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## **Magnetically Levitated Turbo Molecular Pump**

**TMP-2003M,TMP-2203M**

**( Air cooled type )**

**TMP-2003MC,TMP-2203MC**

**( Air cooled chemical type )**

**TMP-2003LM,TMP-2203LM**

**( Wide range type )**

**TMP-2003LMC,TMP-2203LMC**

**( Wide range chemical type )**

## **INSTRUCTION MANUAL**

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Carefully read and follow the instructions in the "Instruction Manual" before  
operating the turbo molecular pump.

Keep the "Instruction Manual" in a safe and accessible place

**SHIMADZU CORPORATION**  
**Semiconductor Equipment Division**



# Introduction

Thank you for choosing the TMP-2003M/MC/LM/LMC Turbo molecular pump and TMP-2203M/MC/LM/LMC Turbo molecular pump (hereafter referred to as "Turbo molecular pump").

Please read the instruction manual carefully in conjunction with the instruction manual of "Power Supply Unit" before using Turbo molecular pump, and save the instruction manual for future reference.

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# Precautions for Safe Operation

The instruction manual's nomenclature for warnings and precautions complies with the following safety warning symbols.

**WARNING**

Moderate level of attention required, failure to comply could possibly lead to serious injury or death.

**CAUTION**

Least level of attention required, failure to comply could possibly lead to injury and/or damage to the turbo molecular pump and/or power supply.

**NOTICE**

Not a hazard, instructions for safe operation of turbo molecular pump.

Strict adherence to all "WARNINGS" and "SAFETY PRECAUTIONS" is strongly recommended. Everyone associated with the operation of the turbo molecular pump is required to carefully read and follow all "WARNINGS" and "SAFETY PRECAUTIONS" listed in the Instruction Manual prior to the installation and/or operation of the turbo molecular pump. Information in greater detail can be found in the appropriate sections of the Instruction Manual.

**WARNING**

Turbo molecular pump repair and/or power supply repair can be very hazardous. Only trained technicians who are authorized by Shimadzu may do service of products.

**WARNING**

Neither overhaul nor modify the pump proper and power supply unit without admission. Doing so would impair safety of the pump proper.





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**CAUTION**

After having operated the turbo molecular pump for evacuation of corrosive gas, keep the pump internal as vacuumed even after shutdown. Inflow of water content in the air to the pump internal would cause rapid erosion trouble of the pump internals.

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**CAUTION**

Avoid to install the pump at the following places.

- (1) Place where the pump is inevitably exposed to significant vibration and impact.
- (2) Unstable place.
- (3) Place where the pump is inevitably exposed to magnetic field and radioactive ray.

The pump proper is a precision machine. Be careful not to apply abnormal vibration, shock/ impact to it during transportation. This pump is not connected to grand. Please provide PE(Protective earth) connection to the chassis of pump in final application.

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**CAUTION**

The following "CAUTIONS" are to prevent operation anomalies.

- 1.This turbo molecular pump is not approved for use in applications exhausting process gas containing gallium (Ga, e.g., triethyl gallium, etc.).
  - 2.Protect the pump from any and all types of impact during operation.
  - 3.Do not operate any equipment (i.e. drill motor, welding machine, etc.) that produces electromagnetic pollution, noise, etc., in the immediate proximity of an operating turbo molecular pumping system (pump, power supply, cables, etc).
  - 4.Do not interrupt the electrical power operating the turbo molecular pump while the turbo molecular pump is in operation.
  - 5.Do not connect or disconnect the turbo molecular pump control cable during the time the power supply is "ON".
  - 6.Be sure to use the chemical type pumps to exhaust of gas which contain chlorine, or fluorine.
  - 7.Plasmas may cause the pump rotor to discharge electrically thus damaging the electrical components.
  - 8.When using the variable speed function to change the pump rotation rate, use a rotation rate that does not cause resonance with other devices installed at the site.
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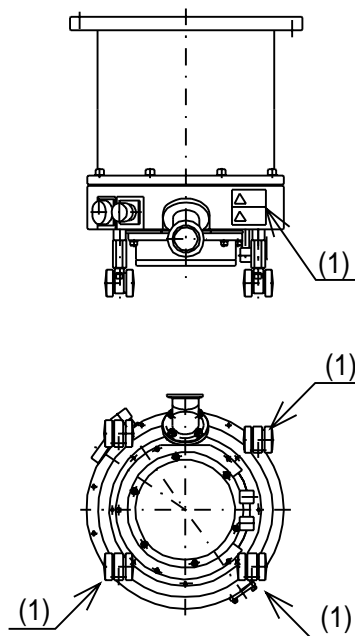
## Explanation of caution marking



1)HOT SURFACE : Risk of burn.

• Keep off from touching surface of the pump as it is heated.

## Location Where Caution Markings are Applied



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## Installation Precautions

Do not apply abnormal loads to the turbo molecular pump control cable plug and/or connector. Abnormal loads may cause cable disconnection.

- (1) Do not pull the turbo molecular pump control cable by the connector or plug.



- (2) Do not twist the turbo molecular pump control cable during connection.



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## Part Replacement

The lifetime of parts are specified as below.

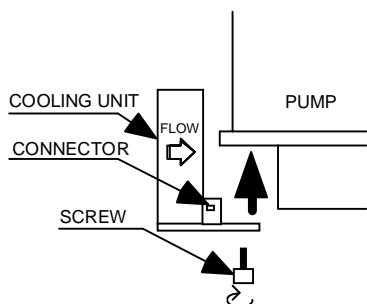
The request for changing parts exceeding the estimated lifetime should be made to Shimadzu or an approved service company in order for safety and adequate performance of the pump and power supply unit.

**Table 1 Estimated Part Life.**

Parts List	Estimated Part Life
Cooling fan	5 years

## Air Cooled Turbo Molecular Pump

For the air cooled turbo molecular pumps TMP-2003M/MC and TMP-2203M/MC, it is necessary to clean the cooling fan periodically because of the cooling fan collecting dust, debris, etc. Shimadzu recommends removal of the cooling fan for all methods of cleaning (compressed air, etc.) to prevent the particles, cleaning debris, from accumulating in or on the turbo molecular pump. Please refer to Fig. 1 how to change fan.



Pump	Model	Parts Number
TMP-2003M/MC	Cooling unit DV24V	262-77445
TMP-2203M/MC	Cooling unit DV24V	262-77445-02

**Fig. 1 How to Change the Cooling Fan Unit**

## Warranty

- 1) Products manufactured by Shimadzu are warranted against defects in material and workmanship for a period of twelve (12) months from the date of delivery from Shimadzu to the buyer.
- 2) Any modification to the product by the buyer or their agent voids this warranty.
- 3) Liability under this warranty is expressly, limited to replacement or repair (at Shimadzu's option) of defective parts.
- 4) Shimadzu may at any time discharge its warranty as to any of its products by refunding the purchase price and taking back the products.
- 5) This warranty applies only to parts manufactured, and labor provided, by Shimadzu under valid warranty claims received by Shimadzu within the applicable warranty period and shall be subject to the terms and conditions hereof.
- 6) Malfunctions caused by abuse or neglect of the product are expressly not covered by this warranty.
- 7) Shimadzu expressly disclaims responsibility for any loss or damage caused by the use of its products other than in accordance with proper operating and safety procedures. Responsible care must be taken by the user to avoid hazards.
- 8) Unless otherwise specified, in-warranty repaired or replacement parts are warranted only for the remaining unexpired portion of the original warranty period applicable to the parts, that have been repaired or replaced.
- 9) Except as stated herein, Shimadzu makes no warranty, expressed or implied (either in fact or by operation of law), statutory or otherwise: And, except as stated herein, Shimadzu shall have no liability for special or consequential damages of any kind or from any cause arising out of the sale, installation, or use of any of its products.
- 10) Statements made by any person, including representatives of Shimadzu, which are inconsistent or in conflict with the terms of this warranty shall not be binding upon Shimadzu unless reduced to writing and approved by an officer of Shimadzu.





## **Disposal of Products and Parts**

When disposing of the product or its accessories, please contact the Shimadzu service representative. Improper disposal of the product or its accessories may cause environmental contamination.

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# OUTLINE AND DESCRIPTIONS



- 1.1 Outline
- 1.2 Descriptions
  - 1.2.1 Pump Main Unit
  - 1.2.2 Standard Accessories

## 1.1 Outline

The turbo molecular pump is a vacuum pump. The turbo molecular pump is used with a backing vacuum pump to create a high vacuum in a vacuum chamber.

Typical Applications ; Semiconductor equipments,  
Industrial equipments,  
R&D applications,  
The other ultra high vacuum applications.

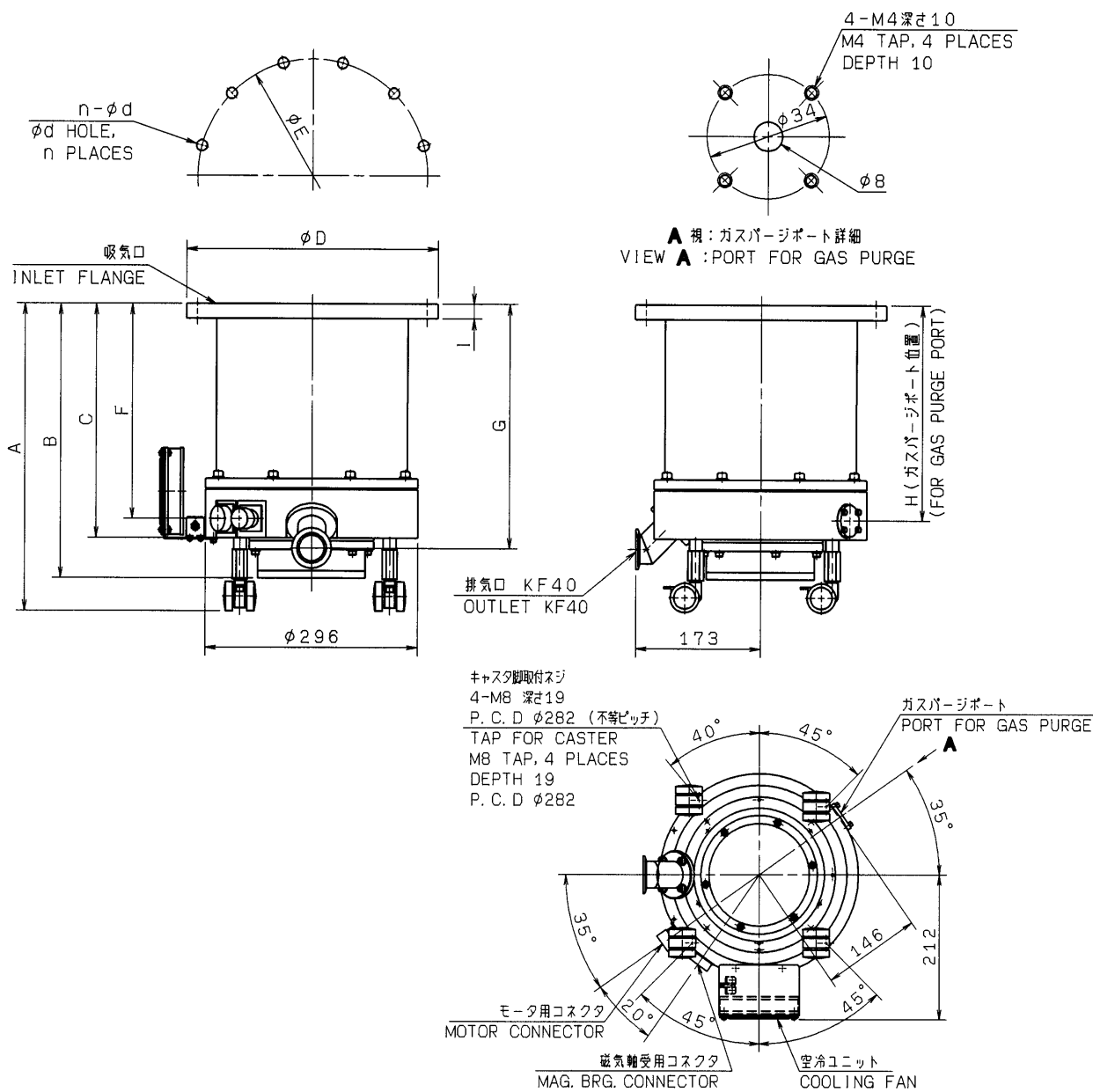
The turbo molecular pump (one standard set) consists of the following items.

- Pump 1
- Power Supply Unit 1
- Control Cable 1
- Motor Cable 1
- Standard Accessories 1 Set

This instruction manual explains the operation of the pump unit. For more detailed instructions regarding the power supply unit, please refer to the Power Supply Unit Instruction Manual.

# 1.2 Descriptions

## 1.2.1 Pump Main Unit



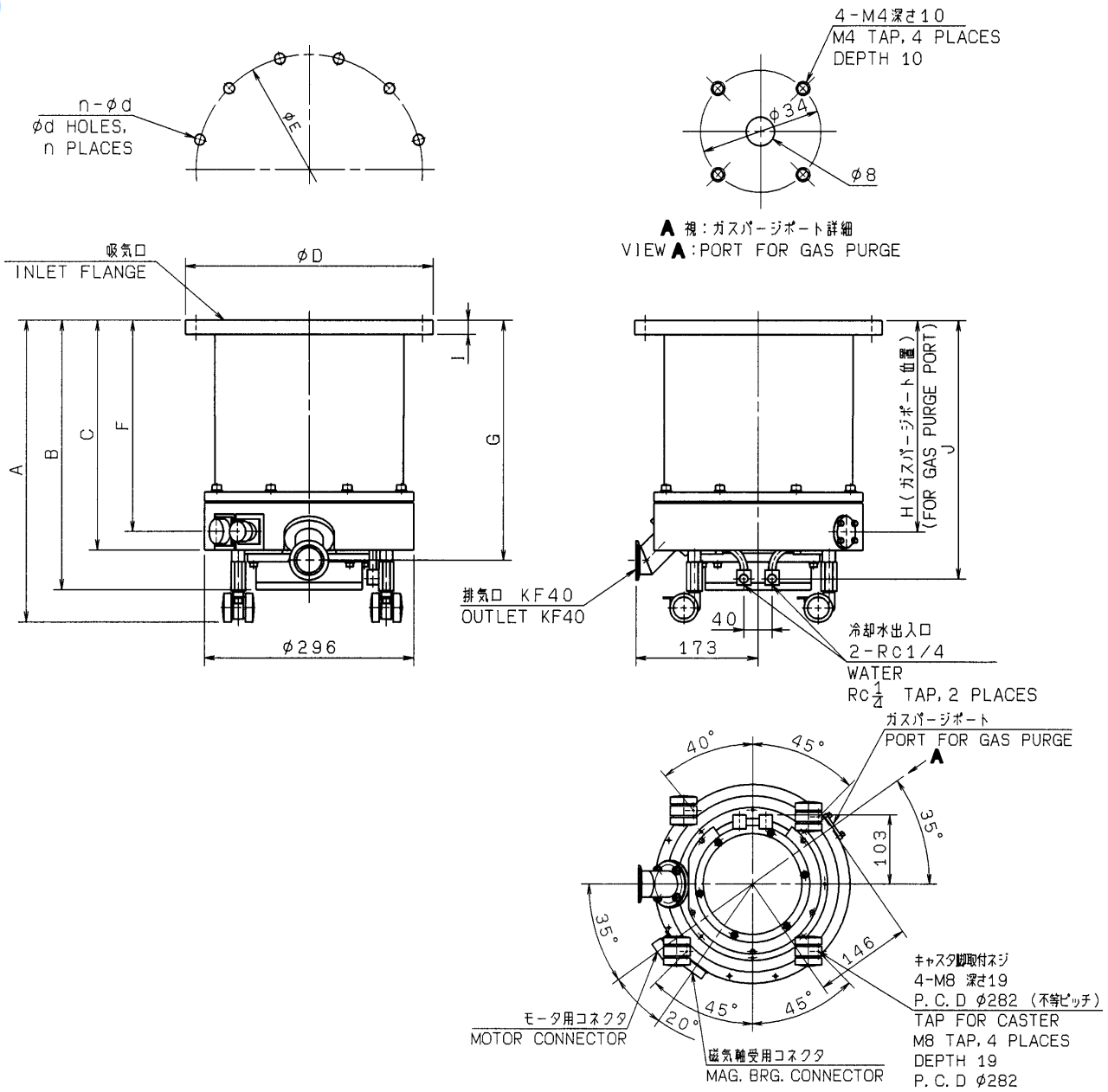
INLET FLANGE	Parts number		A	B	C	D	E	F	G	H	n- d	I
	TMP-2003M	TMP-2003MC										
ICF305	P/N 262-81439-61	P/N 262-81439-71	420	375	320	305	284	294	334	294	32- 8.4	28
VG250	P/N 262-81439-62	P/N 262-81439-72	420	375	320	350	320	294	334	294	12- 15	20
ISO250	P/N 262-81439-63	P/N 262-81439-73	430	385	344	335	310	304	344	304	12- 11	16

**TMP-2003M and TMP-2003MC**  
**Fig.1-1 Outside Dimensions of Pump Proper**



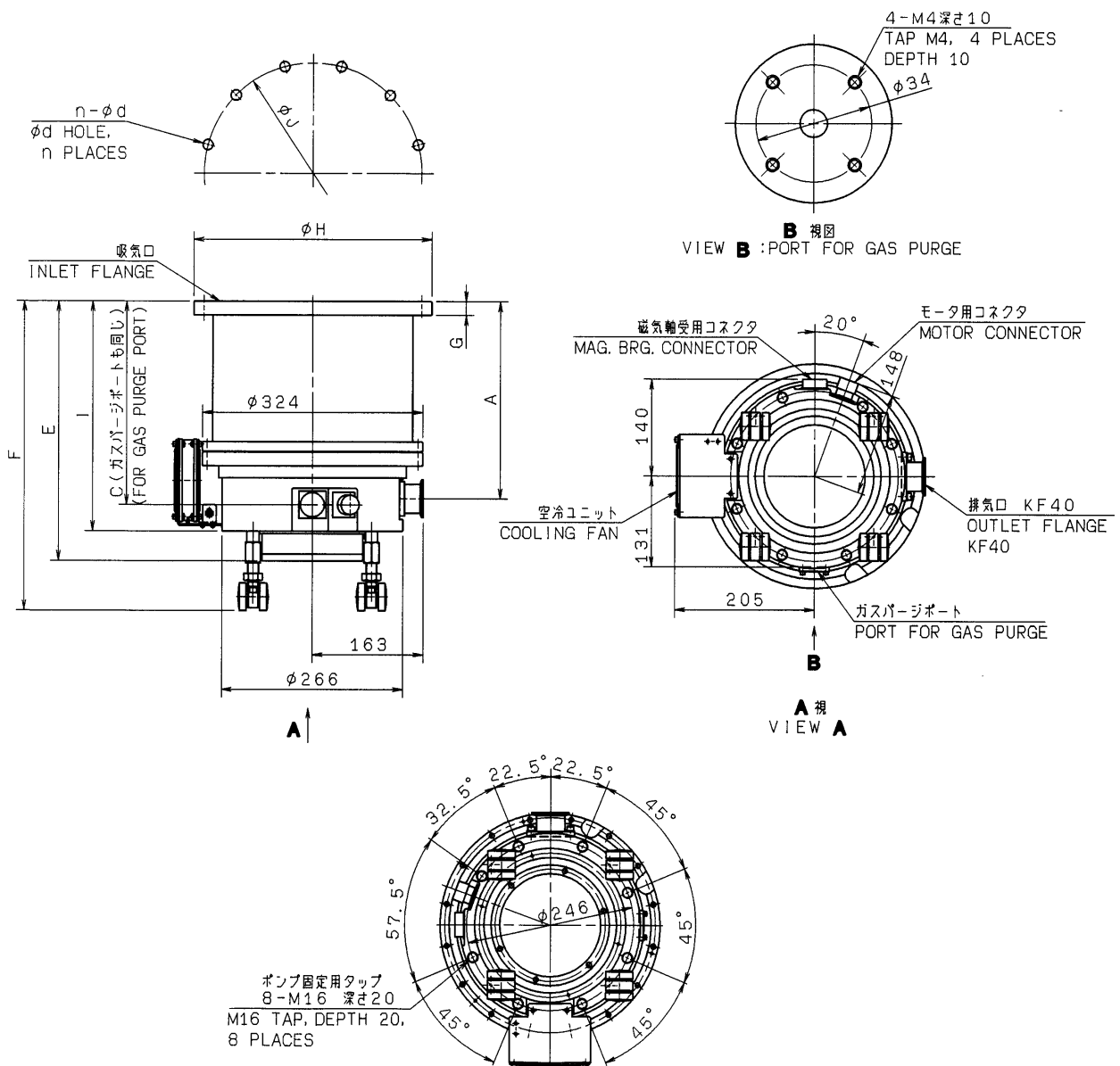
# SECTION 1 OUTLINE AND DESCRIPTIONS

1



INLET FLANGE	Parts number		A	B	C	D	E	F	G	H	J	n- d	l
	TMP-2003LM	TMP-2003LMC											
ICF305	P/N 262-81439-41	P/N 262-81439-51	420	375	320	305	284	294	334	294	360	32- 8.4	28
VG250	P/N 262-81439-42	P/N 262-81439-52	420	375	320	350	320	294	334	294	360	12- 15	20
ISO250	P/N 262-81439-43	P/N 262-81439-53	430	385	344	335	310	304	344	304	370	12- 11	16

**TMP-2003LM and TMP-2003LMC**  
**Fig.1-2 Outside Dimensions of Pump Proper**

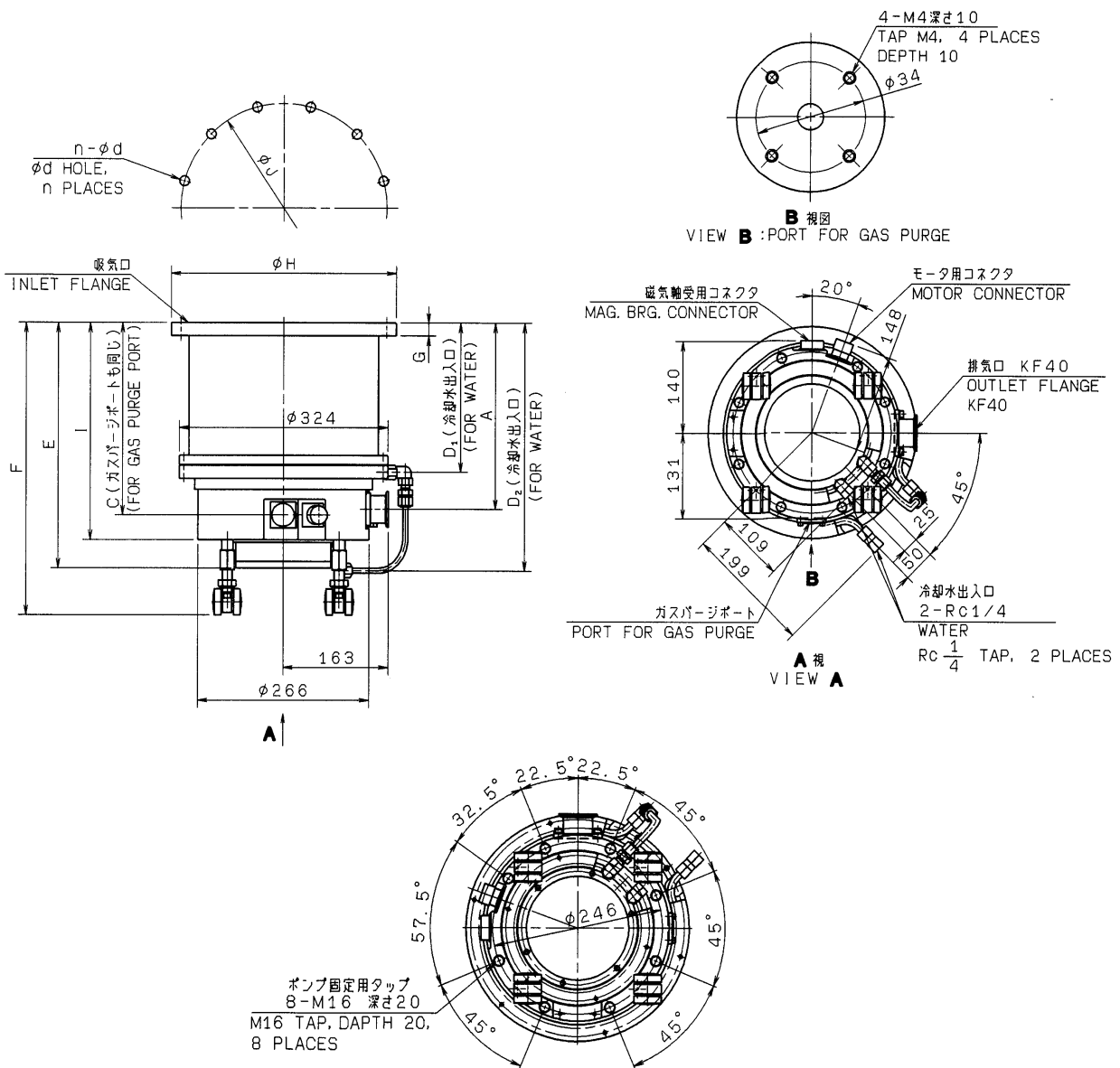


INLET FLANGE	Parts mu,ber		A	C	E	F	G	H	J	n- d	I
	TMP-2203M	TMP-2203MC									
ICF305	P/N 262-78453-21	P/N 262-78453-31	345	354	435	507	28	305	284	32- 8.4	392
VG250	P/N 262-78453-22	P/N 262-78453-32	285	294	375	447	20	350	320	12- 15	332
ISO250	P/N 262-78453-23	P/N 262-78453-33	315	324	405	477	16	335	310	12- 11	362

**TMP-2203M and TMP-2203MC**  
**Fig.1-3 Outside Dimensions of Pump Proper**

# SECTION 1 OUTLINE AND DESCRIPTIONS

1



INLET FLANGE	Parts number		A	C	D <sub>1</sub>	D <sub>2</sub>	E	F	G	H	J	n- d	l
	TMP-2203LM	TMP-2203LMC											
ICF305	P/N 262-78453-01	P/N 262-78453-11	345	354	288.5	439	435	507	28	305	284	32- 8.4	392
VG250	P/N 262-78453-02	P/N 262-78453-12	285	294	228.5	379	375	447	20	350	320	12- 15	332
ISO250	P/N 262-78453-03	P/N 262-78453-13	315	324	258.5	409	405	477	16	335	310	12- 11	362

## TMP-2003LM and TMP-2203LMC

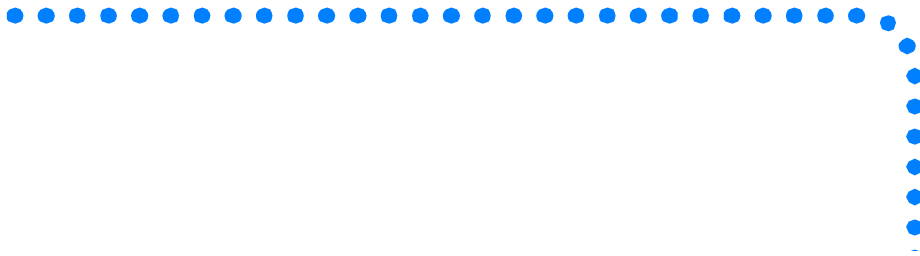
Fig.1-4 Outside Dimensions of Pump Proper

### 1.2.2 Standard Accessories

	Description	Q'ty	Notes	Parts Number
1	Gasket for inlet flange	1	One of followings: O-ring gasket for VG250 Copper gasket for ICF305 A gasket for ISO flange is option.	036-13514 262-77157-10
2	Bolt set for inlet flange	1Set	Bolts, washers, and nuts	
3	Centering ring with O-ring	1	KF40	035-06004-14
4	Clamp	1	KF40	035-06004-03
5	Instruction manual	1		263-13233



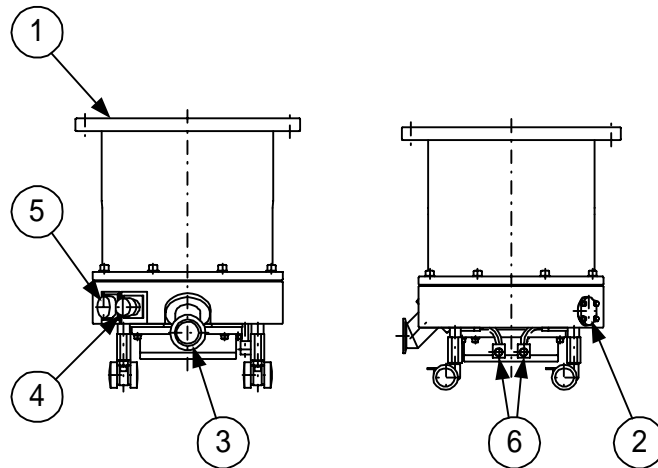
# IDENTIFICATION AND FUNCTION



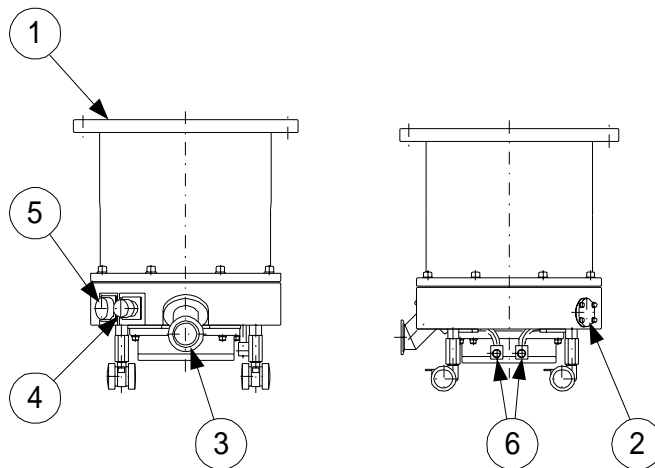
## 2.1 Pump Main Unit

## 2.1 Pump Main Unit

2



**Cooling water method**

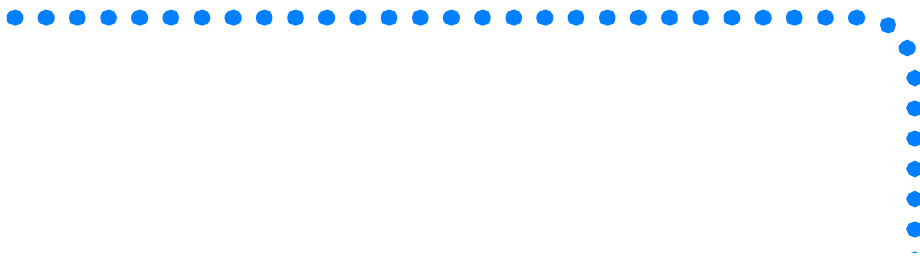


**Cooling fan method**

**Fig.2-1 Pump Main Unit**

- (1) INLET FLANG . . . . . Inlet flange, joint the turbo molecular pump, ICF305, VG250、ISO250 are also available.
- (2) PORT FOR GAS PURGE . . . . . Gas purge adapter port  
(see Section 7 "GAS PURGE")
- (3) OUTLET FLANGE. . . . . Outlet flange, connect a backing vacuum pump or its related pipe connection, KF40.
- (4) MOTOR CONNECTOR. . . . . Motor cable receptacle
- (5) CONTROL CONNECTOR. . . . . Control cable receptacle
- (6) COOLING WATER PIPELINE. . . . . Cooling water pipe connector, Rc1/4
- (7) COOLING FAN . . . . . Cooling Fan

# CONSTRUCTION AND PRINCIPLE



- 3.1 Pump Construction
- 3.2 Principle of Turbo Molecular Pumping



## 3.1 Pump Construction

3

Fig. 3-1 is a sectional drawing of the TMP-2003LM/LMC and TMP-2203LM/LMC magnetic bearing type turbo molecular pump. The built-in high frequency motor (1) is accelerated to the specified revolutions (speed) by the high frequency power supply unit. Rotor blades (4) are fitted onto the drive shaft (3) and the stator blades (5) are arranged in between the rotor blades. A positioning spacer (6) is inserted between the stator blades. The configurations and profiles of the stator blades and rotor blades are designed for high efficiencies in various applications. The upper stages of the rotor blade and stator blade configurations are ideally designed for high gas throughput. The compression ratio of the stator blades and rotor blades becomes higher as the gas molecules converge into the lower stage configurations. The profiles of the stator blades and rotor blades are matched for the desired function.

A radial magnetic bearing (7) is used at the top and bottom of the drive shaft. The axial magnetic bearings (8) are used to levitate a disk attached to the drive shaft between the axial magnetic bearings. Each magnetic bearing is provided with a gap sensor (10) to detect the rotor position. Fig. 3-2 illustrates the outline of 5 - axes control. The rotor is levitated by the control of these 5 axes allowing rotational freedom.

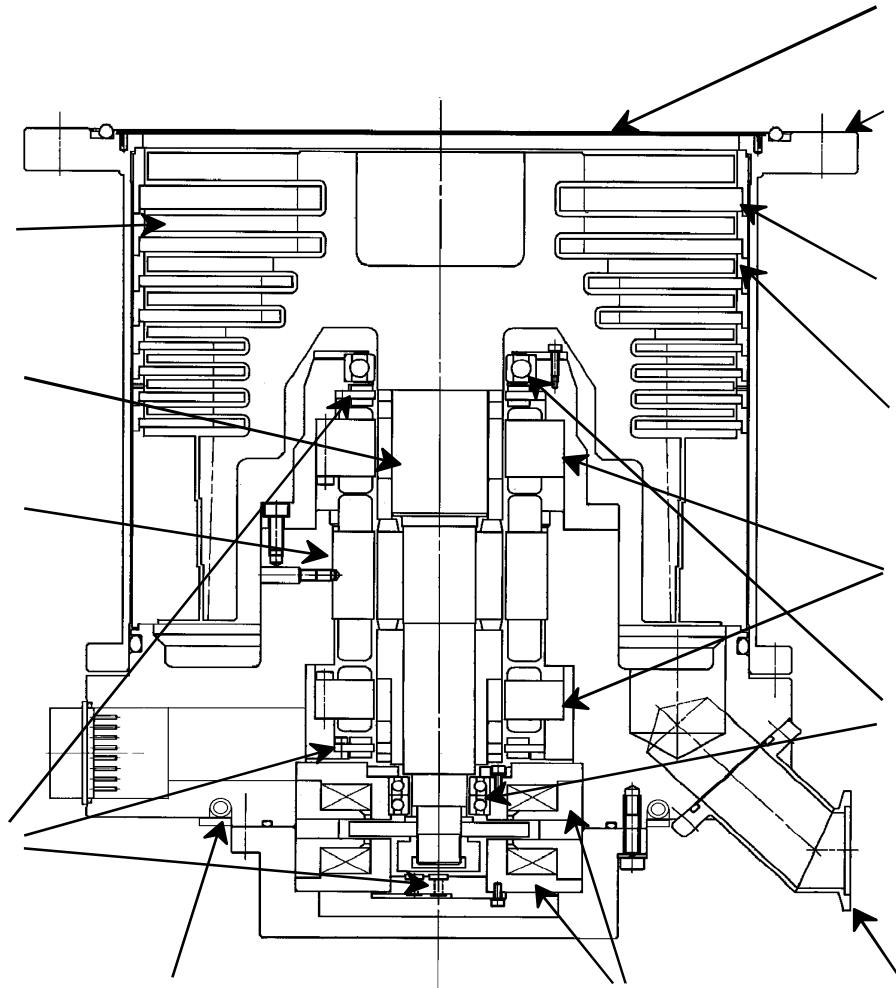
A touchdown bearing is used at the top and bottom of the casing for safety protection of the rotor and pump should the magnetic bearings become damaged. The touchdown bearings are dry and oil free.

The cooling water pipe (14) is provided to cool the pump. With the air-cooled turbo molecular pumps TMP-2003M/MC and TMP-2203M/MC, cooling fans are provided instead of the cooling water pipe (14).

Fig. 1-1 through Fig. 1-4 show the outside dimensions of the turbo molecular pump.

## 3.2 Principle of Turbo Molecular Pumping

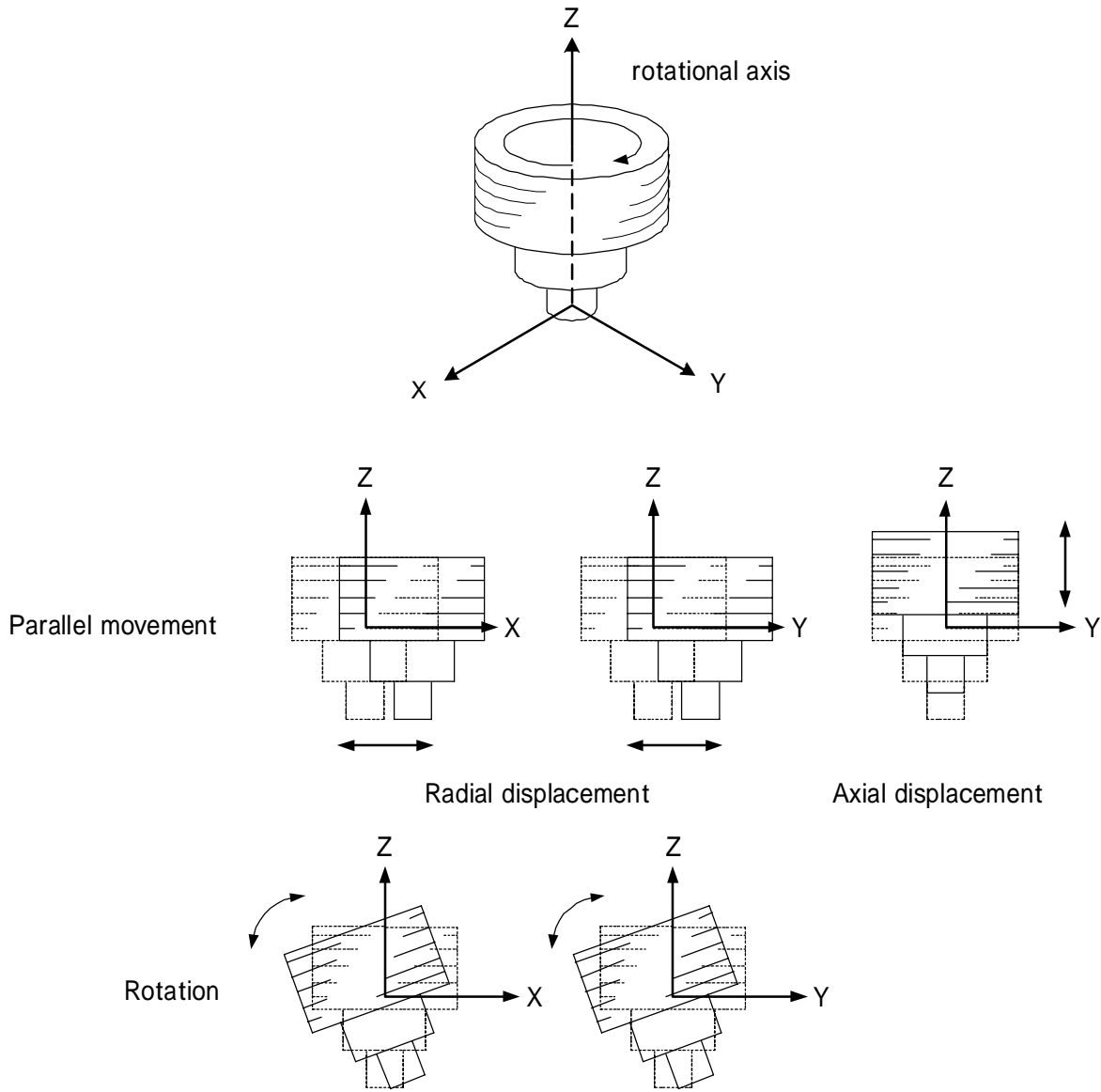
The principle of turbo molecular pumping assumes gas molecules collide with a surface plane (the blade of the pump rotor) moving in a radial span of very high speed in a space with an enlarged mean free gas path (generally a vacuum area of less pressure than 0.1 Pa). Assuming no heat is exchanged between the gas molecule and the pump rotor blade, the speed of the pump rotor blade is added to the speed of the gas molecule, converting the gas molecule's non-oriented thermal motion to a motion with direction. Thus the gas molecule has received an impulse in a desired flow direction.



**Fig.3-1 Pump Sectional Drawing**

- |                          |                             |                             |
|--------------------------|-----------------------------|-----------------------------|
| (1) High frequency motor | (6) Spacer                  | (11) Inlet flange           |
| (2) Receptacle           | (7) Radial magnetic bearing | (12) Outlet flange          |
| (3) Drive shaft          | (8) Axial magnetic bearing  | (13) Protective net         |
| (4) Rotor blade          | (9) Touch-down bearing      | (14) Cooling water pipeline |
| (5) Stator blade         | (10) Gap sensor             | (pipe connection port)      |

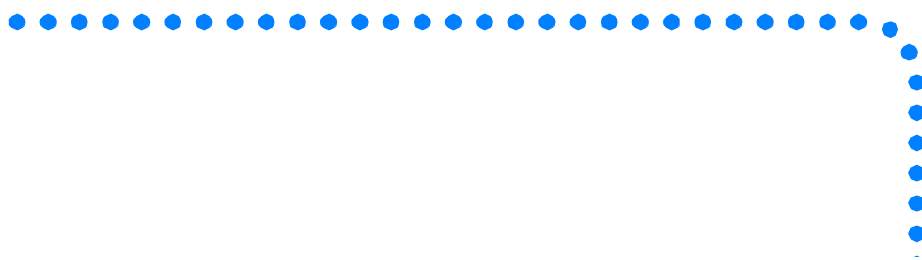
The movement of an object has 6 degrees of freedom. Levitation can be achieved in a turbo molecular pump by controlling the following 5 degrees of freedom (excluding the rotational degree (Z axis) of freedom).



Movement of rotor and restricted five degrees of freedom

**Fig.3-2 Outline of 5-Axes Control**

# SPECIFICATIONS



4.1 Pump Main Unit

4.2 Standards Fulfilled

## 4.1 Pump Main Unit

Turbo molecular pump	TMP-2003M	TMP-2003MC	TMP-2003LM	TMP-2003LMC
Suitable Power supply unit	EI-D2003M			
Cooling method	Cooling fan		Water	
Ultimate pressure (Note 1)	10 <sup>-9</sup> Pa order	10 <sup>-8</sup> Pa order	10 <sup>-9</sup> Pa order	10 <sup>-8</sup> Pa order
Maximum allowable inlet pressure (Nitrogen gas)	0.4 Pa		67 Pa	
Maximum allowable outlet pressure	40 Pa		270 Pa	
Pumping speed (Note 2)	nitrogen	2000 L/s		
	helium	1800 L/s		
	hydrogen	1600 L/s		
Compression ratio	nitrogen	1 × 10 <sup>9</sup> or more		
	helium	7 × 10 <sup>5</sup>		
	hydrogen	1.4 × 10 <sup>4</sup>		
Rated speed	27000 rpm			
Start-up time	9 minutes or less			
Mounting position	In any desired direction (Note 5)			
Bake-out temperature at an inlet flange	120 or less			
Vibration level (by Shimadzu's method)	0.01 μm or less (0-peak)			
Inlet flange	VG250 (Note 4)			
Outlet flange	KF40			
Mass	55 kg			
Admissible throughput of purge gas	20 to 30 mL/min (Note 6)			
Admissible pumping speed of backing vacuum pump in case of gas purge	500 L/min or more			
Admissible ambient magnetic field				
	Radial direction	3 mT		
	Axial direction	15 mT		
Water	Flow rate			1 to 3 L/min
	Pressure	N/A		0.2 to 0.5 MPa
	Temperature			5 to 30

Turbo molecular pump	TMP-2203M	TMP-2203MC	TMP-2203LM	TMP-2203LMC
Suitable Power supply unit	EI-D2203M			
Cooling method	Cooling fan		Water	
Ultimate pressure (Note 1)	10 <sup>-8</sup> Pa order	10 <sup>-7</sup> Pa order	10 <sup>-8</sup> Pa order	10 <sup>-7</sup> Pa order
Maximum Argon through put (Note 6)	800 mL/min	800 mL/min	1300 mL/min	2000 mL/min
Maximum allowable inlet pressure (Nitrogen gas)	0.4 Pa		40 Pa	
Maximum allowable outlet pressure	40 Pa		270 Pa	
Pumping speed (Note 3)	nitrogen	2050 L/s		
	helium	2000 L/s		
	hydrogen	1350 L/s		
Compression ratio	nitrogen	1.4 × 10 <sup>8</sup>		
	helium	1 × 10 <sup>4</sup>		
	hydrogen	1 × 10 <sup>3</sup>		
Rated speed	24600 rpm			
Start-up time	11 minutes			
Mounting position	In any desired direction (Note 5)			
Bake-out temperature at an inlet flange	120 or less			
Vibration level (by Shimadzu's method)	0.01 μ m or less (0-peak)			
Inlet flange	VG250 (Note 4)			
Outlet flange	KF40			
Mass	55 kg			
Admissible throughput of purge gas	20 to 30 mL/min (Note 6)			
Admissible pumping speed of backing vacuum pump in case of gas purge	800 L/min or more			
Admissible ambient magnetic field	Radial direction	3 mT		
	Axial direction	15 mT		
Water	Flow rate	N/A		1 to 3 L/min
	Pressure	N/A		0.2 to 0.5 MPa
	Temperature	N/A		5 to 30

(Note 1) When using a metal at the inlet flange. When using an o-ring gasket , the ultimate pressure is  $10^{-7}$  Pa order.

(Note 2) Without a protective net. Pumping speed for N<sub>2</sub> is 1800 L/s with a protective net.

(Note 3) Without a protective net.

(Note 4) ICF305 flange, ISO250 flange are also available.

(Note 5) The outlet of the magnetic bearing turbo molecular pump should face horizontally or vertically when installing horizontally.

(Note 6) mL/min : volume flow rate at 0 , 1 atm. (Compatible with SCCM.)

## 4.2 Standards Fulfilled

Safety	EN61010-1;1993 + A2;1995 UL3101-1/10.93 SEMI S2 - 0200 EN1012-2; 1996
EMC	EN61326-1; 1997 + A1; 1998 + A2; 2001 class A EN61000-3-2; 1995 + A14; 2000 SEMI F47 - 0200

# INSTALLATION



- 5.1 Installation
  - 5.1.1 Pump Mounting Direction
  - 5.1.2 Installation of the Pump
- 5.2 Connection of the Pump to the Power Supply Unit
- 5.3 Interlock for Vacuum System

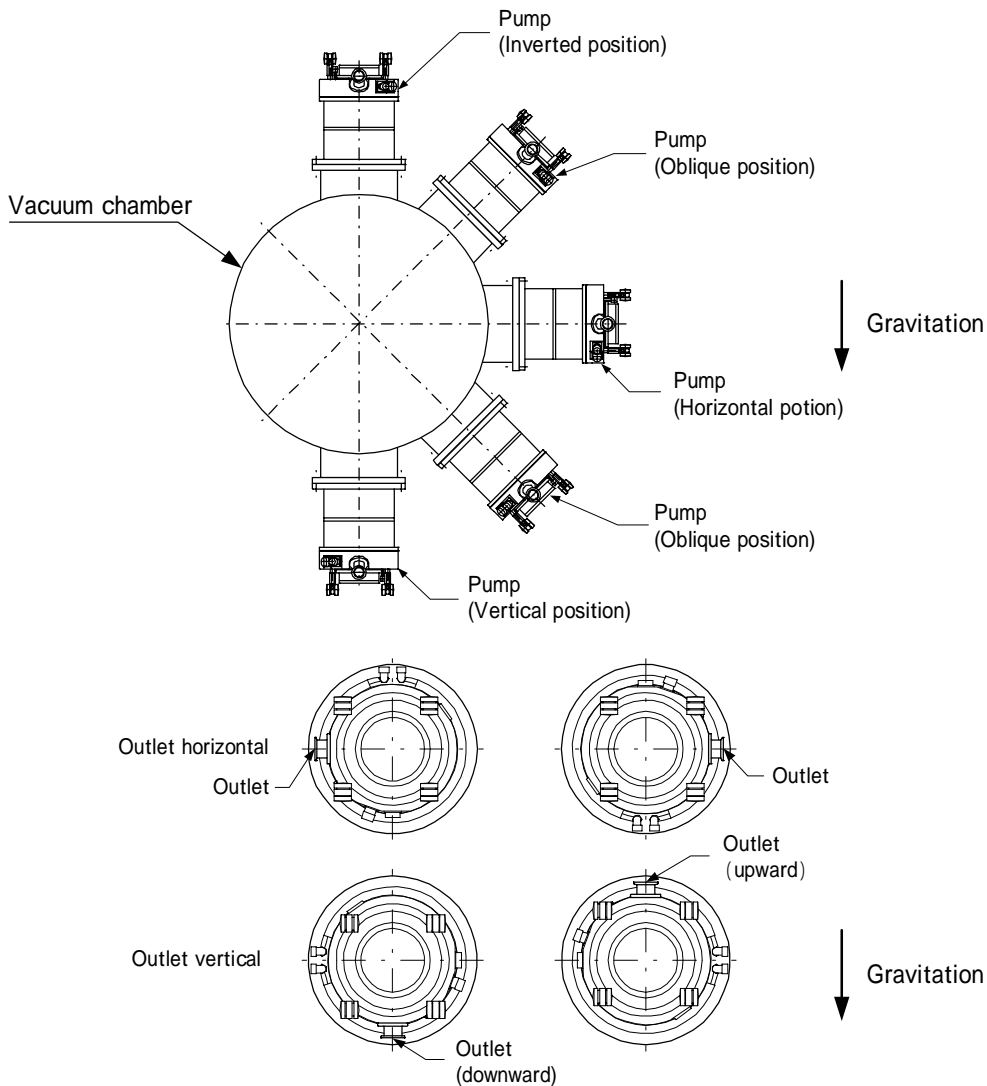


# 5.1 Installation

## 5.1.1 Pump Mounting Direction

5

The inlet flange of magnetic bearing turbo molecular pump must be located in vertical direction, and the outlet flange must be in horizontal position. (Refer to Fig. 5-1)



The outlet of the magnetic bearing turbomolecular pump should face horizontally or vertically when installing horizontally.

**Fig. 5-1 Mounting Direction of Magnetic Levitated Turbo Molecular Pump**

## 5.1.2 Installation of the Pump

### WARNING

Do not operate before safety has been confirmed.

The turbo molecular pump must be securely anchored during any state of operation, by the mounting flange located on the turbo molecular pump's inlet. The quantity of bolts per flange type are:

ICF305 flange requires 32, 8mm bolts, Bolt torque : 4.7 to 7.6 N · m  
 VG250 flange requires 12, 12mm bolts, Bolt torque : 16 to 26 N · m  
 ISO250 flange requires 12, 10mm bolts, Bolt torque : 9.4 to 15 N · m

The bolts used should be made of a material.

TMP-2003M/MC/LM/LMC

Case of ICF305 flange or VG250 flange :

strength division A2-70 (JIS B 1054) or strength division 8.8 (JIS B 1051)

Case of ISO250 flange : strength division 8.8 (JIS B 1051)

TMP-2203M/MC/LM/LMC

Case of ICF305 flange or ISO250 flange : strength division 12.9 (JIS B 1051)

Case of VG250 flange : strength division 8.8 (JIS B 1051)

### CAUTION

Avoid to install the pump at the following places.

- (1) Place where the pump is inevitably exposed to significant vibration and impact.
- (2) Unstable place.
- (3) Place where the pump is inevitably exposed to magnetic field and radioactive ray. The pump proper is a precision machine. Be careful not to apply abnormal vibration, shock/ impact to it during transportation.

This pump is not connected to grand. Please provide PE(Protective earth) connection to the chassis of pump in final application.

### NOTICE

Before touching the pump internals and the vacuum chamber, put a pair of nylon gloves without fail. Avoid direct touch with them. Internal contamination of the vacuum chamber or the pump would cause failure of adequate vacuuming performance.

When using a hydraulic rotary pump with vibration of wide amplitude, as a backing vacuum pump, undertake proper anti-vibration measure. (As a guideline, control the vibration to 0.1 G / 50 Hz max at the outlet connection port of the turbo molecular pump.)

This pump is a precision pump. To protect the pump from torsion due to external piping load, use a bellows joint or a flexible tube to either the pump inlet or outlet, without fail.

CAUTION

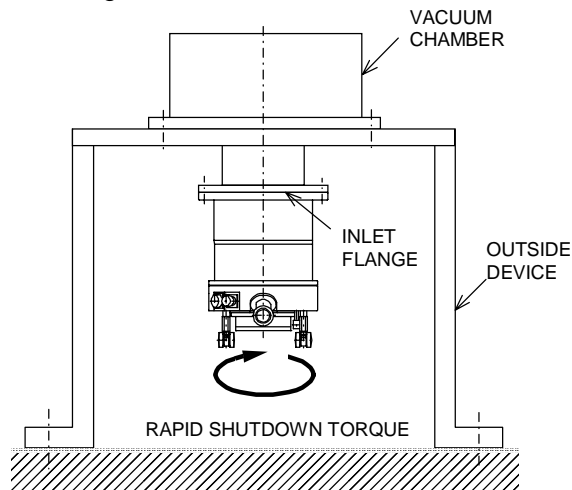
The center of gravity of the pump is indicated in Fig.5-6. Be sure that the pump does not move or fall down during installation or storage.

CAUTION

The casters provided with the pump are only auxiliary equipment for installation and storage. Use a trolley etc. for long-distance transportation.

**Installing Sequence:**

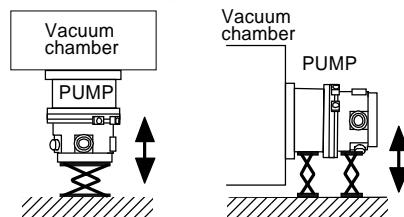
- (1) Joint the inlet flange of the turbo molecular pump to the joint flange of a vacuum chamber, etc. Use all the bolt holes. Fix it at the inlet flange side, as illustrated in Fig. 5-2. The bolt specifications of the inlet flange are as follows:



Description	Rapid Shutdown Torque
TMP-2003M/MC/LM/LMC	43,600 N · m
TMP-2203M/MC/LM/LMC	62,100 N · m

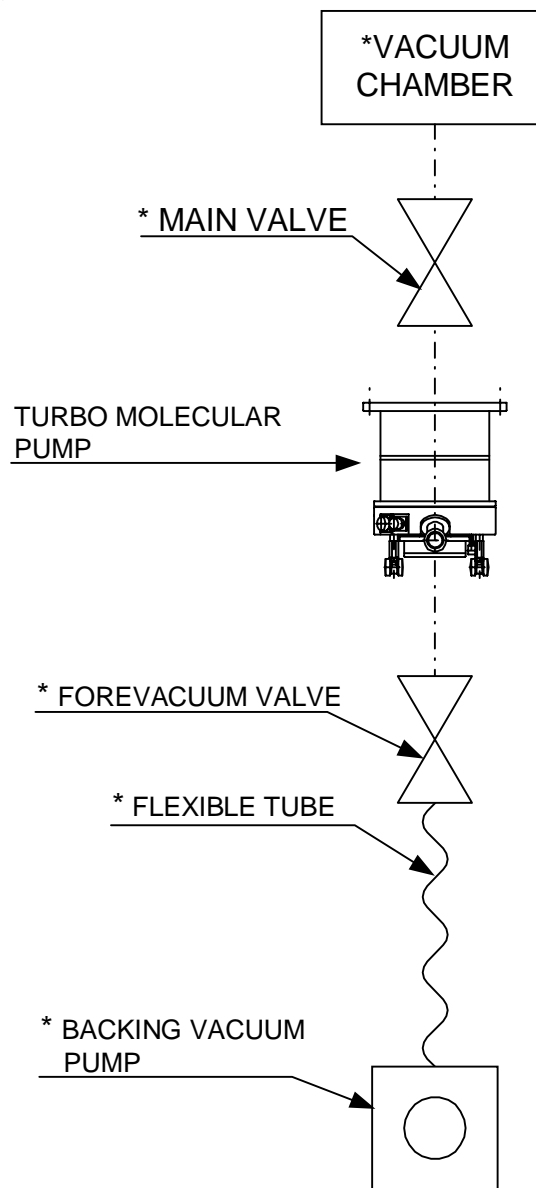
**Fig. 5-2 Installation of Magnetic Bearing Turbo Molecular Pump**

Fix the pump in the manner shown in Fig. 5-3



**Fig. 5-3 Lifting Method**

- (2) Connect a backing vacuum pump or its related pipe connection flange to the outlet flange of the pump. (See Fig. 5-4)



\* marks are not attached to this turbo molecular pump set.

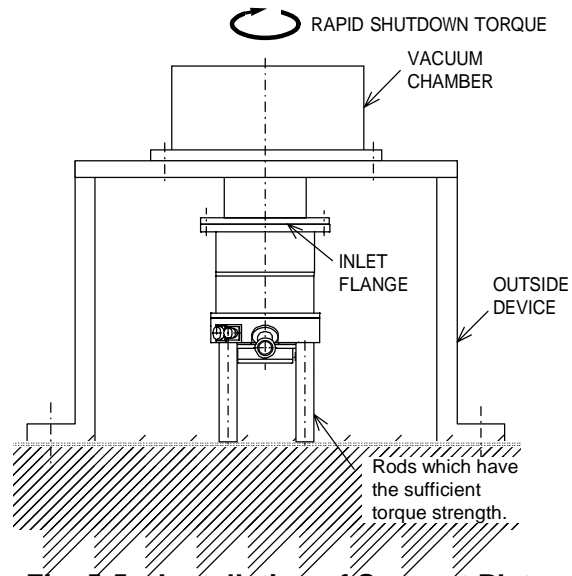
**Fig. 5-4 Example of Exhaust Line**

- (3) When gas purge required, connect the gas purge pipeline to the gas purge port. (For the gas purge detail, see Section 7 "Gas Purge")
- (4) After complete piping connection, check for perfect airtightness by helium leak test.

Anchor the turbo molecular pump to the vacuum chamber with its inlet flange. In addition, anchor the vacuum chamber, etc. on floor. Chamber pipeline and support base shall have the sufficient strength capable of resisting to rapid shutdown torque (See Fig. 5-2) against incidental accident.

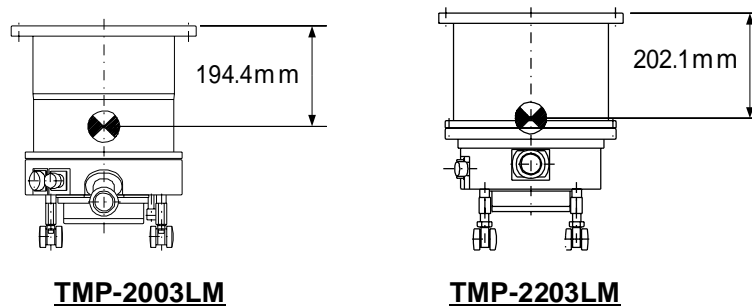
## SECTION 5 INSTALLATION

The support plate that can hold enough strength against the impact torque is highly recommended and to be attached to the rigid frame of the tool. (See Fig. 5-5)



**Fig. 5-5 Installation of Support Plate**

The center of gravity of the pump is shown in Fig. 5-6. Fix securely to avoid moving or falling down in the event of an earthquake.



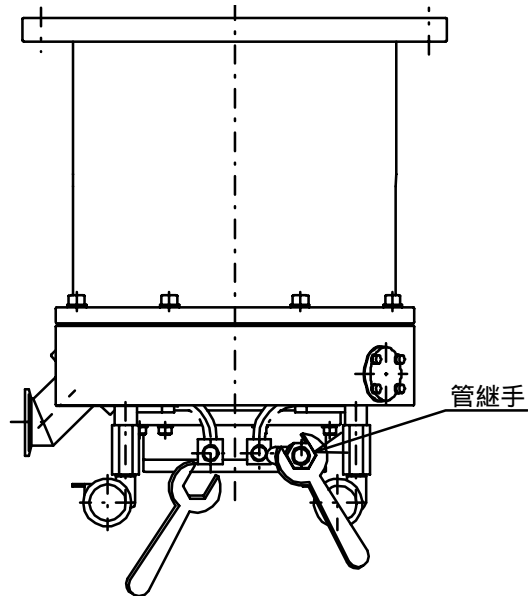
**TMP-2003LM**

**TMP-2203LM**

**Fig. 5-6 Center of gravity of the pump**

**Connection of Cooling Water Line:**

Connect cooling water pipes to these pumps. When connecting the cooling water pipes, screw the pipe joint while also holding the nozzle of the pump with a spanner in order to avoid deforming the cooling water pipe, as illustrated in Fig. 5-7.



**Fig. 5-7 Cooling Water Piping Connection**

## 5.2 Connection of the Pump to the Power Supply Unit

---

CAUTION

Insert straight the control cable connector after checking its key direction.

Inserting it in oblique direction would cause damage of the connector pins. After the insertion, turn the cable connector clockwise until the rotation lock clicks.

---

---

CAUTION

Don't disconnect each cable while the pump is running. Particularly before disconnecting the control cable, Check complete shutdown of the pump by ROTATION lamp goes out and, thereafter, turn off the POWER switch.

---

For information regarding cable connections please refer to the Power Supply Unit Instruction Manual.

## 5.3 Interlock for Vacuum System

- (1) When using, as a backing vacuum pump, a vacuum pump with no check mechanism (backstream flow prevention) such as dry vacuum pump, etc., install a forevacuum valve between the turbo molecular pump and the backing vacuum pump to prevent rapid inverse flow of exhausted gas. And close the forevacuum valve before the backing vacuum pump stops. (See Fig. 5-4)
- (2) Even when "ALARM" signal is emitted, don't cut off the power supply while "ROTATION" signal is being emitted. Even when ALARM lamp lights, don't cut off the power supply while ROTATION lamp lighting.
- (3) If "ALARM" signal is emitted or ALARM lamp lights, shut down the backing vacuum pump or close the forevacuum valve immediately. Furthermore, when main valve is installed between the turbo molecular pump and the vacuum chamber, close this valve, too.  
Provide a flowmeter on the downstream of cooling water line, otherwise the turbo molecular pump will shut down and otherwise set up the interlock which the pump can not start against cut off of water supply.

For more information regarding signals, please refer to the Power Supply Unit Instruction Manual.





# OPERATION

A decorative blue dotted line that starts horizontally from the left, then turns 90 degrees downward on the right side.

- 6.1 Outline
  - 6.1.1 Introduction
- 6.2 Start-up Preparation
  - 6.2.1 Start-up Preparation
- 6.3 Start-up
  - 6.3.1 Start-up Sequence
- 6.4 Shutting Down
- 6.5 Baking Operation

## 6.1 Outline

---

### CAUTION

Neither disconnect and reconnect each cable while the pump is running.

Particularly for unplugging the control cable from the receptacle, check complete shutdown of the pump by ROTATION lamp goes out and, thereafter, turn off the POWER switch.

---

### CAUTION

Do not turn the power off while the pump is running. The touch-down bearing may need to be replaced if the power is turned off repeatedly during operation.

If the power is turned off during rotation, power from regenerative braking will keep the rotor levitated. After slowing down, levitation stops and the rotor is supported by the touchdown bearing. Therefore, repeated touchdowns will reduce the life of the bearing.

---

### 6.1.1 Introduction

---

Please operate by the Power Supply Unit. For more information regarding an operation, please refer to the Power Supply Unit Instruction Manual.

## 6.2 Start-up Preparation

Please select "LOCAL" or "REMOTE" at the switch of the Power Supply Unit.

For more information regarding operation, please refer to the Power Supply Unit Instruction Manual.

---

### 6.2.1 Start-up Preparation

---

- (1) Feed the cooling water into the cooling line. (for cooling water method)
- (2) Turn on the POWER switch of the power supply unit and check if the POWER lamp lights.  
And the rotor of the turbo molecular pump is levitated by the magnetic bearing.
- (3) Evacuate the turbo molecular pump by using a backing vacuum pump.
- (4) Start-up preparation is complete if the pressure in the turbo molecular pump reduces below 200 Pa.

6

## 6.3 Start-up

---

### 6.3.1 Start-up Sequence

---

- (1) Start-up begins when the 6.2.1 "Start-up Preparation Sequence in LOCAL Mode" is complete.
- (2) For more information regarding an operation, please refer to the Power Supply Unit Instruction Manual.

#### REFERENCE

A pressure check using the vacuum gauge attached to the pump inlet shows that the pressure reduces gradually after rotation starts.

## 6.4 Shutting Down

### CAUTION

After having operated the turbo molecular pump for evacuation of corrosive gas, keep the pump internal as vacuumed even after shutdown. Inflow of water content in the air to the pump internal would cause rapid corrosion trouble of the pump internals. The pump corrosion may result in damaging the vacuum vessel interior and other units, causing pressure fluctuation by stopping the pump and dispersal of parts.

### CAUTION

When reducing internal pressure of the turbo molecular pump up to around the atmospheric pressure by use of inert gas, etc., adjust the pressure reducing valve so that the internal pressure of the same pump does not exceed 20 kPa [GAUGE].

For shut-down of the turbo molecular pump, follow the sequence below.

Preparations Prior to Shutting Down Operation:

- (1) Check that process gas inflow is in complete stop. When main valve is provided between the turbo molecular pump and vacuum chamber, close the valve, too.
- (2) When purge gas is being fed into the turbo molecular pump, stop the gas feed, too.
- (3) When forevacuum valve is provided between the turbo molecular pump and backing vacuum pump, close the valve, too.

Shutting Down Sequence in LOCAL Mode:

- (1) For more information regarding an operation, please refer to the Power Supply Unit Instruction Manual.
- (2) Stop the cooling water flow. (for cooling water method)

When the turbo molecular pump is turned off after pumping a corrosive gas, maintain a vacuum inside the turbo molecular pump or purge the interior of the pump with an inert gas.

Further, in such a case when a hydraulic rotary vacuum pump is used as backing vacuum pump and there is possible reverse flow and diffusion of oil from the backing vacuum pump, return the pump internal pressure to atmospheric pressure using dry nitrogen gas, after complete shut-down of the pump [ROTATION lamp goes out], to prevent the turbo molecular pump from being contaminated with oil vapor.

For shutting down the turbo molecular pump in running at high speed with infeed of dry nitrogen gas to the pump, keep the nitrogen gas flow rate at 1500 mL/min maximum.

REFERENCE

ROTATION lamp goes out or "ROTATION" signal turns off when the pump rotational speed is 60rpm or less. Turning off the POWER switch permits the pump rotor to be supported by the touch-down bearings.

## 6.5 Baking Operation

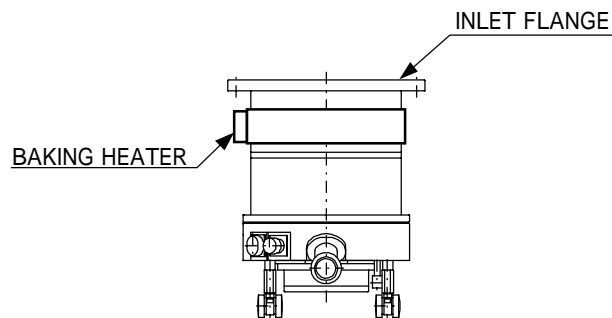
### CAUTION

During baking operation, cool down the turbo molecular pump in either cooling water or cooling fan.

### NOTICE

Baking temperature is not allowed to exceed 120 °C .

The baking heater is installed near the inlet flange.



**Fig. 6-1 Installation of Baking Heater**

Perform baking treatment when the inlet pressure of the turbo molecular pump is  $1 \times 10^{-3}$  Pa or less. It is necessary to apply baking to not only the vacuum chamber but also the pump proper in order to keep an exhausting vessel at super high vacuum. However, the baking temperature is not allowed to exceed 120 °C because generally the rotor of the turbo molecular pump is made of aluminum alloy.

For baking application to the pump proper, carefully adjust the baking temperature. For the purpose, special heater is supplied with the pump system considering the temperature requirements. Use this heater for control of the baking temperature.

# GAS PURGE





The turbo molecular pump is prepared with a gas purge port, see Fig. 2-1 (2). It does not need gas purge during ordinary evacuation. If it evacuates a lot of corrosive gas, for example etching process, it is advised to flow the purge gas for protection of the bearings. An inert and chemically stable non-condensing gas is most suitable for the purge gas. The nitrogen is the most popular purge gas. The proper purge gas flow rate is between 20 and 30 mL/min.

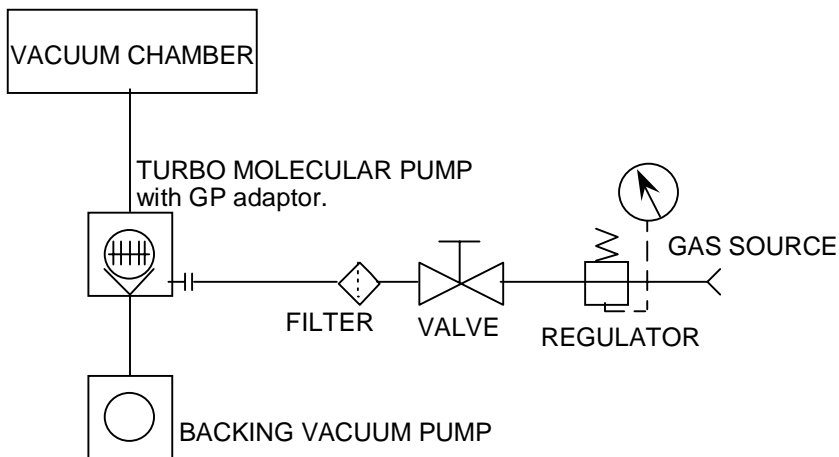
**OPTION**

For the turbo molecular pump with an optional gas purge adapter, an orifice contained in the GP adaptor can hold the gas supply pressure at constant value so as to thereby keep the purge gas flow at constant rate. Use the optional adapter under the following conditions, if chosen.

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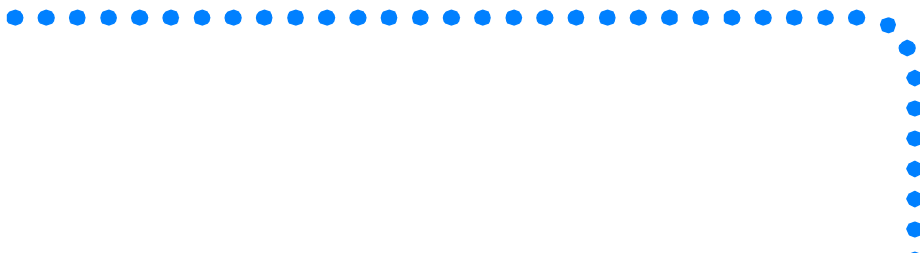
Supplied gas pressure	20±10 kPa (Gauge reading , use of nitrogen gas)
Gas feed start	After start-up of backing vacuum pump, before evacuating of process gas.
Gas feed stop	After evacuating exhaust of process gas, before shutdown of backing vacuum pump.
Type of gas	Nitrogen gas or Argon gas (Purity > 99.99%)

Fig. 7-1 is an example of gas purge piping diagram. Use a filter of 5 μm or less in element size. Use a stop valve to feed/stop the purge gas.



**Fig. 7-1 Gas Purge Method**

# TURBO MOLECULAR PUMP RECONDITION



- 8.1 Turbo Molecular Pump Return Request
- 8.2 Turbo Molecular Pump Decontamination
- 8.3 Touch-Down Bearing Replacement
- 8.4 Check of the rotor blades

## 8.1 Turbo Molecular Pump Return Request

### WARNING

Improper turbo molecular pump use may be hazardous to operator's health in applications not recommended or approved by Shimadzu. In the event removal of the turbo molecular pump from an application is required, full protective measures including purging of the turbo molecular pump with an inert gas and/or apparel are recommended when the turbo molecular pump has been used in applications that required the use of corrosive, reactive, stimulative, or toxic gases.

8

Annual overhaul is recommended.

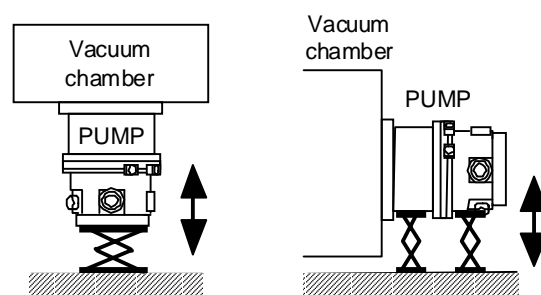
Overhaul, re-manufacturing, refurbishing, or repair of the turbo molecular pump system should always be performed by Shimadzu or an approved service company. (A copy of this from is printed at the end of this manuals "Repair of Magnetic Bearing Turbo Molecular Pump")

The following precautions are required before forwarding the turbo molecular pump to Shimadzu or an approved service company for all service related requests.

- (1) The turbo molecular pump must be void of all process gases. Turbo molecular pumps that were operated in applications using special gases (doping gas, epitaxial gas, film forming gas, etching gas, etc.), likely have the process by-products, reaction-produced matter, etc. Remove them from the turbo molecular pump by repeated gas purge to the pump and fill the pump with an inert gas. The pump interior must be adequately purged with inert gas before uninstalling from the unit.
- (2) The customer is required to submit MSDS (Material Safety Data Sheet) sheets and information of all gases, materials, etc. that have been associated with the turbo molecular pump.

Shimadzu will accept and perform service only on turbo molecular pumps that have been properly prepared as stated in (1) and (2) above. Shimadzu will advise the customer of any failure precaution/prevention procedures that are appropriate to each individual turbo molecular pump service request.

Remove the pump in the manner shown in Fig. 8-1.



**Fig. 8-1 Way to remove the pump**

## 8.2 Turbo Molecular Pump Decontamination

All expenses incurred with the decontamination of the turbo molecular pump are the responsibility of the customer.

## 8.3 Touch-Down Bearing Replacement

The touch-down bearing (Fig. 3-1 (9)) is the only component of Shimadzu's turbo molecular pump that is subjected to friction and wear, normally occurring only during electrical power failure. Repeated and/or frequent rotor touch down will cause wear and bigger rotational resistance and require replacement of touch down bearings.

Shimadzu recommends replacement of the touch-down bearing by Shimadzu or an approved service company.

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## 8.4 Check of the rotor blades

Rotor blades of turbo molecular pump are high-speed rotor made of aluminum alloy. It has the possibility that material strength deteriorates, specially when corrosive gas is evacuated. Regular check (Customer is liable for the cost.) by Shimadzu or a Shimadzu approved/authorized service center is suggested. (Every one year is recommended.) Shimadzu and/or the service center perform fluorescence penetrant testing of rotor blades in every overhaul task and check and suggest a rotor replacement to customers if any cracks are found out.



# TROUBLESHOOTING



9.1 Vacuum Pressure Rise

9.2 Abnormal Noise and/or Vibration

## 9.1 Vacuum Pressure Rise

A rapid rise of vacuum pressure in the turbo molecular pump causes the internal motor of the turbo molecular pump to start braking and the ALARM lamp lights.

## 9.2 Abnormal Noise and/or Vibration

Should the turbo molecular pump ever generate abnormal noise and/or vibration, the turbo molecular pump operation is to be stopped immediately.

But there is possible that a race of touch-down bearing (Fig. 3-1 (9)) may make sounds for seconds when the pump internal pressure gets back to atmospheric pressure using air (or non-activity gas). This phenomena is not abnormal and make no damage to the pump, because the air whirlpool sometimes occurs and then makes the touch-down bearing rotate slightly.

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## TMP Evaluation Form

Please fill out this evaluation form and attach to the product when you send it back to Shimadzu Service Center for repair service, etc. When you fill out this form, please describe the details as much as possible.

Evaluation items (Please check the item box, and fill out the information at the underline.)

Returned : Pump Type TMP- Product No.  
 Power source Type EI- Product No.

Request : Overhaul repair others

Detail \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Alarm name : \_\_\_\_\_ (If there is status indication lamp, light No is : \_\_\_\_\_)

System/Equipment name : \_\_\_\_\_

Date of request (date of occurrence) : \_\_\_\_\_ Expected date of treatment completion : \_\_\_\_\_

Total operation hours : \_\_\_\_\_ hrs. Date of operation start : \_\_\_\_\_ Date of delivery : \_\_\_\_\_

**Please fill out the following items to make sure of worker's safety.**

[Announcement of attraction material and gas]

Repair etc. may not be accepted when attraction material and gas is not removed.

• Type of attraction material : \_\_\_\_\_  
 (Please fill out the etched material in etch system/equipment (GaAs substrate etc.). Please fill out the material of target in PVD system/equipment (sputter, vacuum evaporation etc.).)

• Type of attraction gas

Air, nitrogen, etc. (name : \_\_\_\_\_) Inert gas such as helium, etc. (name : \_\_\_\_\_)

Corrosive gas (name : \_\_\_\_\_) Reactive/active gas (name : \_\_\_\_\_)

Virulent gas (name : \_\_\_\_\_) Others (name : \_\_\_\_\_)

Attraction gas ( : removed, : not removed) Influence on man's body.( YES, NO)

Treatment procedure, handling precaution, etc. for case when attraction gas is not removed.  
 \_\_\_\_\_

• Is there a color changes and adhesion at inlet and outlet flange? Yes No

If there is a color changes and adhesion, we wash the TMP to keep an appropriate performance of vacuum pump.(additional charges)

Customer(Company) : Division : \_\_\_\_\_ Phone # : \_\_\_\_\_

Contact Person : \_\_\_\_\_(ext.#) \_\_\_\_\_ Authorized signature : \_\_\_\_\_

Use condition of equipment :

Gas purge : Used ( \_\_\_\_\_ ml/min) Not used (none)

For the oil type bearing :

Oil type : Standard oil Fluorine base oil(designated oil) Others( \_\_\_\_\_ )

Oil level : near upper limit medium point near lower limit less than lower limit

Others :

Dealer name : \_\_\_\_\_ Contact Person : \_\_\_\_\_ Tel \_\_\_\_\_



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