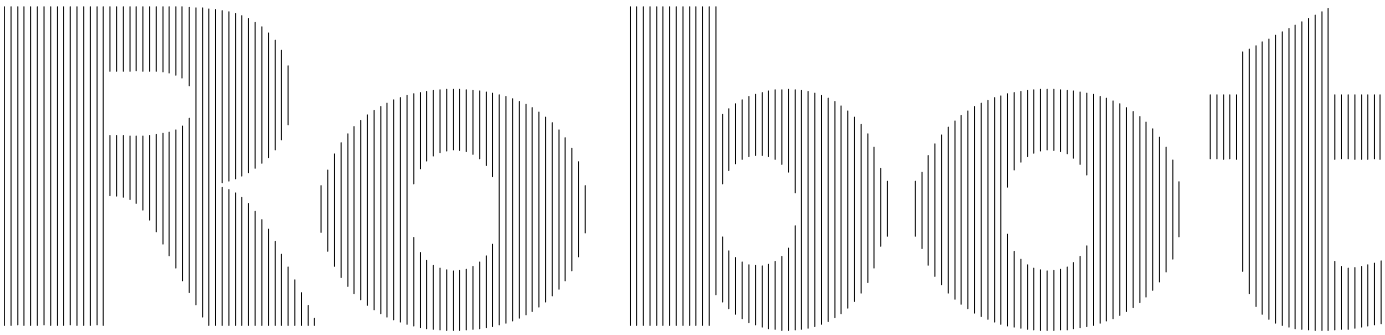
Simple and friendly

Kawasaki

Kawasaki Robot
BU015N (Ver. C)

Installation and Connection Manual



Kawasaki Heavy Industries, Ltd.

90202-1203DEB

Preface

This manual explains the installation and connection procedures for the Kawasaki Robot BU015N (Ver. C).

Please ensure sufficient understanding of the content of this manual, and take heed of the safety precautions described in this manual and the separately provided "Safety Manual" before performing any procedure. Note that this manual only provides descriptions of the installation and connection procedures for the arm. Also see the "Installation and Connection Manual" for 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.

The explanations in the manual are applicable to the following robots.
BU015N

1. This manual does not guarantee the operation of the system with which the robot is used. 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 be reprinted or copied, in whole or in part, 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.

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 damage 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, operation and maintenance.

⚠ WARNING

1. **The accuracy and effectiveness of the diagrams, procedures and detailed explanations given in this manual cannot be confirmed with absolute certainty. Therefore, should any unexplained questions or problems with work arise, please contact your nearest Kawasaki.**
2. **Safety related contents described in this manual apply to the specific matters described and not to all robot work. They are not applicable to other general items or other matters. In order to perform all work safely, read and fully understand the "Safety Manual," all pertinent laws, regulations and related materials as well as all the safety explanations in each chapter, and prepare safety measures suitable for actual work.**

Table of Contents

1 Precautions

1.1 Precautions during Transportation, Installation, and Storage

When transporting the Kawasaki robot to the installation location, observe the following precautions for transportation, installation, and storage.

⚠ WARNING

1. **When transporting the robot by crane or forklift, never allow a person to support it.**
2. **During transport never allow a person to ride on the robot, and never allow a person to get under it when it is suspended.**
3. **Before starting installation, be sure to turn OFF the controller power and external power switches, and after clearly displaying that "inspection and maintenance is in progress," lock out and tag out the external power switch so that an operator or third party does not accidentally turn ON the power, causing an unexpected situation such as electric shock.**
4. **When operating the robot, be sure to confirm safety points and absence of problems regarding robot installation before turning the motor power ON, and moving the robot arm to the designated posture. Take care not to approach the arm and become accidentally caught when doing so.**
   After setting the arm to the desired posture, turn OFF the controller power and external power again as mentioned above, clearly indicate that "inspection and maintenance is in progress," lock out and tag out the external power switch before starting work.

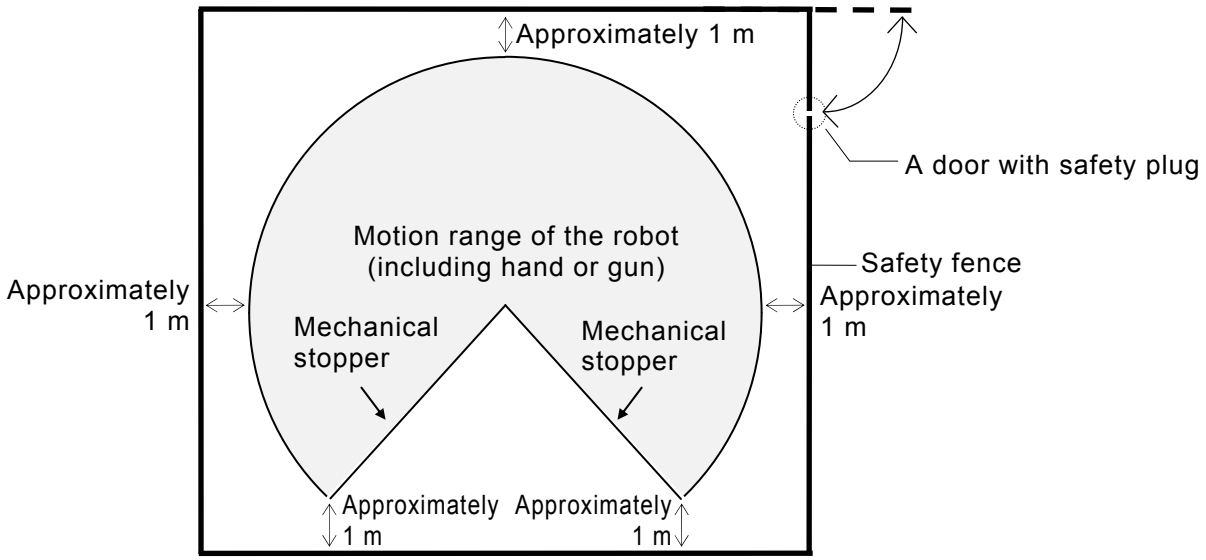
⚠ CAUTION

1. **The robot is made of precision parts. Be careful not to subject it to impact or shock during transport.**
2. **When transporting the robot, clear away obstructions, etc. in advance so that it can be transported safely to the installation location.**
3. **Please pay attention to the following points when transporting or storing the unit.**
   (1) Maintain an ambient temperature within the -10°C to 60°C range.
   (2) Maintain a relative humidity within the 35% to 85% RH range (without any dew condensation).
   (3) Avoid large vibrations or shocks.

1.2 Installation Environment

Install the robot arm in a location that satisfies the following conditions.

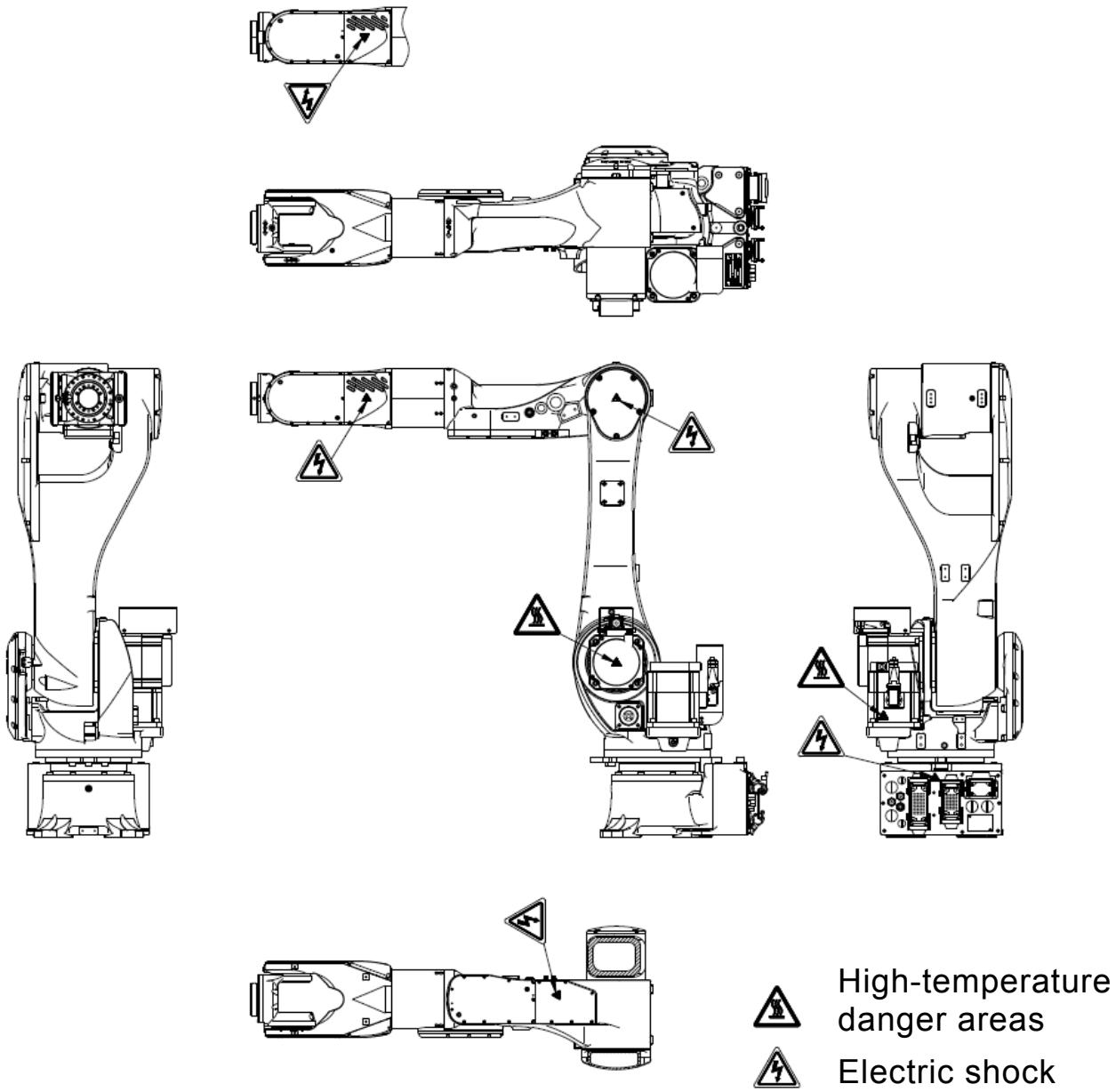
1. For floor-standing installation, the location must be capable of maintaining a horizontal surface within ±5°.
2. The floor and frame must have adequate hardness.
3. The location must be able to maintain flatness so that excess force is not exerted on the installed part.
   (If flatness cannot be ensured, adjust with a liner.)
4. The ambient operating temperature must be between 0°C and 45°C.
   (Starting in low temperatures increases the viscosity of grease and oil, which can lead to deviation errors and excess loads. In such cases, move the robot at low speeds before operating.)
5. The relative humidity must be between 35% and 85% RH. In addition, there must not be any dew condensation.
6. The location must have little dirt, dust, oil, smoke or water, etc.
7. The location must have no flammable or corrosive fluids or gases.
8. The location must not be subject to large vibrations. (0.5 G or less)
9. The location must be well protected against electrical noise.
10. The location must safeguard a space that is larger than the robot arm's range of motion.
    (1) Install a safety fence around the robot, and make sure that it does not interfere with surrounding equipment, even when the arm has a hand or gun attached and is extended to its maximum motion range.
    (2) Minimize the number of entrance gates in the safety fence (only one is best) and equip the entrance gate with a safety plug. Enter and exit the fence from here.
    (3) For details concerning safety fences, observe the ISO 10218 requirements.



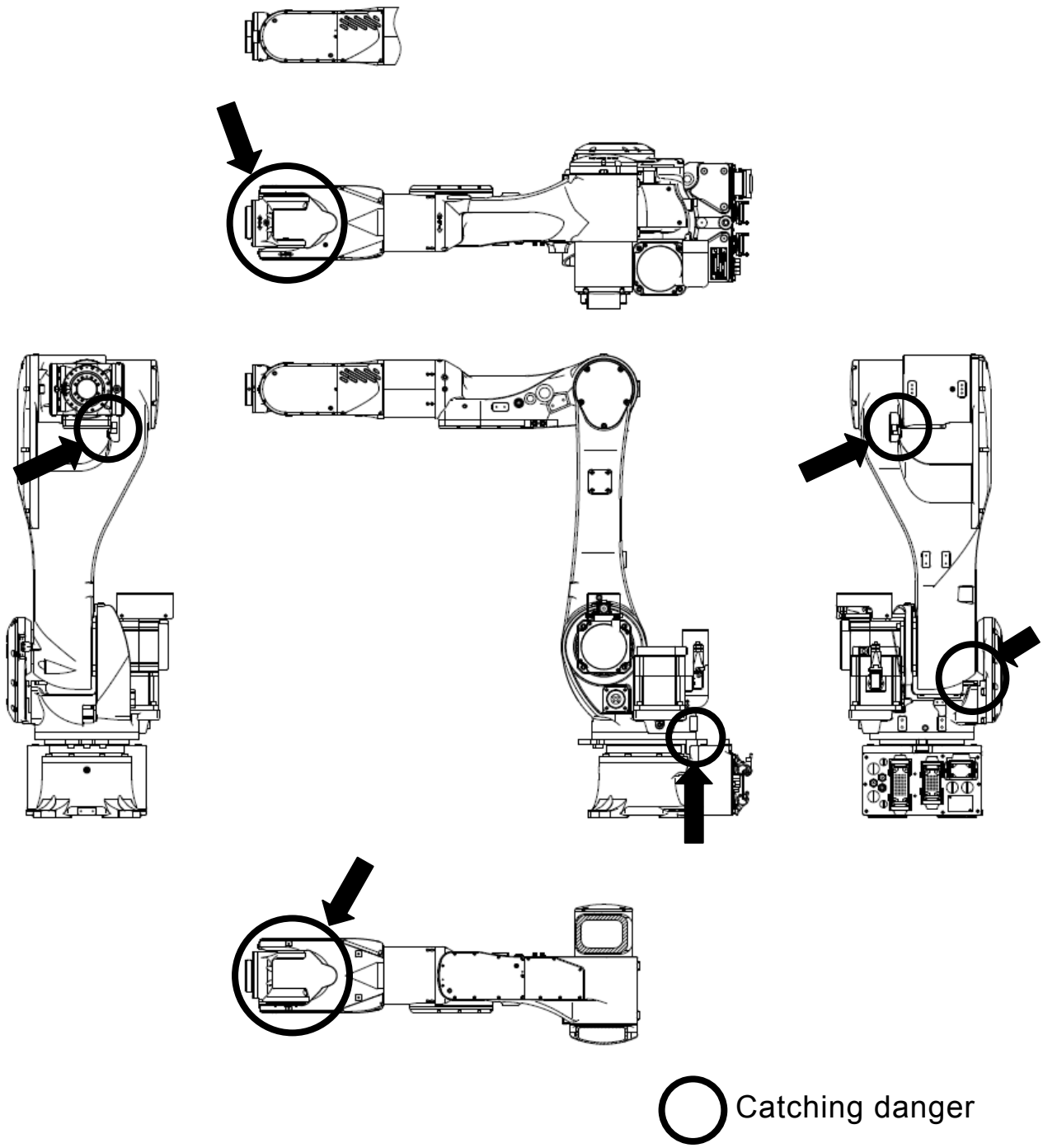
1.3 Residual Risk When Operating

WARNING

Pay attention to the residual risk areas described in the figures below during operation.



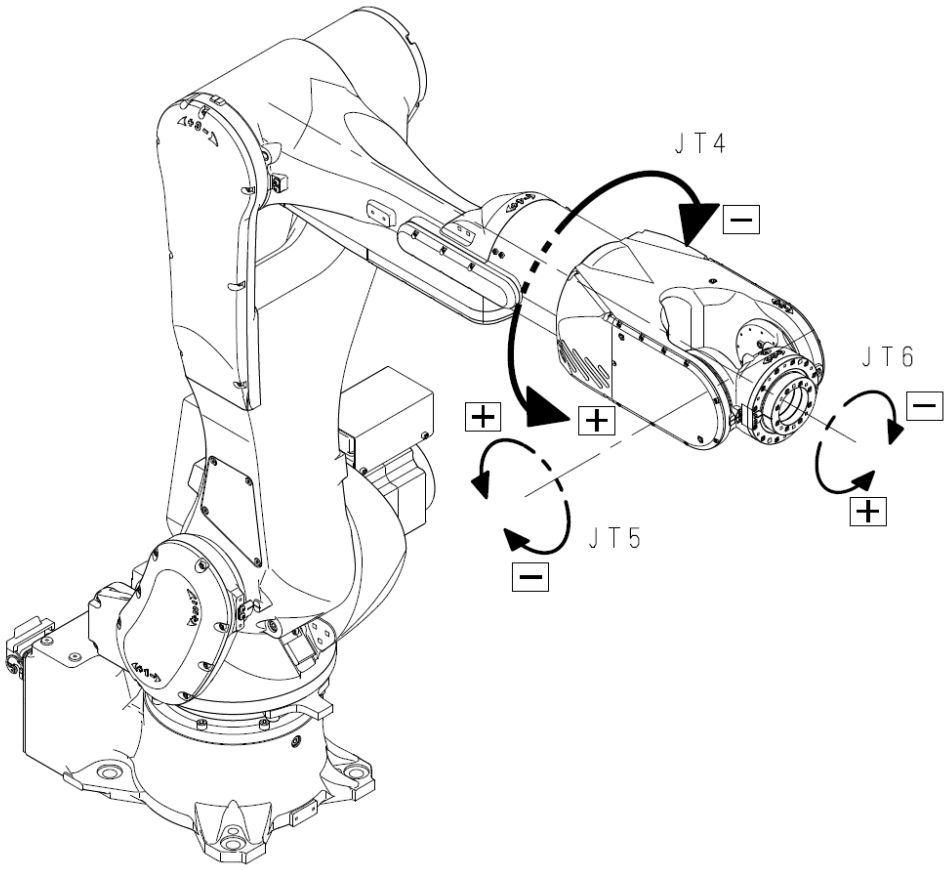
Catching danger



1.4 Precautions for Axis Used by the Harmonic Drive Reducer

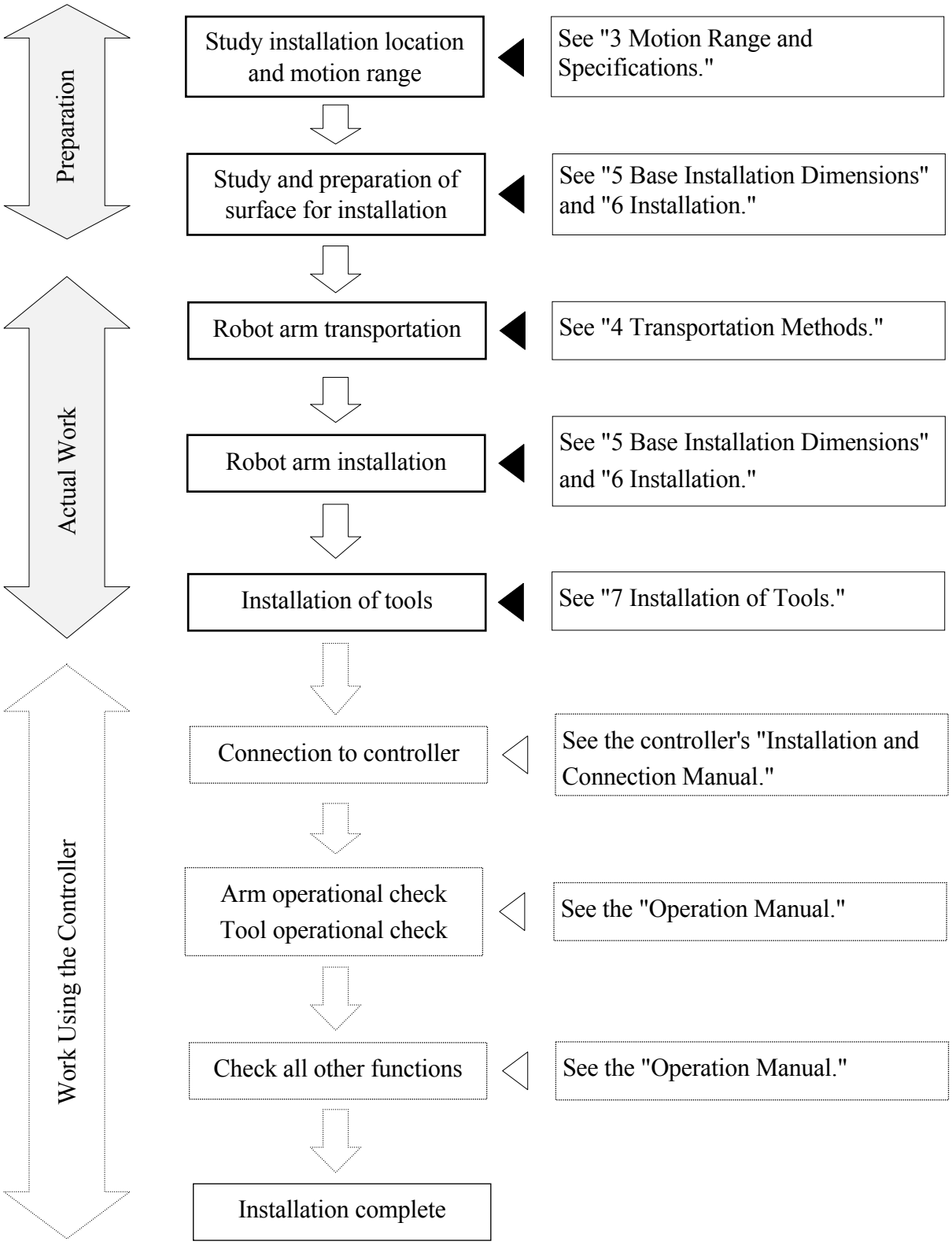
The Harmonic Drive reducer is used as a reducer for JT4, JT5, and JT6.

The Harmonic Drive reducer may vibrate due to resonance depending on the posture or speed of the robot. When vibration occurs, change the teaching for the posture or speed, etc., to avoid resonance.



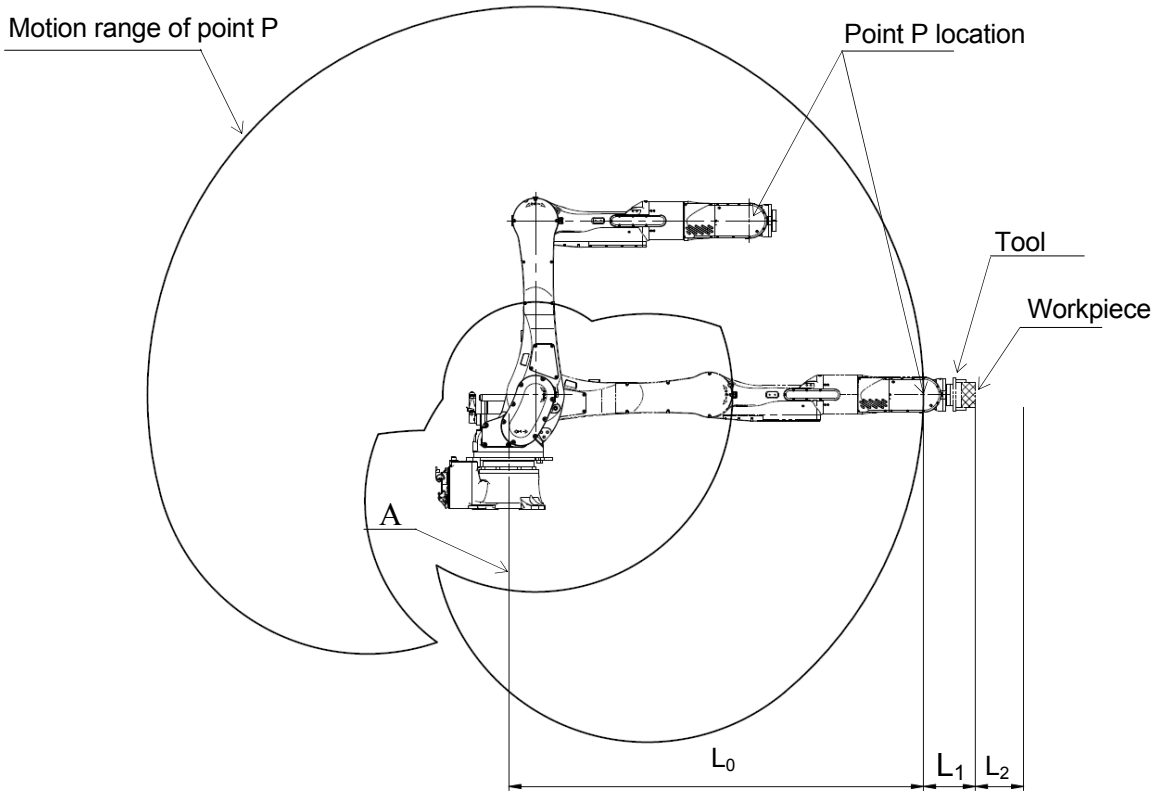
2 Arm Installation and Connection Work Flow

The work flow described here is for the robot arm only. See the controller's "Installation and Connection Manual" for more information regarding the controller.

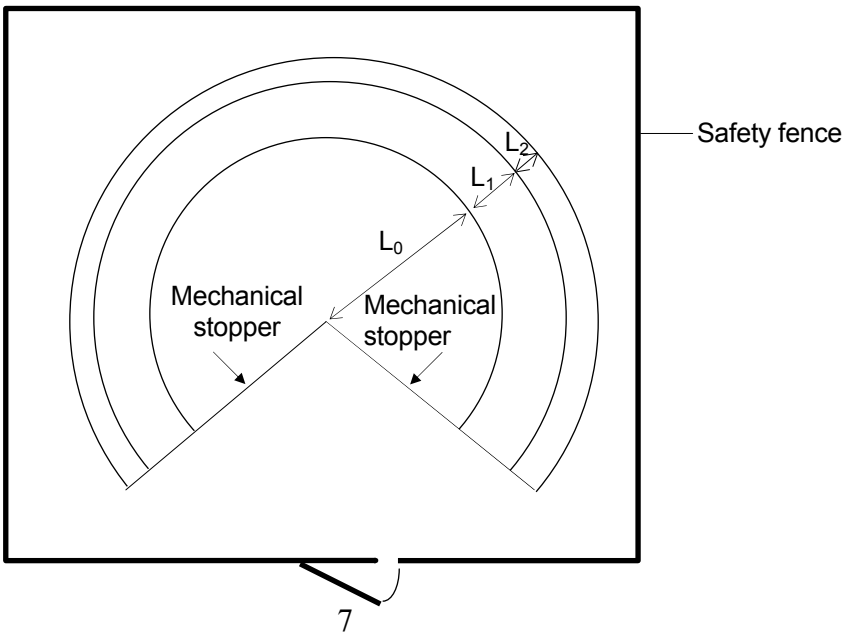


3 Motion Range and Specifications

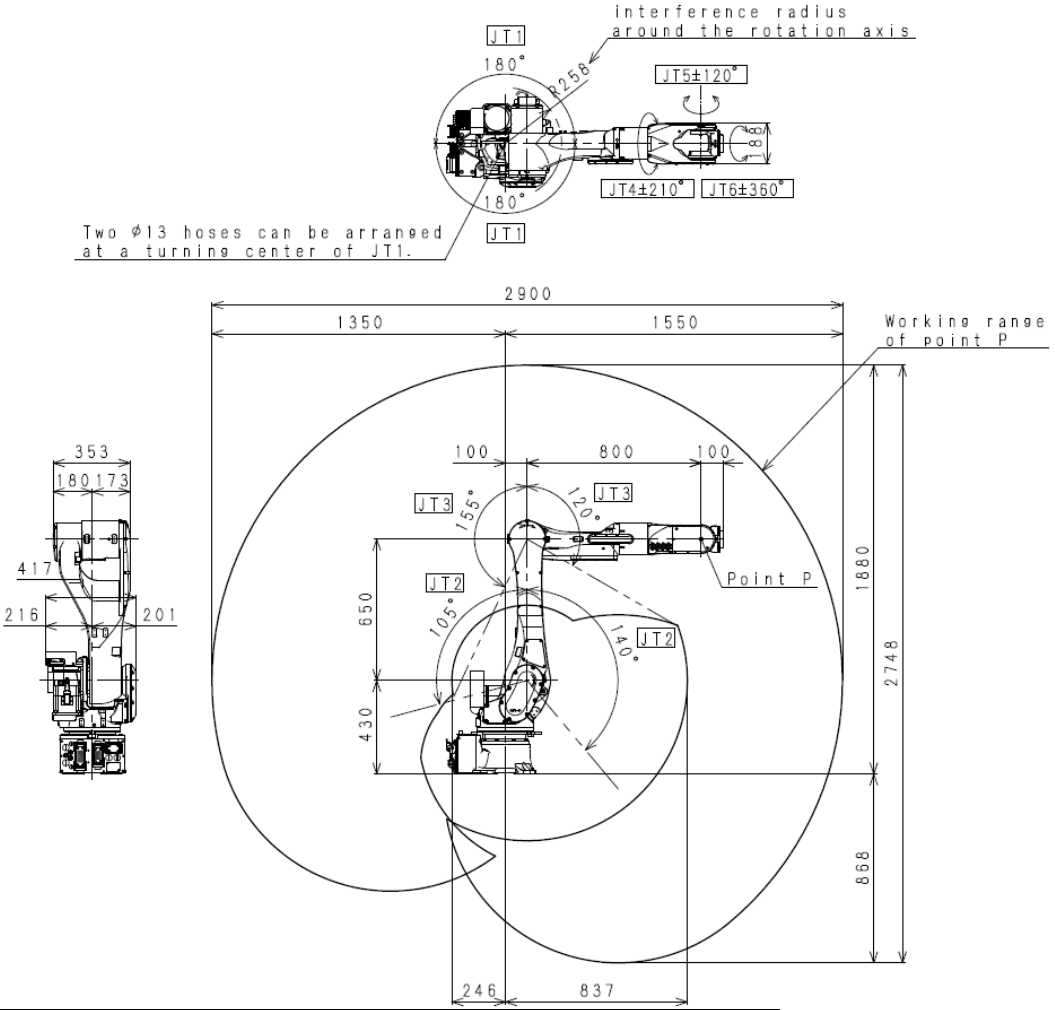
3.1 Determination of Safety Fence Installation Location from Motion Range



The motion range of the robot described below is represented by the motion range of point P in the figure. Therefore, as shown in the figure below, install the safety fence outside the circle whose radius is $L_0+L_1+L_2$, where L_0 is the length from the center line of the arm (point A shown in the figure), L_1 is the length from point P location to the farthest point of wrist flange, tool and workpiece, and L_2 is the safety margin. For the length of L_0, see "3.2 Motion Range and Specifications."



3.2 Motion Range and Specifications



Model	Articulated polar coordinate robot		
Degree of freedom of motion	6		
Motion range and speed	JT	Motion range	Maximum speed
	1	±180°	250°/s
	2	+145° to –105°	250°/s
	3	+155° to –120°	215°/s
	4	±210°	280°/s
	5	±120°	280°/s
	6	±360°	360°/s
Max. payload	15 kg		
Load capacity of wrist	JT	Torque	Moment of inertia
	4	27.0 N·m	0.70 kg·m^2
	5	27.0 N·m	0.70 kg·m^2
	6	22.0 N·m	0.25 kg·m^2
Position repeatability	±0.04 mm		
Mass	160 kg		
Acoustic noise	<80 dB (A)*		

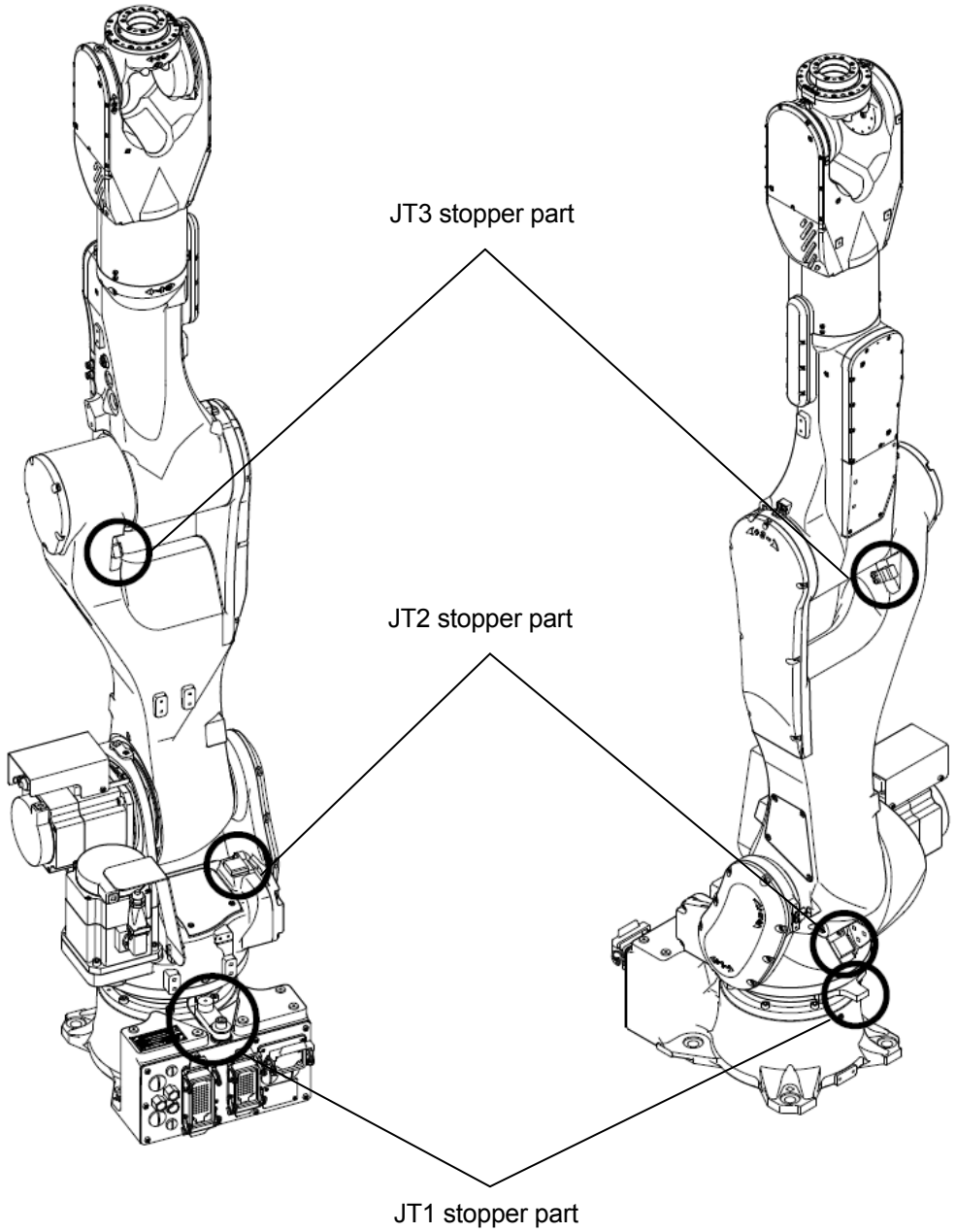
* Measurement conditions
- Robot tightly fixed to a flat floor surface
- 2000 mm from the maximum operating range

Noise level varies situationally.

3.3 Mechanical Stoppers

Mechanical stoppers are installed at the points shown in the figure below at JT1, JT2, and JT3 of the base axes. Among these, the motion range can be changed for JT1 by changing the installation position of the stopper block on the moving-side stopper part.

However, when the motion range is changed, it is necessary to change the upper and lower motion range limits to the corresponding values via auxiliary function 0507.



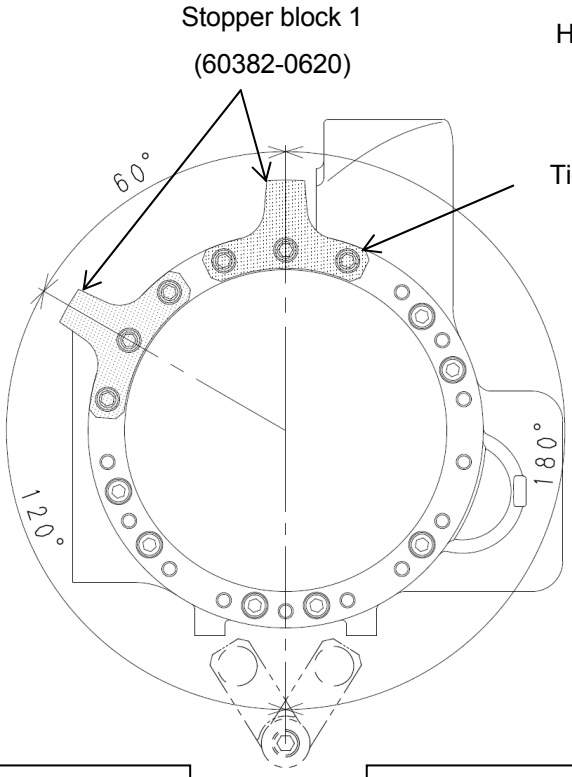
3.3.1 JT1 Stopper Block

The installation position of the JT1 stopper block can be changed in increments of 10°. As an additional option, it is possible to reduce the motion range by installing two stopper blocks.

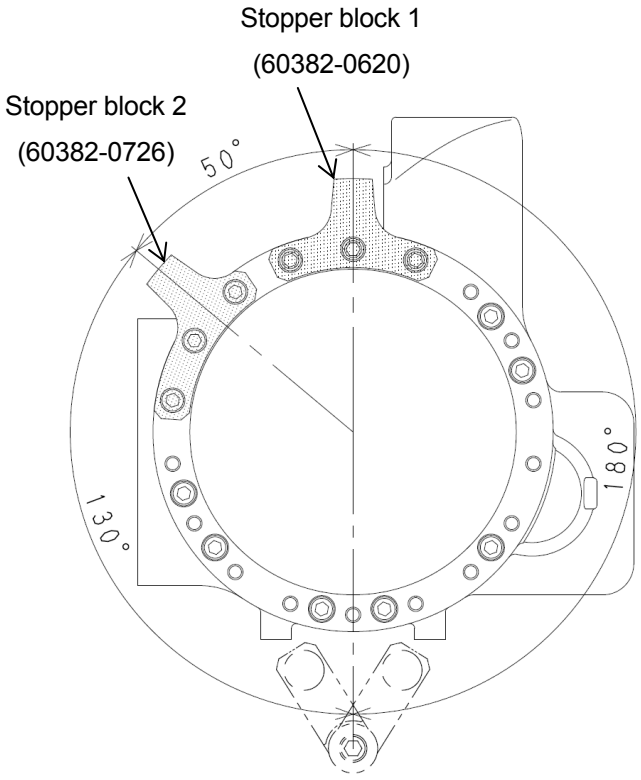
The range of motion that can be adjusted by changing the stopper block installation position is limited to up to 180° on both the + and – sides due to harness treatment and control restrictions. However, the total combined motion range of both sides can be adjusted between 40° and 320°.

The next page shows an example with two stopper blocks installed.

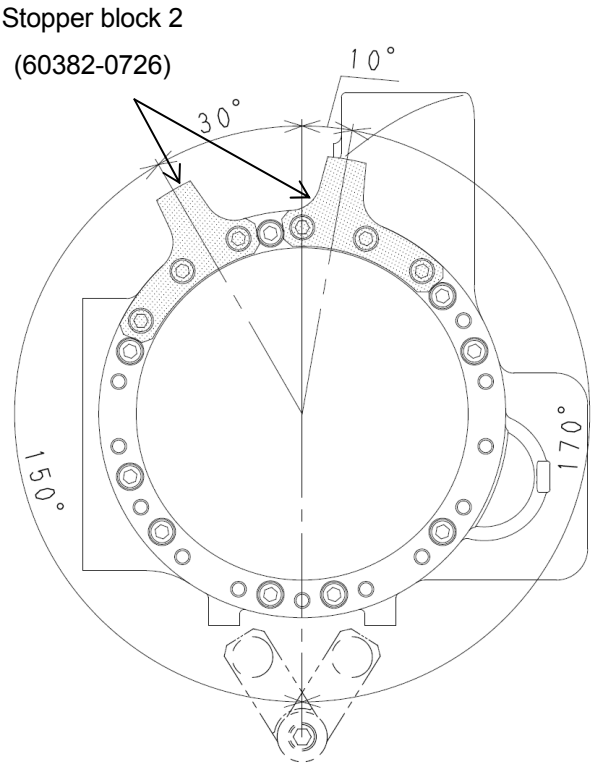
+ side is 120°, – side is 180°



+ side is 130°, – side is 180°



+ side is 150°, – side is 170°

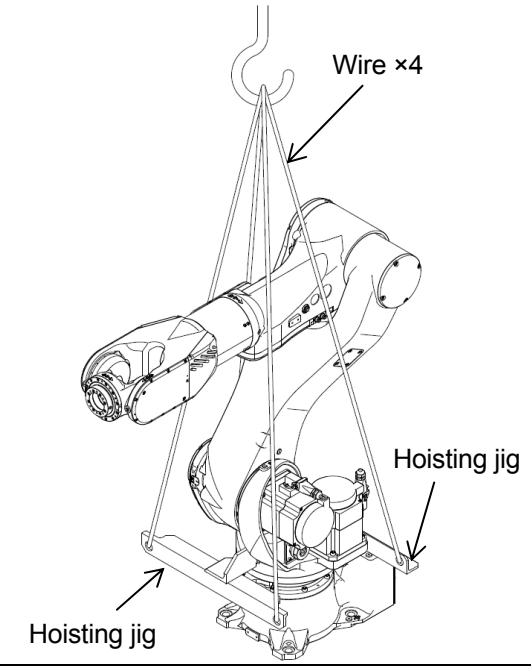


4 Transportation Methods

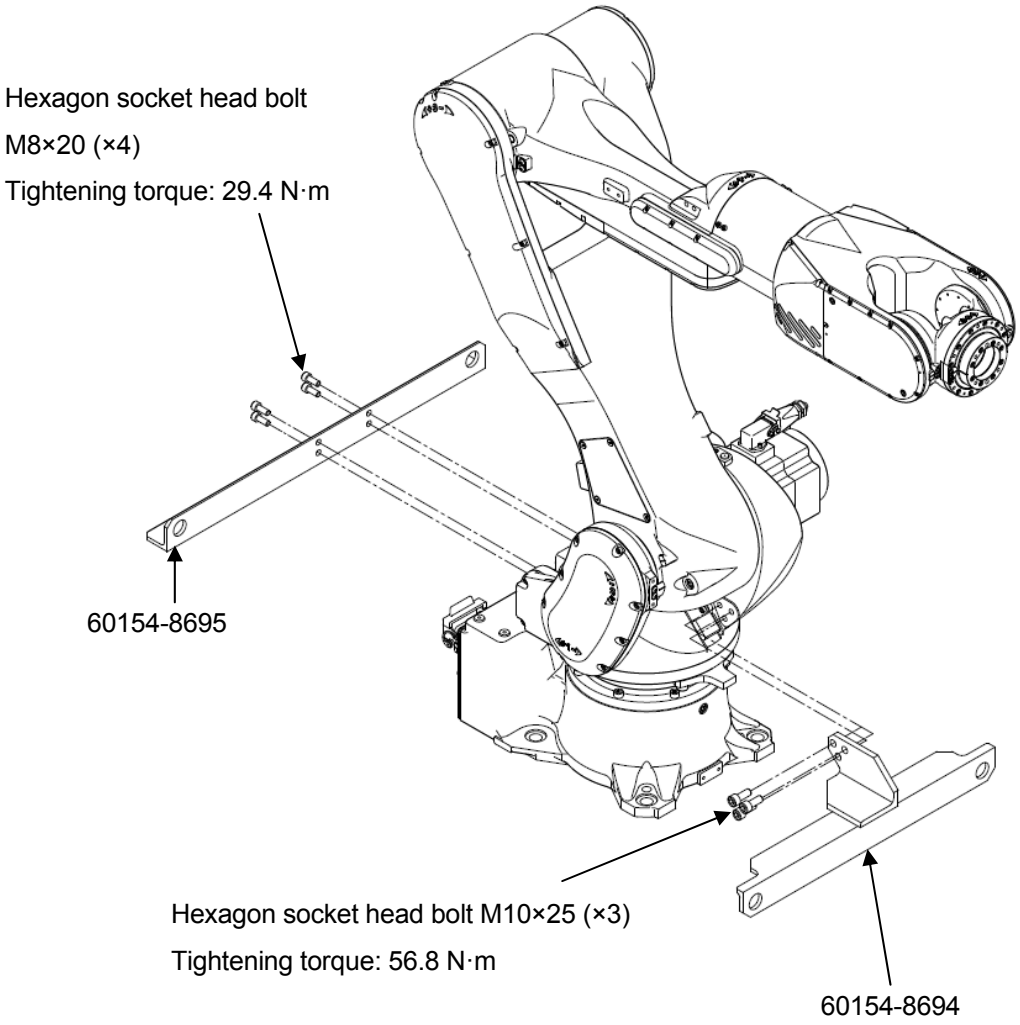
Mount a hoisting jig as shown in the figure below, and hoist up the robot by fastening wires to the hoisting jig (follow the same procedures when attaching to a pedestal).

⚠ CAUTION

When suspending the robot, care is required as it may tip forward or back depending on its posture or installed options. If the robot is suspended while at an angle, shocks may result in swinging or damage; wires may catch on the harness or piping; and external parts may cause interference resulting in damage. After transport is completed, remove the eyebolt attached to the robot arm.

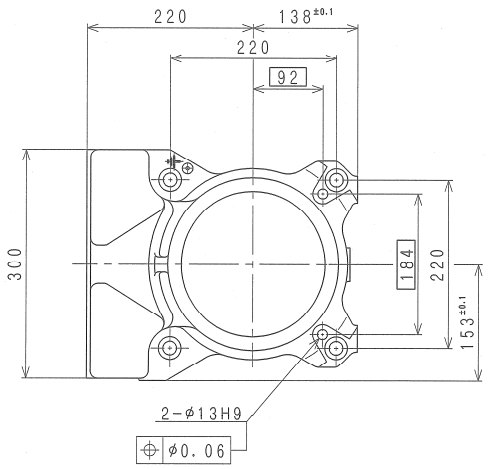
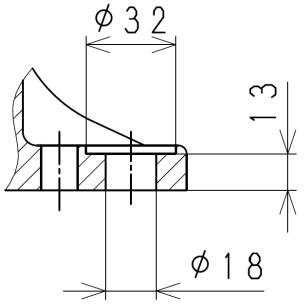
Suspended posture		
Lifting posture	JT1	0°
	JT2	-30°
	JT3	-120°
	JT4	0°
	JT5	0°
	JT6	0°

Attach the hoisting jig as shown in the figure below.



5 Base Installation Dimensions

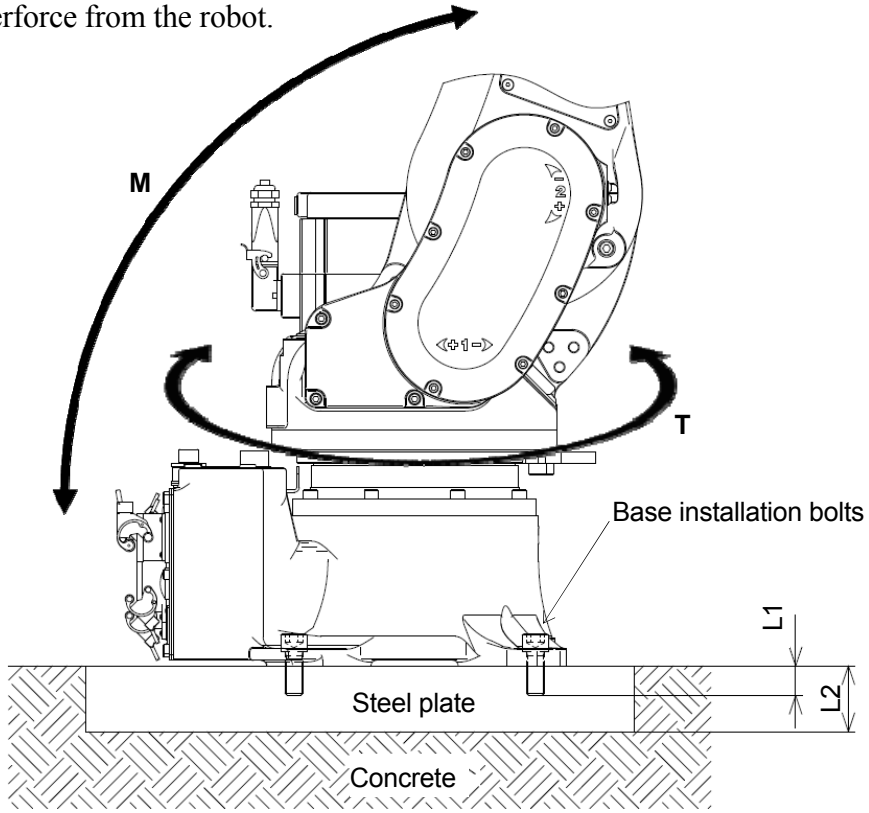
Use the bolt holes and fix with high tensile strength bolts during base installation.

Dimensions of the installed part	
Cross-section figure of the installed part	
Bolt holes	4-φ18
High-tensile bolt	4-M16 Material: SCM435 Strength classification: at least 10.9
Tightening torque	235 N·m
Installation surface angle	±5° or less

6 Installation

6.1 Installing the Base Directly on the Floor

As shown in the figure below, embed a steel plate with a thickness of at least L2 (see table below) into the concrete floor, or fix with anchors. Secure the steel plate firmly enough to withstand counterforce from the robot.



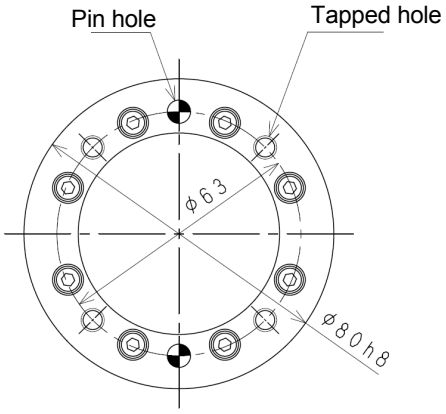
Model	BU015N	
	With Cubic-S Emergency stop function Stop category: 1 (Default setting)	With Cubic-S Emergency stop function Stop category: 0
		Without Cubic-S
M (tipping moment)	2868 N·m	4245 N·m
T (rotational torque)	2125 N·m	3392 N·m
Base installation bolts	4-M16	
Tightening torque	235 N·m	
L1	At least 25 mm	
L2	At least 28 mm	

7 Installation of Tools

WARNING

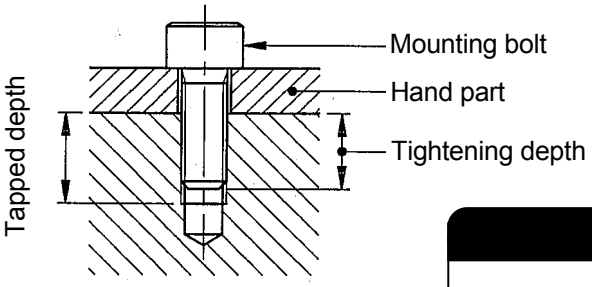
When mounting a hand or other tools, be sure to turn OFF the controller power and external power, and after clearly displaying that "inspection and maintenance is in progress," lock out and tag out the external power so that an operator or third party does not accidentally turn ON the power, causing an unexpected situation such as electric shock.

7.1 Wrist Tip (Flange Surface) Dimensions



The tip of the robot arm features a flange for mounting tools such as a hand or gun. As shown in the figure on the left, tighten the mounting bolts using the tapped holes machined around the φ63 circumference of the flange. Additionally, use the pin holes and spigot holes for positioning the hand and gun.

7.2 Mounting Bolt Specifications



Select bolts with lengths that will reach the designated tightening depth, according to the tapped depths on the tool mounting flange. Additionally, use high-tensile bolts, and tighten to the rated torque.

CAUTION

If the tightening depth is above the rated value, then the mounting bolts will bottom out and the tool may not be secured.

Tapped hole	4-M6
Tapped hole PCD	φ63
Pin hole	φ6H7 depth 6
Spigot shaft	φ80h8 depth 15.5
Tapped depth	12 mm
Bolting depth	10 to 11 mm
High-tensile bolt	SCM435, at least 10.9
Tightening torque	11.76 N·m

7.3 Load Capacity

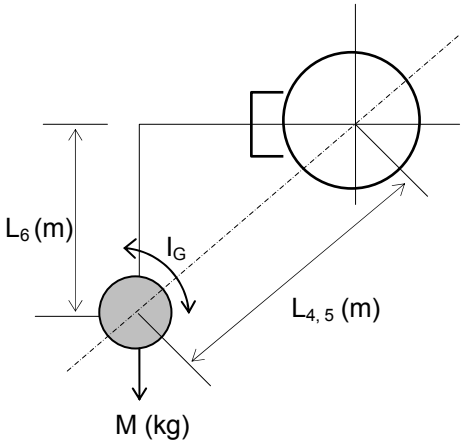
The load mass capacity of the robot, including tool mass, is fixed. Additionally, strictly observe the restrictions for load torque and load moment of inertia around each wrist axis (JT4, JT5, JT6) as shown below.

⚠ CAUTION

If a load at or above the rated value is applied, this can result in deteriorated operational functionality or service life. The load mass includes all items such as hand mass, tool changer mass, shock absorber mass, etc.
If an amount other than the rated load will be applied, consult with Kawasaki.

The load torque and moment of inertia can be calculated using the following formula.

Calculation formula



Load mass (including hand) : $M \leqq Mmax.$ (kg)
Load torque : $T=9.8 \cdot M \cdot L$ (N·m)
Load moment of inertia : $I = M \cdot L^2 + I_G$ (kg·m^2)

Mmax: maximum load mass: See 3.2.

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

I_G : Moment of inertia around the center of gravity (Unit: kg·m^2)

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

L_6 : Distance from JT6 center of rotation to load center of gravity

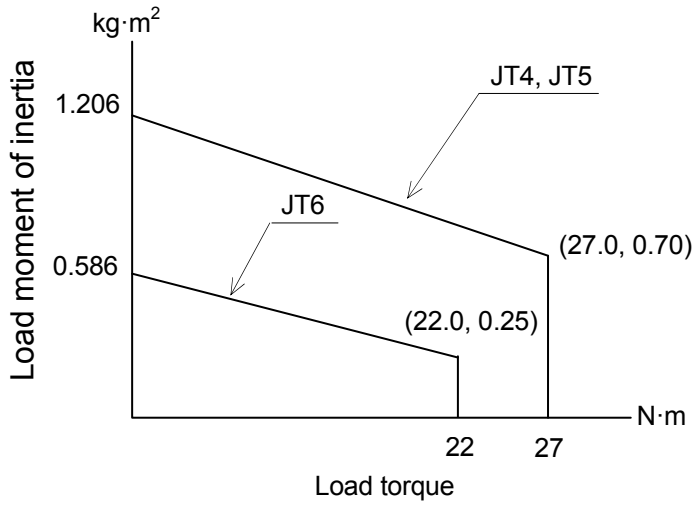
When calculating with the load divided between multiple locations (for example, hand and workpiece, etc.), use the total combined values as the load torque and moment of inertia.

Strictly adhere to the following restrictions regarding load of the wrist part.

1. Keep the load mass at or below 15 kg, including the hand mass.
2. There are restrictions for the load torque and load moment of inertia around each wrist axis (JT4, JT5, JT6).
   Keep the load torque and load moment of inertia around each axis within the allowable ranges shown in the figure below.

⚠ CAUTION

After tool installation, always make sure to set the load via auxiliary function 0304. Operating the robot with incorrect settings may cause vibrations in motion, degradation of movement performance, and shortening of machine service life.



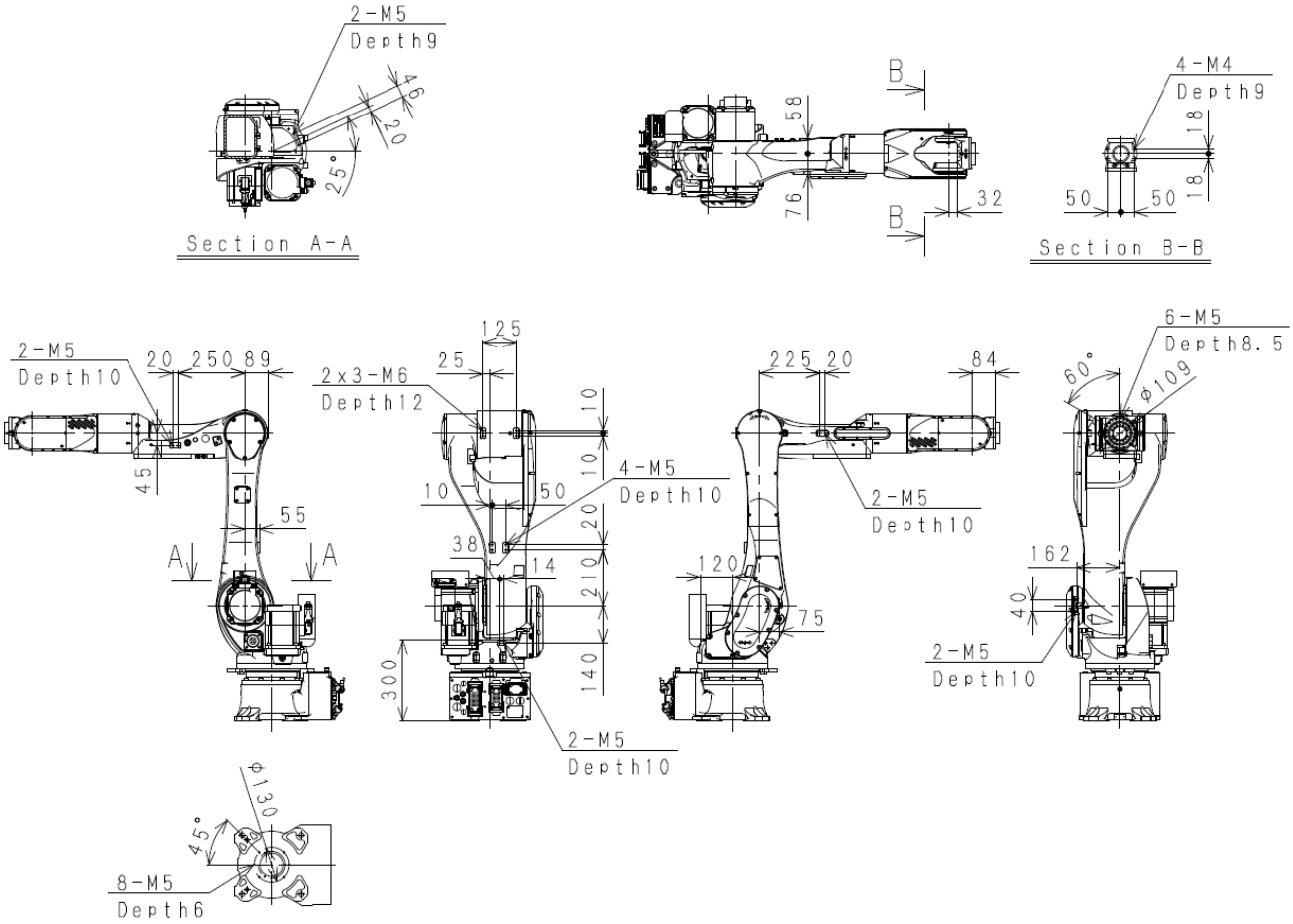
8 Installation of External Devices

8.1 Service Tapped Hole Positions

Service tapped holes, shown in the figure below, are provided on each part of the robot arm for mounting external devices and wiring brackets, etc.

⚠ CAUTION

Perform a thorough operation check to confirm that mounted external devices and brackets do not interfere with peripheral equipment or the robot arm itself.



8.2 Calculation of External Device Load Capacity

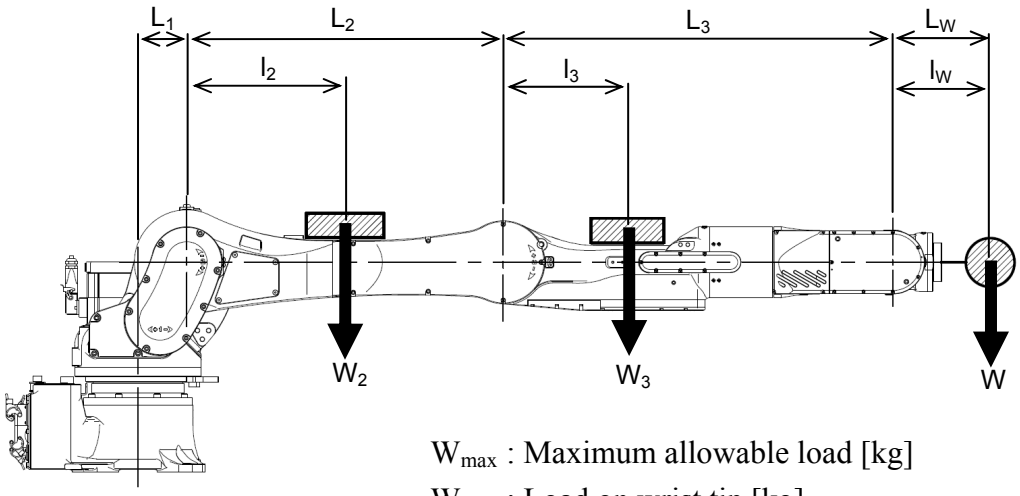
The mass load capacity of the robot is fixed for each model. Additionally, strictly observe the restrictions as follows for the allowable load on the arm.

⚠ CAUTION

If a load at or above the rated value is applied, this can result in deteriorated operational functionality or service life.
If an amount other than the rated load will be applied, consult with Kawasaki.

For both JT2 and JT3, limit the total load torque on the wrist tip and arm so as not to exceed the maximum allowable load torque. The load torque can be calculated using the formula on the next page.

Calculation formula



W_{max} : Maximum allowable load [kg]
W : Load on wrist tip [kg]
W_2 : Total load on lower arm [kg]
W_3 : Total load on upper arm [kg]
l_W : Position of wrist load center of gravity [mm]
l_2 : Total load on lower arm
Position of center of gravity [mm]
l_3 : Total load on upper arm
Position of center of gravity [mm]

$$\begin{cases} \text{JT3: } W(L_3+l_w)+W_3 \cdot l_3 \leqq W_{max}(L_3+L_W) \\ \text{JT2: } W(L_2+L_3+l_w)+W_3(L_2+l_3)+W_2 \cdot l_2 \leqq W_{max}(L_2+L_3+L_W) \end{cases}$$

Use the values shown in the table below for the calculation.

L_1 [mm]	L_2 [mm]	L_3 [mm]	L_w [mm]	W_{max} [kg]
100	650	800	183	15

However, do not exceed the values below for W_2 and W_3.

$$W_3 < \frac{W_{max}(L_1+L_2+L_3+L_W)}{L_1+L_2} \qquad W_2 < \frac{W_{max}(L_1+L_2+L_3+L_W)}{L_1}$$

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