DENSO *ROBOT*

Vertical articulated

VP-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 VP-G (Models configured with RC7M controller)	VP-6242G (6-axis type) VP-5243G (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 VP-6242G, for example, the robot unit model is VP-6242E/GM.

Important

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

NOTE:

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

How this book is organized

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

Chapter 1 Installing Robot Components

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

Chapter 2 Customizing Your Robot

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

Chapter 3 Maintenance and Inspection

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

Contents

Chapter 1 Installing Robot Components

1.1   Preparing a Proper Environment for Installation

Before installing the robot unit and robot controller, confirm that the operating environment is in conformity with each item of SAFETY PRECAUTIONS, "Installation Precautions". Also, take proper measures to protect the components from vibration.

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

1.1.1   Ambient Temperature and Humidity

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

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

1.1.2   Vibration

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

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

1.1.3 Connecting the Robot Unit and Robot Controller

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

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

1.1.4 Installation Environment of the Robot Unit

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

> ⚠**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 (190 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 6.
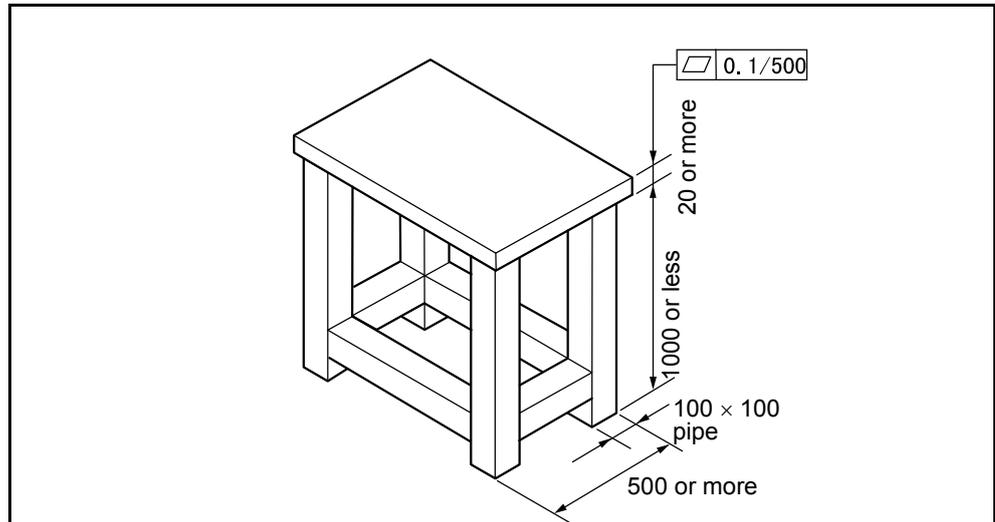
> ⚠**Caution** (1) When the robot operates at high speed, the robot mount undergoes large reaction forces. The mount must be rigid enough so that it will not vibrate or be displaced due to reaction forces. It is also advisable to mechanically join the robot mount with heavy equipment.
>
> (2) Some mounts 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
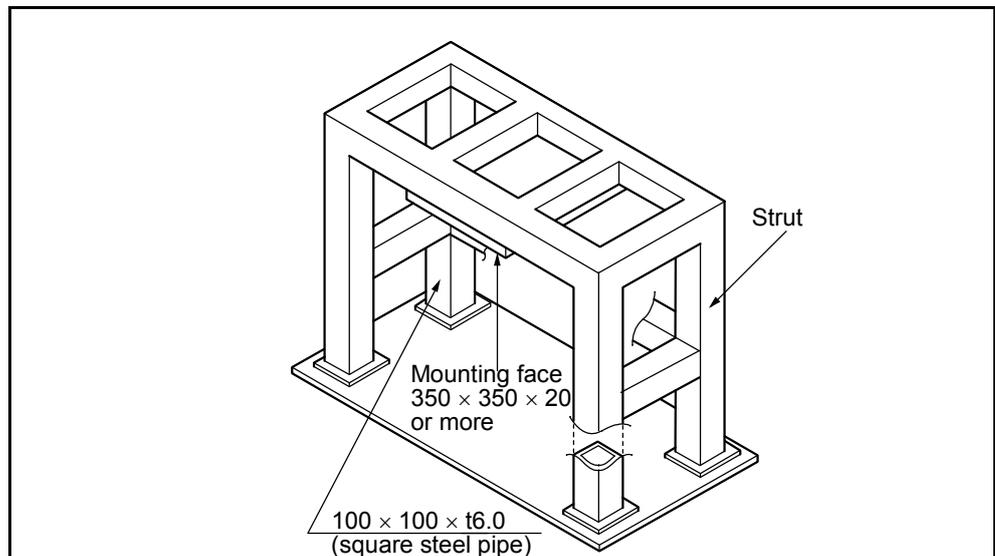
> ⚠**Caution** (1) When the robot operates at high speed, the top plate structure undergoes large reaction forces. Design the vibration-proof mount so that the top plate will not vibrate due to reaction forces. Also design the top plate structure so that it separates from other top plate structures in 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

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1.2　Mounting the Robot Unit

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

1.2.1　Transporting the Robot Unit

An arm fixing plate is used to secure the robot arms during transportation from the factory and should be removed after installation.

> Caution: The robot unit should only be moved prior to installation if the arm fixing plate is in place. The arm fixing plate should also be affixed if there is the possibility of great impact being applied to the robot unit during transportation. (See the table below for axes angles when affixing the arm fixing plate.) If the robot unit is subjected to significant impacts when the arm fixing plate is not in place, the arm angles may shift slightly and cause Error 6773 to be displayed on the controller. Encoder resetting and CALSET must be performed if this occurs.
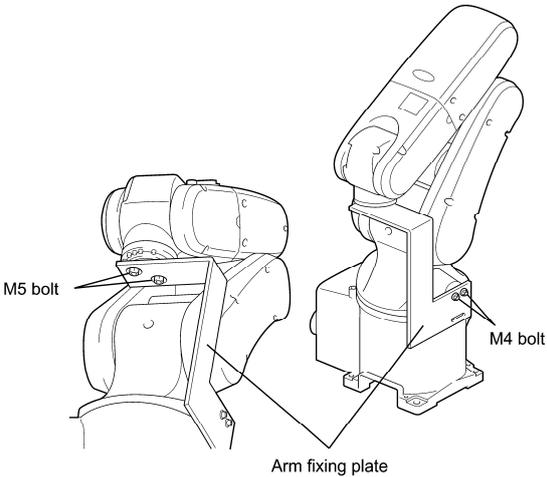
Axis angles when affixing the arm fixing plate (degrees)

Axis	VP-6242G	VP-5243G
J1	-90.0000	-90.0000
J2	-40.0420	-39.9915
J3	158.9266	128.9209
J4	0.0000	-
J5	61.1154	91.0706
J6	0.0000	0.0000

Note: Release the brake for all axes after affixing the arm fixing plate to ensure that stress is not applied to the individual axes.

Robot Unit and Arm Angles When Packaged (When securing the arms with the arm fixing plate)

The VP-G robot unit weighs approximately 15 kg (32 lbs), making it possible for the unit to be moved by one person. Always exercise the necessary level of care and attention when moving the robot unit.
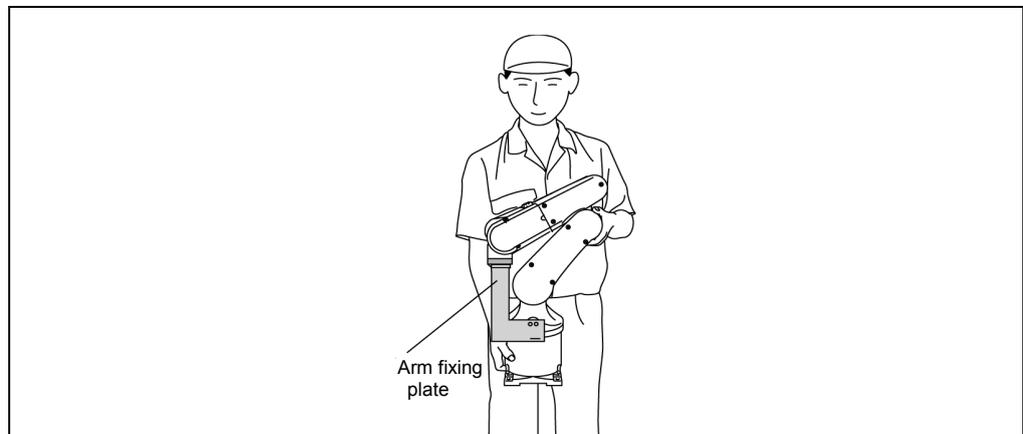
Handling the VP-G Robot Unit

1.2.2   Securing the Robot Unit

(1) Drill four bolt holes (M8) 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.

(5) Secure the robot unit to the mount with four bolts and plain washers.
· Bolt: M8 $\times$ 30 mm (strength class: 12.9)
· Tightening torque: 35 $\pm$7 Nm

Base mounting face (Top view)

160

135

49±0.05   140

2-ϕ6H7 $^{+0.012}_{0}$
(Reference hole)

4-ϕ10

Front

144±0.05

135

160

Connector side

R10

Reference hole (2-ϕ6H7 $^{+0.012}_{0}$)

(Unit: mm)

Diamond-shaped pin

Bolt Positions for Securing the Robot Unit (VP-G series)
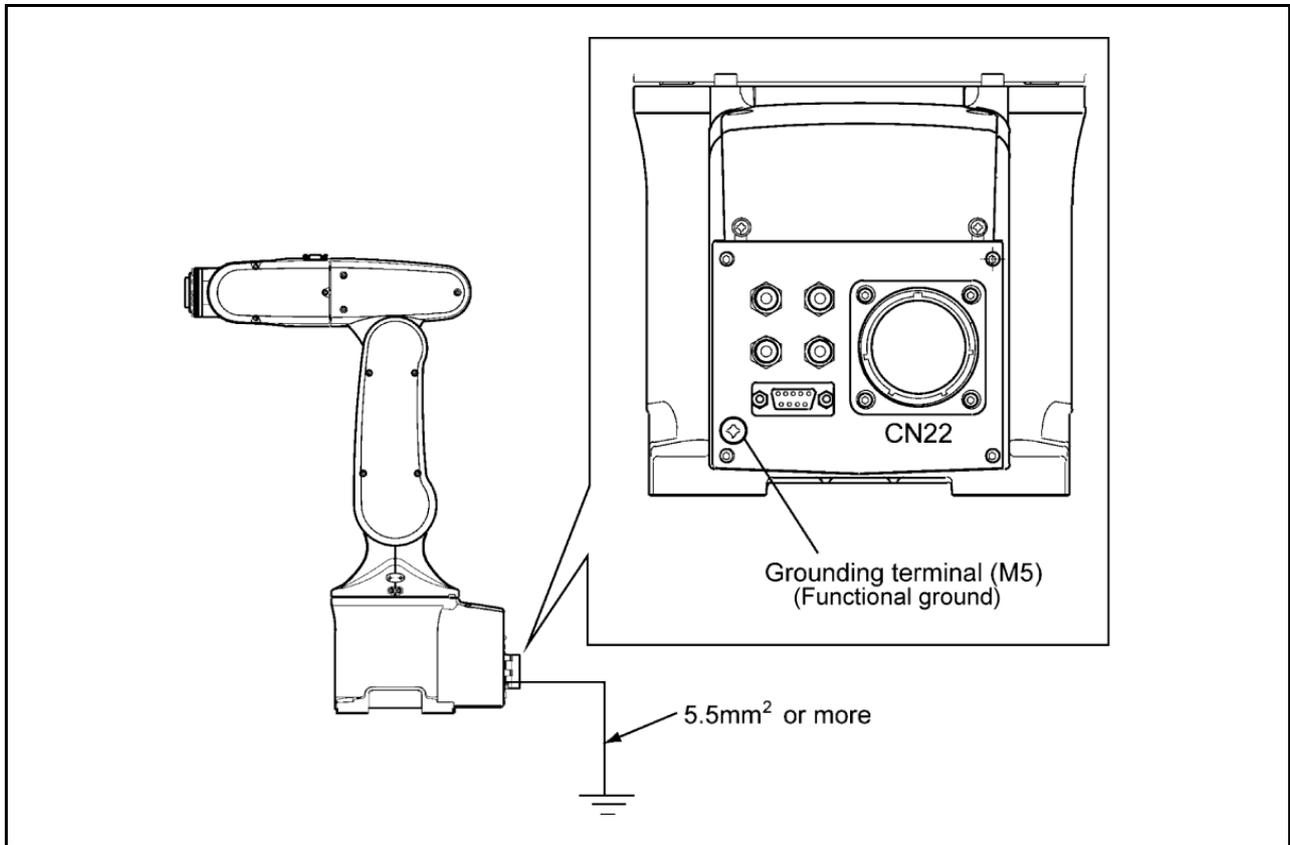
5

1.2.3   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 (VP-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   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.**

Power OFF
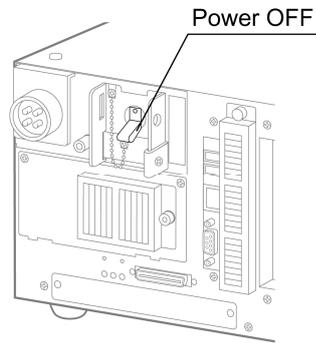
Step 2 | **Remove the lockout bar provided on the robot controller.**
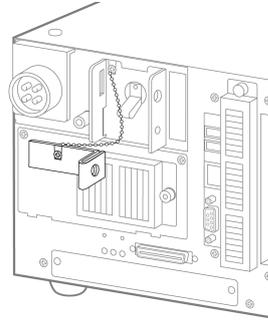
Step 3 | **Put the lockout bar on the upper side of the power switch.**
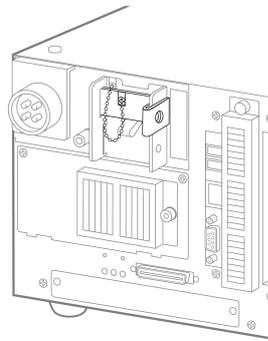
Step 4 | **Padlock the lockout bar.**
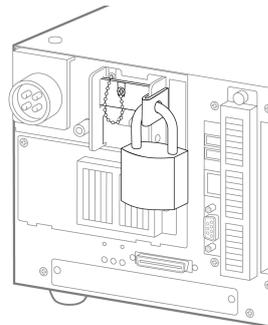
Chapter 2 Customizing Your Robot

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.
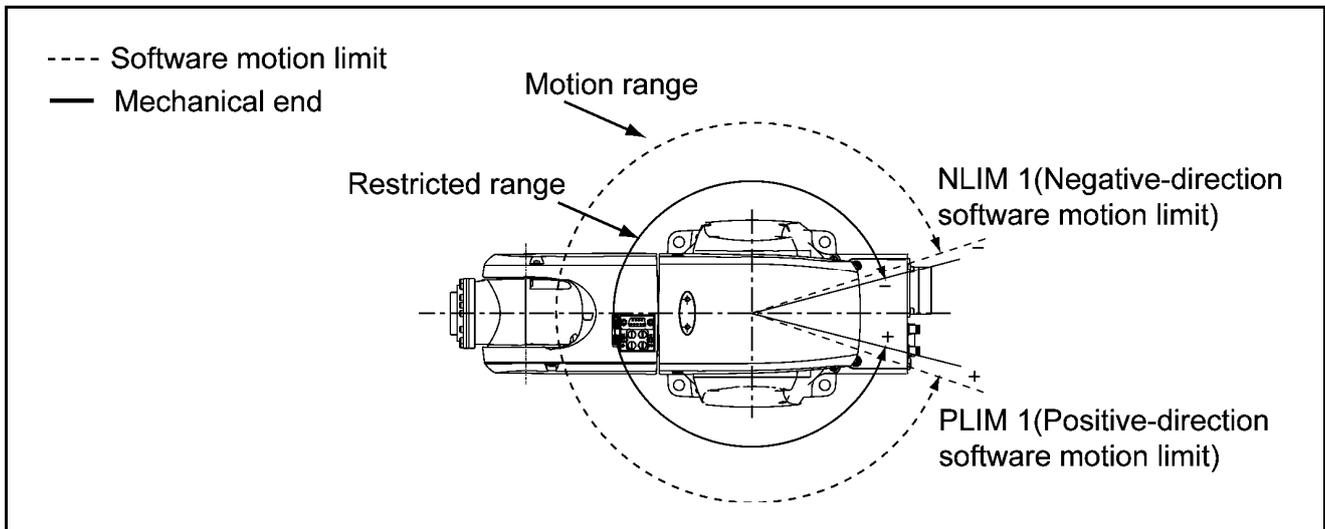
Software Motion Limits and Mechanical Ends

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 (VP-G series)

Robot model		1st axis	2nd axis	3rd axis	4th axis	5th axis	6th axis
VP-6242G	Positive direction	160°	120°	160°	160°	120°	360°
	Negative direction	-160°	-120°	19°	-160°	-120°	-360°
VP-5243G	Positive direction	160°	120°	136°		120°	360°
	Negative direction	-160°	-120°	-128°		-120°	-360°

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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.
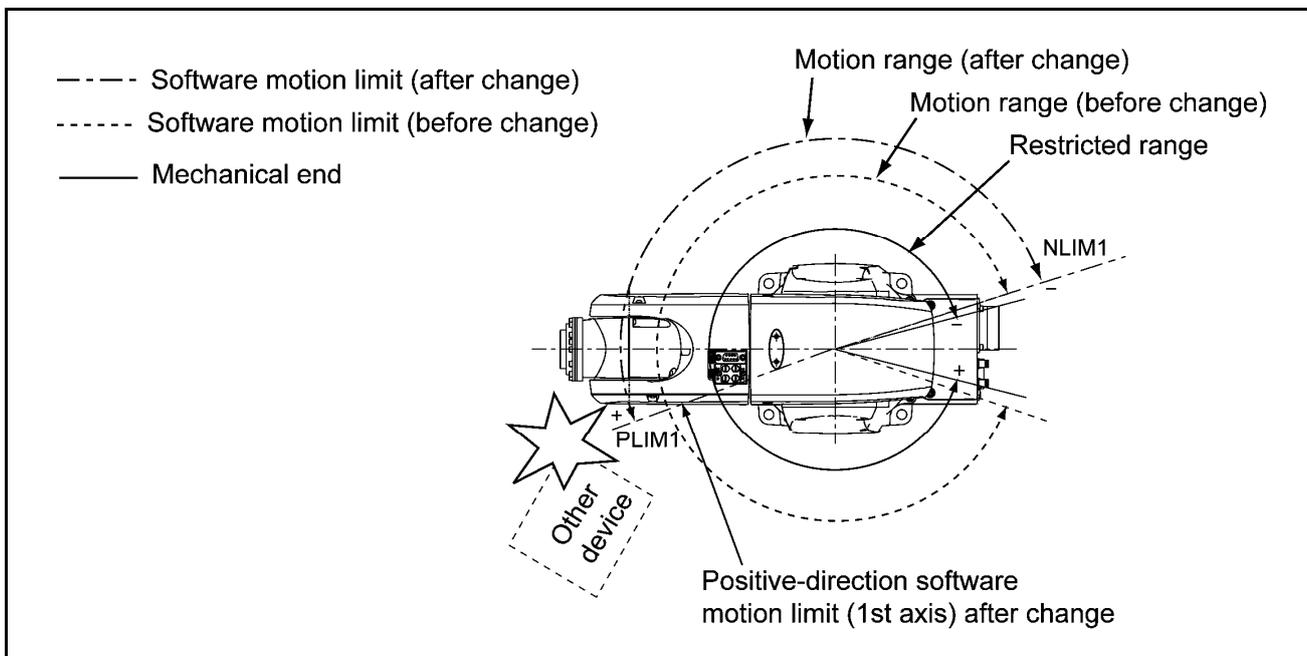
Example 1: Changing Software Motion Limits

Example 2: Changing Software Motion Limits

2.2.4　Precautions When Changing the Software Motion Limits
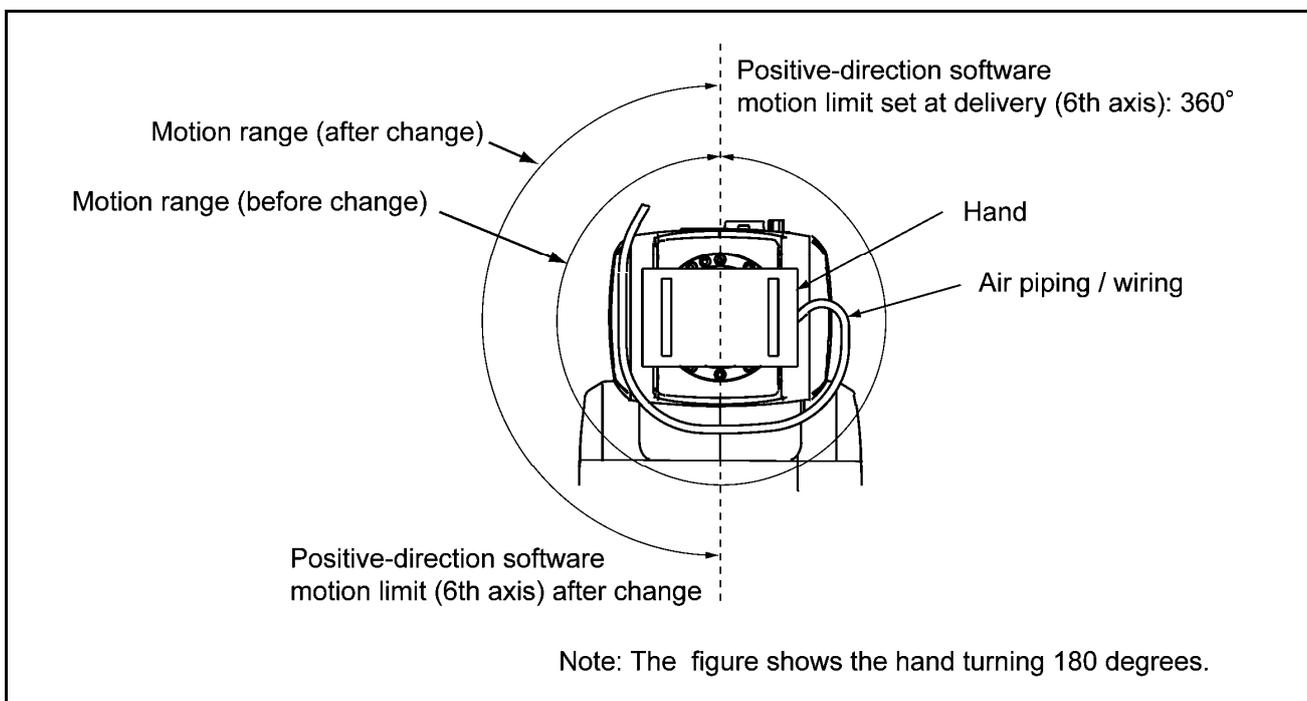
(1) The software motion limits are invalid until CAL is completed.

(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.**
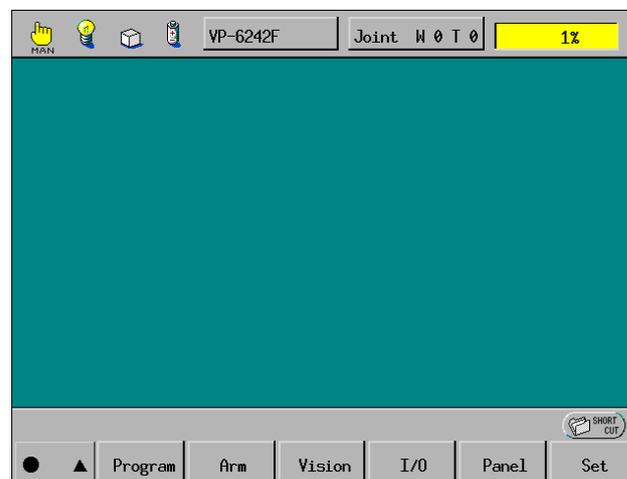
F2

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

11

STEP 4

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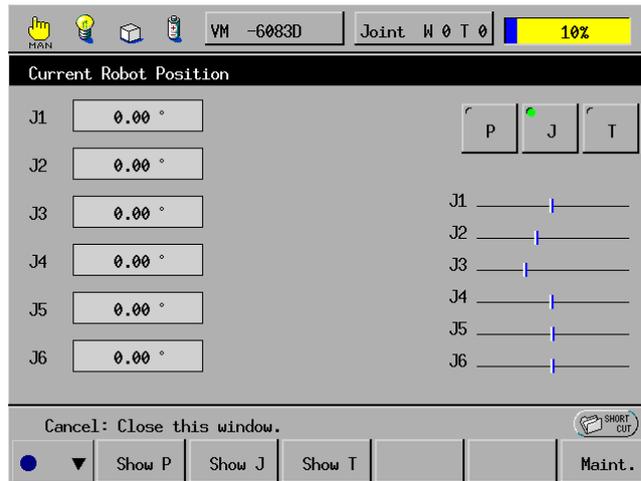
F12

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.
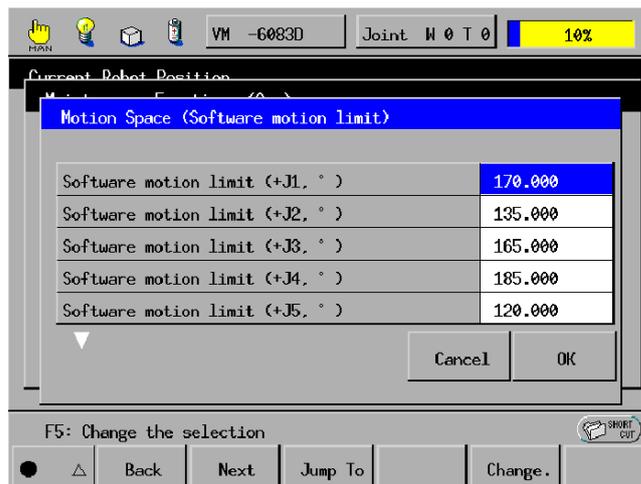
F5

STEP 6

Select the item to be modified, then press [F5 Change].

The numeric keypad will appear as shown below.
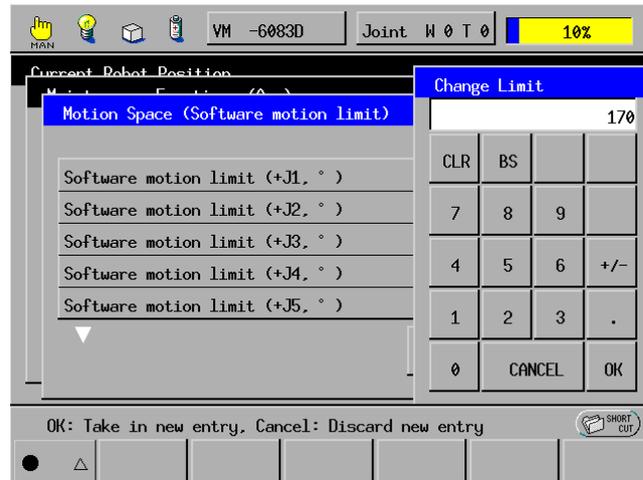
Enter a desired value using the numeric keys, then press OK.

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

Adding mechanical stops to change mechanical ends is called "Mechanical end change."

You may change mechanical ends on the 1st through 3rd axes.

Regarding to the additional mechanical stopper installation, you may need to prepare and install the stopper on your own.

Please contact your DENSO representative for more details.

⚠ **CAUTIONS AT CHANGING THE MECHANICAL ENDS**

1. **When changing the mechanical ends, design the mechanical stoppers according to your usage and manufacture them.**
2. **After changing the mechanical end, the software motion limits (PLIMs, NLIMs) should be changed not to interfere the mechanical end at the robot operation.**
3. **When the robot has collided with a mechanical stopper, contact us for inspection and repairs before using the robot because the robot may be damaged.**
   Also because the mechanical stopper designed and made by the customer may be damaged, do not reuse the mechanical stopper, but replace it before using the robot.
4. **The reference drawings described on this manual cannot be covered on the customer's usage conditions sufficiently. Design, manufacture and install the mechanical stoppers according to your usage conditions.**
5. **The weight addition by the mechanical stoppers may affect the maximum payload.**
6. **The failures caused by the mechanical stoppers shall not be covered by the warranty even if the robot is under warranty.**

NOTE: This manual does not include reference diagram of mechanical stoppers. Please contact your DENSO representative for more details.

2.4 CALSET

2.4.1 What Is CALSET?

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

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

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

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

2.4.2 Cautions at CALSET

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

Caution:	**(1) To CALSET the 6th axis having no mechanical stop, you need to mount the CALSET jig on the axis.**
	(2) 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. In the VP-G series, each of all axes has a brake.
	(3) When performing CALSET, be careful with the robot motion. The execution of the CALSET command releases motor brakes so that the robot arms will move by its own weight.
	(4) After CALSET, confirm in the manual mode that each axis stops at the software motion limit before coming into contact with the mechanical end.
	(5) In automatic operation, start to run the robot at low speed. Ensuring safety, gradually increase the speed. It makes adjustment easy.
	(6) Position-related data in some programs made before CALSET may vary somewhat after CALSET.
	(7) If the RANG values have not been changed after a mechanical end change, remove the changed mechanical end(s) before performing CALSET.

2.4.3 Mounting the CALSET Jig

To CALSET the 6th axis having no mechanical stop, you need to mount the CALSET jig on the axis.

Mounting the CALSET jig on the 6th axis

STEP 1

Fit a stopper pin in the CALSET jig.

Outline View

CALSET jig   Knock Pin   Pin 3 for VP-F/ VP-G/ VS-E/ VS-G
Pin 2 for VC-E
Pin 2 for VS-C/-D
Stopper Pin   Pin 1 for VS-B

Dimensions

10

Pin 3 for VP-F/ VP-G/ VS-E/ VS-G

40

Pin 2 for VC-E

90

Pin 2 for VS-C/-D

Pin 1 for VS-B

Type of Stopper Pin

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

Unit: mm

M6   A   B ϕ13   10
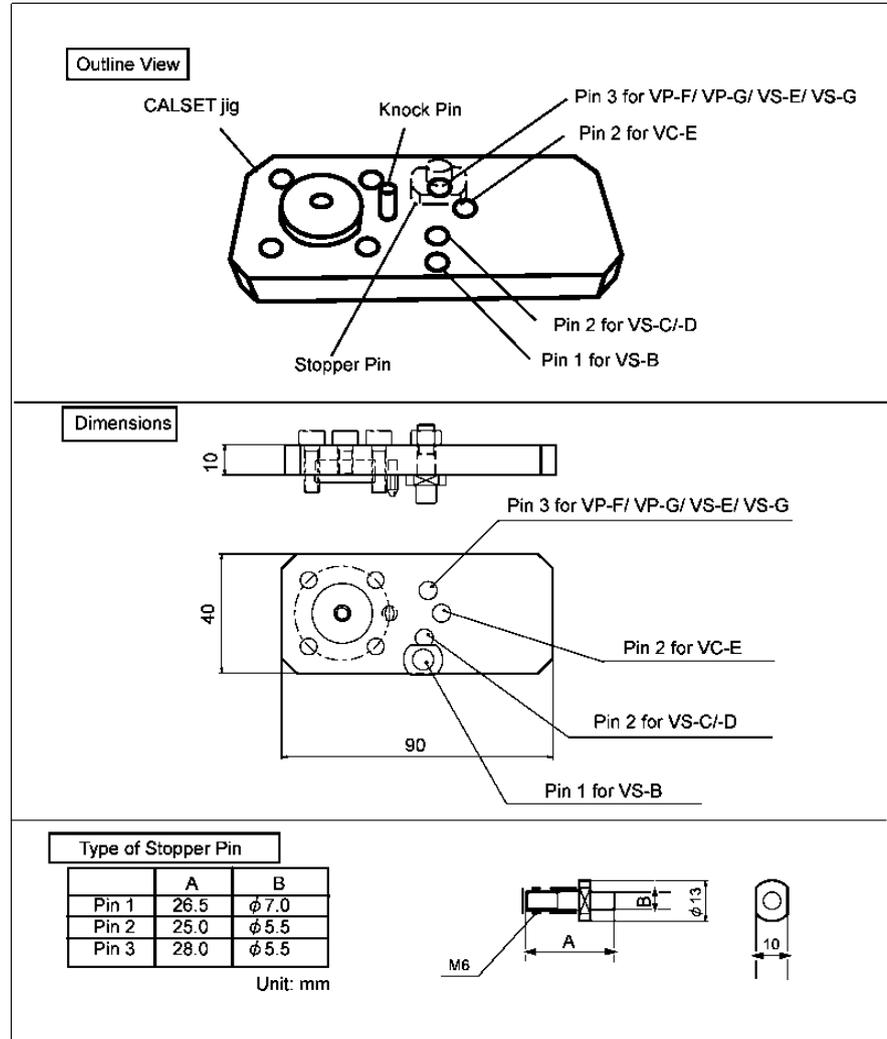
STEP 2

Release the brake of the 6th axis.

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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.
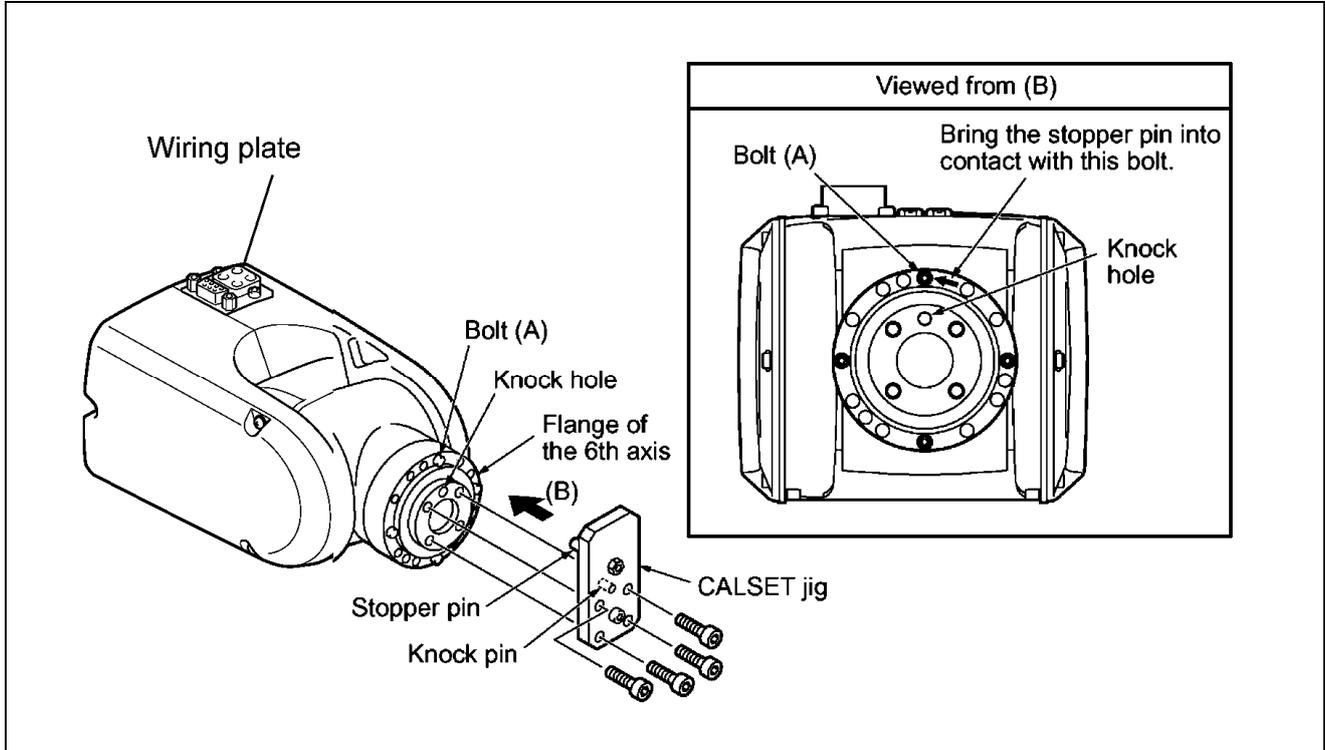

Mounting a CALSET Jig

2.4.4 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.

<VP-6242G>

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 (counterclockwise end when viewed from the arm end)
	5th axis	Turning end in the positive direction
	6th axis	Turning end in the positive direction, which is set by a CALSET jig.
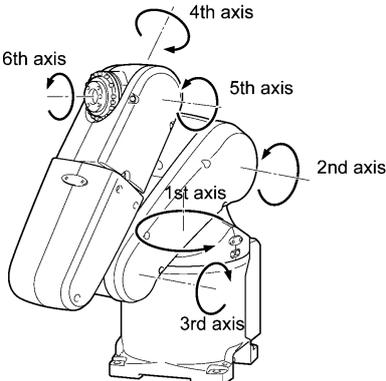
CALSET Positions (VP-6242G)

<VP-5243G>

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
	5th axis	Turning end in the negative direction
	6th axis	Turning end in the positive direction, which is set by a CALSET jig.
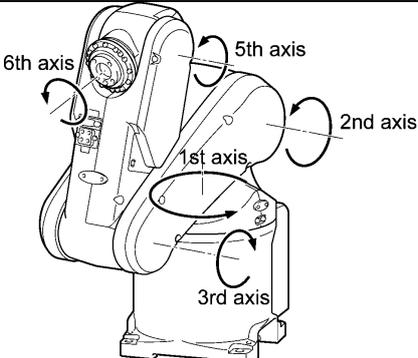
CALSET Positions (VP-5243G)

Caution for using customized mechanical ends:

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

2.4.5 CALSET Procedure

2.4.5.1 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.

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 MOTOR to turn ON the power to the motor.

STEP 4

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

STEP 5

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

STEP 6

Press [F2 Arm] on the teach pendant.

STEP 7

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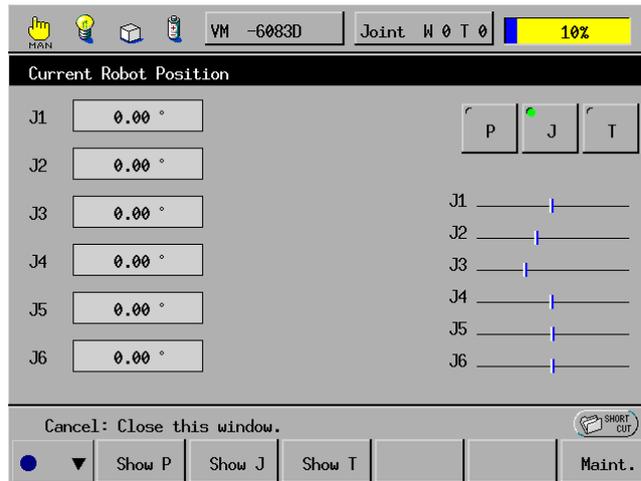
F12

STEP 8

Press [F3 Brake.].
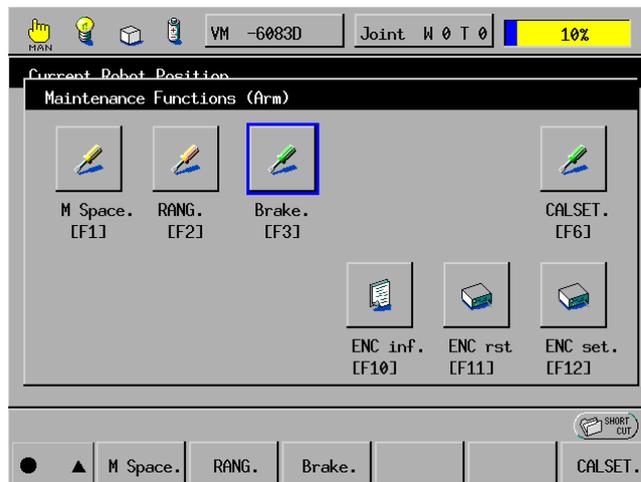
F3

STEP 9

Touch the axis number to be CALSET to select "Brake released" (green display).
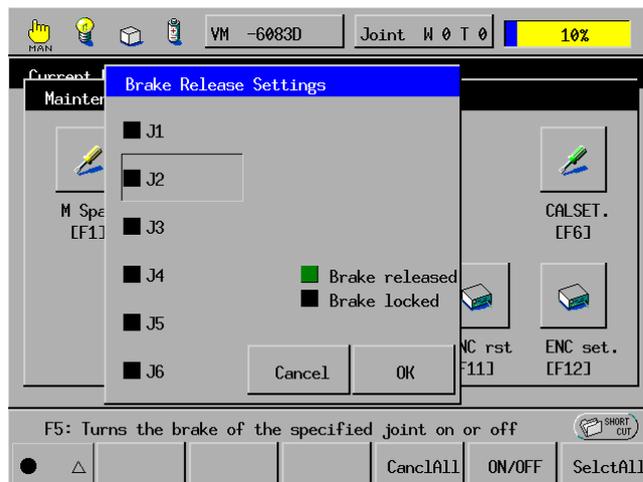
STEP 10

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

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

STEP 11

Press OK.

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

STEP 12

Press OK.

The system message appears informing that the brake is released and warning against drop of arms.
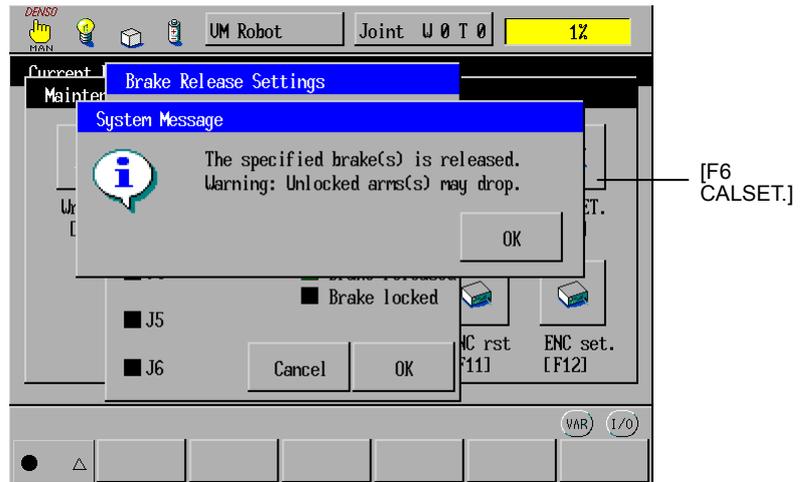
[F6 CALSET.]

STEP 13

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

STEP 14

Press [F6 CALSET.].

The Set CALSET window appears.
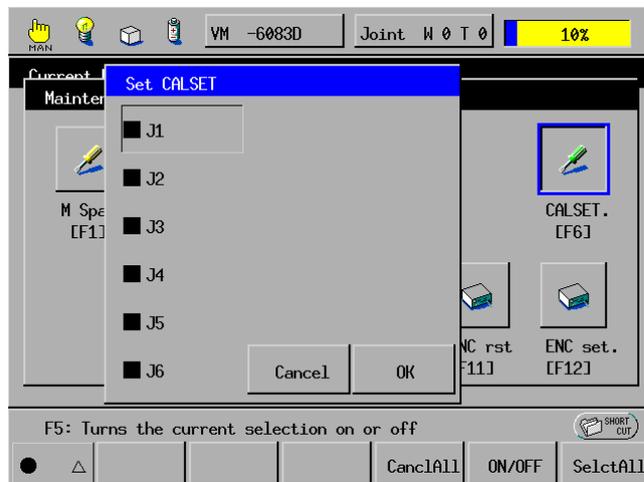
STEP 15

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.
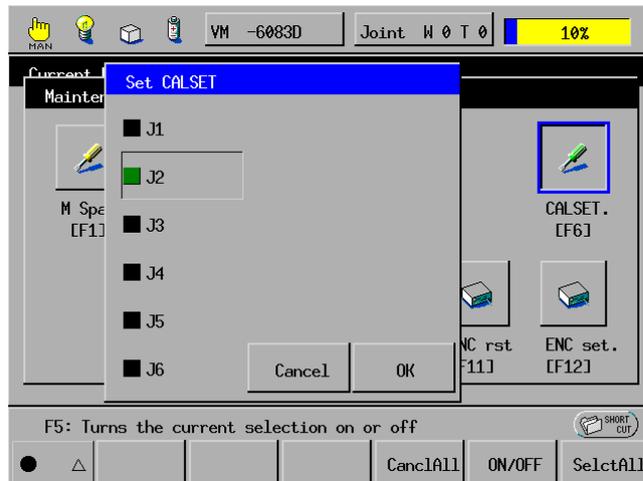
STEP 16

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.
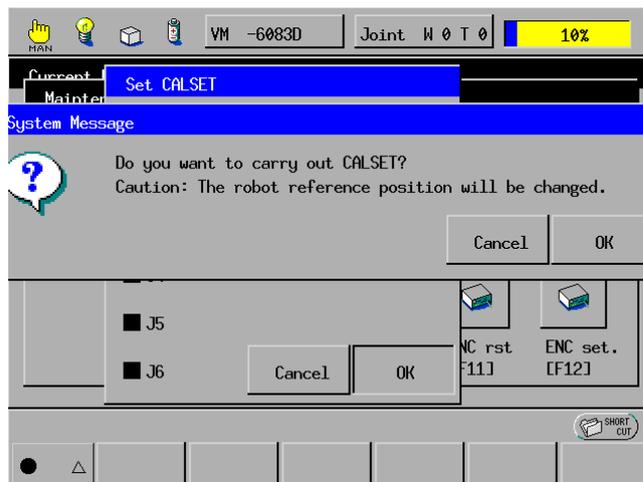
STEP 17

Press OK.

The system message appears informing that CALSET is completed.

STEP 18

Press the EMERGENCY STOP button.

The robot brake becomes activated.

STEP 19

Turn the EMERGENCY STOP button to cancel robot stop.

STEP 20

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 21

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

STEP 22

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

2.4.5.2 CALSETing All Axes

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

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

2.5 Setting Control Set of Motion Optimization

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

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

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

The payload center of gravity is represented by the TOOL0 coordinate system (see 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

Y-axis positive direction (orientation vector)

Z-axis positive direction
(approach vector)

X-axis positive direction
(normal vector)
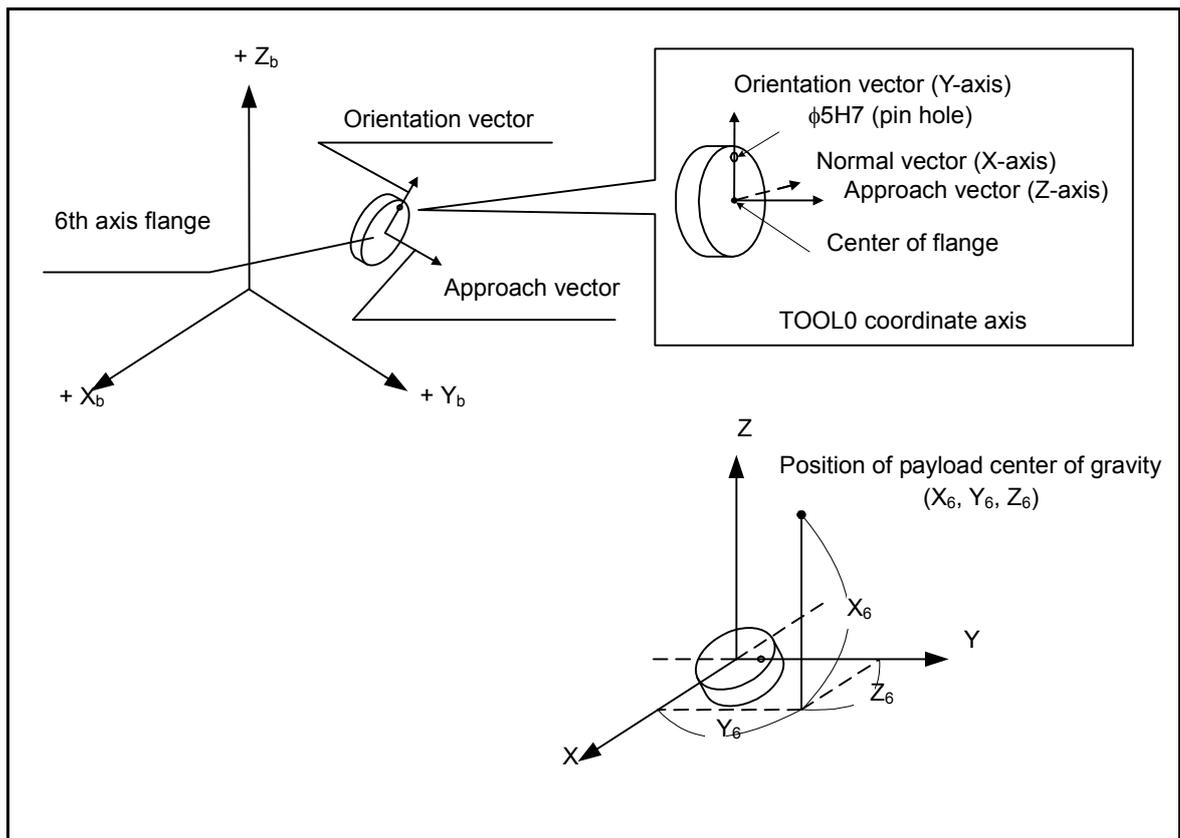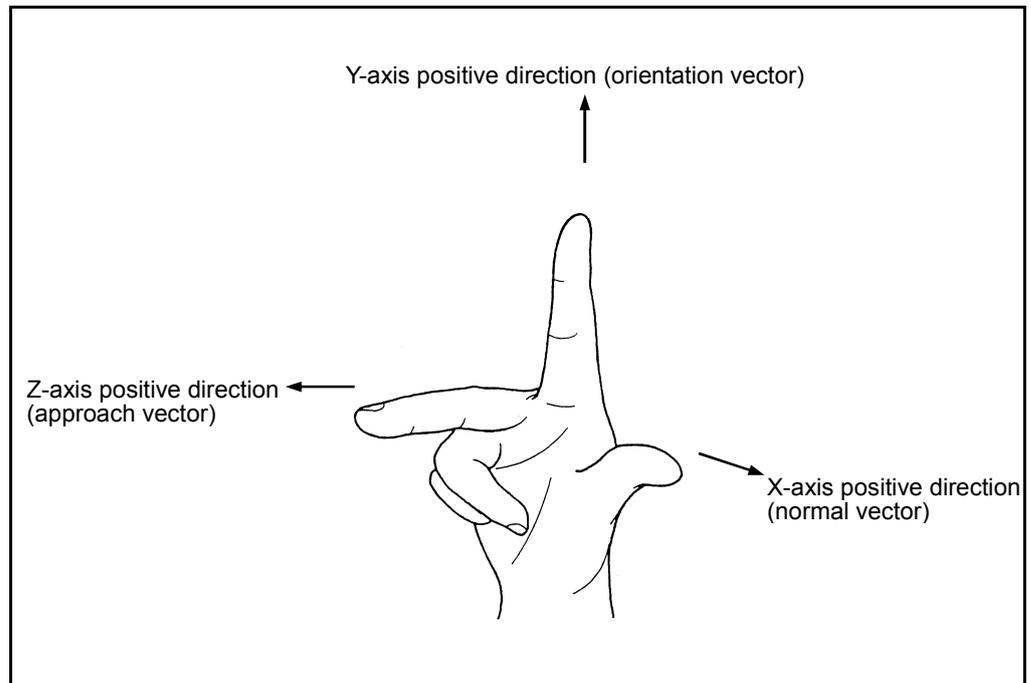
Right Hand Coordinate System

2.6   Setting Robot Installation Conditions

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

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

For the setting procedure, refer to the SETTING-UP MANUAL, Section 2.9 "Setting the Robot Installation Condition" and the PROGRAMMER'S MANUAL, Section 4.7.3 "Setting Robot Installation Conditions."

Chapter 3 Maintenance and Inspection

3.1   Maintenance & Inspection Intervals and Purposes

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

> ⚠ **Caution: Maintenance and inspection must be carried out by a trained worker who possesses the ability to perform these tasks safely.**
> **Before performing maintenance and inspection jobs, read the SAFETY PRECAUTIONS, "4. Precautions while robot is running" and "5. Daily and periodical inspections."**

Maintenance & Inspection Intervals and Purposes

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

3.2   Daily Inspections
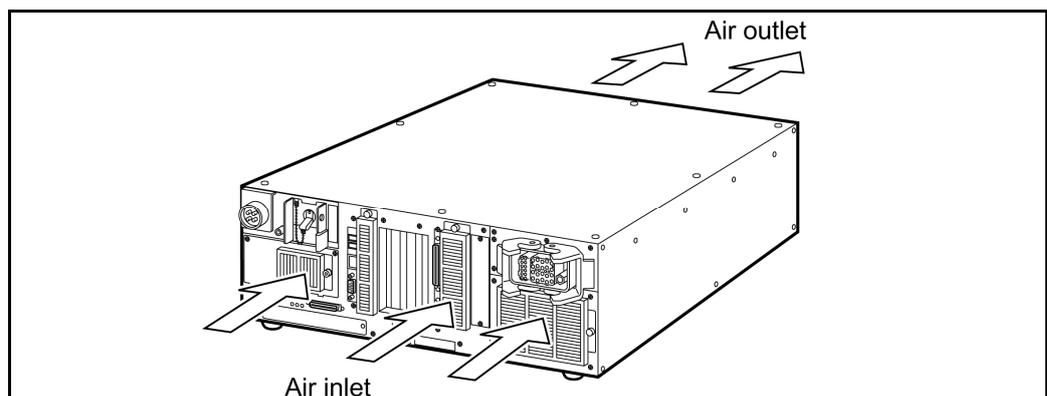
3.2.1   Check Items

Before starting 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	Robot unit	OFF	Visually	No grease leak	Wipe off grease

Note 1	Some repair and replacement operations, shown in "What to do:" column, may involve special work. Contact our Robot Service Section.
Note 2	The normal operation of the cooling fan is as shown below.

Air outlet

Air inlet

Normal Operation of Cooling Fan

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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: 35 ±7 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 Air Intake Filter in the Robot Controller

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

3.4   Biennial Inspections

3.4.1   Battery Replacement and Belt Inspection

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

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

⚠ **Caution** **(1) The battery used in this device may present a risk of fire or chemical burn if mistreated. Do not recharge, disassemble, heat above 100°C (212°F), or incinerate.**

(2) Dispose of used battery promptly. Keep away from children. Do not disassemble and do not dispose of in fire.

Backup Battery Types

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

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

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

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

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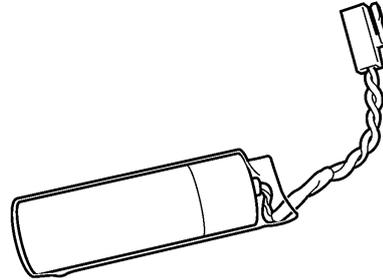

⚠**Caution: Without   replacing   the   backup   batteries,   important robot-specific data stored in each memory will be lost.**

3.4.2 Replacing the Encoder Backup Battery

Replace the encoder backup battery according to the procedure below.

STEP 1 | **Prepare a new set of 3 backup batteries for replacement.**

STEP 2 | **Turn the controller power ON.**

> **Note:** When replacing the encoder backup battery, do not turn the controller power OFF. If you do so, the encoder positional data may be lost.

Power switch
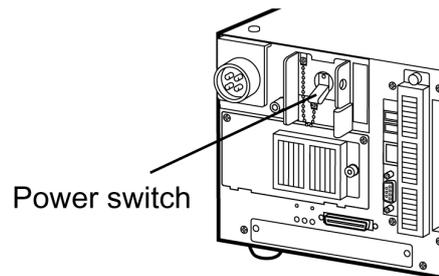
STEP 3 | **Turn the motor power OFF when replacing the battery.**

> **Note:** (1) Push the EMERGENCY STOP button on the teach pendant or mini pendant, and the button is locked in the stop status.
> (2) When rotating the EMERGENCY STOP button clockwise, the button will be released.

STEP 4

Remove the cover from the robot unit.
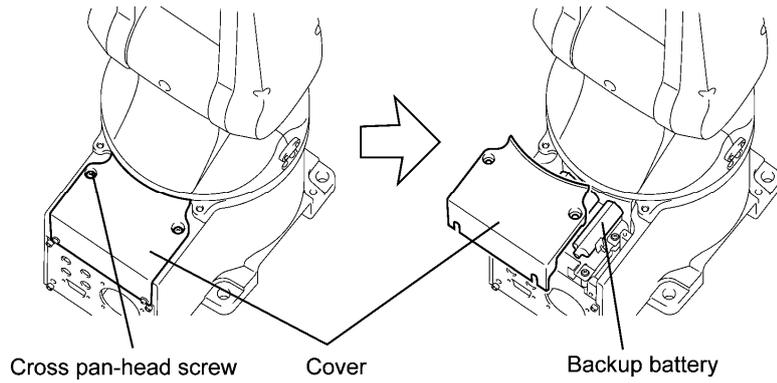
Cross pan-head screw   Cover   Backup battery

STEP 5

Replace an old battery with new one, one by one.

> **Note:** Do not disconnect all old batteries at the same time before connecting a new one. If you do so, the encoder positional data may be lost.

(1) Remove an old battery.   (2) Set a new battery
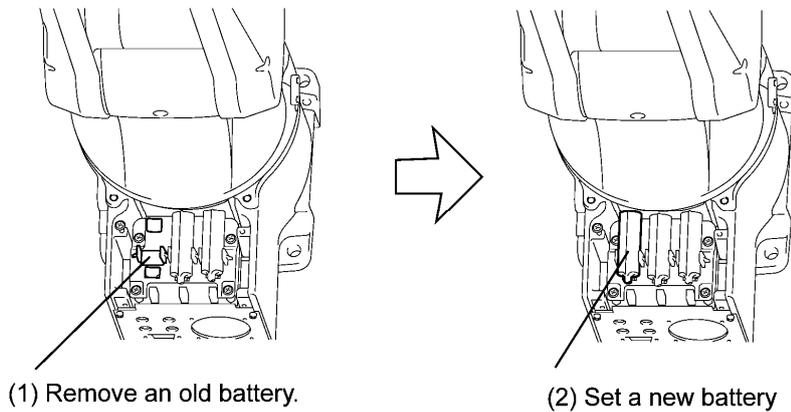
> **Note:** Be sure to replace all of three batteries with new ones at one time. Otherwise, the battery service life will become short.

STEP 6

Reinstall the cover to the robot unit.

Screw

Cover
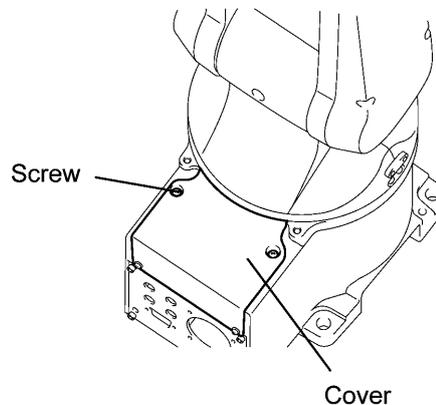
Tightening torque:
  Cross pan-head screw: 0.59 Nm

3.4.3 Replacing the Memory Backup Battery

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

3.4.4 Setting the Next Battery Replacement Date

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

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

STEP 1

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

STEP 2

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

STEP 3

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

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

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

STEP 4

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

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

STEP 5

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

3.5 Supplies and Tools for maintenance

The table below shows the supplies and tools for maintenance.

Supplies and Tools for Maintenance

No	Name	Part No.	Remarks
1	Air filter set	410053-0100	For standard type of controllers (FS-1705W)
		410053-0110	For global type of controllers (FS-1705)
2	Memory backup battery	410076-0260	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	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
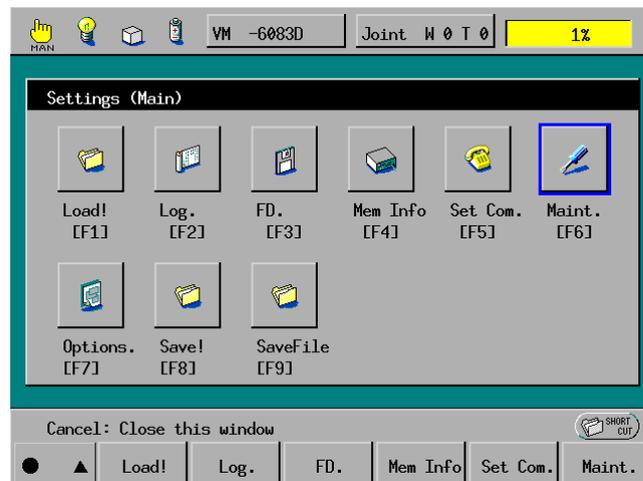
STEP 1

Turn the controller power ON.

STEP 2

On the teach pendant, set the mode switch to the MANUAL position.
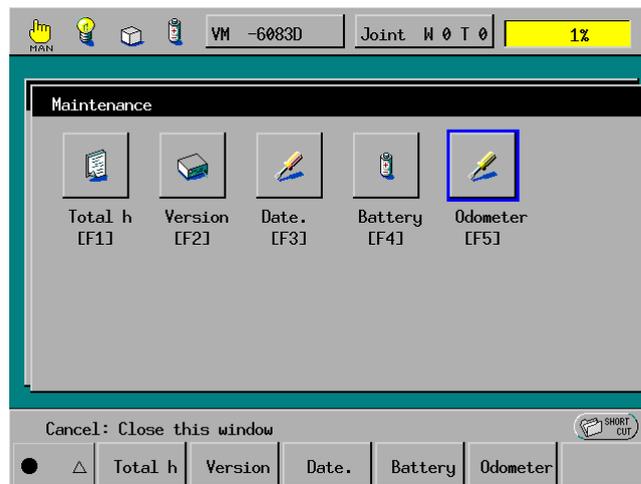
STEP 3

On the top screen, press [F6 Set].

The Settings (Main) window appears as shown below.

F6

Press [F6 Maint.].

STEP 4

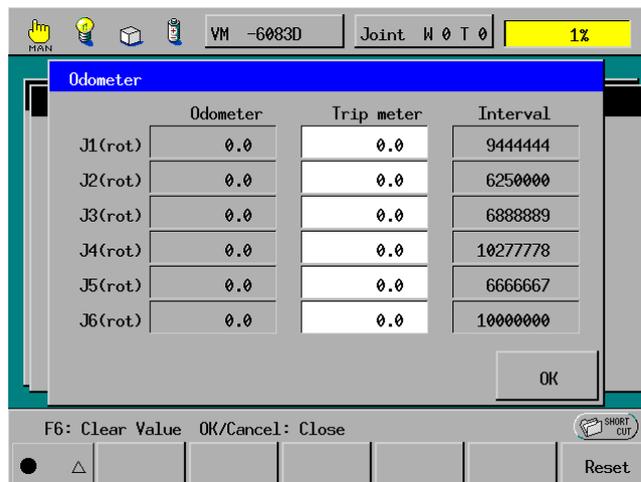The Maintenance menu appears as shown below.

| | MAN | | | VM -6083D | Joint W 0 T 0 | 1% |

Maintenance

| Total h [F1] | Version [F2] | Date. [F3] | Battery [F4] | Odometer [F5] |

Cancel: Close this window

| ● | △ | Total h | Version | Date. | Battery | Odometer | |

F5

Press [F5 Odometer].

STEP 5

The Odometer window appears as shown below.

| | MAN | | | VM -6083D | Joint W 0 T 0 | 1% |

Odometer

	Odometer	Trip meter	Interval
J1(rot)	0.0	0.0	9444444
J2(rot)	0.0	0.0	6250000
J3(rot)	0.0	0.0	6888889
J4(rot)	0.0	0.0	10277778
J5(rot)	0.0	0.0	6666667
J6(rot)	0.0	0.0	10000000

OK

F6: Clear Value   OK/Cancel: Close

| ● | △ | | | | | Reset |

F6

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

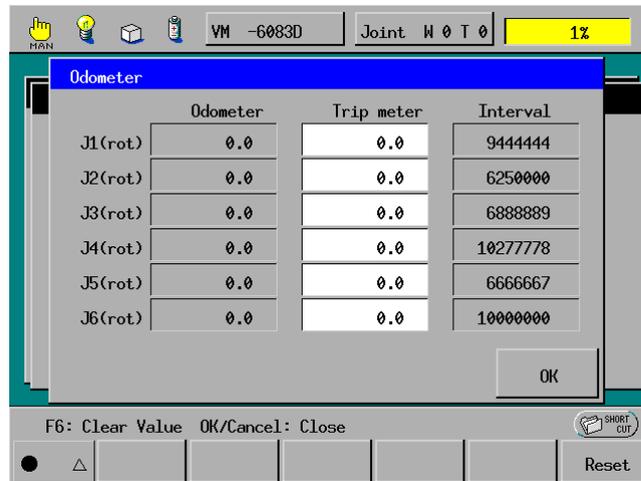If the Trip meter count exceeds the Interval value, the oil change prompt message will appear.

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3.7.2 Resetting the Trip Meter to Zero

STEP 1

Display the Odometer window as shown below.

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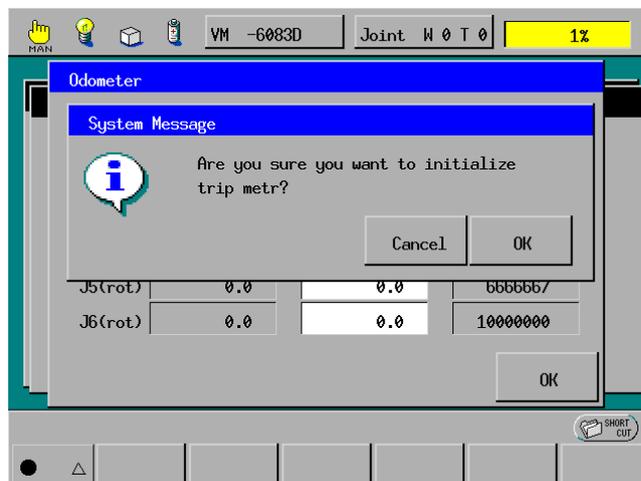

F6

Press [F6 Reset].

STEP 2

The following message appears.

Press the OK button.

The trip meter has been reset to zero.

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

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

The Total hours window shows the following items:

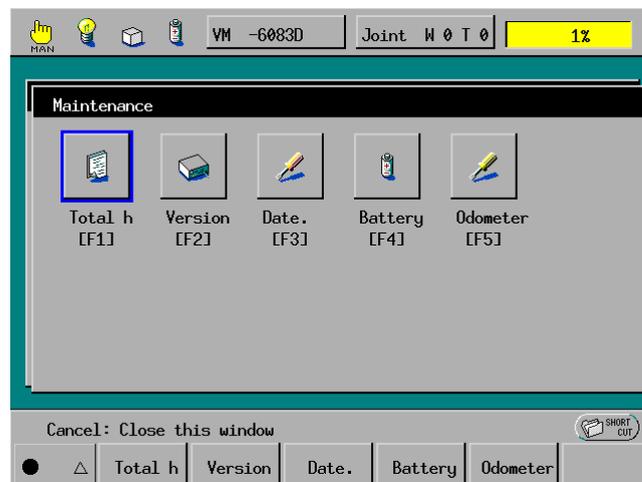|	
[Total operation]	Shows the grand total of the robot controller ON-time counted after the controller leaves the factory.
[Total running]	Shows the grand total of the robot running time counted after the robot leaves the factory.
[Cumu. operation]	Shows the total of the robot controller ON-time counted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

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

STEP 1

Display the Maintenance window as shown below.
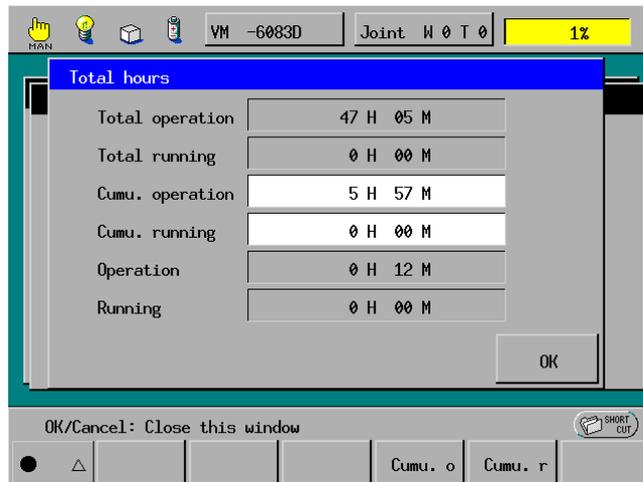
Access: [F6 Set]—[F6 Maint.] from the top screen

F1

Press [F1 Total h].

STEP 2

The Total hours window appears as shown below.

```
 MAN               VM  -6083D      Joint  W 0 T 0      1%
┌─────────────────────────────────────────────────────┐
│ Total hours                                          │
│                                                      │
│   Total operation         47 H  05 M                 │
│                                                      │
│   Total running            0 H  00 M                 │
│                                                      │
│   Cumu. operation          5 H  57 M                 │
│                                                      │
│   Cumu. running            0 H  00 M                 │
│                                                      │
│   Operation                0 H  12 M                 │
│                                                      │
│   Running                  0 H  00 M                 │
│                                                      │
│                                              ┌──────┐│
│                                              │  OK  ││
│                                              └──────┘│
└─────────────────────────────────────────────────────┘
 OK/Cancel: Close this window                   SHORT CUT
  ●    △                          Cumu. o  Cumu. r
```

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

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

STEP 1

Display the Total hours window as shown below.

Access: [F6 Set]—[F6 Maint.]— [F1 Total h] from the top screen
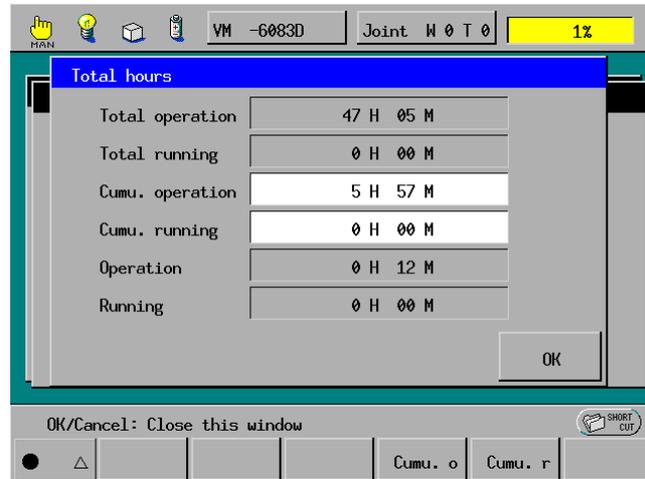
F4

To reset the user counter of the controller ON-time (Cumu.operation), for example, press [F4 Cumu. o].
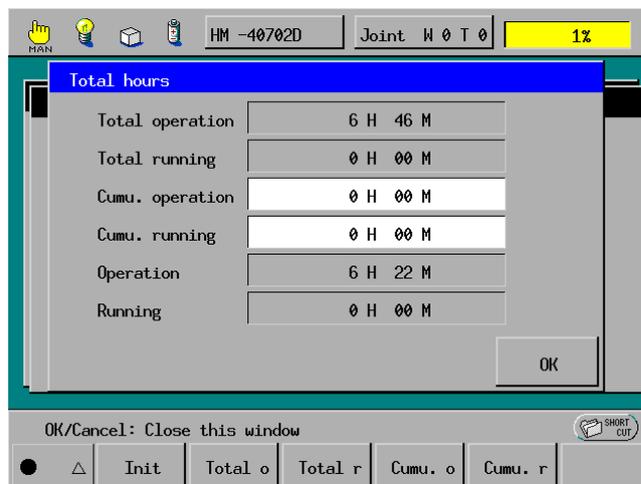
STEP 2

The following system message appears.

Press the OK button.

STEP 3

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

Total operation	6 H 46 M
Total running	0 H 00 M
Cumu. operation	0 H 00 M
Cumu. running	0 H 00 M
Operation	6 H 22 M
Running	0 H 00 M

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 Backing up Projects

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

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

- at the time of purchase

- after performing CALSET

- after changing RANG values

- after replacement of a motor

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

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

3.10.1 Back up project data

Use WINCAPSIII to back up project data.

When a project has been created in WINCAPSIII

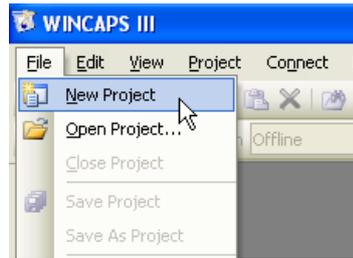Receive all data from the controller and preserve it.
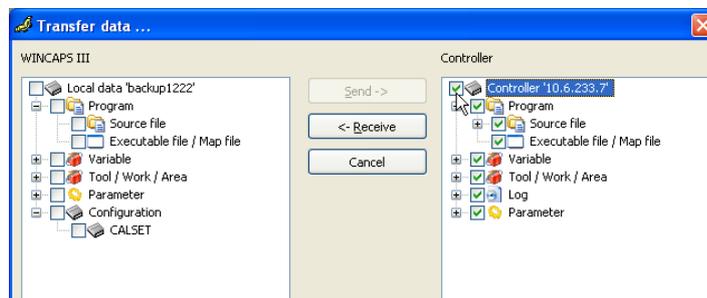
When creating a new project to preserve backup data
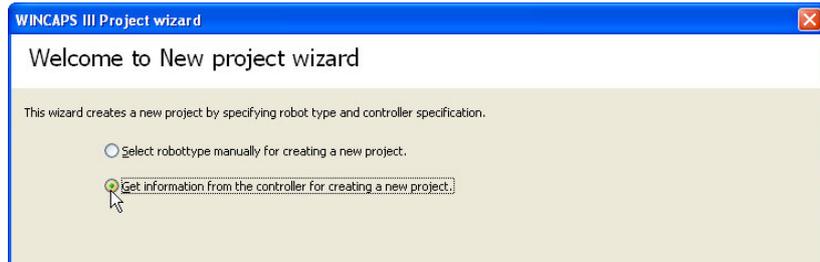
Follow the procedure given below.

STEP 1

Create a new project in WINCAPSIII.

STEP 2

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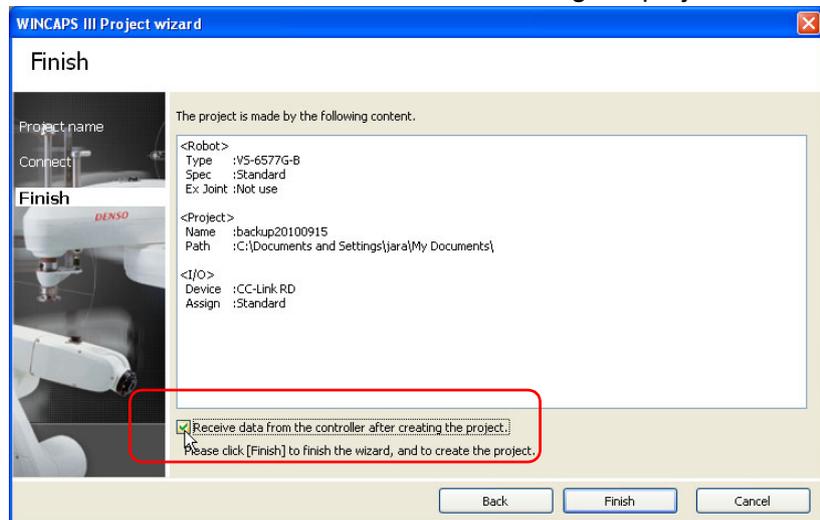

STEP 3

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

STEP 4

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

STEP 5

Close the project.

3.10.2 Transfer arm data

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

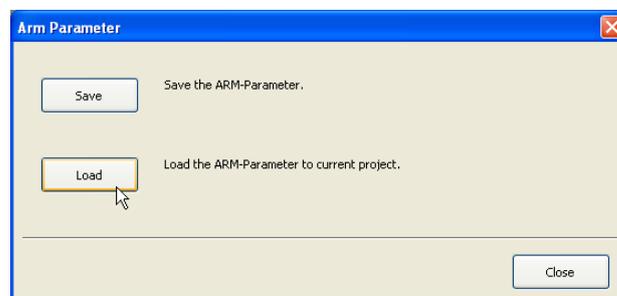To transfer arm data from WINCAPSIII to the robot controller, use the following procedure.

STEP 1

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

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

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

Choose Tool | Arm parameters to display the Arm Parameter window.
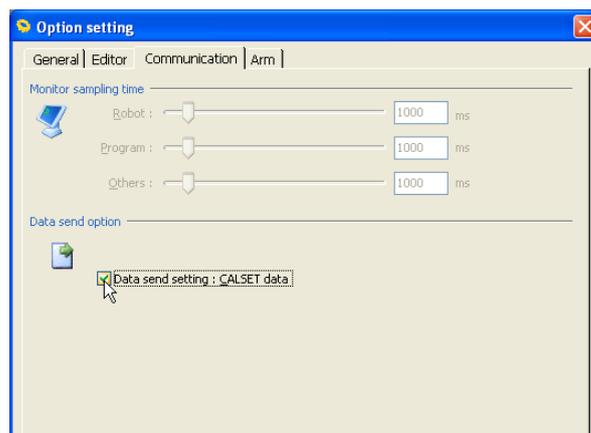
Press Load and select the arm data (***.wam) to load

STEP 2

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

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

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

STEP 3

Transferring arm data to the robot controller

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

Select Parameters | Arm parameters and Configuration | CALSET, then press Send.
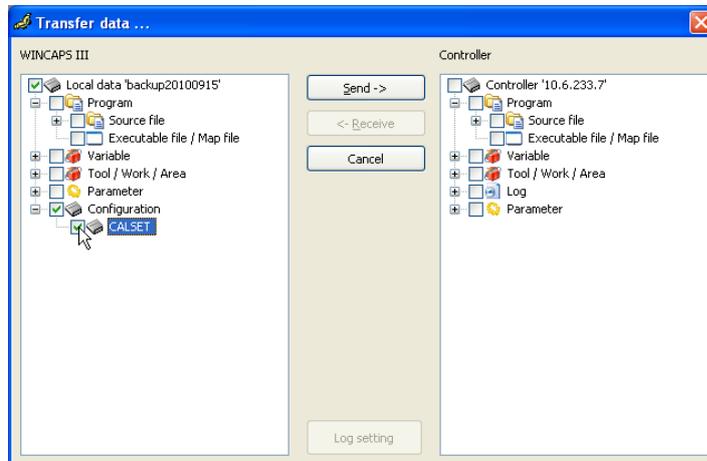
Upon completion of transfer of the CALSET-related arm data, restart the robot controller.

Vertical Articulated Robot
VP-G SERIES

INSTALLATION & MAINTENANCE GUIDE

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.