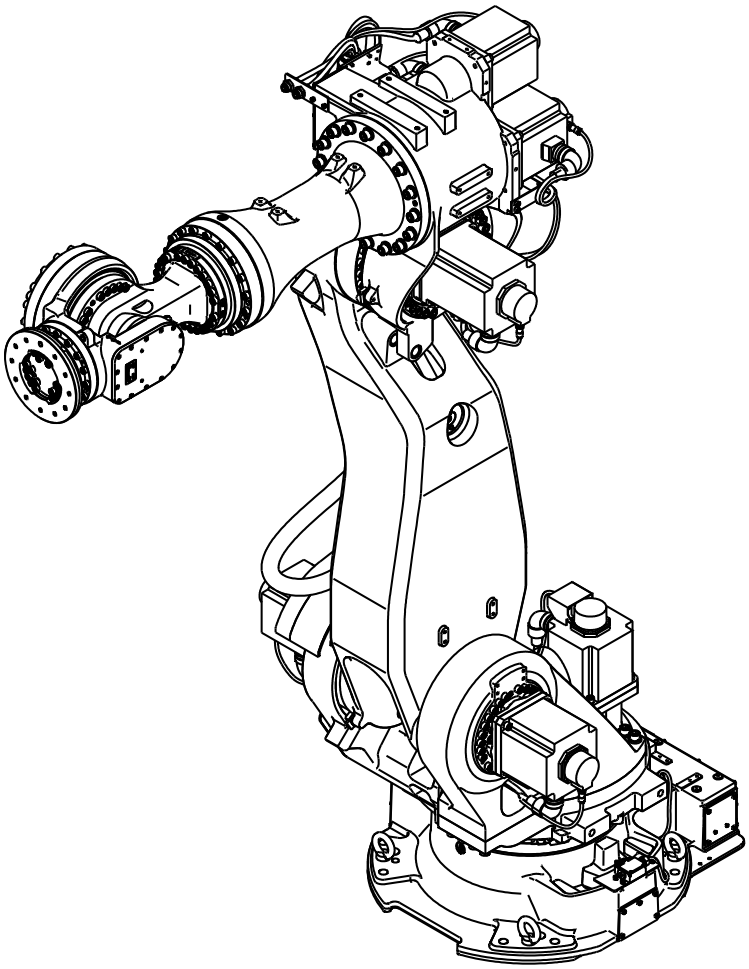
NACHI

Standard specifications

MC350-01-FD11

2nd edition



NACHI-FUJIKOSHI CORP.

1302, SMCEN-044-002,001

NACHI

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1. Outline

“NACHI ROBOT” has used mechatronic techniques, cultivated throughout the last few decades, to supply robots suited for industries utilizing welding and the material handling techniques.
“MC350” is a robot of simple highly rigid structure which is optimal for spot welding and material handling applications.

Max. payload / Installation	350 kg
Floor mount	MC350-01

■ Characteristics

1. Due to high wrist torque and high moment of inertia, this robot is suitable for handling of heavy payload.
2. Wide motion range makes easier applicability than before.
3. By installing the balance unit inside arm, swivel base becomes slim and interference radius gets substantially shorter than before.
4. Due to making higher maximum speed, cycle time is shortened. Also it is possible to get faster air-cut motion that is changing wrist attitude widely.
5. This robot features the largest wrist bend angle in its class due to the slim compact wrist. The reduction of restriction due to wrist operation opens the robot to more diverse applications.
6. The required installation area has been reduced by routing water, air and cables through the swivel base for material handling application.

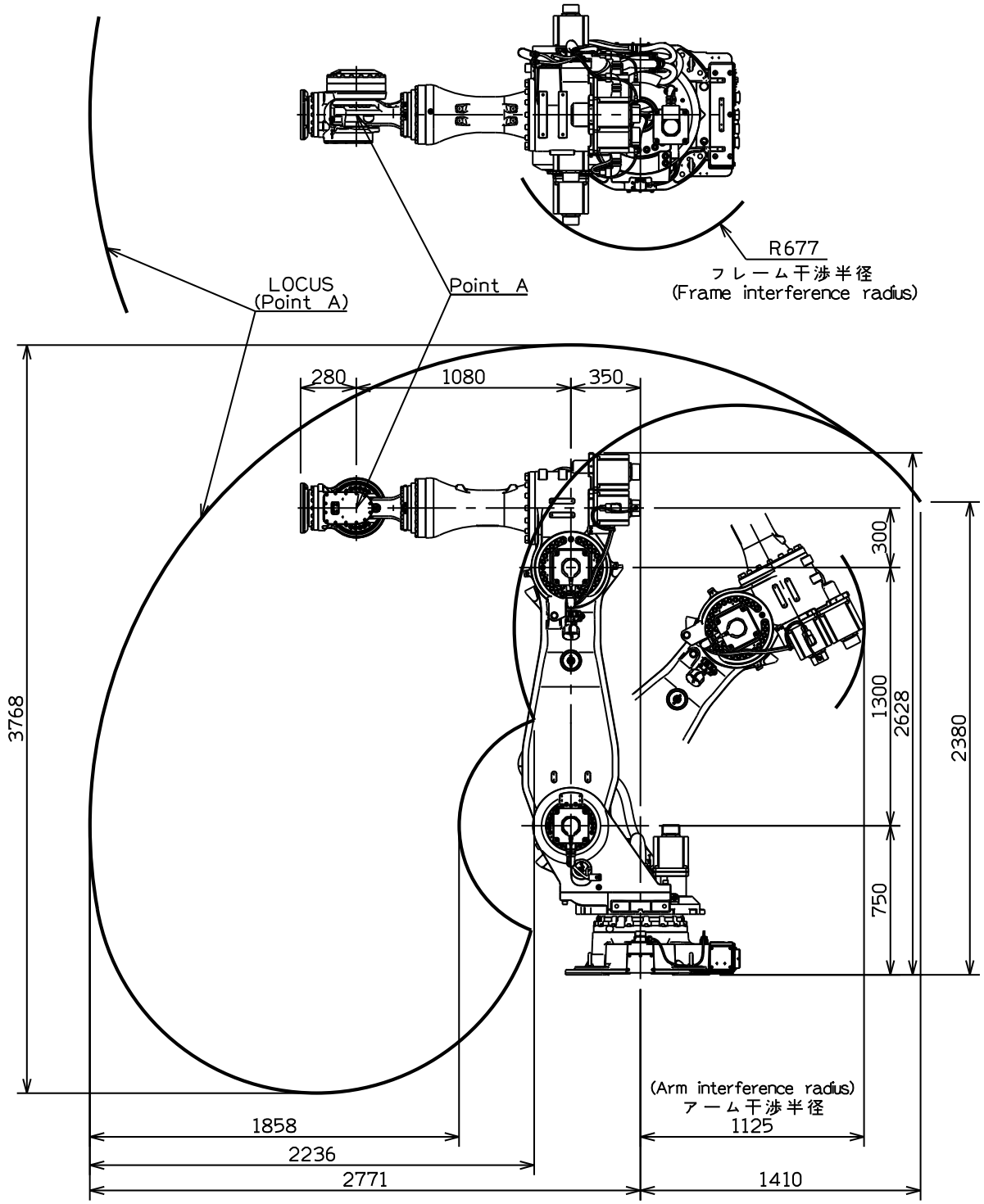
2. Basic specifications

Item		Specifications
Robot model		MC350-01
Construction		Articulated
Number of axis		6
Drive system		AC servo motor
Max. working envelope	Axis 1	±3.14 rad （±180°）
	Axis 2	-1.75 ～ +0.70rad （-100 ～ +40°）
	Axis 3	-3.14 ～ +2.27 rad （-180 ～ +130°）
	Axis 4	±6.28 rad （±360°）
	Axis 5	±2.18 rad （±125°）
	Axis 6	±6.28 rad （±360°）
Max. speed	Axis 1	1.83 rad/s （105°/s）
	Axis 2	1.66 rad/s （95°/s）
	Axis 3	1.66 rad/s （95°/s）
	Axis 4	1.92 rad/s （110°/s）
	Axis 5	1.92 rad/s （110°/s）
	Axis 6	3.14 rad/s （180°/s）
Max. pay load	Wrist	350 kg
	Forearm *1	50 kg at maximum
Allowable static load torque	Axis 4	2750 N·m
	Axis 5	2750 N·m
	Axis 6	1235 N·m
Allowable moment of inertia *2	Axis 4	400 kg·m^2
	Axis 5	400 kg·m^2
	Axis 6	250 kg·m^2
Position repeatability *3		±0.2 mm
Installation		Floor mounting
Ambient conditions		Temperature: 0 to 45 ºC Humidity: 20 to 85%RH (No dew condensation allowed) Height: Not higher than 1,000 meters above sea level Vibration to the installation face: Not more than 0.5G (4.9 m/s^2)
Robot mass		1,620 kg

1[rad] = 180/π[°], 1[N·m] = 1/9.8[kgf·m]
On controller display, axis 1 to 6 is displayed as J1 to J6 for each.
The specification and externals described in this specification might change without a previous notice for the improvement.

*1: This value changes by placement and load conditions of a wrist.
*2: The Allowable moment of inertia of a wrist changes with load conditions of a wrist.
*3: This value conforms to "JIS B 8432".

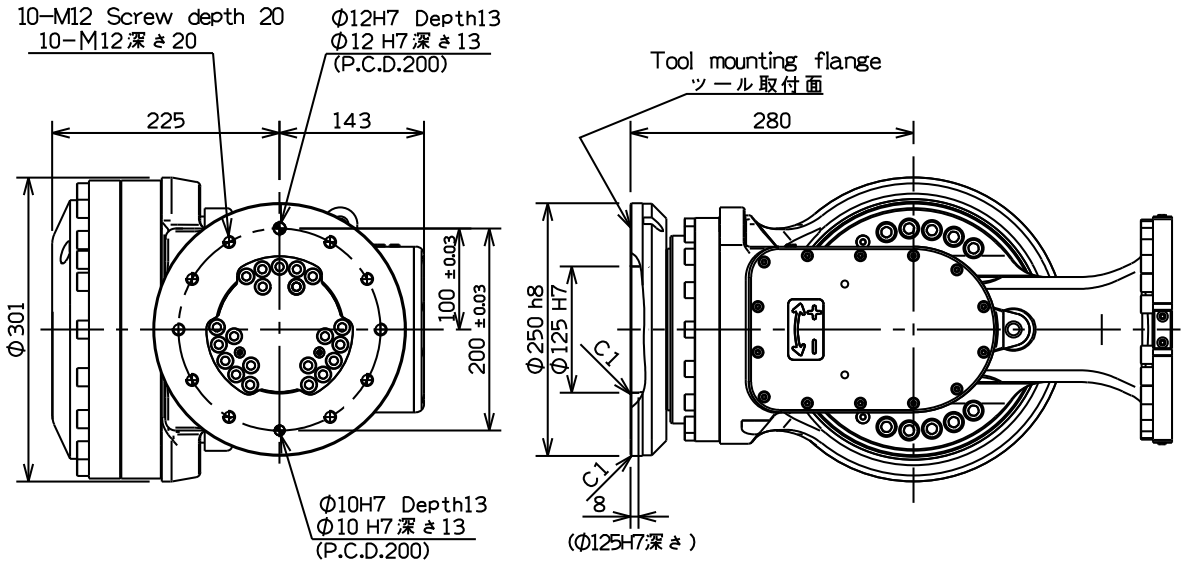
3. Robot dimensions and working envelope



4. Detail of tool mounting plate

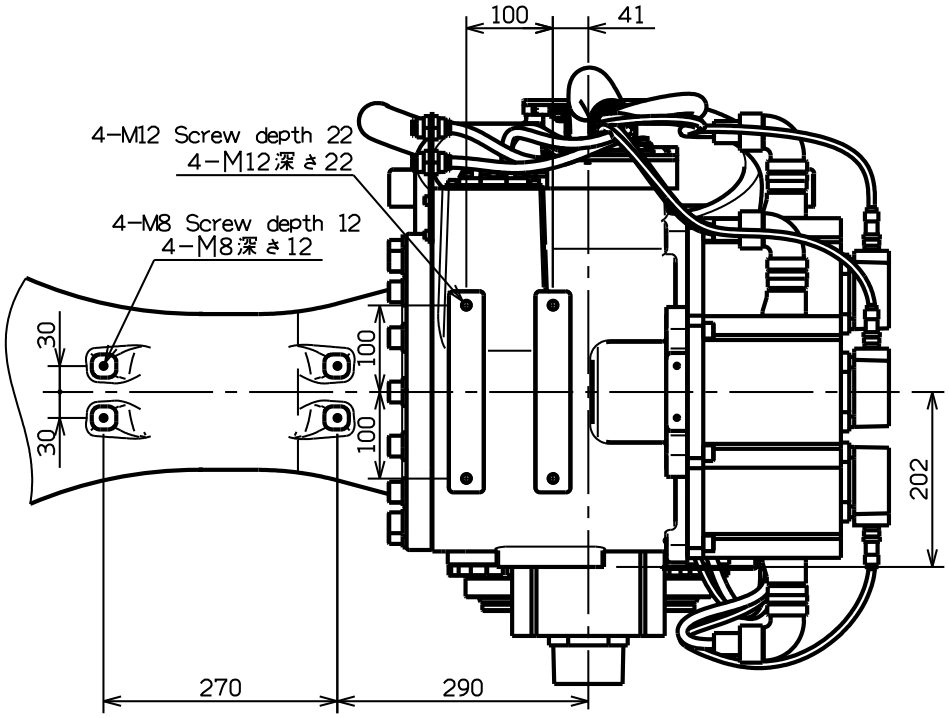
For the end effecter fixing bolts, use the mounting P.C.D. shown in the following figures.
Besides the mounting P.C.D., different P.C.D. (option) is available. For details, contact our service division.

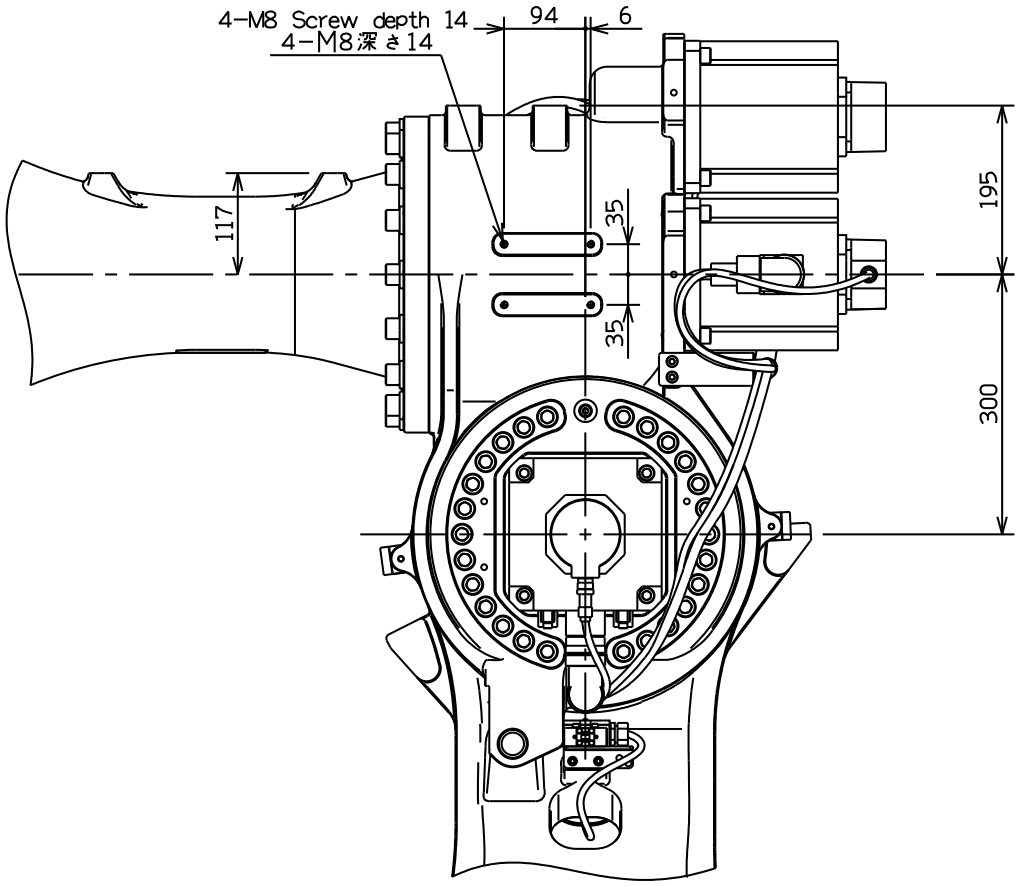
CAUTION	Be sure to screw the M12 tool fixing bolts in the wrist not deeper than the screw depth in the mounting face. Screwing the bolts deeper than the screw depth may damage the wrist.



5. Details of upper part of forearm

Ancillary equipment can be mounted to the upper part of robot forearm.





6. Installation procedure

The installation location and the installation procedure of the robot are critical factors to maintain robot functions. The ambient conditions of installation location not only have influence on the life of mechanical sections of the robot, but also get involved in safety issues. Consequently, strictly observe the environmental conditions shown below. Furthermore, utmost care should be exerted for the installation procedure and the foundation for the robot in order to maintain the robot performance. Strictly observe the installation procedure for the robot provided below.

Installation

To install the robot, give it first priority to thoroughly consider safety of workers and take safety measures. The following describes precautions for this purpose.

Safety measures against entry in the robot operating area

WARNING	While the robot is in operation, workers are in danger of coming in contact with the robot. To avoid that, install a **Safety fence** so as to keep the worker away from the robot. Not doing so will cause the workers or other persons to accidentally enter the operating area, thus resulting in accidents.

■ Installation location and ambient conditions

Conditions (temperature, humidity, height and vibration) are written in “2. Basic Specifications”. Further ambient conditions listed below must be observed.

(1) Location with the drainage structure so that swivel base is not flooded, when the liquid such as water or cutting fluid is splashed on the robot body
(2) Location with no flammable or corrosive fluid or gas.
(3) Type D grounding (the grounding resistance is 100Ω or less) is necessary.

■ Installation procedure

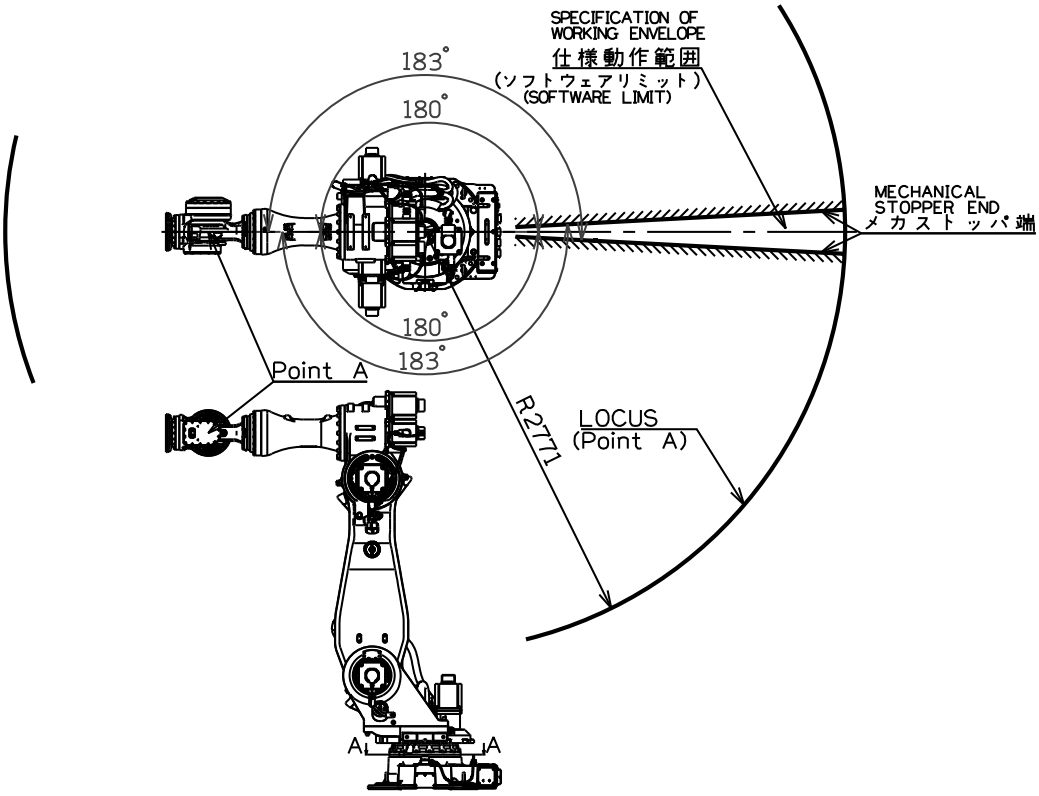
While robot moves, large reaction force is applied to the swiveling base from all directions. Consequently, the robot should be installed in such a manner that the foundation endures reaction force caused by accelerating or decelerating the speed to lock the robot, not to mention that it endures static loads.
To install the robot on the floor, if the floor concrete is not less than 160 mm in thickness, repair uneven spots, cracks, and others on the floor, and then install the robot with the use of 8 bolts (option) of M20 (JIS: Strength class 12.9) not less than 65mm and plain washers (option) of not less than 4.5 mm in thickness and HRC35 in hardness. At this time, apply a coating of lubricating oil to the threaded parts of the bolts, and then torque the bolts to 560 ± 30 N·m. Furthermore, to install the robot in an exact position, use location pins (option). If the floor concrete is not more than 160 mm in thickness, an independent foundation should be constructed. Inspect the foundation prior to the robot installation, and then construct the foundation, if necessary.

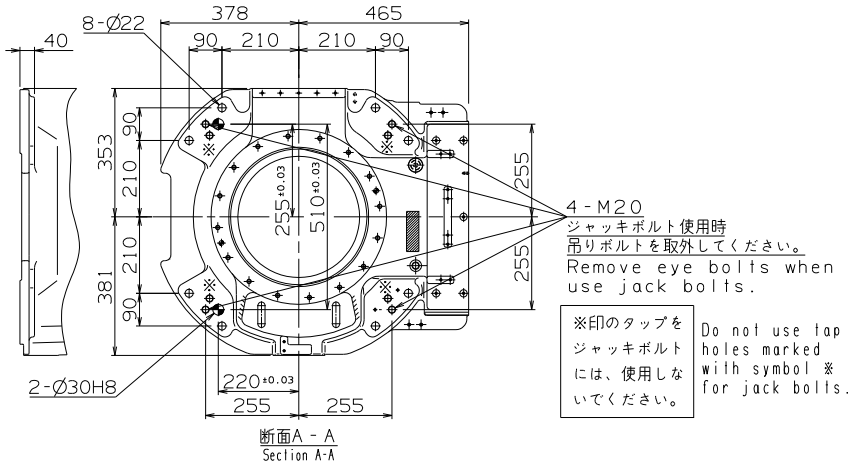
Robot model	Allowable repeated tensile load per foundation bolt when the robot is installed with 8 bolts
MC350-01	Approximately 47,000 N

■ Installation space

To install the robot, lock the swiveling base of the robot.

CAUTION	The mechanical stopper end is located in a position exceeding the specified working envelope (software limit) of axis 1 by 3°. To install the safety fence, with consideration given to the wrist configuration and the shape of end effecter.
DANGER	On axes 1, 2 and 3, the robot working envelope can be regulated for safety (optional function). Since optional parts should be installed to enable this function, do not independently move the standard parts (e.g. mechanical stopper).



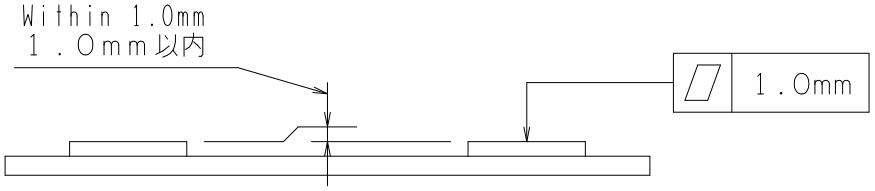


■ Accuracy of installation surface

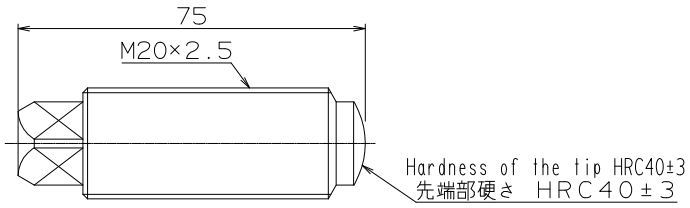
When installing robot, strictly observe precautions listed below to cause no deformation in the swivel base.

(1) Make the deviation from the flatness of the 4 plates on the robot installation surface fall within 1.0 mm.

(2) Make the deviation in height between the 4 places of each base plate installation surface and the robot installation surface fall in the range of 1.0 mm (±0.5 mm).



(3) If the two precautions above cannot be observed, use jack bolts to bring the four places into even contact with the installation surface.

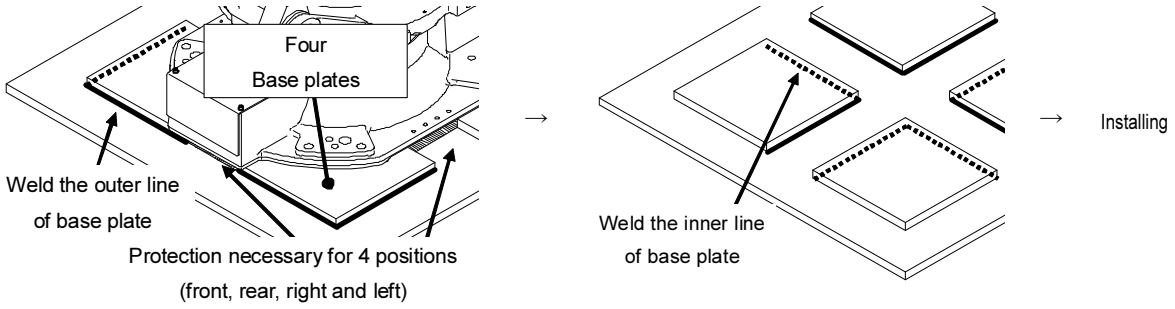


■ Welding of base plate

Protect the space (4 places of the front, back, left and right) on robot bottom and installed side by the cover etc. as follows when you weld with the base plate installed in the robot body by the welding spatter and the spark, etc. so that wiring in the robot should not receive damage. After welding the outer line, once remove the robot and weld the inner line.

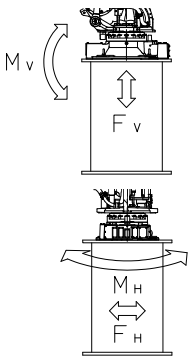
Temporary install the robot, and weld the outer line of base plate.

Once remove the robot and weld the inner line.



■ Maximum robot generative force

Robot model	Max. vertical generative force F_V	Max. horizontal generative force F_H	Max. vertical generative moment M_V	Max. horizontal generative moment M_H
MC350-01	64,900 N	47,300 N	147,700 N·m	122,200 N·m

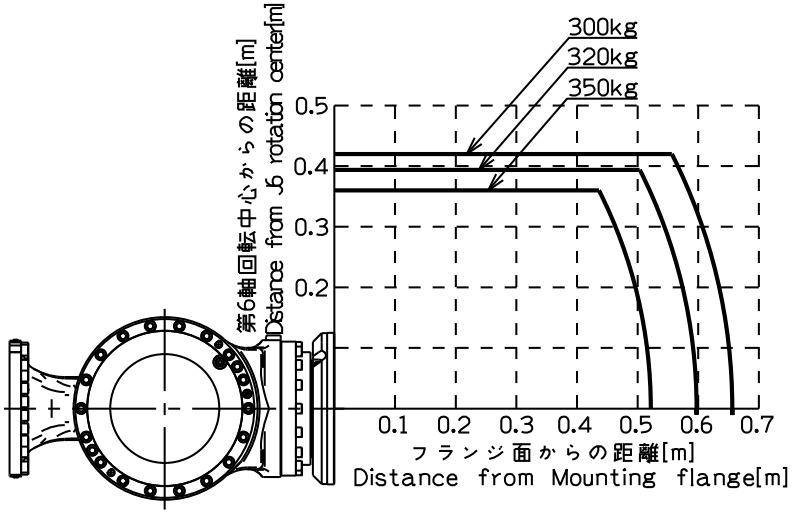


7. Allowable wrist load

CAUTION	Load fixed on the tip of wrist is regulated by “allowable payload mass”, “allowable static load torque”, and “allowable moment of inertia”. Strictly keep the wrist load within each allowable value. If wrist load exceeds the allowable value, this robot is out of guarantee. Refer to the table of “2. Basic specifications” and following figures for the detail of each specification.

■ Torque map

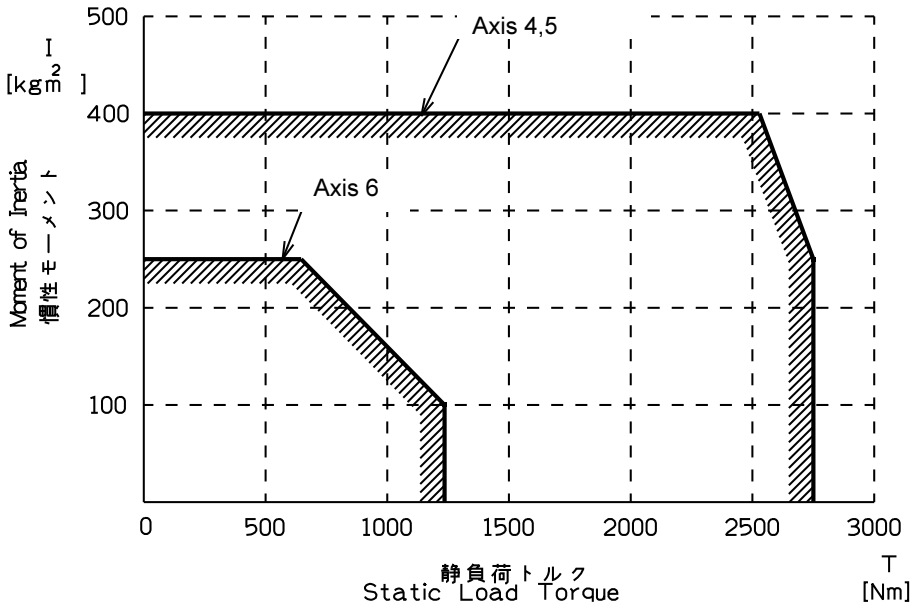
C.O.G. of wrist load should exist inside the range shown below.



■ Wrist load conditions

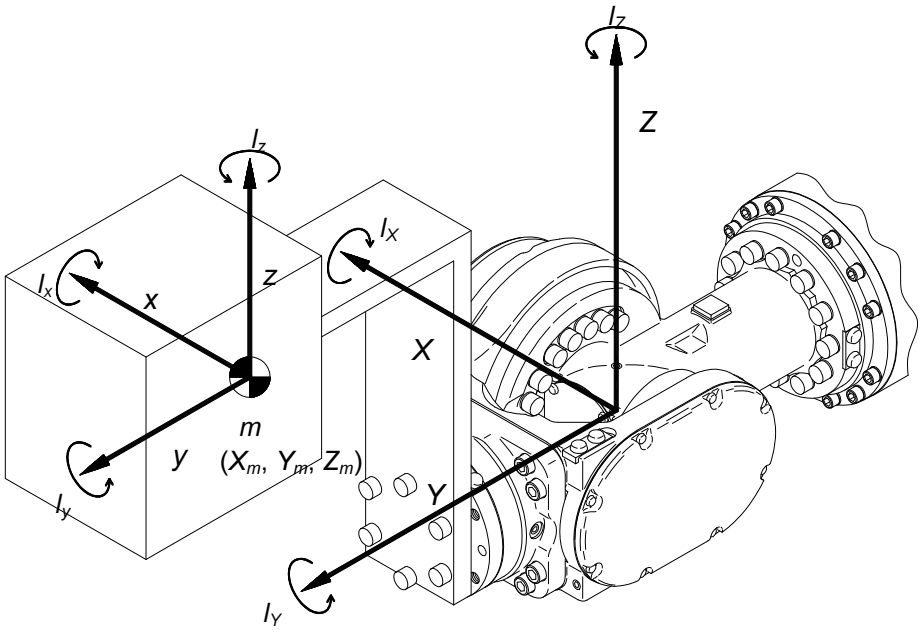
Static load torque and moment of inertia of wrist load should exist inside the range shown below.

IMPORTANT	If the real inertia is over the limit, maximum speed will be restrained by software to protect he robot.



■ How to find the inertia moment of each axis

The following section shows general methods of calculating the inertia moment around each axis.



X: Axis 5 rotation in the basic wrist configuration
Y: Axis 6 and axis 4 rotation in the basic wrist configuration
Z: Axis at right angles to the X and Y axes in the basic wrist configuration
x: Axis parallel to the X axis in the load gravity center
y: Axis parallel to the Y axis in the load gravity center
z: Axis parallel to the Z axis in the load gravity center
I_x: Inertia moment around the X axis passing through the load gravity center
I_y: Inertia moment around the Y axis passing through the load gravity center
I_z: Inertia moment around the Z axis passing through the load gravity center
m: Load mass
(X_m, Y_m, Z_m): Gravity center coordinates of load

1. Inertia moment around axis 6

The inertia moment of around axis 6 is found by the expression shown below.

$$I_{J6} = I_Y = m \cdot (X_m{}^2 + Z_m{}^2) + I_y$$

2. Inertia moment around axis 4 and axis 5

The inertia moment around axis 4 and axis 5 varies with axis 6 configuration. Consequently, in order to simplify the calculation, take a maximum value around the X and Z axes in above figure, as the inertia moment.

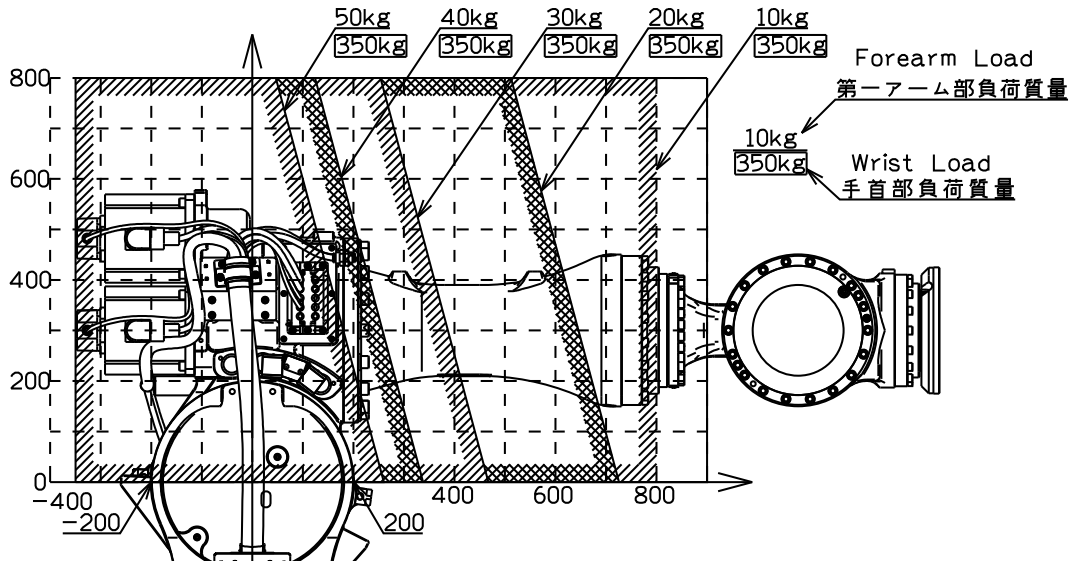
$$I_{J4J5} = \max (I_X , I_Z)$$

$$\because I_X = m \cdot (Y_m{}^2 + Z_m{}^2) + I_x$$

$$\because I_Z = m \cdot (X_m{}^2 + Y_m{}^2) + I_z$$

■ Allowable forearm load

Use the robot under condition that COG of the ancillary equipment on the forearm falls in the range shown below.



8. Option specifications

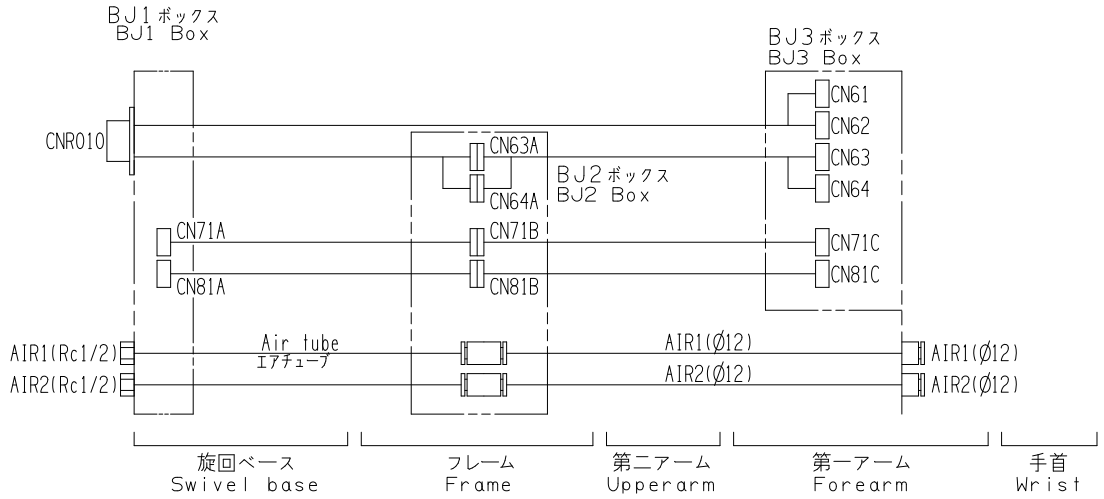
○: Possible to correspond／－: Impossible to correspond

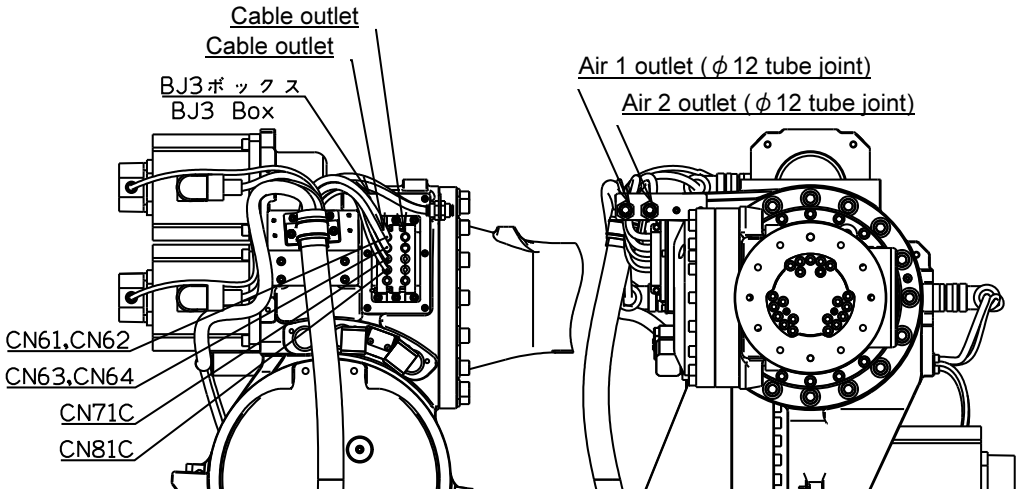
No.	Item	Specifications		Parts No.	Robot model MC350-01
1	Installation parts *1	Chemical anchor specification Base plate welded	with pin hole	OP-F1-024	○
			without pin hole	OP-F1-028	○
		Ore anchor specification Base plate welded	with pin hole	OP-F2-018	○
			without pin hole	OP-F2-019	○
		Pins set (Installation pins & polyethylene plug)		OP-F1-025	○
		Leveling plate (□180mm×t=32mm, 4 plates)		OP-F1-026	○
		Installation bolts & washers		OP-F1-027	○
		Ore anchor		OPJ-F2-0004	○
		Chemical anchor			○
2	Axis 1 adjustable stopper *1	Restriction of axis 1 operation edge Including adjustable limit switch dog (±2.61 rad every 0.17 rad)		OP-S5-012	○
3	Axis 2 adjustable stopper *1	Restriction of axis 2 operation edge (-0.26 and -0.52 rad from the operation edge)		OP-A5-027	○
4	Axis 3 adjustable stopper *1	Restriction of axis 3 upside operation edge (-1.05 rad･-1.31 rad from upper end, -1.31 rad from lower end)		OP-A5-027	○
5	Axis 2 adjustable LS dog	Axis 2 axis adjustable limit switch dog set		OP-S8-008	○
6	Axis 3 adjustable LS dog	Axis 3 axis adjustable limit switch dog set		OP-S4-012	○
7	Axis 1 base LS	To detect Axis 1 zone	No LS (dog only) 1 base		
			No LS (dog only) 3 bases		
8	Axis 2 arm clear LS	To detect axis 2 home position and back position	With dog attaching plate		
			Without dog attaching plate		
9	Transfer jig	Fork bracket for floor mounting type		OP-S2-041	○
10	Zeroing pin & block *1			OP-T2-073	○
11	ISO Flange adaptor	Converts into the tool installation size with ISO		standard	○
12	Dual circuit limit switch	For axes 1, 2 and 3 (3pcs. of dual circuit LS)		standard	○
13	Encoder connector Protector	For axis 2, 3		OP-P6-006	○
14	Bypass cable *1			BCUNIT20-100	○
15	Scale seal	For wrist three axes		OP-N2-020	○

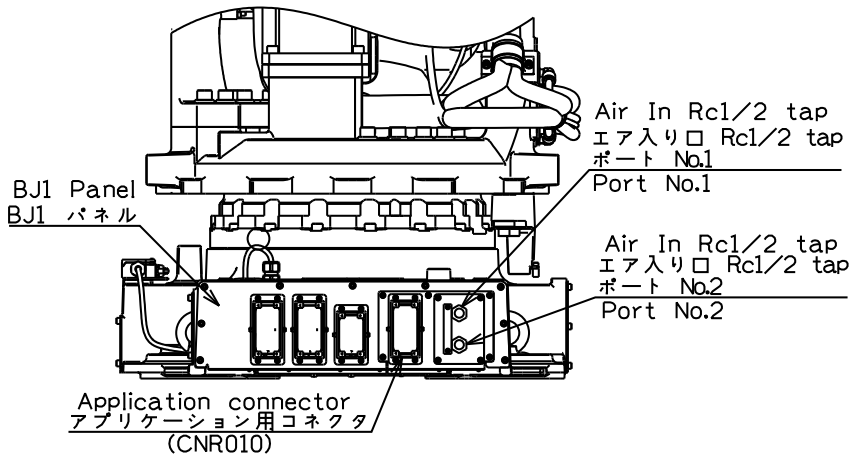
*1 : These parts are packed separately from the robot. (Not attached on the robot)

9. Application wiring and piping diagram

■ **Standard specification**



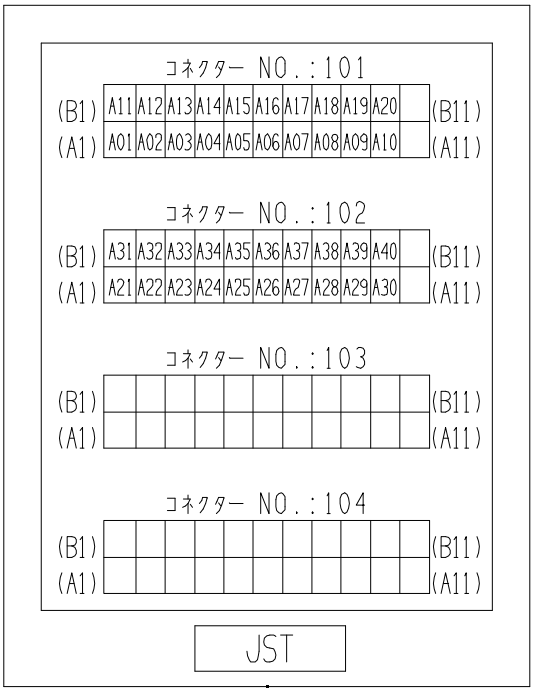




※ In wiring BOX (BJ3 BOX), there is an “application connector of BJ3 side”.

■ Details of application connectors (standard)

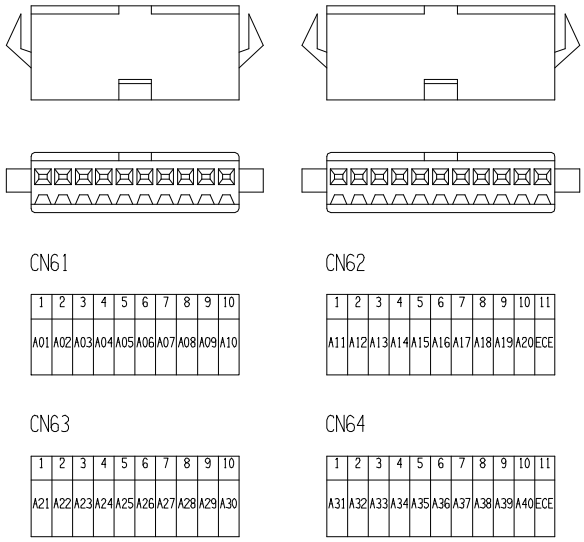
（1）BJ1 side (connector)



User-side Connectors
Wire-side shell: JFM-WSA-4-A (JST)
or JFM-WSA-4-C (JST)
Guide plate A kit: JFM-GPAK-4 (JST)
Receptacle housing: JFM2FDN-22V-K (JST)
Receptacle contact:
a: SJ2F-01GF-P1.0 (JST) (0.20 ~ 0.50sq)
b: SJ2F-21GF-P1.0 (JST) (0.30 ~ 0.75sq)
Manual crimp tool:
a: YRS-8861
b: YRF-1120
Cable diameter suitable for wire-side shell:
JFM-WSA-4-A φ26.2～φ28.0
JFM-WSA-4-C φ15.5～φ16.5
(Pin location shows the connector mounted on robot body and is the view from connecting side.)

Application wiring specification
Rated voltage Max. AC/DC 115 V
Rated current rating Max. 1 A

（2）BJ3 side (connector)



Connector form (CN61, CN63)
Housing SMP-10V-BC (JST)
User-side Connectors
Housing SMR-10V-B (JST)
Contact SYM-001T-P0.6 (Wire of Application : AWG#22～28)
Pressure tool YRS-121

Connector form (CN62, CN64)
Housing SMP-11V-BC (JST)
User-side Connectors
Housing SMR-11V-B (JST)
Contact SYM-001T-P0.6 (Wire of Application : AWG#22～28)
Pressure tool YRS-121

■ **Details of Devicenet connectors (standard)**

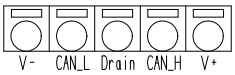
CN71A

1	2	3	4
24V+	24V-	24V+	24V-

CN71C

1	2	3	4
24V+	24V-	24V+	24V-

CN81A



Connector
in wiring box BJ1

CN81C

Connector
in wiring box BJ3

		CN71A	**CN71C**
Connector	Housing	VLR-04V	VLP-04V
User-side connector	Housing	VLP-04V	VLR-04V
	Contact	SVF-61T-P2.0 (0.5～2.0 mm^2) SVF-42T-P2.0 (0.3～1.25 mm^2)	SVM-61T-P2.0 (0.5～2.0 mm^2) SVM-42T-P2.0 (0.3～1.25 mm^2)
	Retainer	VLS-02V	
	Crimp tool	YC-590 (SV*-61T-P2.0) YC-592 (SV*-42T-P2.0)	

		CN81A	**CN81C**
Connector		231-635/010-DM	231-305/037/010-DM
User-side connector	Connector	231-305/037/010-DM	231-635/010-DM
	Crimp tool	231-131	
	Contact	CAN_L, CAN_H : 216-301 V-, V+ : 216-201 Drain : 216-201 Crimp tool : 206-204	

(Pin location shows the connector mounted on robot body and is the view from connecting side.)

(NOTE) Adequate contact and manual crimp tool should be used for each cable.
User-side connectors need to be prepared by customer.

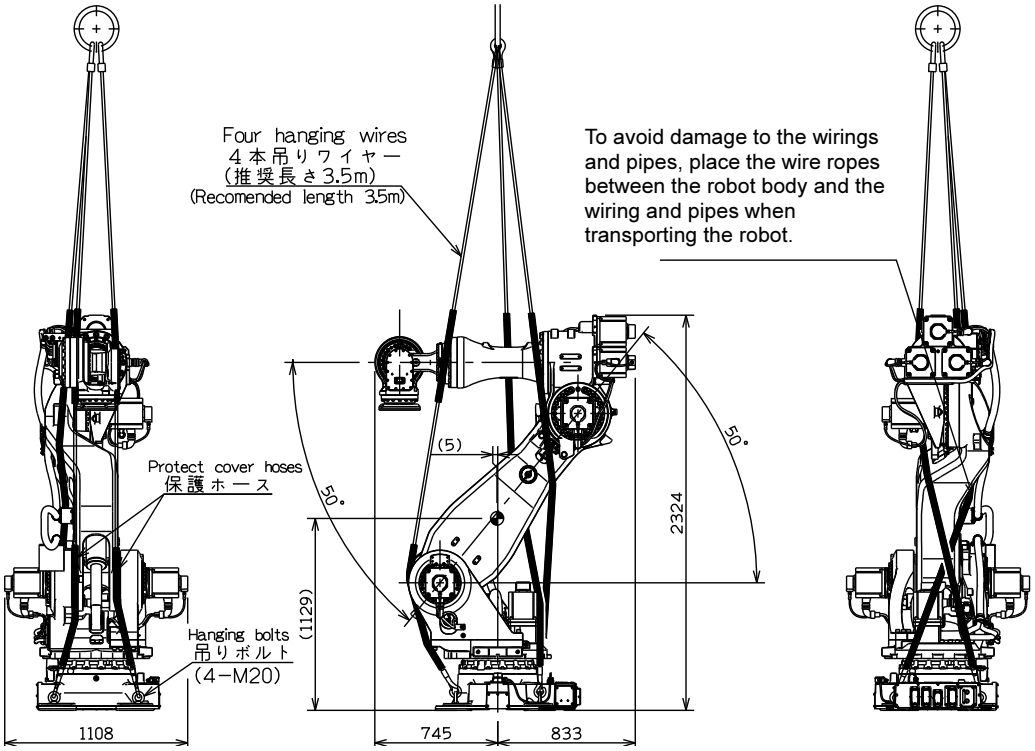
10. Transport procedure

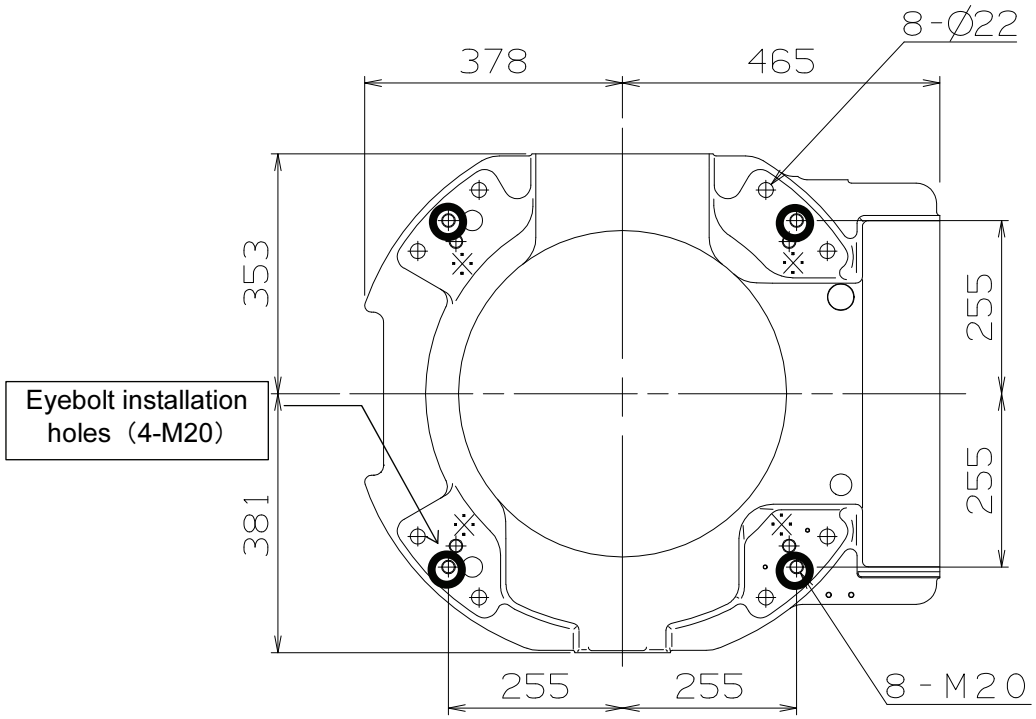
Safety measures against transport

The following describes precautions for transporting the robot. Fully understand the precautions for safe transport work.

⚠ WARNING	The robot must be transported by personnel who have licenses required for slinging work, crane operation, forklift truck operation, and others. The weight of the robot and controller is listed in the Operating Manual and the Maintenance Manual. Check for the weight, and then handle them according to procedures suitable for the weight.
⚠ WARNING	To lift the robot or the controller, follow the procedures specified in the Maintenance Manual. Following any procedures other than those specified will cause the robot to topple over or drop during transport, thus resulting in accidents.
⚠ WARNING	During transport or installation work of the robot, pay utmost care not to cause damage to wirings. Furthermore, after installing the robot, take protective measures such as using protective guards so that the wirings will not be damaged by workers or other persons, or forklift trucks or else.

To transport the robot, make it a rule to use a crane.
At first, put the robot into the configuration shown in figure below and mount the four M20 hanger bolts to the swivel base. Then, be sure to lift the robot using four hanging wires. It is recommended to use hanging wires of 3.5 m in length and protect areas that contact the robot, using rubber hoses to cover the wire ropes. For the areas to be covered with the rubber hoses refer to figure below.





The screw hole of the ※ sign is not used for the hanging bolt.

CAUTION	If hanging wires push the encoder connectors or wiring/piping, they may be broken when hanging the robot. When hanging the robot, please pay attention not to make the wires touch the encoder connectors and wiring/piping.

11. Delivery style (specification which contains a robot)

1. There are three styles as shown below.

	Style	Details
1	Delivery on the truck	Robot is delivered on the truck near the entrance of customer's plant. (Installation and test-run is not included)
2	Delivery after installation and test-run	Robot is installed and test-run is done. (Teaching with work piece is not included.)
3	Delivery after installation and teaching with work piece	After style 2, teaching with work piece is done.

Because the expense is different, which form to choose be sufficiently examined.

2. Operation and maintenance education

The special spot operation guide and the special spot preservation guide are the outside of the estimation. Consult with each NACHI-FUJIKOSHI office for the details as for the schooling system.

12. Consuming power (Robot + Controller)

8.6 kVA at maximum (may vary according to the application and motion pattern.)

13. Paint color

Standard color	Controller cabinet	Munsell 10GY9/1
	Robot body	Munsell 10GY9/1

14. Warranty

Elapse of 1 year after delivery. (8 hours/day running)

The specification and externals described in this document might change without a previous notice for the improvement.