

INSTRUCTION MANUAL

Turbo Molecular Pump

Model

UTM3400 Series

Before using this product, be sure to read this operation manual.

Keep this manual with care to use at any time.

ULVAC, Inc.
Components Division

<http://www.ulvac.co.jp/>

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Introduction

Thank you for choosing the ULVAC Turbo Molecular Pump.
Please read the instruction manual carefully before using turbo molecular pump, and save the instruction manual for future reference.

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In an effort to improve the product, this document may be revised in the future without notice. Every effort has been made to prepare an accurate and complete manual, but if an error or omission should be discovered, revisions might not be possible immediately.

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

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 which, if not avoided, could result in serious injury or possibly death.

CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in minor to moderate injury 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 ULVAC 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, or cause injury by electrical shock.



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 Section 5.1.2.2. 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

Ensure that no oil mist or hazardous substances are present in process line as safe ducting procedure when turbo molecular pump is installed to host equipment.

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 ULVAC. 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 gasses.
 - Please take an adequate safety precaution based on the result of risk assessment of explosion, fire, corrosion, and toxicity, etc. that depends on process gasses.
 - Please execute the maintenance task of the turbo molecular pump after shutting power off by following proper procedure and confirming that the rotor has stopped completely.
-

WARNING

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

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

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. This pump is not intended to be used in a potentially explosive atmosphere.

CAUTION

The pump surface may get hot, there are risk of burn.

Prevent the installation, operation, maintenance, and service personnel from contacting the pump surface easily in all tasks that they are intended to perform.

CAUTION

The standard power input voltage is 200 to 240 VAC \pm 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. Please provide PE (Protective Earth) connection to the chassis of pump in final application.

CAUTION

When pump is removed from a equipment, drain the water from water pipe. If remained water leak from water pipe, pump body will be corroded.

In the case of the specifications with the water valve, drain the water from water pipe during pump power on and water valve open.

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

CAUTION

This turbo molecular pump has the integrated power supply.

Do not separate the power supply from the pump, or the pump cannot be operated even if the power supply is connected again.

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.
-

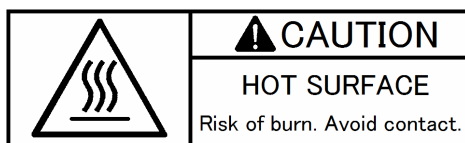
NOTICE

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.



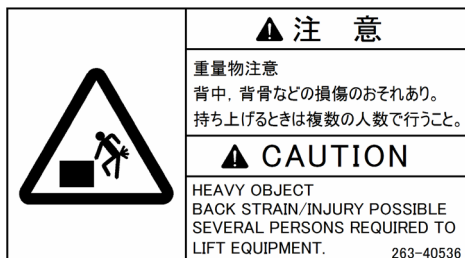
- (2) Pump Securement Label
If the pump is not secured properly, it could become detached and cause injury or damage to surrounding equipment. Be sure to secure the pump according to Section 5.1.2 "Installation of the Pump".



- (3) Remove Label
Do not remove cover, or else it may cause some changes inside and it is failed.



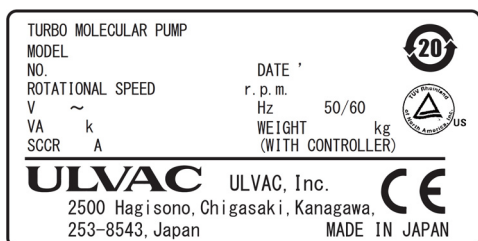
- (4) Cable Label
Be sure to use specified cable for this power supply. If not, it may cause connector be broken and power supply itself failed.



- (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 certifies that the product was made or maintained by ULVAC or by ULVAC authorized facility. In case "this label is removed" or "there is a mark showing once this label has been removed", ULVAC warranty shall not be applied to the product.



- (7) Name Plate

○ Location of Label

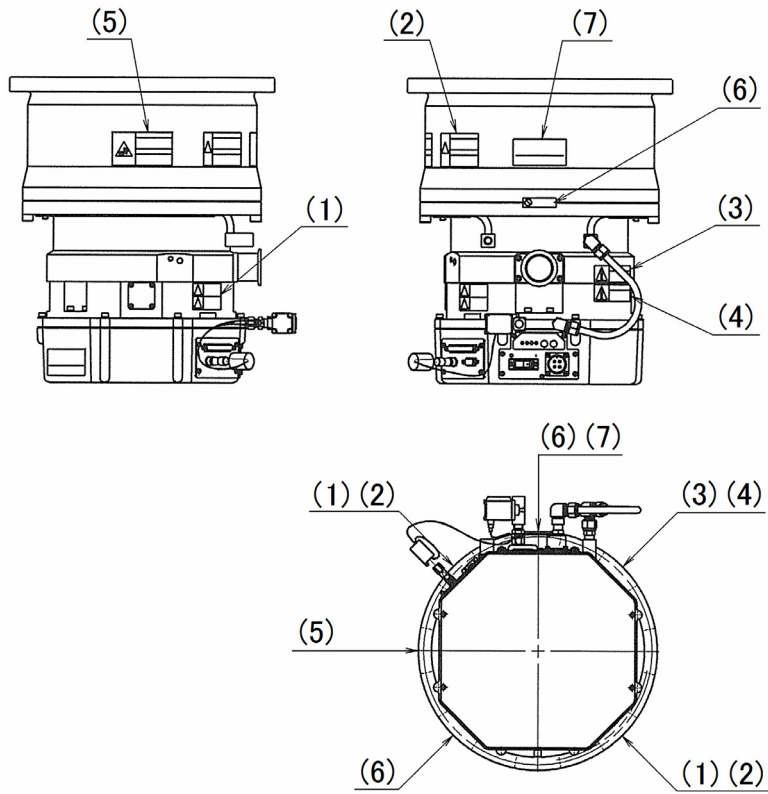


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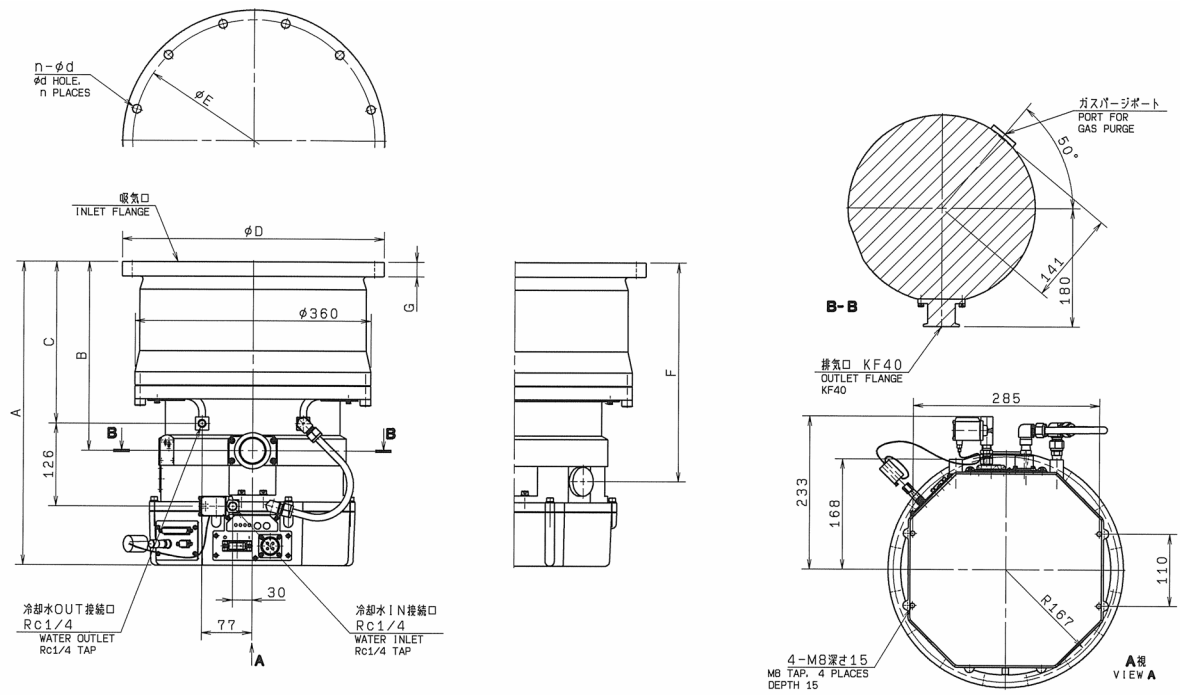
OUTLINE AND DESCRIPTIONS

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- 1.1 Outline
- 1.2 Descriptions
 - 1.2.1 Outside Drawing of Pump Unit
 - 1.2.2 Power Cable
 - 1.2.3 Standard Accessories
 - 1.2.4 Option
 - 1.2.5 Document List

1.2 Descriptions

1.2.1 Outside Drawing of Pump Unit



Description	Inlet flange	A	B	C	ϕD	ϕE	n- ϕd	F	G
UTM3400A-MI-AVWX UTM3400A-MI-CVWX	VG300	462	288	246	$\phi 400$	$\phi 370$	12- $\phi 13$	333	22
UTM3400A-MI-AWWX UTM3400A-MI-CWWX	VG350	462	288	246	$\phi 450$	$\phi 420$	12- $\phi 13$	333	24.5
UTM3400A-MI-AFWX UTM3400A-MI-CFWX	ISO320F	467	292	251	$\phi 425$	$\phi 395$	12- $\phi 13$	338	22.5

Fig.1-1 UTM3400 Series

1.2.2 Power Cable

One of followings.

	Description	Notes
1	AC CABLE, 5 MT	
2	AC CABLE, 10 MT	
3	AC CABLE, 15 MT	
4	AC CABLE, 20 MT	
5	AC CONNECTOR SET	<ul style="list-style-type: none"> ▪ Connector ▪ Clamp ▪ Core ▪ Assembling procedure

1.2.3 Standard Accessories

	Description	Qty	Note
1	Gasket (inlet flange) (Note 1)	1	VG300 : O-ring gasket VG350 : O-ring gasket ISO320F : Not included
2	Bolt set (inlet flange)	—	VG300 : Not included VG350 : Not included ISO320F : Not included
3	Dust cap (outlet flange)	1	KF40
4	Remote-control connector	1	D-sub 37 pin male
5	Serial-control connector	1	D-sub 9 pin female
6	Important safety instructions	1	English and Japanese
7	Instruction manual CD-ROM	1	

(Note 1) One of followings.

1.2.4 Option

Please select if necessary.

Instruction Manual

	Description	Note
1	Instruction manual for UTM3400 series Booklet	English
2	Instruction manual for Serial communication (for UTM2300/3400 series) Booklet	English

Gas Purge Adaptor

	Joint	Orifice size	Description
1	KF10 (Clamp / Centering with O-ring)	Φ0.5 mm	GP ADAPTOR, 0.5 KF10
2	KF10 (Dust cap)	Φ0.5 mm	GP ADAPTOR 0.5, KF DUST CAP
3	UJR 6.35 (Male)	Φ0.5 mm	GP ADAPTOR, 0.5 UJR
4	SWAGELOK Φ6.35	Φ0.5 mm	GP ADAPTOR, 0.5 SWG
5	4-VCR (Female)	Φ0.5 mm	GP ADAPTOR, 0.5 VCR

1.2.5 Document List

Document lists that relates to this product are as follows.

	Component
1	Instruction manual for UTM3400 series (This manual) (Including in instruction manual CD-ROM.)
2	Instruction manual for Serial communication (for UTM2300/3400 series)
3	Important safety instructions for UTM3400 series

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IDENTIFICATION AND FUNCTION



- 2.1 Pump Main Unit
- 2.2 Control Panel
- 2.3 External I/F Panel

2.1 Pump Main Unit

2

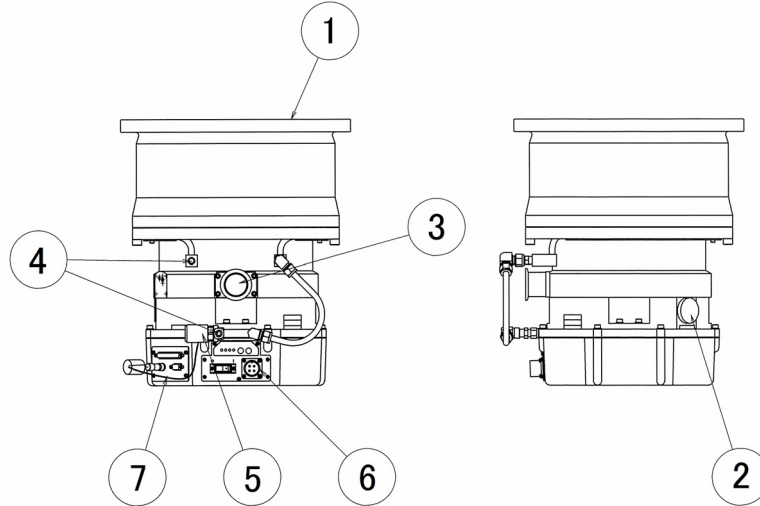


Fig.2-1 Pump Main Unit

- (1) INLET FLANGE Inlet flange, joint the turbo molecular pump, VG300, VG350 and ISO320F are available.
- (2) PORT FOR GAS PURGE..... Gas purge adaptor port, KF10, UJR 6.35, Swagelok $\Phi 6.35$ and 4-VCR are available. (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 energizing, and closed when not energizing.)
- (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

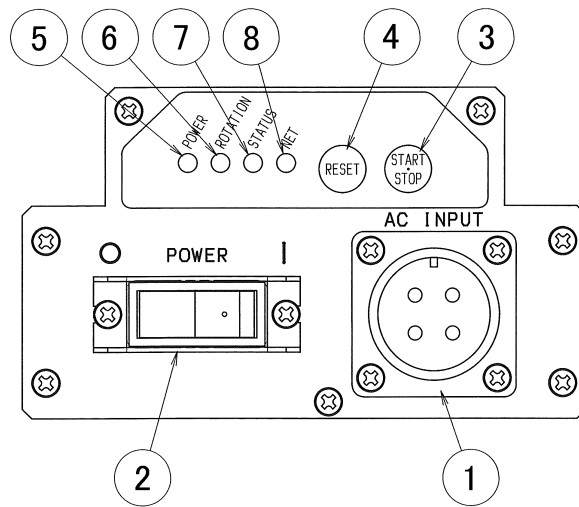


Fig.2-2 Outline View of Control Panel

- (1) AC INPUT connector 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 This lamp is always turned off.

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

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

2.3 External I/F Panel

2

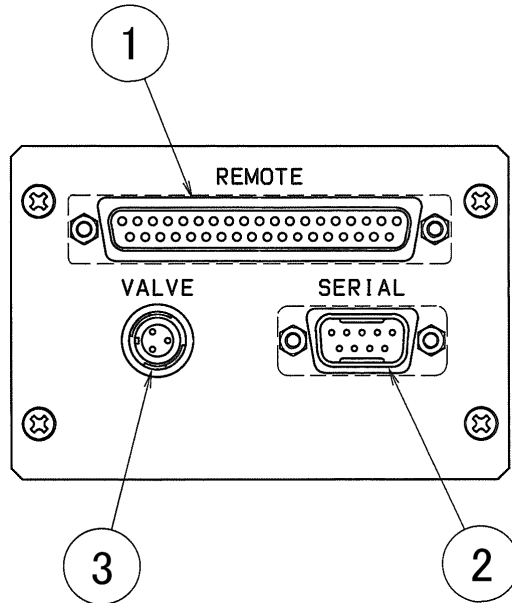


Fig.2-3 I/F Panel

- (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).

CONSTRUCTION AND PRINCIPLE



- 3.1 Pump Construction
- 3.2 Principle of Turbo Molecular Pumping
- 3.3 Controller

3.1 Pump Construction

3

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 (3) are fitted onto the drive shaft (2) and the stator blades (4) are arranged in between the rotor blades. A positioning spacer (5) 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 (6) is used at the top and bottom of the drive shaft. The axial magnetic bearings (7) 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 (9) 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 (8) 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 (12) protects that a foreign object comes in from inlet flange.

The cooling water pipe (13) 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.

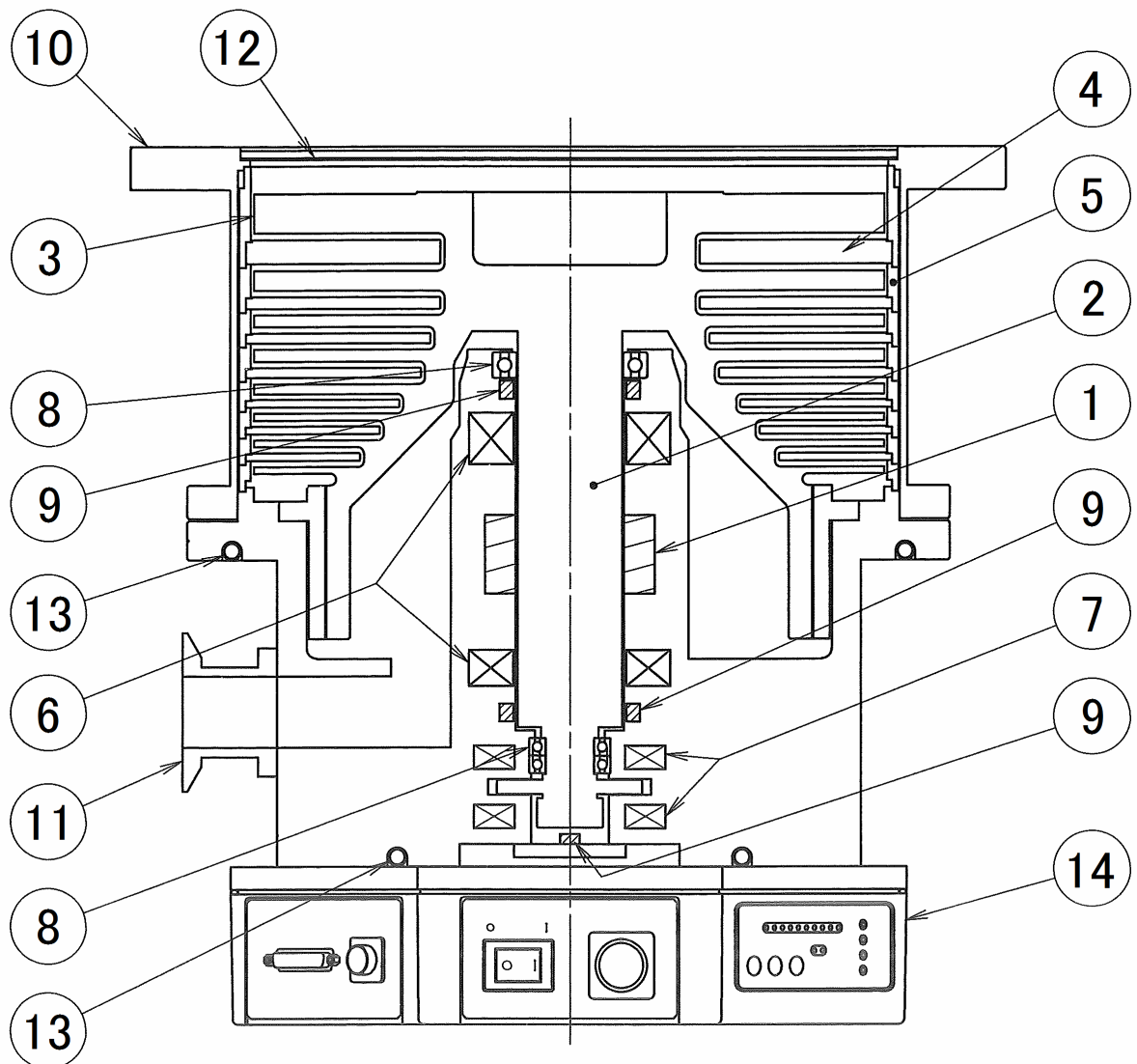


Fig.3-1 Pump Sectional Drawing

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

SECTION 3 CONSTRUCTION AND PRINCIPLE

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).

3

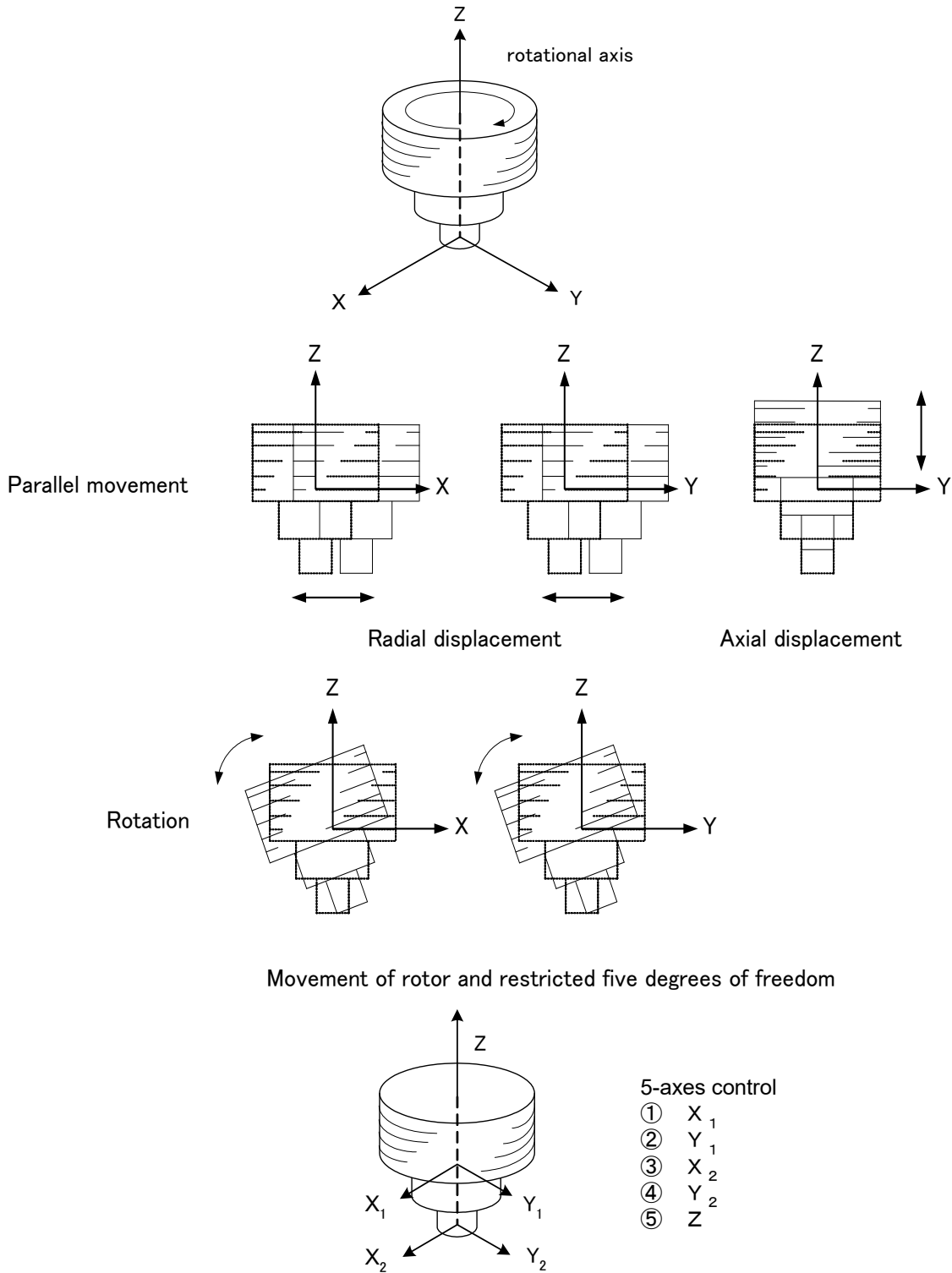


Fig.3-2 Outline of 5-Axes Control

3.3 Controller

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 Section 6.8 "Communication Specifications" and the separate Communication Functions manual.

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SPECIFICATIONS



- 4.1 Standard Specifications for Pump Unit
- 4.2 The Maximum Allowable Flow Rate
- 4.3 Standards Fulfilled

4.1 Standard Specifications for Pump Unit

4

Turbo molecular pump model		UTM3400A-MI-AVWX UTM3400A-MI-AFWX (Note 1) UTM3400A-MI-AWWX	UTM3400A-MI-CVWX UTM3400A-MI-CFWX UTM3400A-MI-CWWX
Inlet flange		VG300 / VG350 / ISO320F	
Outlet flange		KF40	
Cooling method		Water cooled	
Mass		94 kg	
Ultimate pressure (after baking)		10^{-7} Pa order	
Maximum allowable flow rate (Note 2)		Refer to Section 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	3200 L/s	
	Ar	3100 L/s	
	H ₂	2200 L/s	
Compression ratio	N ₂	1×10^9 or more	
	He	1×10^5	
	H ₂	6×10^3	
Rated speed		27600 rpm	
Start-up time		16 minutes or less	
Mounting position		In any desired direction (Note 4)	
Vibration level (by ULVAC's method)		0.01 μ m 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	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 %)	

4.1 Standard Specifications for Pump Unit

Alarm history		Remembers date, time, and description of last 99 alarm events.
Instantaneous power interruption (Note 6)		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, Failure of magnetic bearing, Control system malfunction (Overtemperature 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 supported 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 $\pm 10\%$ (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 7)	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 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	3 mT
	Axial direction	15 mT

SECTION 4 SPECIFICATIONS

Installation conditions (Refer to UL/EN 61010-1 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 tso 80 %RH

4

- (Note 1) Do not use corrosive gasses because there is a possibility that the rotor blade is damaged by corrosion.
- (Note 2) Maximum allowable flow rate, Maximum allowable inlet pressure and Maximum allowable outlet pressure cannot be satisfied at same time.
- (Note 3) Without a protective net. Pumping speed for N₂ is 2900 L/s with a protective net.
- (Note 4) The outlet port of the turbo molecular pump should face horizontally or vertically when installing the pump horizontally and obliquely. (Refer to Section 5.1.1 "Pump Mounting Direction" for detail.)
- (Note 5) mL/min : volume flow rate at 0 degrees C., 1 atm. (Compatible with SCCM.)
- (Note 6) The time can be changed to 2 seconds from 1 second.
- (Note 7) Temperature without dew condensation. 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)
UTM3400A-MI-AVWX UTM3400A-MI-AFWX UTM3400A-MI-AWWX	Ar N ₂	45 degrees C.	0 mL/min	1500 mL/min 2750 mL/min
UTM3400A-MI-CVWX UTM3400A-MI-CFWX UTM3400A-MI-CWWX	Ar N ₂	45 degrees C.	30 mL/min	1900 mL/min 2750 mL/min

(Note 1) Consult your ULVAC 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	EN 61010-1 UL 61010-1 EN 1012-2
EMC	EN 61326-1 Class A EN 61000-6-2

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INSTALLATION



- 5.1 Installation
 - 5.1.1 Pump Mounting Direction
 - 5.1.2 Installation of the Pump
 - 5.1.2.1 Instruction and Lifting Method
 - 5.1.2.2 Installation of Turbo Molecular Pump
 - 5.1.3 Example of Piping Connection
 - 5.1.3.1 Connection of Exhaust Line
 - 5.1.3.2 Connection of Cooling Water Line
- 5.2 Connection of Power Cable
- 5.3 Preparation for Operation
- 5.4 Interlock for Vacuum System
- 5.5 Notes on Transportation

5.1 Installation

5.1.1 Pump Mounting Direction

5

This turbo molecular pump can be installed in vertical, horizontal, inverted, or oblique position. The outlet port of the turbo molecular pump should face horizontally or vertically when installing the pump horizontally and obliquely.

When an installation direction is non-appropriate, reliability of operation may deteriorate. (Refer to Fig. 5-1)

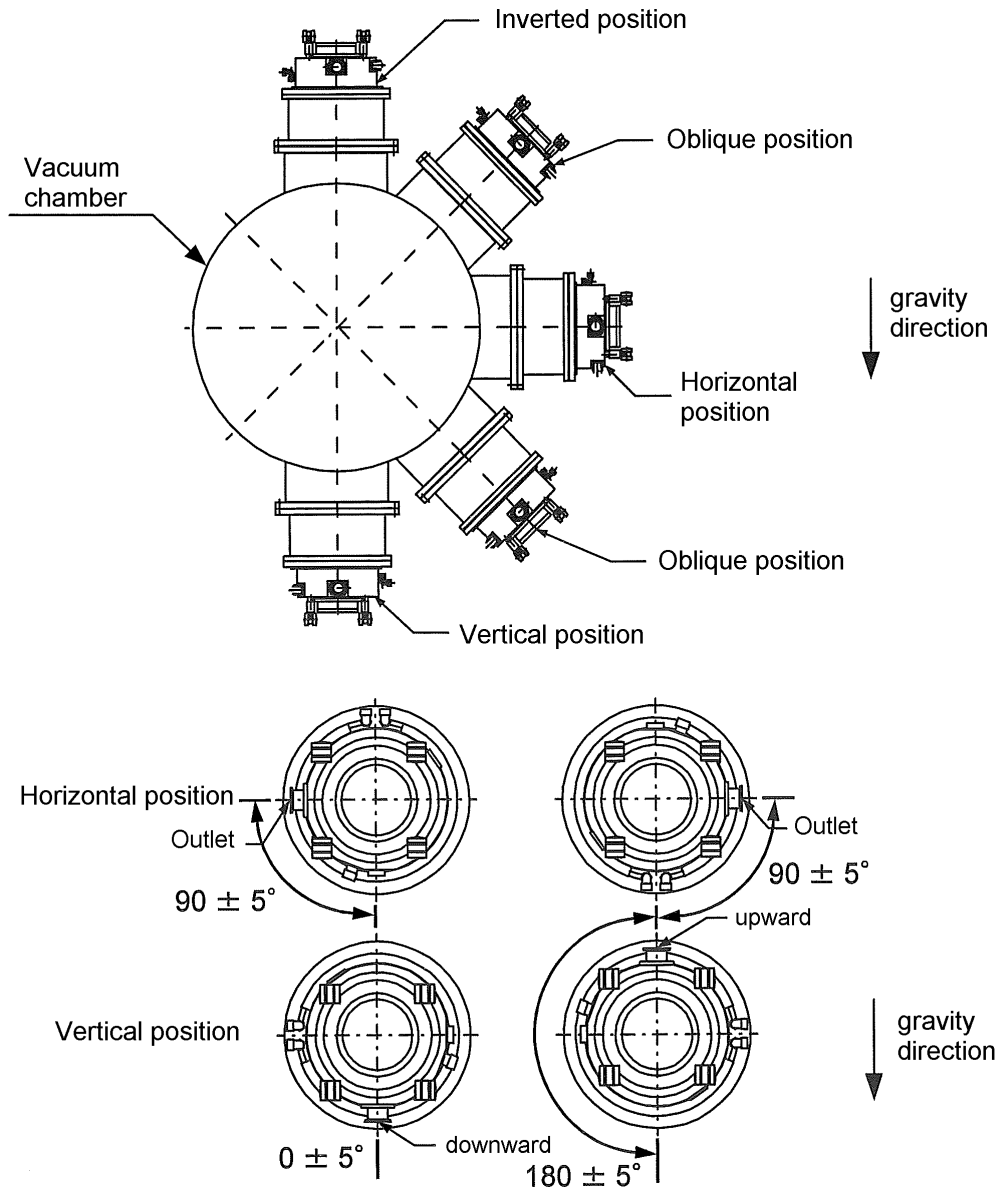


Fig.5-1 Mounting Direction of the Turbo Molecular Pump

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 Section 5.1.2.2. 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

Ensure that no oil mist or hazardous substances are present in process line as safe ducting procedure when turbo molecular pump is installed to host equipment.

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. This pump is not intended to be used in a potentially explosive atmosphere.

CAUTION

The pump surface may get hot, there are risk of burn.

Prevent the installation, operation, maintenance, and service personnel from contacting the pump surface easily in all tasks that they are intended to perform.

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 inverted 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.

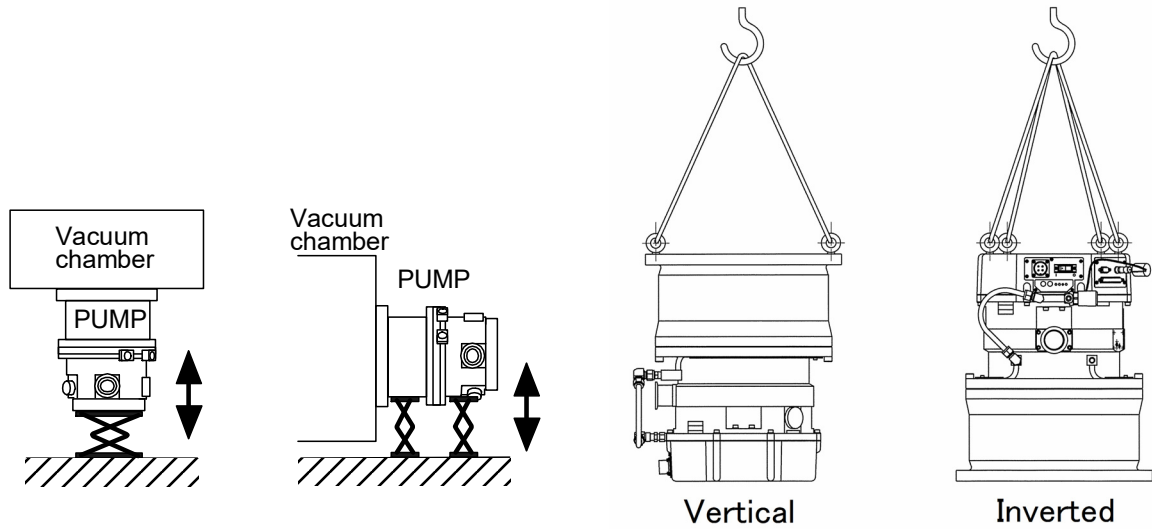


Fig.5-2 Lifting Method

Table 5-1 Eyebolt Size

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

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.

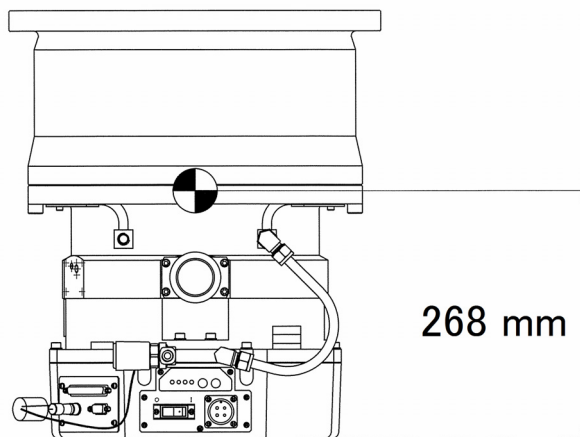


Fig.5-3 Center of Gravity of the Pump

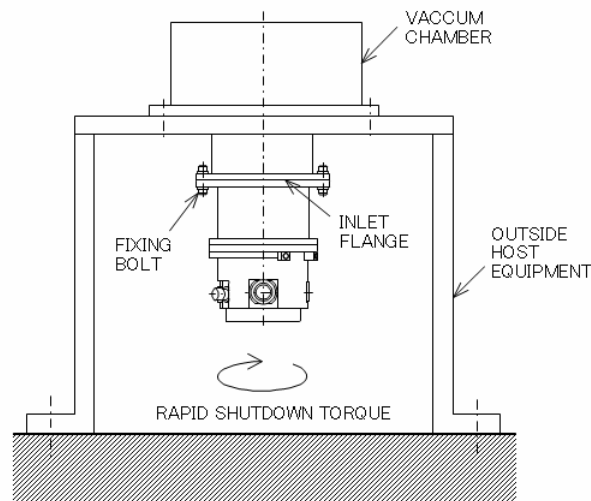
5.1.2.2 Installation of Turbo Molecular Pump

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. Refer to Fig. 5-5 about usage of the bolt.

The sets of half-thread bolt and nut should be used to fix the inlet flange of the pump. Make installation with the cylindrical part of the bolt (not thread 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)
UTM3400 Series	67400 N•m

(Note) Rapid shutdown torque is the typical value measured by the ULVAC'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 Turbo Molecular Pump

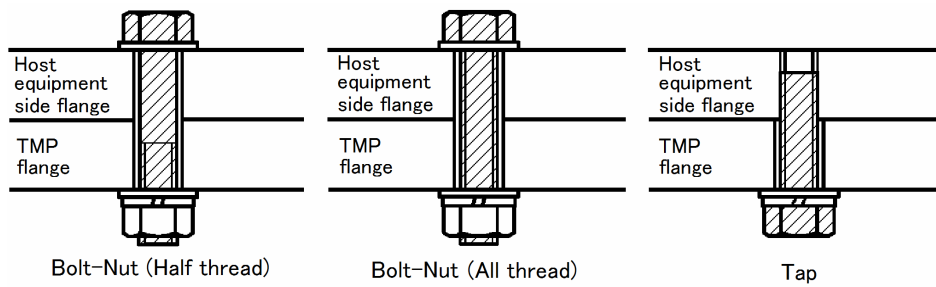


Fig.5-5 How to Use of the Bolt

Table 5-2 The Recommended Fixing Bolt

Bolt-Nut (Half thread)

Fixing method	Only by the inlet flange		
Inlet flange	VG300	VG350	ISO320F
Bolt size, Quantity	M12, 12 PC		
Material	Stainless steel		
Grade	A2-70 (JIS B 1054 / ISO-3506)		
Washer	Plain washer and spring lock washer	Special washer (Note) and spring lock washer	

Bolt-Nut (All thread) · Tap

Fixing method	Only by the inlet flange		
Inlet flange	VG300	VG350	ISO320F
Bolt size, Quantity	M12, 12 PC		
Material	SCM435 (JIS G 4053 / ISO-683) or equivalent		
Grade	12.9 (JIS B 1051 / ISO-898)		
Washer	Plain washer and spring lock 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.

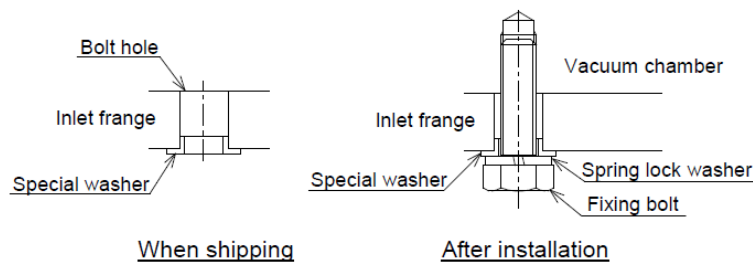


Fig.5-6 Example of the Fixing Method Using the Special Washer

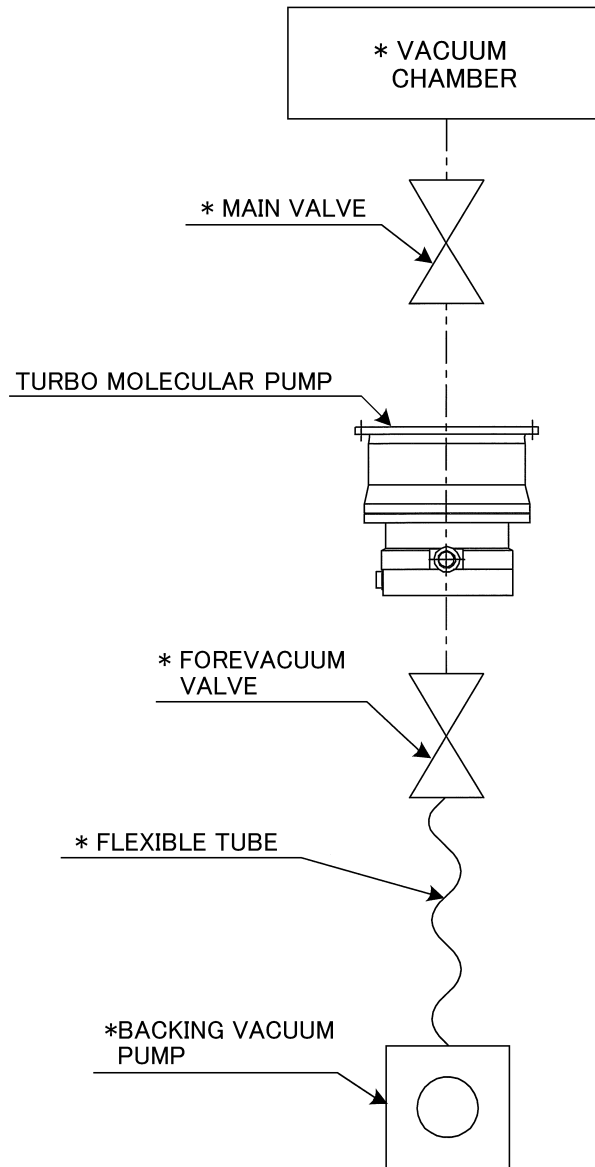
Table 5-3 Tightening Torque of the Fixing Bolt

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

5.1.3 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. 5-7)



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

Fig.5-7 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. 5-8, and drain the cooling water pipe from coolant water OUT connection. The valve to isolate (Lockout / Tagout) cooling water should be installed at user equipment.
- (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. 5-9.
- (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.

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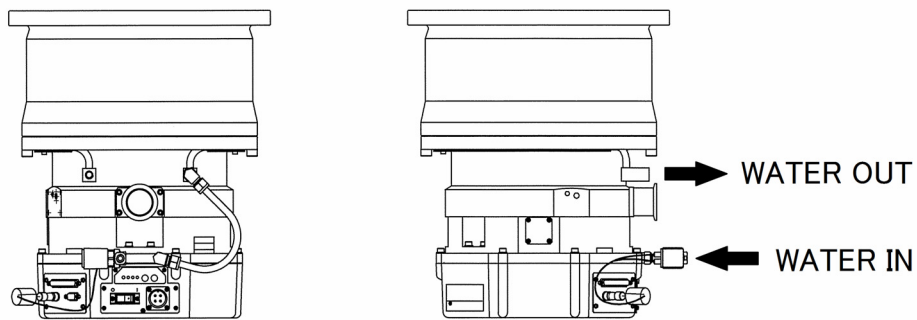


Fig.5-8 Connection of Cooling Water Line

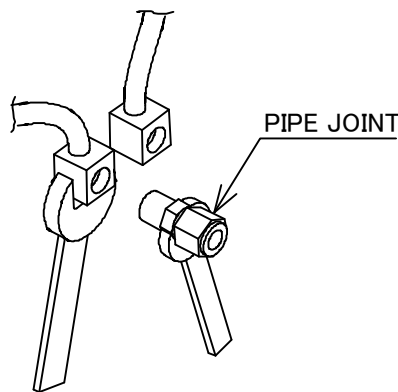


Fig.5-9 Water Coolant Tubing Connections

5.2 Connection of Power Cable

CAUTION

5

The standard power input voltage of this product is 200 to 240 VAC \pm 10 %. 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.

CAUTION

Electrical energy isolation (Lockout / Tagout) should be achieved by opening the main disconnect device or circuit breaker of host equipment, thereby removing power from this product. The main disconnect device or circuit breaker of host equipment should be suitably located and easily reached, and it should be marked as the disconnecting device for the equipment.

Check that the part number stuck on the cable is same as the part number shown in Section 1.2.2 "Power Cable".

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. 5-11, Table 5-4)
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.

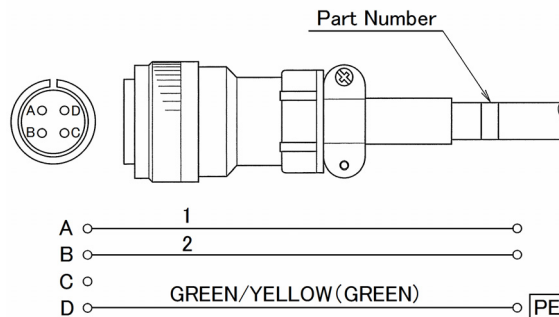


Fig.5-10 Power Cable (Connector)

REFERENCE

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

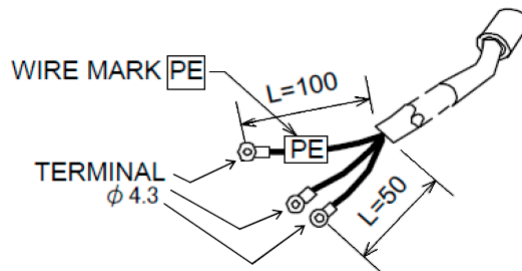


Fig.5-11 Power Cable

Table 5-4 Power Cable CONNECTION

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

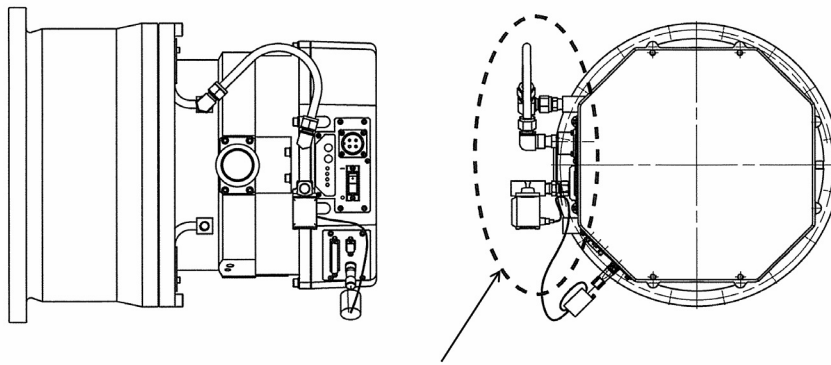
5.3 Preparation for Operation

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- (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. 5-12.
- (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 "TROUBLESHOOTING" for the alarm.
Even if the power supply unit is OFF, do not flow coolant through it that is below dew point.
- (6) Connect the power cable to AC connector of control panel.

(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.



Check for dew condensation

Fig.5-12 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. 5-7.)
- (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 cannot start against cut off of water supply.
(On the condition that Dew Warning has occurred, water valve is closed for the purpose of canceling dew condensation, therefore keep interlock from working.)

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 ULVAC.

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.

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OPERATION



- 6.1 Overview
 - 6.1.1 Introduction : Operation Modes
- 6.2 Startup Preparation
 - 6.2.1 Start-up Preparation Sequence in LOCAL Mode
 - 6.2.2 Start-up Preparation Sequence in REMOTE-control Connector
 - 6.2.3 Start-up Preparation Sequence in Other Communication Means
- 6.3 Start-up
 - 6.3.1 Start-up Sequence in LOCAL Mode
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 - 6.4.2 Shutting Down Sequence in LOCAL Mode
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- 6.5 Variable Speed Operation
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- 6.6 Software Operation
- 6.7 Remote-control Connector
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- 6.8 Communication Specifications
 - 6.8.1 RS-232C
 - 6.8.2 RS-485
 - 6.8.3 Connector

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

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, 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	POWER lamp lights up.	The pump can be started or stopped via a remote control connector, serial connector (RS-232C, RS-485). When using serial 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.

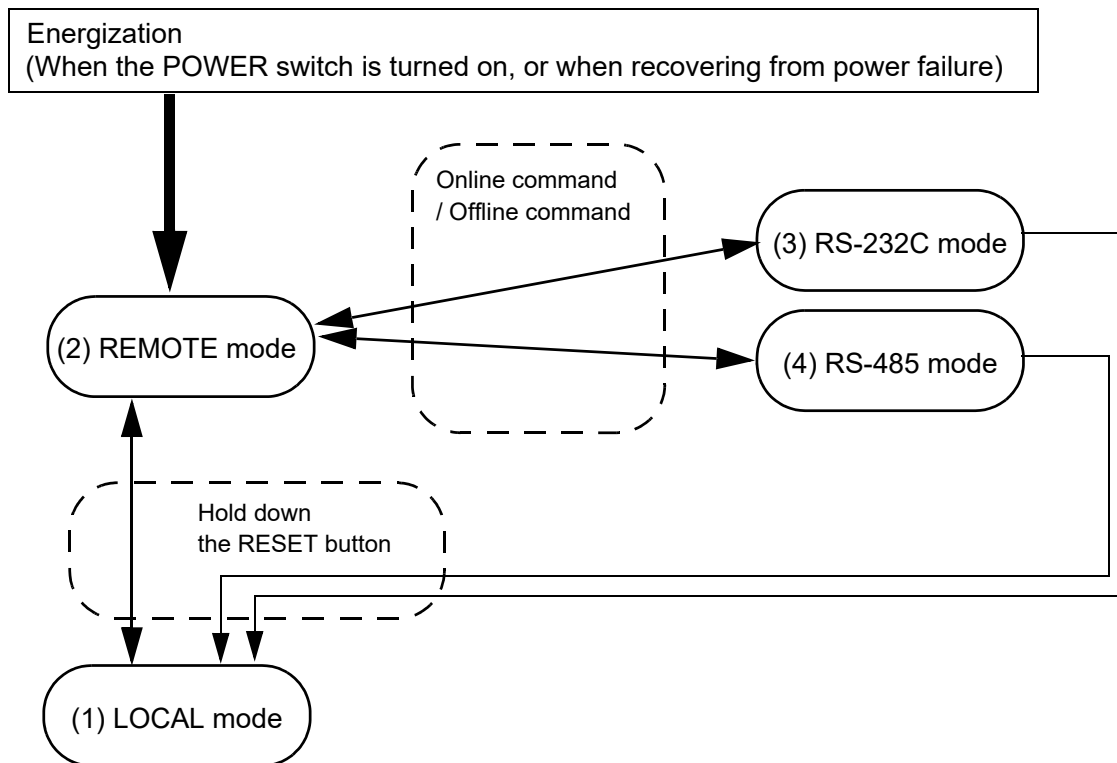


Fig.6-1 Operation Mode Transition Diagram

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.

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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 Section 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 Section 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 Section 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.

6

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.

CAUTION

Electrical energy isolation (Lockout / Tagout) should be achieved by opening the main disconnect device or circuit breaker of host equipment, thereby removing power from this product. The main disconnect device or circuit breaker of host equipment should be suitably located and easily reached, and it should be marked as the disconnecting device for the equipment.

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.
- (5) If you want to isolate this product from electrical supply, unplug AC INPUT connector.

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.
- (5) If you want to isolate this product from electrical supply, unplug AC INPUT connector.

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.
- (5) If you want to isolate this product from electrical supply, unplug AC INPUT connector.

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.

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 Section 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.

(Note) 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 Section 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 communication.
- (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 its 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 its 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.

(Note) If low speed value is set to 100 %, the same operation occurs.

6.6 Software Operation

NOTICE

Settings data can be read and written via serial interface, but cannot be read or written via remote control connector.

Software functions are indicated in Table 6-2 below.

Table 6-2 Software Operating Functions

Function		Description
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 <ul style="list-style-type: none"> ▪ 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	Description
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.

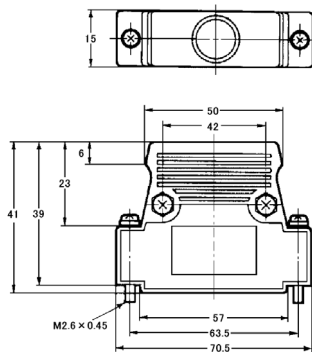


Fig.6-2 Remote-control Connector

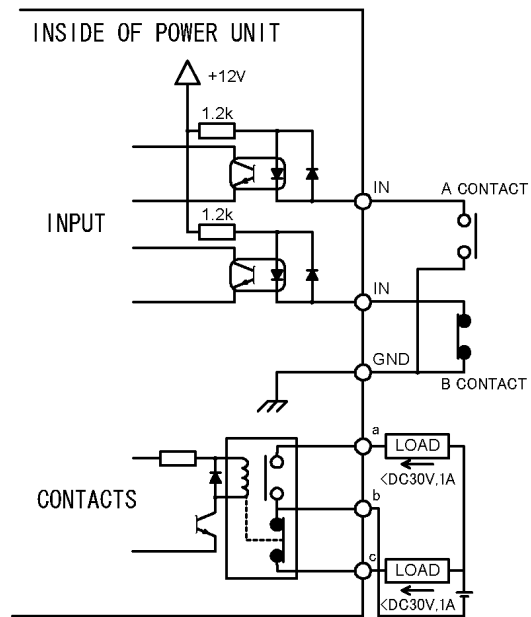


Fig.6-3 Remote-control Circuit Example

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. (Note 1)	Operation (Note 2)	Electric spec
In-put	START	2	Starting operation on short-circuiting between GND and pin No. 2. (Note 3)	Contact Input
	STOP	3	Pump stop by opening GND and pin No. 3. (Note 3) (Note 5)	
	RESET (Note 4)	4	Resetting operation on short-circuiting between GND and pin No. 4.	
	LOW SPEED	6	Variable speed operation on short-circuiting between GND and pin No. 6.	
	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) Don't connect any pins other than specified above.

(Note 2) It takes 6 seconds until it comes to show that this signal is correct, after POWER switch is turned on.

(Note 3) "STOP" signal is prior to "START" signal.

(Note 4) One reset signal is received each time when the contact closes. Repeatedly short and open the contact 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	Close
	Power OFF and no alarm	Close	Open
SEMI E74 (Note 2)	Power OFF and active alarm	Close	Open
	No alarm	Open	Close
WARNING		(30)-(31)	(29)-(31)
EI-03 (Note 1)	Warning occurred	Open	Close
	Power OFF and no alarm	Close	Open
SEMI E74 (Note 2)	Power OFF and active warning	Close	Open
	No alarm	Open	Close
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 ULVAC Turbo Molecular Pump power supply "EI-xx03", "EI-Dxx03" and "EI-R04" 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

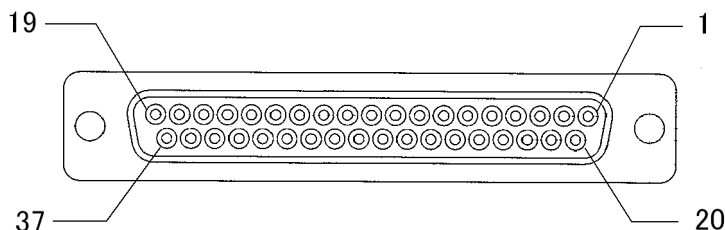


Fig.6-4 Arrangement of Remote-control Connector Pins
(Figure where connector of panel was viewed from the front)

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) Cables used
For connection with this connector, the communication cable with shield is necessary. The shield of the cable should be connected to case.
- (3) 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.

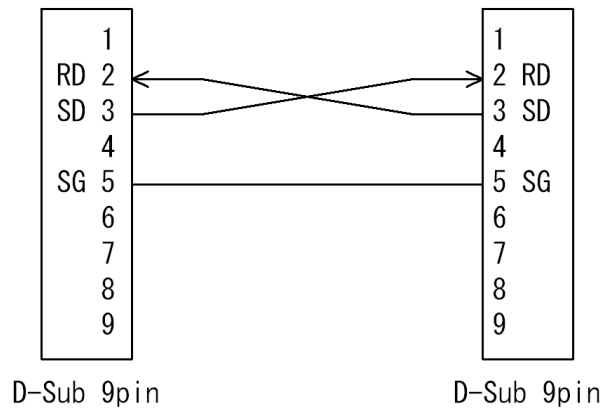


Fig.6-5 Example of RS-232C Cable Wiring Connections

6.8.2 RS-485

6.8.2.1 Transfer Specifications

Interface	RS-485 (2-wire, 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

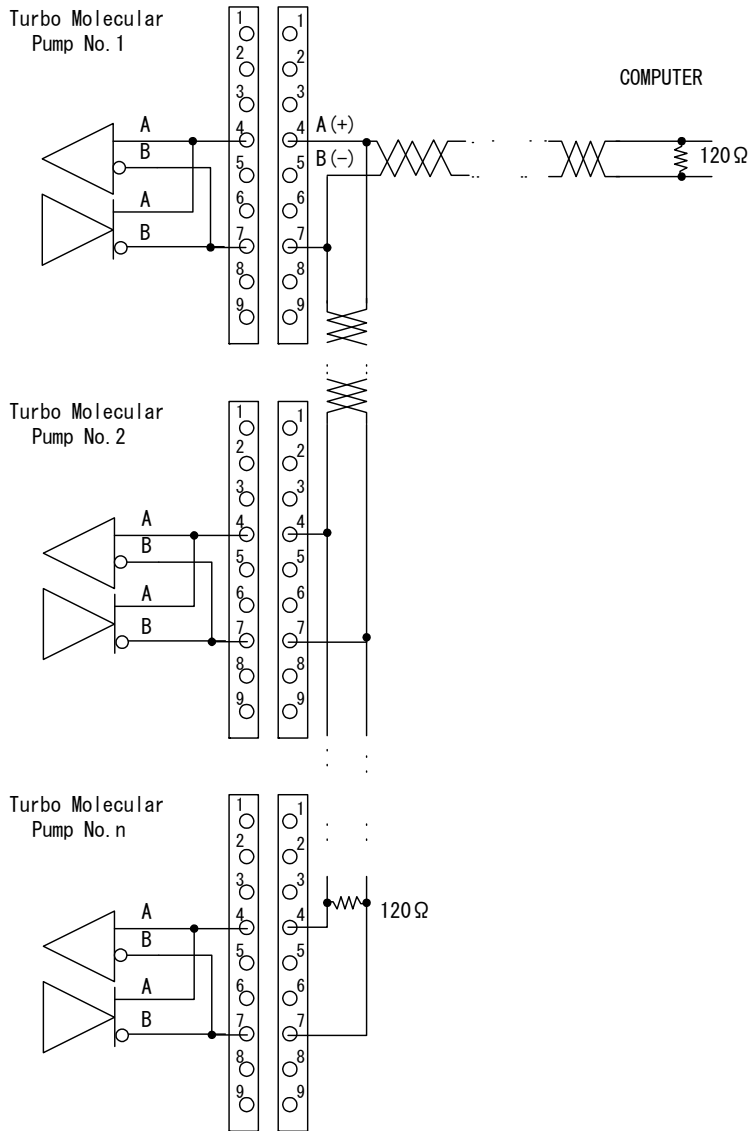


Fig.6-6 Example of RS-485 Cable Wiring Connections

(2) Cables used

RS-485 is a differential transmission and use twisted-pair cables in combinations as shown in Fig. 6-6. The shield of the cable should be connected to case.

(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

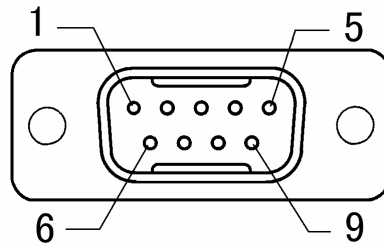


Fig.6-7 Serial Connector Pin Configuration
(Figure where connector of panel was viewed from the front)

NOTICE

Serial communication specifications conform to RS-232C and RS-485.
 These interfaces were tested on a typical condition, but the normal communication with all equipments are not guaranteed.

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GAS PURGE



SECTION 7 GAS PURGE

This product includes a port for purging gasses 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.

Be sure not to use the non-chemical type pumps to exhaust of corrosive gasses such as chlorine type or fluorine type.

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 control the flow rate.

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

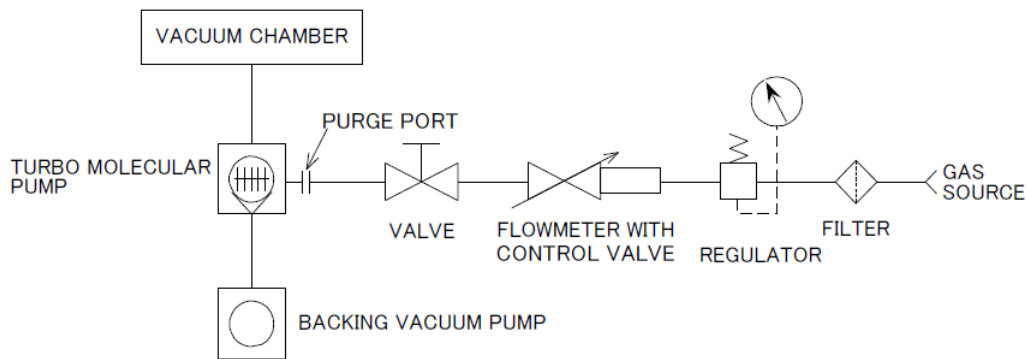


Fig.7-1 Gas Purging Method (adaptor with Φ0.5 mm orifice)

Table 7-1 Table of Gas Purge Adaptor

Joint	Orifice size	Description
KF10 (Clamp / Centering with O-ring)	Φ0.5 mm	GP ADAPTOR, 0.5 KF10
KF10 (Dust cap)	Φ0.5 mm	GP ADAPTOR 0.5, KF DUST CAP
UJR 6.35 (Male)	Φ0.5 mm	GP ADAPTOR, 0.5 UJR
SWAGELOK Φ6.35	Φ0.5 mm	GP ADAPTOR, 0.5 SWG
4-VCR (Female)	Φ0.5 mm	GP ADAPTOR, 0.5 VCR

TURBO MOLECULAR PUMP RECONDITION



- 8.1 Recommended Maintenance Intervals
- 8.2 Turbo Molecular Pump Decontamination
- 8.3 Touch-down Bearing Replacement
- 8.4 Check of the Rotor Blades
- 8.5 Power Supply Unit Parts Replacement
- 8.6 Turbo Molecular Pump Return Request

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 (8)) is the only component of ULVAC'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 ULVAC or an approved service company.

8

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 ULVAC or a ULVAC approved/authorized service center is suggested. (Every one year is recommended.) ULVAC 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 ULVAC service representative or an ULVAC 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 ULVAC. 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 gasses.

WARNING

When pump is removed from host equipment, follow the procedure described below. If not, cause injury by electrical shock, water leak, or gas leak.

- (1) Power off the primary power. (AC SWITCH "OFF", disconnect the power cable.)
- (2) Confirm that the lamps on the control panel turns off.
- (3) Confirm that there is no rotational sound of touch-down bearing.
- (4) Confirm that water line and gas line are cut off.

Annual overhaul is recommended.

Overhaul, re-manufacturing, refurbishing, or repair of the turbo molecular pump system should always be performed by ULVAC or an approved service company. (A copy of this form is printed at the end of this manual's "Repair of the Turbo Molecular Pump")

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

- (1) The turbo molecular pump must be void of all process gasses. Turbo molecular pumps that were operated in applications using special gasses (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 gasses, materials, etc. that have been associated with the turbo molecular pump.

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

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

CAUTION

When pump is removed from a equipment, drain the water from water pipe. If remained water leak from water pipe, pump body will be corroded.

In the case of the specifications with the water valve, drain the water from water pipe during pump power on and water valve open.

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 inverted 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.

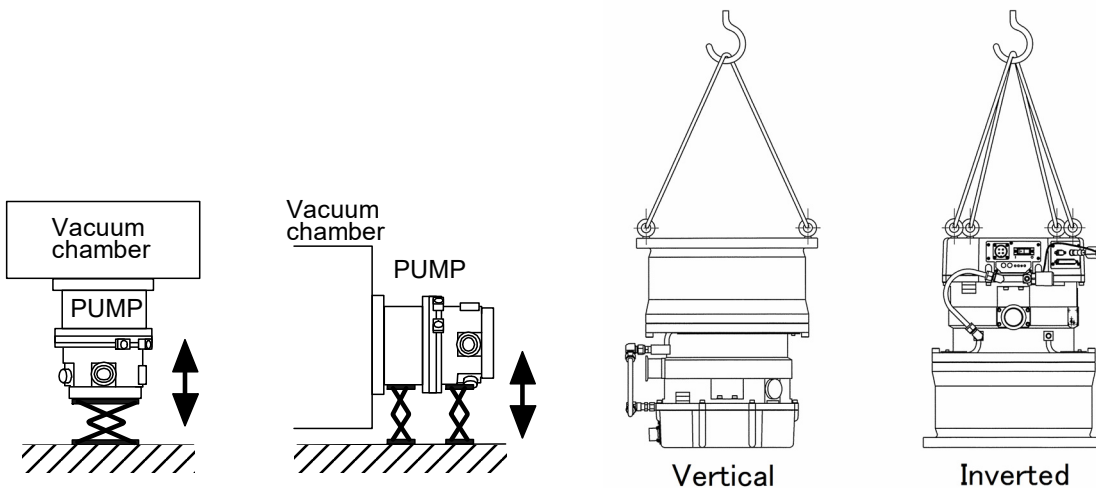


Fig. 8-1 Way to Remove the Pump

Table 8-2 Eyebolt Size

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

CAUTION

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

Please use the packing materials which were used at shipment from ULVAC, or use the packing materials having a same quality or better.

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TROUBLESHOOTING



- 9.1 Vacuum Pressure Rise
- 9.2 Abnormal Noise and/or Vibration
- 9.3 Nothing Happens After an Operation is Made
- 9.4 Power Failures
 - 9.4.1 Power Failure Counter-operation
- 9.5 Alarm Detection Capabilities
 - 9.5.1 Movement in Alarm Detection Capabilities (ALARM)
 - 9.5.2 Movement in Alarm Detection Capabilities (WARNING)
 - 9.5.3 Reset Procedure

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 (8)) 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

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.

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" signal 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)
UTM3400 Series	7500 rpm	9 minutes or less

(Note 1) The time is typical for regenerative braking from the rated speed. Actual time 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)	
	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 read via serial interface, but cannot be read via remote control connector.

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 "Reset Procedure" for the appropriate remedy.

9

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 ULVAC 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 34	EI:MOTOR OVERCURRE EI:INV. OVERCURRE	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 OVERCURRE 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.	

SECTION 9 TROUBLESHOOTING

	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	Section
1	78	TMP:VALVE WARN	Cable of water valve is no connected correctly.	Confirm the cable from water valve is surely connected 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 RUSH 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 OVERCURRE	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. OVERCURRE	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 OVERCURRE	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		

9.5 Alarm Detection Capabilities

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 RUSH B	Atmospheric penetration.	
95	DSP WARNING	Error in the DSP for magnetic bearing control.	
99	MAINTENANCE TIME	Maintenance call timer reaches its set time.	

WARRANTY CLAUSES



○ Warranty Clauses

This product was shipped after rigid company inspection. However, in case any failure occurs under ULVAC's responsibility, such as defect in manufacturing and damage during transportation, Buyer shall inform ULVAC, Inc. or the local ULVAC representatives. ULVAC will repair or exchange it at free of charge.

○ Warranty Items

- a) This equipment.
- b) Attached part just after the delivery.

○ Duration of Guarantee

- a) Domestic business in Japan : one year after shipping date from ULVAC.
- b) Direct export transaction : one year after date of B/L.

○ Warrantee Scope

- a) Domestic business in Japan :
 - Product, which has damage, caused by a failure on delivery.
 - Products not satisfying the standard specifications although this product is used under the service conditions described in this document such as temperature range and power etc.
- b) Direct export transaction:
 - Product, which has damage, caused by a failure on delivery.
In the case of direct export transactions, it shall comply with the guarantee range of trade transaction conditions (INCOTERMS etc) stipulated at individual transactions.
 - Products not satisfying the standard specifications although this product is used under the service conditions described in this document such as temperature range and power etc.

○ Response Procedure

- a) Domestic business in Japan :

ULVAC send a replacement or Buyer return the defective items to ULVAC, Inc. or to the Nearest ULVAC Techno, Ltd. for repair. If field service is required, Buyer shall ask ULVAC, Inc. or the local ULVAC representatives.
- b) Direct export transaction :

ULVAC send a replacement or Buyer return the defective items to ULVAC, Inc. or to the local ULVAC representatives for repair. Return charge shall be paid by Buyer.

○ **Disclaimer**

- a) Failure occurred after expiration of warranty period.
- b) Failure caused by force majeure, such as fire, storm and flood damage, earthquake, lightning strike, war etc.
- c) Failure occurred due to carelessness handling or faulty usage.
- d) Products remodeled, disassembled or repaired without ULVAC's acceptance.
- e) Failure occurred under abnormal environment, such as intense electromagnetic field, radiation, high-temperature, high-humidity, flammable gases, corrosive gases, dust etc.
- f) Failure occurred by noise.
- g) Secondary damage by defect of this Product defect.
- h) Secondary damage to Buyer by the reason that third party sued ULVAC for patent infringement.
- i) ULVAC engineer decided the reason of failure was improper use which does not conform to the use condition of this Product.
- j) Consumable parts.
- k) The "SECURITY seal" certifies that the product was made or maintained by ULVAC or by ULVAC authorized facility. In case "this label is removed" or "there is a mark showing once this label has been removed", ULVAC warranty shall not be applied to the product.

○ **Others**

- a) In case, special agreement or memorandum for specifications is made individually.
- b) Buyer shall inform ULVAC when this product is exported out of Japan. In the meantime, Buyer shall take necessary procedures according to Foreign Exchange and Foreign Trade Law.
- c) As for the question and consultation, Buyer shall check the model and serial number and ask the local representative or ULVAC, Inc.
<https://www.ulvac.co.jp/en/support/>
- d) The contents of this document are subject to change without notice in future.

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Please consult with your closest local ULVAC service center or sales office if our components are used with toxic gases or contaminated with reactive products or substances produced by reaction.

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Model:

Serial No.:

Application:

Remarks: _____

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- I guarantee that above returned item(s) is not contaminated with harmful substances.
- Above returned item(s) is contaminated with the following harmful substances.

	Name of contaminant (molecular formula)	Characteristics
1		
2		
3		
4		
5		

To: ULVAC, Inc

Attn: _____

Date: / / (YYYY/MM/DD)

Your company _____
 Division _____
 Contact _____
 Phone _____
 Fax _____
 E-mail _____

Please pack returned item(s) carefully before shipment. Any accident occurred during transportation to us caused by contaminant is under your responsibility. It is also to be understood that ULVAC may decline to repair returned item(s) depending on the type of contaminant and degree of contamination, and return it to you.

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