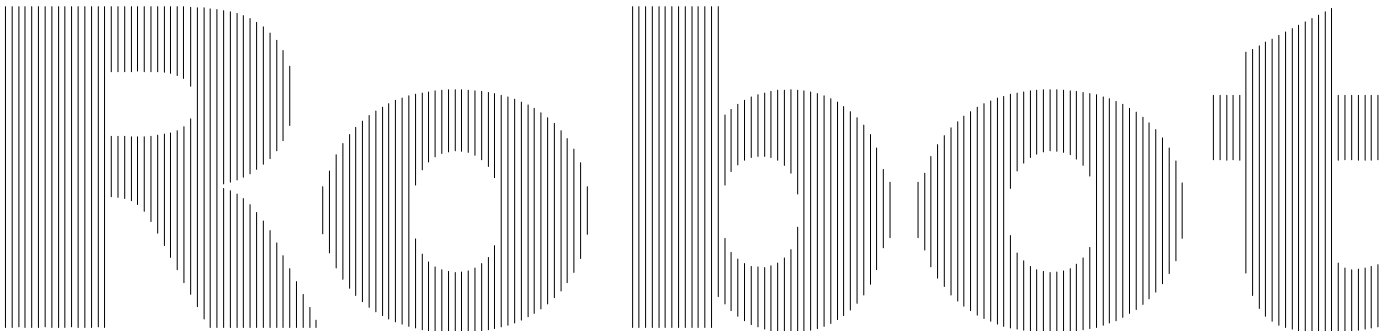
Simple and friendly

Kawasaki

Kawasaki Robot
CX Series

Installation and Connection Manual



Kawasaki Heavy Industries, Ltd.

90202-1146DED

Preface

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

Read and understand the contents of this and safety manuals thoroughly and strictly observe all rules for safety before proceeding with any operation. This manual describes only the installation and connection of the robot arm. For information concerning the control parts, please refer to the "Installation and Connection Manual" for controller.

Never proceed with any operation until you understand the contents of this manual completely. Kawasaki is not responsible for any accidents and/or damages resulting from operations/maintenance based on only a limited reading or limited understanding of some parts of this manual.

This manual is applicable to the following robot arms.

CX110L, CX165L, CX210L

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. Accordingly, it is necessary to give one's fullest attention when using this manual to perform any work. Should any unexplained questions or problems arise, please 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.**

Table of Contents

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 lockout/tagout 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 lockout/tagout the external power switch before starting installation and connection.**
5. **Lower gas pressure in the gas spring can cause the robot arm to fall. Keep out from under the arm.**
6. **Lower gas pressure in the gas spring can cause the robot arm to fall. Keep the robot arm in the hoisted posture when storing (See 4.1.)**

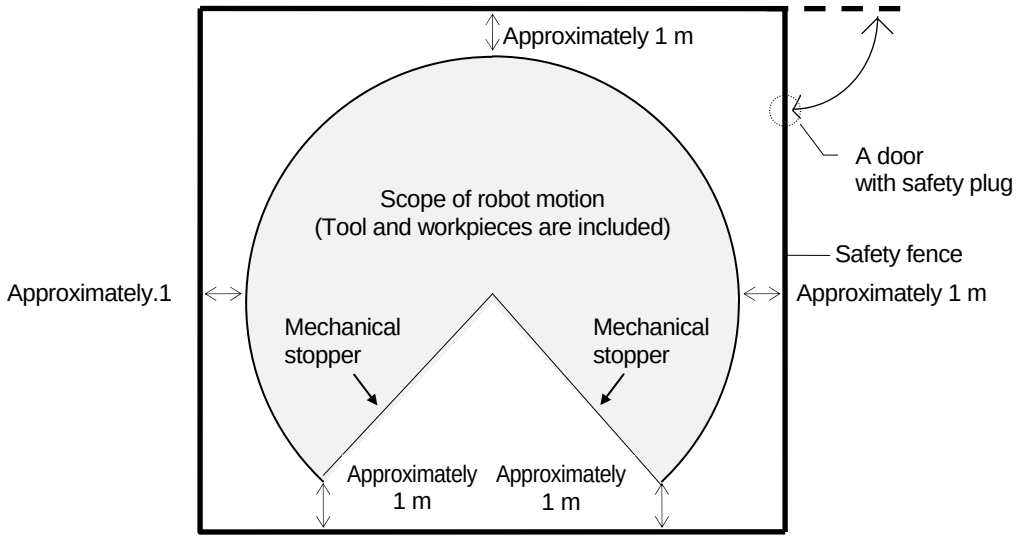
⚠ CAUTION

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 - 85% RH without dew condensation,**
   - **(3) Keep free from excessively strong 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 ±5°.
2. Be sure that the installation floor/pedestal has sufficient rigidity.
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 0 to 45°C. (Deviation or overload error may occur due to high viscosity of grease/oil when starting operation at low temperatures. In this case, move the robot at low speed before regular operation.)
5. Keep the relative humidity during operation within the range of 35-85%RH without dew condensation.
6. The robot installing place should be free from dust, dirt, oil, smoke, water, and other foreign matters.
7. The robot installing place should be free from flammable or corrosive liquid or gas.
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 workpieces) does not cause interference.
    (2) Minimize the number of entrance gates (only one is best) 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.

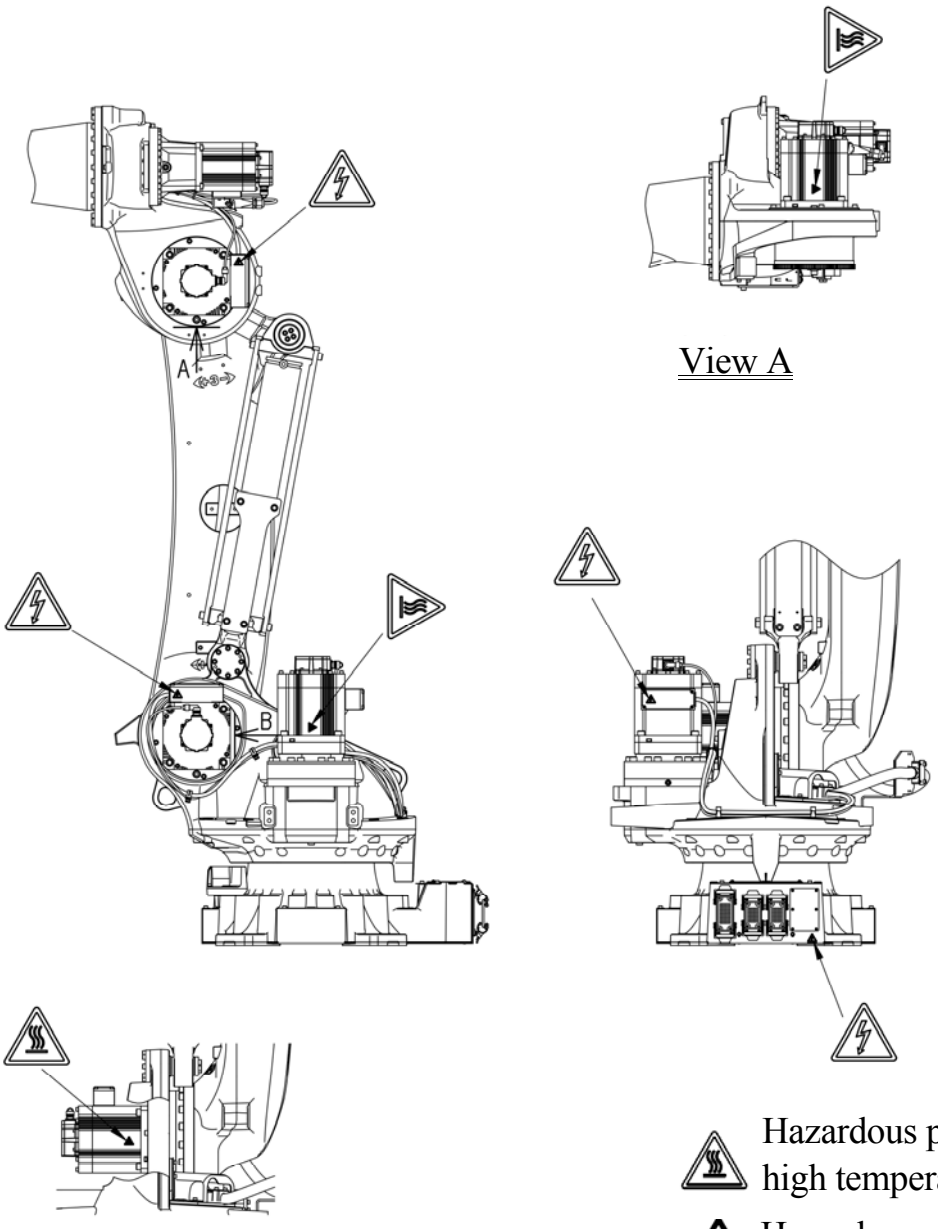


1.3 Residual Risks during Work

WARNING

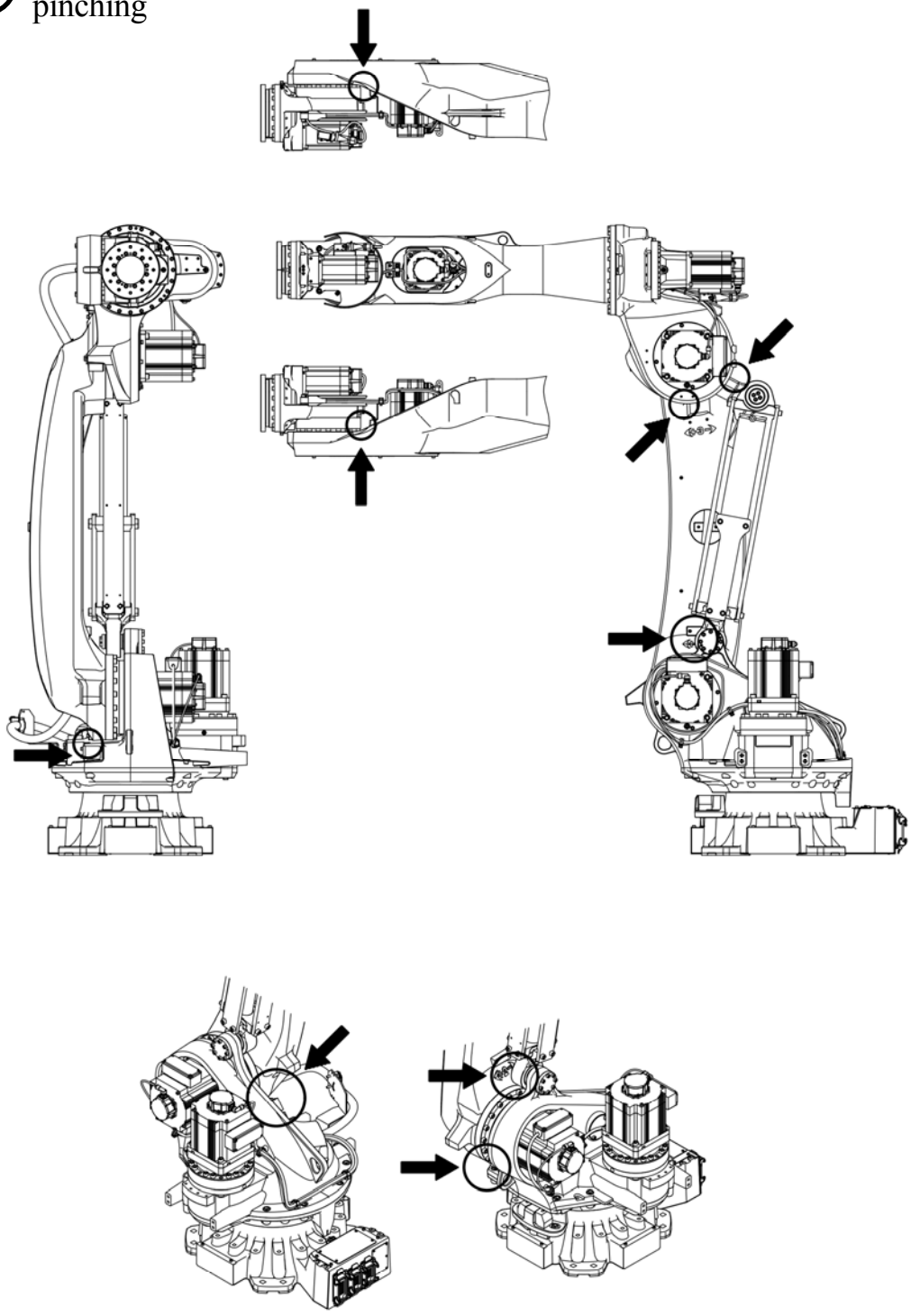
1. **Pay attention to the hazardous places listed in the drawings below.**
2. **When teaching the robot, be sure to identify the motion range, and keep out from the range and from under the robot arm. Pay special attention to the workpiece held by the robot that may fall unexpectedly due to improper operation. Keep away from the workpiece and keep out from under the workpiece.**

Hazardous places for high temperature and electric shock (CX110L, CX165L, CX210L)



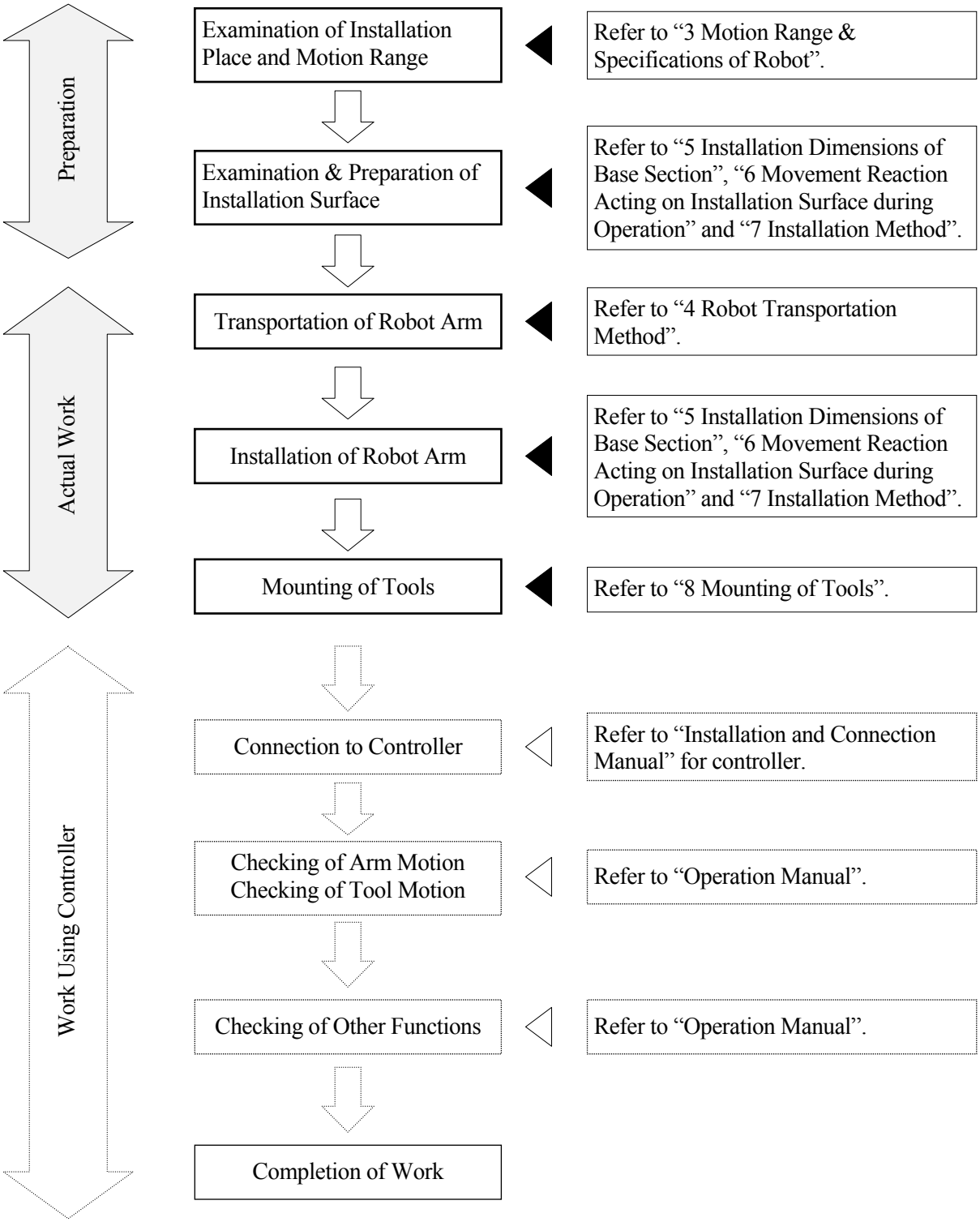
Hazardous places for pinching (CX110L, CX165L, CX210L)

○ Hazardous place for pinching



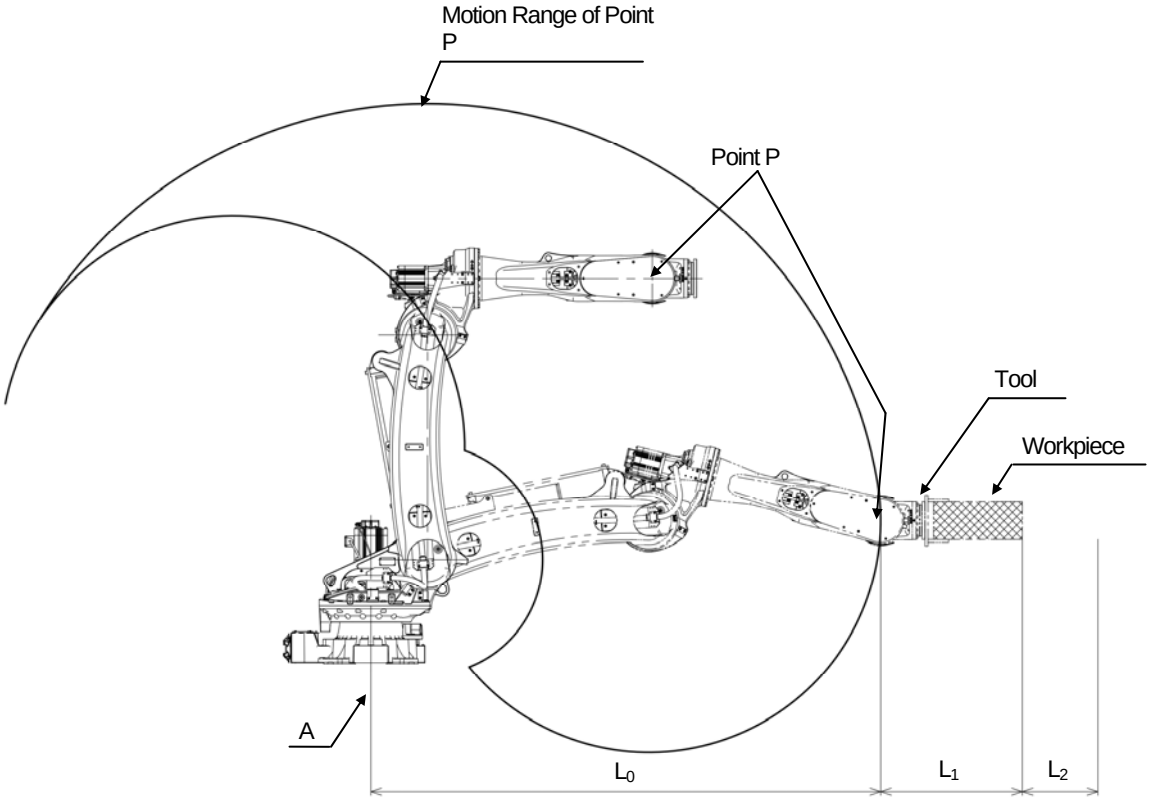
2 Work Flow at Arm Installation and Connection

This workflow describes only the robot arm section. For the controller, refer to "Installation and Connection Manual" for controller.

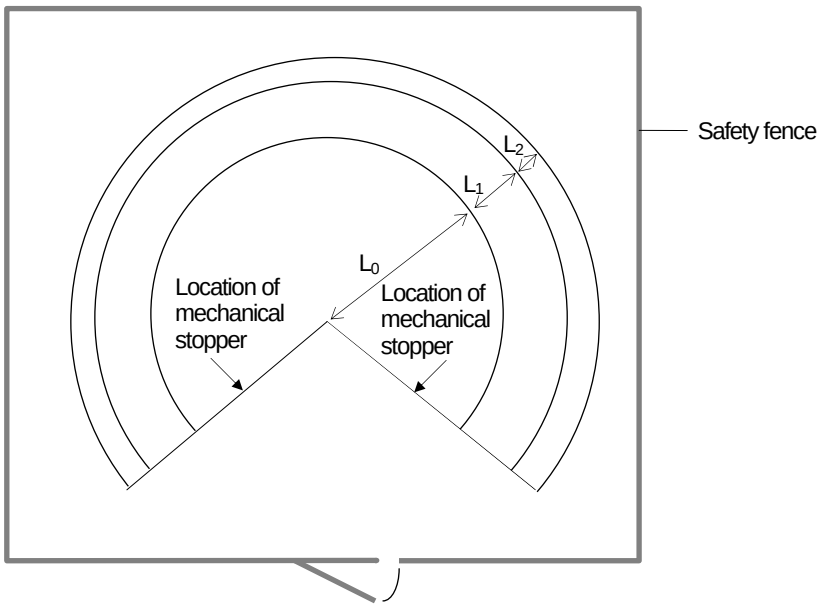


3 Motion Range & Specifications of Robot

3.1 Determination of Safety Fence Installation Location

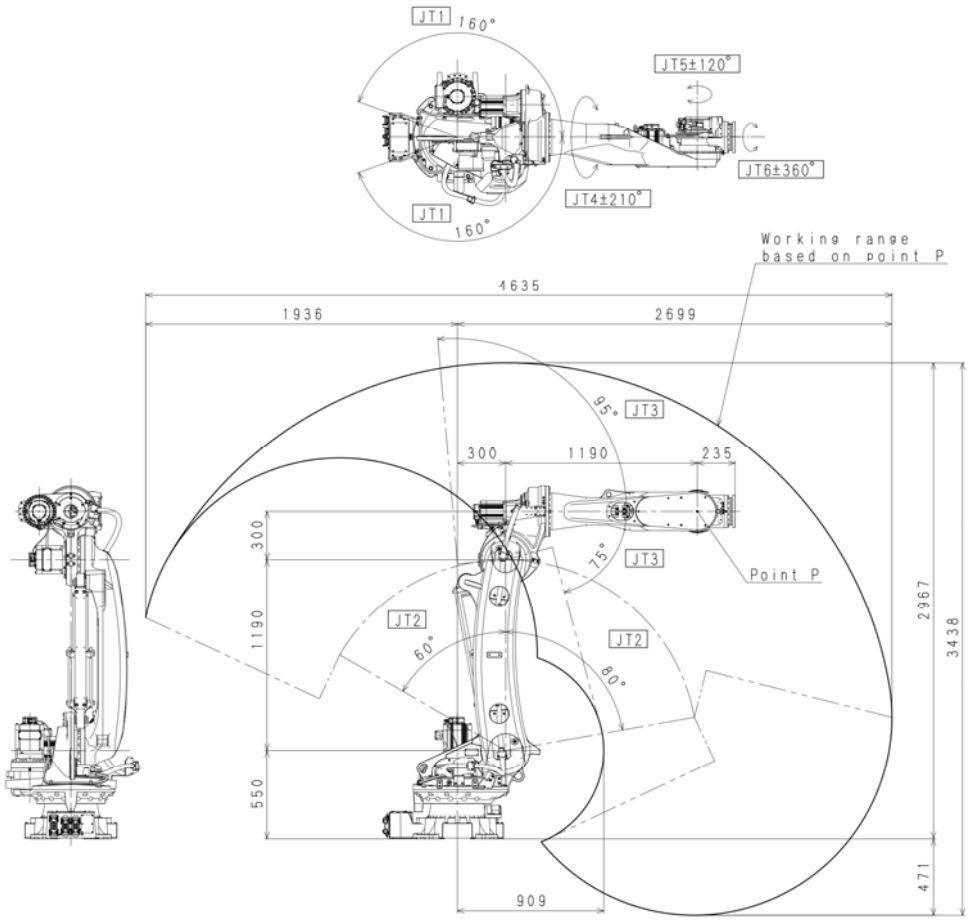


The motion range of the robot is represented by the maximum area that can be covered by point P in the figure above. Therefore, as shown in the figure below, install the safety fence outside circle whose radius is L_0+L_1+L_2. Where; L_0 is the length from the center line of arm (point A shown above) 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 & Specifications of Robot

CX110L

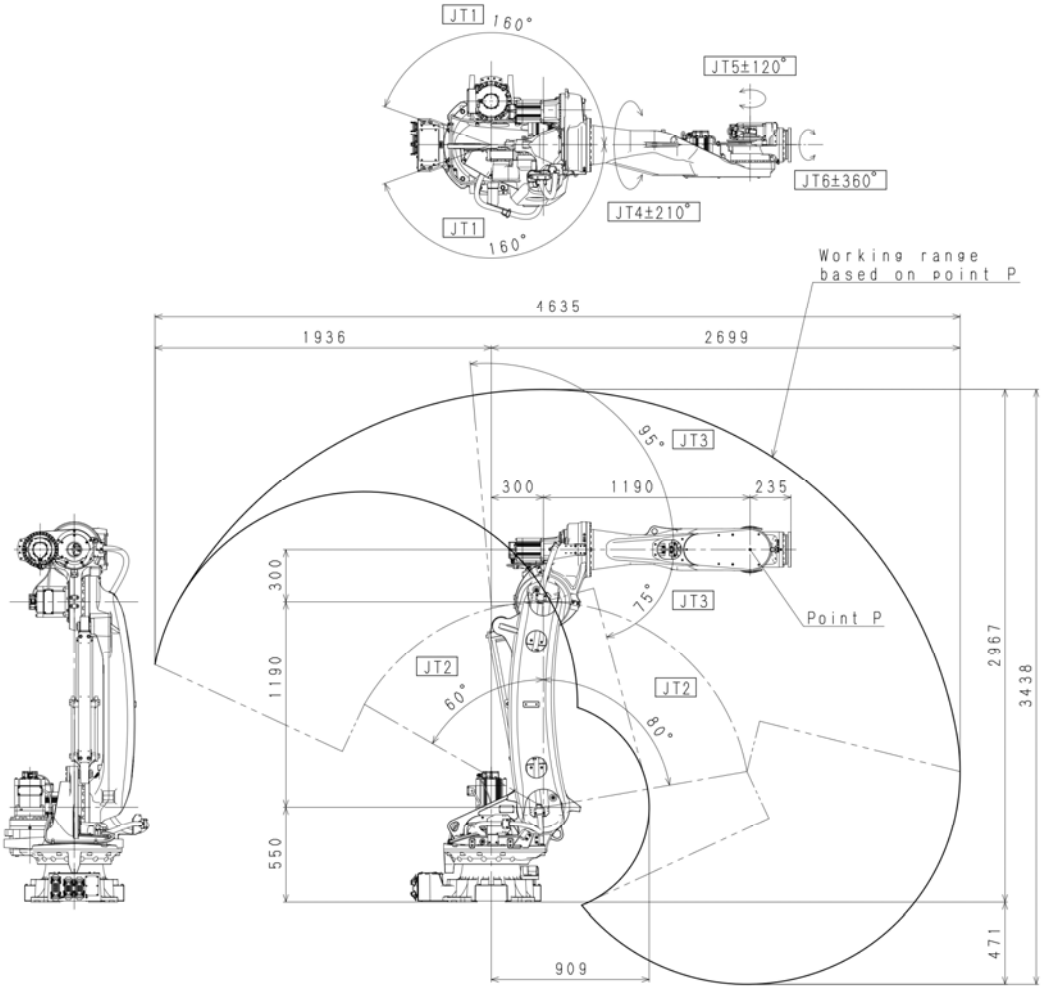


Type	Vertical Articulated Robot		
Degree of Freedom	6		
Motion Range and Maximum Speed	JT	Motion Range	Max. Speed
	1	±160°	140°/s
	2	+80° to -60°	135°/s
	3	+95° to -75°	135°/s
	4	±210°	200°/s
	5	±120°	200°/s
	6	±360°	300°/s
Max. Payload	110 kg		
Wrist Load Capacity	JT	Torque	Moment of Inertia
	4	830 N·m	85 kg·m^2
	5	830 N·m	85 kg·m^2
	6	441 N·m	45 kg·m^2
Repeatability	±0.06 mm		
Mass	870 kg		
Acoustic Noise	< 80 db (A)*		

*measured condition
- installed on the plate rigidly fixed on the floor
- 4700 mm away from JT1 center

The noise level depends on the conditions.

CX165L

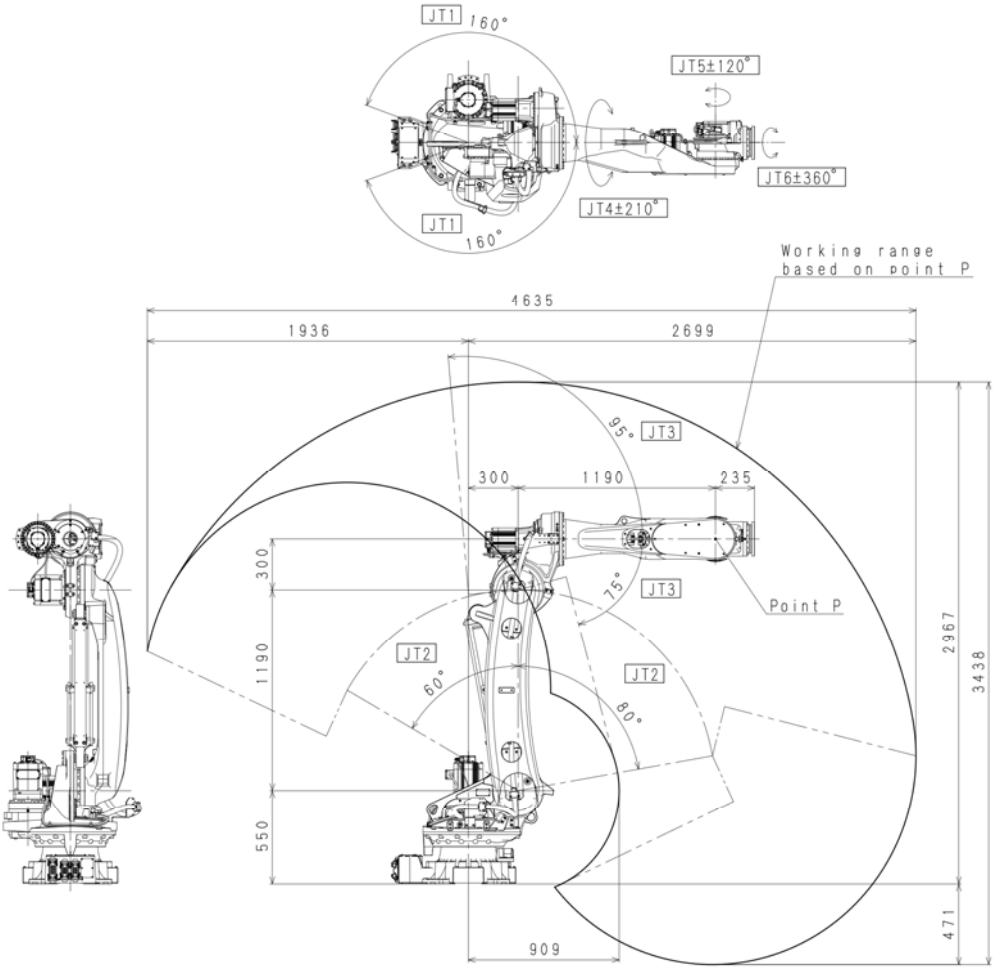


Type	Vertical Articulated Robot		
Degree of Freedom	6		
Motion Range and Maximum Speed	JT	Motion Range	Max. Speed
	1	±160°	130°/s
	2	+80° to -60°	125°/s
	3	+95° to -75°	125°/s
	4	±210°	180°/s
	5	±120°	180°/s
	6	±360°	280°/s
Max. Payload	165 kg		
Wrist Load Capacity	JT	Torque	Moment of Inertia
	4	952 N·m	99 kg·m^2
	5	952 N·m	99 kg·m^2
	6	550 N·m	49.5 kg·m^2
Repeatability	±0.06 mm		
Mass	870 kg		
Acoustic Noise	< 80 db (A)*		

*measured condition
- installed on the plate rigidly fixed on the floor
- 4700 mm away from JT1 center

The noise level depends on the conditions.

CX210L



Type	Vertical Articulated Robot		
Degree of Freedom	6		
Motion Range and Maximum Speed	JT	Motion Range	Max. Speed
	1	±160°	125°/s
	2	+80° to -60°	115°/s
	3	+95° to -75°	115°/s
	4	±210°	155°/s
	5	±120°	160°/s
	6	±360°	220°/s
Max. Payload	210 kg		
Wrist Load Capacity	JT	Torque	Moment of Inertia
	4	1370 N·m	199.8 kg·m^2
	5	1370 N·m	199.8 kg·m^2
	6	700 N·m	154.9 kg·m^2
Repeatability	±0.06 mm		
Mass	870 kg		
Acoustic Noise	< 80 db (A)*		

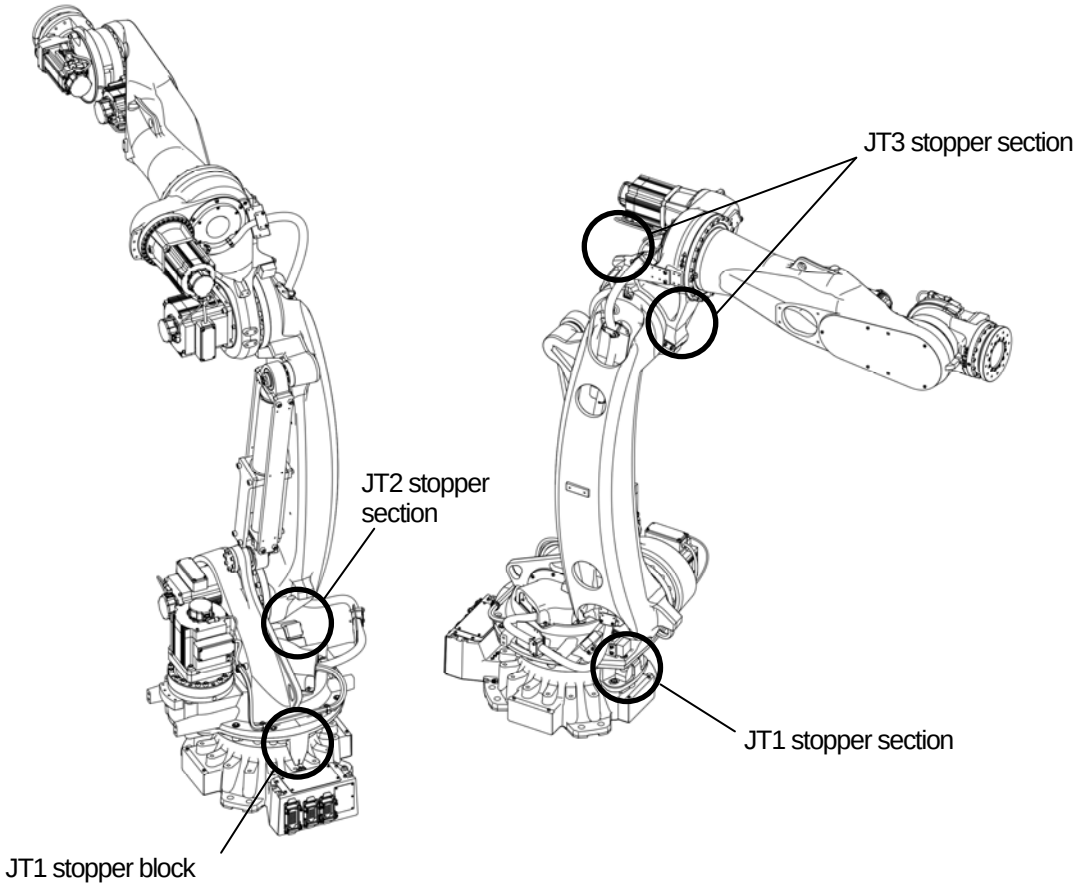
*measured condition
- installed on the plate rigidly fixed on the floor
- 4700 mm away from JT1 center

The noise level depends on the conditions.

3.3 Mechanical Stoppers

For JT1, JT2 and JT3 of base axes, mechanical stoppers are mounted at the places shown in the figure below. Among them, the motion range of JT1 can be changed by changing the mounting position of stopper block of stopper member on the moving side.

However, when the motion range is changed, it is necessary to change the motion range limits to the corresponding values by Auxiliary function 0507.

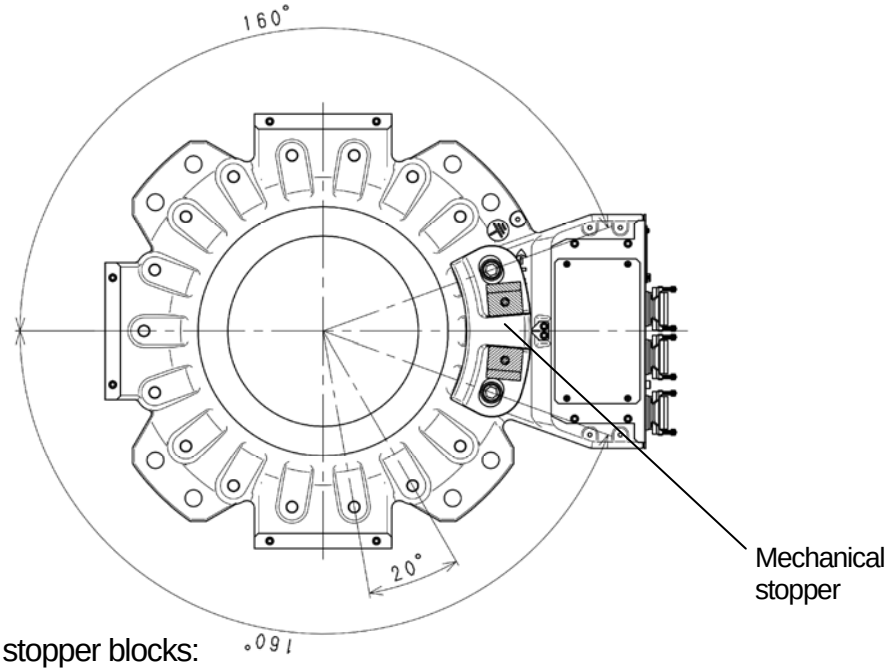


3.3.1 JT1 Stopper Block

Mounting position of JT1 stopper block can be changed by angular unit of 20 degrees. In addition, reducing the motion range is possible by mounting two stopper blocks as an option.

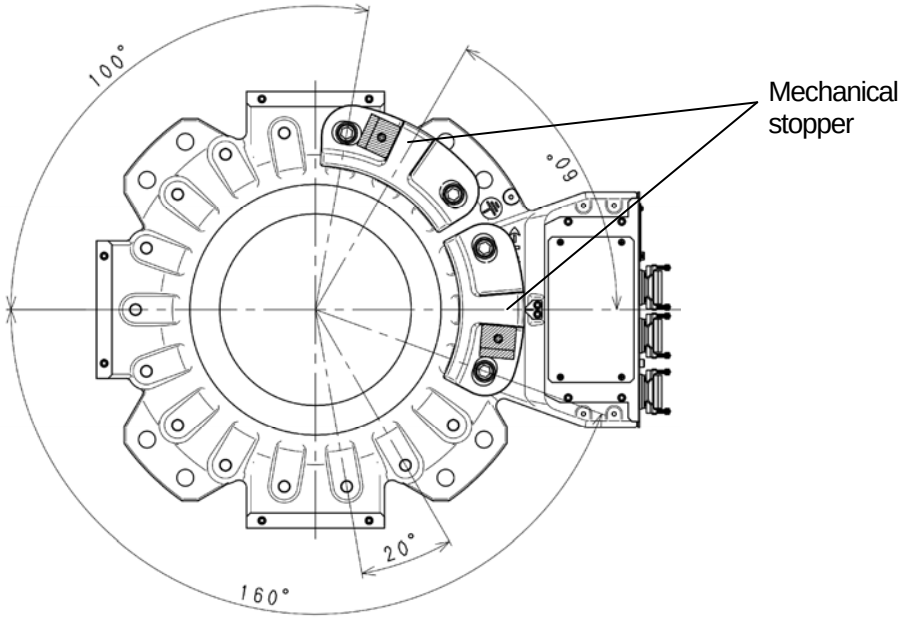
When mounting a stopper block:

The motion range of JT1 for CX series robots is 160° on both plus and minus sides due to the restriction on control treatment, and the motion range cannot be changed when a stopper block is mounted. The figure below shows the motion range at the stopper block mounting position in shipment.



When mounting two stopper blocks:

The motion range of JT1 for CX series robots is 160° on both plus and minus sides due to the restriction on control treatment, and, the total motion range of both plus and minus sides when two stopper blocks are mounted is between 20° and 260°. Mounting stopper blocks as shown below makes the motion range of 100° on the plus side and 160° on the minus side.



4 Robot Transportation Method

4.1 Hoisting by Wire

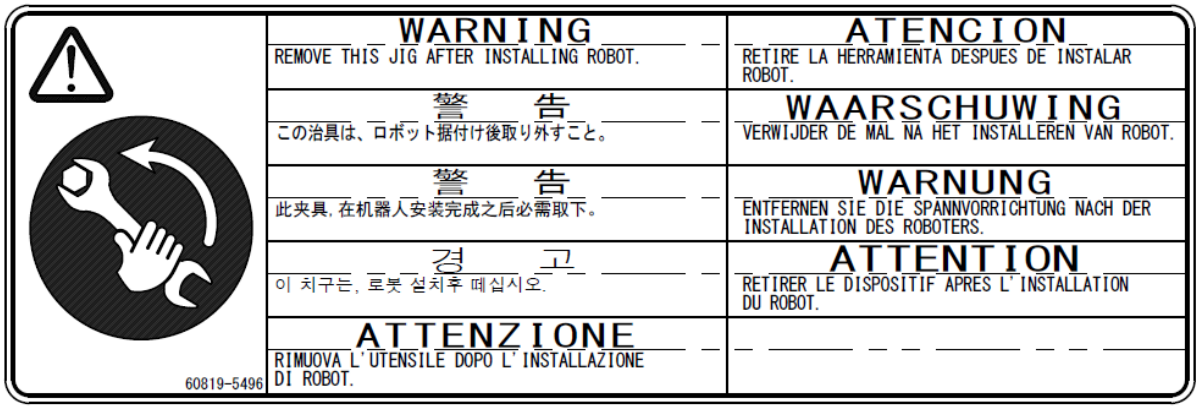
For the arm's hoisted-up posture, see the angles of each axis in a table. Mount a hoisting jig as shown in the figure below, hoist up the robot by fastening the wire slings to the hoisting jig. Then, transport the robot. Remove the hoisting jig attached to robot arm after the transportation of robot is complete.

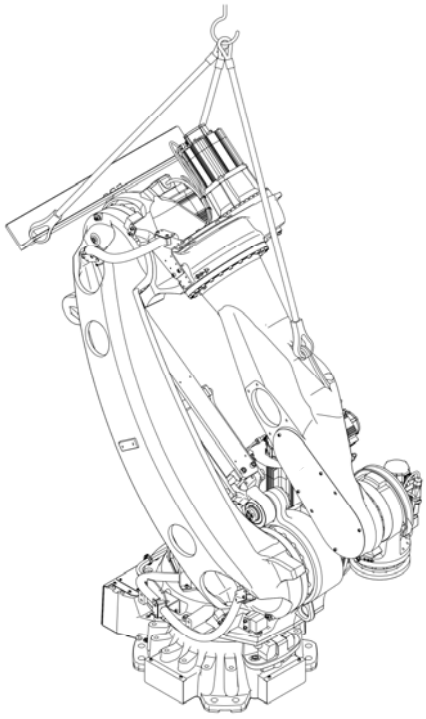
⚠ WARNING

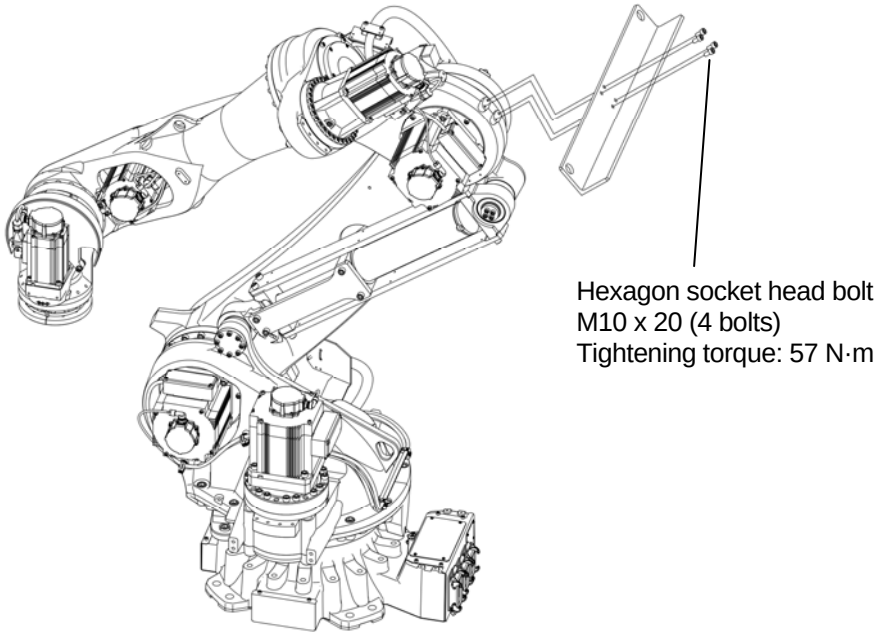
Use a hoisting jig without fail when hoisting up robot. If the robot is hoisted up without using the jig, robot may fall.

⚠ 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. Remove the hoisting jig attached to the arm once the transportation of robot is complete.



Model		CX110L, CX165L, CX210L
Hoisted up posture		
Hoisted up posture	JT1	0°
	JT2	-35°
	JT3	-75°
	JT4	0°
	JT5	-50°
	JT6	0°

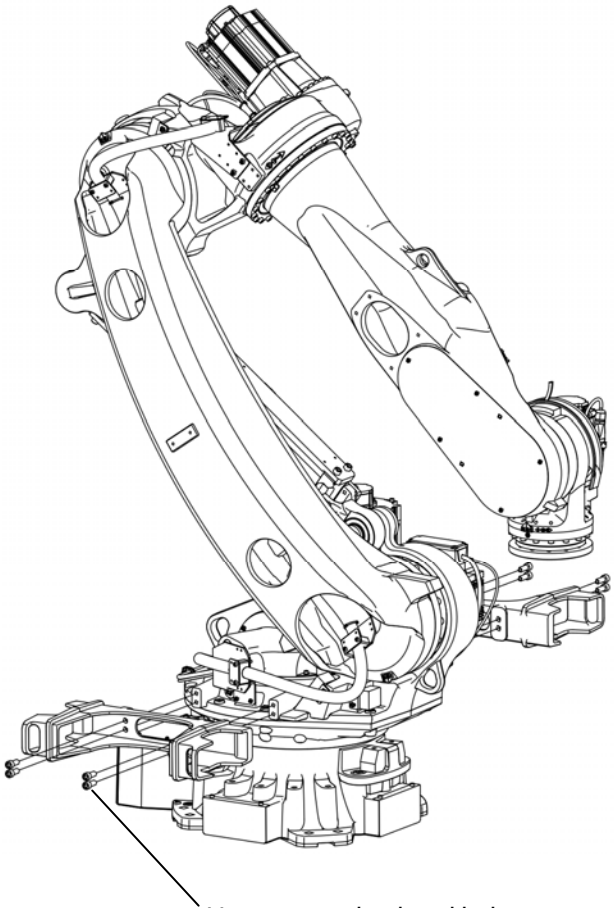


4.2 Forklift

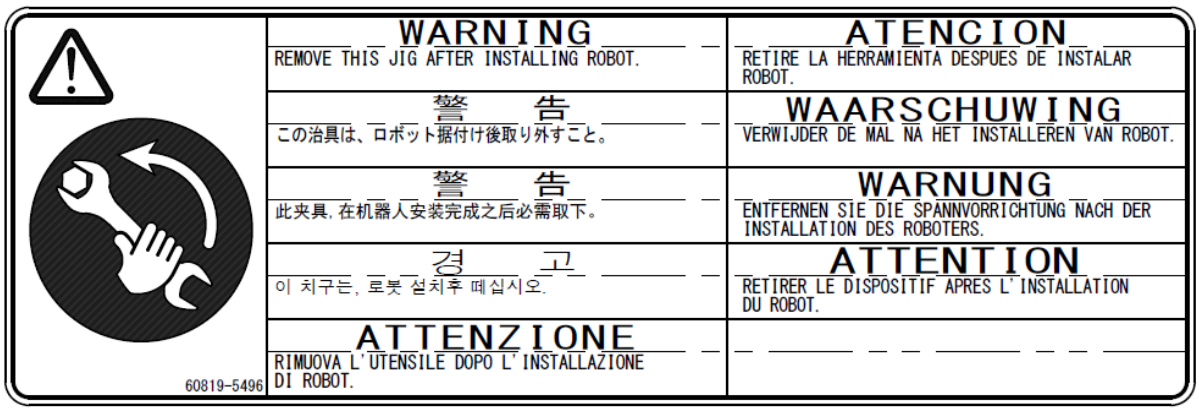
An optional fork pocket is provided as a forklift jig. The fork pocket can be mounted in the arm base section and can be used when using a forklift.
Mount the folk pocket as shown in the figure below.

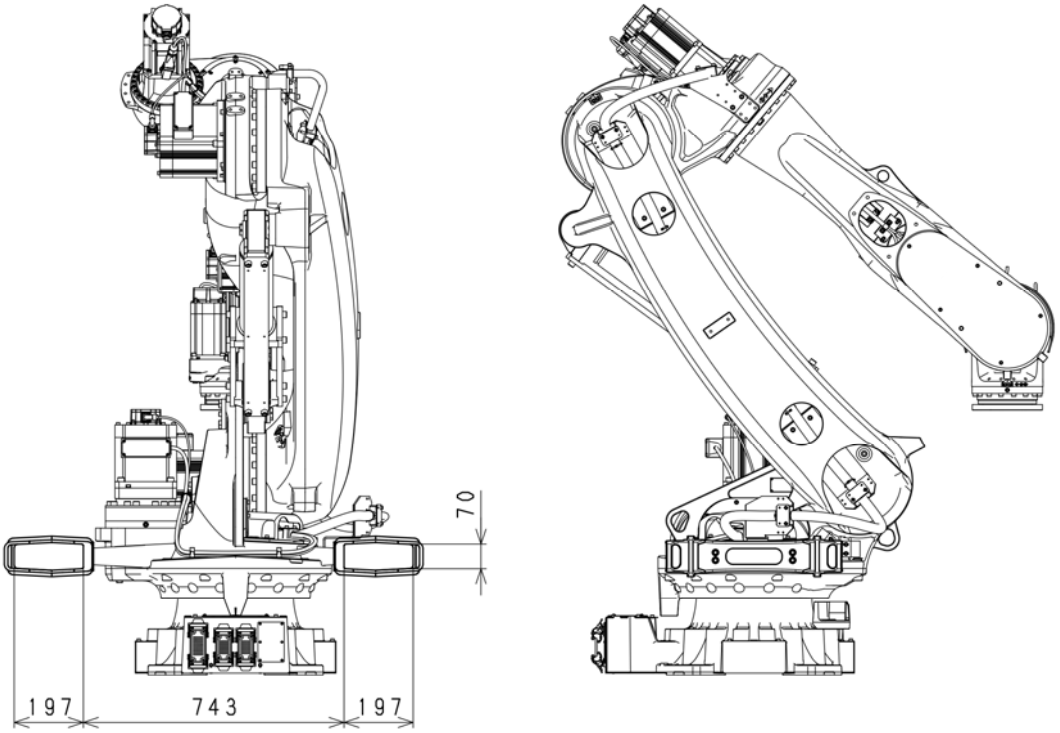
⚠ CAUTION

1. **Check if a fork of the forklift penetrates the transportation jig sufficiently without fail.**
2. **When transporting robot on an inclined or rough surface, be careful to maintain balance to prevent forklift/robot from falling.**
3. **Remove the transportation jig attached to the arm once the installation of robot is complete.**



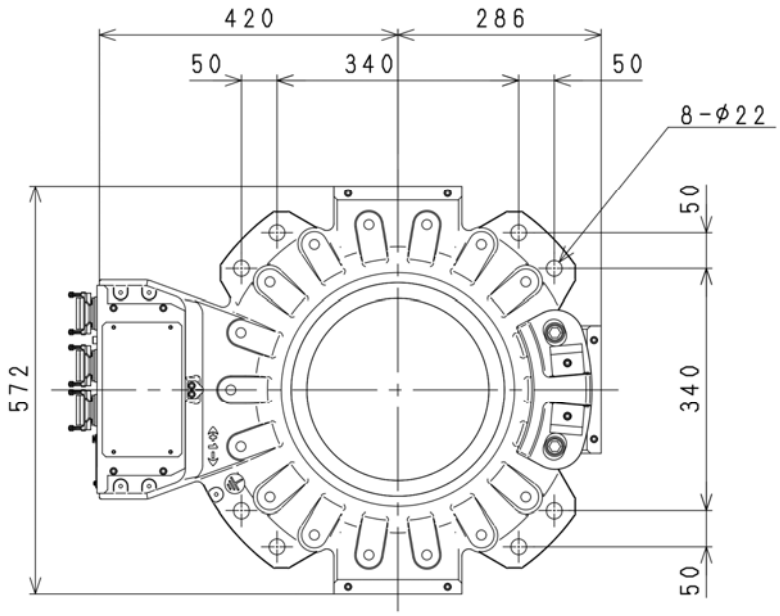
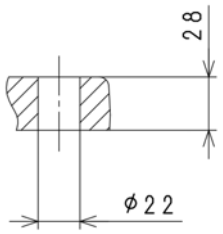
Remove the fork pocket attached to the arm once the transportation of robot is complete.





5 Installation Dimensions of Base Section

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

Model	CX110L, CX165L, CX210L
Dimensions for installation	
Cross-section of installation section	
Bolt hole	8-ϕ22
High tension bolt	8-M20 Material: SCM435 Strength class: 10.9 min.
Tightening torque	431 N·m
Levelness	Within ±5°

6 Movement Reaction Acting on Installation Surface during Operation

Refer to the list below for the movement reaction that acts on the installation surface during operation. Consider these values at installation.

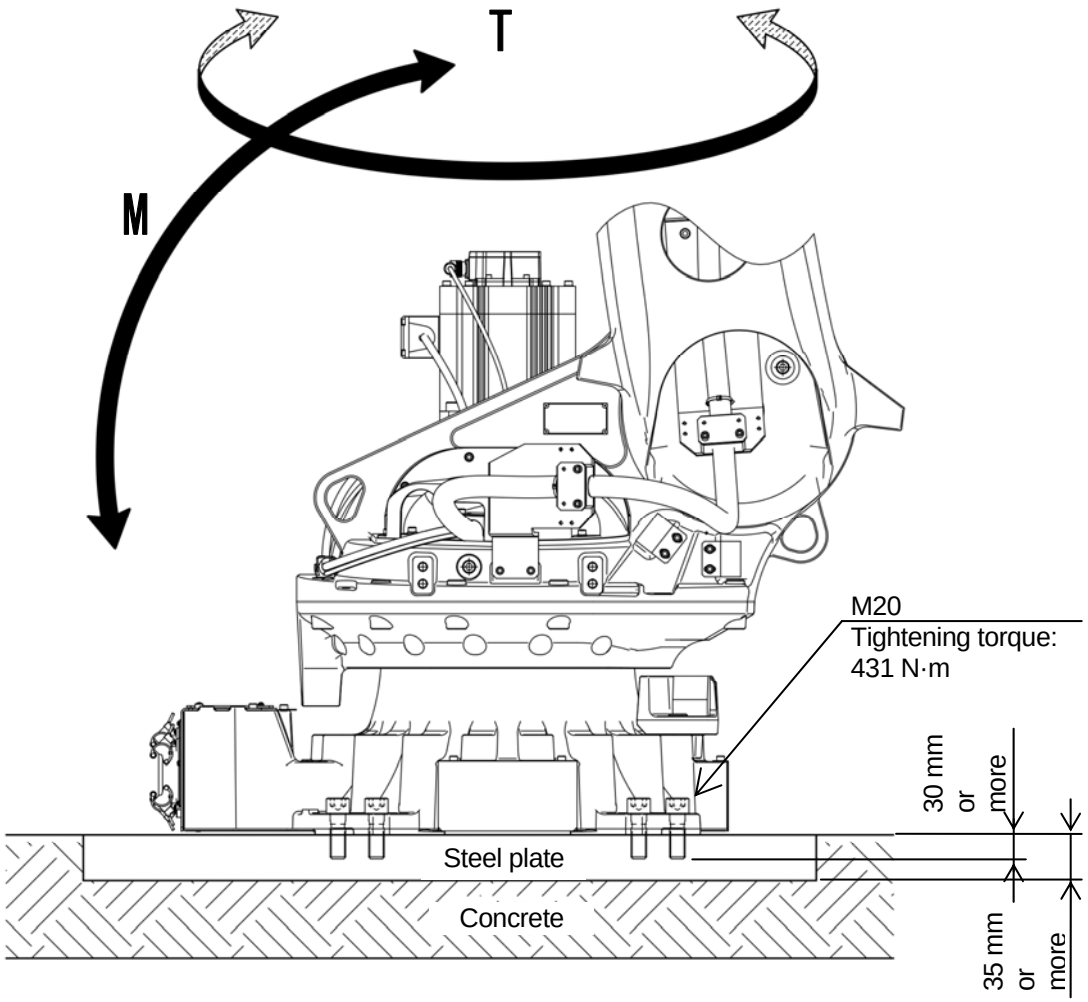
Model	CX110L	CX165L	CX210L
M (Inversion Moment)	32000 N·m	37000 N·m	40000 N·m
T (Rotating Torque)	17500 N·m	17500 N·m	17500 N·m

See the next chapter for M and T.

7 Installation Method

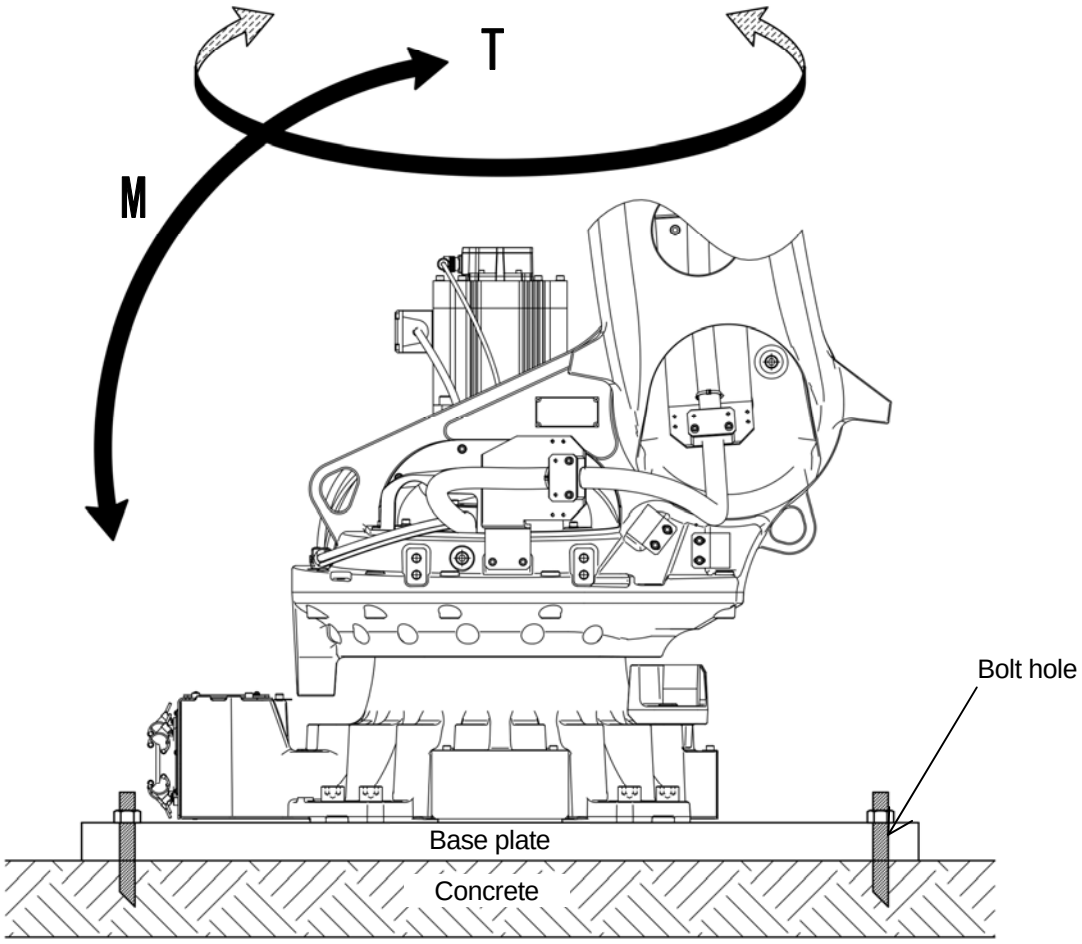
7.1 When Installing the Base Directly on the Floor

In this case, bury steel plate (35 mm Min. thickness) in the concrete floor as shown in the figure below or fix it with anchors. Fix the steel plate firmly enough to endure the reaction forces produced by the robot.



7.2 When Installing the Robot Base Plate on the Floor

In this case, install the base plate on concrete floor or steel plate using bolt holes on the base plate. Reaction forces received from robot are the same as when installing the base directly on the floor.



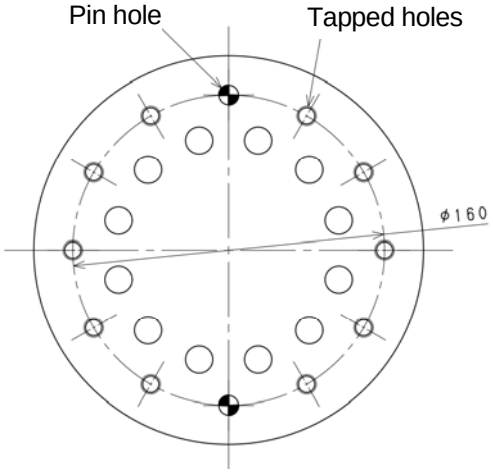
8 Mounting of Tools

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 lockout/tagout the external power switch to prevent personnel from accidentally turning ON the power.

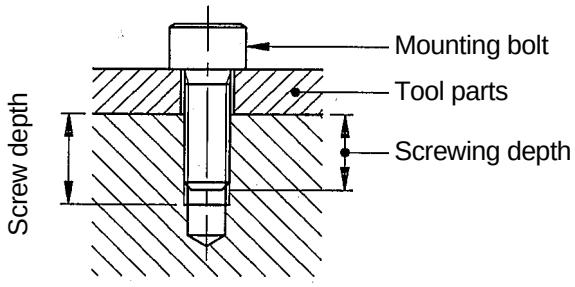
8.1 Dimensions of Wrist End (Flange Surface)

In the robot arm end section, a flange is provided on which tools are mounted. Screw the mounting bolts into the tapped holes on the circumference of ϕ160 on the flange, referring to the below figure. Moreover, position the tool by utilizing the pin holes.



CX110L, CX165L, CX210L Flange

8.2 Specification of Mounting Bolt



	CX110L, CX160L, CX210L
	Standard flange
Tapped holes	10-M10
ϕD	ϕ160
Pin hole	2-ϕ10H7 Depth 12
Screw depth	16 mm
Screwing depth	13 – 14 mm
High tension bolt	SCM435, 10.9 min
Tightening torque	57 N·m

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

CAUTION

If the screwing depth has exceeded the specified value, the mounting bolt might bottom out, and the tool will not be fixed securely.

8.3 Load Capacity

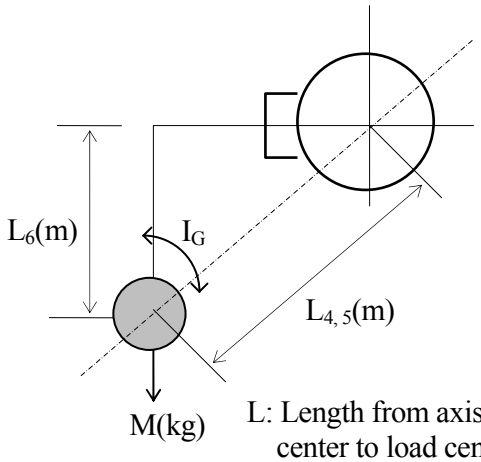
Load mass applicable to robot is specified for each model and includes the mass of tool, etc. Applicable load torque and moment of inertia around wrist axes (JT4, JT5, JT6) are also specified. Strictly observe the following restrictions on them.

⚠ 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



Load mass : M≦Mmax. (kg)
(including workpiece)
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 payload (See 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·m^2)

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 less than the following value.

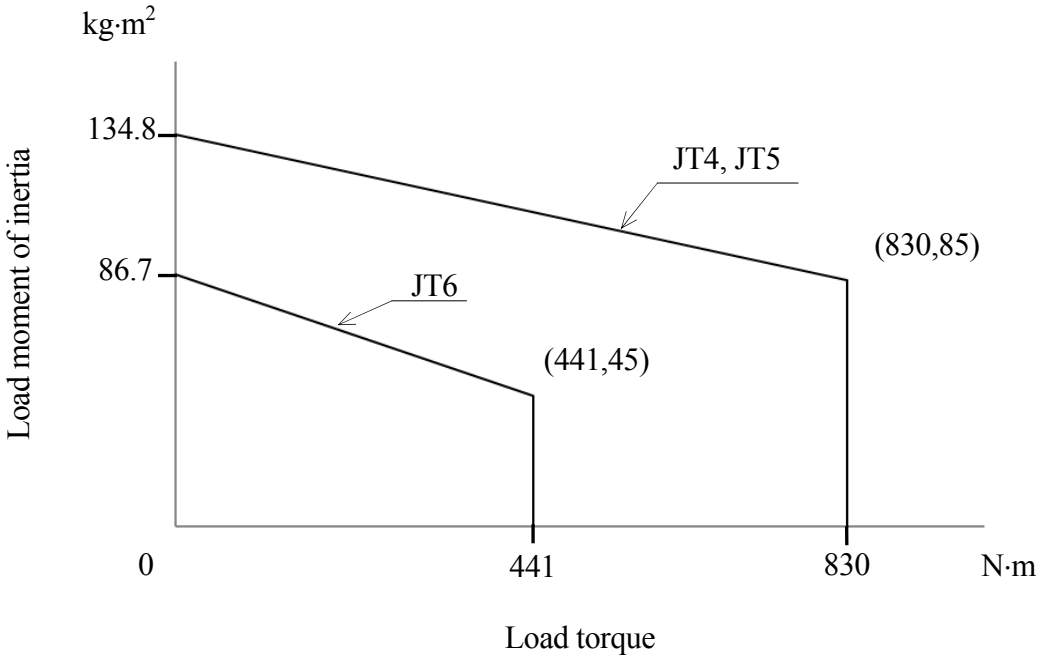
Model	Max. load mass
CX110L	110 kg
CX165L	165 kg
CX210L	210 kg

2. The load torque and the moment of inertia around each wrist axis (JT4, JT5, JT6) should be within the following restriction.

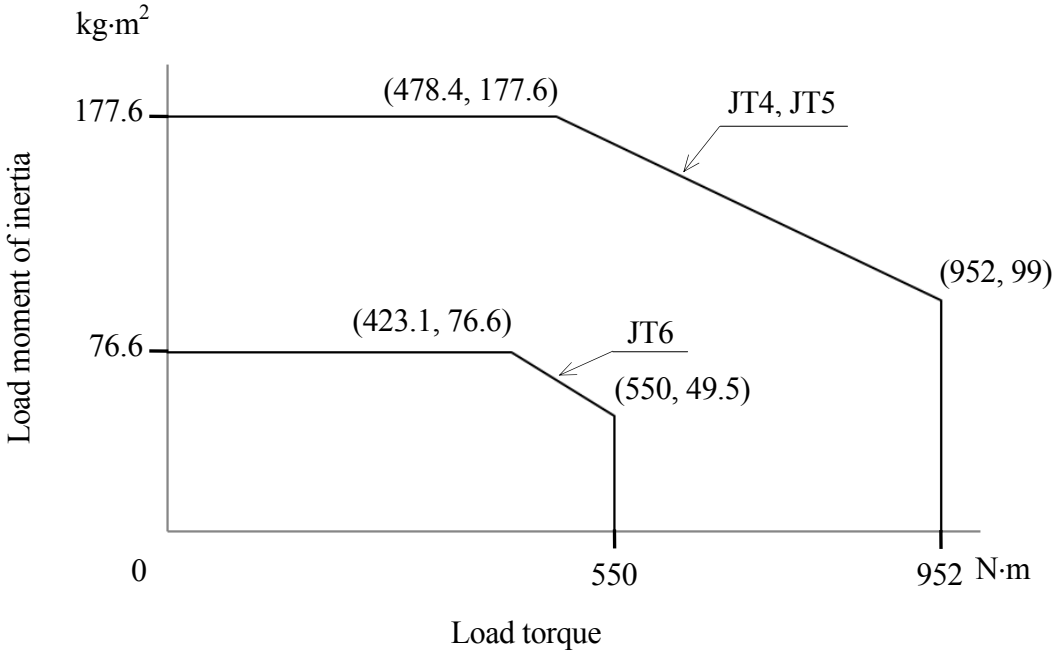
⚠ CAUTION

Set the load data via Auxiliary function 0304 after mounting of tools without fail. Operating robot with wrong settings may cause vibrations in motion, degradation of movement performance and shortening of machine service life.

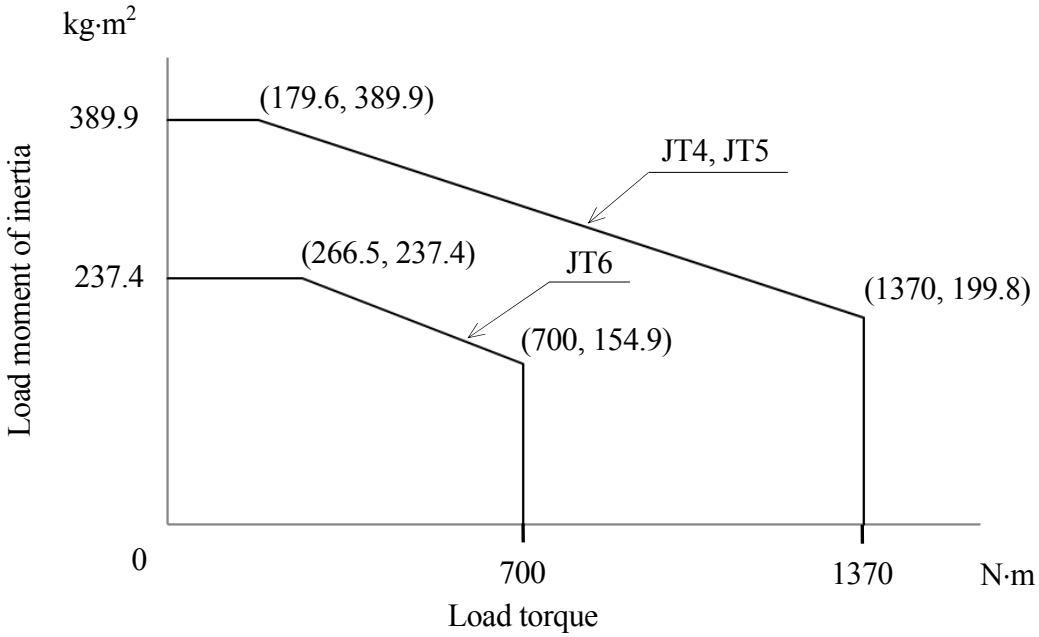
CX110L



CX165L



CX210L



9 Mounting External Equipment

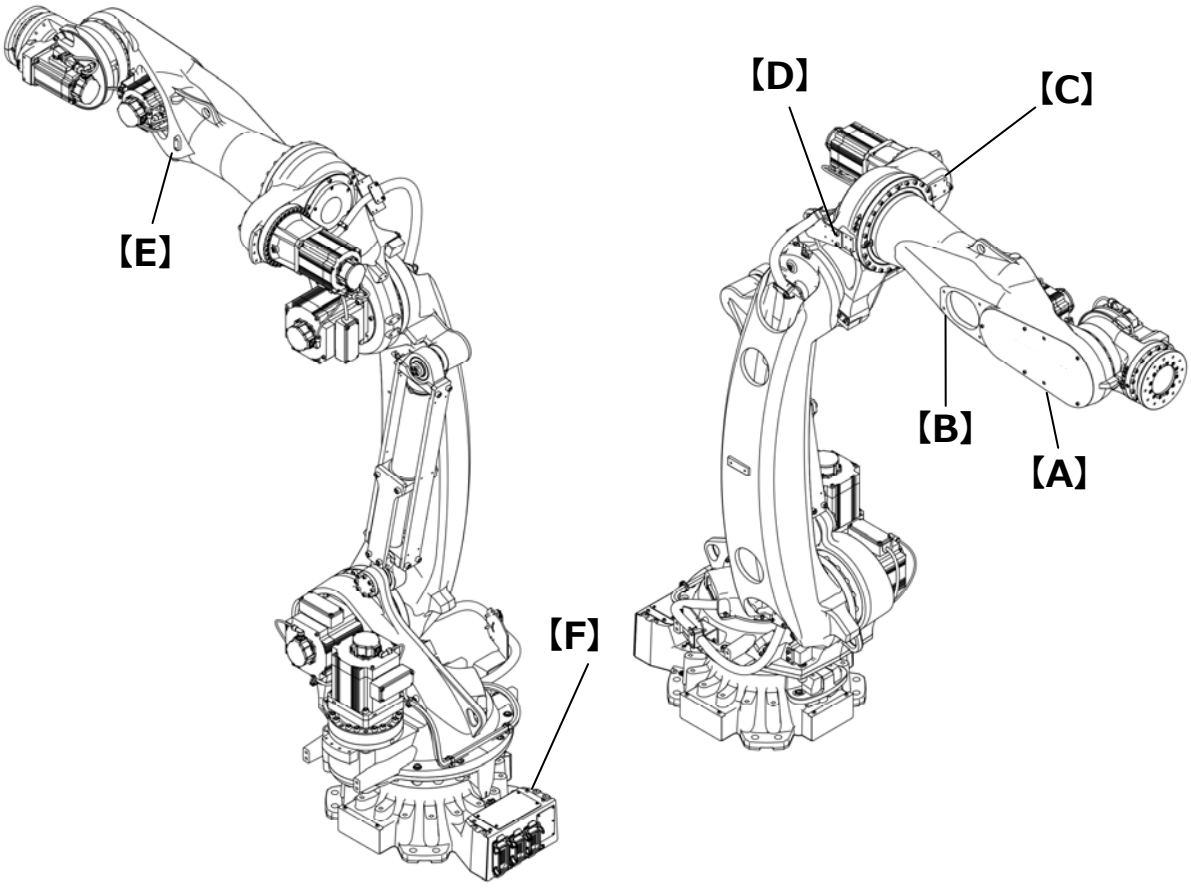
9.1 Service Tapped Hole Positions

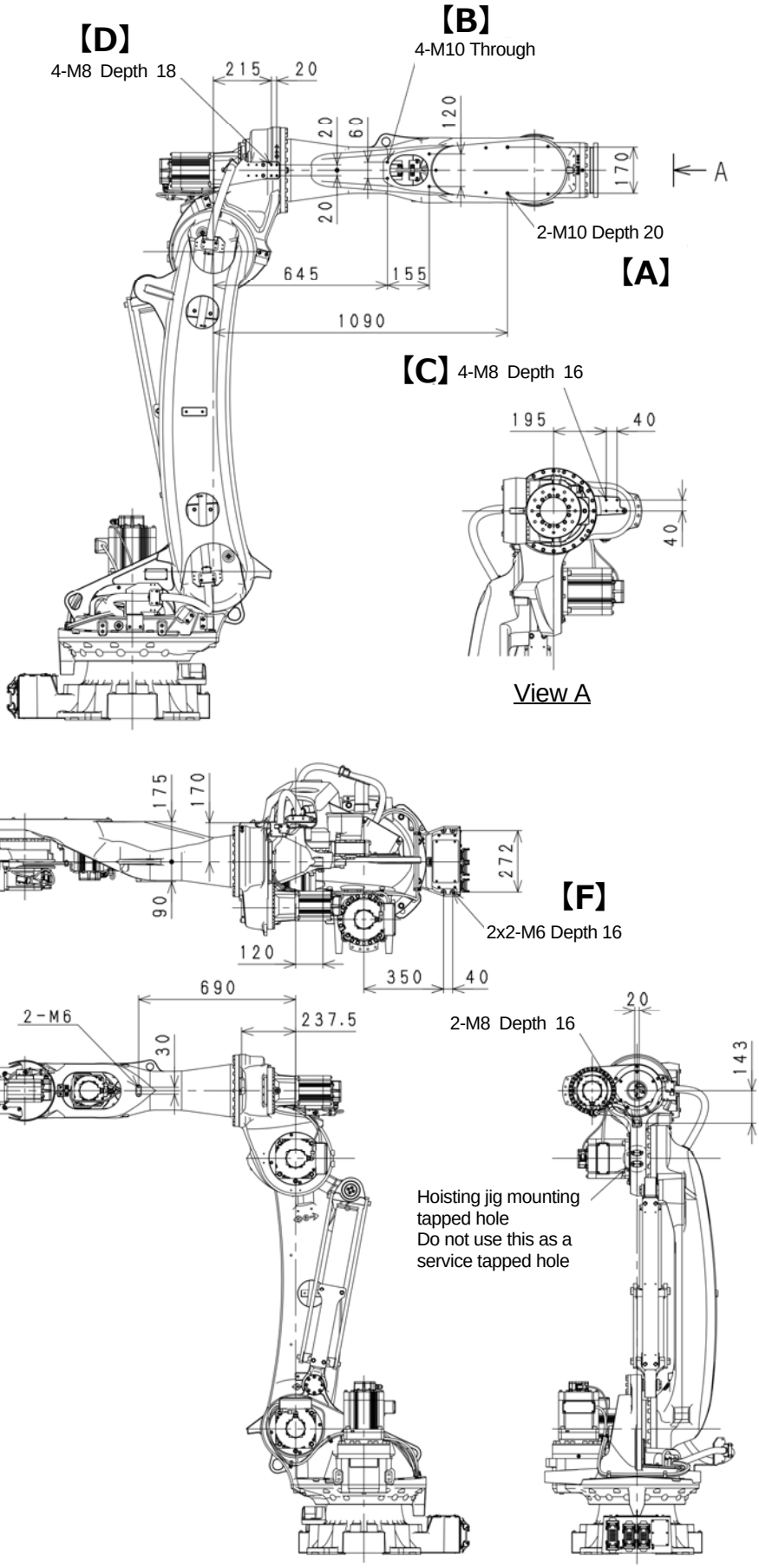
Service tapped holes shown in the figure below are available to mount wiring brackets and external equipment on each part of robot arm.

⚠ CAUTION

Check the robot movement very carefully and confirm that mounted brackets and external equipment do not interfere with peripheral equipment and robot arm itself.

CX110L, CX165L, CX210L




【D】
4-M8 Depth 18
215
20
【B】
4-M10 Through
120
60
20
20
170
A
2-M10 Depth 20
【A】
645
155
1090
【C】 4-M8 Depth 16
195
40
40
View A
175
170
186
90
272
【F】
2x2-M6 Depth 16
120
350
40
690
【E】
2-M6
237.5
30
20
2-M8 Depth 16
143
Hoisting jig mounting
tapped hole
Do not use this as a
service tapped hole

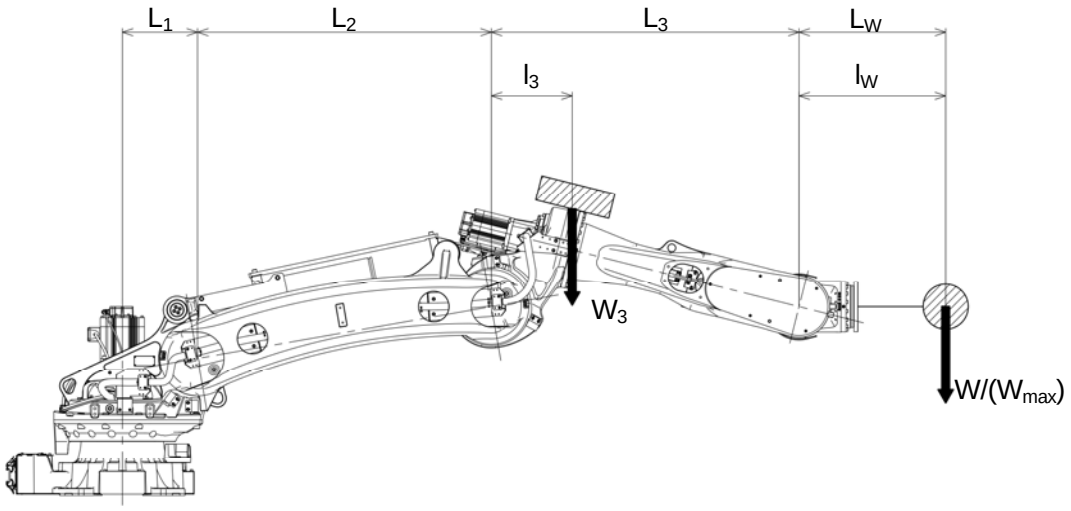
9.2 Calculation of Load Caused by External Equipment

The load capacity is set for each arm model. Strictly observe the following restrictions of the load torque and load moment of inertia on arm.

⚠ CAUTION

Using the robot beyond its specified load capacity may result in degradation of movement performance and shortening of machine service life. If the load exceeds load capacity, first contact Kawasaki without fail.

Calculation Expression



- JT3: $W(L_3+l_w)+W_3 \cdot l_3 \leqq W_{max}(L_3+L_W)$
- JT2: $W(L_2+L_3+l_w)+W_3(L_2+l_3) \leqq W_{max}(L_2+L_3+L_W)$

W_{max} : Max. allowable load [kg]
W : Load on wrist end [kg]
W_3 : Total load on upper arm [kg]
l_w : Length b/w wrist center and the gravity center of load on wrist section [mm]
L_w : Length b/w wrist cntr and gravity cntr of max. allowable load on wrist sect [mm]
l_3 : Length b/w JT2 rotation cntr and gravity center of total load on upper arm [mm]

Use data in the table below for calculation.

	L_1 [mm]	L_2 [mm]	L_3 [mm]	L_w [mm]	W_{max} [kg]
CX110L	300	1172	1227	769	110
CX165L	300	1172	1227	588	165
CX210L	300	1172	1227	665	210

However, do not exceed the value below for W_3.

$W(L_1+L_2+L_3+l_w)+W_3(L_1+L_2+l_3) \leq W_{max}(L_1+L_2+L_3+L_w)$

⚠ CAUTION

W_3, W, l_3 and l_w are set as default in shipment. When using a robot for the first time or when changing the load mass or the position of the gravity center of the load, set the W_3, W, l_3 and l_w via Auxiliary 0304 and 0404. Operating robot with wrong settings may cause vibrations in motion, degradation of movement performance and shortening of machine service life.

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