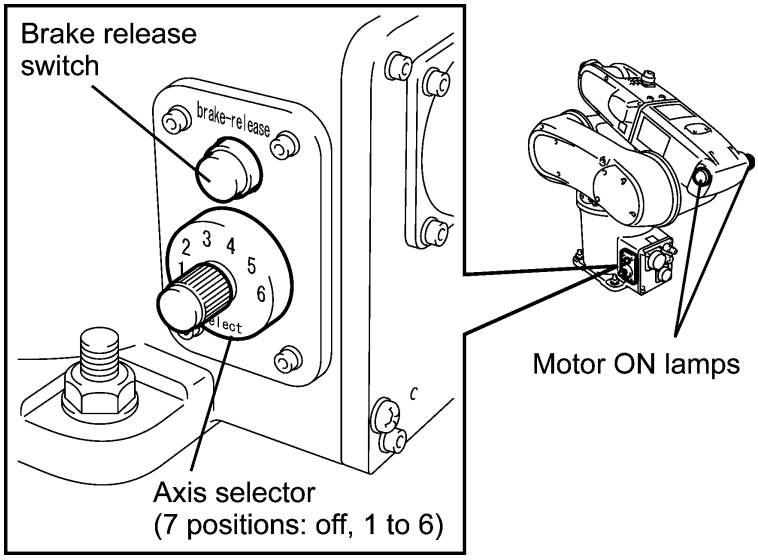
NOTE: Check that the motor ON lamps are not lit (motor power OFF).

STEP 2

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

STEP 3

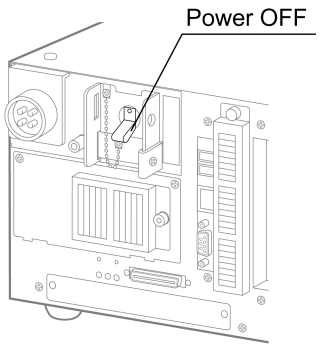
Press the brake release switch. Only when the switch is being pressed, the brake of the selected axis is released.



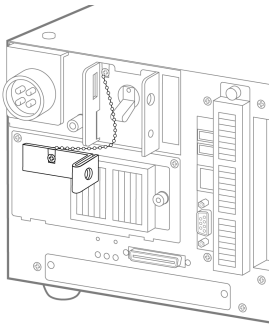
1.7 Locking Out the Power Switch

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

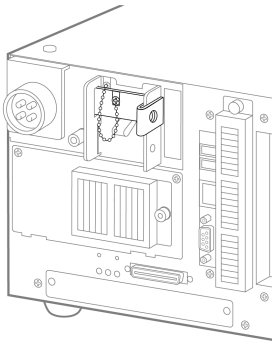
Step 1 **Check that the power switch of the robot controller is turned OFF.**



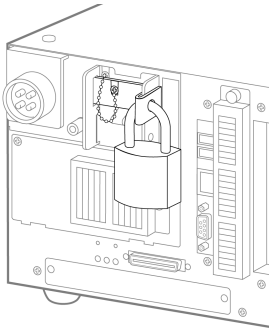
Step 2 **Remove the lockout bar provided on the robot controller.**



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:

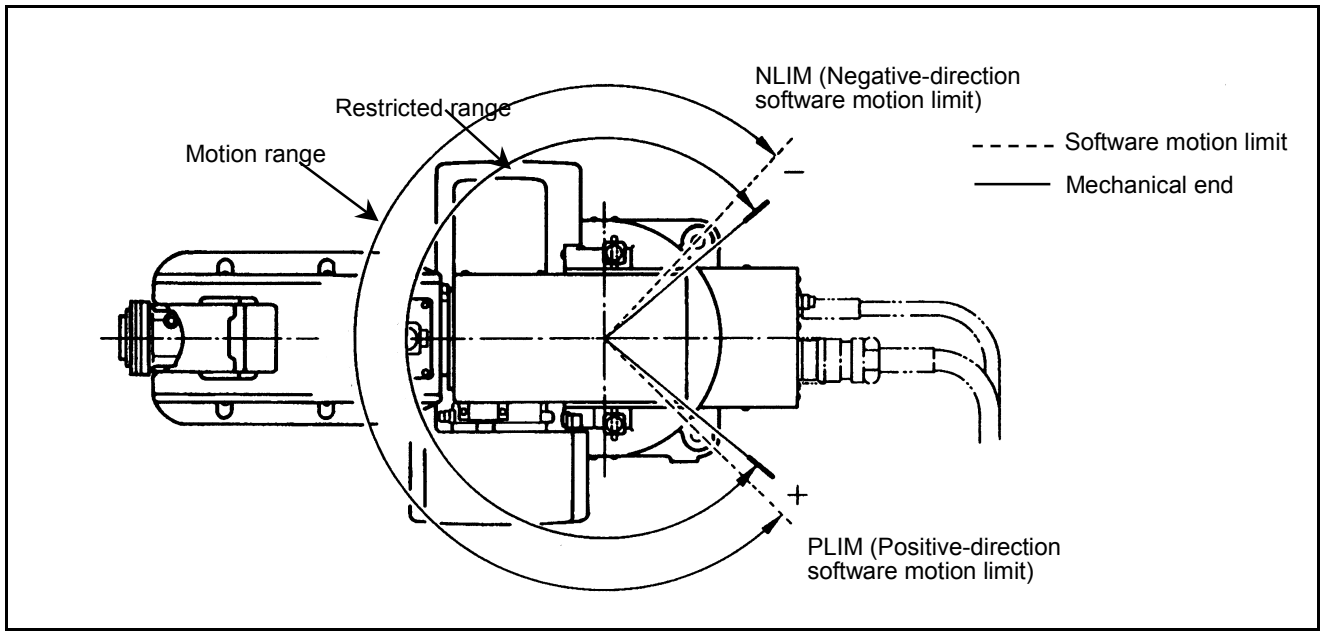
Always set the software motion limits and mechanical ends so that the motion space will be within the restricted space. Otherwise, the robot will bump the mechanical stops, causing serious accidents.

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 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.

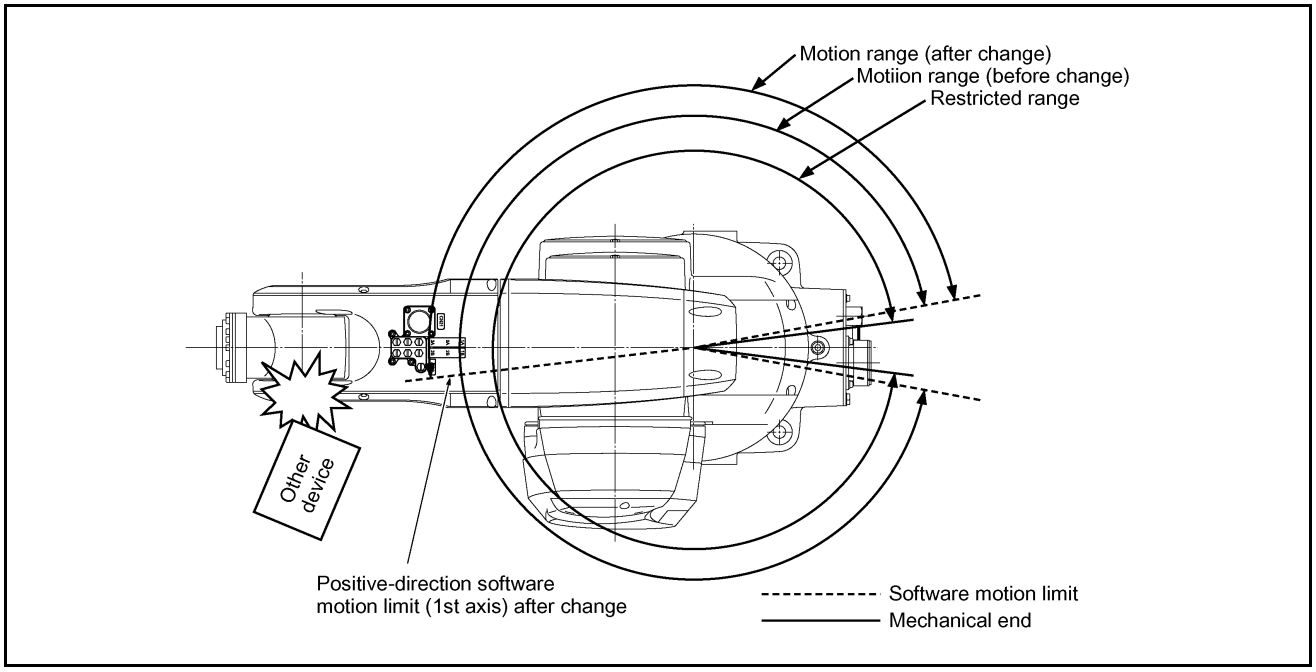
2.2.3 Changing Software Motion Limits

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.

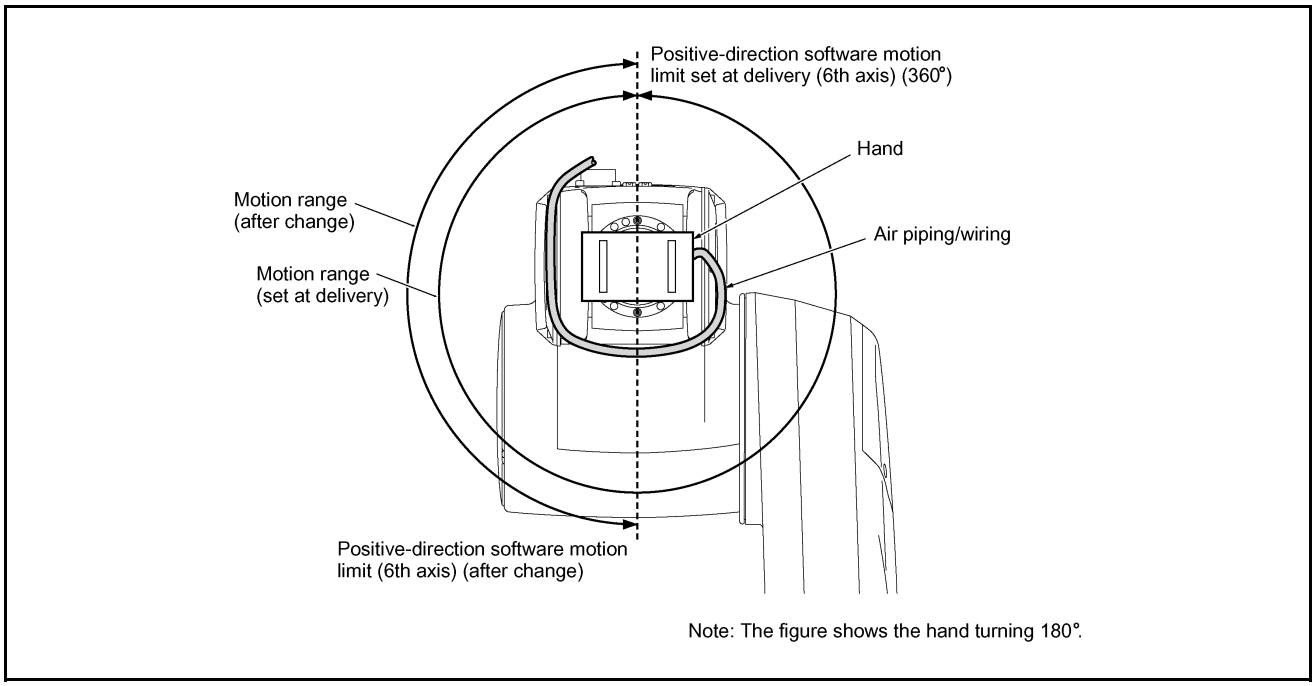
If the air piping or wiring of the end-effector becomes taut as the robot runs, then change the software motion limits to make the motion space smaller as shown in the lower figure on this page.

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

■ VS-G Series



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



Example 2: Changing Software Motion Limits [VS-G 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

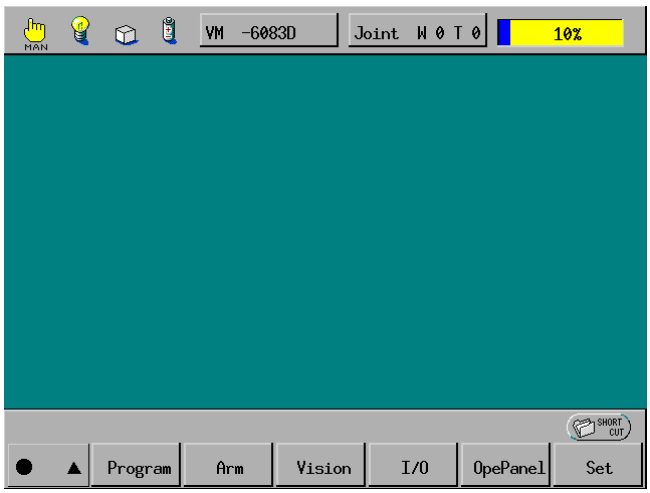
Turn the power switch of the robot controller to ON.

STEP 2

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

STEP 3

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

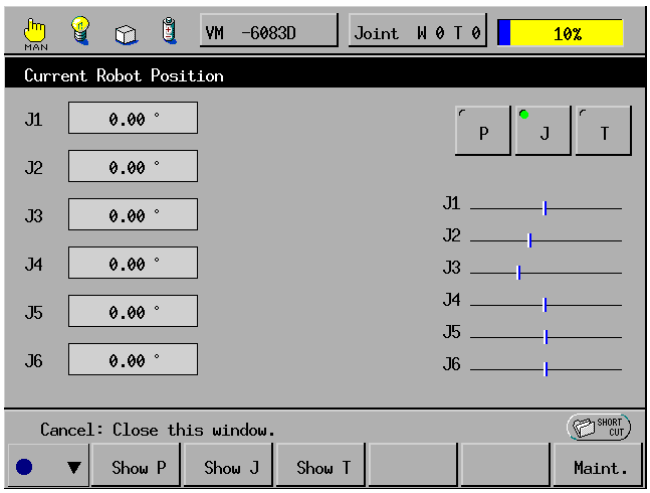


F2

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

STEP 4

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

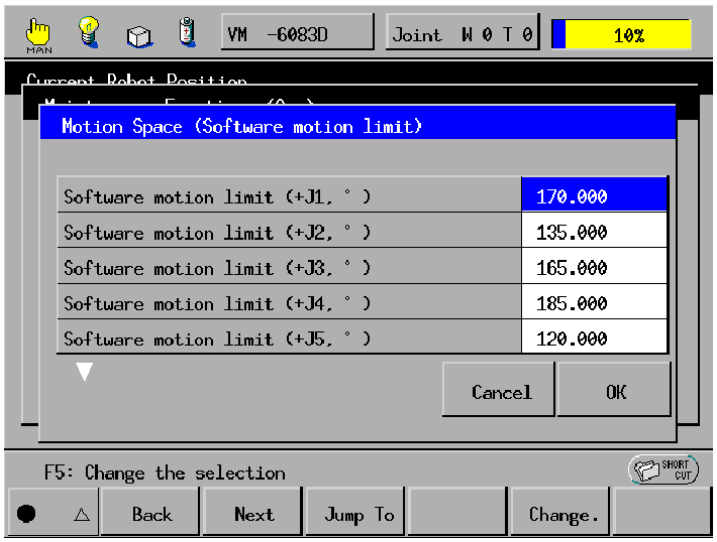


F12

The Maintenance Functions (Arm) window will appear.

STEP 5

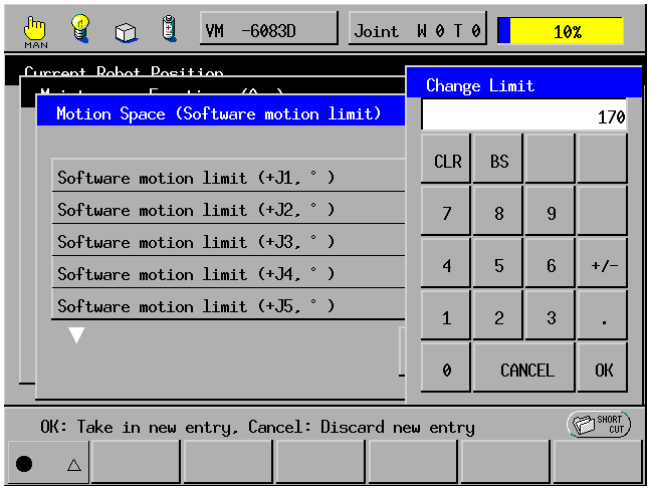
Press [F1 M Space] on the Maintenance Functions (Arm) window.
The Motion Space window will appear as shown below.



F5

STEP 6

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



Enter a desired value using the numeric keys, then press OK.
The new value will be set on the line of the item selected in the Motion Space window.
If two or more items must be changed, repeat Steps 5 and 6.

STEP 7

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

STEP 8

Turn OFF the power to the robot controller.

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

2.3 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 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 series so that the stroke of the 1st axis will be ±170°.

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

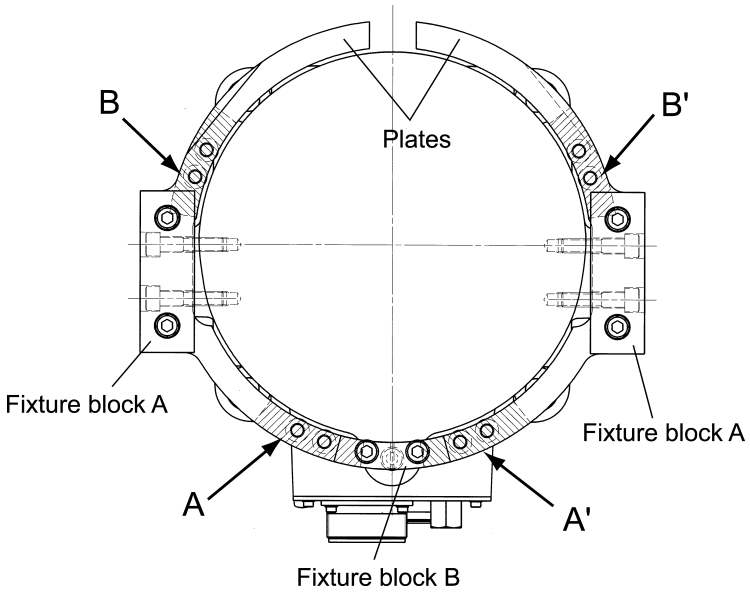
The figure below shows the mechanical stop positions for mechanical end change.

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

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

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

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



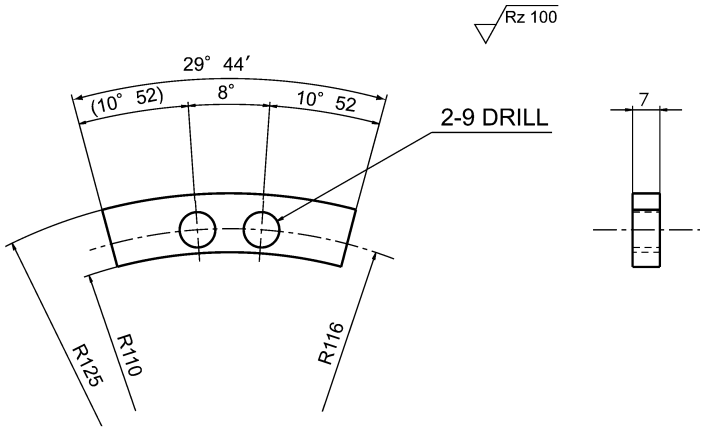
Locations of Mechanical Stops in the VS-G Series

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 series (For 1st-axis)

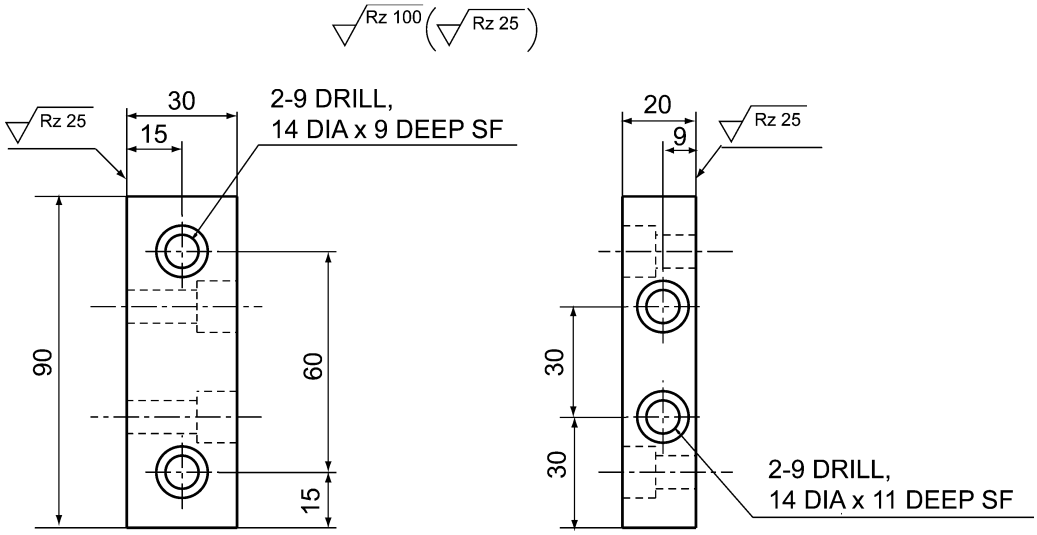


Material: A2017

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

Mechanical Stop

VS-G series (For 1st-axis)

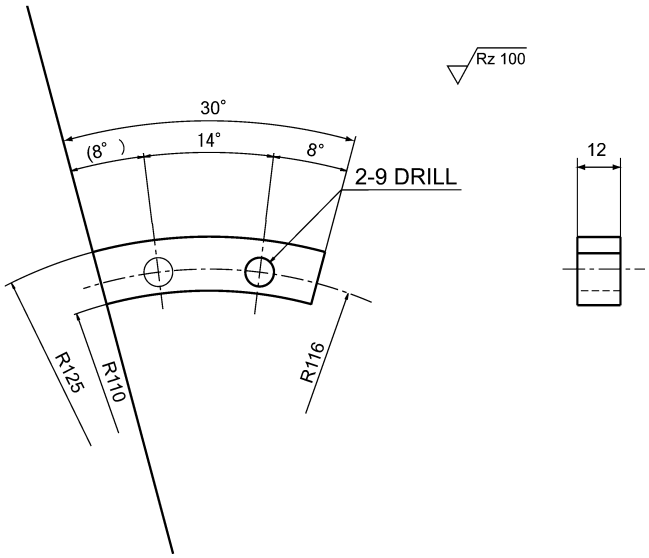


Material: S45C

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

Fixture Block A

VS-G series (For 1st-axis)

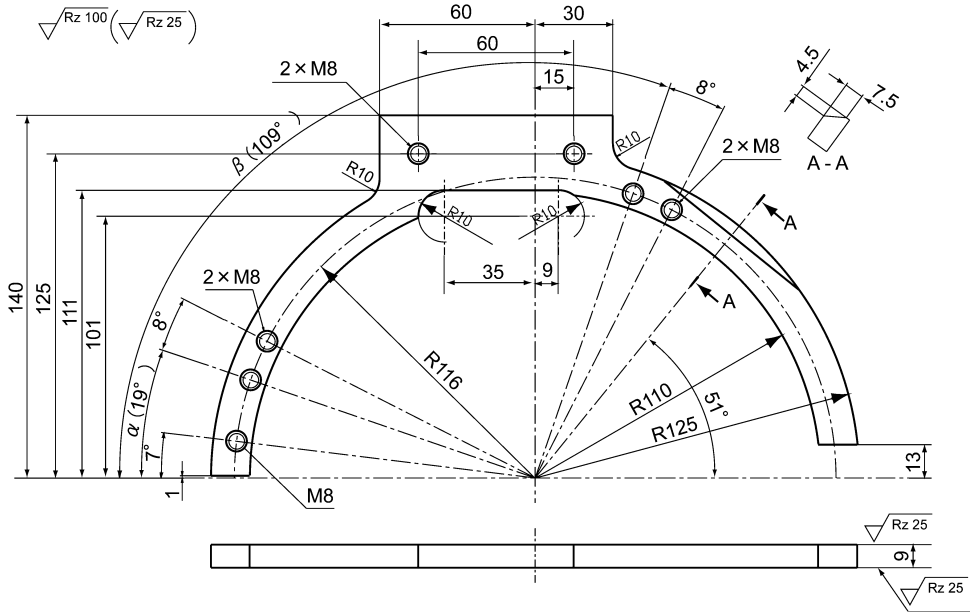


Material: S45C

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

Fixture Block B

VS-G 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 initialization floppy disk holds the factory defaults of the initial RANG values and CALSET values. After performing CALSET, the customer needs to manage the RANG values and CALSET values modified.

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

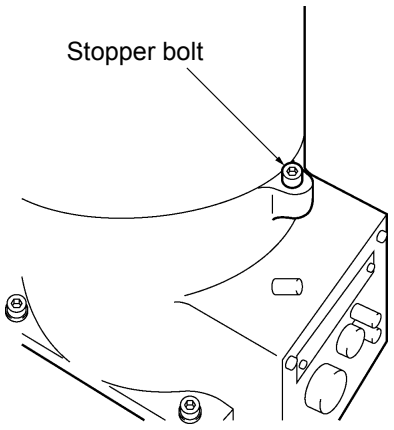
[2] Changing the Mechanical Ends

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

(1) Mounting mechanical stop parts

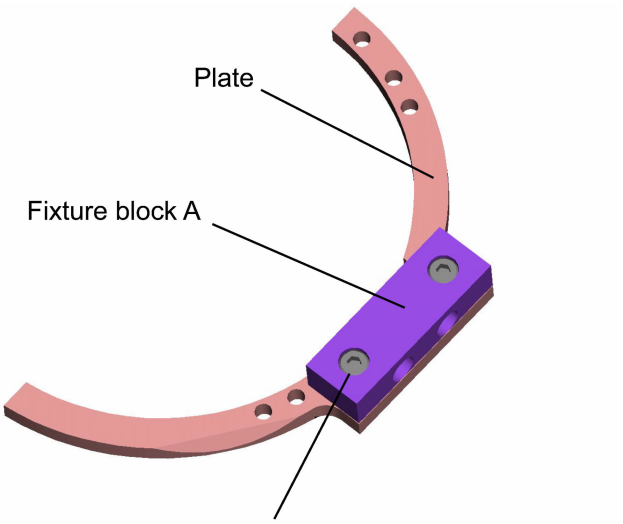
STEP 1

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



STEP 2

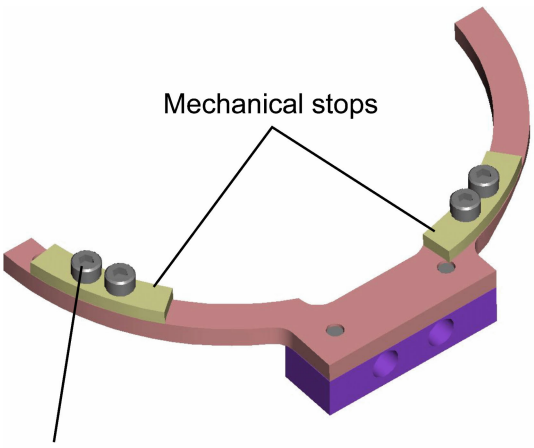
Secure fixture block A to the plate with two hexagonal socket-head bolts. (Make a pair of assemblies.)



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

STEP 3

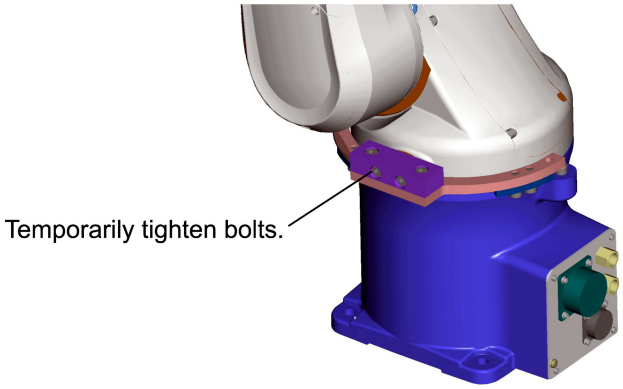
Turn the assemblies made in Step 2 upside down. Secure two mechanical stops to each of those assemblies with two hexagonal socket-head bolts for determining the desired motion space.



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

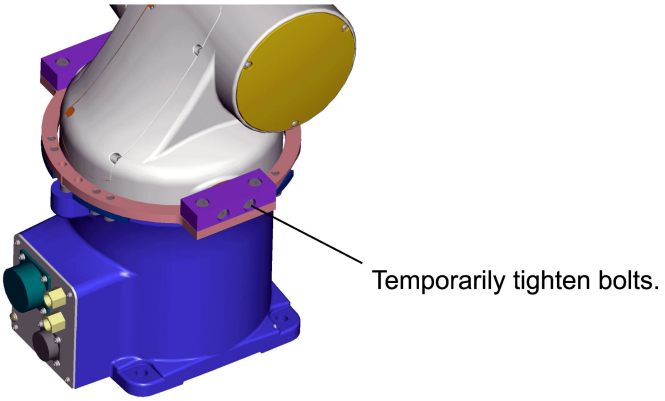
STEP 4

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



STEP 5

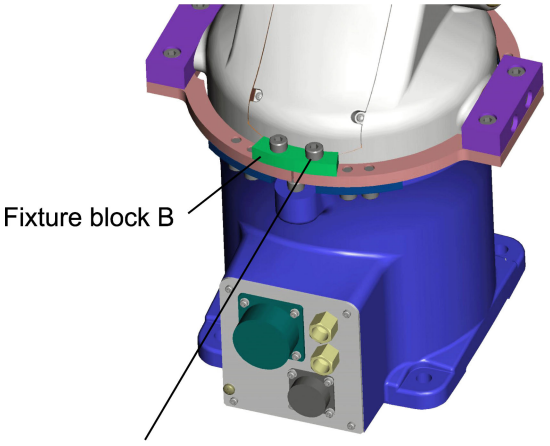
In the same way as in Step 4, temporarily secure the other one of the assemblies to the opposite side.



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.



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

(2) Software motion limits and Set RANG values

Note: If 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 initialization floppy disk holds the factory defaults of the initial RANG values and CALSET values. After performing CALSET, the customer needs to manage the RANG values and CALSET values modified.

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

The relationship between each mechanical end position and software motion limits is shown in the table on page 29.

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

Checking the set RANG values

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

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

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

STEP 1

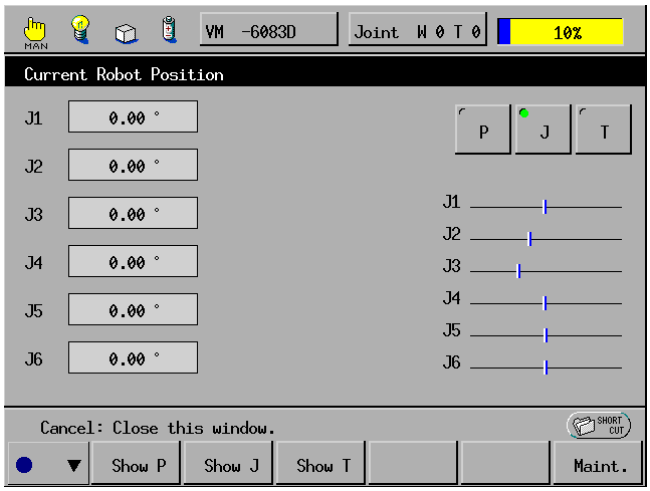
Turn the power switch of the robot controller to ON.

STEP 2

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

STEP 3

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

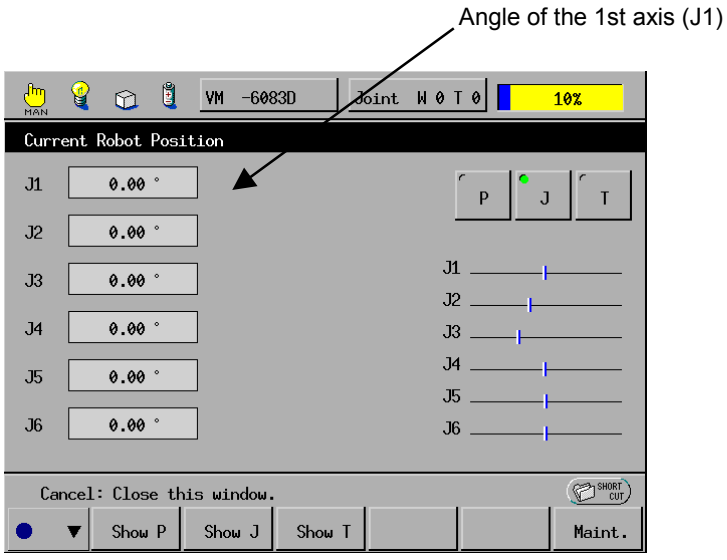


STEP 4

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

STEP 5

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



Mechanical End Positions and Set Software Motion Limits

	Positive-direction mechanical end				Negative-direction mechanical end			
	A	**B**	**A'**	**B'**	**A**	**B**	**A'**	**B'**
Positive-direction software motion limit	0	90	-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 set 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 set RANG value"
Negative-direction software motion limit = 0

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

Positive-direction software motion limit = -46
RANG = value obtained in "Checking the set RANG value"

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

Negative-direction software motion limit = 136

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

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

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

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

Changing Positive-Direction Software Motion Limits (PLIMs)

STEP 1

Turn the power switch of the robot controller to ON.

STEP 2

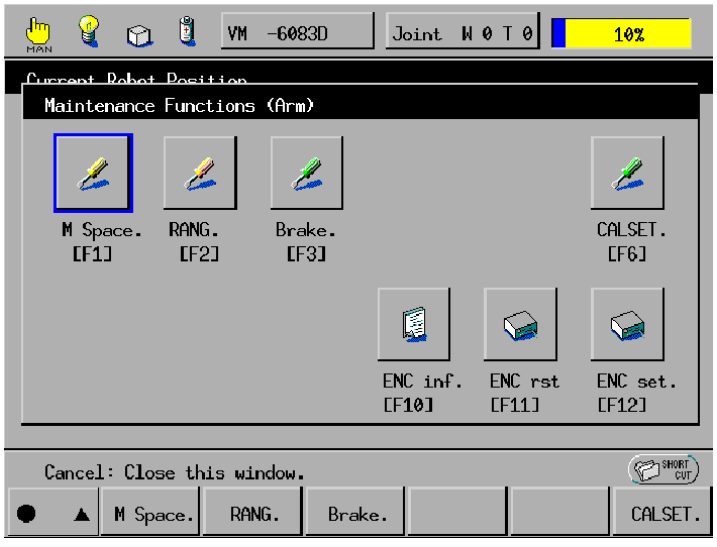
Set the mode selector switch of the teach pendant to MANUAL.

STEP 3

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

STEP 4

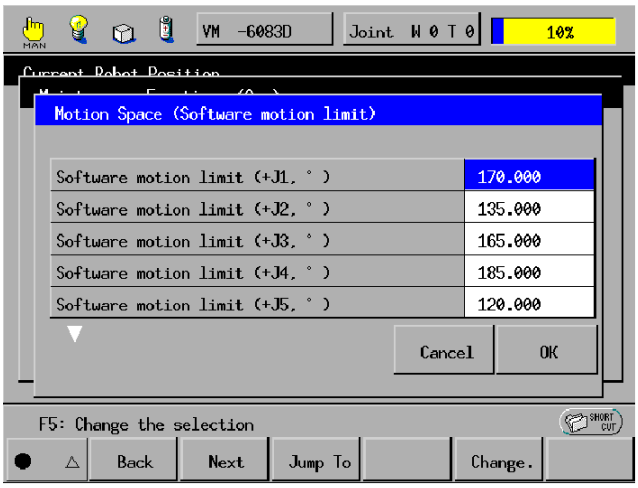
Press [F12 Aux.].
The Maintenance Functions (Arm) window appears.



F1

STEP 5

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



STEP 6

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

STEP 7

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

STEP 8

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

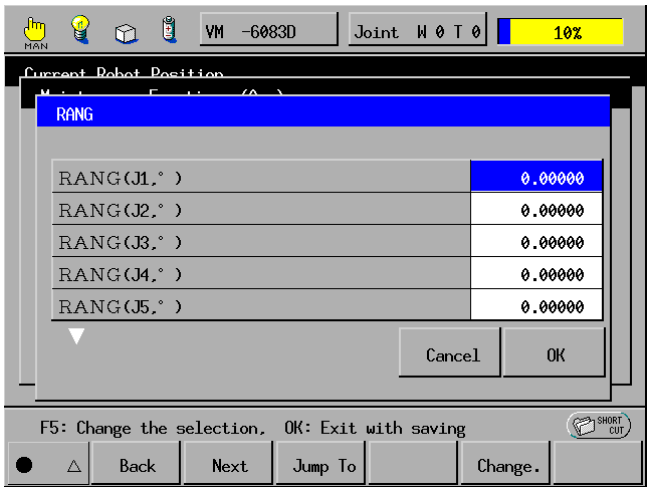
STEP 9

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

Changing Set RANG Values

STEP 10

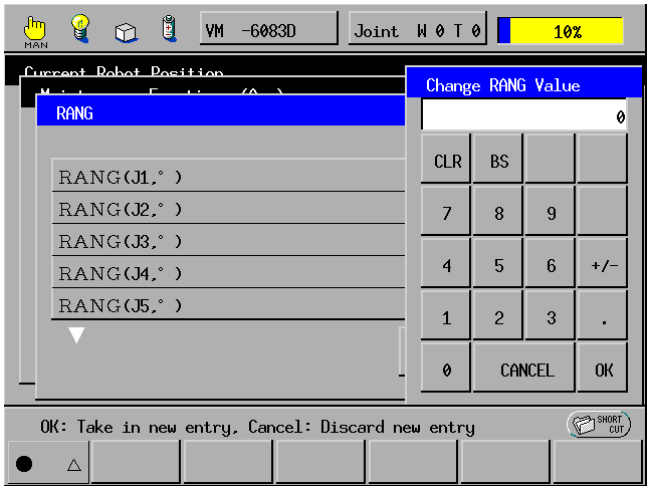
Press [F2 RANG.].
The RANG window appears as shown below.



F5

STEP 11

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



STEP 12

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

STEP 13

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

STEP 14

Turn the power switch of the robot controller to OFF.

STEP 15

Turn the power switch of the robot controller to ON.

STEP 16

Press [F2 Arm] on the top screen.

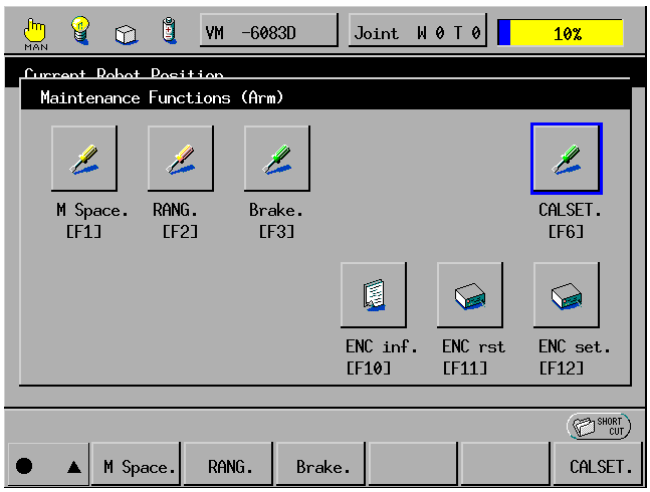
CALSET of the 1st Axis

NOTE: For UL-Listed robot units, release the brake on the 1st axis before CALSETing.

STEP 17

Press SHIFT.

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



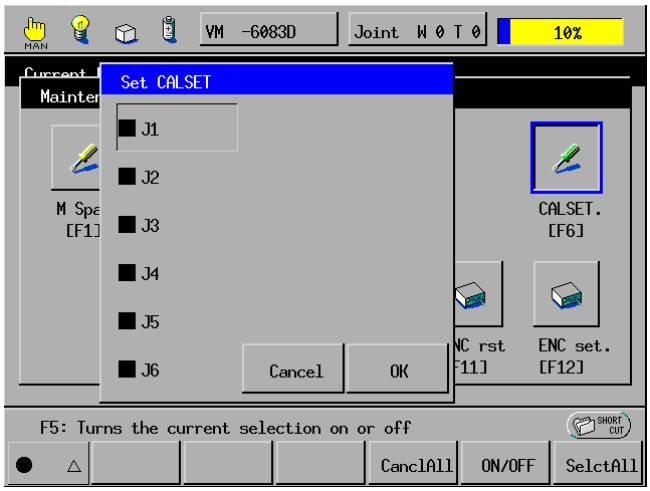
F6

STEP 18

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

STEP 19

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

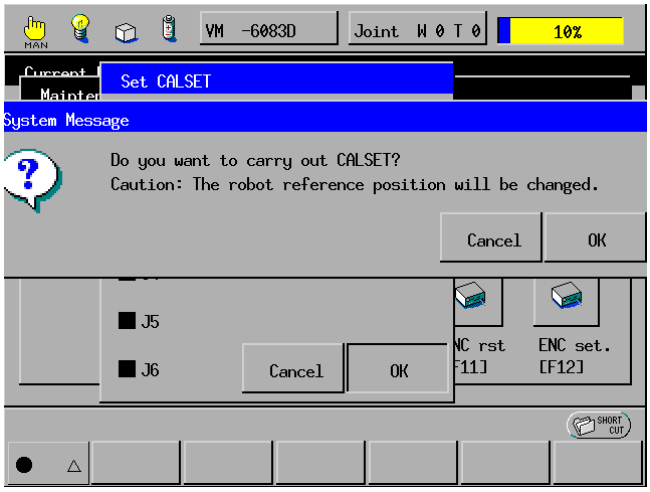


STEP 20

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

STEP 21

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



STEP 22

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

STEP 23

Press OK.

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

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

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

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

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

STEP 1

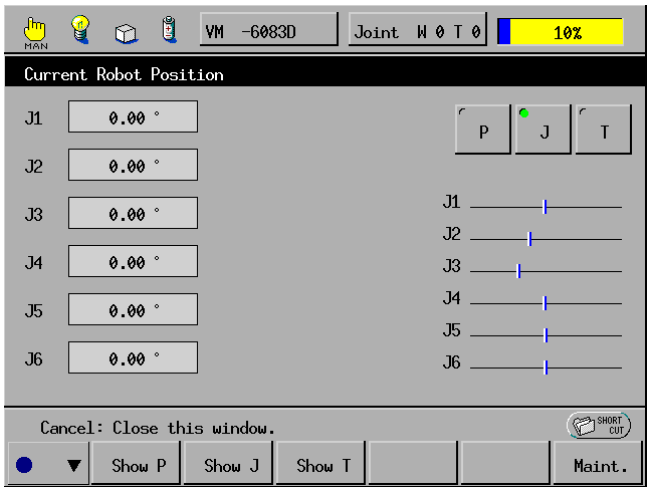
Turn the power switch of the robot controller to ON.

STEP 2

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

STEP 3

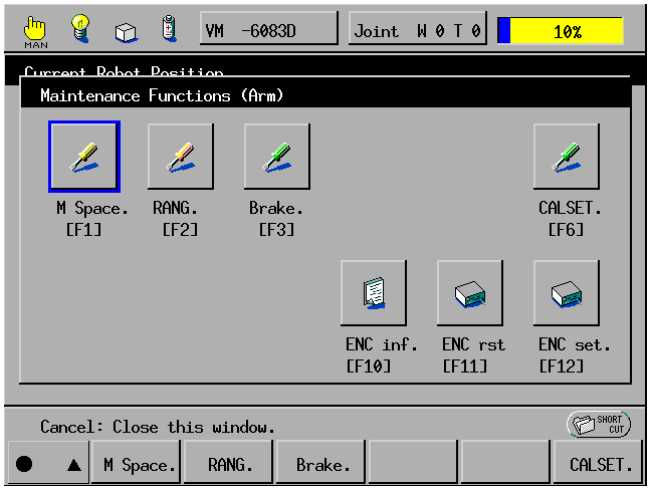
Press [F2 Arm] on the top screen.
The Current Robot Position window appears.



F12

STEP 4

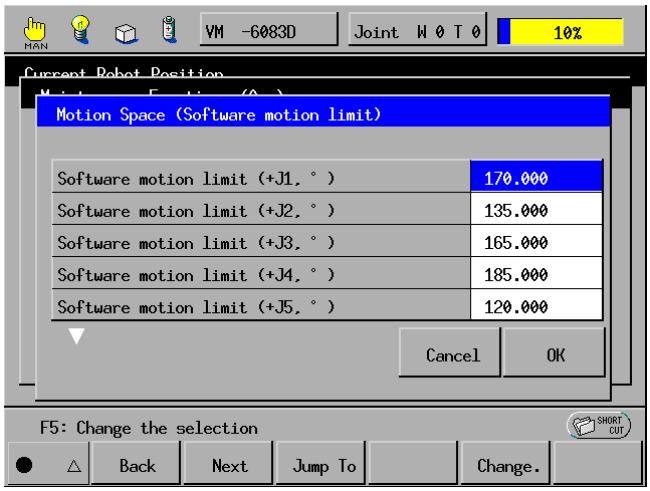
Press [F12 Maint.].
The Maintenance Functions (Arm) window appears.



F1

STEP 5

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



STEP 6

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

STEP 7

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

STEP 8

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

STEP 9

Press OK.

STEP 10

Turn the power switch of the robot controller to OFF.

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

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

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

2.3.2 2nd-axis and 3rd-axis Mechanical Ends Change

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

At the time of delivery from the factory, mechanical ends are preset 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 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.

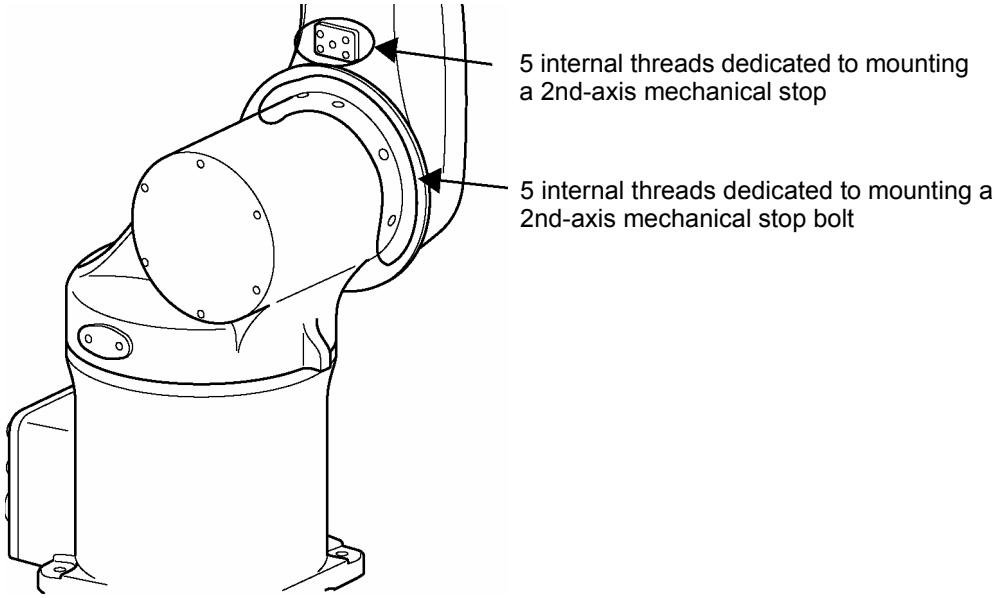
The initialization floppy disk holds the factory defaults of the initial RANG values and CALSET values. After performing CALSET, the customer needs to manage the RANG values and CALSET values modified.

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

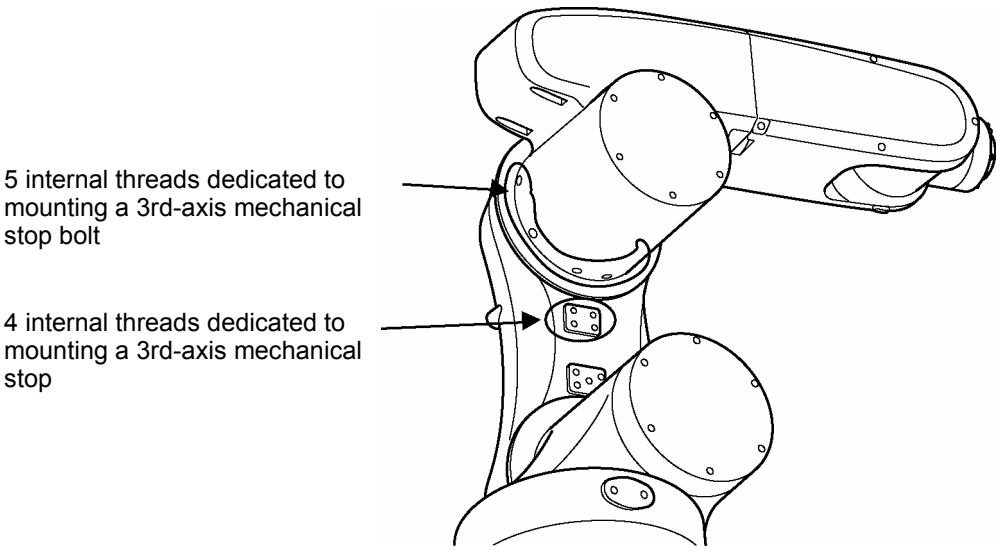
[2] Checking Existence of Particular Internal Threads Dedicated to 2nd- and 3rd-axis Mechanical End Change

The 2nd- and 3rd-axis mechanical end change procedure differs depending upon whether the robot unit has particular internal threads specified below (UL-Listed robot units) or not (Standard type).

For the standard type, proceed to item [3]; for the UL-Listed robot units, proceed to item [4].



Locations of Internal Threads Dedicated to 2nd-axis Mechanical End Change



Locations of Internal Threads Dedicated to 3rd-axis Mechanical End Change

[3] Changing the 2nd- and 3rd-axis Mechanical Ends for Robot Units Having No Particular Internal Threads (Standard Type)

For robot units having no internal threads dedicated to mechanical end change, use undedicated internal threads as shown below.

The 2nd-axis mechanical stops for the VS-6556G and VS-6577G are of the same shape, so the description of mechanical end change in [4-1] is common to both models.

The 3rd-axis mechanical stops for the VS-6556G and VS-6577G are of different shapes, so the descriptions are separately provided for each model, [4-2] for VS-6556G and [4-3] for the VS-6577G.

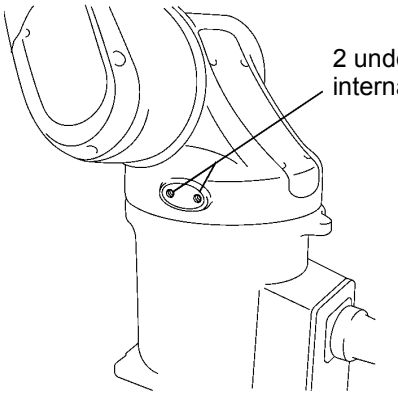
[3-1] 2nd-axis Mechanical End Change (Common to VS-6566G and VS-6577G)

(1) Outline

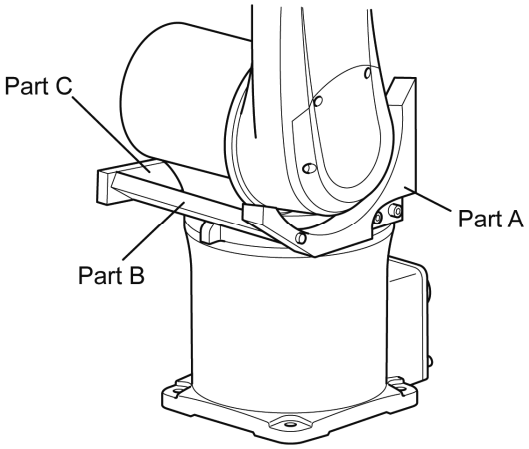
The 2nd-axis mechanical end can be changed by mounting a mechanical stop to the undedicated internal threads as shown below. The mechanical stop consists of three parts--Part A, Part B, and Part C. The mechanical stop and the related parts should be prepared by the customer.

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

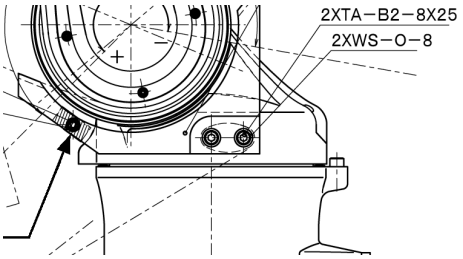
Positions of Undedicated Internal Threads (to be used for 2nd-axis mechanical end change)



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



Note for mounting Part B



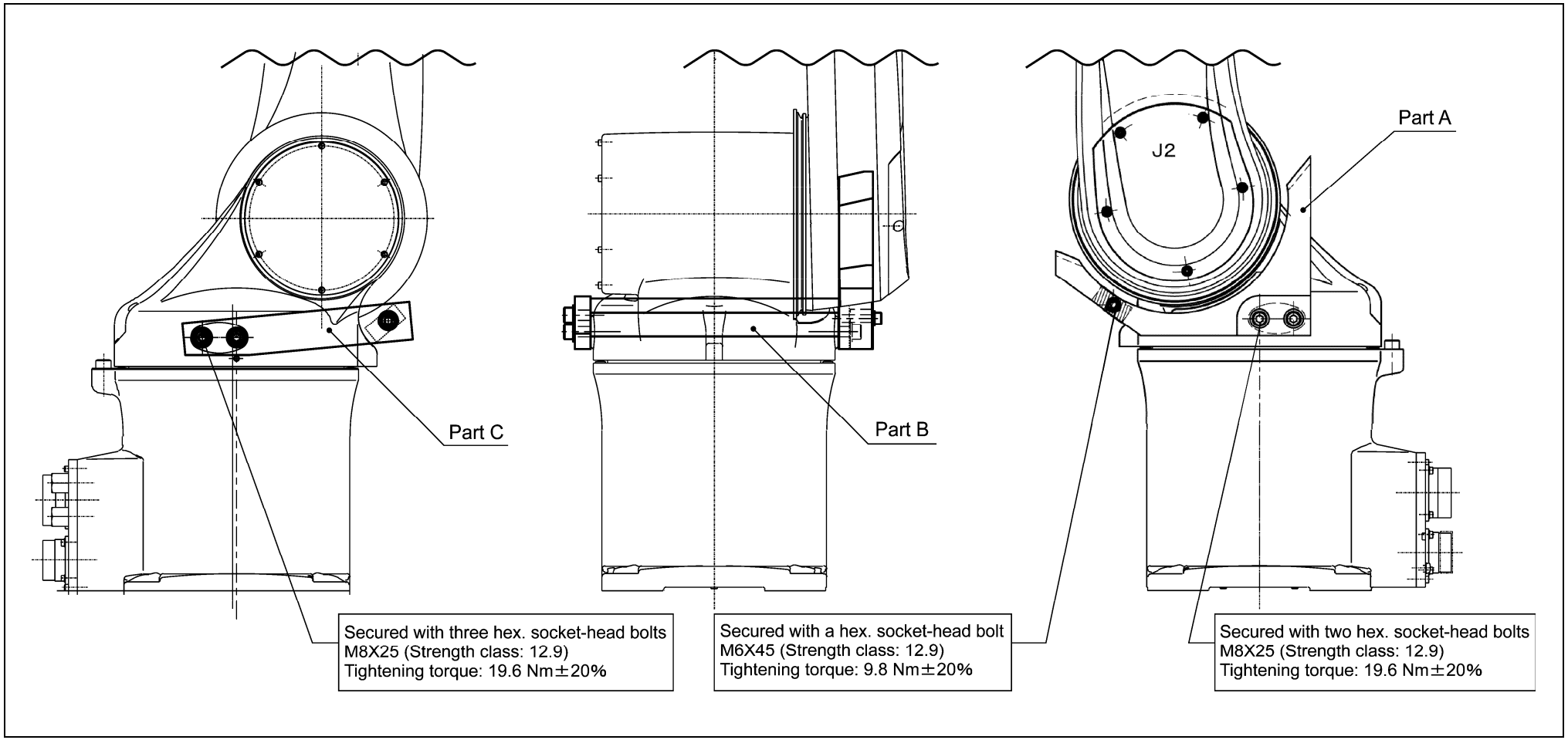
This face of Part A and that of Part B should be parallel with each other.

(2) Reference Drawings of 2nd-axis Mechanical Stop

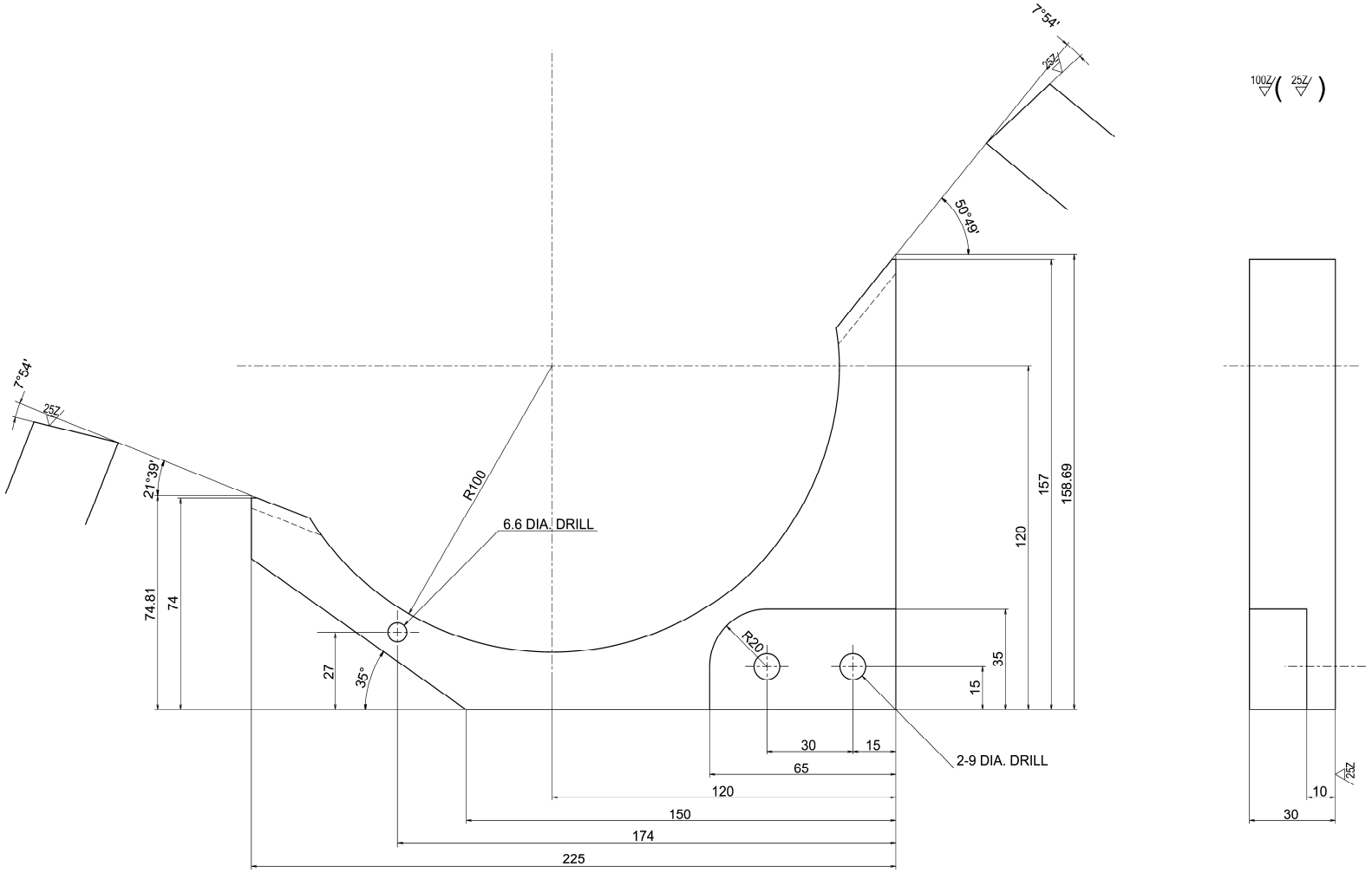
The figures below show the mechanical end configured with a 2nd-axis mechanical stop consisting of Part A, Part B and Part C. The reference drawings of those parts are given on the following pages.

The mechanical stop is designed to set the 2nd-axis motion range between 67.5° in the positive direction and 50° in the negative direction.

2nd-axis Mechanical Stop Mounted on the Robot Unit

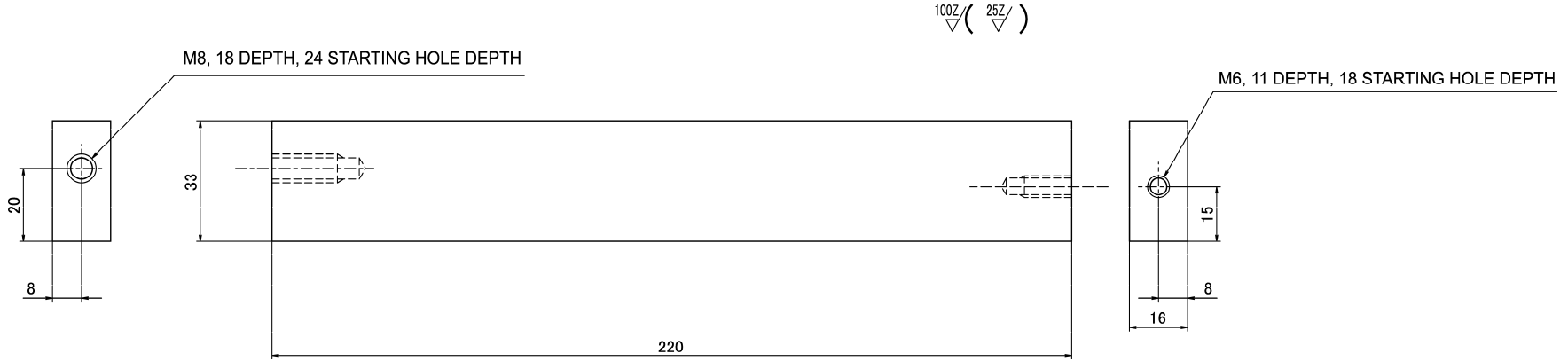


Reference Drawing of Part A



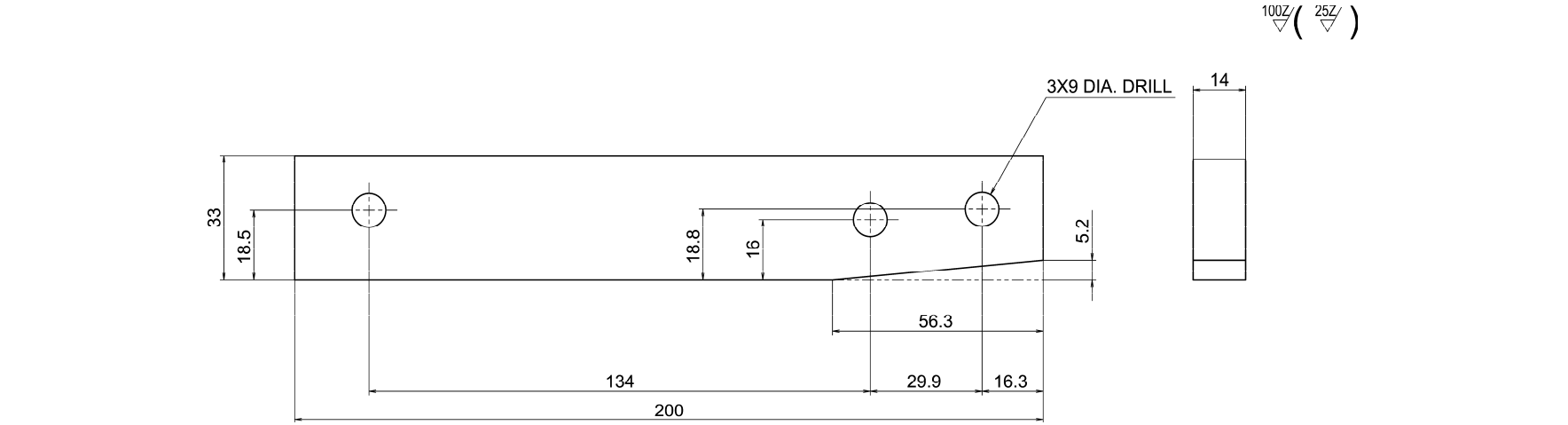
Material: A2017-T4

Reference Drawing of Part B



Material: A2017-T4

Reference Drawing of Part C



Material: A2017-T4

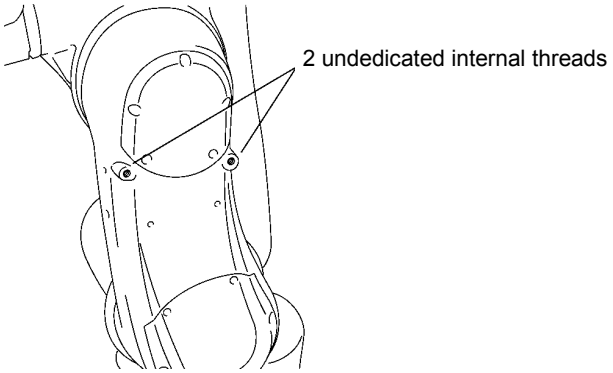
[3-2] 3rd-axis Mechanical End Change (VS6556G)

(1) Outline

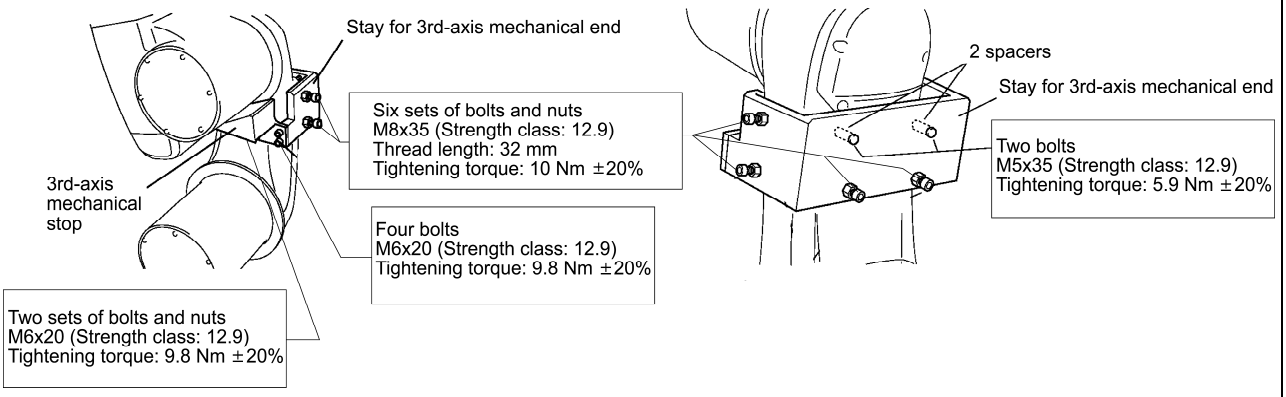
The 3rd-axis mechanical end can be changed by mounting a mechanical stop to the undedicated internal threads as shown below. The mechanical stop and the related parts should be prepared by the customer.

Example of 3rd-axis Mechanical End Configured on the Robot Unit (VS6556G)

Positions of Undedicated Internal Threads
(to be used for 3rd-axis mechanical end change)



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

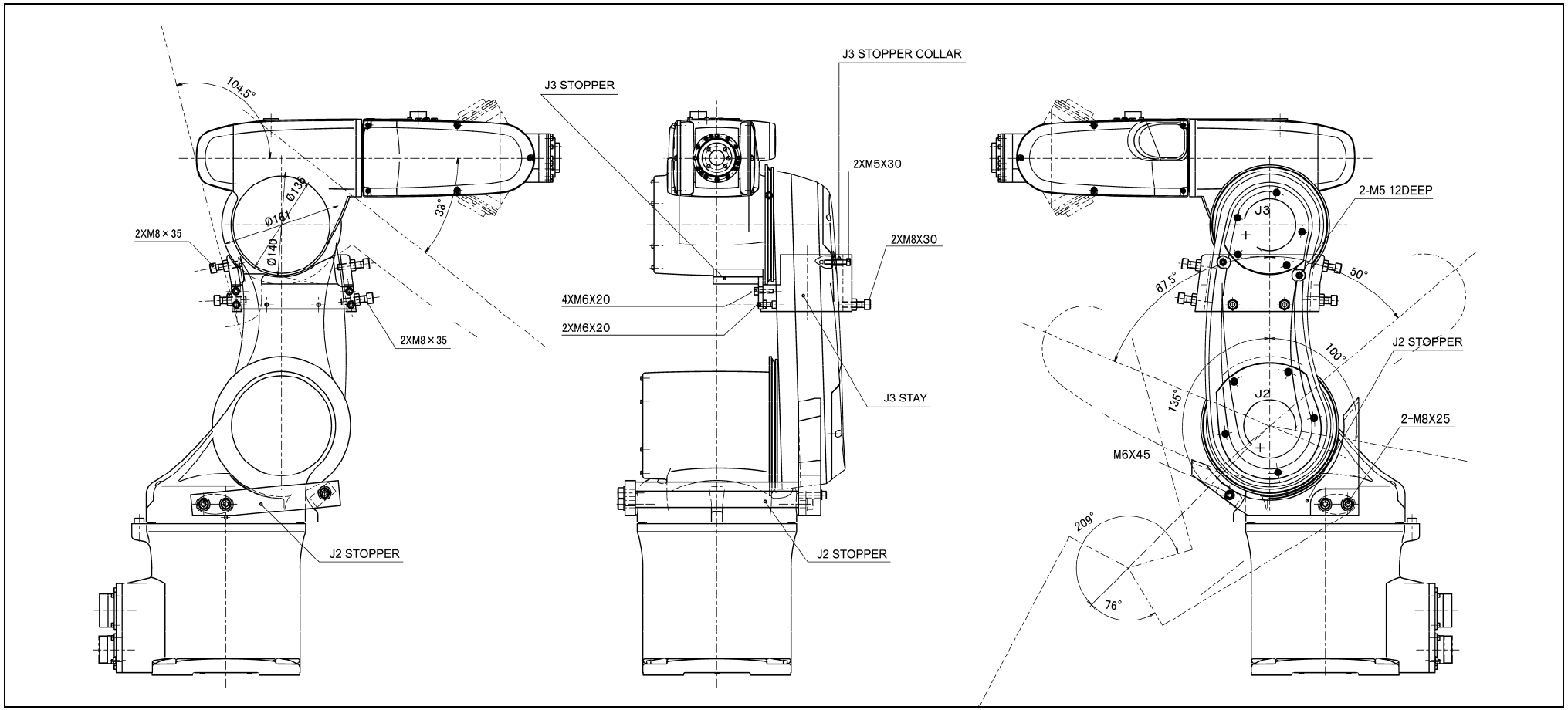


(2) Reference Drawings of 3rd-axis Mechanical Stop (VS6556G)

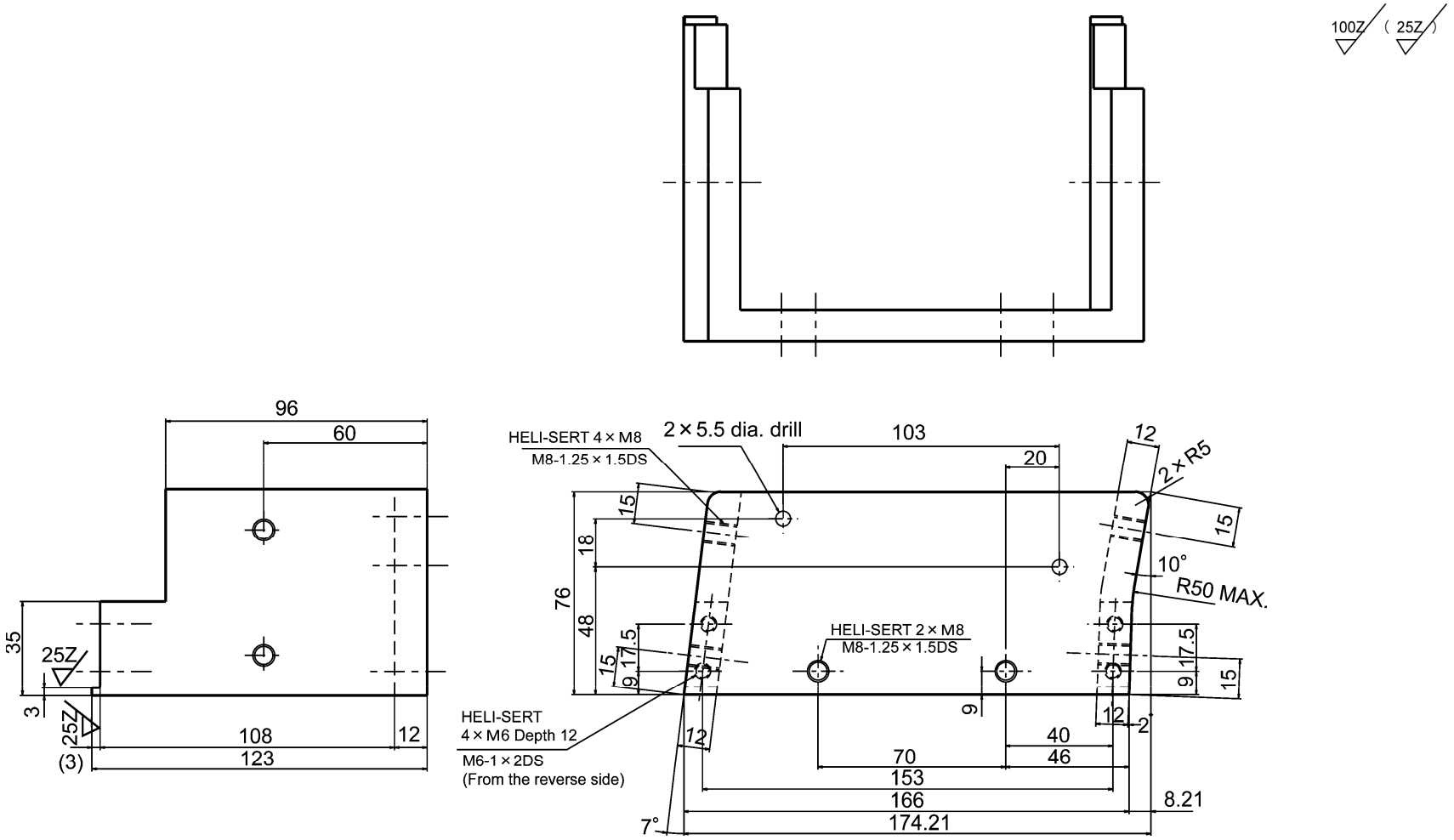
The figures below show the mechanical end configured with a 3rd-axis mechanical stop. The reference drawings of the mechanical stop and the related parts are given on the following pages.

The 3rd-axis mechanical stop is designed to set the 3rd-axis motion range between 128° in the positive direction and 14.5° in the negative direction.

3rd-axis Mechanical Stop Mounted on the Robot Unit (VS6556G)

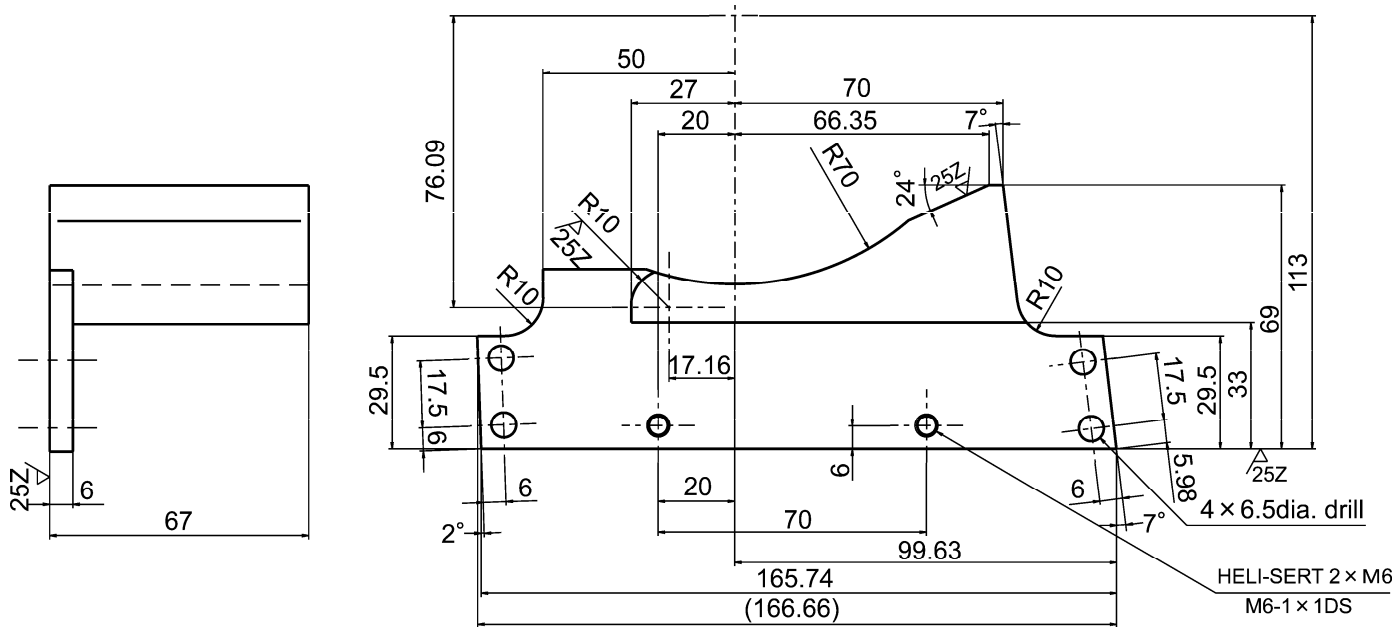


Reference Drawing of Stay for 3rd-axis Mechanical End (VS6556G)



Material: A2017-T4

Reference Drawing of 3rd-axis Mechanical Stop (VS6556G)



Material: A2017-T4

Reference Drawing of Spacer for 3rd-axis Mechanical End (VS6556G)

Material: S45C

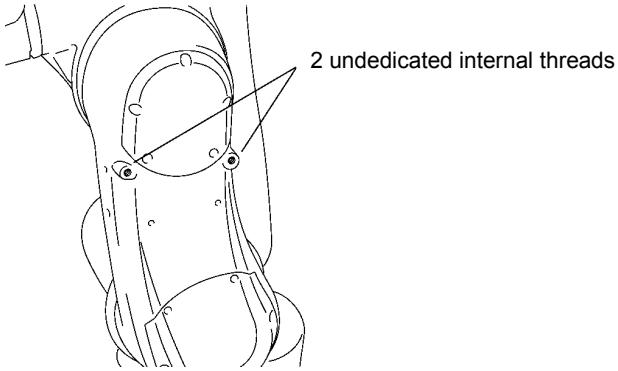
[3-3] 3rd-axis Mechanical End Change (VS6577G)

(1) Outline

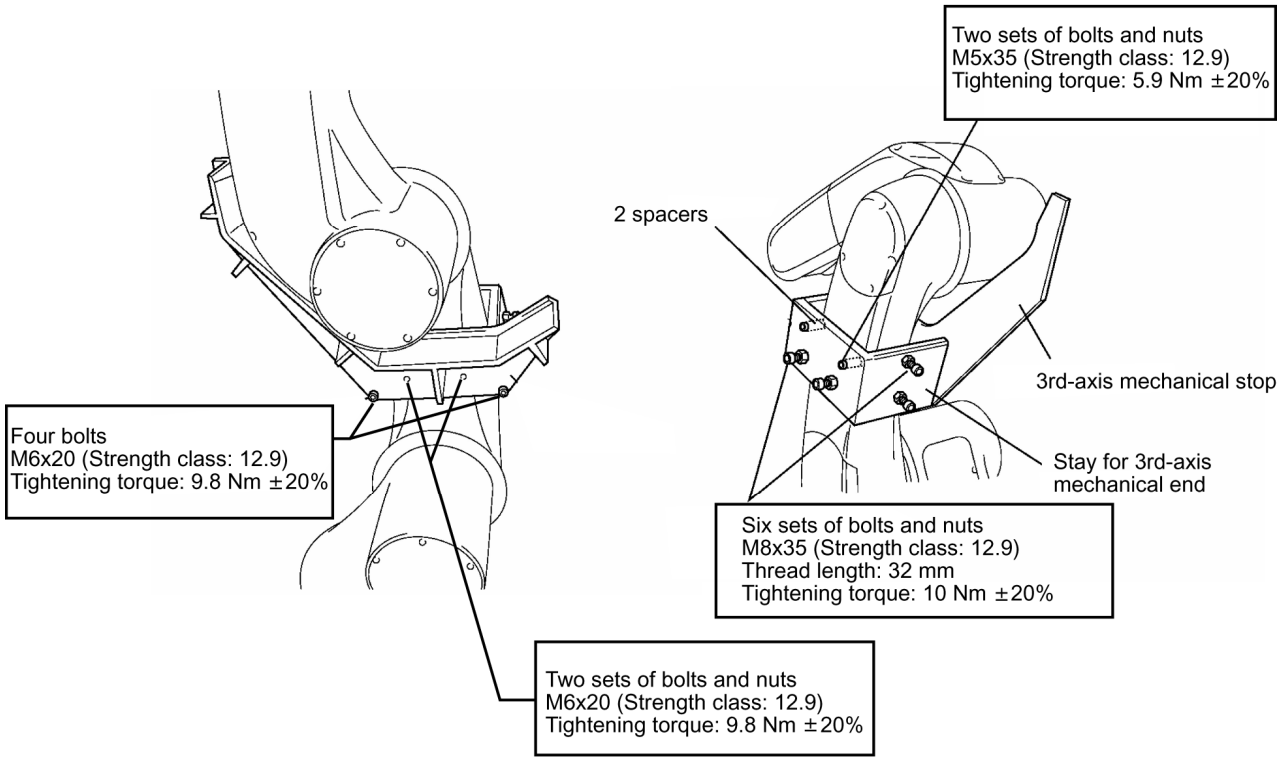
The 3rd-axis mechanical end can be changed by mounting a mechanical stop to the undedicated internal threads as shown below. The mechanical stop and the related parts should be prepared by the customer.

3rd-axis Mechanical Stop Mounted on the Robot Unit (VS6577G)

Positions of Undedicated Internal Threads
(to be used for 3rd-axis mechanical end change)



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

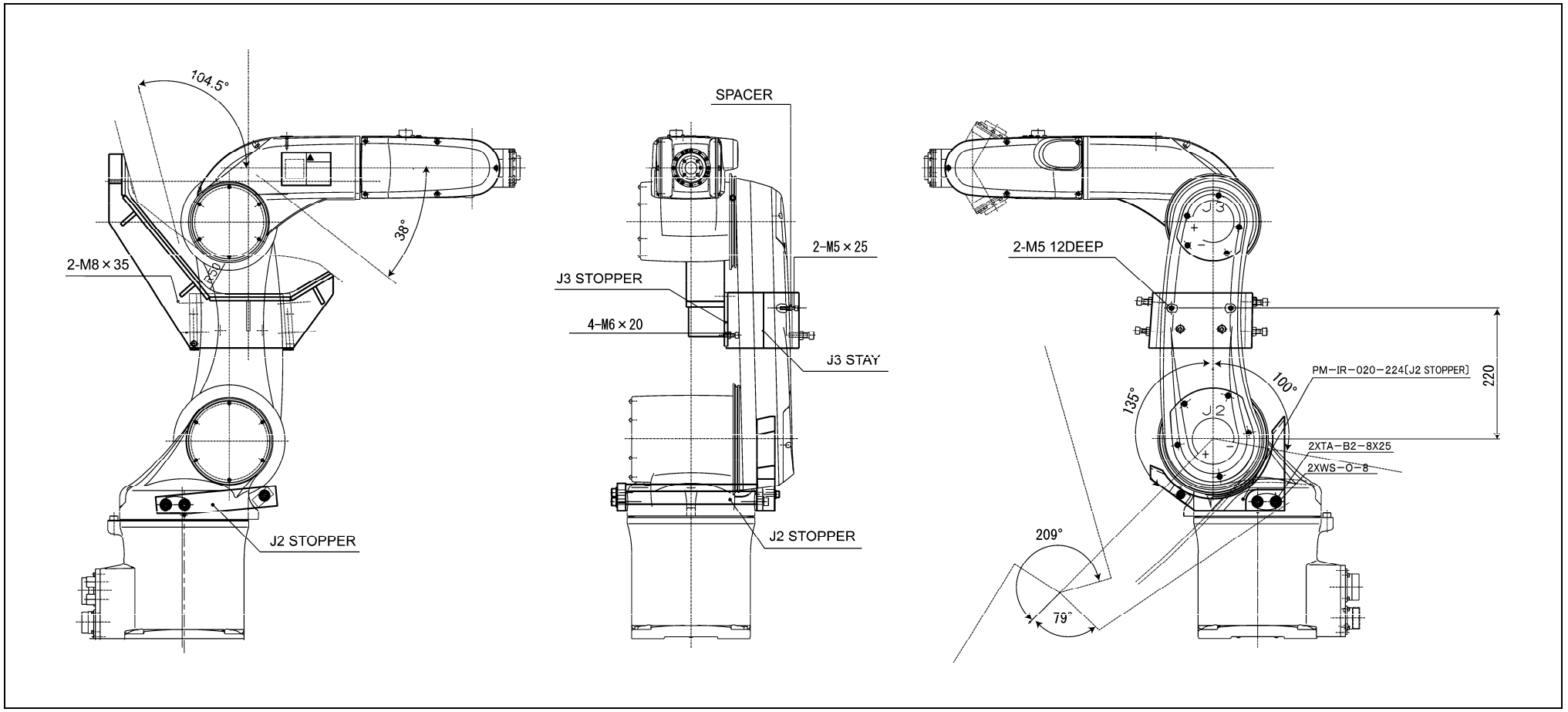


(2) Reference Drawings of 3rd-axis Mechanical Stop (VS6577G)

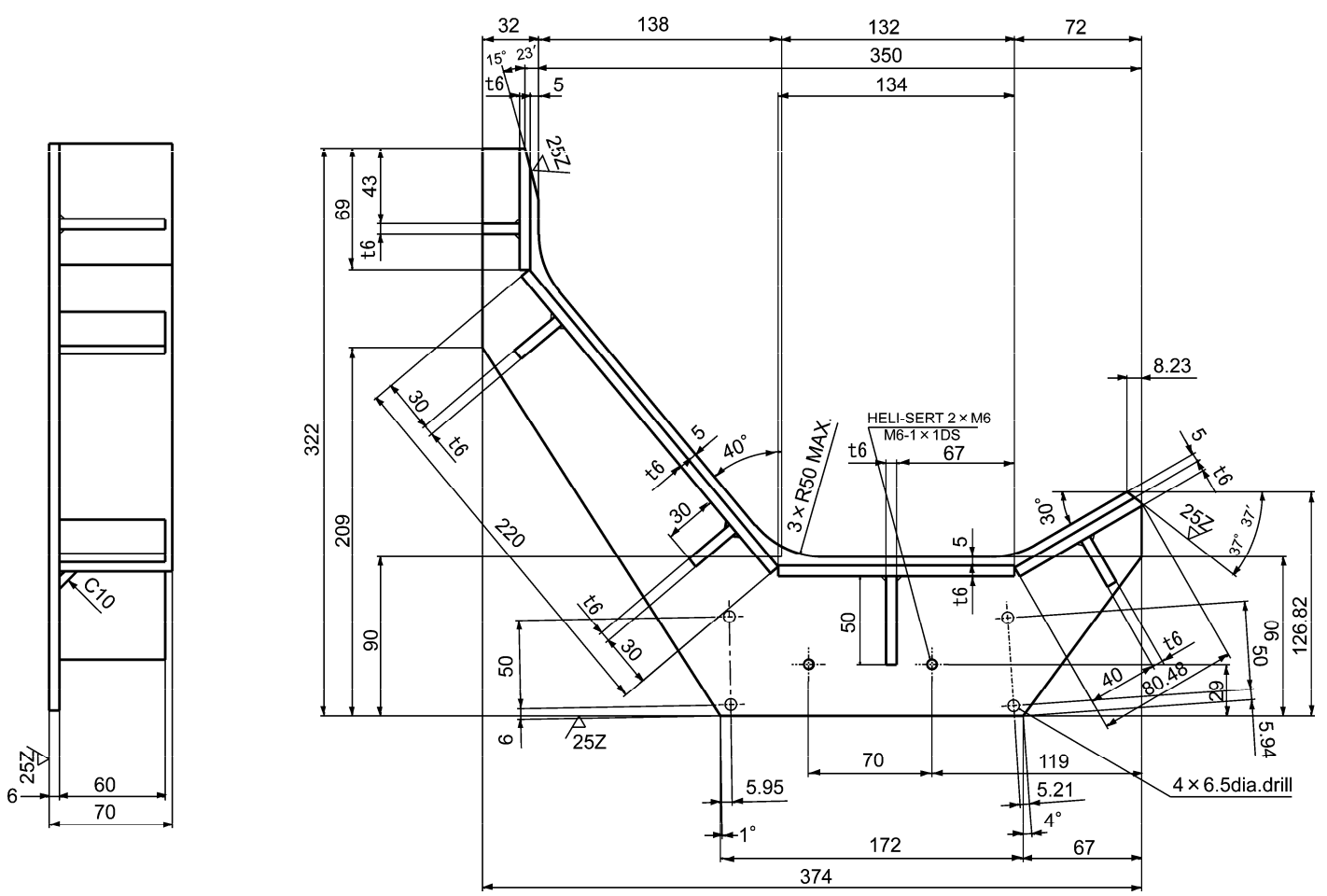
The figures below show the mechanical end configured with a 3rd-axis mechanical stop. The reference drawings of the mechanical stop and the related parts are given on the following pages.

The 3rd-axis mechanical stop is designed to set the 3rd-axis motion range between 128° in the positive direction and 14.5° in the negative direction.

3rd-axis Mechanical Stop Mounted on the Robot Unit (VS6577G)



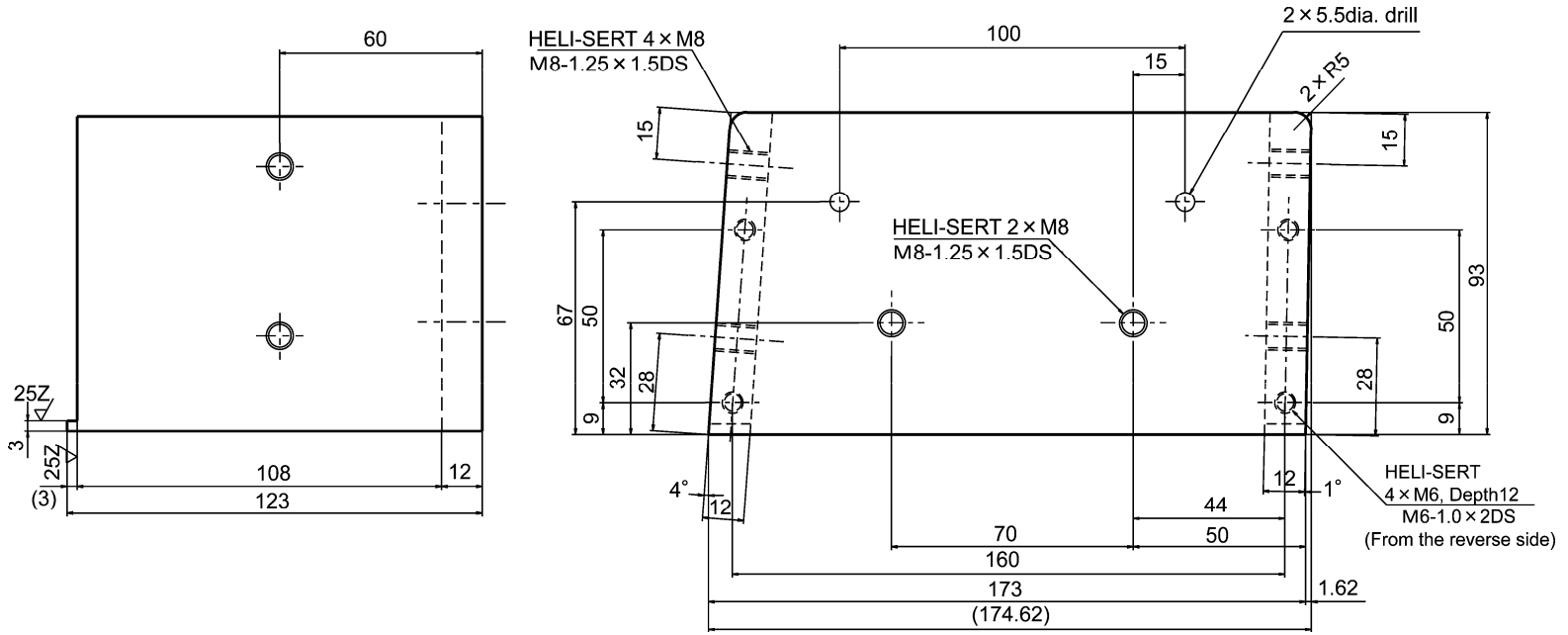
Reference Drawing of 3rd-axis Mechanical Stop (VS6577G)



Material: A5083P-H32

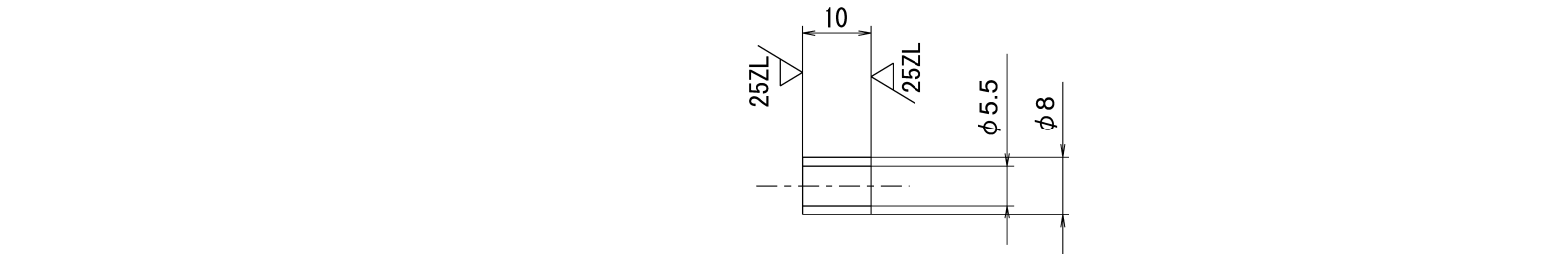
Note: The joint sections should be welded.

Reference Drawing of Stay for 3rd-axis Mechanical End (VS6577G)



Material: A2017BE-T4

Reference Drawing of Spacer for 3rd-axis Mechanical End (VS6577G)



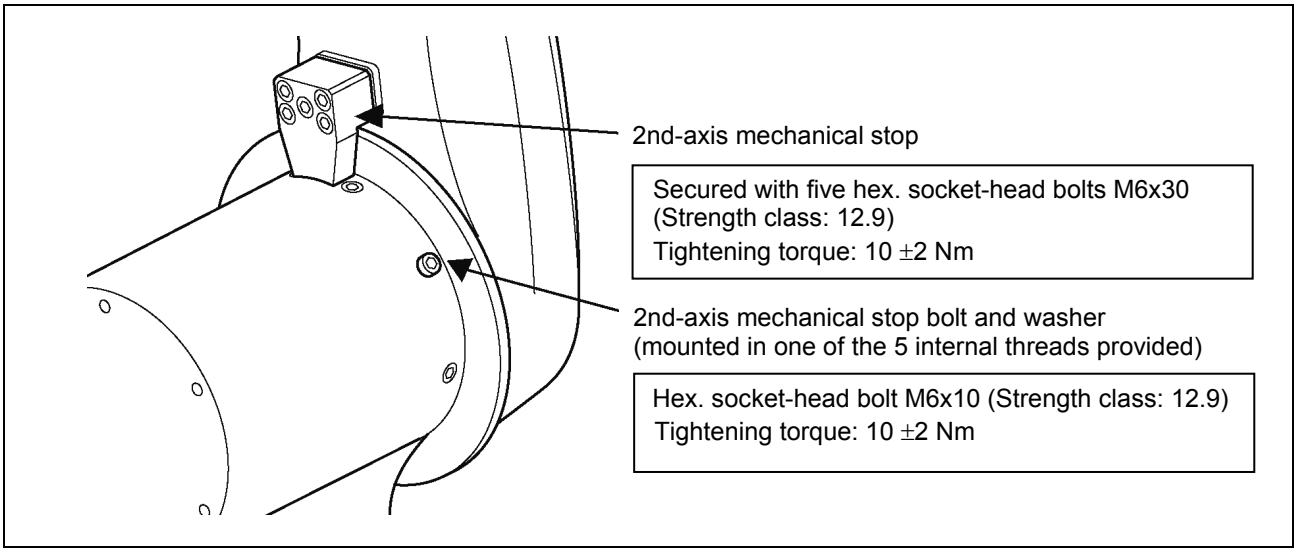
Material: S45C

[4] Changing the 2nd- and 3rd-axis Mechanical Ends for Robot Units Having Particular Internal Threads (UL-Listed Robot Units)

[4-1] 2nd-axis Mechanical End Change

(1) Outline

The 2nd-axis mechanical end can be changed by mounting a mechanical stop and a mechanical stop bolt (with washer) to the internal threads dedicated to 2nd-axis mechanical end change as shown below. The mechanical stop and the related parts should be prepared by the customer.

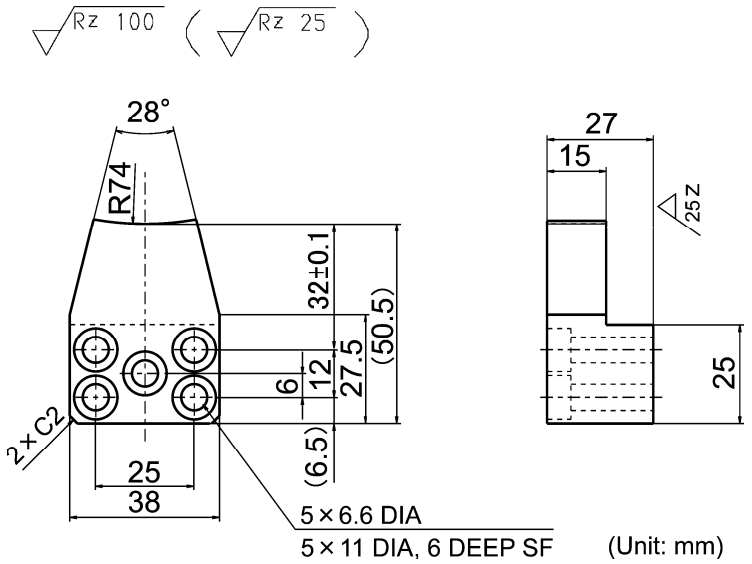
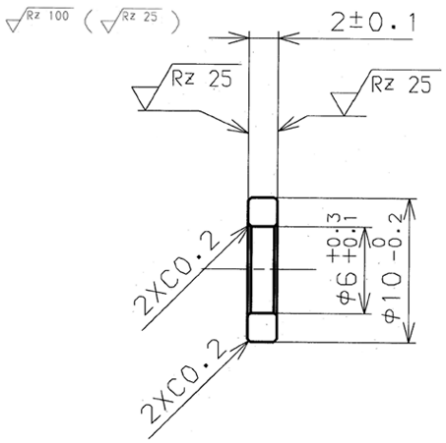


Example of 2nd-axis Mechanical End Configured on the Robot Unit

(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	 Material: A2017 (Unit: mm)
Washer	 Material: A2017 (Unit: mm)
Bolts	• 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) 2nd-axis Mechanical End Positions

The 2nd-axis mechanical end positions available are shown in the VS-G Series INSTALLATION & MAINTENANCE GUIDE. The 2nd-axis motion range defined in it applies as is. Specify the software motion limit that corresponds to the mechanical stop end position actually selected, referring to the above manual.

(3) 2nd-axis Mechanical End Positions

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

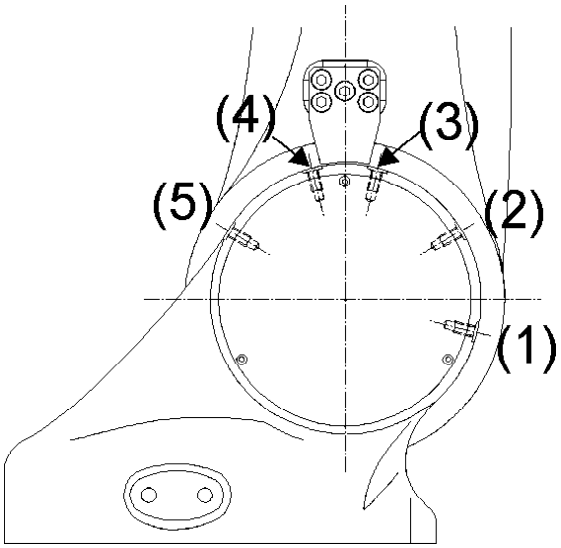
Note: Mounting the 2nd-axis mechanical stop limits the workable angle of the 2nd axis so that the 2nd axis cannot move up to the factory default angle.

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 -100° (-30° on the UL-Listed models) in the negative direction. Set the negative-direction software motion limit for the 3rd axis in the positive side than -100° (-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.

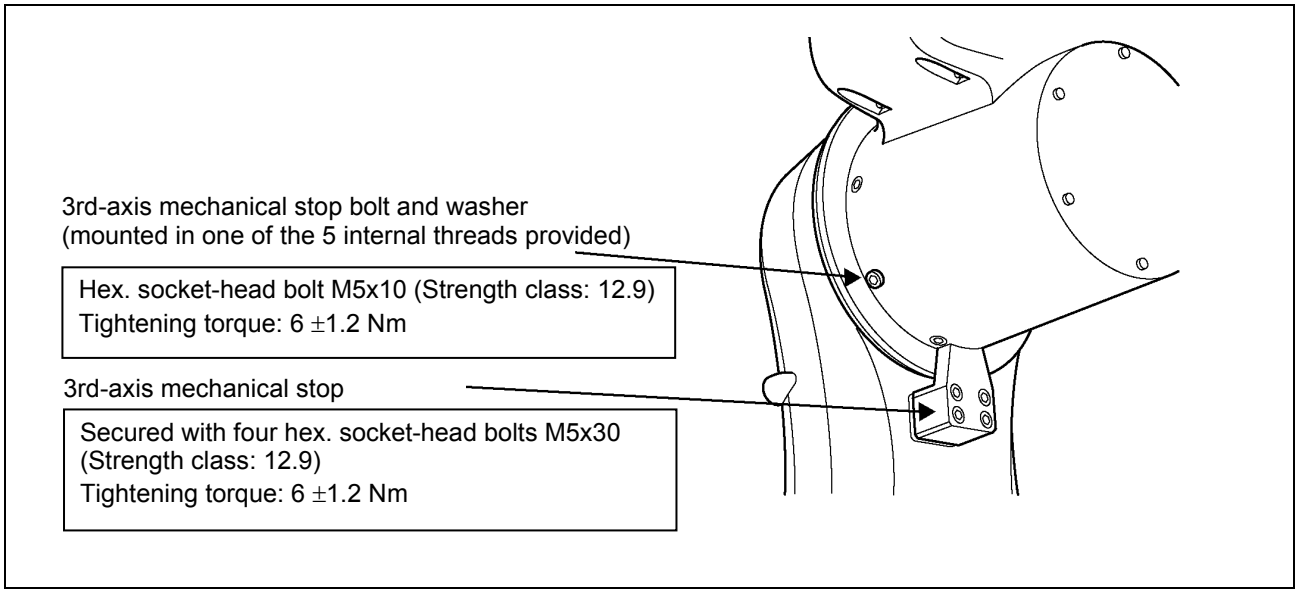
Stop bolt position	Positive direction	Negative direction
(1)	87°	121°
(2)	42°	76°
(3)	-3°	31°
(4)	-31°	3°
(5)	---	-42°

2nd-axis Mechanical End Positions Available

[4-2] 3rd-axis Mechanical End Change

(1) Outline

The 3rd-axis mechanical end can be changed by mounting a mechanical stop and a mechanical stop bolt (with washer) to the internal threads dedicated to 3rd-axis mechanical end change as shown below. The mechanical stop and the related parts should be prepared by the customer.

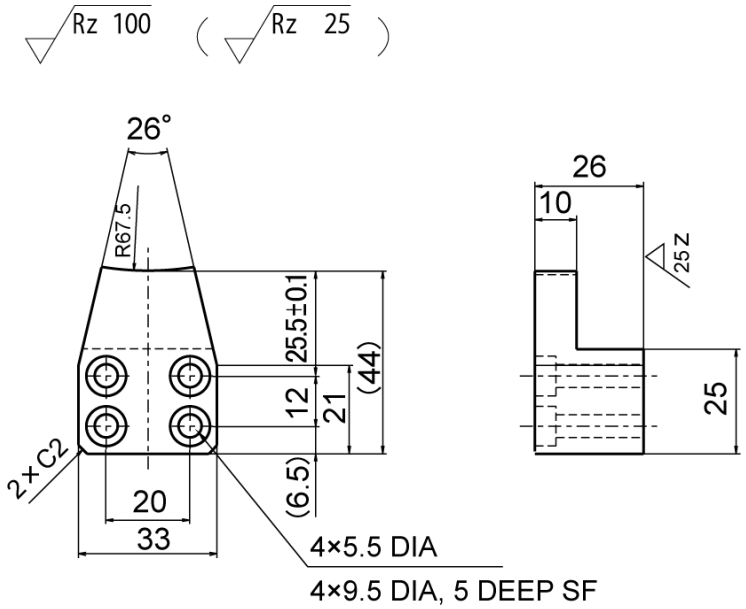
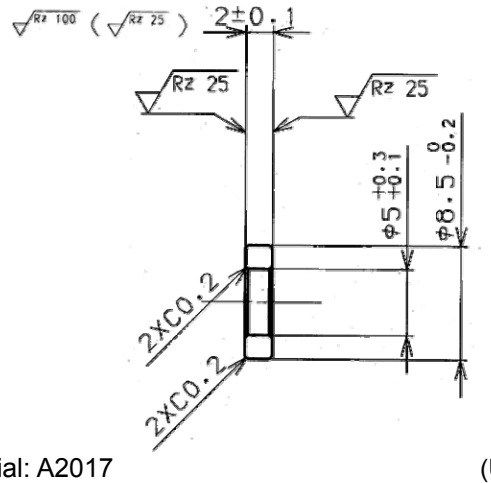


Example of 3rd-axis Mechanical End Configured on the Robot Unit

(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)
3rd-axis mechanical stop	 Material: A2017 (Unit: mm)
Washer	 Material: A2017 (Unit: mm)
Bolts	• Four hex. socket-head bolts M5x30 (Strength class: 12.9) for securing a mechanical stop • One hex. socket-head bolt M5x10 (Strength class: 12.9) as a mechanical stop bolt

(3) 3rd-axis Mechanical End Positions

The 3rd-axis mechanical end positions available are shown in the VS-G Series INSTALLATION & MAINTENANCE GUIDE. The 3rd-axis motion range defined in it applies as is. Specify the software motion limit that corresponds to the mechanical stop end position actually selected, referring to the above manual.

(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.

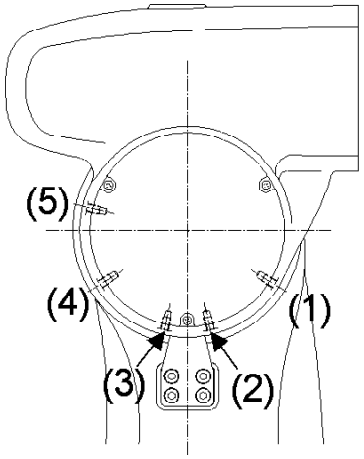
(1) The 3rd axis cannot move overriding 150° in the positive direction, so set the positive-direction software motion limit for the 3rd axis in the negative side than 150°.

(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 -25° (-20° on the UL-Listed models) in the negative direction. Set the negative-direction software motion limit for the 3rd axis in the positive side than -25° (-20°).

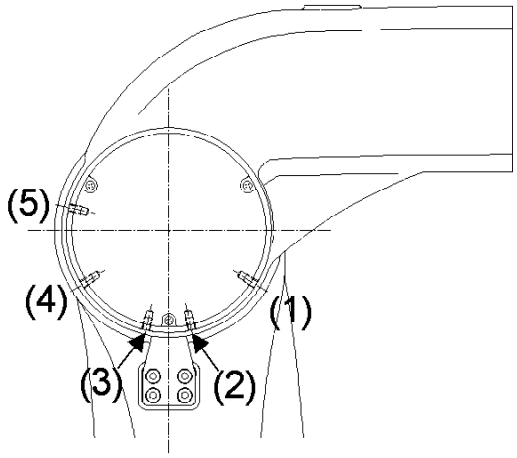
(3) In the VS-6577G series, the 3rd-axis cannot move overriding -65° in the negative direction. Set the negative-direction software motion limit for the 3rd-axis in the positive side than -65°.

(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.

VS-6556G



VS-6577G



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.

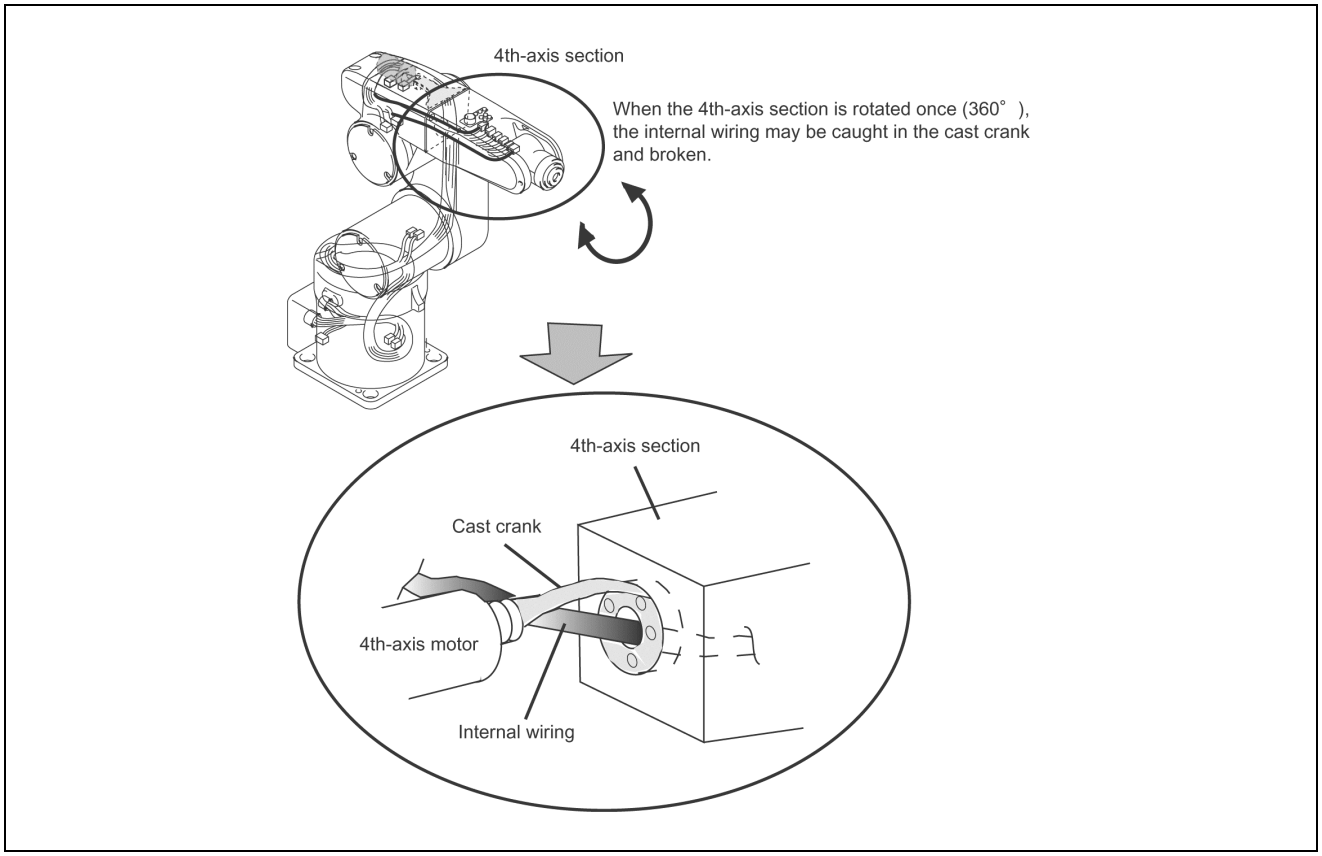
This robot has been CALSET before delivery and the CALSET data is stored in the floppy disks that come with the robot unit. Therefore, even if the memory backup battery in the robot controller dies so that the CALSET data is lost, you do not need to CALSET the robot. Just reload the CALSET data from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

2.4.2 Precautions about CALSET for the VS-G Series

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

Robots in the VS-G 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 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.



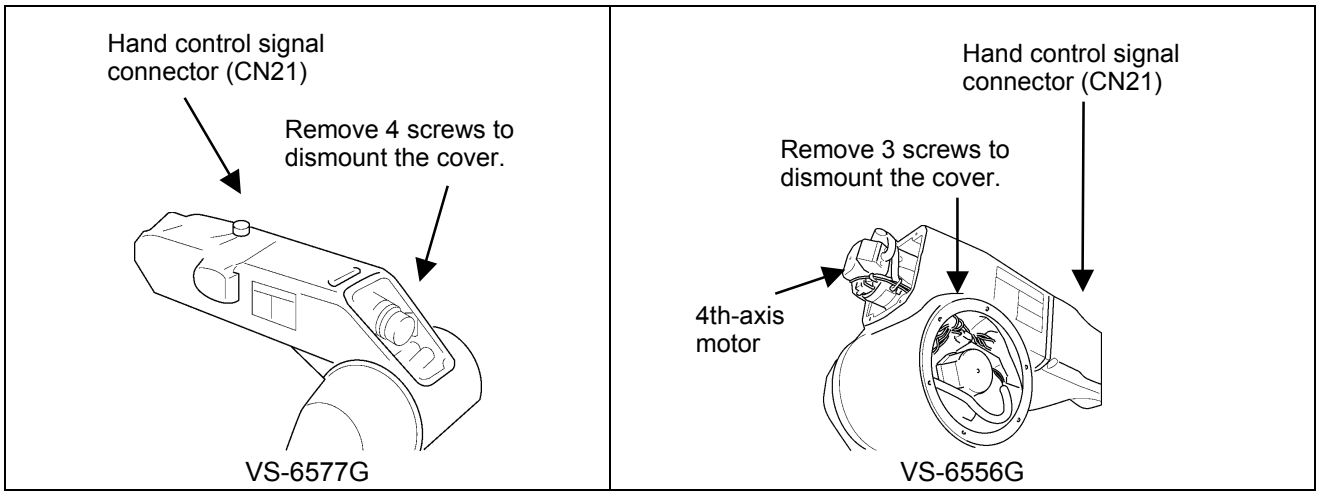
Note that turning the 4th-axis section by more than 360° may break the internal wiring

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:

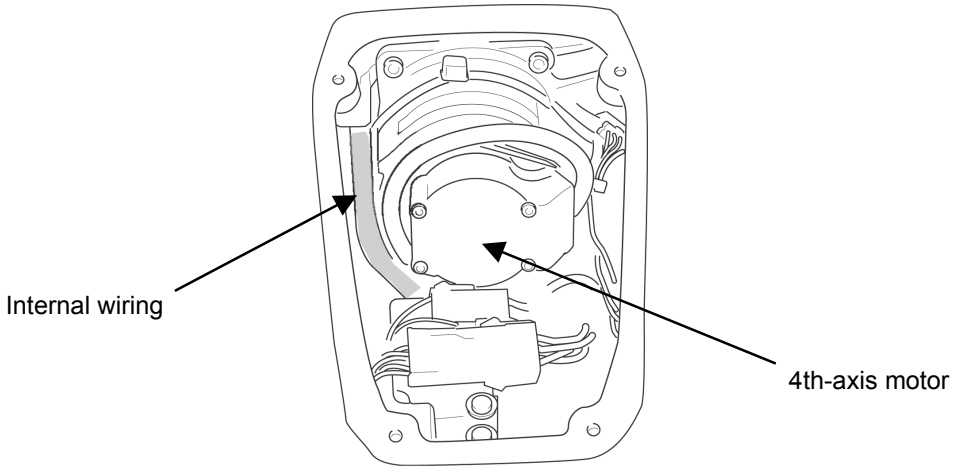


(3) Check that the 4th-axis section is at a designated position.

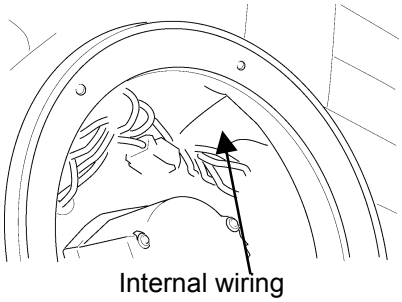
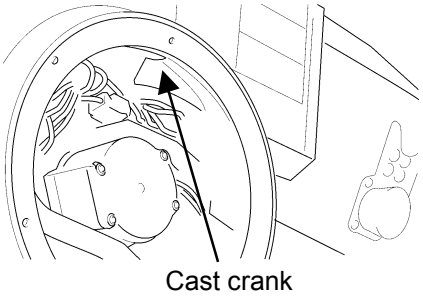
(The hand control signal connector (CN21) of the second arm comes to the upper side and the internal wiring is not caught in the crank at this time.)

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

The internal wiring is visible in the normal condition.
(It is not visible if caught in the crank.)



■ 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 series has no mechanical stop on the 4th and 6th axes.

Mechanical Stops on Axes (VS-G)

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 axis to be CALSET in the vicinity of the mechanical stop, release the brake, and bring the axis into contact with the mechanical stop.

- **The VS-G series can release the brake of the specified axis.**
- **Brake-equipped version of the VS-G series: Each of the 2nd through 6th axes has a brake.**
- **None-brake version of the VS-G series: Only the 2nd to 4th axes have brakes.**
- **UL-Listed robot units of the VS-G series: All axes have brakes.**

(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

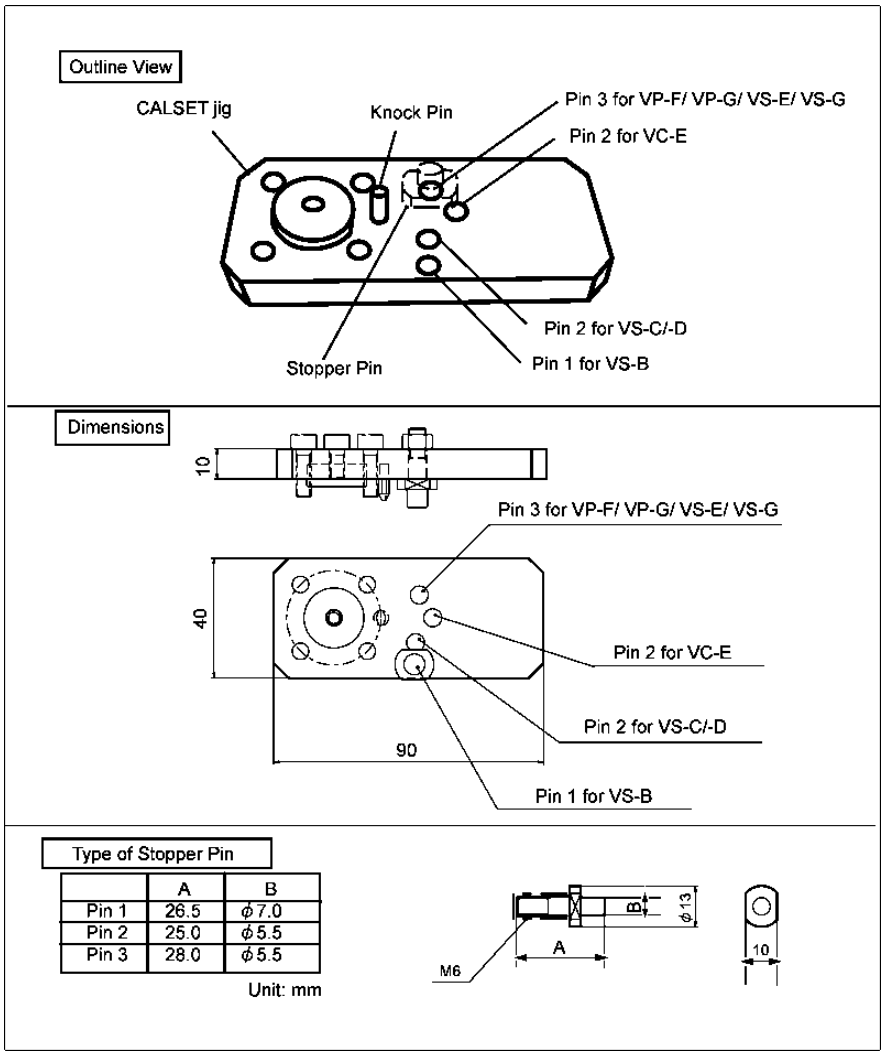
To CALSET the 6th axis on all models or the 4th axis on models having no mechanical stop, you need to mount the CALSET jig on the axis beforehand according to the procedure given in (1) below or (2) given later, respectively.

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.



	A	B
Pin 1	26.5	ϕ7.0
Pin 2	25.0	ϕ5.5
Pin 3	28.0	ϕ5.5

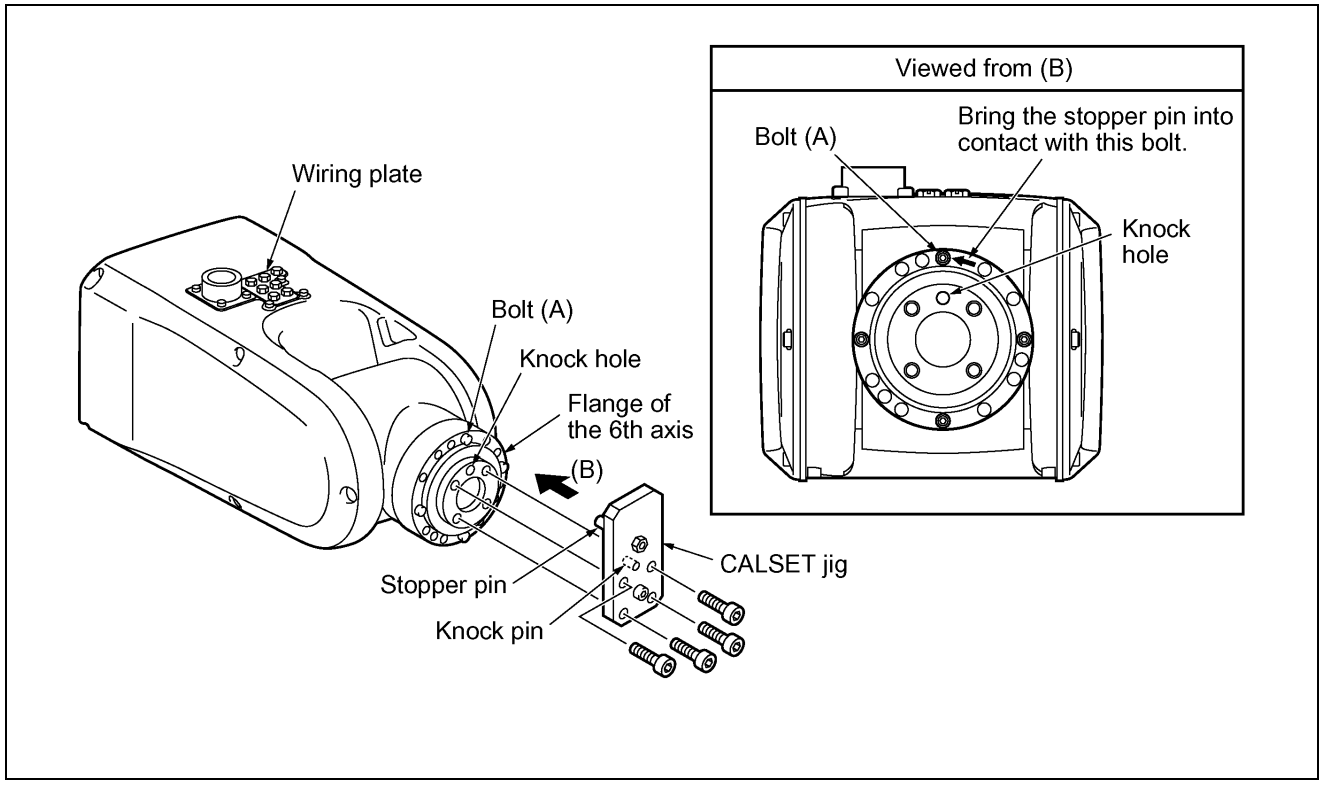
STEP 2

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 series)

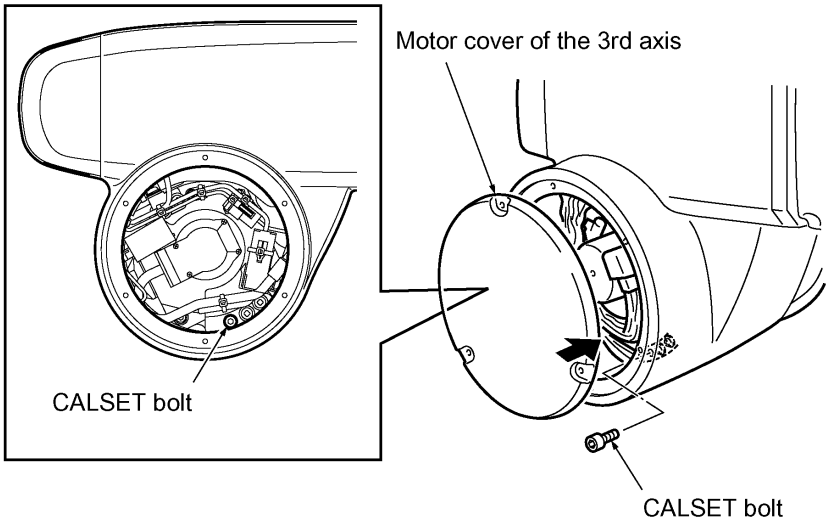
(2) Mounting the CALSET jig on the 4th axis (For models having no mechanical stop on the 4th axis)

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 Nm ±20%.



Removing the CALSET Bolt (VS-G series)

STEP 2

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

STEP 3

Release the brake of the 4th axis.

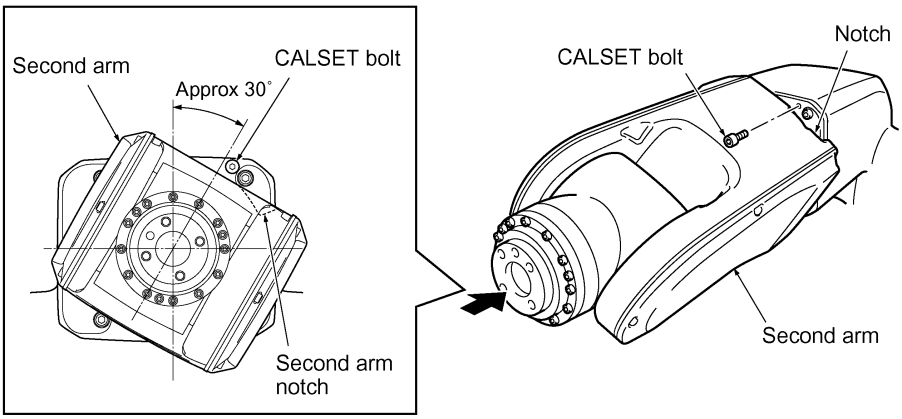
STEP 4

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 Nm ±20%

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

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



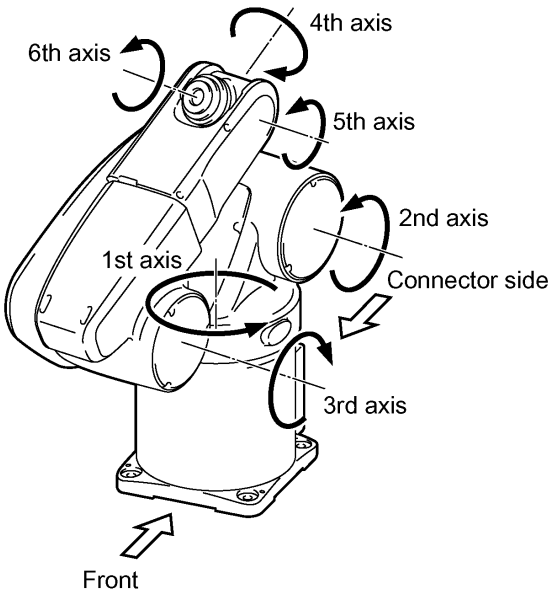
Mounting the CALSET Bolt (VS-G series)

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 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 AT CHANGING THE MECHANICAL ENDS" on page 18.)

2.4.6 CALSET Procedure

2.4.6.1 CALSETing a Single Axis

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

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

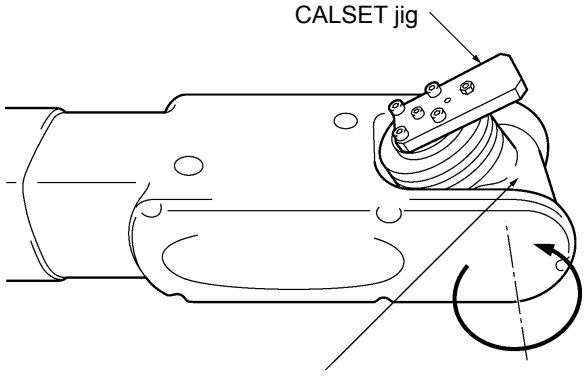
NOTE: Step 1 is required for CALSETing the 4th and 6th axes and Step 2 is for CALSETing the 6th axis. When CALSETing any other axes, skip to Step 3.

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

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

STEP 2
(Required for CALSETing the 6th axis)

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



Turn the 5th axis to its turning end

STEP 3

Turn the power switch of the robot controller to ON.

STEP 4

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

STEP 5

Press MOTOR to turn ON the power to the motor.

STEP 6

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

Releasing brakes

NOTE: For UL-Listed robot units, release brakes referring to Section 1.6 "Releasing Brakes on UL-Listed Robot Units" and then proceed to Step 15.

STEP 7

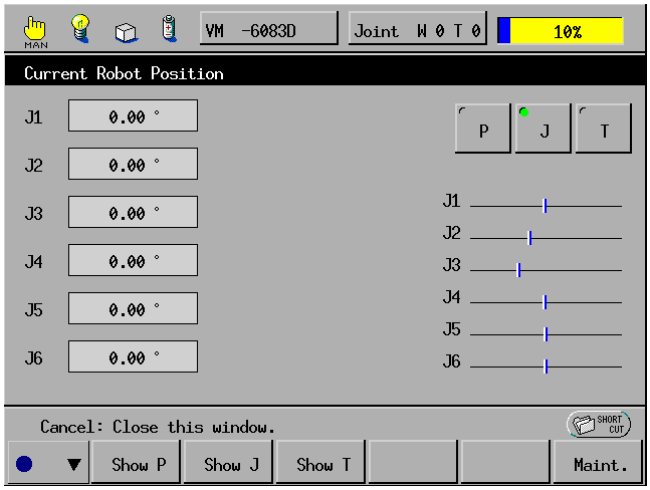
Press the MOTOR key on the teach pendant to turn OFF the power to the motor.

STEP 8

Press [F2 Arm] on the teach pendant.

STEP 9

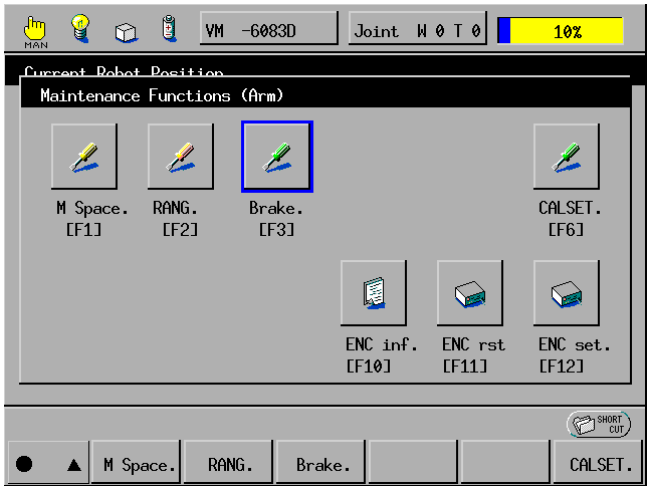
Press the SHIFT key and [F12 Maint.].



F12

STEP 10

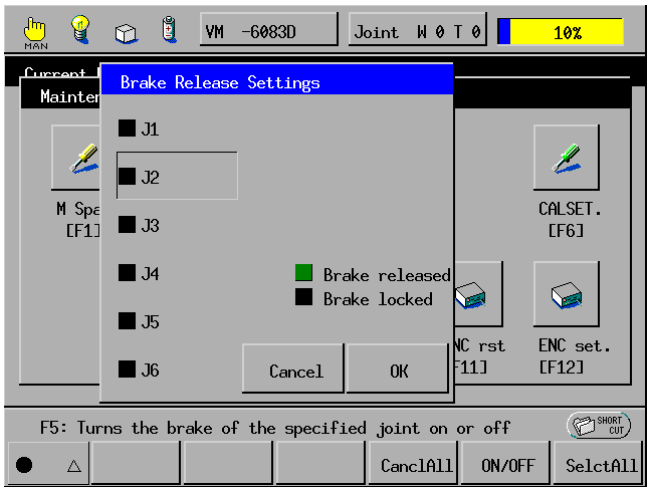
Press [F3 Brake.].



F3

STEP 11

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



STEP 12

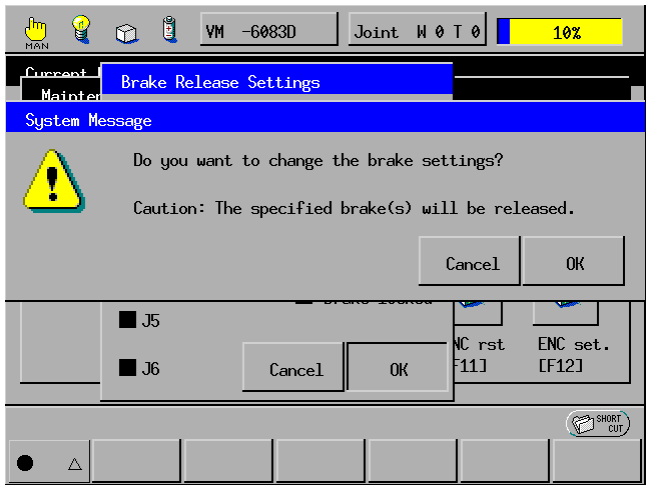
Confirm that there is no danger even if the arms fall as a result of released brakes.

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

STEP 13

Press OK.

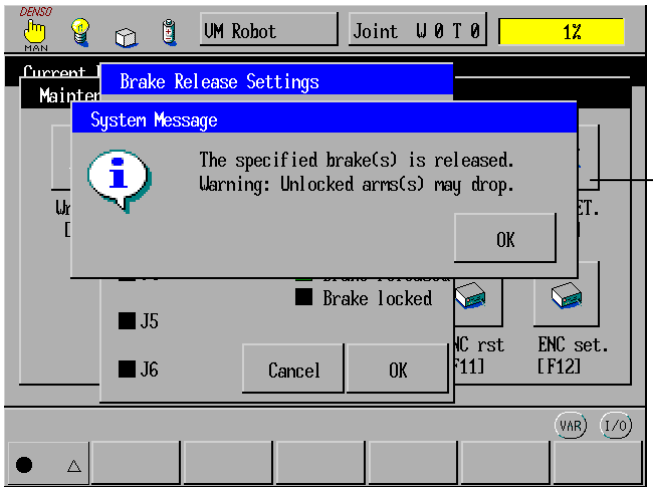
The system message appears asking you whether you want to change the brake settings.



STEP 14

Press OK.

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



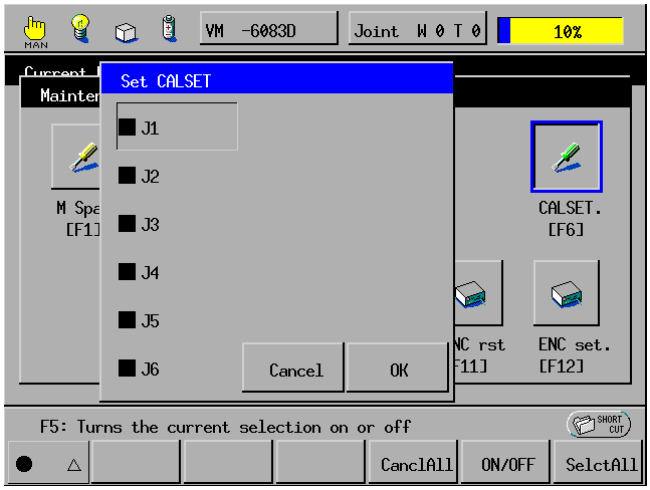
STEP 15

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

STEP 16

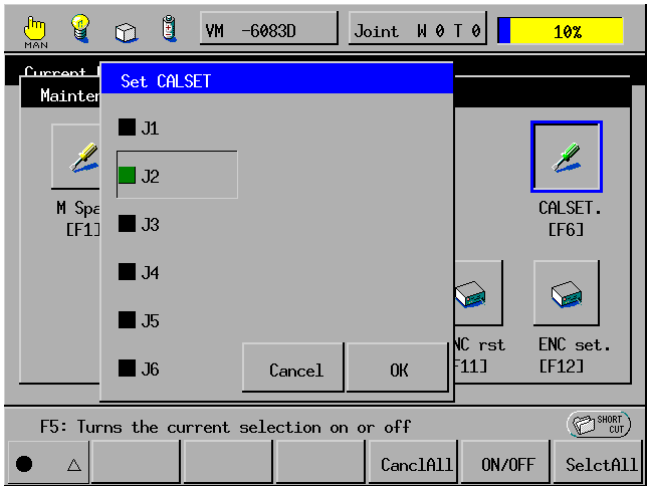
Press [F6 CALSET.].

The Set CALSET window appears.



STEP 17

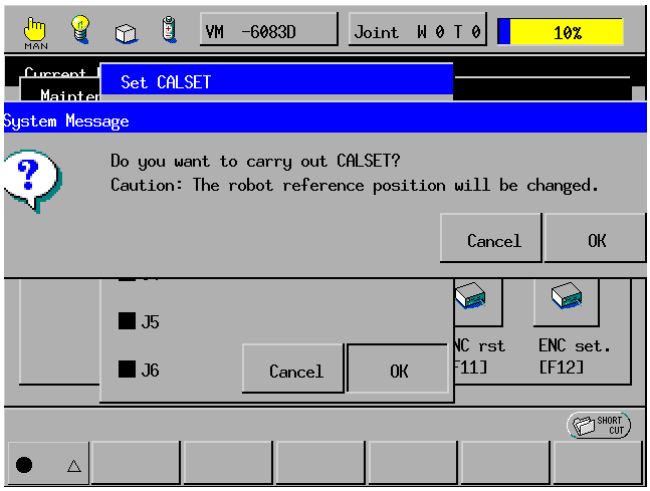
Press the axis number to be CALSET to select CALSET (green display). Deselect CALSET (black display) for the other axes that are not required to be CALSET.



STEP 18

Press OK.

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



STEP 19

Press OK.

The system message appears informing that CALSET is completed.

STEP 20

Press the ROBOT STOP button.

The robot brake becomes activated.

STEP 21

Turn the ROBOT STOP button to cancel robot stop.

STEP 22

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

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

STEP 23

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

STEP 24

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

2.4.6.2 CALSETing All Axes

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

The procedure is the same as that for single-axis CALSET except that you should select all axes when releasing brakes and performing CALSET. For details of the procedure, see Section 2.4.6.1 "CALSETing a Single Axis."

2.4.6.3 5-axis or 6-axis CALSET Procedure for cleanroom type

The flange and cover described are originally attached to the 6-axis of the cleanroom type robot as shown in Figure below. Therefore, perform 5-axis or 6-axis CALSET as follows.

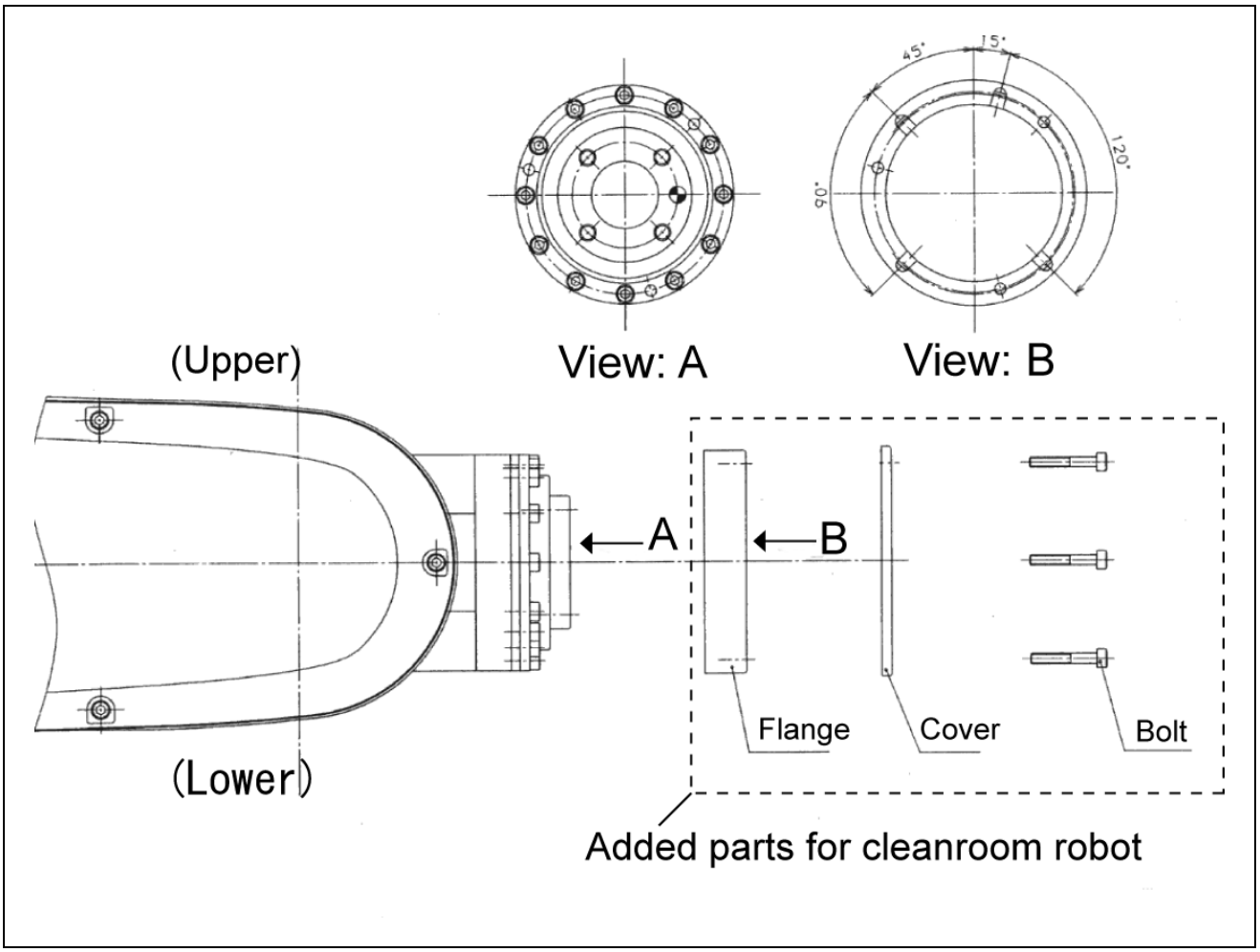
(1) Before performing 5-axis or 6-axis CALSET, remove the flange and cover.

> **Caution: When removing the flange and cover, dusts inside robot may be splashed.**

(2) Perform 5-axis or 6-axis CALSET according to the CALSET procedure described on "VS-G SERIES INSTALLATION & MAINTEANACE GUIDE".

(3) Reinstall the flange and cover using three bolts.

Bolt fixing torque: 1.57 Nm±20%



6-axis of VS-65G-*P100**

2.5 Setting Control Set of Motion Optimization

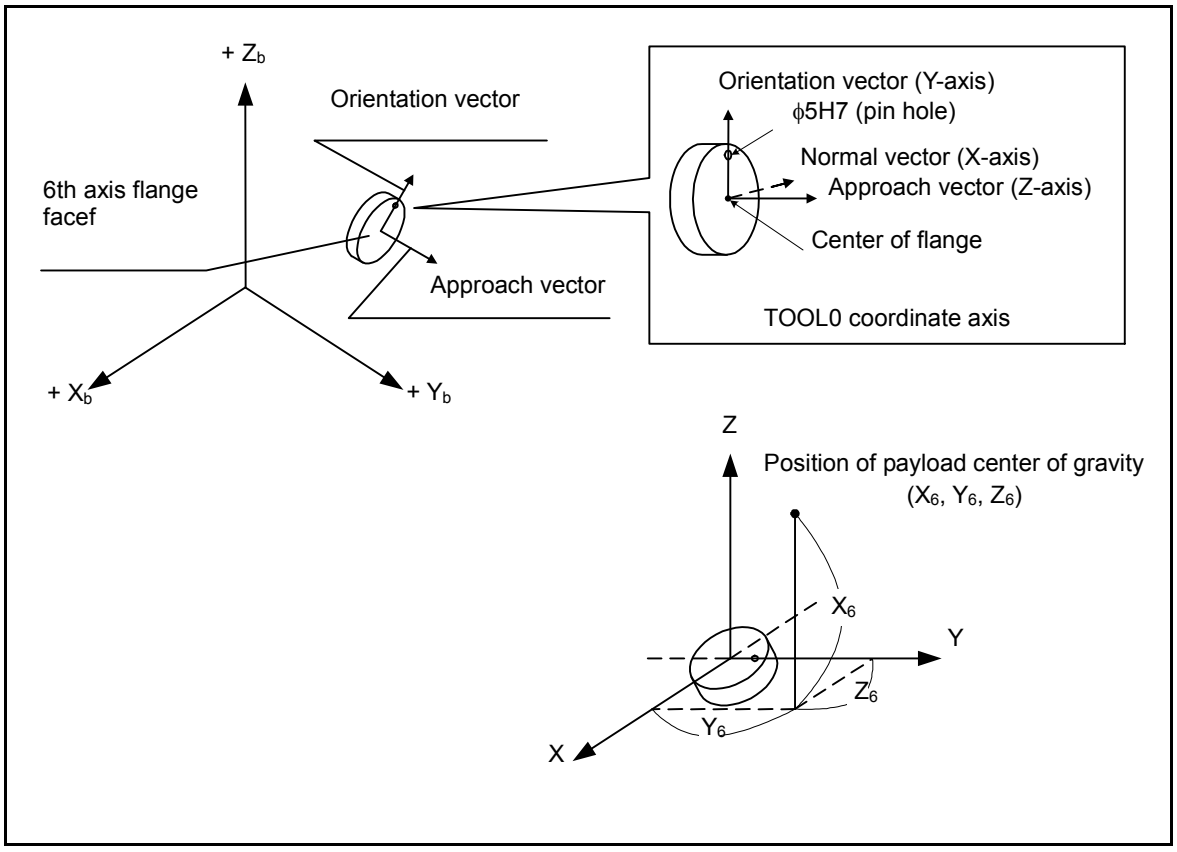
The optimum speed or acceleration will vary depending upon the payload and center of gravity of an end-effector or workpiece that is to be set at the end of the robot flange. Set the payload and center of gravity position of the end-effector or workpiece and the control set of motion optimization according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

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

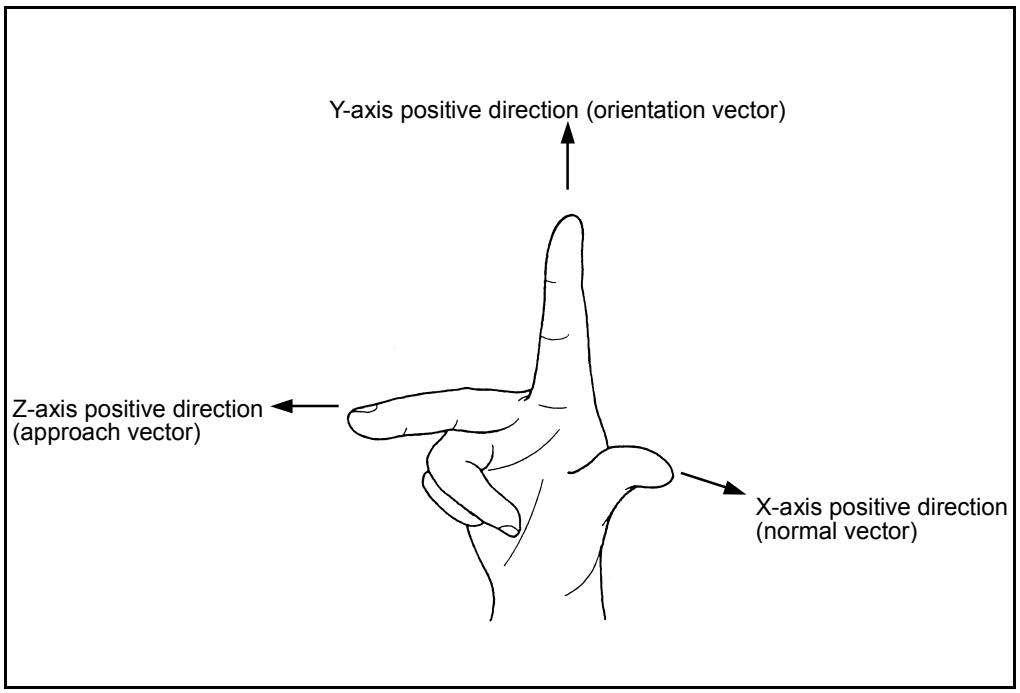
For further information, see the PROGRAMMER'S MANUAL, Section 4.7 "Setting the Master Control Parameters in User Preferences." For the setting procedure, refer to the SETTING-UP MANUAL, Section 2.9 "Setting the Master Control Parameters of the Payload, Center of Gravity, and Control Set of Motion Optimization."

The payload center of gravity is represented by the TOOL0 coordinate system (see 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 ϕ5H7 pin hole (orientation vector direction). The Z-component is in the vertical direction to the flange face across the flange center (approach vector direction). The X-component is in the X-axis direction of the right hand coordinate system (normal vector direction) with the orientation vector as the Y-axis and the approach vector as the Z-axis. (See the figure on the next page.)



Payload Center of Gravity



Right Hand Coordinate System

2.6 Setting Robot Installation Conditions

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

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

For the setting procedure, refer to the SETTING-UP MANUAL, Section 2.10, "Setting the Robot Installation Condition" and the PROGRAMMER'S MANUAL, 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 Section 3.2 every day before starting operations.	To use your robot safely.
2	Quarterly	Perform inspection jobs specified in Section 3.3 every three months.	To maintain the precision of the robot and to prevent failures caused by overheat of the robot controller.
3	Biennial	Replace backup batteries as specified in Section 3.4 every two years.	To retain the robot-specific data (programs, parameters, etc.) stored in the internal memory of the robot controller and the position data stored in the electronic absolute encoder build in the robot unit.

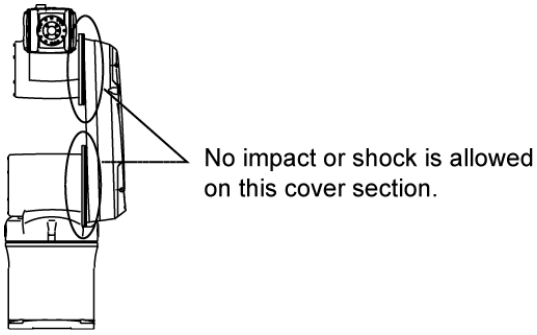
3.1.1 Precautions for installation and maintenance of robots for cleanroom type

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

Jobs requiring special care

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

CAUTION (1) When transporting or maintaining the cleanroom type of robot units, take care not to apply an impact or shock to the cover section specified below. An impact or shock applied to the cover section or the resulting deformed cover section may deteriorate the cleanliness performance.



3.2 Daily Inspections

3.2.1 Check Items

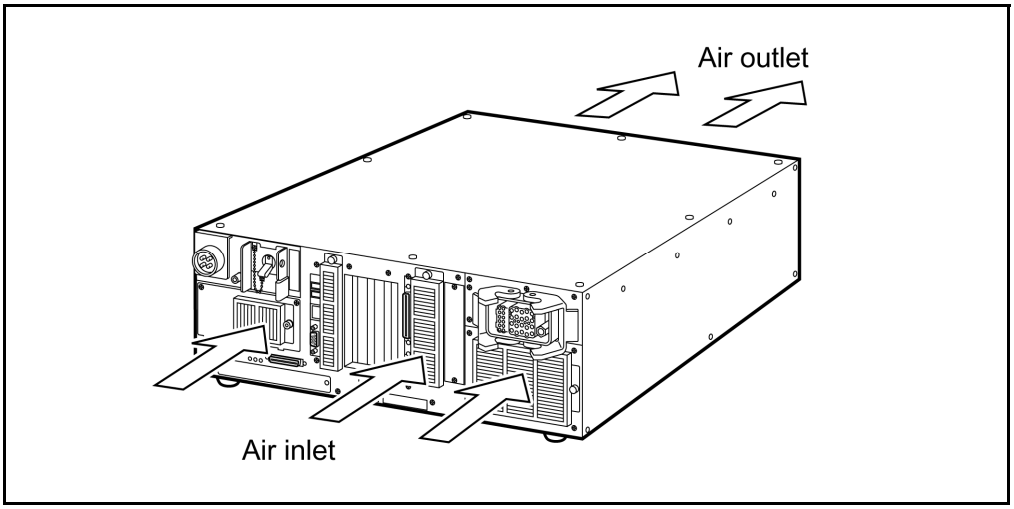
Before starting operation every day, check the items listed in the table below.

Daily Inspections Table

No.	Check:	Controller Power	How to check:	Criterion	What to do: (Note 1)
1	Connectors (CN1 to CN10 on the robot controller) and their mating parts	OFF	Visually	No looseness, disengagement or dirt.	Engage the parts properly and clean them.
2	Cables (connected to CN1 to CN10 on the robot controller) and robot's external cables	OFF	Visually	Free of damage or gouges.	Repair or replace.
3	LCD on the teach pendant	ON	Visually	Properly displayed	Repair or replace.
4	Pilot lamps on the robot controller	ON	Visually	Should light.	Repair or replace.
5	Cooling fan in the robot controller	ON	Visually **(Note 2)**	Should work properly.	Repair or replace.
6	EMERGENCY STOP button on the teach pendant or the mini pendant	ON	Press the EMERGENCY STOP button.	The robot should come to an emergency stop.	Repair or replace.
7	Safety door	ON	Operate the safety door switch and open the switch-wiring door.	The robot should come to an emergency stop.	Repair or replace.
8	Brake release switch on the UL-Listed robot units	OFF	Check for looseness.	No looseness.	Tighten up.
9	Motor ON lamps on the UL-Listed robot units	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)

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, Section 6.4 "Cleaning the Air Intake Filter."

3.4 Biennial Inspections

3.4.1 Battery Replacement and Check Items

Replace the two types of backup batteries listed in the upper table on this page and inspect the timing belts for the 5th and 6th axes shown in the lower table on this page 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 series)

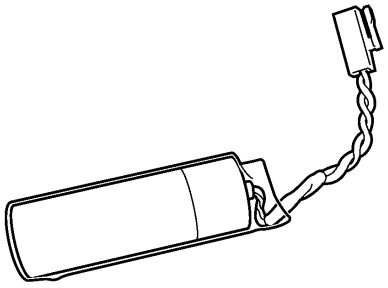
No.	Check:	Controller Power	How to check:	Criterion	What to do:
1	Timing belts on the 5th and 6th axes	OFF	Visually	No lack of teeth or excessive wear.	Contact DENSO, Industrial Systems Product Division.

3.4.2 Replacing the Encoder Backup Battery

Replace the encoder backup battery according to the procedure below.

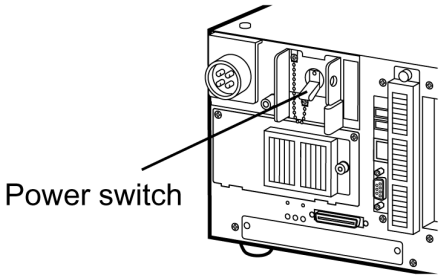
STEP 1

Prepare a new set of 3 backup batteries for replacement.



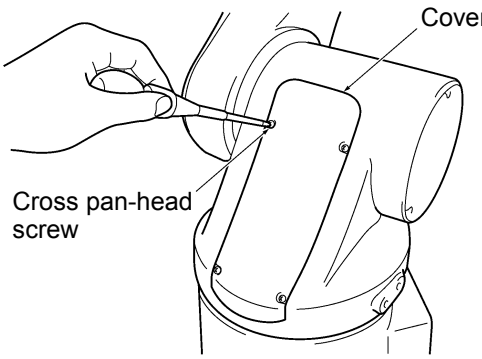
STEP 2

Turn the controller power OFF.

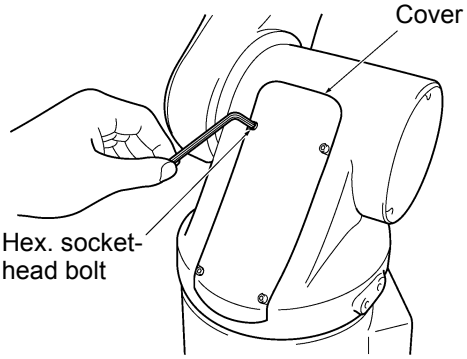


STEP 3

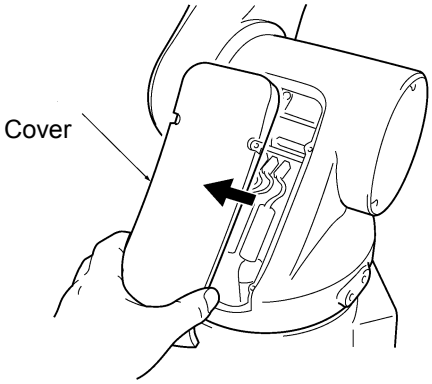
Remove the cover from the robot unit.



Standard type

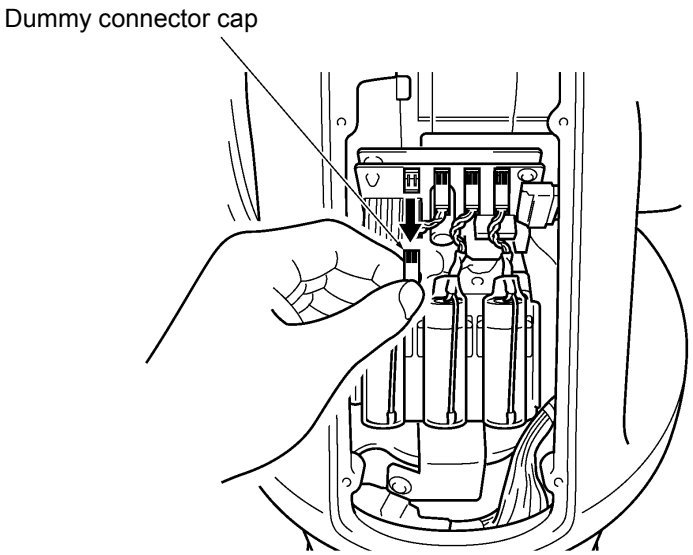


Dust-proof & splash-proof type



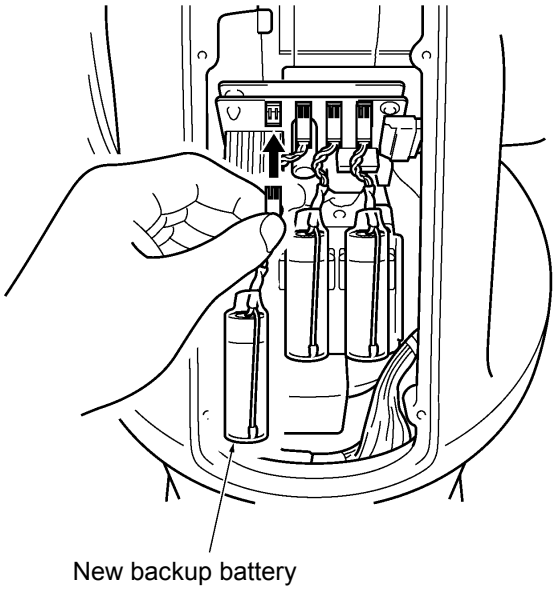
STEP 4

Remove the dummy connector cap from the battery board.



STEP 5

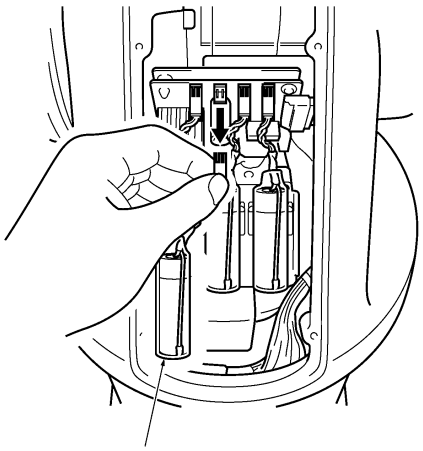
Connect a new battery (1st one) to the pin from which you have disconnected the dummy connector cap in Step 4.



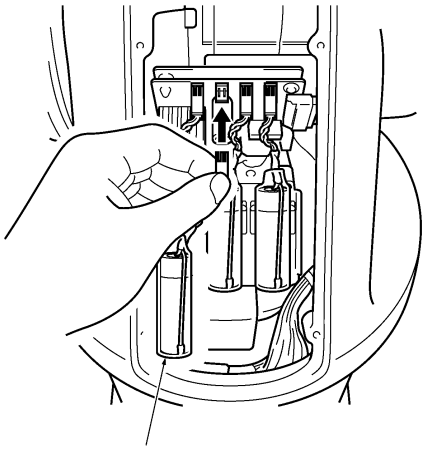
Note: Do not disconnect old backup batteries before connecting a new one to the pin from which the dummy connector cap is removed. If you do so, the encoder positional data may be lost.

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).



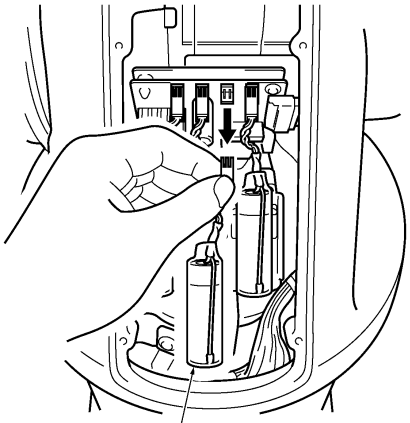
Old backup battery



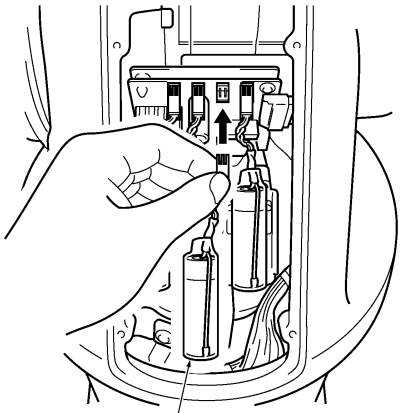
New backup battery

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

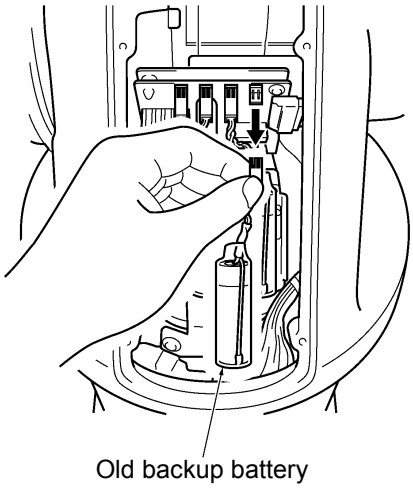


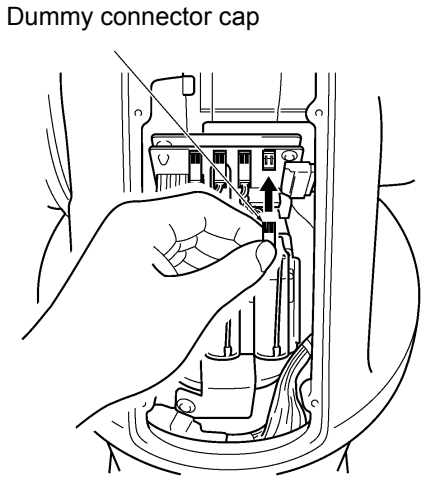
New backup battery

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

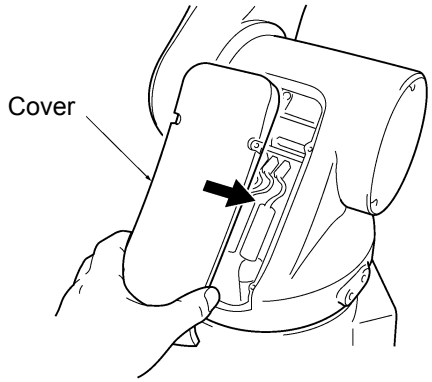
Remove the last old battery and connect the dummy connector cap disconnected in Step 4.

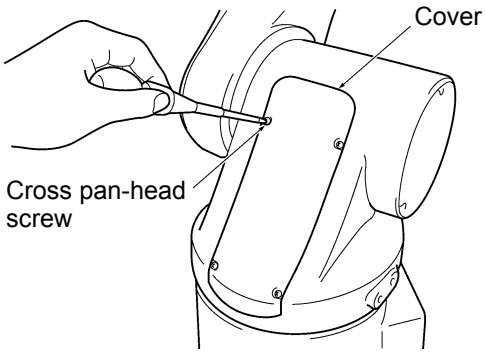




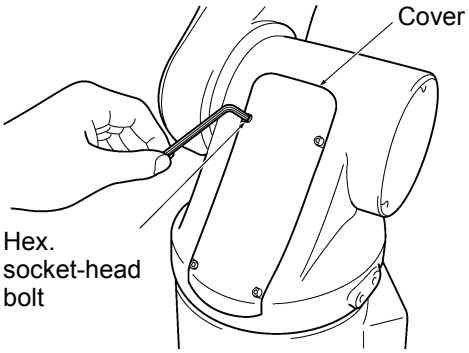
STEP 9

Install the cover to the robot unit.





Standard type



Dust-proof & splash-proof type

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, Section 6.5 "Replacing the Memory Backup battery."

3.4.4 Setting the Next Battery Replacement Date

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

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

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

STEP 1

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

STEP 2

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

STEP 3

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

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

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

STEP 4

Press OK.

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

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

STEP 5

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

3.5 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	410053-0100	For standard type of controllers (FS-1705W)
		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 (NPN)	410077-0010	IC (M54522P) for controller output
6	IC for output (PNP)	410077-0020	IC (M54564P) for controller output
7	Encoder backup battery set	410611-0070	3-battery set
8	CALSET jig	410192-0010	For 6th-axis CALSET

3.6 Replacing Fuses and Output ICs

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

3.7 Checking the Odometer and Trip Meter

You may check the odometer and trip meter which count traversed distance of each axis in the Odometer window of the teach pendant.

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

The Odometer window shows the following items:

[Odometer]	Shows the total distance of each axis traversed after the robot leaves the factory. You cannot reset the odometer.
[Trip meter]	Shows the distance of each axis traversed after you reset the trip meter to zero. You can reset the trip meter by pressing [F6 Reset] in the Odometer window and following the guidance shown on the screen.

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

STEP 1

Turn the controller power ON.

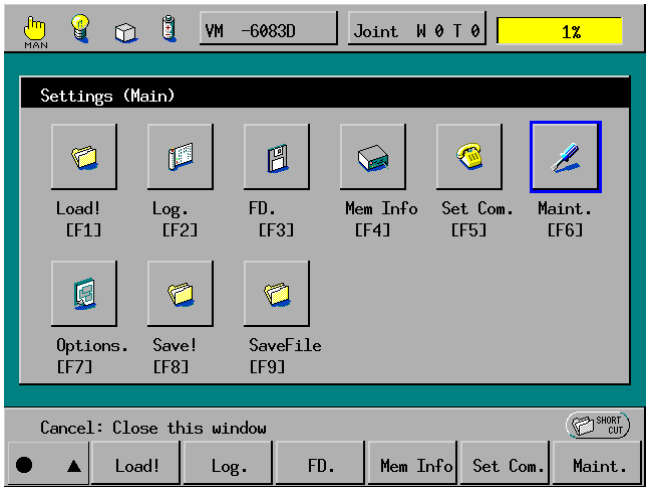
STEP 2

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

STEP 3

On the top screen, press [F6 Set].

The Settings (Main) window appears as shown below.

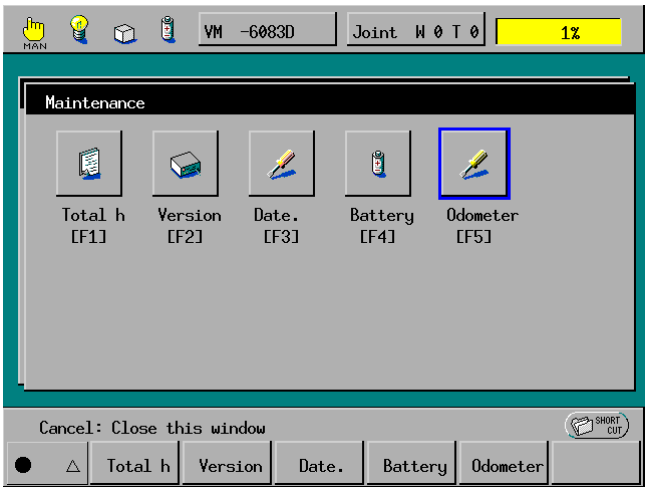


F6

Press [F6 Maint.].

STEP 4

The Maintenance menu appears as shown below.

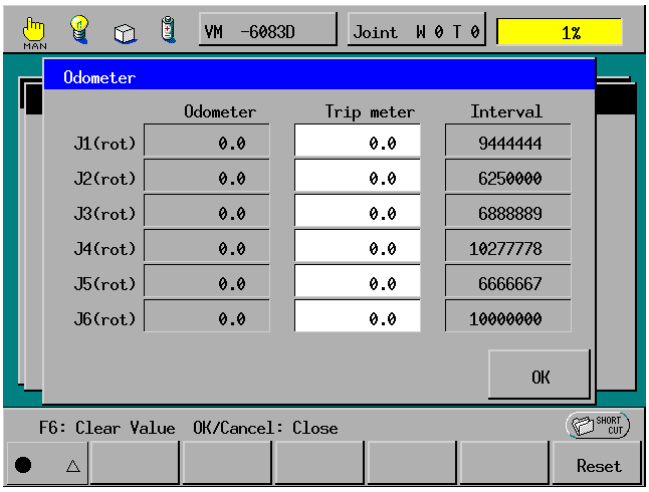


F5

Press [F5 Odometer].

STEP 5

The Odometer window appears as shown below.



F6

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

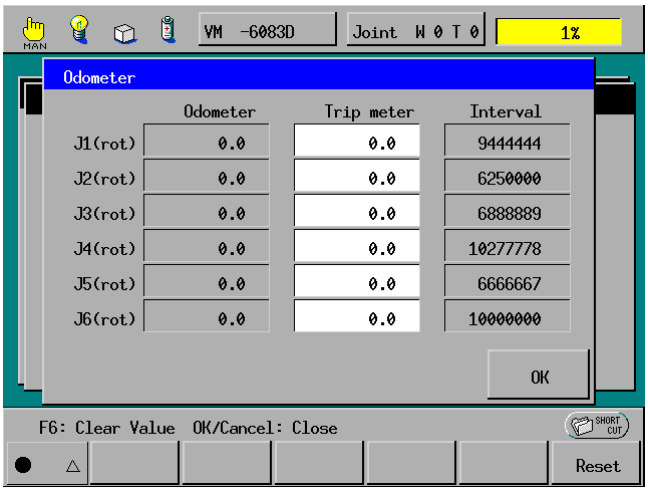
If the Trip meter count exceeds the Interval value, the oil change prompt message will appear.

3.7.2 Resetting the Trip Meter to Zero

STEP 1

Display the Odometer window as shown below.

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

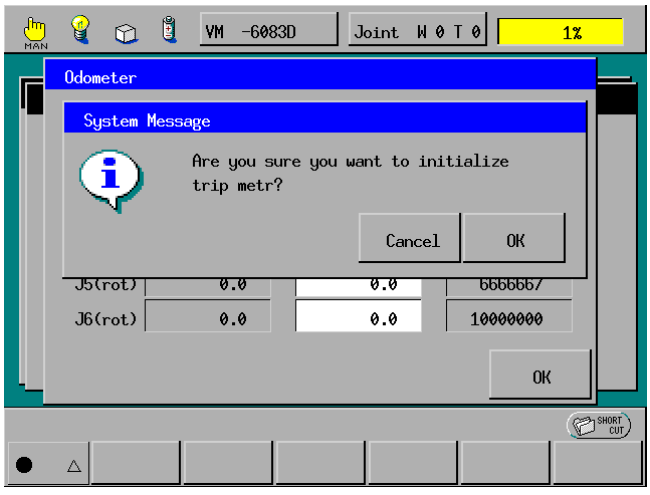


F6

Press [F6 Reset].

STEP 2

The following message appears.



Press the OK button.

The trip meter has been reset to zero.

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

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

The Total hours window shows the following items:

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

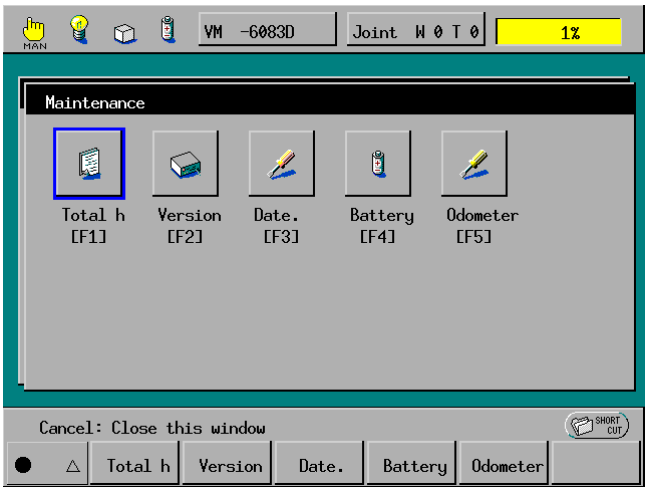
You can reset the user counters of the robot controller ON-time and the robot running time only.

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

STEP 1

Display the Maintenance window as shown below.

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

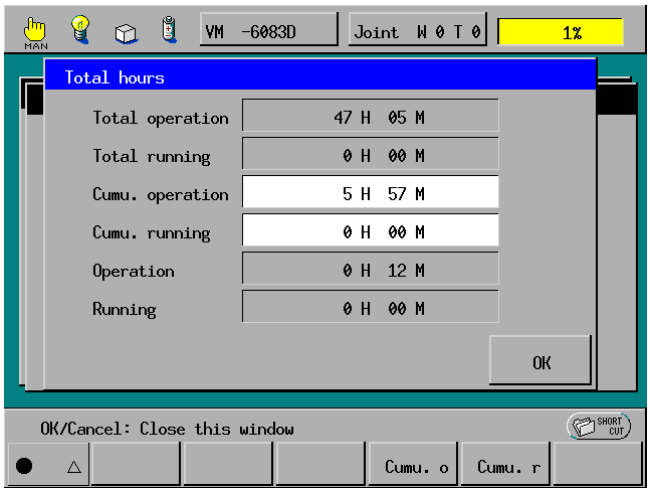


F1

Press [F1 Total h].

STEP 2

The Total hours window appears as shown below.



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

[Total running] Shows the grand total of the robot running time counted after the robot leaves the factory.

[Cumu. operation] Shows the total of the robot controller ON-time counted after you reset the user counter to zero.

[Cumu. running] Shows the total of the robot running time counted after you reset the user counter to zero.

[Operation] Shows the ON-time of the robot controller counted after it is turned ON this time.

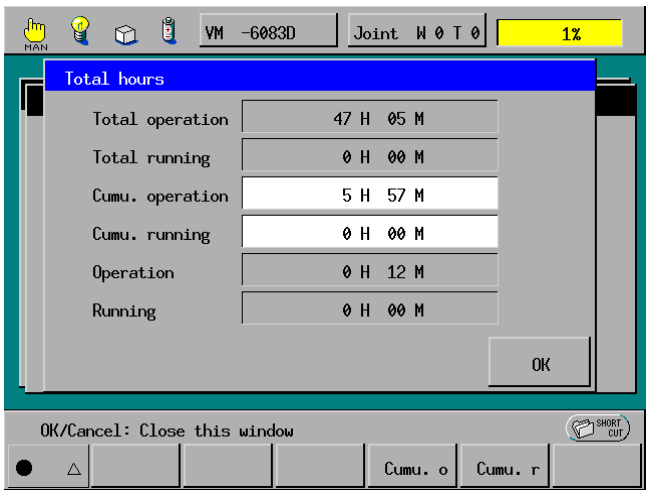
[Running] Shows the running time of the robot counted after the robot controller is turned ON this time.

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

STEP 1

Display the Total hours window as shown below.

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

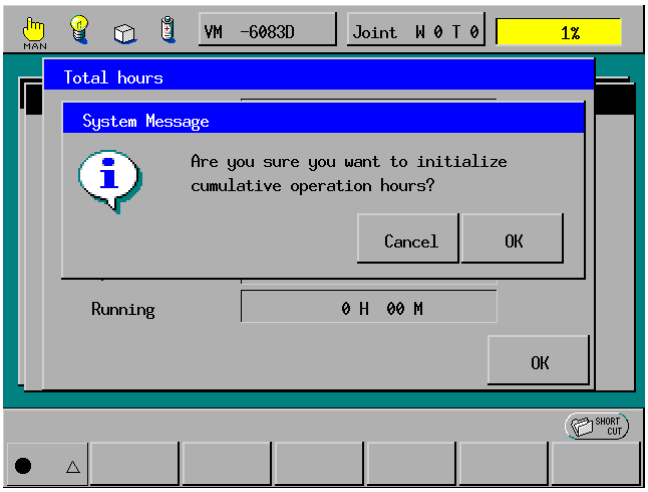


F4

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

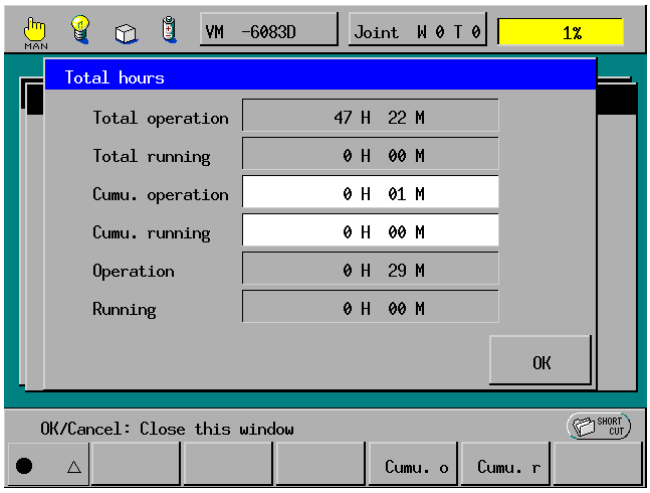
STEP 2

The following system message appears.



Press the OK button.

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



3.9 Resetting Encoders

You need to reset encoders and perform CALSET if:

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

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

This section describes how to reset encoders.

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

3.10 Using the Initialization Floppy Disk

The initialization floppy disk (*.WAM) holds arm data exclusively prepared for your robot.

If CALSET-related data in the robot controller is lost due to exhaustion of the memory backup battery, for instance, use the arm data held in the initialization floppy disk for recovery.

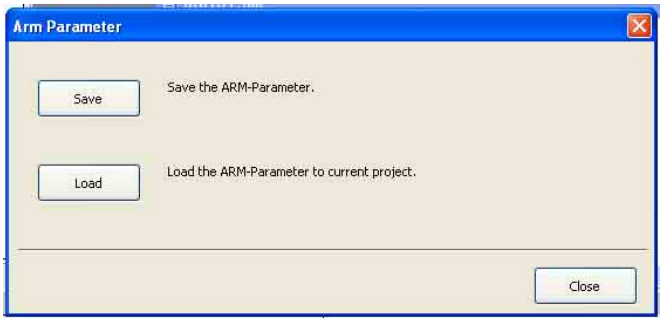
STEP 1

Loading the arm data held in the initialization floppy disk into the WINCAPSIII project

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.

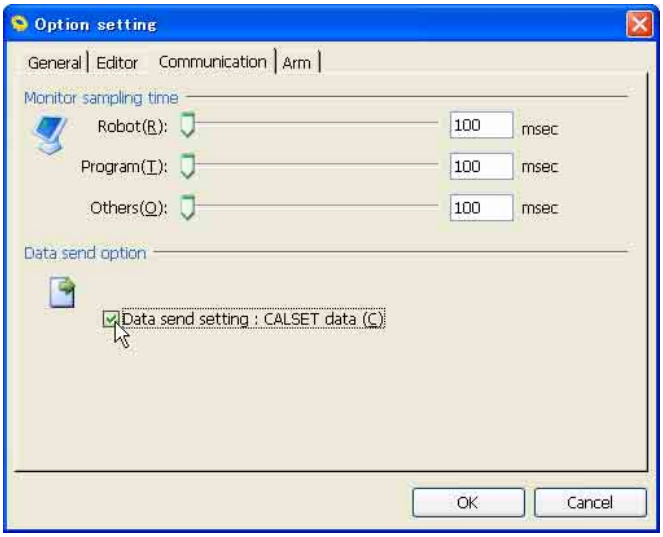
Press Load and select the arm data (***.WAM) held in the floppy disk to load.



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.



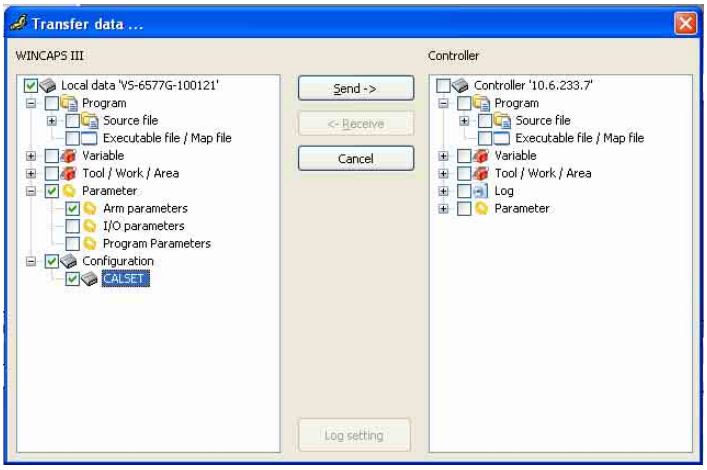
Note: During ordinary operations, the "Data send setting: CALSET data" should be deselected. If it is selected, creating a new project and transferring arm parameters overwrites the CALSET-related data in the robot controller with the transferred data, causing errors in teaching positions.

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.

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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.