

**NACHI**

Standard specifications

**MC470P-01-FD11**

3rd edition

**NACHI-FUJIKOSHI CORP.**

1611, SMCEN-055-003,001

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# 1. Outline

“NACHI ROBOT” has used mechatronic techniques, cultivated throughout the last few decades, to supply robots suited for multi-purpose industries utilizing welding and the material handling techniques.

“MC470P” is a robot of simple highly rigid structure which is optimal for material handling application.

Installation	Max. payload 470 kg
Floor mount	MC470P-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		MC470P-01
Construction		Articulated
Number of axis		6
Drive system		AC servo motor
Max. working envelope	Axis 1	$\pm 3.14$ rad ( $\pm 180^\circ$ )
	Axis 2	-1.75 ~ +0.70rad ( $-100 \sim +40^\circ$ )
	Axis 3	-3.14 ~ +0.61 rad ( $-180 \sim +35^\circ$ )
	Axis 4	$\pm 6.28$ rad ( $\pm 360^\circ$ )
	Axis 5	$\pm 2.18$ rad ( $\pm 125^\circ$ )
	Axis 6	$\pm 6.28$ rad ( $\pm 360^\circ$ )
Max. speed	Axis 1	1.83 rad/s ( $105^\circ/s$ )
	Axis 2	1.66 rad/s ( $95^\circ/s$ )
	Axis 3	1.66 rad/s ( $95^\circ/s$ )
	Axis 4	1.92 rad/s ( $110^\circ/s$ )
	Axis 5	1.92 rad/s ( $110^\circ/s$ )
	Axis 6	3.14 rad/s ( $180^\circ/s$ )
Max. pay load	Wrist	470 kg
	Forearm *1	30 kg at maximum
Allowable static load torque	Axis 4	2750 N·m
	Axis 5	2750 N·m
	Axis 6	0 N·m
Allowable moment of inertia *2	Axis 4	400 kg·m <sup>2</sup>
	Axis 5	400 kg·m <sup>2</sup>
	Axis 6	250 kg·m <sup>2</sup>
Position repeatability *3		$\pm 0.2$ mm
Installation		Floor mounting
Ambient conditions		Temperature: 0 to 45 °C *4 Humidity: 20 to 85%RH (No dew condensation allowed) Vibration to the installation face: Not more than 0.5G (4.9 m/s <sup>2</sup> )
Robot mass		1,620 kg

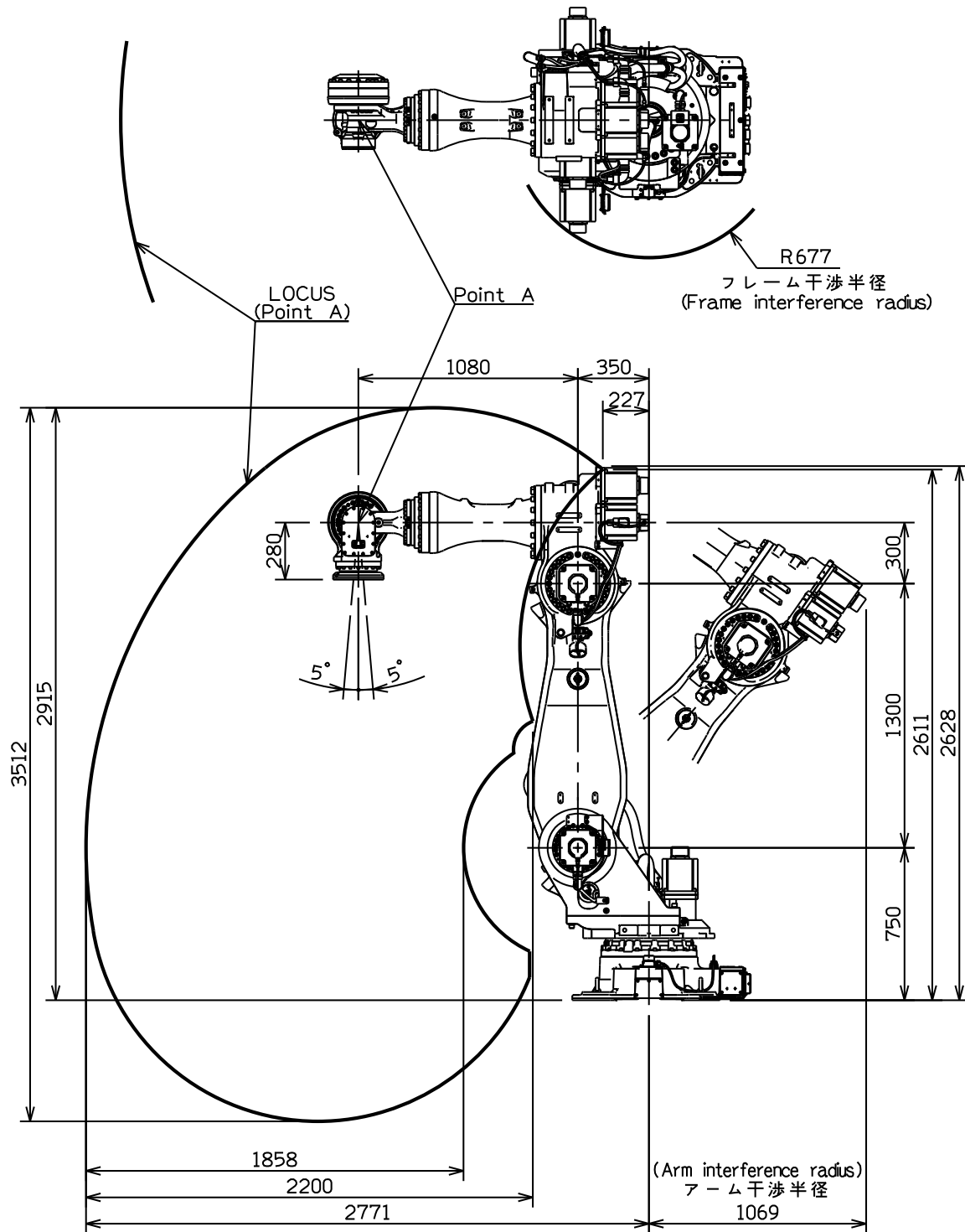
1[rad] =  $180/\pi$ [°], 1[N·m] = 1/9.8[kgf·m]


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". \*4: Permitted height is not higher than 1,000m above sea level. If used in higher place, permitted temperature is affected by height.

### 3. Robot dimensions and working envelope




 <b>IMPORTANT</b>	<ul style="list-style-type: none"> <li>• By software, axis 5 is controlled in order not to exceed +/- 5° of vertical downward direction.</li> <li>• Only in encoder correction and software limit setting screen, axis 4 is permitted to operate +/-360° and axis 5 is permitted to operate +/-125°.</li> </ul>
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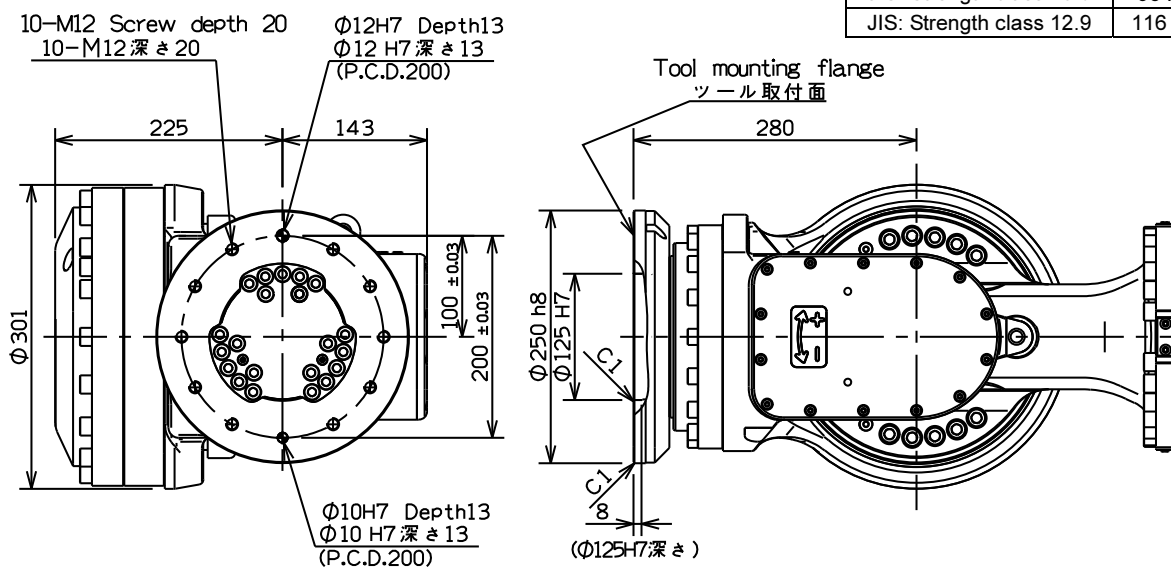
## 4. Detail of load mounting plate

### ■ Wrist

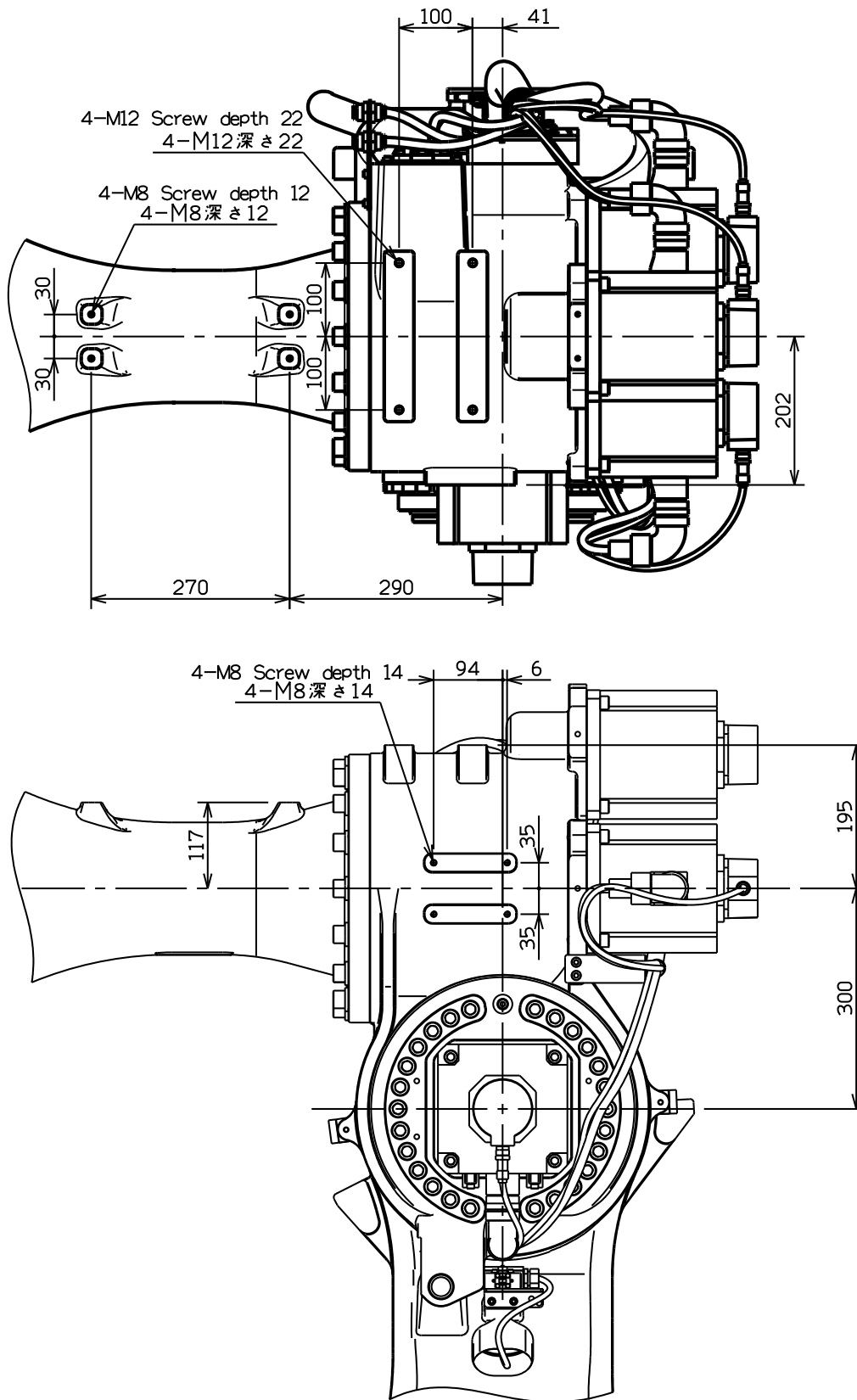
For the end effector fixing bolts, use the mounting P.C.D. shown in the following figures.  
Another P.C.D. is prepared as option. Consult with each NACHI-FUJIKOSHI office for the details.  
division.

 <b>CAUTION</b>	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.
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Tightening torque of M10 Hex. socket head cap screw	
JIS: Strength class 10.9	96 N·m
JIS: Strength class 12.9	116 N·m



■ Upper part of forearm




## 5. 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

 <p>WARNING</p>	<p>While the robot is in operation, workers are in danger of coming in contact with the robot. To avoid that, install a <b>guard fence</b> 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.</p>
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#### ■ 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 not only the static loads but also the reaction force caused by robot movement.

Repair uneven spots, cracks, and others on the floor, and then install the robot by following to the table below. If thickness of floor concrete is less than needed level, an independent foundation should be constructed. Inspect the foundation prior to the robot installation, and then construct the foundation, if necessary.

Robot Model	MC470P-01
Thickness of floor concrete	Not less than 160 mm
Installation parts *1	8 bolts of M20 (JIS: Strength class 12.9) not less than 65mm 8 plain washers of not less than 4.5 mm in thickness and HRC35 in hardness
Tightening torque *2	560 ± 30 N·m
Allowable repeated tensile *3	Approximately 47,000 N

\*1 : Installation parts are not accessory of robot.




\*2 : Apply a coating of lubricating oil to the threaded parts of bolts, and then tighten bolts by using torque wrench to the specified tightening torque.

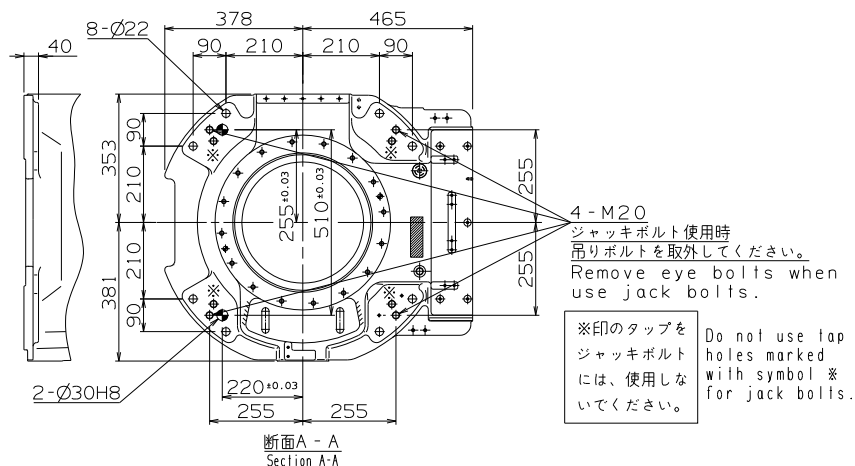
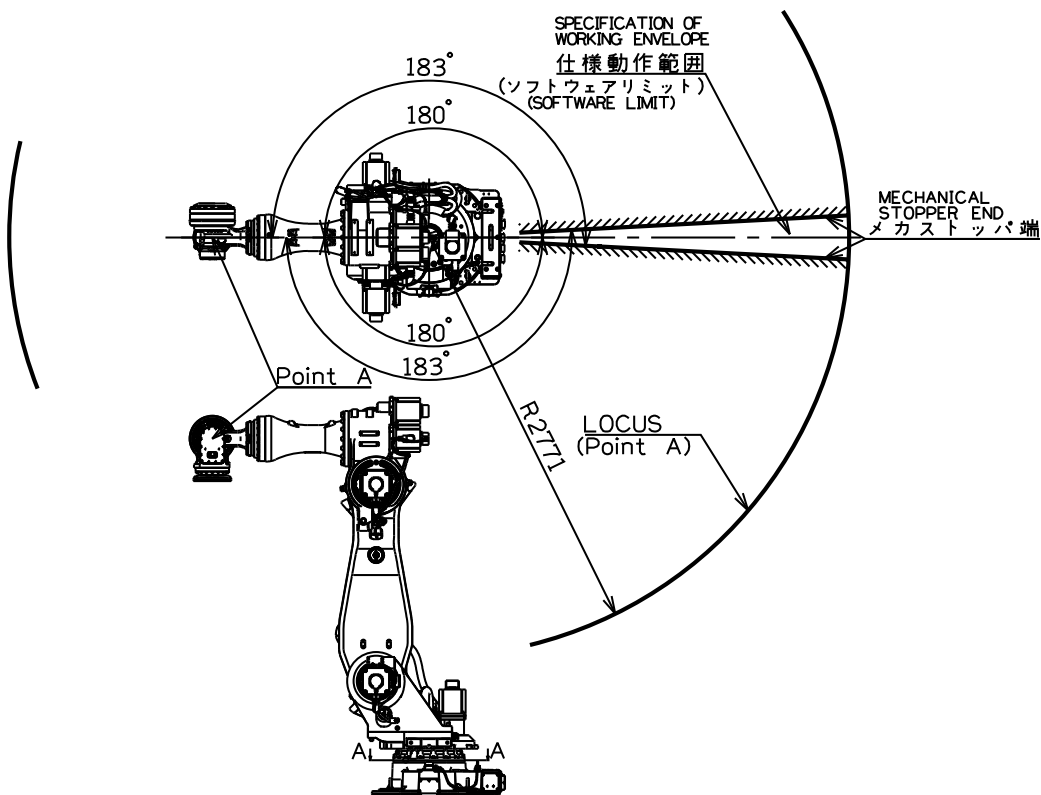
\*3 : This tensile is per installation bolt when robot is installed with all bolts written in table above.



■ Installation space

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

 WARNING	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 effector.
 WARNING	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).
 WARNING	If mechanical stopper collides and robot stops, it's possible that some parts are already damaged, for example, mechanical stopper is transformed or fixing bolts are broken. In this case, sufficient intensity and function can not be kept. Mechanical stopper and reduction gear of collided joint are needed to be replaced to the new one.



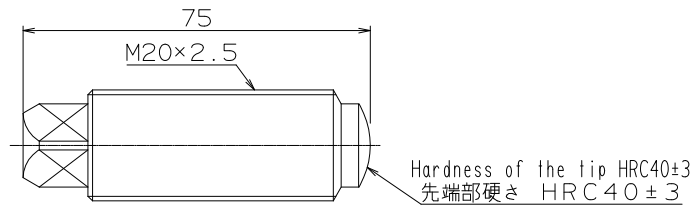
■ Accuracy of installation surface

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 ( $\pm 0.5$  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.

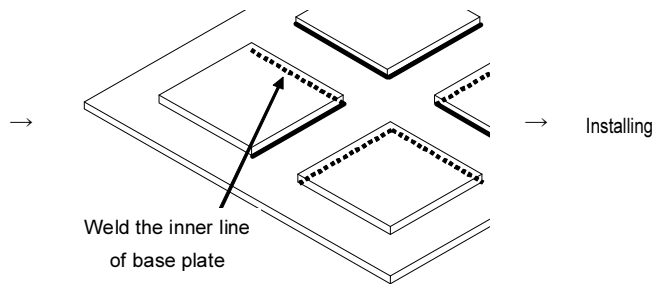
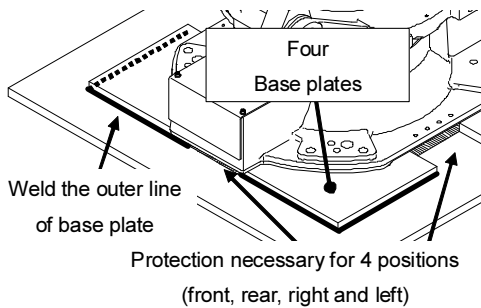


■ Welding of base plate

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.

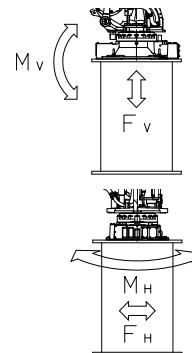
Temporary install the robot, and weld the outer line of base plate.

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 $M_H$
MC470P-01	64,900 N	47,300 N	147,700 N·m	122,200 N·m



## 6. Allowable wrist load

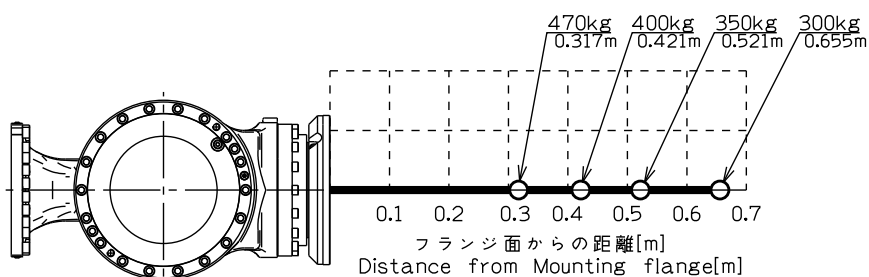


CAUTION

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

Use the robot under condition that COG of wrist load falls on the rotation center of axis 6 and its direction is shorter than the length written below.



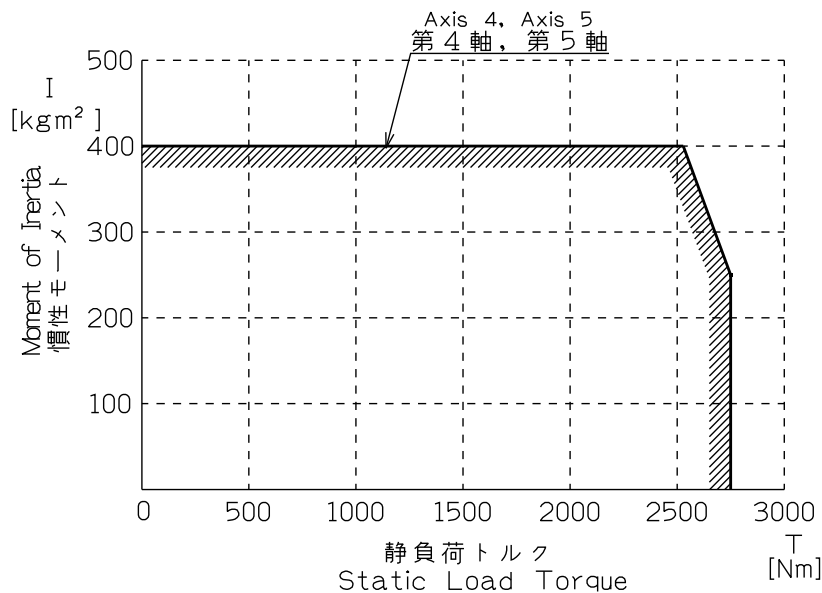
### ■ Wrist load conditions

Static load torque and moment of inertia of wrist load should exist inside the range shown below. Maximum speed may be limited even when inertia of wrist load does not exceed the permitted range.



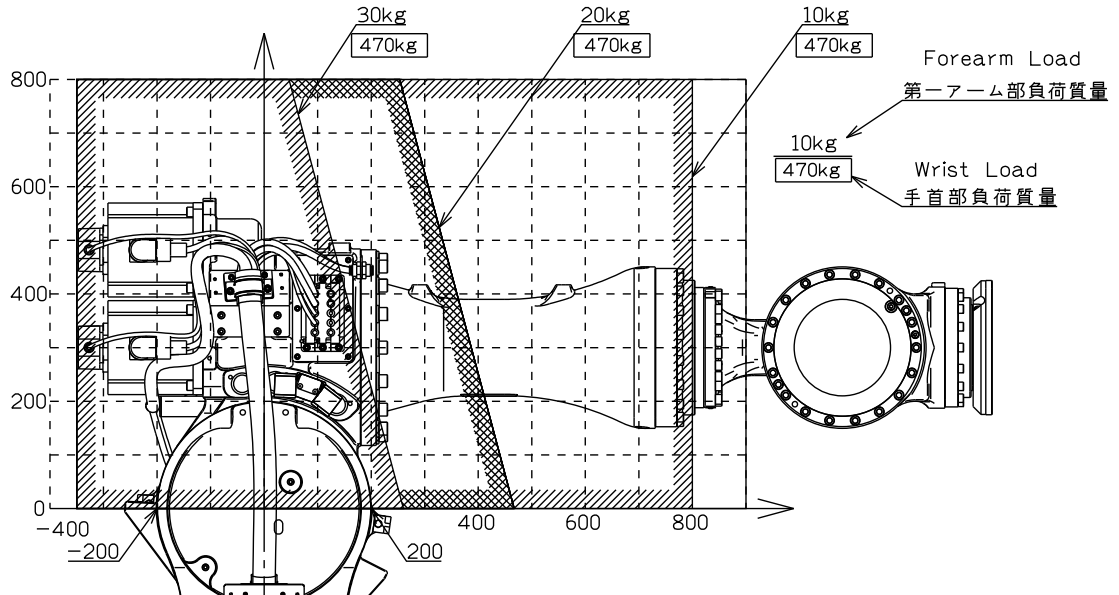
IMPORTANT

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



■ Allowable forearm load

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



## 7. Option specifications

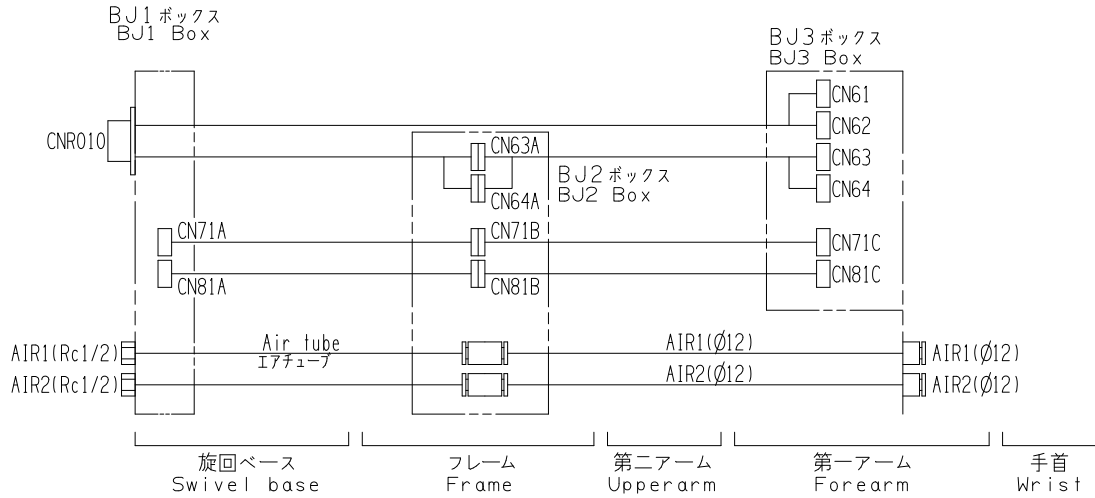
○: Possible to correspond / -: Impossible to correspond

No	Item	Specifications		Parts No.	Robot model
					MC470P-01
1	Installation parts *1	Chemical anchor specification	with pin hole	OP-F1-024	○
		Base plate welded	without pin hole	OP-F1-028	○
		Hammer drive anchor specification	with pin hole	OP-F2-018	○
		Base plate welded	without pin hole	OP-F2-019	○
		Pins set (Installation pins & polyethylene plug)		OP-F1-025	○
		Leveling plate (□200mm×t=32mm, 4 plates)		OP-F1-026	○
		Installation bolts & washers		OP-F1-027	○
		Chemical anchor		OP-F1-038	○
		Hammer drive anchor	OP-F2-023	○	
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	○

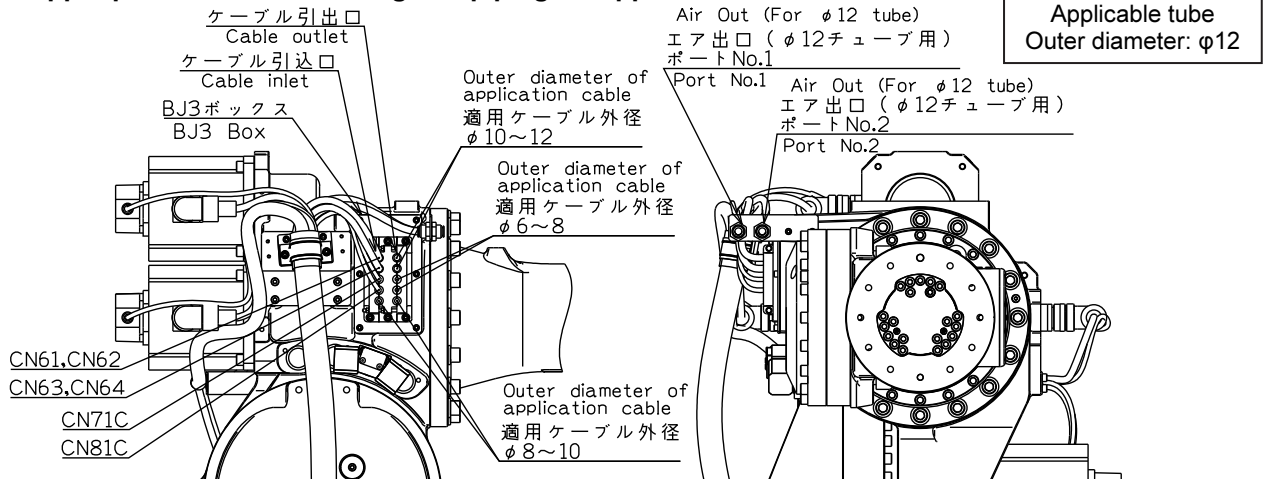
\*1 : These parts are packed separately from the robot. (Not attached on the robot)

## 8. Application wiring and piping diagram

### ■ Standard specification

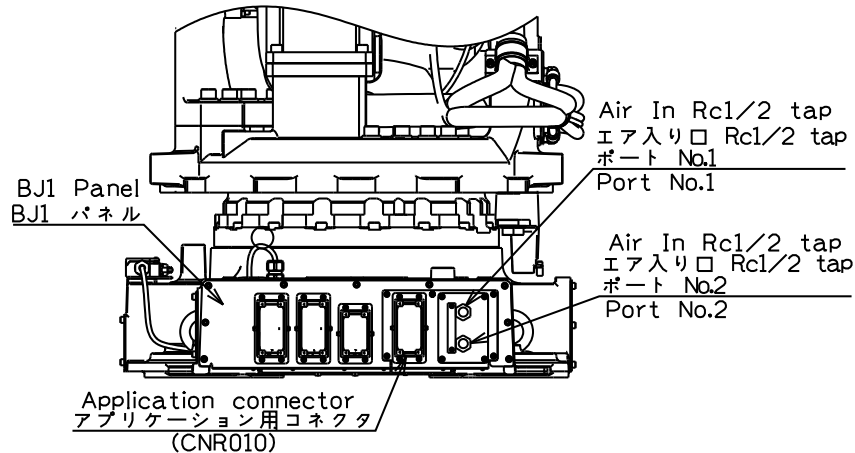


### ■ Upper part of forearm - Wiring and piping for application



(NOTE) In wiring box BJ3, there are application connectors shown in the next page  
When connecting cables inside BJ3, select the adequate hole that corresponds to the cable size.

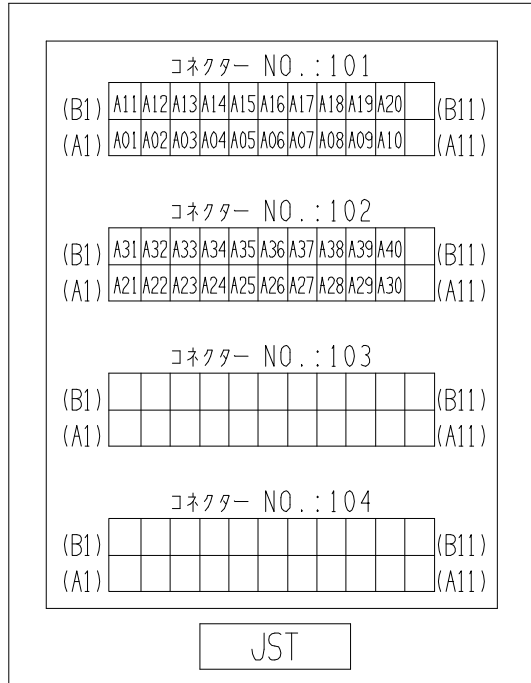
### ■ Base frame block - Wiring and piping for application



(NOTE) 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

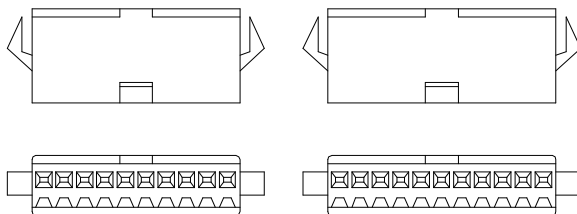
(Pin location shows the connector mounted on robot body and is the view from connecting side.)

Application wiring specification

Rated voltage Max. AC/DC 115 V

Rated current rating Max. 1 A

(2) BJ3 side (connector)



CN61

1	2	3	4	5	6	7	8	9	10
A01	A02	A03	A04	A05	A06	A07	A08	A09	A10

CN62

1	2	3	4	5	6	7	8	9	10	11
A11	A12	A13	A14	A15	A16	A17	A18	A19	A20	ECE

CN63

1	2	3	4	5	6	7	8	9	10
A21	A22	A23	A24	A25	A26	A27	A28	A29	A30

CN64

1	2	3	4	5	6	7	8	9	10	11
A31	A32	A33	A34	A35	A36	A37	A38	A39	A40	ECE

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

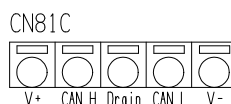
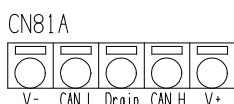
■ Details of Devicenet connectors (standard)

CN71A

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

CN71C

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



Connector  
in wiring box BJ1

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 <sup>2</sup> ) SVF-42T-P2.0 (0.3~1.25 mm <sup>2</sup> )	SVM-61T-P2.0 (0.5~2.0 mm <sup>2</sup> ) SVM-42T-P2.0 (0.3~1.25 mm <sup>2</sup> )
	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.

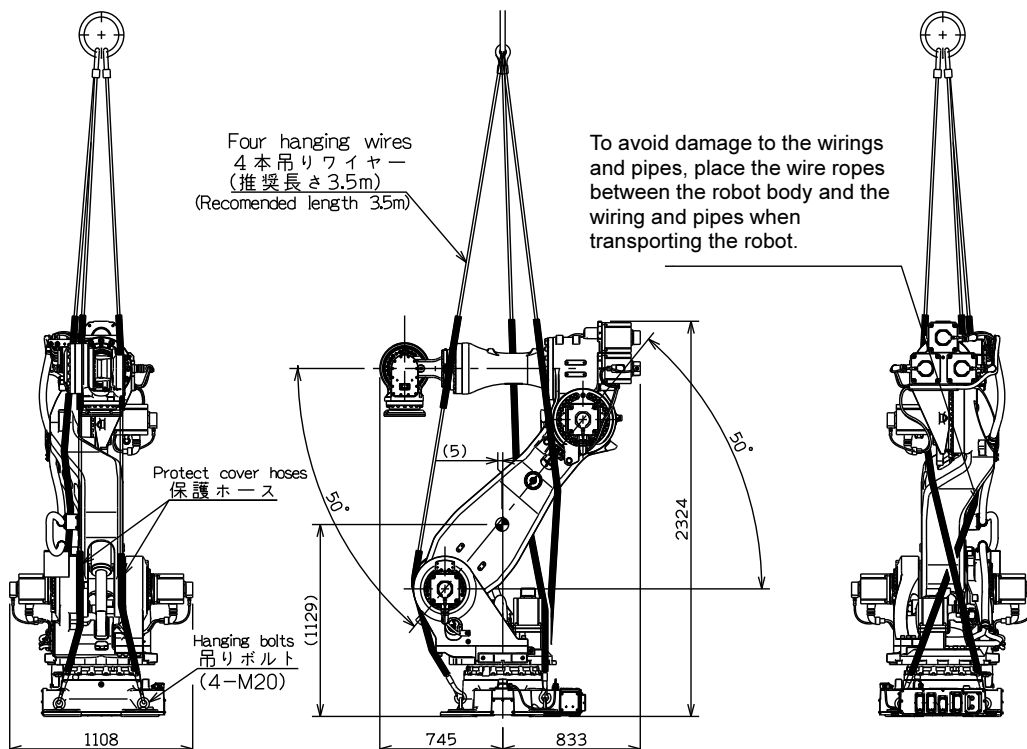
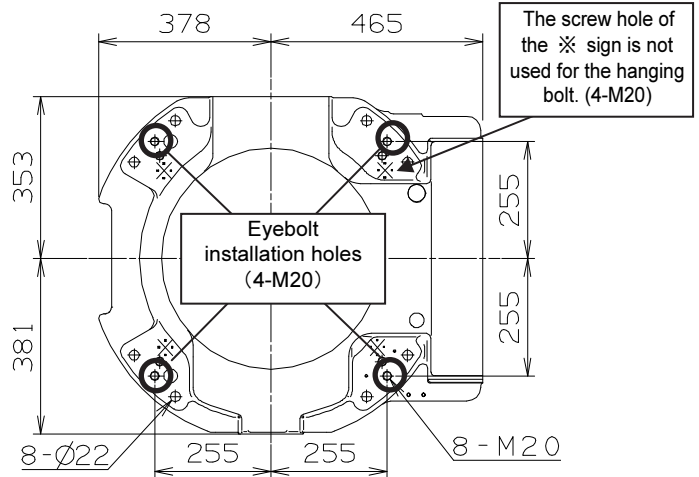


## 9. Transport procedure

 <b>WARNING</b>	<p>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.</p>
 <b>WARNING</b>	<p>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.</p>
 <b>CAUTION</b>	<p>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.</p>
 <b>CAUTION</b>	<p>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.</p>

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.



To avoid damage to the wirings and pipes, place the wire ropes between the robot body and the wiring and pipes when transporting the robot.

**10. 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.

**11. Consuming power (Robot + Controller)**

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

**12. Paint color**

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

**13. 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.



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<b>Indiana Service Center</b>	Phone: 248-305-6545	Fax: 248-305-6542	Greenwood, Indiana
<b>Ohio Service Center</b>	Phone: 248-305-6545	Fax: 248-305-6542	Cincinnati, Ohio
<b>South Carolina Service Center</b>	Phone: 248-305-6545	Fax: 248-305-6542	Greenville, South Carolina
<b>Canada Branch Office</b>	Phone: 905-760-9542	Fax: 905-760-9477	89 Courtland Ave., Unit No.2, Concord, Ontario, L4K 3T4, CANADA
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Original manual is written in Japanese.

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