DENSO ROBOT

Horizontal articulated

H*-E SERIES

INSTALLATION & MAINTENANCE GUIDE

Preface

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

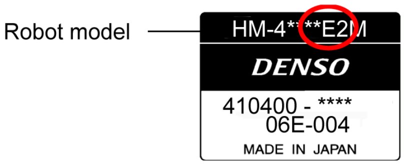
Before operating your robot, read this manual carefully to safely get the maximum benefit from your robot in your assembling operations.

Robot series and/or models covered by this manual

Series	Model (**Note** 1)		Overall arm length
	Floor-mount	Overhead-mount	
HS-E (Small-sized, horizontal articulated)	HS-4535*E HS-4545*E HS-4555*E	— HSS-4545*E HSS-4555*E	350 mm 450 mm 550 mm
HM-E (Medium-sized, horizontal articulated)	HM-4*60*E2 HM-4*70*E2 HM-4*85*E2 HM-4*A0*E2 (**Note** 2)	— HMS-4*70*E2 HMS-4*85*E2 — (**Note** 2)	600mm 700mm 850mm 1000mm

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 HS-4535*E, for example, the robot unit model is HS-4535*EM.

NOTE 2: The second arm of the HM-E series robot was modified, and also, the model name of the robot was changed to the HM-E2 series from the HM-E series at August 2003.



Important

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

How the documentation set is organized

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

GENERAL INFORMATION ABOUT ROBOT

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

INSTALLATION & MAINTENANCE GUIDE - this book -

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

BEGINNER'S GUIDE

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

SETTING-UP MANUAL

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

WINCAPSII GUIDE

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

PROGRAMMER'S MANUAL (I), (II)

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

RC5 CONTROLLER
INTERFACE MANUAL

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

ERROR CODE TABLES

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

OPTIONS MANUAL

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

How this book is organized

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

SAFETY PRECAUTIONS

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

Chapter 1 Installing Robot Components

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

Chapter 2 Customizing Your Robot

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

Chapter 3 Maintenance and Inspection

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

SAFETY PRECAUTIONS

Be sure to observe all of the following safety precautions.

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

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

Terminology and Definitions

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

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

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

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

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

(*RIA: Robotic Industries Association)

1. Introduction

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

2. Installation Precautions

2.1 Insuring the proper installation environment

2.1.1 For standard type

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

(1) there are flammable gases or liquids,

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

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

(4) there is cutting or grinding oil mist,

(5) it may likely be submerged in fluid,

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

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

2.1.2 For dust-proof, splash-proof type

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

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

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

(1) there are any flammable gases or liquids,

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

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

(4) it may likely be submerged in fluid,

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

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

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

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

2.2 Service space

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

2.3 Control devices outside the robot's restricted space

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

2.4 Positioning of gauges

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

2.5 Protection of electrical wiring and hydraulic/pneumatic piping

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

2.6 Positioning of emergency stop switches

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

(1) The emergency stop switches should be red.

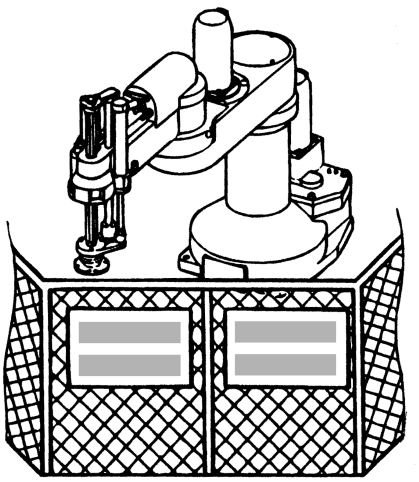
(2) Emergency stop switches should be designed so that they will not be released after pressed, automatically or mistakenly by any other person.

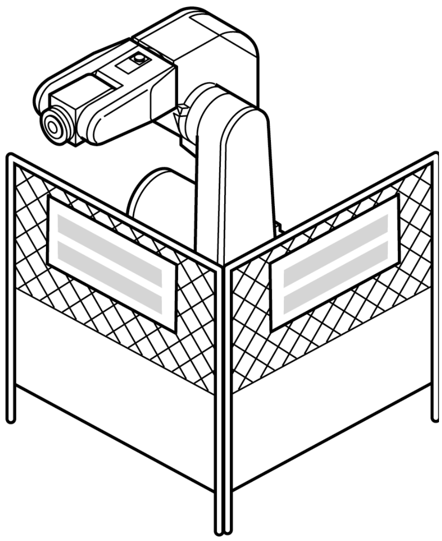
(3) Emergency stop switches should be separate from the power switch.

2.7 Positioning of operating status indicators

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

2.8 Setting-up the safety fence or enclosure





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

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

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

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

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

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

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

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

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

2.9 Positioning of rope or chain

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

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

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

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

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

2.10 Setting the robot's motion space

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

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

Refer to the "INSTALLATION & MAINTENANCE GUIDE."

2.11 No robot modification allowed

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

2.12 Cleaning of tools

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

2.13 Lighting

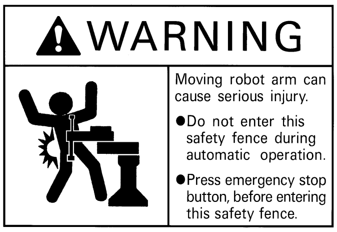
Sufficient illumination should be assured for safe robot operation.

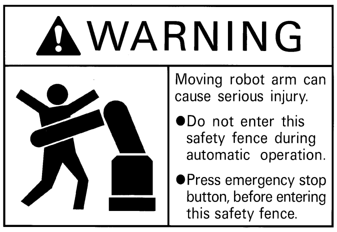
2.14 Protection from objects thrown by the end-effector

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

2.15 Affixing the warning label

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

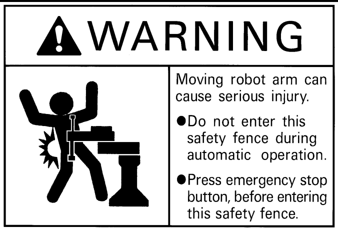


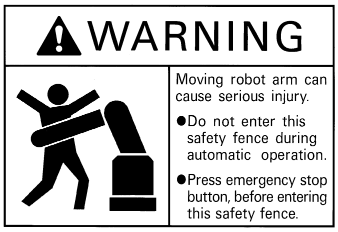


3. Precautions while robot is running

⚠ **Warning**

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





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

3.1 Creation of working regulations and assuring worker adherence

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

(1) Operating procedures required to run the robot.

(2) Robot speed when performing teaching.

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

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

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

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

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

3) Maintaining worker position and stance

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

4) Implementation of measures for noise prevention

5) Signaling methods for workers of related equipment

6) Types of malfunctions and how to distinguish them

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

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

3.2 Display of operation panel

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

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

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

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

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

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

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

3.4 Inspections before commencing work such as teaching

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

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

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

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

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

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

3.5 Release of residual air pressure

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

3.6 Precautions for test runs

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

3.7 Precautions for automatic operation

(1) At start-up

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

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

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

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

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

(3) Steps to be taken when a malfunction occurs

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

3.8 Precautions in repairs

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

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

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

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

4. Daily and periodical inspections

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

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

5. Management of floppy disks

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

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

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

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

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

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Chapter 1 Installing Robot Components

1.1 Preparing a Proper Environment for Installation

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

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

1.1.1 Installation Environments

■ Standard Type

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

(1) there are flammable gases or liquids,

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

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

(4) there is cutting or grinding oil mist,

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

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

■ Dust-proof, Splash-proof Type

The robot is IP65-equivalent dust-proof and splash-proof, but it is not designed to withstand explosions.

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

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

(1) there are flammable gases or liquids,

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

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

(4) it may likely be submerged in fluid,

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

(6) any machining oil 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.

■ Cleanroom Type

The cleanroom type of the HS-E series robot satisfies Clean Class 10 (0.1 µ); however, the robot controller does not.

When carrying out 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.

<u>Jobs requiring special care</u>

- ■ 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
- ■ Greasing

1.1.2 Ambient Temperature and Humidity

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

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

1.1.3 Vibration

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

1.1.4 Connecting the Robot Unit and Robot Controller

Before delivery, the robot unit and the robot controller are adjusted to each other as a set. When two or more robots are to be used, use the robots and robot controllers that have been adjusted to each other as a set.

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

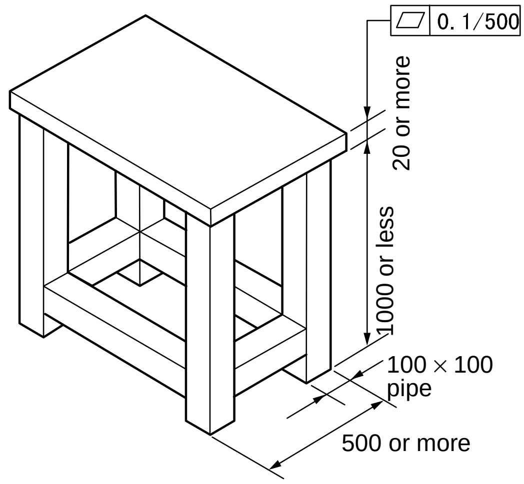
1.1.5 Installation Environment of the Robot Unit

The table on the next page lists the installation requirements for the robot unit. Prepare a highly rigid mount as shown on page 4.

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

Installation Requirements for the Robot Unit

<table>
<tr><th>Item</th><th colspan="2">Environments and Conditions</th></tr>
<tr><td>Flatness of the mount</td><td colspan="2">0.1/500 mm (See the next page.)</td></tr>
<tr><td>Rigidity of the mount</td><td colspan="2">Use steel materials. (See the next page.)</td></tr>
<tr><td>Installation type</td><td colspan="2">Floor-mount or overhead-mount (Only for HSS-E)</td></tr>
<tr><td>Ambient temperature</td><td colspan="2">During operation : 0 to 40ºC
During storage and transportation : -10 to 60ºC</td></tr>
<tr><td>Humidity</td><td colspan="2">During operation : 90% or less (No dew condensation allowed.)
During storage and transportation : 75% or less (No dew condensation allowed.)</td></tr>
<tr><td>Vibration</td><td colspan="2">During operation : 4.9 m/s^2 (0.5G) or less
During storage and transportation : 29.4 m/s^2 (3G) or less</td></tr>
<tr><td rowspan="3">Safe installation environment</td><td colspan="2">The robot should not be installed in an environment where:
• there are flammable gases or liquids,
• there are any acidic, alkaline or other corrosive gases,
• there is sulfuric cutting or grinding oil mist, or
• there are any large-sized inverters, high output/high frequency transmitters, large contactors, welders, or other sources of electrical noise.</td></tr>
<tr><td>Standard type</td><td>The robot should not be installed in an environment where:
• there are any shavings from metal processing or other conductive material flying about,
• there is cutting or grinding oil mist, or
• it may be directly exposed to water, oil or cutting chips.</td></tr>
<tr><td>Dust-proof, splash-proof type
(IP65-equivalent dust-proof and splash-proof structure.)</td><td>The robot should not be installed in an environment where:
• it may likely be submerged in fluid,
• there are any grinding or machining chips or shavings, or
• any machining oil other than Yushiron Oil No. 4C (non-soluble) is in use.</td></tr>
<tr><td>Working space, etc.</td><td colspan="2">• Sufficient service space must be available for inspection and disassembly.
• Keep wiring space (at least 190 mm for Standard type, at least 230 mm for Dust-proof, splash-proof type) behind the robot, and fasten the wiring to the mounting face or beam so that the weight of the cables will not be directly applied to the connectors.</td></tr>
<tr><td>Installation conditions</td><td colspan="2">Grounding resistance: 100 Ω or less
See the figure given on page 12 .</td></tr>
</table>

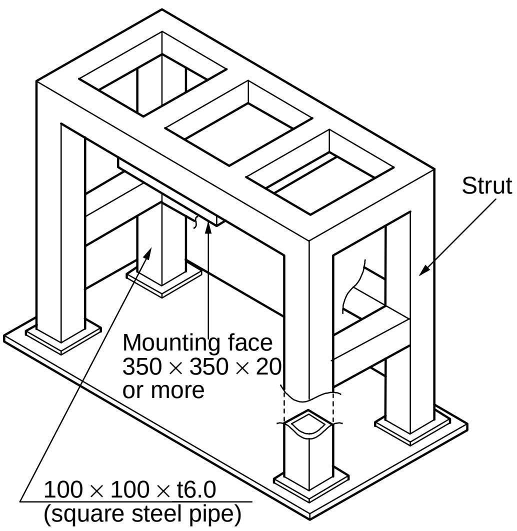


⚠**Caution**

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

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

Robot Mount Sample for Floor-mount Type



⚠**Caution**

(1) When the robot operates at high speed, the top plate structure undergoes large reaction forces. The robot mount must be vibration-proof so that the top plate will not vibrate due to reaction forces. Also it must be designed to be separated 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 Sample for Overhead-mount Type (Only for HSS-E)

1.2 Installing the Robot Unit

⚠Caution 1:	**Before handling or installing the robot unit, be sure to read "SAFETY PRECAUTIONS, 2. Installation Precautions."**
⚠Caution 2:	**The grease is applied to the shaft and rack of the Z-axis for lubrication and rust-proof. Do no touch or wipe the shaft and rack so as to keep rust-proof.**

[1] Transporting the Floor-Mount Type

This section gives the typical installation procedure assuming that you have set up the robot mount bed and prepared robot mounting bolt holes in it. If you have not done it yet, first read "[3] Installing the Robot Unit."

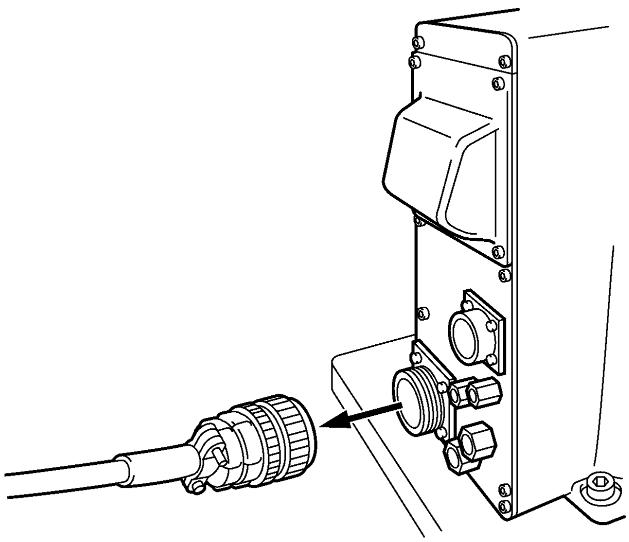
⚠Caution

(1) The installation jobs should be handled by at least two persons.
Robot unit weighs;
HS-E series: approx. 20 kg
HM-E series: approx. 50 kg

(2) Be sure to put on a helmet, safety shoes, and gloves.

Step 1

Disconnect the motor cable, encoder cable, air pipes, hand, and tools from the robot unit, if mounted.

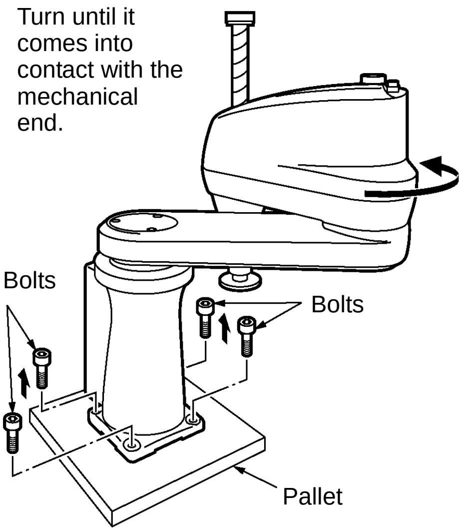


(Illustration: HS-E)

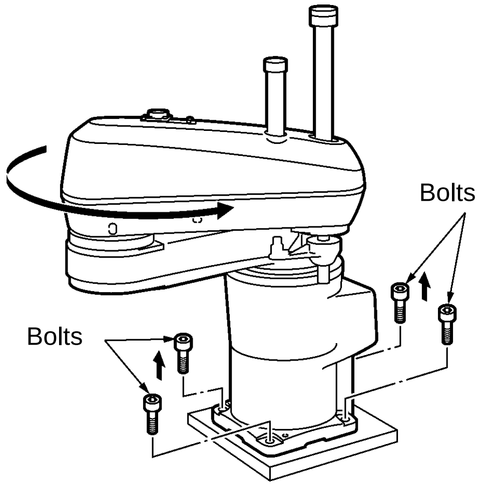
Disconnect the motor cable, encoder cable, and others.

Step 2 Turn the 2nd axis until it comes into contact with the mechanical end in order to keep the safe position. Then remove the four bolts and release the robot unit from the pallet.

> ⚠**Caution:** **When worker A is removing those bolts, worker B should support the 1st-axis arm to prevent the robot unit from overturning.**



(HS-E)

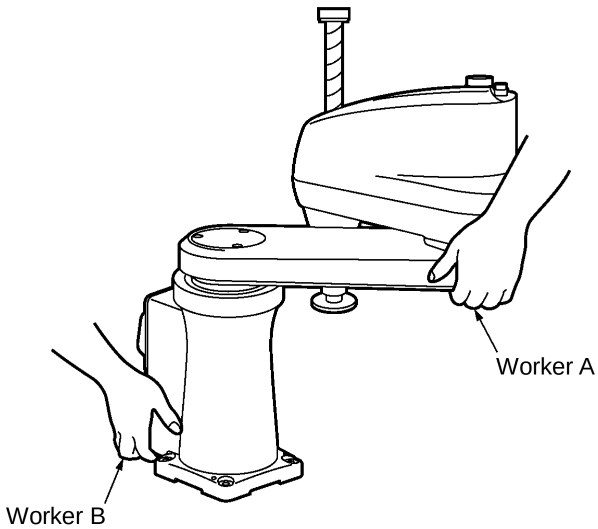


(HM-E)

Step 3 **<In case of HS-E series>**

Workers A and B should hold the robot unit as shown below.

> ⚠**Caution**
> **(1) Do not hold the robot at sections other than those specified below. The plastic cover could easily break.**
> **(2) Before starting transportation, make sure that there are no obstacles in the path to the mounting bed.**

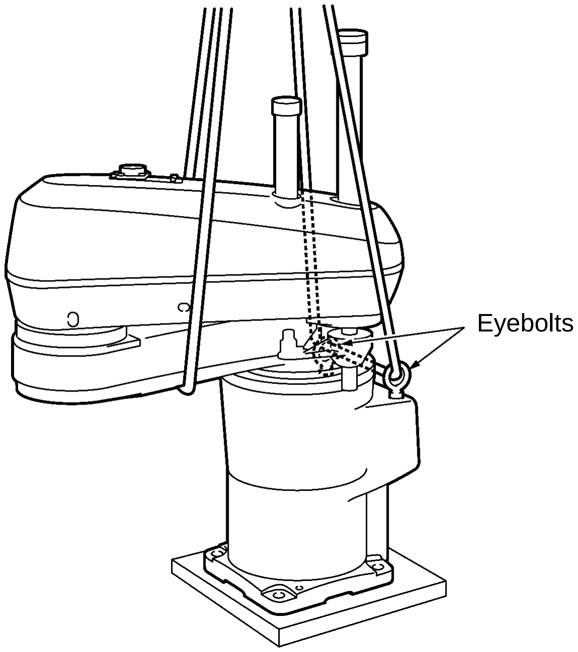


(HS-E)

<In case of HM-E series>

Transport the robot unit to the mounting position using the crane and eyebolts.

⚠**Caution**	**(1)**	**Since the robot unit weighs approx. 50 kg, prepare a crane and forklift with a hoisting load of 0.2 ton or more.**
	(2)	**The mounting job must be handled by at least two persons including a qualified operator for sling, crane and forklift operation.**
	(3)	**Be sure to put on a helmet, safety shoes, and gloves.**
	(4)	**After the mounting job, remove the eyebolts from the robot unit and store them.**



(HM-E)

Step 3 Put the robot unit on the mount bed and secure it with four bolts temporarily.

Step 4 Fix the robot unit, referring to "[3] Installing the Robot."

Tightening torque: 70 ±14 Nm (For HS-E series)
128 ±20 Nm (For HM-E series)

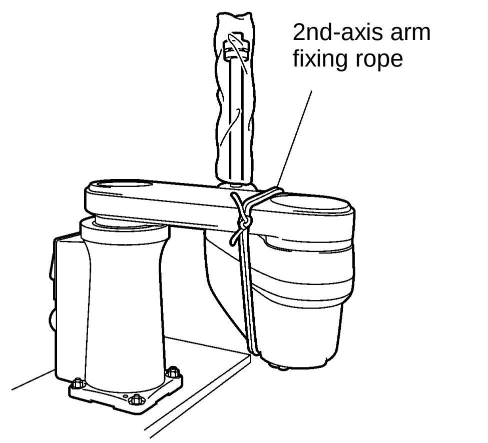
[2] Transporting the Overhead-Mount Type (HSS-E & HMS-E series)

This section gives the typical installation procedure of the robot unit.

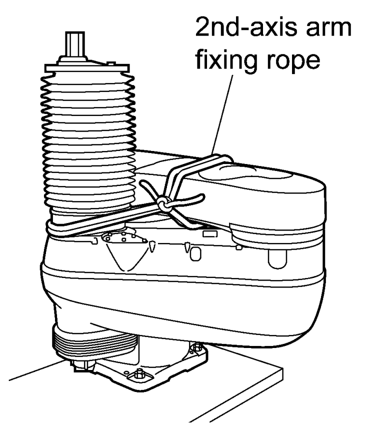
⚠**Caution**	**(1) Since the robot unit weighs approx. 20 kg, prepare a crane and forklift with a hoisting load of 0.2 ton or more.** **(2) The overhead mounting job must be handled by at least two persons including a qualified operator for sling, crane and forklift operation.** **(3) Be sure to put on a helmet, safety shoes, and gloves.**

Step 1 When unpacked, the overhead-mount robot unit is fastened with rope as shown below. Make sure that the robot's 2nd-axis arm cannot rotate.

⚠**Caution:**	**NEVER remove the 2nd-axis arm fixing rope until the installation of the robot unit is completed.** **This is to prevent the robot arm from rotating unexpectedly due to gravity.**



<HSS-E>

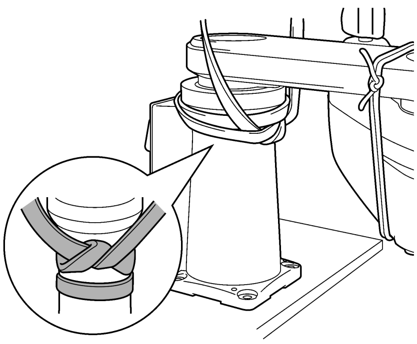


<HMS-E>

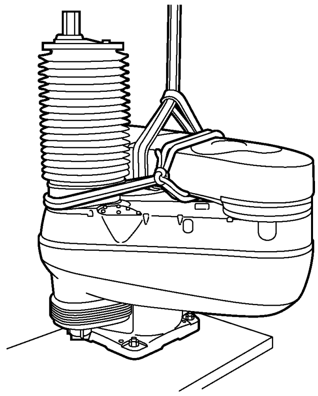
Step 2

<For HSS-E series>
As illustrated below, wind the belt sling around the robot base two turns and make a knot on the side opposite to the power connector.

<For HMS-E series>
As illustrated below, wind the belt sling around the 1st arm one turn.



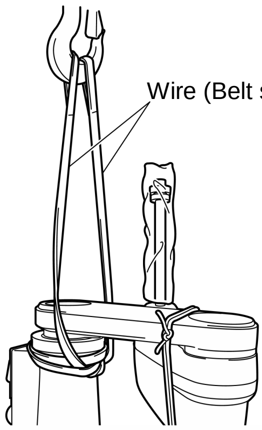
<HSS-E>



<HMS-E>

Step 3

Load the eyes of the belt sling on the hook of the crane.

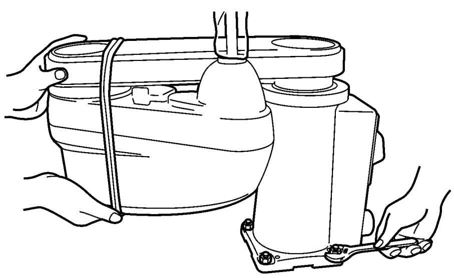


<Example of HSS-E series>

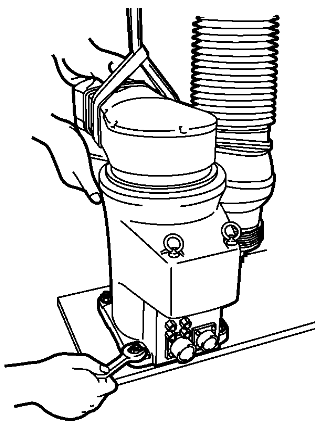
Step 4

Remove the four bolts and release the robot unit from the pallet.

> ⚠**Caution: When worker A is removing those bolts, worker B should support the robot unit as shown below to prevent it from overturning.**



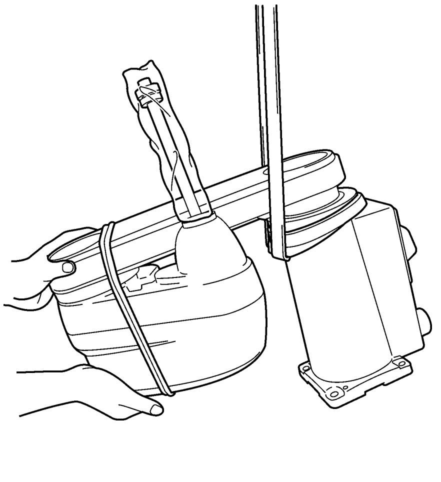
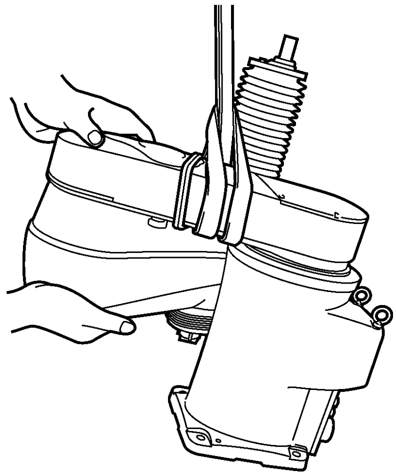
<HSS-E>



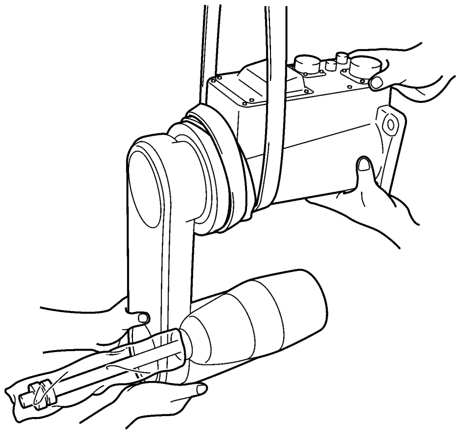
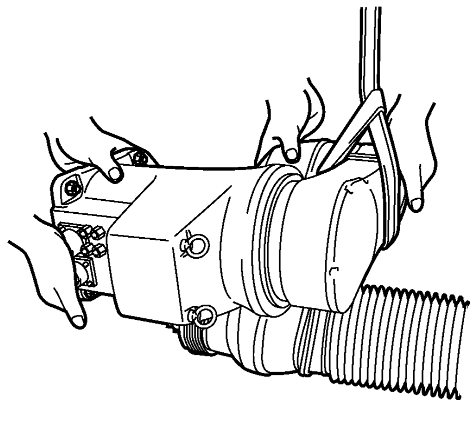
<HMS-E>

Step 5 While keeping the robot posture, slowly hoist the robot unit with the crane.

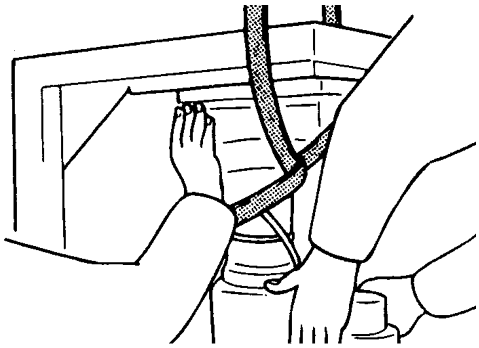
> ⚠**Caution: Before starting this job, make the work floor clear of obstacles.**

 <HSS-E>	 <HMS-E>

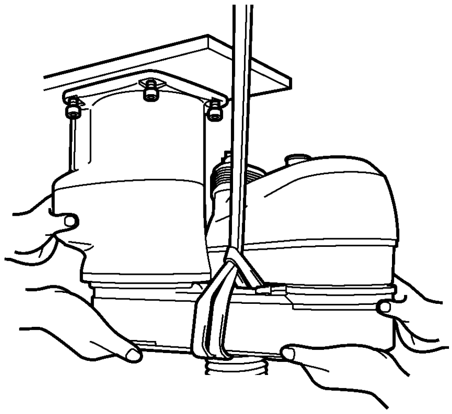
Step 6 If the crane hoists the robot unit until it may be turned upside down, stop the crane and have two workers turn the robot unit upside down, as shown below.

 <HSS-E>	 <HMS-E>

Step 7 While having two workers keep the robot unit in the upside-down position, slowly hoist the robot unit with the crane so that the robot base comes into contact with the robot installation face of the overhead-mount frame. Secure the robot unit with four mounting bolts temporarily.



<HSS-E>

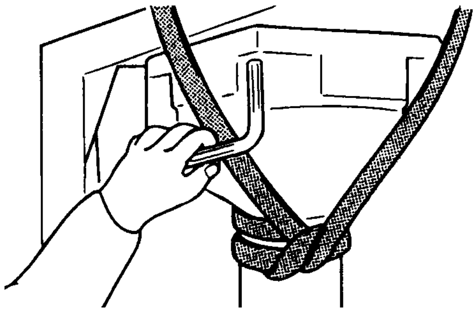


<HMS-E>

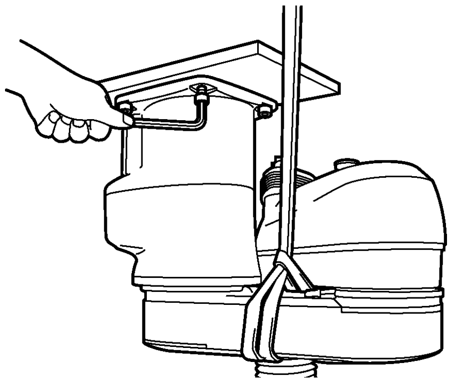
Step 8 Firmly secure the robot unit, referring to "[3] Installing the robot unit."

<For HSS-E Series>
Tightening torque: 70 ±14 Nm

<For HMS-E Series>
Tightening torque: 128 ±20 Nm



<HSS-E>



<HMS-E>

Step 9 After completing bolting, unhook the belt sling from the crane and then remove the 2nd-axis arm fixing rope.

> ⚠**Caution: Store the 2nd-axis arm fixing rope for future removal of the robot unit.**

[3] Installing the Robot Unit

(1) According to the dimensions specified in the figure below, drill four robot fixing holes and two dowel pin holes in the robot mount where the robot unit is to be anchored.

Drilling in the robot mount

Drilling in the robot mount		For HS/HSS-E series	For HM/HMS-E series
Four robot fixing holes		M10 bolt holes a minimum of 20 mm deep	M12 bolt holes a minimum of 20 mm deep
Two holes for dowel pins	For diamond-shaped pin	4H7 dia. hole a minimum of 10 mm deep	6H7 dia. hole a minimum of 12 mm deep
	For internally-threaded positioning pin	6H7 dia. hole a minimum of 10 mm deep	8H7 dia. hole a minimum of 12 mm deep

(2) Drive a diamond-shaped pin into the hole (HS/HSS-E: 4H7 dia., HM/HMS-E: 6H7 dia.) so that the pin becomes oriented as shown below.

(3) Drive an internally-threaded positioning pin into the hole (HS/HSS-E: 6H7 dia., HM/HMS-E: 8H7 dia.).

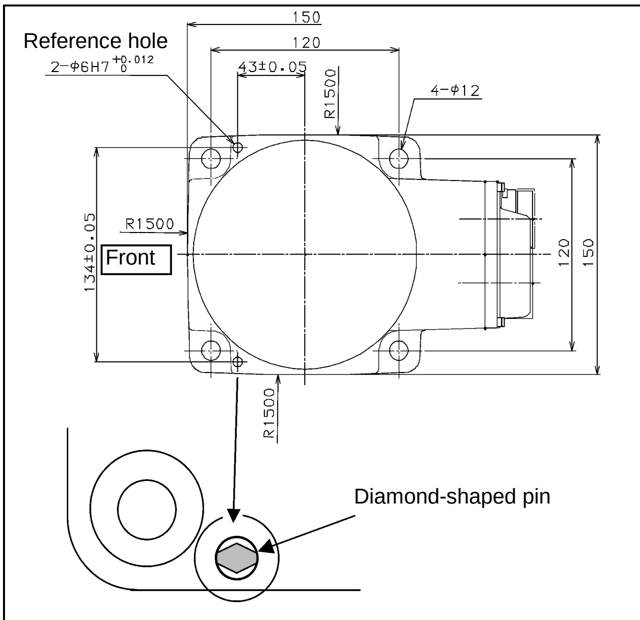
> ⚠**Caution: Never skip this step. These dowel pins may reduce chance of drop off of the robot unit during maintenance and misalignment due to vibration.**

(4) Put the robot unit on the robot mount, following the transport instructions given in "[1] Transporting the Floor-Mount Type" or "[2] Transporting the Overhead-Mount Type."

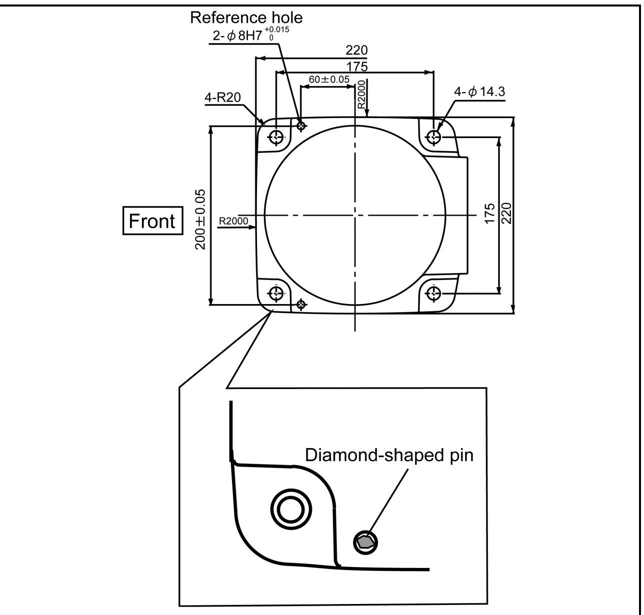
(5) Secure the robot unit with four bolts and plain washers.

Fixing bolts: M10 x 30 mm, JIS strength class: 12.9 (For HS/HSS-E series)
M12 x 35 mm, JIS strength class: 12.9 (For HM/HMS-E series)

Tightening torque: 70 ±14 Nm (For HS/HSS-E series)
128 ±20 Nm (For HM/HMS-E series)



(For HS/HSS-E series)



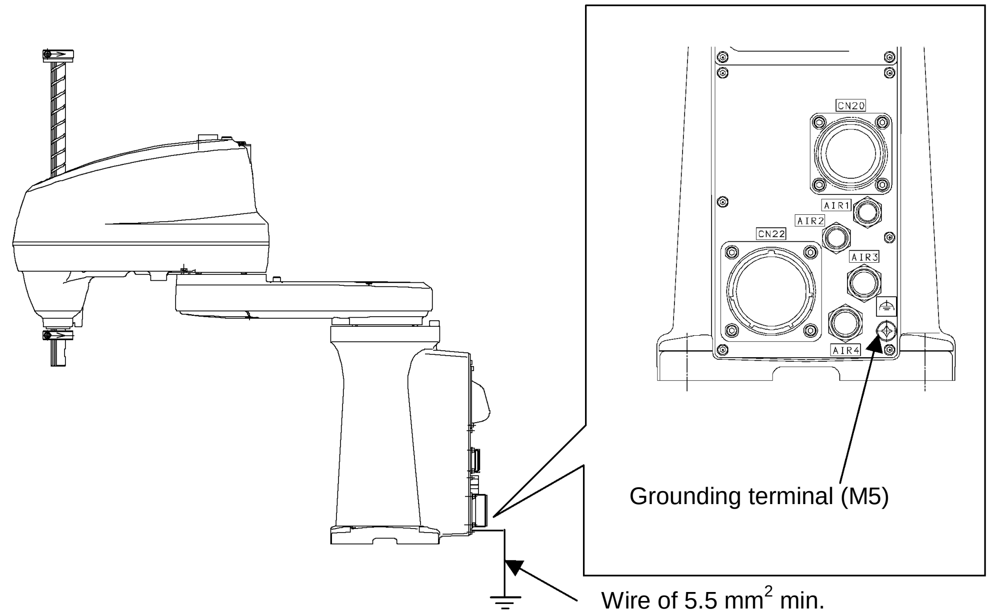
(For HM/HMS-E series)

Bolt Positions for Securing the Robot Unit

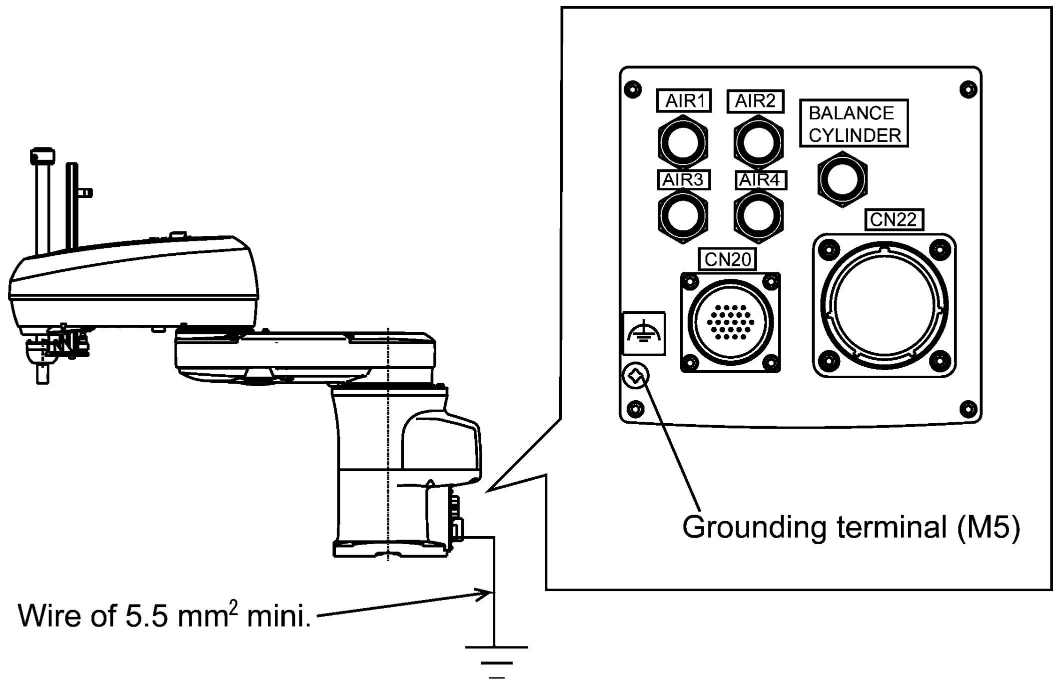
[4] Grounding the Robot Unit

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

⚠Caution:	**Use a dedicated grounding wire and grounding electrode. Do not share them with other power facilities or welding machines.**



(HS/HSS-E)



(HM/HMS-E)

Grounding the Robot Unit

1.3 Installing the Robot Controller

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

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

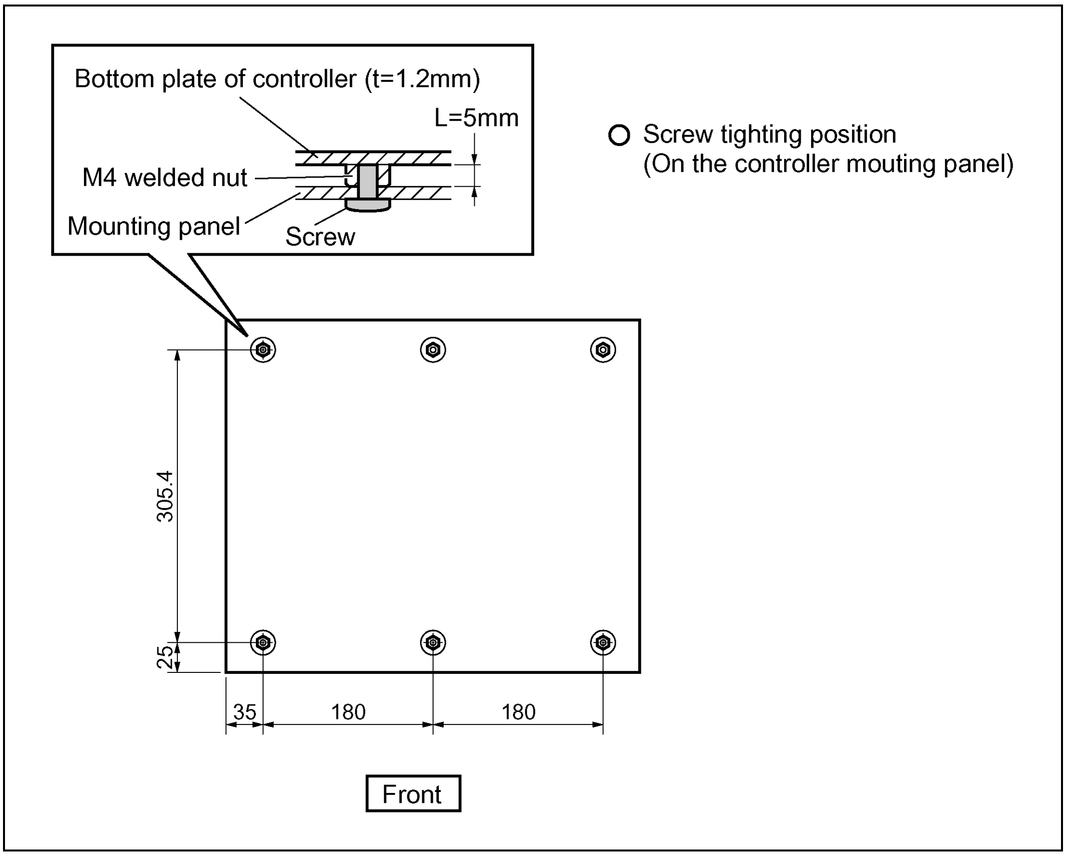
⚠**Caution:**	**When using the robot controller in any environment where there is mist, put the controller in an optional controller protective box. The robot controller is not dust-proof, splash-proof, or explosion-proof.**

1.3.1 Securing the Robot Controller to the Controller Mounting Panel

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

(2) Prepare a mounting panel large enough to mount the robot controller. Secure the robot controller to the mounting panel with six M4 screws at six nut-welded holes marked with "○" as shown on the next page.

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



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

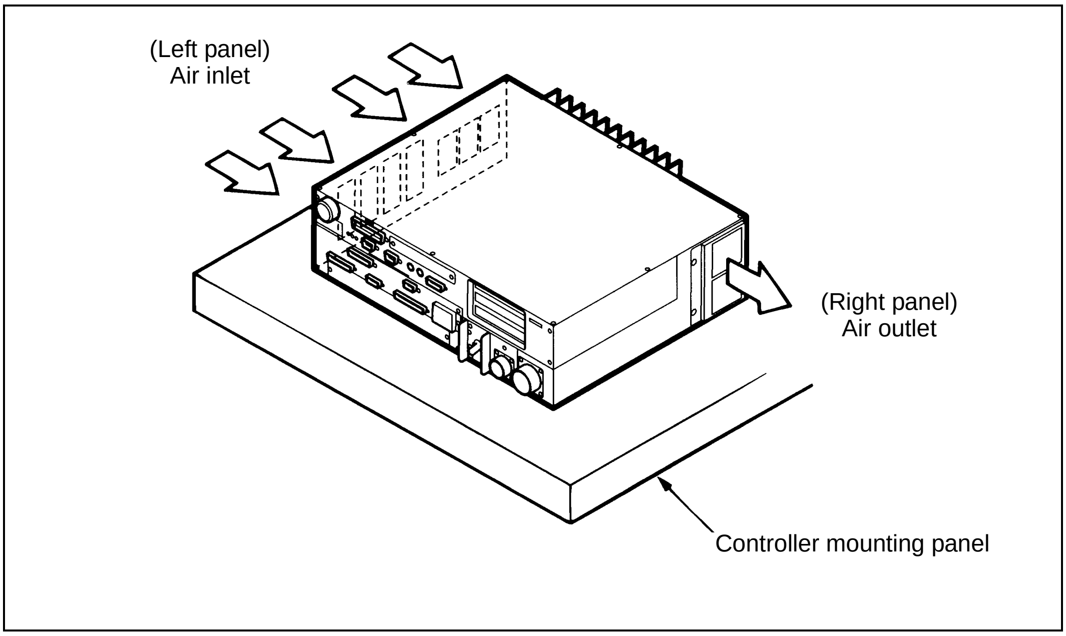
1.3.2 Installing the Robot Controller

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

[1] Stand-Alone

Install the robot controller as shown below.

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

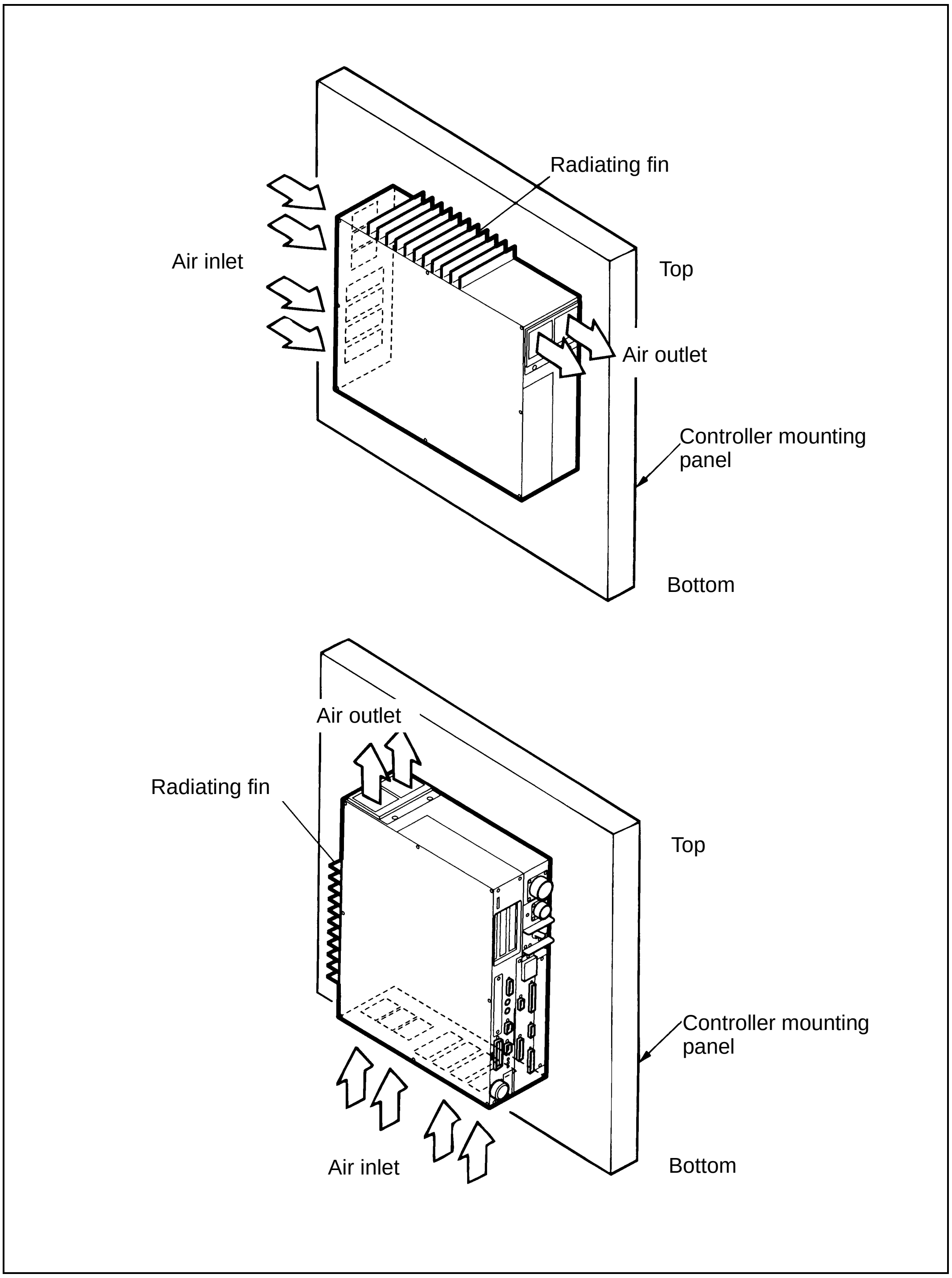


Stand-alone Installation (Example of HS-E)

[2] Wall-Mounted

Install the robot controller as shown below.

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



Wall-mounted Installation (Example of HS-E)

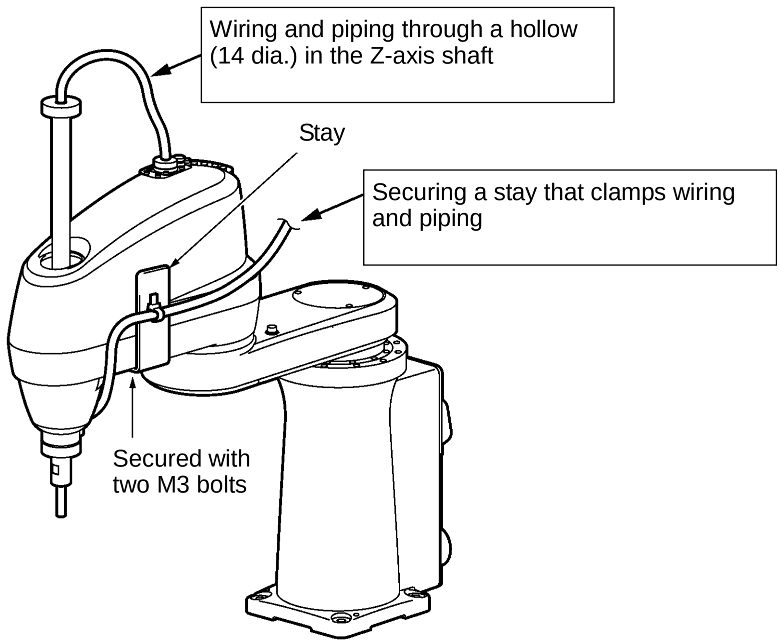
1.4 Electrical Wiring and Air Piping of the Robot Unit

Make electrical wiring and air piping for the hand or tool to be attached to the arm end, referring to the either of examples (1) and (2) below.

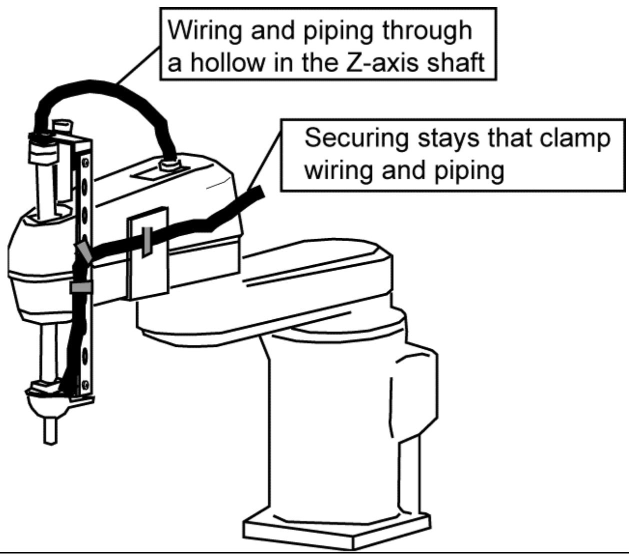
(1) Using a hollow provided in the Z-axis shaft

Robot model	HS/HSS-E series	HM/HMS-40***E series (10kg payload type)	HM/HMS-4A***E series (20kg payload type)
Hollow diameter in the Z-axis shaft	ϕ14	ϕ18	ϕ21

(2) Securing a stay to the robot unit for clamping wiring and piping



Wiring and Piping Image (HS-E series)



Wiring and Piping Image (HM-E series)

1.4.1 Notes for Wiring and Piping Through a Hollow in the Z-axis Shaft

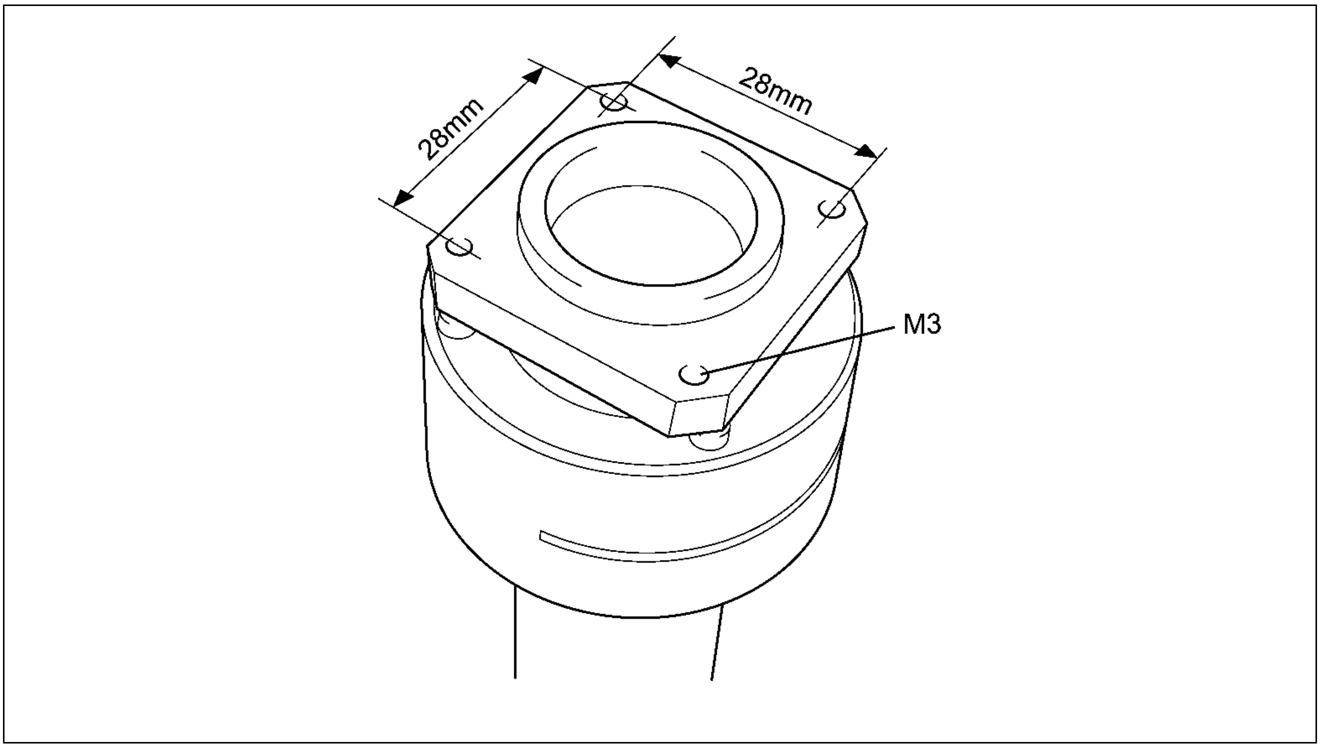
The Z-axis shaft has a hollow through which you may make wiring and piping from the hand control signal connector (CN21) or air piping joints on the top of the 2nd arm.

In this wiring and piping, check that:

(1) When the robot is in motion, the wiring and piping do not become taut or interfere with other sections.

(2) During up- or down-movement of the Z-axis, the wiring and piping inside the hollow do not become taut or interfere with other sections.

(3) In case of HM/HMS-E series, when securing a stay that clamps wiring and piping to the Z-axis upper end, use thread holes (M3) provided in the upper end of the Z-axis shaft.



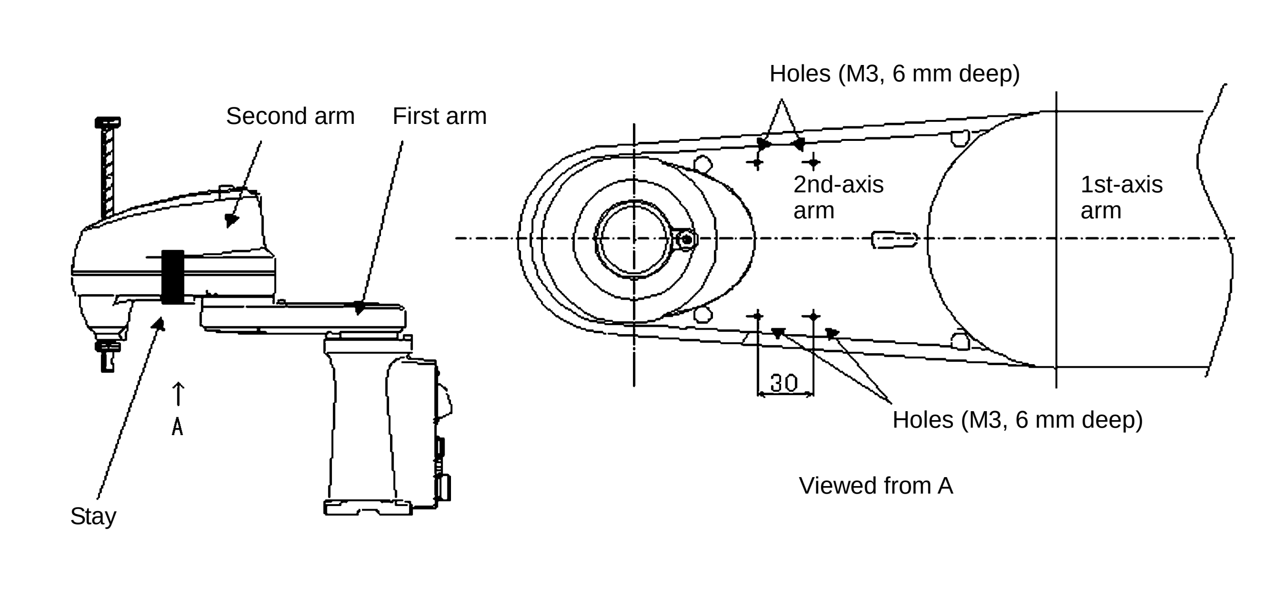
Thread holes provided in the upper end of the Z-axis shaft (HM/HMS-E series)

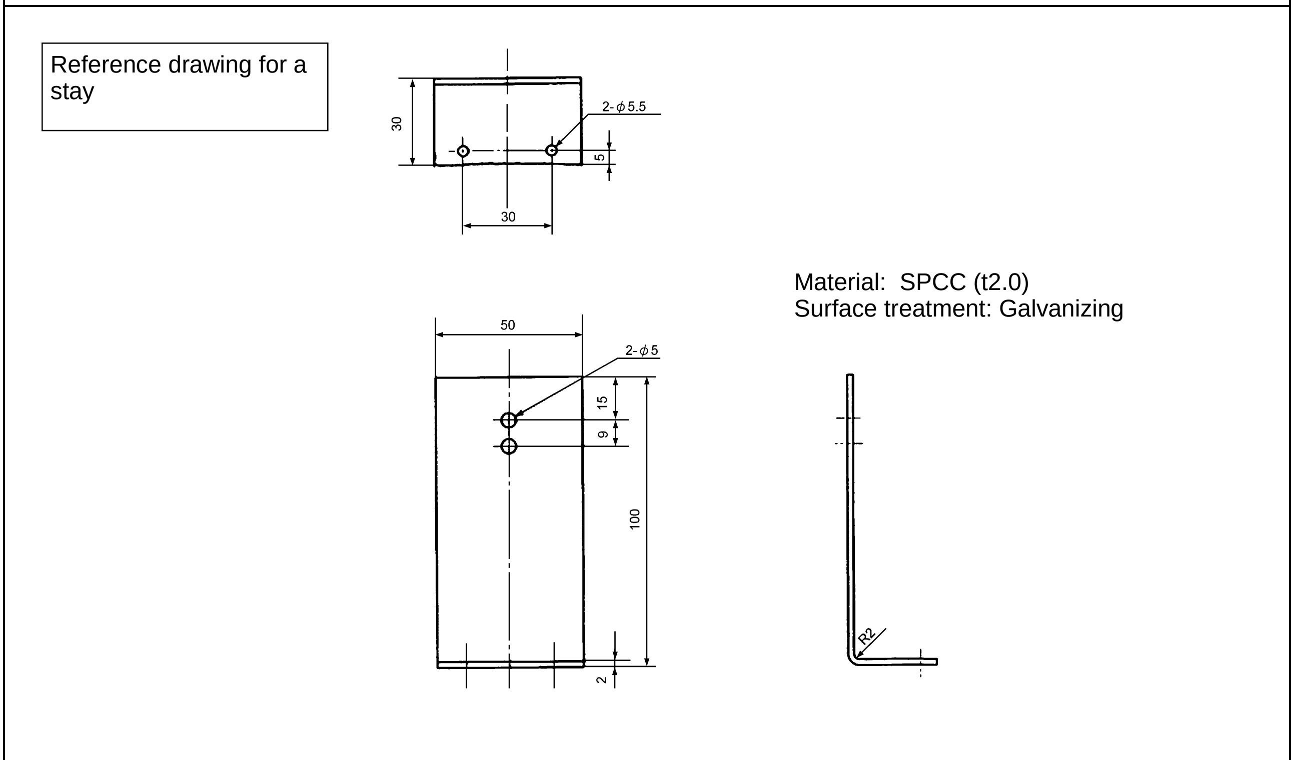
1.4.2 Reference drawings for stays that Clamp Wiring and Piping

1.4.2.1 HS/HSS-E series

When securing a stay that clamps wiring and piping to the robot unit, four thread holes provided in the underside of the second arm.

Referring to the drawing below given, set up a stay.



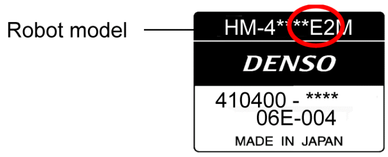


HS/HSS-E series

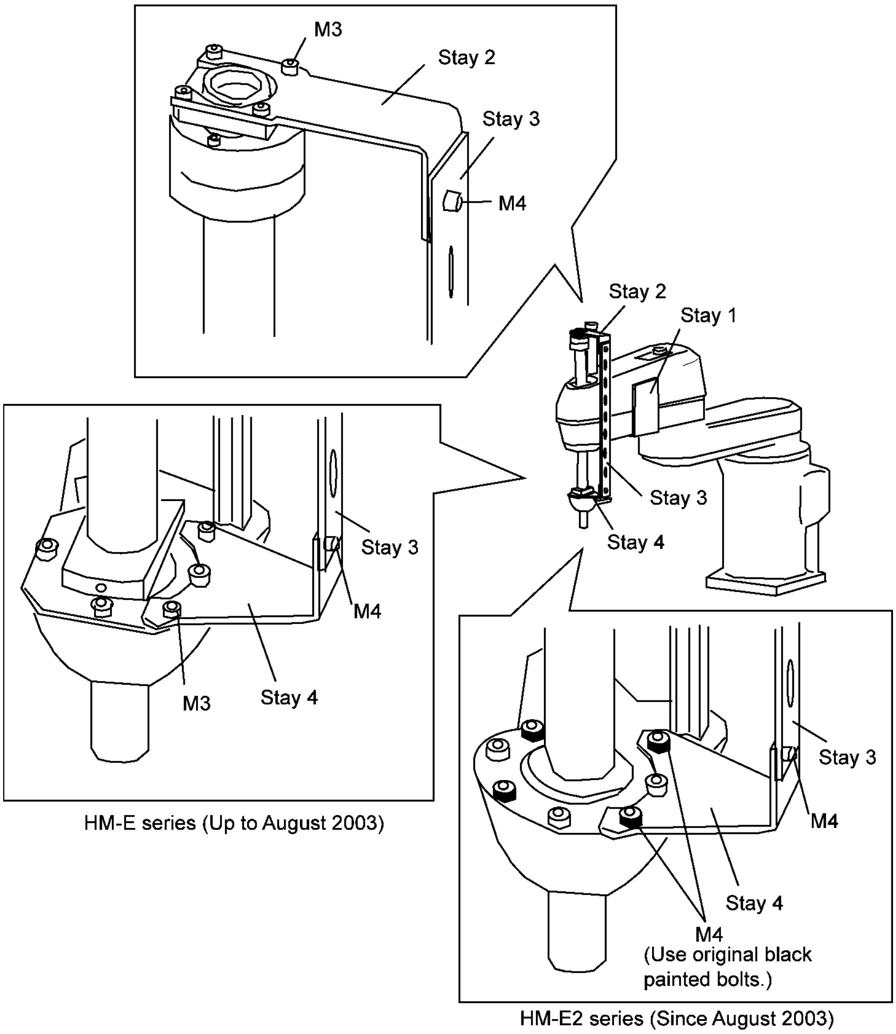
1.4.2.2 HM/HMS-E/E2 series

When securing Stay 1, Stay 2, Stay 3 and Stay 4 that clamp wiring and piping to the robot unit. Referring to the drawings below given, set up stays.

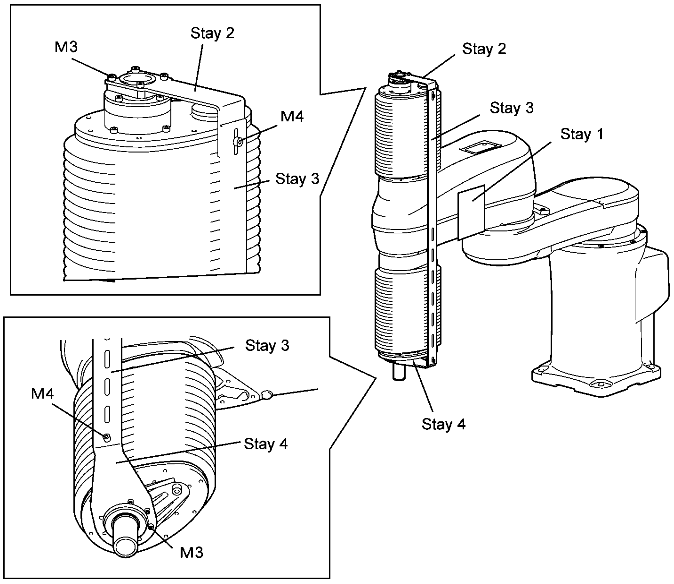
NOTE: The second arm of the HM/HMS-E series robot was modified, and also, the model name of the robot was changed to the HM/HMS-E2 series from the HM/HMS-E series at August 2003. Refer to following pages about dimensions of stays that clamp wiring and piping in this modification.



(1) Installing stays



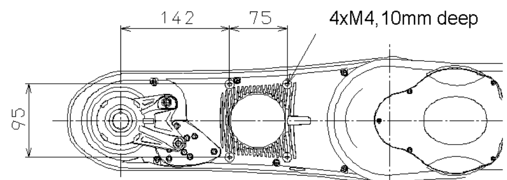
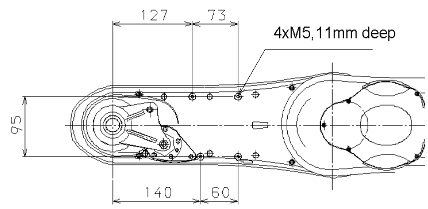
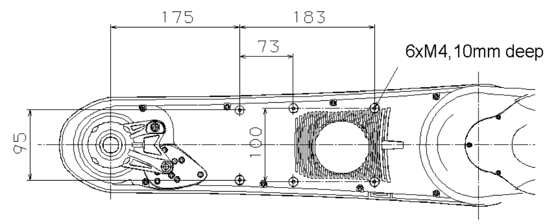
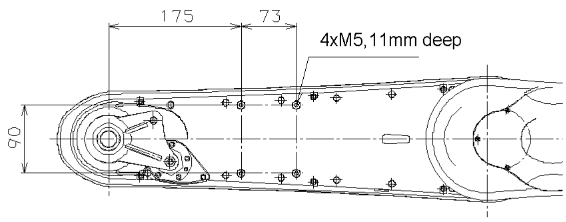
Installing stays (HM/HMS-E/-E2 standard type)



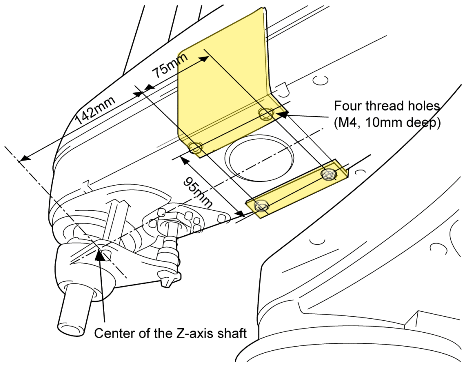
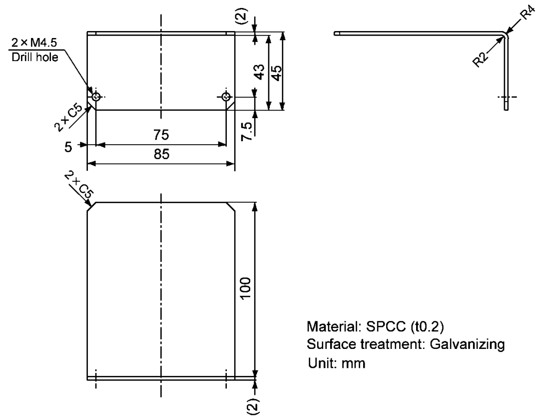
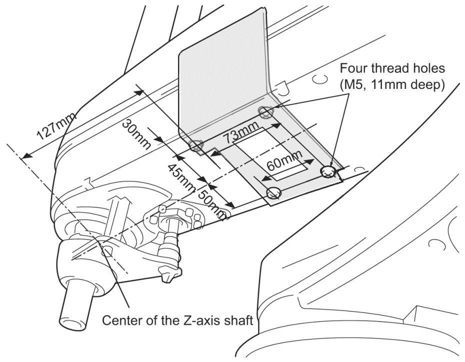
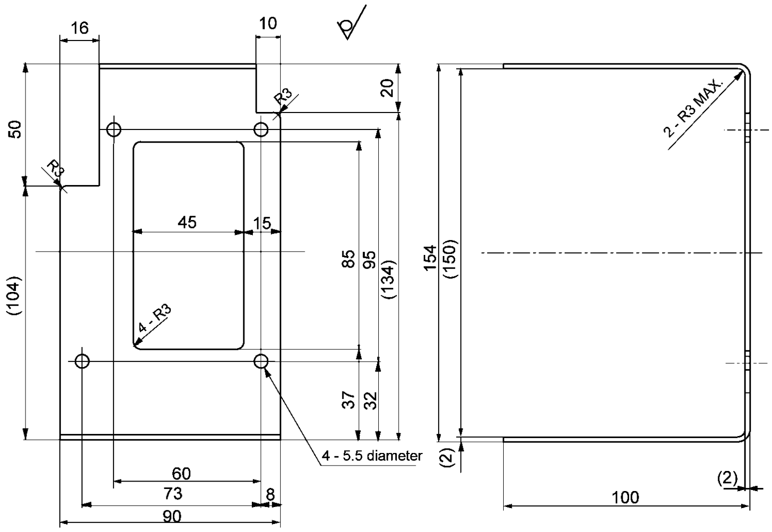
Installing stays (HM/HMS-E/-E2-W dust-proof & splash-proof type)

(2) Original thread-holes of the second arm (HM/HMS-E/-E2 series)

The figures below show thread-holes provided in the underside of the second arm. These holes are used for securing stays that clamp wiring and piping to the robot unit.

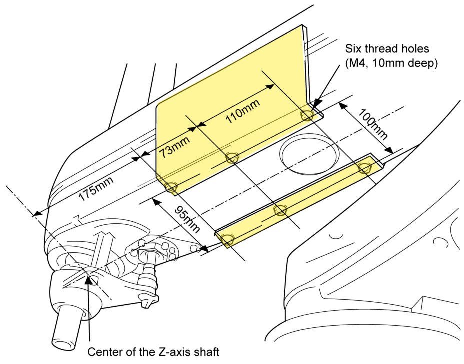
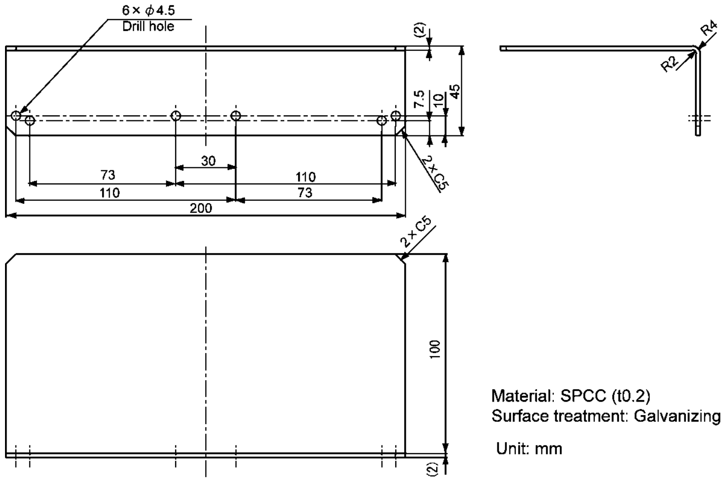
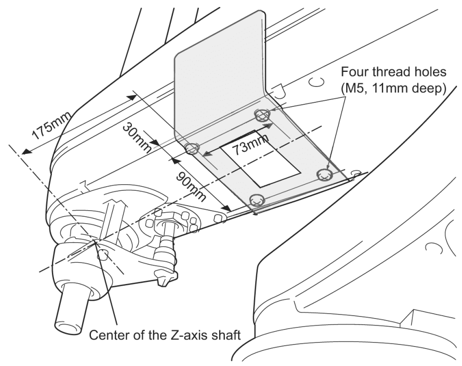
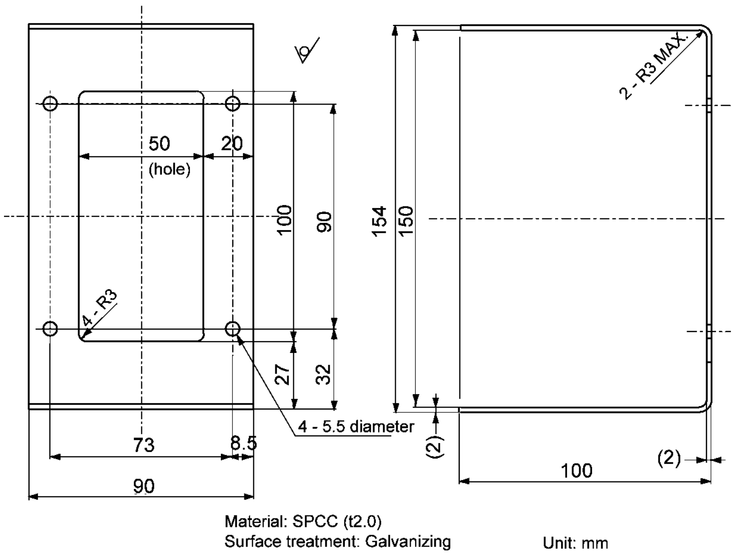
<table>
<tr><td>E2 series
(Current type)</td><td>HM-4*60*E2(-W)
HM/HMS-4*70*E2(-W)</td><td>E series
(Previous type)</td><td>HM-4*60*E(-W)
HM/HMS-4*70*E(-W)</td></tr>
<tr><td colspan="2">
</td><td colspan="2">
</td></tr>
<tr><td>E2 series
(Current type)</td><td>HM/HMS-4*85*E2(-W)
HM-4*A0*E2(-W)</td><td>E series
(Previous type)</td><td>HM/HMS-4*85*E(-W)
HM-4*A0*E(-W)</td></tr>
<tr><td colspan="2">
</td><td colspan="2">
</td></tr>
</table>

(3) Reference drawing for Stay 1 (For HM-4*60*E/E2(-W), HM/HMS-4*70*E/E2(-W))

<table>
<tr><th>Installing Stay1</th><th>Drawing of Stay 1</th></tr>
<tr><td>For current model:
HM-4*60*E2(-W)
HM/HMS-4*70*E2(-W)
</td><td>For current model:
HM-4*60*E2(-W)
HM/HMS-4*70*E2(-W)
</td></tr>
<tr><td>For previous model:
HM-4*60*E(-W)
HM/HMS-4*70*E(-W)
</td><td>For previous model:
HM-4*60*E(-W)
HM/HMS-4*70*E(-W)
</td></tr>
</table>

Stay 1 for HM-4*60*E/E2(-W),HM/HMS-4*70*E/E2(-W)

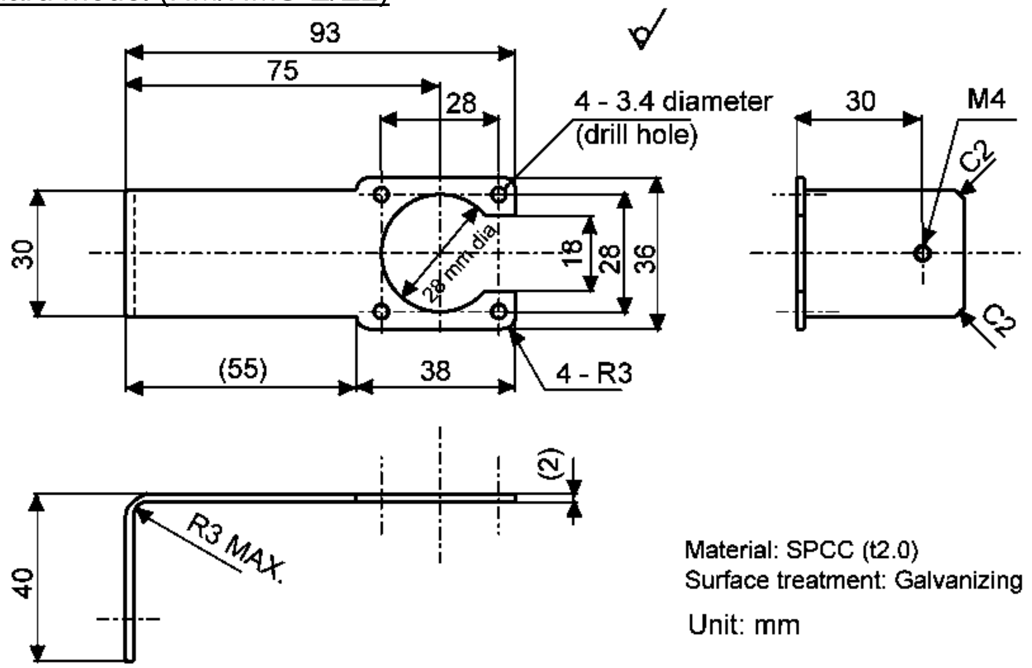
(4) Reference drawing for Stay 1 (For HM/HMS-4*85*E/E2(-W), HM-4*A0*E/E2(-W))

Installing Stay1	Drawing of Stay 1
For current model: HM/HMS-4*85*E2(-W) HM-4*A0*E2(-W) 	For current model: HM/HMS-4*85*E2(-W) HM-4*A0*E2(-W) 
For previous model: HM/HMS-4*85*E(-W) HM-4*A0*E(-W) 	For previous model: HM/HMS-4*85*E(-W) HM-4*A0*E(-W) 

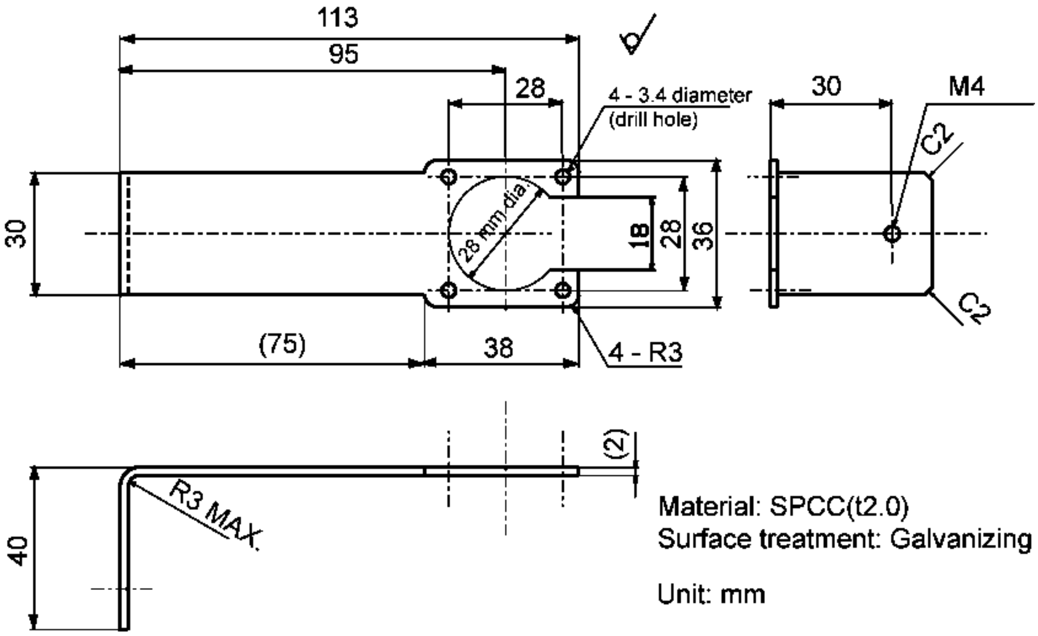
Stay 1 for HM/HMS-4*85E/E2(-W),HM-4*A0*E/E2(-W)

(5) Reference drawing for Stay 2

For standard model (HM/HMS-E/E2)

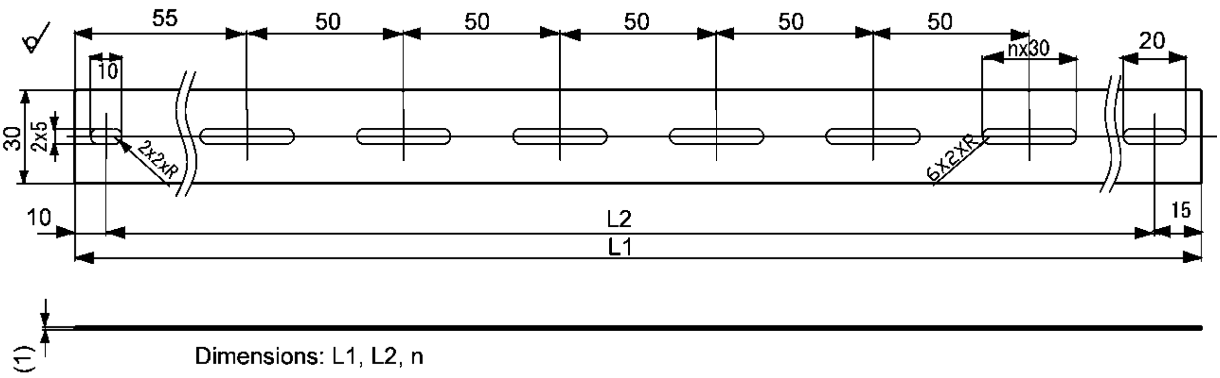


For dust-proof & splash-proof model (HM/HMS-E/E2-W)



Reference drawing for Stay 2

(6) Reference drawing for Stay 3



Dimensions: L1, L2, n

Model	Z-axis stroke	L1	L2	n
HM/HMS-E/-E2 series	200mm	375mm	350mm	6
	300mm	475mm	450mm	8
	400mm	575mm	550mm	10
HM/HMS-E/-E2-W series	200mm	545mm	520mm	9
	300mm	645mm	620mm	11
	400mm	745mm	720mm	13

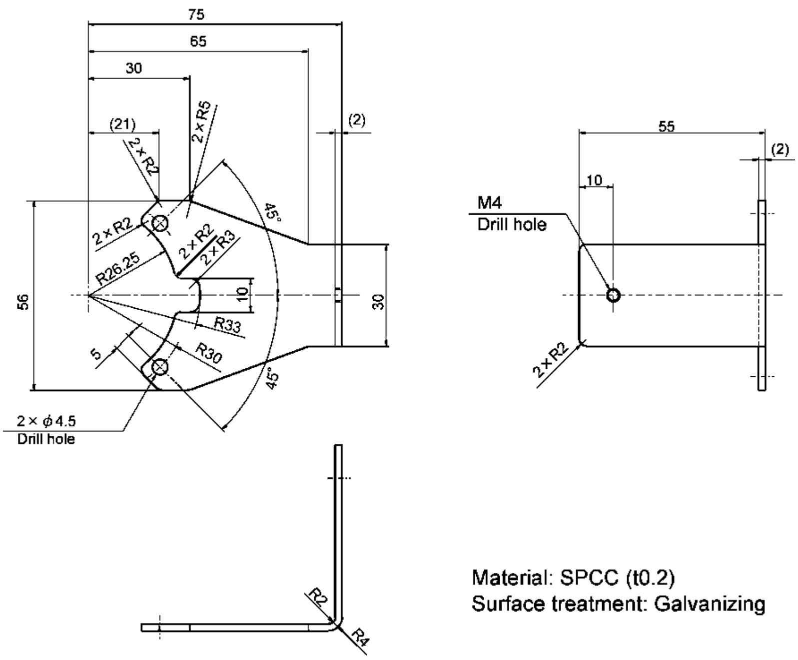
Material: SPCC-SD (t1.0)
Surface treatment: Galvanizing

Unit: mm

Reference drawing for Stay 3

(7) Reference drawing for Stay 4

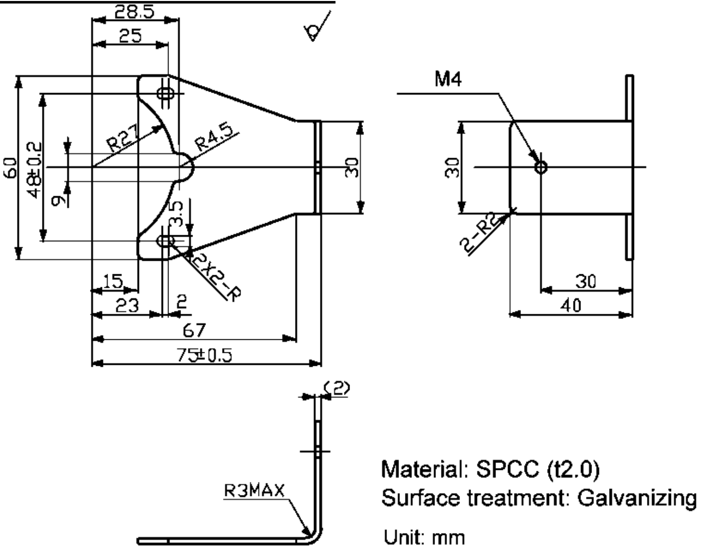
Current standard model: HM/HMS-E2 series



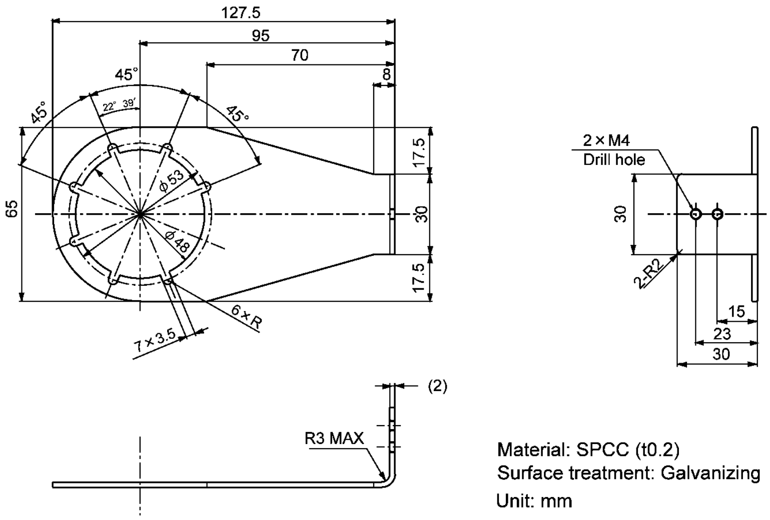
Material: SPCC (t0.2)
Surface treatment: Galvanizing

Reference drawing for Stay 4 (1)

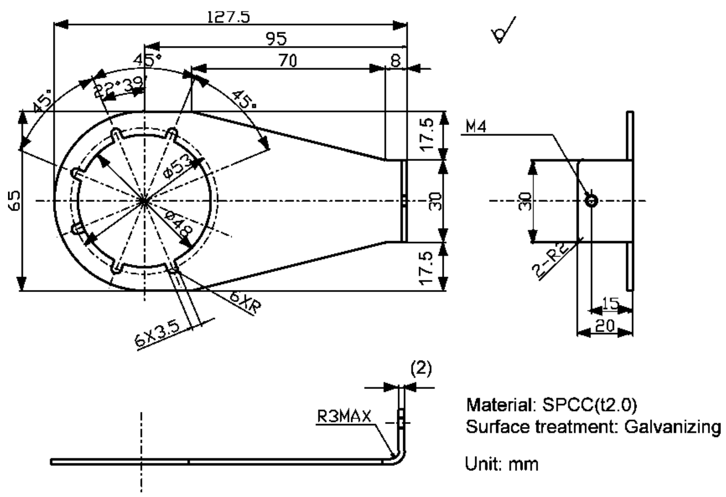
Previous standard model: HM/HMS-E series



New dust-proof & splash-proof model: HM/HMS-E2-W series



Previous dust-proof & splash-proof model: HM/HMS-E-W series

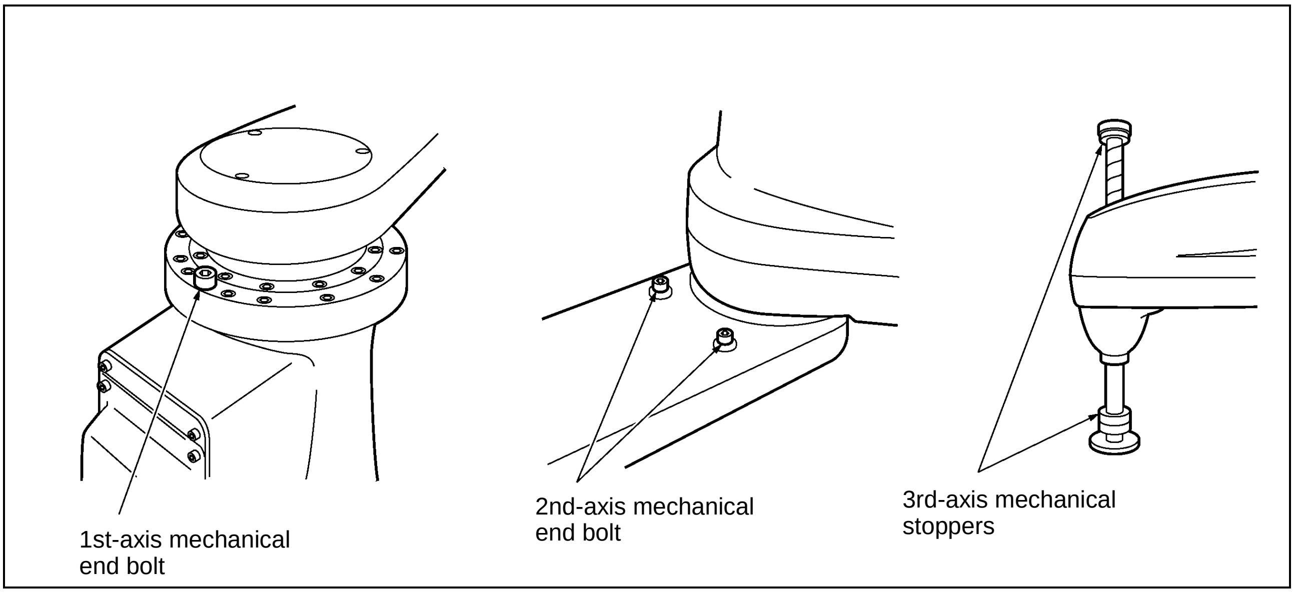


Reference drawing for Stay 4 (2)

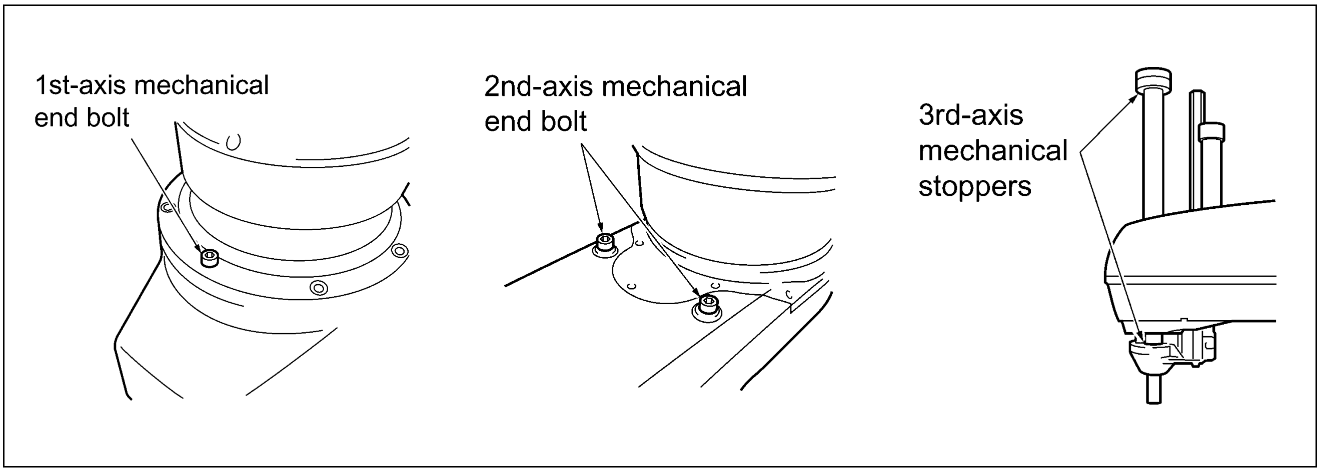
1.4.3 Prohibition Against Use of Mechanical End Bolts and Mechanical Stoppers for Wiring or Piping

Never remove the 1st- or 2nd-axis mechanical end bolts or 3rd-axis mechanical stoppers shown below or use them for securing a stay that clamps wiring or piping.

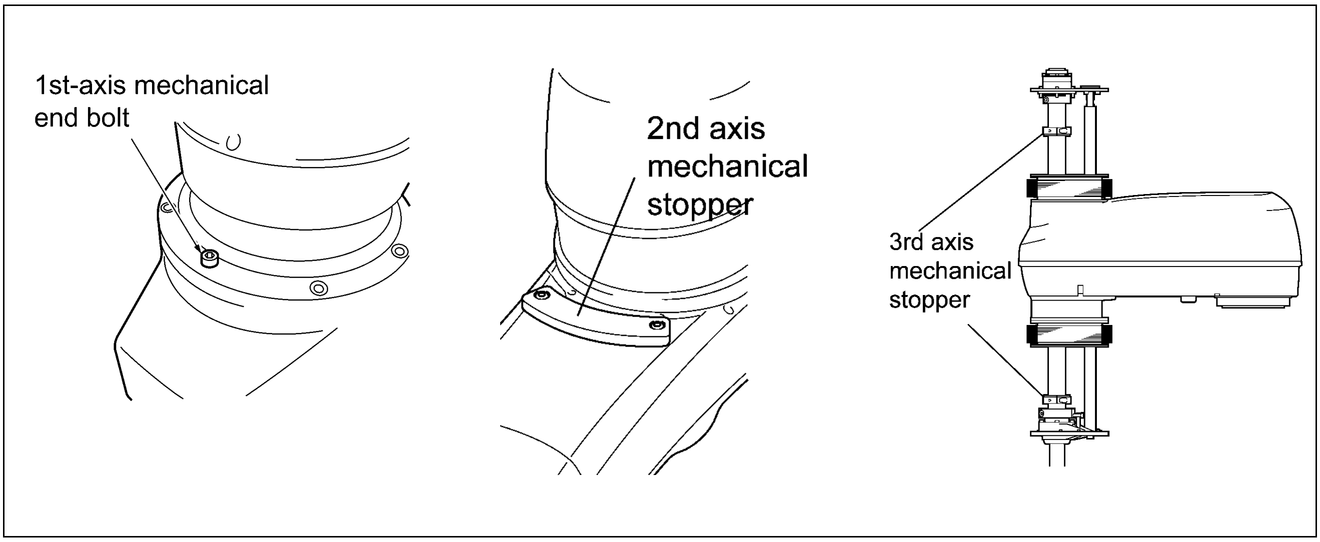
Doing so may result in the following problems: The CALSET initial position will be deviated when CALSET is performed; software limits will become invalid; the robot arm will fail to run as programmed; the robot arm will interfere with its peripheral devices; and so on.



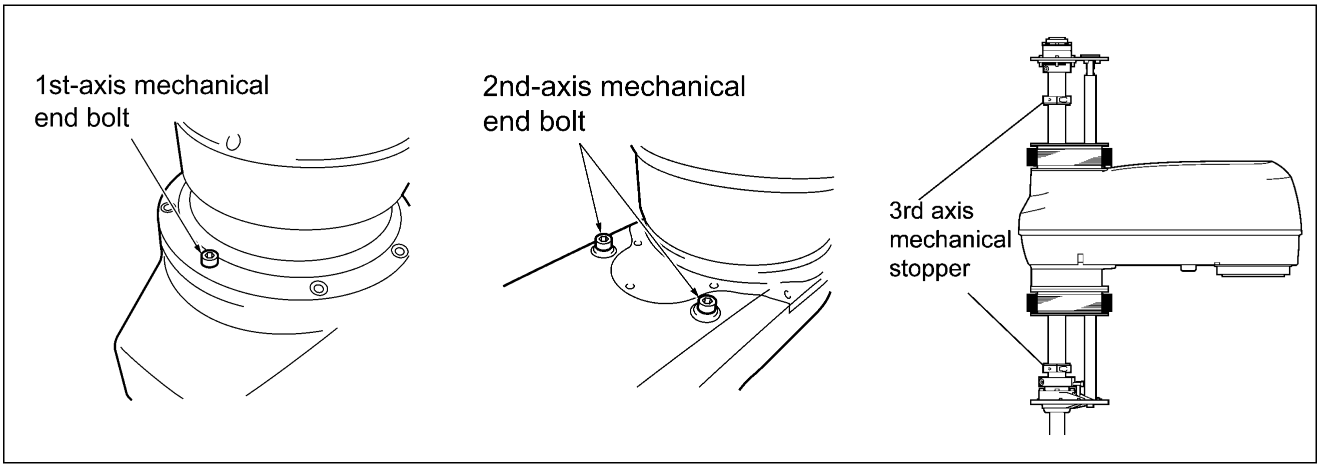
For HS-E series



For HM-E standard type



For HM-4*60*E-W, HM-4*70*E-W dust-proof & splash-proof type



For HM-4*85*E-W, HM-4*A0*E-W dust-proof & splash-proof type

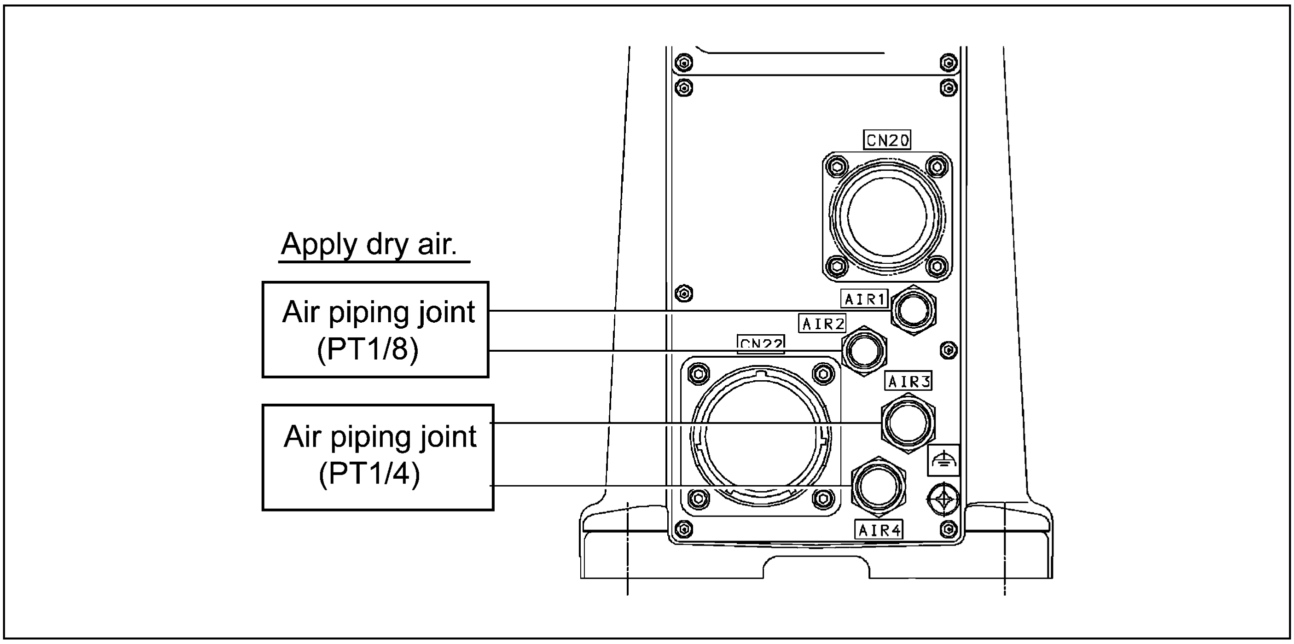
1.4.4 Piping of Source Air

(1) HS/HSS-E series

The robot unit is equipped with four air pipes (two of 4 mm and two of 6 mm in diameter) for controlling hands. The maximum of the source air pressure is listed below.

Apply dry air to the robot unit.

Maximum of source air pressure	0.59 MPa



Air Piping of the Robot Unit (HS/HSS-E)

(2) HM-E series

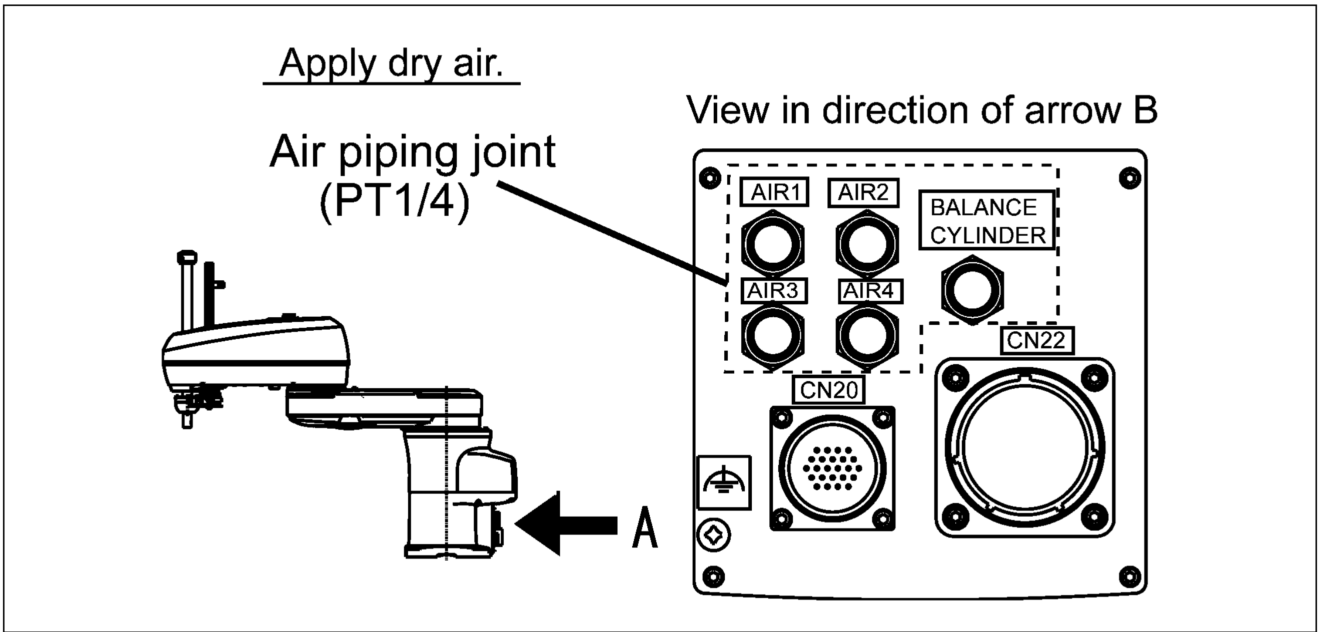
Piping of Source air

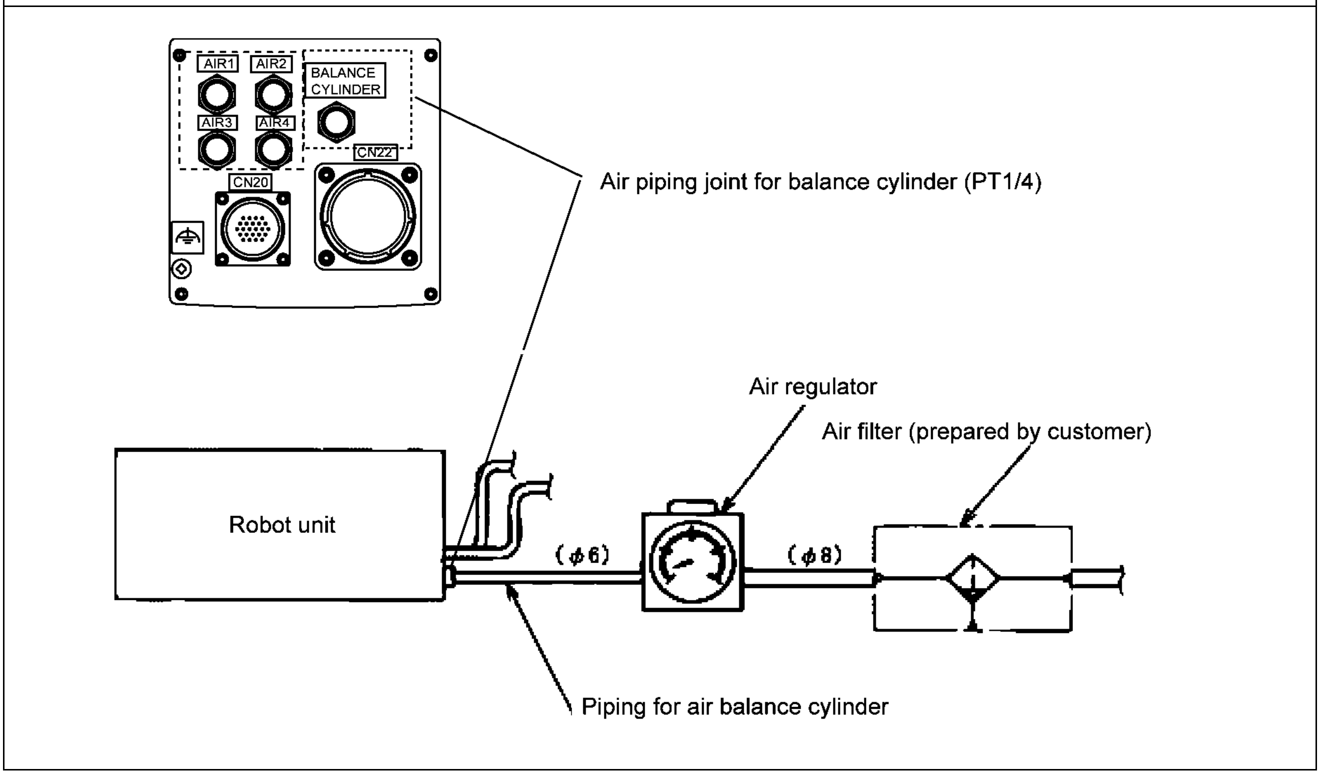
The robot unit is equipped with four air pipes (6 mm in diameter) for controlling hands and an air pipe (6 mm in diameter) for the air balance cylinder. The maximum of the source air pressure is 0.59 Mpa. Apply dry air to the robot unit.

For the air balance cylinder, apply air pressure within the range listed below.

At the primary side of the air regulator, install the air filter as shown in Figure below. (Max. air flow volume required for the robot: 70 N liter/min)

Air source pressure	0.35 to 0.59 MPa



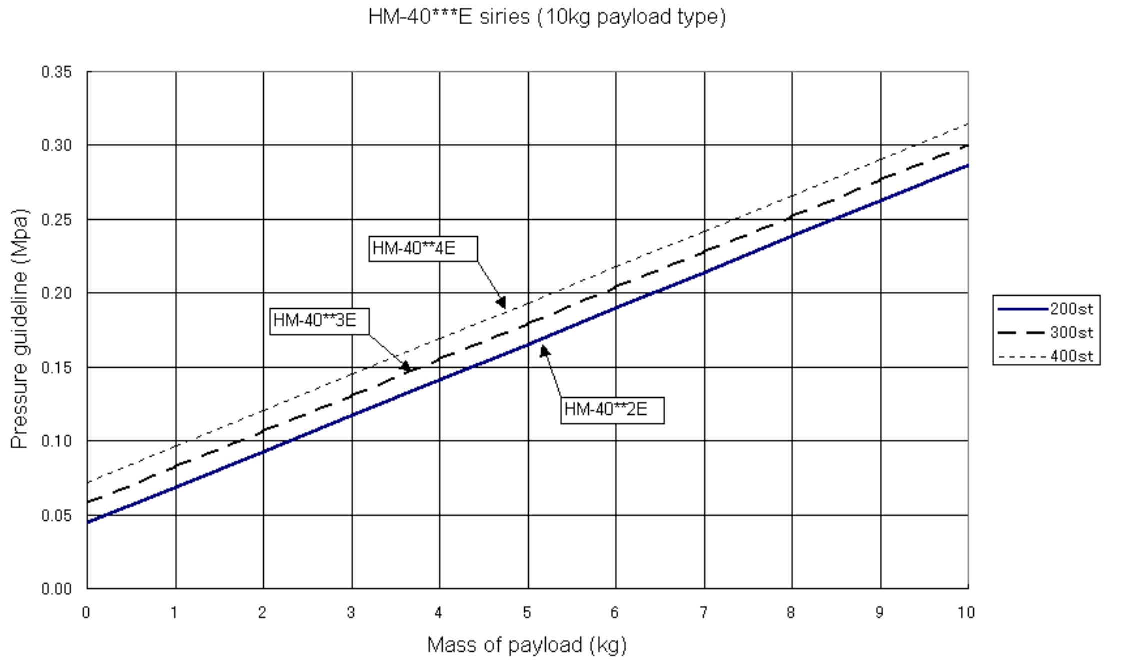


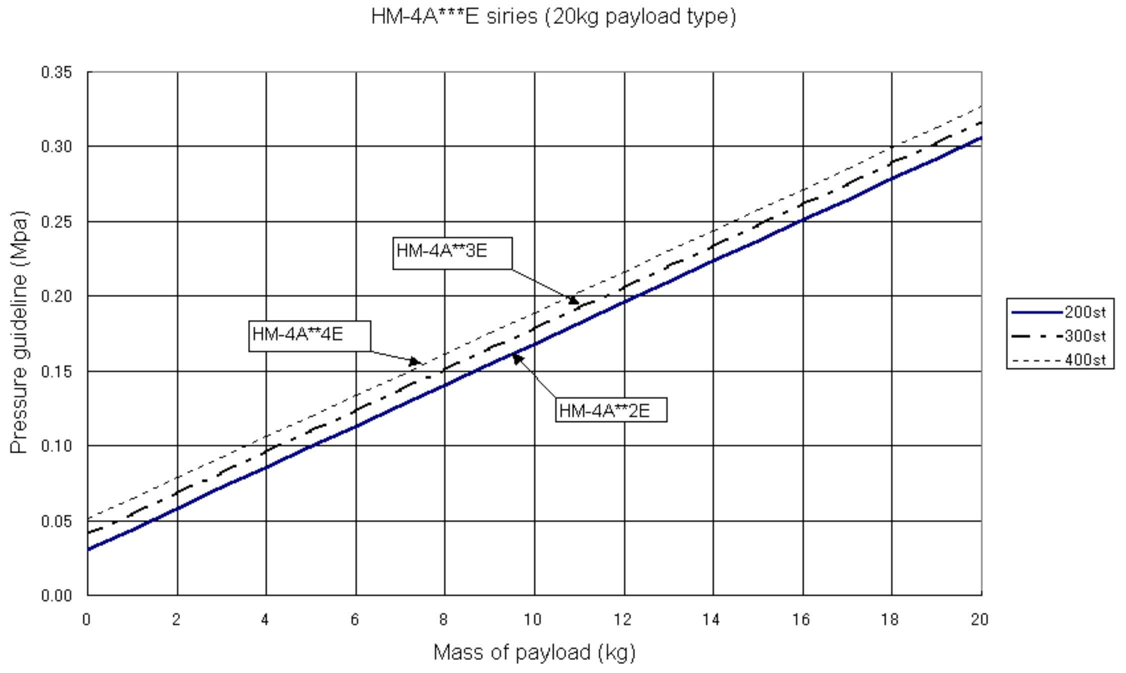
Air Piping of the Robot Unit (HM/HMS-E)

Adjusting the air balance

Adjust the air pressure by using the air regulator so that the end-effector plus payload chucked by the end-effector will balance with gravity.

For details, refer to Figure below and the SETTING-UP MANUAL, Section 5.3, "Adjusting the air pressure balance of the Z-axis, [F1 Arm]—[F12 Maint.]—[F4 Adj.Z.Bal]."





Note: This graph shows only a guideline.

Air Pressure Guideline

1.5 Installing the Flange Kit (Option)

<For HS/HSS-E series>

The flange kit consists of a flange, fixing bolt (M5x16), and setscrew (M4x6). Install the flange to the T-axis shaft according to the procedure below.

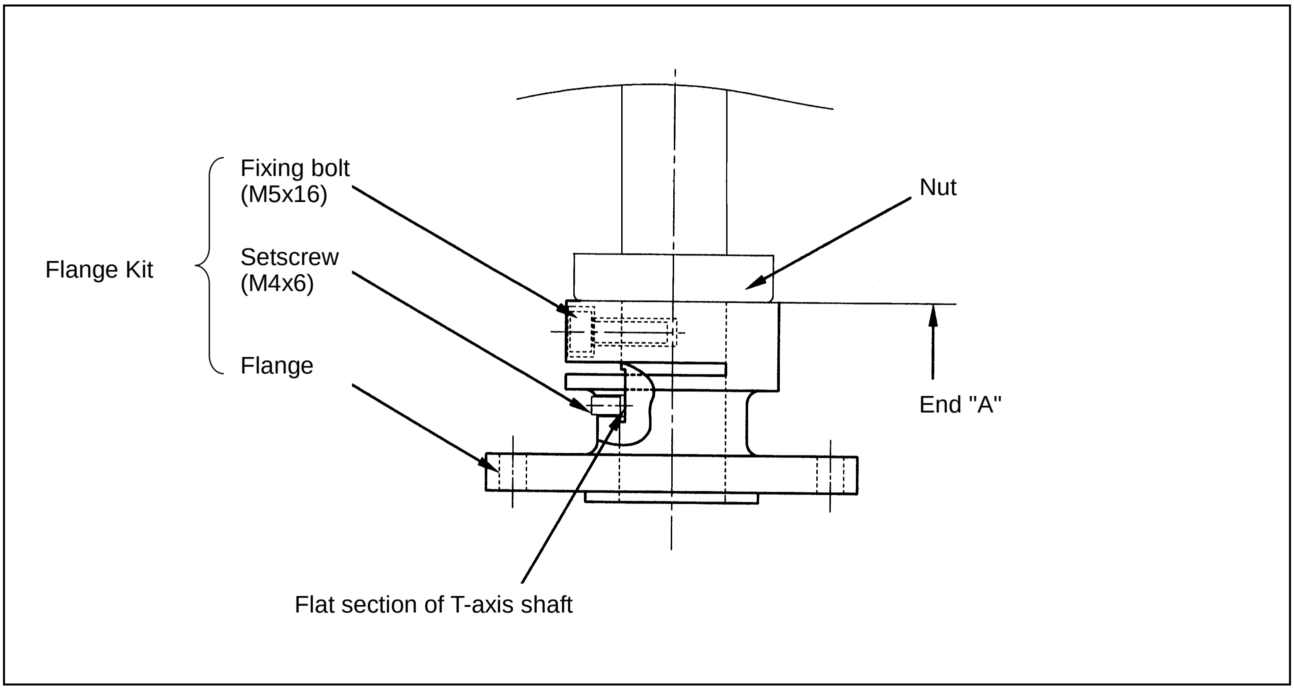
(1) Wipe off oil from the circumference of the T-axis shaft which the flange should be fitted on.

(2) Loosen the setscrew of the flange so that the flange can be fitted on the T axis.

(3) Push the flange until it comes into contact with nut end "A," and then rotate the flange so that the setscrew becomes aligned with the flat section of the T-axis shaft.

(4) Gradually tighten the setscrew until it comes into contact with the flat section of the T-axis shaft and the flange can be rotated without looseness.
Then torque the setscrew to 1.6 ±0.3 Nm.

(5) Tighten the fixing bolt (M5x16) to 8.8 ±0.9 Nm for securing the flange.



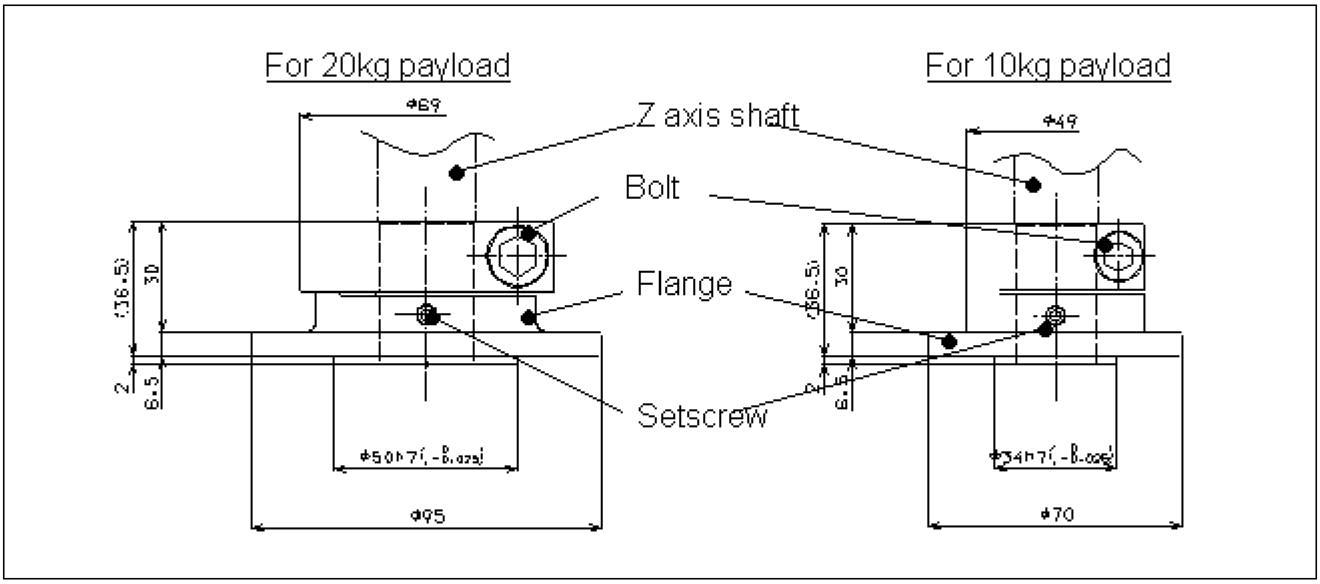
Installing the Flange Kit (HS/HSS-E)

<For HM/HMS-E series>

The flange kit consists of a flange, fixing bolt, and setscrew. Install the flange to the T-axis shaft.

Robot model	Bolt & screw	Fixing torque
For 10kg payload	Fixing bolt (M8)	35±6 Nm
	Setscrew (M5)	1.5±0.15 Nm
For 20kg payload	Fixing bolt (M10)	70±13 Nm
	Setscrew (M5)	1.5±0.15 Nm

Caution: (1) After moving the Z-axis shaft to the upper end, install the flange.
(2) The setscrew is only for positioning. Never use it for hand fixing.



Installing the Flange Kit (HM/HMS-E)

1.6 Engineering-design Notes for Robot Hands

1.6.1 HS/HSS-E series

Design a hand (end-effector) so that it will satisfy conditions (1) and (2) described below.

⚠**Caution**: Strictly observe these engineering-design notes. Otherwise, the clamped sections of the robot unit will become loose, rattle or be out of position. In the worst case, the mechanical parts of the robot unit and the robot controller may be damaged.

(1) Mass of hand

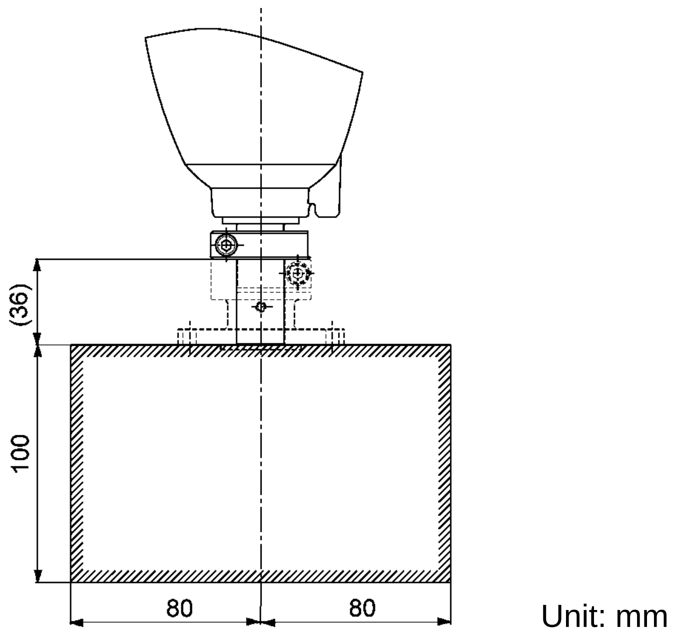
The total mass of a hand or tool (including work-piece) should be less than the maximum allowable payload of the robot. Be sure to include the mass of wirings and piping used for a hand or tool.

Total mass of hand or tool (incl. Work-piece) ≤ Max. allowable payload

NOTE: The maximum allowable payload refers to a mass of payload that you have preset.

(2) Hand center of gravity

The center of gravity of a hand or tool (including work-piece) should be located within the range specified in Figure below.



Hand center of gravity (HS/HSS-E)

(3) Moment of inertia around the T axis

The moment of inertia of a hand or tool (including work-piece) around the T axis should be less than the maximum allowable moment of inertia around the T axis of the robot.

Hand's moment of inertia (incl. Work-piece) around the T axis ≤
Max. allowable moment of inertia

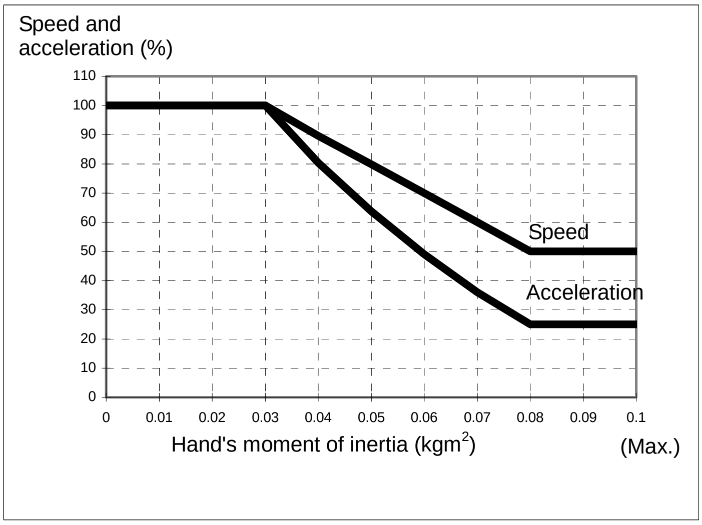
Calculate the moment of inertia around the T axis according to the graph given below.

NOTE: You may program the reduced ratio of the speed and acceleration individually within the range specified below. If you set the reduced ratio of the programmed speed only, the controller automatically calculates that of the acceleration according to the formula below.

$$\text{Acceleration (\%)} = (\text{Speed}/100)^2 \text{x}100$$

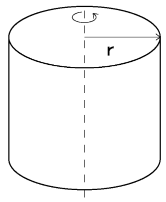
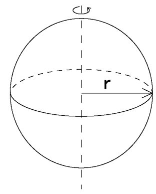
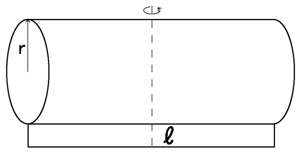
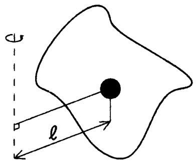
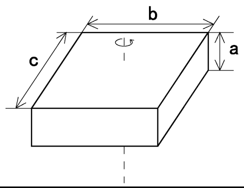
<u>Application sample of hand's moment of inertia</u>

- To run the robot at 100% of the programmed speed and acceleration: The moment of inertia around the T axis should be 0.03 kgm^2 or less.
- If the moment of inertia around the T axis is 0.04 kgm^2: Run the robot at 90% or less of the programmed speed and at 81% or less of the programmed acceleration.

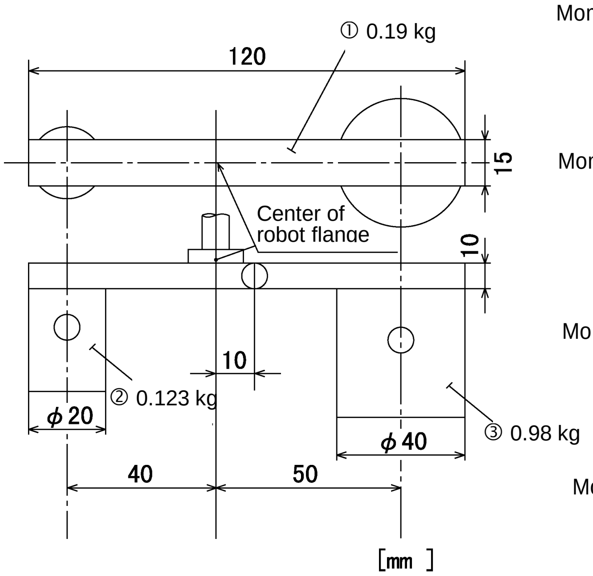


When calculating the hand's or tool's moment of inertia around the T axis, refer to the moment-of-inertia formulas on the next page.

Moment-of-inertia Formulas

1. Cylinder (1) (Axis of rotation = Center axis)  $I = \frac{mr^2}{2}$	4. Sphere (Axis of rotation = Center axis)  $I = \frac{2mr^2}{5}$
2. Cylinder (2) (The axis of rotation passes through the center of gravity.)  $I = \frac{m}{4}\left(r^2 + \frac{\ell^2}{3}\right)$	5. Center of gravity not on the axis of rotation. Ig: Moment of inertia around center of gravity  [kgm²] $I = I_g + m\ell^2$
3. Rectangular parallelepiped (The axis of rotation passes through the center of gravity.)  $I = \frac{m}{12}(b^2 + c^2)$	I: Moment of inertia 〔kgm²〕 m: Mass 〔kg〕 r: Radius 〔m〕 a, b, c, ℓ: Length 〔m〕

Calculation example : When calculating the moment of inertia of a complicated shape, divide it into simple parts as much as possible for easier calculations.
As shown in the figure below, divide the hand into three parts (①, ②, ③).



Moment of inertia around T-axis of ①: I_1 (from 3 and 5 in the above table.)

$$I_1 = \frac{0.19}{12}(0.12^2 + 0.015^2) + 0.19 \times 0.01^2 = 2.51 \times 10^{-4}$$

[kgm²]

Moment of inertia around T-axis of ②: I_2 (from 1 and 5 in the above table.)

$$I_2 = \frac{0.123 \times 0.01^2}{2} + 0.123 \times 0.04^2 = 2.03 \times 10^{-4}$$

[kgm²]

Moment of inertia around T-axis of ③: I_3 (from 1 and 5 in the above table.)

$$I_3 = \frac{0.98 \times 0.02^2}{2} + 0.98 \times 0.05^2 = 2.65 \times 10^{-3}$$

[kgm²]

Moment of inertia around T-axis of entire hand: I

$$I = I_1 + I_2 + I_3 = 0.003 \quad [kgm^2]$$

Calculation Example of Hand's Moment of Inertia Around the T Axis

1.6.2 HM/HMS-E series

Design a hand (end-effector) so that it will satisfy conditions (1) and (3) described below.

⚠**Caution**: Strictly observe these engineering-design notes. Otherwise, the clamped sections of the robot unit will become loose, rattle or be out of position. In the worst case, the mechanical parts of the robot unit and the robot controller may be damaged.

(1) Mass of hand

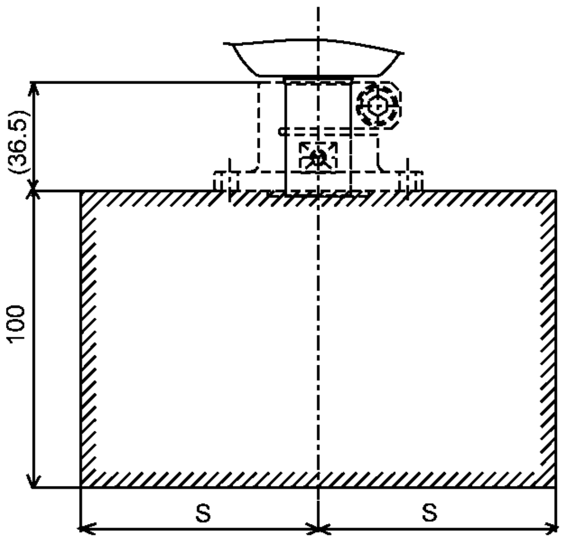
The total mass of a hand or tool (including work-piece) should be less than the maximum allowable payload of the robot. Be sure to include the mass of wirings and piping used for a hand or tool.

Total mass of hand or tool (incl. Work-piece) ≤ Max. allowable payload

NOTE: The maximum allowable payload refers to a mass of payload that you have preset.

(2) Hand center of gravity

The center of gravity of a hand or tool (including work-piece) should be located within the range specified in Figure below.



Robot model	S
HM/HMS-40***E(10kg payload)	80mm
HM/HMS-4A***E(20kg payload)	60mm

(Unit: mm)

Hand center of gravity (HM/HMS-E)

(3) Moment of inertia around the T axis

The moment of inertia of a hand or tool (including work-piece) around the T axis should be less than the maximum allowable moment of inertia around the T axis of the robot.

Hand's moment of inertia (incl. Work-piece) around the T axis ≤
Max. allowable moment of inertia

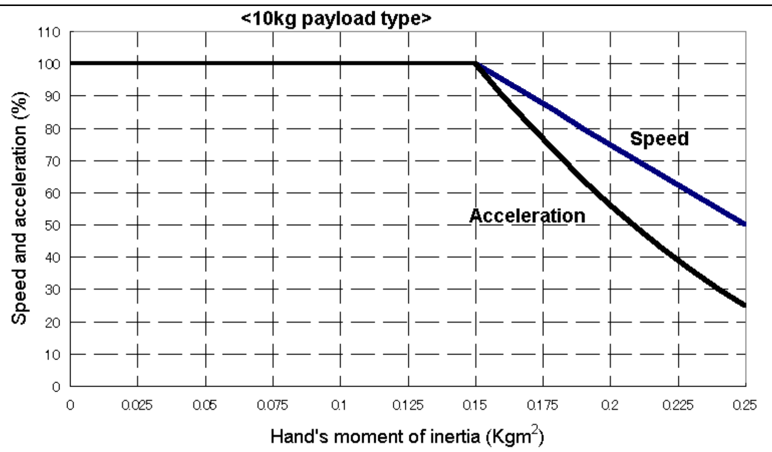
Calculate the moment of inertia around the T axis according to the graph given below.

NOTE: You may program the reduced ratio of the speed and acceleration individually within the range specified below. If you set the reduced ratio of the programmed speed only, the controller automatically calculates that of the acceleration according to the formula below.

Acceleration (%) = $(\text{Speed}/100)^2 \text{x} 100$

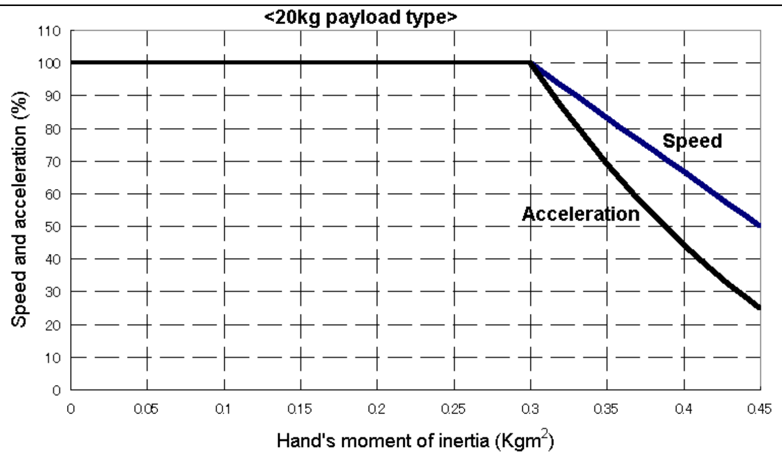
<u>Application sample of hand's moment of inertia: HM/HMS-E series, 10 kg payload type</u>

- To run the robot at 100% of the programmed speed and acceleration: The moment of inertia around the T axis should be 0.15 kgm^2 or less.
- If the moment of inertia around the T axis is 0.17 kgm^2: Run the robot at 90% or less of the programmed speed and at 81% or less of the programmed acceleration.



<u>Application sample of hand's moment of inertia: HM/HMS-E series, 20 kg payload type</u>

- To run the robot at 100% of the programmed speed and acceleration: The moment of inertia around the T axis should be 0.3 kgm^2 or less.
- If the moment of inertia around the T axis is 0.33 kgm^2: Run the robot at 90% or less of the programmed speed and at 81% or less of the programmed acceleration.

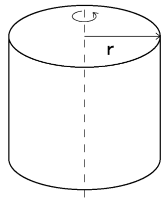


When calculating the hand's or tool's moment of inertia around the T axis, refer to the moment-of-inertia formulas on the next page.

Moment-of-inertia Formulas

1. Cylinder (1)

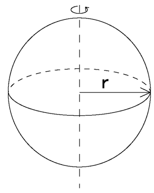
(Axis of rotation = Center axis)



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

4. Sphere

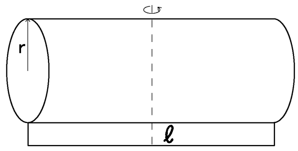
(Axis of rotation = Center axis)



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

2. Cylinder (2)

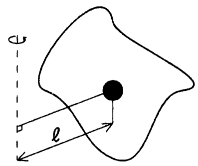
(The axis of rotation passes through the center of gravity.)



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

5. Center of gravity not on the axis of rotation.

Ig: Moment of inertia around center of gravity

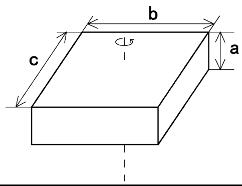


[kgm²]

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

3. Rectangular parallelepiped

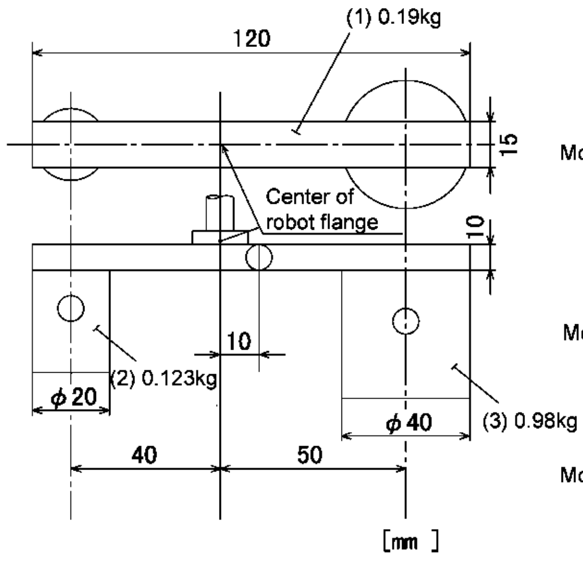
(The axis of rotation passes through the center of gravity.)



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

I:	Moment of inertia	[kgm²]
m:	Mass	[kg]
r:	Radius	[m]
a, b, c, ℓ:	Length	[m]

Calculation example : When calculating the moment of inertia of a complicated shape, divide it into simple parts as much as possible for easier calculations.
As shown in the figure below, divide the hand into three parts ((1), (2), (3)).



Moment of inertia around T-axis of (1): I1 (from 3 and 5 in the above table)

$$I_1 = \frac{0.19}{12}\left(0.12^2 + 0.015^2\right) + 0.19 \times 0.01^2 = 2.51 \times 10^{-4}$$

[kgm²]

Moment of inertia around T-axis of (2): I2 (from 1 and 5 in the above table)

$$I_2 = \frac{0.123 \times 0.01^2}{2} + 0.123 \times 0.04^2 = 2.03 \times 10^{-4}$$

[kgm²]

Moment of inertia around T-axis of (3): I3 (from 1 and 5 in the above table)

$$I_3 = \frac{0.98 \times 0.02^2}{2} + 0.98 \times 0.05^2 = 2.65 \times 10^{-3}$$

[kgm²]

Moment of inertia around T-axis of entire hand: I

$$I = I_1 + I_2 + I_3 = 0.003$$ [kgm²]

Calculation Example of Hand's Moment of Inertia Around the T Axis

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 the motion space
- Mechanical ends for defining the 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 hand's 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

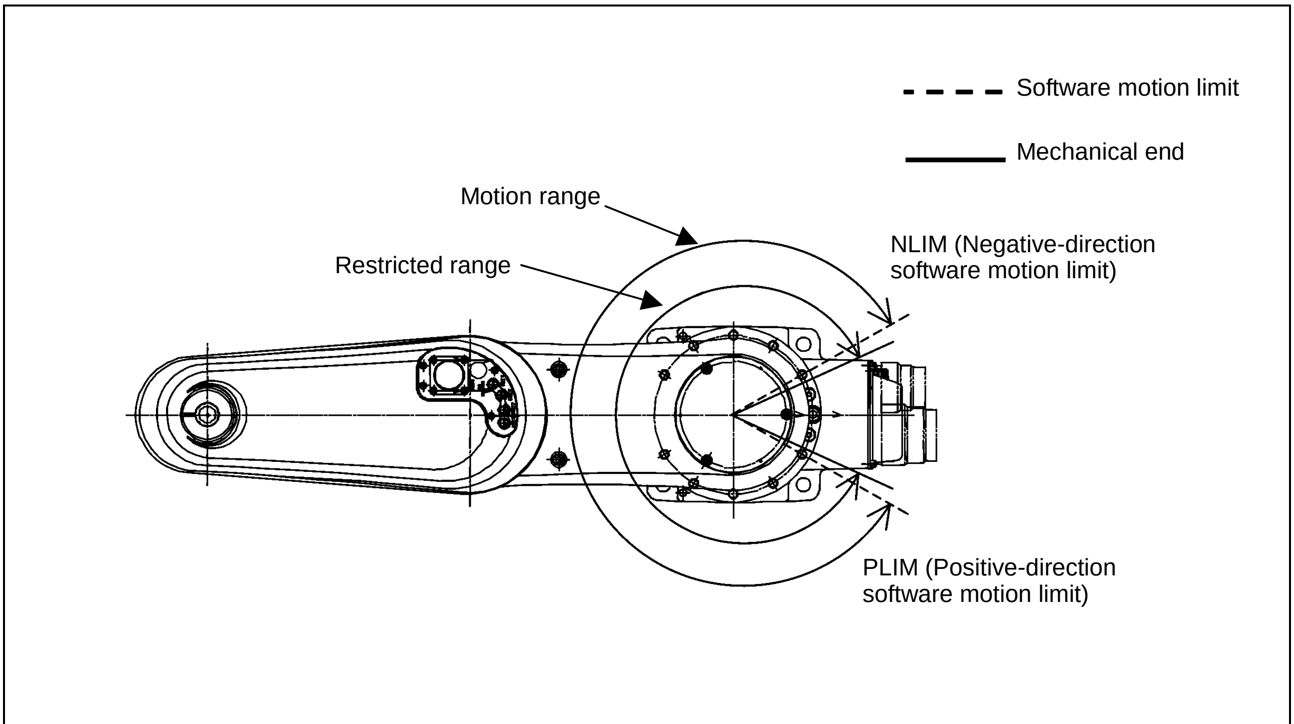
2.2.1 What Is a Software Motion Limit?

A limit to the operation range of the robot defined by 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 motion limit is called a mechanical end and set by a mechanical stop. To prevent the robot from striking against a mechanical stop, each software motion limit is set slightly in front of the mechanical end as shown below.

If the robot reaches a software motion limit during manual or automatic operation, an error message will be displayed (error code starting from 607x where x represents the axis number) and the robot will come to a stop. The power to the motor will be also turned OFF if the robot is in automatic operation.

Each of all axes is 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 (Example of HS-E)

2.2.2 Software Motion Limits (Factory defaults)

The table below lists the factory defaults of software motion limits.

(1) HS-E series (Floor-mount type)

Robot type		Standard type		Dust-proof, splash-proof type		Cleanroom type	
		HS-45**2E	HS-45**3E	HS-45**2E-W	HS-45**3E-W	HS-45**2E-P	HS-45**3E-P
3rd-axis (Z-axis) stroke		200 mm	320 mm	200 mm	320 mm	200 mm	320 mm
1st axis	Positive direction	155º					
	Negative direction	-155º					
2nd axis	Positive direction	145º					
	Negative direction	-145º					
3rd axis	Positive direction	246 mm	246 mm	206 mm	206 mm	206 mm	206 mm
	Negative direction	46 mm	-74 mm	6 mm	-114 mm	6 mm	-114 mm
4th axis	Positive direction	360º					
	Negative direction	-360º					

(2) HSS-4545*E (Overhead-mount type, Overall arm length 450 mm)

Robot type		Standard type			Dust-proof, splash-proof type		
		HSS-45451 E	HSS-45452 E	HSS-45453 E	HSS-45451 E-W	HSS-45452 E-W	HSS-45453 E-W
3rd-axis (Z-axis) stroke		150 mm	200 mm	320 mm	150 mm	200 mm	320 mm
1st axis	Positive direction	152º					
	Negative direction	-152º					
2nd axis	Positive direction	141º					
	Negative direction	-141º					
3rd axis	Positive direction	-431 mm	-431 mm	-431 mm	-471 mm	-471 mm	-471 mm
	Negative direction	-581 mm	-631 mm	-751 mm	-621 mm	-671 mm	-791 mm
4th axis	Positive direction	360º					
	Negative direction	-360º					

(3) HSS-4555*E (Overhead-mount type, Overall arm length 550 mm)

Robot type		Standard type			Dust-proof, splash-proof type		
		HSS-45551 E	HSS-45552 E	HSS-45553 E	HSS-45551 E-W	HSS-45552 E-W	HSS-45553 E-W
3rd-axis (Z-axis) stroke		150 mm	200 mm	320 mm	150 mm	200 mm	320 mm
1st axis	Positive direction	155°					
	Negative direction	-155°					
2nd axis	Positive direction	145°					
	Negative direction	-145°					
3rd axis	Positive direction	-431 mm	-431 mm	-431 mm	-471 mm	-471 mm	-471 mm
	Negative direction	-581 mm	-631 mm	-751 mm	-621 mm	-671 mm	-791 mm
4th axis	Positive direction	360°					
	Negative direction	-360°					

(4) HM-E standard type

Robot type		Standard type		
		HM-4***2E	HM-4***3E	HM-4***4E
3rd-axis (Z-axis) stroke		200mm	300mm	400mm
1st axis	Positive direction	165°		
	Negative direction	-165°		
2nd axis	Positive direction	147° HM-4*60*E: 143°		
	Negative direction	-147° HM-4*60*E: -143°		
3rd axis	Positive direction	350mm	350mm	350mm
	Negative direction	150mm	50mm	-50mm
4th axis	Positive direction	360°		
	Negative direction	-360°		

(5) HM-E-W dust-proof & splash-proof type

Robot type		Dust-proof & splash-proof type		
		HM-4***2E-W	HM-4***3E-W	HM-4***4E-W
3rd-axis (Z-axis) stroke		200mm	300mm	400mm
1st axis	Positive direction	165º		
	Negative direction	-165º		
2nd axis	Positive direction	147º HM-4*60*E-W: 140º, HM-4*70*E-W: 146º		
	Negative direction	-147º HM-4*60*E-W: -140º, HM-4*70*E-W: -146º		
3rd axis	Positive direction	310mm	310mm	310mm
	Negative direction	110mm	10mm	-90mm
4th axis	Positive direction	360º		
	Negative direction	-360º		

(6) HMS-4*70*E (Overhead-mount type, Overall arm length 700 mm)

Robot type		Standard type			Dust-proof, splash-proof type		
		HMS-4*702 E	HMS-4*703 E	HMS-4*704 E	HMS-4*702 E-W	HMS-4*703 E-W	HMS-4*704 E-W
3rd-axis (Z-axis) stroke		200 mm	300 mm	400 mm	200 mm	300 mm	400 mm
1st axis	Positive direction	165º			165º		
	Negative direction	-165º			-165º		
2nd axis	Positive direction	145º			142º		
	Negative direction	-145º			-142º		
3rd axis	Positive direction	-436 mm	-456 mm	-456 mm	-496 mm	-496 mm	-496 mm
	Negative direction	-656 mm	-756 mm	-856 mm	-696 mm	-796 mm	-896 mm
4th axis	Positive direction	360º					
	Negative direction	-360º					

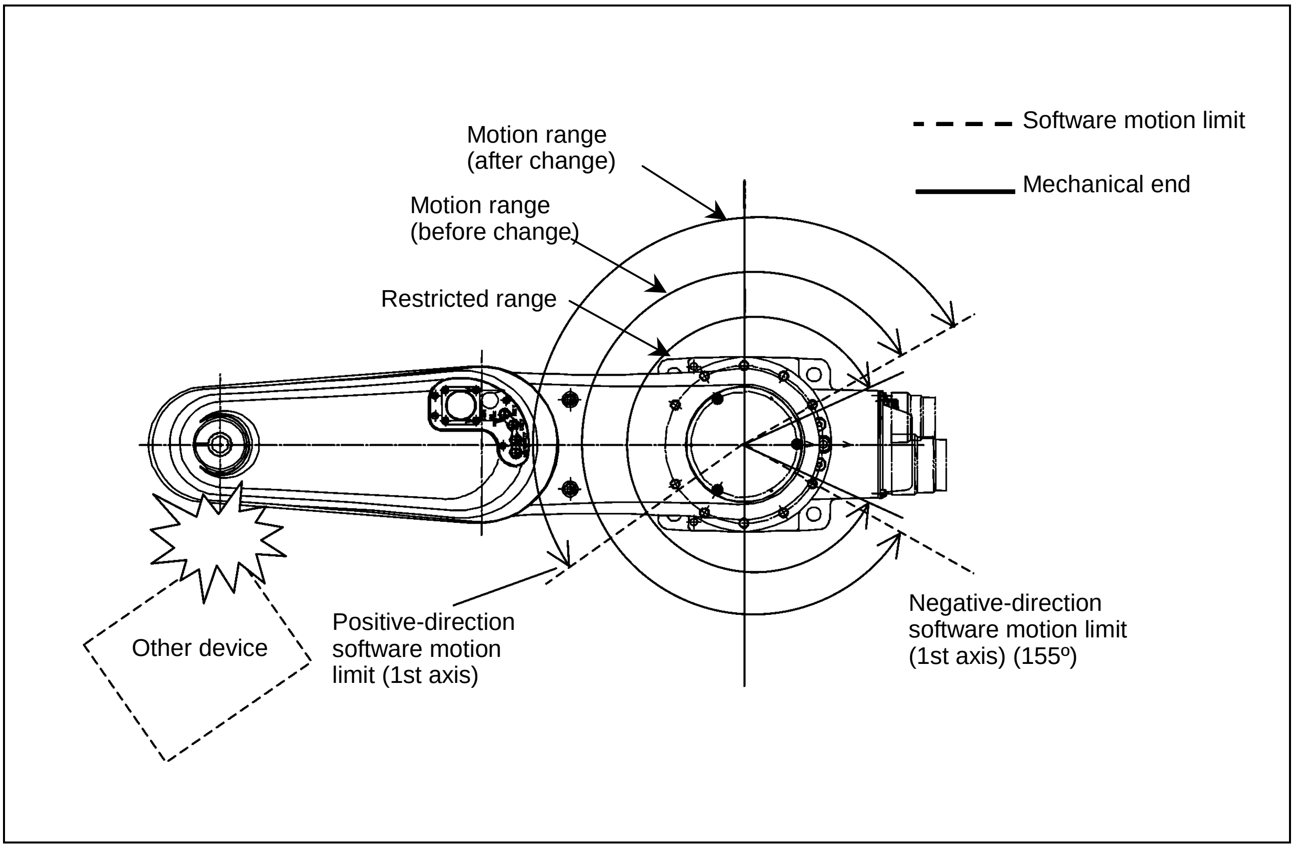
(7) HMS-4*85*E (Overhead-mount type, Overall arm length 850 mm)

Robot type		Standard type			Dust-proof, splash-proof type		
		HMS-4*852 E	HMS-4*853 E	HMS-4*854 E	HMS-4*852 E-W	HMS-4*853 E-W	HMS-4*854 E-W
3rd-axis (Z-axis) stroke		200 mm	300 mm	400 mm	200 mm	300 mm	400 mm
1st axis	Positive direction	165º			165º		
	Negative direction	-165º			-165º		
2nd axis	Positive direction	142º			142º		
	Negative direction	-142º			-142º		
3rd axis	Positive direction	-436 mm	-456 mm	-456 mm	-496 mm	-496 mm	-496 mm
	Negative direction	-656 mm	-756 mm	-856 mm	-696 mm	-796 mm	-896 mm
4th axis	Positive direction	360º					
	Negative direction	-360º					

2.2.3 Changing Software Motion Limits

If the robot interferes with other devices or the air piping and wiring of the hand become taut as the robot arm moves, then change the software motion limits to make the motion space smaller as shown below.

Caution:	**When changing software motion limits, always take into account that the robot arm will motion within the range specified by the initial software motion limits.**



Changing Software Motion Limits (Example of HS-E)

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 range of the robot in the actual working environment.
Set the software motion limits using the correct unit.
If the operating range is too small, the robot may seem to become inoperable.

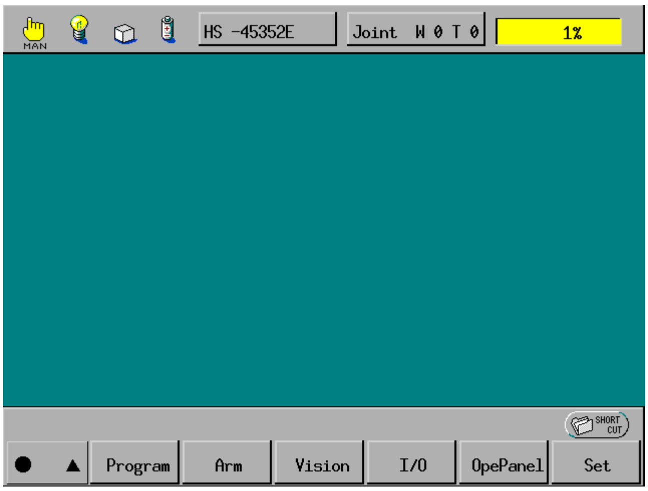
2.2.5 Procedure for Changing the Software Motion Limits

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

Step 1 **Turn the power switch of the robot controller 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.**

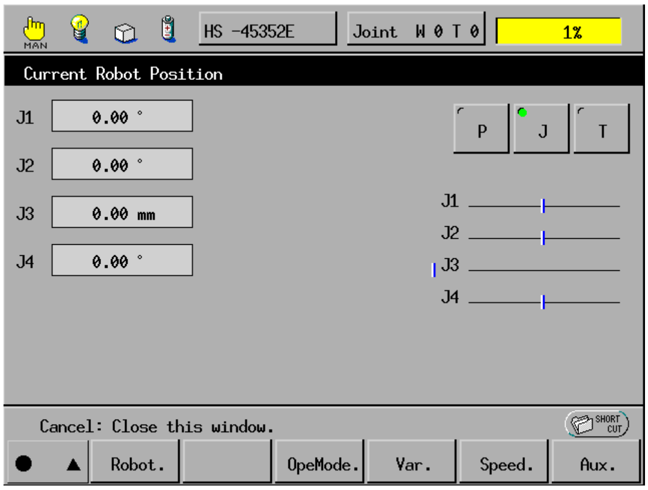


F2

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

Step 4

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



F12

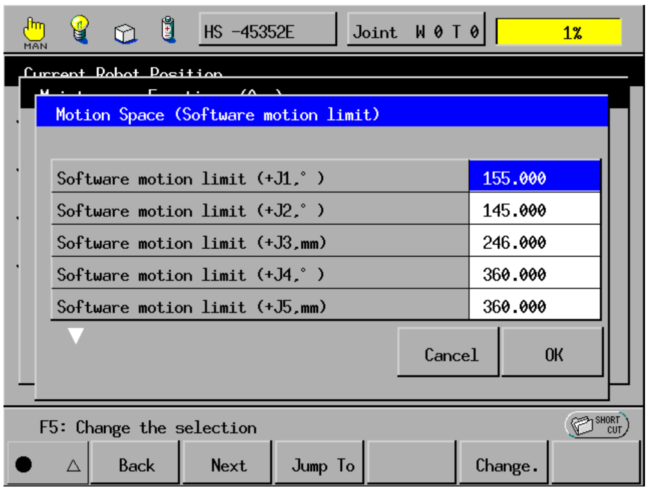
The Maintenance Functions (Arm) window will appear.

Step 5

In the Maintenance Functions (Arm) window, press [F1 M Space].

The Motion Space window will appear as shown below.

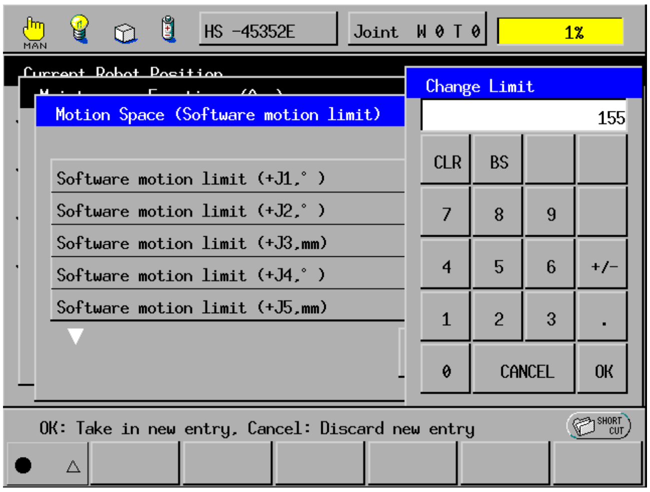
Select the item to be modified, then press [F5 Change].



F5

Step 6 The numeric keypad will appear as shown below.

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



Step 7 The new value will be set on the line of the item selected in the Motion Space window.

If two or more items must be changed, repeat Steps 4 and 5.

Step 8 **Press OK in the Motion Space window.**

Step 9 **Turn the robot controller off.**

> **Caution:** The new setting(s) (software motion limit(s)) for the motion space will take effect after the power is turned ON again and CAL is completed.

2.3 Changing Mechanical Ends to Define New Restricted Space

2.3.1 What is a Mechanical End Change?

In the case of the HS-E series, you may change mechanical ends on the 1st through 3rd (Z) axes.

When the robot leaves the factory, the mechanical ends are set at points 2° to 3° outside the default software motion limits. (Refer to Subsection 2.2.2 "Software Motion Limits (Factory defaults).")

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

> ⚠**Note: Once you have changed mechanical ends, be sure to change the software motion limits.**

2.3.2 Preparing mechanical stops

To change mechanical ends, you need to prepare mechanical stops for each of the 1st through 3rd axes as specified below.

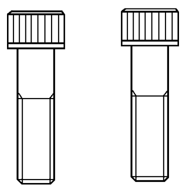
For the 1st axis: Two mechanical stop bolts
(M8x12, plated hex. socket-head bolt, strength class 10.9)

For the 2nd axis: Mechanical stop plate

For the 3rd axis: Mechanical stop collars and two mechanical stop bolts (per collar)
(M5x18, plated hex. socket-head bolt, strength class 10.9)

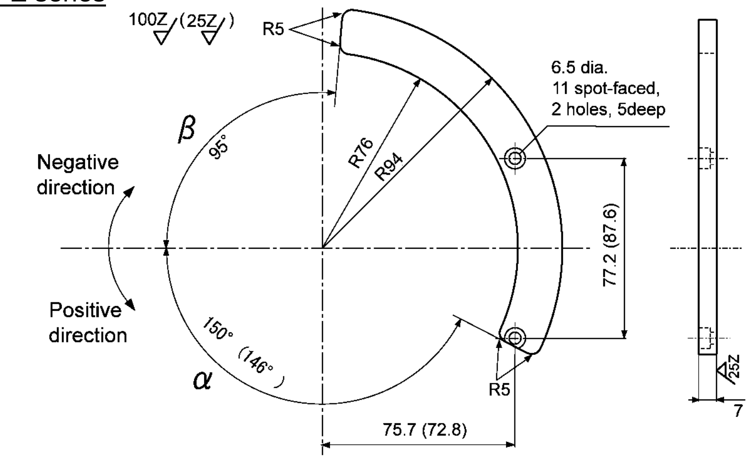
Determine the desired travel range and prepare those mechanical stops if necessary.

Preparing mechanical stops (1)

Axis	Mechanical stops
1st axis	Two mechanical stop bolts (M8x12, plated hex. socket-head bolt, strength class 10.9) 

Preparing mechanical stops (2)

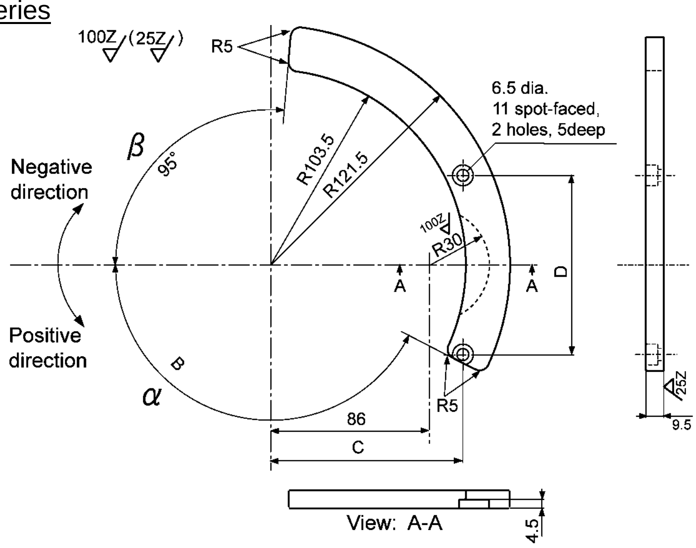
Axis	Mechanical stops
2nd axis	For HS/HSS-E series



NOTE: 1. Values in parentheses apply to the HSS-4545*E.

2. For α and β in the above drawing, enter your desired values which are added 5 degrees to the travel range.
   If using an original 2nd-axis stopper bolt, enter 150 degrees (For HSS-4545*E: 146 degrees) for α or β .
3. This reference drawing shows a motion change sample of -90 degrees in the negative-direction. In this case, change the software motion limits to +145 degrees and -90 degrees.
4. Unless otherwise specified, corners should be chamfered to C 0.3 to C 0.5.
5. Recommended material: S45C

For HM/HMS-E series



NOTE: 1. This reference drawing shows a motion change sample of -90 degrees in the negative-direction. In this case,

2. For α and β in the above drawing, enter your desired values which are added 5 degrees to the travel range.
   If using an original 2nd-axis stopper bolt, enter the value described in the B of the tabble below 150 degrees for α or β .
3. Dimensions

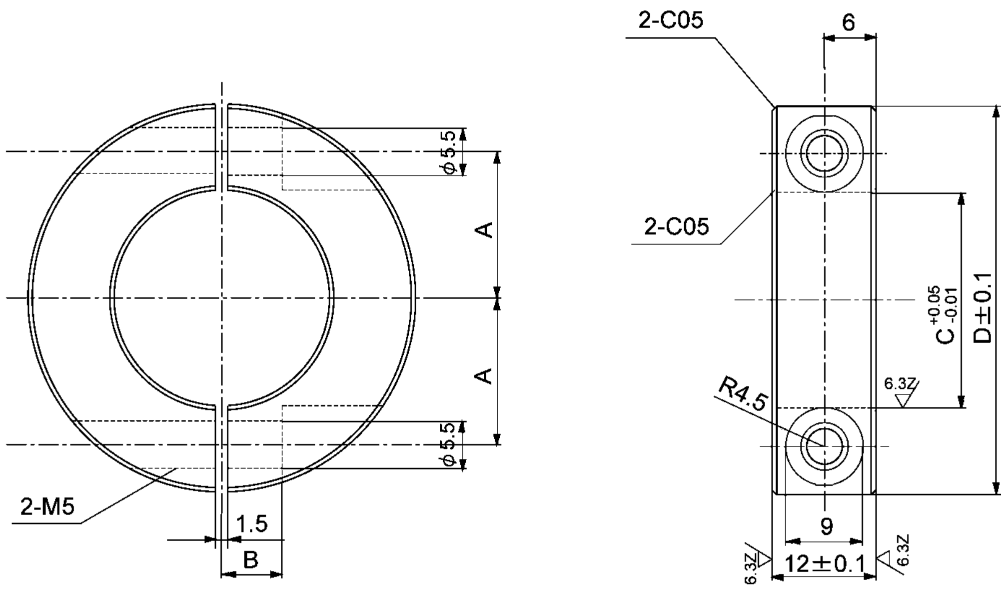
Robot type	B	C	D
HM/HMS-4*60*E	148°	97.5	112.5
HM/HMS-4*70*E	153°	102	95
HM/HMS-4*60*E-W	150.5°	97.5	112.5
HM/HMS-4*70*E-W	144.5°	102	95

4. Unless otherwise specified, corners should be chamfered to C 0.3 to C 0.5.
5. Recommended material: S45C

Preparing mechanical stops (3)

<table>
<tr><th>Axis</th><th>Mechanical stops</th></tr>
<tr><td rowspan="2">3rd axis</td><td>

<u>Mechanical stop collars</u>



Material: S45C
Surface treatment: Electroless nickel plating

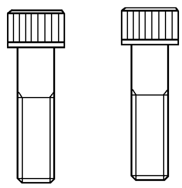
Dimensions

<table>
<tr><td>Robot type
HS/HSS-E</td><td>A
14</td><td>B
7</td><td>C
20</td><td>D
40</td></tr>
<tr><td>HM/HMS-40***E(10kg可搬)</td><td>17</td><td>7</td><td>25</td><td>45</td></tr>
<tr><td>HM/HMS-4A***E(20kg可搬)</td><td>20</td><td>10</td><td>30</td><td>55</td></tr>
</table>

Unit：mm

</td></tr>
<tr><td>

<u>Two mechanical stop bolts (per collar)</u>
(M5x18, plated hex. socket-head bolt, strength class 10.9)



</td></tr>
</table>

After Changing Mechanical Ends

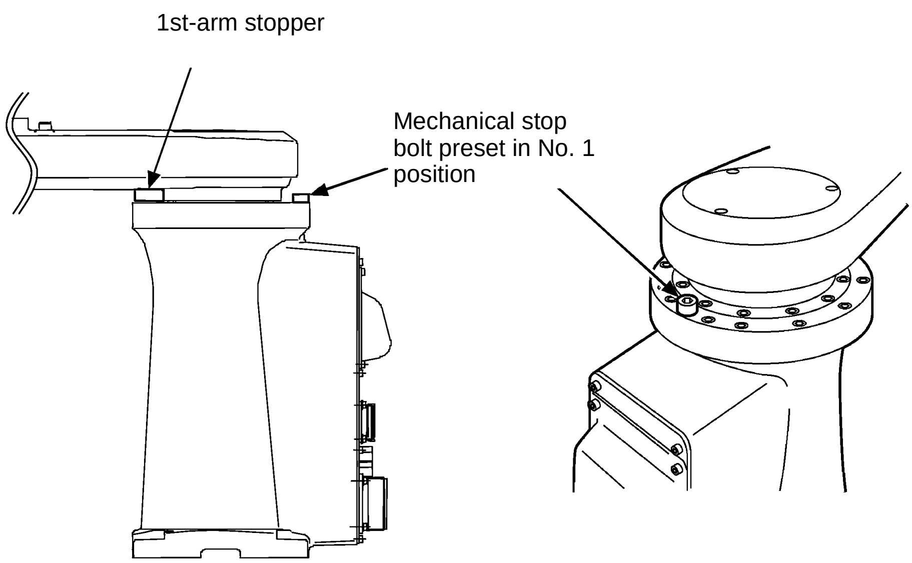
After you have changed the mechanical ends, you need to change the software motion limits (PLIMs, NLIMs) and RANG values, and then perform CALSET.

2.3.3 Changing the Mechanical Ends

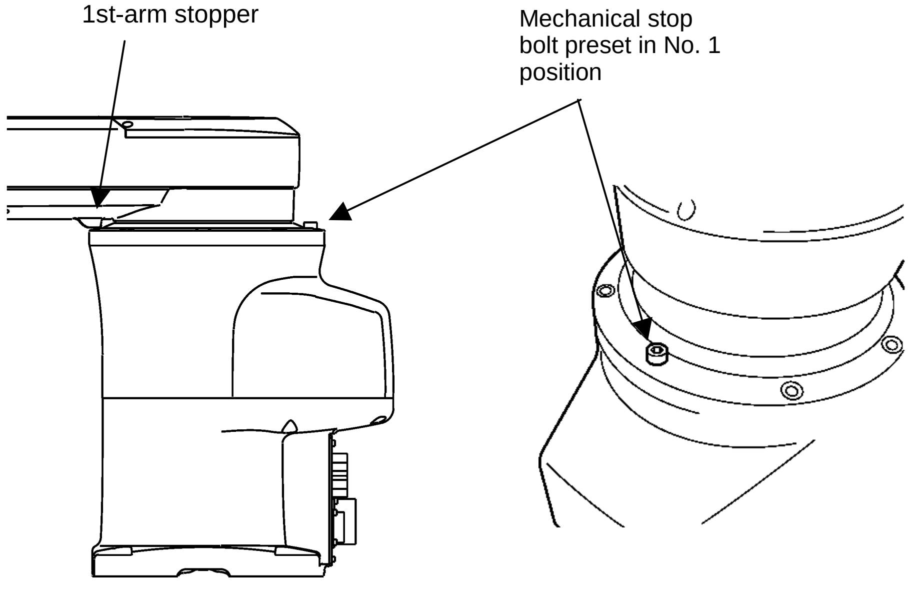
According to the procedures given below, set two mechanical stop bolts to the 1st axis, a mechanical stop plate to the 2nd axis, and a mechanical stop collar and two mechanical stop bolts to the 3rd axis. After that, change the software motion limits and RANG values (refer to Subsections 2.3.3 through 2.3.5).

[1] Changing the 1st-axis mechanical ends

Step 1 **Move the 1st axis of the robot to bring the 1st-arm stopper inside the restricted range that is to be set.**



<HS/HSS-E series>



<HM/HMS-E series>

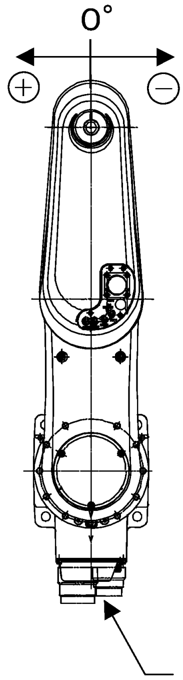
Step 2 **In addition to the current mechanical stop bolt preset in No. 1 position, mount two mechanical stop bolts to the desired mechanical end positions.**

Specifications of those bolts: Hex. socket-head, M8x12, SCM435 (JIS G4105), HRC34 to 44

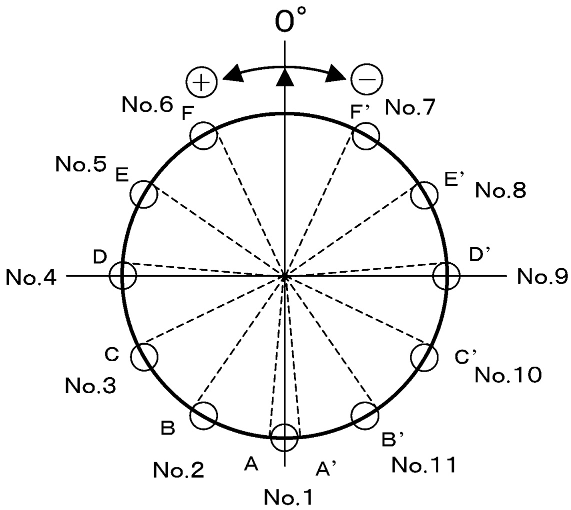
Tightening torque: 19.6 ±3.9 Nm

> ⚠**Caution: Do not move the 1st axis beyond points A and A' at the (+) and (-) ends, respectively. Do not remove the mechanical stop bolt preset in No. 1 position.**
>
> **Doing so may damage wirings inside the robot unit.**

<HS/HSS-E series>



Connector side



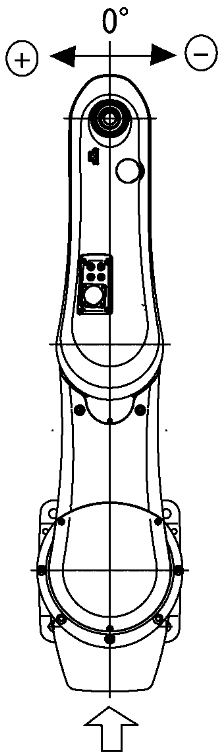
Nos. 1 through 11: Stop positions

Mechanical Ends at Bolt Positions
(Values in parentheses apply to the HSS-4545*E)

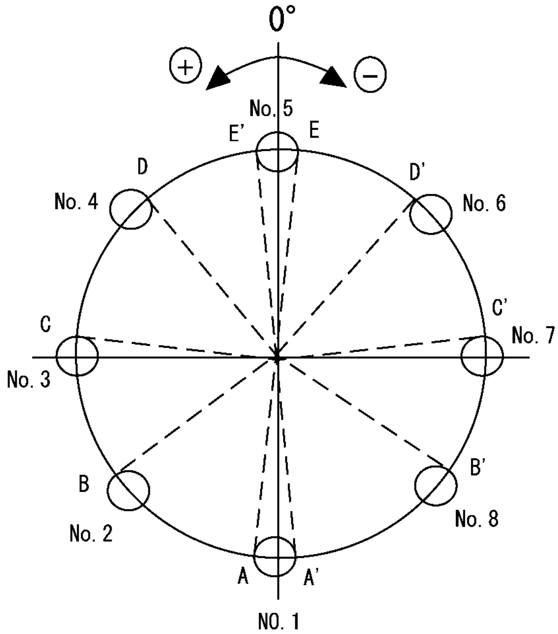
	Positive direction	Negative direction		Positive direction	Negative direction
A	158° (154°)	—	A'	—	-158° (-154°)
B	128° (124°)	—	B'	—	-128° (-124°)
C	98° (94°)	142° (146°)	C'	-142° (-146°)	-98° (-94°)
D	68° (64°)	112° (116°)	D'	-112° (-116°)	-68° (-64°)
E	38° (34°)	82° (86°)	E'	-82° (-86°)	-38° (-34°)
F	8° (4°)	52° (56°)	F'	-52° (-56°)	-8° (-4°)

(NOTE: Software motion limits should be 2° to 3° inside the mechanical end positions.)

<HM/HMS-E series>



Connector side



Nos. 1 through 8: Stop position

Mechanical Ends at Bolt Positions
Note: Values in parentheses apply to the HMS-E.

	Positive direction	Negative direction		Positive direction	Negative direction
A	168°(167°)	—	A'	—	-168°(-167°)
B	123°(122°)	—	B'	—	-123°(-122°)
C	78°(77°)	102°(103°)	C'	-102°(-103°)	-78°(-77°)
D	33°(32°)	57°(58°)	D'	-57°(-58°)	-33°(-32°)
E	-12°(-13°)	—	E'	—	12°(13°)

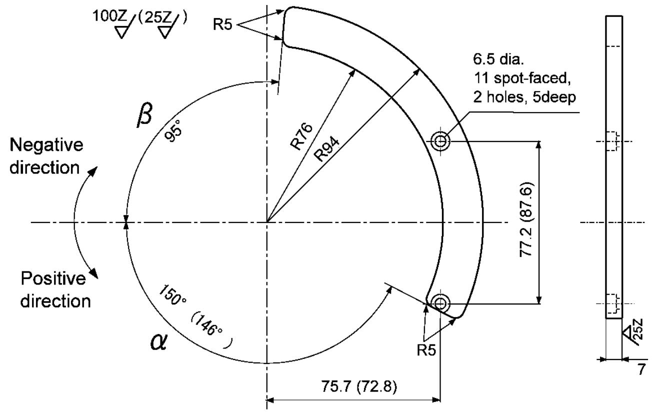
(NOTE: Software motion limits should be 2° to 3° inside the mechanical end positions.)

[2] Changing the 2nd-axis mechanical ends

You may change the 2nd-axis mechanical ends to arbitrary positions by using a mechanical stop plate you prepare.

Step 1 **Prepare a mechanical stop plate. (To be prepared by the customer)**

<HS/HSS-E series>



NOTE: 1. Values in parentheses apply to the HSS-4545*E.

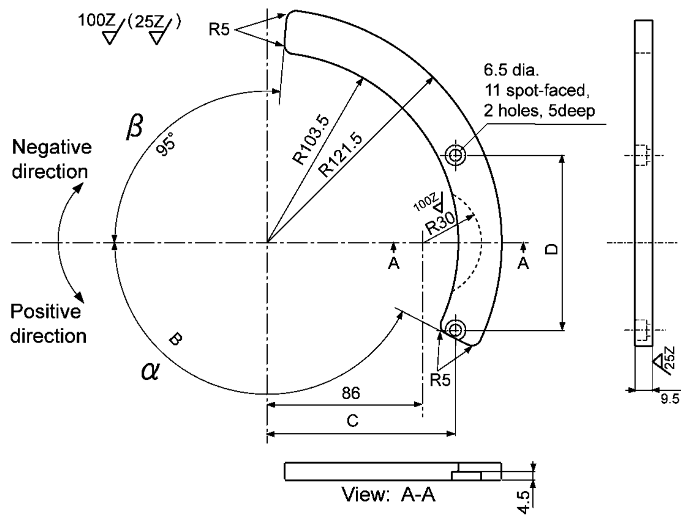
2. For α and β in the above drawing, enter your desired values which are added 5 degrees to the travel range.
If using an original 2nd-axis stopper bolt, enter 150 degrees (For HSS-4545*E: 146 degrees) for α or β .

3. This reference drawing shows a motion change sample of -90 degrees in the negative-direction. In this case, change the software motion limits to +145 degrees and -90 degrees.

4. Unless otherwise specified, corners should be chamfered to C 0.3 to C 0.5.

5. Recommended material: S45C

<HM/HMS-E series>



NOTE: 1. This reference drawing shows a motion change sample of -90 degrees in the negative-direction. In this case,

2. For α and β in the above drawing, enter your desired values which are added 5 degrees to the travel range.
If using an original 2nd-axis stopper bolt, enter the value described in the B of the tabble below 150 degrees for α or β .

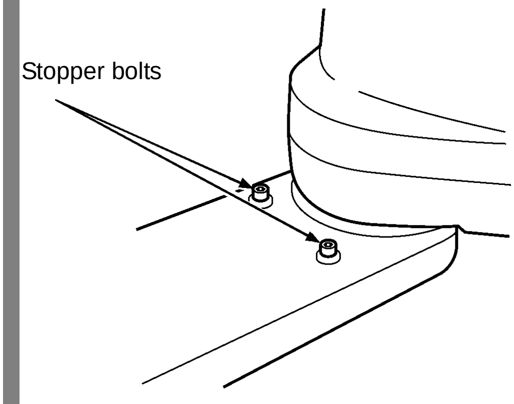
3. Dimensions

Robot type	B	C	D
HM/HMS-4*60*E	148°	97.5	112.5
HM/HMS-4*70*E	153°	102	95
HM/HMS-4*60*E-W	150.5°	97.5	112.5
HM/HMS-4*70*E-W	144.5°	102	95

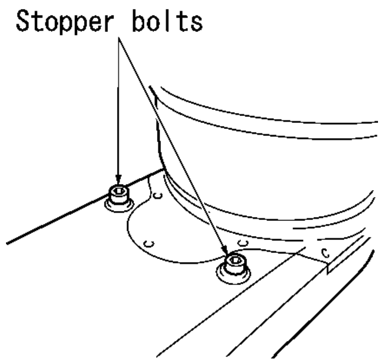
4. Unless otherwise specified, corners should be chamfered to C 0.3 to C 0.5.

5. Recommended material: S45C

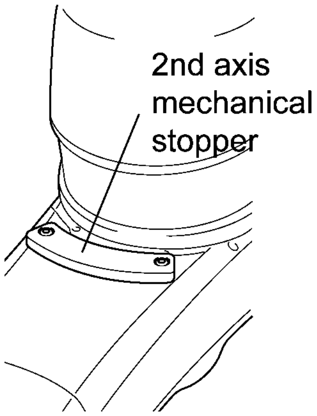
Step 2 **Remove the two stopper bolts.**



<HS-E>



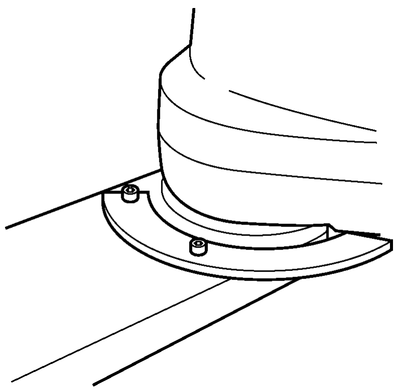
<HM-E>



Note: For HM-4*60*E-W, HM/HMS-4*70*E-W, HMS-4*85*E and HMS-4*85-E-W, remove the 2nd axis mechanical stopper.

Step 3 **Secure the mechanical stop plate you have prepared in Step 1 with two stopper bolts removed in Step 2.**

Tightening torque: 9.8 ±1.9 Nm



<Example of HS-E>

[3] Changing the 3rd (Z)-axis mechanical ends (HS/HSS-E series)

You may change the 3rd-axis mechanical ends to arbitrary positions by using mechanical stop collars you prepare.

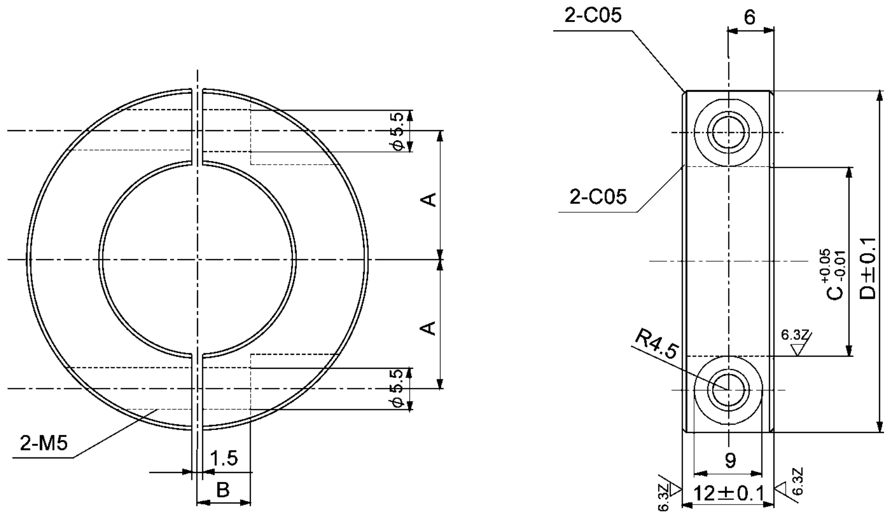
> **Caution: The 3rd-axis (Z-axis) has a brake. You may release the brake not only from the teach pendant but with the brake release button provided on the top of the 2nd arm. While the brake release button is held down *in direct teaching mode*, the brake will be released.**
>
> **Caution: The brake releasing operation should be performed with the controller power off and the motor off in direct teaching mode.**

■ Preparation (common to the HS/HSS-E series robots)

Step 1 **Prepare the mechanical stop collar (to be prepared by the customer) as given below and two mechanical stop bolts.**

Specifications of those bolts: M5x18, plated hex. socket-head bolt, strength class 10.9

Mechanical stop collar



Material: S45C
Surface treatment: Electroless nickel plating

Dimensions

Robot type	A	B	C	D
HS/HSS-E	14	7	20	40
HM/HMS-40***E(10kg可搬)	17	7	25	45
HM/HMS-4A***E(20kg可搬)	20	10	30	55

Unit : mm

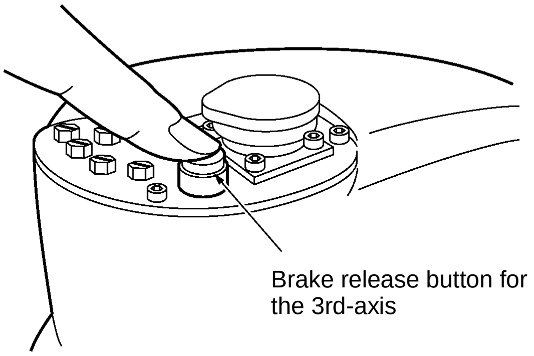
Step 2 **Place the robot controller in direct teaching mode as follows:**

On the teach pendant, set the mode switch to the MANUAL position and make sure that the motor is off.

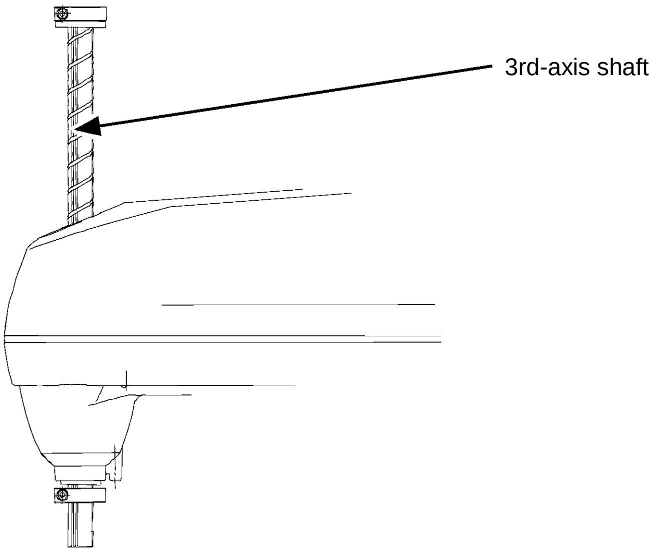
Then press [F2 Arm]—[F6 Aux.]—[F3 Direct.]—[OK].

Step 3 **Hold down the brake release button (for the 3rd-axis). Only while the switch is held down, the brake is released.**

Caution: Be careful with the robot motion when pressing the brake release button. Releasing the brake with the switch will cause the 3rd-axis to lower by the hand's weight.



Step 4 **Move the 3rd-axis shaft to the desired position where you want to set the mechanical end.**



Step 5 **Release the brake release button. The brake comes on.**

■ Standard type of HS/HSS-E series robots: Changing the upper and lower mechanical ends

(a) Changing the lower mechanical end

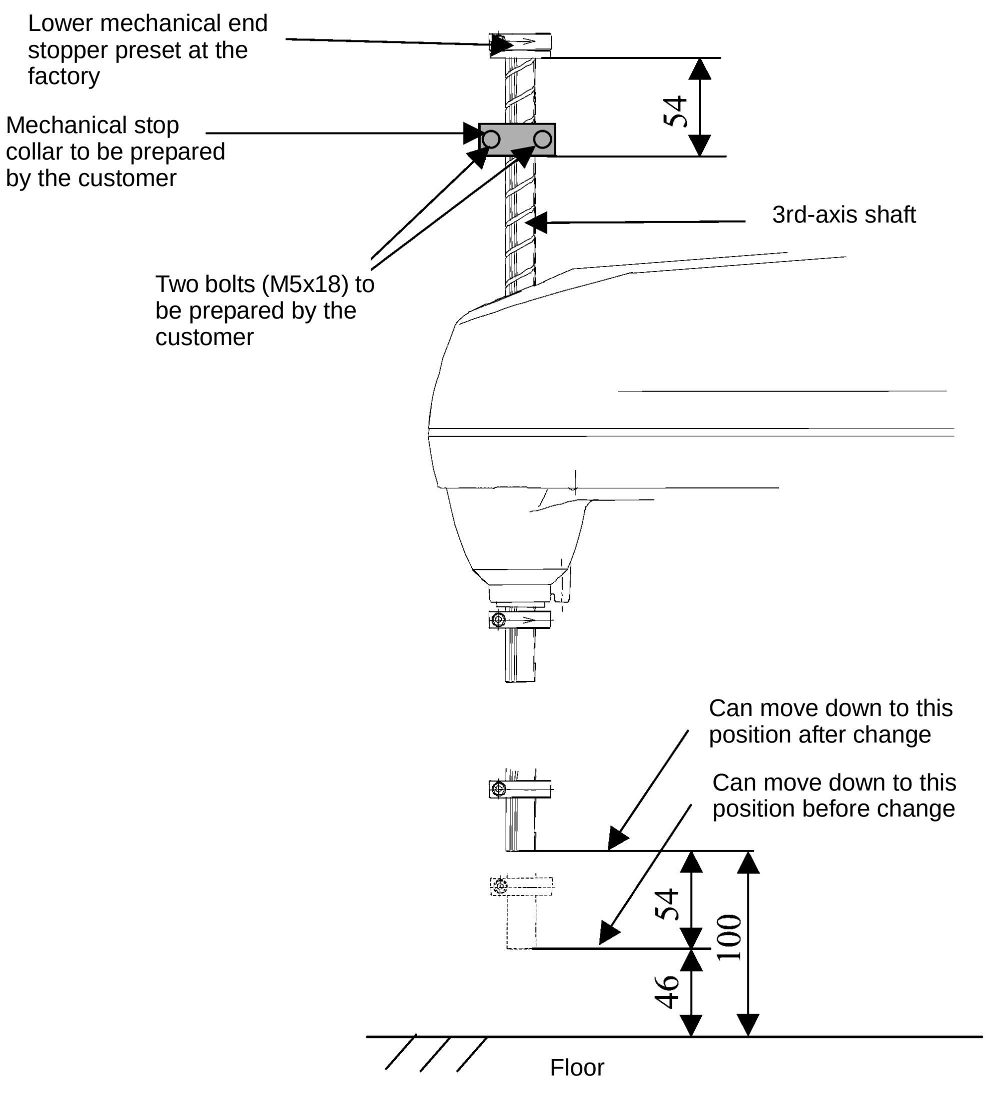
> ⚠**Caution:** **Never remove the lower mechanical end stopper preset at the factory.**

Step 1 **Secure a mechanical stop collar you have prepared to the desired position of the 3rd-axis shaft with two bolts.**

Tightening torque recommended: 8.8 ±1.7 Nm

At the top of the 3rd-axis shaft is a lower mechanical end stopper that is preset at the factory for the maximum stroke. If the stroke is 200 mm in the standard type of robots, for example, the z-axis may move down to the position 46 mm above the floor.

To change from 46 mm to 100 mm, set a mechanical stop collar 54 mm below the bottom of the lower mechanical stopper preset. Use a vernier calipers when measuring the distance.



<Example of HSS-E>

(b) Changing the upper mechanical end

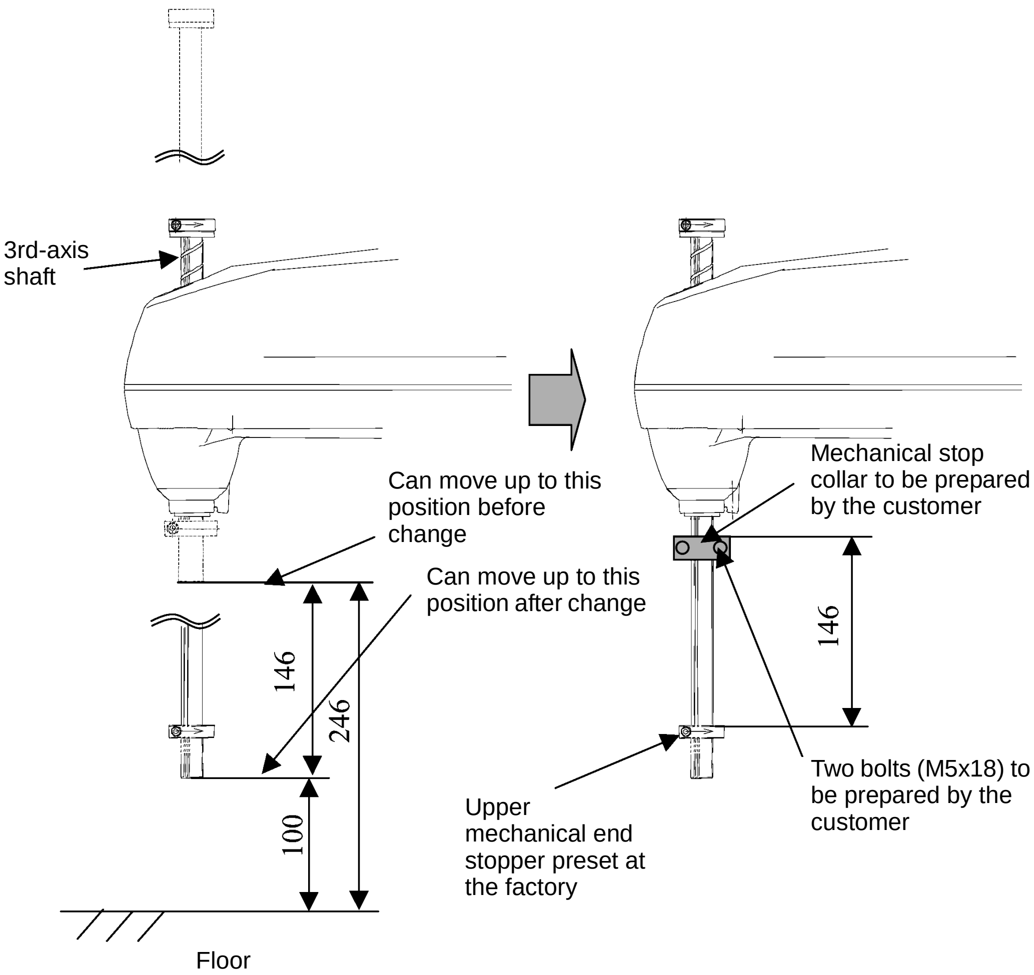
> ⚠**Caution:** **Never remove the upper mechanical end stopper preset at the factory.**

Step 1 **Secure a mechanical stop collar you have prepared to the desired position of the 3rd-axis shaft with two bolts.**

Tightening torque recommended: 8.8 ±1.7 Nm

At the lower section of the 3rd-axis shaft is an upper mechanical end stopper that is preset at the factory for the maximum stroke. If the stroke is 200 mm in the standard type of robots, for example, the z-axis may move up to the position 246 mm above the floor.

To change from 246 mm to 100 mm, set a mechanical stop collar 146 mm below the top of the upper mechanical stopper preset. Use a vernier calipers when measuring the distance.



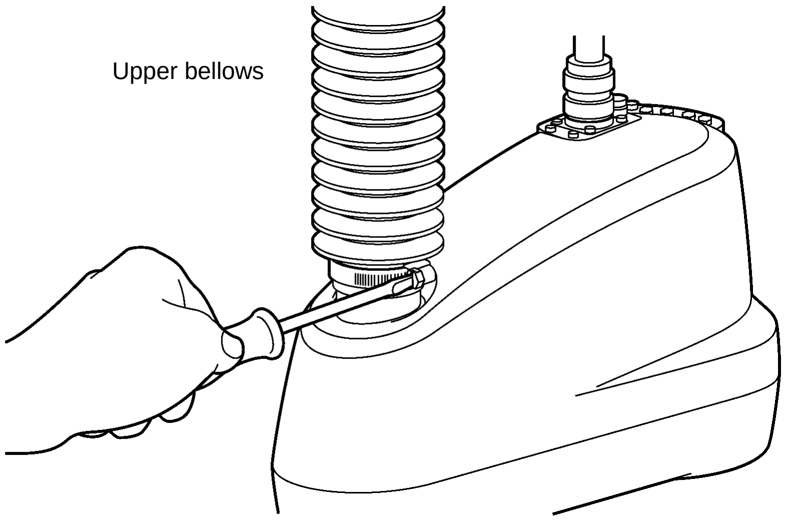
<Example of HSS-E>

■ Dust-proof, splash-proof type and cleanroom type of HS/HSS-E series robots: Changing the upper and lower mechanical ends

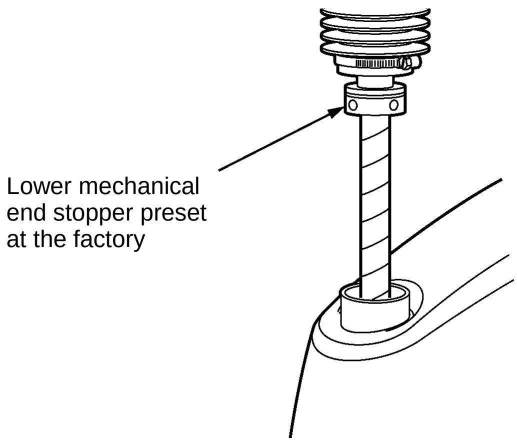
(a) Changing the lower mechanical end

> ⚠**Caution:** **Never remove the lower mechanical end stopper preset at the factory.**

Step 1 **Loosen the clamp band at the bottom of the upper bellows with a flat screwdriver.**



Step 2 **Pull up the bellows.**

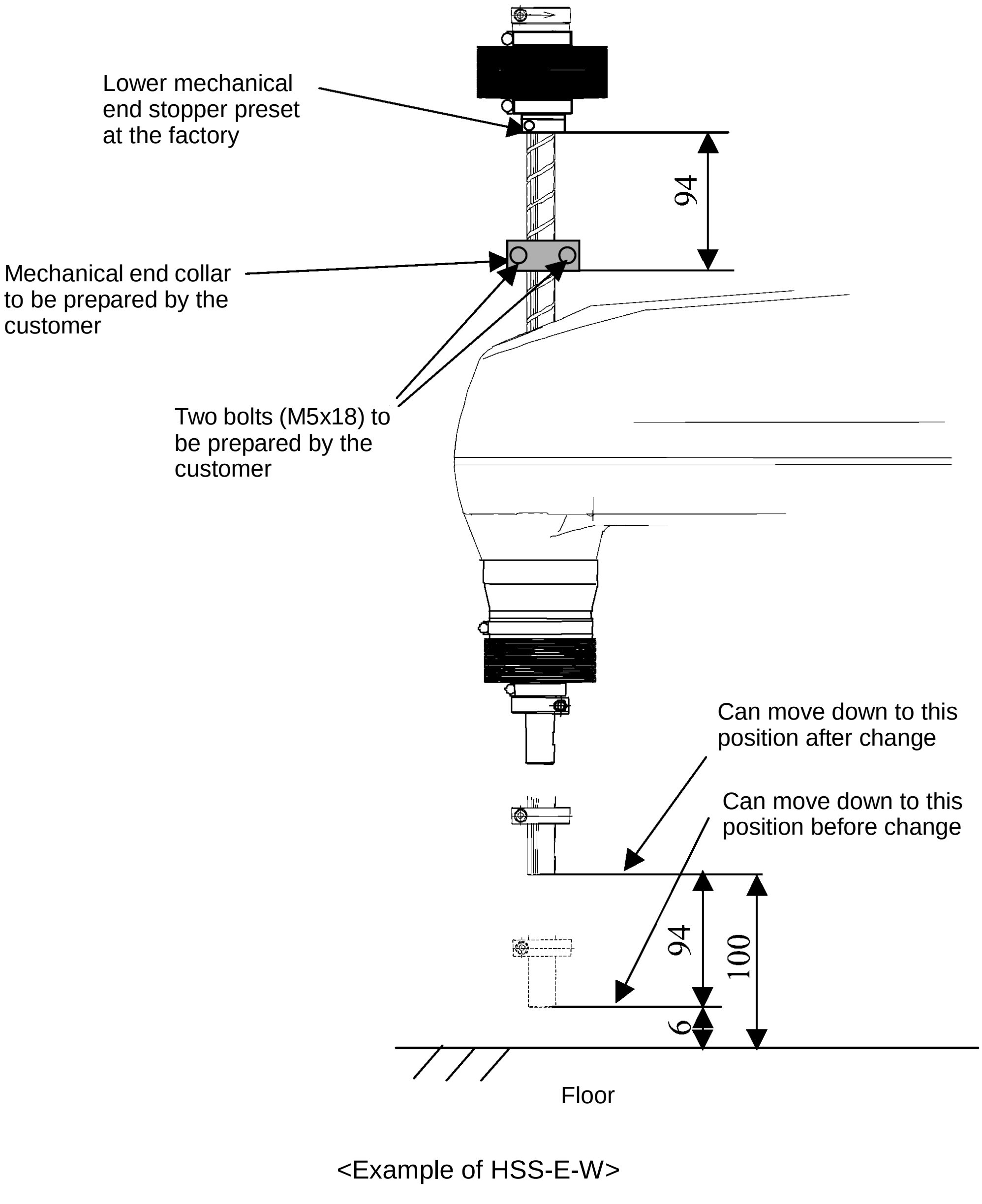


Step 3 **Secure a mechanical stop collar you have prepared to the desired position of the 3rd-axis shaft with two bolts.**

Tightening torque recommended: 8.8 ±1.7 Nm

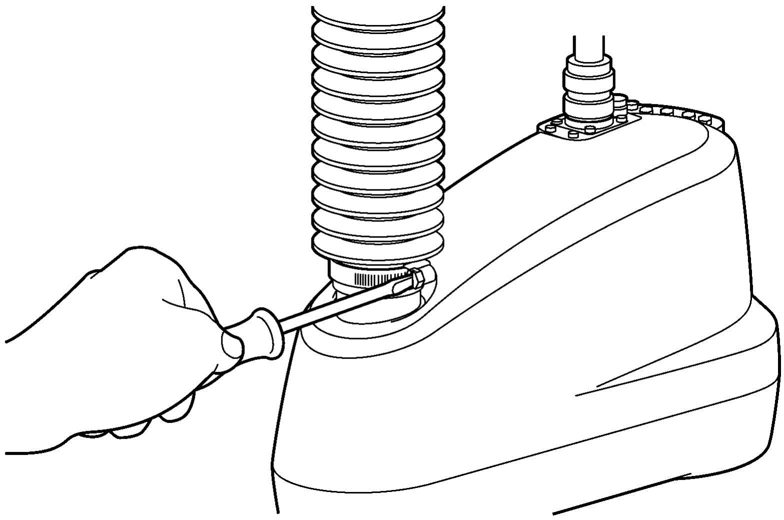
At the top of the 3rd-axis shaft is a lower mechanical end stopper that is preset at the factory for the maximum stroke. If the stroke is 200 mm in the dust-proof, splash-proof type of robots, for example, the z-axis may move down to the position 6 mm above the floor.

To change from 6 mm to 100 mm, set a mechanical stop collar 94 mm below the bottom of the lower mechanical stopper preset. Use a vernier calipers when measuring the distance.



<Example of HSS-E-W>

Step 4 **Pull the bellows down to the original position and tighten the clamp band loosened in Step 1 with a flat screwdriver.**



(b) Changing the upper mechanical end

⚠Caution:	**Never remove the upper mechanical end stopper preset at the factory.**

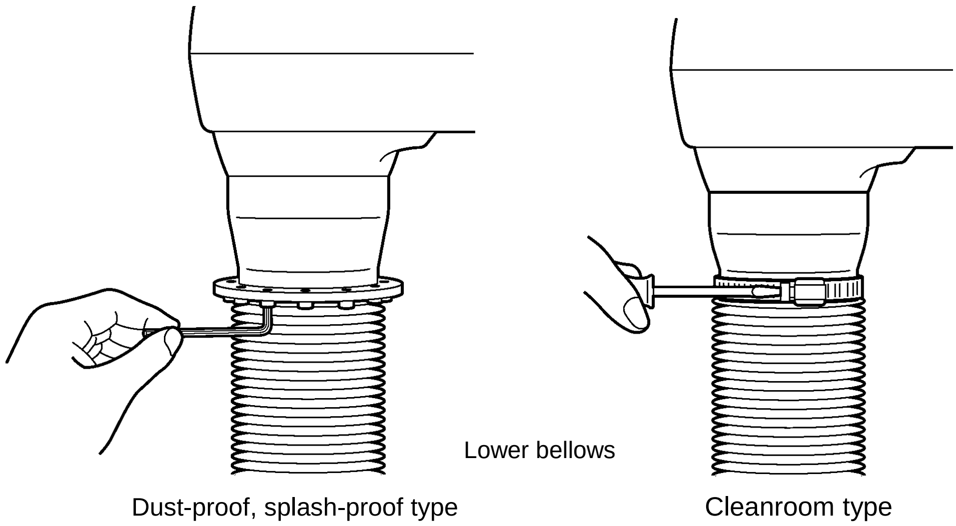
Step 1

<u>Dust-proof, splash-proof type</u>

Remove 12 bolts (M3) on the top of the lower bellows with a hexagonal wrench.

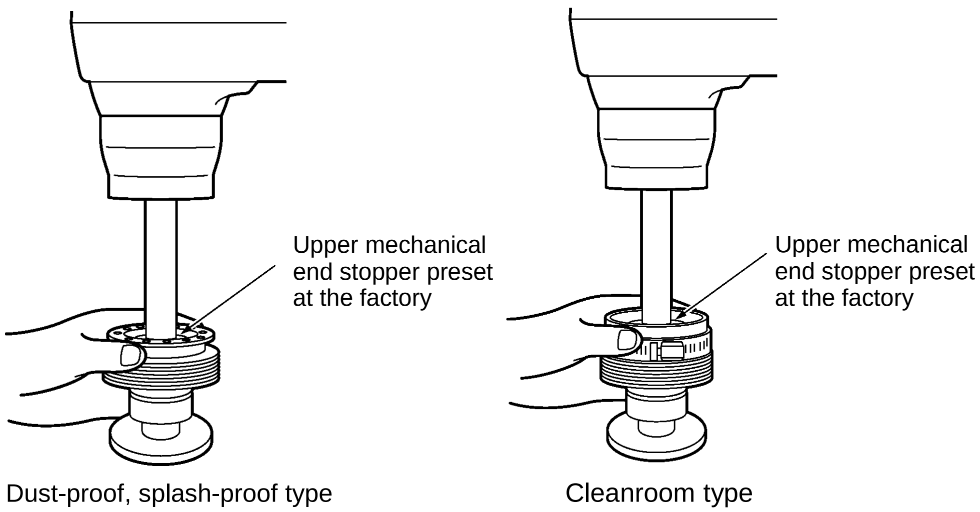
<u>Cleanroom type</u>

Loosen the clamp band at the top of the lower bellows with a flat screwdriver.



Step 2

Pull down the bellows.

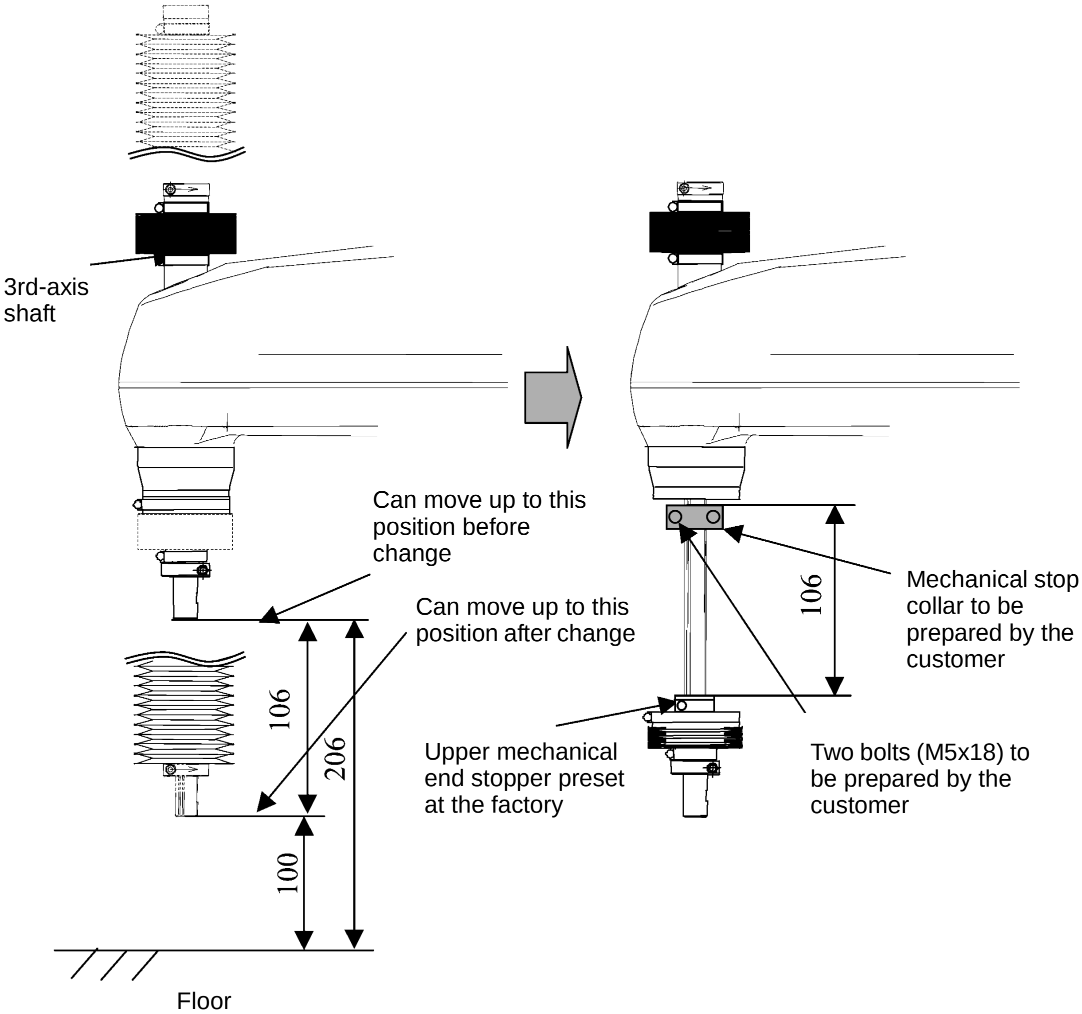


Step 3 **Secure a mechanical stop collar you have prepared to the desired position of the 3rd-axis shaft with two bolts.**

Tightening torque recommended: 8.8 ±1.7 Nm

At the lower section of the 3rd-axis shaft is an upper mechanical end stopper that is preset at the factory for the maximum stroke. If the stroke is 200 mm in the dust-proof, splash-proof type of robots, for example, the z-axis may move up to the position 206 mm above the floor.

To change from 206 mm to 100 mm, set a mechanical stop collar 106 mm below the top of the upper mechanical stopper preset. Use a vernier calipers when measuring the distance.



<Example of HSS-E-W>

Step 4

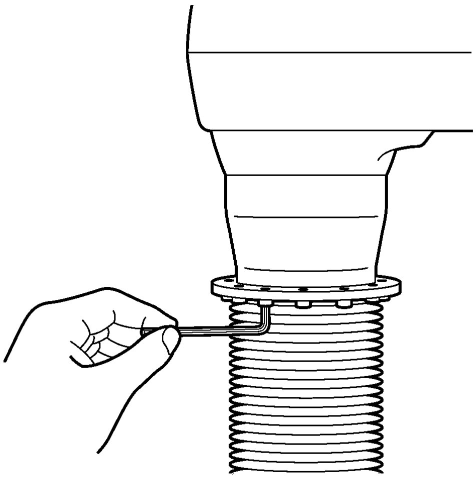
Dust-proof, splash-proof type

Pull the bellows up to the original position and tighten 12 bolts removed in Step 1 with a hexagonal wrench.

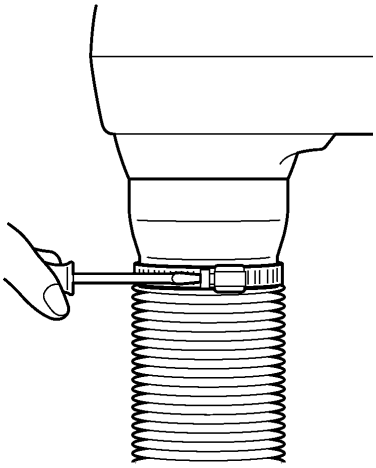
Tightening torque recommended: 1.6 ±0.3 Nm

Cleanroom type

Pull the bellows up to the original position and tighten the clamp band loosened in Step 1 with a flat screwdriver.



Dust-proof, splash-proof type



Cleanroom type

[4] Changing the 3rd (Z)-axis mechanical ends (HM/HMS-E series)

You may change the 3rd-axis mechanical ends to arbitrary positions by using mechanical stop collars you prepare.

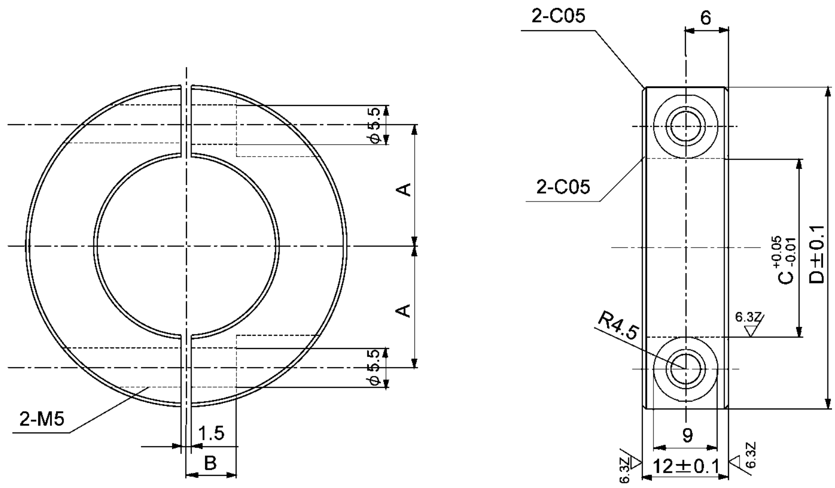
> **Caution: The brake releasing operation should be performed with the controller power off and the motor off in direct teaching mode.**

■ Preparation (common to the HM/HMS-E series robots)

Step 1 **Prepare the mechanical stop collar (to be prepared by the customer) as given below and two mechanical stop bolts.**

Specifications of those bolts: M5x18, plated hex. socket-head bolt, strength class 10.9

<u>Mechanical stop collar</u>



Material: S45C
Surface treatment: Electroless nickel plating

Dimensions

Robot type	A	B	C	D
HS/HSS-E	14	7	20	40
HM/HMS-40***E(10kg可搬)	17	7	25	45
HM/HMS-4A***E(20kg可搬)	20	10	30	55

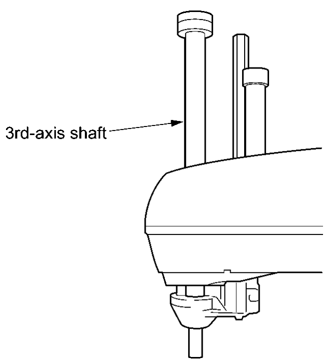
Unit : mm

Step 2 **Place the robot controller in direct teaching mode as follows:**

On the teach pendant, set the mode switch to the MANUAL position and make sure that the motor is off.

Then press [F2 Arm]—[F6 Aux.]—[F3 Direct.]—[OK].

Step 3 **Move the 3rd-axis shaft to the desired position where you want to set the mechanical end.**



■Changing the lower and upper mechanical ends for HM/HMS series

(1) Changing the lower mechanical end (HM/HMS-E standard type)

⚠**Caution:**	**Never remove the lower mechanical end stopper preset at the factory.**

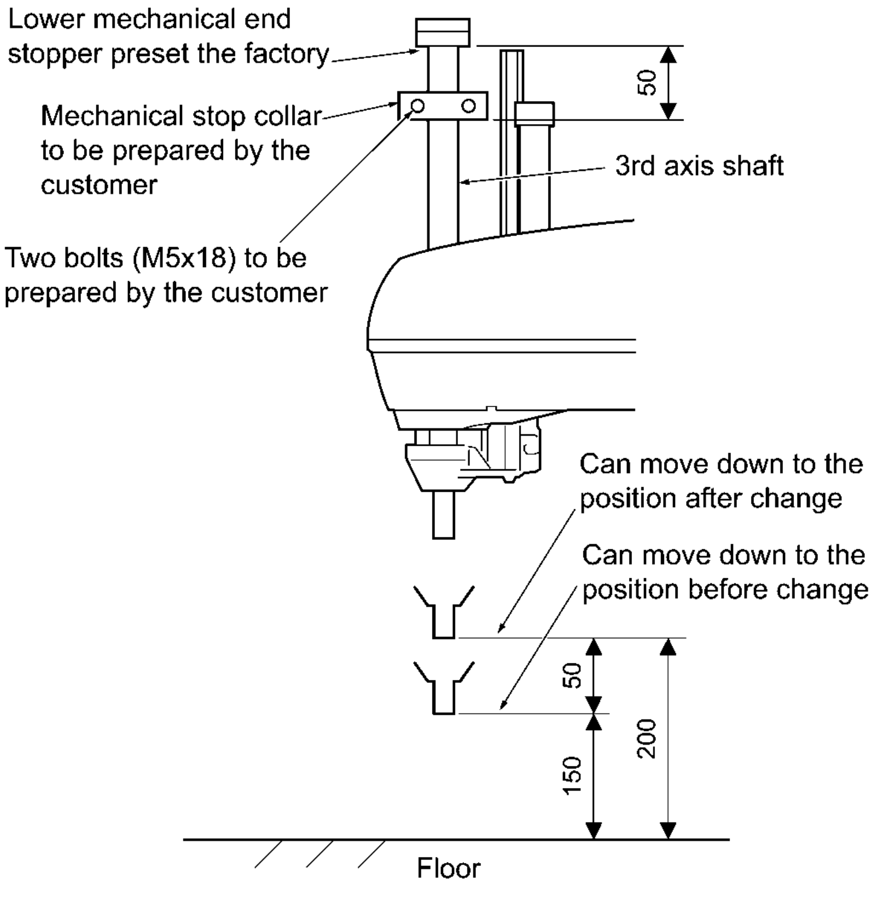
Step 1

Secure a mechanical stop collar you have prepared to the desired position of the 3rd-axis shaft with two bolts.

Tightening torque recommended: 8.8 ±1.7 Nm

At the top of the 3rd-axis shaft is a lower mechanical end stopper that is preset at the factory for the maximum stroke. If the stroke is 200 mm in the standard type of robots, for example, the z-axis may move down to the position 50 mm above the floor.

To change from 150 mm to 200 mm, set a mechanical stop collar 50 mm below the bottom of the lower mechanical stopper preset. Use a vernier calipers when measuring the distance.



<Example of HM-E>

(1) Changing the lower mechanical end (HM/HMS-E-W dust-proof & splash-proof type)

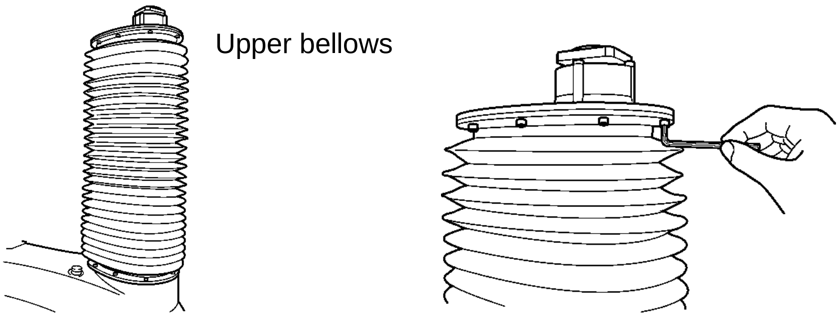
⚠Caution:	**Never remove the lower mechanical end stopper preset at the factory.**

Step 1 **Move the Z-axis to near the upper end manually with the teach pendant in order to attach the collar.**

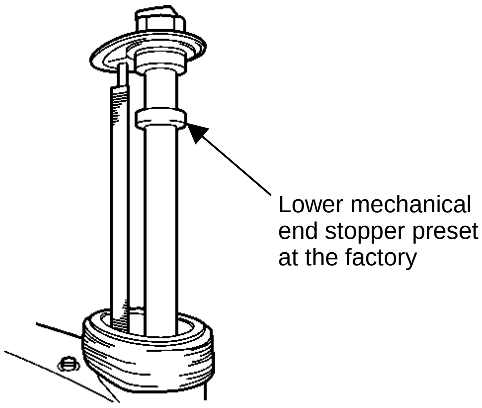
Turn the motor power OFF, and turn the controller power OFF.

⚠Caution: If the brake is released, the Z-axis will drop downward because that the dust-proof & splash-proof type robot has no air balance cylinder on the Z-axis. Do not release the brake in this working. The brake releasing may cause damage to person or equipment.

Step 2 **Remove 8 bolts (M3) on the top of the upper bellows with a hexagon wrench.**



Step 3 **Pull down the bellows.**

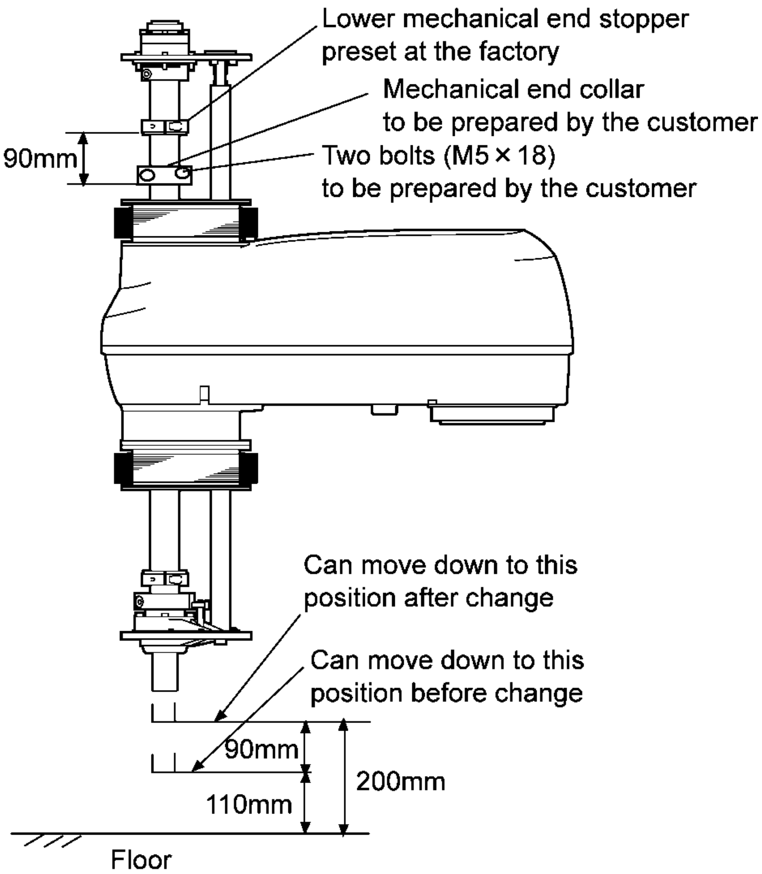


Step 4 **Secure a mechanical stop collar you have prepared to the desired position of the 3rd-axis shaft with two bolts.**

Tightening torque recommended: 8.8 ±1.7 Nm

At the upper section of the 3rd-axis shaft is a lower mechanical end stopper that is preset at the factory for the maximum stroke. If the stroke is 200 mm in the dust-proof & splash-proof type of robots, for example, the z-axis may move up to the position 110 mm above the floor.

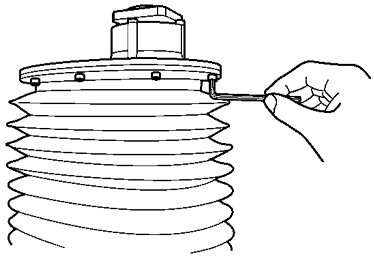
To change from 110 mm to 200 mm, set a mechanical stop collar 90 mm below the bottom of the upper mechanical stopper preset. Use a vernier calipers when measuring the distance.

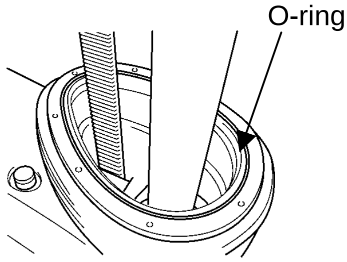


<Example of HM-E-W>

Step 5 **Pull the bellows up to the original position and tighten 8 bolts (M3) with a hexagon wrench.**

Tightening torque recommended: 1.6 ±0.3 Nm





Caution: **Take care not to pinch the O-ring when reinstalling the upper bellows.**

(2) Changing the upper mechanical end (HM/HMS-E standard type)

⚠Caution:	**Never remove the upper mechanical end stopper preset at the factory.**

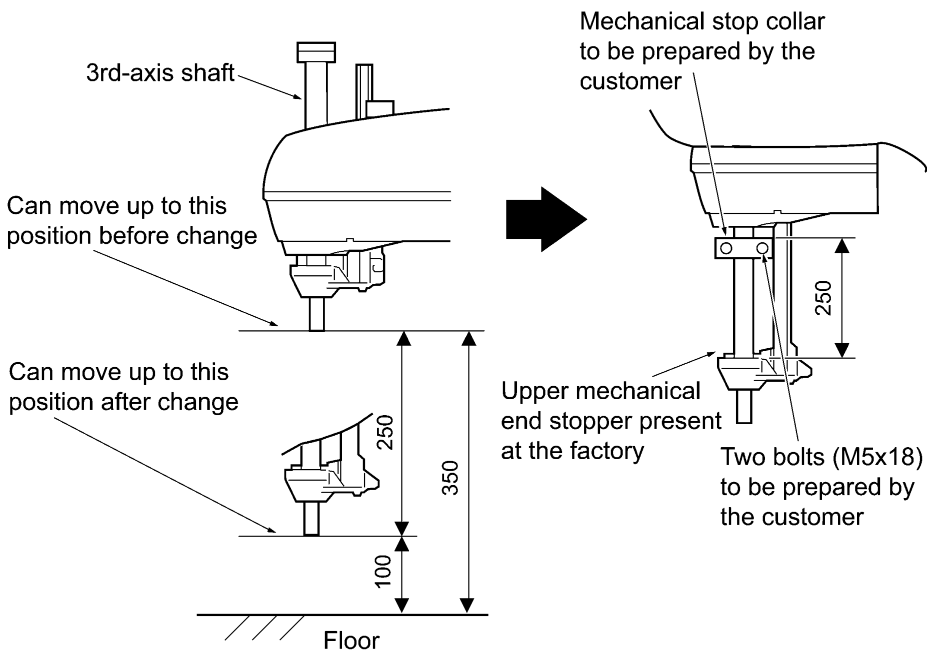
Step 1

Secure a mechanical stop collar you have prepared to the desired position of the 3rd-axis shaft with two bolts.

Tightening torque recommended: 8.8 ±1.7 Nm

At the lower section of the 3rd-axis shaft is an upper mechanical end stopper that is preset at the factory for the maximum stroke. If the stroke is 200 mm in the standard type of robots, for example, the z-axis may move up to the position 350 mm above the floor.

To change from 350 mm to 100 mm, set a mechanical stop collar 250 mm below the top of the upper mechanical stopper preset. Use a vernier calipers when measuring the distance.



<Example of HM-E>

(3) Changing the upper mechanical end (HM/HMS-E-W dust-proof & splash-proof type)

> **⚠Caution: Never remove the upper mechanical end stopper preset at the factory.**

Step 1

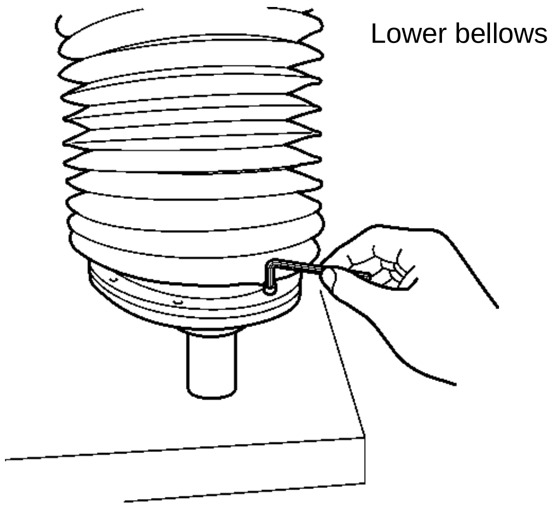
Move the Z-axis to near the lower end manually with the teach pendant in order to attach the collar.

Turn the motor power OFF, and turn the controller power OFF.

⚠Caution: If the brake is released, the Z-axis will drop downward because that the dust-proof & splash-proof type robot has no air balance cylinder on the Z-axis. Do not release the brake in this working. The brake releasing may cause damage to person or equipment.

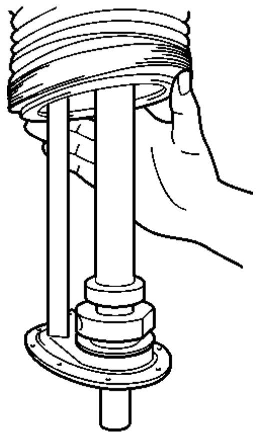
Step 2

Remove 8 bolts (M3) on the bottom of the lower bellows with a hexagon wrench.



Step 3

Pull up the bellows.

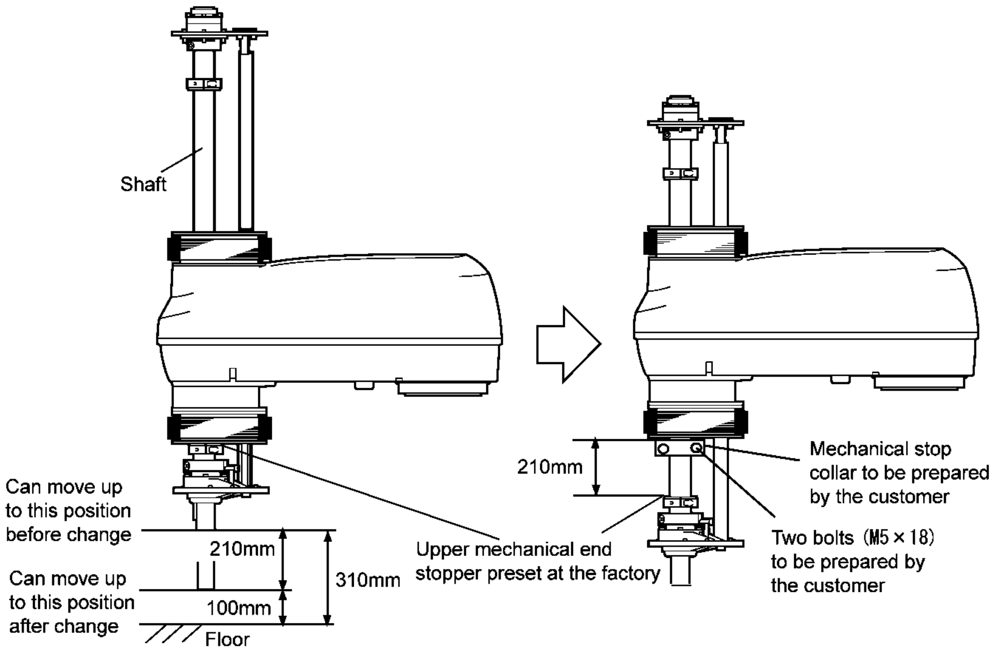


Step 4 **Secure a mechanical stop collar you have prepared to the desired position of the 3rd-axis shaft with two bolts.**

Tightening torque recommended: 8.8 ±1.7 Nm

At the lower section of the 3rd-axis shaft is an upper mechanical end stopper that is preset at the factory for the maximum stroke. If the stroke is 300 mm in the dust-proof & splash-proof type of robots, for example, the z-axis may move up to the position 310 mm above the floor.

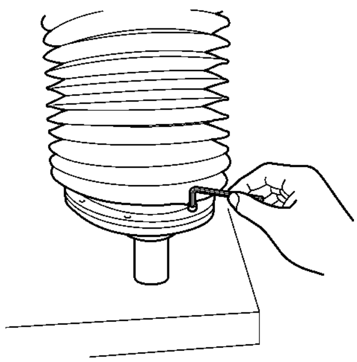
To change from 310 mm to 100 mm, set a mechanical stop collar 210 mm above the top of the upper mechanical stopper preset. Use a vernier calipers when measuring the distance.

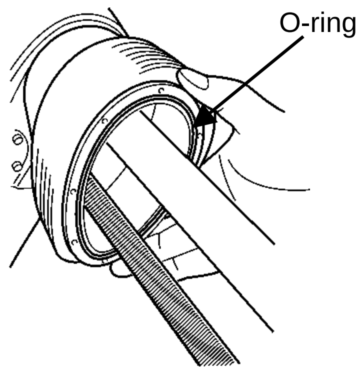


<Example of HM-E-W>

Step 5 **Pull the bellows down to the original position and tighten 8 bolts (M3) with a hexagon wrench.**

Tightening torque recommended: 1.6 ±0.3 Nm





Caution: **Take care not to pinch the O-ring when reinstalling the lower bellows.**

2.3.4 Setting the software motion limits and origin coordinates (RANG)

The table below lists the origin coordinates (RANG) and software motion limits that should be apply for each of 1st-axis (J1) mechanical stop positions. If you add or change a mechanical stop position, you need to change the (+) and (-) software motion limits and RANG to values listed below.

(1) Location of Mechanical Stops, Software Motion Limits, and RANG (HS/HSS-E series)
Note: Values in parentheses apply to the HSS-4545*E.

Parameters \ Bolt No.	No. 1 (Typical)	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11
(+) software motion limit	155 (152)	125 (122)	95 (92)	65 (62)	35 (32)	5 (2)	-	-	-	-	-
RANG 1	158 (154)	128 (124)	98 (94)	68 (64)	38 (34)	8 (4)	-	-	-	-	-
(-) software motion limit	-155	-	-	-	-	-	-5 (-2)	-35 (-32)	-65 (-62)	-95 (-92)	-125 (-122)

Example 1: If you add a mechanical stop into No. 2 position (without removing the stop from No. 1 position).

Change the (+) software motion limit to 125 and RANG1 to 128.

Example 2: If you add a mechanical stop into No. 9 position (without removing the stop from No. 1 position).

Change the (-) software motion limit to -65.

Example 3: If you add a mechanical stop into Nos. 3 and 10 positions each (removing the stop from No. 1 position).

Change the (+) and (-) software motion limits to 95 and -95, respectively, and RANG1, 98.

(2) Location of Mechanical Stops, Software Motion Limits, and RANG (HM/HMS-E series)
Note: Values in parentheses apply to the HMS-E series.

Parameters \ Bolt No.	No. 1 (Typical)	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8
(+) software motion limit	165	120	75	30	-	-	-	-
RANG 1	168.5 (167.5)	123.5 (122.5)	78.5 (77.5)	33.5 (32.5)	-	-	-	-
(-) software motion limit	-165	-	-	-	-	-30	-75	-120

Example 1: If you add a mechanical stop into No. 2 position (without removing the stop from No. 1 position).

Change the (+) software motion limit to 120 and RANG1 to 123.5.

Example 2: If you add a mechanical stop into No. 7 position (without removing the stop from No. 1 position).

Change the (-) software motion limit to -75.

Example 3: If you add a mechanical stop into Nos. 3 and 6 positions each (removing the stop from No. 1 position).

Change the (+) and (-) software motion limits to 75 and -30, respectively, and RANG1, 78.5.

Checking the set RANG values

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

The RANG values that you check here should be entered to the 1st through 3rd axes in the procedures given in Subsection 2.3.4 "Changing Positive-Direction Software Motion Limits (PLIMs) and RANG values" and Subsection 2.3.5 "Changing Negative-Direction Software Motion Limits (NLIMs)."

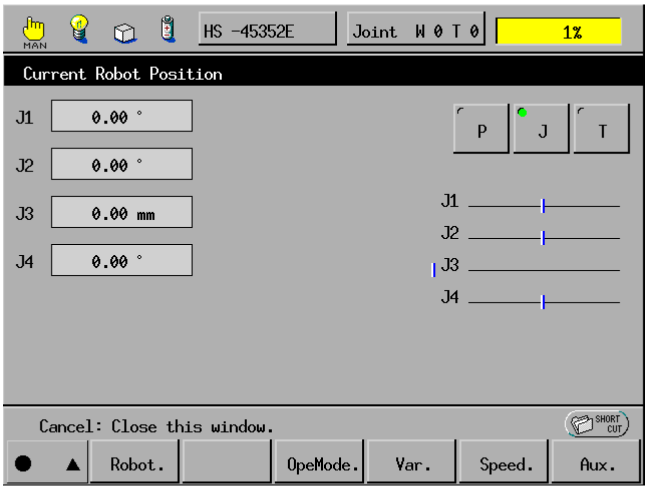
As long as you use the permanent mechanical end, this checking job is not required. Once you remove the permanent mechanical end, however, it is necessary to set the RANG values and software motion limits.

Step 1 **Turn the power switch of the robot controller 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.**

The Current Robot Position window appears as shown below.



Step 4 **If you have changed the 1st- and 3rd-axis mechanical ends, bring those axes into contact with their new positive-direction mechanical ends by hand.**

If you have changed the 2nd-axis mechanical end, bring the axis into contact with the new negative-direction mechanical end by hand.

Step 5 **In the Current Robot Position window, check the value in each of J1 through J4 boxes that appears when each axis is in contact with the mechanical end in Step 4. The value is RANG value to be newly set.**

Mechanical End Positions and Software Motion Limits to be Set

J1 through J3	Set each software motion limit as follows:
1st axis (J1)	3° inside from the mechanical end
2nd axis (J2)	2.5° inside from the mechanical end
3rd axis (J3)	4 mm inside from the mechanical end

CAUTION: If the software motion limits are set to less than the values specified above, the robot arm may bump against the mechanical stops before it stops by software.

2.3.5 Changing Positive-Direction Software Motion Limits (PLIMs) and RANG Values

If you change the positive-direction mechanical ends, you need to change the preset positive-direction software motion limits (PLIMs) and RANG in succession according to Steps 1 through 35 given below.

Changing Positive-Direction Software Motion Limits (PLIMs)

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

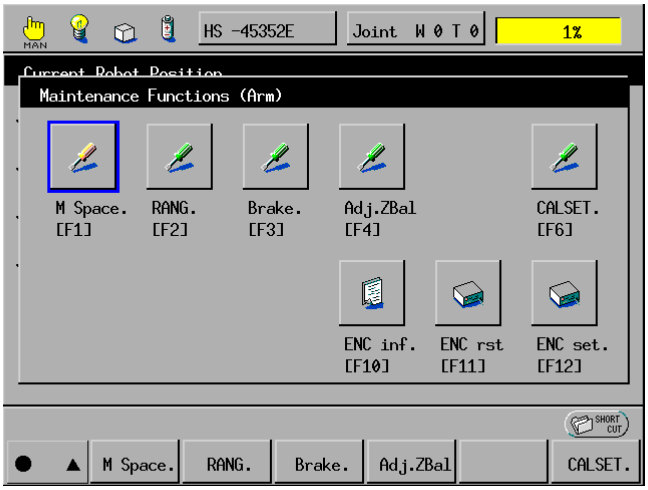
Step 2 **Set the mode selector switch of the teach pendant to MANUAL.**

Step 3 **Press [F2 Arm] on the top screen.**

The Current Robot Position window appears.

Step 4 **In the Current Robot Position window, press [F12 Maint.].**

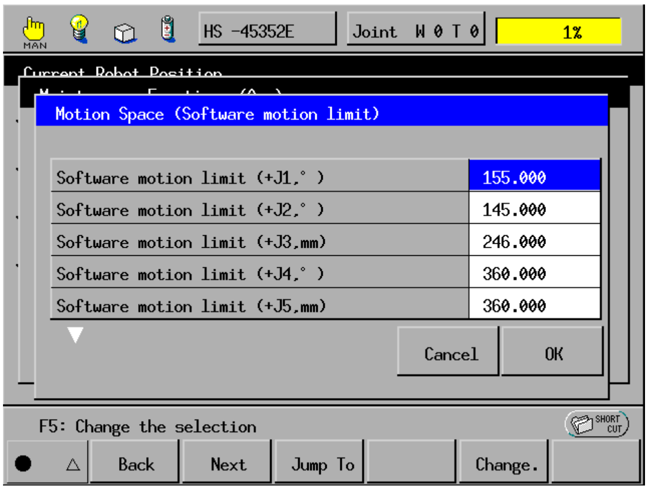
The Maintenance Functions (Arm) window appears as shown below.



F1

Press [F1 M Space.].

Step 5 The Motion Space (Software motion limit) window appears as shown below.



Step 6 **In the Motion Space (Software motion limit) window, select the positive-direction software motion limit of the target axis with the jog dial or cursor keys.**

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.

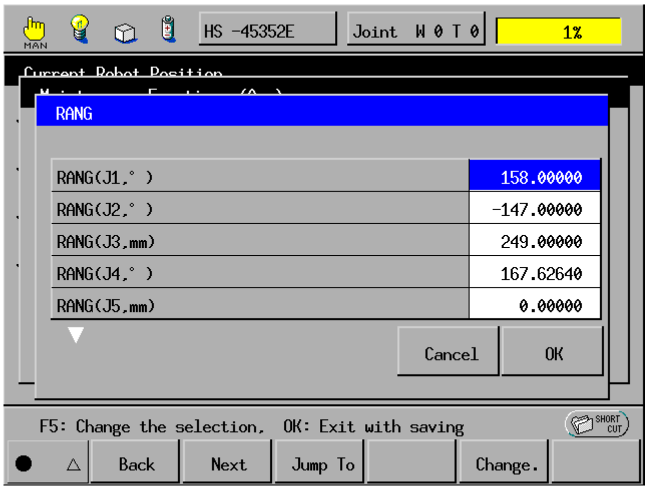
Step 9 **Press OK.**

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

Changing the RANG Values

Step 10 **In the Maintenance Functions (Arm) window, press [F2 RANG.].**

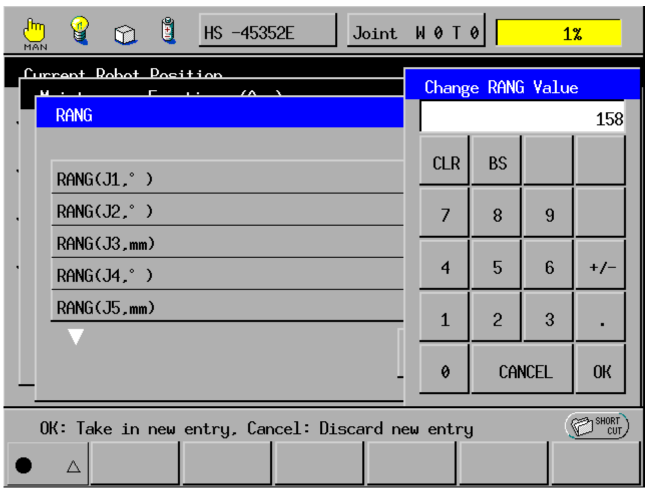
The RANG window appears as shown below.



F5

Select the RANG of the target axis, then press [F5 Change.].

Step 11 The numeric keypad appears.



Step 12 **Using the numeric keys, enter RANG values and 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 **Set the power switch of the robot controller to OFF.**

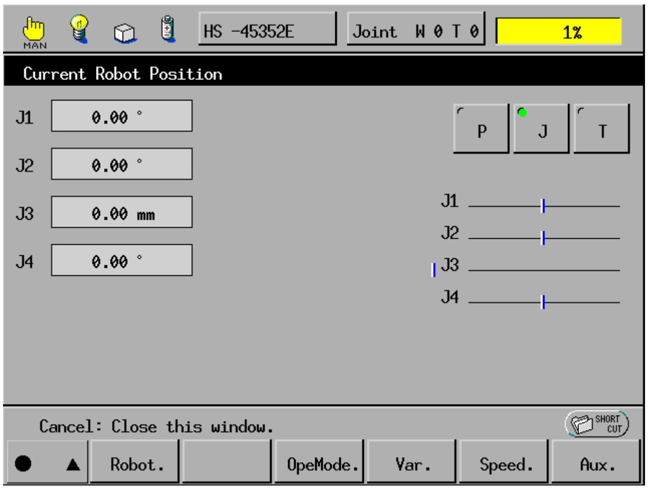
Executing CAL

Step 15 **Confirm that the pilot lamps of the robot controller go off, and then turn the power switch ON again.**

Step 16 **Press MOTOR to turn ON the power to the motor.**

Step 17 **Press [F2 Arm] on the top screen.**

The Current Robot Position window appears as shown below.

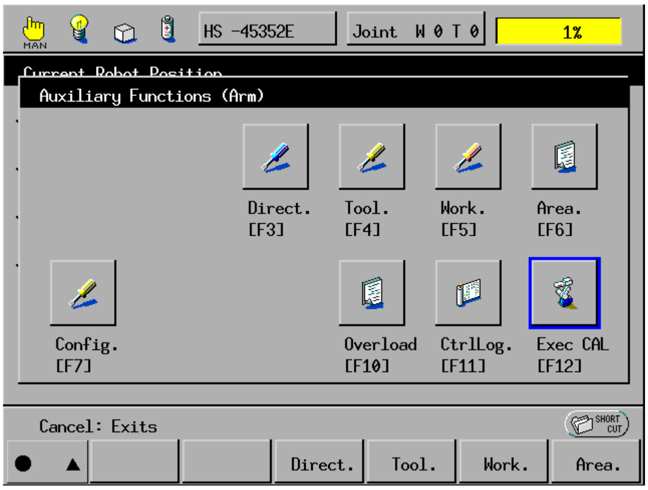


F6

Press [F6 Aux.].

Step 18

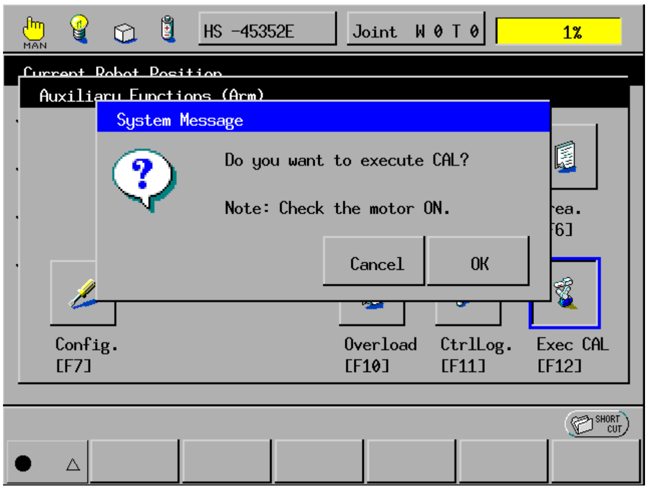
The Auxiliary Functions (Arm) window appears as shown below.



Press [F12 Exec CAL].

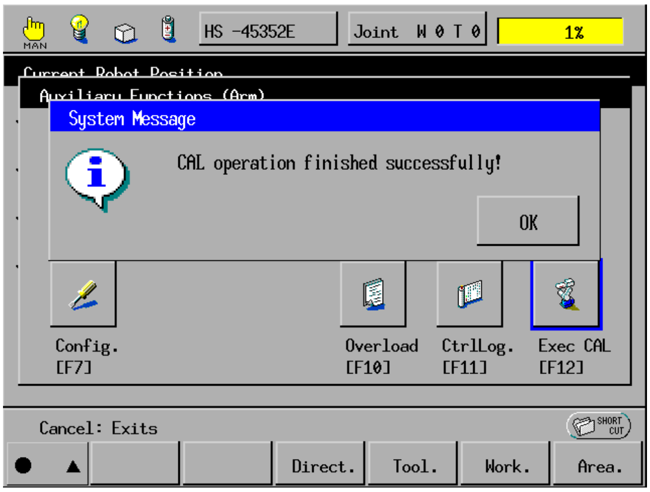
Step 19

The message window appears asking whether you want to carry out CAL.



Press OK.

Step 20 The message window appears informing you that CAL is successfully completed.



Step 21 **Press OK.**

Step 22 **Press the MOTOR key to turn the motor OFF.**

Step 23 **Press Cancel.**

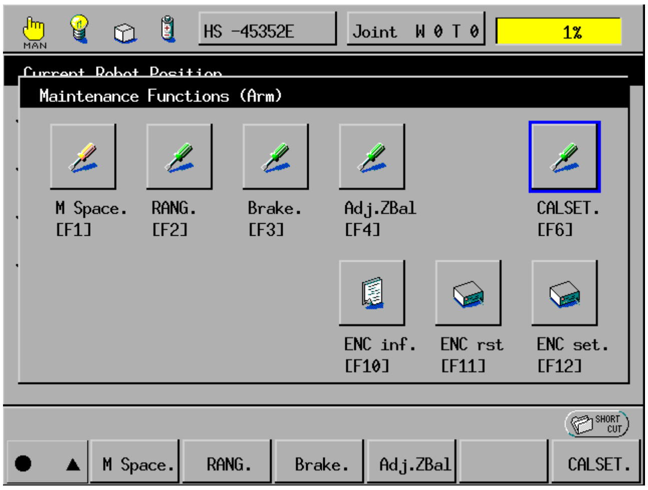
The screen returns to the Current Robot Position window.

Performing CALSET (Example for the 1st Axis)

Step 24 **Press SHIFT.**

Step 25 **Press [F12 Maint.].**

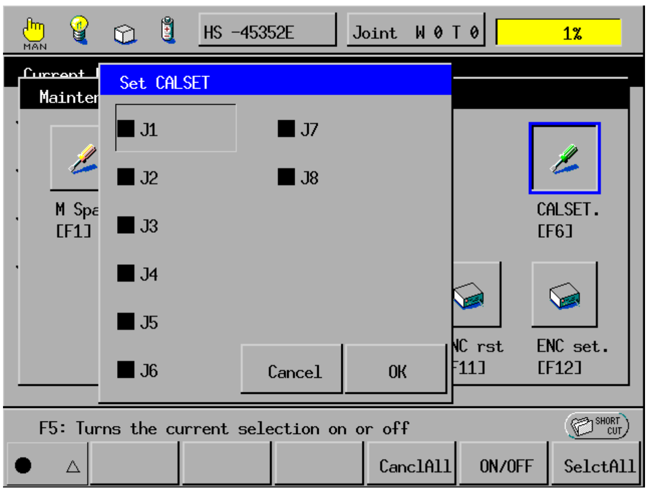
The Maintenance Functions (Arm) window appears as shown below.



F6

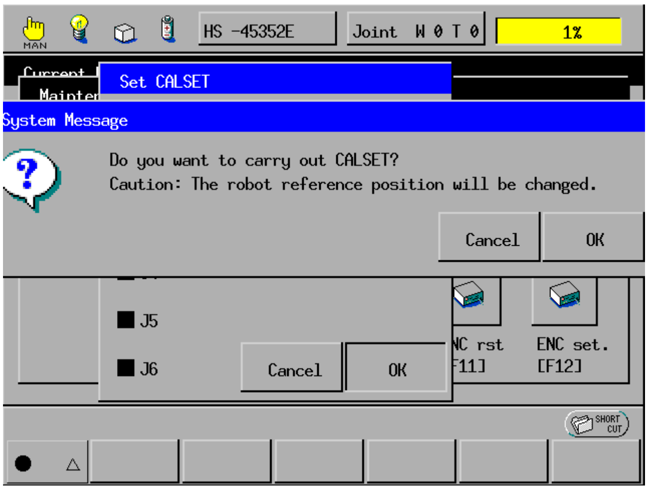
Press [F6 CALSET.].

Step 26 The Set CALSET window appears as shown below.



Touch the J1 field and confirm that the mark turns green, then press OK.

Step 27 The message window appears asking you whether you want to execute CALSET.



Press OK.

Step 28 The message window appears informing you that CALSET is successfully completed.

Press OK.

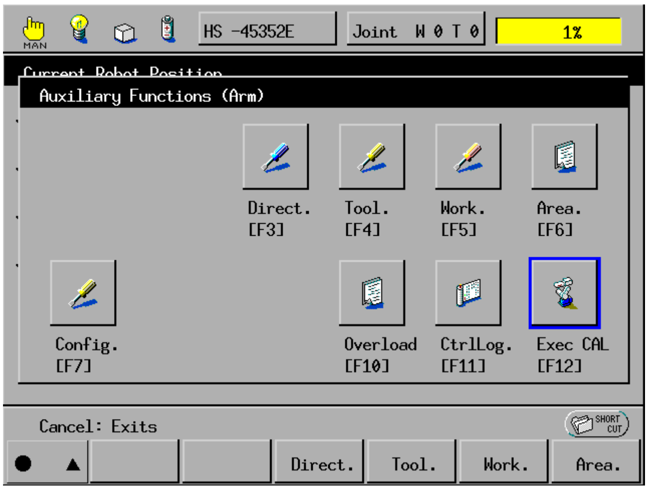
Step 29 **Press MOTOR to turn ON the power to the motor.**

Step 30 **Press Cancel.**

Step 31 The screen returns to the Current Robot Position window.

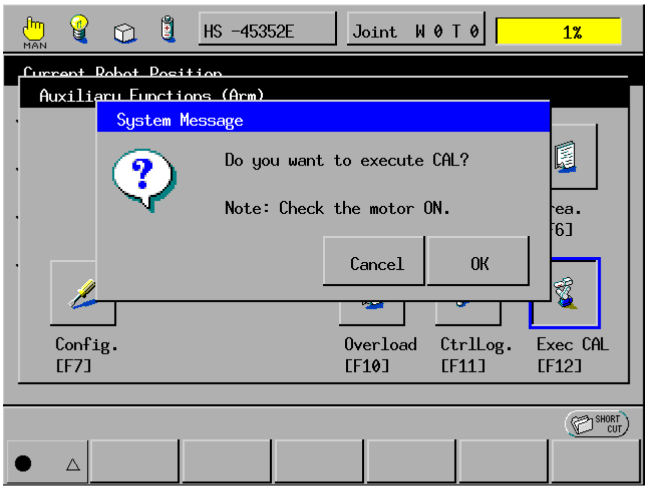
Press [F6 Aux.].

Step 32 The Auxiliary Functions (Arm) window appears.



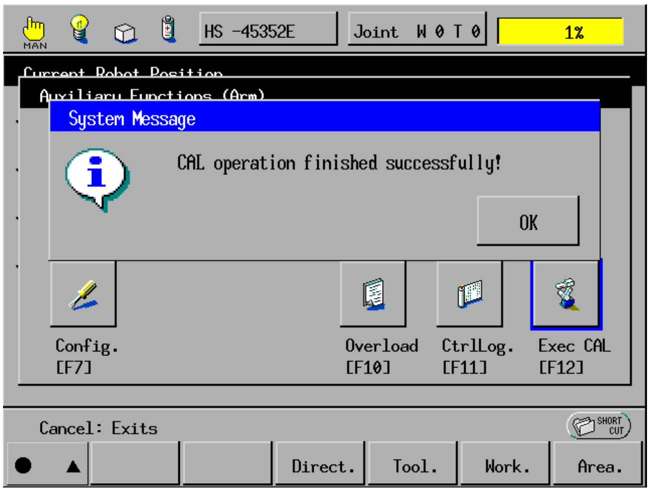
Press [F12 Exec CAL].

Step 33 The system message window appears asking you whether you want to execute CAL.



Press OK.

Step 34 The system message window appears informing you that CAL is successfully completed.



Step 35 **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 any of those axes is near a mechanical end and any other error (6111, 6121 or 6171) occurs.

2) A software motion limit error (ERROR6071) occurs although none of those axes is near a mechanical end.

2.3.6 Changing Negative-Direction Software Motion Limits (NLIMs)

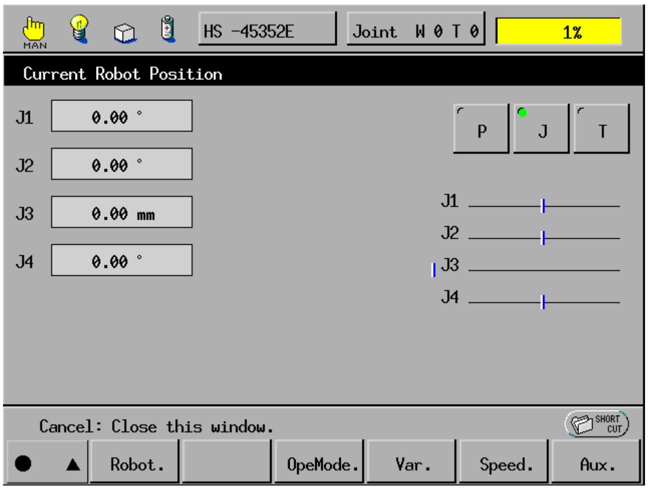
If you change the negative-direction mechanical ends, you need to change the preset negative-direction software motion limits (NLIMs) according to Steps 1 through 17 given below.

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

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

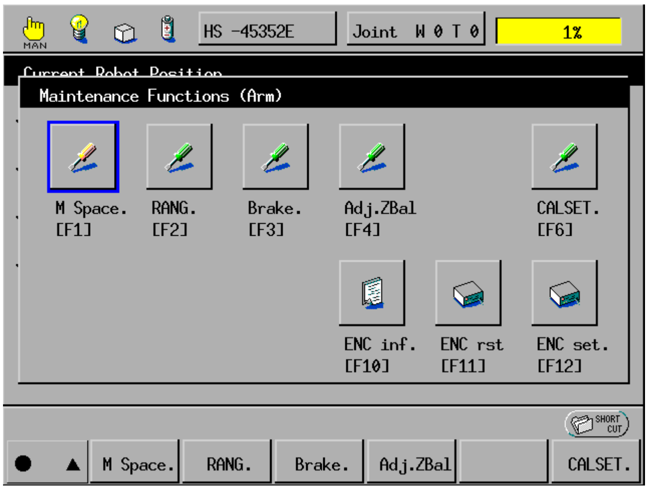
Step 3 **On the top screen, press [F2 Arm].**

The Current Robot Position window appears.



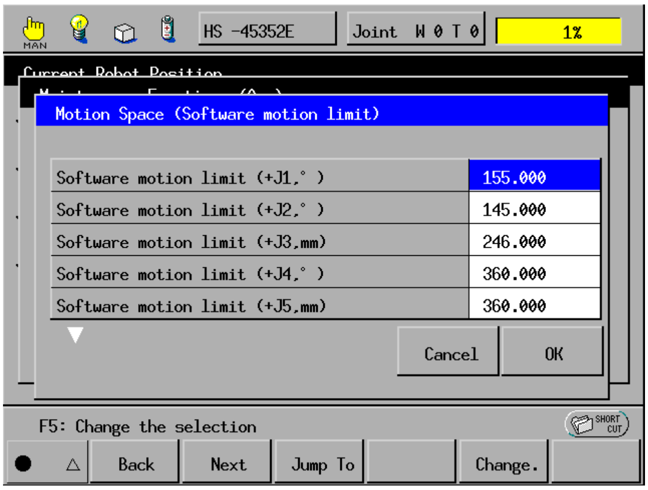
Step 4 **Press [F12 Maint.].**

The Maintenance Functions (Arm) window appears.



Step 5 **In the Maintenance Function (Arm) window, press [F1 M Space.].**

The Motion Space window appears as shown below.



Step 6 **Select the negative-direction software motion limit of the target axis, using the jog dial or cursor keys.**

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 window.

Step 9 **Press OK.**

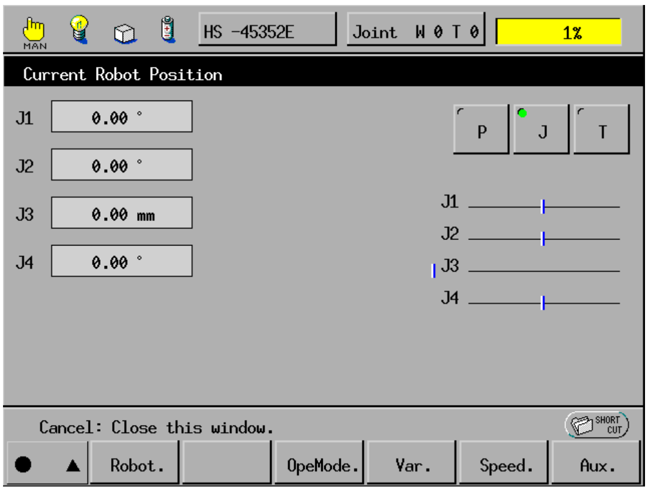
Step 10 **Set the power switch of the robot controller to OFF.**

Step 11 **Set the power switch of the robot controller to ON.**

Step 12 **Press MOTOR.**

Step 13 **On the top screen, press [F2 Arm].**

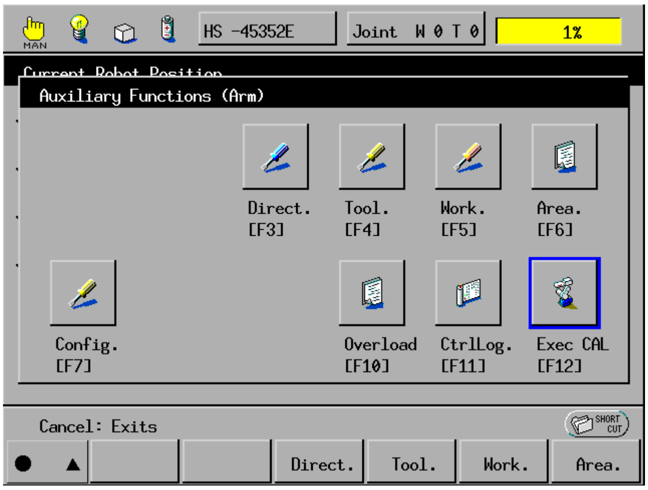
The Current Robot Position window appears.



Step 14

Press [F6 Aux.].

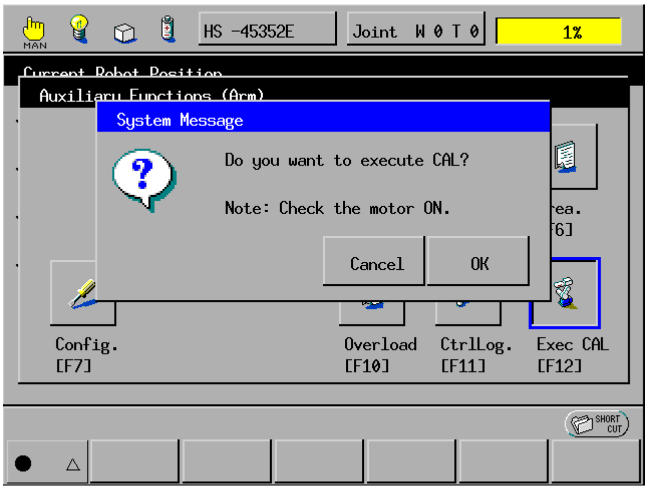
The Auxiliary Functions (Arm) window appears.



Step 15

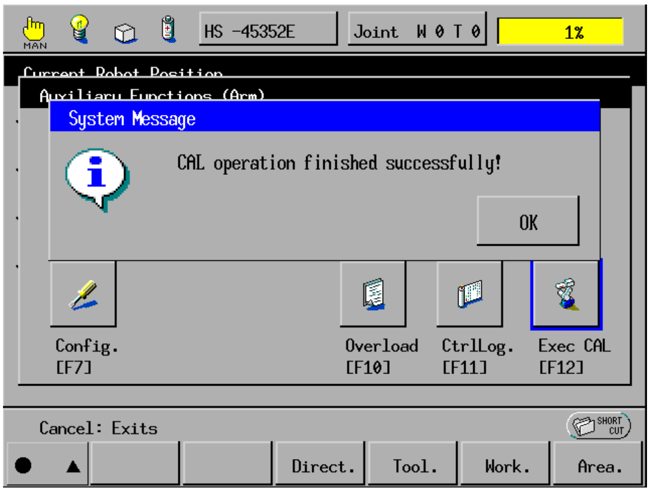
Press [F12 Exec.].

The message window appears asking you whether you want to execute CAL.



Step 16 **Press OK.**

The system message window appears informing that CAL is successfully completed.



Step 17 **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 any of those axes is near a mechanical end and any other error (6111, 6121 or 6171) occurs. 2) A software motion limit error (ERROR6071) occurs although none of those axes is near a mechanical end.

2.4 Performing 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 any motor is replaced or when any encoder backup battery goes dead so that 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 differs 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 Preparation for CALSET

Press each of the 1st- to 4th-axes against the associated mechanical ends by hand to get the actual positions.

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.
(2) After CALSET, confirm in the manual mode that each axis stops at the software motion limit before coming into contact with the mechanical end.
(3) In automatic operation, start to run the robot at low speed. Ensuring safety, gradually increase the speed. It makes adjustment easy.
(4) Position-related data in some programs made before CALSET may vary somewhat after CALSET.

NOTE: When CALSETing the 4th axis of the dust-proof, splash-proof type or cleanroom type, you need to pull down the lower bellows for setting the CALSET bolt.

What is a CALSET position?

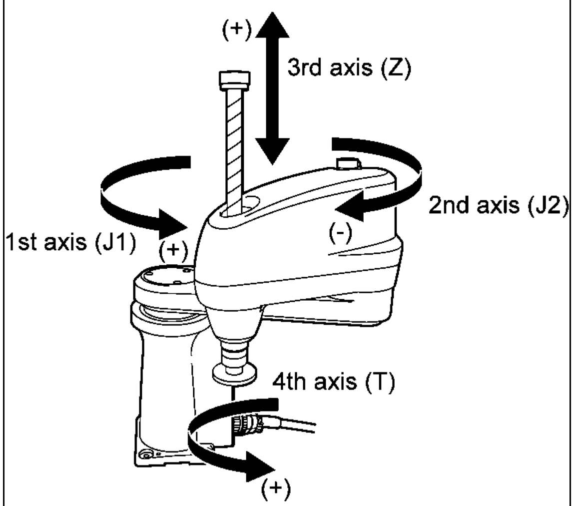
The limit position of an axis to be CALSET is called a CALSET position. Each axis has a mechanical end in each of the positive and negative directions. The CALSET to be carried out before shipment uses mechanical ends shown below as CALSET positions.

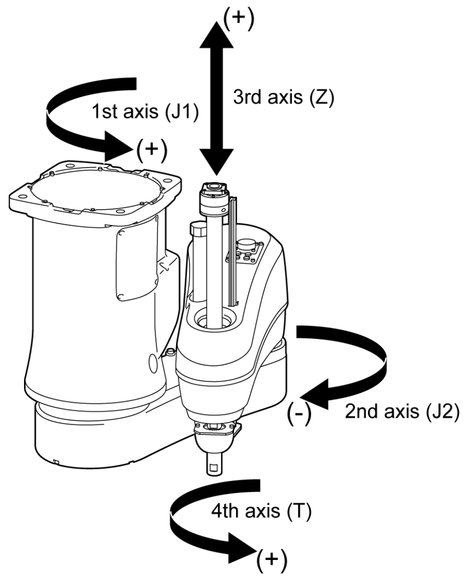
(1) CALSET position (HS/HSS-E series)

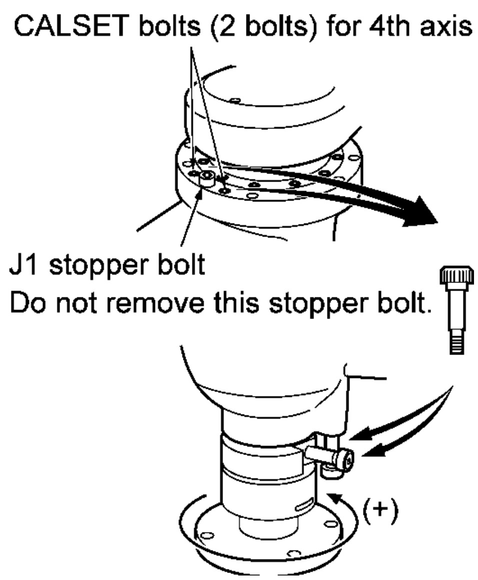
Mounting CALSET bolts on the 4th axis: To CALSET the 4th axis, you need to mount two CALSET bolts on the axis. As illustrated below, the CALSET bolts are built in the robot unit, so remove them and set them up into the specified positions. After completion of CALSET, put them back into place.

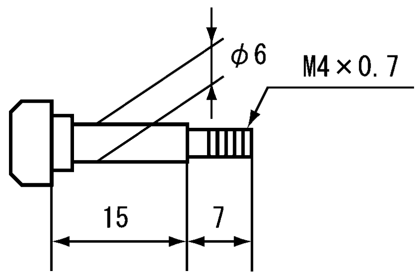
Location	1st axis	Turning end in the positive direction (counterclockwise end when viewed from the top)
	2nd axis	Turning end in the negative direction (clockwise end when viewed from the top)
	3rd axis	Upper end (in the positive direction)
	4th axis	Turning end in the positive direction (counterclockwise end when viewed from the top)

External appearance









CALSET Bolt (built in the robot unit)

CALSET Positions at Shipment (HS/HSS-E series)

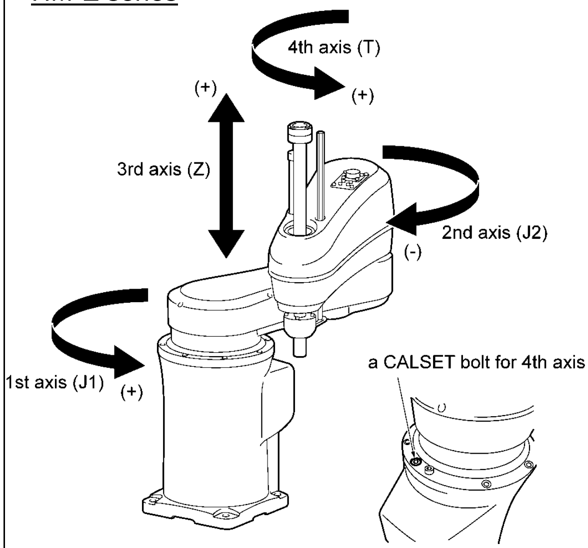
(2) CALSET position (HM/HMS-E series)

Mounting CALSET bolts on the 4th axis: To CALSET the 4th axis, you need to mount a CALSET bolt on the axis. As illustrated below, the CALSET bolt is built in the robot unit, so remove it and set it up into the specified position. After completion of CALSET, put it back into place.

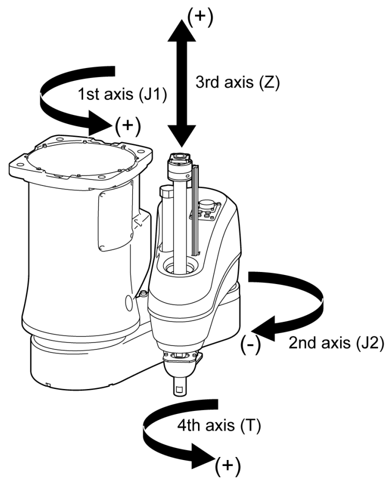
Location	1st axis	Turning end in the positive direction (counterclockwise end when viewed from the top)
	2nd axis	Turning end in the negative direction (clockwise end when viewed from the top)
	3rd axis	Upper end (in the positive direction)
	4th axis	Turning end in the positive direction (counterclockwise end when viewed from the top)

External appearance

HM-E series



HMS-E series



Notes for 4th axis CALSET

(1) Remove the CALSET bolt from the robot and set it as shown in right Figures.

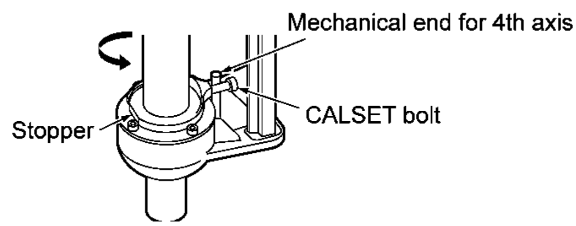
(2) Rotate the 4th axis shaft to the CALSET position by moving the stopper with hand.

Caution: Never push with too large torque.

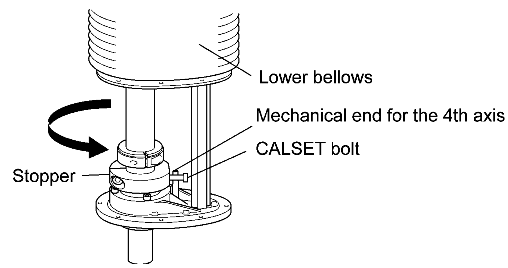
Pushing torque: 0.5Nm or less

(3) In case of the dust-proof & splash-proof type, perform 4-axis CALSET after removing the lower bellows.
Refer to ”Changing the upper mechanical end”.

For HM-E series



For HM-E-W series



CALSET Positions at Shipment (HM/HMS-E series)

2.4.3 Performing CALSET

[1] CALSET of 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.

In the procedure below, releasing the brake is required only for the 3rd axis.

Caution for performing single-axis CALSET in HS-E series

The CALSET position of the 3rd axis is related with the CALSET position of the 4th axis.

(1) Before performing the 3rd axis (4th axis) CALSET, move the 4th axis (3rd axis) to the CALSET position.

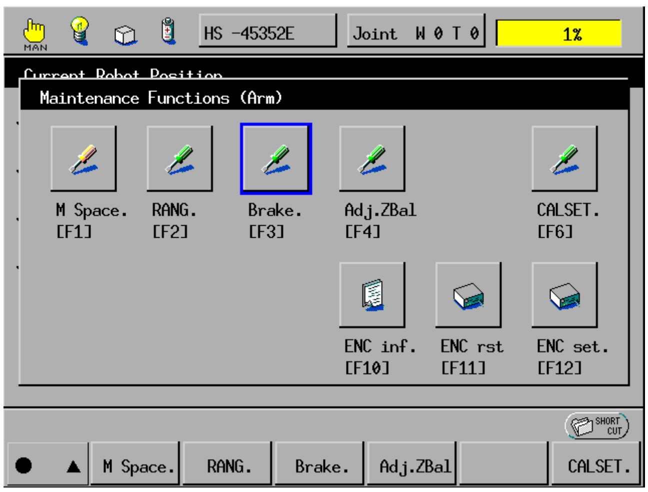
(2) When performing the 3rd axis (4th axis) CALSET, perform the 4th axis (3rd axis) CALSET at the same time.

Step 1 **Move the axis to be CALSET to the mechanical stop position.**

Step 2 **On the top screen of the teach pendant, press [F2 Arm].**

Step 3 **Press the SHIFT key and [F12 Maint.].**

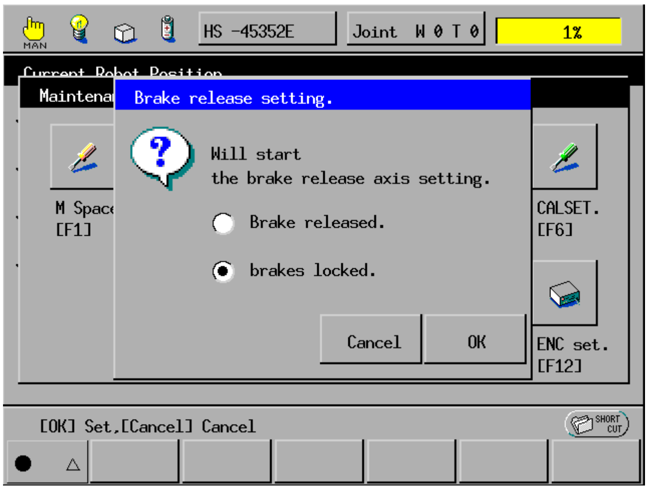
The Maintenance Functions (Arm) window appears as shown below.



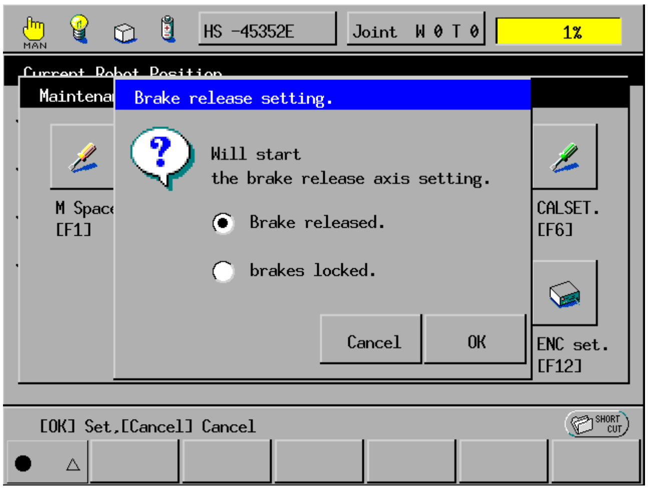
F3

Press [F3 Brake.].

Step 4 The Brake release setting window appears as shown below.



Step 5 **Select "Brake released."**

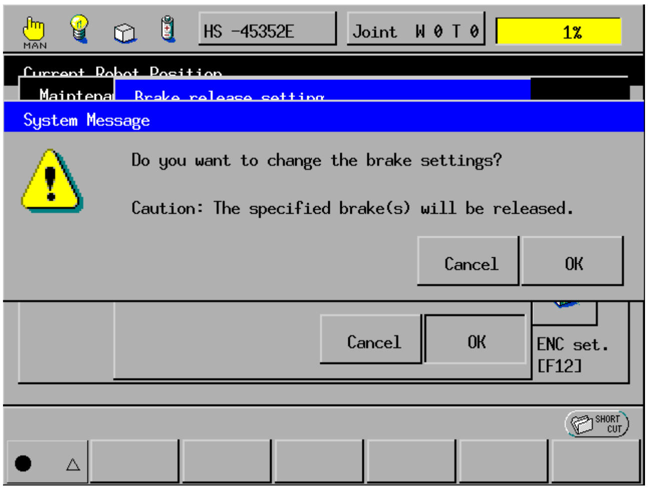


Step 6 **Confirm that there is no danger even if the arm falls as a result of the brake being released.**

Then press OK.

Step 7

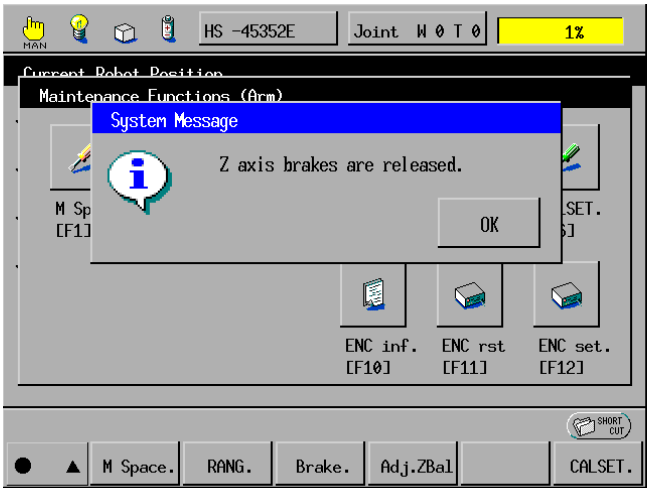
The system message appears asking you whether you want to change the brake settings.



Press OK.

Step 8

The system message appears informing that the brake is released.



Press OK.

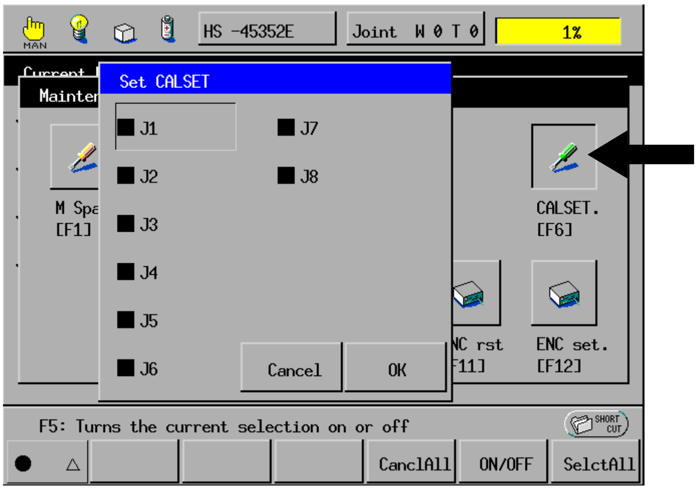
Step 9

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

Step 10

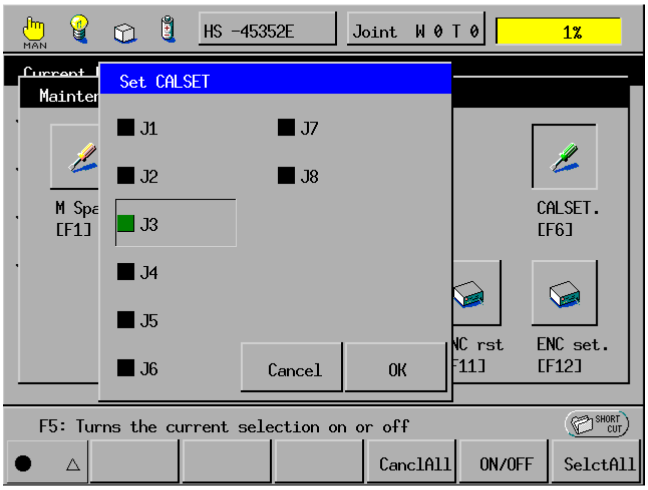
Press [F6 CALSET.].

The Set CALSET window appears as shown below.



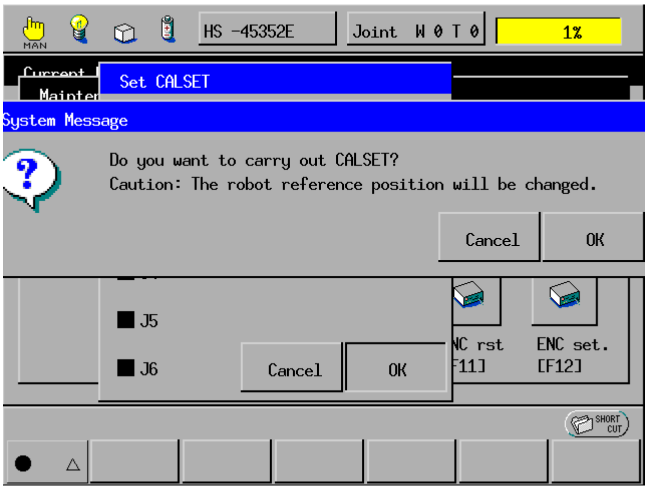
Step 11

Press the axis number to be CALSET to turn it on (green). For other axes that are not to be CALSET, turn it off (black).



Press OK.

Step 12 The system message appears asking whether you want to carry out CALSET.



Press OK.

Step 13 The system message appears informing that CALSET is successfully completed.

Press OK.

Step 14 **Press the ROBOT STOP button.**

The robot brake becomes activated.

Step 15 **Turn the ROBOT STOP button to cancel robot stop.**

Step 16 **Press the MOTOR key to turn the motor ON.**

> **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 to the motor several times, or release the brake, move the axis a little in the opposite direction of the mechanical end, and turn ON the power to the motor again.

Step 17 **Move the CALSET axis in the opposite direction from the mechanical end by manual operation from the teach pendant.**

Step 18 **Perform CAL. The single-axis CALSET of the specified axis is completed.**

[2] CALSET of 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 in Step 11. For detailed procedure, see “[1] CALSET of 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 the hand and/or workpiece that are to be set at the end of the robot flange. Set the payload and center of gravity position of the hand or workpiece and the control set of motion optimization according to the payload and the robot posture.

The mass of payload is a total mass of a hand and workpiece, expressed in gram.

For further information, see the PROGRAMMER'S MANUAL (I), 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."

2.6 Setting Robot Installation Conditions

Depending on whether the robot is floor-mounted or overhead-mounted, the optimum operating conditions differ.

However, as for horizontal articulated type; the HM/HS-E series (floor-mount type) and HMS/HSS-E series (overhead-mount type), the installation conditions are preset at the factory. You do not need to change the factory default of the installation settings.

2.7 Switching to the Vibration Suppression Control
--for the time when the moment of inertia exceeds the max. limit--

Each robot model is so designed that the maximum allowable moment of inertia is specified value. Assuming that the robot will be used under that moment of inertia, the gain is set.

If the actual moment of inertia exceeds the maximum allowable value, therefore, the robot may cause low-frequency vibration during T-axis motion, resulting in a halt as an error.

To prevent it, you may switch to the vibration suppression control that allows the robot to run in a stable motion even if the moment of inertia exceeds the maximum allowable limit. On the User Preferences window of the teach pendant, you may select the normal control (0) or vibration suppression control (1).

Control method	0: Normal control (factory default)
	1: Vibration suppression control

Under the vibration suppression control, however, the residual vibration may increase and an overcurrent error or related errors may easily occur in high-speed running. In such a case, adjust the reduced ratios of the programmed speed and acceleration.

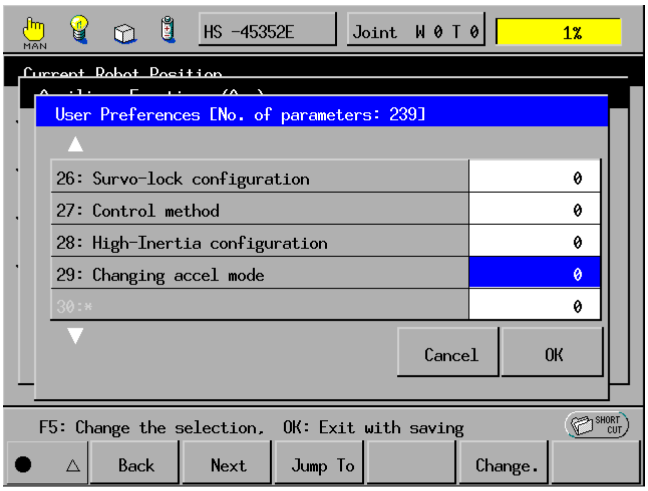
Operating procedure

Step 1 Turn the motor power off.

Step 2 Call up the User Preferences window.

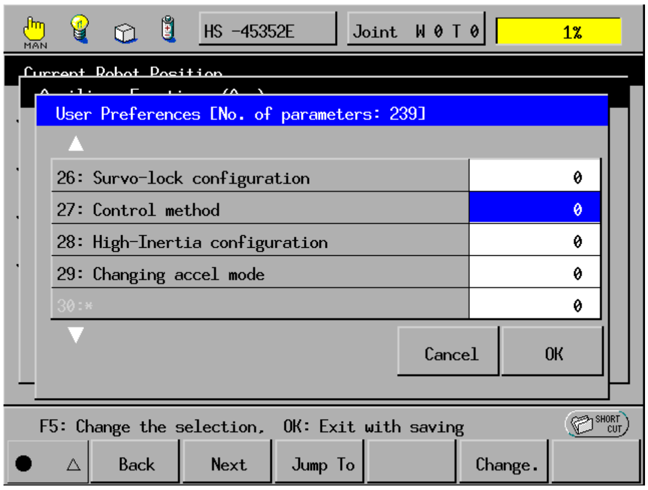
Access: [F2 Arm]—[F6 Aux.]—[F7 Config.]

Step 3 Display "29: Changing accel mode" using the job dial or [F3 Jump To].



Step 4 Check that the "Changing accel mode" is set to 0. If it is not set to 0, change it to 0.

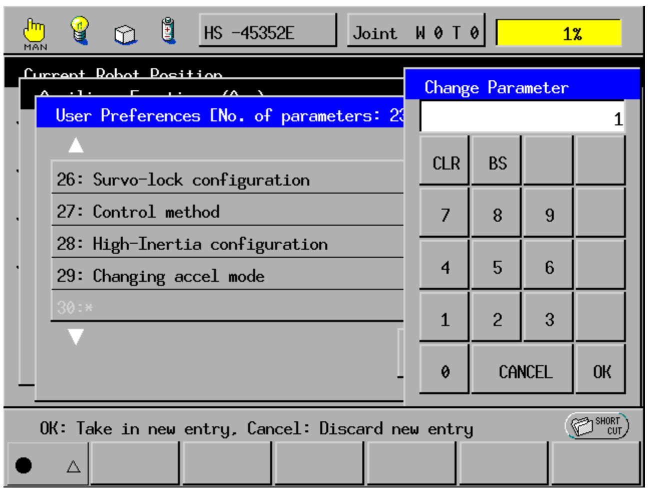
Step 5 Move the cursor to the "27: Control method."



F5

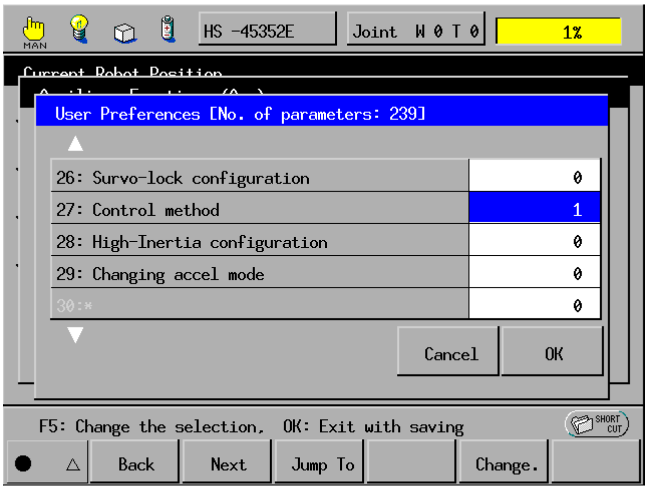
Press [F5 Change.].

Step 6 The numeric keypad will appear as shown below.



Enter 1 and press OK.

Step 7 The "Control method" is changed to 1.



Turn the controller power off and then on to restart.

The new setting will go into effect.

2.8 Setting the High-Inertia Configuration

--for the time when the moment of inertia exceeds the max. limit--

Like the vibration suppression control, the high-inertia configuration allows the robot to run in a stable motion even if the moment of inertia exceeds the maximum allowable limit. On the User Preferences window of the teach pendant, you may select (1) or deselect (0) the high-inertia configuration.

High-inertia configuration   0: Deselect (Normal gain, factory default)
                              1: Select

As shown below, the maximum allowable moment of inertia (MMI) when the high-inertial configuration is selected is less than that under the vibration suppression control.

MMI under usual control	<	MMI with high-inertial configuration	<	MMI under vibration suppression control

Unlike the vibration suppression control, the high-inertia configuration does not increase the residual vibration or cause an overcurrent error or related errors in high-speed running.

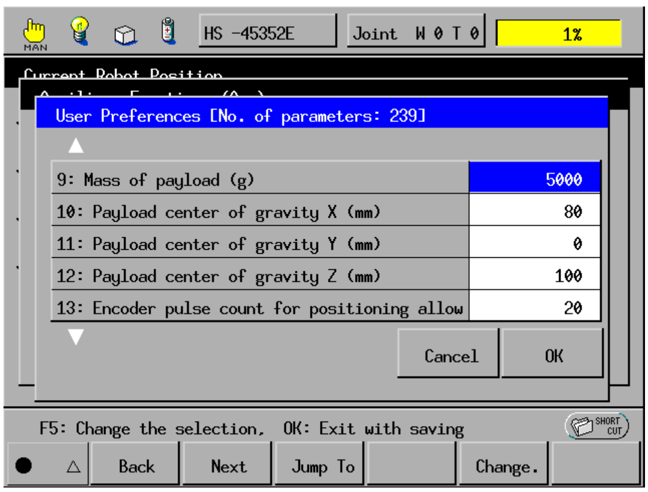
Operating procedure

Step 1 Turn the motor power off.

Step 2 Call up the User Preferences window.

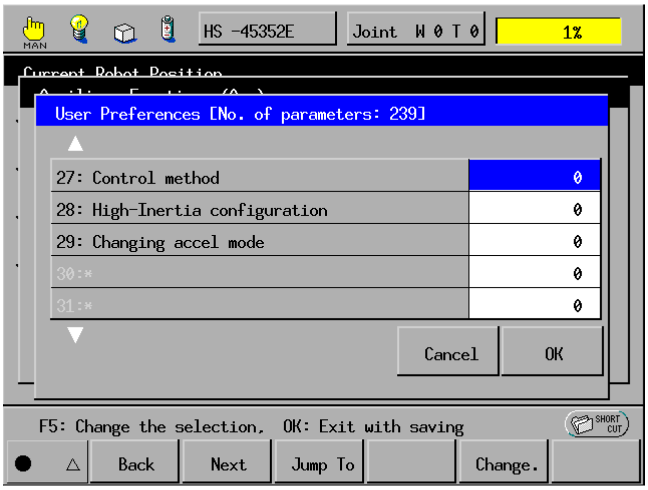
Access: [F2 Arm]—[F6 Aux.]—[F7 Config.]

Step 3 Display "9: Mass of payload (g)" using the job dial or [F3 Jump To].



Step 4 Check that the "Mass of payload (g)" is set to maximum payload value. If it is not set to maximum payload value, change it to. (For example of HS-E, its value is 5000.)

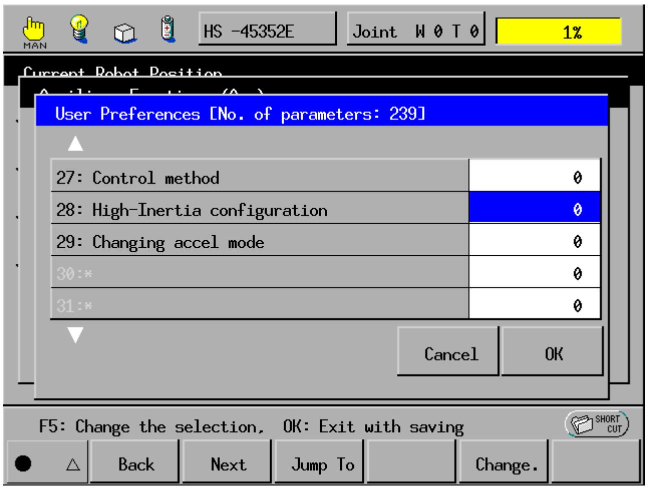
Step 5 Move the cursor to the "27: Control method."



Check that the "Control method" is set to 0. If it is not set to 0, change it to 0. Then turn the controller off and then on to restart.

Step 6 Check that the "29: Changing accel mode" is set to 0. If it is not set to 0, change it to 0.

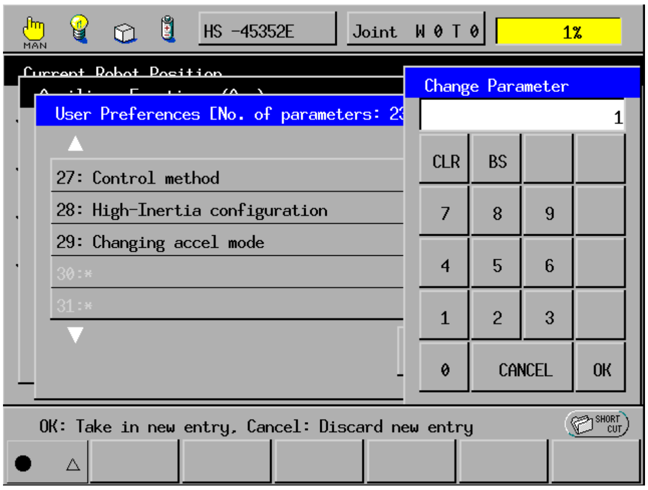
Step 7 Move the cursor to the "28: High-Inertia configuration."



F5

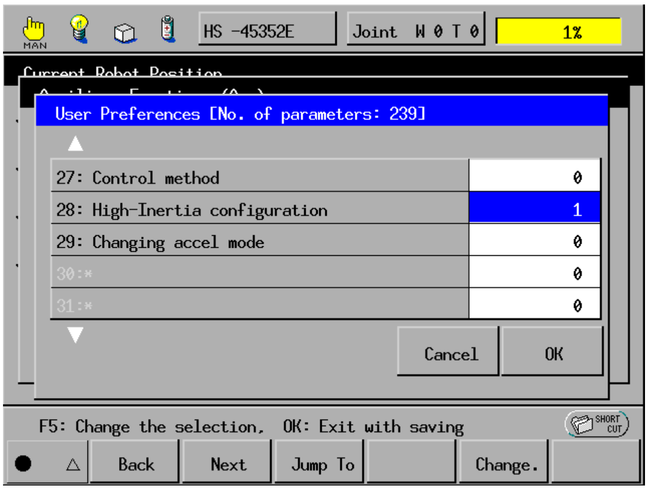
Press [F5 Change.].

Step 8 The numeric keypad will appear as shown below.



Enter 1 and press the OK button.

Step 9 The "High-Inertia configuration" is changed to 1.



Turn the controller power off and then on to restart.

The new setting will go into effect.

Chapter 3 Maintenance and Inspection

3.1 Maintenance & Inspection Intervals and Purposes

The table below lists the intervals and purposes of maintenance & inspection required for your robot.

Maintenance & Inspection Intervals and Purposes

No.	Intervals	What to do:	Needed:
1	Daily before starting operations	Inspection jobs specified in Section 3.2.	To use your robot safely.
2	Quarterly	Inspection jobs specified in Section 3.3.	To maintain the precision of the robot and to prevent failures caused by overheat of the robot controller.
3	Semiyearly	Inspection jobs specified in Section 3.4.	To check the rotary sections and slideways of the robot and its controller for wear, preventing seizure, breakage, and other serious failures that could result from wear.
4	Biennial	Replacement of backup batteries and inspection of timing belts specified in Section 3.5.	To retain the position data stored in the electronic absolute encoders built in the robot unit and the robot-specific data (programs, parameters, etc.) stored in the internal memory of the robot controller. To maintain the precision of the robot motion.

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

3.2 Daily Inspections

3.2.1 Check Items

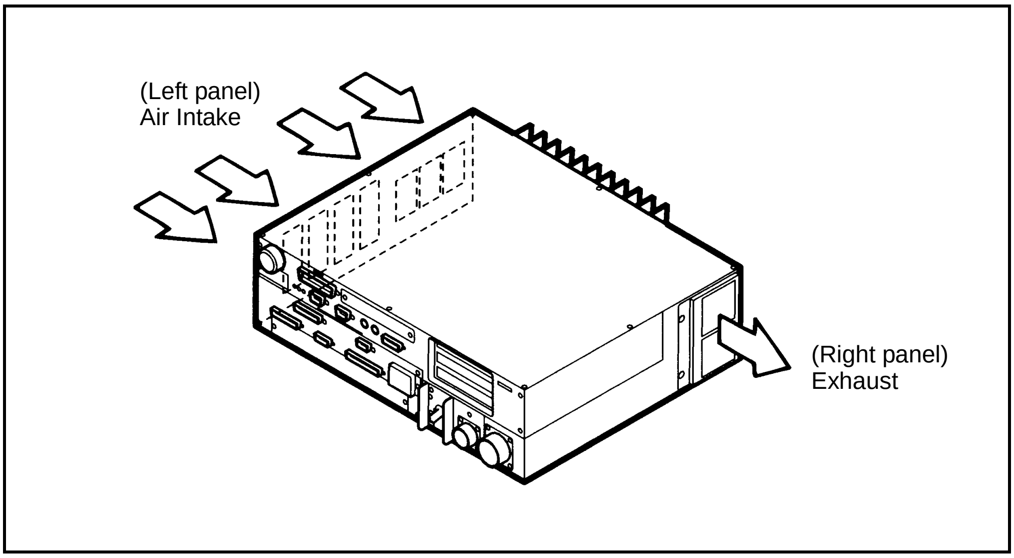
Before starting operations, check the items listed below every day.

Daily Inspections Table

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

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

Note 2 The normal operation of the cooling fan is as shown on the next page.



Normal Operation of Cooling Fan (Example of HS-E)

3.3 Quarterly Inspections

3.3.1 Check Items and Lubrication

Check the items listed 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 Subsection 3.3.2.)

3.3.2 Cleaning the Cooling Fan Filters in the Robot Controller

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

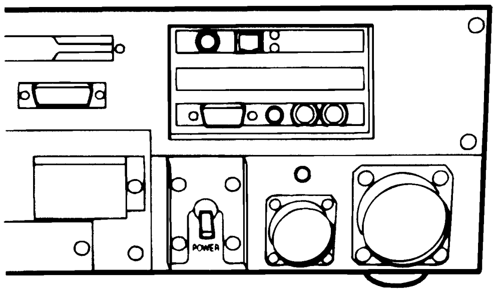
If either of the filters is clogged, the robot controller becomes badly ventilated to overheat so that the internal electronic devices may fail due to heat.

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

Following descriptions are example for HS-E series.

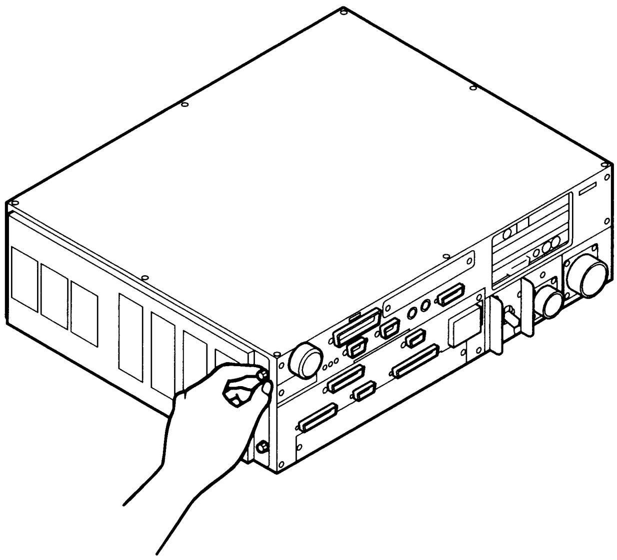
▶ STEP 1

Turn the POWER switch of the robot controller OFF.



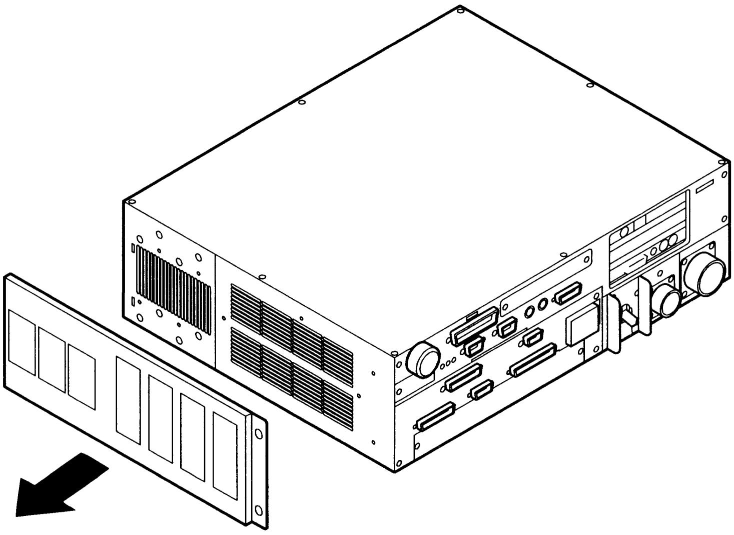
▶ STEP 2

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



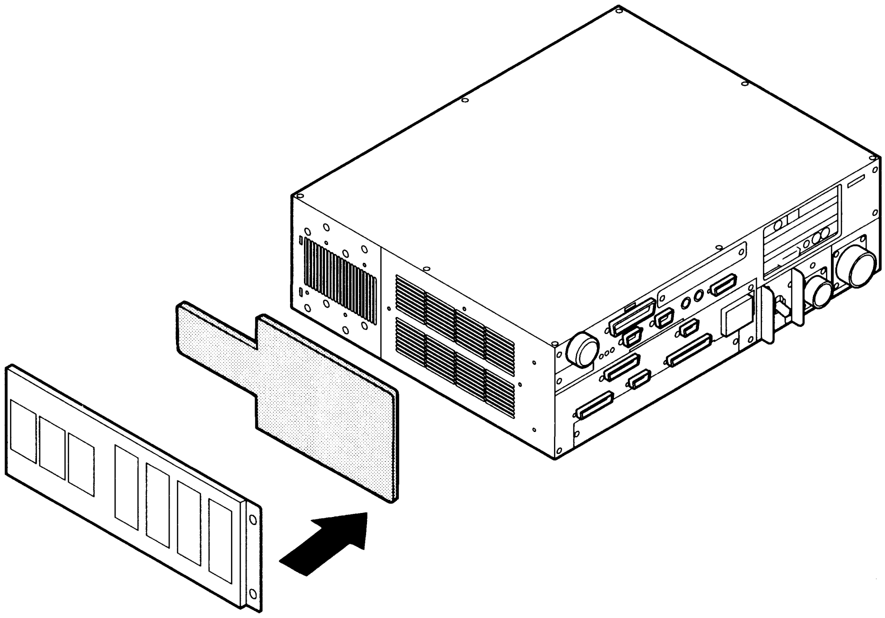
STEP 3

Remove the support frame of the inlet port filter.



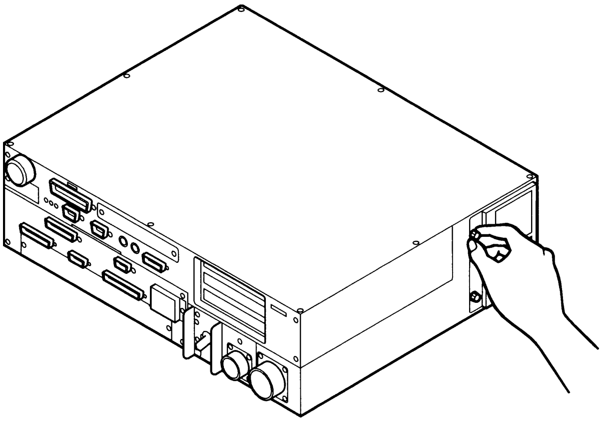
STEP 4

Remove the filter element from the support frame.



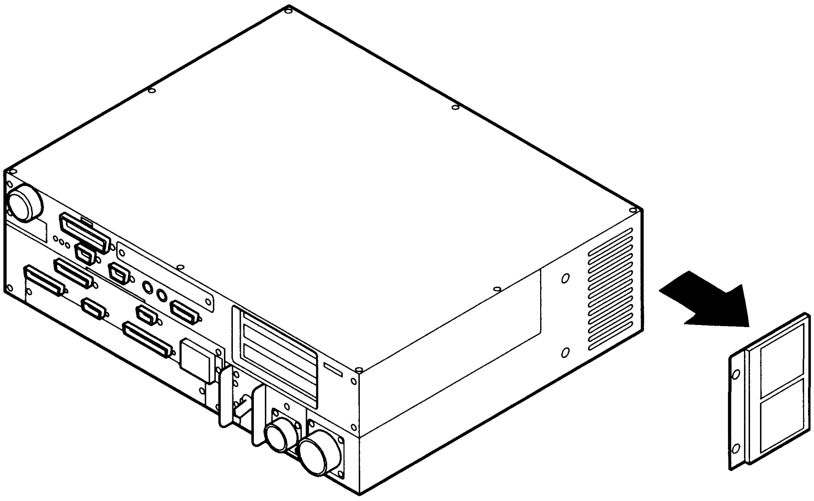
STEP 5

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



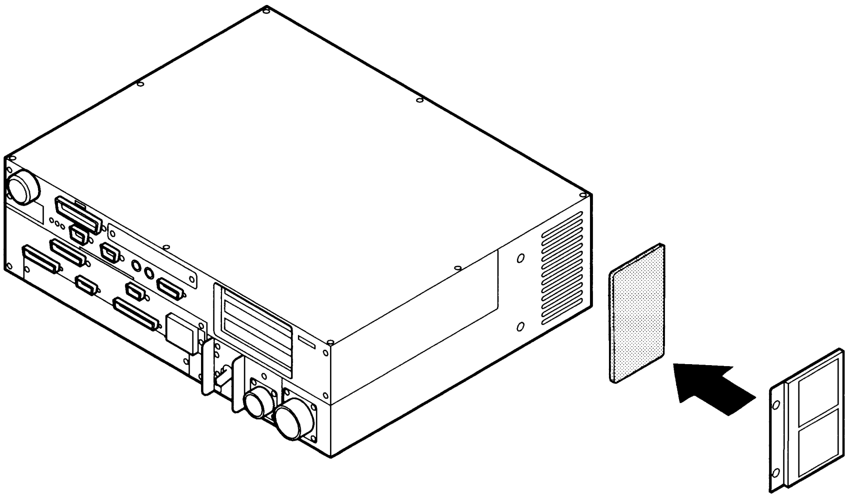
STEP 6

Remove the support frame of the exhaust port filter.



STEP 7

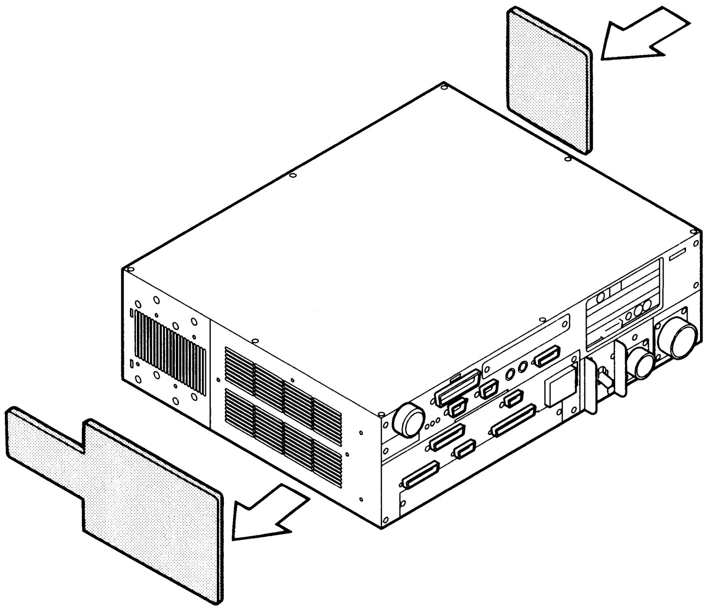
Remove the filter element from the support frame.



▸ STEP 8

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

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



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

NOTES
(1) Dry the washed filters completely before replacing them.
(2) If the filters are still dirty after air blowing or washing, replace them with new ones.

▸ STEP 9

Reinstall the filters in the reverse order of removal.

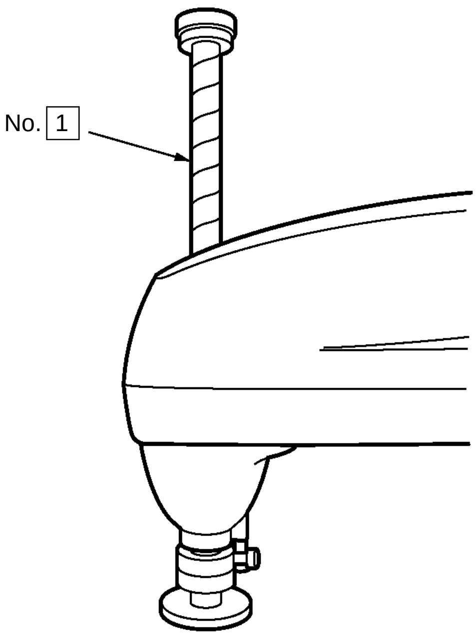
3.4 Semiyearly Inspections

3.4.1 Lubrication

Apply the specified grease to the whole Z-axis shaft as shown below every six months.

Lubrication Points and Lubricants (HS/HSS-E series)

No.	Lubrication points	Lubricant type	Lubricant amount	Remarks
1	Z-axis shaft	Epinoc AP1	2 to 3 cc	Apply the grease to the whole Z-axis shaft.



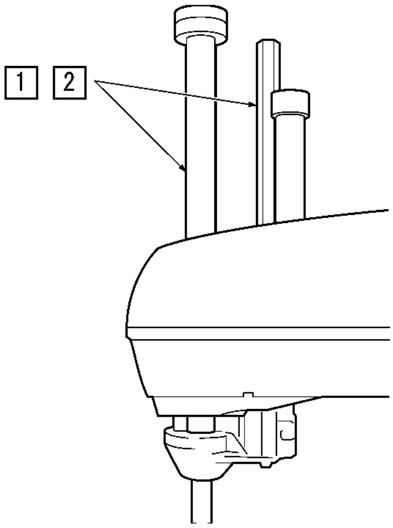
<Example of HS-E>

NOTE: When applying grease to the dust-proof & splash-proof type or cleanroom type, you need to pull up and down the upper and lower bellows on the Z-axis shaft, respectively.

Refer to "Changing the 3rd (Z)-axis mechanical end".

Lubrication Points and Lubricants (HM/HMS-E series)

No.	Lubrication points	Lubricant type	Lubricant amount	Remarks
1	Z-axis shaft	Epinoc AP1	2 to 3 cc	Apply the grease to the whole Z-axis shaft.
2	Z-axis rack	Epinoc AP1	2 to 3 cc	Apply the grease to the rack and gear of the Z-axis shaft.



<Example of HM-E>

NOTE 1: When applying grease to the dust-proof & splash-proof type, you need to pull up and down the lower bellow on the Z-axis shaft.

Refer to ”Changing the 3rd (Z)-axis mechanical end”.

3.5 Biennial Inspections

3.5.1 Battery Replacement

Replace the two types of backup batteries listed below and inspect the timing belts on the 3rd- and 4th-axes every two years.

Types of Backup Batteries

	Battery type	Used to:	Located:	Refer to:
1	Encoder backup battery	Back up the position data of the servomotor encoder.	In the robot unit	Subsection 3.5.2
2	Memory backup battery	Back up programs, parameters, and CAL data.	In the robot controller	Subsection 3.5.3

The position data of the encoder contained 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.

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

Check Items

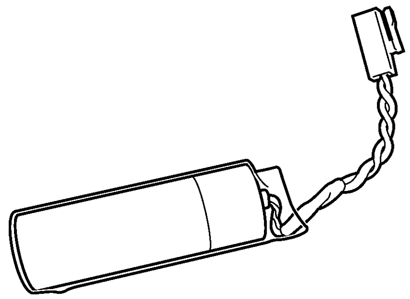
No.	Check:	Controller Power	How to check:	Criterion	What to do:
1	Timings belts on the 3rd and 4th axes	OFF	Visually	No lack of teeth or excessive wear.	Contact our Robot Service Section.

3.5.2 Replacing the Encoder Backup Battery

Replace the encoder backup battery according to the procedure given below.

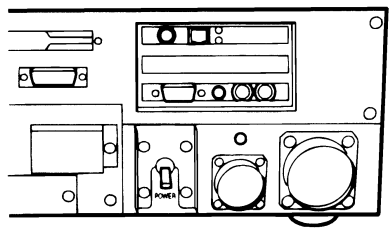
STEP 1

Prepare two new backup batteries for replacement.



STEP 2

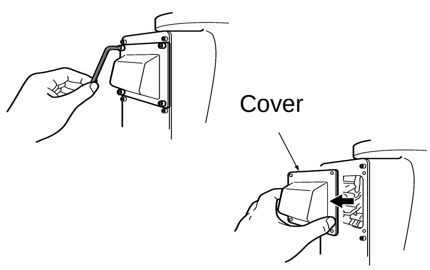
Turn the controller power OFF.



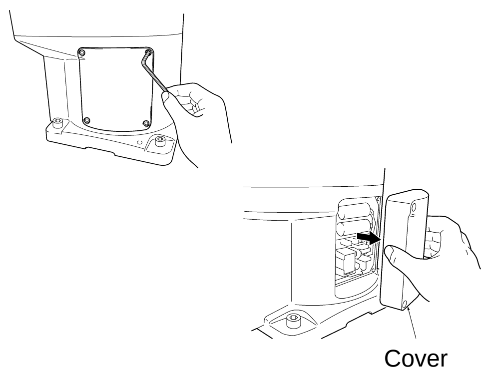
STEP 3

Remove the cover from the robot unit.

Four hex. socket-head bolts (M3x8)



<HS/HSS-E>

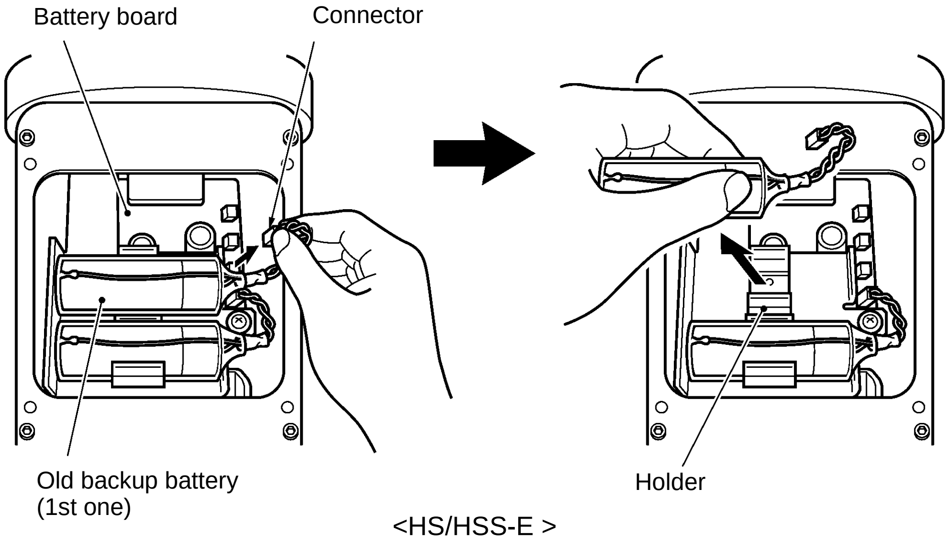


<HM/HMS-E>

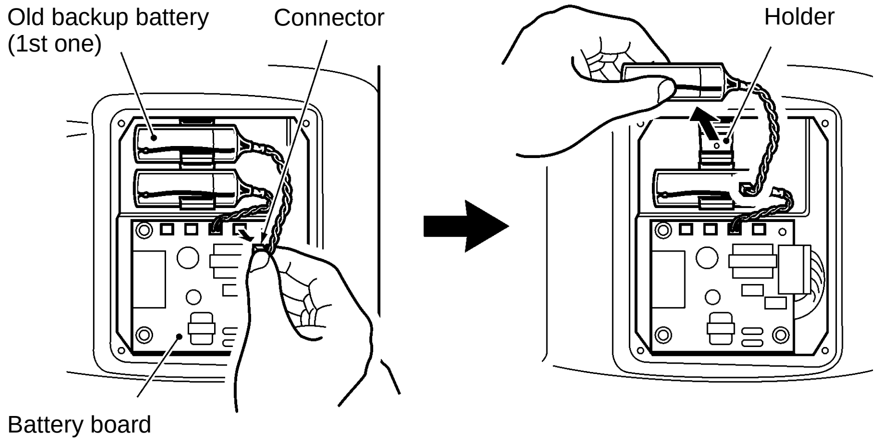
NOTE: On the dust-proof & splash-proof type or cleanroom type, the cover has a packing for sealing. Take care not to lose it.

▸ STEP 4

Disconnect the old battery (1st one) from the battery board and then remove it from the holder.



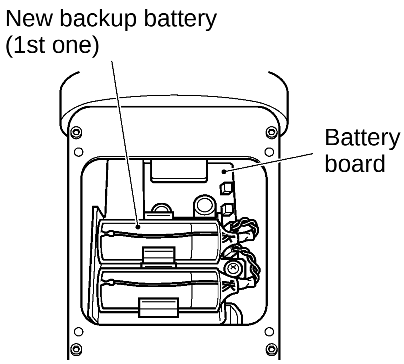
<HS/HSS-E >



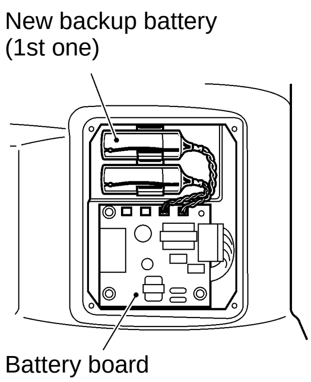
<HM/HMS-E >

▸ STEP 5

Connect a new battery (1st one) to the battery board from which you have disconnected the old one in Step 4, and then load it into the holder.



<HS/HSS-E>

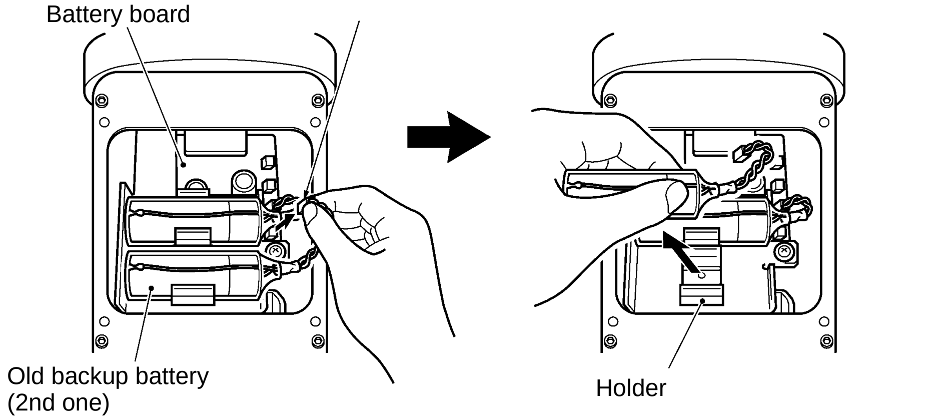


<HM/HMS-E>

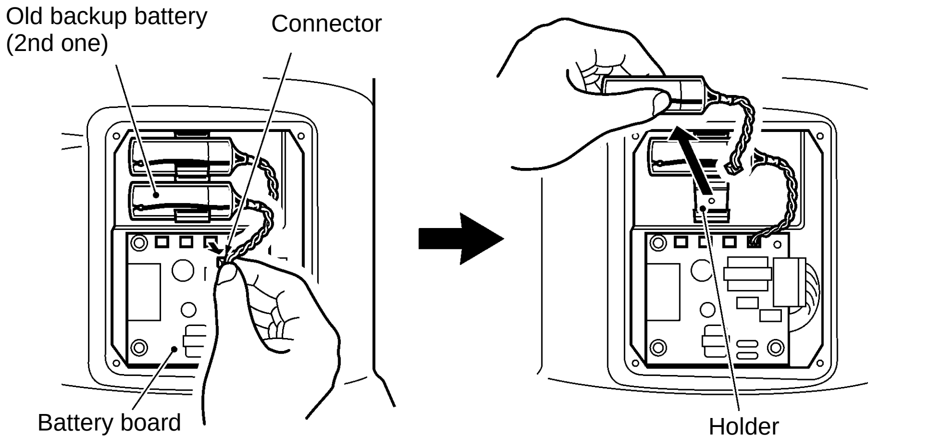
NOTE: Do not disconnect both of the current batteries at the same time. Doing so will lose the encoder positional data.

STEP 6

Disconnect the remaining old battery (2nd one) from the battery board and then remove it from the holder.



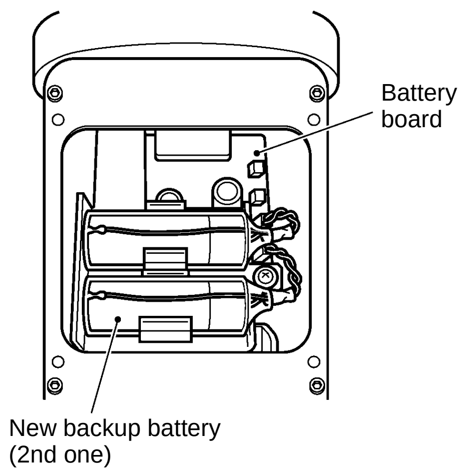
<HS/HSS-E>



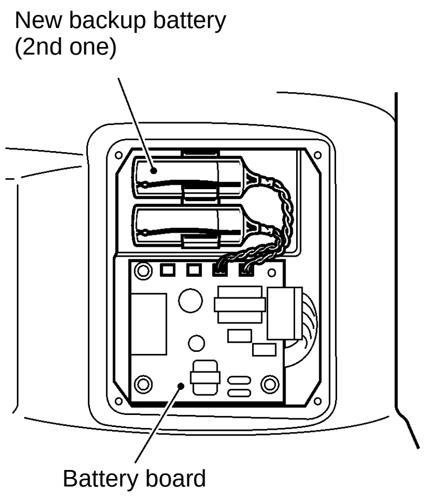
<HM/HMS-E>

STEP 7

Connect a new battery (2nd one) to the battery board from which you have disconnected the old one in Step 6, and then load it into the holder.



<HS/HSS-E>



<HM/HMS-E>

NOTE: Be sure to replace both of two batteries with new ones at one time. Otherwise, the battery service life will become short.

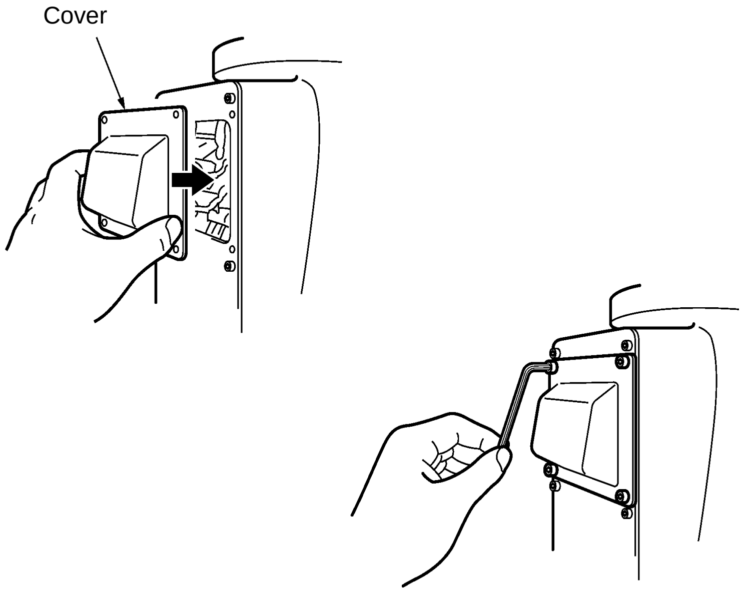
STEP 8

Install the cover to the robot unit.

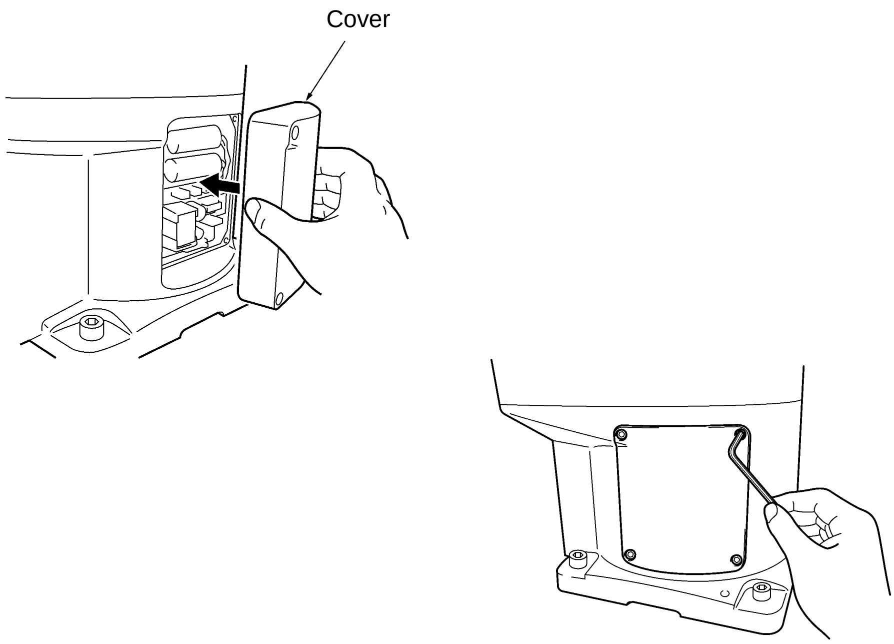
NOTE: On the dust-proof & splash-proof type or cleanroom type, the cover has a packing for sealing. Take care not to lose or pinch it.

Tightening toque

Hex. socket-head bolt (M3x8): 1.6±0.3 N•m



<HS/HSS-E>



<HM/HMS-E>

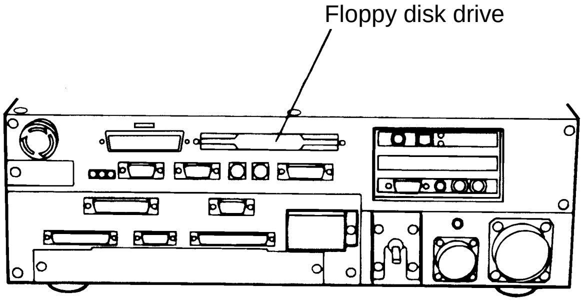
3.5.3 Replacing the Memory Backup Battery

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

Caution:	**Before replacing the memory backup battery, save (write) the Robot Controller memory data onto a floppy disk. The built-in floppy disk drive is an option.**

▶ STEP 1

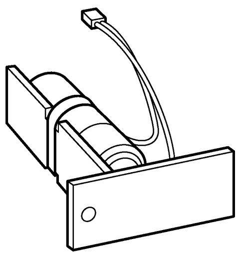
Save (write) the robot controller memory data onto a floppy disk.



For the procedure on saving the memory data, see the SETTING-UP MANUAL, Section 5.7, “Displaying the FDD Access Menu, [F6 Set]—[F3 FD.]."

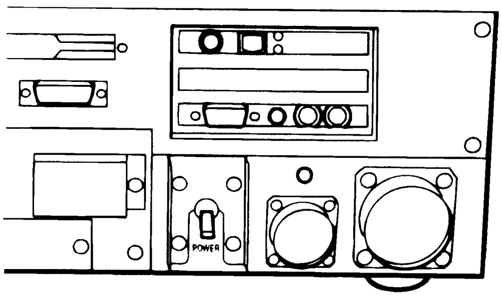
▶ STEP 2

Prepare a new memory backup battery.



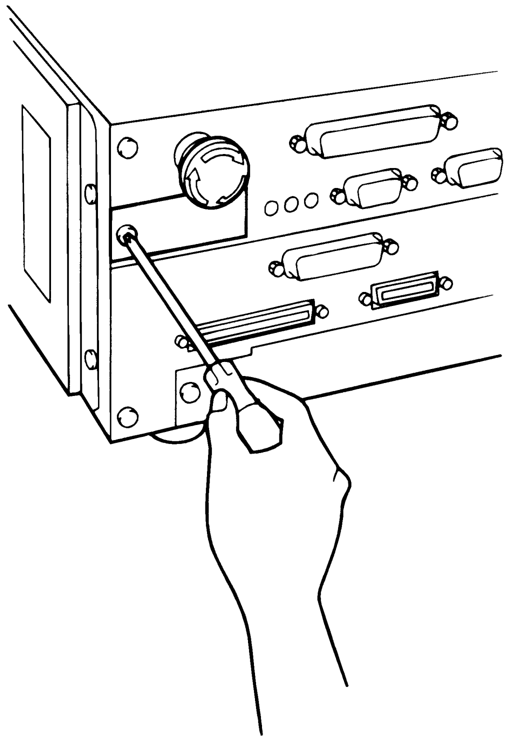
▶ STEP 3

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



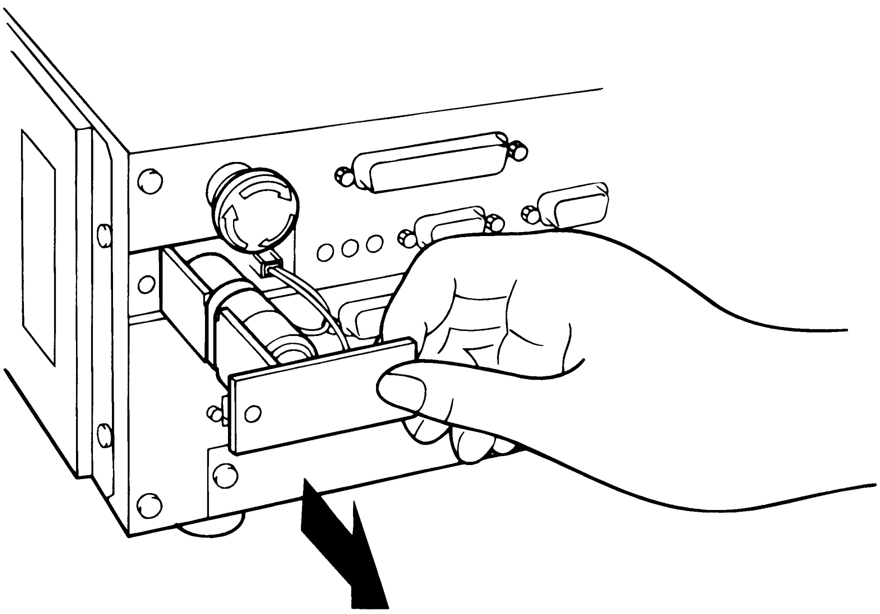
▸ STEP 4

Remove the screw to release the backup battery support.



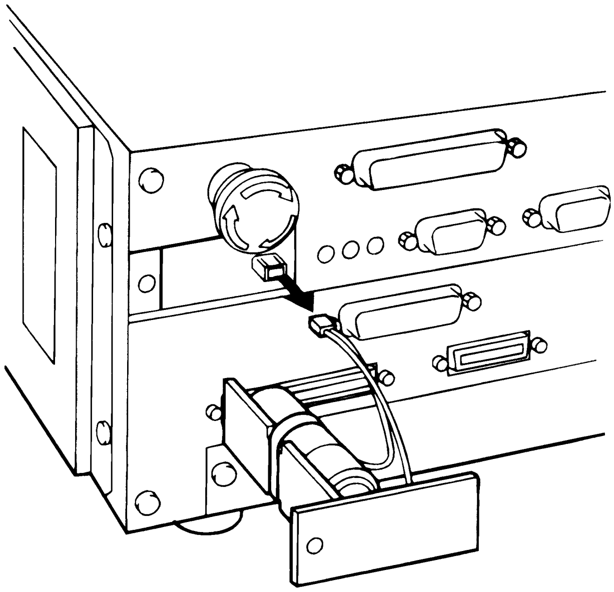
▸ STEP 5

Pull out the backup battery support.



STEP 6

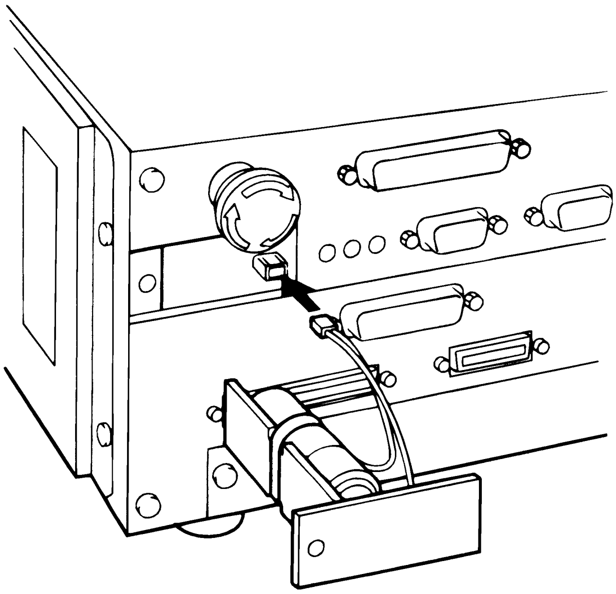
Disconnect the memory backup battery connector.



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

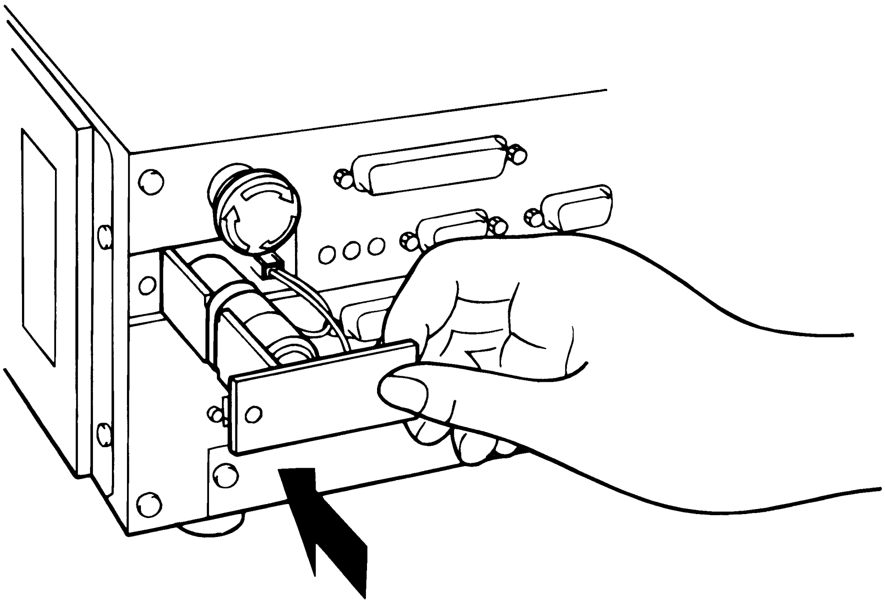
STEP 7

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



STEP 8

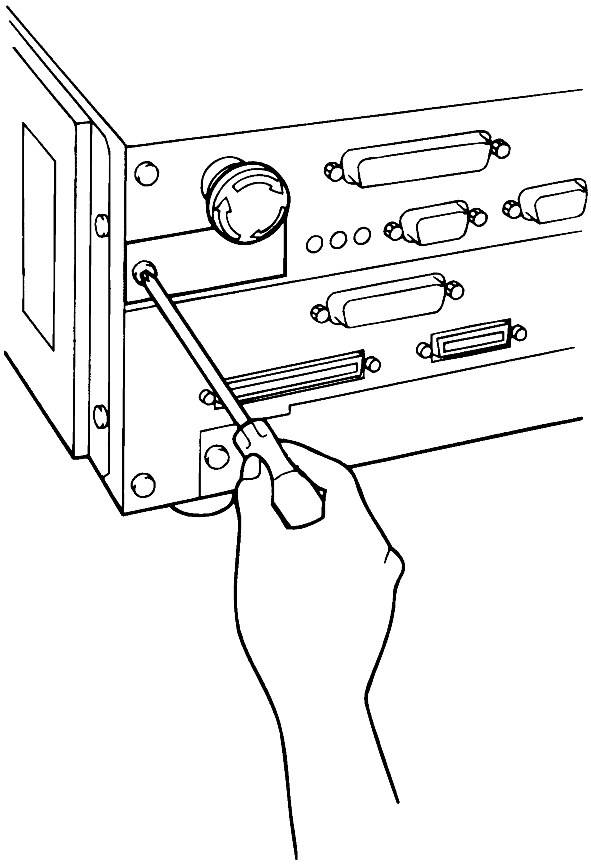
Push the new backup battery support into the robot controller.



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

STEP 9

Tighten the screw to secure the backup battery support with a screwdriver.



3.5.4 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.

3.6 Supplies and Tools for Maintenance

The table below lists the supplies and components to be replaced regularly.

List of Supplies and Components

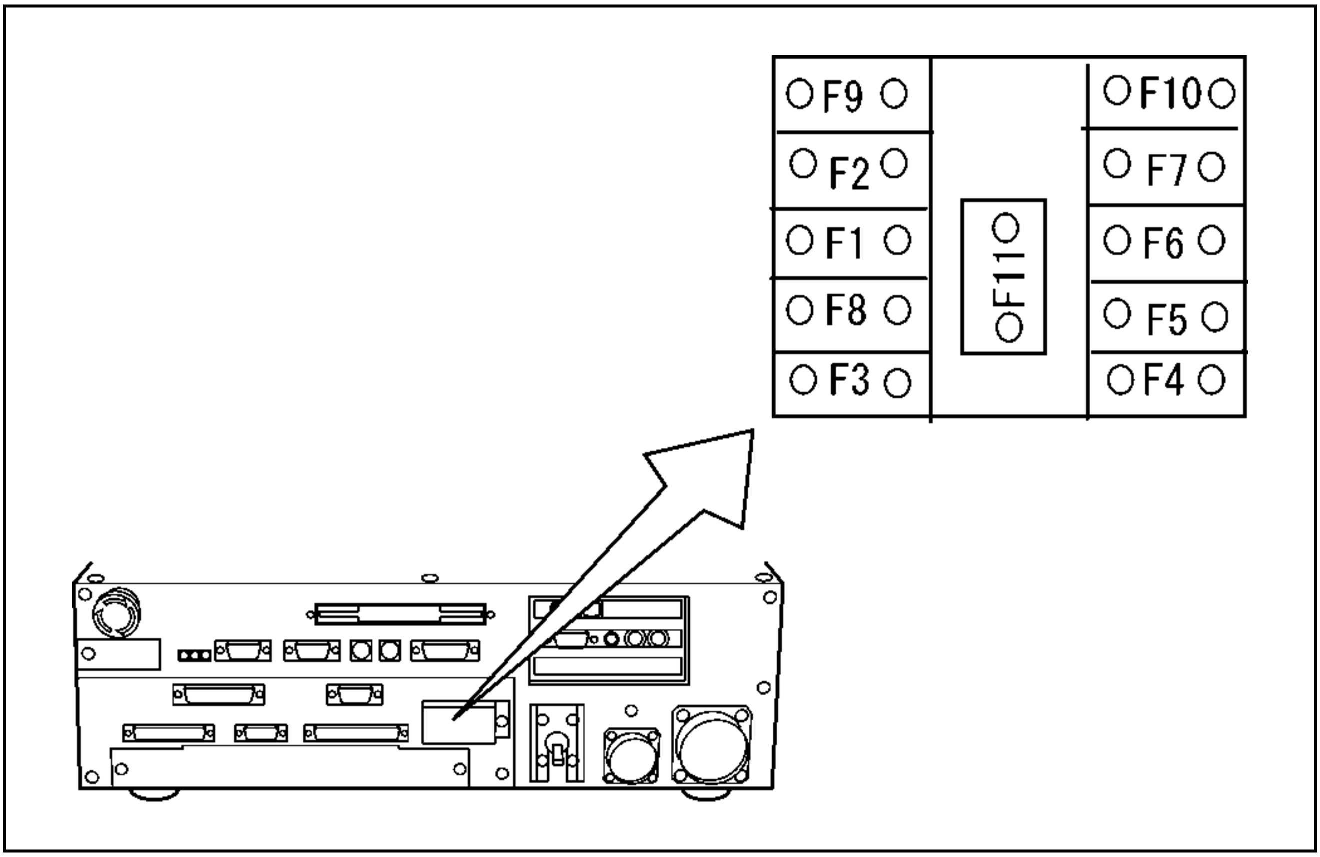
No	Name	Part No.	Remarks	
1	Grease	410971-0040	2.5 kg can	Epinoc AP-1
2	Grease	410971-0050	16 kg can	
3	Filter (left side)	410041-0760	Cooling fan filter (inlet port filter) in the robot controller	
4	Filter (for fan) (For HS-E)	410041-1220	Cooling fan filter (exhaust port filter) in the robot controller	
	Filter (for fan) (For HM-E)	410041-0750	Cooling fan filter (exhaust port filter) in the robot controller	
5	Memory backup unit	410076-0090	Memory backup battery for controller (with metal plate)	
6	Encoder battery kit	410679-0010	A set of two batteries (HS-E17500)	
7	Fuse (1.3A)	410054-0230	Fuse LM13 for controller I/O	
8	Fuse (0.3A)	410054-0240	Fuse LM03 for controller I/O	
9	IC for output (NPN)	410077-0010	IC (M54522P) for controller output	
10	IC for output (PNP)	410077-0020	IC (M54564P) for controller output	

3.7 Replacing Fuses

The robot controller is equipped with fuses to protect itself from overcurrent caused by short circuit of the external wiring.

If any fuse is blown, replace it according to the following procedure

The fuse box containing fuses is mounted on the panel of the robot controller. See the figure given below.



Positions and Names of Fuses

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

Fuses and Their Corresponding Output Connectors

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

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

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

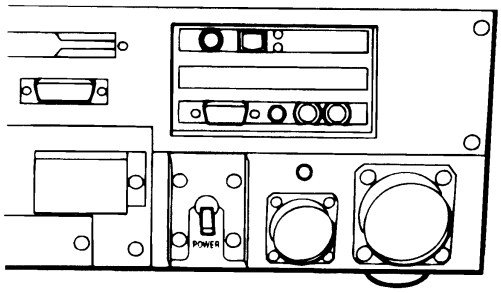
Note: For the connector pin layout, refer to the RC5 CONNECTOR INTERFACE MANUAL.

3.7.1 Replacing Fuses

Replace fuses according to the following procedure:

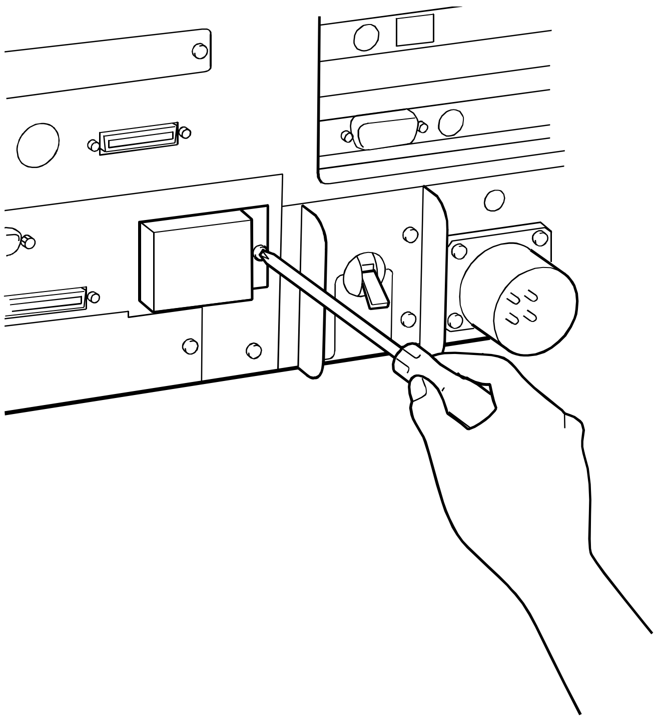
STEP 1

Turn the controller power OFF.



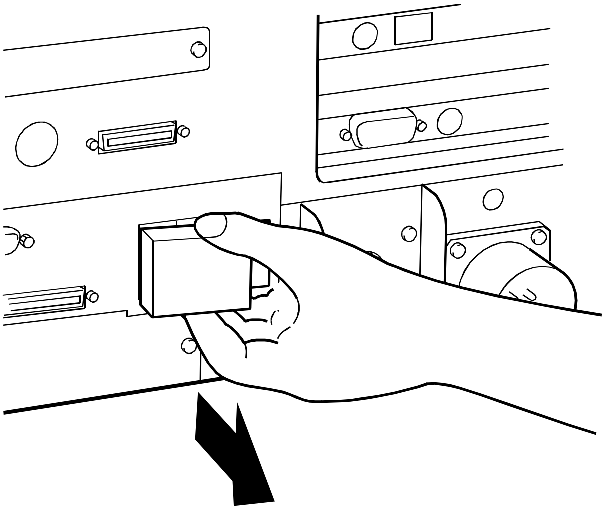
STEP 2

Remove the fuse cover mounting screw with a screwdriver.



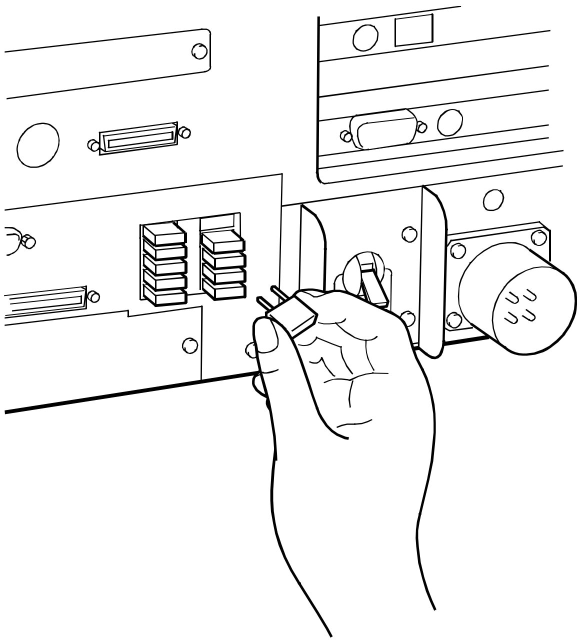
▸ STEP 3

Remove the fuse cover.



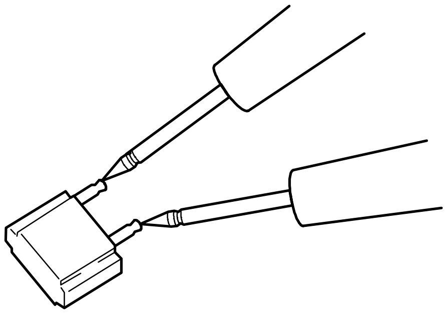
▸ STEP 4

Pull out the fuse to be checked.



STEP 5

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

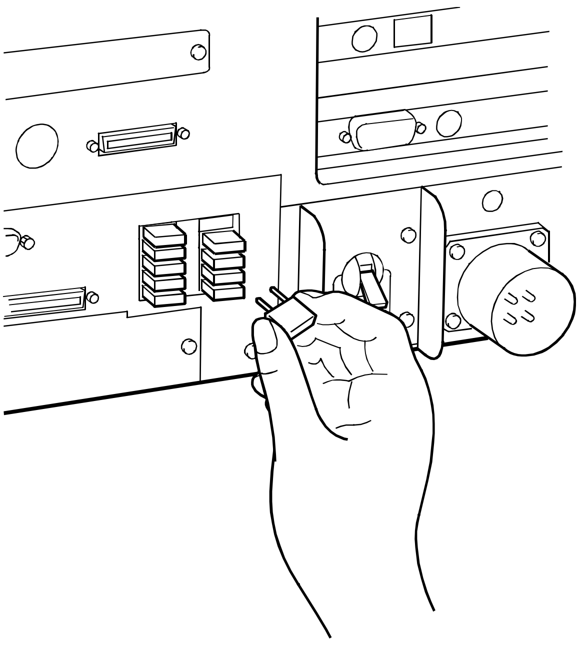


STEP 6

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

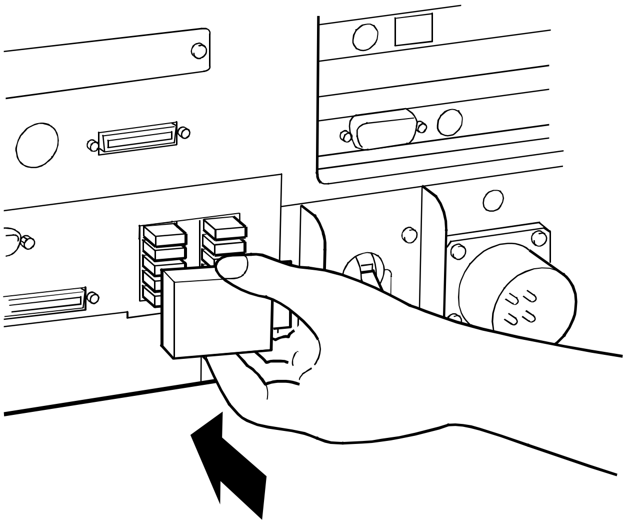
(1) Check the wiring of the related output connector and remove the cause of the blown fuse.
(2) Insert a new fuse into position in the fuse box.

If continuity is observed with the fuse in STEP 5:
Set the removed fuse back into the position in the fuse box.



STEP 7

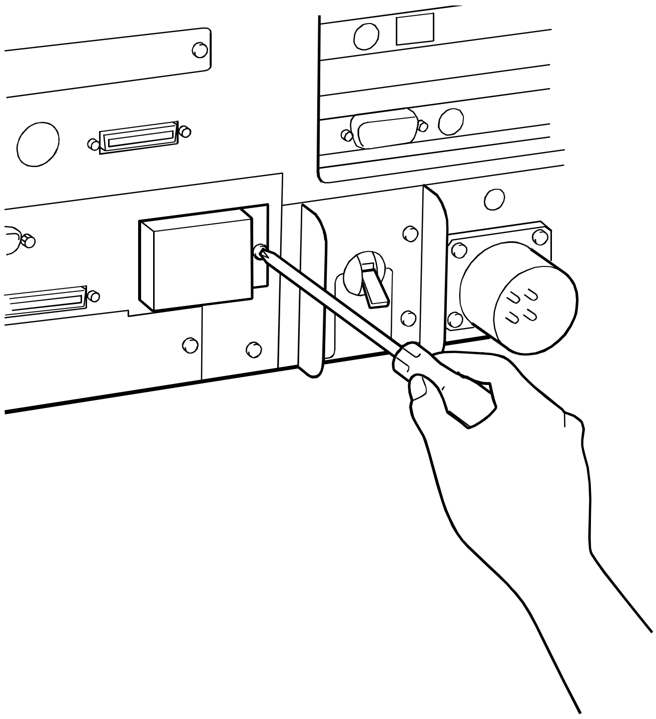
Set the fuse cover to the robot controller.



STEP 8

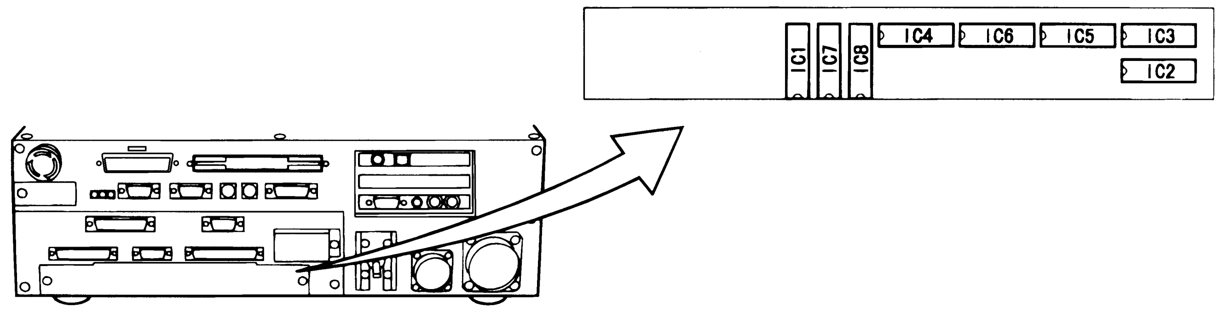
Secure the fuse cover with mounting screw by using a screwdriver.

Tightening torque: 0.6 ±0.2 N•m



3.8 Replacing the Output ICs

If an abnormal output signal does not recover its normal status, although the corresponding output fuse is replaced, the IC for output needs to be replaced. The ICs for output are contained in the panel of the robot controller, as shown below.



Positions and Names of ICs for Output

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

Table of Corresponding IC Numbers for Output and Fuses

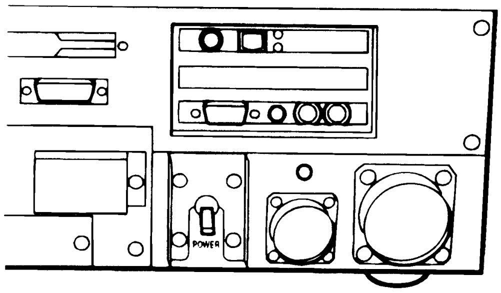
Connector No.	Connector terminal No.	I/O Port No.	Output IC No.	Fuse No.
HAND I/O CN9	1	64	IC 1	F4 (1.3A)
	2	65		
	3	66		
	4	67		
	5	68		
	6	69		
	7	70		
	8	71		
OUTPUT CN10	1	72	IC 2	
	2	73		
	3	74		
	4	75		
	5	76		
	6	77		
	7	78		
	8	79		
	9	80	IC 3	F5 (1.3A)
	10	81		
	11	82		
	12	83		
	13	84		
	14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

3.8.1 Replacing an Output IC

Replace an output IC according to the procedure given below:

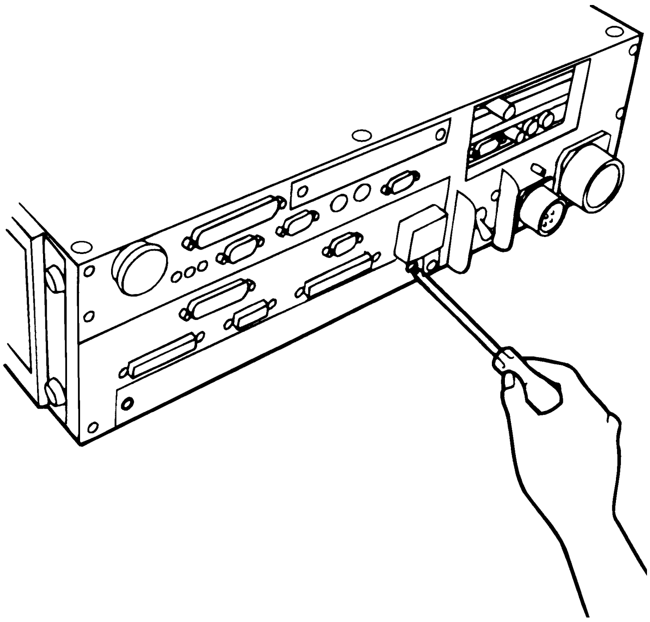
▶ STEP 1

Turn the controller power OFF.



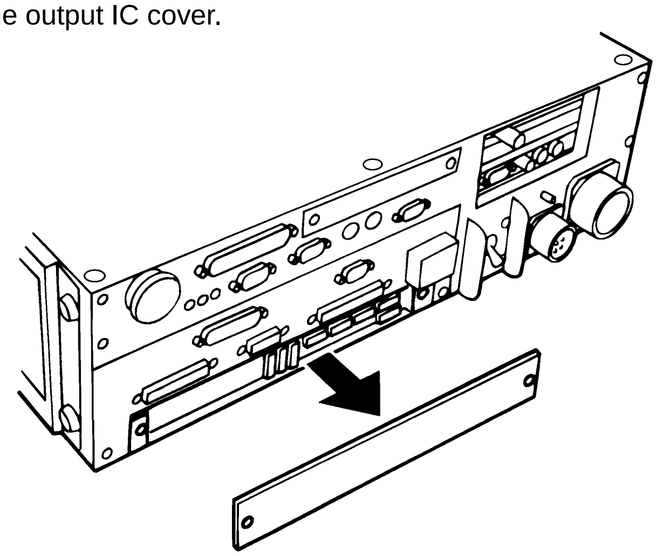
▶ STEP 2

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



▶ STEP 3

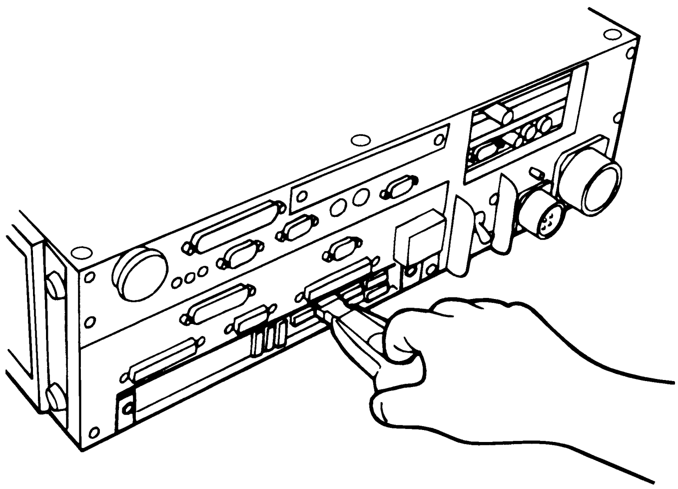
Remove the output IC cover.



▶ STEP 4

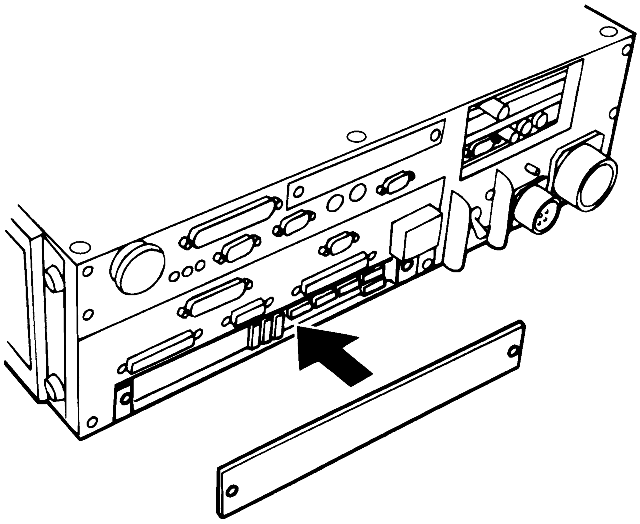
Check the ICs marked with "IC1” to “IC8” on the PC board, and remove the defective output IC with an IC pull-out jig and replace it.

> ⚠**Caution:** **(1) If any output IC is damaged, remove the cause of damage, and replace it with a new output IC.**
>
> **(2) Do not directly touch the elements and their terminals on each PC board.**



STEP 5

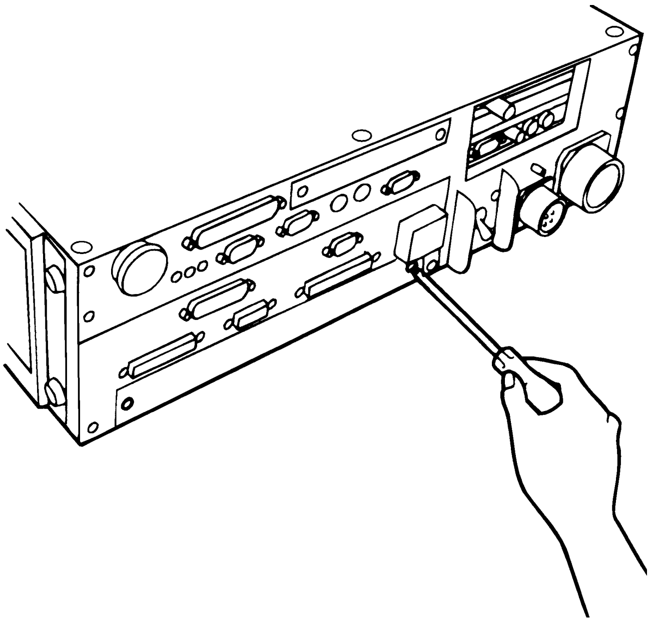
Attach the output IC cover to the robot controller.



STEP 6

Secure the output IC cover with the two mounting screws.

Tightening screws: 0.6 ±0.2 N•m



3.9 Checking the Odometer and Trip Meter

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

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.

3.9.1 Displaying the Odometer and Trip Meter

STEP 1

Turn the robot controller ON.

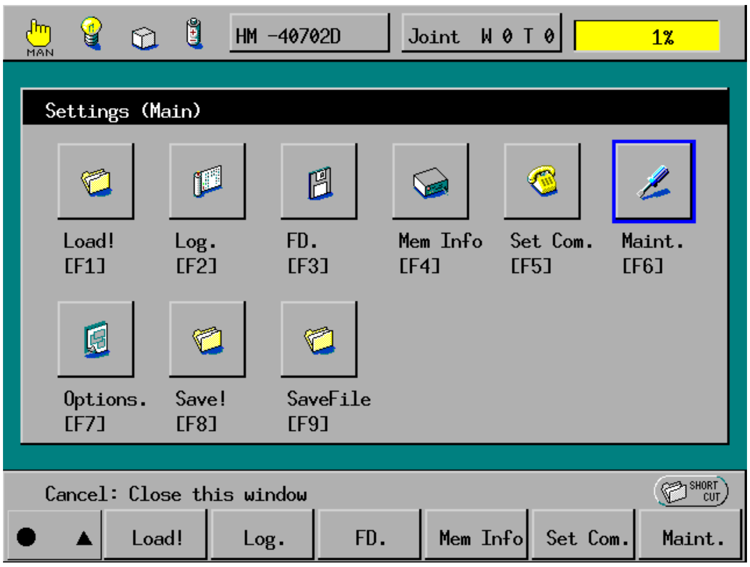
STEP 2

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.

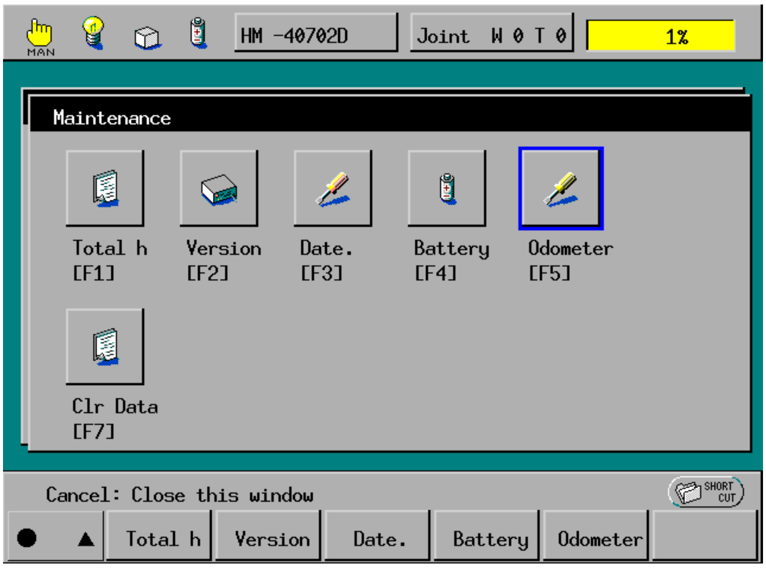


F6

Press [F6 Maint.].

▶ STEP 4

The Maintenance menu appears as shown below.

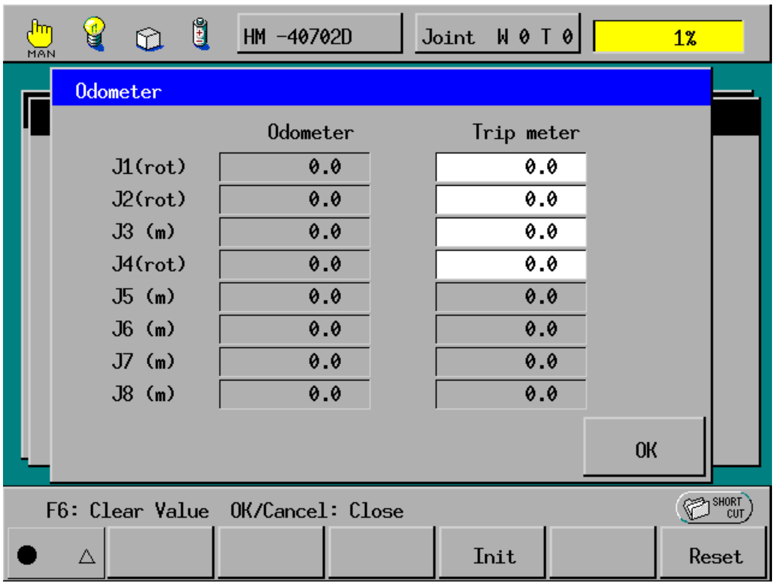


F5

Press [F5 Odometer].

▶ STEP 5

The Odometer window appears as shown below.



F6

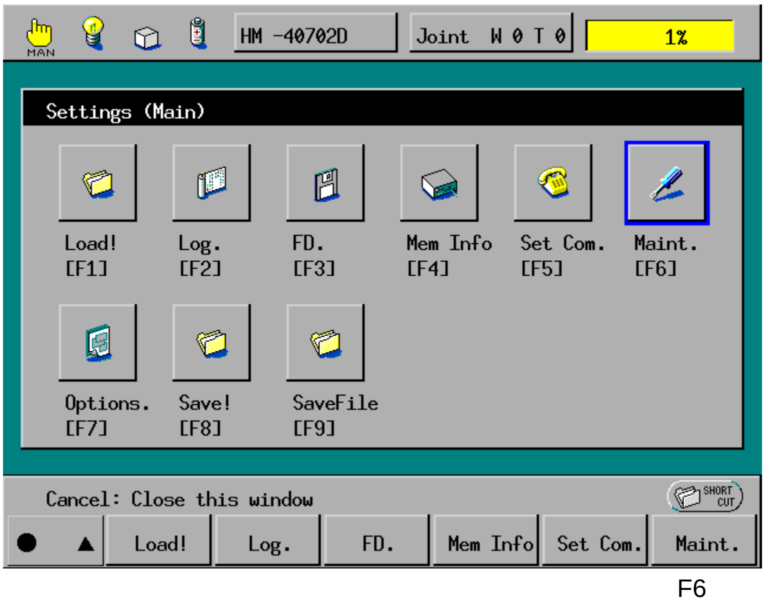
In the above Odometer window, the J1, J2 and J4 are expressed in number of revolutions and J3 in meter.

3.9.2 Resetting the Trip Meter to Zero

STEP 1

On the top screen, press [F6 Set].

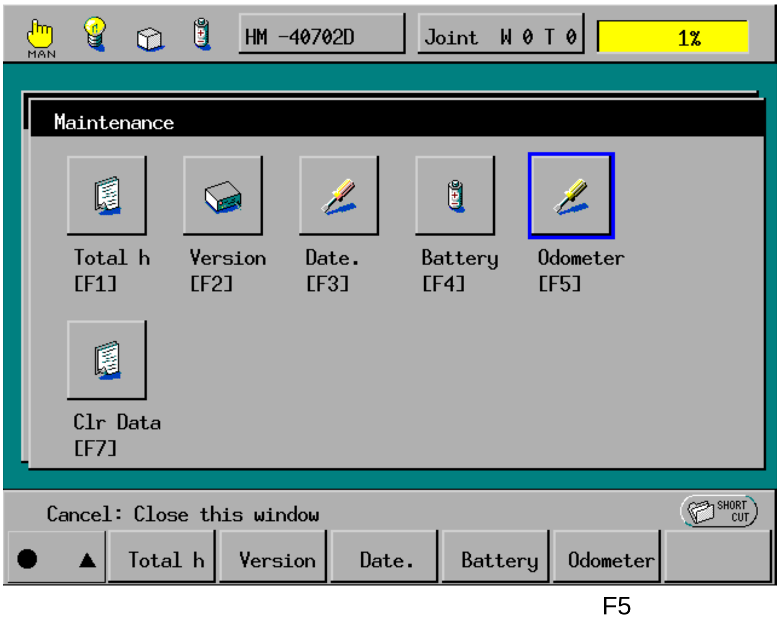
The Settings (Main) window appears as shown below.



Press [F6 Maint.].

STEP 2

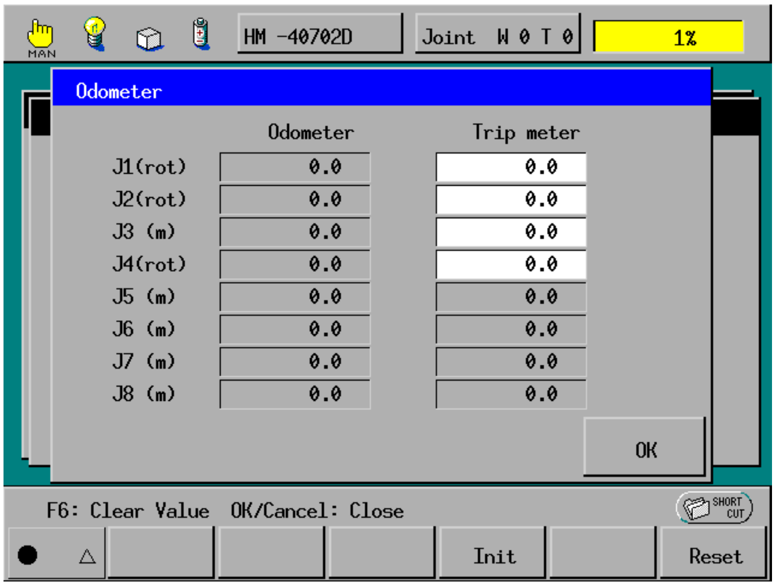
The Maintenance menu appears as shown below.



Press [F5 Odometer].

STEP 3

The Odometer window appears as shown below.

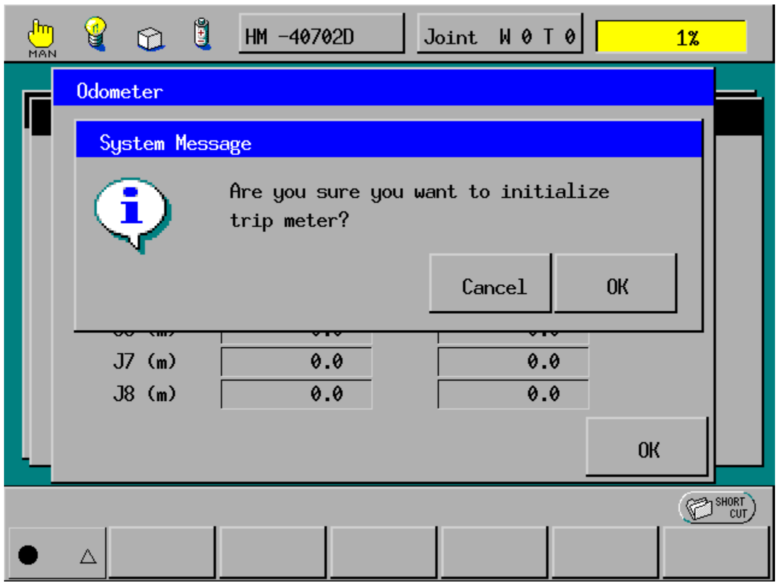


F6

Press [F6 Reset].

STEP 4

The following message appears.



Press the OK button.

The trip meter has been reset to zero.

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

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

The Total hours window shows the following items:

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

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

STEP 1

Turn the robot controller power ON.

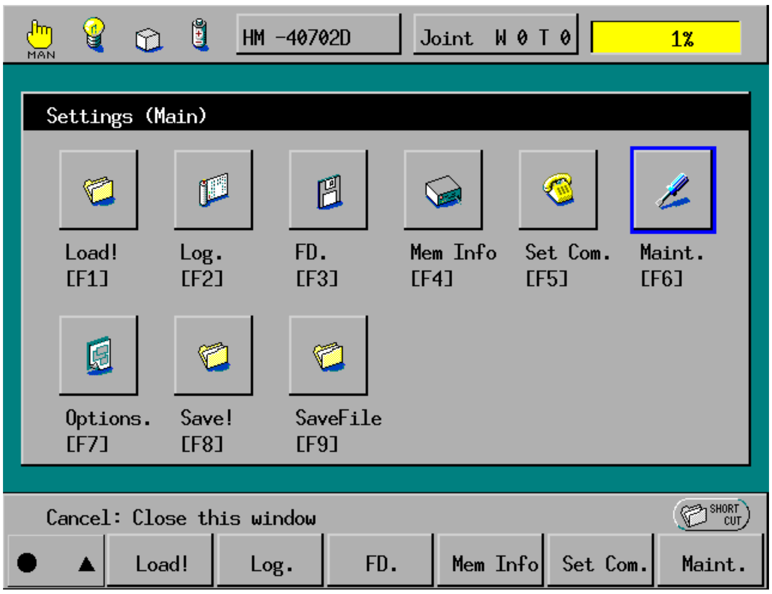
STEP 2

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

STEP 3

On the top screen, press [F6 Set].

The Settings (Main) window appears as shown below.

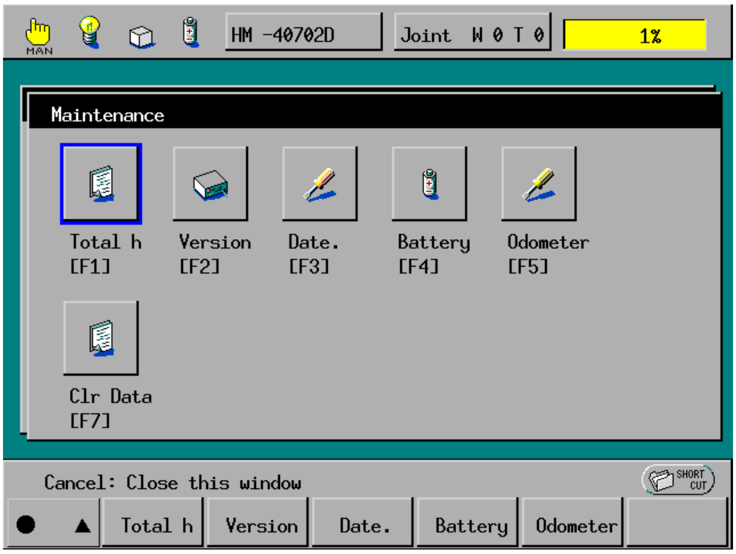


F6

Press [F6 Maint.].

▶ STEP 4

The Maintenance menu appears as shown below.

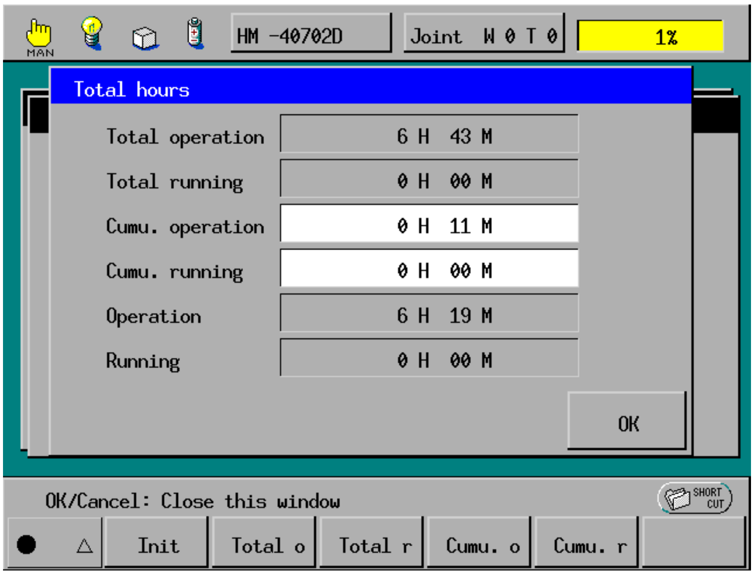


F1

Press [F1 Total h].

▶ STEP 5

The Total hours window appears as shown below.

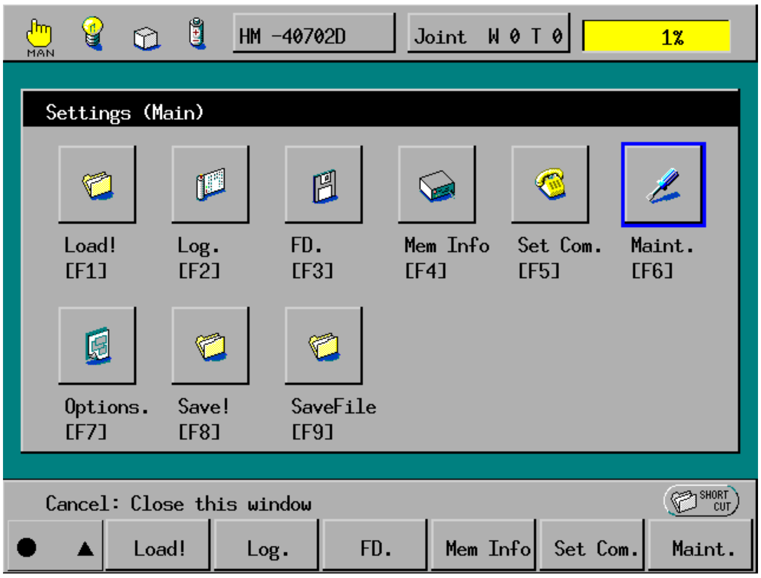


3.10.2 Resetting the User Counters of the Controller ON-Time and the Robot Running Time

STEP 1

On the teach pendant, press [F6 Set].

The Settings (Main) window appears as shown below.

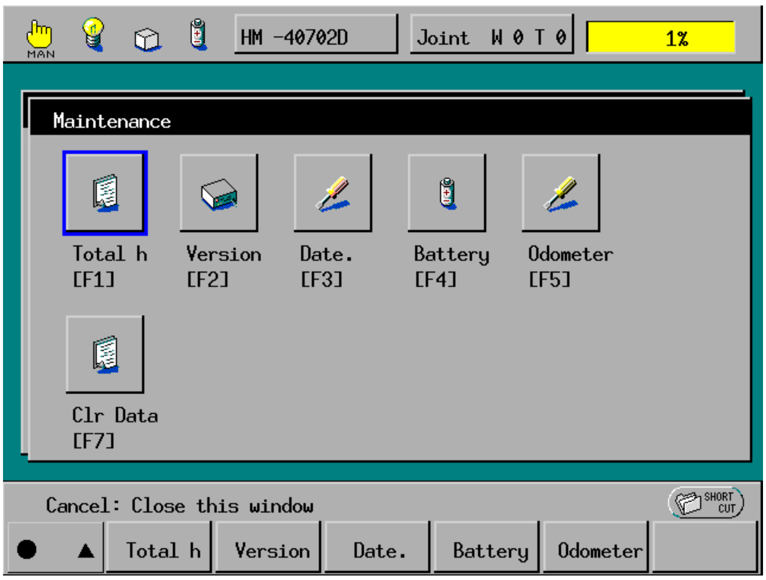


F6

Press [F6 Maint.].

STEP 2

The Maintenance menu appears as shown below.

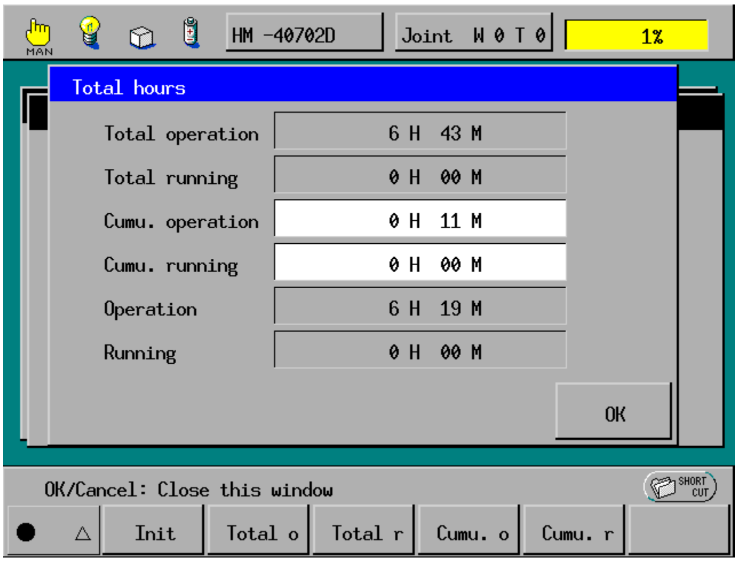


F1

Press [F1 Total h].

▶ STEP 3

The Total hours window appears as shown below.

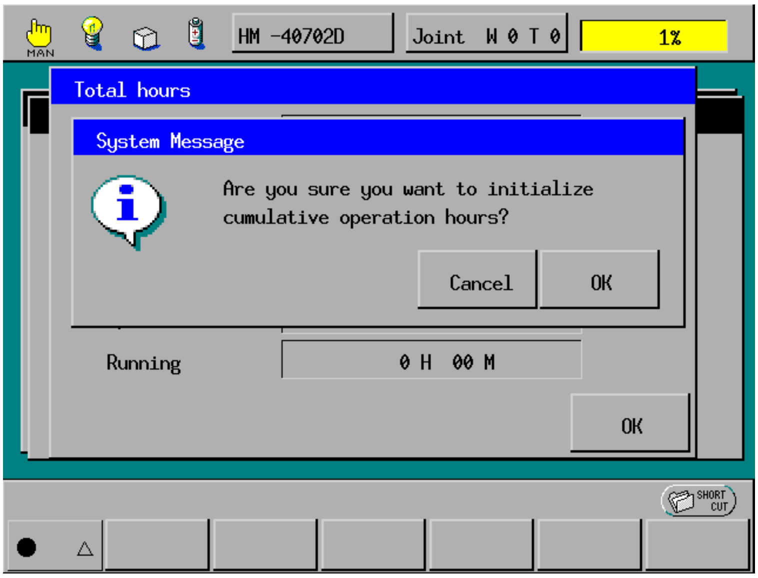


F4

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

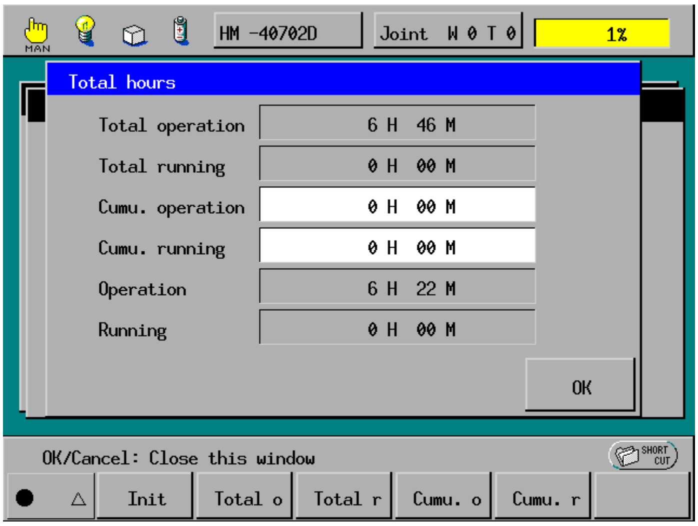
▶ STEP 4

The following system message appears.



Press the OK button.

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



3.11 Using the Initialization Floppy Disk

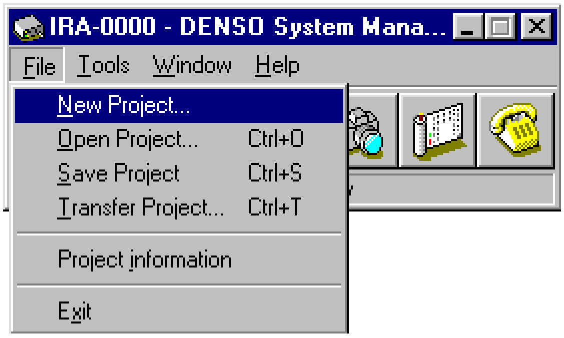
The initialization floppy disk (*.arm) stores arm data in WINCAPSII format.
You transfer the stored arm data to the robot controller in these two steps:
(1) Create a project by using the data stored in the floppy disk.
(2) Transfer the trajectory generation file in the project to the robot controller.

Creating a project to be transferred

STEP 1

Create a new project.

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

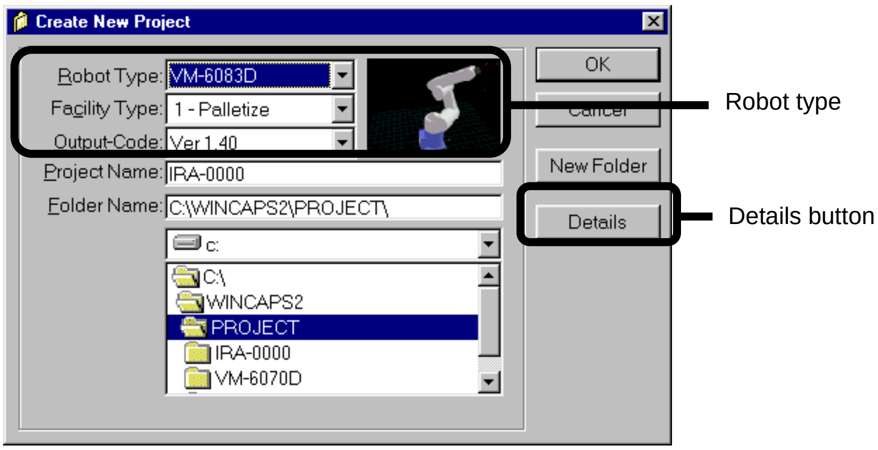


[File menu: Creating a new project]

STEP 2

Select your robot type.

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

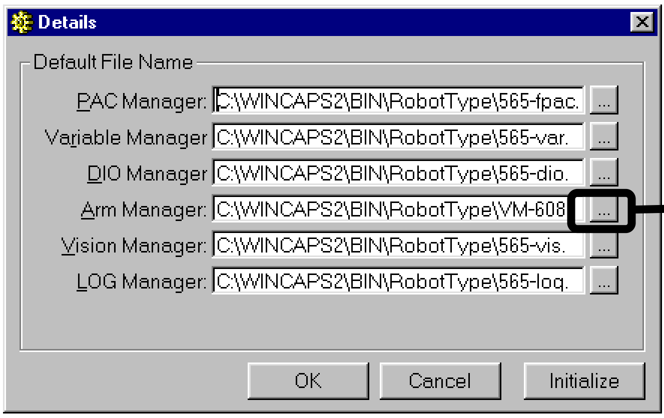


[Create New Project window]

▸ STEP 3

Select arm data.

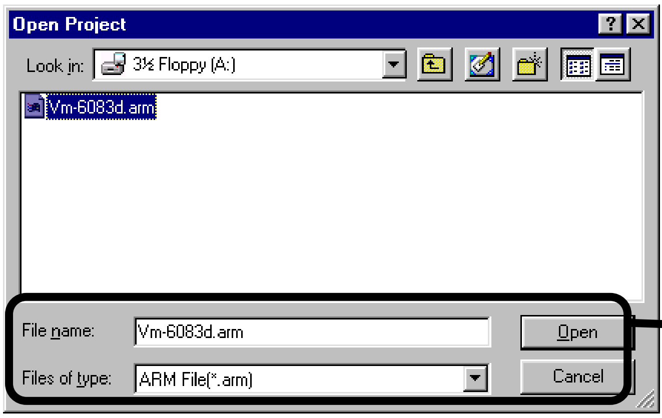
(1) Press the Details button to call up the window below.



[Details window]

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

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



[Selecting a file]

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

▸ STEP 4

Create a project.

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

Transferring the trajectory generation file

▶ STEP 1

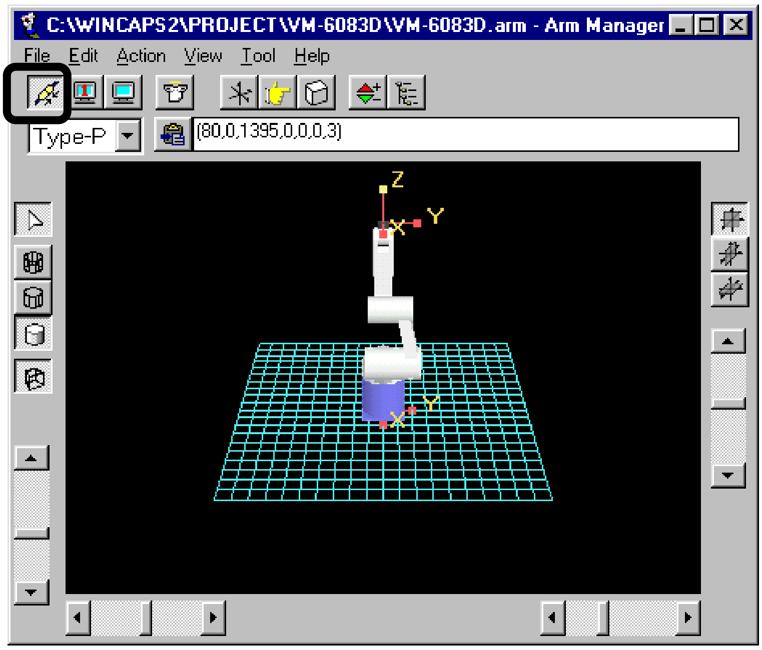
Start of Arm Manager

From System Manager, run Arm Manager.

▶ STEP 2

Connection with the robot controller

Press the Connect button to connect with the robot controller.

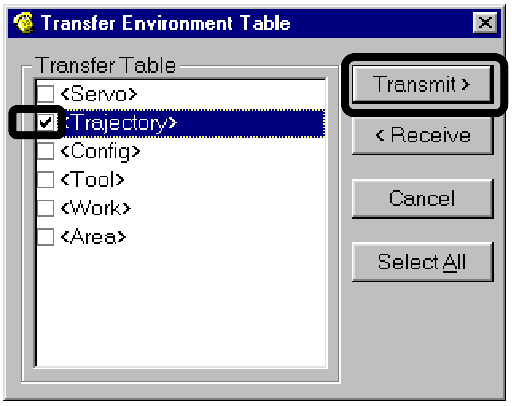


[Arm Manager window]

▶ STEP 3

Data transmission

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

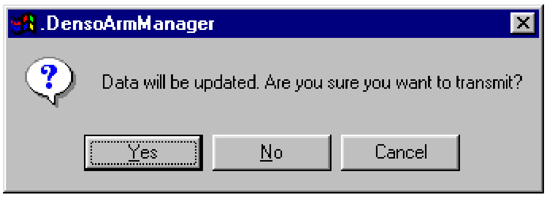


[Transfer Environment Table]

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

(3) The following message appears.

Press Yes.



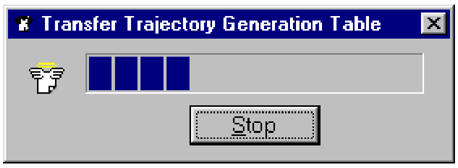
[Confirmation dialog]

The following message appears.

Press OK.

[Configuration transfer dialog]

During data transfer, the following dialog is displayed.



[Transfer Trajectory Generation Table]

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

Press OK.

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

Turn the controller power off and then on.

[Transfer completion message]

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First Edition	February 2002
Second Edition	May 2002
Third Edition	July 2002
Fourth Edition	September 2002
Fifth Edition	November 2002
Sixth Edition	May 2003
Seventh Edition	March 2004

DENSO WAVE INCORPORATED
Factory Automation Division

3F20C

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.