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## **Magnetically Levitated Turbo Molecular Pump**

**TMP-203M,TMP-303M,TMP-403M**

**(Air cooled type)**

**TMP-203MC,TMP-303MC,TMP-403MC**

**(Air cooled chemical type)**

**TMP-203LM,TMP-303LM,TMP-403LM**

**(Wide range type)**

**TMP-203LMC,TMP-303LMC,TMP-403LMC**

**(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-203M/MC/LM/LMC Turbo molecular pump, TMP-303M/MC/LM/LMC Turbo molecular pump and TMP-403M/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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In an effort to improve the product, this document may be revised in the future without notice.

Every effort has been made to prepare an accurate and complete manual, but if an error or omission should be discovered, revisions might not be possible immediately.

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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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**WARNING**

Decisions on system compatibility should be made by the system designer or the person deciding the specifications after conducting tests as necessary. The responsibility for guaranteeing the expected performance and safety of the system lies with the person who decides system compatibility.

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**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:

ICF152 flange	requires 16,	8mm bolts,	Bolt torque :	4.7 to 7.6 N · m
VG100 flange	requires 8,	10mm bolts,	Bolt torque :	9.4 to 15 N · m
ISO100 flange	requires 8,	10mm bolts,	Bolt torque :	9.4 to 15 N · m
ICF203 flange	requires 20,	8mm bolts,	Bolt torque :	4.7 to 7.6 N · m
VG150 flange	requires 8,	10mm bolts,	Bolt torque :	9.4 to 15 N · m
ISO160 flange	requires 8,	10mm bolts,	Bolt torque :	9.4 to 15 N · m

The bolts used should be CRSS304 or made of a material of strength division 8.8 (JIS B 1051).

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**WARNING**

Do not remove the turbo molecular pump, before safety has been confirmed.

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.

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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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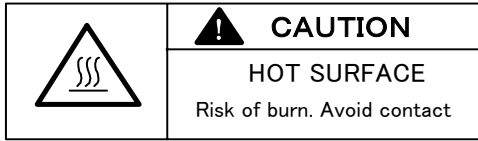
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**CAUTION**

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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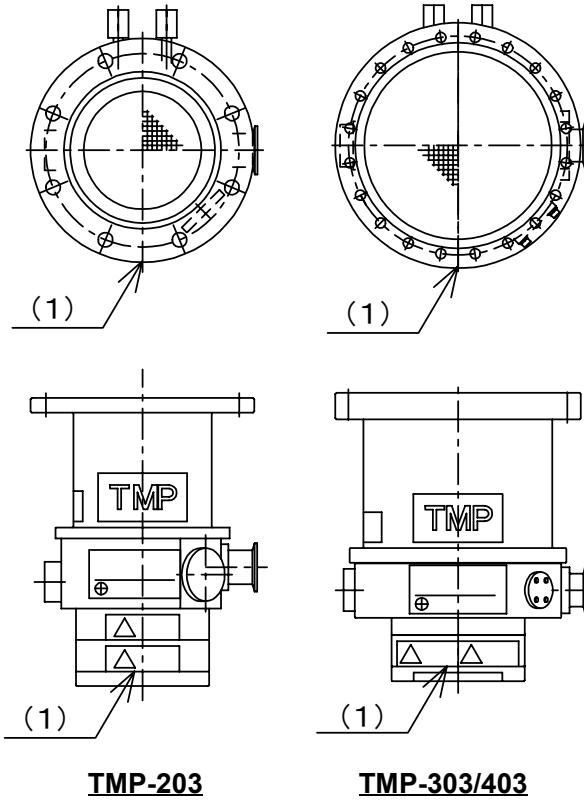
○ Explanation of caution marking



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 allow any electrical cables to be in tension or to have very tight bending radii.



- (3) 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.

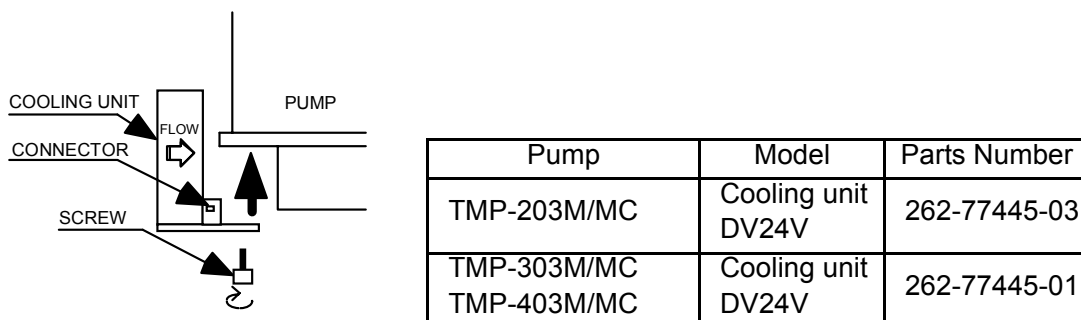
The request for changing parts exceeding the estimated lifetime should be made to Shimadzu or an approved service company in order for safety and adequate performance of the pump and power supply unit.

**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-203M/MC, TMP-303M/MC and TMP-403M/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.




**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) Damage or malfunction to the Shimadzu TMP product, directly or indirectly caused by natural disasters, such as, but not limited to, earthquakes, hurricanes, tornadoes, typhoons, and the like, will not be covered by this warranty.
- 10) 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.





11) 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.

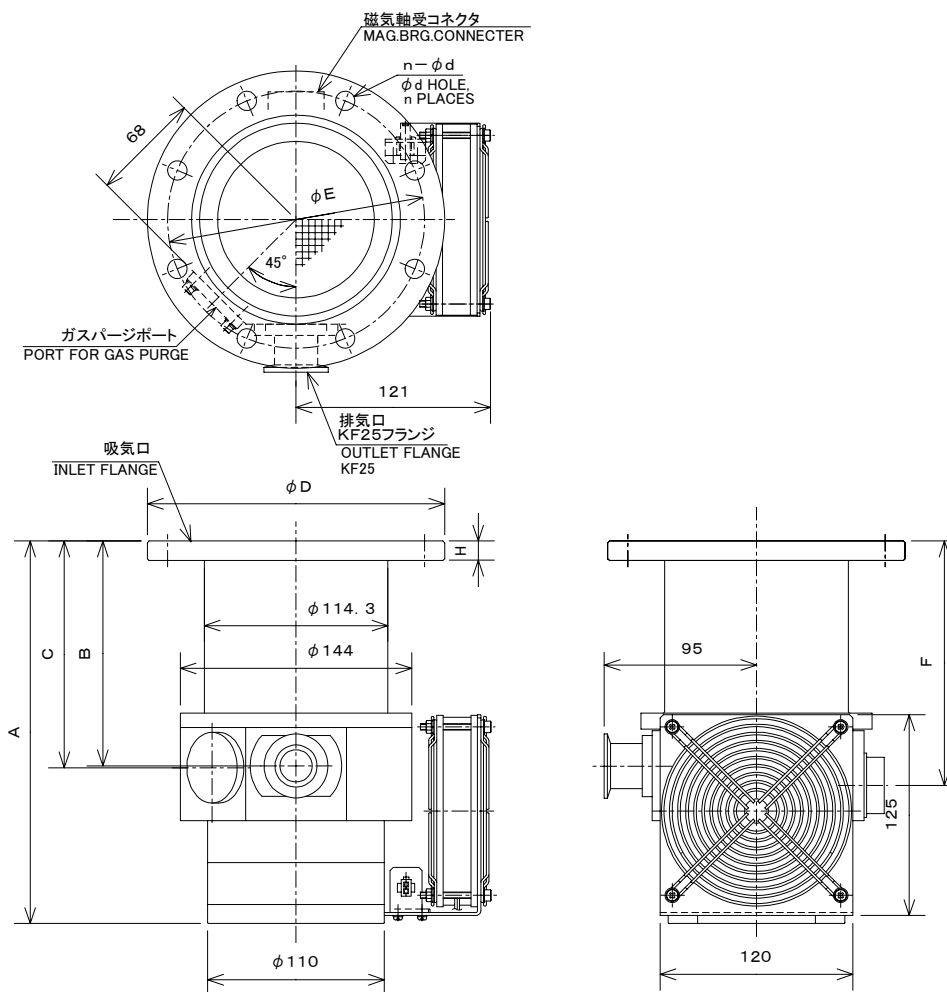
The turbo molecular pump (one standard set) consists of the following items.

- Pump                               1
- Power Supply Unit           1
- Control Cable                 1
- Fan Cable                     1 (for Air cooled type)
- Standard Accessories       1 Set

# 1.2 Descriptions

1

## 1.2.1 Pump Main Unit



INLET FLANGE	Parts number		A	B	C	$\phi D$	$\phi E$	$n-\phi d$	F	H
	TMP-203M	TMP-203MC								
ICF152	P/N 262-81445-61	P/N 262-81445-71	252	154	155	$\phi 152$	$\phi 130.3$	16- $\phi 8.4$	166	20
VG100	P/N 262-81445-62	P/N 262-81445-72	238	140	141	$\phi 185$	$\phi 160$	8- $\phi 12$	152	12
ISO100 (Collar for clamp)	P/N 262-81445-63	P/N 262-81445-73	239	141	142	$\phi 130$	—	—	153	12

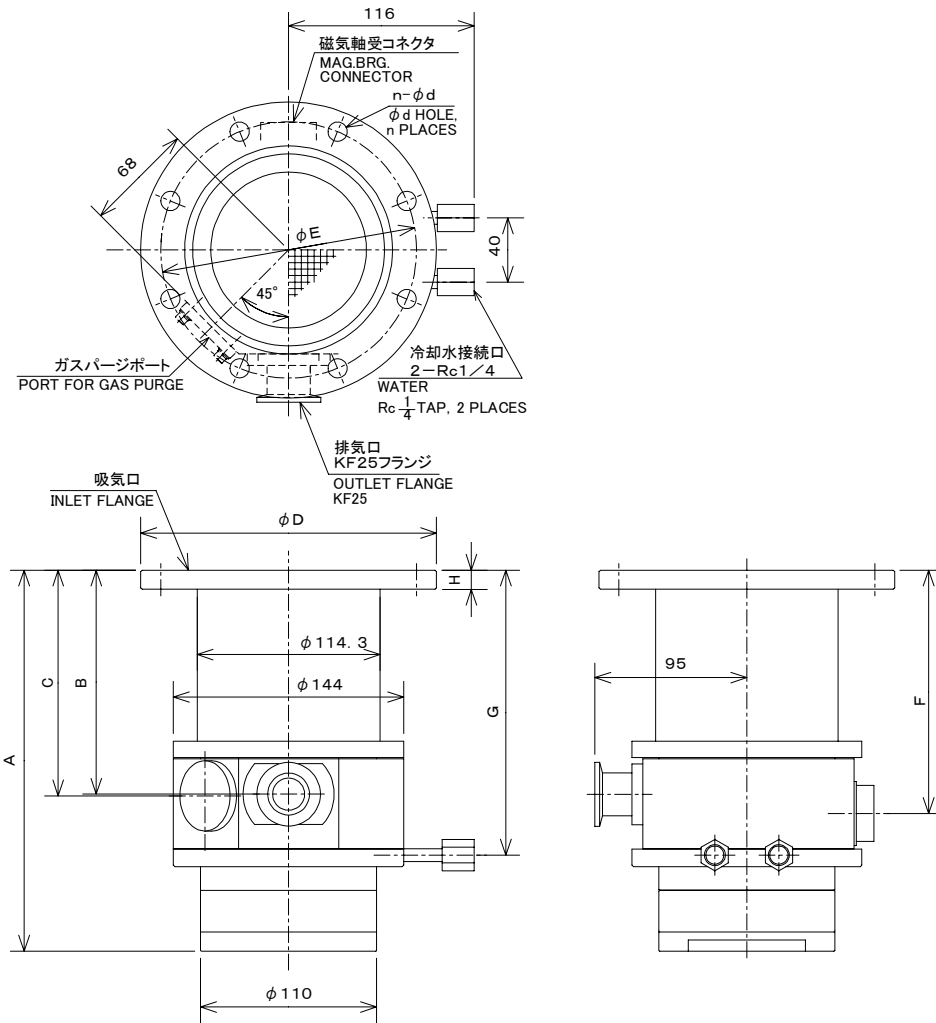
### **TMP-203M and TMP-203MC**

**Fig.1-1 Outside Dimensions of Pump Proper**



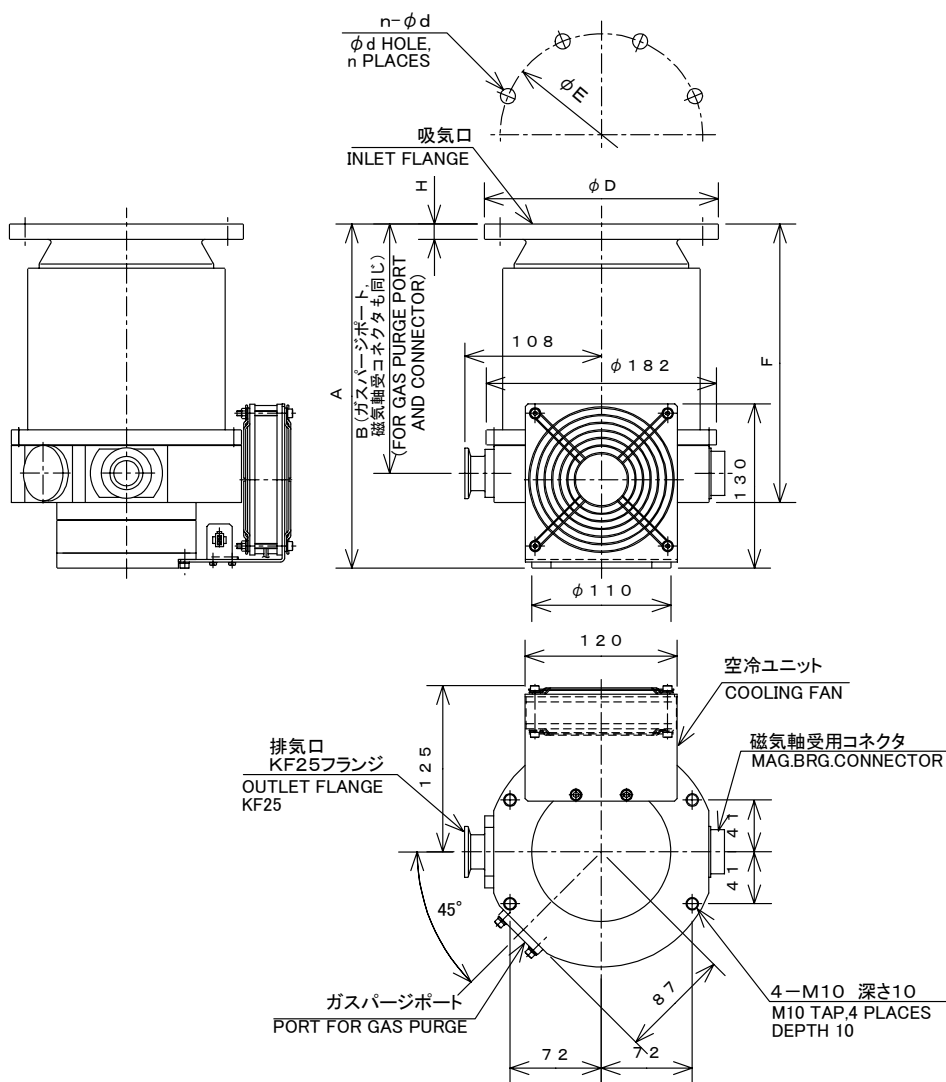
# SECTION 1 OUTLINE AND DESCRIPTIONS

1



INLET FLANGE	Parts number		A	B	C	$\phi D$	$\phi E$	n- $\phi d$	F	G	H
	TMP-203LM	TMP-203LMC									
ICF152	P/N 262-81445-41	P/N 262-81445-51	252	154	155	$\phi 152$	$\phi 130.3$	16- $\phi 8.4$	166	192	20
VG100	P/N 262-81445-62	P/N 262-81445-72	238	140	141	$\phi 185$	$\phi 160$	8- $\phi 12$	152	178	12
ISO100 (Collar for clamp)	P/N 262-81445-63	P/N 262-81445-73	239	141	142	$\phi 130$	—	—	153	178	12

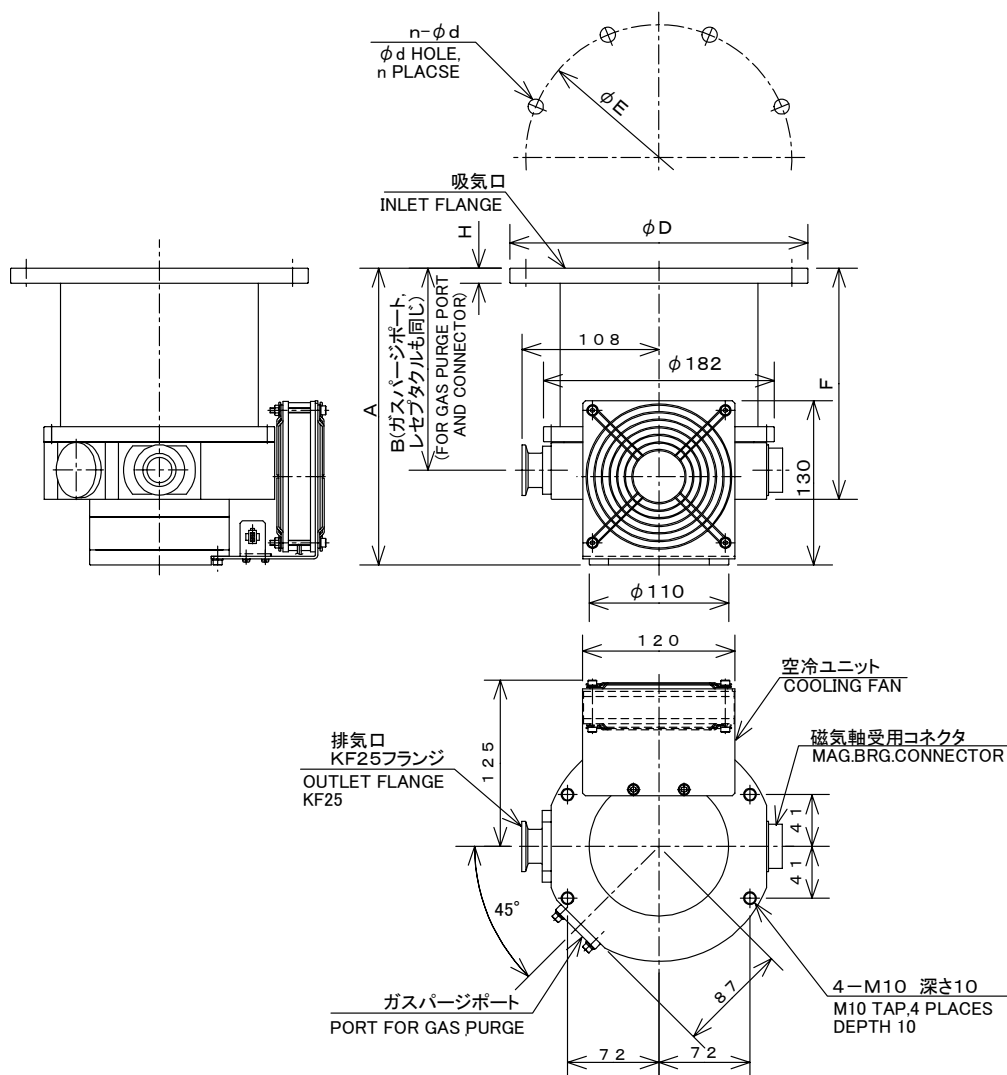
**TMP-203LM and TMP-203LMC**  
**Fig.1-2 Outside Dimensions of Pump Proper**



INLET FLANGE	Parts number		A	B	φD	φE	n-φd	F	H
	TMP-303M	TMP-303MC							
ICF152	P/N 262-81435-61	P/N 262-81435-71	279	204	φ 152	φ 130.3	16-φ 8.4	227	20
VG100	P/N 262-81435-62	P/N 262-81435-72	272	197	φ 185	φ 160	8-φ 12	220	12
ISO100 (Collar for clamp)	P/N 262-81435-63	P/N 262-81435-73	279	204	φ 130	—	—	227	12

**TMP-303M and TMP-303MC**  
**Fig.1-3 Outside Dimensions of Pump Proper**





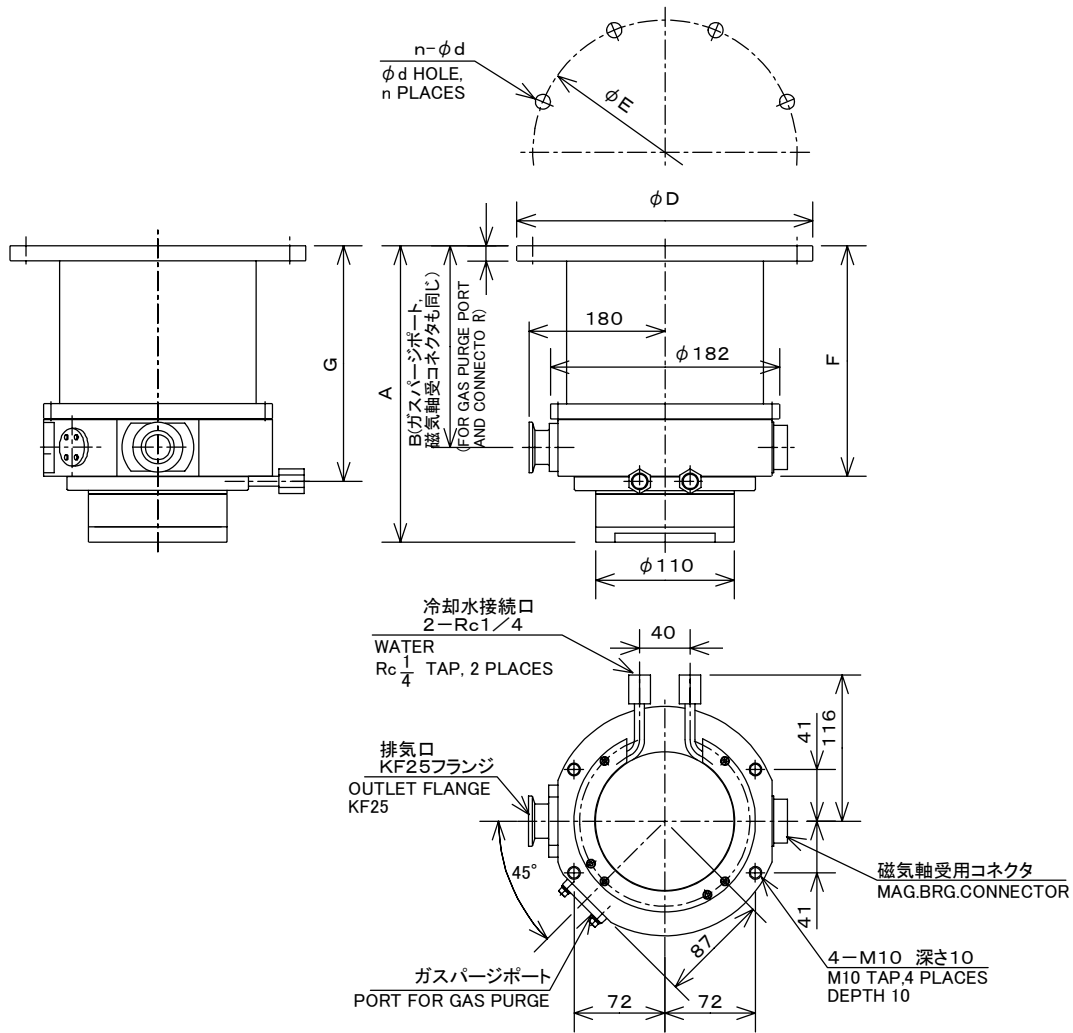
INLET FLANGE	Parts number		A	B	φD	φE	n-φd	F	H
	TMP-403M	TMP-403MC							
ICF203	P/N 262-81455-61	P/N 262-81455-71	238	163	φ 203	φ 181.1	20-φ 8.4	186	22
VG150	P/N 262-81455-62	P/N 262-81455-72	235	160	φ 235	φ 210	8-φ 12	183	12
ISO160 (Collar for clamp)	P/N 262-81455-63	P/N 262-81455-73	241	166	φ 180	—	—	189	12

**TMP-403M and TMP-403MC**

**Fig.1-5 Outside Dimensions of Pump Proper**

SECTION 1 OUTLINE AND DESCRIPTIONS

1



INLET FLANGE	Parts number		A	B	$\phi D$	$\phi E$	n- $\phi d$	F	G	H
	TMP-403LM	TMP-403LMC								
ICF203	P/N 262-81455-41	P/N 262-81455-51	238	163	$\phi 203$	$\phi 181.1$	20- $\phi 8.4$	186	190	22
VG150	P/N 262-81455-42	P/N 262-81455-52	235	160	$\phi 235$	$\phi 210$	8- $\phi 12$	183	187	12
ISO160 (Collar for clamp)	P/N 262-81455-43	P/N 262-81455-53	241	166	$\phi 180$	—	—	189	193	12

**TMP-403LM and TMP-403LMC**

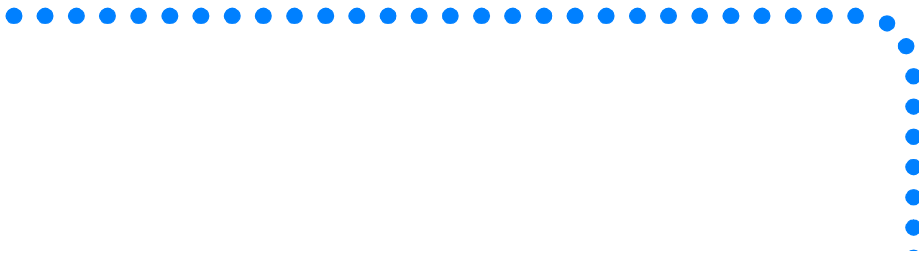
**Fig.1-6 Outside Dimensions of Pump Proper**

### 1.2.2 Standard Accessories

	Description	Q'ty	Notes	Parts Number
1	Gasket for inlet flange	1	One of followings: Copper gasket for ICF152 O-ring gasket for VG100 Copper gasket for ICF203 O-ring gasket for VG150 A gasket for ISO flange is option.	263-10896-04 036-13509 263-10896-05 036-13512
2	Bolt set for inlet flange	1Set	Bolts, washers, and nuts	—
3	Centering ring with O-ring	1	KF25	035-06004-13
4	Clamp	1	KF25	035-06004-02
5	Instruction manual	1		263-13238



# IDENTIFICATION AND FUNCTION

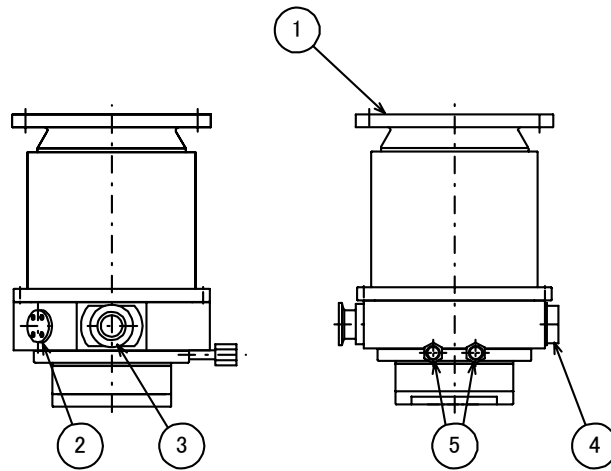


## 2.1 Pump Main Unit

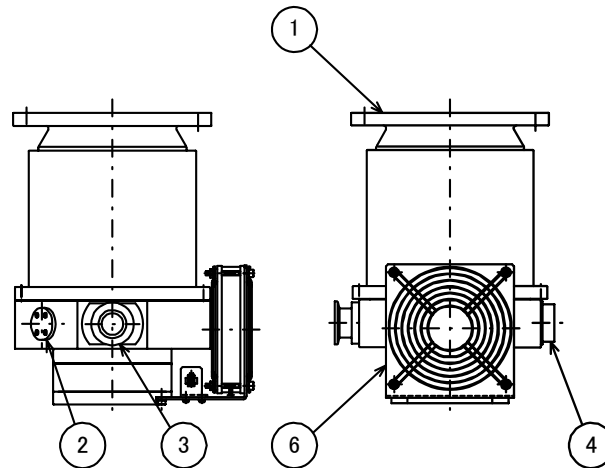


## 2.1 Pump Main Unit

2



**Cooling water method**



**Cooling fan method**

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

- (1) INLET FLANGE..... Inlet flange, joint the turbo molecular pump, ICF152, VG100, ISO100, ICF203, VG150, ISO160 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, KF25.
- (4) CONTROL CONNECTOR. .... Control cable receptacle
- (5) COOLING WATER PIPELINE. . Cooling water pipe connector, Rc1/4
- (6) 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-203LM/LMC, TMP-303LM/LMC and TMP-403LM/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.

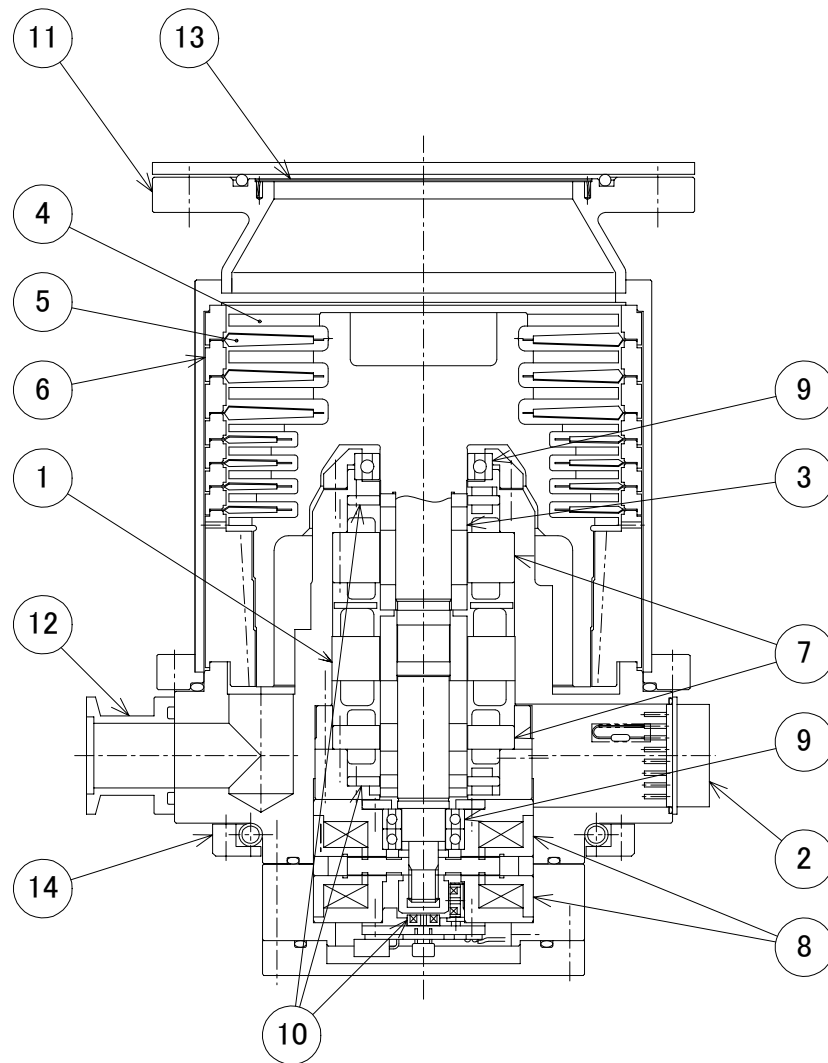
A touchdown bearing is used at the top and bottom of the casing for safety protection of the rotor and pump should the magnetic bearings become damaged. The touchdown bearings are dry and oil free.

The cooling water pipe (14) is provided to cool the pump. With the air-cooled turbo molecular pumps TMP-203M/MC and TMP-303M/MC and TMP-403M/MC, cooling fans are provided instead of the cooling water pipe (14).

Fig. 1-1 through Fig. 1-6 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.



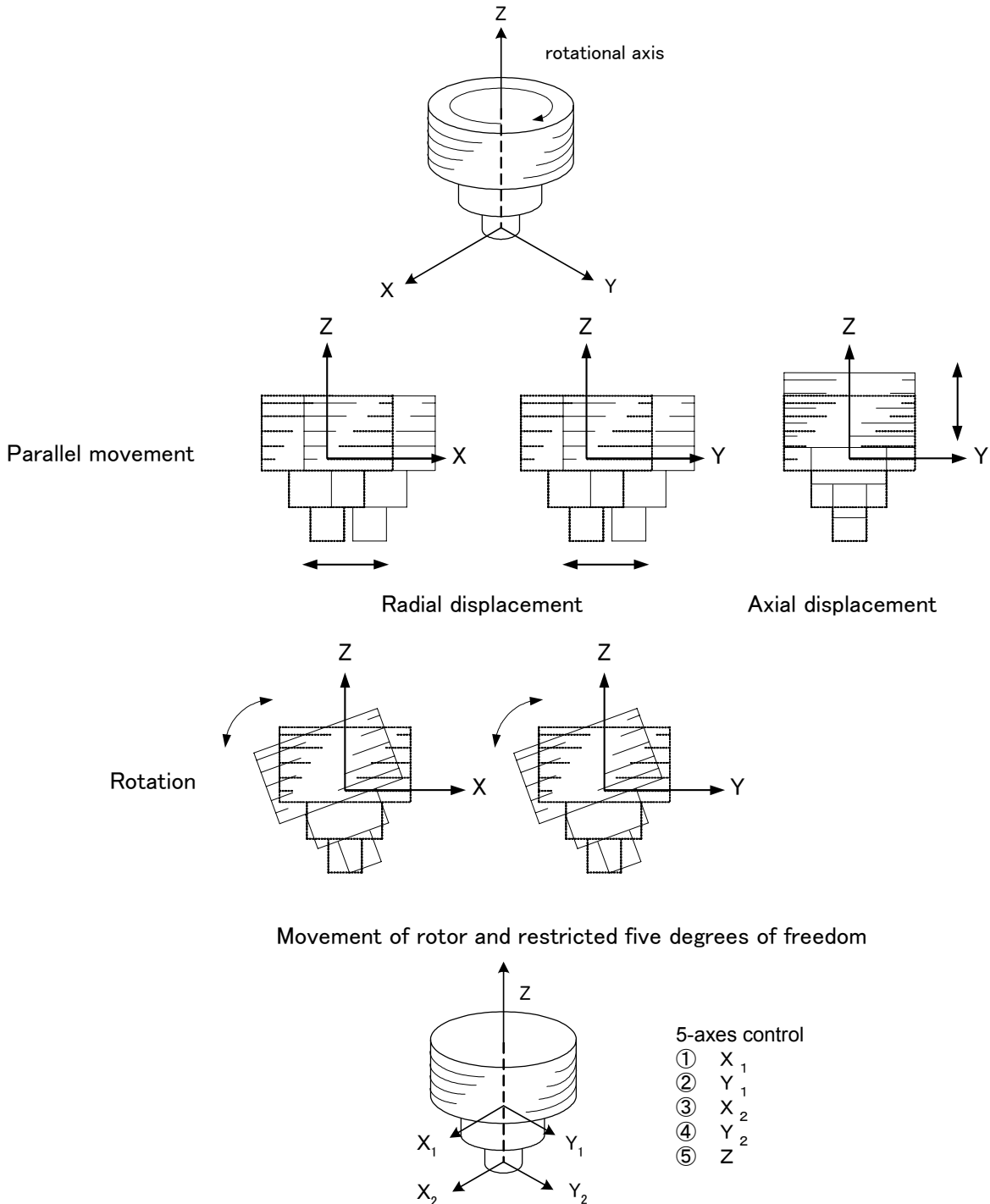
**Fig.3-1 Pump Sectional Drawing**

- |                          |                             |   |
|--------------------------|-----------------------------|---|
| (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<br>(pipe connection port) |
| (5) Stator blade         | (10) Gap sensor             |   |

### SECTION 3 CONSTRUCTION AND PRINCIPLE

3

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).



**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-203M	TMP-203MC	TMP-203LM	TMP-203LMC
Suitable Power supply unit	EI-D203M			
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 allowable inlet pressure (Nitrogen gas)	1.3 Pa		200 Pa	
Maximum allowable outlet pressure	40 Pa		400 Pa	
Pumping speed (Note 2)	nitrogen	190 L/s		
	helium	140 L/s		
	hydrogen	120 L/s		
Compression ratio	nitrogen	1 × 10 <sup>9</sup>		
	helium	6 × 10 <sup>4</sup>		
	hydrogen	4 × 10 <sup>3</sup>		
Rated speed	50000 rpm			
Start-up time	5 minutes or less			
Mounting position	In any desired direction (Note 7)			
Bake-out temperature at an inlet flange	120 °C or less			
Vibration level (by Shimadzu's method)	0.012 μm or less (0-peak)			
Inlet flange	ICF152 (Note 5)			
Outlet flange	KF25			
Mass	9 kg			
Admissible throughput of purge gas	20 to 30 mL/min (Note 8)			
Admissible pumping speed of backing vacuum pump in case of gas purge	200 L/min or more			
Environmental Temperatures	Operation : 10 to 40 °C / Storage : -25 to 70 °C			
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 °C

Turbo molecular pump	TMP-303M	TMP-303MC	TMP-303LM	TMP-303LMC
Suitable Power supply unit	EI-D303M			
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 allowable inlet pressure (Nitrogen gas)	1.3 Pa		200 Pa	
Maximum allowable outlet pressure	40 Pa		400 Pa	
Pumping speed (Note 3)	nitrogen	320 L/s		
	helium	340 L/s		
	hydrogen	320 L/s		
Compression ratio	nitrogen	1 × 10 <sup>9</sup>		
	helium	8 × 10 <sup>4</sup>		
	hydrogen	4 × 10 <sup>3</sup>		
Rated speed	45000 rpm			
Start-up time	5 minutes or less			
Mounting position	In any desired direction (Note 7)			
Bake-out temperature at an inlet flange	120 °C or less			
Vibration level (by Shimadzu's method)	0.012 μm or less (0-peak)			
Inlet flange	ICF152 (Note 5)			
Outlet flange	KF25			
Mass	14 kg			
Admissible throughput of purge gas	20 to 30 mL/min (Note 8)			
Admissible pumping speed of backing vacuum pump in case of gas purge	200 L/min or more			
Environmental Temperatures	Operation : 10 to 40 °C / Storage : -25 to 70 °C			
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 °C



## SECTION 4 SPECIFICATIONS

4

Turbo molecular pump	TMP-403M	TMP-403MC	TMP-403LM	TMP-403LMC
Suitable Power supply unit	EI-D303M			
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 allowable inlet pressure (Nitrogen gas)	1.3 Pa		200 Pa	
Maximum allowable outlet pressure	40 Pa		400 Pa	
Pumping speed (Note 4)	nitrogen	420 L/s		
	helium	360 L/s		
	hydrogen	340 L/s		
Compression ratio	nitrogen	1 × 10 <sup>9</sup>		
	helium	8 × 10 <sup>4</sup>		
	hydrogen	1 × 10 <sup>4</sup>		
Rated speed	45000 rpm			
Start-up time	5 minutes or less			
Mounting position	In any desired direction (Note 7)			
Bake-out temperature at an inlet flange	120 °C or less			
Vibration level (by Shimadzu's method)	0.012 μm or less (0-peak)			
Inlet flange	ICF203 (Note 6)			
Outlet flange	KF25			
Mass	14 kg			
Admissible throughput of purge gas	20 to 30 mL/min (Note 8)			
Admissible pumping speed of backing vacuum pump in case of gas purge	200 L/min or more			
Environmental Temperatures	Operation : 10 to 40 °C / Storage : -25 to 70 °C			
Admissible ambient magnetic field				
	Radial direction	3 mT		
	Axial direction	15 mT		
Water	Flow rate	N/A		1 to 3 L/min
	Pressure			0.2 to 0.5 MPa
	Temperature			5 to 30 °C

(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 180 L/s with a protective net.

(Note 3) Without a protective net. Pumping speed for N<sub>2</sub> is 300 L/s with a protective net.

(Note 4) Without a protective net. Pumping speed for N<sub>2</sub> is 400 L/s with a protective net.

(Note 5) ISO100 bolted flange, VG100 flange are also available.

(Note 6) ISO160 bolted flange, VG150 flange are also available.

(Note 7) The outlet of the magnetic bearing turbo molecular pump should face horizontally or vertically when installing horizontally.

(Note 8) mL/min : volume flow rate at 0 °C , 1 atm. (Compatible with SCCM.)

## 4.2 Standards Fulfilled

Safety	EN61010-1; 2001 UL61010A-1 SEMI S2 EN1012-2; 1996
EMC	EN61326-1; 1997 + A1; 1998 + A2; 2001 class A SEMI F47



# INSTALLATION



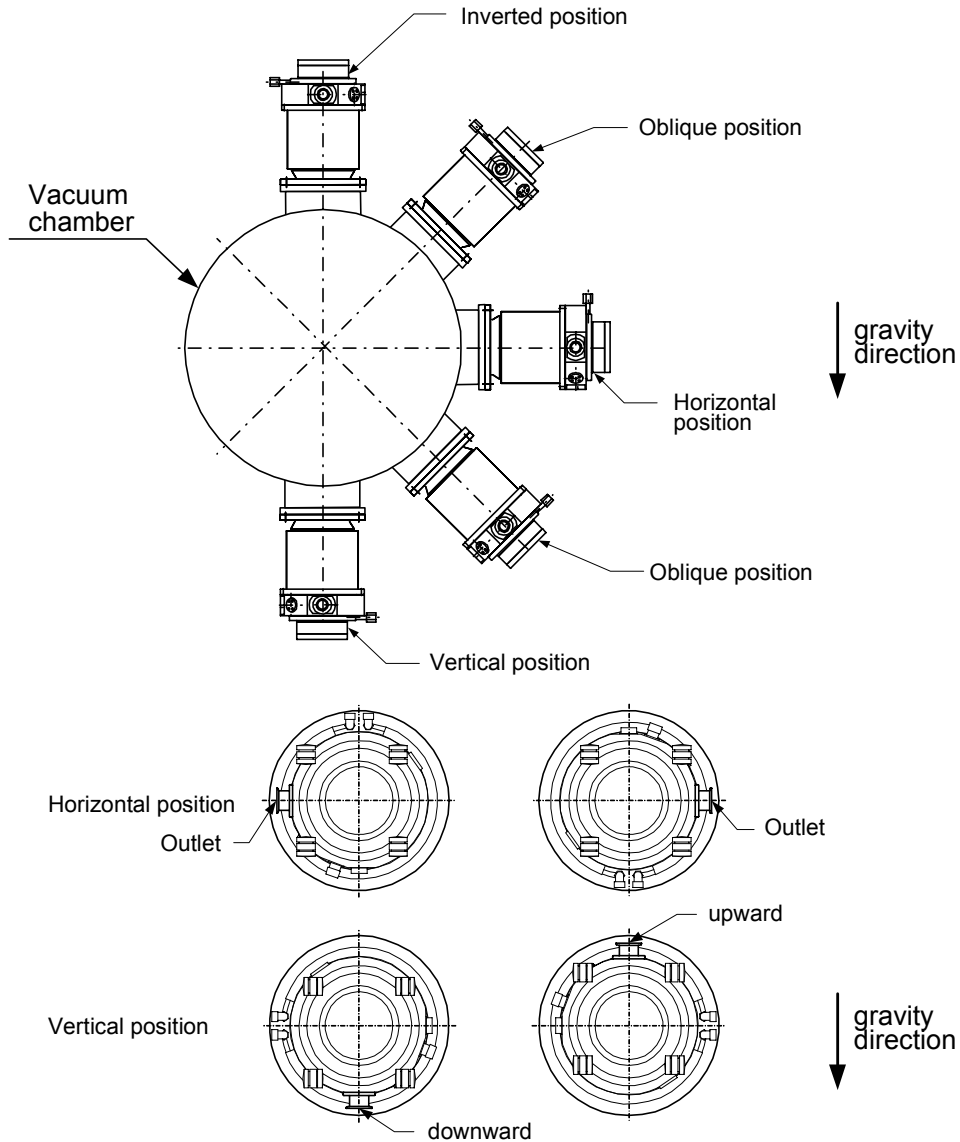
- 5.1 Installation
  - 5.1.1 Pump Mounting Direction
  - 5.1.2 Installation of the Pump
- 5.2 Connection of the Pump to the Power Supply Unit
- 5.3 Interlock for Vacuum System

# 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:

ICF152 flange	requires 16,	8mm bolts,	Bolt torque :	4.7 to 7.6 N · m
VG100 flange	requires 8,	10mm bolts,	Bolt torque :	9.4 to 15 N · m
ISO100 flange	requires 8,	10mm bolts,	Bolt torque :	9.4 to 15 N · m
ICF203 flange	requires 20,	8mm bolts,	Bolt torque :	4.7 to 7.6 N · m
VG150 flange	requires 8,	10mm bolts,	Bolt torque :	9.4 to 15 N · m
ISO160 flange	requires 8,	10mm bolts,	Bolt torque :	9.4 to 15 N · m

The bolts used should be CRSS304 or made of a material of 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

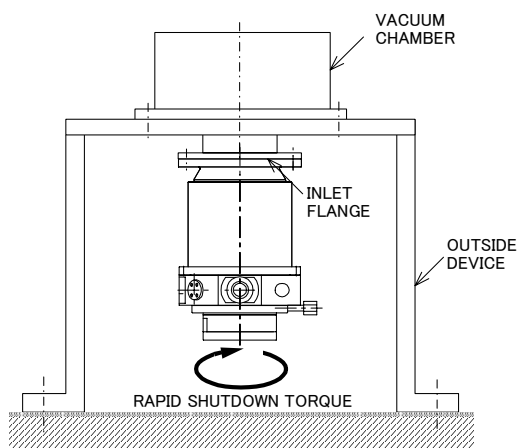
The center of gravity of the pump is indicated in Fig.5-6. Be sure that the pump does not move or fall down during installation or storage.

## 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:

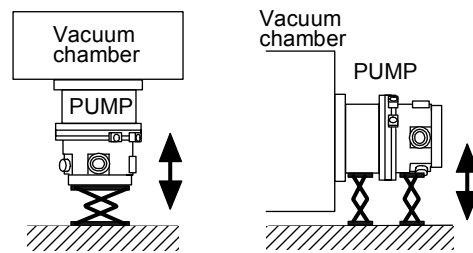


Description	Rapid Shutdown Torque
TMP-203M/MC/LM/LMC	2,300 N · m
TMP-303M/MC/LM/LMC	4,400 N · m
TMP-403M/MC/LM/LMC	4,400 N · m

The bolts used should be CRSS304 or made of a material of strength division 8.8 (JIS B 1051).

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

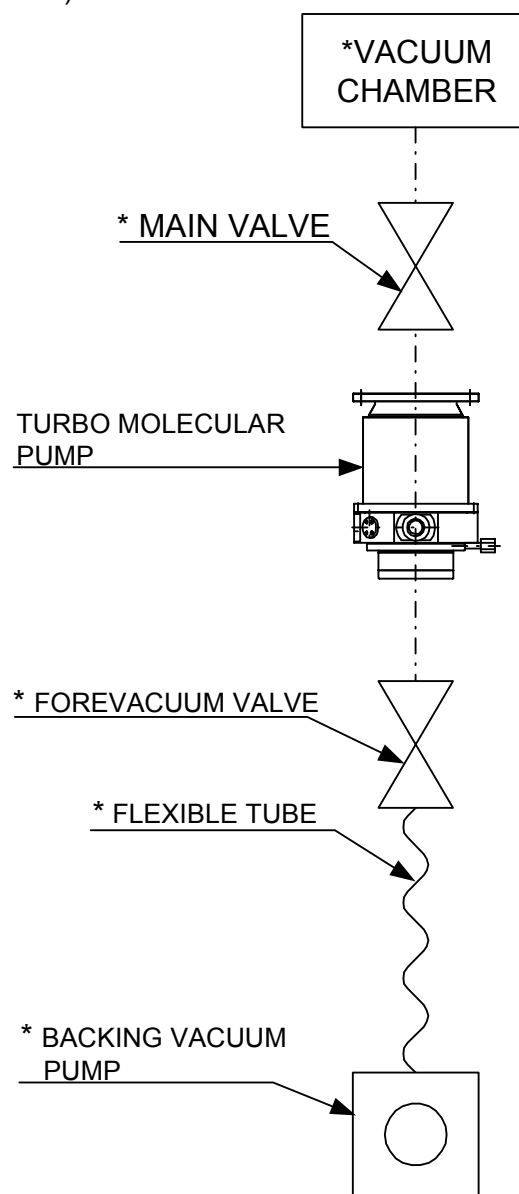
Fix the pump in the manner shown in Fig. 5-3



**Fig. 5-3 Lifting Method**

5

(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**

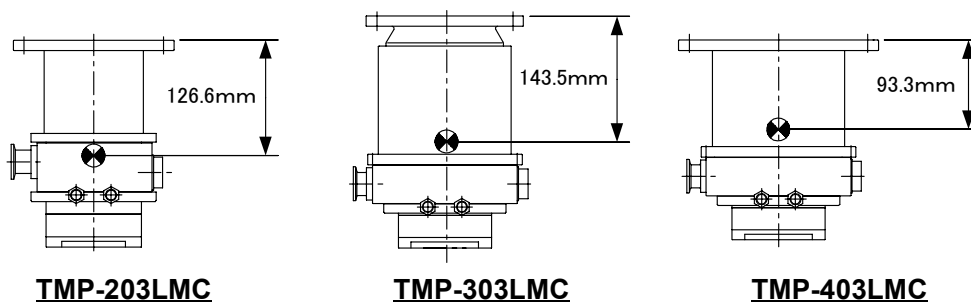


- (3) When gas purge required, connect the gas purge pipeline to the gas purge port. (For the gas purge detail, see Section 7 "Gas Purge")
- (4) After complete piping connection, check for perfect airtightness by helium leak test.

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.

5

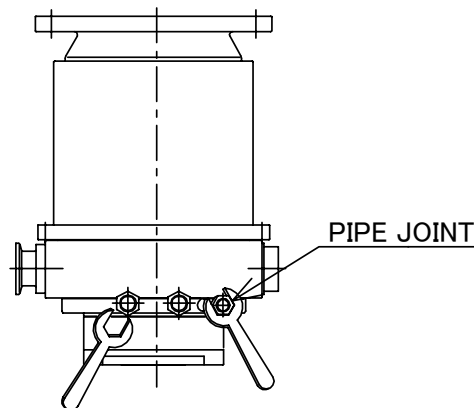
The center of gravity of the pump is shown in Fig. 5-5. Fix securely to avoid moving or falling down in the event of an earthquake.



**Fig. 5-5 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. 5-6.



**Fig. 5-6 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)
- 5 (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 at the end.

- 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.

---

6

### 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.

## 6.3 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

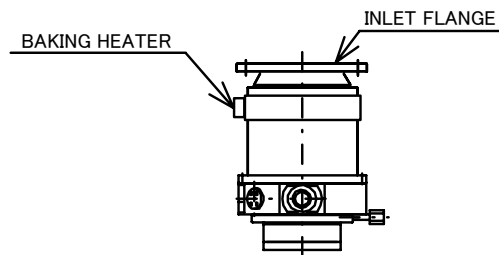
### CAUTION

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.

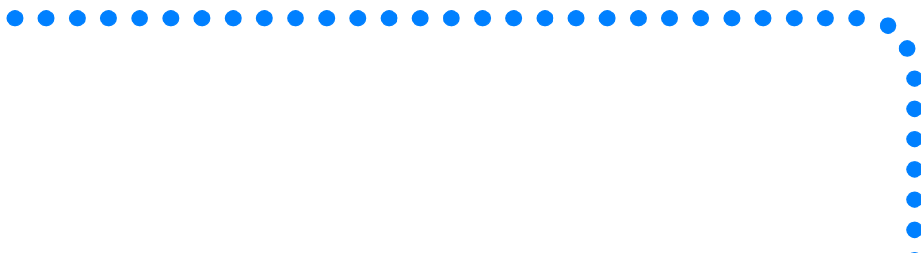


**Fig. 6-1 Installation of Baking Heater**

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



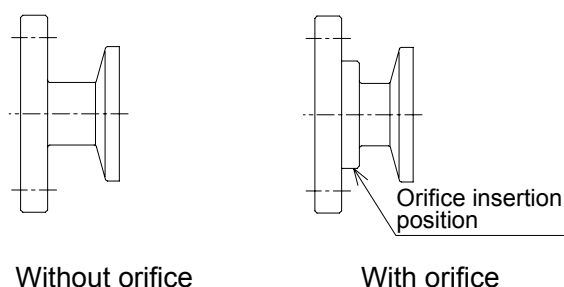
## SECTION 7 GAS PURGE

The turbo molecular pump incorporates a gas purge port (Fig. 2-1 (2)). Gas purging is not required for ordinary evacuation. However, a purge gas flow is recommended to protect the bearings during evacuation of large quantities of corrosive gas during an etching process, for example. An inert and chemically stable non-condensing gas is most suitable for the purge gas. Nitrogen is the most popular purge gas. A purge gas flowrate between 20 and 30 mL/min is appropriate.

Please consult your shimadzu representative, during evacuation of corrosive gas.

The gas-purge adaptor is available without an orifice (recommended) or with an orifice (option).

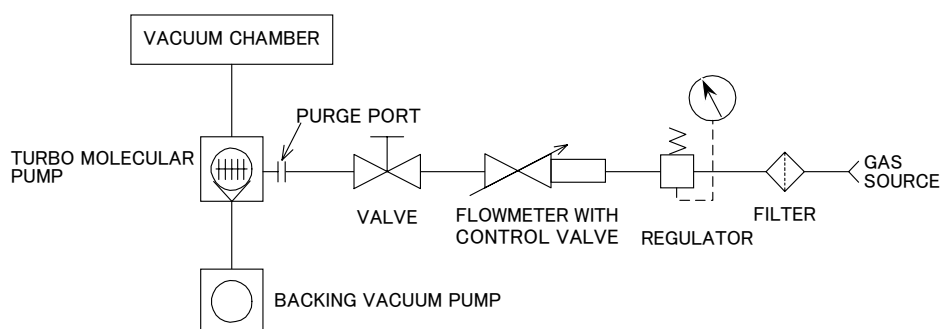
Refer to Fig. 7-1 to check whether the gas-purge adaptor attached to the purchased pump incorporates an orifice. Connect the gas-purge adaptor correctly, according to the piping diagrams below. The diagram shows the KF10 joint, but the method of recognizing the orifice is the same for all joints.



**Fig. 7-1 How to Recognize if the Gas-purge Adaptor Incorporates an Orifice**

Fig. 7-2 shows an example of a gas-purge piping diagram. Use a filter element size of 5  $\mu$  m, or less. Use a stop valve to start and stop the purge gas flow.

Gas supply	20 $\pm$ 10 kPa gauge pressure (nitrogen gas)
Gas feed start	After starting backing vacuum pump; before evacuating process gas
Gas feed stop	After exhausting process gas sufficiently; before stopping backing vacuum
Type of gas	Nitrogen gas or argon gas (Purity > 99.99%)



**Fig. 7-2 Gas Purge Method (no orifice)**

Joint	PART No.	Description
KF10	262-77592-19	GP ADAPTOR, 0.5 KF10
UJR 6.35	263-14770	GP ADAPTOR, 0.5 UJR
SWAGELOK $\phi$ 6.35	263-14771	GP ADAPTOR, 0.5 SWG
4-VCR	263-14772	GP ADAPTOR, 0.5 VCR

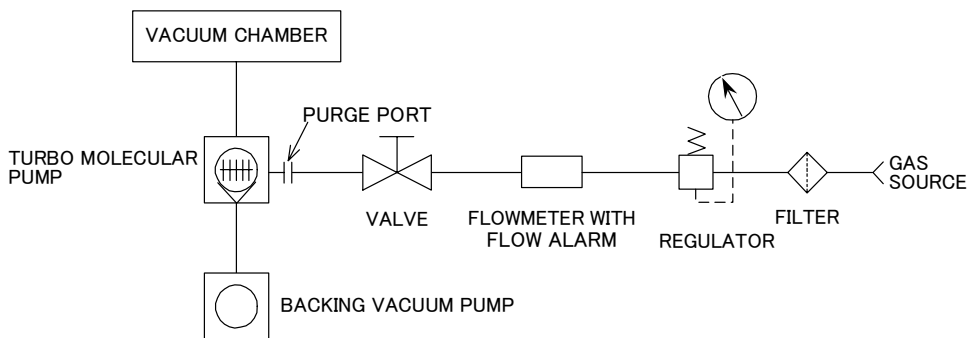
**Table 7-1 Table of Gas-purge Ports (no orifice)**

## OPTION

A gas purge adaptor with an orifice is available as an option. The gas purge adaptor with an orifice maintains the purge gas flow between 20 and 30 mL/min if the gas-supply pressure lies within the range below. Flow control with a flowmeter is not required.

Note: Gas purge adaptors with no orifice are recommended for applications in which large amounts of reaction products are generated (e.g., metal etchers). Adaptors with an orifice will cause clogging.

Gas supply	20 ± 10 kPa gauge pressure (nitrogen gas)
Gas feed start	After starting backing vacuum pump; before evacuating process gas
Gas feed stop	After fully exhausting process gas; before stopping backing vacuum pump
Type of gas	Nitrogen gas or argon gas (Purity > 99.99%)



**Fig. 7-3 Gas Purge Method (with orifice)**

Joint	PART No.	Description
KF10	262-77592-03	GP ADAPTOR, 802 KF10
UJR 6.35	262-77592-01	GP ADAPTOR, 802 UJR
SWAGELOK $\phi$ 6.35	262-77592-06	GPA, SS-400 STRAIGHT
4-VCR	262-77592-14	GP ADAPTOR, 4-VCR

**Table. 7-2 Table of Gas-purge Ports (with orifice)**



# 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.

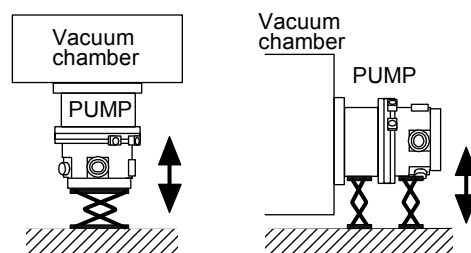
Overhaul, re-manufacturing, refurbishing, or repair of the turbo molecular pump system should always be performed by Shimadzu or an approved service company. (A copy of this from is printed at the end of this manuals "Repair of Magnetic Bearing Turbo Molecular Pump")

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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# Declaration of Conformity

**SHIMADZU CORPORATION SEMICONDUCTOR EQUIPMENT DIVISION**

**Address :380-1,HORIYAMASHITA,HADANO-CITY,  
KANAGAWA, 259-1304, JAPAN**

as the Manufacturer

declares in sole responsibility that the following product

Product Name **Turbo Molecular Pump**

Model Name , P/ N

Vacuum Pump		Power Supply	
Model name	P / N	Model name	P / N
<b>TMP-203LM/LMC/M/MC</b>	262-81445-xx	<b>EI-D203M</b>	262-78757-xx
<b>TMP-303LM/LMC/M/MC</b>	262-81435-xx	<b>EI-D303M</b>	262-78758-xx
<b>TMP-403LM/LMC/M/MC</b>	262-81455-xx		

Note: -xx (P/ N ) means 00 to 99 or blank

referred to in this declaration conforms with following directives and standards

**Machinery directive 98/37/EC amended by 98/79/EC**  
**EN292-1:1991, EN292-2:1991+A1:1995,**  
**EN1012-2:1996**

**Low Voltage directive 73/23/EEC amended by 93/68/EEC**  
**EN61010-1:2001**

**EMC directive 89/336/EEC amended by 91/263/EEC, 92/31/EEC, 93/68/EEC, 93/97/EEC**  
**EN61326:1997+A1:1998+A2:2001, class A**

Note 1) This declaration becomes invalid if technical or operational modifications are introduced without manufacturer's consent.

Note 2) This declaration is valid if this product is used alone or in combination with the accessories of this product or other instruments which fulfill with the requirement of mentioned directive.

Note3) Importer/Distributor and Authorized Representative in EU is as follows:  
**KRATOS ANALYTICAL LTD.**

Address : Whartisid, Trafford Wharf Road, Manchester M17 1GP England

Hadano, JAPAN, 22 March 2004.  
 place and date of issue

  
 signature

Shinzo Inoue  
 name

*Manager of Quality Assurance Dept.*  
*Semiconductor Equipment Division*

Shimadzu Corporation  
 Position

### 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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