263-43069 I

TURBO MOLECULAR PUMP

Model : TMP-V3304LM/LMC (F)
Model : TMP-V2804LM/LMC (F)

Instruction Manual
(Original Instructions)

Read the instruction manual thoroughly before you use the product.
Keep this instruction manual for future reference.

SHIMADZU

Semiconductor Equipment Division

Introduction

Thank you for choosing the Turbo Molecular Pump.

Please read the instruction manual carefully before using turbo molecular pump, and save the instruction manual for future reference.

Copyrights and Disclaimers

This document is copyrighted by Shimadzu Corporation. Please refrain from reproducing or copying part or all of this document without permission from Shimadzu.

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.

Shimadzu does not take responsibility for any effects that may result from the use of this manual.

Copyright © 2010-2013 Shimadzu Corporation.All rights reserved.

Precautions for Safe Operation

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

WARNING	Indicates a potentially hazardous situation whitch, if not avoided, could result in serious injuly or possibly death.
CAUTION	Indicates a potentially hazardous situation whitch, if not avoided, may result in minor to moderate injuly or equipment damage.
NOTICE	Emphasizes additional information that is provided to ensure the proper use of this product.

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.

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.

WARNING

Do not operate the turbo molecular pump until safety is confirmed.

- The rotor assembly of the turbo molecular pump rotates at high speed. Large rapid shutdown torque should be generated when abnormality occurs in the pump by any chance. Incidental accident will cause the pump to drop out and to make a catastrophe if the pump is fixed by insufficient method.
- Fix the pump to host equipment according to 5.1.2.2 and 5.1.2.3. The method to fix the pump is different depending on the pump model and the size of inlet flange of the pump.
- Host equipment should be fixed to the floor so as not to move. Host equipment should be designed to have enough margins in strength, in preparation for an emergency accident.

WARNING

Do not remove or do maintenance 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.

WARNING

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.

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 an explosion proof product. Do not use flammable gas and explosive gas.

CAUTION

The standard power input voltage is 200 - 240 VAC ± 10 %. Connection to the incorrect input voltage can cause damage to the equipment. Supply the power via a circuit breaker (rating 15 A). Please provide PE (Protective Earth) connection to the terminal of a "PE" marked wire in final application.

CAUTION

When pump is removed from a equipment, drain the water from water pipe during pump power on and water valve open. If remained water leak from water pipe, pump body will be corroded.

After the water drained, shut water pipe by the cap which is attached at shipment.

CAUTION

The following "CAUTIONS" are to prevent operation anomalies.

○ Operating Precautions

(1) Do not interrupt the electrical power operating the turbo molecular pump while the turbo molecular pump is in operation.
(2) Protect the pump from any and all types of impact during operation. Impacts can also be transmitted via the flange, so be careful of impacts near the pump as well.
(3) Do not operate any equipment (i.e. drill motor, welding machine, etc.) that produces electro-magnetic pollution, noise, etc., in the immediate proximity of an operating turbo molecular pumping system ((1) pump, (2) cables, etc).
(4) This turbo molecular pump is not approved for use in applications exhausting process gas containing gallium (Ga, e.g., triethyl gallium, etc.).
(5) Plasmas may cause the pump rotor to discharge electrically thus damaging the electrical components.
(6) Be sure to use the chemical type pumps to exhaust of gas which contain chlorine, or fluorine.
(7) 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.
(8) Be careful to prevent a rapid pressure rise or air rush during operation.

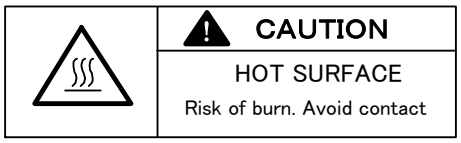
NOTICE

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 deterioration 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.)

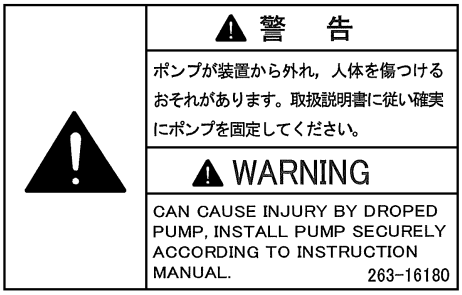
This pump is a precision pump. To protect the pump from torsion due to external piping load, use a bellows joint or a flexible tube to either the pump inlet or outlet, without fail.

○ Explanation of label



(1) HOT SURFACE Label

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



(2) Pump Securement Label

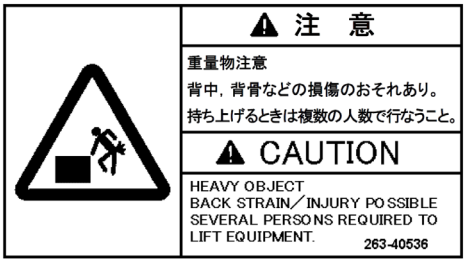
If the pump is not secured properly, it could become detached and cause injury or damage to surrounding equipment. Be sure to secure the pump according to 5.1.2 "Installation of the Pump".

(3) Rremove Label

Do not remove cover, or else it may cause some changes inside and it is failed.

(4) Cable Label

Be sure to use specified cable for this power supply. If not, it may cause connector be broken and power supply itself failed.



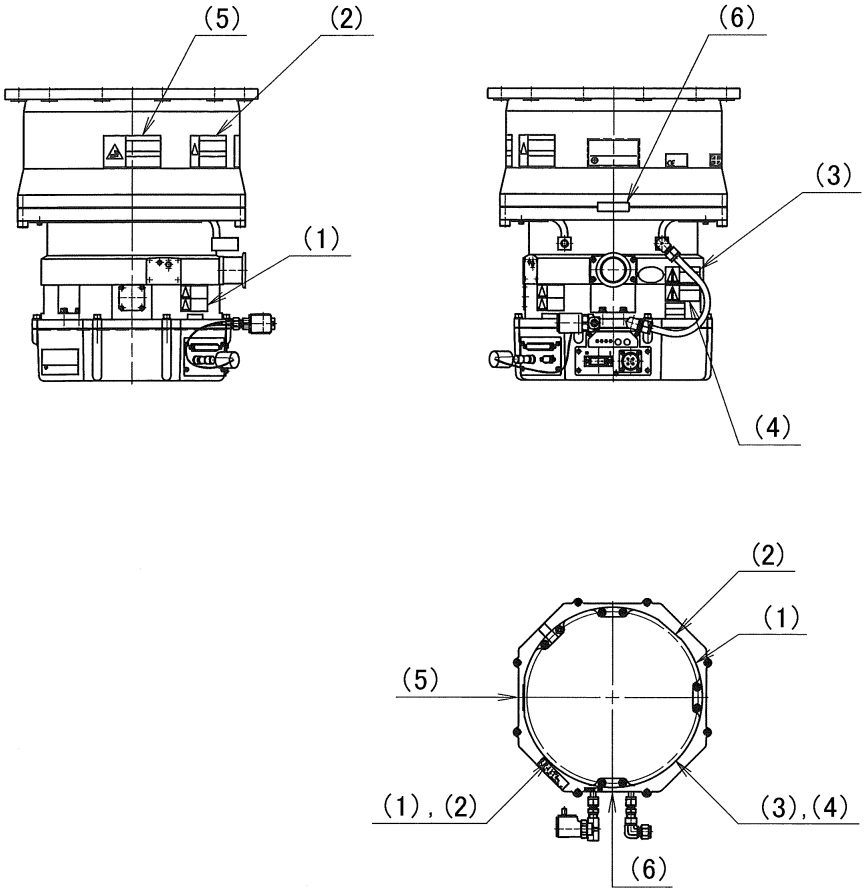
(5) Heavy Equipment Label

Be sure to lift by two or more people or use the lifter or the crane etc. when lifting because this product is a heavy lift.

(6) SECURITY seal

This label certificates that the product was made or maintenanced by Shimadzu or by Shimadzu authorized facility. In case "this label is removed" or "there is a mark showing once this label has been removed", Shimadzu warranty shall not be applied to the product.

○ Location of label



○ Warranty period

12 months on new TMP's from the date of shipment from Shimadzu, or from any of its worldwide sales offices.

○ Conditional warranty

During the warranty period and under normal operation, if the TMP fails to meet its product specification due to defects in material and/or workmanship, Shimadzu will, at its discretion, either repair it or exchange it with a new one for free.

○ Scope of the warranty

The warranty covers only TMPs, controllers and accessories sold by Shimadzu.

○ Warranty of repaired or replacement parts

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.

○ Exemption from the warranty

During the warranty period, Shimadzu will charge for repair or exchange in the following cases :

1) Failure caused by natural disasters or fire.
2) Failure or functional deterioration due to the following :
   a) Pumping of special gases and materials
   b) Ingestion of foreign object (solid and liquid) and attachment of reacted object through the TMP's protective net.
   c) TMP is operated differently than what is prescribed in the instruction manual
   d) When Shimadzu determines through failure analysis that the cause of failure was due to abnormal operation or external circumstances. Our engineers judge that the cause of the trouble is an irregular operation
3) Warranty is voided if the "Security Seal" on the product has been removed, hampered with, or altered.

○ Disposal of Products and Parts

Please contact Shimadzu for proper disposal of its products or parts. There is a possibility to pollute the environment with the material of the parts, when you dispose this product in an inappropriate way.

○ LIMITATION OF LIABILITY

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.

This page is intentionally left blank.

Table of contents

Introduction

Section 1 OUTLINE AND DESCRIPTIONS

Section 2 IDENTIFICATION AND FUNCTION

Section 3 CONSTRUCTION AND PRINCIPLE

Section 4 SPECIFICATIONS

Section 5 INSTALLATION

Section 6 OPERATION

Section 7 GAS PURGE

Section 8 TURBO MOLECULAR PUMP RECONDITION

Section 9 TROUBLESHOOTING

1

OUTLINE AND DESCRIPTIONS

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.

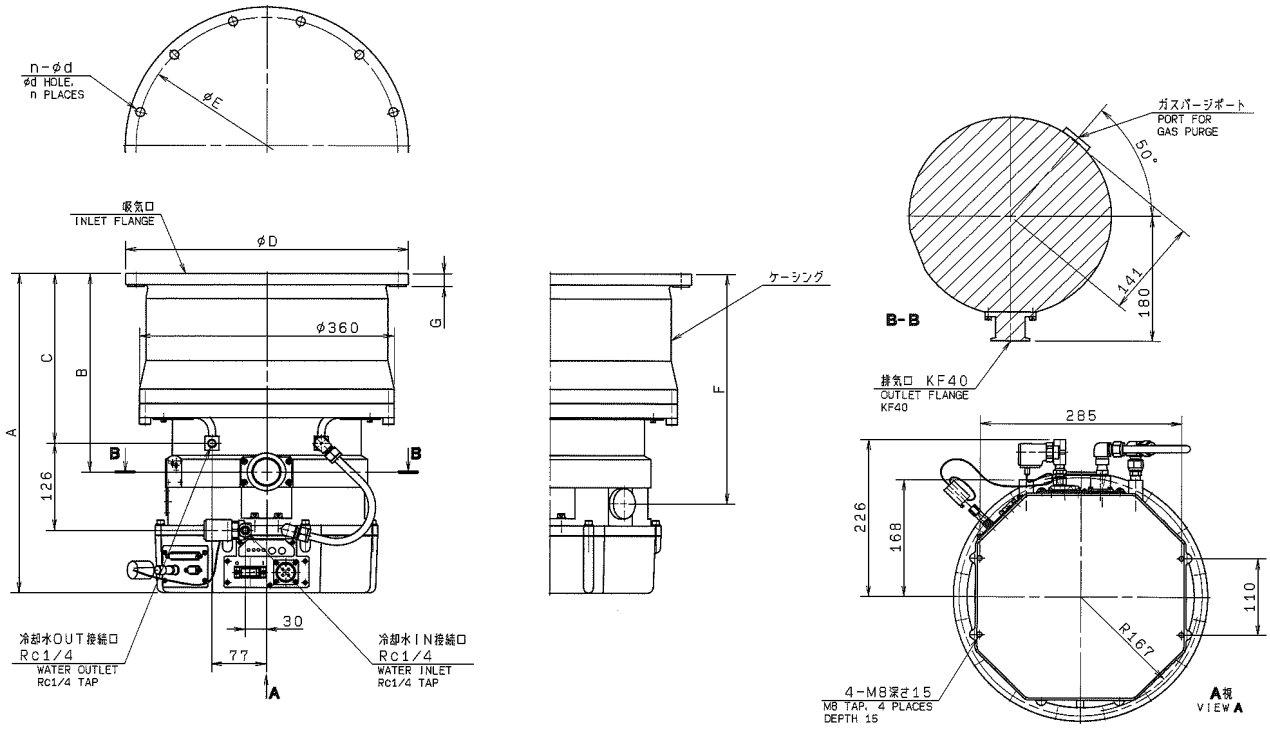
The turbo molecular pump (one standard set) consists of the following items.

- Pump 1
- Power Cable 1
- Standard Accessories 1 Set

1.2 Descriptions

1.2.1 Exterior

1.2.1.1 TMP-V3304LM/LMC (F) Outside drawing



Inlet flange	A	B	C	φD	φE	n-φd	F	G
VG300	462	288	246	φ400	φ370	12-φ13	333	18.5
VG350	462	288	246	φ450	φ420	12-φ13	333	24.5
ISO320B	467	292	251	φ425	φ395	12-φ13	338	22.5

Fig. 1-1 TMP-V3304LM/LMC (F) Outside drawing

1.2.1.2 TMP-V2804LM/LMC (F) Outside drawing

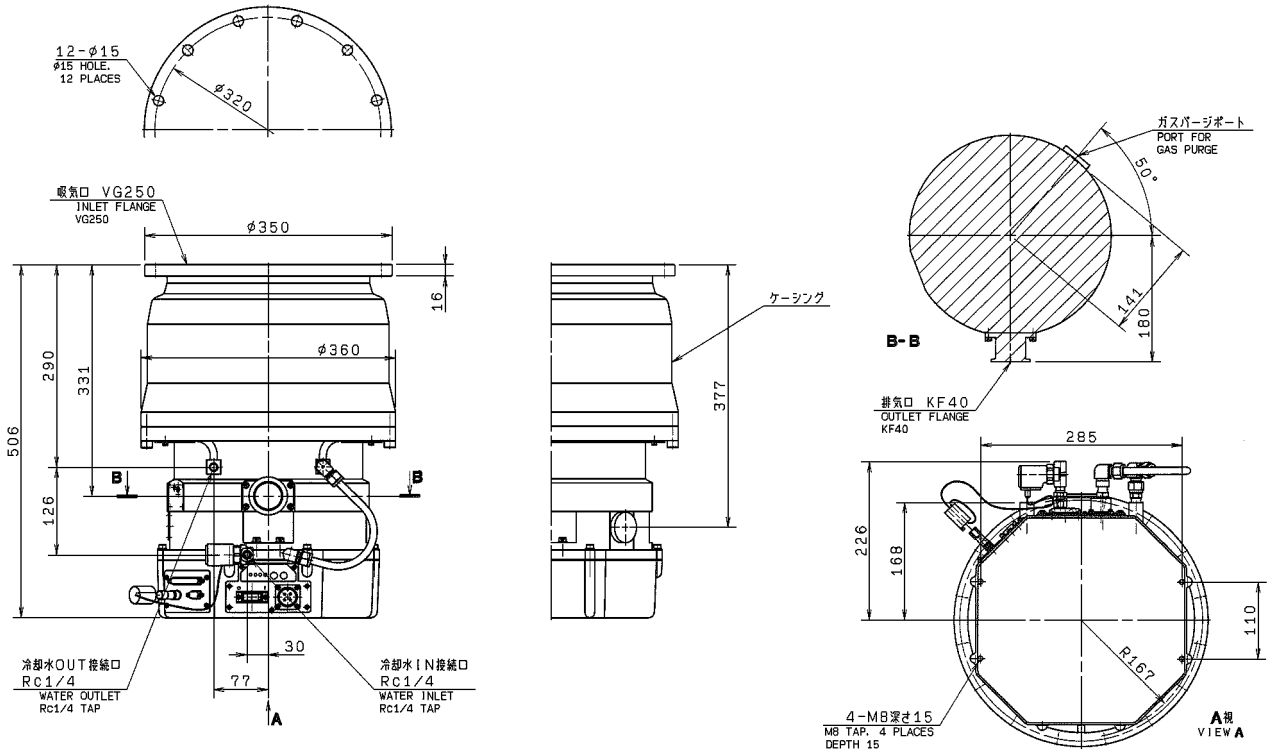


Fig. 1-2 TMP-V2804LM/LMC (F) (VG250) Outside drawing

1.2.2 Power Cable

One of followings :

	Part number	Description	Notes
1	262-76773-05	AC cable, 1003MD05 200	5 MT
2	262-76773-10	AC cable, 1003MD10 200	10 MT
3	262-76773-15	AC cable, 1003MD15 200	15 MT
4	262-76773-20	AC cable, 1003MD20 200	20 MT
5	263-41042	AC connector set	・Connector ・Clamp ・Core ・Assembling procedure

1.2.3 Standard Accessories

TMP-V3304LM/LMC (F)

	Description	Qty	Note	Part number
1	Gasket (inlet flange) (Note)	1	VG300 : O-ring gasket	036-13529-86
			VG350 : O-ring gasket	036-13529-97
			ISO320B : Not included	—
2	Bolt set (inlet flange)	—	VG300 : Not included VG350 : Not included ISO320B : Not included	—
3	Dust cap (outlet flange)	1	KF40	267-93896-03
4	Connector for Remote Control	1	D-sub 37 pin male	070-02844-04 070-02174-03
5	Instruction Manual	1	This manual Serial Communication	263-43069 263-13476

(Note) One of followings.

TMP-V2804LM/LMC (F)

	Description	Qty	Note	Part number
1	Gasket (inlet flange)	1	VG250 : O-ring gasket	036-13529-76
2	Bolt set (inlet flange)	—	VG250 : Not included	—
3	Dust cap (outlet flange)	1	KF40	267-93896-03
4	Connector for Remote Control	1	D-sub 37 pin male	070-02844-04 070-02174-03
5	Instruction Manual	1	This manual Serial Communication	263-43069 263-13476

This page is intentionally left blank.

2

IDENTIFICATION AND FUNCTION

2.1 Pump Main Unit

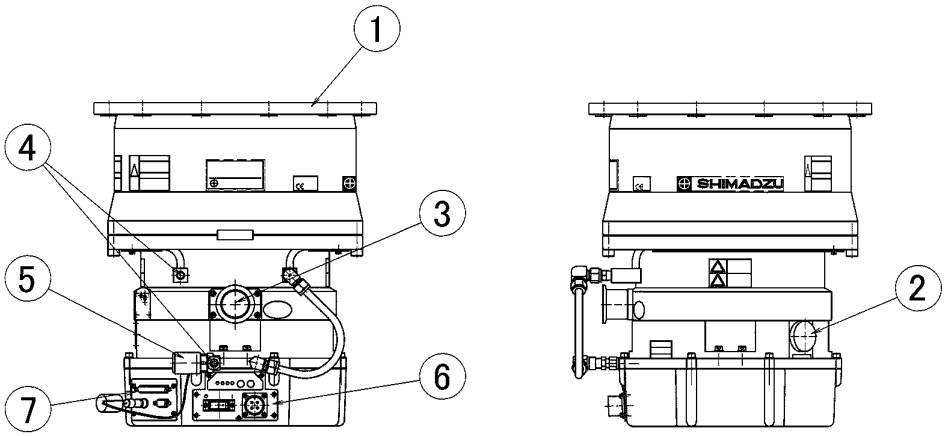


Fig. 2-1 Pump Main Unit

(1) INLET FLANGE . . . . . Inlet flange, joint the turbo molecular pump, VG300, VG350, ISO320B, VG250.

(2) PORT FOR GAS PURGE. . . . . Gas purge adaptor port
(Refer to Section 7 "GAS PURGE")

(3) OUTLET FLANGE . . . . . Outlet flange, connect a backing vacuum pump or its related pipe connection, KF40.

(4) COOLING WATER PIPELINE . . . . Cooling water pipe connector, Rc1/4

(5) WATER VALVE . . . . . For protection from dew
(Refer to Section 5.3 "Preparation for operation")
This valve is normally closed valve. (opened when energing, and closed when not energing)

(6) CONTROL PANEL . . . . . AC Input connector, Power Switch, and local control switch
(Refer to Section 2.2 "Control Panel")

(7) External I/F PANEL . . . . . Communication Interface
(Refer to Section 2.3 "External I/F Panel")

2.2 Control Panel

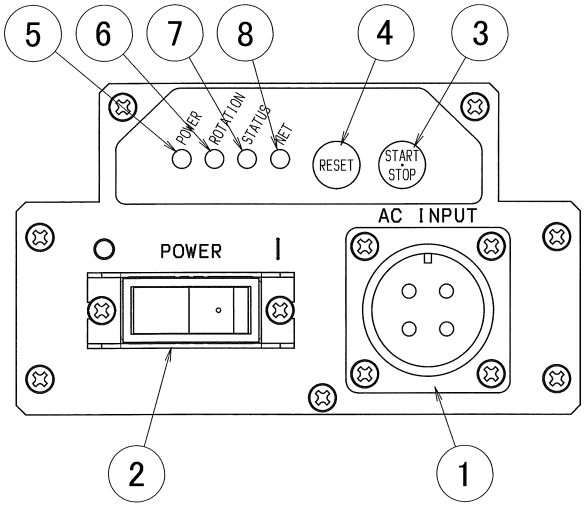


Fig. 2-2 Outline view of control panel

(1) AC INPUT connecter . . . . . Power cable receptacle
Refer to Section 5.2 "Connection of Power Cable".

(2) POWER Switch. . . . . Power switch

(3) START/STOP button . . . . . Push to acceleration or deceleration
During LOCAL MODE, control by maintained push.

(4) RESET button. . . . . When occur ALARM or WARNING, After remedying the cause of the ALARM, An abnormal state is released by pushing button. By maintained push, REMOTE MODE and LOCAL MODE are changed.

(5) POWER lamp . . . . . This lamp lights or blinks while power on. (green)
lights : REMOTE MODE
blinks : LOCAL MODE

(6) ROTATION lamp . . . . . Operation indicator lamp indicating that the pump's rotor is running. (green)

(7) STATUS lamp . . . . . Operation indicator lamp indicating that the pump's operation status. (green・orange) (Note 1)
green/lights : Rotational speed reaches 80 % rated value
green/blinks : Accelerating
orange/lights : ALARM occurs
orange/blinks : Warning occurs

(8) NET lamp . . . . . For option.
This lamp is always turned off.

(Note 1) The pattern when both green and orange are lit and blink becomes the following.

- When warning occured during rating speed.
  green/light and orange/blink : green - orange - green - orange - ⋯
- When warning occured during acceleration.
  green/blink and orange/blink : green - orange - turned off - green - orange - turned off -⋯

2.3 External I/F Panel

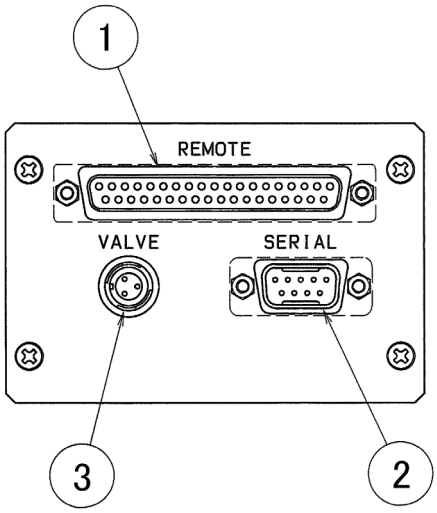


Fig. 2-3 I/F Panel

(1) REMOTE connector . . . . . Connector for Remote-control
Refer to Section 6.7 "Remote-Control Connector".

(2) SERIAL connector . . . . . Connector for RS-232C or RS-485 communication
Refer to Section 6.8 "Communication Specifications".

(3) VALVE connector . . . . . Water valve connector
Refer to Section 5.3 "Preparation for operation".

(Note 1) All interfaces are SELV (safety extra-low voltage).

(Note 2) If this product has the option I/F, this I/F panel may be different from the standard I/F panel. Refer to option I/F manual for details.

3

CONSTRUCTION AND PRINCIPLE

3.1 Pump Construction

Fig. 3-1 is a sectional drawing of a 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 touch-down bearing (9) 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.

Protective net (13) protects that a foreign object comes in from inlet flange.

The cooling water pipe (14) is provided to cool the 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.

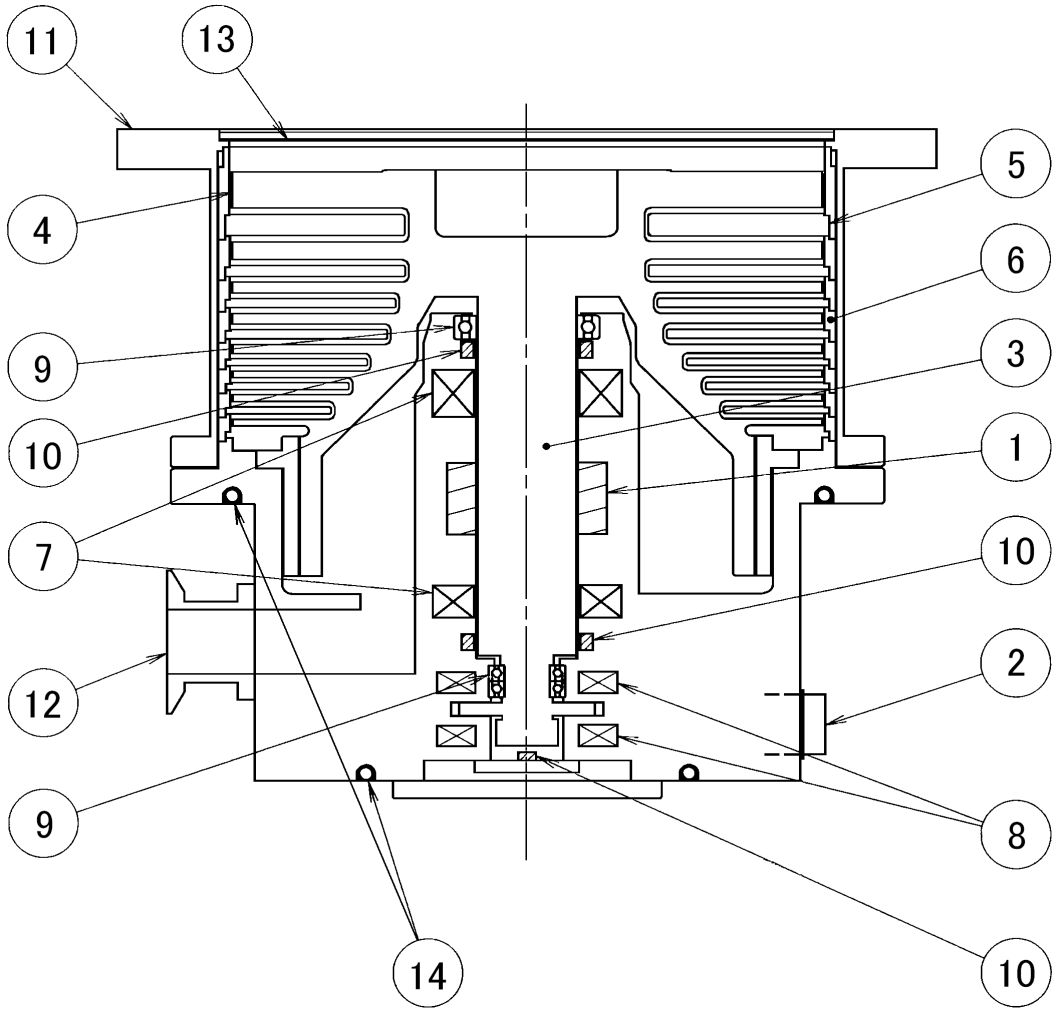


Fig. 3-1 Pump Sectional Drawing

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

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).

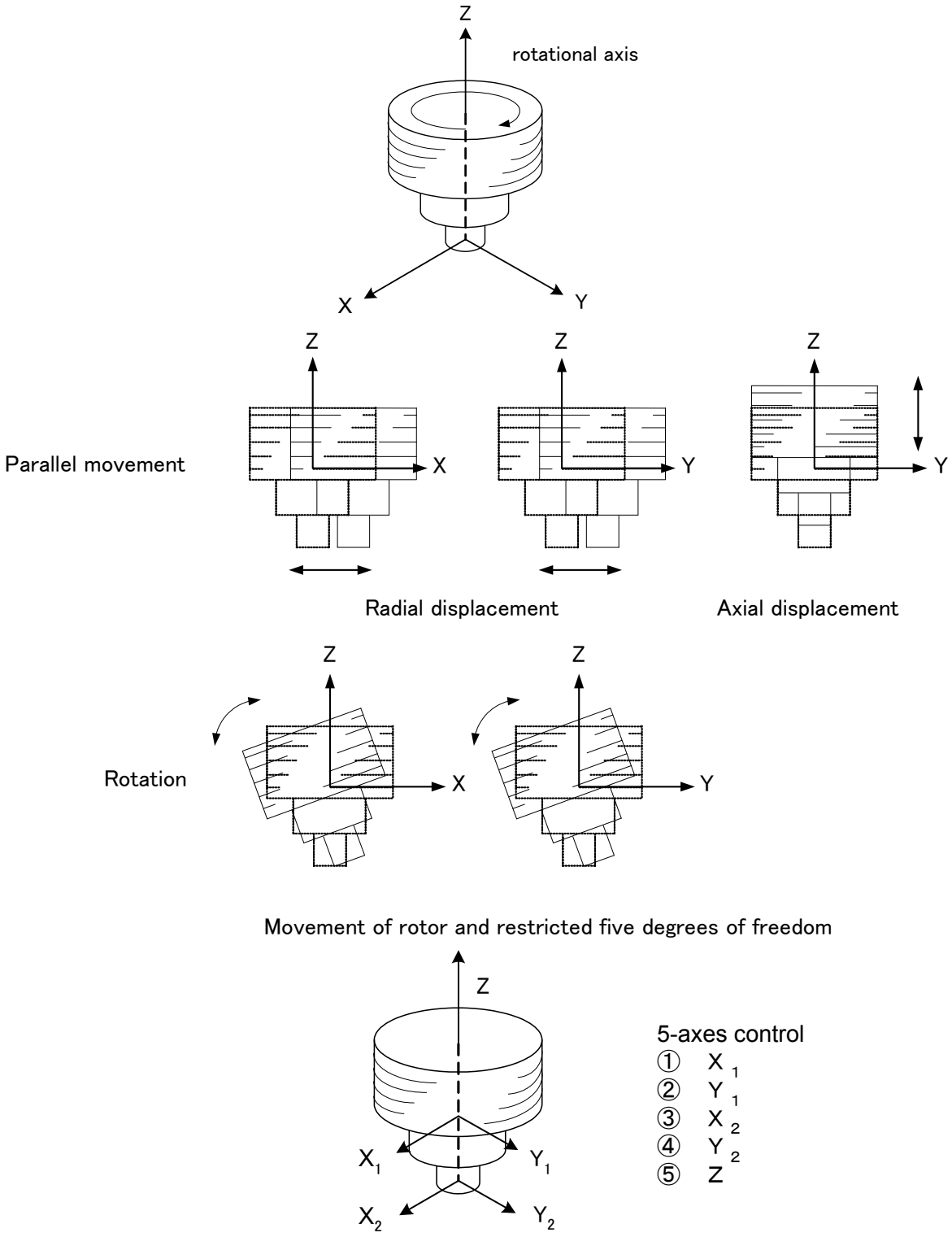


Fig. 3-2 Outline of 5-Axes Control

3.3 Control system

This product has a controller comprising a magnetic bearing control system that levitates the rotors in a specific position inside the turbo molecular pump, a high frequency power supply system that rotates the rotor at a specific speed, and a pump temperature control system. The magnetic bearing control system levitates the rotor at a given position by using a gap sensor inside the pump to detect the rotor position and controlling the electromagnet current. The high frequency power supply unit first converts the commercial power supply to direct current, then uses a three phase inverter to control AC frequency. If a power interruption occurs when the rotor is rotating at high speed, the power supply unit uses the motor as a generator to control the magnetic bearing with the regenerated power obtained. It does not use a battery as backup for power interruptions.

Since it controls the turbo molecular pump externally, by remote control, the control system includes RS-232C and RS-485 serial interface ports, in addition to input/output ports for contact signals. The RS-232C and RS-485 ports allows monitoring the operating status and loading history data. For more information regarding the serial interfaces, refer to Section6.8 "Communication Specifications" and the separate Communication Functions manual.

This page is intentionally left blank.

4

SPECIFICATIONS

4.1 Standard Specifications for Pump Unit

Turbo molecular pump model (Note 1)		TMP-V3304LM/LMC (F)	TMP-V2804LM/LMC (F)
Battery		Not Necessary	
Inlet flange		VG300 / VG350 / ISO320B	VG250
Outlet flange		KF40	
Cooling Method		Water Cooled	
Mass		94 kg	
Ultimate pressure (after baking)		10^{-7} Pa order	
Maximum allowable flow rate		Refer to 4.2	
Maximum allowable inlet pressure (N_2 continuous exhaust) (Note 2)		7 Pa	
Maximum allowable outlet pressure (N_2 continuous exhaust) (Note 2)		270 Pa	
Pumping speed (Note 3)	N_2 Ar	3200 L/s 3100 L/s	2800 L/s 2700 L/s
Compression ratio	N_2 He H_2	1×10^9 or more 1×10^5 6×10^3	
Rated speed		27600 rpm	
Start-up time		16 mimutes or less	
Mounting position		In any desired direction (Note 4)	
Vibration level (by Shimadzu's method)		0.01 μm or less (0-peak)	
Noise		60 dB(A) or less	
Recommended flow rate of purge gas (Note 5)		30 mL/min	
Recommended pumping speed of backing pump in case of gas purge		1500 L/min or more	
Display	LED	POWER / STATUS / ROTATION / NET	
Communication (Note 6)	Contact	REMOTE (D-sub 37 pin female, Screw lock size M2.6) (cf.Section 6.7 "Remote-Control Connector") Input : START / STOP / RESET / LOW SPEED Output : ROTATION / ACC. / BRAKE / NORMAL / REMOTE / ALARM / WARNING / CONNECTION	
	Serial	RS-232C / RS-485 (D-sub 9 pin male, Screw lock size M2.6) (cf.Section 6.8 "Communication Specifications")	
Speed variation		Speed is variable between 25 % and 100 % of the rated speed (set as 0.1 %)	
Alarm History		Remembers date, time, and description of last 99 alarm events.	

Instantaneous Power Interruption (Note 7)		If power interruption is 1 second or less, pre-interruption functions are maintained. If interruption exceeds 1 second, the brake is activated, which allows the pump to be restarted after resetting.
Water valve for dew interlock		This valve is closed during power supply OFF, and the coolant water is stopped. This valve is opened during power supply ON, and the coolant water is supplied.
Alarm Detection	Alarms	Pump temperature, Pump startup error, Overload, and Overspin for motor, Magnetic bearing failure, Control system malfunction (Over temperature inside control system or failure of drive circuit), Power interruption, Dew condensation, etc.
	Warnings	Failure of magnetic bearing, Control system malfunction (Overtemperature inside control system), Dew condensation (Water valve close.)
Protective Functions	Alarms	STATUS orange lamp illuminates. Power Interruption Alarm : Decelerated while maintaining levitation using regenerative power. After decelerating to specified low speed, levitation is stopped and rotor is suppurted by touchdown bearing. When power is restored, the pump can be restarted by resetting. Dew Alarm : The pump is decelerated after dew condensation alarm is detected. When other alarms occur : Stops operation or decelerates. Magnetic levitation is continued.
	Warnings	STATUS orange lamp flashes and pump continues to function. (Dew Warning : Water valve is closed.)
Input electric power	Voltage	Single phase 200 to 240 VAC ± 10 % (50 / 60 Hz ± 2 Hz)
	Maximum power	1.2 kVA
	Insulation withstand voltage	1500 V, 1 minute
	Short Circuit Current Ratings (SCCR)	200 A
Water (Note 8)	Flow rate Pressure Temperature	3 to 4 L/min 0.2 to 0.4 MPa 19 to 30 degrees C. (above dew point)
	Water quality	Non-corrosive industrial water (not purified water) Solid particle size (Max) : 0.025 mm^2 PH (@25 degrees C.) : 6.5-8.2 Electrical conductivity (@25 degrees C.) : 100-800 μ S/cm (Electrical resistivity : 1250-10000 Ω•cm)
Admissible ambient magnetic field	Radial direction Axial direction	3 mT 15 mT

Installation conditions (Refer to EN61010-1 standard)	Use: Indoor, Altitude max : 2000 m, Overvoltage category III, Pollution degree 2 IP classification 40
Environmental Temperatures	Operation : 10 to 40 degrees C. / Storage : -25 to 70 degrees C. (No dew condensation)
Relative humidity	40 to 80 %RH

(Note 1) (F) apply ferromagnetic steel with nickel plating.

(Note 2) Maximum allowable flow rate, Maximum allowable inlet pressure and Maximum allowable outlet pressure can not be satisfied at same time.

(Note 3) Without a protective net. Pumping speed for N_2 is 2900 L/s (VG300 / VG350 / ISO320B), 2550 L/s (VG250) with a protective net.

(Note 4) The outlet of the turbo molecular pump should face horizontally or vertically when installing horizontally and obliquely. (Refer to 5.1.1 "Pump Mounting Direction")

(Note 5) mL/min : volume flow rate at 0 degrees C., 1 atm. (Compatible with SCCM.)

(Note 6) Communictaion Interface is depends on optional unit.

(Note 7) The time can be changed to two seconds from one second.

(Note 8) Non condensing. Refer to Section 5.3 "Preparation for operation".

4.2 The maximum allowable flow rate

Description	Gas type (Note 1)	APC Valve temperature	Gas purge flow rate	The maximum allowable flow rate (Note 2) (Note 3)
TMP-V3304LM (F) TMP-V2804LM (F)	Ar	45 degrees C.	0 mL/min	1500 mL/min
	N_2			2750 mL/min
TMP-V3304LMC (F) TMP-V2804LMC (F)	Ar		30 mL/min	1900 mL/min
	N_2			2750 mL/min

(Note 1) Consult your Shimadzu representative before using gasses except shown in above table.

(Note 2) mL/min : volume flow rate at 0 degrees C., 1 atm. (Compatible with SCCM.)

(Note 3) The maximum allowable flow rate depends on the gas type, the Assuming the parts connected to the molecular pump inlet and the gas purge flow rate.

4.3 Standards Fulfilled

Safety	EN61010-1 : 2001 UL61010-1 SEMI S2 EN1012-2 : 1996 + A1 : 2009
EMC	EN61326-1 : 2006 class A SEMI F47

5

INSTALLATION

5.1 Installation

5.1.1 Pump Mounting Direction

This turbo molecular pump can be installed in vertical, horizontal, inverted, or oblique position.

The control connector of the turbo molecular pump should face horizontally or vertically when the turbo molecular pump is mounted in the horizontally and obliquely.

When the outlet flange is installed in a non-appropriate position, reliability of operation may deteriorate.

The direction of the outlet flange becomes as shown in Figure. (Refer to Fig. 5-1)

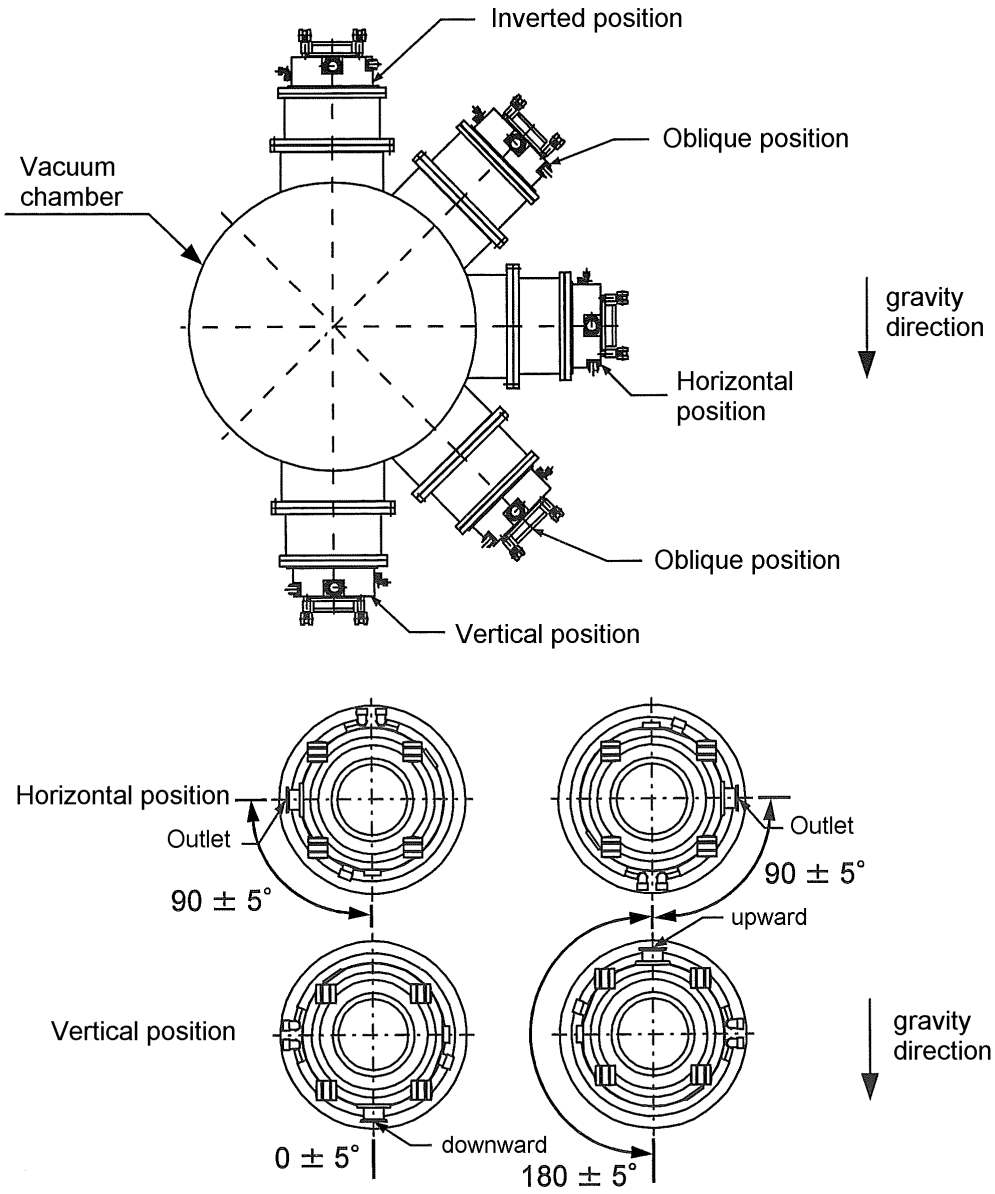


Fig. 5-1 Mounting Direction of the Turbo Molecular Pump

5.1.2 Installation of the Pump

WARNING

Do not operate the turbo molecular pump until safety is confirmed.

- The rotor assembly of the turbo molecular pump rotates at high speed. Large rapid shutdown torque should be generated when abnormality occurs in the pump by any chance. Incidental accident will cause the pump to drop out and to make a catastrophe if the pump is fixed by insufficient method.
- Fix the pump to host equipment according to 5.1.2.2 and 5.1.2.3. The method to fix the pump is different depending on the pump model and the size of inlet flange of the pump.
- Host equipment should be fixed to the floor so as not to move. Host equipment should be designed to have enough margins in strength, in preparation for an emergency accident.

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 an explosion proof product. Do not use flammable gas and explosive gas.

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 deterioration 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. 5-3. Be sure that the pump does not move or fall down during installation or storage.

CAUTION

This pump is a heavy equipment.

Lift this pump by two or more people or by using the lifter or the crane, during installation.

Need two or more eyebolts as described in Fig. 5-2 when lifting this pump on vertical position. Need four eyebolts as described in Fig. 5-2 when lifting this pump on headstand position. There is a possibility that the pump falls when using less eyebolts, than specified in Table 5-1.

A crane and eyebolts due to lifting operations should withstand the load of five times or more the weight of the TMP pump, and rope should be seven times or more. Use an eyebolt which confirms to ISO 3266.

There is a possibility that the pump falls when installing it on other positions.

5.1.2.1 Instruction and Lifting Method

This product lift the pump in the manner shown in Fig. 5-2.

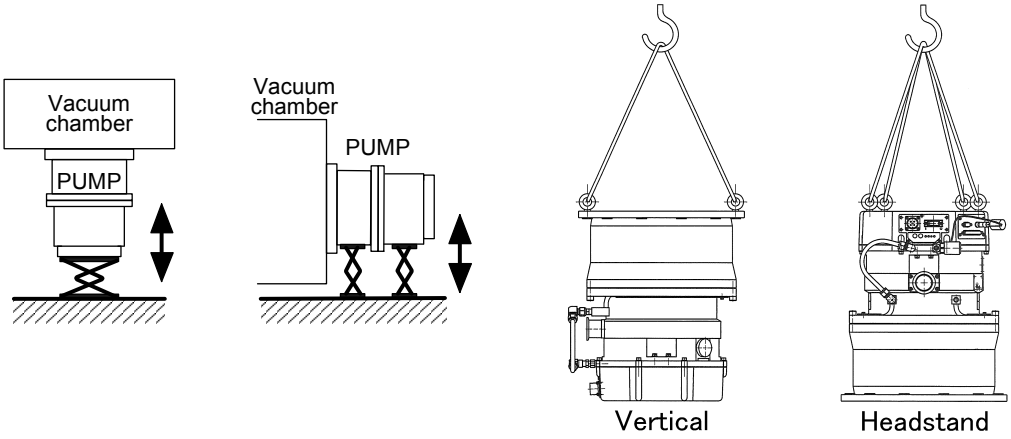


Fig. 5-2 Lifting Method

Table 5-1 Eyebolt size

Position	Eyebolt size	Number of eyebolts	Remark
Vertical	M12	2	Not bundled items
Headstand	M8	4	Not bundled items

The center of gravity of the pump is shown in Fig. 5-3. Fix securely to avoid moving or falling down in the event of an earthquake.

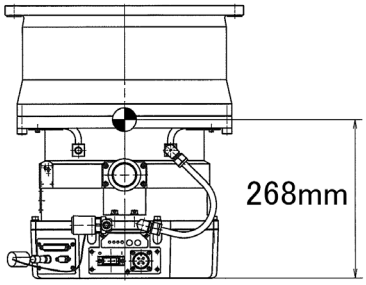


Fig. 5-3 Center of gravity of the pump

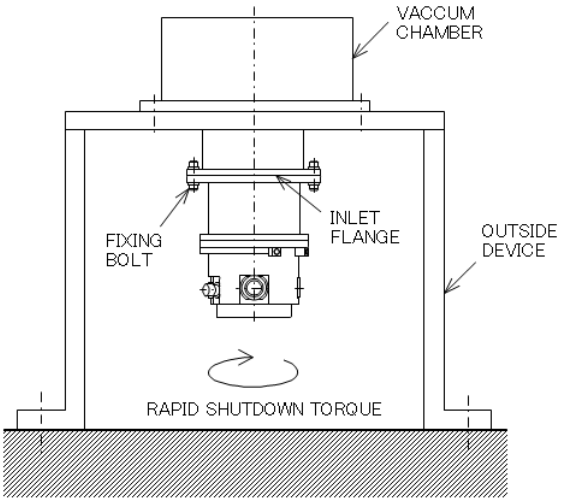
5.1.2.2 Installation of TMP-V3304LM/LMC (F)

Please fix the inlet flange of the turbo molecular pump to the flange of vacuum chamber (Refer to Fig. 5-4).

When you fix the pump, use of the bolts regulated grade, size, number and tightening torque (Refer to Table 5-2 and Table 5-3). And use all the bolt-holes of the inlet flange of the pump.

The sets of half-screw bolt and nut should be used to fix the inlet flange of the pump. Make installation with the cylindrical part of the bolt (not screw part) fit in the mating section of flanges.

When you connect piping or valve between the chamber and the pump, please fix the same method as the inlet flange.



Fixed only by the inlet flange of TMP

Description	Rapid shutdown torque (Note)
TMP-V3304LM/LMC (F)	67400 N•m

(Note) Rapid shutdown torque is the typical value measured by the Shimadzu's test condition. The torque to transmit to host equipment might be different according to the rigidity of host equipment. Host equipment should be designed to have enough margins in strength.

Fig. 5-4 Installation of TMP-V3304LM/LMC (F)

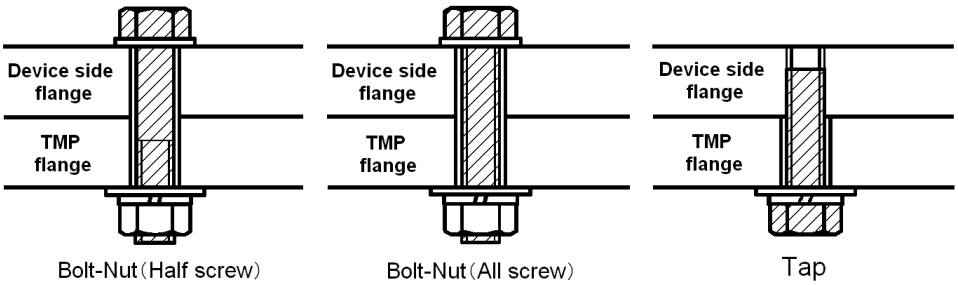


Fig. 5-5 How to use of the bolt

Table 5-2 The recommended fixing bolt

Bolt-Nut (Half screw)

Fixing method	Only by the inlet flange		
Inlet flange	VG300	VG350	ISO320B
Bolt Size, Quantity	M12, 12 PC		
Material	Stainless steel		
Grade	A2-70 (JIS B 1054 / ISO-3506)		
Washer	Special washer (Note) and spring lock washer		

Bolt-Nut (All screw)・Tap

Fixing method	Only by the inlet flange		
Inlet flange	VG300	VG350	ISO320B
Bolt Size, Quantity	M12, 12 PC		
Material	SCM435 (JIS G 4053 / ISO-683) or equivalent		
Grade	12.9 (JIS B 1051 / ISO-898)		
Washer	Special washer (Note) and spring lock washer		

(Note) The special washers are attached to the inlet flange of TMP when shipping.
Do not remove them at the time of TMP installation.
Refer to Fig. 5-6 for the details of the bolt attaching part.

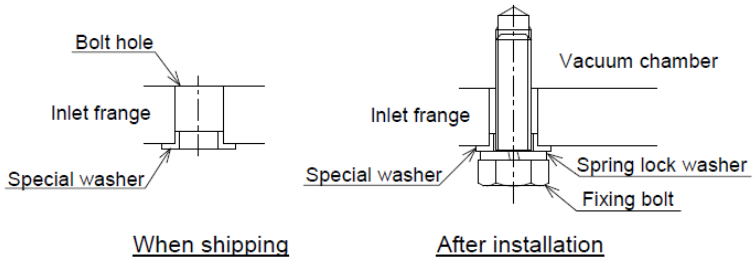


Fig. 5-6 Example of the fixing method using the special washer

Table 5-3 Tightening torque of the fixing bolt

Size of bolt	Tightening torque [N•m]
M12	16 to 26

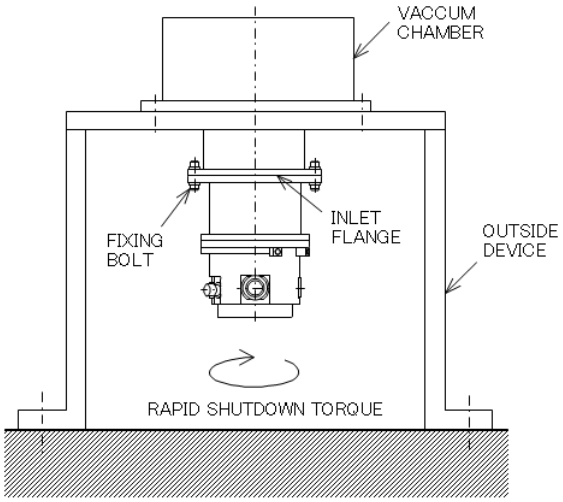
5.1.2.3 Installation of TMP-V2804LM/LMC (F)

Please fix the inlet flange of the turbo molecular pump to the flange of vacuum chamber (Refer to Fig. 5-7).

When you fix the pump, use of the bolts regulated grade, size, number and tightening torque (Refer to Table 5-3 and Table 5-4). And use all the bolt-holes of the inlet flange of the pump.

The sets of half-screw bolt and nut should be used to fix the inlet flange of the pump. Make installation with the cylindrical part of the bolt (not screw part) fit in the mating section of flanges.

When you connect piping or valve between the chamber and the pump, please fix the same method as the inlet flange.



Fixed only by the inlet flange of TMP

Description	Rapid shutdown torque (Note)
TMP-V2804LM/LMC (F)	67400 N•m

(Note) Rapid shutdown torque is the typical value measured by the Shimadzu's test condition. The torque to transmit to host equipment might be different according to the rigidity of host equipment. Host equipment should be designed to have enough margins in strength.

Fig. 5-7 Installation of TMP-V2804LM/LMC (F)

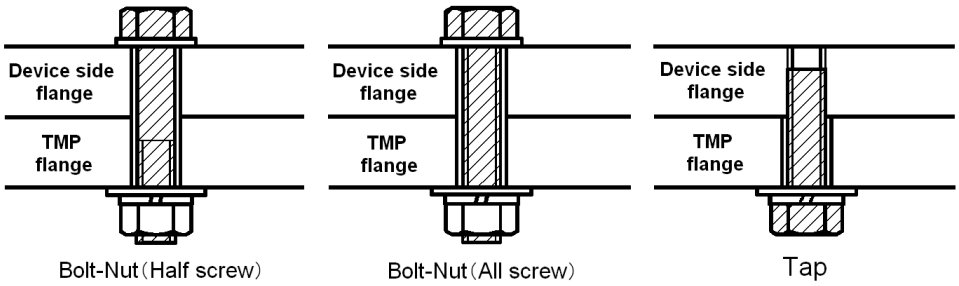


Fig. 5-8 How to use of the bolt

Table 5-4 The recommended fixing bolt

Bolt-Nut (Half screw)

Fixing method	Only by the inlet flange
Inlet flange	VG250
Bolt Size, Quantity	M12, 12 PC
Material	Stainless steel
Grade	A2-70 (JIS B 1054 / ISO-3506)
Washer	Special washer (Note) and spring lock washer

Bolt-Nut (All screw)・Tap

Fixing method	Only by the inlet flange
Inlet flange	VG250
Bolt Size, Quantity	M12, 12 PC
Material	SCM435 (JIS G 4053 / ISO-683) or equivalent
Grade	12.9 (JIS B 1051 / ISO-898)
Washer	Special washer (Note) and spring lock washer

(Note) The special washers are attached to the inlet flange of TMP when shipping.
Do not remove them at the time of TMP installation.
Refer to Fig. 5-9 for the details of the bolt attaching part.

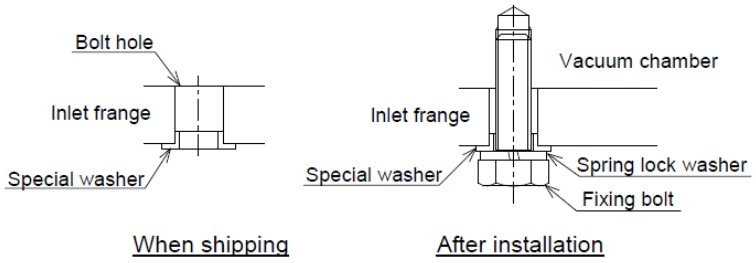
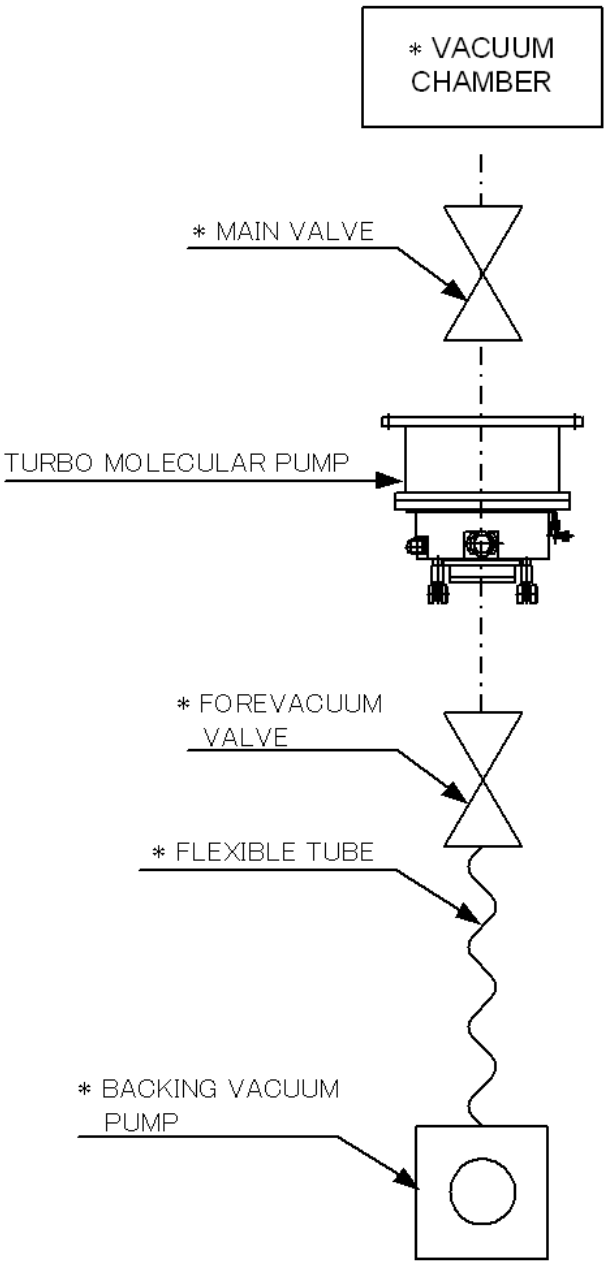


Fig. 5-9 Example of the fixing method using the special washer

5.1.3 Example of piping connection

5.1.3.1 Connection of exhaust line

Connect a backing vacuum pump or its related pipe connection flange to the outlet flange of the pump. (Refer to Fig. 5-10)



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

Fig. 5-10 Example of Exhaust Line

When gas purge required, connect the gas purge pipeline to the gas purge port. (For the gas purge detail, Refer to Section 7 "GAS PURGE")

After complete piping connection, check for perfect airtightness by helium leak test.

5.1.3.2 Connection of Cooling Water Line

(1) Supply the coolant water to coolant water IN connection of the solenoid valve for the coolant water as shown in Fig. 5-11, and drain the cooling water pipe from coolant water OUT connection.

(2) 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. 5-12.

(3) The water valve is closed and coolant water supply is stopped at AC input OFF. Customer prepares the cross valve and piping, the pump is bypassed, and the coolant water can be thrown. Addition and the pipework of the valve in the customer are necessary.

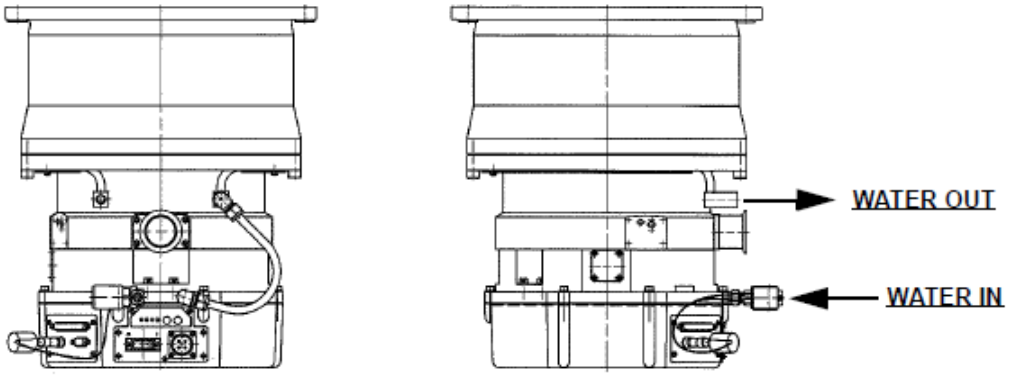


Fig. 5-11 Connection of Cooling Water Line

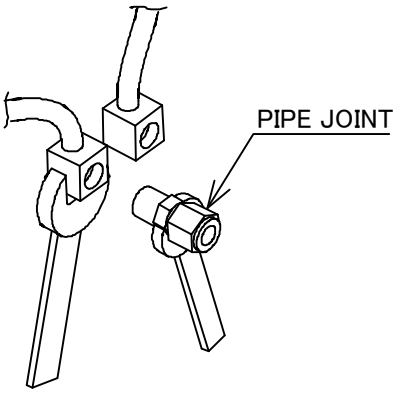


Fig. 5-12 Water Coolant Tubing Connections

5.2 Connection of Power Cable

CAUTION

The power input voltage of this product is 200 to 240 VAC ± 10 %. Connect Connection of the control system to the incorrect input voltage can cause damage to the equipment. Supply the power via a circuit breaker (rating 15 A). Please provide PE (Protective Earth) connection to the terminal of a "PE" marked wire in final application.

Connection of Power Cable

(1) Connect the power cable terminal to the terminal board of customer's power distribution board for equipment. The wire with [PE] mark is for earth use and other remaining two wires are for single phase AC power. (Refer to Fig. 5-13, Table 5-5)
First, connect the wire [PE] mark. Next connect the other two wires.

(2) Turn off the POWER switch on the control panel of this product.
Or otherwise be sure to check that it is in off.

(3) Connect the power cable connectors to the AC INPUT connector.

REFERENCE

For the specified power voltage, refer to the side panel of the power supply unit.

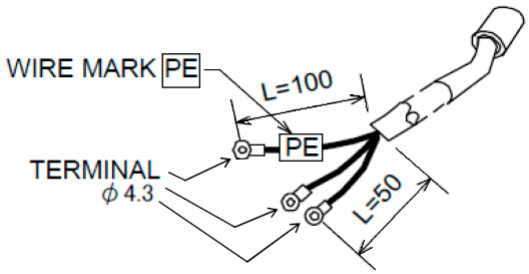


Fig. 5-13 Power Cable

Table 5-5 Power Cable CONNECTION

Wire color of power cable		Green/Yellow	Black	White
Location	EU	PE	N	L
	US	GND	L2	L1

5.3 Preparation for operation

(1) This product is a water cooled model. Always provide a flow of coolant water that meets the indicated specifications. (Note 1)
(2) Make sure no water is leaking from the coolant lines. Do not spill coolant on the pump.
(3) Confirm the cable from water valve is surely connected to VALVE connector of External I/F panel.
(4) Make sure that there is no condensation and not high humidity environment. Do not switch the power supply unit ON with condensation at the location indicated in Fig. 5-14.
(5) If dew condenses inside controller during operation, dew warning turns on and the water valve is turns off so that the coolant water should not enter in the pump. If the dew is not disappeared for a while, dew alarm turns on and decelerate the motor to avoid a controller fault. Please use it at the temperature that the dew condensation is not generated and keep environment humidity low. Refer to Section 9 for the alarm.
Even if the power supply unit is OFF, do not run coolant through it that is below dew point.
(6) Connect the power cable to AC connector of control panel deteriorate.

(Note 1) Non condensing.

Water Coolant Flow Rate :	3 L/min to 4 L/min
Water Pressure :	0.2 MPa to 0.4 MPa
Temperature :	19 degrees C. to 30 degrees C.

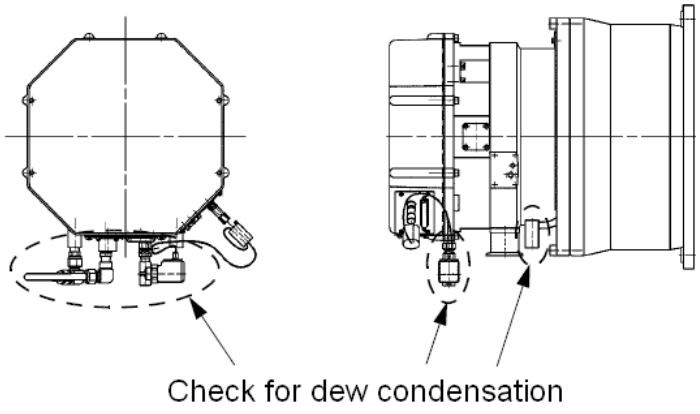


Fig. 5-14 Locations to Check for Dew Condensation

5.4 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. (Refer to Fig. 5-10)

(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.

(4) 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.

5.5 Notes on transportation

This product is precision equipment. Do not give any strong impact or continuous vibration in transportation, otherwise the product could be damaged. In transportation, please use a means of transportation which have vibration-proof function (an air suspension truck, for example). Especially when passing by rough road, we recommend that the product is transported keeping the packing condition when it ships from Shimadzu.

When the product is put on the high temperature / humidity environment for a long time, it causes the breakdown of the product due to corrosion of mechanical parts or performance loss of electrical parts. Please transport or store the product under an appropriate environment.

6

OPERATION

6.1 Overview

CAUTION

Do not turn off the power during pump operation. If the power is turned off repeatedly, the touch-down bearing may need to be replaced. When the power is turned off during operation, levitation is maintained using regenerative power. After decelerating to a lower speed, levitation is stopped and the rotor is supported by the touch-down bearing.

Therefore, repeated touchdown shortens the life of the bearing.

6.1.1 Introduction : Operation Modes

When the POWER switch is turned on, the pump starts self-diagnosis.

When the result is normal, operation is enabled. When an abnormal condition is detected, the STATUS lamp lights up in orange.

The pump can be started/stopped in a number of different ways ; using a switch, contact signal, or communication.

However, the pump cannot be started/stopped using two or more of these ways at the same time.

Determination of which start/stop instruction to be followed depends on the operation mode selected.

There are five operation modes as listed below.

(1) LOCAL mode where switches on the control panel are used for control

(2) REMOTE mode where contact signals are used for control

(3) RS-232C mode where RS-232C communication is used for control

(4) RS-485 mode where RS-485 communication is used for control

(5) Optional Communication mode (when a communication option is selected)

The pump starts in the REMOTE mode described in (2) when the power is turned on including when recovering from a power failure.

Switch to an operation mode prior to starting/stopping the operation.

Transit between operation modes is shown in Fig. 6-1. The state of the POWER lamp is different between the LOCAL and other modes, as shown in Table 6-1.

Hold down the RESET button to transit between the LOCAL and REMOTE modes.

To transit to a communication mode or Optional Communication mode, send an online request via the corresponding communication media.

Table 6-1 LOCAL and REMOTE Modes

mode	lamp state	Start/Stop procedure
LOCAL	POWER lamp flashes.	The pump can be started or stopped by holding down the START/STOP button.
REMOTE RS-232C RS-485 Optional Communication	POWER lamp lights up.	The pump can be started or stopped via a remote control connector, serial connector (RS-232C, RS-485), or optional communication connector (when an option is selected). When using serial communication or optional communication, the pump can be started or stopped by sending an online request command via the corresponding communication specification. To return from a communication mode to the REMOTE mode, send an offline request command via the corresponding communication specification.

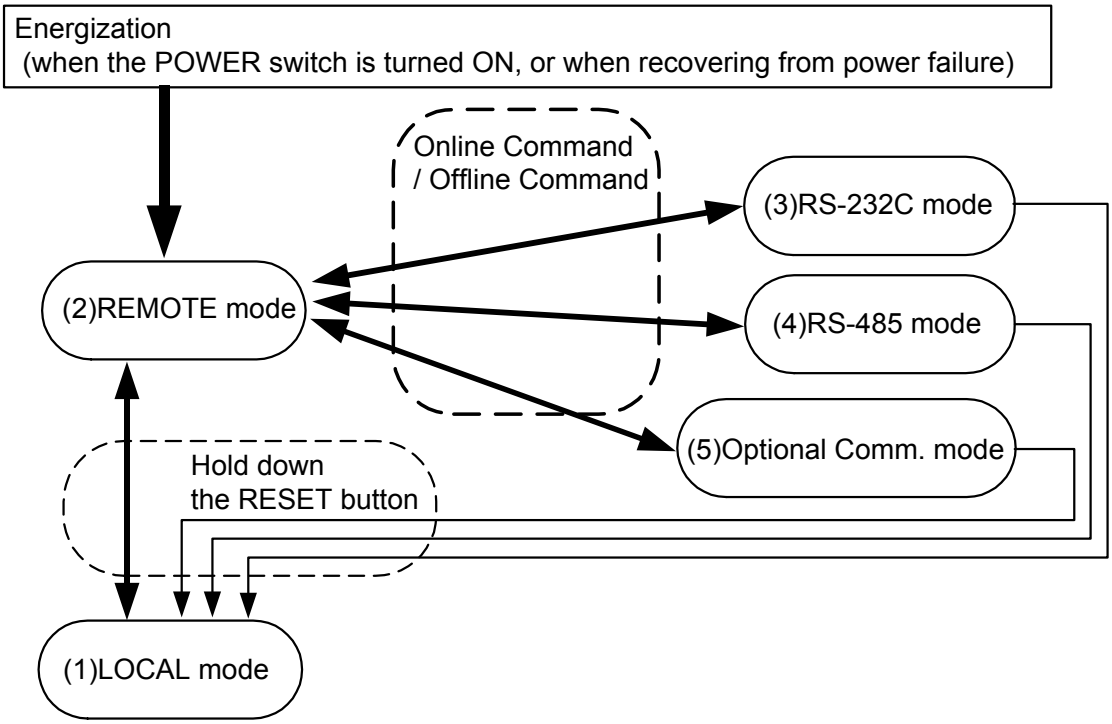


Fig. 6-1 Operation Mode Transition Diagram

6.2 Startup Preparation

NOTICE

When turning the POWER switch ON or OFF, a "clunk" sound may be heard from inside the pump. This sound is from the rotor inside the pump being levitated or de-levitated. This is normal.

When the power is switched ON, the unit starts up in the REMOTE mode. It also starts up in the REMOTE mode when restoring power after a power interruption.

6.2.1 Start-up Preparation Sequence in LOCAL Mode

(1) Feed the cooling water into the cooling line.
(2) Turn on the POWER switch and check if the POWER lamp (Fig. 2-2 (5)) lights. And the rotor of the turbo molecular pump is levitated by the magnetic bearing.
Maintained push the RESET button to change from REMOTE mode to LOCAL mode.
The POWER lamp blinks when becoming a LOCAL mode.
(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.

6.2.2 Start-up Preparation Sequence in REMOTE-control connector

(1) Feed the cooling water into the cooling line.
(2) Turn on the POWER switch and check that the POWER lamp are illuminated and, in addition, the "REMOTE" signal (Refer to Table 6-4) of the remote-control connector is ON in this product of a standard spec. Under this condition, 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.

6.2.3 Start-up Preparation Sequence in other communication means

(1) Feed the cooling water into the cooling line.
(2) Turn on the POWER switch and check that the POWER lamp. Under this condition, the rotor of the turbo molecular pump is levitated by the magnetic bearing.
(3) Online command is demanded from the communication means and confirm the mode was switched to the communication means mode.
(4) Evacuate the turbo molecular pump by using a backing vacuum pump.
(5) 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 in LOCAL Mode

(1) Start-up begins when the 6.2.1 "Start-up Preparation Sequence in LOCAL Mode" is complete.
(2) Maintained push the START/STOP button (Fig. 2-2 (3)).
(3) Pump acceleration starts. The ROTATION lamp (Fig. 2-2 (6)) lights and the STATUS (Fig. 2-2 (7)) green lamp blinks.
(4) When the rotational speed reaches 80 % rated value, the STATUS green lamp lights.
Pump start-up is complete.

6.3.2 Start-up Sequence in REMOTE-control connector

(1) Start-up begins when the 6.2.2 "Start-up Preparation Sequence in REMOTE-control connector" is complete.
(2) "START" signal (Refer to Table 6-4) is input from the remote-control connector (Fig. 2-3 (1)).
(3) The pump starts to accelerate and after a few seconds ,the "ROTATION" signal turns on. In this product of a standard spec, "ACCELERATION" signal (Refer to Table 6-4) from the remote-control connector turns on when the pump starts to accelerate.
(4) When the rotational speed reaches 80 % rated value, the remote-control connector "ACCELERATION" signal (Refer to Table 6-4) turns off and the "NORMAL" signal (Refer to Table 6-4) turns on.
Pump start-up is complete.

6.3.3 Start-up Sequence in other communication means

(1) Start-up begins when the 6.2.3 "Start-up Preparation Sequence in other communication means" is complete.
(2) "START" command is input via the communication means.
(3) The pump acceleration starts. Status is changed from "STOP" to "ACCELERATION".
(4) When the rotational speed reaches 80 % rated value, status is changed from "ACCELERATION" to "NORMAL".
Pump start-up is complete.

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.

6.4.1 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.

6.4.2 Shutting Down Sequence in LOCAL Mode

(1) Maintained push the START/STOP button (Fig. 2-2 (3)) and check that the STATUS green lamp (Fig. 2-2 (7)) is turned off.
(2) Wait until the ROTATION lamp (Fig. 2-2 (6)) goes out.
(3) Turn off the POWER switch.
(4) Stop the cooling water flow.

6.4.3 Shutting Down Sequence in REMOTE-control connector

(1) Input the "STOP" signal (Refer to Table 6-4) from the remote-control connector.
If stop from "NORMAL" status, "NORMAL" signal is OFF. In addition, and check that the "BRAKE" signal (Refer to Table 6-4) is ON in this product of a standard spec.
(2) Wait until the "ROTATION" signal (Refer to Table 6-4) turns off. At this time, the "BRAKE" signal (Refer to Table 6-4) also turns off in the device of a standard spec.
(3) Turn off the POWER switch.
(4) Stop the cooling water flow.

6.4.4 Shutting Down Sequence in other communication means

(1) Input the "STOP" command via the communication means.
The pump deceleration starts. Status is changed from "NORMAL" or "ACCELERATION" to "BRAKE".
(2) Wait until status changes to "STOP" status.
(3) Turn off the POWER switch.
(4) Stop the cooling water flow.

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

The ROTATION lamp goes out, "ROTATION" signal (Refer to Table 6-4) turns off, or change to stop status when the pump rotational speed is 60 rpm or less. Turning off the POWER switch permits the pump rotor to be supported by the touch-down bearings.

6.5 Variable Speed Operation

CAUTION

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.

NOTICE

The variable rotation speed function is only available by remote control. Rotation speed cannot be varied by local control.

6.5.1 Outline

(1) The rotational speed settings function sets the rotational speed by selecting between the NORMAL speed mode or LOW SPEED mode.
(2) Select the NORMAL mode or LOW SPEED mode by REMOTE operation using the remote-control connector "LOW SPEED" signal input (Refer to Table 6-4).
(3) The NORMAL mode or LOW SPEED mode selection can be made before or after start-up.
(4) Set the low speed value between 25 % and 100 % of the rated speed in 0.1 % increments, using the serial communications interface.
(5) The low speed value can be set while the pump is rotating in the LOW SPEED mode. The pump then accelerates or decelerates to the new set value and maintains the set speed.
(6) The time required for the speed to change is the same as the time for normal acceleration or deceleration.
For example, if the low speed value is set to 80 % and the LOW SPEED mode is selected during normal rotation, the time for the speed to drop to 80 % is approximately one-fifth the time required to stop from rated speed.

6.5.2 Operation from Start-up to Low Speed Rotation

This is the procedure until low-speed rotation is achieved when the speed setting is made with the pump stopped.

6.5.2.1 REMOTE Operation

(1) Start-up begins when the 6.2.2 "Start-up Preparation Sequence in REMOTE-control connector" is complete.
(2) Set rotation to low speed via the serial interface or the other communication means. Once it is set, it does not need to be set each time.
(3) Input the "LOW SPEED" signal (Refer to Table 6-4) from the remote-control connector.
(4) Input the "START" signal from the remote-control connector (Refer to Table 6-4).
(5) The pump starts to accelerate and after a few seconds, the "ROTATION" signal turns on. In this product of a standard spec, "ACCELERATION" signal (Refer to Table 6-4) from the remote-control connector turns on when the pump starts to accelerate.
(6) When the rotational speed reaches 80 % of low speed value, the "NORMAL" signal turns on. In this product of a standard spec, the remote-control connector "ACCELERATION" signal turns off.
(7) When the pump speed reaches the set low speed value, acceleration stops and the pump speed is maintained.

※ The same operation occurs if the "LOW SPEED" signal is input after the "START" signal is input but before the pump speed reaches the set low speed value.

6.5.2.2 Serial interface Operation

(1) Start-up begins when the 6.2.3 "Start-up Preparation Sequence in other communication means" is complete.
(2) Set rotation to low speed via the serial communication.
(3) "LOW SPEED" command is input via the serial communication.
(4) "START" command is input via the serial communicaton.
(5) The pump acceleration starts. Status is changed from "STOP" to "ACCELERATION". When the rotational speed reaches 80 % rated value, status is changed from "ACCELERATION" to "NORMAL".
(6) When the pump speed reaches the set low speed value, acceleration stops and the pump speed is maintained.

6.5.3 Operation From Rated Speed Rotation to Low Speed Rotation

The following procedure is used to change the rotation speed setting and operate in the low-speed mode when currently operating at the rated speed or accelerating at a speed greater than low speed rotation.

6.5.3.1 Remote Control Startup Procedure

(1) Use the serial interface to specify low speed rotation. Once set, it does not need to be set each time.
(2) Input a low-speed signal via the remote control connector (Refer to Table 6-4).
(3) This switches the "NORMAL" signal OFF (Refer to Table 6-4) and starts decelerating the pump. The "BRAKE" signal ON (Refer to Table 6-4), in this product of a standard spec.
(4) Once rotation reaches the low-speed rotation speed, the "NORMAL" signal ON. In this product of a standard spec, the "BRAKE" signal is switched OFF.
(5) The pump stops decelerating and maintains it current rotation speed.

(Note) If the "LOW SPEED" signal is canceled before reaching low-speed rotation, then it will function the same as for normal startup mode.

6.5.3.2 Serial interface Operation

(1) Set rotation to low speed via the serial communication.
(2) "LOW SPEED" command is input via the serial communication.
(3) Status is changed from "NORMAL" to "BRAKE", and status decelerating the pump.
(4) Once rotation reaches the low speed rotation speed, status is changed from "BRAKE" to "NORMAL". The pump stops decelerating and maintains it current rotation speed.

6.5.4 Operation from Low Speed Rotation to Rated Speed Rotation

This is the procedure to select normal speed operation during low speed rotation.

6.5.4.1 REMOTE Operation

(1) Cancel the "LOW SPEED" signal (Refer to Table 6-4) inputted in the remote-control connector.
(2) Pump starts to accelerate. If the set low speed value did not exceed 80 % rated speed, the "NORMAL" signal turns off. At this time, "ACCELERATION" signal turns on in this product of a standard spec.
(3) When the rotational speed reaches 80 % rated speed, the "NORMAL" signal turns on (Refer to Table 6-4).
At this time, "ACCELERATION" signal turns off in this product of a standard spec.
(4) If the set low speed value exceed 80 % rated speed, remote-control signals remain unchanged and the pump accelerates.
(5) When the rated speed is reached, the pump stops accelerating and the pump speed is maintained.

6.5.4.2 Serial interface Operation

(1) "NORMAL SPEED" command is input via the serial communication.
(2) Pump starts to accelerate. If the set low speed value did not exceed 80 % rated speed, status is changed from "NORMAL" to "ACCELERATION".
(3) When the rotational speed reaches 80 % rated value, status is changed from "ACCELERATION" to "NORMAL".
(4) If the set low speed value exceed 80 % rated speed, status remain unchanged and the pump accelerates.
(5) When the rated speed is reached, the pump stops accelerating and the pump speed is maintained.

※ If low speed value is set to 100 %, the same operation occurs.

6.6 Software Operation

NOTICE

Settings data can be loaded and overwritten via serial interface.
Settings data cannot be loaded or overwritten via remote control.

Software functions are indicated in Table 6-2 below.

Table 6-2 Software Operating Functions

Function		Descripition
Status	Operation mode	LOCAL, REMOTE or the other communication means
	Rotational Speed	
	Motor current	
	Run Status	(Note 1)
	MB Sensor	Magnet bearing Sensor output value
	Unbalance	Rotor unbalance monitor
Operation	START	Acceleration
	STOP	Deceleration
	ALARM reset	Reset operation when alarm occur
Timer	Run time	Timer and Counter Monitoring and reset
	maintenance timer	
	Power failure touch-down count	
	High-speed touch-down count	
	MB warning count	
Setting	Variable Rotation Speed (Low SPEED)	Changes or sets pump rotation speed.
	Remote-control connector Signal	Sets actions for remote-control signals
	Warning output	Sets external output for warning events Of the alarm codes listed in Table 9-7 "Table of Warnings", this setting changes the actions for warnings with alarm code 86 to 95, as indicated below ・Status orange lamp flashes ・Alarm event set via serial communication ・Remote control "WARNING" ON
	RS-485	Sets communications environment Multidrop setting Network ID setting
History	ALARM history	

(Note 1) List of run status.

STATUS	Descripition
NORMAL	Rotating at rated rotation speed
ACCELERATION	Accelerating
BRAKE	Decelerating
STOP	Stopped
E-STOP	Alarm is active (stopped)
E-BRAKE	Alarm is active (decelerating)
E-IDLE	Alarm is active (coasting motor is off)

6.7 Remote-Control Connector

6.7.1 Specification

This turbo molecular pump is provided with remote-control connector for connection with remote operation, ALARM signals, etc. (Refer to Fig. 6-2, Fig. 6-3, and Table 6-3)

For connection with this connector, cable with shield is necessary. The shield of the cable should be connected to case.

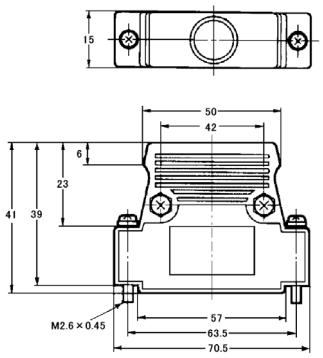


Fig. 6-2 Remote-Control Connector

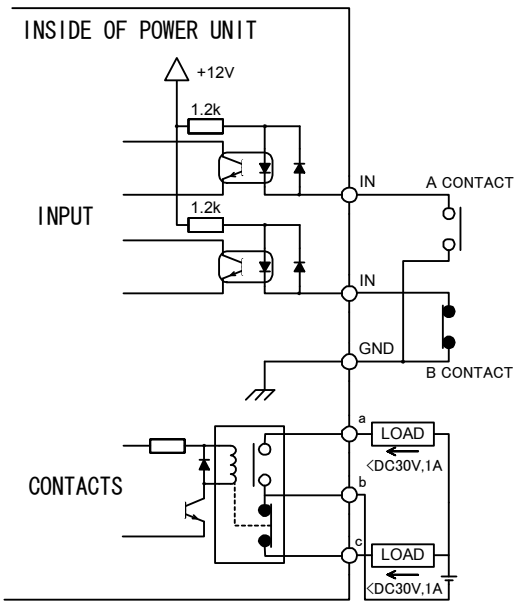
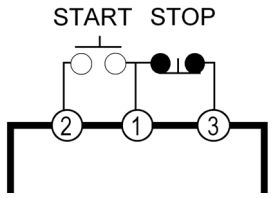
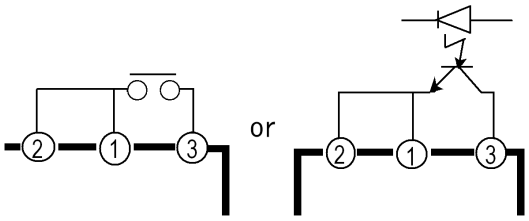


Fig. 6-3 Remote-Control Circuit

Table 6-3 Start/Stop According to Remote-Control Signals

Connection method	By momentary type START/STOP switch	By alternate type switch
Wiring connection		
Control	Pump start by short-circuiting (2) and (1). Pump stop by opening (3) and (1).	Pump start, with the contact close or photo transistor ON ((3) to (1) short-circuit). Pump stop, with the contact open or photo transistor OFF((3) to (1) open).
Electric Capacity	[Contact] It is connected to +12 V circuit and subject to stable open-close of 5 VDC, 1 mA. Voltage…30 VDC or more, Current…10mA or more [Photo transistor] Select a photo transistor with a collector-emitter voltage limit of 30 VDC and an on-state collector current of 10 mA or more	
Input rating	Direct forward current 50 mA ; DC reverse voltage 5 V	

6.7.2 Pin Assignment

Table 6-4 Remote-Control Signals

	Name	Pin No.	Operation	Electric spec
In-put	START	2	Starting operation on GND and short-circuiting (Note 1)	Contact Input
	STOP	3	Stopping operation on GND and circuit opening (Note 1)	
	RESET (Note 4)	4	Resetting operation on GND and short-circuiting	
	LOW SPEED	6	Variable speed operation on GND and short-circuiting	
	GND	1	GND	
Out-put	ROTATION	17 18 19	During rotation (17)-(19) open → close (make contact) (18)-(19) close → open (break contact)	Contact Output Contact capacity (resistance load) 30 VDC 1 A
	NORMAL	11 12 13	During rotational speed is more than 80 % rated value (11)-(13) open → close (make contact) (12)-(13) close → open (break contact)	
	ACCELERATION	8 9 10	During acceleration (8)-(10) open → close (make contact) (9)-(10) close → open (break contact)	
	BRAKE	14 15 16	During deceleration (14)-(16) open → close (make contact) (15)-(16) close → open (break contact)	
	REMOTE	20 21 22	Remote-controlled operation is available (Note 5) (20)-(22) open → close (make contact) (21)-(22) close → open (break contact)	
	ALARM	26 27 28	Against ALARM (Note 5) (26)-(28) open → close (make contact) (27)-(28) close → open (break contact)	
	WARNING	29 30 31	Against WARNING (Note 5) (29)-(31) open → close (make contact) (30)-(31) close → open (break contact)	
	CONNECTION	23 25	(23)-(25) Always closed	

(Note 1) "STOP" signal is prior to "START" signal.

(Note 2) Don't connect any pins other than specified above.

(Note 3) It takes six seconds until it comes to show that this signal is correct, after POWER switch is turned on.

(Note 4) One Reset signal is input each time the contacts close. Repeatedly short and open the contacts to input multiple Reset signals.

(Note 5) It is possible to change movement by remote-control signal settings of serial communication (Refer to Table 6-5).

Table 6-5 Remote-Control Signals setting mode

Signal		Description	Pin No.	
ALARM			(27)-(28)	(26)-(28)
	EI-03 (Note 1)	Alarm occurred	Open	Closed
		Power OFF and no alarm	Closed	Open
	SEMI E74 (Note 2)	Power OFF and active alarm	Closed	Open
		No alarm	Open	Closed
WARNING			(30)-(31)	(29)-(31)
	EI-03 (Note 1)	Warning occurred	Open	Closed
		Power OFF and no alarm	Closed	Open
	SEMI E74 (Note 2)	Power OFF and active warning	Closed	Open
		No alarm	Open	Closed
REMOTE	EI-03 (Note 1)	Even if remote control is possible, "REMOTE" signal is OFF during power interruption regenerative control.		
	SEMI E74 (Note 2)	"REMOTE" signal is normally ON when remote control is enabled.		
STOP	REMOTE ONLY	"STOP" signal (open between (1) and (3)) is enabled only when remote control is enabled.		
	REMOTE & RS-XXX	"STOP" signal (open between (1) and (3)) is enabled by priority even during RS-232C and RS-485 operation. Use this setting such as when using hardware interlock.		

(Note 1) When set to EI-03, behavior of remote-control signals is the same as SHIMADZU Turbo Molecular Pump power supply "EI-xx03M" series.

(Note 2) When set to SEMI E74, behavior of remote-control signals conform to SEMI E74 standard "Specification for vacuum Pump Interface-Turbo Molecular Pumps".
Refer to the same standard about the shape of connectors and the pin configuration.

6.7.3 Connector

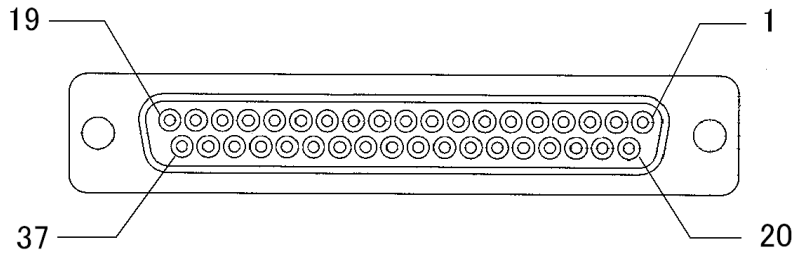


Fig. 6-4 Arrangement of Remote-Control Connector Pins
(Figure where connector of panel was viewed from the front)

6.8 Communication Specifications

6.8.1 RS-232C

6.8.1.1 Transfer Specifications

Interface	RS-232C
Synchronous system	Asynchronous
Transmission rate	9600 bps (fixed)
Character configuration	Start bit : 1 Data bits : 8 Parity : None Stop bit : 1
Flow control	None

6.8.1.2 Connector Specifications

Connector	SERIAL Connector (shared with RS-485)
Connector type	D-Sub 9 pin male, Screw lock size : M2.6
Pin Assignment	2 : RD (Receive data) 3 : SD (Transmit data) 5 : SG (Signal ground) ※ Don't connect other pins except the above-mentioned.

6.8.1.3 CABLE

(1) Cable Connection
Use the connection cable as shown in Fig. 6-5 to connect the turbo molecular pump and computer. (Number on figure is pin number of connector.)

(2) Cable Length
Connection cables can be extended up to 15 meters, but may be subjects to errors depending on actual operational environment.

a. Cable wiring connections for 9-pin connector cables.

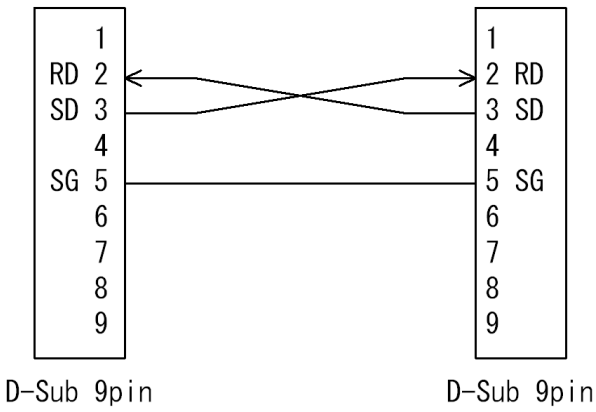


Fig. 6-5 Example of RS-232C cable wiring connections

6.8.2 RS-485

6.8.2.1 Transfer Specifications

Interface	RS-485 (2-wired, half duplex)
Synchronous system	Asynchronous
Transmission rate	9600 bps (fixed)
Character configuration	Start bit : 1 Data bits : 8 Parity : None Stop bit : 1
Flow control	None
Number of power supply	max 1 (multi-drop function is not supported) Multi-drop function OFF : 1 ON : Max 32 (*1)

(*1) There may be restrictions depending on cable length or cable type.
Perform appropriate checks in the actual operating environment.

6.8.2.2 Connector Specifications

Connector	SERIAL Connector (shared with RS-232C)
Connector type	D-Sub 9 pin male, Screw lock size : M2.6
Pin Assignment	4 : RXA (Received data ＋) 7 : RXB (Received data －) ※ Don’ t connect other pins except the above-mentioned.

6.8.2.3 CABLE

(1) Cable Connection

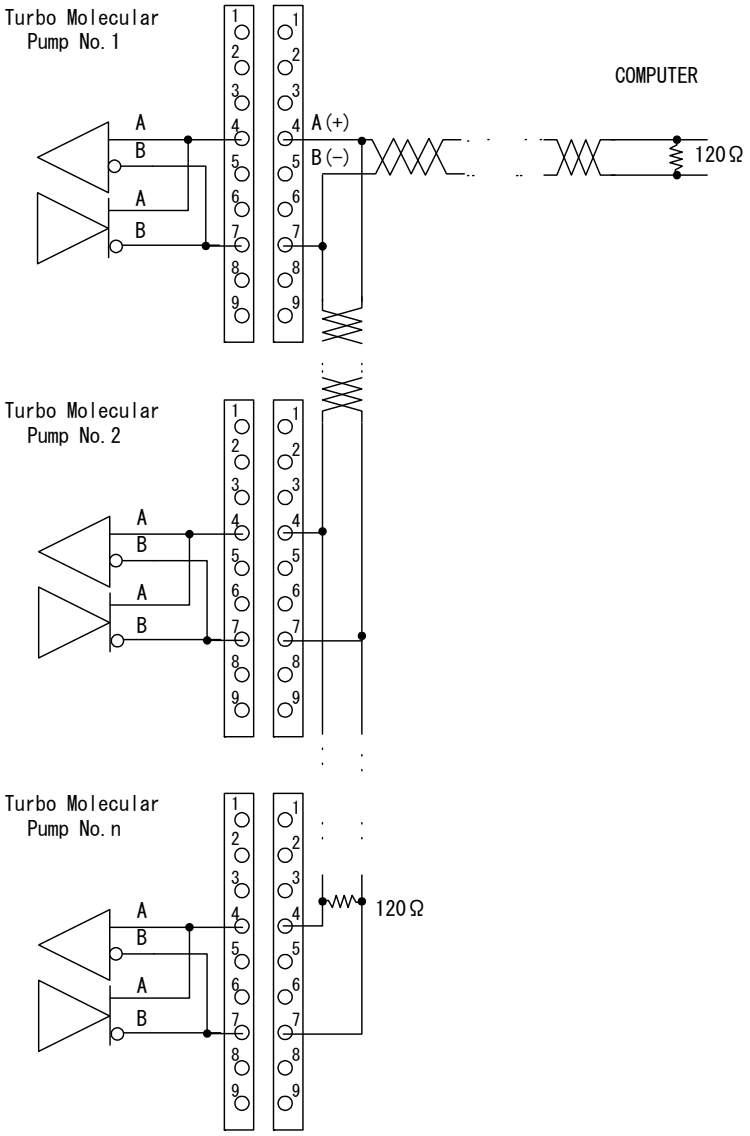


Fig. 6-6 Example of RS-485 cable wiring connections

(2) Cables used

RS-485 is a differential transmission and use twisted-pair cables in combinations as shown in Fig. 6-6.

(3) Connecting the terminator

A terminator (120 Ω, 1/4 W min.) is required for connection.
Terminators are not necessary for multidropped turbo molecular pump with another pump or pump to which the computer connects is connected to both ends (pump 1 through N-1 in Fig. 6-6).
However, connection of the terminator may prevent communications with certain cable lengths and RS-485 device types. Connect the terminator to determine whether it is required.

(4) Cable Length
Connection cables can be extended up to 1.2 kilometers, but may be subjects to errors depending on actual operational environment.

6.8.3 Connector

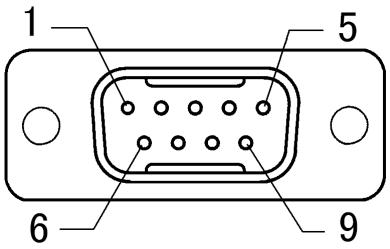


Fig. 6-7 Serial Connector Pin Configuration
(Figure where connector of panel was viewed from the front)

NOTICE

Serial interface protocol are compliant RS-232C / RS-485.
We have tested only our environment, all communication with apparatus is not guaranteed.

This page is intentionally left blank.

7

GAS PURGE

This product includes a port for purging gases in optional specification (Fig. 2-1 (2)). Though not necessary for normal evacuation, use it to inject purging gas to increase maximum allowable flow rate. A purge gas flow rate 30 mL/min is appropriate.

Fig. 7-1 is an example of gas purge piping diagram. Use a filter of 5 μm or less in element size. Use flow control valve to contorl the flow rate.

Start Gas Supply	After starting auxiliary pump, but before exhausting process gas
Stop Gas Supply	After thoroughly exhuasting process gas, but before shutting off auxiliary pump
Gas Type	Nitrogen, purity 4N (99.99 %) or better

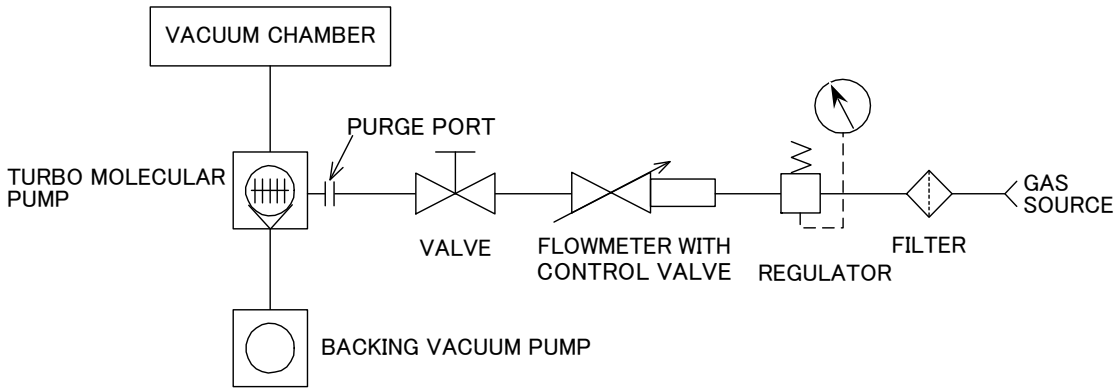


Fig. 7-1 Gas Purging Method (adaptor with ϕ0.5 mm orifice)

Table 7-1 Table of gas purge adaptor

Joint	Part number	Orifice size	Description
KF10 (Clamp / Centering with O-ring)	262-77592-19	ϕ0.5 mm	GP ADAPTOR, 0.5 KF10
KF10 (Dust cap)	262-77592-25	ϕ0.5 mm	GP ADAPTOR 0.5, KF DUST CAP
UJR 6.35	263-14770	ϕ0.5 mm	GP ADAPTOR, 0.5 UJR
SWAGELOK ϕ6.35	263-14771	ϕ0.5 mm	GP ADAPTOR, 0.5 SWG
4-VCR	263-14772	ϕ0.5 mm	GP ADAPTOR, 0.5 VCR

8

TURBO MOLECULAR PUMP RECONDITION

8.1 Recommended maintenance intervals

It is different for deterioration progress speed of each part changes greatly by pump condition.
Refer to the following list as overhaul of each process.
These are not terms of warranty.

	Process	Recommended maintenance intervals
1	Non-active gas (Sputtering, Evaporation and so on) and Light load process	3 years

(1) Recommended maintenance intervals for parts
These are not terms of warranty.

1) Non-active gas and Light load process

	Part name	Recommended maintenance intervals
1	Touch down bearing	3 years
2	Shaft	7 years It has a possibility of under 2 years (Dependent on condition)
3	Rotor	
4	Motor	7 years
5	Magnetic bearing parts	

(2) Recommended maintenance intervals for other parts

1) It has the possibility that the following part is exchanged, when cleaning TMP.

Part name
55-pin Receptacle

2) Others
When exchanging parts, it has possibility that other parts are exchanged for improving a reliability.
(Example : Old type lower and upper radial sensor had changed dimensions for reliability.
When exchanging them, these housing must also be exchanged.)

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.

The replacement of the touch-down bearing is done only by Shimadzu or an approved service company.

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 investigate rotor blades in every overhaul task and check and suggest a rotor replacement to customers if any cracks are found out.

8.5 Power Supply Unit Parts Replacement

The service life of respective parts (estimated) is indicated below. To ensure safe operation, avoid using parts beyond their expected service life. Doing so may prevent obtaining the maximum performance.

To obtain ensure the pump and power supply unit operate safely and perform as designed, have parts that exceed their expected service life be replaced by a Shimadzu service representative or an Shimadzu authorized service provider.

Table 8-1 Estimated Service Life for Parts

Part name	Estimated service life
Transformer	10 years
Electrolytic Capacitor	5 years
Button Battery	10 years

8.6 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.

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 the 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 advice 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.

CAUTION

When pump is removed from a equipment, drain the water from water pipe during pump power on and water valve open. If remained water leak from water pipe, pump body will be corroded.

After the water drained, shut water pipe by the cap which is attached at shipment.

CAUTION

This pump is a heavy equipment.

Lift this pump by two or more people or by using the lifter or the crane, during installation.

Need two or more eyebolts as described in Fig. 8-1 when lifting this pump on vertical position. Need four eyebolts as described in Fig. 8-1 when lifting this pump on headstand position. There is a possibility that the pump falls when using less eyebolts, than specified in Table 8-2.

A crane and eyebolts due to lifting operations should withstand the load of five times or more the weight of the TMP pump, and rope should be seven times or more. Use an eyebolt which confirms to ISO 3266.

There is a possibility that the pump falls when installing it on other positions.

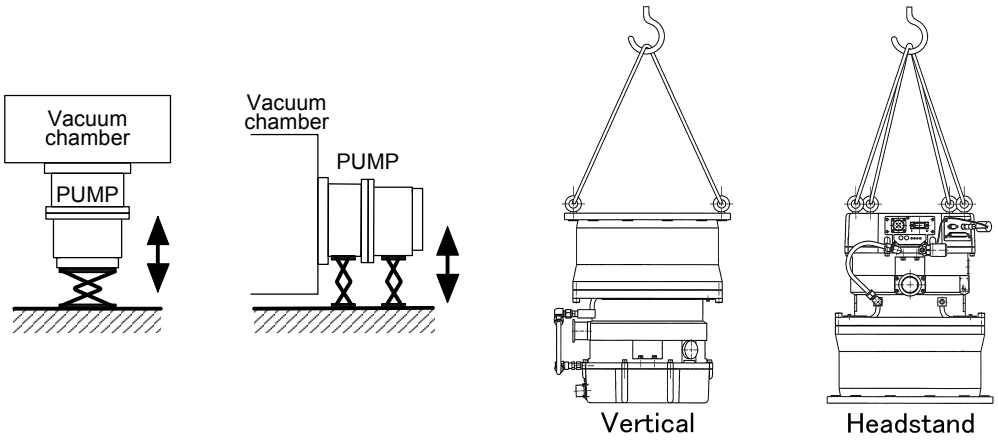


Fig. 8-1 Way to remove the pump

Table 8-2 Eyebolt size

Position	Eyebolt size	Number of eyebolts	Remark
Vertical	M12	2	Not bundled items
Headstand	M8	4	Not bundled items

CAUTION

Please pack it surely so as not to damage it by the impact, the vibration, and the high temperature and humidity environmetnt, etc. from the outside when the pump is returned.

Please use the packing materials used when it ships it from our company or the packing materials of quality more than equal to it.

9

TROUBLESHOOTING

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 STATUS orange lamp lights.

Do not suddenly increase the pressure or let atmospheric air enter the pump during pump operation.

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.

NOTICE

A "clunk" sound may be emitted from inside the pump when the power switch on the power supply unit is switched ON/OFF, but this is the sound of the rotor levitating or touching down inside the pump and is normal.

9.3 Nothing Happens After an Operation is Made

Table 9-1 Nothing Happens After an Operation is Made

	PROBLEM	POSSIBLE CAUSES	CORRECTIVE ACTION	Section
1	Power ON/OFF switch in the ON position but the turbo molecular pump fails to operate.	Electrical power cable not properly connected.	Properly connect the electrical power cable.	5.2
		Electrical power outside power supply unit's power range.	Operate within power supply unit's power range.	4.1
2	START/STOP button is pushed but the turbo molecular pump does not accelerate.	In REMOTE mode (POWER lamp lights)	By maintained push, change to LOCAL mode (POWER lamp blinks)	6.2
		Other causes.	Check the STATUS lamp is not lights in orange. If an alarm is indicated, correct the malfunction and reset alarm.	9.5
3	Remote "STOP" signal active but the turbo molecular pump does not accelerate.	In LOCAL mode (POWER lamp blinks)	By maintained push, change to REMOTE mode (POWER lamp lights)	6.2
		"STOP" ignal active.	Deactivate "STOP" signal.	6.7
		Other problems.	Check the STATUS orange lamp is not ON. If an alarm is indicated, correct the malfunction and reset.	9.5
4	START/STOP button is pushed but the turbo molecular pump does not decelerate.	In REMOTE mode (POWER lamp lights)	By maintained push, change to LOCAL mode (POWER lamp blinks)	6.2
5	Remote "STOP" signal activated but the turbo molecular pump does not decelerate.	In LOCAL mode (POWER lamp blinks)	By maintained push, change to REMOTE mode (POWER lamp lights)	6.2

9.4 Power Failures

When a power interruption occurs, the motor inside the turbo molecular pump immediately begins regenerative braking. The magnetic bearing will use this generated electricity to keep functioning and the rotor inside the turbo molecular pump will continue being levitated. The rotation will slow down due to the regenerative braking and eventually the rotor will be supported by the touchdown bearing. Table 9-2 shows the number of revolutions and period of time that will elapse before being supported by the touchdown bearing, when the power fails at the rated speed.

Table 9-2 Time and Rotational Speed During a Power Interruption Before Being Supported by Touchdown Bearing

Pump Model	Rotational Speed Before Support by Touchdown Bearing	Period of Time Before Support by Touchdown Bearing (Note 1)
TMP-V3304LM/LMC (F)	7500 rpm	9 minutes or less
TMP-V2804LM/LMC (F)		

(Note 1) Times are typical for regenerative braking from the rated speed.
Actual times will vary depending on vacuum conditions inside the pump and the rotational speed when the power fails.

9.4.1 Power Failure Counter-Operation

Table 9-3 shows the counter-operations against power interruption which occurred while the pump rotor is normally rotating.

Table 9-3 Counter-Operations Against Power Supply Failure

Interruption time	1 second or less (Note 1)		Over 1 second (Note 1)	
Interrupt/re-supply	During interruption	After re-supply	During interruption	After re-supply
Pump status				
Magnetic levitation	Levitation goes on	Levitation goes on	Levitation goes on	Levitation goes on
Run	Decelerates	Returns to before power-failure running condition	Decelerates	Decelerates (Note 2)
Indicator lamp				
ROTATION	Lamp ON goes on	Lamp ON goes on	Lamp ON goes on	Lamp ON goes on
STATUS	Before-power-failure indication goes on	Before-power-failure indication goes on	Orange lamp turns on	Orange lamp ON goes on
Remote-control output signals (Note 3)				
ROTATION Pin no. (17)-(19) (18)-(19)	 "CLOSE" goes on "OPEN" goes on	 "CLOSE" goes on "OPEN" goes on	 "CLOSE" goes on "OPEN" goes on	 "CLOSE" goes on "OPEN" goes on
NORMAL Pin no. (11)-(13) (12)-(13)	 Before-power-failure condition goes on Before-power-failure condition goes on	 Before-power-failure condition goes on Before-power-failure condition goes on	 Contact open Contact close	 "OPEN" goes on "CLOSE" goes on
ACCELERATION Pin no. (8)-(10) (9)-(10)	 Before-power-failure condition goes on Before-power-failure condition goes on	 Before-power-failure condition goes on Before-power-failure condition goes on	 Contact open Contact close	 "OPEN" goes on "CLOSE" goes on
BRAKE Pin no. (14)-(16) (15)-(16)	 Before-power-failure condition goes on Before-power-failure condition goes on	 Before-power-failure condition goes on Before-power-failure condition goes on	 Contact close Contact open	 "CLOSE" goes on "OPEN" goes on
REMOTE Pin no. (20)-(22) (21)-(22)	 Before-power-failure condition goes on Before-power-failure condition goes on	 Before-power-failure condition goes on Before-power-failure condition goes on	 Contact open Contact close	 Return to Before power-failure Return to Before power-failure
ALARM (Note 4) Pin no. (27)-(28) (26)-(28)	 "CLOSE" goes on "OPEN" goes on	 "CLOSE" goes on "OPEN" goes on	 Contact open Contact close	 By resetting Contact close Contact open
WARNING (Note 4) Pin no. (29)-(31) (30)-(31)	 "OPEN" goes on "CLOSE" goes on	 "OPEN" goes on "CLOSE" goes on	 "OPEN" goes on "CLOSE" goes on	 By resetting "OPEN" goes on "CLOSE" goes on

(Note 1) The time can be changed to 2 seconds from 1 second via communication operation. Refer to separate manual for serial communication.

(Note 2) For restarting after the power re-supply (restoration), push the RESET button.

(Note 3) The pin numbers are shown in Fig. 6-4 "Arrangement of Remote-Control Connector Pins".

(Note 4) Actions can be changed via communication operations. Refer to Section 6.7 "Remote-Control Connector".

9.5 Alarm Detection Capabilities

NOTICE

Alarm history data can be loaded using the serial interface, but not using the remote control signal.

The fault detection functions shown in Table 9-6 "Table of Alarms" and Table 9-7 "Table of Warnings" are incorporated for protection in the event of a problem with the turbo molecular pump or power supply unit.

When an error is detected, check the STATUS lamp (Fig. 2-2 (7)) and Refer to Section 9.5.3 for the appropriate remedy.

9.5.1 Movement in Alarm Detection Capabilities (ALARM)

1. STATUS orange lamp (Fig. 2-2 (7)) lights.
2. The remote-control connector "ALARM" signal turn on.
3. The pump start the protective operations shown in Table 9-6 "Table of Alarms".
4. The detection error is recorded in the error log.

9.5.2 Movement in Alarm Detection Capabilities (WARNING)

1. STATUS orange lamp (Fig. 2-2 (7)) flashes.
2. The remote-control connector "WARNING" signal turn on.
3. Pump operation continues.
4. The detection error is recorded in the error log.

9.5.3 Reset Procedure

1. Refer to the Troubleshooting information and eliminate the cause of the problem.
2. Conduct the reset operation.
3. (ALARM) If the problem has been eliminated, the STATUS orange lamp (Fig. 2-2 (7)) goes out, the "ALARM" remote-control signals (Refer to Table 6-4) turn off after an alarm was given, the pump rotor decelerates rotational speed.
   (WARNING) When the problem is eliminated after a warning occurred, pump operation continues.
4. If the problem was not completely eliminated, the alarm is not cancelled.

Table 9-4 If the STATUS orange Lamp Lights

	Alarm Code	Alarm Name	Possible Cause	Remedy	Section
1	11 12	TD COUNTER LIMIT PF COUNTER LIMIT	The number of high speed or power failure touch-downs has exceeded the prescribed number.	The touch-down bearing may have deteriorated. Consult Shimadzu or an approved service company regarding replacement of the touch-down bearing.	
2	14 15	AC LOW VOLTAGE POWER FAILURE	Power failure or reduction in the power supply voltage.	Wait for the power to be restored. An unfamiliar sound will be heard a few minutes after a power failure. This sound occurs when the rotor contacts the protective bearing as magnetic levitation cannot be maintained. This is not an abnormal sound.	
			POWER switch was turned off by mistake.	Wait about 5 seconds before turning the POWER switch back on. Re-acceleration is possible after resetting and start-up.	
3	16	TMP:OVERLOAD	Drop in rotation speed during rotation at rated speed (increased internal pump pressure).	Check that the outlet and inlet pressures are below the specified maximum pressures. Check for leakage. Check that too much purge gas is not flowing. Check that process gas flow rate is not too high.	4.1
4	21 24	TMP TEMP/MB CABLE TMP:OVER TEMP	High pump unit temperature.	Check that the ambient temperature around the pump is within the specified range. Check that the temperature and flow rate of the cooling water are within the specified ranges. Check that no load in excess of the specified range is continuously applied to the pump.	4.1
5	22 46 47	TMP:SENSOR ERROR MOTOR OVERSPEED EI:R-SPEED ERROR	Rotation detection signal from the motor cannot be detected correctly.	Check that equipment causing noise is not used around the pump and power cable.	5.2
6	23 24	EI:MOTOR OVERCURR EI:INV. OVERCURR	Overcurrent supplied to the motor.	Check that the ambient temperature around the pump is within the specified range. Check that the temperature and flow rate of the cooling water are within the specified ranges.	4.1 5.3
7	31 32	EI:BR OVERTEMP EI:DC-DC OVERTEMP	Temperature increase in the control system.	Check that the ambient temperature around the pump is within the specified range. Check that the temperature and flow rate of the cooling water are within the specified ranges.	4.1 5.3
8	35 36 37 38 45	EI:INV. OVERVOLT EI:DC-DC LOW VOLT EI:DC-DC OVERCURR EI:DC-DC OVERVOLT EI:BRAKE OVERTIME	Defective circuit in the power supply unit.	Turn the power on again after the pump stops. The power supply unit must be repaired if the problem occurs again.	

	Alarm Code	Alarm Name	Possible Cause	Remedy	Section
9	39	EI:DEW ERROR	Internal condensation	Check that the ambient temperature and humidity around the pump and the temperature of cooling water are within the specified range. Check there are no solids piled up in the water valve. Drive again after leave it for a while.	4.1 5.3
10	43	EI:PARAM ERROR	Defective circuit in the power supply unit.	Turn the power on again after the pump stops. The pump must be repaired if the problem occurs again.	
11	44 66 67	EI:CPU ERROR MB:DSP ERROR MB:DSP OVERFLOW	Abnormal operation of circuit in the power supply unit.	Check that the ambient temperature around the pump is within the specified range. Check that the temperature and flow rate of the cooling water are within the specified ranges. Check that equipment causing noise is not used around the pump and power cable.	4.1 5.2 5.3
12	48	EI:ACCEL OVERTIME	Rotation speed does not increase at start-up.	Check that the outlet and inlet pressures are not too high. Check for leakage. Check that too much purge gas is not flowing.	6.2
13	49	TMP:CAN NOT START	Pump does not rotate.	Adhesion of reaction products or damage to the protective bearing is the possible cause. Remove the pump from the unit and check that the rotor blades rotate smoothly at the inlet. An overhaul is required if blades do not rotate smoothly.	
14	51 52 53 54 55 56 57 58 59 60	MB:VIBRATION2 X1 MB:VIBRATION2 Y1 MB:VIBRATION2 X2 MB:VIBRATION2 Y2 MB:VIBRATION2 Z MB:VIBRATION1 X1 MB:VIBRATION1 Y1 MB:VIBRATION1 X2 MB:VIBRATION1 Y2 MB:VIBRATION1 Z	Strong external shock or vibrations.	If the shock or vibrations are transient re-acceleration is possible. If the shock or vibrations occur frequently, stop the pump and remove the source of the shock or vibrations; or re-examine the pump mounting method.	5.2
15	61 62 63 64 65	MB:SENSOR ERR. X1 MB:SENSOR ERR. Y1 MB:SENSOR ERR. X2 MB:SENSOR ERR. Y2 MB:SENSOR ERR. Z	The rotor does not move due to adhering matter or a damaged touchdown bearing.	Remove the pump and check that the rotor rotates smoothly. The pump requires an overhaul if the rotor does not rotate or the resistance to rotation is large.	
16	68 69	MB:BALANCE AXIS1 MB:BALANCE AXIS2	Rotor inside the pump is out of balance.	Adhesion of reaction products is a possibility. An overhaul is required.	

Table 9-5 If the STATUS orange Lamp Flashes

	Alarm Code	Alarm Name	Possible Cause	Remedy	Sec-tion
1	78	TMP:VALVE WARN	Cable of water valve is no connected correctly.	Confirm the cable from water valve is surely connectied to VALVE connector of External I/F panel.	4.1 5.3
2	79	EI:DEW WARN	Internal condensation	Check that the ambient temperature and humidity around the pump and the temperature of cooling water are within the specified range.	4.1 5.3
3	80	EI:CONT.TEMP.WARN	Temperature increase in the control system.	Check that the ambient temperature around the pump is within the specified range. Check that the temperature and flow rate of the cooling water are within the specified ranges.	4.1 5.3
4	81 82 83 84 85	MB:SELFCHECK X1 MB:SELFCHECK Y1 MB:SELFCHECK X2 MB:SELFCHECK Y2 MB:SELFCHECK Z	Rattling of the protective bearing becomes pronounced.	Deterioration of the protective bearing is likely. Overhaul as soon as possible to avoid damage to the protective bearing in the event of a power failure etc.	
5	86 87 88 89 90	MB:VIB. WARN. X1 MB:VIB. WARN. Y1 MB:VIB. WARN. X2 MB:VIB. WARN. Y2 MB:VIB. WARN. Z	Transient strong external shock or vibrations.	Continuous operation is possible However, if the shock or vibrations occur frequently, stop the pump and remove the source of the shock or vibrations; or re-examine the pump mounting method.	5.2
6	91 92	MB:BALANCE WARN.1 MB:BALANCE WARN.2	Rotor inside the pump is out of balance	Adhesion of reaction products is a possibility. An overhaul is recommended.	
7	94	MB:AIR RASH B	Atmospheric penetration has occurred.	Create a vacuum system not allowing atmospheric penetration by reexamining the operating sequence of the back pump and valves etc.	
8	95	MB:DSP WARNING	Abnormal operation of circuit in the power supply unit.	Check that the ambient temperature around the pump is within the specified range. Check that the temperature and flow rate of the cooling water are within the specified ranges. Check that equipment causing noise is not used around the pump and power cable.	4.1 5.2 5.3
9	99	MAINTENANCE TIME	Maintenance call timer has reached the set time.	Implement maintenance works prescribed by the customer, such an overhaul. The alarm can be cancelled by resetting the maintenance call timer after implementing necessary works.	6.6

Table 9-6 Table of Alarms

Alarm Code	Alarm Name	Possible Cause	Protective Action
11	TD COUNTER LIMIT	Counts of the high speed touch-down counter exceeded the specified number.	Start-up impossible (detected during power supply self-diagnostics)
12	PF COUNTER LIMIT	Counts of the power failure touchdown counter exceeded the specified number.	
14	AC LOW VOLTAGE	Fall in AC input power voltage.	Regenerative braking
15	POWER FAILURE	Power failure.	
16	TMP:OVERLOAD	After accelerating to 80 % of the designated speed or low-speed setting, the speed dropped below 80 % due to overloading etc.	Deceleration
21	TMP TEMP/MB CABLE	Increased pump drive motor temperature.	Free run (motor stop)
22	TMP:SENSOR ERROR	Pump rotation signal could not be detected correctly.	
23	EI:MOTOR OVERCURR	Overcurrent ran through the motor.	
24	TMP:OVER TEMP	Increased pump Temperature	Deceleration
30	EI:CONT. TEMP ERR	Increased temperature inside the control system	Deceleration
32	EI:DC-DC OVERTEMP	Increased temperature inside control system.	Free run (motor stop)
34	EI:INV. OVERCURR	Overcurrent ran through the motor.	
35	EI:INV. OVERVOLT	Defective circuit.	
36	EI:DC-DC LOW VOLT	Defective circuit.	Regenerative braking
37	EI:DC-DC OVERCURR	Defective circuit.	Deceleration
38	EI:DC-DC OVERVOLT	Defective circuit.	
39	EI:DEW ERROR	Dew ERROR	Deceleration
43	EI:PARAM ERROR	Stored parameters are not correct.	Start-up impossible (detected during power supply self-diagnostics)
44	EI:CPU ERROR	Error in the CPU for inverter control.	Free run (motor stop)
45	EI:BRAKE OVERTIME	Pump does not stop within the specified time after the stop operation.	
46	MOTOR OVERSPEED	Pump rotation speed is too high.	
47	EI:R-SPEED ERROR	Pump rotation speed cannot be detected.	
48	EI:ACCEL OVERTIME	Pump does not accelerate to 80 % of the designated speed or low-speed setting within the specified time after start-up.	Deceleration
49	TMP:CAN NOT START	Pump fails to rotate within 2 minutes after start-up.	
51	MB:VIBRATION2 X1	Continuous excessive vibration of the magnetic bearing.	
52	MB:VIBRATION2 Y1		
53	MB:VIBRATION2 X2		
54	MB:VIBRATION2 Y2		
55	MB:VIBRATION2 Z		

Alarm Code	Alarm Name	Possible Cause	Protective Action
56	MB:VIBRATION1 X1	Excessive magnetic bearing vibration.	Deceleration
57	MB:VIBRATION1 Y1		
58	MB:VIBRATION1 X2		
59	MB:VIBRATION1 Y2		
60	MB:VIBRATION1 Z		
61	MB:SENSOR ERR. X1	Abnormal output signal from the magnetic bearing sensor.	
62	MB:SENSOR ERR. Y1		
63	MB:SENSOR ERR. X2		
64	MB:SENSOR ERR. Y2		
65	MB:SENSOR ERR. Z		
66	MB:DSP ERROR	Error in the DSP for magnetic bearing control.	
67	MB:DSP OVERFLOW	Overflow in the magnetic bearing control calculations.	
68	MB:BALANCE AXIS1	Rotor is out of balance.	
69	MB:BALANCE AXIS2		

Table 9-7 Table of Warnings

Alarm Code	Alarm Name	Possible Cause	Protective Action
78	TMP:VALVE WARN	Abnormal coolant valve	Operation continued.
79	EI:DEW WARN	Dew warning	Operation continued. Water valve is closed.
80	EI:CONT.TEMP.WARN	Increased temperature inside power supply unit.	Operation continued.
81	MB:SELFCHECK X1	Results of magnetic bearing sensor self-diagnostics are abnormal.	Operation is possible (detected during power supply self-diagnostics).
82	MB:SELFCHECK Y1		
83	MB:SELFCHECK X2		
84	MB:SELFCHECK Y2		
85	MB:SELFCHECK Z		
86	MB:VIB. WARN. X1	Vibrations of the magnetic bearing become temporarily excessive.	Operation continued.
87	MB:VIB. WARN. Y1		
88	MB:VIB. WARN. X2		
89	MB:VIB. WARN. Y2		
90	MB:VIB. WARN. Z		
91	MB:BAL. WARN. AXIS1	Rotor is slightly out of balance.	
92	MB:BAL. WARN. AXIS2		
94	MB:AIR RASH B	Atmospheric penetration.	
95	DSP WARNING	Error in the DSP for magnetic bearing control.	
99	MAINTENANCE TIME	Maintenance call timer reaches its set time.	

Index

This page is intentionally left blank.

No. FE8A-0139C

Declaration of Conformity

SHIMADZU CORPORATION SEMICONDUCTOR EQUIPMENT DIVISION

Address : 1,NISHINOKYO-KUWABARACHO,NAKAGYO-KU,

KYOTO ,604-8511, JAPAN

as the Manufacturer

declares in sole responsibility that the following product

Product Name **Turbo-Molecular Pump and Power Supply**

Model Name
TMP-V2304LMa
TMP-V1704LMa
TMP-V1804LMa
TMP-V2804LMa
TMP-V3304LMa

Pumps: **TMP-2304LMa**
TMP-1704LMa

Power Supply: **EI-V04M**

a: **C,B,F,G,BG,FG, or blank**

Designation suffix:
TMP = Turbo-Molecular Pump
V = On board controller type
L= Water cooling
M = Magnetic Levitated (all model)
C = Nickel plating (rotor)
B = Black nickel plating (rotor)
F = Black nickel plating (rotor & stator)
G = Thick nickel plating (rotor)
BG = Black thick nickel plating (rotor)
FG = Black thick nickel plating (rotor & stator)
EI= Power Supply MODEL NAME

referred to in this declaration conforms with following directives and standards

Machinery directive 2006/42/EC
EN ISO 12100-1:2010
EN1012-2:1996+A1:2009

Low Voltage directive 2006/95/EC
EN61010-1:2001

EMC directive 2004/108/EC
EN61326:2006, 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

Kyoto, JAPAN 11 Jan. 2012
place and date of issue

Akitoshi Igata
signature

Akitoshi Igata
name

Manager of Quality Assurance Dept.
Semiconductor Equipment Division
Shimadzu Corporation
Position

FE9R-0021-02A

TMP overhaul / repair request form

Please fill out this request form and attach to the product before you send back to Shimadzu service center for overhaul or repair service. We ask that you fill out this form completely to expedite the service and return shipment.

Please mark the item box, and fill out the blank.

(1) Product	☐Pump (TMP-) s/n ( ) ☐Controller (EI-) s/n ( ) ☐Attachiment ( )
(2) Request	☐Overhaul ☐Repair ☐Other
(3) Details	
(4) Alarm code	(If status lamp indicates, No is)

(5) Date of failure occurrence ( )	(6) Date for return shipment request ( )
(7) Date of TMP operation start ( )	(8) Date of previous delivery ( )

(9) Parts exchange recommendation	If any parts exchange is recommended due to the excess of usage recommendation period, ☐(a) Please exchange the parts. ☐(b) Don't exchange unless any deterioration is found in the inspection. In case of (b), even if any failure occurs with the cause of parts for which customers choose continuous usage, it's out of warranty. Especially at rotor, it causes the material deterioration which even the fluorescent penetrant test can't detect after long term running. For this reason, periodical exchange is recommended in order to use the rotor safely.
(10) Declaration of contamination	**Please fill out the following items to make sure of our safety.** Components which have been contaminated by hazardius substrates will not be accepted or served without written evidence of decontamination. - Equipment process ☐Etch ☐PVD ☐CVD ☐Others ( ) - Materials the equipment has been exposed to ( ) (Eched material, CVD/PVD target, etc) - Gases the equipment has been exposed to ☐Air, Nitrogen, etc ( ) ☐Reactive/active gas ( ) ☐Hazardous gas ( ) - Is it hazardous to human ? ☐Yes ☐No ☐Inert gas such as helium, etc ( ) ☐Corrosive gas ( ) ☐Others ( ) - Is there color change or adhesion at inlet or outlet flange ? ☐Yes ☐No (If yes, please let us perform TMP cleaning at additional charge to keep appropriate performance. - Precaution and procedure for decontamination in case it's necessary at Shimadzu. ( )
(11) Gas purge	☐Used (sccm) ☐Not used

I declare that the TMP being returned doesn't contain any amount of hazardous residues that exceed the permissible exposure limits on the MSDS and that the information provided above is complete and accurate.

Date ( )

Company ( ) Job title ( )

Name ( ) Signature ( )

Phone ( ) Fax ( )

「電子情報製品汚染防止管理弁法」（中華人民共和国 信息産業部発行）に基づく、
「環境保護使用期限」と「製品中の有毒有害物質または元素の名称および含有量」表示

Markings regarding the "Environmental Protection Use Period" and the "Names and Contents of Toxic or Hazardous Substances or Elements" for "Management Methods for Controlling Pollution by Electronic Information Products" (Issued by: Ministry of Information Industry of the People's Republic of China)

Model Name： **TMP-Vxx04 series**
(Pump Unit：TMP-xx04 series,　Power Supply：EI-V04M)

環境保護使用期限 [环保使用期限标识]
Environmental Protection Use Period

この環境保護使用期限標識（マーク）は【電子情報製品汚染防止管理弁法】及び【電子情報製品汚染防止標識に関する要求】に基づき策定され、中国国内で販売される電子情報製品に適用されます。マーク中央の数字は、環境保護使用期限の年数です。この製品に関する安全や使用上の注意をお守りいただく限り、製造日から起算するこの年限内では、有害・有毒物質または元素が外部へ漏れ出したり変化をおこしたりせず、重大な環境汚染や人体や財産に影響を及ぼすことはありません。なお、この標識の期限は、製品の品質や機能に関する保証期間と異なります。

[环保使用期限标识（标记）是根据《电子信息产品污染控制管理办法》以及《电子信息产品污染控制标识要求》制定的，适用于在中国境内销售的电子信息产品。标记中央处的数字即为环保使用期限的年数。只要遵守相关产品安全与使用方面的注意事项，则从生产日期算起，在此期限内产品不会向外界泄漏有害、有毒物质或元素和发生化学变化，不会对环境造成严重污染或对人身、财产造成影响。另外，此标识中的期限不同于产品质量与功能的保证期，望周知 。]

The Marking of Environmental Protection Use Period is formulated according to the stipulations in the "Management Methods for Controlling Pollution by Electronic Information Products" and "Marking for Control of Pollution Caused by Electronic Information Products", and applies to the electronic information products sold in the People's Republic of China.
The number in the middle of the logo means the unit of years for the actual environmental protection use period for this product. Within the indicated period from the date of manufacture, the toxic or hazardous substances or elements contained in the electronic information products will not leak or mutate under normal operating conditions so that the use of this electronic information products will not result in any severe environmental pollution, any bodily injury or any damage to assets.
In addition, note that a time limit in this marking is different from a guarantee period for quality and functions of this product.

製品中の有毒有害物質または元素の名称および含有量 [产品中有毒有害物质或元素的名称及含量]
Names and Contents of Toxic or Hazardous Substances or Elements

部品名称 [部件名称] Part Name	有毒有害物質または元素 [有毒有害物质或元素] Toxic or Hazardous Substances and Elements					
	鉛 [铅] Lead (Pb)	水銀 [汞] Mercury (Hg)	カドミウム [镉] Cadmium (Cd)	六価クロム [六价铬] Hexavalent Chromium (Cr (VI))	ポリ臭化ビフェニル [多溴联苯] Polybrominated biphenyls (PBB)	ポリ臭化ジフェニルエーテル [多溴二苯醚] Polybrominated diphenyl ethers (PBDE)
Pump Unit	X	O	X	O	O	O
Power Supply	X	O	X	O	O	O
Cables	X	O	X	O	O	O

O: 当該部材に使用されているすべての均質材料中における当該有毒有害物質の含有量がいずれも SJ/T11363-2006 標準に規定する限度量の要求以下であることを示す。
[表示该有毒有害物质在该部件所有均质材料中的含量均在SJ/T 11363-2006 标准规定的限量要求以下。]
Indicates that this toxic or hazardous substance contained in all of the homogeneous materials used for this part is below the limit requirement in SJ/T11363-2006.

X: 当該部材に使用されているある均質材料中における当該有毒有害物質の含有量が SJ/T11363-2006 標準に規定する限度量の要求を上回ることを示す。
[表示该有毒有害物质至少在该部件的某一均质材料中的含量超出SJ/T 11363-2006 标准规定的限量要求。]
Indicates that this toxic or hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement in SJ/T11363-2006.

To all user of Shimadzu equipment in the European Union:

Thank you for using Shimadzu equipment.

WEEE Mark

Equipment marked with this symbol indicates that it was sold on or after 13th August 2005, which means it should not be disposed of with general household waste. Please note that our equipment is for industrial/professional use only.

With your co-operation we are aiming to reduce contamination from waste electronic and electrical equipment and preserve natural resource through re-use and recycling. Please do not hesitate to ask your Shimadzu office or Shimadzu distributor, if you require further information.

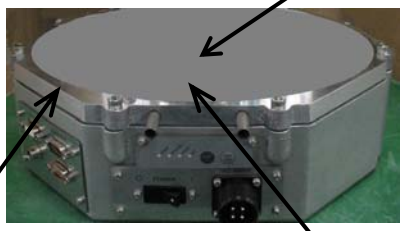
Information for treatment facilities (TMP-Vxx04 series)

Pump and Power Supply

Power Cable
(Accessory)

Printed circuit boards (inside)

Power Supply



Capacitors (inside)
(4 pieces)

Battery (inside)

Shimadzu Corporation

SHIMADZU CORPORATION. International Marketing Division
3. Kanda-Nishikicho 1-chome, Chiyoda-ku, Tokyo 101-8448, Japan
Phone : 81(3)3219-5641 Fax : 81(3)3219-5710

SHIMADZU INDUSTRIAL EQUIPMENT, U.S.A.
2340-C Walsh Avenue, Santa Clara, CA95051 U.S.A.
Phone : 1(408)566-0960 Fax : 1(408)566-0961 E-mail : tmp@spi-inc.com

KRATOS ANALYTICAL LTD.
Wharfside, Trafford Wharf Road, Manchester M17 1GP England
Phone : 44(161)888-4400 Fax : 44(161)888-4402 E-mail : vacuum@kratos.co.uk

SHIMADZU (ASIA PACIFIC) PTE LTD.
16 Science Park Drive #01-01 Singapore Science Park, Singapore 118227, Republic of Singapore
Phone : 65-6778-6280 Fax : 65-6779-2935

SHIMADZU (CHINA) Co., LTD SHANGHAI BRANCH
Block E, No.570 West Huaihai Road, Shanghai, 200052
Phone : 86(21)2201-3888 Fax : 86(21)2201-3666

URL http : //www.shimadzu.com