DENSO ROBOT

Vertical articulated
VS-*** Series
(VS-050 / VS-060 / VS-068 / VS-087)

INTRODUCTION GUIDE TO ROBOT

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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
VS-*** (Small-sized, vertical articulated)	VS-050 VS-060 VS-068 VS-087

Important

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

NOTE:

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

How this book is organized

This book consists of the following chapters.

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

Outlines the configuration of the robot system and describes the options.

Chapter 3 Specifications of the Robot Unit

Describes the specifications, signal wiring and air piping, and engineering-design notes for robot hands.

Chapter 4 Installation of Robot

Provides information about physical site planning, installation procedures, and brake release procedures.

Chapter 5 Limiting the Motion Range

Describes the instructions on how to change the motion range of the robot unit.

Chapter 6 Maintenance and Inspection

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

Chapter 7 Warranty

Provides the warranty information.

Chapter 8 Appendixes

Provides the drawings of the robot unit, robot positioning time for calculation of cycle times, and other related data.

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Chapter 1 Packing List of the Robot

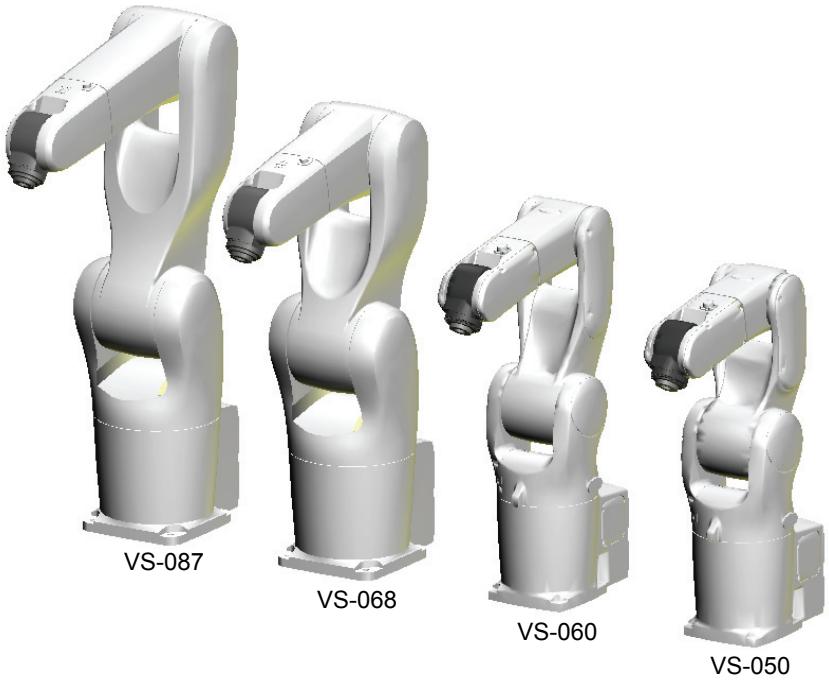
1.1 Standard Components

The components listed below are contained in the product package.

1.1.1 List of Standard Components

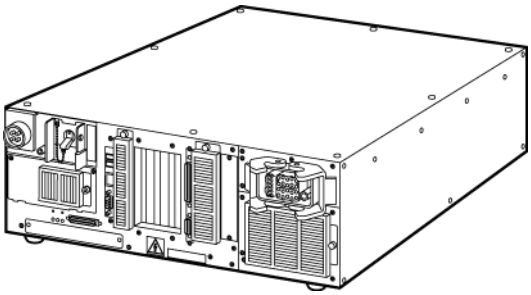
Item	Q'ty
Robot unit	1
Robot controller	1
Power cable (5 m)	1
Motor & encoder cable (option)	1
Manuals ("Manual Pack CD" and "Safety Precautions")	1 set
WINCAPS III trial version installer CD	1
Spare fuses for robot controller	3
Pendantless connector (Dummy connector)	1
Sheet of direction indicator labels	1
Warning label	1
Spare output IC for robot controller	1
Dowel pins (internally threaded positioning pin and diamond-shaped pin)	1 set
Short sockets for robot controller	2
Stopper bolts for J2/J3 mechanical ends	4

[1] Robot unit



Robot units

[2] Robot controller



RC7M controller that controls the robot unit

[3] Power cable

Cable that supplies power to the robot controller
it is 5 m long.

[4] Motor & encoder cable

Cable that connects the robot unit to the robot controller, consisting of a motor cable and an encoder cable

When placing an order for a robot system, select a motor & encoder cable from the list given below.

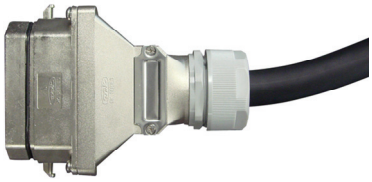
Item	Part No.
Motor & encoder cable RC7-B, 2 m	410141-4560
Motor & encoder cable RC7-B, 4 m	410141-4570
Motor & encoder cable RC7-B, 6 m	410141-4580
Motor & encoder cable RC7-B, 12 m	410141-4590
Motor & encoder cable RC7-B, 20 m (*)	410141-4600

* The 20-m motor & encoder cable RC7-B is not available for controllers equipped with extended-joint options.

NOTE

The bending radius (internal) of a motor & encoder cable should be at least 33.8 mm when the cable is stationary, and at least 225 mm when it is movable. Excessively bending will result in broken lead wires.

Connector to join the cable to the robot unit

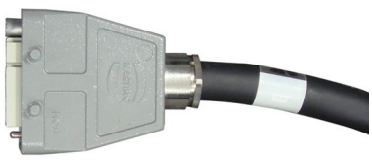


This is IP67 rated when it is connected.

NOTE

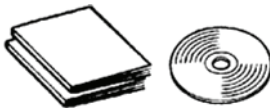
Do not touch the O-ring on the connection face.

Connector to join the cable to the robot controller



This is not IP67 rated.

[5] Manuals ("Manual Pack CD" and "Safety Precautions")



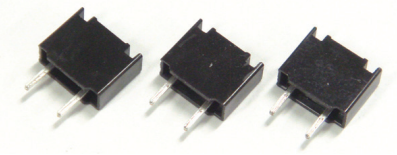
Manual pack CD containing the manuals (specifications and handling instructions) and printed material "Safety Precautions"

[6] WINCAPS III trial version installer CD

Installer CD containing the trial version (functionally limited) of the programming support tool WINCAPS III

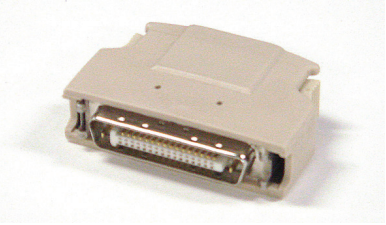
For details, refer to the WINCAPS III Guide.

[7] Spare fuses for robot controller



Spare fuses to be used for the I/O board in the robot controller

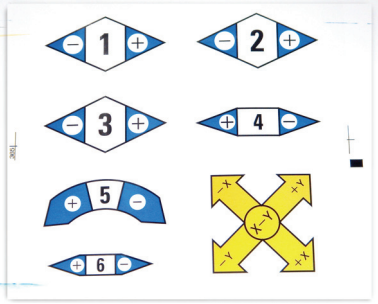
[8] Pendantless connector (Dummy connector)



Connector to be plugged in the controller when neither the teach pendant (TP) nor the mini-pendant (MP) is connected

For details, refer to the Setting-up Manual.

[9] Sheet of direction indicator labels



Labels that indicate the motion directions of individual axes.

⚠CAUTION

After installation, attach the direction indicator labels in a position on the robot unit that can be easily seen.

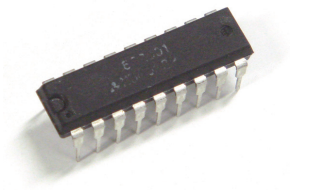
[10] Warning label

Label that indicates the danger of the robot motion space for prohibiting people from entering it.

⚠CAUTION

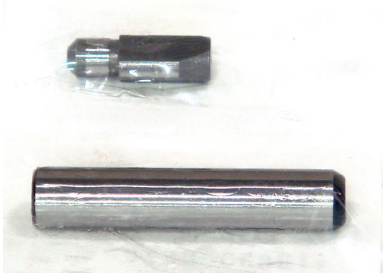
Attach the warning label on the robot safety fence or other location where people easily notice it. If necessary, prepare a plate for attaching the label.

[11] Spare output IC for robot controller



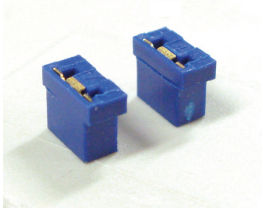
Spare output IC for mini I/O

[12] Dowel pins (internally threaded positioning pin and diamond-shaped pin)



Pins to determine the mounting position of the robot unit

[13] Short sockets for robot controller



Short sockets to change the configuration of the internal/external power supply of the mini I/O

[14] Stopper bolts for J2/J3 mechanical ends

Stopper bolts to change the mechanical ends on the 2nd and 3rd axes

VS-050/060: Two M8 bolts (with bolt head of ϕ6) for J2 and two M5 bolts (with bolt head of ϕ4) for J3 come with the robot unit.

VS-068/087: Four M10 bolts (with bolt head of ϕ7.5) common to J2 and J3 come with the robot unit.

Please contact your DENSO representative for more details.

1.2 Optional Components

1.2.1 List of Optional Components

The table below lists the optional components available. Purchase them as needed.

I/O cables

Item	Remarks	Part No.
Standard I/O cable set	Consisting of 8-m I/O cables for "Mini I/O" and "HAND I/O."	410149-0940
	Consisting of 15-m I/O cables for "Mini I/O" and "HAND I/O."	410149-0950
I/O cable for "Mini I/O" (68 pins)	8 m	410141-2700
	15 m	410141-2710
I/O cable for "HAND I/O" (20 pins)	8 m	410141-1740
	15 m	410141-1750
I/O cable for "Parallel I/O board" (96 pins)	8 m	410141-3050
	15 m	410141-3060
I/O cable for "SAFETY I/O" (36 pins) (For global type of controllers)	8 m	410141-3580
	15 m	410141-3590

Operation devices

Item	Remarks		Part No.
Teach pendant	With 4 m cable		410100-1572
	With 8 m cable		410100-1582
	With 12 m cable		410100-1592
Mini-pendant kit (Incl. cable and WINCAPS III Light version)	With 4 m cable	Japanese language version	410109-0392
		English language version	410109-0402
	With 8 m cable	Japanese language version	410109-0412
		English language version	410109-0422
	With 12 m cable	Japanese language version	410109-0432
		English language version	410109-0442
Pendant extension cable	4 m	For TP / MP	410141-3711
	8 m	For TP / MP	410141-3721

Programming support tool

Item	Remarks	Part No.
WINCAPS III CD-ROM	Several languages supported (common to the languages--Japanese, English, German, Korean, and Chinese)	410090-0980

Optional boards for the robot controller RC7M

Item	Remarks		Part No.
Parallel I/O board	Shipped after integrated in the controller	NPN	410010-3320
		PNP	410010-3330
	Shipped separately as a spare part	NPN	410010-3340
		PNP	410010-3350
DeviceNet board	Shipped after integrated in the controller	For slave station	410010-3370
		For master station	410010-3380
		For master and slave stations	410010-3390
	Shipped separately as a spare part	For slave station	410010-3400
		For master station	410010-3410
		For master and slave stations	410010-3480
CC-Link board	Shipped after integrated in the controller		410010-3430
	Shipped separately as a spare part		410010-3440
Conveyor tracking board	Shipped after integrated in the controller		410010-3460
	Shipped separately as a spare part		410010-3470

Optional functions (for extension boards arranged by customers)

Item	Remarks	Part No.
RS-232C extension interface Manufactured by: CONTEC Co., Ltd. Model: COM-2P (PCI) H	Added at the time of shipment of the controller	410006-0260
	Added when the board is separately purchased	410006-0270
S-LINK V Manufactured by: SUNX Co., Ltd. Model: SL-VPCI	Added at the time of shipment of the controller	410006-0280
	Added when the board is separately purchased	410006-0290
PROFIBUS-DP slave Manufactured by: Hilscher GmbH Model: CIF50-DPS/DENSO	Added at the time of shipment of the controller	410006-0300
	Added when the board is separately purchased	410006-0310
Ethernet/IP Manufactured by: Hilscher GmbH Model: CIFX50-RE/DENSO	Added at the time of shipment of the controller	410006-0800
	Added when the board is separately purchased	410006-0810
Memory extension	Added only at the time of shipment of the controller Expandable from 3.25 to 5.5 megabytes (only allowed on the program area)	410006-0320

Optional box

Item	Remarks	Part No.
Controller protection box		410181-0090
I/O conversion box	For interchangeability with RC5 controller	410181-0100

Manuals

Item	Remarks	Part No.
Manual Pack CD	Contained in the robot package.	410002-2661

Options for robot unit

Item	Remarks	Part No.
External battery extension unit	With 4 m cable	410076-0360
	With 8 m cable	410076-0370
	With 12 m cable	410076-0380
Encoder backup battery	2 pieces	410679-0010
Brake release unit	With 4 m cable	410191-0060
	With 8 m cable	410191-0070
	With 12 m cable	410191-0080
Air purge unit	Only for protected type robots (IP67)	410690-0050
Second arm cover R (with tapped holes) for VS-050 / 060	Only for standard type robots (IP40)	411040-0950
Second arm cover R (with tapped holes) for VS-068 / 087	Only for standard type robots (IP40)	411040-0500
Stopper bolt M8 for J2 mechanical ends for VS-050/060	For the 2nd axis	410813-0970
Stopper bolt M5 for J3 mechanical ends for VS-050/060	For the 3rd axis	410813-0950
Stopper bolt M10 for J2/J3 mechanical ends for VS-068/087	For the 2nd and 3rd axes	410813-0930

[1] External battery extension unit

This unit allows an encoder backup battery to connect to the robot unit from the outside of the robot, making the battery replacement easy.

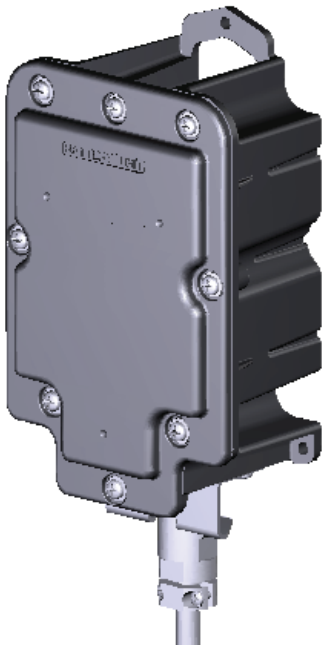
The cable length is 4 m, 8 m or 12 m.

This unit is IP54 rated.

For details, refer to Section 8.5.1 "External Battery Extension Unit".

NOTE

This unit does not include the encoder backup battery with shipment. Please purchase it together with this robot.



[2] Brake release unit

This unit releases a brake on each axis only when the controller power is ON. (The wiring is directly connected to the brake release signal of each axis.)

The cable length is 4 m, 8 m or 12 m.

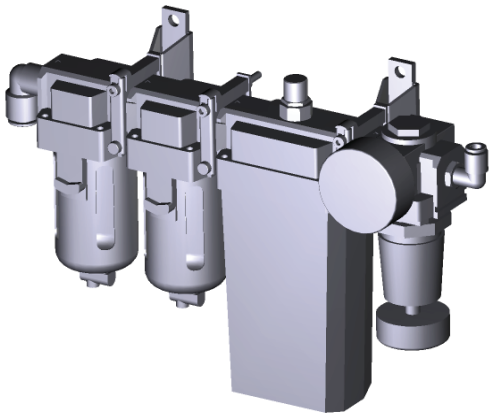
This unit is IP54 rated.

For details, refer to Section 8.5.2 "Brake Release Unit".

[3] Air purge unit

This unit is used for protected type robots (IP67) to apply air pressure to the inside of the robot unit for maintaining the IP67 rating.

For details, refer to Section 8.5.3 "Air Purge Unit".



[4] Second arm cover R (with tapped holes)

The second arm cover R, which is made of coated aluminum material, has tapped holes for wiring.

For VS-050 / 060

For VS-068 / 087

For VS-050/060

Wiring Tapped hole

Size:	M3 depth 5.5 (x 2)
Pitch:	70 mm
Tightening torque:	0.8 +/- 0.1 Nm

Cover mounting bolt

Tightening torque:	1.6 +/- 0.2 Nm

For VS-068/087

Wiring Tapped hole

Size:	M4 depth 9 (x 2)
Pitch:	87.2 mm
Tightening torque:	0.8 +/- 0.1 Nm

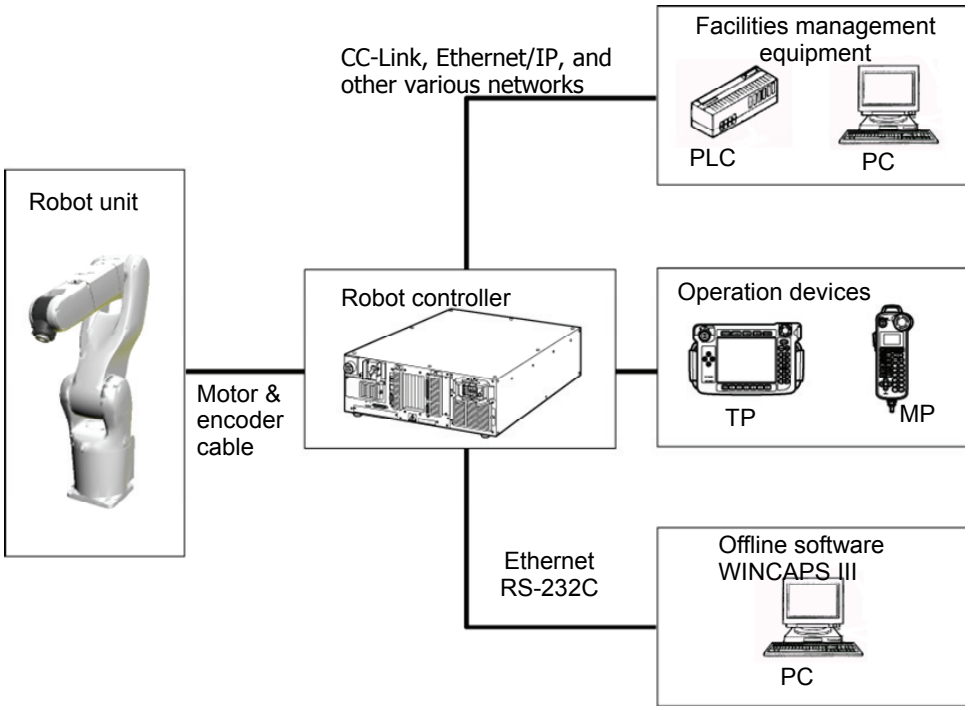
Cover mounting bolt

Tightening torque:	1.6 +/- 0.2 Nm

Chapter 2 Configuration of the Robot System

2.1 Configurators

The whole configuration of the robot system is shown below.



Robot unit

This is an industry robot that drives the arms with the motors to assemble and transport workpieces. Hands or other end effectors should be attached to the flange by the customer.

Robot controller RC7M

The controller controls the motion of the robot unit according to programs built with signals sent from the connected facilities management equipment.

It also allows the customer to teach the robot unit by operating it with any of the operation devices.

Operation devices

The operation devices are used to manually operate the robot unit or make various settings.

For details about hardware, refer to the Options Manual. For instructions on how to operate these devices, refer to the Setting-up Manual.

Teach pendant (TP)

The teach pendant is a multifunctional operation device that enables robot operation, teaching, mode switching, programmed start, programming, and all settings.

The teach pendant can also be used as an operation panel created by the teach pendant panel editor.

Mini-pendant (MP)

The mini-pendant is a simplified operation device that enables robot operation, teaching, mode switching, programmed start, and a part of settings.

Offline software

The software enables backing up of project data in the controller and editing, management, movement simulation of programs. WINCAPS III is an offline software designed for the Denso robot system. The trial version comes with the robot system at no extra charge. For details, refer to the WINCAPS III Guide.

Facilities management equipment

The management equipment is a system that the customer sets up for managing the facilities. Denso robots can be linked with it via the CC-Link, Ethernet/IP, and other various networks.

Optional devices

I/O conversion box

The box enables the signals fed to the I/O connectors on the RC5 controller to be used as is in the RC7M controller.

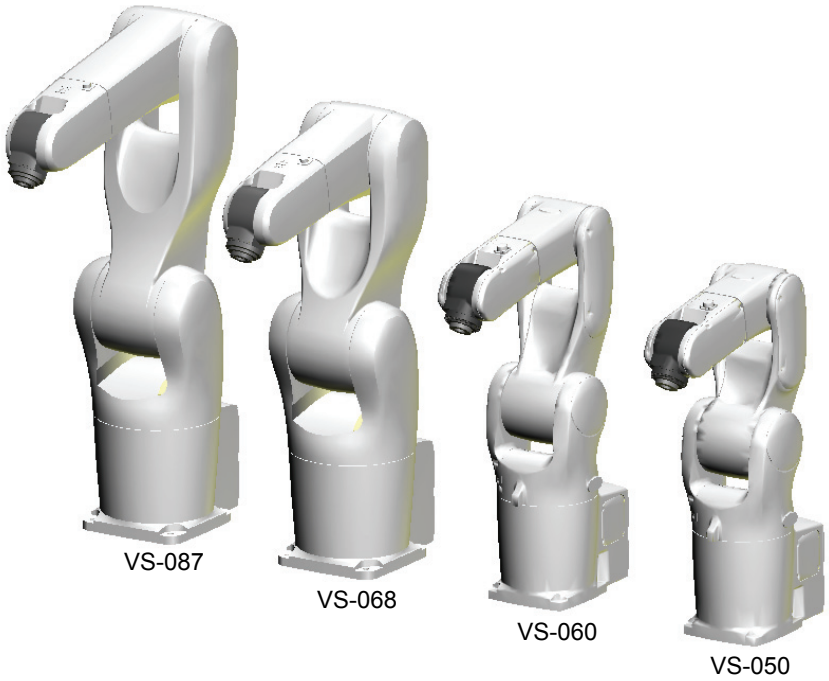
Controller protection box

The box protects the controller from dust, dirt and oil mist existing in the factory. It is equipped with a heat exchanger for cooling the air warmed up by the controller inside the box down to the ambient temperature. It is IP54 rated.

2.2 Factory Options

The robot unit provides the following choices of factory options.

Arm length



VS-050: 505 mm (The maximum payload is 4 kg.)

VS-060: 605 mm (The maximum payload is 4 kg.)

VS-068: 680 mm (The maximum payload is 7 kg.)

VS-087: 875 mm (The maximum payload is 7 kg.)

Ingress Protection

Protected type（IP67)

Protected type robots (IP67) can be used in an environment where it may be exposed to water or cutting fluid. However, it cannot be used under water. (Note that it can be immersed in water provided that it does not run.)

The surface treatment of the robot unit is "unpainted." If painting is required, contact your Denso representative.

Usable cutting fluids are listed below. If any other cutting fluid is used, contact your Denso representative.

- YUSHIROKEN EC50T-3 (Aqueous cutting fluid), Concentration 5%

  (manufactured by YUSHIRO CHEMICAL INDUSTRY CO., LTD.)

- YUSHIRON KM315A (Water-insoluble cutting oil)

  (manufactured by YUSHIRO CHEMICAL INDUSTRY CO., LTD.)

Dust- & splash-proof type (IP54)

Dust- & splash-proof structure to meet IP54 standard. The Wrist part is equivalent to IP65.

Usable cutting fluids are listed below.

- YUSHIRON KM315A (Water-insoluble cutting oil)

  (manufactured by YUSHIRO CHEMICAL INDUSTRY CO., LTD.)

Standard type (IP40)

IP40 rated robots can be used in a general environment where no water or cutting fluid is used.

Connector Panel

Rear connector panel

Bottom connector panel

The connector panel is used to connect the motor & encoder cable and other cables to the robot unit.

Bottom connector panel

The panel is arranged face down on the bottom of the robot base so that the work space is free of cables and is neat. A cabling space is required under the bottom of the robot base.

Rear connector panel (standard)

The panel is arranged at the rear of the robot base. A cabling space is required at the rear of the robot unit.

Signal Lines and Air Piping

The three choices of solenoid valves are available for the VS-068/087. For the specifications of each solenoid valve, refer to the Solenoid Valves Specifications. (The standard is "No signal lines or air piping.")

VS-050 / 060

- 2 x solenoid valves (2 positions, Double Solenoids)

VS-068 / 087

- 3 x solenoid valves (2 positions, Double Solenoids)
- 3 x solenoid valves (3 positions, Exhaust Center Solenoids)
- 3 x solenoid valves (3 positions, Closed Center Solenoids)

Flange

Communication interface flange-A

Standard flange

Communication interface flange-A

The flange has connectors for signal wiring and Ethernet (1000 BASE-T) interface. It eliminates the need for wiring from the second arm, allowing wiring without regard to wiring problems that could be caused by movement of 5th and 6th axes.

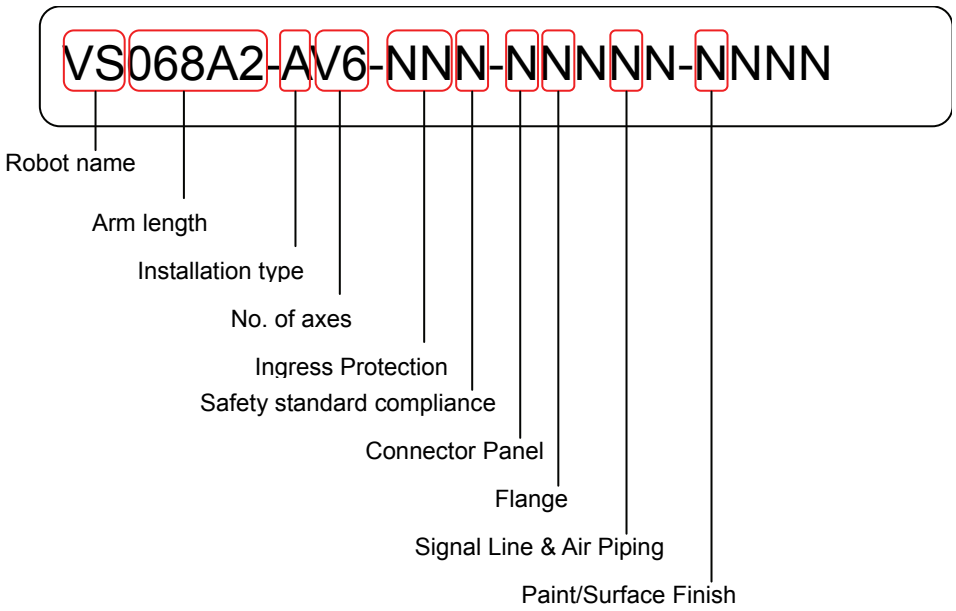
This option is available only for standard type (IP40) robots.

Standard flange

This is provided as standard.

2.2.1 Coding Information of Robot Model

The robot model is coded as shown below.



Robot name

VS	Vertical, articulated robot

Arm length

050A1	505 mm
060A1	605 mm
068A2	680 mm
087A2	875 mm

Installation type

A	Omnidirectional

No. of axes

V6	6 axes

Ingress protection

NN	Standard type (IP40)
W4	Dust- & splash-proof type (IP54)
W7	Protected type (IP67)

Safety standard compliance

N	-

Connector panel

N	Rear connector panel
A	Bottom connector panel

Flange

N	Standard flange
A	Communication interface flange-A (Ethernet)

Signal lines & air piping

N	Standard
A	2 x solenoid valves (2 positions, Double Solenoids)
B	3 x solenoid valves (2 positions, Double Solenoids)
C	3 x solenoid valves (3 positions, Exhaust Center Solenoids)
D	3 x solenoid valves (3 positions, Closed Center Solenoids)

Paint/surface finish

N	Denso standard colors
A	Unpainted

Chapter 3 Specifications of the Robot Unit

3.1 Robot Specifications

The tables below list the specifications of the VS-*** series of robot units.

3.1.1 VS-050

Item	Specifications
Model of robot unit	VS-050
Overall arm length	250 mm (first arm) + 255 mm (second arm) = 505 mm
Maximum motion area	R = 505 mm (Point P: J4, J5, J6 center)
Motion range	J1: +/- 170° (* 1) J2: +120°, -120° J3: +151°, -120° J4: +/- 270° J5: +/- 120° (+120°, -110° when the communication interface flange-A is selected) J6: +/- 360°
Maximum payload	4 kg
Maximum composite speed	9,000 mm/s (at the center of an end-effector mounting face)
Position repeatability (* 2)	In each of X, Y and Z directions: 0.02 mm (at the center of an end-effector mounting face)
Maximum allowable moment of inertia	Around J4 and J5: 0.200 kgm^2 Around J6: 0.050 kgm^2
Maximum allowable moment	Around J4 and J5: 6.66 Nm Around J6: 3.13 Nm
Position detection	Absolute encoder
Drive motor and brake	AC servomotors for all joints, Brakes for all joints
Brake releasing	Operating the teach pendant or mini-pendant, or Using the brake release unit (* 3)
Signal line & air piping (2nd arm)	Factory option: Refer to "Signal Lines & Air Piping" and "Communication Interface Flange-A".
Degree of protection	Standard type : IP40 Dust- & splash-proof type : IP54 Protected type : IP67
Airborne noise (A-weighted equivalent continuous sound pressure level)	65 dB or less
Weight	Approx. 34 kg (approx. 75 lbs)

* 1: The motion range is smaller when the robot unit is wall-mounted. For details, contact the Denso service representative.

* 2: The position repeatability is the value at constant ambient temperature.

* 3: Available only when the controller power is ON.

3.1.2 VS-060

Item	Specifications
Model of robot unit	VS-060
Overall arm length	305 mm (first arm) + 300 mm (second arm) = 605 mm
Maximum motion area	R = 605 mm (Point P: J4, J5, J6 center)
Motion range	J1: +/- 170° (* 1) J2: +/- 120° J3: +155°, -125° J4: +/- 270° J5: +/- 120° (+120°, -110° when the communication interface flange-A is selected) J6: +/- 360°
Maximum payload	4 kg
Maximum composite speed	9,000 mm/s (at the center of an end-effector mounting face)
Position repeatability (* 2)	In each of X, Y and Z directions: 0.02 mm (at the center of an end-effector mounting face)
Maximum allowable moment of inertia	Around J4 and J5: 0.200 kgm^2 Around J6: 0.050 kgm^2
Maximum allowable moment	Around J4 and J5: 6.66 Nm Around J6: 3.13 Nm
Position detection	Absolute encoder
Drive motor and brake	AC servomotors for all joints, Brakes for all joints
Brake releasing	Operating the teach pendant or mini-pendant, or Using the brake release unit (* 3)
Signal line & air piping (2nd arm)	Factory option: Refer to "Signal Lines & Air Piping" and "Communication Interface Flange-A".
Degree of protection	Standard type : IP40 Dust- & splash-proof type : IP54 Protected type : IP67
Airborne noise (A-weighted equivalent continuous sound pressure level)	65 dB or less
Weight	Approx. 35 kg (approx. 77 lbs)

* 1: The motion range is smaller when the robot unit is wall-mounted. For details, contact the Denso service representative.

* 2: The position repeatability is the value at constant ambient temperature.

* 3: Available only when the controller power is ON.

3.1.3 VS-068

Item	Specifications
Model of robot unit	VS-068
Overall arm length	340 mm (first arm) + 340 mm (second arm) = 680 mm
Maximum motion area	R = 710 mm (Point P: J4, J5, J6 center)
Motion range	J1: +/- 170° (* 1) J2: +135°, -100° J3: +153°, -120° J4: +/- 270° J5: +/- 120° J6: +/- 360°
Maximum payload	7 kg
Maximum composite speed	11,000 mm/s (at the center of an end-effector mounting face)
Position repeatability (* 2)	In each of X, Y and Z directions: 0.02 mm (at the center of an end-effector mounting face)
Maximum allowable moment of inertia	Around J4 and J5: 0.450 kgm^2 Around J6: 0.100 kgm^2
Maximum allowable moment	Around J4 and J5: 16.2 Nm Around J6: 6.86 Nm
Position detection	Absolute encoder
Drive motor and brake	AC servomotors for all joints, Brakes for all joints
Brake releasing	Operating the teach pendant or mini-pendant, or Using the brake release unit (* 3)
Signal line & air piping (2nd Arm)	Factory option: Refer to "Signal Lines & Air Piping" and "Communication Interface Flange-A".
Degree of protection	Standard type : IP40 Dust- & splash-proof type : IP54 Protected type : IP67
Airborne noise (A-weighted equivalent continuous sound pressure level)	65 dB or less
Weight	Approx. 49 kg (approx. 108 lbs)

* 1: The motion range is smaller when the robot unit is wall-mounted. For details, contact the Denso service representative.

* 2: The position repeatability is the value at constant ambient temperature.

* 3: Available only when the controller power is ON.

3.1.4 VS-087

Item	Specifications
Model of robot unit	VS-087
Overall arm length	445 mm (first arm) + 430 mm (second arm) = 875 mm
Maximum motion area	R = 905 mm (Point P: J4, J5, J6 center)
Motion range	J1: +/- 170° (* 1) J2: +135°, -100° J3: +153°, -136° J4: +/- 270° J5: +/- 120° J6: +/- 360°
Maximum payload	7 kg
Maximum composite speed	11.000 mm/s (at the center of an end-effector mounting face)
Position repeatability (* 2)	In each of X, Y and Z directions: 0.03 mm (at the center of an end-effector mounting face)
Maximum allowable moment of inertia	Around J4 and J5: 0.450 kgm^2 Around J6: 0.100 kgm^2
Maximum allowable moment	Around J4 and J5: J16.2 Nm Around J6: 6.86 Nm
Position detection	Absolute encoder
Drive motor and brake	AC servomotors for all joints, Brakes for all joints
Brake releasing	Operating the teach pendant or mini-pendant, or Using the brake release unit (* 3)
Signal Line & Air Piping (2nd Arm)	Factory option: Refer to "Signal Lines & Air Piping" and "Communication Interface Flange-A".
Degree of protection	Standard type : IP40 Dust- & splash-proof type : IP54 Protected type : IP67
Airborne noise (A-weighted equivalent continuous sound pressure level)	65 dB or less
Weight	Approx. 51 kg (approx. 112 lbs)

* 1: The motion range is smaller when the robot unit is wall-mounted. For details, contact the Denso service representative.

* 2: The position repeatability is the value at constant ambient temperature.

* 3: Available only when the controller power is ON.

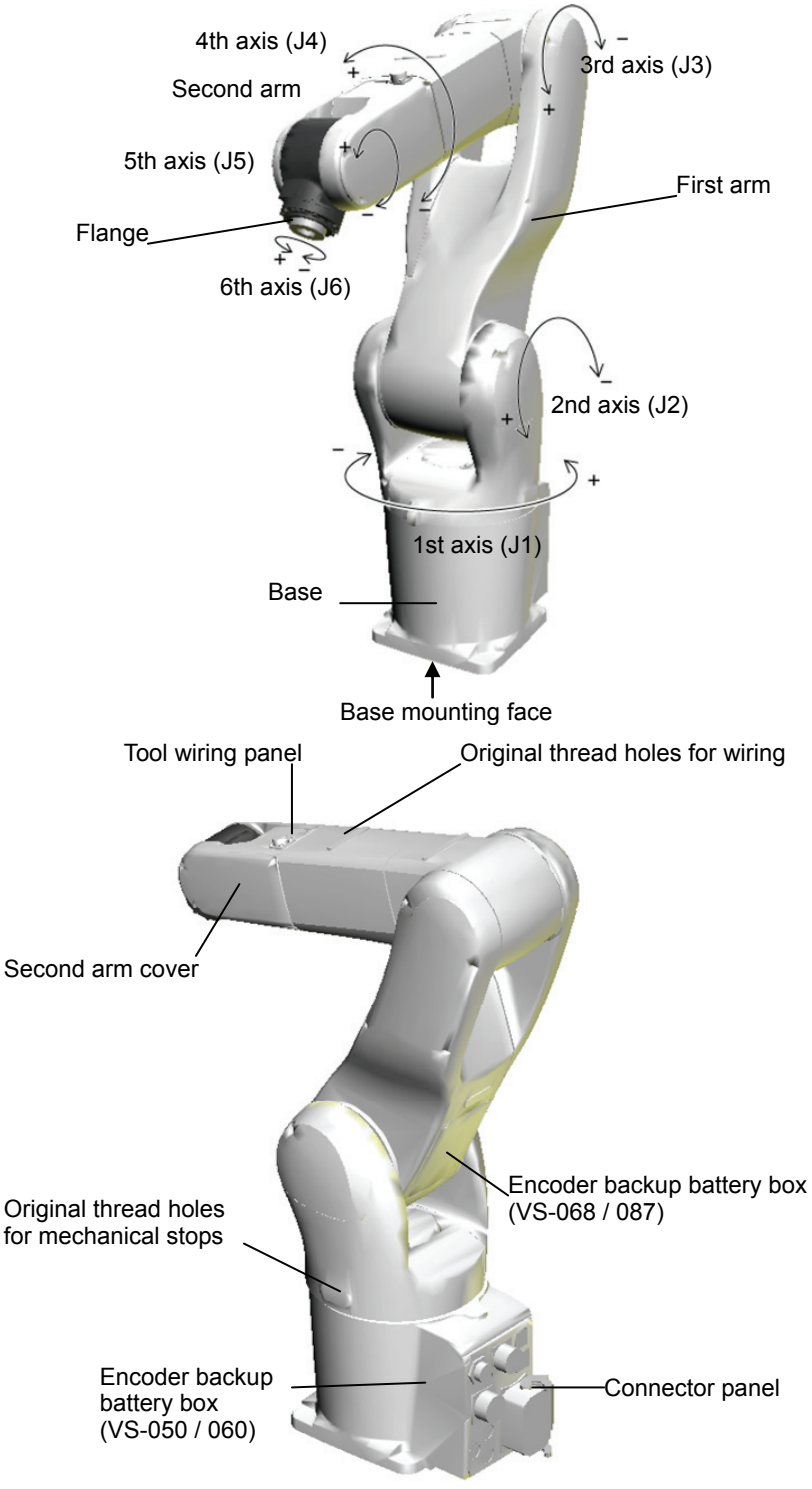
3.2 Outer Dimensions and Work Space of the Robot Unit

Refer to Section 8.1 "Reference Drawings" for the outer dimension, work space, flange dimensions and installation area.

3.3 Names of Robot Unit Components

3.3.1 Robot Unit Components and Rotation Direction

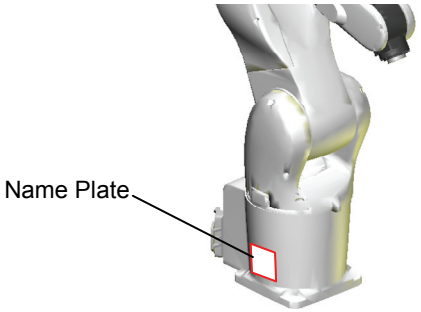
The figures below show the names of the components of the robot unit and the rotation direction of each axis.



3.3.2 Name Plate

The name plate is affixed in the base part, which includes serial number of the robot, robot model, and day of manufacturer, etc.

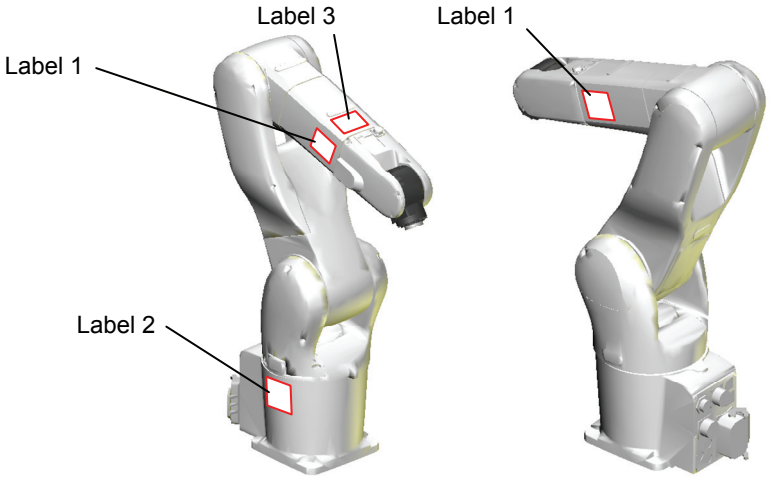
The serial number is the figure which identifies the robot of each customer and it is paired with the figure of the controller.



3.3.3 Warning and Caution Labels

The robot unit has warning and caution labels pasted as shown below. They alert the user to the dangers of the areas on which they are pasted. Be sure to observe the instructions printed on those labels.

Location of labels

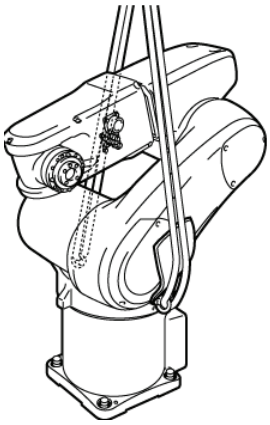


Label 1

Serious injury can result from contact with the robot if it is running. Never enter the motion space when the robot is running or the power is ON.

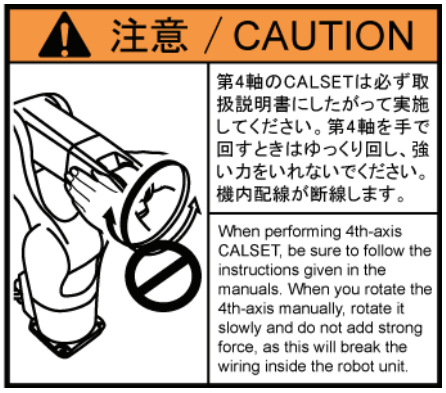
When entering the motion space for troubleshooting, be sure to cut off power to the robot motors by activating the emergency stop device, etc.

Label 2



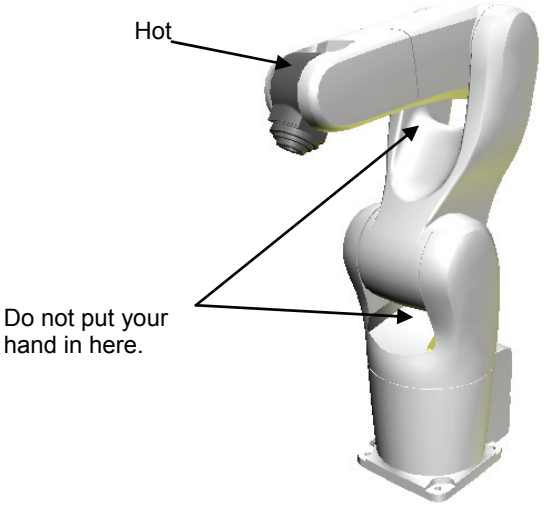
When transporting the robot unit, hoist it with a crane in a posture shown above.

Label 3



When performing 4th-axis CALSET, be sure to follow the instructions given in the manuals. When you rotate the 4th-axis manually, rotate it slowly and do not add strong force, as this will break the wiring inside the robot unit.

3.3.4 Caution



Do not touch around 5th axis. It is hot due to heat generation of a motor.

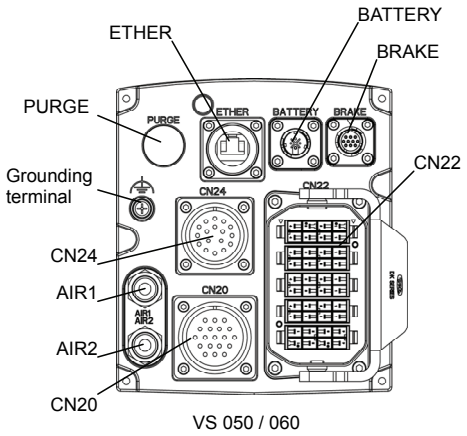
Do not put your hand in spaces under 2nd axis and 3rd axis. Your hand might be stuck.

3.3.5 Connectors

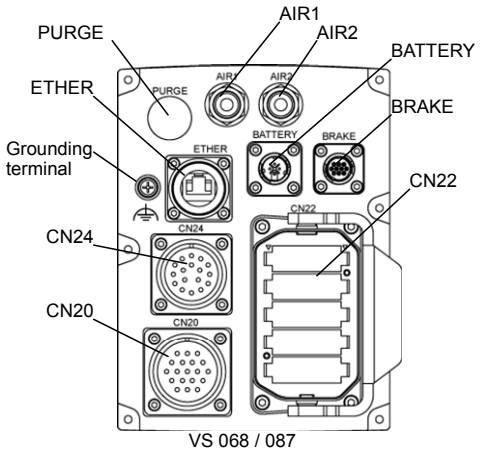
This section shows the connectors on the robot unit.

[1] Connector Panel

Rear connector panel

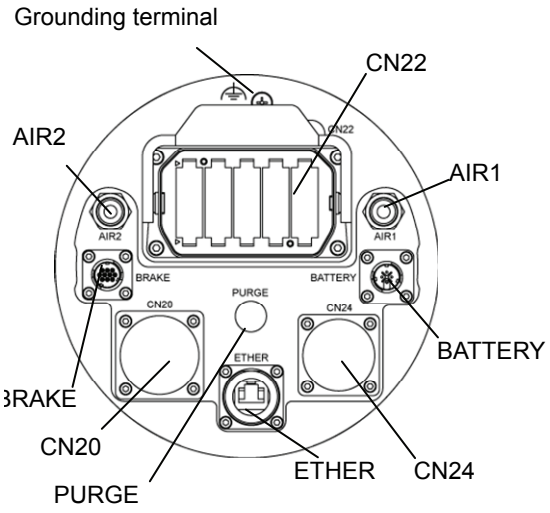


VS 050 / 060



VS 068 / 087

Bottom connector panel



VS-068 / 087

Details of connectors

Connector name	Description	Remarks
CN20	Connector for hand signals Connected to CN21 on the tool wiring panel.	Use attached connectors for wiring. Not provided on robots having no signal lines or air piping.
CN22	Connector for motor & encoder cable	
CN24	Connector for hand signals Connected to the signal wiring connector on the communication interface flange.	Use attached connectors for wiring. Provided on robots having a communication interface flange-A
AIR1	Joint for air to be supplied to solenoid valves. (PT 1/4) (* 1)	Not provided on robots having no signal lines or air piping.
AIR2	Directly connected to AIR2 on the tool wiring panel. (PT 1/4)	Not provided on robots having no signal lines or air piping.
BATTERY	Connected to an external battery unit.	
BRAKE	Connected to a brake release unit.	
ETHER	Connected to the Ethernet cable. (*2)	Provided on robots having a communication interface flange-A
PURGE	Connected to the air purge unit.(PT 1/4)	Provided on protected type robots (IP67). The source air pressure is 0.01 to 0.03 MPa. (* 3)
GROUND	Grounding terminal (Functional ground)	M5

NOTE

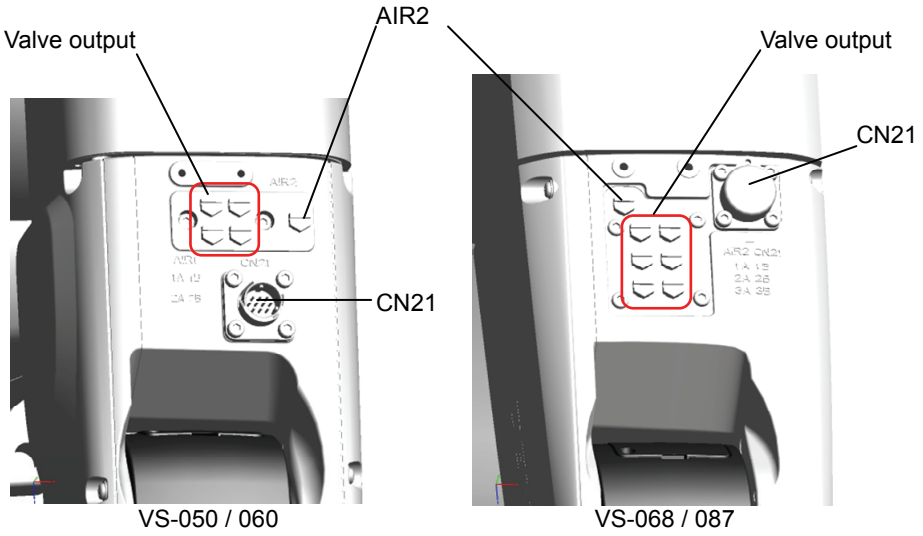
* 1: To AIR1, supply dry air filtered through an air filter (recommended filtration rating: 5 μm or below).
Before piping, blow the air tube out with dry air to clean out the inside (flushing); otherwise, any chips, cutting oil, dust or dist remaining in the air tube may result in a damaged valve.

* 2: To the ethernet cable, use the shielded flex resistance LAN cable.

* 3: To PURGE, apply the specified air pressure. Connecting air prepared for hands mistakenly may lose the ingress protection.

[2] Tool wiring panel

This is provided only when any signal lines & air piping type is selected.



CN21	Connector for hand signals Use attached connectors for wiring.
AIR2	Directly connected to AIR2 on the connector panel. (M5)
Valve output	Air piping joint for hands (M5)

3.4 Signal Lines & Air Piping

The robot unit can incorporate signal lines & air piping as a factory option. The following types of solenoid valves are available. As standard, the robot unit has no signal lines or air piping, as well as not having related connectors.

Signal lines & air piping (VS-050 / 060)

- 2 x solenoid valves (2 positions, Double Solenoids)

Signal lines & air piping (VS-068 / 087)

- 3 x solenoid valves (2 positions, Double Solenoids)
- 3 x solenoid valves (3 positions, Exhaust Center Solenoids)
- 3 x solenoid valves (3 positions, Closed Center Solenoids)

NOTE

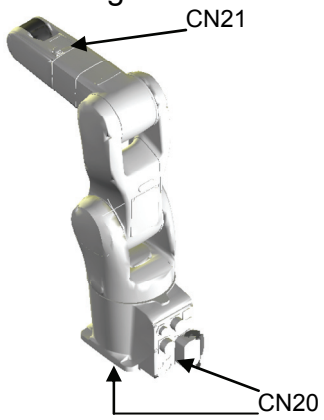
To AIR1, supply dry air filtered through an air filter (recommended filtration rating: 5 μm or below).

Before piping, blow the air tube out with dry air to clean out the inside (flushing); otherwise, any chips, cutting oil, dust or dist remaining in the air tube may result in a damaged valve.

No signal lines or air piping (standard)

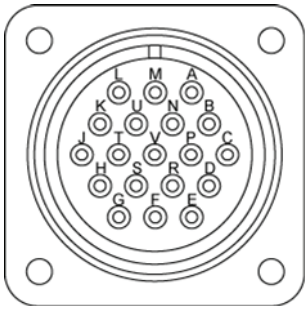
Neither CN20, AIR1 or AIR2 on the connector panel nor CN21, AIR2 or valve output connectors on the tool wiring panel are provided.

3.4.1 Pin Assignment on Signal Line Connectors (CN20, CN21)

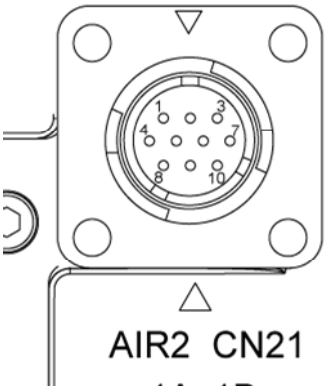


Pin assignment on CN20 and CN21

CN20 on the connector panel



CN21 on the tool wiring panel



Wiring between CN20 and CN21, and wiring from solenoid valves

Pins on CN20	Pins and solenoid valve input on CN21 (allowable current/allowable voltage)	
	Standard flange	Communication interface flange-A
A	CN21 -1 (1.0 A / 50 VAC)	CN21 -1 (1.0 A / 50 VAC)
B	CN21 -2 (1.0 A / 50 VAC)	CN21 -2 (1.0 A / 50 VAC)
C	CN21 -3 (1.0 A / 50 VAC)	CN21 -3 (0.5 A / 50 VAC)
D	CN21 -4 (1.0 A / 50 VAC)	CN21 -4 (0.5 A / 50 VAC)
E	CN21 -5 (1.0 A / 50 VAC)	(No connection)
F	CN21 -6 (1.0 A / 50 VAC)	(No connection)
G	CN21 -7 (0.5 A / 50 VAC)	(No connection)
H	CN21 -8 (0.5 A / 50 VAC)	(No connection)
J	CN21 -9 (0.5 A / 50 VAC)	(No connection)
K	CN21 -10 (0.5 A / 50 VAC)	(No connection)
L	-	-
M	Solenoid valve, +24V (NPN) / 0V (PNP)	Solenoid valve, +24V (NPN) / 0V (PNP)
N	Solenoid valve 1A (Solenoid valve 1)	Solenoid valve 1A (Solenoid valve 1)
P	Solenoid valve 1B (Solenoid valve 1)	Solenoid valve 1B (Solenoid valve 1)
R	Solenoid valve 2A (Solenoid valve 2)	Solenoid valve 2A (Solenoid valve 2)
S	Solenoid valve 2B (Solenoid valve 2)	Solenoid valve 2B (Solenoid valve 2)
T	Solenoid valve 3A (Solenoid valve 3) *	Solenoid valve 3A (Solenoid valve 3) *
U	Solenoid valve 3B (Solenoid valve 3) *	Solenoid valve 3B (Solenoid valve 3) *
V	-	-

* Not used on the VS-050/060.

3.4.2 Solenoid Valve Specifications

Valves

Switching system	2-position, Double Solenoids 3-position, Exhaust Center Solenoids 3-position, Closed Center Solenoids
Applicable fluid	Air
Operating system	Pilot type
Effective cross section (Cv value)	P->A・B：1.116 mm^2 (0.062) A・B->R：1.188 mm^2 (0.066)
Lubrication	Oilless
Operating pressure range	0.2 to 0.7 MPa *
Response time	15 ms or below（when operating pressure is 0.5 MPa）
Maximum operating frequency	10 Hz
Ambient temperature	-5 to 50°C (No dew condensation allowed. When dry air is used.)

* The air source to be connected to the robot unit should be used within the operating pressure range from 0.20 to 0.39 MPa.

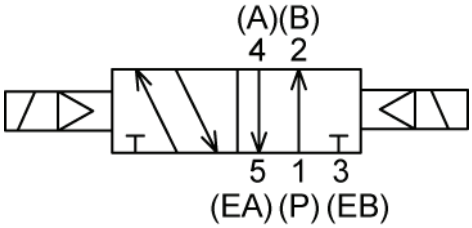
Solenoids

Operating voltage	24 V +/- 10%
Power consumption (current)	0.5 W (21 mA)
Surge voltage protection circuit	Zener diode

[1] Switching system: 2-position, double solenoid

When both solenoids A and B are deenergized, the valve holds its position.

This system is available for the VS-050 / 060 / 068 / 087.



A, B : Air outlet to tools

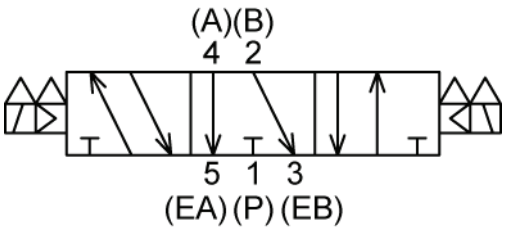
P : Air inlet from AIR1

EA、EB : To exhaust ports

[2] Switching system: 3-position, exhaust center solenoid

When both solenoids A and B are deenergized or when the power is OFF, the valve is in the center position to exhaust the residual pressure of solenoids A and B.

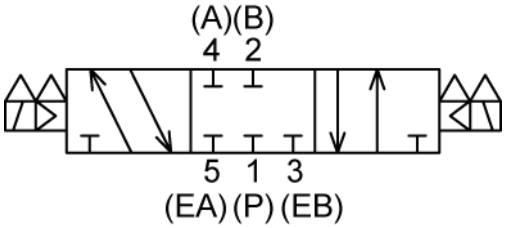
This system is available for the VS-068 / 087.



[3] Switching system: 3-position, closed center solenoid

When both solenoids A and B are deenergized or when the power is OFF, the valve is in the center position to hold the residual pressure of solenoids A and B.

This system is available for the VS-068 / 087.



3.4.3 Accessories

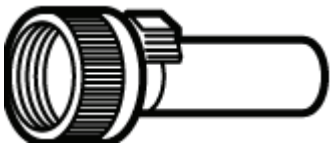
The robot unit equipped with signal lines & air piping (factory option) comes with a connector set consisting of the following parts.

Straight plug (for CN20)

Manufacturer: Hirose Electric Co., Ltd.

Model: H/MS3106A22-14S (73)

Cord clamp (For CN20), two types



Manufacturer: Hirose Electric Co., Ltd.

Model:	H/MS3057-12A (73)	Wire diameter ø11.4-15.9
	H/MS3057-12A1 (73)	Wire diameter ø8-11.6

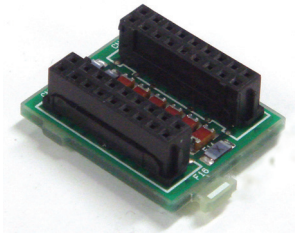
L type plug connector (For CN21)

Manufacturer:	Japan Aviation Electronics Industry, Ltd.
Model:	JN2FS10SL2-R
Wire diameter:	ø6.5-8.0

Connector pin (For CN21 L type plug connector), 10 pieces

Manufacturer:	Japan Aviation Electronics Industry, Ltd.
Model:	JN1-22-22F-PKG10

Fuse board for signal lines & air piping (CN20-CN21)



Part number: 410220-0210

For the replacement procedure of the fuse, refer to "Replacing Fuses in the Robot Unit".

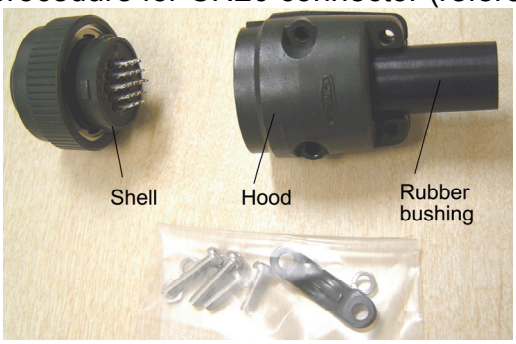
Notes for connector set

Only when signal line connectors CN20 and CN21 are connected to each other, the robot is IP67 rated.

Make a sheathed cable having a suitable diameter ready for use. Using an unsheathed cable cannot assure the splash-proof rating.

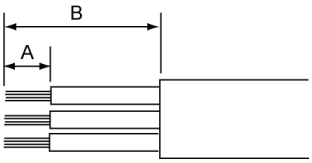
For the assembling procedure of the connector set, exactly follow the instructions given by the connector manufacturer.

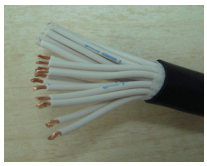
[1] Assembling procedure for CN20 connector (reference)



STEP 1

Treatment of wire ends: Strip the wire ends of the cable (prepared by the customer). The cable diameter and the lengths "A" and "B" should be in accordance with the instructions given by the connector manufacturer.





STEP 2

Pretinning: Tin both the core wires and the connector contacts.

STEP 3

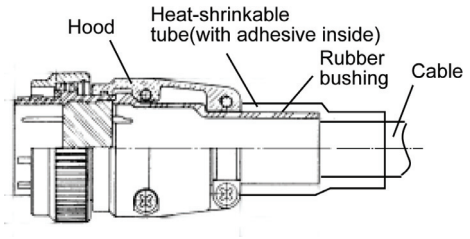
Pass the cable through the heat-shrinkable tube for splash-proof purpose (with adhesive inside, prepared by the customer) and the rubber bushing.

STEP 4

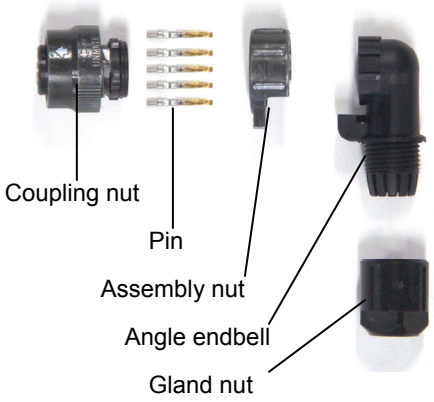
Solder the core wires onto the connector contacts to connect them each other.

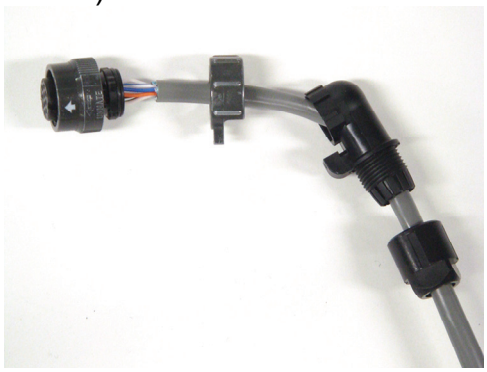
STEP 5

Press the rubber bushing against the shell to fit the hood. Then cover the rubber bushing with the heat-shrinkable tube and apply heat to shrink the tube.



[2] Assembling procedure for CN21 connector (reference)





STEP 1

Pass the wires (ø6.5-8.0) through the gland nut, angle endbell, and assembly nut.

STEP 2

Solder the wires onto the pins.

STEP 3

Insert the pins into the coupling nut.

STEP 4

Select the orientation of the angle endbell and assemble the related parts.

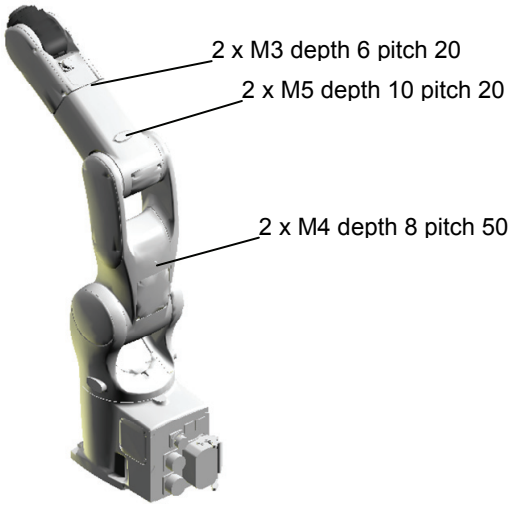
STEP 5

Lock the assembled parts with the coupling nut.

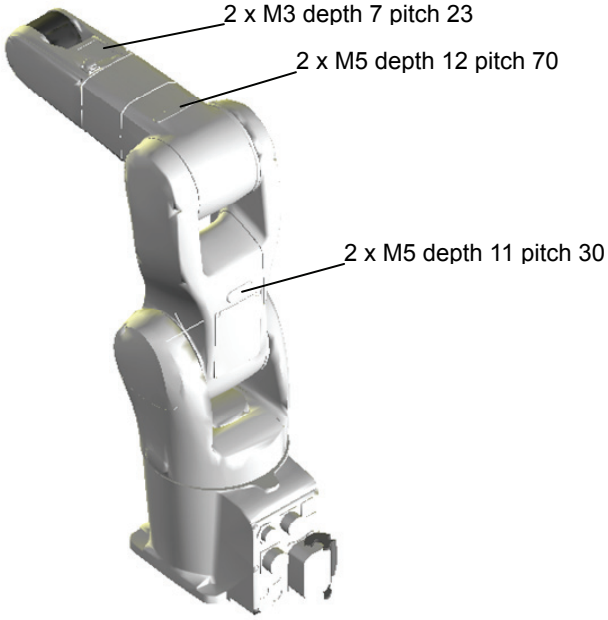
3.5 Existing Internal Threads for Wiring and Piping

The robot unit has internal threads to secure wiring and piping to itself.

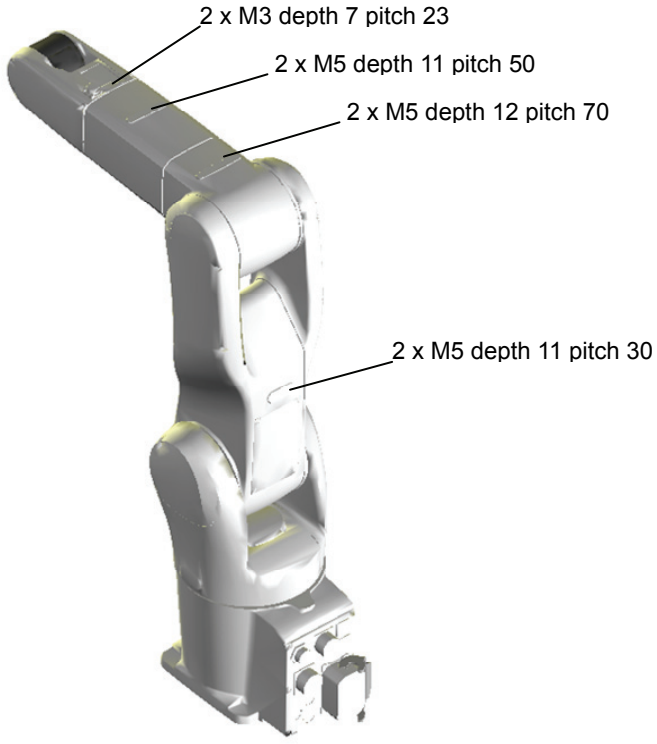
Location of internal threads on the VS-050 / 060



Location of internal threads on the VS-068

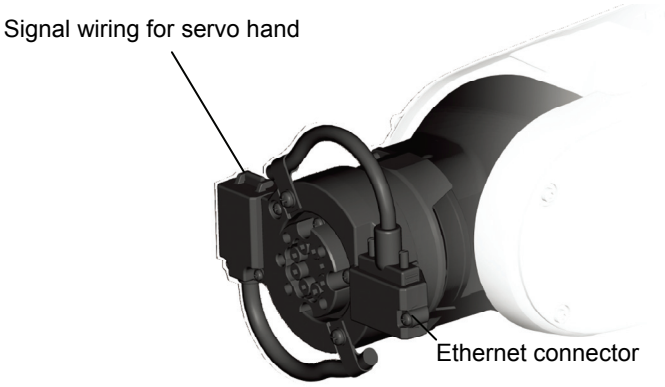


Location of internal threads on the VS-087



3.6 Communication Interface Flange-A

The flange has connectors for signal wiring and Ethernet (1000 BASE-T) interface. Connect them to the CN24 and Ethernet connectors on the connector panel at the robot base.



⚠CAUTION

The signal lines should be used within the rated current (allowable voltage/current).

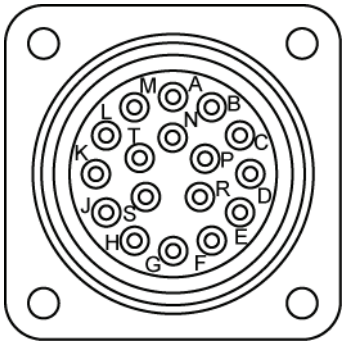
The Ethernet cable length from a device (e.g., camera) connected to the flange to a device (e.g., image analyzer) connected to the control panel should be a maximum of 20 m.

TIP

The communication interface flange-A is IP40 rated. It cannot be used for Protected type robots (IP67).

Selecting the communication interface flange-A uses four cores of CN20-CN21 signal wiring. Refer to "Pin Assignment on Signal Line Connectors (CN20, CN21)."

[1] Pin assignment on CN24



Pin assignment on CN24	Wiring on the flange (twisted)		Allowable current (Allowable voltage)
A	Green/white	Green	Each pin: 1.0 A or below (50 VAC or below) Total of A to M: 6.0 A or below
B	Yellow/white	Yellow	
C		White	
D	Black/white	Black	
E		White	
F	Purple/white	Purple	
G		White	
H	Blue/white	Blue	
J		White	
K	Red/white	Red	
L		White	
M	Brown/white	Brown	
N		White	Each pin: 0.5 A or below (50 VAC or below) Total of N to T: 1.5 A or below
P	Pink/white	Pink	
R		White	
S	Gray/white	Gray	
T		White	

TIP

For wiring of electric grippers, refer to the Additional Information separately issued.

Manual pack CD - "Supplement" - "Additional Information"

[2] Accessory for communication interface flange-A

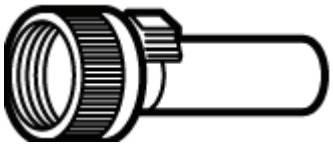
The robot unit equipped with communication interface flange-A (factory option) comes with a connector set consisting of the following parts.

Straight plug (for CN24)

Manufacturer: Hirose Electric Co., Ltd.

Model: H/MS3106A20-29S (73)

Cord clamp (For CN24), two types



Manufacturer: Hirose Electric Co., Ltd.

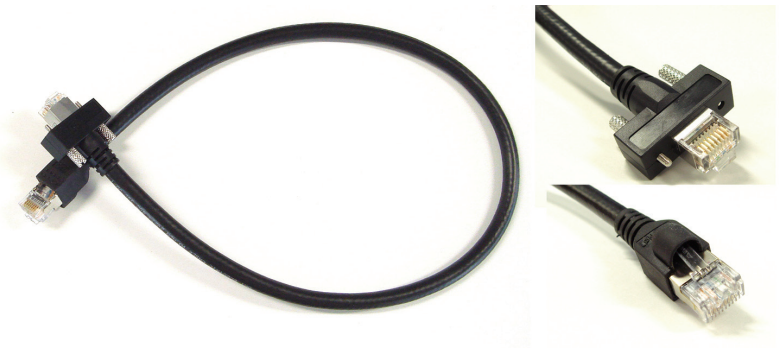
Model:	H/MS3057-12A (73)	Wire diameter ø11.4-15.9
	H/MS3057-12A1 (73)	Wire diameter ø8-11.6

For the assembling procedure, refer to "Assembling procedure for CN20 connector (reference)."

Ethernet cable for flange

Cable length: 50 cm

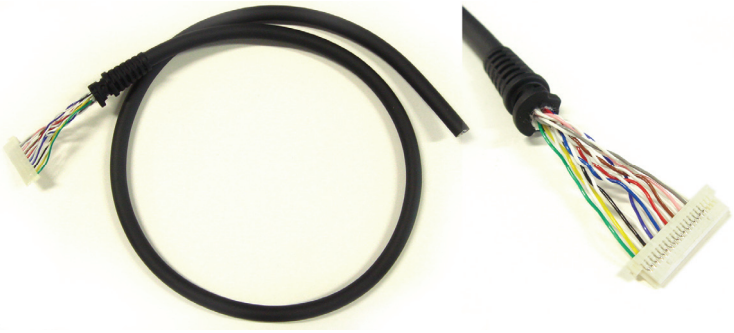
Part number: 410870-4680



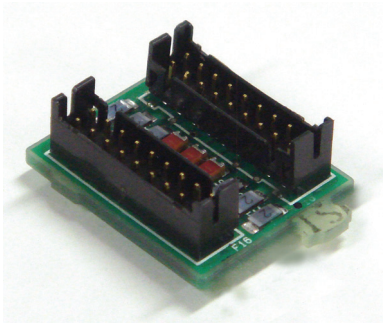
Signal wiring for flange

Cable length: 50 cm

Part number: 410870-4670



Fuse board for communication interface flange (CN24-flange CN)



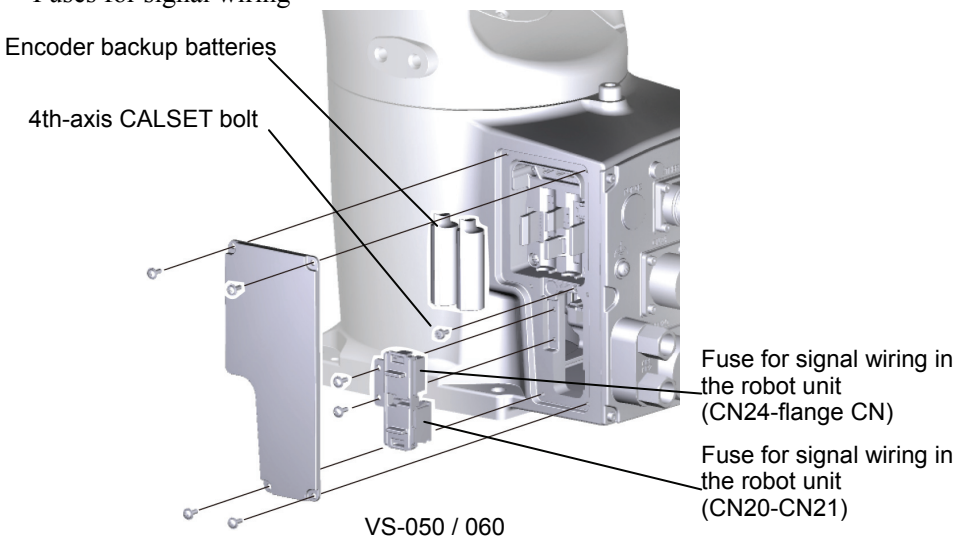
Part number: 410220-0200

For the replacement procedure of the fuse, refer to "Replacing Fuses in the Robot Unit".

3.7 Encoder Backup Battery Box

The encoder backup battery box contains the following.

- Encoder backup batteries
- 4th-axis CALSET bolt
- Fuses for signal wiring



VS-050 / 060

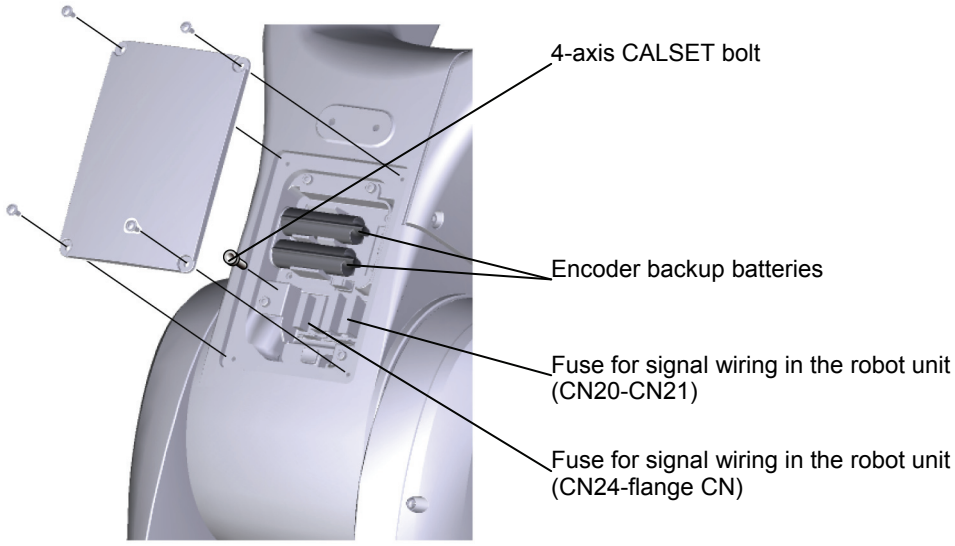
Tightening Torque

Cover mounting bolts

Standard type robots (IP40)	0.6 +/- 0.1 Nm
Dust- & splash-proof type robots (IP54)	1.6 +/- 0.2 Nm
Protected type robots (IP67)	1.6 +/- 0.2 Nm

Fuse board mounting bolts

0.6 +/- 0.1 Nm



VS-068 / 087

Tightening Torque

Cover mounting bolts

Standard type robots (IP40)	0.6 +/- 0.1 Nm
Dust- & splash-proof type robots (IP54)	1.6 +/- 0.2 Nm
Protected type robots (IP67)	1.6 +/- 0.2 Nm

NOTE

Protected type robots (IP67) or dust- & splash-proof type robots (IP54) have an O-ring on the inside of the cover. Take care not to break the O-ring.

3.8 Precautions When Designing End-effectors

The following specifications of an end-effector should not exceed those of the robot unit (refer to Section 3.1 "Robot Specifications").

- Maximum payload
- Allowable moment of inertia (kgm^2)
- Allowable moment (Nm)

An end-effector (including workpiece) should not vibrate.

In calculation for an end-effector design, take into account not only an end-effector but also all loads to be applied to the flange such as workpieces, wiring and piping.

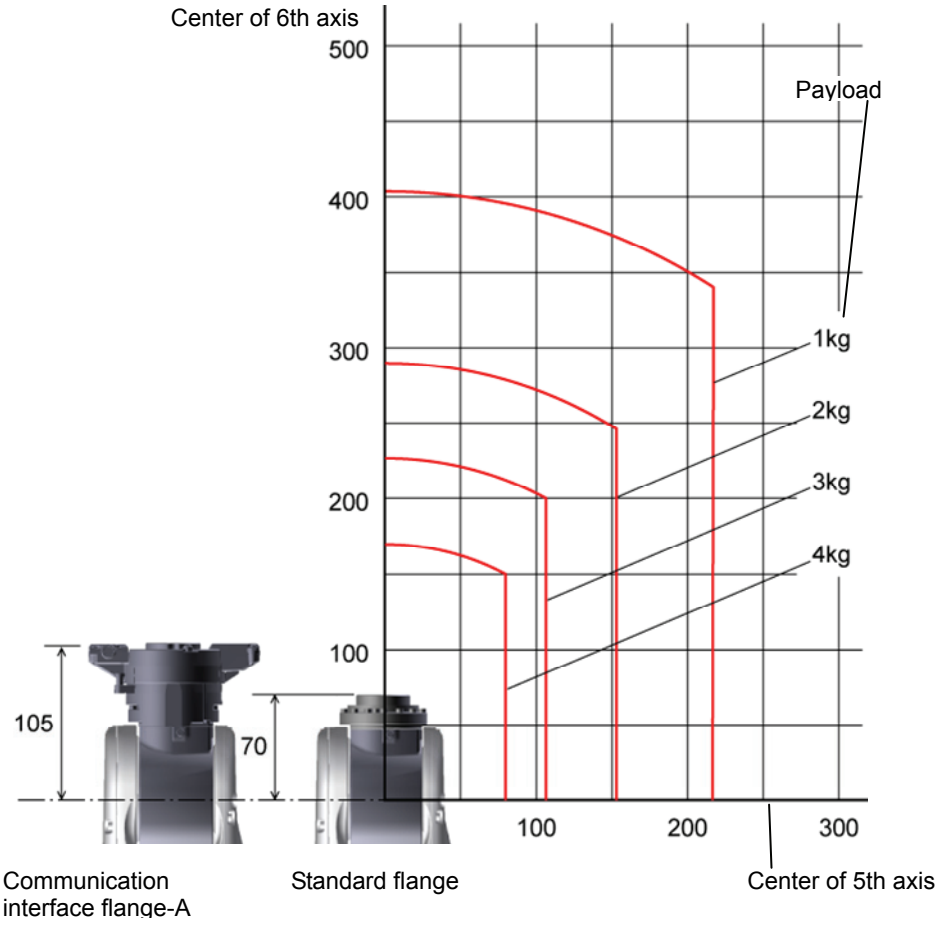
⚠CAUTION

If the end-effector design requirements are not met, the clamped sections of the robot unit may become loose, rattle or get out of position. In the worst case, the mechanical parts of the robot and the controller may become damaged.

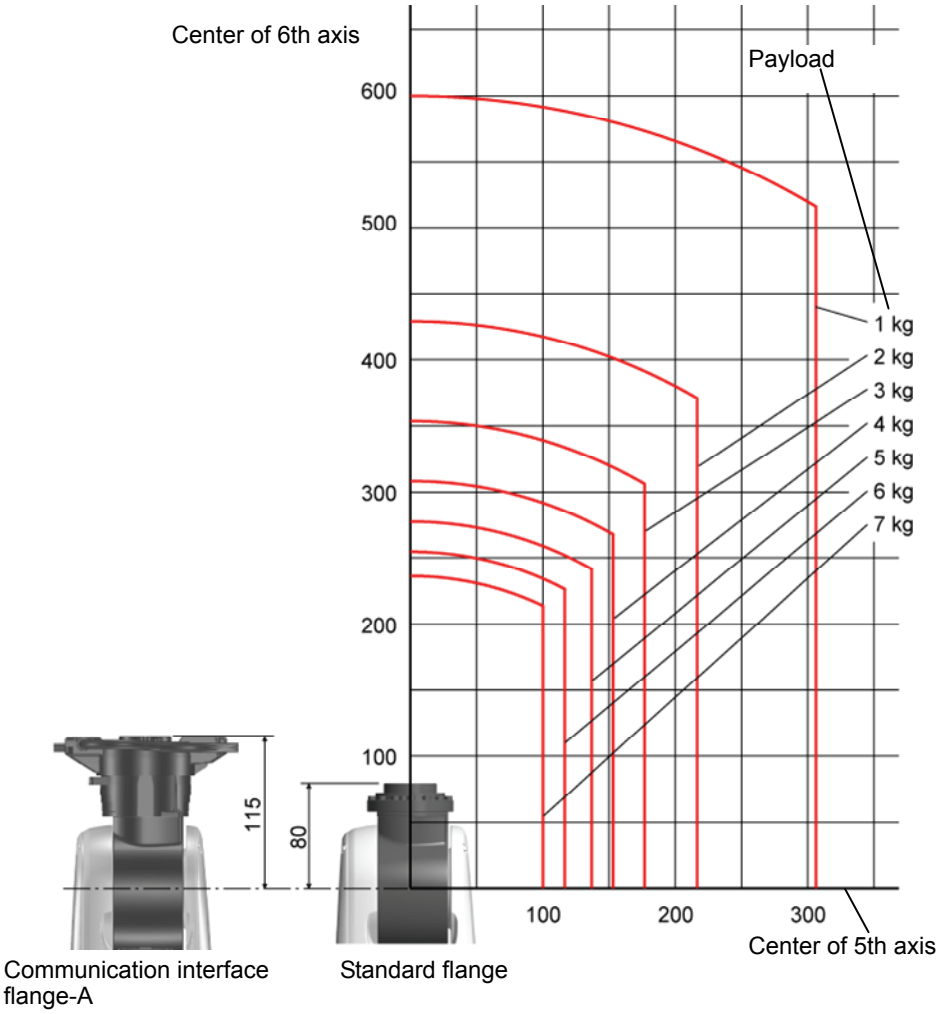
A continuous fine, low speed motion may cause an overload error.

The graph below shows the distribution of the center of gravity position of an end-effector (including workpiece) whose volume is relatively small. Referring to the graph, design an end-effector.

VS-050 / 060



VS-068 / 087



When calculating moment of inertia around J4, J5 and J6 of a designed end-effector, refer to Section 8.2 "Sample Calculation in Designing End-effectors."

3.9 Robot Positioning Time

Refer to Section 8.3 "Positioning Time of Each Axis" that includes positioning time data to be used in calculation of cycle times.

Positioning time refers to the time required from the start of robot operation to the arrival to the target point.

After the robot arm moves towards the target point and passes through it, vibration is dampened so that the robot arm is positioned at the target point as shown in the graph below. No vibration dampening time is considered in the graph.

⚠CAUTION

The vibration dampening time is dependent on the weight of the end-effector and others. If the robot is to be used where overshooting or vibration dampening time particularly becomes a problem, carry out an adequate test for confirmation beforehand.

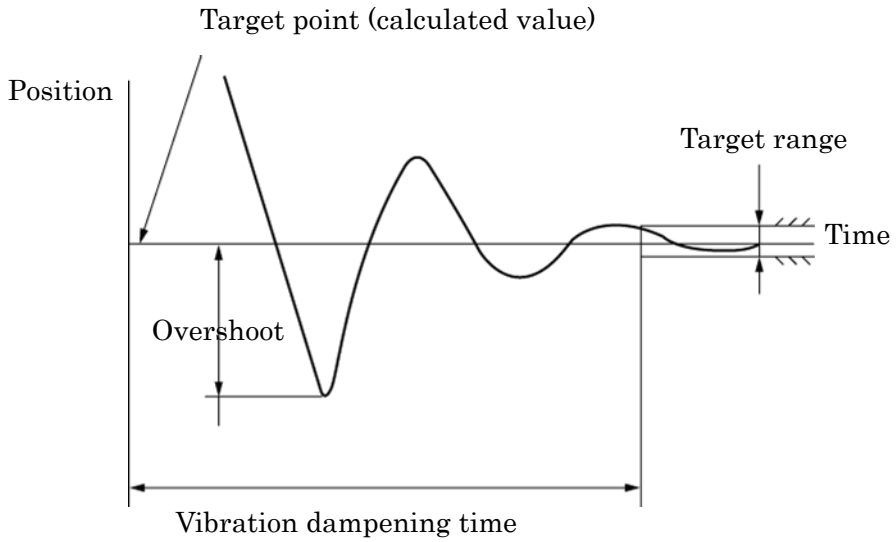
If acceleration begins before residual vibration of the robot arm stops, an overcurrent error (ERROR6120s, the first digit represents the axis number) may be displayed. In this case, take one of the following measures:

・Lower the deceleration of the preceding operation with a DECEL command to reduce residual vibration.

・Keep the robot waiting with a DELAY command until residual vibration stops.

・Lower acceleration with an ACCEL command.

Check the weights of the end-effector and workpiece sufficiently and run the robot with the optimum load settings. Improper settings may result in a robot failure.



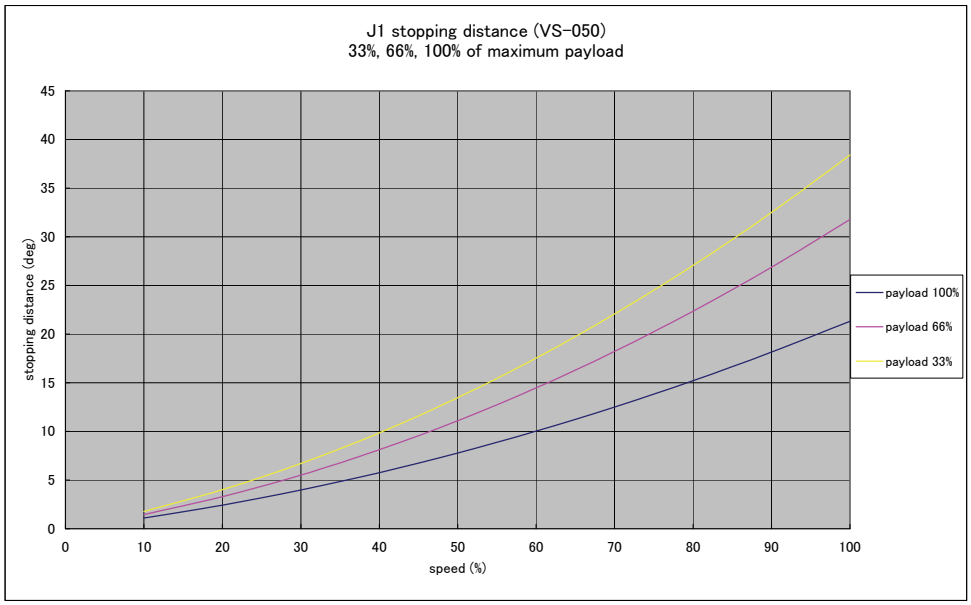
3.10 Stopping Time and Distance (Angle) at an Emergency Stop

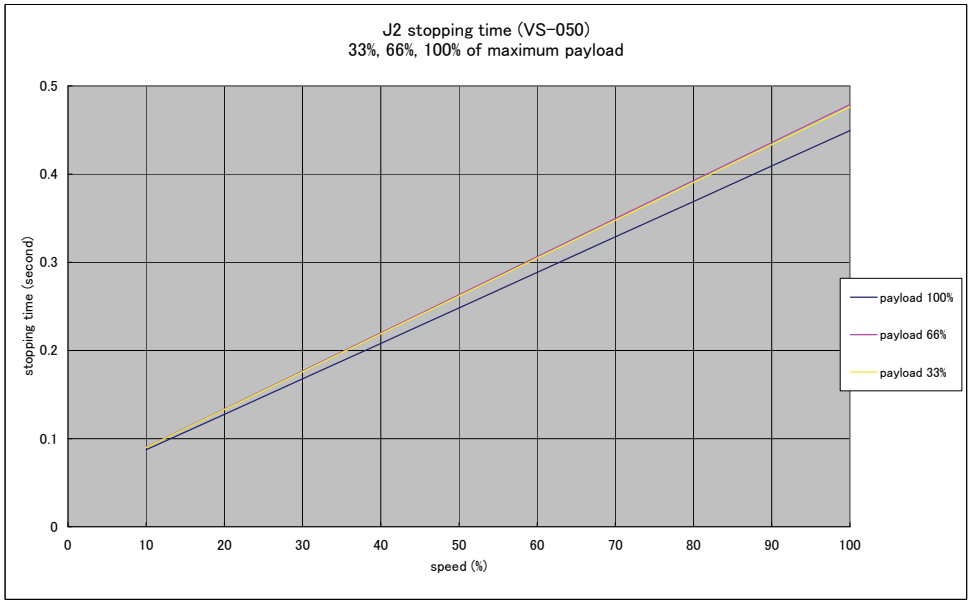
Pressing the emergency stop button when the robot is in motion stops the robot. The stopping time and the distance (angle) for major three joints vary with the robot speed as shown in the graphs below. The measuring conditions are: Robot arm extended and 33%, 66% and 100% of the maximum payload.

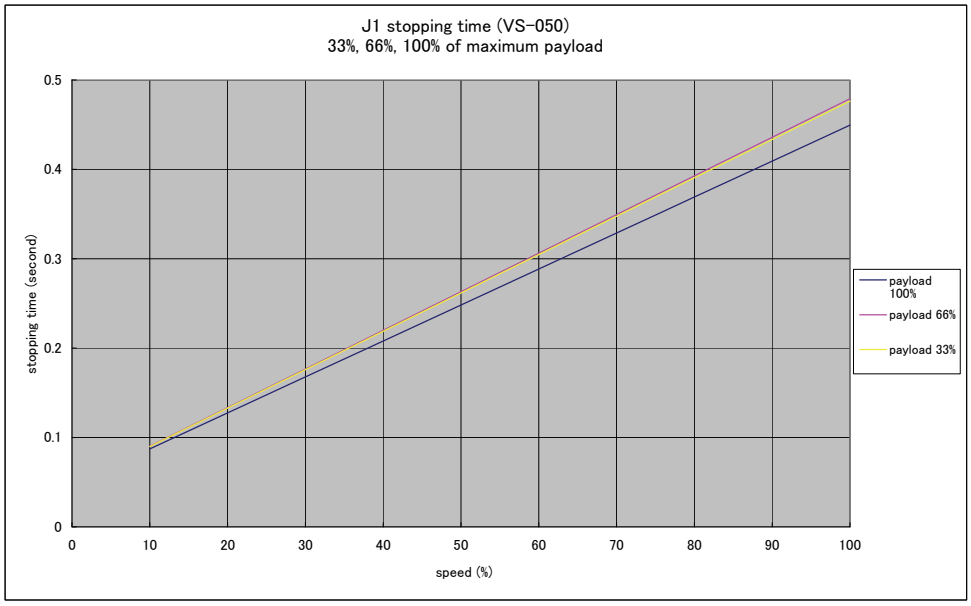
TIP

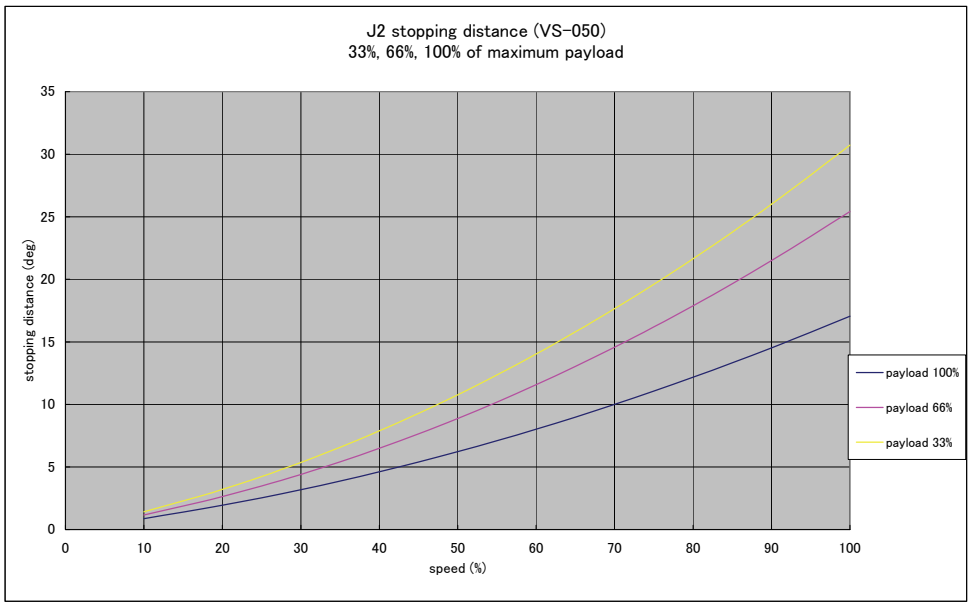
The acceleration differs depending upon the mass of payload setting. The graphs below show the cases where the stopping distance or stopping time comes to be the maximum.

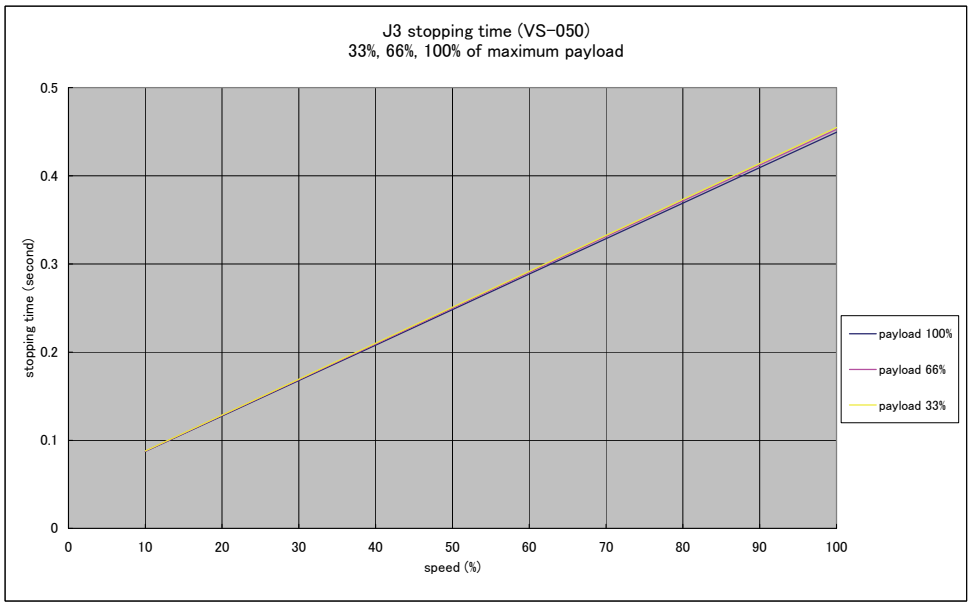
VS-050

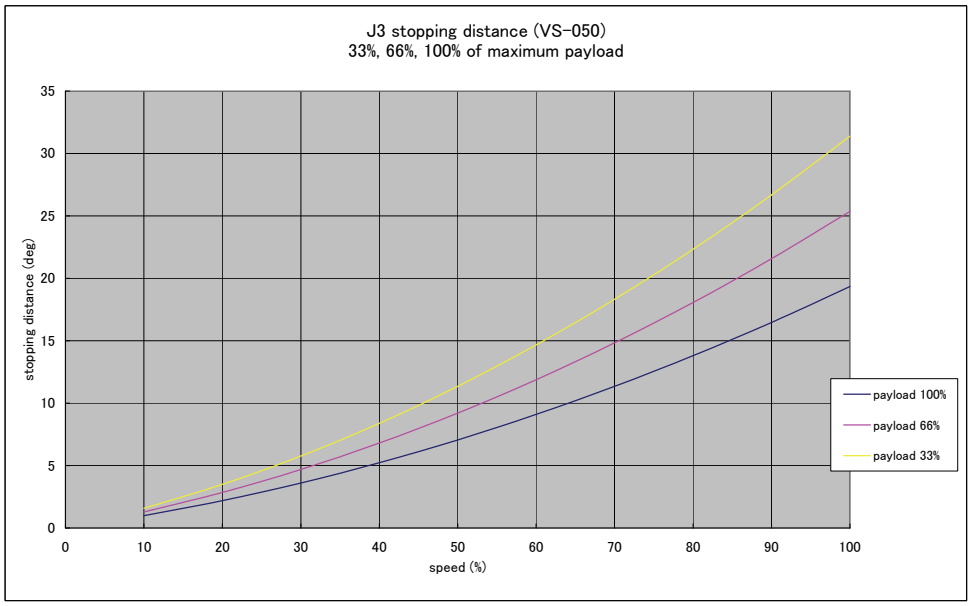

J1 stopping distance (VS-050)
33%, 66%, 100% of maximum payload
stopping distance (deg)
speed (%)
payload 100%
payload 66%
payload 33%


J2 stopping time (VS-050)
33%, 66%, 100% of maximum payload
stopping time (second)
speed (%)
payload 100%
payload 66%
payload 33%

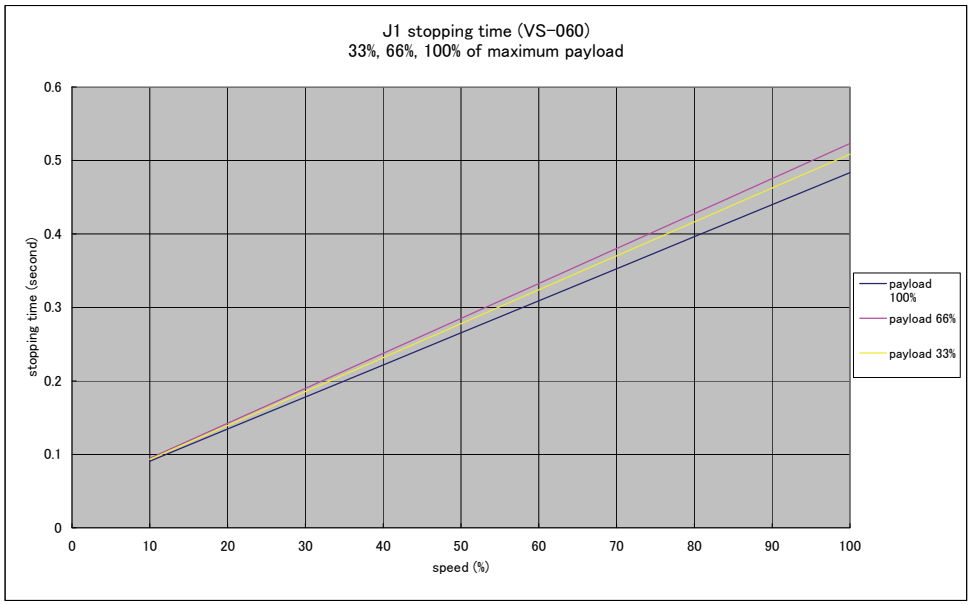

J1 stopping time (VS-050)
33%, 66%, 100% of maximum payload
stopping time (second)
speed (%)
payload 100%
payload 66%
payload 33%

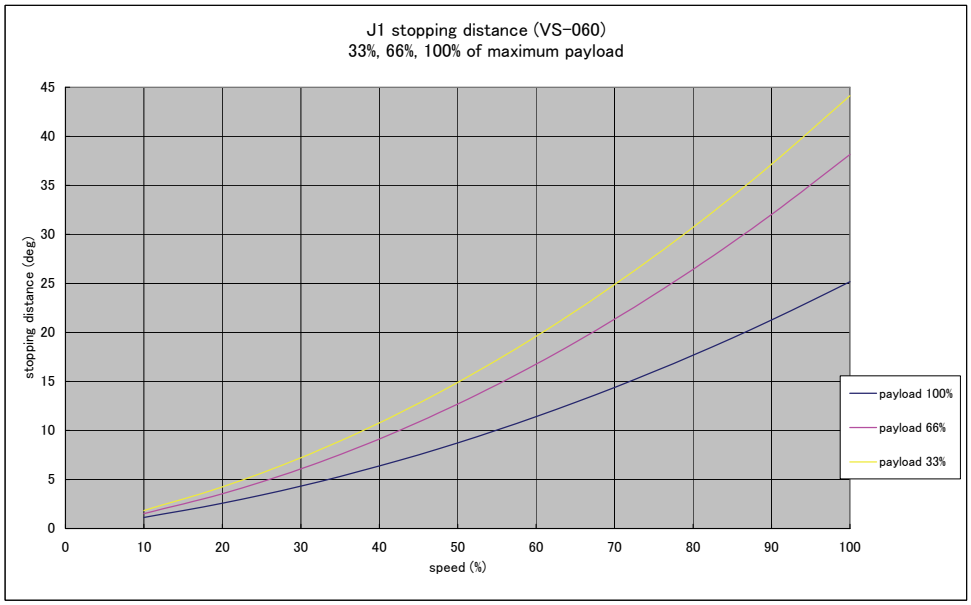

J2 stopping distance (VS-050)
33%, 66%, 100% of maximum payload
stopping distance (deg)
speed (%)
payload 100%
payload 66%
payload 33%

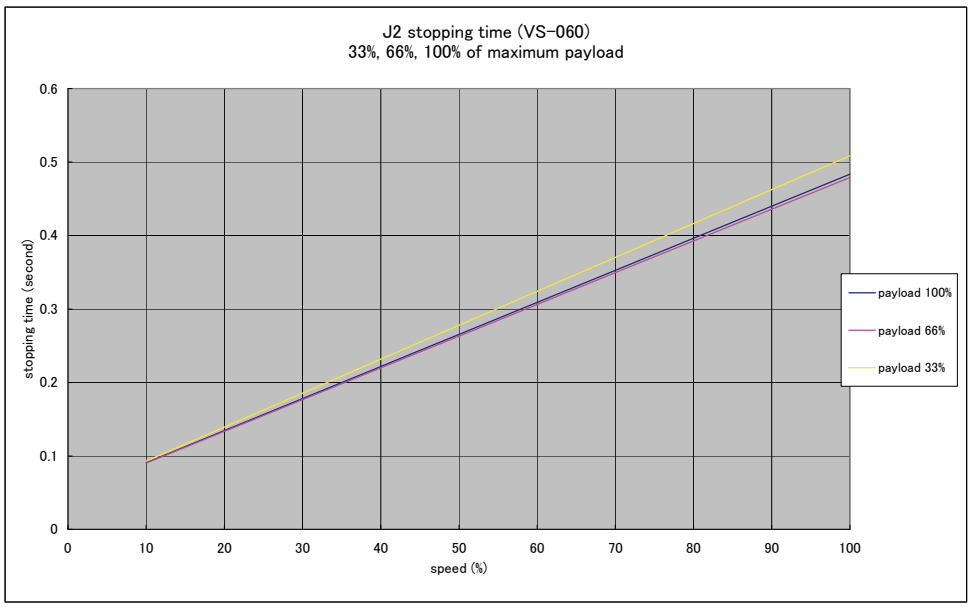

J3 stopping time (VS-050)
33%, 66%, 100% of maximum payload
stopping time (second)
speed (%)
payload 100%
payload 66%
payload 33%

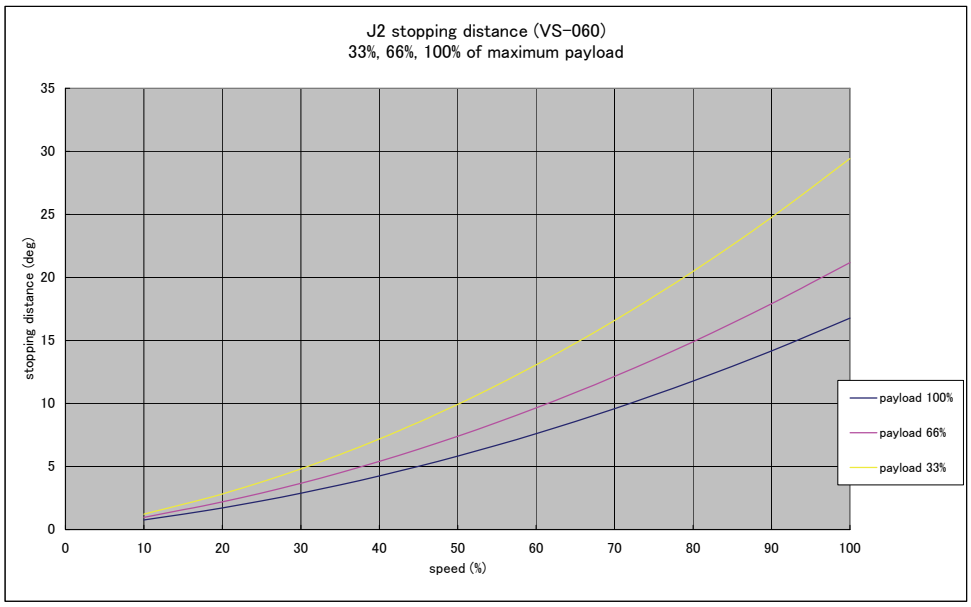

J3 stopping distance (VS-050)
33%, 66%, 100% of maximum payload
stopping distance (deg)
speed (%)
payload 100%
payload 66%
payload 33%

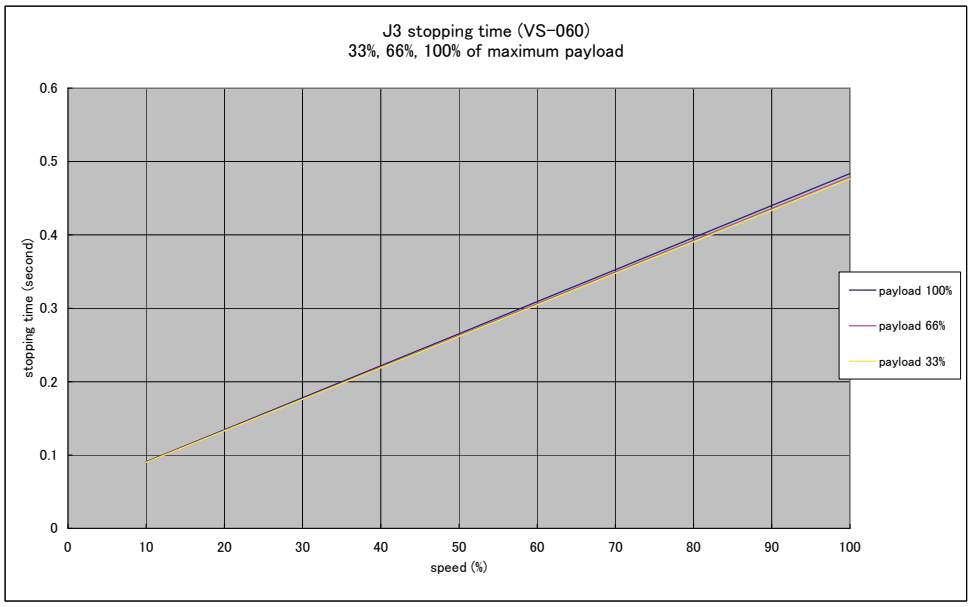
VS-060

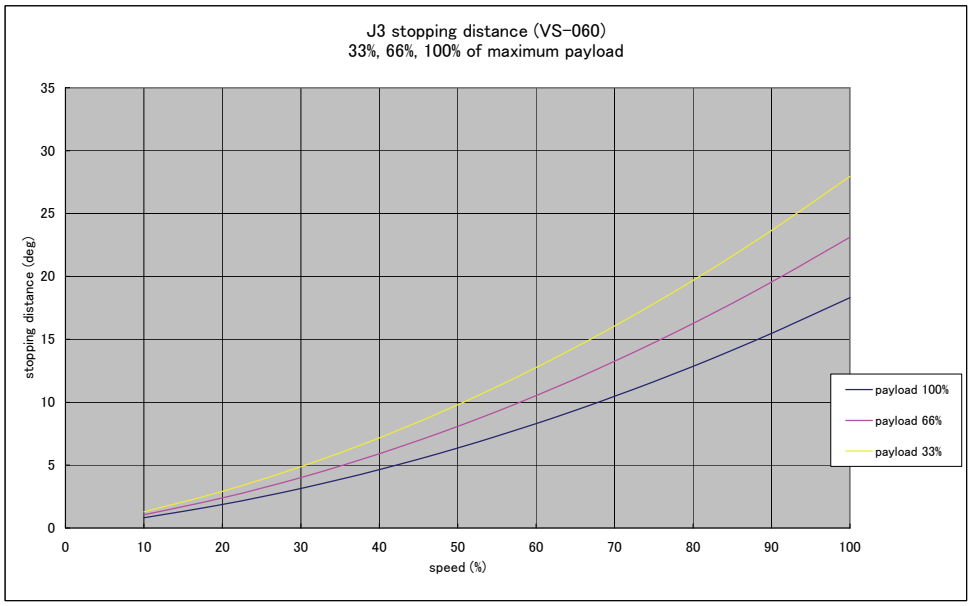

J1 stopping time (VS-060)
33%, 66%, 100% of maximum payload
stopping time (second)
0.6
0.5
0.4
0.3
0.2
0.1
0
0
10
20
30
40
50
60
70
80
90
100
speed (%)
payload 100%
payload 66%
payload 33%


J1 stopping distance (VS-060)
33%, 66%, 100% of maximum payload
stopping distance (deg)
45
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
100
speed (%)
payload 100%
payload 66%
payload 33%

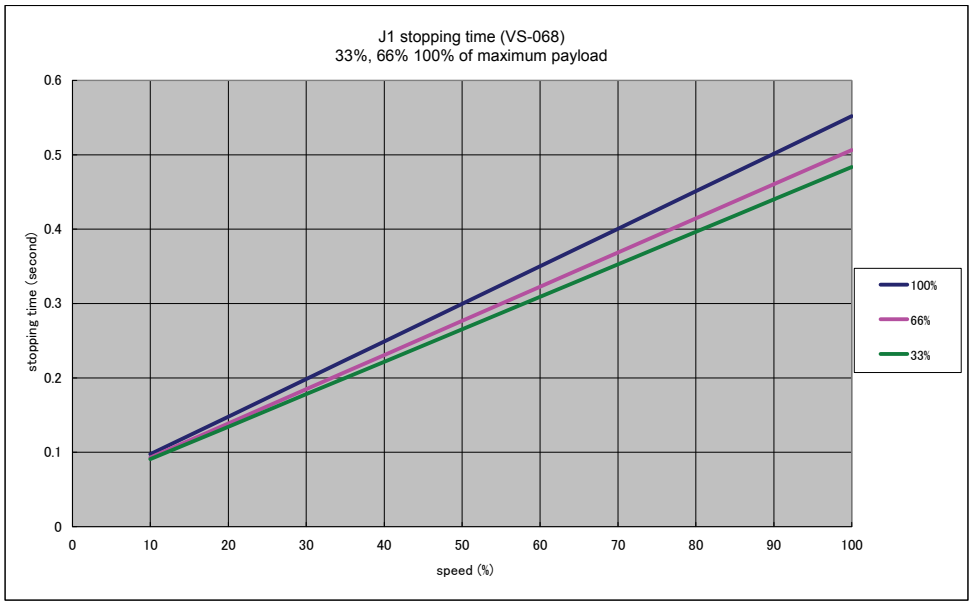

J2 stopping time (VS-060)
33%, 66%, 100% of maximum payload
stopping time (second)
0.6
0.5
0.4
0.3
0.2
0.1
0
0
10
20
30
40
50
60
70
80
90
100
speed (%)
payload 100%
payload 66%
payload 33%

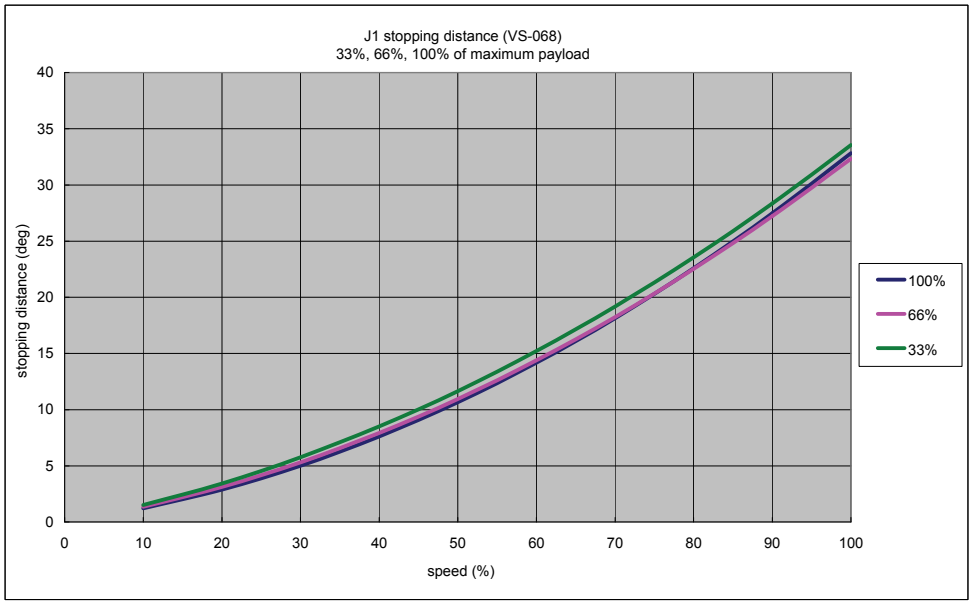

J2 stopping distance (VS-060)
33%, 66%, 100% of maximum payload
stopping distance (deg)
speed (%)
payload 100%
payload 66%
payload 33%

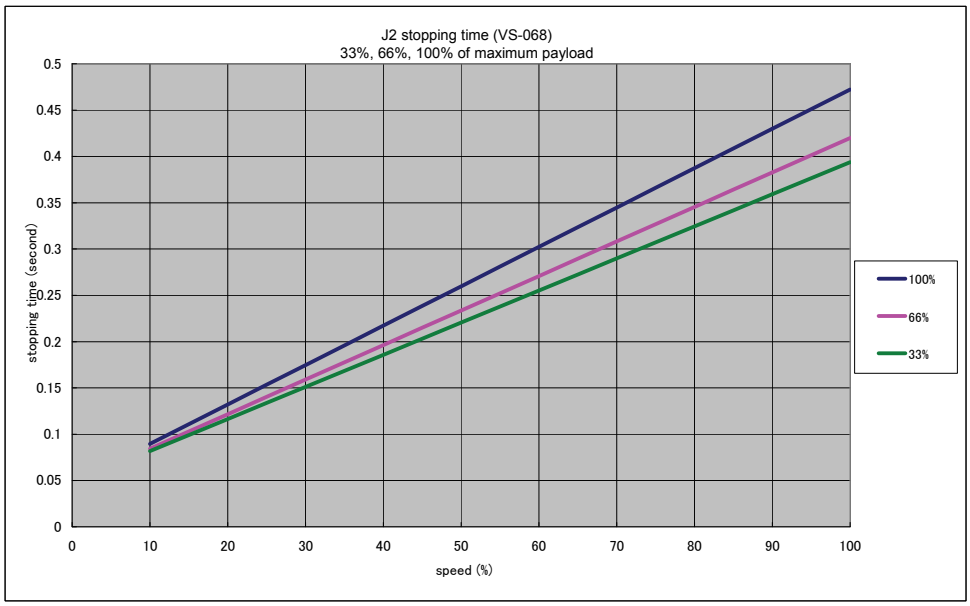

J3 stopping time (VS-060)
33%, 66%, 100% of maximum payload
stopping time (second)
speed (%)
payload 100%
payload 66%
payload 33%

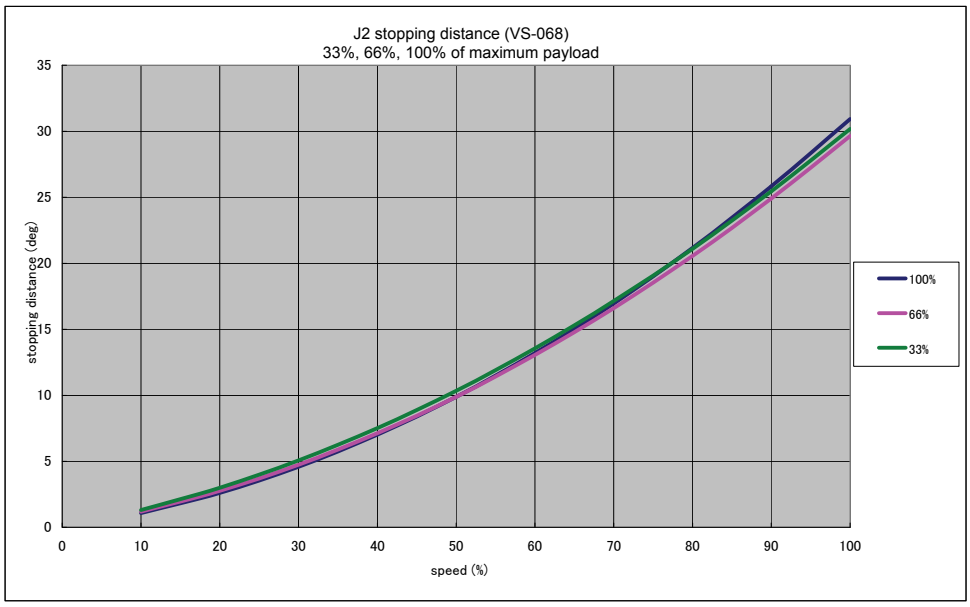

J3 stopping distance (VS-060)
33%, 66%, 100% of maximum payload
stopping distance (deg)
speed (%)
payload 100%
payload 66%
payload 33%

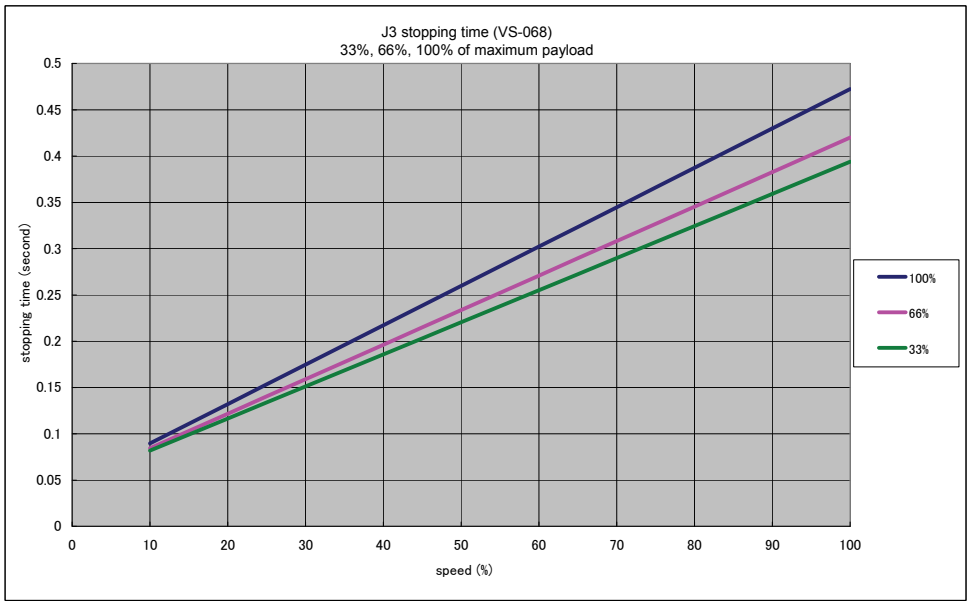
VS-068

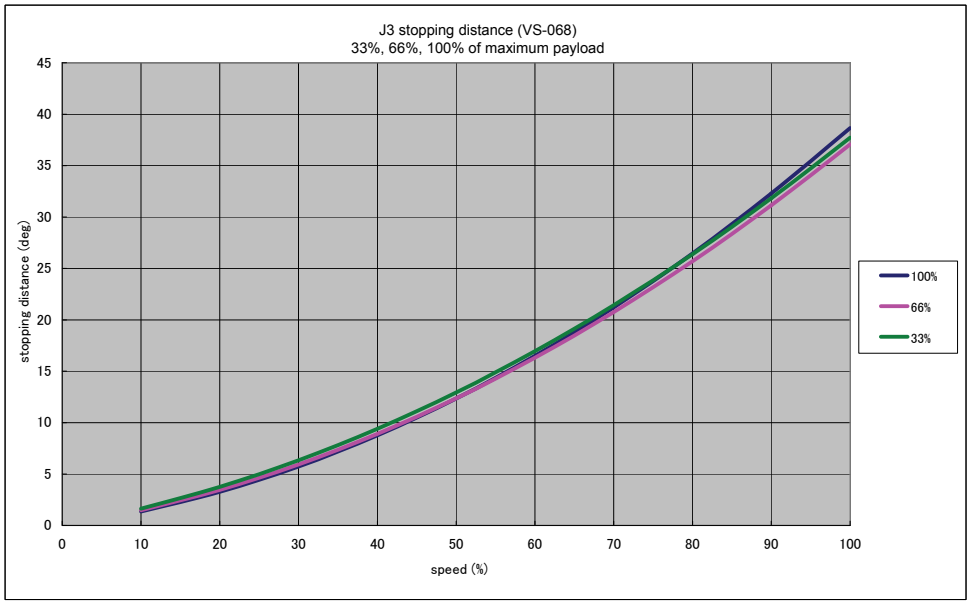

J1 stopping time (VS-068)
33%, 66% 100% of maximum payload
stopping time (second)
0.6
0.5
0.4
0.3
0.2
0.1
0
0
10
20
30
40
50
60
70
80
90
100
speed (%)
100%
66%
33%


J1 stopping distance (VS-068)
33%, 66%, 100% of maximum payload
stopping distance (deg)
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
100
speed (%)
100%
66%
33%

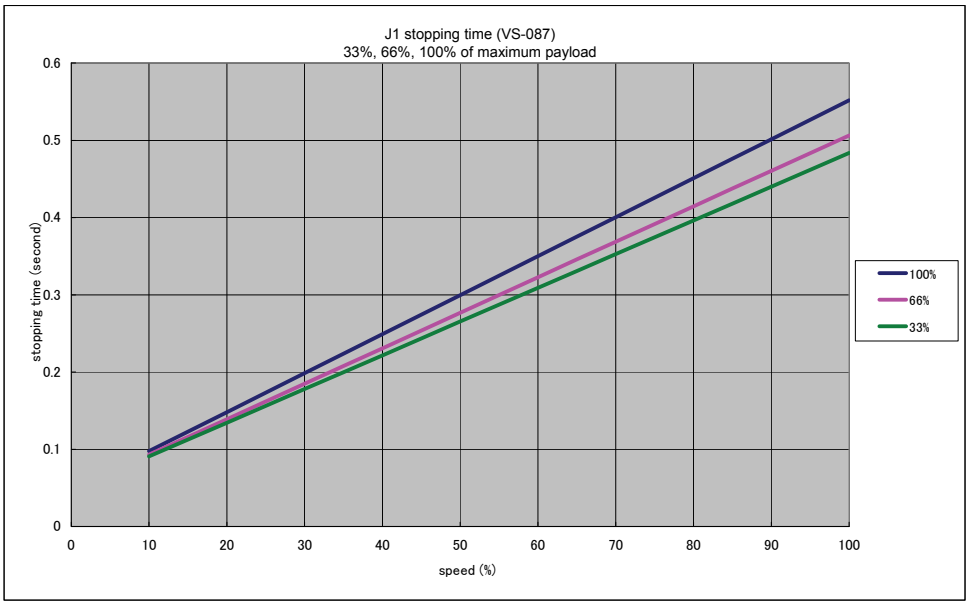

J2 stopping time (VS-068)
33%, 66%, 100% of maximum payload
stopping time (second)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
10
20
30
40
50
60
70
80
90
100
speed (%)
100%
66%
33%

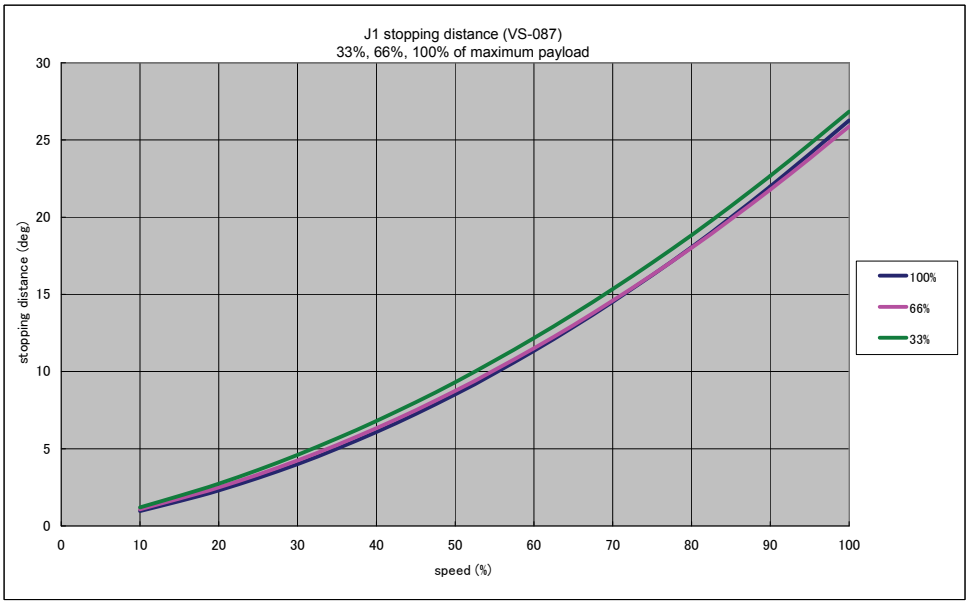

J2 stopping distance (VS-068)
33%, 66%, 100% of maximum payload
stopping distance (deg)
speed (%)
100%
66%
33%

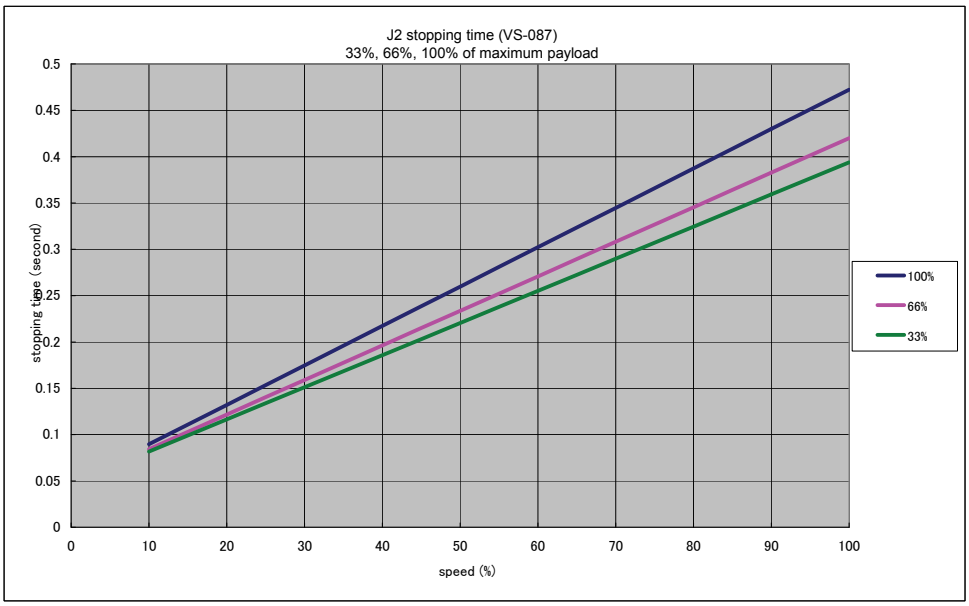

J3 stopping time (VS-068)
33%, 66%, 100% of maximum payload
stopping time (second)
speed (%)
100%
66%
33%

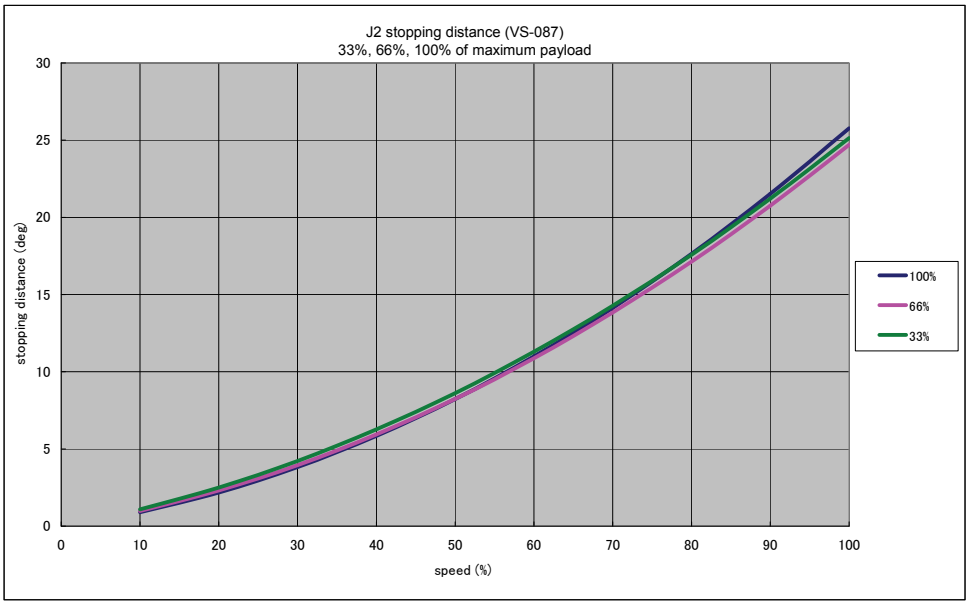

J3 stopping distance (VS-068)
33%, 66%, 100% of maximum payload
stopping distance (deg)
speed (%)
100%
66%
33%

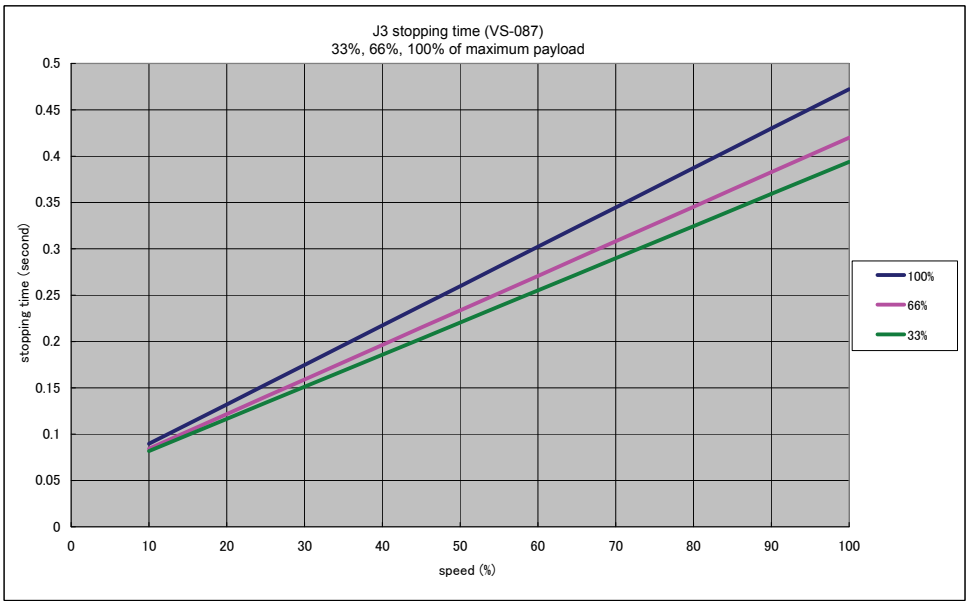
VS-087

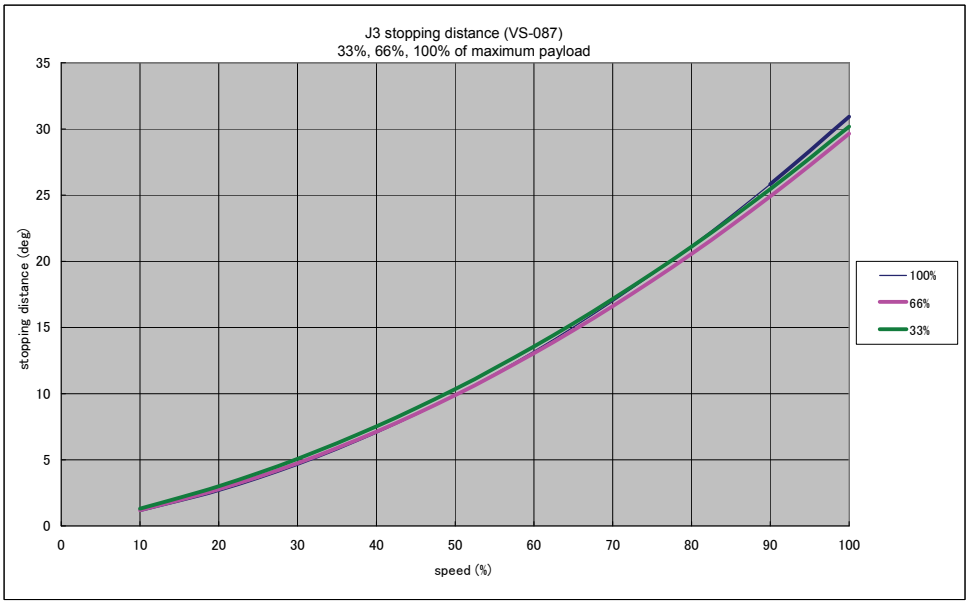

J1 stopping time (VS-087)
33%, 66%, 100% of maximum payload
stopping time (second)
0.6
0.5
0.4
0.3
0.2
0.1
0
0
10
20
30
40
50
60
70
80
90
100
speed (%)
100%
66%
33%


J1 stopping distance (VS-087)
33%, 66%, 100% of maximum payload
stopping distance (deg)
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
100
speed (%)
100%
66%
33%


J2 stopping time (VS-087)
33%, 66%, 100% of maximum payload
stopping time (second)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
10
20
30
40
50
60
70
80
90
100
speed (%)
100%
66%
33%


J2 stopping distance (VS-087)
33%, 66%, 100% of maximum payload
stopping distance (deg)
speed (%)
100%
66%
33%


J3 stopping time (VS-087)
33%, 66%, 100% of maximum payload
stopping time (second)
speed (%)
100%
66%
33%


J3 stopping distance (VS-087)
33%, 66%, 100% of maximum payload
stopping distance (deg)
speed (%)
100%
66%
33%

Chapter 4 Installation of Robot

4.1 Preparing a Proper Environment for Installation

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

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

4.2 Installation Environment of the Robot Unit

The installation requirements for the robot unit are listed below. Prepare a highly rigid mount.

⚠CAUTION

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

With regards to the dust- & splash proof type robot (IP54), please be aware that it has possibility to come off the robot coating due to the splash, the environment, or location of the robot.

Item	Environments and Requirements
Flatness of the mount	0.1/500 mm
Rigidity of the mount	Use steel materials.
Installation type	Floor-mount, overhead-mount, or wall-mount (*)
Ambient temperature	In operation: 0 to 40°C In storage or transportation: -10 to 60°C
Humidity	In operation: 40 to 90% RH (No dew condensation allowed.) In storage or transportation: 40 to 75% RH (No dew condensation allowed.)
Vibration	In operation: 4.9 m/s^2 (0.5G) or below In storage or transportation: 29.4 m/s^2 (3G) or below
Altitude	In operation: 1,000 m or below
Safe installation environment	Refer to the SAFETY PRECAUTIONS, 3.1 "Insuring the proper installation environment."
Working space, etc.	- Ensure a sufficient service space for inspection and disassembly. - Ensure a sufficient wiring space so that the bending radius (internal) of a motor & encoder cable is at least 191.3 mm when the cable is fixed, and at least 382.5 mm when it is movable.
Grounding conditions	Functional ground, wiring of 5.5 mm^2 or more

* The motion range of the 1st axis is smaller when the robot unit is wall-mounted. For details, contact the Denso service representative.

4.2.1 Vibration

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

⚠CAUTION

When the robot unit with the power off has undergone an excessive vibration during transportation, the ERROR 2AF1 (Encoder reference position error) may occur.

If the ERROR 2AF1 occurs when the robot power is first turned ON after purchase, refer to the "ERROR CODE TABLES" or contact the Denso service representative.

4.2.2 Combination of Robot Unit and Robot Controller

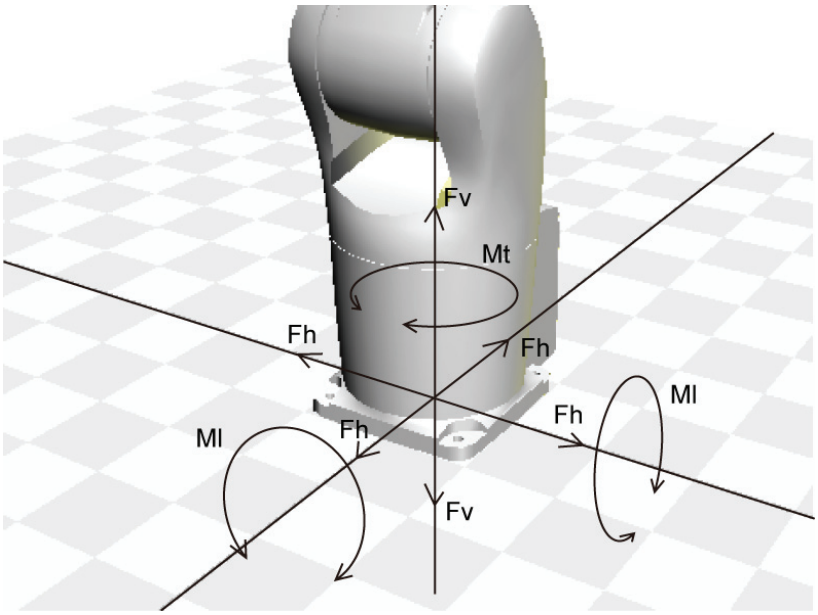
A robot unit and a robot controller are configured as a set before delivery. If you purchase two or more robot systems, therefore, configure the combination correctly, checking the serial numbers.

4.2.3 Robot Mount

The robot mount should be rigid enough. It is also advisable to mechanically join the robot mount with heavy equipment.

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

Maximum reaction force applied to the robot mount



VS-050 / 060

Overturning moment Ml:	900 Nm
Torsional moment Mt:	301 Nm
Horizontal translational force Fh:	1150 N
Vertical translational force Fv:	1221 N

VS-068 / 087

Overturning moment Ml:	2054 Nm
Torsional moment Mt:	986 Nm
Horizontal translational force Fh:	3156 N
Vertical translational force Fv:	2153 N:

⚠CAUTION

Design the top plate structure so that it is independent from other top plate structures in the equipment.

4.2.4 Transporting the Robot Unit

[1] Precautions for transporting the robot unit

The VS-*** series weighs approximately 50 kg. Use a crane with suitable capacity.

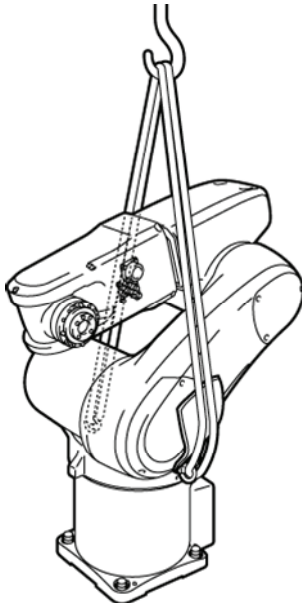
Transporting should be handled by at least two people, while wearing a helmet, safety shoes, and gloves.

⚠CAUTION

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

[2] Transport posture

Before transportation, set the robot unit in a well-balanced transport posture as shown below.



Joint angles for keeping the robot unit in a well-balanced posture when hoisting it with eyebolts

VS-050: J1 = 0°, J2 = -10°, J3 = 140°, J4 = 0°, J5 = 50°, J6 = 180°

VS-060: J1 = 0°, J2 = -20°, J3 = 130°, J4 = 0°, J5 = 70°, J6 = 180°

VS-068: J1 = 0°, J2 = -10°, J3 = 140°, J4 = 0°, J5 = 50°, J6 = 180°

VS-087: J1 = 0°, J2 = -20°, J3 = 130°, J4 = 0°, J5 = 70°, J6 = 180°

[3] Precautions for transporting the robot unit equipped with a bottom connector panel

When transporting the robot unit equipped with a bottom connector panel, clear the pathway to the destination and make careful preparations beforehand to mount the robot unit at the destination. This is because connectors protrude from the bottom of the robot base so that the robot unit cannot be temporarily laid down on the floor.

[4] Precautions for overhead-mount and wall-mount

When mounting the robot unit overhead or on a wall, observe the following for safety.

⚠WARNING

Mounting should be handled by at least two people, while wearing safety shoes, gloves, safety goggles, a helmet, etc., for ensuring safety.

Ensure a sufficient work space around the mounting place.

When hoisting the robot unit, use a lift or crane with sufficient capacity.

Make a jig exclusively designed to turn the robot unit safely.

Check places where there is a potential danger of getting hands or body caught between the robot unit and the surroundings if you hoist the robot unit or turn it to the mounting position, then remove the danger beforehand.

Ensure safety for the on-site environment, facilities, and the number of persons when mounting the robot unit. An installation example is given in Section "Overhead-mount Example"

[5] Precautions for transporting a wall-mount type of robot units

Consult the Denso service representative.

[6] Precaution for the robot equipped with the External Battery Extension Unit

The robot equipped with the external battery extension unit has been removed the encoder backup battery which originally installed inside the robot. In the event of transporting or removing the robot, make sure to reinstall the encoder backup battery to the robot before removing the external battery extension unit from the robot. Removing the external battery extension unit without reinstallation of the encoder backup battery causes the loss of encoder data. Please confirm the reinstallation of the encoder backup battery in the robot before removing the external battery extension unit.

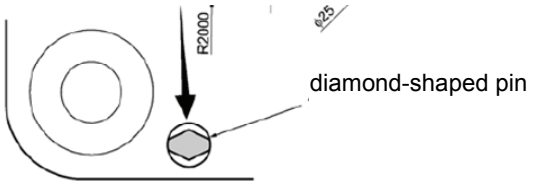
4.2.5 Securing the Robot Unit

STEP 1

Check that the robot mount has four fixing bolt holes, two dowel pin holes (ø4H7 for diamond-shaped pin and ø6H7 for internally threaded positioning pin) and cabling space in accordance with the external dimensions of the robot unit. Refer to Section 8.1 "Reference Drawings."

STEP 2

Drive the diamond-shaped pin into the ø4H7 hole so that it orients as shown below.



STEP 3

Drive the internally threaded positioning pin into the ø6H7 hole.

NOTE

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

STEP 4

Set the robot unit into place on the robot mount.

STEP 5

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

VS-050 / 060

- Fixing bolt: M8 × 30 mm (strength class: 12.9)
- Tightening torque: 35 +/- 7 Nm

VS-068 / 087

- Fixing bolt: M10 × 30 mm (strength class: 12.9)
- Tightening torque: 70 +/- 14 Nm

4.2.6 Grounding the Robot Unit

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

⚠CAUTION

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

4.3 Installing the Robot Controller

For the installing procedures of the robot controller, refer to the RC7M Controller Manual, Section 6.2 "Mounting the Controller"

4.4 Releasing Brakes on Individual Axes

The VS-*** series of robots has brakes on all axes. At the time of an emergency stop, to move axes with the motors OFF, release the brakes using either of the following two procedures.

Release the brakes using the teach pendant

Turn the controller power ON.

Top screen - [F2 Arm] - [F12 Maint.] - [F3 Brake.]

Select the brake to be released and press OK.

Release the brakes using the brake release unit

Select the axis to be released with the axis selector switch.

Press the brake release button.

NOTE

Only when the controller power is ON, brakes can be released.

Chapter 5 Limiting the Motion Range

5.1 Outline

To prevent interference with other devices or entanglement of the end-effector wiring and piping, limit the motion range as needed by setting the mechanical ends for defining the "restricted space" and the software motion limits for defining the "motion space."

After changing the mechanical ends, change also the software motion limits so that the motion space comes within the restricted space.

Please contact your DENSO representative for more details.

5.2 Changing the Mechanical Ends

The VS-*** series of robots allows you to change the mechanical ends of the 1st, 2nd, and 3rd axes.

Changing the following three mechanical ends requires modifying the RANG values in some cases as described below.

- 1st axis, the positive direction
- 2nd axis, the negative direction
- 3rd axis, the positive direction

If it is possible to remove the mechanical stop parts and move the robot arm to the previous mechanical end, no modification of the RANG values is required. If it is impossible (e.g., due to interference with the surrounding equipment), however, modification of the RANG values is required.

After modification of the RANG values, perform CALSET and back up both the RANG and CALSET values.

For details about CALSET and RANG values, refer to Section 5.4 "CALSET" and Section 5.5 "Changing RANG Values."

⚠CAUTIONS IN CHANGING THE MECHANICAL ENDS

1. To change the mechanical ends, design and produce the mechanical stoppers suited for the usage conditions, referring to this manual.
2. After changing the mechanical ends using the mechanical stoppers, be sure to change also the software motion limits to prevent the robot arm from coming into contact with the mechanical stoppers when the robot runs.
3. If the robot arm collides against any mechanical stopper, it may be damaged. Before use, contact the Denso service representative for inspection and repair.

   The mechanical stopper designed and produced by the customer may also be damaged. Do not use it again and replace it.
4. The reference drawings given in this manual do not fully cover the customer's usage conditions. Design, manufacture and mount the mechanical stoppers according to the motion range and other usage conditions.
5. A mass increase due to the mounted mechanical stoppers may influence the payload capacity of the robot unit.
6. The robot failures resulting from the mechanical stoppers shall not be covered by the warranty even if the robot is under warranty.

Note

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

5.3 Changing the software motion limits

To avoid damages that could be caused by collision or contact with mechanical stoppers, configure the motion space by setting the software motion limits on individual axes.

By default, the software motion limits are configured slightly inside the mechanical ends.

If the robot arm reaches a software motion limit during manual or automatic operation, the robot displays an error message (ERROR6070s, the first digit represents the axis number) and comes to a stop. If the robot is in automatic operation, it also cuts off the power to the motors.

This function becomes valid after the robot arm enters the motion space configured by the software motion limits.

⚠CAUTION

Software motion limits are not functions in accordance with safety standards.

5.3.1 Precautions When Changing the Software Motion Limits

Confirm the robot motion range in actual working environment. Set the software motion limits using the correct unit of measurement.

If the robot arm lies in the position overriding the software motion limits, e.g., immediately after change of the software motion limits, only a manual operation that moves the robot arm towards the motion space is possible. Move the robot arm in Joint mode.

5.3.2 Software Motion Limits Changing Procedure

STEP 1

Turn the power switch of the robot controller to ON.

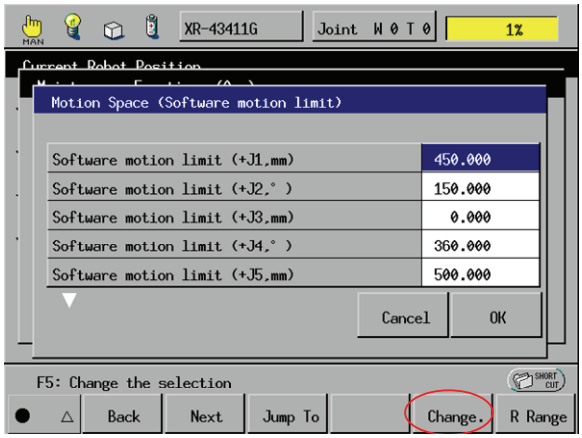
STEP 2

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

STEP 3

Use the teach pendant to display the Motion Space (Software motion limit) window.

Top screen - [F2 Arm] - [F12 Maint.] - [F1 M Space.]



STEP 4

Select the item to be modified, press [F5 Change.], and enter the desired value.

After entry, press OK to close the window.

STEP 5

Restart the robot controller.

NOTE

Newly entered settings (software motion limits) go into effect after the restart of the controller.

5.4 CALSET

5.4.1 What Is CALSET?

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

CALSET uses a previously determined axis position where an axis can be secured. It creates calibration data (CALSET data) that matches the actual axis position (CALSET position) with the encoder value. The angle of the CALSET position is saved in the robot controller as a RANG value.

The CALSET data is different on each robot.

CALSET must be performed when any of the motors is replaced or the encoder backup battery goes dead so that the position-related data retained in the encoder is lost.

CALSET data should be managed by the customer. Back up the CALSET data periodically, referring to Section 6.11 "Backing up Projects."

Factory defaults of CALSET position

Axis	CALSET position
1st axis	Positive-direction mechanical end (at the time of shipment)
2nd axis	Negative-direction mechanical end (at the time of shipment)
3rd axis	Positive-direction mechanical end (at the time of shipment)
4th axis	Location of 4th-axis CALSET bolt (Refer to "4th-axis CALSET position")
5th axis	Negative -direction end VS-050/060: Use CALSET bolt. Refer to "5th-axis CALSET position (VS-050/060)"
6th axis	Location of CALSET jig Please refer to the following information as a function of the flange type. - 6th-Axis CALSET Position (Standard Type Robot, Standard Flange) - 6th-Axis CALSET Position (Communication Interface Flange-A) - 6th-Axis CALSET Position (Dust- & Splash-proof Type and Protected Type)

5.4.2 CALSET Procedure

STEP 1

Release the brake of an axis to be CALSET and move the axis to the CALSET position.

STEP 2

Use the teach pendant to select CALSET.

Top screen - [F2 Arm] - [F12 Maint.] - [F6 CALSET]

Select the target axis and press OK.

[1] 4th-axis CALSET position

The 4th axis physically rotates 360°or more but it is not a boundless rotation joint. It has no mechanical ends.

Rotate the 4th axis slowly but surely and set the 4th axis in a correct CALSET position.

Performing CALSET in a wrong position may break internal wiring.

STEP 1

Release the brake of the 4th axis.

STEP 2

Rotate the 4th axis in the positive direction slowly but surely until it gets blocked.

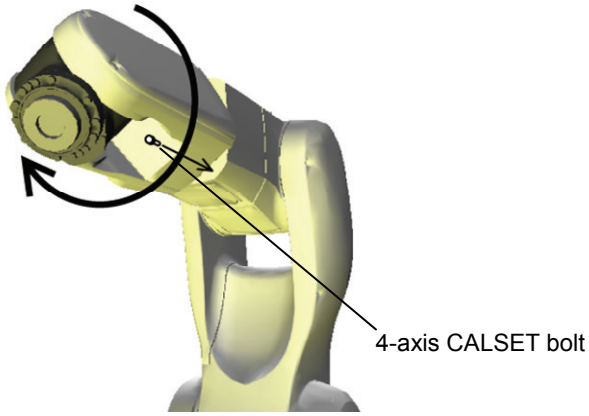
⚠CAUTION

Slowly rotate the axis. If it gets blocked, do not push it hard further.

STEP 3

Rotate the 4th axis from the position blocked in STEP 2 approx. 270° (VS-050/060) or approx. 330° (VS-068/087) in the negative direction by hand to place it in the position shown below.

Set the 4th-axis CALSET bolt in that position. (The 4th-axis CALSET bolt is stored in the encoder backup battery box. Refer to Section 3.7 "Encoder Backup Battery Box".



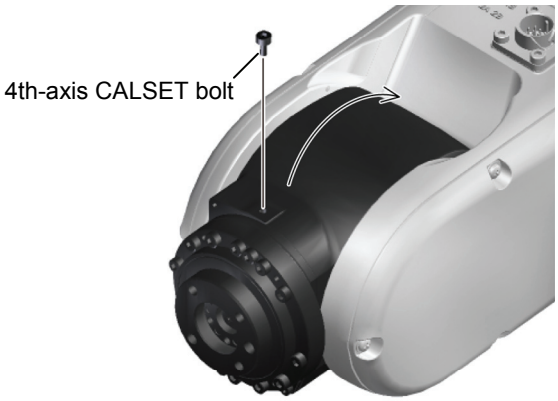
STEP 4

Rotate the 4th axis in the negative direction by hand and gently press it against the 4th-axis CALSET bolt for performing CALSET.

[2] 5th-axis CALSET position (VS-050/060)

Determine the CALSET position of the 5th axis of the VS-050/060 using the 4th-axis CALSET bolt.

Set the 4th-axis CALSET bolt in the position shown below and then gently press the 5th axis against the negative-direction end by hand. (The 4th-axis CALSET bolt is stored in the encoder backup battery box. Refer to Section 3.7 "Encoder Backup Battery Box".)

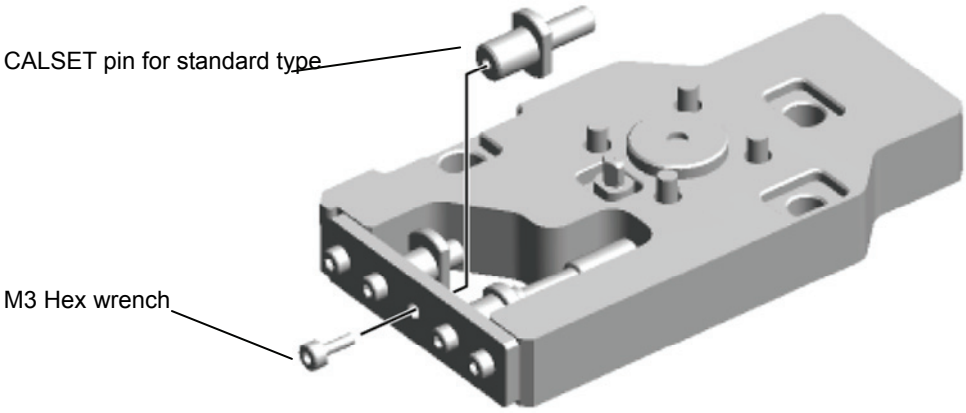


[3] 6th-Axis CALSET Position (Standard Type Robot, Standard Flange)

For robots equipped with a standard flange, determine the 6th-axis CALSET position using a dedicated CALSET jig. Checking the number of rotations of the axis is not necessary because the 6th axis is a boundless rotation joint.

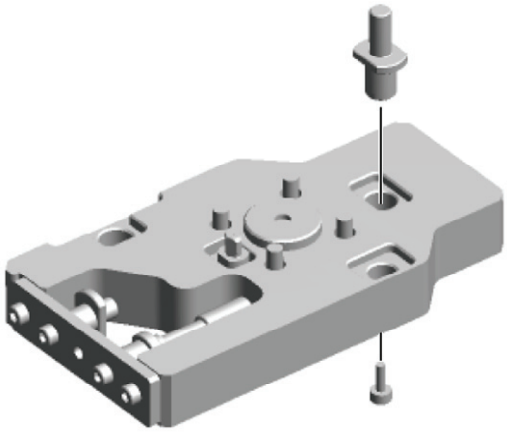
STEP 1 CALSET jig assembly

Remove the standard-type CALSET pin.



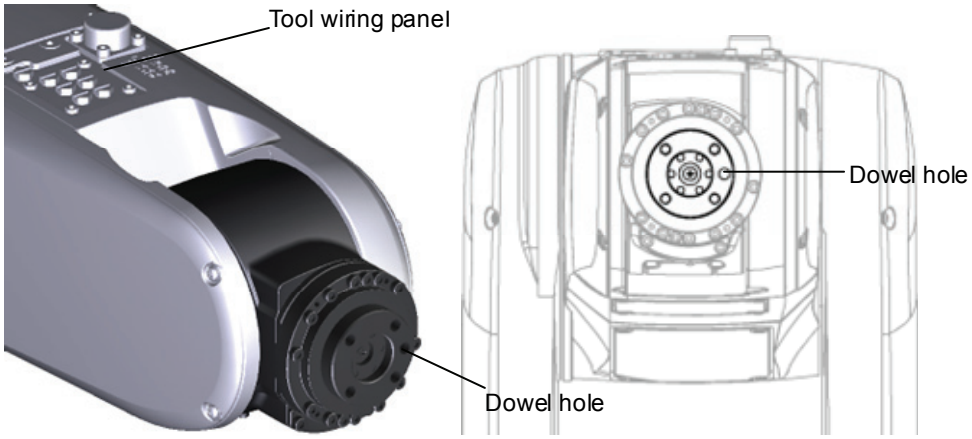
Mount the CALSET pin (for standard type) to the place drawing below indicates.

Tightening Torque: 2.0 +/- 0.4 Nm



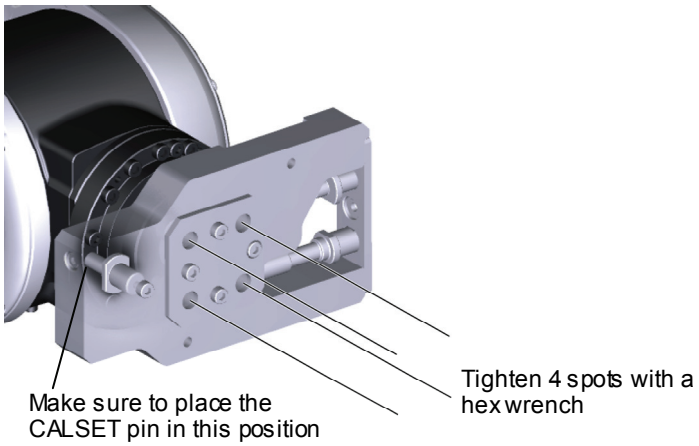
STEP 2 CALSET jig installation

Set the 6 axis to the place drawing below indicates. (near the 0 degree)



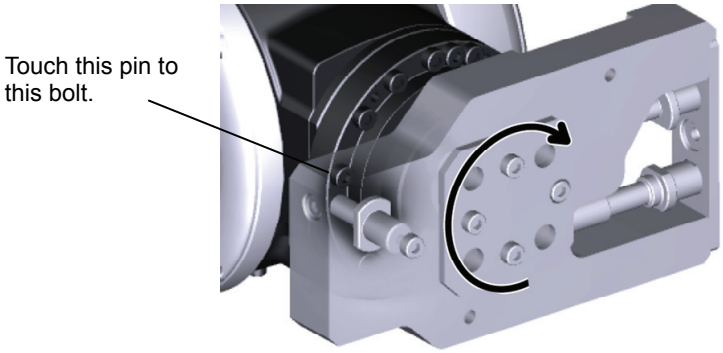
Mount the CALSET jig.

Tightening Torque: 8.8 +/- 1.7 Nm



STEP 3 Positioning

Rotate the CALSET jig clockwise, and then touch the pin to the bolt slightly.

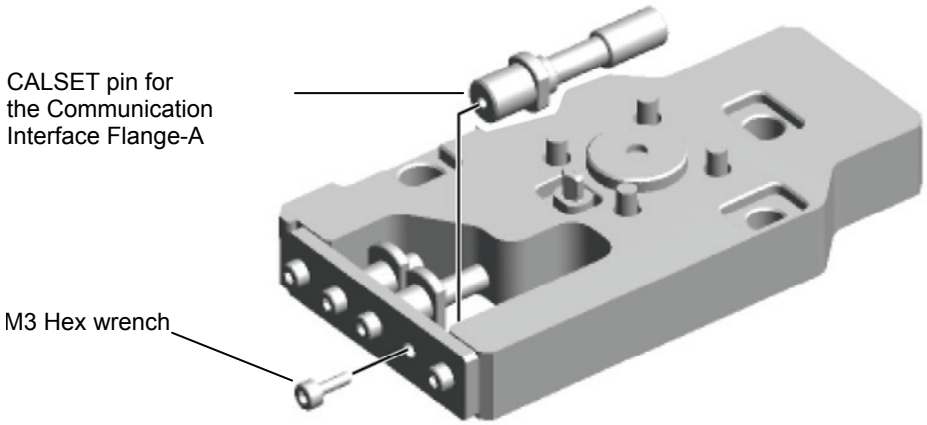


[4] 6th-Axis CALSET Position (Communication Interface Flange-A)

For robots equipped with a communication interface flange-A, determine the 6th-axis CALSET position using a dedicated CALSET pin. The 6th axis is not a boundless rotation joint, so checking secure rotations of the axis is necessary.

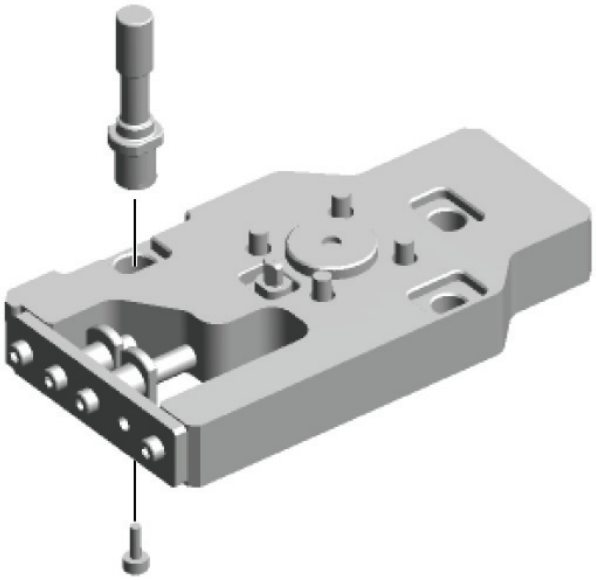
STEP 1 CALSET jig assembly

Remove the CALSET pin for the communication interface flange-A.

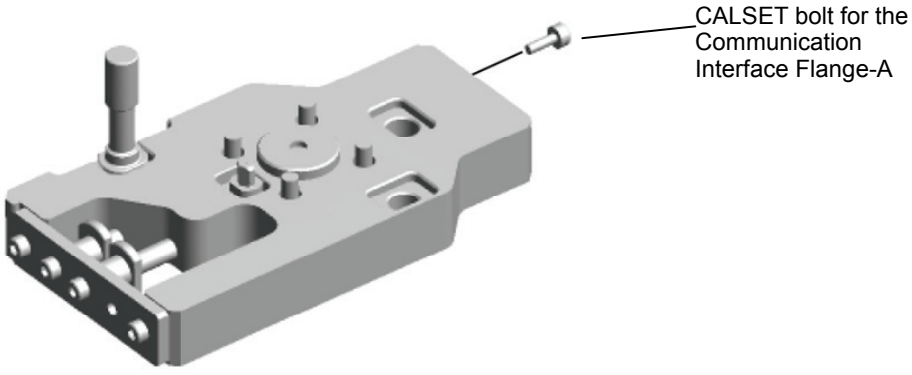


Mount the CALSET pin to the place drawing below indicates.

Tightening Torque: 2.0 +/- 0.4 Nm

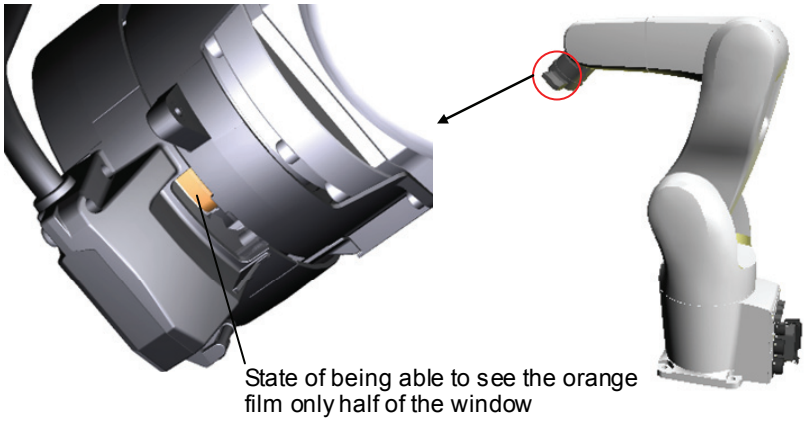


Remove the CALSET bolt for the communication interface flange-A

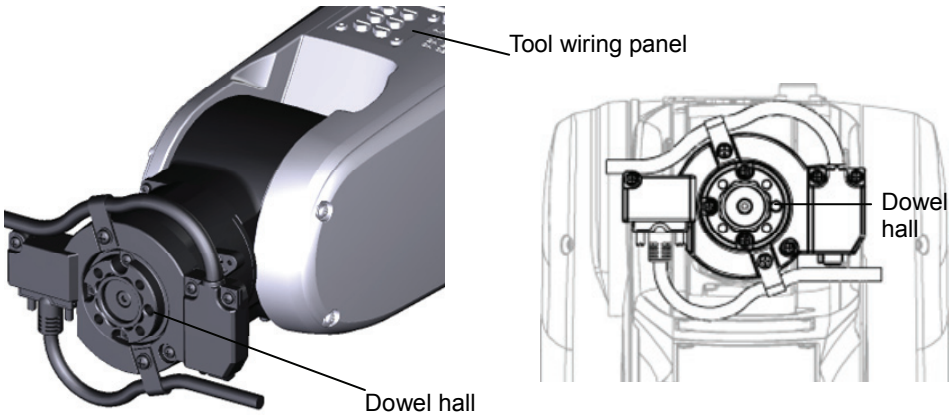


STEP 2 CALSET jig installation

Turn the 6th axis until being able to see the orange film from a half of the window next to the flange. In case of not being able to see the orange film from the window next to the flange at all, turn the 6th axis to the negative direction (clockwise from the front of the flange). In case of being able to see the orange film from the entire window, turn the 6th axis to the positive direction (anti-clockwise).

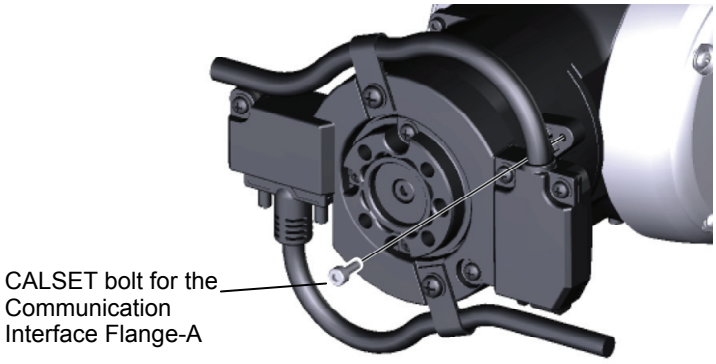


Set the 6 axis to the place drawing below indicates. (Near the 0 degree)



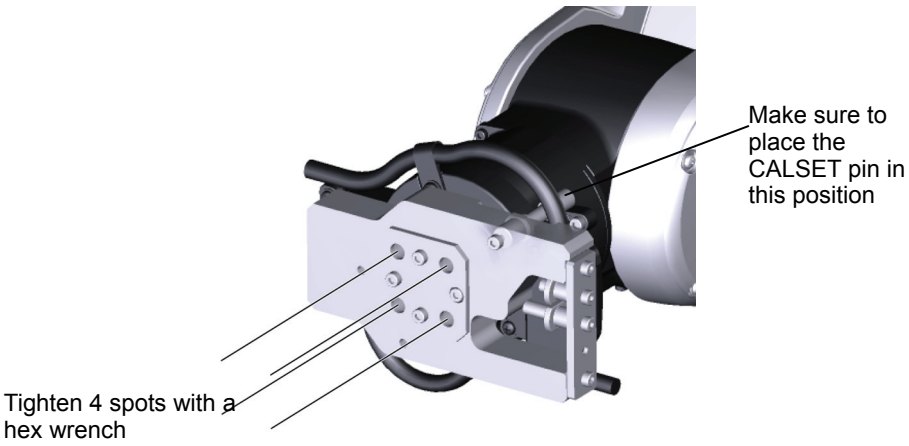
Mount the CALSET bolt for the communication interface flange-A.

Tightening Torque; 0.8+/-0.1Nm



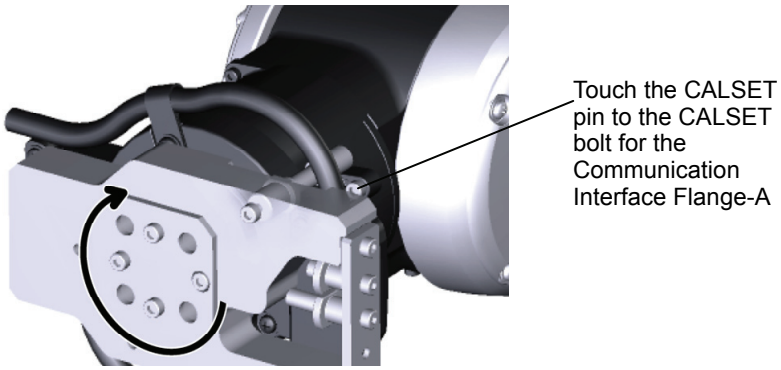
Mount the CALSET jig.

Tightening Torque：8.8 +/- 1.7 Nm



STEP 3 Positioning

Rotate the CALSET jig clockwise, touch the CALSET pin to the CALSET bolt for communication cable flange specification for A slightly.

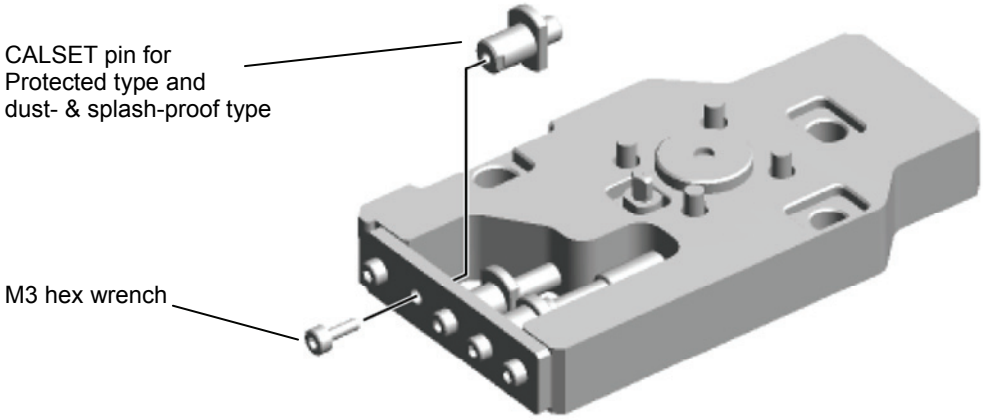


[5] 6th-Axis CALSET Position (Dust- & Splash-proof Type and Protected Type)

The position of the 6th-axis of VS-*** series of robots (dust- &splash-proof type and protected type) is determined by special Jig. The 6th axis is a boundless rotation joint, so checking the number of rotations of the axis is not necessary.

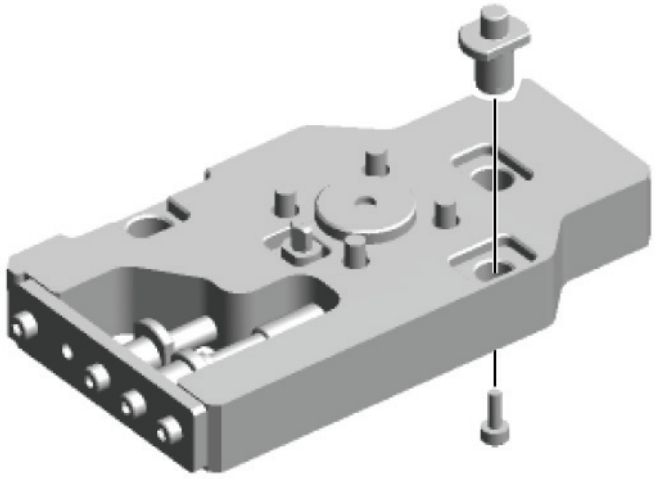
STEP 1 CALSET jig assembly

Remove the CALSET pin as shown below.



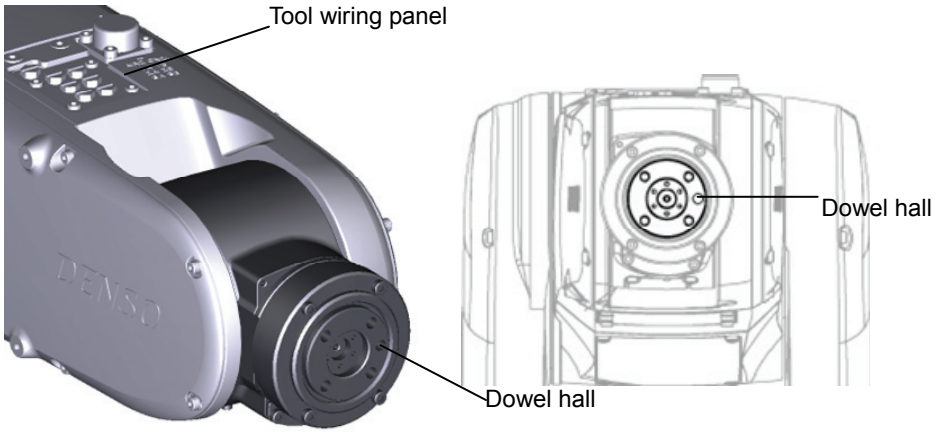
Mount the CALSET pin to the place drawing below indicates.

Tightening Torque：2.0 +/- 0.4 Nm



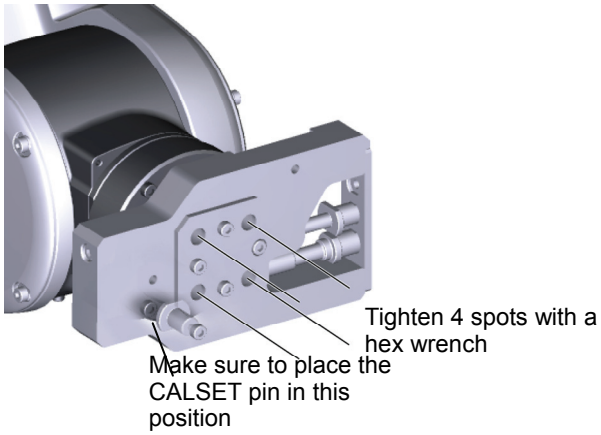
STEP 2 CALSET jig installation

Set the 6 axis to the place drawing below indicates. (Near the 0 degree)



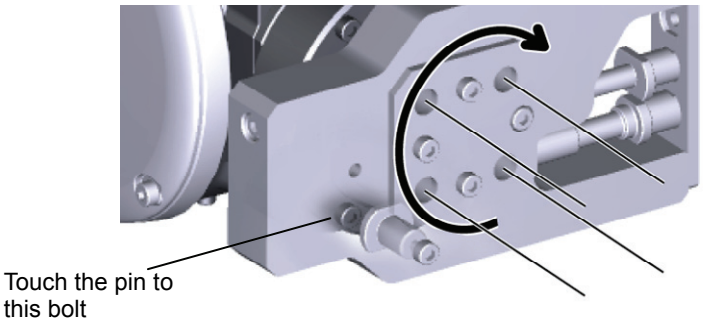
Mount the CALSET jig.

Tightening Torque; 8.8 +/- 1.7 Nm



STEP 3 Positioning

Rotate the CALSET jig clockwise, touch the pin to the bolt slightly.



5.5 Changing RANG Values

A RANG value refers to an angle that determines the relationship between the reference position of the robot arm and the CALSET position, and is also called a reference angle or ready angle.

The factory defaults of RANG values for the 1st, 2nd, and 3rd axes are obtained when each axis is in contact with the corresponding mechanical end configured at the time of shipment.

When CALSET is required but mechanical stop parts mounted by the customer cannot be removed so that the robot arm cannot take a posture in the CALSET position determined at the time of shipment, then it is necessary to change the RANG values stored in the controller to the ones obtained by the CALSET position determined by the mechanical stopper parts mounted by the customer.

NOTE

If the RANG values are changed, the mechanical stop parts mounted by the customer influence the precision of CALSET.

STEP 1

Move an axis whose RANG value is to be changed towards the mechanical end by manual operation in Joint mode and slowly press the axis against the mechanical end.

STEP 2

Make a note of the RANG value of the corresponding axis in Joint mode which is shown in the current position.

STEP 3

On the RANG window, change the current RANG value of the corresponding axis to the value of the note made in STEP 2

Top screen - [F2 Arm] - [F12 Maint.] - [F2 RANG.]

5.6 Setting the Control Set of Motion Optimization

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

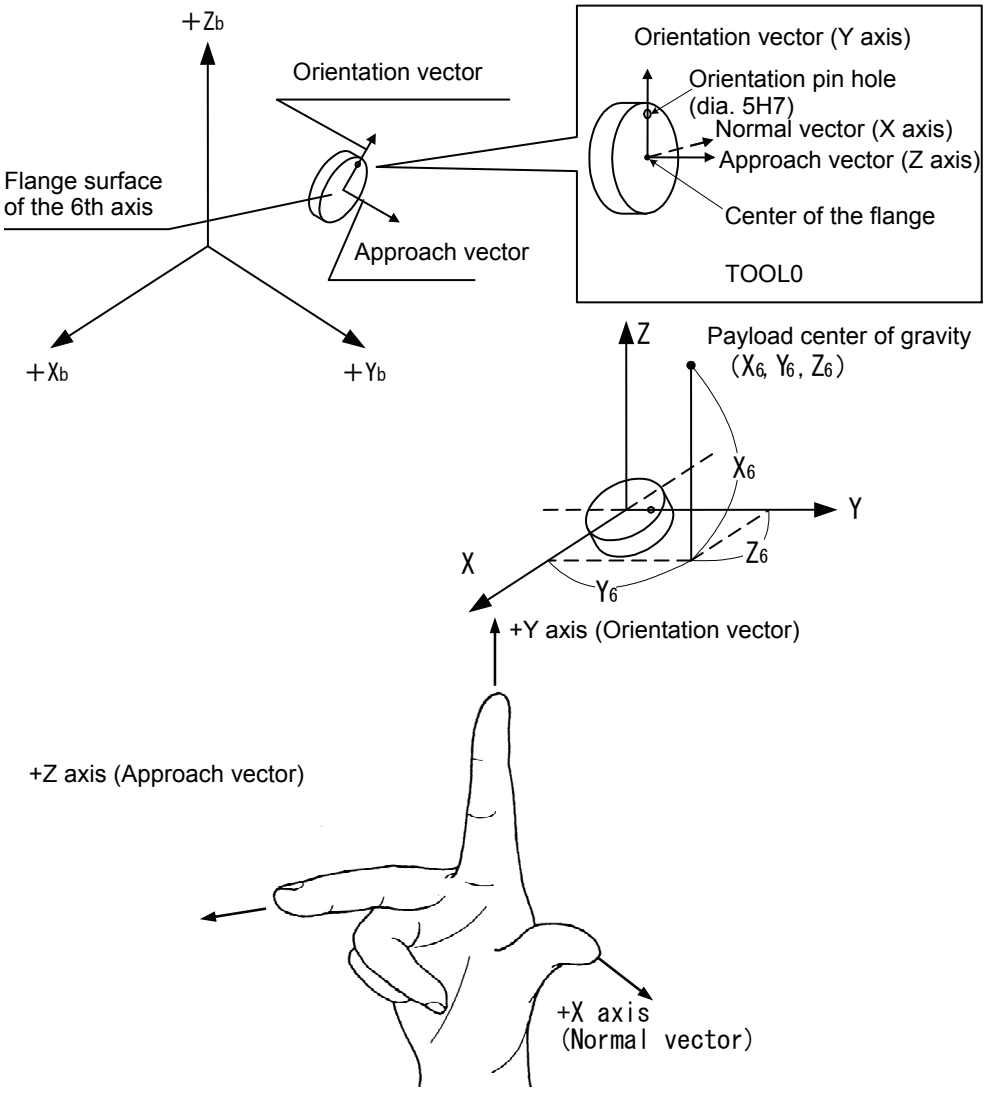
For details, refer to the Programmer's Manual, Section 4.7 "Setting the Master Control Parameters in User Preferences." For the operating procedure, refer to the Setting-up Manual, Section 2.8 "Setting the Master Control Parameters of the Payload, Center of Gravity, and Control Set of Motion Optimization (TP/WC)."

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

Define the payload center of gravity in the TOOL0 coordinates in units of mm (see the figure below).

The origin of the TOOL0 coordinates is located in the center of the flange surface on the 6th axis.

The Y component is defined on the orientation vector directed from the center of the flange to the center of the orientation pin hole (dia. 5H7). The Z component is defined on the approach vector directed from the center of the flange to the normal line of the flange center. The X component is defined on the normal vector directed along the X axis (+) in the right-hand coordinates whose Y axis is an orientation vector and whose Z axis is an approach vector.



Chapter 6 Maintenance and Inspection

6.1 Maintenance & Inspection Intervals and Purposes

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

⚠CAUTION

Maintenance and inspection must be carried out by a trained person who possesses the ability to perform these tasks safely.

Before performing maintenance and inspection jobs, read the SAFETY PRECAUTIONS, "4. Precautions while Robot is Running" and "5. Daily and Periodical Inspections."

Maintenance & Inspection Intervals and Purposes

Intervals		Purposes
Daily	Perform inspection jobs specified in Section 6.2 every day before starting operations.	To use your robot safely.
Quarterly	Perform inspection jobs specified in Section 6.3 every three months.	To maintain the precision of the robot and prevent failures caused by overheat of the robot controller.
Biennial	Replace backup batteries as specified in Section 6.4 every two years.	To retain the robot-specific data (programs, parameters, etc.) stored in the internal memory of the robot controller and the position data stored in the electronic absolute encoder built in the robot unit.

6.2 Daily Inspections

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

Inspections to be made with the power OFF

Check:	How to check:	Criterion	What to do: (See note below.)
Connectors	Visually	No looseness, disengagement or dirt.	Engage the parts properly and clean them.
Cables	Visually	Free of damage or gouges.	Repair or replace.
Brake release unit	Check for looseness.	No looseness.	Tighten up.
Robot unit	Visually	No grease leak	Wipe off grease

Inspections to be made with the power ON

Check:	How to check:	Criterion	What to do: (See note below.)
LCD on the teach pendant	Visually	Properly displayed	Repair or replace.
Pilot lamps on the robot controller	Visually	Should light.	Repair or replace.
Cooling fan in the robot controller	Visually	Should work properly.	Repair or replace.
EMERGENCY STOP button on the teach pendant or the mini pendant	Press the EMERGENCY STOP button.	The robot should come to an emergency stop.	Repair or replace.
Safety door	Operate the safety door switch and open the switch-wiring door.	The robot should come to an emergency stop.	Check or repair.

NOTE

Some repair and replacement jobs, shown in "What to do:" column, may involve special work. Contact the Denso service representative.

6.3 Quarterly Inspections

Check the items listed below every three months.

Quarterly inspections

Check:	How to check:	Criterion	What to do:
Robot base mounting bolts	Measure the tightening torque with a torque wrench.	No looseness. Specified torque: 70+/- 14 Nm	Tighten the bolts to the specified torque.
Cooling fan filters in the robot controller	Visually	No dust or dirt.	Clean the cooling fan filters. (Refer to the RC7M Controller Manual.)

6.4 Biennial Inspections

Replace the two types of backup batteries and inspect the timing belts.

6.4.1 Inspection and Adjustment of Timing Belts

Contact your Denso robot service/sales representative for information about inspection and adjustment.

6.4.2 Replacement of Backup Batteries

⚠ CAUTION

There is a danger of fire or explosion if batteries used in the robot unit and controller are incorrectly replaced.

Never recharge or disassemble the batteries. Never heat them above 100°C or dispose of them in fire.

Dispose of used batteries promptly. Remove them from a child's reach. Never disassemble them or dispose of them in fire.

[1] Replacing the memory backup battery

Programs, parameters, CALSET data and others are stored in the internal memory of the robot controller.

The memory backup battery retains the above data while the power to the robot controller is OFF. However, using the battery without replacement may lose the data since it has a limited lifetime.

To prevent CALSET data specific to individual robots from being lost, perform the following two.

Periodical replacement of the memory backup battery

The memory backup battery is loaded in the robot controller. For details about the replacement procedure, refer to the RC7M Controller Manual.

Backup of arm data including CALSET data

Refer to Section 6.11 "Backing up Projects."

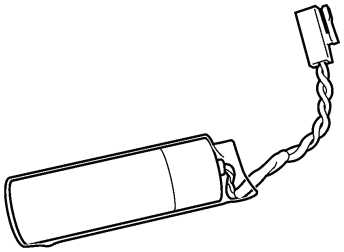
[2] Replacing the encoder backup batteries

The encoder built in the servomotor stores position data. To prevent the position data from being lost, the encoder backup batteries supply power to the encoder memory.

Periodically replace the encoder backup batteries that are loaded in the robot unit. In the event of using the external battery extension unit, replace the battery of the external battery extension unit. For detail, please refer to the external battery extension unit.

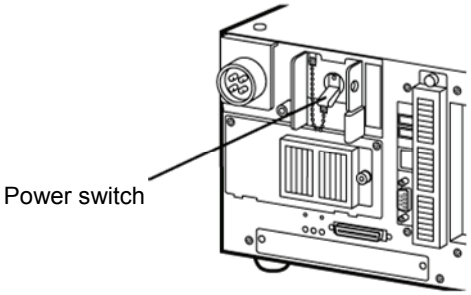
STEP 1

Make two new backup batteries ready for use.



STEP 2

Turn the controller power OFF.



STEP 3

Remove the cover from the robot unit.

Refer to Section 3.7 "Encoder Backup Battery Box".

NOTE

Protected type robots (IP67) or Dust- & splash-proof type robots (IP54) have an O-ring on the inside of the cover. Take care not to break the O-ring.

STEP 4

Replace the backup batteries using the procedure below.

First join the connector of a new battery to an empty connector on the robot unit, disconnect and remove the old battery, then load the new one.

NOTE

During replacement, at least one battery should be connected. Disconnecting all batteries loses position data.
Be sure to replace all batteries with new ones at one time. Using old and new batteries together shortens the service life.

STEP 5

Put the cover back to the robot unit.

6.4.3 Setting the Next Battery Replacement Date

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

NOTE

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

STEP 1

Use the teach pendant to display the Next Battery Replacement Data window.

Top screen - [F6 Set] - [F6 Maint.] - [F4 Battery]

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

STEP 2

Check the current setting and press OK.

6.5 Supplies and Tools for Maintenance

The table below lists the supplies and tools for maintenance.

⚠CAUTION

There is a danger of fire or explosion if batteries used in the robot unit and controller are incorrectly replaced.

Never recharge or disassemble the batteries. Never heat them above 100°C or dispose of them in fire.

Dispose of used batteries promptly. Remove them from a child's reach. Never disassemble them or dispose of them in fire.

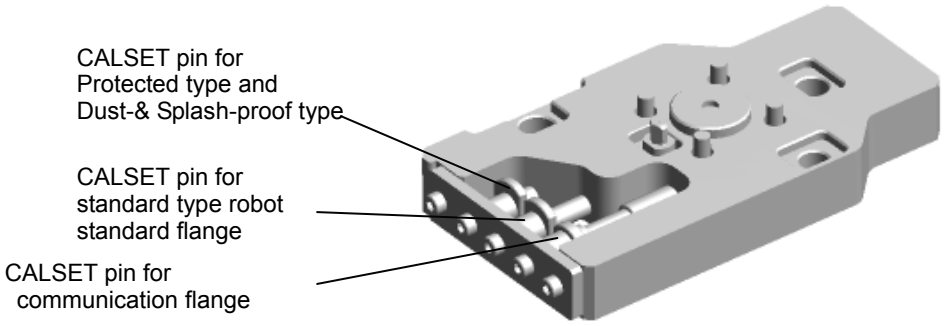
Names	Part No.	Remarks
Air filter set	410053-0100	For standard type of controllers (FS-1705W)
	410053-0110	For global type of controllers (FS-1705)
Memory backup battery	410076-0260	For RC7M controller
Fuse (1.3A)	410054-0230	For LM13 for controller I/O
Fuse (3.2A)	410054-0270	For LM32 for controller I/O
IC for output (NPN)	410077-0010	IC (M54522P) for controller output
IC for output (PNP)	410077-0020	IC (M54564P) for controller output
Encoder backup battery	410679-0010	2 pieces
CALSET jig	410192-0050	For 6th-axis CALSET
Fuse board for signal lines and air piping (CN20-CN21)	410220-0210	For CN20-CN21 signal lines
Fuse board for communication interface flange (CN24-flange CN)	410220-0200	For signal lines between CN24 and communication interface flange-A

6.6 The 6th Axis CALSET Jig

Positioning Jig for 6th axis CALSET of VS-*** series robot.

Since the usage varies according to the robot type, please refer to each procedure.

- 6th-Axis CALSET Position (Standard Type Robot, Standard Flange)
- 6th-Axis CALSET Position (Communication Interface Flange-A)
- 6th-Axis CALSET Position (Dust- & Splash-proof Type and Protected Type)



6.7 Replacement of Fuses and Output ICs

6.7.1 Replacing Fuses in the Robot Unit

If an overcurrent flows through signal wirings in the robot unit, the related fuses will be blown. Replace them. Refer to Section 3.7 "Encoder Backup Battery Box".

6.7.2 Replacing Fuses and Output ICs in the Robot Controller

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

6.8 Checking the Odometer and Trip Meter

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

The Odometer window shows the following items:

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

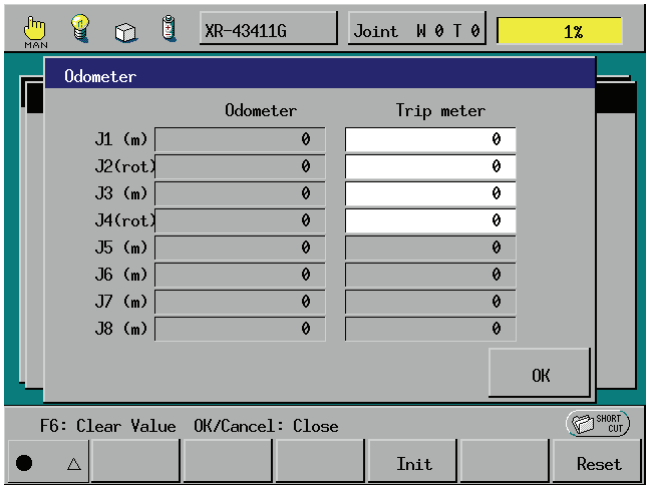
STEP 1

Turn the controller power ON and turn the mode switch to the MANUAL position.

STEP 2

Use the teach pendant to display the Odometer window.

Top screen - [F6 Set] -[F6 Maint.] - [F5 Odometer]



Odometer

Shows the total distance of each axis traversed after the robot leaves the factory. The odometer cannot be reset.

Trip meter

Shows the distance of each axis traversed after the trip meter is reset to zero.

Pressing [F5 Reset] in this window and following the guidance shown on the screen can reset the trip meter to zero.

6.9 Checking the Controller ON-Time and the Robot Running Time

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

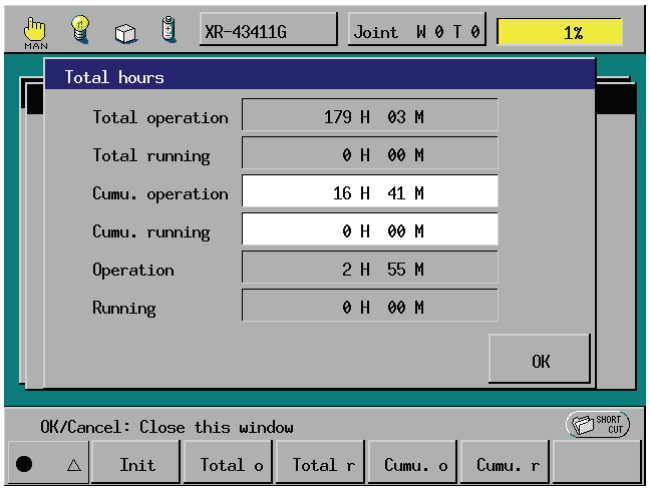
The Total hours window shows the items shown below.

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

STEP 1

Display the Total hours window.

Top screen - [F6 Set] - [F6 Maint.] - [F1 Total h]



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

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

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

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

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

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

The Cumu. operation and Cumu. running counters can be reset.

6.10 Resetting Encoders

You need to reset encoders and perform CALSET if: Error 641* occurs due to run-down encoder backup batteries, or Error 677* occurs due to a great impact applied to the robot when the power is off. (* is any of 1 to 6 denoting the object axis.) This section describes how to reset encoders. For the encoder resetting procedure, refer to the Setting-up Manual, Section 5.3, [F2 Arm]-[F12 Maint.]-[M11 ENC rst]".

6.11 Backing up Projects

Back up project data periodically in WINCAPS III in order to recover the robot controller smoothly after loss of project data due to unexpected accidents such as expired service life of memory backup batteries.

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

- at the time of purchase

- after performing CALSET

- after changing RANG values

- after replacement of a motor

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

TIP

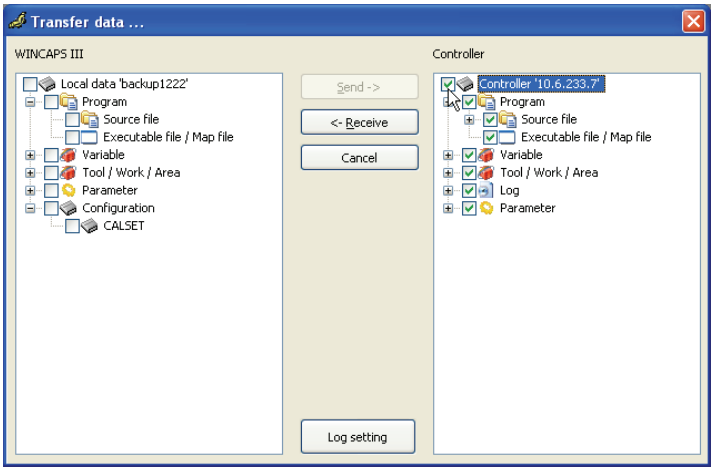
Arm data refers to CALSET and RANG values in project data, which is unique to individual robots and determines the position of each joint.

6.11.1 Back Up Project Data

Use WINCAPS III to back up project data.

When a project has been created in WINCAPS III:

Receive all data from the controller and preserve it.

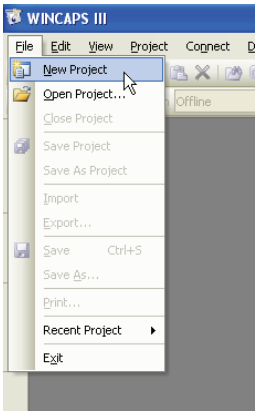


When creating a new project to preserve backup data:

Follow the procedure given below.

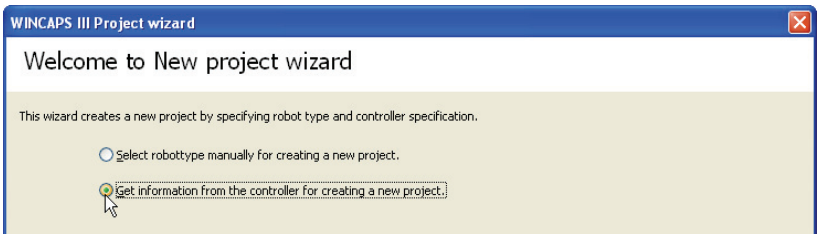
STEP 1

Create a new project in WINCAPS III.



STEP 2

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

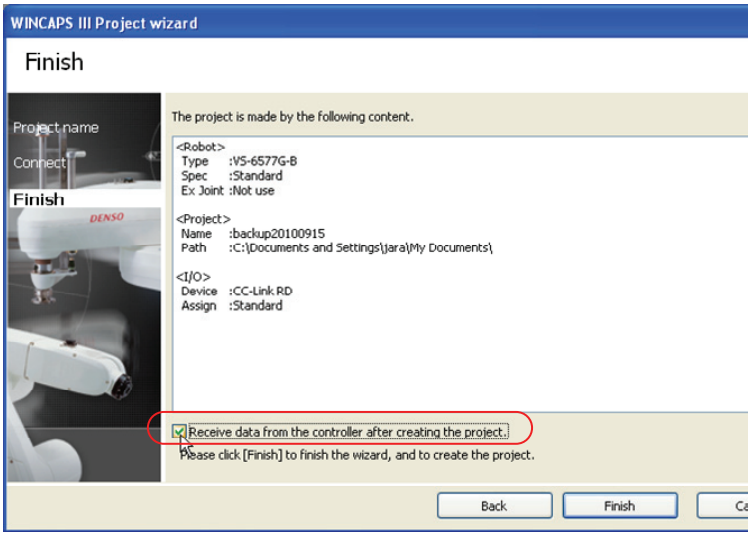


STEP 3

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

STEP 4

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



STEP 5

Close the project.

6.11.2 Transfer Arm Data

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

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

STEP 1

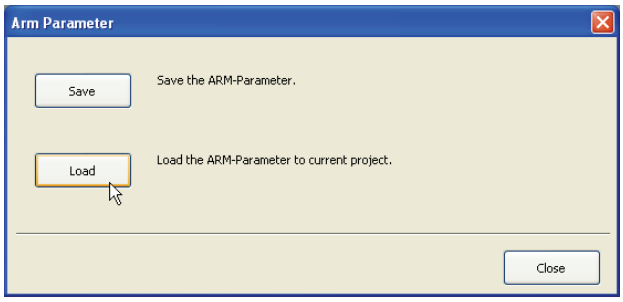
Loading the arm data (***.wam) into the WINCAPS III project

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

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

Choose Tool | Arm parameters to display the Arm Parameter window.

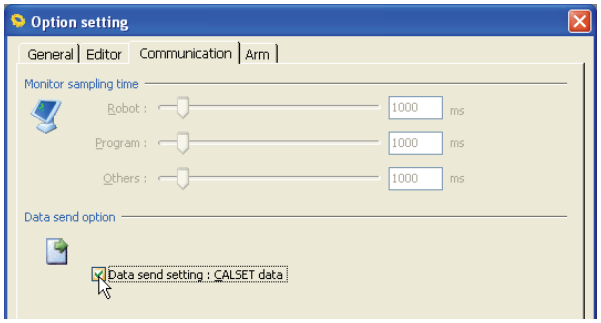
Press Load and select the arm data (***.wam) to load.



STEP 2

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

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



NOTE

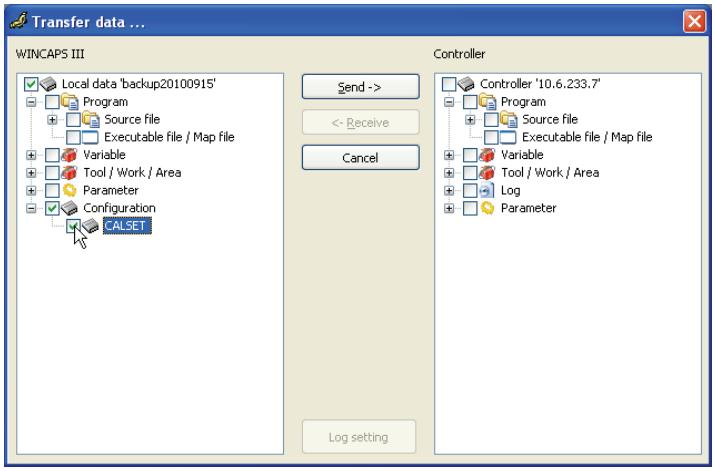
During ordinary operations, the "Data send setting: CALSET data" should be deselected. If it is selected, creating a new project and transferring arm parameters overwrites the CALSET-related data in the robot controller with the transferred data, causing errors in teaching positions.

STEP 3

Transferring arm data to the robot controller

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

Select Parameters | Arm parameters and Configuration | CALSET, then press Send.



Upon completion of transfer of the CALSET-related arm data, restart the robot controller.

Chapter 7 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.

- Failures caused by improper repair, modification, transfer or handling by you or a third party;
- Failures caused by the use of a part or oil/grease other than those specified in the related manuals;
- Failures caused by a fire, salt damage, earthquake, storm/flood or other acts of God;
- 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;
- Failures caused by a worn-out consumable, such as a fan filter;
- Failures caused by improper performance or non-performance of lubrication, maintenance or inspections stated in this manual; and
- Damages other than the robot repair costs.

Chapter 8 Appendixes

8.1 Reference Drawings

VS-050

Connector panel	Flange	Ingress Protection	Drawings
Rear	Standard	Standard type (IP40)	refer to
Rear	Standard	Dust- & splash-proof type (IP54)	refer to (※)
Rear	Standard	Protected type (IP67)	refer to
Rear	Communication Interface Flange-A	Standard type (IP40)	refer to

VS-060

Connector panel	Flange	Ingress Protection	Drawings
Rear	Standard	Standard type (IP40)	refer to
Rear	Standard	Dust- & splash-proof type (IP54)	refer to (*)
Rear	Standard	Protected type (IP67)	refer to
Rear	Communication Interface Flange-A	Standard type (IP40)	refer to

VS-068

Connector panel	Flange	Ingress Protection	Drawings
Rear	Standard	Standard type (IP40)	refer to
Rear	Standard	Dust- & splash-proof type (IP54)	refer to (*)
Rear	Standard	Protected type (IP67)	refer to
Rear	Communication Interface Flange-A	Standard type (IP40)	refer to
Bottom	Standard	Standard type (IP40)	refer to
Bottom	Standard	Dust- & splash-proof type (IP54)	refer to (*)
Bottom	Standard	Protected type (IP67)	refer to
Bottom	Communication Interface Flange-A	Standard type (IP40)	refer to

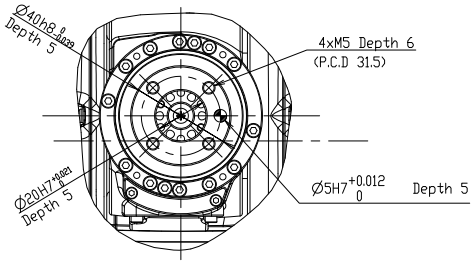
VS-087

Connector panel	Flange	Ingress Protection	Drawings
Rear	Standard	Standard type (IP40)	refer to
Rear	Standard	Dust- & splash-proof type (IP54)	refer to (*)
Rear	Standard	Protected type (IP67)	refer to
Rear	Communication Interface Flange-A	Standard type (IP40)	refer to
Bottom	Standard	Standard type (IP40)	refer to
Bottom	Standard	Dust- & splash-proof type (IP54)	refer to (*)
Bottom	Standard	Protected type (IP67)	refer to
Bottom	Communication Interface Flange-A	Standard type (IP40)	refer to

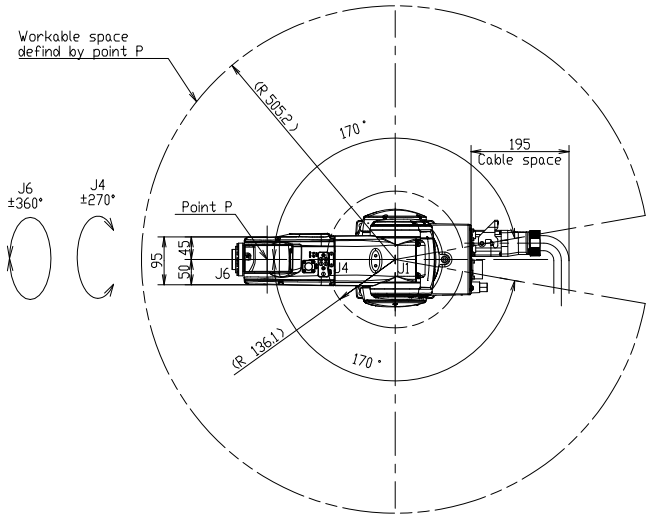
* Please refer to the drawing of same size. Regarding the dust-&splash-proof type, please refer to the drawing of the protected type.

VS-050 (Rear Connector Panel, Standard Flange)
410590-3290

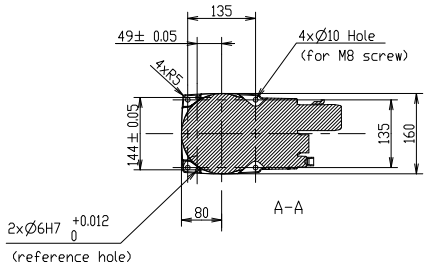
Detailed drawing of end-effector mounting face



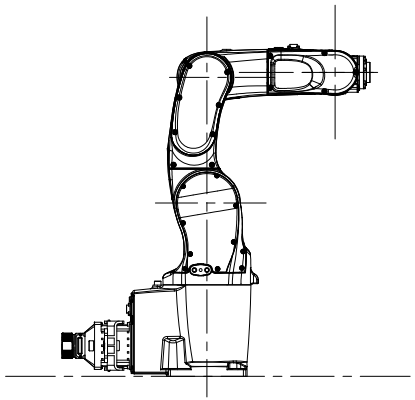
B
1:1

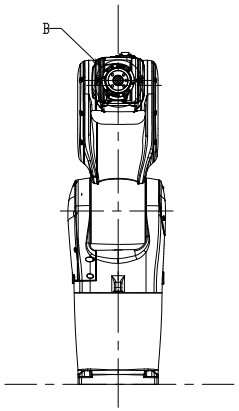


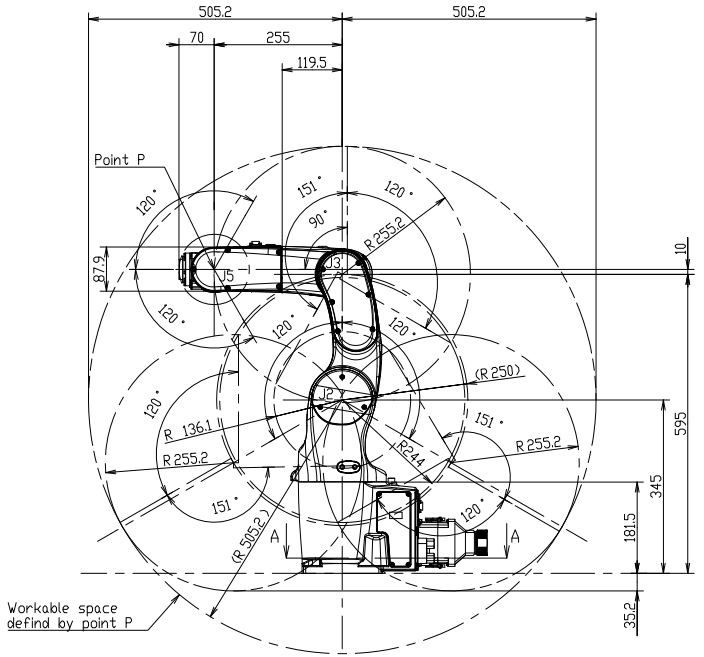
Detailed drawing of base mounting face



J1=±170°
J2=±120°
J3=+151°,-120°
J4=±270°
J5=+120°,-120°
J6=±360°

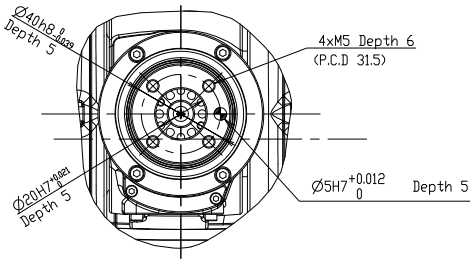






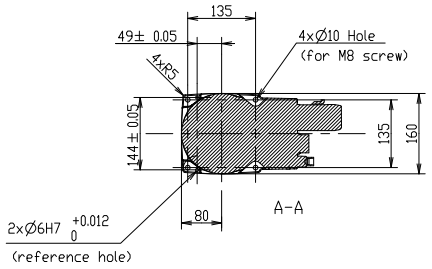
VS-050 (Rear Connector Panel, Standard Flange, Protected type(IP67))
410590-3330

Detailed drawing of end-effector mounting face

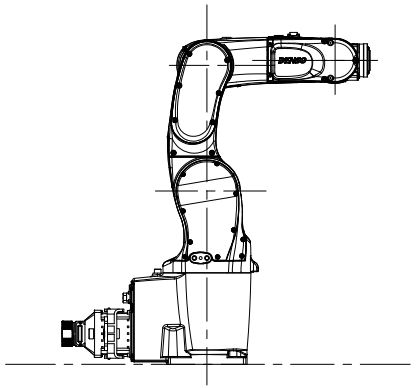


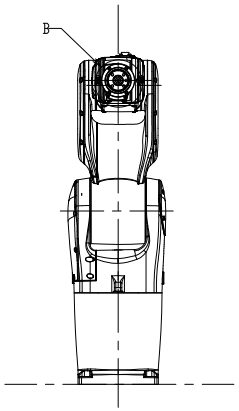
B
1:1

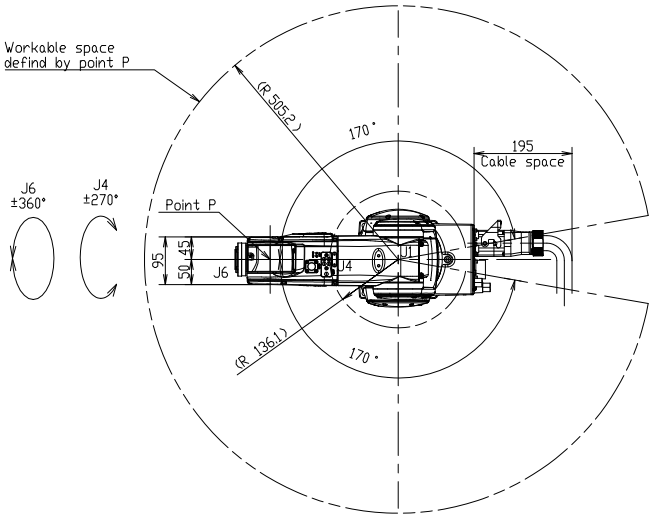
Detailed drawing of base mounting face



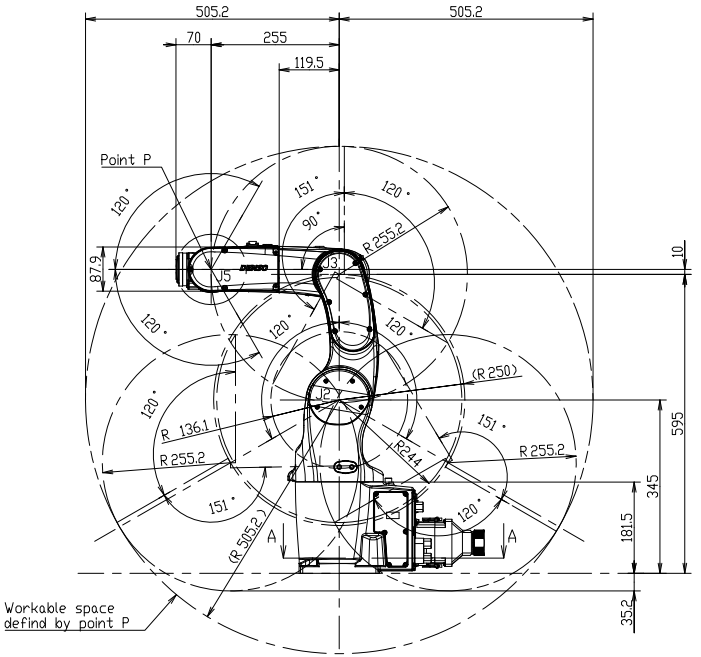
A-A





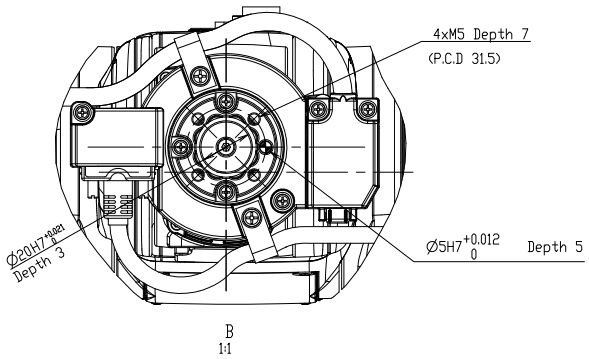


J1=±170°
J2=±120°
J3=+151°,-120°
J4=±270°
J5=+120°,-120°
J6=±360°



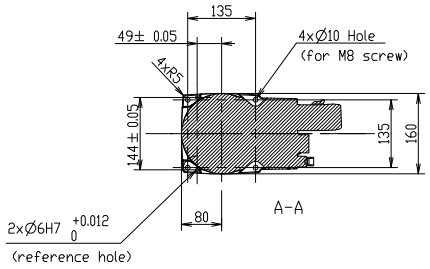
VS-050 (Rear Connector Panel, Communication Interface Flange-A)
410590-3300

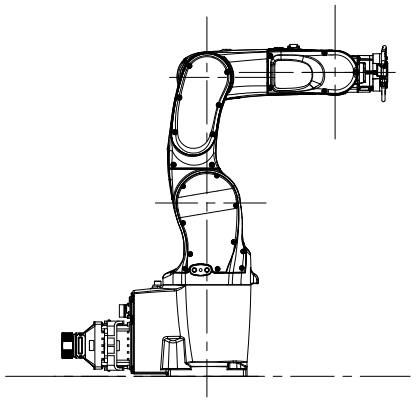
Detailed drawing of end-effector mounting face

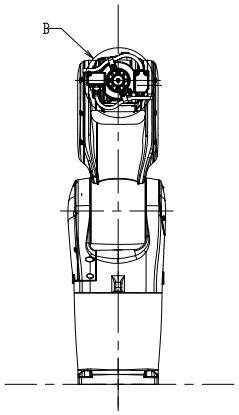


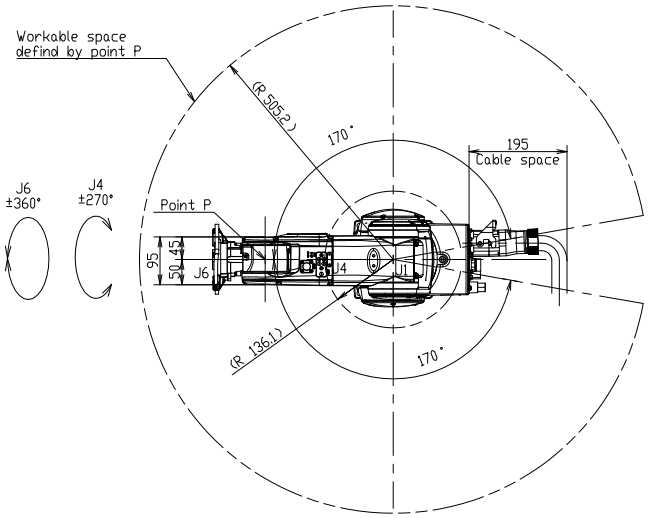
B
1:1

Detailed drawing of base mounting face

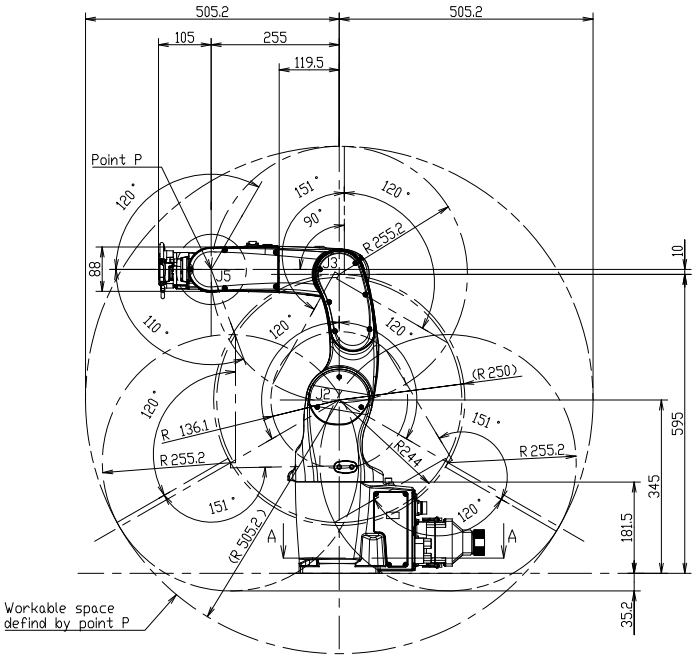




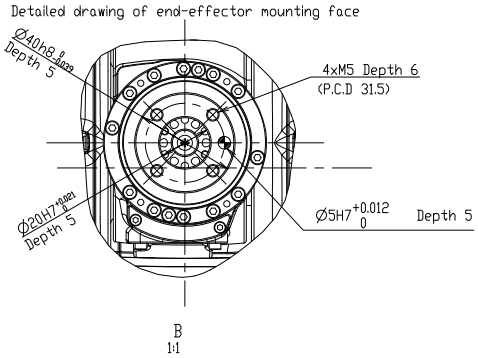


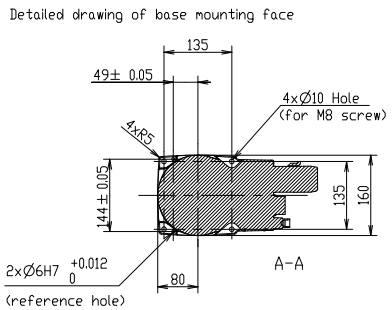


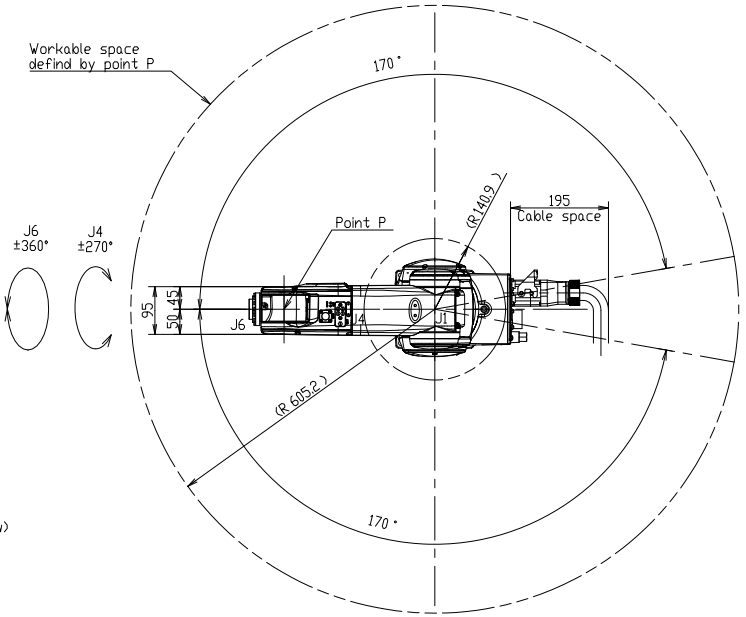
J1=±170°
J2=±120°
J3=+151°,-120°
J4=±270°
J5=+120°,-110°
J6=±360°

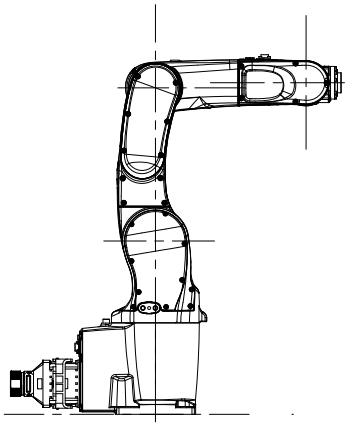


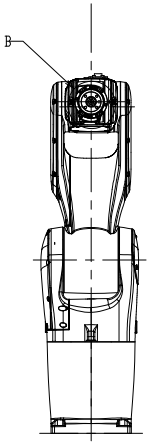
VS-060 (Rear Connector Panel, Standard Flange)
410590-3310

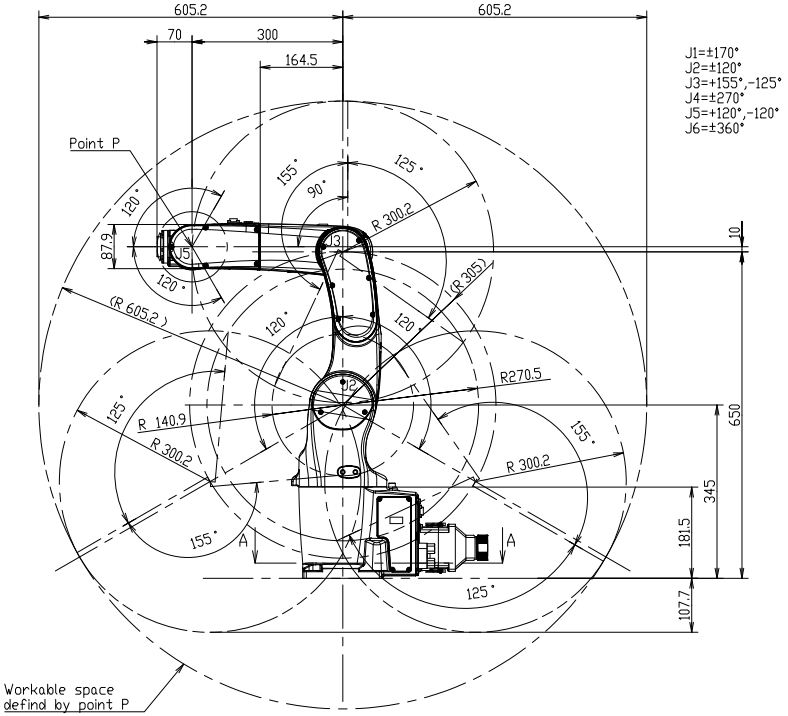






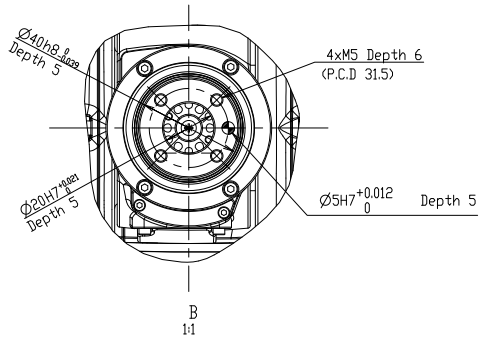




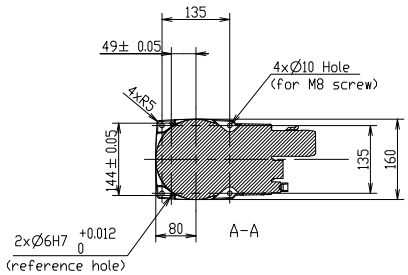


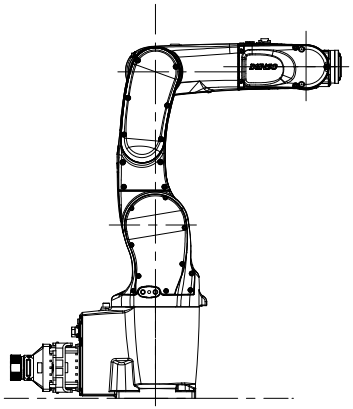
VS-060 (Rear Connector Panel, Standard Flange, Protected type(IP67))
410590-3340

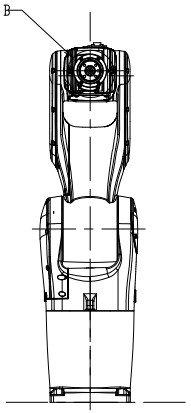
Detailed drawing of end-effector mounting face

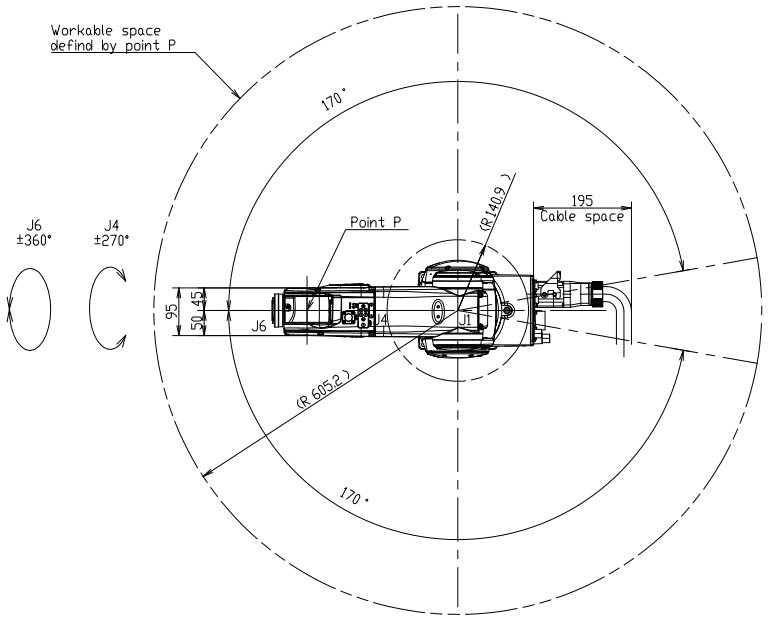


Detailed drawing of base mounting face

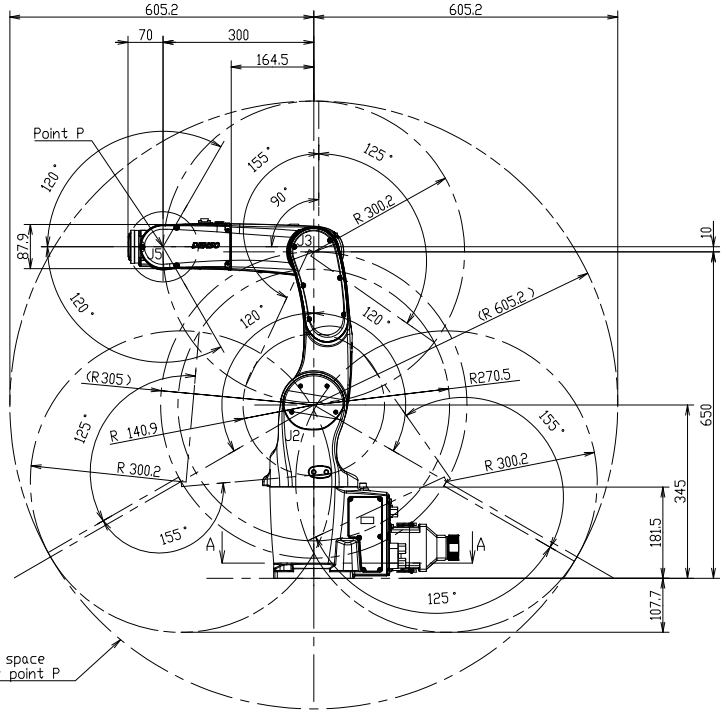






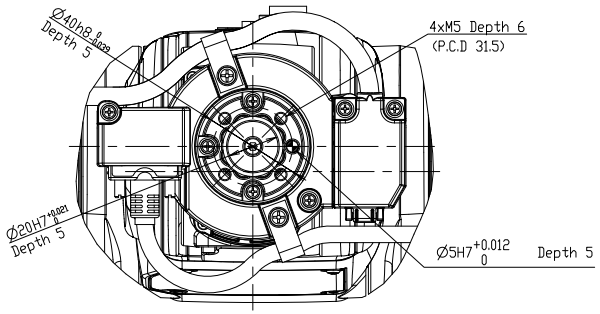


J1=±170°
J2=±120°
J3=+155°,-125°
J4=±270°
J5=+120°,-120°
J6=±360°



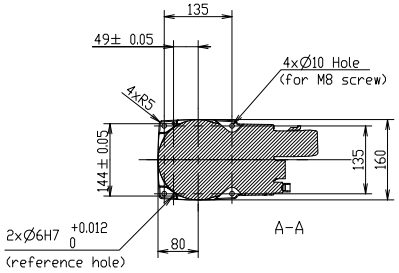
VS-060 (Rear Connector Panel, Communication Interface Flange-A)
410590-3320

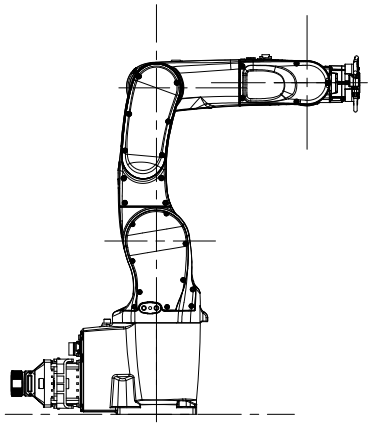
Detailed drawing of end-effector mounting face

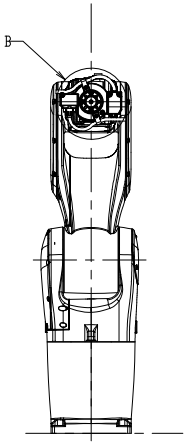


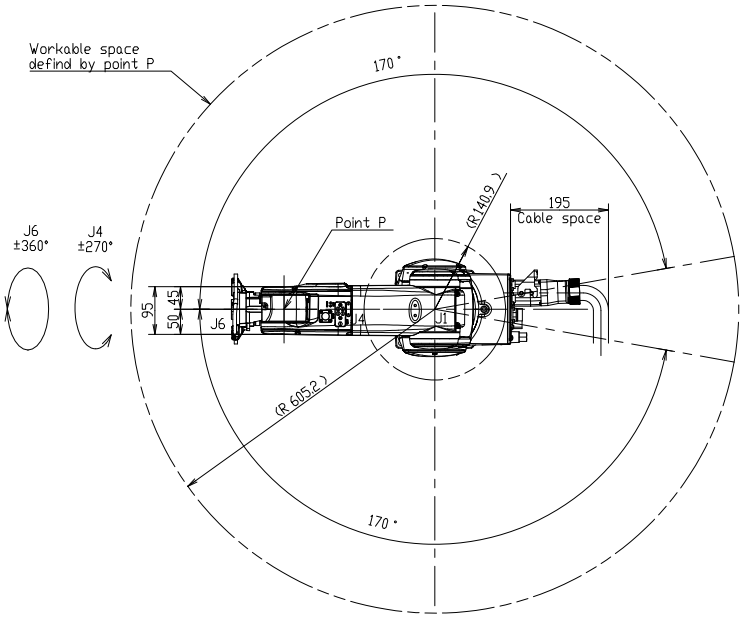
B
1:1

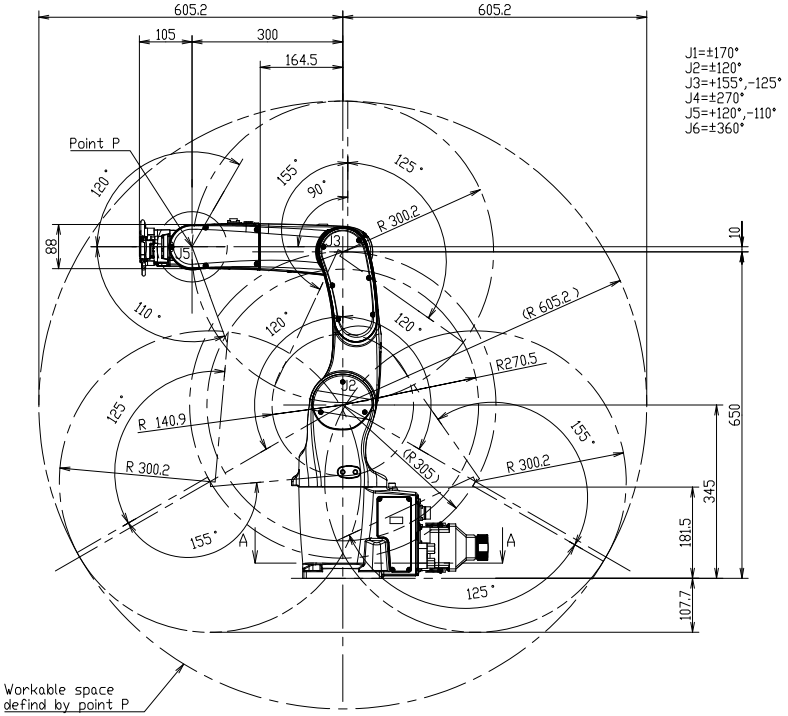
Detailed drawing of base mounting face





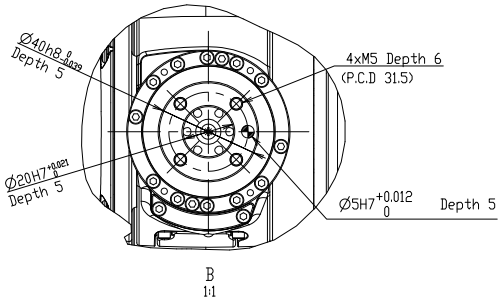




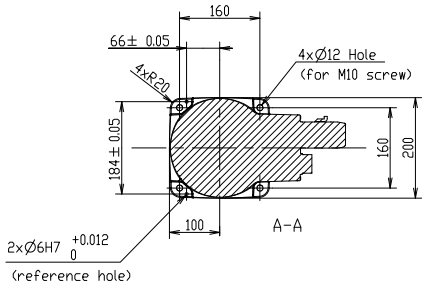


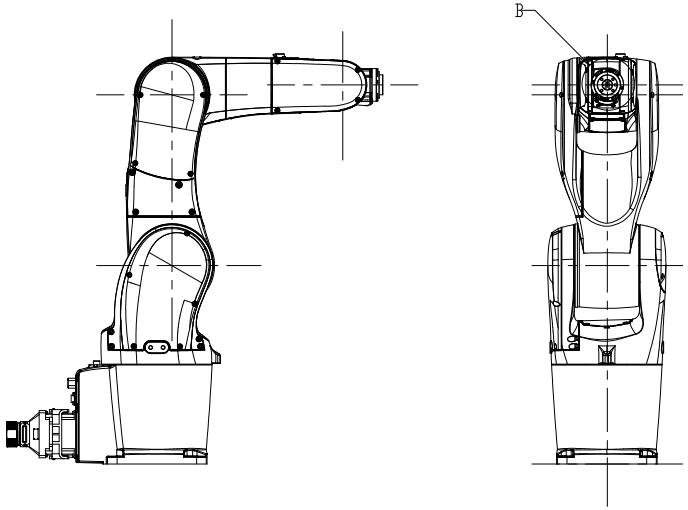
VS-068 (Rear Connector Panel, Standard Flange)
410590-3170

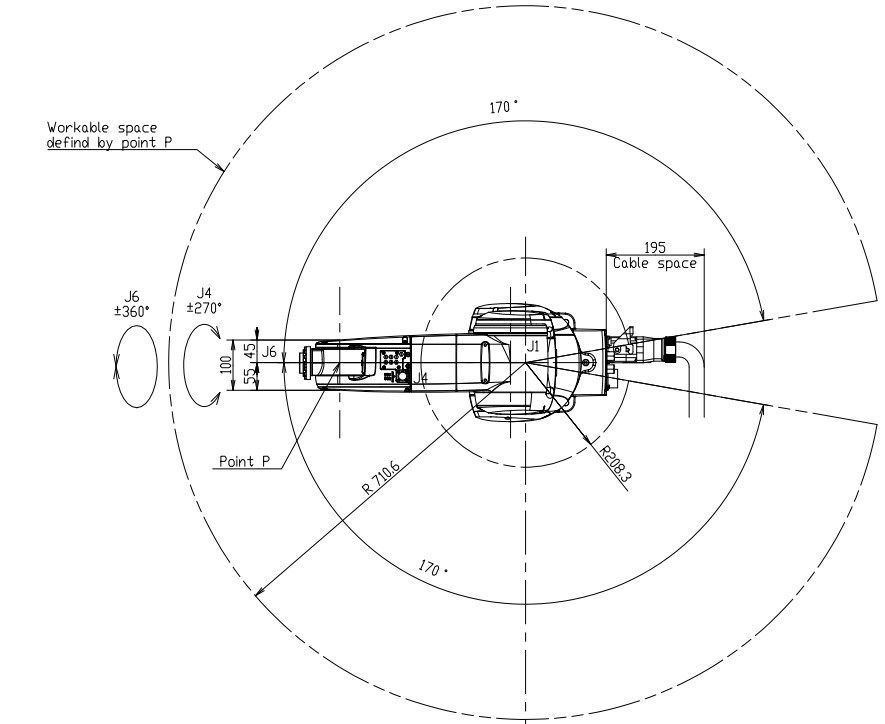
Detailed drawing of end-effector mounting face



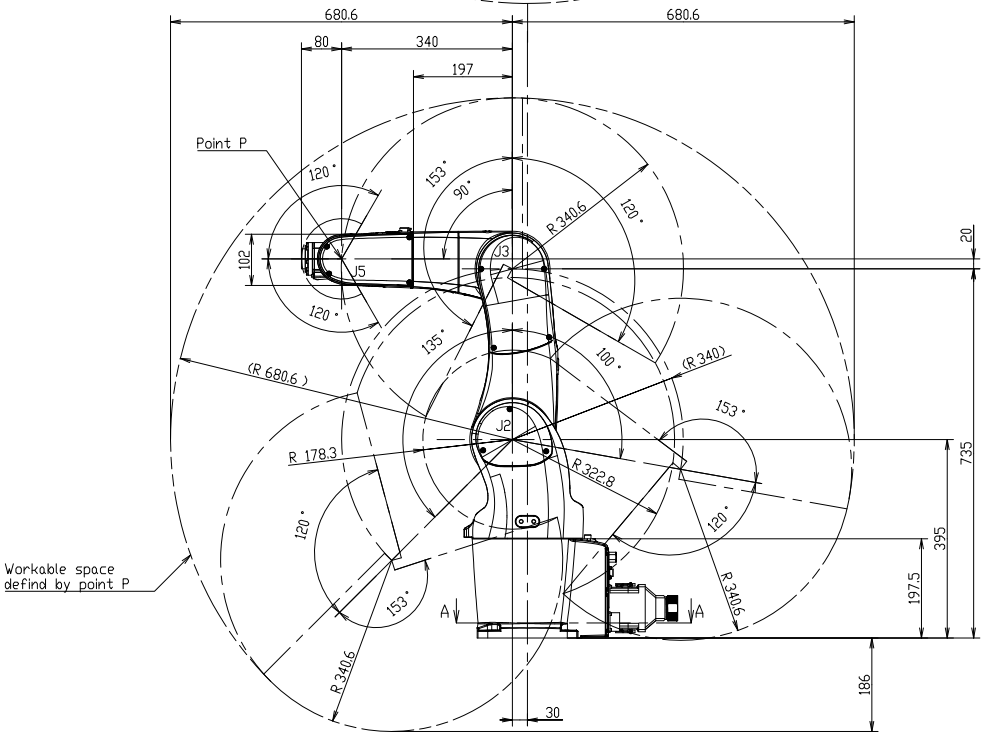
Detailed drawing of base mounting face





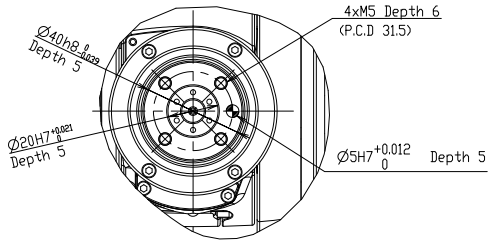


J1=±170°
J2=+135°,-100°
J3=+153°,-120°
J4=±270°
J5=±120°
J6=±360°



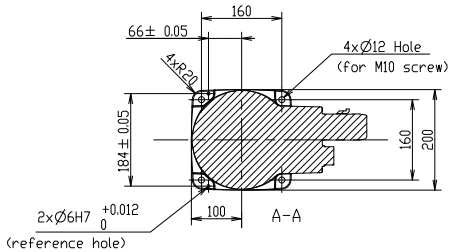
VS-068 (Rear Connector Panel, Standard Flange, Protected type(IP67))
410590-3250

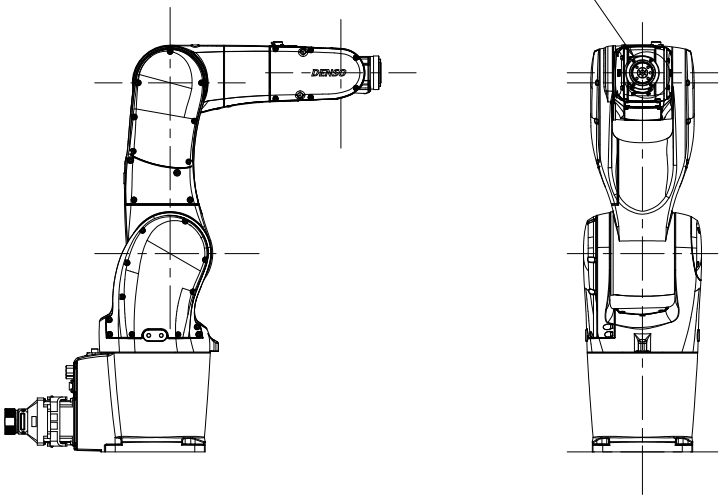
Detailed drawing of end-effector mounting face

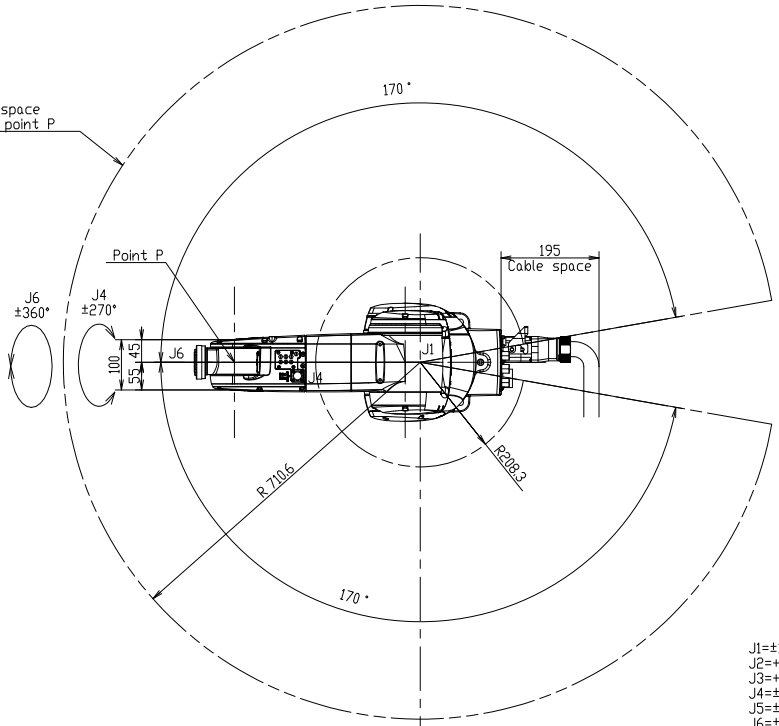


B
1:1

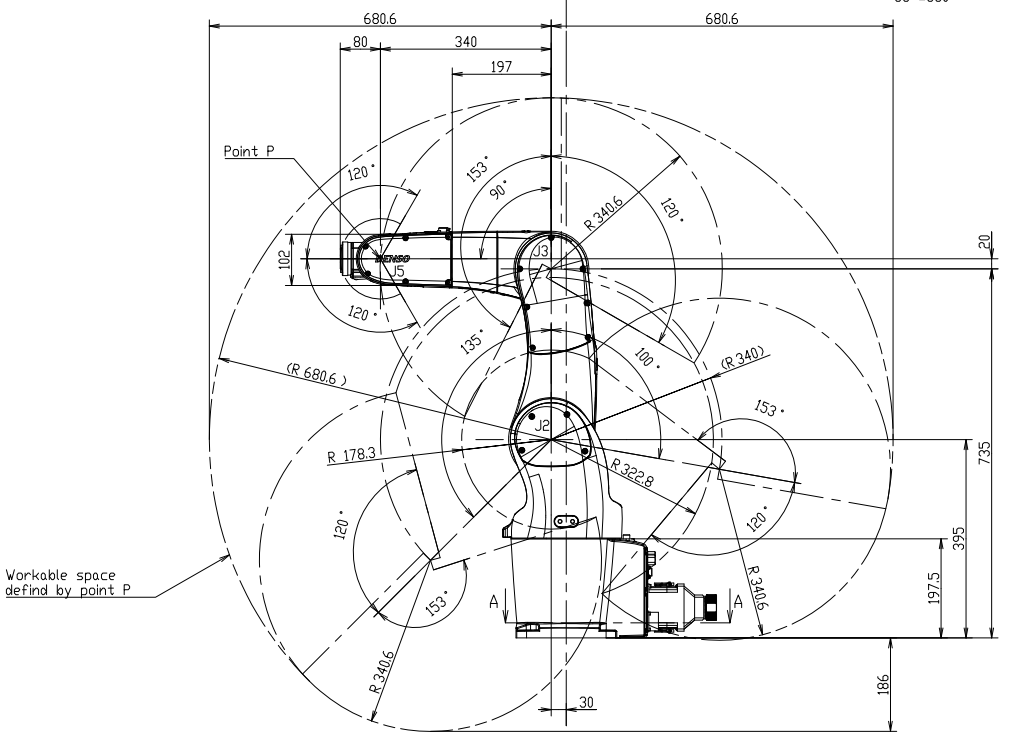
Detailed drawing of base mounting face





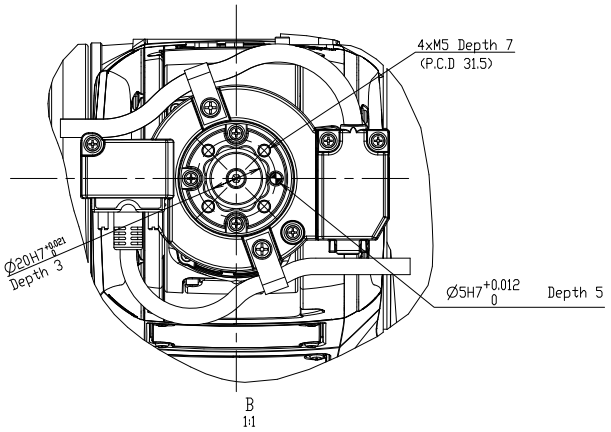


J1=±170°
J2=+135°,-100°
J3=+153°,-120°
J4=±270°
J5=±120°
J6=±360°

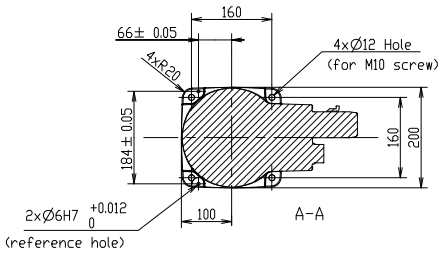


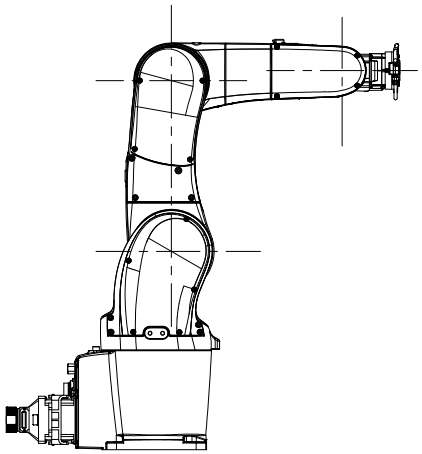
VS-068 (Rear Connector Panel, Communication Interface Flange-A)
410590-3180

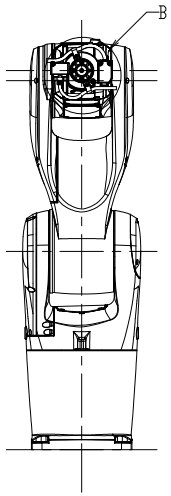
Detailed drawing of end-effector mounting face

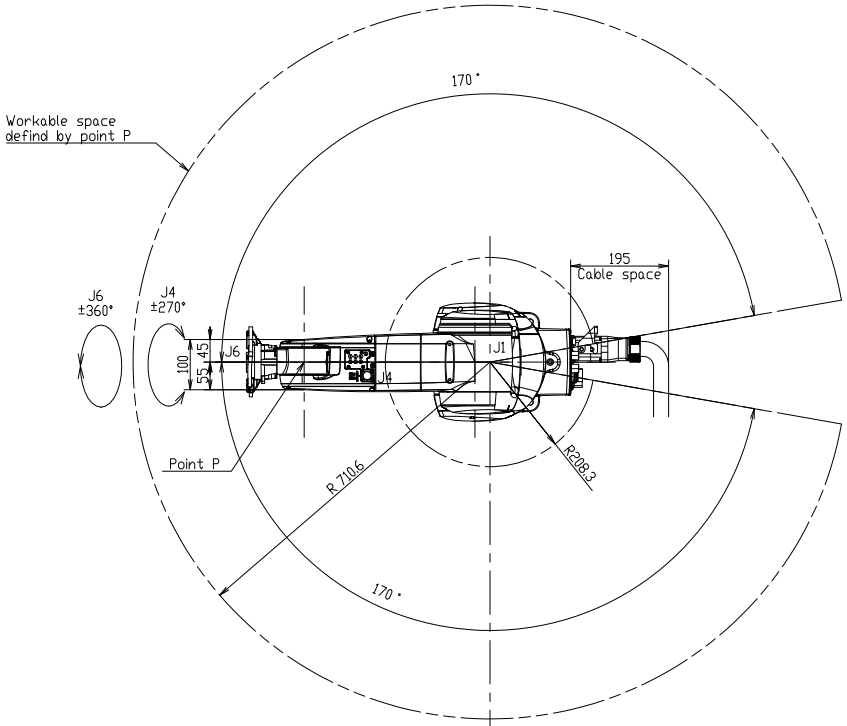


Detailed drawing of base mounting face

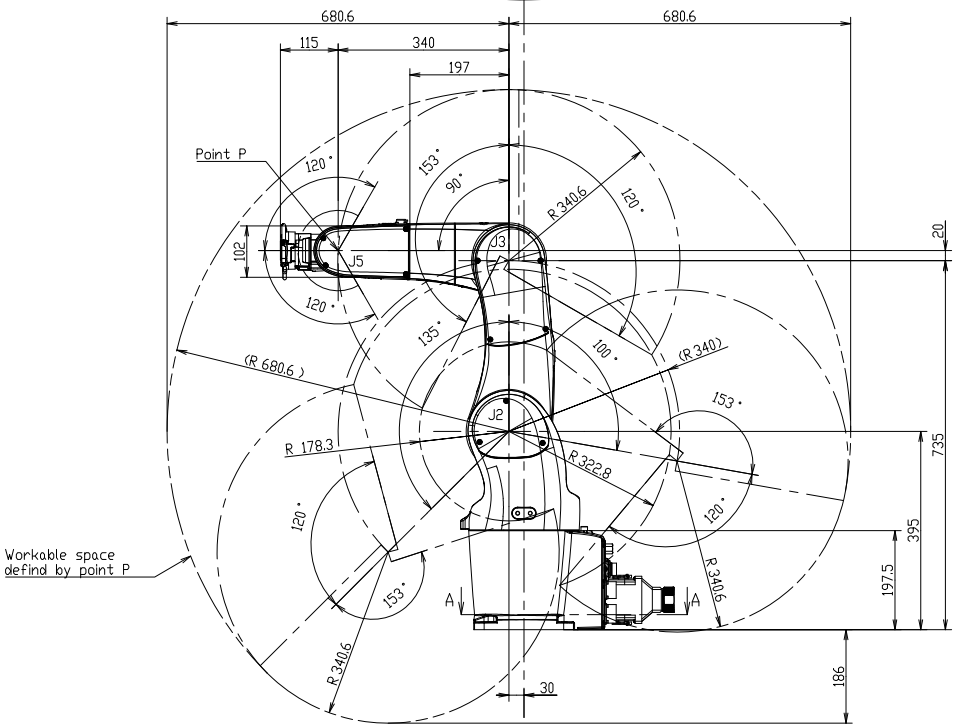






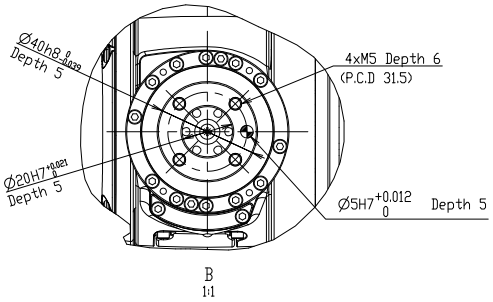


J1=±170°
J2=+135°,-100°
J3=+153°,-120°
J4=±270°
J5=±120°
J6=±360°



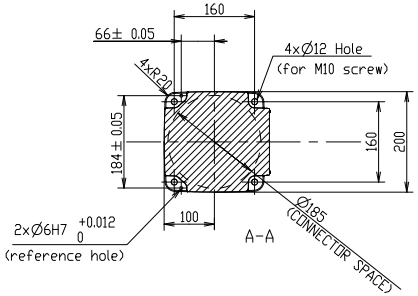
VS-068 (Bottom Connector Panel, Standard Flange)
410590-3190

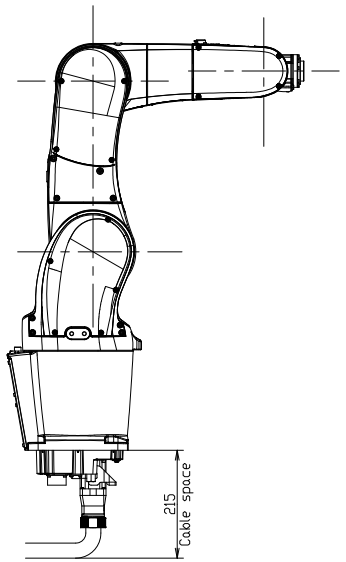
Detailed drawing of end-effector mounting face

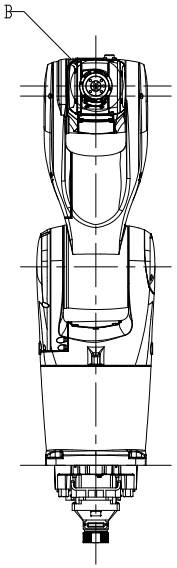


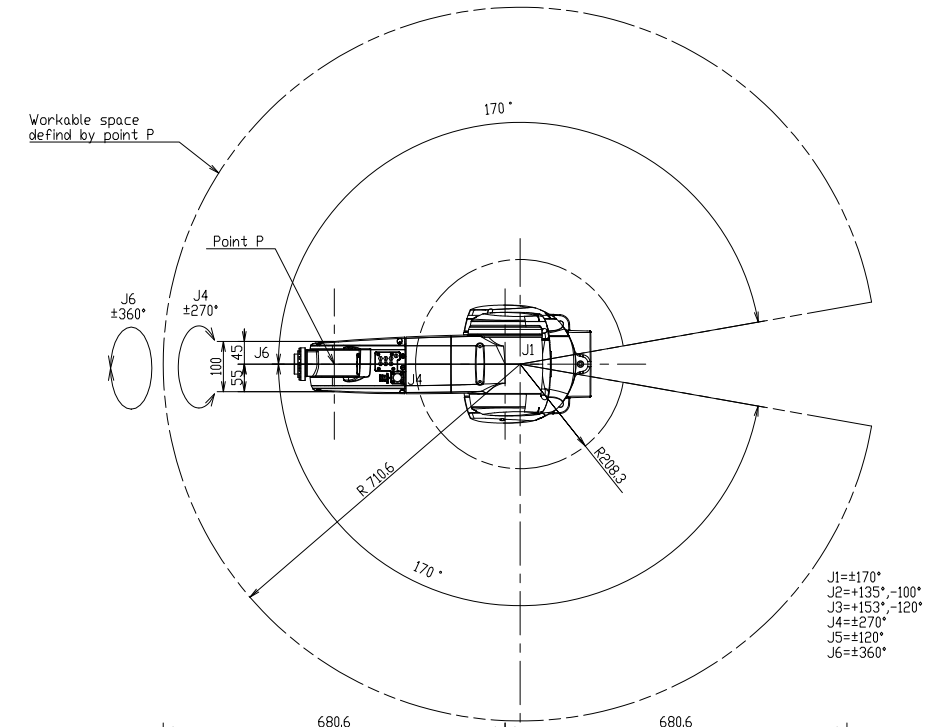
B
1:1

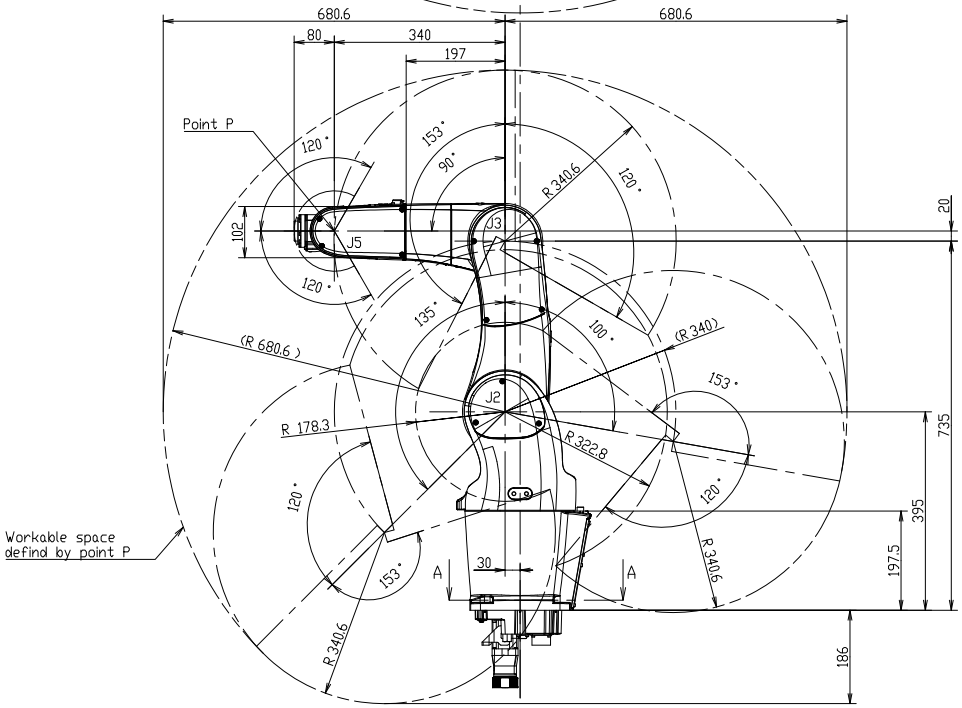
Detailed drawing of base mounting face





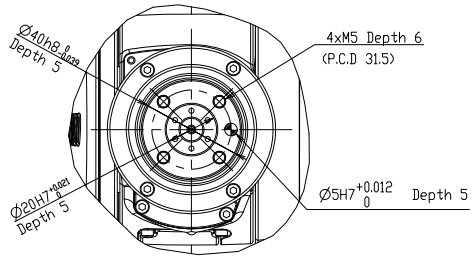






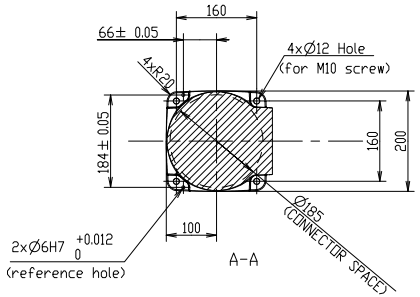
VS-068 (Bottom Connector Panel, Standard Flange, Protected type(IP67))
410590-3260

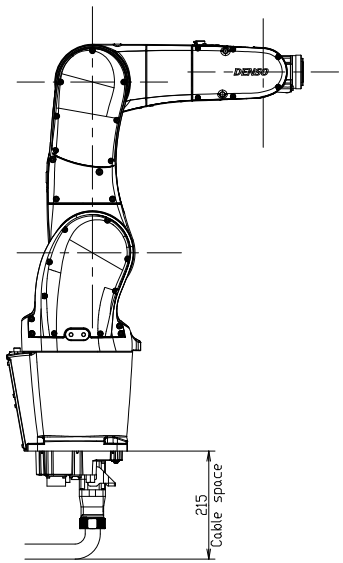
Detailed drawing of end-effector mounting face

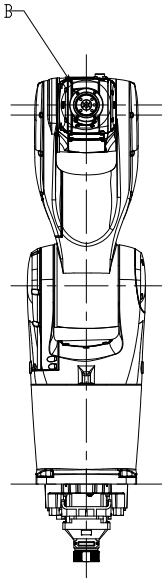


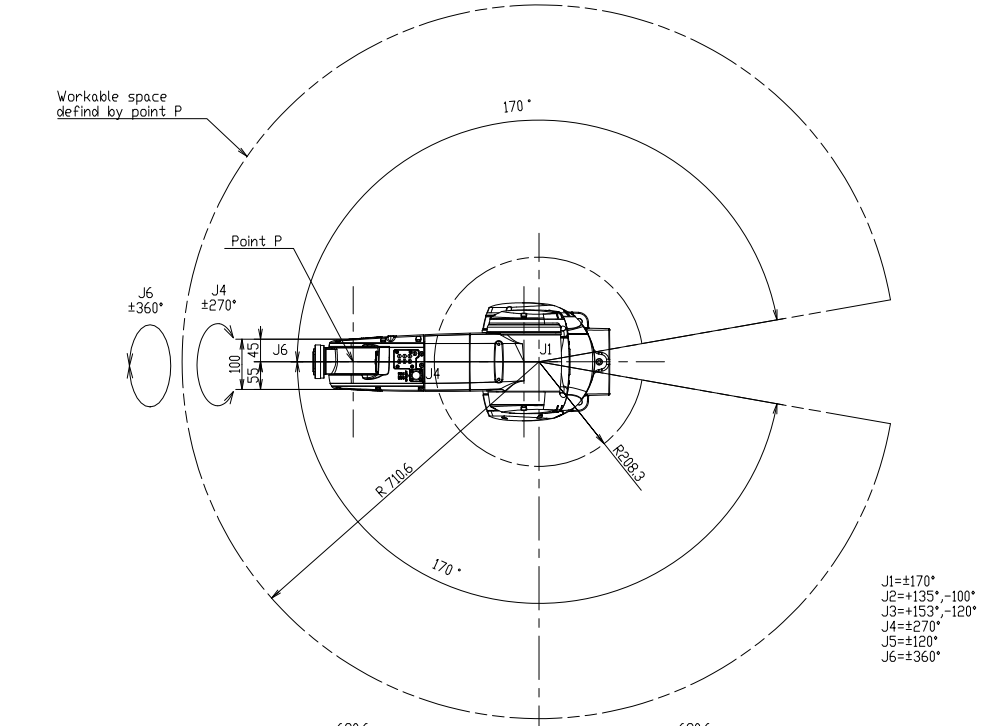
B
1:1

Detailed drawing of base mounting face

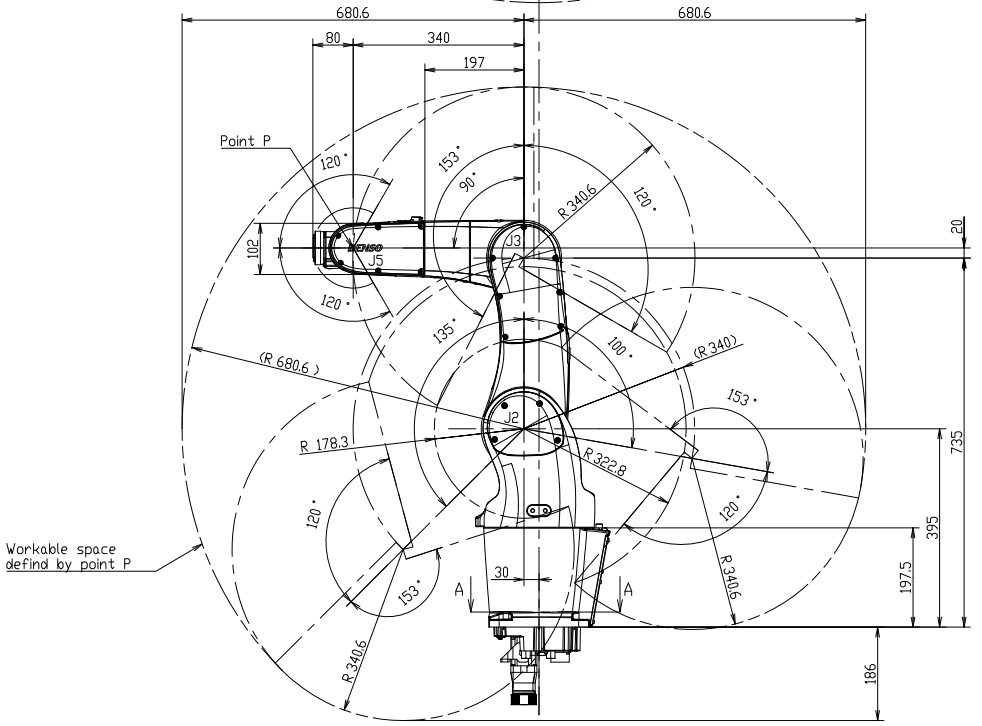






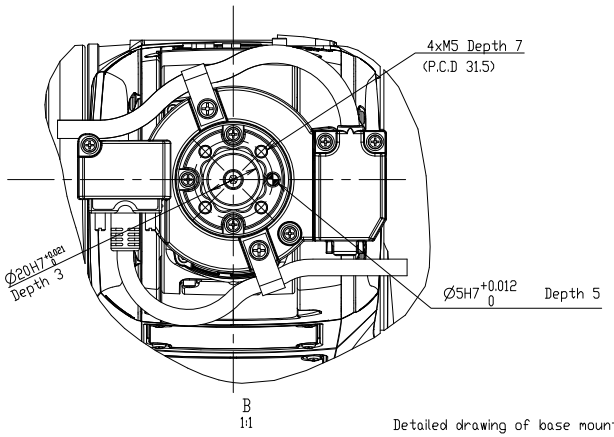


J1=±170°
J2=+135°,-100°
J3=+153°,-120°
J4=±270°
J5=±120°
J6=±360°

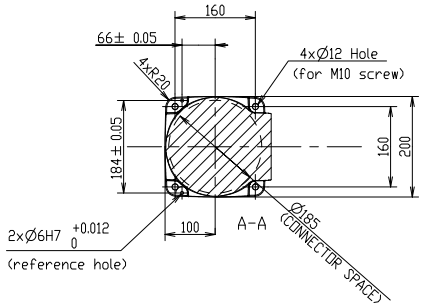


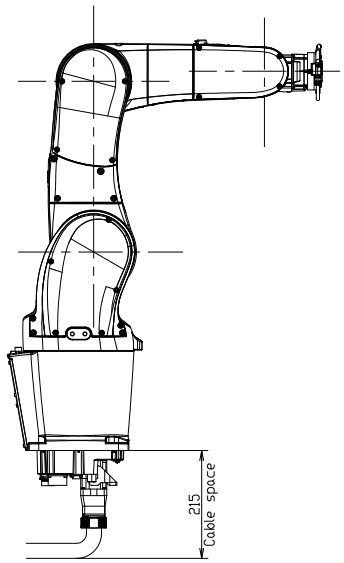
VS-068 (Bottom Connector Panel, Communication Interface Flange-A)
410590-3200

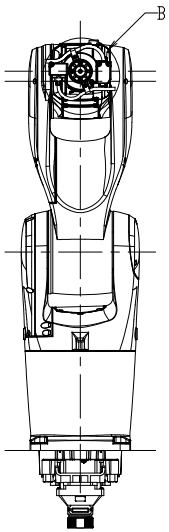
Detailed drawing of end-effector mounting face

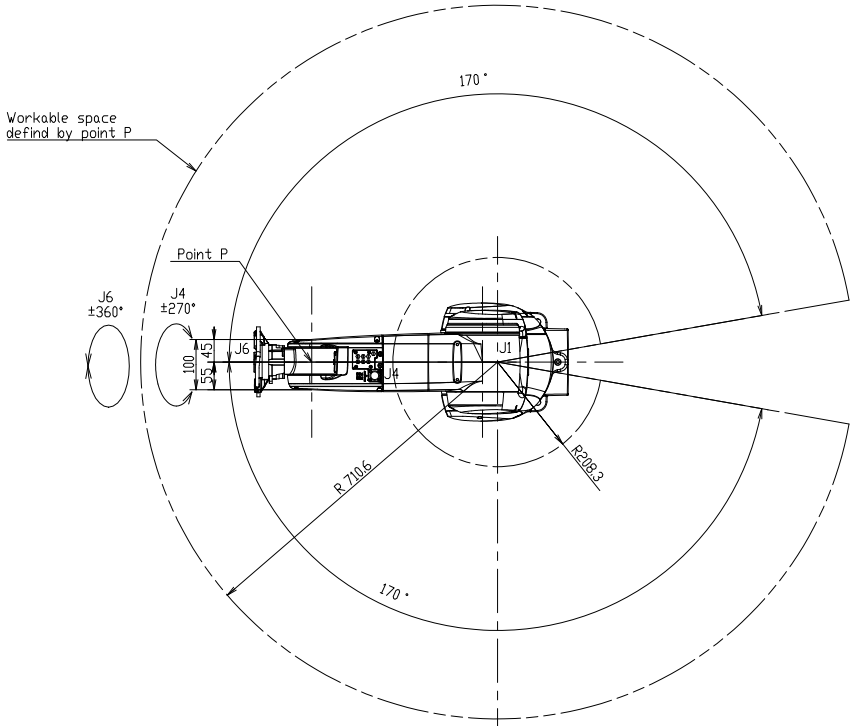


Detailed drawing of base mounting face

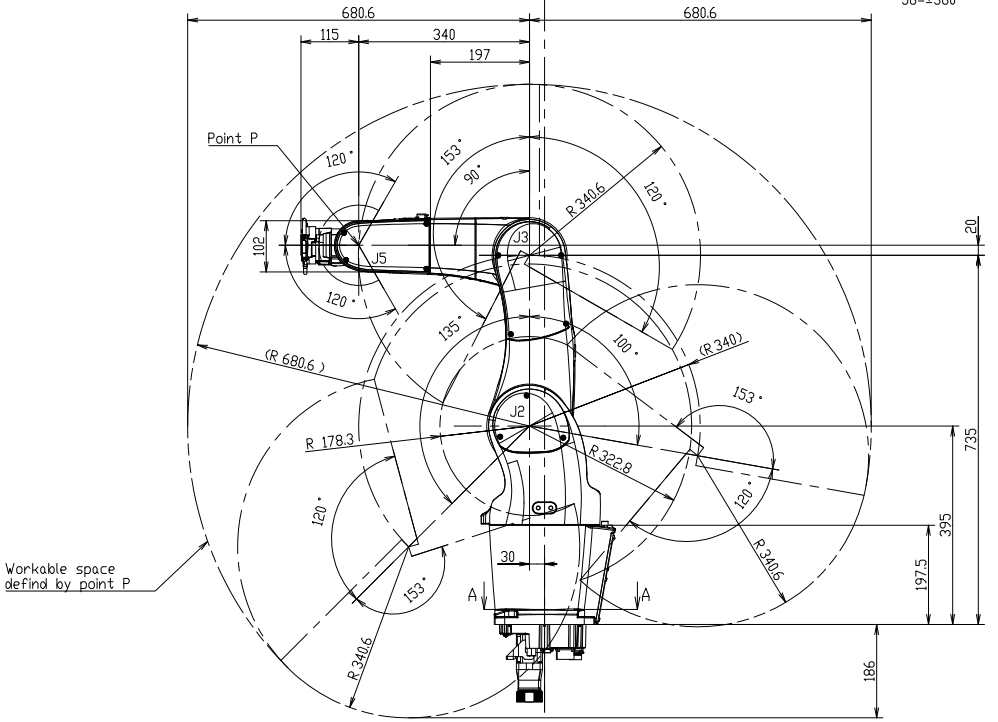




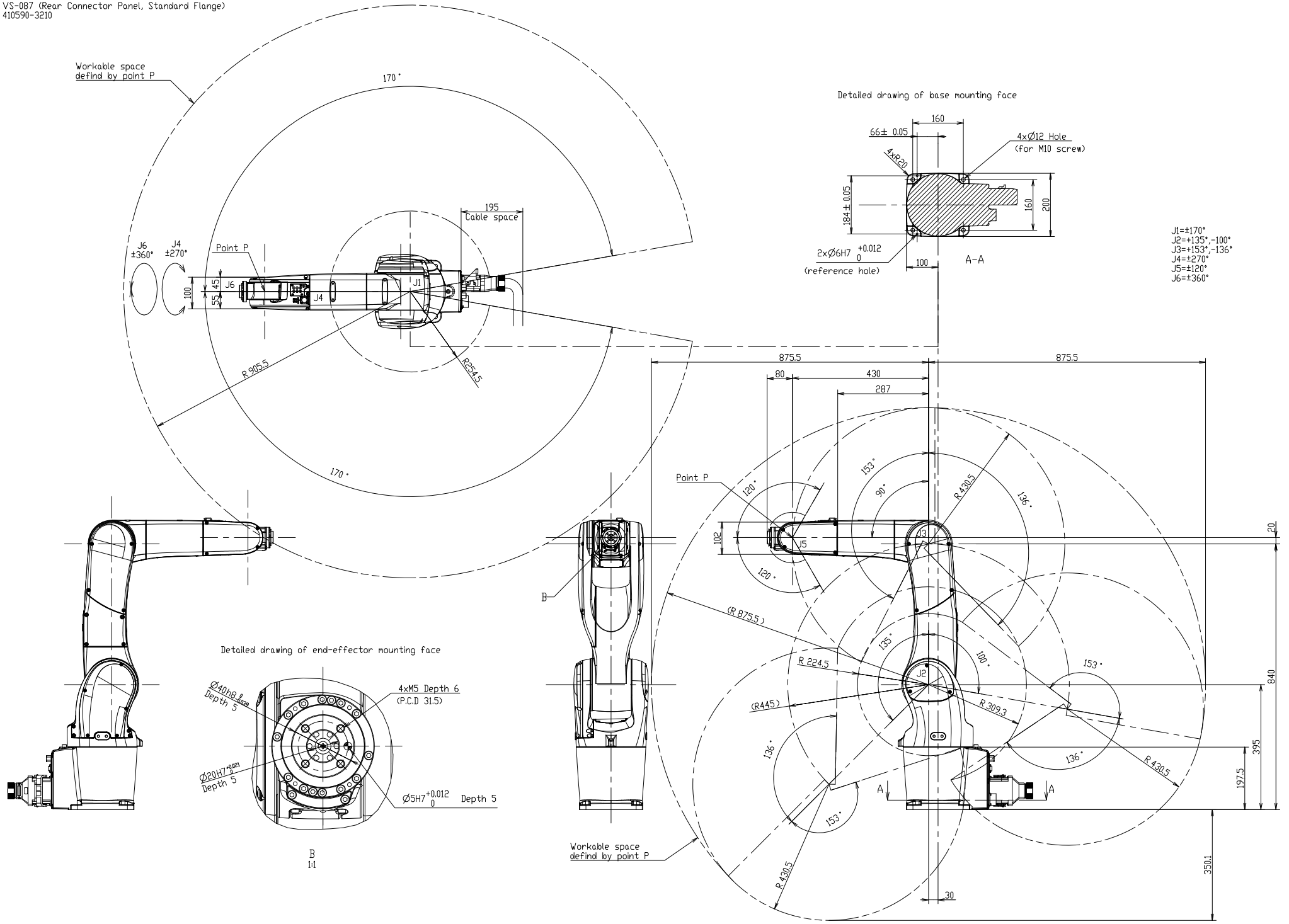




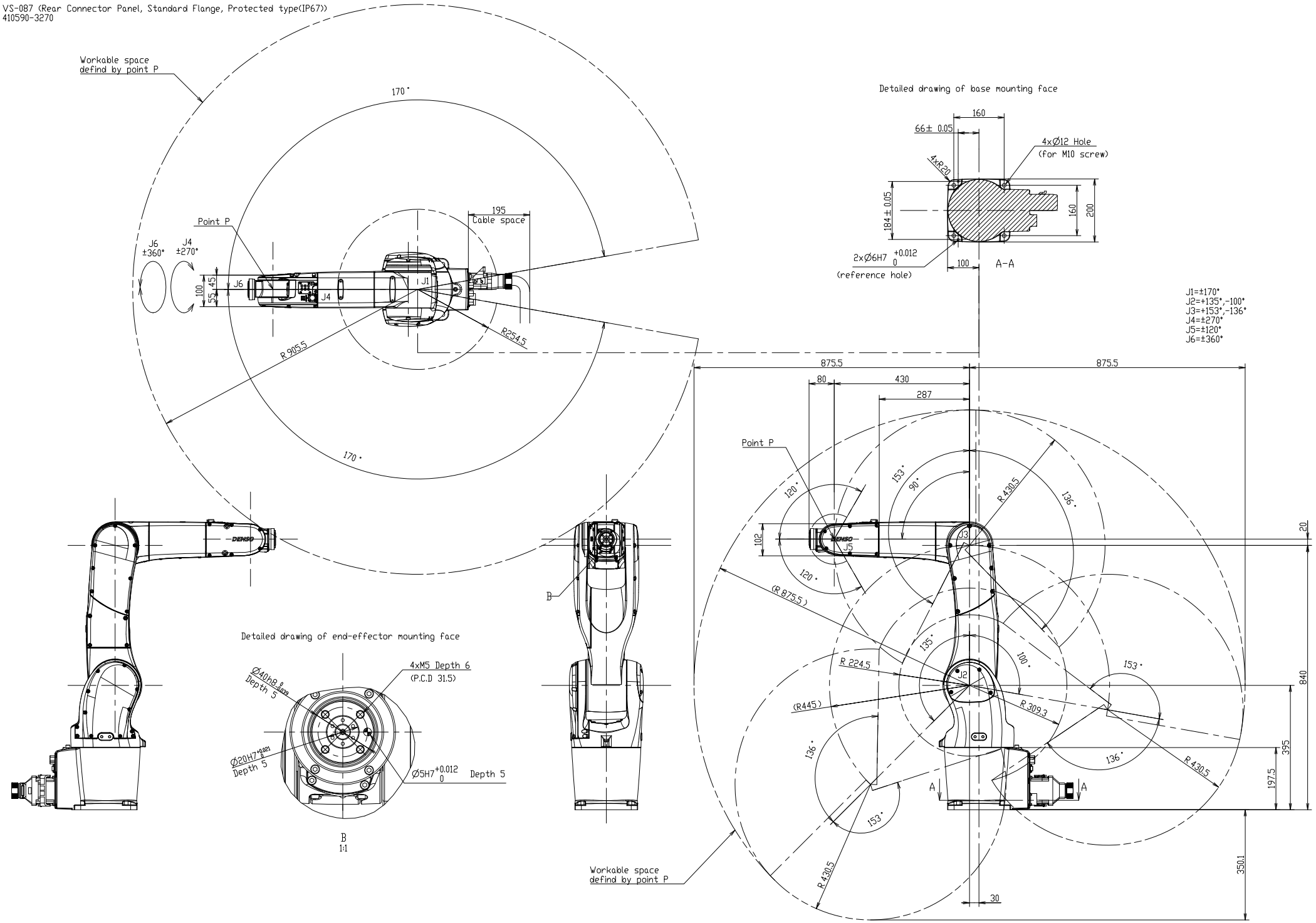
J1=±170°
J2=+135°,-100°
J3=+153°,-120°
J4=±270°
J5=±120°
J6=±360°



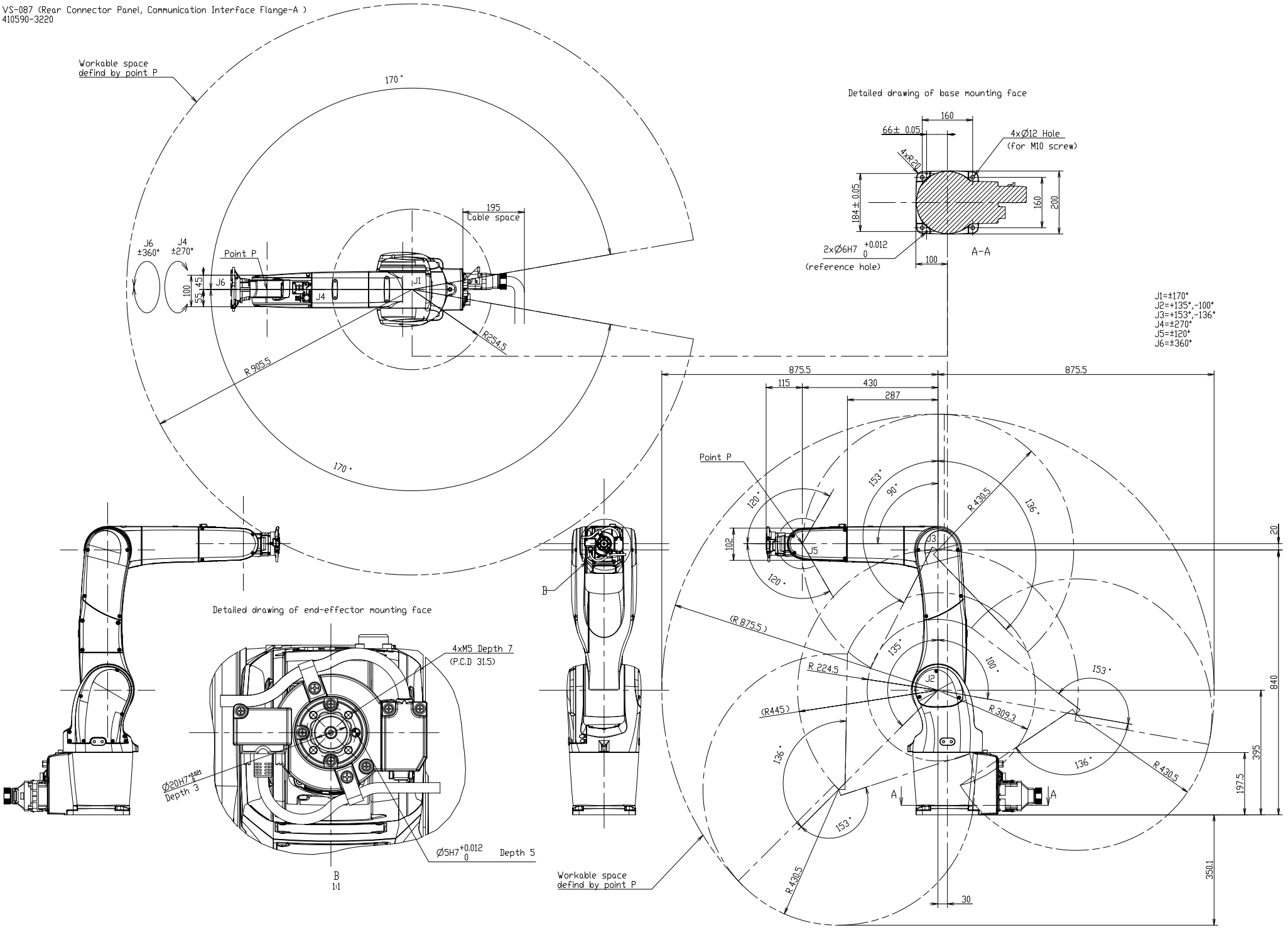
VS-087 (Rear Connector Panel, Standard Flange)
410590-3210



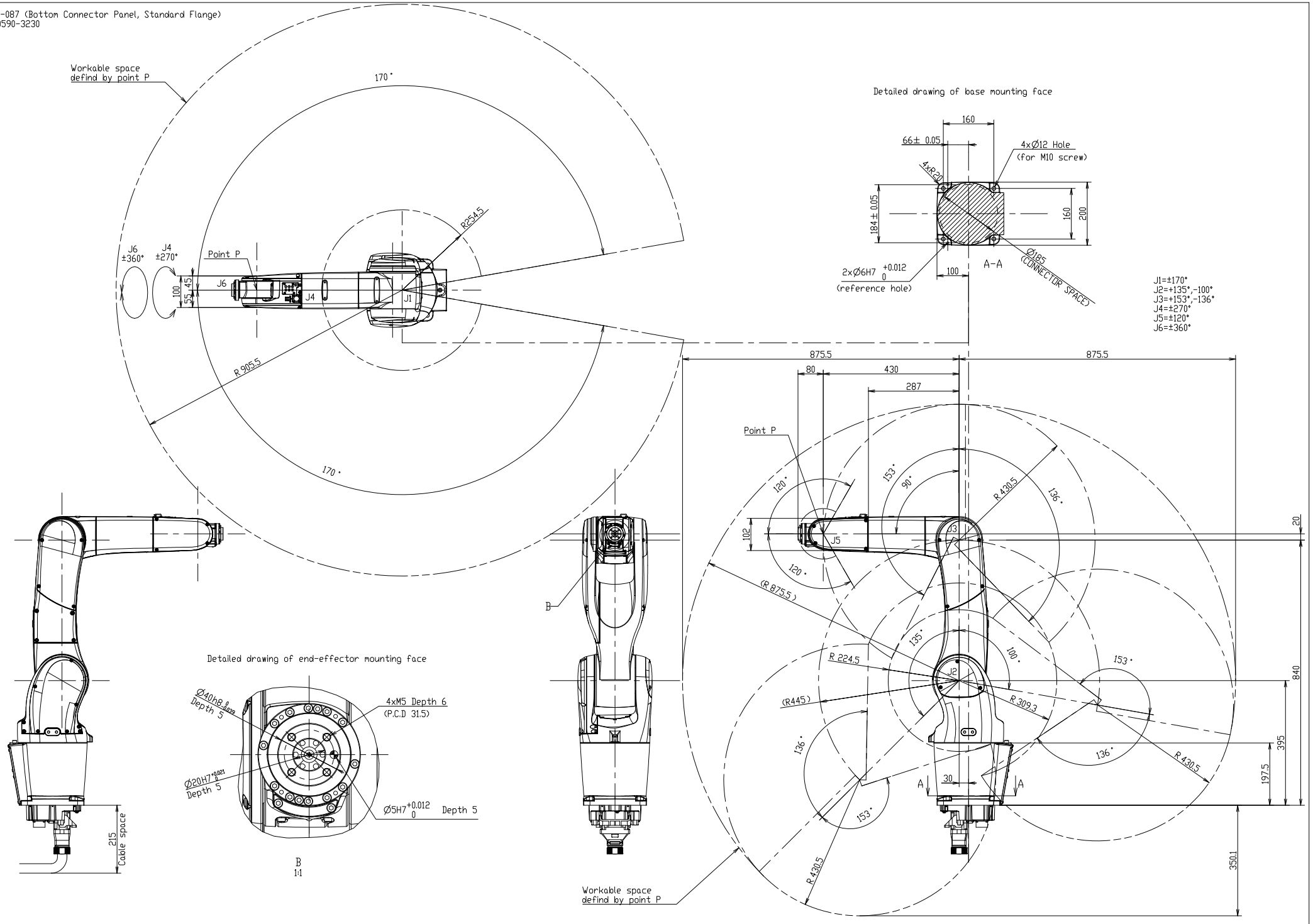
VS-087 (Rear Connector Panel, Standard Flange, Protected type(IP67))
410590-3270



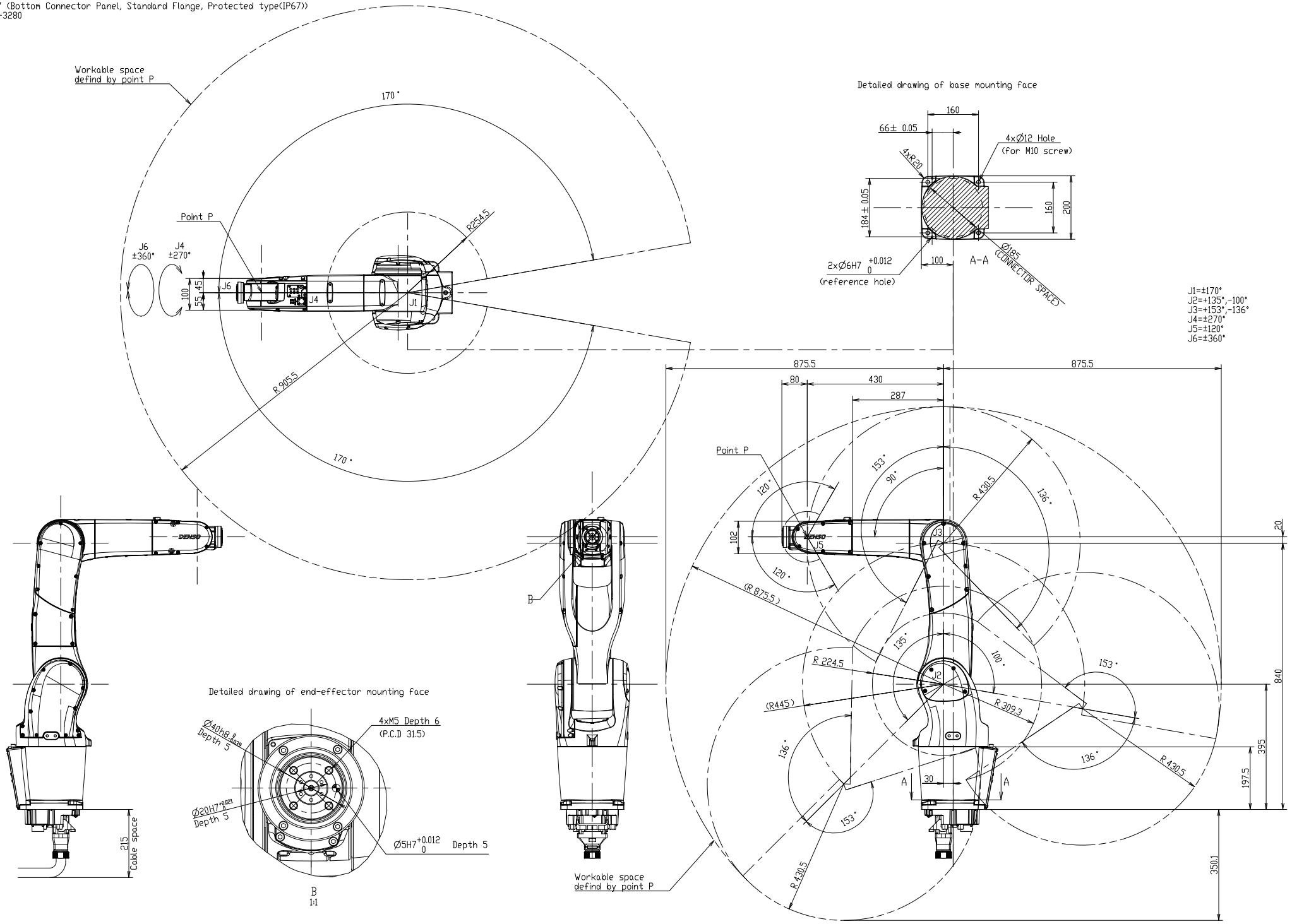
VS-087 (Rear Connector Panel, Communication Interface Flange-A)
410590-3220



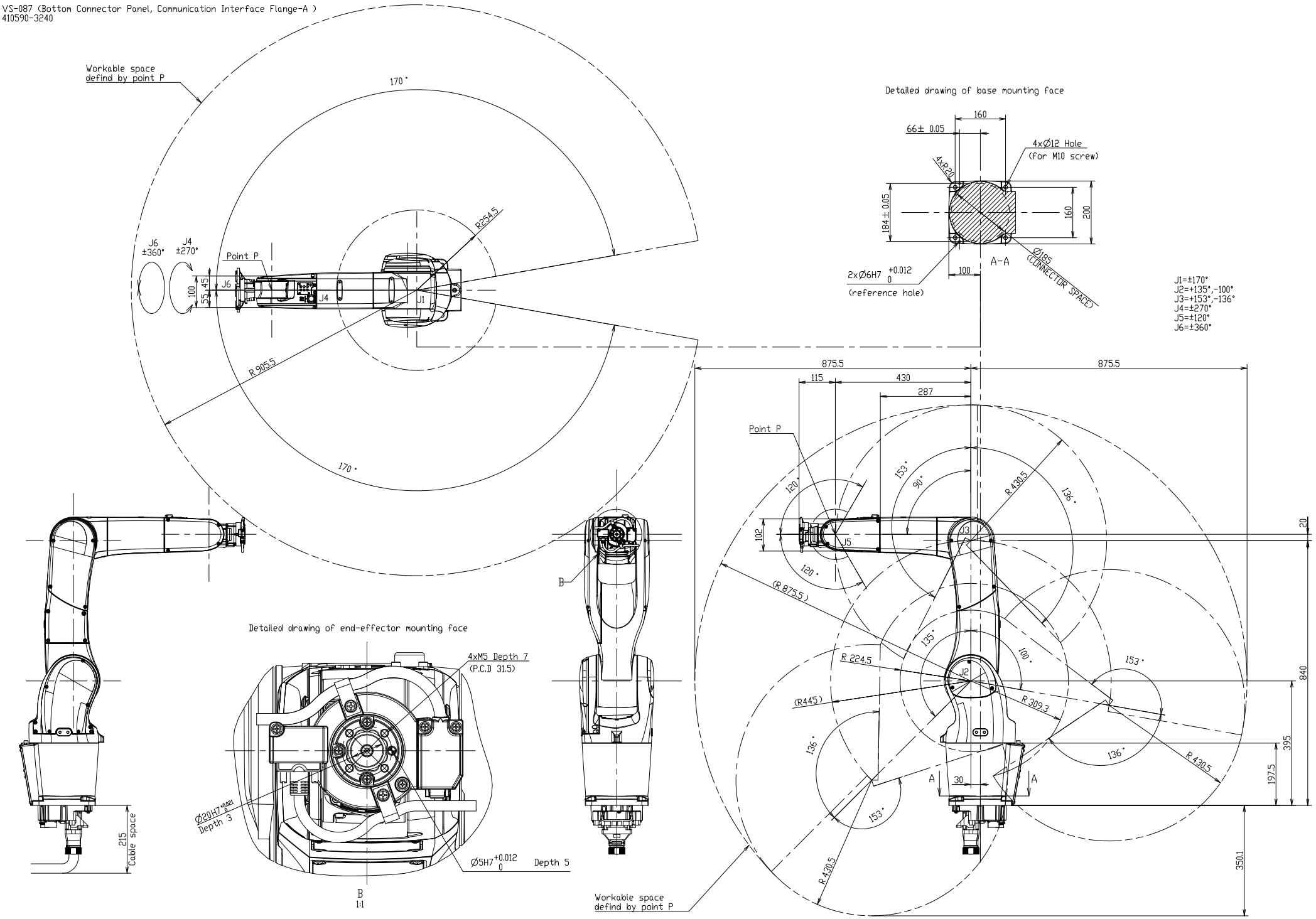
VS-087 (Bottom Connector Panel, Standard Flange)
410590-3230



VS-087 (Bottom Connector Panel, Standard Flange, Protected type(IP67))
410590-3280



VS-087 (Bottom Connector Panel, Communication Interface Flange-A)
410590-3240

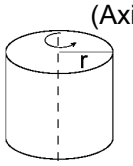


8.2 Sample Calculation in Designing End-effectors

8.2.1 Moment-of-Inertia Formulas

1. Cylinder (1)

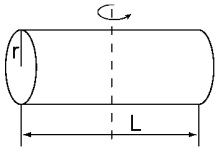
(Axis of rotation = Center axis)



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

2. Cylinder (2)

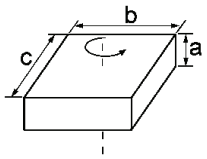
(The axis of rotation passes through the center of gravity.)



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

3. Rectangular parallelepiped

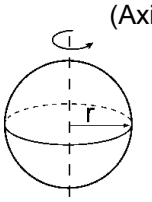
(The axis of rotation passes through the center of gravity.)



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

4. Sphere

(Axis of rotation = Center axis)

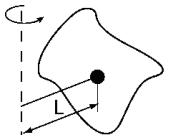


$$I = \frac{2mr^2}{5}$$

5. Center of gravity not on the axis of rotation

Moment of inertia around center of gravity

[kgm²]



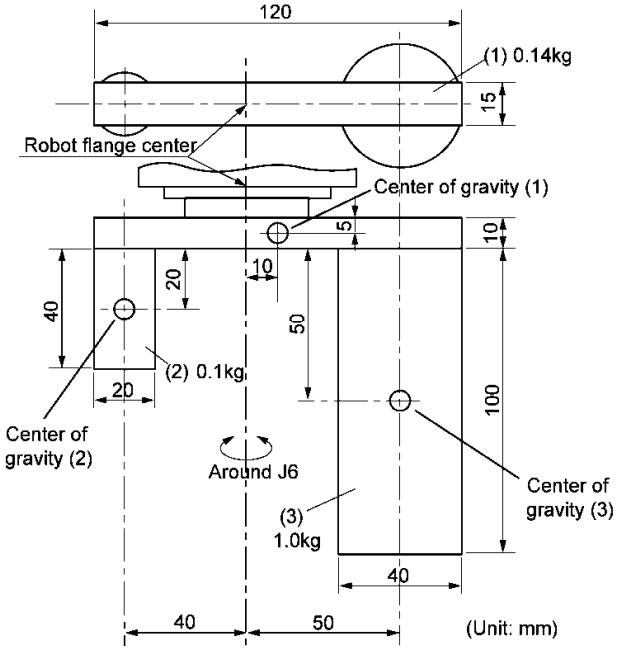
$$I = I_g + mL^2$$

I: Moment of inertia (kgm^2)
m: Mass (kg)
r: Radius 〔m〕
a, b, c, L: Length 〔m〕

8.2.2 Calculation Example of Moment of Inertia for End-effector

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) and (3).

(1) Moment of inertia around J6



Moment of inertia around J6 of (1): I_1 (from 3 and 5 in the above table)

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

Moment of inertia around J6 of (2): I_2 (from 1 and 5 in the above table)

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

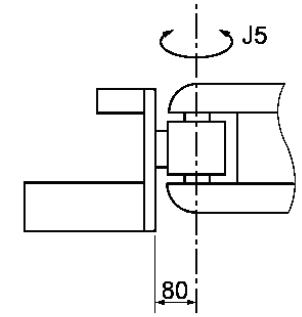
Moment of inertia around J6 of (3): I_3 (from 1 and 5 in the above table)

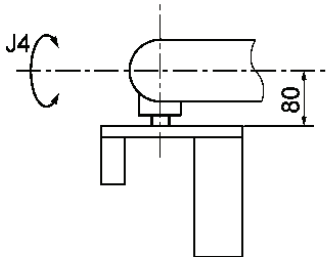
$$I_3 = \frac{1.0 \times 0.02^2}{2} + 1.0 \times 0.05^2 = 2.7 \times 10^{-3} \quad [kgm^2]$$

Moment of inertia around J6 of entire hand: I_{J6}

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

Around J6 For the end-effector shown below, 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 the above table)

$$I_1 = \frac{0.14}{12}(0.015^2 + 0.01^2) + 0.14 \times (0.08 + 0.005)^2 = 1.02 \times 10^{-3} \quad [kgm^2]$$

Moment of inertia around J4 and J5 of (2): I_2 (from 2 and 5 in the above table)

$$I_2 = \frac{0.1}{4}\left(0.01^2 + \frac{0.04^2}{3}\right) + 0.1 \times (0.08 + 0.01 + 0.02)^2 = 1.23 \times 10^{-3} \quad [kgm^2]$$

Moment of inertia around J4 and J5 of (3): I_3 (from 2 and 5 in the above table)

$$I_3 = \frac{1.0}{4}\left(0.02^2 + \frac{0.1^2}{3}\right) + 1.0 \times (0.08 + 0.01 + 0.05)^2 = 2.0 \times 10^{-2} \quad [kgm^2]$$

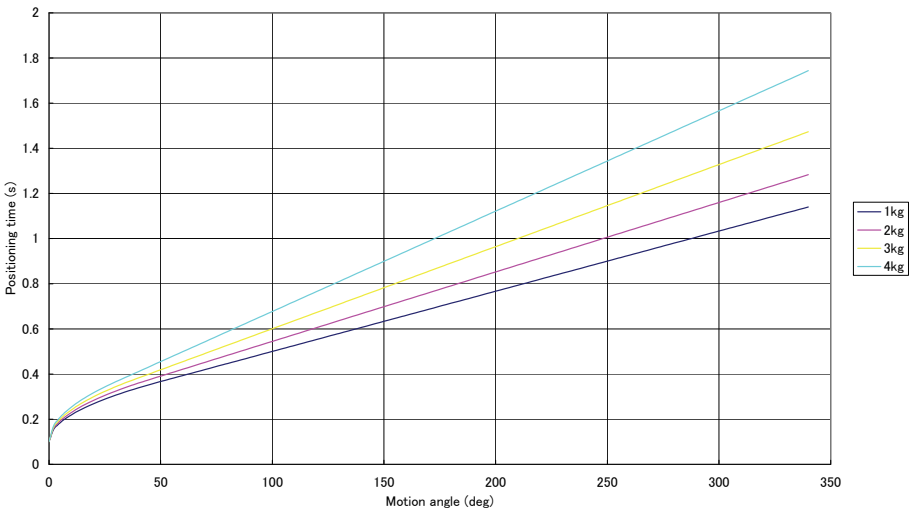
Moment of inertia around J4 and J5 of entire end-effector: I_{J4}, I_{J5}

$$I_{J4} = I_{J5} = I_1 + I_2 + I_3 = 2.22 \times 10^{-2} \quad [kgm^2]$$

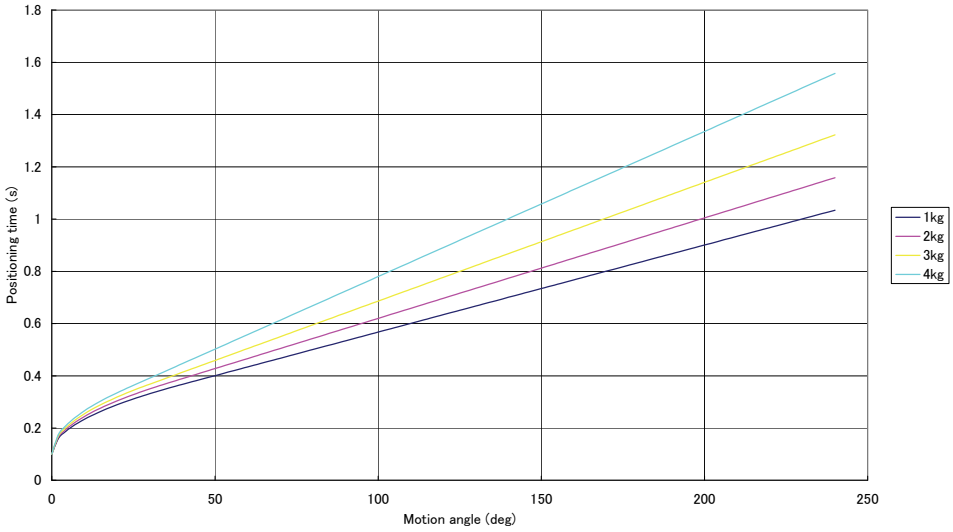
8.3 Positioning Time of Each Axis

VS-050

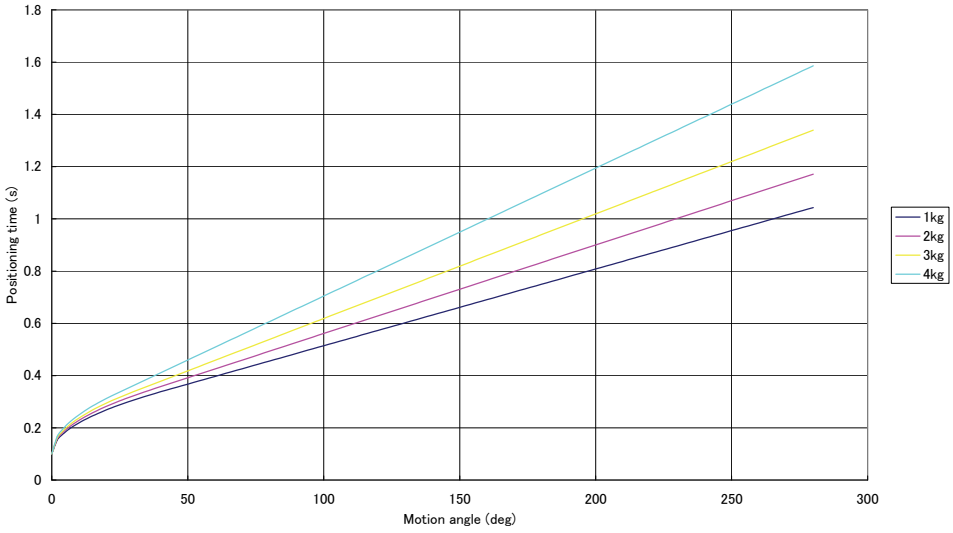
J1 axis



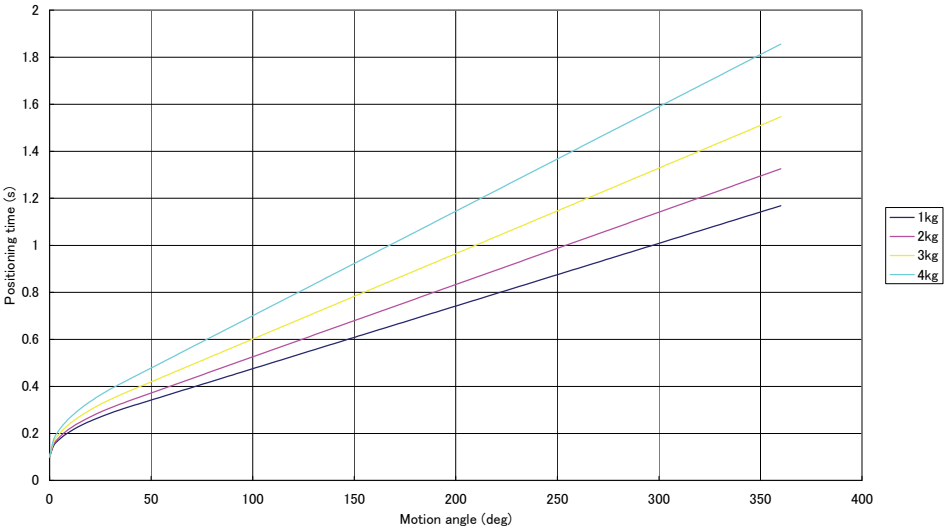
J2 axis



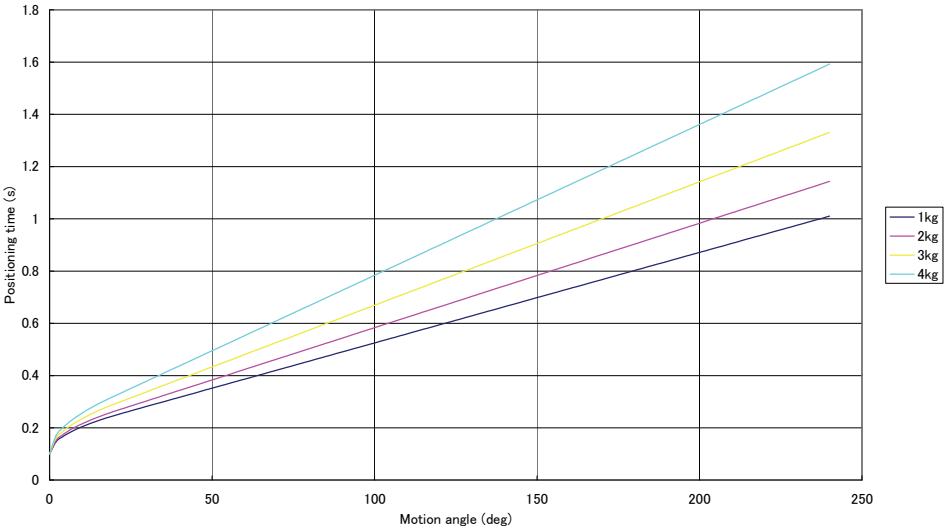
J3 axis



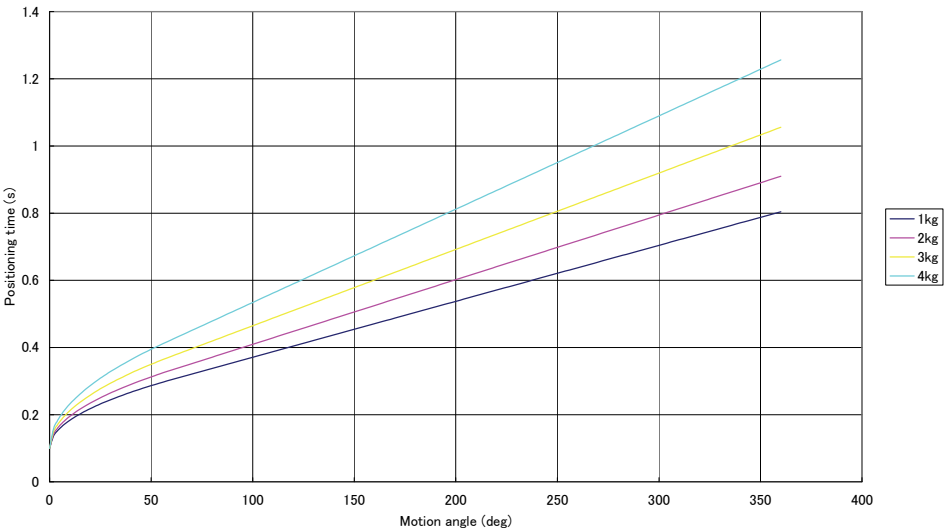
J4 axis

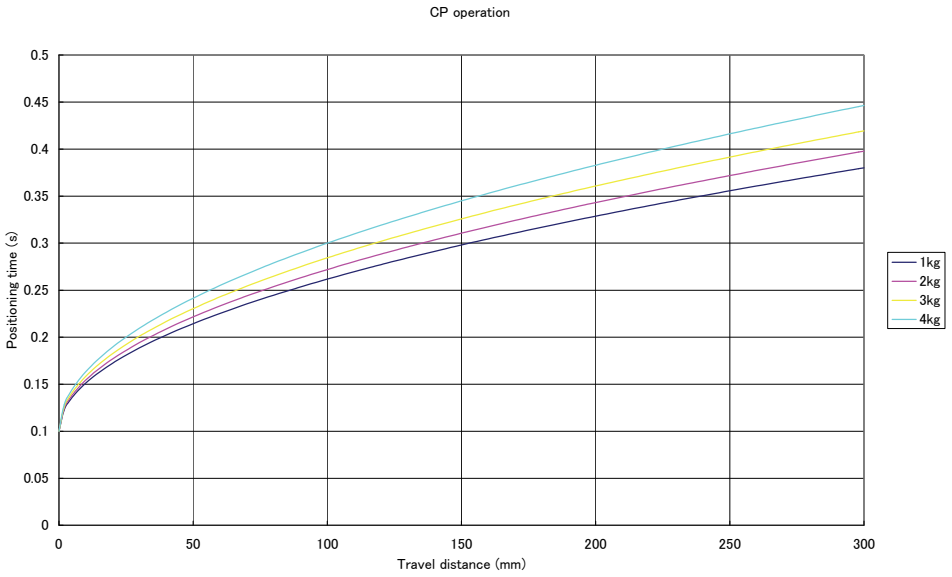


J5 axis

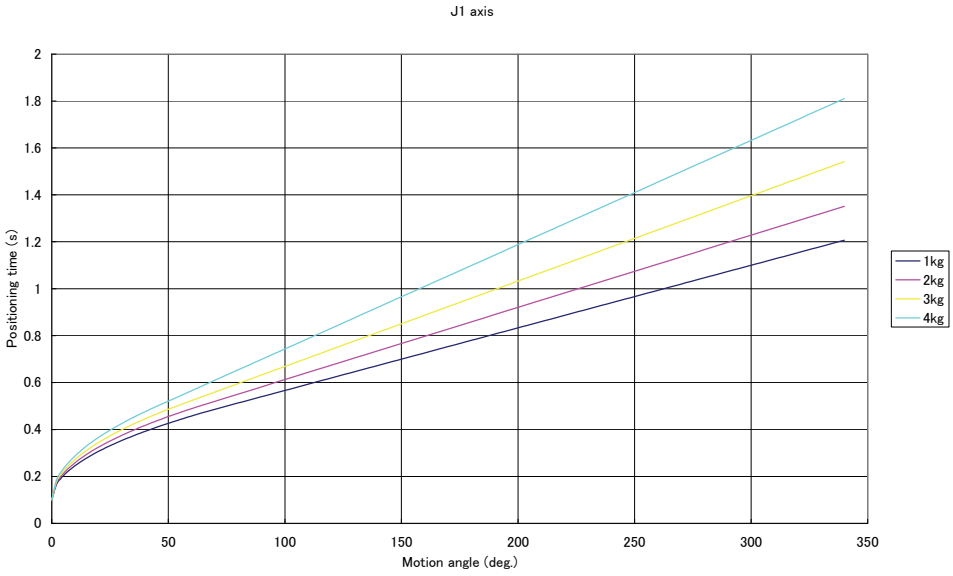


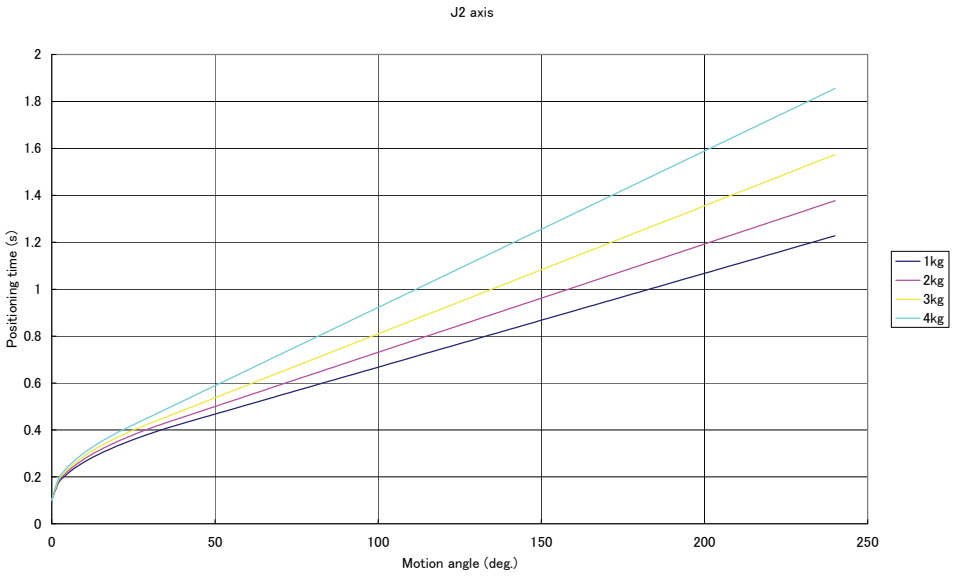
J6 axis



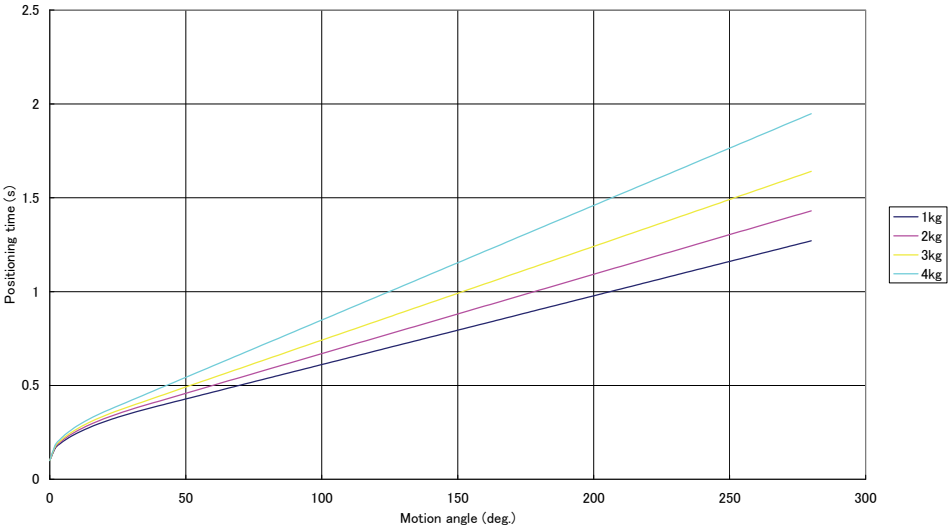

CP operation
Positioning time (s)
Travel distance (mm)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0
50
100
150
200
250
300
1kg
2kg
3kg
4kg

VS-060

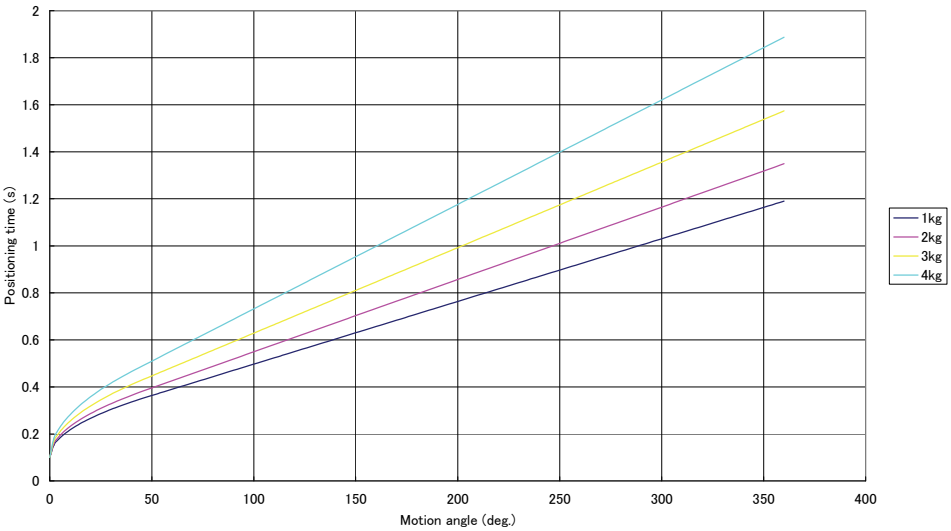

J1 axis
Positioning time (s)
Motion angle (deg.)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
0
50
100
150
200
250
300
350
1kg
2kg
3kg
4kg


J2 axis
Positioning time (s)
Motion angle (deg.)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
0
50
100
150
200
250
1kg
2kg
3kg
4kg

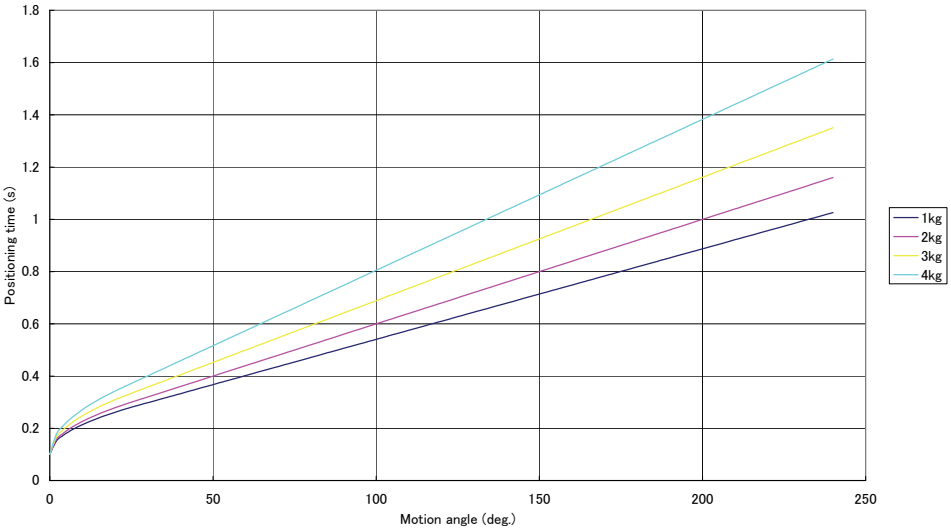
J3 axis

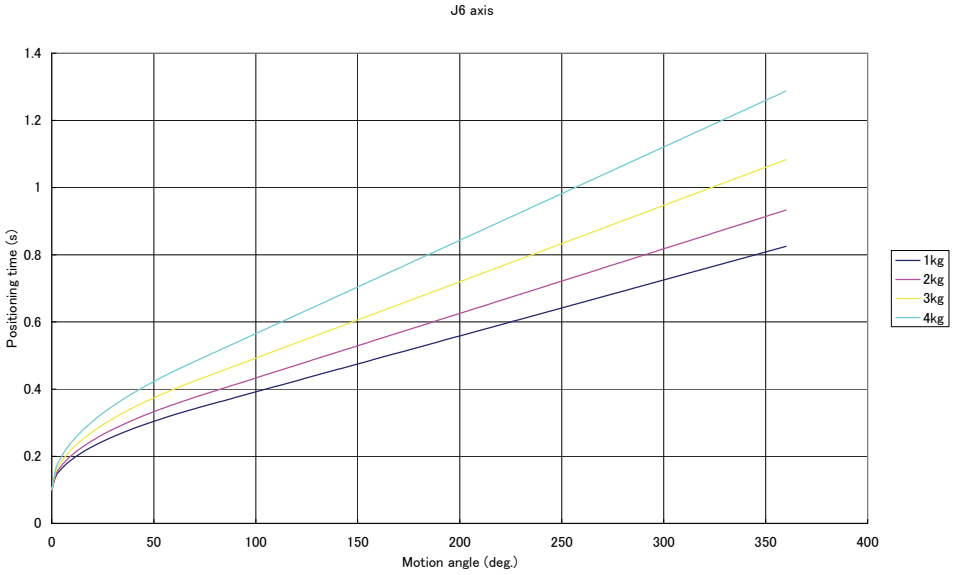


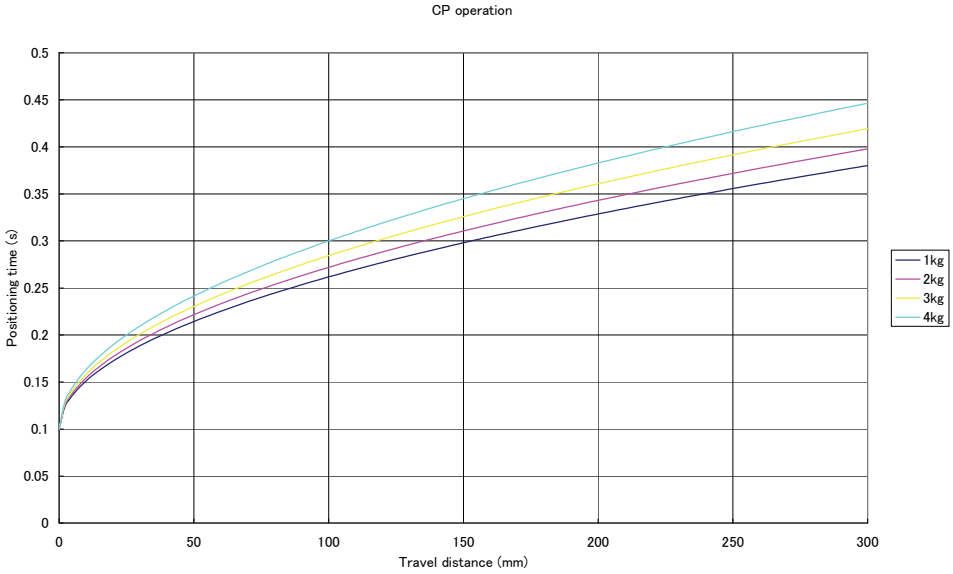
J4 axis



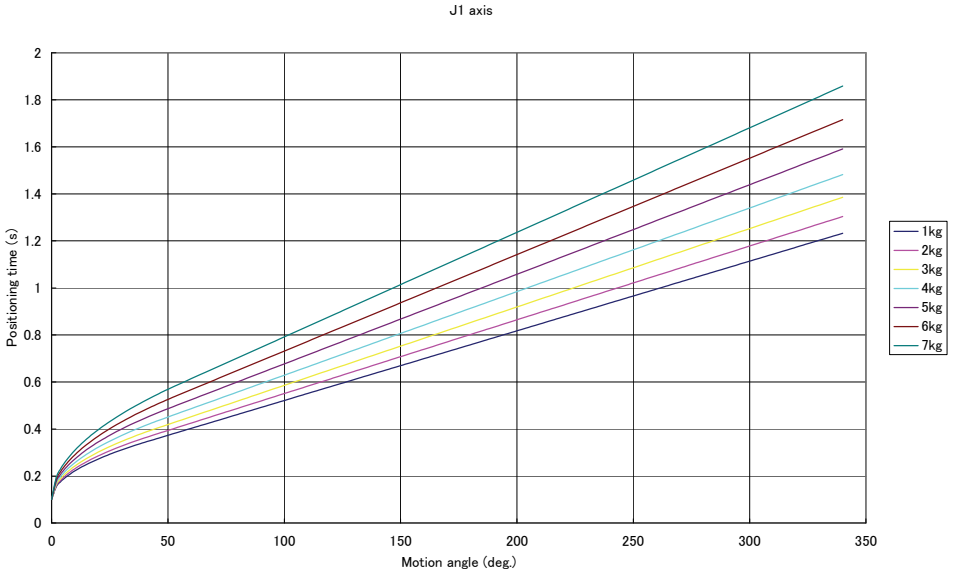
J5 axis



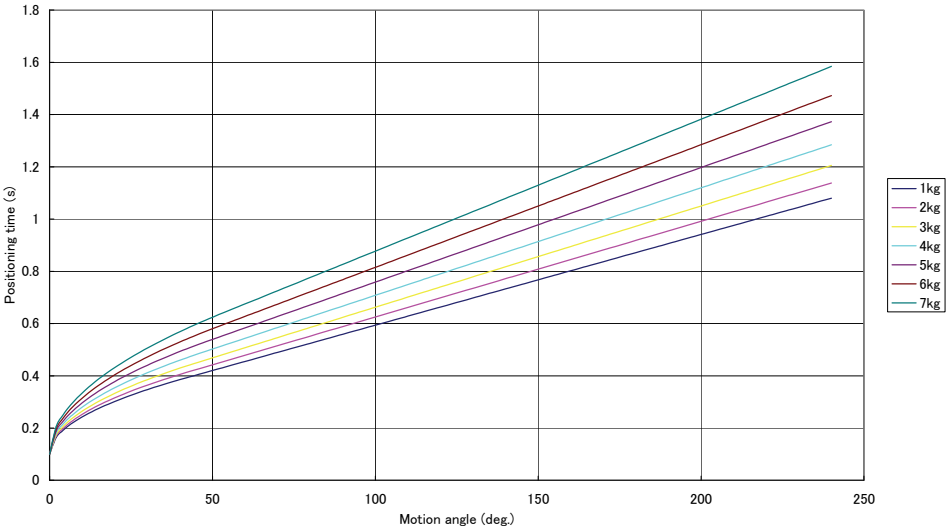

J6 axis
Positioning time (s)
Motion angle (deg.)
1kg
2kg
3kg
4kg


CP operation
Positioning time (s)
Travel distance (mm)
1kg
2kg
3kg
4kg

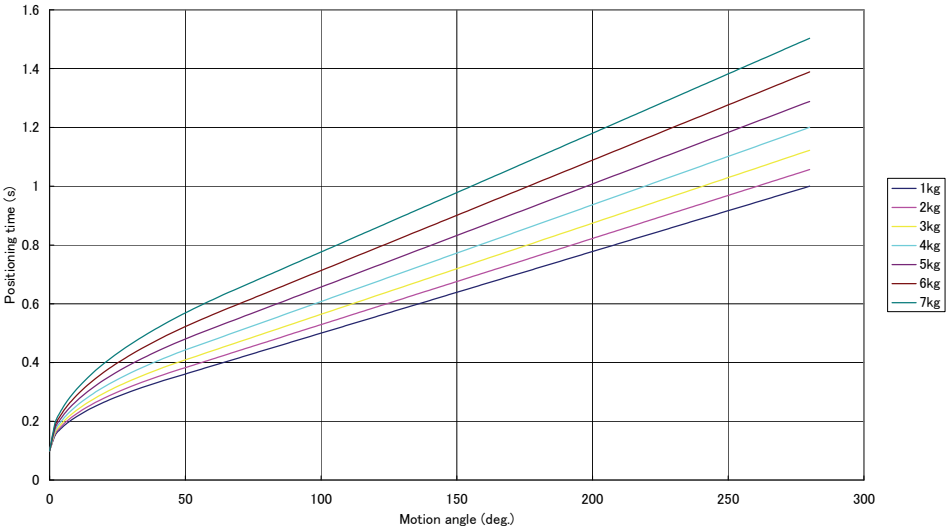
VS-068


J1 axis
Positioning time (s)
Motion angle (deg.)
1kg
2kg
3kg
4kg
5kg
6kg
7kg

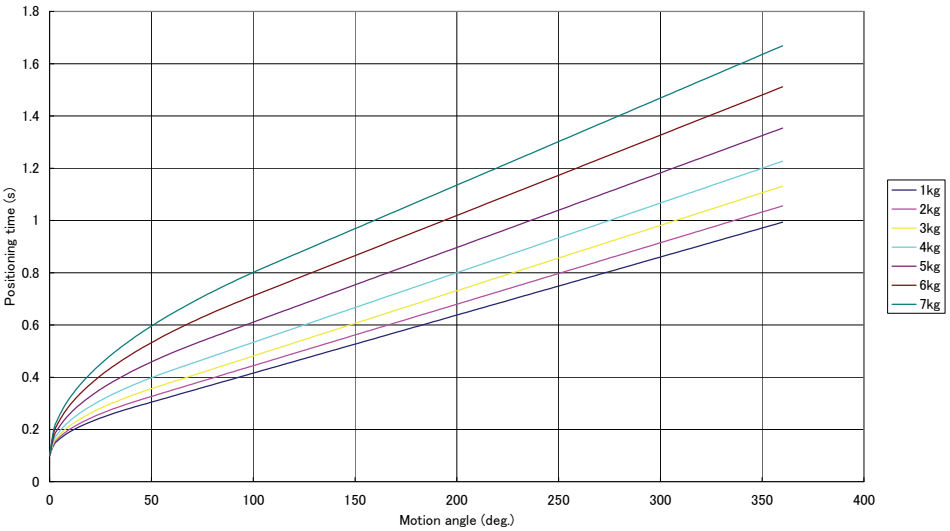
J2 axis



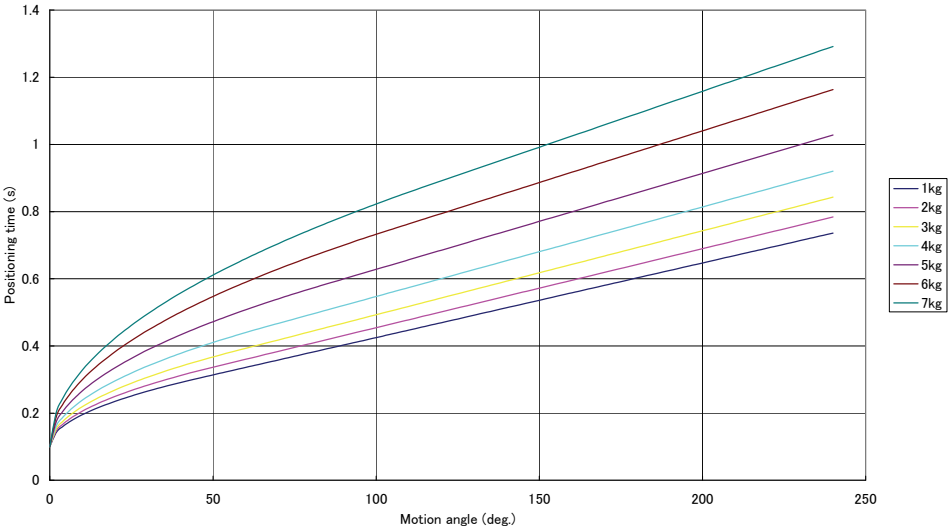
J3 axis



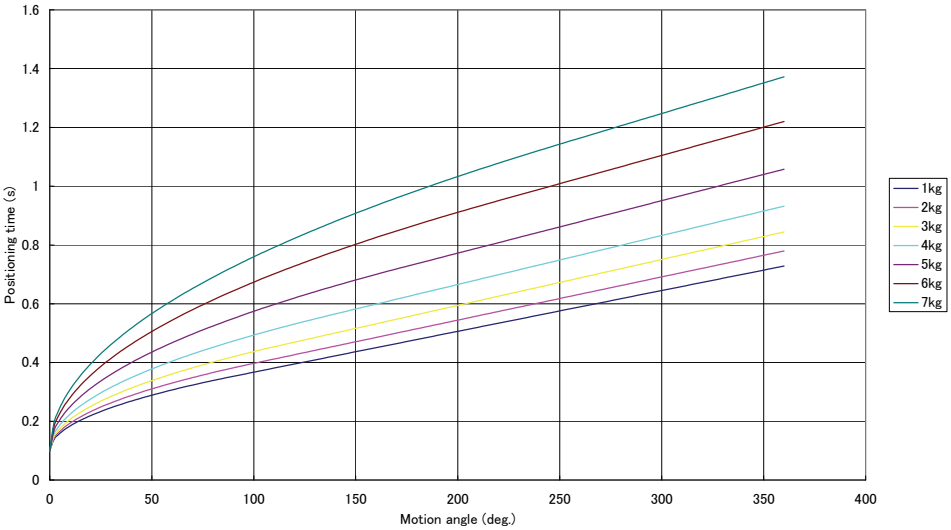
J4 axis



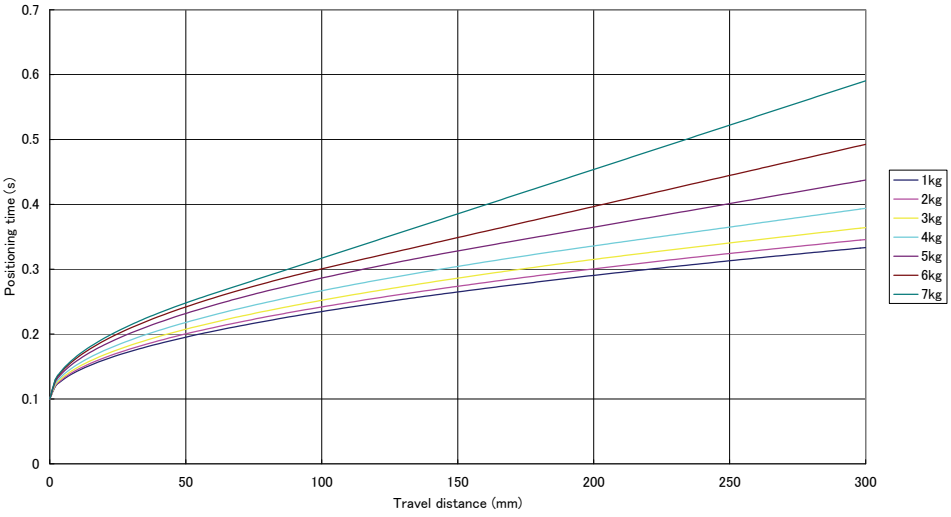
J5 axis



J6 axis

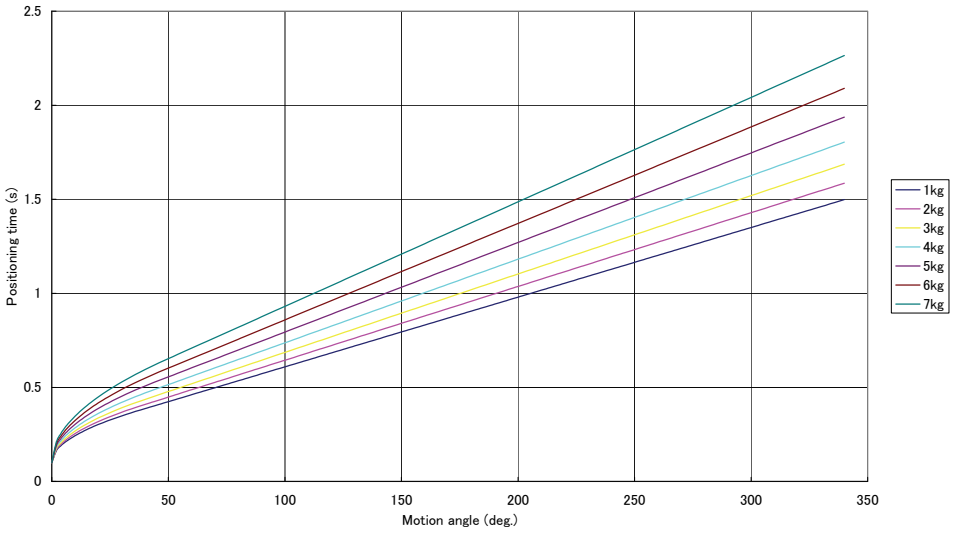


VS6556G,VS6577G
CP operation

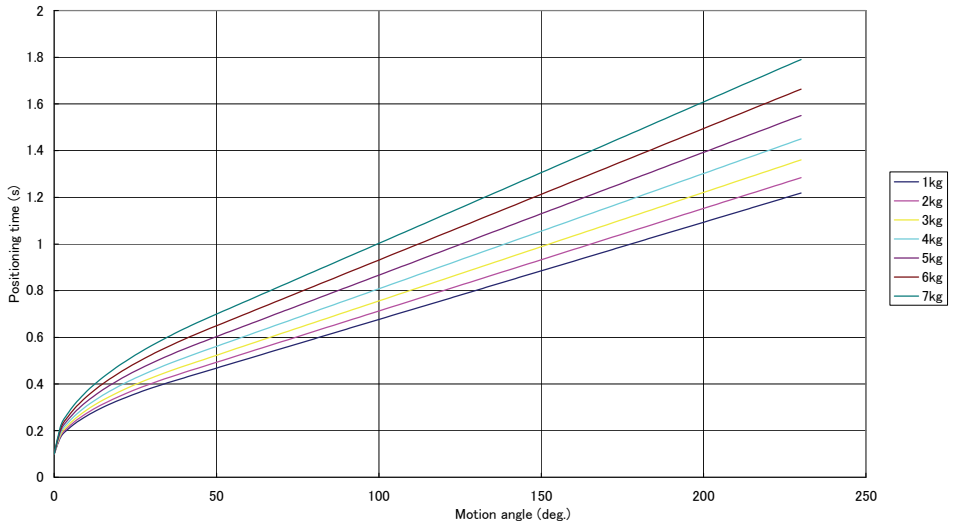


VS-087

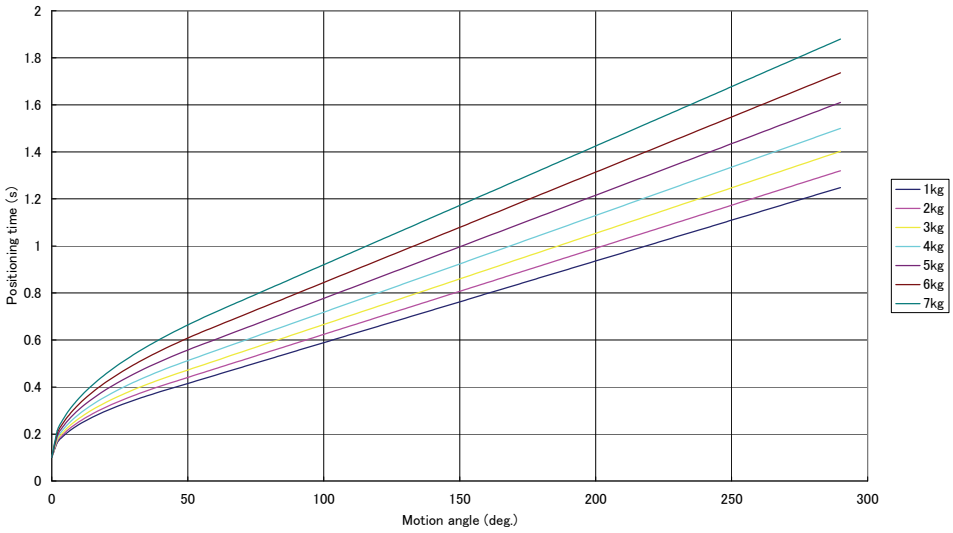
J1 axis



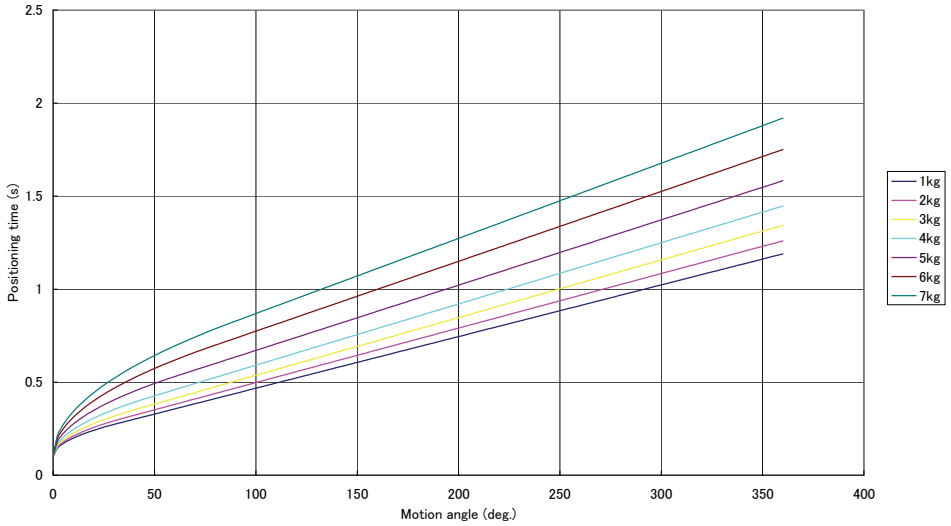
J2 axis



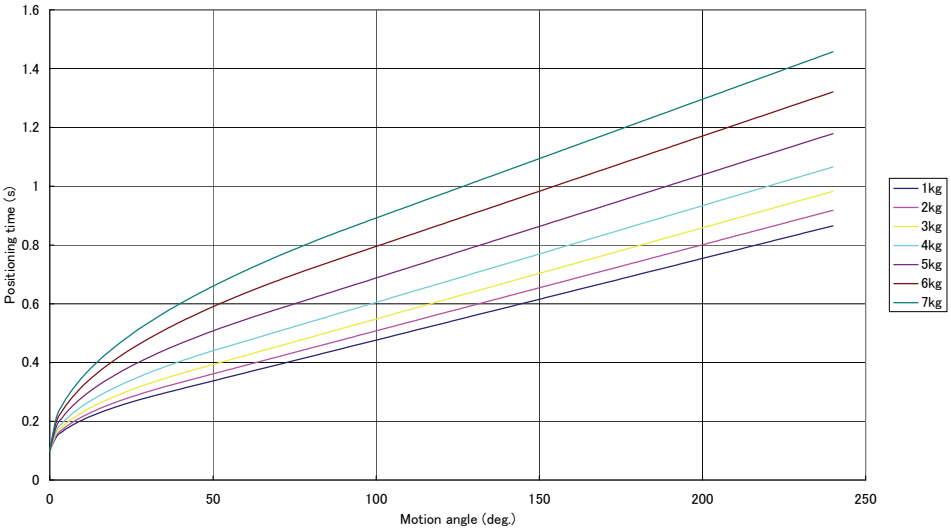
J3 axis



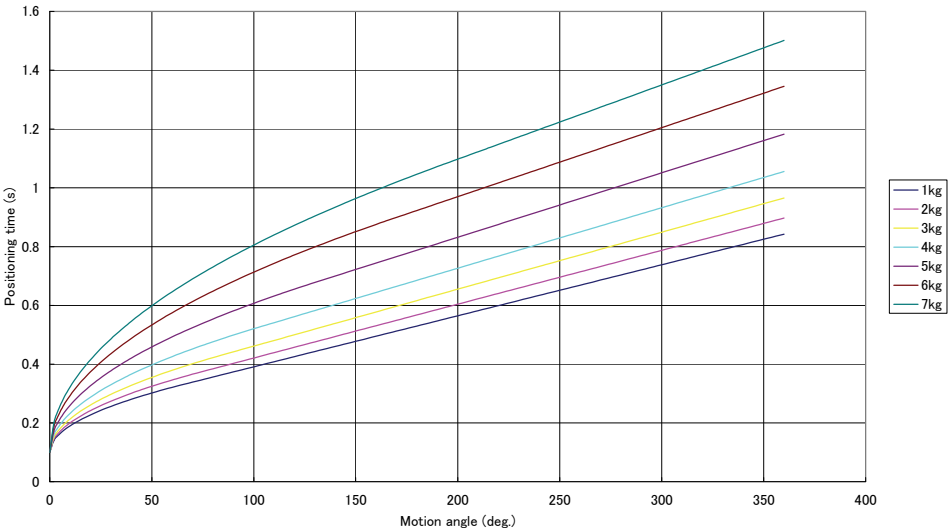
J4 axis

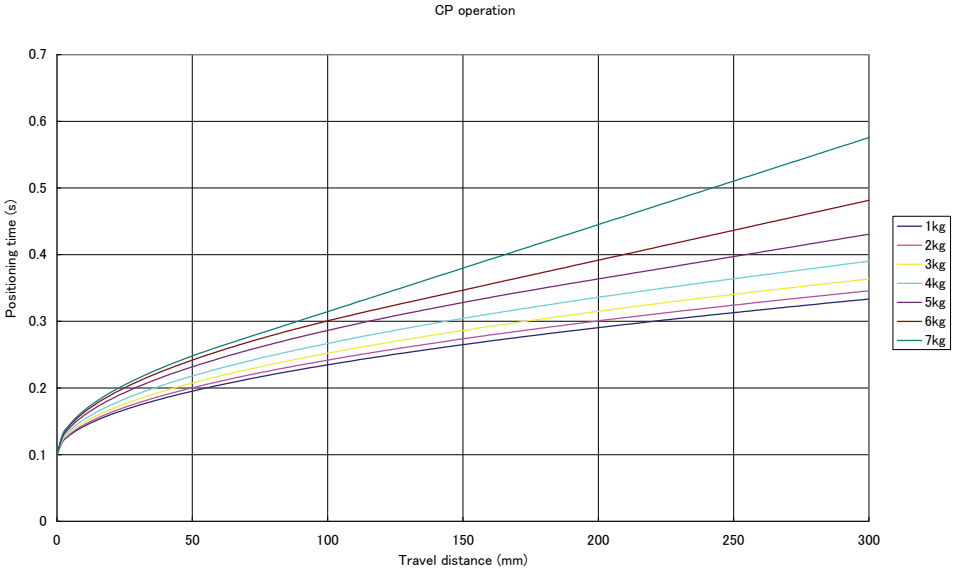


J5 axis



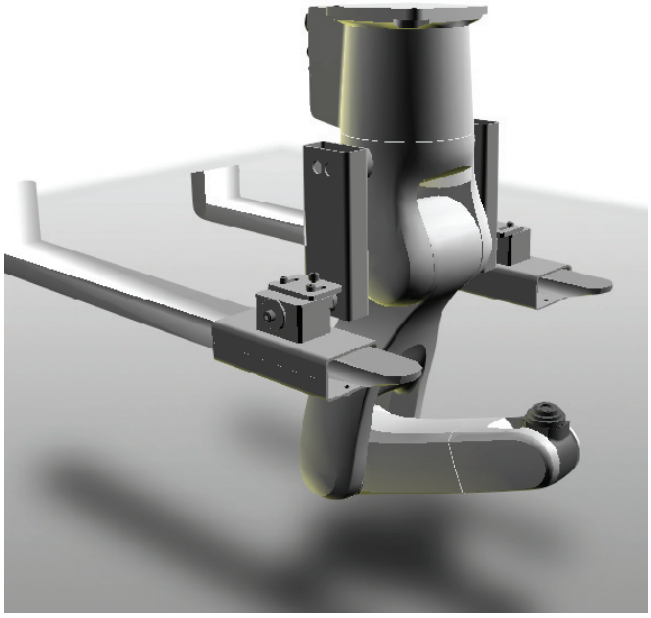
J6 axis



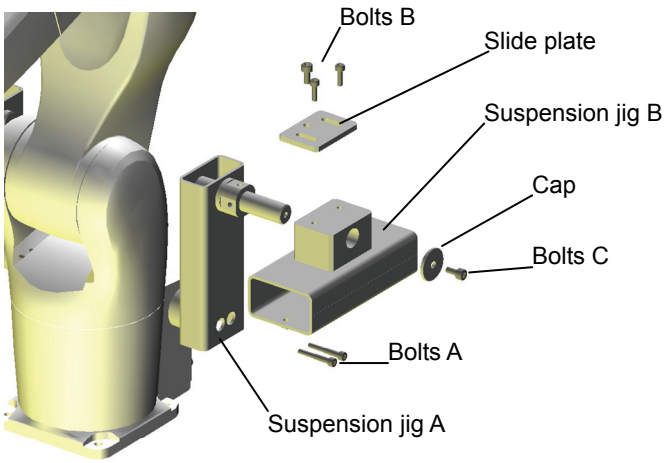

CP operation
Positioning time (s)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
50
100
150
200
250
300
Travel distance (mm)
1kg
2kg
3kg
4kg
5kg
6kg
7kg

8.4 Overhead-mount Example

This section gives a rotation example of overhead-mount robot. Mount the robot unit safely, matching the installation environment.



Jig examples for overhead-mount and wall-mount



Reference Drawing of Suspension jig A

Reference Drawing of Suspension jig B

(Note: Produce these jigs in size suitable for facilities to be supported.)

Reference Drawing of Slide plate

Reference Drawing of Cap

Bolts A

Hex. socket-head bolts M8 x 55 (Strength class : 12.9)

Tightening torque: 20 +/- 4 Nm

Bolts B

Hex. socket-head bolts M10 x 20 (Strength class : 12.9)

Tightening torque: 70 +/- 14 Nm

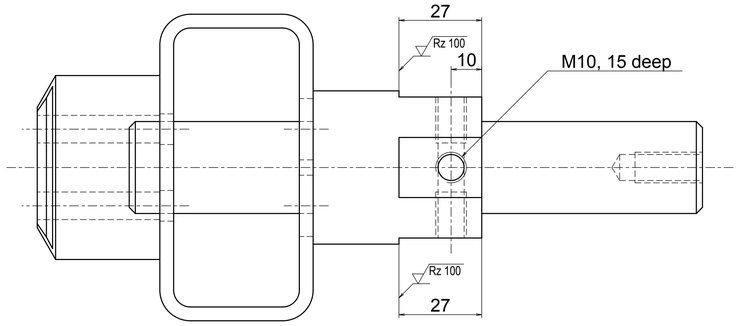
Bolts C

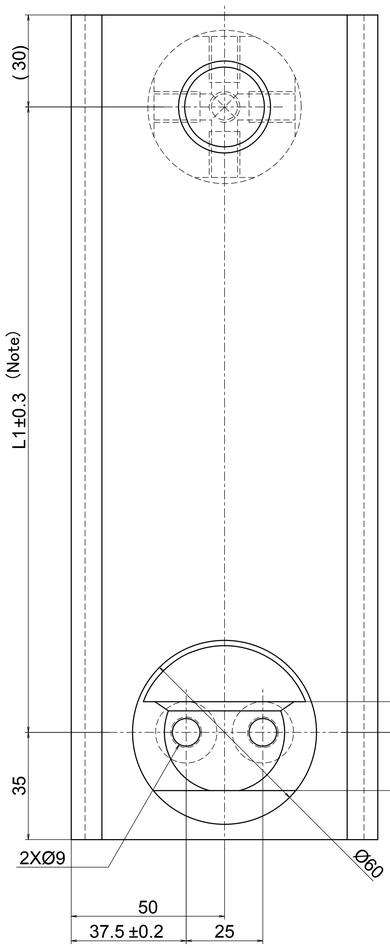
Hex. socket-head bolts M10 x 20 (Strength class : 12.9)

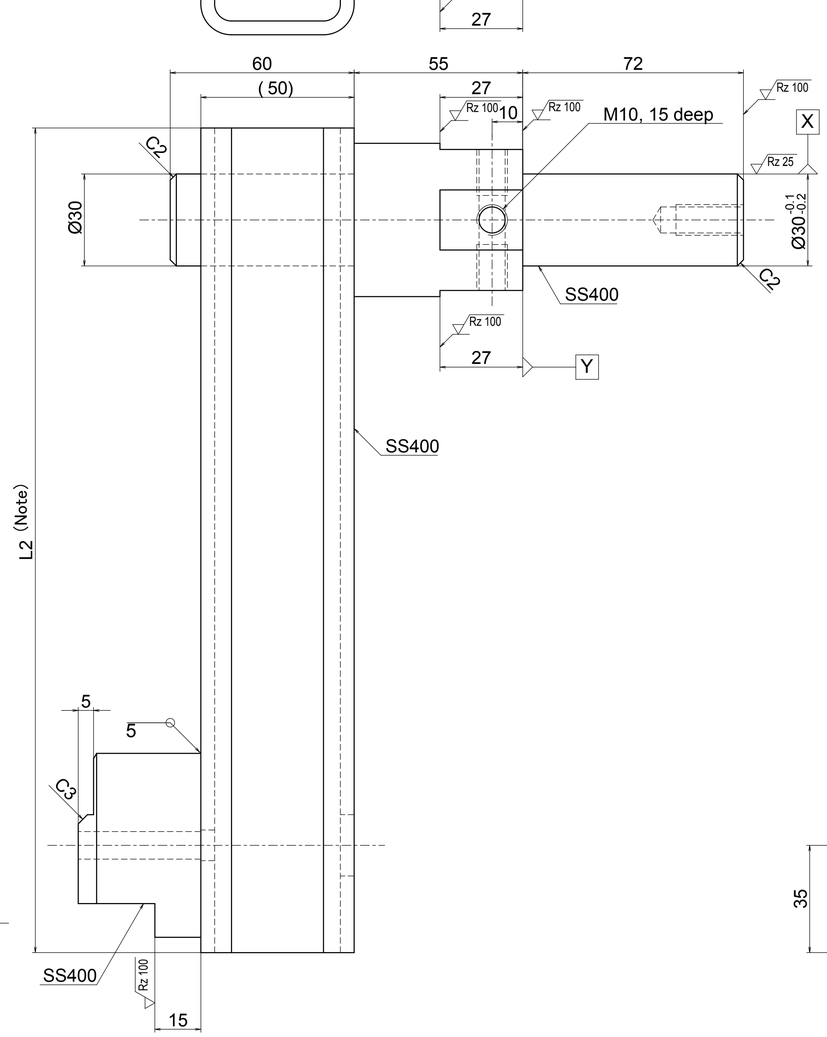
Tightening torque: 36 +/- 14 Nm

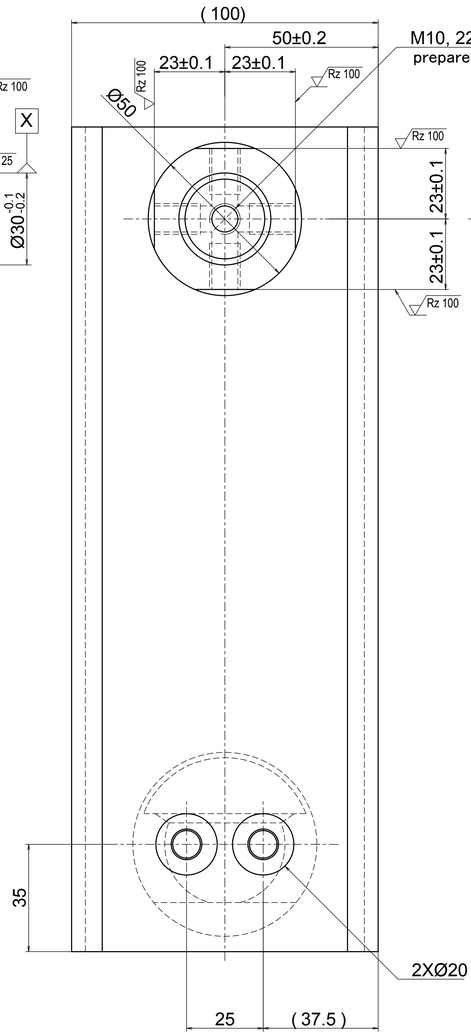
Reference Drawings of Suspension Jig A

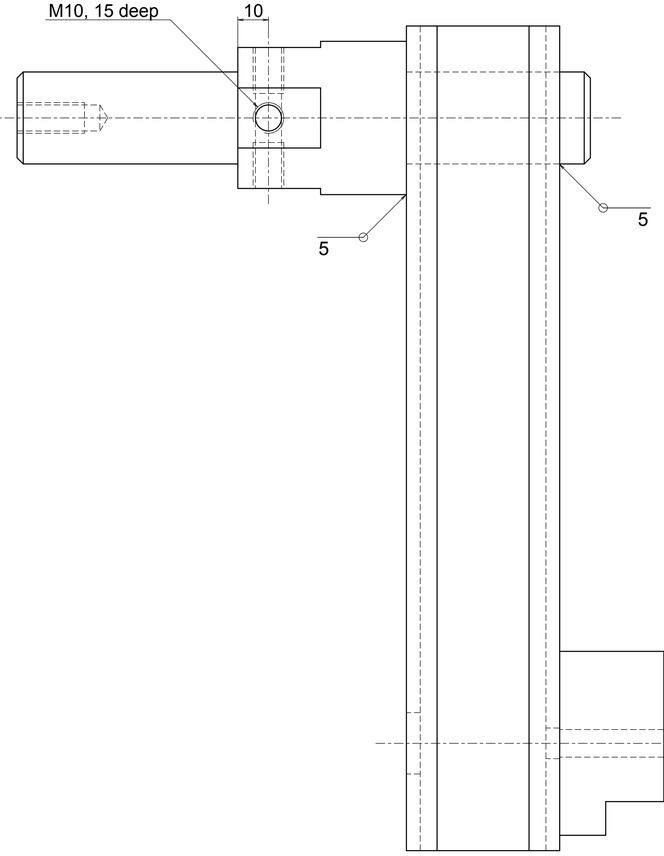
(Rz 100 Rz 25)

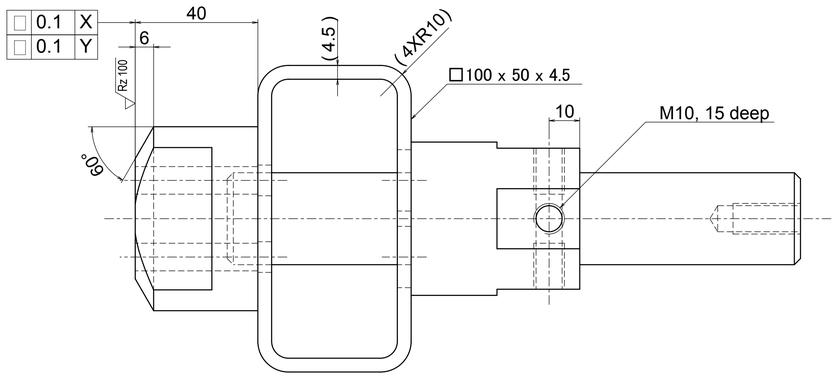












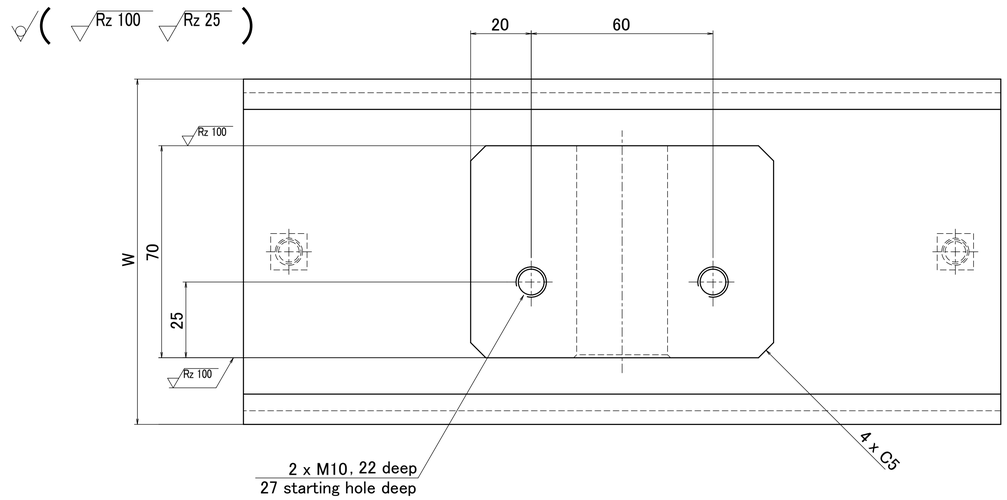
Note [unit : mm]

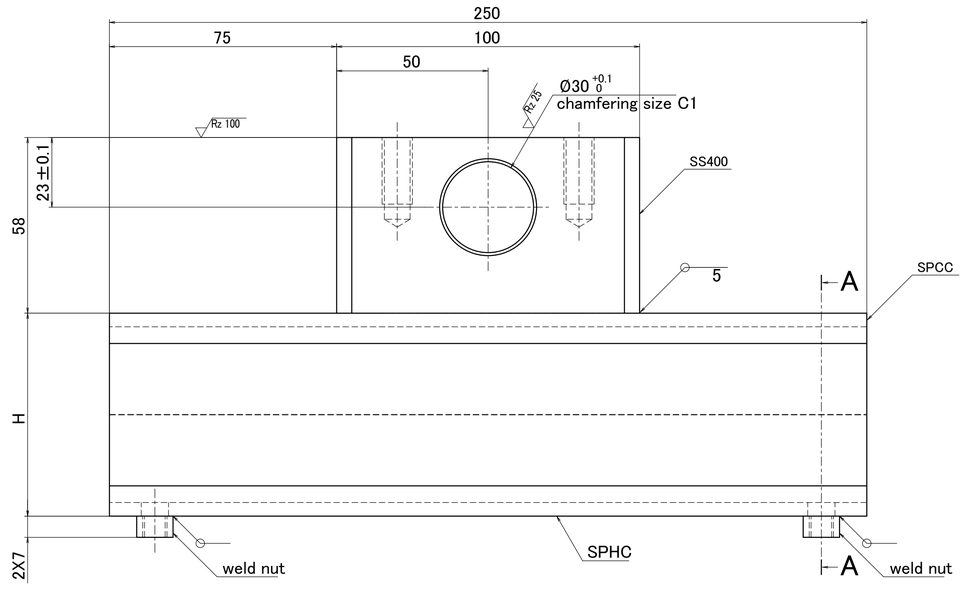
Robot type	Length	
	L1	L2
VS-087	204	269
VS-068	159	224
VS-060	100	165
VS-050	76	141

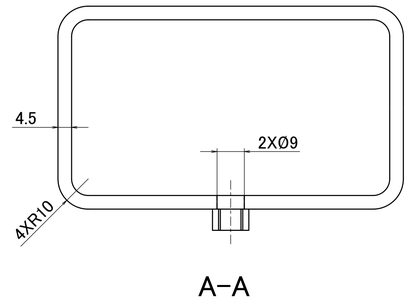
Joint angles for keeping the robot unit in a well-balanced posture when hoisting it with eyebolts
VS-050: J1 = 0° , J2 = -10° , J3 = 140° , J4 = 0° , J5 = 50° , J6 = 180°
VS-060: J1 = 0° , J2 = -20° , J3 = 130° , J4 = 0° , J5 = 70° , J6 = 180°
VS-068: J1 = 0° , J2 = -10° , J3 = 140° , J4 = 0° , J5 = 50° , J6 = 180°
VS-087: J1 = 0° , J2 = -20° , J3 = 130° , J4 = 0° , J5 = 70° , J6 = 180°

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

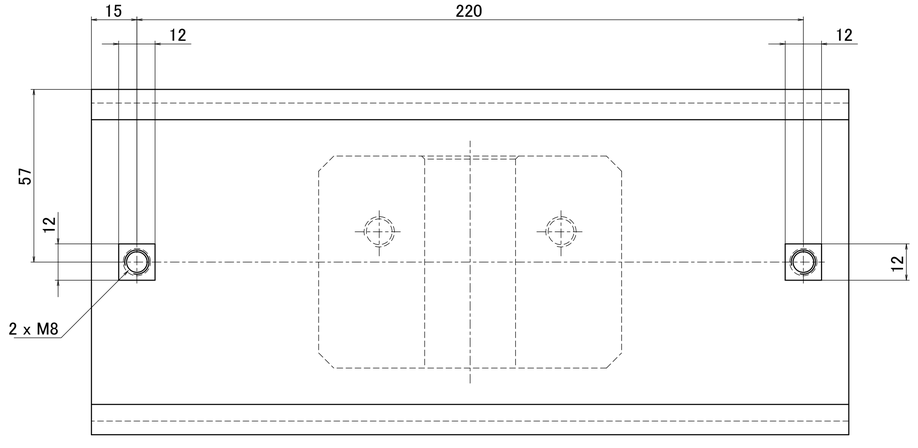
Reference Drawings of Suspension Jig B







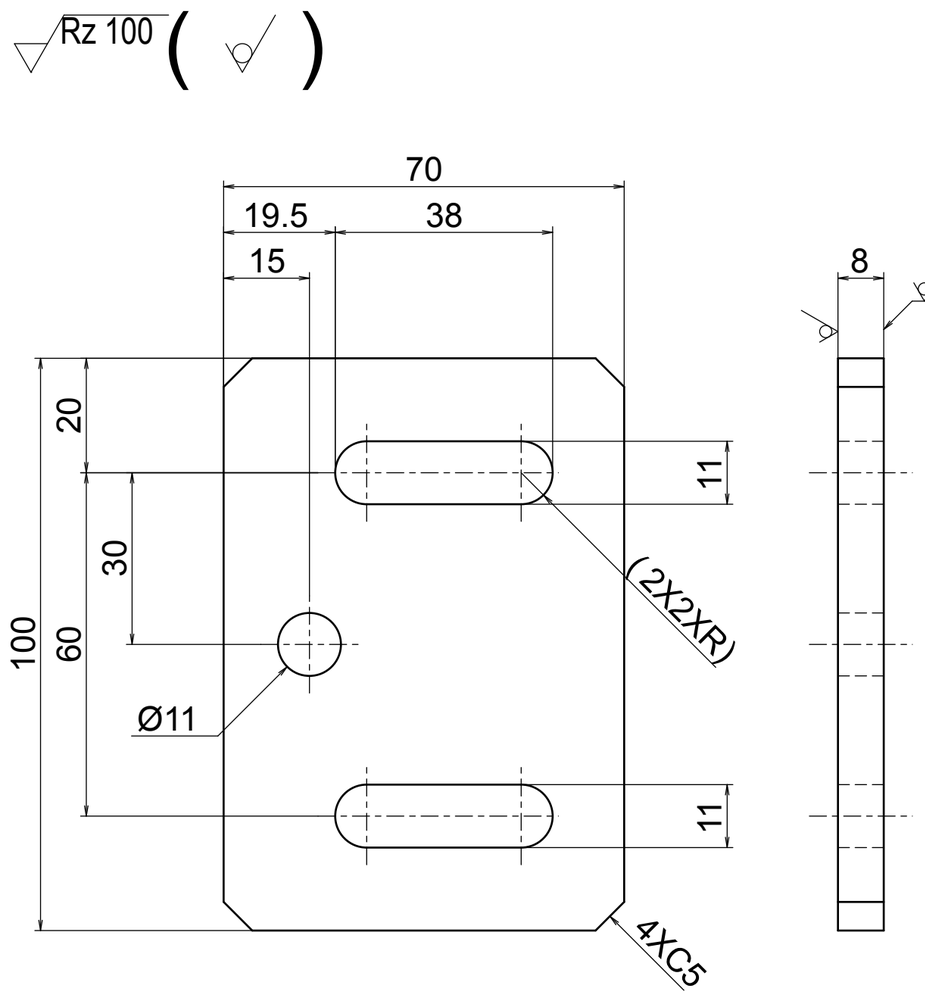
A–A



W and H should be adjusted to match the user's lifter.

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

Reference Drawings of Slide Plate

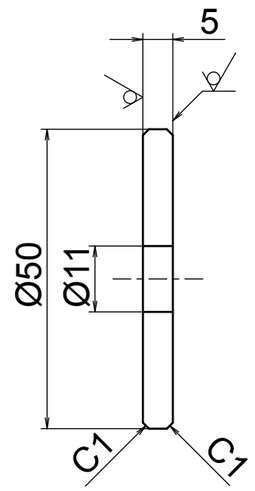


Material: S45C

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

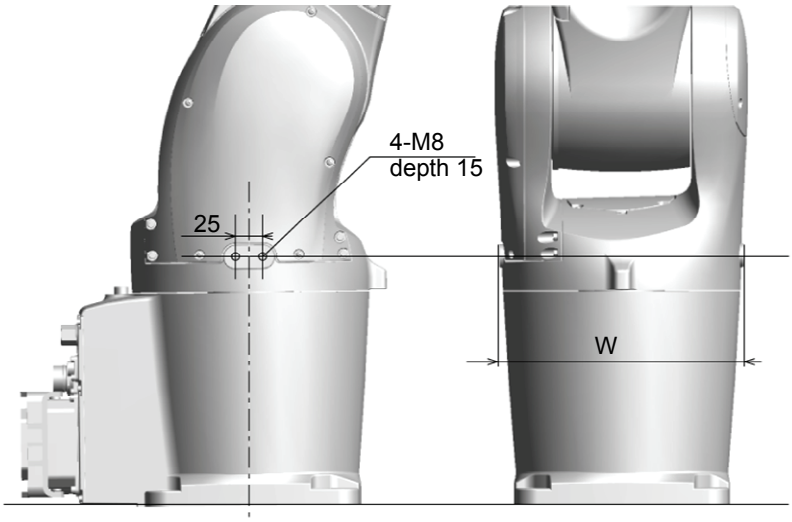
Reference Drawings of Cap

Rz 100 ( )



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

[5] Location of hoisting bolt holes

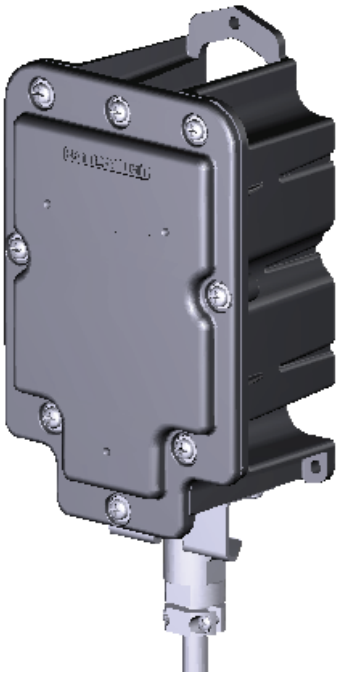


VS-050 / 060 : W=182 mm

VS-068 / 087 : W=226 mm

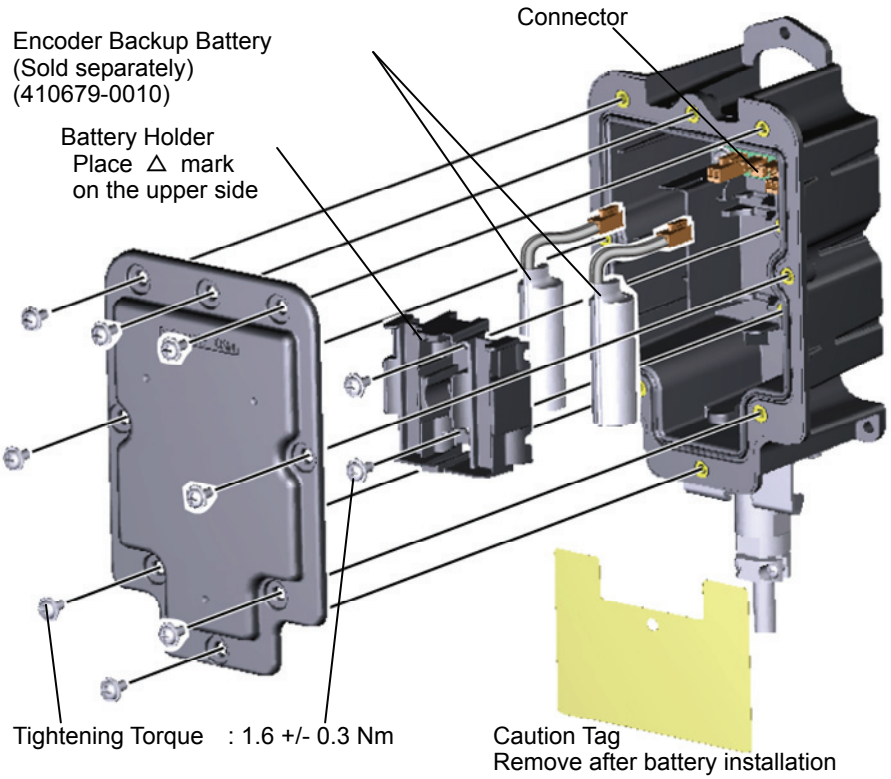
8.5 Options

8.5.1 External Battery Extension Unit

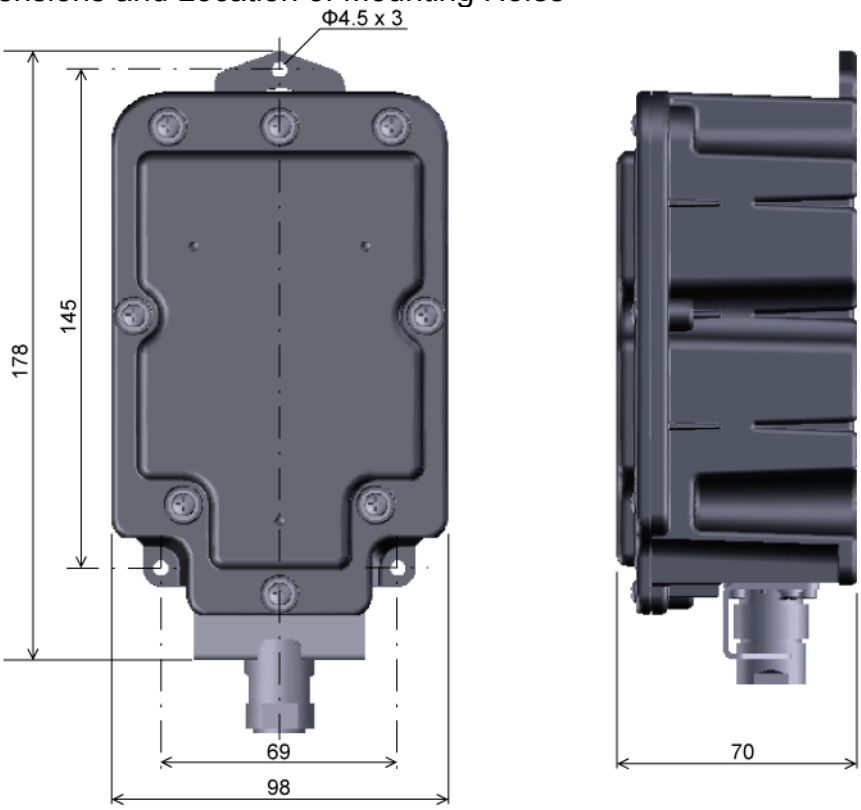


This unit is able to connect the encoder backup battery embedded the robot from outside the robot, and enables easy replacement of encoder backup batteries.

Ingress Protection code rating; IP54. The battery is sold separately. Three of mounting bolts (M4*12) are included. Use these bolts to fix the robot to facilities.



[1] External Dimensions and Location of Mounting Holes



[2] Setup Procedure

To setup the external battery extension unit, follow the process below.

NOTE

The External battery extension unit does not include batteries in shipment. Do not connect this unit to the robot without battery installation.

Be sure to install the external battery extension unit after robot setting has completed.

Removing the external battery extension unit causes the loss of battery supply to the encoder, and then will result in a loss of data.

When installation, Set the unit to the wall (vertical surface) and be sure to place the cable on the underside.

STEP 1

Open the lid.

STEP 2

Connect the battery (sold separately) to connector.

STEP 3

Replace the battery holder and the lid.

NOTE

Confirm the direction of the battery holder so as not to mistake the upside and the downside. Install the battery holder so as to the triangle mark is upside.

Attach the lid carefully not to damage the O-ring.

STEP 4

Connect the cable of the external battery extension unit to the connector panel of the robot.

STEP 5

Remove the encoder backup battery of the robot body.

Refer to" Replacing the encoder backup batteries"

NOTE

Using both the encoder backup battery of the robot and the external battery extension unit together may cause the battery leakage.

STEP 6

Be sure to input the next battery replacement date of the encoder backup battery.

[3] Precaution for the External Battery Extension Unit.

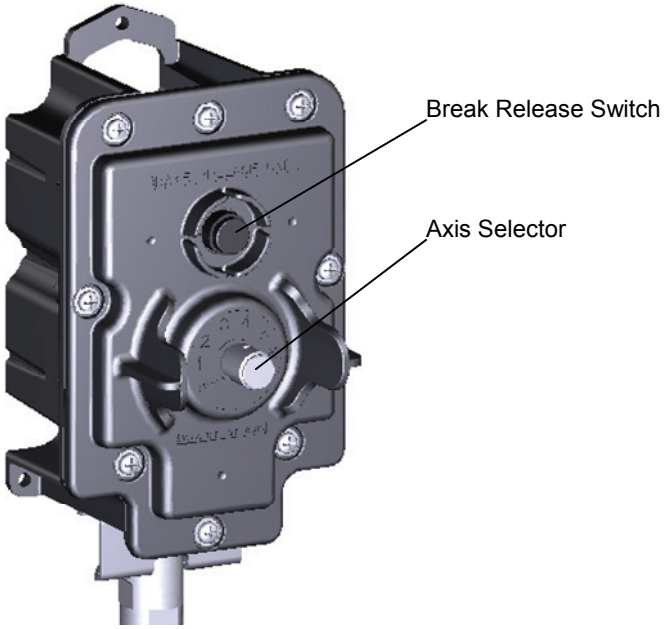
Do not mix new batteries and old batteries when replacing the batteries of the external battery extension unit.

In case of replacing batteries, avoid conditions that all the batteries are unconnected. Install new batteries first by using auxiliary connector, then remove the old batteries.

In the event of removing the external battery extension unit from the robot, such as transportation, relocation and removing, make sure to reinstall the encoder backup battery of the robot body. Removing the external battery extension unit without the reinstallation of the encoder backup battery causes the loss of encoder data. Make sure to confirm the installation of the encoder backup battery before removing the external battery extension unit.

To avoid the loss of encoder data, do not break or damage the cable.

8.5.2 Brake Release Unit



While the brake release switch is held down, the brake of the axis selected by the axis selector is released.

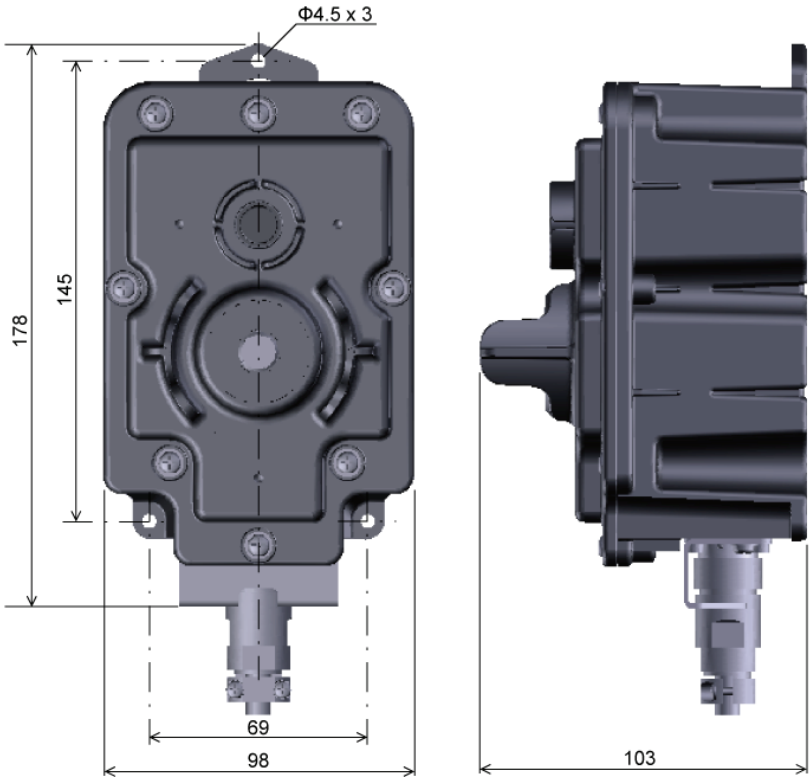
NOTE

Brakes are able to be released only when the controller power is ON.

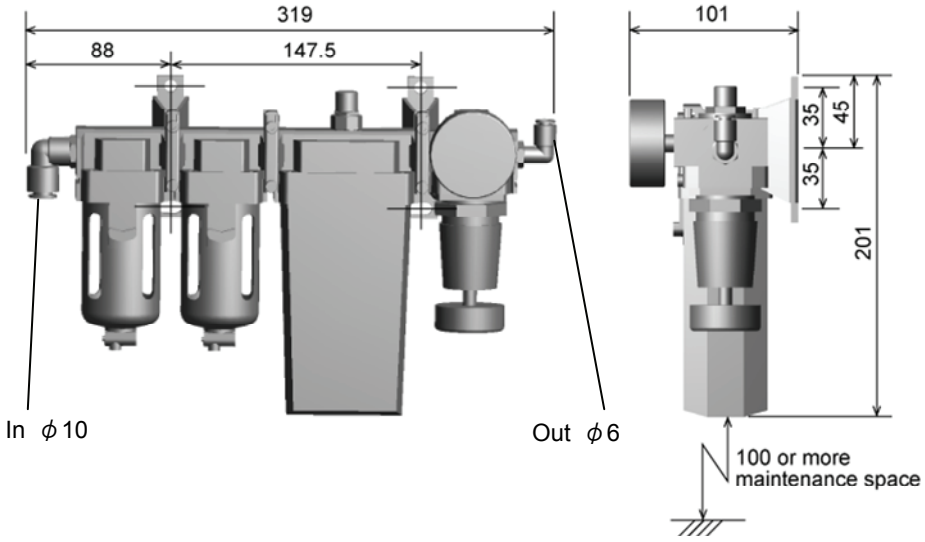
Do not turn the axis selector with the brake release switch being held down.

Ingress Protection code rating; IP54. The battery is sold separately. Three of mounting bolts (M4*12) are included. Use these bolts to fix the robot to facilities.

External dimensions and location of mounting holes



8.5.3 Air Purge Unit



Specifications

Range of operating conditions

Applicable fluid	Compressed air
Maximum operating pressure	0.85 MPa
Minimum operating pressure	0.3 MPa
Ambient and fluid temperature	-5 to 55°C (Freezing not allowed)

Reference performance

Atmospheric dew point of outlet air	20°C

Reference performance conditions

Inlet air flowrate	128 L/min (ANR)
Outlet air flowrate	100 L/min (ANR)
Purging air flowrate	25 L/min (ANR)
Inlet air pressure	0.7 MPa
Inlet air temperature	25°C
Saturation temperature of inlet air	25°C
Ambient temperature	25°C
Purge air flowrate of dew point checker	1 L/min (ANR) (when the inlet air pressure is 0.7 MPa)
Filtration degree of micromist separator	0.01 μm (Efficiency 99.9%)
Air consumption of precision pressure reducing valve	3 L/min (ANR) (when the inlet air pressure is 0.7 MPa)
Air consumption of precision pressure reduction valve	0.005 to 0.2 MPa
Mass	1.9 kg

ANR (Atmosphere Normale de Reference) refers to quantity of air at 20°C under atmospheric pressure.

⚠CAUTION

The air purge unit is not splashproof. Place it in a place where it will not be subjected to water.

Vertical Articulated Robot
VS-*** Series

INTRODUCTION GUIDE TO ROBOT

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The purpose of this manual is to provide accurate information in the handling and operating of the robot. Please feel free to send your comments regarding any errors or omissions you may have found, or any suggestions you may have for generally improving the manual.

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