

**Kawasaki Robot
MC Series**

**Installation and
Connection Manual**

Robot

Kawasaki Heavy Industries, Ltd.

Preface

This manual describes installation and connection procedures for Kawasaki Robot MC Series.

Read and understand the contents of this and safety manuals thoroughly and strictly observe all rules for safety before proceeding with any operation. Note that this manual only provides descriptions of the installation and connection procedures for the arm. For the controller, see the "Installation and Connection Manual" of the controller.

Again, do not perform any kind of work until you fully understand all of the contents of this manual. Also, Kawasaki is not responsible for damages or problems that occur as a result of performing work after referring to specific pages only.

This manual is applicable to the following robot arms.


MC004N, MC004V

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1. This manual does not constitute a guarantee of the systems in which the robot is utilized. Accordingly, Kawasaki is not responsible for any accidents, damages, and/or problems relating to industrial property rights as a result of using the system.
 2. It is recommended that all personnel assigned for activation of operation, teaching, maintenance or inspection of the robot attend the necessary education/training course(s) prepared by Kawasaki, before assuming their responsibilities.
 3. Kawasaki reserves the right to change, revise, or update this manual without prior notice.
 4. This manual may not, in whole or in part, be reprinted or copied without the prior written consent of Kawasaki.
 5. Store this manual with care and keep it available for use at any time. If the robot is reinstalled or moved to a different site or sold off to a different user, attach this manual to the robot without fail. In the event the manual is lost or damaged severely, contact Kawasaki.
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Symbols

The items that require special attention in this manual are designated with the following symbols.


Ensure proper and safe operation of the robot and prevent physical injury or property damages by complying with the safety matters given in the boxes with these symbols.

 **DANGER**

Failure to comply with indicated matters can result in imminent injury or death.

 **WARNING**


Failure to comply with indicated matters may possibly lead to injury or death.

 **CAUTION**

Failure to comply with indicated matters may lead to physical injury and/or mechanical damage.

[NOTE]

Denotes precautions regarding robot specification, handling, teaching, operation, and maintenance.

 **WARNING**

- 1. The accuracy and effectiveness of the diagrams, procedures, and detail explanations given in this manual cannot be confirmed with absolute certainty. Should any unexplained questions or problems arise, contact Kawasaki.**
- 2. Safety related contents described in this manual apply to each individual work and not to all robot work. In order to perform every work in safety, read and fully understand the safety manual, all pertinent laws, regulations and related materials as well as all the safety explanation described in each chapter, and prepare safety measures suitable for actual work.**

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1 Precautions

1.1 Precautions During Transportation, Installation and Storage

When transporting the Kawasaki Robot to its installation site, strictly observe the following cautions.



WARNING

1. When the robot arm is to be transported by using a crane or forklift, never support the robot arm manually.
2. During transportation, never climb on the robot arm or stay under the hoisted robot arm.
3. Prior to installation, turn OFF the controller power switch and the external power switch for shutting down power supply to the controller. Display signs indicating clearly “Installation and connection in progress”, and lock out/tag out the external power switch to prevent accidents of electric shock etc. caused when someone accidentally turns ON the power.
4. Prior to moving robot, ensure safety by first confirming no abnormality is observed in installing condition, etc., and then turn ON motor power to set robot to the desired pose. Be careful not to be caught by/between any moving parts due to careless approach to robot and peripheral equipment. After setting robot to the specified pose, turn OFF the controller power and the external power switch again as mentioned above. Display signs indicating clearly “Installation and connection in progress”, and lock out/tag out the external power switch before starting installation and connection.



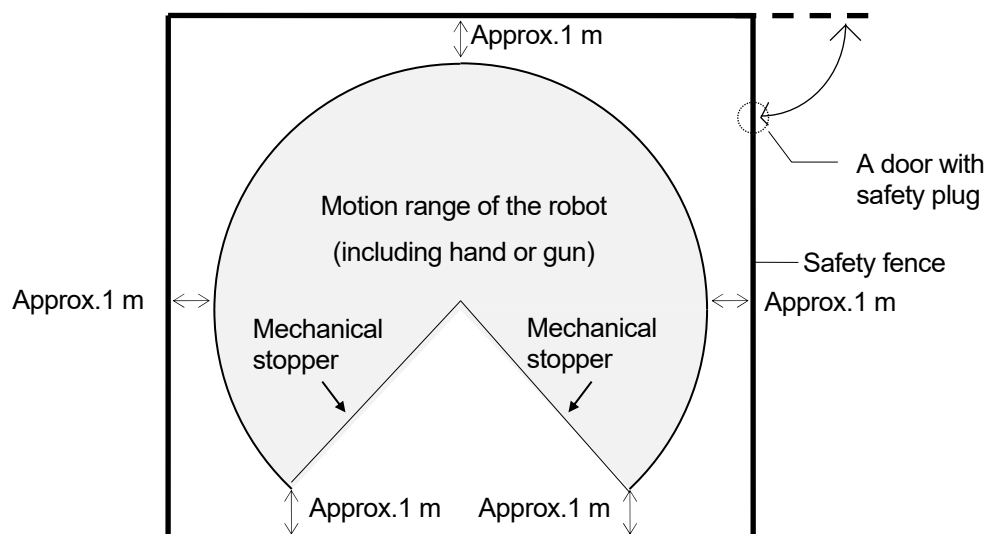
CAUTION

1. Since the robot arm is composed of precision parts, be careful not to apply excessive shocks or vibrations during transportation.
2. Prior to installation, remove all obstacles so the installation is carried out smoothly and safely. Clear a passage to the installation area for transportation of the robot arm using a crane or forklift.
3. During transportation and storage,
 - (1) Keep the ambient temperature within the range of minus 10 to 60°C,
 - (2) Keep the relative humidity within the range of 35 to 85% RH without dew condensation,
 - (3) Keep free from excessively strong shock and vibration.

1.2 Installing Environment of Robot Arm

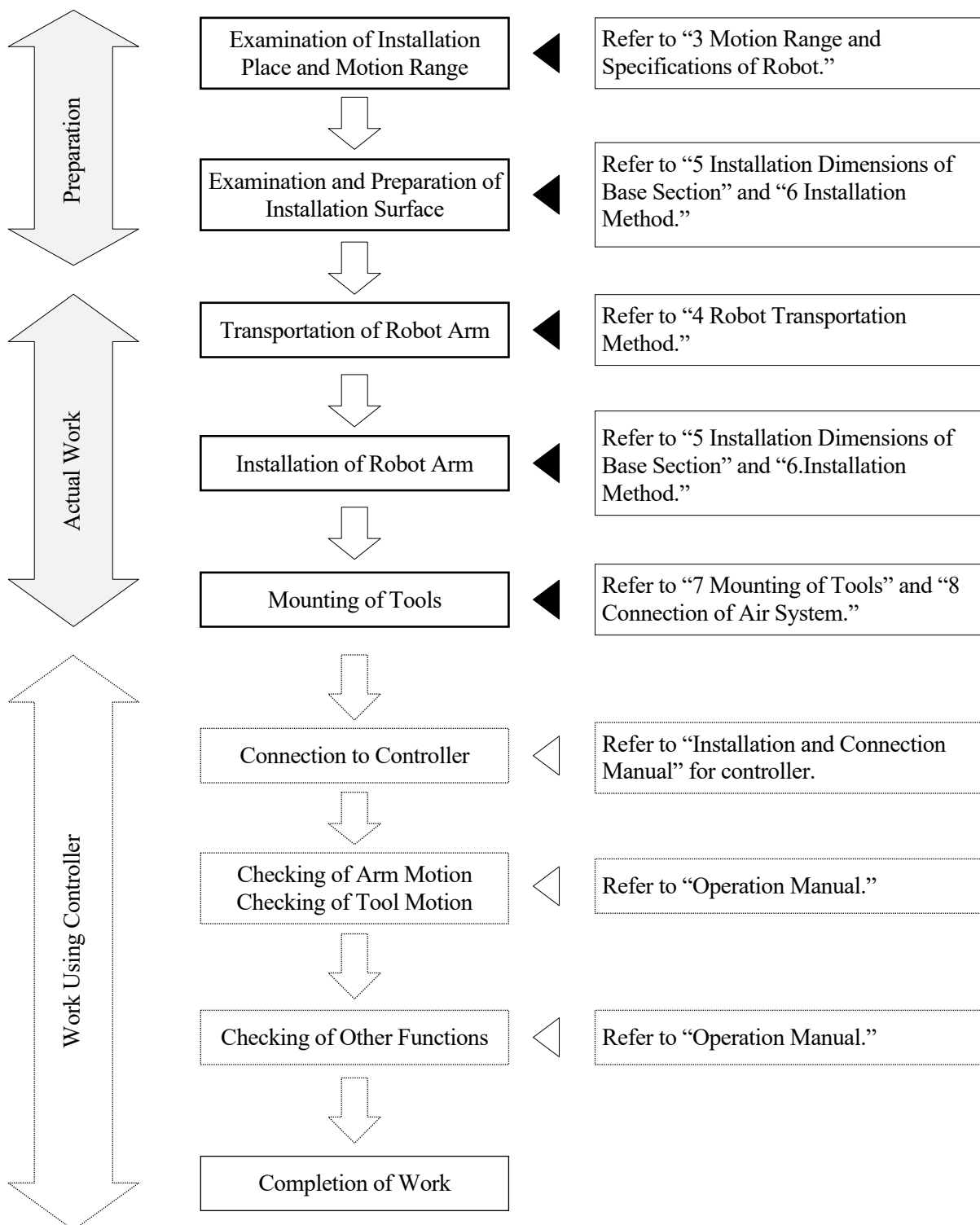
The robot arm must be installed in a place that satisfies all the following environmental conditions:

1. When robot is installed on the floor, the levelness must be within $\pm 5^\circ$.
2. Be sure that the installation floor/pedestal has sufficient rigidity. (Natural frequency: 30 Hz or more)
3. Secure a flatness to prevent undue force applied to the installation section. (If sufficient flatness is unobtainable, insert liners and adjust the flatness.)
4. Keep the ambient temperature during operation within the range of 10 to 35°C.
(Deviation or overload error may occur due to high viscosity of grease/oil when starting operation at low temperatures. In such cases, move the robot at low speeds before operating.)
5. Keep the relative humidity during operation within the range of 35 to 85%RH without dew condensation.
6. The robot installing place should be free from dust, dirt, oil, smoke, water, and other foreign matters. (MC series conforms to the IP65 dust and water protection ratings (IP67 for the wrist part).)
7. The robot installing place should be free from flammable or corrosive liquid or gas.*
*MC004V is compatible with the specific condition of hydrogen peroxide gas.
(Refer to "Standard Specifications" for the conditions.)
8. The robot installing place should be free from excessively strong vibration. (0.5 G or less)
9. The robot installing place should be free from electric noise interference.
10. The robot installing place should be sufficiently larger than the motion range of robot arm.
 - (1) Install safety fence so the maximum movement of fully equipped robot arm (with tools and workpiece) does not cause interference.
 - (2) Minimize the number of entrance gates (preferably only one) and equip the entrance gate with a safety plug.
 - (3) Observe the requirements of ISO 10218, etc. established in each region for details of the safety fence.



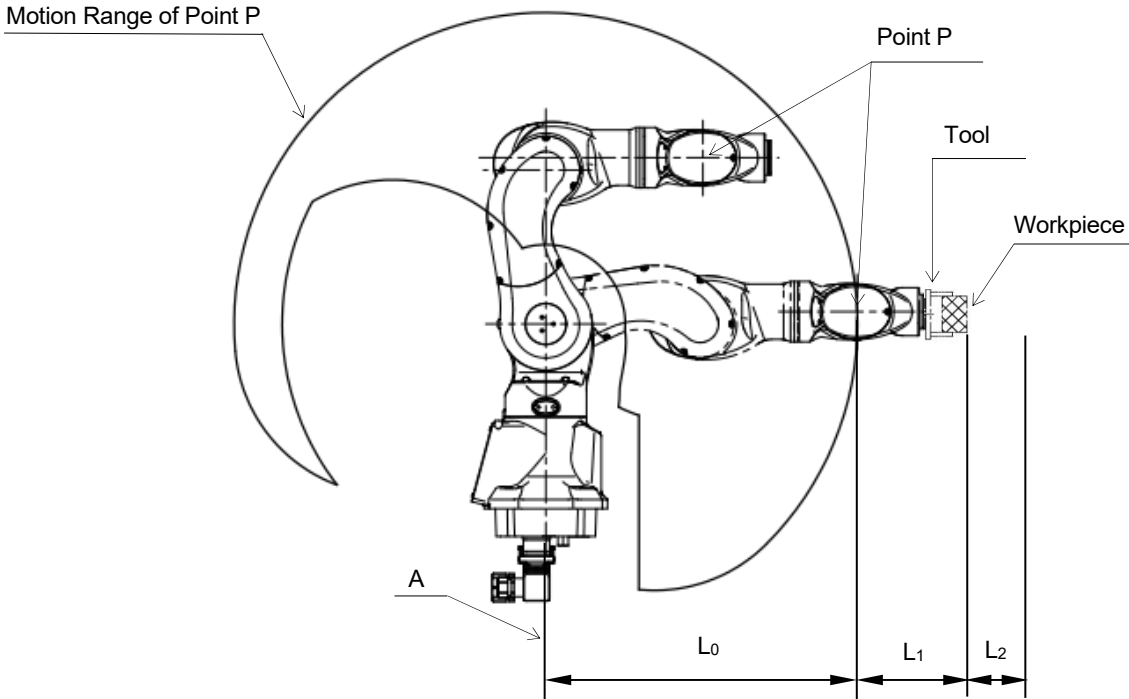
2 Work Flow at Arm Installation and Connection

This workflow describes only the robot arm section. See the controller's "Installation and Connection Manual" for more information regarding the controller.

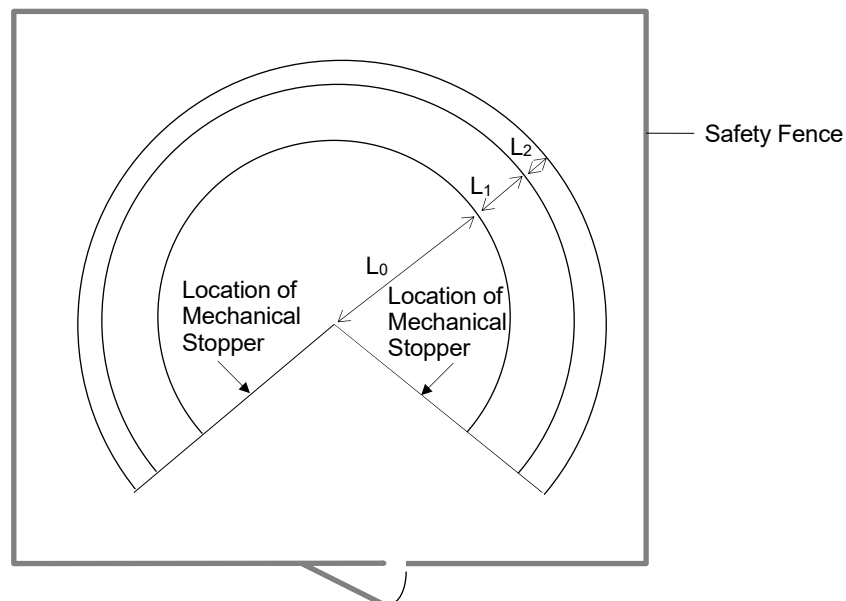


3 Motion Range and Specifications of Robot

3.1 Determination of Safety Fence Installation Location



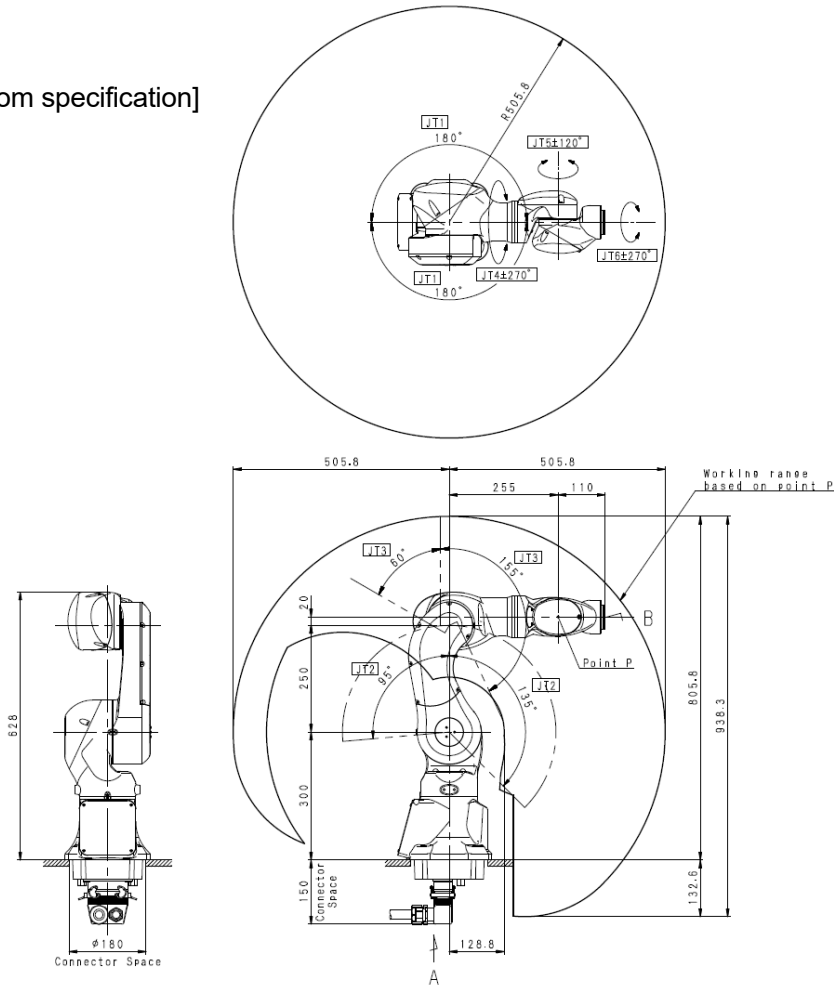
The motion range of the robot is represented by the maximum area that can be covered by point P in the figure above. Therefore, as shown in the figure below, install the safety fence outside circle whose radius is $L_0+L_1+L_2$, where L_0 is the length from the center line of arm (point A shown in the figure) to the farthest point of P, L_1 is the length from point P to the farthest point of wrist flange, tool and workpiece, and L_2 is safety margin. For the length of L_0 , refer to the drawings in the section 3.2.



3.2 Motion Range and Specifications of Robot

MC004N

[Connector bottom specification]



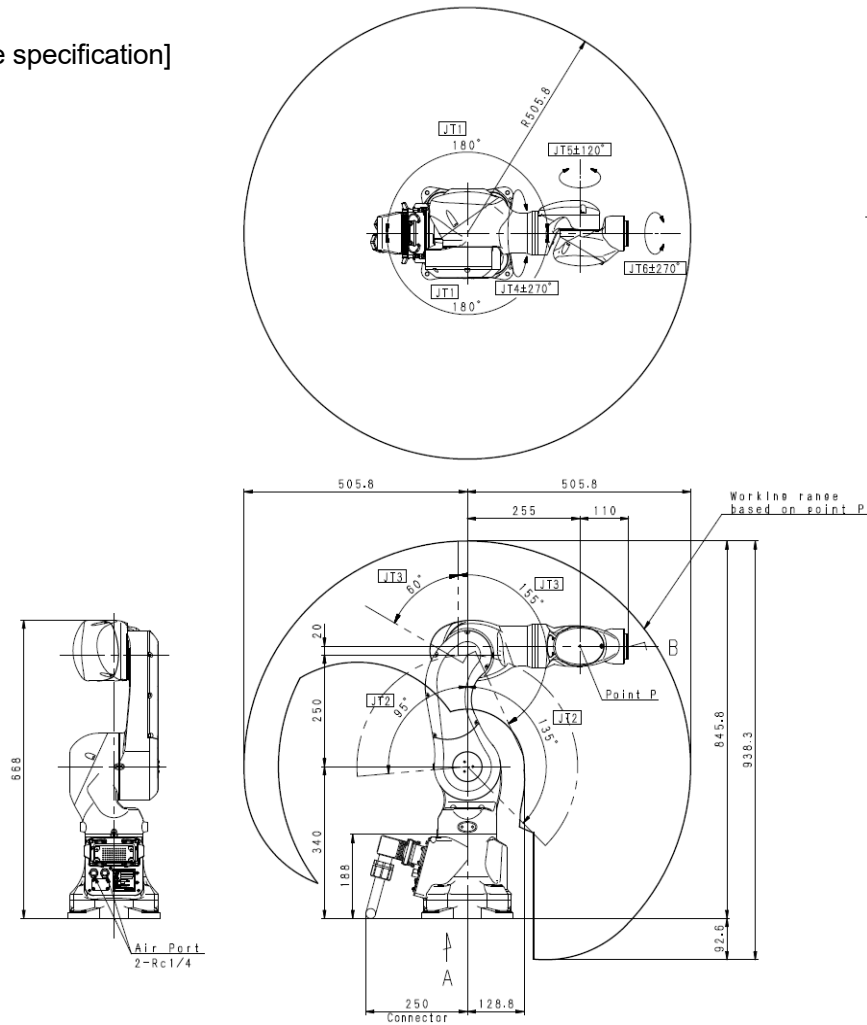
Type	Vertically articulated robot		
Degree of freedom	6		
Motion range and maximum speed	JT	Motion range	Max. speed
	1	±180°	200°/s
	2	+135° to -95°	180°/s
	3	+60° to -155°	225°/s
	4	±270°	700°/s
	5	±120°	500°/s
6	±270°	350°/s	
Max. payload	4 kg		
Wrist load capacity	JT	Torque	Moment of inertia
	4	8.5 N·m	0.2 kg·m ²
	5	8.5 N·m	0.2 kg·m ²
6	4.0 N·m	0.1 kg·m ²	
Repeatability	±0.028 mm		
Mass	25 kg		
Acoustic noise	<70 dB (A)*		

*Measured condition
 • fixed on the flat floor rigidly
 • 2,000 mm away from JT1 center

[The noise level depends on the conditions.]

MC004N

[Connector backside specification]



Type	Vertically articulated robot		
Degree of freedom	6		
Motion range and maximum speed	JT	Motion range	Max. speed
	1	±180°	200°/s
	2	+135° to -95°	180°/s
	3	+60° to -155°	225°/s
	4	±270°	700°/s
	5	±120°	500°/s
6	±270°	350°/s	
Max. payload	4 kg		
Wrist load capacity	JT	Torque	Moment of inertia
	4	8.5 N·m	0.2 kg·m ²
	5	8.5 N·m	0.2 kg·m ²
6	4.0 N·m	0.1 kg·m ²	
Repeatability	±0.028 mm		
Mass	25 kg		
Acoustic noise	<70 dB (A)*		

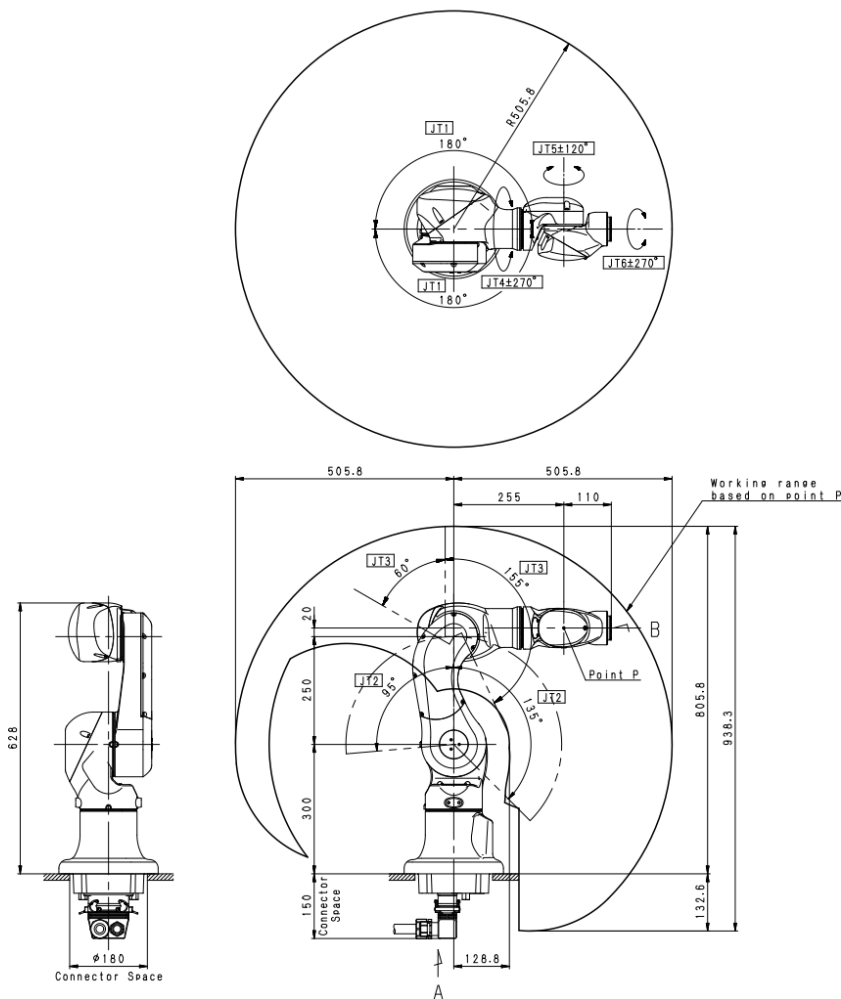
*Measured condition

- fixed on the flat floor rigidly
- 2,000 mm away from JT1 center

[The noise level depends on the conditions.]

MC004V

[Hydrogen peroxide gas sterilization specification]



Type	Vertically articulated robot		
Degree of freedom	6		
Motion range and maximum speed	JT	Motion range	Max. speed
	1	±180°	200°/s
	2	+135° to -95°	180°/s
	3	+60° to -155°	225°/s
	4	±270°	700°/s
	5	±120°	500°/s
6	±270°	350°/s	
Max. payload	4 kg		
Wrist load capacity	JT	Torque	Moment of inertia
	4	8.5 N·m	0.2 kg·m ²
	5	8.5 N·m	0.2 kg·m ²
6	4.0 N·m	0.1 kg·m ²	
Repeatability	±0.028 mm		
Mass	25 kg		
Acoustic noise	<70 dB (A)*		

*Measured condition
 • fixed on the flat floor rigidly
 • 2,000 mm away from JT1 center

[The noise level depends on the conditions.]

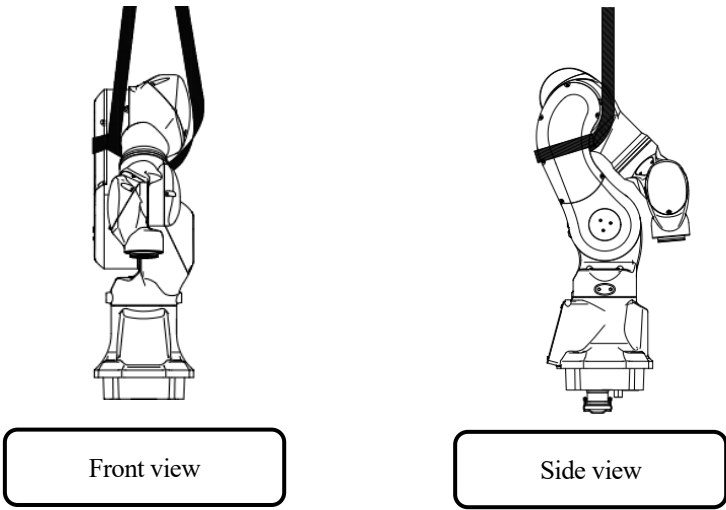
4 Robot Transportation Method

4.1 Using Wire Sling

For MC004N, there are no service tap holes for hoisting the robot with wire. Therefore, secure a belt around the rear arm to hoist up the robot.

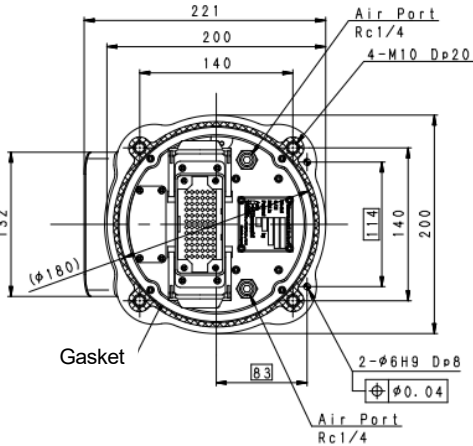
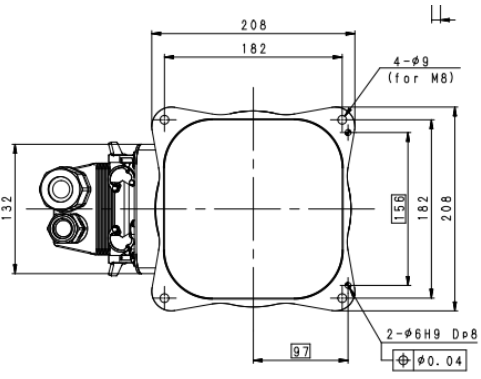
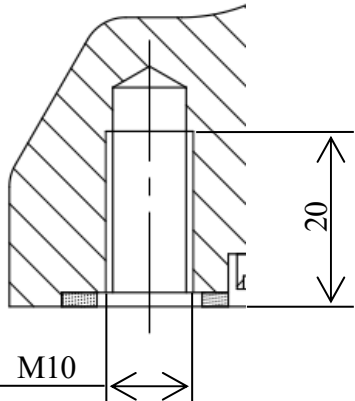
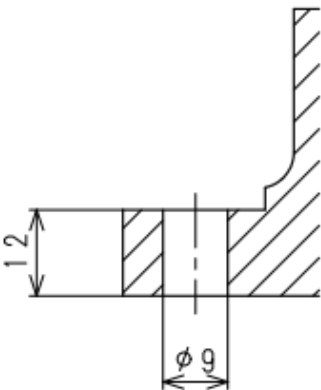
⚠ CAUTION

When hoisting up the robot, be careful as robot may lean forward/backward depending on robot posture and installation condition of the options. If the robot is hoisted up in an inclined posture, it may swing, damage or the wire may interfere with the harness, piping etc., or it may damage due to interfering with surrounding objects.

Hoisted up posture		
Hoisted up posture	JT1	0°
Hoisted up posture	JT2	-15°
Hoisted up posture	JT3	-150°
Hoisted up posture	JT4	0°
Hoisted up posture	JT5	-40°
Hoisted up posture	JT6	0°

5 Installation Dimensions of Base Section

When installing a robot, fix the base section with high tensile bolts through the bolt holes.

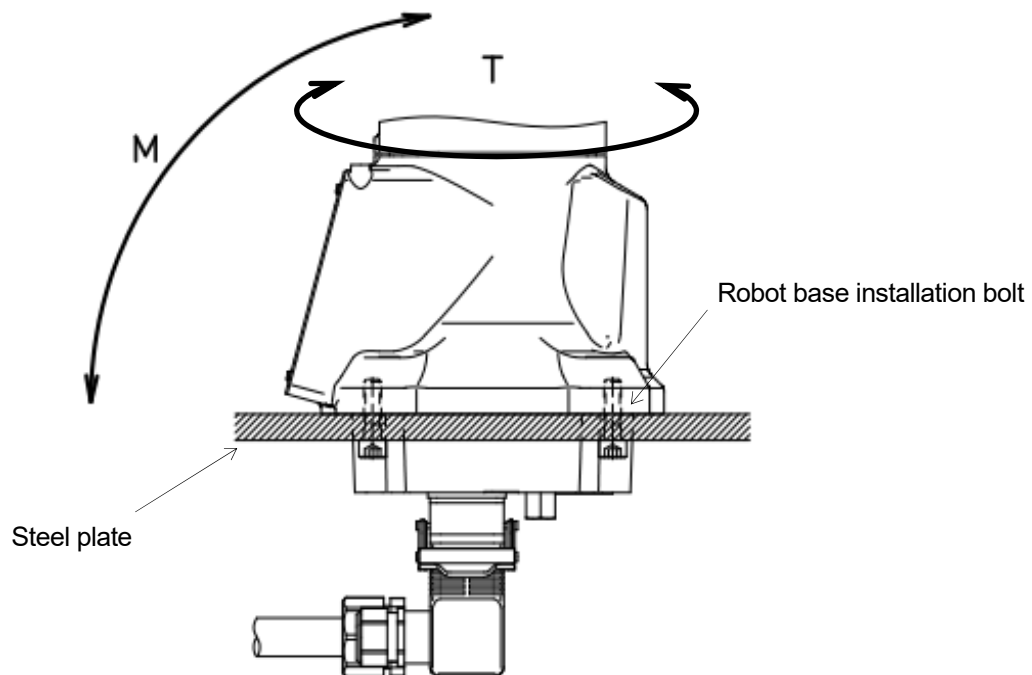
Model	MC004N (Connector bottom specification)	MC004N (Connector backside specification)
Dimensions for installation		
Cross-section of installation section		
Bolt holes	—	4-φ9
High tensile bolt	4-M10 Material: SCM435 Strength category: 10.9 or more	4-M8 Material: SCM435 Strength category: 10.9 or more
Tightening torque	57 N·m	29 N·m
Levelness	Within ±5°	Within ±5°

<p>Model</p>	<p>MC004V (Hydrogen peroxide gas sterilization specification)</p>
<p>Dimensions for installation</p>	
<p>Cross-section of installation section</p>	
<p>Bolt holes</p>	<p>—</p>
<p>High tensile bolt</p>	<p>4-M10 Material: SCM435 Strength category: 10.9 or more</p>
<p>Tightening torque</p>	<p>57 N·m</p>
<p>Levelness</p>	<p>Within $\pm 5^\circ$</p>

6 Installation Method

6.1 For MC004N Connector Bottom Specification and MC004V

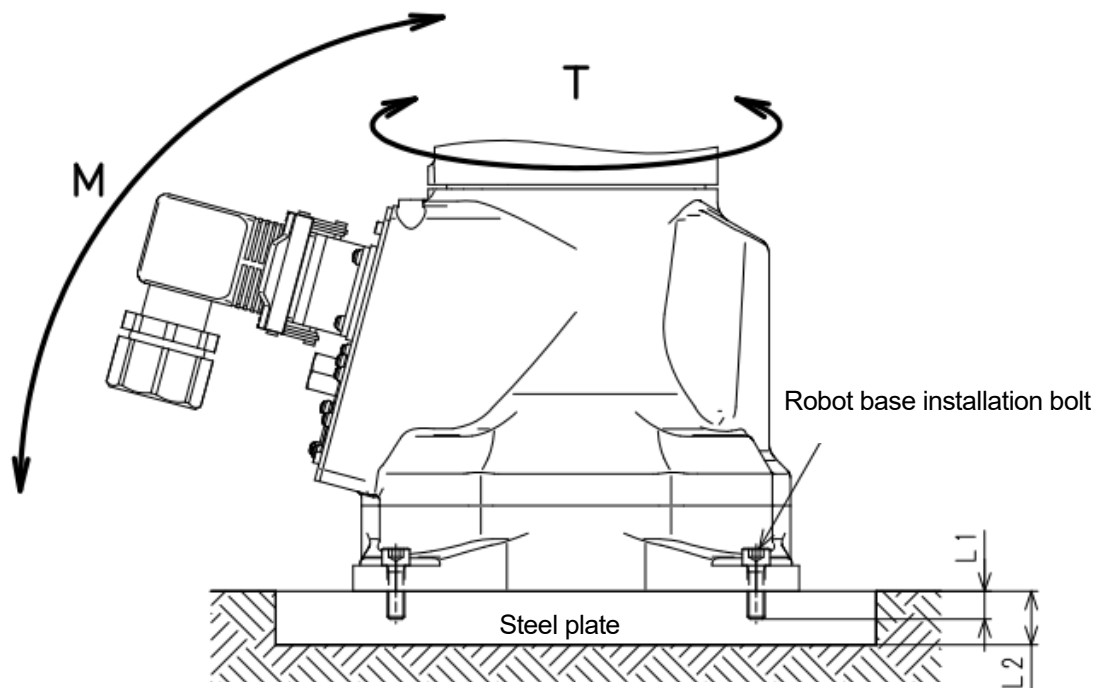
Fix the robot on the pedestal through steel plate of thickness of 17 mm or more as shown in the figure below. Fix the pedestal firmly enough to endure the reaction forces produced by the robot.



M (Inversion moment)	490 N·m
T (Rotating torque)	378 N·m
Robot base installation bolt	4-M10
Tightening torque	57 N·m
Thickness of steel plate	17 mm or more

6.2 For MC004N Connector Backside Specification

The connector backside specification is installed in almost the same way as when installing the robot base directly to the floor.



M (Inversion moment)	490 N·m
T (Rotating torque)	378 N·m
Robot base installation bolt	4-M8
Tightening torque	57 N·m
L1	15 mm or more
L2	17 mm or more

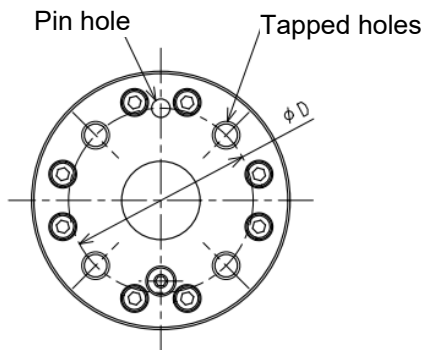
7 Mounting of Tools



WARNING

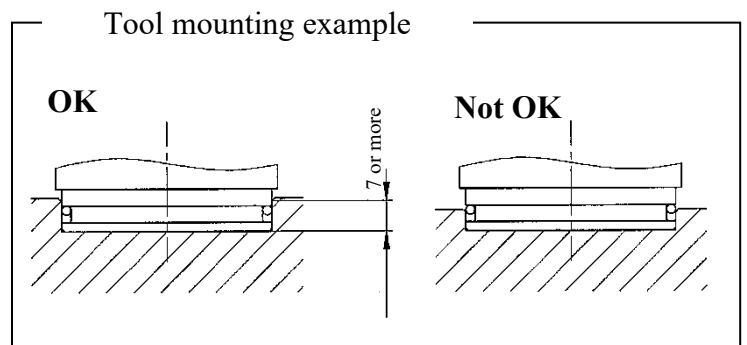
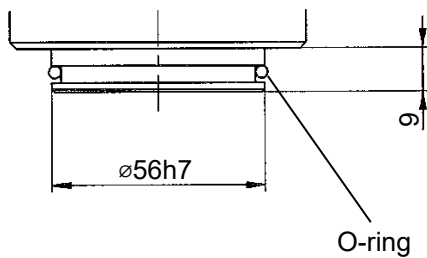
Prior to mounting tools on the robot, turn OFF the controller power switch and the external power switch. Display signs indicating clearly “Installation and connection in progress”, and lock out/tag out the external power switch to prevent accidents of electric shock etc. caused when someone accidentally turns ON the power.

7.1 Dimensions of Wrist End (Flange Face)

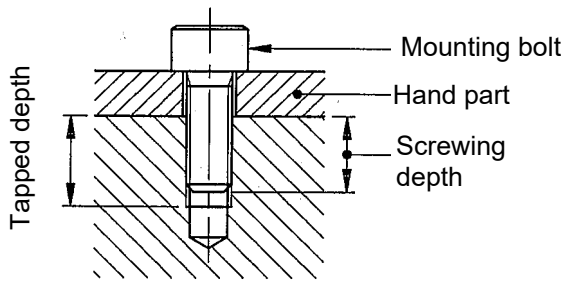


In the robot arm end section, a flange is provided on which hand, gun, or other tools are mounted. Screw the mounting bolts into the tapped holes on the circumference of ϕD on the flange, referring to the figure on the left.

Moreover, position the tool by utilizing the pin hole and the spigot hole. To keep the seal, keep the depth of the scribe mark (depth of the scribe mark minus the chamfered part) on the hand side deeper than 7 mm or more.



7.2 Specification of Mounting Bolt



Select mounting bolts with proper length to secure the specified screwing depth according to the tapped depth of tool mounting flange. Use high tensile bolts and tighten to the specified torque.



CAUTION

If the screwing depth has exceeded the specified value, the mounting bolt might touch the end of the screw hole, and the tool will not be fixed securely.

Tapped holes	4-M6
$\varnothing D$	$\varnothing 40$
Pin hole	$\varnothing 4H7$ Depth 6
Spigot hole	$\varnothing 56h7$
Tapped depth	7.5 mm
Screwing depth	5 to 7 mm
High tensile bolt	SCM435, 10.9 or more
Tightening torque	12 N·m

7.3 Load Capacity

The load mass capacity of the robot, including mass of hand and gun, is fixed for each robot type. Additionally, strictly observe the restrictions for load torque and load moment of inertia around each wrist axis (JT4, JT5, JT6) as shown below.

⚠ CAUTION

Using the robot beyond its specified load may result in degradation of movement performance and shortening of machine service life. The load mass includes the tool mass such as hand, tool changer, shock absorber, etc. If using the robot in excess of its load capacity, first contact Kawasaki without fail.

The load torque and the moment of inertia can be calculated by the expression below:

Calculation Expression

The diagram illustrates a robot wrist axis (JT6) with a load mass $M(kg)$ at a distance $L_6(m)$ from the axis. The load has a moment of inertia I_G around its center of gravity. The distance from the JT4(5) axis to the load center of gravity is $L_{4,5}(m)$.

Load mass : $M \leq M_{max}$. (kg)
(including tool)

Load torque : $T=9.8 \cdot M \cdot L$ (N·m)

Load moment of inertia : $I=M \cdot L^2+I_G$ (kg·m²)

M_{max} : Maximum load mass: See section 3.2.

L : Length from axis rotation center to load center of gravity.
(Unit: m) (See the figure)

L_6 : Length from JT6 axis rotation center to load center of gravity.

$L_{4,5}$: Length from JT4(5) axis rotation center to load center of gravity.

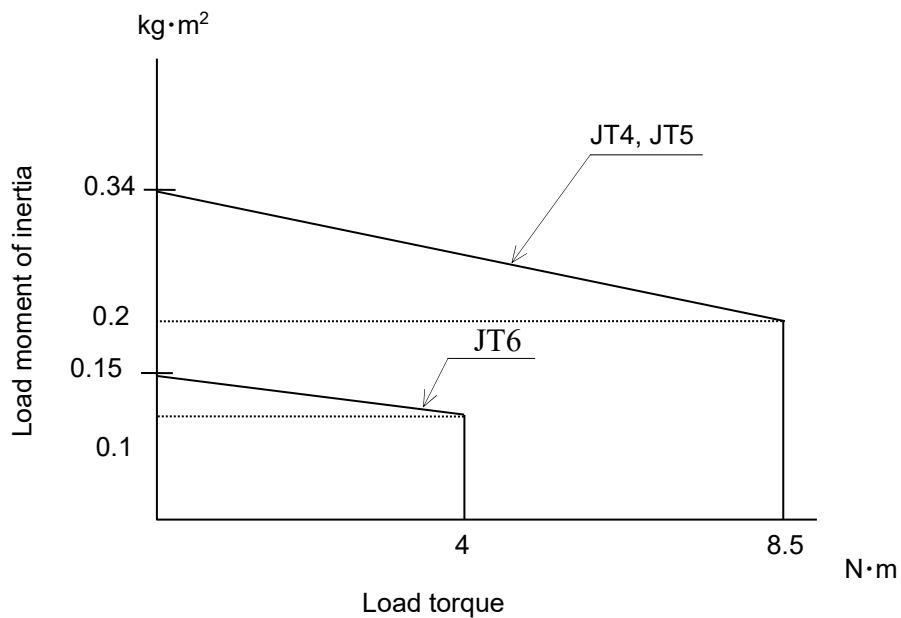
I_G : Moment of inertia around center of gravity. (Unit: kg·m²)

If calculation of load is made by dividing the load into construction parts, such as tools and workpieces, use the total calculation values of each part as load torque and moment of inertia.

Regarding the load on the robot wrist section, meet the following restriction conditions:

1. The load mass including tool mass should be 4 kg or less.
2. The load torque and the moment of inertia around each wrist axis (JT4, JT5, JT6) should be within the following restriction.* Keep the load torque and load moment of inertia around each axis within the allowable ranges shown in the figure below.

NOTE* Load moment of inertia exceeding the restriction may be acceptable. In this case, ensure to specify the load. (However, the robot movement may become slow because of optimizing acceleration and deceleration.) For the settings of the load, refer to "AS Language Reference Manual." Operating the robot with wrong settings may result in degradation of movement performance and shortening of machine service life.

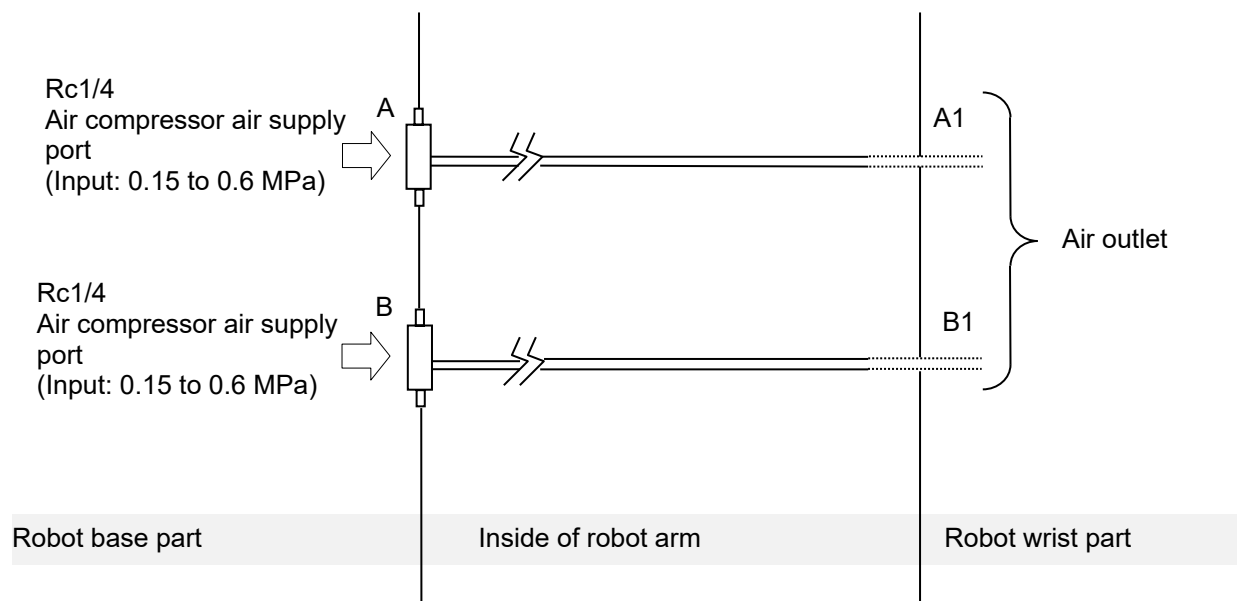


8 Connection of Air System

8.1 Air Piping Arrangement

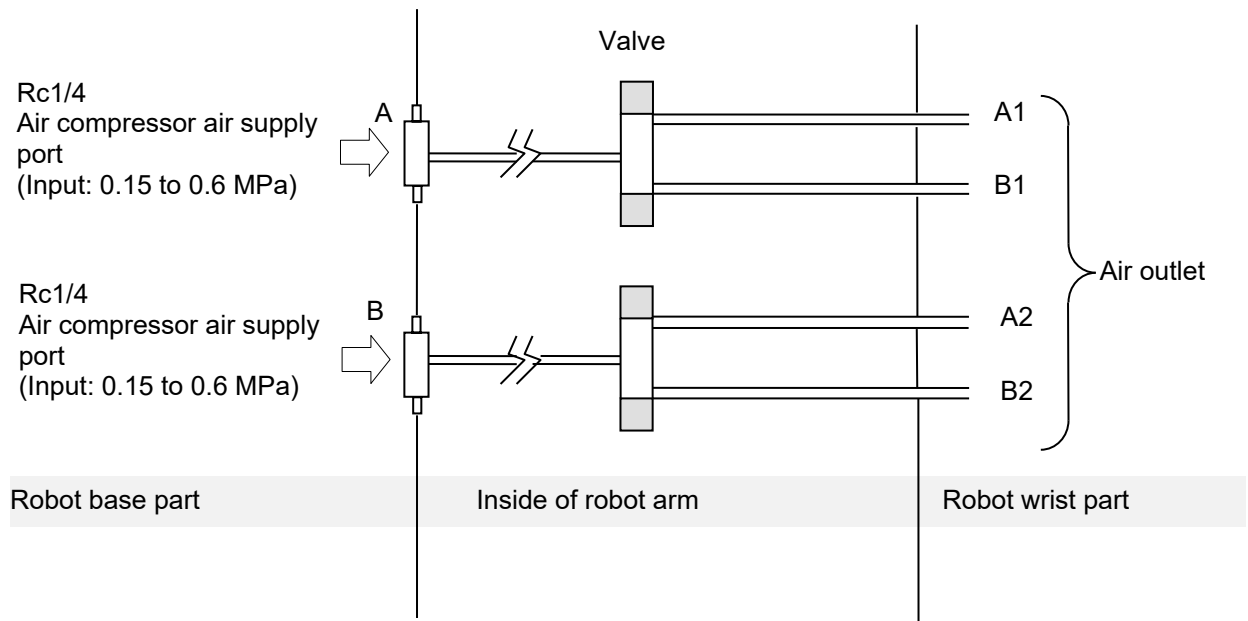
Standard: Without valves

MC series robot houses air piping and valves for driving the tool on the robot arm. For the air specifications, connect supply air to ports A and B in the base section.



Option: With valves

Valves can be integrated in the air system for driving the tools. The valves can be turned ON/OFF via Teach Pendant without using the interlock panel.



The specification for the integrated valves is as shown below.

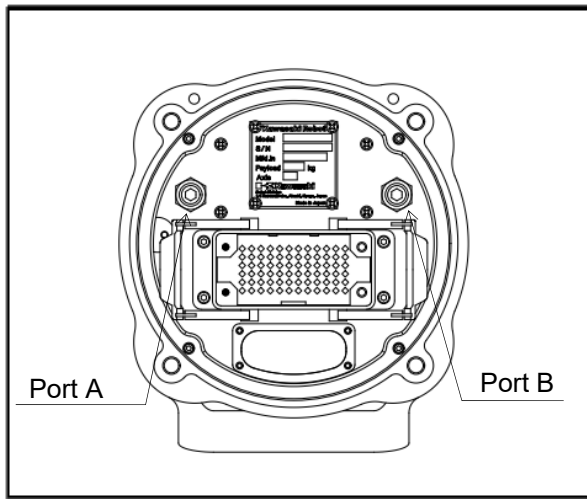
Standard	No integrated valve	
Option	Double solenoid/single solenoid	Total within 2 valves

Note Use valves of 0.2 Cv, 2-position specification.

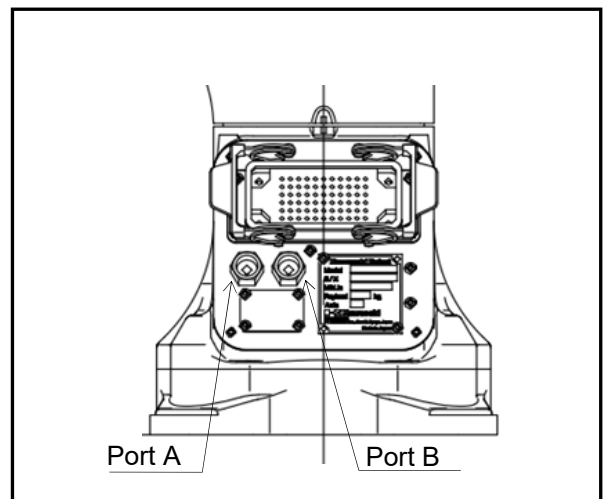
[NOTE]

Valves out of the above specification, cannot be integrated in the arm.
In this case, consult Kawasaki for the air system specification.

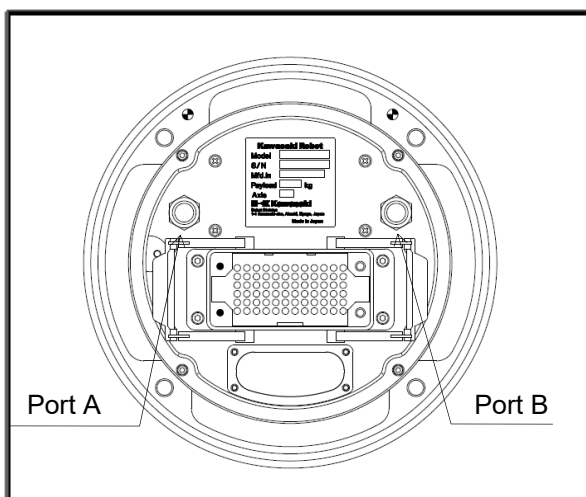
8.2 Air Supply to the Robot Arm



MC004N connector bottom specification



MC004N connector backside specification



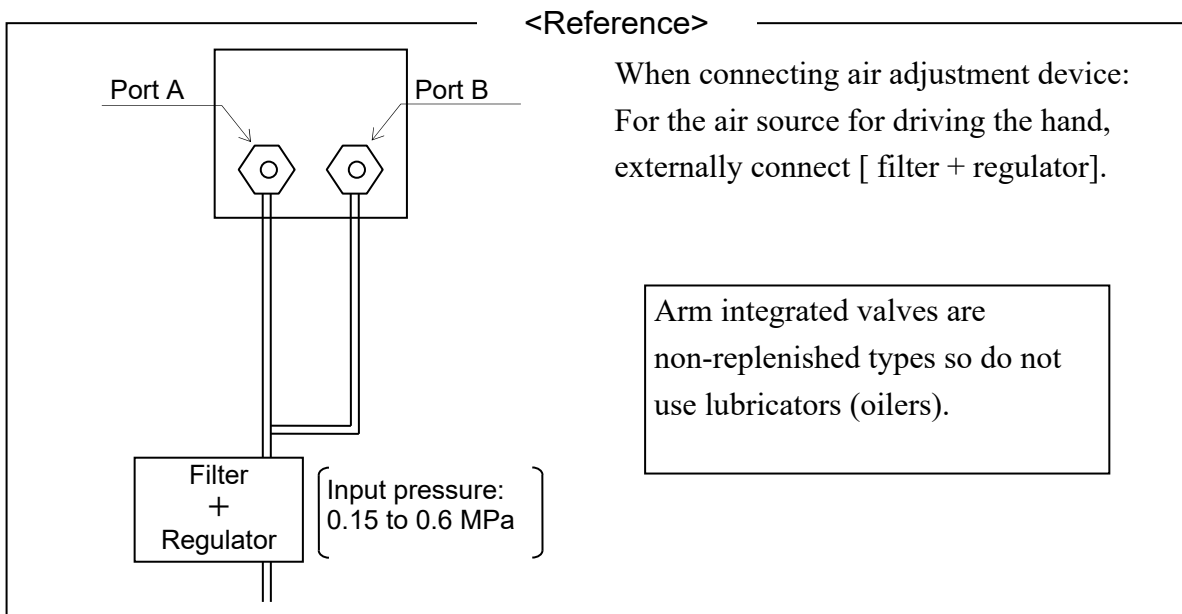
MC004V

The air connection port is on the robot arm base as in the figure above.



CAUTION

Supply input pressure; 0.15 to 0.6 MPa to the Ports A and B (Rc1/4).



9 Connecting an External Encoder Battery

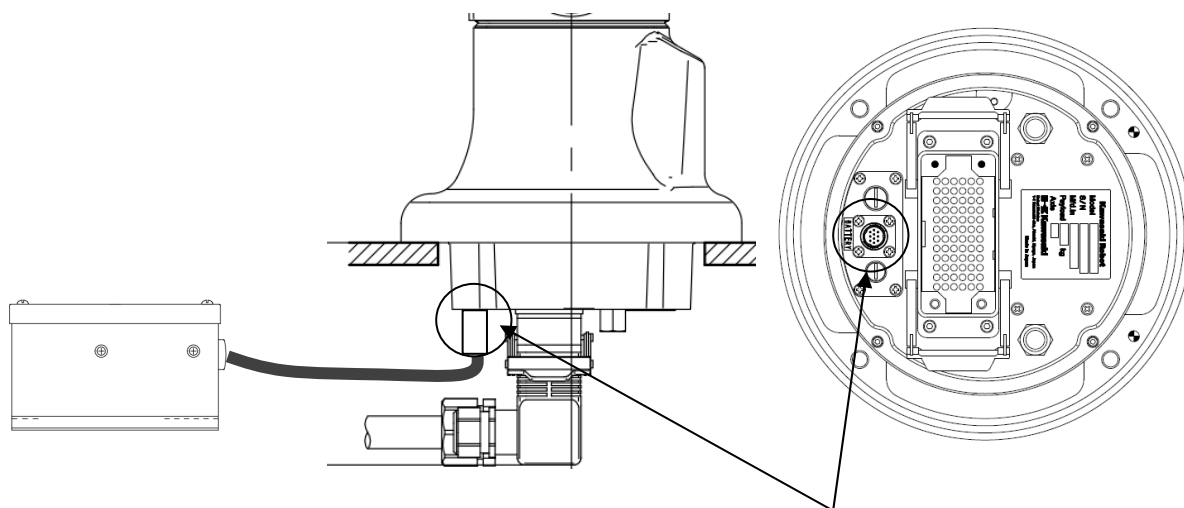


WARNING

When operating the connector for the external encoder battery, be sure to turn OFF the controller power and external power, and after clearly displaying that "Inspection and maintenance is in progress," lock out and tag out the external power switch so that an operator does not accidentally turn ON the power.

MC004V (hydrogen peroxide gas sterilization specification) has a connector in the connector space so that an encoder battery can be placed on the outside of the robot. The encoder battery is connected to the robot after shipment.

If there is interference when installing the robot, the battery can be temporary removed.



Encoder battery connector



WARNING

If the external encoder battery is removed for a long period of time (three hours or more), the multi-rotational data of the encoder may not be retained. Therefore, if the external encoder battery is removed, avoid leaving it for too long (one hour or less). If the battery has been removed for a long period of time, be sure to reset the encoder rotation counter before operating. (Refer to the "Zeroing and Motor Replacement Manual" for how to reset the encoder rotation counter.) If you move the robot without performing this operation, its origin point will not match the encoder origin point. This can cause unexpected movements that can be extremely dangerous.

Kawasaki Robot MC Series
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