# *DENSO* ROBOT

**Vertical articulated**

## VM-D SERIES

# GENERAL INFORMATION ABOUT ROBOT

# Preface

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

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

### Robot series and/or models covered by this manual

| Series | Model | | Remarks (Max. reach nickname) |
|---|---|---|---|
| | Floor-mount | Overhead-mount | |
| VM-D (Medium-sized, vertical articulated) | VM-6070D<br>VM-6083D<br>VM-60B1D | Same as left.<br>Same as left.<br>Same as left. | (VM900)<br>(VM1000)<br>(VM1300) |

**NOTE 1:** Model names listed above apply to the models of robot systems. The model names of robot units are followed by M. If the robot system model is VM-6083D, for example, the robot unit model is VM-6083DM.

### Important

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

Instructions on how to use the Manual Pack CD are given in Appendix.

# 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 - this book -**

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

**INSTALLATION & MAINTENANCE GUIDE**

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 five, and appendix.

**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 Packing List of the Robot**
Lists the standard components contained in the product package and optional components.

**Chapter 2 Configuration of the Robot System**
Illustrates the configuration of the robot system and describes the component names of the robot unit and controller.

**Chapter 3 Specifications of the Robot Unit**
Describes the specifications, motion space, robot positioning time, air piping and signal wiring, and engineering-design notes for robot hands.

**Chapter 4 Specifications of the Robot Controller**
Lists the specifications of the robot controller and controller setting table (SETPRM LIST).

**Chapter 5 Warranty**
Describes the warranty period and coverage.

**Appendix How to Use the Manual Pack CD**

# 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.

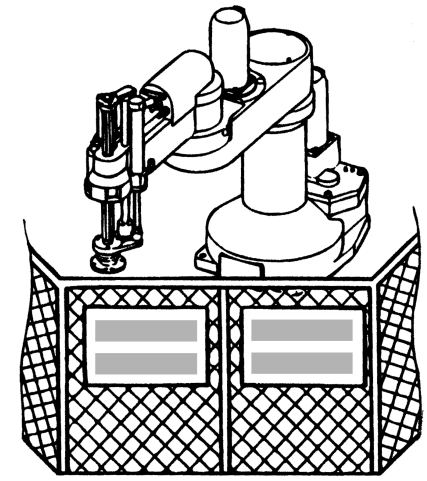
(2) Emergency stop switches should be designed so that they will not be released after pressed, automatically or mistakenly by any other person.

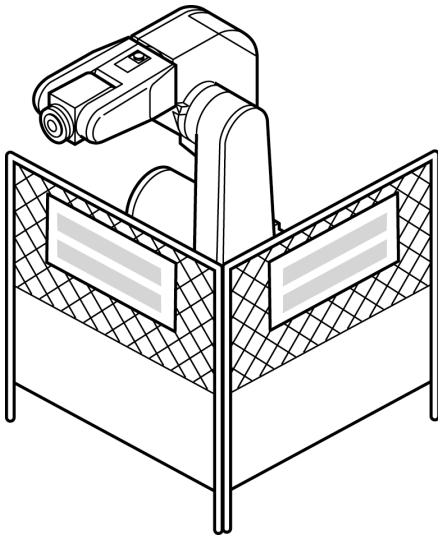
(3) Emergency stop switches should be separate from the power switch.

## 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

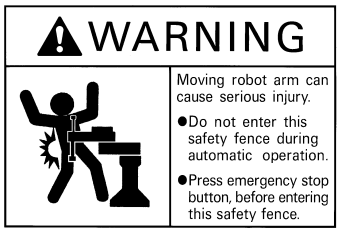
Sufficient illumination should be assured for safe robot operation.

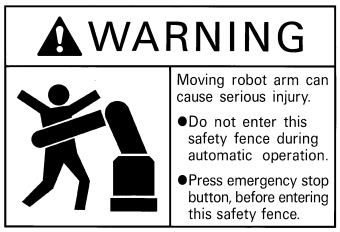
## 2.14 Protection from objects thrown by the end-effector

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.

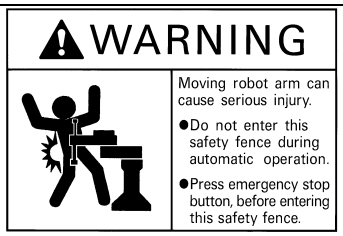


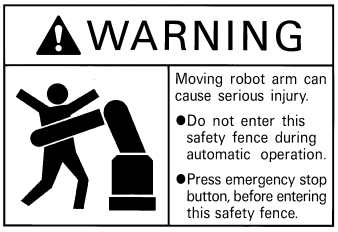



# 3. Precautions while robot is running

**⚠ 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.

# Contents

# Chapter 1 Packing List of the Robot

## 1.1 Standard Components

The components listed below are contained in the product package.

**Standard Components**

| No. | Item | Q'ty |
|---|---|---|
| (1) | Robot unit | 1 |
| (2) | Robot controller | 1 |
| (3) | Power cable (5 m) **(Note 1)** | 1 |
| (4) | Motor & encoder cable **(Note 2)** (Option) | 1 |
| (5) | Manuals | 1 set |
| (6) | NetwoRC CD (containing WINCAPSII beta version) | 1 |
| (7) | Spare fuses for robot controller | 3 |
| (8) | Initialization floppy disk (1.44 MB format) **(Note 3)** | 1 |
| (9) | Pendantless connector (Dummy connector) | 1 |
| (10) | Connector set for hand control signals (for CN20 and CN21) | 1 set |
| (11) | Power connector for I/O | 1 |
| (12) | Direction indicator label **(Note 4)** | 1 |
| (13) | Warning label **(Note 5)** | 1 |
| (14) | Spare output IC for robot controller | 1 |

**Note 1:** Not only the standard power cable but also the UL-compliant one is available. The CE-compliant one consists of a power connector only.

**Note 2:** Choose and order a motor & encoder cable from the table below. The internal cable bending radius shall at least be 200 mm. Excessively bending will result in broken lead wires.

| No. | Motor & encoder cable | | Part No. |
|---|---|---|---|
| (1) | Standard cable | 4 m | 410141-1551 |
| (2) | Standard cable | 6 m | 410141-1561 |
| (3) | Splash-proof cable | 4 m | 410141-1571 |
| (4) | Splash-proof cable | 6 m | 410141-1581 |
| (5) | High-strength cable | 6 m | 410141-1591 |
| (6) | High-strength cable | 12 m | 410141-1601 |
| (7) | Splash-proof & high-strength cable | 6 m | 410141-1611 |
| (8) | Splash-proof & high-strength cable | 12 m | 410141-1621 |

**Note 3:** Preserve the initialization floppy disk in a safe place. The disk contains arm data in WINCAPSII format. If a memory error appears on the teach pendant due to a memory failure, use the disk to load the arm data to the robot controller. (Refer to the INSTALLATION & MAINTENANCE GUIDE, "Using the Initialization Floppy Disk.")

**Note 4:** After installation, attach the direction indicator label in a position on the robot unit that can be easily seen.

**Note 5:** Attach the warning label on the robot safety fence or other location where workers will easily notice it. If necessary, prepare a plate for attaching the seal.

# 1.2 Optional Components

The table below lists the optional components.

**Optional Components (1)**

| Classification | No. | Item | Remarks | Part No. |
|---|---|---|---|---|
| I/O cables | 1 | I/O cable set | (8 m) (Consists of Nos.1-1 to 1-3, one each) | 410149-0330 |
| | 1-1 | Input cable | (8 m) | 410141-1630 |
| | 1-2 | Output cable | (8 m) | 410141-1650 |
| | 1-3 | Hand I/O cable | (8 m) | 410141-1740 |
| | 2 | I/O cable set (Only hand I/O cable is a high-strength type.) | (8 m) (Consists of Nos.2-1 to 2-3, one each) | 410149-0350 |
| | 2-1 | Input cable | (8 m) | 410141-1630 |
| | 2-2 | Output cable | (8 m) | 410141-1650 |
| | 2-3 | Hand I/O cable (high-strength) | (8 m) | 410141-1670 |
| | 3 | I/O cable set | (15 m) (Consists of Nos.3-1 to 3-3, one each) | 410149-0340 |
| | 3-1 | Input cable | (15 m) | 410141-1640 |
| | 3-2 | Output cable | (15 m) | 410141-1660 |
| | 3-3 | Hand I/O cable | (15 m) | 410141-1750 |
| | 4 | I/O cable set (Only the hand I/O cable is a high-strength type.) | (15 m) (Consists of Nos.4-1 to 4-3, one each) | 410149-0360 |
| | 4-1 | Input cable | (15 m) | 410141-1640 |
| | 4-2 | Output cable | (15 m) | 410141-1660 |
| | 4-3 | Hand I/O cable (high-strength) | (15 m) | 410141-1680 |
| Operation devices | 5 | Operating panel **(Note 1)** | (4 m) | 410100-0970 |
| | 6 | Operating panel **(Note 1)** | (8 m) | 410100-0980 |
| | 7 | Teach pendant **(Note 1)** | (4 m) | 410100-0940 |
| | 8 | Teach pendant **(Note 1)** | (8 m) | 410100-0950 |
| | 9 | Teach pendant **(Note 1)** | (12 m) | 410100-0960 |
| | 10 | Mini-pendant (Version 1.7 or later) (Incl. WINCAPSII Light) | (4 m) | 410109-0020 |
| | 11 | Mini-pendant (Version 1.7 or later) (Incl. WINCAPSII Light) | (8 m) | 410109-0040 |
| | 12 | Mini-pendant (Version 1.7 or later) (Incl. WINCAPSII Light) | (12 m) | 410109-0060 |
| | 13 | Pendant extension cable **(Note 2)** | (4 m) For TP/MP/OP | 410141-2390 |
| | 14 | Pendant extension cable **(Note 2)** | (8 m) For TP/MP/OP | 410141-2400 |

**Note1:** The total cable length must not be more than 12 m when the operating panel and the teach pendant are to be connected in series.

Note 2: The total cable length must not be more than 12 m when the pendant extension cable is connected to the TP, MP or OP. Do not connect two or more pendant extension cables to the TP, MP or OP.

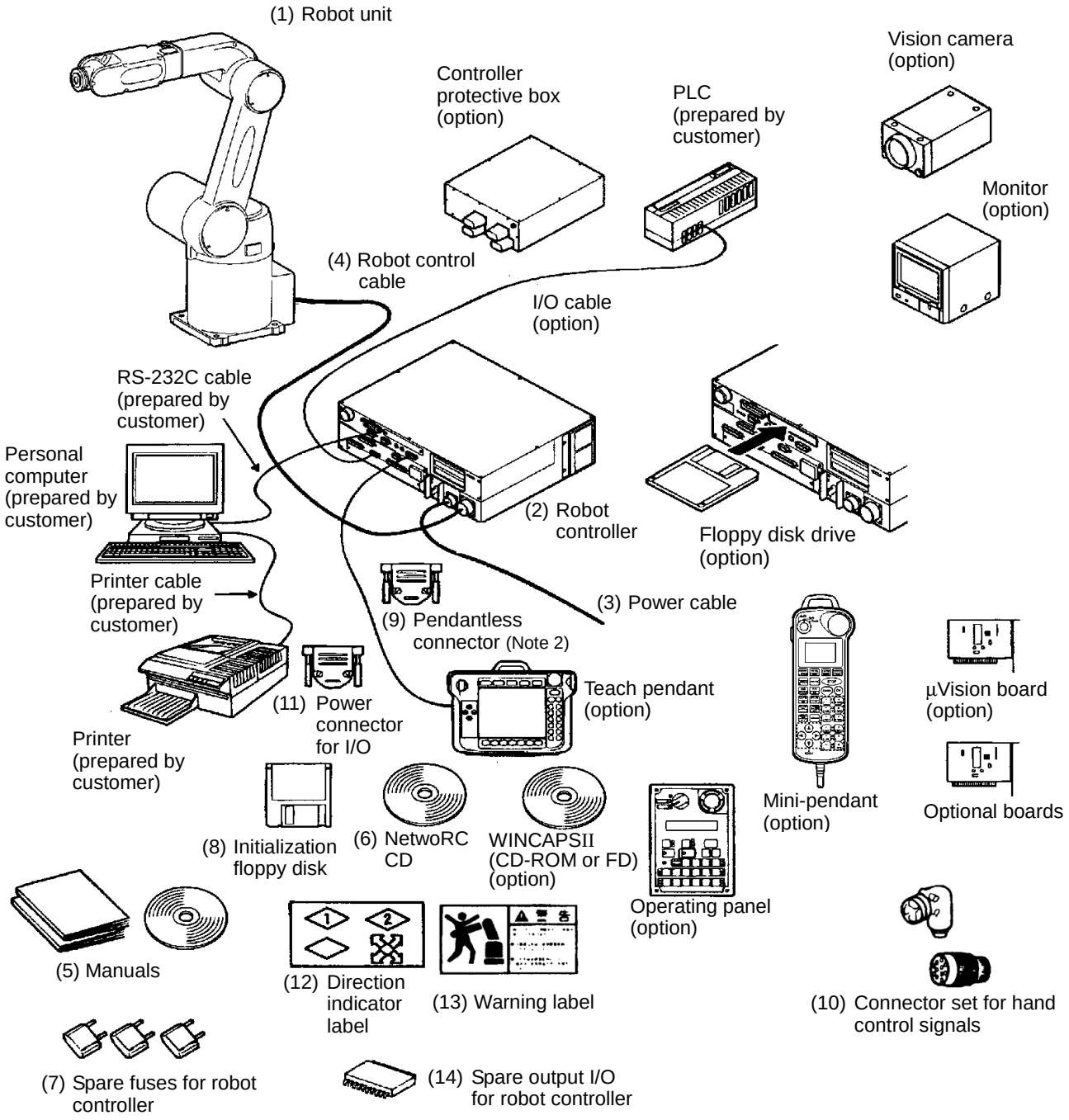
**Optional Components (2)**

| Classification | No. | Item | Remarks | Part No. |
|---|---|---|---|---|
| PC teaching software | 15 | WINCAPSII | (in CD-ROM) | 410090-0860 |
| | 16 | WINCAPSII | (in floppy disk) | 410090-0870 |
| Visual equipment | 17 | μVision (built-in visual) board | (NTSC) | 410010-2070 |
| | 18 | μvision (built-in visual) board (for Europe) | (PAL) | 410010-2080 |
| | 19 | Camera | | 463980-0030 |
| | 20 | Monitor | | 463980-0021 |
| | 21 | Camera cable | (3 m) | 463981-0110 |
| | 22 | Camera cable | (5 m) | 463981-0120 |
| | 23 | Camera cable | (15 m) | 463981-0160 |
| | 24 | Monitor cable | (BNC) (1 m) | 463981-0010 |
| | 25 | Monitor cable | (BNC) (3 m) | 463981-0030 |
| | 26 | Monitor cable | (BNC) (5 m) | 463981-0050 |
| Optional boards for the robot controller | 27 | Ethernet board | For models except VM-6070D | 410010-0710 |
| | | | For VM-6070D | 410010-0460 |
| | 28 | Built-in floppy disk drive | (for 1.44 MB floppy disk) | 410010-0520 |
| | 29 | DeviceNet slave board | (Slave station) For models except VM-6070D | 410010-0720 |
| | | | (Slave station) For VM-6070D | 410010-0450 |
| | 30 | DeviceNet master board | (Master station) Not applicable to the VM-6070D | 410010-0740 |
| | 31 | PROFIBUS slave board | (Slave station) | 410010-1190 |
| Controller-related components | 32 | Controller protection box | (FB-9) | 410181-0030 |
| | 33 | I/O connector set for RC5 | For parallel I/O | 410159-0070 |
| | 34 | Transformer box (destined for Europe) | From 400VAC 3-phase to 200VAC 3-phase | 410000-7130 |
| Manuals (Printed materials) | 35 | VM-D GENERAL INFORMATION ABOUT ROBOT | | 410002-2100 |
| | 36 | VM-D INSTALLATION & MAINTENANCE GUIDE | | 410002-2110 |
| | 37 | RC5 CONTROLLER INTERFACE MANUAL | (Common to all robot series) | 410002-2040 |
| | 38 | OPTIONS MANUAL | (Common to all robot series) | 410002-2070 |
| | 39 | BEGINNER'S GUIDE | | 410002-1540 |
| | 40 | SETTING-UP MANUAL | (Common to all robot series) | 410002-1320 |
| | 41 | PROGRAMMER'S MANUAL (I) | (Common to all robot series) | 410002-2050 |
| | 42 | PROGRAMMER'S MANUAL (II) | (Common to all robot series) | 410002-2060 |
| | 43 | ERROR CODE TABLES | (Common to all robot series) | 410002-1430 |
| | 44 | WINCAPS II GUIDE | (Common to all robot series) | 410002-0930 |

# Chapter 2 Configuration of the Robot System

## 2.1 Configurators

The figure below shows configurators of the typical robot system.




Note 1: Items (1) to (14) are the standard components listed on page 1.

Note 2: The pendantless connector is attached to the robot controller connector when no teach pendant is connected.

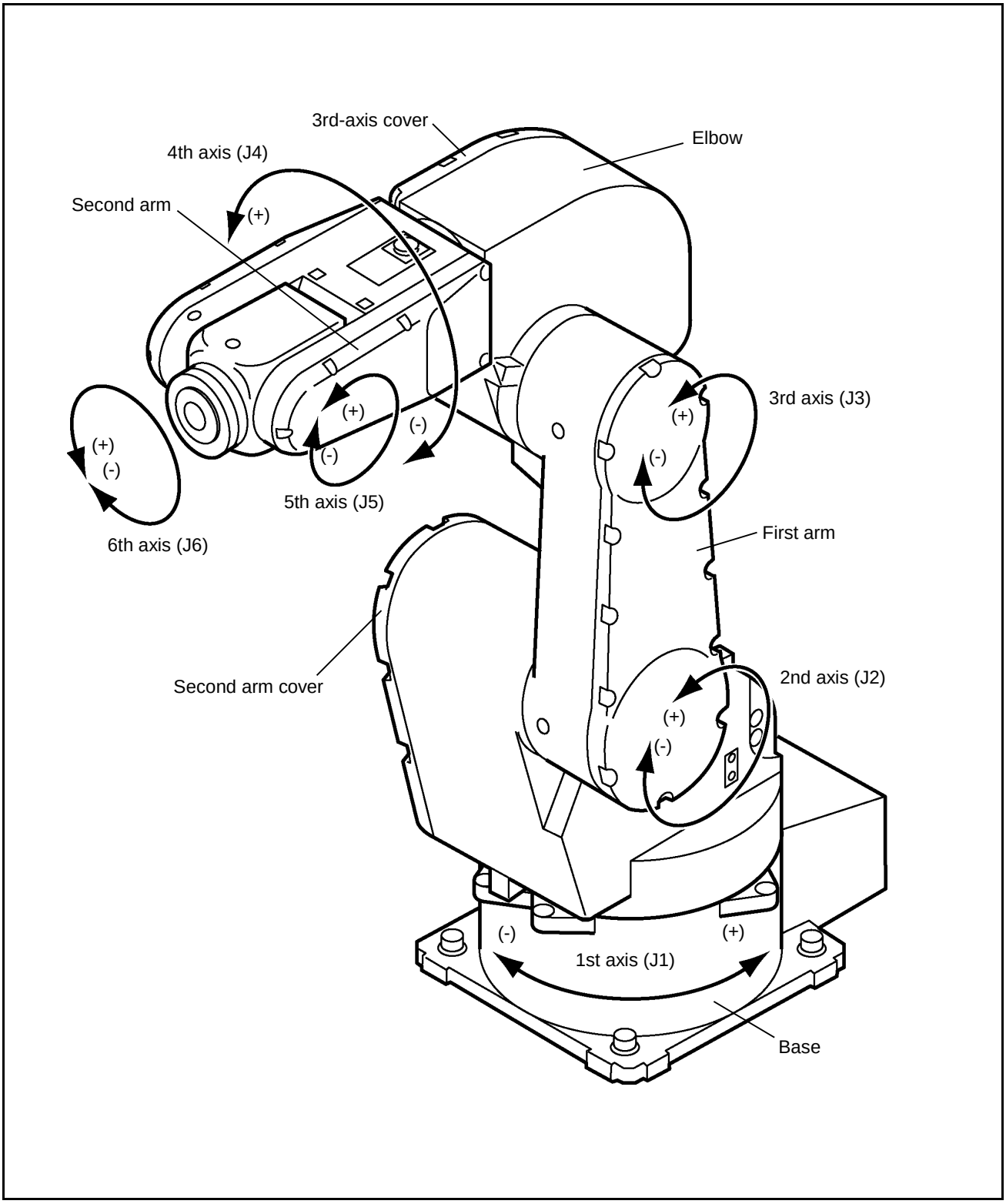
Note 3: The components illustrated above are typical models or parts.

**Configurators of the Robot System**

# 2.2 Names of Robot Unit Components

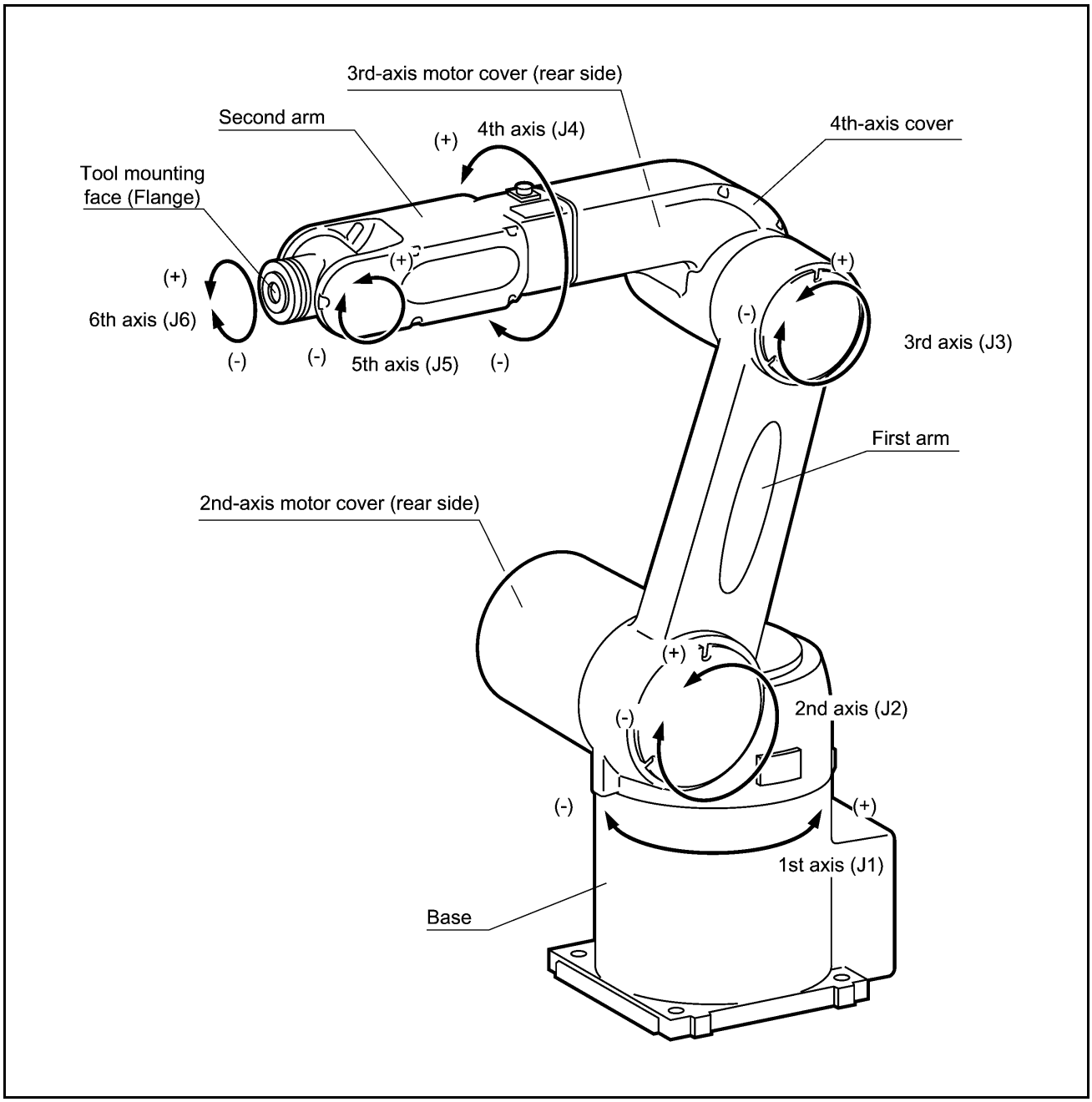
Following figures show the names of the components of the robot unit and the rotation direction of each axis.

**[VM-6070D]**




**Names of Components [VM-6070D]**

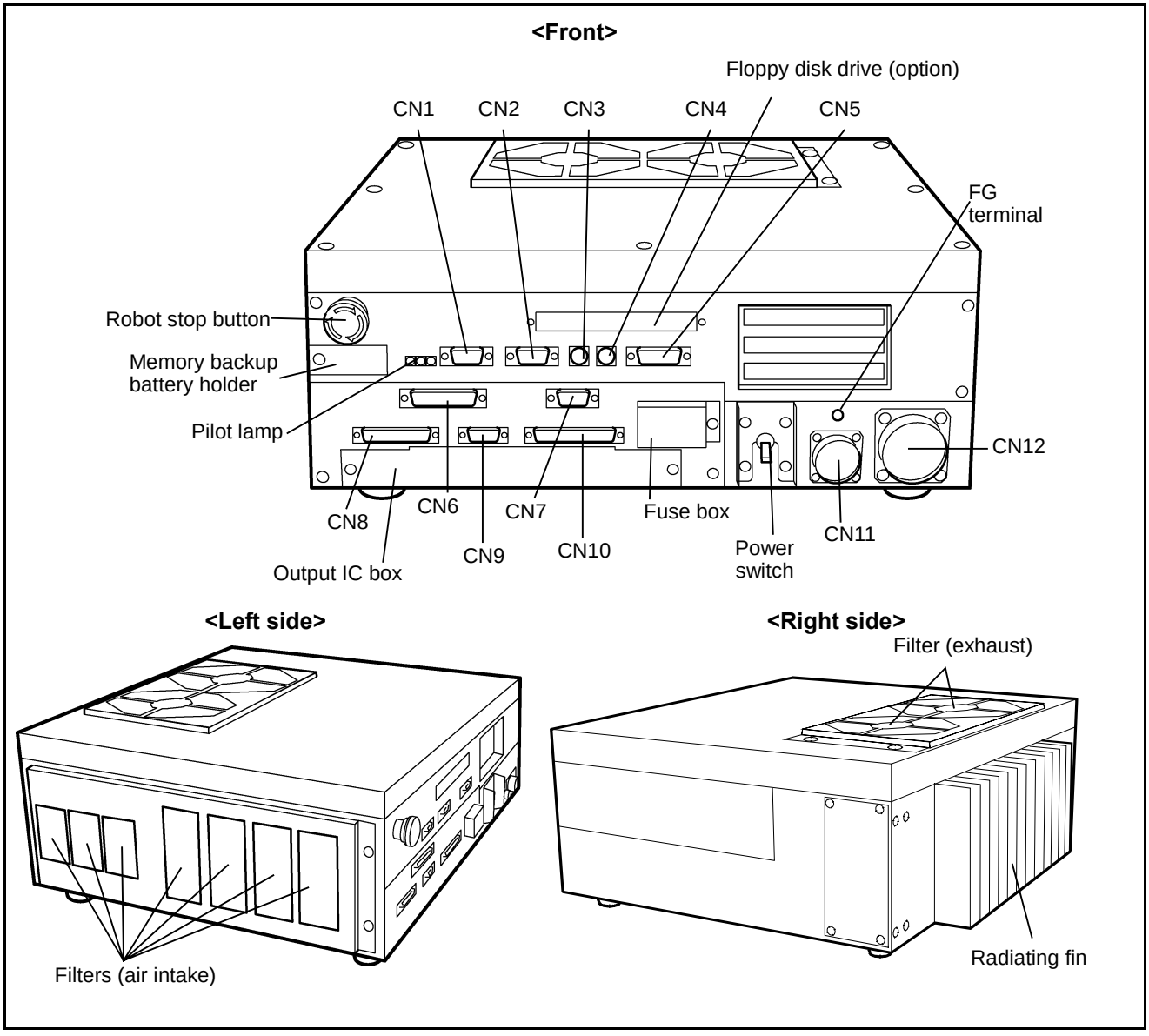
**[VM-6083D/VM-60B1D]**




**Names of Components [VM-6083D/VM-60B1D]**

# 2.3 Names of the Robot Controller Components

Following figure and table 1-4 show the names of the robot controller components.




**Names of Robot Controller Components (VM-D series)**

**Connector Names (VM-D/VS-E series)**

| Connector No. | Marking | Name | Connector No. | Marking | Name |
|---|---|---|---|---|---|
| CN1 | RS232C | Serial interface connector | CN7 | I/O POWER | Power connector for I/O |
| CN2 | CRT | CRT connector | CN8 | INPUT | Connector for user input or system input |
| CN3 | KEYBD | Keyboard connector | CN9 | HAND I/O | Connector for end-effector I/O |
| CN4 | MOUSE | Connector for PS/2 mouse | CN10 | OUTPUT | Connector for user output or system output |
| CN5 | PENDANT | Connector for teach pendant | CN11 | INPUT AC | Power connector |
| CN6 | PRINTER | Printer connector (Not used.) | CN12 | MOTOR | Connector for motor/encoder |

**⚠Caution: The robot controller connectors are of a screw-lock type or ring-lock type. Lock the connectors securely. If even one of the connectors is not locked, weak contact may result thereby causing an error.**

**Be sure to turn the robot controller OFF before connecting/ disconnecting the power connector or motor connector. Otherwise, the internal circuits of the robot controller may be damaged.**

# Chapter 3 Specifications of the Robot Unit

## 3.1 Robot Specifications

### [ 1 ] Robot Unit Specifications

Following table list the robot unit specifications of the VM-D series.

#### (1) VM-6070D (Nickname: VM900)

**VM-6070D Specifications**

| Item | | Specifications | |
|---|---|---|---|
| | | **Standard type (VM)** | **Dust-proof & splash-proof type (VM-W)** |
| Model name of robot set **(Note 1)** | | VM-6070D | VM-6070D-W |
| Model name of robot unit | | VM-6070DM | VM-6070DM-W |
| Overall arm length | | 350 (first arm) + 350 (second arm) = 700 mm | |
| Arm offset | | J1 (swing): 150 mm, J3 (front arm): 135 mm | |
| Maximum workable space | | R = 965 mm (end-effector mounting face)<br>R = 875 mm (Point P: J4, J5, J6 center) | |
| Motion range | | J1: ±170°, J2: +135°, -90°, J3: +165°, -100°<br>J4: ±185°, J5: ±120°, J6: ±360° | |
| Maximum payload | | 10 kg<br>(Note that the robot can withstand more than 7 kg payload only with the wrist facing down.) | |
| Maximum composite speed | | 8100 mm/s (at the center of an end-effector mounting face) | |
| Position repeatability **(Note 2)** | | In each of X, Y and Z directions: ±0.05 mm<br>(at the center of an end-effector mounting face) | |
| Maximum allowable inertia moment | | Around J4 and J5: 0.25 $kgm^2$<br>Around J6: 0.055 $kgm^2$ | |
| Position detection | | Simplified absolute encoder | |
| Drive motor and brake | | AC servomotors for all joints,<br>Brakes for joints J2 to J6 | |
| User air piping | | 6 systems ($\phi$4), 3 solenoid valves<br>(2-position, double solenoid) contained. | |
| User signal line | | 10 (for proximity sensor signals, etc.) | |
| Air source | Operating pressure | $1.0 \times 10^5$ Pa to $3.9 \times 10^5$ Pa | |
| | Maximum allowable pressure | $4.9 \times 10^5$ Pa | |
| Degree of protection | | IP40 | IP54 (Wrist: IP65) |
| Weight | | Approx. 95 kg | |

**Note 1: The model name of robot set refers to the model name of a complete set including a robot unit and robot controller.**

**Note 2: Position repeatability is the value at constant ambient temperature.**

## (2) VM-6083D (Nickname: VM1000)

**Table 1-5 (b) VM-6083D Specifications**

| Item | | Specifications | |
|---|---|---|---|
| | | **Standard type (VM)** | **Dust-proof & splash-proof type (VM-W)** |
| Model name of robot set **(Note 1)** | | VM-6083D | VM-6083D-W |
| Model name of robot unit | | VM-6083DM | VM-6083DM-W |
| Overall arm length | | 385 (first arm) + 445 (second arm) = 830 mm | |
| Arm offset | | J1 (swing): 180 mm, J3 (front arm): 100 mm | |
| Maximum workable space | | R = 1,111 mm (end-effector mounting face)<br>R = 1,021 mm (Point P: J4, J5, J6 center) | |
| Motion range | | J1: ±170°, J2: +135°, -90°, J3: +165°, -80°<br>J4: ±185°, J5: ±120°, J6: ±360° | |
| Maximum payload | | 10 kg | |
| Maximum composite speed | | 8300 mm/s (at the center of an end-effector mounting face) | |
| Position repeatability **(Note 2)** | | In each of X, Y and Z directions: ±0.05 mm<br>(at the center of an end-effector mounting face) | |
| Maximum allowable inertia moment | | Around J4 and J5: 0.36 $kgm^2$<br>Around J6: 0.064 $kgm^2$ | |
| Position detection | | Absolute encoder | |
| Drive motor and brake | | AC servomotors for all joints,<br>Brakes for joints J2 to J6 | |
| User air piping **(Note 3)** | | 7 systems (ϕ4x6, ϕ6x1), 3 solenoid valves<br>(2-position, double solenoid) contained. | |
| User signal line | | 10 (for proximity sensor signals, etc.) | |
| Air source | Operating pressure | $1.0 \times 10^5$ Pa to $3.9 \times 10^5$ Pa | |
| | Maximum allowable pressure | $4.9 \times 10^5$ Pa | |
| Degree of protection | | IP40 | IP54 (Wrist: IP65) |
| Weight | | Approx. 76 kg | Approx. 78 kg |

**Note 1: The model name of robot set refers to the model name of a complete set including a robot unit and robot controller.**

**Note 2: Position repeatability is the value at constant ambient temperature.**

**Note 3: Only the ϕ4x6 air piping system may be controlled by built-in solenoid valves.**

### (3) VM-60B1D (Nickname: VM1300)

**VM-60B1D Specifications**

| Item | | Specifications | |
|---|---|---|---|
| | | **Standard type (VM)** | **Dust-proof & splash-proof type (VM-W)** |
| Model name of robot set **(Note 1)** | | VM-60B1D | VM-60B1D-W |
| Model name of robot unit | | VM-60B1DM | VM-60B1DM-W |
| Overall arm length | | 520 (first arm) + 590 (second arm) = 1,110 mm | |
| Arm offset | | J1 (swing): 180 mm, J3 (front arm): 100 mm | |
| Maximum workable space | | R = 1,388 mm (end-effector mounting face)<br>R = 1,298 mm (Point P: J4, J5, J6 center) | |
| Motion range | | J1: ±170°, J2: +135°, -90°, J3: +165°, -80°<br>J4: ±185°, J5: ±120°, J6: ±360° | |
| Maximum payload | | 10 kg | |
| Maximum composite speed | | 8300 mm/s (at the center of an end-effector mounting face) | |
| Position repeatability **(Note 2)** | | In each of X, Y and Z directions: ±0.07 mm<br>(at the center of an end-effector mounting face) | |
| Maximum allowable inertia moment | | Around J4 and J5: 0.36 $kgm^2$<br>Around J6: 0.064 $kgm^2$ | |
| Position detection | | Absolute encoder | |
| Drive motor and brake | | AC servomotors for all joints,<br>Brakes for joints J2 to J6 | |
| User air piping **(Note 3)** | | 7 systems (ϕ4x6, ϕ6x1), 3 solenoid valves<br>(2-position, double solenoid) contained. | |
| User signal line | | 10 (for proximity sensor signals, etc.) | |
| Air source | Operating pressure | $1.0 \times 10^5$ Pa to $3.9 \times 10^5$ Pa | |
| | Maximum allowable pressure | $4.9 \times 10^5$ Pa | |
| Degree of protection | | IP40 | IP54 (Wrist: IP65) |
| Weight | | Approx. 78 kg | Approx. 80 kg |

**Note 1: The model name of robot set refers to the model name of a complete set including a robot unit and robot controller.**

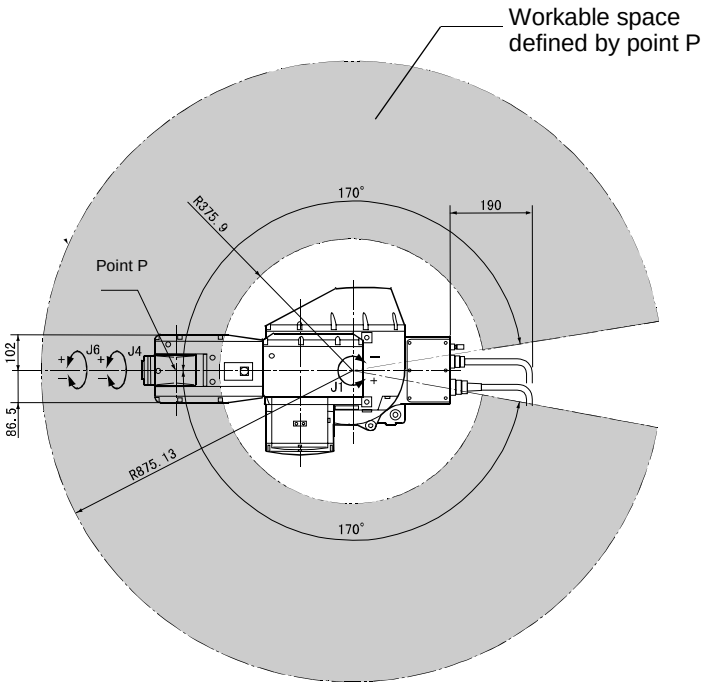
**Note 2: Position repeatability is the value at constant ambient temperature.**

**Note 3: Only the ϕ4x6 air piping system may be controlled by built-in solenoid valves.**

# 3.2 Outer Dimensions and Workable Space of the Robot Unit

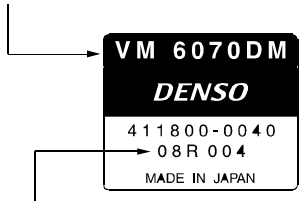
Following figures show the outer dimensions and workable space of the VM-D series robot.

**(1) VM-6070D (Standard type)**

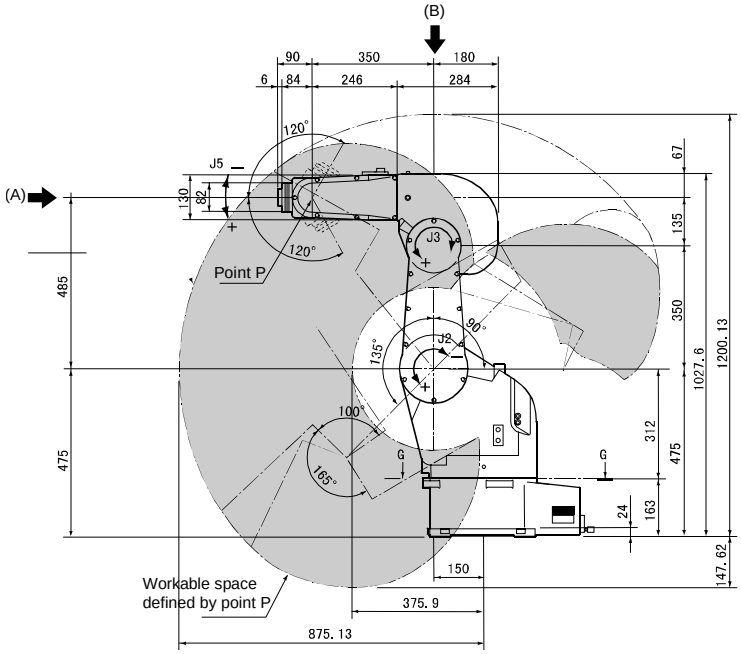



Example of nameplate (below)

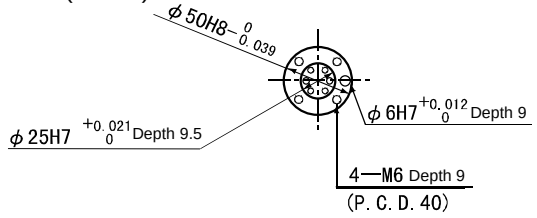
Robot model



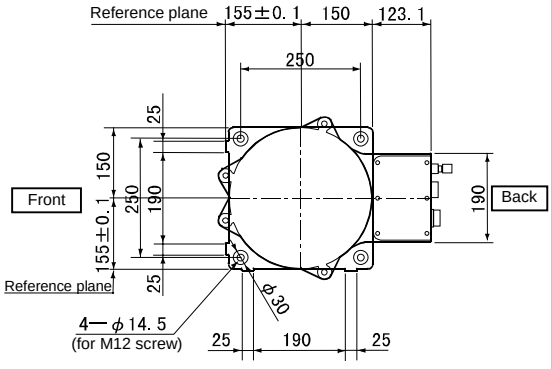

Serial number




Detailed drawing of end-effector mounting face (view A)

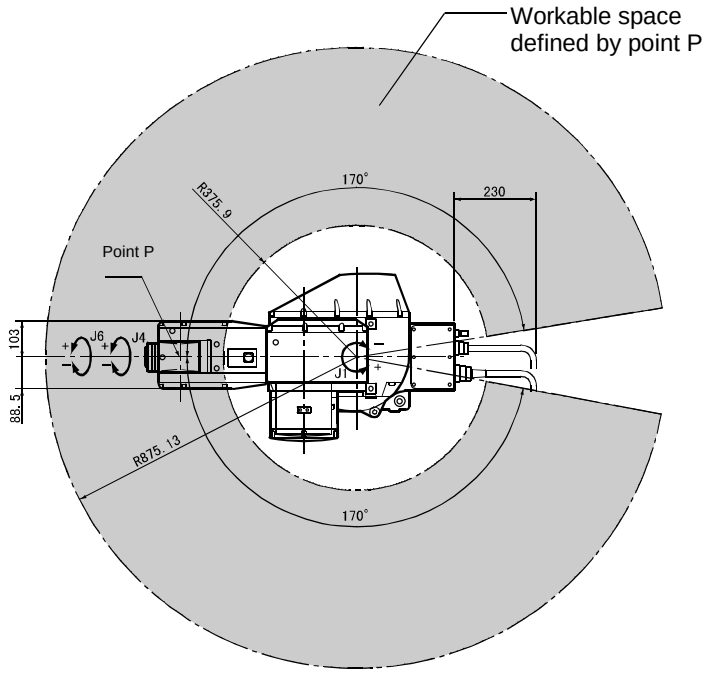



Detailed drawing of base mounting face (view B)



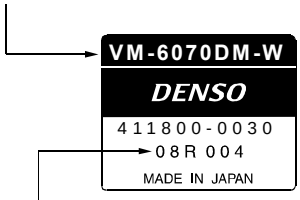

**Outer Dimensions and Workable Space Defined by P [VM-6070D]**

**(2) VM-6070D-W (Dust-proof & splash-proof type)**

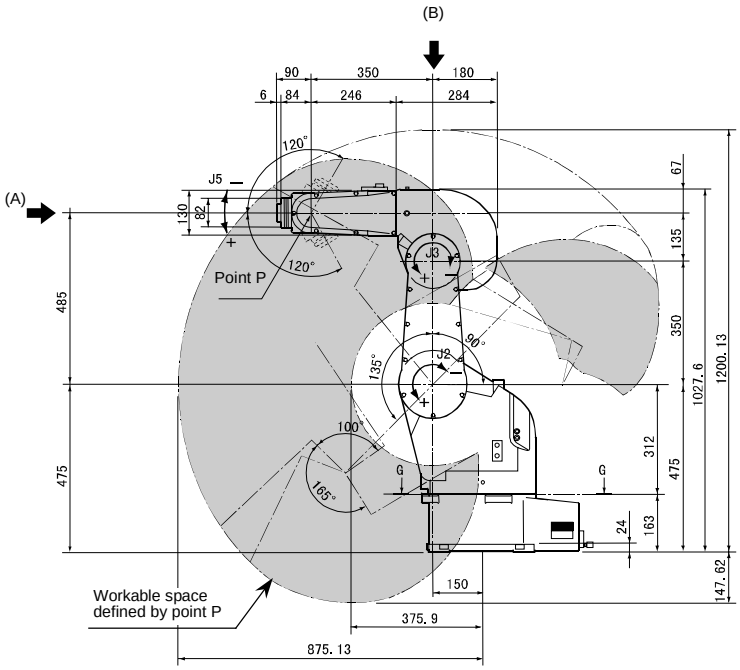



Example of nameplate (below)

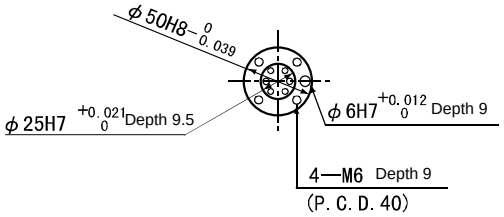
Robot model



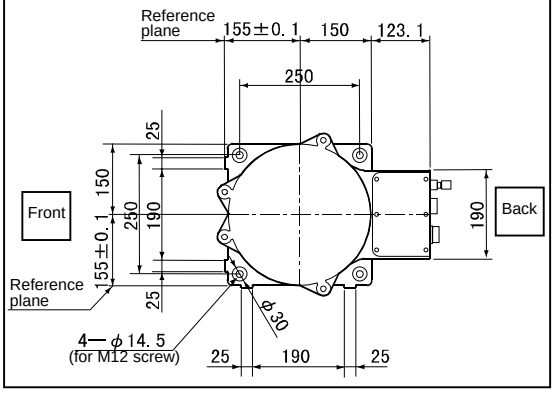

Serial number




Detailed drawing of end-effector mounting face (view A)

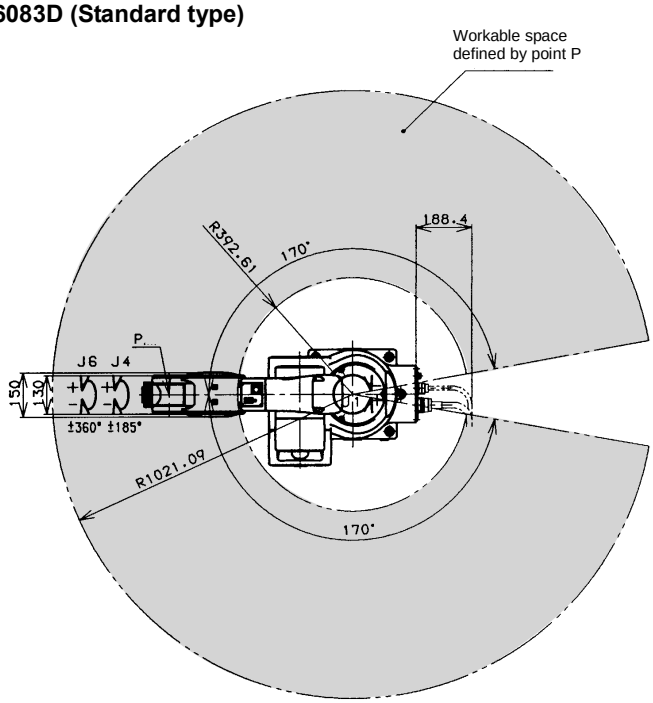



Detailed drawing of base mounting face (view B)

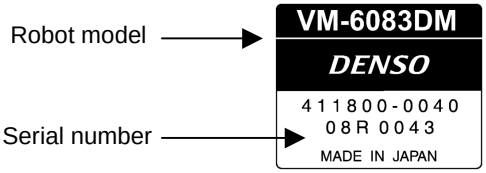


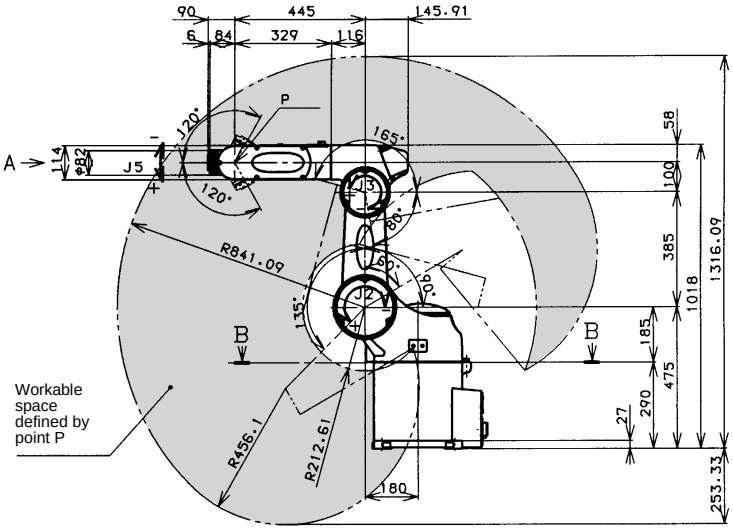

**Outer Dimensions and Workable Space [VM-6070D-W]**

**(3) VM-6083D (Standard type)**

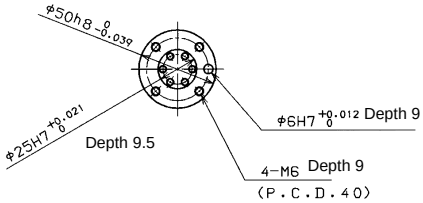



Example of nameplate (below)

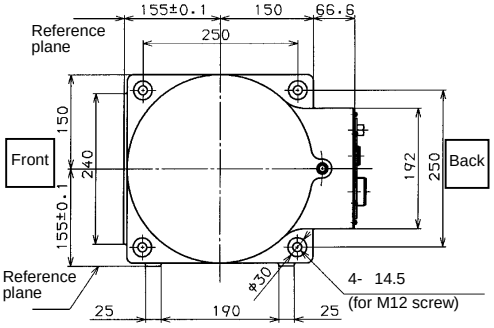



Detailed drawing of end-effector mounting face (view A)

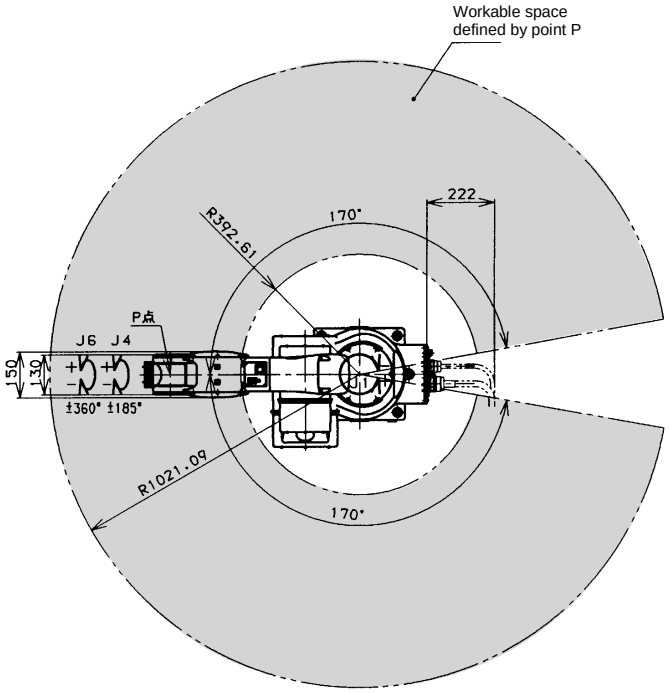



Detailed drawing of base mounting face (Sect. B-B)

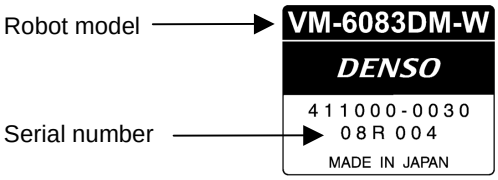



**Outer Dimensions and Workable Space [VM-6083D]**

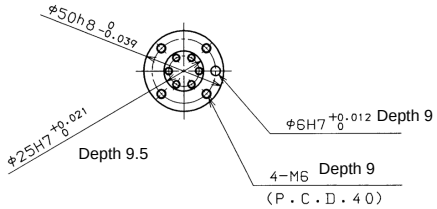
**(4) VM-6083D-W (Dust-proof & splash-proof type)**

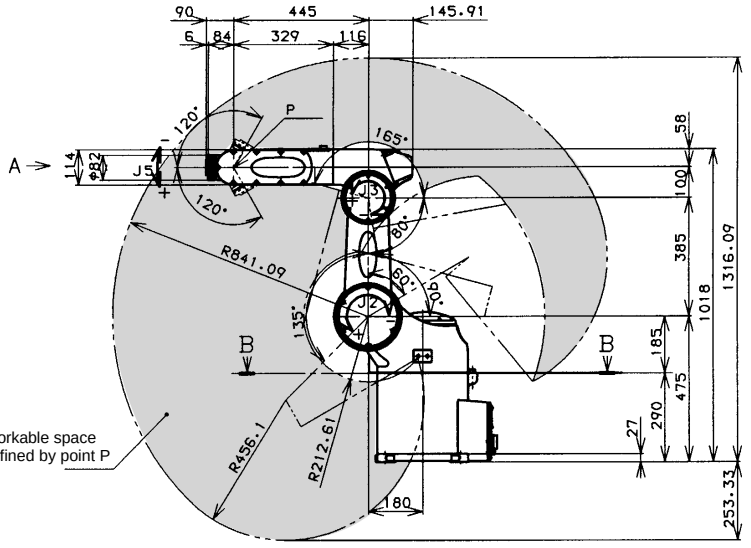



Example of nameplate (below)

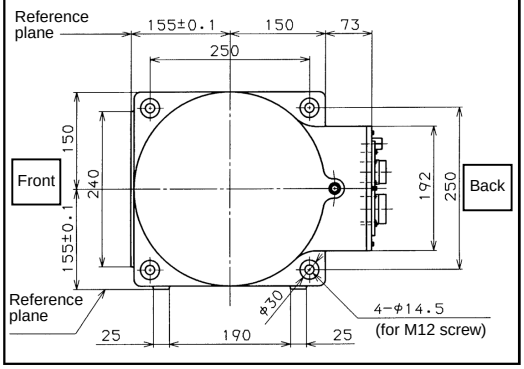



Detailed drawing of end-effector mounting face (view A)



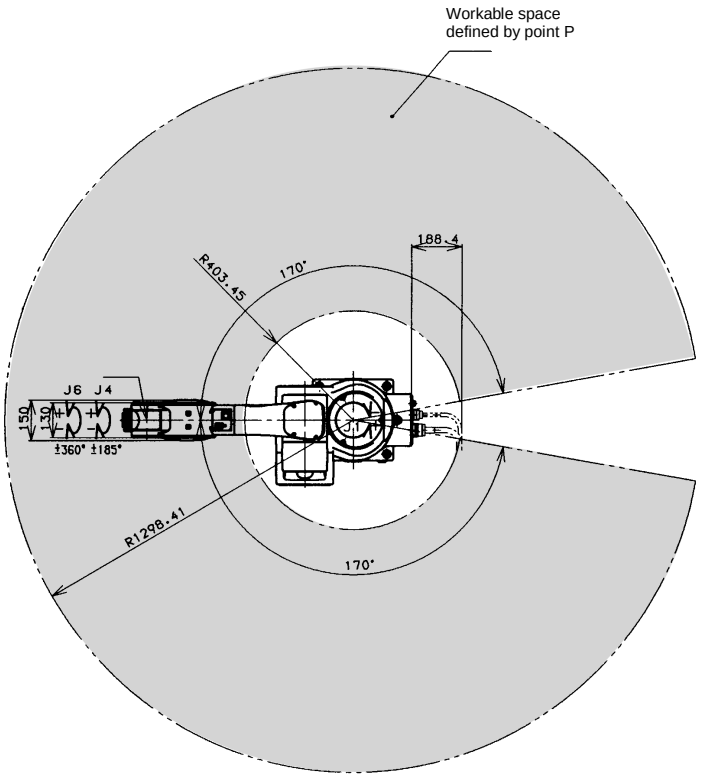




Detailed drawing of base mounting face (Sect. B-B)

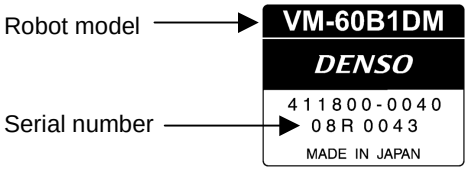


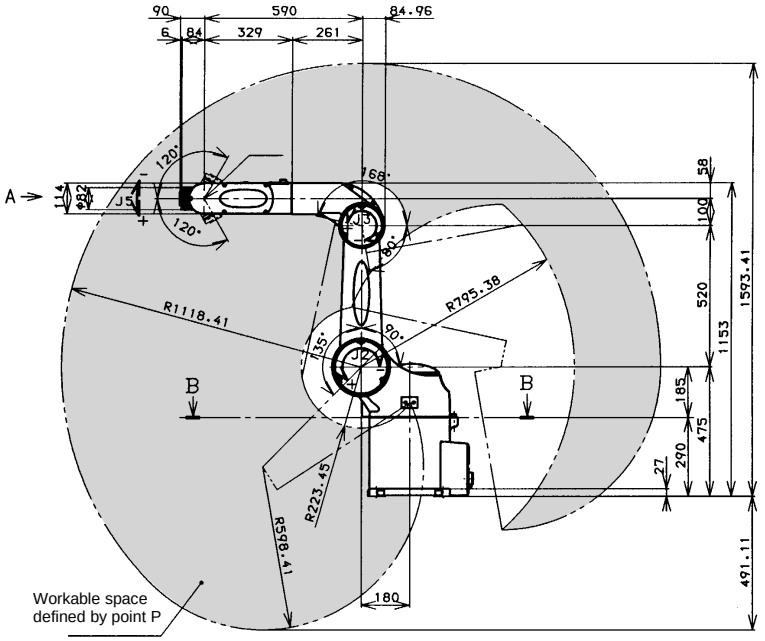

**Outer Dimensions and Workable Space [VM-6083D-W]**

**(5) VM-60B1D (Standard type)**

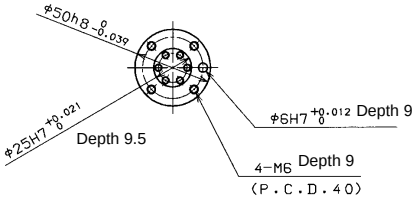



Example of nameplate (below)

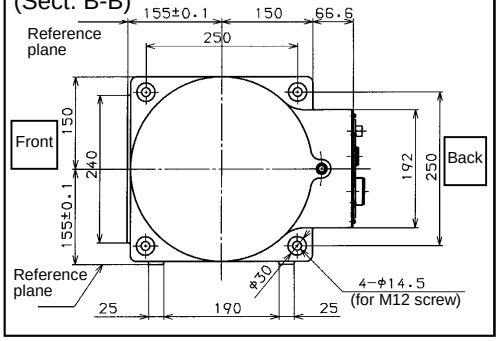



Detailed drawing of end-effector mounting face (view A)

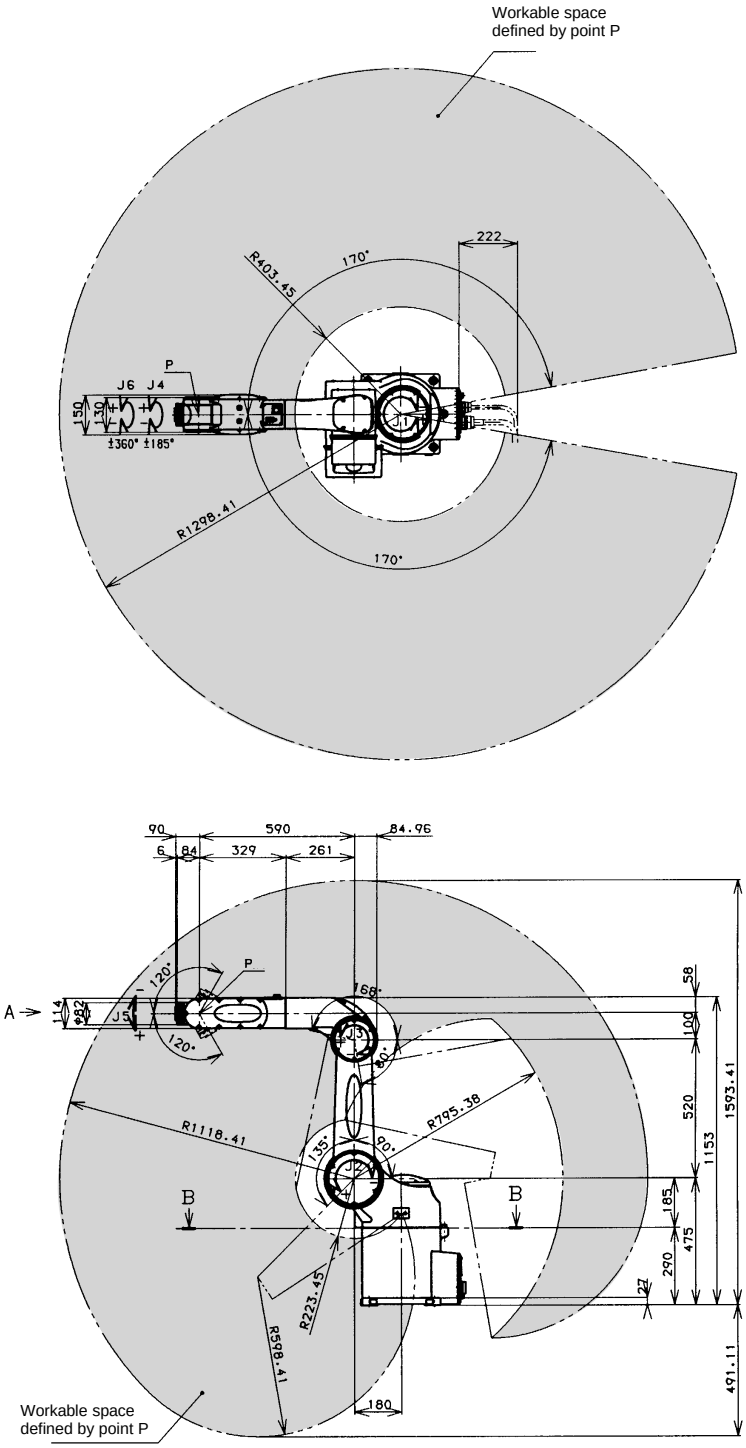



Detailed drawing of base mounting face (Sect. B-B)

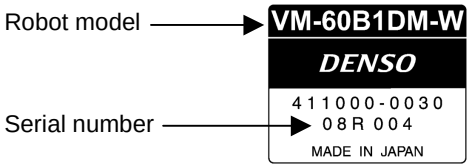



**Outer Dimensions and Workable Space [VM-60B1D]**

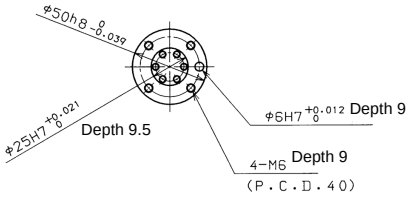
**(6) VM-60B1D-W (Dust-proof & splash-proof type)**



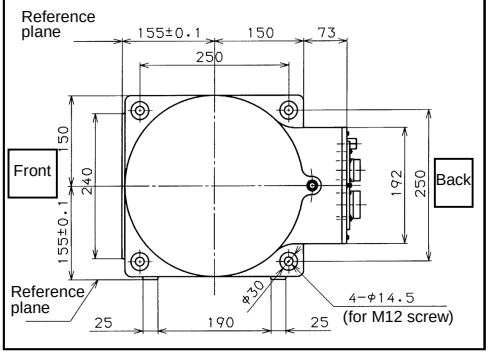

Example of nameplate (below)




Detailed drawing of end-effector mounting face (view A)




Detailed drawing of base mounting face (Sect. B-B)




**Outer Dimensions and Workable Space [VM-60B1D-W]**

# 3.3 Robot Positioning Time

VM-D series robot positioning time

1. Following figures show the positioning times used to calculate the cycle time.
2. Positioning time means the time from the start of robot operation to the arrival at the target positioning point.
3. After the robot moves to and passes the target positioning point, vibration will be dampened and the robot positioned at the target positioning point as shown in Figure below. This vibration dampening time is not considered in the graph.

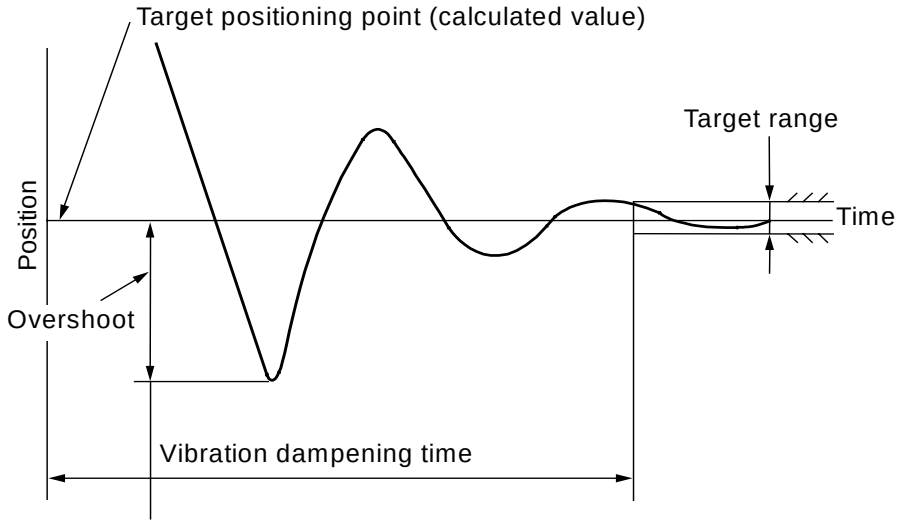
**Caution (1) The vibration dampening time depends on factors such as the weight of the end-effector. If the robot is to be used in such a way that it overshoots or if the vibration damping time is of great concern, test the robot carefully beforehand.**

**(2) If acceleration begins before residual vibration of the robot stops, an overcurrent error (code starts from ERROR6120; the first digit represents the axis number) may be displayed. In this case, take one of the following measures:**

- **Lower the deceleration of the preceding operation with a DECEL command to reduce residual vibration.**
- **Keep the robot in stand-by with a DELAY command until residual vibration stops.**
- **Lower acceleration with an ACCEL command.**

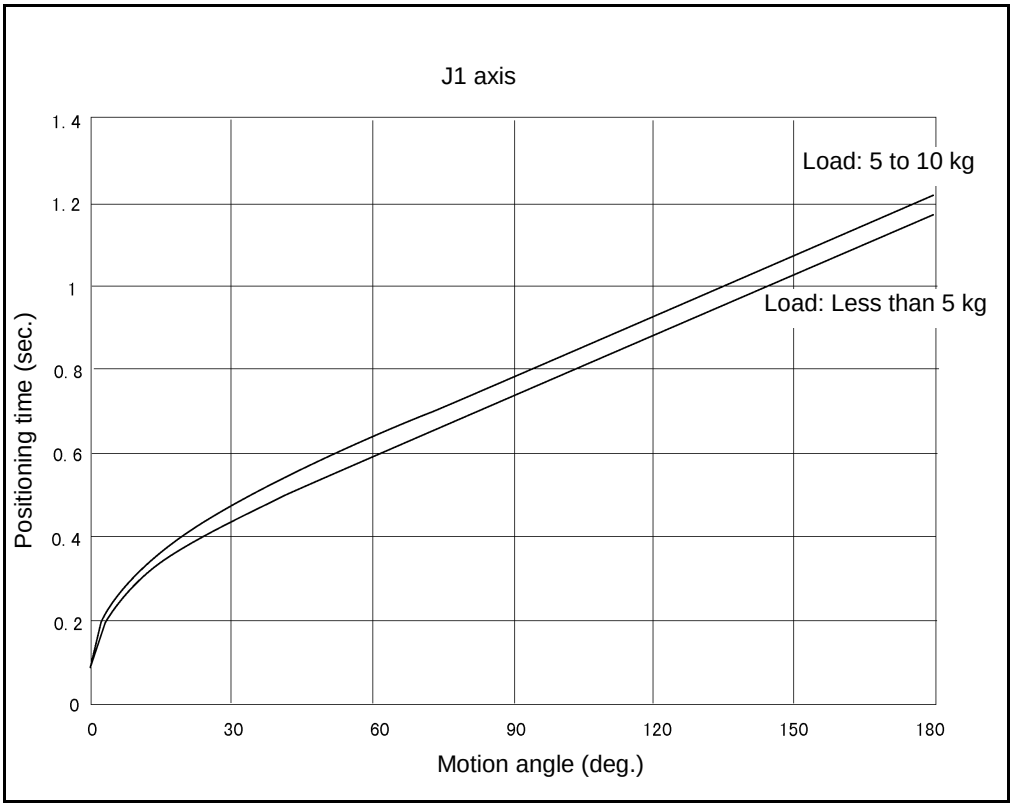
**(3) Operate the robot with the optimum load setting in accordance with the end-effector weight and workpiece weight. If not, a robot failure may result.**

**(4) Whenever the payload is heavier than 7 kg, use the robot with the flanged side of the 6th axis facing down. If the flanged side is not facing down, an over-deviation error (code starts from ERROR6100; the first digit represents the axis number), overcurrent error (code starts from ERROR6120; the first digit represents the axis number) or overload error (code starts from ERROR6170; the first digit represents the axis number) may be displayed.**

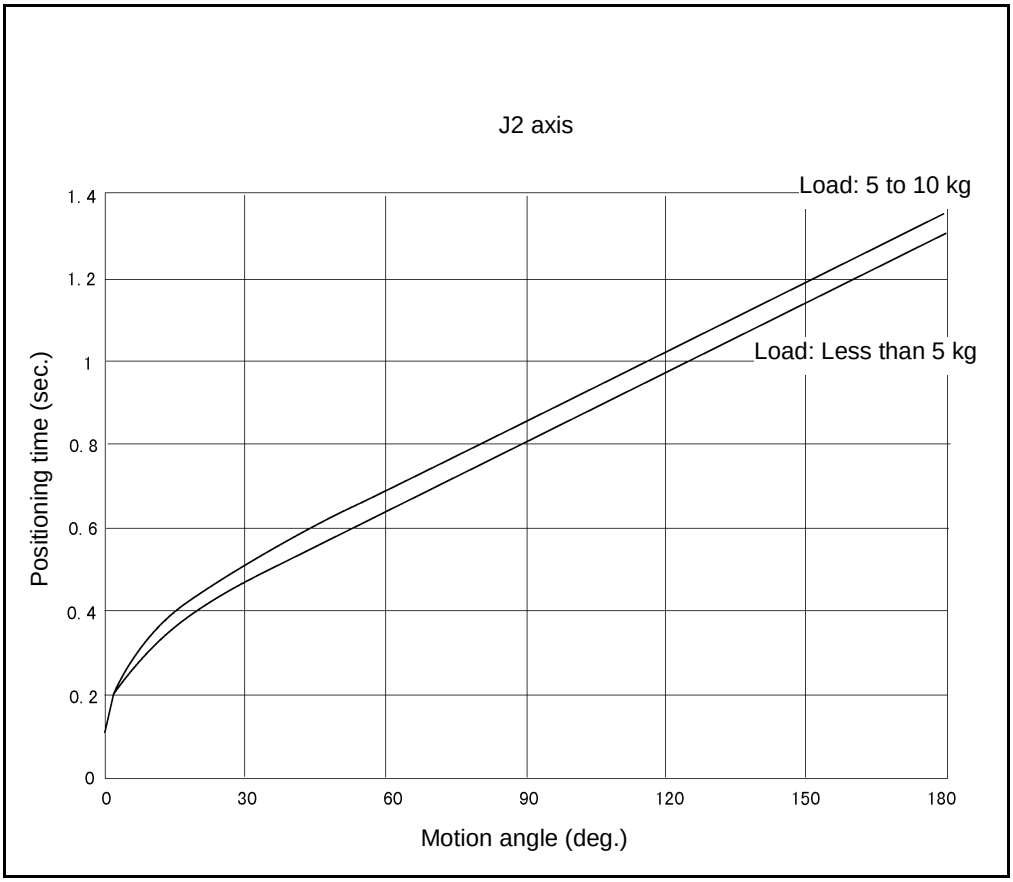



**Vibration Dampening Time**

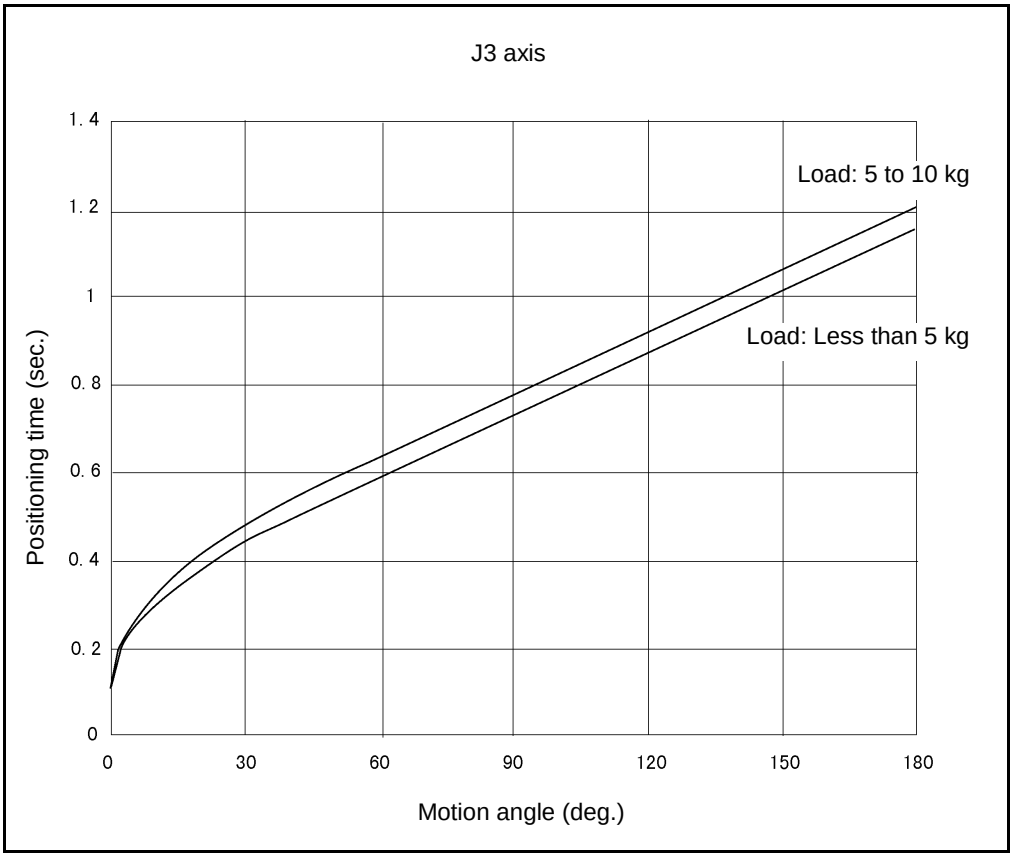
### (1) VM-6070D robot positioning time



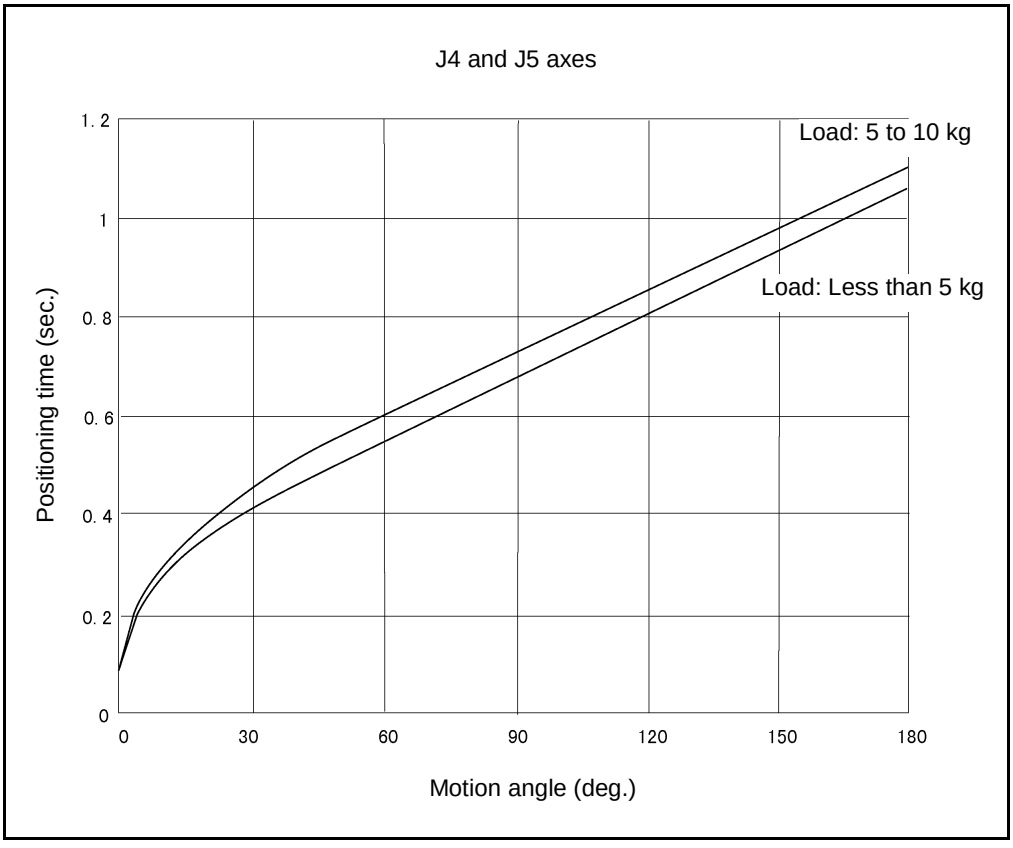

**J1 Axis (MOVE P Motion) [VM-6070D]**



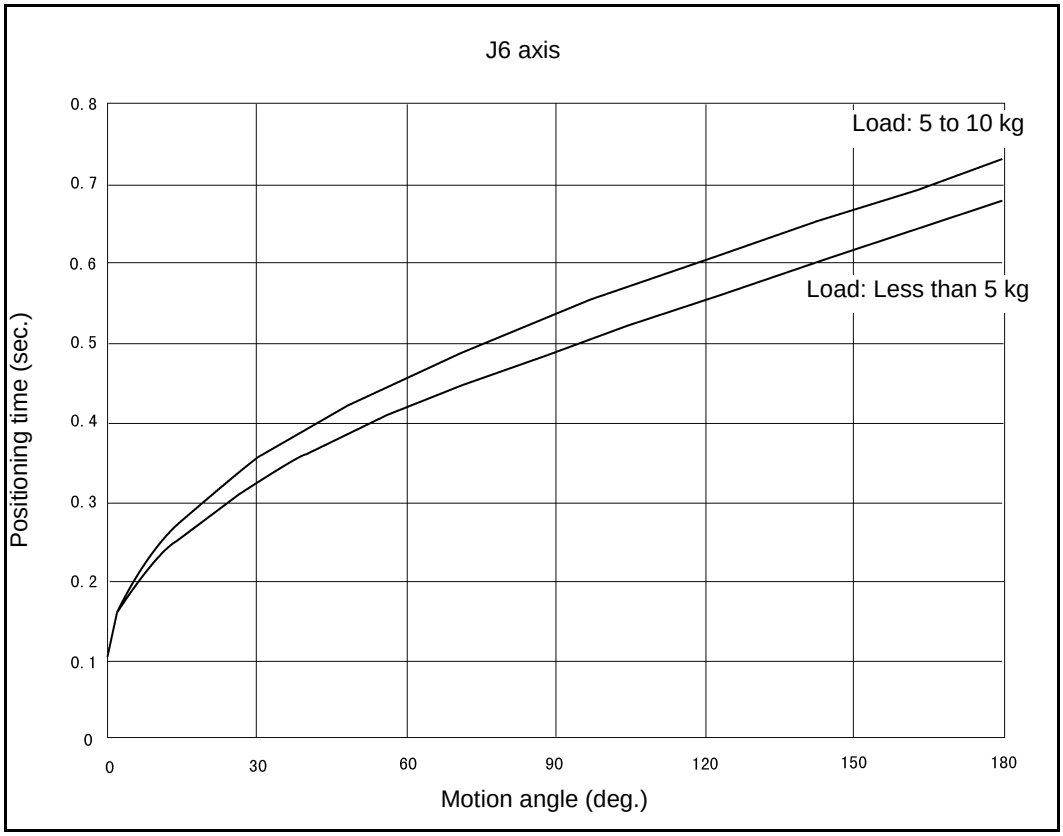

**J2 Axis (MOVE P Motion) [VM-6070D]**



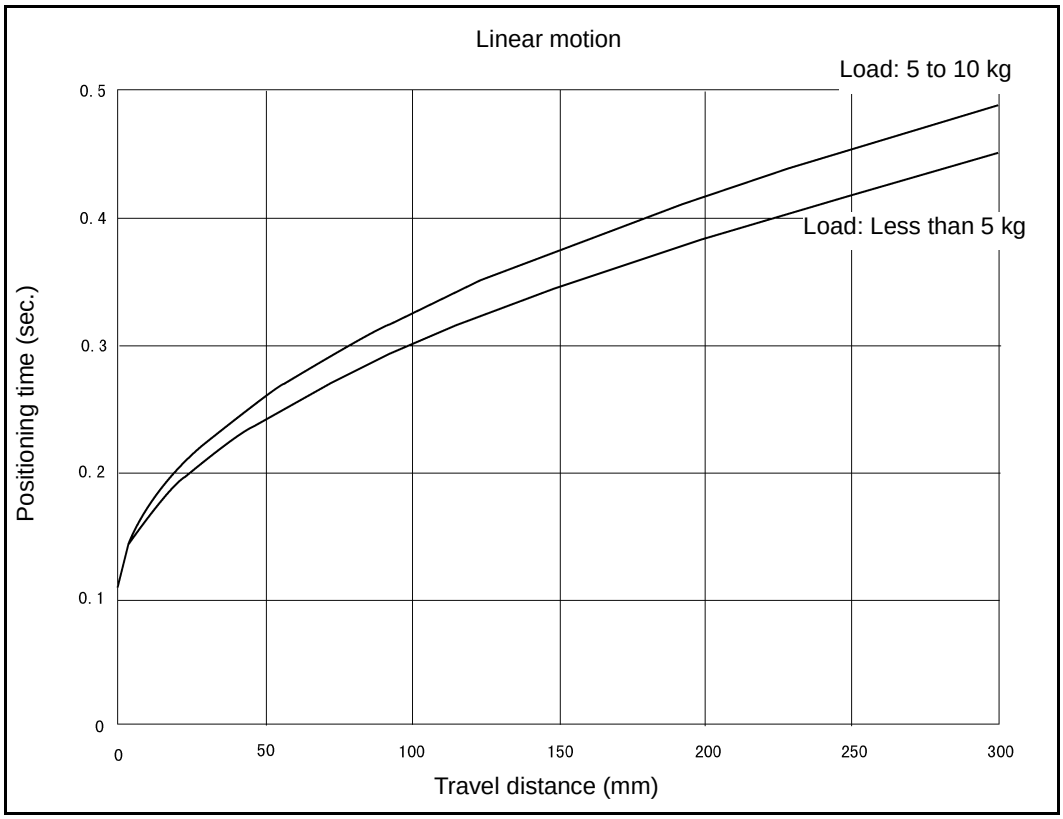

**J3 Axis (MOVE P Motion) [VM-6070D]**




**J4/J5 Axis (MOVE P Motion) [VM-6070D]**

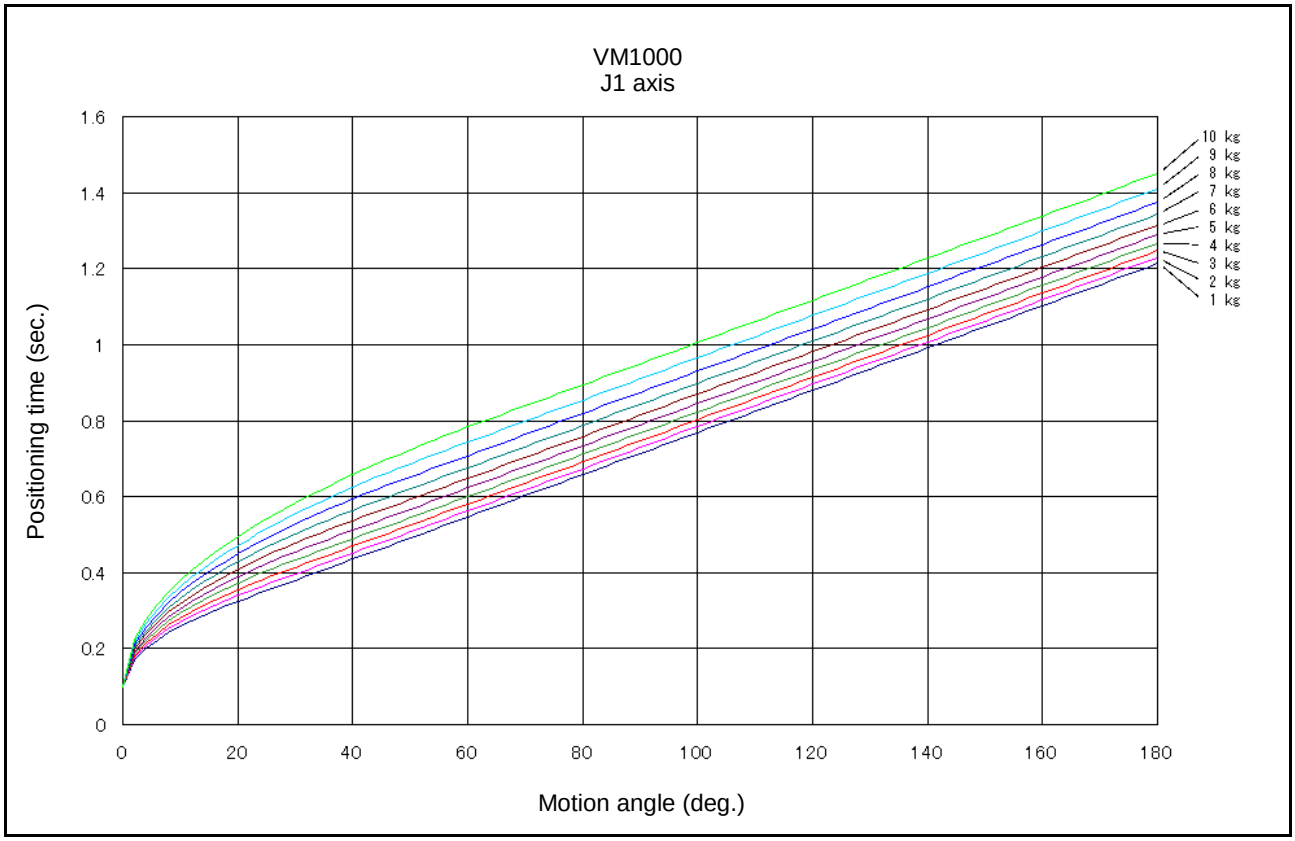



**J6 Axis (MOVE P Motion) [VM-6070D]**

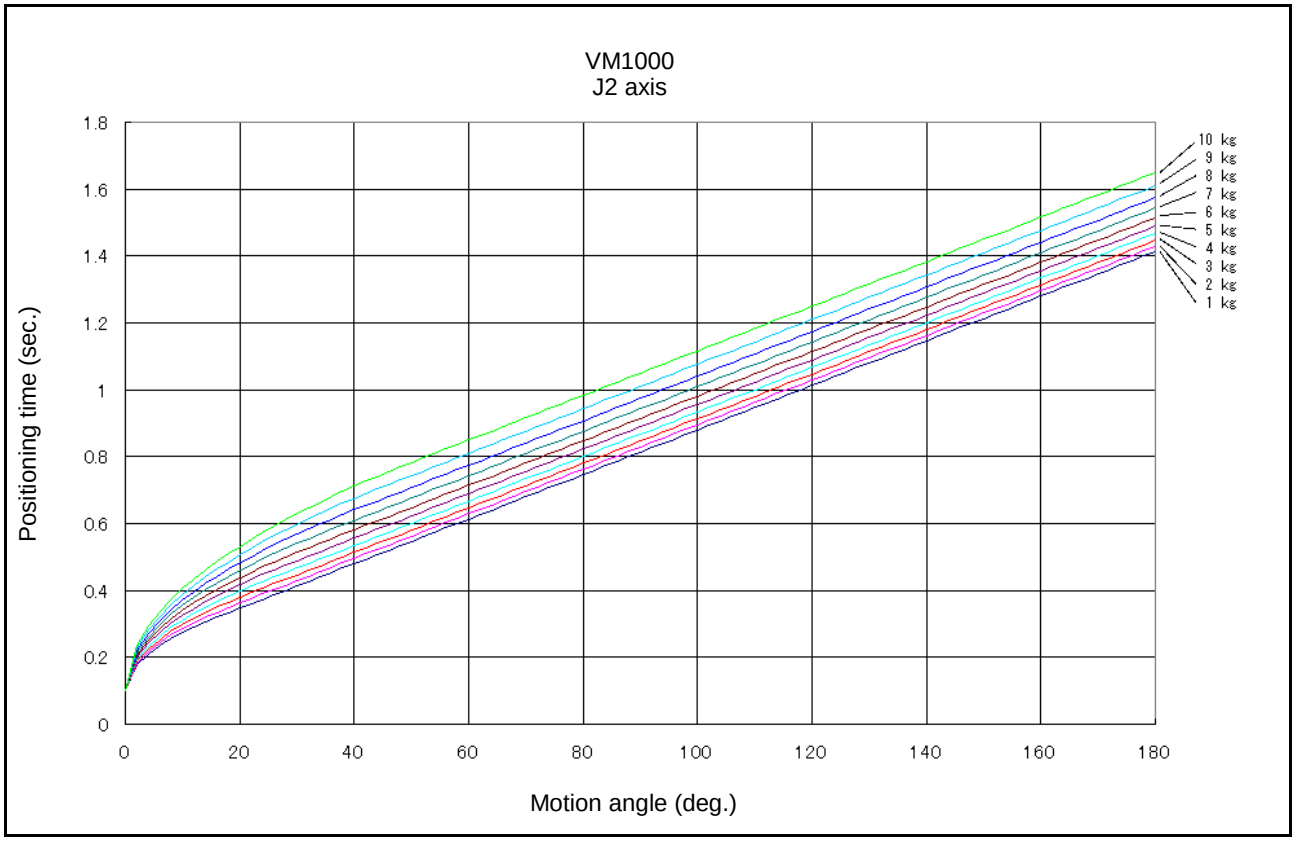



**CP Operation (MOVE L Motion) [VM-6070D]**

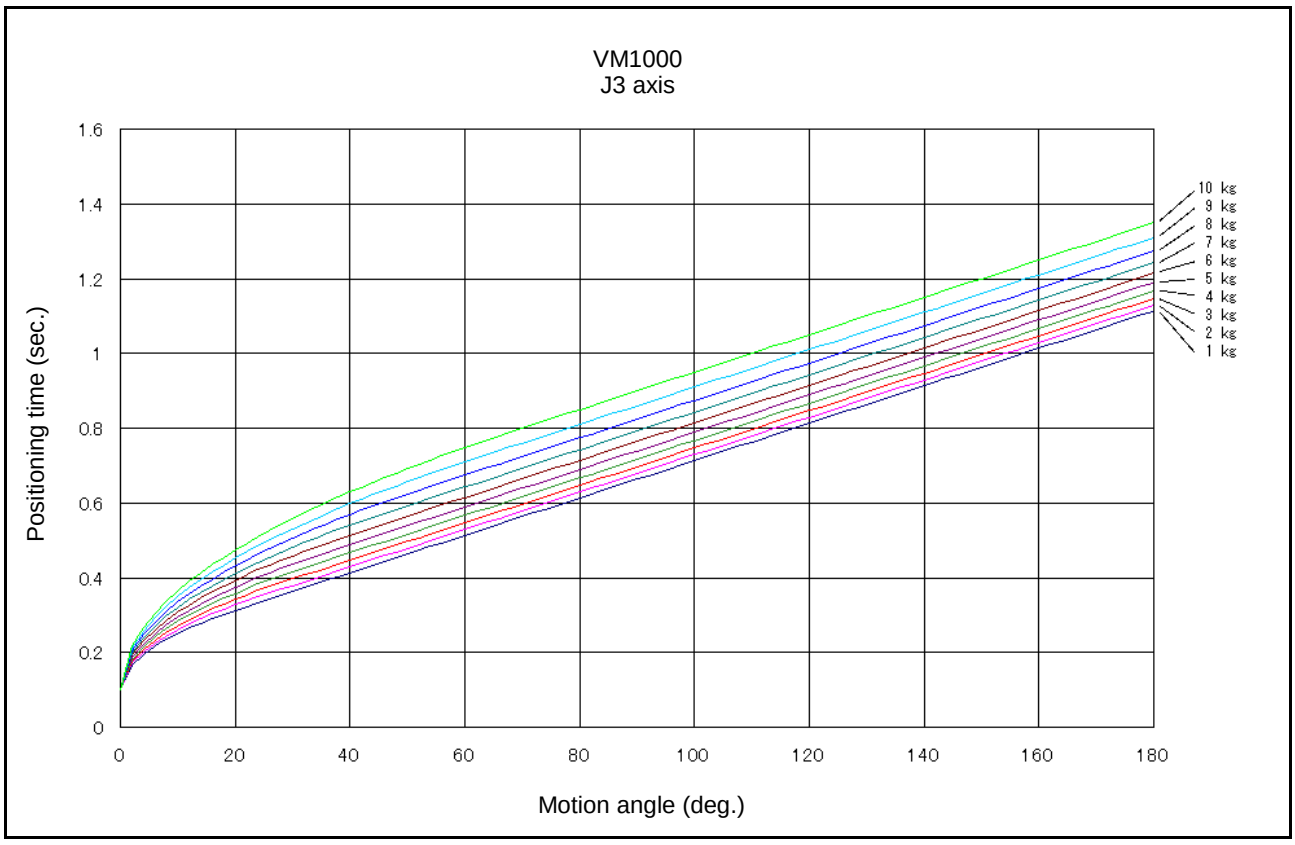
## (2) VM-6083D robot positioning time



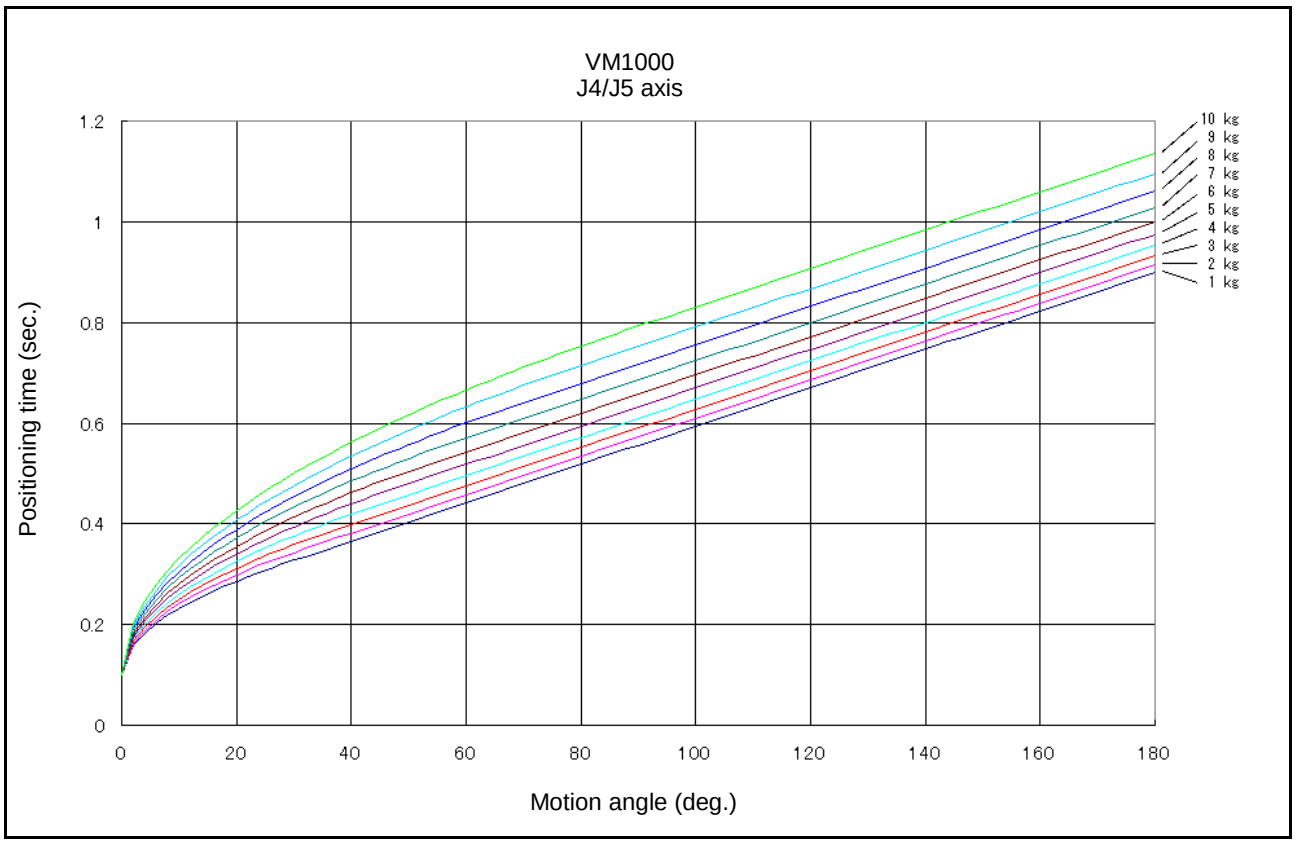

**J1 Axis [VM-6083D]**



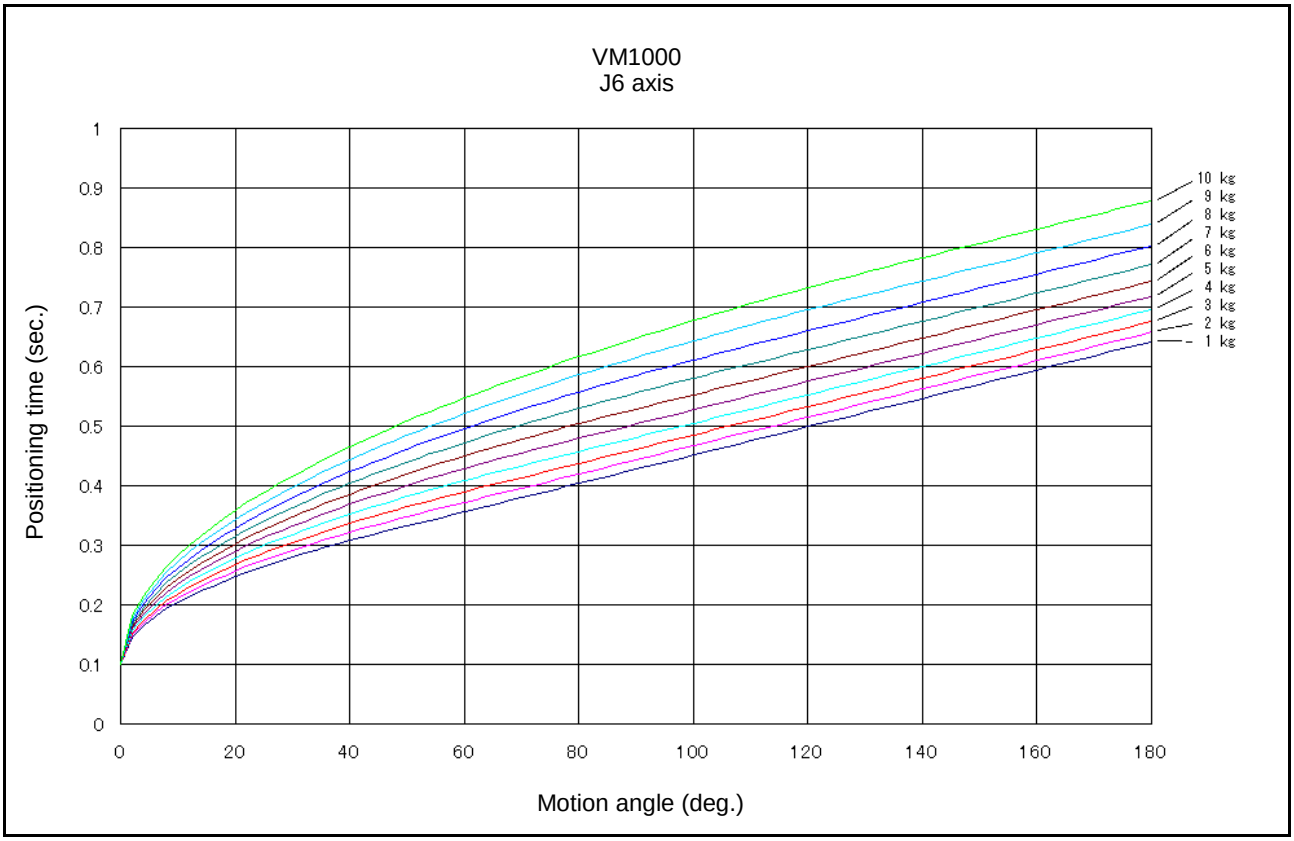

**J2 Axis [VM-6083D]**



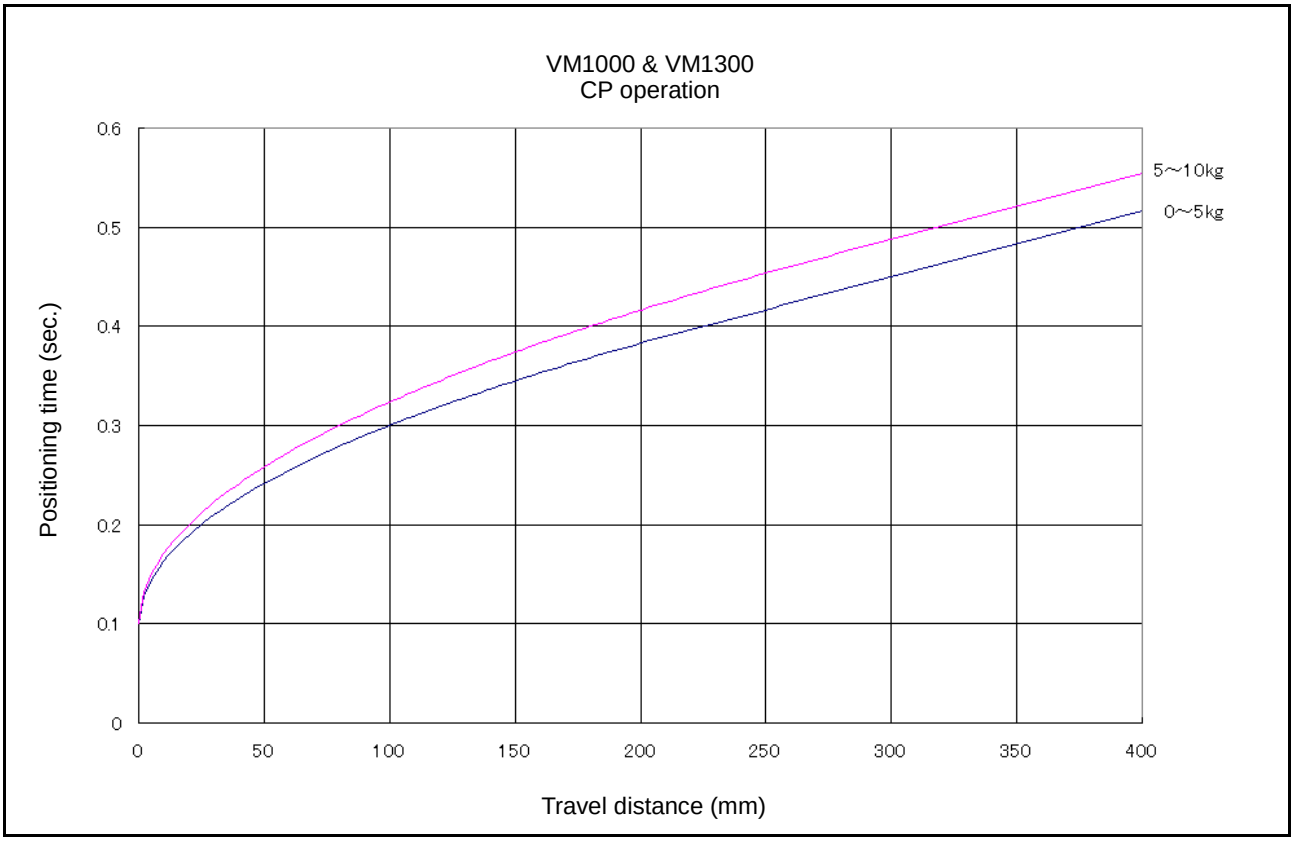

**J3 Axis [VM-6083D]**




**J4/J5 Axis [VM-6083D]**

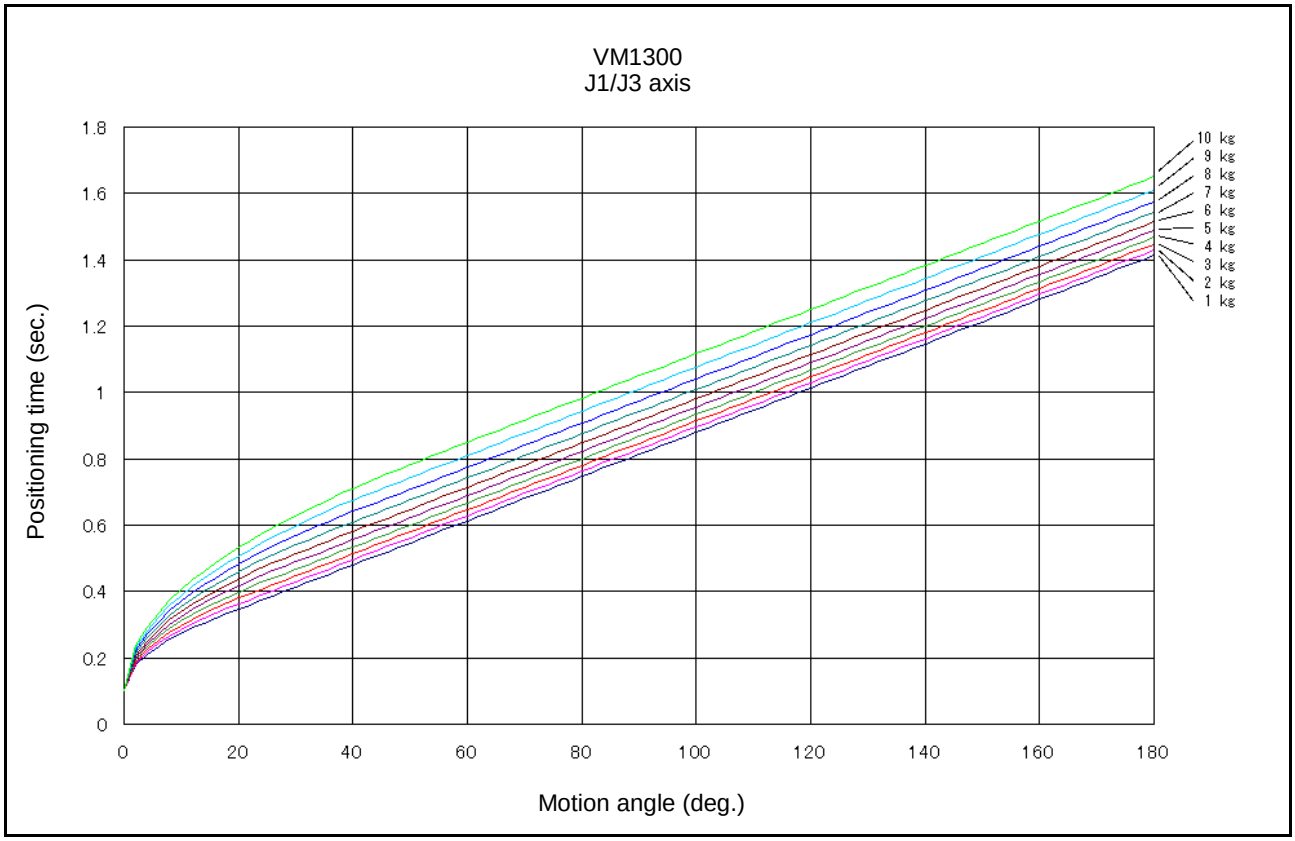



**J6 Axis [VM-6083D]**

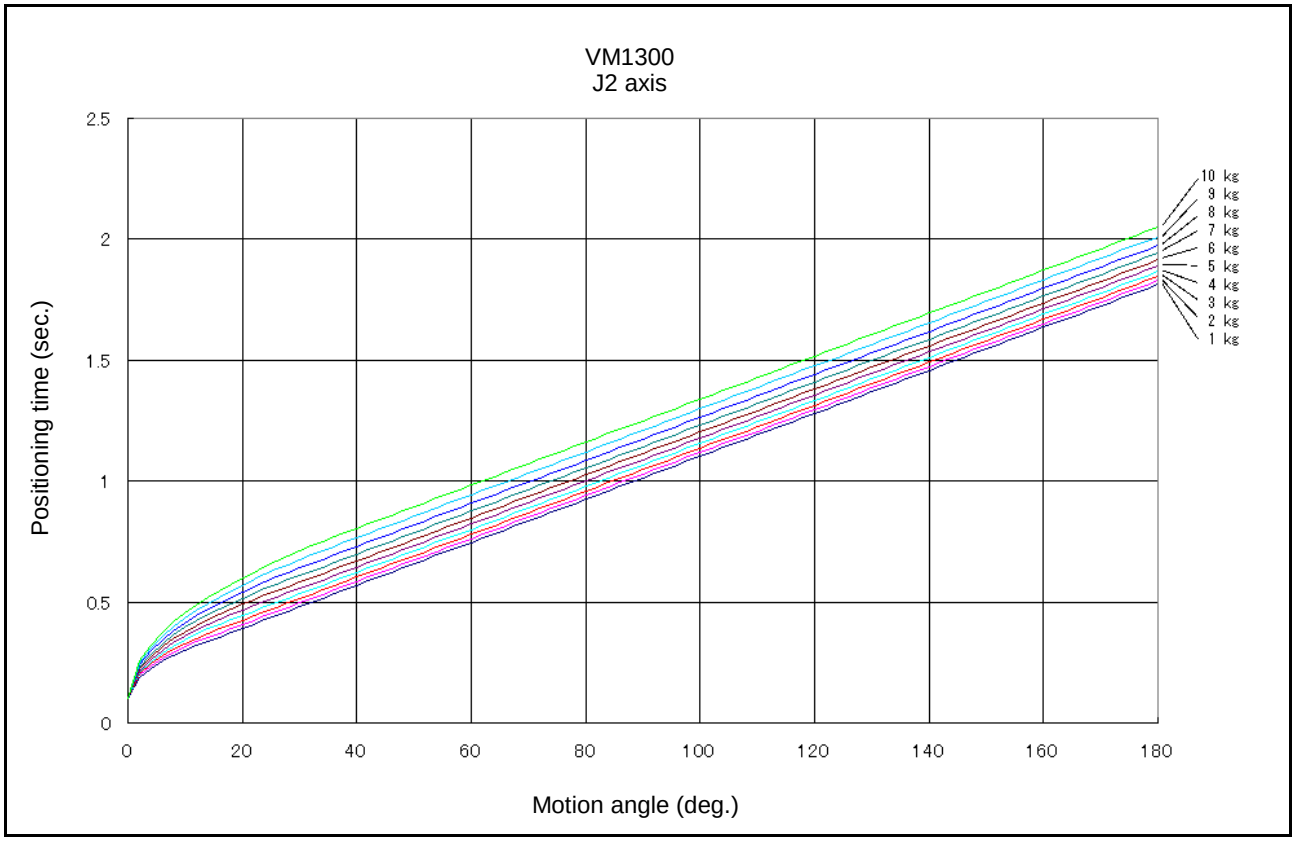



**CP Operation [VM-6083D]**

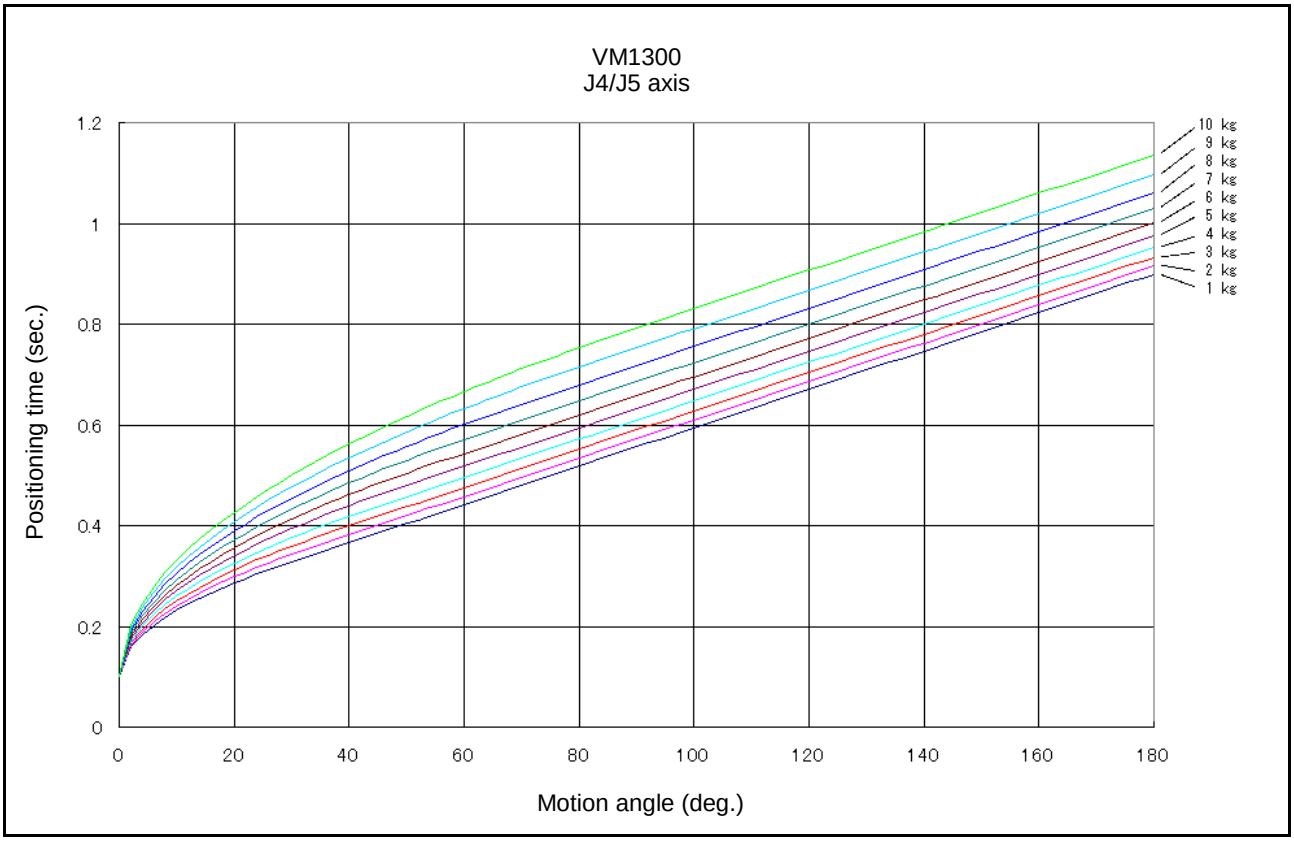
### (3) VM-60B1D robot positioning time



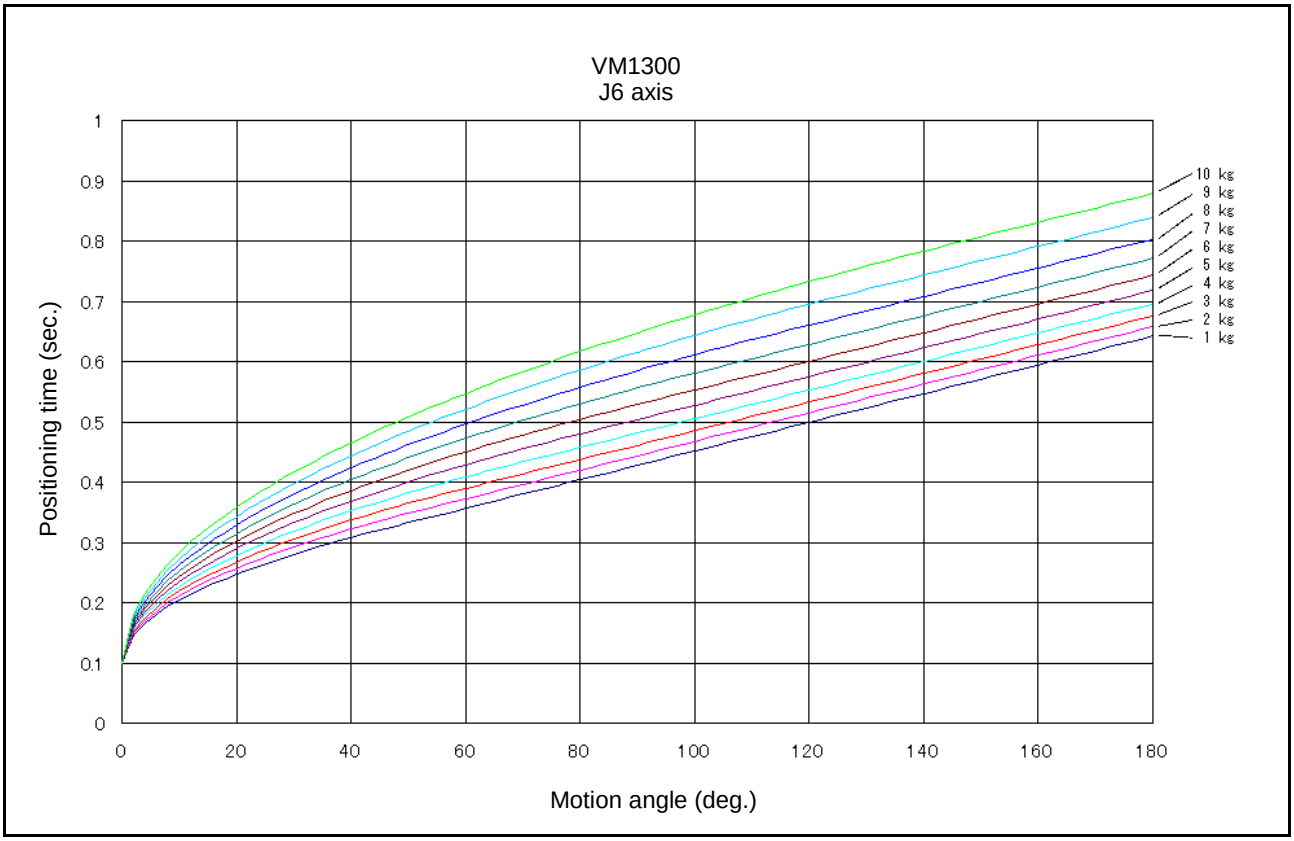

**J1/J3 Axis [VM-60B1D]**



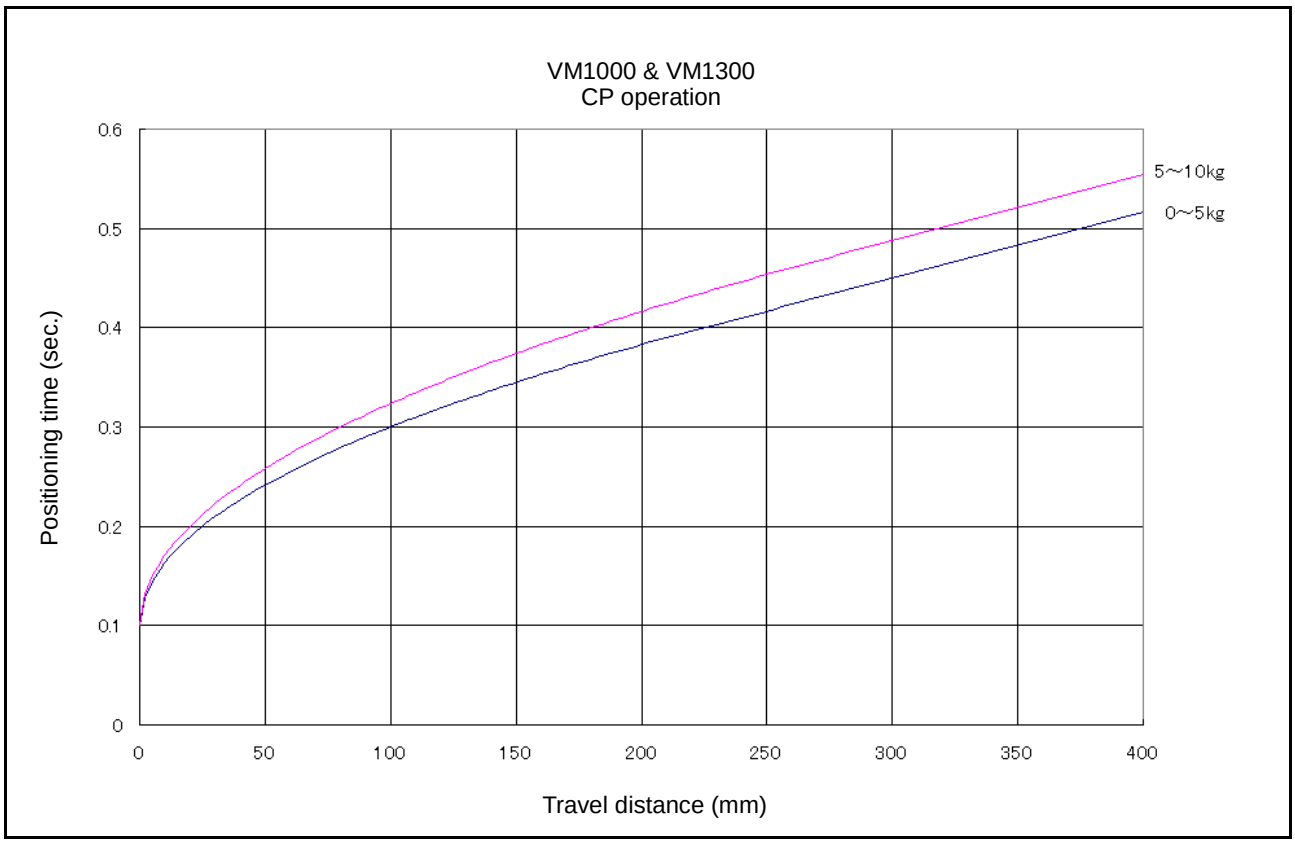

**J2 Axis [VM-60B1D]**




**J4/J5 Axis [VM-60B1D]**




**J6 Axis [VM-60B1D]**



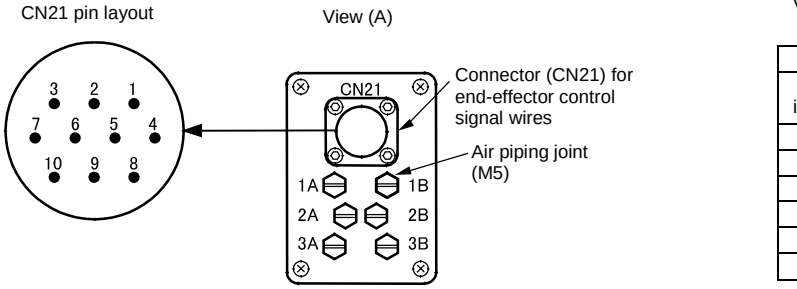

**CP Operation [VM-60B1D]**

# 3.4 Air Piping and Signal Wiring

The VM-D series is equipped with air pipes (6 pipes in the VM-6070D, 7 pipes in the VM-6083D/VM-60B1D) for air chuck, 10 signal lines, and 3 solenoid valves in it. The air piping and signal wiring of the VM-D series are shown in following figures.

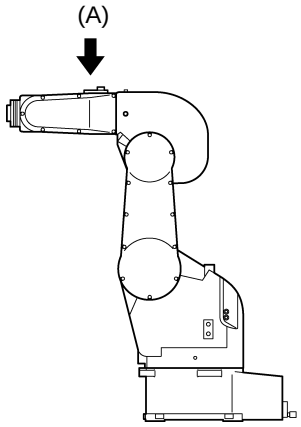
Table on page 32 lists the specifications of the solenoid valves. Those specifications are common to the VM-D series.

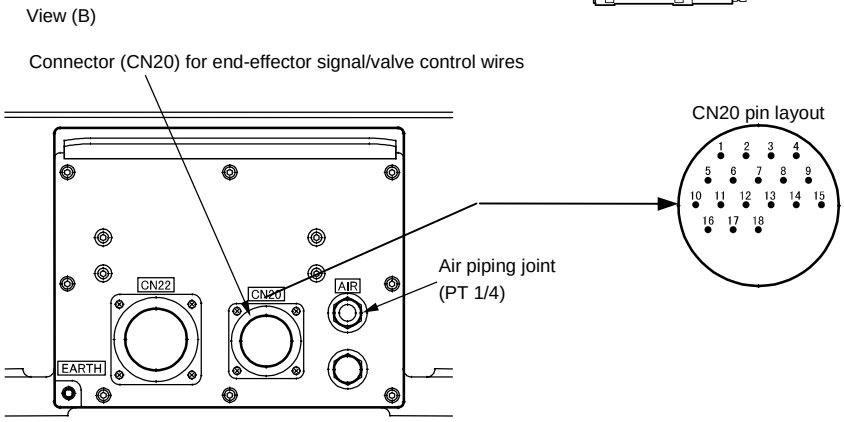
(1) VM-6070D




Valve Symbols and Air Intake/Exhaust States
(1A and 1B are piping joint symbols.)

| Air piping joint | | Valve signal | | |
|---|---|---|---|---|
| Air intake | Exhaust | Solenoid valve | Solenoid | |
| | | | A | B |
| 1A | 1B | 1 | ON | OFF |
| 1B | 1A | 1 | OFF | ON |
| 2A | 2B | 2 | ON | OFF |
| 2B | 2A | 2 | OFF | ON |
| 3A | 3B | 3 | ON | OFF |
| 3B | 3A | 3 | OFF | ON |




CN20 Pin Assignment

For controller I/O unit, NPN type (source IN, sink OUT)

| CN20 pin No. | Used for: |
|---|---|
| 12 | +24V |
| 13 | Solenoid 1A (solenoid valve 1) |
| 14 | Solenoid 1B (solenoid valve 1) |
| 15 | Solenoid 2A (solenoid valve 2) |
| 16 | Solenoid 2B (solenoid valve 2) |
| 17 | Solenoid 3A (solenoid valve 3) |
| 18 | Solenoid 3B (solenoid valve 3) |

For controller I/O unit, PNP type (sink IN, source OUT)

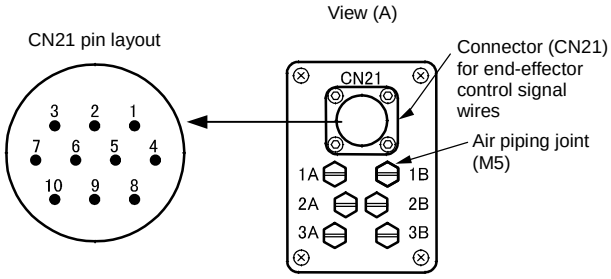
| CN20 pin No. | Used for: |
|---|---|
| 12 | 0V |
| 13 | Solenoid 1A (solenoid valve 1) |
| 14 | Solenoid 1B (solenoid valve 1) |
| 15 | Solenoid 2A (solenoid valve 2) |
| 16 | Solenoid 2B (solenoid valve 2) |
| 17 | Solenoid 3A (solenoid valve 3) |
| 18 | Solenoid 3B (solenoid valve 3) |

Note 1: Pins #1 to #10 on CN21 and those on CN20 are connected with each other. The allowable current per line is 1 A.
Note 2: Use the attached connector sets for CN20 and CN21.

| Connector set part No. | Part No. | Model and part name | Appearance |
|---|---|---|---|
| 410889-0030 | 410887-0170 (for CN20) | SRCN6A25-24S (round type connector) (Japan Aviation Electronics Industry Ltd) |  |
| | 410877-0180 (for CN1) | JMLP1610M (L type plug connector) DDK Electronics, Inc. |  |

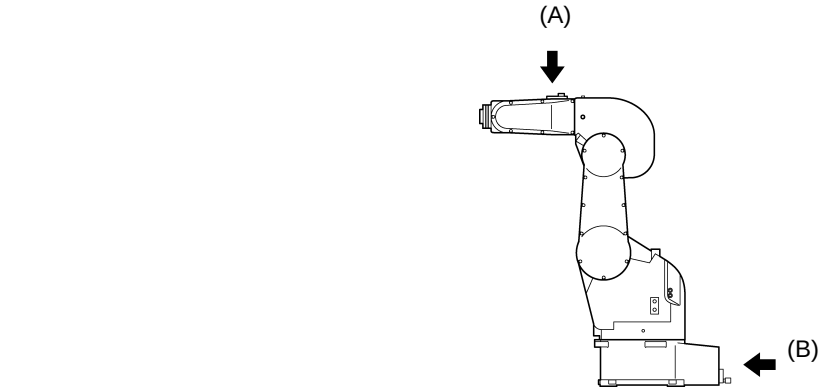
**Air Piping and Signal Wiring [VM-6070D]**

(2) VM-6070D-W




Valve Symbols and Air Intake and Exhaust States
(1A and 1B are piping joint symbols.)

| Air piping joint | | Valve signal | | |
|---|---|---|---|---|
| Air intake | Exhaust | Solenoid valve | Solenoid | |
| | | | A | B |
| 1A | 1B | 1 | ON | OFF |
| 1B | 1A | 1 | OFF | ON |
| 2A | 2B | 2 | ON | OFF |
| 2B | 2A | 2 | OFF | ON |
| 3A | 3B | 3 | ON | OFF |
| 3B | 3A | 3 | OFF | ON |




CN20 Pin Assignment

For controller I/O unit, NPN type (source IN, sink OUT)

| CN20 pin No. | Used for: |
|---|---|
| M | +24V |
| N | Solenoid 1A (solenoid valve 1) |
| P | Solenoid 1B (solenoid valve 1) |
| R | Solenoid 2A (solenoid valve 2) |
| S | Solenoid 2B (solenoid valve 2) |
| T | Solenoid 3A (solenoid valve 3) |
| U | Solenoid 3B (solenoid valve 3) |

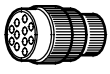
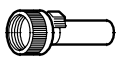
For controller I/O unit, PNP type (sink IN, source OUT)

| CN20 pin No. | Used for: |
|---|---|
| M | 0V |
| N | Solenoid 1A (solenoid valve 1) |
| P | Solenoid 1B (solenoid valve 1) |
| R | Solenoid 2A (solenoid valve 2) |
| S | Solenoid 2B (solenoid valve 2) |
| T | Solenoid 3A (solenoid valve 3) |
| U | Solenoid 3B (solenoid valve 3) |

Note 1 Pins A to K on CN20 and pins #1 to #10 on CN21 are connected with each other as shown below. The allowable current per line is 1 A.

| CN20 | A | B | C | D | E | F | G | H | J | K |
|---|---|---|---|---|---|---|---|---|---|---|
| CN21 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

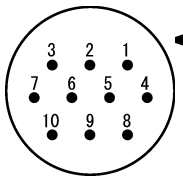
Note 2 Use the attached connector sets for CN20 and CN21.

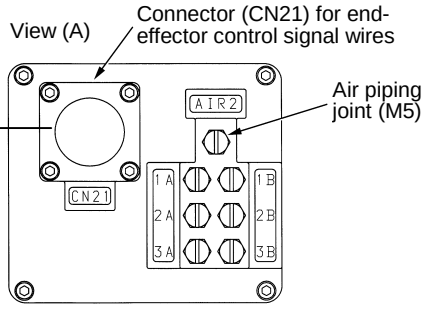
| Connector set part No. | Part No. | Model and part name | Appearance |
|---|---|---|---|
| 410889-0010 | 410877-0120 (for CN20) | H/M3106A22-14S (straight plug) HIROSE ELECTRIC CO., LTD. |  |
| | 410877-0130 (for CN20) | H/MS3057-12A (cord clamp) HIROSE ELECTRIC CO., LTD. | Applicable wire diameter ϕ11.4-15.9  |
| | 410877-0140 (for CN20) | H/MS3057-12A1 (cord clamp) HIROSE ELECTRIC CO., LTD. | Applicable wire diameter ϕ8-11.6 |
| | 410877-0070 (for CN21) | EBLP1610M (L type plug connector) DDK Electronics, Inc. |  |

**Air Piping and Signal Wiring [VM-6070D-W]**

(3) VM-6083D/VM-60B1D

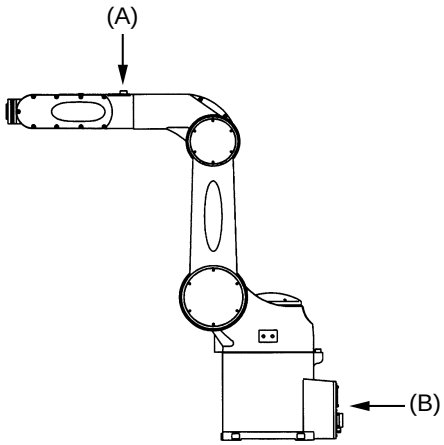
CN21 pin layout



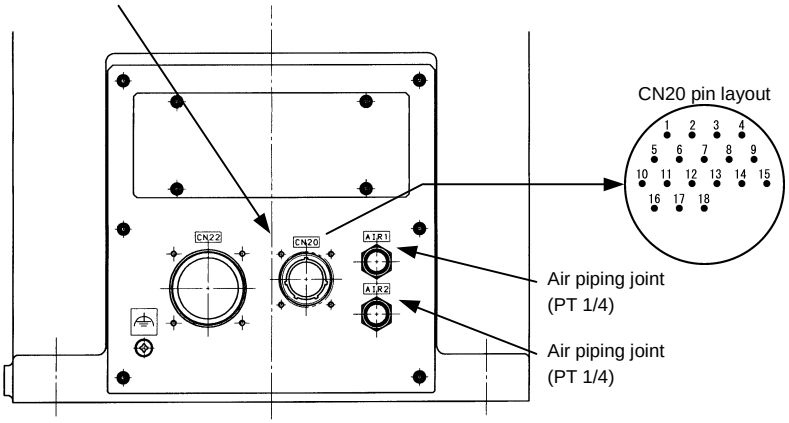

Valve Symbols and Air Intake and Exhaust States
(1A and 1B are piping joint symbols.)

| Air piping joint | | | Valve signal | | |
|---|---|---|---|---|---|
| | Air intake | Exhaust | Solenoid valve | Solenoid | |
| | | | | A | B |
| AIR1 | 1A | 1B | 1 | ON | OFF |
| | 1B | 1A | 1 | OFF | ON |
| | 2A | 2B | 2 | ON | OFF |
| | 2B | 2A | 2 | OFF | ON |
| | 3A | 3B | 3 | ON | OFF |
| | 3B | 3A | 3 | OFF | ON |
| AIR2 | | | | | |




View (B)

Connector (CN20) for end-effector signal/valve control wires




CN20 Pin Assignment

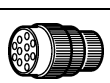
For controller I/O unit, NPN type (source IN, sink OUT)

| CN20 pin No. | Used for: |
|---|---|
| 12 | +24V |
| 13 | Solenoid 1A (solenoid valve 1) |
| 14 | Solenoid 1B (solenoid valve 1) |
| 15 | Solenoid 2A (solenoid valve 2) |
| 16 | Solenoid 2B (solenoid valve 2) |
| 17 | Solenoid 3A (solenoid valve 3) |
| 18 | Solenoid 3B (solenoid valve 3) |

For controller I/O unit, PNP type (sink IN, source OUT)

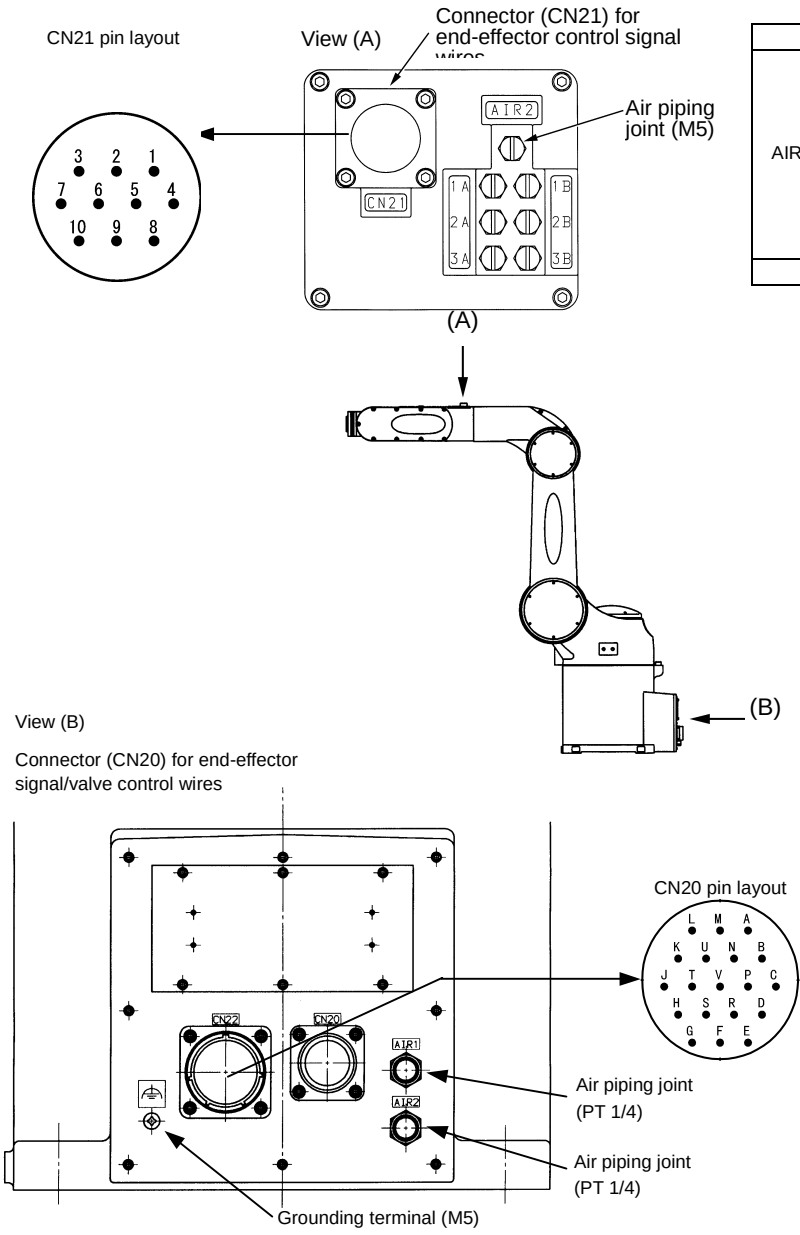
| CN20 pin No. | Used for: |
|---|---|
| 12 | 0V |
| 13 | Solenoid 1A (solenoid valve 1) |
| 14 | Solenoid 1B (solenoid valve 1) |
| 15 | Solenoid 2A (solenoid valve 2) |
| 16 | Solenoid 2B (solenoid valve 2) |
| 17 | Solenoid 3A (solenoid valve 3) |
| 18 | Solenoid 3B (solenoid valve 3) |

Note 1: Pin #1 to #10 on CN21 and those on CN20 are connected with each other. The allowable current per line is 1 A.
Note 2: Use the attached connector sets for CN20 and CN21.

| Connector set part No. | Part No. | Model and part name | Appearance |
|---|---|---|---|
| 410889-0030 | 410877-0170 (for CN20) | SRCN6A25-24S (round type connector) (Japan Aviation Electronics Industry Ltd) |  |
| | 410877-0180 (for CN21) | JMLP1610M (L type plug connector) DDK Electronics, Inc. |  |

**Air Piping and Signal Wiring [VM-6083D/VM-60B1D]**

(4) VM-6083D-W/VM-60B1D-W




Valve Symbols and Air Intake and Exhaust States
(1A and 1B are piping joint symbols.)

| Air piping joint | | | Valve signal | | |
|---|---|---|---|---|---|
| | Air intake | Exhaust | Solenoid valve | Solenoid A | Solenoid B |
| AIR1 | 1A | 1B | 1 | ON | OFF |
| | 1B | 1A | 1 | OFF | ON |
| | 2A | 2B | 2 | ON | OFF |
| | 2B | 2A | 2 | OFF | ON |
| | 3A | 3B | 3 | ON | OFF |
| | 3B | 3A | 3 | OFF | ON |
| AIR2 | | | | | |

CN20 Pin Assignment

For controller I/O unit, NPN type (source IN, sink OUT)

| CN20 pin No. | Used for: |
|---|---|
| M | +24V |
| N | Solenoid 1A (solenoid valve 1) |
| P | Solenoid 1B (solenoid valve 1) |
| R | Solenoid 2A (solenoid valve 2) |
| S | Solenoid 2B (solenoid valve 2) |
| T | Solenoid 3A (solenoid valve 3) |
| U | Solenoid 3B (solenoid valve 3) |

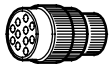
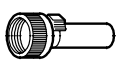
For controller I/O unit, PNP type (sink IN, source OUT)

| CN20 pin No. | Used for: |
|---|---|
| M | 0V |
| N | Solenoid 1A (solenoid valve 1) |
| P | Solenoid 1B (solenoid valve 1) |
| R | Solenoid 2A (solenoid valve 2) |
| S | Solenoid 2B (solenoid valve 2) |
| T | Solenoid 3A (solenoid valve 3) |
| U | Solenoid 3B (solenoid valve 3) |

Note 1: Pins A to K on CN21 and pins #1 to #10 on CN20 are connected with each other as shown below. The allowable current per line is 1 A.

| CN20 | A | B | C | D | E | F | G | H | J | K |
|---|---|---|---|---|---|---|---|---|---|---|
| CN21 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

Note 2: Use the attached connector sets for CN20 and CN21.

| Connector set part No. | Part No. | Model and part name | Appearance |
|---|---|---|---|
| 410889-0010 | 410877-0120 (for CN20) | H/M3106A22-14S (straight plug) HIROSE ELECTRIC CO., LTD. |  |
| | 410877-0130 (for CN20) | H/MS3057-12A (cord clamp) HIROSE ELECTRIC CO., LTD. | Applicable wire dia. ϕ11.4-15.9  |
| | 410877-0140 (for CN20) | H/MS3057-12A1 (cord clamp) HIROSE ELECTRIC CO., LTD. | Applicable wire dia. ϕ8-11.6 |
| | 410877-0070 (for CN21) | EBLP1610M (L type plug connector) DDK Electronics, Inc. |  |

**Air Piping and Signal Wiring [VM-6083D-W/VM-60B1D-W]**

**Solenoid Valve Specifications (VM-D series)**

| | Item | Specifications |
|---|---|---|
| Valve | Switching system | 2-position double |
| | Applicable fluid | Air |
| | Operating system | Pilot type |
| | Effective cross section (Cv value) | 0.27 (P→A/B), 0.3 (A/B→EA/EB) |
| | Lubrication | Oilless |
| | Operating pressure range | 0.1 to 0.7 Mpa |
| | Response time | 10 ms or less (at 0.5 Mpa) |
| | Maximum operating frequency | 10 Hz |
| | Ambient temperature | -5 to 50°C<br>(No dew condensation allowed.<br>When dry air is used) |
| Solenoid | Operating voltage | 24 V ±10% |
| | Power consumption (current) | 0.65 W (27 mA) |
| | Surge voltage protection circuit | Diode |

# 3.5 Precautions When Designing the End-effectors

## ■ VM-D Series

Design an end-effector such that it is in compliance with items (1) to (3) described below.

> **⚠CAUTION** **If the end-effector design precautions are not observed, the clamped parts of the robot unit may become loose, rattle or be out of position. In the worst case, the mechanical parts of the robot and robot controller may become damaged.**

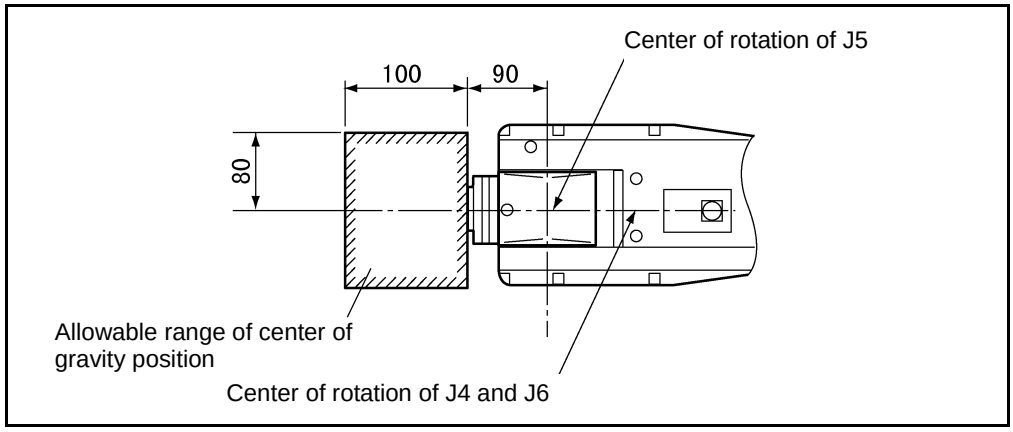
### (1) Mass of end-effector

Design the end-effector so that the total mass of the end-effector (including workpiece) will be less than the maximum payload capacity of the robot. The total mass includes the wiring, piping, etc.

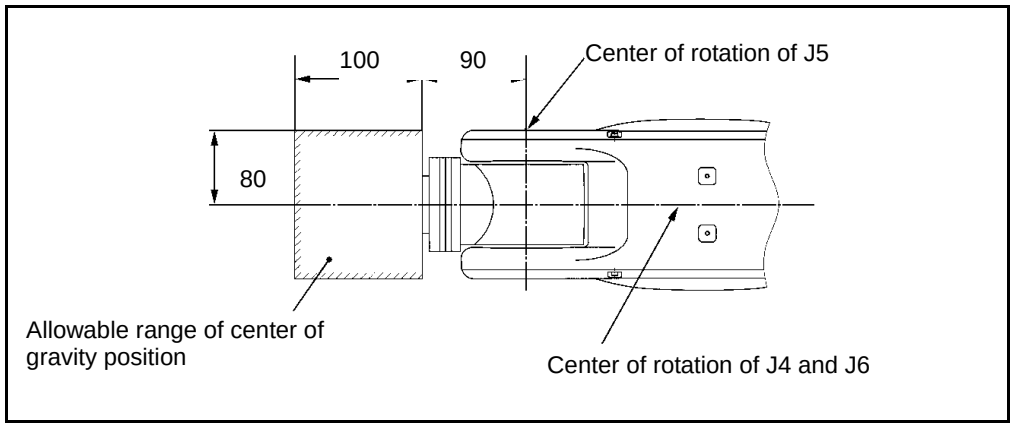
**Maximum total mass of end-effector (including workpiece) ≤ Maximum payload capacity (10 kg)**

### (2) Center of gravity position of end-effector

Design an end-effector so that the position of the center of gravity of the end-effector (including workpiece) is within the range shown in Figure below.




**Allowable Range of Center of Gravity Position [VM-6070D]**




**Allowable Range of Center of Gravity Position [VM-6083D/VM-60B1D]**

### (3) Moment of inertia around J4, J5 and J6

Design an end-effector so that its moments of inertia around J4, J5 and J6 (including workpiece) do not exceed the maximum allowable moment of inertia of the robot.

**Moment of inertia around J4, J5 and J6 of end-effector (incl. mass of workpiece) ≤ Max. allowable moment of inertia (Note)**

**Note (1) Max. allowable moment of inertia around J4 and J5**

| | |
|---|---|
| VM-6070D | 0.25 kgm$^2$ |
| VM-6083D/VM-60B1D | 0.36 kgm$^2$ |

**(2) Max. allowable moment of inertia around J6**

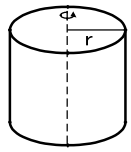
| | |
|---|---|
| VM-6070D | 0.055 kgm$^2$ |
| VM-6083D/VM-60B1D | 0.064 kgm$^2$ |

When calculating the moment of inertia around J4, J5 and J6 of the end-effector, use the formulas given in following table and figure.

**Moment-of-Inertia Formulas (VM-D series)**

1. Cylinder (1)

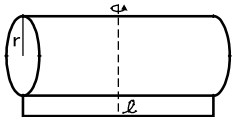
(Axis of rotation = Center axis)




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

2. Cylinder (2)

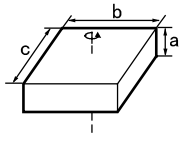
(The axis of rotation passes through the center of gravity.)




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

3. Rectangular parallelepiped

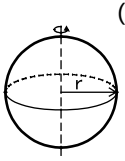
(The axis of rotation passes through the center of gravity.)




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

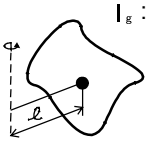
4. Sphere

(Axis of rotation = Center axis)




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

5. Center of gravity not on the axis of rotation




$I_g$ : Inertia moment around center of gravity 〔kgm$^2$〕

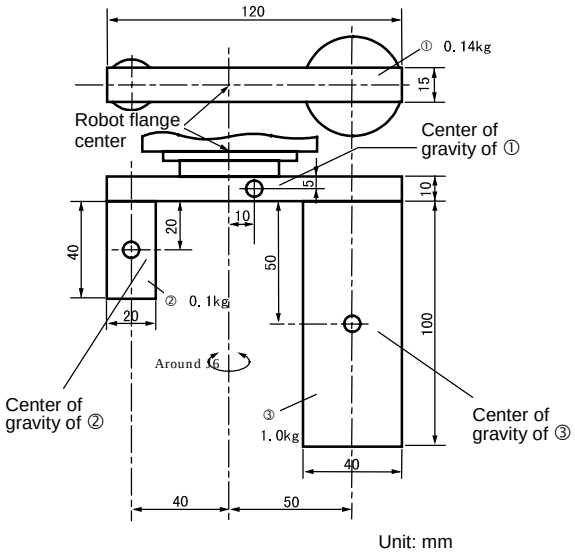
$$I = I_g + m\ell^2$$

I: Moment of inertia 〔kgm$^2$〕
m: Mass 〔kg〕
r: Radius 〔m〕
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 end-effector into three parts (①, ②, ③).

(1) Moment of inertia around J6




Unit: mm

Moment of inertia around J6 of ① : $I_1$ (from 3 and 5 in Table 2-2)

$$I_1 = \frac{0.14}{12}(0.12^2 + 0.015^2) + 0.14 \times 0.01^2$$
$$= 1.85 \times 10^{-4} \ [\mathrm{kgm^2}]$$

Moment of inertia around J6 of ② : $I_2$ (from 1 and 5 in Table 2-2)

$$I_2 = \frac{0.1 \times 0.01^2}{2} + 0.1 \times 0.04^2$$
$$= 1.65 \times 10^{-4} \ [\mathrm{kgm^2}]$$

Moment of inertia around J6 of ③ : $I_3$ (from 1 and 5 in Table 2-2)

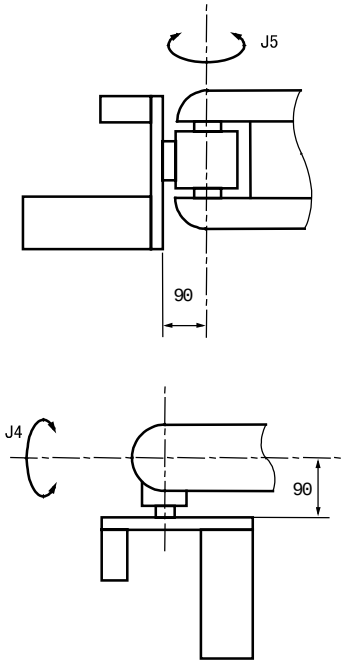
$$I_3 = \frac{1.0 \times 0.02^2}{2} + 1.0 \times 0.05^2$$
$$= 2.7 \times 10^{-3} \ [\mathrm{kgm^2}]$$

Moment of inertia around J6 of entire end-effector: $I_{J6}$

$$I_{J6} = I_1 + I_2 + I_3 = 0.003 \ [\mathrm{kgm^2}]$$

2 Moment of inertia around J4 and J5

For the following figure, the moment of inertia around J4 and J5 can be calculated according to the same formula.




Moment of inertia around J4 and J5 of ① : $I_1$ (from 3 and 5 in Table 2-2)

$$I_1 = \frac{0.14}{12}(0.015^2 + 0.01^2) + 0.14 \times (0.09 + 0.005)^2$$
$$= 1.3 \times 10^{-3} \ [\mathrm{kgm^2}]$$

Moment of inertia around J4 and J5 of ② : $I_2$ (from 2 and 5 in Table 2-2)

$$I_2 = \frac{0.1}{4}\left(0.01^2 + \frac{0.04^2}{3}\right) + 0.1 \times (0.09 + 0.01 + 0.02)^2$$
$$= 1.46 \times 10^{-3} \ [\mathrm{kgm^2}]$$

Moment of inertia around J4 and J5 of ③ : $I_3$ (from 2 and 5 in Table 2-2)

$$I_3 = \frac{1.0}{4}\left(0.02^2 + \frac{0.1^2}{3}\right) + 1.0 \times (0.09 + 0.01 + 0.05)^2$$
$$= 2.3 \times 10^{-3} \ [\mathrm{kgm^2}]$$

Moment of inertia around J4 and J5 of entire end-effector: $I_{J4}$, $I_{J5}$

$$I_{J4} = I_{J5} = I_1 + I_2 + I_3 = 2.6 \times 10^{-2} \ [\mathrm{kgm^2}]$$

**End-effector Moment of Inertia Calculation Example (VM-D series)**

# Chapter 4
# Specifications of the Robot Controller

## 4.1 Robot Controller Specifications

### [ 1 ] Specifications

Table below lists the robot controller specifications.

**Robot Controller Specifications (VM-D series)**

| Item | | Specifications |
|---|---|---|
| Applicable robot | | Medium-sized, vertical articulated type (VM-D series) |
| Model | | RC5-VM6A (VM-6070D), RC5-VM6B (VM-6083D/VM-60B1D) |
| Control system | | PTP, CP 3-dimensional linear, 3-dimensional circular |
| No. of controllable axes | | Up to six axes simultaneously |
| Drive system | | All axes: Full-digital AC servo |
| Memory capacity | | 1.25 MB (equivalent to 5000 steps, 13,000 points) |
| Language used | | DENSO robot language (conforming to SLIM) |
| No. of teach programs loadable to the memory | | 255 |
| Teaching system | | 1) Remote teaching 2) Numerical input (MDI) |
| External signals (I/O) | Input signal | 20 user open points (PLC 12, hand input 8) + 36 fixed system points |
| | Output signal | 32 user open points (PLC 24, hand output 8) + 33 fixed system points |
| External communication | | RS-232C: 1 line<br>Ethernet: 1 line (option) |
| Timer function | | 0.02 to 10 sec. (in units of 1/60 sec.) |
| Self-diagnosis function | | Overrun, servo error, memory error, input error, etc. |
| Error display | | Error codes will be displayed on the external I/O or the operating panel (option).<br>Error messages will be displayed in English on the teach pendant (option). |
| Power source | | 3-phase, 200 VAC-15% to 230 VAC+10%, 50/60 Hz, 3.3 kVA |
| Environmental conditions (in operation) | | Temperature: 0 to 40°C<br>Humidity: 90% RH or less (no condensation allowed) |
| Degree of protection | | IP20 |
| Cables | Robot control cable | Standard: 4 m, 6 m<br>High strength: 6 m, 12 m (selective) |
| | I/O cable | 8 m, 15 m (option) |
| | Power cable | 5 m |
| Weight | | Approx. 19 kg (excluding attached cables) |

**⚠WARNING**

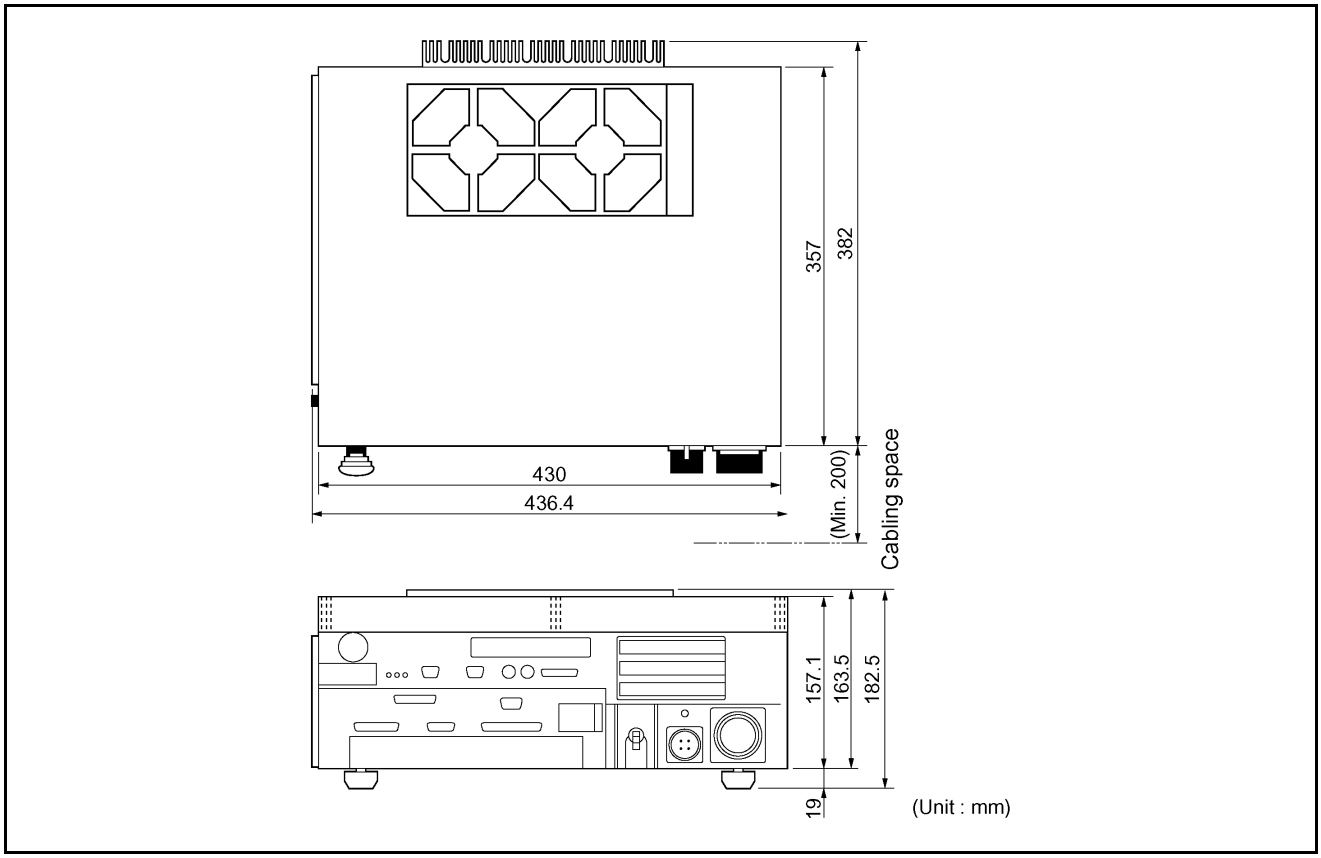
- **DO NOT touch fins. Their hot surfaces may cause severe burns.**
- **DO NOT insert fingers or foreign objects into openings. Doing so may cause bodily injury.**
- **Before opening the controller cover and accessing the inside of the controller for maintenance, be sure to turn off the power switch, disconnect the power cable, and wait 3 minutes or more. This is for protecting you from electric shock.**
- **DO NOT connect or disconnect connectors to/from the controller while the power switch is on. Doing so may cause electric shock or controller failure.**

**⚠ CAUTION IN INSTALLATION**

- **This controller is not designed to be dust-proof, splash-proof, or explosion-proof.**
- **Read operation manuals before installation.**
- **Do not place anything on the controller.**

## 4.2 Outer Dimensions

Figure below shows the outer dimensions of the robot controller.




**Outer Dimensions of Robot Controller (VM-D series)**

# 4.3 Controller Setting Table

The controller setting table given in Figure on next page is attached to the controller. It shows the parameters that are set before delivery of the robot, as well as the next replacement dates of the memory backup battery and encoder backup battery.

- Parameters (① in Figure)
  Shows only parameters changed from typical values. Blanks indicate that the typical values are set.
  For further information about parameters, see "INSTALLATION & MAINTENANCE GUIDE, Chapter 2" Customizing Your Robot.
- Main software Ver. (② in Figure)
  Shows the version of the main software for the controller.
- Sub software Ver. (③ in Figure)
  Shows the version of the control software.
- Battery replacement date (④ in Figure)
  Shows the next battery replacement date.
- SER No. (⑤ in Figure)
  Shows the serial number of the robot.
- TYPE (⑥ in Figure)
  Shows the model of the robot set. Its coding system is described below:

**Medium-sized, vertical articulated type (VM-D series)**

VM -6 0 70 D-W / E

- Language
  - E: English
  - J: Japanese
- Variation
  - None: Standard type
  - W: Dust-proof & splash-proof type
- Arm length
  - 70: 700 mm
  - 83: 830 mm
  - B1: 1100 mm
- Maximum payload (10 kg)
- Number of axes (6 axes)
- Medium-sized, vertical articulated robot

## コントローラ設定表/THE SETPRM LIST

注記1.標準値から変更された個所のみ値を示します。空欄のものは標準値が設定されています。
　　2.パラメータ値を変更した場合は、必ず下表の値の書き直し、または記入をしてください。
Note1.Only the different value from the defaults of the SETPRM are written. The blank means default.
　　2.Write the new values on this list when you modify the SETPRM values.

① 1 パラメータ/PARAMETER

| パラメータ PARAMETER | | 値 VALUE |
|---|---|---|
| 正方向ソフトリミット PLIM | 1 | |
| | 2 | |
| | 3 | |
| | 4 | |
| | 5 | |
| | 6 | |
| | 7 | |
| | 8 | |
| 負方向ソフトリミット NLIM | 1 | |
| | 2 | |
| | 3 | |
| | 4 | |
| | 5 | |
| | 6 | |
| | 7 | |
| | 8 | |
| RANG | 1 | |
| | 2 | |
| | 3 | |
| | 4 | |
| | 5 | |
| | 6 | |
| | 7 | |
| | 8 | |
| I/Oモード I/O MODE | | |

② メインソフト Ver.
MAIN SOFTWARE Ver.

③ サブソフト Ver.
SUB SOFTWARE Ver.

④ 電池交換日
DATE OF RENEWING BAT.

⑤ SERIAL No.

⑥ TYPE

2 サブアッセンブリ/SUBASSEMBLY

| 名称 BOARD | 型式 BOARD TYPE | 備考 REMARK |
|---|---|---|
| メインボード MAIN BOARD | RP227 | |
| I/Oボード I/O BOARD | RP228, 229 | |
| 電源ボード POWER SUPPLY BOARD | RP214A,B | |
| ハーネスボード HARNESS BOARD | RP231 | |
| NFボード NF BOARD | RP235A | |
| コンパクトABSボード C-ABS BOARD | RP240A | |
| ブレーキリレーボード BRAKE RELAY BOARD | RP242 | |
| 回生抵抗ボード RESISTER BOARD | RP243 | |
| IPMボード (L) IPM BOARD (L) | RP232 | |
| IPMボード (M) IPM BOARD (M) | RP232 | |
| IPMボード (S) IPM BOARD (S) | RP232 | |
| IPMボード (SS) IPM BOARD (SS) | RP232 | |
| 拡張ボード1 EXTENSION BOARD 1 | | |
| 拡張ボード2 EXTENSION BOARD 2 | | |
| 拡張ボード3 EXTENSION BOARD 3 | | |
| メモリボード MEMORY BOARD | RP234 | |
| FD | | |

3 その他の変更点/OTHER MODIFICATIONS

**Controller Setting Table**

# Chapter 5 Warranty

DENSO robots are manufactured under strict quality control. In case of failure, we warranty the robot under the following conditions:

## Warranty Period

The warranty shall be effective for one year from the date of purchase.

## Warranty Coverage

DENSO WAVE shall repair the robot free of charge when a failure occurs and is attributable to the design, manufacture or material of the robot within the warranty period in spite of proper use.

## Items Not Covered

Failures, which arise from one of the following, shall not be covered by the warranty even if the robot is under warranty:

(1) Failures caused by improper repair, modification, transfer or handling by you or a third party;

(2) Failures caused by the use of a part or oil/fat other than those specified in the related manuals;

(3) Failures caused by a fire, salt damage, earthquake, storm/flood or other acts of God;

(4) Failures caused by the use of the robot in an environment other than the environment specified in the related manuals, such as dust and water ingress;

(5) Failures caused by a worn-out consumable, such as a fan filter;

(6) Failures caused by improper performance or non-performance of lubrication, maintenance or inspections stated in this owner's manual; and

(7) Damages other than the robot repair costs.

# Appendix How to Use the Manual Pack CD

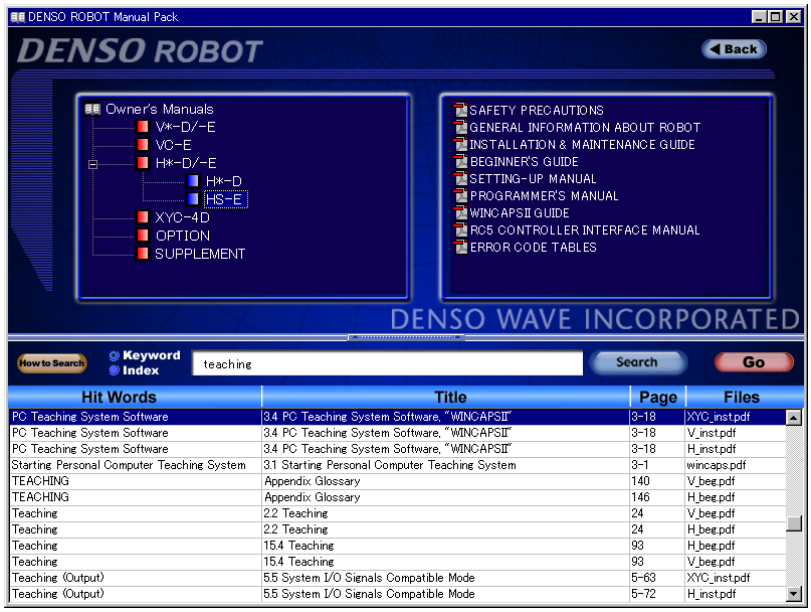
## — A convenient and easy-to-use electronic manual! —

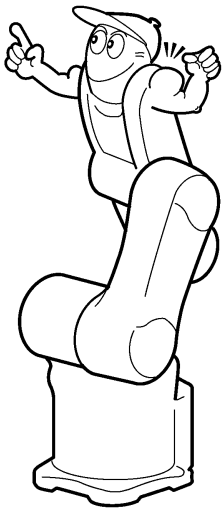
There are a number of electronic manuals for Denso robots included in this manual pack CD. Using the top screen shown below, it is possible to view a list of all the manuals for a robot series and then select and open the manual you want to view.

In this new manual pack, the search function, which is the key component of electronic manuals, has been further improved. The scope of the search function has been enhanced so that by using a keyword and index, it is possible to perform searches of individual manuals, all manuals related to a particular robot series or of all the manuals included in the manual pack CD. With the keyword search, it is also possible to perform a search using two or more words (AND search).

How to call up the top screen is described in "1. Using this electronic manual," and how to perform searches in "2. Performing a keyword search" and "3. Using the index."

(The screens shown in the descriptions that follow may differ slightly to those actually displayed.)



## — Electronic manuals are much easier to use than printed ones! —

### Printed Manuals

Any number of manuals

Search for the desired term in the index and search the corresponding page(s) after the term has been located.

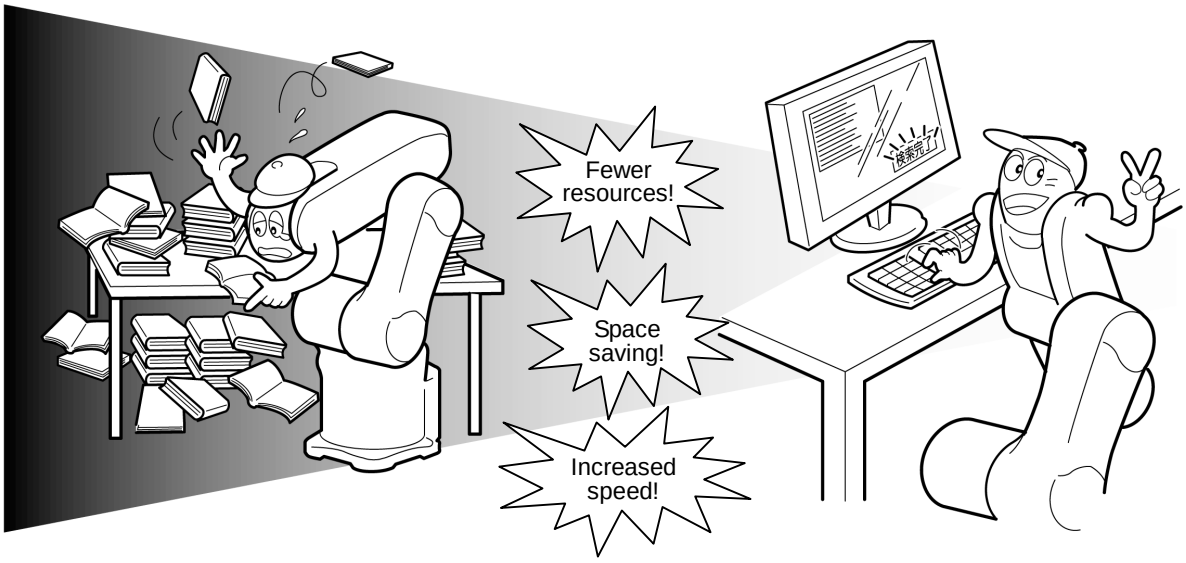
Search is confined to one manual at a time.

### Electronic Manuals

A single CD

Simply type the desired term on the top screen, and a list of pages where the term can be found will be displayed. Double-click on any item in the list to display the corresponding page.

- Search all manuals at once
- Search all manuals within a specific robot series
- Search each manual individually



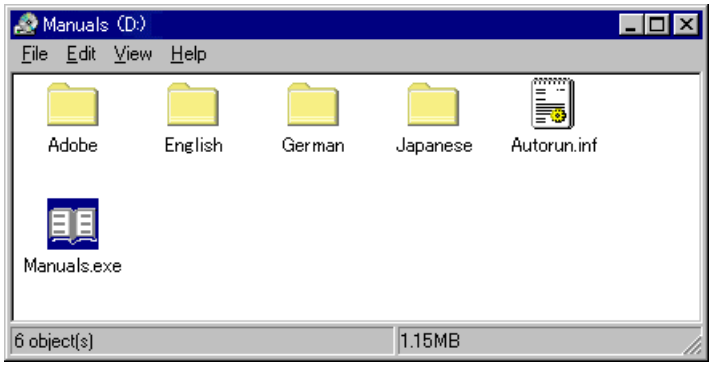
# 1. Using this electronic manual


(1) Insert the manual pack CD into your computer.

The top screen shown at left appears.

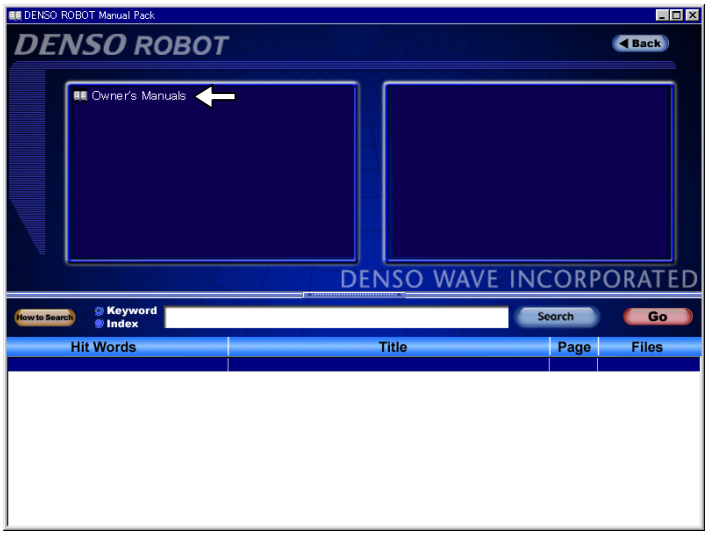
(2) Choose either of the English or Japanese version of the manuals. (In this example, select ENGLISH.)

The electronic manuals included in the manual pack CD are PDF files, just as with the previous NetwoRC CD version and require Acrobat Reader 4.0 or higher to be installed. If Acrobat Reader 4.0 or higher has not been installed on your computer, install it according to the following steps:

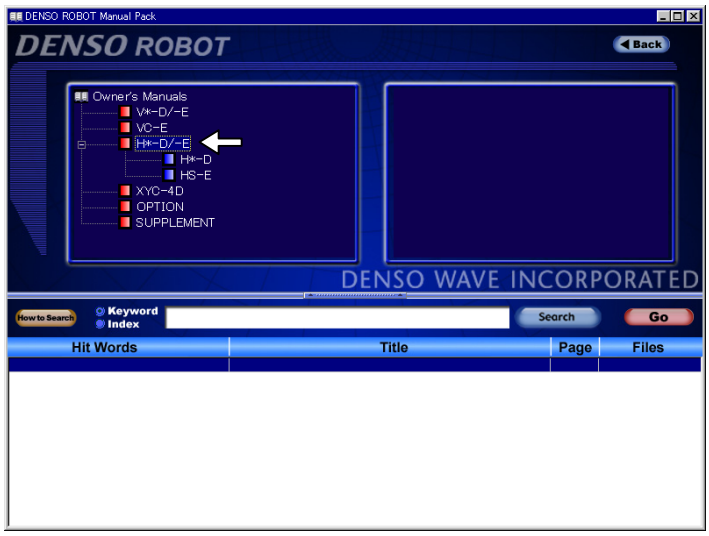



1) Double-click **My Computer** in Windows to open it.
2) Select the drive where the manual pack CD is loaded. On the File menu, point to Open.
3) All the contents of the manual pack CD appear as shown at left. Double-click on the Adobe folder and then click the **Ar405eng.exe** to install Acrobat Reader.

Clicking  on this screen will call up the top screen shown in step (1).




(3) Double-click on **Owner's Manuals**.




(4) In this example, double-click on **H*-D/-E** to display the horizontal articulated robot series.

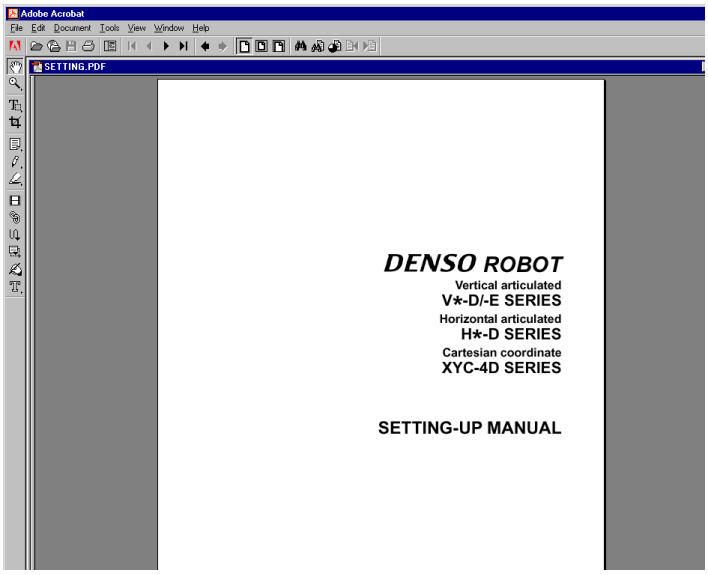

(5) Click on the robot series you want to refer to.

This time, click on **HS-E**.

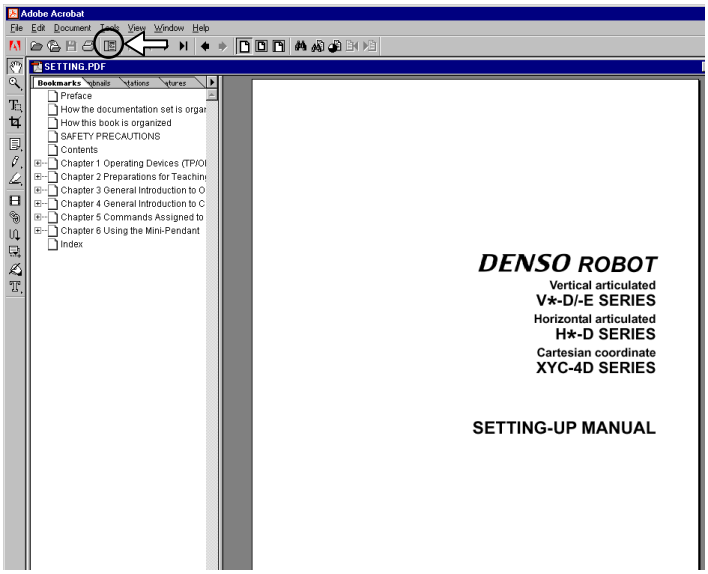
All related manuals will appear in the window on the right.


(6) Click on the manual you want to refer to.

In this example, click on **SETTING-UP MANUAL**.




The SETTING-UP MANUAL is opened.

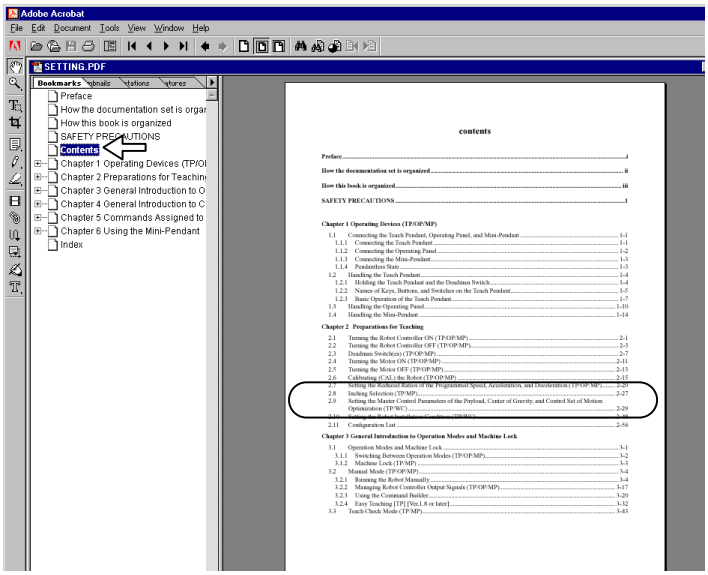



These manuals are all PDF files. As with previous versions of electronic manuals, you can select from "Bookmarks," "Contents" or "Index." (You can also select "Commands List" in the Programmer's Manuals.)

## ■ Bookmarks

Click on  on the tool bar to call up the list of bookmarked items.

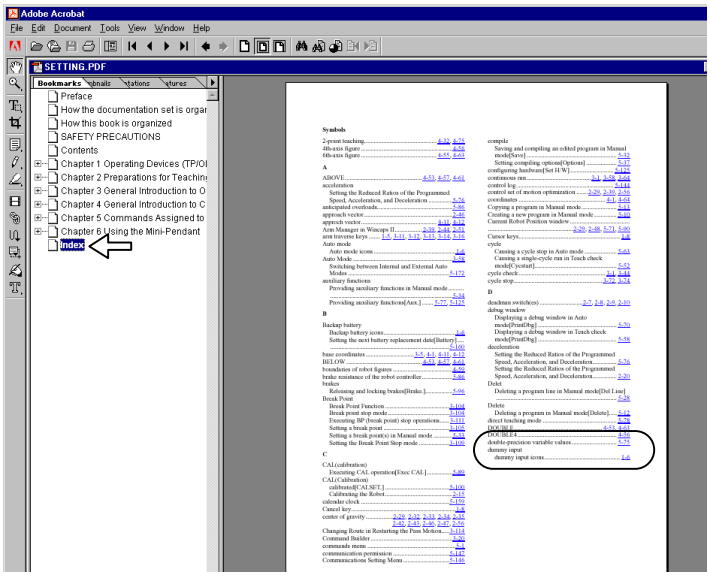
Click on the desired item in this list to display the corresponding page.




## ■ Contents

Click on **Contents** in the list of bookmarked items.

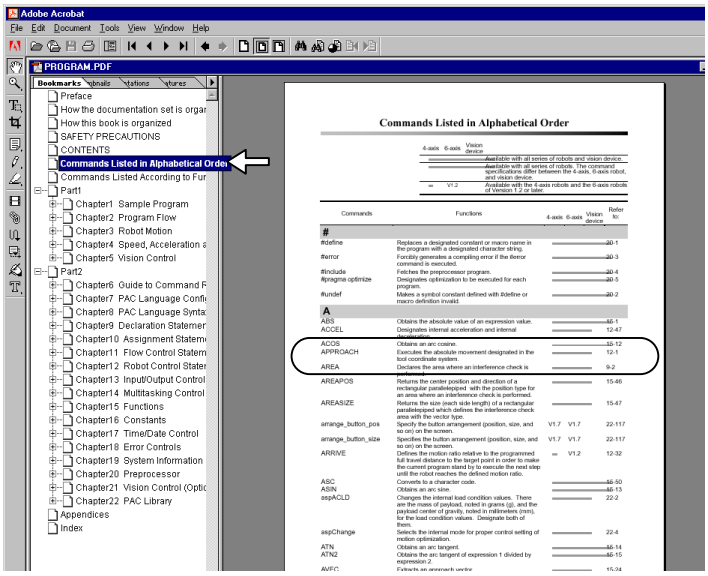
In the table of contents, place the arrow pointer over the page you want to view (the arrow pointer will change to a finger pointer over pages which have an active link) and click to open that page.




## ■ Index

Click on **Index** in the list of bookmarked items to open the index page.

In the index page, place the arrow pointer over the page you want to view (the arrow pointer will change to a finger pointer over pages which have an active link) and click to open that page.




## ■ Command List

Two types of command lists are provided in the Programmer's Manuals.

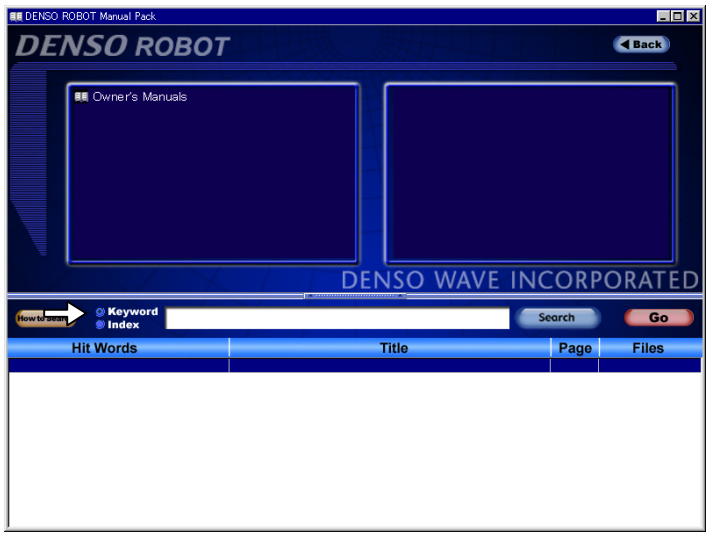
Click on **Commands Listed in Alphabetical Order** or **Commands Listed According to Functions** in the list of bookmarked items to display the corresponding list.

Place the arrow pointer over the page containing the command you want to view (the arrow pointer will change to a finger pointer over pages which have an active link) and click to open that page.

# 2. Performing a keyword search

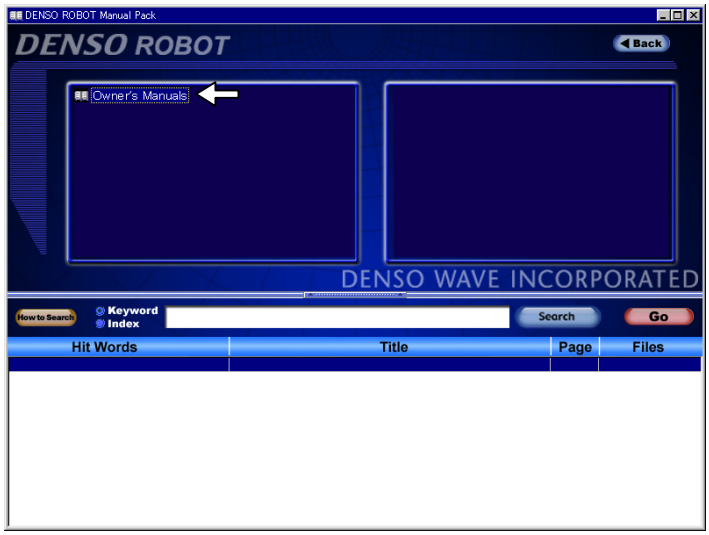
In previous versions of electronic manuals, searches were limited to one manual at a time. In this new manual pack CD, however, it is possible to select the scope of the search. In other words you can set the scope to meet your needs, such as "Search manuals related to the selected robot series," "Search all manuals related to the horizontal (vertical) articulated robot series" and "Search all manuals included on the manual pack CD."

---




(1) Click on **Keyword**.

---




(2) Select the scope of the search.

If the search to be performed is going to be "Search all manuals included on the manual pack CD," for example, click on **Owner's Manuals**.

If it is going to be "Search manuals related to the horizontal articulated robot series," for example, click on **H∗-D/-E**.

If it is going to be "Search manuals related to the selected robot series," for example, click on **HS-E**.

In this example, click on **Owner's Manuals**.

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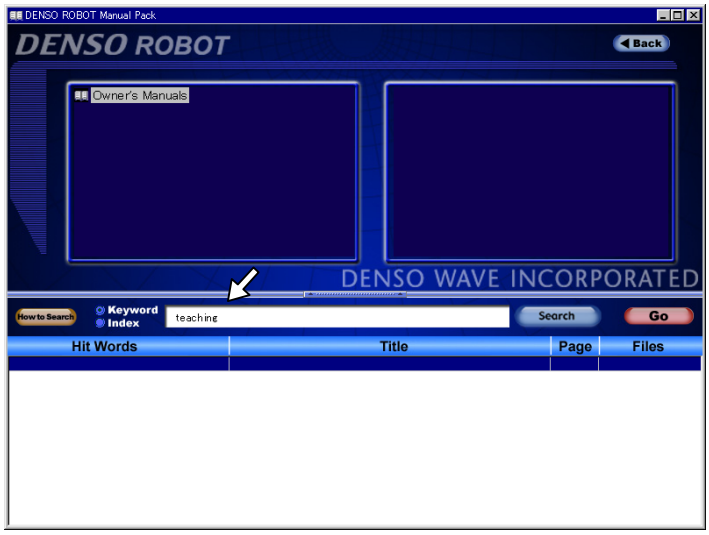
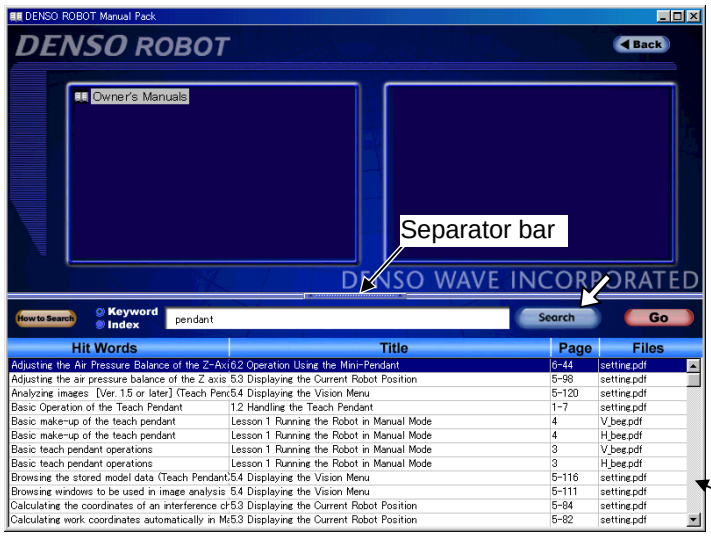



(3) Type the keyword for the search. This time, type "teaching."

If, for example, it is going to be an AND search and you want to include "teaching" and "connections," enter the two words separated by a space.

It is also possible to use wildcards. If you type "*pendant," for example, both mini pendant and teaching pendant will be included in the search.



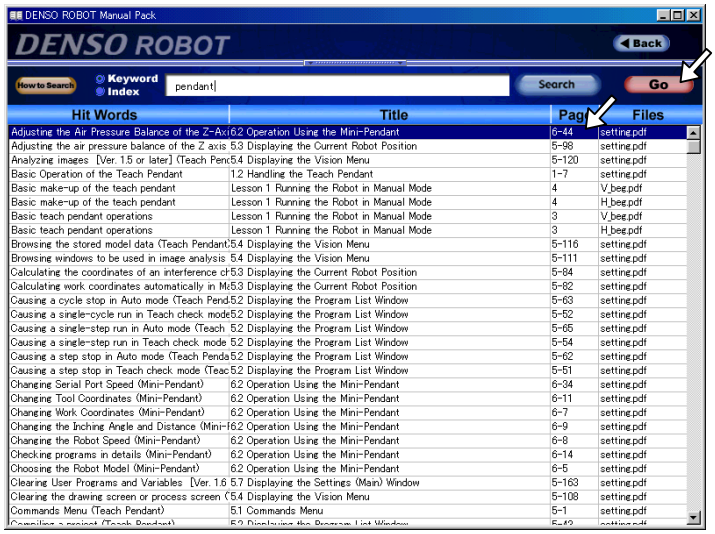

(4) Click on the **Search** button or press the Enter key.

All hit words will display, followed by titles, pages, and file names that contain those hit words.

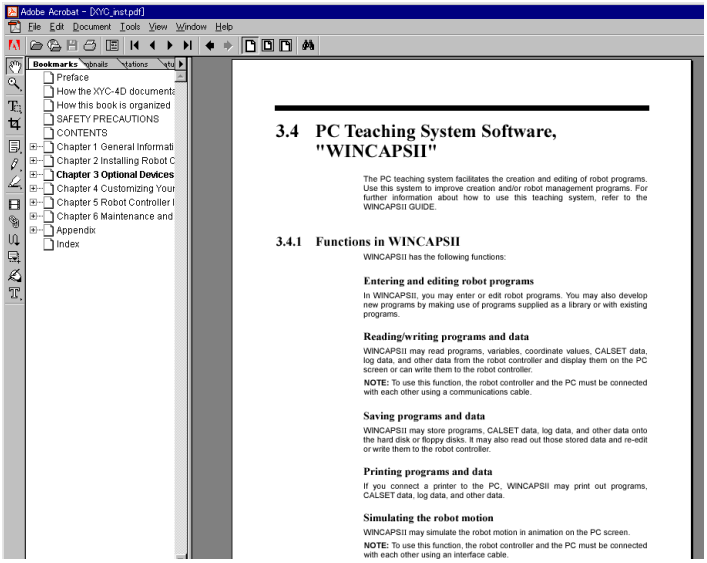
If there are so many hit words that do not fit inside the current search window, click on the separator bar. The search window will be enlarged to its maximum size. (You may drag the separator bar to adjust the search window to the desired size.)

Clicking the separator bar again will return the enlarged window to its previous size.

You may also scroll through all hit words with the vertical scroll bar.




(5) Select the item you want to view and click on the **Go** button or double-click on the highlighted line itself.




The page containing the specified keyword is opened.

# 3. Using the Index

In previous versions of electronic manuals, the index was simply a list of the vocabulary found in the manual which was attached to the end. In this new manual pack CD, the index can be included as the scope of the search in the same way as a keyword. You can select the type of index to be viewed to meet your needs, such as "Indexes of manuals related to the selected robot series," "Indexes of all manuals related to the horizontal (vertical) articulated robot series" and "Indexes of all manuals included on the manual pack CD."

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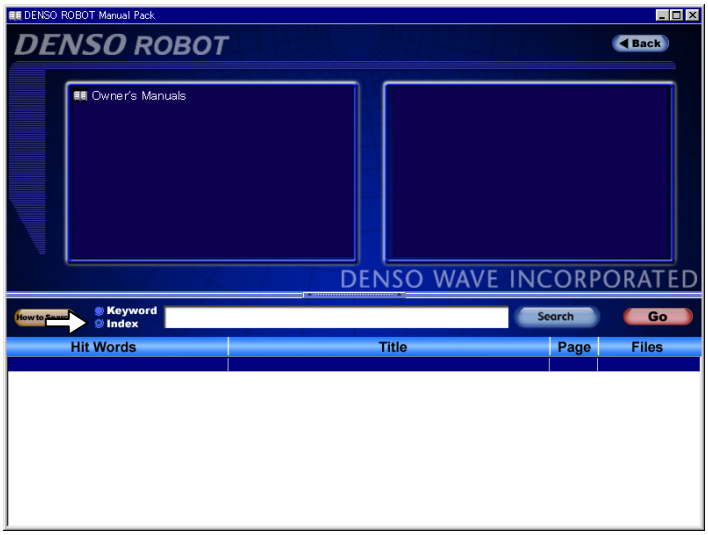


(1) Click on **Index**.

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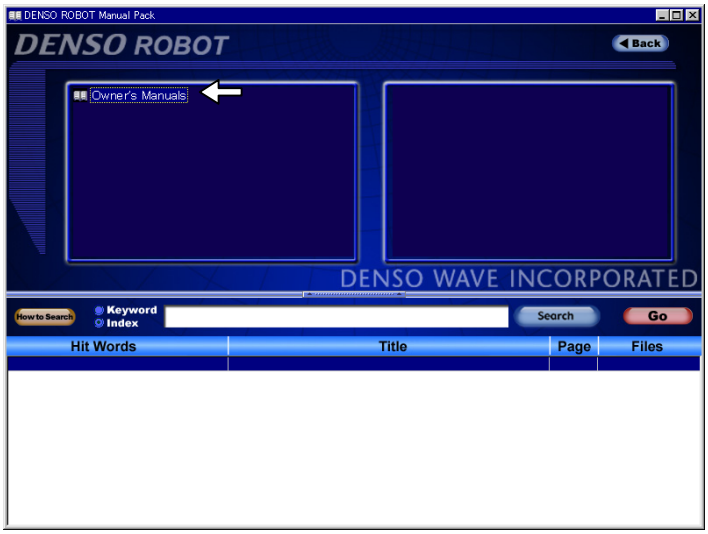


(2) Select the type of the index(es).

If you want to view "Indexes of all manuals included on the manual pack CD," for example, click on **Owner's Manuals**.

If you want to view "Indexes of manuals related to the horizontal articulated robot series," for example, click on **H∗-D/-E**.

If you want to view "Indexes of manuals related to the selected robot series," for example, click on **HS-E**.

In this example, click on **Owner's Manuals.**

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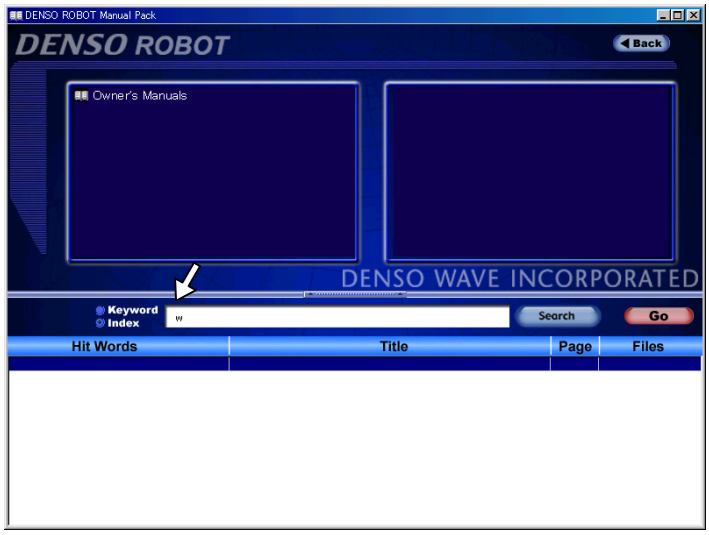
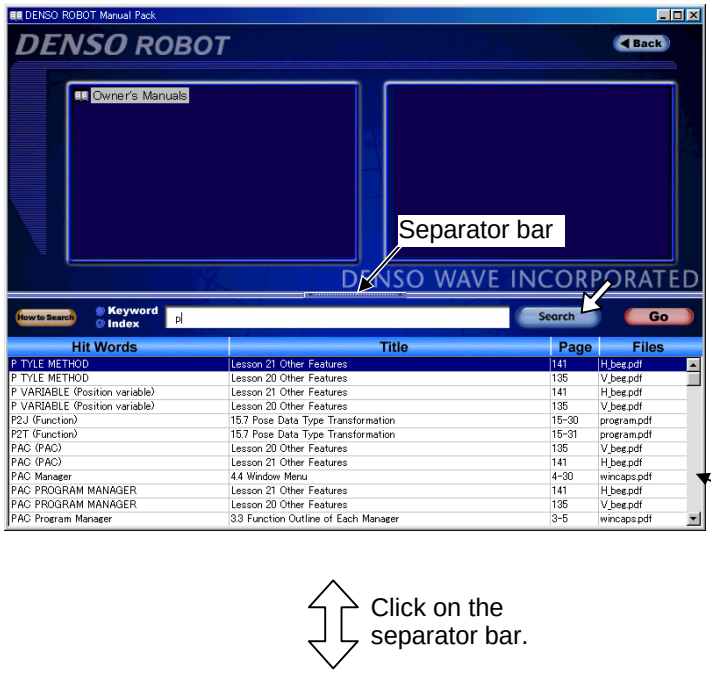



(3) Type a single letter to choose the part of the index(es) you want to view. In this example, type "w."

It is also possible to search within the index(es) you want to view. For example, within the "w" part of the index(es), it is possible to further define your search to view items which also include "command" by inputting "w" and "command" separated by a space. In this example, the page containing "WAIT Command" will be displayed.



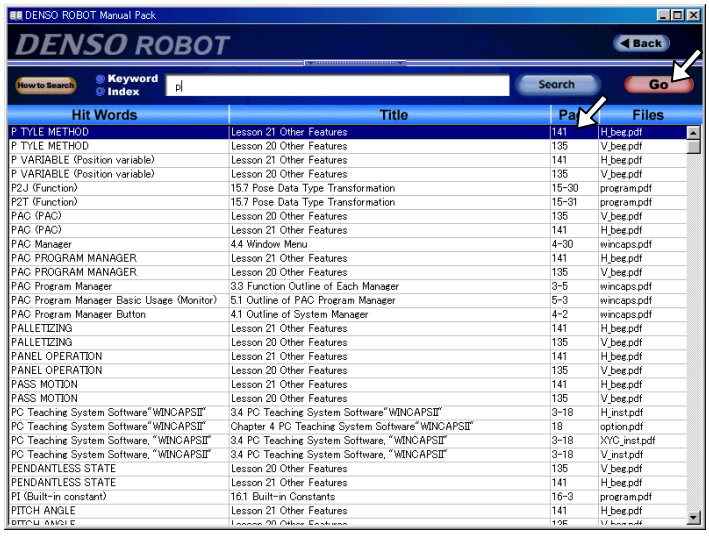

(4) Click on the **Search** button.

In this example, all hit words starting with "w" in the index(es) selected will be displayed, followed by titles, pages, and file names that contain those hit words.

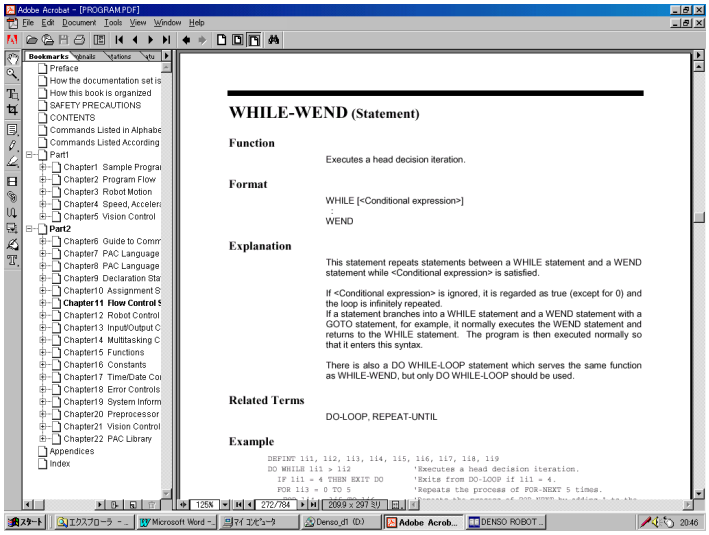
If there are so many hit words that do not fit inside the current search window, click on the separator bar. The search window will be enlarged to its maximum size. (You may drag the separator bar to adjust the search window to the desired size.)

Clicking the separator bar again will return the enlarged window to its previous size.

You may also scroll through all hit words with the vertical scroll bar.




(5) Select the item you want to view and click on the **Go** button or double-click on the highlighted line itself.




The page containing the word you want to view, which was searched from the index(es), is opened.

# Index

# Vertical Articulated Robot
# VM-D SERIES

## GENERAL INFORMATION ABOUT ROBOT

First Edition September 2002

DENSO WAVE INCORPORATED
Factory Automation Division

9D30C

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.