Magnetically Levitated Turbomolecular Pumps

TMP-1003M	TMP-803M	(Air-cooled type)
TMP-1003MC	TMP-803MC	(Air-cooled chemical type)
TMP-1003LM	TMP-803LM	(Wide range type)
TMP-1003LMC	TMP-803LMC	(Wide range chemical type)

INSTRUCTION MANUAL

Before operating, carefully read and follow this Instruction Manual.
Furthermore, store it carefully so as to be accessible anytime as necessary.

SIMADZU CORPORATION
Industrial Machinery Division

NOTICE

This Manual defines as follows the terms of warning and caution used therein.

WARNING Instructions with which failure of compliance would possibly lead to death accident or serious injury accident.

CAUTION Instructions with which failure of compliance would possibly lead to light injury or medium extent of damage and physical damage as well.

NOTICE Information to be noted for proper operation of the product.

WARNING

Repairing the pump proper and its power unit by user itself is very hazardous. Don't repair them. Repair by others than maintenance man specially educated and trained at our Division would impair the specific safety.

WARNING

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

WARNING

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

All operators and maintenance men are requested to carefully read and follow the warning and caution instructions given in this Manual, before putting this pump in initial run. Particularly strict compliance with the WARNINGS and CAUTIONS given below is very important. For the detail, read the respective applicable texts in this Manual.

WARNING

Incidental accident would possibly cause the pump proper to displace. When starting the pump, anchor its body (casing) and inlet flange using the bolts of sizes specified below.

24 M8 bolts for ICF253 flange, 24 M8 bolts for ICF203 flange, 8 M12 bolts for VG200 flange, 8 M10 bolts for VG150 flange, 8 M10 bolts for ISO200 flange, and 8 M10 bolts for ISO160 flange. The material and strength classification of these bolts shall be SUS304 and 8.8 respectively.

WARNING

Use of this pump for non-specific application may occasionally impair operator health. Where the pump is used for exhaust of corrosive gas, reactive gas, stimulative gas or harmful gas to human body and it is removed from main equipment for repair, etc., take the following protective measures to secure safety and to prevent harmful gas and reaction product from directly touching human body; purging harmful gases by use of inert gas, putting a protective mask on, putting a pair of gloves and protective working uniform on, etc.

CAUTION

When operating the magnetic bearing turbomolecular pump, follow the cautions given below to avoid expected or unexpected trouble.

○ Cautions during run

1. Don't turn OFF the pump power switch while the pump is in running. In addition, don't turn OFF the power unit power switch as well as the power switch for your equipment.
2. While the power unit power switch is ON, don't plug and unplug the control cable.
3. Don't apply strong impact to the pump proper (casing) while it is in running. Even impact to the pump flanges may occasionally be transferred to the pump internals through the flange. Therefore, when working around the pump, take good care not to apply such impact to the pump.
4. Pay good care to generation of magnetic noise around the pump.While the pump is in running, don't operate other equipment which may generate great magnetic noise (e.g. welding machine, hand drill, etc.) at proximity with (1) pump proper, (2) control cable, (3) power unit.
5. Don't apply this pump to exhaust of gas which contains gallium (Ga) (e.g. triethyl gallium, etc.).

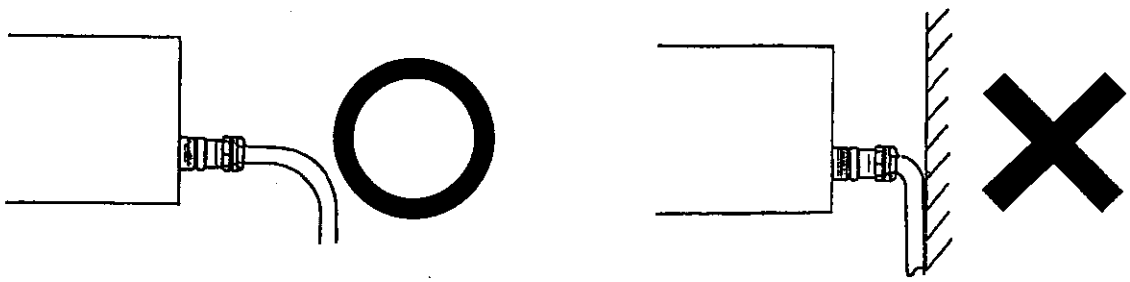
CAUTION

○ Cautions in installing

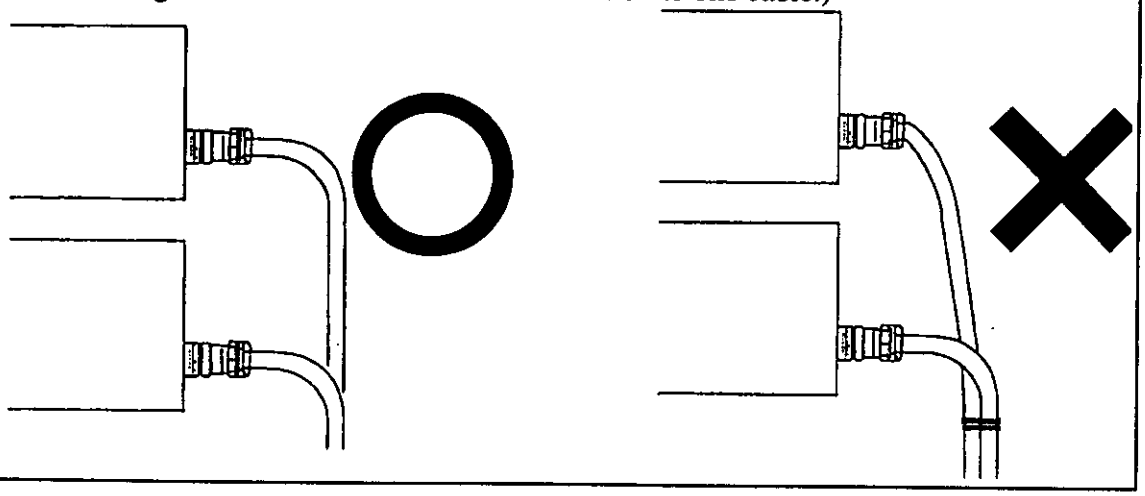
1. Don't apply abnormal load to the control cable plug and connector. Doing so would cause cable disconnection.

   (1) Don't twist the control cable and, when connecting it to the corresponding connector, don't pull the cable with its plug only in hand.

   (2) When installing the power unit inside a rack, etc., guide and connect the control cable to the connector on the rear panel, with good care, so as to be free from abnormal bending and tension.



   (3) When connecting the control cable, don't bundle it with other cables. (Usually this bundling is done to avoid tension concentration to one cable.)



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1. Specifications

1.1 Pump main unit

Turbomolecular pump	TMP-1003M	TMP-1003MC	TMP-1003LM	TMP-1003LMC
Cooling method	Cooling fan		Water	
Ultimate pressure (Note 1) Pa (Torr)	10^{-9} order (10^{-11}order)	10^{-8} order (10^{-10}order)	10^{-9} order (10^{-11}order)	10^{-8} order (10^{-10}order)
Maximum allowable inlet pressure	1.3 Pa (0.01 Torr)		400 Pa (3 Torr)	
Maximum allowable outlet pressure	40 Pa (0.3 Torr)		630 Pa (5 Torr)	
Pumping speed (Note 2) nitrogen helium hydrogen	1080 L/s 930 L/s 790 L/s			
Compression ratio nitrogen helium hydrogen	$1x10^9$ $8x10^4$ $4x10^3$			
Rated speed	35000 r.p.m.			
Start-up time	5 minutes			
Mounting position	In any desired direction			
Bake-out temperature at an inlet flange	< 120 °C (< 248 F)			
Vibration level (by SHIMADZU's method)	< 0.01 μm (0 - peek)			
Inlet flange Gasket for the inlet flange	253CF (Note 4) Copper gasket			
Outlet flange	KF40			
Weight	32 kg			
Admissible thruouput of purge gas	20 ~ 30 Ncc/min			
Admissible pumping speed of backing vacuum pump in case of gas purge	> 500 L/min			
Admissible ambient temperature	0 ~ 40 °C			
Admissible ambient magnetic field Radial direction Axial direction	 3 mT 15 mT			
Water Flow rate Pressure Temperature	N/A		1 ~ 3 liters/min. 2 ~ 5 kgf/cm^2 5 ~ 30 °C	

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

(Note 2) Without a protective net

(Note 3) Should not be baked

(Note 4) ISO 200 flange and JIS B 2290 VG200 flange are also available.

Turbomolecular pump	TMP-803M	TMP-803MC	TMP-803LM	TMP-803LMC
Cooling method	Cooling fan		Water	
Ultimate pressure (Note 1) Pa (Torr)	10^{-9} order (10^{-11}order)	10^{-8} order (10^{-10}order)	10^{-9} order (10^{-11}order)	10^{-8} order (10^{-10}order)
Maximum allowable inlet pressure	1.3 Pa (0.01 Torr)		400 Pa (3 Torr)	
Maximum allowable outlet pressure	40 Pa (0.3 Torr)		630 Pa (5 Torr)	
Pumping speed (Note 2) nitrogen helium hydrogen	800 L/s 800 L/s 700 L/s			
Compression ratio nitrogen helium hydrogen	$1x10^9$ $8x10^4$ $4x10^3$			
Rated speed	35000 r.p.m.			
Start-up time	5 minutes			
Mounting position	In any desired direction			
Bake-out temperature at an inlet flange	< 120 °C (< 248 F)			
Vibration level (by SHIMADZU's method)	< 0.01 μm (0 - peek)			
Inlet flange Gasket for the inlet flange	203CF (Note 4) Copper gasket			
Outlet flange	KF40			
Weight	32 kg			
Admissible thruouput of purge gas	20 ~ 30 Ncc/min			
Admissible pumping speed of backing vacuum pump in case of gas purge	> 500 L/min			
Admissible ambient temperature	0 ~ 40 °C			
Admissible ambient magnetic field Radial direction Axial direction	3 mT 15 mT			
Water Flow rate Pressure Temperature	N/A		1 ~ 3 liters/min. 2 ~ 5 kgf/cm^2 5 ~ 30 °C	

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

(Note 2) Without a protective net

(Note 3) Should not be baked

(Note 4) ISO 160 flange and JIS B 2290 VG150 flange are also available.

1.2 Power unit

Power unit		EI-1003M
Suitable turbomolecular pump		TMP-1003M, TMP-1003MC, TMP-1003LM, TMP-1003LMC, TMP-803M, TMP-803MC, TMP-803LM, TMP-803LMC
Rated frequency		1166Hz
Batteries		Not necessary
Conpatibility		A combination among a pump, a power unit, a control cable and a motor cable is exchangeable.
Brake system		The rotor is decelerated in case of "STOP" or power failure.
Momentary power failure		If the power has been recovered in less than 0.5 second, the operation prior to power failure continues. If power failure continues for over 0.5 second, the pump rotor is decelerated.
Protection system	Too long acceleration time Rotation failure Invertor failure	"MOTOR" lamp comes on. The pump rotor is decelerated.
	Failure of magnetic bearing	"MAG. BEARING" lamp comes on. The pump rotor is decelerated.
	Over temperature of power unit	"CONTROLLER TEMP." lamp comes on. Motor drive is stopped.
	Over temperature of pump	"PUMP TEMP." lamp comes on. Motor drive is stopped.
	Power failure	If power failure continues for over 0.5 second, "POWER FAILURE" lamp comes on and the pump rotor is decelerated.
Ambient temperature		0 ~ 4 0 ℃
Supply voltage (50/60 Hz ± 2 Hz)		single phase 200~240VAC ±10%
Maximum input power		1.5 kVA
Weight		15 kg

1.3 Cables

	Description	Note	Part number
1	Control cable	One of followings: 3 meters length, straight plugs for both sides. 5 meters length, straight plugs for both sides. 7 meters length, straight plugs for both sides. 10 meters length, straight plugs for both sides. 15 meters length, straight plugs for both sides. 20 meters length, straight plugs for both sides. 30 meters length, straight plugs for both sides.	 262-75525-03 262-75525-05 262-75525-07 262-75525-10 262-75525-15 262-75525-20 262-75525-30
2	Motor cable	One of followings: (for TMP-803M, TMP-1003M, TMP-803MC, or TMP-1003MC) 3 meters length, straight plugs for both sides. 5 meters length, straight plugs for both sides. 7 meters length, straight plugs for both sides. 10 meters length, straight plugs for both sides. 15 meters length, straight plugs for both sides. 20 meters length, straight plugs for both sides. 30 meters length, straight plugs for both sides. (for TMP-803LM, TMP-1003LM, TMP-803LMC, or TMP-1003LMC) 3 meters length, straight plugs for both sides. 5 meters length, straight plugs for both sides. 7 meters length, straight plugs for both sides. 10 meters length, straight plugs for both sides. 15 meters length, straight plugs for both sides. 20 meters length, straight plugs for both sides. 30 meters length, straight plugs for both sides.	 262-77462-03 262-77462-05 262-77462-07 262-77462-10 262-77462-15 262-77462-20 262-77462-30 262-75229-03 262-75229-05 262-75229-07 262-75229-10 262-75229-15 262-75229-20 262-75229-30

1.4 Standard accessories

	Description	Q'ty	Note	Part number
1	Gasket for inlet flange	1	One of followings: copper gasket for 253ICF O-ring gasket for JIS VG200 copper gasket for 203ICF O-ring gasket for JIS VG150 A gasket for ISO flange is option.	 260-13512-26 036-13513 260-13512-25 036-13512
2	Bolt set for inlet flange	1	Bolts, washers, and nuts	—
3	Centering ring with O-ring	1	KF40	035-02404-06
4	Clamp	1	KF40	035-02404-03
5	Power cable	1	5 meters	262-77458-02
6	Plug for remote-control connector	1	MR-34ML	070-50791-63 070-50792-23
7	Bracket B	2	only for EI-1003M	263-05083
8	Screw, M4X8	8		020-15054-21
9	Instruction manual	1		086-03805

1.5 Standard spare parts

	Description	Q'ty	Note	Part number
1	Fuse	2	250V, 10A	072-01670-14

2. Principle and Construction

2.1 Principle of turbomolecular pump

The principle outline of the turbomolecular pump is as follows.

Herein it is assumed that gas molecules collide against a wall, so called, rotor blade which is moving at high speed in span until gas molecules collide against each other, that is, space with enlarged mean free pass (generally vacuum area of less than 0.1Pa[10^{-3} Torr]). When the gas molecule jumps out of the rotor blade, they reflect at telescopic angle of 180° while keeping the maximum probability perpendicularly to the rotor blade surface, regardless of the incident direction. Assuming no heat exchange is made on the rotor blade surface, the jumped-out gas molecule speed is equivalent to that determined by adding in form of vector the rotor speed to its own thermal velocity. The speed which is given to the gas molecules by the rotor is determined from geometric profile and rotational speed of the rotor. This permits the gas molecules to change over their motion from non-oriented thermal motion to motion with directivity.

2.2 Pump construction and outside dimension

Fig. 2-1 is the sectional drawing of our wide range type mangetic bearing turbomolecular pump TMP-1003LM. The construction of model TMP-803LM is identical to the said model. The built-in high frequency motor (1) is accelerated to the specified revolutions (speed) by high frequency power unit (Refer to Subsection 2.3). Rotor blades (4) are fitted in the shaft (3) and stator blade (5) is arranged between the rotor blades. Spacer (6) is inserted between the blades to position the stator blades. The configurations and profiles of the stator blades and rotor blades are ideally designed so as to enable the pump to fulfill its various performance (e.g. exhaust speed, compression ratio, etc.) the most efficiently. The upper stage rotor blade and stator blade are so designed that mainly high exhaust performance is ensured and, in addition, the compressive performance gets higher step by step in direction to the lower stage blades. Hence, the profiles of the rotor blades and stator blades depend on their main actions. Radial magnetic bearing (7) is inserted in the upper and lower shaft ends and the axial magnetic bearings (8) acts to float up a disk installed between the bearings. Each magnetic bearing is provided with gap sensor (10) to detect the rotor position. Fig. 2-2 illustrates the outline of 5-axis control. The rotor is floated up by control of 5 axes except rotation freedom.

Touch-down bearing (9) is provided at each of the casing upper and lower so as to protect the pump, should the magnetic bearing be damaged. This bearing is an oiless dry bearing.

Cooling water pipeline(14) is connected to the pump for cooling. On the other hand, the air-cooled turbomolecular pumps TMP-1003M and TMP-803M are equipped with air cooling fan instead of the cooling water pipeline (14). Figs 2-3 and 2-4 show the outside dimensions of the pump proper and Fig. 2-5 shows the outside dimension of the power unit.

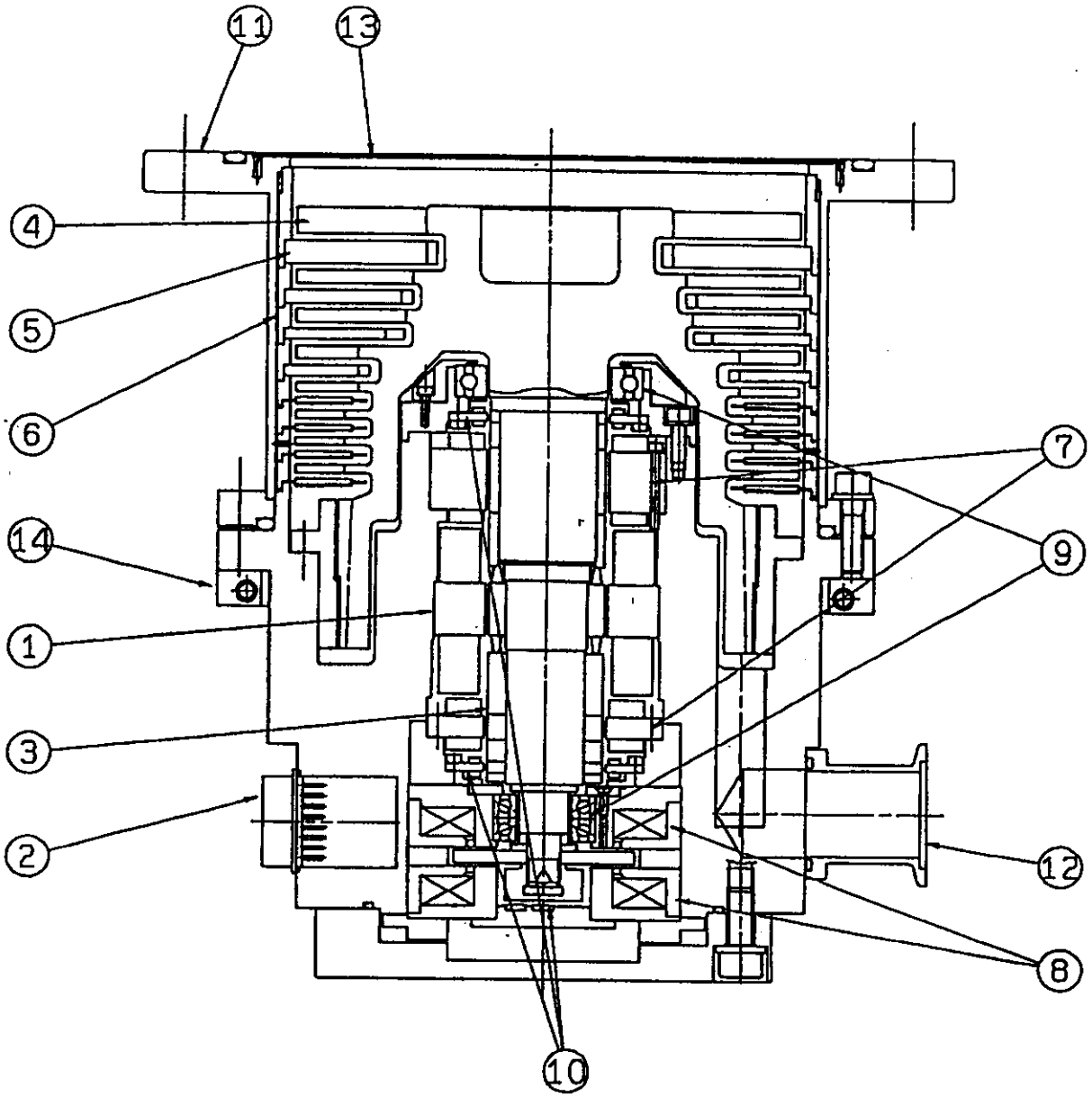
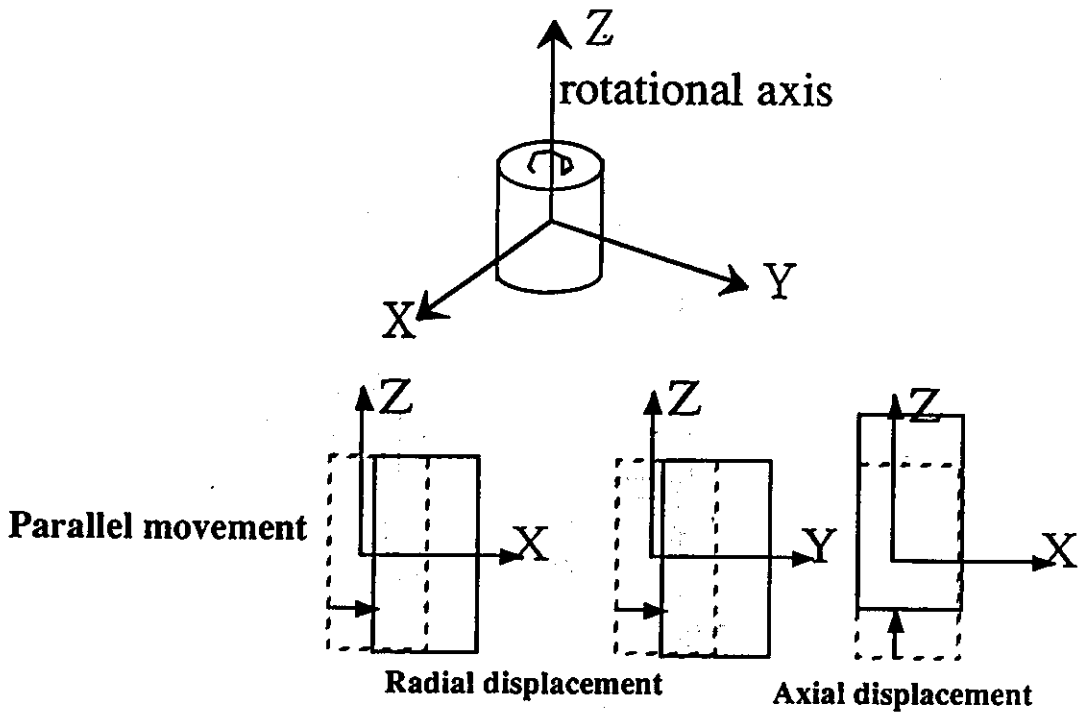


Fig. 2-1 Pump Sectional Drawing

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

The freedom to support an object is 6. For the turbomolecular pump, 5-axis freedom may be controlled subject to its free rotation.



Movement of rotor and restricted five degrees of freedom

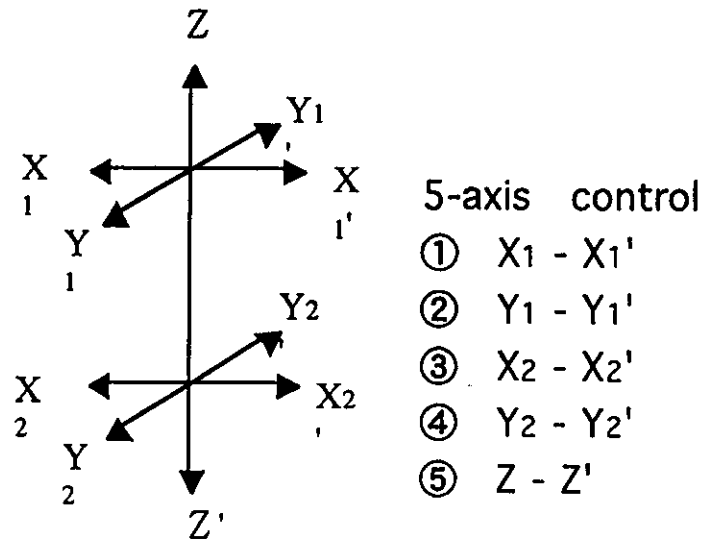
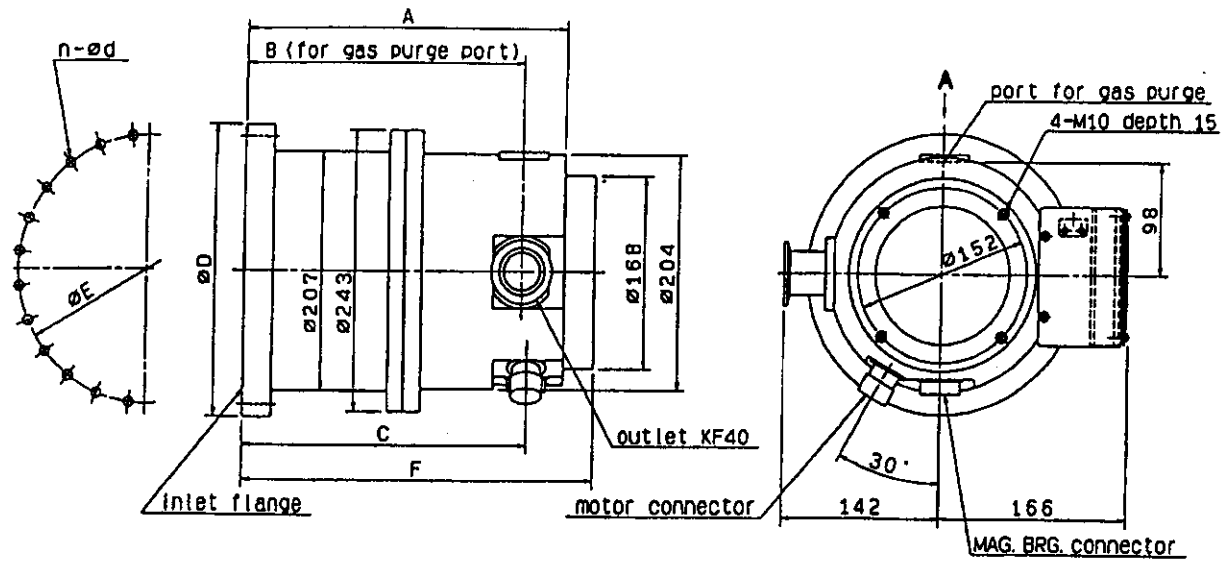
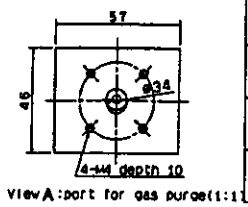


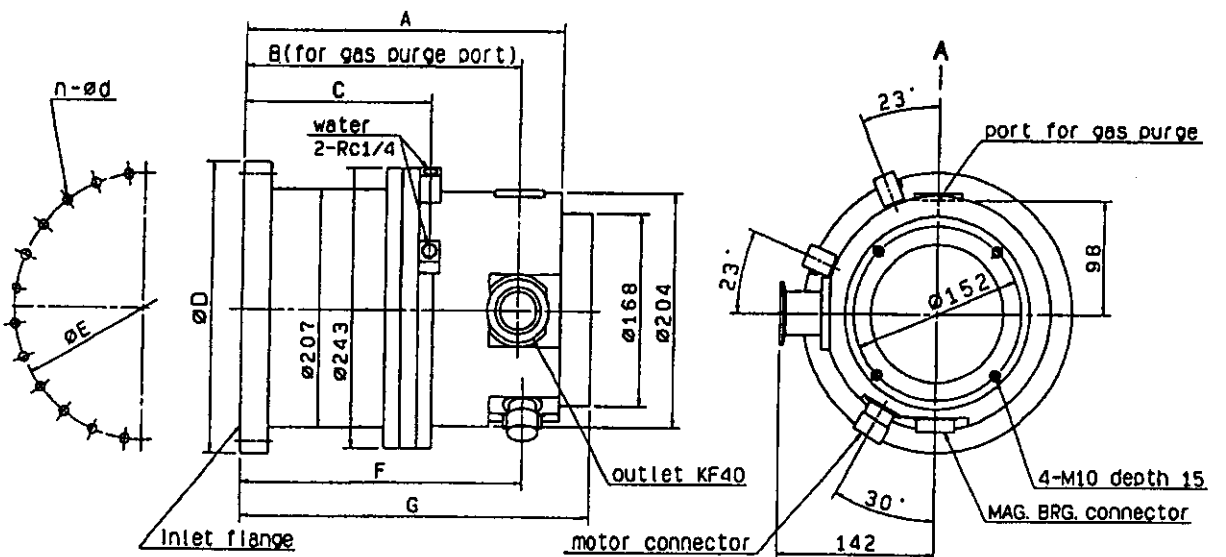
Fig. 2-2 Outline of 5-axis Control





INLET FLANGE	PART NUMBER		A	B	C	φ D	φ E	n-φ d	F
	TMP-1003M	TMP-1003MC							
ICF253	P/N 262-81410-21	P/N 262-81410-31	288	250	255	253	231.9	24-φ 8.4	315
VG200	P/N 262-81410-22	P/N 262-81410-32	288	250	255	300	270	8-φ 15	315
ISO200	P/N 262-81410-23	P/N 262-81410-33	280	242	247	240			307

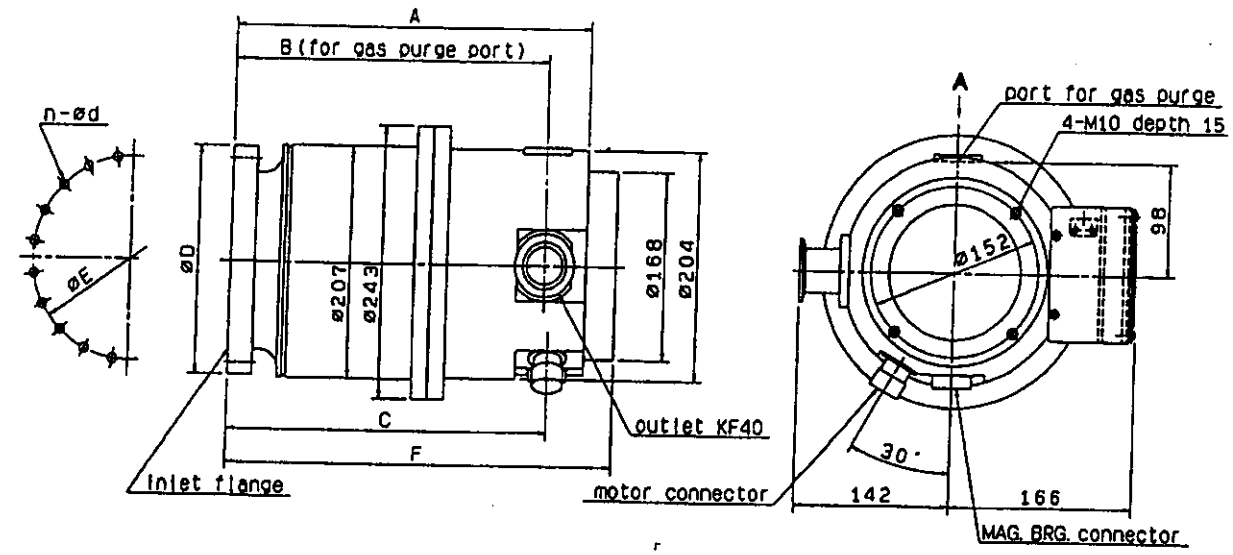
TMP-1003M & TMP-1003MC

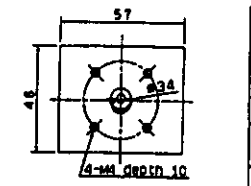


INLET FLANGE	PART NUMBER		A	B	C	φ D	φ E	n-φ d	F	G
	TMP-1003LM	TMP-1003LMC								
ICF253	P/N 262-81410-01	P/N 262-81410-11	288	250	169	253	231.9	24-φ 8.4	255	315
VG200	P/N 262-81410-02	P/N 262-81410-12	288	250	169	300	270	8-φ 15	255	315
ISO200	P/N 262-81410-03	P/N 262-81410-13	280	242	161	240			247	307

TMP-1003LM & TMP-1003LMC

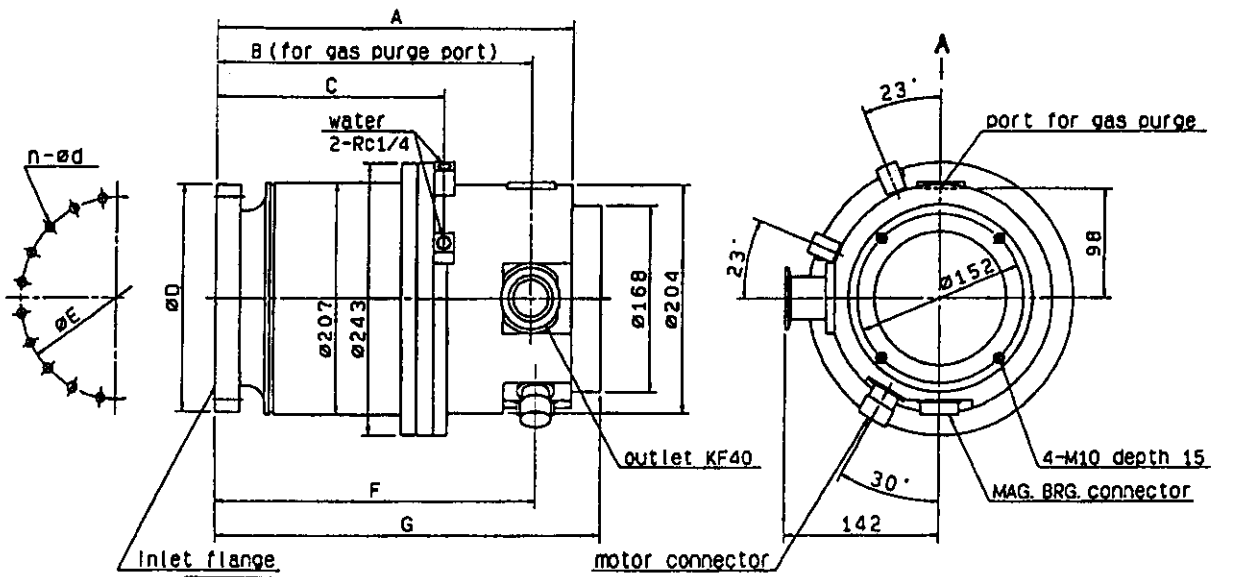
Fig. 2-3 Outside Dimensions of Pump Proper





INLET FLANGE	PART NUMBER		A	B	C	ϕ D	ϕ E	n-ϕ d	F
	TMP-803M	TMP-803MC							
ICF203	P/N 262-81453-21	P/N 262-81453-31	329	291	296	203	181.1	20-ϕ 8.4	356
VG150	P/N 262-81453-22	P/N 262-81453-32	323	285	290	235	210	8-ϕ 12	350
ISO160	P/N 262-81453-23	P/N 262-81453-33	328	290	295	180			355

TMP-803M & TMP-803MC



INLET FLANGE	PART NUMBER		A	B	C	ϕ D	ϕ E	n-ϕ d	F	G
	TMP-803LM	TMP-803LMC								
ICF203	P/N 262-81453-01	P/N 262-81453-11	329	291	21	203	181.1	20-ϕ 8.4	296	356
VG150	P/N 262-81453-02	P/N 262-81453-12	323	285	204	235	210	8-ϕ 12	290	350
ISO160	P/N 262-81453-03	P/N 262-81453-13	328	290	210	180			295	355

TMP-803LM & TMP-803LMC

Fig. 2-3 Outside Dimensions of Pump Proper

2.3 Power Unit

The power unit EI-1003M is a controller composed of the magnetic bearing control system intended to control the rotor built in the turbomolecular pump to a specific position and the high frequency power system intended to drive the rotor at specific rotationl speed. The magnetic bearing control system detects the rotor position by gap sensors built in the pump and controls the magnet current so as to hold the rotor at the specific position according to position signal emitted from the sensor. On the other hand, the high frequency power system controls the AC frequency by a three-phase inverter after having once converted the commercial power voltage to DC voltage. Should the power supply be interrupted while the rotor is in high speed rotation, the motor is used as a generator to enable the magnetic bearing system to function on the generative power obtained from the generator.

The power unit is provided with a serial interface conforming to the RS-232C, in addition to the contact signal connector, to remote-control the turbomolecular pump from external equipment. For operating instructions of the serial interface, refer to Supplement A [RS-232C Communication Function].

For its outside dimension, refer to Fig. 2-5.

Each pump proper, the power unit (EI-1003M), the control cable and the motor cable are interchangeable with each other.

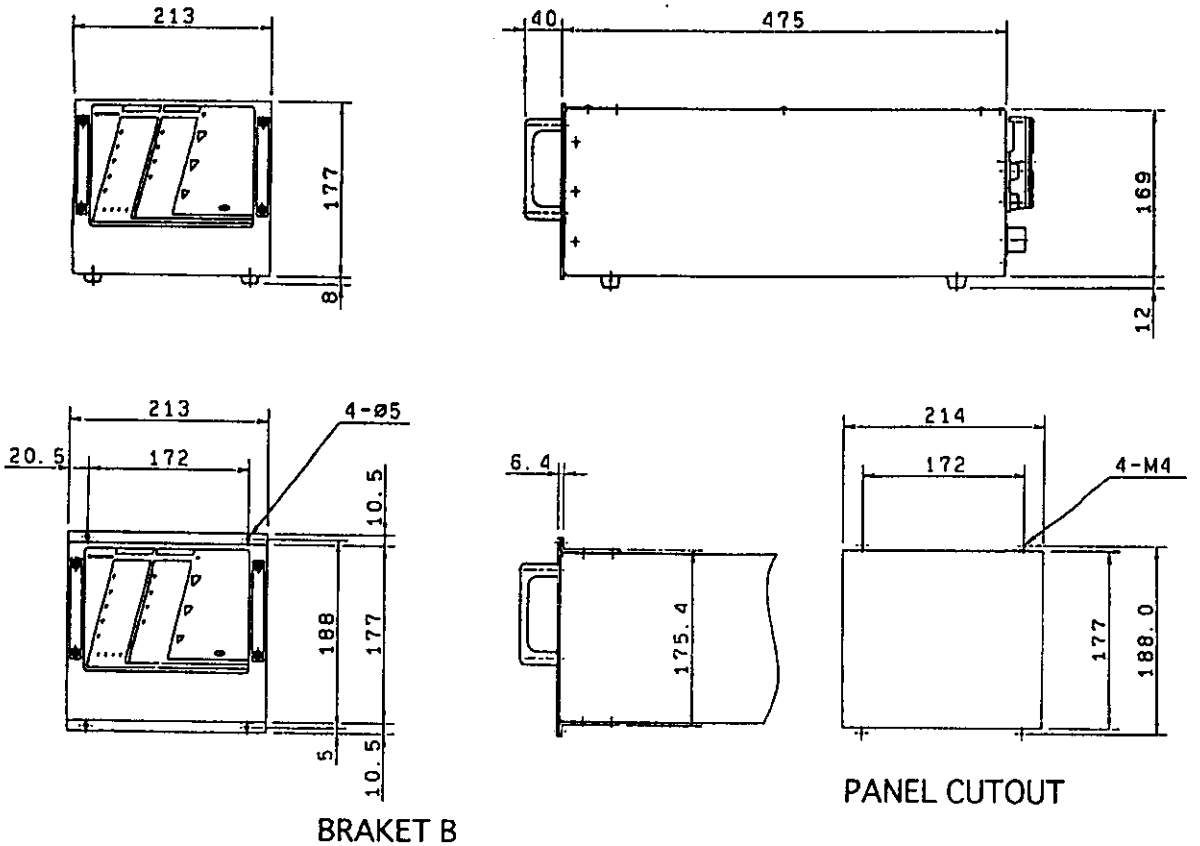


Fig. 2-5 Outside Dimensions of Power Unit EI-1003M

2.3.1 Identification and function of power unit components (Figs. 2-6, 2-7)

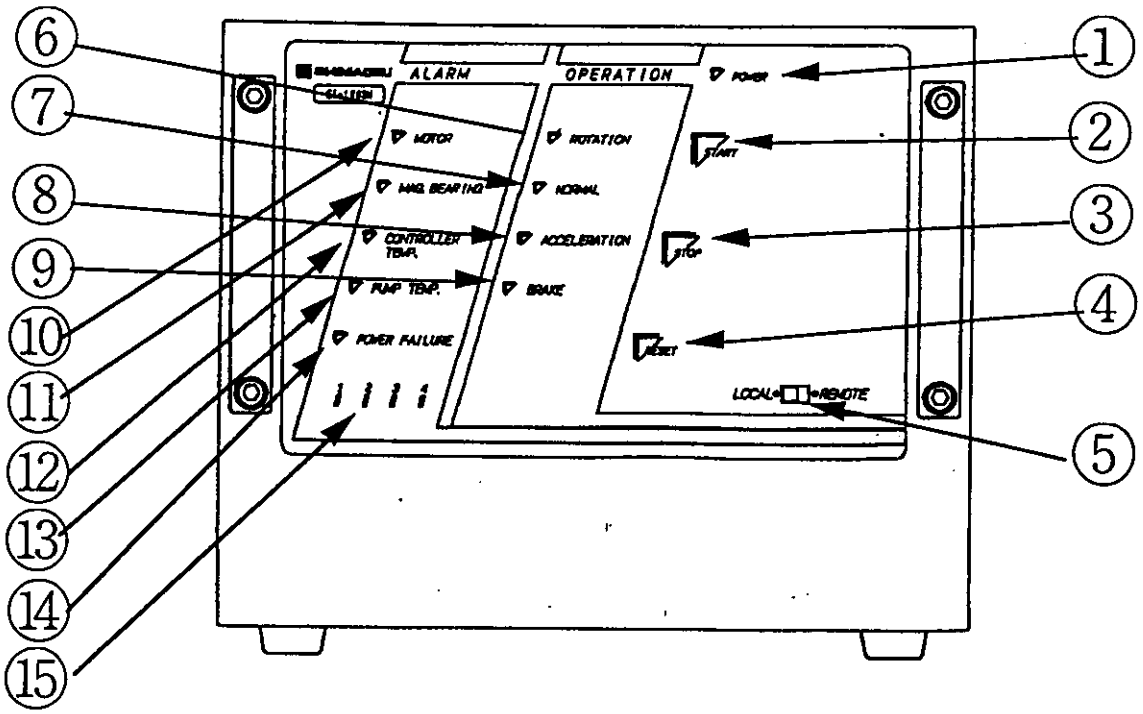


Fig. 2-6 Front Control Panel

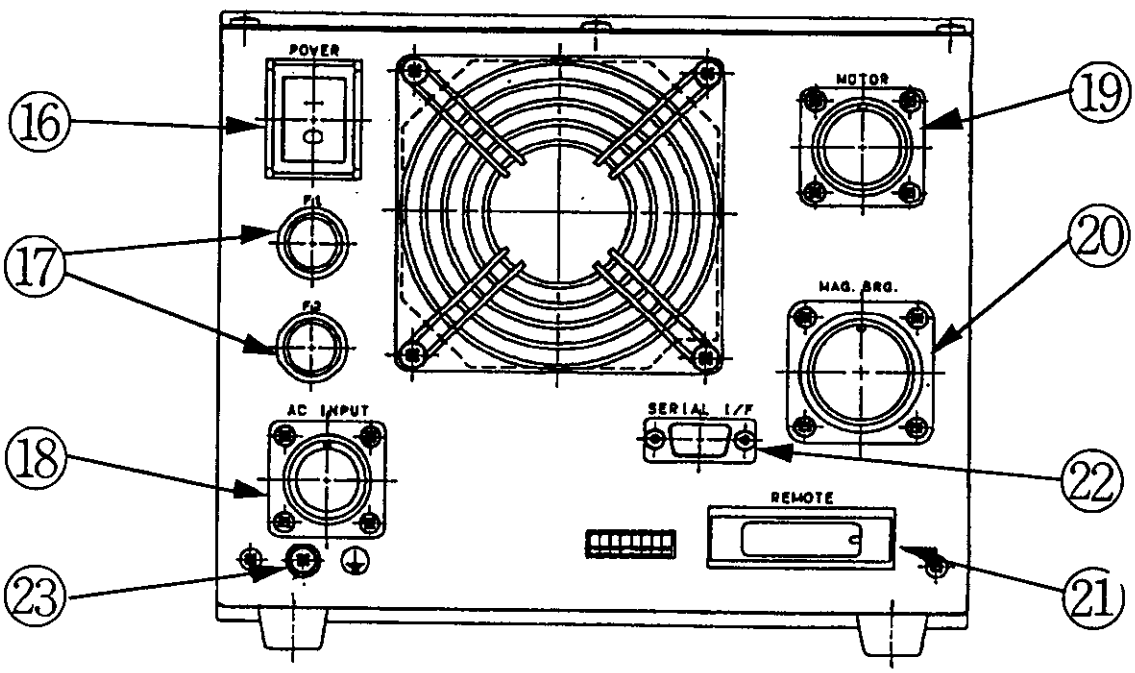


Fig. 2-7 Rear Panel

(1) POWER ·····Power ON indication lamp

(2) START switch ·····Pressing this switch starts the rotor.

(3) STOP switch ·····Pressing this switch brakes the rotor rotation.

(4) RESET switch ·····Against alarming, pressing this switch resets the buzzer. After removal of the alarm cause (trouble cause), repressing this switch permits the alarm indication to turn OFF. However, repressing it with no alarm (trouble) cause removed permits re-sounding of the buzzer.

(5) REMOTE/LOCAL select switch ·····Selecting REMOTE mode effectuates START/STOP input from the external control connector on the real panel. Selecting LOCAL mode effectuates operation of START switch and STOP switch on the front panel.

(6) ROTATION ·····Run indication lamp showing the rotor in rotating. (Green)

(7) NORMAL ·····Normal run indication lamp showing the rotor in regular (normal) rotating. (Green)

(8) Acceleration ·····Run indication lamp showing the rotor in accelerating (Yellow)

(9) BRAKE ·····Run indication lamp showing the rotor in decelerating. (Yellow)

(10) MOTOR ·····Alarm lamp (Red) (Refer to 2.3.3 "Alarm detection circuit".)

(11) MAG. BEARING ····Alarm lamp (Red) (Refer to 2.3.3 "Alarm detection circuit")

(12) CONTROLLER TEMP ·····Alarm lamp (Red) (Refer to 2.3.3 "Alarm detection circuit".)

(13) PUMP TEMP ·····Alarm lamp (Red) (Refer to 2.3.3 "Alarm detection circuit".)

(14) POWER FAILURE···Power supply failure indication lamp (Red) (Refer to 2.3.3 "Abnormality detection circuit".)

(15) 1 2 3 4 ·····Status indication lamps, which are used in combination with alarm lamps (10) to (14).

(16) POWER ·····Power switch

(17) F1, F2 ·····Fuses

(18) AC INPUT ·····Power cable receptacle

(19) MOTOR ·····Motor cable receptacle, used for connection with the in-pump motor.

(20) MAG. BRG. ·····Receptacle for control cable. Used for connection with the magnetic bearing of pump proper. Securely lock the both pump cable connector and the control power cable connector.

(21) REMOTE ·····External control connector

(22) SERIAL I/F ·····Serial interface conforming to the RS-232C Standard. For the detail, refer to Supplement A "RS-232C Communication Function".

(23) EARTH ·····Earthing terminal of the power unit casing.

2.3.2 Power voltage

The standard power voltage is single phase AC200V. Supply it within fluctuation of AC200 to 240V ± 10% on 50 or 60Hz.

2.3.3 Alarm detection circuits

The turbomolecular pump and the power unit are both provided with built-in trouble detection circuits as follows to protect them from trouble.

(1) Motor (failure of the motor driving line)

Conditions for detection	When the motor rotational speed fails to reach 80% of the specified rate or when it reduces below 80%, in 10 minutes after start-up. When the motor fails to start in 15 seconds after starting operation.	
Indication lamp	"MOTOR" lamp ON	
Remote-control connector	"ALARM" and "MOTOR" signals output	
Pump protection	The buzzer sounds and the motor decelerates (braking torque acts on the motor.)	
Resetting method	After eliminating the cause of trouble, press RESET button twice.	First: Release the buzzer. Second: Release alarm signal.

(2) MAG. BEARING (failure of the magnetic bearing system)

Conditions for detection	Vibration or shock applied to the bearing from outside, or failure of the magnetic bearing.	
Indication lamp	"MAG. BEARING" lamp ON	
Remote-control connector	"ALARM" and "MAG. BEARING" signals output	
Pump protection	The buzzer sounds and the motor decelerates (braking torque acts on the motor.)	
Resetting method	After eliminating the cause of trouble, press RESET button twice.	First: Release the buzzer. Second: Release alarm signal.

(3) CONTROLLER TEMP. (Abnormal temperature rise of the power unit)

Conditions for detection	Against abnormal rise of power unit temperature and excitement of built-in thermal protector.	
Indication lamp	"CONTROLLER TEMP." lamp ON	
Remote-control connector	"ALARM" and "CONTROLLER TEMP." signals output	
Pump protection	The buzzer sounds and the motor decelerates (braking torque acts on the motor.)	
Resetting method	After eliminating the cause of trouble, press RESET button twice.	First: Release the buzzer. Second: Release alarm signal.

(4) PUMP TEMP. (abnormal pump temperature)

Conditions for detection	Against excitement of thermal protector built in the turbomolecular pump due to abnormal rise of its temperature. Against disconnection of the control cable. Against disconnection of the motor cable.	
Indication lamp	"PUMP TEMP." lamp ON	
Remote-control connector	"ALARM" and "PUMP TEMP." signals output	
Pump protection	The buzzer sounds and the motor decelerates (braking torque acts on the motor.)	
Resetting method	After eliminating the cause of trouble, press RESET button twice.	First: Release the buzzer. Second: Release alarm signal.

(5) POWER FAILURE

Conditions for detection	Against power supply failure while the rotor is rotating at high speed.	
Indication lamp	"POWER FAILURE" lamp ON	
Remote-control connector	"ALARM" and "POWER FAILURE" signals output	
Pump protection	The buzzer sounds and the motor decelerates (braking torque acts on the motor.)	
Resetting method	After eliminating the cause of trouble, press RESET button twice.	First: Release the buzzer. Second: Release alarm signal.

2.3.4 Remote-control connector

The controller is provided with remote-control connector for connection with remote operation, alarm signals, etc. Use this connector as necessary. (Refer to Fig.2-8 and Tables 2-1, 2-2.)

For remote-controlled operation, shift the REMOTE/LOCAL select switch to REMOTE mode in advance.

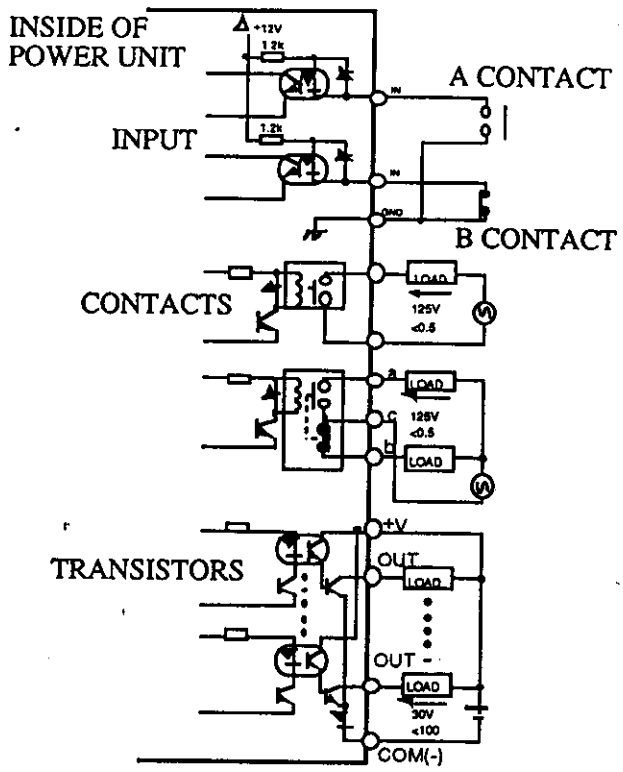


Fig. 2-8 Remote-Control Connector

Table 2-1 Start/Stop According to Remote-Control Signals

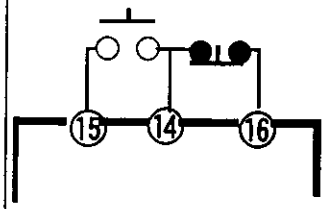
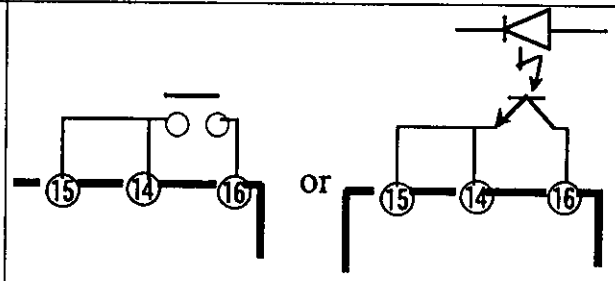
Connection method	By momentary type START/STOP switch	By alternate type switch
Wiring connection		
Starting	Pump start by short-circuiting (15) and (14). Pump stop by opening (14) and (16).	Pump start, with the contact close or photo transistor ON ((14) to (15) short-circuit) Pump stop, with the contact open or photo transistor OFF ((14) to (16) open)
Electric capacity	[Contact] Voltage...30VDC or over Current...10mA or over	Subject to stable open-close of DC 5 V, 1 mA.
	[Photo transistor] Voltage limit between collector and emitter...30VDC or over	Subject to flow of the collector current of 10 mA or over, after the photo transistor ON.

Table 2-2 Remote-Control Signals

Classification	Signals	Pin No.	Operation	Electric spec.
Inputs	START	15	Starting operation on GND and short-circuiting (refer to Note 1)	Contact input
	STOP	16	Stopping operation on GND and circuit opening (refer to Note 1)	
	RESET	17	Resetting operation on GND an short-circuiting	
	GND	14		
Outputs 1	ROTATION	29, 30	Contact closed during rotation	Contact output Contact capacity (resistance load) 125 VAC 0.5 A or 30 VDC 2 A
	NORMAL	25, 26	Contact closed during normal rotation	
	ACCELERATION	23, 24	Contact closed during acceleration	
	BRAKE	27, 28	Contact close during deceleration	
	ALARM	a 21 b 20 c 22	Against trouble; a - c: open -> close b - c: close -> open	
	REMOTE	31, 32	Contact closed when remote-controlled operation is available.	
Outputs 2	MOTOR	3	Transistor ON against occurrence of applicable alarm.	Transistor output Maximum ratings: 30 VDC, 100 mA
	MAG. BEARING	4		
	POWER FAILURE	5		
	PUMP TEMP.	7		
	CONTROLLER TEMP.	8		
	+V	1		
	COM (-)	2		

Note 1: "STOP" signal is prior to "START" signal.
Note 2: Output from the open collector of transistor.
Note 3: Don't connect any pins other than specified above.

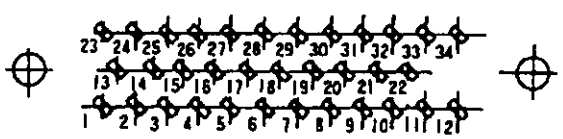


Fig. 2-9 Pin Array in Remote-Control Connector

2.3.5 Counter-operation against power failure

Table 2-3 shows the counter-operations against power supply failure which occurred while the pump rotor is normally rotating at approximately 7200 rpm or more. Refer to Subsection 4.2 "Power Supply Failure", too.

Table 2-3 Counter-operations Against Power Supply Failure

Interruption time	0.5 sec or less		Over 0.5 sec	
Interrupt/re-supply	During interruption	After re-supply	During interruption	After re-supply
Magnetic levitation	Levitation goes on	Levitation goes on	Levitation goes on	Levitation goes on
Run	Decelerates with braking action	Returns to before-power-failure running condition	Decelerates with braking action	Decelerates with braking action Refer to [Note 1]
Indication ACCELERATION NORMAL BRAKE POWER FAILURE	Before-power-failure indication goes on. Before-power-failure indication goes on. Before-power-failure indication goes on. Before-power-failure indication goes on.		Turns OFF Turns OFF Turns ON Turns ON	Lamp OFF goes on. Lamp OFF goes on. Lamp ON goes on. Lamp ON goes on.
Remote-control output signals ACCELERATION NORMAL BRAKE ALARM a-contact b-contact	Before-power-failure condition goes on. Before-power-failure condition goes on. Before-power-failure condition goes on. "OPEN" goes on "CLOSE" goes on		Contact open Contact open Contact close Contact close Contact open	"OPEN" goes on "OPEN" goes on "CLOSE" goes on By resetting, "CLOSE" -> "OPEN" "OPEN" -> "CLOSE"
Buzzer	Fails to sound	Fails to sound	Refer to [Note 1] Before resetting: Sounds After resetting: Released (reset)	Refer to [Note 1] Before resetting: Sounds After resetting: Released (reset)

[Note 1] For restarting after the power re-supply (restoration), press the RESET switch twice and, thereafter, perform the starting operation. First pressing of the RESET releases the buzzer and second pressing of the RESET releases ALARM signal.

3. Installation

3.1 Installation of the pump

3.1.1 Pump mounting direction

The inlet flange of magnetic bearing turbomolecular pump be located in any desired direction, but the outlet flange must be in vertical or horizontal position.

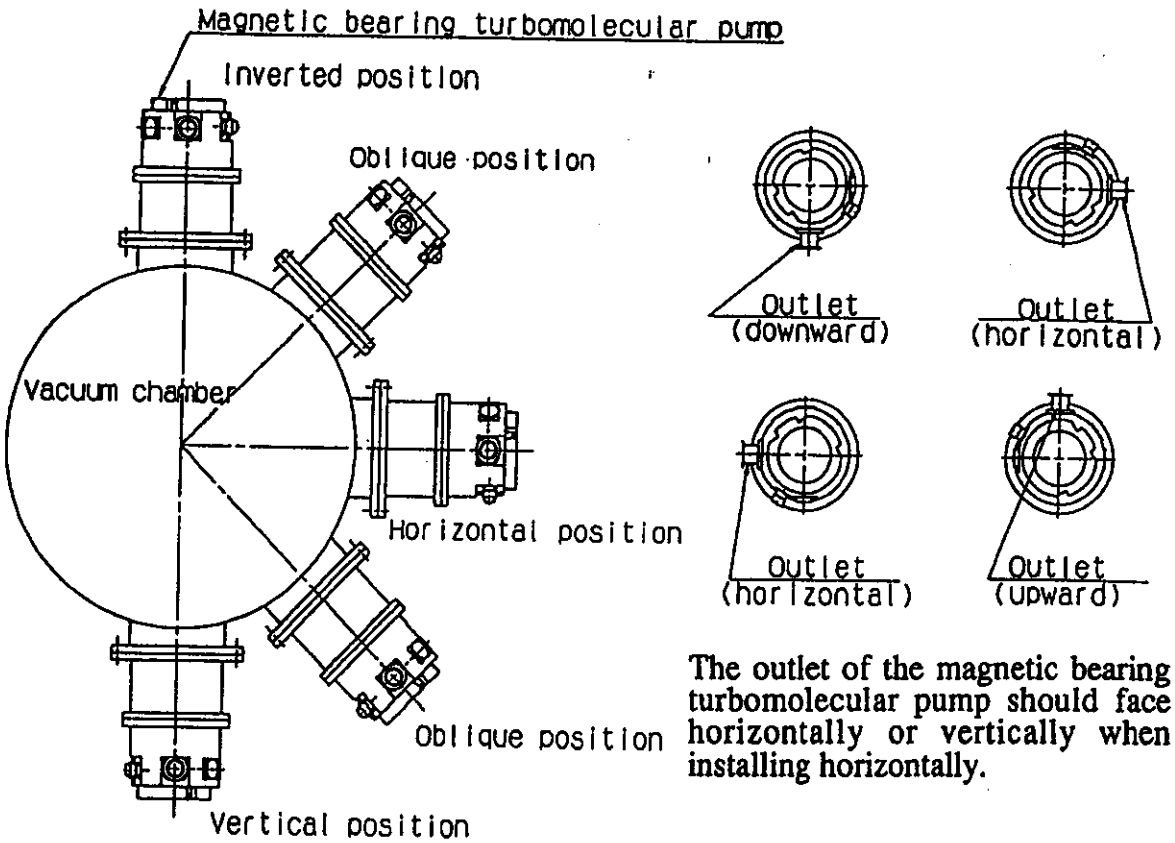


Fig. 3-1 Mounting Direction of Magnetic Levitated Turbomolecular Pump

3.1.2 Installation of the pump

WARNING

Incidental accident would possibly cause the pump proper to displace. When starting the pump, anchor itsinlet flange using the bolts of sizes specified below.

24 M8 bolts for ICF253 flange, 20 M8 bolts for ICF203 flange,

8 M12 bolts for VG200 flange, 8 M10 bolts for VG150 flange,

8 M10 bolts for ISO200 flange, and 8 M10 bolts for ISO160 flange.

The material and strength classification of these bolts shall be SUS304 or 8.8 respectively.

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.

Installing Sequence:

1) Joint the inlet flange of the turbomolecular pump to the joint flange of a vacuum chamber, etc. by inserting and screwing the accessory bolts in all the flange holes. Fix it at the inlet flange side, as illustrated in Fig.3-2.
2) Connect an backing vacuum pump or its related pipe connection flange to the outlet flange of the pump.
3) When gas purge required, connect the gas purge pipeline to the outlet flange. (For the gas purge detail, refer to Section 5 "Gas Purge")
4) After complete piping connection, conduct helium leak test or the like for the entire pipeline to check for perfect airtightness.

Connection of cooling water line:

For the pump models TMP-803LM, TMP-803LMC, TMP1003LM, TMP-1003LMC, connect a cooling water pipe to these pumps.

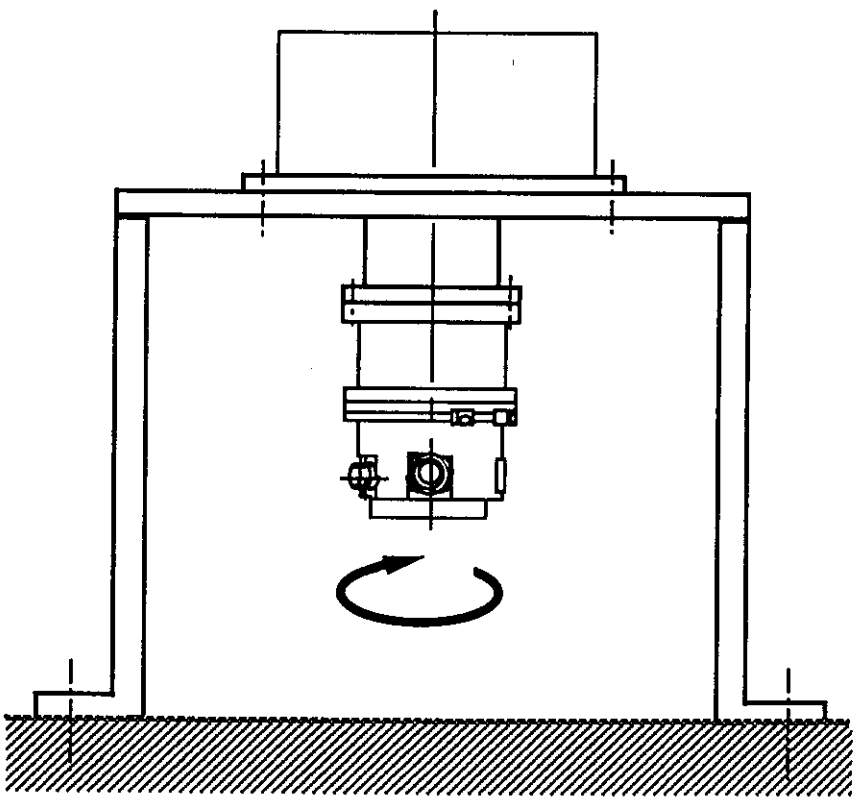
When connecting the cooling water pipe, screw the pipe joint in the connection nozzle of the pump while locking the nozzle with spanner wrench, as illustrated in Fig .3-3.

NOTICE

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

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



Anchor the turbomolecular pump to the vacuum chamber with its inlet flange. In addition, anchor the vacuum chamber, etc. on floor. Chamber pipeline and support base shall have the sufficient strength capable of resisting to rapid shutdown torque of 4000 Nm (408 kgf m) against incidental accident.

Fig. 3-2 Installation of Magnetic Bearing Turbomolecular Pump

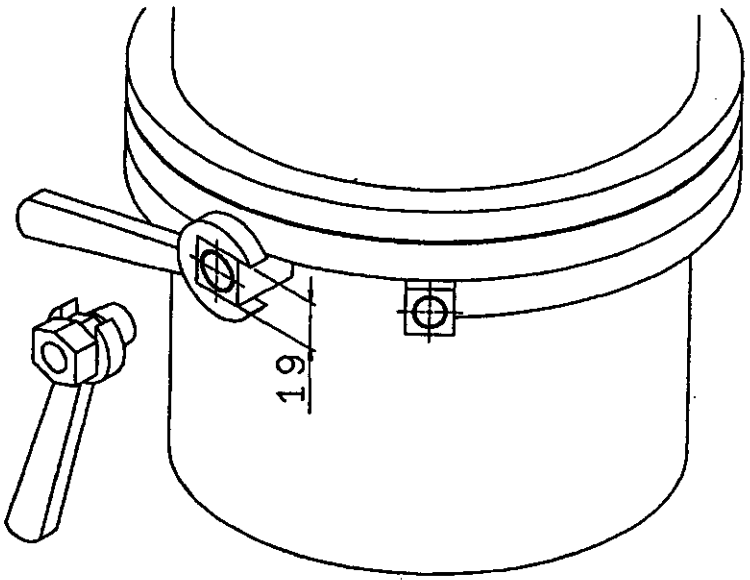


Fig. 3-3 Cooling Water Piping Connection

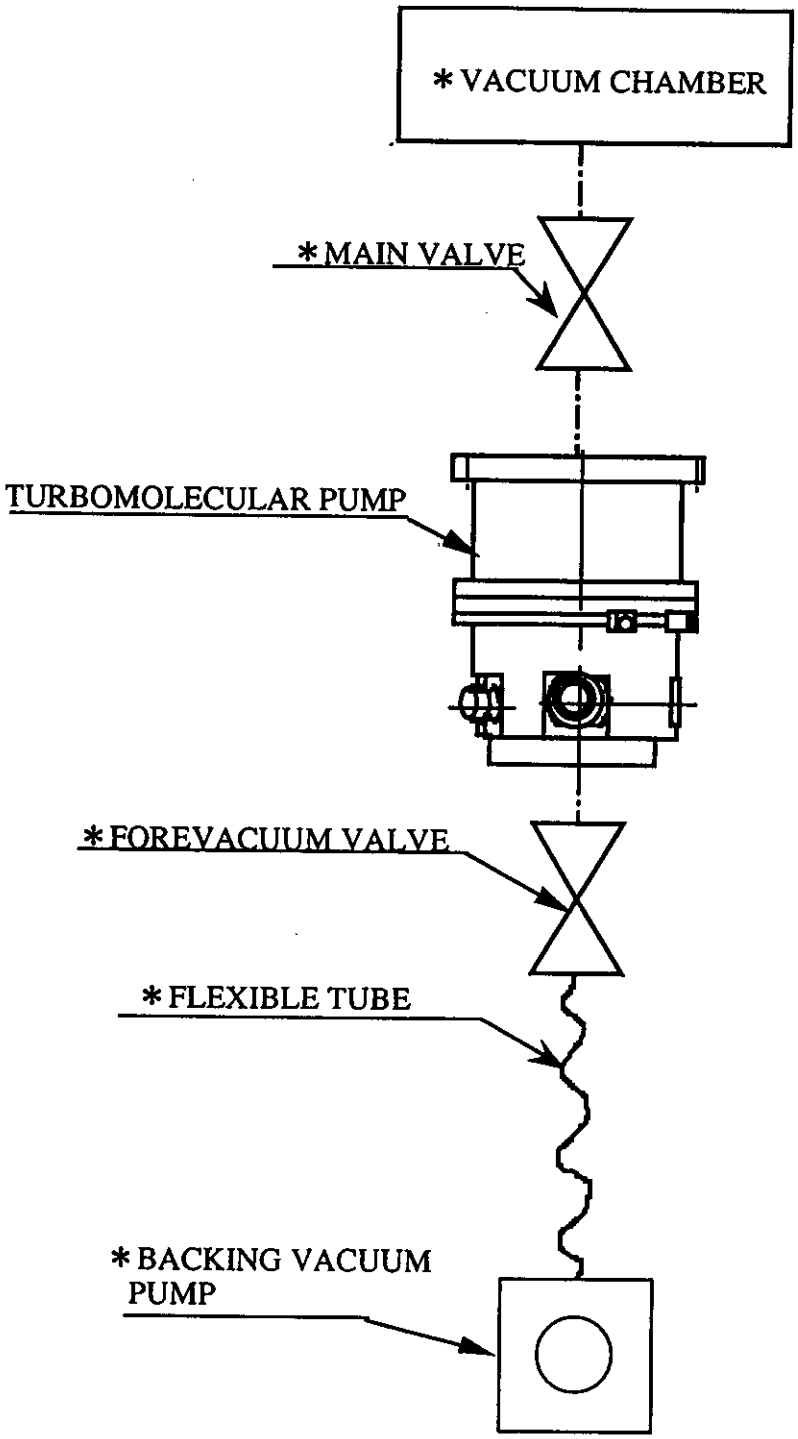


Fig. 3-4 Example of Exhaust Line

3.2 Installation of the Power Unit

3.2.1 Location of the power unit

Install and anchor the power unit inside a rack, which shall be located at a place where it is not exposed to direct sun ray and well ventilated. Avoid to locate it at the following places.

(1) Place where it is very humid, dusty and, in addition, oil smoke, vapor. water, etc. are exist.

(2) Place where the power unit is exposed to direct sun ray and abnormaly high temperature

(3) Place with high amplitude of vibration and impact

(4) Near chemically active gas and explosive/combustible gas

(5) Place with strong magnetic field and electric field, noisy place, and place with strong radioactive ray

(6) Unventilatable place

3.2.2 Installation of the power unit

When mounting the power unit on user's rack, attach the rack bracket B to the both top and bottom of the power unit. (Bracket B is one of the accessories.)

How to attach the rack bracket B:

(1) Unscrew off 4 pan-head screws close to the front panel, of M4 pan-head screws fixing the top cover of the power unit.

(2) Attach and fix the rack bracket B to the top cover using accessory M4 sunk head screws (4 pcs.)

(3) Turn the power unit upside down.

(4) Remove four rubber pads.

(5) Attach and fix another rack bracket B to the bottom of the power unit using accessory M4 sunk head screws (4 pcs.).

(6) Again turn the power unit upside down.(Restore it in original condition.)

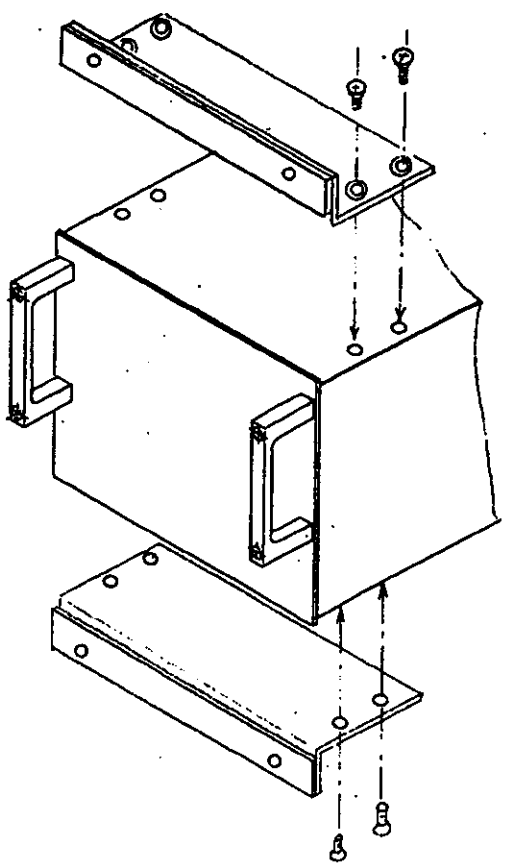


Fig. 3-5 Rack Bracket B

3.3 Connection of Power Cable

The standard power input voltage of the power unit EI-1003M is AC 200 v (AC 200 to 240 V ± 10%).

Be careful not to apply abnormal surge pressure to the input power line and the external terminal.

Connection of power cable:

(1) Connect the power cable crimp terminal to the terminal board of user's power distribution board for equipment. The wire with [E] mark is for earth use and other remaining two wires are for single phase AC power .

(2) Turn OFF the power switch on the rear panel of the power unit. Or otherwise be sure to check that it is in OFF.

(3) Insert the power cable plug in the receptacle with "AC INPUT" marking on the power unit.

[REFERENCE]

For the specified power voltage, see the rear panel of the power unit.

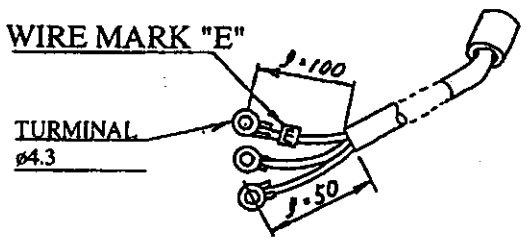


Fig. 3-6 Power Cable

3.4 Connection of the Pump to the Power Unit

CAUTION

Insert straight the control cable connector after checking its key direction. Inserting it in oblique direction would cause damage of the connector pins.

After the insertion, turn the cable connector clockwise until the rotation lock clicks.

CAUTION

Don't disconnect each cable while the pump is in running. Particularly before disconnecting the control cable, Check complete shutdown of the pump by [ROTATION] indication lamp OFF and, thereafter, turn OFF the power switch.

control cable:

Control cables available for the use are identified with "262-75369". Check that it is identified as specified. Even the use of other similar cable would disable starting of the pump, even though it could be connected.

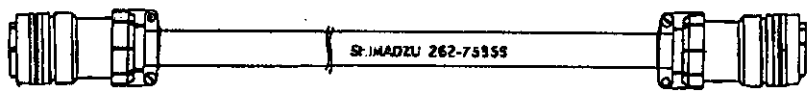


Fig. 3-7 control cable

Connecting Sequence (Refer to Fig. 3-8)

(1) Turn OFF the power switch on the rear panel of the power unit. Or otherwise check that it is OFF.

(2) Connect the power unit to the 55-pin receptacle of the pump proper with the control cable.

(3) Connect the power unit to 10-pin receptacle of the pump proper with the motor cable.

(4) For the pump models TMP-1003M, TMP-803M, TMP-1003MC, and TMP-803MC, connect the fan cord to the air cooling fan, too.

(5) When remote-operating the turbomolecular pump and intaking status signal, etc., make wiring connection as instructed in Para. 2.3.4 " Remote-control Connector".

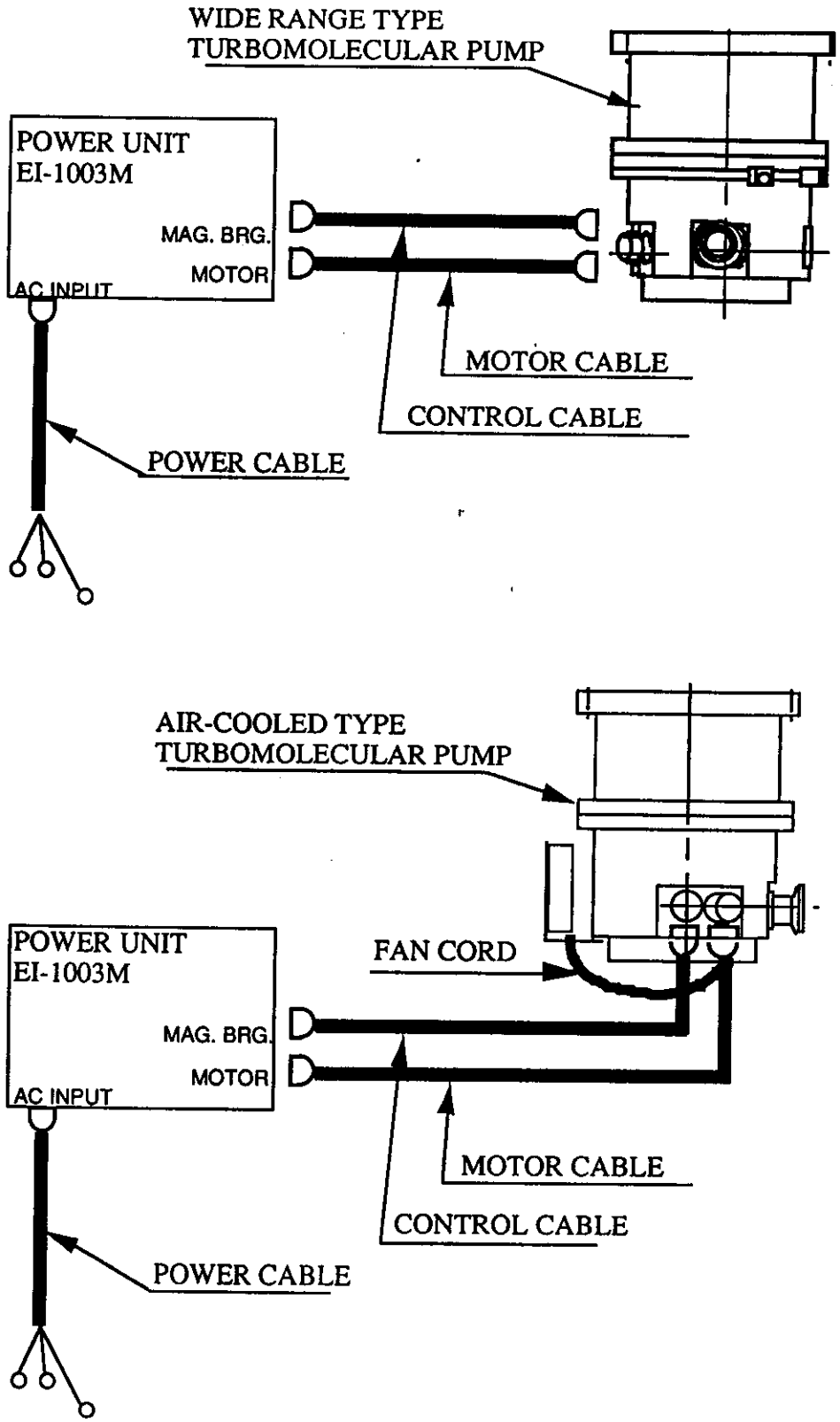


Fig. 3-8 Connection of Cables

3.5 Interlock for vacuum system

1) When using, as a backing vacuum pump, a vacuum pump with no check mechanism (inverse flow prevention) such as dry vacuum pump, etc., install a forevacuum valve between the turbomolecular 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.
2) Even when "ALARM" signal is emitted, don't cut off the power supply while "ROTATION" signal is being emitted.
3) If "MAG. BEARING" signal is emitted, shut down the backing vacuum pump or close the forevacuum valve immediately. Furthermore, when main valve is installed between the turbomolecular pump and the vacuum chamber, close this valve, too.
4) For wide range type pumps TMP-1003LM, TMP-803LM and wide range chemical type pumps TMP-1003LMC, TMP-803LMC

   Provide a flowmeter on the downstream of cooling water line so that the turbomolecular pump is shut down or otherwise alarm is output against cut off of water supply.

4. OPERATION

CAUTION

Neither disconnect and reconnect each cable while the pump is in running. Particularly for unplugging the control cable from the receptacle, check complete shutdown of the pump by "ROTATION" indication lamp OFF and, thereafter, turn OFF the power switch.

4.1 Starting

Shift the REMOTE/LOCAL select switch to either LOCAL or REMOTE mode. Under LOCAL mode, the pump can be started/stopped by pressing START/STOP button switch on the front panel of the power unit, but under REMOTE mode the pump runs only according to input signal from the remote control connector.

Starting Sequence in LOCAL mode:

1) Feed the cooling water into the cooling line. (for TMP-803LM, TMP-803LMC, TMP-1003LM, TMP-1003LMC)
2) Turn ON the power switch of the power unit and check if the "POWER" lamp turns ON. And the rotor of the turbomolecular pump is levitated by the magnetic bearing.
3) Evacuate the turbomolecular pump by using a backing vacuum pump.
4) Wait until the internal pressure of the pump reaches below 200 Pa .
5) Press "START" switch.

Starting Sequence in REMOTE mode:

1) Feed the cooling water into the cooling line.(for TMP-803LM, TMP-803LMC, TMP-1003LM, TMP-1003LMC)
2) Turn ON the power switch of the power unit and check that "REMOTE" output signal a-contact from the remote control connector is closed. Under this condition, the rotor of the turbomolecular pump is floated up by the magnetic bearing.
3) Evacuate the turbomolecular pump by using a backing vacuum pump.
4) Wait until the internal pressure of the pump reaches below 200 Pa .
5) "START" signal is input from the remote control connector.

REFERENCE:

Upon the above starting sequence operation, "ACCELERATION" lamp lights and, several seconds later, "ROTATION" lamp lights. Thereafter, when the pump rotational speed reaches 80% of the rated speed, "ACCELERATION" turns OFF and "NORMAL" lamp lights

simultaneously.

Gradual reduction of the pressure from the rotating start-up can be monitored by checking the pressure on a vacuum gauge connected to the pump inlet nozzle.

4.2 Shutting down

WARNING

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

CAUTION

When reducing internal pressure of the turbomolecular 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 0.2 kgf/cm^2.

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

Preparations prior to shutting-down operation:

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

Shutting down sequence in LOCAL mode:

1) Press "STOP" SWITCH and check "BRAKE" lamp ON.
2) Wait until "ROTATION" lamp turns out (approximately 5 minutes). "BRAKE" lamp turns OFF simultaneously.
3) Turn OFF the power switch of the power unit.
4) Stop cooling water feed. (for TMP-803LM, TMP-803LMC, TMP-1003LM, TMP-1003LMC)

Shutting down sequence in REMOTE mode:

1) Input "STOP" signal from the remote-control connector and check "BRAKE" signal, a-contact is closed.
2) Wait until "ROTATION" signal, a-contact is opened. (approximately 5 minutes) At same time, "BRAKE" signal a-contact opens, too.

3) Turn OFF the power switch of the power unit.
4) Stop cooling water feed. (for TMP-803LM, TMP-803LMC, TMP-1003LM, TMP-1003LMC)

When having exhausted corrosive gas, keep the magnetic bearing turbomolecular pump as vacuumed even after shut-down of the same pump.

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 OFF), to prevent the turbomolecular pump from being contaminated with oil.

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

REFERENCE

"ROTATION" lamp OFF shows that the pump rotational speed is 60rpm or less. Turning OFF the power switch permits the pump rotor to be supported with the touch-down bearings.

4.3 Baking Operation

CAUTION

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

The baking heater is installed near the inlet flange.

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

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

4.4 Cooling the pump proper

4.4 Cooling the pump proper

The pump proper is subjected to cooling when its inlet pressure or outlet pressure is high. Put the pump in continuous run within the pressure range specified in Section 1 "Specifications of Pump Proper".

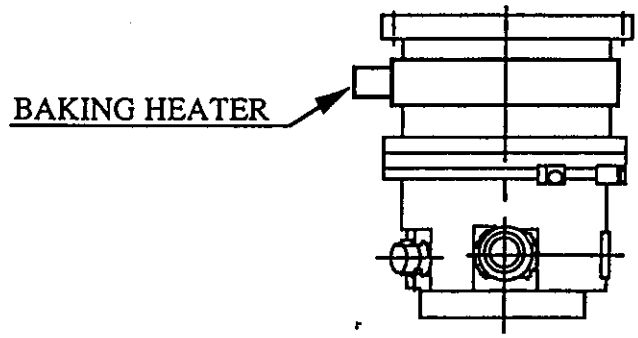


Fig.4.-1 Installation of Baking Heater

5. Gas Purge

The turbomolecular pump is prepared with the gas purge port. It does not need the gas purge during ordinary evacuation. If it evacuate a lot of corrosive gas, for example etching process, it is advised to flow the purge gas for protection of bearing. The inert and chemically stable non-condensing gas is most suitable to the purge gas. The nitrogen(N2) is the most popular purge gas. The proper purge gas flow rate is 20~30 Ncc/min.

OPTION

For the turbomolecular pump with GP adapter (option), an orifice contained in the GP adapter can hold the gas supply pressure at constant value so as to thereby keep the purge gas flow at constant rate. Use this GP adapter under the following conditions.

Supplied gas pressure	0.2 ± 0.1 kgf/cm^{2}G (Use of nitrogen gas)
Gas feed start	After start-up of backing vacuum pump, before evacuating of process gas.
Gas feed stop	After evacuating exhaust of process gas, before shutdown of backing vacuum pump.
Type of gas	Chemically stable non-condensable inert gas for example. nitrogen gas

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

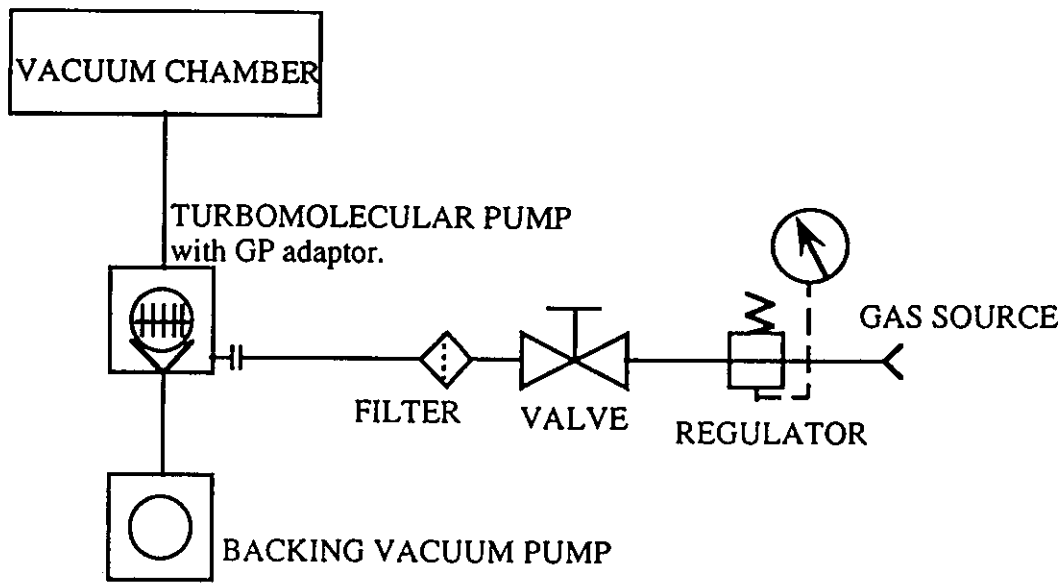


Fig. 5-1 Gas Purge Method

WARNING

Improper handling of this turbomolecular pump would possibly impair personal health. When having used this pump to exhaust corrosive gas, reactive gas, stimulative gas or other harmful gas to human body, feed inert gas into the pump for purging before removing the pump proper from main equipment for repair, etc. In addition to this gas purge treatment, undertake proper protective measures such as room ventilation, wearing protective mask, a pair of gloves and protective working uniform uniform, etc. to prevent harmful gas and reactive gas from directly touching human body.

6.1 Troubles and corresponding counteractions/countermeasures

Should trouble occur while the turbomolecular pump is in use, check which has lit, of the warning lamps and status lamps with "1 2 3 4" display on the front panel of the power unit. Thereafter, take appropriate counteraction/countermeasure against the trouble, in reference to the Troubleshooting Instructions given in Tabled 6-1, 6-2 and 6-3.

Table 6-1 Pump was operated, but fail to start (react)

	Phenomena	Possible causes	Counteractions/countermeasures
1	Power switch ON, but POWER lamp fails to turn ON.	Power switch in OFF	Turn ON the power switch.
		Improper connection of power cable	Re-connect the power cable properly.
		Power voltage deviated from the specified voltage	Operate on correct voltage.
		Fuse blown (F1, F2)	Check if the power voltage is as specified. Replace with spare fuse.
2	START switch pressed, but ACCELERATION lamp fails to light.	REMOTE/LOCAL select switch shifted to REMOTE mode	Shift the switch to LOCAL mode.
		Other trouble	Check if ALARM lamp is ON. If it is ON, reset ALARM after removal of trouble cause. Check the pump type connected.
3	START signal input by remote-controlled operation, but ACCELERATION lamp fails to light.	REMOTE/LOCAL select switch remained as shifted to LOCAL	Shift the switch to REMOTE mode.
		STOP signal input	Turn OFF the STOP signal.
		Other trouble	Check if other ALARM lamp is ON. If ON, reset ALARM after removal of trouble cause.
4	STOP switch pressed, but BRAKE lamp fails to light.	REMOTE/LOCAL select switch remained as shifted to REMOTE mode.	Shift the switch to LOCAL mode.
5	STOP signal inputted by remote operation, but BRAKE lamp fails to light.	REMOTE/LOCAL select switch remained as shifted to LOCAL mode.	Shift the switch to REMOTE mode.

Table 6-2 Counteractions/Countermeasures against ALARM Lamps ON

	Turned-ON lamp (*:ON -:OFF)	Possible causes	Counteractions/Countermeasures
6	* MOTOR 1 2 3 4 - - - - * - - - * * - - - * * - * - - *	Abnormal excitement of internal circuit in the power supply	Check if the ambient temperature of the power supply ranges from 0 to 40°C. Furthermore, check if such an equipment as deemed as noise source is used or not around and close to the power supply, pump proper, motor cable, and control cable.
7	* MOTOR 1 2 3 4 - - - *	Rotation detection signal from motor is not detected properly.	Check if such an equipment as deemed as noise source is used or not around and close to the power supply, pump proper, motor cable, and control cable.
8	* MOTOR 1 2 3 4 - * - -	Rotation detection signal from motor is not detected properly.	Check if a control cable for older model is not used. (See section 3.4 "Connection of the Pump to the Power supply") Check if such an equipment as deemed as noise source is used or not around and close to the power supply, pump proper, motor cable, and control cable.
9	* MOTOR 1 2 3 4 - - * - * - * -	Over-current across the motor	Check that the motor cable and control cable are both abnormal free. (connected properly? Cable route not such as causes disconnection and short-circuit?)
10	* MOTOR 1 2 3 4 * * * - - * - * - * * *	Trouble of power supply internal circuit	After complete stop of the pump, rethrow in the power. If the same trouble reoccurs, the power supply will have to be repaired.
11	* MOTOR 1 2 3 4 * * - *	The pump rotational speed fail to reach 80% or more of the rated speed even after 14 minutes from starting operation. (Too high internal pressure of the pump)	Check if the outlet pressure and inlet pressure are both sufficiently low. (backing vacuum pump in running? Forevacuum valve is opened?) Check for leak or not. Purge gas flow rate is not too high?
12	* MOTOR 1 2 3 4 - - * *	The motor fails to rotate even after 15 seconds from starting operation.	Possible causes are adhesion of reactive byproduct and damage of the touch-down bearing. Remove the pump from main equipment and, thereafter, check by hand at the inlet side whether the rotor blades rotate smoothly. If the rotation thereof is not smooth, the pump must be overhauled.
13	* MOTOR 1 2 3 4 * - * *	The pump rotation speed decelerated to 80% or less of the rated speed while the pump is in running at the rated speed. (abnormal rise of pump internal pressure)	Check if the outlet pressure and inlet pressure are both below the maximum pressure specified in the pump specifications. (backing vacuum pump in running? Forevalve opened?) Check for leak or not. Purge gas flow rate is not too high? Process gas flow rate is not too high?

	Turned-ON lamp (*:ON -:OFF)	Possible causes	Counteractions/Countermeasures
14	* MAG. BEARING 1 2 3 4 - - - -	Strong impact and vibration loads from outside. Rotor unbalance due to reaction- produced matter adhered to rotor blade	If the loaded impact and vibration are temporary, no problem even after re-accelerated. When impact and vibration are frequent,shut down the pump and review the pump anchor method, with elimination of vibration and impact. It is necessary to overhaul the pump at make side (on user account).
15	* MAG. BEARING 1 2 3 4 * - - -	control cable not connected properly.	Check the control cable for proper connection. In addition, check if the connector pins are bending free. For checking the control cable, turn OFF the power switch after complete stop of the pump. Don't disconnect absolutely the cable during current feed.
16	* PUMP TEMP. 1 2 3 4 - - - -	High temperature of pump proper control cable not connected properly.	Check that the cooling water temperature ranges from 5 to 30°C and flow rate from 1 to 2 liters/min. Check the control cable for proper connection. For checking the control cable, turn OFF the power switch after complete stop of the pump. Don't disconnect absolutely the cable during current feed.
17	* PUMP TEMP. 1 2 3 4 * - - -	Motor cable not connected properly.	Check the motor cable for proper connection. For checking the motor cable, turn OFF the power switch after complete stop of the pump. Don't disconnect absolutely the cable during current feed.
18	* CONTROLLER TEMP 1 2 3 4 - - - - * - - -	Internal temperature rise of the power supply	Check that the ambient temperature of the power supply ranges from 0 to 40°C. In addition, check if the power supply is adequately ventilated. Such a way of installation as permits heat accumulation is not applied?
19	* POWER FAILURE 1 2 3 4 - - - -	Power supply interrupted Power switch turned OFF carelessly	Wait until power re-supply. Several minutes later from the power interruption, the unit generates a sound, but this is a sound generating from contact of the rotor with the protection bearing when magnet floating can not be held. This is not abnormal sound. The time until generation of this sound is approximately 5 minutes under normal rotation. Turn ON the power switch, 5 seconds later. The starting operation subsequent to resetting operation can not re-accelerate the pump.

Table 6-3 Counteractions/Countermeasures against Abnormal Noise

	Phenomena	Possible causes	Counteractions/Countermeasures
20	ALARM lamp not ON, but abnormal noise generates from the pump.	Damage of the touch-down bearing.	Remove the pump from main equipment and try to turn,by hand at the inlet side, the rotor blades to check for its smooth rotation. If it is not smooth, the pump must be overhauled.

6.2 Power Supply Failure

If the commercial power supply is interrupted, the motor built in the turbomolecular pump starts regenerative braking immediately. The magnetic bearing continues its action due to this generative power and permits further continued floating of the pump rotor. Should the power supply be interrupted while the pump is running at specific rotational speed, the pump rotational speed decelerates up to approximately 7000 rpm in approximately 5 minutes under vacuumed condition because of the regenerative braking. Thereafter, the rotor is supported with the protection bearings (touch-down bearings). After current re-feed, the magnetic bearing restarts to support the rotor.

For the detail, refer to Para. 2.3.5 "Counter-Operation against Power Failure".

6.3 Inclusion of Foreign Matter

CAUTION

Our warranty will occasionally be out of application to such damage or trouble of the turbomolecular pump which may arise from non-attachment of a protective net to the pump.

Attach the accessory protective net, without fail, to the inlet flange of the turbomolecular pump to protect it from inclusion of foreign matter.

The standard mesh size of this net is 4 mm square. Dust and powder of fine particles which pass through the protective net would incur various problems such as contamination of the rotor, short service life of the protective (touch-down) bearings, etc.

6.4 Pressure rise

Rapid pressure rise (EX. rush into the atmosphere), if any, would cause the rotor speed to decelerate and the motor to stop simultaneously, with "MOTOR" or "MAG. BEARING" lamp ON.

6.5 Abnormal noise and vibration

Should the turbomolecular pump generate abnormal noise or vibration other than that generating from its rotation, stop it immediately.

7. Maintenance

7.1 For air-cooled pumps

For the air-cooled turbomolecular pumps, TMP-1003M, TMP-803M, TMP-1003MC, and TMP-803MC, dust accumulates at the cooling fan when they are installed near a place where oil is handled or very dusty. From time to time, check the cooling fan for cooling effect by throwing paper pieces, etc. in front of the fan.

8. OVERHAUL OF TURBOMOLECULAR PUMP

WARNING

Improper handling of the turbomolecular pump would possibly impair personal health. Where this pump is used for exhaust of corrosive gas, reactive gas, stimulative gas or other harmful gas to human body and it is removed from main equipment for repair, etc., apply gas purging to the pump using inert gas. In addition to this treatment, undertake proper protective measures such as room ventilating, putting safety mask, a pair of gloves and protective working uniform on, etc. for safety work and for preventing harmful gas and reaction product from directly touching human body.

8.1 Requests in sending back the pump:

When overhaul or repair of the turbomolecular pump is required, feel free to request it to SHIMADZU or its authorized local service agency.

Further, when sending back the pump for modification, repair, etc., follow the cautions given below.

1) For the turbomolecular pump in use for exhaust of special gas (doping gas, epitaxial gas, film forming gas, etching gas, etc.), completely remove the gas and reaction-produced matter from the pump and undertake proper safety measures for transportation and handling. In addition, fill the pump with inert gas.
2) The user is requested to send the information on type of exhausted gas and other. If such an information is available, we shall finish modification or repair of the pump earlier as usual and, in addition, able to give advance advice to the user for prevention of possible troubles.

These are important points in steadily proceeding with overhaul of the turbomolecular pump. (On occasion we can not repair the pump or otherwise can not accept maintenance service though depending on whether the pump is treated as instructed in the foregoing paragraphs.) Confirm and note this matter in use of the pump.

8.2 Cleaning the turbomolecular pump

Overhaul and cleaning of the turbomolecular pump at our side is only acceptable on user account.

8.3 Replacement of touch-down bearing

Only part subjected to friction and wear in this pump is the protection bearing (touch-down bearing). Normally this bearing is used only under power OFF. Against power failure, the regenerative brake acts to decelerate the rotor speed and, about 5 minutes later, the rotating rotor is supported with the touch-down bearings after functioning stop of the magnetic bearing. If touch-down operation is repeated frequently, replacement of the touch-down bearing will be required.

Pay special attention to abnormal noise which may result from touching-down. Replacement of the touch-down bearing is available at SHIMAZDU or its authorized local service agency.

9. CHEMICAL TYPE

Chemical type pumps (TMP-1003LMC, TMP-803LMC,TMP-1003MC and TMP-803MC) with fluorine resin-coated rotor are also offerable on special request.

10. Warranty

10.1 The warranty period of any turbomolecular pump shall be one year commencing from the date of delivery if the period is not specially contracted.

10.2 The delivered pump shall be repaired or replaced at free cost against functional deterioration and trouble of the turbomolecular pump which may occur due to factors of pump itself during the said warranty period.

10.3 Any trouble of the following cases are excluded from warranty. Repair or replacement of the delivered pump and related products due to the following cases, will be charged regardless of the warranty period.

a) Troubles caused by disaster and/or fire.

b) Trouble caused by inclusion of rigid foreign matter which passes through the protective net

c) Trouble caused by use of the pump for application other than specified in the Instruction Manual.

d) In such a case when trouble is deemed as caused by improper operation, that is, failure of compliance with Instruction Manual by our engineer.

10.4 Coverage of our warranty shall be limited to the delivered turbomolecular pump, power supply, and/or accessories.

APPENDIX-A RS-232C COMMUNICATIONS

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APPENDIX-A RS-232C COMMUNICATIONS

A1. General

The power unit is provided with a serial interface conforming to RS-232C, whereby the following functions become available for use subject to connection of this unit to computer available for RS-232C and creation of appropriate software.

(1) Obtaining current operation mode

The serial interface enables to check the status of REMOTE / LOCAL select switch and, under REMOTE mode, check if the operation mode is on-line or not (on-communication operation available).

(2) Operation

In the case of on-line operation mode, the interface enables operations equivalent to START, STOP and RESET switches.

(3) Obtaining pump running status

The serial interface enables to check pump running status such as "decelerating", "accelerating", "normal rotation", "failure occurrence", etc.

(4) Obtaining parameters

The serial interface enables to read parameters such as pump rotation speed, motor current, etc. which are stored in the power unit.

(5) Receiving events

The power unit transmits each status command at each time of failure occurrence, rotation start / stop, and normal rotation.

A2. Interface Specifications

A2.1 Transmission specification

(1)	Interface :	RS-232C
(2)	Synchronous system :	Asynchronous
(3)	Transmission rate :	9600, 4800, 2400, 1200 bits/sec
		(set up with dip switch)
(4)	Character configuration :	start bits 1
		data bits 8
		parity bits None
		stop bits 1
(5)	Flow control :	None
		(RTS and DTR keep ON during power switch is ON.)

A2.2 Connector

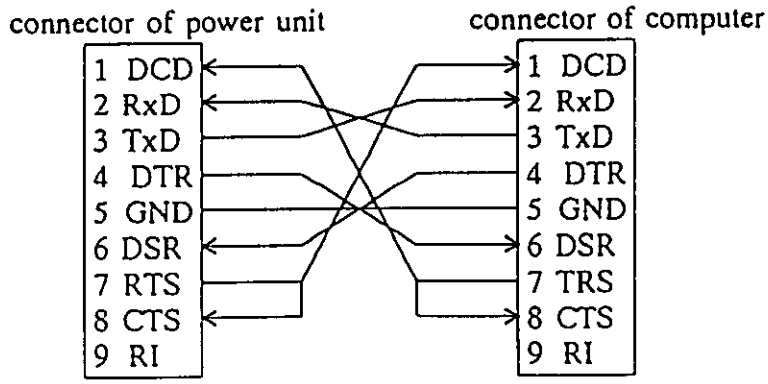
(1)	Connector type :	D-Sub 9-pin, plug
(2)	Pin assignment	2 : RxD
		3 : TxD
		4 : DTR
		5 : GND
		7 : RTS
		8 : CTS
		* Other pins are not connected.

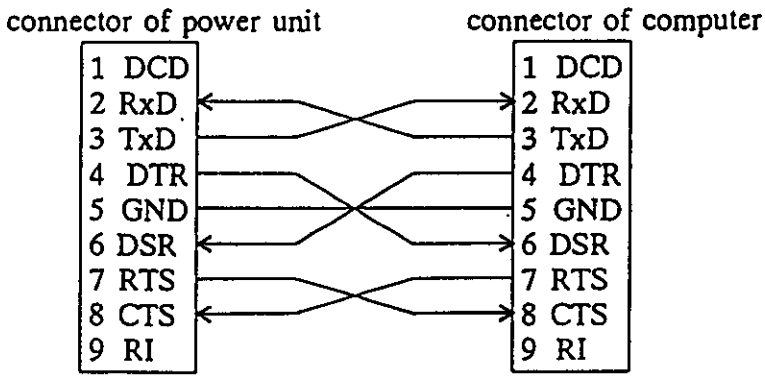
A2.3 Cable

A2.3.1 Cable connection

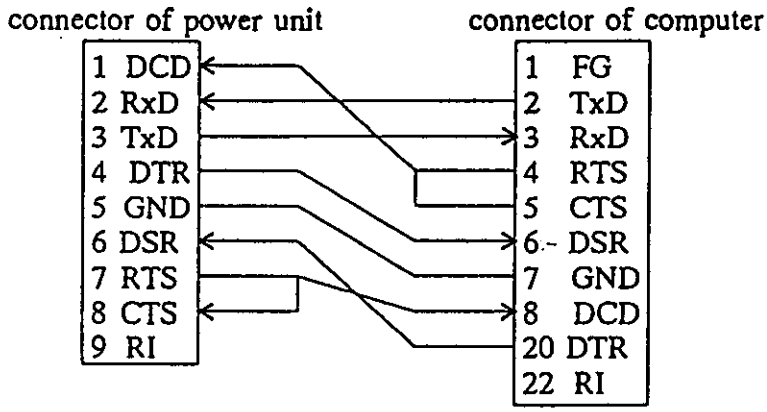
RS-232C cables, which is on the market (REVERSE or CROSS), as follows can be used for connection of the power unit to computer. (Each number in Figure represents Pin No.)

a. When RS-232C connector of computer is D-Sub 9-pin connector;





b. When RS-232C connector of computer is D-Sub 5-pin connector



A2.3.2 Cable length

Connection cable can be extended up to 15 meter maximum, but subject to unusable depending on actual operating environment. The use of these cables at 5 meter length maximum is recommended. (Countermeasures against communication failure are as detailed later.)

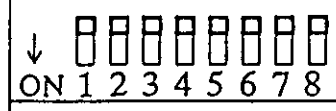
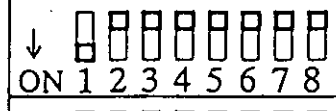
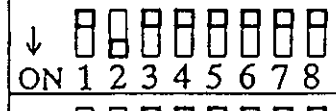
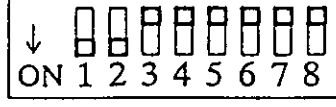
A3. Power Unit to Computer Connection

A3.1 Connection of cables

Keep the power switch OFF for the both power unit and computer. Under this condition, connect the connection cables to "SERIAL I/F" connector (Refer to Fig. 2-7) on the power unit rear panel and the RS-232C port of computer.

A3.2 Setting up transmission specification

Set up the transmission specification of RS-232C interface of computer, based on the specification given in A2.1. Set up the transmission rate (baud rate) of the power unit using the dip switch on the left part of "REMOTE" connector (Fig. 2-7 in Instruction Manual) on the rear panel.

Dip switch	SW1	SW2	Transmission rate
	OFF	OFF	9600bps (default setting)
	ON	OFF	4800bps
	OFF	ON	2400bps
	ON	ON	1200bps

A4. Transmission Protocol

When required, create application software in accordance with the specifications given in the following paragraphs.

(1) Basic structure of transmitting/receiving message

A message which begins with characters "MJ" and ends with carriage return code (0dH) shall be deemed as the basic unit in transmitting and receiving. (Detailed Fig.A-1)
Furthermore, message to be first sent shall be referred to as COMMAND and message to be sent back in response to the command shall be referred to as ANSWER.

(2) Character to character time-out: 0.1 sec

If more than 0.1 sec elapses between character of answer message, deem it as trouble in the power unit or the transmission route and make exceptional processing such as re-sending command.

(3) Command to Answer time-out: 1 sec

If more than 1 sec elapses between Command message and Answer message, deem it as a trouble in the power unit or the transmission route and make exceptional processing such as re-sending same command, etc.
When the power unit has no computer answer to the command, which was sent to the computer from the unit, for over 1.0 second, the power unit re-sends same command to the computer.

(4) Command sending retry cycles by power unit: 5

When the power unit has no computer answer to the command, which was sent to the computer from the unit, for over 1.0 second (when timed out between command and answer), the power unit re-sends same command up to 5 times maximum.

(5) Continuous sending of command

Sending next command shall be unavailable until computer receives from the power unit its answer to the command sent to it previously. However, this is out of application when time-out occurs between command and answer. (Actually answer is sent within 100 msec.)

(6) Initialization of receiving sequence

When command header character "MJ" is received continually, initialize the receiving sequence and ignore the message received until that time, even on midway of receiving message, and newly start receiving of message.

ex. : "MJ01LMJ01LS97$" ($ represents carriage return code.)

When this message is received, create such a receiving sequence as enables to correctly receive the characters of midway "MJ" to last "$", that is, "MJ01LS97·".

(7) Utilization of CHECKSUM characters

Apply CHECKSUM calculation to received messages to check that the messages were correctly received, through comparison with the data of the CHECKSUM characters. In addition, when incorrectly CHECKSUM characters message is received, make exceptional processing such as re-sending command, etc.

Example of calculation :

For "MJ01LS97$" ($ represents carriage return code.)

In this case CHECKSUM characters are "97".

'M' 'J' '0' '1' 'L' 'S'

CHECKSUM = 4dH + 4aH + 30H + 31H + 4cH + 53H = 197H =97H

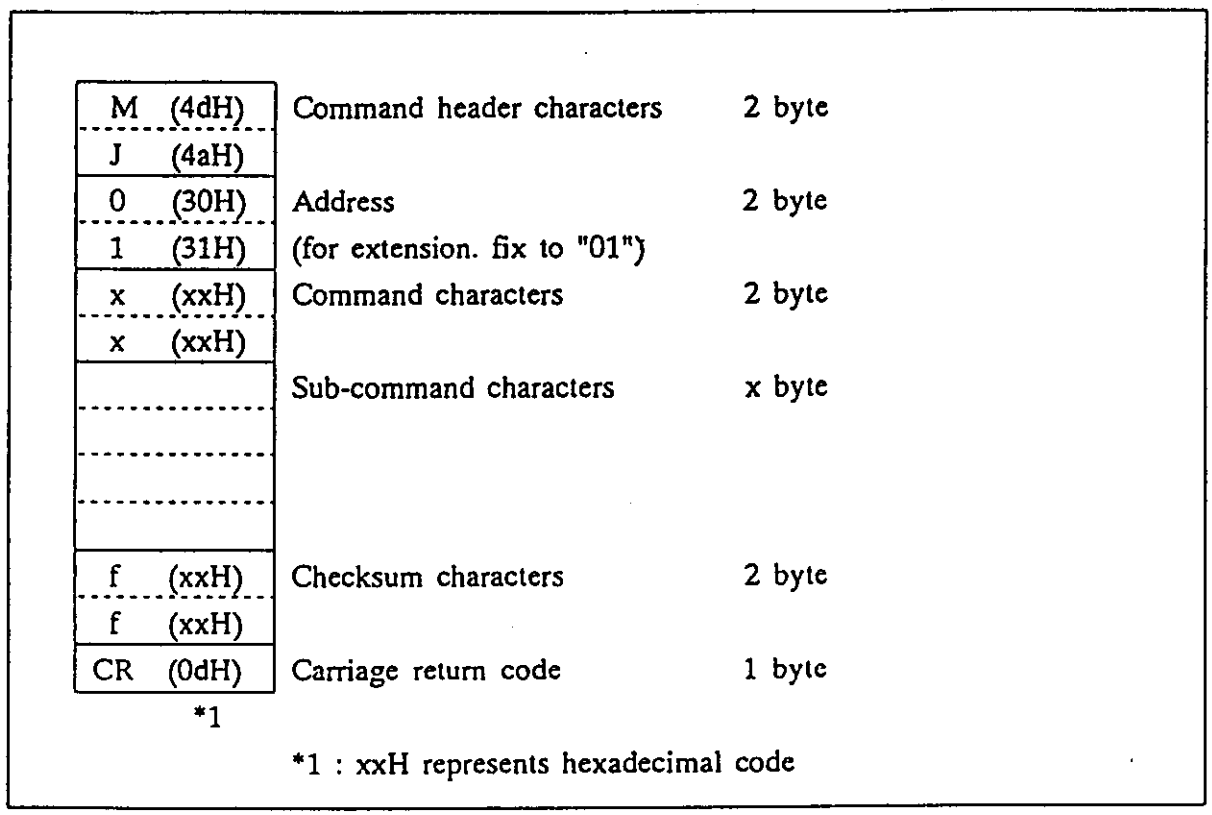


Fig. A-1: Basic Structure of Commands and Answers

A5. COMMANDS TABLE

Classification	Command /Answer	Name	Command message	Sub-command message
Operation mode	Command	Operation mode check	LS	none
		On-line request	LN	none
		Off-line request	LF	none
	Answer	Local	LL	none
		Remote	LR	none
		On-line	LC	none
Operation	Command	Start operation	RT	none
		Stop operation	RP	none
		Reset operation	RR	none
	Answer	Acceleration start	RA	none
		Deceleration start	RB	none
		Buzzer off	RZ	none
		Failure occurrence	RF	ff *1
		Failure elimination	RC	none
		Operation ineffective	RV	none
Run status	Command	Run status check	CS	none
	Answer	Stop	NS	00 *2
		Acceleration	NA	00 *2
		Deceleration	NB	00 *2
		Normal rotation	NN	00 *2
		Failure-Stop	FS	ff *1
		Failure-Free run	FF	ff *1
		Failure-Regeneration	FR	ff *1
		Failure-Deceleration	FB	ff *1
Parameters	Command	Read parameters	PR	ff *3
	Answer	Parameter sending	PA	ff9999 *4
		Ineffective parameter	PV	ff *3
Event	Command	Failure occurrence	EF	ff *1
		Rotation start	ER	none
		Rotation stop	ES	none
		Normal rotation	EN	none
	Answer	Event confirm	EC	xx *7
Shared answer	Answer	Invalid command	AN	none

*1 ff : alarm No. (hexadecimal)

*2 00 : Fixed

*3 ff : Parameter No. (hexadecimal)

*4 ff : Parameter No. (hexadecimal)

9999 : parameter value

*5 Definition of alarm No.

1st digit : showing alarm LED ON condition.

1 → MOTOR

2 → MAG. BEARING

3 → CONTROLLER TEMP.

4 → PUMP TEMP.

5 → POWER FAILURE

2nd digit : showing STATUS LED (1 2 3 4) ON condition

displayed as 1=BIT1, 2=BIT2, 3=BIT3, 4=BIT4.

ex. : 1 = 1 2 3 4 7 = 1 2 3 4 C = 1 2 3 4

* - - - * * * - - - * * (* : ON, - : OFF)

*6 Parameter No., parameter value

No.	Name	Range	Parameter type
01	Model identification No.	Fixed	EI-1003M : 1003 stored EI-1303M : 1303 stored EI-2003M : 2003 stored EI-3003M : 3003 stored EI-203M : 0203 stored EI-303M : 0303 stored
02	Software version No.	0 to 9999	Ver1.00 → 0100
03	Rotation speed	0 to 3500	Actual measured value / 10 ex.: 35000rpm → 3500
04	Motor current	0 to 100	Actual measured value * 10 ex.: 5.3A → 0053

*7 xx : Confirmed event command message

Send the command characters of confirmed event command, as it is.

ex. : Failure detected → "EF"

A6. Description of Commands

A6.1 Operation mode

(1) Commands

LS : Operation mode check

Enables to check operation mode (LOCAL / REMOTE / ON-LINE).

Action : send back ANSWER showing present operation mode.

LN : ON-LINE request

If operation mode is REMOTE, operation mode is shifted to ON-LINE. It is ineffective even if this command is sent under other operation mode.

Action : send back ANSWER showing changed operation mode.

LF : OFF-LINE request

If operation mode is ON-LINE, operation mode is shifted to REMOTE. It is ineffective even if this command is sent under other operation mode.

Action : send back ANSWER showing changed operation mode.

(2) Answers

LL : Operation mode LOCAL

Answer in the case of LOCAL operation mode.

Operation mode is shifted to LOCAL when "REMOTE / LOCAL" select switch on the front panel is in "LOCAL".

LR : Operation mode REMOTE

Answer in the case of REMOTE operation mode.

The operation mode is shifted to REMOTE when "REMOTE / LOCAL" select switch on the front panel is shifted from "LOCAL" to "REMOTE" or when, under ON-LINE operation mode, "OFF-LINE request" command is sent.

LC : Operation mode ON-LINE

Answer in the case of ON-LINE operation mode. The operation mode is shifted to ON-LINE when "ON-LINE request" command is sent under REMOTE operation mode.

A6.2 Operation

(1) Commands

RT : Start operation

This command is equivalent to pressing START switch on the front panel.

Action : If this operation is effective, the pump starts accelerating and sends "Acceleration start" answer. If it is ineffective (ex. command is sent during acceleration), "Ineffective operation" answer is sent back.

RP : Stop operation

This command is equivalent to pressing the STOP switch on the front panel.

Action : If this operation is effective, the pump starts decelerating and sends "Deceleration start" answer. If it is ineffective (ex. command is sent during stop), "Ineffective operation" answer is sent back.

RR : Reset operation

This command is equivalent to pressing RESET switch on the front panel.

Action : This is effective against failure occurrence. When the buzzer is sounding, this command sends back "Buzzer off" answer after turning off the buzzer. When the buzzer is already in off, ALARM is reset. If the cause of alarm is already removed upon resetting, "Failure elimination" answer is sent back and, if it is not yet removed, the buzzer resounds and "Failure occurrence" answer is sent back. If the operation is ineffective (failure non-occurrence), "Ineffective operation" answer is sent back.

(2) Answers

RA : Acceleration start

Answer to be sent back when the acceleration started on start operation.

RB : Deceleration start

Answer to be sent back when the deceleration started on stop operation.

RZ : Buzzer off

Answer to be sent back when the buzzer turned off on resetting operation.

RC : Failure elimination

Answer to be sent back when failure cause is removed, on resetting operation.

RF : Failure occurrence

Answer to be sent back when failure cause is not removed, on resetting operation.

As sub-command, failure under occurring is sent in message of 2-digit hexadecimal expression.

RV : Ineffective operation

Answer to be sent back when the requested operation is ineffective.

A6.3 Run Status

(1) Commands

CS : Run status check

Enables to check pump run status.

(2) Answers

NS : Stop

Answer to be sent back when the pump rotor is in stop condition. Equivalent to "POWER" lamp only ON. Two-digit message of "00" is sent back as sub-command.

NA : ACCELERATING

Answer to be sent back when the pump is in accelerating. Equivalent to "ACCELERATION" lamp ON. It is sent back in two-digit message of "00", as sub-command.

NA : Acceleration

Answer to be sent back when the pump is in accelerating. Equivalent to "ACCELERATION" lamp ON. It is sent back in two-digit message of "00", as sub-command.

NN : Normal rotation

Answer to be sent back when the pump is in normal rotation. Equivalent to "NORMAL" lamp ON. Two-digit message of "00" is sent back as sub command.

NB : Deceleration

Answer to be sent back when the pump is in decelerating. Equivalent to ON status of "POWER", "ROTATION", and "BRAKE" lamps. This answer is sent back in two-digit message of "00", as sub-command.

NN : Normal rotation

Answer to be sent back when the pump is in normal rotation. Equivalent to "NORMAL" lamp ON. Two-digit message of "00" is sent back as sub command.

FS : Failure- Stop

Answer to be sent back when the pump is in stop condition while failure is occurring. Equivalent to ON status of "POWER", "ALARM" lamps. The failure in occurring is sent back in message of two-digit hexadecimal expression, as sub-command.

FF : Failure-Free run

Answer to be sent back when the pump is in free run condition (neither accelerate nor decelerate) while failure is occurring. Equivalent to ON status of "POWER", "ALARM" and "ROTATION" lamps. It is sent back in message of two-digit hexadecimal expression, as sub-command.

FB : Failure-Deceleration

Answer to be sent back when the pump is decelerating while failure is occurring. Equivalent to ON status of "POWER", "ALARM", "ROTATION", and "BRAKE" lamps. It is sent back in message of two-digit hexadecimal expression, as sub-command.

FR : Failure-Regeneration

Answer to be sent back when the pump is in regenerative braking while the power supply is in interruption. It is sent back in message of two-digit hexadecimal expression, as sub-command.

A6.4 Parameters

(1) Command

PR : Parameter read

Reads the parameter of No. designated with sub-command.

(2) Answers

PA : Parameter answer

Sends back the parameter value of designated No.

PV : Ineffective parameter

Answer when designated parameter No. was ineffective.

A6.5 Events

For the event function only, commands are sent from the power unit to computer and the answer to each command is sent back to the power unit from the computer.

(1) Commands

EF : Failure occurrence

Failure is sent to computer when it occurred. It is sent in message of two-digit hexadecimal expression.

ER : Rotation start

This command is sent to computer when the pump starts rotating. Equivalent to "ROTATION" lamp ON.

ES : Rotation stop

This command is sent to computer when the pump stops rotating. Equivalent to "ROTATION" lamp OFF.

EN : Normal rotation

This command is sent to computer when the pump has reached normal rotation speed. Equivalent to "NORMAL" lamp ON.

(2) Answer

EC : Event confirm

When receiving event from the power unit, send this answer to the power unit. The power unit. re-send the event command at 1 sec interval up to 5 times maximum, until it receives this answer. Send the received event command in applicable command message, as sub-command.

A6.6 Shared Answer

AN : Invalid command

Answer to be sent back when the power unit receives invalid command from computer.

A7. COMMANDS / ANSWERS SENDING AND RECEIVING (Example)

Classification	Com-puter	Power unit	Sent / Received message *1	Command / Answer	Remarks
Operation mode	→		MJ01LS97$	Operation mode check	
	←		MJ01LL90$	LOCAL	
			MJ01LR96$	REMOTE	
			MJ01LC87$	ON-LINE	
	→		MJ01LN92$	ON-LINE request	
	←		MJ01LC87$	ON-LINE	Operation mode shifted to On-line.
			MJ01LL90$	Ineffective request	When operation mode is Local.
	→		MJ01LF8A$	OFF-LINE request	
	←		MJ01LR96$	REMOTE	Operation mode shifted to Remote.
			MJ01LL90$	Ineffective request	When operation mode is Local.
Operation	→		MJ01RT9E$	Start operation	
	←		MJ01RA8B$	Acceleration start	
			MJ01RVA0$	Ineffective operation	When start operation is ineffective.
			MJ01LR96$	Ineffective operation	When operation mode is Remote.
			MJ01LL90$	Ineffective operation	When operation mode is Local.
	→		MJ01RP9A$	Stop operation	
	←		MJ01RB8C$	Deceleration start	
			MJ01RVA0$	Ineffective operation	When stop operation is ineffective.
			MJ01LR96$	Ineffective operation	When operation mode is Remote.
			MJ01LL90$	Ineffective operation	When operation mode is Local.
	→		MJ01RR9C$	Reset operation	
	←		MJ01RZA4$	Buzzer off	
			MJ01RF50F5$	Failure recurrence	When no failure cause eliminated.
			MJ01RC8D$	Failure eliminate	
			MJ01RVA0$	Ineffective operation	When reset operation is ineffective.
			MJ01LR96$	Ineffective operation	When operation mode is Remote.
			MJ01LL90$	Ineffective operation	When operation mode is Local.

Classification	Com-puter	Power unit	Sent / Received message *1	Command / Answer	Remarks
Run status	→		MJ01CS8E$	Run status check	
	←		MJ01NS00F9$	Stop	
			MJ01NA00E7$	Acceleration	
			MJ01NB00E8$	Deceleration	
			MJ01NN00F4$	Normal rotation	
			MJ01FS1C0D$	Failure-Stop	ex. Acceleration failure of pump.
			MJ01FF30E7$	Failure-Free run	ex. Power unit temperature failure.
			MJ01FR50F5$	Failure-Regeneration	ex. Power supply failure.
			MJ01FB21E3$	Failure-Deceleration	ex. Magnetic bearing cable failure.
Parameter	→		MJ01PR03FD$	Parameter read	ex. Parameter No.03H (rotation speed)
	←		MJ01PA033500B4$	Parameter answer	ex. Data = 3500 (35,000rpm)
Event	←		MJ01EF50E8$	Failure occurrence	ex. Power supply failure
	→		MJ01ECEF0B$	Event confirm	
	←		MJ01ER8F$	Rotation start	
	→		MJ01ECER17$	Event confirm	
	←		MJ01ES90$	Rotation stop	
	→		MJ01ECES18$	Event confirm	
	←		MJ01EN8B$	Normal Rotation	
	→		MJ01ECEN13$	Event confirm	
Others	→		MJ01AA7A$	Undefined command	When undefined command is received.
	←		MJ01AN87$	Invalid command	
	→		MJ01LS20$	Operation mode check	When command is correct, but CHECKSUM is undue.
	←		MJ01AN87$	Invalid command	

*1 "$" represents carriage return code (0dH).

A8. Relation of LOCAL Mode to REMOTE Mode Operations

(1) Input of front panel switch is only effective when "REMOTE / LOCAL" select switch is in "LOCAL" mode.

(2) When the select switch is in "REMOTE" mode, REMOTE input signal only is effective under initial status.

(3) When the select switch is in "REMOTE" mode and the operation mode is shifted to ON-LINE in response to ON-LINE request of operation mode command, only operation by the operation request command from computer is effective.

(4) "RESET" switch input and "REMOTE RESET" signals are all-time effective.

(5) When the select switch is shifted to "LOCAL" under ON-LINE operation mode, the operation mode is force-shifted to LOCAL.

(6) Commands other than operation commands are all-time effective, and the power unit sends back an answer message to computer. In addition, event commands are all-time sent against event occurrence.

A9. Troubleshooting

A9.1 No message can transmit and receive

(1) Start the pump in LOCAL mode and check if the event command of Rotation start can be received in the timing at which "ROTATION" lamp lights.

   a. Could be received → check if command from connected computer can be received or not, using another computer, etc.

   b. Not receivable → (2)

(2) Check the connection of RS-232C cable in reference to A2.3.1.

(3) Check the transmission specification of RS-232C at computer side.

A9.2 Sending and receiving are done, but receivable messages are invalid.

(1) Check the transmission rate of the power unit and computer.

A9.3 Characters get disordered from time to time, then resulting in CHECKSUM error.

(1) Remove the RS-232C cable from equipment as noise source if it runs near it.

(2) When the RS-232C cable in use is not a shield cable, replace it with the latter cable. When shield cable is used, be sure to check that it is connected to the frame gland of the connected computer.

(3) When 10 m or longer RS-232C cable is used, replace it with another cable as short as possible.

(4) Make the transmission rate smaller unless there is problem in application program .